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*LFI Project System Team*

**Planck LFI**

**TITLE:**

# **FM 30GHz RCA27 Data Analysis Report**

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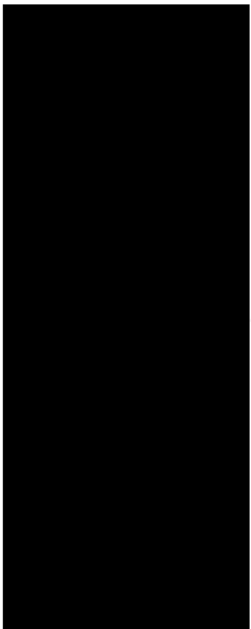
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## 1 INTRODUCTION AND SCOPE

This document reports on the RCA27 Flight Model on – ground calibration. Tests were performed from 01 April 2006 to 09 April 2006 (including functional tests) at Alcatel Alenia Space – Milano according to the LFI Calibration Plan.

| Date      | Filename                         | Notes                                                                                                                                    |
|-----------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 01-apr-06 | 030LFI27_RCA_FM_AMB_200604011426 | Warm functional test                                                                                                                     |
| 03-apr-06 | 030LFI27_RCA_FM_CRY_200604031224 | Cryogenic functional test                                                                                                                |
| 03-apr-06 | 030LFI27_RCA_FM_XXX_200604031528 | Phase switch curves (I-V curves)                                                                                                         |
| 03-apr-06 | 030LFI27_RCA_FM_TUN_200604031628 | Phase switch tuning                                                                                                                      |
| 03-apr-06 | 030LFI27_RCA_FM_TUN_200604031811 | VG1 tuning first step                                                                                                                    |
| 04-apr-06 | 030LFI27_RCA_FM_TUN_200604041546 | VG1 tuning second step                                                                                                                   |
| 04-apr-06 | 030LFI27_RCA_FM_TUN_200604041842 | VG2 tuning first step                                                                                                                    |
| 05-apr-06 | 030LFI27_RCA_FM_TUN_200604050823 | VG2 tuning second step                                                                                                                   |
| 05-apr-06 | 030LFI27_RCA_FM_XXX_200604051022 | Check on spikes, offset, etc.                                                                                                            |
| 05-apr-06 | 030LFI27_RCA_FM_TUN_200604051127 | VG2 tuning second step (check after BEM thermalisation)                                                                                  |
| 05-apr-06 | 030LFI27_RCA_FM_XXX_200604051246 | Check on spikes, offset, etc. with environmental parameters acquisition off                                                              |
| 05-apr-06 | 030LFI27_RCA_FM_TUN_200604051457 | DAE calibration                                                                                                                          |
| 05-apr-06 | 030LFI27_RCA_FM_TUN_200604051515 | DAE calibration                                                                                                                          |
| 05-apr-06 | 030LFI27_RCA_FM_XXX_200604051608 | Test on T ref                                                                                                                            |
| 05-apr-06 | 030LFI27_RCA_FM_TUN_200604051734 | DAE calibration                                                                                                                          |
| 05-apr-06 | 030LFI27_RCA_FM_TNG_200604051756 | TNG test with 3 T steps on sky (12.8 -- 19 --- 25K) and 2 T steps on ref (9.5 --- 25K). Offset and PGA gain as from DAE calibration test |
| 06-apr-06 | 030LFI27_RCA_FM_TNG_200604060233 | "                                                                                                                                        |
| 06-apr-06 | 030LFI27_RCA_FM_OFT_200604061041 | OFT test, Tref High Tsky changing to 25 K                                                                                                |
| 06-apr-06 | 030LFI27_RCA_FM_SPR_200604061449 | RCA SPR test                                                                                                                             |
| 06-apr-06 | 030LFI27_RCA_FM_XXX_200604061641 | Check on DAE BB output channel w.r.t. slow output RCA response to temperature steps on loads (A ---> C, B --> D, C -----> A, D -----> B) |
| 06-apr-06 | 030LFI27_RCA_FM_SPR_200604061728 | SPR test with output channels as in XXX_200604061641                                                                                     |
| 06-apr-06 | 030LFI27_RCA_FM_XXX_200604061837 | Check on output signal on sky T change                                                                                                   |
| 06-apr-06 | 030LFI27_RCA_FM_ST3_200604061922 | STn test                                                                                                                                 |
| 07-apr-06 | 030LFI27_RCA_FM_ST3_200604070402 | RACHEL crashed during file closing                                                                                                       |
| 07-apr-06 | 030LFI18_RCA_FM_ELE_200604071241 | RCA ELE test. Test erroneously closed                                                                                                    |
| 07-apr-06 | 030LFI27_RCA_FM_ELE_200604071244 | RCA ELE test on VG1                                                                                                                      |
| 07-apr-06 | 030LFI27_RCA_FM_AMB_200604071354 | RCA ELE test on VG2. Note: test name is erroneously named AMB                                                                            |
| 07-apr-06 | 030LFI27_RCA_FM_ELE_200604071503 | RCA ELE test on Vdrain.                                                                                                                  |
| 07-apr-06 | 030LFI27_RCA_FM_XXX_200604071759 | Check on PS/SW diodes                                                                                                                    |
| 07-apr-06 | 030LFI27_RCA_FM_THF_200604071851 | RCA susceptibility test to temperature changes of the FEM                                                                                |
| 07-apr-06 | 030LFI27_RCA_FM_ST3_200604071940 | STn test                                                                                                                                 |
| 08-apr-06 | 030LFI27_RCA_FM_ST3_200604080415 | "                                                                                                                                        |
| 08-apr-06 | 030LFI27_RCA_FM_THV_200604081124 | RCA susceptibility test to temperature changes of the 3rd VG                                                                             |
| 08-apr-06 | 030LFI27_RCA_FM_UNC_200604081247 | Noise properties with unchopped radiometer in all the 4 states                                                                           |
| 08-apr-06 | 030LFI27_RCA_FM_LIS_200604081545 | RCA LIS test with temp. steps on sky and ref                                                                                             |
| 09-apr-06 | 030LFI27_RCA_FM_LIS_200604090020 | "                                                                                                                                        |
| 09-apr-06 | 030LFI27_RCA_FM_LIS_200604090853 | "                                                                                                                                        |



|           |                                  |                                                                                                 |
|-----------|----------------------------------|-------------------------------------------------------------------------------------------------|
| 09-apr-06 | 030LFI27_RCA_FM_LIS_200604091726 | "                                                                                               |
| 10-apr-06 | 030LFI27_RCA_FM_LIS_200604100200 | "                                                                                               |
| 10-apr-06 | 030LFI27_RCA_FM_LIS_200604101035 | "                                                                                               |
| 10-apr-06 | 030LFI27_RCA_FM_THB_200604101419 | RCA susceptibility test to thermal changes in the BEM                                           |
| 10-apr-06 | 030LFI27_RCA_FM_XXX_200604101756 | RCA susceptibility check to thermal changes in the BEM with PGA gain=1 and offset = 0           |
| 10-apr-06 | 030LFI27_RCA_FM_XXX_200604101804 | "                                                                                               |
| 12-apr-06 | 030LFI27_RCA_FM_AMB_200604121456 | RCA SPR check at room temp; 4K target as in test campaign. Test ended due to BEM thermalisation |



The following tests have been performed specifically at room temperature to investigate the SPR problems we encountered at cryo temperature.

|           |                                  |                                                                                                 |
|-----------|----------------------------------|-------------------------------------------------------------------------------------------------|
| 12-apr-06 | 030LFI27_RCA_FM_AMB_200604121456 | RCA SPR check at room temp; 4K target as in test campaign. Test ended due to BEM thermalisation |
| 12-apr-06 | 030LFI27_RCA_FM_AMB_200604121605 | RCA SPR check at room temp. for sky load polarization investigation                             |
| 12-apr-06 | 030LFI27_RCA_FM_AMB_200604121840 | "                                                                                               |
| 12-apr-06 | 030LFI27_RCA_FM_AMB_200604121909 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131021 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131026 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131115 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131124 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131131 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131140 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131520 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131524 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131559 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131601 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131603 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131646 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131721 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131902 | "                                                                                               |
| 13-apr-06 | 030LFI27_RCA_FM_AMB_200604131939 | "                                                                                               |
| 14-apr-06 | 030LFI27_RCA_FM_AMB_200604141357 | "                                                                                               |
| 14-apr-06 | 030LFI27_RCA_FM_AMB_200604141431 | "                                                                                               |
| 14-apr-06 | 030LFI27_RCA_FM_AMB_200604141515 | "                                                                                               |
| 14-apr-06 | 030LFI27_RCA_FM_AMB_200604141524 | "                                                                                               |
| 14-apr-06 | 030LFI27_RCA_FM_AMB_200604141549 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181034 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181058 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181134 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181155 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181426 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181434 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181454 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181518 | "                                                                                               |
| 18-apr-06 | 030LFI27_RCA_FM_AMB_200604181537 | "                                                                                               |



Termometers:

SKY LOAD: based on the RCA28, a delta T between the back plate sensor (SKY\_TEMP) and the eccosorb pyramids (SMON\_TMP) is expected.

Based on the RCA28 TNG data the following DT is applied:

| SKY_TEMP                 | SMON_TMP                  | DIFFERENCE |
|--------------------------|---------------------------|------------|
| 15.0000 +/- 0.000000     | 15.4134 +/- 0.00757300    | 0.4134     |
| 9.19999 +/- 3.94658E-005 | 9.77658 +/- 8.39263 E-005 | 0.57659    |
| 20.0000 +/-0.000000      | 20.372 +/-0.0126364       | 0.372      |
| AVERAGE                  |                           | 0.454      |



## **2 APPLICABLE DOCUMENTS**

- [AD 1] M.Bersanelli, *Planck-LFI Calibration Plan*, PL-LFI-PST-PL-008, Issue/Rev 1.0, July 2003
- [AD 2] E.Alippi, P.Guzzi, *Planck LFI 30GHz Radiometer Chain Assembly (RCA) Specification*, PL-LFI-PST-SP-006, Issue/Rev. 2.0, March 2002

## **3 REFERENCE DOCUMENTS**

- [RD 1] A.Mennella, et. al, *Data analysis and calibration matrix of LFI 44 GHz QM receiver (LFI24)*, PL-LFI-PST-AN-003, Issue/Rev 1.0, May 2005
- [RD 2] P. Battaglia, *44GHz RCA #24 FM Test Report*, PL-LFI-LAB-RP-059, Issue 1
- [RD 3] F. Cuttaia, A. D'Arcangelo, D. Lawson, L. Stringhetti, *nonlinearity investigation at 44 GHz using prototype units: BEM44\_B3\_DC and BEM44\_B4\_DC*, PL-LFI-PST-TN-073, 1.0
- [RD 4] N. Roddis, D. Lawson, F. Cuttaia D. Kettle et al. *Planck LFI – 44 GHz FM FEM 4F2 Final Performance Test Report*, PL-LFI-JBO-RP-090



## 4 TUNING

### 4.1 RADIOMETER TUNING

See [RD 2]

### 4.2 BACK END MODULE OFFSET

BEM offset is determined by recording each detector output when the FEM is off. The values stored are used in data analysis when required. The values are reported in *Table 5-1*.

*Table 5-1: BEM radiometric offset values.*

|            | BEM offset (Volts) |
|------------|--------------------|
| Detector A | 0.0322             |
| Detector B | 0.0377             |
| Detector C | 0.0327             |
| Detector D | 0.0377             |

## 5 BASIC PERFORMANCES

### 5.1 RCA\_OFT: RADIOMETER OFFSET

It is calculated by measuring the voltage difference at the crossing between the reference and Load temperature.

file considered: 030LFI27\_RCA\_FM\_OFT\_200604061041

| Channel    | offset (V) | Abs Error (V) |
|------------|------------|---------------|
| Detector A | -0.0274    | 0.0003        |
| Detector B | -0.0447    | 0.0008        |
| Detector C | 0.029      | 0.001         |
| Detector D | 0.022      | 0.001         |

*Figure 6-1: Voltage offset derived at crossing point between the REF and SKY*

### 5.2 RCA\_LIS: LINEARITY AND ISOLATION

The linearity has been evaluated extensively by changing both the REF and the SKY temperature in several steps.

|  | T Noise FEM<br>(K) |
|--|--------------------|
|  |                    |



|            |     |
|------------|-----|
| DETECTOR 1 | 7.7 |
| DETECTOR 2 | 7.7 |
| DETECTOR 3 | 7.9 |
| DETECTOR 4 | 7.9 |

Specifically the analysis has been performed on the following datasets:

reference load temperature steps are:

030LFI27\_RCA\_FM\_LIS\_200604081545

sky load temperature steps:

030LFI27\_RCA\_FM\_LIS\_200604090020

030LFI27\_RCA\_FM\_LIS\_200604090853

030LFI27\_RCA\_FM\_LIS\_200604091726

030LFI27\_RCA\_FM\_LIS\_200604100200

From these datasets the characteristic curves V output Vs. T input were built for each detector and then a parabolic fit has been performed, as reported in next sections.

### 5.2.1 Reference temperature steps

In the first data set the REF temperature has been varied from 11.98 Kelvin to 30.54 Kelvin and the SKY has been kept to 12.8 Kelvin.

The REF temperature sequence is shown in figure below

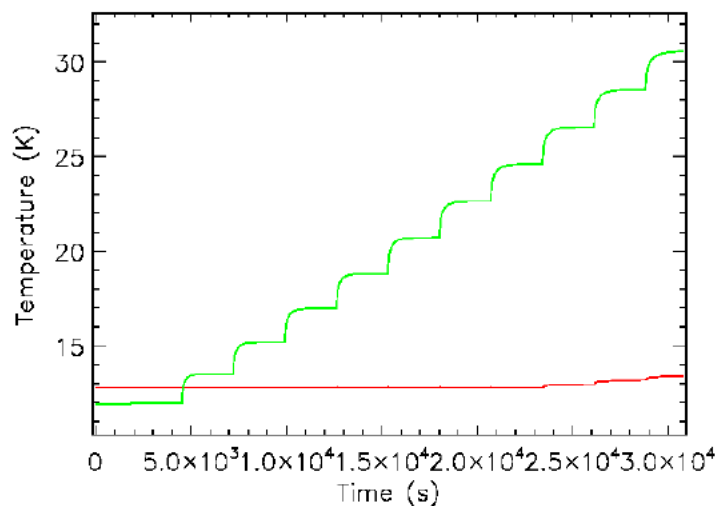


Figure 6-2 Temperature of the Reference load (green line) is taken from R\_MON monitor sensor, and of the Skyload temperature (Red line) taken from SKY\_TEMP monitor sensor.



The results are reported here. The error is the fit uncertainty and does not includes any systematic error from measurements.

*Table 6-1: basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY\_TEMP probe as a sky load temperature, and R\_MON sensor for the REF load temperature. For isolation the error has not been calculated. It will be reported in the next update of the document.*

|            | Gain<br>[V/K]   | Gain<br>[K/V]    | Tnoise<br>[K]  | Tnoise<br>[K]  | Isolation<br>[dB] |
|------------|-----------------|------------------|----------------|----------------|-------------------|
|            | $\times 1E-02$  |                  | Linear         | Parabolic      |                   |
| DETECTOR A | $4.05 \pm 0.02$ | $24.67 \pm 0.12$ | $21.9 \pm 0.1$ | $12.9 \pm 0.3$ | -13.5             |
| DETECTOR B | $4.24 \pm 0.02$ | $23.54 \pm 0.12$ | $22.0 \pm 0.2$ | $12.4 \pm 0.2$ | -13.5             |
| DETECTOR C | $3.57 \pm 0.01$ | $27.99 \pm 0.13$ | $18.2 \pm 0.1$ | $5.3 \pm 0.1$  | -15.4             |
| DETECTOR D | $4.02 \pm 0.02$ | $24.87 \pm 0.12$ | $19.4 \pm 0.1$ | $5.5 \pm 0.1$  | -15.8             |

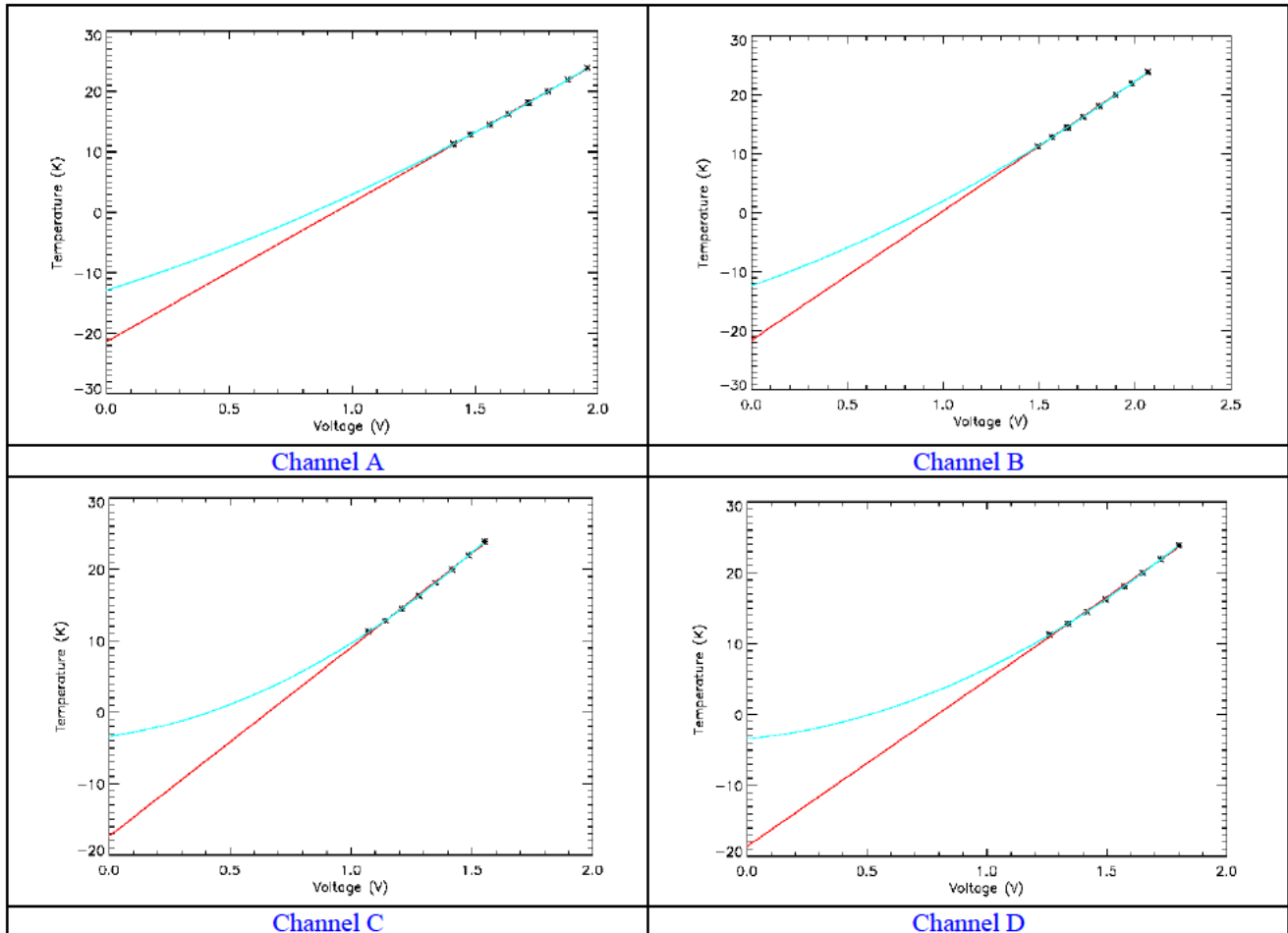


Figure 6-3



The complete RaNA output is reported here (RCA27\_LIS\_results270406\_Rmon\_all)

```
=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: A
Changing signal: Load
BEM offset (V): 0.0324000

There are 10 time windows
      tmin      tmax
2497.2600    4412.8398
5693.6602    7178.5200
8345.9502    9773.2900
11270.600    12502.000
14008.700    15209.400
16710.199    17965.400
19448.801    20639.600
22227.301    23392.500
24790.900    26001.699
27494.500    28764.000

      Tchange      Tfixed      Vchange      Vfixed
11.982322    12.800000    1.4105380    1.4251746
13.509169    12.800000    1.4812570    1.4281826
15.186212    12.800000    1.5568790    1.4314597
16.965200    12.800000    1.6357016    1.4351822
18.807430    12.800000    1.7160128    1.4397292
20.705917    12.800000    1.7965322    1.4442323
22.636772    12.800000    1.8770256    1.4489416
24.586245    12.800000    1.9565939    1.4535419
26.557276    12.961075    2.0351867    1.4613251
28.518431    13.179775    2.1124076    1.4733380

=====
OUTPUT
***** Linear fit *****

Parameters
      Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
0.040531575    21.963663    -13.469614    0.0067496200

Statistical uncertainties
      Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
0.00020593050    0.15934146    3.6632220    0.0048521364

***** Parabolic fit *****

Average noise temperature
      Tn (k)      Sigma (K)
12.921948    0.29479409

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
      a0      a1      a2
-12.835060    12.783111    3.0561483

      sigma(a0)      sigma(a1)      sigma(a2)
0.054579956    0.063393886    0.018157849

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
      a0      a1      a2
0.85606163    0.051938677    -0.00024457003

      sigma(a0)      sigma(a1)      sigma(a2)
0.0094998647    0.0011702050    3.3716585e-005

=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: B
Changing signal: Load
BEM offset (V): 0.0377000

There are 10 time windows
      tmin      tmax
2497.2600    4412.8398
5693.6602    7178.5200
8345.9502    9773.2900
11270.600    12502.000
14008.700    15209.400
16710.199    17965.400
19448.801    20639.600
22227.301    23392.500
24790.900    26001.699
27494.500    28764.000

      Tchange      Tfixed      Vchange      Vfixed
11.982322    12.800000    1.4917148    1.4952721
13.509169    12.800000    1.5665141    1.4983287
```



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|           |           |           |           |
|-----------|-----------|-----------|-----------|
| 15.186212 | 12.800000 | 1.6460691 | 1.5016040 |
| 16.965200 | 12.800000 | 1.7292415 | 1.5057696 |
| 18.807430 | 12.800000 | 1.8136894 | 1.5106824 |
| 20.705917 | 12.800000 | 1.8982015 | 1.5155882 |
| 22.636772 | 12.800000 | 1.9825594 | 1.5207612 |
| 24.586245 | 12.800000 | 2.0657377 | 1.5257153 |
| 26.557276 | 12.961075 | 2.1479642 | 1.5341149 |
| 28.518431 | 13.179775 | 2.2285644 | 1.5467267 |

=====

OUTPUT

\*\*\*\*\* Linear fit \*\*\*\*\*

Parameters

|             |           |            |              |
|-------------|-----------|------------|--------------|
| Gain (V/K)  | Tn (K)    | Iso. (dB)  | Lin. coeff   |
| 0.042476291 | 22.206567 | -13.454329 | 0.0068696078 |

Statistical uncertainties

|               |            |           |              |
|---------------|------------|-----------|--------------|
| Gain (V/K)    | Tn (K)     | Iso. (dB) | Lin. coeff   |
| 0.00022352514 | 0.16405984 | 3.6560878 | 0.0049954459 |

\*\*\*\*\* Parabolic fit \*\*\*\*\*

Average noise temperature

|           |            |
|-----------|------------|
| Tn (k)    | Sigma (K)  |
| 12.418021 | 0.27175270 |

Temperature versus Voltage parabolic fit parameters

Equation:  $T = a_0 + a_1 * V + a_2 * V^2$

|            |           |           |
|------------|-----------|-----------|
| a0         | a1        | a2        |
| -12.281689 | 11.349180 | 2.9788944 |

|             |             |             |
|-------------|-------------|-------------|
| sigma(a0)   | sigma(a1)   | sigma(a2)   |
| 0.058928511 | 0.064805163 | 0.017578642 |

Voltage versus temperature parabolic fit parameters

Equation:  $V = a_0 + a_1 * T + a_2 * T^2$

|            |             |                |
|------------|-------------|----------------|
| a0         | a1          | a2             |
| 0.90343961 | 0.055304939 | -0.00027707104 |

|              |              |                |
|--------------|--------------|----------------|
| sigma(a0)    | sigma(a1)    | sigma(a2)      |
| 0.0094998647 | 0.0011702050 | 3.3716585e-005 |

=====

INPUT

Centre frequency (Hz) = 3.0000000e+010

Channel: C

Changing signal: Load

BEM offset (V): 0.00327000

There are 10 time windows

|           |           |
|-----------|-----------|
| tmin      | tmax      |
| 2497.2600 | 4412.8398 |
| 5693.6602 | 7178.5200 |
| 8345.9502 | 9773.2900 |
| 11270.600 | 12502.000 |
| 14008.700 | 15209.400 |
| 16710.199 | 17965.400 |
| 19448.801 | 20639.600 |
| 22227.301 | 23392.500 |
| 24790.900 | 26001.699 |
| 27494.500 | 28764.000 |

|           |           |           |           |
|-----------|-----------|-----------|-----------|
| Tchange   | Tfixed    | Vchange   | Vfixed    |
| 11.982322 | 12.800000 | 1.0733526 | 1.1701301 |
| 13.509169 | 12.800000 | 1.1416276 | 1.1720702 |
| 15.186212 | 12.800000 | 1.2110989 | 1.1737736 |
| 16.965200 | 12.800000 | 1.2806156 | 1.1758445 |
| 18.807430 | 12.800000 | 1.3496331 | 1.1783184 |
| 20.705917 | 12.800000 | 1.4180264 | 1.1809619 |
| 22.636772 | 12.800000 | 1.4856140 | 1.1837386 |
| 24.586245 | 12.800000 | 1.5522061 | 1.1864666 |
| 26.557276 | 12.961075 | 1.6182045 | 1.1918062 |
| 28.518431 | 13.179775 | 1.6828035 | 1.2003605 |

=====

OUTPUT

\*\*\*\*\* Linear fit \*\*\*\*\*

Parameters

|             |           |            |              |
|-------------|-----------|------------|--------------|
| Gain (V/K)  | Tn (K)    | Iso. (dB)  | Lin. coeff   |
| 0.035721762 | 18.176724 | -15.401536 | 0.0095725425 |

Statistical uncertainties

|               |            |           |              |
|---------------|------------|-----------|--------------|
| Gain (V/K)    | Tn (K)     | Iso. (dB) | Lin. coeff   |
| 0.00016685559 | 0.13759650 | 5.1282361 | 0.0038499024 |

\*\*\*\*\* Parabolic fit \*\*\*\*\*

Average noise temperature

|           |            |
|-----------|------------|
| Tn (k)    | Sigma (K)  |
| 5.3130860 | 0.10739157 |



Temperature versus Voltage parabolic fit parameters

Equation:  $T = a_0 + a_1 * V + a_2 * V^2$ 

| a0         | a1        | a2        |
|------------|-----------|-----------|
| -4.8187945 | 7.1049069 | 7.3169605 |

| sigma(a0)   | sigma(a1)   | sigma(a2)   |
|-------------|-------------|-------------|
| 0.035482637 | 0.052931938 | 0.019411342 |

Voltage versus temperature parabolic fit parameters

Equation:  $V = a_0 + a_1 * T + a_2 * T^2$ 

| a0         | a1          | a2             |
|------------|-------------|----------------|
| 0.53171512 | 0.052914343 | -0.00042518128 |

| sigma(a0)    | sigma(a1)    | sigma(a2)      |
|--------------|--------------|----------------|
| 0.0094998647 | 0.0011702050 | 3.3716585e-005 |

=====

INPUT

Centre frequency (Hz) = 3.0000000e+010

Channel: D

Changing signal: Load

BEM offset (V): 0.0377000

There are 10 time windows

| tmin      | tmax      |
|-----------|-----------|
| 2497.2600 | 4412.8398 |
| 5693.6602 | 7178.5200 |
| 8345.9502 | 9773.2900 |
| 11270.600 | 12502.000 |
| 14008.700 | 15209.400 |
| 16710.199 | 17965.400 |
| 19448.801 | 20639.600 |
| 22227.301 | 23392.500 |
| 24790.900 | 26001.699 |
| 27494.500 | 28764.000 |

| Tchange   | Tfixed    | Vchange   | Vfixed    |
|-----------|-----------|-----------|-----------|
| 11.982322 | 12.800000 | 1.2605763 | 1.3549547 |
| 13.509169 | 12.800000 | 1.3376361 | 1.3568271 |
| 15.186212 | 12.800000 | 1.4158259 | 1.3586560 |
| 16.965200 | 12.800000 | 1.4941894 | 1.3609702 |
| 18.807430 | 12.800000 | 1.5719327 | 1.3637776 |
| 20.705917 | 12.800000 | 1.6490337 | 1.3669504 |
| 22.636772 | 12.800000 | 1.7250289 | 1.3700829 |
| 24.586245 | 12.800000 | 1.7998794 | 1.3732380 |
| 26.557276 | 12.961075 | 1.8738744 | 1.3792534 |
| 28.518431 | 13.179775 | 1.9465522 | 1.3890173 |

=====

OUTPUT

\*\*\*\*\* Linear fit \*\*\*\*\*

Parameters

| Gain (V/K)  | Tn (K)    | Iso. (dB)  | Lin. coeff  |
|-------------|-----------|------------|-------------|
| 0.040206340 | 19.457278 | -15.582287 | 0.011057168 |

Statistical uncertainties

| Gain (V/K)    | Tn (K)     | Iso. (dB) | Lin. coeff   |
|---------------|------------|-----------|--------------|
| 0.00020160157 | 0.12641129 | 5.1905093 | 0.0042757244 |

\*\*\*\*\* Parabolic fit \*\*\*\*\*

Average noise temperature

| Tn (k)    | Sigma (K)  |
|-----------|------------|
| 5.5637705 | 0.11794025 |

Temperature versus Voltage parabolic fit parameters

Equation:  $T = a_0 + a_1 * V + a_2 * V^2$ 

| a0         | a1        | a2        |
|------------|-----------|-----------|
| -4.9461279 | 5.4617803 | 5.8513698 |

| sigma(a0)   | sigma(a1)   | sigma(a2)   |
|-------------|-------------|-------------|
| 0.041097401 | 0.052559651 | 0.016543547 |

Voltage versus temperature parabolic fit parameters

Equation:  $V = a_0 + a_1 * T + a_2 * T^2$ 

| a0         | a1          | a2             |
|------------|-------------|----------------|
| 0.64890883 | 0.059811852 | -0.00048510693 |

| sigma(a0)    | sigma(a1)    | sigma(a2)      |
|--------------|--------------|----------------|
| 0.0094998647 | 0.0011702050 | 3.3716585e-005 |

It is important to notice that at higher temperature the Sky Signal is following the Reference Signal as shown in the figure below.

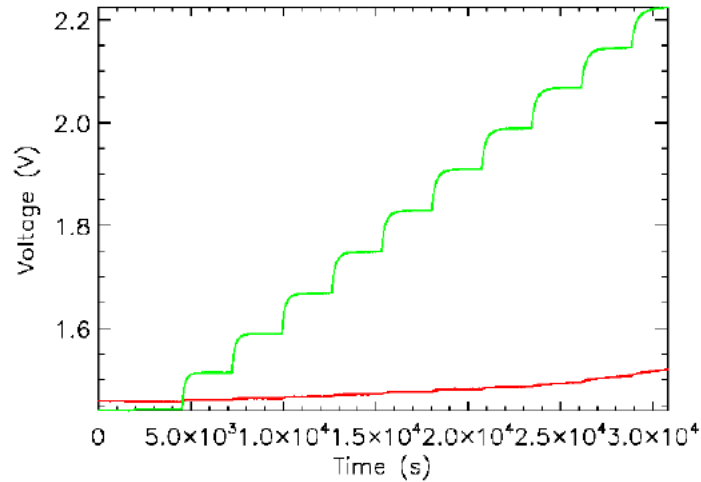


Figure 6-4 Output voltage of the Reference (green), and of the Sky (Red).

The analysis has been repeated considering only the first seven steps where the T-SKY does not change.

|            | Gain<br>[V/K]   | Gain<br>[K/V]    | Tnoise<br>[K]  | Tnoise<br>[K]  | Isolation<br>[dB] |
|------------|-----------------|------------------|----------------|----------------|-------------------|
|            | $\times 1E-02$  |                  | Linear         | Parabolic      |                   |
| DETECTOR A | $4.41 \pm 0.02$ | $24.29 \pm 0.17$ | $21.3 \pm 0.2$ | $13.1 \pm 0.4$ | -13.4             |
| DETECTOR B | $4.32 \pm 0.02$ | $23.14 \pm 0.15$ | $21.5 \pm 0.3$ | $12.6 \pm 0.3$ | -13.5             |
| DETECTOR C | $3.66 \pm 0.02$ | $27.26 \pm 0.17$ | $17.1 \pm 0.2$ | $4.3 \pm 0.1$  | -13.5             |
| DETECTOR D | $4.13 \pm 0.02$ | $24.20 \pm 0.14$ | $18.4 \pm 0.2$ | $4.5 \pm 0.1$  | -15.6             |

From the table above it is clear that there is something strange on the Channel C and D where we get the lowest noise temperature from the linear fit and from the parabolic one. The positions of reference temperature sensors with respect the Channel A/B and C/D is shown in the figure below



Figure 6-5 The green circle correspond to REF\_TEMP and the Reference horn (green spotted) refers to channel C/D. The red circle correspond to R\_MON sensor and the reference horn (red spotted) refers to channel A/B.

Doing the analysis in the same time set but using the REF\_TEMP we can obtain the following results.

Table XXX : Tnoise with REF\_TEMP

|            | Gain<br>[V/K] | Gain<br>[K/V] | Tnoise<br>[K] | Tnoise<br>[K] | Isolation<br>[dB] |
|------------|---------------|---------------|---------------|---------------|-------------------|
|            | x 1E-02       |               | Linear        | Parabolic     |                   |
| DETECTOR A | 3.38±0.02     | 29.54±0.21    | 30.5±0.2      | 35.1±0.1      | -13.5             |
| DETECTOR B | 3.55±0.02     | 28.14±0.18    | 30.7±0.2      | 34.1±0.2      | -13.5             |
| DETECTOR C | 3.01±0.01     | 33.15±0.20    | 25.5±0.2      | 22.3±0.1      | -15.3             |
| DETECTOR D | 3.39±0.01     | 29.43±0.17    | 26.9±0.2      | 23.5±0.1      | -15.6             |

The complete RaNA output is reported here (RCA27\_LIS\_results270406\_REF\_TEMP)

```
=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: A
Changing signal: Load
BEM offset (V): 0.0324000

There are 8 time windows
      tmin      tmax
2497.2600    4412.8398
5693.6602    7178.5200
8345.9502    9773.2900
11270.600    12502.000
14008.700    15209.400
16710.199    17965.400
19448.801    20639.600
22227.301    23392.500

      Tchange      Tfixed      Vchange      Vfixed
11.982322    12.800000    1.4105380    1.4251746
13.509169    12.800000    1.4812570    1.4281826
15.186212    12.800000    1.5568790    1.4314597
16.965200    12.800000    1.6357016    1.4351822
18.807430    12.800000    1.7160128    1.4397292
20.705917    12.800000    1.7965322    1.4442323
```



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|           |           |           |           |
|-----------|-----------|-----------|-----------|
| 22.636772 | 12.800000 | 1.8770256 | 1.4489416 |
| 24.586245 | 12.800000 | 1.9565939 | 1.4535419 |

=====

OUTPUT

\*\*\*\*\* Linear fit \*\*\*\*\*

| Parameters  |           |            |              |  |
|-------------|-----------|------------|--------------|--|
| Gain (V/K)  | Tn (K)    | Iso. (dB)  | Lin. coeff   |  |
| 0.041165852 | 21.286488 | -13.468907 | 0.0048375240 |  |

| Statistical uncertainties |            |           |              |  |
|---------------------------|------------|-----------|--------------|--|
| Gain (V/K)                | Tn (K)     | Iso. (dB) | Lin. coeff   |  |
| 0.00029037077             | 0.18405473 | 4.1198349 | 0.0049962727 |  |

\*\*\*\*\* Parabolic fit \*\*\*\*\*

| Average noise temperature |            |  |
|---------------------------|------------|--|
| Tn (k)                    | Sigma (K)  |  |
| 13.062968                 | 0.36822283 |  |

Temperature versus Voltage parabolic fit parameters

| Equation: $T = a_0 + a_1 * V + a_2 * V^2$ |            |             |
|-------------------------------------------|------------|-------------|
| a0                                        | a1         | a2          |
| -12.933478                                | 12.905680  | 3.0183310   |
| sigma(a0)                                 | sigma(a1)  | sigma(a2)   |
| 0.086254501                               | 0.10406526 | 0.031094201 |

Voltage versus temperature parabolic fit parameters

| Equation: $V = a_0 + a_1 * T + a_2 * T^2$ |              |                |
|-------------------------------------------|--------------|----------------|
| a0                                        | a1           | a2             |
| 0.85493403                                | 0.052089511  | -0.00024930216 |
| sigma(a0)                                 | sigma(a1)    | sigma(a2)      |
| 0.011378848                               | 0.0014411203 | 4.2903354e-005 |

=====

INPUT

Centre frequency (Hz) = 3.0000000e+010

Channel: B

Changing signal: Load

BEM offset (V): 0.0377000

There are 8 time windows

| tmin      | tmax      |
|-----------|-----------|
| 2497.2600 | 4412.8398 |
| 5693.6602 | 7178.5200 |
| 8345.9502 | 9773.2900 |
| 11270.600 | 12502.000 |
| 14008.700 | 15209.400 |
| 16710.199 | 17965.400 |
| 19448.801 | 20639.600 |
| 22227.301 | 23392.500 |

| Tchange   | Tfixed    | Vchange   | Vfixed    |
|-----------|-----------|-----------|-----------|
| 11.982322 | 12.800000 | 1.4917148 | 1.4952721 |
| 13.509169 | 12.800000 | 1.5665141 | 1.4983287 |
| 15.186212 | 12.800000 | 1.6460691 | 1.5016040 |
| 16.965200 | 12.800000 | 1.7292415 | 1.5057696 |
| 18.807430 | 12.800000 | 1.8136894 | 1.5106824 |
| 20.705917 | 12.800000 | 1.8982015 | 1.5155882 |
| 22.636772 | 12.800000 | 1.9825594 | 1.5207612 |
| 24.586245 | 12.800000 | 2.0657377 | 1.5257153 |

=====

OUTPUT

\*\*\*\*\* Linear fit \*\*\*\*\*

| Parameters  |           |            |              |  |
|-------------|-----------|------------|--------------|--|
| Gain (V/K)  | Tn (K)    | Iso. (dB)  | Lin. coeff   |  |
| 0.043208134 | 21.484348 | -13.481771 | 0.0055526952 |  |

| Statistical uncertainties |            |           |              |  |
|---------------------------|------------|-----------|--------------|--|
| Gain (V/K)                | Tn (K)     | Iso. (dB) | Lin. coeff   |  |
| 0.00027941433             | 0.18309243 | 4.1382248 | 0.0051538015 |  |

\*\*\*\*\* Parabolic fit \*\*\*\*\*

| Average noise temperature |            |  |
|---------------------------|------------|--|
| Tn (k)                    | Sigma (K)  |  |
| 12.575482                 | 0.33984271 |  |

Temperature versus Voltage parabolic fit parameters

| Equation: $T = a_0 + a_1 * V + a_2 * V^2$ |            |             |
|-------------------------------------------|------------|-------------|
| a0                                        | a1         | a2          |
| -12.372842                                | 11.456558  | 2.9475564   |
| sigma(a0)                                 | sigma(a1)  | sigma(a2)   |
| 0.092869539                               | 0.10601582 | 0.029973245 |

Voltage versus temperature parabolic fit parameters

Equation:  $V = a_0 + a_1 * T + a_2 * T^2$



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```

      a0          a1          a2
    0.90192364    0.055507860  -0.00028344317

    sigma(a0)    sigma(a1)    sigma(a2)
    0.011378848  0.0014411203  4.2903354e-005
=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: C
Changing signal: Load
BEM offset (V): 0.00327000

There are      8 time windows
      tmin      tmax
    2497.2600    4412.8398
    5693.6602    7178.5200
    8345.9502    9773.2900
    11270.600    12502.000
    14008.700    15209.400
    16710.199    17965.400
    19448.801    20639.600
    22227.301    23392.500

      Tchange      Tfixed      Vchange      Vfixed
    11.982322    12.800000    1.0733526    1.1701301
    13.509169    12.800000    1.1416276    1.1720702
    15.186212    12.800000    1.2110989    1.1737736
    16.965200    12.800000    1.2806156    1.1758445
    18.807430    12.800000    1.3496331    1.1783184
    20.705917    12.800000    1.4180264    1.1809619
    22.636772    12.800000    1.4856140    1.1837386
    24.586245    12.800000    1.5522061    1.1864666
=====
OUTPUT
***** Linear fit *****

Parameters
      Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
    0.036679950      17.105820    -15.345523    0.0083996614

Statistical uncertainties
      Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
    0.00023094054    0.16517815    5.6858752    0.0043044790

***** Parabolic fit *****

Average noise temperature
      Tn (k)      Sigma (K)
    4.2821680    0.12193271

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
      a0          a1          a2
    -3.1241238      4.4031331    8.3798019

      sigma(a0)    sigma(a1)    sigma(a2)
    0.054578118    0.084797991    0.032546199

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
      a0          a1          a2
    0.52109793    0.054338165  -0.00047000591

      sigma(a0)    sigma(a1)    sigma(a2)
    0.011378848    0.0014411203  4.2903354e-005
=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (V): 0.0377000

There are      8 time windows
      tmin      tmax
    2497.2600    4412.8398
    5693.6602    7178.5200
    8345.9502    9773.2900
    11270.600    12502.000
    14008.700    15209.400
    16710.199    17965.400
    19448.801    20639.600
    22227.301    23392.500

      Tchange      Tfixed      Vchange      Vfixed
    11.982322    12.800000    1.2605763    1.3549547
    13.509169    12.800000    1.3376361    1.3568271
    15.186212    12.800000    1.4158259    1.3586560
    16.965200    12.800000    1.4941894    1.3609702
    18.807430    12.800000    1.5719327    1.3637776
    20.705917    12.800000    1.6490337    1.3669504
```



```
22.636772      12.800000      1.7250289      1.3700829
24.586245      12.800000      1.7998794      1.3732380

=====
OUTPUT
***** Linear fit *****

Parameters
Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
0.041318823     18.389086     -15.573935     0.0096852724

Statistical uncertainties
Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
0.00024843663   0.16484363   5.8185385      0.0045476131

***** Parabolic fit *****

Average noise temperature
Tn (K)      Sigma (K)
4.5483250   0.13774193

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
a0          a1          a2
-3.1887366   3.0656388   6.6581587

sigma(a0)    sigma(a1)    sigma(a2)
0.063528449   0.084531303  0.027807632

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
a0          a1          a2
0.63716730   0.061386254 -0.00053466361

sigma(a0)    sigma(a1)    sigma(a2)
0.011378848   0.0014411203  4.2903354e-005

=====
```

Using the mean temperature between the two sensors we can obtain a different set of values. To run this new calculation that was not foreseen in the RANA software a simple tool in MATLAB has been developed. The tool has been tested with the results already obtained in the case of R\_MON variation. We can see that due to a different algorithm to find the best fit there is a slightly difference from the two methods but the error is kept under 0.5K. The results founded are shown in the table below. Only C/D channels are displayed because the A/B should look always at the R\_MON sensor.

Table 6-2: Noise temperature and R coefficients for Channel C and D evaluated from linear fits and Parabolic Fit on data with REF step using the average values between R\_MON and REF\_TEMP sensors.

|            | Gain<br>[V/K] | Tnoise<br>[K] | R2     | Tnoise<br>[K] | R2     |
|------------|---------------|---------------|--------|---------------|--------|
|            | x 1E-02       | Linear        |        | Parabolic     |        |
| DETECTOR C | 3.42          | 21.46         | 0.9901 | 14.44         | 0.9975 |
| DETECTOR D | 3.85          | 22.80         | 0.9887 | 15.18         | 0.9989 |

The fit results are the following:

Linear fit:

$$V\_C(T) = 0.0342 * T + 0.7339$$

$$V\_D(T) = 0.0385 * T + 0.8784$$

Parabolic fit:

$$V\_C(T) = -0.0002 * T^2 + 0.0407 * T + 0.6821$$

$$V\_D(T) = -0.0002 * T^2 + 0.0460 * T + 0.8189$$



$$T(V\_C) = 4.7936 * V^2 + 16.6420 * V - 13.2986$$
$$T(V\_D) = 3.8514 * V^2 + 14.1626 * V - 13.8863$$

### 5.2.2 Sky Temperature Steps

In the data set the SKY temperature has been varied from 12.8 Kelvin to 33.8 Kelvin and the REF has been keep to 12.8 Kelvin.

| T Change | T Fixed |
|----------|---------|
| 12.8     | 12.0    |
| 14.2     | 12.1    |
| 16.0     | 12.4    |
| 19.4     | 13.0    |
| 22.4     | 13.7    |
| 25.6     | 14.4    |
| 28.8     | 15.2    |
| 33.8     | -       |

The results are reported here. The error is the fit uncertainty and does not includes any systematic error from measurements. A linear Fit and a Parabolic Fit has been calculated and their behaviors are shown in the figure below.

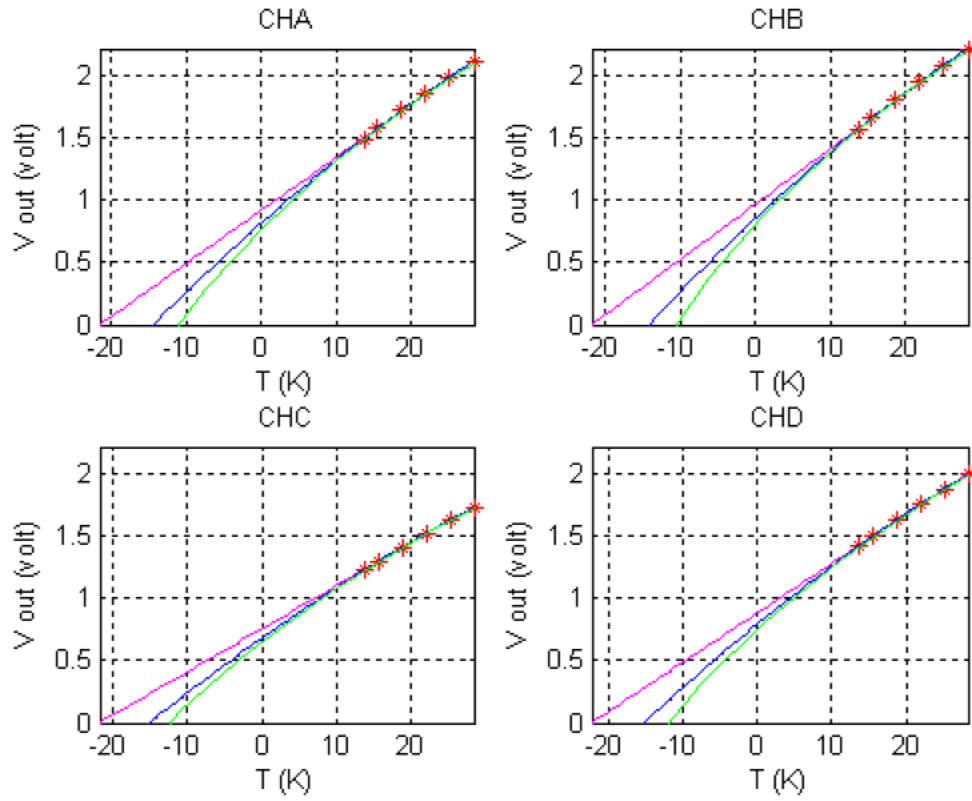


Figure 6-6: Non linearity of the RCA27. The magenta line is the linear best fit. The blue line is the parabolic fit  $V(T)$ , and the green line is the parabolic best fit for  $T(V)$  data.

The noise temperature is then evaluated as the intersection on the T axis and results are reported in **Errore**.  
L'origine riferimento non è stata trovata.

Table 6-3: Noise temperature and R coefficients evaluated from linear fits and Parabolic Fit.

| Detector Id | Tn from Linear (K) | R2 (Linear) | Tn from Parabolic (K) | R2 (Parabolic) |
|-------------|--------------------|-------------|-----------------------|----------------|
| A           | 21.52              | 0.9869      | 12.80                 | 0.9973         |
| B           | 21.77              | 0.9855      | 12.43                 | 0.9972         |
| C           | 21.76              | 0.9905      | 13.78                 | 0.9980         |
| D           | 21.27              | 0.9886      | 13.71                 | 0.9977         |

The fit results are the following:

Linear fit:

$$V\_A(T) = 0.0427 * T + 0.9186$$

$$V\_B(T) = 0.0445 * T + 0.9687$$

$$V\_C(T) = 0.0347 * T + 0.7562$$

$$V\_D(T) = 0.0397 * T + 0.8831$$



Parabolic fit:

$$V\_A(T) = -0.000248344 * T^2 + 0.053057288 * T + 0.816806123$$

$$V\_B(T) = -0.000276441 * T^2 + 0.056032191 * T + 0.855333121$$

$$V\_C(T) = -0.000180869 * T^2 + 0.042301959 * T + 0.652635268$$

$$V\_D(T) = -0.000217483 * T^2 + 0.048742725 * T + 0.793997091$$

$$T(V\_A) = 3.213100827 * V^2 + 11.82294 * V - 11.19584691$$

$$T(V\_B) = 3.160023678 * V^2 + 10.51502 * V - 10.61390596$$

$$T(V\_C) = 4.336028988 * V^2 + 16.20976 * V - 11.94399474$$

$$T(V\_D) = 3.506887337 * V^2 + 13.23740 * V - 12.18571493$$

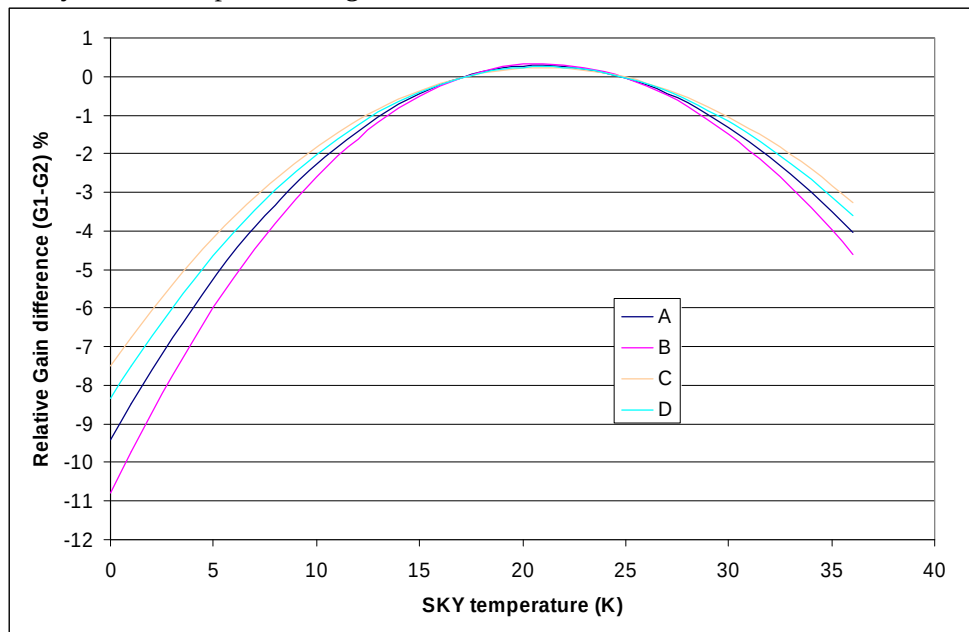
To check for best fit the following exercise has been performed.

From  $V=f(T)$  parabolic fit the gain ( $G1$  in V/K) has been calculated as  $G1=dV/dT$ , so that the Gain is the slope of the  $f(T)$  function as the temperature varies.

The gain in V/K has been derived in two ways:

- (i) Calculated as  $G2 = 1/G1$
- (ii) Calculated from  $T=f(V)$  parabolic fit as  $G2 = dT/dV$  in K/V

The two gains derived as in (i) and (ii) have been compared and the relative difference (percentage values) as a function of  $T$  sky has been reported in figure below:



It should be noted that, without any other assumption on the gain curve, the intrinsic relative error on the gain is less than 1 % within the measured temperature range and goes up to ~10 % near the flight condition (SKY temp ~ 3K). **This evaluation does not include systematics and should be considered as intrinsic error due to knowledge of the Gain function at  $T \sim 3K$  based on the parabolic fits.**



### 5.2.3 Linearity

See Annex A

Table 6-4: Summary of linearity behaviors

| Detector Id | Linearity from sky steps | Isolation from sky steps (dB) | Linearity from Ref steps | Isolation from Ref steps (dB) |
|-------------|--------------------------|-------------------------------|--------------------------|-------------------------------|
| A           | 0.008914                 | -10.77                        | 0.007241                 | -12.9                         |
| B           | 0.009150                 | -10.75                        | 0.007769                 | -12.7                         |
| C           | 0.006114                 | -11.28                        | 0.003163                 | -14.7                         |
| D           | 0.009806                 | -10.97                        | 0.003631                 | -14.6                         |

### 5.2.4 Consistency of the Results

The white noise limit has been calculated and compared with the requirement. The white noise limit is defined at a given SKY temperature as follows:

$$\text{Eq. 1:} \quad \Delta T = \sqrt{2} \cdot \frac{T_{SKY} + T_{SYS}}{\sqrt{B}} \cdot 1000 \left[ \text{mK} \cdot \sqrt{\text{sec}} \right]$$

where B is the bandwidth [Hz],  $\tau$  is the integration time [sec],  $T_{SKY}$  and  $T_{SYS}$  are the Skyload antenna temperature [K] and noise system temperature [K] respectively.

From measurements the white noise limit is calculated as follows:

$$\text{Eq. 2:} \quad \Delta T = G[K/V] \cdot \frac{1}{\sqrt{2}} \cdot WN \cdot \sqrt{\frac{\tau}{\tau - \tau_{BT}}}$$

where  $WN$  is the white noise as derived from RaNA,  $\tau$  is the 122 microSec (1/8KHz) integration time and  $\tau_{BT}$  is the blanking time (7.5 microSec). G is the gain (K/V) which needs to be know from RCA\_TNG tests.

The requirements has been calculated assuming  $T_{sys} = 10.7$  Kelvin (see [AD 2]), while the white noise limit form measurements has been derived in three ways:

1. From the  $T_{sys}$  and B derived from tests applying the Eq. 1.  $T_{sys}$  values were obtained from parabolic values of Table 6-3 and B were obtained from RCA\_SPR test from
2. Table 6-7.
3. Directly From WN measurements applying the Eq. 2 where  $WN$  is the white noise level derived from RaNA FFT module when the detector output is calibrated. Firstly the white noise limit has been derived form *RaNA\_FFT* module selecting a stable (600 sec) calibrated acquisition data chunk. The White noise of differenced calibrated<sup>1</sup> detectors has been selected (A-B and C-D). Then the number has been corrected by the Blanking time.

<sup>1</sup> The calibration has been obtained in the following way:



4. White noise derived from B obtained from WN level (from RaNA FFT) and Tsys from Table 6-3.

*Table 6-5: white noise as derived from measurements (Tsys, B from SPR, calibrated WN) compared with the requirements*

|                              | Requirement | From Measured Tsys & B | ratio Over requirement | From Data After calibration | Ratio over requirement | Consistency ratio |
|------------------------------|-------------|------------------------|------------------------|-----------------------------|------------------------|-------------------|
|                              | mK*Sqrt (s) | mK*Sqrt (s)            |                        | mK*Sqrt (s)                 |                        |                   |
| SKY = 14.2 K<br>REF = 9.70 K |             |                        |                        |                             |                        |                   |
| Detector A-B                 | 0.44168860  | 0.56936877             | 1.29                   | 0.53865251                  | 1.22                   | 0.95              |
| Detector C-D                 |             | 0.62486608             | 1.41                   | 0.54082949                  | 1.22                   | 0.87              |

*Table 6-6: white noise as derived from measurements (Tsys, B from WN, calibrated WN) compared with the requirements*

|                              | Requirement | From Measured Tsys & B | ratio Over requirement | From Data After calibration | Ratio over requirement | Consistency ratio |
|------------------------------|-------------|------------------------|------------------------|-----------------------------|------------------------|-------------------|
|                              | mK*Sqrt (s) | mK*Sqrt (s)            |                        | mK*Sqrt (s)                 |                        |                   |
| SKY = 14.2 K<br>REF = 9.70 K |             |                        |                        |                             |                        |                   |
| Detector A-B                 | 0.44168860  | 0.41854747             | 0.95                   | 0.53865251                  | 1.22                   | 1.29              |
| Detector C-D                 |             | 0.43115791             | 0.98                   | 0.54082949                  | 1.22                   | 1.25              |

These calculations have been used to search for best Tnoise and B pairs in order to obtain a consistency ratio near unity (CR = 1). This means to obtain from radiometer equation the WN level as measured from calibrated data.

Required bandwidth for CR = 1 using Tnoise from LIS test:

A-B 4.70 GHz

C-D 5.07 GHz

Required Tnoise for CR = 1 using B from WN level:

A-B 20.1 K

C-D 20.7 K

Required Tnoise for CR = 1 using B from SPR test:

A-B 11.2 K

C-D 10.1 K

### 5.3 RCA\_SPR: BANDPASS MEASUREMENT

The RCA\_SPR was performed several times with two different measurement setup. Here we report on the tests performed with the ESA equipment and coax – waveguide WR28 transition of INAF / IRA – Bologna. The following equipment has been used:

- Sweeper: AGILENT Model HP83650B, Synthesized sweeper generator, 10 MHz-50 GHz, output coaxial connector: 2.4 mm, s/n 3844A00889 Option 001<sup>2</sup>

<sup>2</sup> Thanks to ESA – ESTEC



- WR28 to Coax Transition: HPU281A S/N 00271 PC2.4 Female<sup>3</sup>
- Cable Gore PC24 M-F<sup>4</sup>

Typical data steam is showed hereafter:

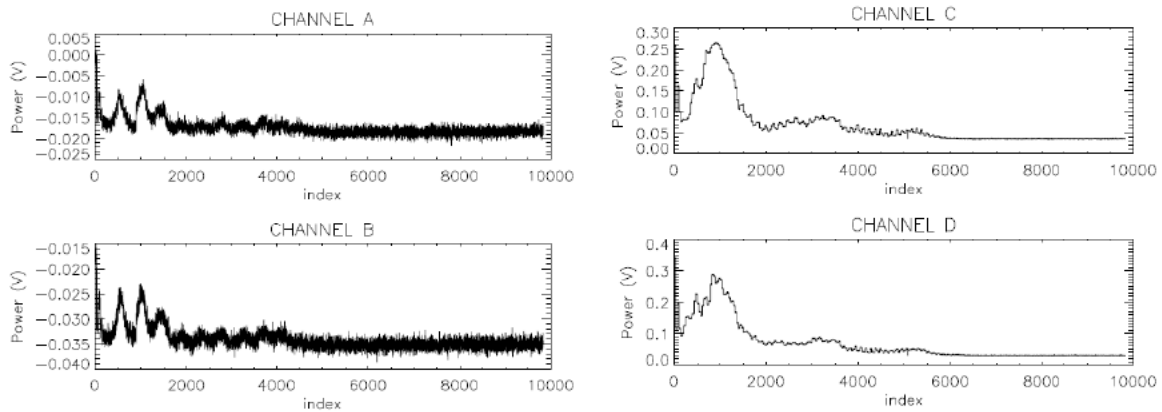


Figure 6-7: typical data steam of the SPR test after trigger removal.

Test has been performed with  $-34$  dBm power level at the sweeper. Data were selected with a BIN = 10, i.e with sampling frequency of 409,6 Hz on the data stream: 030LFI27\_RCA\_FM\_SPR\_200604061449

| Data set                         | Trigger sequence<br>[dB] to Power level | Fmin<br>[GHz] | Fmax<br>[GHz] | Step<br>[GHz] | Power<br>level<br>[dBm] |
|----------------------------------|-----------------------------------------|---------------|---------------|---------------|-------------------------|
| 030LFI27_RCA_FM_SPR_200604061449 | [+6, 0, +3, 0]@ 27GHz                   | 26.5          | 40.0          | 0.05          | -34.0                   |

Table 6-7: Bandwidth and centre frequencies as calculated from RCA\_SPR tests at different input power levels.

|            | Power level            |       |
|------------|------------------------|-------|
| DETECTOR A | Centre frequency [GHz] | 31.8  |
|            | Bandwidth [GHz]        | 4.3   |
| DETECTOR B | Centre frequency [GHz] | 31.30 |
|            | Bandwidth [GHz]        | 4.11  |
| DETECTOR C | Centre frequency [GHz] | 30.70 |
|            | Bandwidth [GHz]        | 3.71  |
| DETECTOR D | Centre frequency [GHz] | 30.45 |
|            | Bandwidth [GHz]        | 3.89  |

The RaNA report is attached.

<sup>3</sup> Thanks to Segio Mariotti INAF/IRA - Bologna

<sup>4</sup> Thanks to ESA – ESTEC

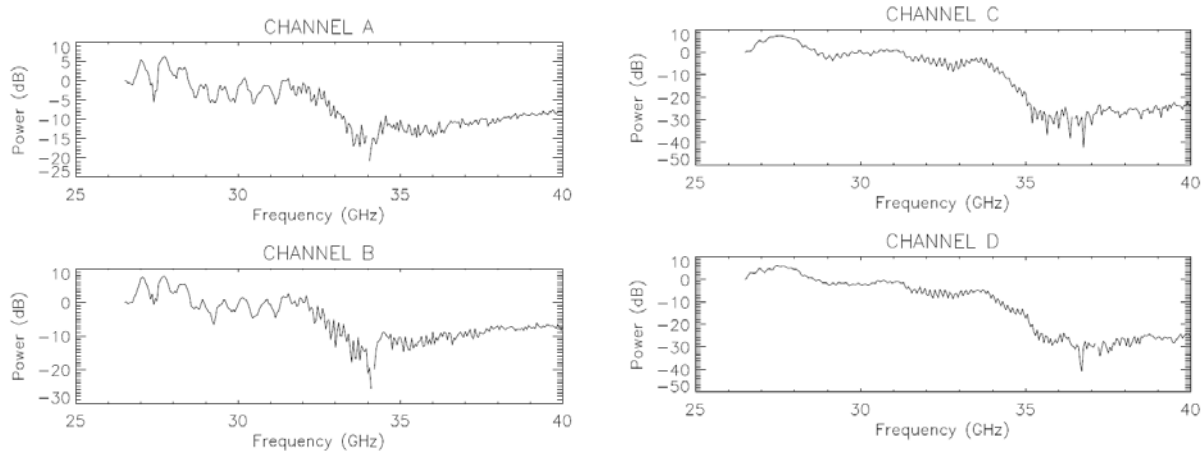


Figure 6-8: Bandpass shape of the all four channels. Obviously the channel A and B show ripples that are not found on channel C and D..

Figure 6-8 shows that for channel A and B a ripple is present with a period of 1 GHz. Moreover the Figure XXX shows that the data stream of these channels are very different with respect to the data stream of the other two channel: the output signal appeared noisy and low in amplitude for A and B, while for channel C and D appeared well defined and clearly visible.

Since for channel A and B results were not satisfactory, the RCA\_SPR test was not successfully passed for these two channel. We decided to perform a deeply investigation at warm temperature. Hereafter we report on the results obtained.

### 5.3.1 Warm tests

Several warm SPR tests have been performed at RCA level, on BEM / waveguide assembly and on BEM stand alone. Specifically at RCA level tests have been performed at different SPR test setup condition, changing the orientation of the waveguide injector w.r.t the OMT arms and SKY load pyramids.

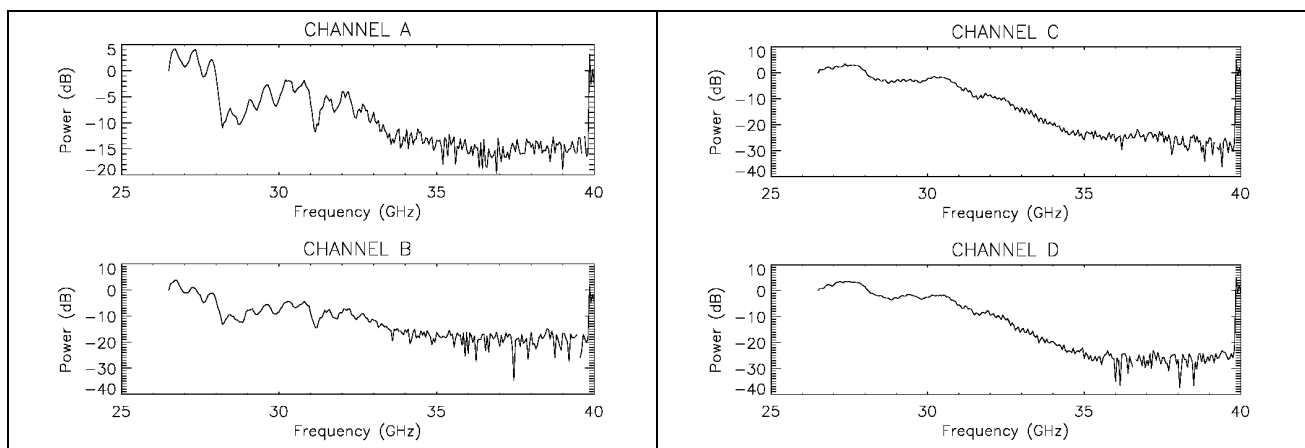
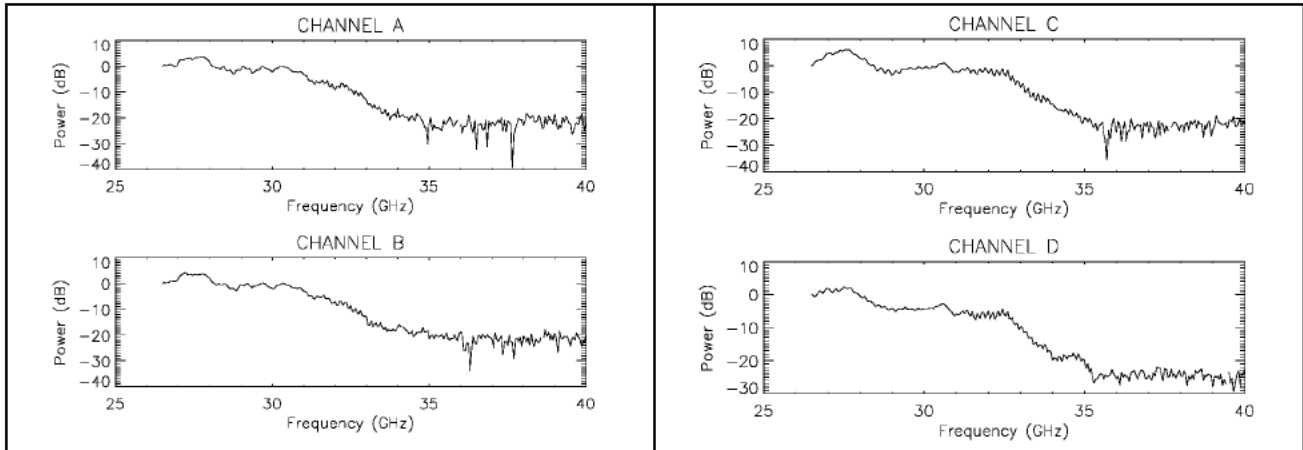


Figure 6-9: Bandpass shape of the all four channels. Obviously the channel A and B show ripples that are not found on channel C and D..



SPR\_TEST @ room temperature where the Ripples are quite visible in Channel A/B



SPR\_TEST @ Changing the polarization position angle of the launcher waveguide the ripples disappear

The position that minimize the ripple effect in the band is when the Polarization plane of launcher is at 45 DEG respect to the Polarization plane of the Main arm of the OMT (and obviously 45DEG from the polarization plane of the Side arm of OMT).

|            | Pass Band (GHz) | Pass Band (GHz) |
|------------|-----------------|-----------------|
|            | 0 DEG           | 45 DEG          |
| Detector A | 3.55            | 4.29            |
| Detector B | 2.79            | 4.24            |
| Detector C | 3.77            | 4.07            |
| Detector D | 3.69            | 4.34            |

The measure values are obtained at room temperature and it is not clear or evident how to compare these results with the one obtained during Cryo tests.

Swept source test on LFI 27 RCA test Campaign.

## 6 NOISE PROPERTIES

### 6.1 RCA\_STN

Long acquisition time has been performed with the aim to derive noise spectra.

The complete data set of the RCA\_STN test with 7.5 uSec Blanking time is composed by the following files:  
030LFI27\_RCA\_FM\_ST3\_200604071940



030LFI27\_RCA\_FM\_ST3\_200604080415

the temperature step sequence is reported in Table 7-1

Table 7-1: Reference Temperature steps for Noise properties test ( $ST_n$ ) with blanking time set at 7.5  $\mu$ Sec

| SKY Temperature | REF Temperature | Duration  |
|-----------------|-----------------|-----------|
| 12.8 K          | 9.5 K           | 3 hours   |
| 12.8 K          | 15.0 K          | 3 hours   |
| 12.8 K          | 20.0 K          | 3 hours   |
| 20.0 K          | 20.0 K          | > 3 hours |

### 6.1.1 One-Over-F Noise

A fourier transform has been applied on data to obtain the 1/f knee frequency and noise properties. In the following table the 1/f characteristics obtained by an optimized fitting is reported. The numbers of point used for the low frequency fit is reported for each detector. BIN = 10 is used ( $fs_{\text{sampl}} = 409.600$ ).

The following data set have been used:

12.8 / 9.5 Selected from **7000 – 10600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 15.0 Selected from **18000 – 21600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 20.0 Selected from **26400 – 30000** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

20.0 / 20.0 Selected from **15900 – 19500** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604080415

| T sky = 12.8 K<br>T ref = 9.5 K | Detector A | Detector B | Detector C | Detector D |
|---------------------------------|------------|------------|------------|------------|
| N points                        | 19         | 24         | 37         | 200        |
| 1/f knee frequency              | 0.00674279 | 0.0100795  | 0.0248627  | 0.0310573  |
| R factor                        | 1.0117289  | 1.0039085  | 1.0925592  | 1.0751076  |
| 1/f Slope                       | -1.02472   | -1.18724   | -1.38526   | -0.900950  |

| T sky = 12.8 K<br>T ref = 15 K | Detector A  | Detector B  | Detector C  | Detector D |
|--------------------------------|-------------|-------------|-------------|------------|
| N points                       | 167         | 90          | 16          | 50         |
| 1/f knee frequency             | 0.052728323 | 0.040813165 | 0.022304566 | 0.0162680  |
| R factor                       | 0.90196009  | 0.89537801  | 0.94551358  | 0.93842167 |
| 1/f Slope                      | -1.0732873  | -1.2644164  | -1.0548012  | -1.36251   |

| T sky = 12.8 K<br>T ref = 20 K | Detector A  | Detector B  | Detector C  | Detector D  |
|--------------------------------|-------------|-------------|-------------|-------------|
| N points                       | 134         | 120         | 20          | 50          |
| 1/f knee frequency             | 0.061293342 | 0.049936296 | 0.016397661 | 0.022567225 |
| R factor                       | 0.81677914  | 0.81158679  | 0.84400192  | 0.84295173  |
| 1/f Slope                      | -1.1884388  | -1.1765550  | -1.3109853  | -1.3295316  |

| T sky = 20 K<br>T ref = 20 K | Detector A | Detector B | Detector C | Detector D |
|------------------------------|------------|------------|------------|------------|
| N points                     | 35         | 40         | 40         | 35         |
| 1/f knee frequency           | 0.0352489  | 0.0338384  | 0.0218724  | 0.0181386  |
| R factor                     | 0.98492659 | 0.97730596 | 1.0207044  | 1.0126508  |
| 1/f Slope                    | -1.26637   | -1.23750   | -1.09768   | -1.42355   |



A further check has been done on the following data:

12.8 / 9.5 Selected from **1000 – 4600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 15.0 Selected from **12000 – 15600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 20.0 Selected from **23000 – 26000** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

| T sky = 12.8 K<br>T ref = 9.5 K | Detector A  | Detector B  | Detector C  | Detector D  |
|---------------------------------|-------------|-------------|-------------|-------------|
| N points                        | 60          | 90          | 28          | 45          |
| 1/f knee frequency              | 0.010862375 | 0.012912768 | 0.021882927 | 0.030154401 |
| R factor                        | 1.0113834   | 1.0113834   | 1.0921599   | 1.0747619   |
| 1/f Slope                       | -1.0070003  | -1.0234596  | -1.0968903  | -0.95164386 |

| T sky = 12.8 K<br>T ref = 15 K | Detector A | Detector B | Detector C | Detector D |
|--------------------------------|------------|------------|------------|------------|
| N points                       | 50         | 110        | 50         | 80         |
| 1/f knee frequency             | 0.0501855  | 0.0352692  | 0.0216174  | 0.0236875  |
| R factor                       | 0.90226751 | 0.89564600 | 0.94555593 | 0.93848066 |
| 1/f Slope                      | -1.52064   | -1.63499   | -1.20444   | -1.07799   |

| T sky = 12.8 K<br>T ref = 20 K | Detector A  | Detector B  | Detector C | Detector D |
|--------------------------------|-------------|-------------|------------|------------|
| N points                       | 140         | 150         | 145        | 50         |
| 1/f knee frequency             | 0.064950925 | 0.054528675 | 0.0459296  | 0.0243880  |
| R factor                       | 0.81689483  | 0.81169119  | 0.84403441 | 0.84299581 |
| 1/f Slope                      | -1.4407961  | -1.4718621  | -0.598078  | -0.991792  |

Finally, also this data have been analysed:

12.8 / 9.5 Selected from **4000 – 7600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 15.0 Selected from **15000 – 18600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 20.0 Selected from **25000 – 28600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

20.0 / 20.0 Selected from **15900 – 19500** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604080415

| T sky = 12.8 K<br>T ref = 9.5 K | Detector A  | Detector B  | Detector C  | Detector D  |
|---------------------------------|-------------|-------------|-------------|-------------|
| N points                        | 50          | 70          | 100         | 50          |
| 1/f knee frequency              | 0.011723189 | 0.010437344 | 0.028225476 | 0.029128471 |
| R factor                        | 1.0115488   | 1.0037355   | 1.0924103   | 1.0749771   |
| 1/f Slope                       | -0.99894215 | -1.1217005  | -1.0055711  | -1.0309422  |

| T sky = 12.8 K<br>T ref = 15 K | Detector A  | Detector B | Detector C | Detector D |
|--------------------------------|-------------|------------|------------|------------|
| N points                       | 160         | 160        | 60         | 70         |
| 1/f knee frequency             | 0.048587980 | 0.0428731  | 0.0189623  | 0.0225853  |
| R factor                       | 0.90205405  | 0.89545550 | 0.94553092 | 0.93842245 |
| 1/f Slope                      | -0.94149592 | -1.29612   | -0.943855  | -1.07147   |



|                                |             |            |            |            |
|--------------------------------|-------------|------------|------------|------------|
| T sky = 12.8 K<br>T ref = 20 K | Detector A  | Detector B | Detector C | Detector D |
| N points                       | 66          | 123        | 51         | 50         |
| 1/f knee frequency             | 0.094050256 | 0.0731736  | 0.0244508  | 0.0258737  |
| R factor                       | 0.81680047  | 0.81160392 | 0.84400453 | 0.84296170 |
| 1/f Slope                      | -0.89563201 | -0.830475  | -1.10793   | -0.947067  |

### 6.1.2 White Noise Level and Equivalent Bandwidth

The white noise level has been calculated with the *RaNA\_FFT* module using the high frequency part of the amplitude spectrum. From the white noise limit the equivalent bandwidth has been derived. Same data stream as the 1/f calculation has been used. Data were not binned and 10 minutes have been taken for each reference temperature step. For each step the last 600 seconds of the data taken for 1/f noise have been taken for this analysis.

12.8 / 9.5 Selected from **10000 – 10600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 15.0 Selected from **21000 – 21600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 20.0 Selected from **29400 – 30000** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

20.0 / 20.0 Selected from **18900 – 19500** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604080415

| T sky = 12.8 K<br>T ref = 9.5 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |             |             |
|---------------------------------|-----------------------------------|----------------|----------------|------------------------------|-------------|-------------|
|                                 | <i>Sky</i>                        | <i>Load</i>    | <i>Diff</i>    | <i>Sky</i>                   | <i>Load</i> | <i>Diff</i> |
| DETECTOR A                      | 3.3435988e-005                    | 3.2342572e-005 | 4.6778515e-005 | 7.60                         | 7.93        | 7.77        |
| DETECTOR B                      | 3.5278226e-005                    | 3.4511582e-005 | 4.9385869e-005 | 7.54                         | 7.82        | 7.70        |
| DETECTOR C                      | 2.7727442e-005                    | 2.5396591e-005 | 3.9143590e-005 | 7.16                         | 7.15        | 7.18        |
| DETECTOR D                      | 2.9941649e-005                    | 2.7584003e-005 | 4.2145125e-005 | 8.65                         | 8.82        | 8.73        |

| T sky = 12.8 K<br>T ref = 15 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |             |             |
|--------------------------------|-----------------------------------|----------------|----------------|------------------------------|-------------|-------------|
|                                | <i>Sky</i>                        | <i>Load</i>    | <i>Diff</i>    | <i>Sky</i>                   | <i>Load</i> | <i>Diff</i> |
| DETECTOR A                     | 3.3644264e-005                    | 3.5675069e-005 | 4.6557472e-005 | 7.63                         | 8.34        | 7.97        |
| DETECTOR B                     | 3.5368858e-005                    | 3.7934642e-005 | 4.9065764e-005 | 7.62                         | 8.27        | 7.92        |
| DETECTOR C                     | 2.8033363e-005                    | 2.9161193e-005 | 3.9319945e-005 | 7.10                         | 7.34        | 7.22        |
| DETECTOR D                     | 3.0140437e-005                    | 3.1397785e-005 | 4.2073550e-005 | 8.64                         | 9.05        | 8.87        |

| T sky = 12.8 K<br>T ref = 20 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |             |             |
|--------------------------------|-----------------------------------|----------------|----------------|------------------------------|-------------|-------------|
|                                | <i>Sky</i>                        | <i>Load</i>    | <i>Diff</i>    | <i>Sky</i>                   | <i>Load</i> | <i>Diff</i> |
| DETECTOR A                     | 3.3590779e-005                    | 3.8442429e-005 | 4.6020686e-005 | 7.76                         | 8.89        | 8.27        |
| DETECTOR B                     | 3.5403473e-005                    | 4.1253903e-005 | 4.8691289e-005 | 7.72                         | 8.64        | 8.17        |
| DETECTOR C                     | 2.7932176e-005                    | 3.1758679e-005 | 3.8670899e-005 | 7.23                         | 7.85        | 7.54        |
| DETECTOR D                     | 3.0055345e-005                    | 3.4170126e-005 | 4.1604718e-005 | 8.78                         | 9.56        | 9.16        |

| T sky = 20 K<br>T ref = 20 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |             |             |
|------------------------------|-----------------------------------|----------------|----------------|------------------------------|-------------|-------------|
|                              | <i>Sky</i>                        | <i>Load</i>    | <i>Diff</i>    | <i>Sky</i>                   | <i>Load</i> | <i>Diff</i> |
| DETECTOR A                   | 3.9607126e-005                    | 3.9023383e-005 | 5.5158916e-005 | 8.34                         | 8.85        | 8.60        |



|            |                |                |                |      |      |      |
|------------|----------------|----------------|----------------|------|------|------|
| DETECTOR B | 4.1667565e-005 | 4.1447719e-005 | 5.8092124e-005 | 8.29 | 8.77 | 8.53 |
| DETECTOR C | 3.2733853e-005 | 3.2390443e-005 | 4.6539301e-005 | 7.90 | 7.74 | 7.82 |
| DETECTOR D | 3.5313326e-005 | 3.4740264e-005 | 4.9813563e-005 | 9.43 | 9.49 | 9.48 |

A further check has been done on the following data:

12.8 / 9.5 Selected from **4000 – 4600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 15.0 Selected from **15000 – 15600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 20.0 Selected from **25400 – 26000** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

| T sky = 12.8 K<br>T ref = 9.5 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |      |      |
|---------------------------------|-----------------------------------|----------------|----------------|------------------------------|------|------|
|                                 | Sky                               | Load           | Diff           | Sky                          | Load | Diff |
| DETECTOR A                      | 3.3540639e-005                    | 3.2026162e-005 | 4.6480214e-005 | 7.53                         | 8.08 | 7.85 |
| DETECTOR B                      | 3.5191239e-005                    | 3.4472392e-005 | 4.9258708e-005 | 7.56                         | 7.82 | 7.71 |
| DETECTOR C                      | 2.7836948e-005                    | 2.5248287e-005 | 3.9130481e-005 | 7.08                         | 7.22 | 7.17 |
| DETECTOR D                      | 2.9850261e-005                    | 2.7523769e-005 | 4.2083530e-005 | 8.68                         | 8.83 | 8.73 |

| T sky = 12.8 K<br>T ref = 15 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |      |      |
|--------------------------------|-----------------------------------|----------------|----------------|------------------------------|------|------|
|                                | Sky                               | Load           | Diff           | Sky                          | Load | Diff |
| DETECTOR A                     | 3.3480648e-005                    | 3.5779994e-005 | 4.6427225e-005 | 7.69                         | 8.27 | 8.00 |
| DETECTOR B                     | 3.5268394e-005                    | 3.7776802e-005 | 4.8800127e-005 | 7.65                         | 8.32 | 7.99 |
| DETECTOR C                     | 2.8043838e-005                    | 2.9178984e-005 | 3.9301802e-005 | 7.08                         | 7.32 | 7.21 |
| DETECTOR D                     | 3.0022738e-005                    | 3.1586202e-005 | 4.2169438e-005 | 8.70                         | 8.92 | 8.82 |
| T sky = 12.8 K<br>T ref = 20 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |      |      |
|                                | Sky                               | Load           | Diff           | Sky                          | Load | Diff |
| DETECTOR A                     | 3.3395226e-005                    | 3.8457177e-005 | 4.5880478e-005 | 7.85                         | 8.87 | 8.32 |
| DETECTOR B                     | 3.5391205e-005                    | 4.1121776e-005 | 4.8622548e-005 | 7.72                         | 8.68 | 8.18 |
| DETECTOR C                     | 2.7868565e-005                    | 3.1711425e-005 | 3.8539880e-005 | 7.26                         | 7.87 | 7.59 |
| DETECTOR D                     | 3.0142478e-005                    | 3.4110919e-005 | 4.1608357e-005 | 8.72                         | 9.59 | 9.16 |

Finally, also this data have been analysed:

12.8 / 9.5 Selected from **7000 – 7600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 15.0 Selected from **18000 – 18600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

12.8 / 20.0 Selected from **28000 – 28600** sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_ST3\_200604071940

| T sky = 12.8 K<br>T ref = 9.5 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |      |      |
|---------------------------------|-----------------------------------|----------------|----------------|------------------------------|------|------|
|                                 | Sky                               | Load           | Diff           | Sky                          | Load | Diff |
| DETECTOR A                      | 3.3526986e-005                    | 3.2181533e-005 | 4.6792230e-005 | 7.55                         | 8.01 | 7.75 |
| DETECTOR B                      | 3.5412713e-005                    | 3.4546965e-005 | 4.9493533e-005 | 7.47                         | 7.79 | 7.65 |
| DETECTOR C                      | 2.7870115e-005                    | 2.5301355e-005 | 3.9074936e-005 | 7.08                         | 7.19 | 7.20 |



|            |                |                |                |      |      |      |
|------------|----------------|----------------|----------------|------|------|------|
| DETECTOR D | 2.9968213e-005 | 2.7630755e-005 | 4.2177082e-005 | 8.62 | 8.78 | 8.71 |
|------------|----------------|----------------|----------------|------|------|------|

| T sky = 12.8 K<br>T ref = 15 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |      |      |
|--------------------------------|-----------------------------------|----------------|----------------|------------------------------|------|------|
|                                | Sky                               | Load           | Diff           | Sky                          | Load | Diff |
| DETECTOR A                     | 3.3583706e-005                    | 3.5769961e-005 | 4.6507810e-005 | 7.65                         | 8.29 | 7.98 |
| DETECTOR B                     | 3.5224597e-005                    | 3.7896268e-005 | 4.8769514e-005 | 7.68                         | 8.27 | 8.01 |
| DETECTOR C                     | 2.8046126e-005                    | 2.9126792e-005 | 3.9319864e-005 | 7.09                         | 7.35 | 7.21 |
| DETECTOR D                     | 3.0118637e-005                    | 3.1550318e-005 | 4.2277287e-005 | 8.65                         | 8.95 | 8.78 |

| T sky = 12.8 K<br>T ref = 20 K | White noise level<br>[V/Sqrt(Hz)] |                |                | Effective bandwidth<br>[GHz] |      |      |
|--------------------------------|-----------------------------------|----------------|----------------|------------------------------|------|------|
|                                | Sky                               | Load           | Diff           | Sky                          | Load | Diff |
| DETECTOR A                     | 3.3504507e-005                    | 3.8407273e-005 | 4.5934878e-005 | 7.80                         | 8.90 | 8.30 |
| DETECTOR B                     | 3.5355420e-005                    | 4.1069514e-005 | 4.8445124e-005 | 7.74                         | 8.71 | 8.24 |
| DETECTOR C                     | 2.7863254e-005                    | 3.1719901e-005 | 3.8608725e-005 | 7.26                         | 7.87 | 7.57 |
| DETECTOR D                     | 3.0111617e-005                    | 3.4152561e-005 | 4.1549893e-005 | 8.75                         | 9.57 | 9.19 |

## 6.2 RCA UNC: UNCHOPPED DATA

Noise properties have been derived also from unchopped data, i.e. with all the phase switches off. The following data set has been used:

12.8 / 9.5 Selected from 2075 – 5475 sec, bin 10 for FFT and 1/f from file

030LFI27\_RCA\_FM\_UNC\_200604081247

The corresponding RaNA report is reported in [\[ANNEX\]](#), section RaNA\_FFT\_001.

| T sky = 12.8 K<br>T ref = 9.5 K | Detector A | Detector B | Detector C | Detector D |
|---------------------------------|------------|------------|------------|------------|
| SKY                             |            |            |            |            |
| N points                        | 38         | 43         | 27         | 40         |
| 1/f knee frequency              | 114.866    | 393.502    | 329.784    | 369.068    |
| 1/f Slope                       | -0.631812  | -0.578270  | -0.579105  | -0.578354  |
| REF                             |            |            |            |            |
| N points                        | 38         | 43         | 27         | 43         |
| 1/f knee frequency              | 169.265    | 701.620    | 133.739    | 524.124    |
| 1/f Slope                       | -0.610953  | -0.551522  | -0.627111  | -0.562112  |

The white noise level has been calculated with the *RaNA\_FFT* module using the high frequency part of the amplitude spectrum. From the white noise limit the equivalent bandwidth has been derived. Same data stream as the 1/f calculation has been used. Data were not binned and 10 minutes have been taken for each reference temperature step. For each step the last 600 seconds of the data taken for 1/f noise have been taken for this analysis.

The corresponding RaNA report is reported is attached, section RaNA\_FFT\_002.

| T sky = 12.8 K<br>T ref = 9.5 K | White noise level<br>[V/Sqrt(Hz)] |      |      | Effective bandwidth<br>[GHz] |      |      |
|---------------------------------|-----------------------------------|------|------|------------------------------|------|------|
|                                 | Sky                               | Load | Diff | Sky                          | Load | Diff |



|            |                |                |                |      |      |      |
|------------|----------------|----------------|----------------|------|------|------|
| DETECTOR A | 3.2320391e-005 | 3.2170511e-005 | 4.5637558e-005 | 8.19 | 8.27 | 8.22 |
| DETECTOR B | 3.5644954e-005 | 3.5802131e-005 | 5.0504697e-005 | 7.68 | 7.61 | 7.65 |
| DETECTOR C | 2.8233743e-005 | 2.8231127e-005 | 3.9929094e-005 | 7.12 | 7.12 | 7.12 |
| DETECTOR D | 2.7995929e-005 | 2.8032187e-005 | 3.9640900e-005 | 8.75 | 8.73 | 8.73 |



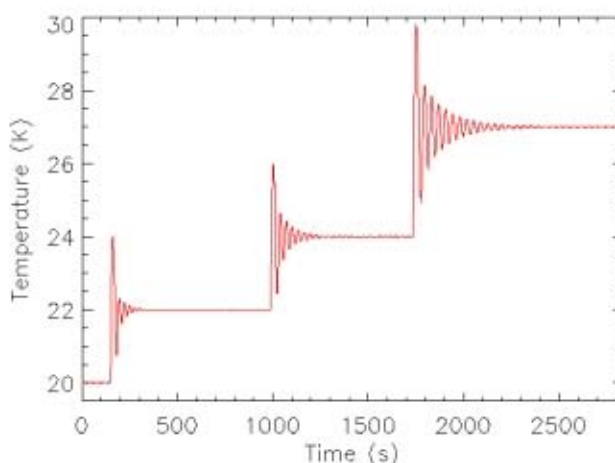
## 7 SUSCEPTIBILITY TESTS

Any thermal and electrical variation on the RCA subsystem units produces an variation of the output signal from each of the four detector.

### 7.1 RCA\_THF: SUSCEPTIBILITY TO FEM TEMPERATURE VARIATIONS

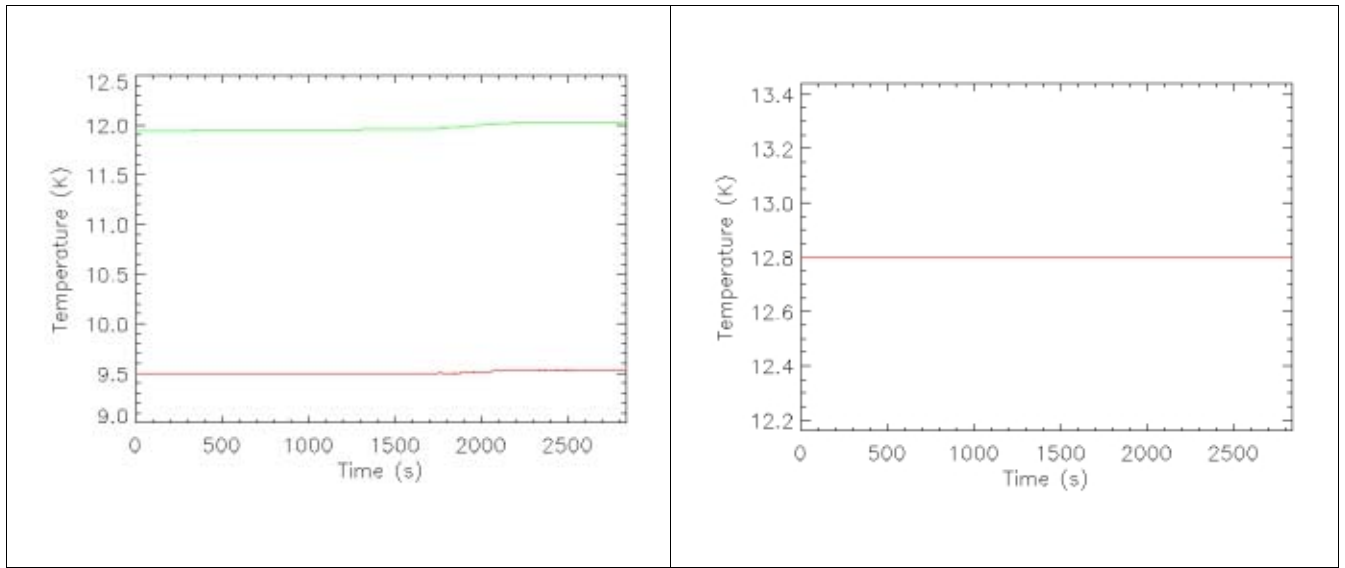
The test has been performed by varying the temperature of the FEM keeping constant the temperatures of the other thermal interfaces.

The temperature of the FEM has been set to 20K (nominal), 22K, 24K, and 27K as seen in Figure -1

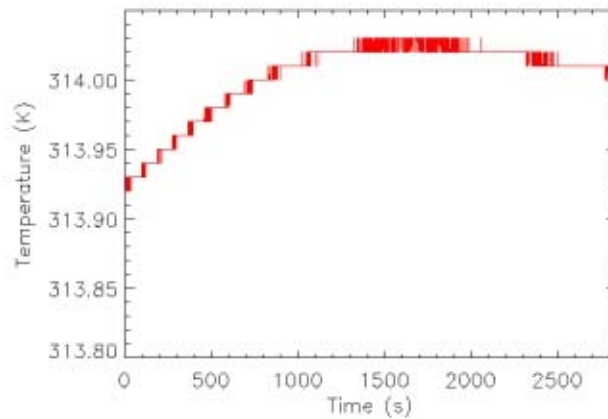


**Figure -10: FEM temperature step during the RCA\_THF test**

The temperature behaviour of the other thermal interfaces are reported in the next figures (Figure -2 and Figure -3) showing the reference load (REF\_TEMP and RMON\_TMP) and sky load temperatures , and the BEM temperature.

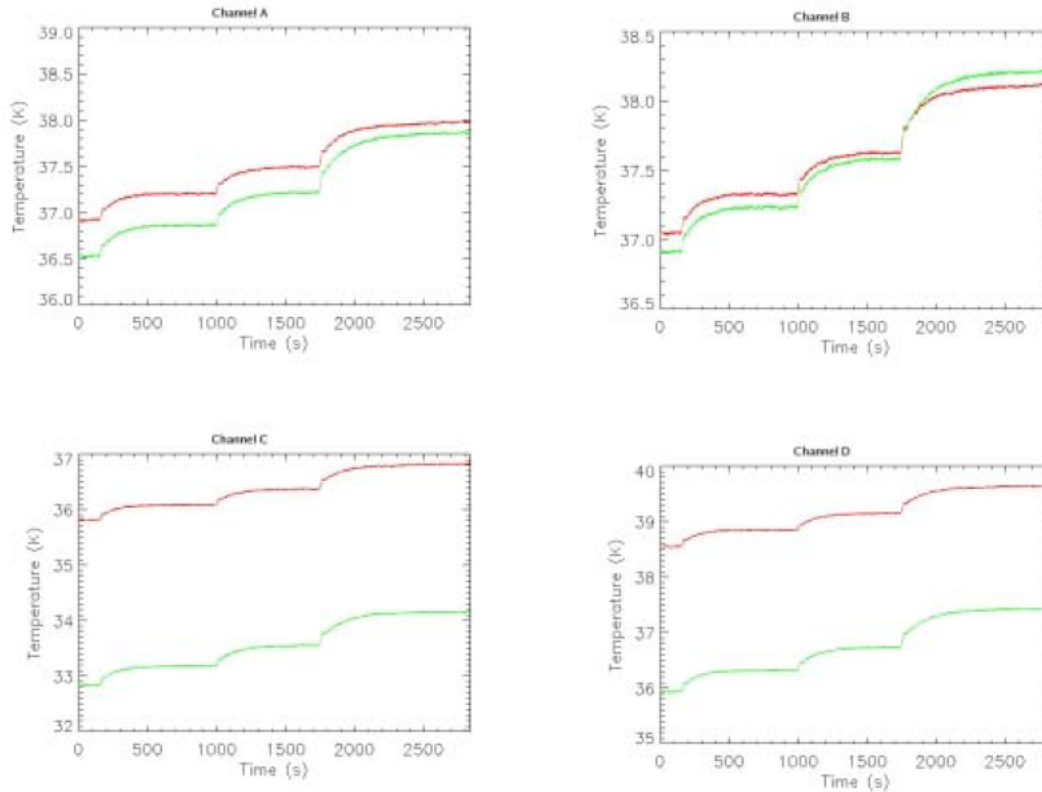


**Figure -11:** Left – Reference Load (REF\_TEMP probe (red) and RMON\_TMP probe (green)) temperature behaviour during the RCA\_THF test; right – Sky Load SKY\_TEMP probe (red)



**Figure -12:** BEM temperature behaviour during the RCA\_THF test

To do the analysis, the radiometric output for each channel in the three steps was recorded. We can see the output of the channels in the figures below:



**Figure -13:** Radiometric output of the 4 detectors during the RCA\_THF test. Sky (red) -Reference (green)

### Analysis using the SKY\_TEMP probe as sky load temperature:

The default parameters for the four channels are:

**Table -2:** Default input parameters for RCA THF analysis

|                                                                          | Ch. A     | Ch. B     | Ch. C     | Ch. D     |
|--------------------------------------------------------------------------|-----------|-----------|-----------|-----------|
| <b>Freq (GHz)</b>                                                        | 30        |           |           |           |
| <b>L<sub>feed-OMT</sub> (dB)</b>                                         | 0.25      |           |           |           |
| <b>L<sub>4k</sub> (dB)</b>                                               | 0.2       |           |           |           |
| <b>r</b>                                                                 | 1.0106878 | 1.0035895 | 1.0907821 | 1.0728292 |
| <b>T<sub>sky</sub> (K)</b>                                               | 12.8      |           |           |           |
| <b>T<sub>ref</sub> (K)</b>                                               | 9.49988   |           |           |           |
| <b>G<sub>F1</sub><sup>dB</sup> (dB)</b>                                  | 35        |           |           |           |
| <b>G<sub>F2</sub><sup>dB</sup> (dB)</b>                                  | 35        |           |           |           |
| <b>T<sub>nF1</sub> (K)</b>                                               | 20        | 20        | 20        | 20        |
| <b>T<sub>nF2</sub> (K)</b>                                               | 20        | 20        | 20        | 20        |
| <b><math>\partial G_{F1}^{dB} / \partial T_{phys}^{FE}</math> (dB/K)</b> | -0.05     | -0.05     | -0.05     | -0.05     |



|                                                        |        |        |         |         |
|--------------------------------------------------------|--------|--------|---------|---------|
| $\partial G_{F2}^{dB} / \partial T_{phys}^{FE} (dB/K)$ | -0.05  | -0.05  | -0.05   | -0.05   |
| $\partial T_{nF1} / \partial T_{phys}^{FE} (K/K)$      | 0.08   | 0.08   | 0.08    | 0.08    |
| $\partial T_{nF2} / \partial T_{phys}^{FE} (K/K)$      | 0.08   | 0.08   | 0.08    | 0.08    |
| Gain Calibration Factor (V/K)                          | 0.0399 | 0.0418 | 0.03299 | 0.03651 |

Calculating the theoretical and the measured transfer functions with RaNA, we obtain:

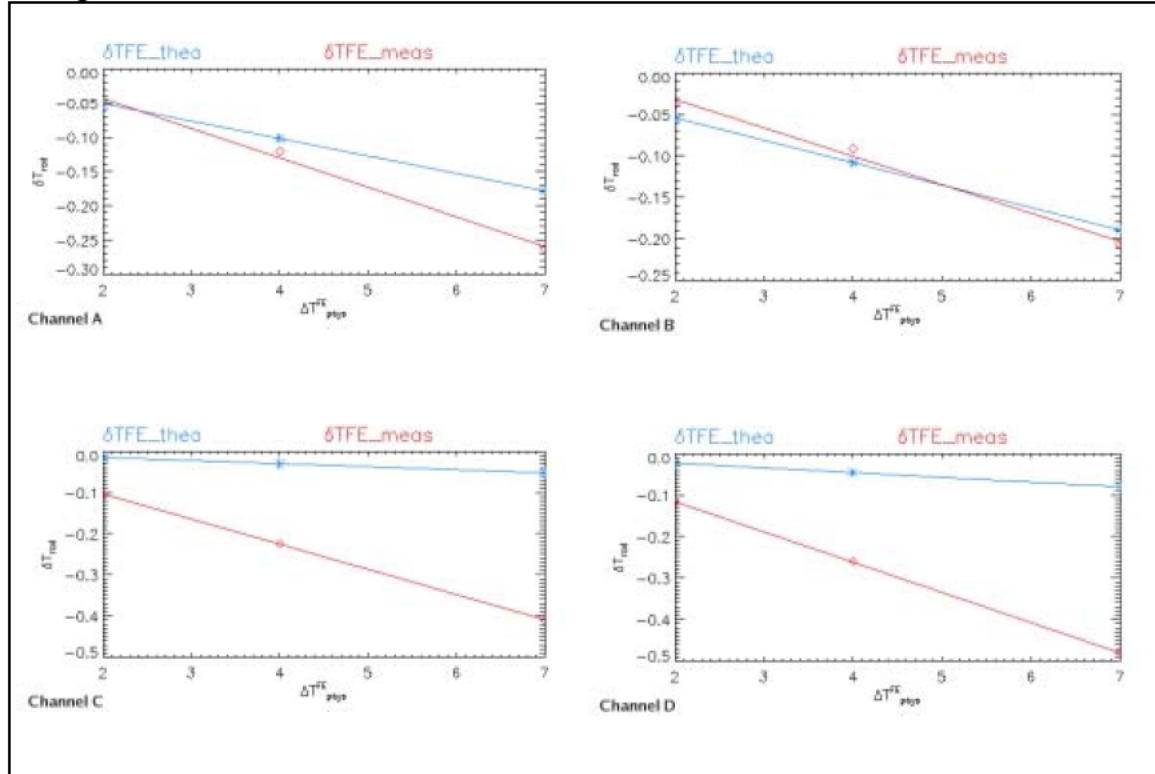


Figure -14: RCA\_THF theoretical (blue) Vs measured (red) transfer function

Table -3: RCA\_THF Analysis Result based on default parameters

|                                           | Channel A | Channel B | Channel C | Channel D |
|-------------------------------------------|-----------|-----------|-----------|-----------|
| $f_{front-end}^{therm} (K/K)$ theoretical | -0.025451 | -0.027047 | -0.007434 | -0.011473 |
| $f_{front-end}^{therm} (K/K)$ measured    | -0.043035 | -0.034227 | -0.061077 | -0.072906 |

The complete RaNA output:

|                                                                                                                                                                                               |                                                                                                                                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FEM susceptibility<br>INPUT<br>Frequency (GHz) = 30<br>Receiver: LFI<br>Channel : A<br>Load correct : Yes<br>r = 1.0106864<br>Model: FM<br>Gain calibration factor (V/K) = value of RaNA_View | FEM susceptibility<br>INPUT<br>Frequency (GHz) = 30<br>Receiver: LFI<br>Channel : B<br>Load correct : Yes<br>r = 1.0035884<br>Model: FM<br>Gain calibration factor (V/K) = value of RaNA_View |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LfeedOMT_dB = 0.250000<br>L4K_dB = 0.200000<br>GF1_dB = 35<br>GF2_dB = 35<br>TnF1_K = 20<br>TnF2_K = 20<br>dGF1_dB_dTFEphys_K = -0.0500000<br>dGF2_dB_dTFEphys_K = -0.0500000<br>dTn1_dTFEphys_K = 0.0800000<br>dTn2_dTFEphys_K = 0.0800000<br><br>There are 4 time windows<br>tmin tmax<br>8.00 128.00<br>419.00 977.00<br>1369.00 1725.00<br>2644.00 2836.00<br><br>Sky Sensor = SKY_TEMP<br>Ref Sensor = REF_TEMP<br>FEM Sensor = FEM_TEMP<br><br>SKY_TEMP REF_TEMP FEM_TEMP<br>12.80001068 9.49986649 20.00002289<br>12.79993534 9.49992180 22.00016212<br>12.80000973 9.49994278 24.00003052<br>12.80002499 9.52705288 27.00001335<br><br>Radiometer outputs (K)<br>Tsky Tref<br>36.921345 36.530961<br>37.201213 36.856692<br>37.489589 37.212887<br>37.974078 37.832494<br><br>Tsky-r*Tref<br>-0.049344155<br>-0.12096870<br>-0.26270762<br><br>OUTPUT<br>fttheo (K/K) fmeas (K/K)<br>-0.025451 -0.043035                                                                                                                                | LfeedOMT_dB = 0.250000<br>L4K_dB = 0.200000<br>GF1_dB = 35<br>GF2_dB = 35<br>TnF1_K = 20<br>TnF2_K = 20<br>dGF1_dB_dTFEphys_K = -0.0500000<br>dGF2_dB_dTFEphys_K = -0.0500000<br>dTn1_dTFEphys_K = 0.0800000<br>dTn2_dTFEphys_K = 0.0800000<br><br>There are 4 time windows<br>tmin tmax<br>8.00 128.00<br>419.00 977.00<br>1369.00 1725.00<br>2644.00 2836.00<br><br>Sky Sensor = SKY_TEMP<br>Ref Sensor = REF_TEMP<br>FEM Sensor = FEM_TEMP<br><br>SKY_TEMP REF_TEMP FEM_TEMP<br>12.80001068 9.49986649 20.00002289<br>12.79993534 9.49992180 22.00016212<br>12.80000973 9.49994278 24.00003052<br>12.80002499 9.52705288 27.00001335<br><br>Radiometer outputs (K)<br>Tsky Tref<br>37.047712 36.915245<br>37.324963 37.229047<br>37.621944 37.578131<br>38.113177 38.183080<br><br>Tsky-r*Tref<br>-0.037678060<br>-0.091032804<br>-0.20691991<br><br>OUTPUT<br>fttheo (K/K) fmeas (K/K)<br>-0.027047 -0.034227                                                                                                                               |
| FEM susceptibility<br>INPUT<br>Frequency (GHz) = 30<br>Receiver: LFI<br>Channel : C<br>Load correct : Yes<br>r = 1.0907850<br>Model: FM<br>Gain calibration factor (V/K) = value of RaNA_View<br>LfeedOMT_dB = 0.250000<br>L4K_dB = 0.200000<br>GF1_dB = 35<br>GF2_dB = 35<br>TnF1_K = 20<br>TnF2_K = 20<br>dGF1_dB_dTFEphys_K = -0.0500000<br>dGF2_dB_dTFEphys_K = -0.0500000<br>dTn1_dTFEphys_K = 0.0800000<br>dTn2_dTFEphys_K = 0.0800000<br><br>There are 4 time windows<br>tmin tmax<br>8.00 128.00<br>419.00 977.00<br>1369.00 1725.00<br>2644.00 2836.00<br><br>Sky Sensor = SKY_TEMP<br>Ref Sensor = REF_TEMP<br>FEM Sensor = FEM_TEMP<br><br>SKY_TEMP REF_TEMP FEM_TEMP<br>12.80001068 9.49986649 20.00002289<br>12.79993534 9.49992180 22.00016212<br>12.80000973 9.49994278 24.00003052<br>12.80002499 9.52705288 27.00001335<br><br>Radiometer outputs (K)<br>Tsky Tref<br>35.817435 32.836384<br>36.082631 33.175413<br>36.366584 33.545250<br>36.821706 34.132627<br><br>Tsky-r*Tref<br>-0.10461108<br>-0.22407079<br>-0.40965067 | FEM susceptibility<br>INPUT<br>Frequency (GHz) = 30<br>Receiver: LFI<br>Channel : D<br>Load correct : Yes<br>r = 1.0728284<br>Model: FM<br>Gain calibration factor (V/K) = value of RaNA_View<br>LfeedOMT_dB = 0.250000<br>L4K_dB = 0.200000<br>GF1_dB = 35<br>GF2_dB = 35<br>TnF1_K = 20<br>TnF2_K = 20<br>dGF1_dB_dTFEphys_K = -0.0500000<br>dGF2_dB_dTFEphys_K = -0.0500000<br>dTn1_dTFEphys_K = 0.0800000<br>dTn2_dTFEphys_K = 0.0800000<br><br>There are 4 time windows<br>tmin tmax<br>8.00 128.00<br>419.00 977.00<br>1369.00 1725.00<br>2644.00 2836.00<br><br>Sky Sensor = SKY_TEMP<br>Ref Sensor = REF_TEMP<br>FEM Sensor = FEM_TEMP<br><br>SKY_TEMP REF_TEMP FEM_TEMP<br>12.80001068 9.49986649 20.00002289<br>12.79993534 9.49992180 22.00016212<br>12.80000973 9.49994278 24.00003052<br>12.80002499 9.52705288 27.00001335<br><br>Radiometer outputs (K)<br>Tsky Tref<br>38.553199 35.936036<br>38.845617 36.318154<br>39.146076 36.730706<br>39.644090 37.401768<br><br>Tsky-r*Tref<br>-0.11752943<br>-0.25966793<br>-0.48158836 |



OUTPUT  
ftheo (K/K) fmeas (K/K)  
-0.007434 -0.061077

OUTPUT  
ftheo (K/K) fmeas (K/K)  
-0.011473 -0.072906

To improve the results obtained with the default parameters, I am going to change any of them. In particular, I change the  $\partial G_{FE}^{dB}/\partial T_{phys}^{FE}$  and  $\partial T_{nFE}/\partial T_{phys}^{FE}$ . The best values will be:

*Table -4: Optimized parameters of RCA\_THF test*

|                                                      | Ch. A  | Ch. B  | Ch. C  | Ch. D |
|------------------------------------------------------|--------|--------|--------|-------|
| $\partial G_{F1}^{dB}/\partial T_{phys}^{FE}$ (dB/K) | -0.075 | -0.059 | -0.028 | -0.1  |
| $\partial G_{F2}^{dB}/\partial T_{phys}^{FE}$ (dB/K) | -0.075 | -0.059 | -0.028 | -0.1  |
| $\partial T_{nF1}/\partial T_{phys}^{FE}$ (K/K)      | 0.06   | 0.08   | 0.67   | 0.7   |
| $\partial T_{nF2}/\partial T_{phys}^{FE}$ (K/K)      | 0.06   | 0.08   | 0.67   | 0.7   |

and calculating the transfer functions, the new results:

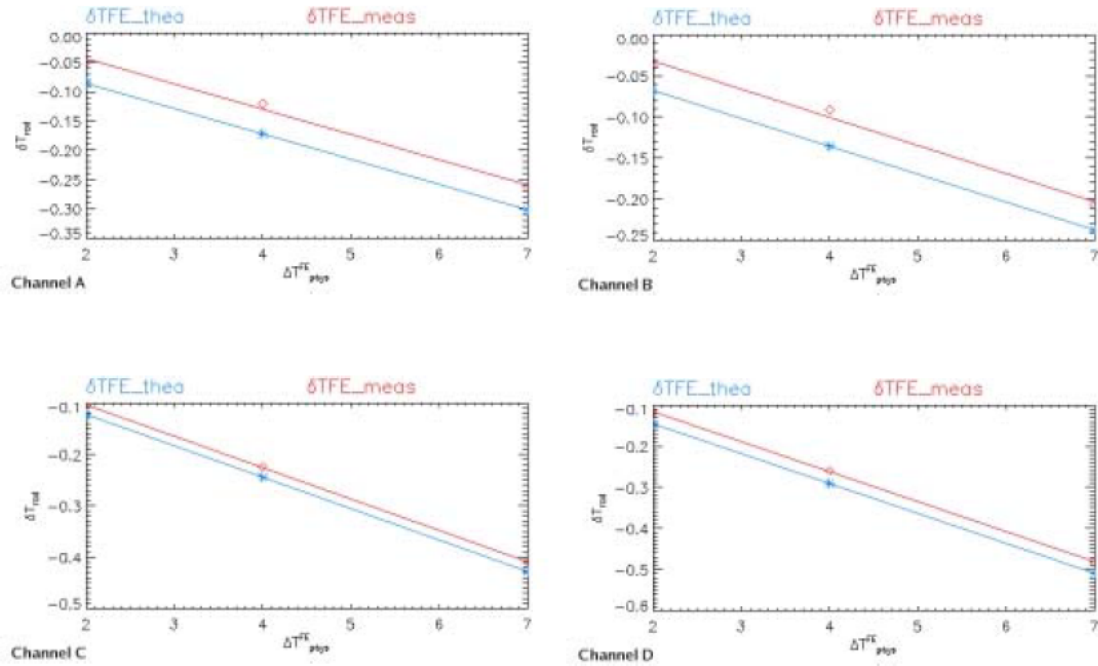


Figure -15: RCA\_THF theoretical Vs measured transfer function after optimisation of the parameters.

Table -5: RCA\_THF Optimal transfer function Vs. theoretical

|                              |                   | Channel A | Channel B | Channel C | Channel D |
|------------------------------|-------------------|-----------|-----------|-----------|-----------|
| $f_{\text{front-end therm}}$ | (K/K) theoretical | -0.043032 | -0.033914 | -0.061095 | -0.072711 |
| $f_{\text{front-end therm}}$ | (K/K) measured    | -0.043035 | -0.034227 | -0.061077 | -0.072906 |

The complete RaNA output:

| <p>FEM susceptibility<br/>INPUT<br/>Frequency (GHz) = 30<br/>Receiver: LFI<br/>Channel : A<br/>Load correct : Yes<br/>r = 1.0106864<br/>Model: FM<br/>Gain calibration factor (V/K) = value of RaNA_View<br/>LfeedOMT_dB = 0.250000<br/>L4K_dB = 0.200000<br/>GF1_dB = 35<br/>GF2_dB = 35<br/>TnF1_K = 20<br/>TnF2_K = 20<br/>dGF1_dB_dTFEphys_K = -0.0750000<br/>dGF2_dB_dTFEphys_K = -0.0750000<br/>dTn1_dTFEphys_K = 0.0600000<br/>dTn2_dTFEphys_K = 0.0600000</p> <p>There are 4 time windows</p> <table> <tr> <th>tmin</th><th>tmax</th></tr> <tr> <td>8.00</td><td>128.00</td></tr> <tr> <td>419.00</td><td>977.00</td></tr> <tr> <td>1369.00</td><td>1725.00</td></tr> <tr> <td>2644.00</td><td>2836.00</td></tr> </table> <p>Sky Sensor = SKY_TEMP</p> | tmin    | tmax | 8.00 | 128.00 | 419.00 | 977.00 | 1369.00 | 1725.00 | 2644.00 | 2836.00 | <p>FEM susceptibility<br/>INPUT<br/>Frequency (GHz) = 30<br/>Receiver: LFI<br/>Channel : B<br/>Load correct : Yes<br/>r = 1.0035884<br/>Model: FM<br/>Gain calibration factor (V/K) = value of RaNA_View<br/>LfeedOMT_dB = 0.250000<br/>L4K_dB = 0.200000<br/>GF1_dB = 35<br/>GF2_dB = 35<br/>TnF1_K = 20<br/>TnF2_K = 20<br/>dGF1_dB_dTFEphys_K = -0.0590000<br/>dGF2_dB_dTFEphys_K = -0.0590000<br/>dTn1_dTFEphys_K = 0.0800000<br/>dTn2_dTFEphys_K = 0.0800000</p> <p>There are 4 time windows</p> <table> <tr> <th>tmin</th><th>tmax</th></tr> <tr> <td>8.00</td><td>128.00</td></tr> <tr> <td>419.00</td><td>977.00</td></tr> <tr> <td>1369.00</td><td>1725.00</td></tr> <tr> <td>2644.00</td><td>2836.00</td></tr> </table> <p>Sky Sensor = SKY_TEMP</p> | tmin | tmax | 8.00 | 128.00 | 419.00 | 977.00 | 1369.00 | 1725.00 | 2644.00 | 2836.00 |
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| tmin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | tmax    |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| 8.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 128.00  |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| 419.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 977.00  |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| 1369.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1725.00 |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| 2644.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2836.00 |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| tmin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | tmax    |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| 8.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 128.00  |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| 419.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 977.00  |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| 1369.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1725.00 |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |
| 2644.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2836.00 |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |        |        |        |         |         |         |         |



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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------|----------|-------------|------------|-------------|-------------|------------|-------------|-------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|------------|-------------|-------------|------------|-------------|-------------|------------|-------------|-------------|--------------|-------------|-------------|-------------|-------------|-----------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-------------|------------|-------------|--------|---------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|------------|-------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|------------|-------------|------|------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-----------|-----------|
| Ref Sensor = REF_TEMP<br>FEM Sensor = FEM_TEMP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Ref Sensor = REF_TEMP<br>FEM Sensor = FEM_TEMP |             |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |    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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| <table><tr><td>SKY_TEMP</td><td>REF_TEMP</td><td>FEM_TEMP</td></tr><tr><td>12.80001068</td><td>9.49986649</td><td>20.00002289</td></tr><tr><td>12.79993534</td><td>9.49992180</td><td>22.00016212</td></tr><tr><td>12.80000973</td><td>9.49994278</td><td>24.00003052</td></tr><tr><td>12.80002499</td><td>9.52705288</td><td>27.00001335</td></tr></table><br>Radiometer outputs (K)<br><table><tr><td>Tsky</td><td>Tref</td></tr><tr><td>36.921345</td><td>36.530961</td></tr><tr><td>37.201213</td><td>36.856692</td></tr><tr><td>37.489589</td><td>37.212887</td></tr><tr><td>37.974078</td><td>37.832494</td></tr></table><br><table><tr><td>Tsky-r*Tref</td></tr><tr><td>-0.049344155</td></tr><tr><td>-0.12096870</td></tr><tr><td>-0.26270762</td></tr></table><br>OUTPUT<br><table><tr><td>ftheo (K/K)</td><td>fmeas (K/K)</td></tr><tr><td>-0.043032</td><td>-0.043035</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | SKY_TEMP                                       | REF_TEMP    | FEM_TEMP | 12.80001068 | 9.49986649 | 20.00002289 | 12.79993534 | 9.49992180 | 22.00016212 | 12.80000973 | 9.49994278 | 24.00003052 | 12.80002499 | 9.52705288  | 27.00001335 | Tsky        | Tref        | 36.921345  | 36.530961   | 37.201213   | 36.856692  | 37.489589   | 37.212887   | 37.974078  | 37.832494   | Tsky-r*Tref | -0.049344155 | -0.12096870 | -0.26270762 | ftheo (K/K) | fmeas (K/K) | -0.043032 | -0.043035 | <table><tr><td>SKY_TEMP</td><td>REF_TEMP</td><td>FEM_TEMP</td></tr><tr><td>12.80001068</td><td>9.49986649</td><td>20.00002289</td></tr><tr><td>12.79993534</td><td>9.49992180</td><td>22.00016212</td></tr><tr><td>12.80000973</td><td>9.49994278</td><td>24.00003052</td></tr><tr><td>12.80002499</td><td>9.52705288</td><td>27.00001335</td></tr></table><br>Radiometer outputs (K)<br><table><tr><td>Tsky</td><td>Tref</td></tr><tr><td>37.047712</td><td>36.915245</td></tr><tr><td>37.324963</td><td>37.229047</td></tr><tr><td>37.621944</td><td>37.578131</td></tr><tr><td>38.113177</td><td>38.183080</td></tr></table><br><table><tr><td>Tsky-r*Tref</td></tr><tr><td>-0.037678060</td></tr><tr><td>-0.091032804</td></tr><tr><td>-0.20691991</td></tr></table><br>OUTPUT<br><table><tr><td>ftheo (K/K)</td><td>fmeas (K/K)</td></tr><tr><td>-0.033914</td><td>-0.034227</td></tr></table> | SKY_TEMP  | REF_TEMP    | FEM_TEMP    | 12.80001068 | 9.49986649  | 20.00002289 | 12.79993534 | 9.49992180 | 22.00016212 | 12.80000973                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 9.49994278 | 24.00003052 | 12.80002499 | 9.52705288 | 27.00001335 | Tsky   | Tref    | 37.047712 | 36.915245 | 37.324963 | 37.229047 | 37.621944 | 37.578131 | 38.113177   | 38.183080  | Tsky-r*Tref | -0.037678060 | -0.091032804 | -0.20691991 | ftheo (K/K) | fmeas (K/K) | -0.033914   | -0.034227   |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| SKY_TEMP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | REF_TEMP                                       | FEM_TEMP    |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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| 12.80001068                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9.49986649                                     | 20.00002289 |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 12.79993534                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9.49992180                                     | 22.00016212 |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 12.80000973                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9.49994278                                     | 24.00003052 |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 12.80002499                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9.52705288                                     | 27.00001335 |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| Tsky                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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         |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 36.921345                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 37.201213                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 37.489589                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 37.974078                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| Tsky-r*Tref                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.049344155                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.12096870                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.26270762                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| ftheo (K/K)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| -0.043032                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| SKY_TEMP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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| 12.80001068                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 12.79993534                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| 12.80000973                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| 12.80002499                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| Tsky                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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| 37.047712                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 37.324963                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 37.621944                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 38.113177                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| Tsky-r*Tref                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| -0.037678060                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| -0.091032804                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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| -0.20691991                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| ftheo (K/K)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.033914                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| FEM susceptibility<br>INPUT<br>Frequency (GHz) = 30<br>Receiver: LFI<br>Channel : C<br>Load correct : Yes<br>r = 1.0907850<br>Model: FM<br>Gain calibration factor (V/K) = value of RaNA_View<br>LfeedOMT_dB = 0.250000<br>L4K_dB = 0.200000<br>GF1_dB = 35<br>GF2_dB = 35<br>TnF1_K = 20<br>TnF2_K = 20<br>dGF1_dB_dTFEphys_K = -0.0280000<br>dGF2_dB_dTFEphys_K = -0.0280000<br>dTn1_dTFEphys_K = 0.670000<br>dTn2_dTFEphys_K = 0.670000<br><br>There are 4 time windows<br><table><tr><td>tmin</td><td>tmax</td></tr><tr><td>8.00</td><td>128.00</td></tr><tr><td>419.00</td><td>977.00</td></tr><tr><td>1369.00</td><td>1725.00</td></tr><tr><td>2644.00</td><td>2836.00</td></tr></table><br>Sky Sensor = SKY_TEMP<br>Ref Sensor = REF_TEMP<br>FEM Sensor = FEM_TEMP<br><br><table><tr><td>SKY_TEMP</td><td>REF_TEMP</td><td>FEM_TEMP</td></tr><tr><td>12.80001068</td><td>9.49986649</td><td>20.00002289</td></tr><tr><td>12.79993534</td><td>9.49992180</td><td>22.00016212</td></tr><tr><td>12.80000973</td><td>9.49994278</td><td>24.00003052</td></tr><tr><td>12.80002499</td><td>9.52705288</td><td>27.00001335</td></tr></table><br>Radiometer outputs (K)<br><table><tr><td>Tsky</td><td>Tref</td></tr><tr><td>35.817435</td><td>32.836384</td></tr><tr><td>36.082631</td><td>33.175413</td></tr><tr><td>36.366584</td><td>33.545250</td></tr><tr><td>36.821706</td><td>34.132627</td></tr></table><br><table><tr><td>Tsky-r*Tref</td></tr><tr><td>-0.10461108</td></tr><tr><td>-0.22407079</td></tr><tr><td>-0.40965067</td></tr></table><br>OUTPUT<br><table><tr><td>ftheo (K/K)</td><td>fmeas (K/K)</td></tr><tr><td>-0.061095</td><td>-0.061077</td></tr></table> | tmin                                           | tmax        | 8.00     | 128.00      | 419.00     | 977.00      | 1369.00     | 1725.00    | 2644.00     | 2836.00     | SKY_TEMP   | REF_TEMP    | FEM_TEMP    | 12.80001068 | 9.49986649  | 20.00002289 | 12.79993534 | 9.49992180 | 22.00016212 | 12.80000973 | 9.49994278 | 24.00003052 | 12.80002499 | 9.52705288 | 27.00001335 | Tsky        | Tref         | 35.817435   | 32.836384   | 36.082631   | 33.175413   | 36.366584 | 33.545250 | 36.821706                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 34.132627 | Tsky-r*Tref | -0.10461108 | -0.22407079 | -0.40965067 | ftheo (K/K) | fmeas (K/K) | -0.061095  | -0.061077   | FEM susceptibility<br>INPUT<br>Frequency (GHz) = 30<br>Receiver: LFI<br>Channel : D<br>Load correct : Yes<br>r = 1.0728284<br>Model: FM<br>Gain calibration factor (V/K) = value of RaNA_View<br>LfeedOMT_dB = 0.250000<br>L4K_dB = 0.200000<br>GF1_dB = 35<br>GF2_dB = 35<br>TnF1_K = 20<br>TnF2_K = 20<br>dGF1_dB_dTFEphys_K = -0.100000<br>dGF2_dB_dTFEphys_K = -0.100000<br>dTn1_dTFEphys_K = 0.700000<br>dTn2_dTFEphys_K = 0.700000<br><br>There are 4 time windows<br><table><tr><td>tmin</td><td>tmax</td></tr><tr><td>8.00</td><td>128.00</td></tr><tr><td>419.00</td><td>977.00</td></tr><tr><td>1369.00</td><td>1725.00</td></tr><tr><td>2644.00</td><td>2836.00</td></tr></table><br>Sky Sensor = SKY_TEMP<br>Ref Sensor = REF_TEMP<br>FEM Sensor = FEM_TEMP<br><br><table><tr><td>SKY_TEMP</td><td>REF_TEMP</td><td>FEM_TEMP</td></tr><tr><td>12.80001068</td><td>9.49986649</td><td>20.00002289</td></tr><tr><td>12.79993534</td><td>9.49992180</td><td>22.00016212</td></tr><tr><td>12.80000973</td><td>9.49994278</td><td>24.00003052</td></tr><tr><td>12.80002499</td><td>9.52705288</td><td>27.00001335</td></tr></table><br>Radiometer outputs (K)<br><table><tr><td>Tsky</td><td>Tref</td></tr><tr><td>38.553199</td><td>35.936036</td></tr><tr><td>38.845617</td><td>36.318154</td></tr><tr><td>39.146076</td><td>36.730706</td></tr><tr><td>39.644090</td><td>37.401768</td></tr></table><br><table><tr><td>Tsky-r*Tref</td></tr><tr><td>-0.11752943</td></tr><tr><td>-0.25966793</td></tr><tr><td>-0.48158836</td></tr></table><br>OUTPUT<br><table><tr><td>ftheo (K/K)</td><td>fmeas (K/K)</td></tr><tr><td>-0.072711</td><td>-0.072906</td></tr></table> | tmin       | tmax        | 8.00        | 128.00     | 419.00      | 977.00 | 1369.00 | 1725.00   | 2644.00   | 2836.00   | SKY_TEMP  | REF_TEMP  | FEM_TEMP  | 12.80001068 | 9.49986649 | 20.00002289 | 12.79993534  | 9.49992180   | 22.00016212 | 12.80000973 | 9.49994278  | 24.00003052 | 12.80002499 | 9.52705288 | 27.00001335 | Tsky | Tref | 38.553199 | 35.936036 | 38.845617 | 36.318154 | 39.146076 | 36.730706 | 39.644090 | 37.401768 | Tsky-r*Tref | -0.11752943 | -0.25966793 | -0.48158836 | ftheo (K/K) | fmeas (K/K) | -0.072711 | -0.072906 |
| tmin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
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| 419.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| 1369.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 2644.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| SKY_TEMP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | REF_TEMP                                       | FEM_TEMP    |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 12.80001068                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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         |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 12.79993534                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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         |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 12.80000973                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9.49994278                                     | 24.00003052 |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 12.80002499                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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         |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| Tsky                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 35.817435                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 36.082631                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 36.366584                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| 36.821706                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| Tsky-r*Tref                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.10461108                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.22407079                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| -0.40965067                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| -0.061095                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 8.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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| 419.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| 1369.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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| 2644.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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| 12.80001068                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| 12.79993534                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| 12.80000973                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| 12.80002499                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| 38.553199                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 38.845617                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 39.146076                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| 39.644090                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| Tsky-r*Tref                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| -0.11752943                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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|             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.25966793                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                |             |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             |             |             |             |             |             |            |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |             |            |             |        |         |           |           |           |           |           |           |             |            |             |              |              |             |             |             |             |             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.48158836                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                |             |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             |             |             |             |             |             |            |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |             |            |             |        |         |           |           |           |           |           |           |             |            |             |              |              |             |             |             |             |             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| ftheo (K/K)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | fmeas (K/K)                                    |             |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             |             |             |             |             |             |            |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |             |            |             |        |         |           |           |           |           |           |           |             |            |             |              |              |             |             |             |             |             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |
| -0.072711                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | -0.072906                                      |             |          |             |            |             |             |            |             |             |            |             |             |             |             |             |             |            |             |             |            |             |             |            |             |             |              |             |             |             |             |           |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             |             |             |             |             |             |            |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |             |            |             |        |         |           |           |           |           |           |           |             |            |             |              |              |             |             |             |             |             |            |             |      |      |           |           |           |           |           |           |           |           |             |             |             |             |             |             |           |           |

**Analysis using the RMON\_TMP probe as reference load temperature:**

The default parameters for the four channels are:

*Table -6: Default input parameters for RCA\_THF analysis*



|                                                        | Ch. A     | Ch. B     | Ch. C     | Ch. D     |
|--------------------------------------------------------|-----------|-----------|-----------|-----------|
| Freq (GHz)                                             | 30        |           |           |           |
| L <sub>feed-OMT</sub> (dB)                             | 0.25      |           |           |           |
| L <sub>4k</sub> (dB)                                   | 0.2       |           |           |           |
| r                                                      | 1.0106878 | 1.0035895 | 1.0907821 | 1.0728292 |
| T <sub>sky</sub> (K)                                   | 12.8      |           |           |           |
| T <sub>ref</sub> (K)                                   | 11.944    |           |           |           |
| G <sub>F1</sub> <sup>dB</sup> (dB)                     | 35        |           |           |           |
| G <sub>F2</sub> <sup>dB</sup> (dB)                     | 35        |           |           |           |
| T <sub>nF1</sub> (K)                                   | 20        | 20        | 20        | 20        |
| T <sub>nF2</sub> (K)                                   | 20        | 20        | 20        | 20        |
| $\partial G_{F1}^{dB} / \partial T_{phys}^{FE}$ (dB/K) | -0.05     | -0.05     | -0.05     | -0.05     |
| $\partial G_{F2}^{dB} / \partial T_{phys}^{FE}$ (dB/K) | -0.05     | -0.05     | -0.05     | -0.05     |
| $\partial T_{nF1} / \partial T_{phys}^{FE}$ (K/K)      | 0.08      | 0.08      | 0.08      | 0.08      |
| $\partial T_{nF2} / \partial T_{phys}^{FE}$ (K/K)      | 0.08      | 0.08      | 0.08      | 0.08      |
| Gain Calibration Factor (V/K)                          | 0.0399    | 0.0418    | 0.03299   | 0.03651   |

Table -7: RCA\_THF Analysis Result based on default parameters

|                                                | Channel A | Channel B | Channel C | Channel D |
|------------------------------------------------|-----------|-----------|-----------|-----------|
| f <sub>front-end therm</sub> (K/K) theoretical | 0.003272  | 0.001474  | 0.023565  | 0.019016  |
| f <sub>front-end therm</sub> (K/K) measured    | -0.0326   | -0.023865 | -0.049815 | -0.061829 |

The complete RaNA output:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |         |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------|------|--------|--------|--------|---------|---------|---------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|--------|--------|--------|---------|---------|---------|---------|
| <p>FEM susceptibility<br/>INPUT<br/>Frequency (GHz) = 30<br/>Receiver: LFI<br/>Channel : A<br/>Load correct : Yes<br/>r = 1.0106864<br/>Model: FM<br/>Gain calibration factor (V/K) = value of RaNA_View<br/>LfeedOMT_dB = 0.250000<br/>L4K_dB = 0.200000<br/>GF1_dB = 35<br/>GF2_dB = 35<br/>TnF1_K = 20<br/>TnF2_K = 20<br/>dGF1_dB_dT<sub>FEphys</sub>_K = -0.0500000<br/>dGF2_dB_dT<sub>FEphys</sub>_K = -0.0500000<br/>dTn1_dT<sub>FEphys</sub>_K = 0.0800000<br/>dTn2_dT<sub>FEphys</sub>_K = 0.0800000</p> <p>There are 4 time windows</p> <table><tr><td>tmin</td><td>tmax</td></tr><tr><td>8.00</td><td>128.00</td></tr><tr><td>419.00</td><td>977.00</td></tr><tr><td>1369.00</td><td>1725.00</td></tr><tr><td>2644.00</td><td>2836.00</td></tr></table> <p>Sky Sensor = SKY_TEMP<br/>Ref Sensor = RMON_TEMP<br/>FEM Sensor = FEM_TEMP</p> | tmin    | tmax | 8.00 | 128.00 | 419.00 | 977.00 | 1369.00 | 1725.00 | 2644.00 | 2836.00 | <p>FEM susceptibility<br/>INPUT<br/>Frequency (GHz) = 30<br/>Receiver: LFI<br/>Channel : B<br/>Load correct : Yes<br/>r = 1.0035884<br/>Model: FM<br/>Gain calibration factor (V/K) = value of RaNA_View<br/>LfeedOMT_dB = 0.250000<br/>L4K_dB = 0.200000<br/>GF1_dB = 35<br/>GF2_dB = 35<br/>TnF1_K = 20<br/>TnF2_K = 20<br/>dGF1_dB_dT<sub>FEphys</sub>_K = -0.0500000<br/>dGF2_dB_dT<sub>FEphys</sub>_K = -0.0500000<br/>dTn1_dT<sub>FEphys</sub>_K = 0.0800000<br/>dTn2_dT<sub>FEphys</sub>_K = 0.0800000</p> <p>There are 4 time windows</p> <table><tr><td>tmin</td><td>tmax</td></tr><tr><td>8.00</td><td>128.00</td></tr><tr><td>419.00</td><td>977.00</td></tr><tr><td>1369.00</td><td>1725.00</td></tr><tr><td>2644.00</td><td>2836.00</td></tr></table> <p>Sky Sensor = SKY_TEMP<br/>Ref Sensor = RMON_TEMP<br/>FEM Sensor = FEM_TEMP</p> | tmin | tmax | 8.00 | 128.00 | 419.00 | 977.00 | 1369.00 | 1725.00 | 2644.00 | 2836.00 |
| tmin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | tmax    |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| 8.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 128.00  |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| 419.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 977.00  |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| 1369.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1725.00 |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| 2644.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2836.00 |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| tmin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | tmax    |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| 8.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 128.00  |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| 419.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 977.00  |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| 1369.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1725.00 |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |
| 2644.00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2836.00 |      |      |        |        |        |         |         |         |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |        |        |        |         |         |         |         |



## FM 30 GHZ RCA27 DATA ANALYSIS REPORT

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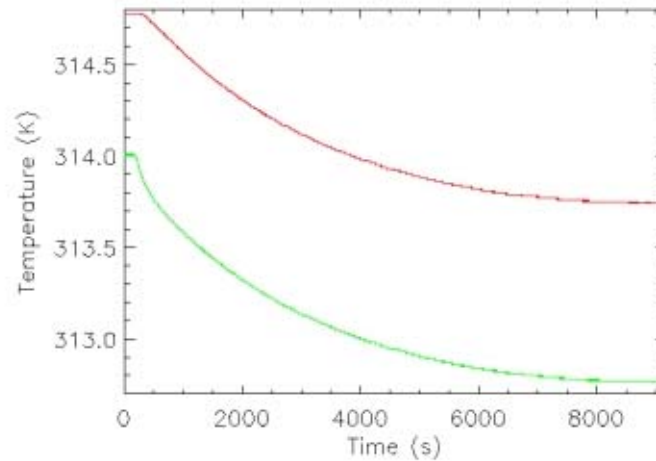
|                             |             |             |                             |             |             |
|-----------------------------|-------------|-------------|-----------------------------|-------------|-------------|
| SKY_TEMP RMON_TEMP FEM_TEMP |             |             | SKY_TEMP RMON_TEMP FEM_TEMP |             |             |
| 12.80001068                 | 11.94380093 | 20.00002289 | 12.80001068                 | 11.94380093 | 20.00002289 |
| 12.79993534                 | 11.94746971 | 22.00016212 | 12.79993534                 | 11.94746971 | 22.00016212 |
| 12.80000973                 | 11.95826912 | 24.00003052 | 12.80000973                 | 11.95826912 | 24.00003052 |
| 12.80002499                 | 12.02499008 | 27.00001335 | 12.80002499                 | 12.02499008 | 27.00001335 |
| Radiometer outputs (K)      |             |             | Radiometer outputs (K)      |             |             |
| Tsky                        | Tref        |             | Tsky                        | Tref        |             |
| 36.921345                   | 36.530961   |             | 37.047712                   | 36.915245   |             |
| 37.201213                   | 36.853079   |             | 37.324963                   | 37.225434   |             |
| 37.489589                   | 37.198495   |             | 37.621944                   | 37.563739   |             |
| 37.974078                   | 37.778491   |             | 38.113177                   | 38.129077   |             |
| Tsky-r*Tref                 |             |             | Tsky-r*Tref                 |             |             |
| -0.045692068                |             |             | -0.034051621                |             |             |
| -0.10642300                 |             |             | -0.076589261                |             |             |
| -0.20812776                 |             |             | -0.15272336                 |             |             |
| OUTPUT                      |             |             | OUTPUT                      |             |             |
| ftheo (K/K)                 | fmeas (K/K) |             | ftheo (K/K)                 | fmeas (K/K) |             |
| 0.003272                    | -0.032600   |             | 0.001474                    | -0.023865   |             |

|                                 |                    |             |                                 |                    |             |
|---------------------------------|--------------------|-------------|---------------------------------|--------------------|-------------|
| FEM susceptibility              |                    |             | FEM susceptibility              |                    |             |
| INPUT                           |                    |             | INPUT                           |                    |             |
| Frequency (GHz) =               | 30                 |             | Frequency (GHz) =               | 30                 |             |
| Receiver: LFI                   |                    |             | Receiver: LFI                   |                    |             |
| Channel : C                     |                    |             | Channel : D                     |                    |             |
| Load correct : Yes              |                    |             | Load correct : Yes              |                    |             |
| r =                             | 1.0907850          |             | r =                             | 1.0728284          |             |
| Model: FM                       |                    |             | Model: FM                       |                    |             |
| Gain calibration factor (V/K) = | value of RaNA_View |             | Gain calibration factor (V/K) = | value of RaNA_View |             |
| LfeedOMT_dB =                   | 0.250000           |             | LfeedOMT_dB =                   | 0.250000           |             |
| L4K_dB =                        | 0.200000           |             | L4K_dB =                        | 0.200000           |             |
| GF1_dB =                        | 35                 |             | GF1_dB =                        | 35                 |             |
| GF2_dB =                        | 35                 |             | GF2_dB =                        | 35                 |             |
| TnF1_K =                        | 20                 |             | TnF1_K =                        | 20                 |             |
| TnF2_K =                        | 20                 |             | TnF2_K =                        | 20                 |             |
| dGF1_dB_dTFEphys_K =            | -0.0500000         |             | dGF1_dB_dTFEphys_K =            | -0.0500000         |             |
| dGF2_dB_dTFEphys_K =            | -0.0500000         |             | dGF2_dB_dTFEphys_K =            | -0.0500000         |             |
| dTn1_dTFEphys_K =               | 0.0800000          |             | dTn1_dTFEphys_K =               | 0.0800000          |             |
| dTn2_dTFEphys_K =               | 0.0800000          |             | dTn2_dTFEphys_K =               | 0.0800000          |             |
| There are 4 time windows        |                    |             | There are 4 time windows        |                    |             |
| tmin                            | tmax               |             | tmin                            | tmax               |             |
| 8.00                            | 128.00             |             | 8.00                            | 128.00             |             |
| 419.00                          | 977.00             |             | 419.00                          | 977.00             |             |
| 1369.00                         | 1725.00            |             | 1369.00                         | 1725.00            |             |
| 2644.00                         | 2836.00            |             | 2644.00                         | 2836.00            |             |
| Sky Sensor = SKY_TEMP           |                    |             | Sky Sensor = SKY_TEMP           |                    |             |
| Ref Sensor = RMON_TEMP          |                    |             | Ref Sensor = RMON_TEMP          |                    |             |
| FEM Sensor = FEM_TEMP           |                    |             | FEM Sensor = FEM_TEMP           |                    |             |
| SKY_TEMP RMON_TEMP FEM_TEMP     |                    |             | SKY_TEMP RMON_TEMP FEM_TEMP     |                    |             |
| 12.80001068                     | 11.94380093        | 20.00002289 | 12.80001068                     | 11.94380093        | 20.00002289 |
| 12.79993534                     | 11.94746971        | 22.00016212 | 12.79993534                     | 11.94746971        | 22.00016212 |
| 12.80000973                     | 11.95826912        | 24.00003052 | 12.80000973                     | 11.95826912        | 24.00003052 |
| 12.80002499                     | 12.02499008        | 27.00001335 | 12.80002499                     | 12.02499008        | 27.00001335 |
| Radiometer outputs (K)          |                    |             | Radiometer outputs (K)          |                    |             |
| Tsky                            | Tref               |             | Tsky                            | Tref               |             |
| 35.817435                       | 32.836384          |             | 38.553199                       | 35.936036          |             |
| 36.082631                       | 33.171800          |             | 38.845617                       | 36.314541          |             |
| 36.366584                       | 33.530858          |             | 39.146076                       | 36.716314          |             |
| 36.821706                       | 34.078624          |             | 39.644090                       | 37.347765          |             |
| Tsky-r*Tref                     |                    |             | Tsky-r*Tref                     |                    |             |
| -0.10066956                     |                    |             | -0.11365280                     |                    |             |
| -0.20837232                     |                    |             | -0.24422789                     |                    |             |
| -0.35074527                     |                    |             | -0.42365266                     |                    |             |
| OUTPUT                          |                    |             | OUTPUT                          |                    |             |
| ftheo (K/K)                     | fmeas (K/K)        |             | ftheo (K/K)                     | fmeas (K/K)        |             |
| 0.023565                        | -0.049815          |             | 0.019016                        | -0.061829          |             |



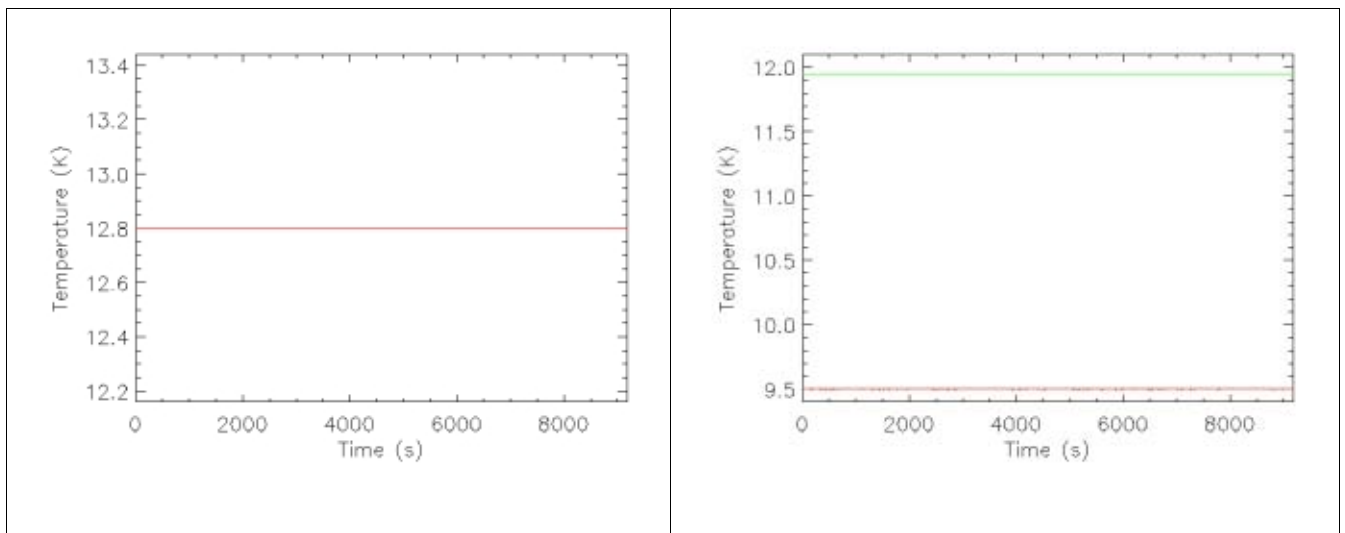
## 7.2 RCA\_THB: SUSCEPTIBILITY TO BEM TEMPERATURE VARIATIONS

The BEM temperature was cooled continuously from a maximum (306K) to a minimum (304K). In the data analysis, small section of data in which the temperature did not change significantly were used assuming quasi-stationary conditions.

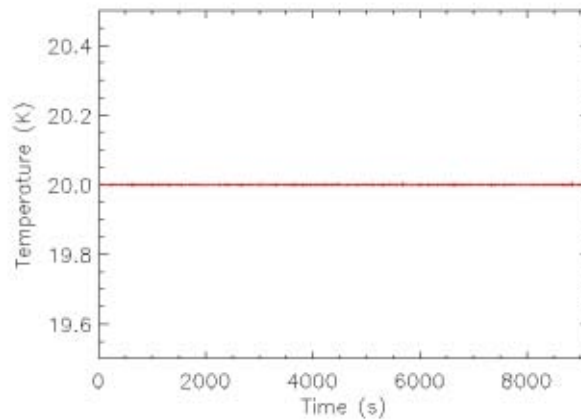


**Figure -16:** BEM temperature during the RCA\_THB test. VG2\_TEMP probe (red) and BEM\_TEMP probe (green)

The temperature behaviour of the other thermal interfaces are reported in the next figures (Figure -2 and Figure -3) showing the sky load and reference load temperatures (REF\_TEMP and RMON\_TMP), and the FEM temperature.



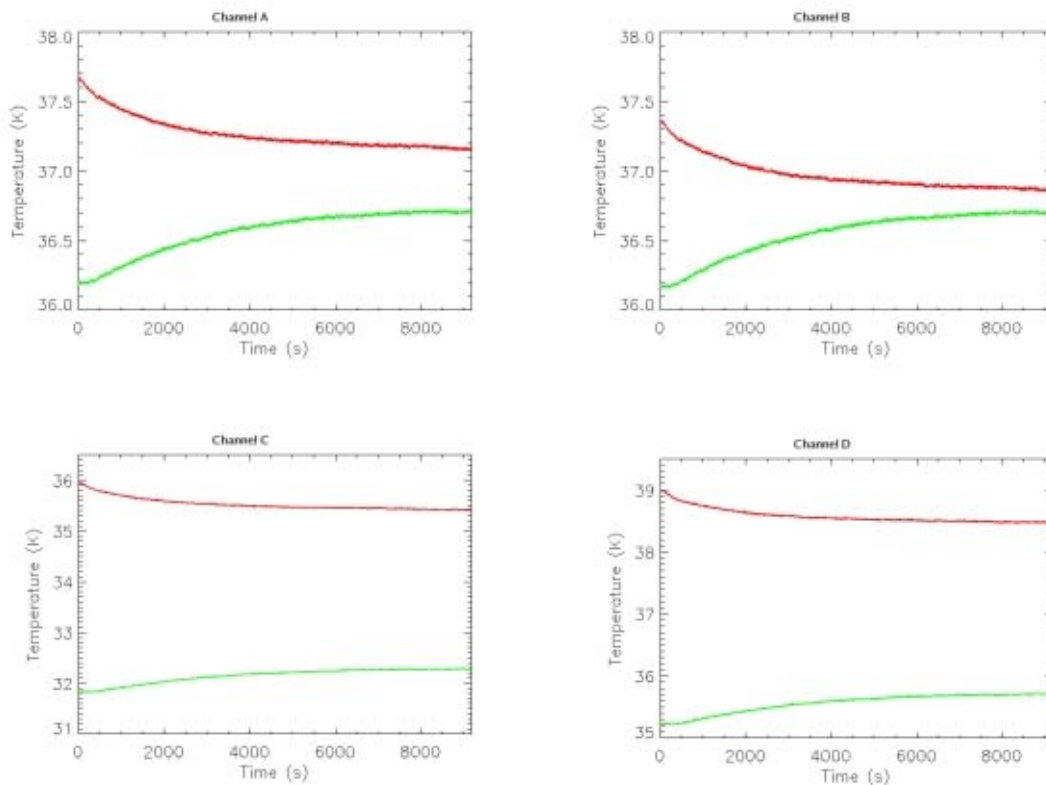
**Figure -17:** Left – Sky Load temperature behaviour during the RCA\_THF test; right – REF\_TEMP probe (red) and RMON\_TMP probe (green)



**Figure -18:** FEM temperature behaviour during the RCA\_THB test

To do the analysis, the radiometric output for each channel in the three steps was recorded. We can see the output of the channels in the figures below:

**Figure -19:** Radiometric output of the 4 detectors during the RCA\_THB test. Sky (red) and Reference (green)





The parameters for the four channels are:

|                                                        | Ch. A     | Ch. B     | Ch. C     | Ch. D     |
|--------------------------------------------------------|-----------|-----------|-----------|-----------|
| Freq(GHz)                                              | 30        |           |           |           |
| L <sub>feed-OMT</sub> (dB)                             | 0.25      |           |           |           |
| L <sub>4k</sub> (dB)                                   | 0.2       |           |           |           |
| r                                                      | 1.0389378 | 1.0312000 | 1.1273369 | 1.1051599 |
| T <sub>FEphys</sub> (K)                                | 20        |           |           |           |
| G <sub>F1</sub> <sup>dB</sup> (dB)                     | 35        |           |           |           |
| G <sub>F2</sub> <sup>dB</sup> (dB)                     | 35        |           |           |           |
| T <sub>nF1</sub> (K)                                   | 20        | 20        | 20        | 20        |
| T <sub>nF2</sub> (K)                                   | 20        | 20        | 20        | 20        |
| $\partial G_{B1}^{dB} / \partial T_{phys}^{BE}$ (dB/K) | -0.034    | -0.04     | -0.03     | -0.027    |
| $\partial G_{B2}^{dB} / \partial T_{phys}^{BE}$ (dB/K) | -0.034    | -0.04     | -0.03     | -0.027    |
| $\partial a^{dB} / \partial T_{phys}^{BE}$ (dB/K)      | -0.01     | -0.01     | -0.01     | -0.01     |
| Gain Calibration Factor (V/K)                          | 0.0399    | 0.0418    | 0.03299   | 0.03651   |

Analysis using the REF\_TEMP probe as Reference load temperature and BEM\_TEMP probe as BEM temperature:

|                      |      |
|----------------------|------|
| T <sub>sky</sub> (K) | 12.8 |
| T <sub>ref</sub> (K) | 9.5  |

Calculating the theoretical and the measured transfer functions with RaNA, we obtain:

|                                        |                   | Channel A | Channel B | Channel C | Channel D |
|----------------------------------------|-------------------|-----------|-----------|-----------|-----------|
| f <sub>therm</sub> <sup>back-end</sup> | (K/K) theoretical | -0.022414 | -0.028246 | 0.004990  | -0.001271 |
| f <sub>therm</sub> <sup>back-end</sup> | (K/K) measured    | 0.789433  | 0.793694  | 0.0784877 | 0.801166  |

The complete RaNA output:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BEM susceptibility<br>INPUT<br>Frequency (GHz) = 30<br>Receiver: LFI<br>Channel : A<br>Load correct : Yes<br>r = 1.0389378<br>Model: FM<br>Gain calibration factor (V/K) = value of RaNA_View<br>L <sub>feedOMT</sub> _dB = 0.250000<br>L <sub>4K</sub> _dB = 0.200000<br>GF1_dB = 35<br>GF2_dB = 35<br>TnF1_K = 20<br>TnF2_K = 20<br>TnB1_K = 350<br>TnB2_K = 350<br>dGB1_dB_dTBEphys_K = -0.0340000<br>dGB2_dB_dTBEphys_K = -0.0340000<br>da_dB_dTBEphys_K = -0.0100000 | BEM susceptibility<br>INPUT<br>Frequency (GHz) = 30<br>Receiver: LFI<br>Channel : B<br>Load correct : Yes<br>r = 1.0312000<br>Model: FM<br>Gain calibration factor (V/K) = value of RaNA_View<br>L <sub>feedOMT</sub> _dB = 0.250000<br>L <sub>4K</sub> _dB = 0.200000<br>GF1_dB = 35<br>GF2_dB = 35<br>TnF1_K = 20<br>TnF2_K = 20<br>TnB1_K = 350<br>TnB2_K = 350<br>dGB1_dB_dTBEphys_K = -0.0400000<br>dGB2_dB_dTBEphys_K = -0.0400000<br>da_dB_dTBEphys_K = -0.0100000<br>There are 2 time windows |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div>There are2 time windows</div> <div><div><div>tmin tmax</div><div>167.00195.00</div><div>8252.009195.00</div></div></div> <div>Sky Sensor = SKY_TEMP<br/>Ref Sensor = REF_TEMP<br/>BEM Sensor = BEM_TEMP<br/>FEM Sensor = FEM_TEMP</div> <div><div><div>SKY_TEMP REF_TEMP BEM_TEMP FEM_TEMP</div><div>12.799997339.49956322314.00000000</div><div>20.0001392412.799882899.49991703312.76986694</div><div>19.99994278</div></div></div> <div>Radiometer outputs (K)</div> <div><div><div>Tsky Tref</div><div>37.60788436.198398</div><div>37.16408236.705941</div></div></div> <div><div>Tsky-r*Tref</div><div>-0.97110770</div></div> <div>OUTPUT</div> <div><div>ftheo (K/K) fmeas (K/K)</div><div>-0.0224140.789433</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <div><div>tmin tmax</div><div>167.00195.00</div><div>8252.009195.00</div></div> <div>Sky Sensor = SKY_TEMP<br/>Ref Sensor = REF_TEMP<br/>BEM Sensor = BEM_TEMP<br/>FEM Sensor = FEM_TEMP</div> <div><div><div>SKY_TEMP REF_TEMP BEM_TEMP FEM_TEMP</div><div>12.799997339.49956322314.00000000</div><div>20.0001392412.799882899.49991703312.76986694</div><div>19.99994278</div></div></div> <div>Radiometer outputs (K)</div> <div><div><div>Tsky Tref</div><div>37.29853036.170025</div><div>36.87024836.701509</div></div></div> <div><div>Tsky-r*Tref</div><div>-0.97634925</div></div> <div>OUTPUT</div> <div><div>ftheo (K/K) fmeas (K/K)</div><div>-0.0282460.793694</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <div>BEM susceptibility</div> <div>INPUT</div> <div>Frequency (GHz) =30</div> <div>Receiver: LFI</div> <div>Channel : C</div> <div>Load correct : Yes</div> <div>r =1.1273369</div> <div>Model: FM</div> <div>Gain calibration factor (V/K) = value of RaNA_View</div> <div>LfeedOMT_dB =0.250000</div> <div>L4K_dB =0.200000</div> <div>GF1_dB =35</div> <div>GF2_dB =35</div> <div>TnF1_K =20</div> <div>TnF2_K =20</div> <div>TnB1_K =350</div> <div>TnB2_K =350</div> <div>dGB1_dB_dTBephys_K =-0.0300000</div> <div>dGB2_dB_dTBephys_K =-0.0300000</div> <div>da_dB_dTBephys_K =-0.0100000</div> <div>There are2 time windows</div> <div><div><div>tmin tmax</div><div>167.00195.00</div><div>8252.009195.00</div></div></div> <div>Sky Sensor = SKY_TEMP<br/>Ref Sensor = REF_TEMP<br/>BEM Sensor = BEM_TEMP<br/>FEM Sensor = FEM_TEMP</div> <div><div><div>SKY_TEMP REF_TEMP BEM_TEMP FEM_TEMP</div><div>12.799997339.49956322314.00000000</div><div>20.0001392412.799882899.49991703312.76986694</div><div>19.99994278</div></div></div> <div>Radiometer outputs (K)</div> <div><div><div>Tsky Tref</div><div>35.88889631.835113</div><div>35.42534932.280371</div></div></div> <div><div>Tsky-r*Tref</div><div>-0.96550279</div></div> <div>OUTPUT</div> <div><div>ftheo (K/K) fmeas (K/K)</div><div>0.0049900.784877</div></div> | <div>BEM susceptibility</div> <div>INPUT</div> <div>Frequency (GHz) =30</div> <div>Receiver: LFI</div> <div>Channel : D</div> <div>Load correct : Yes</div> <div>r =1.1051599</div> <div>Model: FM</div> <div>Gain calibration factor (V/K) = value of RaNA_View</div> <div>LfeedOMT_dB =0.250000</div> <div>L4K_dB =0.200000</div> <div>GF1_dB =35</div> <div>GF2_dB =35</div> <div>TnF1_K =20</div> <div>TnF2_K =20</div> <div>TnB1_K =350</div> <div>TnB2_K =350</div> <div>dGB1_dB_dTBephys_K =-0.0270000</div> <div>dGB2_dB_dTBephys_K =-0.0270000</div> <div>da_dB_dTBephys_K =-0.0100000</div> <div>There are2 time windows</div> <div><div><div>tmin tmax</div><div>167.00195.00</div><div>8252.009195.00</div></div></div> <div>Sky Sensor = SKY_TEMP<br/>Ref Sensor = REF_TEMP<br/>BEM Sensor = BEM_TEMP<br/>FEM Sensor = FEM_TEMP</div> <div><div><div>SKY_TEMP REF_TEMP BEM_TEMP FEM_TEMP</div><div>12.799997339.49956322314.00000000</div><div>20.0001392412.799882899.49991703312.76986694</div><div>19.99994278</div></div></div> <div>Radiometer outputs (K)</div> <div><div><div>Tsky Tref</div><div>38.92729735.223225</div><div>38.47863835.709021</div></div></div> <div><div>Tsky-r*Tref</div><div>-0.98554114</div></div> <div>OUTPUT</div> <div><div>ftheo (K/K) fmeas (K/K)</div><div>-0.0012710.801166</div></div> |

Analysis using the RMON\_TEMP probe as Reference load temperature and BEM\_TEMP probe as BEM temperature:

|                      |        |
|----------------------|--------|
| T <sub>sky</sub> (K) | 12.8   |
| T <sub>ref</sub> (K) | 11.948 |



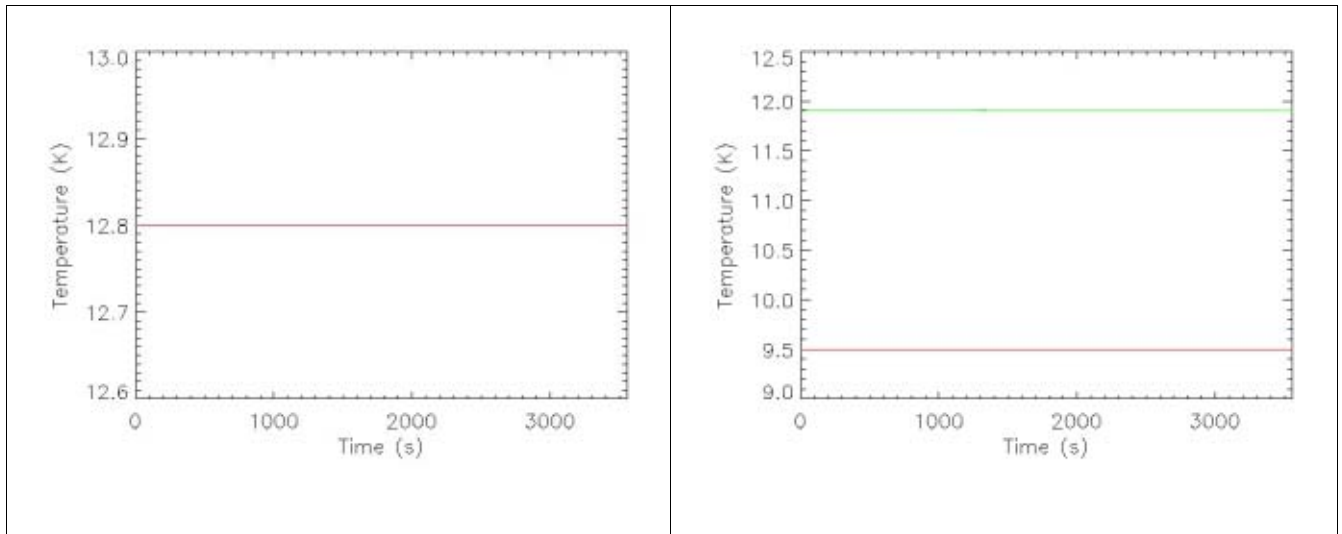
Calculating the theoretical and the measured transfer functions with RaNA, we obtain:

|                             |                   | Channel A | Channel B | Channel C | Channel D |
|-----------------------------|-------------------|-----------|-----------|-----------|-----------|
| $f_{\text{back-end therm}}$ | (K/K) theoretical | 0.003618  | 0.001115  | 0.030668  | 0.022015  |
| $f_{\text{back-end therm}}$ | (K/K) measured    | 0.786148  | 0.790433  | 0.781312  | 0.797671  |

The complete RaNA output:

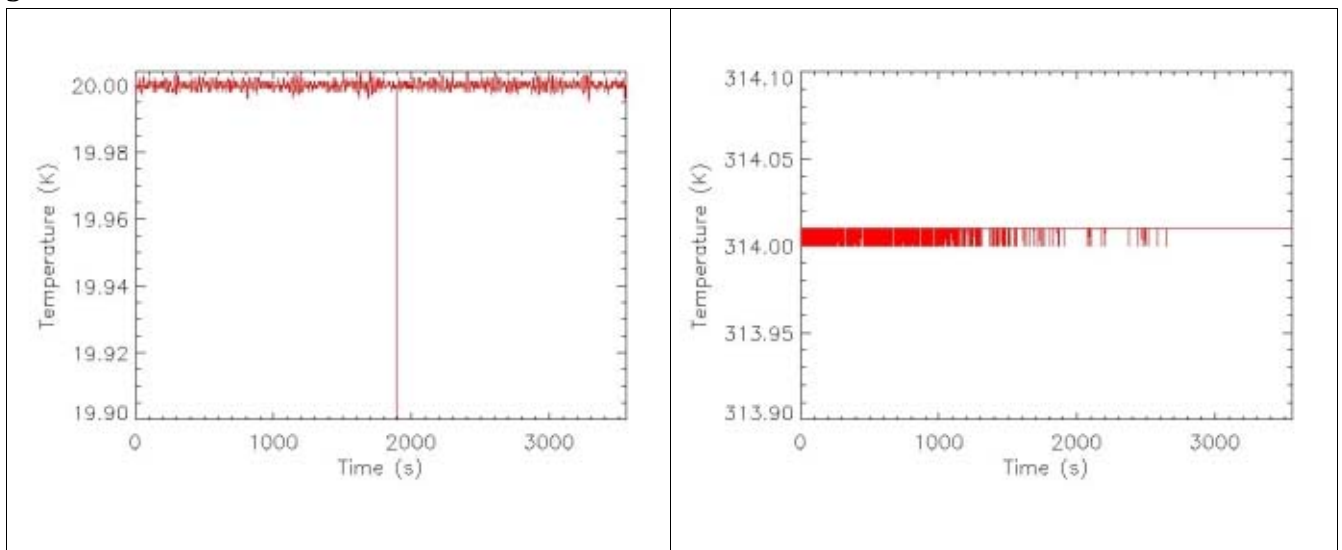
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>BEM susceptibility INPUT Frequency (GHz) =      30 Receiver:  LFI Channel :   A Load correct :   Yes r =      1.0389378 Model:  FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_dB =      0.250000 L4K_dB =      0.200000 GF1_dB =      35 GF2_dB =      35 TnF1_K =      20 TnF2_K =      20 TnB1_K =      350 TnB2_K =      350 dGB1_dB_dTBephys_K = -0.0340000 dGB2_dB_dTBephys_K = -0.0340000 da_dB_dTBephys_K = -0.0100000  There are      2 time windows tmin tmax 167.00      195.00 8252.00     9195.00  Sky Sensor = SKY_TEMP Ref Sensor = RMON_TEMP BEM Sensor = BEM_TEMP FEM Sensor = FEM_TEMP        SKY_TEMP RMON_TEMP BEM_TEMP FEM_TEMP 12.79999733      11.94810200      314.00000000 20.00013924 12.79988289      11.95234585      312.76986694 19.99994278  Radiometer outputs (K) Tsky Tref 37.607884      36.198398 37.164082      36.702051  Tsky-r*Tref -0.96706620  OUTPUT ftheo (K/K) fmeas (K/K) 0.003618      0.786148</pre> | <pre>BEM susceptibility INPUT Frequency (GHz) =      30 Receiver:  LFI Channel :   B Load correct :   Yes r =      1.0312000 Model:  FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_dB =      0.250000 L4K_dB =      0.200000 GF1_dB =      35 GF2_dB =      35 TnF1_K =      20 TnF2_K =      20 TnB1_K =      350 TnB2_K =      350 dGB1_dB_dTBephys_K = -0.0400000 dGB2_dB_dTBephys_K = -0.0400000 da_dB_dTBephys_K = -0.0100000  There are      2 time windows tmin tmax 167.00      195.00 8252.00     9195.00  Sky Sensor = SKY_TEMP Ref Sensor = RMON_TEMP BEM Sensor = BEM_TEMP FEM Sensor = FEM_TEMP        SKY_TEMP RMON_TEMP BEM_TEMP FEM_TEMP 12.79999733      11.94810200      314.00000000 20.00013924 12.79988289      11.95234585      312.76986694 19.99994278  Radiometer outputs (K) Tsky Tref 37.298530      36.170025 36.870248      36.697619  Tsky-r*Tref -0.97233784  OUTPUT ftheo (K/K) fmeas (K/K) 0.001115      0.790433</pre> |
| <pre>BEM susceptibility INPUT Frequency (GHz) =      30 Receiver:  LFI Channel :   C Load correct :   Yes r =      1.1273369 Model:  FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_dB =      0.250000 L4K_dB =      0.200000 GF1_dB =      35 GF2_dB =      35 TnF1_K =      20 TnF2_K =      20 TnB1_K =      350 TnB2_K =      350 dGB1_dB_dTBephys_K = -0.0300000 dGB2_dB_dTBephys_K = -0.0300000 da_dB_dTBephys_K = -0.0100000  There are      2 time windows tmin tmax</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <pre>BEM susceptibility INPUT Frequency (GHz) =      30 Receiver:  LFI Channel :   D Load correct :   Yes r =      1.1051599 Model:  FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_dB =      0.250000 L4K_dB =      0.200000 GF1_dB =      35 GF2_dB =      35 TnF1_K =      20 TnF2_K =      20 TnB1_K =      350 TnB2_K =      350 dGB1_dB_dTBephys_K = -0.0270000 dGB2_dB_dTBephys_K = -0.0270000 da_dB_dTBephys_K = -0.0100000  There are      2 time windows tmin tmax</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |





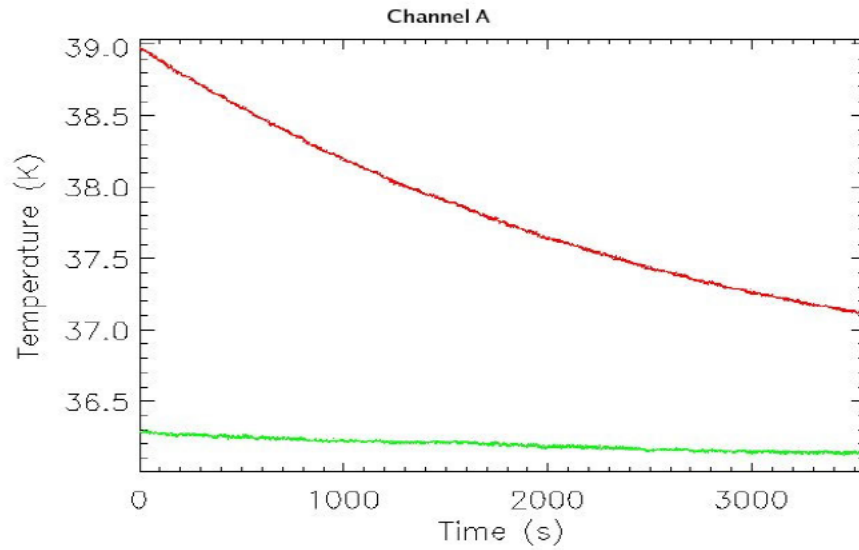
**Figure -21:** Left – Sky Load: (SKY\_TEMP) probe temperature behaviour during the RCA\_THF test; right – Reference Load : REF\_TEMP probe (red) and RMON\_TMP probe (green)

Also the FEM and BEM temperatures were controlled during the test. They are reported in Figure - 3



**Figure -22:** FEM (left) and BEM (right) temperature behaviour during the RCA\_THV test

### 7.3.1 Detector A analysis



**Figure -23: Detector A calibrated output. Sky (red) -Reference (green)**

Receiver parameters used in the computation of the theoretical transfer functions:

|                            |           |
|----------------------------|-----------|
| Frequency (GHz)            | 30        |
| $L_{\text{feed-OMT}}$ (dB) | 0.25      |
| $r$                        | 1.0732684 |
| $G_{F1}$ (dB)              | 35        |
| $G_{F2}$ (dB)              | 35        |
| $L_{WG1}$ (dB)             | 0.03      |
| $L_{WG2}$ (dB)             | 1.08      |
| $L_{WG3}$ (dB)             | 0.11      |
| $L_{WG4}$ (dB)             | 0.15      |
| $L_{WG5}$ (dB)             | 0.13      |
| $G$ (V/K)                  | 0.0399    |

**Analysis using the REF\_TEMP probe as Reference load temperature:**

The transfer functions obtained with RaNA:

|                         |             |
|-------------------------|-------------|
| $F_{\text{meas}}$ (K/K) | -0.31991206 |
| $F_{\text{theo}}$ (K/K) | -0.00000389 |

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel :    A
Load correct :    Yes
```



```
r = 1.0732684
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB = 0.250000
Vgroove number = 1 coldest
LWG1_dB = 0.0300000
LWG2_dB = 1.08000
LWG3_dB = 0.110000
LWG4_dB = 0.150000
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = REF_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP REF_TEMP VG3_TEMP
12.79999161 9.49986649 66.50115204
12.79995251 9.49990845 68.49982452
12.80003452 9.49991322 70.49695587

Radiometer outputs (K)
Tsky Tref
38.942603 36.284125
37.867792 36.207070
37.156871 36.139971

Tsky-r*Tref
-0.99211000
-1.6310164

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000389 -0.31991206
```

## Analysis using the RMON\_TEMP probe as Reference load temperature:

The transfer functions obtained with RaNA:

|                    |             |
|--------------------|-------------|
| <i>Fmeas</i> (K/K) | -0.32130865 |
| <i>Ftheo</i> (K/K) | -0.00000389 |

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) = 30
Receiver: LFI
Channel : A
Load correct : Yes
r = 1.0732684
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB = 0.250000
Vgroove number = 1 coldest
LWG1_dB = 0.0300000
LWG2_dB = 1.08000
LWG3_dB = 0.110000
LWG4_dB = 0.150000
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = RMON_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP RMON_TEMP VG3_TEMP
```



```
12.79999161 11.91124153 66.50115204
12.79995251 11.90805435 68.49982452
12.80003452 11.90546036 70.49695587
```

Radiometer outputs (K)

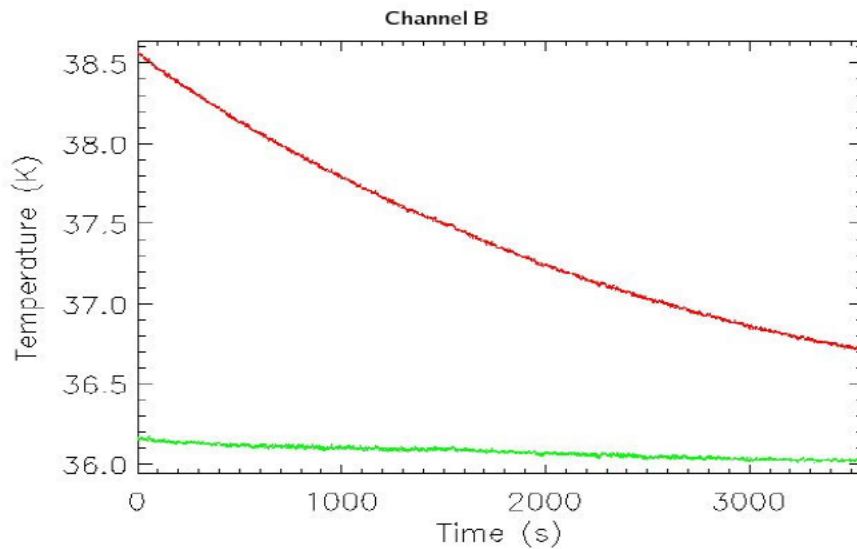
```
Tsky Tref
38.942603 36.284125
37.867792 36.210299
37.156871 36.145799
```

```
Tsky-r*Tref
-0.99557573
-1.6372713
```

OUTPUT

```
ftheo (K/K) fmeas (K/K)
-0.00000389 -0.32130865
```

### 7.3.2 Detector B analysis



*Figure -24: Detector B calibrated output. Sky (red) -Reference (green)*

Receiver parameters used in the computation of the theoretical transfer functions:

|                            |           |
|----------------------------|-----------|
| Frequency (GHz)            | 30        |
| L <sub>feed-OMT</sub> (dB) | 0.25      |
| r                          | 1.0656175 |
| G <sub>P1</sub> (dB)       | 35        |
| G <sub>P2</sub> (dB)       | 35        |
| L <sub>WG1</sub> (dB)      | 0.03      |
| L <sub>WG2</sub> (dB)      | 1.08      |
| L <sub>WG3</sub> (dB)      | 0.11      |
| L <sub>WG4</sub> (dB)      | 0.15      |
| L <sub>WG5</sub> (dB)      | 0.13      |
| G (V/K)                    | 0.0418    |

**Analysis using the REF\_TEMP probe as Reference load temperature:**

The transfer functions obtained with RaNA:

|                                |             |
|--------------------------------|-------------|
| <i>F</i> <sub>meas</sub> (K/K) | -0.32109367 |
| <i>F</i> <sub>theo</sub> (K/K) | -0.00000349 |

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : B
Load correct : Yes
r =      1.0656175
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB =      0.250000
Vgroove number = 1 coldest
LWG1_dB =      0.0300000
LWG2_dB =      1.08000
LWG3_dB =      0.110000
LWG4_dB =      0.150000
LWG5_dB =      0.130000
GF1_dB =      35
GF2_dB =      35

There are      3 time windows
tmin tmax
      1.00      77.00
    1317.00    1812.00
    3225.00    3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = REF_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP REF_TEMP VG3_TEMP
12.79999161      9.49986649      66.50115204
12.79995251      9.49990845      68.49982452
12.80003452      9.49991322      70.49695587

Radiometer outputs (K)
Tsky Tref
    38.527985    36.155549
    37.464941    36.088300
    36.755504    36.024327

Tsky-r*Tref
    -0.99138194
    -1.6326482

OUTPUT
ftheo (K/K) fmeas (K/K)
    -0.00000349    -0.32109367
```

**Analysis using the RMON\_TEMP probe as Reference load temperature:**

The transfer functions obtained with RaNA:

|                                |             |
|--------------------------------|-------------|
| <i>F</i> <sub>meas</sub> (K/K) | -0.3224830  |
| <i>F</i> <sub>theo</sub> (K/K) | -0.00000349 |

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : B
Load correct : Yes
r =      1.0656175
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB =      0.250000
Vgroove number = 1 coldest
LWG1_dB =      0.0300000
LWG2_dB =      1.08000
LWG3_dB =      0.110000
LWG4_dB =      0.150000
```



```
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = RMON_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP RMON_TEMP VG3_TEMP
12.79999161 11.91124153 66.50115204
12.79995251 11.90805435 68.49982452
12.80003452 11.90546036 70.49695587

Radiometer outputs (K)
Tsky Tref
38.527985 36.155549
37.464941 36.091529
36.755504 36.030155

Tsky-r*Tref
-0.99482297
-1.6388585

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000349 -0.32248030
```

### 7.3.3 Detector C analysis

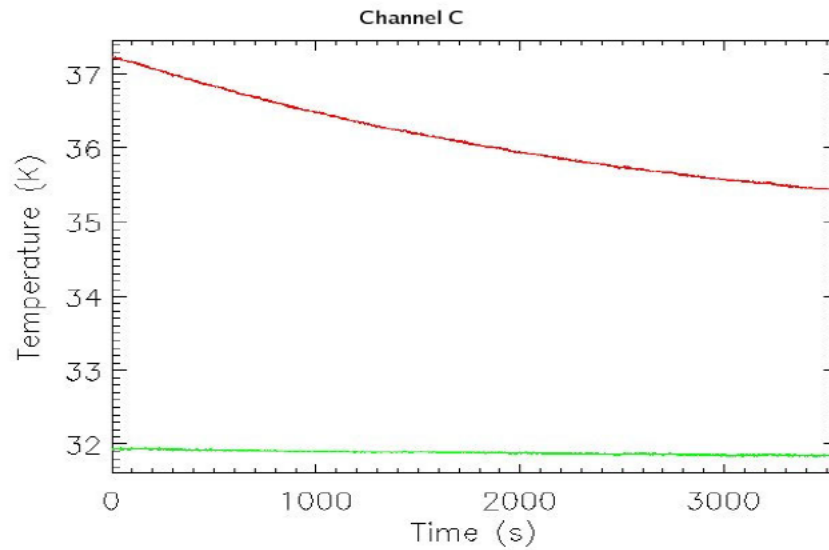


Figure -25: Detector C calibrated output.Sky (red) -Reference (green)

Receiver parameters used in the computation of the theoretical transfer functions:

|                            |           |
|----------------------------|-----------|
| Frequency (GHz)            | 30        |
| $L_{\text{feed-CMT}}$ (dB) | 0.25      |
| $r$                        | 1.1646563 |
| $G_{P1}$ (dB)              | 35        |
| $G_{P2}$ (dB)              | 35        |



|           |         |
|-----------|---------|
| LWG1 (dB) | 0.03    |
| LWG2 (dB) | 1.08    |
| LWG3 (dB) | 0.11    |
| LWG4 (dB) | 0.15    |
| LWG5 (dB) | 0.13    |
| G (V/K)   | 0.03299 |

**Analysis using the REF\_TEMP probe as Reference load temperature:**

The transfer functions obtained with RaNA:

|                                |             |
|--------------------------------|-------------|
| <i>F</i> <sub>meas</sub> (K/K) | -0.31806395 |
| <i>F</i> <sub>theo</sub> (K/K) | -0.00000875 |

**The complete RaNA output:**

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : C
Load correct : Yes
r =      1.1646563
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB =      0.250000
Vgroove number = 1 coldest
LWG1_dB =      0.0300000
LWG2_dB =      1.08000
LWG3_dB =      0.110000
LWG4_dB =      0.150000
LWG5_dB =      0.130000
GF1_dB =      35
GF2_dB =      35

There are      3 time windows
tmin tmax
      1.00      77.00
     1317.00     1812.00
     3225.00     3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = REF_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP REF_TEMP VG3_TEMP
12.79999161      9.49986649      66.50115204
12.79995251      9.49990845      68.49982452
12.80003452      9.49991322      70.49695587

Radiometer outputs (K)
Tsky Tref
      37.203801      31.944016
      36.159615      31.894638
      35.475483      31.852638

Tsky-r*Tref
      -0.98667763
      -1.6218931

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000875 -0.31806395
```

**Analysis using the RMON\_TEMP probe as Reference load temperature:**

The transfer functions obtained with RaNA:

|                                |             |
|--------------------------------|-------------|
| <i>F</i> <sub>meas</sub> (K/K) | -0.31957946 |
| <i>F</i> <sub>theo</sub> (K/K) | -0.00000875 |

**The complete RaNA output:**

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : C
Load correct : Yes
r =      1.1646563
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB =      0.250000
```



```
Vgroove number = 1 coldest
LWG1_dB = 0.0300000
LWG2_dB = 1.08000
LWG3_dB = 0.110000
LWG4_dB = 0.150000
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = RMON_TEMP
Vgroove Sensor = VG3_TEMP

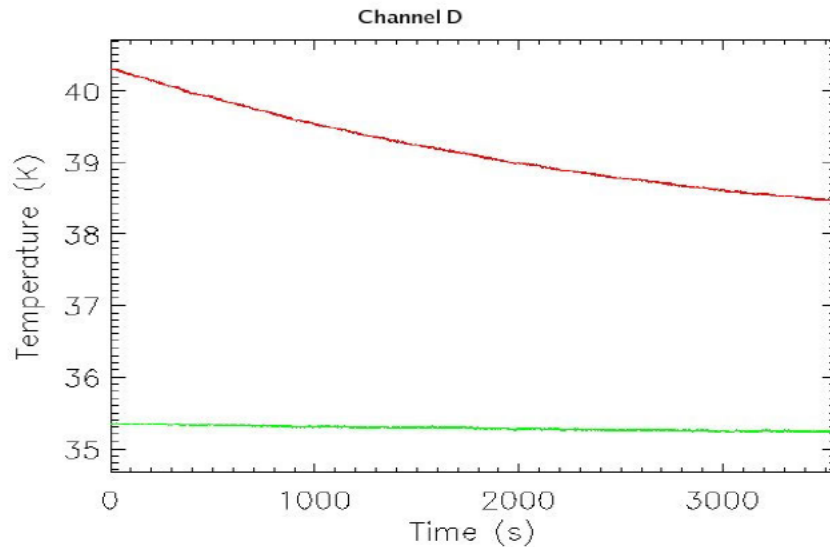
SKY_TEMP RMON_TEMP VG3_TEMP
12.79999161 11.91124153 66.50115204
12.79995251 11.90805435 68.49982452
12.80003452 11.90546036 70.49695587

Radiometer outputs (K)
Tsky Tref
37.203801 31.944016
36.159615 31.897868
35.475483 31.858466

Tsky-r*Tref
-0.99043847
-1.6286806

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000875 -0.31957946
```

### 7.3.4 Detector D analysis



*Figure -26: Detector D calibrated output. Sky (red) -Reference (green)*

Receiver parameters used in the computation of the theoretical transfer functions:

|                            |      |
|----------------------------|------|
| Frequency (GHz)            | 30   |
| $L_{\text{feed-CMT}}$ (dB) | 0.25 |



|                       |          |
|-----------------------|----------|
| r                     | 1.139537 |
| G <sub>P1</sub> (dB)  | 35       |
| G <sub>P2</sub> (dB)  | 35       |
| L <sub>WG1</sub> (dB) | 0.03     |
| L <sub>WG2</sub> (dB) | 1.08     |
| L <sub>WG3</sub> (dB) | 0.11     |
| L <sub>WG4</sub> (dB) | 0.15     |
| L <sub>WG5</sub> (dB) | 0.13     |
| G (V/K)               | 0.0365   |

**Analysis using the REF\_TEMP probe as Reference load temperature:**

The transfer functions obtained with RaNA:

|                         |             |
|-------------------------|-------------|
| F <sub>meas</sub> (K/K) | -0.32517484 |
| F <sub>theo</sub> (K/K) | -0.00000742 |

**The complete RaNA output:**

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : D
Load correct : Yes
r =      1.1395370
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB =      0.250000
Vgroove number = 1 coldest
LWG1_dB =      0.0300000
LWG2_dB =      1.08000
LWG3_dB =      0.110000
LWG4_dB =      0.150000
LWG5_dB =      0.130000
GF1_dB =      35
GF2_dB =      35

There are      3 time windows
  tmin  tmax
    1.00   77.00
  1317.00 1812.00
  3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = REF_TEMP
Vgroove Sensor = VG3_TEMP

  SKY_TEMP REF_TEMP VG3_TEMP
  12.79999161  9.49986649  66.50115204
  12.79995251  9.49990845  68.49982452
  12.80003452  9.49991322  70.49695587

Radiometer outputs (K)
  Tsky  Tref
    40.277087  35.345132
    39.208721  35.292028
    38.506921  35.246059

  Tsky-r*Tref
    -1.0078517
    -1.6572686

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000742 -0.32517484
```

**Analysis using the RMON\_TEMP probe as Reference load temperature:**

The transfer functions obtained with RaNA:

|                         |             |
|-------------------------|-------------|
| F <sub>meas</sub> (K/K) | -0.32665766 |
| F <sub>theo</sub> (K/K) | -0.00000742 |

**The complete RaNA output:**

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : D
Load correct : Yes
```



```
r = 1.1395370
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB = 0.250000
Vgroove Number = 1 coldest
LWG1_dB = 0.0300000
LWG2_dB = 1.08000
LWG3_dB = 0.110000
LWG4_dB = 0.150000
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35
```

```
There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00
```

```
Sky Sensor = SKY_TEMP
Ref Sensor = RMON_TEMP
Vgroove Sensor = VG3_TEMP
```

| SKY_TEMP    | RMON_TEMP   | VG3_TEMP    |
|-------------|-------------|-------------|
| 12.79999161 | 11.91124153 | 66.50115204 |
| 12.79995251 | 11.90805435 | 68.49982452 |
| 12.80003452 | 11.90546036 | 70.49695587 |

```
Radiometer outputs (K)
Tsky Tref
40.277087 35.345132
39.208721 35.295257
38.506921 35.251887
```

```
Tsky-r*Tref
-1.0115314
-1.6639097
```

```
OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000742 -0.32665766
```

## 8 APPENDIX FOR TRB

### 8.1 RCA\_LIS: LINEARITY AND ISOLATION WITH REFERENCE TEMPERATURE STEPS

Noise temperatures, linearity, and isolation have been computed considering:

1. BEM offset = 0
2. Reference temperature seen by channels C and D simulated by Luca Terenzi

The data set analysed is 030LFI27\_RCA\_FM\_LIS\_200604081545. Nine steps have been considered in the computation. The time interval selected in each step is 600 seconds long. The error reported in the tables below is the fit uncertainty and does not includes any systematic error from measurements.

#### 8.1.1 BEM Offset = 0

*Table 9-1 Basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY\_TEMP probe as a sky load temperature, and R\_MON sensor for the REF load temperature. For isolation the error has not been calculated. It will be reported in the next update of the document.*

|            | Gain<br>[V/K] | Gain<br>[K/V] | Tnoise<br>[K] | Tnoise<br>[K] | Isolation<br>[dB] |
|------------|---------------|---------------|---------------|---------------|-------------------|
|            | x 1E-02       |               | Linear        | Parabolic     |                   |
| DETECTOR A | 4.08±0.02     | 24.5±0.1      | 22.4±0.2      | 14.1±0.1      | -13.43            |



|            |           |          |          |          |        |
|------------|-----------|----------|----------|----------|--------|
| DETECTOR B | 4.28±0.02 | 23.4±0.1 | 22.6±0.2 | 13.9±0.1 | -13.40 |
| DETECTOR C | 3.61±0.02 | 27.7±0.2 | 17.8±0.2 | 7.4±0.1  | -15.35 |
| DETECTOR D | 4.07±0.02 | 24.6±0.1 | 19.9±0.1 | 8.1±0.1  | -15.52 |

The complete RaNA output is reported (RCA27\_LIS\_results\_100506\_Rmon\_9.txt):

```
=====
INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: A
Changing signal: Load
BEM offset (v) =, 0.000000

There are , 9 , time windows
, tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 11.983419418335 , 12.800000190735 , 1.442863831712 , 1.457443225608
, 13.510450363159 , 12.800000190735 , 1.513649832629 , 1.460513550473
, 15.188432693481 , 12.800000190735 , 1.589175773890 , 1.463630553546
, 16.967086791992 , 12.800000190735 , 1.668228343935 , 1.467573307340
, 18.809181213379 , 12.800000190735 , 1.748639875669 , 1.472246842100
, 20.707633972168 , 12.800000190735 , 1.829081392251 , 1.476682181874
, 22.638475418091 , 12.800000190735 , 1.909555616777 , 1.481358057582
, 24.587665557861 , 12.800000190735 , 1.989164634414 , 1.486008527985
, 26.560396194458 , 12.966036796570 , 2.067890311825 , 1.494392018569

OUTPUT
***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.040799856796 , 22.400856426138 , -13.428386025930 , 0.005971560426

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.000239777788 , 0.156494227351 , 3.822651956296 , 0.004649178963

***** Parabolic fit *****

Average noise temperature
, Tn (K), Sigma (K)
, 14.053056503690 , 0.123721939608

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
, -13.188189625420 , 12.528367130144 , 3.069282957142
, sigma(a0), sigma(a1), sigma(a2)
, 0.069660428681 , 0.080824948766 , 0.023185067035

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
, a0, a1, a2
, 0.888463232002 , 0.051933197810 , -0.000244250719
, sigma(a0), sigma(a1), sigma(a2)
, 0.003376643659 , 0.000400108753 , 0.000011247155
=====
INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: B
Changing signal: Load
BEM offset (v) =, 0.000000

There are , 9 , time windows
, tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00
```



```
,Tchange, Tfixed, Vchange, Vfixed
, 11.983419418335 , 12.800000190735 , 1.529292099949 , 1.532790296498
, 13.510450363159 , 12.800000190735 , 1.604244062961 , 1.535992843862
, 15.188432693481 , 12.800000190735 , 1.683733008725 , 1.539137266210
, 16.967086791992 , 12.800000190735 , 1.767172086159 , 1.543558540796
, 18.809181213379 , 12.800000190735 , 1.851625177445 , 1.548501488260
, 20.707633972168 , 12.800000190735 , 1.936017992035 , 1.553294026849
, 22.638475418091 , 12.800000190735 , 2.020385471888 , 1.558469248013
, 24.587665557861 , 12.800000190735 , 2.103495404693 , 1.563404301564
, 26.560396194458 , 12.966036796570 , 2.186019328322 , 1.572559460051
```

## OUTPUT

\*\*\*\*\* Linear fit \*\*\*\*\*

## Parameters

```
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.042782129934 , 22.612468835761 , -13.396931148718 , 0.006063018995
```

## Statistical uncertainties

```
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000249032248 , 0.186607749991 , 3.789583631764 , 0.005352469002
```

\*\*\*\*\* Parabolic fit \*\*\*\*\*

## Average noise temperature

```
,Tn (k),Sigma (K)
, 13.851486435263 , 0.120433469813
```

## Temperature versus Voltage parabolic fit parameters

Equation:  $T = a_0 + a_1 * V + a_2 * V^2$ 

```
,a0,a1,a2
, -12.618319376343 , 11.037084746640 , 3.000288585237
,sigma(a0),sigma(a1),sigma(a2)
, 0.075389285270 , 0.082640881983 , 0.022400430326
```

## Voltage versus temperature parabolic fit parameters

Equation:  $V = a_0 + a_1 * T + a_2 * T^2$ 

```
,a0,a1,a2
, 0.941039390684 , 0.055317110117 , -0.000277403501
,sigma(a0),sigma(a1),sigma(a2)
, 0.003376643659 , 0.000400108753 , 0.000011247155
```

## INPUT

Centre frequency (Hz) =, 3.0000000e+010

Channel: C

Changing signal: Load

BEM offset (v) =, 0.000000

There are, 9, time windows

```
,tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00
```

```
,Tchange, Tfixed, Vchange, Vfixed
, 11.983419418335 , 12.800000190735 , 1.076551973368 , 1.173347073582
, 13.510450363159 , 12.800000190735 , 1.144867297709 , 1.175293276363
, 15.188432693481 , 12.800000190735 , 1.214220150276 , 1.176877361659
, 16.967086791992 , 12.800000190735 , 1.283933045120 , 1.179131631755
, 18.809181213379 , 12.800000190735 , 1.352918417478 , 1.181589383331
, 20.707633972168 , 12.800000190735 , 1.421346614524 , 1.184258395148
, 22.638475418091 , 12.800000190735 , 1.488874645890 , 1.186978879277
, 24.587665557861 , 12.800000190735 , 1.555498772780 , 1.189740570975
, 26.560396194458 , 12.966036796570 , 1.621525835891 , 1.195541282744
```

## OUTPUT

\*\*\*\*\* Linear fit \*\*\*\*\*

## Parameters

```
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.036117461777 , 17.825943119341 , -15.349032729995 , 0.009169856757
```

## Statistical uncertainties

```
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000197891215 , 0.150905363410 , 5.347003281768 , 0.004148644499
```

\*\*\*\*\* Parabolic fit \*\*\*\*\*

## Average noise temperature

```
,Tn (k),Sigma (K)
, 7.392596073342 , 0.055985258341
```

## Temperature versus Voltage parabolic fit parameters



```
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
, -4.012704527762 , 5.757491377037 , 7.820221962895

,sigma(a0),sigma(a1),sigma(a2)
, 0.043447741209 , 0.065935926923 , 0.024660812071

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.541136693952 , 0.052277926123 , -0.000409981414

,sigma(a0),sigma(a1),sigma(a2)
, 0.003376643659 , 0.000400108753 , 0.000011247155
=====

INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (v) =, 0.000000

There are , 9 , time windows
,tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

,Tchange, Tfixed, Vchange, Vfixed
, 11.983419418335 , 12.800000190735 , 1.298223213341 , 1.392564401085
, 13.510450363159 , 12.800000190735 , 1.375275348304 , 1.394448960707
, 15.188432693481 , 12.800000190735 , 1.453491858018 , 1.396284414987
, 16.967086791992 , 12.800000190735 , 1.531916913126 , 1.398669659485
, 18.809181213379 , 12.800000190735 , 1.609653893897 , 1.401462855288
, 20.707633972168 , 12.800000190735 , 1.686784565067 , 1.404653020605
, 22.638475418091 , 12.800000190735 , 1.762826699974 , 1.407844626644
, 24.587665557861 , 12.800000190735 , 1.837551938049 , 1.410904094410
, 26.560396194458 , 12.966036796570 , 1.911643160952 , 1.417496814318

OUTPUT
***** Linear fit *****

Parameters
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.040655426197 , 19.867767961453 , -15.524353555743 , 0.010596126088

Statistical uncertainties
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000211309683 , 0.147173837732 , 5.405509310843 , 0.004331423284

***** Parabolic fit *****

Average noise temperature
,Tn (k),Sigma (K)
, 8.141332487364 , 0.068256397563

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
, -4.192266000551 , 3.771914688012 , 6.256560884081

,sigma(a0),sigma(a1),sigma(a2)
, 0.052767365429 , 0.067133808774 , 0.021082245227

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.693289566713 , 0.059128844826 , -0.000468967446

,sigma(a0),sigma(a1),sigma(a2)
, 0.003376643659 , 0.000400108753 , 0.000011247155
=====
```

The same analysis has been done using the REF\_TEMP. The results are reported below.



*Table 9-2 Basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY\_TEMP probe as a sky load temperature, and REF\_TEMP sensor for the REF load temperature. For isolation the error has not been calculated. It will be reported in the next update of the document.*

|            | Gain<br>[V/K] | Gain<br>[K/V] | Tnoise<br>[K] | Tnoise<br>[K] | Isolation<br>[dB] |
|------------|---------------|---------------|---------------|---------------|-------------------|
|            | x 1E-02       |               | Linear        | Parabolic     |                   |
| DETECTOR A | 3.40±0.02     | 29.4±0.2      | 38.3±0.1      | 37.76±0.01    | -13.41            |
| DETECTOR B | 3.56±0.02     | 28.1±0.2      | 36.5±0.1      | 36.22±0.01    | -13.38            |
| DETECTOR C | 3.00±0.02     | 33.3±0.2      | 43.5±0.1      | 43.5±0.1      | -15.32            |
| DETECTOR D | 3.38±0.02     | 29.6±0.2      | 39.9±0.1      | 41.07±0.01    | -15.49            |

The complete RaNA output is reported (RCA27\_LIS\_results\_100506\_REF\_TEMP\_9.txt):

```
INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: A
Changing signal: Load
BEM offset (v) =, 0.000000

There are, 9, time windows
, tmin, tmax
, 3800.00, 4400.00
, 6500.00, 7100.00
, 9200.00, 9800.00
, 12000.00, 12600.00
, 14700.00, 15300.00
, 17400.00, 18000.00
, 20000.00, 20600.00
, 22700.00, 23300.00
, 25400.00, 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 9.599903106689, 12.800000190735, -1.044191231535, -1.029611837640
, 11.800000190735, 12.800000190735, -0.973405230619, -1.026541512775
, 14.000000000000, 12.800000190735, -0.897879289358, -1.023424509702
, 16.200000762939, 12.800000190735, -0.818826719312, -1.019481755907
, 18.399999618530, 12.800000190735, -0.738415187579, -1.014808221148
, 20.600000381470, 12.800000190735, -0.657973670997, -1.010372881373
, 22.799999237061, 12.800000190735, -0.577499446471, -1.005697005666
, 25.000000000000, 12.800000190735, -0.497890428833, -1.001046535262
, 27.200000762939, 12.966036796570, -0.419164751423, -0.992663044678

OUTPUT
***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.033950507447, -38.257616603349, -13.408691903651, 0.005468720783

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.000196529367, -0.087109776657, 3.805356471200, 0.004086998591

***** Parabolic fit *****

Average noise temperature
, Tn (K), Sigma (K)
, -37.764540319386, 0.012418027852

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
, 37.150215211043, 24.719256545473, -2.164370657913

, sigma(a0), sigma(a1), sigma(a2)
, 0.012388995333, 0.034841285859, 0.023185067023

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
, a0, a1, a2
, -1.366944232368, 0.034967341380, 0.000032472356

, sigma(a0), sigma(a1), sigma(a2)
, 0.000005403194, 0.000000603664, 0.000000015955
=====

INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: B
Changing signal: Load
```



```
BEM offset (v) =,      0.000000

There are ,          9 , time windows
, tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 9.599903106689 , 12.800000190735 , -1.032910592083 , -1.029412395534
, 11.800000190735 , 12.800000190735 , -0.957958629070 , -1.026209848170
, 14.000000000000 , 12.800000190735 , -0.878469683307 , -1.023065425822
, 16.200000762939 , 12.800000190735 , -0.795030605873 , -1.018644151236
, 18.399999618530 , 12.800000190735 , -0.710577514587 , -1.013701203772
, 20.600000381470 , 12.800000190735 , -0.626184699997 , -1.008908665183
, 22.799999237061 , 12.800000190735 , -0.541817220144 , -1.003733444018
, 25.000000000000 , 12.800000190735 , -0.458707287339 , -0.998798390468
, 27.200000762939 , 12.966036796570 , -0.376183363710 , -0.989643231981

OUTPUT

***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.035602343942 , -36.540259033702 , -13.377478880095 , 0.004813739735

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.000213657017 , -0.081740277047 , 3.772647850908 , 0.004780780104

***** Parabolic fit *****

Average noise temperature
, Tn (k), Sigma (K)
, -36.221431773957 , 0.011088931984

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
, 35.737950777591 , 24.152673092588 , -1.700437439647
, sigma(a0), sigma(a1), sigma(a2)
, 0.011062223898 , 0.032513793859 , 0.022400430332

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
, a0, a1, a2
, -1.374761522434 , 0.037177874675 , 0.000021368385
, sigma(a0), sigma(a1), sigma(a2)
, 0.000005403194 , 0.000000603664 , 0.000000015955
=====

INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: C
Changing signal: Load
BEM offset (v) =, 0.000000

There are ,          9 , time windows
, tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 9.599903106689 , 12.800000190735 , -1.076816022848 , -0.980020922633
, 11.800000190735 , 12.800000190735 , -1.008500698507 , -0.978074719853
, 14.000000000000 , 12.800000190735 , -0.939147845940 , -0.976490634557
, 16.200000762939 , 12.800000190735 , -0.869434951096 , -0.974236364461
, 18.399999618530 , 12.800000190735 , -0.800449578738 , -0.971778612885
, 20.600000381470 , 12.800000190735 , -0.732021381692 , -0.969109601068
, 22.799999237061 , 12.800000190735 , -0.664493350326 , -0.966389116938
, 25.000000000000 , 12.800000190735 , -0.597869223436 , -0.963627425241
, 27.200000762939 , 12.966036796570 , -0.531842160325 , -0.957826713472

OUTPUT

***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
```



```
,      0.030044766864 ,      -43.473286535439 ,      -15.316783906761 ,      0.002490791700

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
,      0.000151474658 ,      -0.070039922702 ,      5.307445807090 ,      0.003928949446

***** Parabolic fit *****

Average noise temperature
, Tn (k), Sigma (K)
,      -45.030738356260 ,      0.016164263940

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
,      44.486569932234 ,      34.731644832256 ,      1.583770363415

, sigma(a0), sigma(a1), sigma(a2)
,      0.016091630868 ,      0.040558098449 ,      0.024660812068

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
, a0, a1, a2
,      -1.373069423102 ,      0.033591665789 ,      -0.000068904808

, sigma(a0), sigma(a1), sigma(a2)
,      0.000005403194 ,      0.000000603664 ,      0.000000015955
=====

INPUT
Centre frequency (Hz) =,      3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (v) =,      0.000000

There are ,      9 , time windows
, tmin, tmax
,      3800.00 ,      4400.00
,      6500.00 ,      7100.00
,      9200.00 ,      9800.00
,      12000.00 ,      12600.00
,      14700.00 ,      15300.00
,      17400.00 ,      18000.00
,      20000.00 ,      20600.00
,      22700.00 ,      23300.00
,      25400.00 ,      26000.00

, Tchange, Tfixed, Vchange, Vfixed
,      9.599903106689 ,      12.800000190735 ,      -1.086190028999 ,      -0.991848841255
,      11.800000190735 ,      12.800000190735 ,      -1.009137894036 ,      -0.989964281633
,      14.000000000000 ,      12.800000190735 ,      -0.930921384322 ,      -0.988128827353
,      16.200000762939 ,      12.800000190735 ,      -0.852496329214 ,      -0.985743582855
,      18.399999618530 ,      12.800000190735 ,      -0.774759348443 ,      -0.982950387052
,      20.600000381470 ,      12.800000190735 ,      -0.697628677273 ,      -0.979760221735
,      22.799999237061 ,      12.800000190735 ,      -0.621586542366 ,      -0.976568615696
,      25.000000000000 ,      12.800000190735 ,      -0.546861304291 ,      -0.973509147930
,      27.200000762939 ,      12.966036796570 ,      -0.472770081388 ,      -0.966916428022

OUTPUT

***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
,      0.033814842763 ,      -39.872895849143 ,      -15.490750779797 ,      0.003089181854

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
,      0.000166570149 ,      -0.065534342879 ,      5.363846518974 ,      0.004057179417

***** Parabolic fit *****

Average noise temperature
, Tn (k), Sigma (K)
,      -41.071170723029 ,      0.012897117874

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
,      40.681030574267 ,      30.728492596307 ,      1.373524761037

, sigma(a0), sigma(a1), sigma(a2)
,      0.012844753354 ,      0.033700109488 ,      0.021082245233

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
, a0, a1, a2
,      -1.421203121729 ,      0.038025602046 ,      -0.000083382037

, sigma(a0), sigma(a1), sigma(a2)
,      0.000005403194 ,      0.000000603664 ,      0.000000015955
=====
```



### 8.1.2 Reference temperature seen by channels C and D simulated by Luca Terenzi

Finally, the temperatures seen by channels C and D have been estimated by Luca Terenzi and used in this analysis. The results are shown in the table below. Only C/D channels are displayed because the A/B should look always at the R\_MON sensor.

*Table 9-3 Basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY\_TEMP probe as a sky load temperature, and the REF load temperature estimated by Luca Terenzi. For isolation the error has not been calculated. It will be reported in the next update of the document.*

|            | Gain<br>[V/K] | Gain<br>[K/V] | Tnoise<br>[K] | Tnoise<br>[K] | Isolation<br>[dB] |
|------------|---------------|---------------|---------------|---------------|-------------------|
|            | x 1E-02       |               | Linear        | Parabolic     |                   |
| DETECTOR C | 3.27±0.02     | 30.6±0.2      | 22.0±0.2      | 15.53±0.04    | -15.33            |
| DETECTOR D | 3.67±0.02     | 27.3±0.1      | 24.2±0.2      | 17.01±0.05    | -15.51            |

The complete RaNA output is reported here (RCA27\_LIS\_results\_100506\_LT\_9.txt):

```
=====
INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: C
Changing signal: Load
BEM offset (v) =, 0.000000

There are, 9, time windows
, tmin, tmax
, 3800.00, 4400.00
, 6500.00, 7100.00
, 9200.00, 9800.00
, 12000.00, 12600.00
, 14700.00, 15300.00
, 17400.00, 18000.00
, 20000.00, 20600.00
, 22700.00, 23300.00
, 25400.00, 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 10.762539863586, 12.800000190735, 1.076551973368, 1.173347073582
, 12.609809875488, 12.800000190735, 1.144867297709, 1.175293276363
, 14.545989036560, 12.800000190735, 1.214220150276, 1.176877361659
, 16.540719985962, 12.800000190735, 1.283933045120, 1.179131631755
, 18.575880050659, 12.800000190735, 1.352918417478, 1.181589383331
, 20.63999389648, 12.800000190735, 1.421346614524, 1.184258395148
, 22.725469589233, 12.800000190735, 1.488874645890, 1.186978879277
, 24.827119827271, 12.800000190735, 1.555498772780, 1.189740570975
, 26.941320419312, 12.966036796570, 1.621525835891, 1.195541282744

OUTPUT
***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.032651885070, 21.962338266439, -15.330585428090, 0.005460028071

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.000184697185, 0.150925153342, 5.324339261173, 0.003641960316

***** Parabolic fit *****

Average noise temperature
, Tn (K), Sigma (K)
, 15.532482104038, 0.043448024153

Temperature versus voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
, -12.571996312268, 15.252082758496, 5.354508998666

, sigma(a0), sigma(a1), sigma(a2)
, 0.043447741209, 0.065935926923, 0.024660812071

Voltage versus temperature parabolic fit parameters
```



```
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.685441520064 , 0.040982118724 , -0.000202628188

,sigma(a0),sigma(a1),sigma(a2)
, 0.000004358950 , 0.000000509450 , 0.00000013956
=====

INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (v) =, 0.000000

There are , 9 , time windows
,tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

,Tchange, Tfixed, Vchange, Vfixed
, 10.762539863586 , 12.800000190735 , 1.298223213341 , 1.392564401085
, 12.609809875488 , 12.800000190735 , 1.375275348304 , 1.394448960707
, 14.545989036560 , 12.800000190735 , 1.453491858018 , 1.396284414987
, 16.540719985962 , 12.800000190735 , 1.531916913126 , 1.398669659485
, 18.575880050659 , 12.800000190735 , 1.609653893897 , 1.401462855288
, 20.639999389648 , 12.800000190735 , 1.686784565067 , 1.404653020605
, 22.725469589233 , 12.800000190735 , 1.762826699974 , 1.407844626644
, 24.827119827271 , 12.800000190735 , 1.837551938049 , 1.410904094410
, 26.941320419312 , 12.966036796570 , 1.911643160952 , 1.417496814318

OUTPUT
***** Linear fit *****

Parameters
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.036749201343 , 24.226239443023 , -15.505118539673 , 0.006422456353

Statistical uncertainties
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000201489079 , 0.168702138197 , 5.381621108663 , 0.004114328063

***** Parabolic fit *****

Average noise temperature
,Tn (k),Sigma (K)
, 17.007350015067 , 0.052767597727

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
, -13.447603877823 , 12.482321761287 , 4.329471785444

,sigma(a0),sigma(a1),sigma(a2)
, 0.052767365429 , 0.067133808774 , 0.021082245227

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.856261819240 , 0.046361299480 , -0.000234320759

,sigma(a0),sigma(a1),sigma(a2)
, 0.000004358950 , 0.000000509450 , 0.00000013956
=====
```



### 8.1.3 Summary Table

*Table 9-4 Basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY\_TEMP probe as a sky load temperature, and R\_MON sensor for the REF load temperature for A and B channels, and using the REF load temperature estimated by Luca Terenzi for channels C and D. For isolation the error has not been calculated. It will be reported in the next update of the document*

|            | Gain<br>[V/K] | Gain<br>[K/V] | Tnoise<br>[K] | Tnoise<br>[K] | Isolation<br>[dB] |
|------------|---------------|---------------|---------------|---------------|-------------------|
|            | x 1E-02       |               | Linear        | Parabolic     |                   |
| DETECTOR A | 4.08±0.02     | 24.5±0.1      | 22.4±0.2      | 14.1±0.1      | -13.43            |
| DETECTOR B | 4.28±0.02     | 23.4±0.1      | 22.6±0.2      | 13.9±0.1      | -13.40            |
| DETECTOR C | 3.27±0.02     | 30.6±0.2      | 22.0±0.2      | 15.53±0.04    | -15.33            |
| DETECTOR D | 3.67±0.02     | 27.3±0.1      | 24.2±0.2      | 17.01±0.05    | -15.51            |

## 8.2 RCA\_LIS: LINEARITY WITH SKY LOAD TEMPERATURE STEPS

DELTA TC = 200 mK --- Offset not Removed

DETECTOR A --- LINEAR FIT

$$V = 0.95080845 + 0.042680694 * T$$

$$V = 0.84900612 + 0.053057288 * T - 0.00024834363 * T^2$$

$$T = -11.573214 + 11.616020 * V + 3.2131008 * V^2$$

DETECTOR B --- LINEAR FIT

$$V = 1.0063535 + 0.044481579 * T$$

$$V = 0.89303312 + 0.056032191 * T - 0.00027644146 * T^2$$

$$T = -11.005831 + 10.276757 * V + 3.1600237 * V^2$$

DETECTOR C --- LINEAR FIT

$$V = 0.75947810 + 0.034744666 * T$$

$$V = 0.68533527 + 0.042301959 * T - 0.00018086914 * T^2$$

$$T = -12.469418 + 15.926188 * V + 4.3360290 * V^2$$

DETECTOR D --- LINEAR FIT

$$V = 0.92084882 + 0.039655592 * T$$

$$V = 0.83169709 + 0.048742725 * T - 0.00021748289 * T^2$$

$$T = -12.679781 + 12.972981 * V + 3.5068873 * V^2$$

| DELTA TC = 200 mK --- Offset not Removed |               |                  |                  |                 |
|------------------------------------------|---------------|------------------|------------------|-----------------|
|                                          | Tnoise Linear | T noise par V(T) | T noise par T(V) | T noise par AVE |
| Detector A                               | 22.28         | 14.95            | 11.57            | 13.26           |
| Detector B                               | 22.62         | 14.85            | 11.01            | 12.93           |
| Detector C                               | 21.86         | 15.21            | 12.47            | 13.84           |
| Detector D                               | 23.22         | 15.93            | 12.68            | 14.31           |

DELTA TC = 200 mK --- Offset Removed

DETECTOR A

$$V = 0.91860845 + 0.042680694 * T$$

$$V = 0.81680612 + 0.053057288 * T - 0.00024834363 * T^2$$

$$T = -11.195847 + 11.822944 * V + 3.2131008 * V^2$$

DETECTOR B --- LINEAR FIT

$$V = 0.96865346 + 0.044481579 * T$$



V = 0.85533312 + 0.056032191 \* T - 0.00027644146 \* T^2  
T = -10.613906 + 10.515023 \* V + 3.1600237 \* V^2  
DETECTOR C --- LINEAR FIT  
V = 0.72677810 + 0.034744666 \* T  
0.65263527 + 0.042301959 \* T - 0.00018086914 \* T^2  
T = -11.943995 + 16.209764 \* V + 4.3360290 \* V^2  
DETECTOR D --- LINEAR FIT  
V = 0.88314882 + 0.039655592 \* T  
V = 0.79399709 + 0.048742725 \* T - 0.00021748289 \* T^2  
T = -12.185715 + 13.237401 \* V + 3.5068873 \* V^2

| DELTA TC = 200 mK --- Offset Removed |               |                  |                  |                 |
|--------------------------------------|---------------|------------------|------------------|-----------------|
|                                      | Tnoise Linear | T noise par V(T) | T noise par T(V) | T noise par AVE |
| Detector A                           | 21.52         | 14.42            | 11.20            | 12.81           |
| Detector B                           | 21.78         | 14.26            | 10.61            | 12.44           |
| Detector C                           | 20.92         | 14.52            | 11.94            | 13.23           |
| Detector D                           | 22.27         | 15.25            | 12.19            | 13.72           |

# Report

RaNA

Mon Apr 10 16:07:47 2006

## Chapter 1

**/root/RaNA-Mon-Apr-10-  
14:22:47-2006/rana-view**

## Chapter 2

**/root/RaNA-Mon-Apr-10-  
14:22:47-2006/rana-tn**

## Chapter 3

**/root/RaNA-Mon-Apr-10-  
14:22:47-2006/rana-oft**

## Chapter 4

**/root/RaNA-Mon-Apr-10-  
14:22:47-2006/rana-ling**

### 4.1 rana\_ling\_mini\_report\_001

**RANA\_LING 001**

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604081545

Contained in directory: /moredata

INPUT

Channel: A

Sky temperature source: RMON\_TEMP

Ref temperature source: SKY\_TEMP

Changing voltage channel: Ref

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 11.982578               | 0.00066796871                  | 12.800000              | 0.0000000                     | 1.4209387               | 0.0021535281                   | 1.4355605              | 0.0000000                     |
| 13.509188               | 0.0013647235                   | 12.800000              | 0.0000000                     | 1.4916528               | 0.0022109362                   | 1.4385777              | 0.0000000                     |
| 15.186900               | 0.0015477908                   | 12.800000              | 0.0000000                     | 1.5673083               | 0.0023210500                   | 1.4418543              | 0.0000000                     |
| 16.965250               | 0.0016629766                   | 12.800000              | 0.0000000                     | 1.6460962               | 0.0023835342                   | 1.4455770              | 0.0000000                     |
| 18.807276               | 0.0017292171                   | 12.800000              | 0.0000000                     | 1.7263672               | 0.0024650950                   | 1.4500986              | 0.0000000                     |
| 20.703377               | 0.0047018002                   | 12.800000              | 0.0000000                     | 1.8067493               | 0.0026095085                   | 1.4545985              | 0.0000000                     |
| 22.633661               | 0.0064634359                   | 12.800000              | 0.0000000                     | 1.8872256               | 0.0027163964                   | 1.4593149              | 0.0000000                     |
| 24.584471               | 0.0035923487                   | 12.800000              | 0.0000000                     | 1.9668155               | 0.0027759676                   | 1.4638804              | 0.0000000                     |
| 26.557478               | 0.0033608228                   | 12.961092              | 0.0051455456                  | 2.0456022               | 0.0028479151                   | 1.4717213              | 0.0000000                     |
| 28.513538               | 0.011756675                    | 13.175012              | 0.011214501                   | 2.1224890               | 0.0030078064                   | 1.4831747              | 0.0000000                     |
| 30.546484               | 0.0048519443                   | 13.412120              | 0.0033968948                  | 2.2013029               | 0.0030138429                   | 1.4972374              | 0.0000000                     |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -13.467028 | -0.13559971     | 0.040164367 | 0.00018631635    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0075895407 | 0.0045004748 | 22.575577              | 0.14877793                    |

## COMMENTS

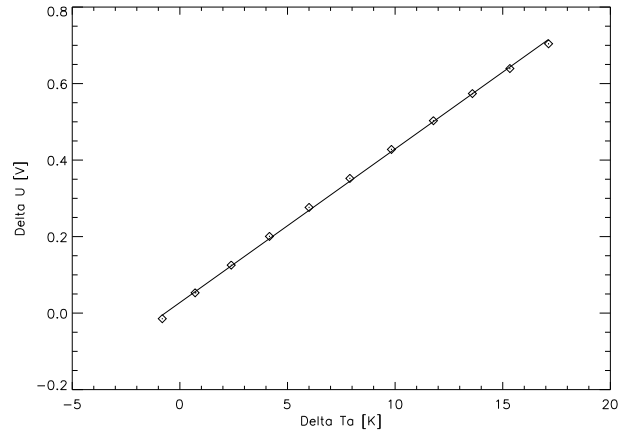


Figure 4.1: Response linearity (differenced values)

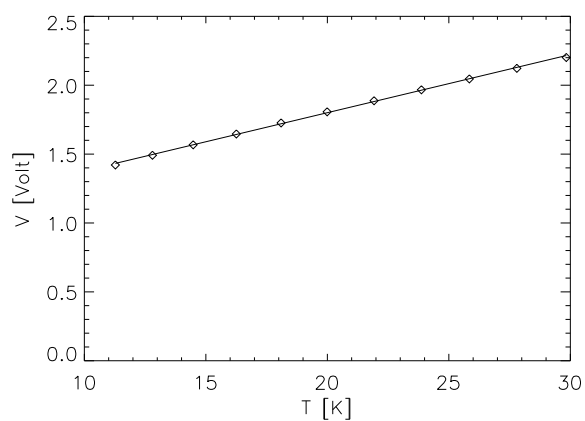


Figure 4.2: Response linearity (changing temperature vs changing voltage)

## 4.2 rana\_ling\_mini\_report\_002

### RANA\_LING 002

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604081545

Contained in directory: /moredata

INPUT

Channel: B

Sky temperature source: RMON\_TEMP

Ref temperature source: SKY\_TEMP

Changing voltage channel: Ref

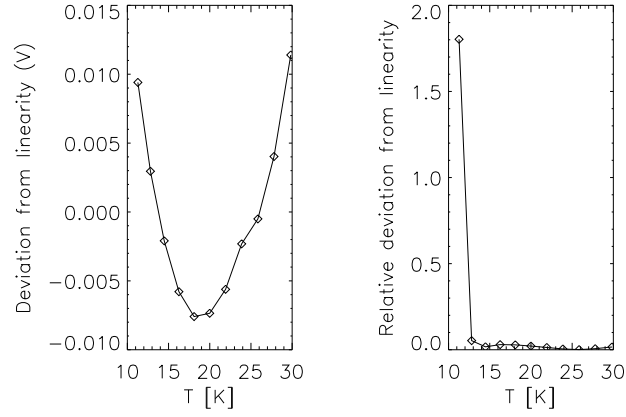


Figure 4.3: Deviation from linearity

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 11.982347               | 0.00071689778                  | 12.800000              | 0.0000000                     | 1.5054175               | 0.0022926114                   | 1.5089695              | 0.0000000                     |
| 13.509529               | 0.00097130542                  | 12.800000              | 0.0000000                     | 1.5802207               | 0.0023770129                   | 1.5120145              | 0.0000000                     |
| 15.187235               | 0.0013530200                   | 12.800000              | 0.0000000                     | 1.6597703               | 0.0024611853                   | 1.5152448              | 0.0000000                     |
| 16.964268               | 0.0027196549                   | 12.800000              | 0.0000000                     | 1.7428286               | 0.0025682056                   | 1.5194170              | 0.0000000                     |
| 18.807703               | 0.0014253096                   | 12.800000              | 0.0000000                     | 1.8273898               | 0.0026552156                   | 1.5243730              | 0.0000000                     |
| 20.704794               | 0.0032021415                   | 12.800000              | 0.0000000                     | 1.9117911               | 0.0027553566                   | 1.5292517              | 0.0000000                     |
| 22.635660               | 0.0034663822                   | 12.800000              | 0.0000000                     | 1.9961787               | 0.0028426470                   | 1.5344513              | 0.0000000                     |
| 24.585888               | 0.0021992659                   | 12.800000              | 0.0000000                     | 2.0794190               | 0.0029329682                   | 1.5394163              | 0.0000000                     |
| 26.553930               | 0.0075820000                   | 12.957900              | 0.0075384169                  | 2.1614101               | 0.0030779622                   | 1.5474368              | 0.0000000                     |
| 28.520657               | 0.0063672578                   | 13.181936              | 0.0082141897                  | 2.2424208               | 0.0031549820                   | 1.5606986              | 0.0000000                     |
| 30.541199               | 0.0098965922                   | 13.409437              | 0.0056114802                  | 2.3239418               | 0.0032550974                   | 1.5742642              | 0.0000000                     |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -13.449503 | -0.13491007     | 0.042056476 | 0.00018822718    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0076865760 | 0.0045168049 | 22.909080              | 0.13128681                    |

## COMMENTS

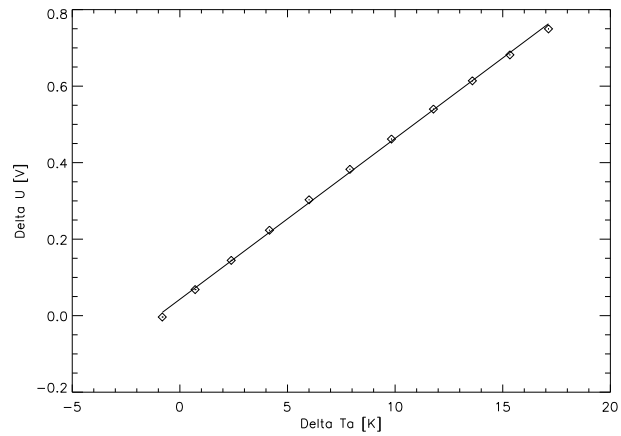


Figure 4.4: Response linearity (differenced values)

### 4.3 rana\_ling\_mini\_report\_003

#### RANA\_LING 003

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604081545  
 Contained in directory: /moredata

INPUT

Channel: C

Sky temperature source: REF\_TEMP

Ref temperature source: SKY\_TEMP

Changing voltage channel: Ref

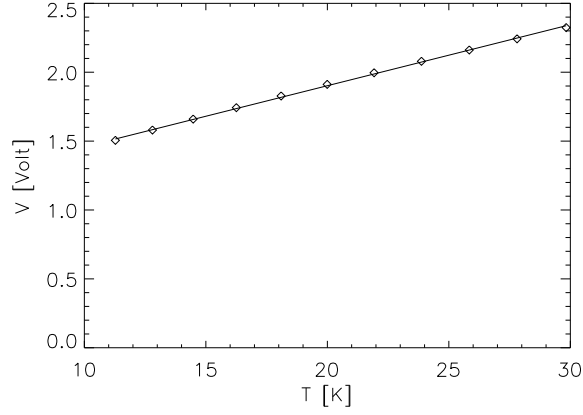


Figure 4.5: Response linearity (changing temperature vs changing voltage)

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 9.5999022               | 6.6839639e-05                  | 12.800000              | 0.0000000                     | 1.0555964               | 0.0016767969                   | 1.1523812              | 0.0016767969                  |
| 11.800000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.1238877               | 0.0017887861                   | 1.1543394              | 0.0017887861                  |
| 14.000000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.1934081               | 0.0018605301                   | 1.1560887              | 0.0018605301                  |
| 16.200001               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.2628413               | 0.0019549326                   | 1.1580869              | 0.0019549326                  |
| 18.400000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.3319033               | 0.0020406471                   | 1.1606103              | 0.0020406471                  |
| 20.600000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.4002203               | 0.0021264964                   | 1.1631813              | 0.0021264964                  |
| 22.799999               | 0.0000000                      | 12.800001              | 0.0000000                     | 1.4677575               | 0.0022045620                   | 1.1659388              | 0.0022045620                  |
| 25.000000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.5343932               | 0.0022816783                   | 1.1686811              | 0.0022816783                  |
| 27.200001               | 0.0000000                      | 12.958149              | 0.0065274816                  | 1.6004446               | 0.0023560188                   | 1.1738289              | 0.0023560188                  |
| 29.400000               | 0.0000000                      | 13.166924              | 0.015469675                   | 1.6648729               | 0.0024547950                   | 1.1814923              | 0.0024547950                  |
| 31.600002               | 0.0000000                      | 13.398949              | 0.0094590932                  | 1.7283325               | 0.0025166261                   | 1.1909163              | 0.0025166261                  |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -15.323569 | -0.26511811     | 0.029811657 | 0.00012478735    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0035281224 | 0.0035034611 | 25.399550              | 0.13324288                    |

## COMMENTS

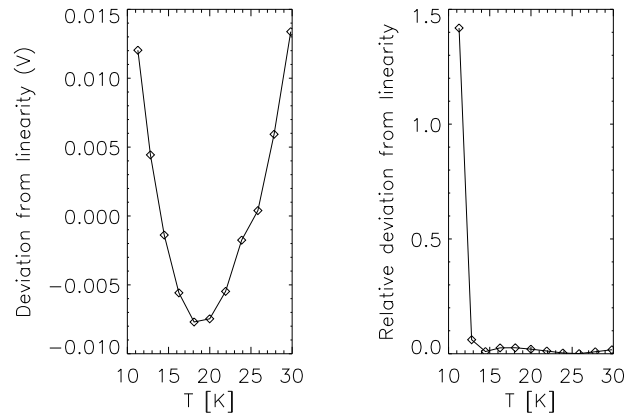


Figure 4.6: Deviation from linearity

## 4.4 rana\_ling\_mini\_report\_004

### RANA\_LING 004

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604081545  
 Contained in directory: /moredata

#### INPUT

Channel: D

Sky temperature source: REF\_TEMP

Ref temperature source: SKY\_TEMP

Changing voltage channel: Ref

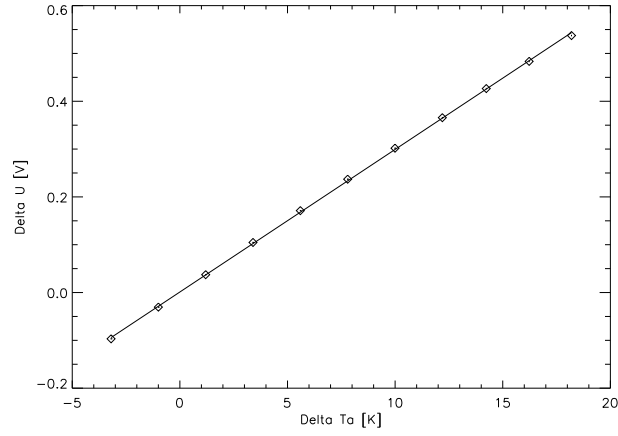


Figure 4.7: Response linearity (differenced values)

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 9.5999022               | 6.6062283e-05                  | 12.800000              | 0.0000000                     | 1.2732846               | 0.0018410388                   | 1.3676590              | 0.0018410388                  |
| 11.800000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.3503327               | 0.0019517352                   | 1.3695240              | 0.0019517352                  |
| 14.000000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.4285145               | 0.0020358699                   | 1.3713513              | 0.0020358699                  |
| 16.200001               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.5068821               | 0.0021209899                   | 1.3736672              | 0.0021209899                  |
| 18.400000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.5846124               | 0.0022005127                   | 1.3764739              | 0.0022005127                  |
| 20.600000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.6617167               | 0.0022795654                   | 1.3796544              | 0.0022795654                  |
| 22.799999               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.7376172               | 0.0023612054                   | 1.3827143              | 0.0023612054                  |
| 25.000000               | 0.0000000                      | 12.800001              | 0.0000000                     | 1.8124754               | 0.0024467182                   | 1.3858918              | 0.0024467182                  |
| 27.200001               | 0.0000000                      | 12.958264              | 0.0076941960                  | 1.8865034               | 0.0025276615                   | 1.3916747              | 0.0025276615                  |
| 29.400000               | 0.0000000                      | 13.175714              | 0.010735376                   | 1.9591901               | 0.0025978271                   | 1.4012844              | 0.0025978271                  |
| 31.600000               | 0.0000000                      | 13.398812              | 0.010492285                   | 2.0301294               | 0.0026866043                   | 1.4110700              | 0.0026866043                  |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -15.484884 | -0.26963822     | 0.033519697 | 0.00013195655    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0036199950 | 0.0036486634 | 27.935176              | 0.12856437                    |

## COMMENTS

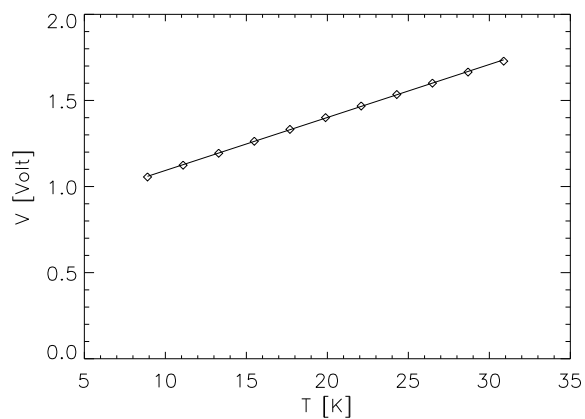


Figure 4.8: Response linearity (changing temperature vs changing voltage

## 4.5 rana\_ling\_mini\_report\_005

### RANA\_LING 005

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604081545

Contained in directory: /moredata

#### INPUT

Channel: A

Sky temperature source: REF\_TEMP

Ref temperature source: SKY\_TEMP

Changing voltage channel: Ref

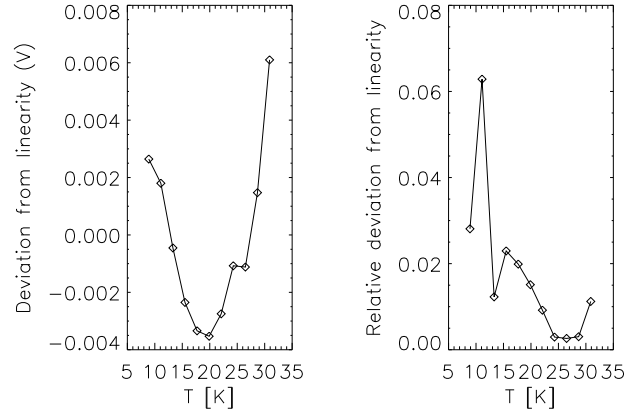


Figure 4.9: Deviation from linearity

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 9.5999022               | 6.6677218e-05                  | 12.800000              | 0.0000000                     | 1.4209142               | 0.0021538318                   | 1.4355180              | 0.0021538318                  |
| 11.800000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.4916281               | 0.0022102136                   | 1.4385289              | 0.0022102136                  |
| 14.000000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.5673028               | 0.0023209889                   | 1.4418419              | 0.0023209889                  |
| 16.200001               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.6460588               | 0.0023864211                   | 1.4455650              | 0.0023864211                  |
| 18.400000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.7261720               | 0.0024869987                   | 1.4500236              | 0.0024869987                  |
| 20.600000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.8069735               | 0.0025951705                   | 1.4546474              | 0.0025951705                  |
| 22.799999               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.8874299               | 0.0026846734                   | 1.4593411              | 0.0026846734                  |
| 25.000000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.9669446               | 0.0027727446                   | 1.4639282              | 0.0027727446                  |
| 27.200001               | 0.0000000                      | 12.958024              | 0.0070174984                  | 2.0454048               | 0.0028672986                   | 1.4713954              | 0.0028672986                  |
| 29.400000               | 0.0000000                      | 13.178581              | 0.0077455672                  | 2.1227390               | 0.0029527192                   | 1.4835465              | 0.0029527192                  |
| 31.599998               | 0.0000000                      | 13.405363              | 0.0060779983                  | 2.2006045               | 0.0030622754                   | 1.4964363              | 0.0030622754                  |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -13.380139 | -0.12988374     | 0.033906725 | 0.00015705949    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0050573139 | 0.0040459915 | 30.658146              | 0.16810497                    |

## COMMENTS

With  $T_{\text{ref}} = T$  measured by the sensor on Cu plate

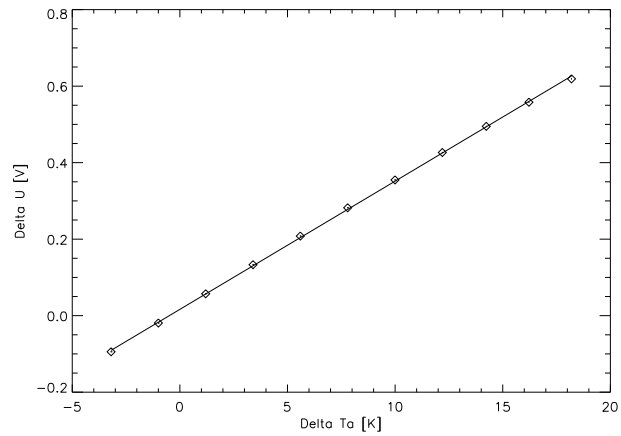


Figure 4.10: Response linearity (differenced values)

## 4.6 rana\_ling\_mini\_report\_006

### RANA\_LING 006

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604081545  
 Contained in directory: /moredata

#### INPUT

Channel: B

Sky temperature source: REF\_TEMP

Ref temperature source: SKY\_TEMP

Changing voltage channel: Ref

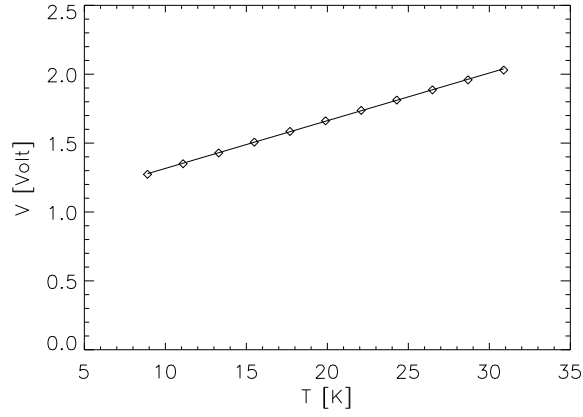


Figure 4.11: Response linearity (changing temperature vs changing voltage)

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 9.5999022               | 6.5479777e-05                  | 12.800001              | 0.0000000                     | 1.5054041               | 0.0022935124                   | 1.5089478              | 0.0000000                     |
| 11.800000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.5802373               | 0.0023770738                   | 1.5120287              | 0.0000000                     |
| 14.000000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.6597763               | 0.0024614655                   | 1.5152916              | 0.0000000                     |
| 16.200001               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.7429079               | 0.0025586125                   | 1.5194516              | 0.0000000                     |
| 18.400000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.8274309               | 0.0026510906                   | 1.5243976              | 0.0000000                     |
| 20.600000               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.9117480               | 0.0027575097                   | 1.5292502              | 0.0000000                     |
| 22.799999               | 0.0000000                      | 12.800000              | 0.0000000                     | 1.9962186               | 0.0028389309                   | 1.5344575              | 0.0000000                     |
| 25.000000               | 0.0000000                      | 12.800000              | 0.0000000                     | 2.0793468               | 0.0029381590                   | 1.5394008              | 0.0000000                     |
| 27.200001               | 0.0000000                      | 12.960229              | 0.0057820906                  | 2.1616024               | 0.0030485231                   | 1.5476928              | 0.0000000                     |
| 29.400002               | 0.0000000                      | 13.174619              | 0.0093795089                  | 2.2418880               | 0.0031789776                   | 1.5597359              | 0.0000000                     |
| 31.600000               | 0.0000000                      | 13.409122              | 0.0050511207                  | 2.3239233               | 0.0032466074                   | 1.5742188              | 0.0000000                     |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -13.358636 | -0.12896226     | 0.035563895 | 0.00017179535    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0046087545 | 0.0041752696 | 31.086467              | 0.16799631                    |

## COMMENTS

With T ref= T measured by the sensor on Cu plate

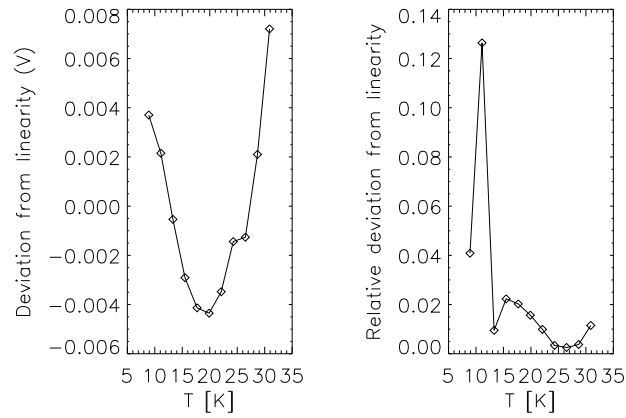


Figure 4.12: Deviation from linearity

## 4.7 rana\_ling\_mini\_report\_007

### RANA\_LING 007

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604081545  
 Contained in directory: /moredata

INPUT

Channel: C

Sky temperature source: RMON\_TEMP

Ref temperature source: SKY\_TEMP

Changing voltage channel: Ref

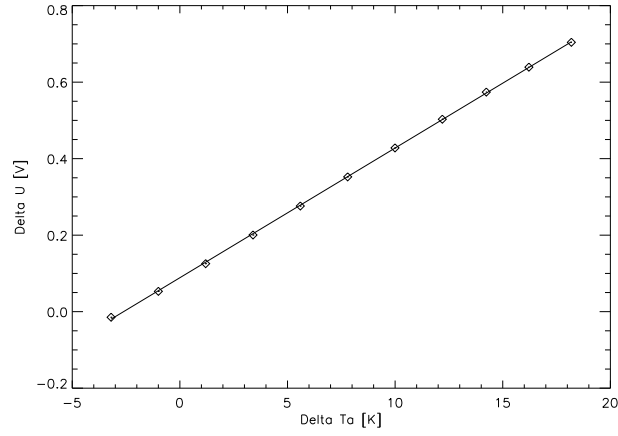


Figure 4.13: Response linearity (differenced values)

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 11.982489               | 0.00069501746                  | 12.800001              | 0.0000000                     | 1.0556184               | 0.0016758161                   | 1.1524026              | 0.0016758161                  |
| 13.508871               | 0.0015950449                   | 12.800000              | 0.0000000                     | 1.1238936               | 0.0017891768                   | 1.1543396              | 0.0017891768                  |
| 15.185651               | 0.0030551120                   | 12.800001              | 0.0000000                     | 1.1933862               | 0.0018619660                   | 1.1560650              | 0.0018619660                  |
| 16.964153               | 0.0026930780                   | 12.800000              | 0.0000000                     | 1.2628562               | 0.0019547193                   | 1.1580978              | 0.0019547193                  |
| 18.805647               | 0.0035486810                   | 12.800000              | 0.0000000                     | 1.3319074               | 0.0020404005                   | 1.1606024              | 0.0020404005                  |
| 20.703917               | 0.0036034249                   | 12.800000              | 0.0000000                     | 1.4002482               | 0.0021249699                   | 1.1632013              | 0.0021249699                  |
| 22.635294               | 0.0039195488                   | 12.800000              | 0.0000000                     | 1.4678285               | 0.0022030339                   | 1.1659717              | 0.0022030339                  |
| 24.582518               | 0.0067112655                   | 12.800000              | 0.0000000                     | 1.5343880               | 0.0022833480                   | 1.1686819              | 0.0022833480                  |
| 26.550461               | 0.011033615                    | 12.955274              | 0.0082292743                  | 1.6003763               | 0.0023578529                   | 1.1735860              | 0.0023578529                  |
| 28.508118               | 0.016046016                    | 13.170852              | 0.012670017                   | 1.6649586               | 0.0024458486                   | 1.1818223              | 0.0024458486                  |
| 30.525085               | 0.017809119                    | 13.401829              | 0.0075325896                  | 1.7283945               | 0.0025137884                   | 1.1911342              | 0.0025137884                  |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -15.471828 | -0.28523369     | 0.035278795 | 0.00014890928    |

| $L$         | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|-------------|--------------|------------------------|-------------------------------|
| 0.011215284 | 0.0037171070 | 18.078506              | 0.12122658                    |

## COMMENTS

With  $T_{\text{ref}} = T$  measured by the sensor on Al

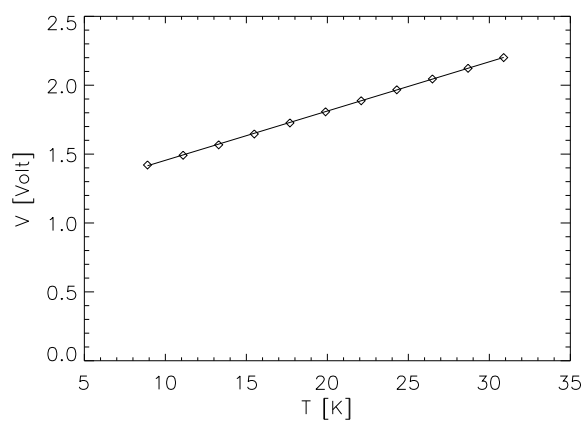


Figure 4.14: Response linearity (changing temperature vs changing voltage)

## 4.8 rana\_ling\_mini\_report\_008

### RANA\_LING 008

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604081545

Contained in directory: /moredata

#### INPUT

Channel: D

Sky temperature source: RMON\_TEMP

Ref temperature source: SKY\_TEMP

Changing voltage channel: Ref

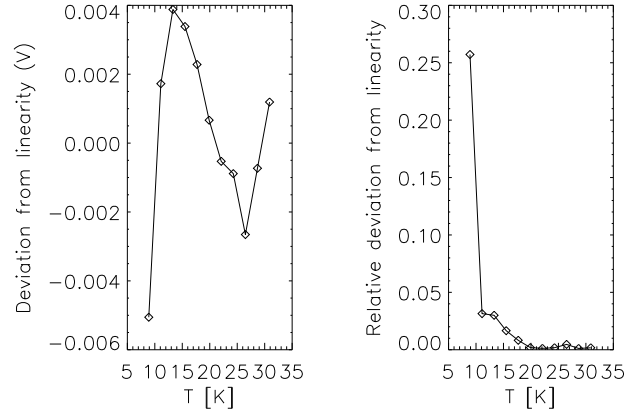


Figure 4.15: Deviation from linearity

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 11.982578               | 0.00061896961                  | 12.800000              | 0.0000000                     | 1.2733024               | 0.0018396107                   | 1.3676787              | 0.0018396107                  |
| 13.508640               | 0.0019545848                   | 12.800001              | 0.0000000                     | 1.3503613               | 0.0019531631                   | 1.3695590              | 0.0019531631                  |
| 15.185583               | 0.0026743696                   | 12.800000              | 0.0000000                     | 1.4285348               | 0.0020373039                   | 1.3713749              | 0.0020373039                  |
| 16.964268               | 0.0027196549                   | 12.800000              | 0.0000000                     | 1.5068523               | 0.0021226241                   | 1.3736436              | 0.0021226241                  |
| 18.804974               | 0.0046042581                   | 12.800000              | 0.0000000                     | 1.5846053               | 0.0021996232                   | 1.3764716              | 0.0021996232                  |
| 20.700945               | 0.0081301164                   | 12.800000              | 0.0000000                     | 1.6616298               | 0.0022836945                   | 1.3796003              | 0.0022836945                  |
| 22.633753               | 0.0050601116                   | 12.800000              | 0.0000000                     | 1.7376238               | 0.0023601788                   | 1.3827165              | 0.0023601788                  |
| 24.577927               | 0.011535820                    | 12.800001              | 0.0000000                     | 1.8124914               | 0.0024462621                   | 1.3859043              | 0.0024462621                  |
| 26.554150               | 0.0067312964                   | 12.957669              | 0.0068794033                  | 1.8865089               | 0.0025270247                   | 1.3916096              | 0.0025270247                  |
| 28.511024               | 0.012391493                    | 13.172464              | 0.010841809                   | 1.9591526               | 0.0025992831                   | 1.4009557              | 0.0025992831                  |
| 30.515636               | 0.027864676                    | 13.398812              | 0.010492285                   | 2.0301294               | 0.0026866043                   | 1.4110700              | 0.0026866043                  |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -15.642376 | -0.29106969     | 0.039756637 | 0.00016856968    |

| $L$         | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|-------------|--------------|------------------------|-------------------------------|
| 0.012961771 | 0.0040619396 | 20.186206              | 0.11781617                    |

## COMMENTS

With  $T_{\text{ref}} = T$  measured by the sensor on A1

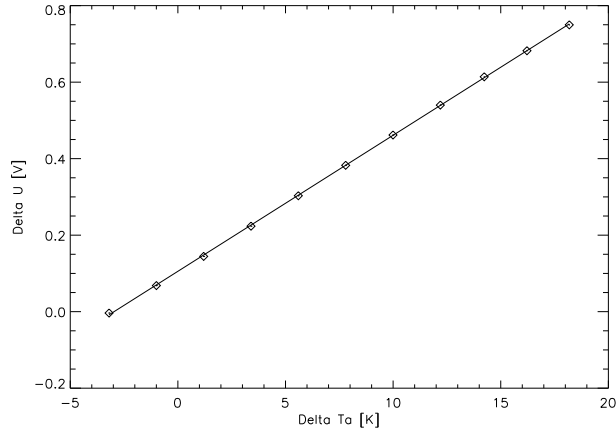


Figure 4.16: Response linearity (differenced values)

## 4.9 rana\_ling\_mini\_report\_009

### RANA\_LING 009

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604100200

Contained in directory: /moredata

INPUT

Channel: A

Sky temperature source: SKY\_TEMP

Ref temperature source: RMON\_TEMP

Changing voltage channel: Sky

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 12.800000               | 0.0000000                      | 11.982988              | 0.00062776817                 | 1.4354838               | 0.0022122709                   | 1.4208905              | 0.0022122709                  |
| 14.200000               | 0.0000000                      | 12.079956              | 0.0012695900                  | 1.5064351               | 0.0022756470                   | 1.4329974              | 0.0022756470                  |
| 16.000000               | 0.0000000                      | 12.373691              | 0.00046188568                 | 1.5918171               | 0.0024025824                   | 1.4519743              | 0.0024025824                  |
| 19.200001               | 0.0000000                      | 12.987848              | 0.00087153388                 | 1.7334707               | 0.0025775087                   | 1.4868075              | 0.0025775087                  |
| 22.471905               | 0.46666265                     | 13.693658              | 0.011330133                   | 1.8694320               | 0.0027319676                   | 1.5244722              | 0.0027319676                  |
| 25.600000               | 0.0000000                      | 14.426159              | 0.00092313456                 | 2.0014689               | 0.0029487814                   | 1.5647184              | 0.0029487814                  |
| 28.799999               | 0.0000000                      | 15.171201              | 0.00087432045                 | 2.1309974               | 0.0030896549                   | 1.6061119              | 0.0030896549                  |

RESULTS

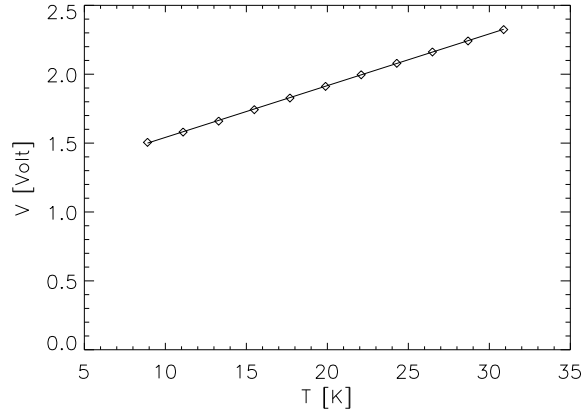


Figure 4.17: Response linearity (changing temperature vs changing voltage)

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -10.775525 | -0.034261107    | 0.039901425 | 0.00031058169    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0089141274 | 0.0048405072 | 21.218289              | 0.16205646                    |

COMMENTS

## 4.10 rana\_ling\_mini\_report\_010

### RANA\_LING 010

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604100200

Contained in directory: /moredata

#### INPUT

Channel: B

Sky temperature source: SKY\_TEMP

Ref temperature source: RMON\_TEMP

Changing voltage channel: Sky

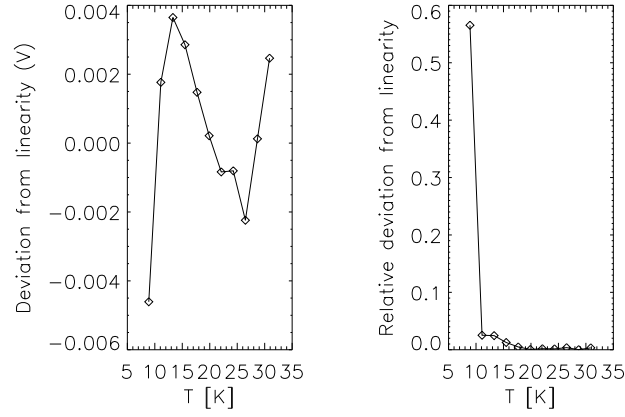


Figure 4.18: Deviation from linearity

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                       |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-----------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{f}}$ |
| 12.800001               | 0.0000000                      | 11.982622              | 0.00078988628                 | 1.5089332               | 0.0023338605                   | 1.5053927              | 0.002                 |
| 14.200000               | 0.0000000                      | 12.080332              | 0.0016035779                  | 1.5837529               | 0.0024312976                   | 1.5184570              | 0.002                 |
| 16.000000               | 0.0000000                      | 12.373694              | 0.00046069993                 | 1.6730980               | 0.0025216331                   | 1.5383054              | 0.002                 |
| 19.200001               | 0.0000000                      | 12.988025              | 0.00089674658                 | 1.8213001               | 0.0026930201                   | 1.5747814              | 0.002                 |
| 22.400000               | 0.0000000                      | 13.692038              | 0.00079987670                 | 1.9626478               | 0.0028770756                   | 1.6136139              | 0.002                 |
| 25.600000               | 0.0000000                      | 14.425656              | 0.00047452483                 | 2.1007900               | 0.0030133040                   | 1.6553950              | 0.002                 |
| 28.799999               | 0.0000000                      | 15.171157              | 0.00091467408                 | 2.2345413               | 0.0032295055                   | 1.6978219              | 0.002                 |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -10.756635 | -0.034274439    | 0.041829548 | 0.00030441953    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0091501555 | 0.0056219511 | 21.403087              | 0.18853232                    |

## COMMENTS

### 4.11 rana\_ling\_mini\_report\_011

#### RANA\_LING 011

Linearity, Isolation and Gain

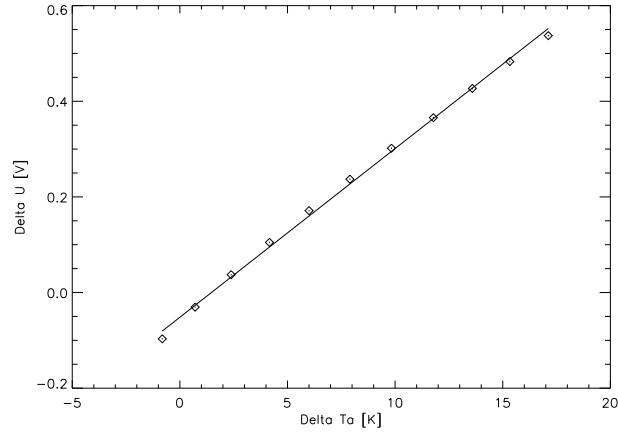


Figure 4.19: Response linearity (differenced values)

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604100200

Contained in directory: /moredata

INPUT

Channel: C

Sky temperature source: SKY\_TEMP

Ref temperature source: REF\_TEMP

Changing voltage channel: Sky

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 12.800000               | 0.0000000                      | 9.5999002              | 7.0969960e-05                 | 1.1524172               | 0.0018314532                   | 1.0556397              | 0.0018314532                  |
| 14.200000               | 0.0000000                      | 9.6933165              | 0.0015294501                  | 1.2091003               | 0.0019130971                   | 1.0648627              | 0.0019130971                  |
| 16.000000               | 0.0000000                      | 10.091539              | 0.0010111423                  | 1.2779468               | 0.0019893987                   | 1.0829606              | 0.0019893987                  |
| 19.200001               | 0.0000000                      | 10.882026              | 0.0010566262                  | 1.3928412               | 0.0021243977                   | 1.1162315              | 0.0021243977                  |
| 22.400000               | 0.0000000                      | 11.738089              | 0.0010492806                  | 1.5035797               | 0.0022344986                   | 1.1510148              | 0.0022344986                  |
| 25.600000               | 0.0000000                      | 12.619502              | 0.00078373024                 | 1.6117942               | 0.0023836430                   | 1.1873016              | 0.0023836430                  |
| 28.799999               | 0.0000000                      | 13.497513              | 0.00095324096                 | 1.7178234               | 0.0025082267                   | 1.2237981              | 0.0025082267                  |

RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -11.284475 | -0.041505530    | 0.032990718 | 0.00025066328    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0061149982 | 0.0041899044 | 20.648450              | 0.16988533                    |

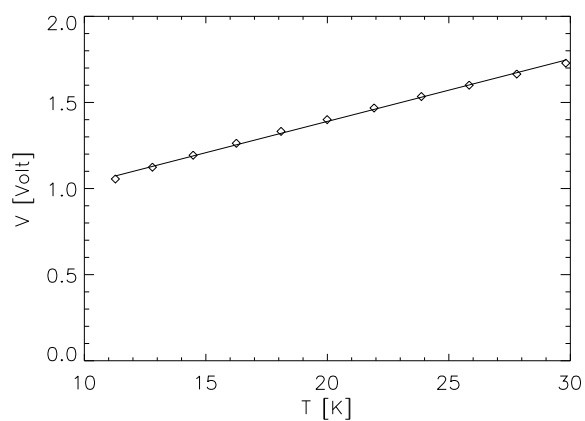


Figure 4.20: Response linearity (changing temperature vs changing voltage)

COMMENTS

## 4.12 rana\_ling\_mini\_report\_012

### RANA\_LING 012

Linearity, Isolation and Gain

Data from file set: 030LFI27\_RCA\_FM\_LIS\_200604100200

Contained in directory: /moredata

#### INPUT

Channel: D

Sky temperature source: SKY\_TEMP

Ref temperature source: REF\_TEMP

Changing voltage channel: Sky

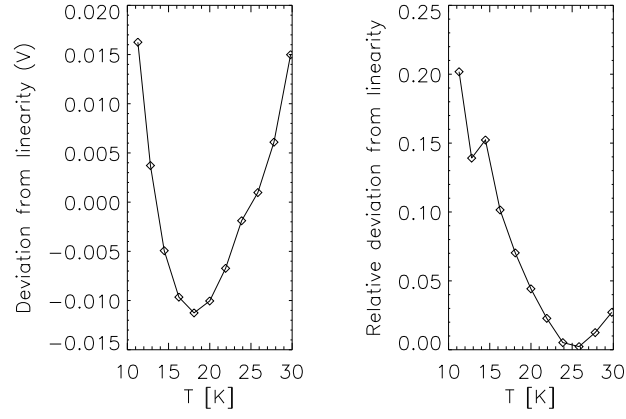


Figure 4.21: Deviation from linearity

| 30.0 GHz radiometer     |                                |                        |                               |                         |                                |                        |                               |
|-------------------------|--------------------------------|------------------------|-------------------------------|-------------------------|--------------------------------|------------------------|-------------------------------|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{fixed}}$ [V] |
| 12.800001               | 0.0000000                      | 9.5999031              | 6.5880464e-05                 | 1.3676630               | 0.0019903738                   | 1.2732850              | 0.0019903738                  |
| 14.200000               | 0.0000000                      | 9.6929407              | 0.0012788934                  | 1.4326905               | 0.0020663458                   | 1.2841624              | 0.0019903738                  |
| 16.000000               | 0.0000000                      | 10.091534              | 0.0010268246                  | 1.5115485               | 0.0021501880                   | 1.3050227              | 0.0019903738                  |
| 19.200001               | 0.0000000                      | 10.882008              | 0.0010476039                  | 1.6429720               | 0.0022897912                   | 1.3431714              | 0.0019903738                  |
| 22.400000               | 0.0000000                      | 11.738315              | 0.0010730720                  | 1.7693073               | 0.0024342936                   | 1.3828550              | 0.0019903738                  |
| 25.600000               | 0.0000000                      | 12.620363              | 0.0015990345                  | 1.8922046               | 0.0025979493                   | 1.4242862              | 0.0019903738                  |
| 28.800001               | 0.0000000                      | 13.497933              | 0.0012280812                  | 2.0132178               | 0.0026997870                   | 1.4662501              | 0.0019903738                  |
| 33.790051               | 0.058180261                    | 14.843652              | 0.00067262113                 | 2.1913474               | 0.0022590579                   | 1.5302533              | 0.0019903738                  |

## RESULTS

| $I$ [dB]   | $\sigma I$ [dB] | $G$ [V/K]   | $\sigma G$ [V/K] |
|------------|-----------------|-------------|------------------|
| -10.975075 | -0.027857450    | 0.036507115 | 0.00022693261    |

| $L$          | $\sigma L$   | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|--------------|--------------|------------------------|-------------------------------|
| 0.0098067546 | 0.0048686898 | 22.638951              | 0.17112143                    |

## COMMENTS

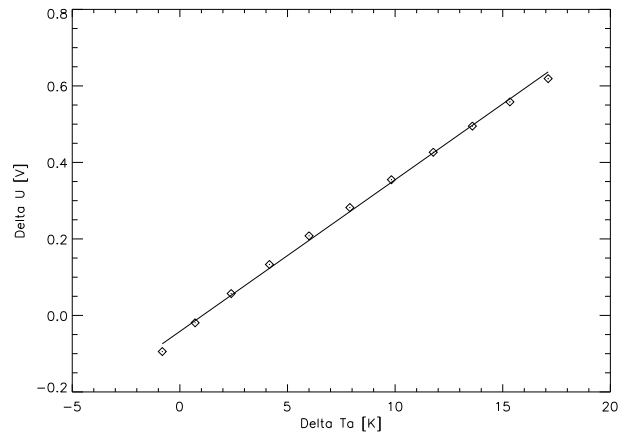


Figure 4.22: Response linearity (differenced values)

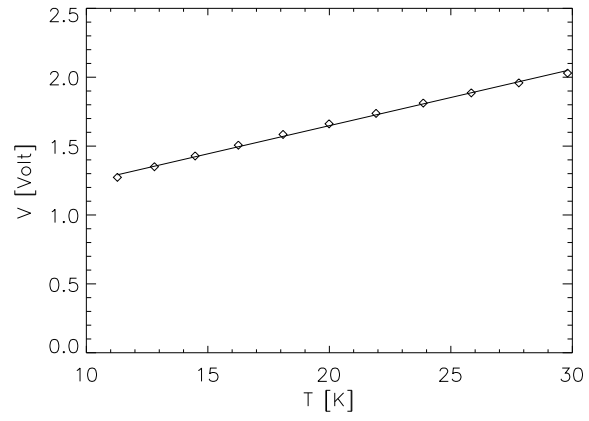


Figure 4.23: Response linearity (changing temperature vs changing voltage)

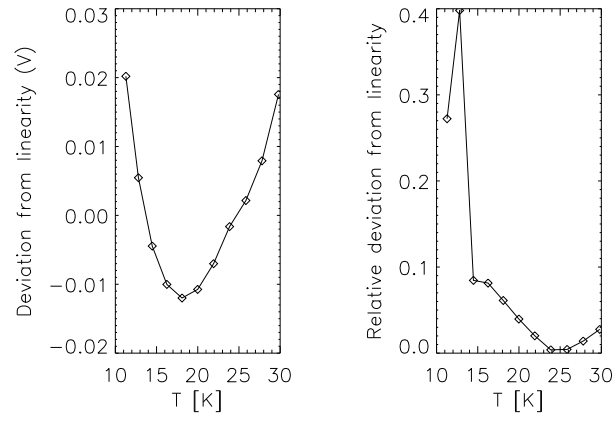


Figure 4.24: Deviation from linearity

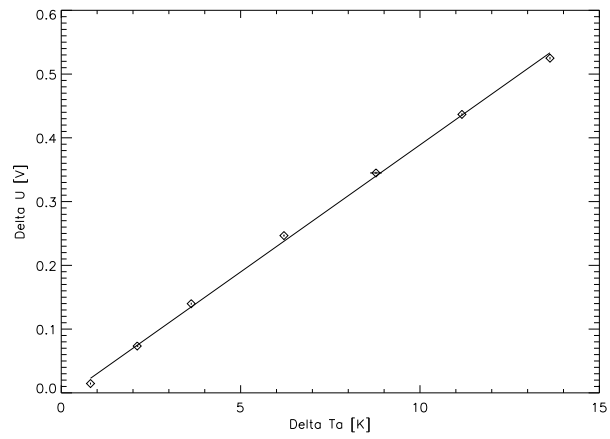


Figure 4.25: Response linearity (differenced values)

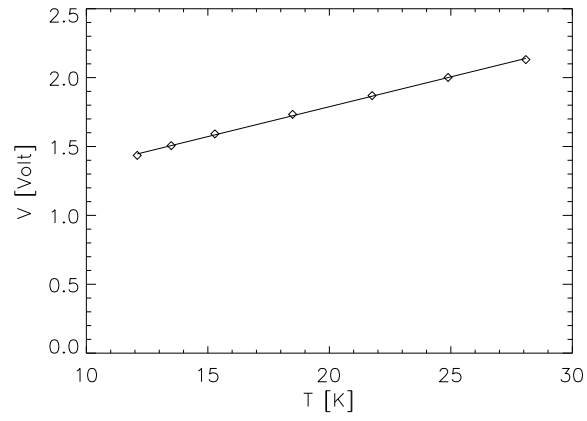


Figure 4.26: Response linearity (changing temperature vs changing voltage)

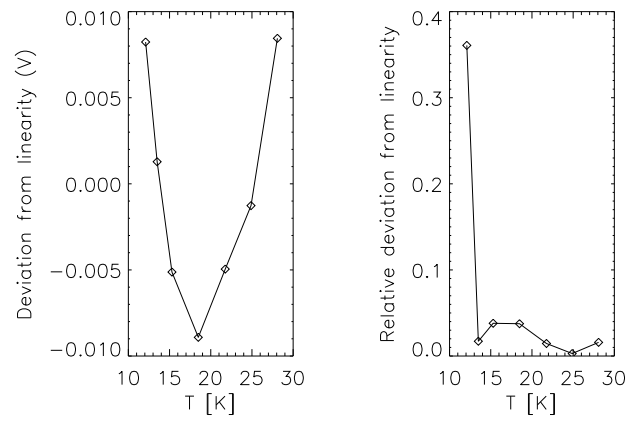


Figure 4.27: Deviation from linearity

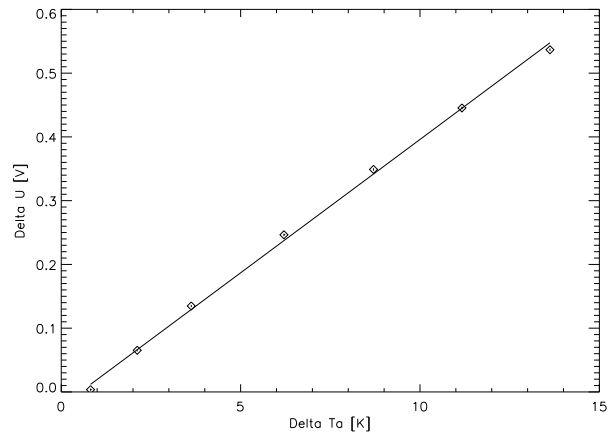


Figure 4.28: Response linearity (differenced values)

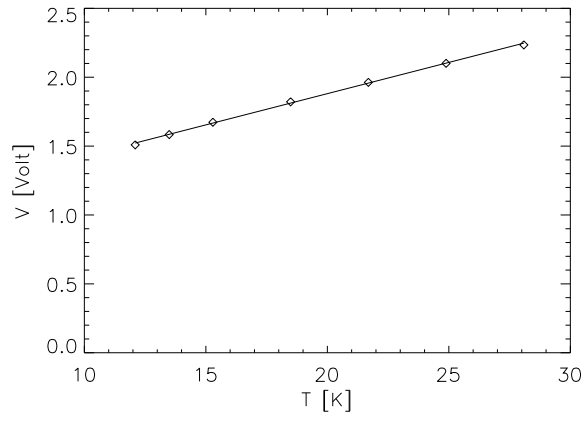


Figure 4.29: Response linearity (changing temperature vs changing voltage)

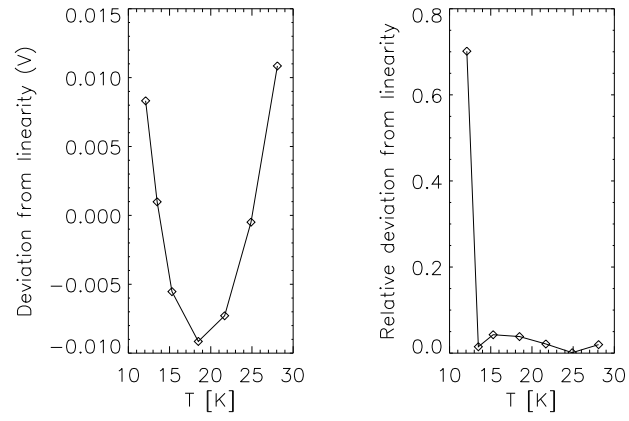


Figure 4.30: Deviation from linearity

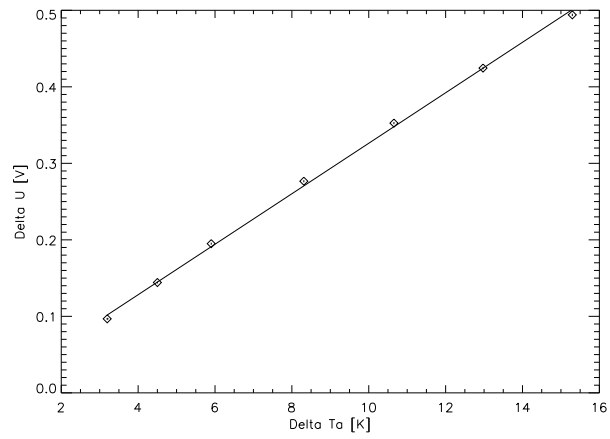


Figure 4.31: Response linearity (differenced values)

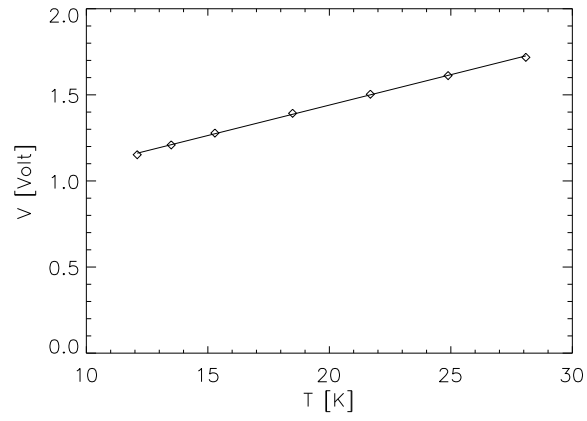


Figure 4.32: Response linearity (changing temperature vs changing voltage)

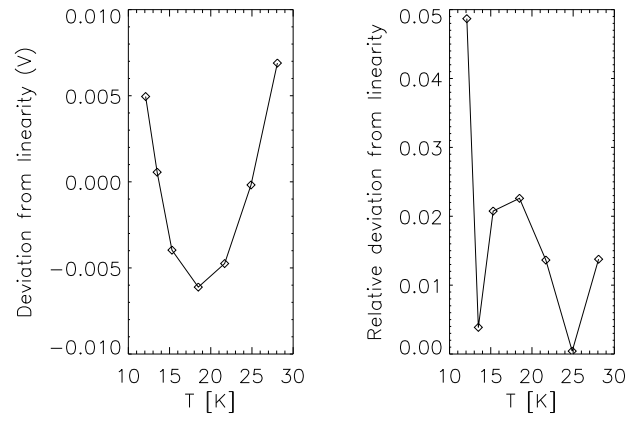


Figure 4.33: Deviation from linearity

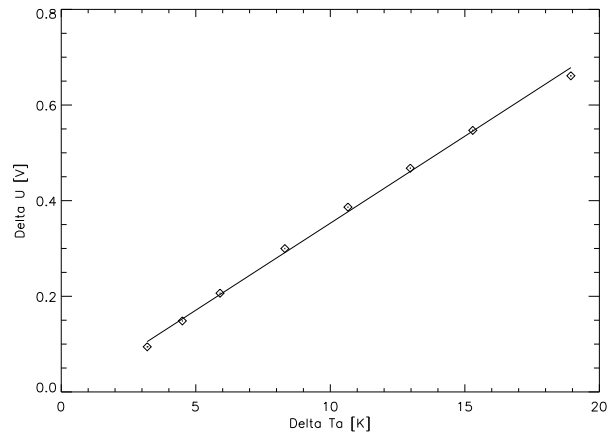


Figure 4.34: Response linearity (differenced values)

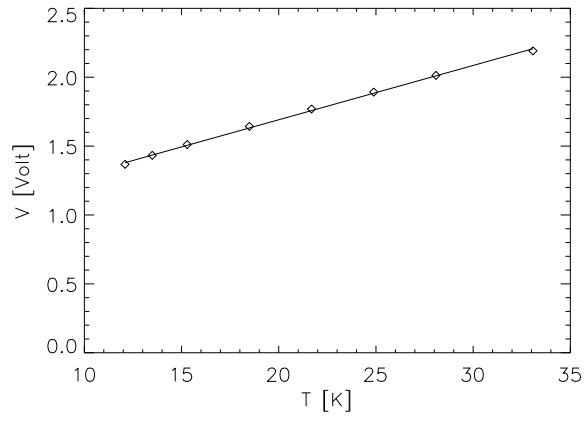


Figure 4.35: Response linearity (changing temperature vs changing voltage)

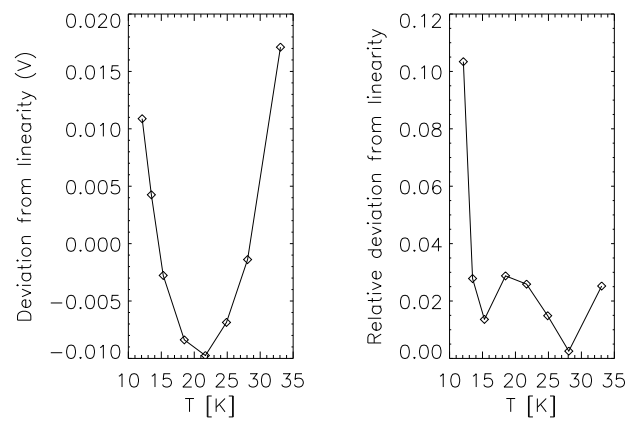


Figure 4.36: Deviation from linearity

## Chapter 5

**/root/RaNA-Mon-Apr-10-  
14:22:47-2006/rana-fft**

## Chapter 6

**/root/RaNA-Mon-Apr-10-  
14:22:47-2006/rana-susc**

## Chapter 7

**/root/RaNA-Mon-Apr-10-  
14:22:47-2006/rana-spr**

Data used in this report are taken from the 030LFI27\_RCA\_FM\_LIS\_200604081545 dataset.

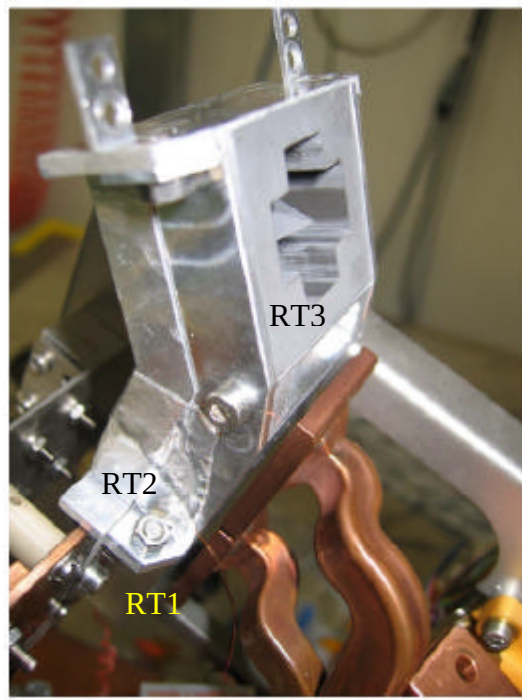


Fig. 1 4K RL mounted on the RCA chamber during RCA27 calibration run.

I assume a thermal contact between the stainless steel support (at about 21.5 K) and the RT2. The temperatures of the RT1 and RT2 will then depend mainly on three thermal conductances:

K1 is the thermal conductance between RT1 and the copper control stage;

K2 is the thermal conductance between RT2 and RT1;

K3 is the contact between support and RT2 envelope.

### First step

I want to reproduce the temperature differences, in a steady state between the REFMON sensor, located on the back of RT2, and the REFCTR sensor, mounted on the copper control stage. We can apply the equation:

$$K3 * \Delta T_{SS-RT2} = \frac{1}{\frac{1}{K1} + \frac{1}{K2}} \cdot \Delta T_{RT2-CTR}$$

to estimate the ratio between the two conductances.

I use then four transient steps to fit the measured curve and evaluate the absolute conductance between REFMON and REFCTR sensors.

The curve for simulated RT2 back temperature is compared with the measured curve in Fig. 2. On the lowest steady state the heat flow through the reference load is about 36 mW.

### Second step

After having fixed a good matching between simulated and measured thermal data, I study the correlation between the temperature curves of RT2 and the RCA outputs A and B. I take as a

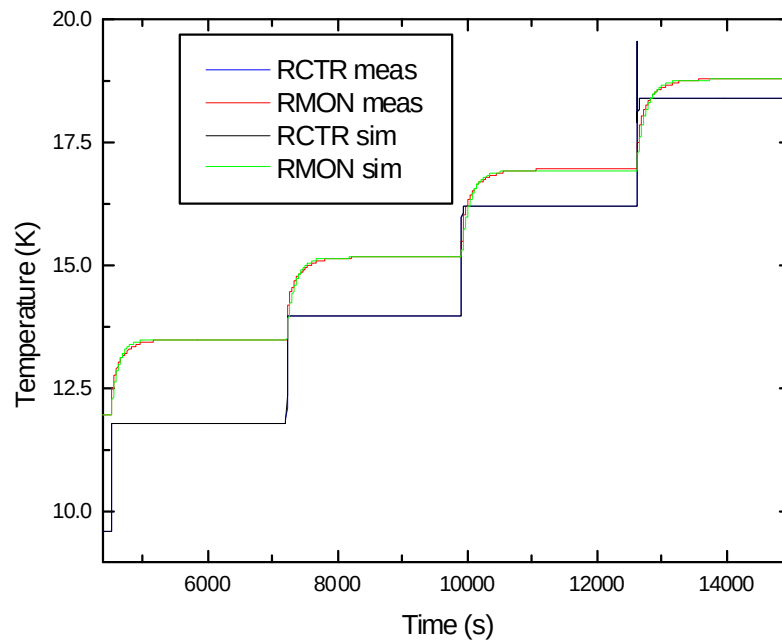


Fig. 2 Comparison between simulated and measured temperatures. RCTR is the input to the simulation so that the simulated and measured curves are not distinguishable

reference a thermal node at half the pyramid height of RT2 and correlate its (antenna) temperature to the BEM voltage. The corresponding Voltage vs Temperature curves are shown in Fig. 3

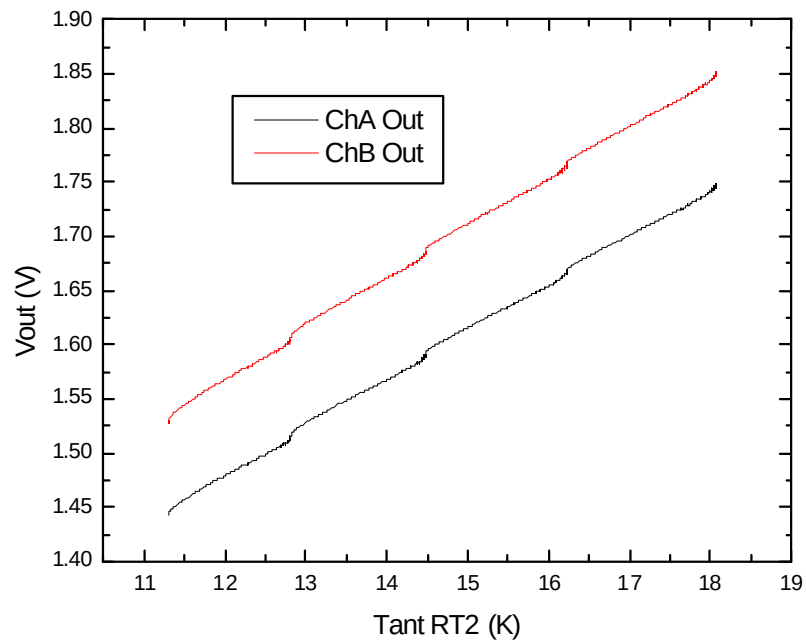


Fig. 3 The V vs T curves whose linear fit is used to estimate the noise temperatures for channels A and B

From a linear fit performed on these curves the noise temperature was calculated (see Conclusions).

### Third step

Finally I modulate K1 and K2 in order to have a correlation between RT1 and channels C and D output comparable to the RT2 one, also during transient steps in order to estimate the right RT1 temperature to be used in the data analysis. The result is shown in Fig. 4

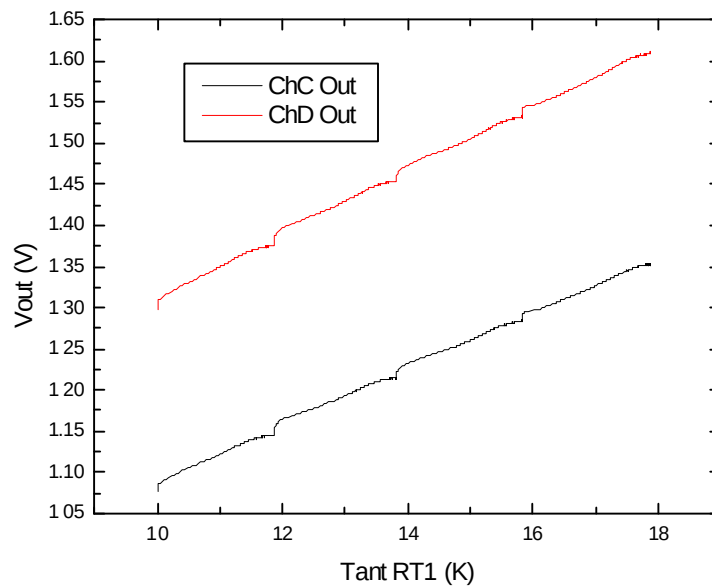


Fig. 4 The V vs T curves whose linear fit is used to estimate the noise temperatures for channels C and D

### Conclusions

A thermal model of the 4 K reference load mounted on the RCA cryochamber during the RCA27 test run was developed in order to estimate the reference targets actual temperature observed by the reference horns. The use of a sensor located on the back of one of the targets provided us a good check for the model. A further analysis is foreseen to

- increase the accuracy for the RT1 temperature curve recovery,
- extend the results at all steps of the dataset in order to check the possibility of a parabolic fit
- hopefully extend this study to obtain similar results for the RCA28 data analysis.

In the table below a summary of the RCA parameters evaluated

| Ch Id                                   | A       | B       | C       | D       |
|-----------------------------------------|---------|---------|---------|---------|
| Gain (V/K)                              | 0.04446 | 0.04683 | 0.03467 | 0.03905 |
| Noise Temperature (K) (from linear fit) | 21.243  | 21.455  | 21.204  | 23.404  |

RCA\_SPR Rana\_Report  
Datafile SPR 1449

F.Villa, P.Battaglia, L.Stringhetti

Thu Apr 6 16:20:08 2006

### 0.0.1 RANA\_SPR\_001

Data from file set: 030LFI27\_RCA\_FM\_SPR\_200604061449

Contained in directory: /moredata

#### Input Data

Frequency: 30 GHz

Trigger Detector: C

F\_min: 26.50 GHz

F\_max: 40.00 GHz

Step: 0.05 GHz

Threshold: 0.1000 V/s

Useful Data: 50.00 %

Calibration File: /home/battaglia/LIFE\_updated/30\_GHz\_FM\_22032006.dat.txt

#### Comments

#### Output Data

Table 1: Central frequency and equivalent bandwidth.

| CHANNEL | CENTRAL FREQUENCY<br>(GHz) | EQUIVALENT BANDWIDTH<br>(GHz) |
|---------|----------------------------|-------------------------------|
| A       | 31.80                      | 4.30                          |
| B       | 31.30                      | 4.11                          |
| C       | 30.70                      | 3.71                          |
| D       | 30.45                      | 3.89                          |

## Derivative Plots

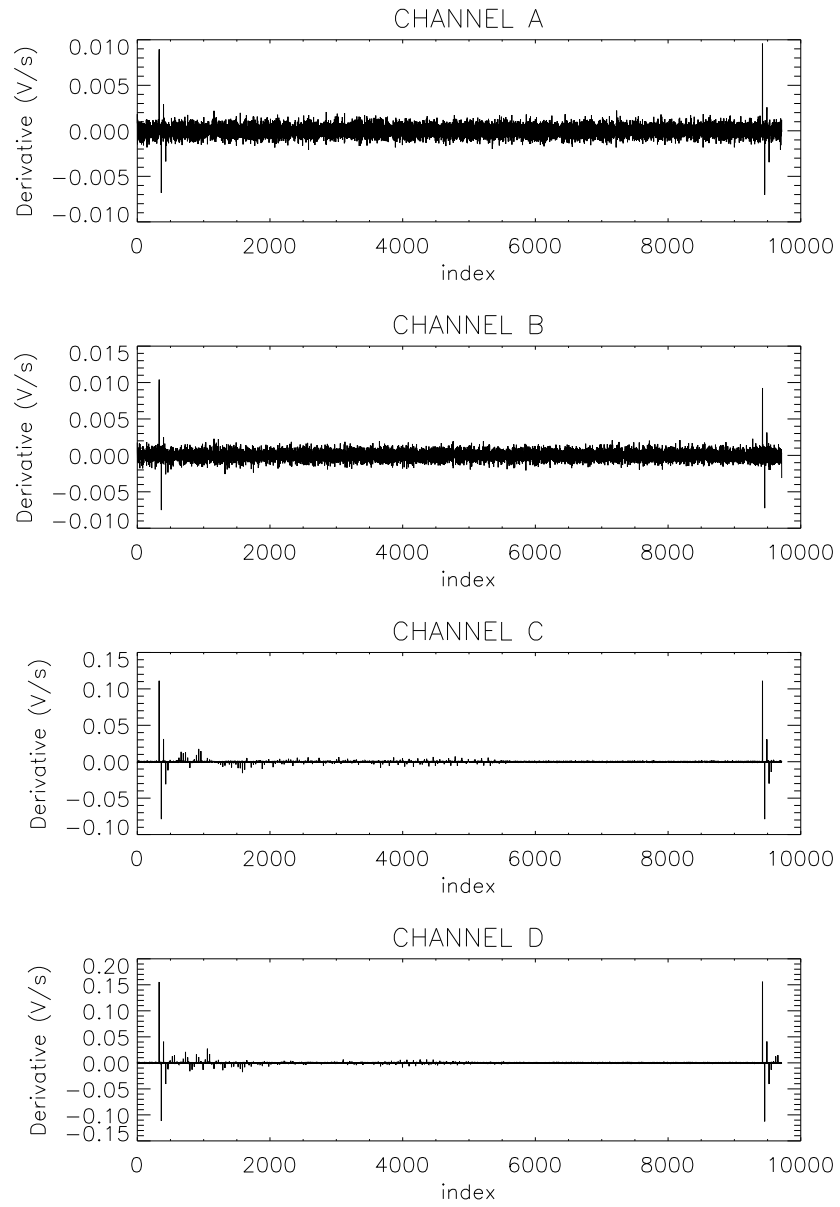


Figure 1: Data binned with a bin equal to 0.

## Selected Plots

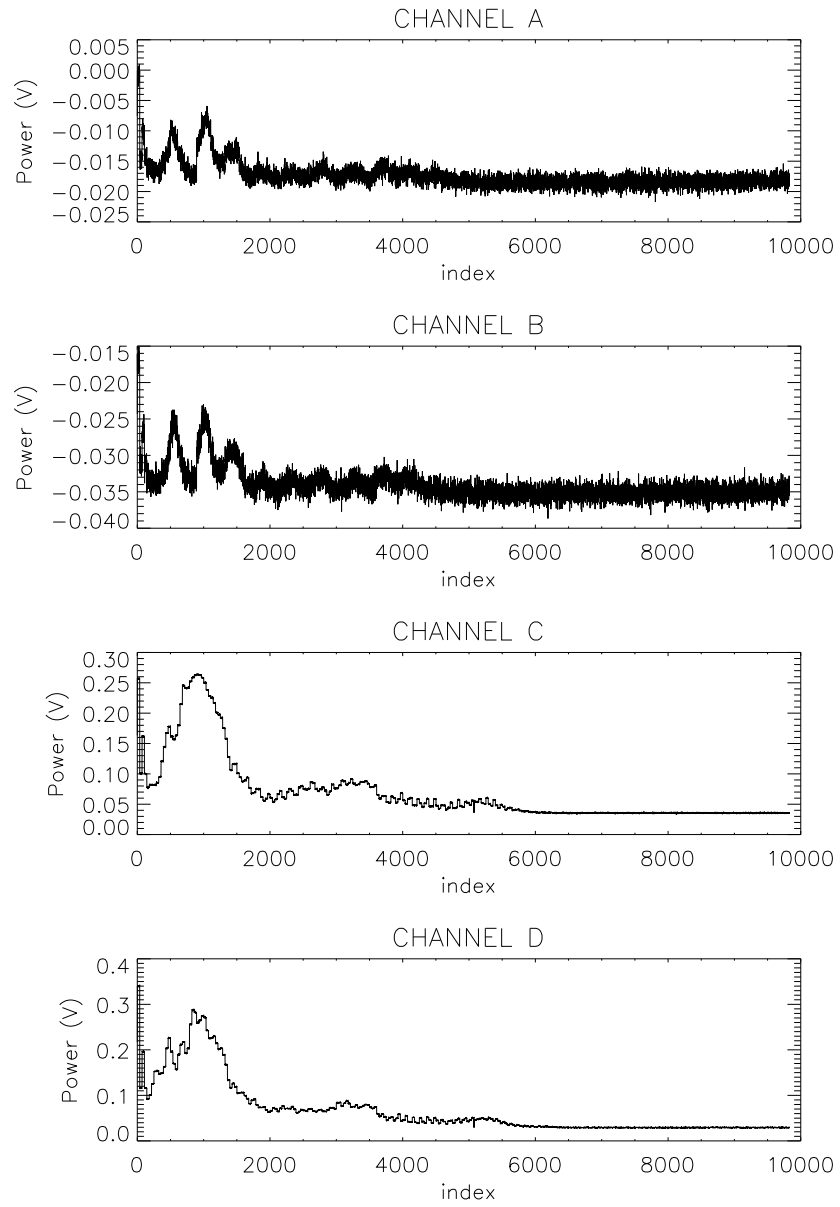


Figure 2: Data binned with a bin equal to 0.

## Radiometer Spectral Response

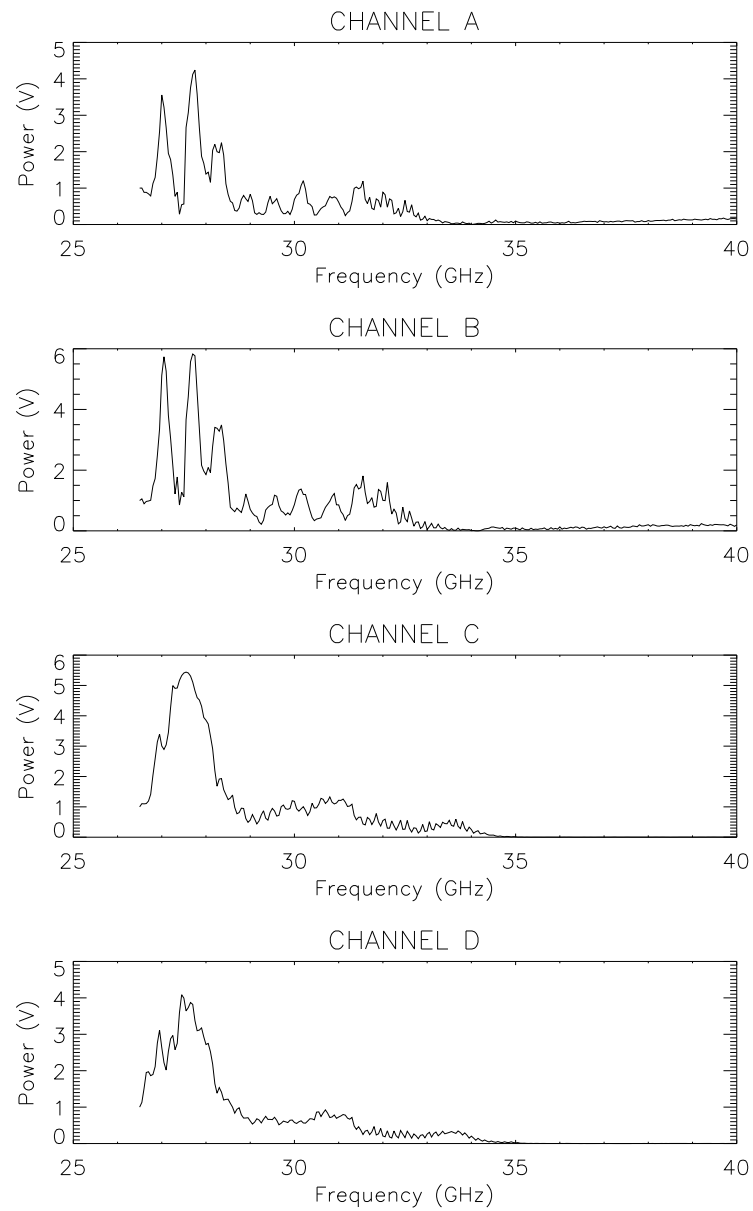


Figure 3: Calibrated data.

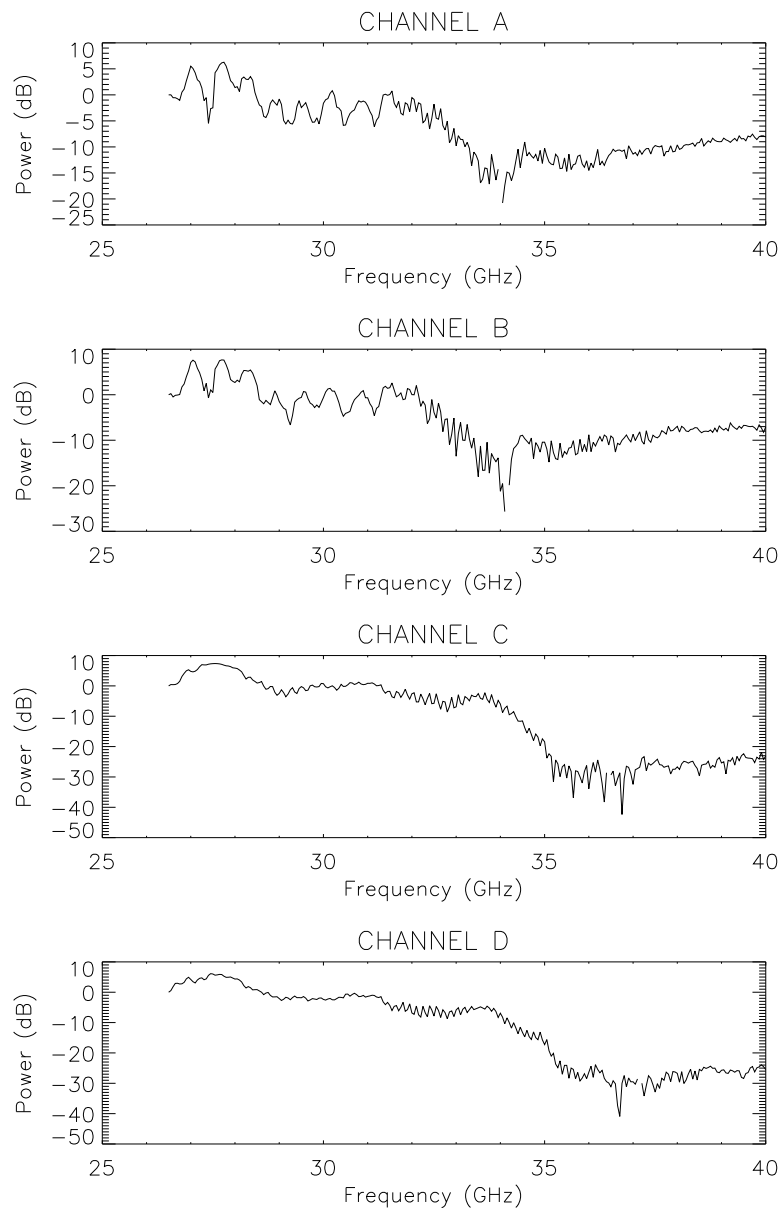


Figure 4: Calibrated data in dB.

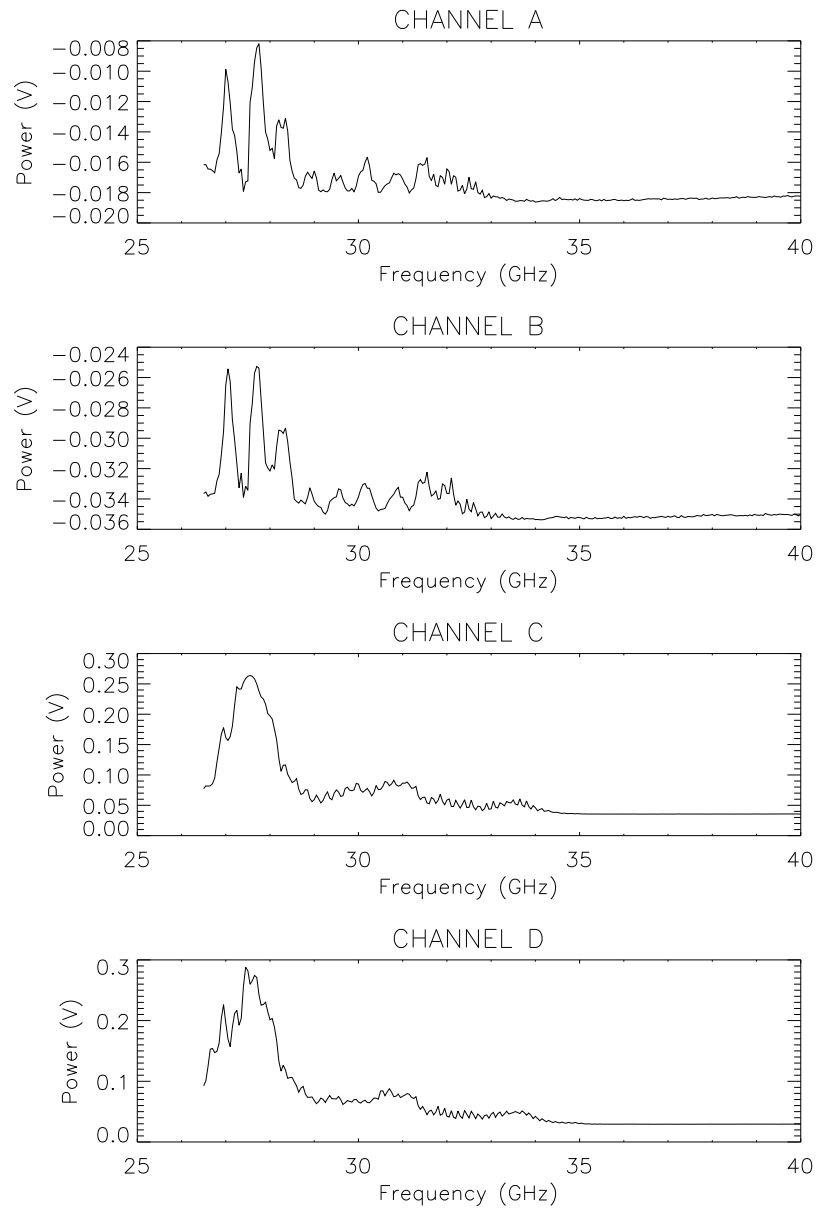


Figure 5: Uncalibrated data.

## 0.1 rana\_spr\_mini\_report\_002

### 0.1.1 RANA\_SPR\_002

Data from file set: 030LFI27\_RCA\_FM\_SPR\_200604061449

Contained in directory: /moredata

#### Input Data

Frequency: 30 GHz

Trigger Detector: A

F\_min: 26.50 GHz

F\_max: 40.00 GHz

Step: 0.05 GHz

Threshold: 0.0075 V/s

Useful Data: 50.00 %

Calibration File: /home/battaglia/LIFE\_updated/30\_GHz\_FM\_22032006.dat.txt

#### Comments

#### Output Data

Table 2: Central frequency and equivalent bandwidth.

| CHANNEL | CENTRAL FREQUENCY<br>(GHz) | EQUIVALENT BANDWIDTH<br>(GHz) |
|---------|----------------------------|-------------------------------|
| A       | 31.80                      | 4.30                          |
| B       | 31.30                      | 4.11                          |
| C       | 30.70                      | 3.71                          |
| D       | 30.45                      | 3.89                          |

## Derivative Plots

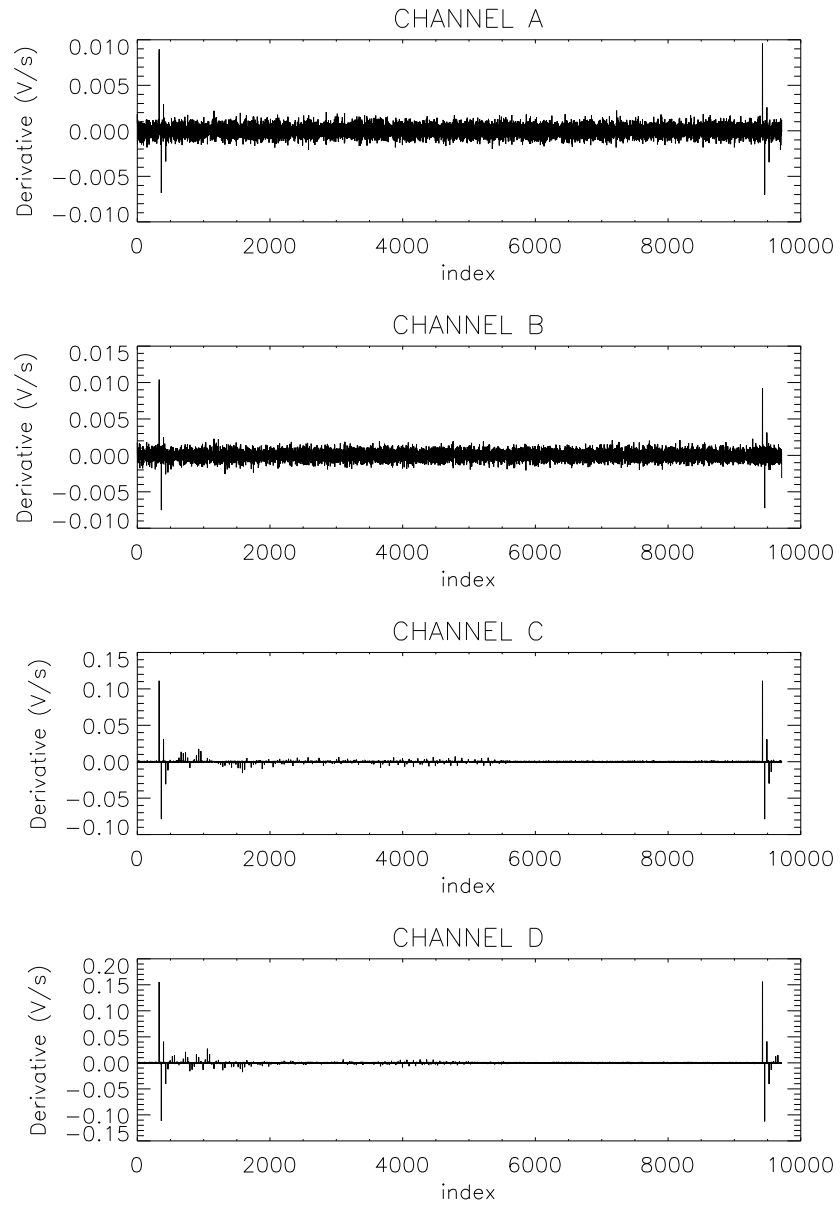


Figure 6: Data binned with a bin equal to 0.

## Selected Plots

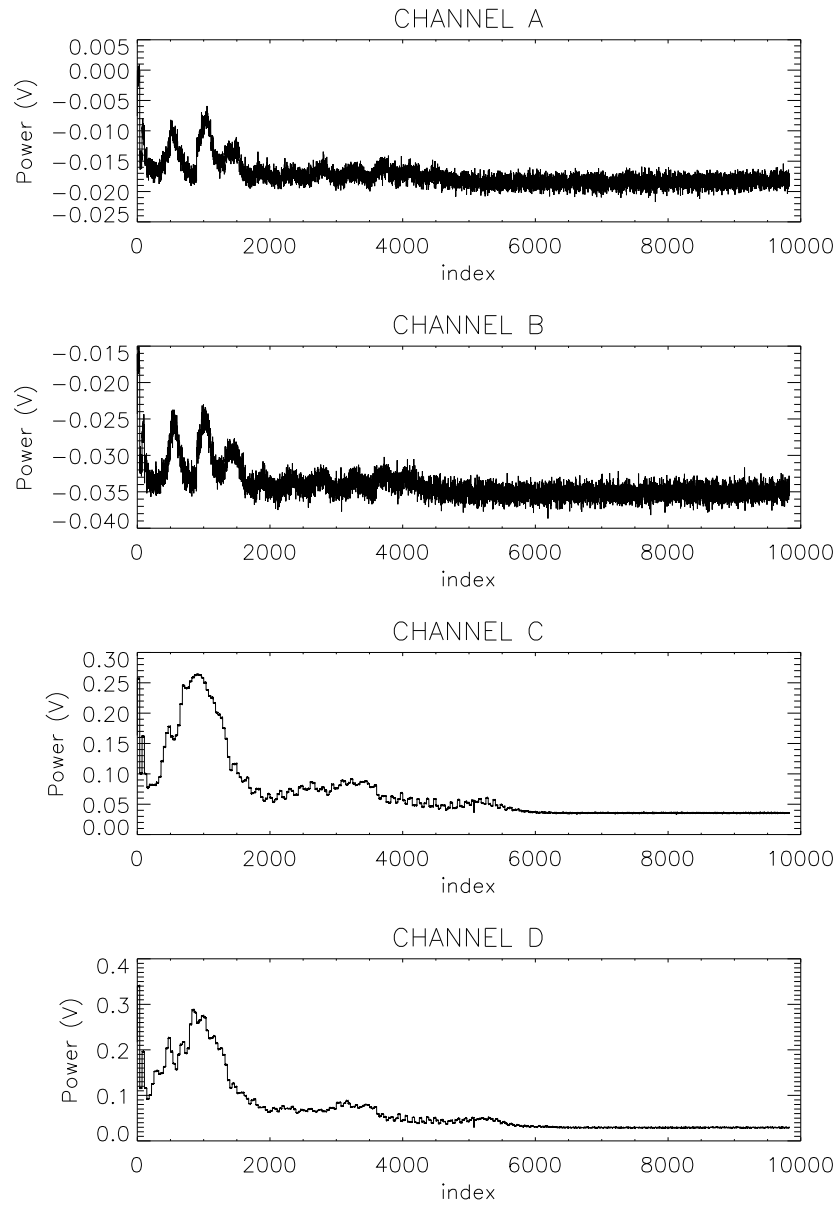


Figure 7: Data binned with a bin equal to 0.

## Radiometer Spectral Response

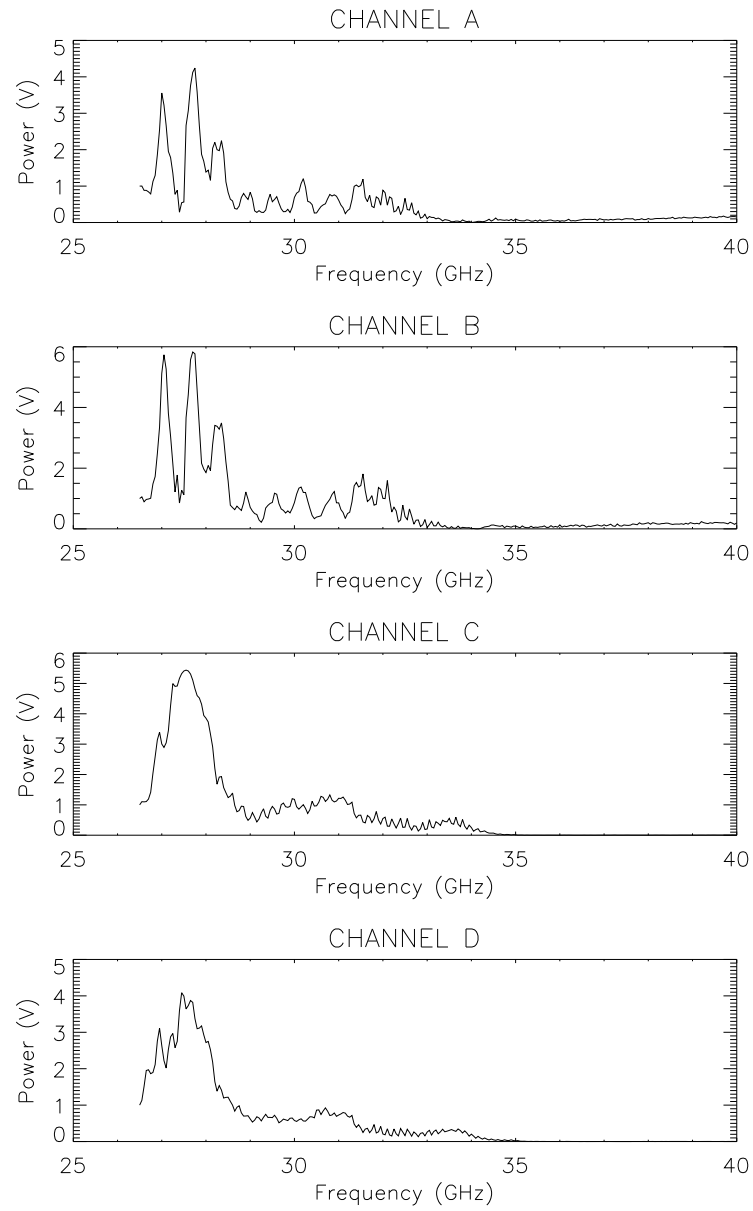


Figure 8: Calibrated data.

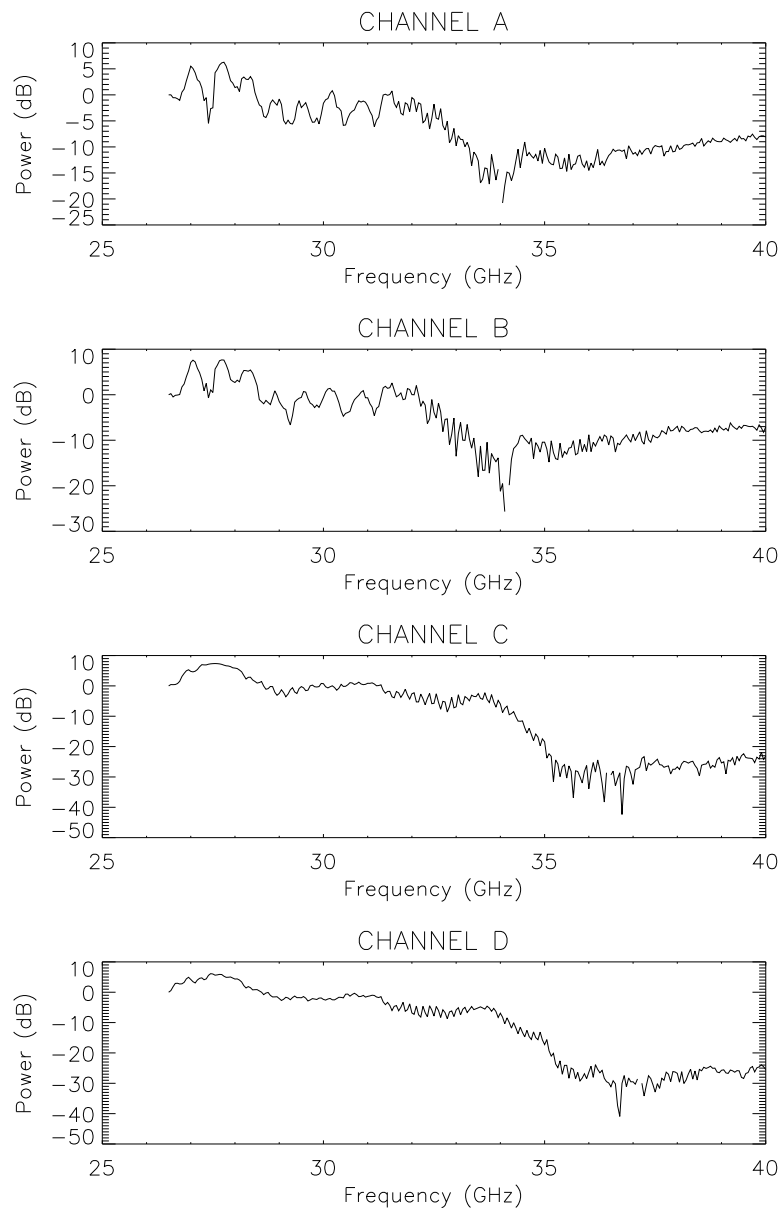


Figure 9: Calibrated data in dB.

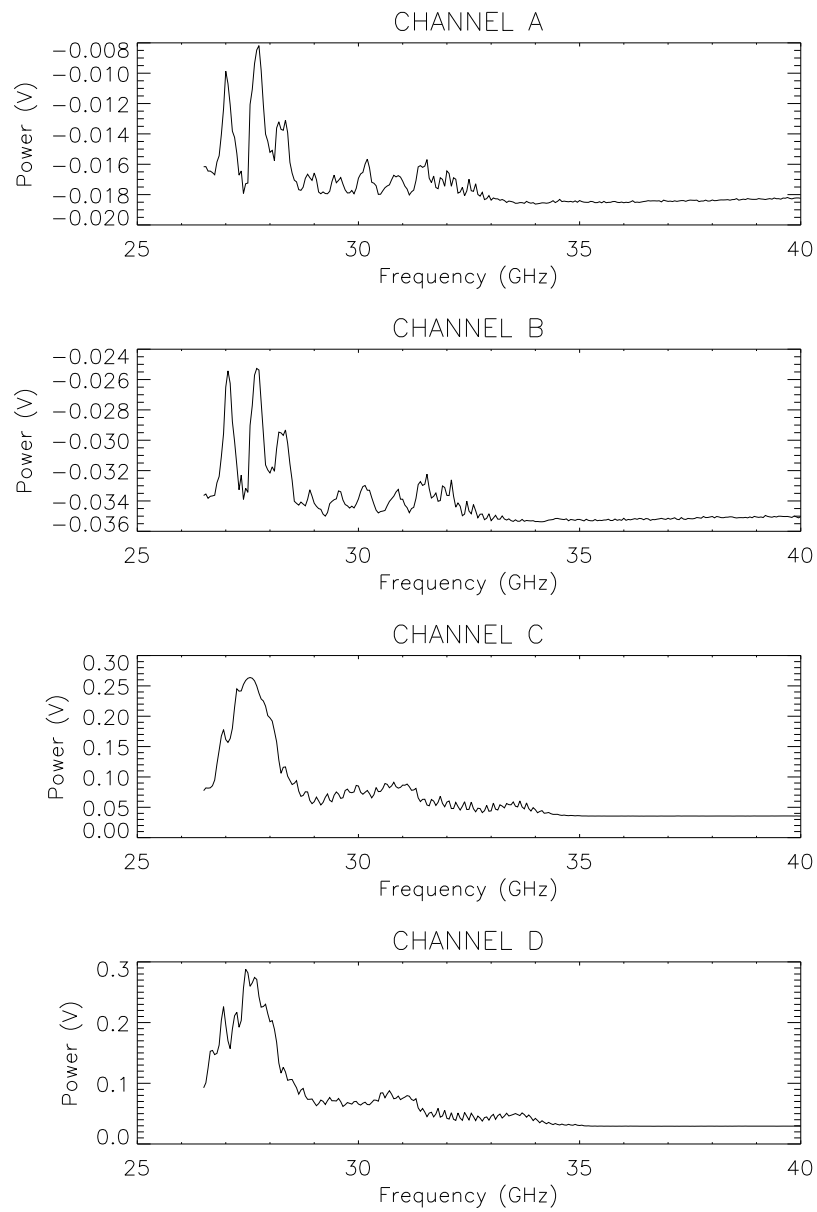


Figure 10: Uncalibrated data.