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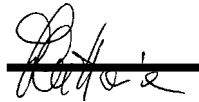
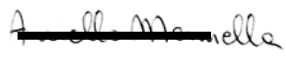
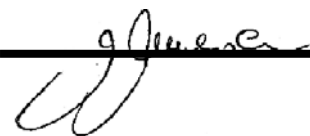
TUNING OF PLANCK-LFI LNAs IN CPV: REQUIREMENTS SPECIFICATION

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1 ACRONYMS

AIV	Assembly, Integration, Verification
TBC	To be completed
TBI	To be included



2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

[AD 1] PL-LFI-PST-TN-091 : *“Proposal for bias tuning during the CPV phase after the CSL test campaign experience”*, Cuttaia, F. , Mennella , A.

[AD 2] PL-LFI-PST-PL-013, *‘Testing Plan of the LFI instrument during the Planck Commissioning and CPV phase’* , L. Stringhetti, Bersanelli, M. , Cuttaia, F. , et al

[AD 3] PL-LFI-PST-TN-090. *‘Matrix Tuning Strategy for CSL’* , Cuttaia, Stringhetti



3 INTRODUCTION

This document describes the specification requirements(number of runs, thermal stability, duration, etc..) for LNAs bias Tuning to be performed during CPV. It is mainly oriented to highlight all the possible aspects of interest for HFI instrument.

Instead, for what concerns the detailed description of the tuning procedure, and the instrumental aspects of it, we refer to specific applicable and reference documents .

The document is divided by two parts, referring to two distinct procedures to be run for tuning bias of LFI radiometers.

- HYPER MATRIX LNAs BIAS TUNING [LFI-05]
- TUNING VERIFICATION WITH 4K LOAD TEMPERATURE STEP [LFI-07]

3.1 Acknowledgments

This document has been issued as a part of the activity performed under the ASI contract for Planck phase E2.



4 HYPER MATRIX TUNING

The HYPER MATRIX TUNING is divided by three phases , logically related with the thermal condition of the 4KRL (commanded by HFI 4K Stage)

4.1 DESCRIPTION

PHASE 1:

The 4K Reference Load is in thermal steady state conditions at about 22K : this phase is considered an hold point before 4HI cooldown.

PHASE 2:

HFI 4K stage is cooling down from 22K to 4K

PHASE 3:

The 4K Reference Load is in thermal steady state conditions at about 4K

The hyper Matrix Tuning procedure foresees a Pre-Tuning Run and the HYPER MATRIX TUNING itself (based on input data coming from Pre – Tuning Run results).
The HYPER MATRIX TUNING implies 4 Bias RUNS

The content of different phases is displayed below:

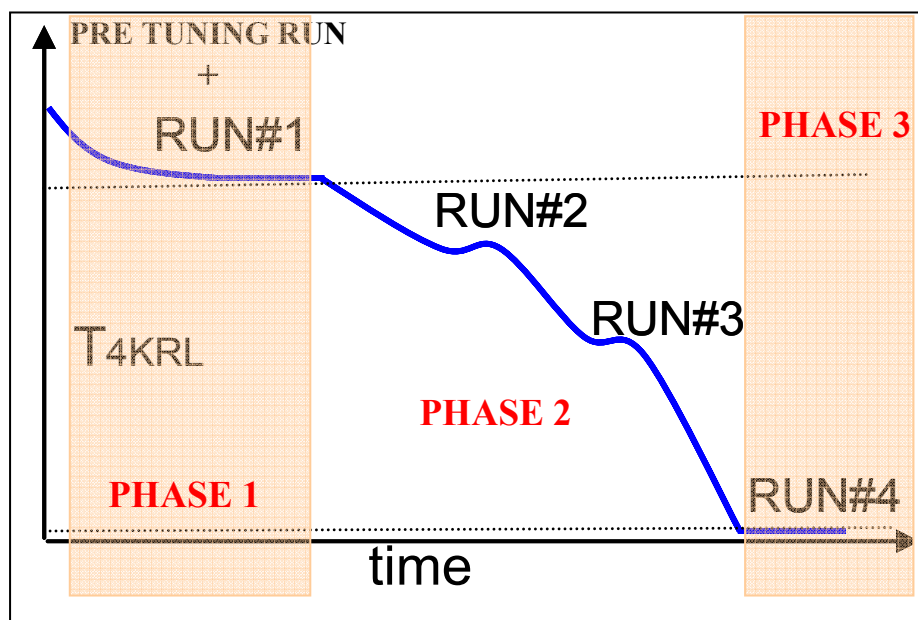


Figure 1 Hyper Matrix Tuning profile



4.2 REQUIREMENTS

Tuning requirements come from the analysis of the two main errors committed when:

Finding the bias quadruplet producing the optimal noise temperature

Estimating the best performances (considering the non linear response of each radiometer).

In both cases we required that the final error be not larger than 1K.

Here follows the basic requirements relevant for HFI. Both goals and Reqs are indicated: goals would put LFI in a safer condition in which both conditions are satisfied simultaneously on all RCAs with a small margin.

The strategy used to stabilize the HFI 4K stage is here not considered, because it is in charge on HFI Team the definition of the optimal way to provide a stable 4K stage: however, it is useful to highlight that the Requirements base on the analysis of Tuning test performed during the CSL FM test campaign (2008), when the HFI stage was stabilized by using Heat switches, and fully met the performance obtained there.

PHASE 1

PRE-TUNING RUN

It must be logically performed before HYPER MATRIX RUN
DURATION: 26 h
Start: During DTCP.
Stop: N/A
SCS: Nominal (TSA is not strictly required to be already tuned)
HFI 4K STAGE : Temperature @ about 22K
4K Stage stability GOAL: $\Delta T < 20 \text{ mK / h}$
4K Stage stability REQ: $\Delta T < 25 \text{ mK / h}$
Time needed to analyze data and produce input for next step: ~ 24 h

HYPER MATRIX TUNING RUN #1

It must be logically performed after PRE TUNING RUN.
DURATION: 33 h
Start: During DTCP.
Stop: N/A
SCS: Nominal (TSA tuned @22K ; set point can not be changed))
HFI 4K STAGE : Temperature @ about 22K
4K Stage stability GOAL: $\Delta T < 5 \text{ mK / h}$
4K Stage stability REQ: $\Delta T < 10 \text{ mK / h}$
Time needed to analyze data and produce input for next step: data need to be verified only in their completeness; estimation 2 hours after receiving data. Data analysis is not required.



PHASE 2

HYPER MATRIX TUNING RUN #2

It must be logically performed after TUNING RUN #1.
DURATION: 33 h
Start: During DTCP.
Stop: N/A
SCS: Nominal (TSA tuned @22K ; set point can not be changed)
HFI 4K STAGE Temperature: in the range 19K - 17K (depending on HFI capabilities)
4K Stage stability GOAL: $\Delta T < 10 \text{ mK} / \text{h}$
4K Stage stability REQ: $\Delta T < 25 \text{ mK} / \text{h}$
Time needed to analyze data and produce input for next step: data need to be verified only in their completeness; estimation 2 hours after receiving data; data analysis is not required.

HYPER MATRIX TUNING RUN #3

It must be logically performed after TUNING RUN #2
DURATION: 33 h
Start: During DTCP.
Stop: N/A
SCS: Nominal (TSA tuned @22K ; set point can not be changed)
HFI 4K STAGE Temperature: in the range 16K - 13K (depending on HFI capabilities and on the temperature of RUN#2: required at least 3K lower than RUN#2)
4K Stage stability GOAL: $\Delta T < 10 \text{ mK} / \text{h}$
4K Stage stability REQ: $\Delta T < 25 \text{ mK} / \text{h}$
Time needed to analyze data and produce input for next step: data need to be verified only in their completeness; estimation 2 hours after receiving data; data analysis is not required.

PHASE 3

HYPER MATRIX TUNING RUN #4

It must be logically performed after TUNING RUN#3
DURATION: 33 h
Start: During DTCP.
Stop: N/A
SCS: Nominal (TSA tuned @22K ; set point can not be changed)
HFI 4K STAGE : Temperature @ about 4K
4K Stage stability GOAL: $\Delta T < 5 \text{ mK} / \text{h}$
4K Stage stability REQ: $\Delta T < 10 \text{ mK} / \text{h}$
Time needed to analyze data and produce input for next step: 22 - 48 hours after receiving data.



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Main Requirements are summarized in the table below. The 4K Stage temperature is traced by using the **sensor**:

HD028260	HD028260_4Tt03_4K_Temp_K	Cernox 4K (K)
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PHASE	STEP	SCS TSA	HFI 4K	4K STAGE STABILITY (GOAL)	4K STAGE STABILITY (REQ)	TIME
1	PRE TUN	NO	~22K	$\Delta T < 20 \text{ mK / h}$	$\Delta T < 25 \text{ mK / h}$	26h
	RUN#1	YES		$\Delta T < 5 \text{ mK / h}$	$\Delta T < 10 \text{ mK / h}$	33h
2	RUN#2	YES	19-17K	$\Delta T < 10 \text{ mK / h}$	$\Delta T < 25 \text{ mK / h}$	33h
	RUN#3	YES	16-XK (>10K)	$\Delta T < 10 \text{ mK / h}$	$\Delta T < 25 \text{ mK / h}$	33h
3	RUN#4	YES	~ 4K	$\Delta T < 5 \text{ mK / h}$	$\Delta T < 10 \text{ mK / h}$	33h

Table 1 Hyper Matrix Tuning goals and requirements

In the table above, the 4K stage lowest temperature in step 2 RUN#3 is indicated as X: this comes from that the non linear behaviour is better characterized when the 4K temperature is close to 10K. However, basing on CSL experience, the 4K stage temperature started decreasing very abruptly when dropping below 15K.



5 LNAs TUNING VERIFICATION WITH HFI 4K STAGE STEP

5.1 DESCRIPTION

Once the LFI radiometers and the DAE are tuned, a bias tuning verification is foreseen: it is based on noise properties optimization through a calibrated white noise measurement.

To do that a step in the 4KRL temperature is required.

The tuning verification consists of two runs of the LNAs bias, at temperatures T1 and T2. T1 is the nominal 4K stage temperature (about 4.5 K) T2 is a higher temperature.

The temperature step can be provided by HFI (as done in CSL, during FM test campaign, 2008) operating on the set point of the 4K stage PID by applying a ΔT of about 80 mK.

The same procedure of HYPER MATRIX Tuning is used when running bias.

This test is divided in two runs :

- RUN #1 @ ~4.5 K
- RUN #2 @ ~4.5K + ΔT

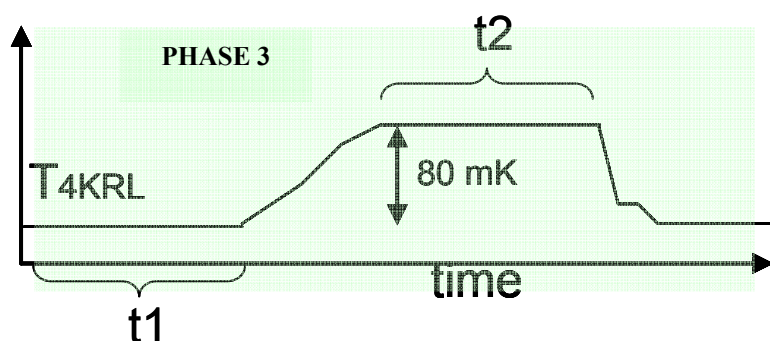


Figure 4K Tuning verification scheme

5.2 REQUIREMENTS

TUNING VERIFICATION RUN #1

It must be logically performed after HYPER MATRIX TUNING AND DAE TUNING
DURATION (GOAL) 33 h
DURATION (REQ) 16h [(4X4X4X4) scheme + Vd verification]
Start: During DTCP (but not mandatory) .
Stop: N/A
DAE: TUNED
SCS: Nominal (TSA tuned @22K or retuned @ 4K)
HFI 4K STAGE : Temperature @ about 4.5 K
4K Stage stability : according to HFI requirements on the HFI 4K PID
Time needed to analyze data and produce input for next step: data need to be verified only in their completeness; <u>e</u> stimation 2 hours after receiving data. Data analysis is not required.
In the eventual case of failure in the procedure or in data storage (missing data) the entire procedure must be run again.



TUNING VERIFICATION RUN #2

It must be logically performed after HYPER MATRIX TUNING AND DAE TUNING
DURATION (GOAL): 33 h
DURATION (REQ) 16h [(4X4X4X4) scheme + Vd verification]
Start: During DTCP (but not mandatory) .
Stop: N/A
DAE: TUNED
SCS: Nominal (TSA tuned @22K or retuned @ 4K : the same condition as in RUN#1)
HFI 4K STAGE : Temperature @ RUN#1 + ΔT (~ 80 mK) .
4K Stage stability : according to HFI requirements on the HFI 4K PID
Time needed to analyze data and produce input for next step: estimation 24-48 hours after receiving data.
In the eventual case of failure in the procedure or in data storage (missing data) the entire procedure (RUN#2) must be run again.

Main Requirements are summarized in the table below.

PHASE	STEP	SCS	HFI 4K STAGE	4K STAGE STABILITY	DURATION (GOAL)	DURATION (REQ)
3	RUN#1	TSA	~ 4.5 K	HFI NOMINAL PID STABILITY	33h	16h
	RUN#2	TSA	~ 4.5 K + $\Delta T(> 60\text{mK})$	HFI NOMINAL PID STABILITY	33h	16h

Table 2 4K Tuning verification: requirements