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The Schmidt 67/92 Robotic Telescope RoboSchmidt - User Manual

ver. 2.0 (Feb 2023)

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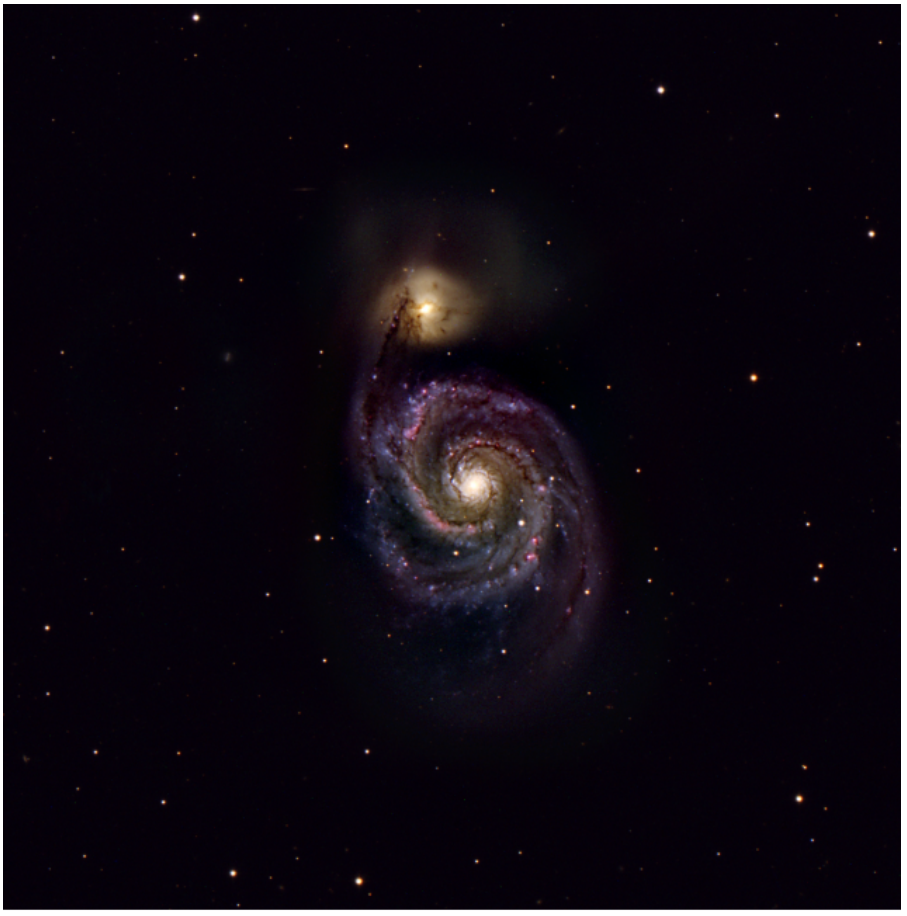
NB: It is mandatory that publications based on Ekar-Asiago proprietary or archive observations include a footnote on the first page of the article or in the Acknowledgments section the following citation:

“Based on observations collected at the Copernico 1.82m telescope [or/and Schmidt 67/9 telescope] (Asiago, Italy) - INAF Osservatorio Astronomico di Padova.”



M51@RoboSchmidt, by Giovanni Benetti

1. Introduction

The 67/91 Schmidt telescope is the largest instrument of this type in Italy. It was officially commissioned in 1966, when it was located in the Pennar Observation Station, near the Galileo telescope; in 1991 the telescope was moved to mount Ekar near the Copernico 1.82m telescope, in order to take advantage of the higher altitude and lower light pollution.

The dome is not a traditional one: it is octagonal in shape for easier mechanical assembling and was originally designed to test the proposed solution for the Telescopio Nazionale Galileo (TNG).

In 2017 the telescope has been considerably refurbished (new CCD camera, new filters, autoguider) and remotely controlled.

Starting from May, 2020 updates of both hardware and software allowed the implementation of the **fully robotic operational mode**. The observing blocks (OB) are submitted at any time by the PIs of the proposals or their collaborators. The Robotic System has a rapid-response capability that allows it to interrupt regular observations in order to observe transient phenomena with high priority.

The procedure for the telescope time allocation is reported at this web page:

https://www.oapd.inaf.it/sede-di-asiago/telescopes-and-instrumentations/call-for-proposals

2. Main Telescope characteristics

The telescope is located on the top of Mount Ekar at the following coordinates:

Longitude: E11° 34’ 07.772”

Latitude: N45° 50’ 58.000”

Height: 1369.9m a.m.s.l.

The telescope is a classical Schmidt reflector with an equatorial fork mount; light is collected at the prime focus and the CCD cameras, located inside the tube, can be moved for focusing.

- Spherical mirror: 910 mm diameter in Schott Duran-50 glass
- Correcting plate: 670 mm diameter in Schott UBK7 glass
- Focal length: 2150 mm (f/3.2, 96 arcsec/mm)

3. Focal plane instrumentation

The technical data of the main imaging camera are:

- ON-Semiconductor KAF-16803 (active area: 4096×4096 pixels, prescan: 30 pixels)
- CCD pixel size: 9 µm
- Detector scale: 0.87 arcsec/pixel (unbinned)
- FOV: 59 x 59 arcmin
- Full well capacity: 100 ke$^-$
- Dark current: 0.01 e$^-$/pixel/sec at -30°C
- A/D Converter: 16 bits
- A/D Gain: 1.6 e$^-$/ADU
- Readout noise: 10 e$^-$
- Full frame readout time: 22 sec
- Multistage Peltier cooler (max ΔT -60°C from the CCD heatsink temperature)
- Filters wheel lodges B, V Johnson-Bessel, u g r i Sloan filters; an empty hole allow for unfiltered exposures,
- Minimum exposure time with electromechanical shutter: 0.2 sec

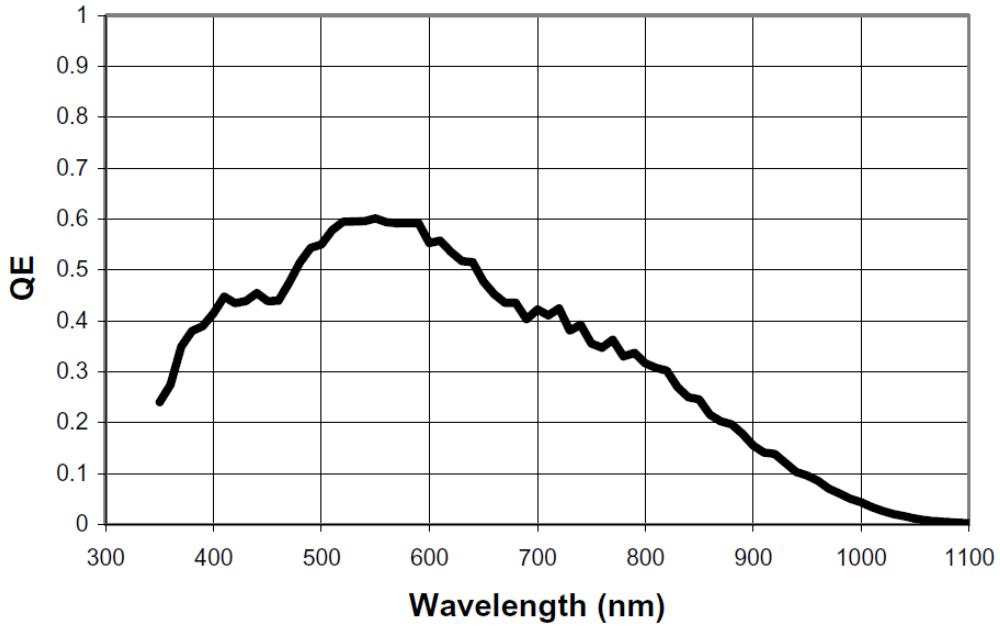


Figure 2: QE of the KAF16803 CCD

The technical data of the autoguider imaging camera are:

- Sony IMX-174M (active area: 1920x1200 pixels)
- CCD scale: 0.56 arcsec/pixel (unbinned)
- Pixel size: 5.87 µm
- FOV: 18 × 11.2 arcmin
- The camera is mounted on a linear positioner that permits to adjust the focus independently from the main CCD camera focus
- Minimum exposure time: 50 µsec

4. Telescope performance

The typical pointing error of the telescope is less than 2 arcmin. The resolution of the encoders is 0.45 arcsec.

The telescope can be manually moved at three different speeds:

- Large: 1 degree/sec
- Medium: 2 arcmin/sec
- Micro: 12 arcsec/sec
- Differential guiding: up to 7200 arcsec/h

The maximum excursion of the medium/micro declination drive is ±4°.

5. Tracking and guiding

The telescope is in sidereal tracking when Micro or Medium movements are inserted. The differential guiding for moving targets is also implemented.

5.1 Autoguiding

The autoguiding procedure is performed by a dedicated software (Autoguider) and based on the calculation of the centroid of a star seen by the guide camera.

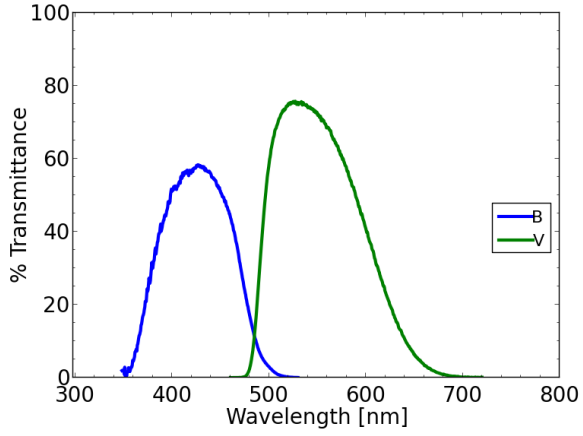
If the flux from the guide star becomes less than 500 ADU over the background (for example, for the onset of clouds), the autoguider stops sending corrections. Once the guide star is detected again, the software takes as reference the previous position, so there will be no shifts of the science-target on the detector.

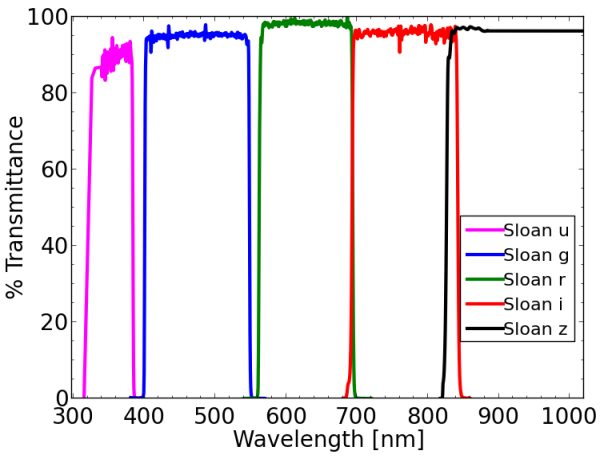
6. Image quality and available filters

The typical natural seeing at Mount Ekar is under 1.5 arcsec. Stellar images with FWHM around 1.0 arcsec, therefore undersampled, are not uncommon.

The whole Schmidt focal plane seen by the CCD is free of aberrations.

The transmission curves of the Bessel B and V filters and the Sloan ugri filters are shown below.





7. Robotic scheduler principles

The robotic scheduler uses a very simple approach. The dome is opened about 2h before sunset after verification that the meteo conditions (humidity, wind, cloud coverage) are compliant with the imposed restrictions. When the sky brightness is appropriate, the system automatically secures flat field sky exposures for all filters.

The scheduler starts the telescope's scientific operation when the Sun is 12 deg below the horizon.

The list of active OBs that, at the given time, are above the required altitude limit, is checked for external constraints (Moon distance, Moon phase). Among the targets with the highest priority, the one that sets first is selected. The target selection process is repeated constantly but the priority is given to complete all observation for the targets with a number of exception:

- the target falls below the altitude limit
- a new target with very high priority becomes visible
- After three attempts, the guiding system cannot find (or lose) the guiding star.

When completed all observations of one target, the OB is marked as completed and the OB deactivated. A new target is selected.

The dome is closed if the sky/weather conditions fall below the acceptable range or if the network connection fails.
When conditions will be again in the acceptable range, scientific operation will resume.

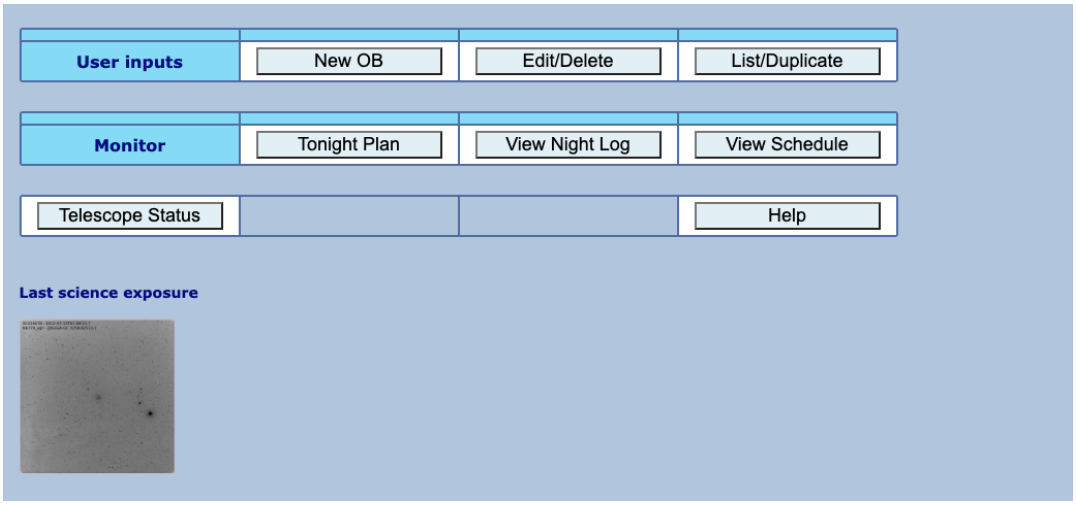
The scientific operation terminates before sunrise, when the Sun is 12 deg below the horizon. Calibrations (sky flats, bias, and dark exposures) are performed before the shutdown of the system.

8. The Robotic Telescope Mode Input

A web-based interface can be accessed by registered users in order to submit the sequence of observations for a given target. The web page address is:

https://sngroup.oapd.inaf.it/rschmidt/

The P.I. (and collaborators, if requested) of approved proposals at Schmidt 67/92 are provided by a personal username and password by the managers of the telescope for the duration of the project. After the access, the home page for the Robotic Telescope Mode Input looks like this:

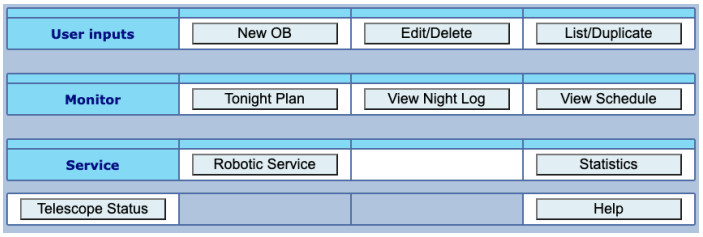


The “User inputs” menu is used for: 1. insert a **New OB** for a target; 2. **Edit/delete** existing active OBs; 3. **list/duplicate** the inserted OBs.

The “Monitor” menu is used for: 1. get an overview of the **Tonight Plan**, based on the active OBs. This is the program that will be executed with good weather and no technical problems; 2. **View Night Log**, i.e. the list of exposures completed in the selected night; 3. **View Schedule** lists the night allocation for the current month.

Telescope Status shows the actual status of the telescope at the time of request; **Help** is a link to this manual.

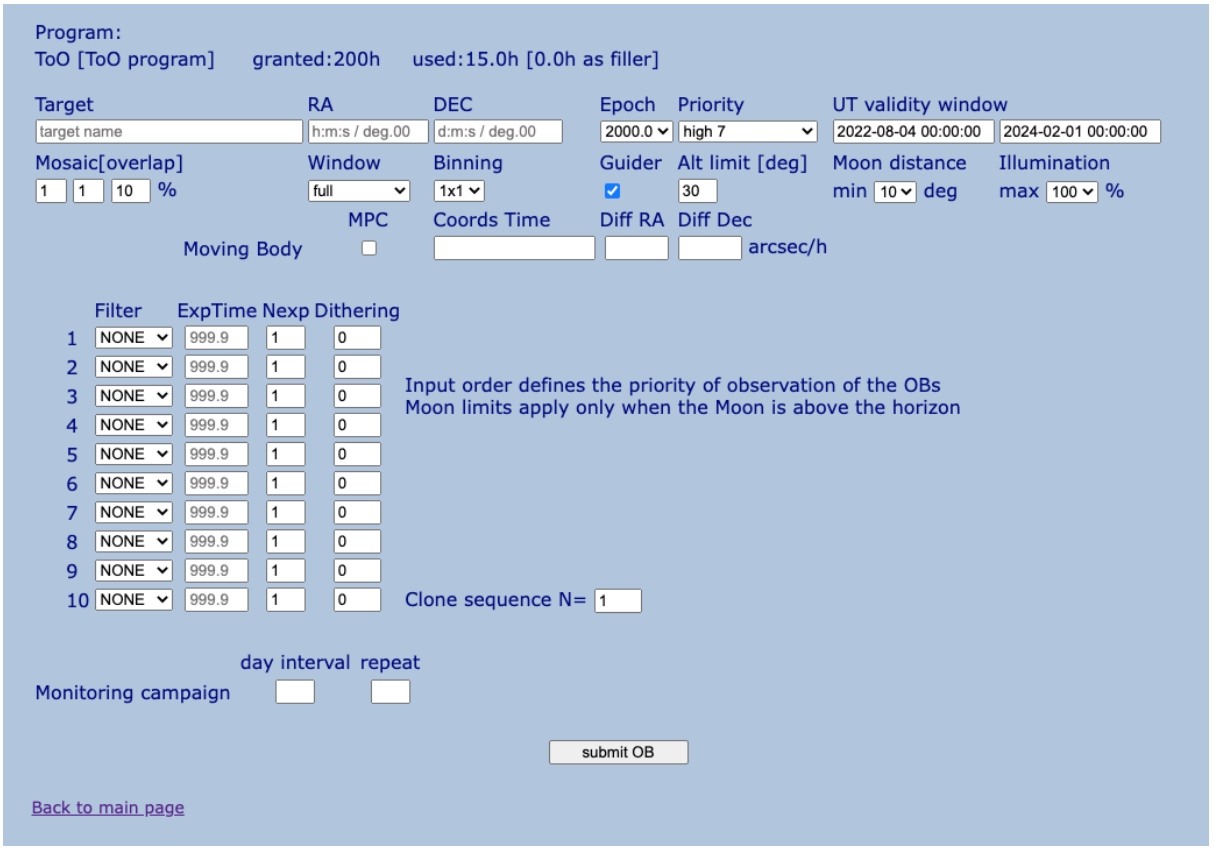
The third line of menu "Service" is available only for system managers (i.e. technical staff): Robotic Service is used to check the telescope status and allows to suspend/terminate or restart Robotic operation if needed; **Statistics** sums up statistical data.



9. User Inputs

8.1 New OB

Click **New OB** to submit an observing block; after the selection of the program, the new OB for every single target is compiled and submitted from this page:



Required fields are:
Target Name, RA, DEC. If the target name is known to SIMBAD, the coordinates will be retrieved after pressing “submit OB”. The input form will be represented to the user for confirmation.
Fields with defaults provided are:
priority*, time-window for image to be executed, mosaic patches (max 9x9) and overlap, detector window size (options: 2000x2000; 1000x1000; 500x500), binning (options: 1x1; 2x2; 3x3; 4x4), the limit for the target altitude over the horizon (default is 30 deg; the mechanical limit of the telescope is 20 deg), the minimum distance from the Moon (default is 10 deg), the maximum illumination of the Moon (default is 100%, i.e. full Moon).

If the target is a moving body (asteroid or comet) which is listed in the Minor Planet Center database, checking the box “MPC” will assure that coordinates and differential tracking will be retrieved at the time of observation. Otherwise you need to fill the epoch of the given coordinates and the differential RA and DEC in arcsec/h in the appropriate boxes.

Required fields for the exposure are:
filter, exposure time (in secs),
Optional fields:
number of exposures per filter (Nexp) and dithering (pixels). It is possible to repeat the whole sequence up to 99 times using the “Clone sequence” box. The whole program can be programmed to be repeated every XX- days for YY-times filling “Monitor campaign” boxes.

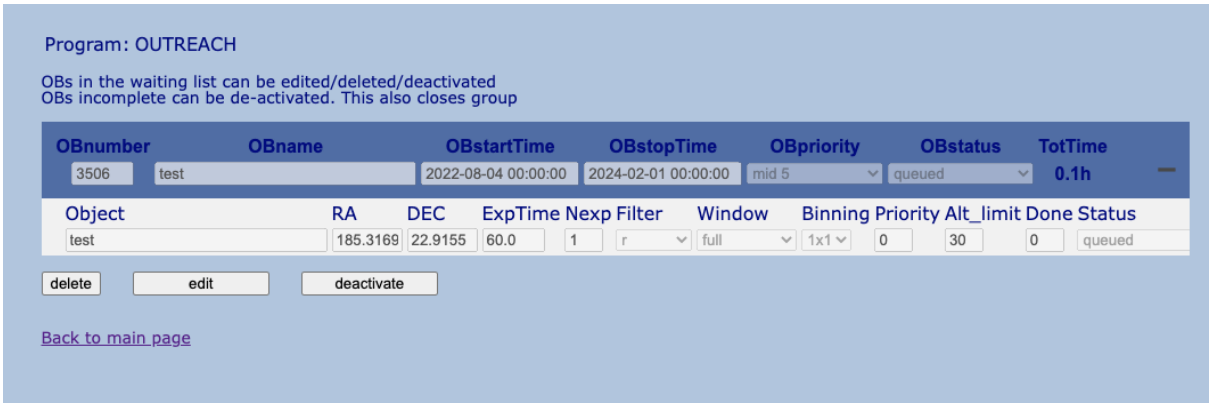
Clicking “submit OB” button will send it to the database list of OBs for the execution.

***priority**: depending on the program (only robotic, with scheduled nights, ToO, Shorts …) the priority can range from a minimum of 2 to a maximum of 13 (priorities 10 to 13 are used

only for urgent targets, i.e. fast transients). The observer can select the priority of each target inside his/her allowed range; the system will execute the night schedule considering the priorities of all OBs, the visibility of every object, the Moon distance, any limitation inserted by the user (i.e. altitude limit, Moon distance and illumination, time-window, etc).

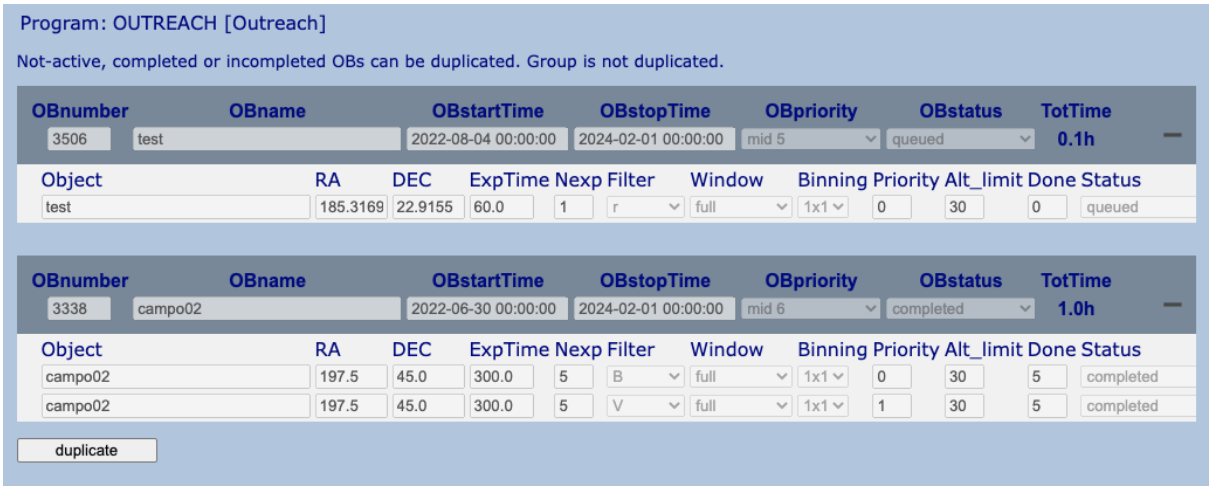
8.2 Edit/Delete

Click **Edit/Delete** to change or to delete an already submitted OB; after the selection of the program, the OB in the waiting list can be deleted (by the owner), edited or deactivated using the appropriate buttons:



8.3 List/Duplicate

Click **List/Duplicate** to see the list of your active/ completed or uncompleted OB; after the selection of the program, completed OB can be submitted again using “duplicate” button:



10. Monitor

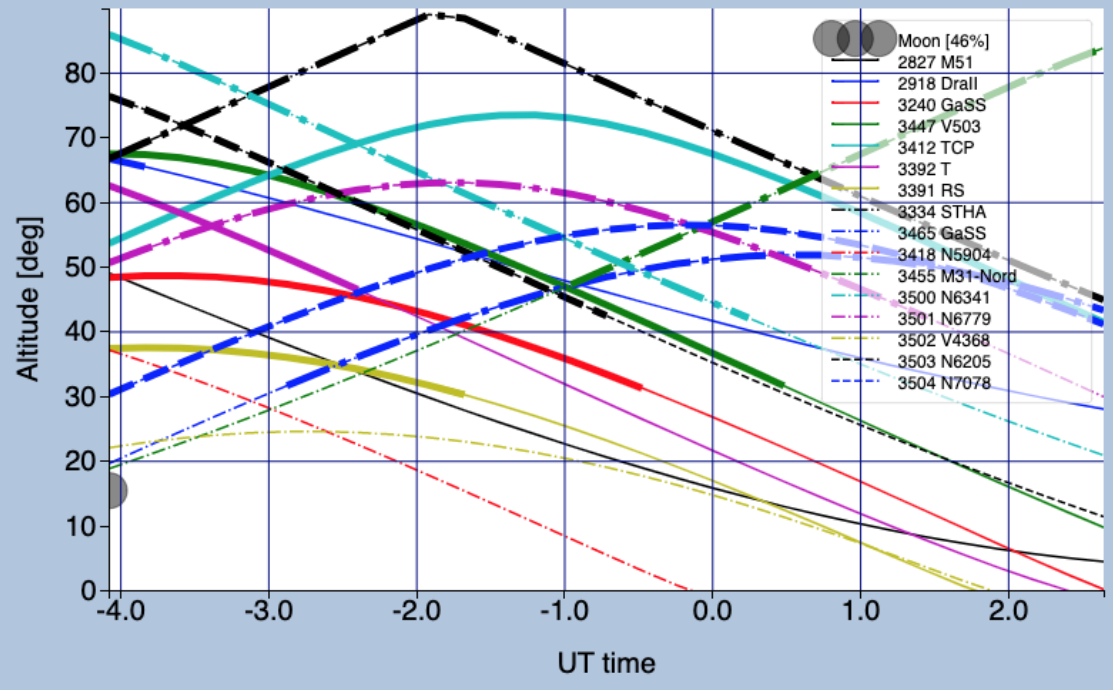
9.1 Tonight plan

Shows the list of active OBs and a simulation of the expected execution for the incoming night. The plot shows the altitude of the target above the horizon depending on the hour, the moon phase and position:

Tonight plan

Night	TimeStart	TimeLength	Program	Override	Complement	Note
2022-08-04			BEDIN-YOC	Yes	Robotic	

Request: 25.8h Night length: 6.8h [over-subscription 3.8]



Tick line when altitude > Alt_limit. ??? never above limit.

List of active OBs

OB	Object	Program	Priority	status	MoonSep	Tot.Time
2827	M51	BEDIN-YOC	9	queued	60 deg	3.6h
2918	DraII	BEDIN-YOC	9	incomplete	80 deg	9.9h
3240	GaSS A2-242	PERKO-SYMB	3	incomplete	60 deg	0.3h
3447	V503_HER SVab	MUNARI-NOVAE	2	queued	62 deg	0.7h

9.2 View Night log

This shows a list of the exposures executed for the selected night (default the last night):

Obs night: 2022-08-03 refresh

total dome open 8.2h total shutter open 4.7h

Dome open close
2022-08-03 17:31:24 2022-08-03 23:58:52
2022-08-04 01:04:13 2022-08-04 02:47:33

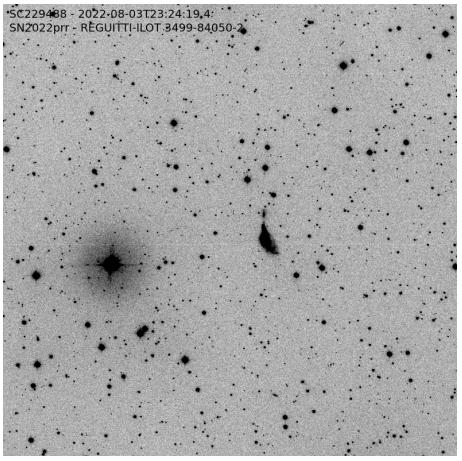
Cal	Type	OBname	Filter	Nexp	StartTime	StopTime
FLAT	SKY	SkyFlat	g	10	2022-08-03T19:05:22	2022-08-03T19:09:44

OBn.	OBname	Program	OBstatus	StartTime	StopTime	Sky
3498	AT2022jzc	REGUITTI-ILOT	completed [6 exp (overall:6/6)]	2022-08-03 19:58:30	2022-08-03 20:33:25	58
3495	N6205_ugr	ZAGGIA-GC	completed [9 exp (overall:9/9)]	2022-08-03 20:33:25	2022-08-03 21:30:27	69
3497	V919_SGR SVab	MUNARI-NOVAE	completed [21 exp (overall:21/21)]	2022-08-03 21:30:28	2022-08-03 22:03:20	30
3491	N6341_ugr	ZAGGIA-GC	completed [9 exp (overall:9/9)]	2022-08-03 22:03:20	2022-08-03 22:59:55	83
3499	SN2022prr	REGUITTI-ILOT	completed [10 exp (overall:10/10)]	2022-08-03 22:59:55	2022-08-03 23:38:00	71
3492	N6779_ugr	ZAGGIA-GC	completed [9 exp (overall:9/9)]	2022-08-03 23:38:00	2022-08-04 01:45:10	67
3496	N7078_ugr	ZAGGIA-GC	completed [9 exp (overall:9/9)]	2022-08-04 01:45:10	2022-08-04 02:48:05	61

Fits file list

Back to main page

Clicking on “Fits file list”, you can see the list of the files sent to the archive. By clicking on the file name, the png icon of the image is shown in order to have a quick look of the image quality:



9.3 View schedule

From “View schedule” you can see the allocated nights of the current month.

11. Calibrations

Sky Flats are automatically performed at twilight in all filters; bias and dark exposures are also regularly taken and can be freely downloaded from the public archive.

12. Data Archive

Proprietary files and (free) calibrations can be downloaded from the official INAF IA2 archive, in Trieste (it should be some delay in the data upload):
http://archives.ia2.inaf.it/aao/

or from the local mirror (which contains images taken in the last 3 months):
http://hactar.oapd.inaf.it/aao/

For downloading your proprietary files you must login with your credentials. After the proprietary period of 1 year, all the data are released and become available to the scientific community.

13. General notes

- OBs can be submitted at any time during the day/night (also if the telescope is already working).

- The telescope is completely robotic: there is no need for human presence during the night to oversee the telescope operations.

- At 08:30 in the morning the telescope's managers and the PI of the achieved observations will receive an email summarizing the night:

ekar@sngroup.oapd.inaf.it Inbox - Google 08:31 E

Ekar Schmidt Log - 2023-02-02

Obs night: 2023-02-02

total dome open 14.1h total shutter open 5.8h

Dome open close
2023-02-02 16:31:20 2023-02-02 19:26:10
2023-02-02 19:18:46 2023-02-02 21:01:05
2023-02-02 20:22:01 2023-02-02 21:51:48
2023-02-02 21:32:10 2023-02-03 05:29:07

Cal	Type	OBname	Filter	Nexp	StartTime	StopTime
FLAT	SKY	SkyFlat	u	10	2023-02-02T16:32:20	2023-02-02T16:36:44
FLAT	SKY	SkyFlat	r	10	2023-02-02T16:40:31	2023-02-02T16:44:21
FLAT	SKY	SkyFlat	NONE	10	2023-02-02T16:47:38	2023-02-02T16:51:28

OBn.	OBname	Program	OBstatus		StartTime	StopTime	Sky
4275	GaSS A2-028	PERKO-SYMB	incomplete	[23 exp (overall:23/96)]	2023-02-02 17:27:52	2023-02-02 20:52:45	16
4277	CK22E030	REGUITTI-ILOT	completed	[7 exp (overall:6/6)]	2023-02-02 17:29:34	2023-02-02 18:04:58	32
4279	TOI-3714	NARDIELLO-YO	incomplete	[0 executed out of 3960] error=fail focus star (1)	2023-02-02 17:37:23	2023-02-02 17:42:19	nan
4282	TOI-3714	NARDIELLO-YO	incomplete	[0 executed out of 298] error=fail guide star (1)	2023-02-02 17:46:55	2023-02-02 17:53:45	nan
4270	N2419_ugr	ZAGGIA-GC	incomplete	[9 exp (overall:9/11)]	2023-02-02 20:51:01	2023-02-02 23:14:20	17
4278	WASP-56	NARDIELLO-YO	incomplete	[569 exp (overall:569/4950)]	2023-02-02 21:33:16	2023-02-03 05:29:39	38
4273	GaSS A2-075	PERKO-SYMB	incomplete	[23 exp (overall:23/60)]	2023-02-02 23:15:53	2023-02-02 23:51:55	25

- The incomplete OBs will be scheduled again (only the not executed steps) the following night.