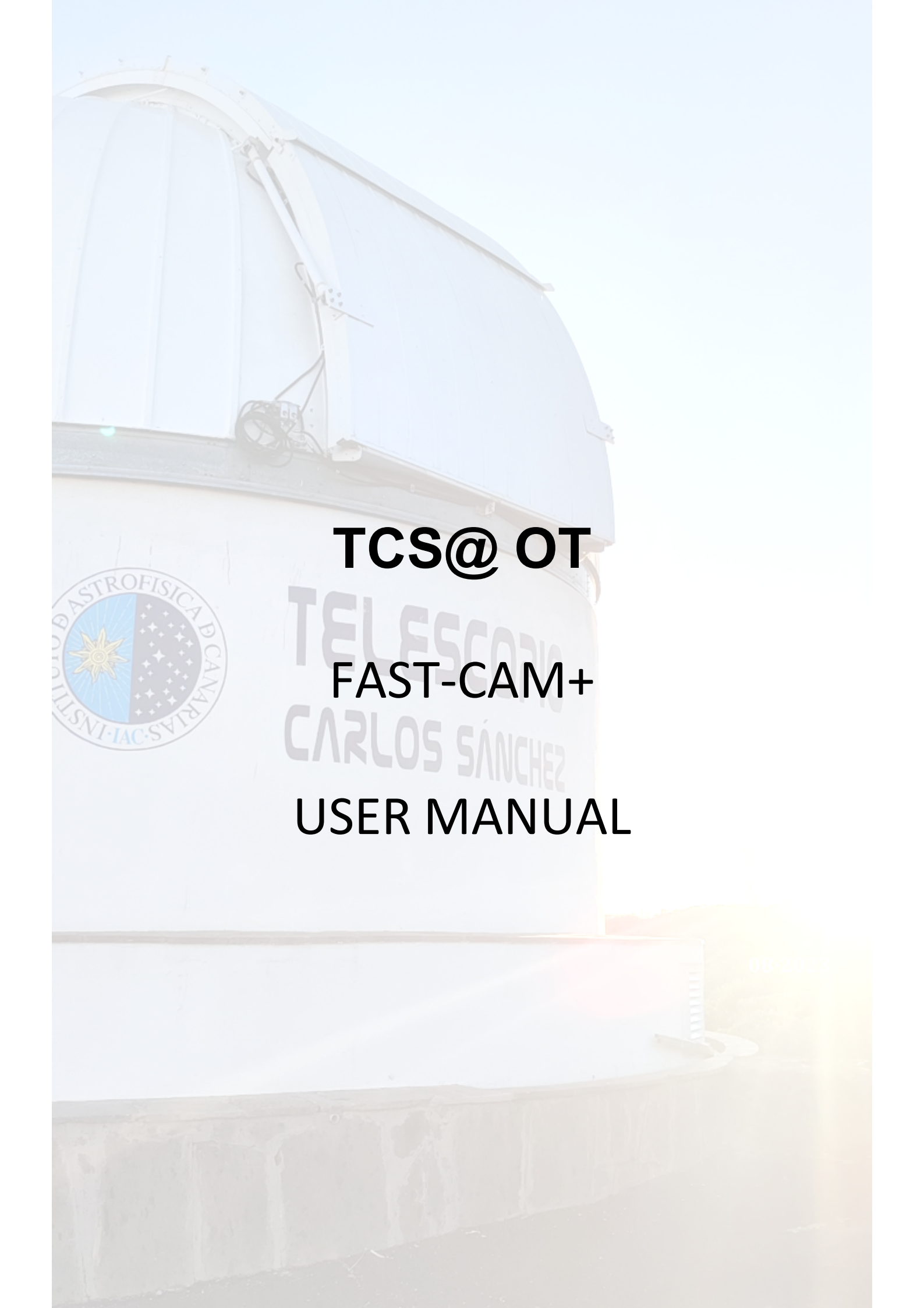




TCS@ OT

FAST-CAM+

USER MANUAL

08/2023

The aim of these series of user guides is to help the observer in some specific tasks concerning the telescopes and instruments available at the Observatorios de Canarias (OCAN). The information is provided in a clear and simple manner, and it comes illustrated with screenshots captures in order to make the manual easy to use.

In particular, here, the user will find a practical description of how to observe with FastCam at the TCS telescope:

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2. Graphical User Interface and connection	pg4
3. Taking calibration images	pg12
4. Autoguiding with CRATOS PC	pg13

For any comments, please contact the staff of the Telescope Operations Group (ttnn_a at iac.es)

August 2023

1. Introduction

FastCam (<http://research.iac.es/OOCC/iac-managed-telescopes/telescopio-carlos-sanchez/fastcam/>) is an instrument jointly developed by the Spanish Instituto de Astrofísica de Canarias and the Universidad Politécnica de Cartagena, designed to obtain high spatial resolution images in the optical wavelength range from ground-based telescopes using the Lucky Imaging technique.



The basic characteristics of FastCam @ TCS are:

Field of View	$35.8 \times 35.8 \text{ arcsec}^2$
Pixel scale	$0.035 \text{ arcsec pix}^{-1}$
Image size	$1024 \times 1024 \text{ pix}$
Read-out speed*	$30 \text{ exposures sec}^{-1}$

*This read-out speed is referred to the full chip, but by using a smaller chip window the read-out speed can be higher.

IMPORTANT NOTE

The volume of raw data generated by FastCam is quite large. For example, a cube of 1000 1024x1024 pixel images contains 2GB of data. If the exposure time is 30ms, one cube like this is created every 30s. Therefore, observing a target during 30min will add 120GB to the disk and in a full night of observation more than 1TB can be collected. Since it is not possible to perform an FTP transfer of this volume of data at the end of the observing session, we encourage the astronomers using FastCam to bring their own external disk.

We also advise that the algorithm and software to process and reduce the raw data are not yet publically available. Therefore, we suggest that users contact the telescopic operations group for such information.

2. Get started

This section is ONLY for the Telescope Operator, NOT for the observer

- Turn on the instrument, connect it to the red 220AC plugs just behind the telescope mirror.
- Turn on the “FASTCAM” computer, in the dome.
- Turn on the cooler box. Press the “Start/Stop” button, then you should see a “-“ sign in the display. The sign is “*” when the cooler is off (see image). Check the glycol level (water & alcohol).



3. Graphical User Interface and Connections

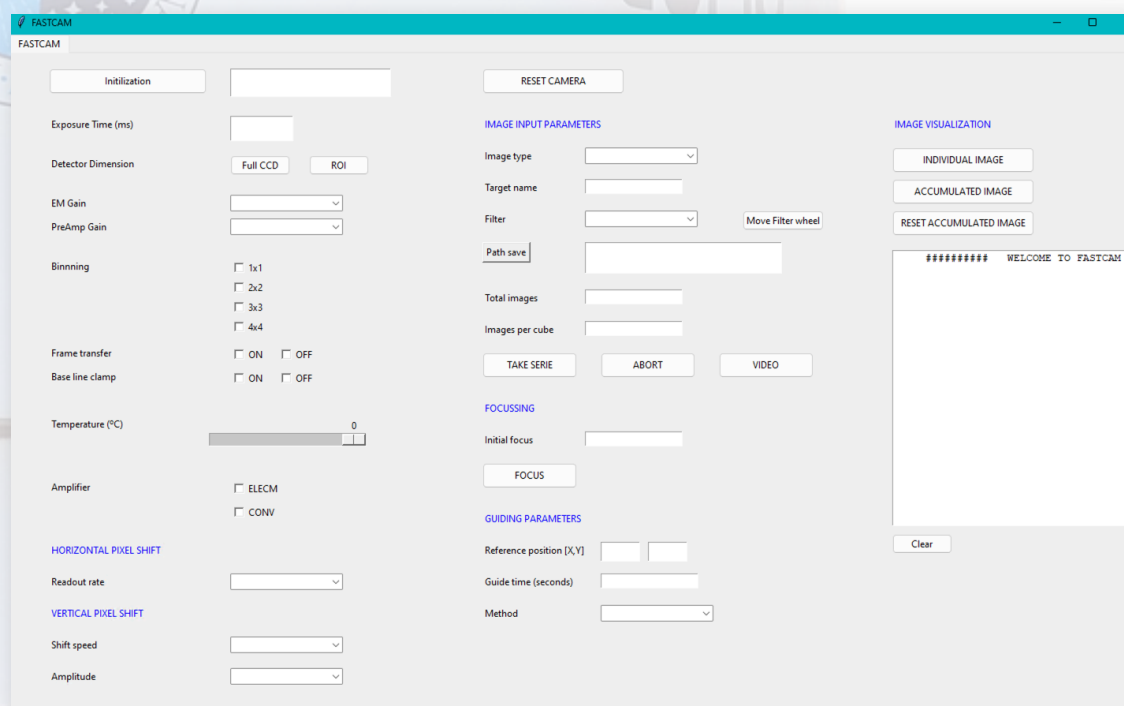
If you are going to observe remotely, make sure that you are within the IAC network; if you are in the IAC remote control room, don't worry about this, otherwise you will need a VPN connection to the IAC (just ask the support astronomers about how to do this).

First you can make the connections to PC-FASTCAM and PC-FOVIA. For this you need the VNC software and user/passwords, just ask the staff of the Telescope Operation Group (ttnn_a at iac.es) for instructions.

The FASTCAM interface is the application to control the EMCCD camera and the filter wheel that allows interactive or advanced modes.

It can be started by double-clicking on the "FASTCAM" icon located on the FASTCAM PC, on the Windows welcome screen.

A window will appear: The FASTCAM control interface



Overview of the FASTCAM interface.

The different options available in the FASTCAM tabs are:

3.1 Initialization and configuration of camera parameters

3.2 Acquisition of cubes

3.3 Focusing the telescope

3.4 Guiding parameters



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3.1 Initialization and configuration of camera parameters

The FASTCAM interface allows you to initialize the camera, set EMCCD parameters, focus the telescope, acquire images, and set guiding parameters.

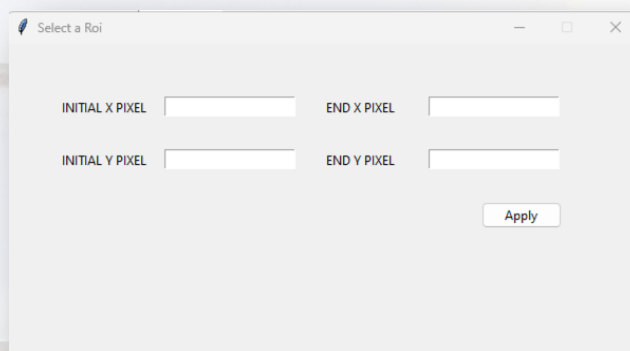
First of all, the camera must be initialized by clicking the "Initialization" button. If the camera initializes successfully, a green "camera initialized" message will appear, otherwise a red "camera not initialized" message will appear.



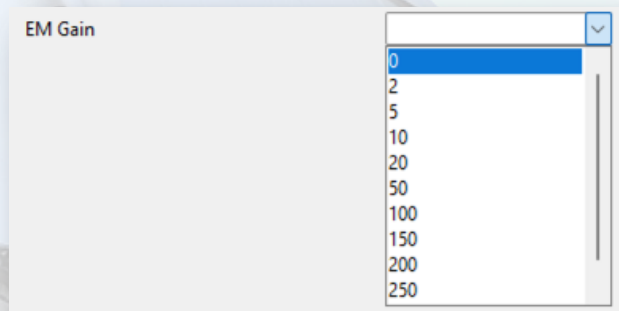
After camera initialization, one must set the camera parameters (gain, binning, detector dimensions and other features).

Detector dimension options are "Full CCD" or "ROI". The first will set up the full chip and therefore the full FOV that FASTCAM offers. The second allows you to select a region of the image's FOV, allowing the image to be smaller and to take up less space.

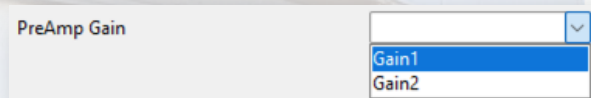
If the "Select a Roi" option is selected, a new box appears and you must select the X and Y initial and end value pixel for the image, and then click on "apply" button.



The EM gain allows values between 0-300 and PreAmp allows two values, Gain1 or Gain2. The difference between them can be found in the instrument characterization section of the FastCam webpage (<http://research.iac.es/OOCC/iac-managed-telescopes/telescopio-carlos-sanchez/fastcam/>).

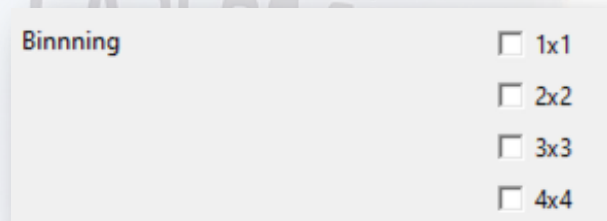


A screenshot of a software interface showing a dropdown menu for 'EM Gain'. The menu is open, displaying a list of numerical values: 0, 2, 5, 10, 20, 50, 100, 150, 200, and 250. The value '0' is currently selected and highlighted in blue.



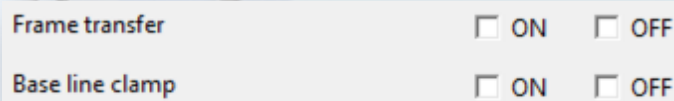
A screenshot of a software interface showing a dropdown menu for 'PreAmp Gain'. The menu is open, displaying two options: 'Gain1' and 'Gain2'. The option 'Gain1' is currently selected and highlighted in blue.

The binning options are 1x1, 2x2, 3x3 and 4x4. The plate scale at 1x1 is 0.035"/pixel. The field of view (FOV) is 35.8 x 35.8 arcsec².



A screenshot of a software interface showing a section labeled 'Binning'. It contains four checkboxes, each followed by a binning option: ☐ 1x1, ☐ 2x2, ☐ 3x3, and ☐ 4x4. All checkboxes are currently unchecked.

Detector features such as frame transfer mode and Base line clamp should be enabled or not depending on our preference. Please note that activating frame transfer mode with full CCD will only allow a minimum exposure time of 34 ms. The difference between them can be found on the website of the instrument (<http://research.iac.es/OOCC/iac-managed-telescopes/telescopio-carlos-sanchez/fastcam/>).



Frame transfer	☐ ON	☐ OFF
Base line clamp	☐ ON	☐ OFF

The detector temperature value (recommended -70°C) must be chosen by dragging the space bar to the required value. While it is cooling, a red sign will appear notified ("cooling down") and when it reaches the target temperature it will be indicated by the sign changing colour to blue ("cooled").



Temperature ($^{\circ}\text{C}$)	-11
Cooling down ...	<input type="text"/>



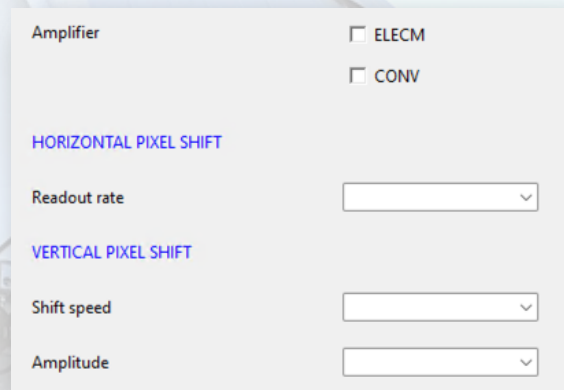
Temperature ($^{\circ}\text{C}$)	0
Cooled	<input type="text"/>

The "CONV" or "ELECM" amplifier mode implies deactivating or not respectively the EM gain and, consequently, the readout rate (horizontal pixel displacement). Here's a brief summary:

"CONV" (disable EM Gain) → readout rate values: 1MHz and 100KHz.

"ELECM" (enable EM Gain) → readout rate values: 1, 10, 20 and 30 MHz.

In addition, the vertical pixel shift must be chosen (shift speed and amplitude). The difference between them can be found in the instrument characterization on the FASTCAM website (<http://research.iac.es/OOCC/iac-managed-telescopes/telescopio-carlos-sanchez/fastcam/>).



Amplifier ☐ ELECM
☐ CONV

HORIZONTAL PIXEL SHIFT

Readout rate

VERTICAL PIXEL SHIFT

Shift speed

Amplitude

3.2 Acquisition of cubes

The images will be automatically saved in the folder chosen in the "path save" button. To acquire the images, it is necessary to enter the following parameters in the "image input parameters" panel:

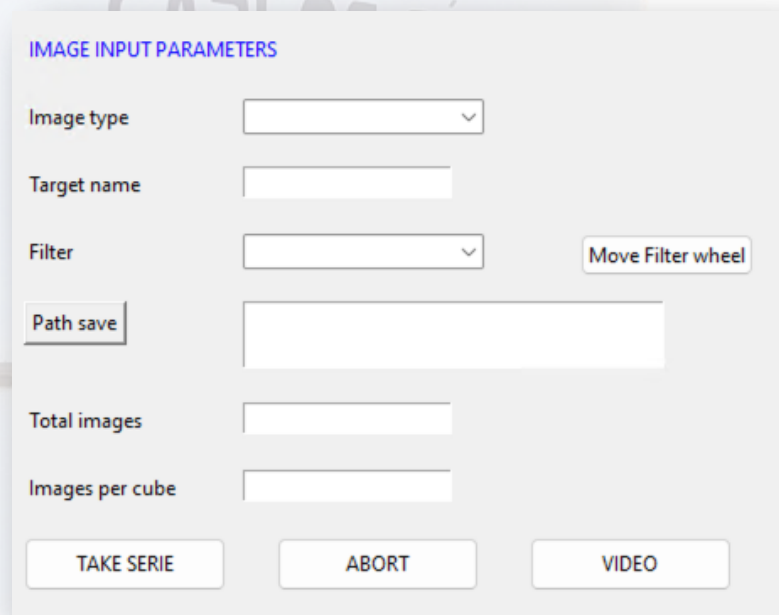


IMAGE INPUT PARAMETERS

Image type

Target name

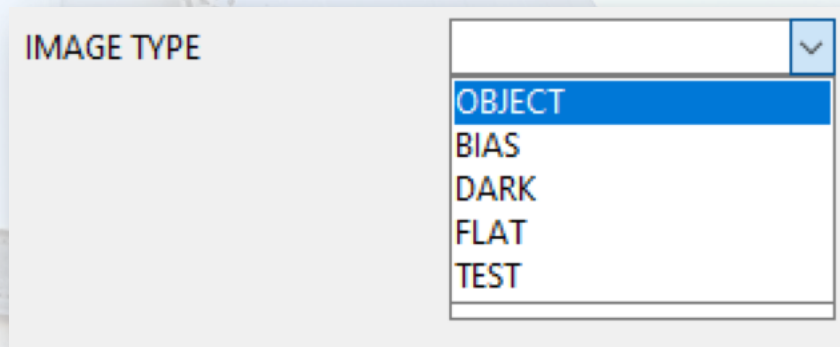
Filter

Total images

Images per cube

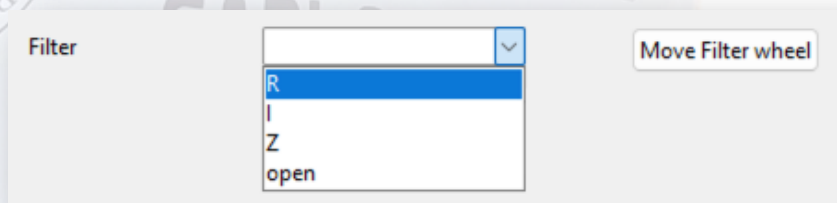
The "target name", which will be the prefix of the images when they are saved and will be used to easily locate them.

Specify the "image type", which is saved in the header and will be used to easily identify it for further reduction and to know if the shutter must be open.



A screenshot of a software window titled "IMAGE TYPE". It features a dropdown menu with a downward arrow on the right. The menu is open, showing a list of options: "OBJECT" (highlighted in blue), "BIAS", "DARK", "FLAT", and "TEST".

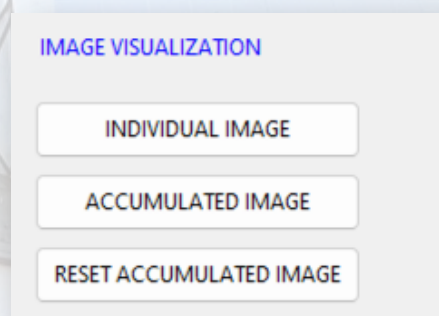
You must also enter the exposure time, in milliseconds, the total number of images required of the object, and the total number of images per cube. You must select the desired filter and press the "Move filter wheel" button to position it. When the button is pressed, the text box will report that the filter wheel is moving and will also notify when it has moved into position.



A screenshot of a software window showing a "Filter" dropdown menu and a "Move Filter wheel" button. The dropdown menu is open, displaying a list of filter options: "R" (highlighted in blue), "I", "Z", and "open". The "Move Filter wheel" button is located to the right of the dropdown menu.

Once all the parameters have been entered, the image can be acquired by pressing the "Take series" button. The acquisition, in both cases, can be canceled at any time by pressing the "Abort" button. Before taking the series, it is possible to identify if the target is in the field of view, so we press the "Video" button. A video will automatically be shown in real time with the previously chosen functions. Once we are ready to take the series, we close the window and press "take series" button.

At the moment, it is not possible to view a real-time video during the acquisition of the cubes. This possibility will be implemented in the near future. However, it is possible to check where the target is in the detector, and even to do a real time "shift and add" of the total number of images taken with the image visualization buttons. These images will be saved in the previously chosen path.



3.3 Focusing the telescope

Currently there is a script that automatically calculates the best focus.

3.4 Guiding parameters

The "guiding parameters" section generates a file with the corrections that the guiding system must make on the Cratos PC to keep the target in the required position of the detector. To do this, we enter the X and Y values, the pixel where we want the target to be placed, then we indicate the calculation time of these corrections in the telescope (0.3s is recommended) and then the method for calculating these corrections must be chosen, "average" when there is poor seeing and "median" when it is stable.

(see section 5. on how to activate guiding on the telescope)

GUIDING PARAMETERS

Reference position [X,Y]

Guide time (seconds)

Method

4. Taking calibrations images

4.1 Bias and Darks

BIAS & DARKS

Note: take them at the end of your observation run

In the calibration images section there is a button prepared to automatically take bias and dark images. It should be taken at the end of the night observations, since the program will take the gains and exposure times used from the headers and this information will be used to take the appropriate bias and darks.

Before leaving the telescope, to launch these calibration images click the button, do not turn off the telescope or the instrument.

4.2 Flats

Flatfields must be taken from the sky (skyflats). The dome flats are not yet uniform enough, although there will soon be a completely homogeneous system. They should be taken an hour before sunset. It is recommended to use exposure times similar to those used in science to use the same darks. The linearity curves of the flats can be found on the instrument's website.

5. Autoguiding with CRATOS PC

Once the observation with FASTCAM has started and the required guiding parameters have been set, the "guiding" application should be launched on the fovia PC. Once opened, just click the "guiding" button, it will automatically start guiding. If you want to stop guiding, just press the "stop guiding" button.



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