

LEIBNIZ INSTITUT FÜR ASTROPHYSIK POTSDAM



LEIBNIZ-INSTITUT FÜR SONNENPHYSIK (KIS)



MAX PLANCK INSTITUT FÜR SONNENSYSTEM-FORSCHUNG

GREGOR: SLITSCANNER INTERFACE

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Signatures & Approval

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1	2023-02-06	O. Grassin	New Document	
1.2	2025-05-20	O.Grassin	Bug correction : Busy state synchronization	9
1.3	2025-06-24	O.Grassin	Add Focus Auto Compensation function. Bug correction: K coefficient, negative.	6.5.3 7.2 / 9

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1 Scope

This document describes the SlitScanner interface software, which moves the slit assembly of the GRIS spectrograph at the GREGOR telescope during setup and observations.

It is integrated in the GREGOR Control System, respecting the infrastructure and communication protocols.

2 Reference and applicable documents

GCS - GREGOR Control System

ICS - Instrument Control System

GRIS - GREGOR Infrared Spectrograph

DCP - Device Communication Protocol

CoSM - Communication of Short Messages system

AO - Adaptive Optics

VI - Virtual Instrument

See: SlitScanner Instrument documentation

See: GRIS observation manual - GRE-GRIS-IAC-MAN-0009_v003_grismanual.pdf

3 Overview

The SlitScanner scans the solar image at the entrance of the GRIS spectrograph by moving the slit mechanically. It is located in the beam after M16, at the IR-F4 focal plane of the telescope. It has to be synchronized with the acquisition of images (GRIS camera). For this purpose, the SlitScanner interface receives the commands from the GRIS software (Polar), and moves the slit assembly with a motor.

A part of the light passes though the slit, going to the spectrograph, while most of the focal plane image is reflected onto the Slit-jaw cameras for a visual reference of the slit on the images.

The SlitScanner also controls a second device, a lens located on the slitjaw bench, which must be moved in a synchronized way with the slit mask in order to keep it in focus.

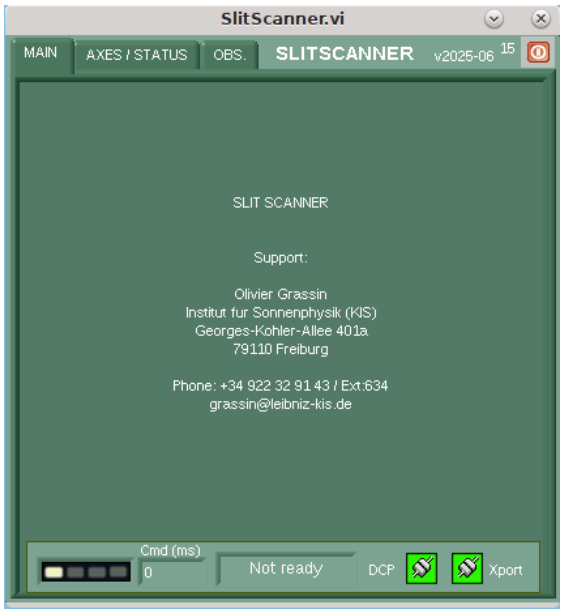
The motorization, driven by two Faulhaber driver modules, is controlled by the SlitScanner interface, as other small motorizations at GREGOR, through the network (Xport/CoSM) to the motor driver, at its serial line port.

4 Features

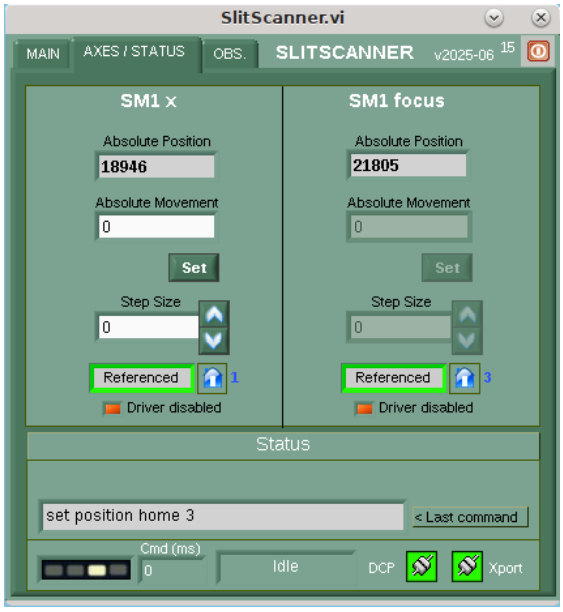
The SlitScanner interface (VI) has been developed in the LabVIEW15/64bits environment, on the CentOS7 Linux operating system. It has evolved over the years to fulfill the science specifications of the instrument. Its goal is to perform an accurate stepping of the slit on the solar image.

It drives 2 motors, one for the vertical slit position (X) and the other for the Focus compensation of the Slit-jaw cameras. During observations, the motors are kept enabled as the supported weight tends to pull the device out of the desired position.

All the functionality for manual or remote control is integrated.







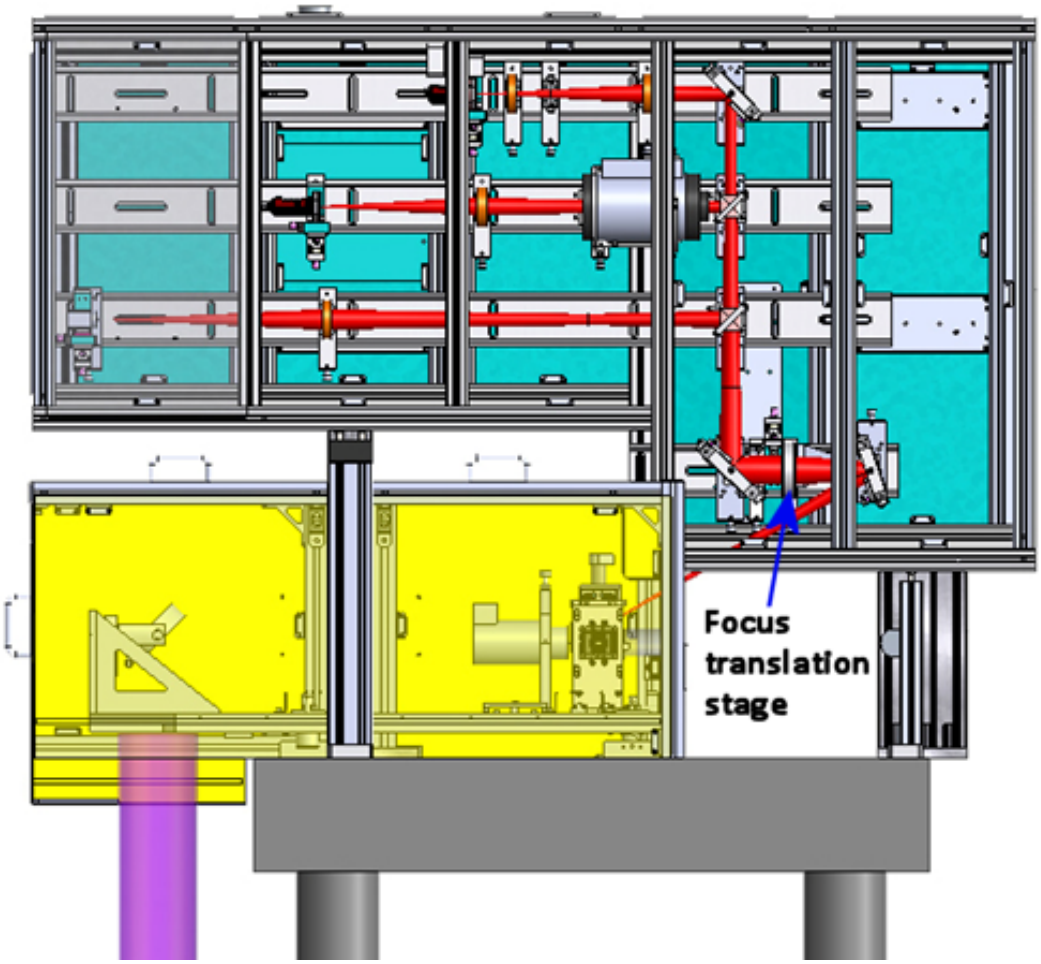


Last version: Version 2025-06

5 Motorization location

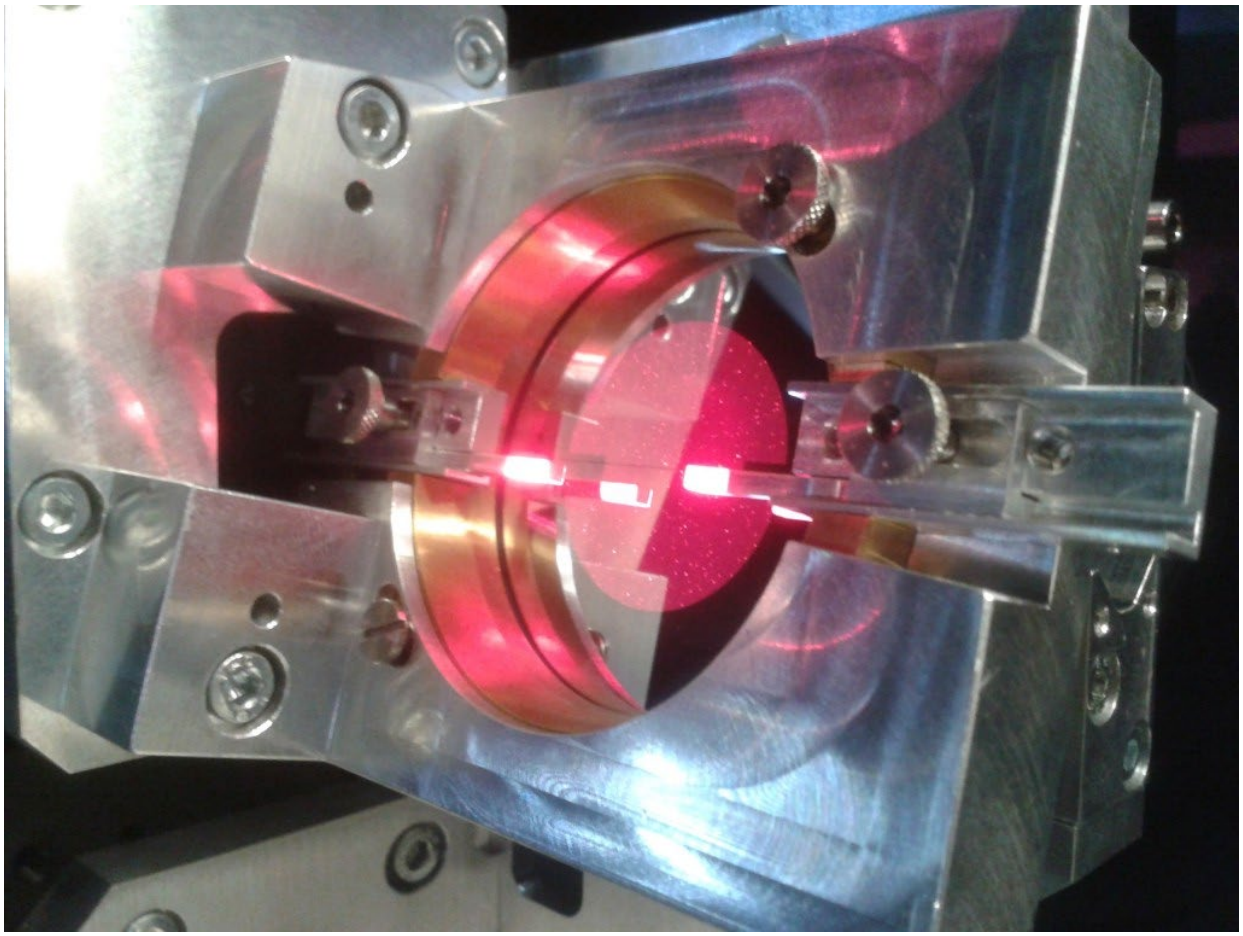
The SlitScanner unit is located after M16, at the entrance of the spectrograph on the GRIS bench. It is interchangeable with the IFU instrument; the focus motorization is shared by the interfaces of both instruments (SlitScanner/IFU).

The focus compensation motorization lays inside the Slit-jaw bench, in the optical path before the cameras and H-Alpha filter. (Picture from the Kleint et al. 2020 paper).



Picture 1 - Focus motorization

The slit is visible on this picture, in the middle of disk mirror.



Picture 2 - Slit mount

6 Software

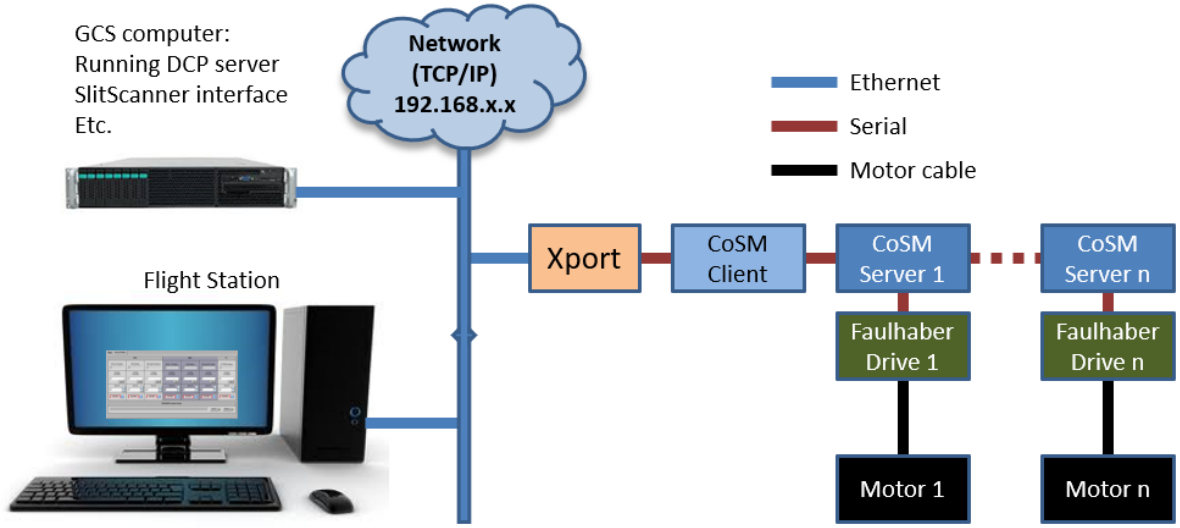
The software should manage events coming from the user front panel and remote commands through the DCP protocol from client instruments, Conductor, GRIS, etc.

As the time of motor displacement is critical for a fast scanning, the interface and motorization have been optimized to minimize it, performing during scans, parallel motorization movements over serial commands.

The SlitScanner also allows “LabVIEW remote panel” connections, for the use from a remote computer, such as GREGOR Flight Stations.

6.1 Installation

The LabVIEW15/64bits IDE is used to compile the source as an executable application.



Picture 3 - Complete system diagram

It should be installed on the GCS computer, at the “/opt/G_Control/SlitScanner/” directory, with two folders:

- “log” for errors and position storage (in the “motors” subfolder).
- “config” containing the configuration file for the communication, motorization and general setting.

The last source version is periodically updated after modifications and available at the KIS-GitLab site (https://gitlab.leibniz-kis.de/ot/labview/).



6.2 Smart homing

This feature is integrated in the motor referencing function. It offers a quick referencing sequence (software only) when a motor is already powered & referenced, …after a restart of the interface, for example. (Thanks to a trick that detects if the Faulhaber driver had a power loss).

To validate the state of a motor driver, it is needed to click on its respective "Home" button. The "Smart Homing" is available in all motorization interfaces, as it gives the freedom to close and restart the interface without the need of referencing with movements, all the controlled motors. The resulting advantages are a gain of time (instantaneous validation), no loss of the current position, reliability and no stress!

If the referencing with movement is required, for example when a drive has been powered down (power voltage << 24V), or if the "Force Homing" option is checked,
the motorization will do the referencing,
by running the stage to find its "zero" end-switch position.

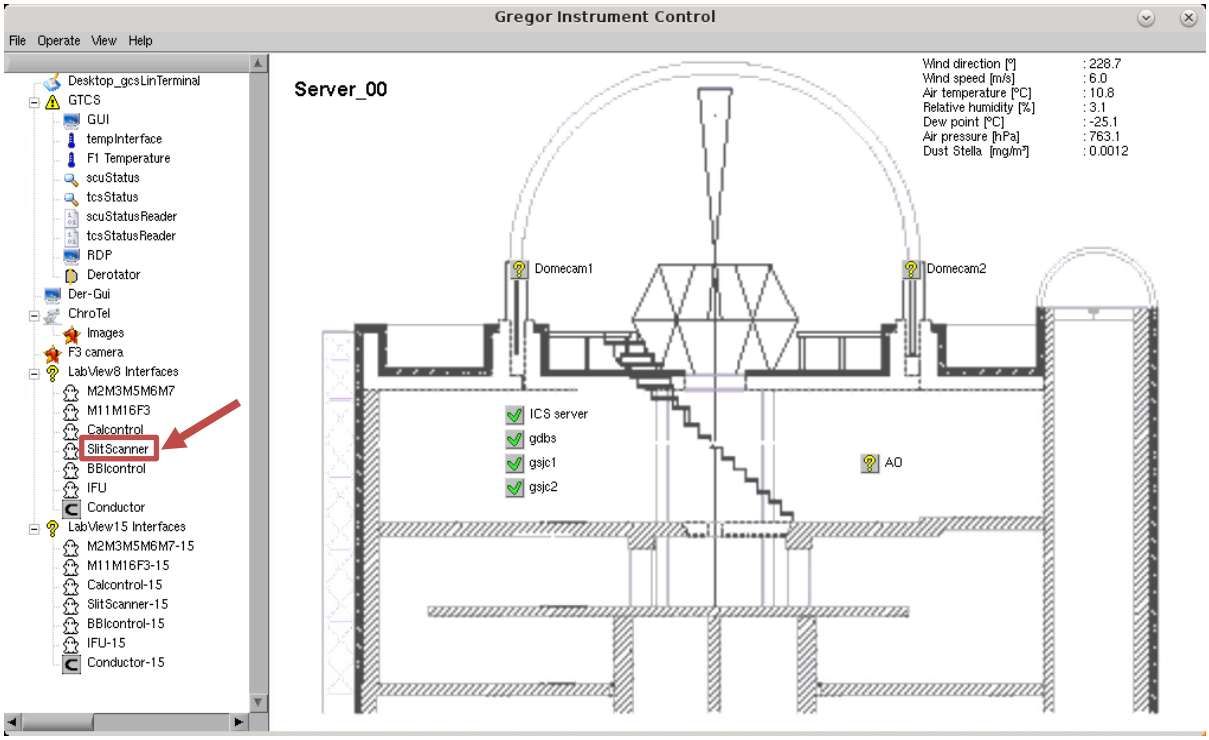
This can last for various tens of seconds to minutes, depending of the travel range of the motor axis.

A repositioning of the motor after a hard referencing
(setting back its former position),
may not bring it to the precise position as before,
even if the position numbers are the same!

Please, refer to the Optical Lab responsible person before referencing any critical motorization with movement for the observations.

6.3 Startup & Use

On the ICS interface (Gregor Instrument Control), just click on the SlitScanner item in the explorer menu at the left side, after verifying that the SlitScanner interface is not running on the system:



Picture 4 - ICS interface – Starting the SlitScanner interface

Only one instance of the interface is allowed to be running; any attempt to start more will generate an error message, as the communication ports for remote panel, the DCP client name at the GCS DCP server, and the motorization Xport are already used by the first one.

After the startup, the GUI appears: verify that the DCP and Xport indicators are green.

The motorization is now ready to reference:

To validate the state of a motor driver, it is needed to click on its respective “Home” button, in the "AXES/STATUS" panel.

Go to the “OBS.“ panel, click on the “Set Mid“ button to ensure the "centering" of both axes; slit and focus, then verify that the Slit-jaw camera images are focused.

Otherwise, something has changed from the slit to the camera along the beam, and needs to be investigated. (Camera or optical parts moved, focus lens axis not referenced, etc.). Any correction or troubleshooting should be reported to the Optical Lab responsible person.

If the checking is finally satisfactory, the motorization is then ready for the observations.

A remote panel of the interface is also available on the Flight Station (FS), the following steps are required to use the SlitScanner remotely:

- Be sure that the SlitScanner interface is correctly running on the GCS computer
- Verify that the SlitScanner interface is not already running on the FS; otherwise, use it.
- On the FS, access the ICS interface (similar to the GCS ICS interface).
- Click on the SlitScanner item, left side of the explorer menu, then the GUI opens.
- Make sure that both DCP and Xport indicators are green.
- Make sure that both motors are shown as "referenced", otherwise an error will appear in GRIS (polar) with a cryptic error message.

6.4 **Configuration file**

It is recommended not to modify any parameter of the configuration file, without the express clearance of the responsible person. The text file of the current state is given below:

```
[General Settings]
SSxPortIP=192.168.90.103
SSxPortRemotePort=10001
SM1xAxisCosmServerAdress=#25
SM1fAxisCosmServerAdress=#26
SM1pAxisCosmServerAdress=#21
GreCoServerHostAdress=192.168.90.1
GreCoServerHostRemotePort=2001
SlitScannerGreCoAdress=SlitScanner
LogFilePath=XoptXG_ControlXSlitScannerXlogX
DequeueElementsTimeout=1111
SSGreCoCommunicationQueueName=SSGreCoCommunicationQueueName
SScommandQueueName=SScommandQueueName
SSerrorLogQueueName=SSerrorLogQueueName
WaitMs=0
LogTimeOut=15

[Limit & Home Positions]
SM1xMinimumPosition=0
SM1xMmaximumPosition=50000
SM1fMinimumPosition=0
SM1fMaximumPosition=52000
SM1xMidPosition=21744
SM1fMidPosition=25453

[SM1 x Motor Controller Settings]
Baud Rate=BAUD9600
Mode=CONTMOD
Diprog=DIPROG
Refin=REFIN
Answer Mode=ANSW1
Power On Homesequence=POHOSEQ0
Motor Resistance=RM5780
KN=KN276
Positive Position Limit=LL50500
Negative Position Limit=LL-2500
Encoder Resolution=ENCRES2000
Velocity Proportional Term=POR6
Velocity Integral Term=I15
Peak Current=LPC1000
Continuous Current=LCC980
Acceleration=AC3000
Speed=SP150
Position Proportional Term=PP170
Position D-Term=PD60
I-term Current=CI89
Sampling Rate=SR1
Homing Speed=HOSP-100
```

Velocity Source=SOR0
Hard Blocking=HB6
Hard Polarity=HP6
Preset Direction=HD4
Home Harming=SHA2
Hard Limit=SHL2
Disable Drive=DI

[SM1 f Motor Controller Settings]
Baud Rate=BAUD9600
Mode=CONTMOD
Diprog=DIPROG
Refin=REFIN
Answer Mode=ANSW1
Power On Homesequence=POHOSEQ0
Motor Resistance=RM5780
KN=KN276
Positive Position Limit=LL52150
Negative Position Limit=LL-600
Encoder Resolution=ENCRES2000
Velocity Proportional Term=POR15
Velocity Integral Term=I22
Peak Current=LPC800
Continuous Current=LCC780
Acceleration=AC30
Speed=SP300
Position Proportional Term=PP140
Position D-Term=PD40
I-term Current=CI90
Sampling Rate=SR1
Homing Speed=HOSP-100
Velocity Source=SOR0
Hard Blocking=HB6
Hard Polarity=HP6
Preset Direction=HD4
Home Harming=SHA2
Hard Limit=SHL2
Disable Drive=DI

[SM1 p Motor Controller Settings]
>>> CoSM 21 <<<
Move TimeOut=30000
Polling Timeloop=2000

6.5 Using the interface

Please, refer to the "Startup & use" section to ensure the correct using condition of the interface.

To validate the state of the motorization drivers, click on the “Home” button and check that the indicator turns to “Referenced”, for both motors. (See “Smart Homing” section).

The interface is now ready to receive DCP or manual commands.

6.5.1 Main panel



Picture 5 - Main panel

Position

- **Sliders:** A pointer slide indicates graphically the last position of each axis. (It is not a control.)
- **Timing indicator:** shows the time of the last movement in ms.
- **Position:** Corresponding position of the slider.

Settings

- **Force homing:** If checked and a "Home" is sent, a referencing movement will be executed to find the zero position. Read the "Smart homing" section for details.
- **Wait:** this control gives the user a possibility to introduce a delay, in millisecond, to wait after the positioning. Should be set to 0 for fastest operation.

Status

See further "All panels" paragraph.

6.5.2 Axis/Status panel



Picture 6 - Axes/Status panel

Absolute movement

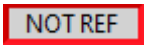
Enter a value into the respective control and click the “Set” button to move the motor to the desired position. Movement is executed and the “Referenced” indicator stays green.

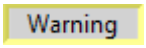
Step

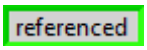
To move the motor by steps, enter the step size in to the respective control. The movement is executed using the up & down arrows. If the destination position is out of range, the movement is not done. From DCP, an error message is returned.

Motorization status

This indicator has 3 states as:

- 

When the motorization state is unknown at start up or when an error happened. Motorization needs to perform a "Home".
- 

The motorization is moving to the referenced "0″ position.
- 

The motorization has referenced and is ready for position movements.

Home

Button for referencing and to validate the motor.

The drive is disabled after referencing, to avoid driver/motor consumption when the system is not used for a long time. An indicator shows the state. The drive will return to the enabled state automatically at first the command/movement request.

Driver disabled

This indicator shows the status of the driver; after referencing (smart homing or not), the driver is disabled, meaning that no current is passing through the motor to maintain its position (light ON). As soon as a command to move is sent, the driver turns on, to guarantee the good position (light OFF).

It is convenient after the observations to disable the driver, by doing a "Home", on both motors.

This will avoid useless heating due to motor power consumption.

Status

- **Last command:** This indicator shows the last action done, DCP or manual mode. (internal parameters displayed)
- **Other indicators:** See further “All panels” paragraph.

6.5.3 OBS. panel



Picture 7 - OBS. panel

Slit & Focus

This panel controls the "middle" positioning (=reference position from GRIS alignment) of the motorization. It does not necessarily correspond to the perfect middle position of the motor. In the following, we will nevertheless use the word "middle" when referring to the aligned position.

Clicking on the "**Set Mid**" button will move the motorization to the "middle" position of the SlitScanner device, that ensures the correct positioning and focusing.

The "**Middle position**" indicators show the values of the Slit and Focus position, referring to the configuration file "Mid" values. The calibration of these position values is validated by the responsible person after a change/alignment of GRIS.

New DCP commands (for more information, see: "DCP commands" section, below):

- "set position conf SM1 0 [*SlitPos value*] [*FocusPos value*]"
  to set the "middle" positions in the configuration file.
- "set position def SM1 0"
  to set the motorization to the middle position.
- "get position def SM1 0"
  to get the "middle" position values of both motors.

The "set position def SM1 0" DCP command should be performed at the beginning of scans, to ensure the perfect start point, unless off-pointing the slit is desired.

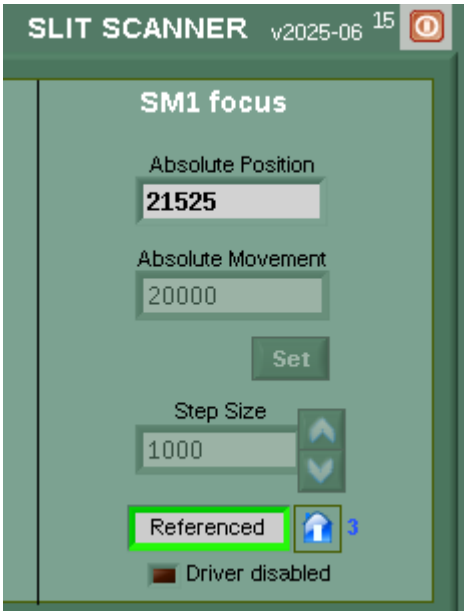
Using the Conductor script "**SlitScanner_Middle_to_Config.script**" located at the GCS server in "**/opt/ConductorData/Scripts/Configuration/"** directory, will simplify storing new values of the middle (as reference) positions, in the configuration file. The process description is commented in the script itself. It should only be used by expert users.

"**Focus Auto Compensation**", when the option is checked, it allows to calculate automatically the focus axis position respectively to the slit axis, on "OBS" mode, through DCP commands:

"set position (rel/abs) SM1 0 [slit value].
No need to put any focus value, or in case it is, it is not taken in account.

This functionality purpose, once checked, is to be use in observation scans, to just rely on the interface to ensure the focus axis position calculation, to guaranty a sharp Slitjaw image on camera. To set it checked, by DCP command: "SlitScanner set config soft 1", or 0 to uncheck.

Warning: This option box, when checked, affects the manual mode of "AXES / STATUS" panel and disables the controls of the focus axis; the user cannot move it manually in a position or relative movement. The proper DCP command "set position abs/rel SM1 3 [value]" neither move the axis and will return an error ACK code.
Just uncheck it, to regain control for tuning the axis position.



Picture 8 - Focus Auto Compensation, checked.

Positions log

This panel shows the state of the Positions log function. The green led ON indicates that the interface registers all movements of the motorization in the log file. The log file is located in the "**/opt/G_Control/SlitScanner/log/motors/**" directory, with a name as "**SlitScanner-PosLog_yyyy-mm-dd.txt**", keeping the date, time, Slit position, Focus positions, and last command… available at the GCS server.

When the "**Disable**" button is clicked, it manually disables the position log, for a delay whose value in seconds is stored in the configuration file. It is currently set to 15 seconds, to allow starting a scan without registering positions in the log file, during the whole scan. Any movement of the slit scanner during the "log disabled state" further prolongs the deactivation of the log file by the value of the delay. After the scan stops, the logging state will return automatically to enabled after the specific delay.

This option of the function allows to by-pass the motorization positions to be written on a file during the scan. It can also stay "enabled", to be used for debugging purposes. An indicator shows the remaining time before the reactivation of the logging function. The disabling and enabling can also be performed through DCP commands:

- "set soft log [0/off/false]" => to disable
- "set soft log [1/on/true]" => to enable

Polarimeter

This panel controls the Polarimeter motorization, using the IN/OUT function.

The software functionality is available, but the hardware motorization control of the polarimeter positioning has not been implemented yet by the IAC team.

"IN" button

Action on this button will insert the Polarimeter in the beam path.

"OUT" button

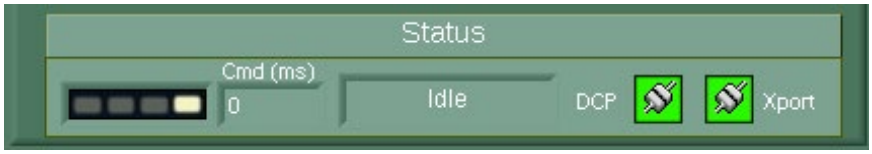
Action on this button will extract the Polarimeter from the beam path.

"Status" indicator

Shows the current message:

- Unknown
- Error
- OUT
- IN
- ENG1 (PolIN/MirrorDown)
- ENG2 (PolOUT/MirrorUp)
- Moving Polarimeter
- Moving Mirror

6.5.4 All panels



Picture 9 - All panels

- **Idle/Busy:** Interface activity; waiting for command or doing some movement… The "NOT READY" message is flashing when a DCP or Xport connection is not opened or the motorization is not referenced. The motorization can also be used manually if the DCP server is not connected.
- **4 LEDs bar:** Display showing that a command has been executed, by a step change.
- **DCP Command timing:** shows the whole time for the DCP command execution. CMD (ms)
- **Status:** No Error/Not Ready/Idle/...Busy... while waiting for command or moving.
- **Communication status:** Both DCP & Xport must be green for a normal function.
- **Exit Button:** When clicked, the interface closes the network connections and exit. It could take a few seconds, please wait…

7 Technical data

7.1 Motor limits

Current position limits (2015-06)

- SM1 X Minimum Position = 0
- SM1 X Maximum Position = 50000
- SM1 Focus Minimum Position = 0
- SM1 Focus Maximum Position = 52000

7.2 Compensation

Step

- One step = 0,5 µm
- Total X travel = 25,0 mm
- Total Focus travel = 26,0 mm

Coefficient

For an X axis relative movement, the corresponding Focus axis movement, to maintain focusing, is calculated applying a coefficient K = -2 * tang(15º) = -0,536

- FocusStep = XStep * K

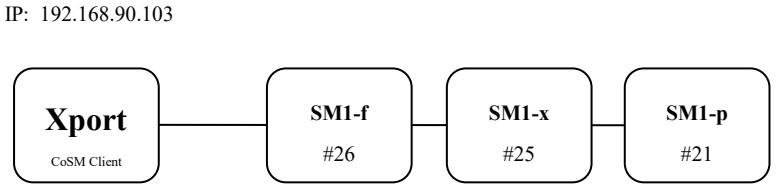
First of all, when the observer adjusts the slit center position, he must manually determine the center focus position, too. Relative DCP commands can then be sent to scan with the calculated step value for focus according to the X step.

An absolute equation can also be used:

- FocusPosition = (Xposition – CenterXposition) * K + CenterFocusPosition

One GRIS step corresponds to -71.28 SM1x and 38.2 lens steps.

7.3 CoSM modules – daisy chain configuration



Picture 10 - CoSM modules - daisy chain configuration

8 DCP commands

To use the DCP functions, this interface name is: **SlitScanner**

The current command list, for the remote use of the interface and its motorization:

- "**set nop**" for communication test
- "**set position abs**" for axis absolute position
- "**set position rel**" for relative movement
- "**get position abs**" for reading axis position
- "**set position def**" for sending both axes to the middle position
- "**get position def**" for reading the middle positions
- "**set position conf**" for setting the middle position in the configuration file
- "**set soft log**" to disable/enable the position log to file

For detailed information and parameters, please refer to the specific last updated version of the DCP documentation, available in the blog at
https://blog.tt.iac.es/telescopes/gregor-2/observation/slitscanner-interface-2/:

SlitScanner – DCP Commands-SM1 Rev4 – (2022-11-08)

9 What's new?

(2025-06-24)

Added Focus Auto Compensation option box, to set the function in "OBS" mode. (see 6.5.3)

Corrected the K coefficient sign: set to negative.

(2025-05-20)

Bug detected with the "set config soft" fast followed by another command, generating a 5-ACK. In the software, at the Command Execution loop, the "busy" signal is still ON, when the following command arrives to the Received Command loop and returns an error "wrong mode". Bug cleaned, resynchronizing the "answered message" after the "busy" signal is cleared.

(2022-11-08)

Log of motorization positions / Middle positioning.

In order to compensate any possible drift accumulated by relative movements during a scan, it is recommended to send manually or remotely (by a DCP command), the SlitScanner motorization to its "middle" (=reference) position, where the slit-jaw focus and slit position are correctly adjusted. The position log can also be disabled during the scan, by sending a DCP command to that purpose.

Please, read the "OBS. panel" paragraph for more details.

- Added log functionality to the "OBS." Panel:
  - "**Disable**" button to stop the log of positions to the file.
- Added "Middle" positioning to the "OBS." Panel:

  - "**Set Mid**" button to send the motorization the middle position.
  - "**Middle position**" indicators (Slit/Focus).
- Added new DCP commands:
  - **set position def SM1 0**
    Send (coordinate system of Slit and Focus) motors to the "Middle" position.
  - **get position def SM1 0**
    Return the "Middle" position values of both motors.
  - **set position conf SM1 0**
    Store in the configuration file, the default Middle positions of the Slit and Focus motors.
  - **set soft log** [0, off, false / 1, on, true]
    Disable/Enable positions log in a file.
- Filter DCP errors when the DCP server is not connected.

(2018-10-02)

Polarimeter Motorization implementation

- Added Polarimeter insertion control to the "OBS." Panel:
  - "**IN**" button to insert the Polarimeter into the beam.
  - "**OUT**" button to extract the Polarimeter into the beam.
  - "**STATUS**" indicator shows messages.
- Added Polarimeter Motorization SlitScanner DCP command:
  - set position def SM1 5 a (a = position 0 or 1)
  - get position def SM1 5

(2016-11-14)

- Total remove of Y axis.
- Correction of Motorization Configuration to avoid initialization problem.

(2016-05-31)

- Modify Config Motor parameter to test at beginning & suppress hidden error message.
- Remake of the error warning in case of limit.
- Modify the parallel relative to prevent reading position and get the driver trusted position.

(2016-03-09)

- Two new DCP functions have been added to allow parallel movements of both axes, with the goal of saving time during a scan, reducing communications.
- A new feature is installed for disabling the drives after referencing, to avoid driver/motor consumption when the system is not used for a long time. An indicator shows the state. The drive will return to the "enabled" state automatically at first the command/movement request.
- Interface has been cleaned from Y motor that will not be used, as IFU, a new instruments project, (Integral Field Unit) with 4 motors (x, y, z, focus) is on the way.

(2015-06-16)

- Closing interface time reduced.
- The current version of SlitScanner software is visible at the top right side of the interface.
- Correction of DCP Communication bug, producing random delay to answer messages to client. The heavy/fast use of SlitScanner movements in observation could reveal the default that is present on all motorization interfaces as they have been nearly built in a same model for the DCP communication procedures.
- Bug corrected for the answer of some “get position” commands that sent at the end 2x (Carriage-return + Line-feed) instead of one.
- Modification of Open/Close CoSM timing routines that reduces the timing in 45 ms for each movement.
- Readjustment of the motors limits to fit inside the end switches and match motors driver configuration.
- On MAIN menu, motors have a new timing indicator that shows the time of the last movement in milliseconds.
- New indicator for DCP commands timing at the bottom left side. Time is in ms, too.