LEIBNIZ INSTITUT FÜR ASTROPHYSIK POTSDAM

LEIBNIZ-INSTITUT FÜR SONNENPHYSIK (KIS)

MAX PLANCK INSTITUT FÜR SONNENSYSTEM-FORSCHUNG

GREGOR:
Calibration Unit Manual

Document No.:	**GRE-KIS-MAN-0016**
Version:	**1**
Date:	**30.4.2022**

Signatures & Approval

	Name	Date
Prepared by	Lucia Kleint - UNIGE Horst Balthasar - AIP Miguel Esteves, Olivier Grassin - KIS	22.3.2022
Reviewed by	all of the above, D. Gisler - IRSOL	
Approved by		
Released by		

Change Log				
Vers.	Date	Author	Description of Changes	Sect./Para.
1	22.3.22	L. Kleint	New Document	
	6.4.22 13.4.	L. Kleint	Combined own draft with Horst's document and Miguel's section. Updates after comments	
	23.4.22		Update Fig 2, add IRSOL ret. cal., add wire grid info	
	28.4.22		Update mounting/dismounting GCU, electronics etc.	

Table of Contents

List of Figures

1 Scope

This document summarizes the GREGOR calibration unit and contains changes that were made to it.

2 Overview

The GREGOR Calibration Unit (GCU) is installed in F2. It consists of two wheels. The first one has four positions. Two positions are fixed, one of them is an open aperture for regular observations and the other one contains a protection filter. There also are two rotatable mounts, one of which is equipped with a polarizer for GRIS, and the other one either with a polarizer for GPP observations, or a counter-weight. The second wheel sits exactly in F2 and contains two quarter-wave retarders for the visible and the infrared, respectively, on rotatable mounts. In addition, this wheel provides a pinhole, a cross-wire grid, and a reticle as adjustment tools.

For a detailed description of the GCU see the publication of Hofmann et al. (2012). https://ui.adsabs.harvard.edu/abs/2012AN....333..854H/abstract.
The calibration unit is theoretically AIP's responsibility, however, KIS and IRSOL mostly have taken over and done the calibration and maintenance.

3 Layout

There are 2 calibration wheels, rotatable by the GREGOR GUI (or their Labview GUI).

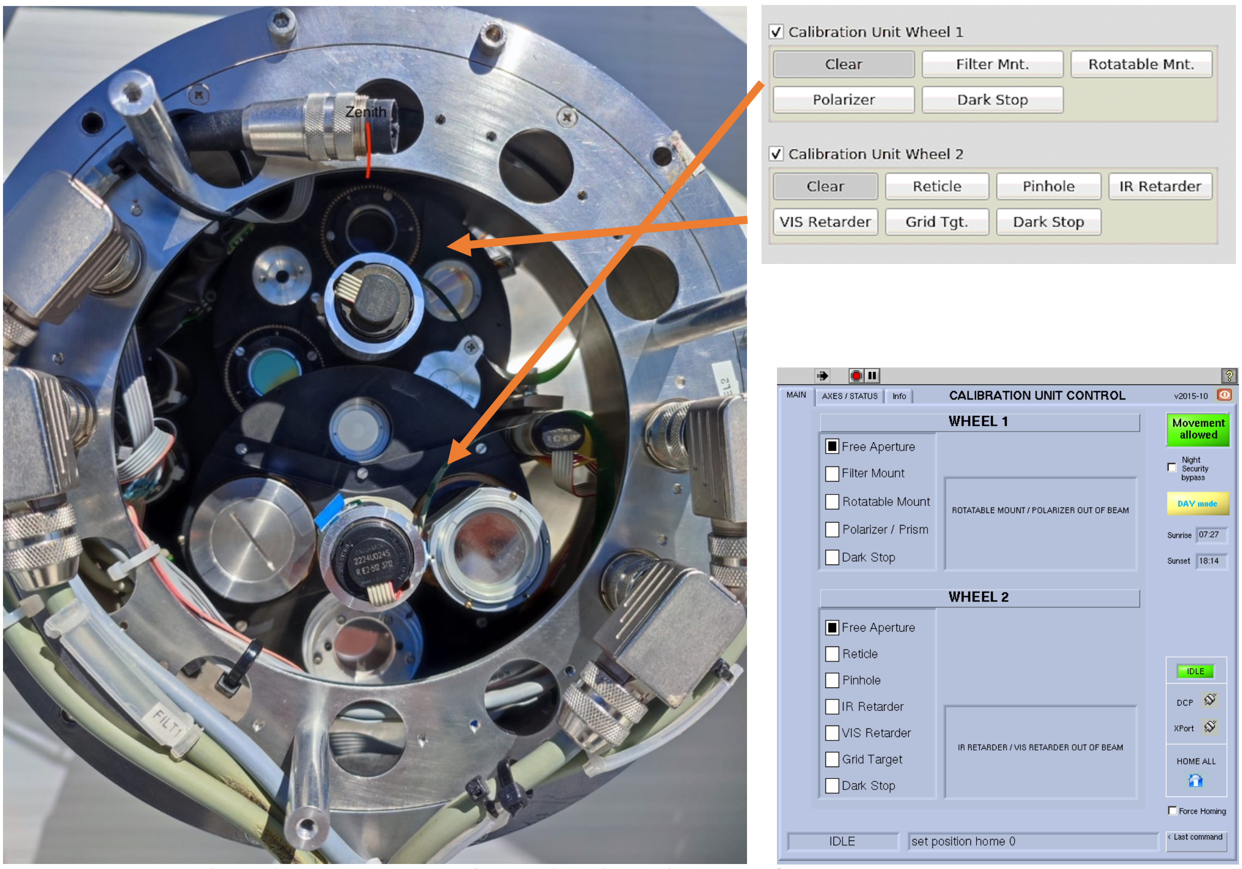


Figure 1: The two wheels of the calibration unit and the GUIs to command them.

From Hofmann's paper, the properties of the most important elements are:

- pinhole (diameter 50 microns, according to its label)
- 0.5 mm grid target. Before the redesign, the grid spacing was 11.75" (+- 0.25") on the sky, as described in GRE-KIS-TN-0006. After the redesign, it should be re-measured, because the scale may have changed slightly.
- The free aperture of 20 mm diameter is for free beam-transmission, the other of 25 mm diameter is equipped with a reticle and can be used to implement further optics. Instead of the 20 mm free aperture, now a 5.5 mm round aperture (=130") is used to provide a sharp edge for the beam tracker in F3.
- VIS and IR retarders. Retarder rotation increment 9.15".
- Polarizer for 350-1600 nm. Rotation increment 5.5".

The different elements are labeled in Fig. 2.

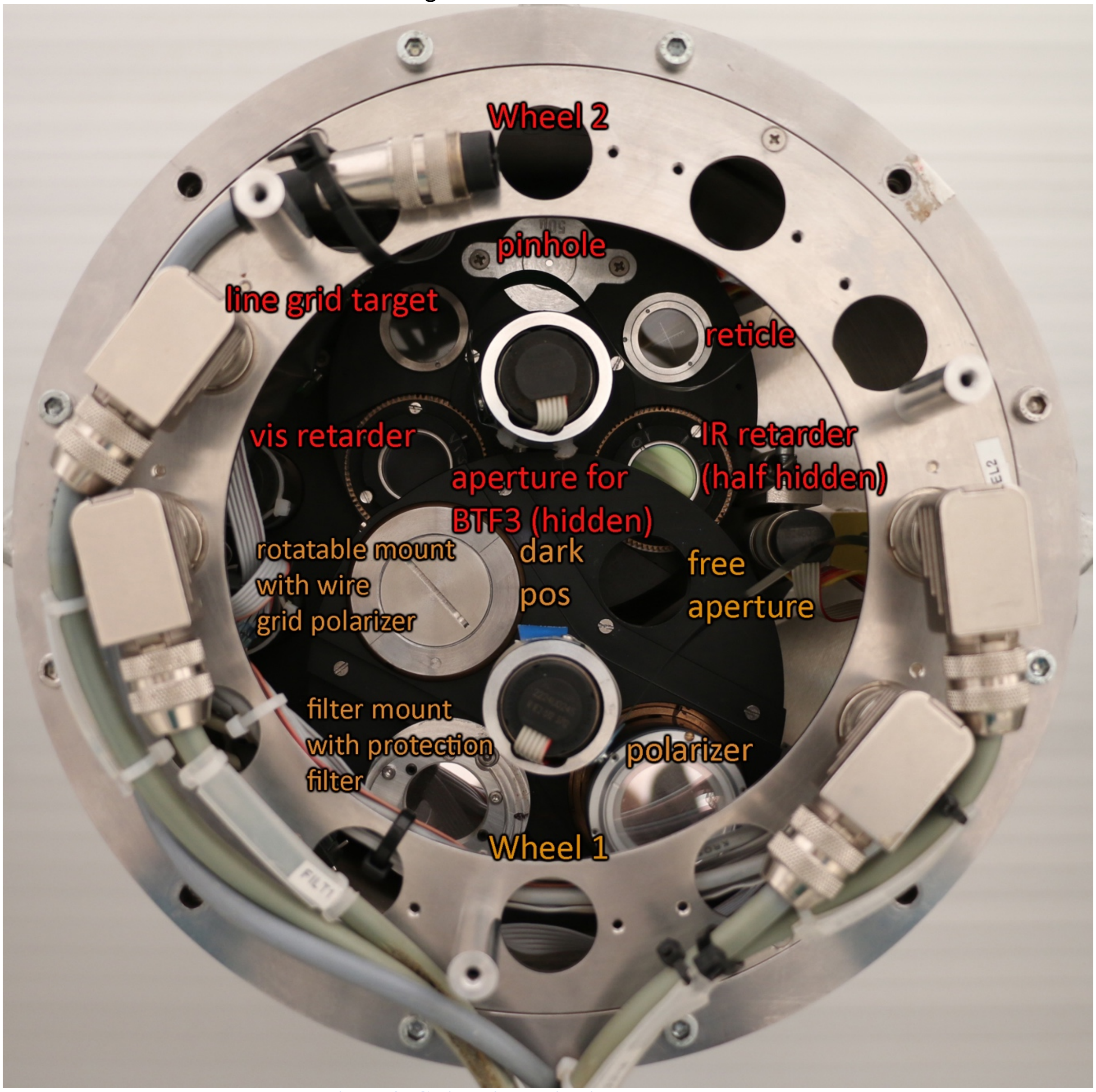


Figure 2: Calibration Unit with labeled elements

3.1 The protection filter

It turned out that the infrared PMMA-retarders might be not resistant enough for the conditions in F2, especially the enormous heat load of 0.5 W mm^{-2}.

To reduce the energy density on the retarder, a special protection filter was designed by LASEROPTIK GmbH in Garbsen. This filter blocks light with wavelengths shorter than 423 nm, reduces the throughput in the visible by a factor of 4 and blocks the infrared light in the ranges where the retarders absorb, especially at wavelengths larger than 1600 nm. The infrared ranges of interest have a high throughput. The filter is realized by two different metal coatings on two separate substrates. Transmission curves of the two coatings are displayed in Fig. 3.

These filters must not be removed when using the calibration unit with sunlight!

Two such filters are installed: 1) These two substrates are combined in two small mounts attached to the front of the polarizer. 2) A second mounted set is installed separately (see Fig. 2) to be available for special measurements of the retarders. Usually, this second mounted set is not used. The retarders are protected by settings in the Labview GUI, meaning that certain combinations of positions of wheel1 and wheel2 are not allowed, or not during daytime. The protection settings are shown in Fig. 4.

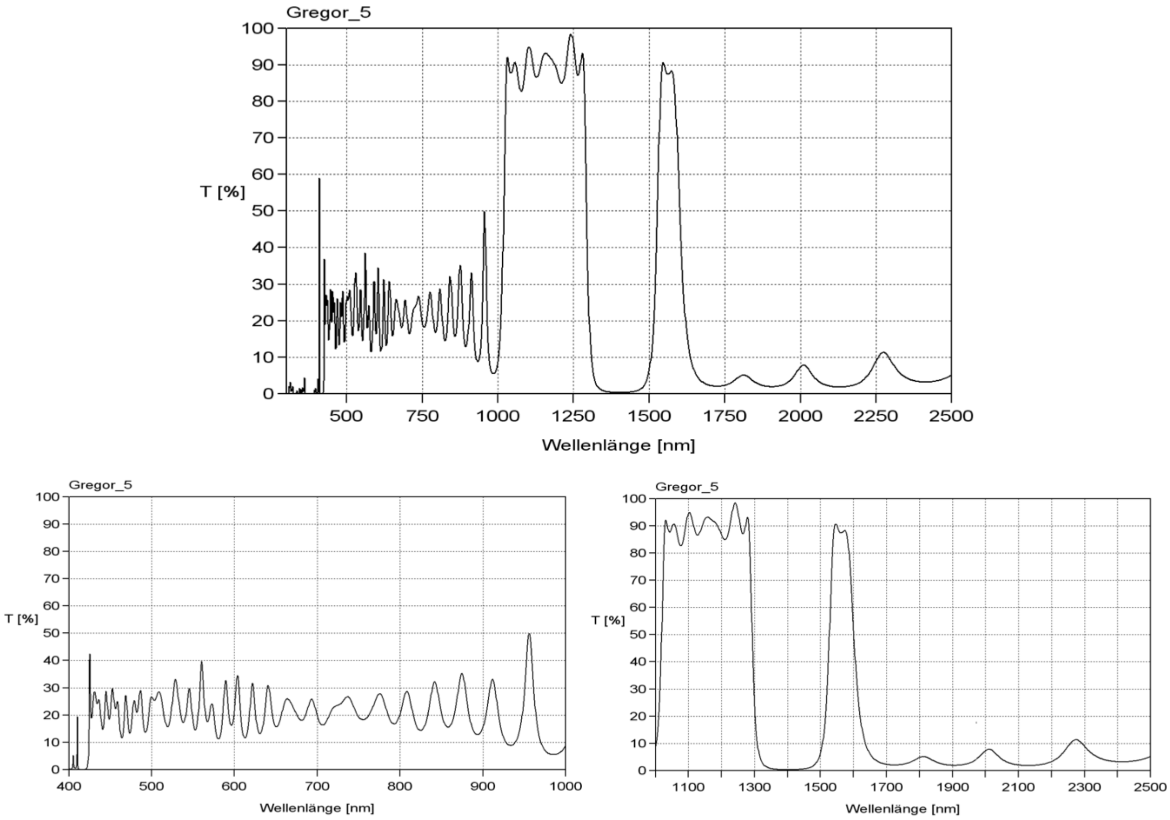


Figure 3: Transmission curves for the protection filter. Top: total wavelength range, bottom: visible and infrared

Security for Calibration Unit / DAY		WHEEL 1				
		Free Aperture	Filter Mount	Rotatable Mount	Polarizer Prism	Dark Stop
WHEEL 2	Free Aperture	OK	OK	OK	OK	OK
	Reticule	OK	OK	OK	OK	OK
	Pinhole	OK	OK	OK	OK	OK
	IR Retarder	Forbidden	Forbidden	Forbidden	OK	OK
	Visible Retarder	Forbidden	Forbidden	Forbidden	OK	OK
	Grid Target	OK	OK	OK	OK	OK
	Dark Stop	OK	OK	OK	OK	OK

Security for Calibration Unit /Night		WHEEL 1				
		Free Aperture	Filter Mount	Rotatable Mount	Polarizer Prism	Dark Stop
WHEEL 2	Free Aperture	OK	OK	OK	OK	OK
	Reticule	OK	OK	OK	OK	OK
	Pinhole	OK	OK	OK	OK	OK
	IR Retarder	Forbidden	Forbidden	OK	OK	OK
	Visible Retarder	Forbidden	Forbidden	OK	OK	OK
	Grid Target	OK	OK	OK	OK	OK
	Dark Stop	OK	OK	OK	OK	OK

Figure 4: Protection settings of wheel 1 and wheel 2 positions

Note: The current settings prohibit using the filter mount (wheel1) and IR/VIS retarder (wheel2). Currently, a protection filter is mounted inside the filter mount, which should make this combination safe. However, because there currently is no scientific need to use this combination, the safety restrictions were left in place, to protect the retarder in case the filter is ever removed.

3.2 Properties of the retarder in the telescope calibration unit

From time to time it might be necessary to determine the properties of the retarders in the GCU. To this purpose, the GCU has to be removed from the telescope (see Sect. 7, including disabling the power to it), and the network connection labeled "Calibration unit" in the az-box has to be unplugged (see Fig. 5).

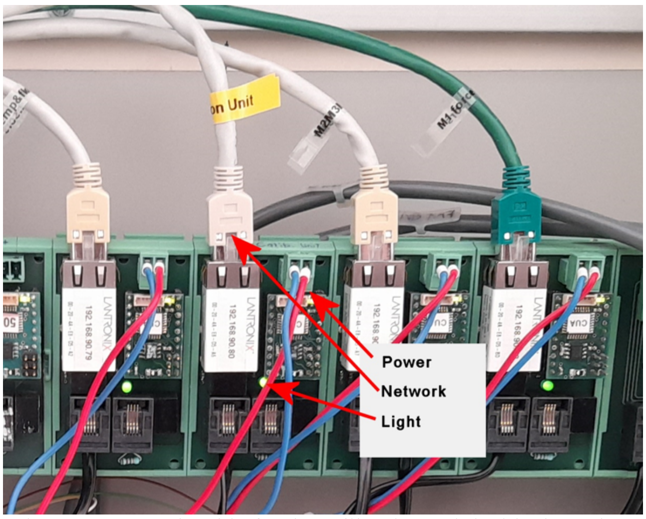


Figure 5: Network cable for the calibration unit inside the az box

Now, the AIP-control box can be connected to the network, and the GCU can be again controlled after restarting the CalControl GUI through the ICS menu, on gcs. (The control box has the same address as the hub at the telescope, therefore an address conflict has to be avoided.)

The GCU now should be mounted on its socket (stored in the “polarizers only” cabinet together with the control box). The GCU can be put directly on the optical rail without a rider, it is heavy enough not to move. Its optical axis is now in a suitable height for the test setup. For the test setup, one needs: the blue halogen lamp, an optical fiber, a fiber holder, two lenses, a linear polarizer, an interference filter for the desired wavelength range, the so-called large KIS-polarimeter with a field stop instead of a wave plate, and a CCD-camera, e.g. a PCO-4000 (the chip of a Sensicam is a bit small). An additional quarter-wave plate (Halle) can be added after the GCU. The setup is shown in Figs. 6 and 7.

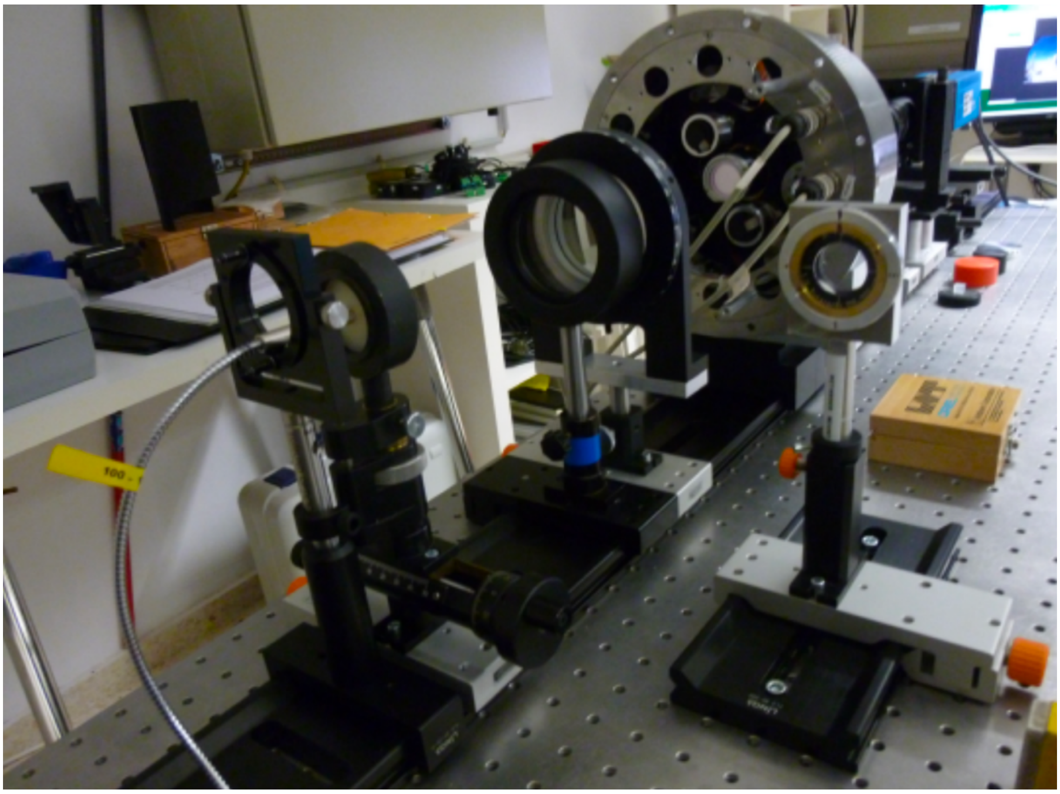


Figure 6: Setup to measure the GCU. View from the light inserting side (fiber)

Note: The properties of the retarders change with wavelength. It is therefore recommended to carry out these measurements with various interference filters, or ideally with a spectrometer. D. Gisler's measurements of the VIS retarder (using the IRSOL method) during 2 different days in 2018 are listed below. The value in the "absolute" column denotes the offset to whatever the zero position was during that time, it does not denote any absolute retardance.

WL [nm]	Relative [deg]	Absolute [deg]
461	69.7	31.7
520	68.7	27.6
620	66.2	28.2
750	62.6	24.6 *

WL [nm]	Relative [deg]	Absolute [deg]
461	70.6	32.6
520		
620	65.7	28.6
750	63.3	25.2
750	65.9	27.9 with IR polarizer

The polarizer of the GCU deflects the unused light (−*Q*) to one side. In the zero position, this side is horizontal. It is indicated by the straight side of the front plate, as shown in Fig 13. It is yet unclear whether there is any importance if this horizontal side is on the top or on the bottom. The difference is the heat dissipation direction in the calibration unit, which may or may not be important.

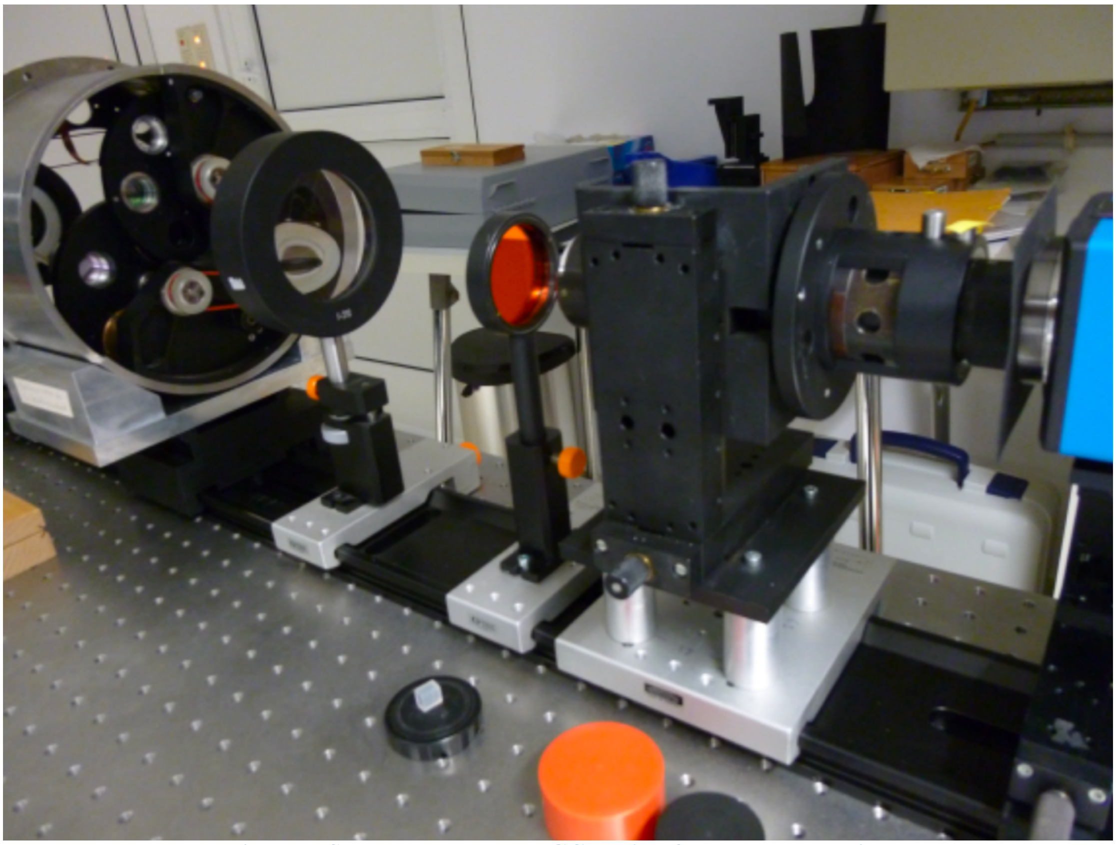


Figure 7: Setup to measure the GCU. View from the camera side

For the measurement without the quarter-wave plate, rotate the retarder in the calibration unit in steps of ideally smaller than 10 deg from 0 to 360 deg (Daniel recommends steps < 5 deg). For each step, a few images with the CCD-camera should be taken. The results can be evaluated with "STOOLS_EXPERTPOL_GCU_RETARD.PRO". This routine determines the amplitude of the modulation and its phase shift. The amplitude depends on the retardation and the phase on the orientation of the fast axis. Fig. 8 displays the measured and fitted curves. In the left panel, the retardation is 89.4 deg and the orientation of the fast axis is 11.1 deg (=first max of black curve, but it could also be the second maximum - one is the fast axis, one the slow axis. In the right panel, the retardation is 83 deg, although probably with some error (not perfect fit to crosses). Confusing the slow and fast axes would lead to an opposite sign in V, which one could check by comparing magnetograms from GREGOR e.g. to SDO/HMI). The values are printed out by the program and hard to see only based on the plot. If the retarder is not an ideal quarter-wave plate, the red and blue curves will be shifted up or down (the black curve is the difference of the colored ones).

A second measurement with the Halle plate tells you if you really deal with the fast axis. Put the Halle plate at 45 deg and rotate the GCU-retarder to 45 deg and 135 deg plus the determined orientation angle. If you deal with the fast axis, both retarders together act as a half-wave plate and $+Q$ becomes $-Q$ at the 45 deg position, detectable as an exchange of the intensities in the two beams. At the 135 deg position, $+Q$ should remain $+Q$. If the opposite is the case, one has to add 90 deg to the value determined for the orientation of the fast axis.

Note: According to IRSOL's experience, not all Halle plates are labeled correctly, meaning 45 deg may actually be -45 deg for some plates. Again, the safest check is to compare magnetograms in the end.

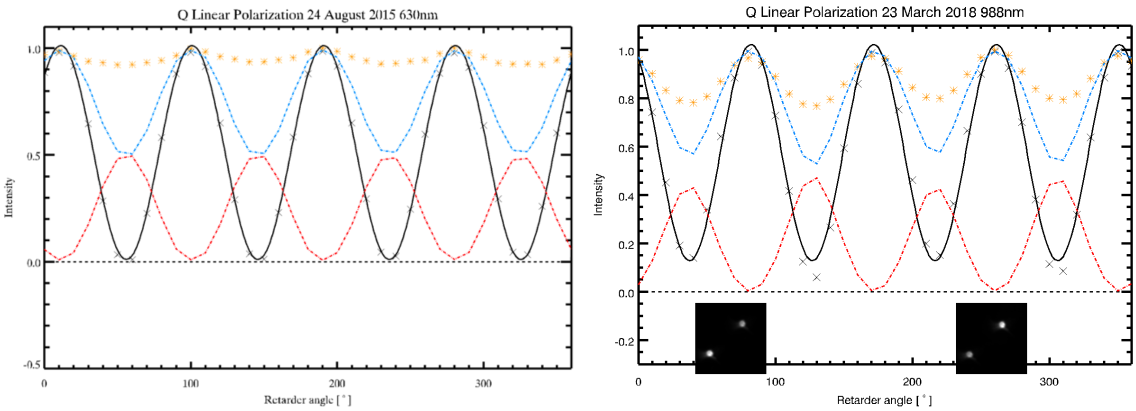


Figure 8: Two different measured (crosses) and fitted curve (black) for the retarder of the Gregor calibration unit. In addition, the curves for the two beams of the polarimeter are shown in blue and red. The summed intensity is given by the orange asterisks.

Alternative method to calibrate the retarder without dismounting the GCU

In 2018 IRSOL measured the retarder properties without dismounting the calibration unit. This is more of an emergency procedure to determine the axis position with the mounted GCU and using the sun as a light source. It is not recommended to use this procedure, but for completeness, it is listed here: Roughly the following was done:

- The polarizer of the GCU was inserted.
- Then the polarizer of the second calibration unit in the 5th floor was inserted and rotated to find the minimum intensity (crossed position).
- Then the retarder of the GCU was inserted and rotated to the minimum intensity. In this position the retarder axis is then parallel to the polarizer axis.

But the method has several drawbacks. There are many other optical components in between which may limit the accuracy. Because of the telescope image rotation, the crossed position of the two polarizers is time-dependent, i.e. this measurement has to be done very fast. Also, one cannot find out if it is the fast or the slow axis of the retarder (would need to compare magnetograms for that).

Exchanging a retarder

It has happened a few times that a retarder got burned and had to be replaced. Here are some hints how to access them.

Dismount the GCU from the telescope. Then open the three slit screws on the front side of the mount. Now pull out the insert. Then open the headless screw on the side and remove the holding ring on top of the retarder. Change the retarder and remount it proceeding in the opposite order. Unfortunately, the manufacturer did not mark the retarders for their axis orientation.

Then one has to determine the exact properties and the orientation of the new retarder according to the procedure above. Communicate the new orientation to Olivier Grassin, such that he modifies the config file to assure that at zero, the fast axis of the retarder is parallel to the elevation plane. It is advisable to then mark this position with a pencil on the GCU. The new retarder might have a slightly different retardation, which should be considered in the calibration programs, e.g. of GRIS. Inform also the person in charge about the replacement and the new values. At least one spare retarder of each type should be available in the polarizer cabinet. These PMMA-retarders have been purchased from Astropribor (see astropribor.com).

Note: To avoid damage, the retarders must not be inserted to the beam without previously inserting the polarizer with the protection filter. The retarders must be removed before removing the polarizer. The software behind the Labview GUI takes care of this.

Adjusting the large KIS-polarimeter

The large KIS-polarimeter consists of three calcite polarizing beam splitters, two small ones and a long one. The two small ones together have the same size as the long one. A quarter-wave plate from Halle with 40 mm diameter can be inserted in the front part. The calcites are not glued together, thus it can happen that their orientation to each other is not correct, and the polarimeter displays four or even eight images. Then the polarimeter has to be re-adjusted. For this purpose, one needs a CCD-camera, and a small circular field stop (not necessarily a pinhole, but not larger than 4 mm in diameter) in front of the polarimeter, so that the individual images are separated.

In the first step, remove the long calcite and one of the small ones. Rotate the remaining calcite until the separation of the two images is either vertical or horizontal. Then insert the other small one and rotate it until again only two images are detectable. The distance of the images must be maximum to assure that these two calcites are parallel. The orientation of the separation of the images is the same as for the single calcite before. To get the same optical path length for the ordinary and the extraordinary beams, both have to be exchanged. That is realized when the large calcite is oriented under 90 deg with respect to the small ones. To achieve this, rotate the large calcite until once more only two images are visible, but now they should appear under 45 deg, and their separation is smaller than it would appear under the orientation of the small calcites.

Note: According to Horst, there probably is an offset of about 5° for the polarimeter adjustment. This whole procedure was done a very long time ago and there are no pictures.

3.3 The wire grid polarizer

The second rotatable mount (wheel 1) currently contains a wire grid polarizer (1 mm thickness). It was constructed at KIS for the GREGOR Planet Polarimeter (GPP). The reason was because the GRIS polarizer causes a large defocus and could not be used at night with small objects like stars but also planets. Usually, there always is a cover on top (as seen in Fig. 2), which is only removed during observation at night. It is unclear if the thin wire grid polarizer would survive a long-time exposure to the sun.

For using the wire grid polarizer Olivier implemented a special night time mode that can be activated in the GUI (Night Security bypass). It only works between sunset and sunrise.

3.4 Example positions of the wheels

The following figures show different commanded positions:

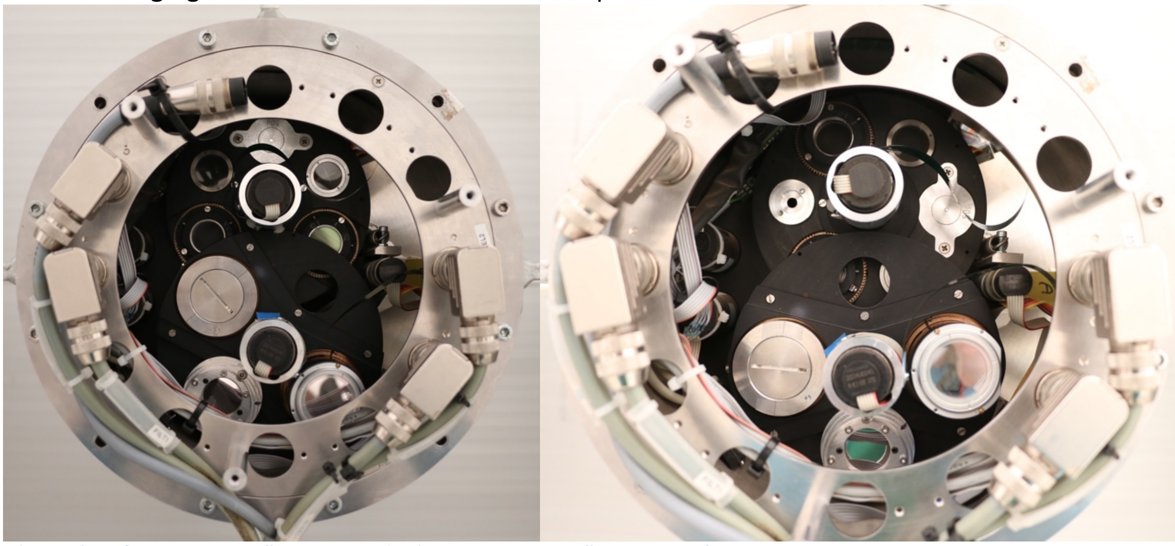


Figure 9: left: dark stop, filter wheel 1, right: dark stop, filter wheel 2

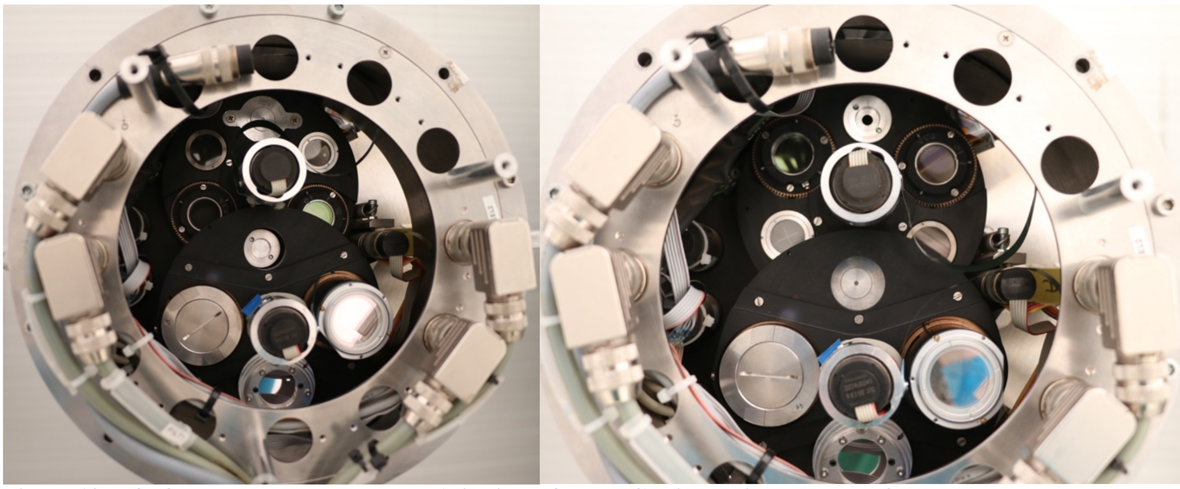


Figure 10: left: free aperture, both wheels (with inset for BTF3), right: Pinhole, wheel 2.

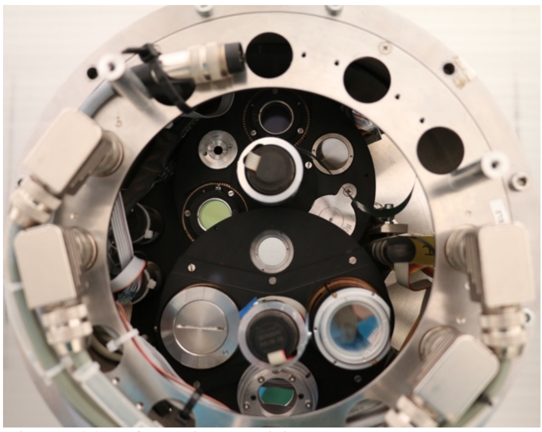


Figure 11: left: reticle position

4 Default Polarizer and Retarder Zero Positions

VIS retarder

To check the zero position of the VIS retarder:

- command the reticle position, which will place the VIS retarder as the top element (at zenith)
- command the VIS retarder to zero via Labview GUI
- check that the line next to the zero is vertical as shown in Fig. 12. The line was drawn by hand, so don't expect perfect accuracy.

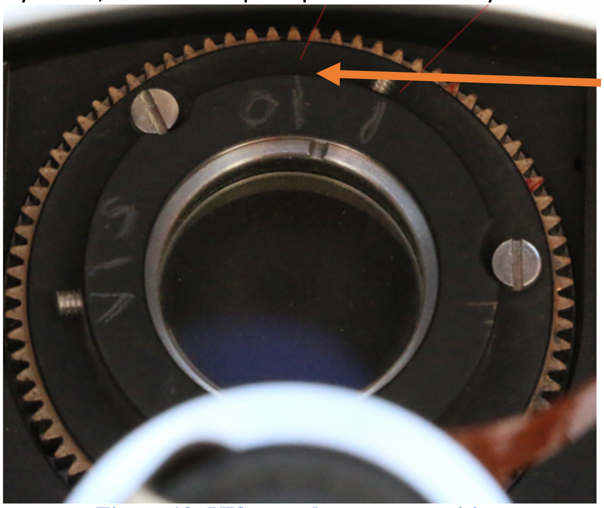


Figure 12: VIS retarder at zero position

polarizer (=VIS+IR)

To check the zero position of the polarizer:

- command the polarizer position, which should place it on top of wheel 1
- command the polarizer to zero via Labview GUI
- check that the flat side is horizontal as shown in Fig. 13

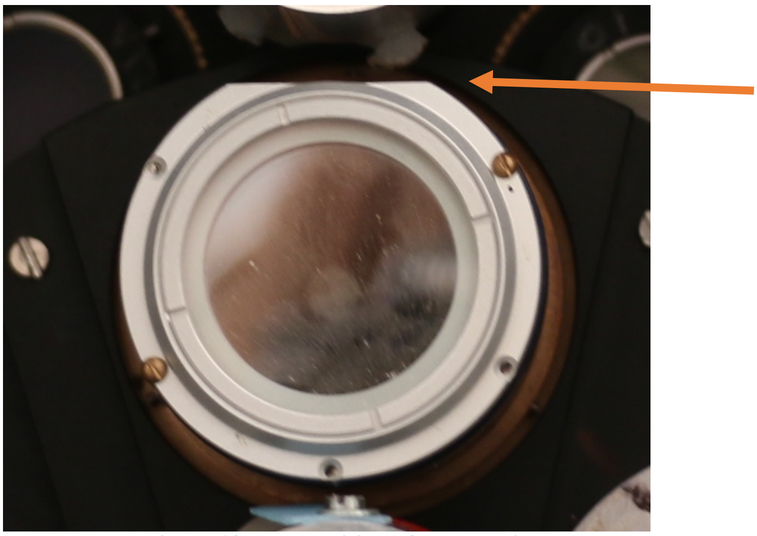
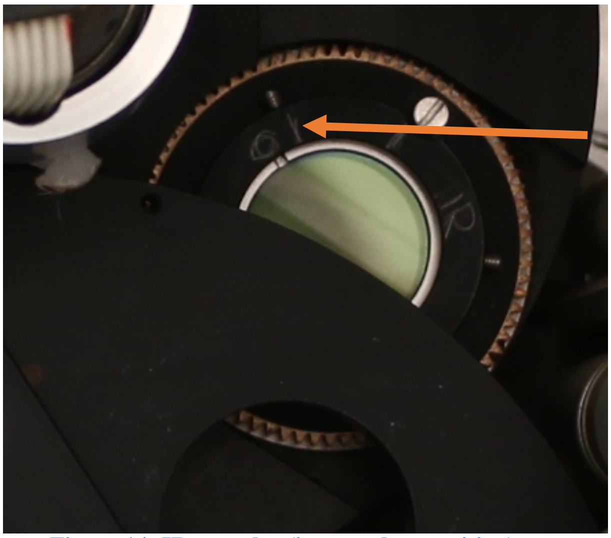


Figure 13: zero position of the polarizer

IR retarder

To check the zero position of the IR retarder:

- command the line grid position, which will place the IR retarder as the top element (at zenith)
- command the IR retarder to zero via Labview GUI
- check that the line next to the zero is vertical as shown in Fig. 14. The line was drawn by hand, so don't expect perfect accuracy.



line should be vertical for 0 deg (this picture was neither taken in line grid position, nor at 0 deg)

Figure 14: IR retarder (in a random position)

5 Log of Issues and Changes

10.8.2018: Calibration unit issue

The calibration unit probably went over its end switch because the az box was not off before it was disconnected. Fig 15 shows that the unit cannot rotate clockwise, but should be able to. Oli moved it manually over the end switch.

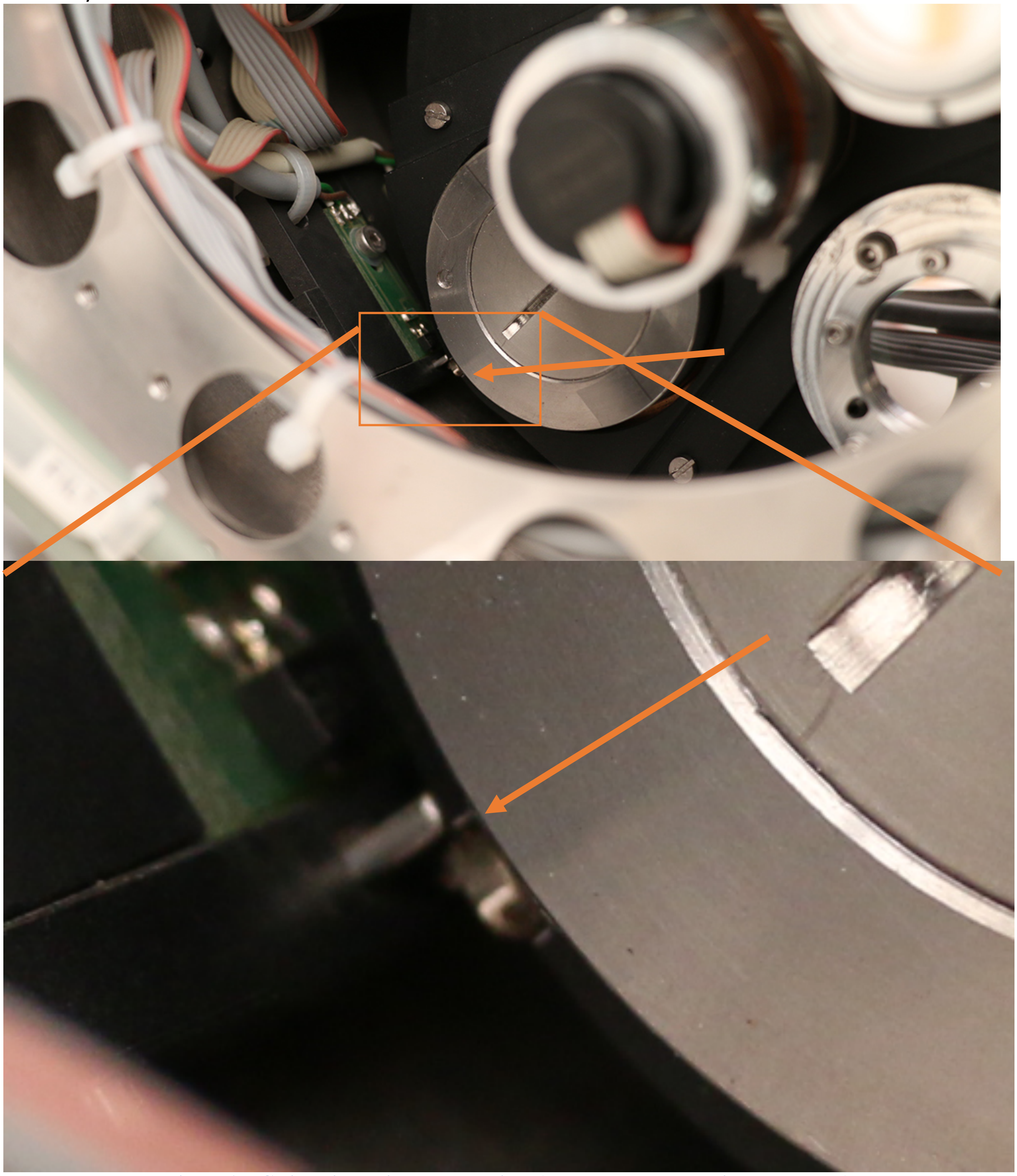


Figure 15: Calibration unit over endswitch (cannot rotate clockwise, but should)

10.8.2018: Calibration of the Polarizer and Retarder

-------- Forwarded Message --------
Subject: new calibration unit settings for VIS polarizer and retarder
Date: Fri, 10 Aug 2018 17:30:16 +0100
From: Lucia Kleint <kleintl@leibniz-kis.de>
To: Manolo Collados <mcv@ll.iac.es>, Carlos Dominguez <carlosd@iac.es>
CC: Olivier Grassin <grassin@leibniz-kis.de>, Daniel Gisler <gisler@leibniz-kis.de>, Horst Balthasar <hbalthasar@aip.de>

Hi all,

Today Olivier and I corrected the offsets in the VIS polarizer (52 deg) and in the VIS retarder (28.4 deg, which corresponds to Daniel's measurements at 620 nm). The IR retarder was not touched.

We verified that the flat side is now at the bottom of the polarizer when 0 deg are commanded [note: this may not have been in the "polarizer" position, there are no pictures]. We also verified that the VIS retarder moved by ~30 deg compared to its previous zero value. There are no default markings on the retarder, therefore we commanded filterwheel2 to the reticle position, which means that the VIS retarder is on the top position, and I drew a vertical line on the VIS retarder mount with a "0" written next to it as a reference for the new zero position.

Manolo, Carlos, could you please change these offsets in the GRIS software?

Thanks,
Lucia

On 8/10/18 5:53 PM, Manuel Collados wrote:

Hi Lucia,

the polarizer (common for both VIS and IR) was aligned with the IR retarder (well, in fact, they were at 90 degrees). Now, they must have an offset of 52 degrees (or -38 degrees). Can you also please change its offset accordingly?

Thanks,
Manolo

-------- Forwarded Message --------
Subject: Re: new calibration unit settings for VIS polarizer and retarder
Date: Mon, 13 Aug 2018 12:05:10 +0100
From: Lucia Kleint <kleintl@leibniz-kis.de>
To: Manuel Collados <mcv@iac.es>, Carlos Dominguez <carlosd@iac.es>
CC: Daniel Gisler <gisler@leibniz-kis.de>, Horst Balthasar <hbalthasar@aip.de>

Hi all,

Ok, the IR retarder is now also rotated by 52 deg. I.e. its relative orientation to the polarizer has not changed compared to the past few months.

cheers,
Lucia

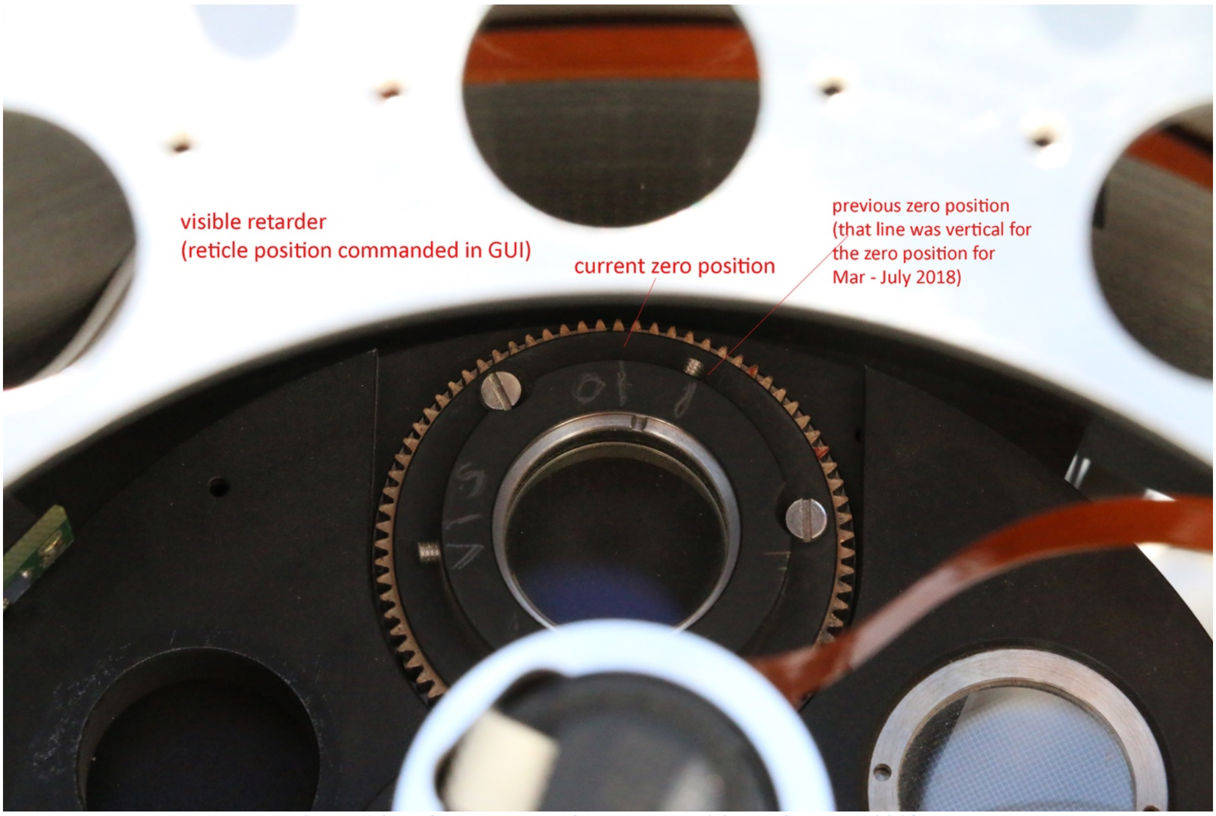


Figure 16: VIS retarder, default zero position (after Aug 2018)

Issue with cable on 27.9.2021 and change of polarizer by 4.5 deg [which however was not seen in data, the GRIS data in March 2022 showed a 12 deg offset]

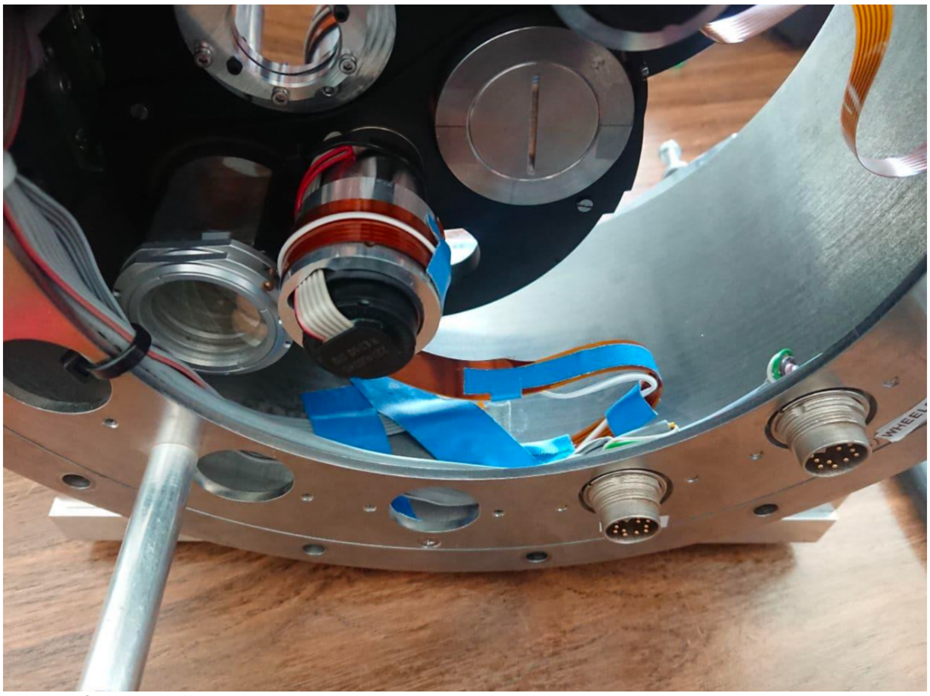
-------- Forwarded Message --------
Subject: Re: Fwd: GRIS and GREGOR
Date: Sun, 20 Mar 2022 13:22:56 +0100
From: Franziska Zeuner <franziska.zeuner@irsol.usi.ch>
To: Reiner Volkmer <volkmer@leibniz-kis.de>, Daniel Gisler <gisler@leibniz-kis.de>
CC: Sergio González Manrique <smanrique@leibniz-kis.de>, Manuel Collados <manuel.collados@iac.es>, Lucia Kleint <lucia.kleint@unige.ch>

Dear all,

when we used the polarization calibration unit in F2 last year (we never used the IR one), there was the issue with the broken cable that controlled the position of the polarizer motor (which was probably broken too). It was fixed by the two KIS assistants Erik and Miguel on 2021-09-27 (I guess they wrote a report) by implementing a new motor and a spare cable. During the repair, the polarizer had to be removed, but the assistants took a lot of care that the reference was not changed when putting it back into the motor. We find that after inserting the new model and cable in our measurements we could not see any significant change of the reference system (according to our log, but please Daniel correct me if I am wrong). We did not touch the retarder.

However, we strongly encouraged that the Potsdam people have a look at the polcal unit, since the cable may cause problems at any time in the future. Was the unit maybe touched by them in the meantime?
I am really sorry that I can only be of limited help here, but please let me know if I should send a more detailed report on what was done (at least I can send what is in our logs, I did not prepare a full technical report of this issue).

Best regards,
Franzi



picture from E. Bärmann

-------- Forwarded Message --------
Subject: Re: GRIS and GREGOR
Date: Mon, 21 Mar 2022 13:29:55 +0100
From: Franziska Zeuner <franziska.zeuner@irsol.usi.ch>
To: Sergio Javier Gonzalez Manrique <smanrique@leibniz-kis.de>, Lucia Kleint <lucia.kleint@unige.ch>
CC: Manuel Collados <manuel.collados@iac.es>, Reiner Volkmer <volkmer@leibniz-kis.de>, Daniel Gisler <gisler@leibniz-kis.de>, Miguel Esteves Perez <esteves@leibniz-kis.de>

Dear Sergio, dear all,

Today I had the chance to check our logs more carefully and I found that after inserting the new motor the angle of the polarizer was changed by 4.5 degrees, which corresponds to (about) one gear of the motor wheel. This is in the order of the error we expected.

Best regards,
Franzi

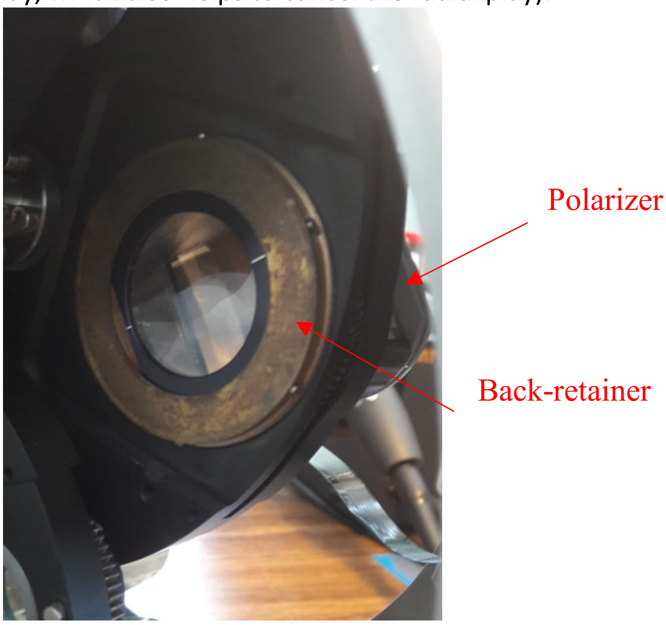
February 2022: Wheels flat cable replaced

After the problems in September 2021 with the flat cable commanding one of the wheels (wheel 1, one line completely broken and temporarily bypassed with an outer cable to allow IRSOL campaign), KIS contacted AIP and they provided us with a set of four new cables.

In February 2022, Olivier and Miguel dismounted the unit and replaced both cables (two wheels), even though the second cable from wheel 2 was still looking ok.

There are other two new spare cables at the BBI cabinet. We recommend having a yearly look to the unit and replace the cable/s if some damage is noticed (damage can be produced due to a combination of a continuous cable bending with the wheel movement and ageing). Also, the orientation from wheel 1 cable is very critical, and if not proper, it can interfere either with the polarizer mount or with the M4 motor, so that its position must be a compromise between both obstacles. Keep this in mind and check yearly too.

On this occasion, we also noticed that the mounting wheel of the polarizer had some wobbling. We removed the back-retaining plate from the wheel and noticed some radial play between the wheel housing (bronze) and the iron ring. To mitigate it, we pushed the mounting back and tightened the retainer (i.e., remove the axial play, which also helps to cancel the radial play).



After that, we did not notice any wobbling.

During the process, the polarizer mount remained installed and did not lose the gearing with the motor and hence the reference. Actually, to remove the mounting one has to remove a front plate, which was not the case during this maintenance.

22.3.2022: Polarizer & Filter mount pinion

We noticed that the polarizer and filter mount were not rotating. However, at the GUI we could command a rotation and the encoder said there was a movement. Here the reason:

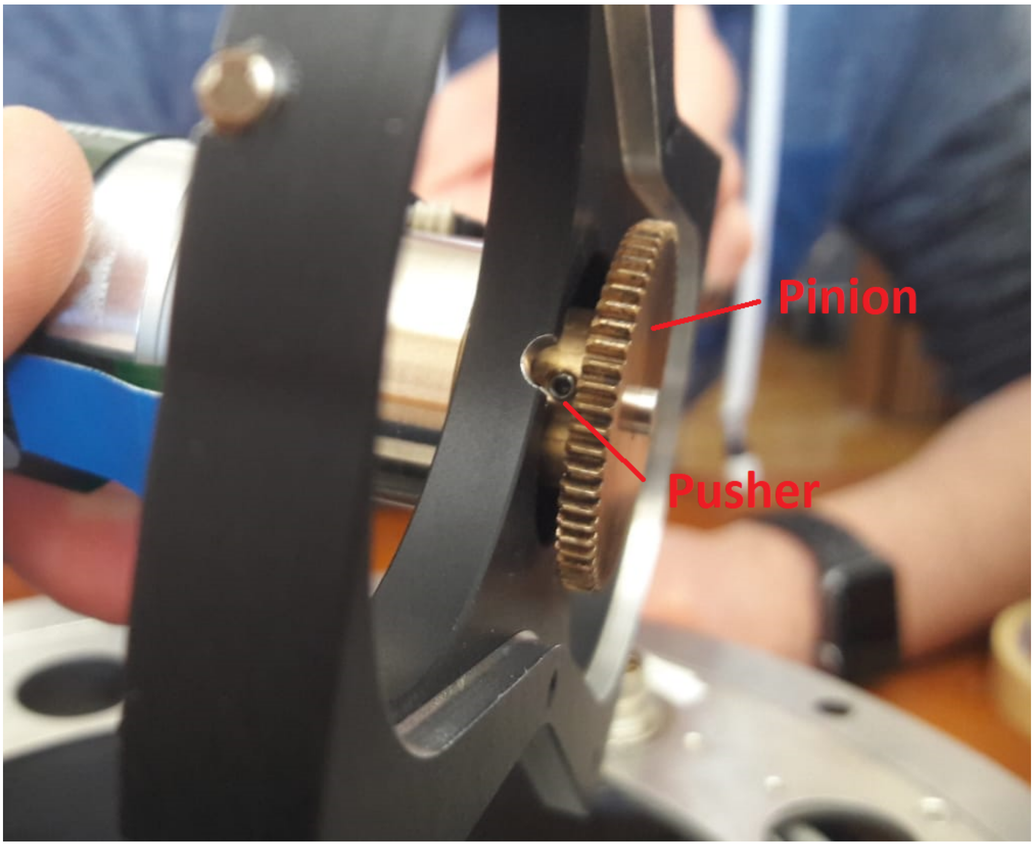
ME Miguel Esteves Perez <esteves@leibniz-kis.de> | 'volkmer@leibniz-kis.de'; 'smanrique@leibniz-kis.de'; 'grassin@leibniz-kis.de'; 'Tobias Preis'

F2 CU

Signed By esteves@leibniz-kis.de

Dear all,

The polarizer from the calibration unit at F2 was not rotating because the pinion was not fully connected to the motor axis. Hence, the motor was freely rotating (and the encoder) but not the wheels, as we had seen at the system interface yesterday.
The pinion is connected to the motor axis by means of 4 radial pushers, all of them were now fully tightened.



This pinion moves the polarizer through a gear. Probably the torque from the pushers were not enough and, our suspicion is that the wheel load (polarizer) made the pinion to slip over the axis. We gave now a good torque to all of them and saw a good behavior after testing it for a while. The system shall be ok for this year.

This is not the first time we have problems with this system (electric and mechanics). As it is partially being hit by the sun, we have noticed that the grease tends to degrade with the time forming a sticking paste making the wheels movements hard. Also, the flat cables tend to degrade with both time and fatigue cycles produced by the system movement. Maybe a yearly maintenance in winter shall be included.

We think the alignment should be the same as before, as we geared the pinion back at exactly the the same position (didn't move the wheels), and also the homing references are mounted on the polarizer wheel and not on the motor. But always better a double optical check.

30.3.2022: Modified polarizer orientation by 12 deg
In agreement with Manolo, who found a 12.0 deg offset in the GRIS calibration (same as we saw visually), Lucia modified the polarizer zero position. Now it is horizontal again at 0 deg. The new step number is -142184. A backup of the config file was created in the directory on gcs.

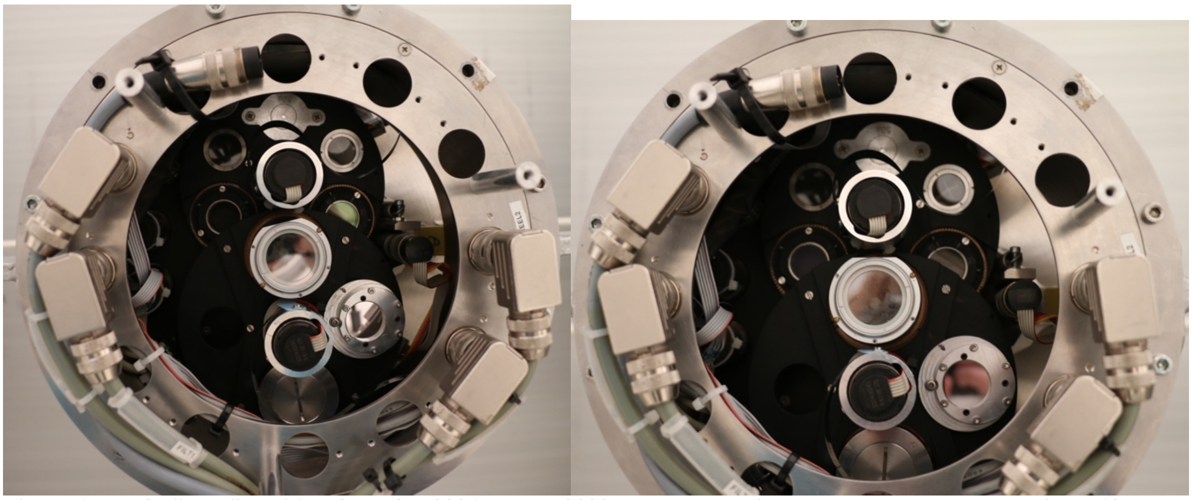


Figure 17: Left: "zero" position from fall 2021-March 2022, but the polarizer does not look correct. Right: 12 deg offset, which looks correct and was set as the new zero position.

We carried out tests by driving to all positions and they look fine. We noticed that the flat cable of wheel 1 "jumps" from being bent to being straight in some positions. We do not think that this poses any mechanical issue and no interference, but such abrupt motions could cause some issue with time and should be monitored.

6 Potential pitfalls

Polarizer

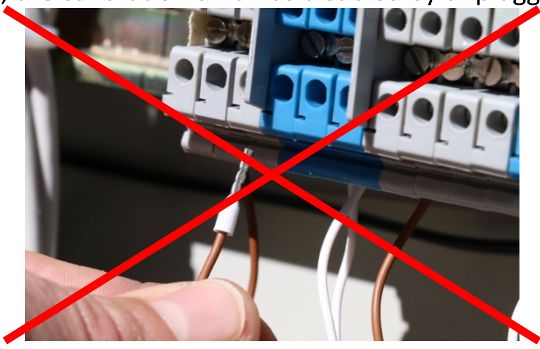
- **There might be a need in the future to check if the polarizer degraded (coatings?).** If the polarizer has to be replaced, do not use an absorbing one! Either the extraordinary beam has to be reflected to the side (as with the present one), or use a reflecting wire grid polarizer. The energy density in F2 is too high, this is also a problem for a silver-nanoparticle polarizer.
- It should be checked whether there is any difference having the flat size of the polarizer on top or on the bottom

Notifications

- GRIS and ZIMPOL are the instruments that are affected by any calibration unit changes and they should be notified if anything is done to the calibration unit.

Do not unplug the brown cable in the az box anymore

- In the past, the calibration unit was disabled by unplugging the following cable in the az-box:



do not touch this cable!

Now the M4 motorization uses the same cable, i.e. if the cable is unplugged, the M4 drivers would lose power and M4 its orientation. Therefore, use the updated procedure in Sect. 7 to unmount the calibration unit and **do not touch this cable**.

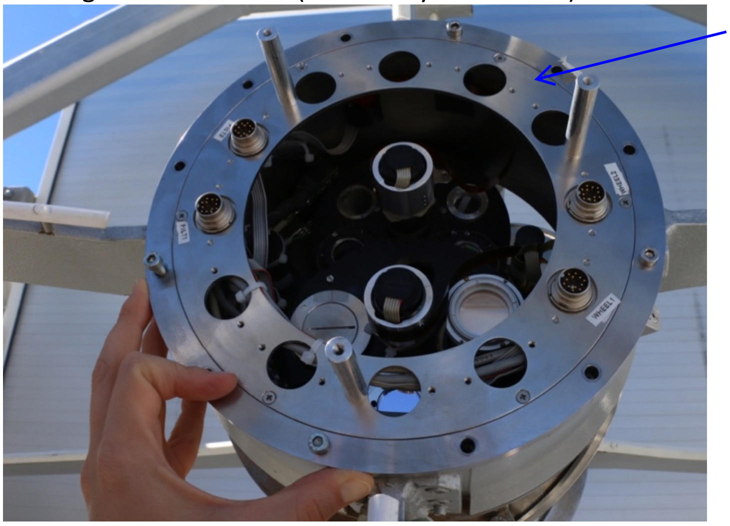
possible GCU network failure

- this is also valid for other devices using xPort/CoSM modules: In case of a communication problem after restarting the device interface at the GCS computer, please look inside the AZ-Box, if there is an orange/red light at the xPort/CoSM module (see Fig. 5, which shows green lights). If the light is not green, an error has been detected and the communication may be broken. To solve the situation, disconnect the power line of the module and the network cable (see Fig. 5), then reconnect the power and the network cable. Wait for a few seconds/minutes, the light should be green. If it is not the case, it is probably a defective module.

7 Mounting and Dismounting of the Calibration Unit, Changing Offsets

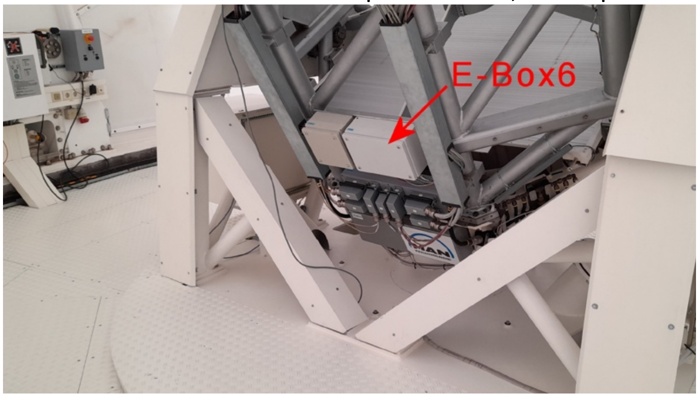
7.1 Instructions: Mounting of the calibration unit

- Align white markers (marked by blue arrow)

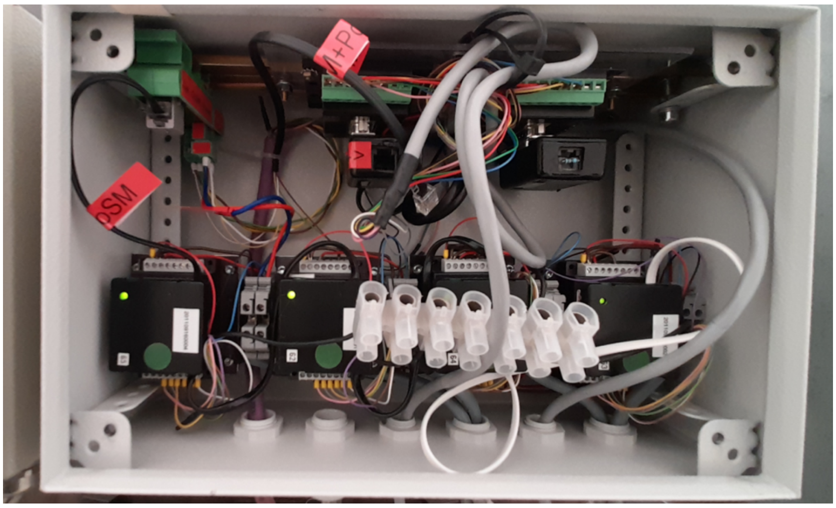


- Rotate unit to align holes for screws
- Put screws, do not tighten
- Push unit upwards to align its borders. Tighten screws.
- Connect cables as labeled, 4 cables total, 2 on each side

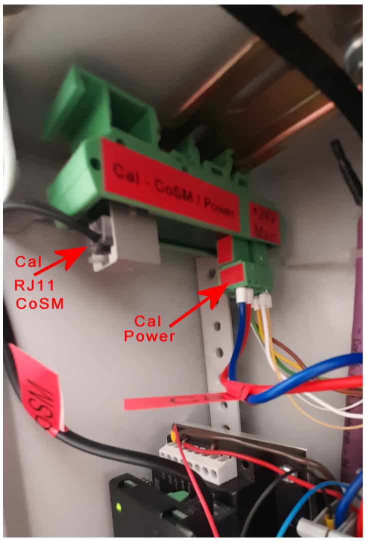
- Now we will connect the power/drivers. The box containing these drivers is located between M1 and M4 on the telescope structure, lower part. The box is called E-Box6.



- The easiest way to access the box is to move the telescope elevation to around 70-80 degrees with the hand-held controller. Remember to move the telescope first in azimuth, to avoid a potential collision with the dome. The other option, though less comfortable, is to lay on the back under the telescope…
- To access the connectors, the box has to be opened by removing the 4 screws of the cover (with a medium cross screw-driver). Do not disconnect any cables, in particular do not touch the +24 V main cable.



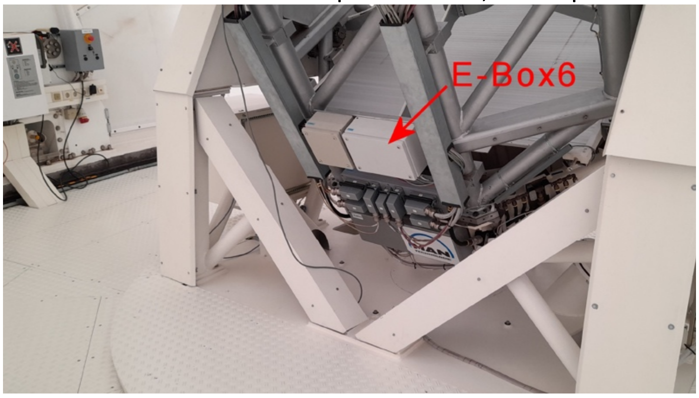
- Insert the “Cal-Power” cable green connector on the “Cal-CoSM / Power” connector on the board, “Power” side. Then, connect the RJ11 connector from the “Cal-CoSM” cable on the female RJ11 grey connector of the “Cal-CoSM / Power”, connector on the board, “Cal-CoSM” side. Then close the E-box6.



- If necessary, move the telescope back to +5 deg el and az to parking position. Put HHP on x.
- Put grey cover onto the Calibration unit. It is held by 3 screws that can be tightened without any tools.
- Launch the CalControl interface at GCS from the ICS menu. Do an “All” Home and wait for the end of the operation. The Calibration Unit is ready for use.

7.2 Instructions: Dismounting of the calibration unit

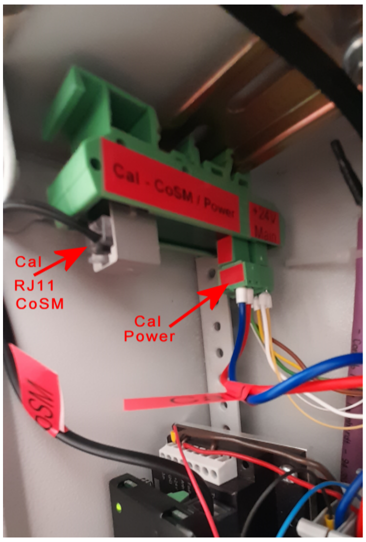
- close GUIs on FSG and gcs.
- Now we need to disconnect the power/drivers. The box containing these drivers is located between M1 and M4 on the telescope structure, lower part. The box is called E-Box6.



- The easiest way to access the box is to move the telescope elevation to around 70-80 deg with the hand-held controller. Remember to move the telescope first in azimuth, to avoid a potential collision with the dome. The other option, though less comfortable, is to lay on the back under the telescope…

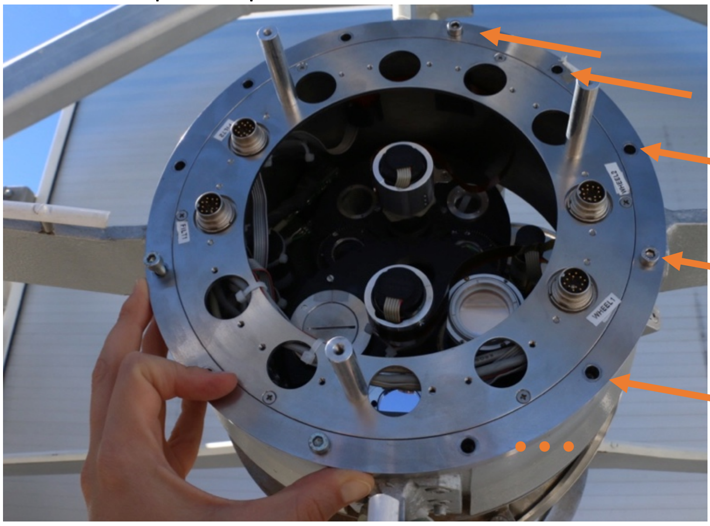
- To access the connectors, the box has to be opened by removing the 4 screws of the cover (with a medium cross screw-driver). Inside, the cables and connectors are labelled to avoid confusion:
  - "M4-CoSM + Power" (cable)
  - "M4 ->" (Sticker with the arrow, on the CoSM module, indicating the place of the RJ11 connector.
  - "Cal-CoSM" (cable)
  - "Cal-Power" (cable)
  - "Cal-CoSM / Power" (connectors on the board)
  - "+24V Main" (Connector on the board – **do not disconnect**)

- To power down the Calibration Unit motorization, disconnect first the "Cal-CoSM" cable at the RJ11 connector, then the power "Cal-Power" cable by pulling out the green connector.



- The Calibration Unit is ready to be disconnected mechanically: Remove its grey cover.
- Remove cables. 4 cables total, 2 on each side.

- Remove screws. Keep the top screw to hold the unit and remove it last.



- Remove the unit, make sure to move it away from the telescope and do not rotate it (hole for motor).

7.3 Instructions: Changing polarizer/ret offsets

Note: this should normally not be necessary and only done by experts. Therefore, the instructions below are written without too much detail to make sure only an expert can follow.

- in calibration unit control -> axes/status (info lists the procedure)
- put desired angle in GUI
- hold shift and click on number below actual polarizer angle. Need to be fast, any DCP command will make this invisible again.
- steps will appear on the bottom: e.g. -134319
- g_control -> calibration unit directory -> config -> CalConfigurationFile.txt
- [Offsets]
- put polarizer offset to value from above
- restart GUI for calibration unit on gcs
- home all