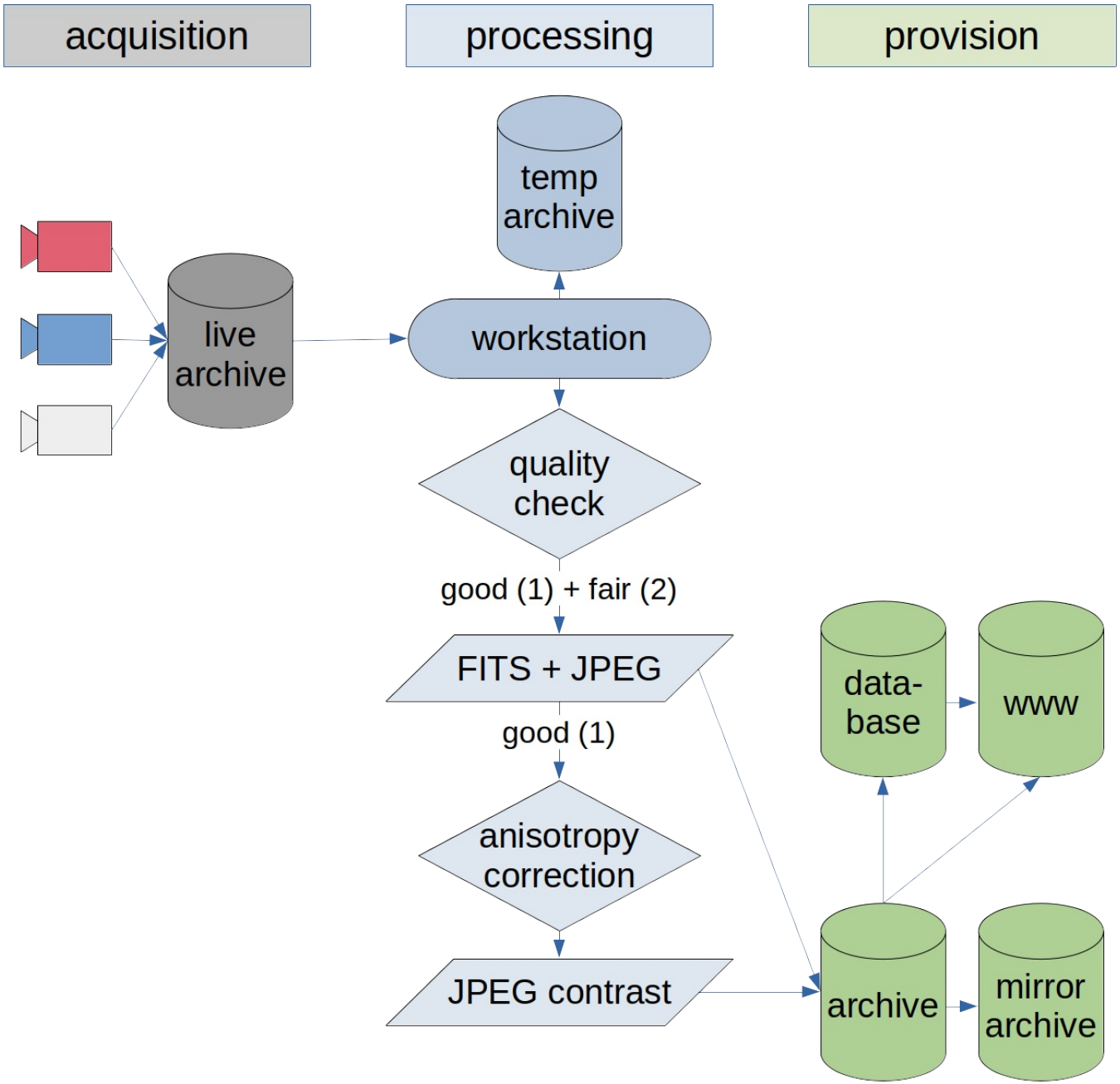
overview of our system

3 branches
=
3 separate systems

(H-alpha has a 4th branch for flare detection)



The observation tower

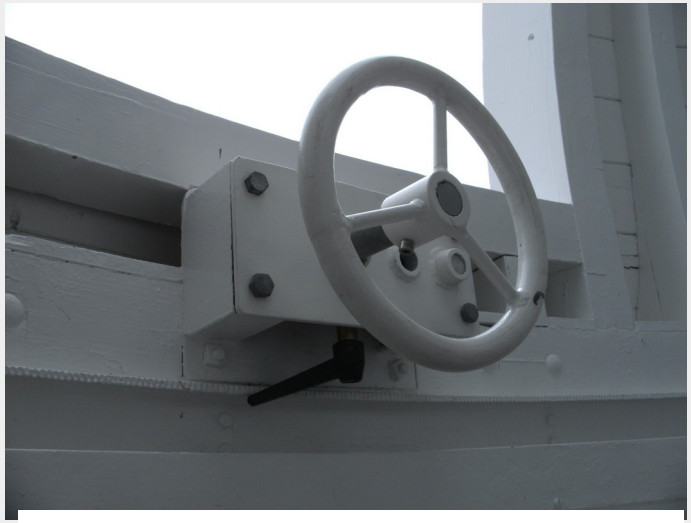
- outside and inside white
- ventilation removing air at lowest part of the tower

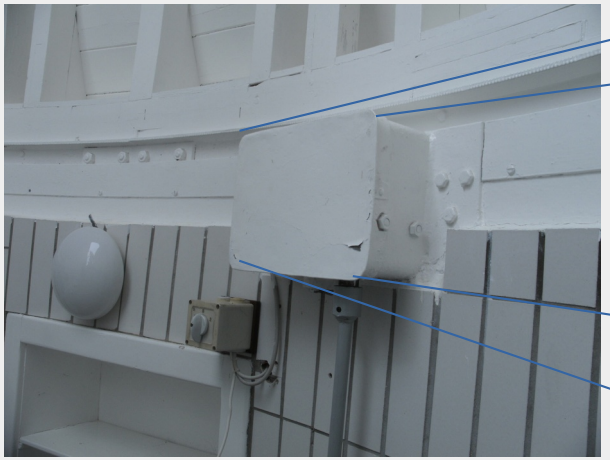
The socket

- the telescope mounting is seated on a concrete tower
- no contact to the floor and dome

The dome

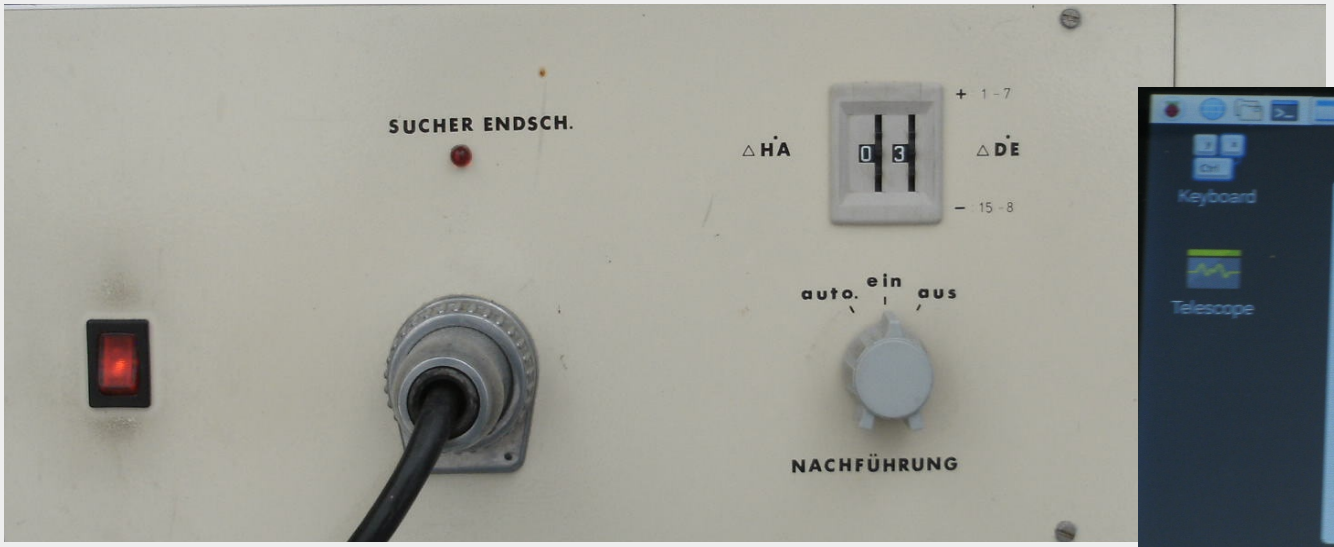
- the slit is opened/closed manually (we are there, so no need of loose cables hanging around)
- the dome moves with the telescope – light sensors detect slit edges (only one direction!)

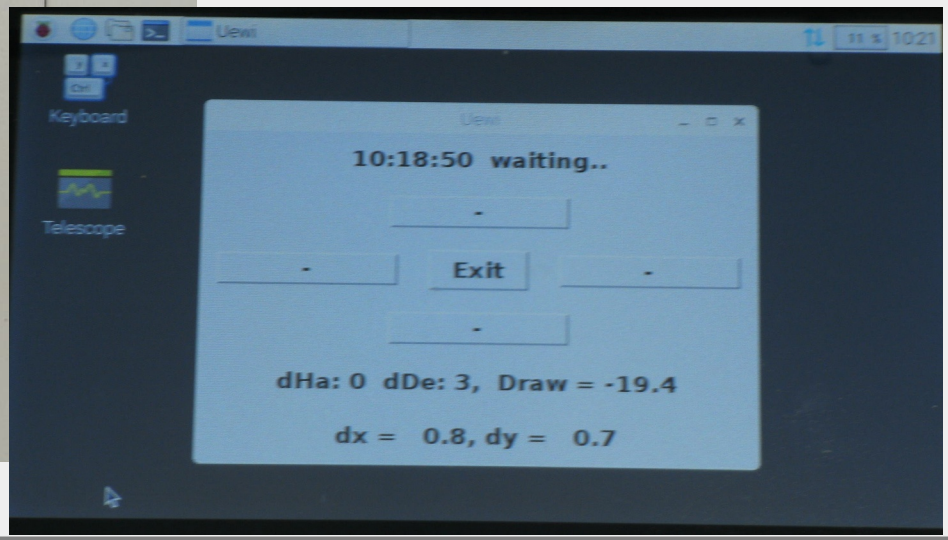




The telescope guiding

- the principal guiding is done via an old but robust microprocessor system
- this guiding is not perfect, it has some switches to adapt it to different vertical and horizontal speeds (seasonal effects of Sun motion in sky)
- for exact guiding we send via a serial interface correction codes obtained from solar disc positions of our observing cameras (Raspberry Pi)





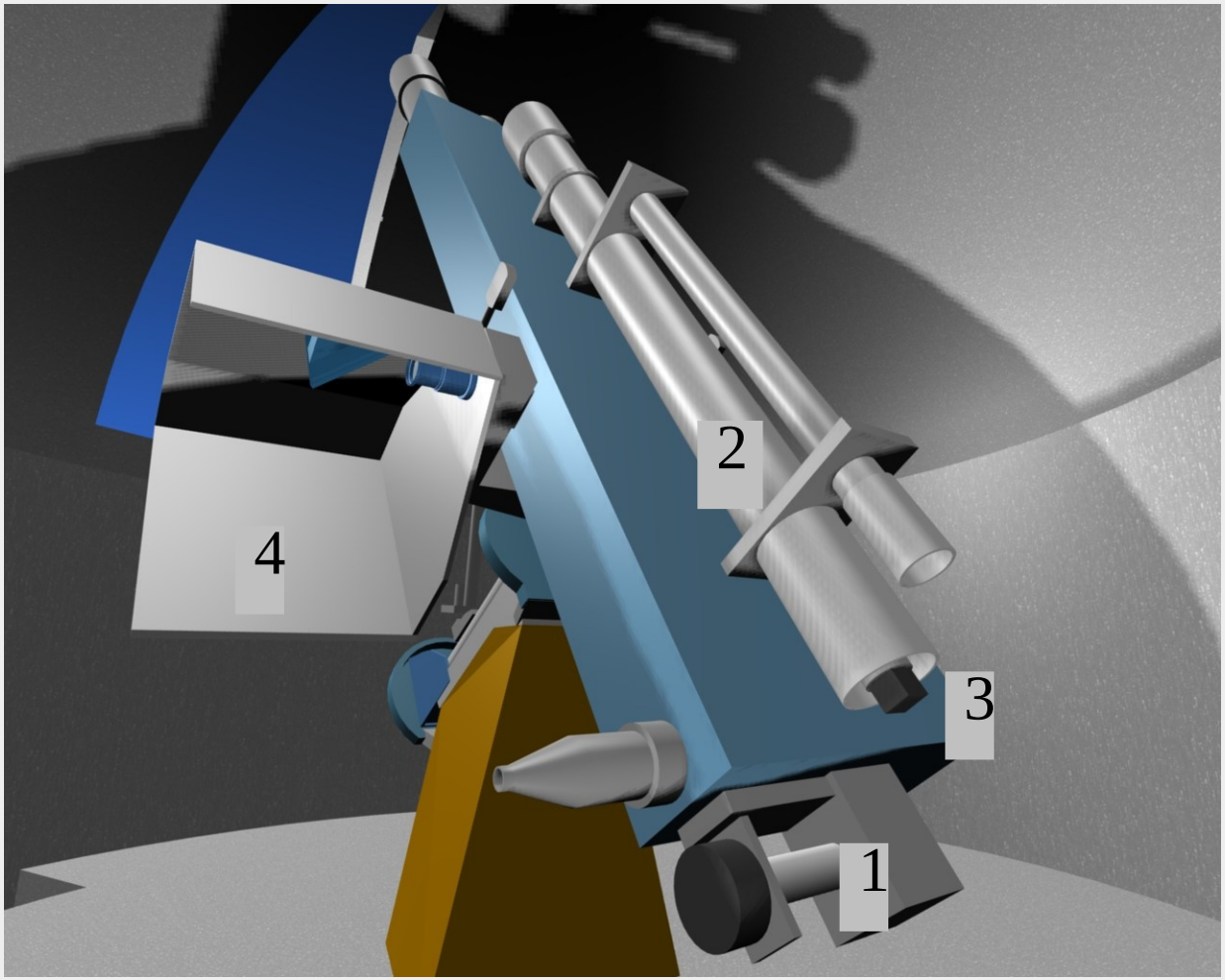
The mount

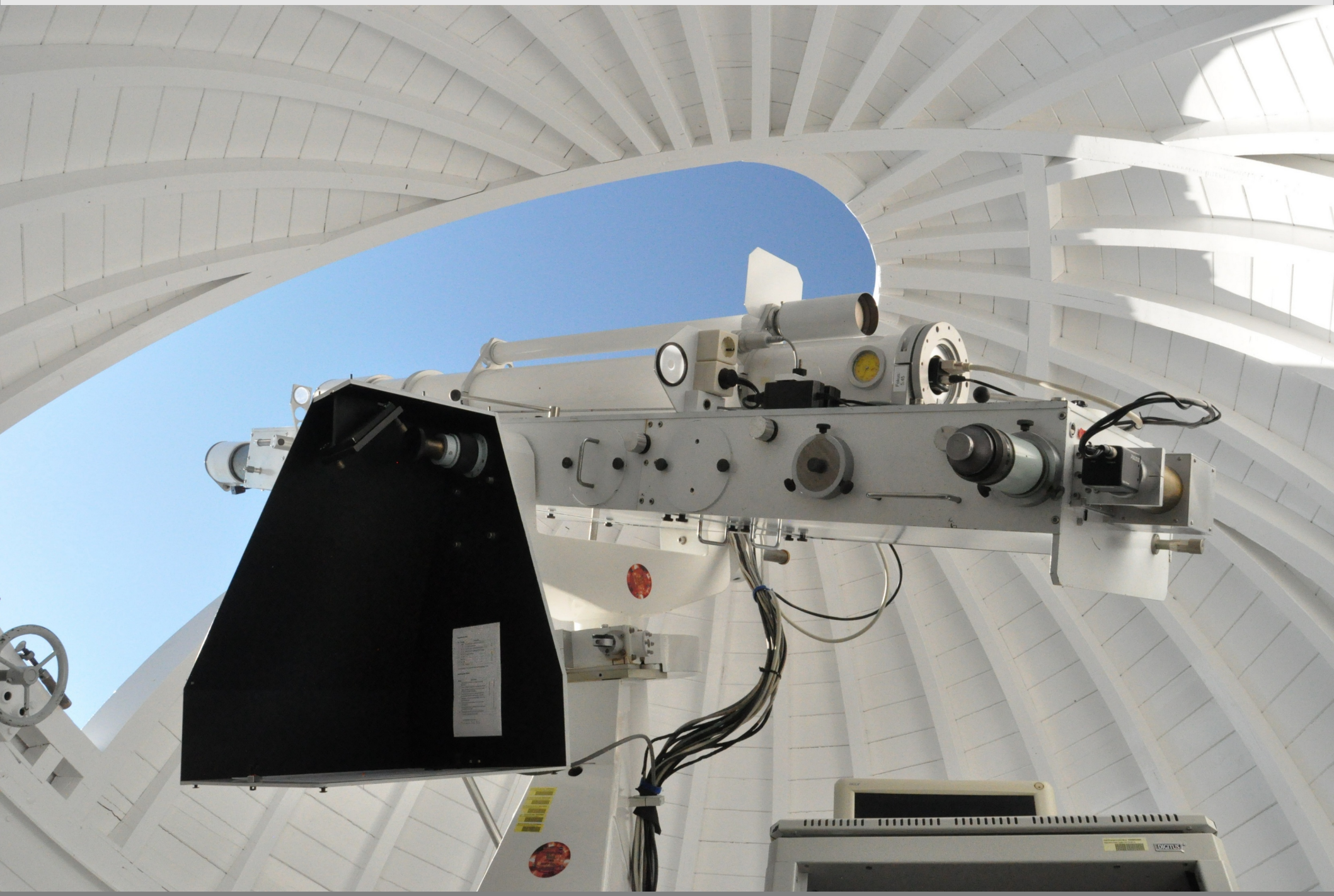
open fork
equatorial mount

- very stable
- easy to control
- balanced

The telescope

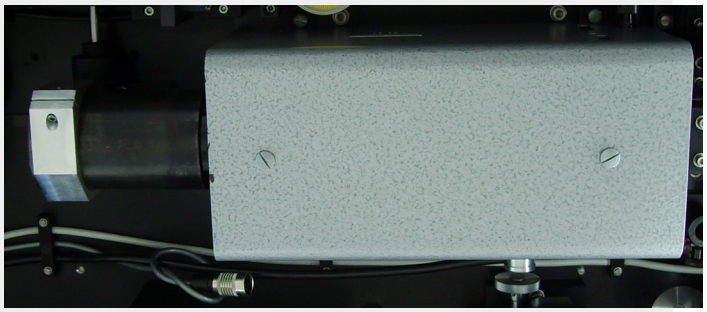
1) H-Alpha
2) Phoka (White-light)
3) CaIIK
4) Drawing device

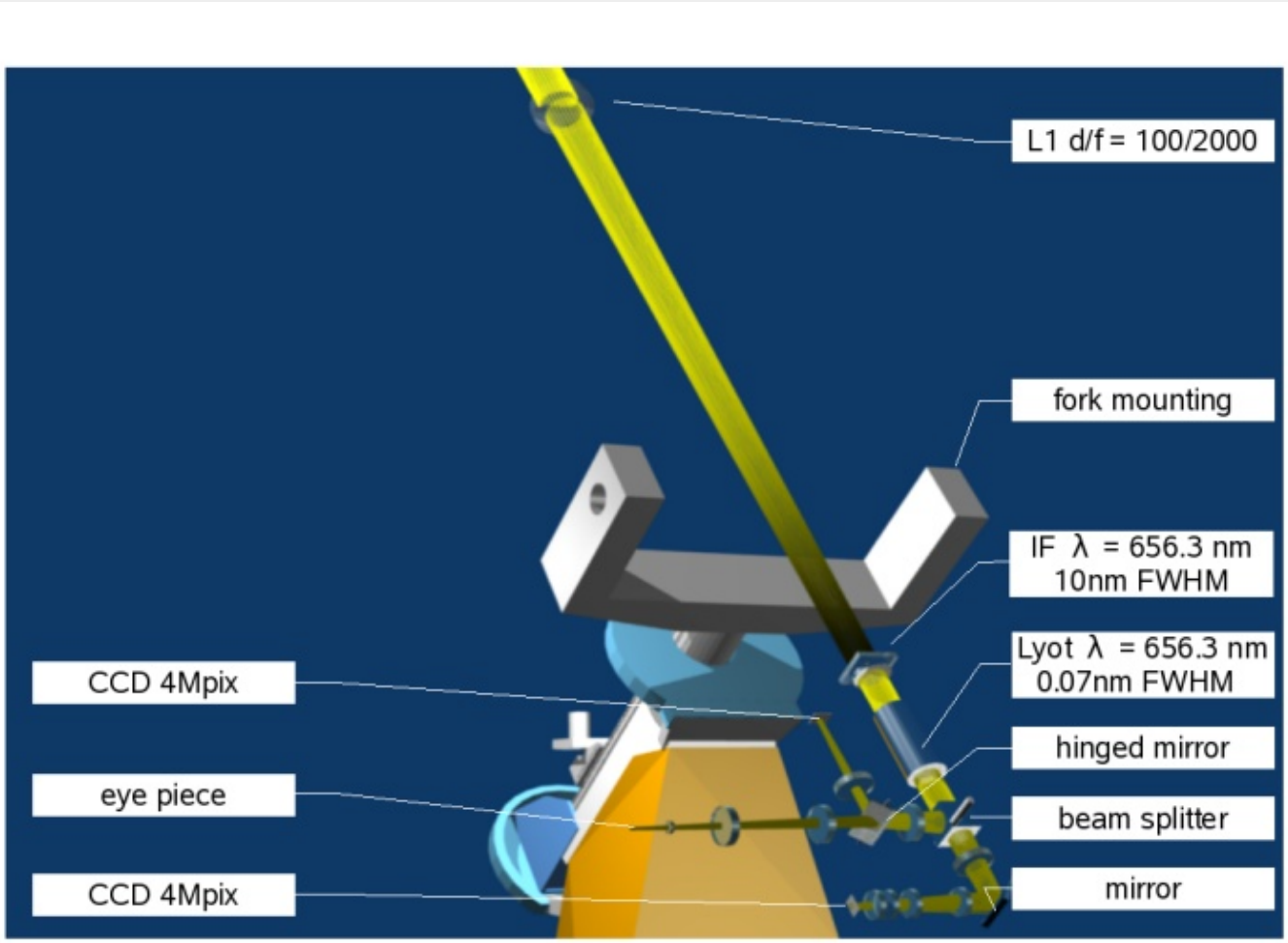




H-alpha telescope

- prefilter (10nm)
- Lyot filter (0.7Å)
- 2 cameras (main, high speed)
- eye piece

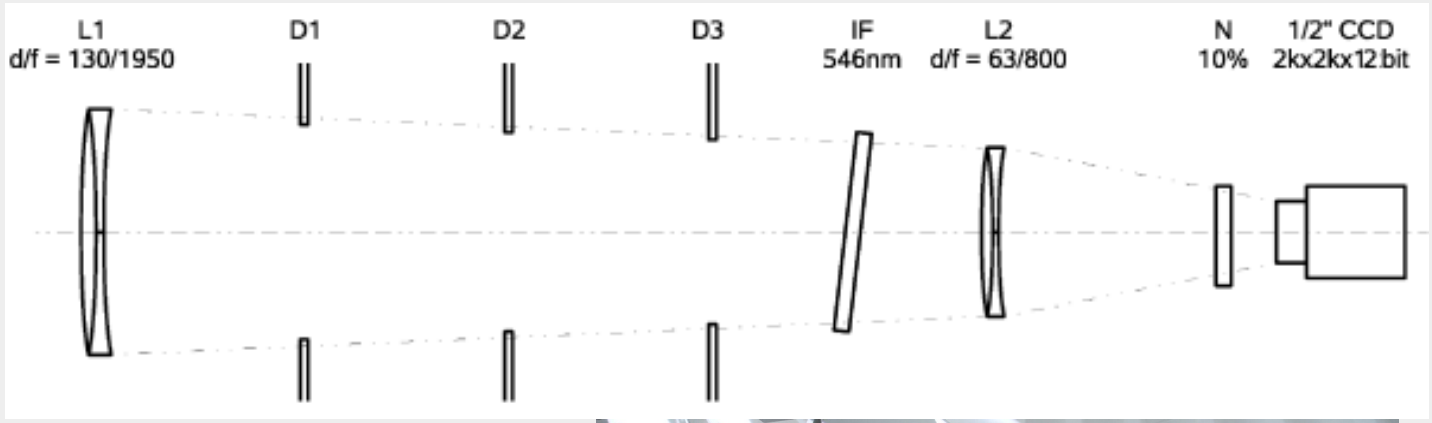


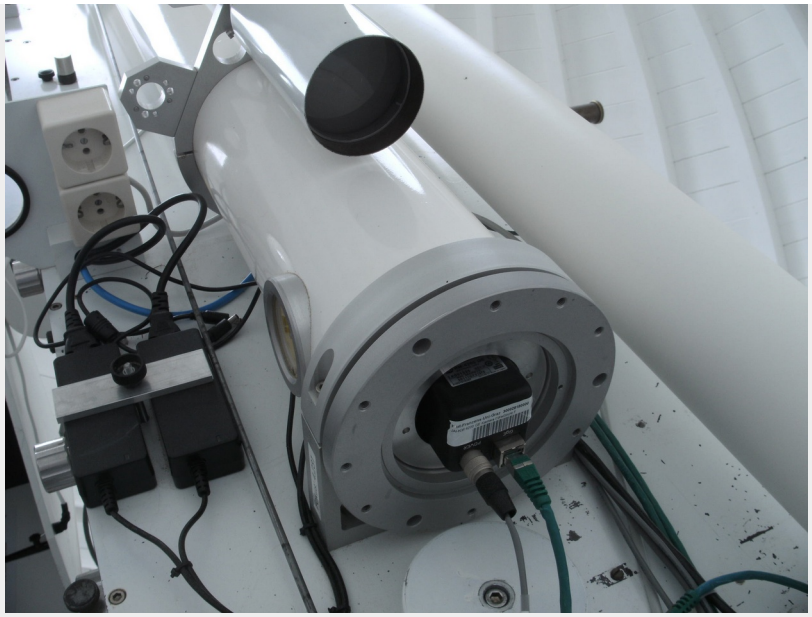


White-light telescope (phoka)

green filter
(546nm/10nm)

gold coating on
objective lense

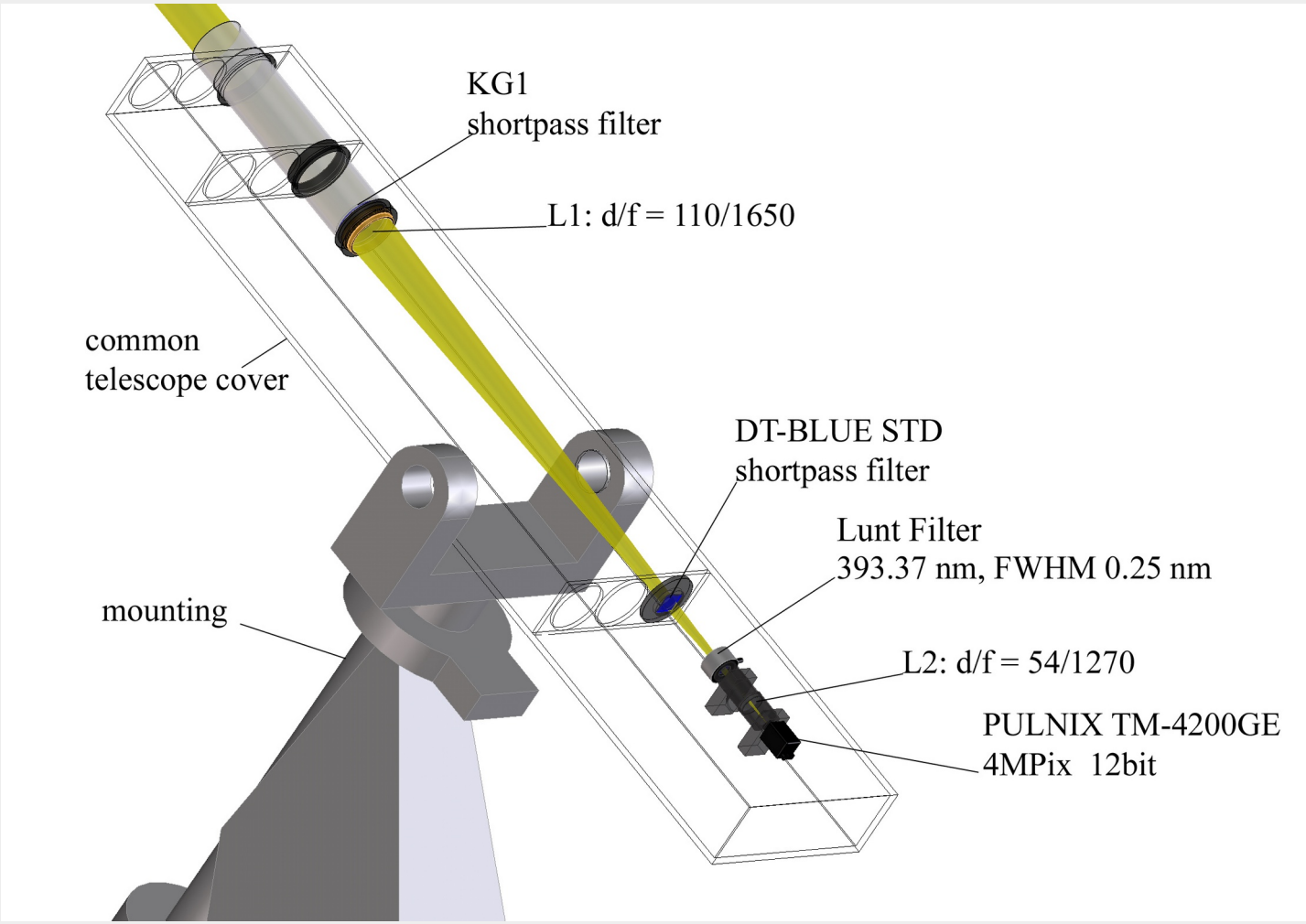




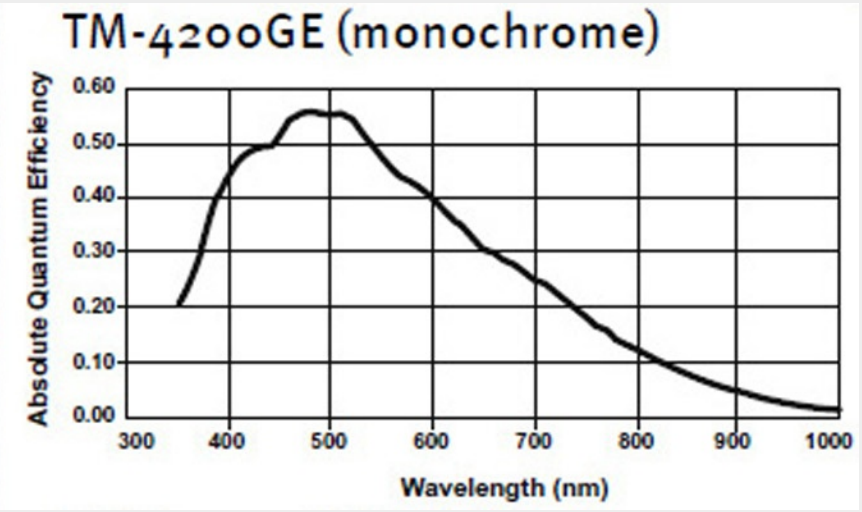
CaII K telescope

Lunt filter (cheap!)

2.5Å



Cameras



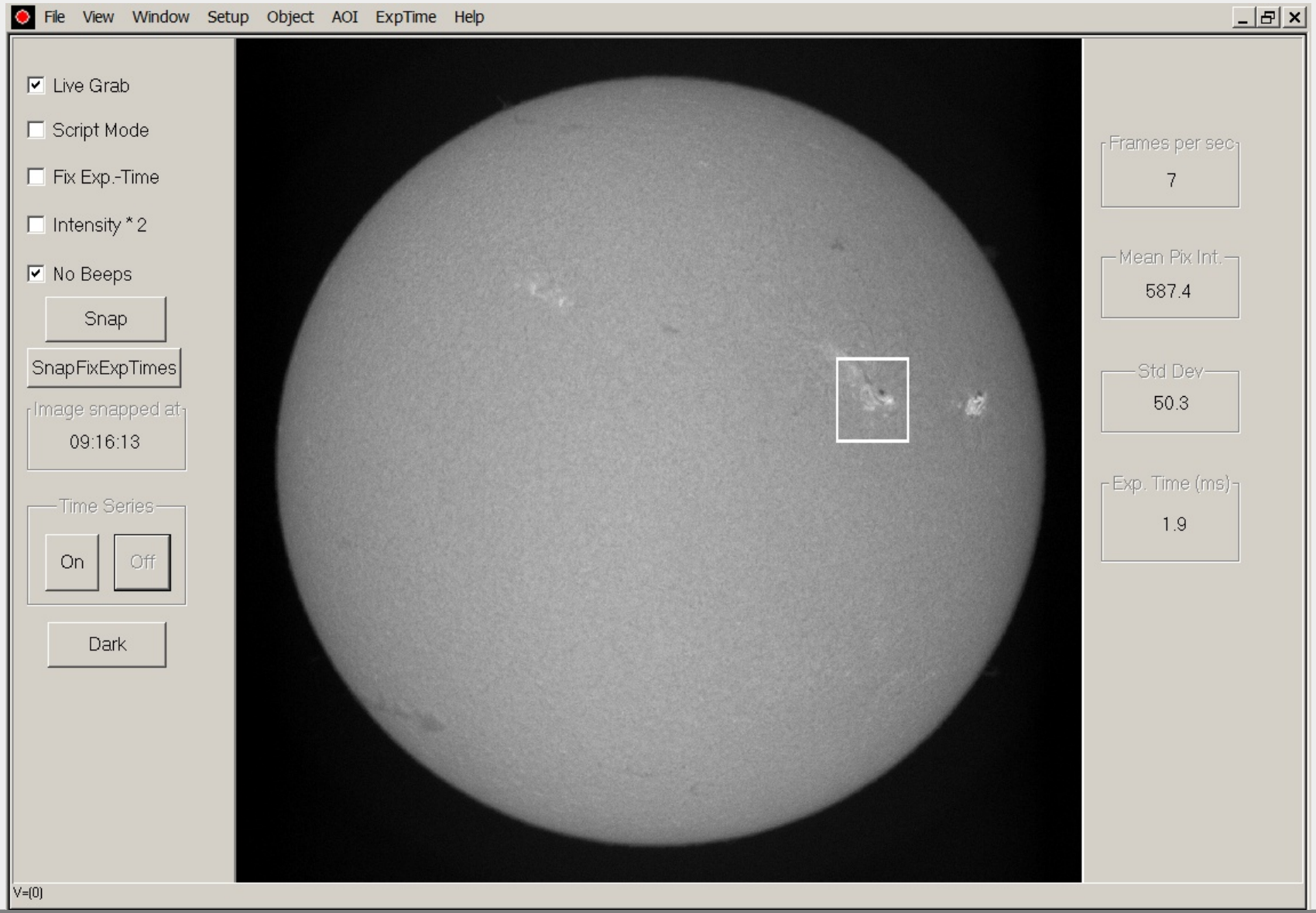
- same camera in all systems
- 4 MPix 12bit monochrome
- 7 images/sec
- Gigabit interface
- exposure times 1.5 to 35ms (2 ms on average)

Camera control

- each camera controlled by one PC (simple 19“ server, low energy CPU, 2 x Gbit interface)
- has to withstand high temperature range (-10 to 30 deg)
- no large local storage necessary

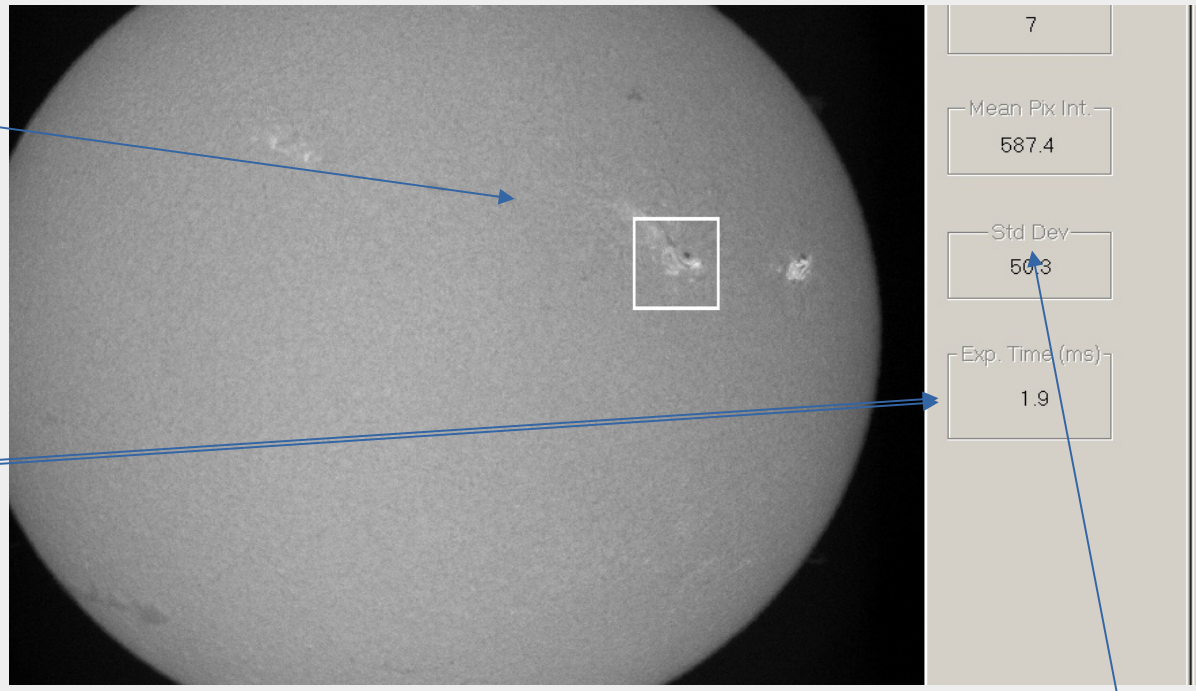
Camera control interface

- the same for all cameras
- Visual C++ and Common Vision Blox libraries (sold with cameras)



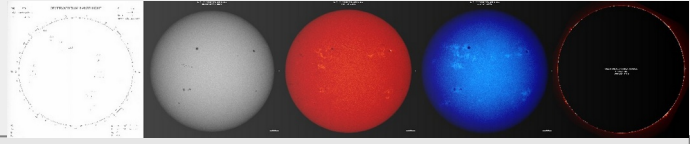
Camera control interface

AOI- Area of Intensity controlls exposure time and frame selection



Exposure: The mean intensity in the AOI is kept constant → flares are not overexposed
(H-alpha = 600 counts,
CaII K = 1200 counts,
White-light = 2000 counts)

Frame selection: the image with the highest rms out of a fixed number (10) is stored → the time delay between the stored images is not always the same (5 to 7 seconds)



acquisition – temporary archive

images are not stored locally

all images are stored on a RAID system in daily directories as FITS and JPEG files

image names contain type, date and time (self sorting!)

```
/caii/incoming/
|
|-- 20220603
|   |-- ca20220603_074912.fts
|   |-- ca20220603_074912.jpg
|   |-- ca20220603_074916.fts
....
|   |
|   |-- ca20220603_105812.fts
|   |-- ca20220603_105812.jpg
|   `--dc20220603_074900.fts
```

```
/phoka/incoming/
|
|-- 20220603
|   |-- dc20220603_074908.FTS
|   |-- wl20220603_074912.FTS
|   |-- wl20220603_074912.jpg
|   |-- wl20220603_074916.FTS
....
|   |
|   |-- wl20220603_105812.FTS
|   `-- wl20220603_105812.jpg
```

data processing

- workstation waits for new image in **incoming/** directory
- process the image
- move the processed image to **processed/** and the original to a temporary **archive/**
- the **incoming/** directory should be empty afterwards if everything runs smooth
- only images newer than the last processed image are processed (live image is always the latest grabbed image!)
- omitted images in **incoming/** (happens very seldom) are processed in the evening
- for each camera the exists a separate processing task (perl + c++)

temporary archive

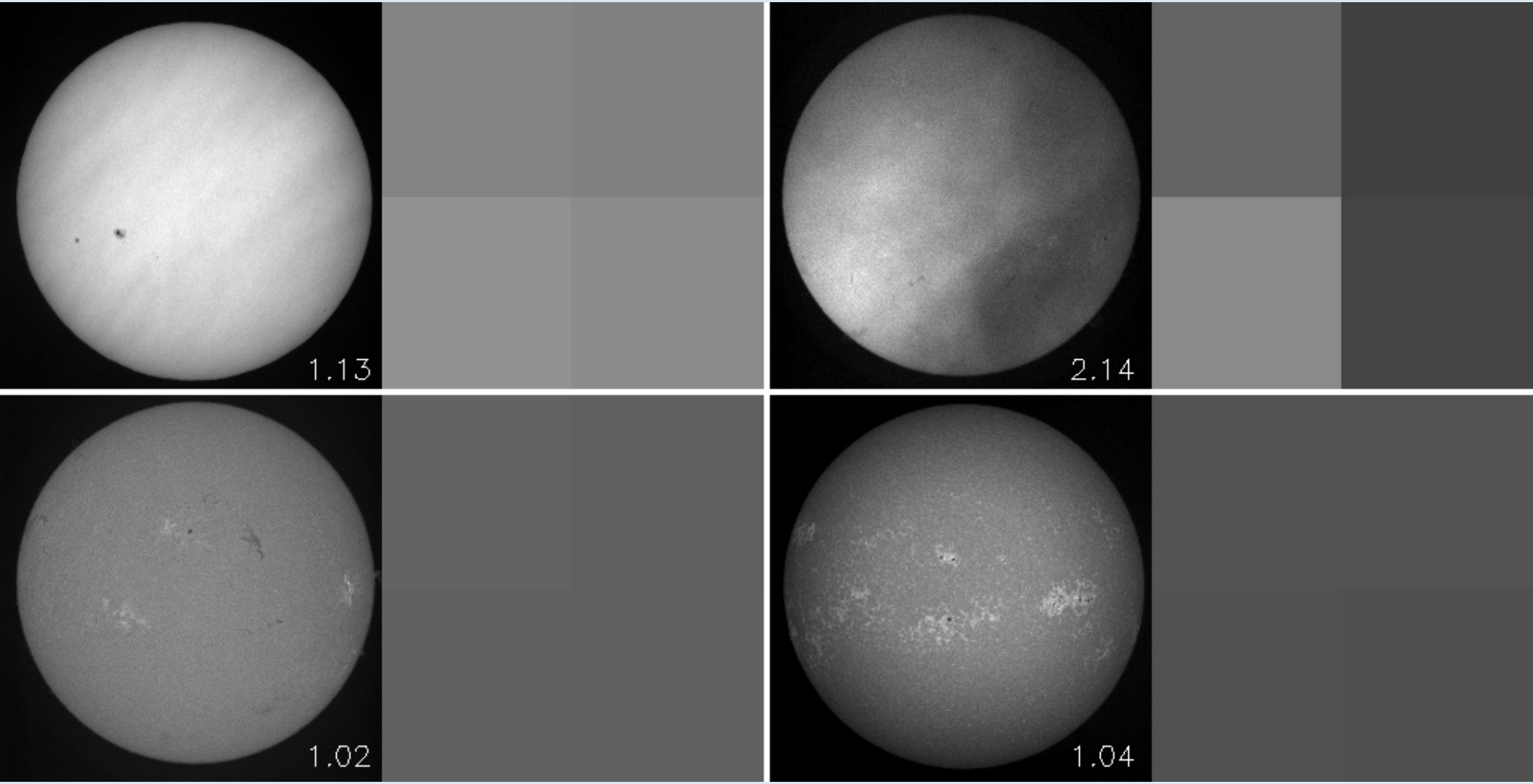
- all grabbed images are there (FITS + JPEG) also bad ones
- can hold up to one year of observations
- can be used to test quality algorithms or for machine learning
- can be used as backup if something went wrong
- „bad“ images like eclipse images can be reprocessed
- UFOs can be found!

processing – quality check

- file size (incomplete files are not used – happens with 1 out of several millions)
- exposure time: long exposure time = bad contrast (thin clouds)
- intensity in AOI – can be too high or too low when clouds move fast and camera control is slower
- inhomogeneities in image
- solar limb detection accuracy
- sharpness of image

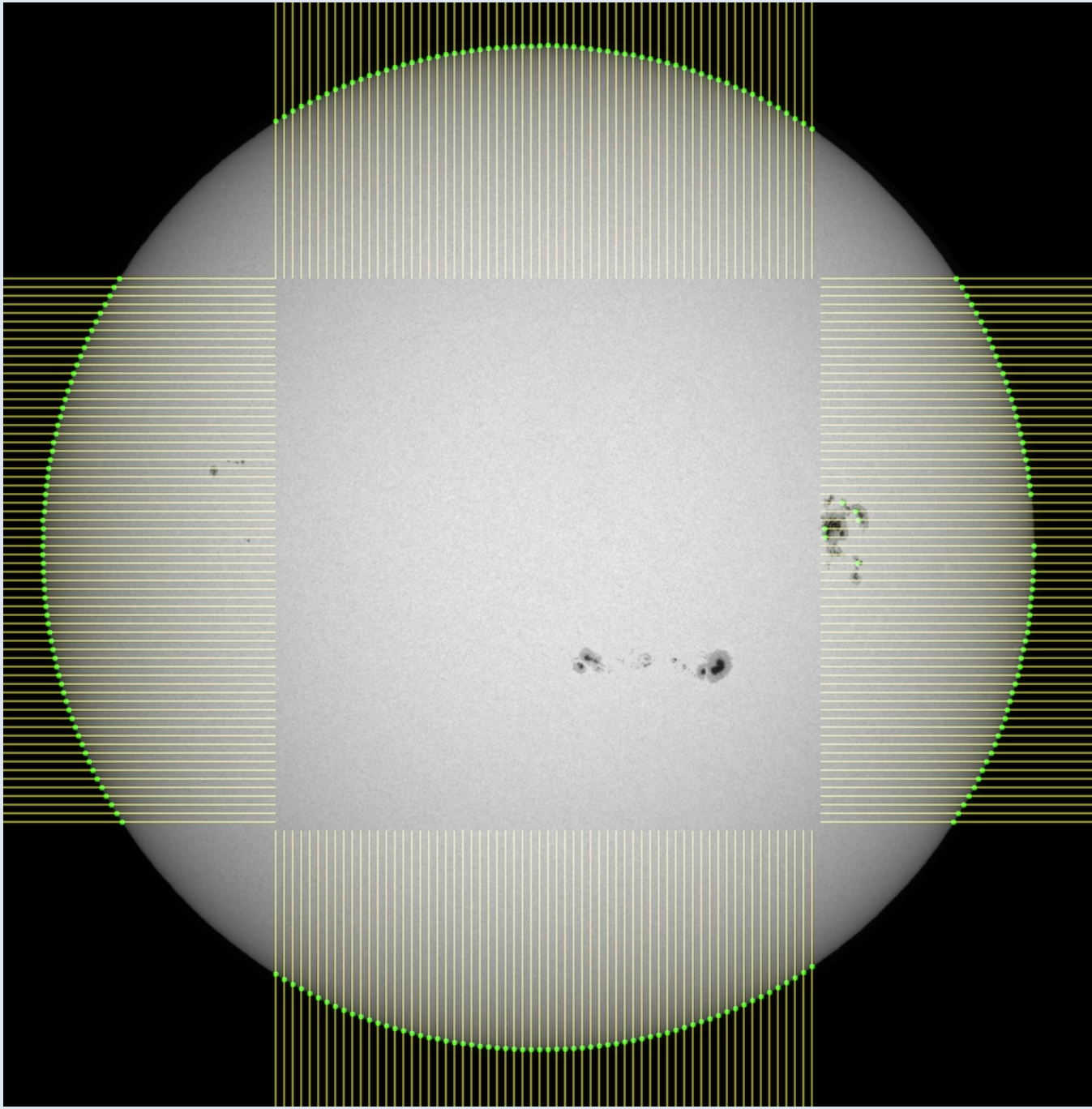
check inhomogeneities

reduce image to 4 pixels and compare brightest to faintest



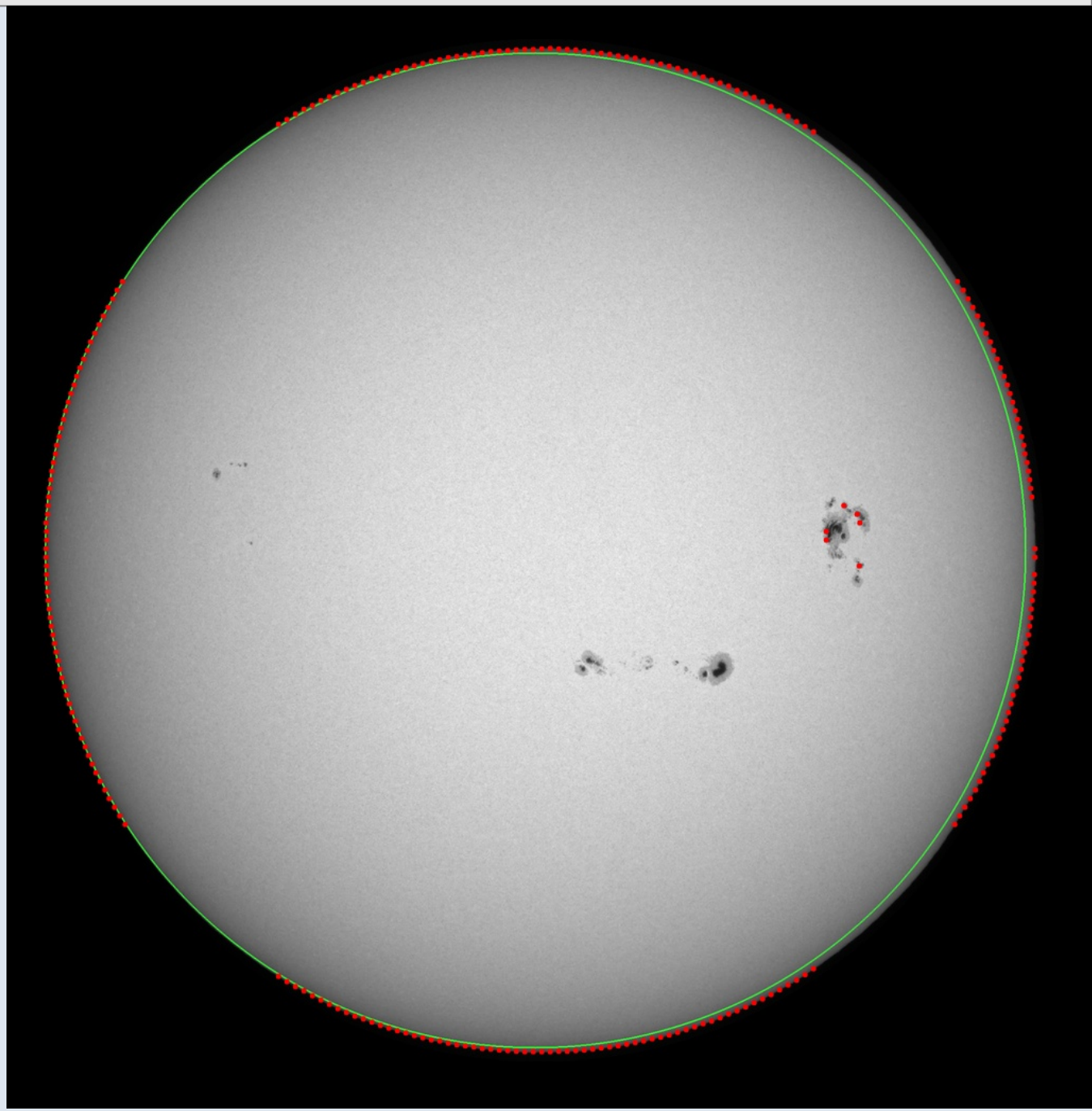
limb detection

- find the highest intensity change in intensity profiles from the four main directions
- use these points as first guess for the solar limb and use a method like Taubin for a cicle fit



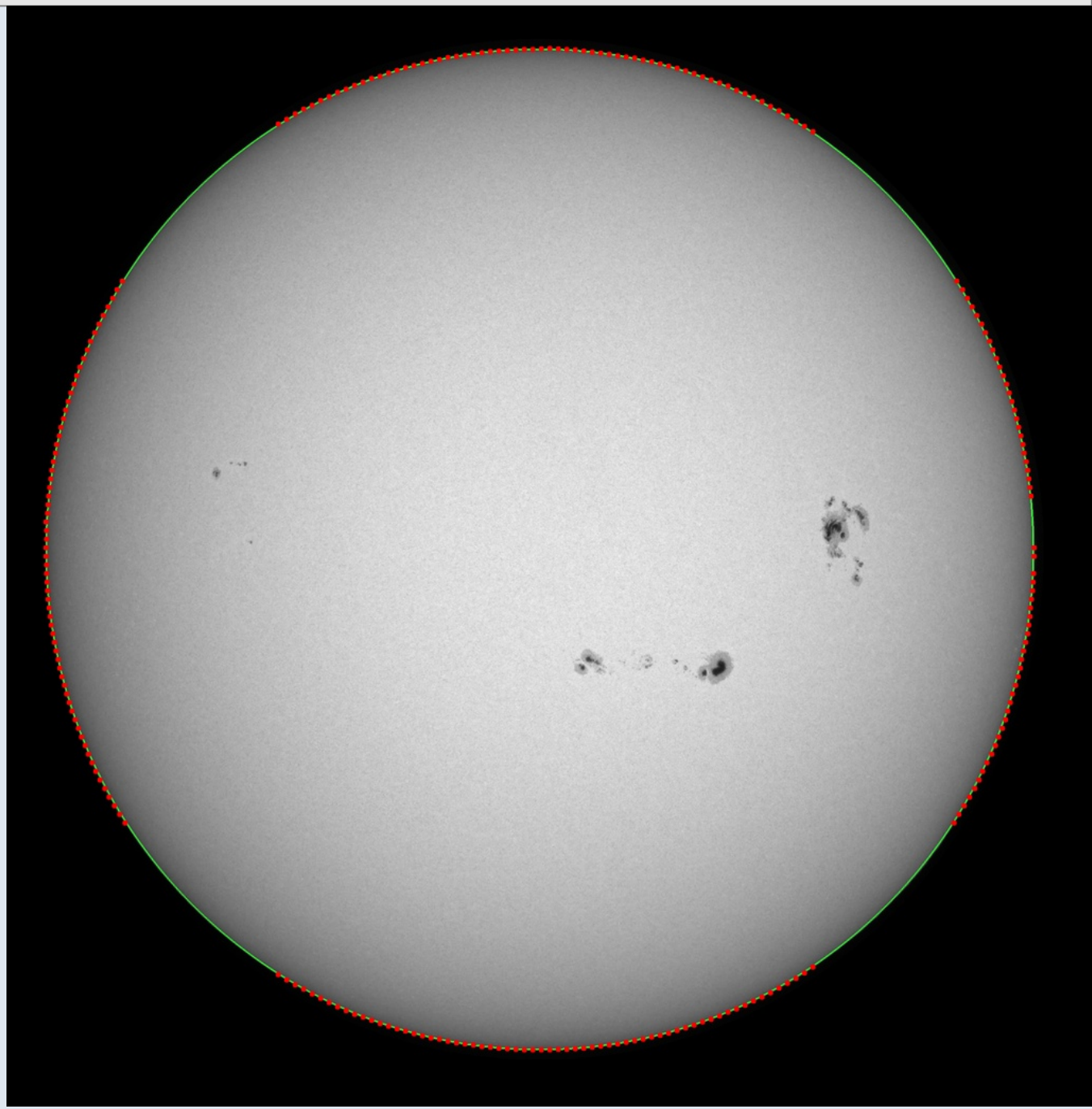
1st iteration

- remove all points that are further away from the mean limb (green)
- in this case the points in the sunspot are removed
- recalculate with Taubin method



2nd iteration

- at least after 3 iterations the rms of the limb should be very low – if not then the image is considered to be bad!
- method is very stable and fast, small clouds are no problem



3 iterations with clouds!

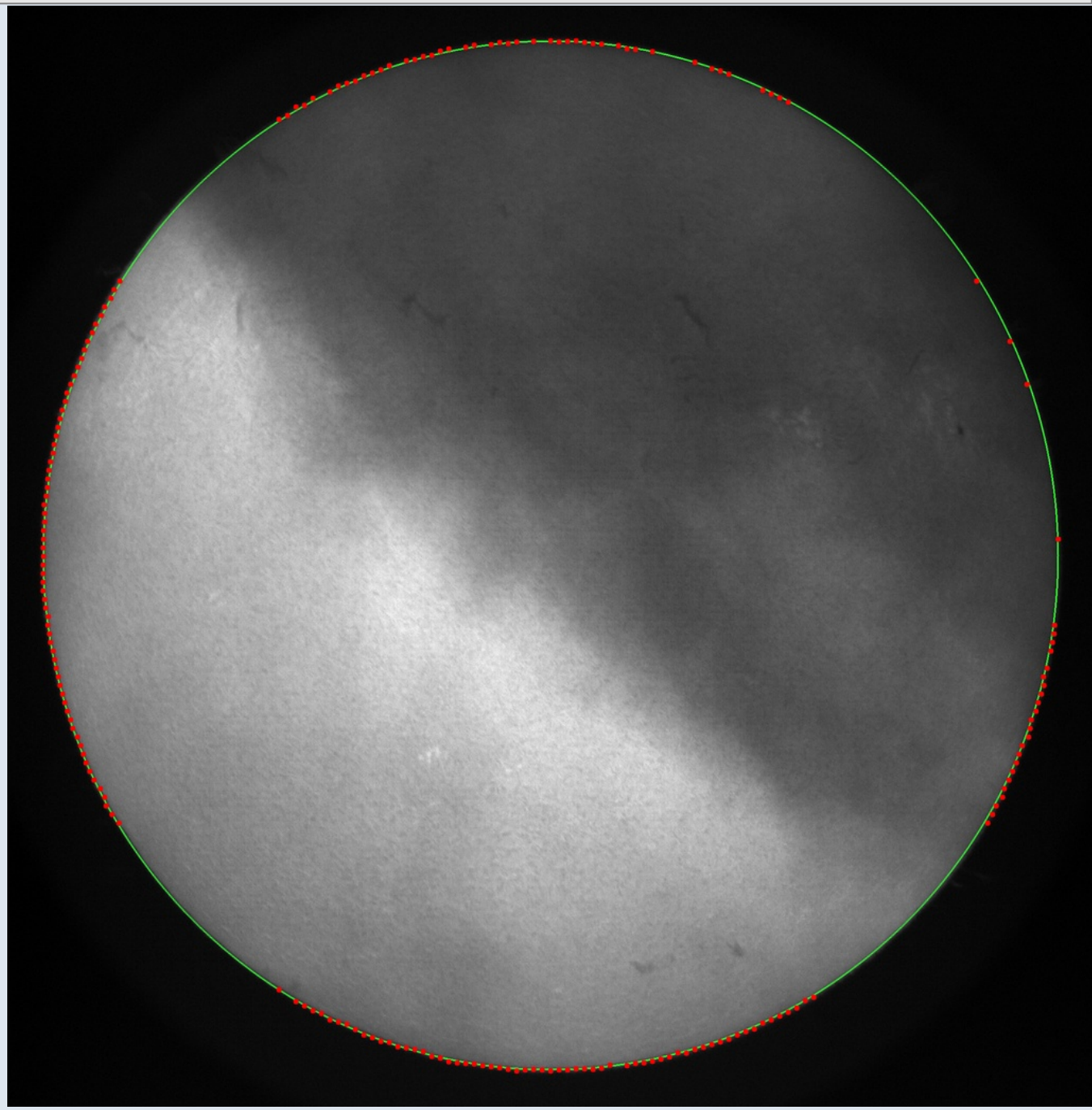
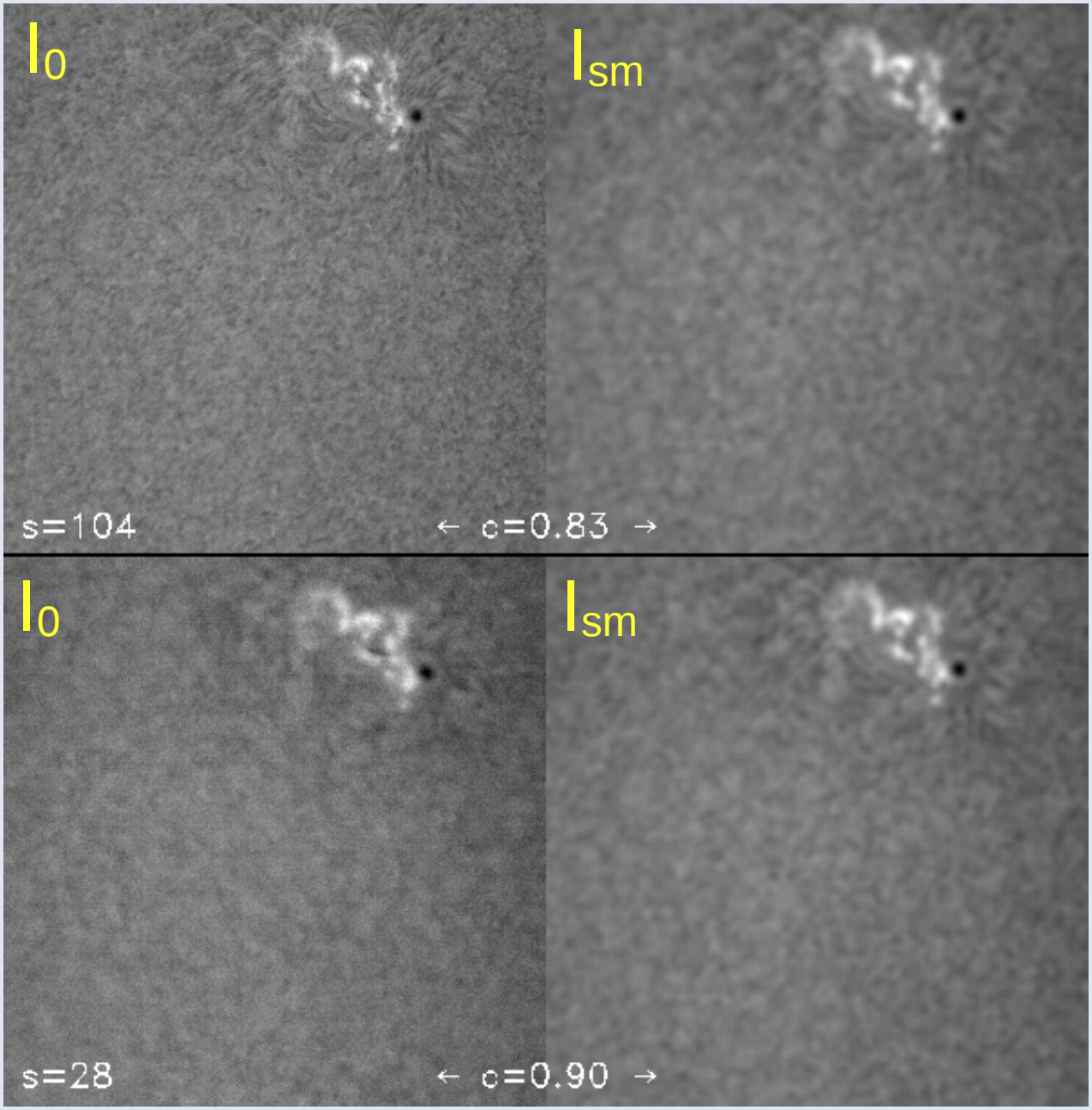


image sharpness

- original image I_0
- smooth $I_0 \rightarrow I_{sm}$
- $c = correlate(I_0, I_{sm})$
- $c \approx 1 \rightarrow$ unsharp original image
- $c \ll 1 \rightarrow$ sharp original image



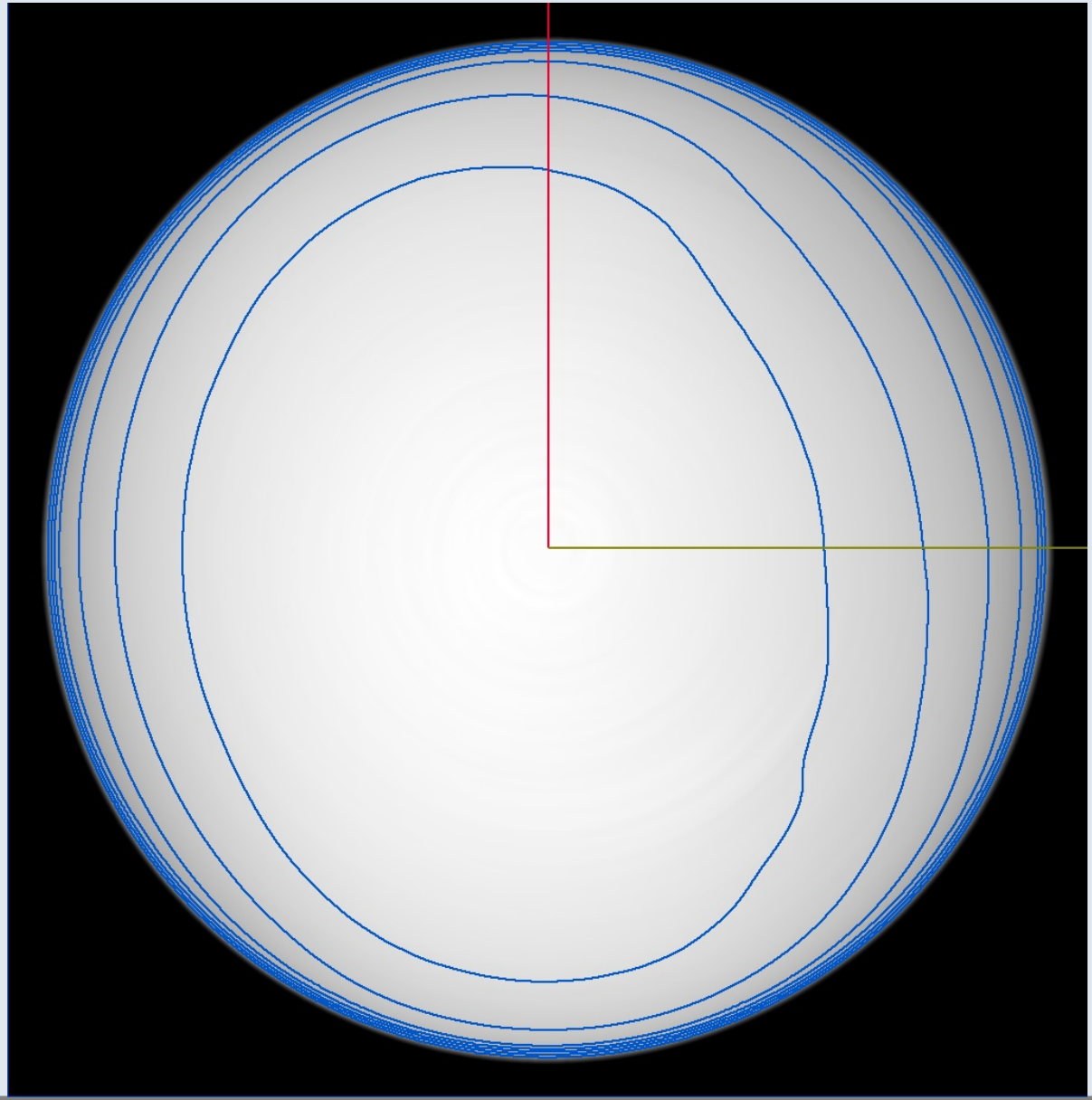
quality decision

- combination of all values
- good = 1 → further processing, for data archive
- fair = 2 → further processed, partially stored in data archive if quality 1 is not available
- bad = 3 → no processing

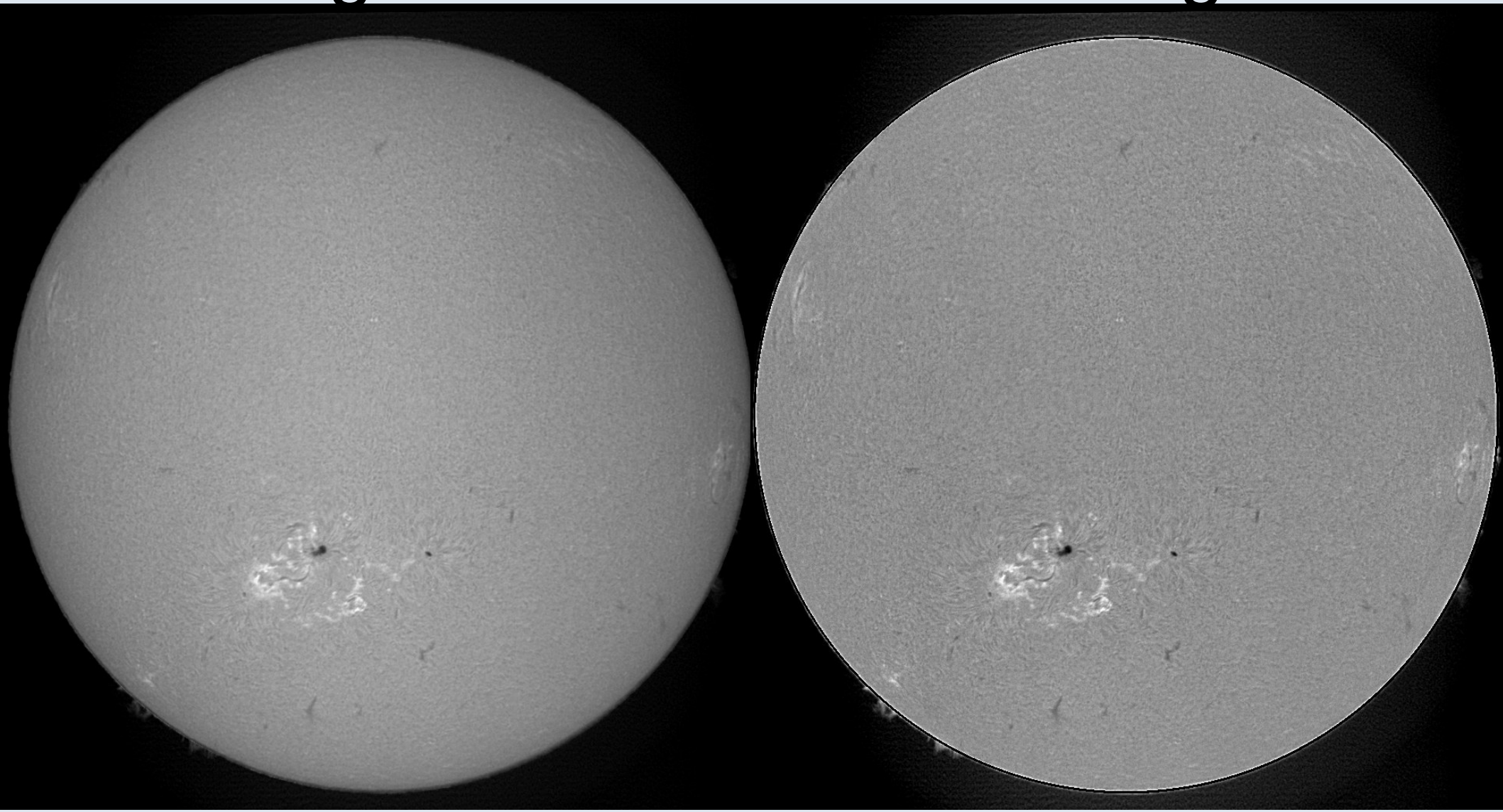
processing – CLV + anisotropic

- take concentric rings
- apply running median filter on each ring
- → map
- image/map → image without large scale anisotropies and removed CLV
- same contrast over the solar disc

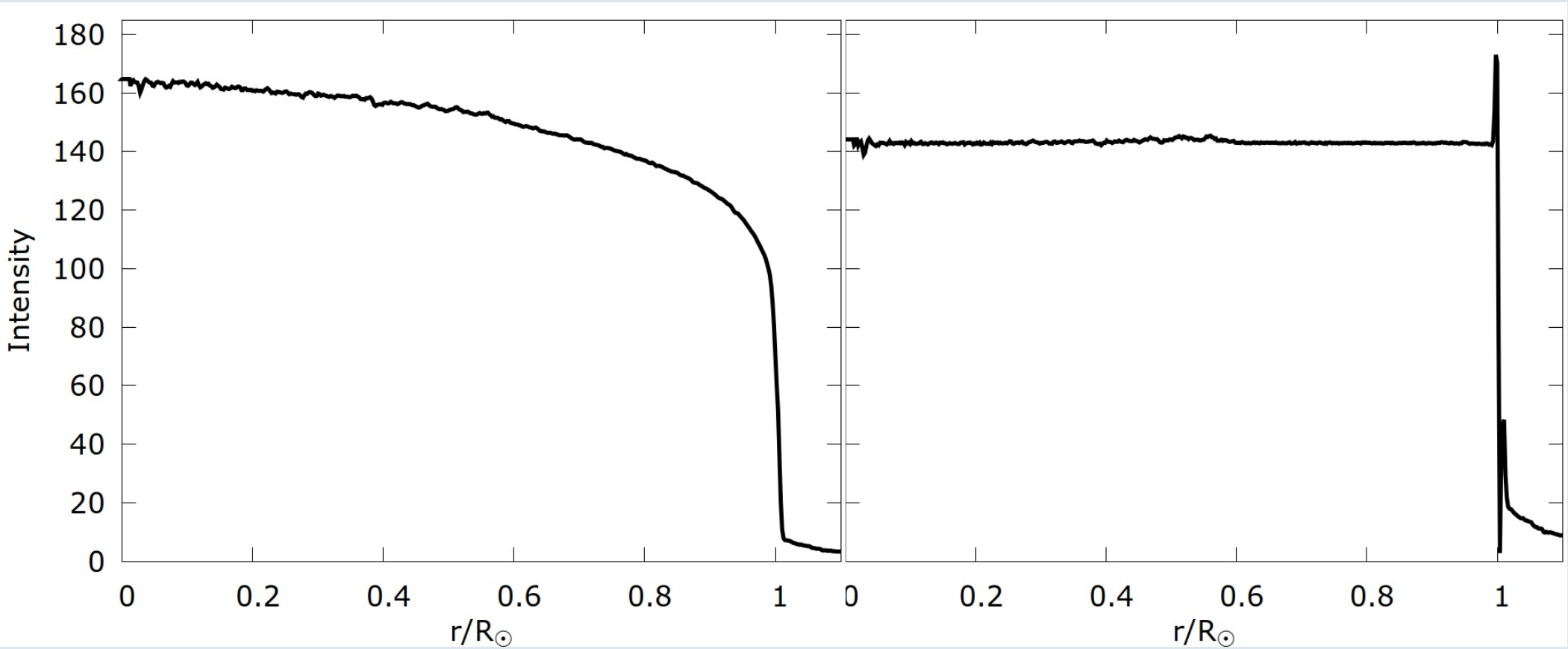
Very computation costly → parallel implementation



original → flat image



intensity profile after correction



file types

- temporary archive: original FITS and JPEG
- archive:
  - processed FITS (raw data + complete header)
  - JPEG: low contrast, high contrast, coloured with grid
  - H-alpha: filament maps (binary and JPEG)

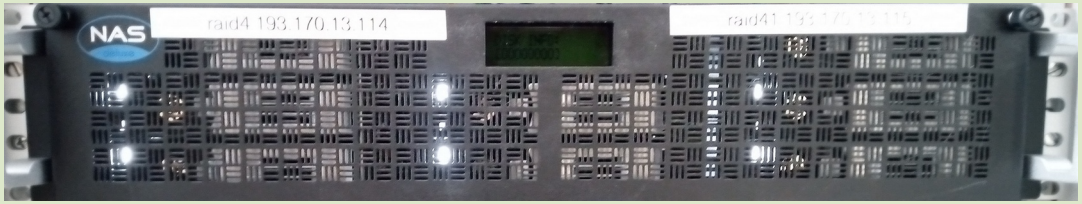
data archive

Stored on 2 RAID systems

mirrored

accessible via www, ftp and API

no direct write access

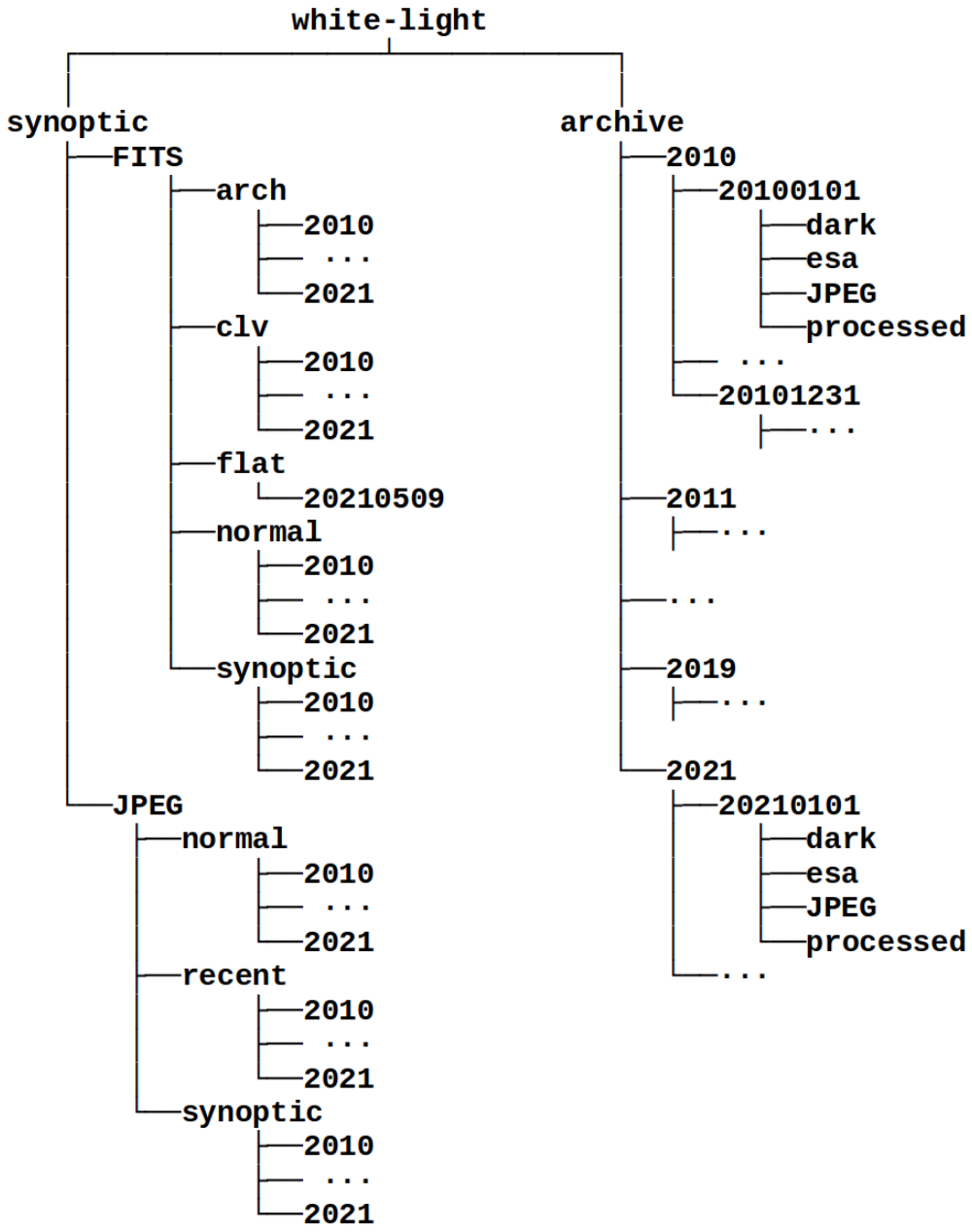


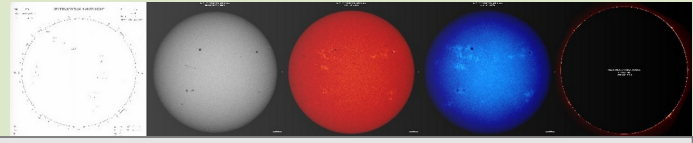
archive structure

hierarchy:

1. camera
2. year
3. day

synoptic branch:
one image per day, just for the www and overview



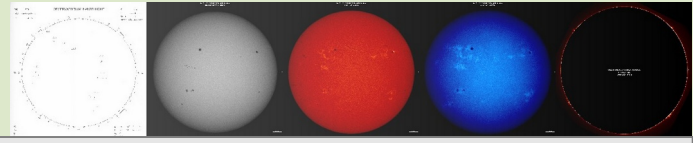


file naming

```
01234567890123456789012345678901234 <=== character index
kanz_halph_fi_20110420_154112.fts.gz <=== filename
---- ----- -- -------- ------ ------
   |     |  |        |      |      |
   |     |  |        |      |      File extension (3-6 chars)
   |     |  |        |      |
   |     |  |        |      Observation time (6 chars, in HHMMSS format)
   |     |  |        |
   |     |  |        Observation date (8 chars, in yyyymmdd format)
   |     |  |
   |     |  Miscellaneous info code (2 chars)
   |     |
   |     Image type code (5 chars)
   |
   Institution or telescope code (4 chars)
```

BBAND	Broadband (Whitelight)	CAIIK	Calcium II K line
HALPH	H-alpha	DRAWX	drawing

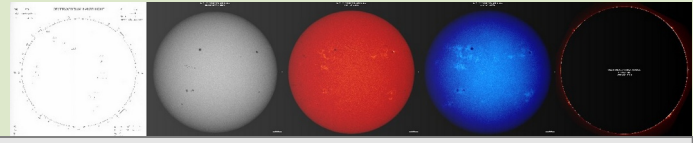
FD,FL	Full disk synoptic
FC	High contrast image (image/clv)
FI	Raw intensity image
FQ,FP	clv table
DC	dark current
FF	flat field
FR	residual image (img-clv)



FITS header

```
SIMPLE  =    T
BITPIX  =   16
NAXIS   =    2
NAXIS1  =2048
NAXIS2  =2048
EXTEND  = 'F    '
FILENAME='kanz_halph_fi_20170416_081837.fts.gz'
DATE    = '2017-04-16T08:18:39'
DATE-OBS= '2017-04-16T08:18:37'
DATE-BEG= '2017-04-16T08:18:37'
TIMESYS = 'UTC     '
OBSVTRY = 'Kanzelhoehe Observatory'
TELESCOP= 'KHPI    '
INSTRUME= 'HA2     '
DETECTOR= 'TM4200-6'
OBJECT  = 'Full Sun'
FILTER  = 'Zeiss Lyot Halpha'
WAVELNTH=              6563.28 / [ANG], FWHM=0.7 [ANG]
WAVEMIN =              6562.93
WAVEMAX =              6563.63
EXP_TIME=                2.752 / Exposure Time [ms]
XPOSURE =             0.002752 / [s]
BSCALE  =                    1
BZERO   =                32768
BUNIT   = 'CCD COUNTS'
DATAMIN =                    0
DATAMEAN=                  572
DATAMAX =                  795
CTYPE1  = 'SOLAR_X '
CTYPE2  = 'SOLAR_Y '
CUNIT1  = 'arcsec  '
CUNIT2  = 'arcsec  '
CRPIX1  =              1024.50
CRPIX2  =              1024.50
```

```
SIMPLE   T for FITS Standard
BITPIX   Bits per Pixel – 16bit  Integer
NAXIS    # ofdimensions
NAXIS1   x-dimension
NAXIS2   y-dimension
EXTEND   F – normal FITS file
FILENAME …
DATE     time of processing
DATE-OBS time of image capture
DATE-BEG      -“-
TIMESYS  time frame
OBSVTRY
TELESCOP name of telescope
INSTRUME name of instrument
DETECTOR name of camera
OBJECT   observed object
FILTER   type of filter
WAVELNTH central wavelength
WAVEMIN  minimum wavelength
WAVEMAX  maximum wavelength
EXP_TIME exposure time in ms
XPOSURE  exposure time in s
BSCALE   intesnity scaling
BZERO    offset of intesity scaling
BUNIT    units
DATAMIN  minimum value
DATAMEAN mean value
DATAMAX  maximum value
CTYPE1   coordinates x-axis
CTYPE2   coordinates y-axis
CUNIT1   coordinate unit x-axis
CUNIT2   coordinate unit y-axis
CRPIX1   center coordinate x
CRPIX2   center coordinate y
```

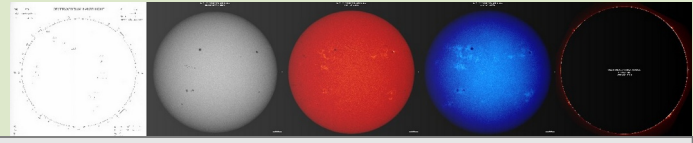


FITS header

```
CDELT1  =              1.019699 / [arcsec/pix]
CDELT2  =              1.019699 / [arcsec/pix]
CRVAL1  =             0.9184746
CRVAL2  =             -16.49616
ANGLE   =             -26.68136 / [deg]
CROTA1  =              26.68136 / [deg]
CENTER_X=              1023.599 / [pix]
CENTER_Y=              1040.677 / [pix]
SOLAR_R =               942.486 / [pix]
RSUN_REF=           6.9938E+08 / [m]
RSUN_ARC=              960.859 / [arcsec]
SOLAR_P0=             -25.92443 / [deg]
SOLAR_B0=             -5.503757 / [deg]
CAR_ROT =                  2189
QUALITY =                     2 / image quality [1-3]
OBS_TYPE= 'HALPH    '
OBS_PROG= 'HALPHA PATROL'
TYPE-DP = 'ARCHIVE '            / Data Processing Type
EXP_MODE=                     0 / Exp. Mode
                                  (0=auto,1=dbl,2=fix,3=both)
PRE_INT =                   600 / Preselected PixInt in AOI
A_O_INT = '1223,714,1223,1032' / Rect. for PixInt [X0,Y0,X1,Y1]
ORIGIN  = 'KANZELHOEHE OBSERVATORY, A-9521 TREFFEN, AUSTRIA
COMMENT Orientation: N up, W right, first pix is left bottom
HISTORY No intensity processing applied
END
```

```
CDELT1    pixel/arcsec x-coordinates
CDELT2    pixel/arcsec y-coordinates
CRVAL1    center coordinate Sun x
CRVAL2    center coordinate Sun y
ANGLE     rotation of solar N (cameratilt+P0)
CROTA1    -rotation of solar N (cameratilt+P0)
CENTER_X  Sun center x
CENTER_Y  Sun center y
SOLAR_R   solar radius in pixel
RSUN_REF  solar radius in m
RSUN_ARC  solar radius in arcsec
SOLAR_P0  solar north
SOLAR_B0  solar ecliptic tilt
CAR-ROT   Carrington rotation number
QUALITY   quality
OBS_TYPE  observation type
OBS_PROG  observation programme
TYPE-DP   data type
EXP_MODE  exposure mode

PRE_INT   fixed intensity in AOI
A_O_INT   AOI coordinates
ORIGIN    data source
COMMENT
HISTORY
END
```



Database - mysql

phpMyAdmin

Letzte Favoriten

- Neu
- gaestebuch
- information_schema
- KEAS
  - Neu
  - caii
  - detector
  - dha_dd_corr
  - file_type
  - filter
  - flares
  - hafilm
  - hafilter_steps_wavelen
  - halpha
  - instrument
  - instrument_detector
  - ISN
  - kfactor
  - korona
  - logbook
  - object_list
  - observation_type
  - observer
  - phoka
  - scientist
  - seasons
  - seeing_quality
  - ssd
  - sunspots
  - syn_data
  - techlog
  - wl
- library

Server: localhost » Datenbank: KEAS

Struktur | SQL | Suche | Abfrage | Exportieren | Importieren | Operationen | Rechte | Routinen | Ereignisse | Trigger

Filter

Beinhalten das Wort:

	Tabelle	Aktion	Datensätze	Typ	Kollation	Größe	Überhang
☐	caii	Anzeigen Struktur Suche Einfügen Leeren Löschen	~1.099.001	InnoDB	utf8_general_ci	185,7 MiB	-
☐	detector	Anzeigen Struktur Suche Einfügen Leeren Löschen	16	InnoDB	utf8_general_ci	16,0 KiB	-
☐	dha_dd_corr	Anzeigen Struktur Suche Einfügen Leeren Löschen	366	InnoDB	utf8_general_ci	16,0 KiB	-
☐	file_type	Anzeigen Struktur Suche Einfügen Leeren Löschen	11	InnoDB	utf8_general_ci	16,0 KiB	-
☐	filter	Anzeigen Struktur Suche Einfügen Leeren Löschen	37	InnoDB	utf8_general_ci	16,0 KiB	-
☐	flares	Anzeigen Struktur Suche Einfügen Leeren Löschen	17.887	InnoDB	utf8_general_ci	1,5 MiB	-
☐	hafilm	Anzeigen Struktur Suche Einfügen Leeren Löschen	~465.103	InnoDB	utf8_general_ci	70,6 MiB	-
☐	hafilter_steps_wavelen	Anzeigen Struktur Suche Einfügen Leeren Löschen	33	InnoDB	utf8_general_ci	16,0 KiB	-
☐	halpha	Anzeigen Struktur Suche Einfügen Leeren Löschen	~3.847.540	InnoDB	utf8_general_ci	775,0 MiB	-
☐	instrument	Anzeigen Struktur Suche Einfügen Leeren Löschen	12	InnoDB	utf8_general_ci	16,0 KiB	-
☐	instrument_detector	Anzeigen Struktur Suche Einfügen Leeren Löschen	17	InnoDB	utf8_general_ci	16,0 KiB	-
☐	ISN	Anzeigen Struktur Suche Einfügen Leeren Löschen	~75.686	InnoDB	utf8_general_ci	2,5 MiB	-
☐	kfactor	Anzeigen Struktur Suche Einfügen Leeren Löschen	5	InnoDB	utf8_general_ci	16,0 KiB	-
☐	korona	Anzeigen Struktur Suche Einfügen Leeren Löschen	4.139	InnoDB	utf8_general_ci	144,0 KiB	-
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☐	observation_type	Anzeigen Struktur Suche Einfügen Leeren Löschen	14	InnoDB	utf8_general_ci	16,0 KiB	-
☐	observer	Anzeigen Struktur Suche Einfügen Leeren Löschen	22	InnoDB	utf8_general_ci	16,0 KiB	-
☐	phoka	Anzeigen Struktur Suche Einfügen Leeren Löschen	13.417	InnoDB	utf8_general_ci	1,5 MiB	-
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☐	seasons	Anzeigen Struktur Suche Einfügen Leeren Löschen	124	InnoDB	utf8_general_ci	16,0 KiB	-
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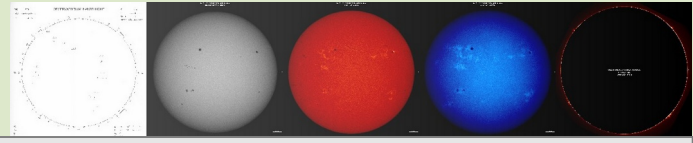

H-alpha data

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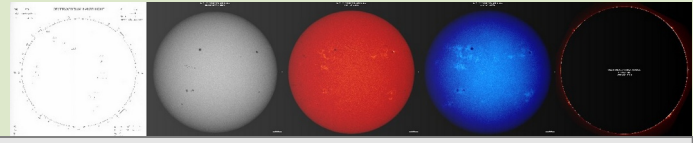

Data access – cesar.kso.ac.at

Kanzelhöhe Observatory

Synoptic Archives

KARL-FRANZENS-UNIVERSITÄT GRAZ
UNIVERSITY OF GRAZ

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- » Sunspot Numbers
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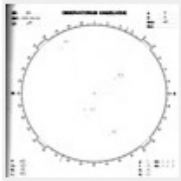
- » Flares (automatically)
- » Flares (NOAA-SWPC)
- » KSO observing logs

Misc.
- » Solar Ephemeris
- » Debrecen Photohel. Data

2023-10-24 Julian Date: 2460240.0001 P = 25.729° B_0 = 5.318° L_0 = 76.64° Carr# 2276

12:00 UTC Dist. = 0.995 AU App. Diam. = 1929.0" Elevation = 30.10° Sunrise 05:31:17 UTC Sunset 16:05:49 UTC

Sun - Photosphere for 2023-10-22



Kanzelhöhe Sunspot Drawing
06:53 UTC
Side reversed!
» Drawing Archive

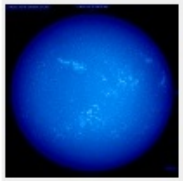
Kanzelhöhe White-light
06:52:23 UTC
Synoptic *.jpg *.fits.gz
Contrast *.jpg *.fits.gz » Synoptic Archive
Movie » Full White-light Archive

R_I = 52
g = 4
f = 12

Observing Log
Monthly Summary
NOAA/SWPC Event List
Hα/GOES Intensity Plot

Sun - Chromosphere for 2023-10-22

Kanzelhöhe Hα
06:53:31 UTC
Synoptic *.jpg *.fits.gz
Contrast *.jpg *.fits.gz » Synoptic Archive
Movie » Full Hα Archive



Kanzelhöhe Ca II K
06:52:15 UTC
Synoptic *.jpg *.fits.gz
Contrast *.jpg *.fits.gz » Synoptic Archive
Movie » Full Ca II K Archive

Kanzelhöhe Hα Prominence Images
06:56:46 UTC
» Synoptic Archive

« 2023-10-21 « 1 Month **2023-10-22** 2023-10-23 »

Panorama: 2023-10-22 12:00 (UTC)

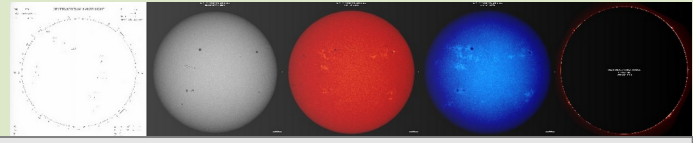
Data access – kanzelhohe.uni-graz.at

Observatorium Kanzelhöhe
für Sonnen- und Umweltforschung

KARL-FRANZENS-UNIVERSITÄT GRAZ
UNIVERSITY OF GRAZ

Kanzelhöhe Hα, Whitelight and CaIIK Data Archive

Hα Archive	Whitelight Archive	CaIIK Archive
		
(latest Hα image from KSO)	(latest Whitelight image from KSO)	(latest CaIIK image from KSO)
» Archive...	» Archive...	» Archive...



Data access – ftp.kso.ac.at

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Connected to halley.kso.ac.at.
220 Welcome on Kanzelhoehe ftp server
Name (ftp.kso.ac.at:poetzi): download
331 Password required for download
Password:
230-Welcome to the Kanzelhoehe Observatory FTP server!
 This account allows just to download files, don't try anything else!
 In case of problems contact poetzi@kso.ac.at!

 CaII          calcium archive data                    2010 -
 caii          calcium synoptic data                   2010 -

 HaFilm        Ha scanned films 1024x1024 @8bit        1973 - 2000
 Ha1Mold       Ha 1 MPixel archive 1008x1016 @8bit     1998 - 2005
 Ha1M          Ha 1 MPixel archive 1000x1012 @10bit    2005 - 2010
 halpha        Ha 1 Mpixel synoptic (8bit and 10bit)   1997 - 2010

 Ha4M          Ha 4 MPixel archive 2024x2048 @12bit    2008 -
 halpha2k      Ha BBSO 4 MPixel synoptic               2000 -
 halpha4M      Ha 4 Mpixel synoptic                    2008 -
 korona        Korona Images of Ha 4 Mpixel            2009 -

 Phoka         Whitelight 4 MPixel archive 2024x2048   2007 -
 phokaD        Whitelight 4 Mpixel synoptic            2007 -
 phokascan     Scanned Whitelight images               1989 - 2007

 KSO_flares    Flare data from KSO                     1984 -
 Patrol_Times Patrol time data (graph and text)        2000 -
 sunspots      Drawings, Sunspot Numbers               1944 -
 uvb           UV data archive                         2004 - 2013

230 User download logged in
Remote system type is UNIX.
Using binary mode to transfer files.
ftp>
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