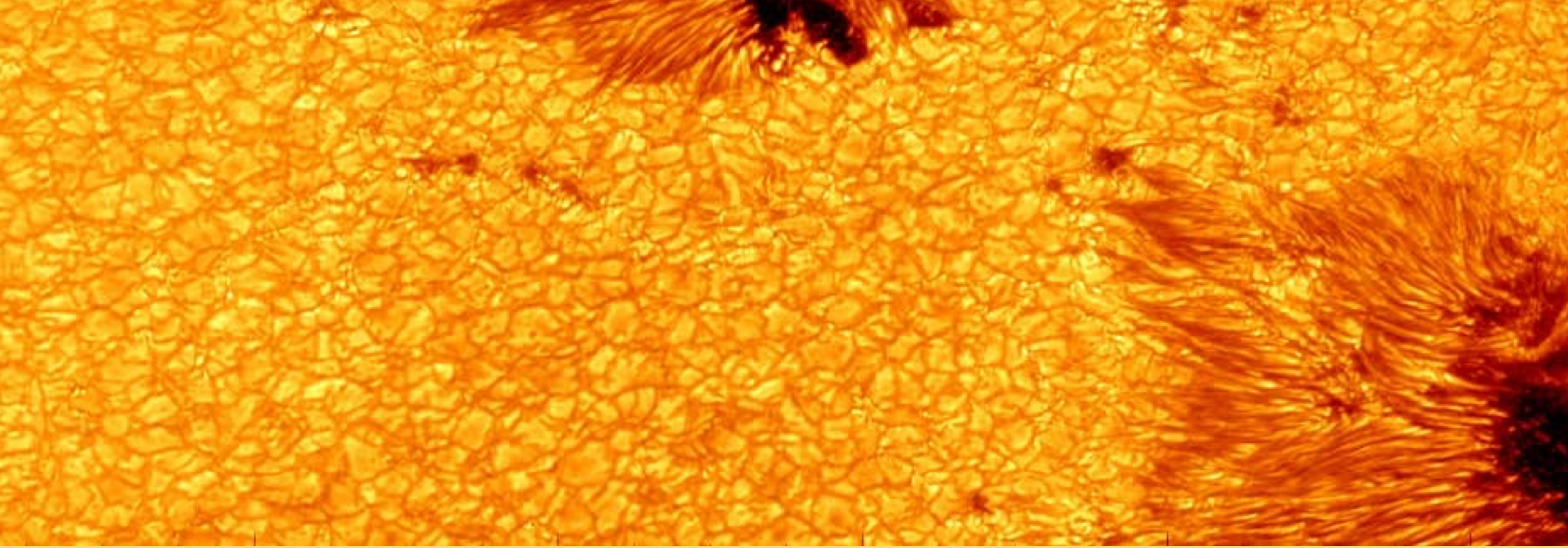


Getting and complementing your data

Catherine Fischer

A week above the clouds

SOLARNET SCHOOL FOR OBSERVERS 2019

Data taken by GREGOR

Outline

Short Intro to SolarSoft

PART I

Data acquisition:

- Data archives
- Writing an Observing Proposal
- Applying for Co-Observing

PART II

- Alignment of data
- Catalogues, Event search
- Reading and Viewing data
- Practical: Context data for the GREGOR GFPI data 12.08.2014

SSW IDL SESSION

Type along…
commandsfile.pro
change main data directory

SolarSoft -Solar data analysis

http://www.lmsal.com/solarsoft/

Some of the primary goals of the SSW system are:
Provide a large reusable SW library
Provide a system which is largely hardware-system and site independent
Promote the use of certain standards which facilitate coordinated data analysis
Promote an evolutionary environment
Provide access to supporting ancillary data bases
Provide a file-format independent analysis environment

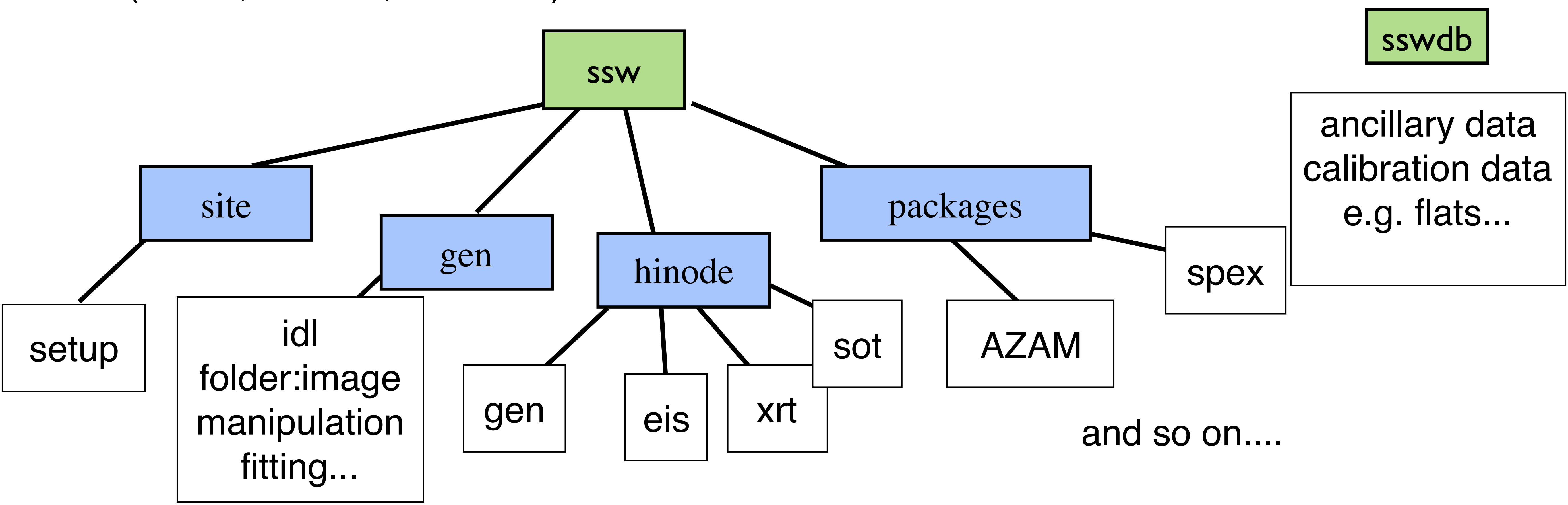
- Time series analysis, time conversions, time series plotting
- Spectral fitting
- Image and image cube (movie) processing and display
- Solar image data routines (limb fitting, image and grid overlay, coordinate transformations, feature tracking, co-alignment...)
- File I/O (generic binary, ascii, FITS...)
- IDL data manipulation (structure, string, array, mathematics...)
- WWW interface (html conversion, file conversions, FORM handling, WWW server mode)

similar: SunPy using python

sunpy
A Community Python Library for Solar Physics

SolarSoft - Solar data analysis

<u>SolarSoftWare (ssw)</u>
Mission libraries
(SoHO, TRACE, Hinode...)



Tutorial for setup http://www.mssl.ucl.ac.uk/surf/sswdoc/solarsoft/

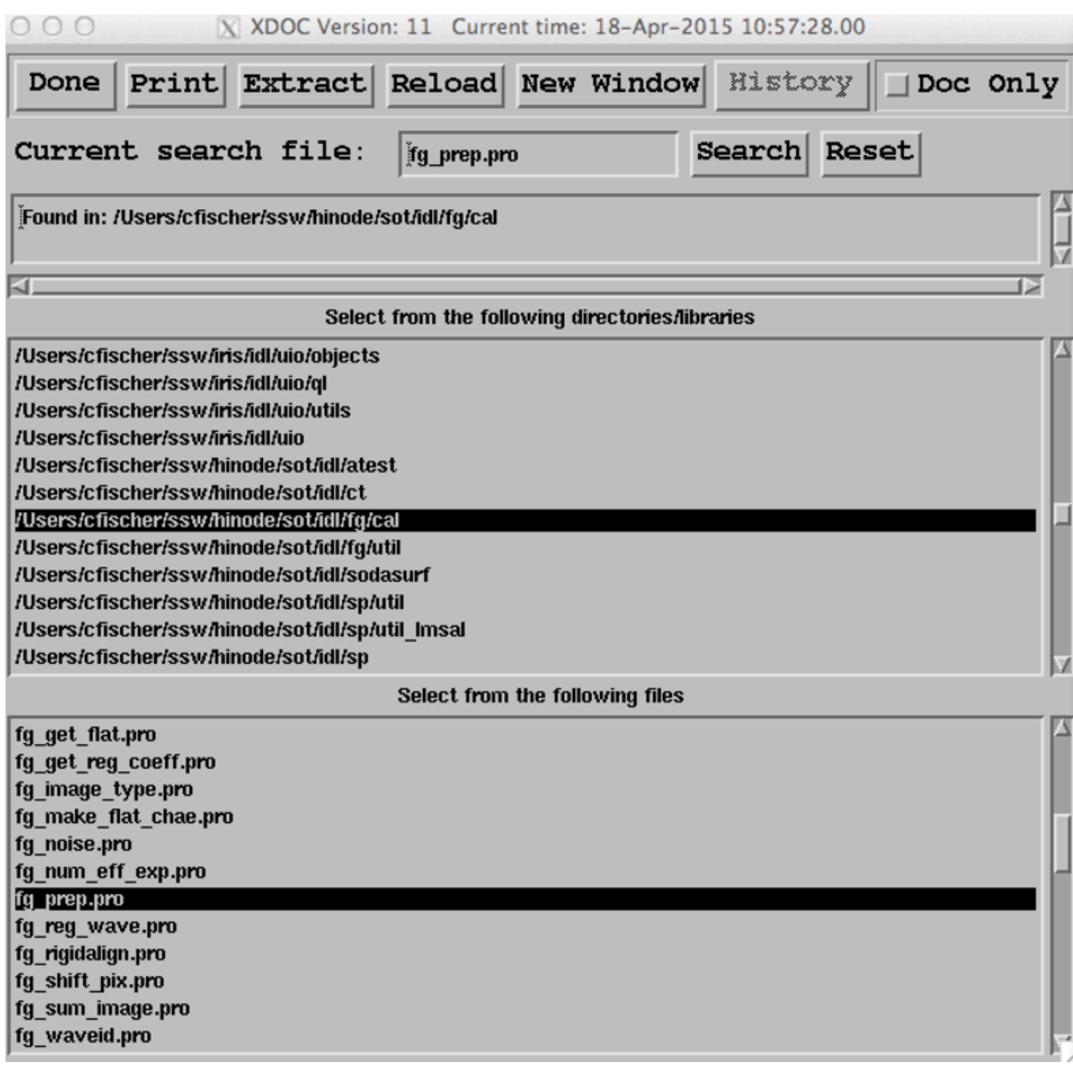
SolarSoft - Solar data analysis

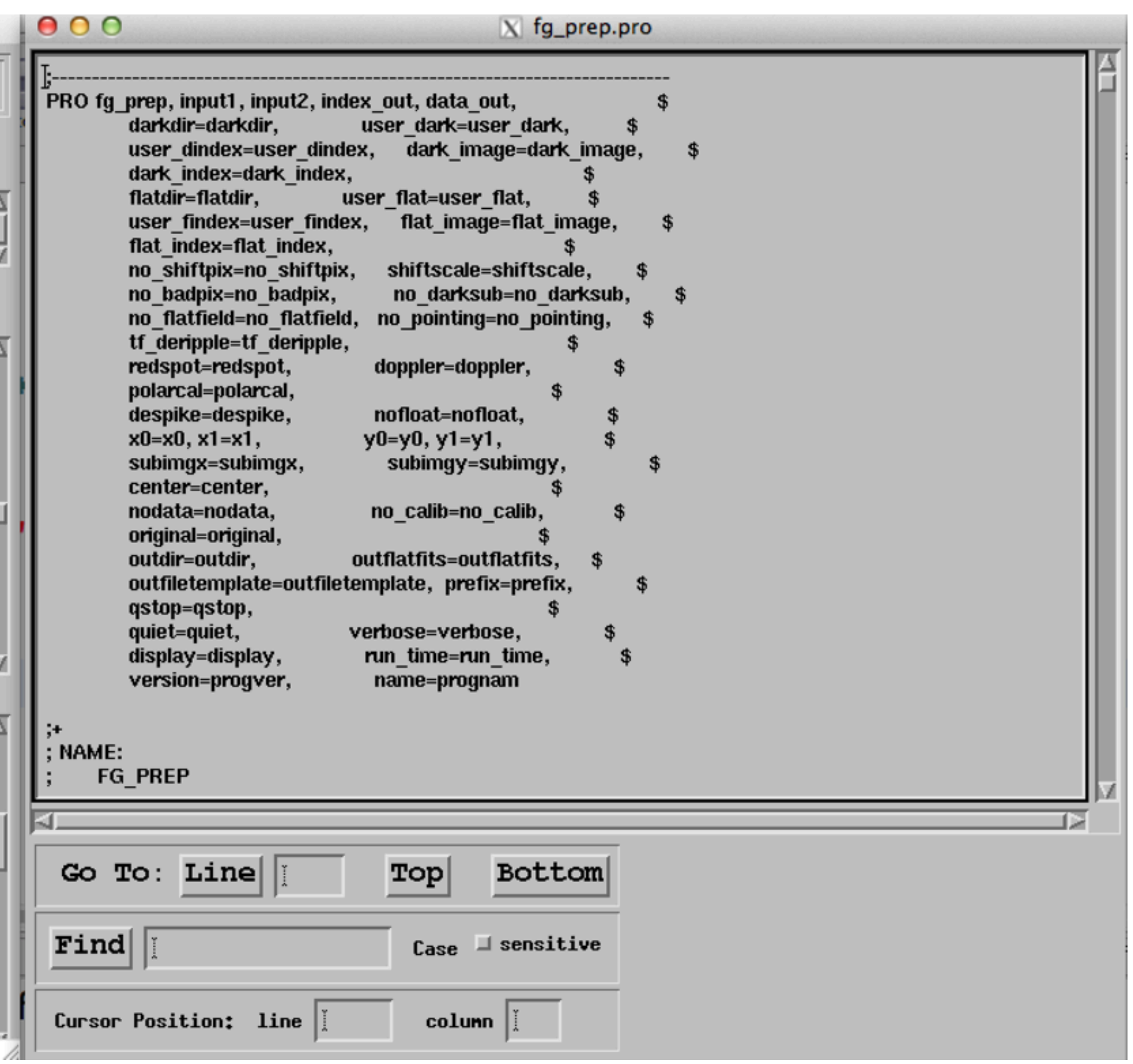
SSW IDL SESSION

Setup of environ. variables

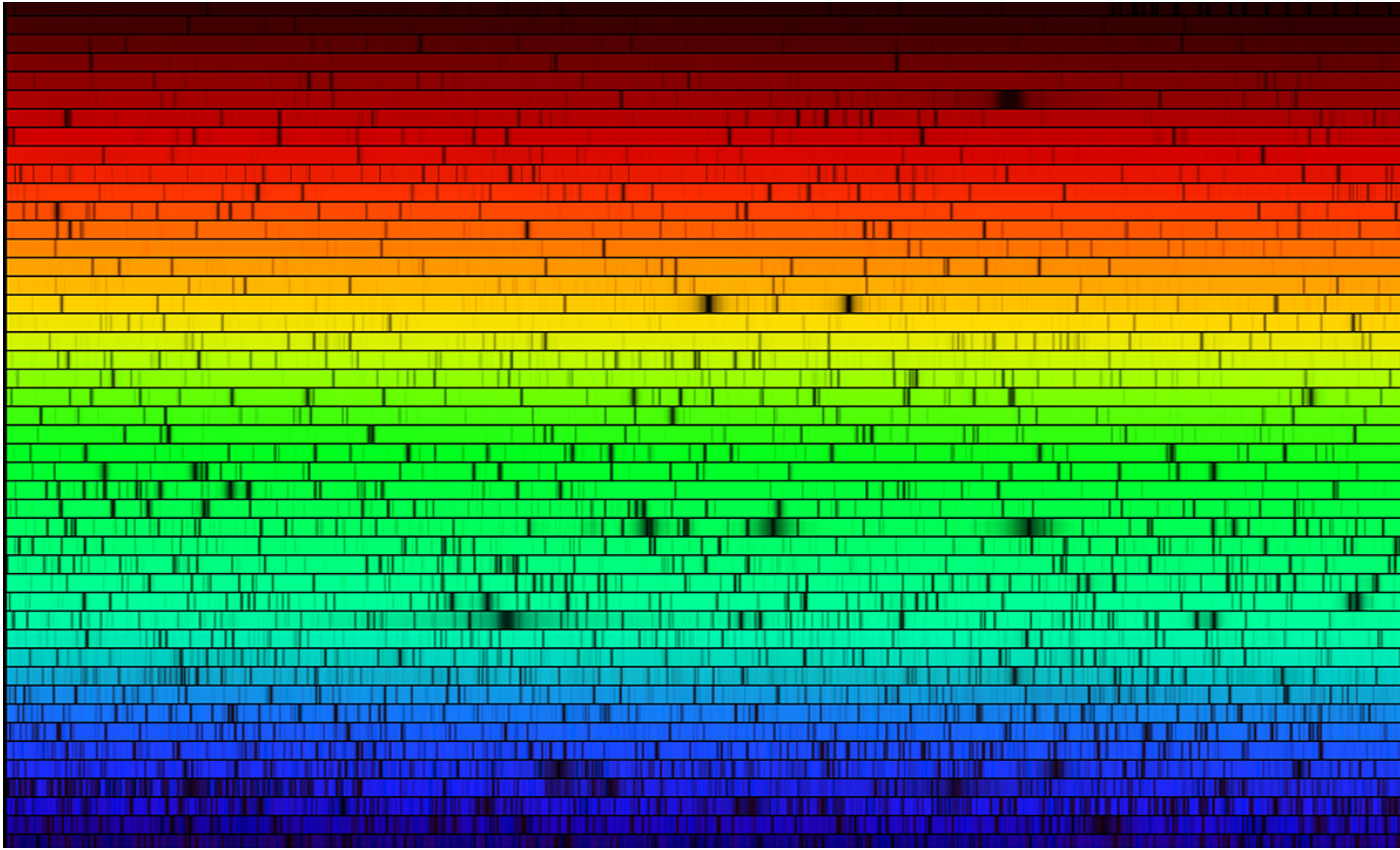
To find out about routines

```
pr_env,/sot
print, getenv('SOT_SSWDB_FG_CAL')
ssw_path,/sot
xdoc
xdoc,'fg_prep
doc_library, '*FFT*
findpro,'fg_prep'
```





Part I

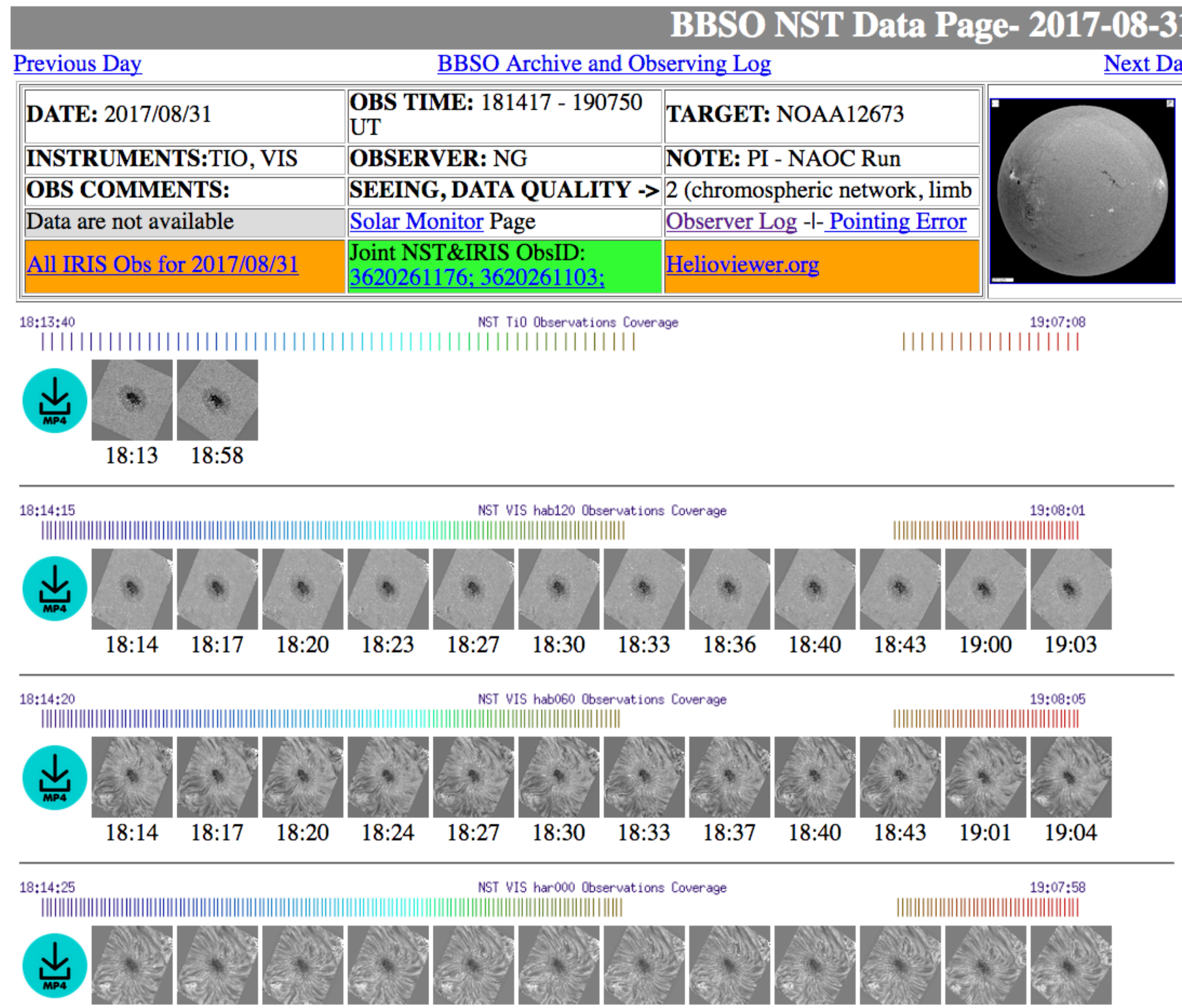


N.A.Sharp, NOAO/NSO/Kitt Peak FTS/AURA/NSF

Data archives from ground-based telescopes

Goode Solar Telescope
(formerly New Solar Telescope)

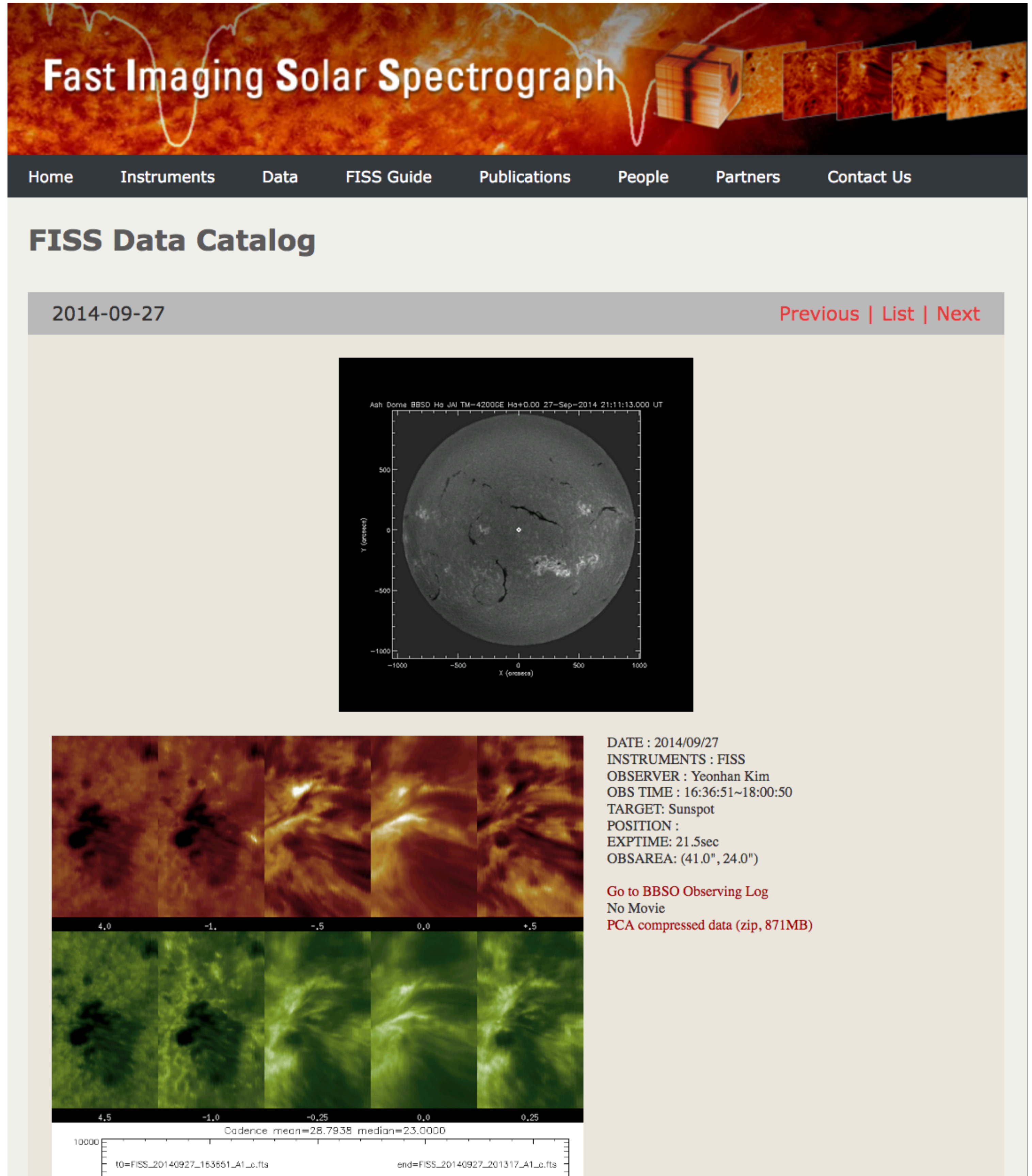
http://www.bbso.njit.edu/~vayur/nst_requests/#data



Data archives from ground-based telescopes

Goode Solar Telescope
(formerly New Solar Telescope)

http://fiss.snu.ac.kr/data_catalog_list.php



Data archives from ground-based telescopes

Dunn Solar Telescope

https://www.nso.edu/

NSO — ABOUT · RESEARCH · PROJECTS · DATA ACCESS · FOR PUBLIC · GALLERY · NEWS — SEARCH

Home » Telescopes » Dunn Solar Telescope » **DST Service Mode**

Overview

Between and January 2013 and October 2014, the Dunn Solar Telescope was used in "Service Mode". All data acquired during DST Service Mode Operations is made freely available to the scientific community. The data is made available for download via the NISP's ftp server.

This process was repeated for 3 cycles.

- Cycle 1: 15/01/2013 – 15/02/2013
- Cycle 2: 01/10/2013 – 31/10/2013
- Cycle 3: 01/10/2014 – 31/10/2014

In this operational mode, the DST Service Mode Operations Team executed the observing programs according to proposal ranking and when best suited to the current solar and atmospheric conditions, without the principal investigator (PI) present. This provided scientists the opportunity to more easily obtain high-resolution observations from the DST.

Contact

dstservice@nso.edu

Service Mode Setup

IBIS
ROSA
FIRS

Data

FTP access
SMO Observations Log
Data Reduction Software
Data Use Policy

https://www.nso.edu/telescopes/dunn-solar-telescope/dst-smo-2/

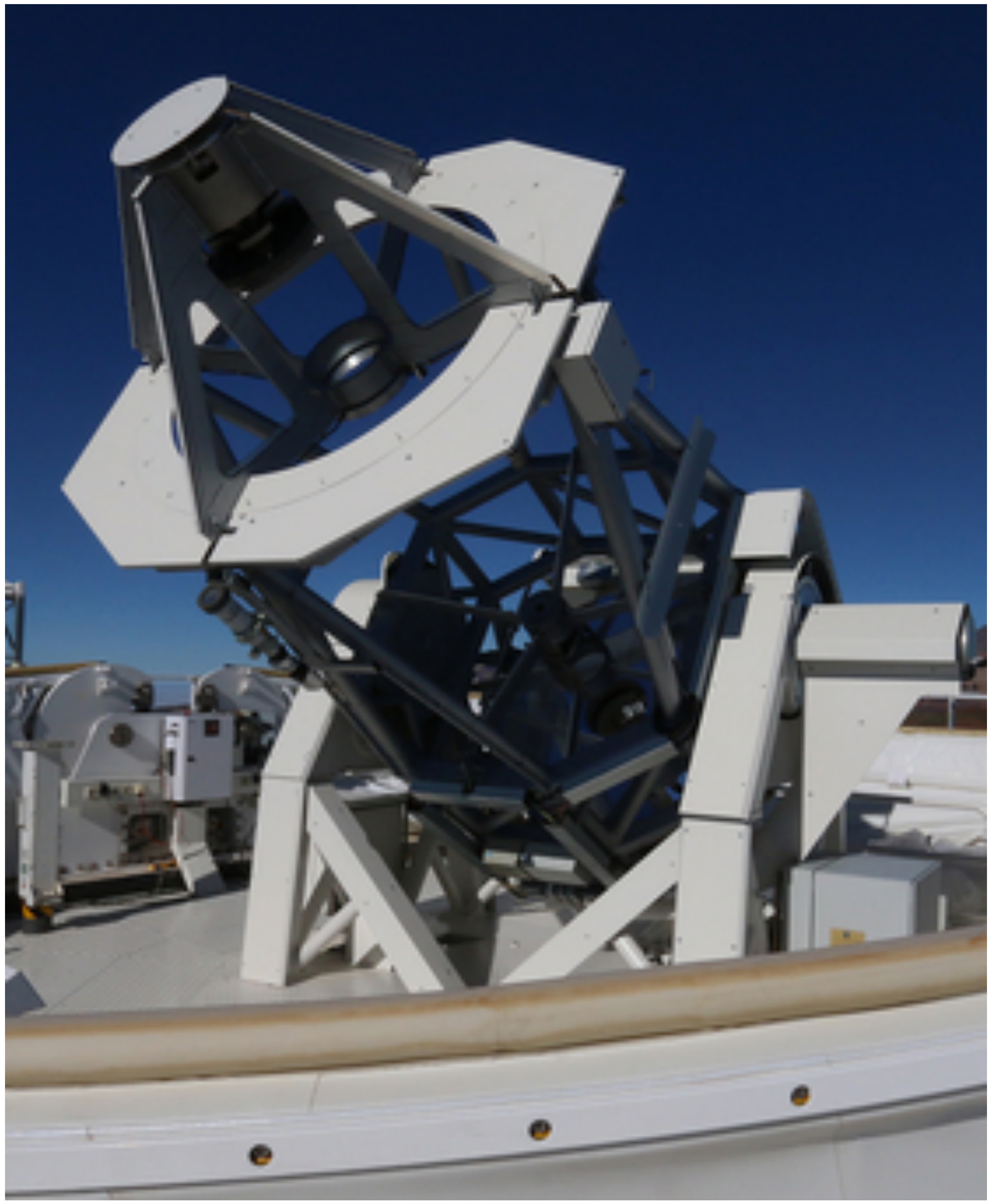
Service Mode Observation Log

Show 30 entries — Search:

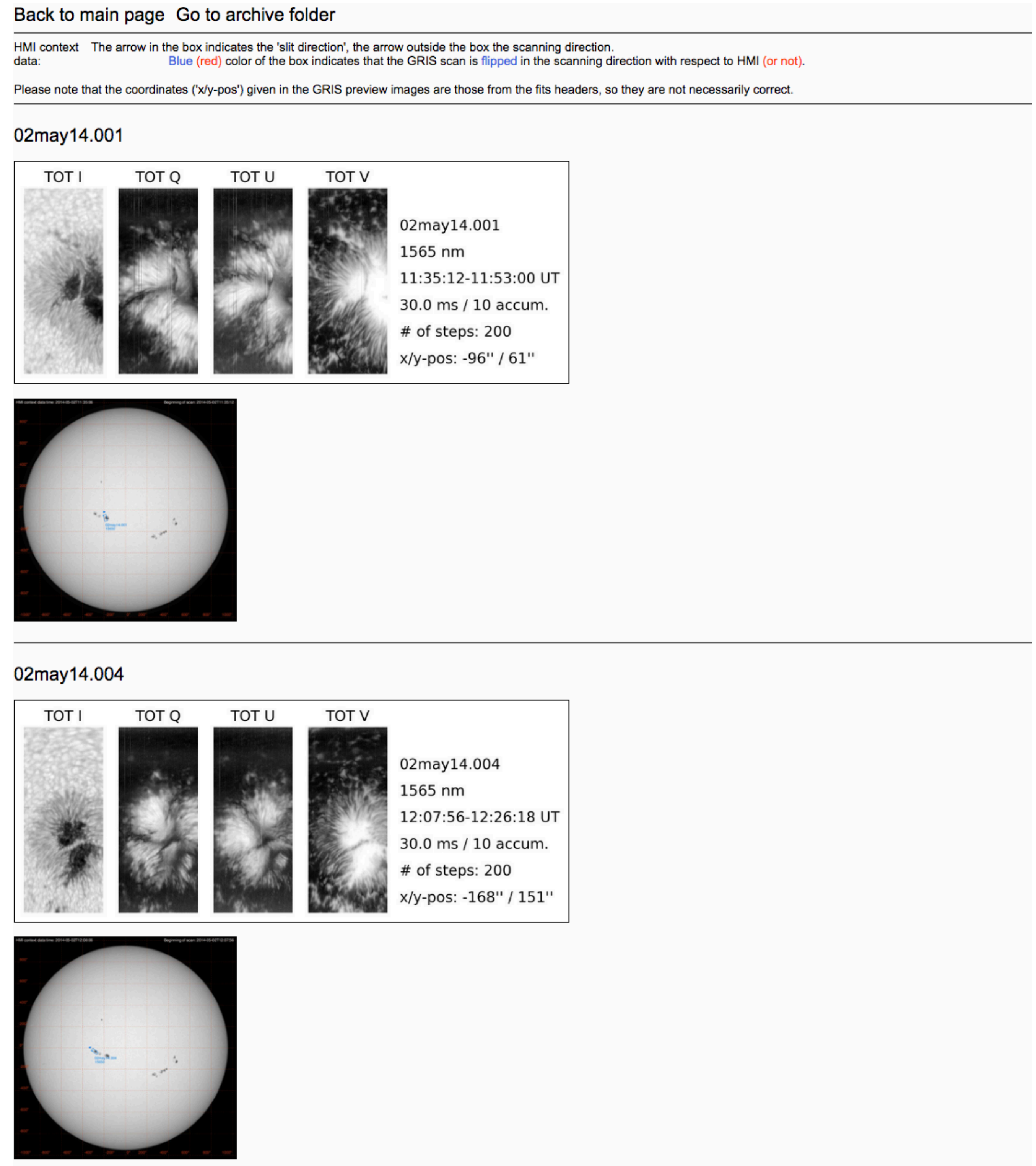
Cycle	Observation Date	Program ID	Title	PI	Instruments Used	Comments
Cycle 1	January 18, 2013	115	Cycle Variations of Sunspot Magnetic Fields	Rezaei, R.	FIRS	Sunspot ; NOAA 11658; leading polarity - Sunspot: NOAA 11654; following polarity
Cycle 1	January 19, 2013	126	Horizontal Dynamics of the QS near the Limb	Berrilli, F.	IBIS - ROSA - FIRS	North Pole; HPA 0 deg; NE limb; HPA 40 deg
Cycle 1	January 19, 2013	115	Cycle Variations of Sunspot Magnetic Fields	Rezaei, R.	FIRS	North Pole; HPA 0 deg; NE limb; HPA

Data archives from ground-based telescopes

GREGOR telescope



From KIS pages http://www.leibniz-kis.de/

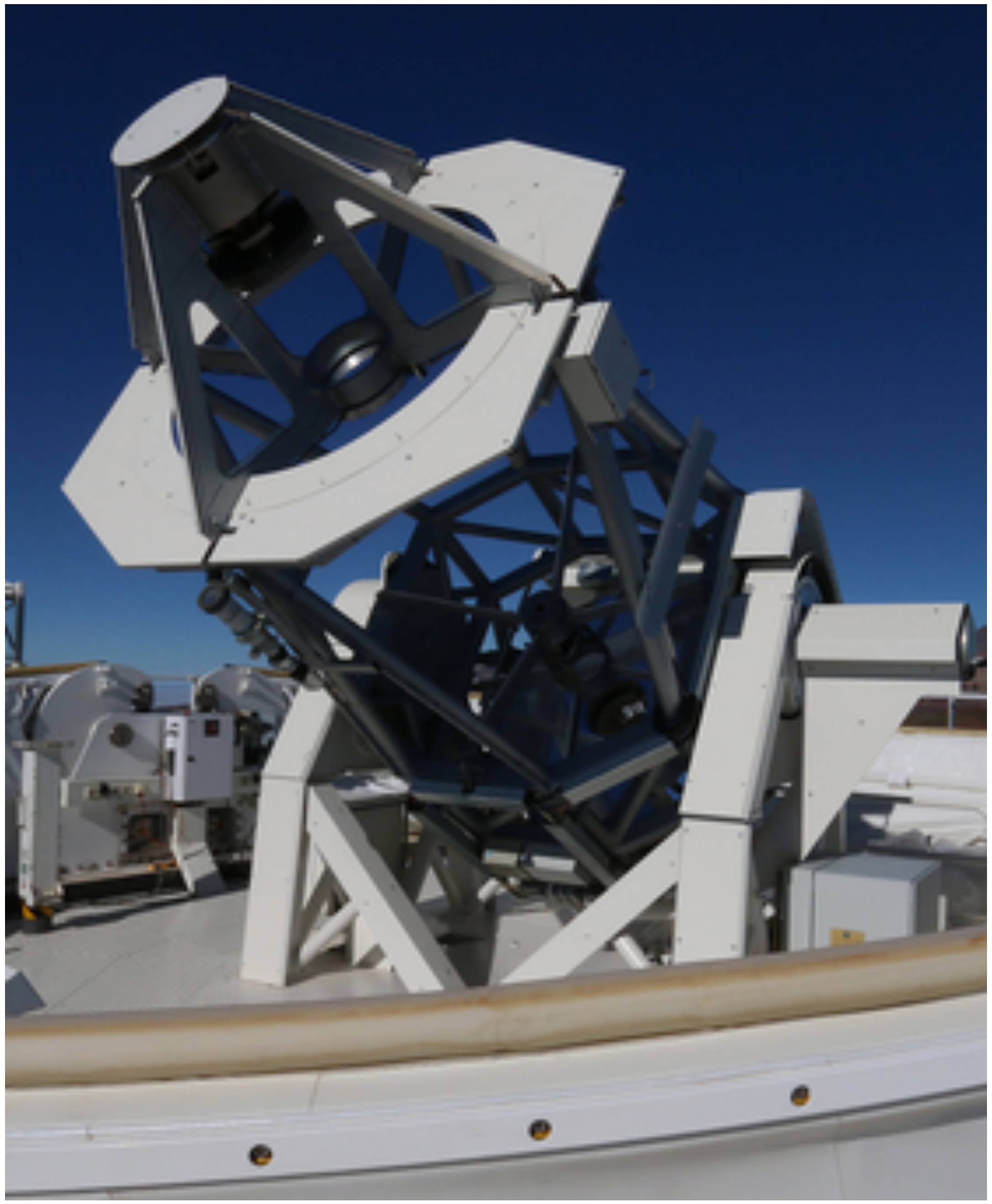


http://archive.leibniz-kis.de/pub/gris/index.html

+ NEW searchable web interface http://sdc.leibniz-kis.de:8080/

Data archives from ground-based telescopes

GREGOR telescope



From KIS pages http://www.leibniz-kis.de/

gregor.aip.de News Instruments Observations Contact

GREGOR GFPI/BIC/HiFI Archive

This webpage provides access to the »quick-look« data products of GFPI (Levels 0.0 and 1.0), HiFi (Level 1.0), and BI
products requires registration. The website is under continuous development.

Here you can find our Data Policy.

Link to the observers list and observing logs (you have to be logged in).

2019

July
GFPI Level 0.0: [10] [13] [14] [16] [17] [18]
HiFI Level 1.0: [13] [14] [16] [17] [18]

June
GFPI Level 0.0: [04] [05] [06] [07] [09] [11] [13] [14] [16] [19]
HiFI Level 1.0: [02] [04] [06] [07] [09] [11] [13] [14] [16] [19] [20]

May
HiFI Level 1.0: [06] [07] [10] [11] [13] [28] [29] [30] [31]

2018

December
HiFI Level 1.0: [01] [02] [03] [04] [08] [09] [11]

October
HiFI Level 1.0: [11] [12] [13] [15] [17]

August
HiFI Level 1.0: [18] [19] [20] [24] [25]

July

https://gregor.aip.de/data/observations/

Observing proposals to ground-based telescopes

- GREGOR
- SST (Swedish 1-m Solar Telescope)
- THEMIS
- VTT

Solarnet Access time: First call for proposals 2019

Published on Friday, 14 December 2018 14:20

SOLARNET Access Time: First call for proposals 2019

Proposals are hereby invited under the SOLARNET Trans-National Access Programme for observing time at GREGOR, SST, THEMIS, and VTT.

This call also includes observing time in the International Time Program (ITP). Proposals will be handled by the EAST TAC, a common European time allocation committee installed by the European Association for Solar Telescopes.

Typically, campaigns will be awarded for 10 observing days at each telescope. SOLARNET campaigns also include travel grants for going to the telescope.

In 2019, the SST will provide some of its time in service mode, thus not requiring visits by the investigators.

Certain criteria of eligibility related to the nationalities of the applicants apply. Data acquired in the SOLARNET Access Programme will become public one year after being delivered to the PI. Information on instrumentation and proposal details are available at the telescope web pages:

Observing proposals to ground-based telescopes

- Spanish and International time time open to all
- German time from KIS open to all if at least one Co-I from KIS, has been twice a year

Observatories Projects Organization Public Outreach Contact

Observing Season and applications for observing time

General Info

Due to changes in setup and instrumentation, the observing season 2019 is split into two halves: April - beginning of August and from mid August - end of November, 2019. The call for proposals is closed for 2019. The next call for 2020A may be expected in ~December 2019.

GREGOR Observing plan 2019 (updated Jun 23, 2019):
GREGOR_obs_plan_2019.pdf

Options for telescope access

CCI international time program (ITP):

5% of the telescope time are reserved for international access to all solar telescopes on the Canary Islands (GREGOR, VTT, THEMIS). The observing time is assigned by the EAST TAC. Anybody apart from the operator of each telescope can apply for observing time (e.g. KIS cannot apply for GREGOR or VTT time). Contact Dan Kiselman or Lucia Kleint for more information.

Spanish time (solar CAT)

See **www.iac.es/OOCC/solar-cat/** for more information. According to international agreements, 20% of the observing time is reserved for assignment by the Spanish solar CAT. Presently, there are no restrictions on nationality to apply for GREGOR and VTT time through the solar CAT.

SOLARNET time

A total of 40 days (GREGOR) or 20 days (VTT) are available for SOLARNET observers in 2019. The observing time is assigned by the EAST TAC.

German time

(split 20%/20%/60% between the **AIP**, **MPS**, and KIS, leading to effective observing times of 15%/15%/45% of the total available time). Each institute has guaranteed observing time at GREGOR and VTT. KIS decided to open their observing time with no restriction on nationality/institute provided that at least one Co-I on the observing proposal is from KIS. Contact **tac@leibniz-kis.de** for more information.

Observing proposals to ground-based telescopes

- Two calls a year
- Service mode possible

Two Proposal Submission Deadlines

- 15 March 2019 for Session 1 (April 15 - June 30)
- 24 May 2019 for Session 2 (July 1 - 31 and September 15 - October 31)

1. Time windows available for 2019: April 15 - July 31 and September 15 - October 31.
2. For information on GST and BBSO, please visit http://bbso.njit.edu.
3. For instrument information feel free to contact Prof. Wenda Cao at wcao@bbso.njit.edu.
4. Final decision on telescope allocation for session 1 and session 2 will be made no later than April 5 and June 21, 2019, respectively, by the BBSO Telescope Allocation Committee (TAC). High priority may be given to PIs who produced good scientific results from previous observations, to proposals with scientifically challenging and achievable objectives, and to observing proposals involving coordinated observations with other observatories.

Make sure to submit your proposal before the deadlines.

Qualified internal and external applicants:

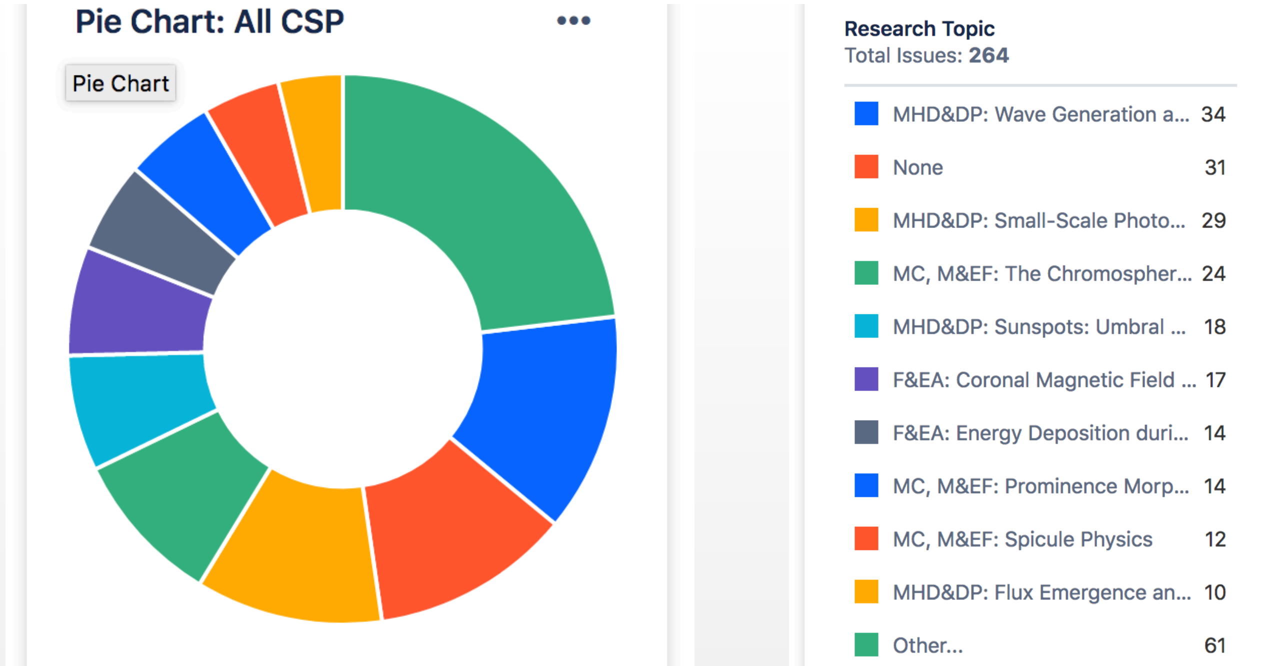
1. *Internal applicants* refers to the scientific staff residing at BBSO, scientists and students in NJIT's Center for Solar-Terrestrial Research, and BBSO partners.
2. *External applicants* refers to scientists and students from institutes or universities in the USA recognized by NSF or NASA.
3. The PI (principal investigator) must have a Ph.D. degree or be a Ph.D. student with the supervisor as the Co-I (co-investigator).

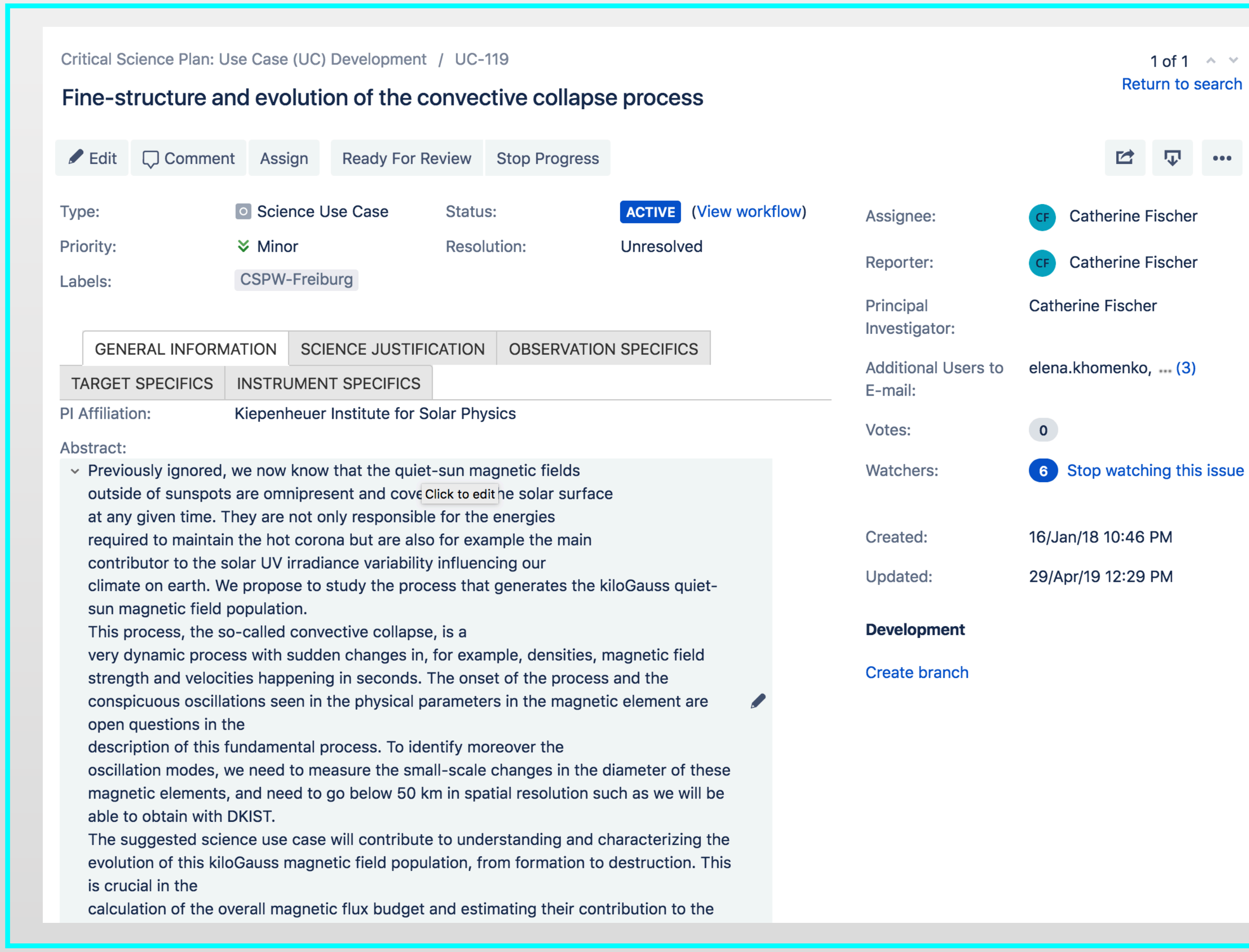
Observing proposals to ground-based telescopes

DKIST Critical Science Plan (CSP)

- Science Use Cases (S)UC submitted online, reviews by Science Working Group

- Calls in first phase, should be open





https://nso-atst.atlassian.net/secure/Dashboard.jspa

The Proposal - typical template

Science case

Observing strategy

Analysis strategy

Instrument specifics

+ Co-observing

Observing days are expensive!
Example GREGOR: Including all expenses also for maintenance 4451 Euro a day

Telescope time usually oversubscribed

Read the manuals.
Contact instrument team early on.

The Proposal - typical template

Science case

What will be observed, why new/important
Timeliness and impact, Why this telescope, why now?
Why is this work relevant to current state of the art?

Observing strategy

Target
Which lines for what purpose
Which Instruments (has to be possible and consistent)
Priorities

Analysis strategy

Codes used for analysis
Already similar analysis done before show results

Instrument specifics

Target, Duration,
wavelengthpoints, repetitions,
accumulations,

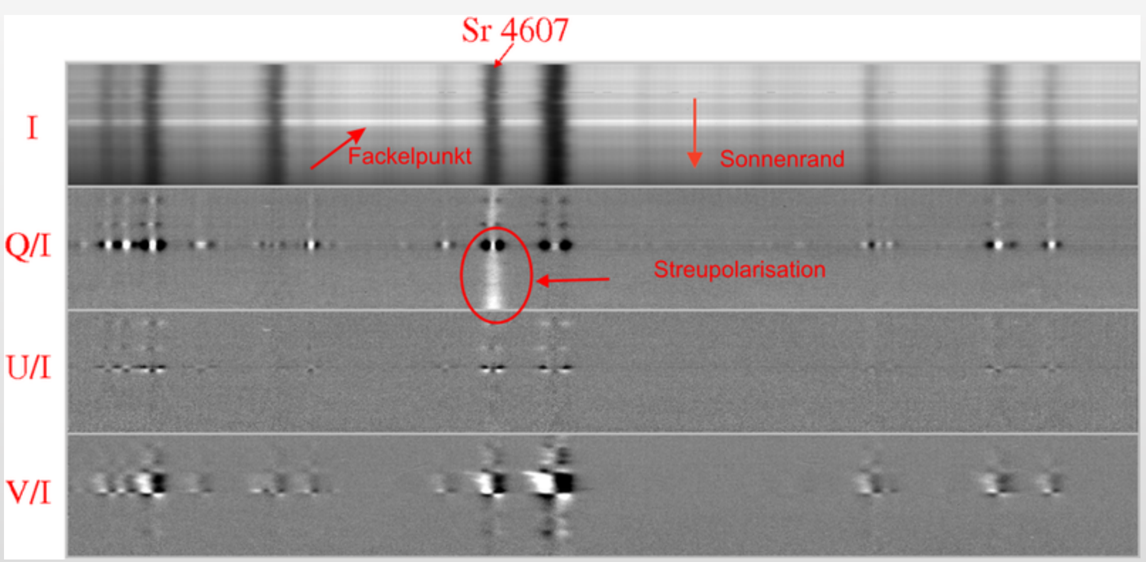
The Proposal - setting priorities

Starts with a clear science case: What questions do I want to answer? Be precise. What type of data would I want ideally? What is my priority?

Observations always trade-off between spatial, spectral, temporal wishes

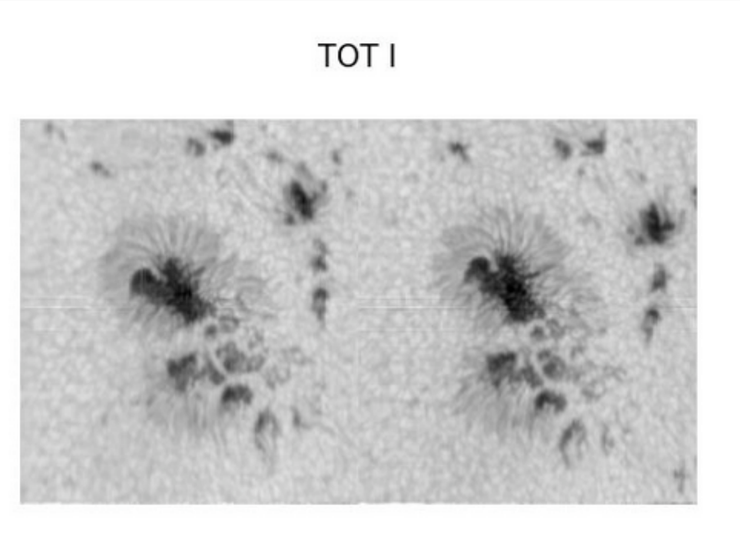
Taking data takes time and reaching a required S/N takes time.

Ex: ZIMPOL @ GREGOR pol. sensitivity of 10-4 however 1 minute total exposure



http://www.leibniz-kis.de/en/institute/pictures-of-the-month/single-view/first-observations-with-zimpol-at-gregor/

Ex: GRIS @ GREGOR polarimetric scan of sunspot 30 minutes

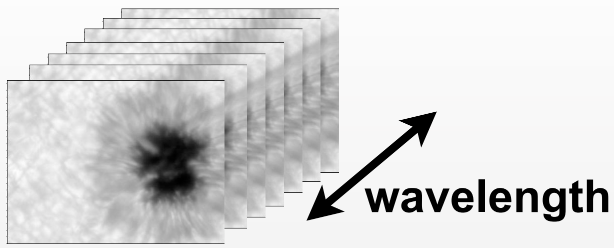


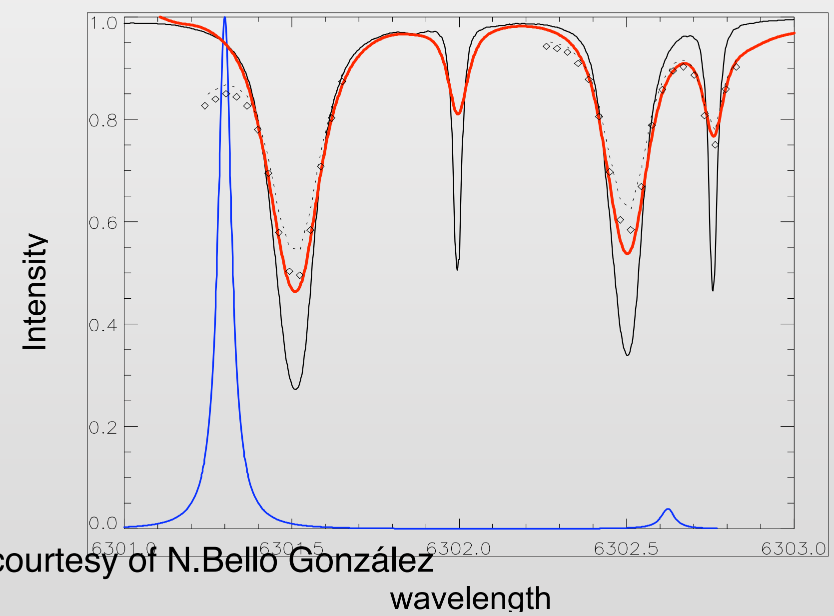
15sep15.001
1565 nm
08:10:06-09:07:18 UT
60.0 ms / 10 accum.
# of steps: 800
x/y-pos: -22'' / -499''

http://archive.leibniz-kis.de/pub/gris/web/2015/09/15/20150915.html

The Proposal - which instrument(s)?

2D spectro-polarimeters

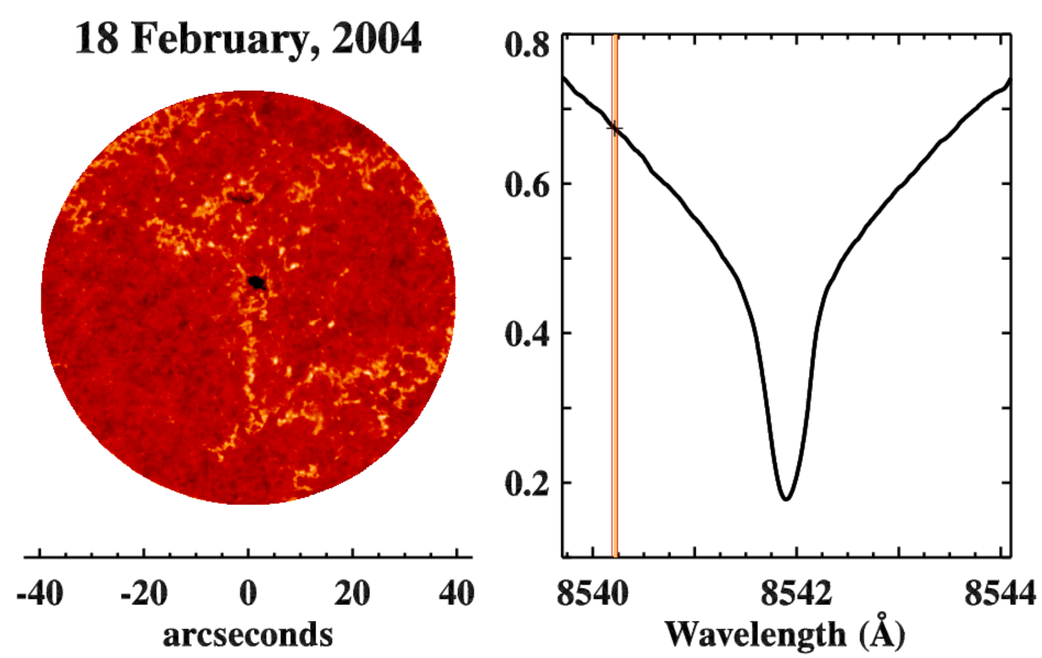




courtesy of N.Bello González

Large FOV at once (example GFPI at GREGOR 50 arcsec to 38 arcsec)

Need time to scan spectrally, few points (few tens of seconds), need to be faster than solar evolution (change in flows in the atmosphere, movement magn. elements)



IBIS webpage

Example: Timing equation VTF

$$T = \{[n_k \cdot (t_e + t_s) \cdot n_j + t_w] \cdot n_l + t_f\} \cdot n_f$$

Default values:

$n_k = 8$	(1 - 12, number of repetitions)
$n_j = 4$	(Fixed, polarization states)
$n_l = 12$	(9 - 15, depending on line)
$n_f = 1, 2, 3$	(Number of prefilters in obs. task)
$t_e = 25$ ms	(Exposure time)
$t_s = 8.4$ ms	(Modulator switch time)
$t_w = 33.4$ ms	(Etalon tuning time, =0, if n_l=1)
$t_f = 2000$ ms	(Prefilter change time, =0, if n_f=1)

Example: With 1 prefilter 12 wavelength positions and 8 repetitions: T = 13 s

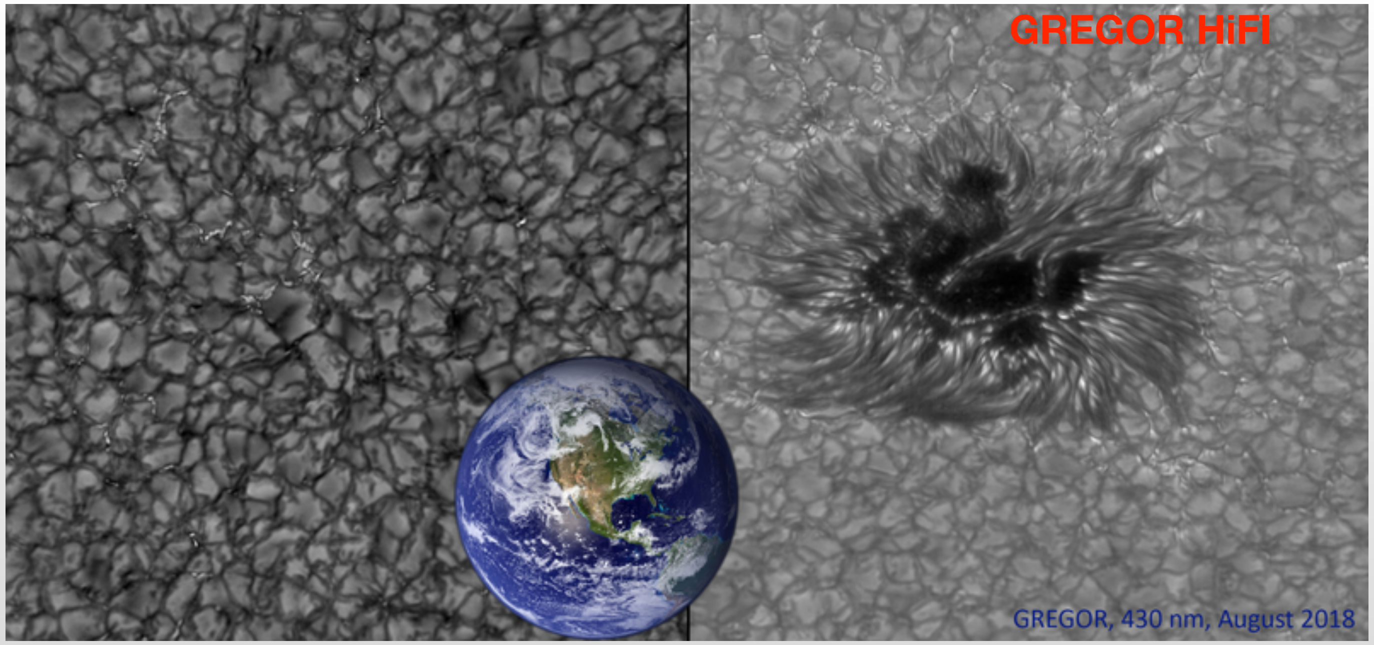
courtesy of Wolfgang Schmidt

Less to be fast
More for better SNR

Multi wavelength?

Can not really safe anything when reducing as frame camera 30 Hz

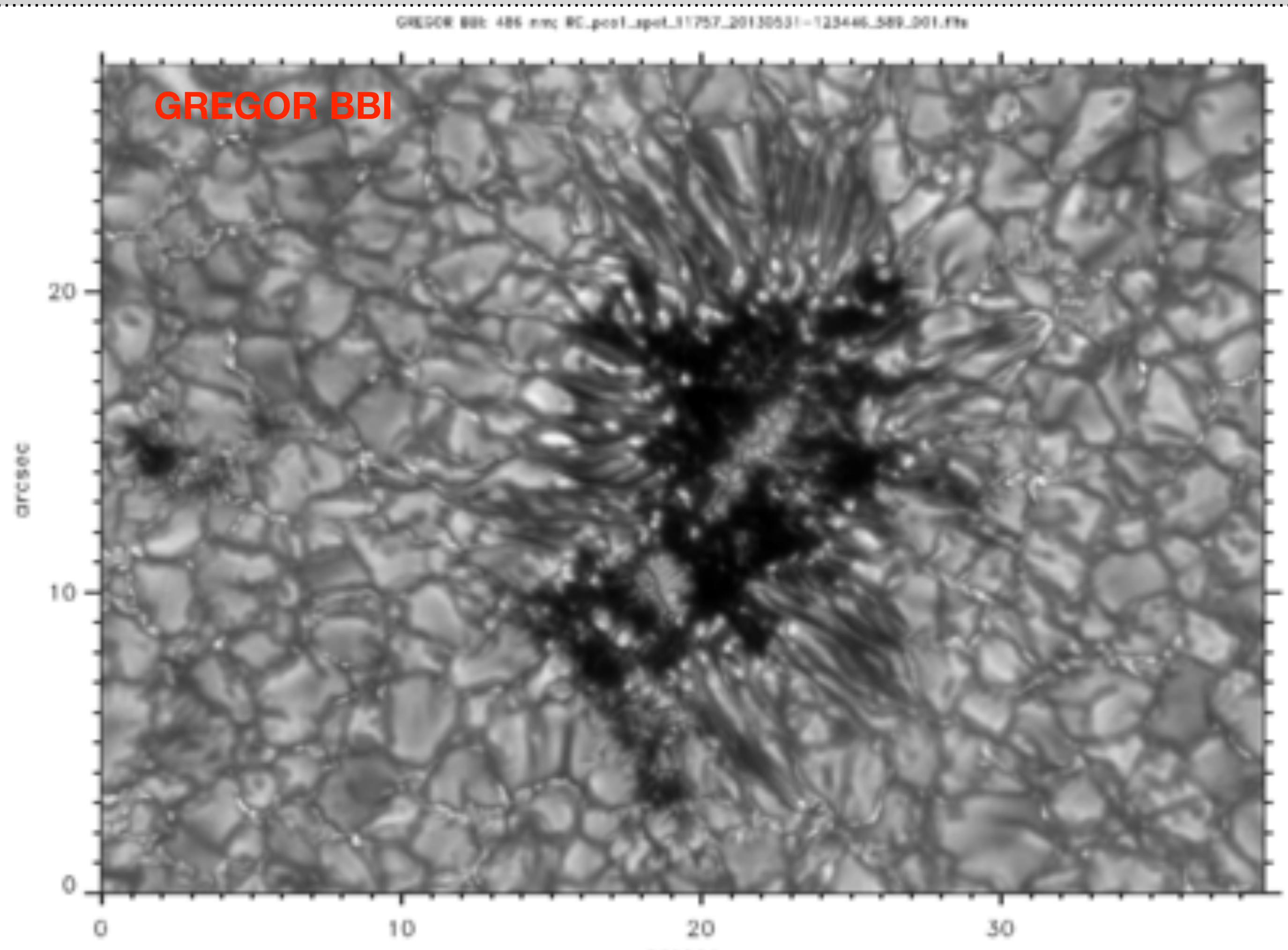
The Proposal - which instrument(s)?



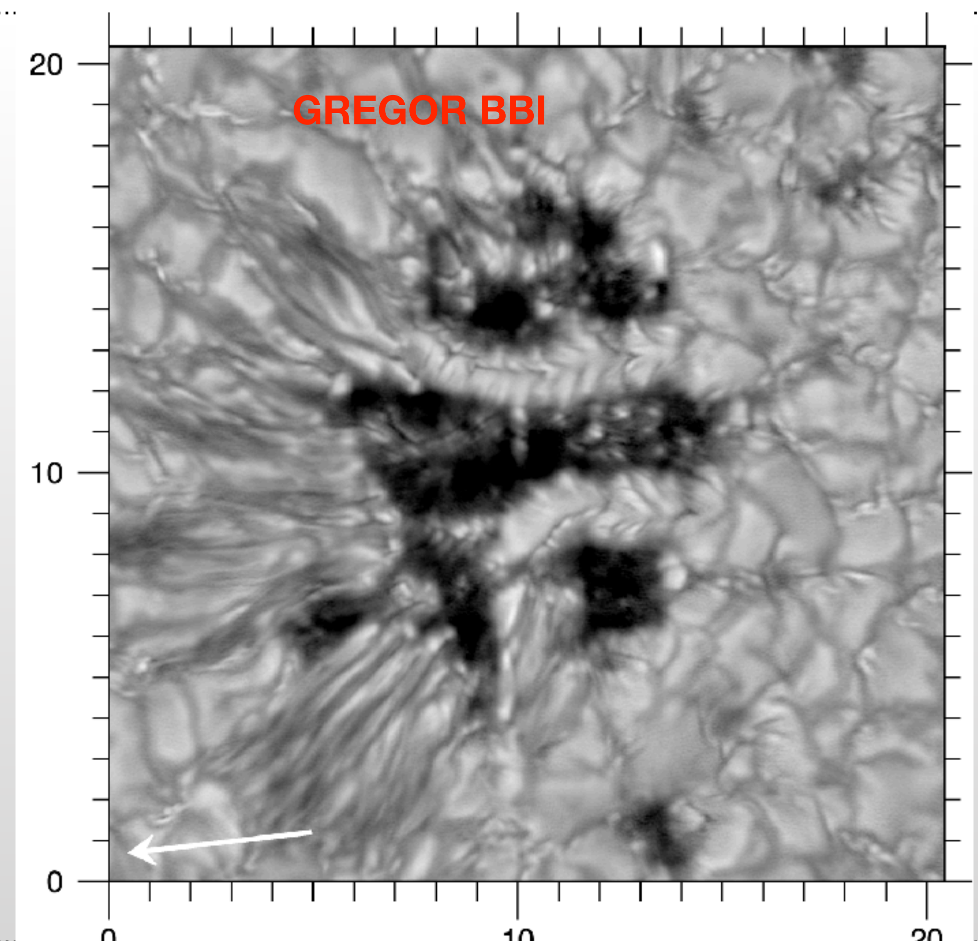
http://www.leibniz-kis.de/en/institute/pictures-of-the-month/single-view/gregor-the-sun-in-high-resolution/

Imaging: BBI, HiFI @ GREGOR
Large FOV
High spatial resolution
High cadence -fast
HiFI can be combined with GFPI/GRIS

*No spectroscopy
*No polarimetry

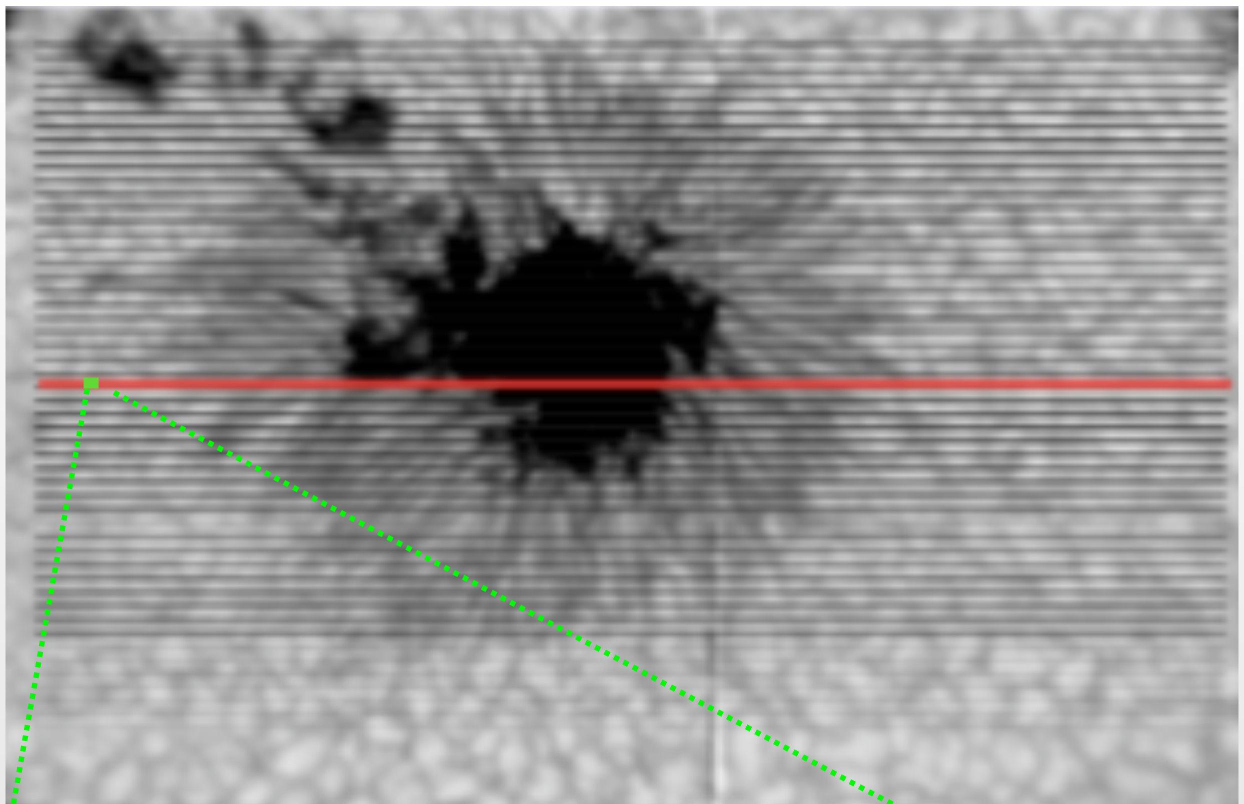


http://www.leibniz-kis.de/de/forschung/forschungsschwerpunkte/hochaufloesende-spektropolarimetrie/

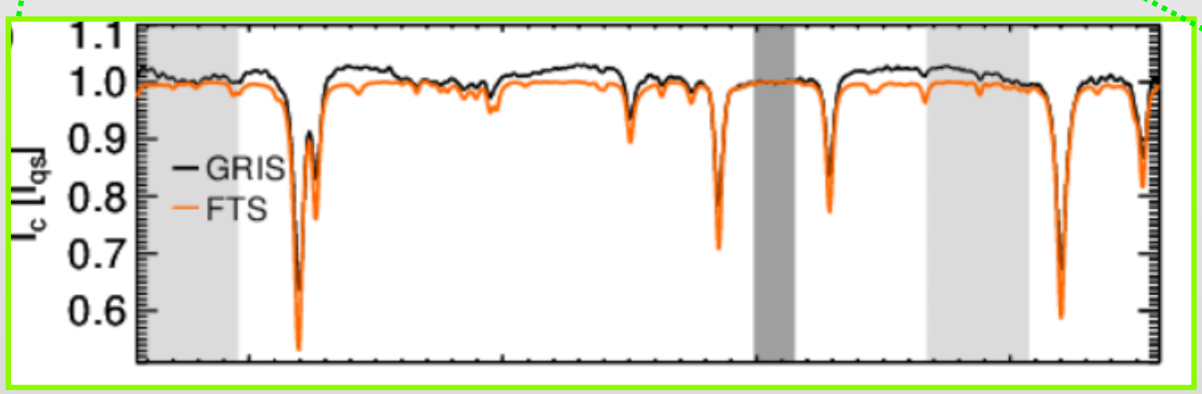


Schlichenmaier et al. (2016)

The Proposal - which instrument(s)?



GRIS manual

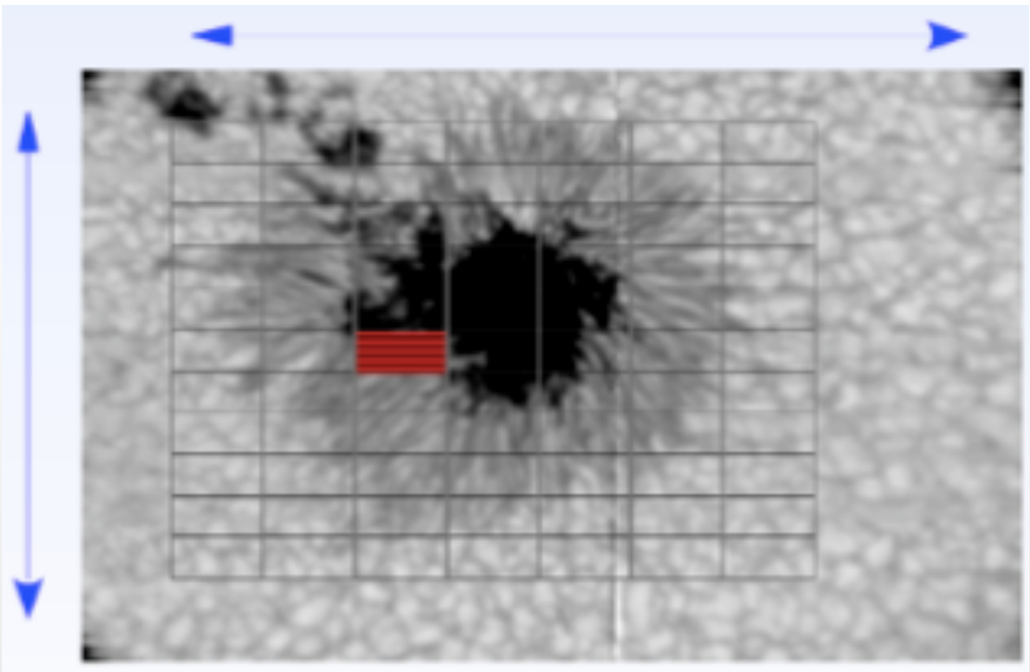


Franz et al. 2016

High spectral resolution

Only one spatial dimension
need time to scan spatially

The Proposal - which instrument(s)?



The scan time is given by:

```
T_scan=[4 * nac * (t_int + t_readout) + t_mov] * double_sampling * nv * nh
```

where,

- `nac` = accumulations
- `t_int` = Integration time
- `t_readout` = 30 ms
- `t_mov` = 700 ms approx.
- `double_sampling` = 1 for single, 2 for double sampling
- `nv` = Number of Vertical steps
- `nh` = Number of Horizontal steps

For example, a 3x3 scan, 10 accs. and 100 ms, would take:

```
T_scan=[4 * 10 * (0.1 + 0.03) + 0.7] * 2 * 3 * 3 = 106 s
```

GRIS IFU manual

NEW Integral field Unit (IFU)

Best of both worlds!

Can also build mosaic

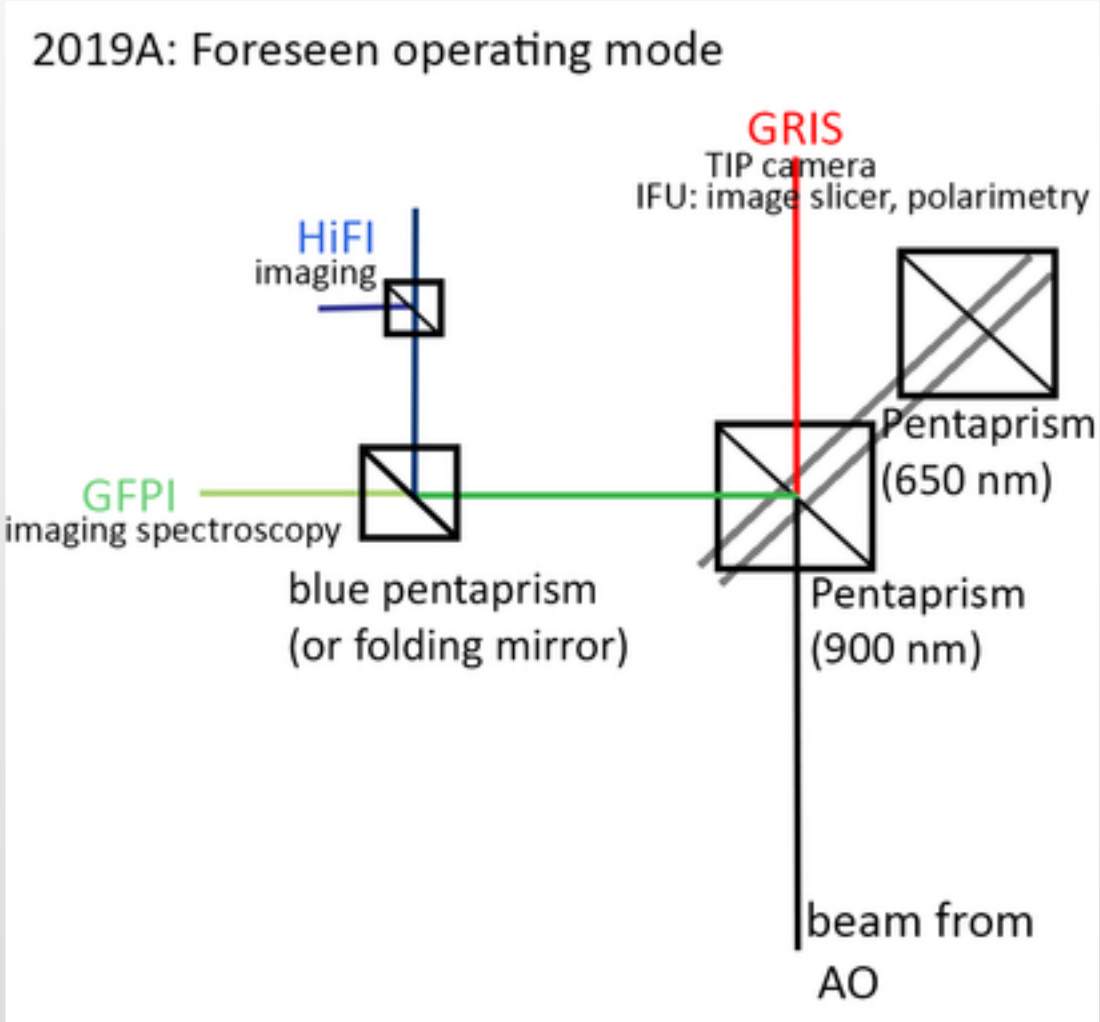
Combining instruments

- Clearly diagnostics should complement each other

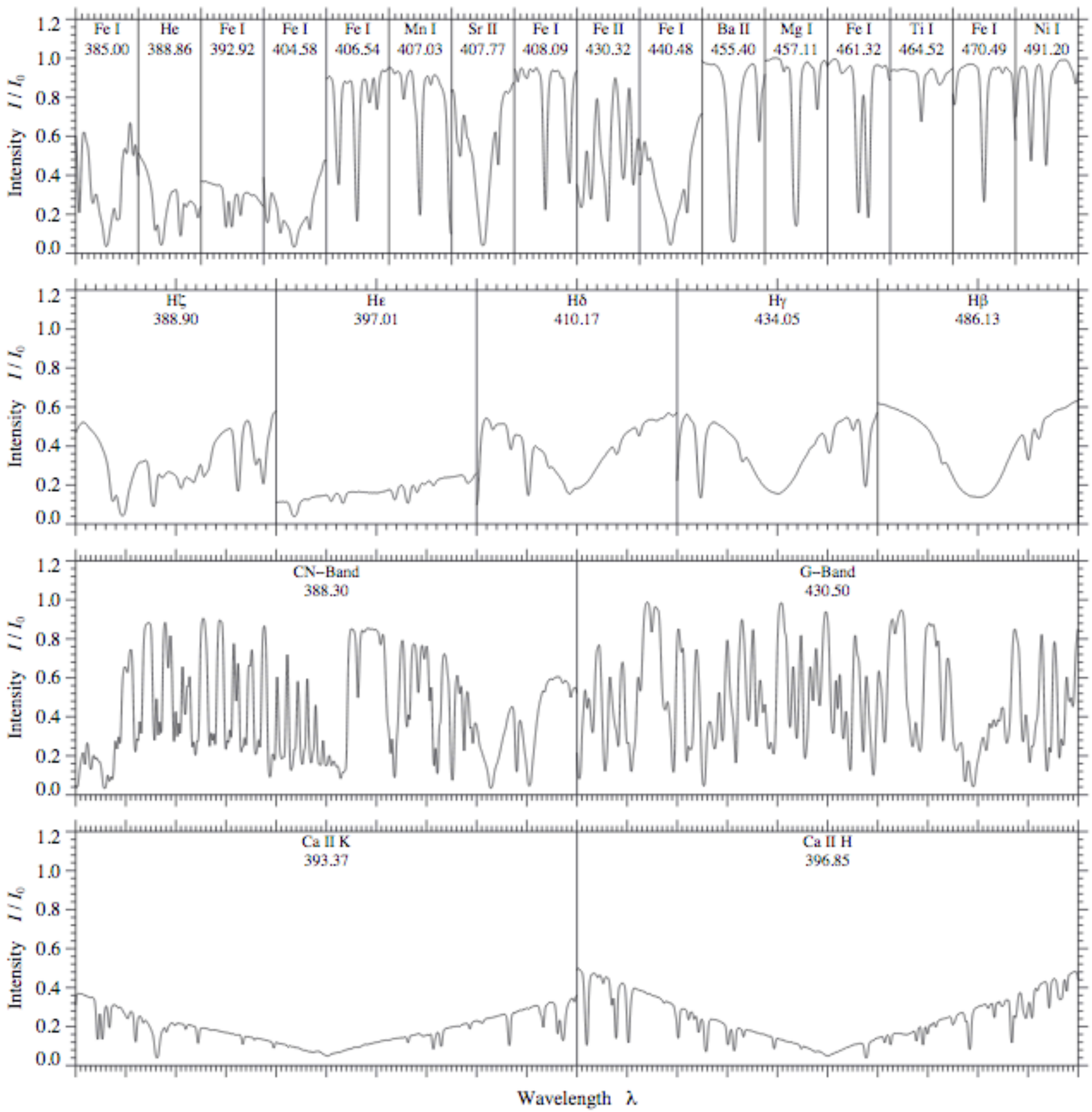
- Which wavelength in which instrument?
- Do I loose important diagnostics if I combine instruments? Example GREGOR GFPI/GRIS H-alpha, Ca IR

- What is my FOV overlapp? Timing of slit scan vs spectral scan?

Example GREGOR



Which spectral band, line(s)?



PuschmannarXiv:1207.2084v1 [astro-ph.IM]

- Formation layers? Information for several “heights”
- Magnetic sensitivity?

- Important: do I have the tools to analyse the line?

- Visible or Infrared?

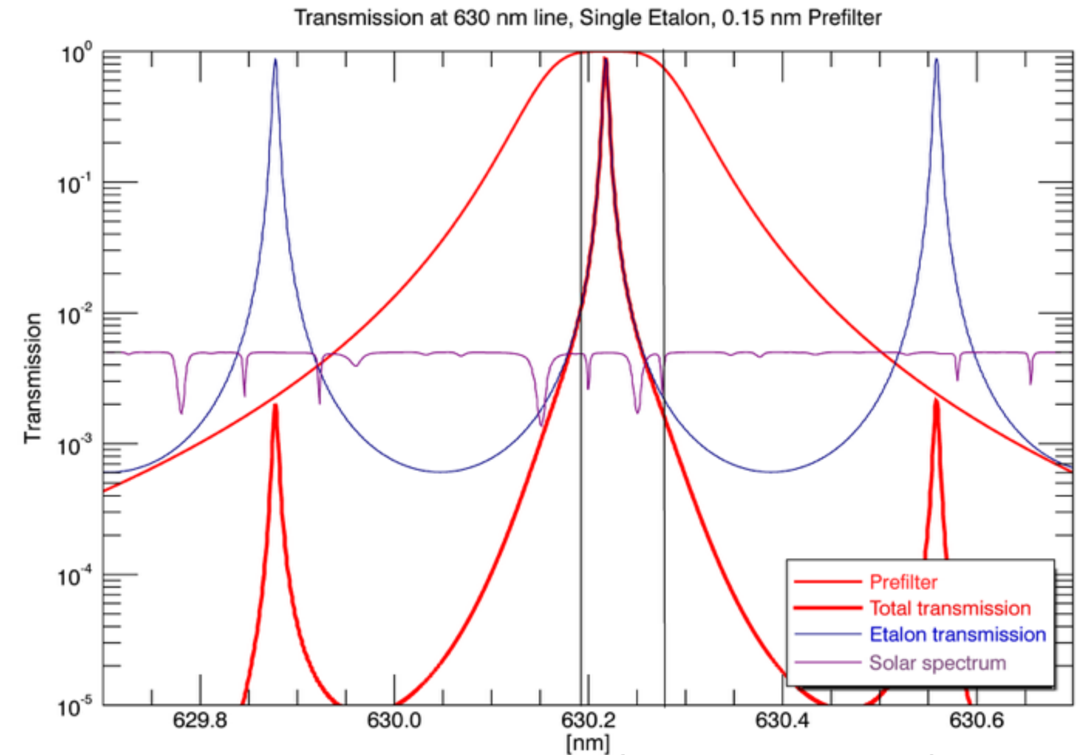
VIS: Lower diffraction limit

IR: Increased magnetic resolution (splitting/broadening)

- splitting with lambda^2
- doppler broadening with lambda

- Are the required filters available?

Critical spectral sampling



Courtesy of W. Schmidt

FPI:
Usually prefilter (several) Angstrom FWHM
(several) Etalons
-> Total transmission curve

Spectral resolution

$$R = \frac{\lambda}{\Delta\lambda}$$

Example IBIS/DST R=212 000 - 274 000

Example GFPI
Dual Etalon achieved spectral resolution

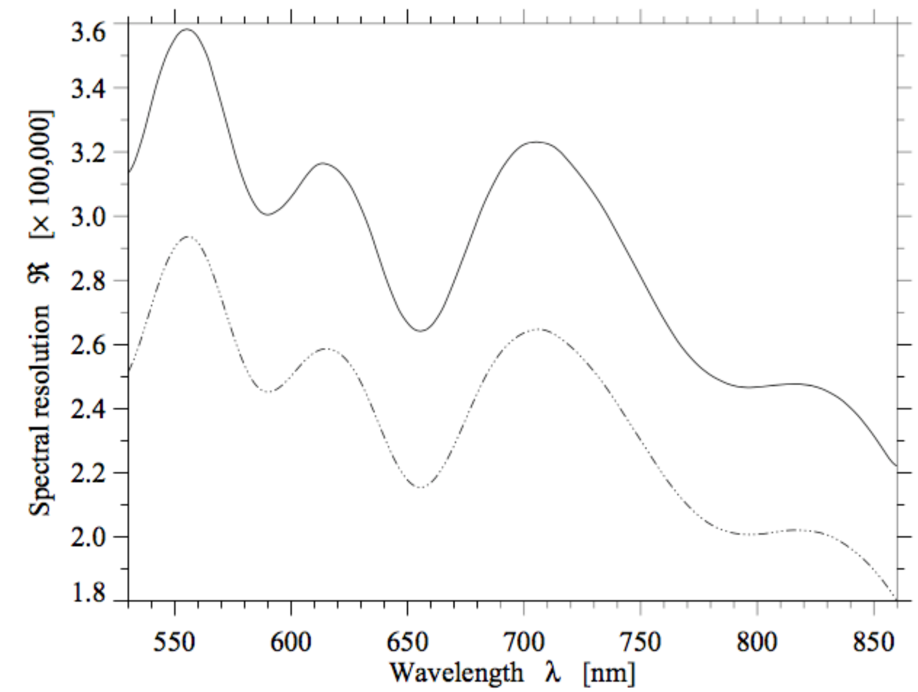


Fig. 12 Spectral resolution $\mathcal{R}$ as a function of wavelength λ based on the FWHM (solid) and equivalent width (dash-dotted) of the dual-etalon system.

PuschmannarXiv:1207.2084v1 [astro-ph.IM]

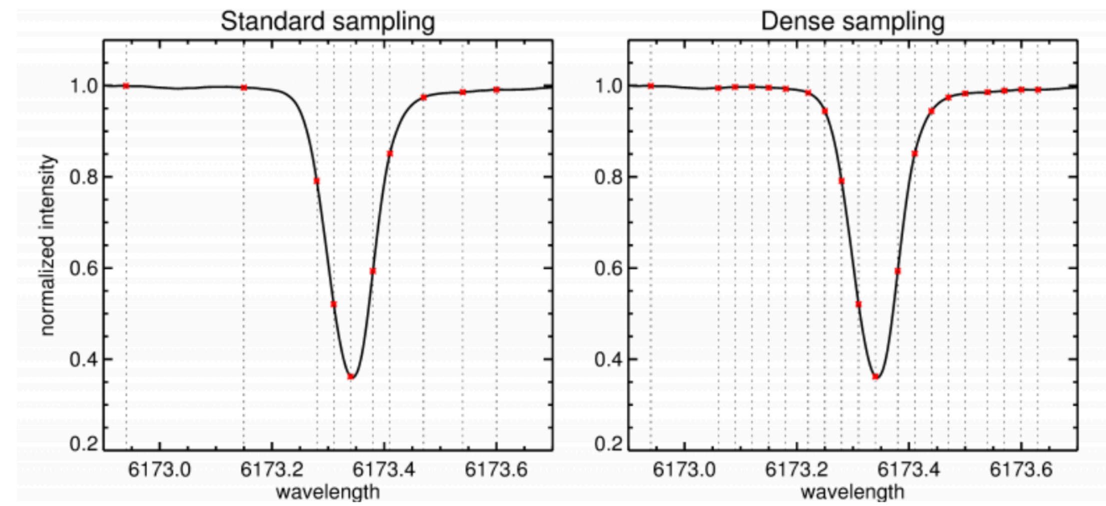
Ex.: lambda sampling IBIS/DST (past)

- Continuum point
- Core well enough sampled
- Wing in chromospheric lines
  ->additional photospheric information

FeI 6173:

Standard sampling: 6172.94, 6173.15, 6173.28, 6173.31, 6173.34, 6173.38, 6173.41, 6173.47, 6173.54, 6173.60.

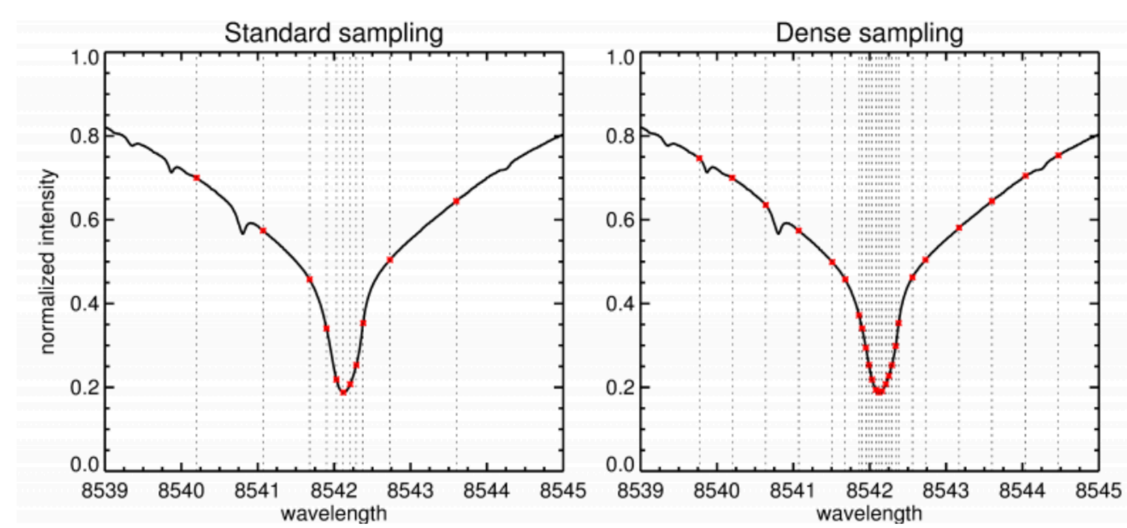
Dense sampling: 6172.94, 6173.06, 6173.09, 6173.12, 6173.15, 6173.18, 6173.22, 6173.25, 6173.28, 6173.31, 6173.34, 6173.38, 6173.41, 6173.44, 6173.47, 6173.50, 6173.54, 6173.57, 6173.60, 6173.63.



CaII 8542:

Standard sampling: 8540.20, 8541.07, 8541.68, 8541.90, 8542.03, 8542.12, 8542.21, 8542.29, 8542.38, 8542.73, 8543.60.

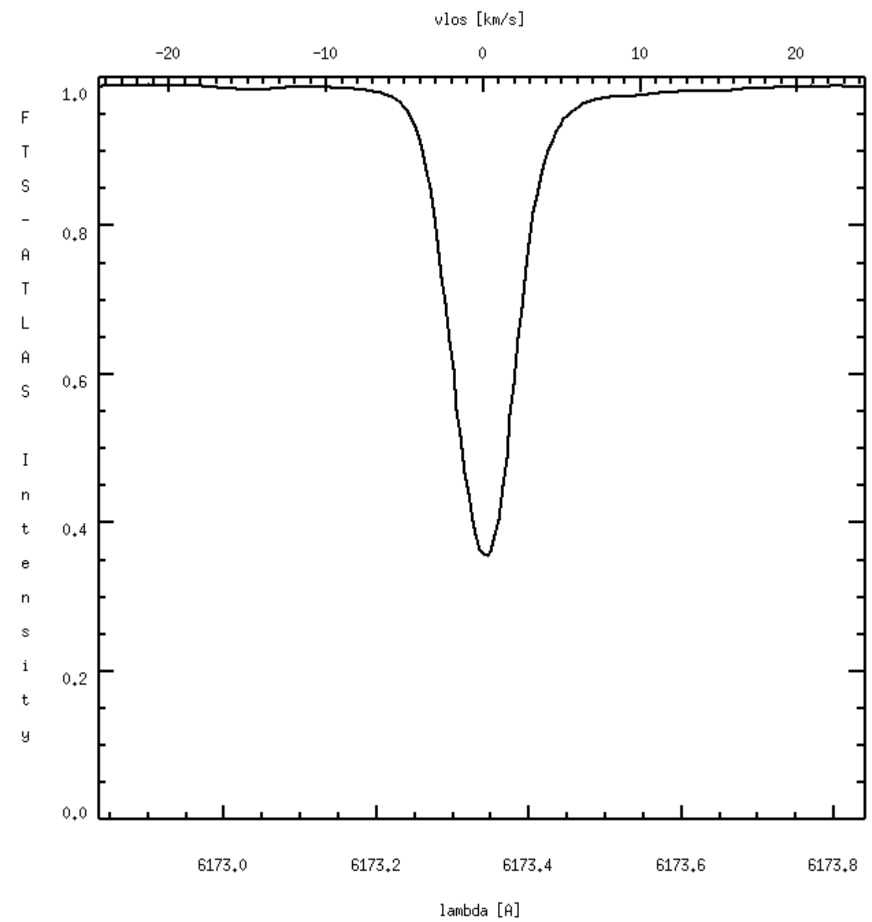
Dense sampling: 8539.77, 8540.20, 8540.64, 8541.07, 8541.51, 8541.68, 8541.86, 8541.90, 8541.95, 8541.99, 8542.03, 8542.08, 8542.12, 8542.16, 8542.21, 8542.25, 8542.29, 8542.34, 8542.38, 8542.56, 8542.73, 8543.17, 8543.60, 8544.04, 8544.47.

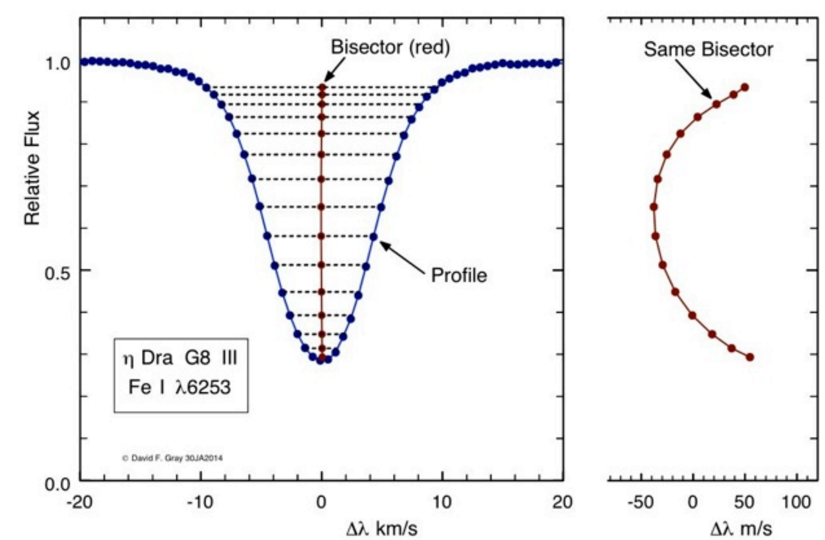


Spectral line shapes

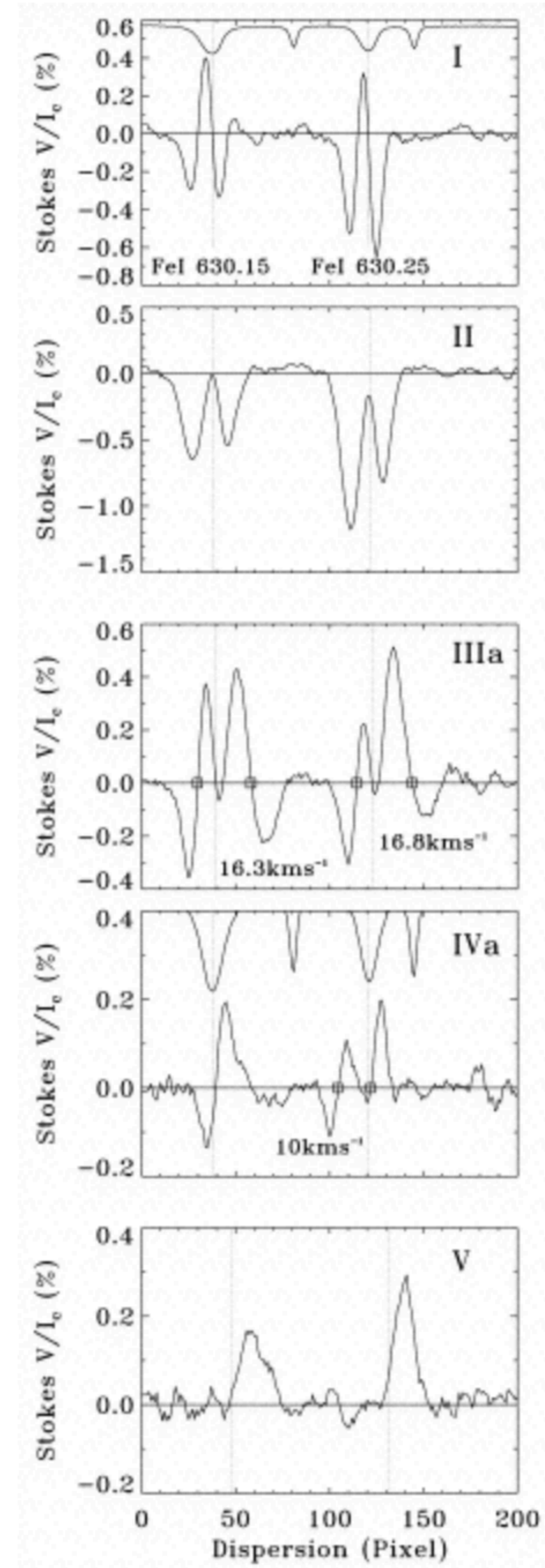
When choosing range and wavelength points need to be aware of line shift/shapes, check atlas and/or synthesize line before hand:

- High speeds?
- Also magnetic shifts -> infrared can be quite large in sunspots
- Bisector analysis?
- Unusual, asymmetric Stokes profiles?





http://astro.uwo.ca/~dfgray/Granulation.html



Sigwarth et al. 2001

Sample VTF Observational requirements

Magnetic flux emergence and disappearance

Science: Magnetic flux constantly emerges from the solar surface at different scales. It is crucial to understand the rate at which the magnetic flux emerges, interacts with opposite polarity and consequently dissipates, is expunged or submerged back into the sun. We need to understand the distribution of the magnetic field properties at emergence (strength, orientation, net unsigned flux), its content in active and quiet regions and their solar cycle dependence, and the plasma flows associated with the field. These observations will help develop understanding the rates at which the magnetic flux rises from buoyancy and by advection, how the magnetic field coalesces to the ubiquitous "kilo-gauss" style flux tubes and how the flux cancellation process takes place.

Observational Requirements: Spatial resolution of 35 km at the solar surface; Doppler velocity resolution of 75-150 m/s at the sun for bisector analysis; spectral resolution 3 pm. Different photospheric and chromospheric spectral lines to span a range of heights; Polarization calibrated LOS magnetograms for field-strengths in the range of 20-2000 G, Transverse magnetic fields > 50 G ; FOV 30 > arcseconds.

Magneto-convection in Sunspots

Science: Sunspots are the largest and highest field strength magnetic structures visible in the The core magnetic fields of the sunspot umbra are now known to be highly structured formations with convection-like elements. Sometimes, light bridges appear within the umbra, they are thought to demarcate fracture lines along which sunspots eventually break up. Umbrae are surrounded by the filamentary penumbral magnetic fibrils, where dynamic flows and variations of angles within the penumbra are modulated by the local thermodynamics. Particularly in the case of the penumbra, we are yet to develop a clear model of how sunspots form, evolve, and disperse. Dark cores in penumbral filaments also remain unexplained. As with the magneto-convective flows in the photosphere, important insights about sunspot structures have come from MHD numerical simulations. Using the VTF we can address observational questions such as: What is the origin and dynamics of umbral dots? What mechanisms can trigger and sustain umbral and penumbral oscillations? What is the size distribution of penumbral filaments? What drives the photospheric and chromospheric Evershed flows? How are they linked?

Observational Requirements: Spatial resolution: 35 km on the sun; Temporal Resolution: 10-30 seconds; Temporal coverage: > 0.5 hours, continuously; Spectral Resolution > 150,000; Polarimetric accuracy: 10-2; FOV 1 arcminute; wavelength band: nonmagnetic line 557.6 nm, or 709.0 nm. *Multi-instrument mode:* VTF operated simultaneously with other spectroscopic instruments, covering the following spectral lines: MgI 517.2, FeI 557.6 nm, FeI 569.1 nm, HI 656.2 nm, NaI 587.6nm, nm, CaI 854.2 nm, FeI 868.8;

Exampels from VTF Science Requirement Document

Co-Observing with satellites

Need to get in contact very early (ideally months before)

Coordination in Space and Time is tricky.
Things to think about for example:
Tracking on? How will my region move
Slit scanning: Which solar direction is slit placed? Which way scanned?

During run need to take care of communication….

```
Please let IRIS planner ( iris_planner@lmsal.com ) confirm/know
your target information (QS disk center, OBS ID = 3600106829, tracking ?)
and observing duration, e.g., 12-17 UT.

Our deadline is:

- 15 UT on Thursday (tomorrow) for Friday observation
- 15 UT on Friday for this weekend observation from Saturday to Monday
- 15 UT on Monday for Tuesday obs.
- ...
```

Example "IHOP"

IRIS + Hinode Operation Plan (IHOP) Submission

Comments or questions about this form should be directed toward
Sabrina . Savage (at) nasa . gov.

* Erforderlich

E-Mail-Adresse *

Ihre E-Mail-Adresse

Submission Guidance & Helpful Links

Planning for Hinode operations is performed on a three month cycle that is updated monthly. At the end of every month a monthly meeting is held to confirm the observations for the coming month and to lay out the broad objectives for the second and third months.

The cut-off for consideration is the 14th day of each month. For example, requests for observations received between the 15th of June and the 14th of July will be presented and discussed at the monthly meeting held at the end of July.

It is recommended that proposers make their submissions as early as possible, so that the Science Schedule Coordinators (SSCs) have time to refine the proposals to fit the current Hinode situation.

Late submissions may be considered only exceptionally, if scheduling conflicts can be easily resolved in the operation planning meetings.

For more detailed information, refer to the following:

http://www.isas.jaxa.jp/home/solar/guidance/index.html

http://hinode.msfc.nasa.gov/hops.html

Title of Proposed Observation *

Meine Antwort

Proposer name[s] *

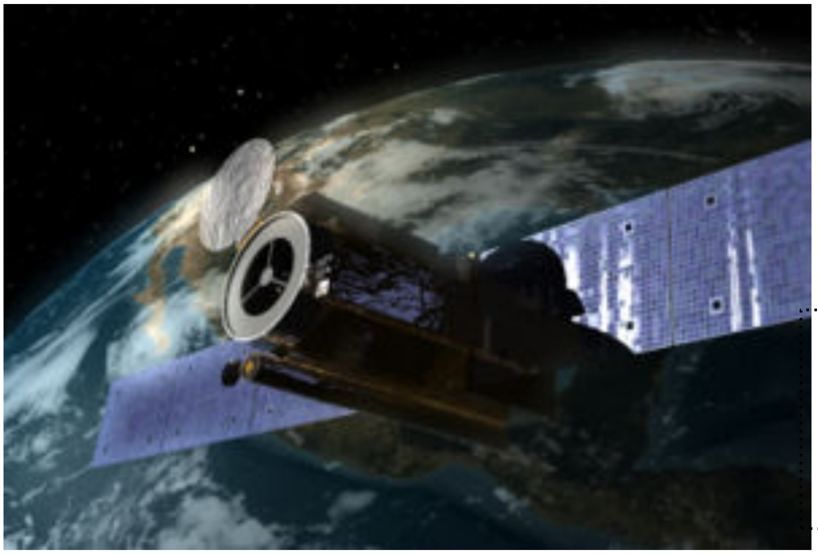
List primary proposer name first. Provide given name first.

Meine Antwort

Proposer email[s] *

List primary proposer email first. (The email required above is for submission form correspondence.)

https://docs.google.com/forms/d/e/1FAIpQLSeQ0I38aMvCXFD-MJu_JXl-ek-cV2qcAy6AI6hWgAHyGGNXNQ/viewform



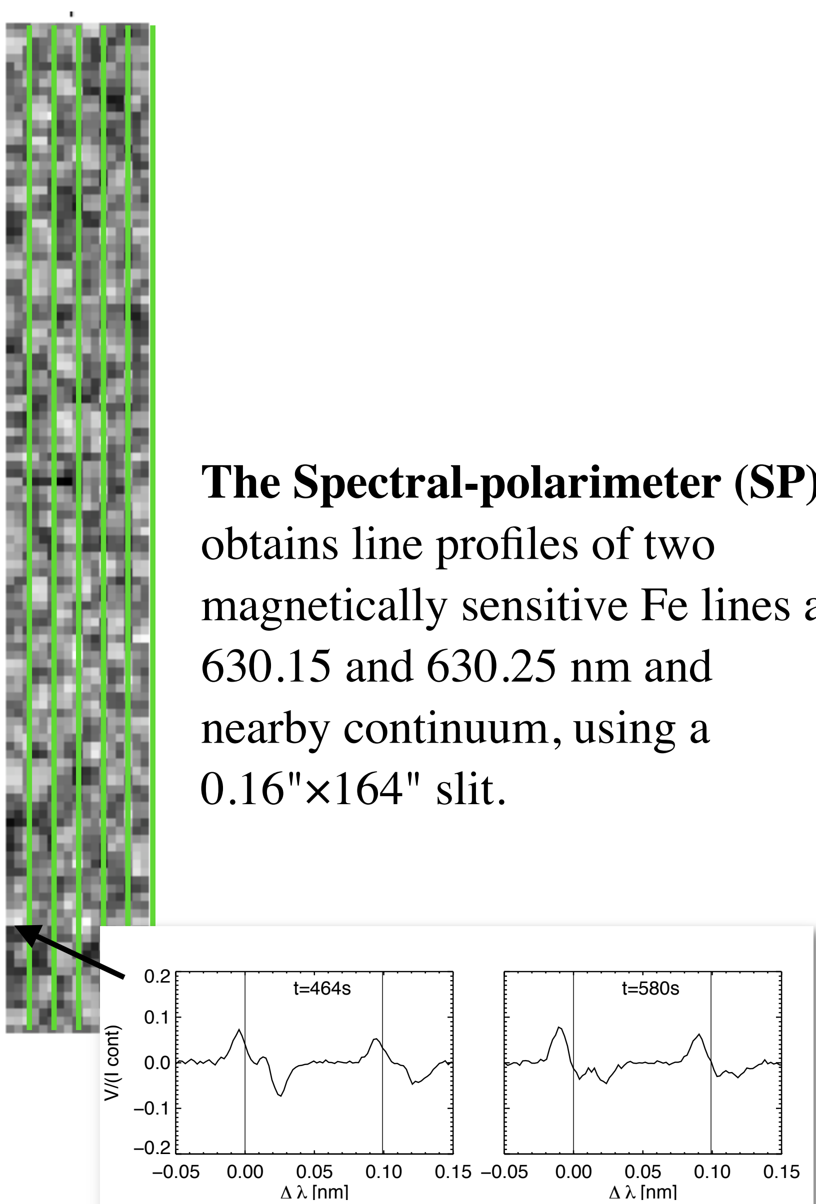
From NASA

Hinode

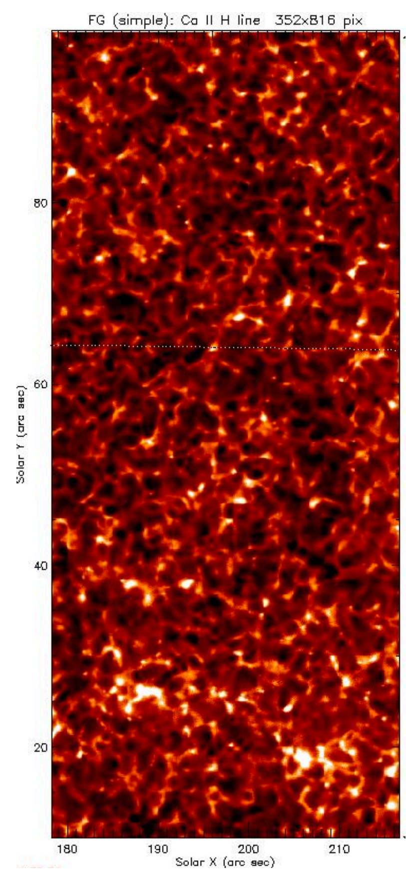
Launch date: 23-September-2006
Orbit: polar Sun synchronous,
altitude = 600 km
inclination = 97.9
Eclipse season: mid-May - August
Nominal mission lifetime = 3 years

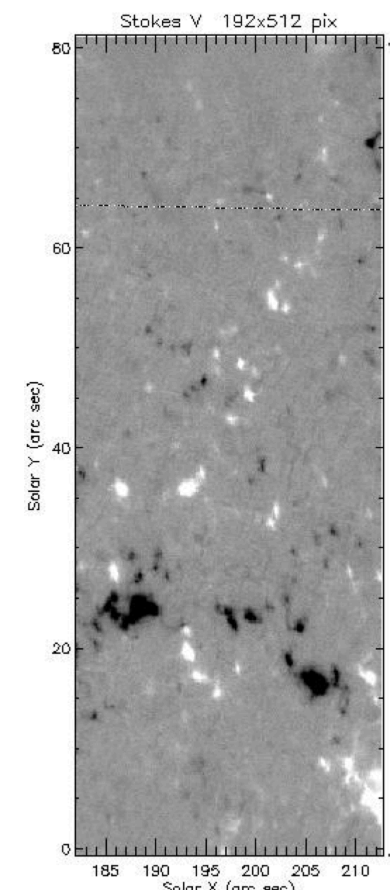
Hinode is a Japanese/US/UK mission designed to investigate the Sun's generation of magnetic field, heating of the outer atmosphere, and initiation of flares and mass ejections.
SOT EIS XRT

SOT-Solar optical Telescope



The Spectral-polarimeter (SP) obtains line profiles of two magnetically sensitive Fe lines at 630.15 and 630.25 nm and nearby continuum, using a 0.16"×164" slit.





The Broadband Filter Imager till Feb. 2015

* 6 bands (CN band, Ca II H line, G band, and 3 continuum bands)
0.0541 arcsec/pixel
* 218" × 109" FOV.

The Narrowband Filter Imager till Feb. 2015
* intensity, Doppler, and full Stokes polarimetric imaging
* 0.08 arcsec/pixel
* 10 lines spanning the photosphere to the lower chrom.
* 328" × 164"FOV

Hinode

Science ready...but be aware

Data sometimes corrupted during download -> Large FOV with 0 pixel value.

http://www.uni-graz.at/~temmerma/hinode.html

- Partial eclipse mid-May until August - all instruments suffer due to atmospheric absorption effects (jitter, focus troubles, ...).
  Be careful when analyzing data from this period. E.g. SOT might be 0.2-0.6" out of focus during ecplise season.
- SOT/BFI experienced chromatic aberration (vacuum focus turned out to be different from air focus in the lab):0.3-0.4" for particular wavelengtht.
- Do not use SOT Fe I 630.25 nm line for magnetograms (use Sodium instead).
- SOT/NFI has air-bubbles or oil bubbles in filter: a slow tuning of the filter is needed to keep bubbles out of FoV;
  quick switch between major wavelength regimes might cause the bubbles to move;
- H-alpha filter has troubles with tuning (4° too cold); granulation is seen in the center; wings are ok.
  This happened after the eclipse season, hence, differences in the data from 2006 and 2007 are seen.
- SOT G-band may have large slots of zeros (black blocks in images).
- There is a significant shift between SOT G-band and Ca images
- There is an offset between SOT and XRT of 0.6-1"
- XRT bakeout caused spots on the CCD.
- Offset between EIS CCD-A and CCD-B (x=2px, y=15-20px).
- Cross calibration between EIS and XRT is difficult.
- EIS has a lot of blended lines which are not useful for studies, and the degree of blending changes with the solar conditions.

Many ways to get Hinode data…

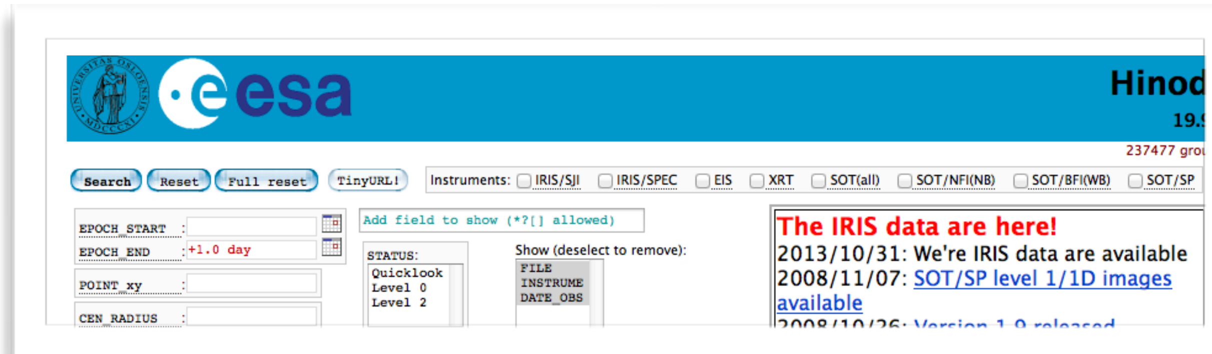
Hinode SDC (Science Data Center)

http://sdc.uio.no/search/form

Quick look

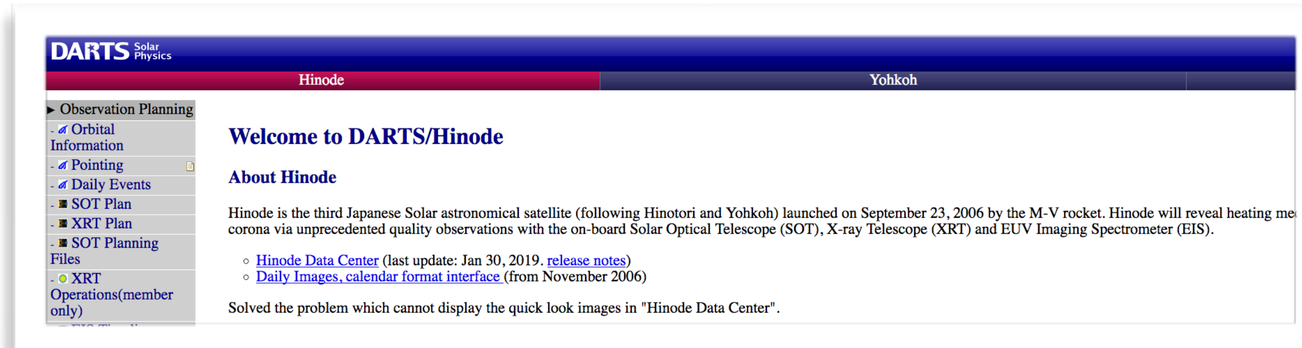
IRIS data

keywords display



Hinode DARTS archive, NAOJ

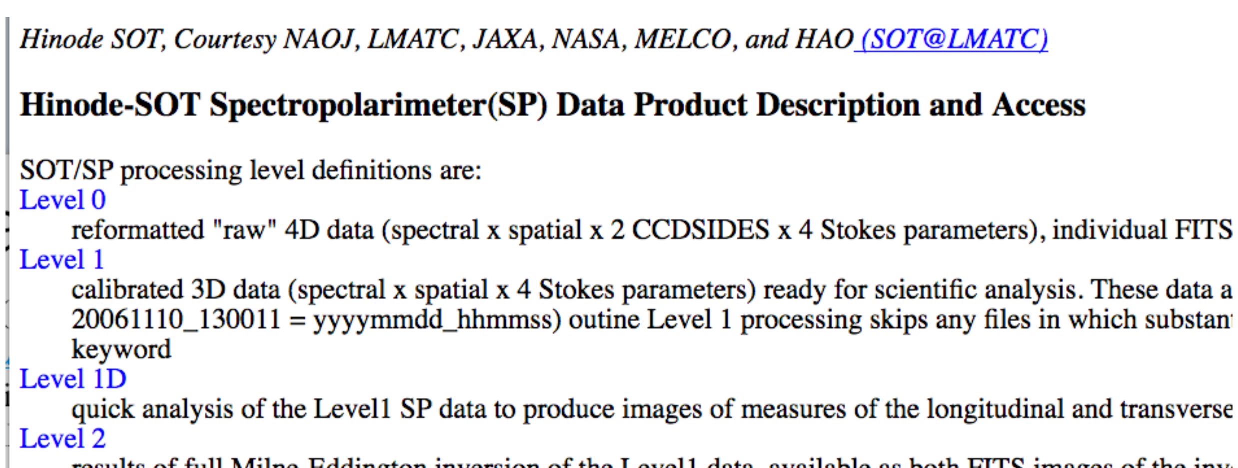
https://darts.isas.jaxa.jp/solar/hinode/



Hinode EIS Archive (MSSL, UK) and so on...

Tip: Hinode SP level1 +level2 (Inversions) at LMSAL

http://sot.lmsal.com/data/sot/level1d/



Hinode SOT, Courtesy NAOJ, LMATC, JAXA, NASA, MELCO, and HAO (SOT@LMATC)

Hinode-SOT Spectropolarimeter(SP) Data Product Description and Access

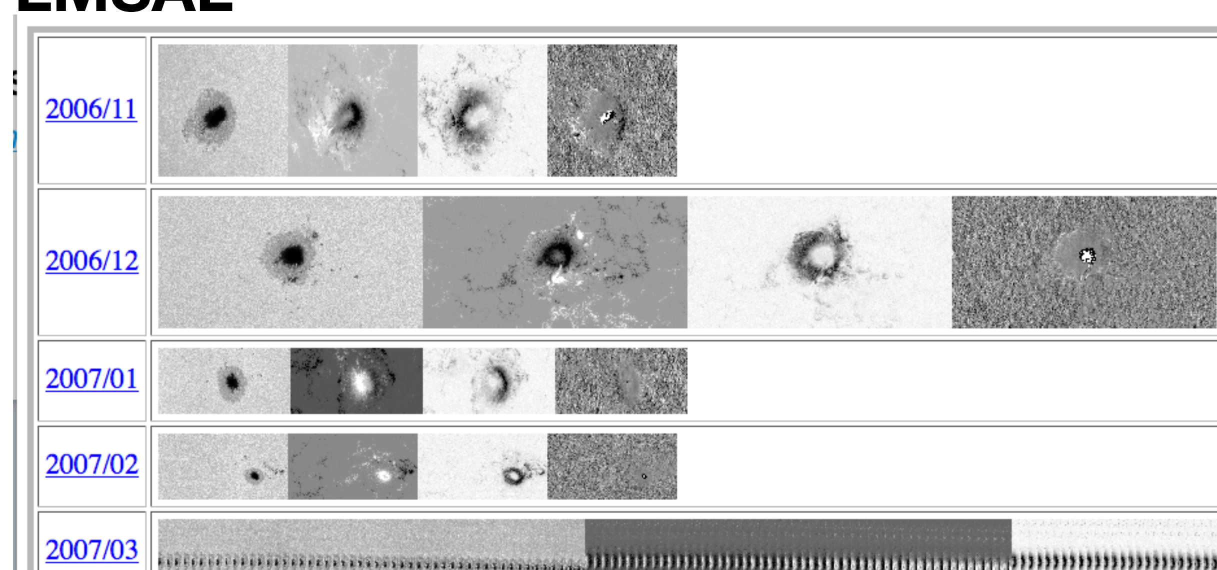
SOT/SP processing level definitions are:

Level 0
: reformatted "raw" 4D data (spectral x spatial x 2 CCDSIDES x 4 Stokes parameters), individual FITS

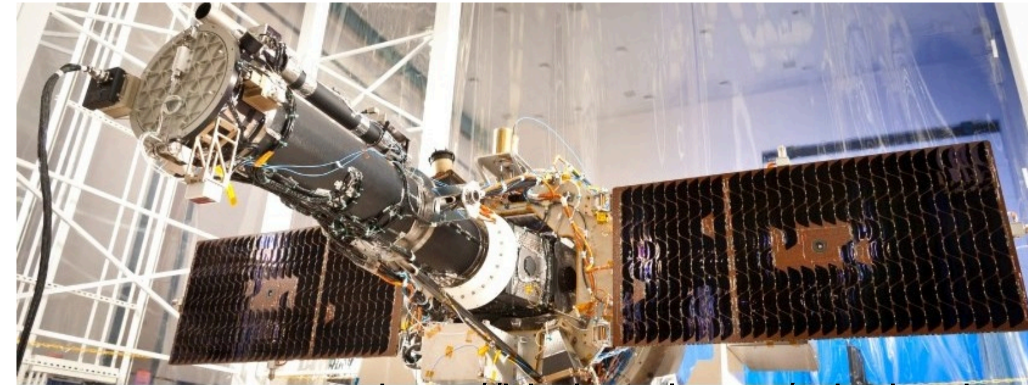
Level 1
: calibrated 3D data (spectral x spatial x 4 Stokes parameters) ready for scientific analysis. These data a 20061110_130011 = yyyymmdd_hhmmss) outine Level 1 processing skips any files in which substan keyword

Level 1D
: quick analysis of the Level1 SP data to produce images of measures of the longitudinal and transverse

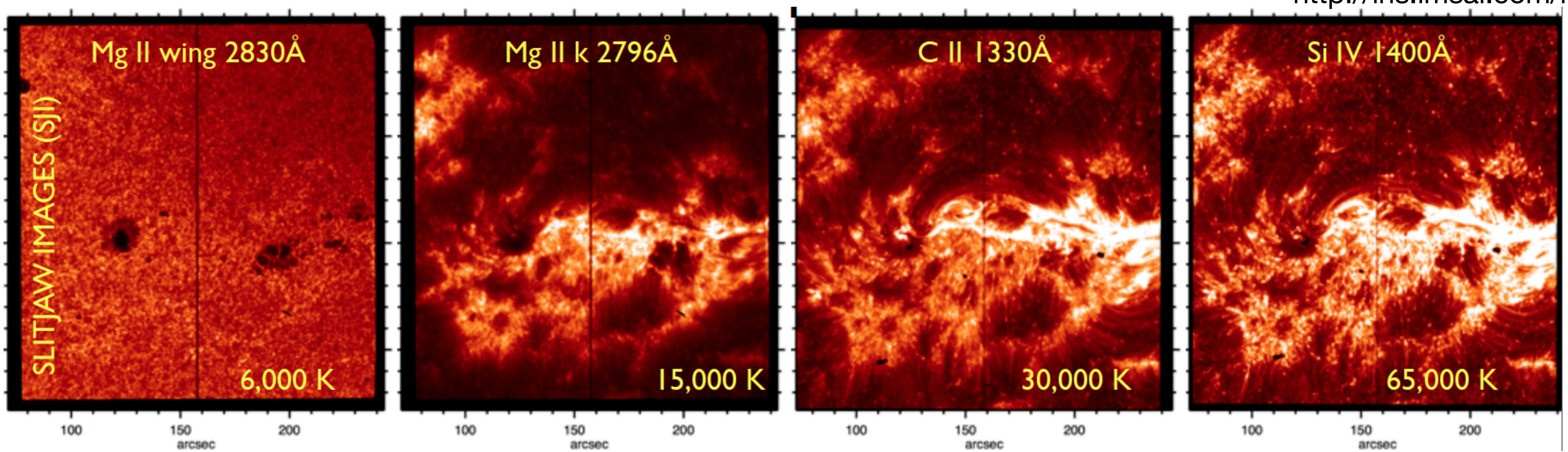
Level 2
: results of full Milne-Eddington inversion of the Level1 data, available as both FITS images of the inv



IRIS Interface Region Imaging Spectrograph



http://iris.lmsal.com/mission.html



IRIS talk at SOLAR-C meeting B. de Pontieu

conversion T ⇒ log T

6000	10000	20000	30000	65000
3.78	4.00	4.30	4.48	4.81

Ion	Wavelength [Å]	Dispersion [mÅ pix^{-1}]	Log T [log K]	Passband	CEB
Mg II wing	2820	25.46	3.7-3.9	NUV	2
O I	1355.6	12.98	3.8	FUV 1	1
Mg II h	2803.5	25.46	4.0	NUV	2
Mg II k	2796.4	25.46	4.0	NUV	2
C II	1334.5	12.98	4.3	FUV 1	1
C II	1335.7	12.98	4.3	FUV 1	1
Si IV	1402.8	12.72	4.8	FUV 2	1
Si IV	1393.8	12.72	4.8	FUV 2	1
O IV	1399.8	12.72	5.2	FUV 2	1
O IV	1401.2	12.72	5.2	FUV 2	1
Fe XII	1349.4	12.98	6.2	FUV 1	1
Fe XXI	1354.1	12.98	7.0	FUV 1	1

B. de Pontieu et al., 2014

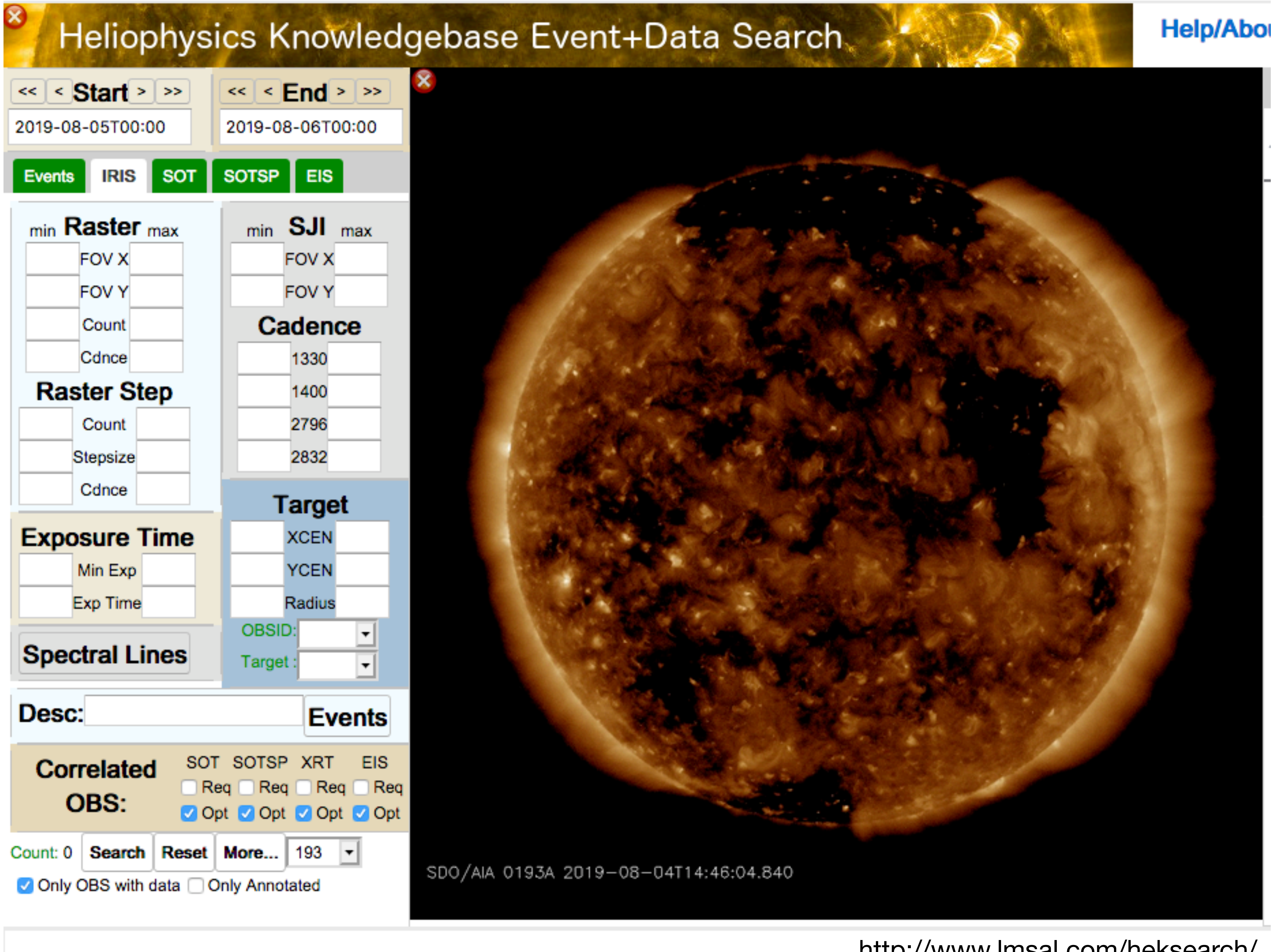
Spectrograph (SG): passing through a slit that is 0.33 arcsec wide and 175 arcsec long, onto a grating that is sensitive in both FUV and NUV passbands, then onto 3 CCDs to produce spectra in three passbands

Slitjaw

FOV 175x175 arcsec^2

Pixelsize 0.166 arcsec

IRIS - Data



http://www.lmsal.com/heksearch/

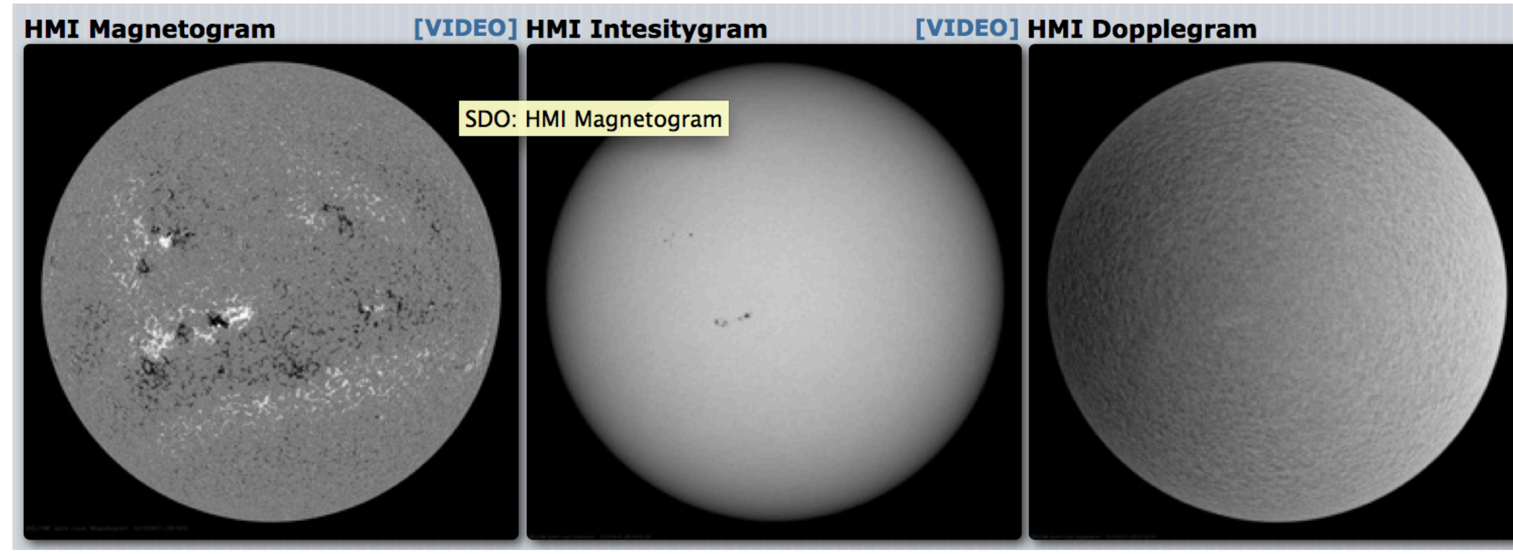
Solar Dynamics Observatory SDO

HMI

http://hmi.stanford.edu/

HMI is an instrument designed to study oscillations and the magnetic field at the solar surface, or photosphere.

* full solar disk at 6173 Å with a resolution of 1 arcsecond

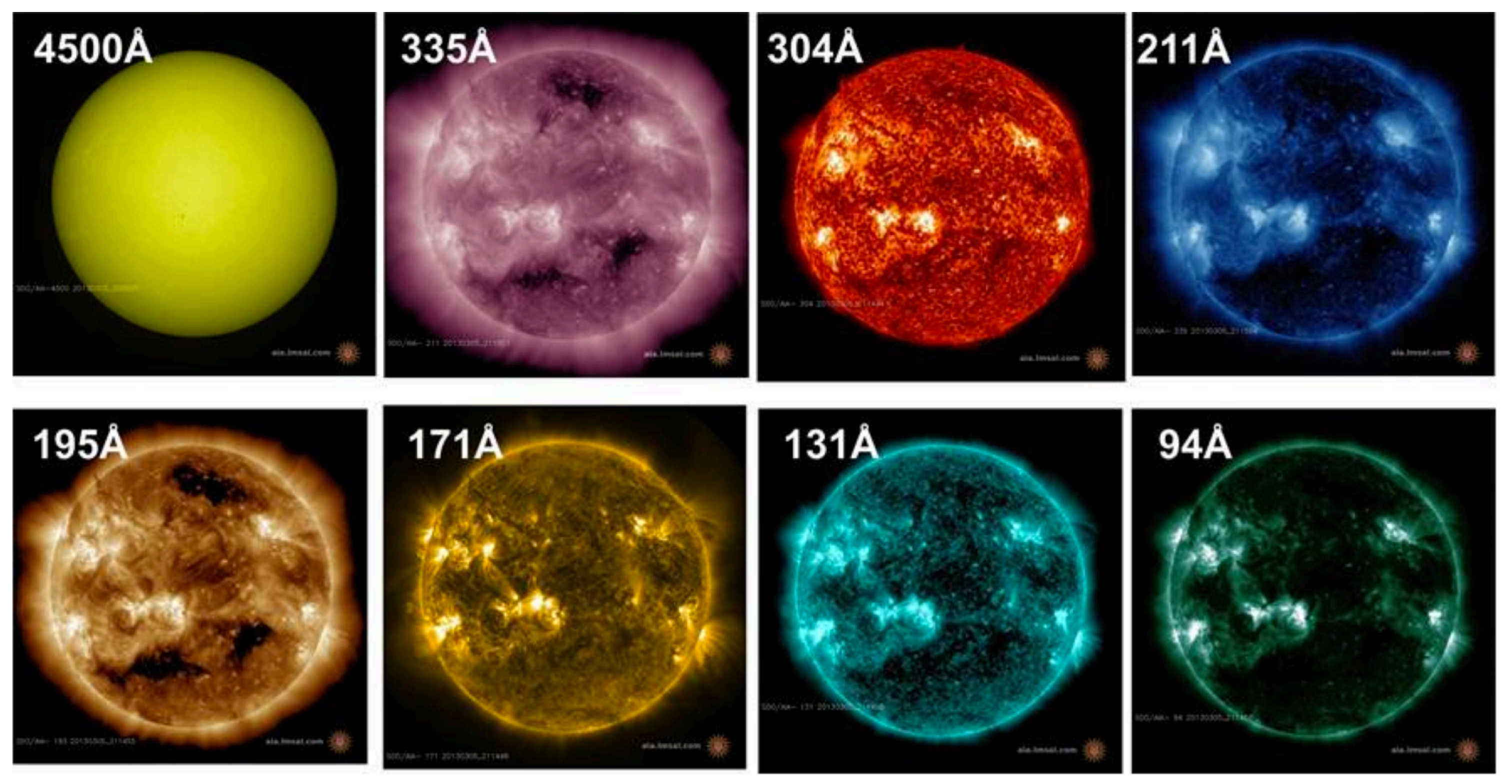


AIA

http://aia.lmsal.com/

The Atmospheric Imaging Assembly (AIA)

* images with at least 1.3 solar diameters in multiple (E)UV wavelengths nearly simultaneously
* at a resolution of about 0.6 arcsec pixel size and at a cadence of 10 seconds or better.



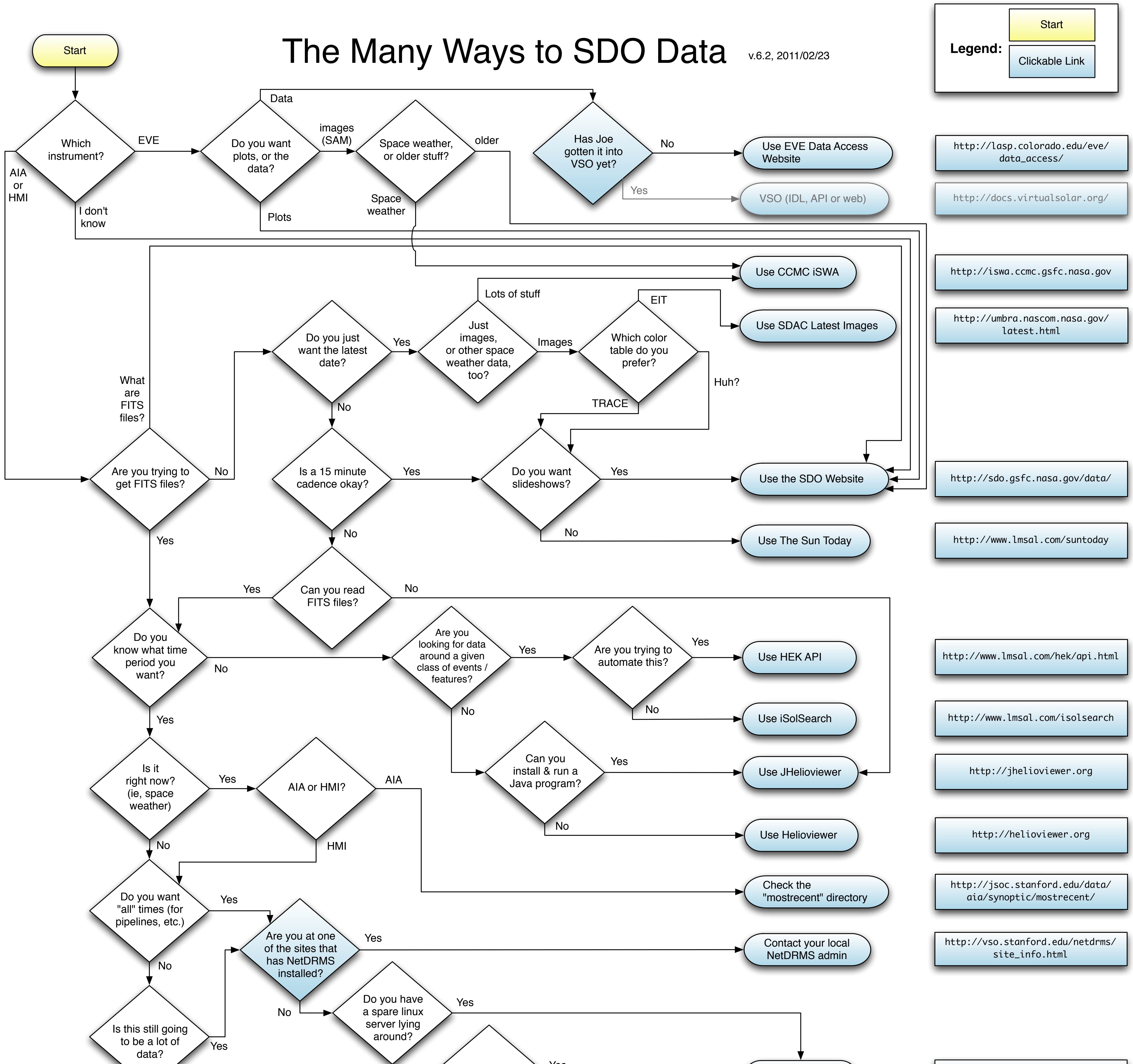
EVE

http://lasp.colorado.edu/home/eve/

EVE measures the solar extreme ultraviolet (EUV) irradiance with unprecedented spectral resolution, temporal cadence, accuracy, and precision.

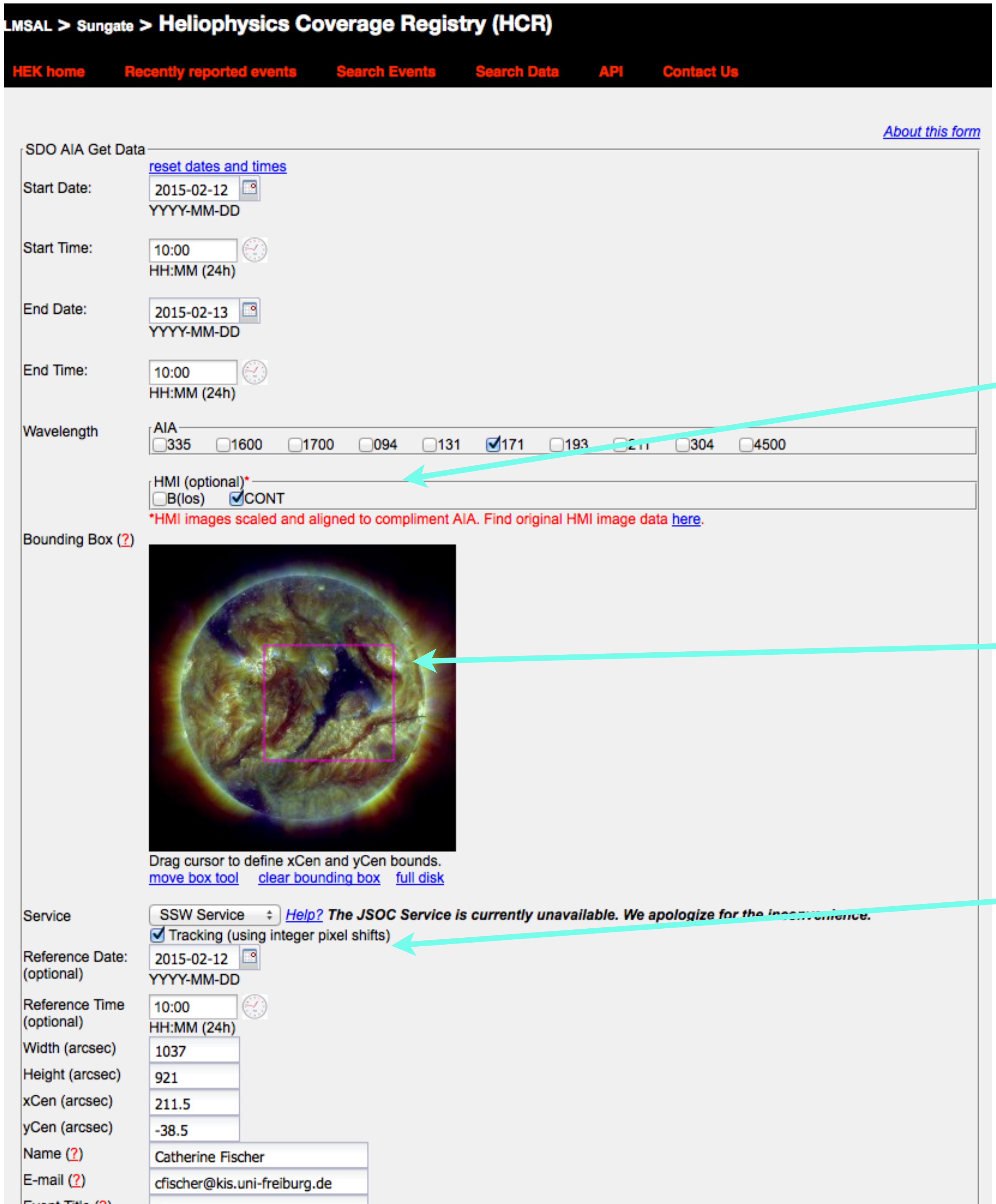
SDO - Data

http://vso1.nascom.nasa.gov/sdo/sdo_flowchart.pdf



SDO - Solar Dynamics Observatory

https://www.lmsal.com/get_aia_data/


LMSAL > Sungate > **Heliophysics Coverage Registry (HCR)**

HEK home | Recently reported events | Search Events | Search Data | API | Contact Us

About this form

SDO AIA Get Data

reset dates and times

Start Date: 2015-02-12 YYYY-MM-DD

Start Time: 10:00 HH:MM (24h)

End Date: 2015-02-13 YYYY-MM-DD

End Time: 10:00 HH:MM (24h)

Wavelength
AIA: ☐335 ☐1600 ☐1700 ☐094 ☐131 ☑171 ☐193 ☐ ☐304 ☐4500

HMI (optional)*: ☐B(los) ☑CONT

*HMI images scaled and aligned to compliment AIA. Find original HMI image data here.

Bounding Box (?)

Drag cursor to define xCen and yCen bounds.

move box tool | clear bounding box | full disk

Service: SSW Service | *Help?* ***The JSOC Service is currently unavailable. We apologize for the***

☑ Tracking (using integer pixel shifts)

Reference Date: (optional) 2015-02-12 YYYY-MM-DD

Reference Time (optional) 10:00 HH:MM (24h)

Width (arcsec) 1037

Height (arcsec) 921

xCen (arcsec) 211.5

yCen (arcsec) -38.5

Name (?) Catherine Fischer

E-mail (?) cfischer@kis.uni-freiburg.de

Event Title (?) Demo

simultaneous HMI data

Select Cutout

FOV tracking

Direct download or ssw commands

ssw_service_get_data,"ssw_service_150324_092019_26920",/loud

Our observing proposal

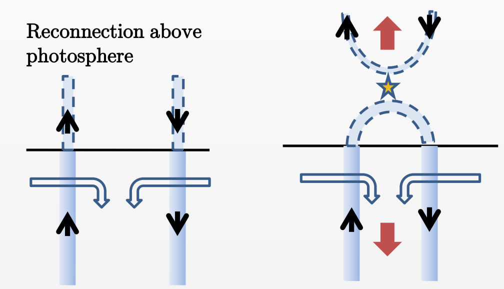
GREGOR observing proposal First call 2020

Topic within QUEST
(QUiet-sun Event STatistics)

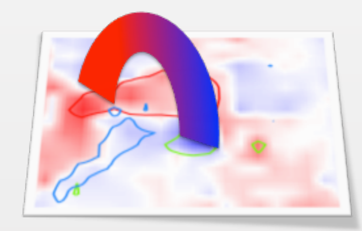
The **QUEST** project aims to characterise quiet-sun events involving the small-scale magnetic field using statistical analysis of multi-wavelength and spatially and temporally diverse data sets. Our goal is to follow, for e.g., magnetic flux emergence, flux cancellation, and magnetic intensification events…

Quiet sun events

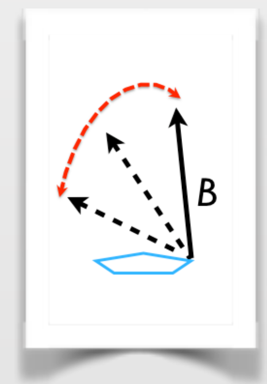
Magnetic flux removal



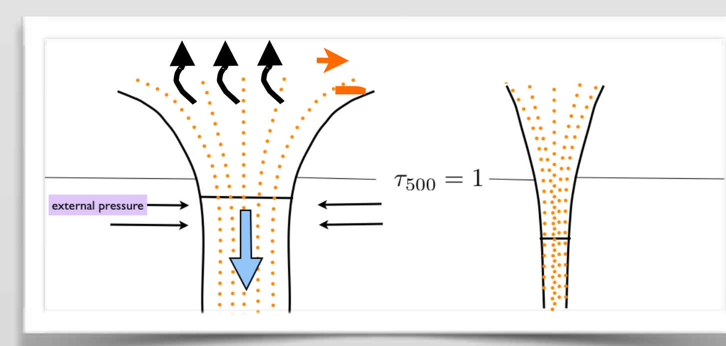
Siphon flows



Horizontal field transients



Convective collapse



? **And so on…**

Our observing proposal

https://tinyurl.com/obspropsonetschool

1 Title of Project:

2 Applicants

Principal Investigator:
Affiliation:
Email address: Co–Investigators(s):
Affiliation(s):
Email address(es):

3.1 Scientific Relevance

3.2 Previous data

4 Observing requests:

Setup requested:
(For 2019B, the possible setup is
- GRIS: IFU (image slicer) spectropolarimetry at wavelengths 1.0-1.3 or 1.5-1.8 microns or
- GRIS: slit spectropolarimetry at wavelengths 1.0-1.3 or 1.5-1.8 microns
- Fast context imaging. Wavelengths below 900 nm (if not using GFPI) or wavelengths below 480 nm (if using GFPI). Specify any required filters. If using wavelengths above 650 nm for context imaging, be aware that the H-alpha SJ channel will not get any light.
- GFPI: available in spectroscopic (not polarimetric) mode and only in collaboration with AIP. Please contact them before proposal submission.
- Please state whether you plan to use the SJ imaging system.

If applicable, describe any non-standard setup. Please also list the foreseen observing mode (FOV, exposure times, duration of raster, required S/N, targets, ...))

Coordinated observations:

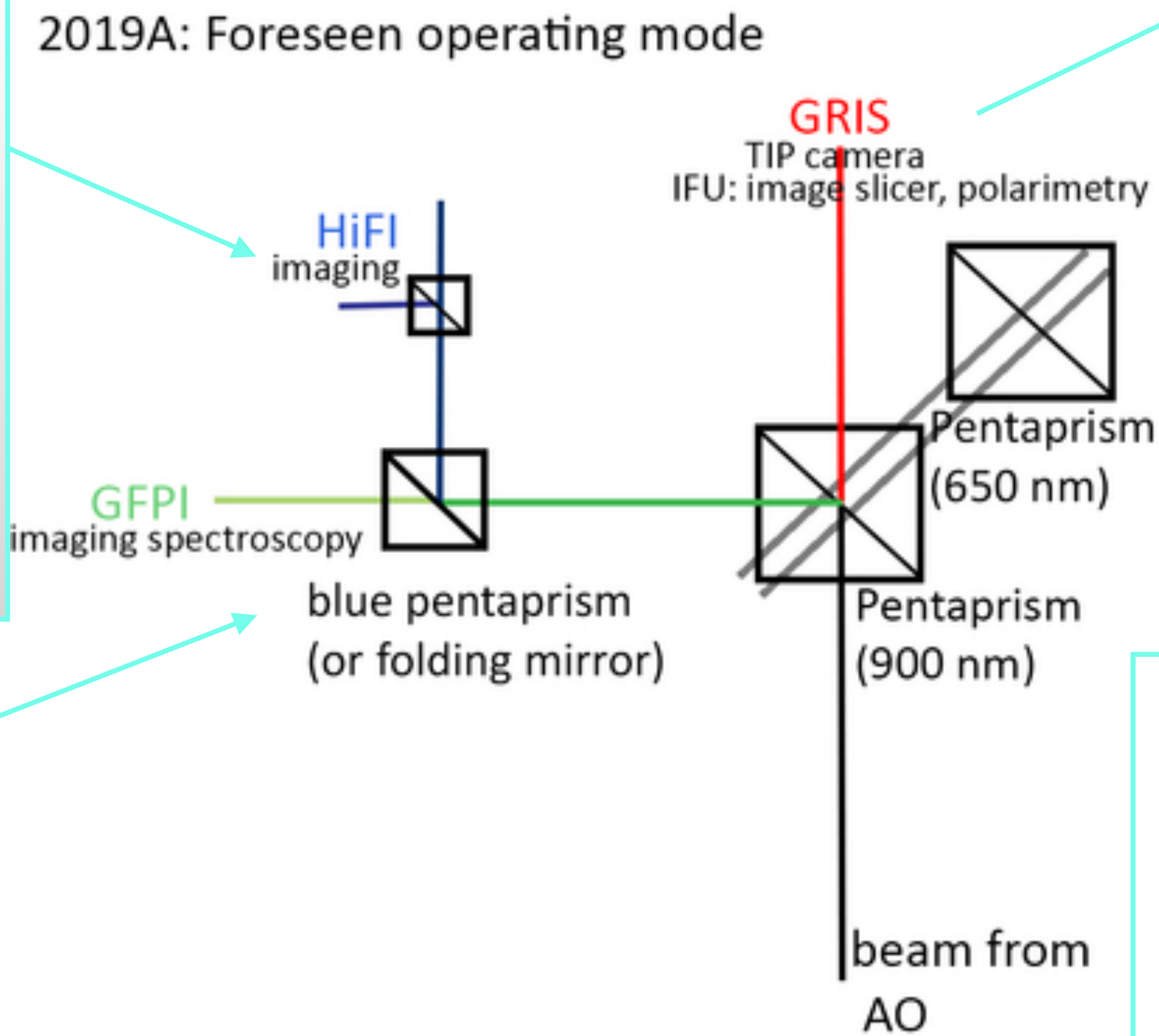
Impossible dates:

Our observing proposal

https://tinyurl.com/obspropsonetschool

Choose 2 Filters

- CaIIH λ396.8 nm,
- CaII H λ396.8 nm +- 0.1 nm
- G-band λ430.7 nm
- blue continuum λ450.8nm)



GRIS slit or IFU?

1565 nm range?
10830nm range?

Only in collaboration with AIP

"Only 2 spectral lines maximally 100 nm apart can be observed at a time due to the focus shift induced by the non-apochromatic lenses"

2 Prefilter positions

.New! Motorized Cameras

Maybe only spectroscopic

Slitjaw
H-alpha (0.4 A FWHM) and continuum at 777 nm

Available filters?

http://www.leibniz-kis.de/fileadmin/user_upload/vtt_filters_17.pdf

Filterlist VTT/GF

If you want to use one of the filters for a long duration setup
please inform Thomas Kentische
This is also true if a filter is damadge
All filter curves are available on ww
Please return the filter to its box as soon as y

Last Change: 18.02

CWL {nm]	FWHM [nm]	T[%]	REF#	Art#	Manufactorer
386,9	1,00		AM-20107	ANDV3106	Andover
393,5	3,10	43	AM-6564	ANDV10555	Andover
393,6	1,00	16	AM-10322	010FC04-50	Andover
396,8	1,08	70	LOT#3802		BARR
396,8	0,12	17,1	WO#58537-1	10966-4311	Materion
401,9	1,00	15	AM-18355	ANDV2737	Andover
430,6	0,89	37	AM-29406	ANDV4328	Andover
430,8	0,39	18	AM-39548	ANDV6545	Andover
440,1	0,90	52	AM-58850	ANDV9556	Andover
450,5	0,56	37	AM27410	005FC10	Andover
450,6	0,24	38	AM29472	ANDV4746	Andover
455,6	1,00		AM-61821-01	ANDV10019	Andover
460,0			AM-27997	460FS10-50	Andover
460,9	1,00		AM61821-01	ANDV10018	Andover
475,4	1,03	50	AM-65070	ANDV10450	Andover
486,4	0,90	47	AM-12565	010FC35-50	Andover
487,6	10,30	45	AM-36760	486FS10-50	Andover
491,4	0.9	52	AM-48771	ANDV8250	Andover
491,5	1,00	60	3501		BARR
491,5	0,23	29	AM-39548	ANDV6547	Andover
500,0	10,00		AM-15242	500FS10-50	Andover
510,0			AM-27997-01	510FS10-50	Andover

Our observing proposal - Co-observing

https://tinyurl.com/obspropsonetschool

Hinode SP

Number of Slitposition and cadence

Data volume?

Target? Tracking?

IRIS

Number of Slitposition (Raster positions)
Target? Tracking? Roll angle?

Stepsize 0.35,1,2 arcsec
Linelist, SLJ -> **OBSID**

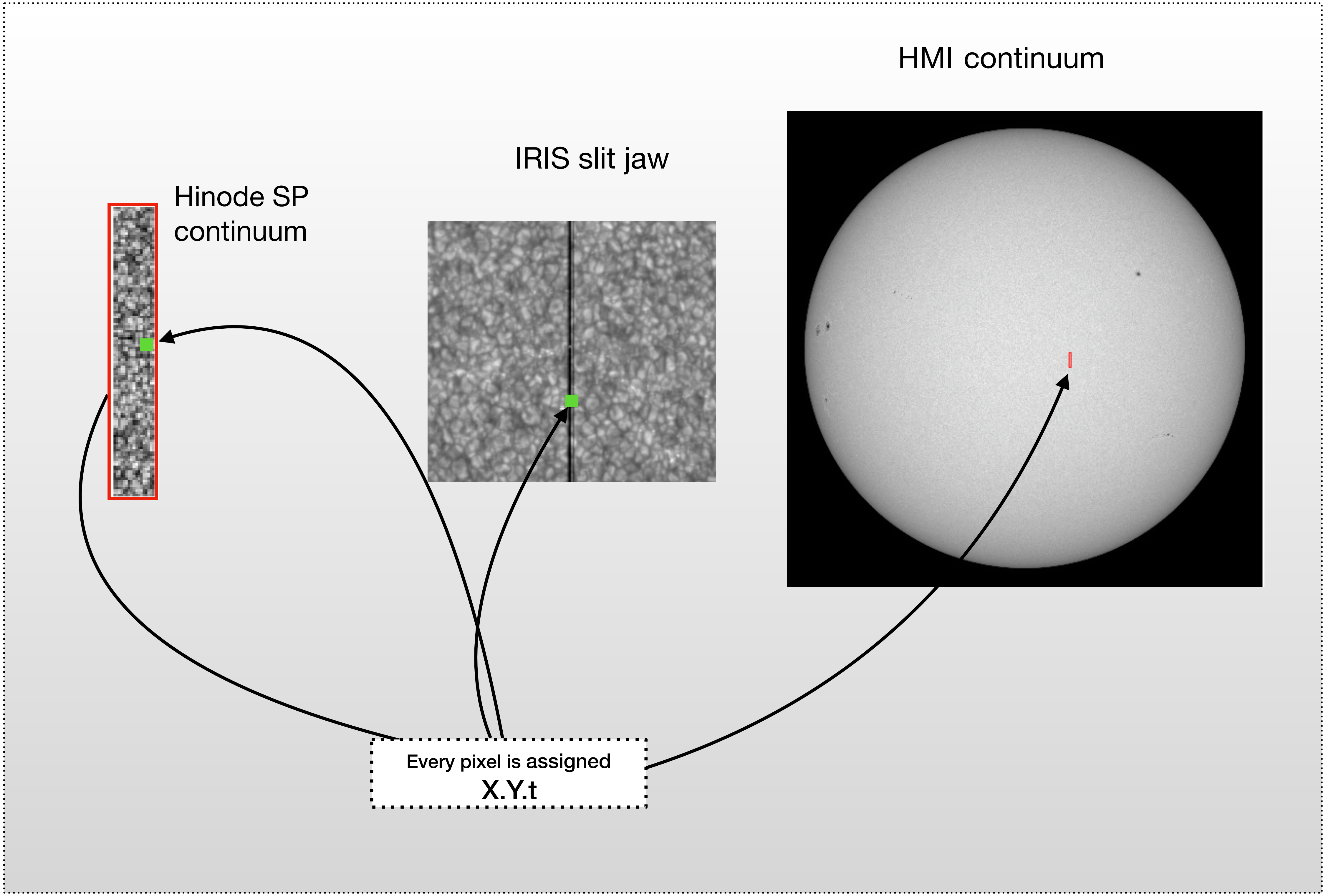
New! ITN 50

OBS ID parent	Description
0-100	Basic raster type (sit-and-stare, rasters, ...)
0-2,000	SJI choices
0-14,000	Exposure times
0-220,000	Summing modes (applied to FUV, NUV, SJI)
0-500,000	FUV summing modes
0-4,000,000	SJI cadence
0-5,000,000	Readout method (simultaneous, non-simultaneous)
0-10,000,000	Compression choices
0-80,000,000	Linelists
3.6-4 billion	OBS table generation number

Observations: Medium sparse 4-step raster with 1400, 2796, 2832 slitjaws

OBS-ID: 3600258819

Part II



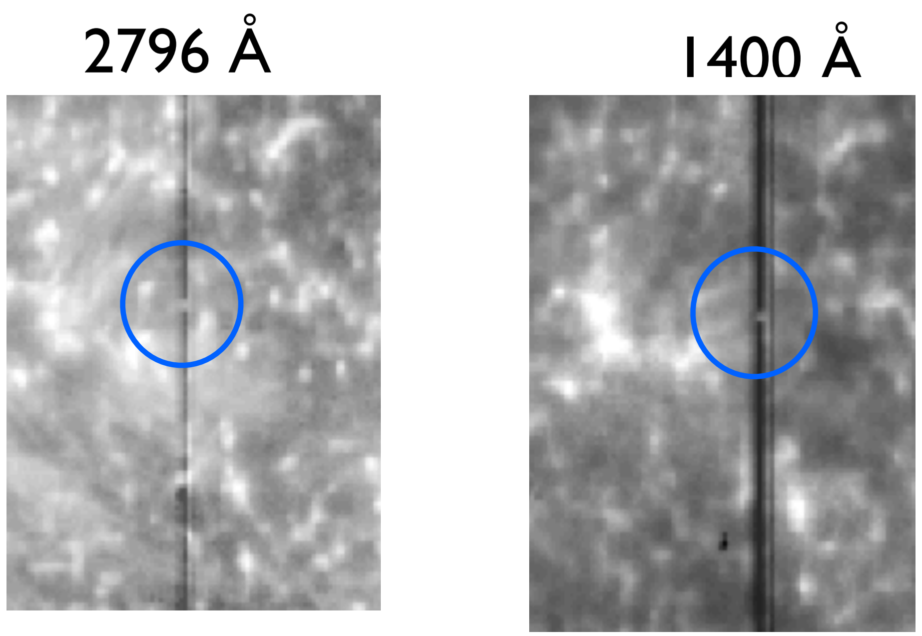
Hinode SP
continuum
IRIS slit jaw
HMI continuum
Every pixel is assigned
X.Y.t

Alignment - Issues, choices

- Standard for definition in files http://fits.gsfc.nasa.gov/fits_home.html
  The FITS standard

- Coordinates can be off by several arcsec, gb Telescopes - seeing, space based -jitter
- Not yet standard in gb data to write conform headers for data

- Internal alignment of instruments
- Example IRIS:
- Slitjaw images - slit fidicual



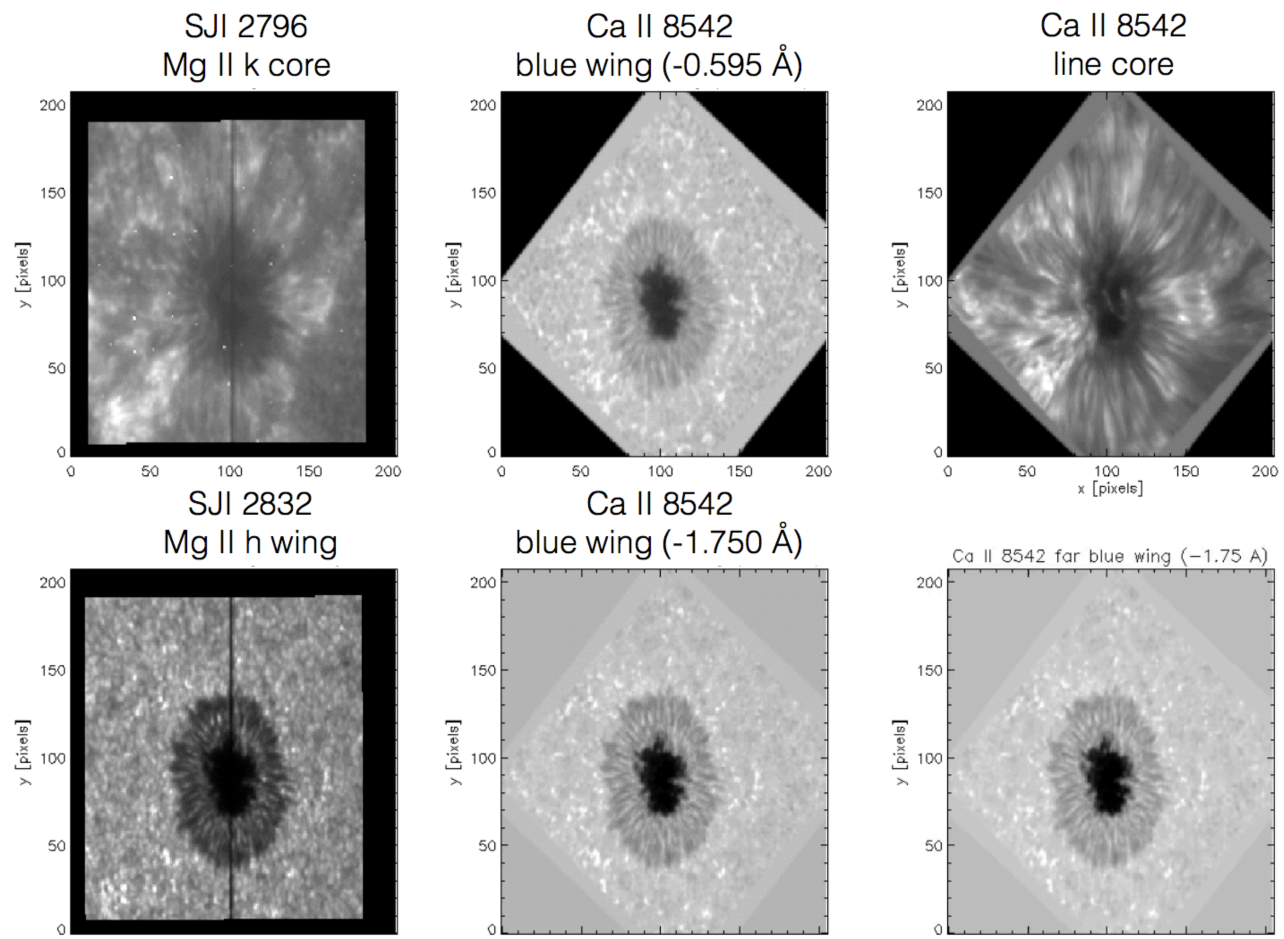
Issues

Which time?
Which Coordinates? - also congrid issues
Which data as reference data? -> taking care of slit etc.
Which wavelength show the same features? What can I cross-correlate?

Alignment - Issues, choices

See tutorial by Luc Rouppe van der Voort, IRIS 9 meeting

Which wavelength compatible for cross-correlation?
Exampels



Exampels:

azimuth ambiguity.

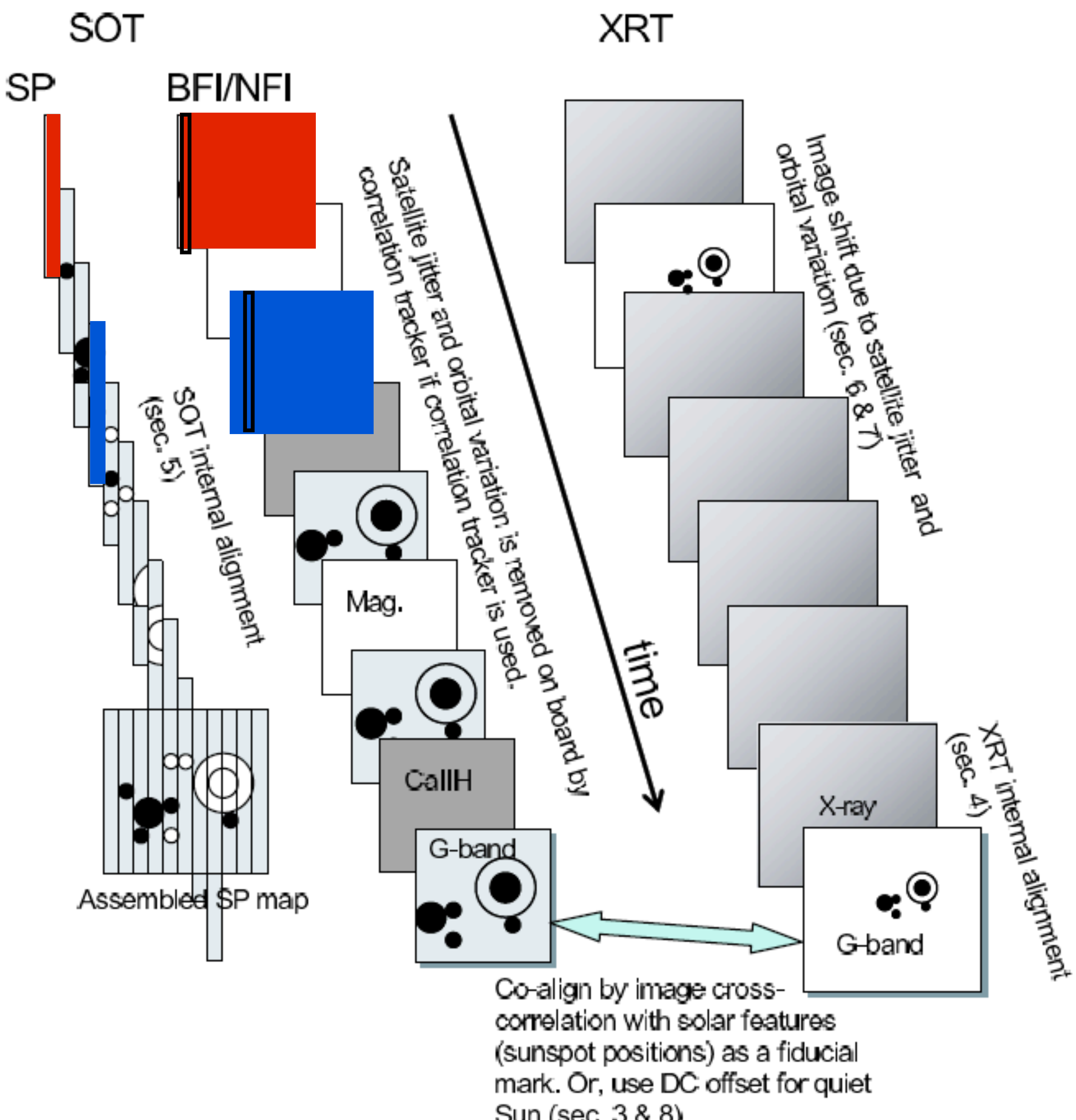
Image co-alignment is necessary for comparing images taken at different times, or at differing wavelengths. When we investigate the relationship between the bright features seen in Ca II H (using the BFI) and the photospheric magnetic fields (using the SP), we determine their relative alignment using an image cross-correlation technique. We cross-correlate the continuum intensity map from the SP with the G-band image taken at the time of midpoint of the closest SP observation.

M. Kubo et al. , 2007

The alignment of the various datasets was carried out as follows. First, the IRIS slit-jaw images were compensated for solar rotation and scaled up to match the SST pixel size. We then aligned the IRIS and SST observations using prominent NE features and bright points in SST Fe I 6173 continuum intensity and IRIS SJI 2832 images. Since both channels practically show the same photospheric structures, the accuracy of the alignment is on the order of the IRIS pixel size. The other SST and IRIS channels were aligned to these two channels.

M. Gosic et al. , 2018

Alignment - Slit and Imaging



Shimizu et al. 2007

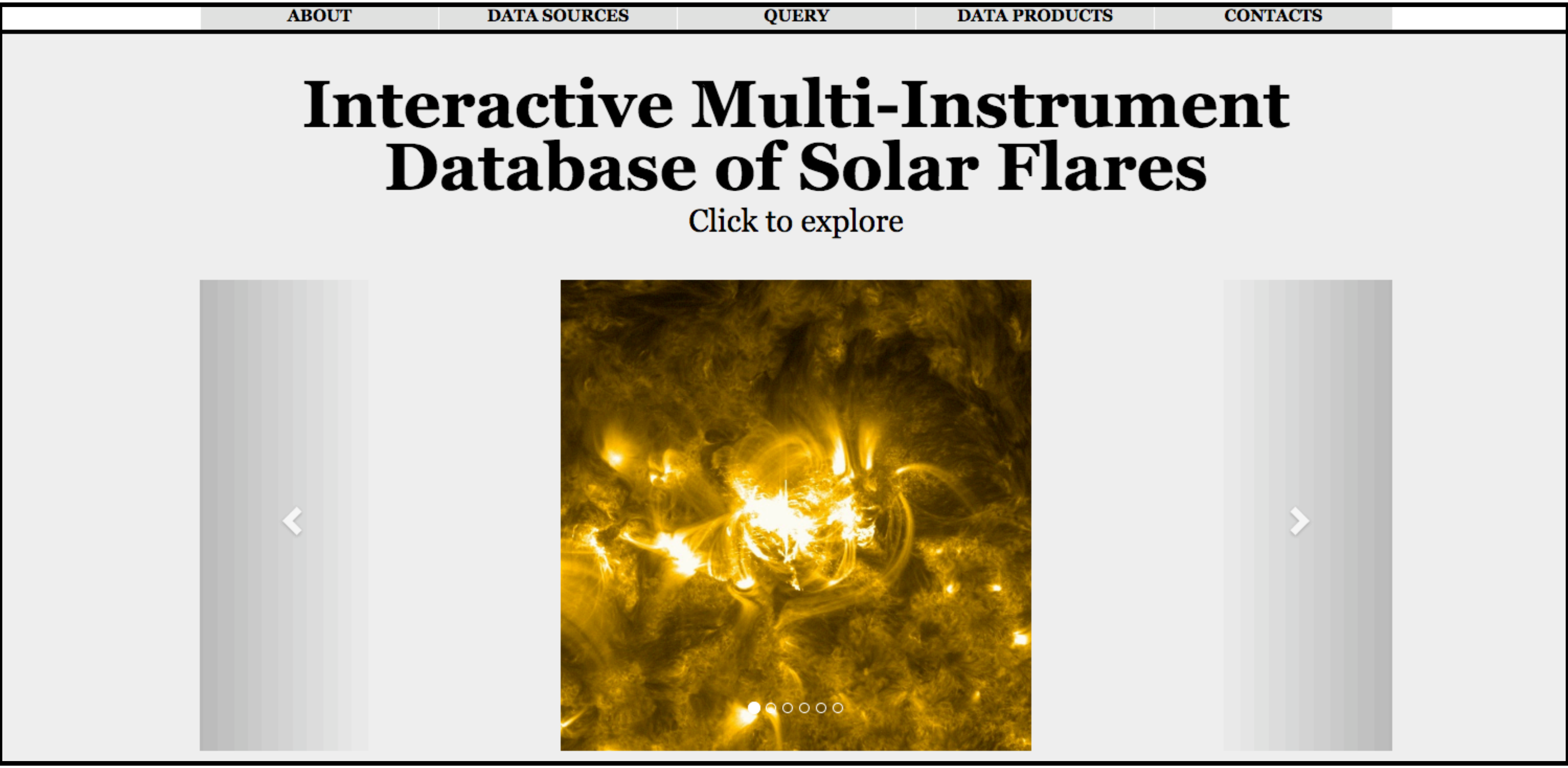
Takes time to “build” a map with the slit

Assemble G-band map according to slit position times

Practical Dataset 1

Searching for a flare….

https://solarflare.njit.edu/



IRIS flare list

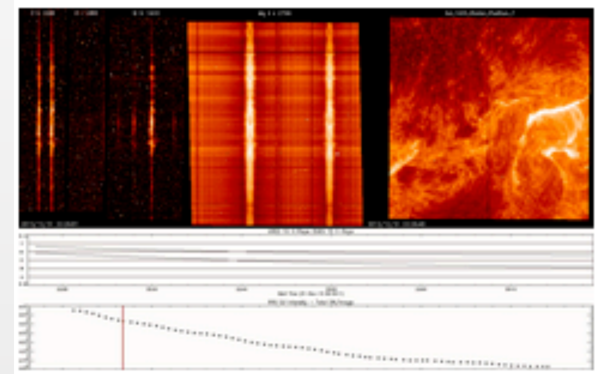
IRIS Flare List (maintained by Kathy Reeves, Jakub Prchlik, and Hui Tian & supplemented by Ying Li)

NOTE: Highlighted Events have already been used for IRIS MOD as of 10/22/18

20131011 14:54 C4.7, Fe XXI, ribbon
20131012 01:57 C5.2, full frame spectra, many unidentified lines, Fe XXI
20131015 05:42-05:50 Fe XXI line observed, raster of ribbons
20131024 19:55 no GOES class, SJI only, two-ribbon flare
20131024 21:14 C3.3, slit on ribbons and loops after peak
20131024 22:10 C5.7, slit missed, SJI only
20131102 15:20-15:30 strong Fe XXI line, but no SJI images because of flight software problem
20131114 18:29-20:44 C2.2, flare ribbon
20131225 05:18-15:00 C1.1, limb eruptions, flare and surge, no SADs in AIA - Fe XXI at 6:56 (raster 0) and 14:06 (raster 7)
20131225 21:53 flare at the edge of sunspot
20131229 23:45 no GOES class, slit on loops
20131230 02:43 no GOES class, loop brightening and plasma flows at bottom of SJI
20131230 08:04 no GOES class, SJI only
20131231 22:22 loops & footpoints from M flare visible in 1400 SJI images.
20140104 06:30 C5.6 flare. Nice 1400 SJI movie of footpoints, slit nowhere near them, though
20140105 02:24 C4.5 flare got footpoints
20140105 15:15 C6.6, ribbons, Fe XXI, good XRT data
20140105 18:13 C3.4, interesting loop brightening and flows at bottom of SJI
20140111 23:27:39-00:22:22 C6 raster 20 - interesting rotation in CII, very weak Fe XXI, nice eruption in 1400 SJI images
20140127 23:22-00:16 Small eruption on the limb, no GOES class, maybe some Fe XII in raster 8
20140128 07:30 M3.6 One edge of the raster landed on the footprints. All kinds of crazy unidentified lines, lots of Fe XXI, ~150 km/s redshifts in the C II lines. Good one for analysis.
20140129 14:24 long duration C7 flare. Pointing is a little too far south. Some interesting ribbons, though.
20140130 00:09 C2 flare. SJI only.
20140202 11:35 Continuum enhancement starting at 11:35, observation ends at 11:42. Beginning of the C9.7 flare starting at 11:45? Interesting loop with brightening at top, right by slit.
20140202 16:12 interesting cuspy configuration - outflows? Not the M1 flare, which was in a different active region.
20140202 19:32 eruption in AR 11968, mostly seen in SJIs. 64 step raster, full spectrum.
20140202 21:24 M1.3 flare - caught beginning during a 64 step raster, slit on ribbons. Full spectrum.
20140203 - C6.5 at 13:22 - IRIS gets rise. Being analyzed by Polito, Reeves, del Zanna, Mason. Fascinating XRT data with what look like null points.
20140204 - 11:54 C5.9 flare, interesting loops, sit'n'stare
20140204 - 15:30 M1.5, 64 step raster, slit mostly on western ribbons, missed some loops.
20140204 - 18:49 C4.7 flare, got some of the ribbons
20140205 - 16:20 M1.3, slit covers ribbon, Fe XXI visible
20140211 - 13:40 C8 flare, slit on some ribbons.
20140211 - 16:47 M1.8 flare, slit nicely on ribbons. No obvious Fe XXI.
20140212 23:05 C5.9, ribbon, Fe XXI, 400 km/s blue shift of cool lines
20140213 01:36 M1.8, ribbon, loops, nice eruption

https://iris.lmsal.com/data.html

Event Details

IRIS	Where	Raster
2013-12-31T22:20:34 - 2013-12-31T23:14:18	Flarewatch with Hinode OBS 3860257480	
	x, y: 497", -219" Max FOV: 133" x 119" Target: AR	FOV: 14" x 119" Steps: 8" x 2" Step Cad: 5.3 Raster Cad: 42s , 76

SJI wavel: cadence, # images	Data Links	
	Annotate	
FOV: 119" x 119" 1400: 0.2 min 303 imgs 2796: 0.2 min 303 imgs	1400 2796 Raster	209 MB 198 MB 784 MB

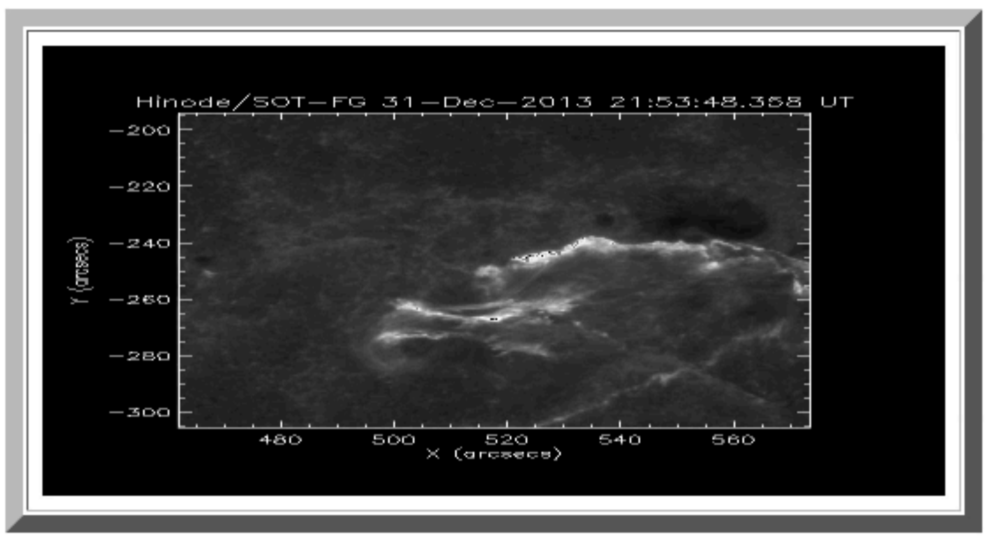
Downloaded to **iris** DATASET1

HINODE flare list

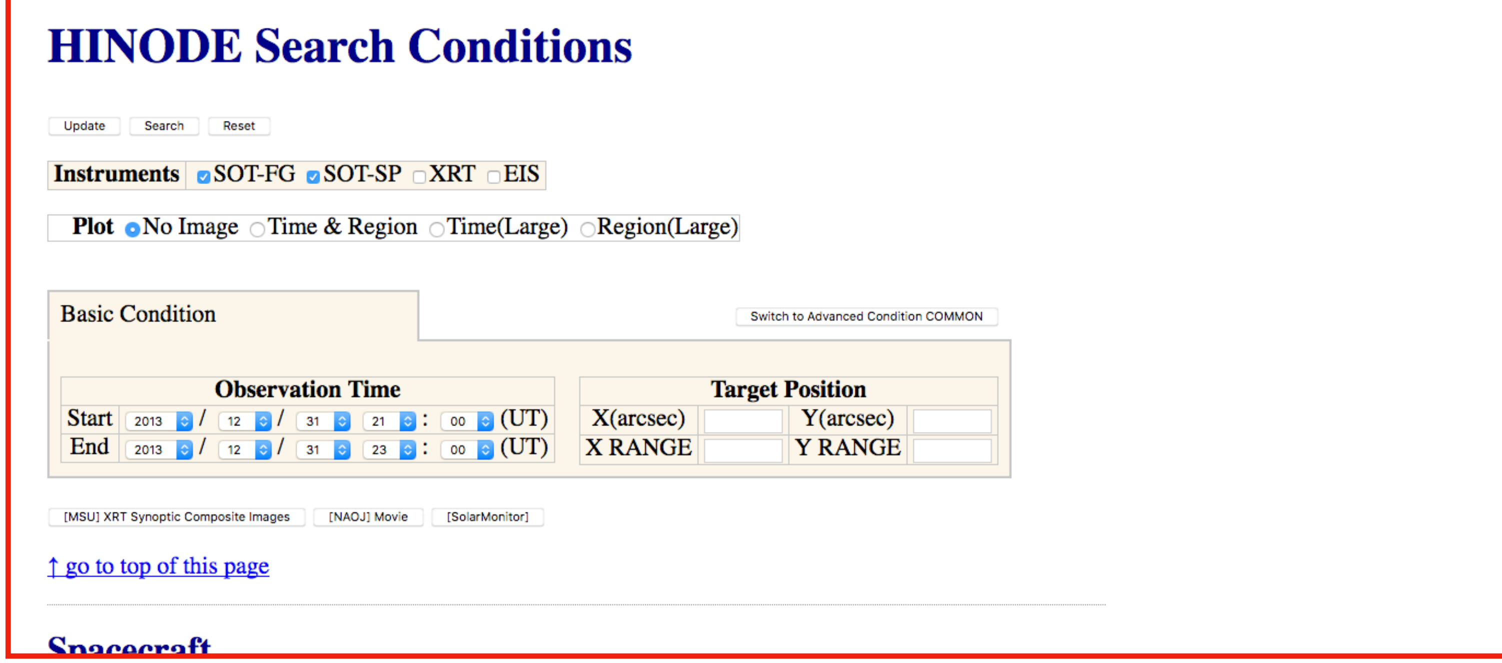
https://hinode.isee.nagoya-u.ac.jp/flare_catalogue/

Event number	GOES			AR location	X-ray class	SOT		XRT	EIS	DARTS	RHESSI
	start	peak	end			FG	SP				
120130	2015/01/25 11:56	2015/01/25 12:12	2015/01/25 12:21	S08E89	C1.4	0	0	0	0		6-12
096120	2013/12/31 21:45	2013/12/31 21:58	2013/12/31 22:20	S16W35	M6.4	180	4	159	4		50-100
096110	2013/12/31 19:49	2013/12/31 19:53	2013/12/31 19:56	S13W41	C2.9	0	5	4	0		no
096100	2013/12/31 18:53	2013/12/31 18:59	2013/12/31 19:03	S13W41	C4.0	18	6	79	1		6-12
096090	2013/12/31 18:20	2013/12/31 18:25	2013/12/31 18:31	S16W16	C1.8	0	3	0	0		no
096080	2013/12/31 16:42	2013/12/31 16:49	2013/12/31 16:55	S13E16	C2.0	0	0	0	0		no

Flare Event ID: 096120



https://darts.isas.jaxa.jp/solar/hinode/query.php



Downloaded

Run fg_prep with /despike
Produces level1 data
hinode in DATASET1

SolarMonitor

https://www.solarmonitor.org/

SolarMonitor for 31.12.2013

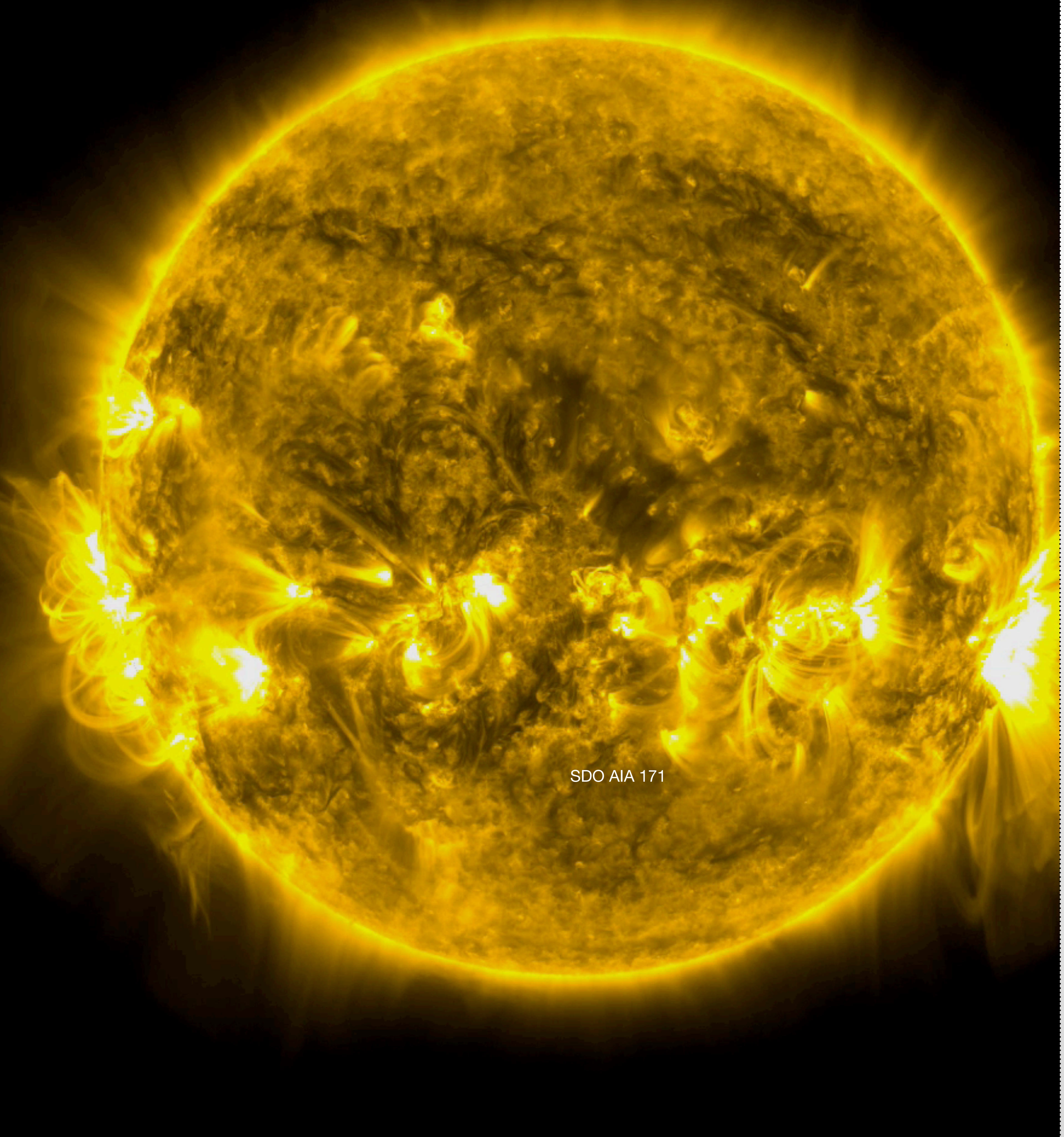
Today's/Yesterday's NOAA Active Regions						
NOAA Number	Latest Position	Hale Class	McIntosh Class	Sunspot Area [millionths]	Number of Spots	Recent Flares
11931	S14W91 (946",-236")	α/α	Hax/Hsx	0130/0110	01/01	-
11934	S17W78 (913",-274")	βγδ/βγδ	Eac/Esc	0140/0160	09/17	-
11936	S16W32 (498",-228")	βγδ/βγ	Eac/Eac	0180/0170	28/30	C5.6(02:29) / C1.7(17:41) C2.4(16:38) C2.3(15:09)
11937	S12W05 (83",-154")	β/β	Bxo/Bxo	0010/0010	03/03	-
11938	S09E12 (-201",-104")	α/β	Hax/Cao	0050/0060	02/03	-
11935	S06W63 (866",-79")	/	/	/	/	-
11939	S06W91 (969",-102")	/β	/Bxo	/0010	/05	-

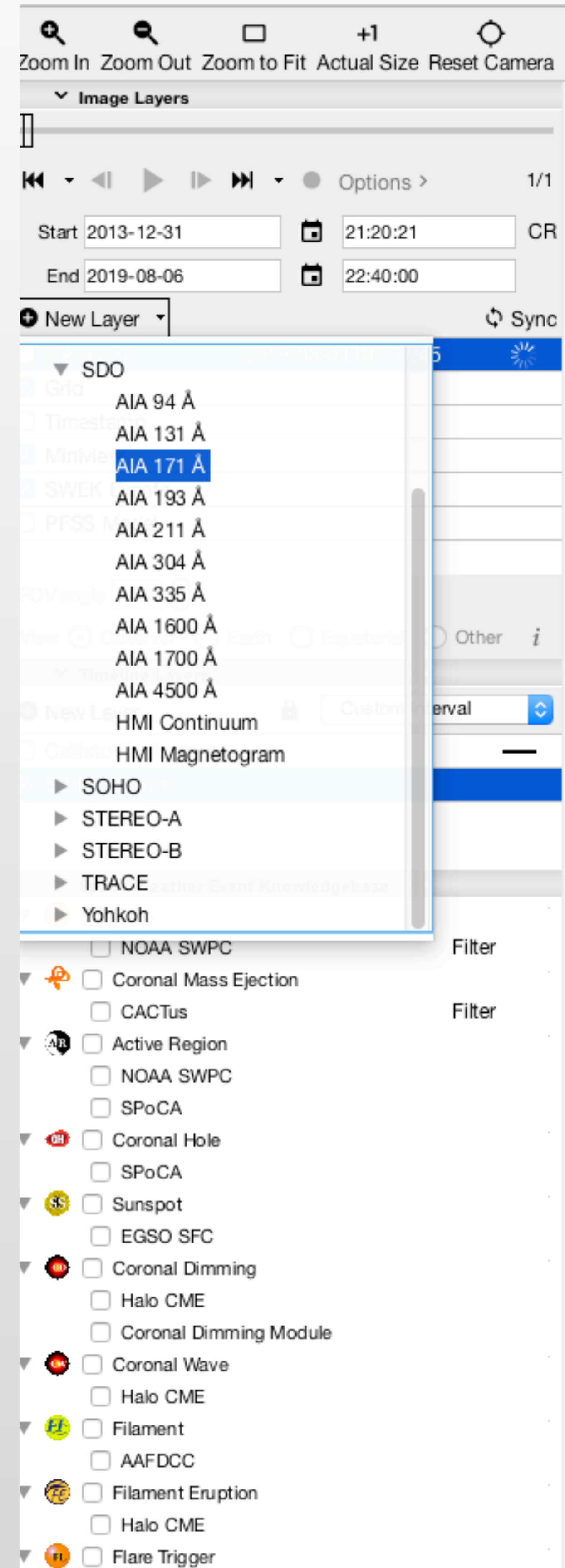
SolarMonitor for 01.01.2014

Today's/Yesterday's NOAA Active Regions						
NOAA Number	Latest Position	Hale Class	McIntosh Class	Sunspot Area [millionths]	Number of Spots	Recent Flares
11934	S16W91 (937",-269")	βγδ/βγδ	Eac/Eac	0080/0140	05/09	-
11936	S16W48 (698",-235")	βγδ/βγδ	Eac/Eac	0280/0180	36/28	M9.9(18:40) / M6.4(21:45) C2.9(19:49) C4.0(18:53) C1.8(18:20) C5.6(02:29)
11937	S12W21 (343",-154")	β/β	Bxo/Bxo	0010/0010	03/03	-
11938	S09W03 (50",-100")	α/α	Hax/Hax	0030/0050	03/02	- / C2.0(16:42)
11940	S12W56 (792",-174")	β/-	Dro/---	0020/----	04/--	C3.2(07:21) / -
11941	S13W34 (533",-177")	β/-	Dro/---	0030/----	03/--	-
11942	N10E50 (-737",203")	α/-	Hrx/---	0020/----	01/--	-
11943	S11E55 (-786",-156")	β/-	Cro/---	0020/----	01/--	-

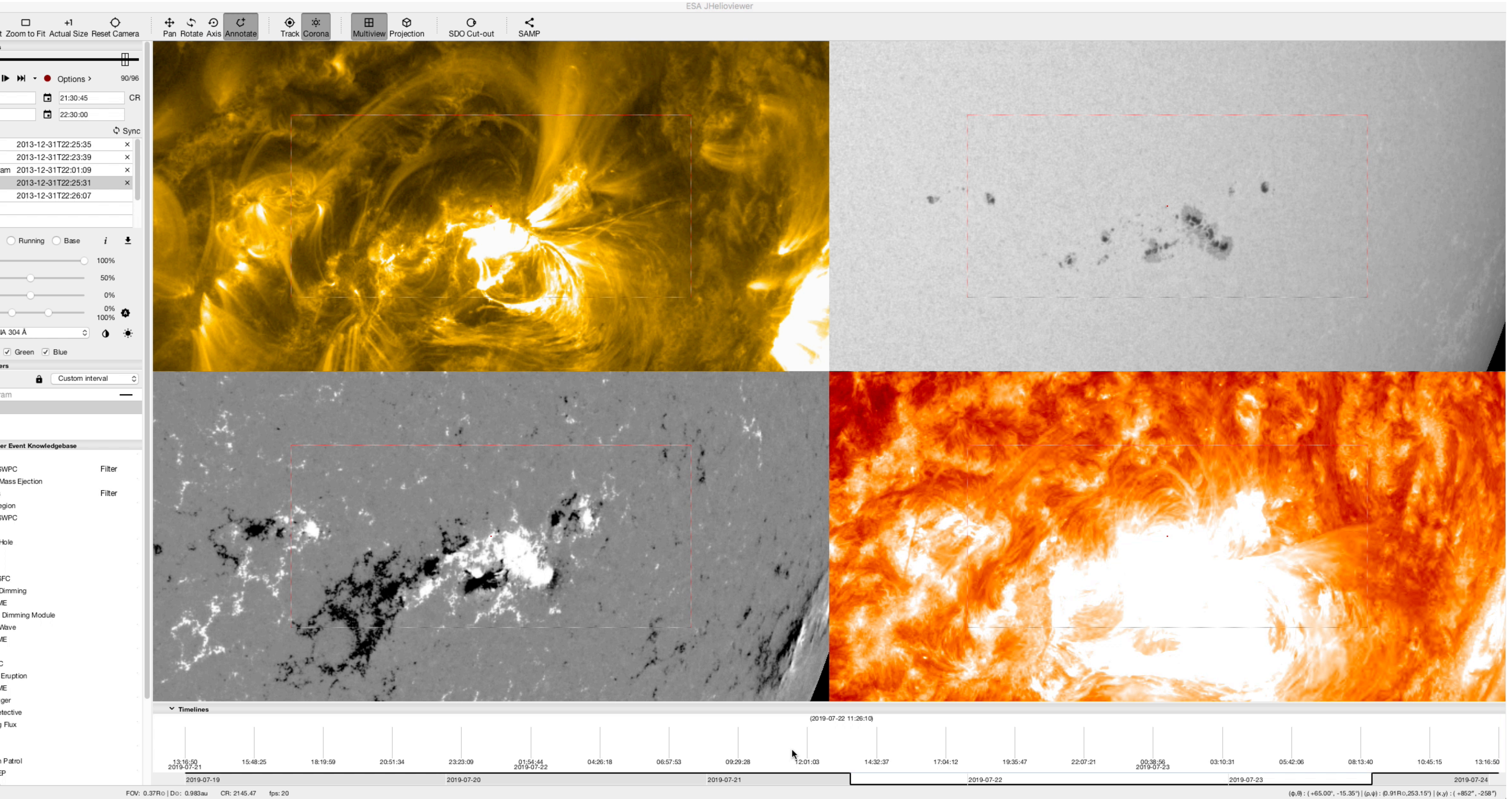
Event#	EName	Start	Stop	Peak	GOES Class	Derived Position
5	gev_20131231_2145	2013/12/31 21:45:00	22:20:00	21:58:00	M6.4	S15W36 (1936)

JHelioviewer

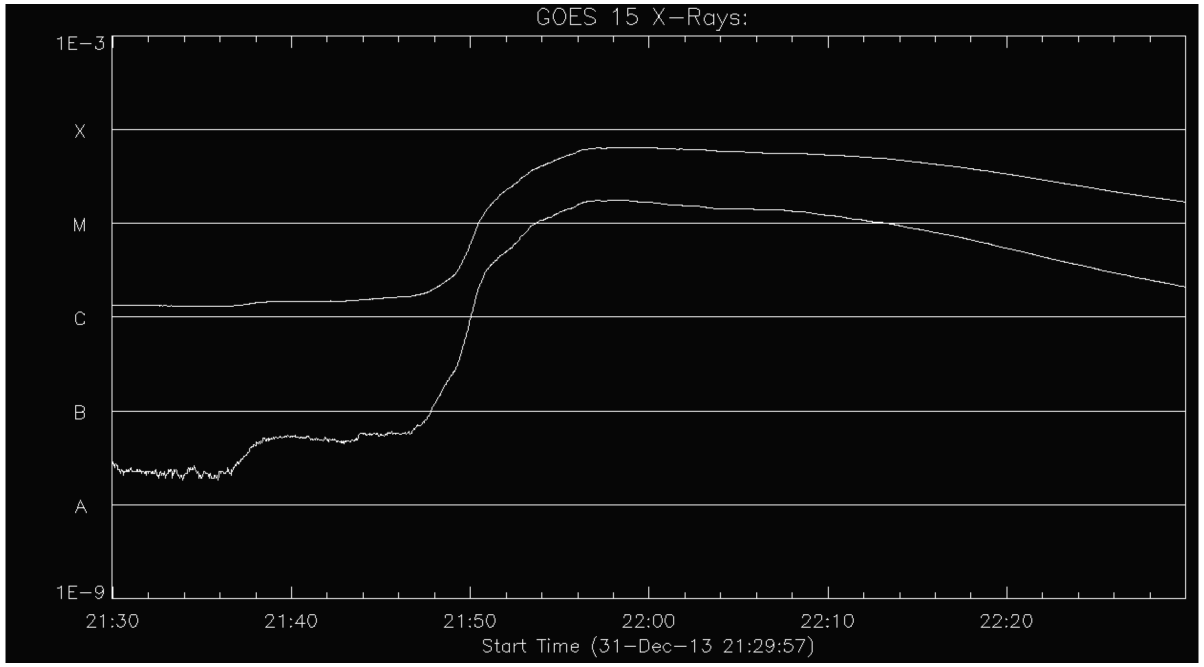




JHelioviewer



X-ray flux

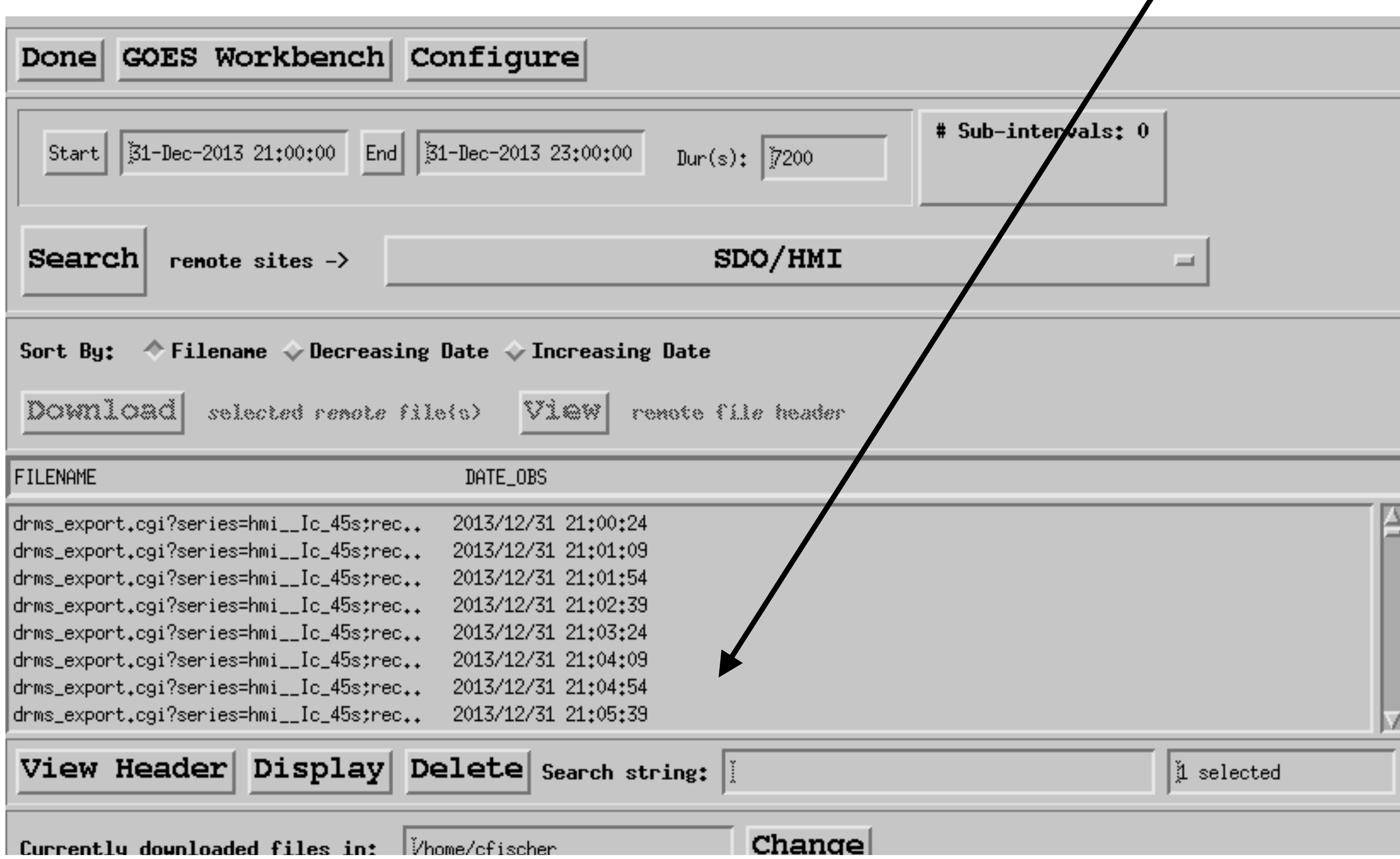


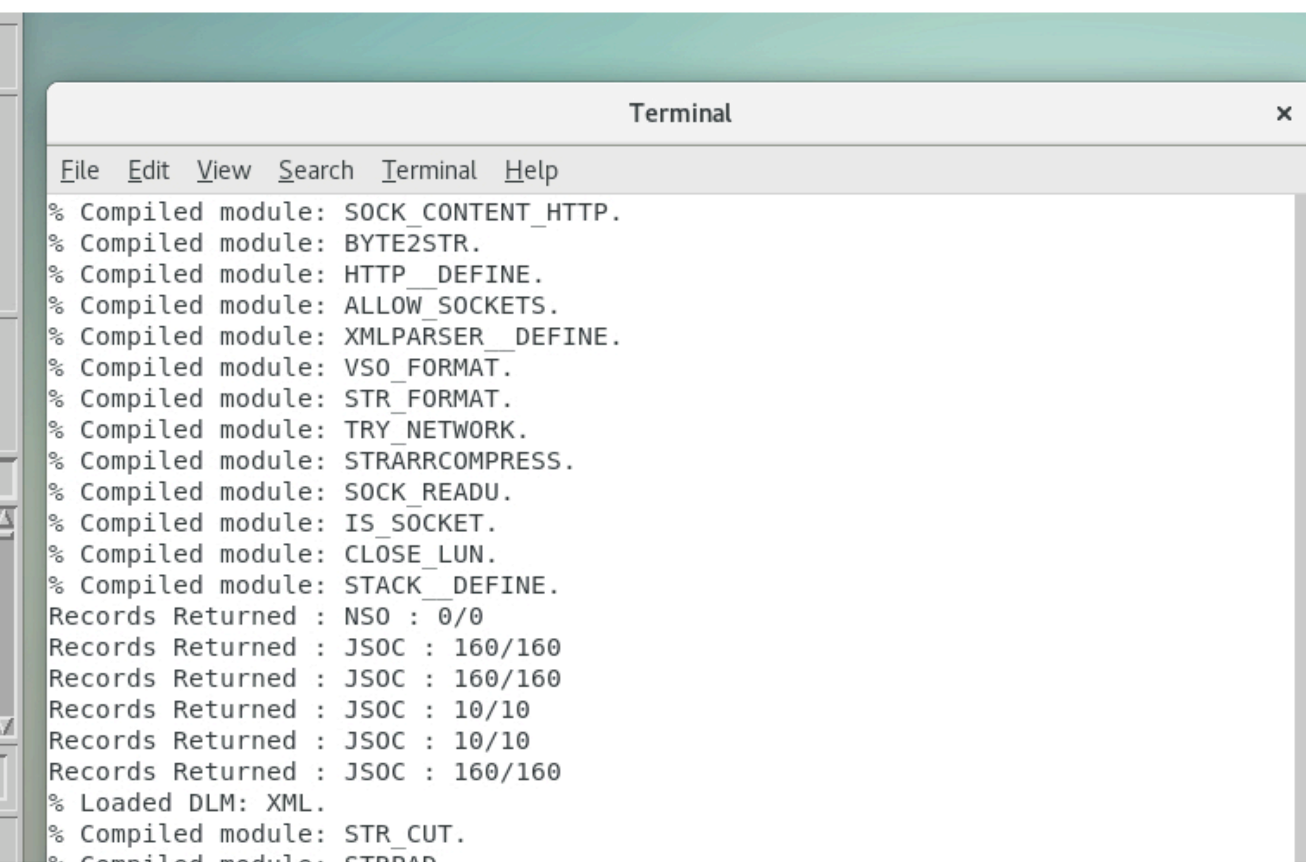
SSW IDL SESSION

```
t0='21:30 31-dec-2013'
t1='22:30 31-dec-2013'
plot_goes,t0,t1,/one_minute,background=11
```

```
show_synop
```

Downloaded to **sdo_hmi** DATASET1





Reading Data

CDELTn

```
COMMENT:   coordinate increment along axis
DEFINITION: The value field shall contain a floating point number
giving the partial derivative of the coordinate specified by the CTYPEn
keywords with respect to the pixel index, evaluated at the reference
point CRPIXn, in units of the coordinate specified by  the CTYPEn
keyword.  These units must follow the prescriptions of section 5.3 of
the FITS Standard.
```

DATE_OBS

```
COMMENT:   date of the observation
DEFINITION: The date of the observation, in the format specified in the
FITS Standard.  The old date format was 'yy/mm/dd' and may be used only
for dates from 1900 through 1999.  The new Y2K compliant date format is
'yyyy-mm-dd' or 'yyyy-mm-ddTHH:MM:SS[.sss]'.
```

CUNITn

```
COMMENT:   coordinate increment along axis
DEFINITION: The value field shall contain a floating point number
giving the partial derivative of the coordinate specified by the CTYPEn
keywords with respect to the pixel index, evaluated at the reference
point CRPIXn, in units of the coordinate specified by  the CTYPEn
keyword.  These units must follow the prescriptions of section 5.3 of
the FITS Standard.
```

SSW IDL SESSION

```
read_sdo,'./sdo_hmi/hmi.ic_45s.2013.12.31_22_26_15_TAI.continuum.fits',indexsdocont, $
datasdocont
help,indexsdocont,/str
print,indexsdocont.cunit2
```

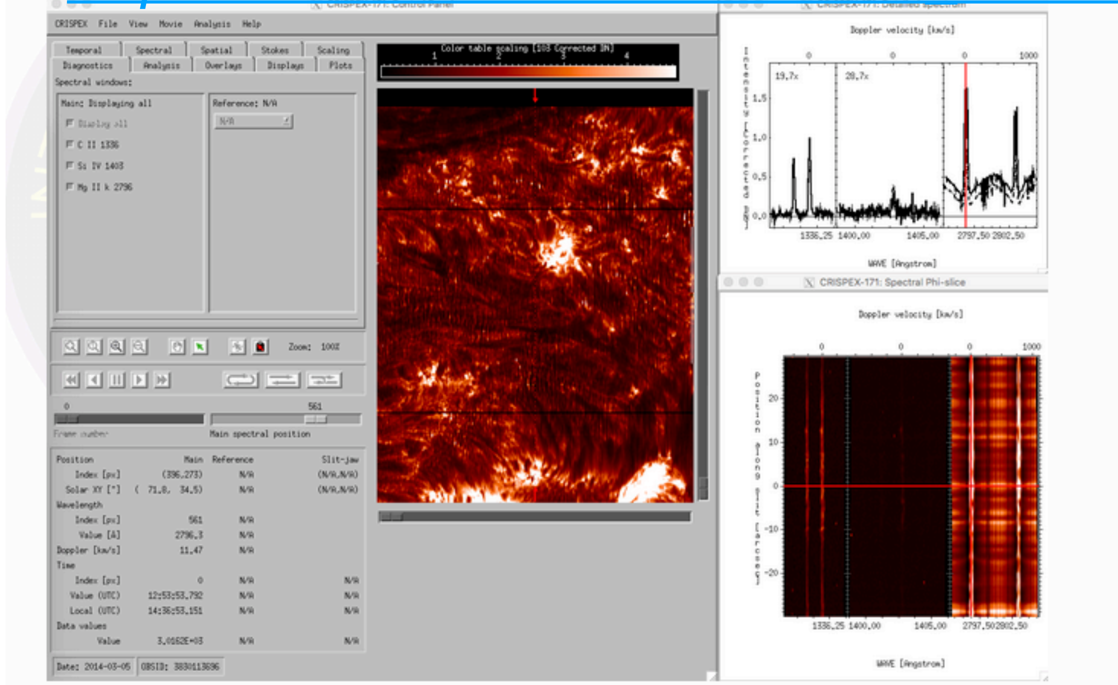
```
…
DATE_OBS        STRING    ‘2013-12-31T21:40:09.10'
CDELT1          DOUBLE          0.50428700
CDELT2          DOUBLE          0.50428700
…
```

Same for read_sot

Viewing IRIS Data

CRISPEX

https://iris.lmsal.com/itn26/iris_level3.html



crispex main view with a 400-step IRIS raster.

Many excellent tutorials available

Useful Programs:

find_closest Finds the subscript of closest value v in array

tim2dset Given a structure (roadmap or index), find the dataset with the time closest to an input time.

anytim This function converts one of several recognized time formats into the selected output format.

```
read_iris_l2,'./iris/
iris_l2_20131231_222034_3860257480_SJI_2796_t000.fits',indexiris2796,datairis2796
timesiris=indexiris2796.date_obs
timesdo=indexsdocont.date_obs
s2=find_closest(anytim(timesdo,/tai),anytim(timesiris,/tai))
print,timesiris[s2]
print,timesdo
```

SSW IDL SESSION

Reading Data

An IDL map is a structure that contains two-dimensional (2-d) image data with accompanying pixel coordinate and spatial scale information.

Create maps:

index2map (map2index) fits2map (map2fits)

$SSW/gen/idl/maps This directory contains a package of image mapping and co-alignment software.

Tutorial:

http://www.sipwork.org/idl-map-software-for-analyzing-solar-images/

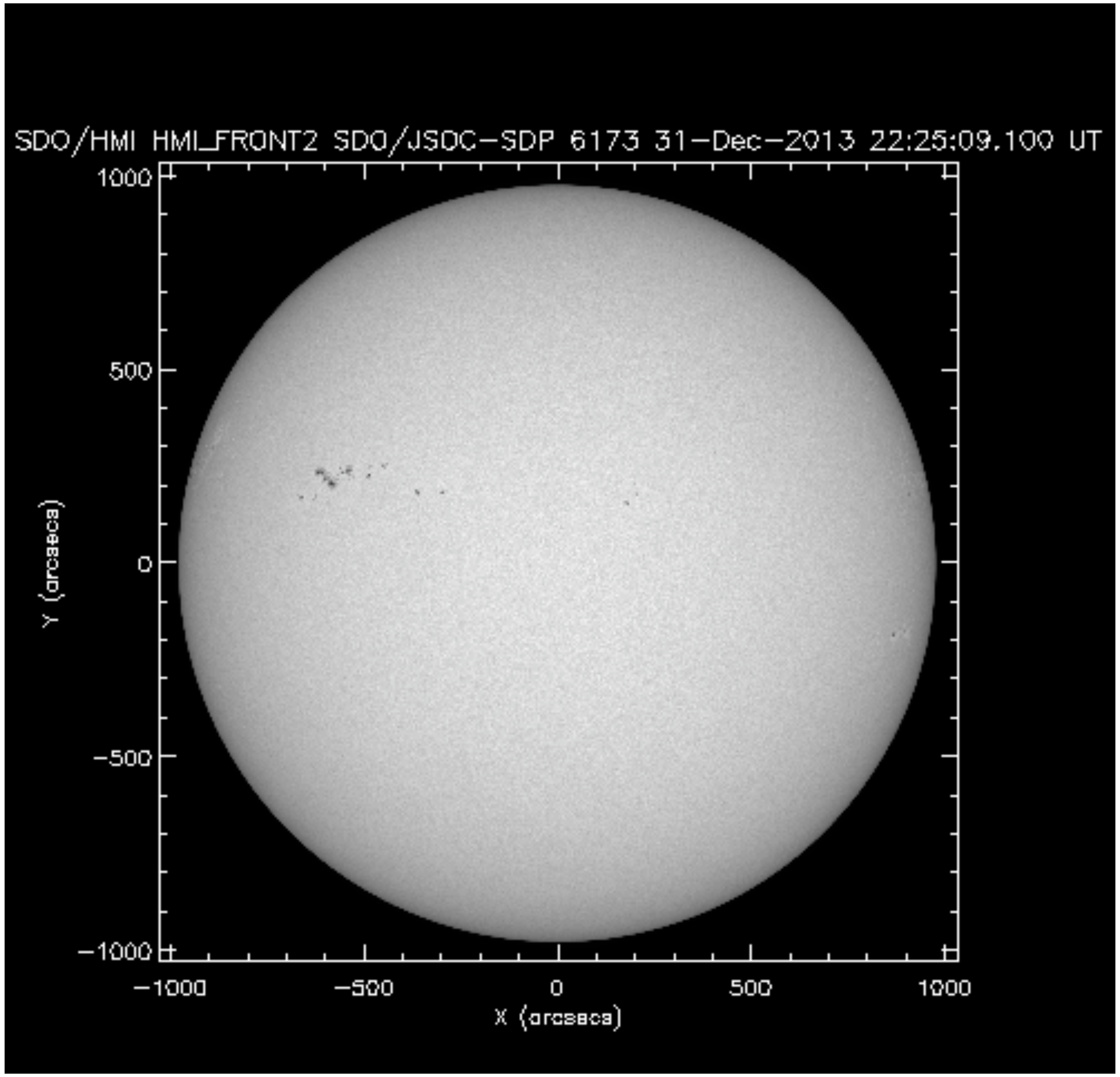
make_map	create your own maps
scale_map	scale a map in x- and y-directions by changing pixel spacings
grid_map	regrid an image map
shift_map	translate a map in x- and y-directions by moving it's centroid
movie_map	make movie of series of map images

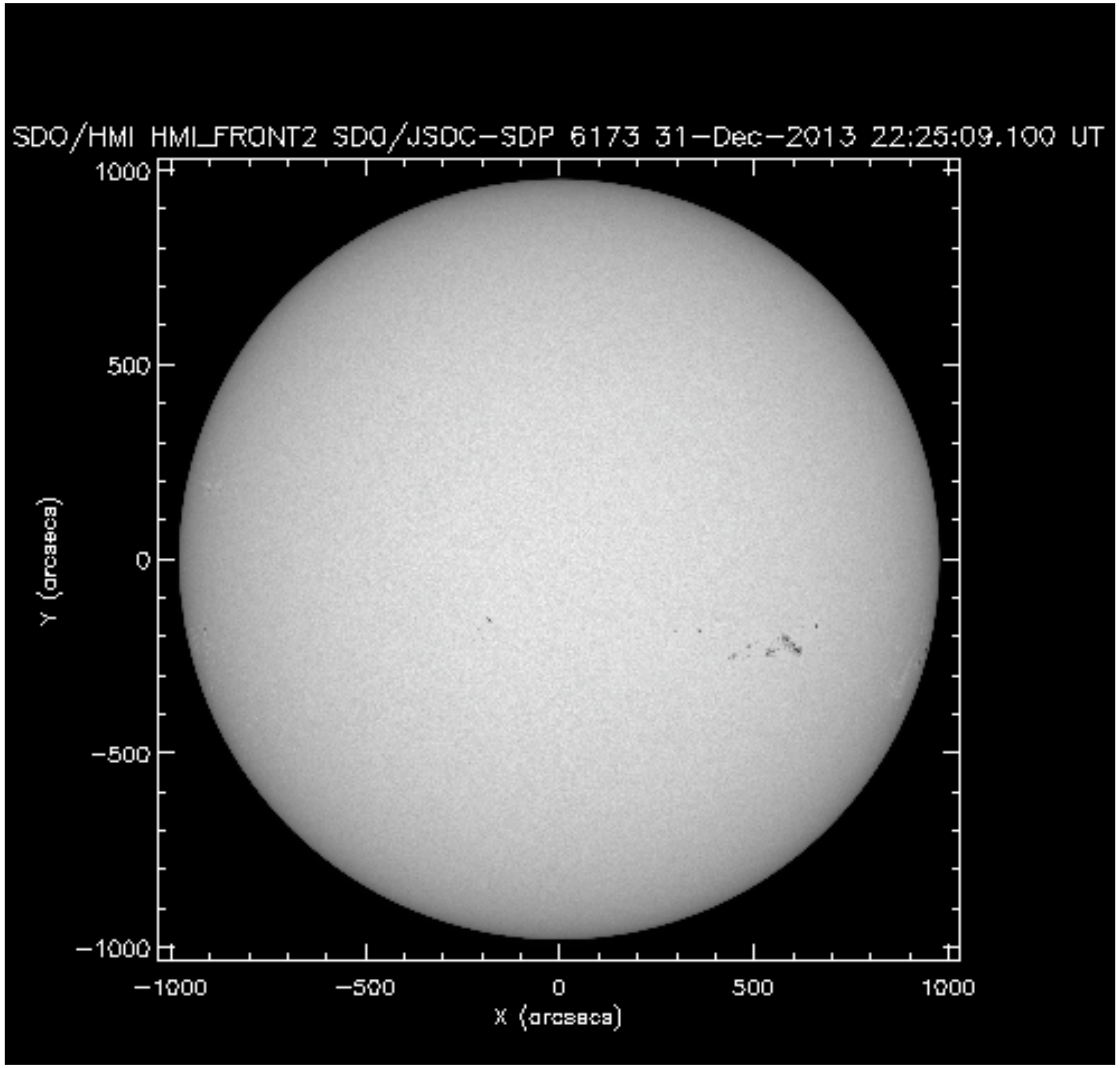
and so on...

Reading Data

SSW IDL SESSION

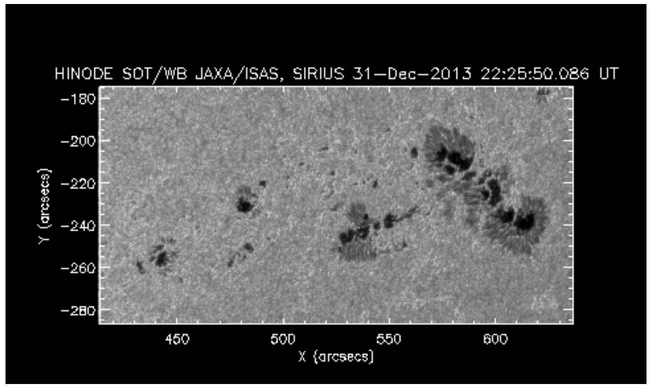
```
fits2map,'./sdo_hmi/hmi.ic_45s.2013.12.31_22_26_15_TAI.continuum.fits',cont_hmimap
plot_map,cont_hmimap

cont_hmimap=rot_map(cont_hmimap,cont_hmimap.roll_angle)
plot_map,cont_hmimap
```

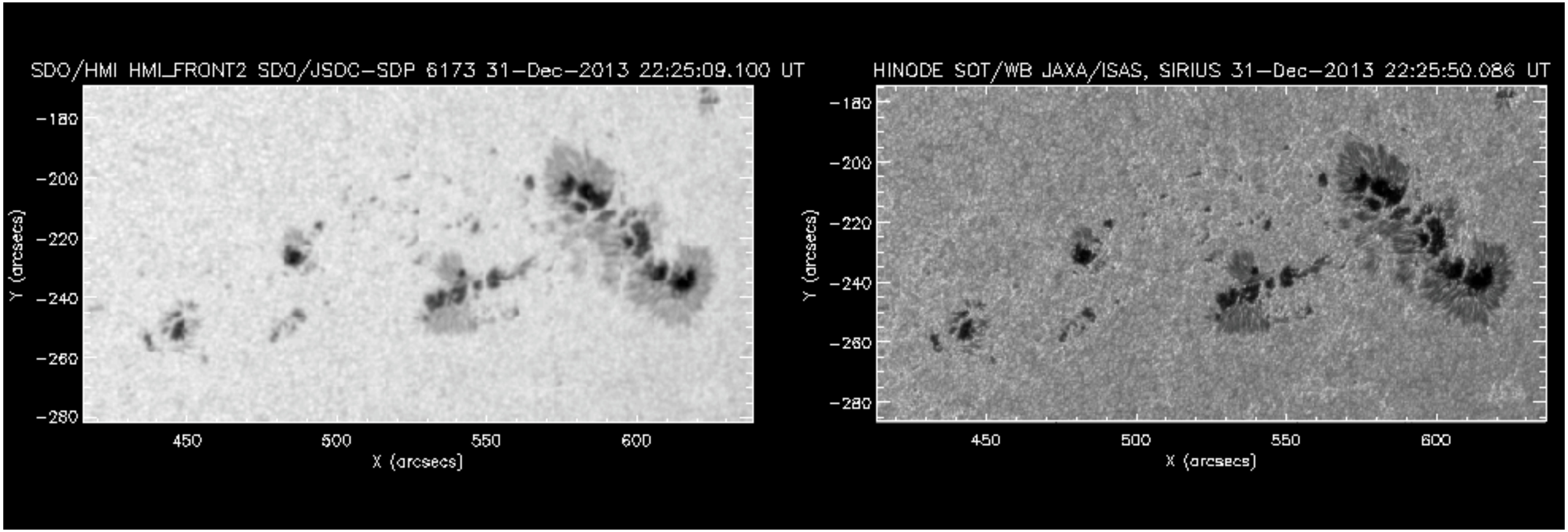




SSW IDL SESSION

```
read_sot,'./hinode/FG20131231_222550lev1.fits',indexsotfg,datasotfg
indexsotfg.wave
fits2map,'./hinode/FG20131231_222550lev1.fits',gband_sotmap
plot_map,gband_sotmap
sub_map,cont_hmimap,smap_cont_hmimap,ref_map=gband_sotmap
window,xs=1000,ys=500
!p.multi=[0,2,1]
plot_map,smap_cont_hmimap
plot_map,gband_sotmap
!p.multi=0
```





Alignment Useful Programs

Shifts

corshft_sbsp find the shift between line 1 and line 2 by correlation
sub-pixel accuracy with polynomial interpolation

fshft_sbsp shift array line by non-integer pixel shift sh by fourier
or linear interpolation; uses wraparound for ends

correl_optimize Find the optimal (x,y) pixel offset of
image_B relative to image_A

Rotation

rotate The ROTATE function returns a rotated and/or transposed copy of
Array. ROTATE can only rotate arrays in multiples of 90 degrees.

rot To rotate by amounts other than multiples of 90 degrees,
use the ROT function.

Scaling

rebin REBIN requires integral factors of the original image size.

congrid Shrink or expand the size of an array by an arbitrary amount.

frebin FREBIN is an alternative to CONGRID or REBIN. Like CONGRID it allows expansion or contraction by an arbitrary amount. Like REBIN it conserves flux by ensuring that each input pixel is equally represented in the output array.

Alignment

Alignment using shift for a time series `align_cube_correl`

Alignment using shift,rotation,scaling and opt. general warping

<u>METCALF ROUTINES</u>

auto_align_images *used in for example trace_mdi_align. Can take long!*

Example:

inew=auto_align_images(transformed_image,reference_image,pin,qin,pout,qout)

Need very good first guess!

```
;NAME:
;     AUTO_ALIGN_IMAGES
;PURPOSE:
;     Align arbitrary images using a cross correlation.  This routine is
;     particularly useful for images from different instruments in which
;     a very general transformation between the two images is required.
;     Don't use this routine if you only need to shift the two images on
;     top of one another.  It'll work, but it will be much slower than
;     you need.
```

rss2pq Given a rotation, shift and scale change, returns the p and q variables used in poly_2d to warp images.

pq2rss Converts the P and Q variables in a call to poly_2d into a rotation, scale change, and shift.

Alignment

Just taking the submap from before and congridding. Result:

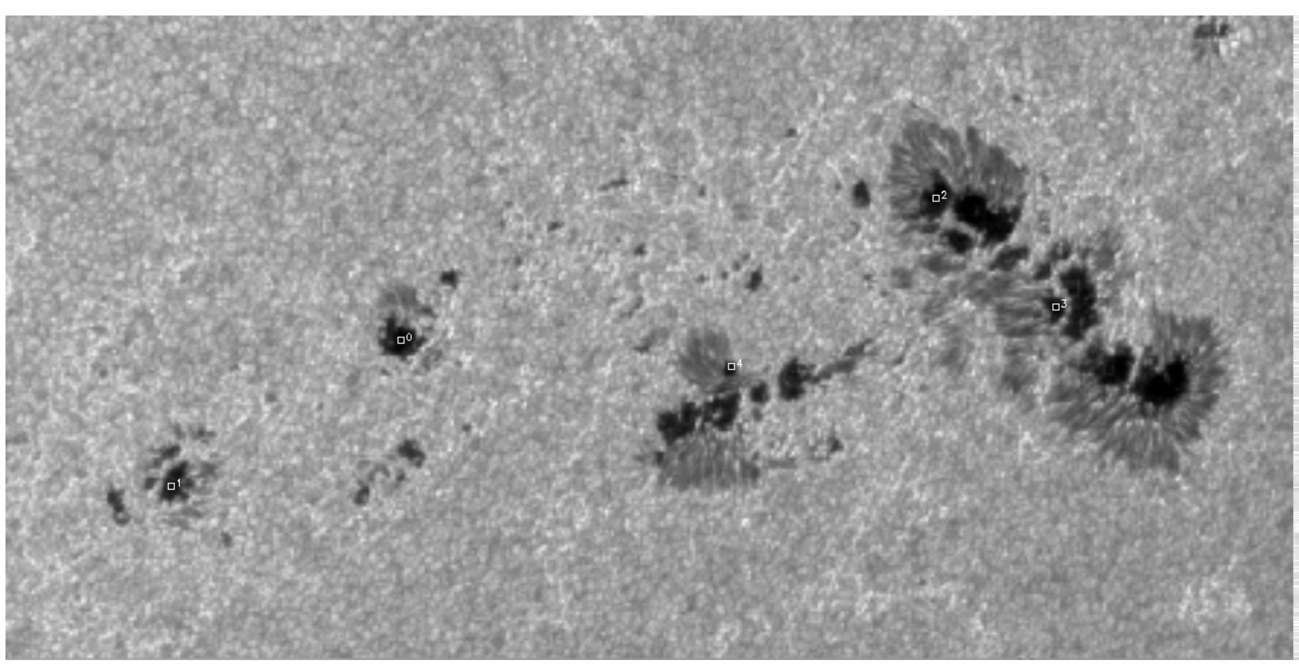
SSW IDL SESSION

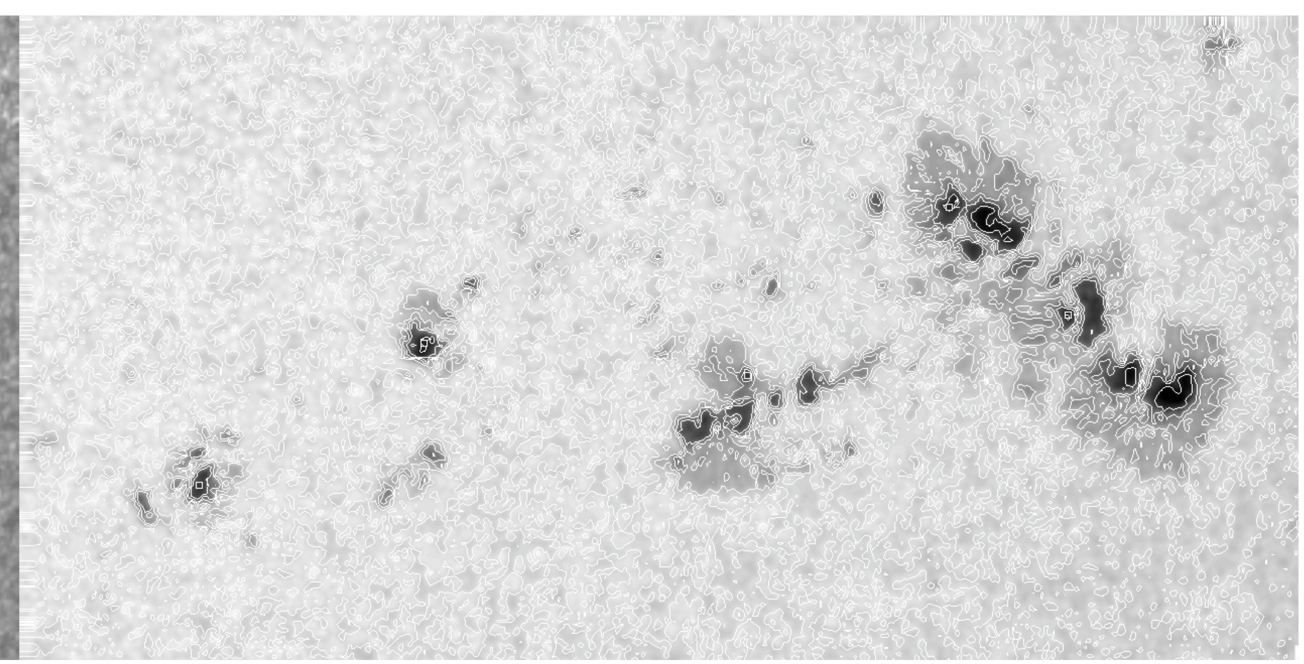
```
help,smap_cont_hmimap.data
help,gband_sotmap.data
newgb=congrid(gband_sotmap.data,443,222)
window,xs=443,ys=222
tvscl,newgb
window,2,xs=443,ys=222
contsdo=smap_cont_hmimap.data
tvscl,contsdo
blink,[0,2]
```

Finetuning:

```
Setpts,pp,contsdo,newgb
tt = caltrans(pp)
```

SSW IDL SESSION





Alignment

SSW IDL SESSION

```
pin = tt[*,0]
qin = tt[*,1]
resim=auto_align_images(contsdo,newgb,pin,qin,pout,qout,scale=1,/quiet)
pq2rss,pout,qout,erot,exscl,eyscl,exshft,eyshft
```

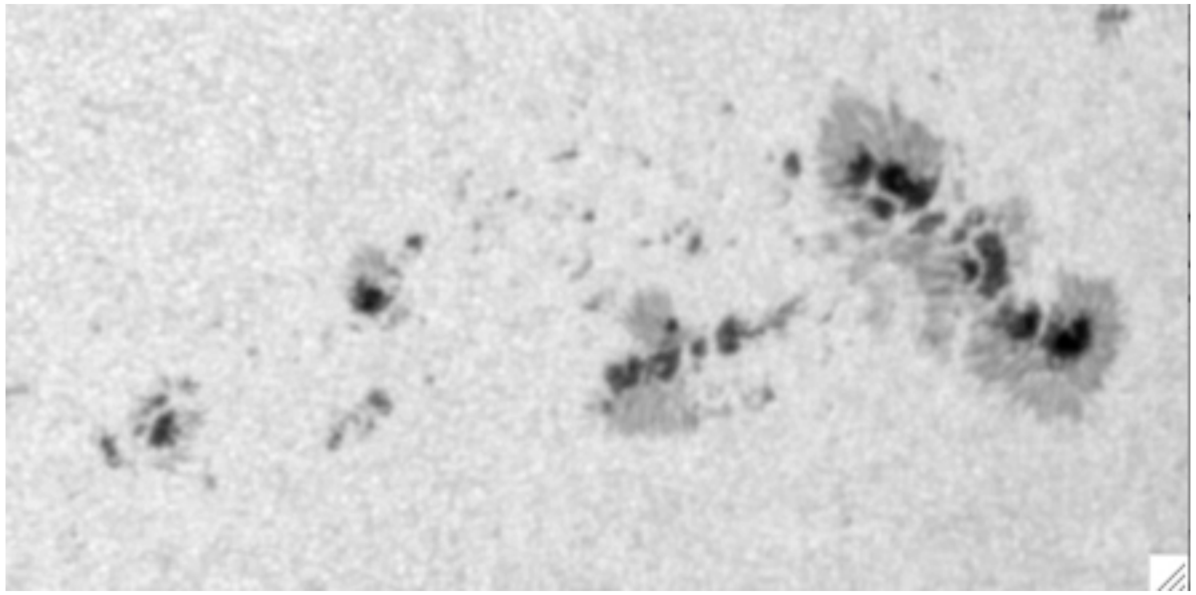
Reference image

New transformed image

```
rotation =  0.167860 degrees
scale x =  1.01772
scale y =  1.01854
shift x =  -4.48291
shift y =  -0.545593
```

Before

After



AR ?????   GB data

(1) Get an overview of the active region

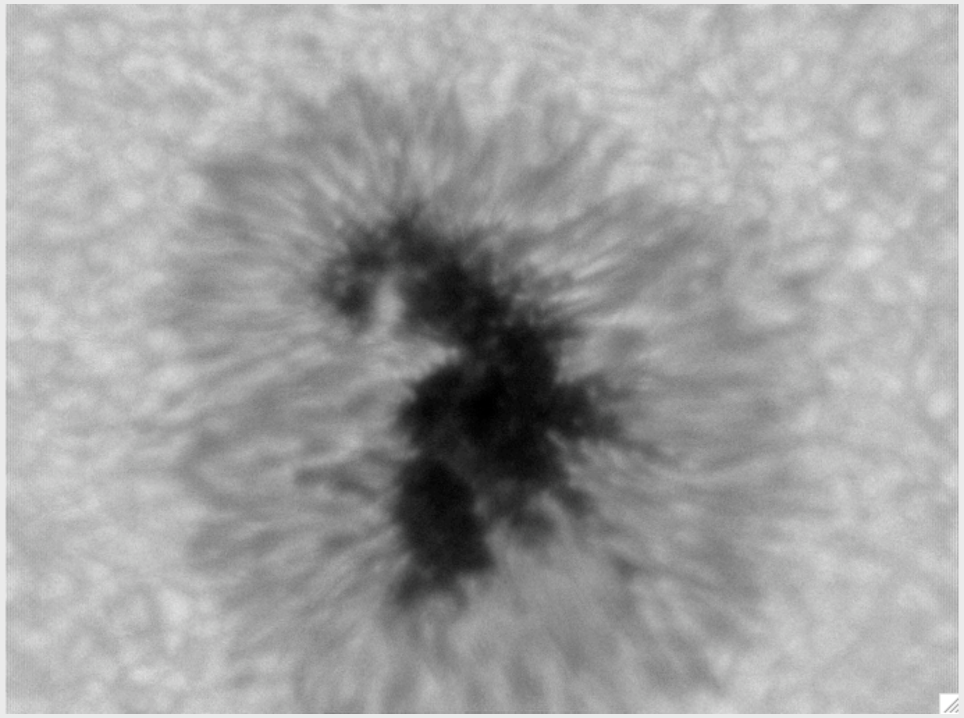
https://www.solarmonitor.org/
JHelioviewer

(2) Look for co-observations (no data download)

IRIS/ HINODE
https://iris.lmsal.com/data.html
http://sdc.uio.no/sdc/

Folder DATASET2
dataset2/gfpi/

Example BB_TS image



Need to rotate(image,7)

Data_gfpi_12-08-2014.sav

Contains

BB_TS A broadband image from line scan
DATE_OBS The times of the observations
NBCORE_TS A Narrowband image in the core of the line
CDELT1 GFPI Pixel size
CDELT2 GFPI Pixel size

scannb_080935.sav

Contains

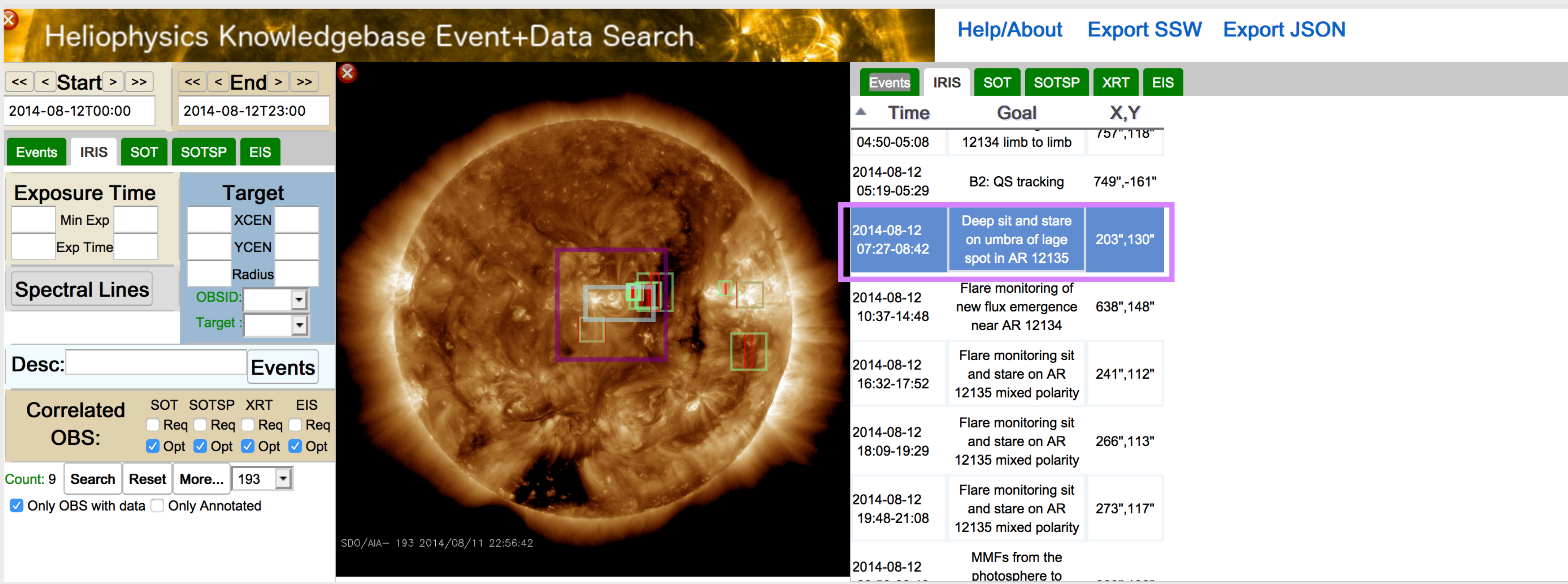
NBSCAN A Narrowband scan through the line with 8 accumulations per wavelength point

DATASET2 CONTENT FOR AR 12135

Download from http://www.lmsal.com/heksearch/

Level 2 Slitjaw
Raster
Movies

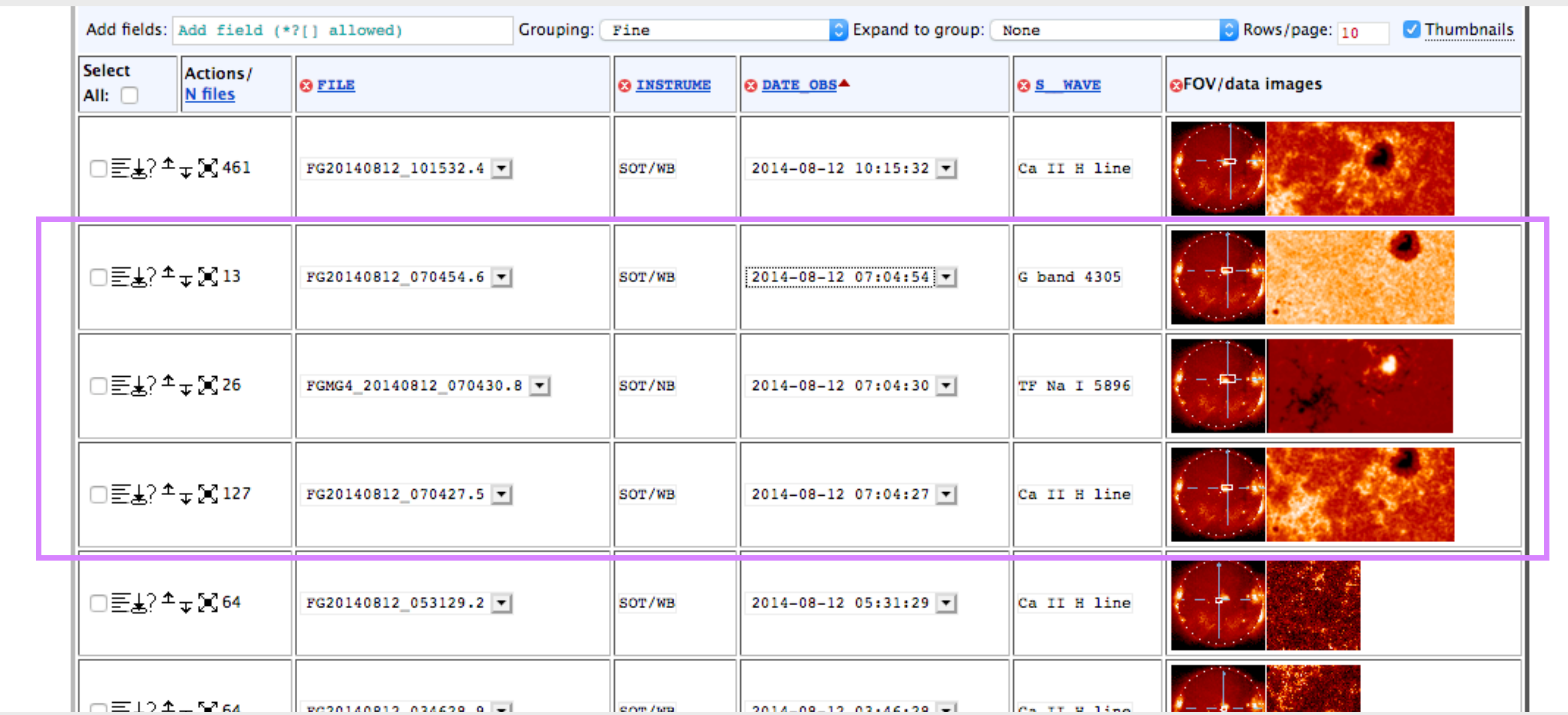
Folder DATASET2
dataset2/iris/



DATASET2 CONTENT FOR AR 12135

Download
Need to:
Run fg_prep with despike -> Obtain level 1 fits files
Make FG los magnetograms
OR Download level 1 products from
http://sot.lmsal.com/data/sot/level1d/

Folder DATASET2
dataset2/hinode/


Add fields: Add field (*?[] allowed) Grouping: Fine Expand to group: None Rows/page: 10 Thumbnails

Select All:	Actions/ N files	FILE	INSTRUME	DATE_OBS	S__WAVE	FOV/data images
	461	FG20140812_101532.4	SOT/WB	2014-08-12 10:15:32	Ca II H line	
	13	FG20140812_070454.6	SOT/WB	2014-08-12 07:04:54	G band 4305	
	26	FGMG4_20140812_070430.8	SOT/NB	2014-08-12 07:04:30	TF Na I 5896	
	127	FG20140812_070427.5	SOT/WB	2014-08-12 07:04:27	Ca II H line	
	64	FG20140812_053129.2	SOT/WB	2014-08-12 05:31:29	Ca II H line	
	64	FG20140812_034628.9	SOT/WB	2014-08-12 03:46:28	Ca II H line	

DATASET2 CONTENT FOR AR 12135

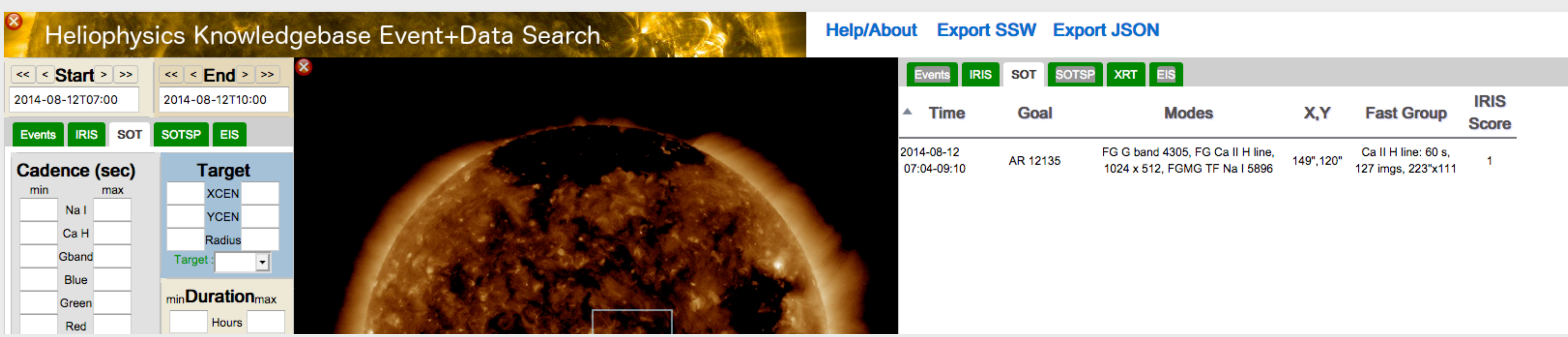
Download from http://www.lmsal.com/heksearch/

Folder DATASET2
dataset2/hin_sdo_ir_aligned/

+ SDO_1600_1700 in dataset2/sdo_aia_cutout/

"Similarly, Hinode/SOT and IRIS images are co-aligned using their respective header information. For these co-aligned datacubes, the headers of the Hinode/SOT images are updated with results from cross-correlation between ***SOT Ca II H images with the AIA 1700 Å channel.*** *This co-alignment does not always work perfectly, errors up to 10-15 arcsec ar possible, but usually much less. As such, the co-alignment between Hinode and IRIS data is not perfect due to uncertainties of the pointing information in the headers of the IRIS and Hinode/SOT data. The offsets can be up to about ±5 arcsec in x and y directions for observations taken near the solar disk center and increase for observations recorded closer to the limb. Therefore, the cubes may need a small co-alignment tuning by the user. "*

ITN 32

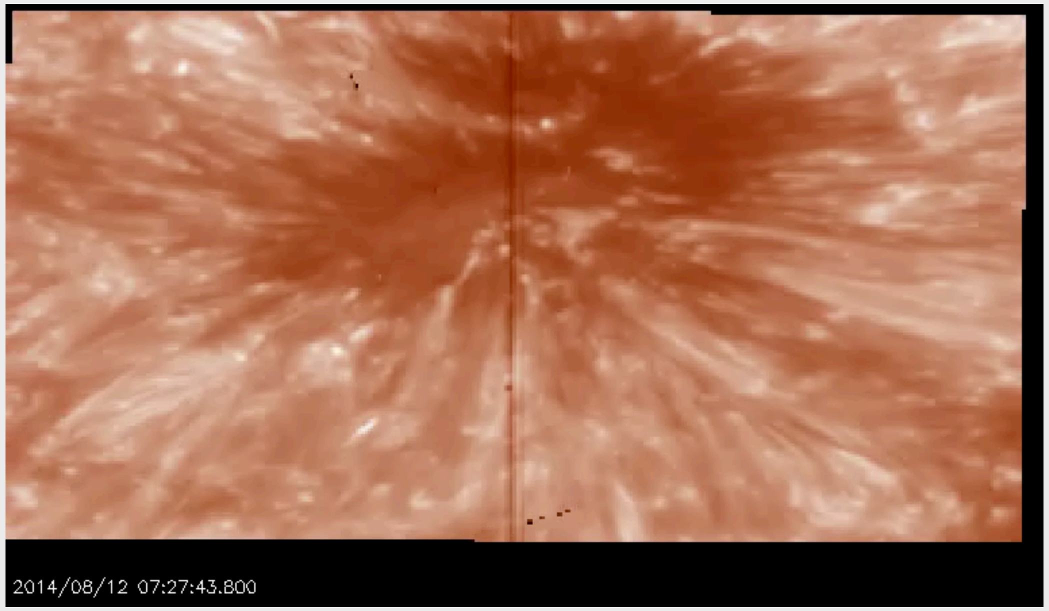


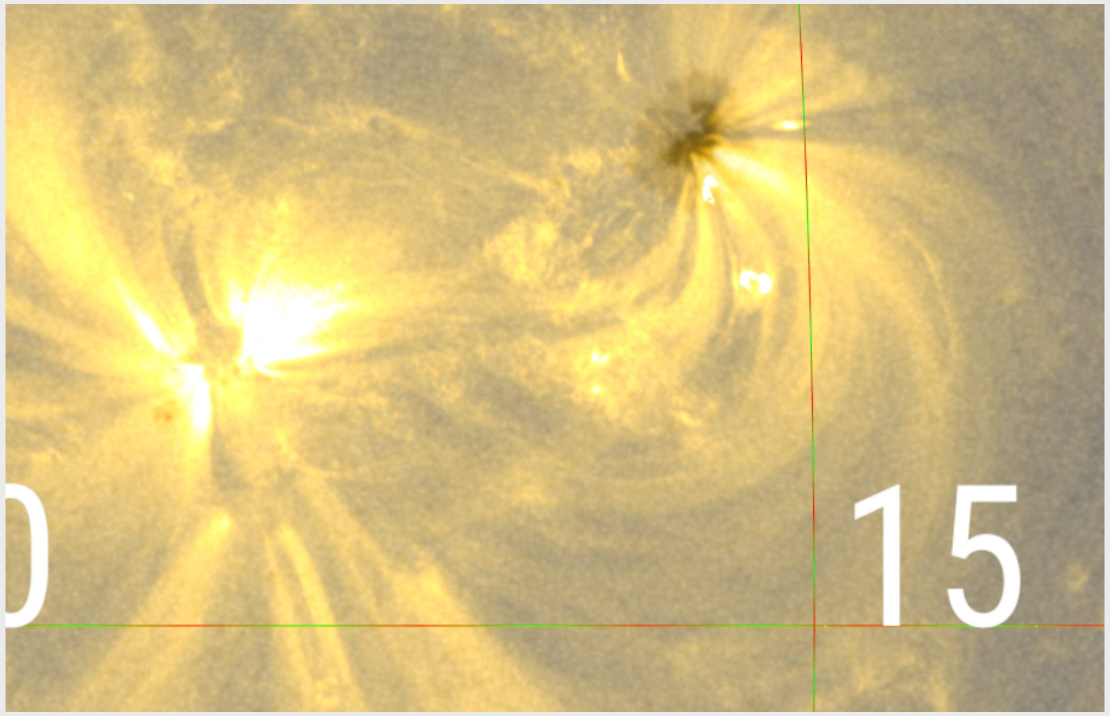
EVENT SUMMARY AR 12135

(4) Find interesting times/areas you want to look into, for example check the IRIS Slitjaw movie or Jhelioviewer (SDO HMI data is also available on the USB stick at 08.09 UT in **DATASET2/sdo_hmi**)
(5) See if you have co-observations
(6) Read in the data
(7) Extract for example submaps to compare
(8) Align for your chosen timestamp, for example, one of the co-observed Hinode SOT Gband images with one of the Broadband images of GFPI or other compatible wavelength, or the SDO HMI cont. with GFPI BB data
(9) Check a GFPI scan H-alpha profile, a sample scan from 08.09 UT is on the USB stick in case you do not have the files from the Wednesday tutorial

EVENT SUMMARY AR 12135

(4) Find interesting times/areas you want to look into, for example check the IRIS Slitjaw movie or Jhelioviewer (SDO HMI data is also available on the USB stick at 08.09 UT in **DATASET2/sdo_hmi**)
(5) See if you have co-observations
(6) Read in the data
(7) Extract for example submaps to compare
(8) Align for your chosen timestamp, for example, one of the co-observed Hinode SOT Gband images with one of the Broadband images of GFPI or other compatible wavelength, or the SDO HMI cont. with GFPI BB data
(9) Check a GFPI scan H-alpha profile, a sample scan from 08.09 UT is on the USB stick in case you do not have the files from the Wednesday tutorial

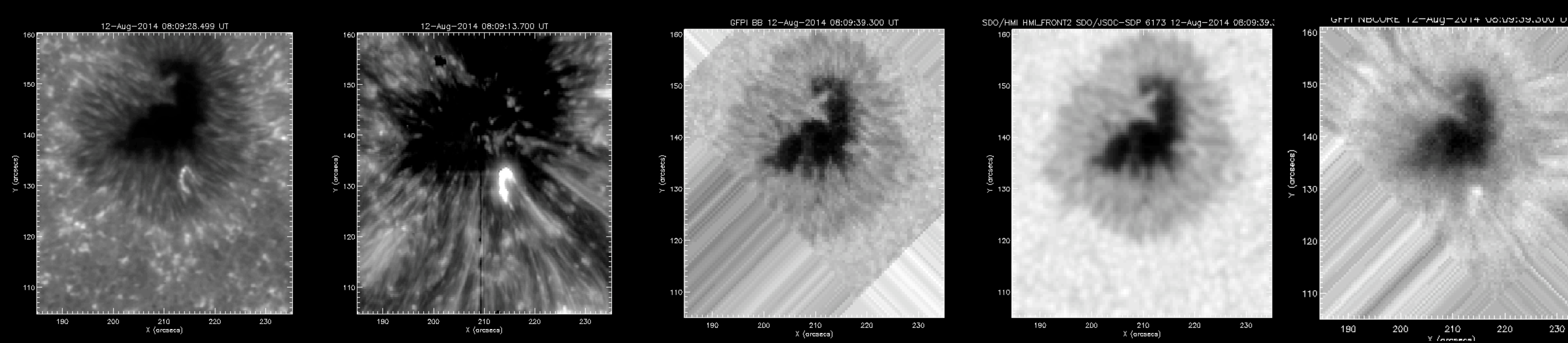




EVENT SUMMARY AR 12135

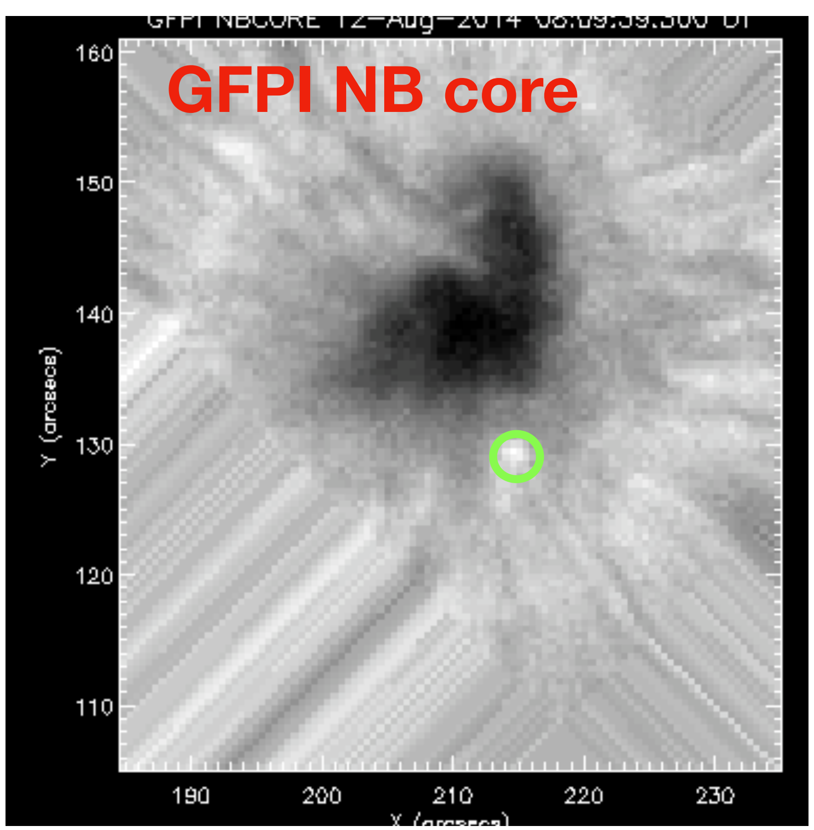
(4) Find interesting times/areas you want to look into, for example check the IRIS Slitjaw movie or Jhelioviewer (SDO HMI data is also available on the USB stick at 08.09 UT in **DATASET2/sdo_hmi**)
(5) See if you have co-observations
(6) Read in the data
(7) Extract for example submaps to compare
(8) Align for your chosen timestamp, for example, one of the co-observed Hinode SOT Gband images with one of the Broadband images of GFPI or other compatible wavelength, or the SDO HMI cont. with GFPI BB data
(9) Check a GFPI scan H-alpha profile, a sample scan from 08.09 UT is on the USB stick in case you do not have the files from the Wednesday tutorial

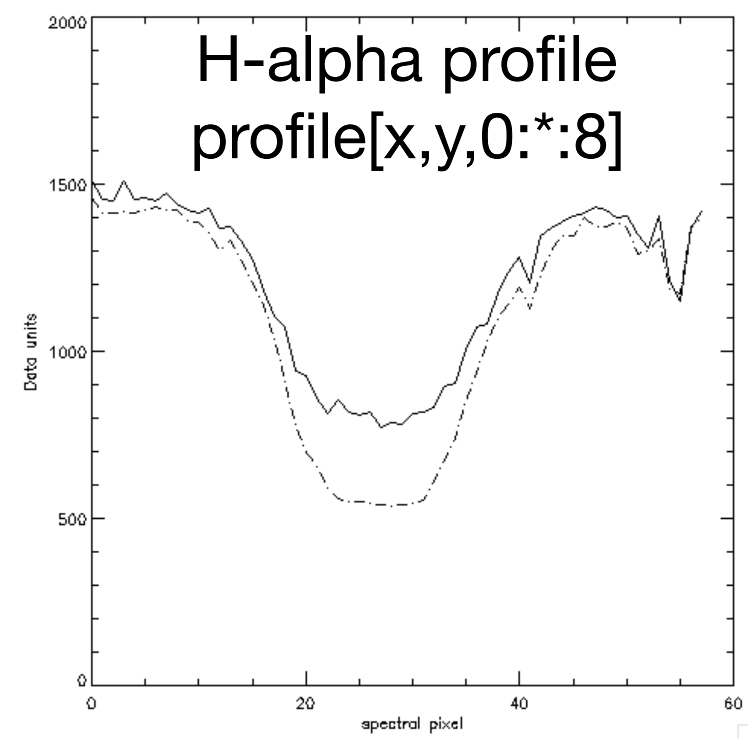
Hinode Ca II H | IRIS 1400 SLJ | GFPI BB | SDO HMI | GFPI NB Core



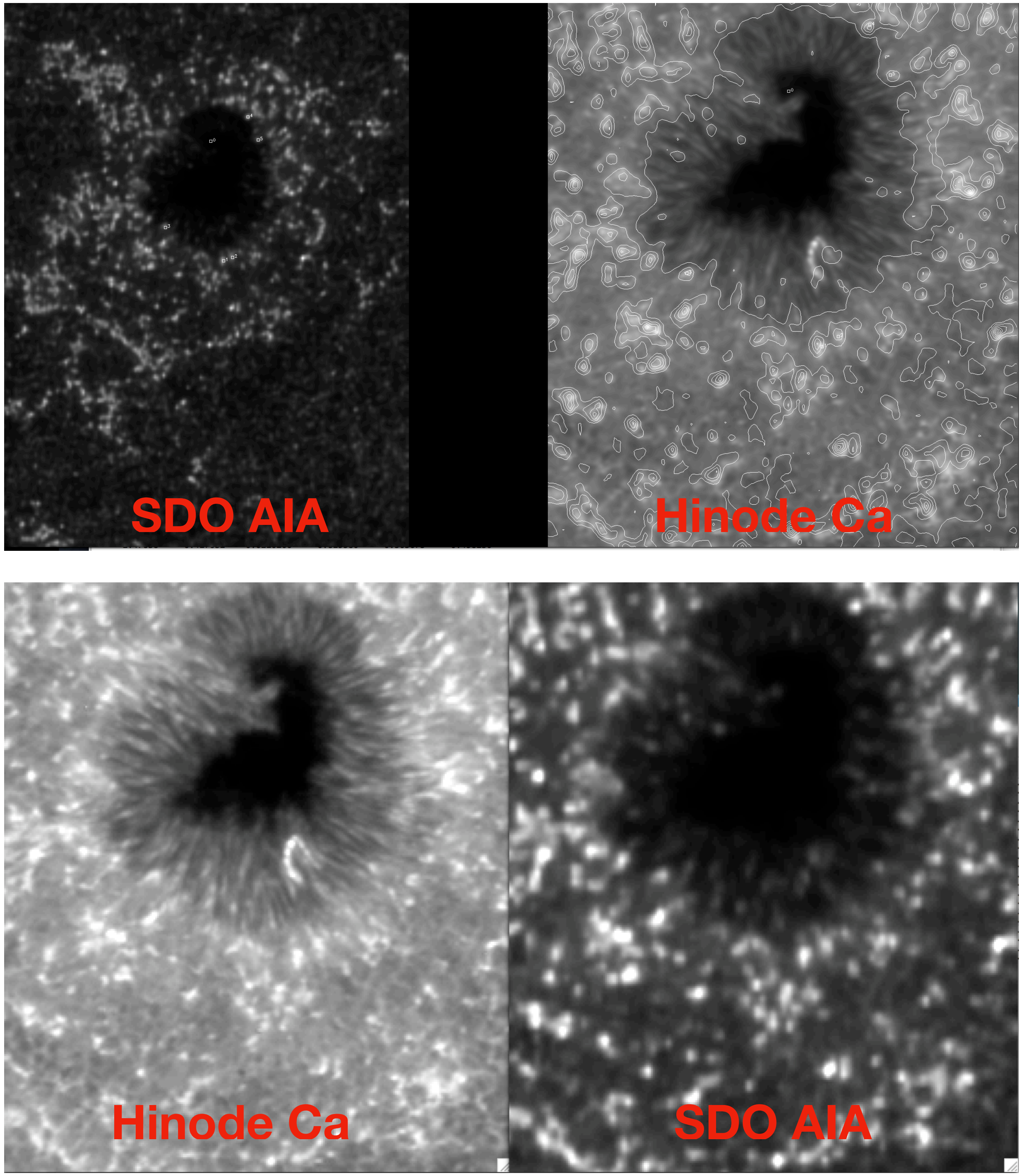
EVENT SUMMARY AR 12135

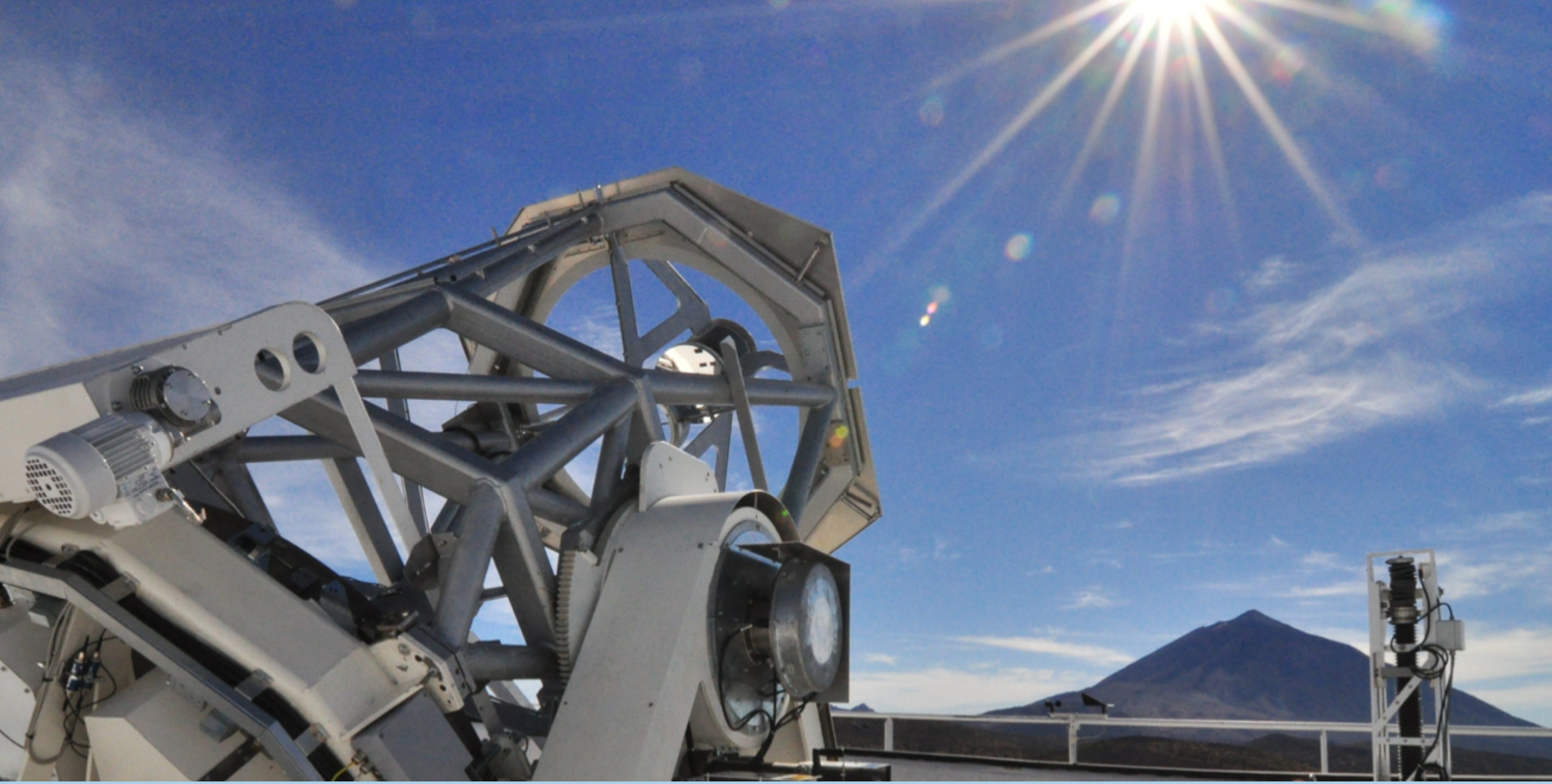
(4) Find interesting times/areas you want to look into, for example check the IRIS Slitjaw movie or Jhelioviewer (SDO HMI data is also available on the USB stick at 08.09 UT in **DATASET2/sdo_hmi**)
(5) See if you have co-observations
(6) Read in the data
(7) Extract for example submaps to compare
(8) Align for your chosen timestamp, for example, one of the co-observed Hinode SOT Gband images with one of the Broadband images of GFPI or other compatible wavelength, or the SDO HMI cont. with GFPI BB data
(9) Check a GFPI scan H-alpha profile, a sample scan from 08.09 UT is on the USB stick in case you do not have the files from the Wednesday tutorial





Alignment SDO - Hinode





GREGOR, image taken by HP Doerr

***QUEST PhD positions will be announced 30 August in solar news**

Thank you for your attention