

Introduction to IRIS data analysis

Tiago M. D. Pereira

Monday, May 2, 2016

10:00–11:00 Introduction to IRIS

11:00–11:15 *Break*

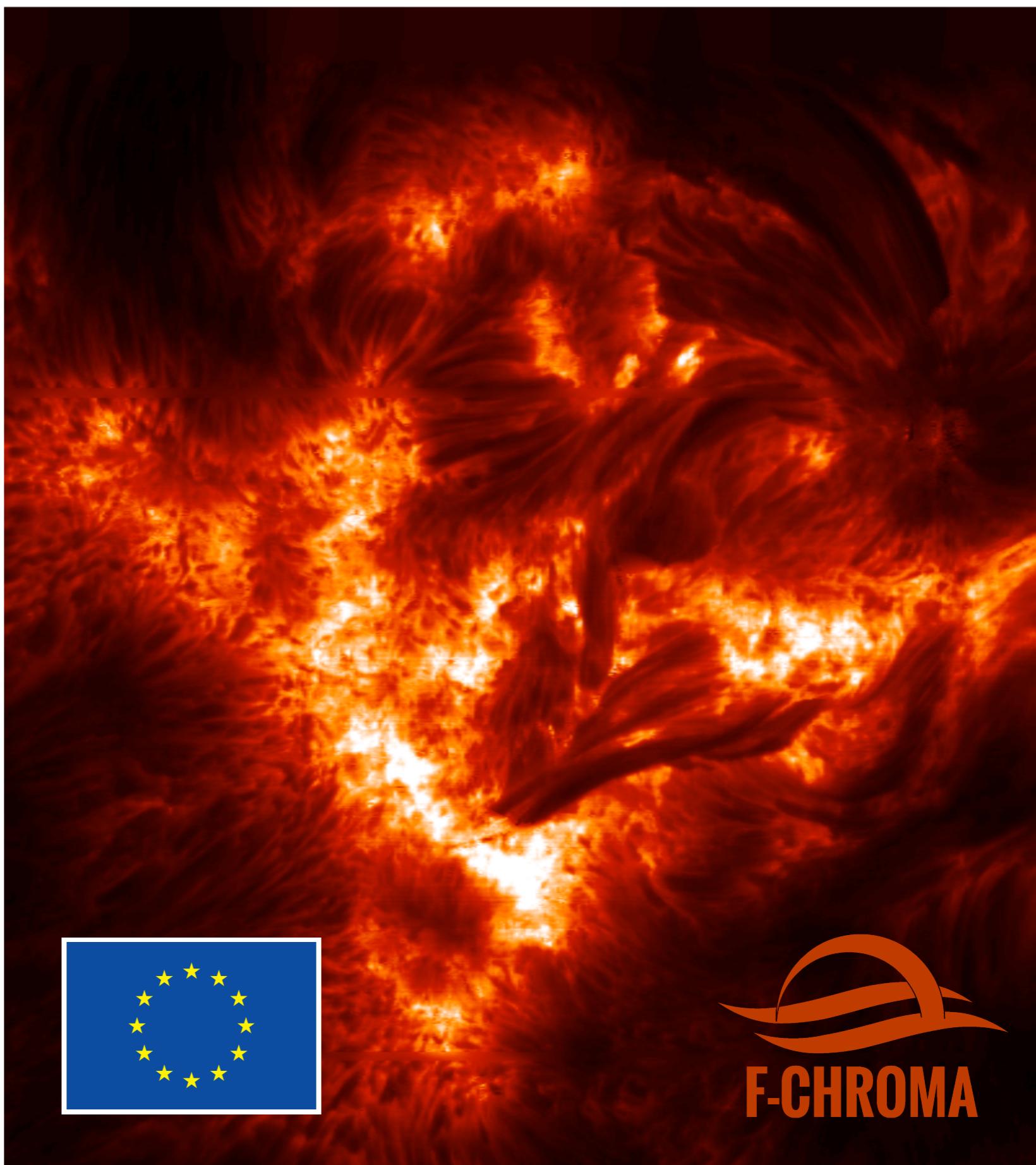
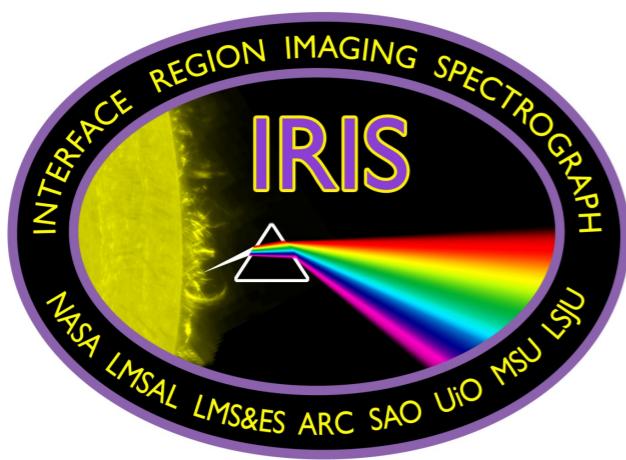
11:30–12:30 CRISPEX

12:30–13:30 *Lunch*

13:30–14:30 Hands-on tutorials

14:30–14:45 *Break*

14:45–16:00 Hands-on tutorials



Lecture resources

Slides, notes, exercises:

http://folk.uio.no/tiago/iris_catania

Lecture overview

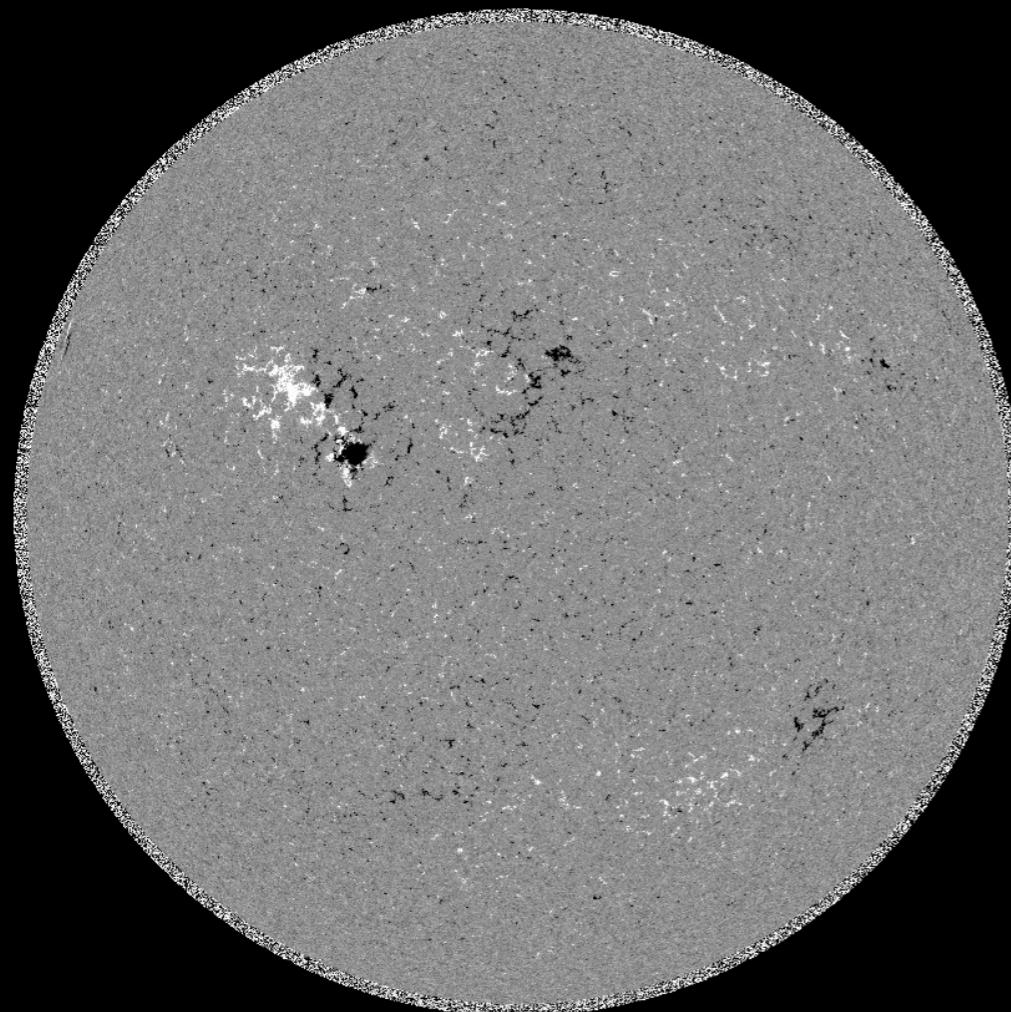
- Part 1
 - Overview of IRIS, capabilities and resources
 - Getting the data, quicklook tools
 - Working with IRIS data
- Part 2
 - Additional Data Calibration
 - Utility functions for Mg II lines
 - CRISPEX
 - Time to work on questions
- Tutorial
 - Exercise questions
 - Hands-on tutorials

Lecture overview

- Overview of IRIS, capabilities and resources
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- Additional Data Calibration
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 - Time to work on questions
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What is the interface region?

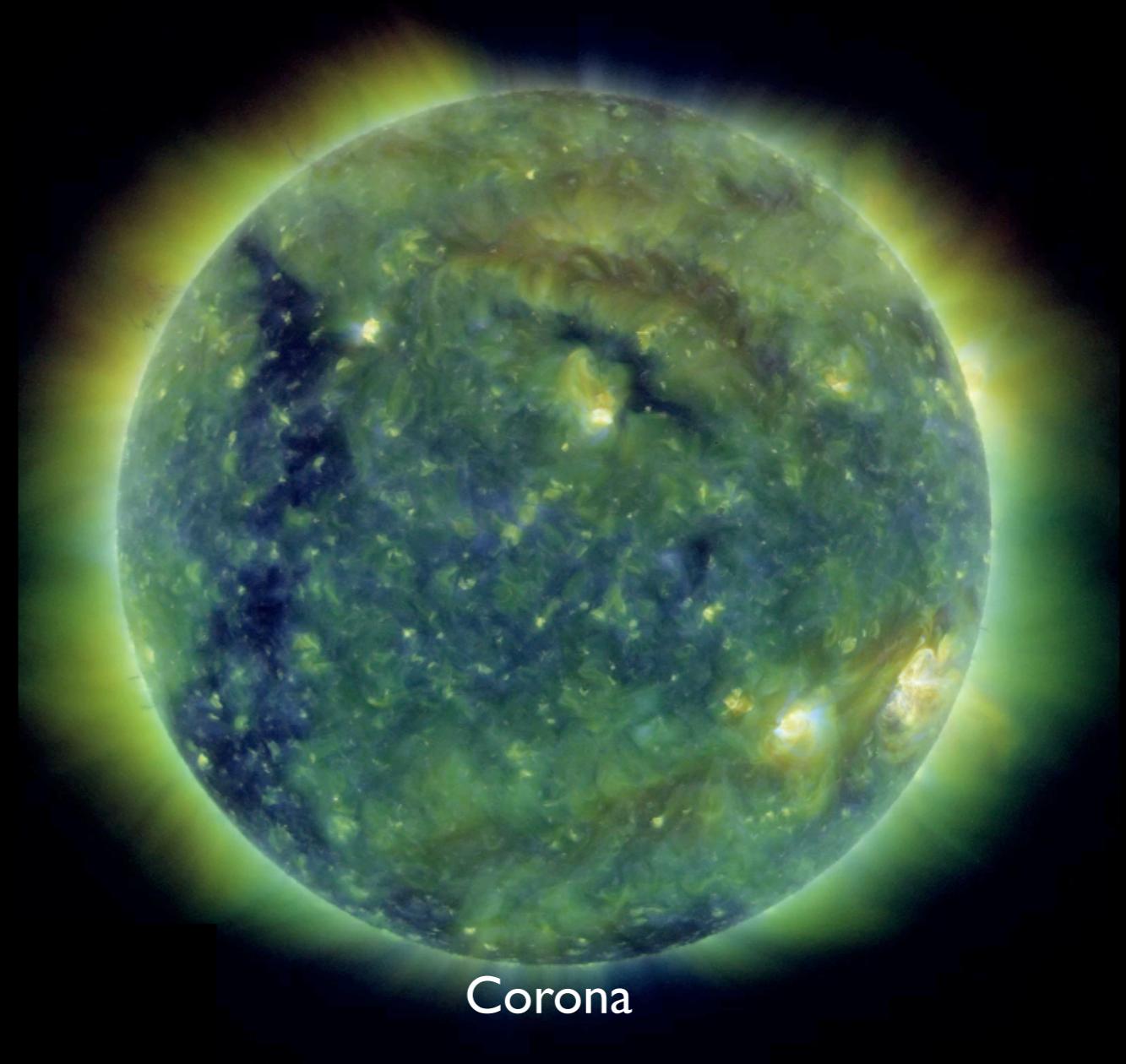
Source of magneto-convective energy



Photosphere

SDO/HMI 2010-08-01T23:44:03.500

1-10% of mechanical energy deposited in corona



Corona

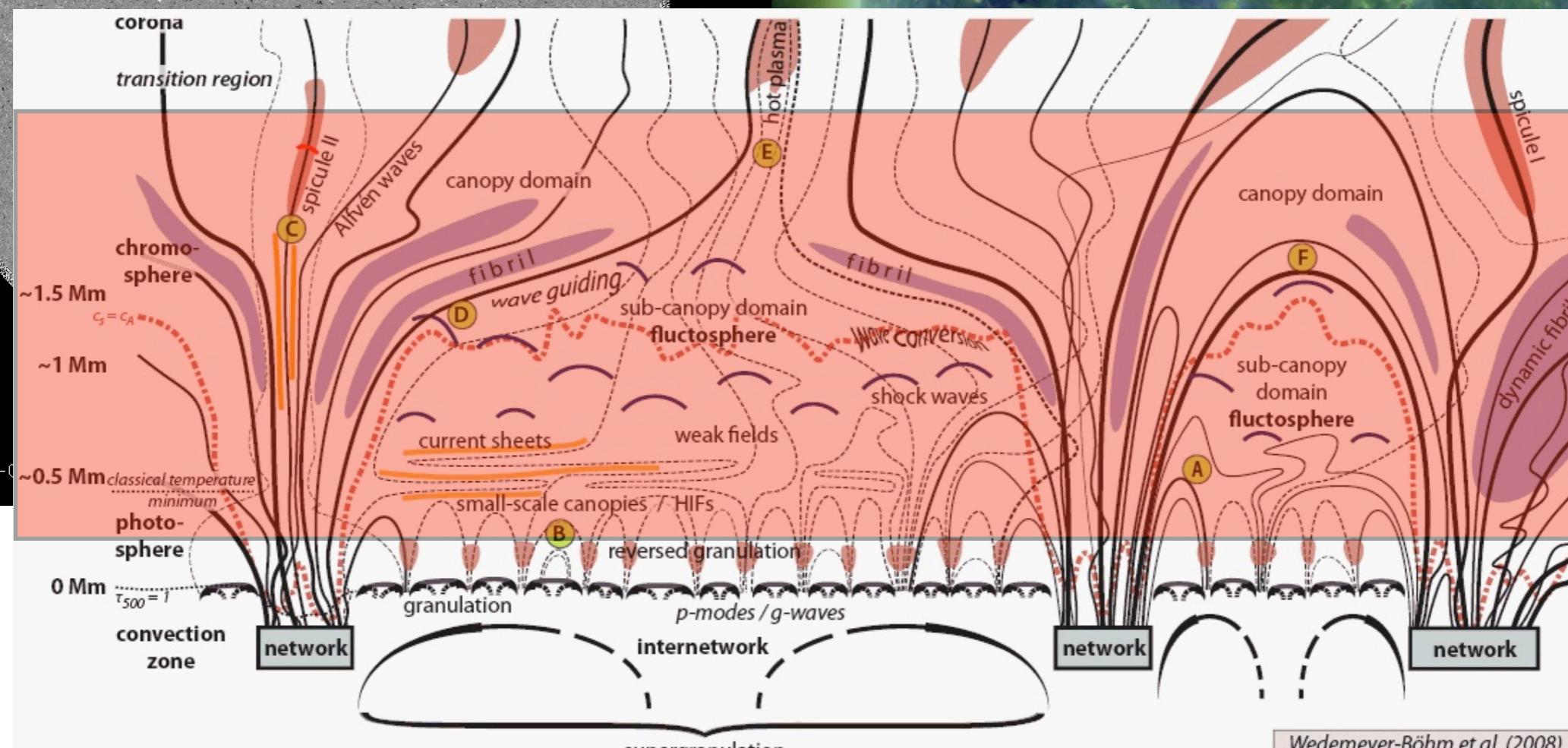
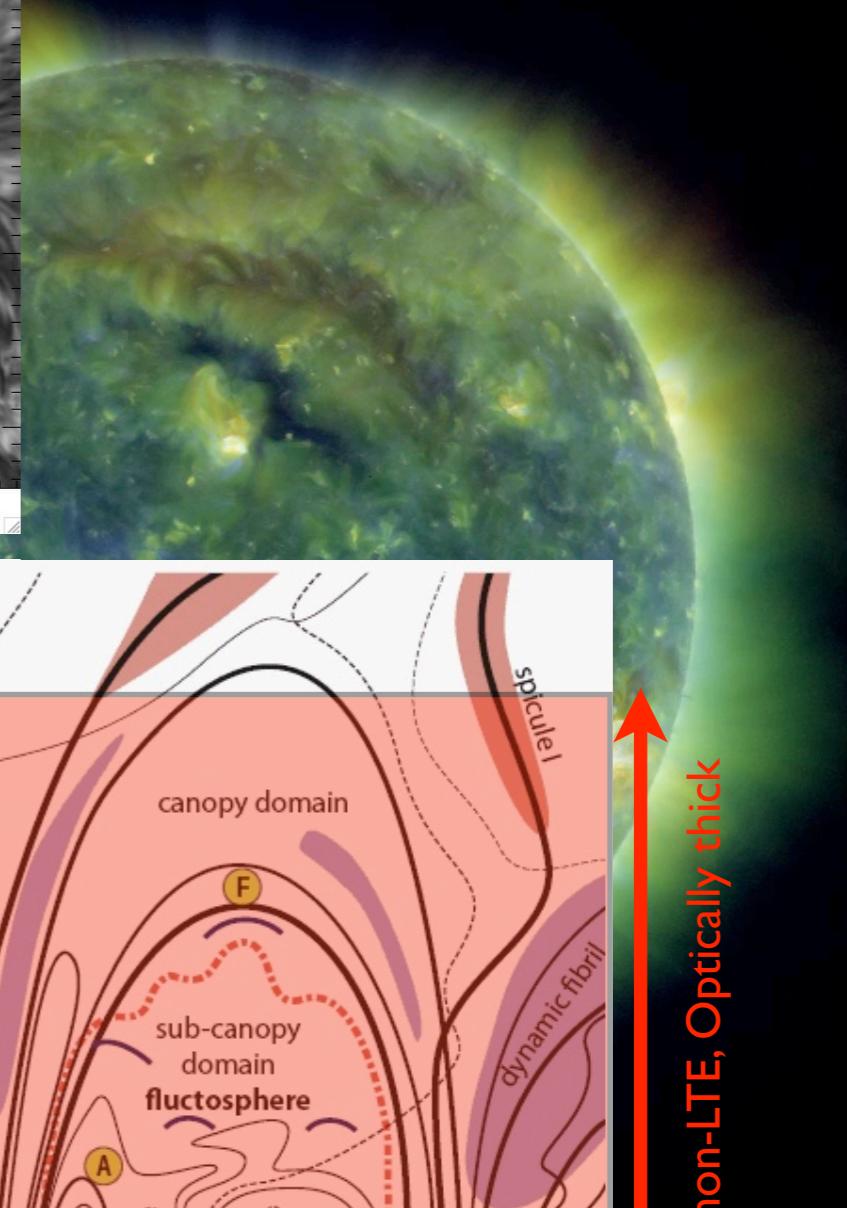
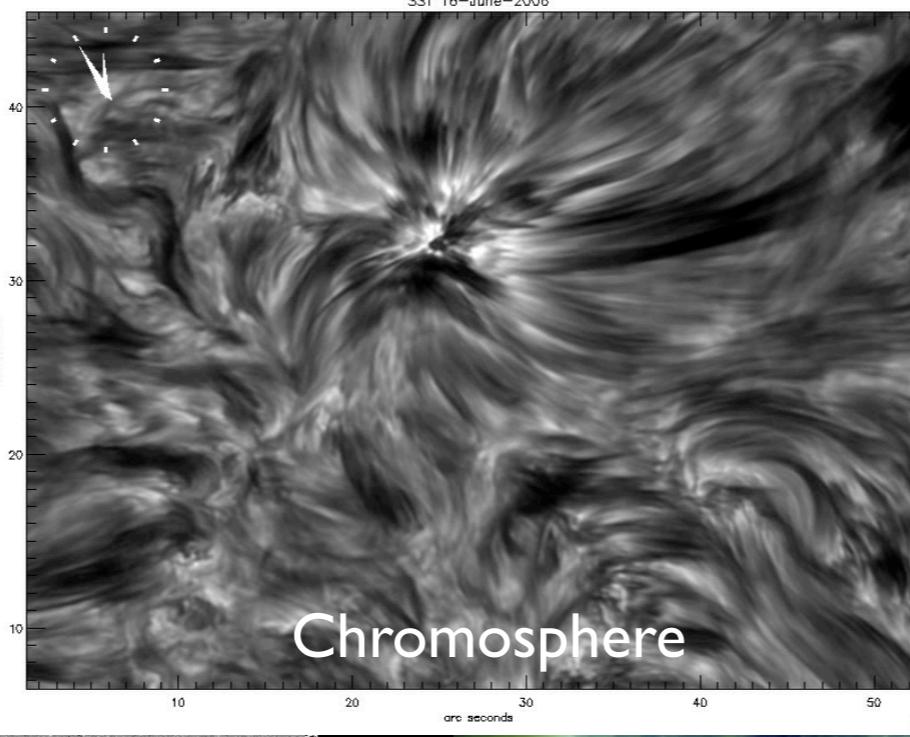
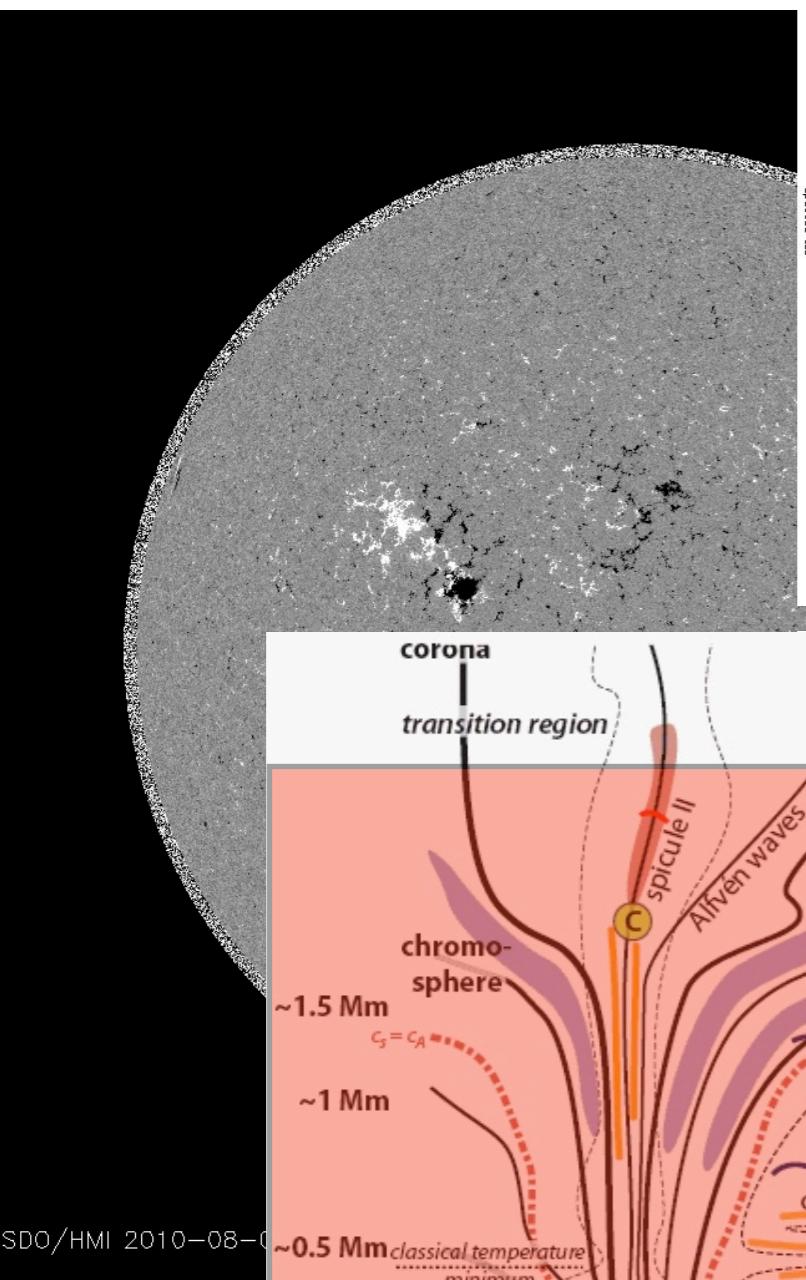
Courtesy Bart De Pontieu

What is the interface region?

Source of magneto-conve

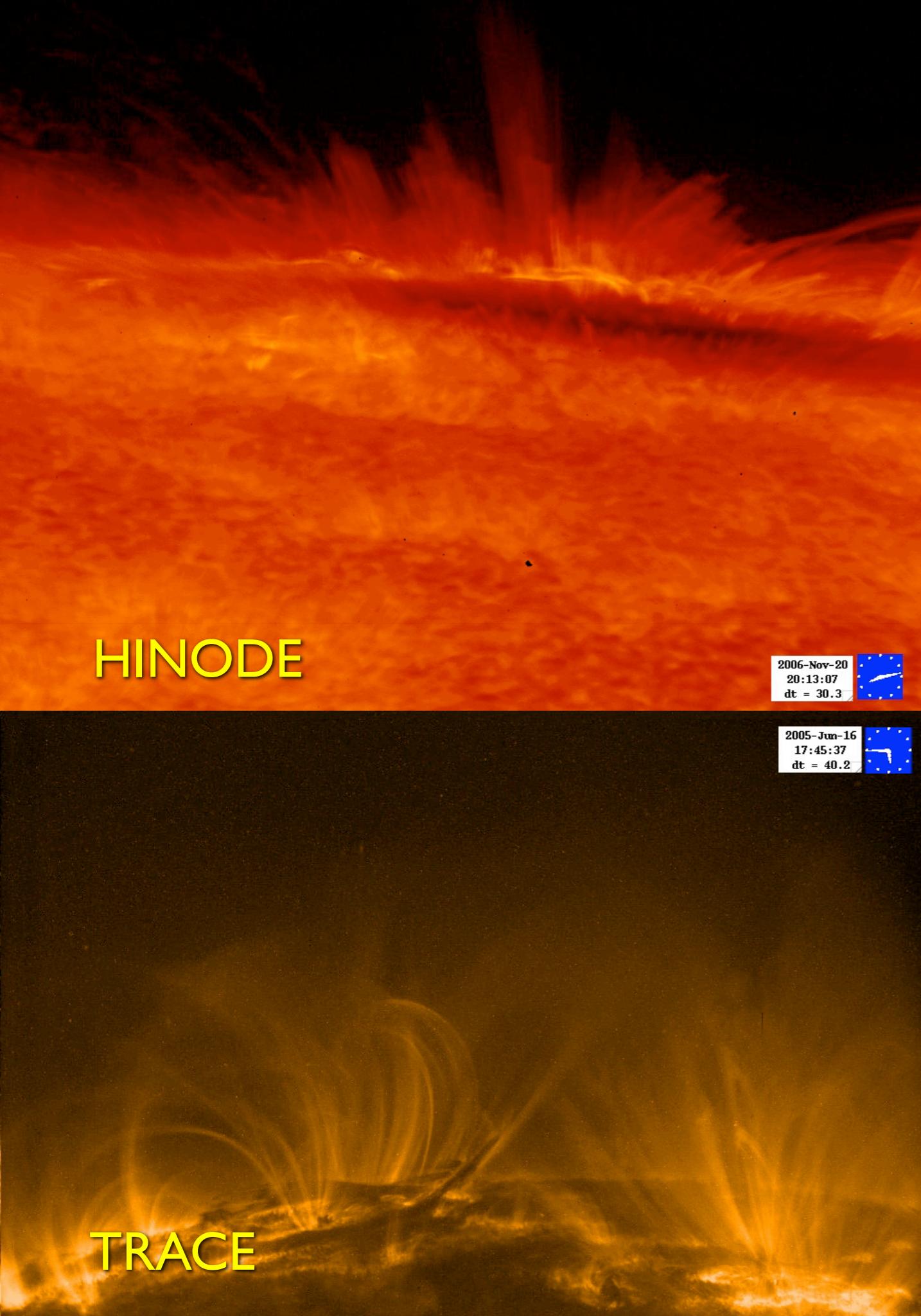
Most mechanical energy deposited in chromosphere

mechanical energy deposited in corona



Major Science Goals of IRIS

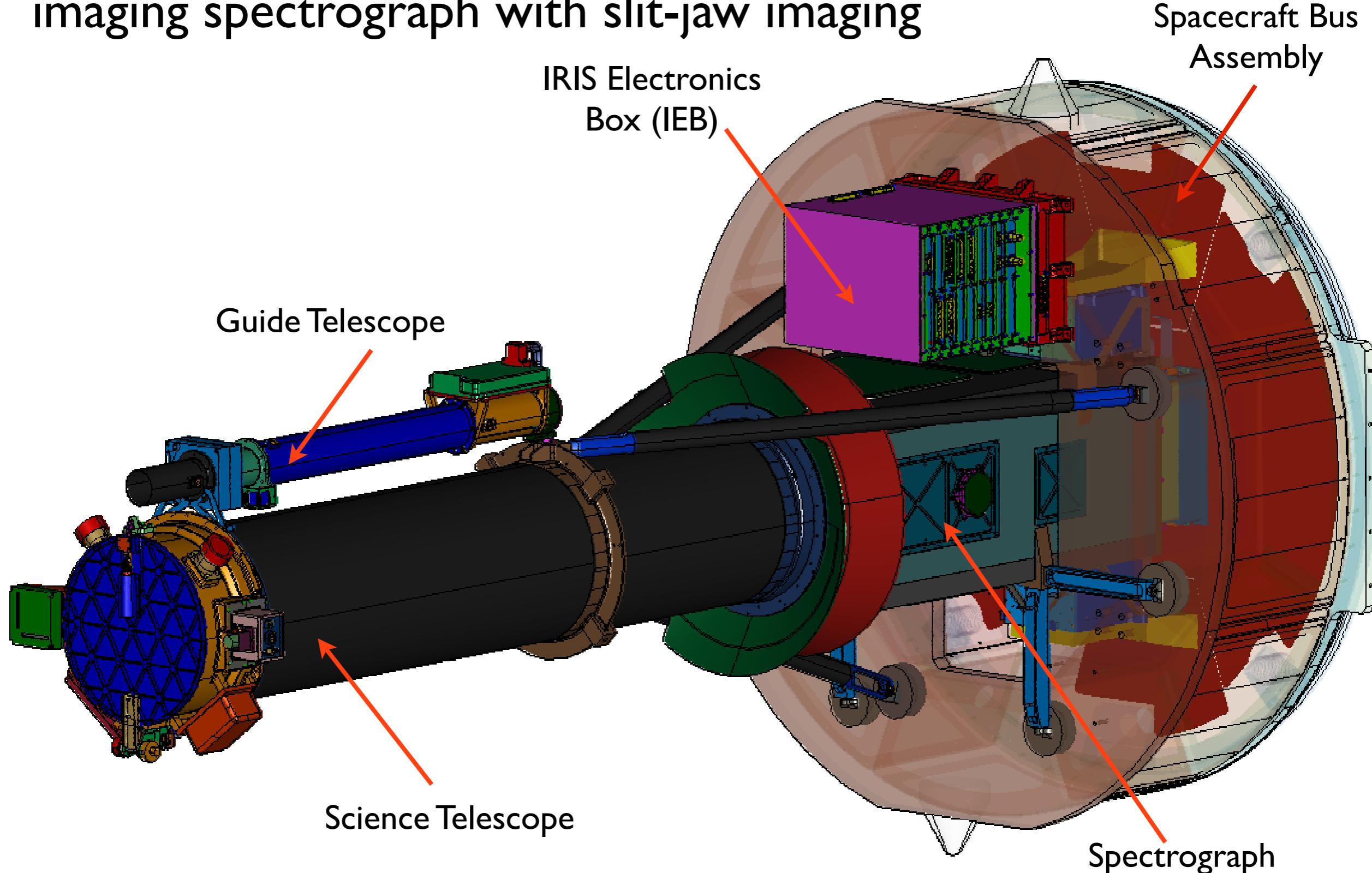
- A. Which types of non-thermal energy dominate in the chromosphere and beyond?
- B. How does the chromosphere regulate the mass and energy supplied to the corona and heliosphere?
- C. How does magnetic flux and matter rise through the lower atmosphere, and what is the role of flux emergence in powering flares and mass ejections?



Courtesy Bart De Pontieu

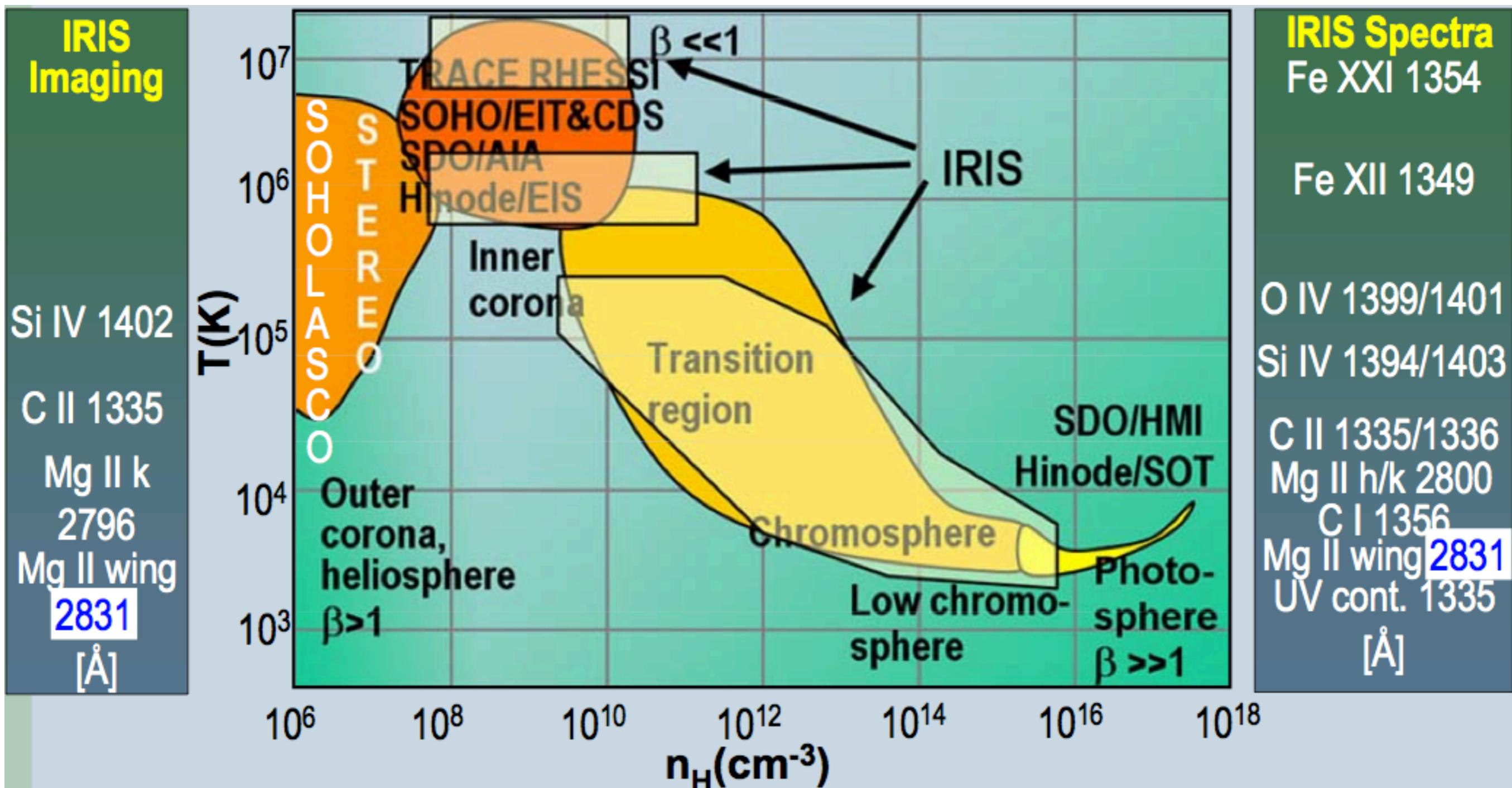
What is IRIS?

High resolution, far/near UV
imaging spectrograph with slit-jaw imaging



Courtesy Bart De Pontieu

IRIS spectra and slit-jaw imaging cover the photosphere, chromosphere, transition region and corona - 4,500 to 10,000,000 K



Courtesy Bart De Pontieu

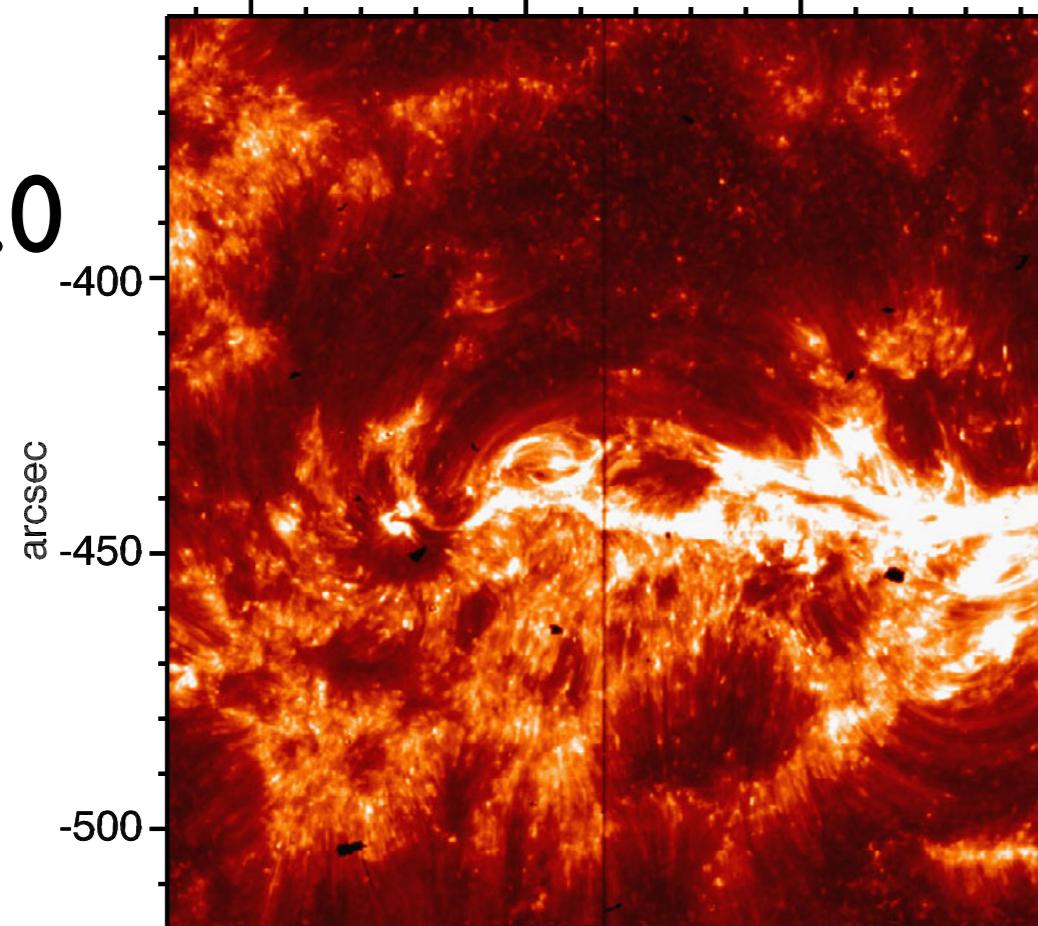
Table 2 IRIS spectrograph channels. Dispersion, Camera Electronics Box (CEB), and Effective Area (EA) vary for the three bandpasses.

Band	Wavelength [Å]	Disp. [mÅ pix ⁻¹]	FOV [""]	Pixel [""]	CEB	Shutter	EA [cm ²]	Temp. [log T]
FUV 1	1331.7–1358.4	12.98	175	0.1663	1	FUV SG	1.6	3.7–7.0
FUV 2	1389.0–1407.0	12.72	175	0.1663	1	FUV SG	2.2	3.7–5.2
NUV	2782.7–2835.1	25.46	175	0.1664	2	NUV SG	0.2	3.7–4.2

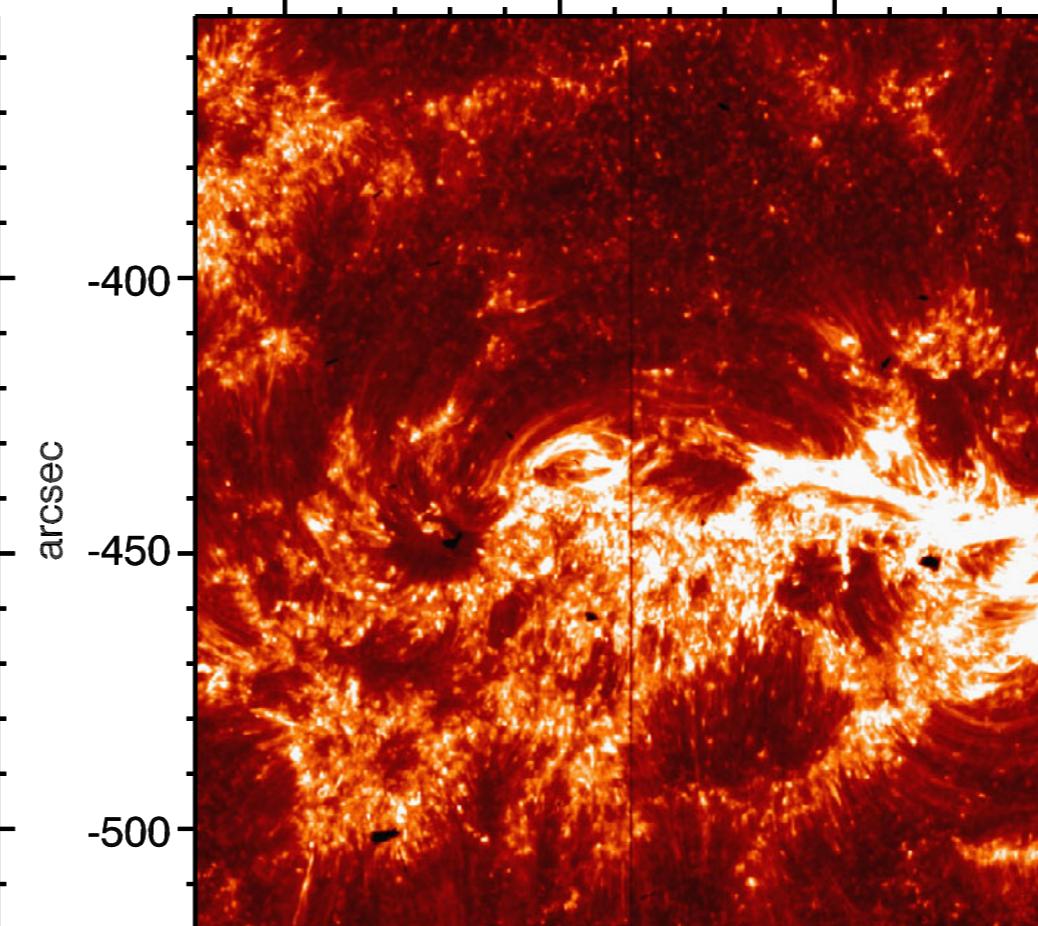
Table 3 IRIS slot channels. Filter-wheel positions can be either transmitting (T) or reflecting/mirrors (M).

Band-pass	Filter wheel	Name	Center [Å]	Width [Å]	FOV [""×""]	Pix. [""]	EA [cm ²]	Temp. [log T]
Glass	1 T	5000	5000	broad	175 ²	0.1679	–	–
C II	31 M	1330	1340	55	175 ²	0.1656	0.5	3.7–7.0
Mg II h/k	61 T	2796	2796	4	175 ²	0.1679	0.005	3.7–4.2
Si IV	91 M	1400	1390	55	175 ²	0.1656	0.6	3.7–5.2
Mg II wing	121 T	2832	2830	4	175 ²	0.1679	0.004	3.7–3.8
Broad	151 M	1600W	1370	90	175 ²	0.1656	–	–

SJI
133.0



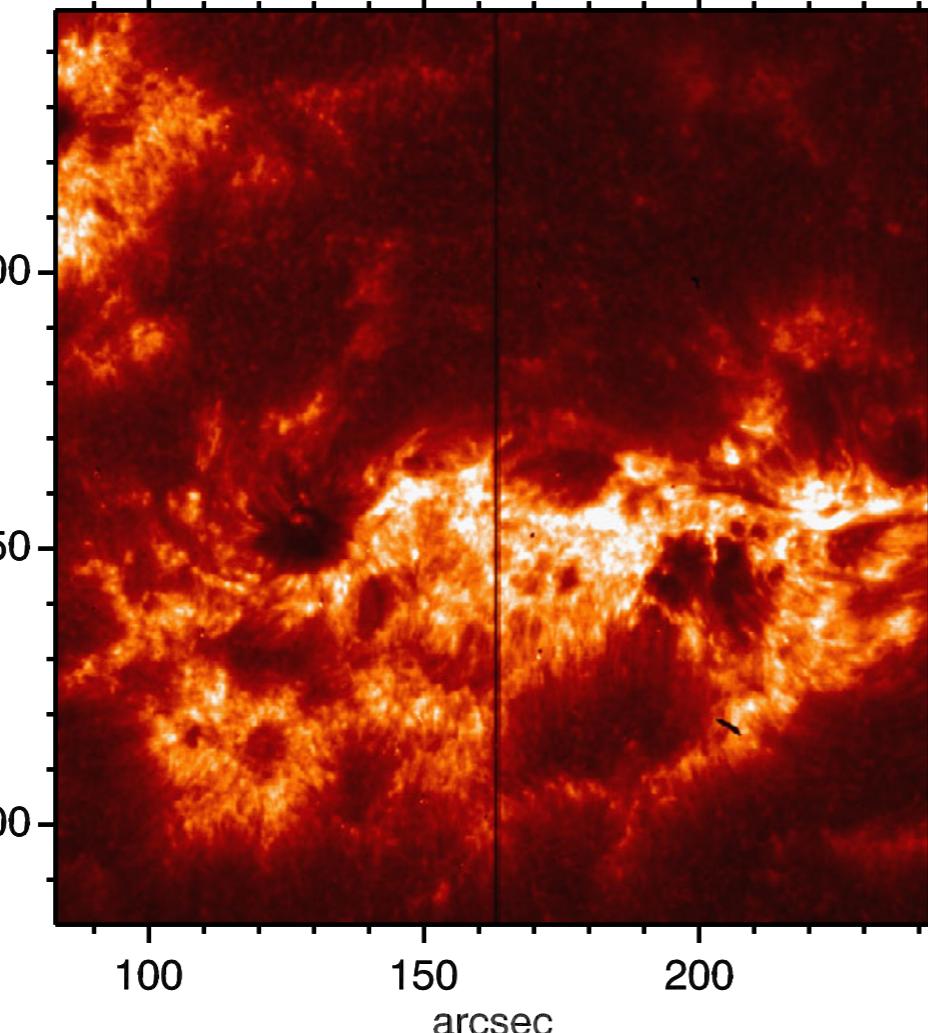
arcsec



arcsec

arcsec

SJI
279.6



arcsec

arcsec

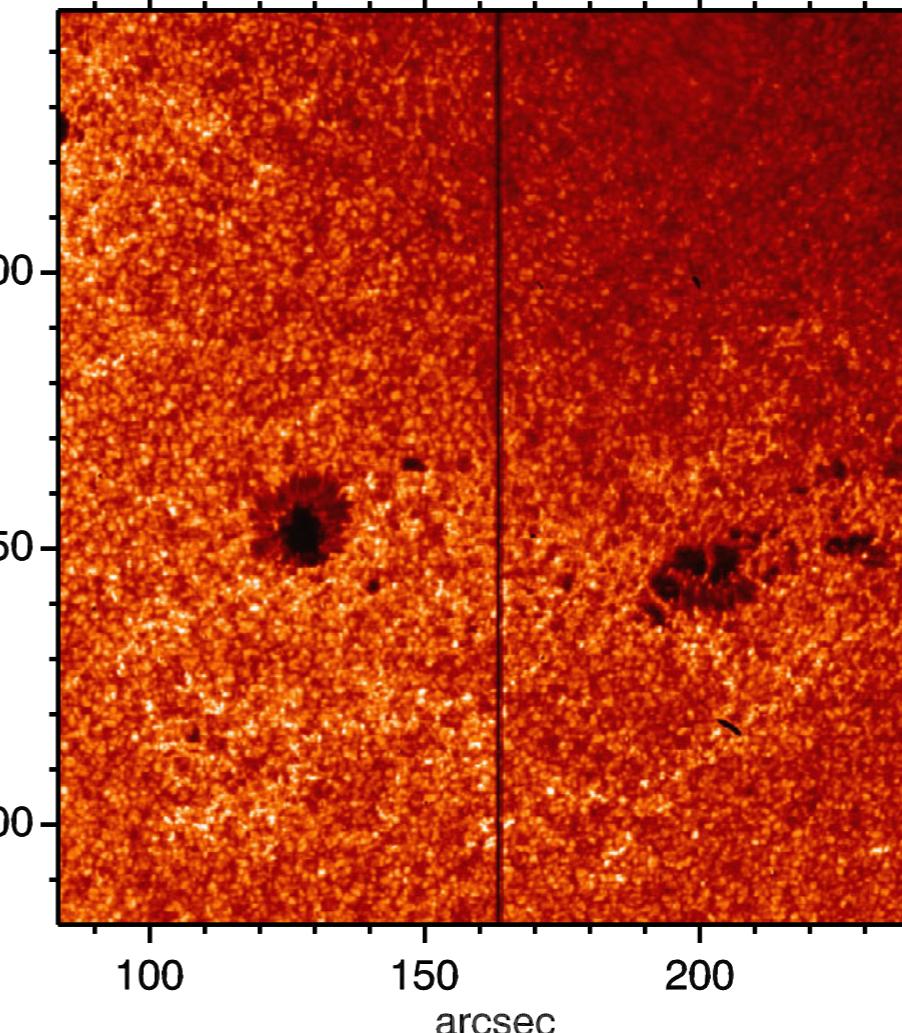
arcsec

arcsec

arcsec

SJI
140.0

SJI
283.2



arcsec

100

150

200

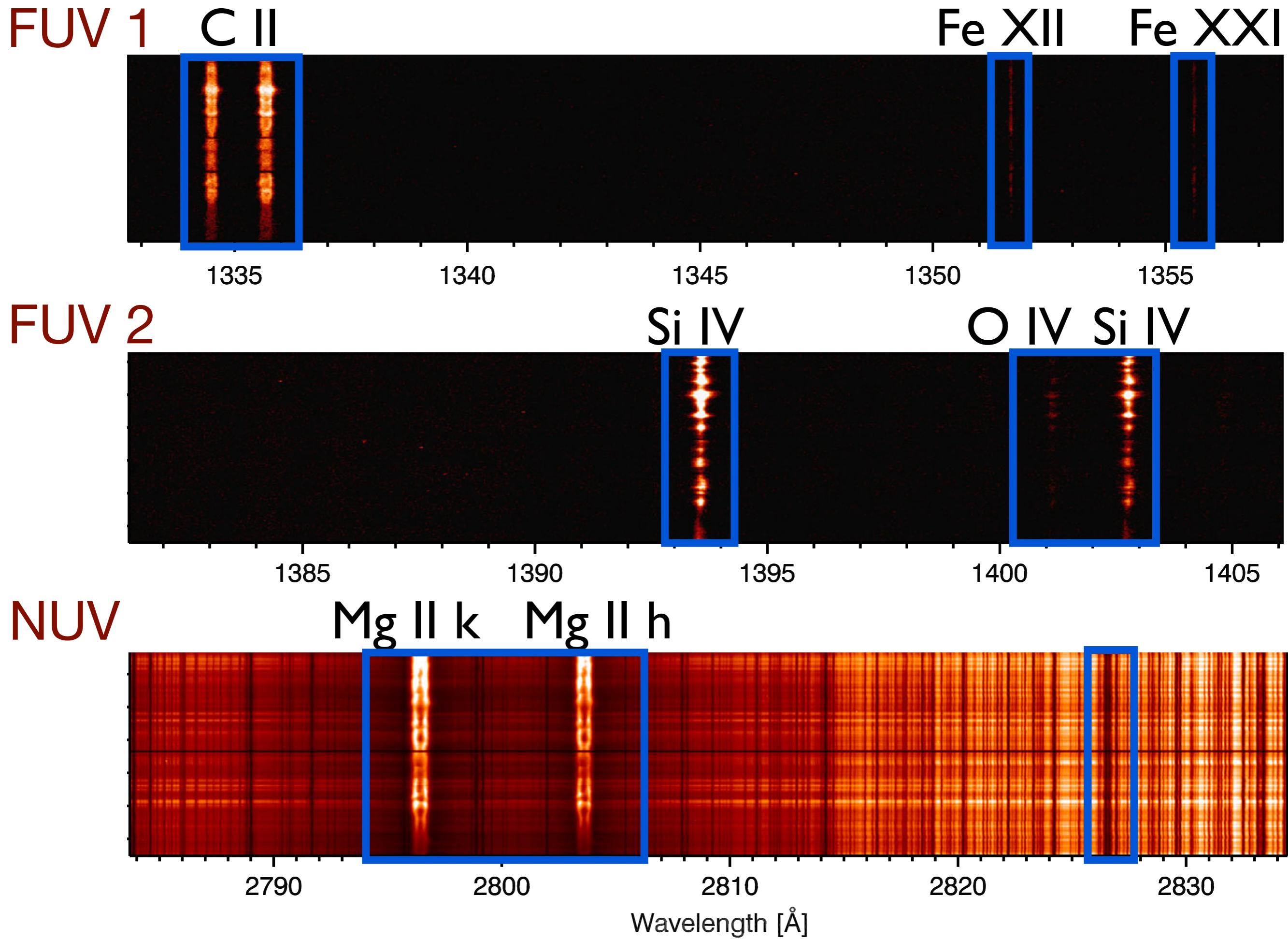
arcsec

100

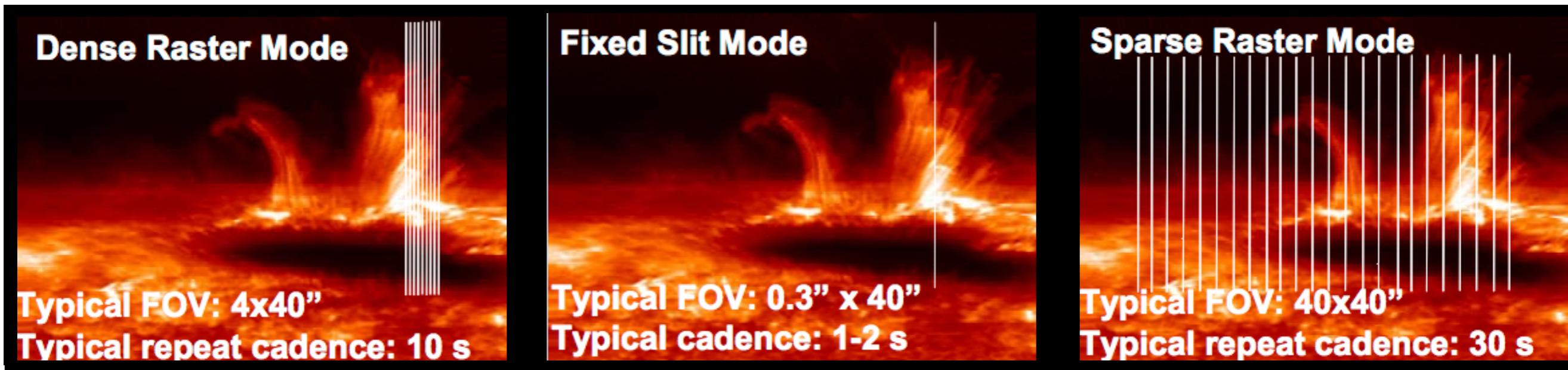
150

200

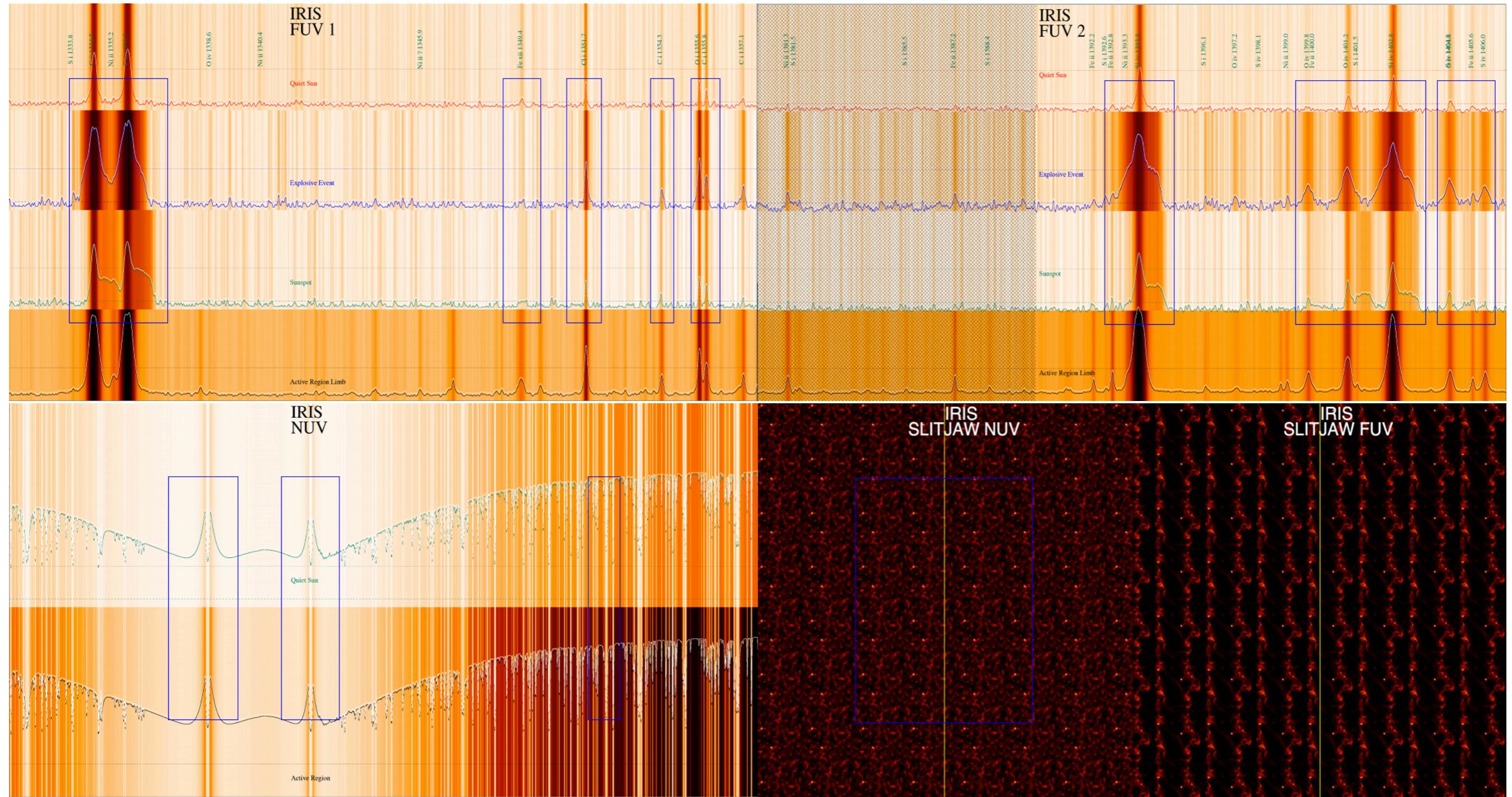
arcsec



IRIS also performs sparse rasters to improve cadence (resulting in reduced data rate)



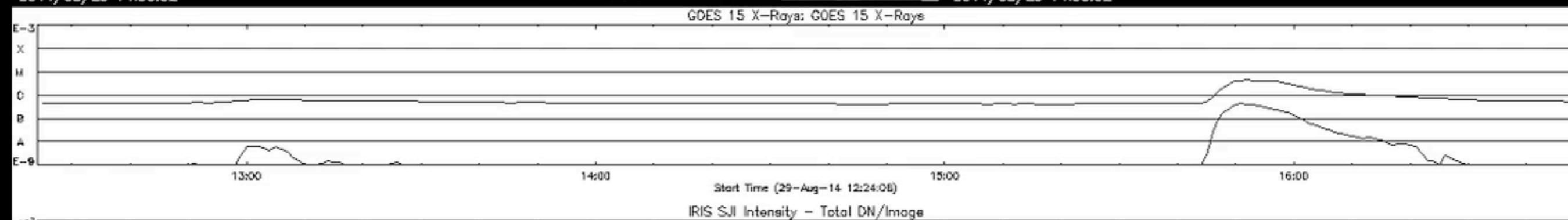
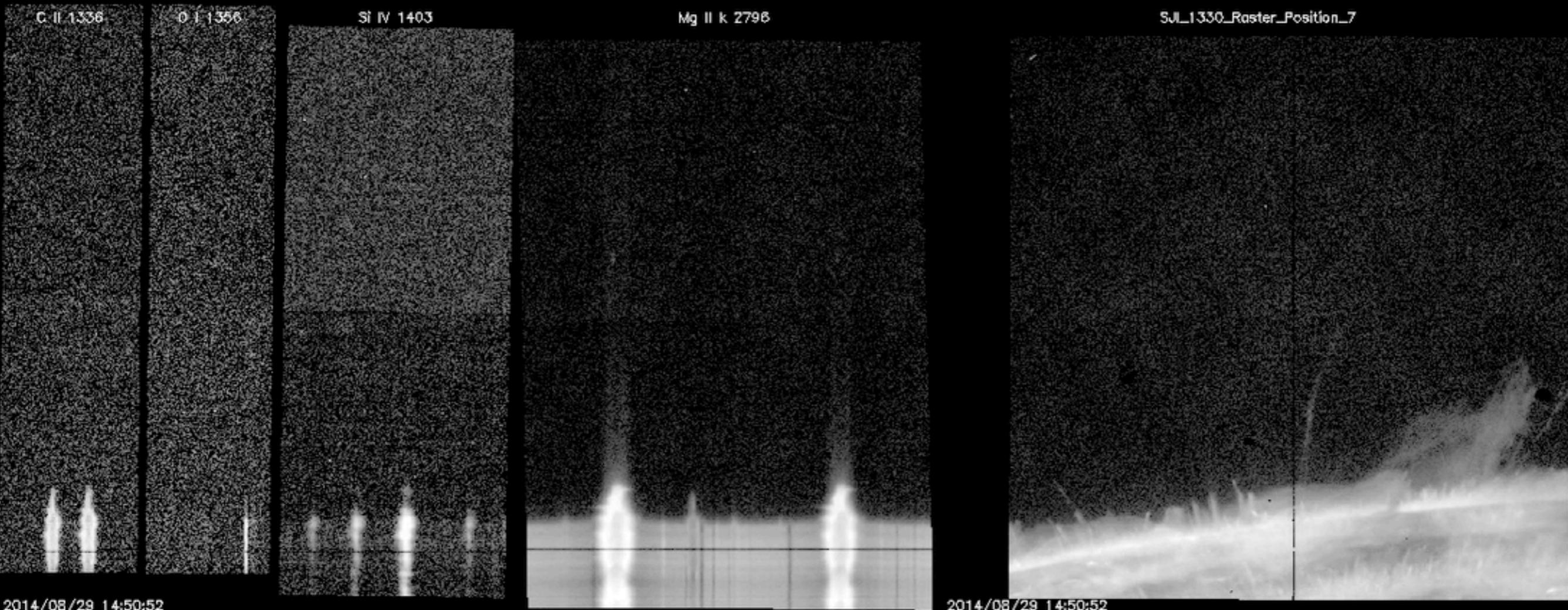
IRIS camera layout



C II O I Si IV
133.6 135.5 140.3

Mg II

SJI 133 (C II + Fe XII)

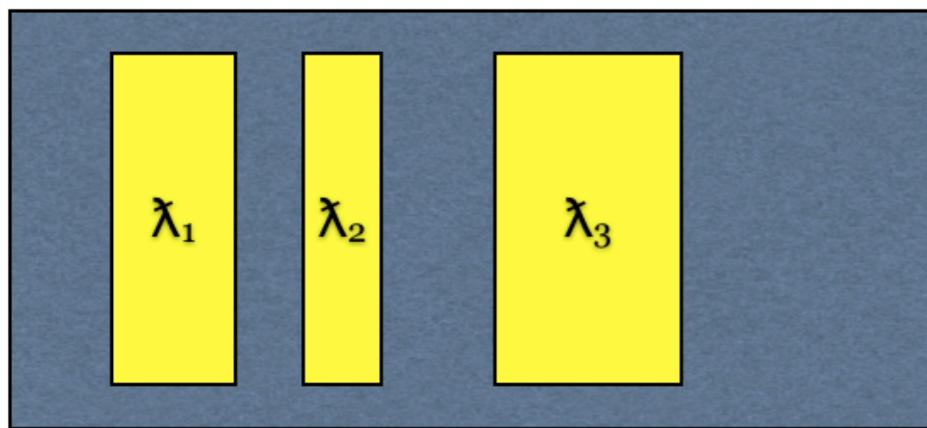


IRIS data levels

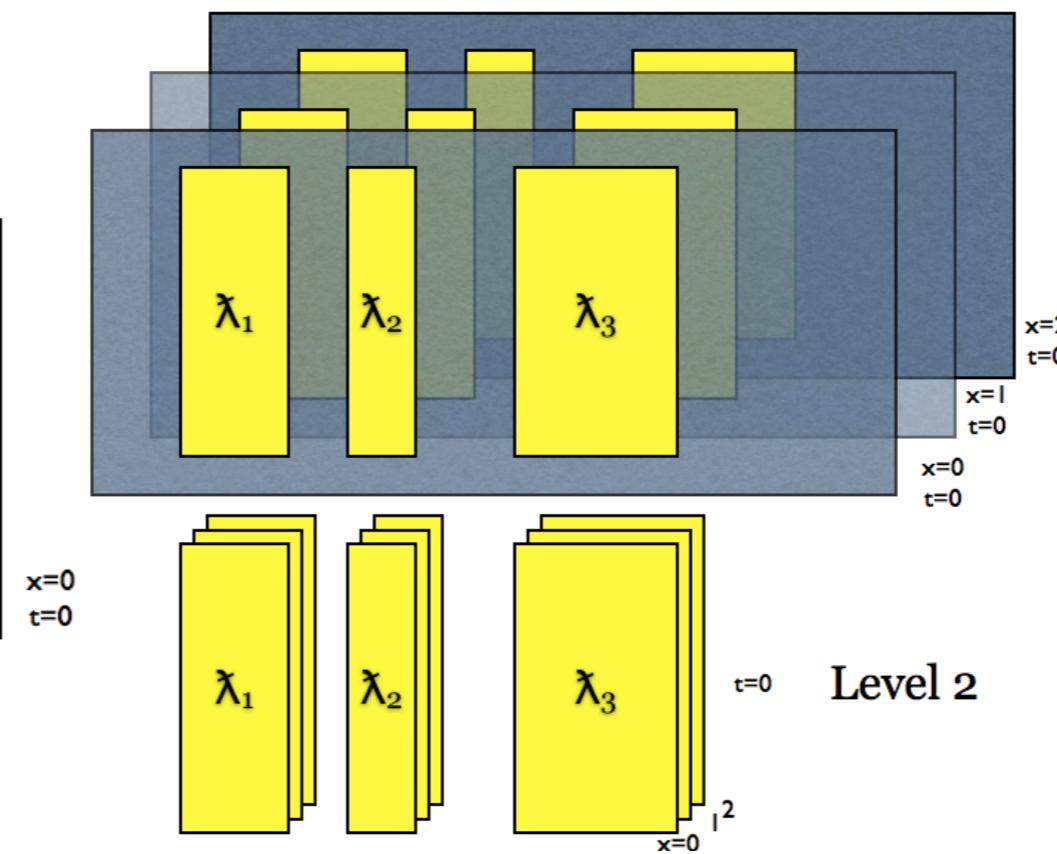
Level	Processing	Notes
TLM	Capture	Raw telemetry
0	Depacketized	Raw images with basic keywords
1	Reorient images to common axes: North up (0° roll), increasing wavelength to right	Lowest distributed level
1.5	Dark current and offsets removed Flag bad pixels and pixels with spikes Flat-field correction Geometric and wavelength calibration	Transitory data product for level 2 production. Not distributed, for internal use only. Use <code>iris_prep</code> to go from level 1 to 1.5
2	Recast as rasters and SJI time series	Standard science product. Scaled and stored as 16-bit integer.
3	Recast as 4D cubes for NUV/FUV spectra.	<i>CRISPEX</i> format. May include transposed (sp) version. No SJI.

IRIS data levels

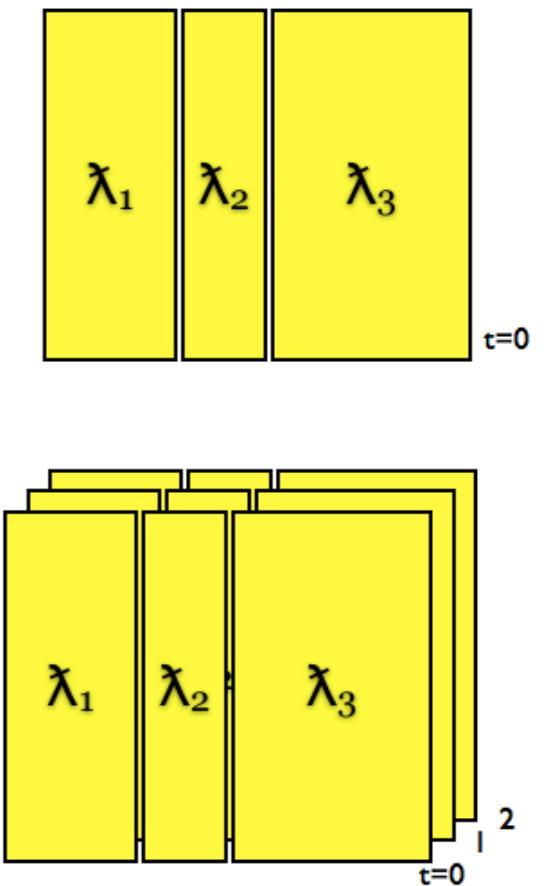
Level 1



Level 2



Level 3



INTERFACE REGION IMAGING SPECTROGRAPH

Home Mission Operations Data Analysis Modeling Documents Software Team Press Contact

[IRIS mission/instrument paper](#)

Operations/Planning

- [ITN 1 - IRIS Operations Overview](#)
- [ITN 2 - Manual for Table Creator](#)
- [ITN 3 - Manual for Timeline Tool](#)
- [ITN 4 - Manual for Synthetic Observations Tool](#)
- [ITN 5 - Operations Under Roll Conditions](#)
- [ITN 6 - AEC Operations](#)
- [ITN 7 - Compression Approach](#)
- [ITN 8 - Checklist for IRIS planner](#)
- [ITN 9 - Periodic Calibration Activities](#)

Data Flow

- [ITN 10 - General Approach to Data Flow and Archiving](#)
- [ITN 11 - Definition of Data Levels](#)
- [ITN 12 - Definition of Keywords](#)
- [ITN 13 - VSO and IRIS](#)

Calibration

- [ITN 14 - Dark Current/Offset](#)
- [ITN 15 - Despiking](#)
- [ITN 16 - Flat-field](#)
- [ITN 19 - Geometric Calibration](#)
- [ITN 20 - Wavelength Calibration](#)
- [ITN 21 - Recasting into Level 2/3 Data](#)
- [ITN 22 - Co-alignment, Plate Scale Analysis](#)
- [ITN 23 - MTF/PSF Determination](#)
- [ITN 24 - Stellar Calibration](#)
- [ITN 25 - Gain Determination](#)

Data Analysis

- [ITN 26 - User Guide To Data Analysis](#)
- [ITN 27 - Quicklook Tools Manual](#)
- [ITN 28 - IRIS IDL Data Structure](#)
- [ITN 29 - Deconvolution Approach](#)
- [ITN 30 - 60 Day Observing Plan](#)
- [ITN 31 - IRIS science planning: tables, linelists, targets SolarSoft Tree and UVSP Database](#)

Numerical Modeling

- [ITN 33 - General Overview of Numerical Simulations](#)
- [ITN 34 - Numerical Simulations Quicklook Tools](#)
- [ITN 35 - Numerical Simulations Synthetic Observables](#)
- [ITN 36 - RH 1.5 D Manual](#)
- [ITN 37 - How to Derive Physical Information from Mg II h/k](#)

IRIS Technical Notes List (ITN)

Talks & Posters

- [Invited Talks at the SDO-4/IRIS/Hinode Workshop - March 2012](#)
- [IRIS Talk Hinode 5 Meeting Keynote \(430 MB\) PDF \(36 MB\)](#)
- [IRIS Poster](#)
- [FUV Camera View](#)
- [NUV Camera View](#)

Concept Study Report

- [Executive Summary](#)
- [Science Goals](#)
- [Instrument Description](#)

Lecture overview

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Searching, downloading, browsing data

- IRIS search webpage <http://iris.lmsal.com/search/>
- Hinode SDC Europe <http://sdc.uio.no/search/API>
- SolarSoft IDL
- IRIS today: <http://iris.lmsal.com/iristoday/>
- HEK recent observations:
<http://www.lmsal.com/hek/hcr?cmd=view-recent-events&instrument=iris>

Live demo:
searching and downloading

X Iris_Xfiles - QL Control Window

Exit



Select data source

◆ IRIS ◆ EIS/CCSDS ◆ EIS/FITS ◆ EIS/HK

Start/Stop for file search, Time Units: [D]D-MON-[YR]YR HH:MM:SS[,MS]

Last 5 days

Recent time-windows

6-Aug-2013 - 20-Aug-2013

Start Time: 6-Aug-2013 13:17:10

Stop Time: 20-Aug-2013 13:17:10

Up until now

ignore times (only if no tree structure)

Set search filter iris 12*

Search Pattern:

free search

Edit

Start Search

Stop Search

Search Directory

/Users/tiago/data/iris/data/level2/2013/09/14/20130914_215908_4004257747/

Change

STARTOBS	OBSID	OBS_DESC	XCEN	YCEN	SAT_ROT
2013-09-14T21:59:08.000	4004257747	Medium sit-and-stare 0.3"x60" 1s	Mg II h	169.9	-127.7
				-0.0	

/Users/tiago/data/iris/data/level2/2013/09/14/20130914_215908_4004257747/iris_12_20130914_215908_4004257747_SJI_2796_t000.fits

/Users/tiago/data/iris/data/level2/2013/09/14/20130914_215908_4004257747/iris_12_20130914_215908_4004257747_raster_t000_r00000.fits

Live demo:
IRIS xfiles

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IDL object interface for level 2 data

```
IDL> f = 'iris_l2_20131010_100202_3820259146_raster_t000_r00000.fits'  
IDL> d = iris_obj(f)
```

```
IDL> d->show_lines  
Spectral regions(windows)  
0 1335.71 C II 1336  
1 1349.43 Fe XII 1349  
2 1355.60 O I 1356  
3 1393.78 Si IV 1394  
4 1402.77 Si IV 1403  
5 2832.76 2832  
6 2814.50 2814  
7 2796.20 Mg II k 2796
```

Read IRIS L2

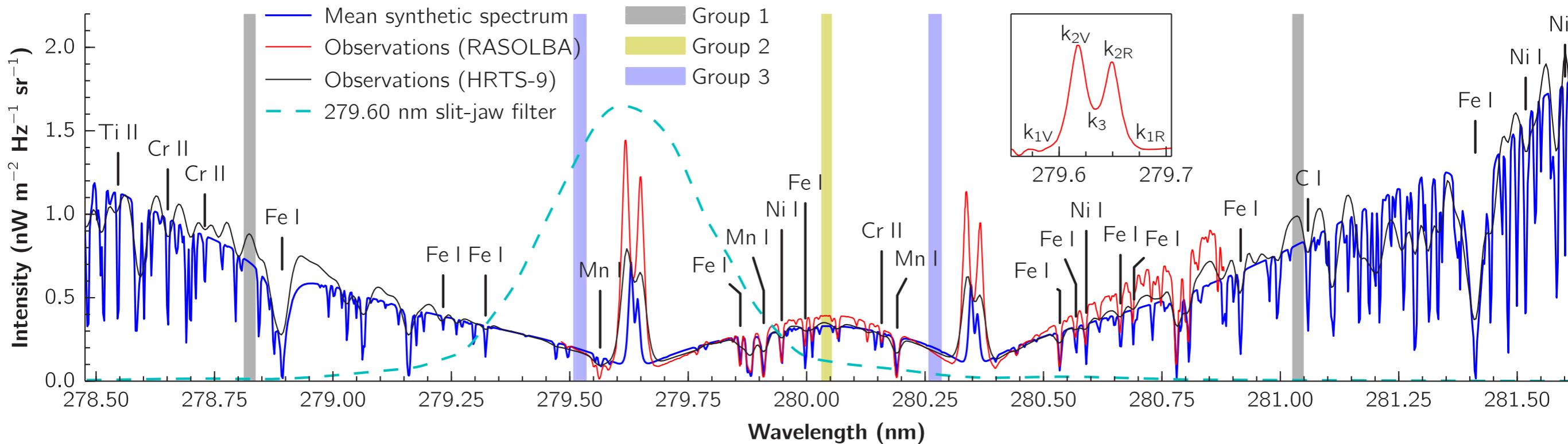
```
IDL> sjifile = 'iris_l2_20131010_100202_3820259146_SJI_2796_t000.fits'  
IDL> read_iris_l2, sjifile, header, data  
(...)  
IDL> help, header, data  
HEADER           STRUCT      = -> <Anonymous> Array[100]  
DATA             FLOAT       = Array[1860, 1092, 100]
```

Live demo:
Read IRIS data in IDL

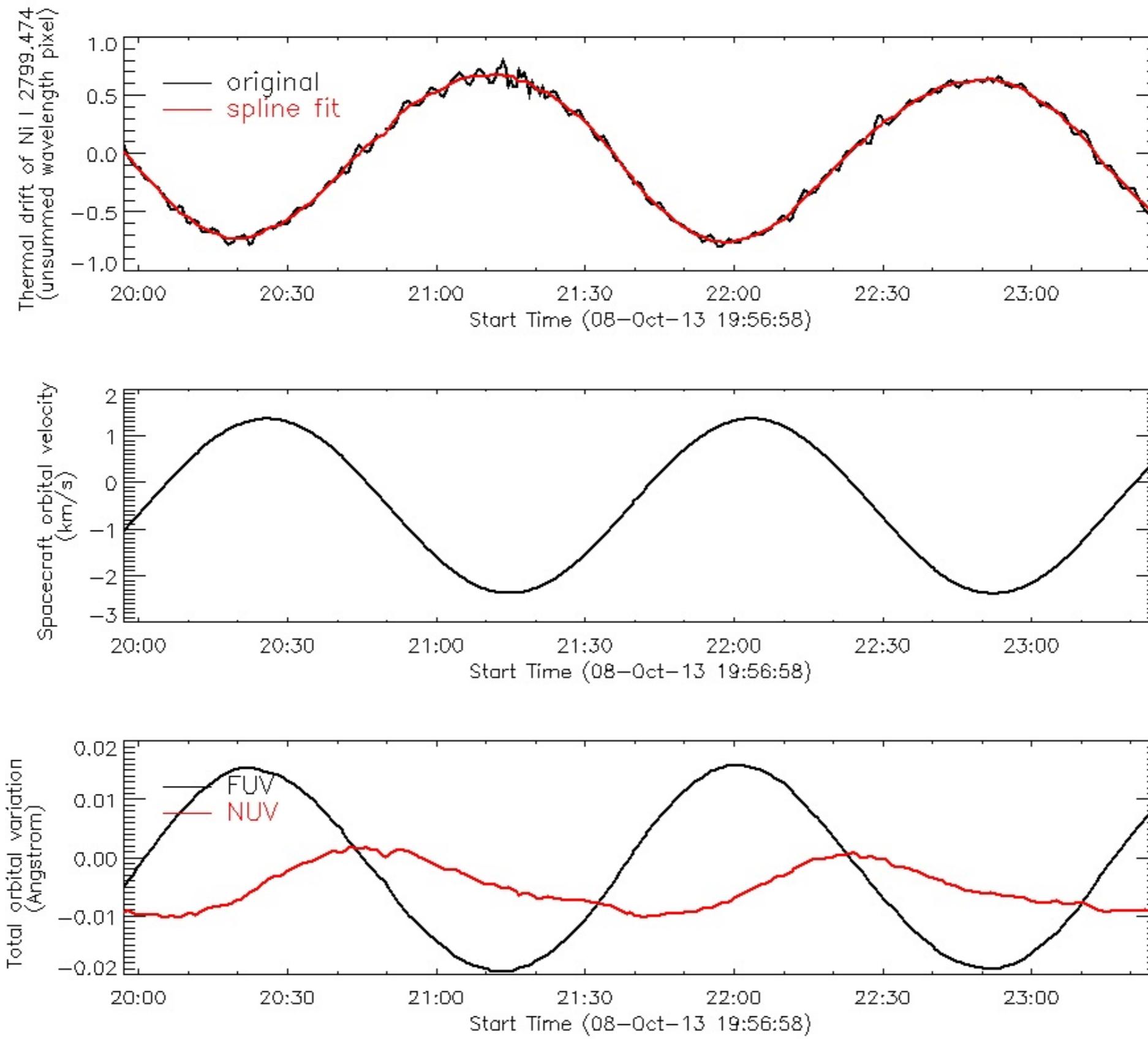
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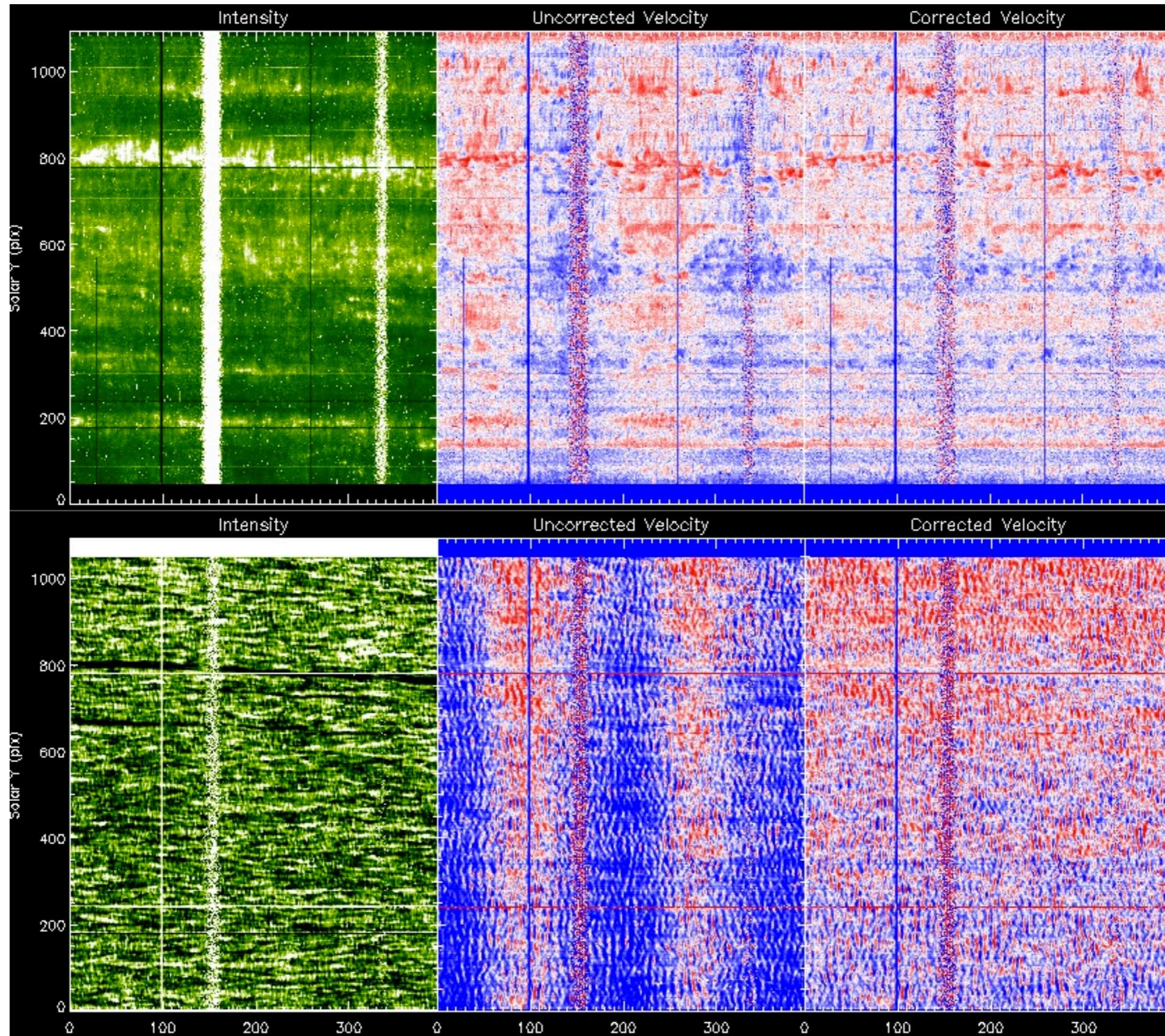
Precise wavelength calibration

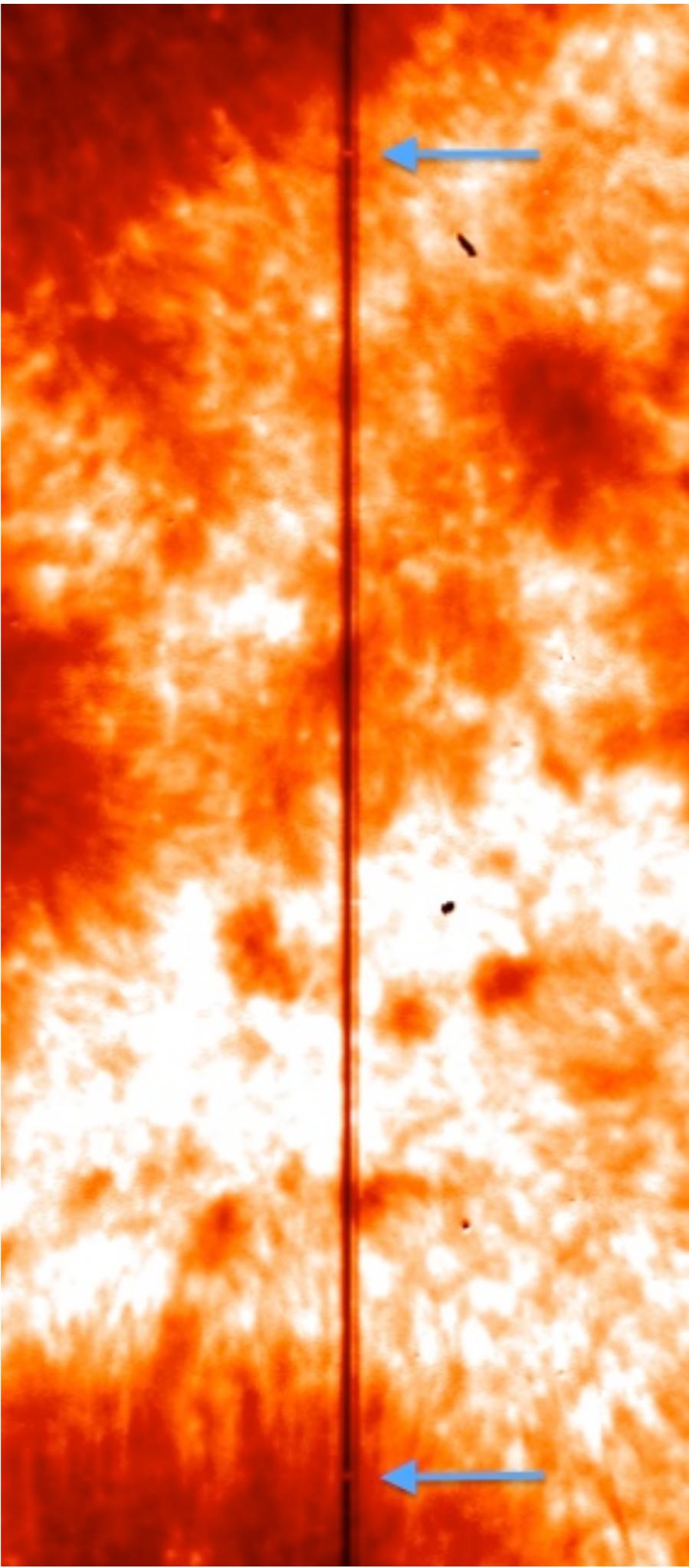


Precise wavelength calibration



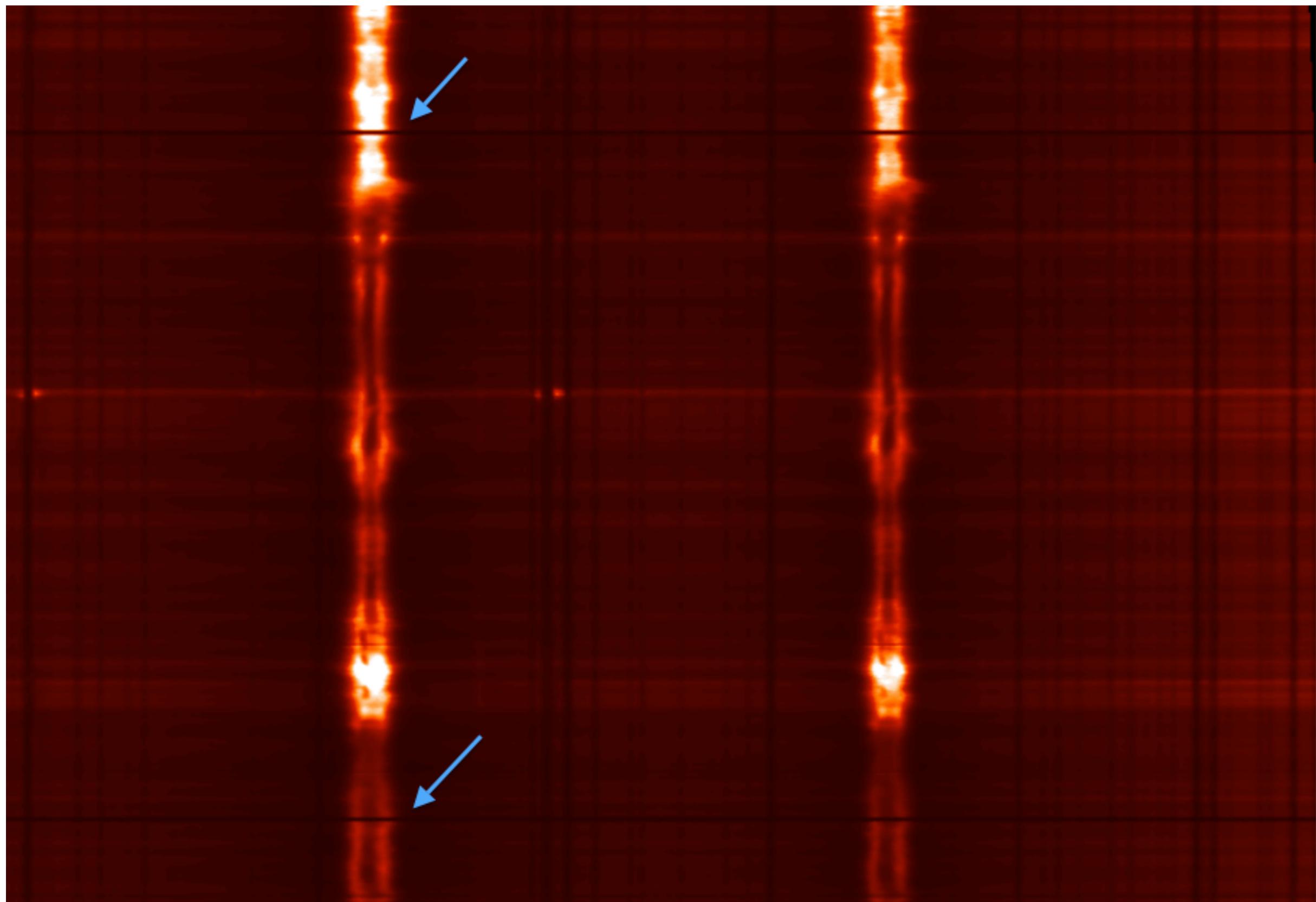
Precise wavelength calibration





**Co-alignment
between SJs**

Co-alignment between spectra



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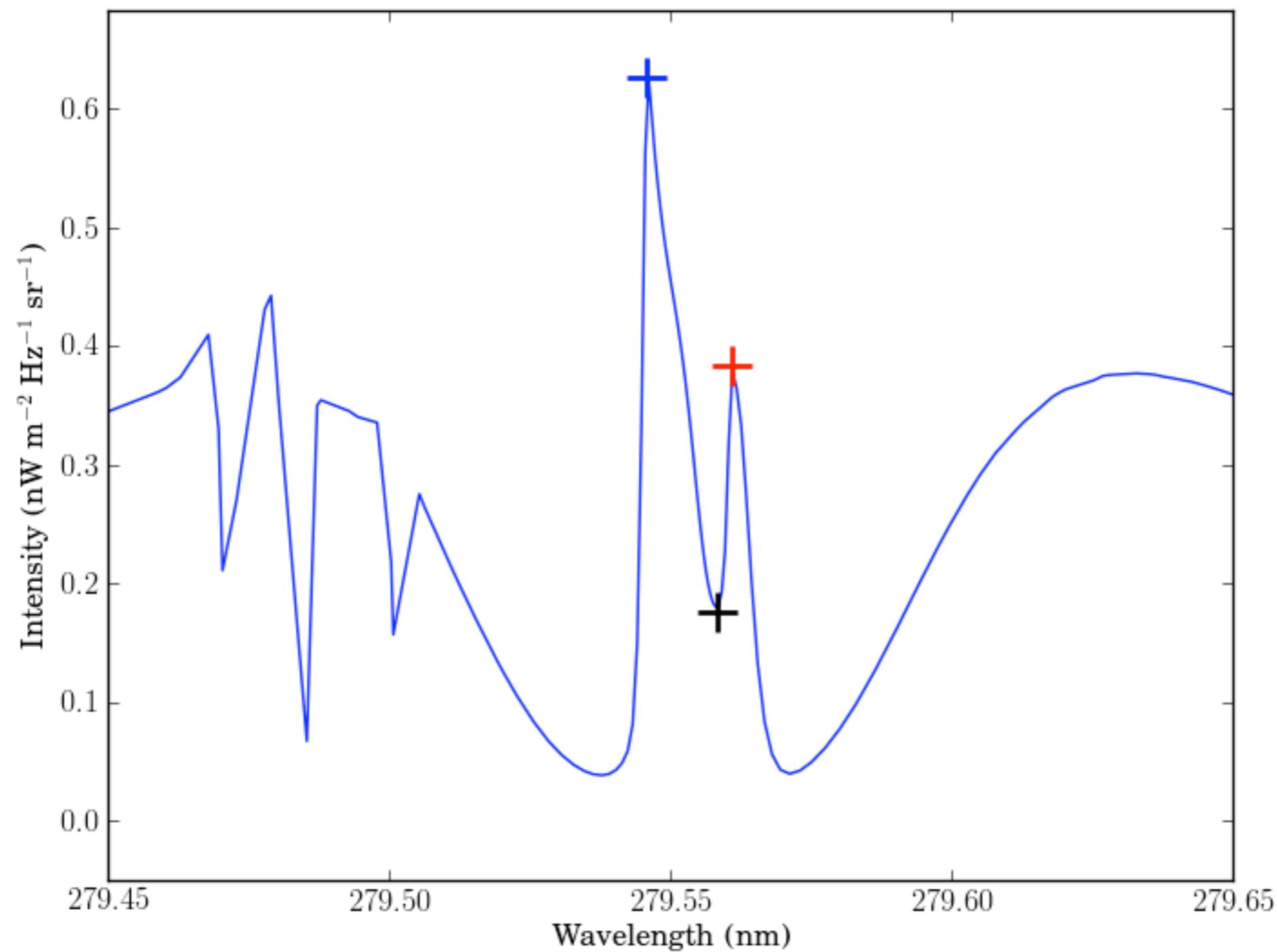
- Part 2
- Additional Data Calibration
 - Utility functions for Mg II lines
 - CRISPEX
 - Time to work on questions

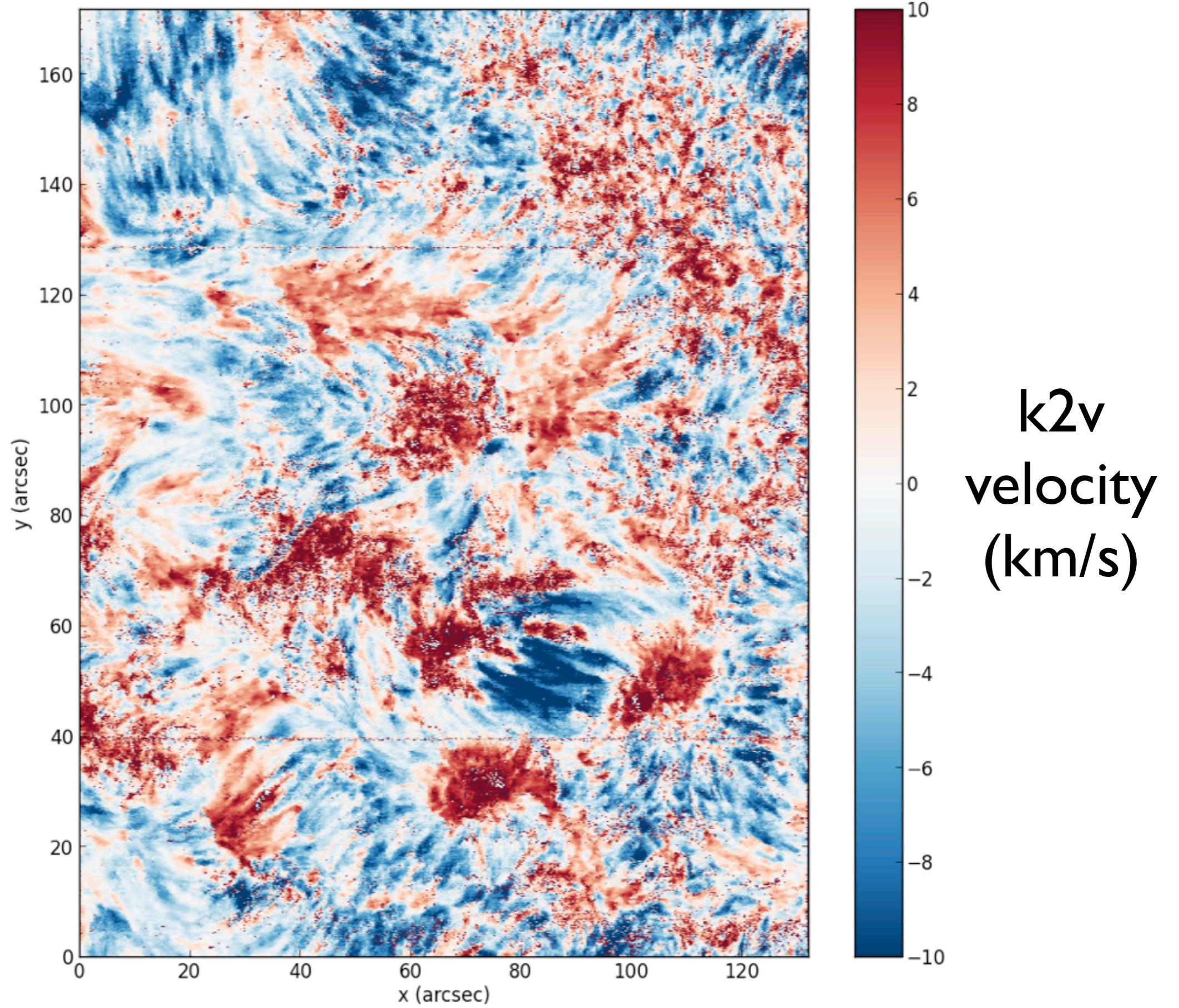
- Tutorial
- Exercise questions
 - Hands-on tutorials

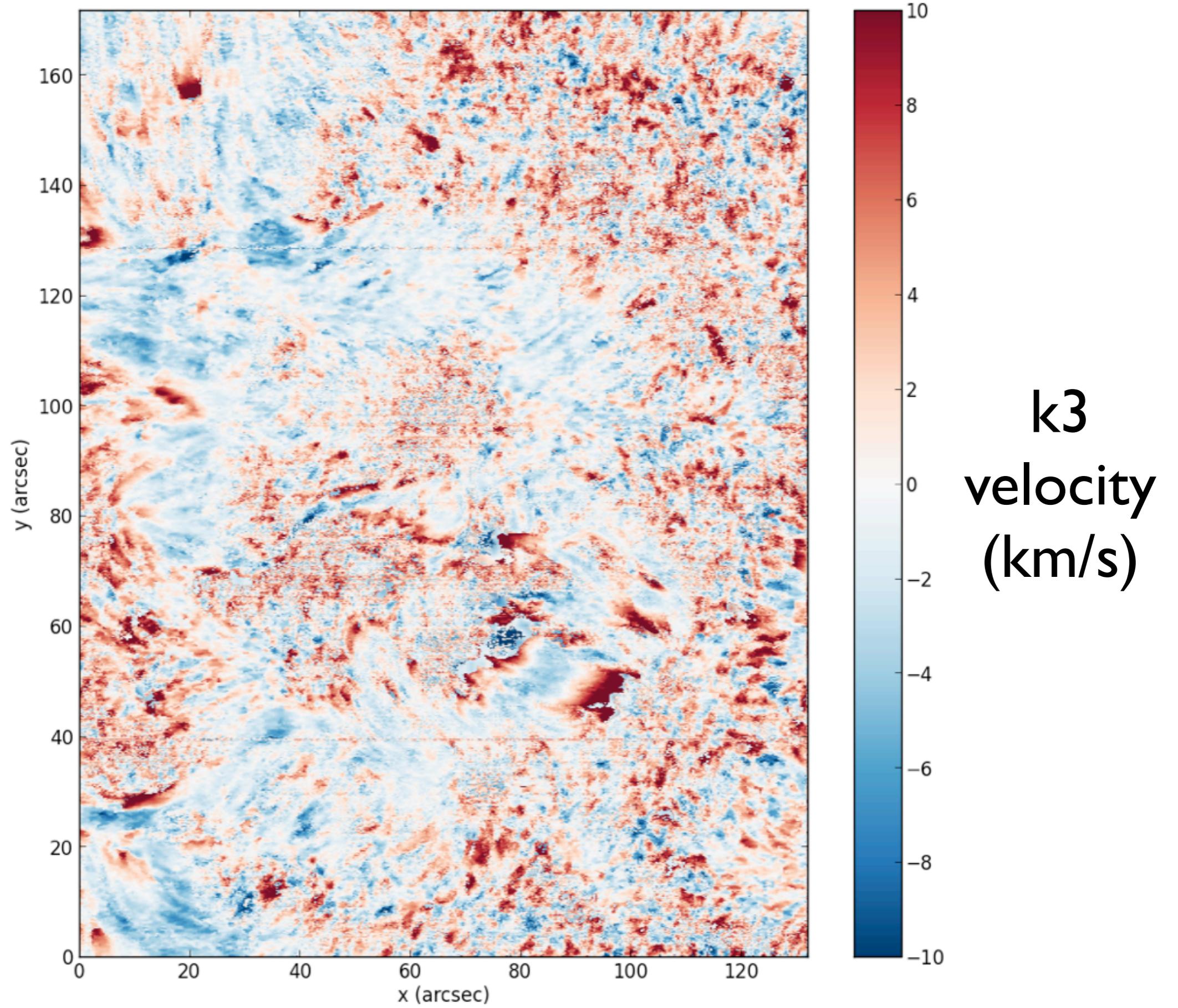
Algorithm to automatically measure Mg II line properties available on solarsoft:

`iris_get_mg_features_lev2, file, mg_id, vr, lc, rp, bp`

Based on the algorithm described in Pereira et al. (2013)

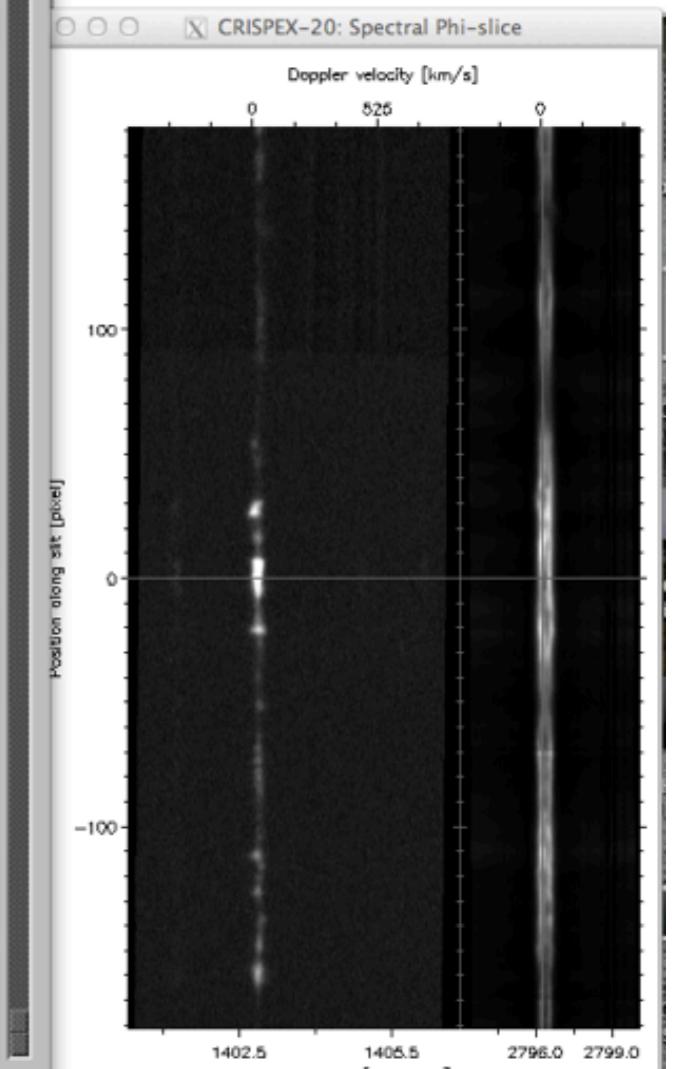
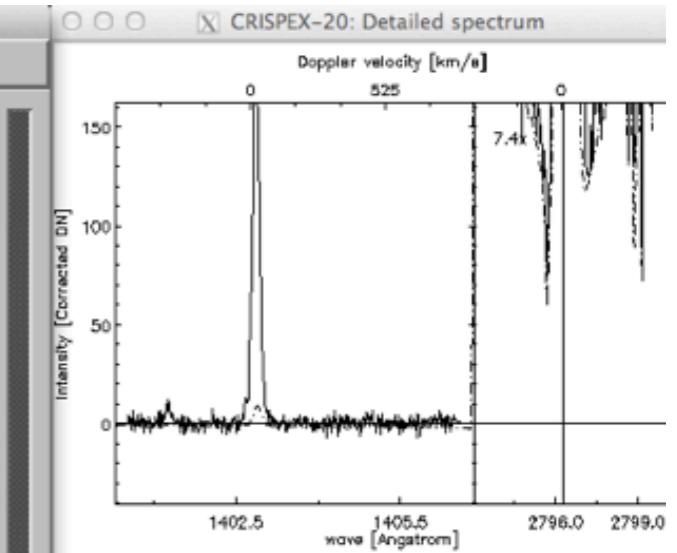
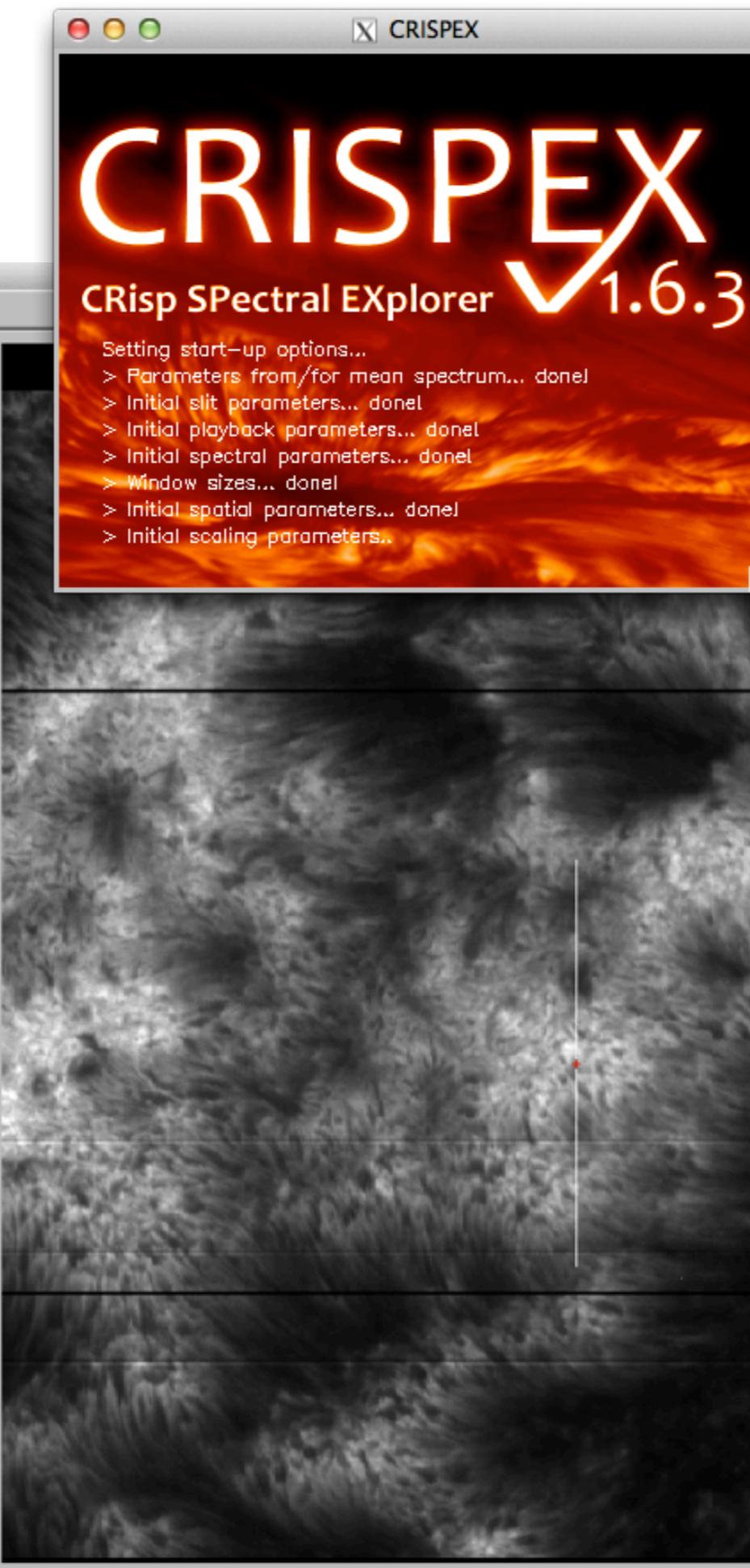
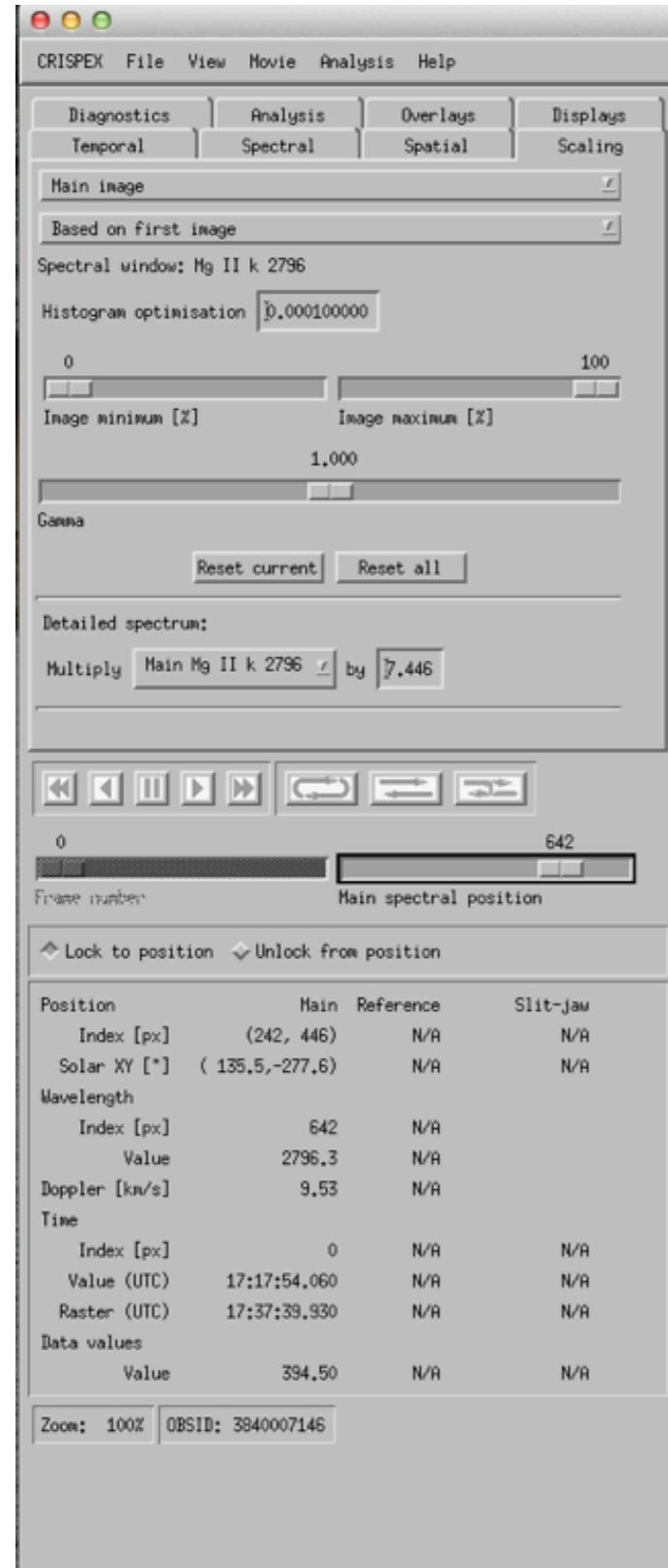






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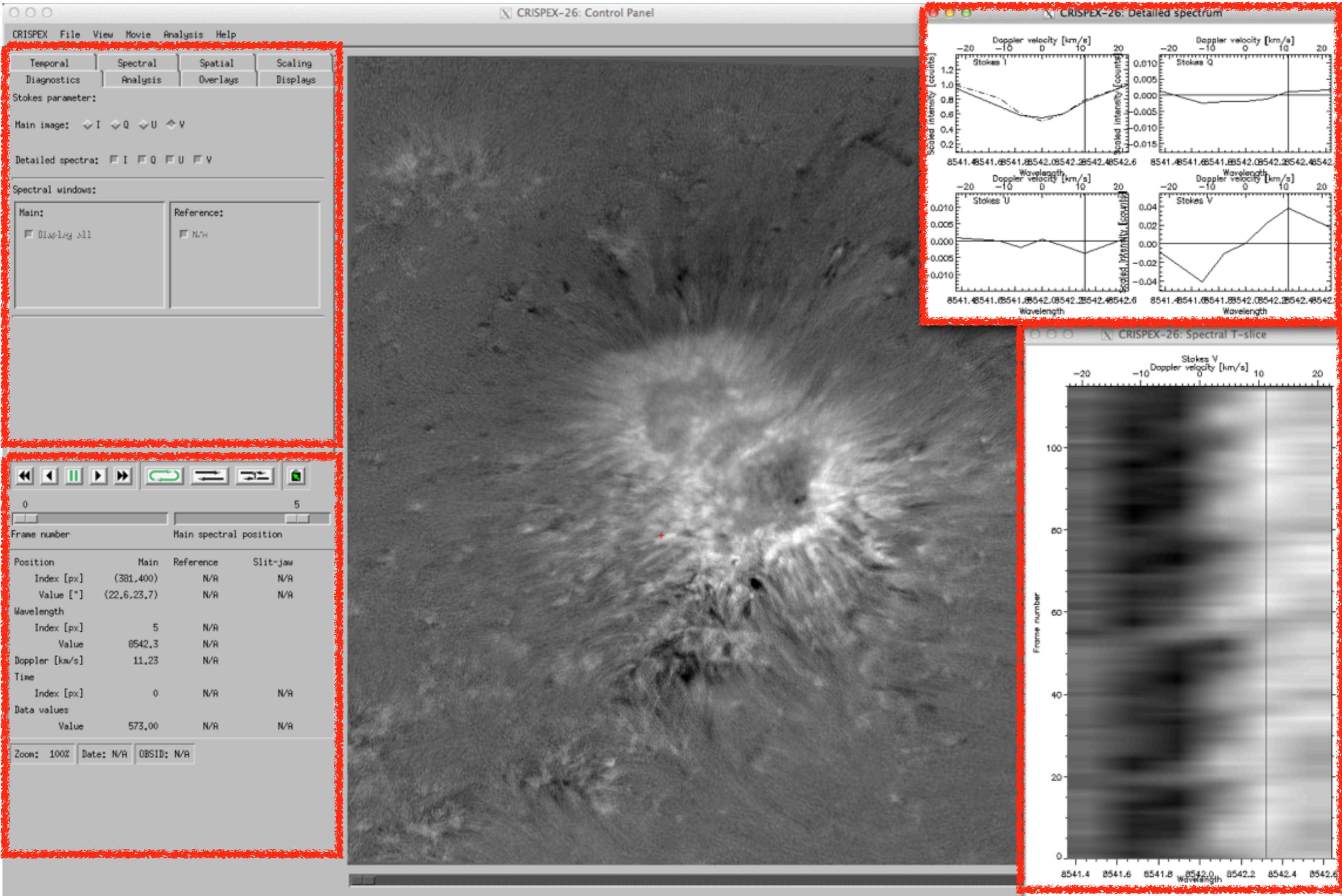


CRISPEX file formats

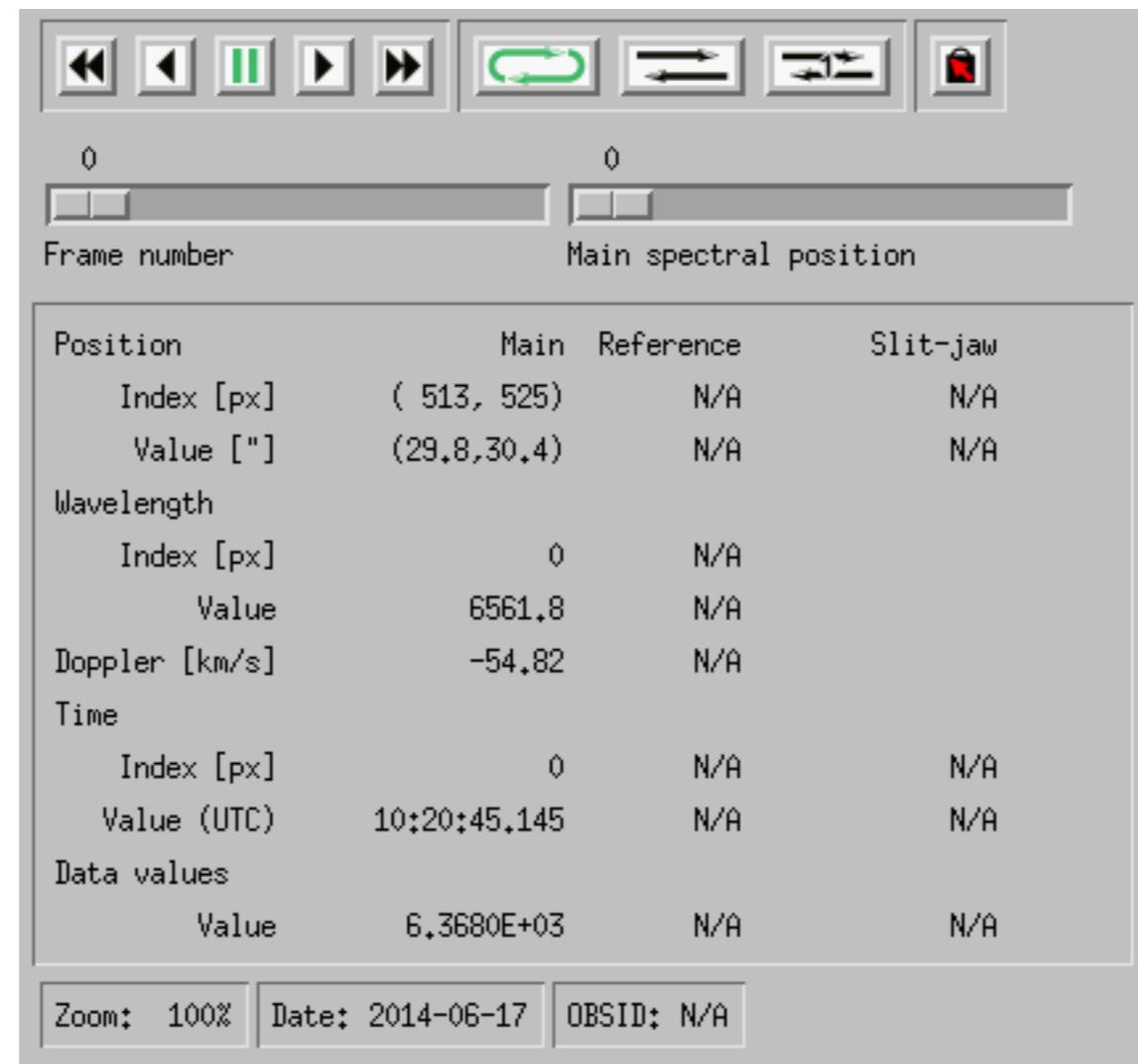
- “La Palma cubes”
 - ★ Simple cubes of (nx, ny, nwave * nt * nstokes)
 - ★ Combined with “spectfile”
- IRIS level 3 fits files
 - ★ FITS file with main image (nx, ny, nwave, nt)
 - ★ FITS keywords used for coordinates, time
 - ★ Extensions with wavelength and time values
 - ★ Not limited to IRIS data; to be further standardised

Two types of files: (same data)

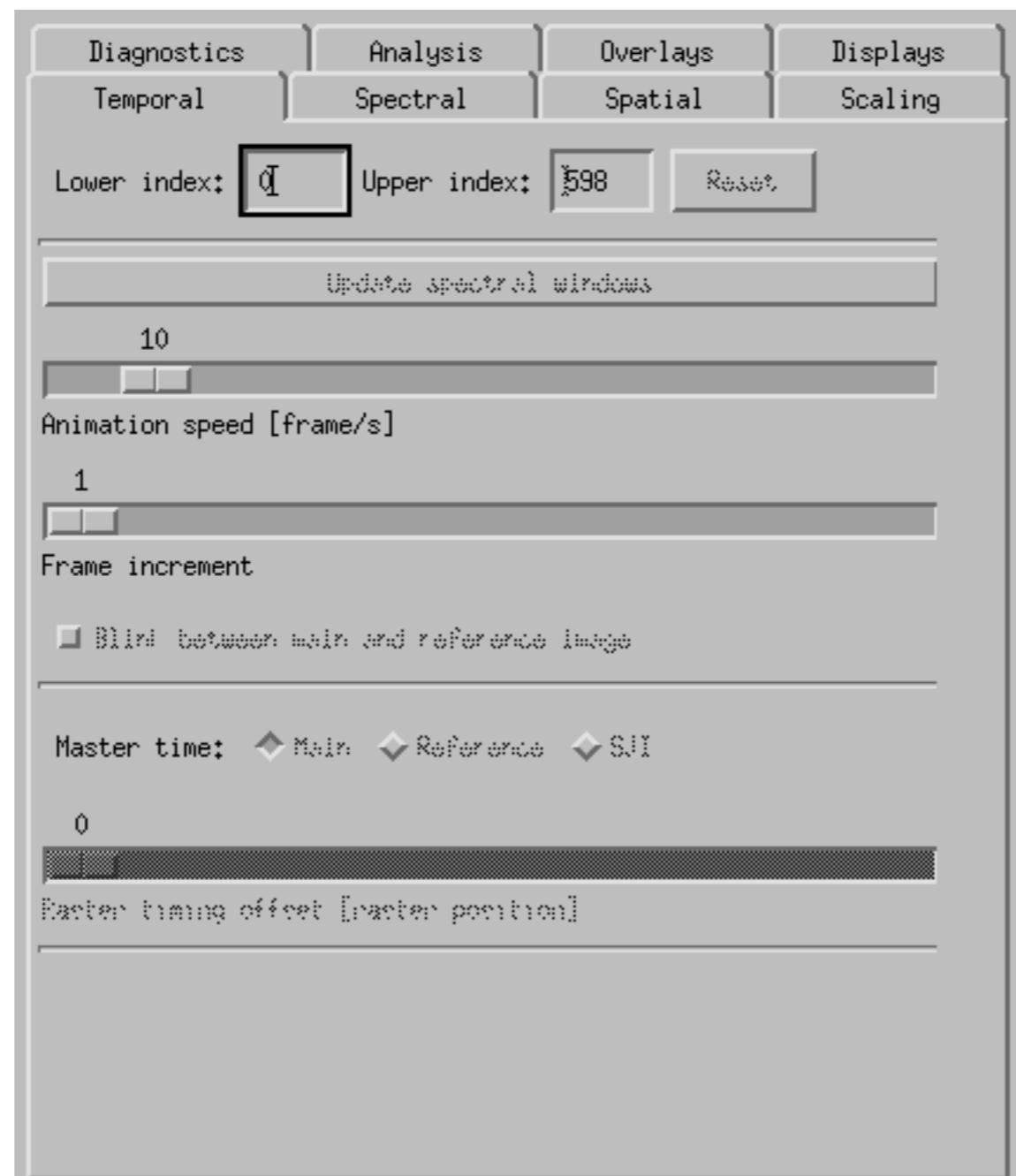
‘im’ (nx, ny, nw, nt) and ‘sp’ (nw, nt, nx, ny)

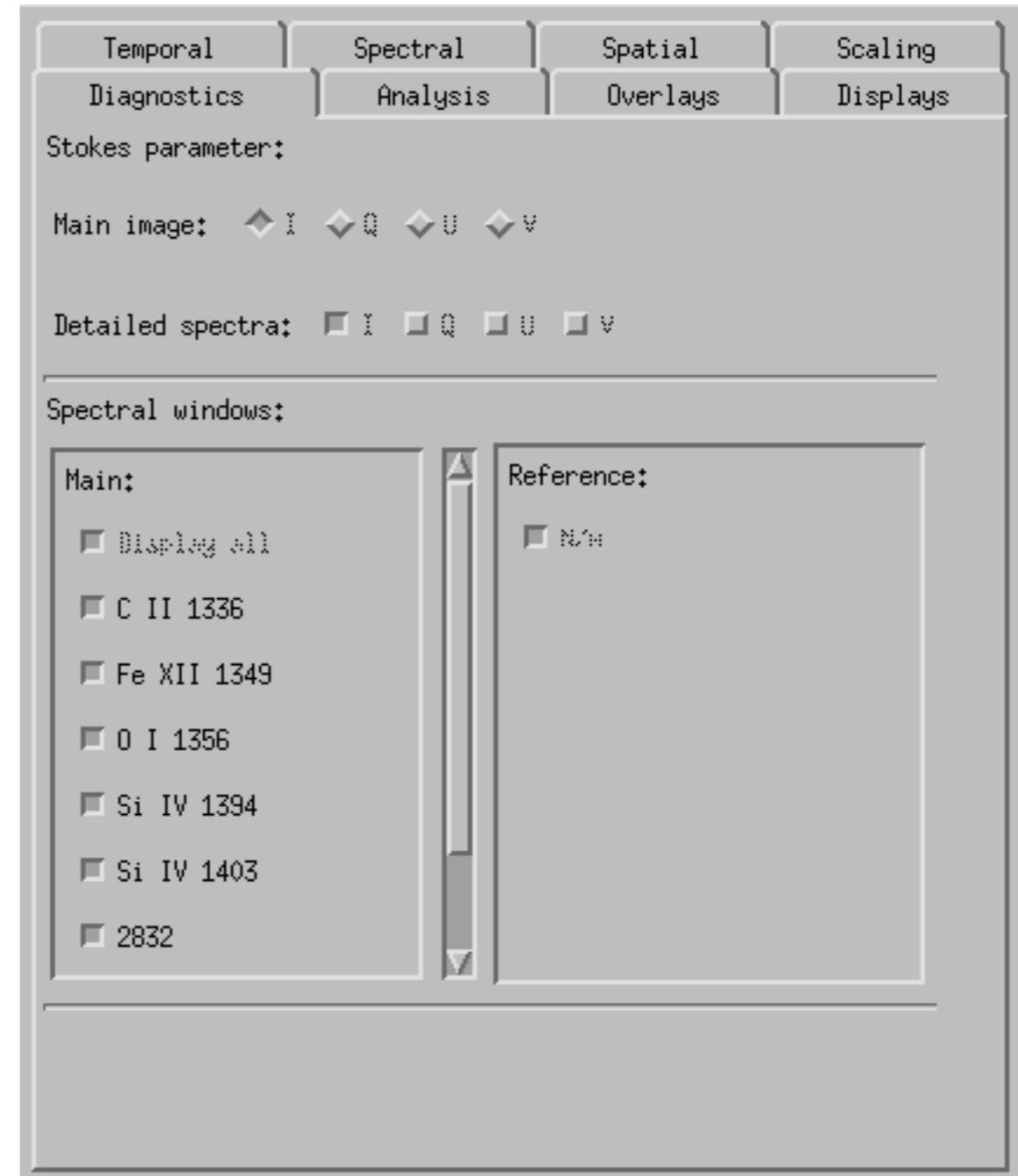
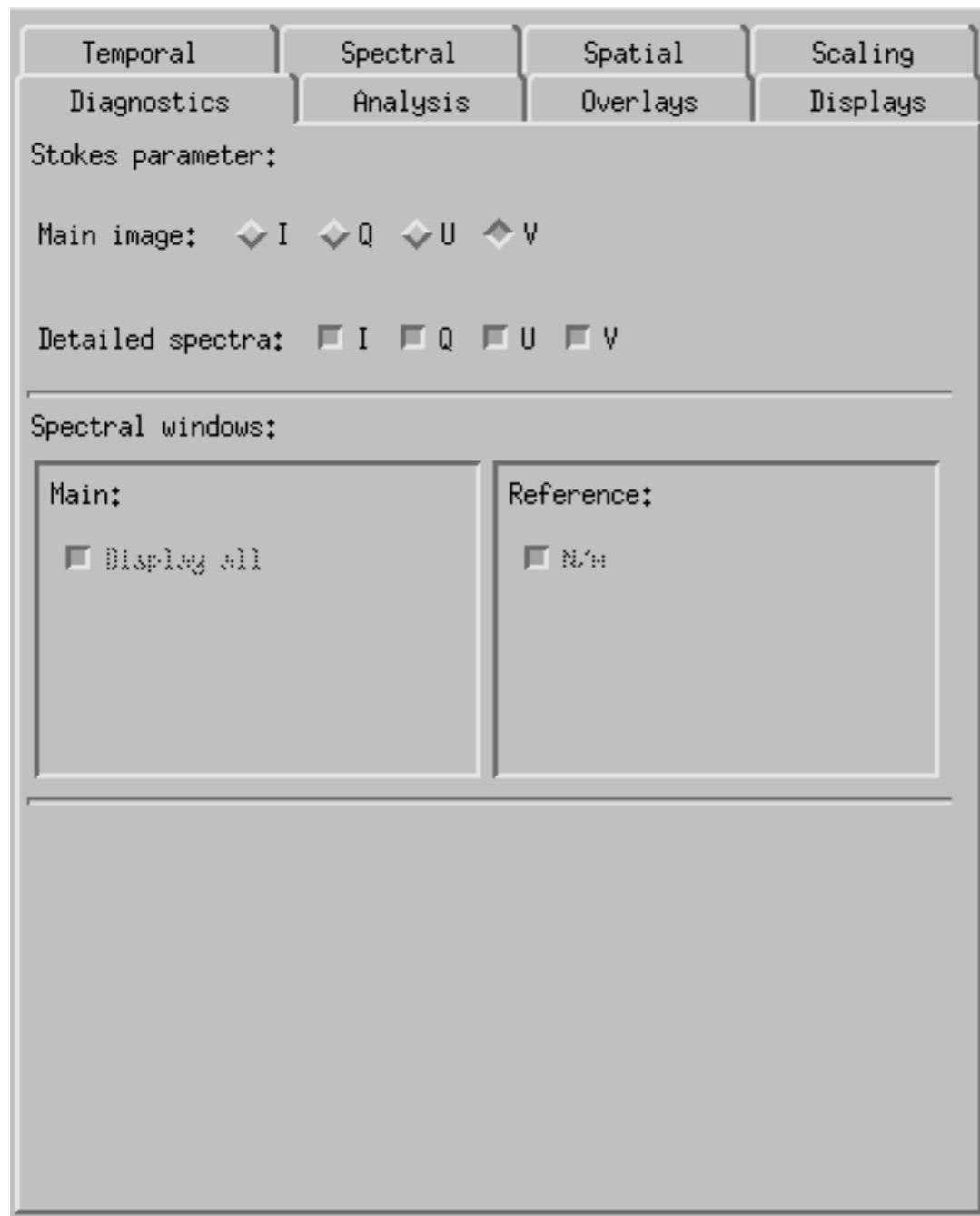


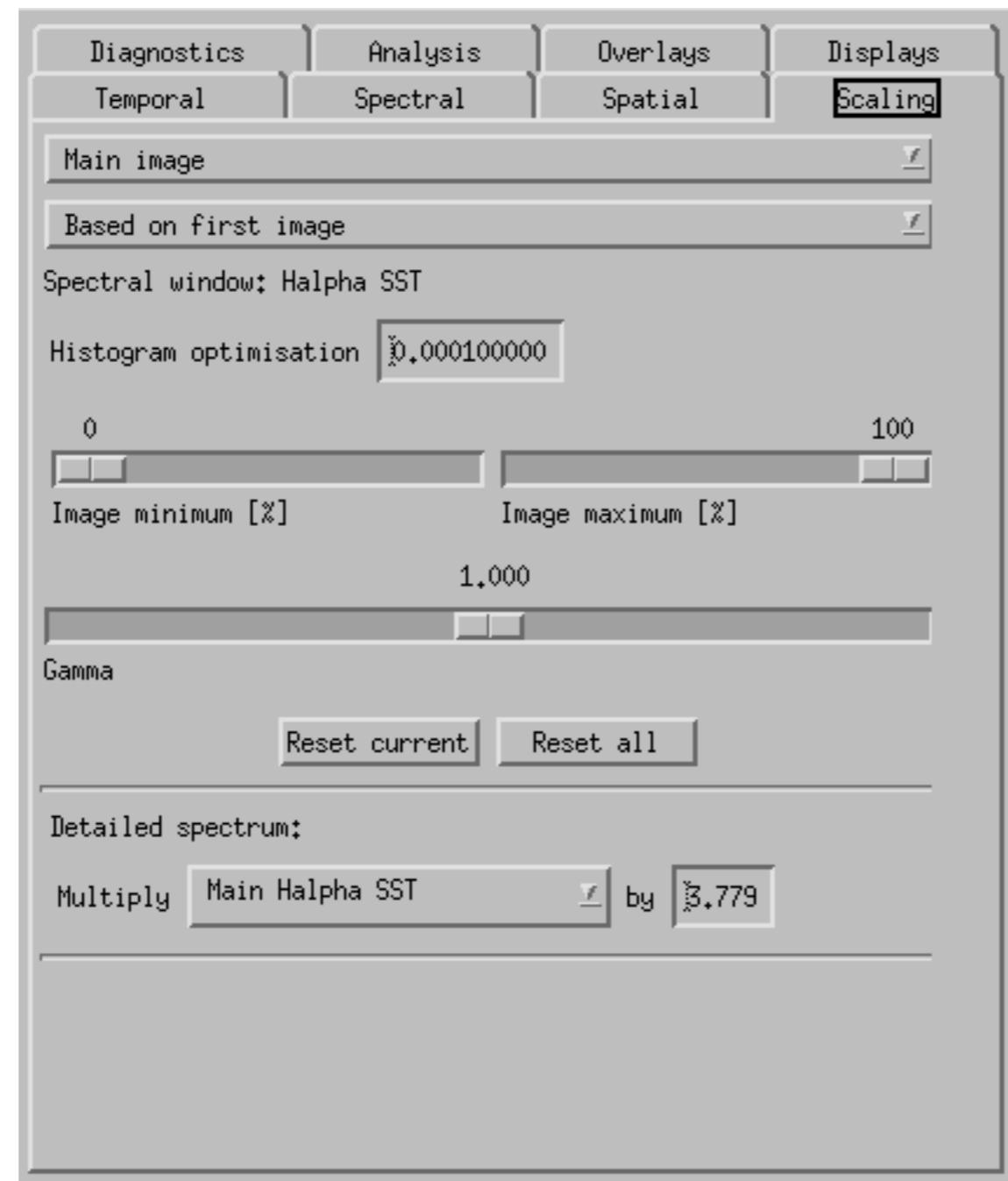
Bottom control panel

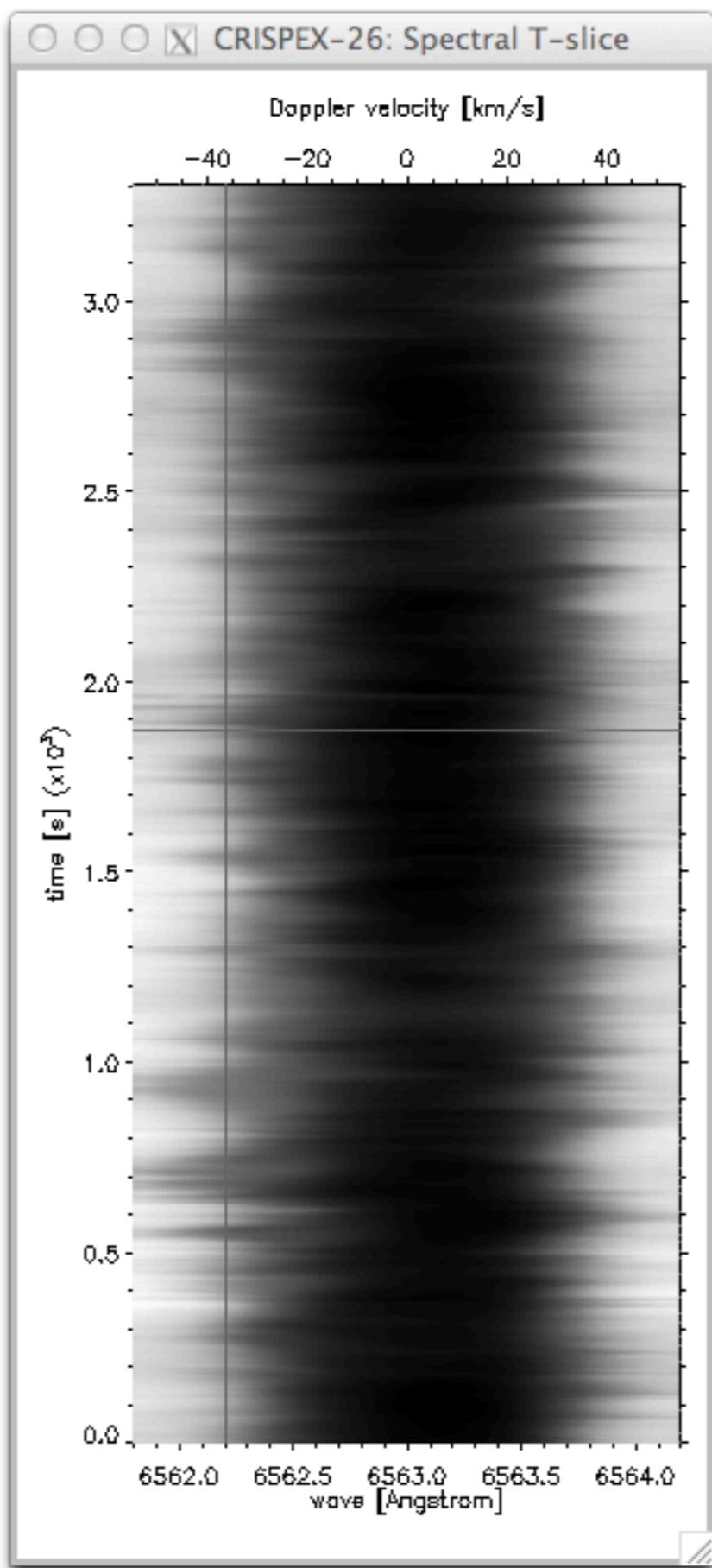


Tabs









Live demo:
CRISPEX

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