

Alignment between IRIS and ground-based data

Luc Rouppe van der Voort

Rosseland Centre for Solar Physics, University of Oslo

tutorial, IRIS-9 Workshop in Göttingen, 25-June-2018



Rosseland
Centre
for Solar
Physics

steps in alignment SST and IRIS

- check pointing / common FOV
- common time range
- match spatial sampling: factor 3 pixel scale difference
 - scale SST to match IRIS *or* scale IRIS to match SST
- matching diagnostics:
 - SJI 2832 Mg h wing vs H α /Ca 8542 far wing
 - SJI 2796 Mg k core vs Ca 8542 wing
- find offsets through cross-correlation
- IRIS internal alignment: fiducial marks

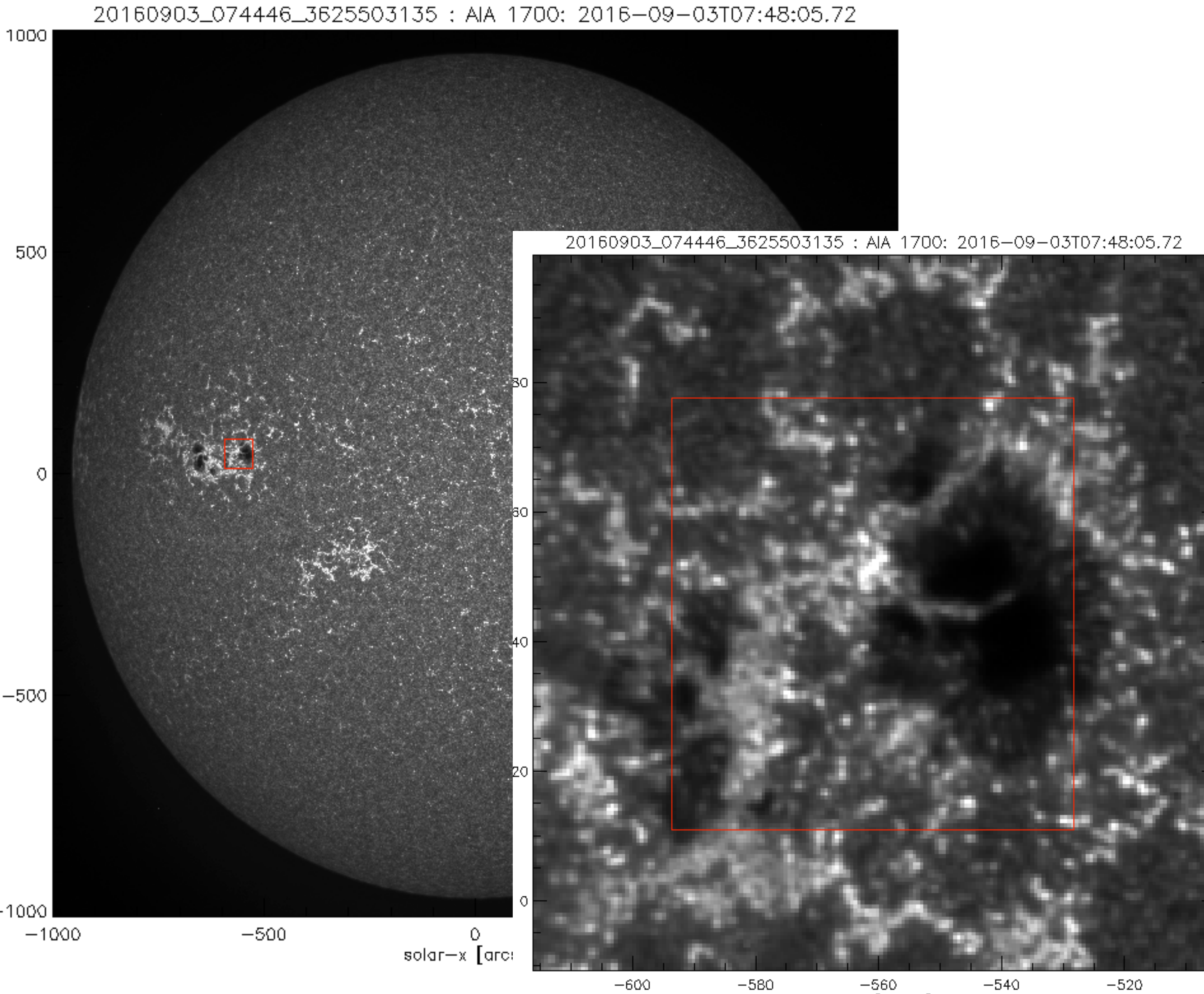
→ make level3 data cubes for crispex viewing

steps in alignment SST and IRIS

- check pointing / common FOV
- common time range
- match spatial sampling: factor 3 pixel scale difference
 - scale SST to match IRIS *or* scale IRIS to match SST
- matching diagnostics:
 - SJI 2832 Mg h wing vs H α /Ca 8542 far wing
 - SJI 2796 Mg k core vs Ca 8542 wing
- find offsets through cross-correlation
- IRIS internal alignment: fiducial marks

→ make level3 data cubes for crispex viewing

example: 3-Sep-2016



•pointing

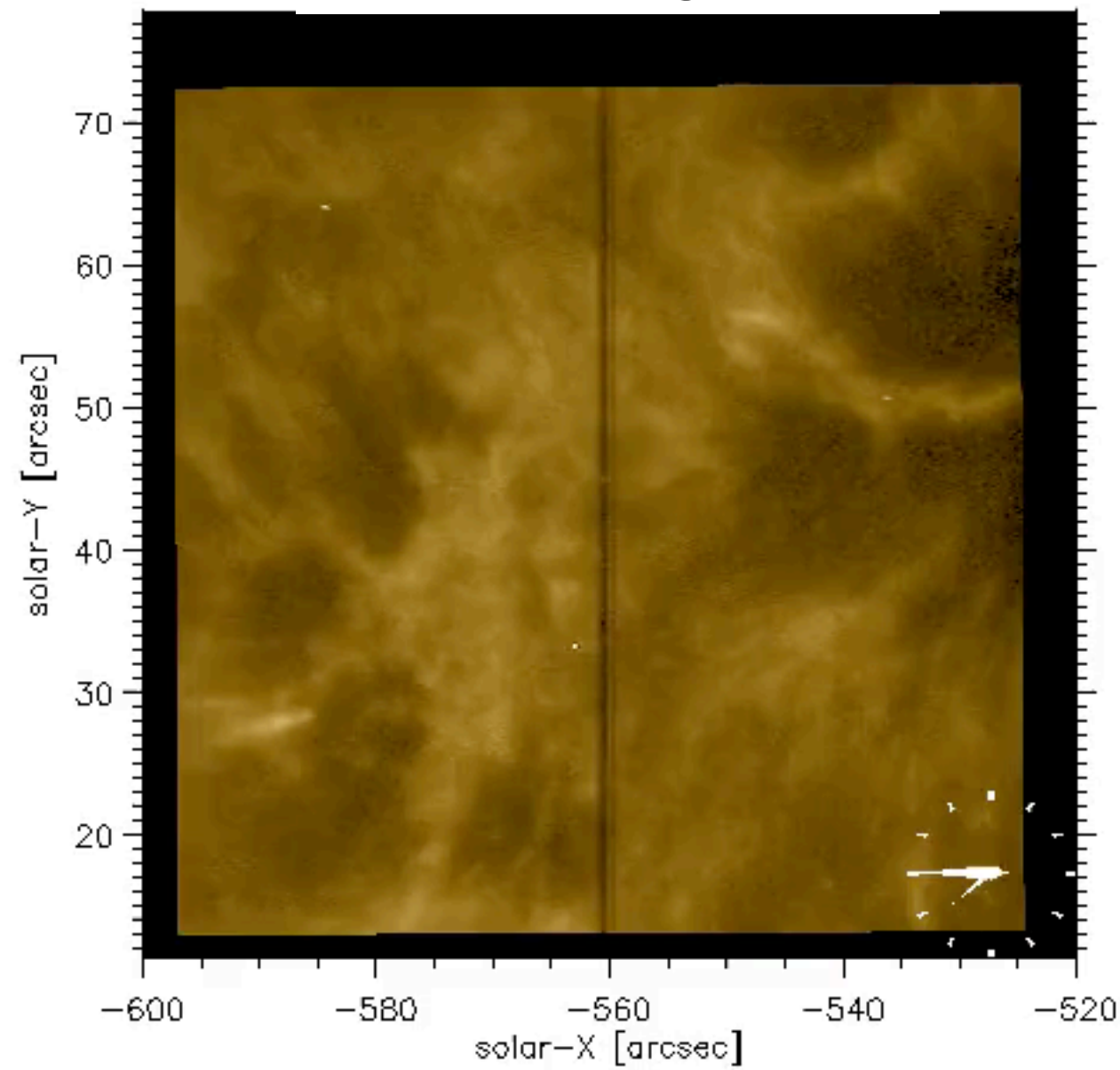
- common time range
- match spatial sampling
- matching diagnostics
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

example: 3-Sep-2016

IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

SJI 2796 Mg k core



20160903_074446_3625503135 0 : 07:44:53

- pointing
- common time range
- match spatial sampling
- matching diagnostics
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

example: 3-Sep-2016

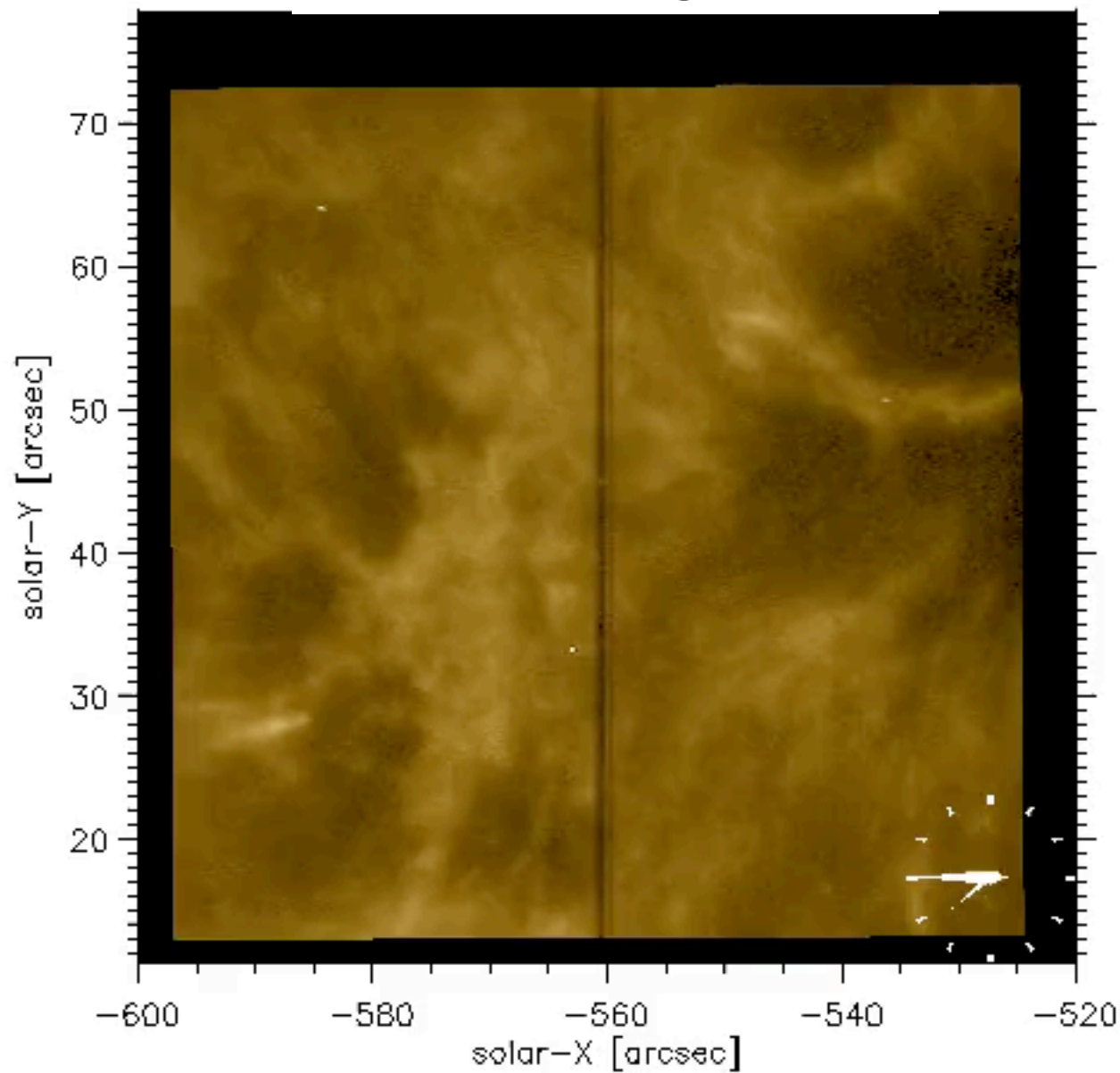
IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

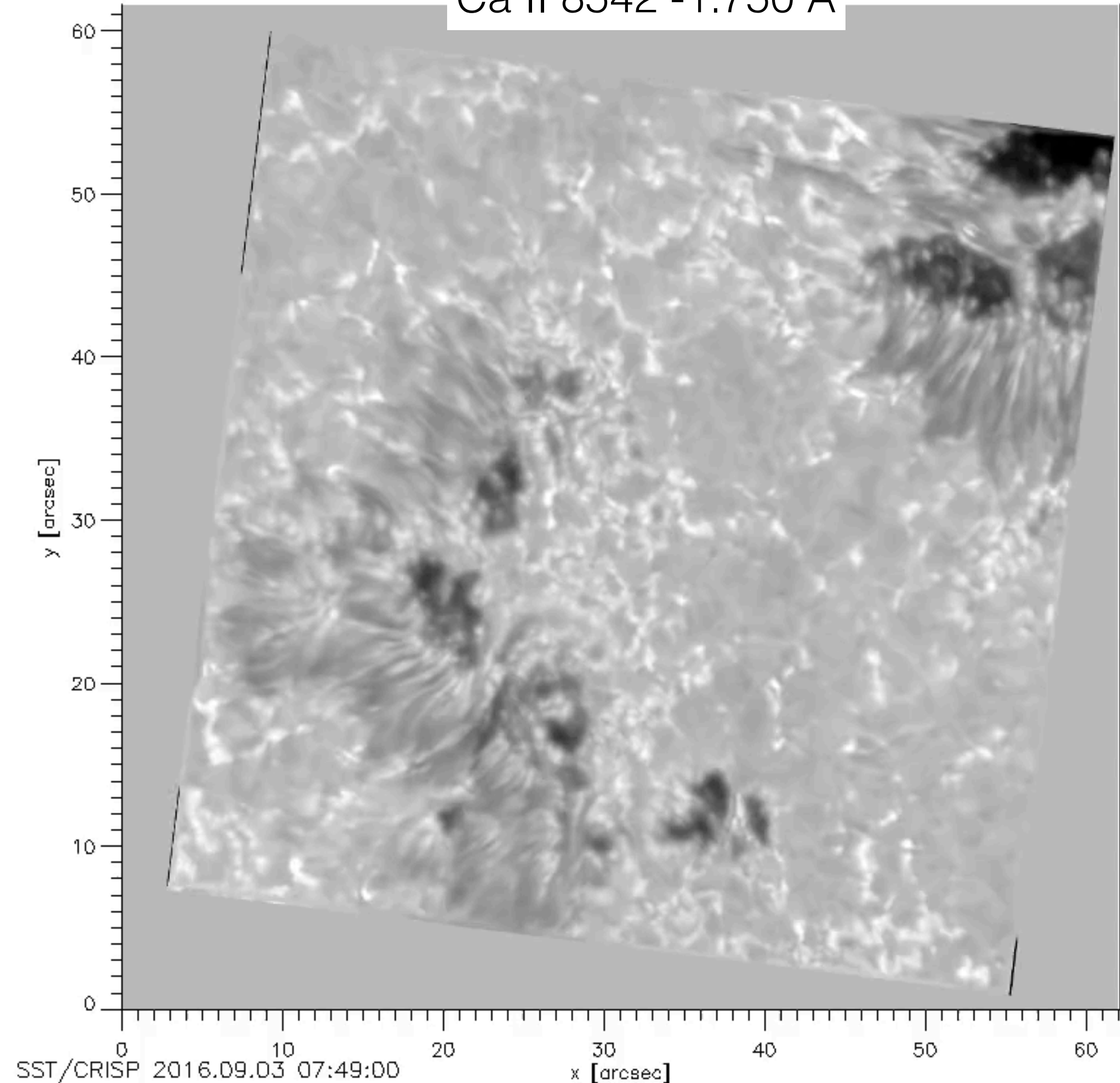
SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel

SJI 2796 Mg k core



Ca II 8542 -1.750 Å



- pointing
- common time range
- match spatial sampling
- matching diagnostics
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

example: 3-Sep-2016

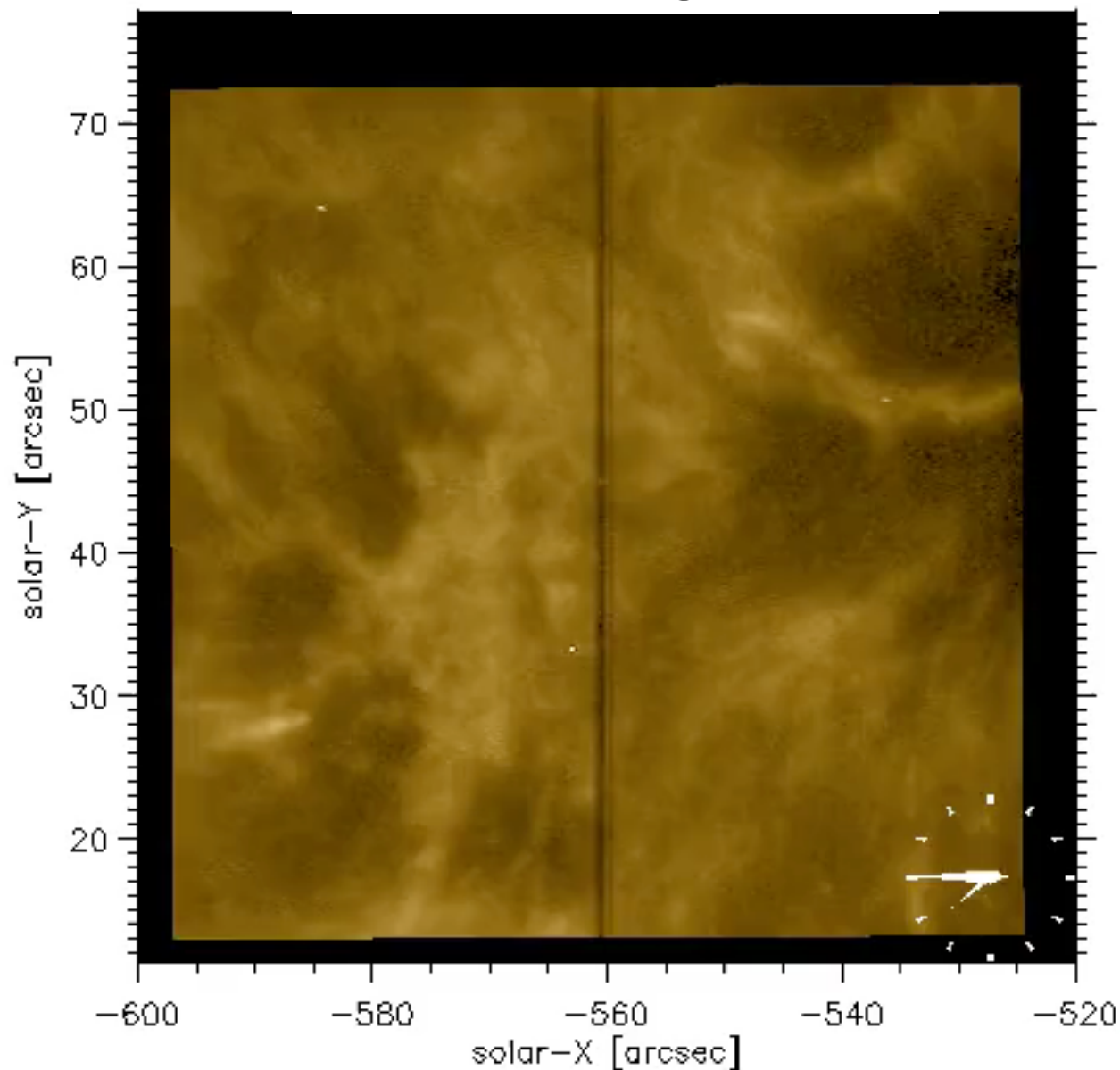
IRIS

Medium dense 16-step raster 5x60
07:44 - 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

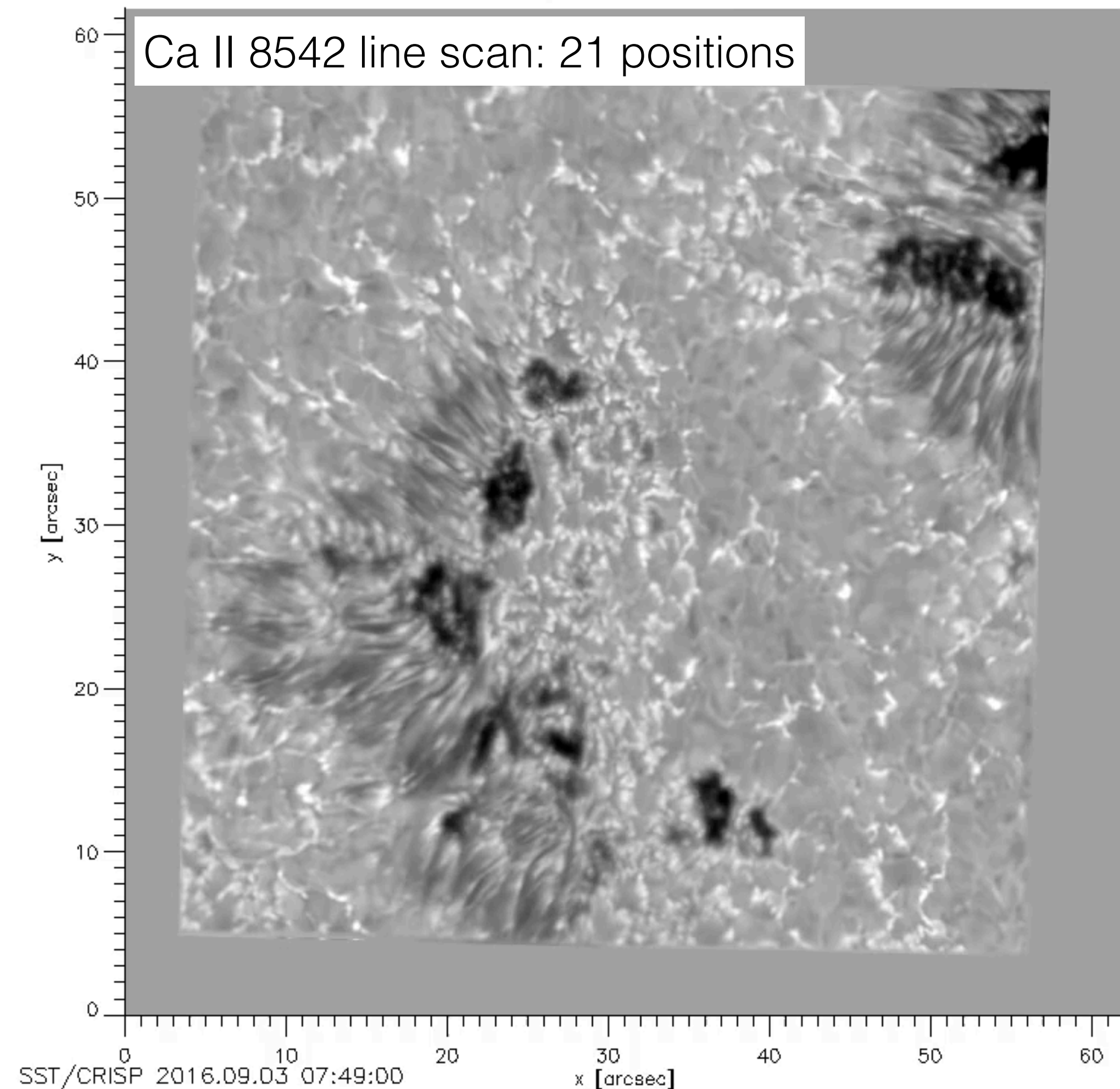
SST

CRISP Ca II 8542, H-alpha
07:49 - 10:10
0.057 arcsec / pixel

SJI 2796 Mg k core



Ca II 8542 -1.750 Å



- pointing
- common time range
- match spatial sampling
- matching diagnostics
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

example: 3-Sep-2016

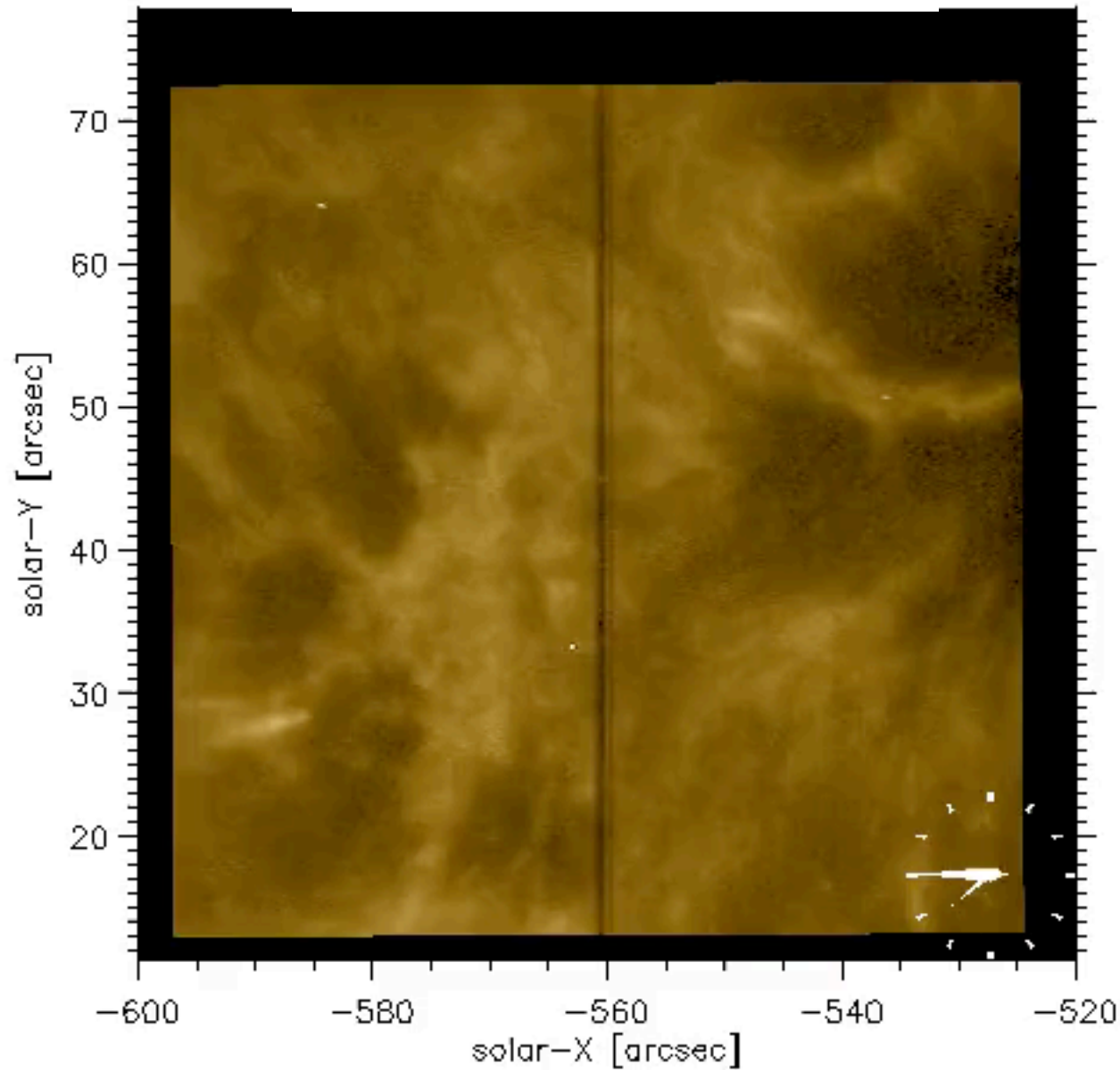
IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

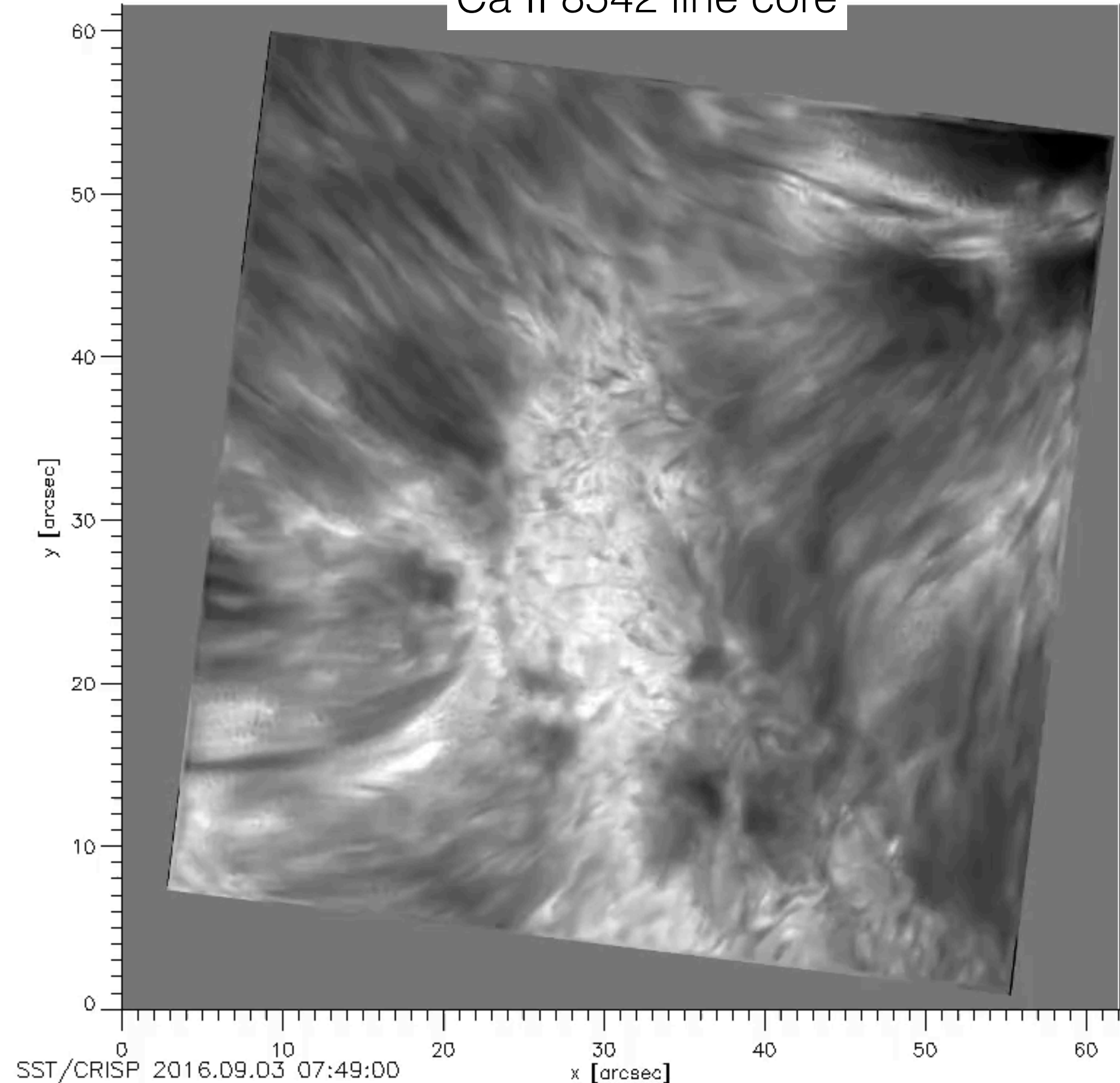
SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel

SJI 2796 Mg k core



Ca II 8542 line core



- pointing
- common time range
- match spatial sampling
- matching diagnostics
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

20160903_074446_3625503135 0 : 07:44:53

SST/CRISP 2016.09.03 07:49:00

x [arcsec]

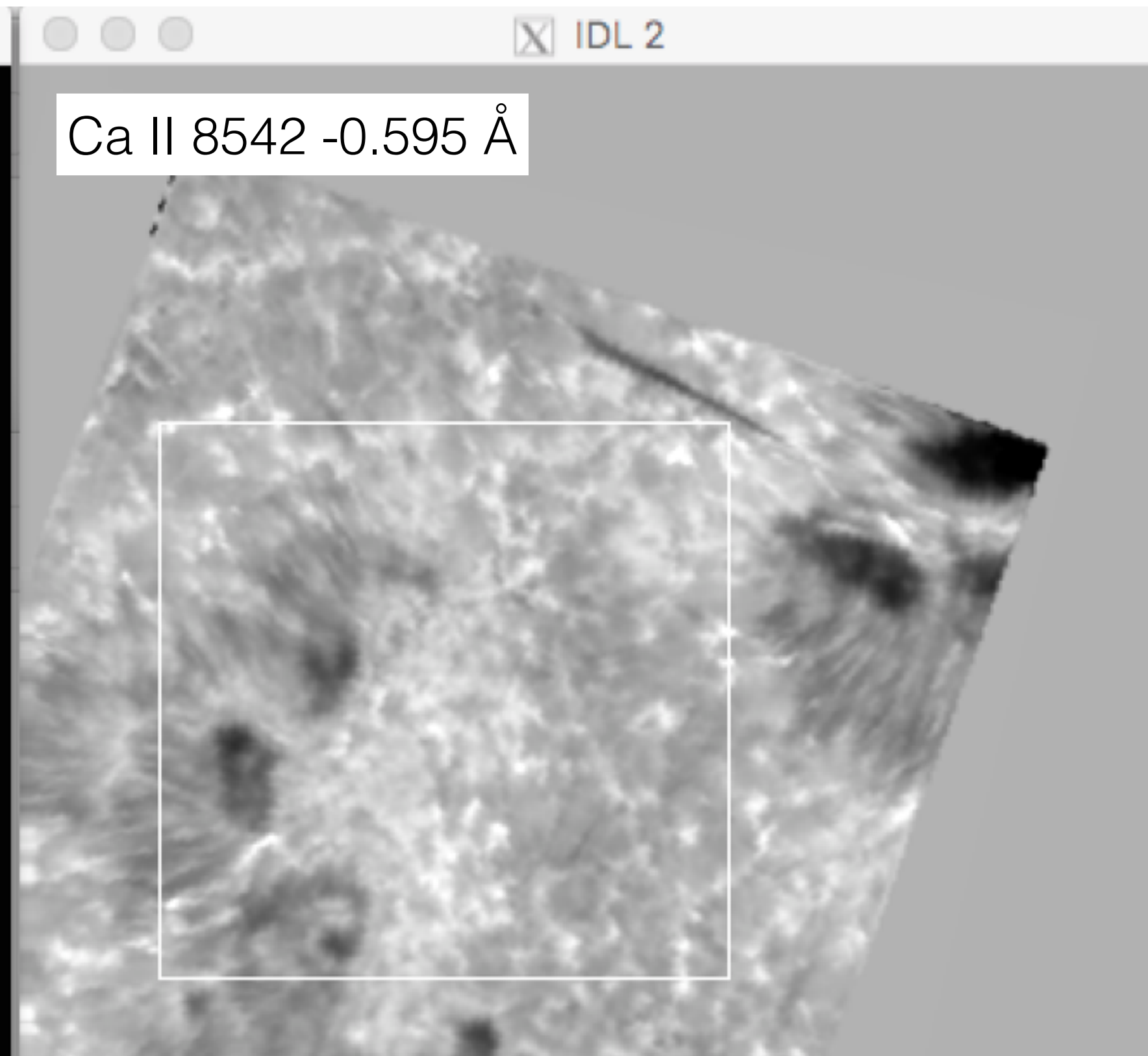
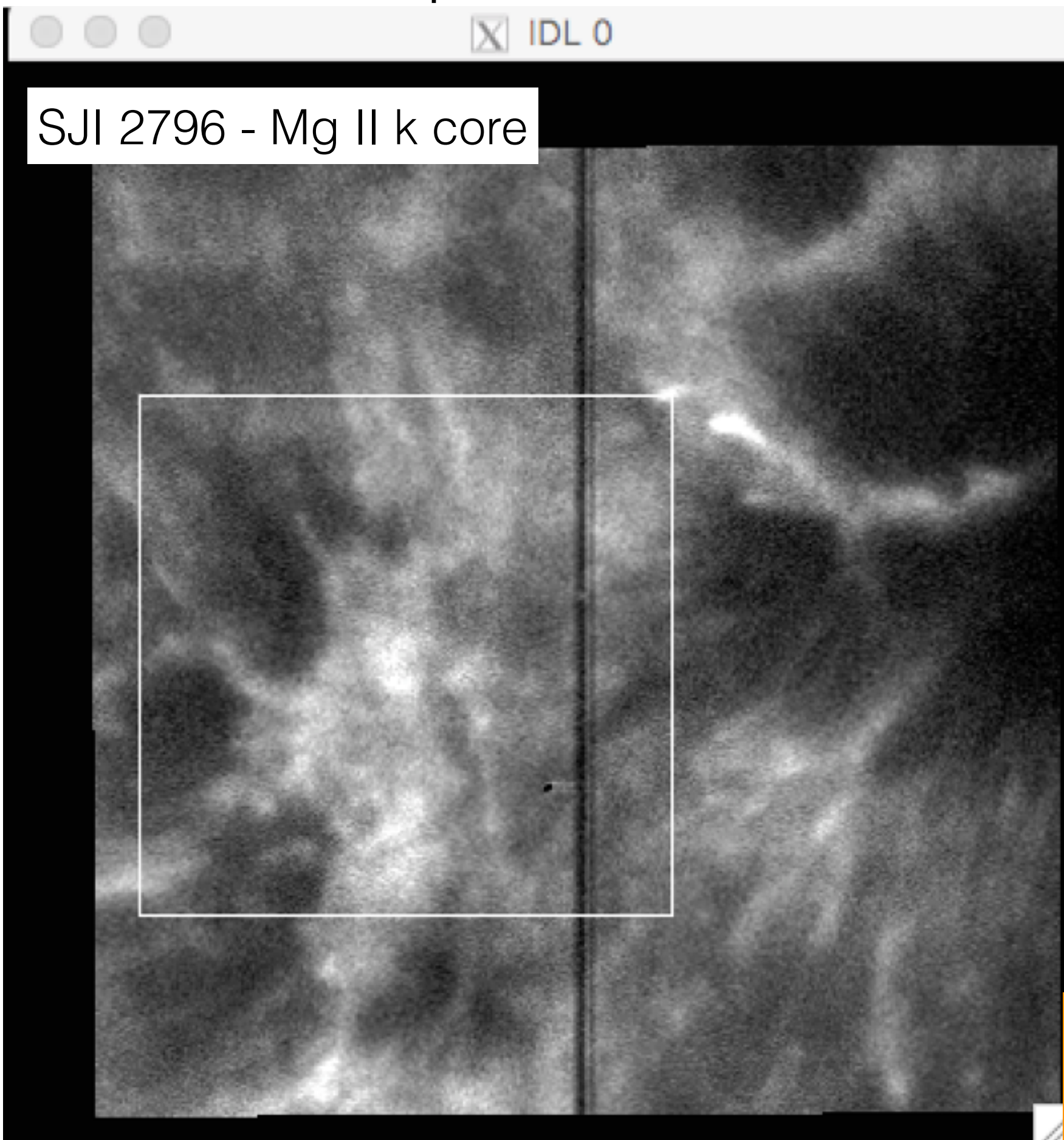
example: 3-Sep-2016

IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel



- **pointing**
- **common time range**
- **match spatial sampling**
- **matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

photospheric SJI 2832 would have been best match
but was not chosen to keep fast cadence and telemetry

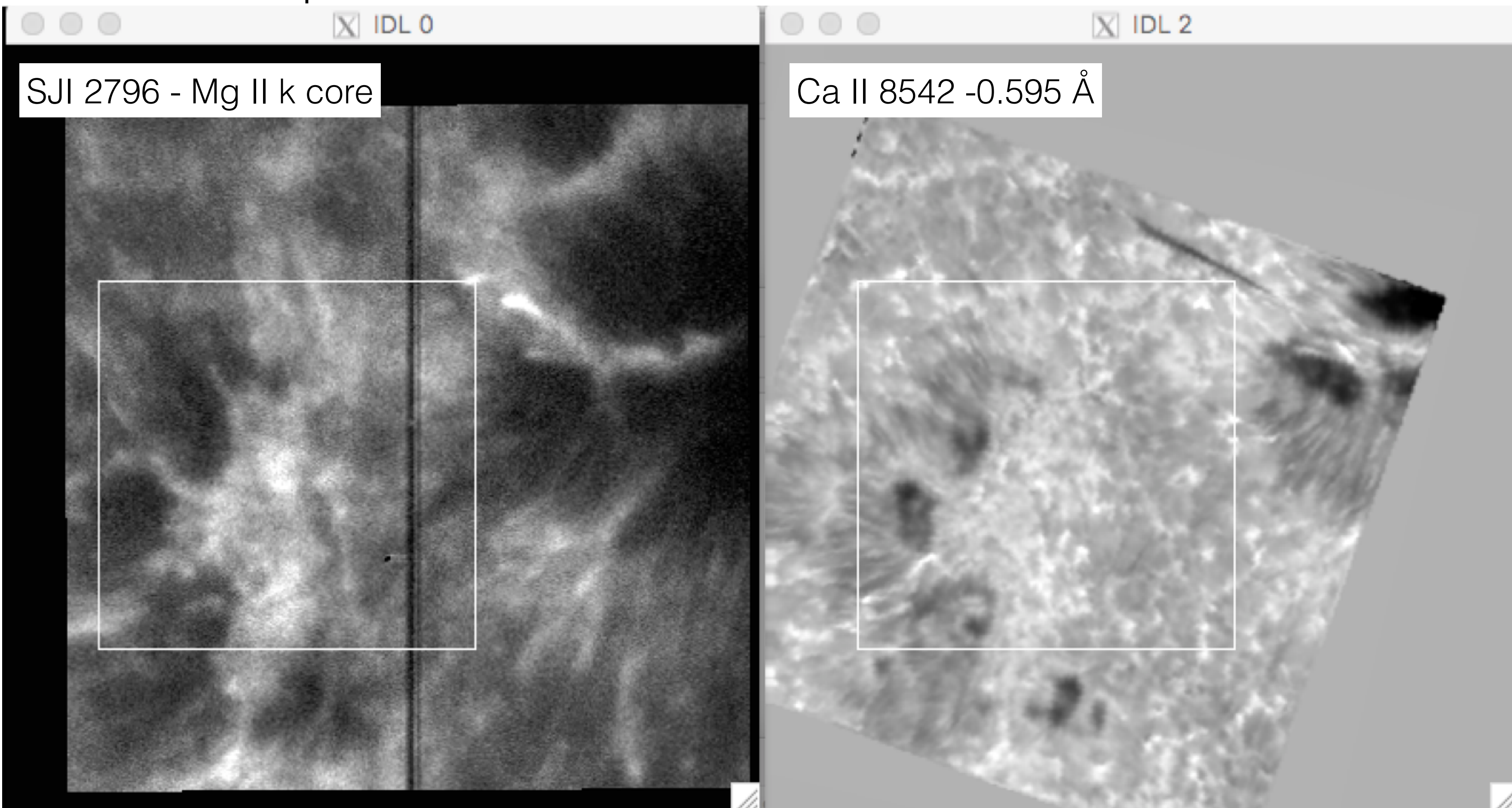
example: 3-Sep-2016

IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel



- pointing
- common time range
- match spatial sampling
- matching diagnostics
- cross-correlation**
- IRIS internal alignment
- level3 cubes (crispex)

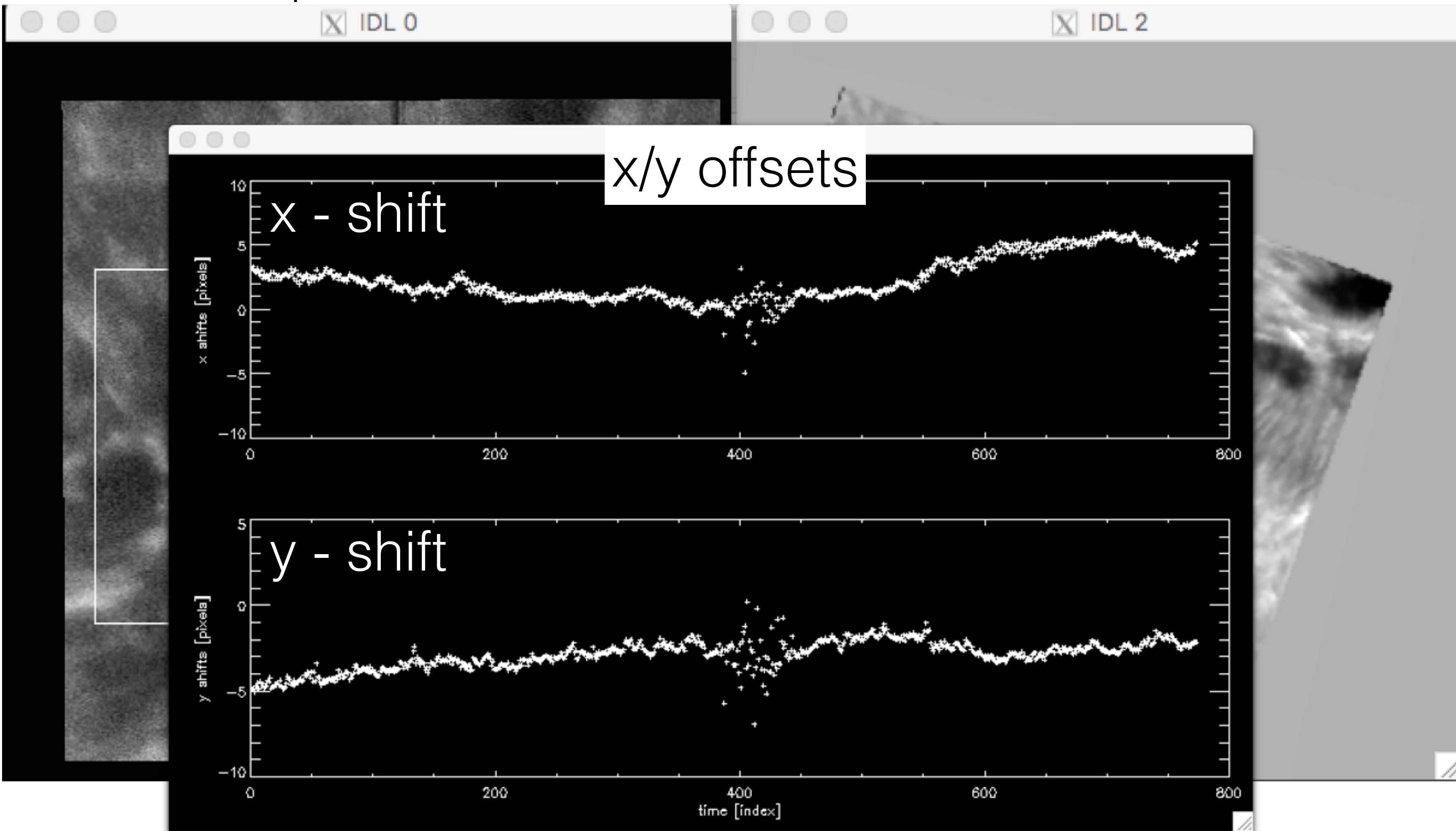
example: 3-Sep-2016

IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel



- pointing
- common time range
- match spatial sampling
- matching diagnostics
- **cross-correlation**
- IRIS internal alignment
- level3 cubes (crispex)

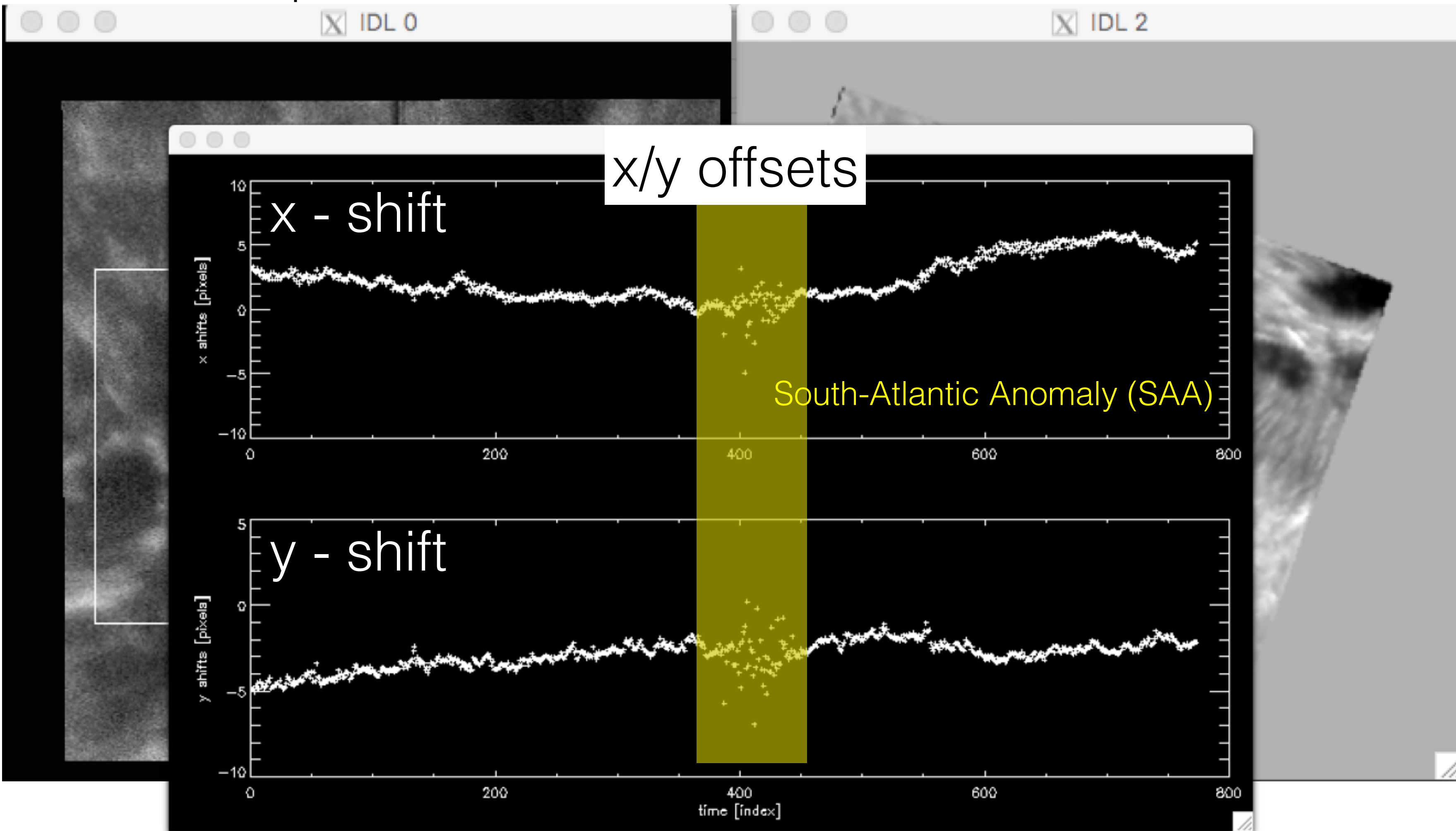
example: 3-Sep-2016

IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel



- pointing
- common time
- match spatial sampling
- matching diagnostics
- **cross-correlation**
- IRIS internal alignment
- level3 cubes (crispex)

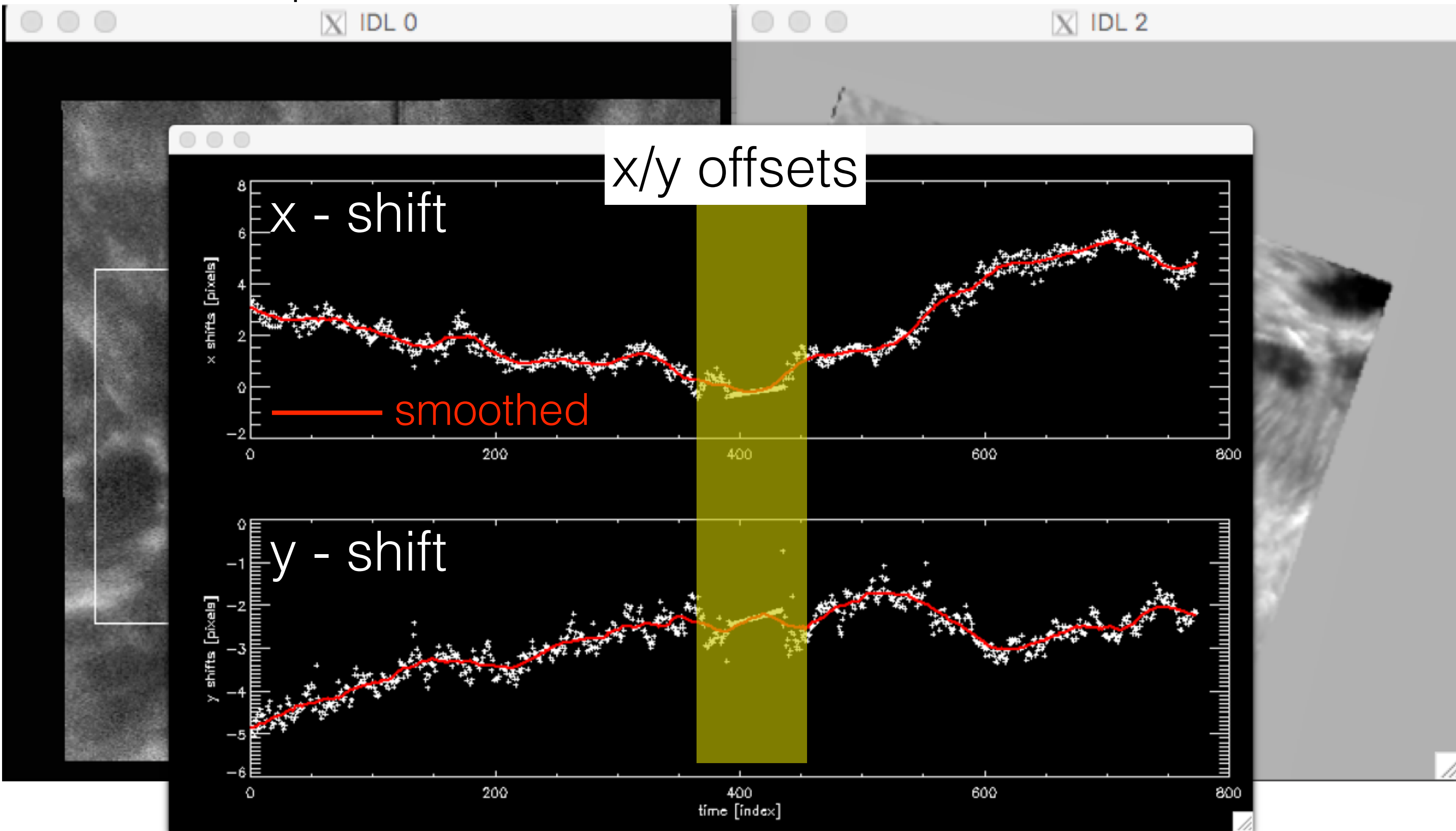
example: 3-Sep-2016

IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel

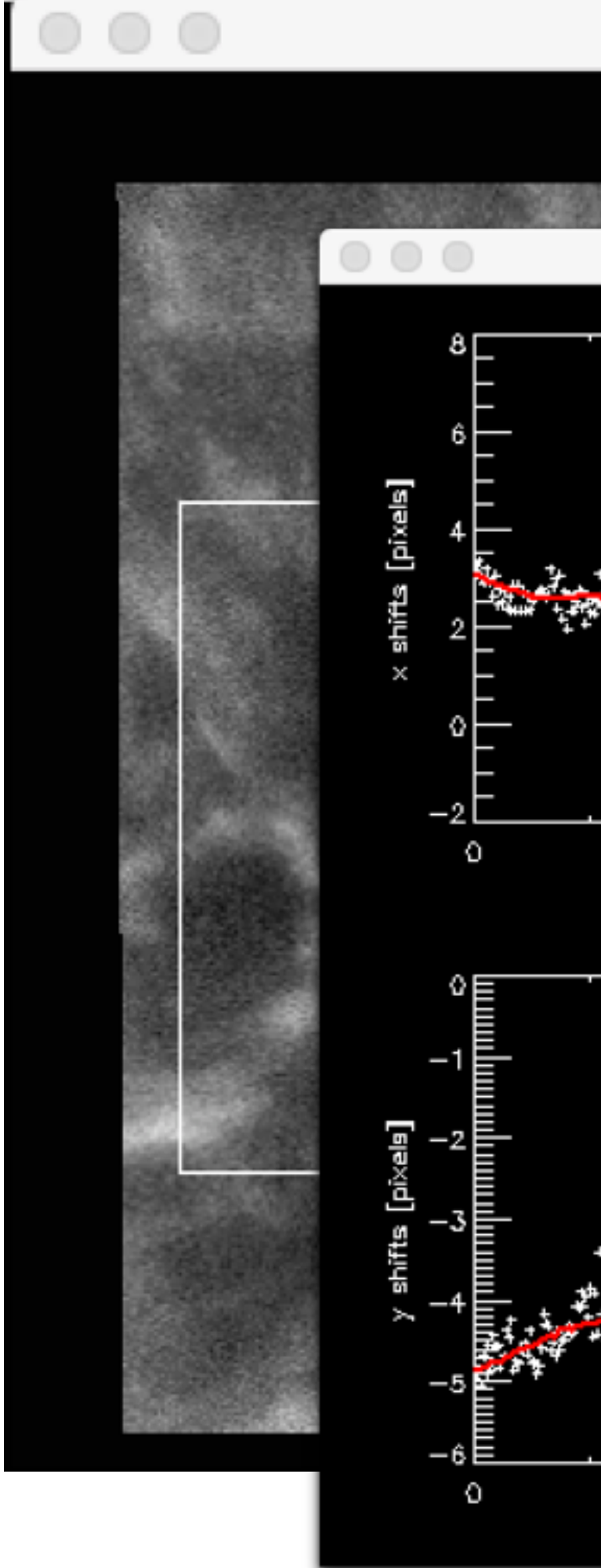


- pointing
- common time
- match spatial sampling
- matching diagnostics
- **cross-correlation**
- IRIS internal alignment
- level3 cubes (crispex)

example: 3-Sep-2016

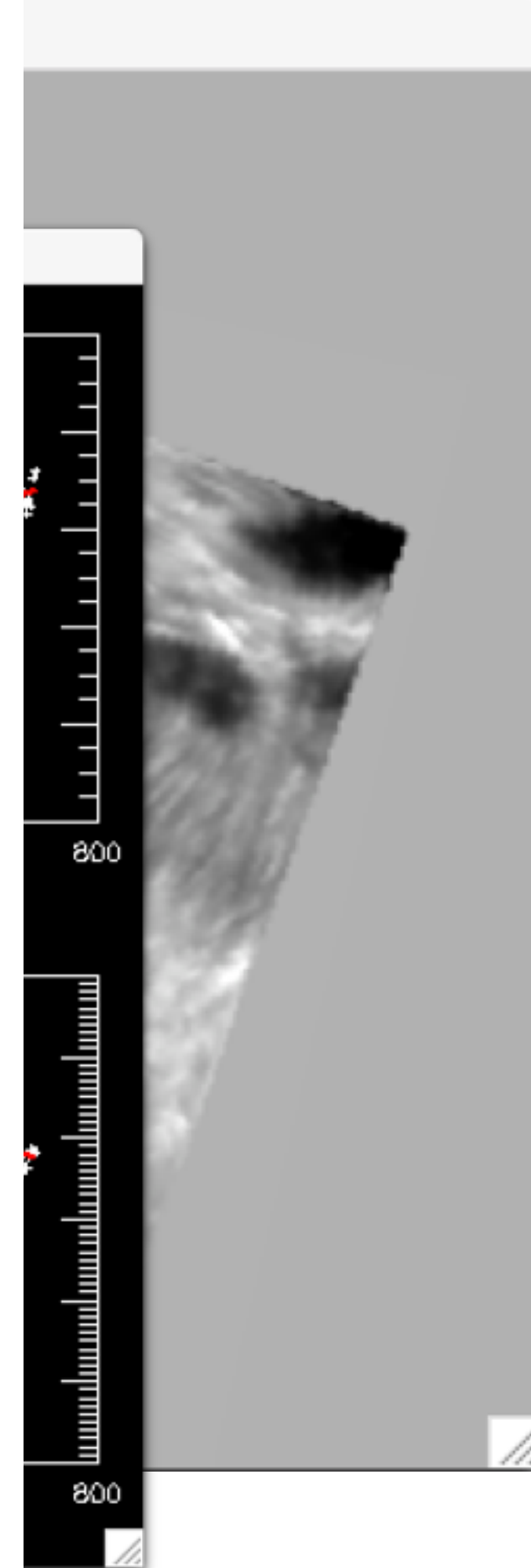
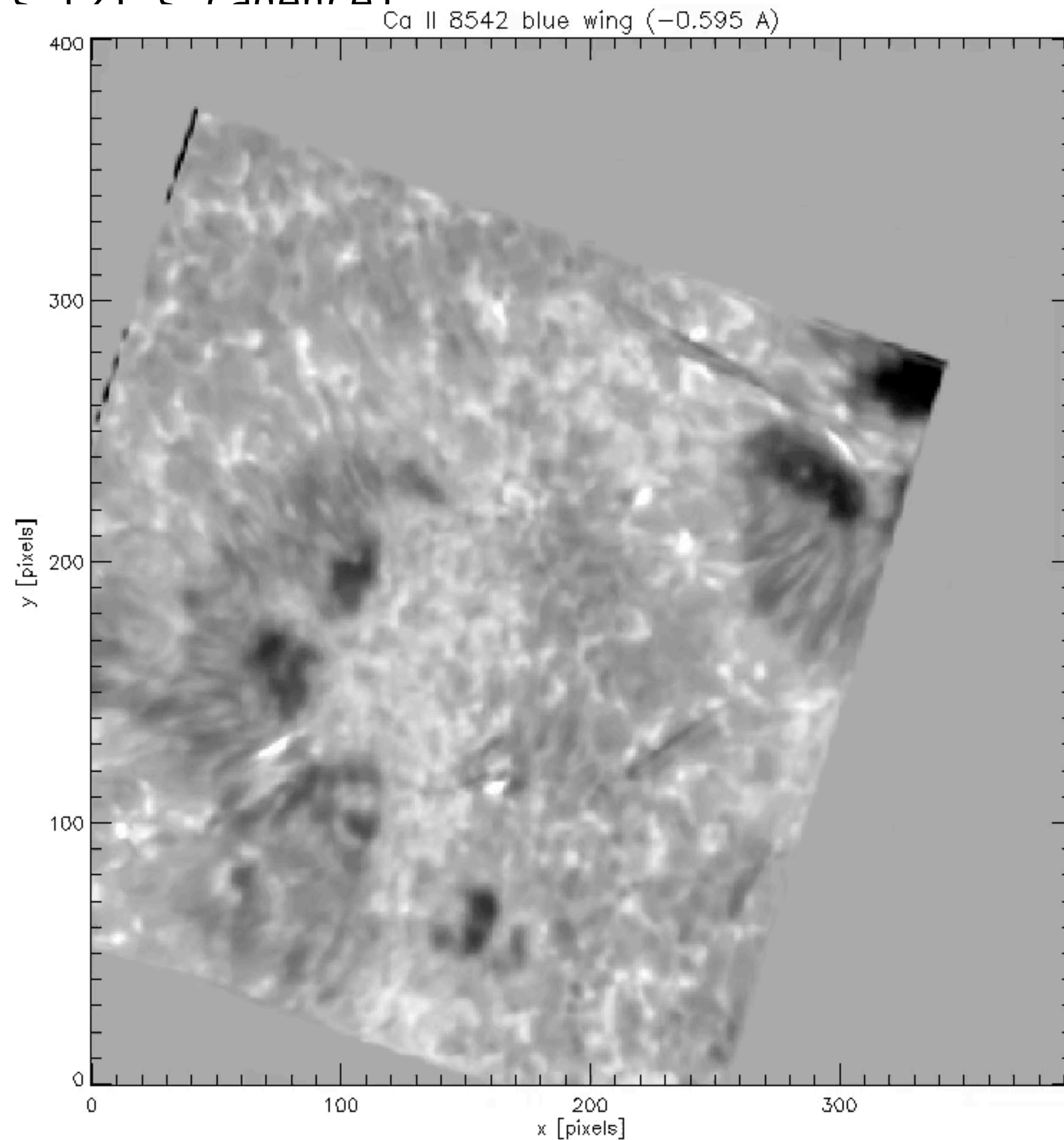
IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel



SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel



- pointing
- common time
- match spatial sampling
- matching diagnostics
- **cross-correlation**
- IRIS internal alignment
- level3 cubes (crispex)

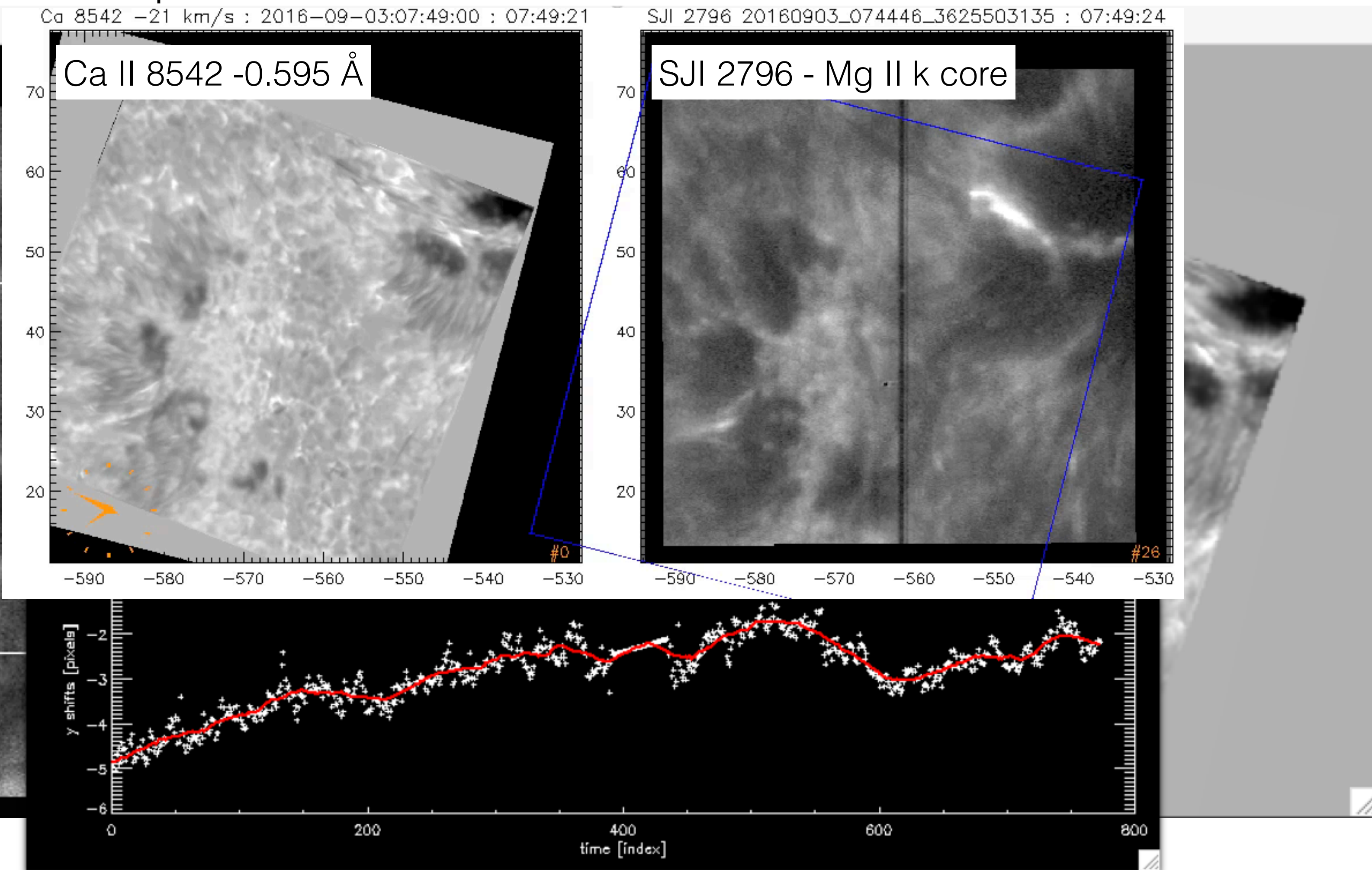
example: 3-Sep-2016

IRIS

Medium dense 16-step raster 5x60
07:44 – 10:03 UT
SJI 1330, 1400, 2796
exposure time 0.5 s (21 s cadence)
0.166 arcsec / pixel

SST

CRISP Ca II 8542, H-alpha
07:49 – 10:10
0.057 arcsec / pixel



- pointing
- common time
- match spatial sampling
- matching diagnostics
- **cross-correlation**
- IRIS internal alignment
- level3 cubes (crispex)

CRISPEX File View Movie Analysis Help

Diagnosics Analysis Overlays Displays Plots
Temporal Spectral Spatial Stokes Scaling

Main image
Based on first non-zero image
Spectral window: Mg II k 2796
Histogram optimisation 0.000100000

Image minimum [Z] 0 Image maximum [Z] 100
0.887

Gain
Reset current Reset all

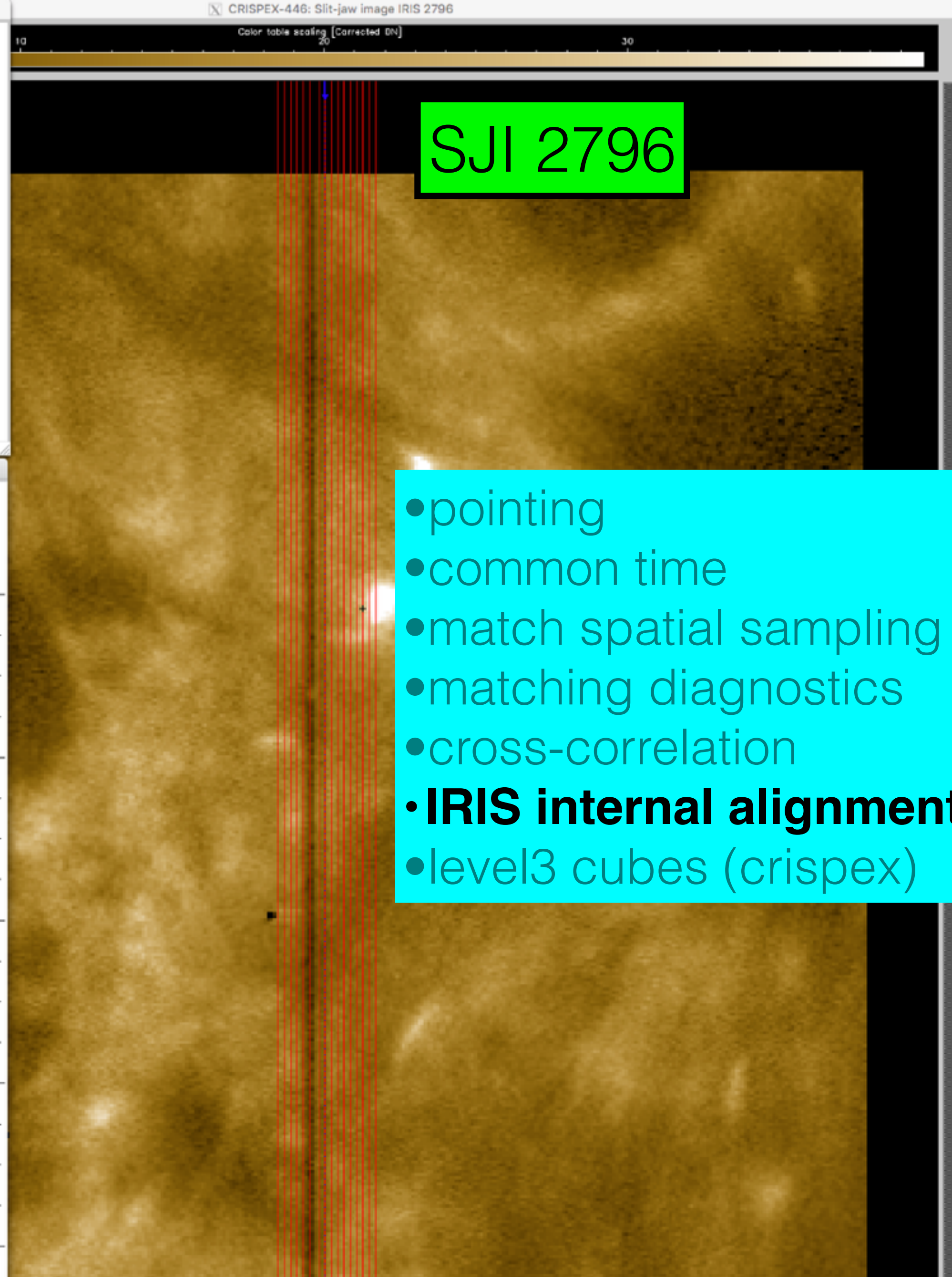
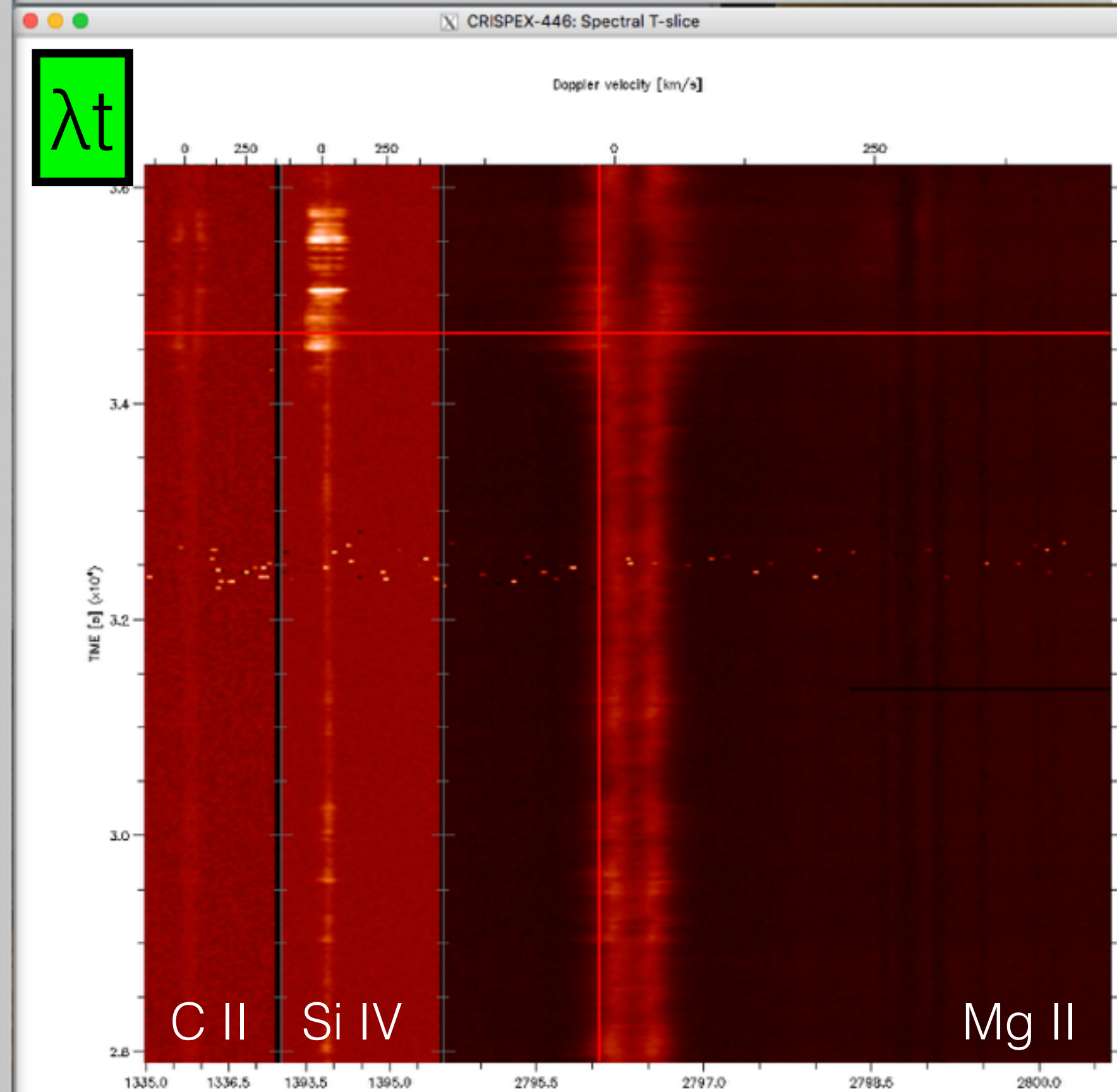
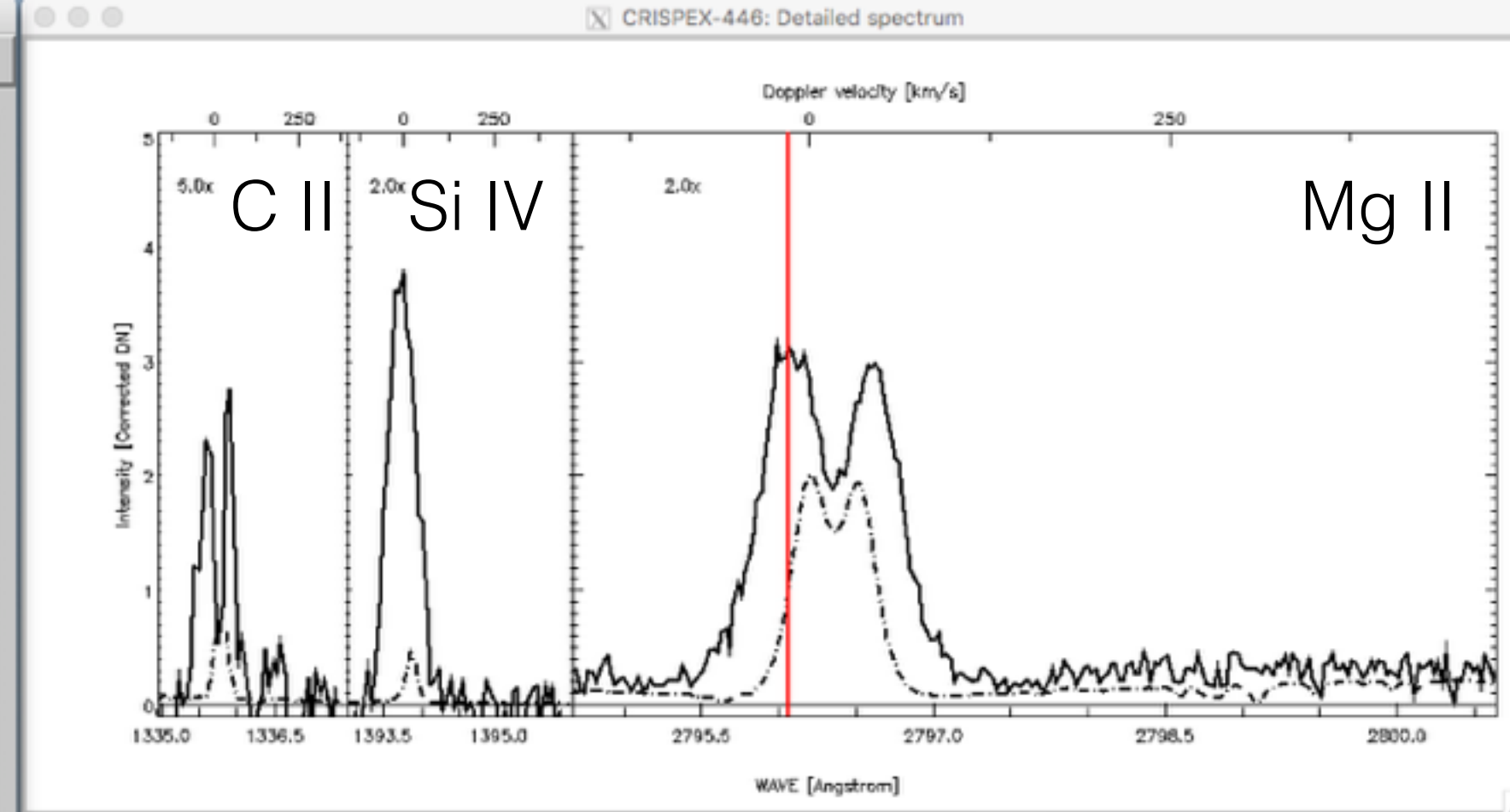
Zoom: 333x

Frame number 324 Main spectral position 825

Position	Main	Reference	Slit-jaw
Index [px]	(13,232)	N/A	(210,232)
Solar XY ["]	(-558.4, 49.7)	N/A	(-559.5, 49.7)
Wavelength			
Index [px]	825	N/A	
Value [Å]	2796.1	N/A	
Doppler [km/s]	-14.55	N/A	
Time			
Index [px]	324	N/A	648
Value (UTC)	09:37:28.940	N/A	09:37:26.490
Local (UTC)	09:37:36.840	N/A	N/A
Data values			
Value	48.25	N/A	24.75

Date: 2016-09-03 OBSID: 3629503135

xy raster



- pointing
- common time
- match spatial sampling
- matching diagnostics
- cross-correlation
- **IRIS internal alignment**
- level3 cubes (crispex)

IDL> crispex, <im cube>, <sp cube>, sji=<sji>

CRISPEX File View Movie Analysis Help

Diagnosics Analysis Overlays Displays Plots

Temporal Spectral Spatial Stokes Scaling

Main image

Based on first non-zero image

Spectral window: Mg II k 2796

Histogram optimisation 0,000100000

Image minimum [Z] 0 Image maximum [Z] 100

Image minimum [X] Image maximum [X] 0,887

Gamma

Reset current Reset all

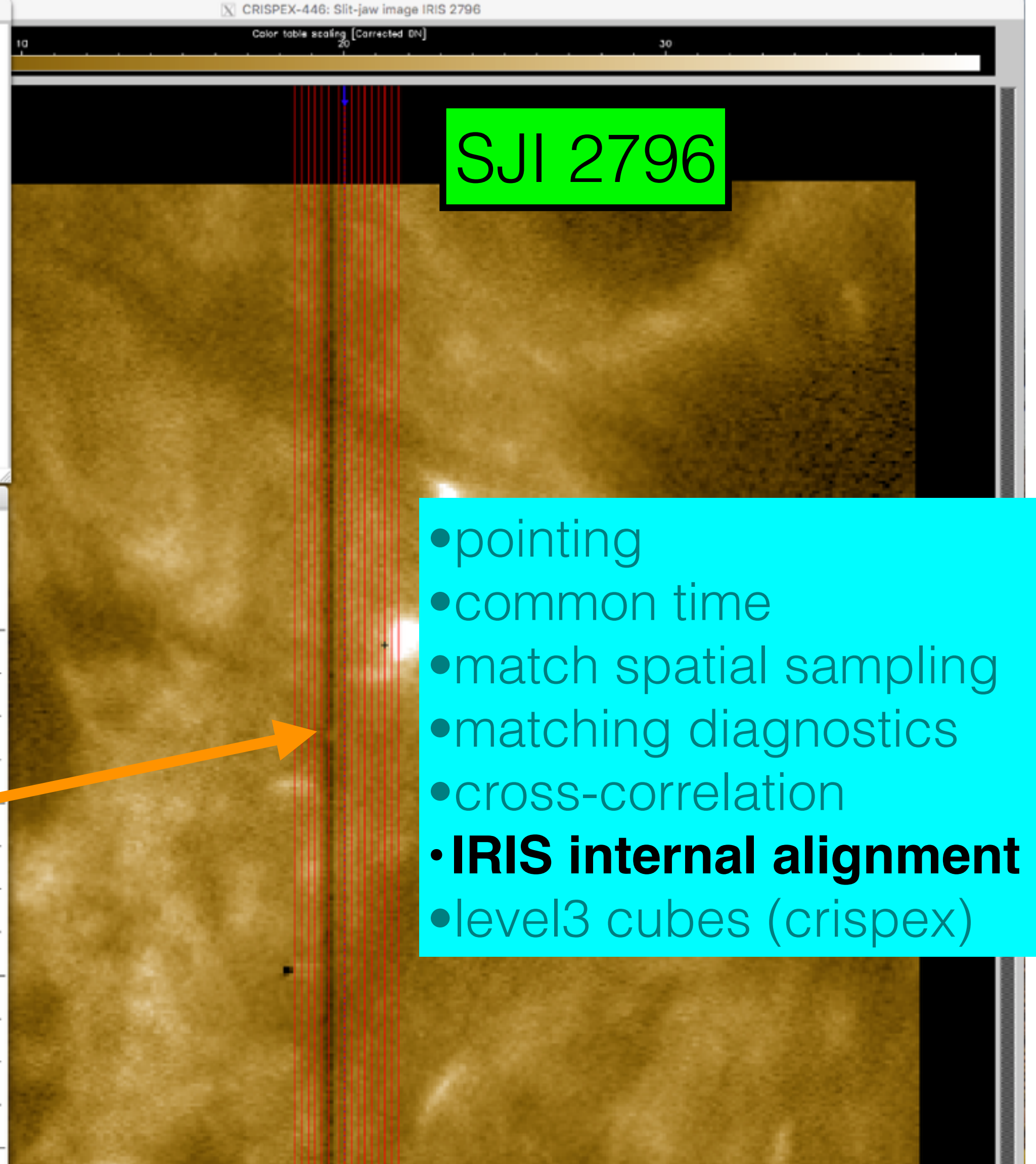
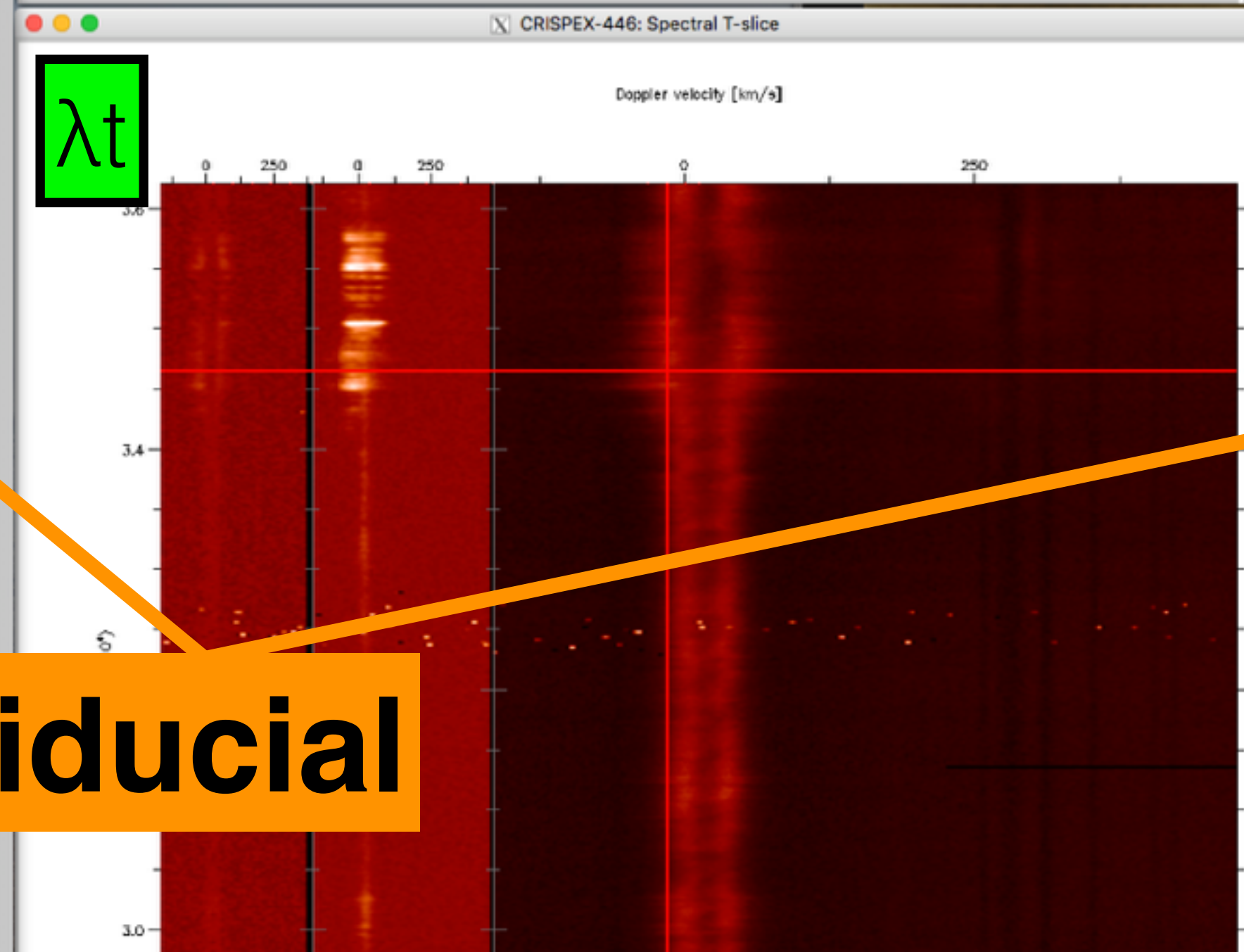
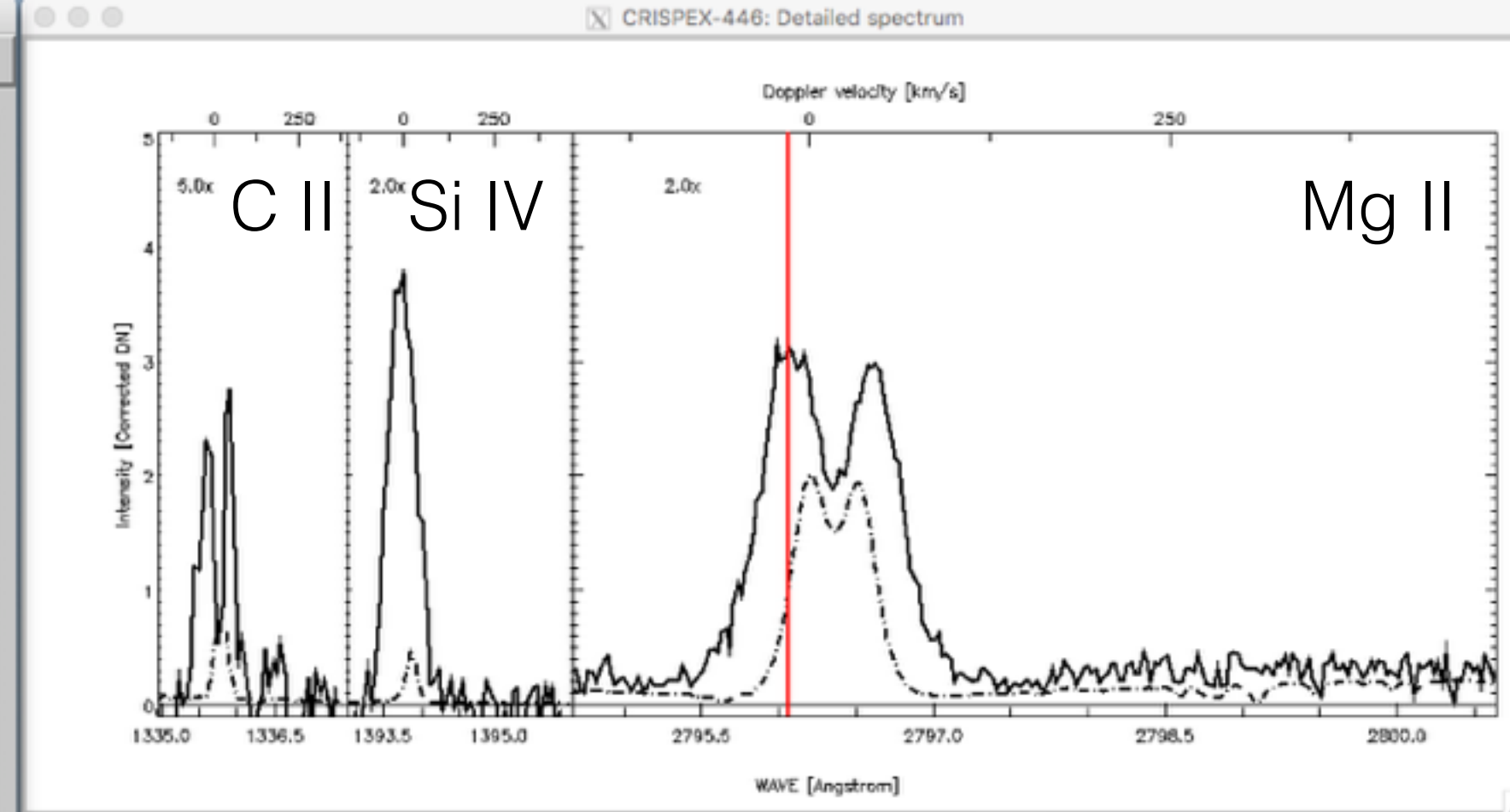
Zoom: 333x

Frame number 324 Main spectral position 825

Position	Main	Reference	Slit-jaw
Index [px]	(13,232)	N/A	(210,232)
Solar XY ["]	(-558.4, 49.7)	N/A	(-559.5, 49.7)
Wavelength			
Index [px]	825	N/A	
Value [Å]	2796.1	N/A	
Doppler [km/s]	-14.55	N/A	
Time			
Index [px]	324	N/A	648
Value (UTC)	09:37:28,940	N/A	09:37:26,490
Local (UTC)	09:37:36,840	N/A	N/A
Data values			
Value	48.25	N/A	24.75

Date: 2016-09-03 OBSID: 3629503135

xy raster

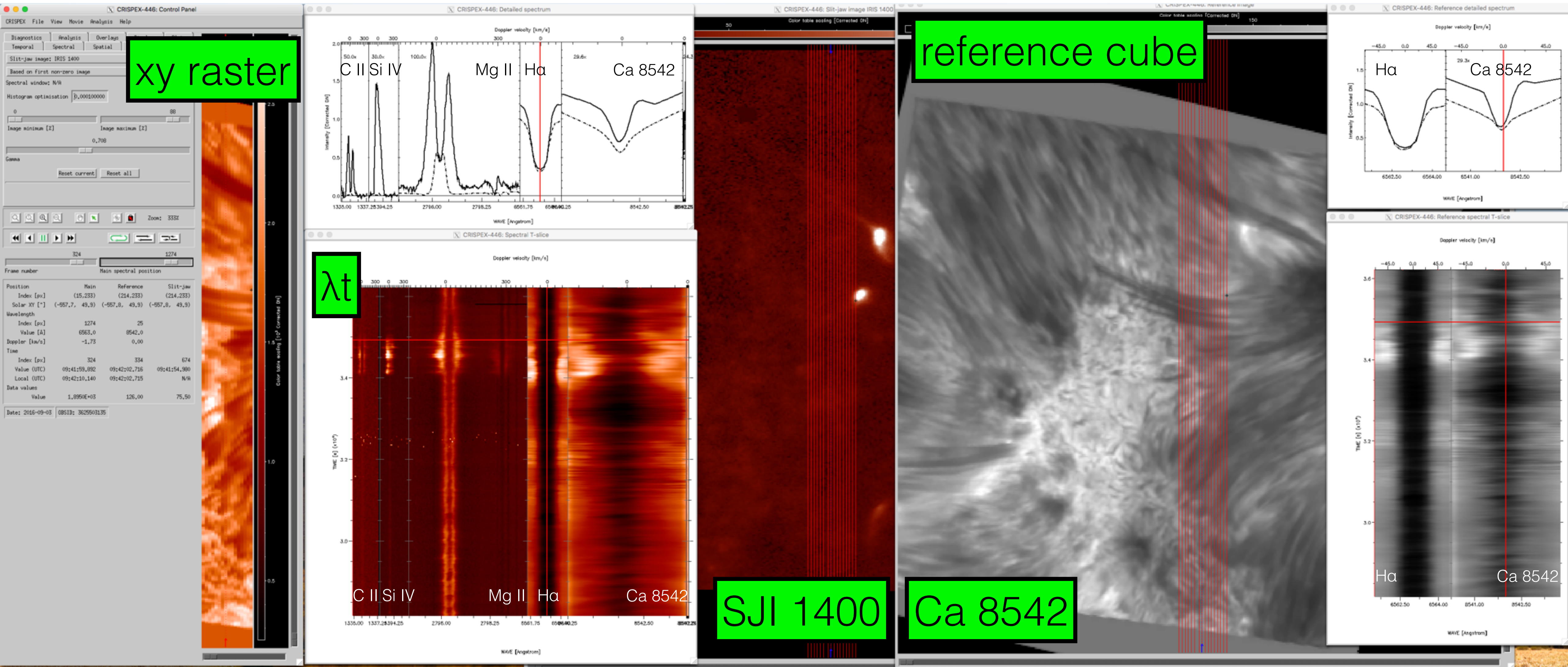


- pointing
- common time
- match spatial sampling
- matching diagnostics
- cross-correlation
- **IRIS internal alignment**
- level3 cubes (crispex)

fiducial

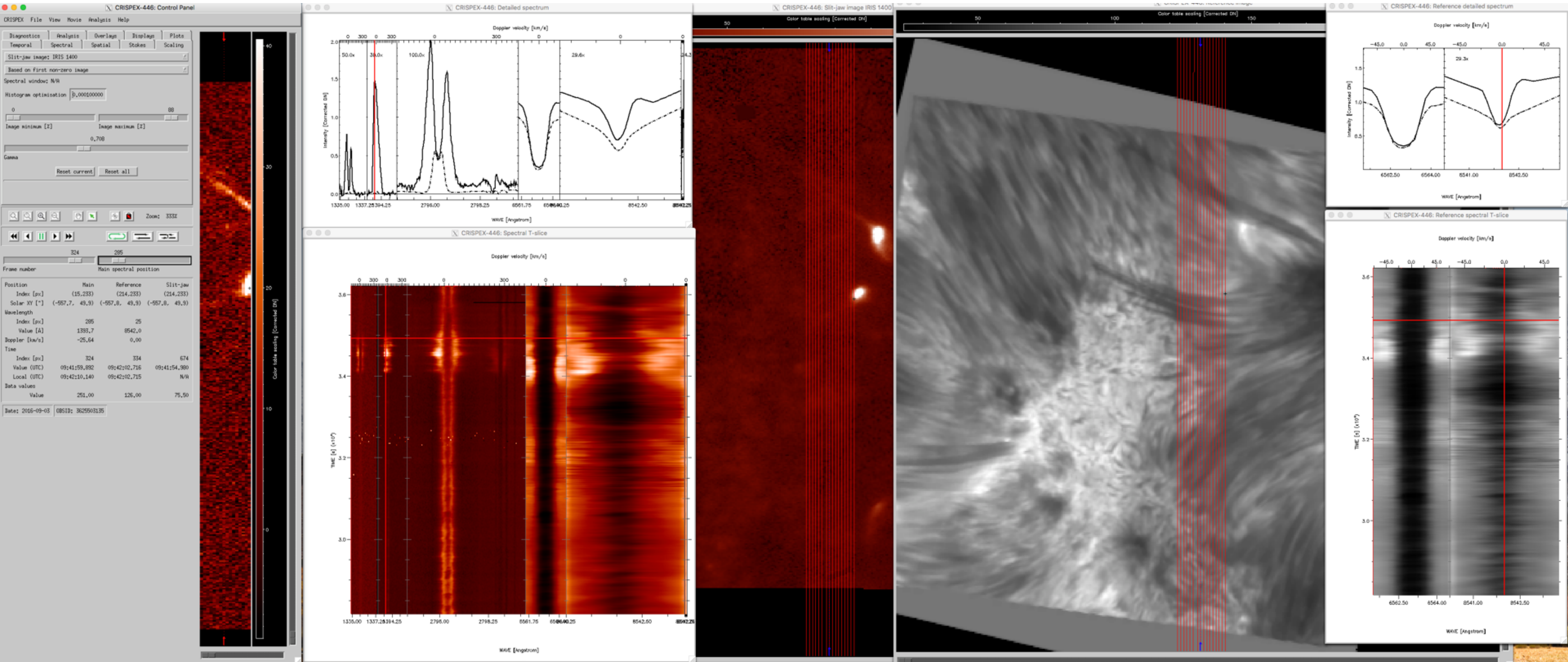
IRIS internal alignment:
check the fiducial mark in FUV, NUV spectra and all SJI

level 3 cubes with SST lines included



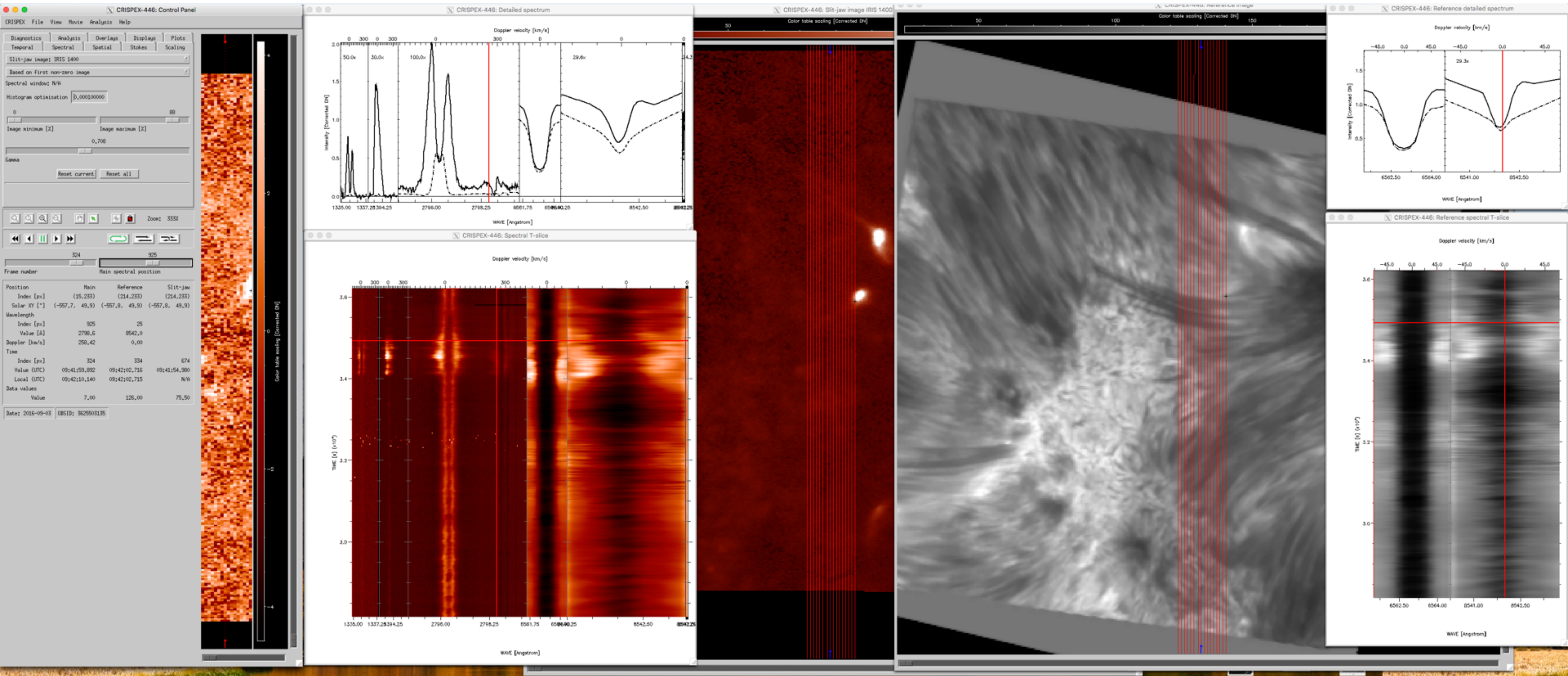
IDL> crispex, <im cube>, <sp cube>, sji=<sji>, ref=<ref>

example: UV burst / Ellerman bomb under surge



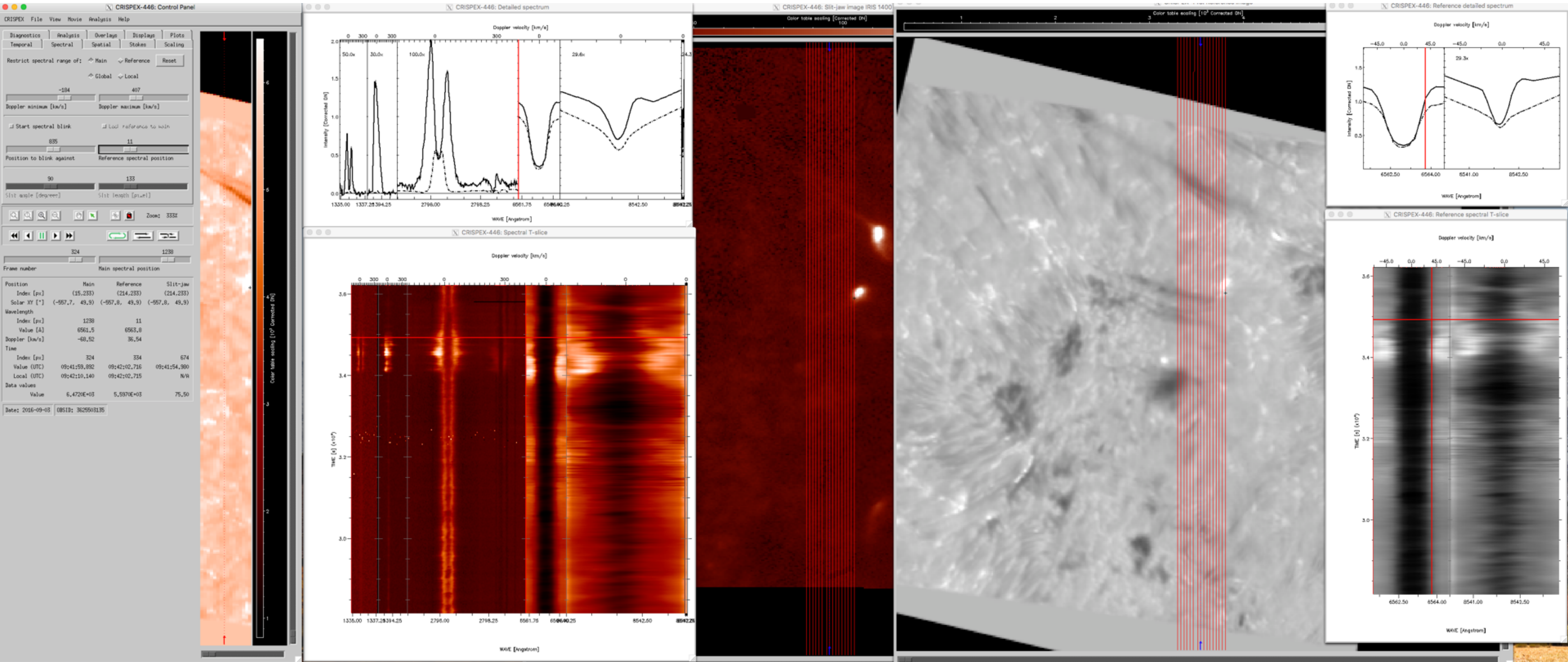
IDL> crispex, <im cube>, <sp cube>, sji=<sji>, ref=<ref>

example: UV burst / Ellerman bomb under surge



IDL> crispex, <im cube>, <sp cube>, sji=<sji>, ref=<ref>

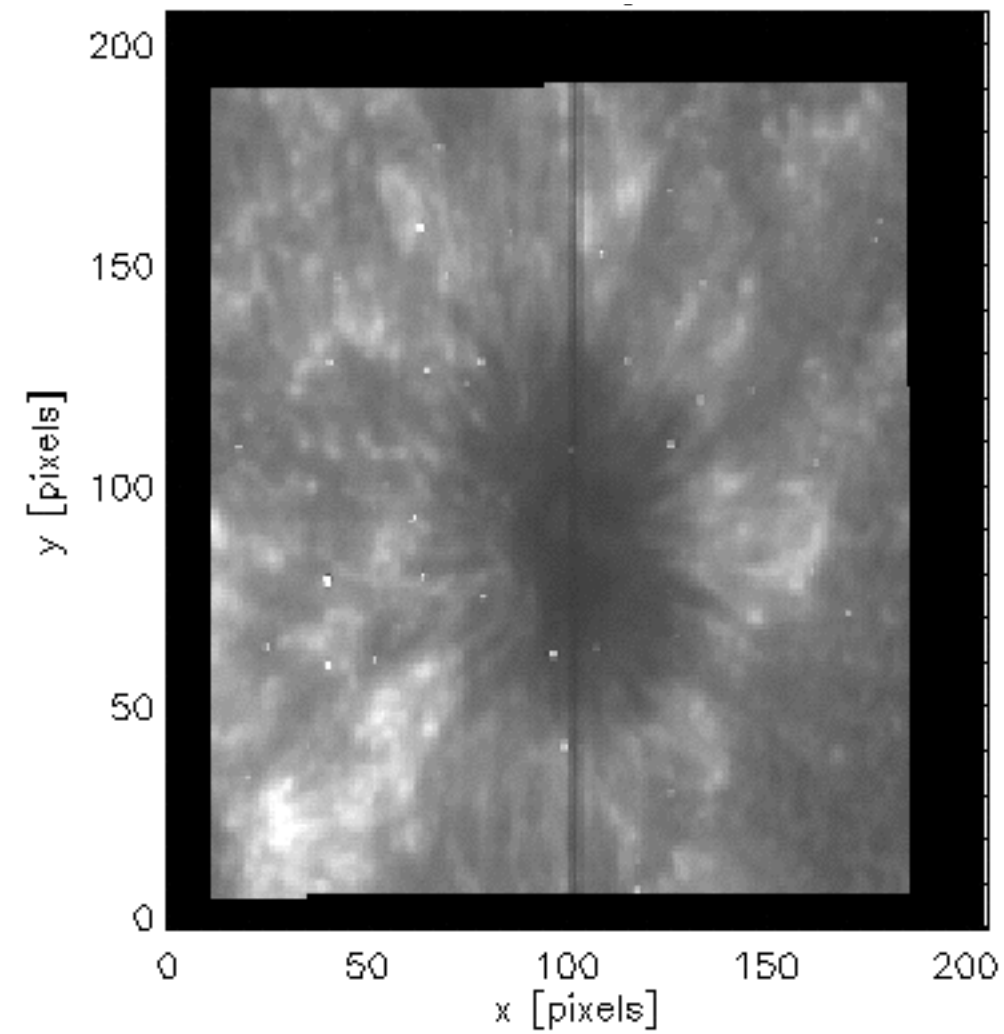
example: UV burst / Ellerman bomb under surge



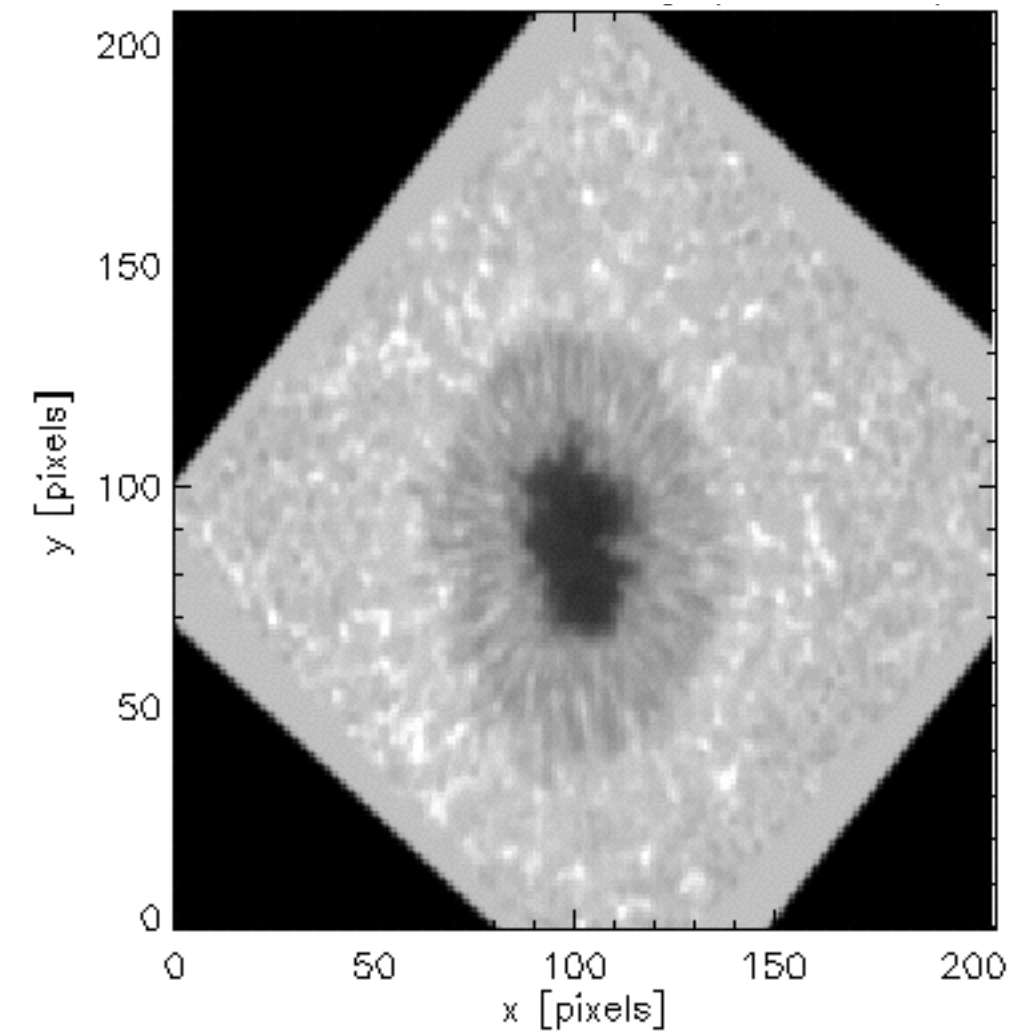
IDL> crispex, <im cube>, <sp cube>, sji=<sji>, ref=<ref>

sunspot: SJI 2796 vs Ca 8542

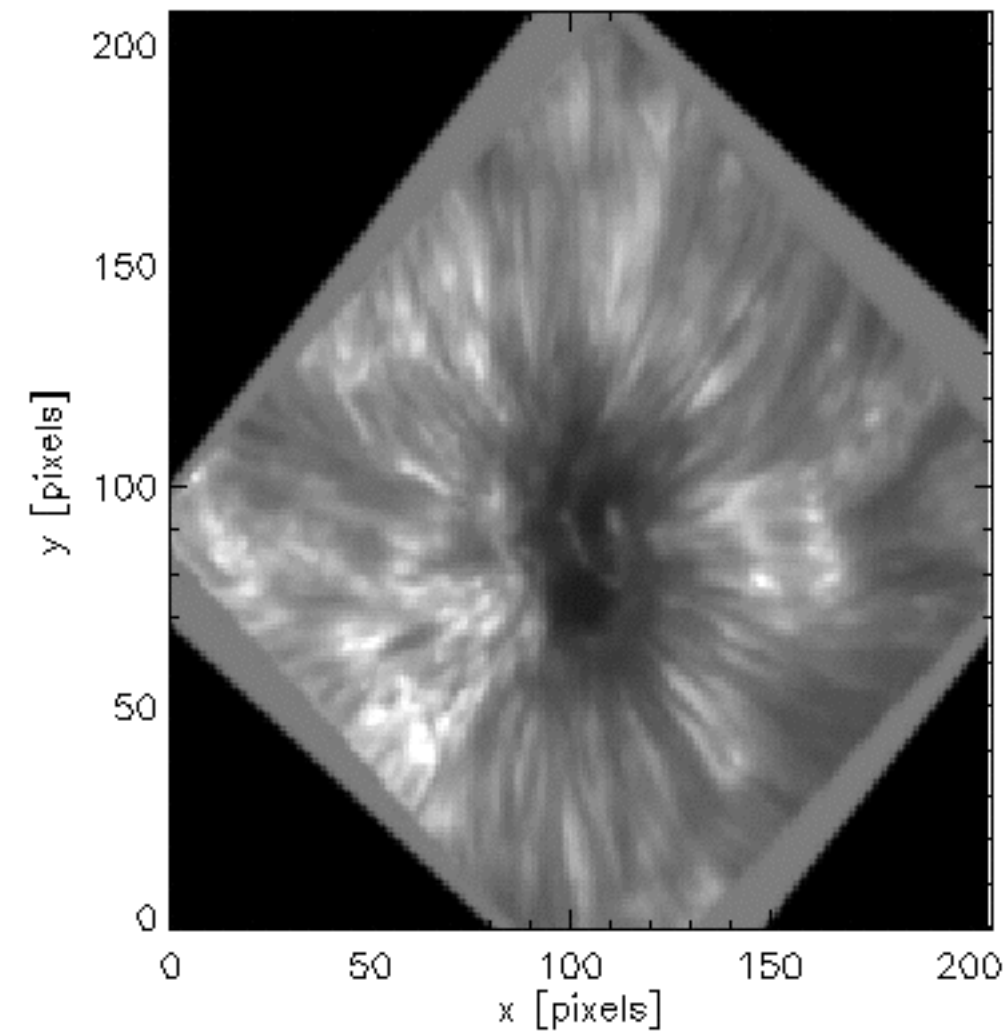
SJI 2796
Mg II k core



Ca II 8542
blue wing (-0.595 Å)



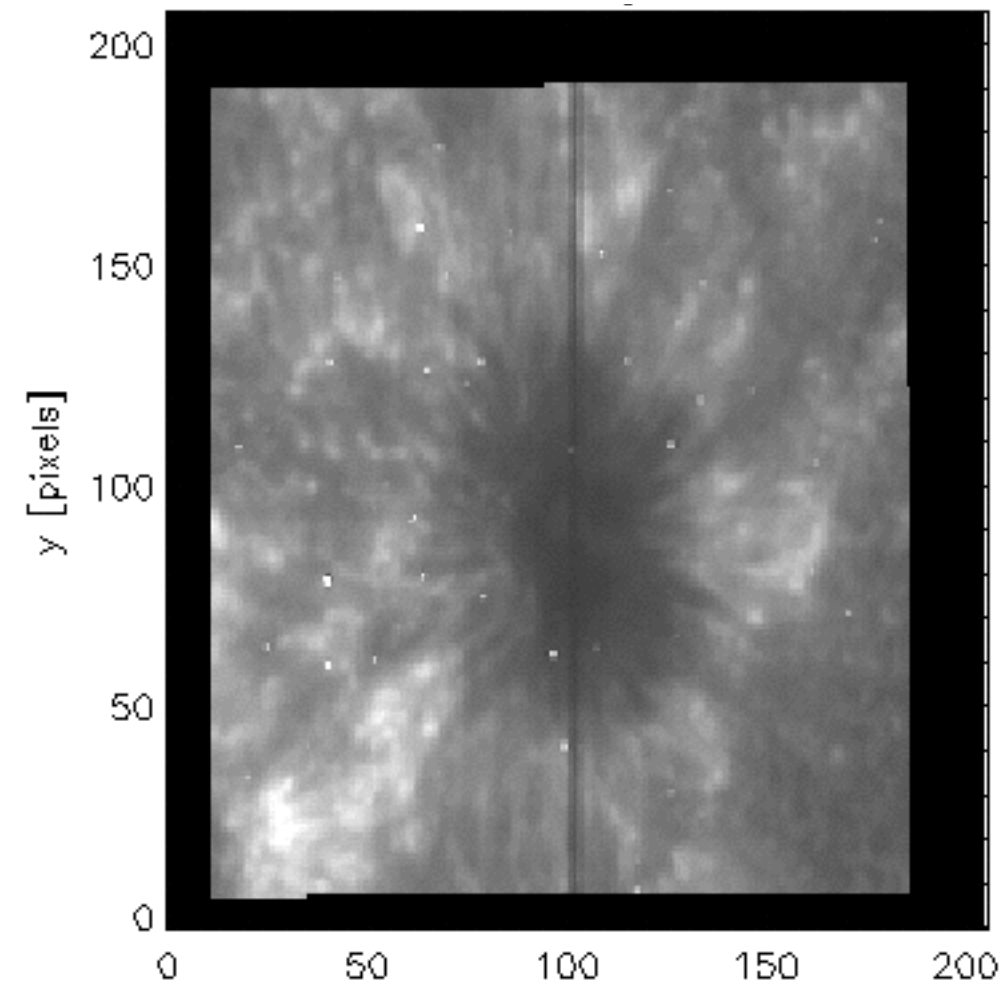
Ca II 8542
line core



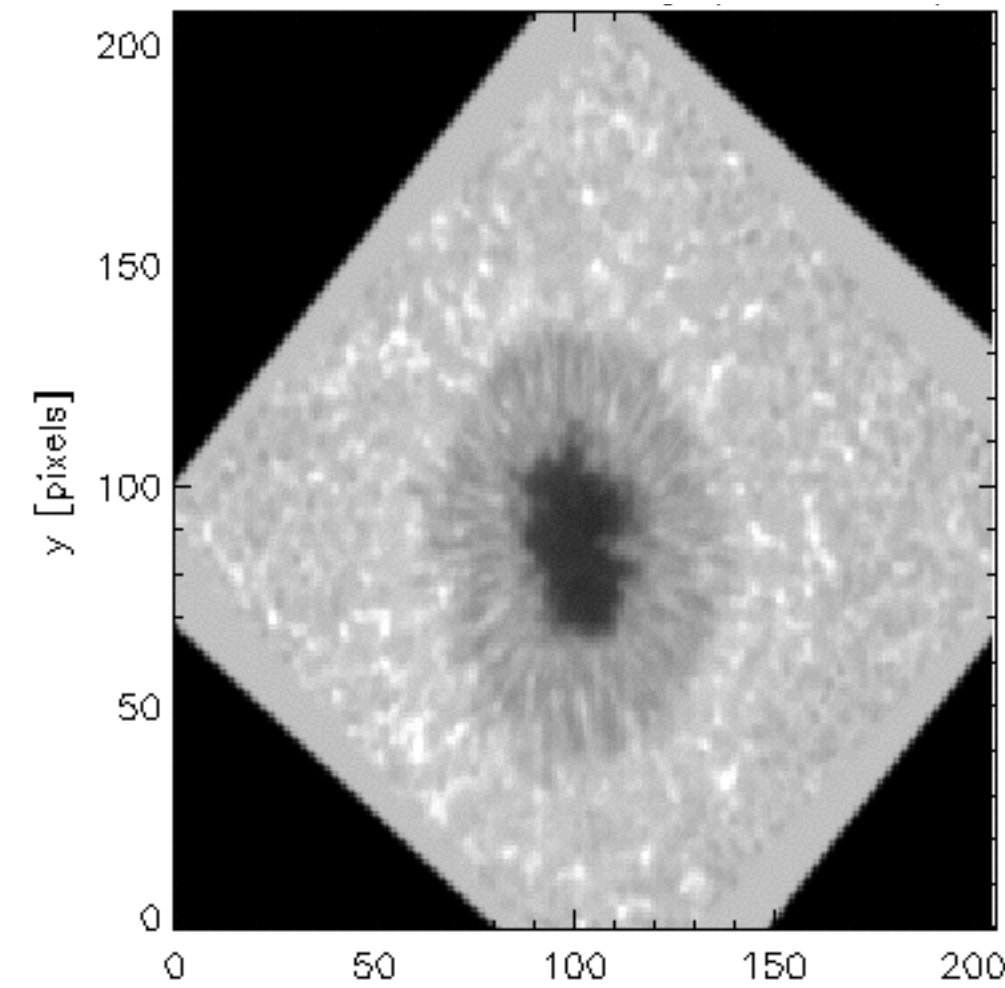
- pointing
- common time
- match spatial sampling
- matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

sunspot: SJI 2832 vs Ca 8542

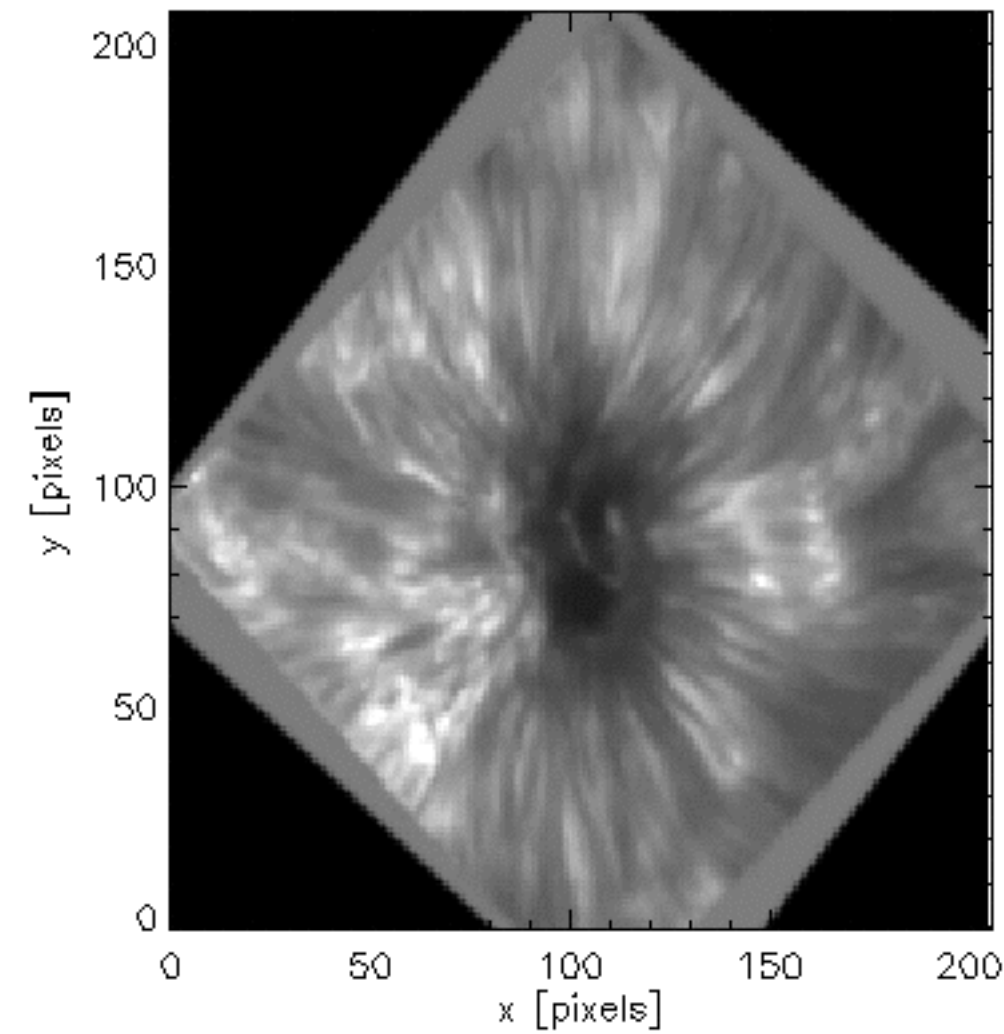
SJI 2796
Mg II k core



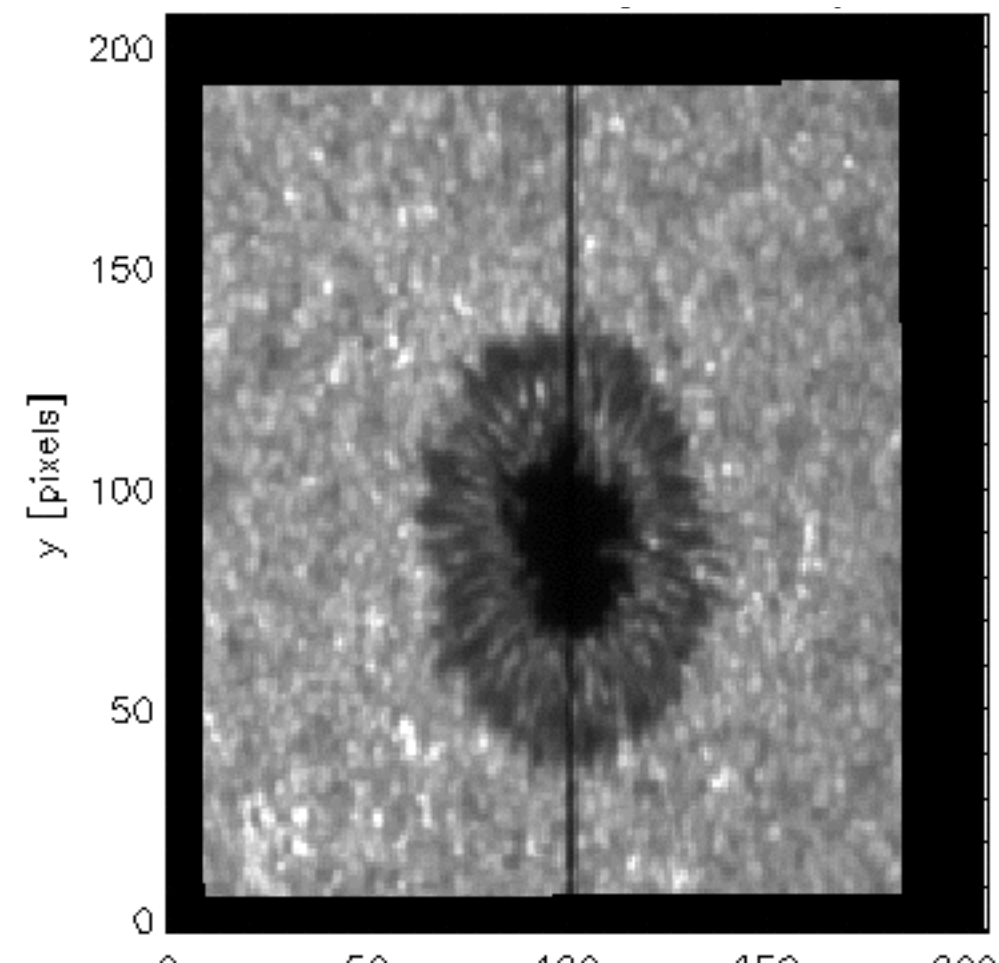
Ca II 8542
blue wing (-0.595 Å)



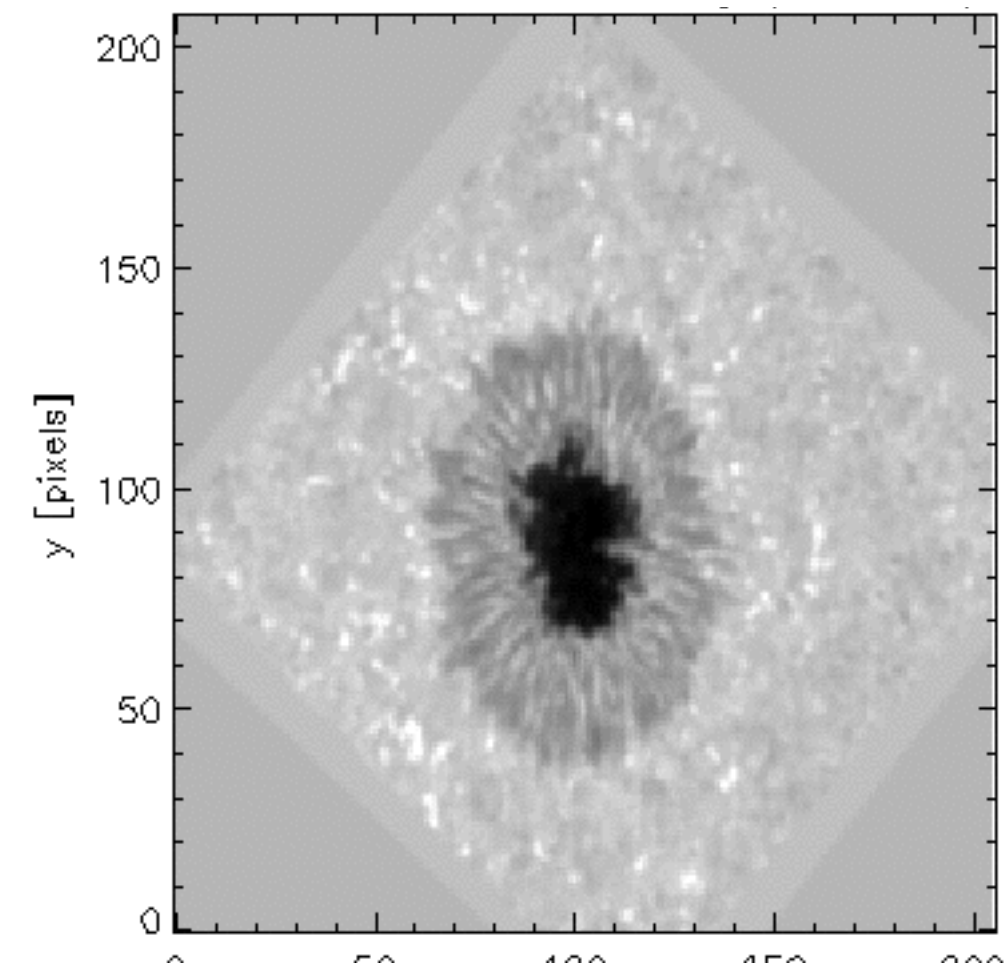
Ca II 8542
line core



SJI 2832
Mg II h wing



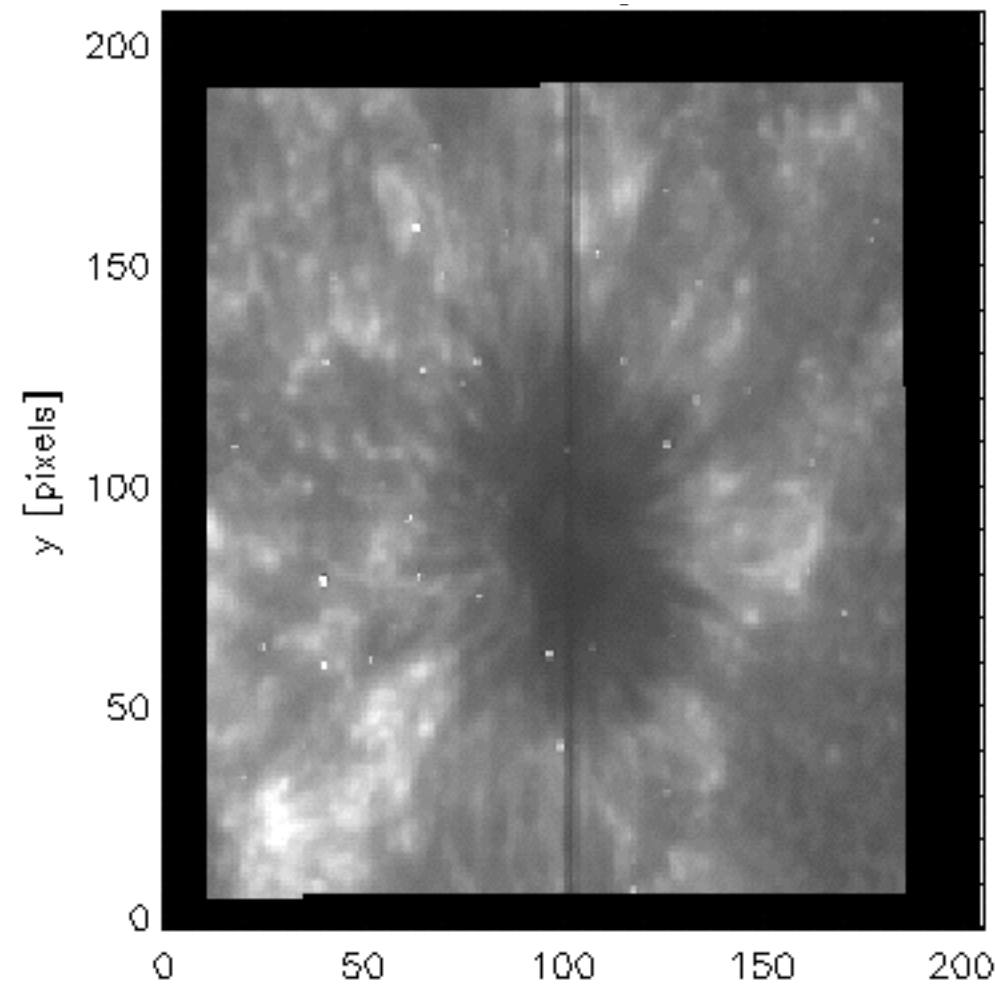
Ca II 8542
blue wing (-1.750 Å)



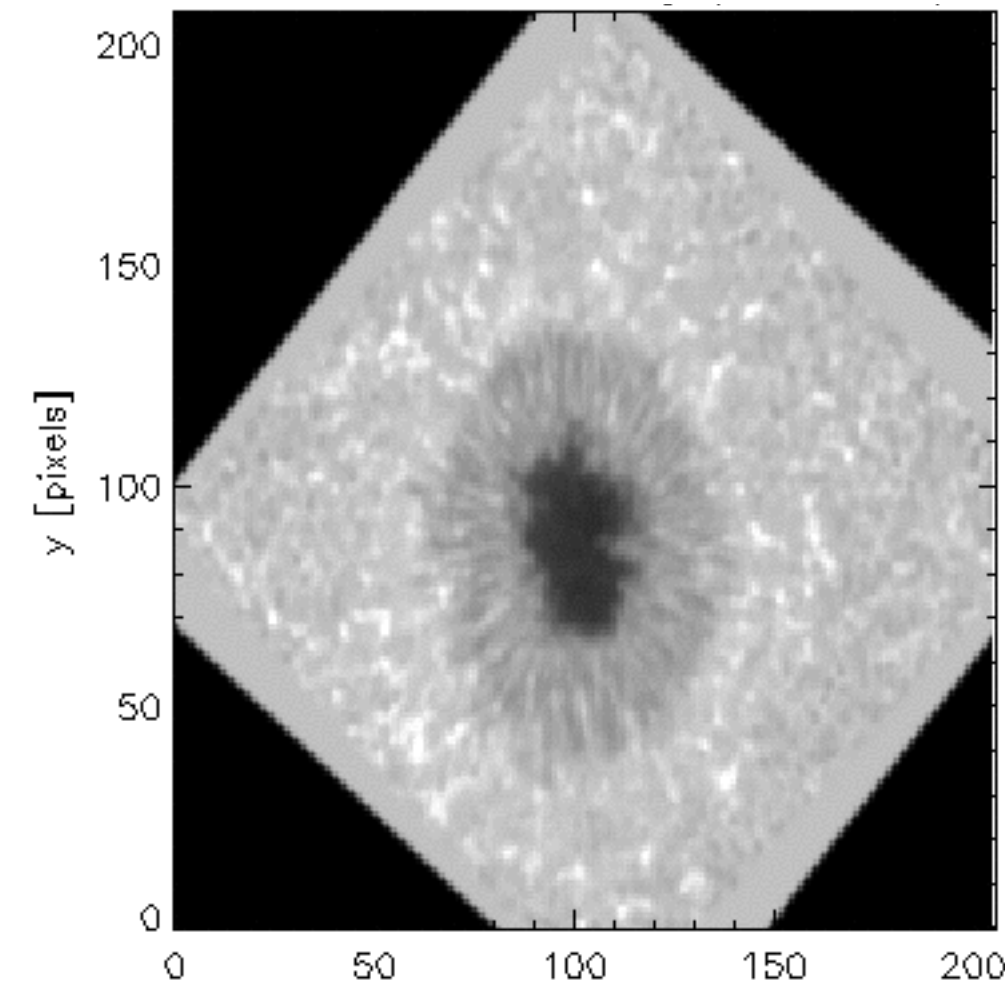
- pointing
- common time
- match spatial sampling
- **matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

sunspot: photospheric SJI 2832 is needed

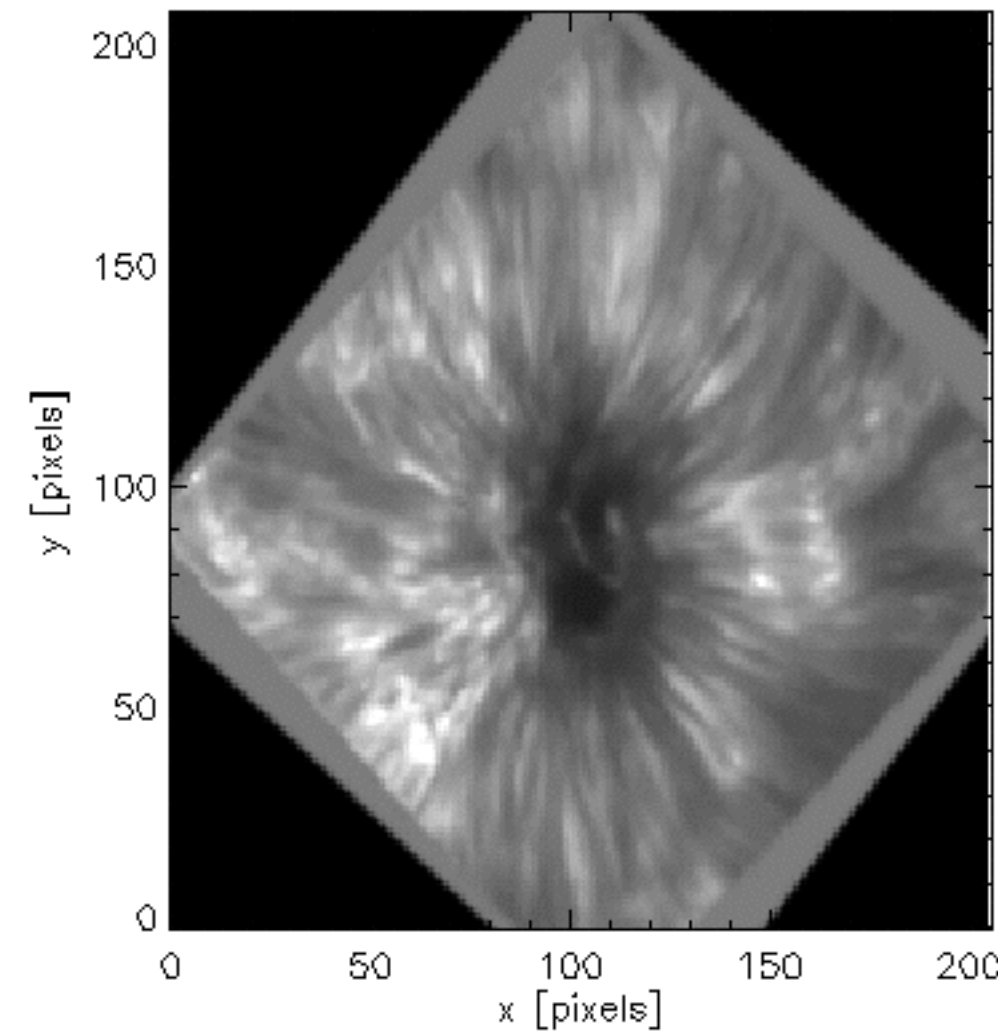
SJI 2796
Mg II k core



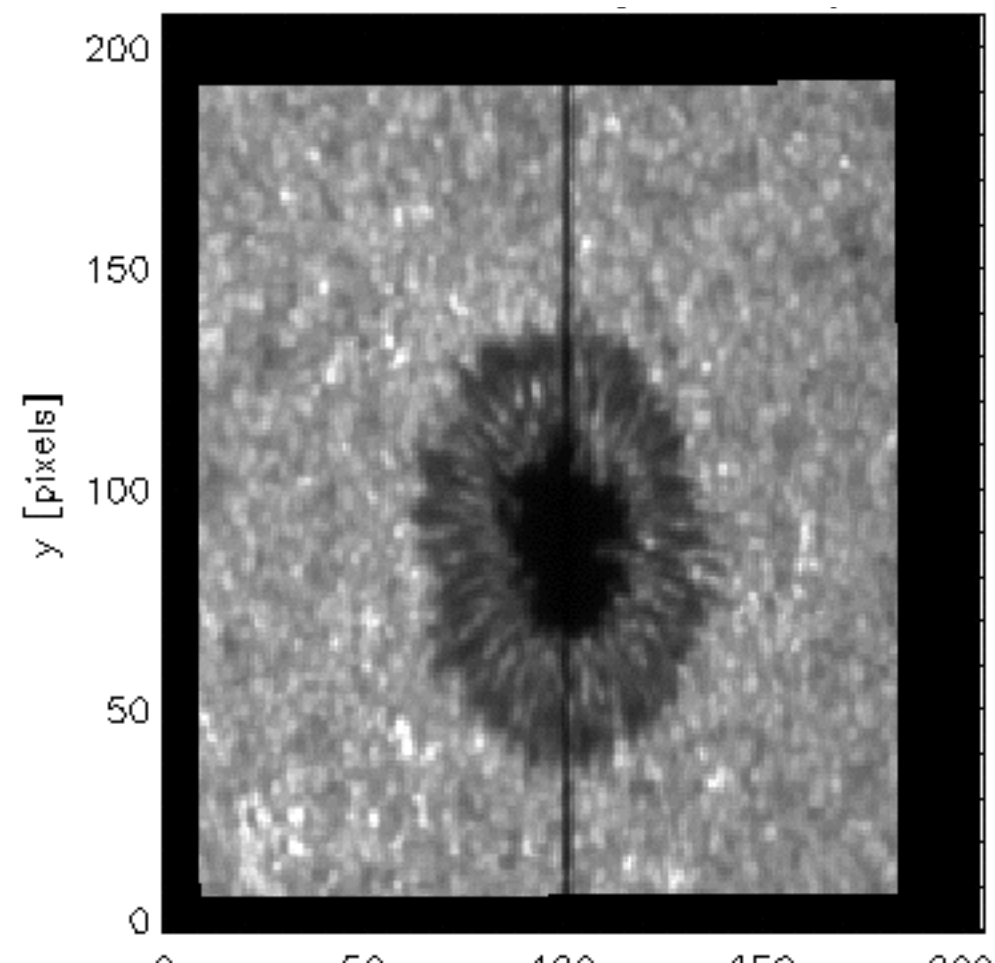
Ca II 8542
blue wing (-0.595 Å)



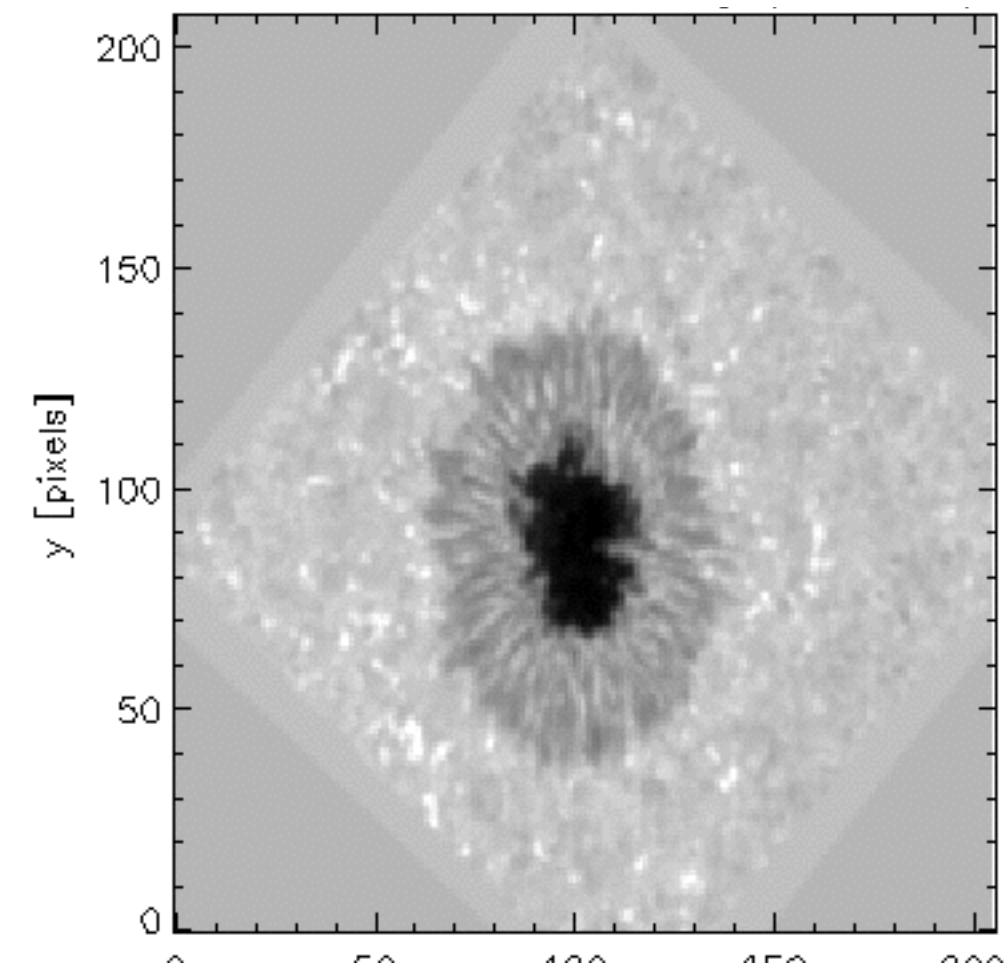
Ca II 8542
line core



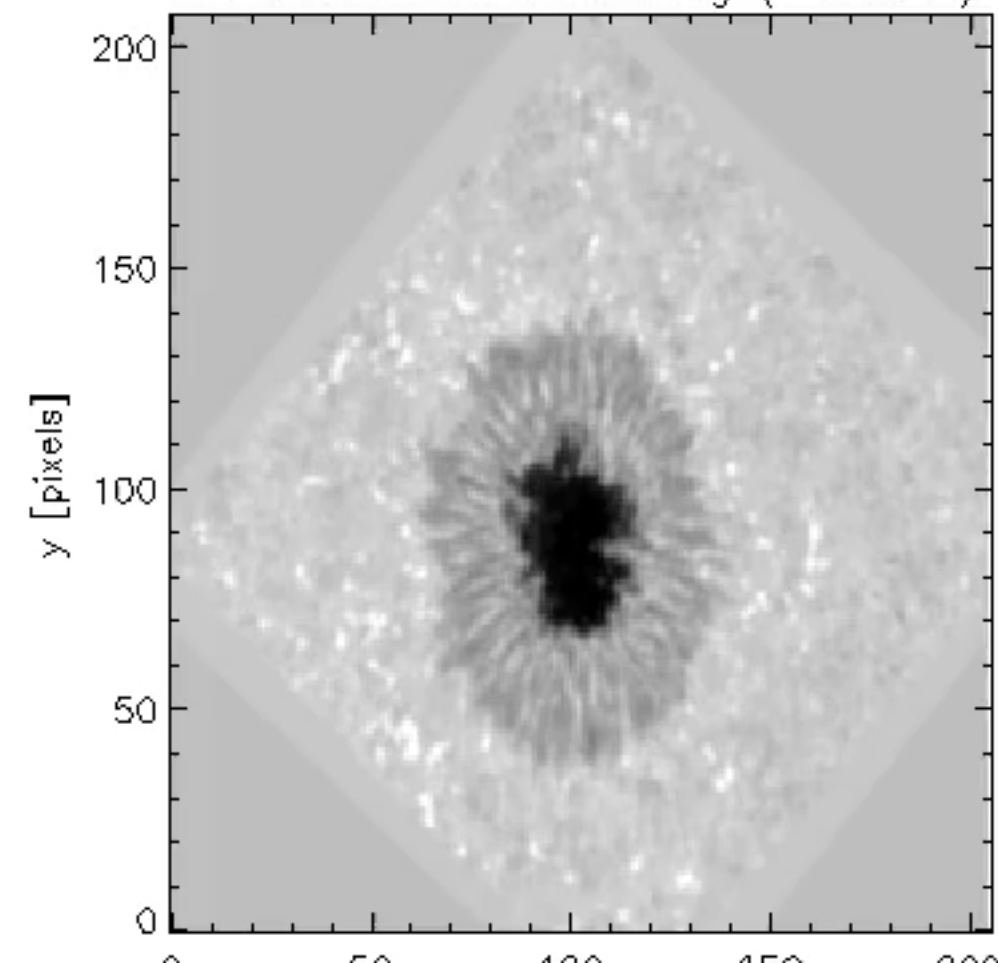
SJI 2832
Mg II h wing



Ca II 8542
blue wing (-1.750 Å)



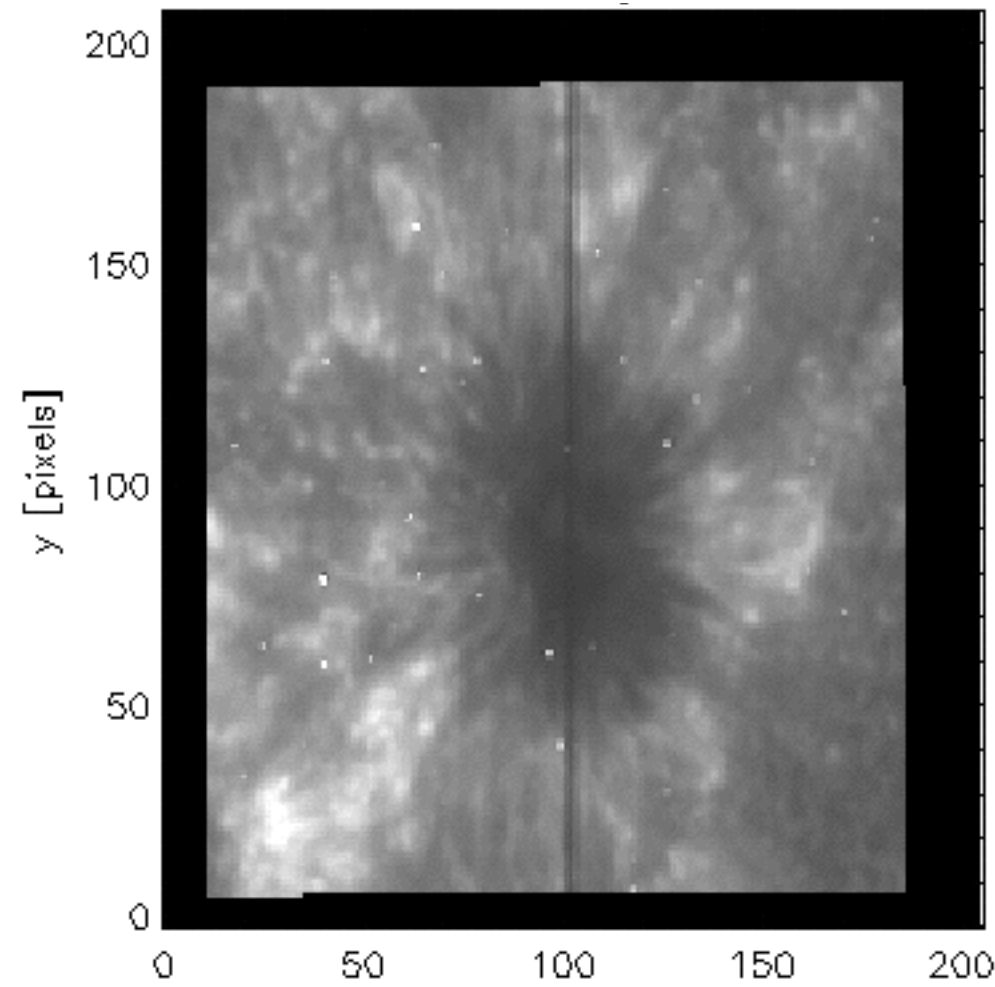
Ca II 8542 far blue wing (-1.75 Å)



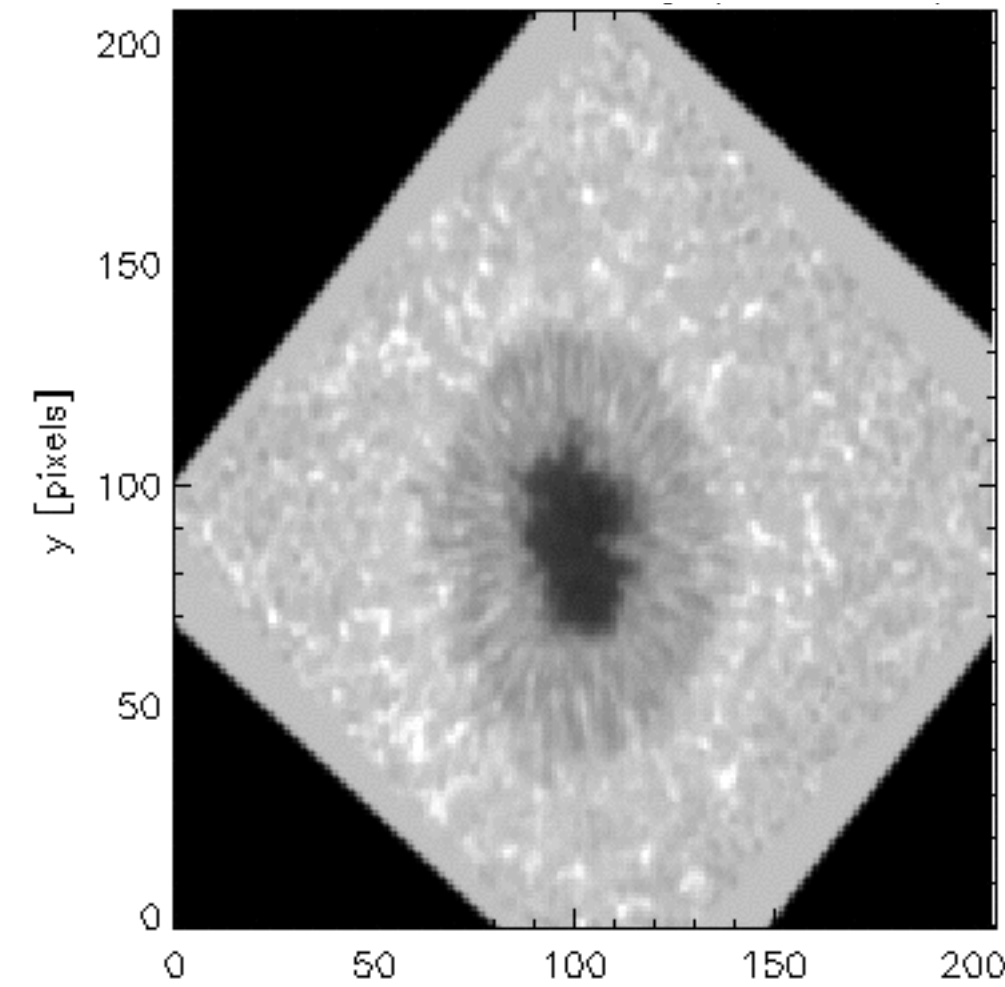
- pointing
- common time
- match spatial sampling
- matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

sunspot: photospheric SJI 2832 is needed

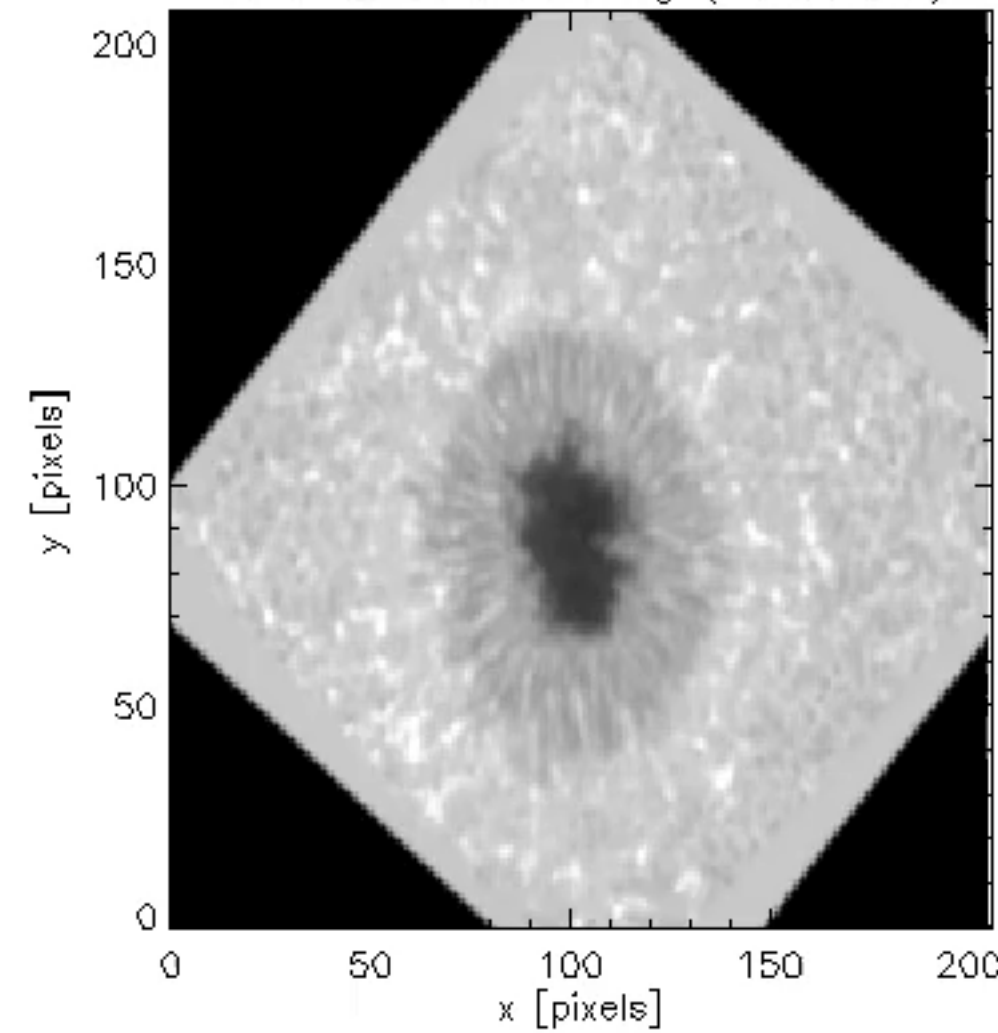
SJI 2796
Mg II k core



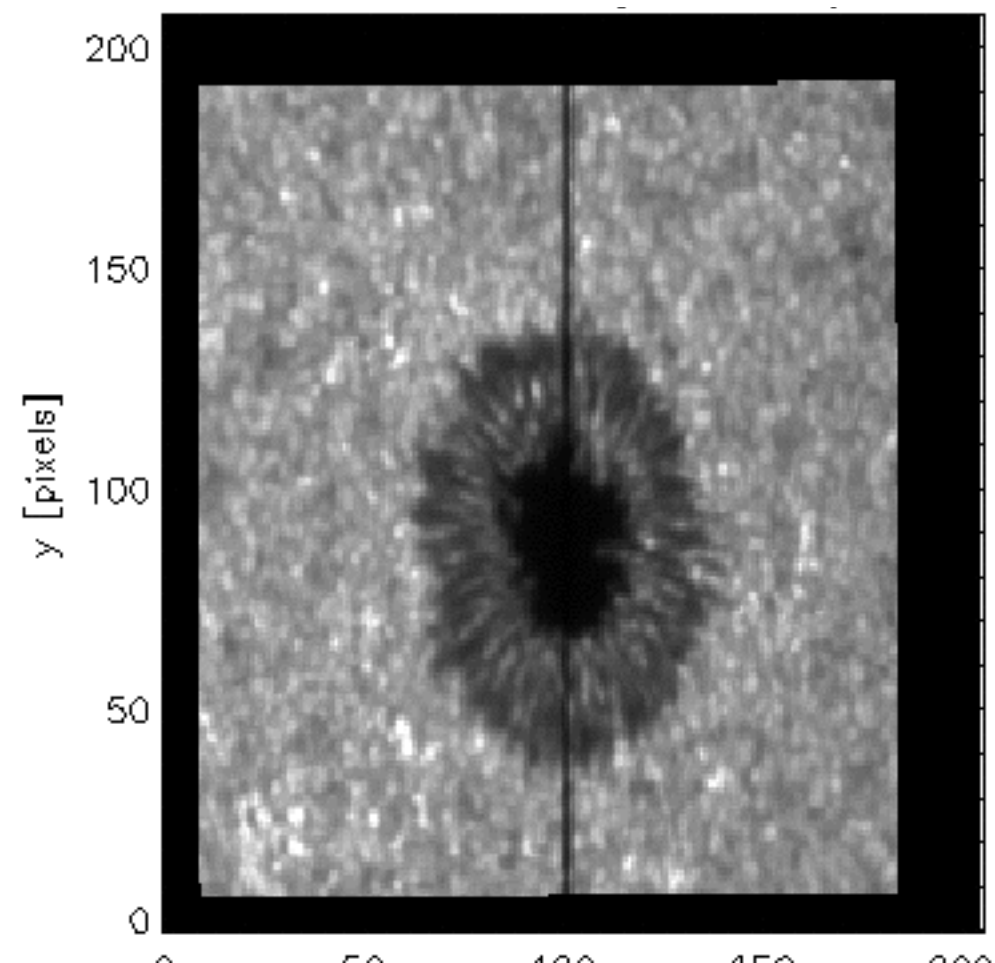
Ca II 8542
blue wing (-0.595 Å)



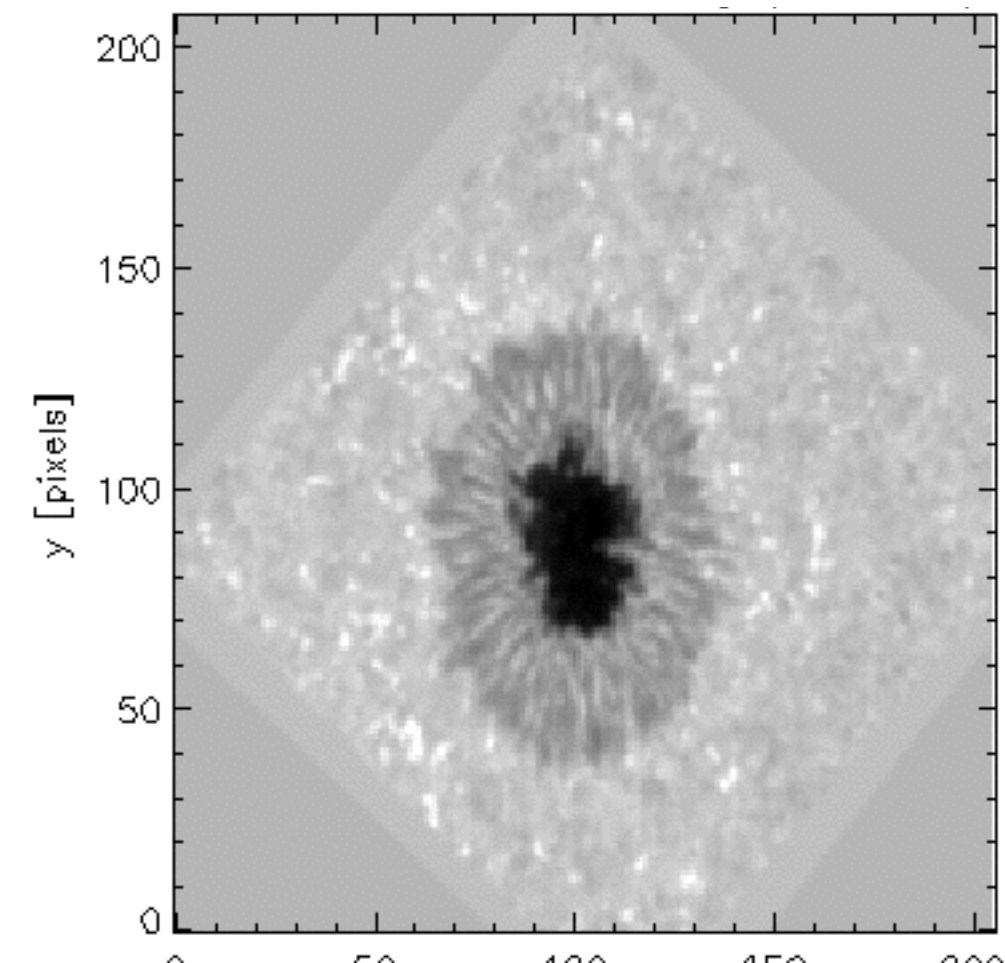
Ca II 8542 blue wing (-0.595 Å)



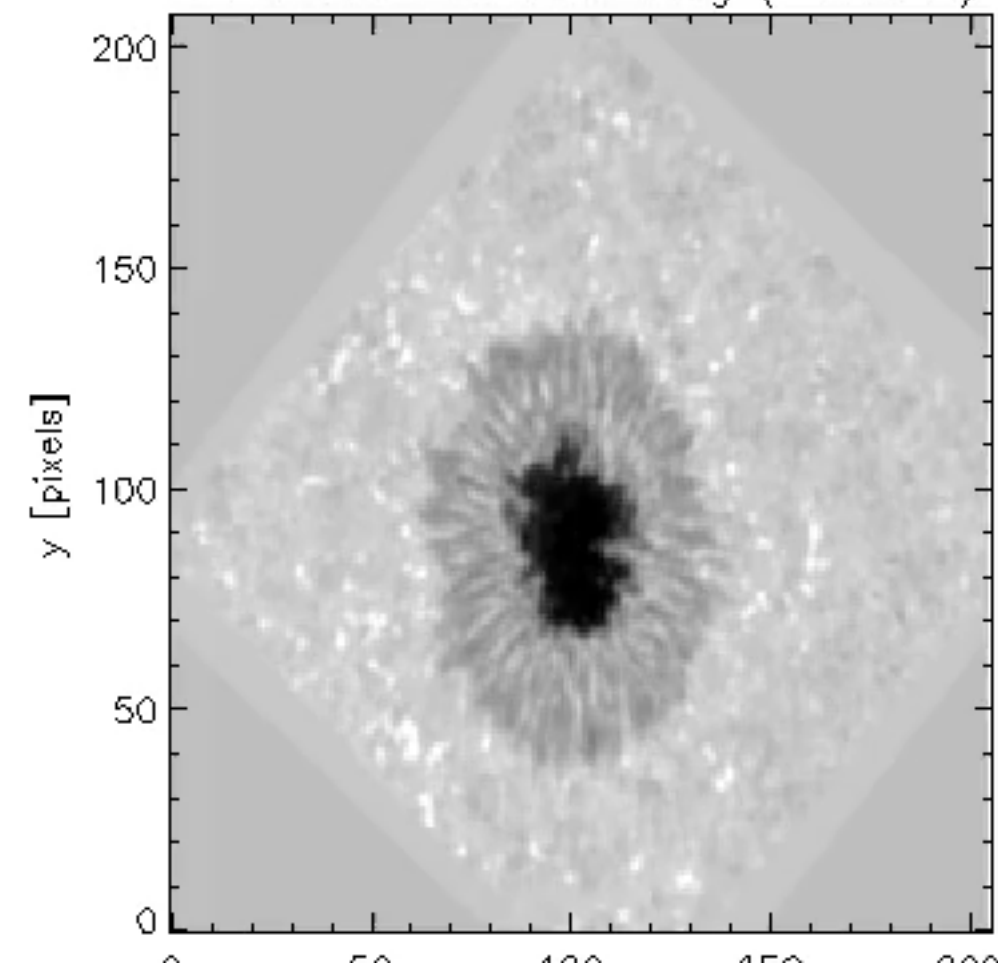
SJI 2832
Mg II h wing



Ca II 8542
blue wing (-1.750 Å)



Ca II 8542 far blue wing (-1.75 Å)

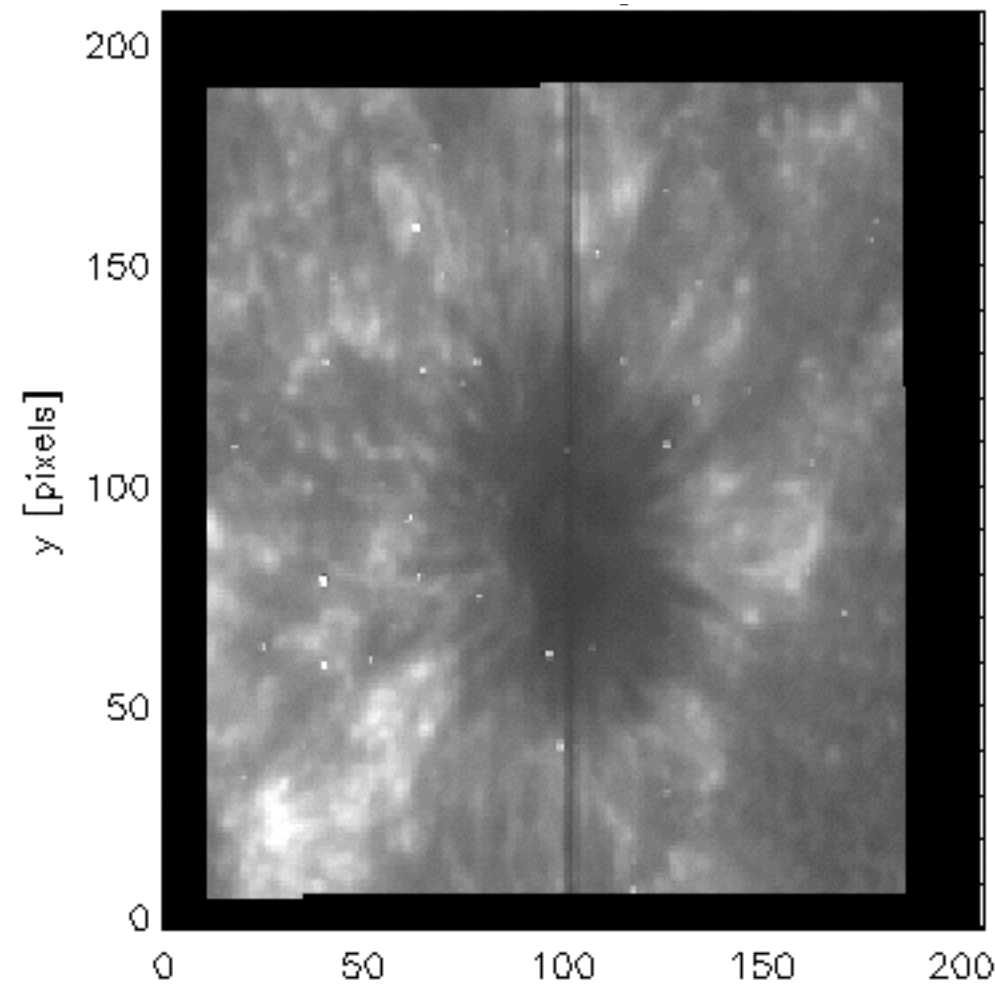


- pointing
- common time
- match spatial sampling
- matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

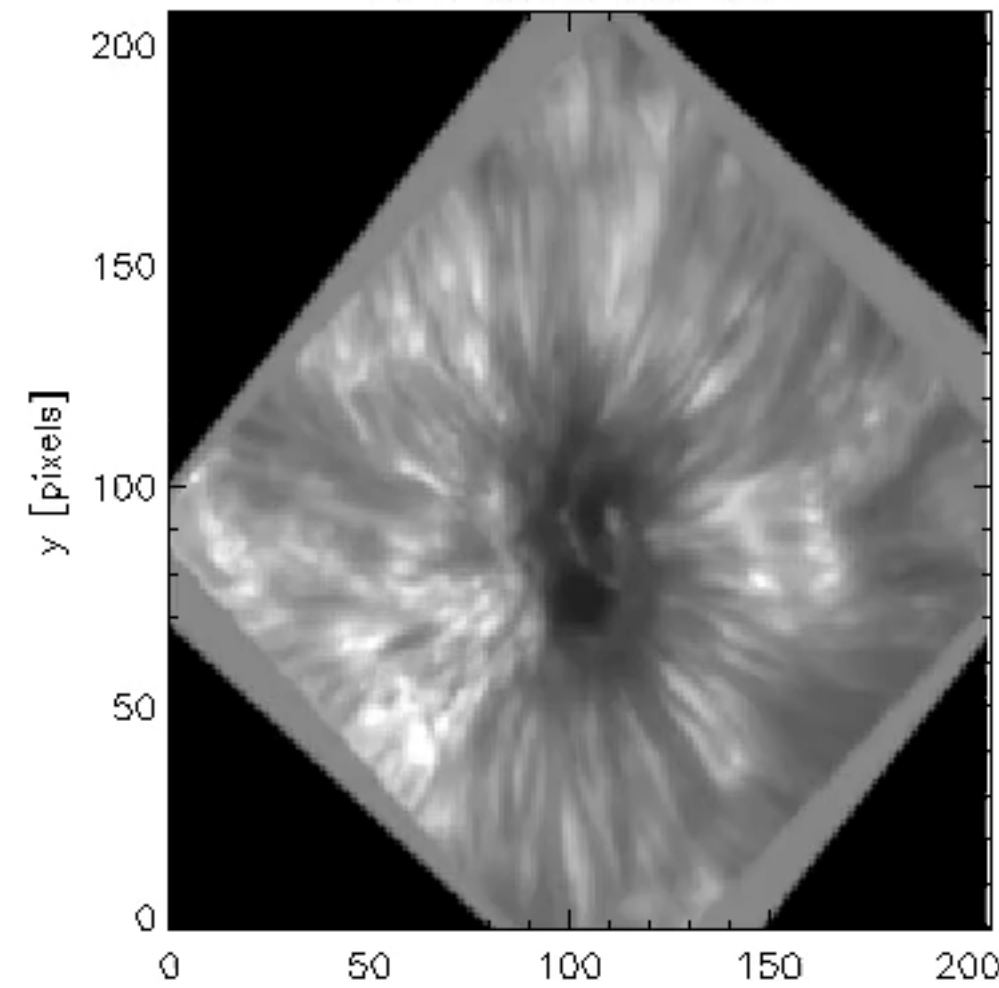
sunspot: SJI 2796 vs Ca 8542

$\mu=0.57$: offset due to formation height difference

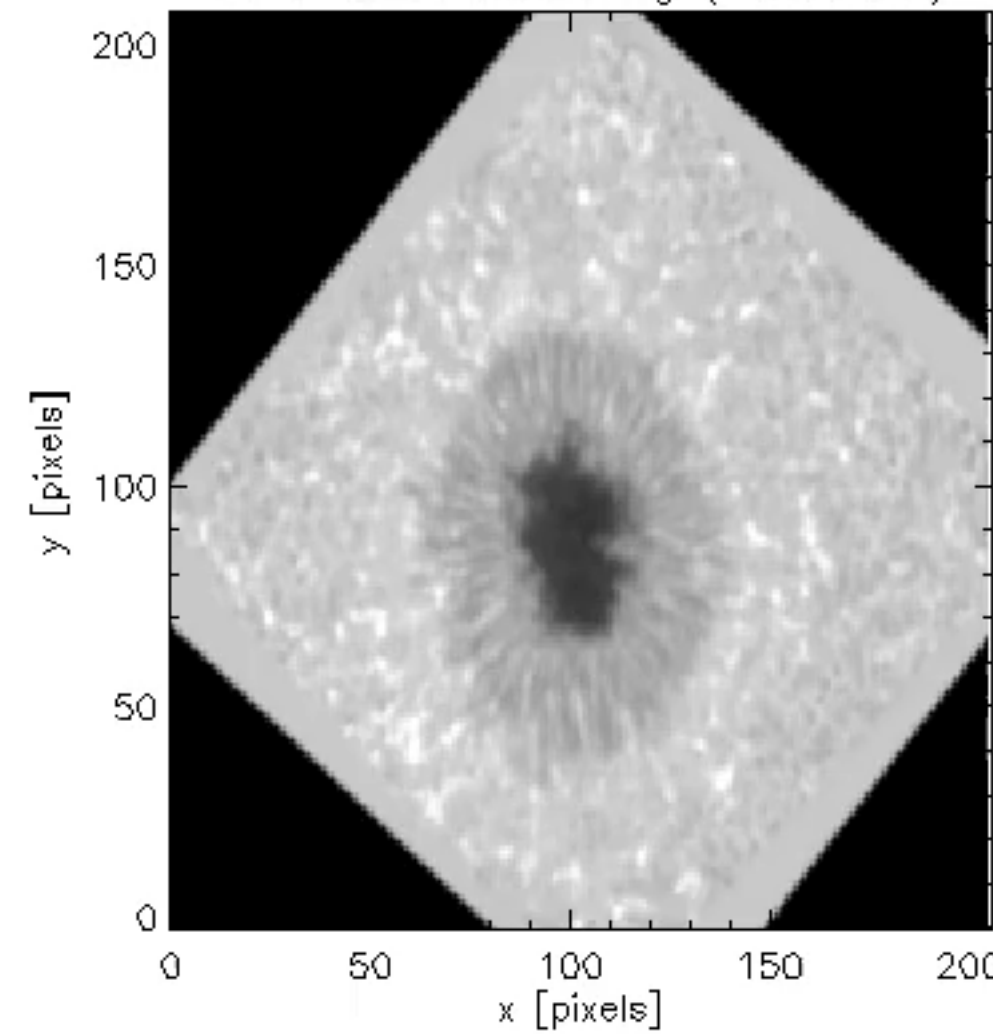
SJI 2796
Mg II k core



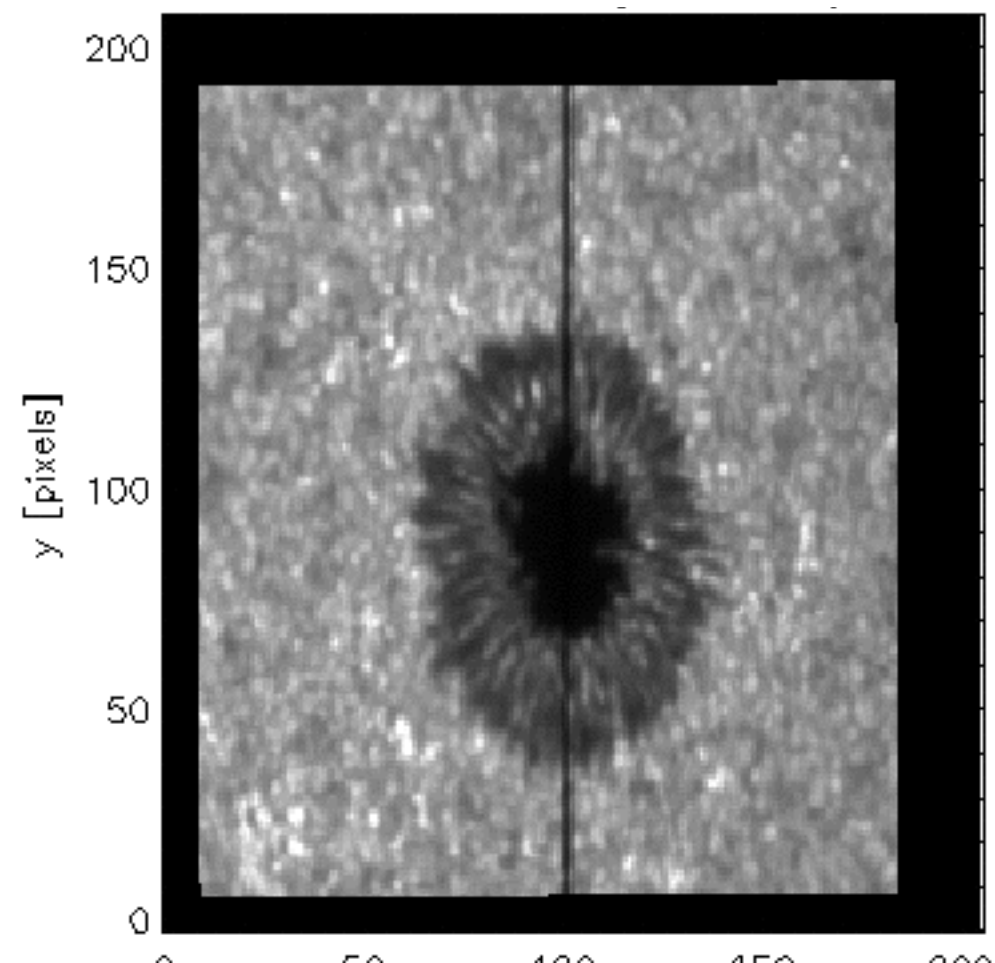
Ca II 8542 line core



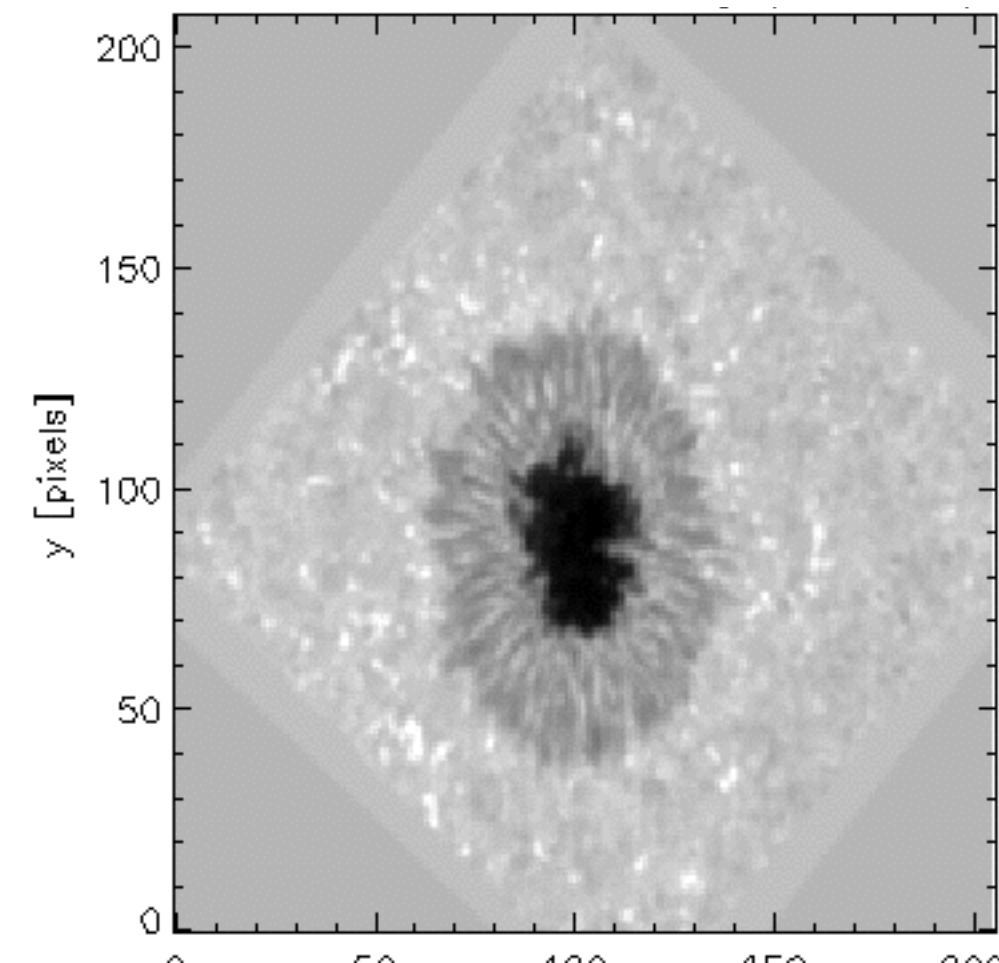
Ca II 8542 blue wing (-0.595 Å)



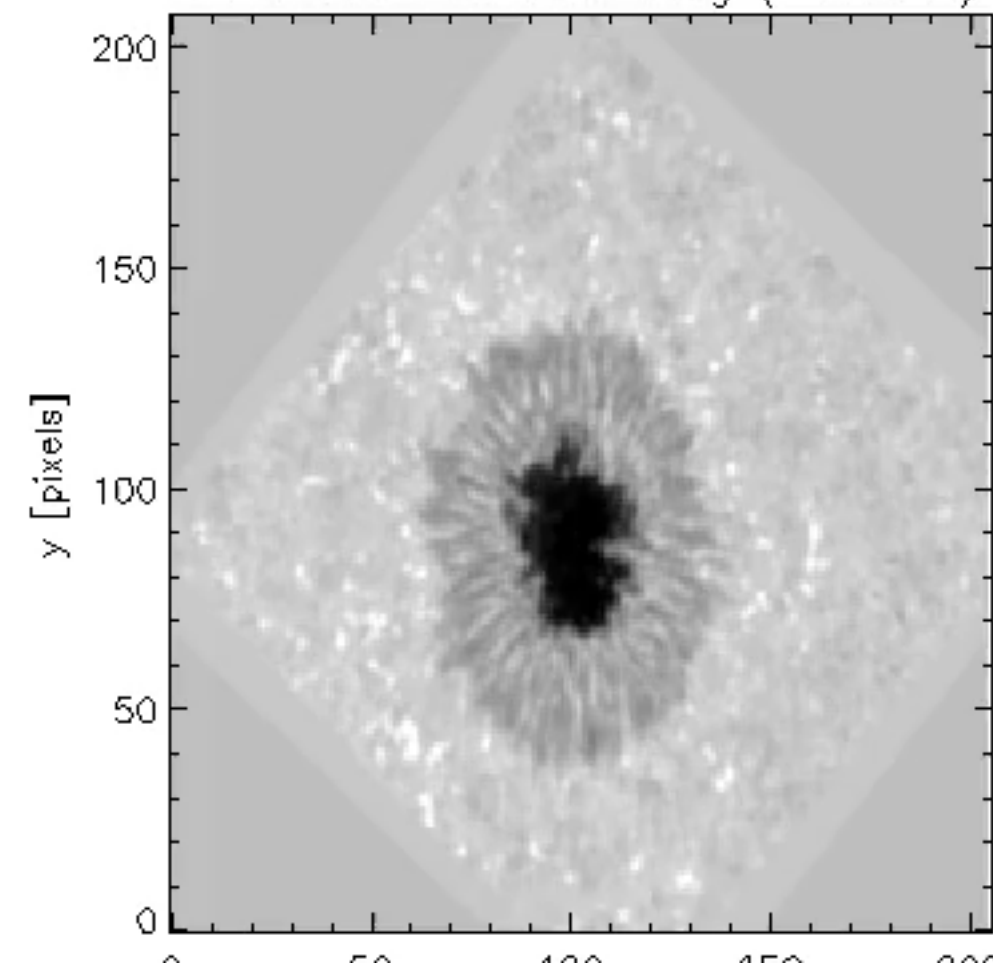
SJI 2832
Mg II h wing



Ca II 8542
blue wing (-1.750 Å)

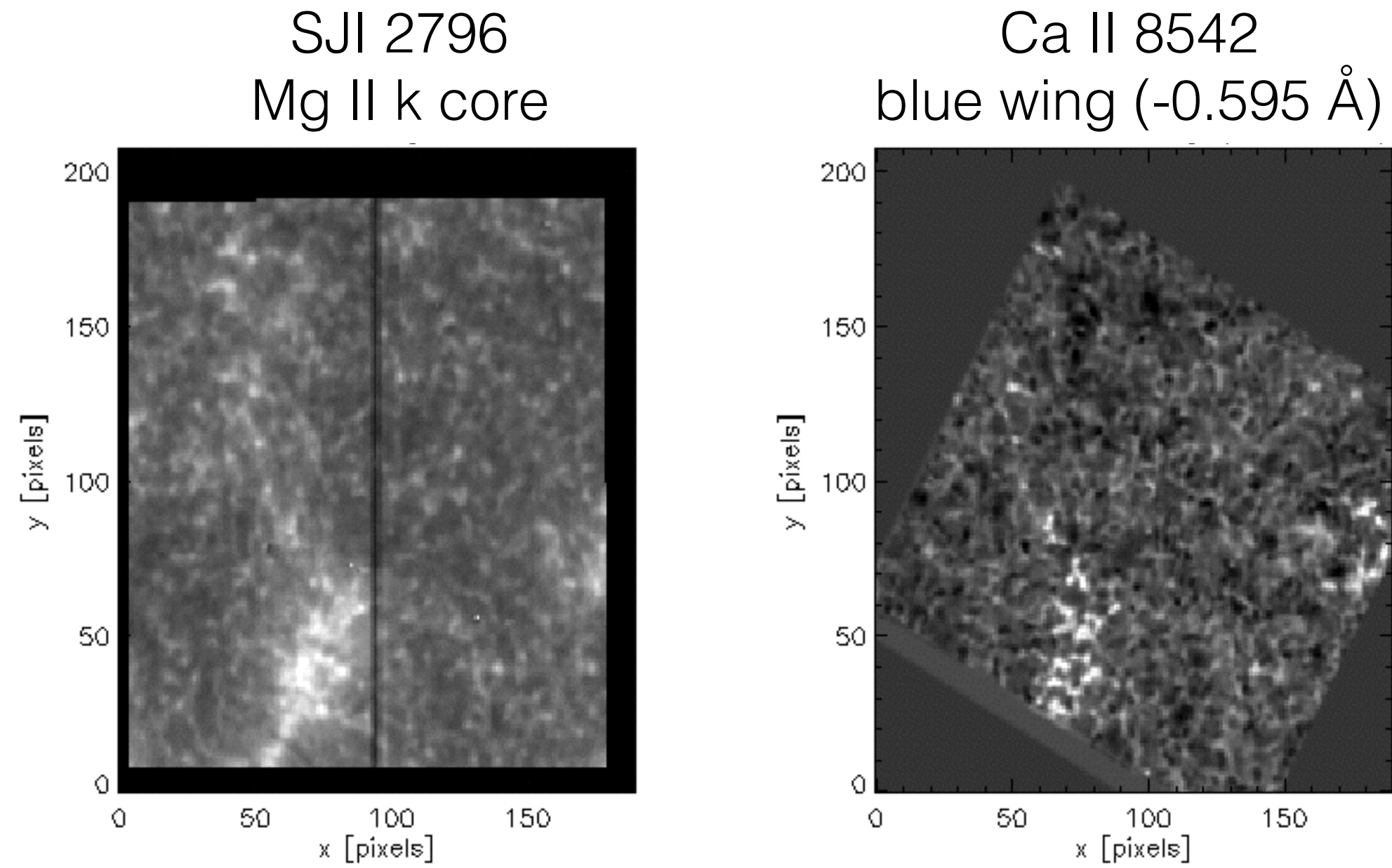


Ca II 8542 far blue wing (-1.75 Å)



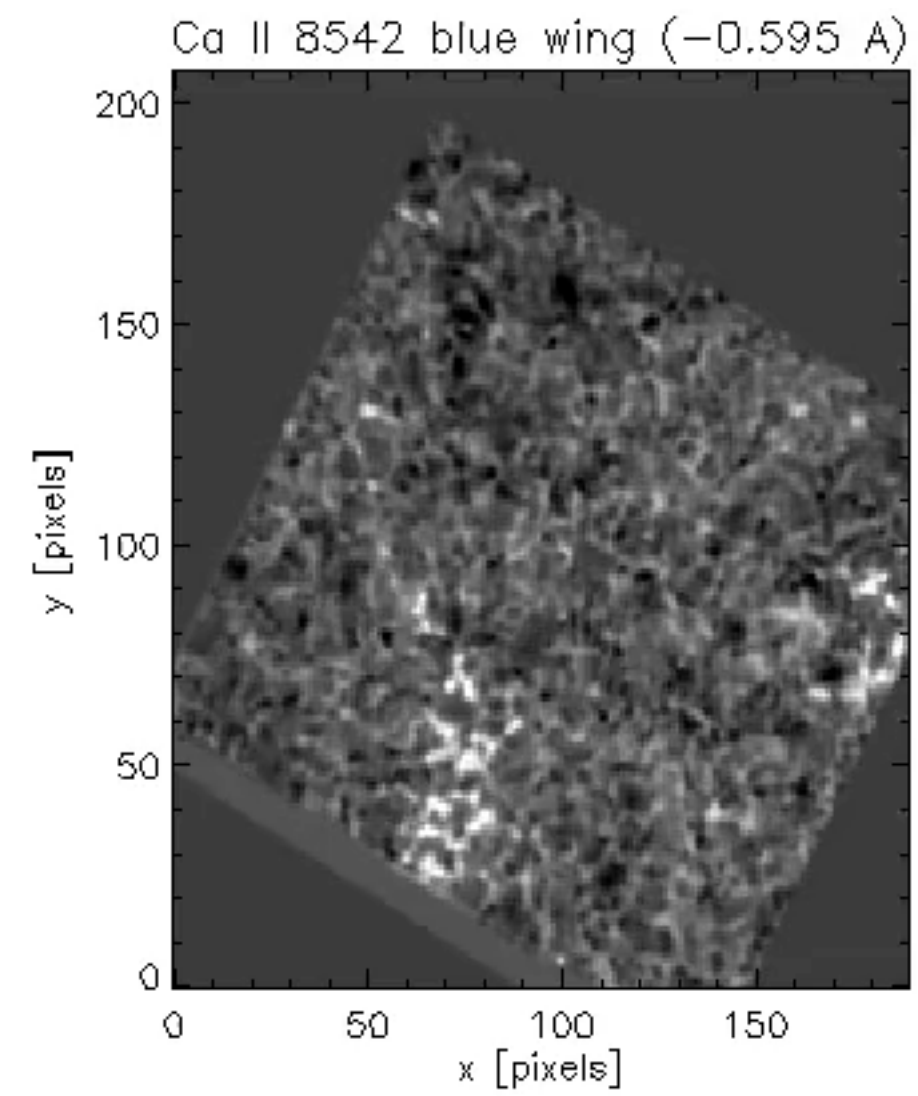
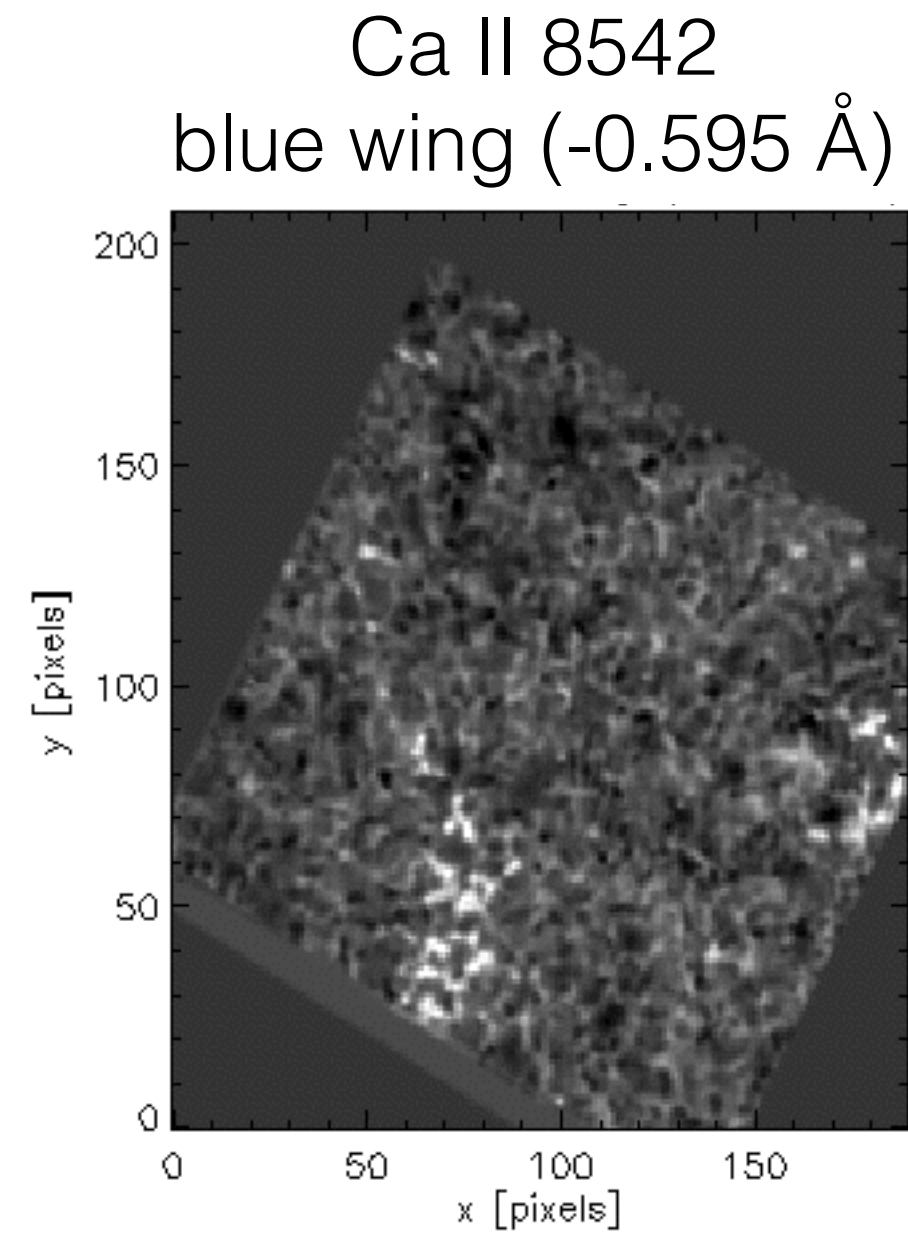
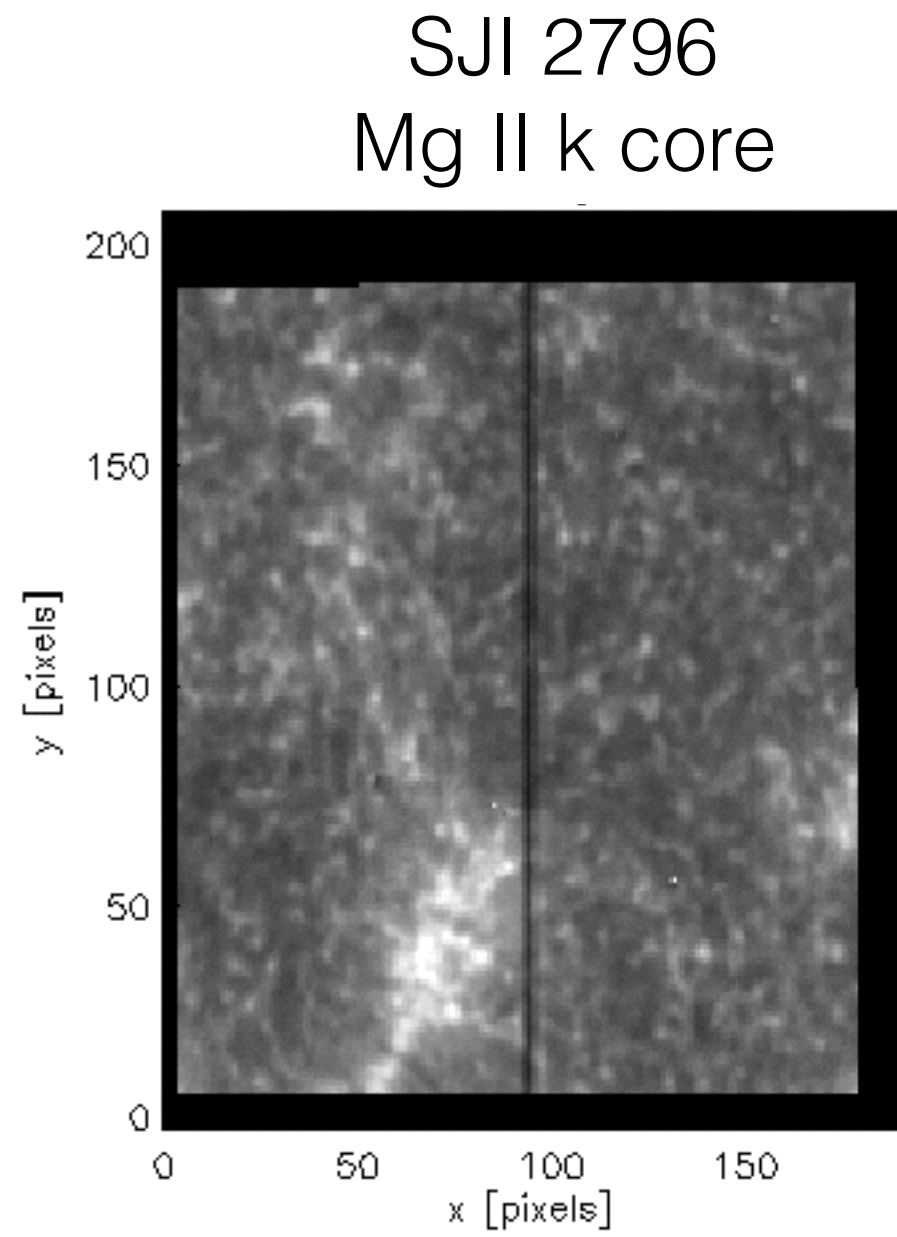
- pointing
- common time
- match spatial sampling
- **matching diagnostics**
- cross-correlation
- **IRIS internal alignment**
- level3 cubes (crispex)

disk center Quiet Sun: SJI 2796 vs Ca 8542



- pointing
- common time
- match spatial sampling
- matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

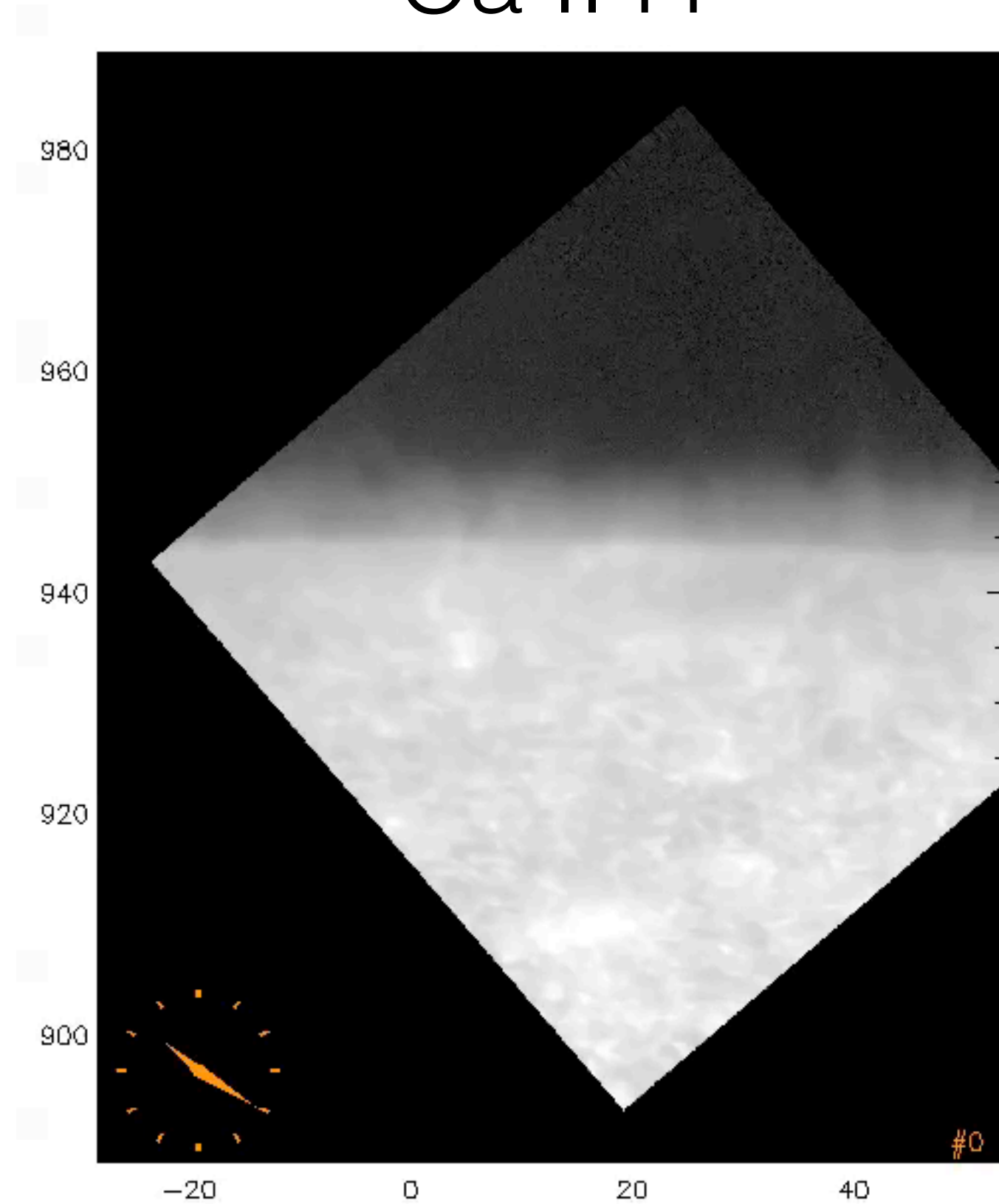
disk center Quiet Sun: SJI 2796 vs Ca 8542



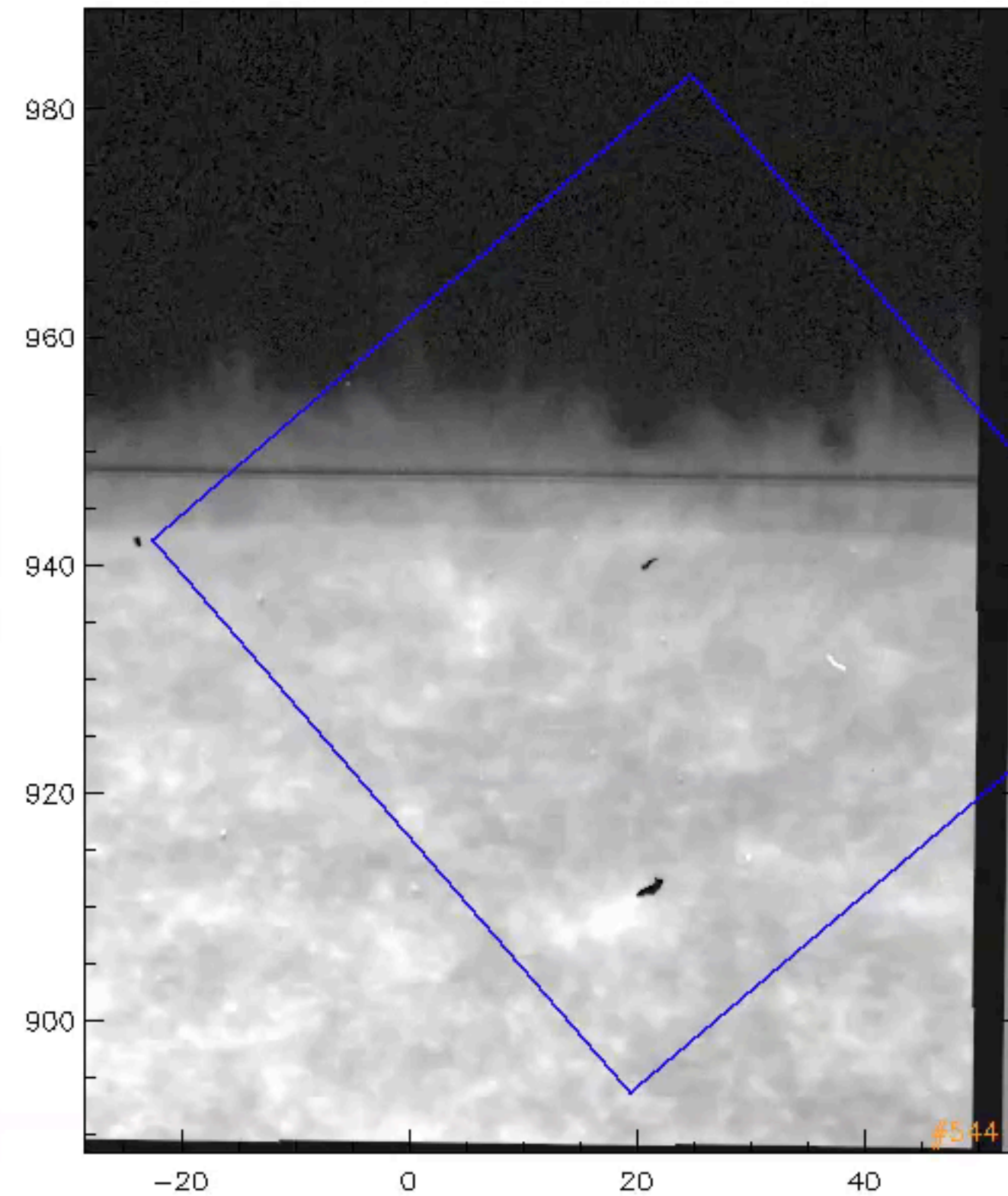
- pointing
- common time
- match spatial sampling
- **matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

limb: SJI 2796 vs Ca II H

Ca II H



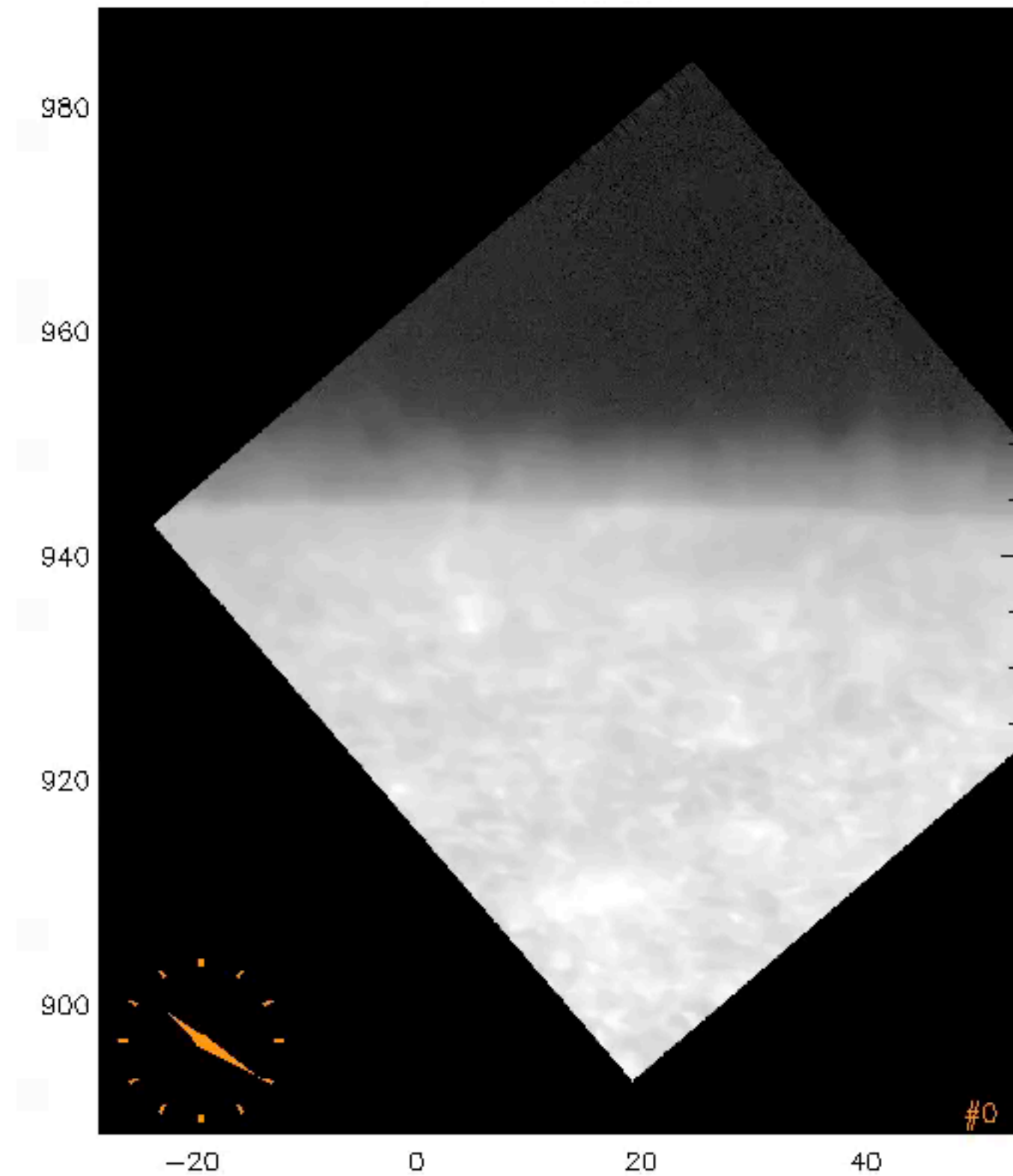
SJI 2796 - Mg k core



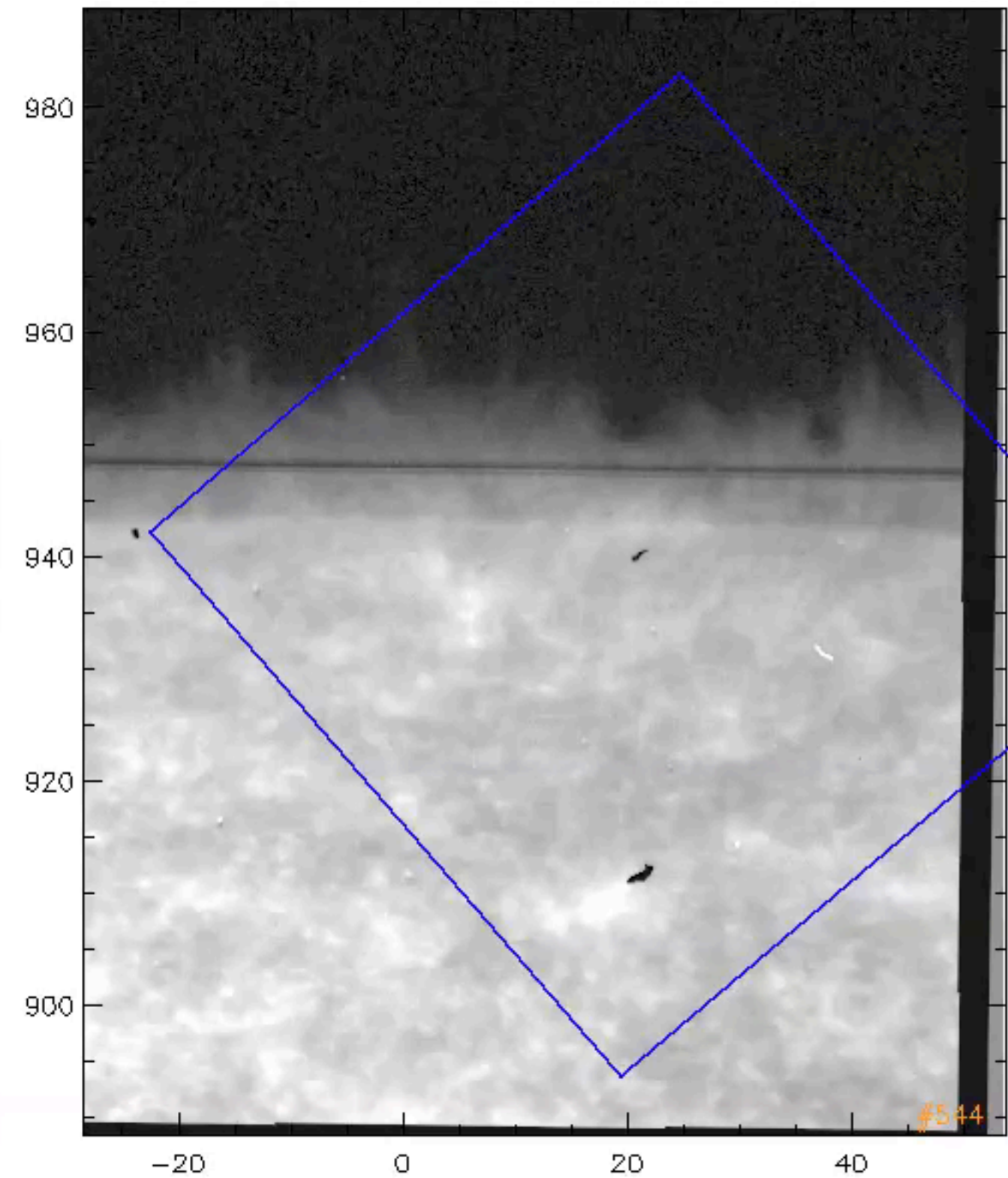
- pointing
- common time
- match spatial sampling
- matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

limb: SJI 2796 vs Ca II H

Ca II H



SJI 2796 - Mg k core



- pointing
- common time
- match spatial sampling
- **matching diagnostics**
- cross-correlation
- IRIS internal alignment
- level3 cubes (crispex)

Limb: make sure significant disk is in FOV
consider to include photospheric SJI 2832

Alignment between IRIS and ground-based data concluding remarks

planning

vertical slit
in crispex

SJI 2832 not
always required

ignore SAA

mostly issue in
early IRIS days

- check pointing / common FOV
- common time range
- match spatial sampling: factor 3 pixel scale difference
 - scale SST to match IRIS *or* scale IRIS to match SST
- matching diagnostics:
 - SJI 2832 Mg h wing vs H α /Ca 8542 far wing
 - SJI 2796 Mg k core vs Ca 8542 wing
- find offsets through cross-correlation
- IRIS internal alignment: fiducial marks