Discovery of short-timescale oscillations in the transition region by CLASP at high "temporal" resolution

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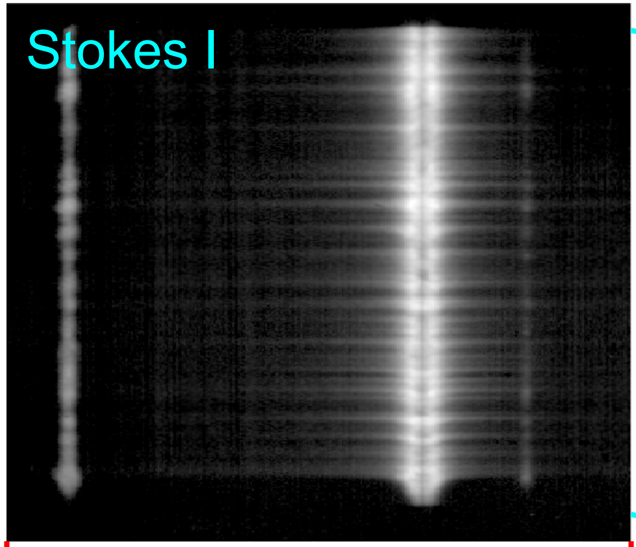
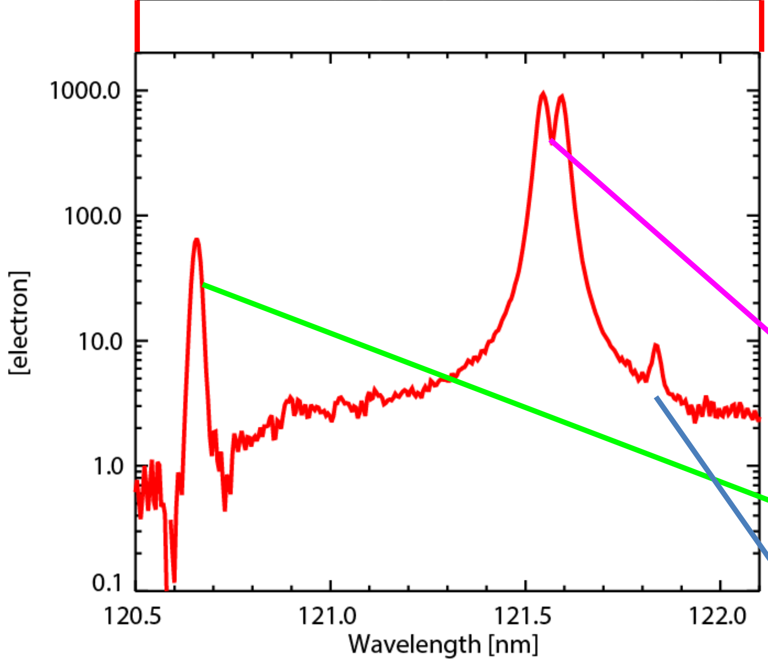
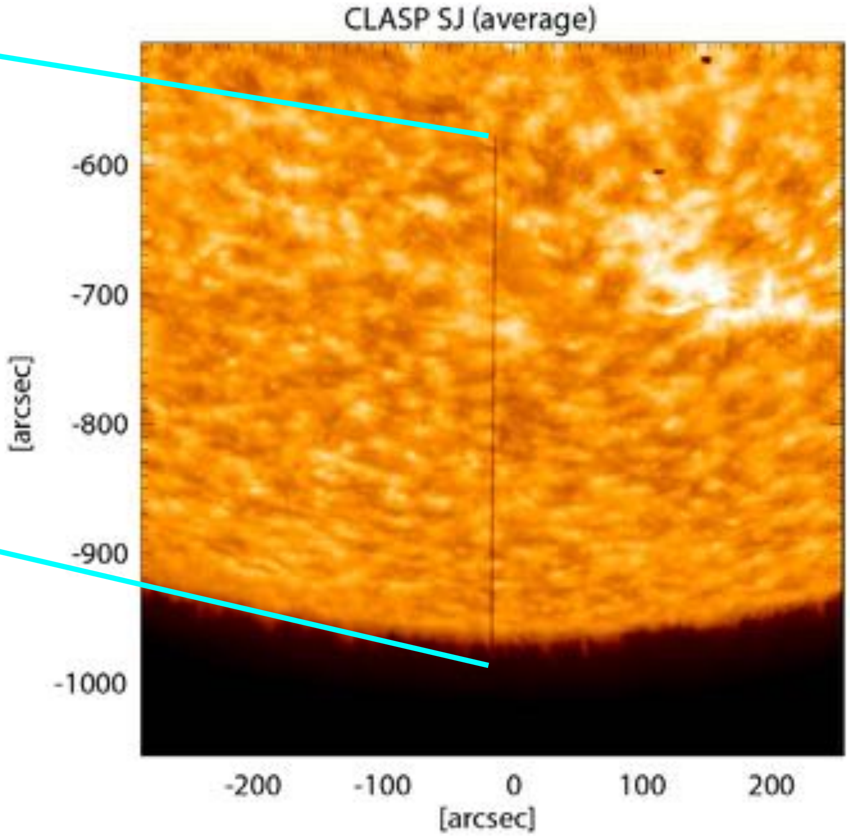
Lyman-alpha spectra with CLASP





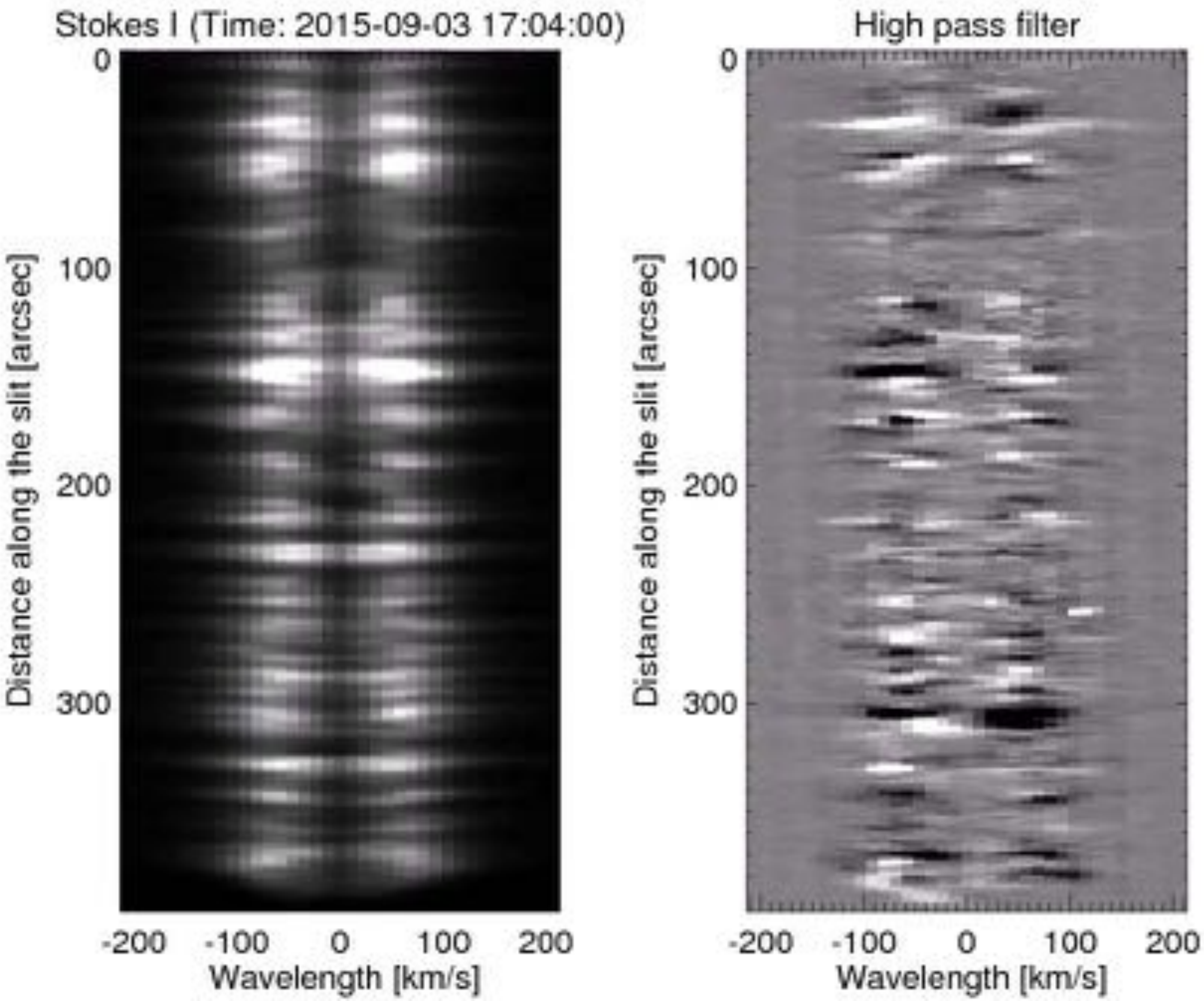


Lyα (121.57nm):
upper chromosphere ~ transition region

Si III (120.65nm): similar height of Lyα

O V (121.83nm)

Time series of Lyα Stokes I profile

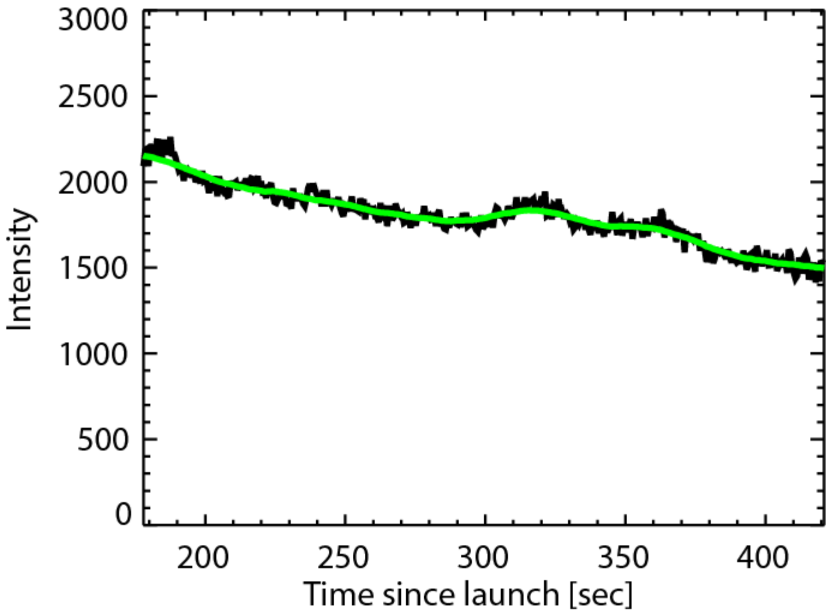


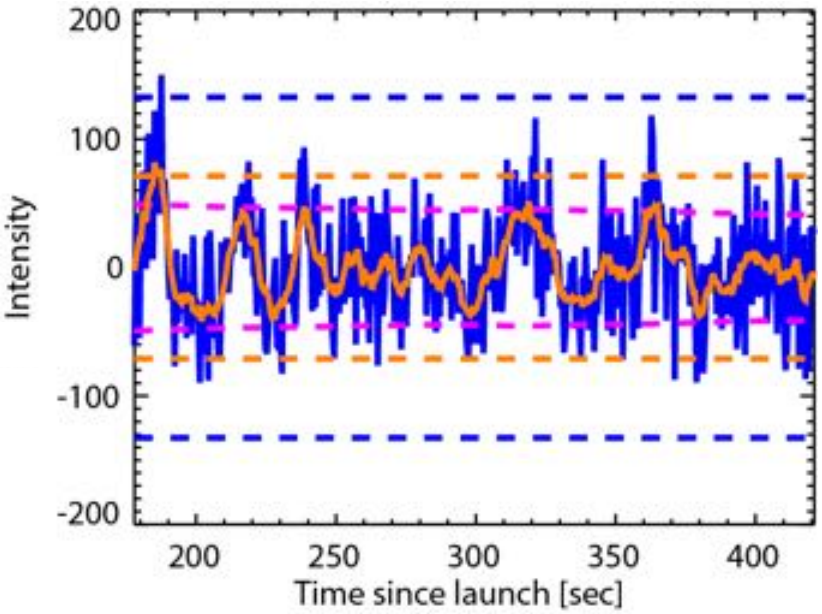
- **Cadence: 0.3s**
- **1.1”/pixel**
- **280s duration**
- Level-1
- Channel 2
- Correction of slit rotation
- Correction of drift of line center
- Correction of intensity decrease

- High pass filter: same way as SJ
  - ✓ smoothing width: 30s
  - ✓ running average: 4.8s

High cadence & throughput → subtle & short-time scale changes of profiles

High pass filter

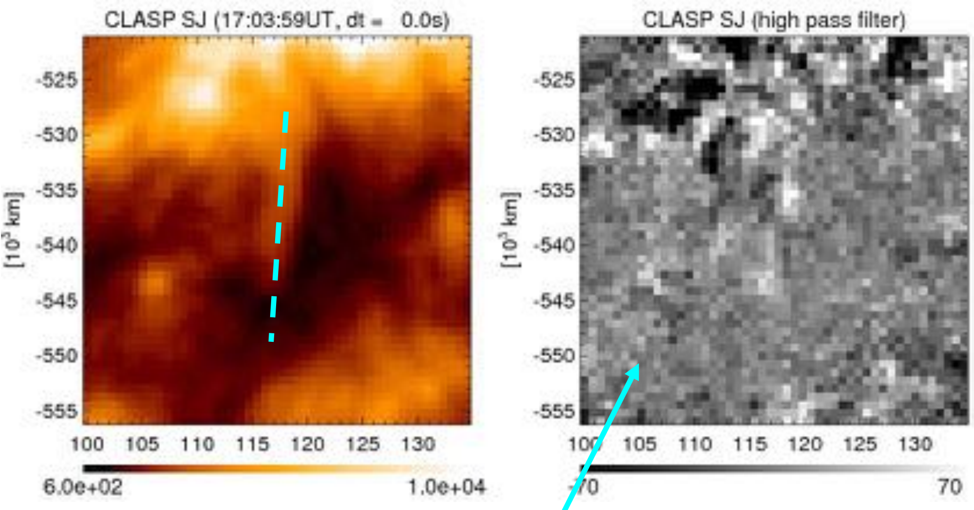




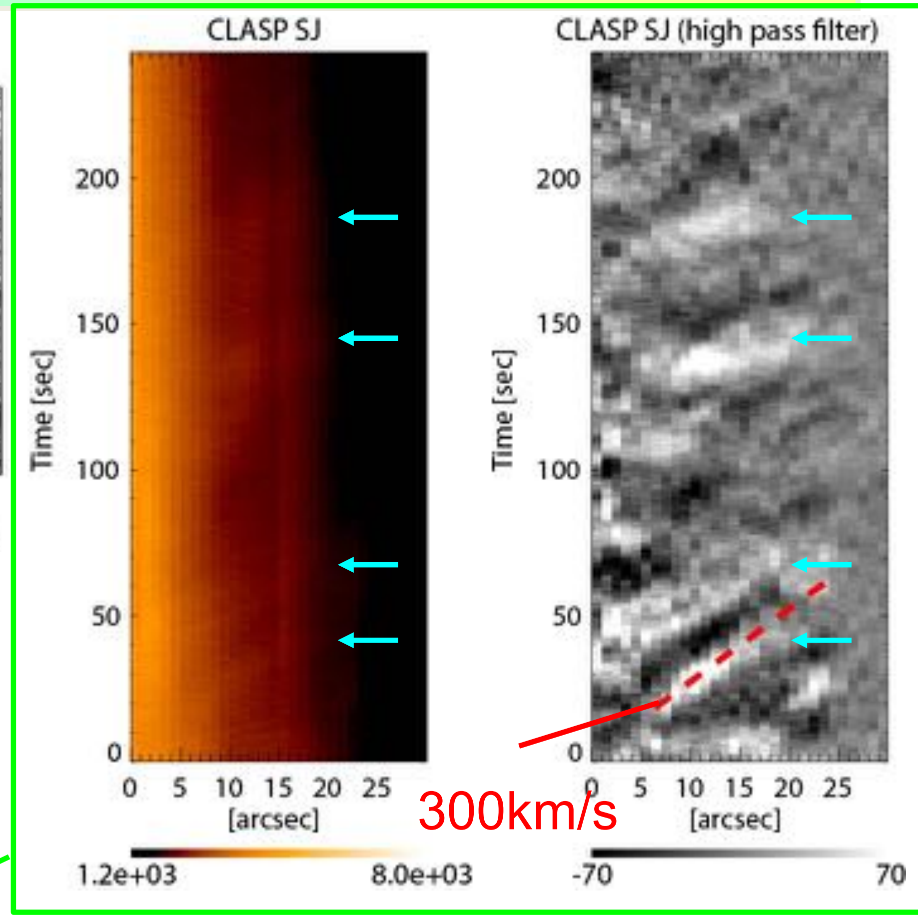
① Calculate a running average over 30 s (=100 images) → green line
② Remove the green line from a original time profile (black line) → blue line
③ Calculate a running average over 4.8s (=16 images) of the blue line → orange line

* The purpose of ③ is to increase S/N and to reduce intensity fluctuation affected by the rotating waveplate (4.8sec/rotation).

SJ Fast-propagating Intensity Disturbances



Movie after removal of running average over 30s

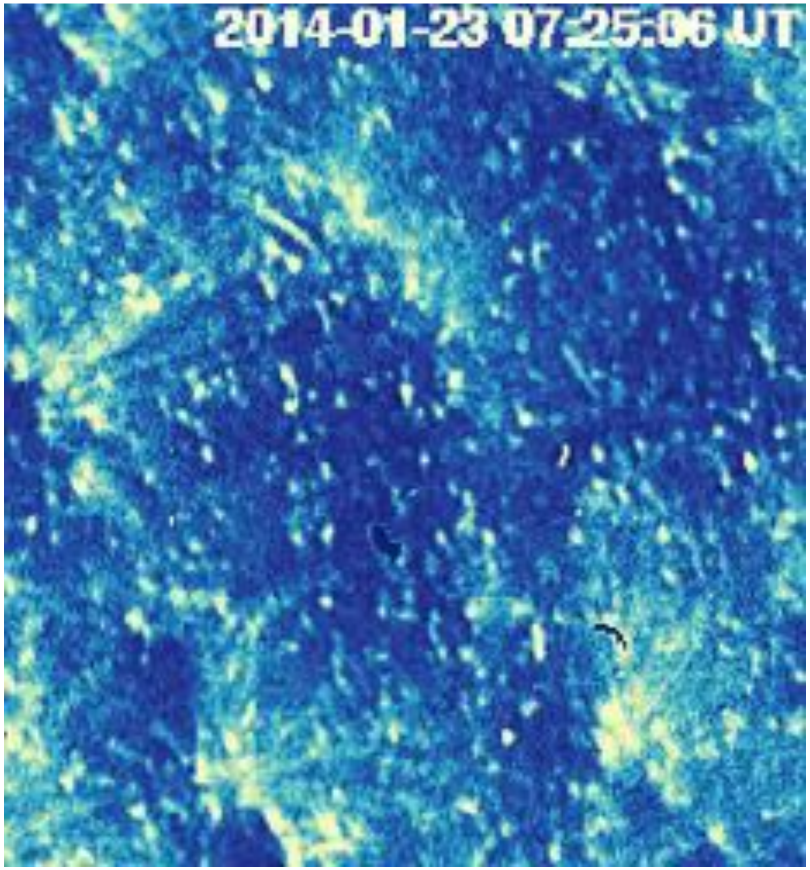


Space vs. time plot along the dashed line

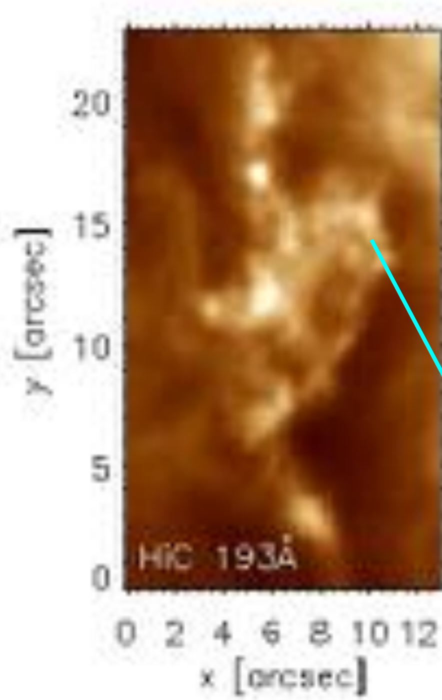
Kubo et al. 2016

CLASP/SJ reveals ubiquitous intensity disturbances that recurrently propagate in the chromosphere - transition region at a speed > 150km/s.

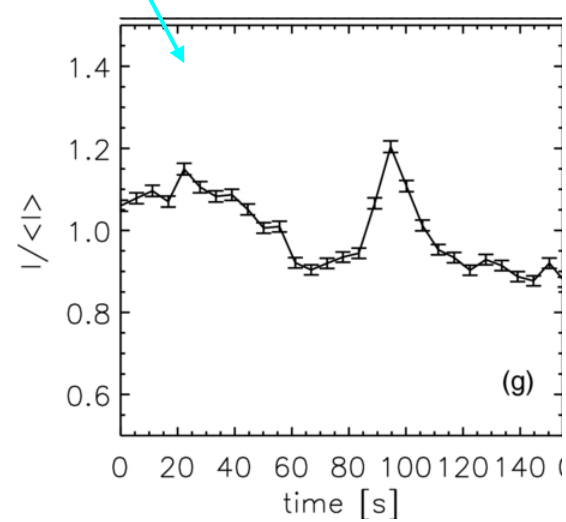
Short-timescale events in TR and corona



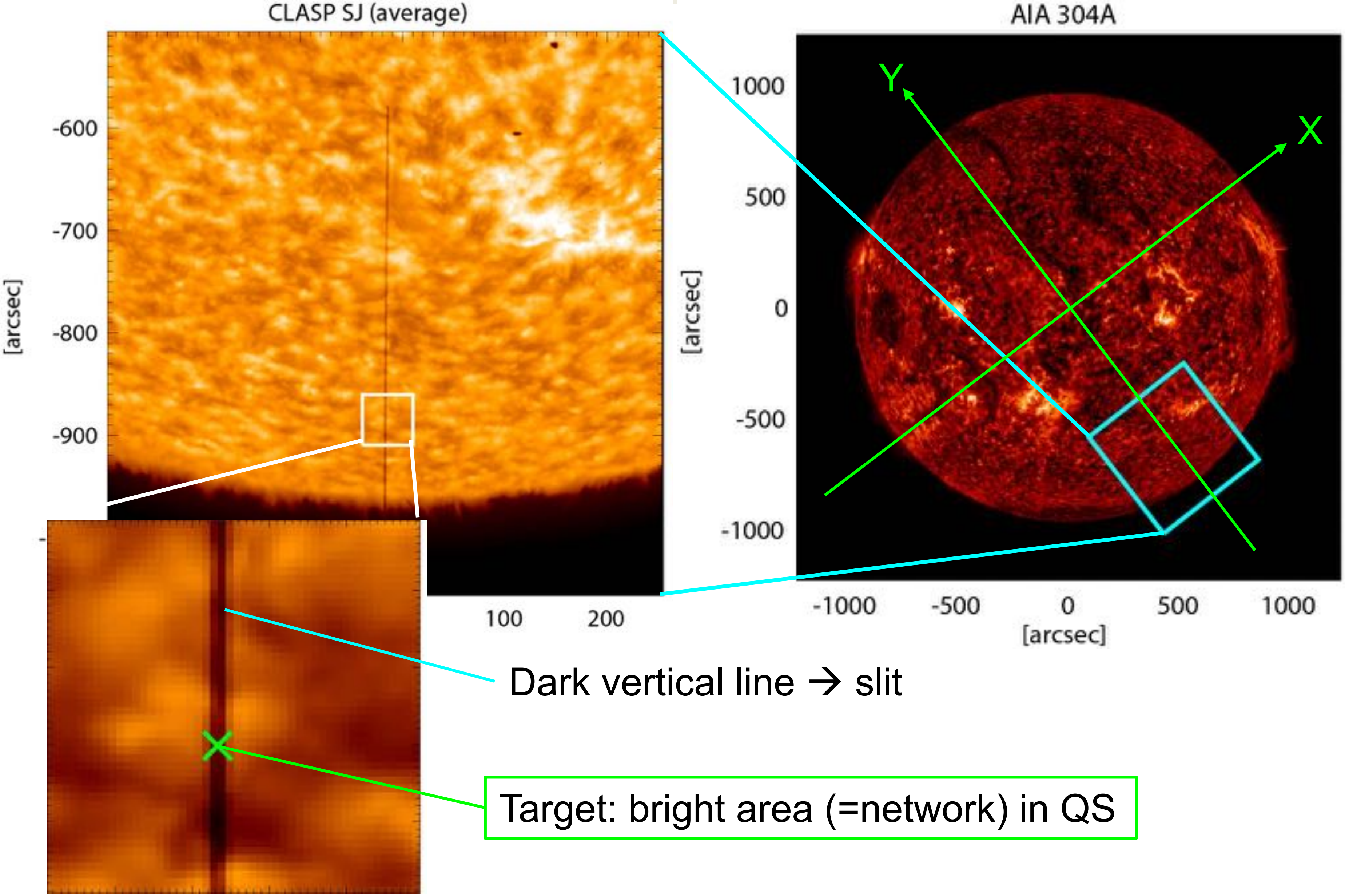
Network jets with IRIS
(Tian et al. 2014)



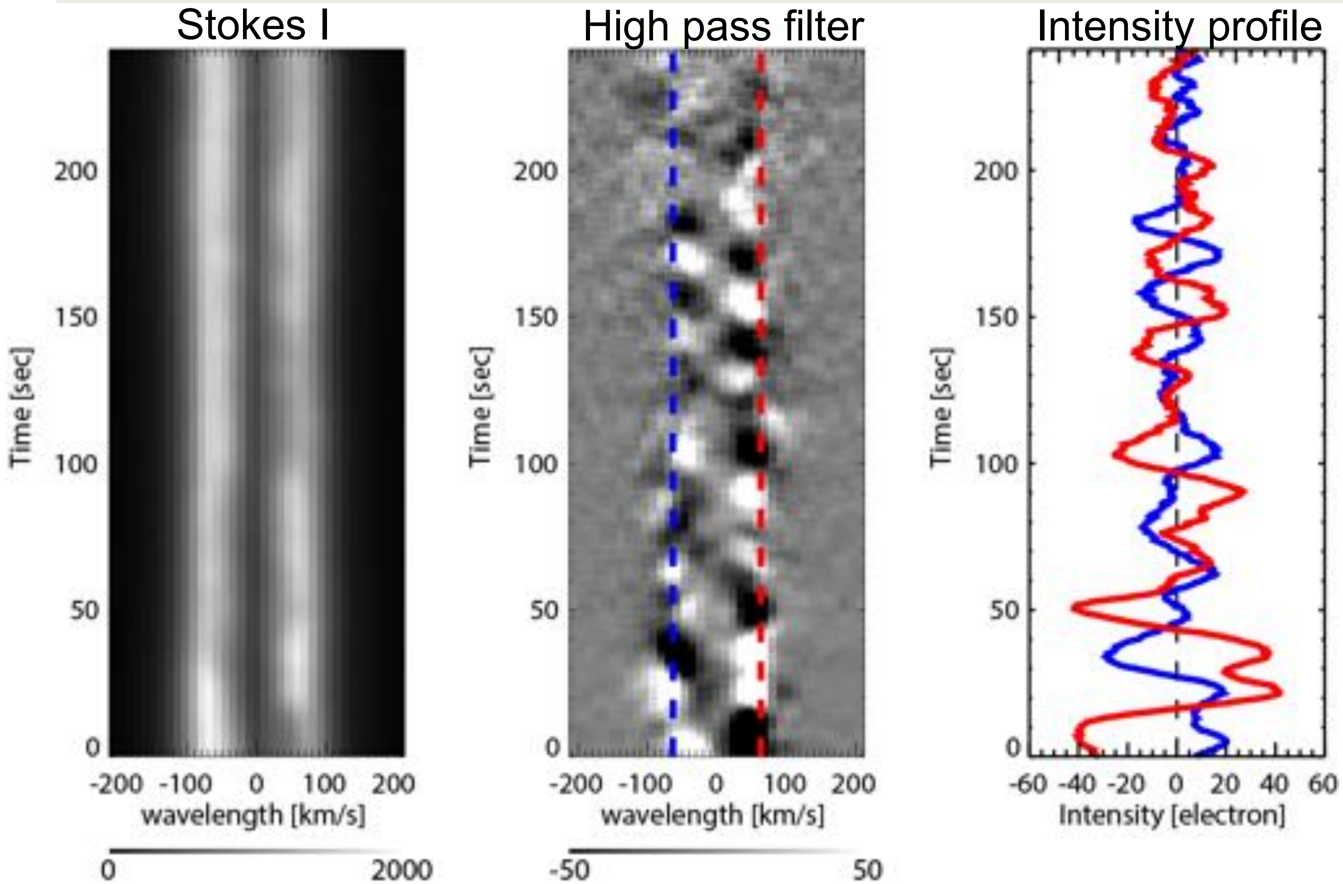
Short-timescale variability in moss region with Hi-C (Testa et al. 2013)



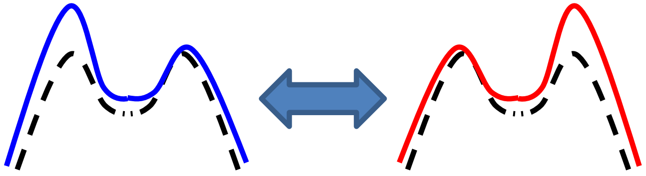
Region of Interest



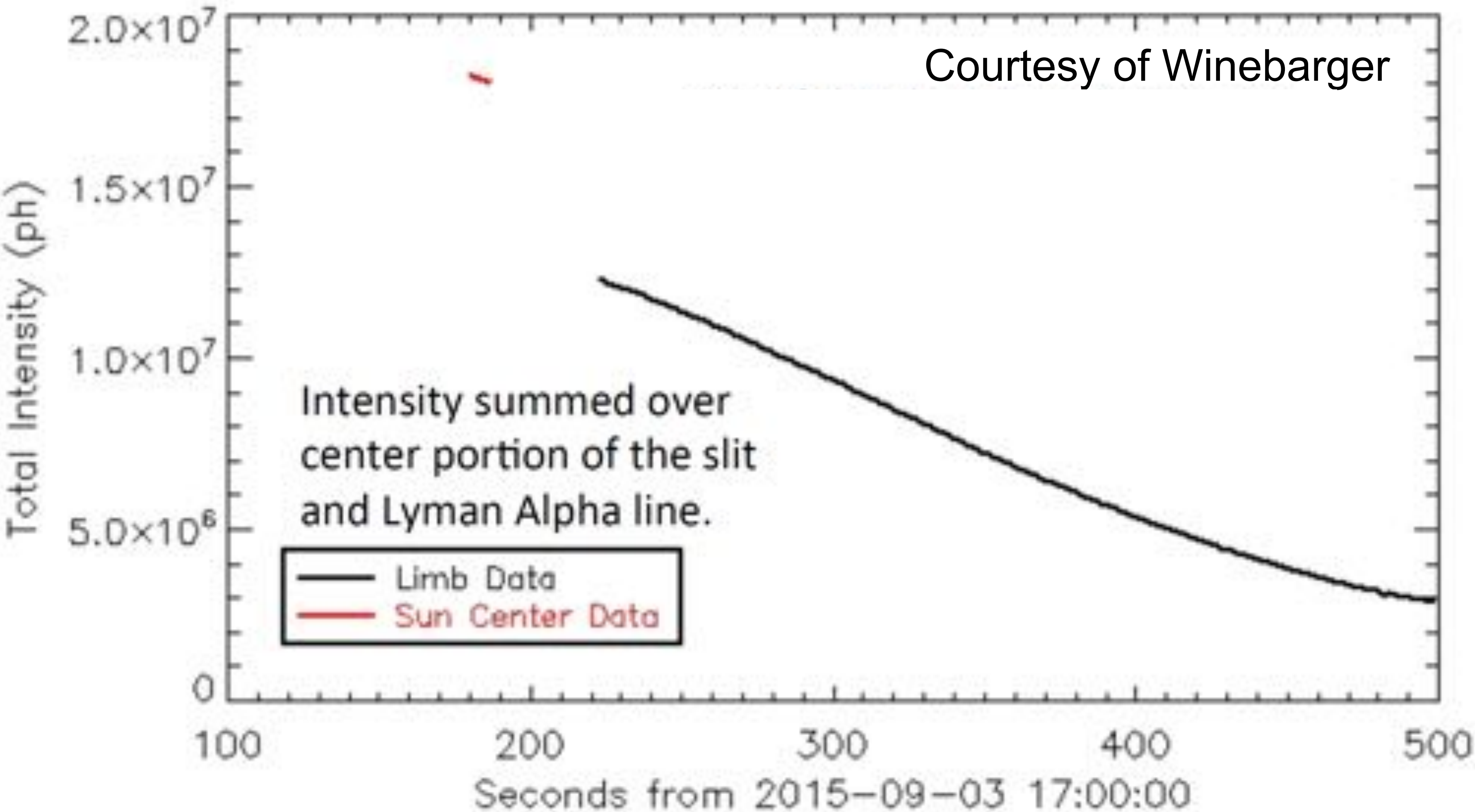
λ – t plots Lyα Stokes I profile



The intensity of the blue and red peaks fluctuates at time scale shorter than 30s in opposite phase with each other. Such fluctuation is visible in raw Stokes I data.

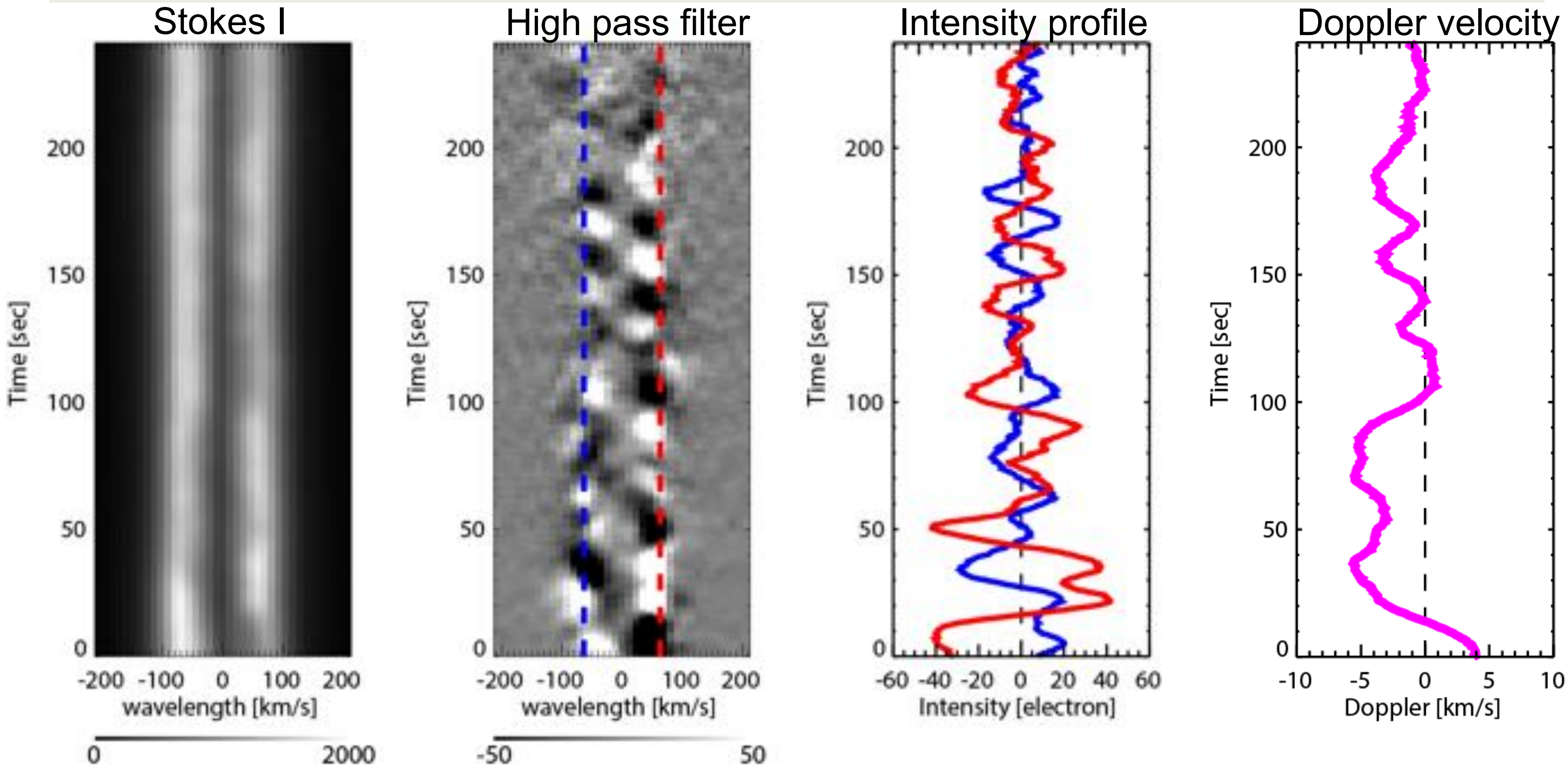


Intensity Drop during Flight due to Water Vapor



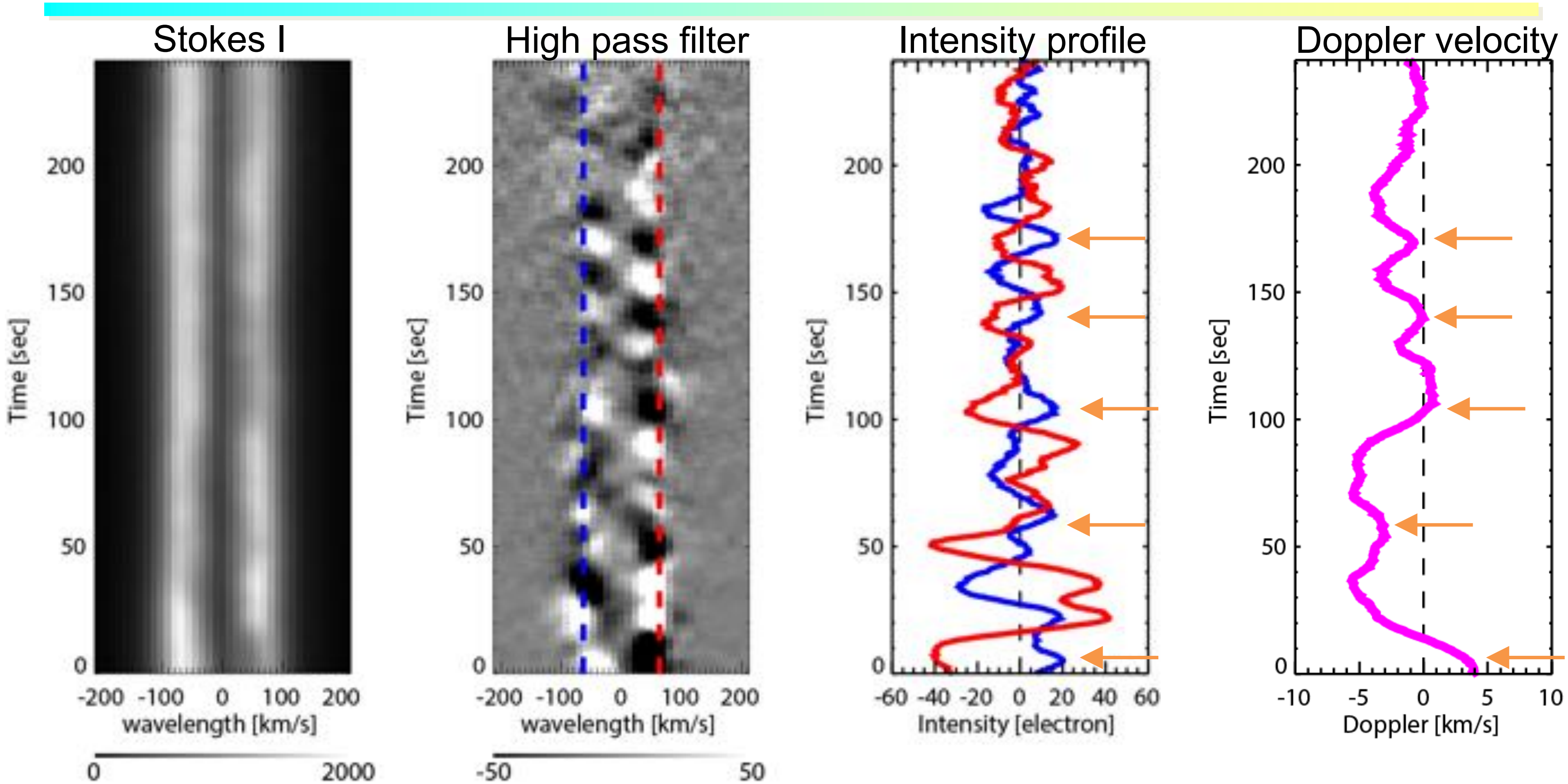
The intensity degradation is corrected as make the intensity averaged over the slit constant, but S/N becomes worse with time.

Doppler velocity of Lyα line center

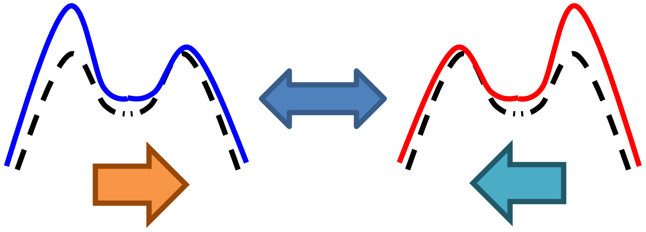


- The short timescale fluctuations also can be seen in the Doppler shift of a central dip of the Lyα line.
- The range of Doppler velocity is ±10 km/s.

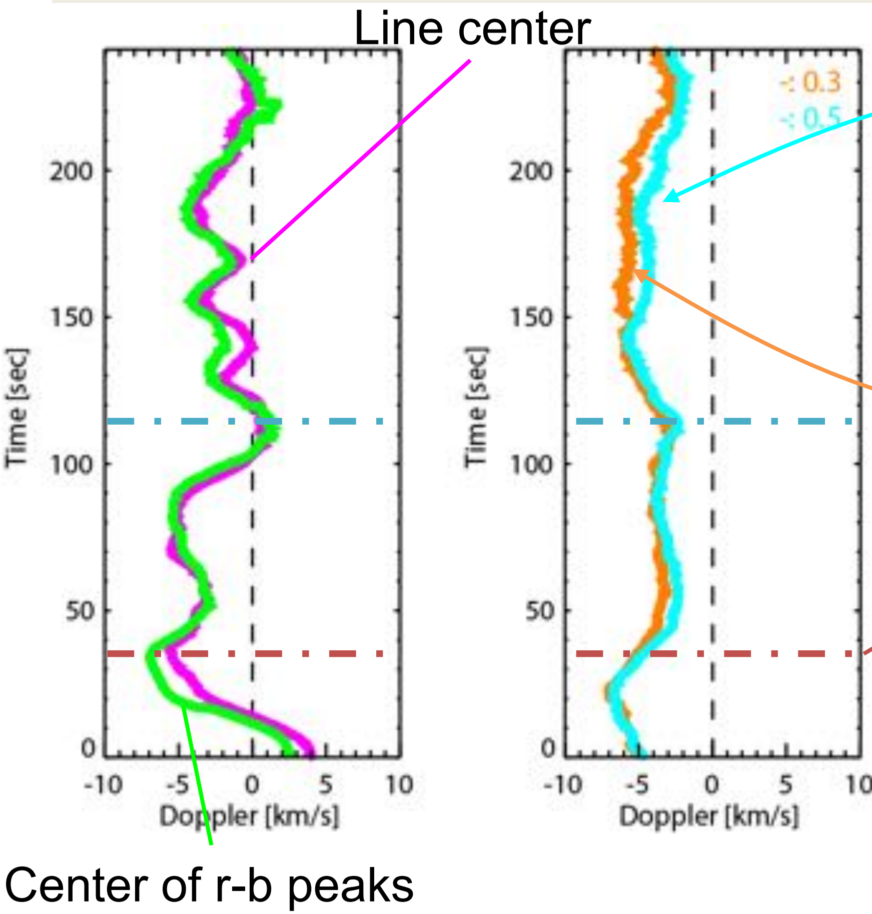
Doppler velocity of Lyα line center

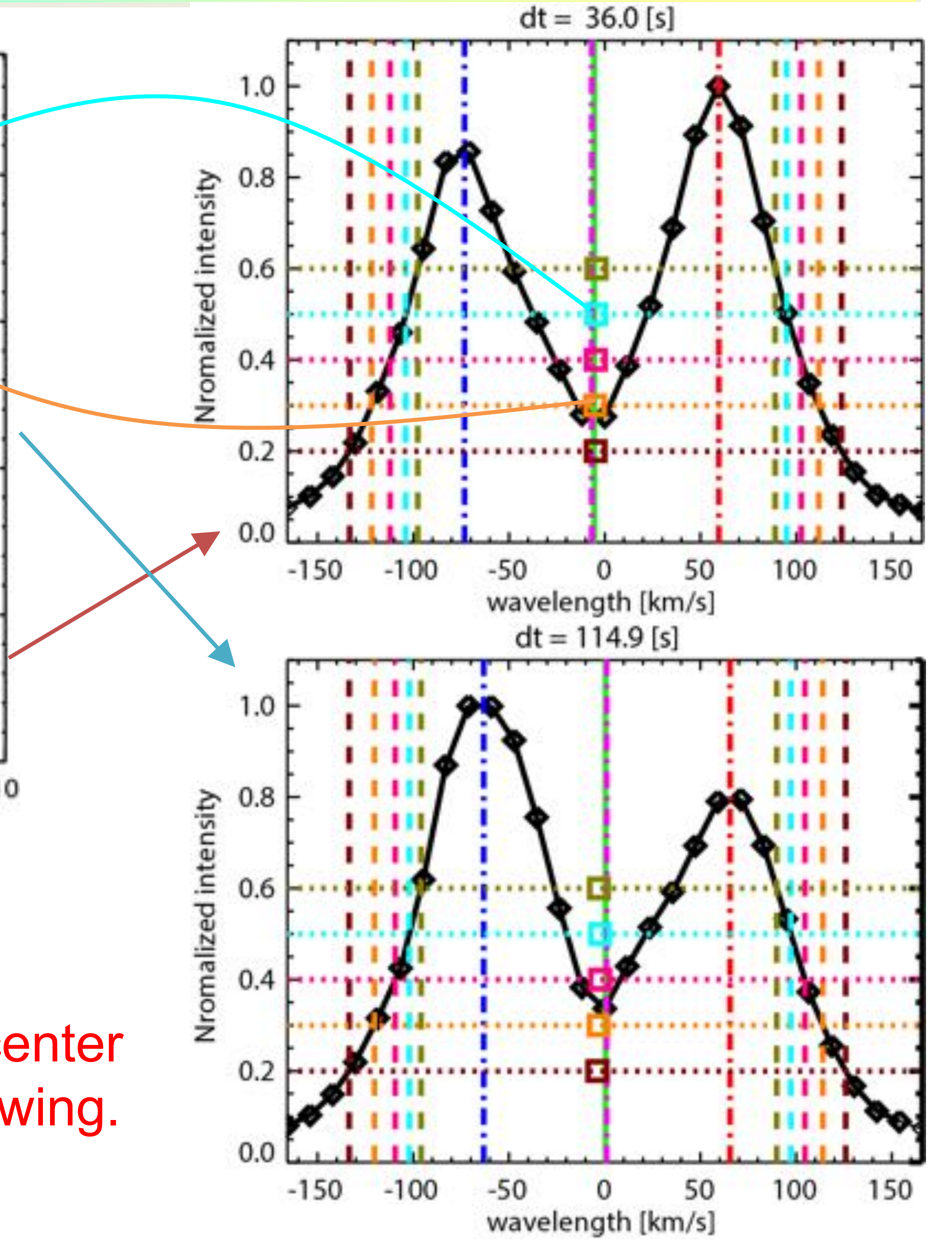


When the central dip of the Lyα line moves red-ward, the blue peak tends to be enhanced, and vice versa.



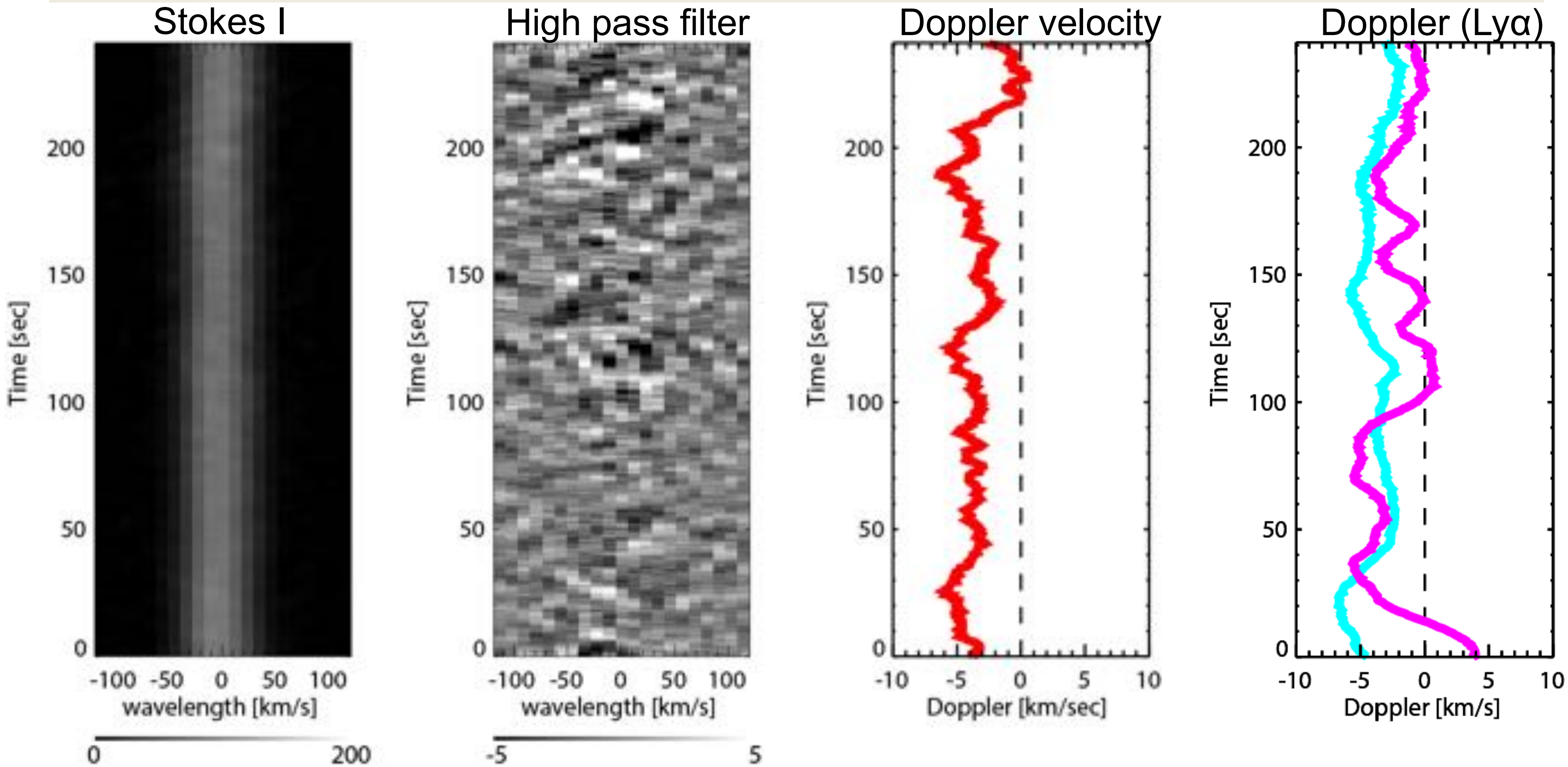
Bisector analysis of Lyα line





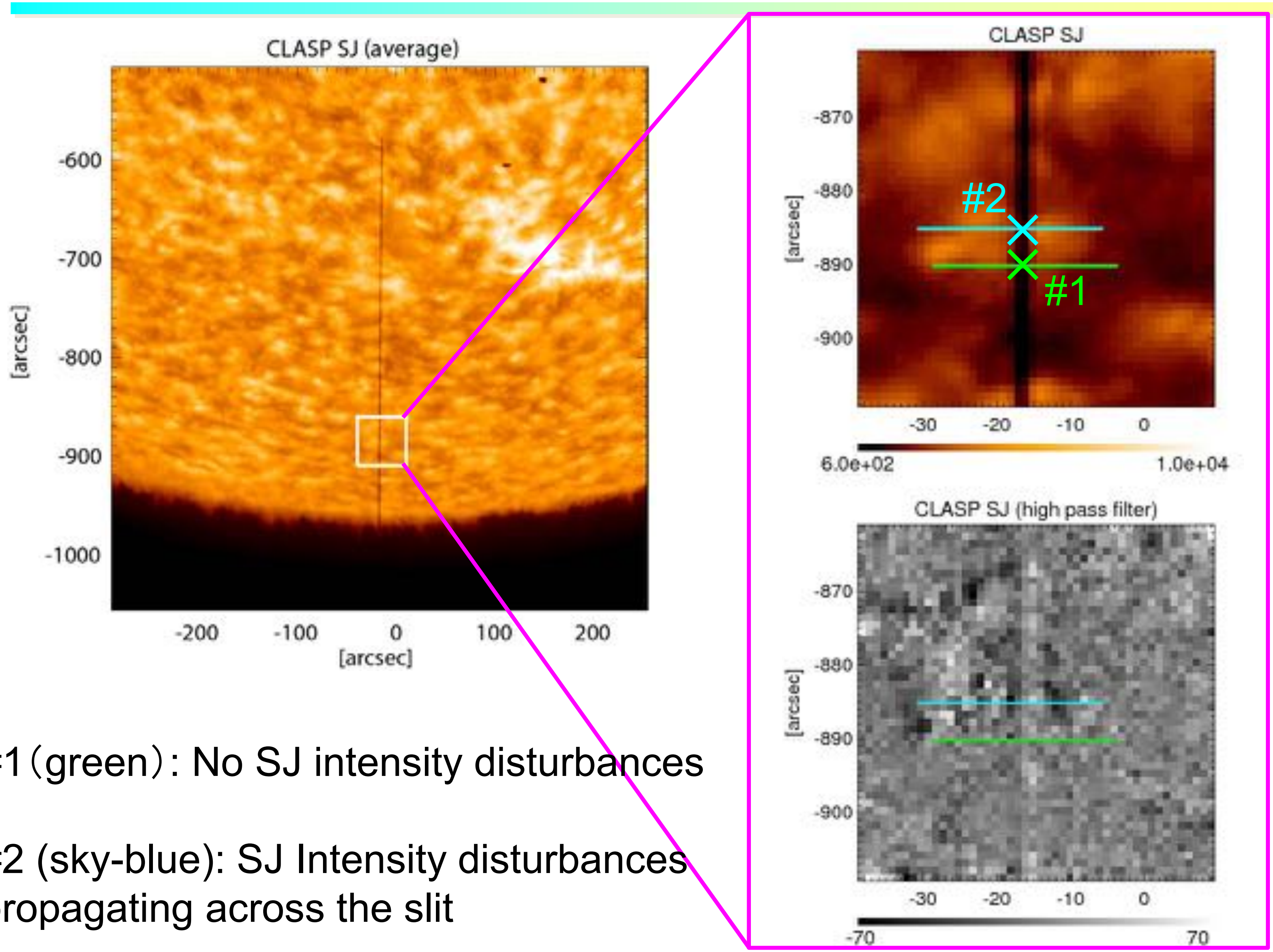
The Doppler velocities of the line center are different from those of the line wing.

λ – t plots Si III Stokes I profile



- High frequency components observed in Lyα Stokes I profile cannot be seen in Si III line.
- The Doppler velocity of Si III line center is similar to the Doppler velocity of Lyα line wing rather than the Lyα line center (?).

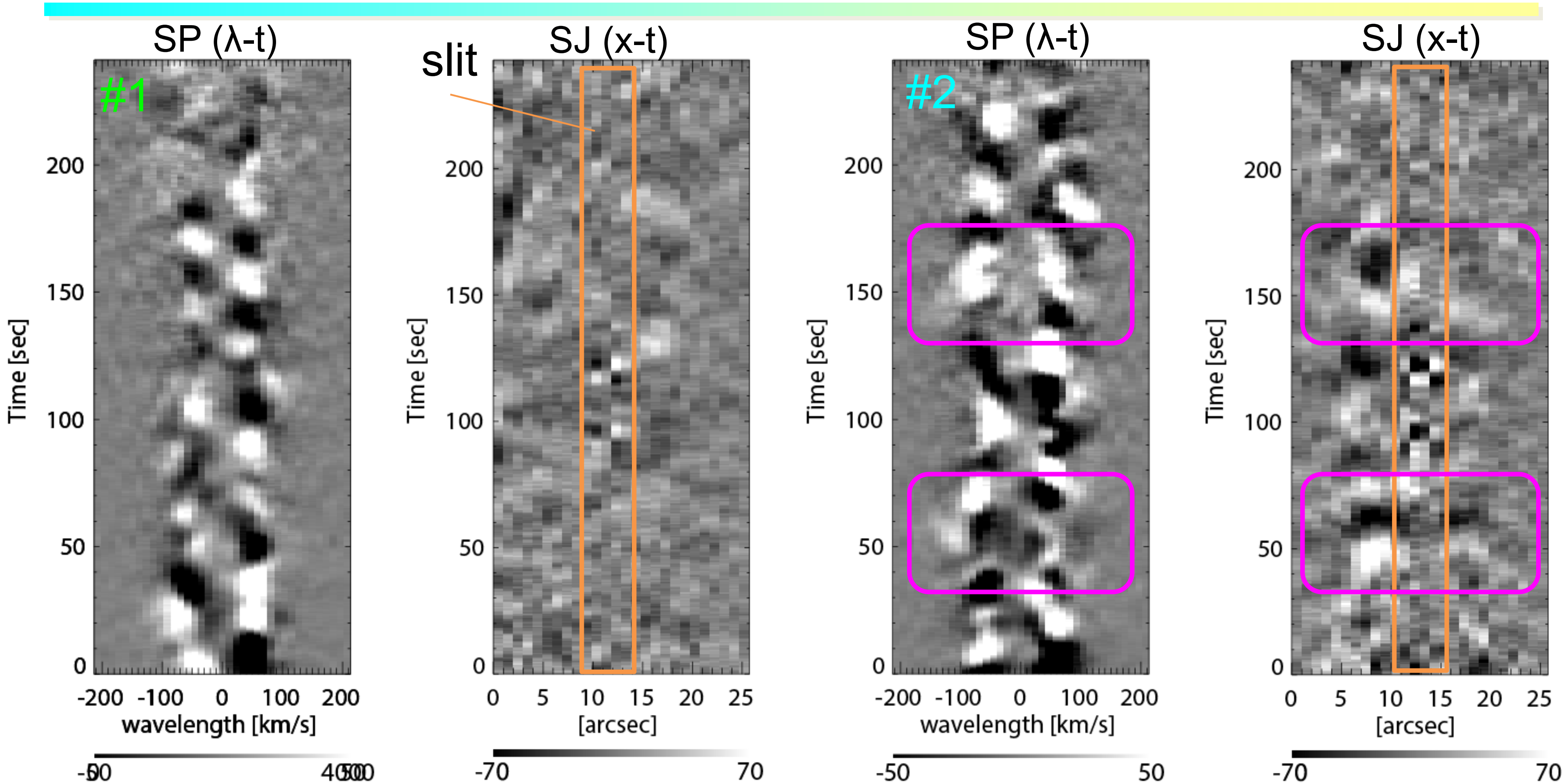
Fast-Propagating Intensity Disturbances in ROI



#1（green）: No SJ intensity disturbances

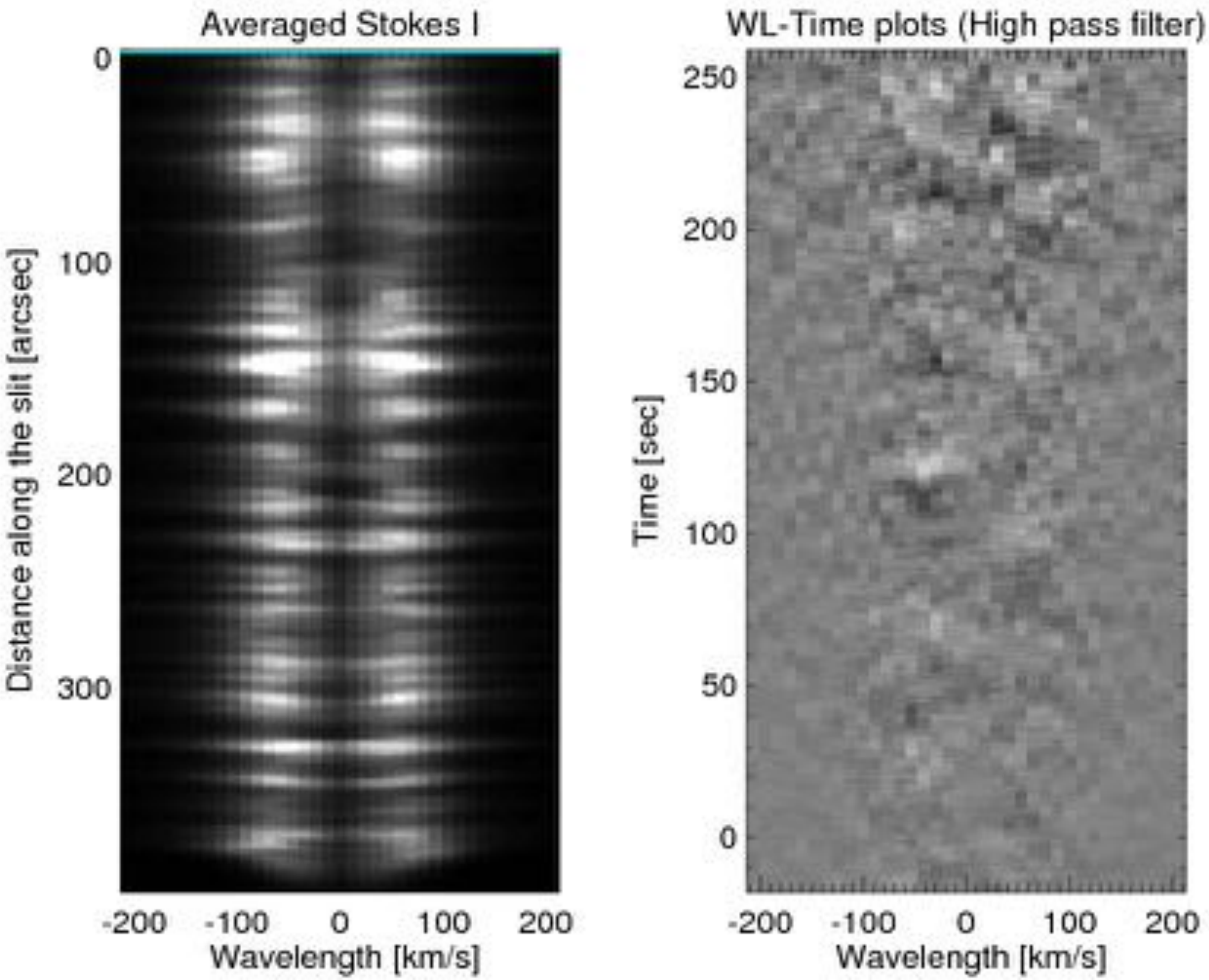
#2 (sky-blue): SJ Intensity disturbances propagating across the slit

Relation with Fast-Propagating Intensity Disturbances



- Such alternate intensity changes of the blue and red peaks are more clearly observed in the bright areas but in the period without the fast propagating intensity disturbances with CLASP/SJ.

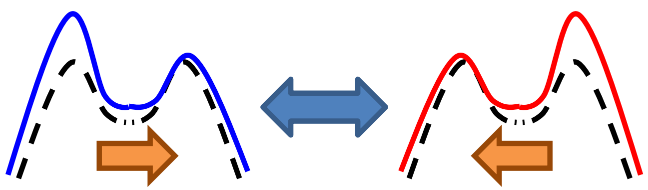
λ – t plots along the slit



The alternate intensity changes of the blue and red peaks are commonly observed in stable, bright areas in QS.

Summary from CLASP Observations

- We find that alternate intensity changes of the blue and red peaks recurrently appear in the short time scale.



- The short timescale fluctuations also can be seen in the Doppler shift ranging ±10km/s.

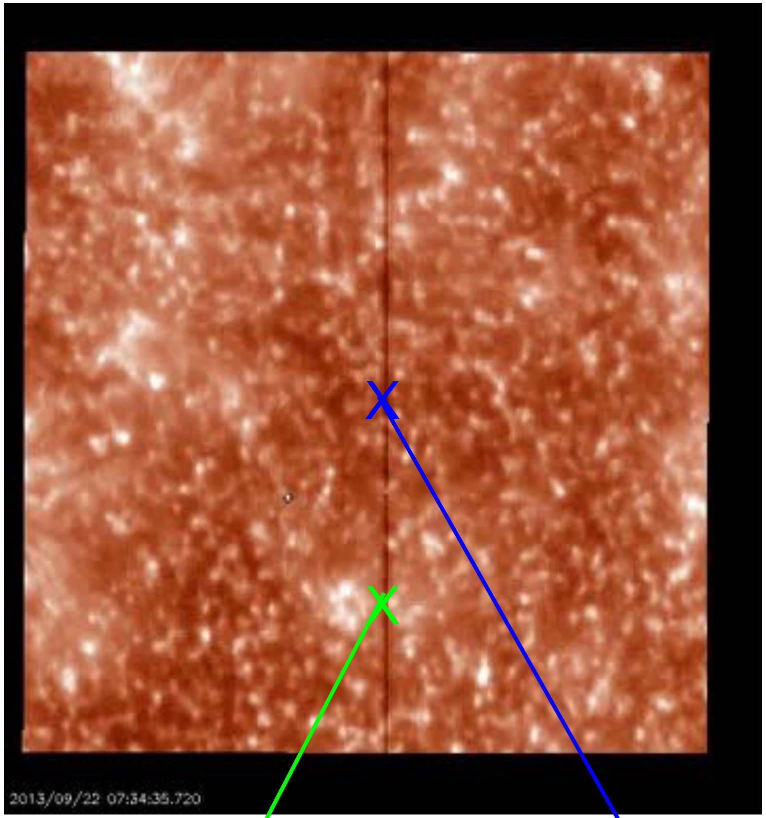
- The Doppler shifts of the line center are related to the changes of the blue and red peaks.

- The short-timescale fluctuations of intensity with the Doppler shift are more clearly observed in the period without the intensity disturbances in SJ images.

→ Oscillations or torsional motion only in the upper chromosphere – transition region.

IRIS sit-&-stare observations

IRIS SJI 1400A



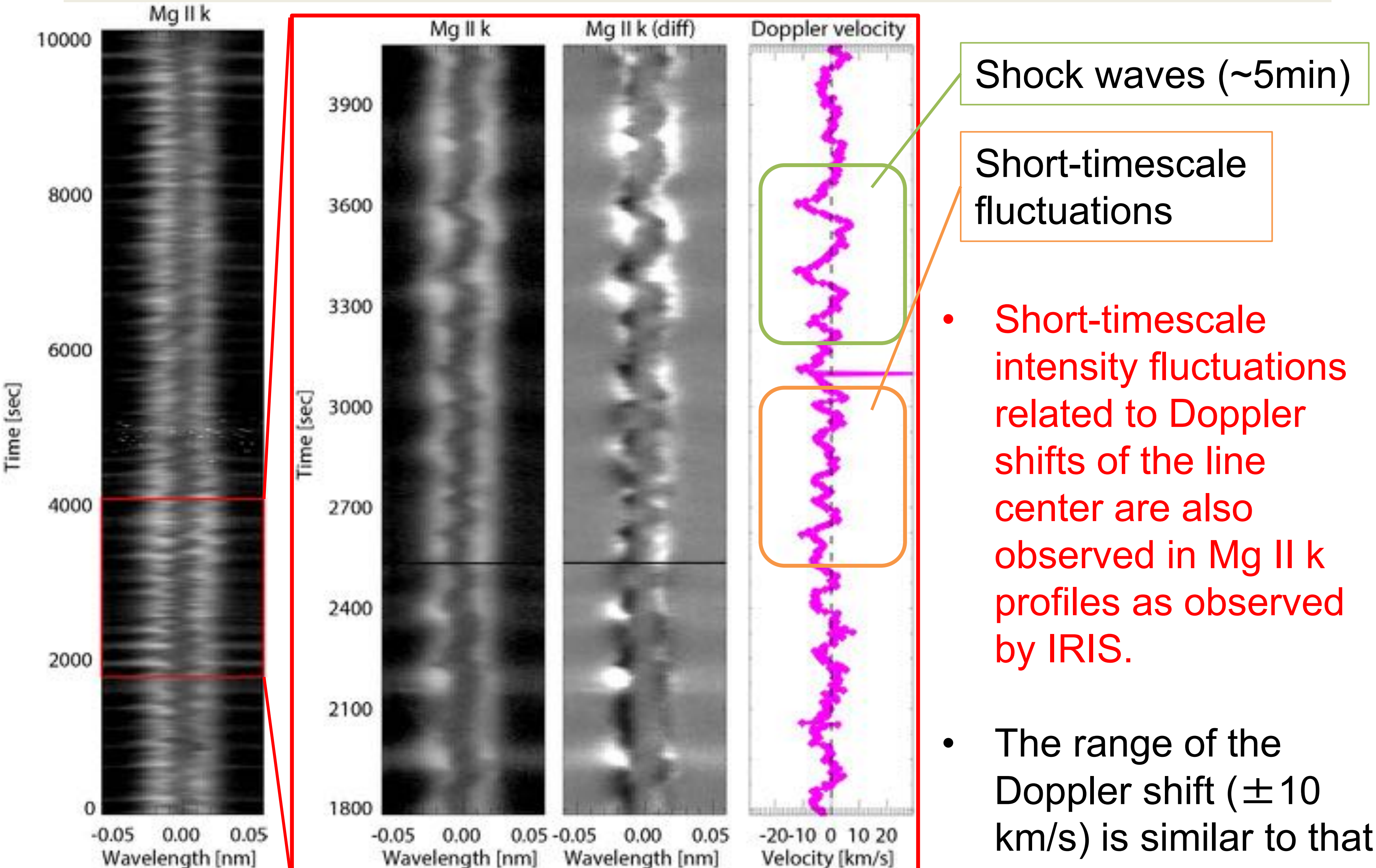
IRIS → many examples, long duration, high spatial resolution

Item	Value
Date	September 22,2013
Mode	Sit-and-stare
Cadence	5.1s
Duration	3.5 hour
Target	Quiet Sun
Coordinate	(537", 295")
Pixel sampling	0".16

"Network" bright area

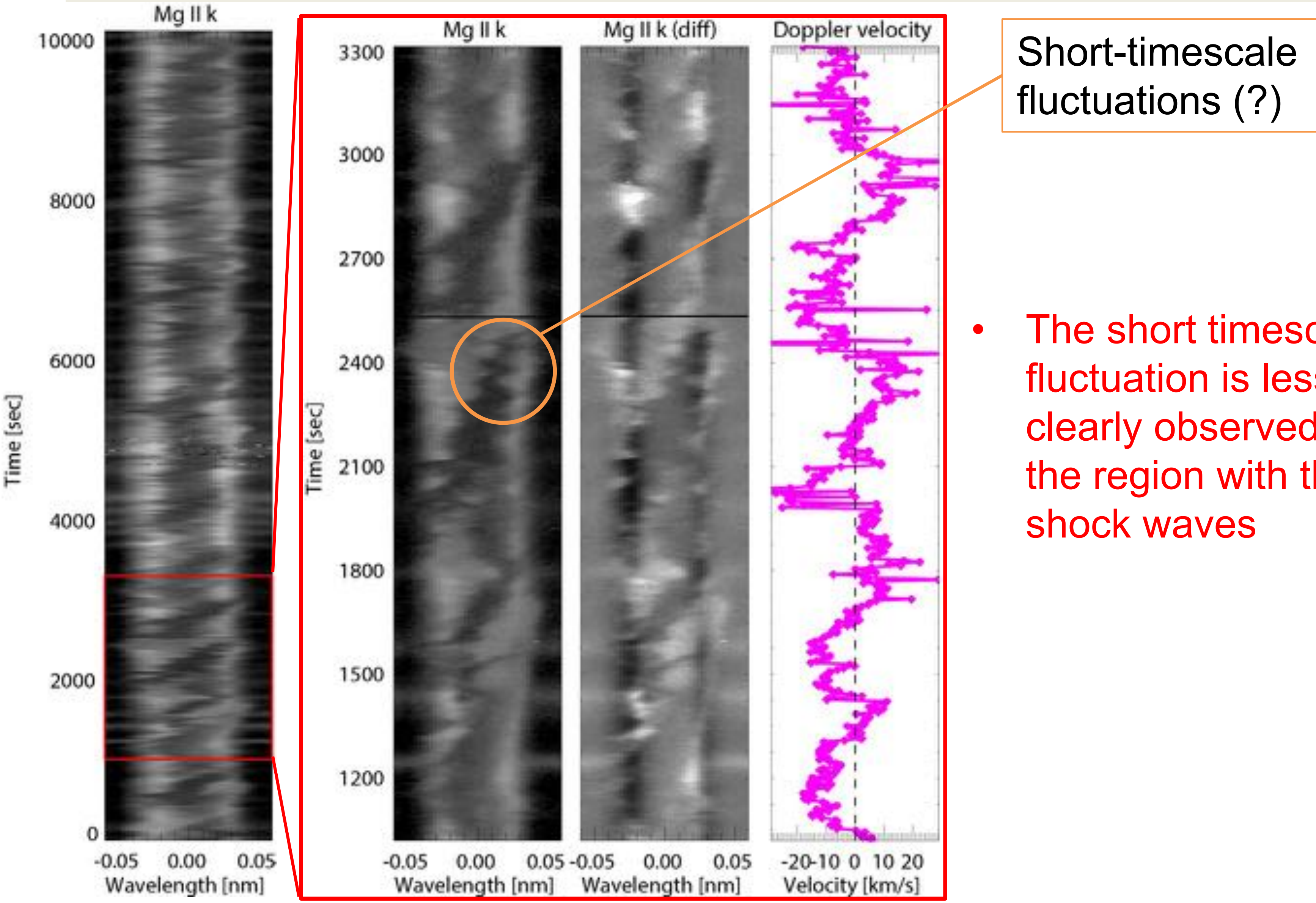
"Internetwork" bright area

λ – t plots Mg II k profile @ internetwork



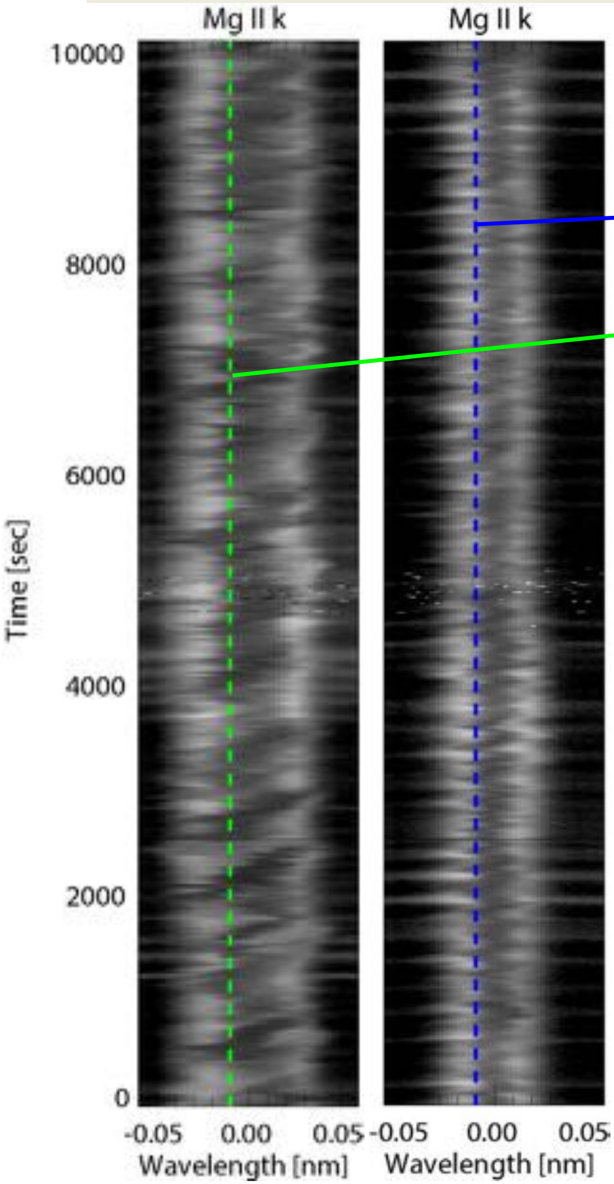
- Short-timescale intensity fluctuations related to Doppler shifts of the line center are also observed in Mg II k profiles as observed by IRIS.
- The range of the Doppler shift (±10 km/s) is similar to that observed by CLASP

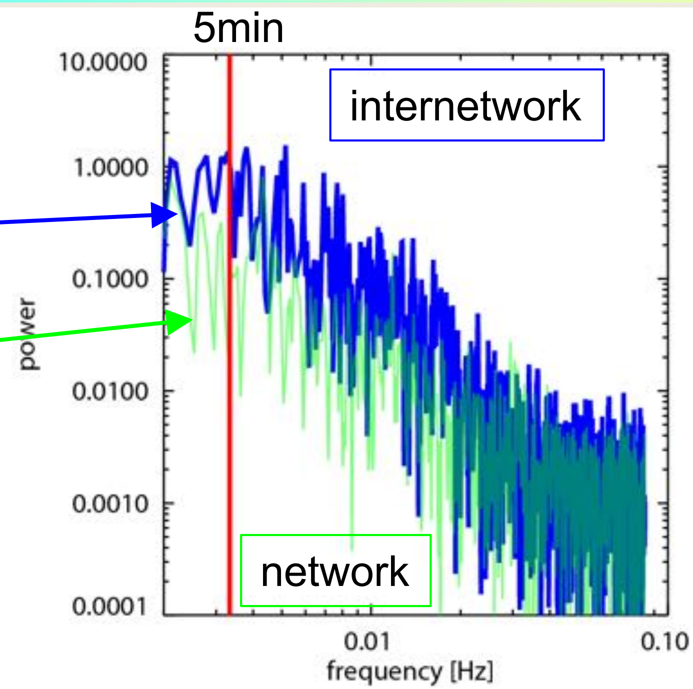
λ – t plots Mg II k profile @ network



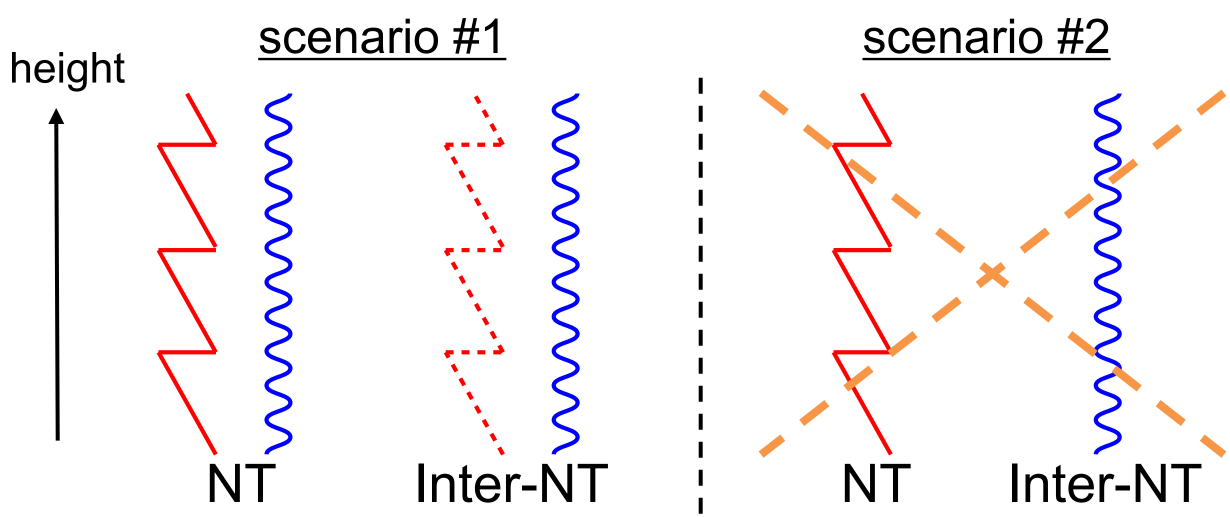
- The short timescale fluctuation is less clearly observed in the region with the shock waves

Power Spectrum Density of Intensity



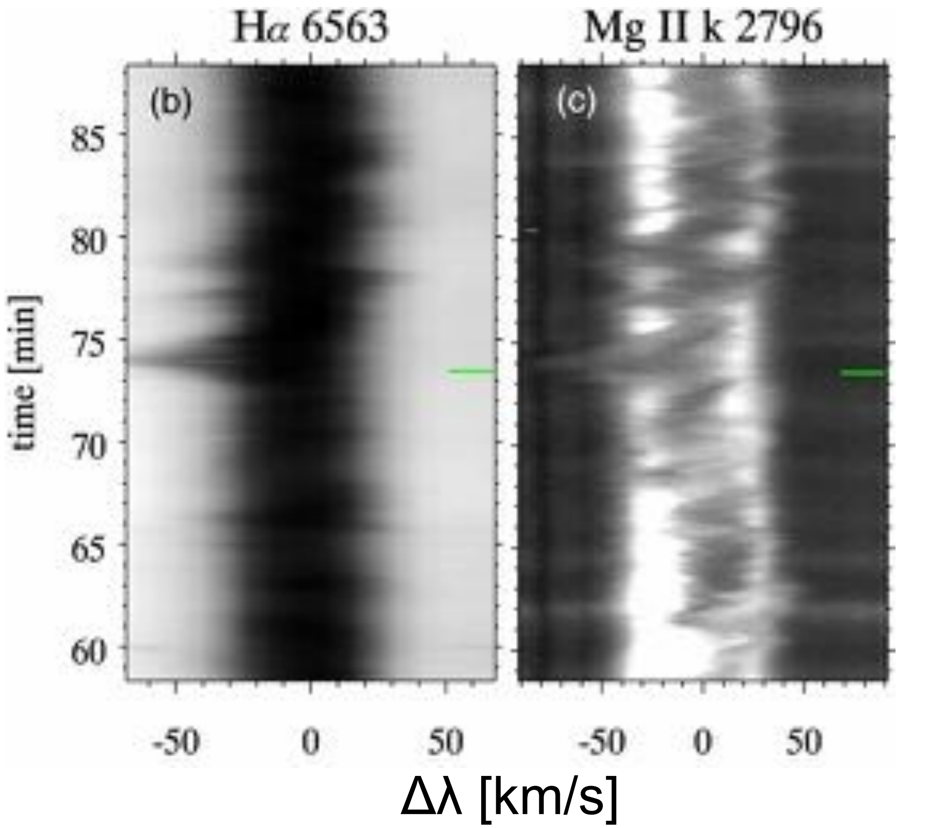


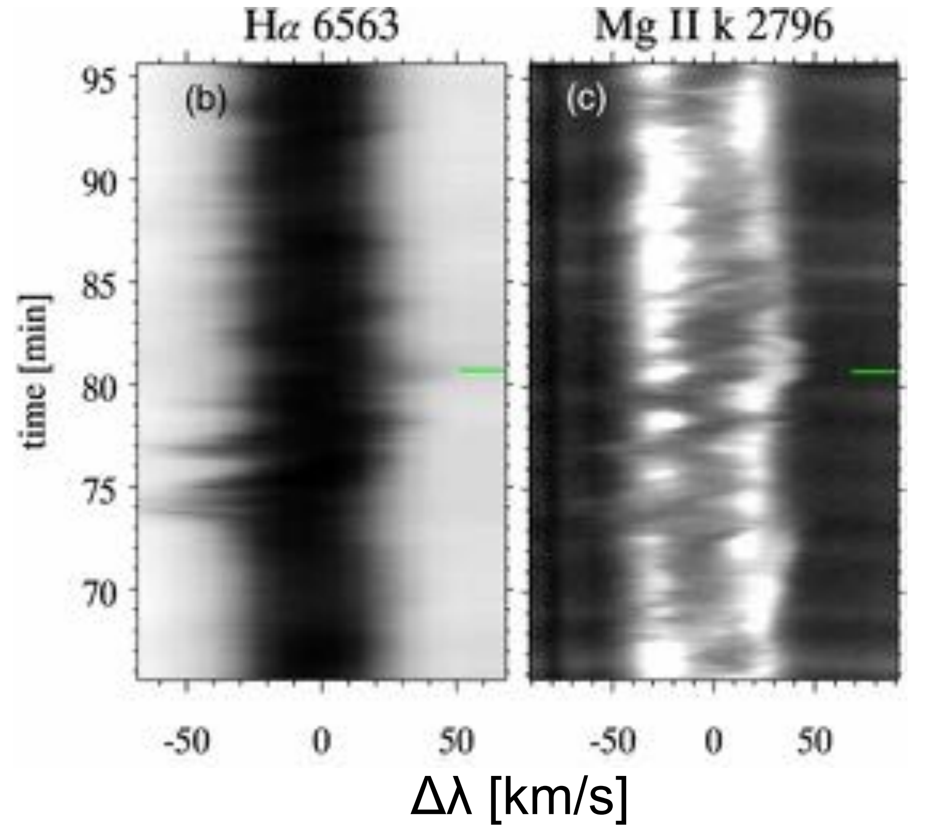
No typical time scale (no peak) for short-timescale intensity fluctuations in PSD



RBEs? RREs?

Rapid Blueshifted Excursions (RBEs) | Rapid Redshifted Excursions (RREs)





Rouppe van der Voort et al. 2014

- Our events most probably do not correspond to typical RBEs or RREs (weak RREs?).
- Recurrent RBEs were reported in Sekse et al. 2013 but recurrent RREs?

Summary from IRIS observations

- Short-timescale intensity fluctuations related to the Doppler shifts of the line center are also observed in Mg II k profiles as observed by IRIS as well as in Lyα profiles as observed by CLASP.

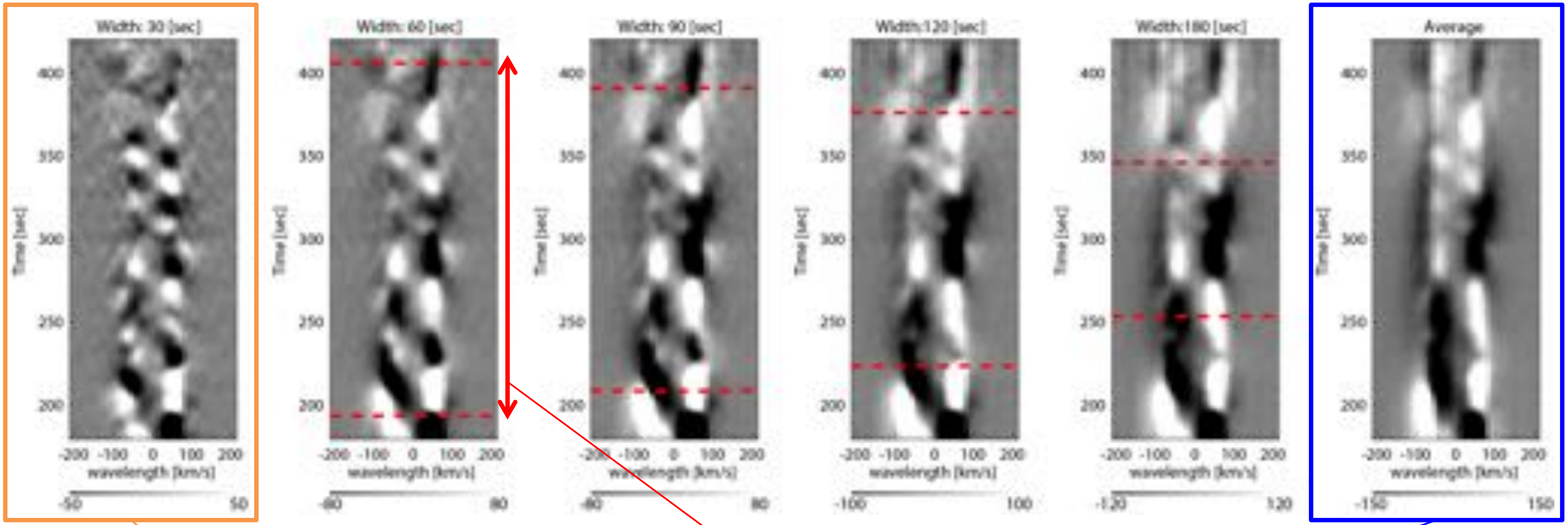
- The range of the Doppler shift (±10 km/s) is also similar to that observed by CLASP

→ We can study these phenomena in more detail by using IRIS data.

- A typical time scale (no peak) for short-timescale intensity fluctuations is not yet obtained in the power spectrum.

Thanks!

Dependence of the width of smoothing window



Same as previous page

Period without influence of the edge

Removal of temporal average over the whole period

- The high frequency components of intensity fluctuations become less clear as the smoothing width is longer because low frequency components with strong power are more contaminated.
- The high frequency components can be identified at least the space-time plots with the smoothing time window shorter than 90 s.