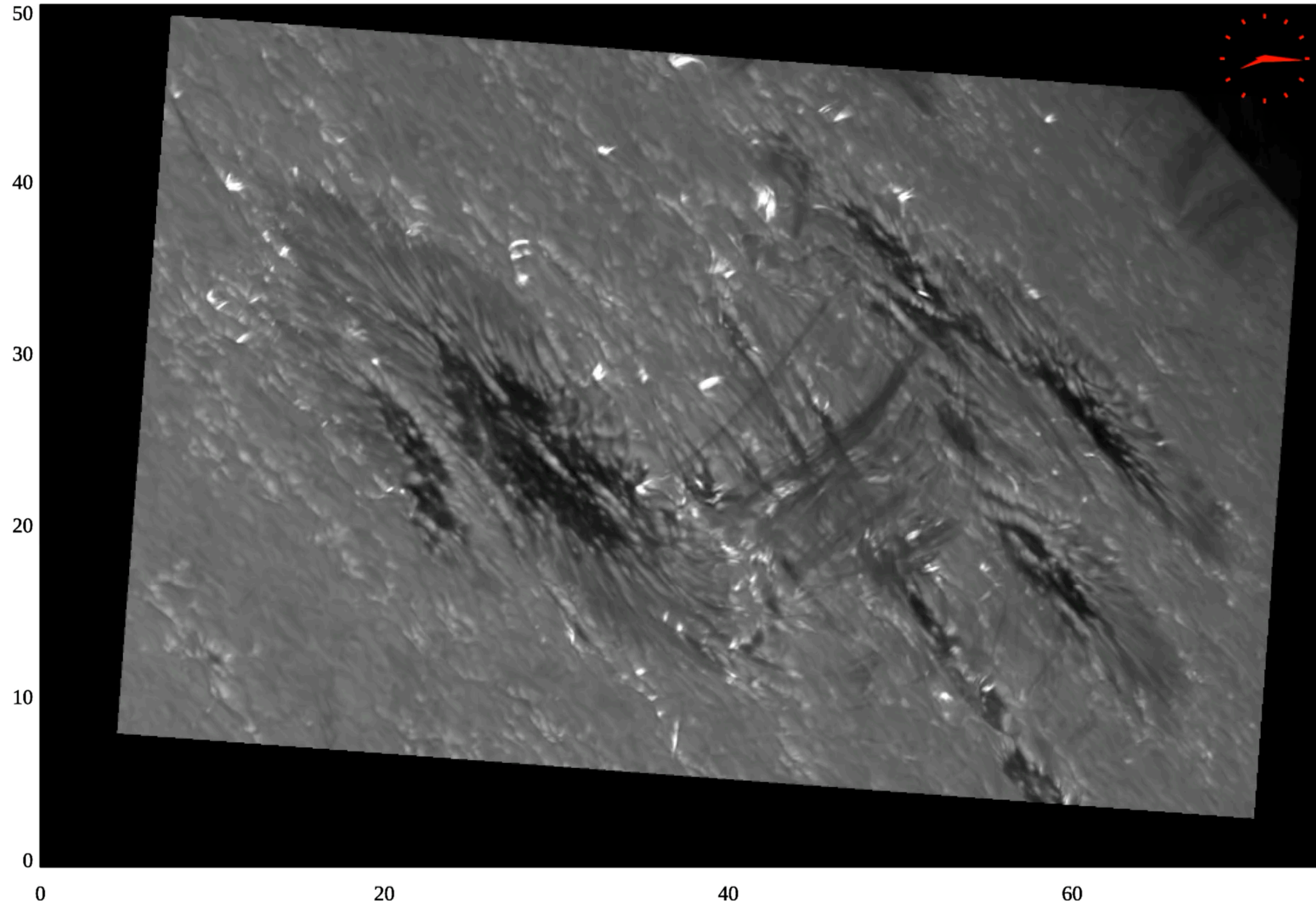


Roseland
Centre
for Solar
Physics

Impact of small-scale photospheric magnetic reconnection events on the upper atmosphere

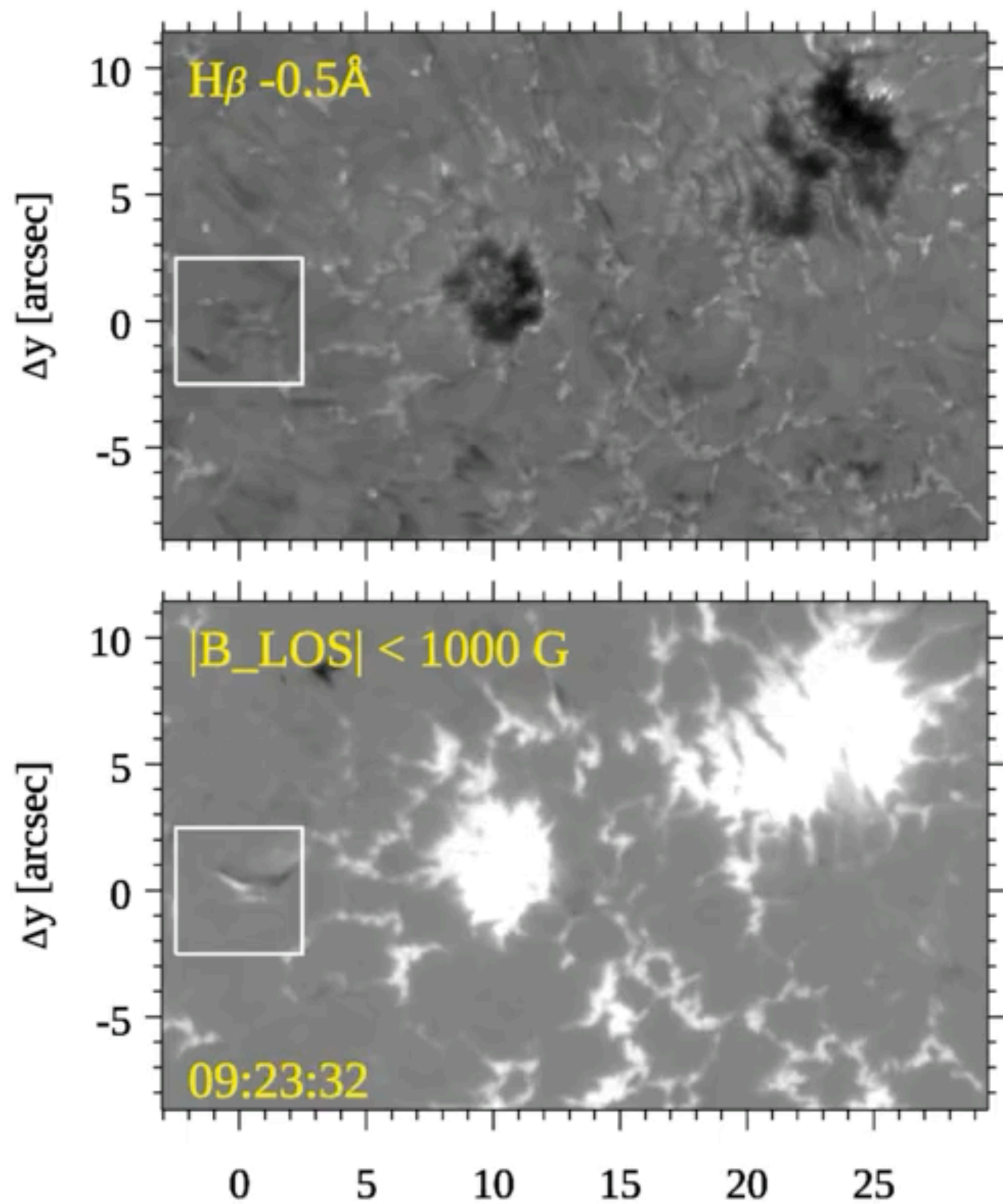
Luc Rouppe van der Voort
Roseland Centre for Solar Physics (RoCS), University of Oslo

In collaboration with Jayant Joshi (IIA Bengaluru), Aditi Bhatnagar (RoCS Oslo) & Mats Ola Sand (RoCS Oslo)

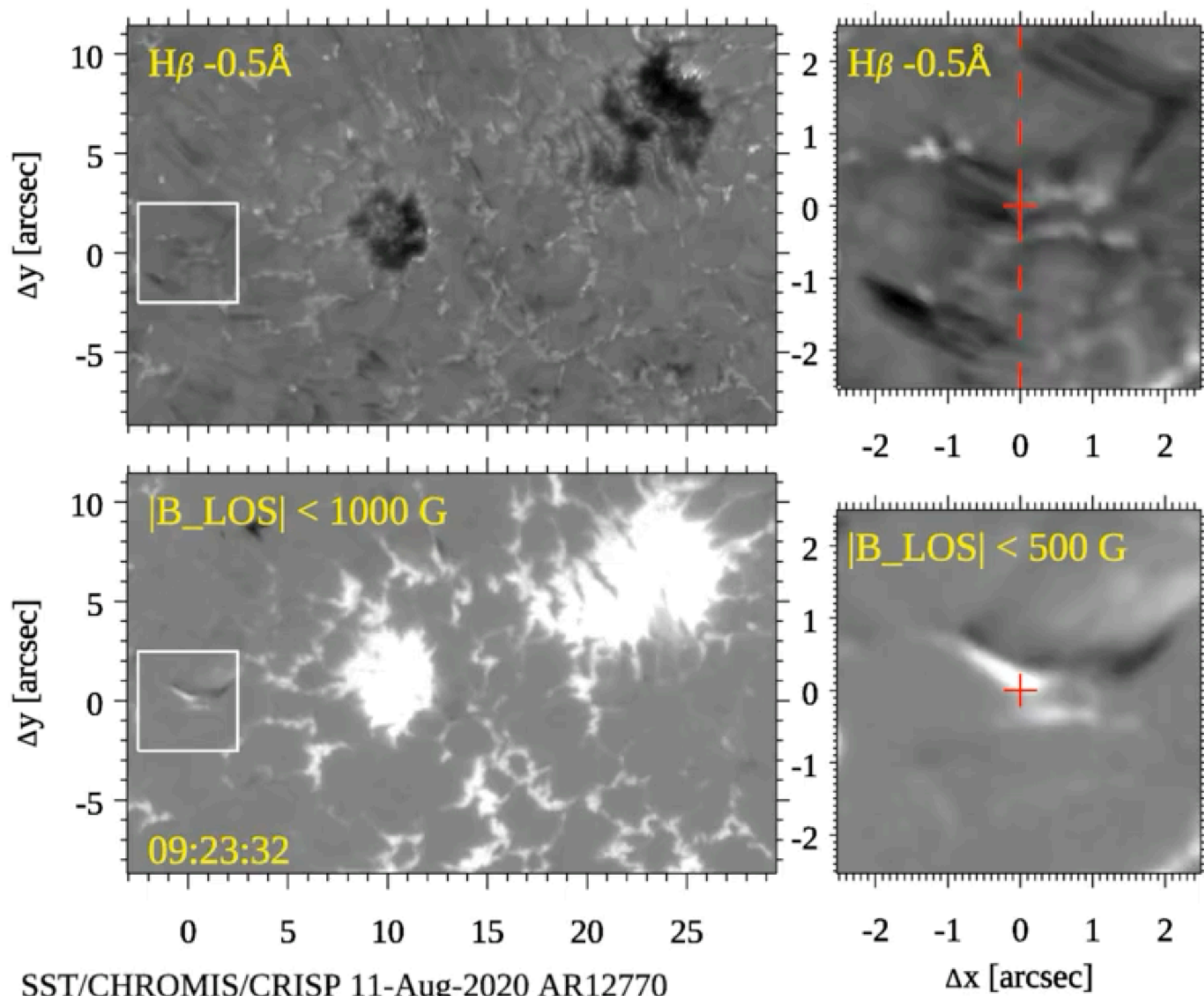


Ellerman bombs:
magnetic reconnection
in low solar atmosphere

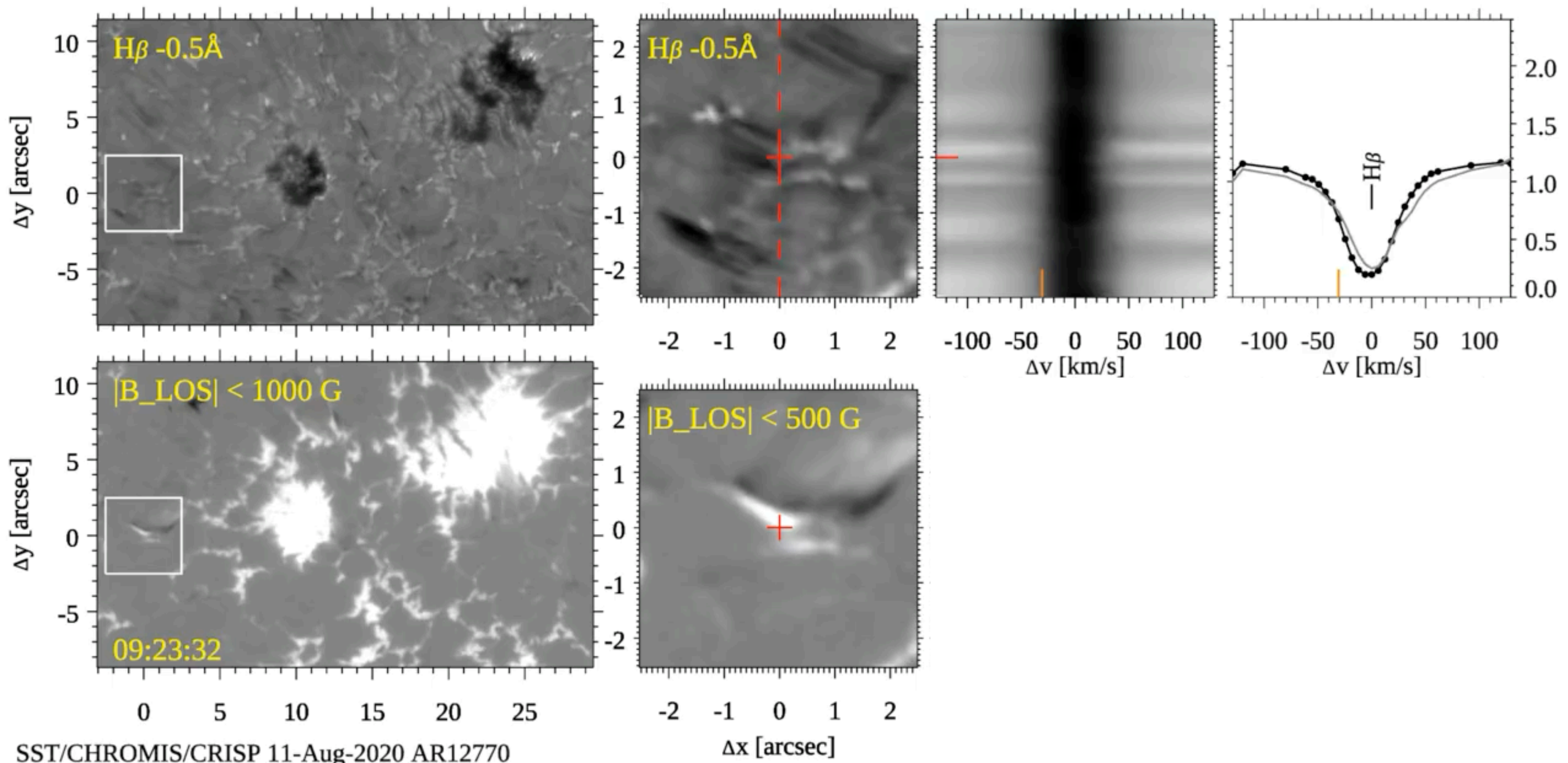
Ellerman bombs: magnetic reconnection in low solar atmosphere



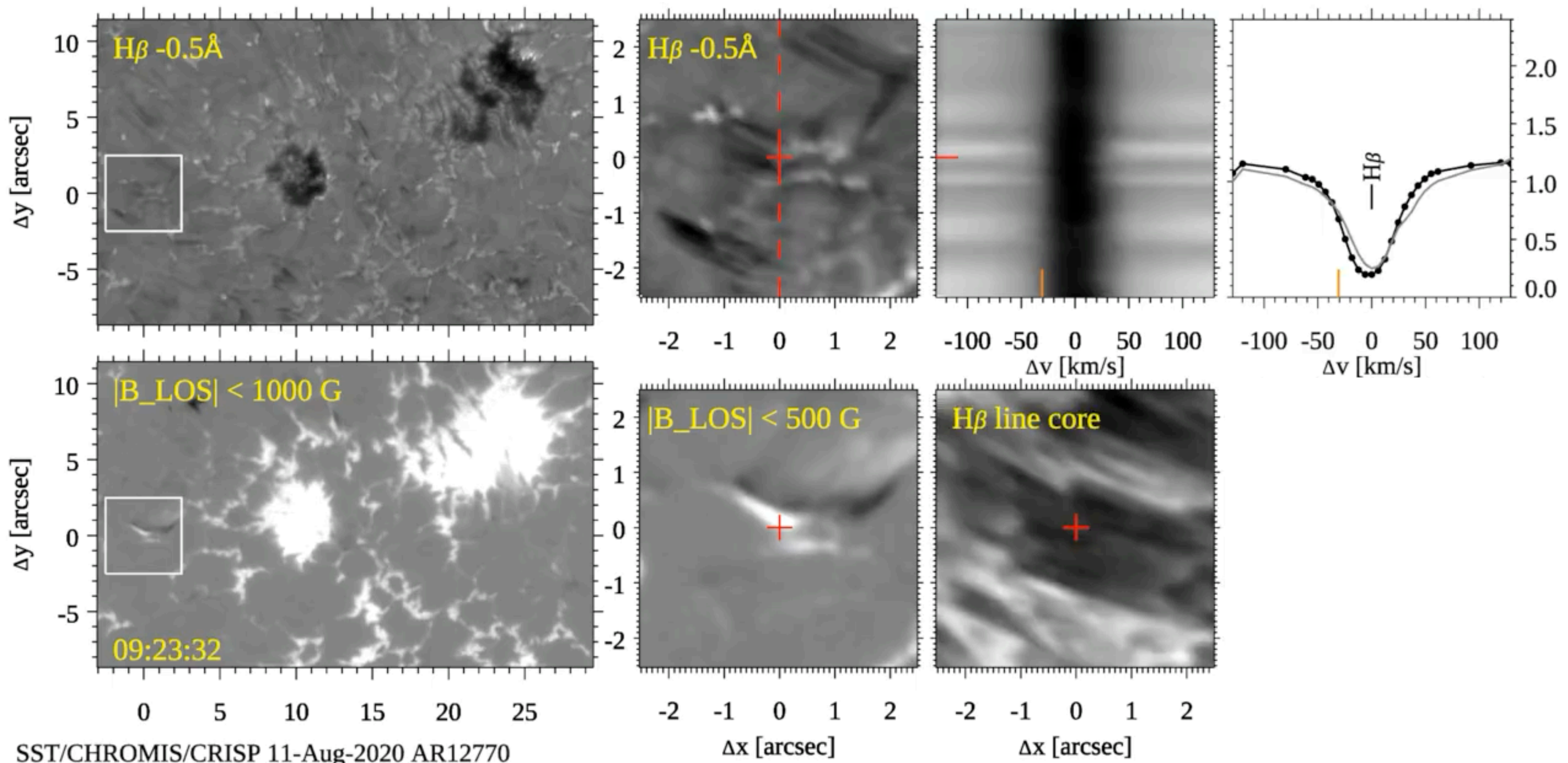
Ellerman bombs: magnetic reconnection in low solar atmosphere



Ellerman bombs: magnetic reconnection in low solar atmosphere

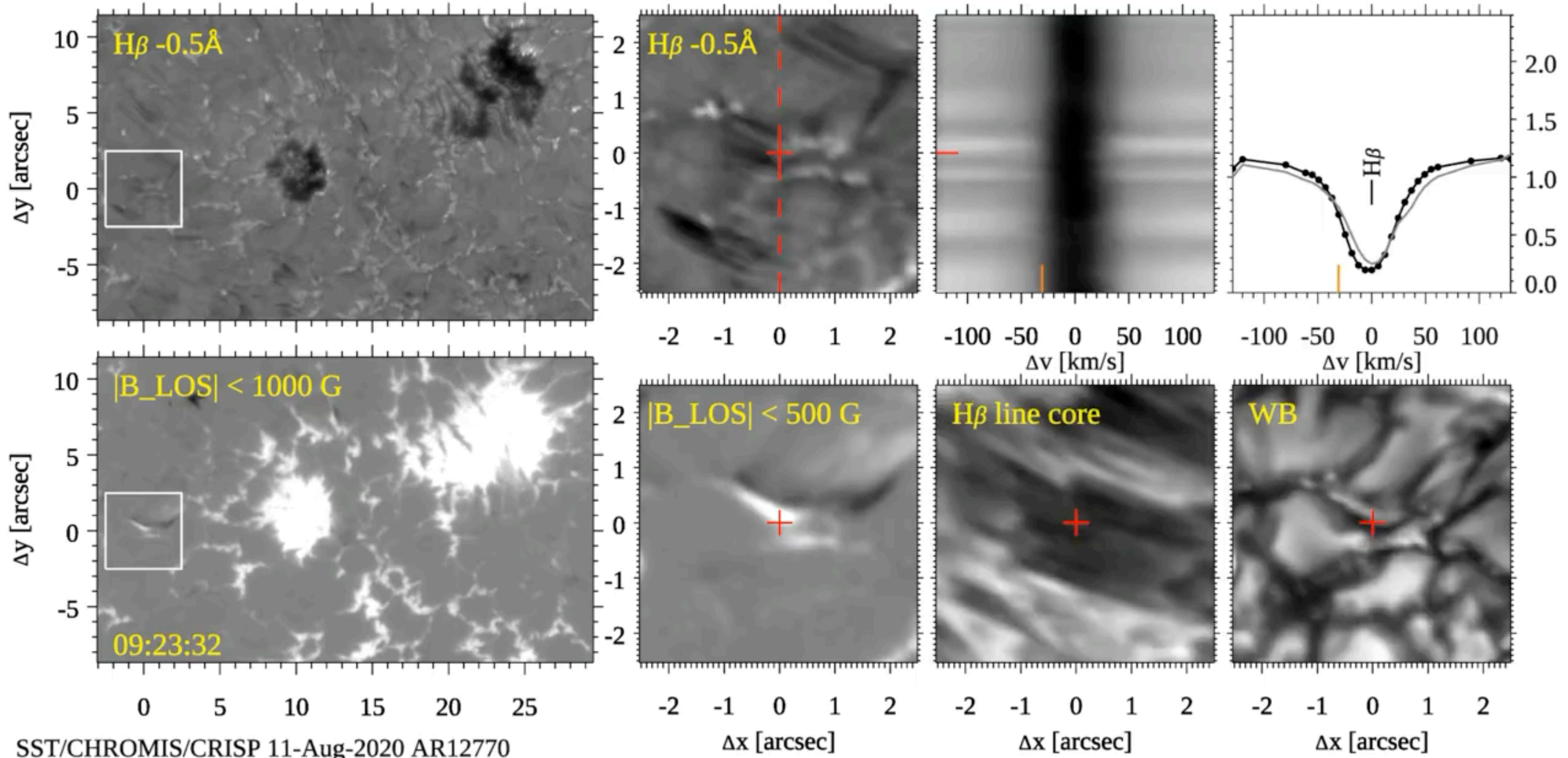


Ellerman bombs: magnetic reconnection in low solar atmosphere

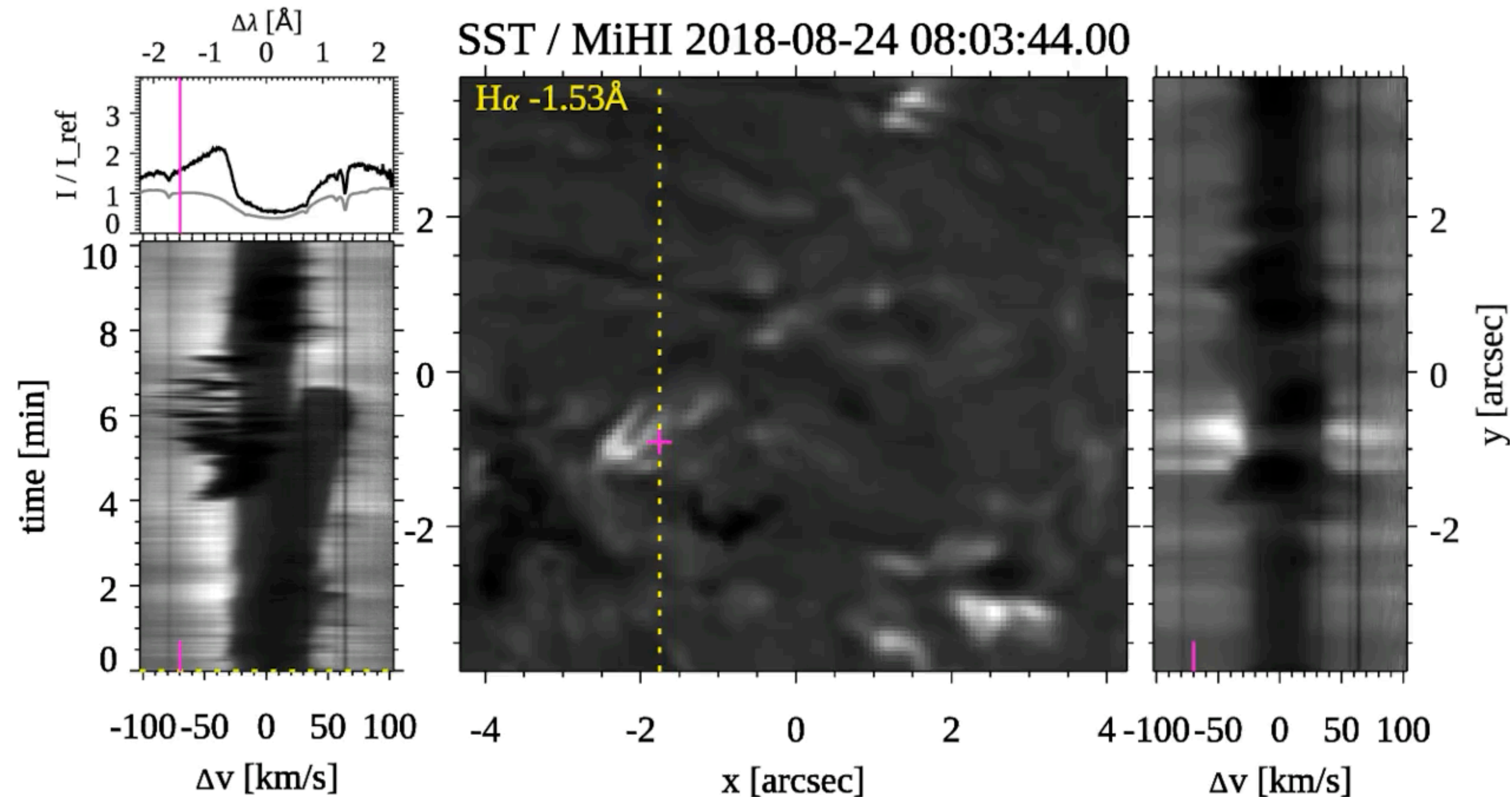


Ellerman bombs: magnetic reconnection in low solar atmosphere

http://tsih3.uio.no/lapalma/gallery/textbook_EB_hbeta_11Aug2020.mp4



Unique observations of Ellerman bombs with MiHI instrument



H-alpha 6563 Å

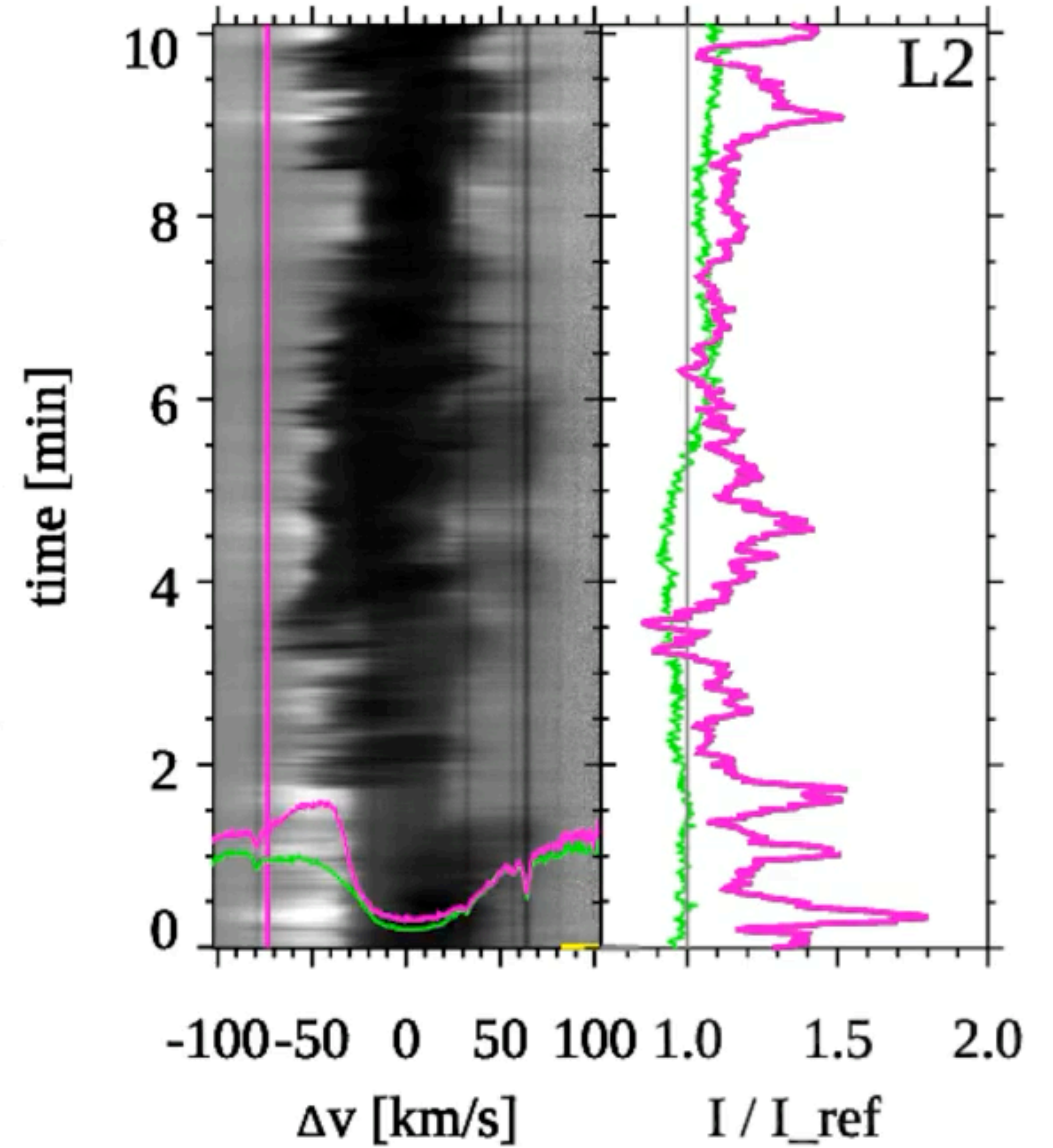
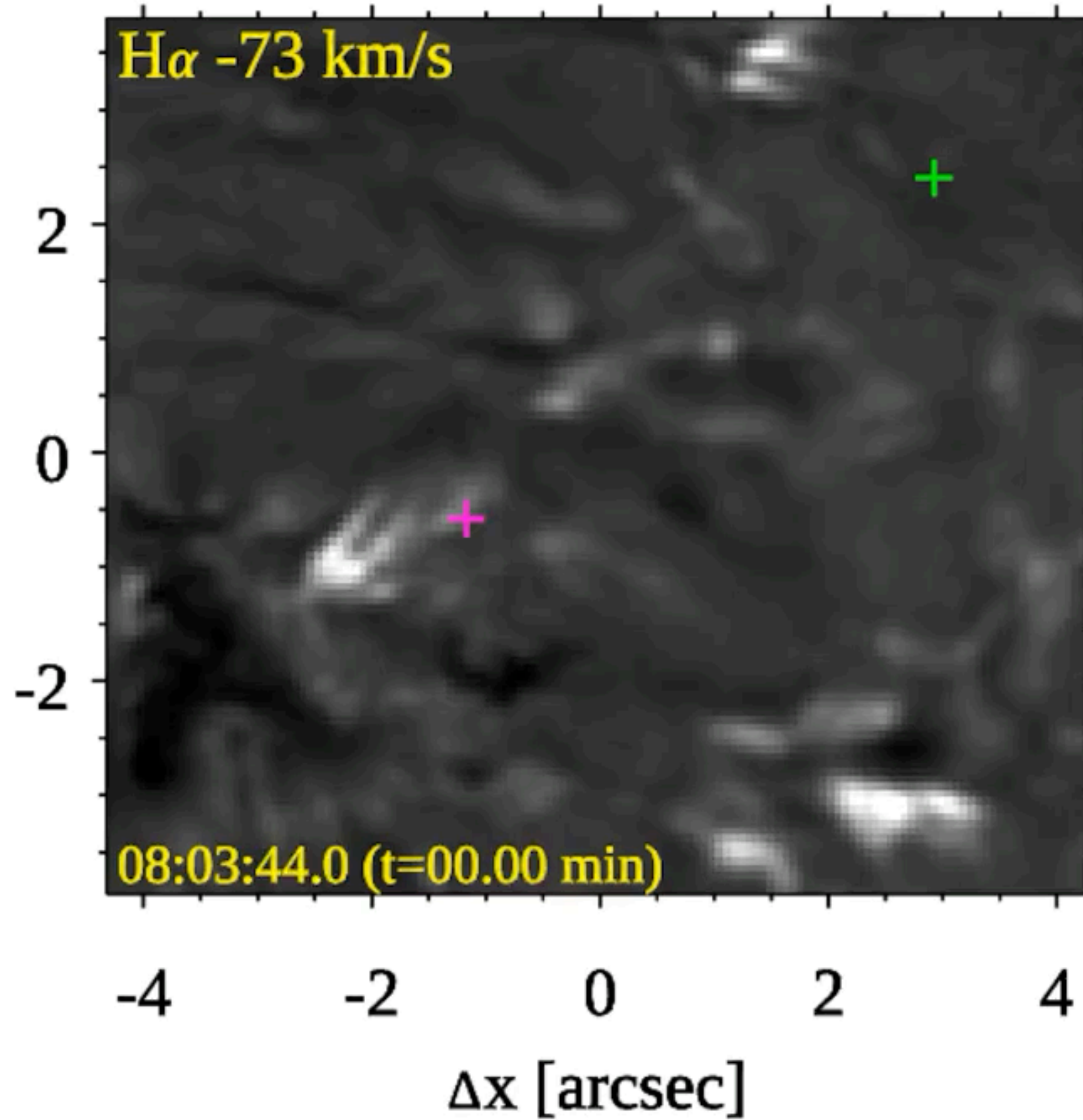
8.6" x 7.7"

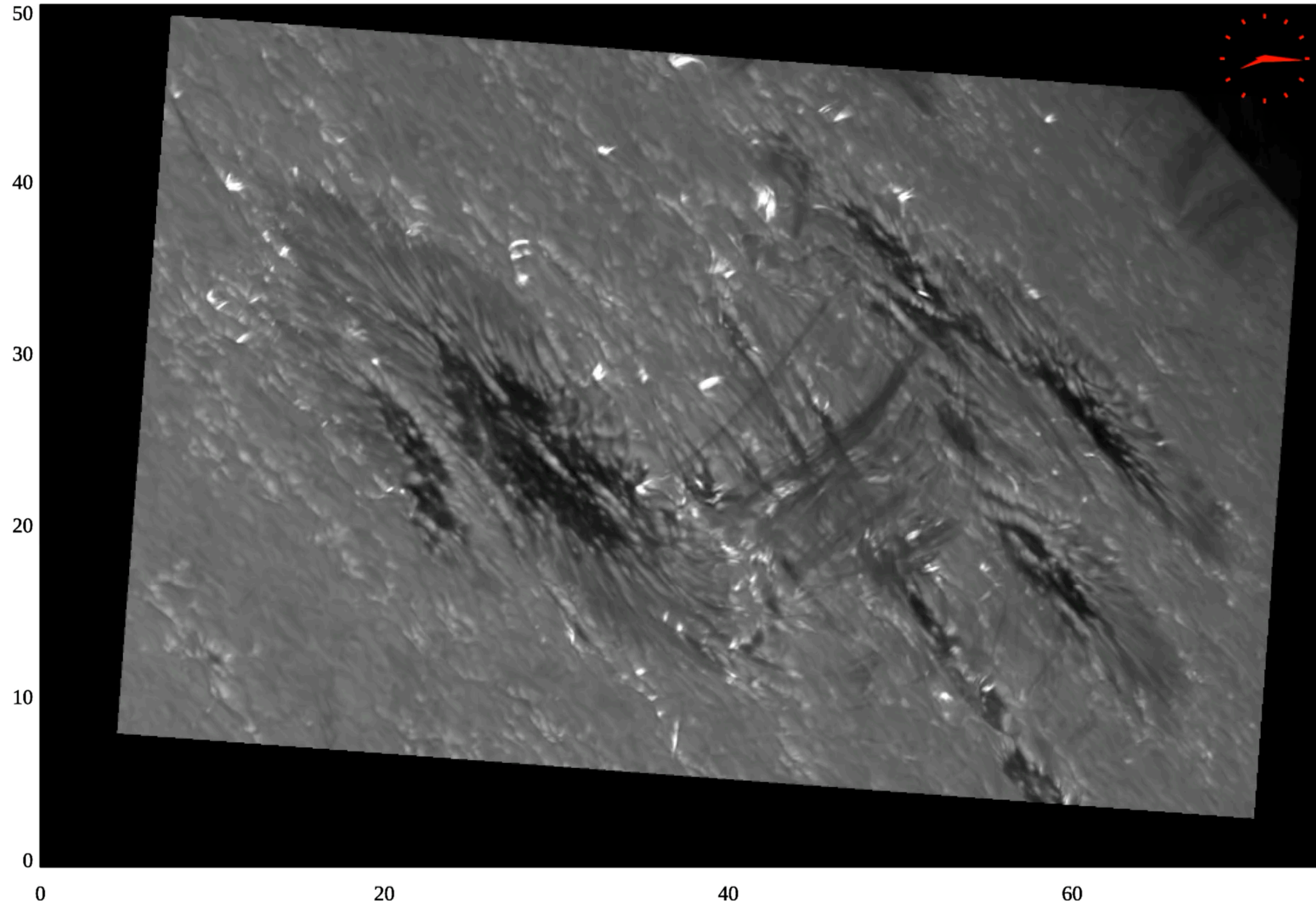
4.5 Å or ± 102 km/s

1.33 s cadence

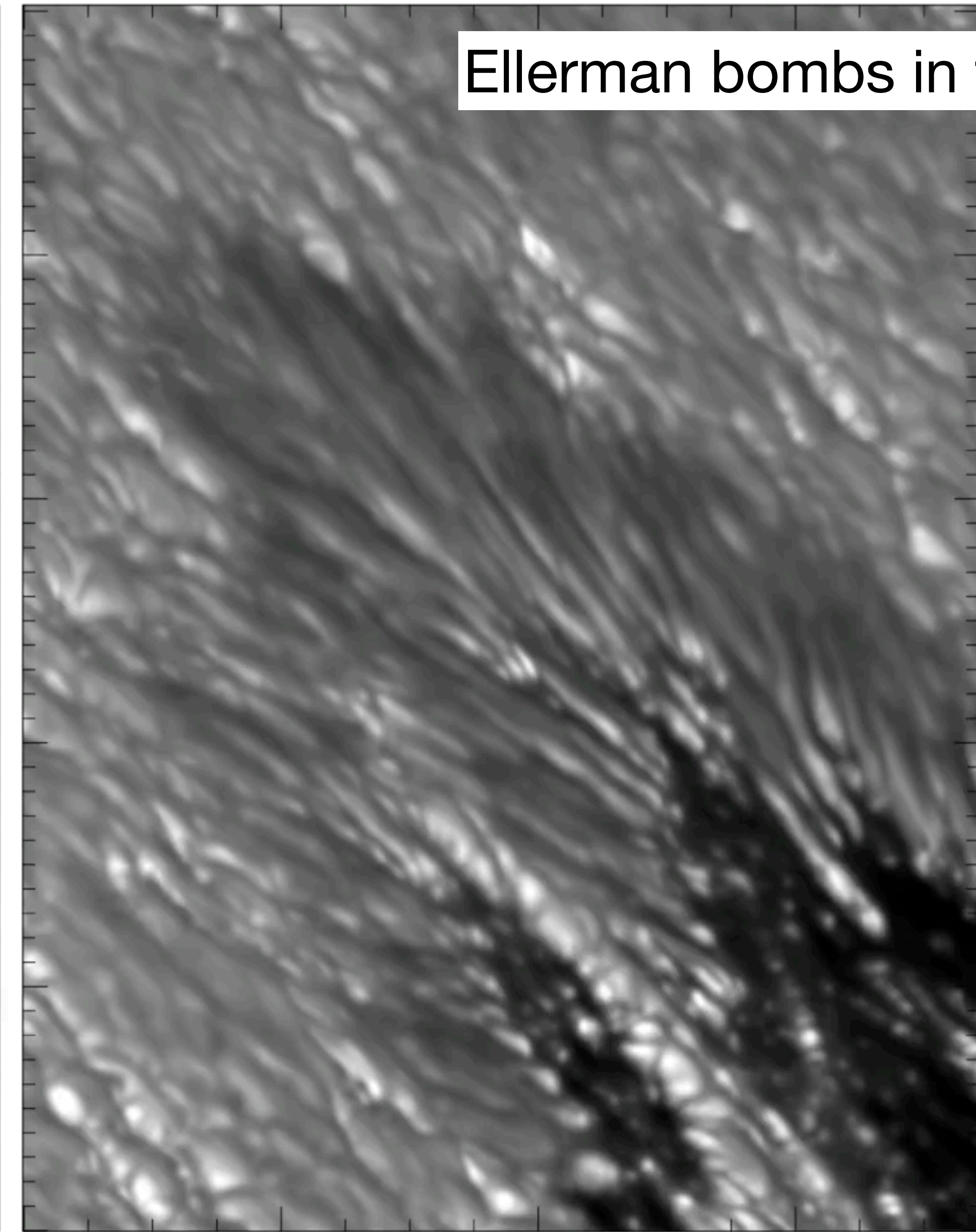
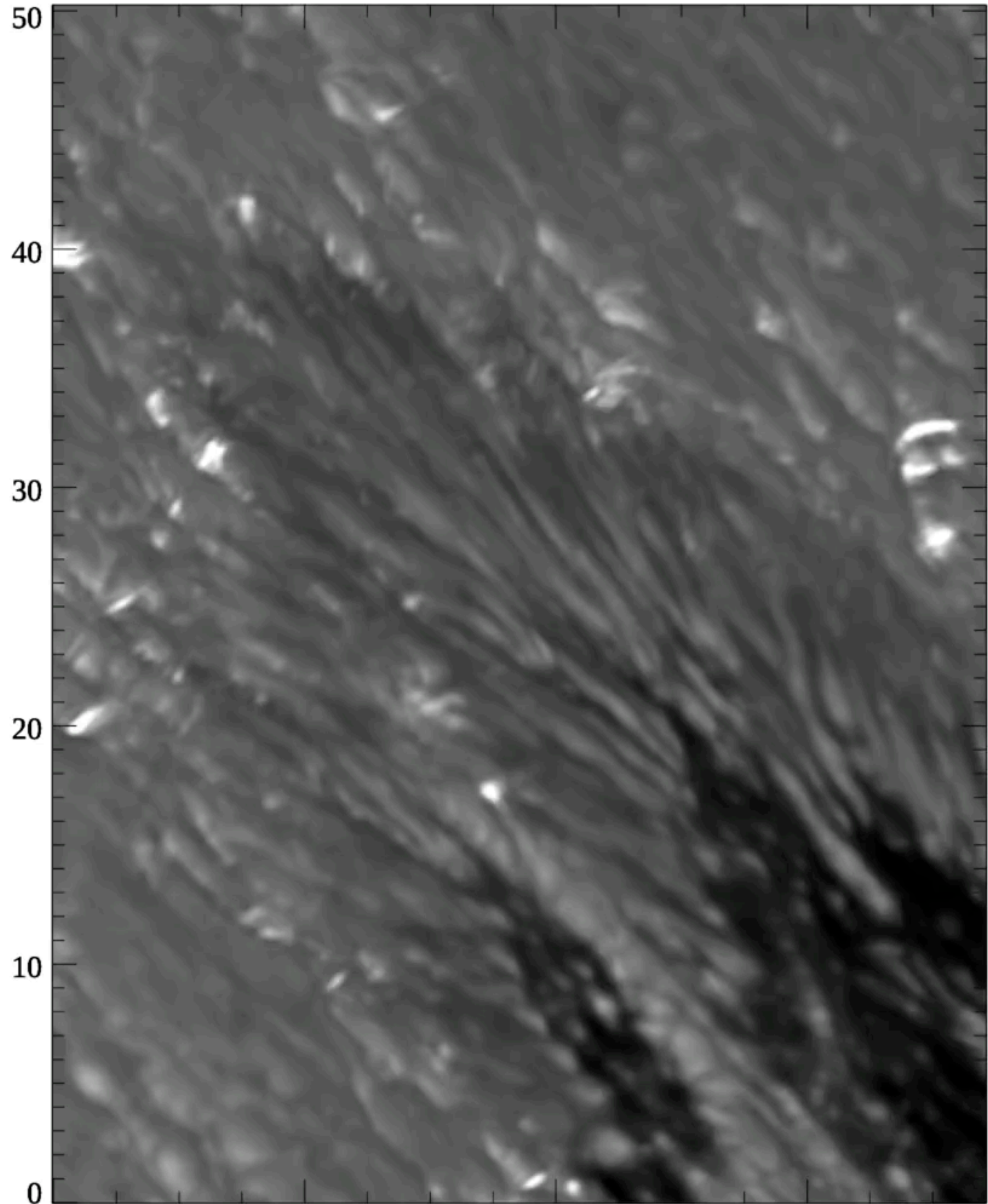
10 min duration

Plasmoid-like blobs emerging from Ellerman bombs: FWHM sizes 0.1 - 0.4''



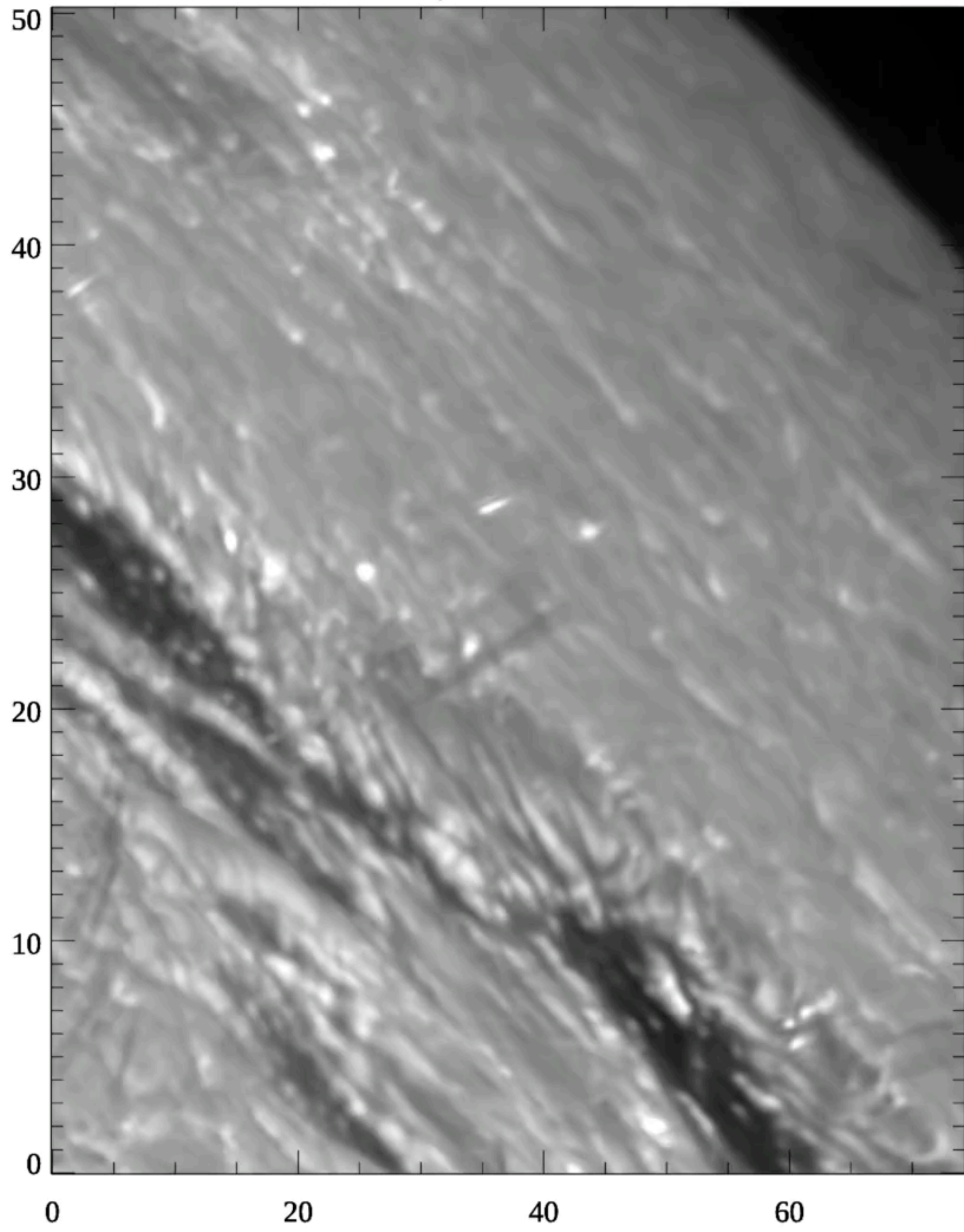


Ellerman bombs:
magnetic reconnection
in low solar atmosphere



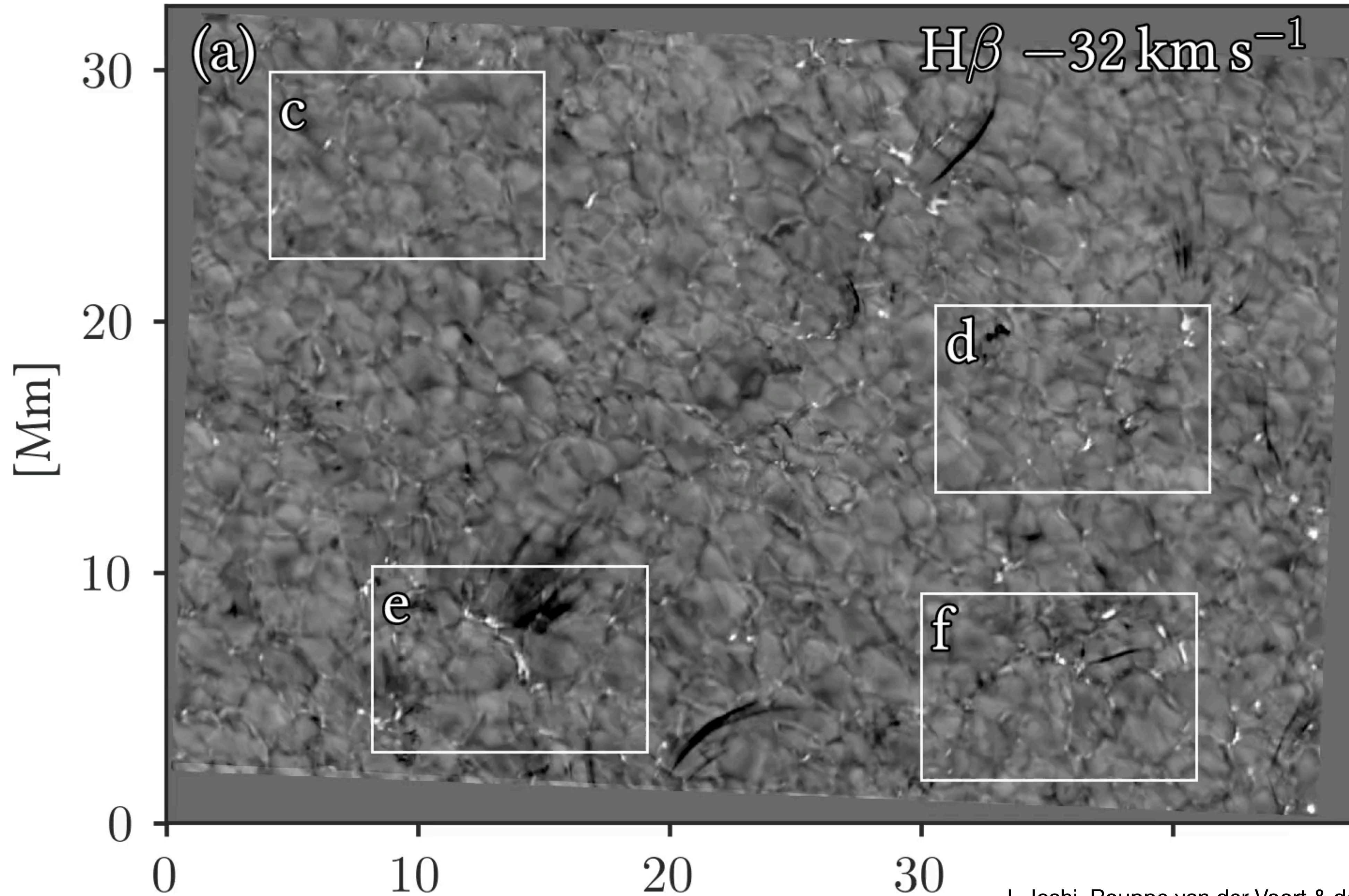
Ellerman bombs in the penumbra

SST / CHROMIS 2024-05-24 H β -0.7 Å



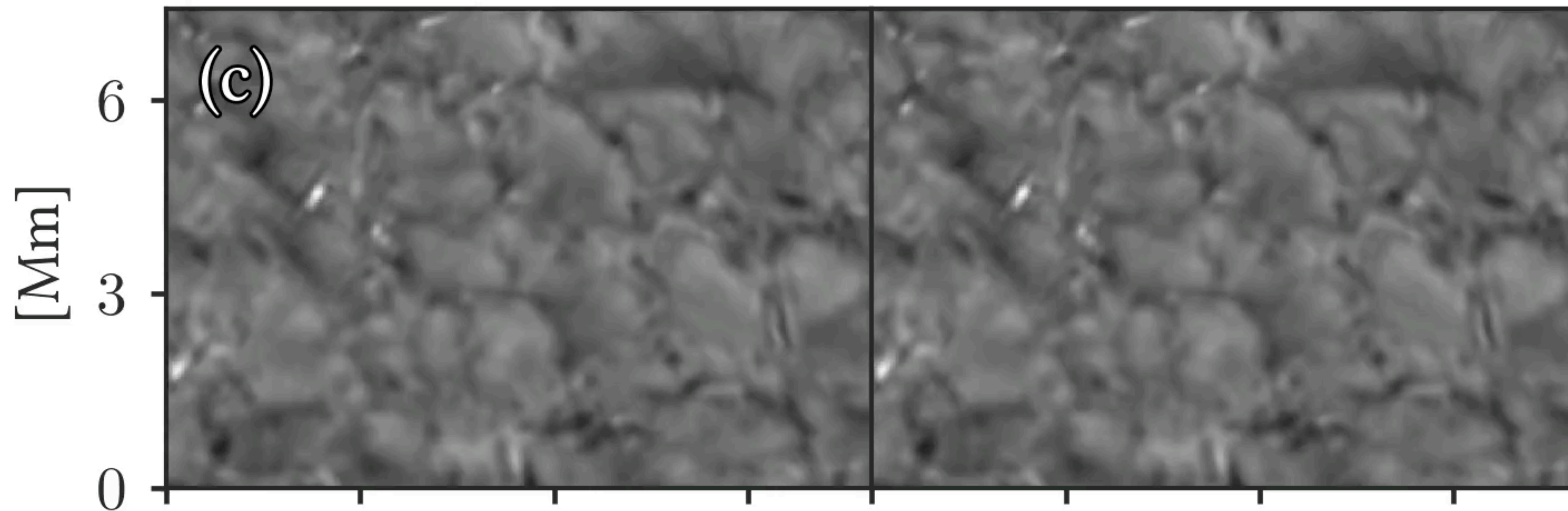
Ellerman bombs in the Quiet Sun

2019-06-06 08:41:14 UT



Large numbers of
Ellerman bombs in
quiet Sun:

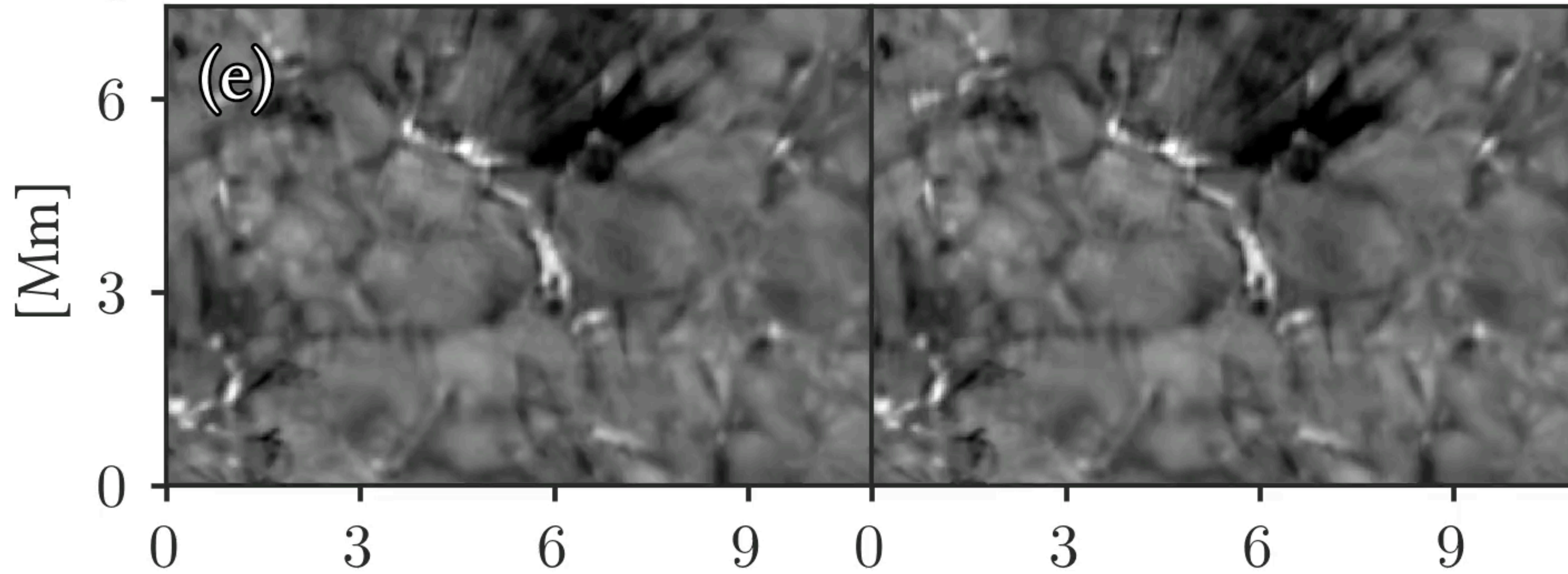
>120 QSEBs

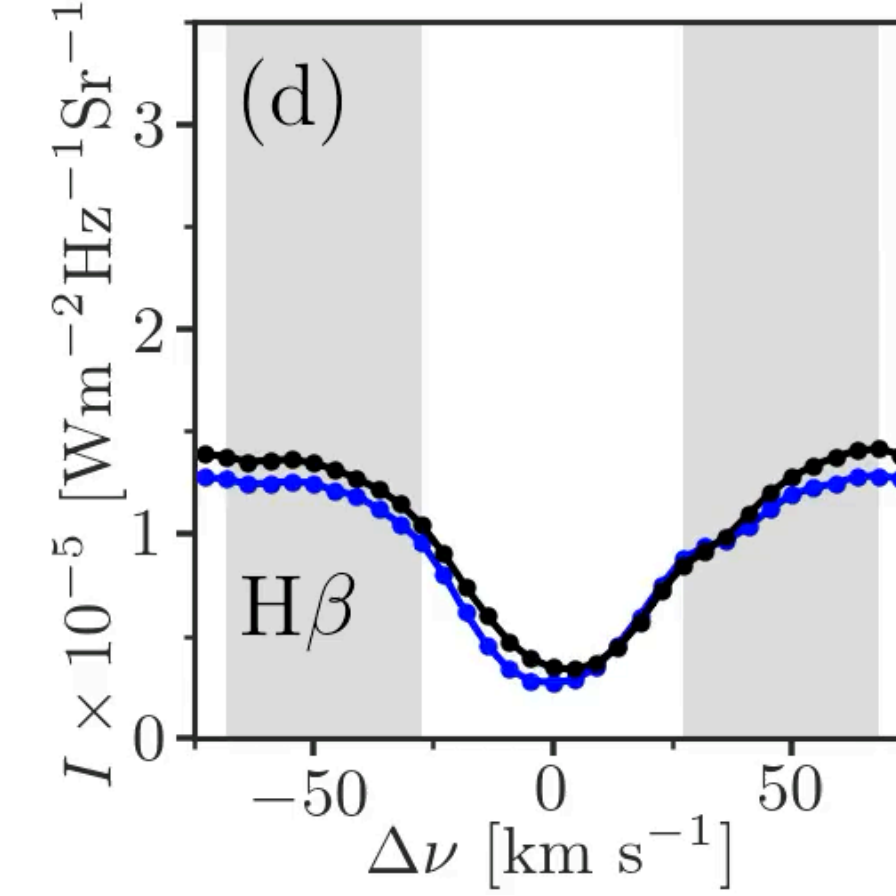
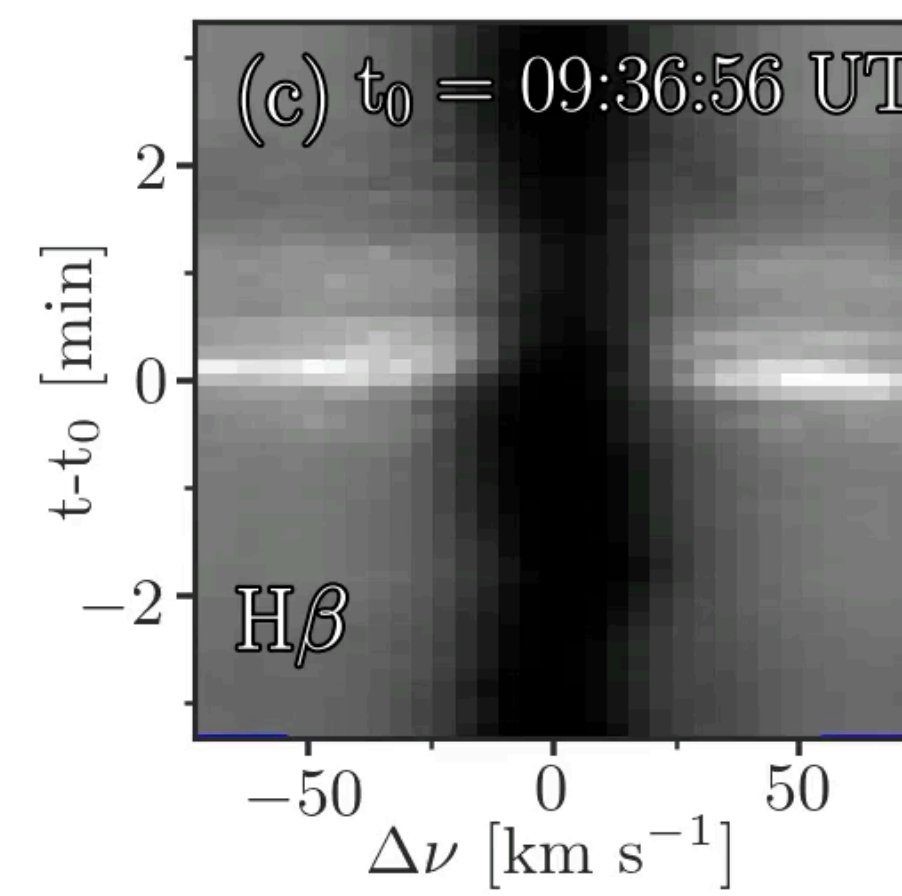
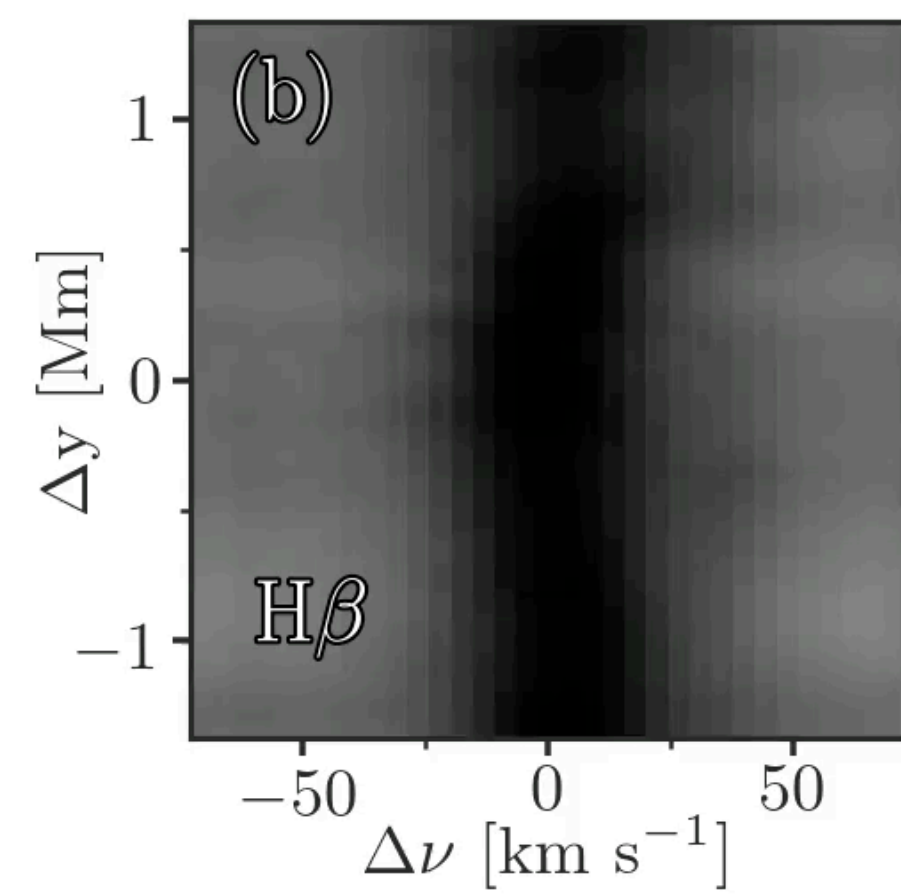
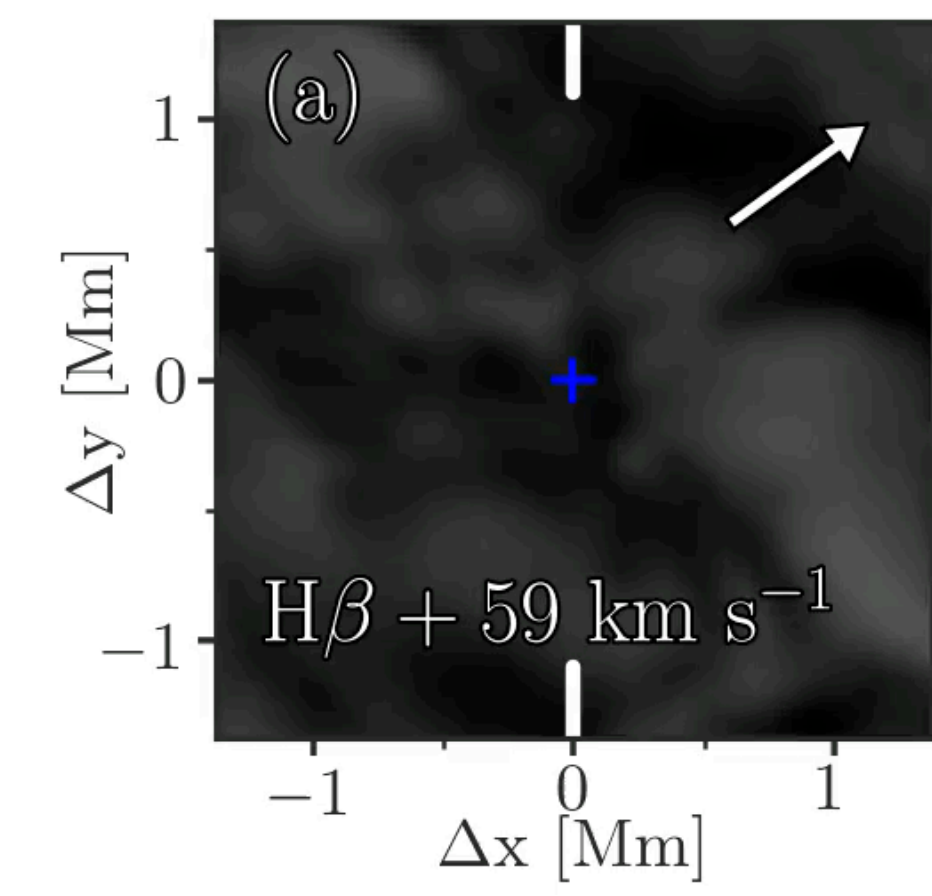


Large numbers of
Ellerman bombs in
quiet Sun:

>120 QSEBs

→ >750,000 over
whole Sun





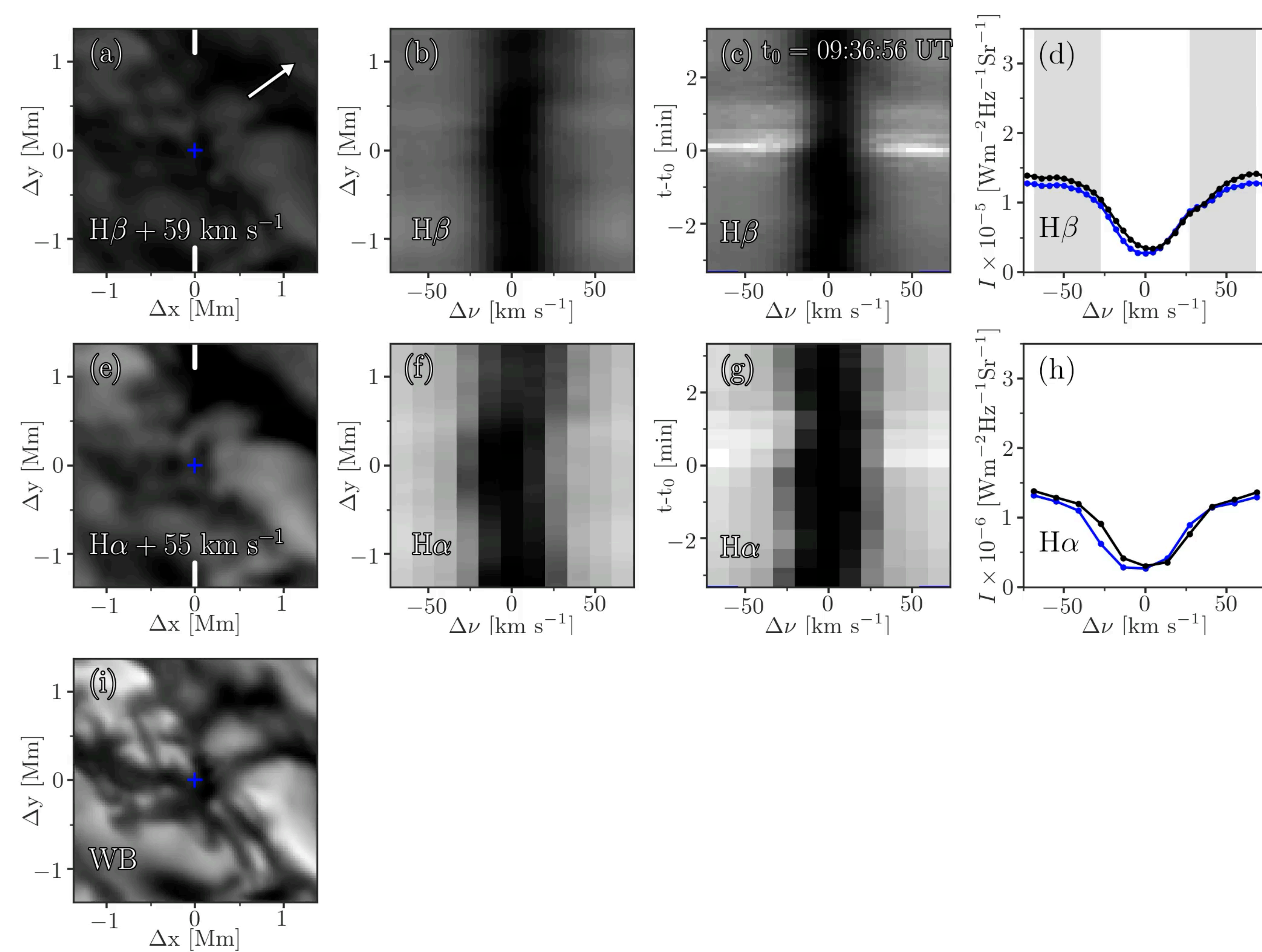
QSEB at $\mu=0.76$
 Flame, strong $H\beta$ wing

QSEB at $\mu=0.76$

Flame, strong $H\beta$ wing

Weak in $H\alpha$ wing

Absent in WB cont



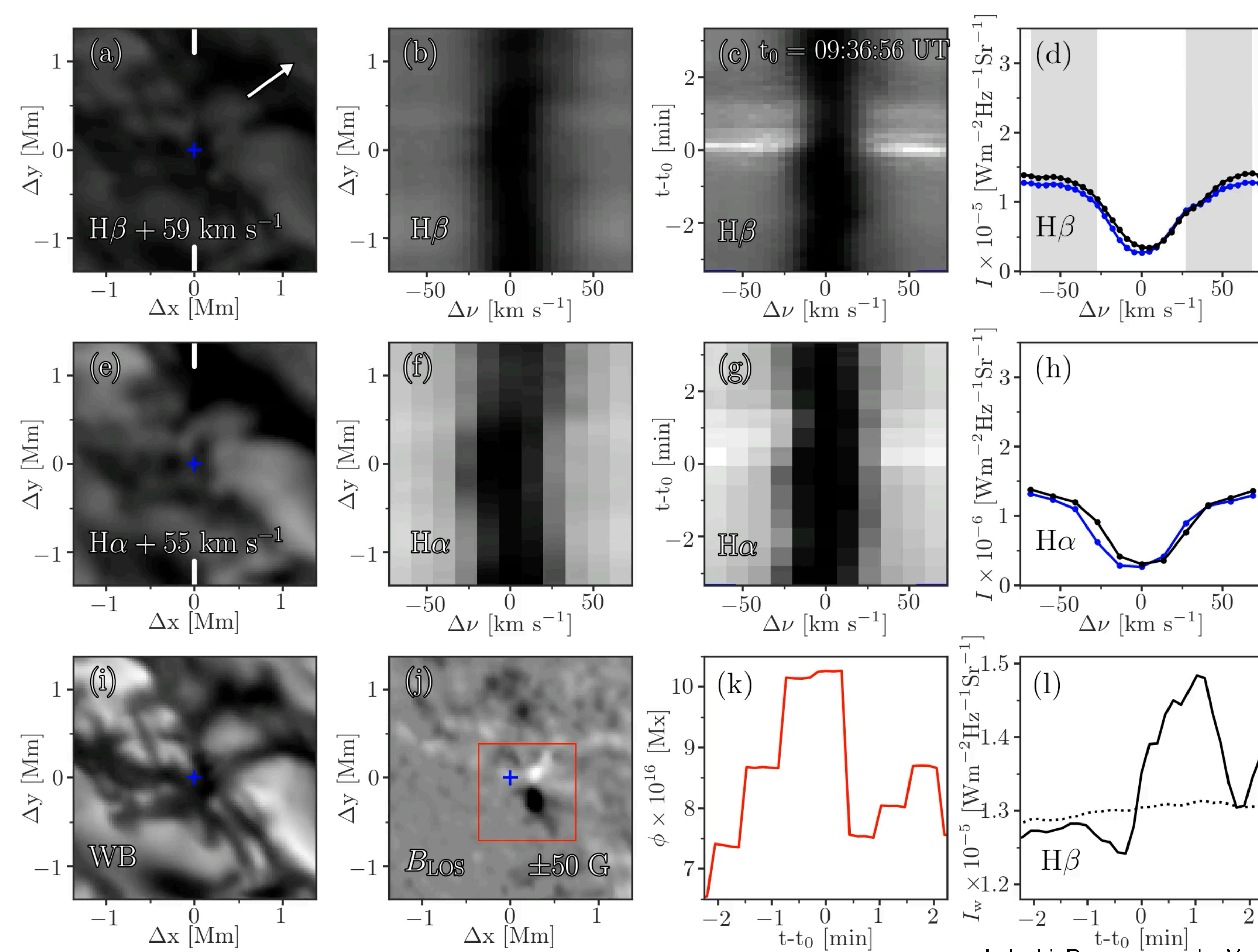
QSEB at $\mu=0.76$

Flame, strong H β wing

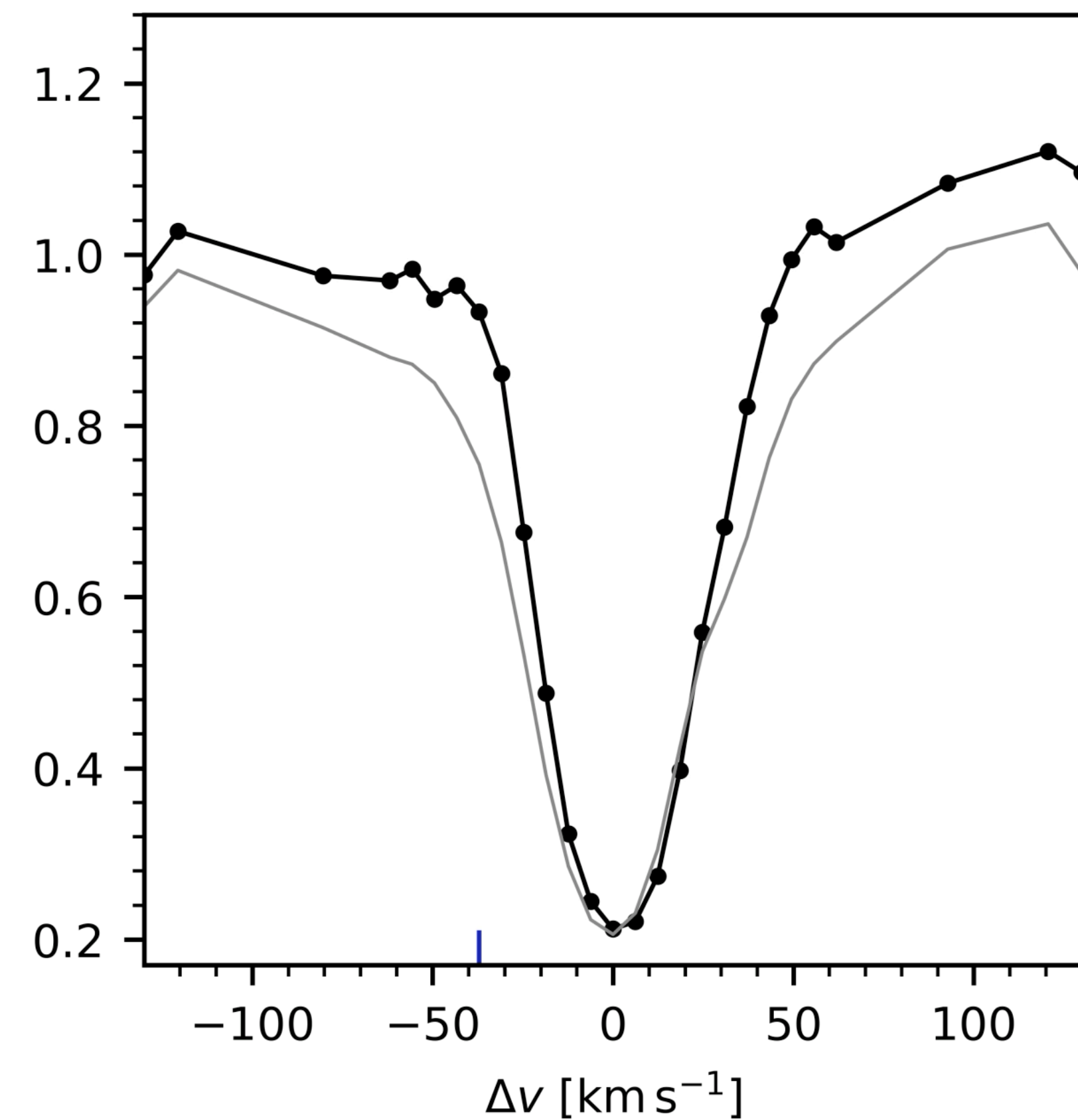
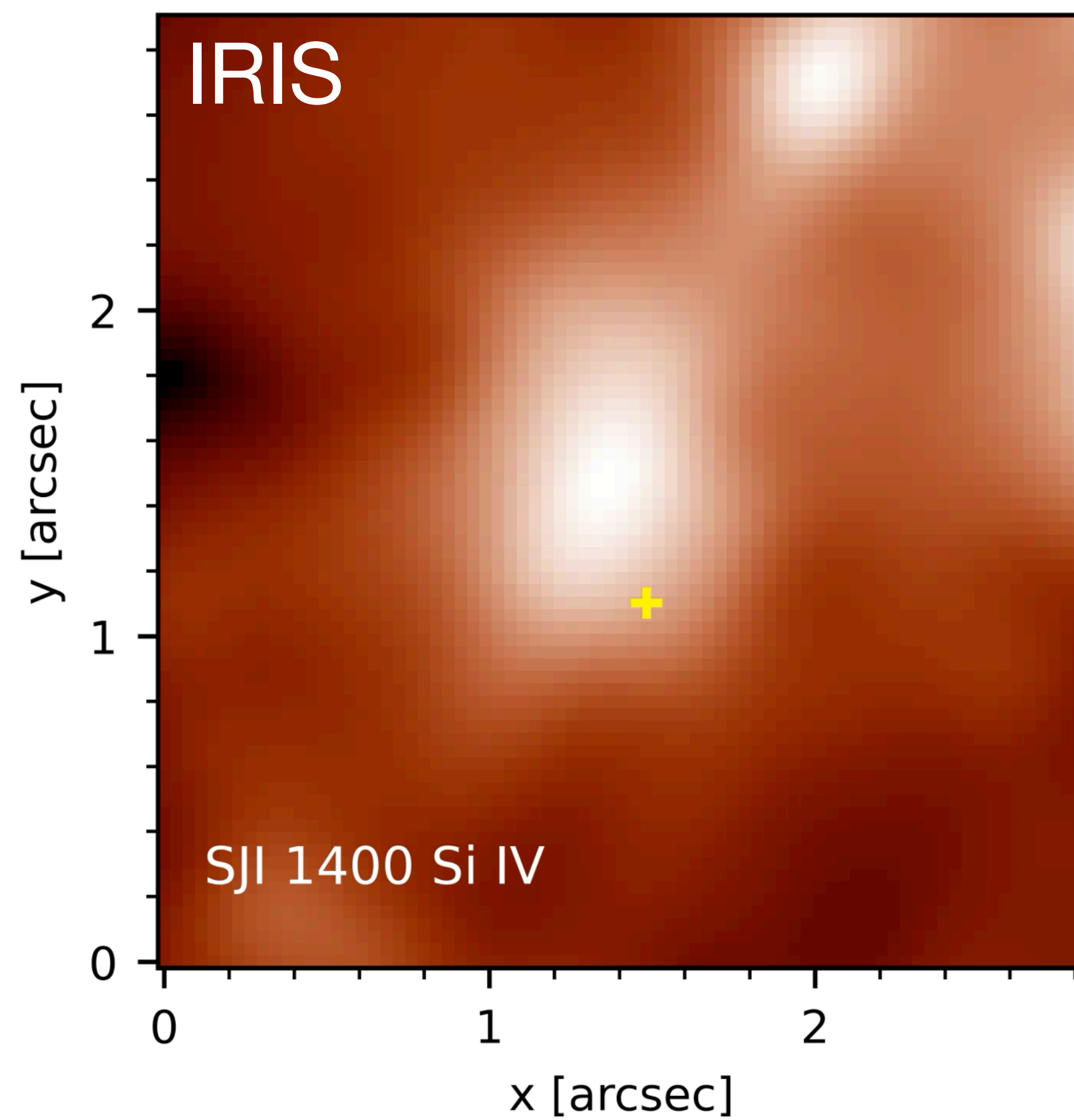
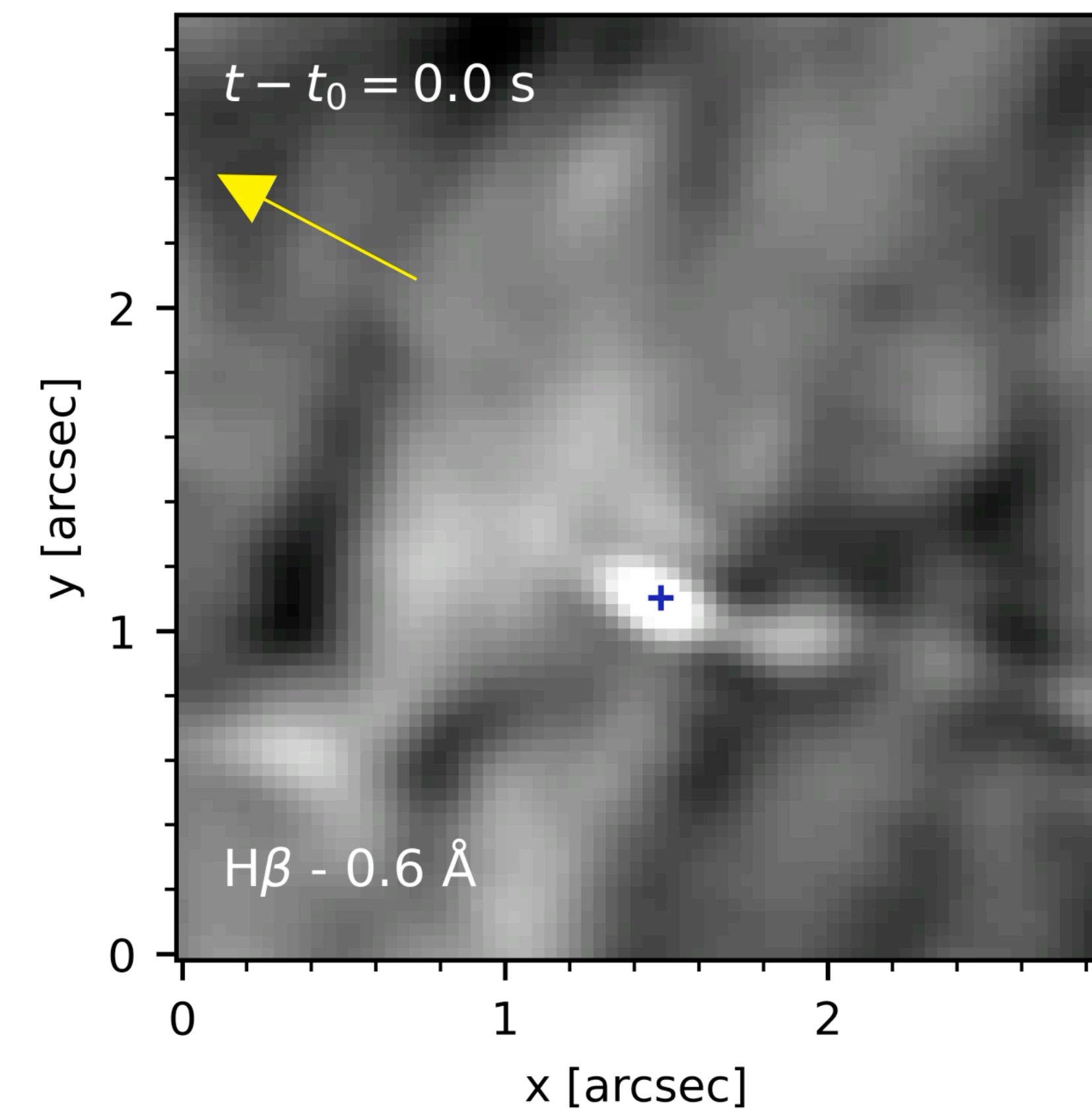
Weak in H α wing

Absent in WB cont

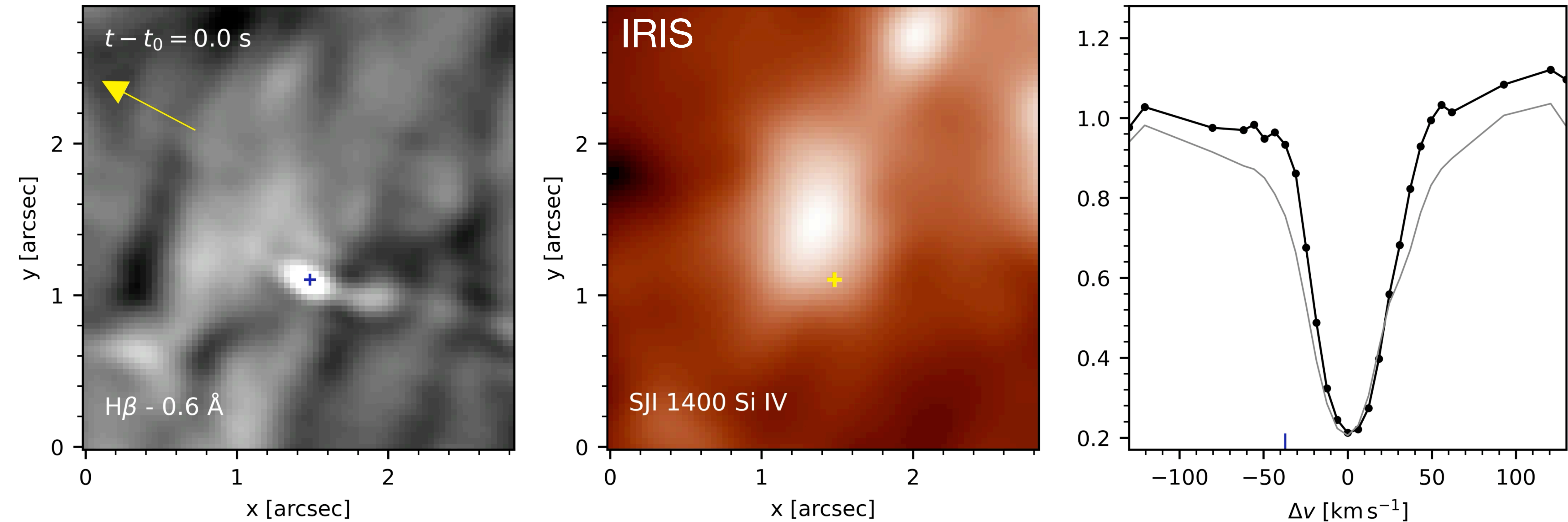
Flux cancellation



Impact of Quiet Sun Ellerman bombs on upper atmosphere?



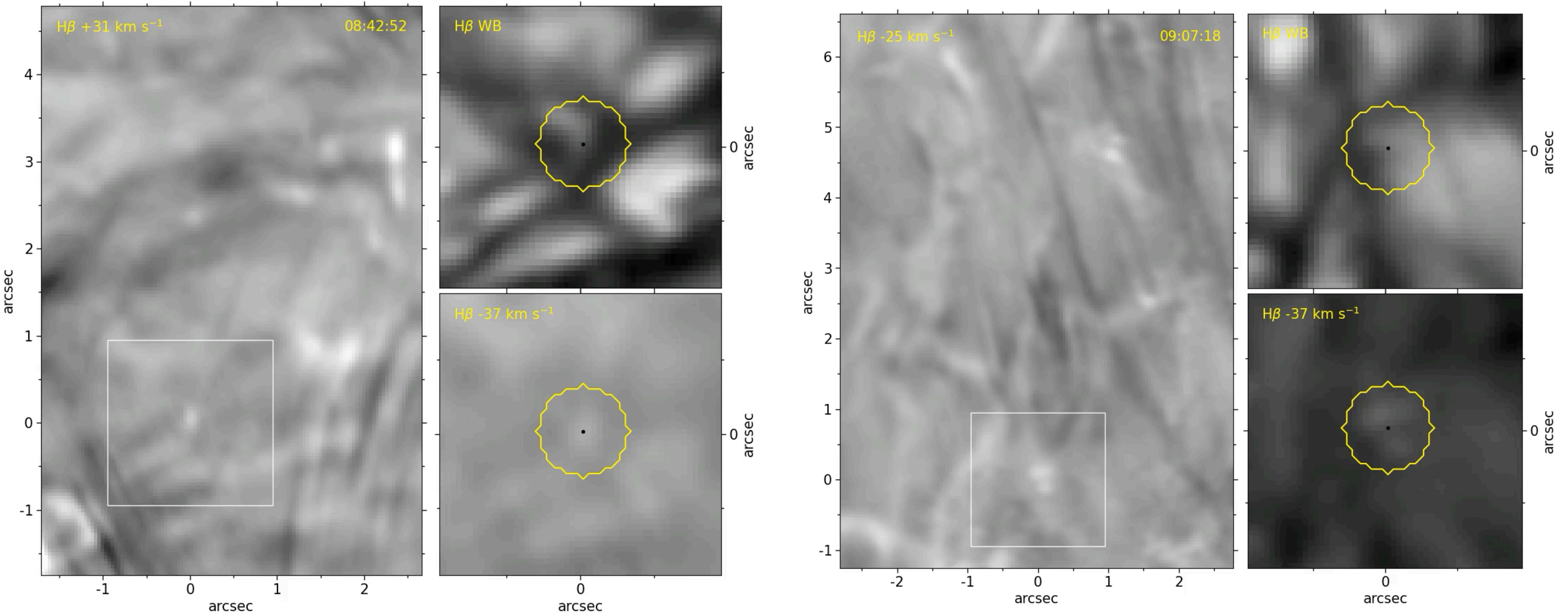
Impact of Quiet Sun Ellerman bombs on upper atmosphere?



Longer-lived QSEBs (> 1 min):

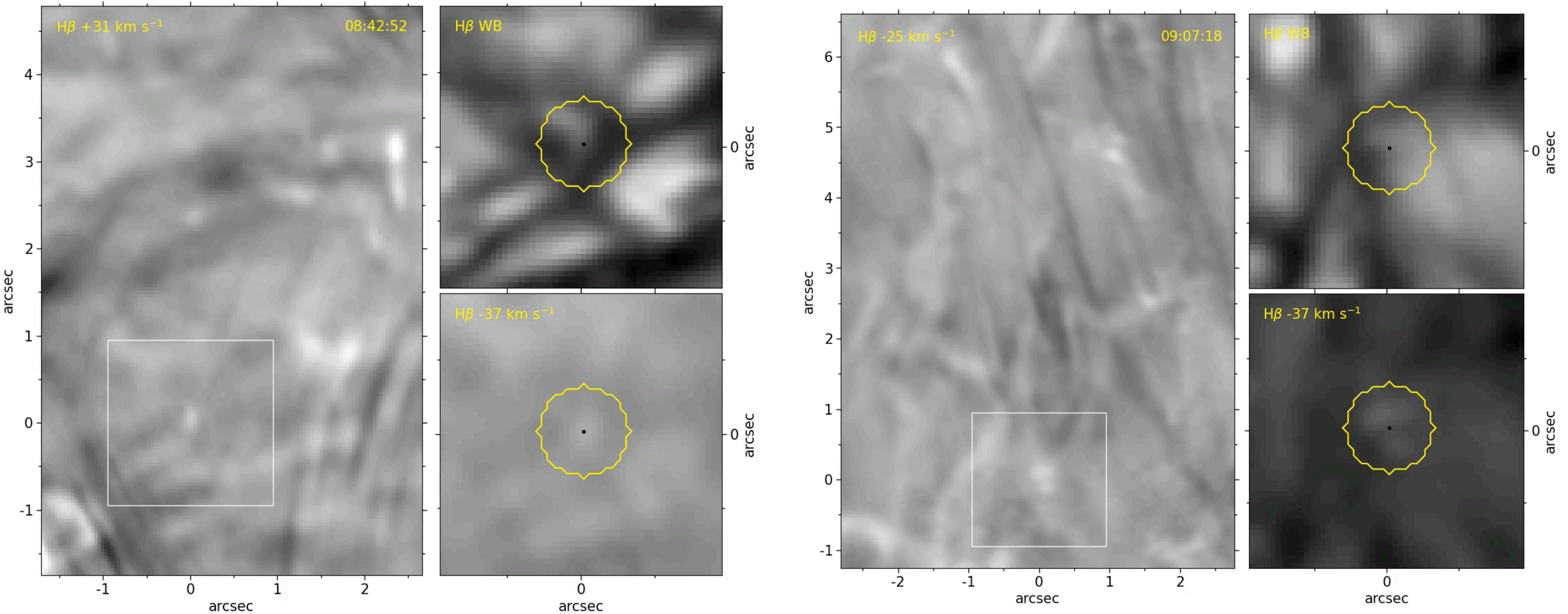
Some (15%) can be associated with brightenings in SJI 1400 and have Si IV 1394 \AA emission
 \rightarrow *impact on overall atmosphere is limited*

Connection between Quiet Sun Ellerman bombs and spicules?



Some suggestive cases of QSEBs with spicule activity

Connection between Quiet Sun Ellerman bombs and spicules?



Some suggestive cases of QSEBs with spicule activity

....but: majority of spicules have no QSEB....and majority of QSEBs have no spicules

Conclusions

- Ellerman bombs can be found in many different environments: Active Region, sunspot penumbra, and Quiet Sun
- Ellerman bombs in Quiet Sun are ubiquitous: $>750,000$ at any time
- Impact on upper atmosphere is limited
 - Some have signatures in transition region diagnostics
 - Some seem to be associated with spicule activity