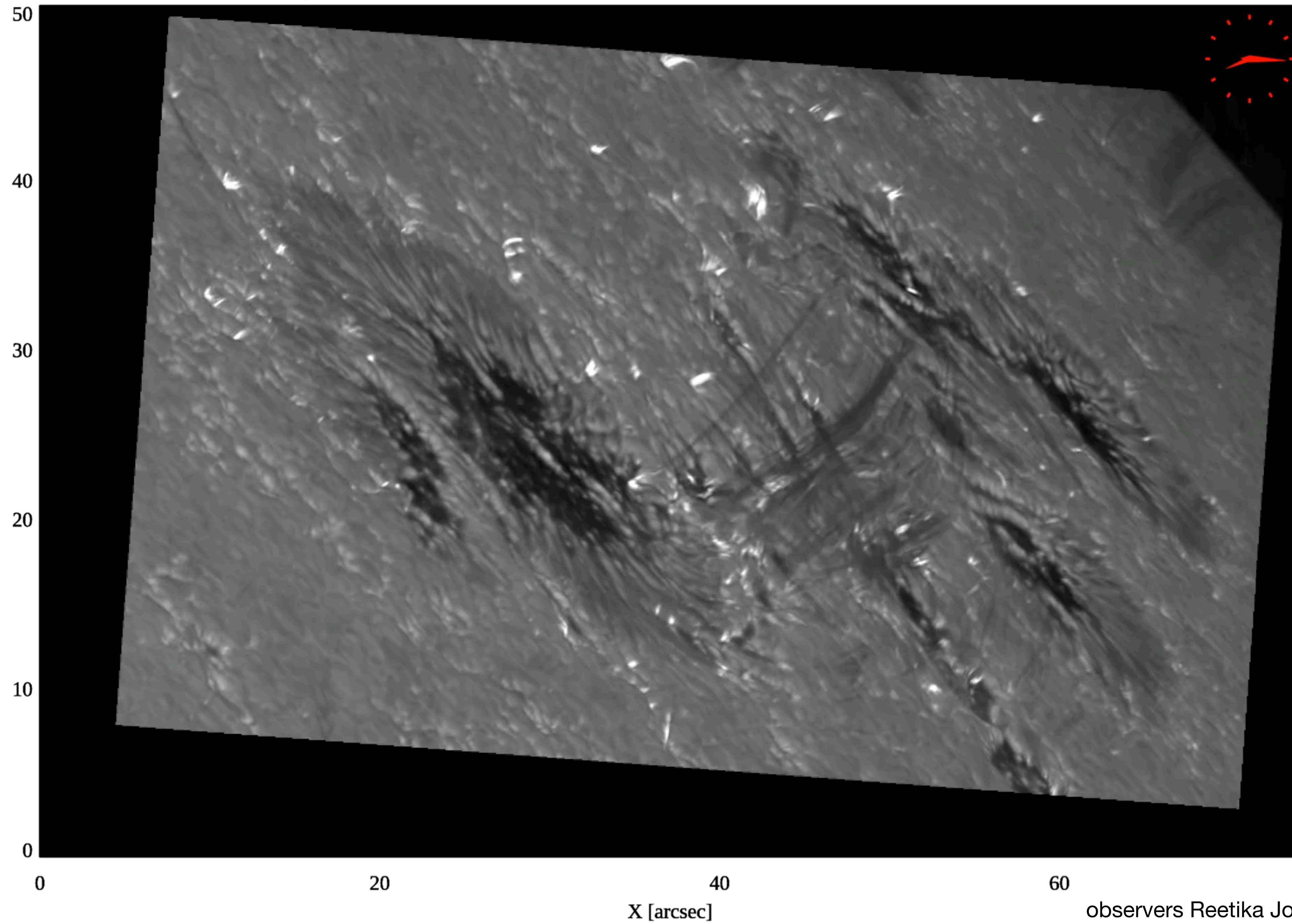


Recent insights from chromospheric observations

Luc Rouppe van der Voort

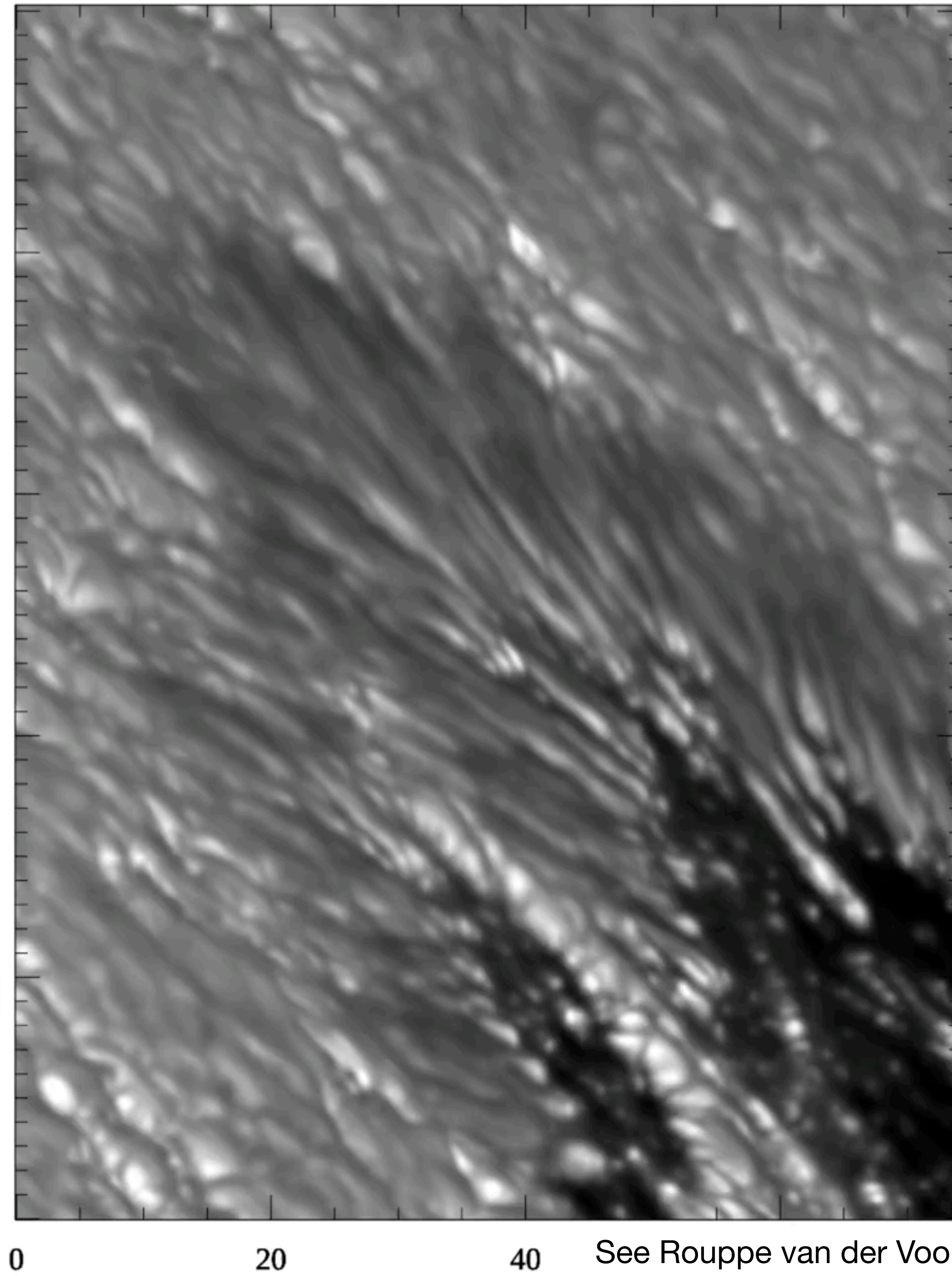
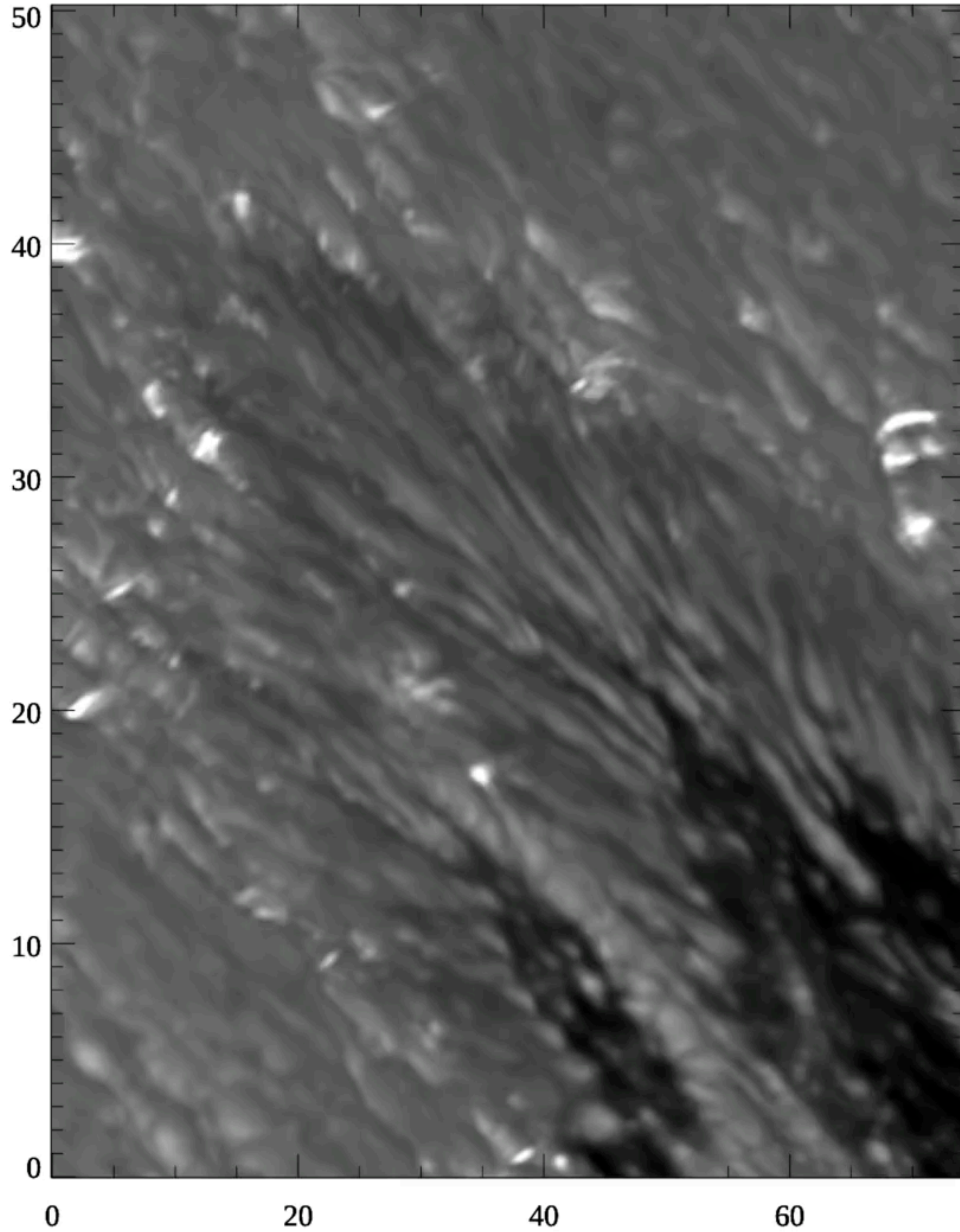
Roseland Centre for Solar Physics (RoCS), University of Oslo

In collaboration with Aditi Bhatnagar, Mats Ola Sand, Jayant Joshi, Quentin Noraz

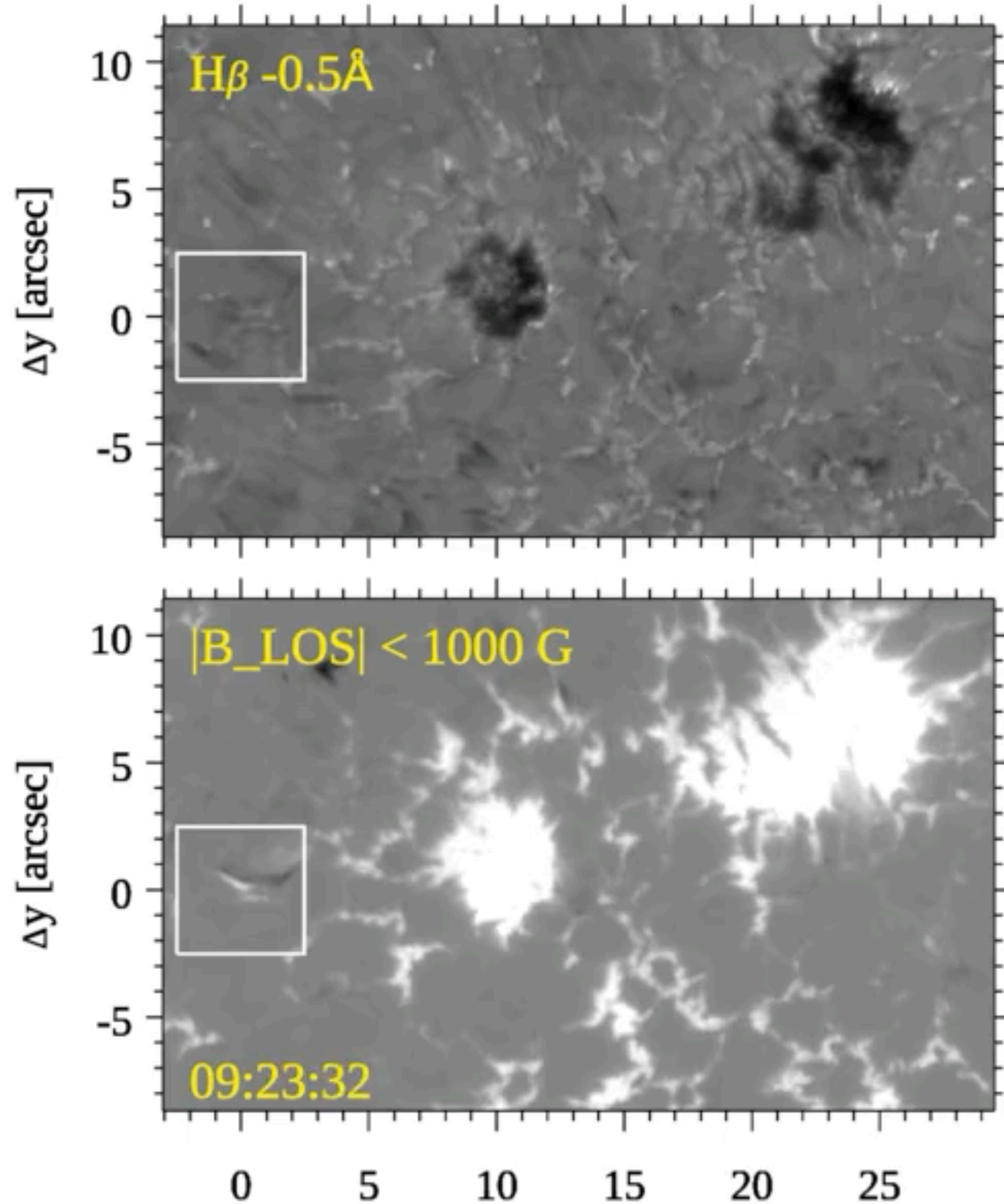


Ellerman bombs:

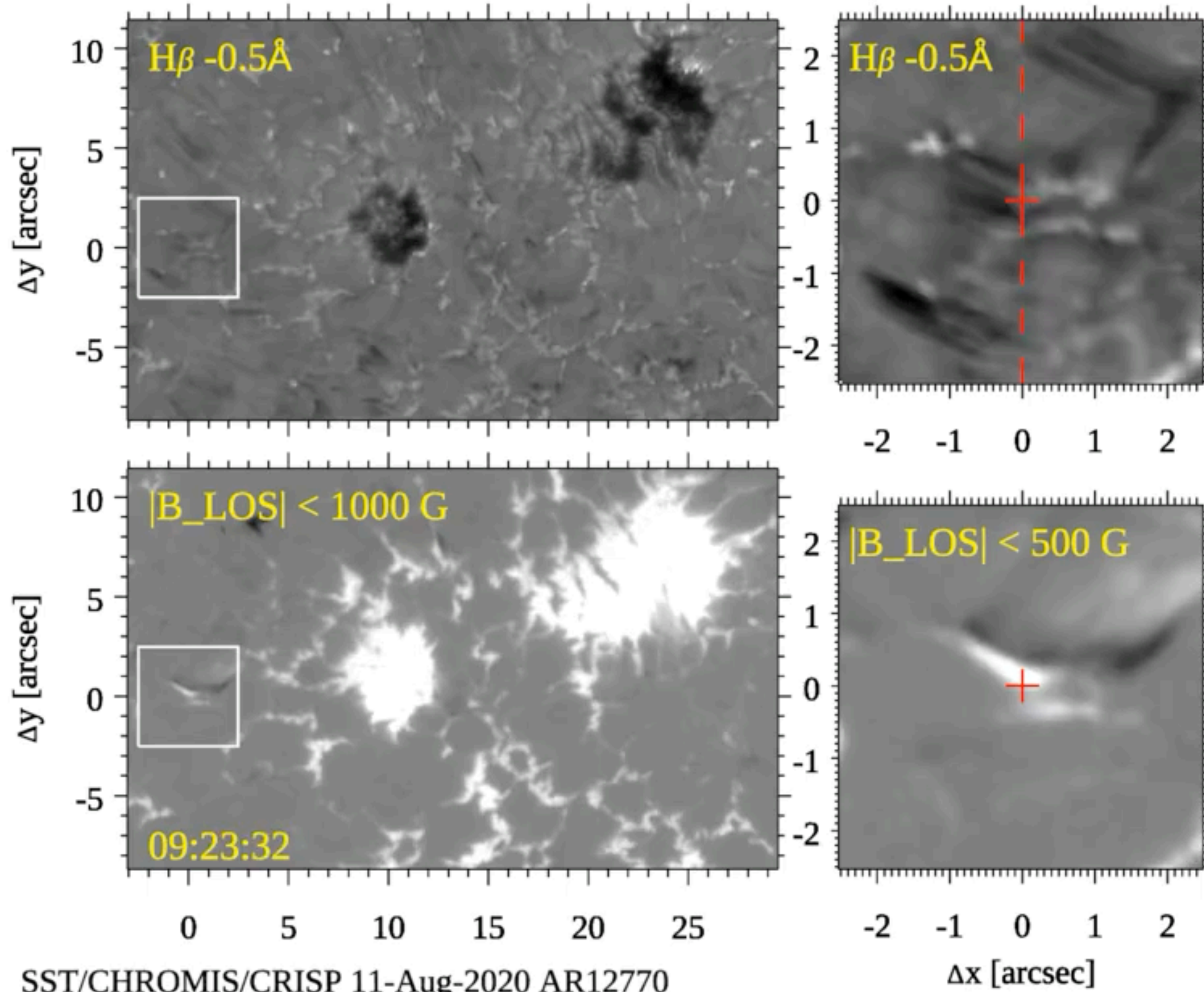
magnetic reconnection
in low solar atmosphere



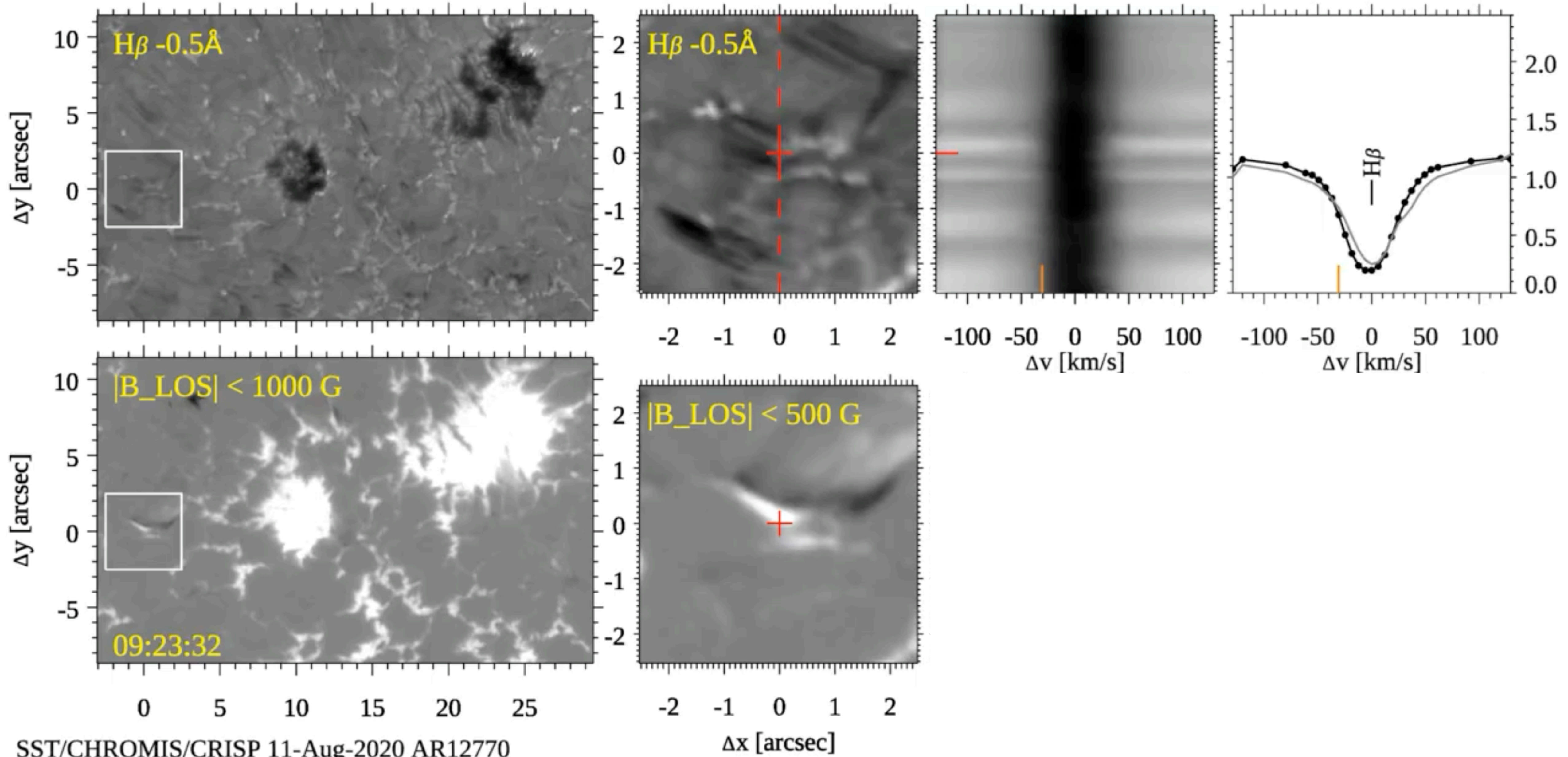
Ellerman bombs: magnetic reconnection in low solar atmosphere



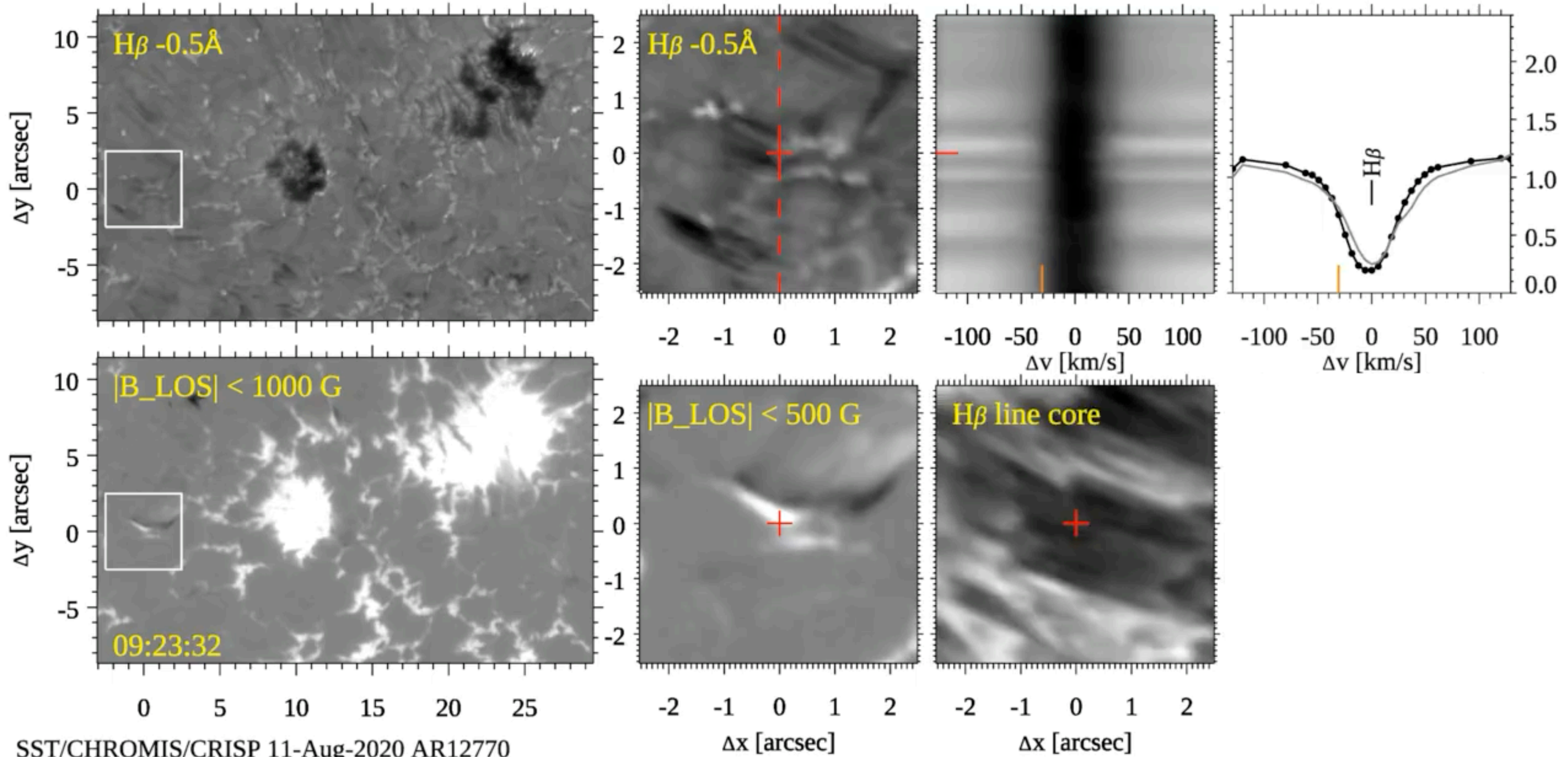
Ellerman bombs: magnetic reconnection in low solar atmosphere



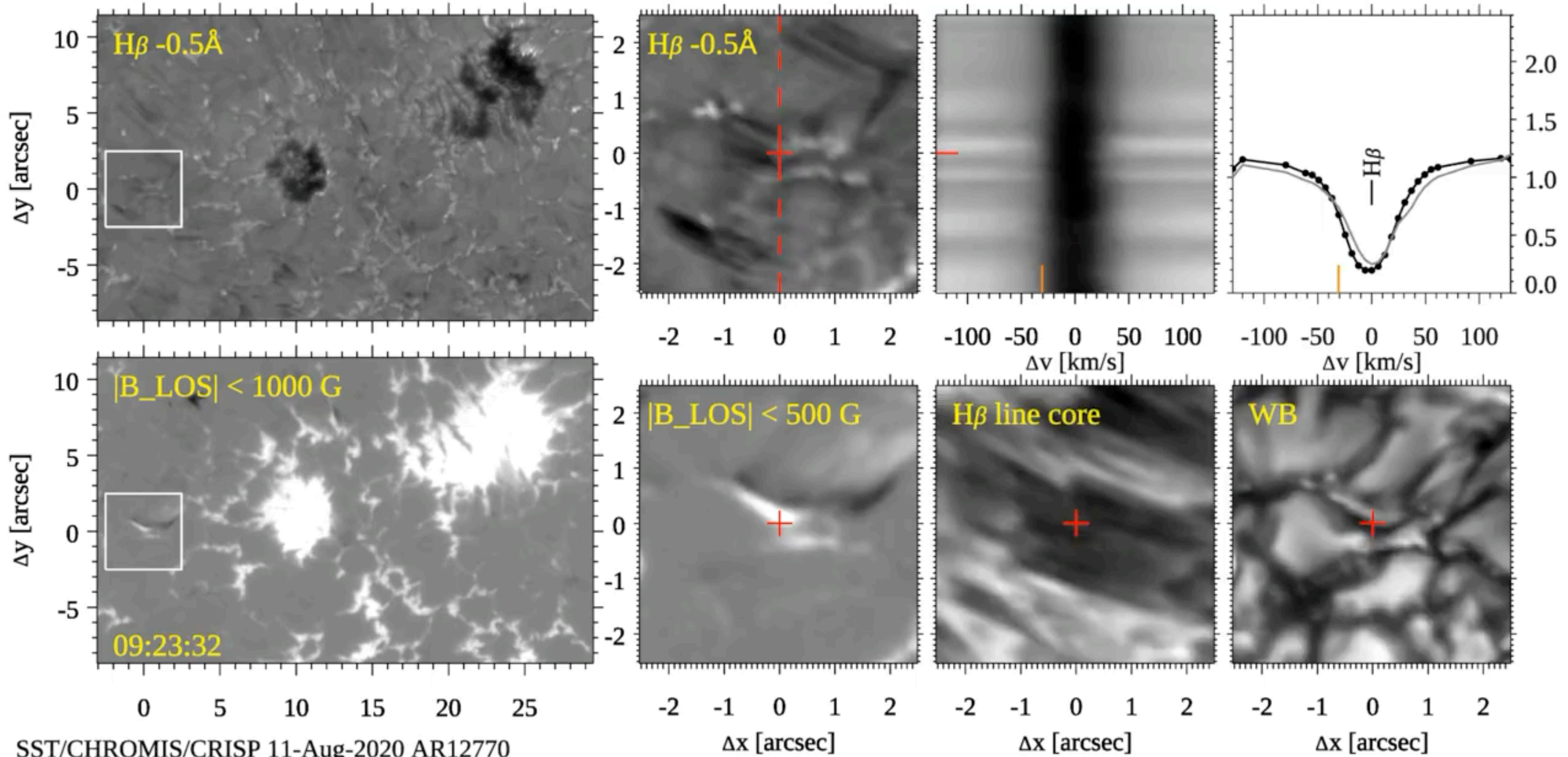
Ellerman bombs: magnetic reconnection in low solar atmosphere



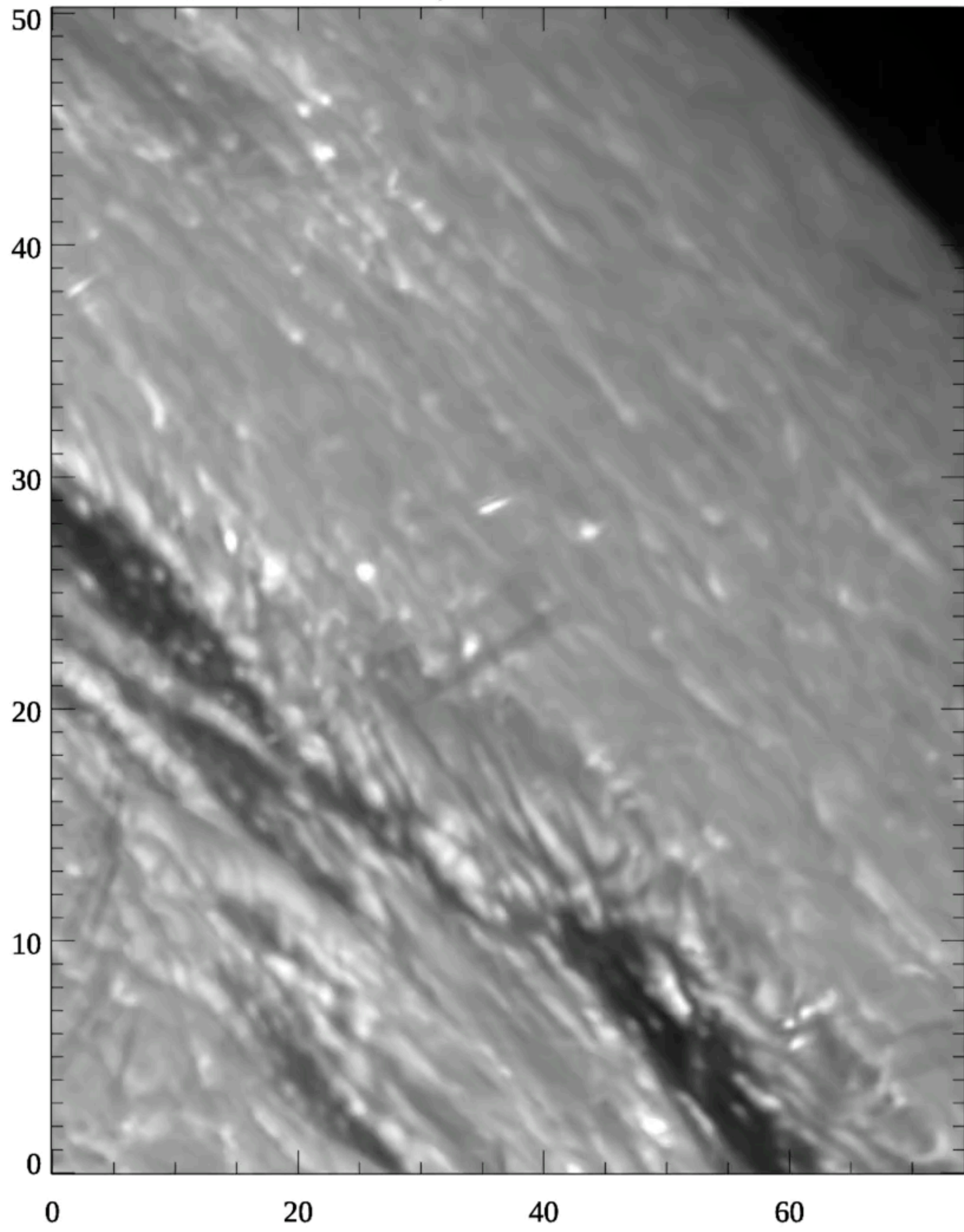
Ellerman bombs: magnetic reconnection in low solar atmosphere



Ellerman bombs: magnetic reconnection in low solar atmosphere

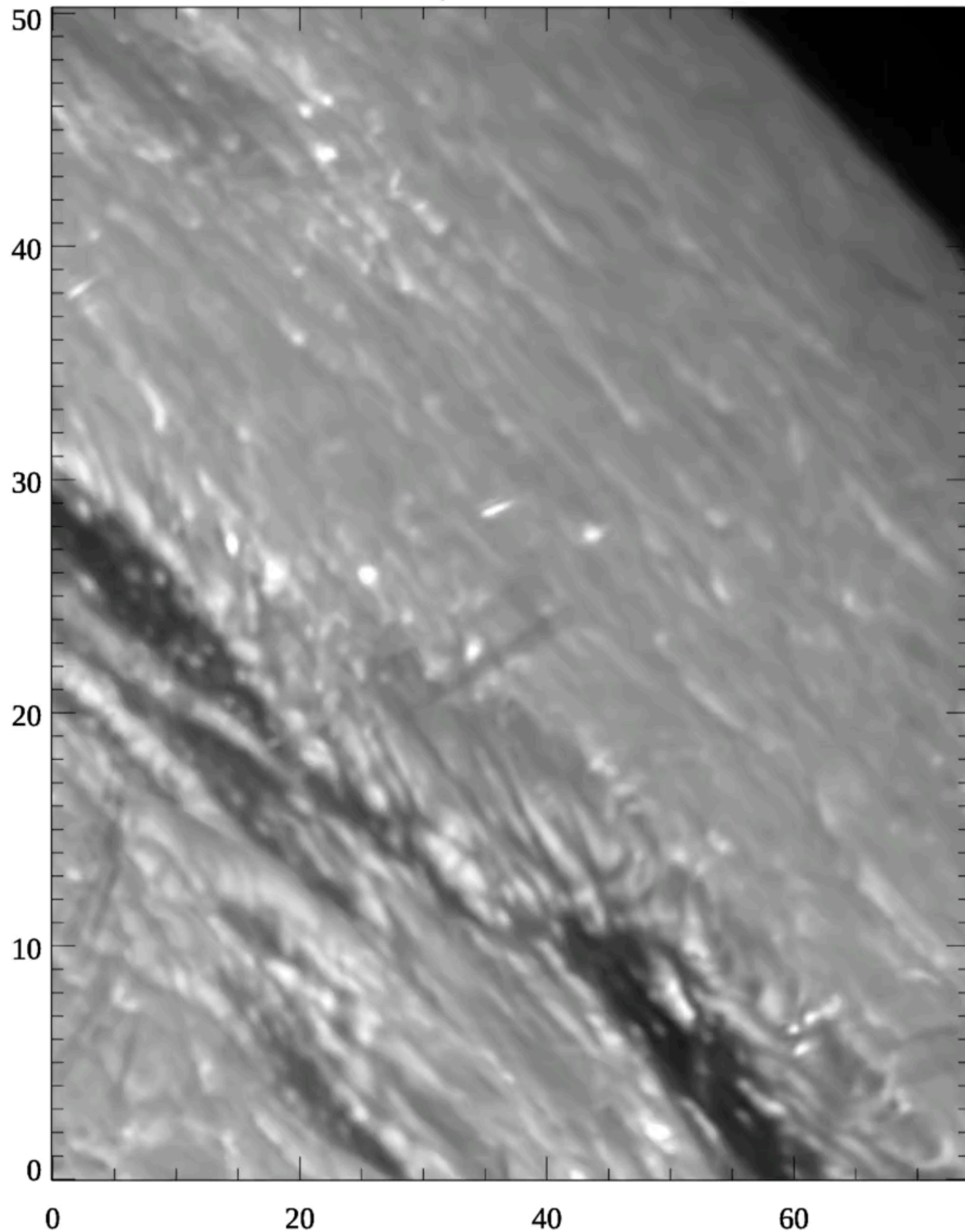


SST / CHROMIS 2024-05-24 H β -0.7 Å



Ellerman bombs in the Quiet Sun (QSEBs)

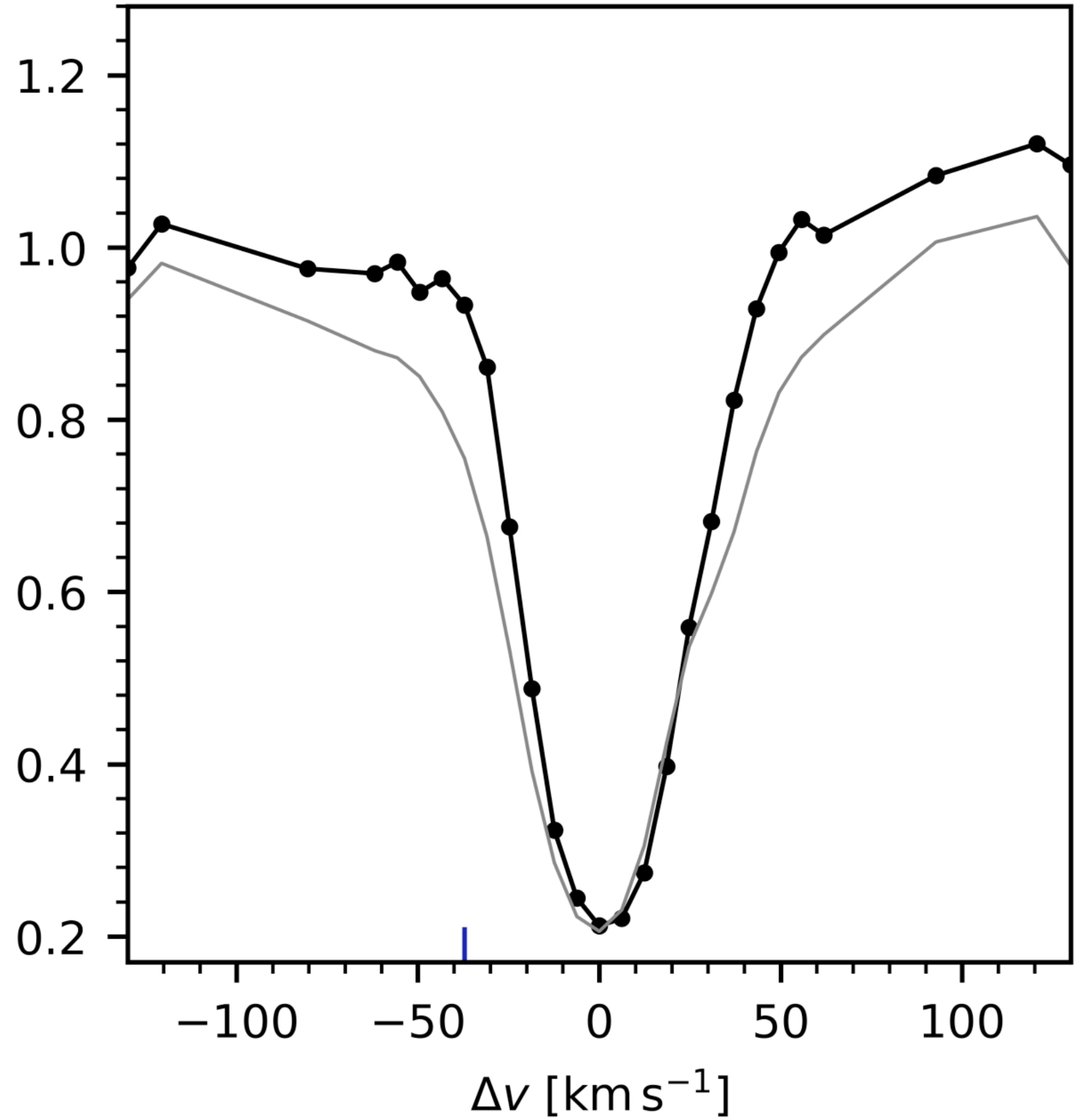
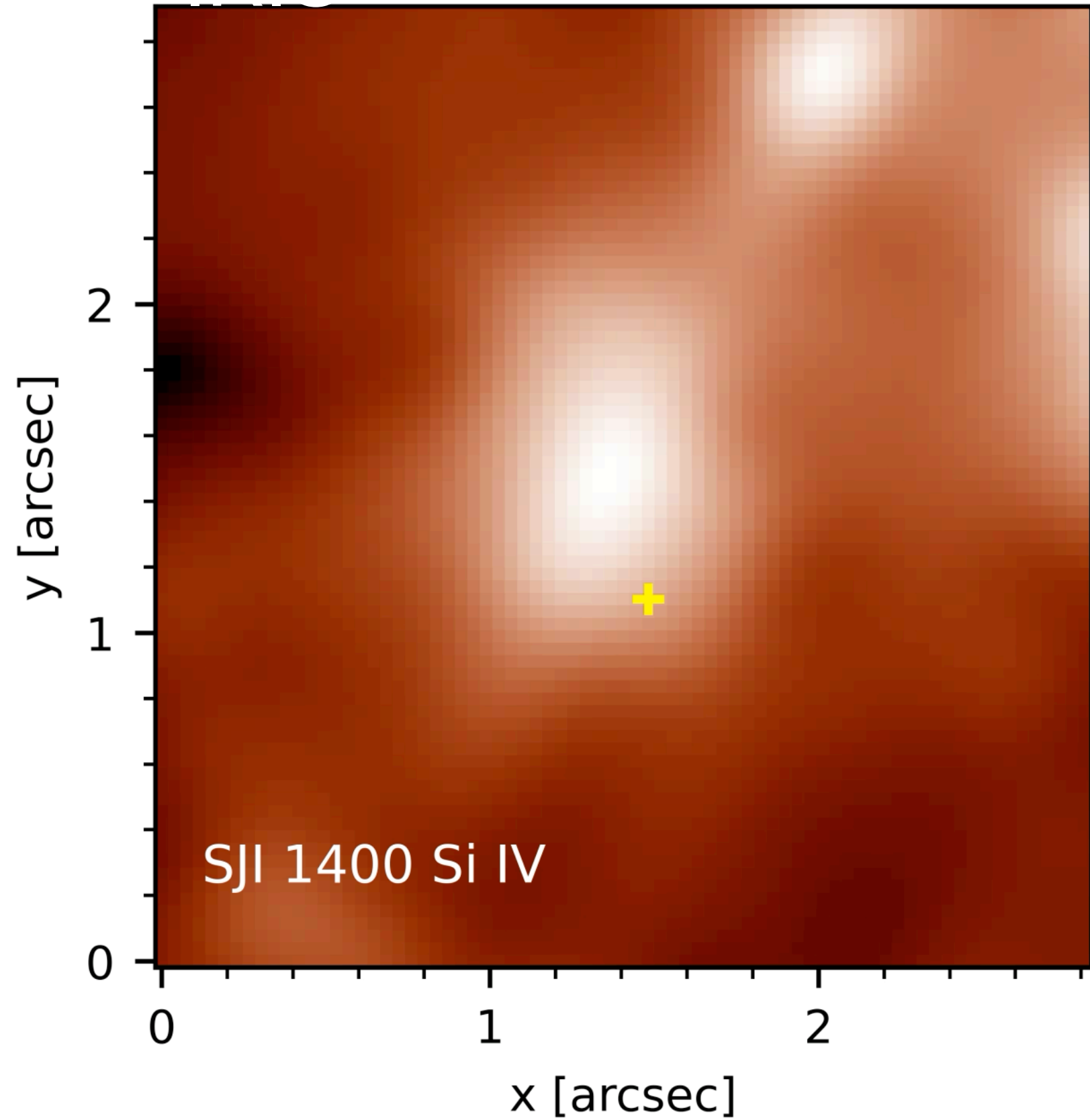
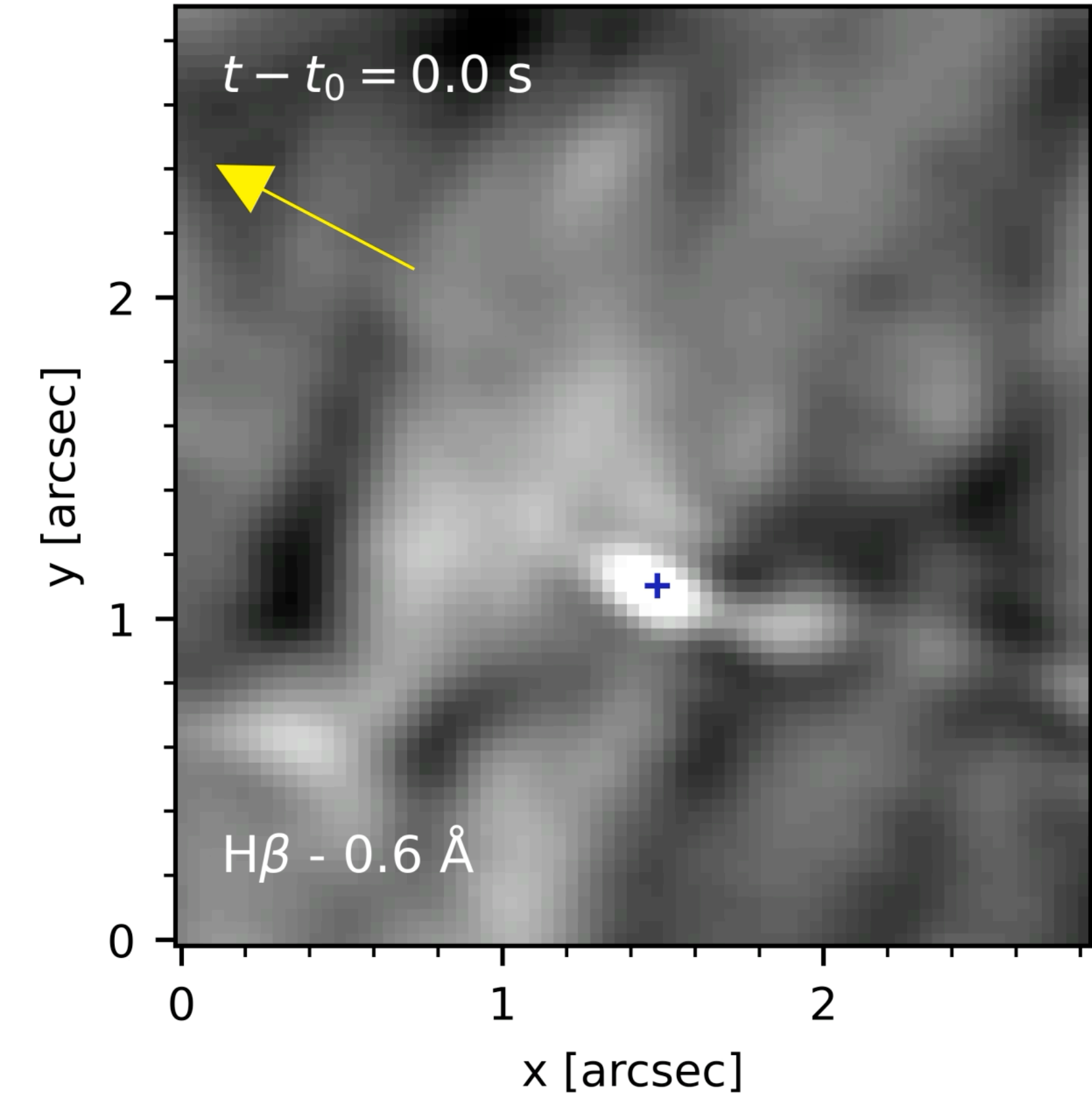
SST / CHROMIS 2024-05-24 H β -0.7 Å



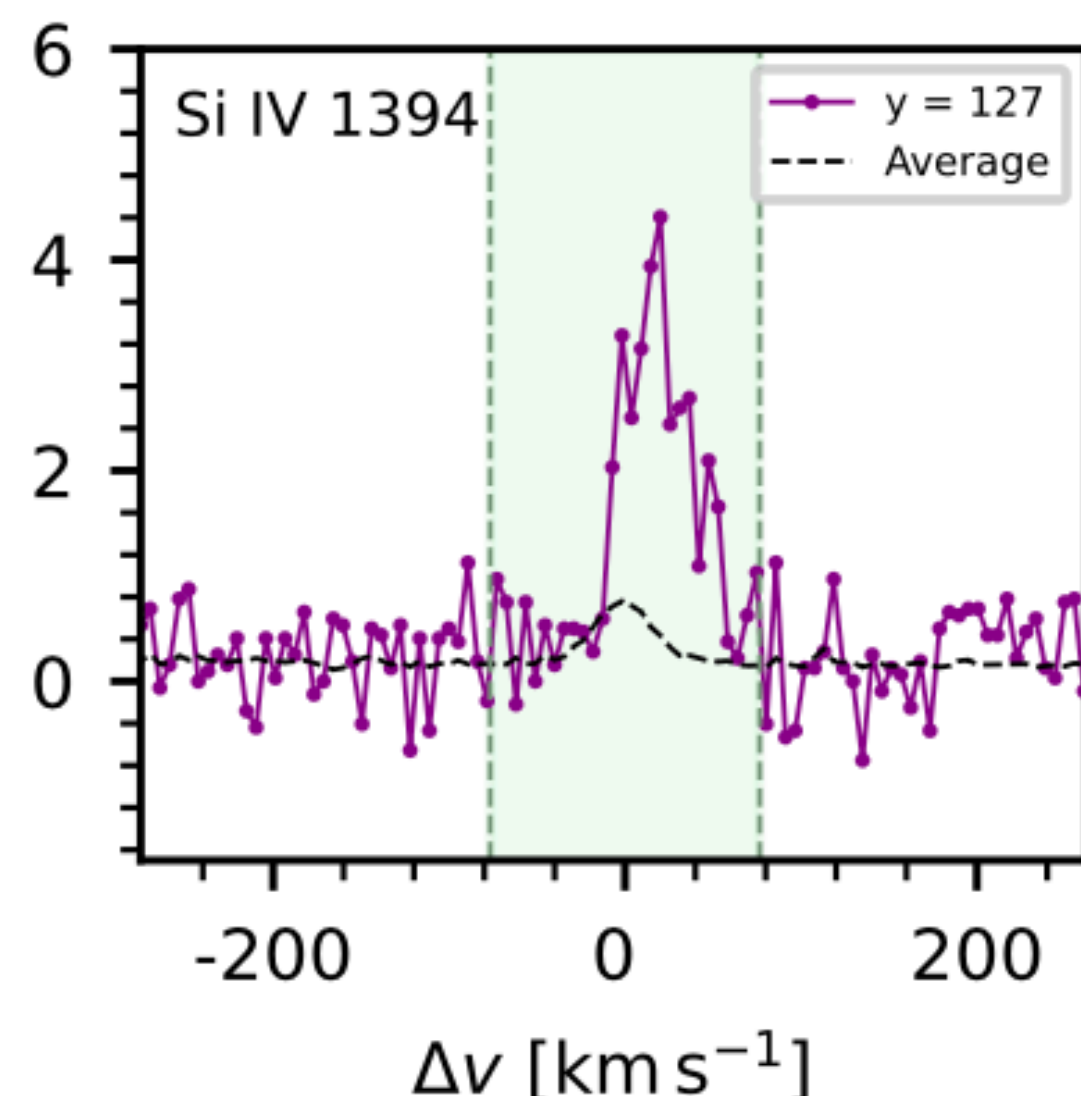
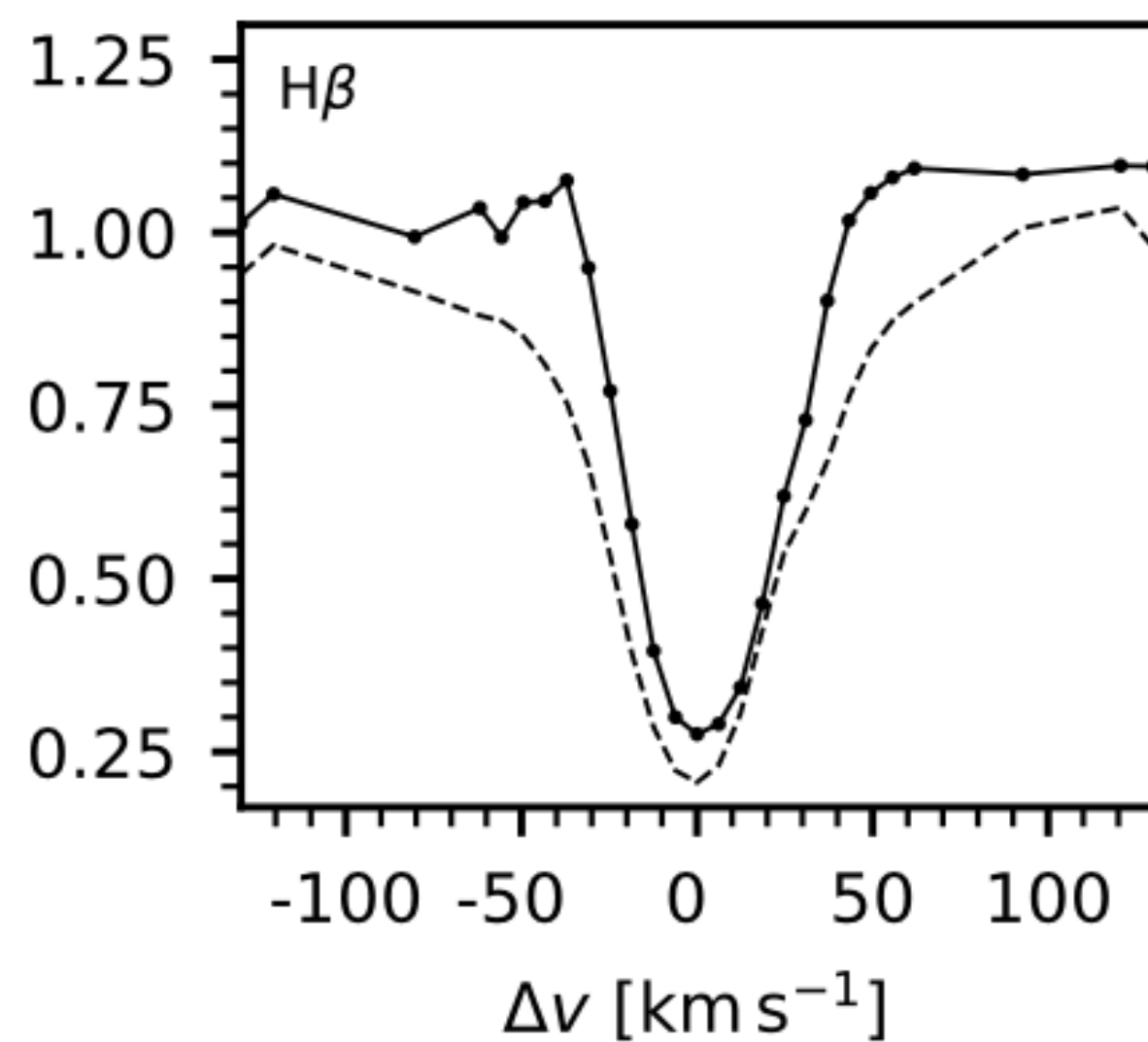
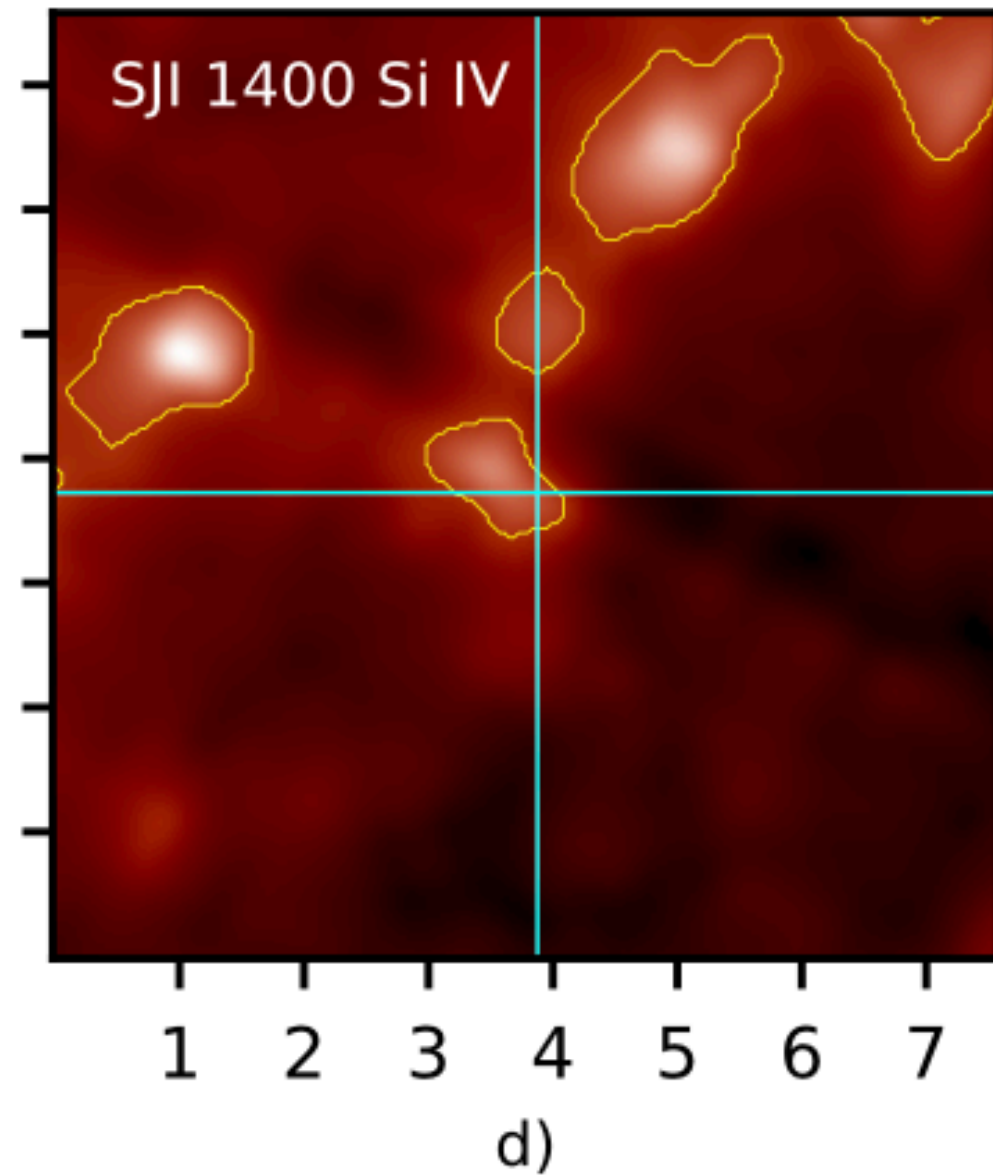
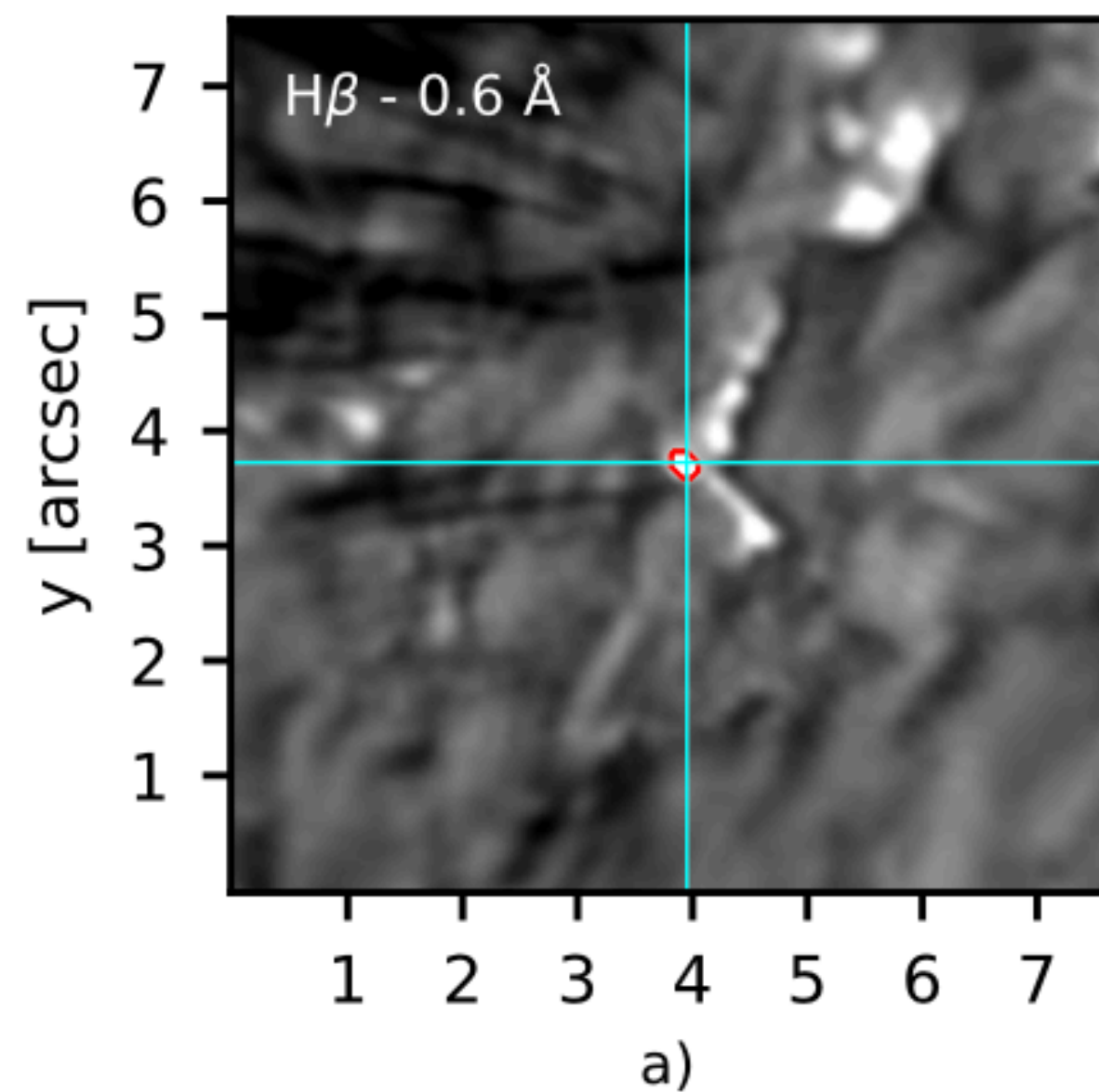
Ellerman bombs in the Quiet Sun (QSEBs)

>750,000 QSEBs over whole Sun
(Joshi et al. 2022, Rouppe van der Voort et al. 2024)

Impact of Quiet Sun Ellerman bombs on upper atmosphere?

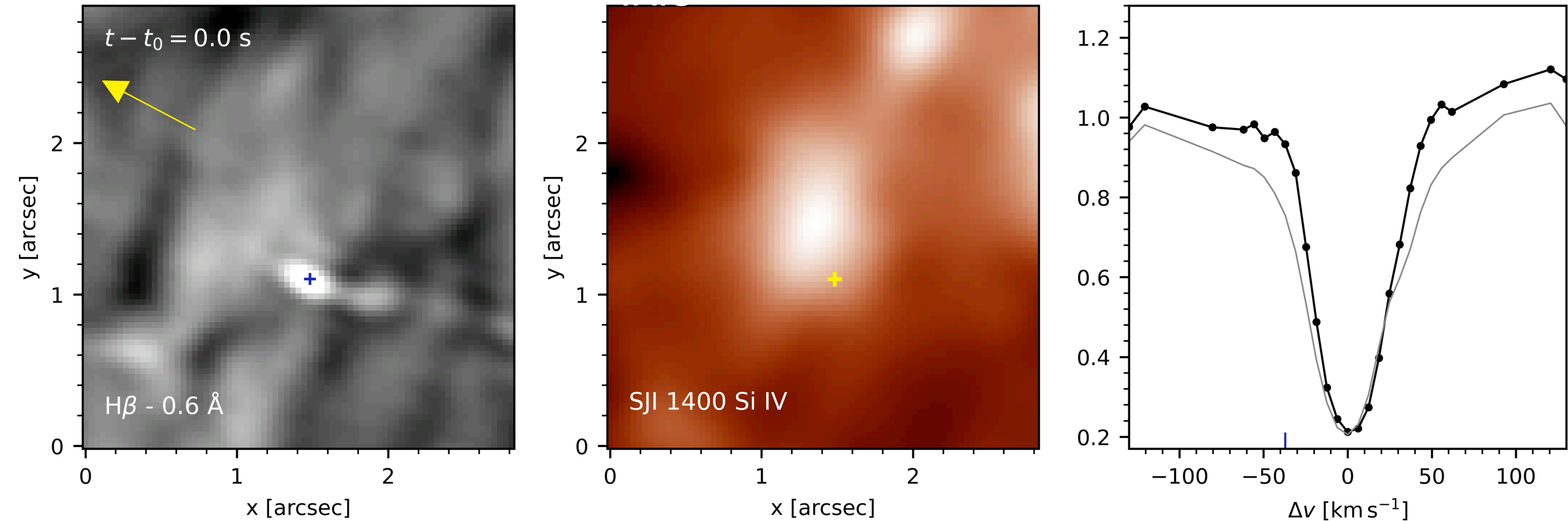


Impact of Quiet Sun Ellerman bombs on upper atmosphere?



(much) weaker Si IV emission than in UV bursts

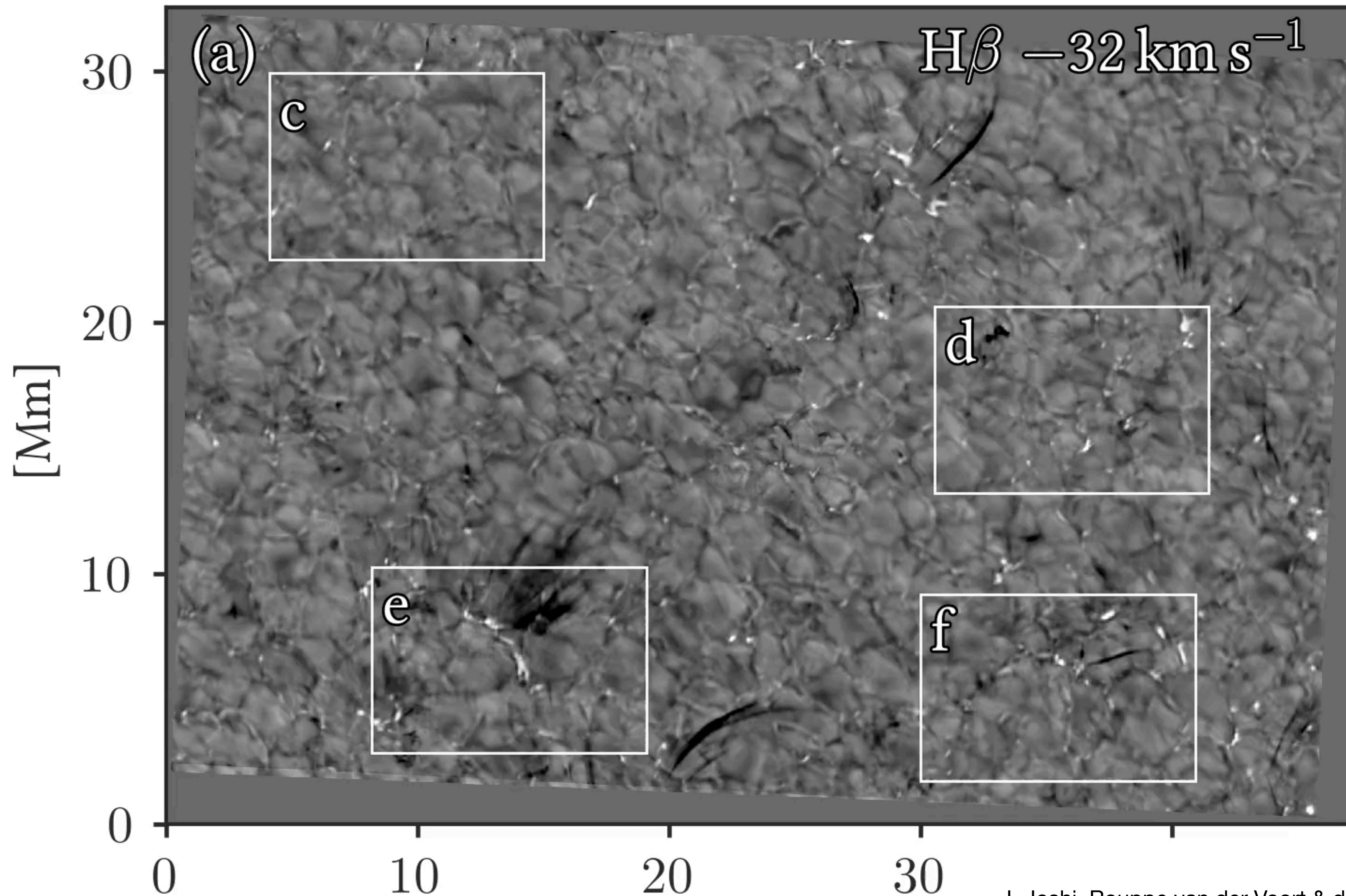
Impact of Quiet Sun Ellerman bombs on upper atmosphere?



Longer-lived QSEBs (> 1 min):

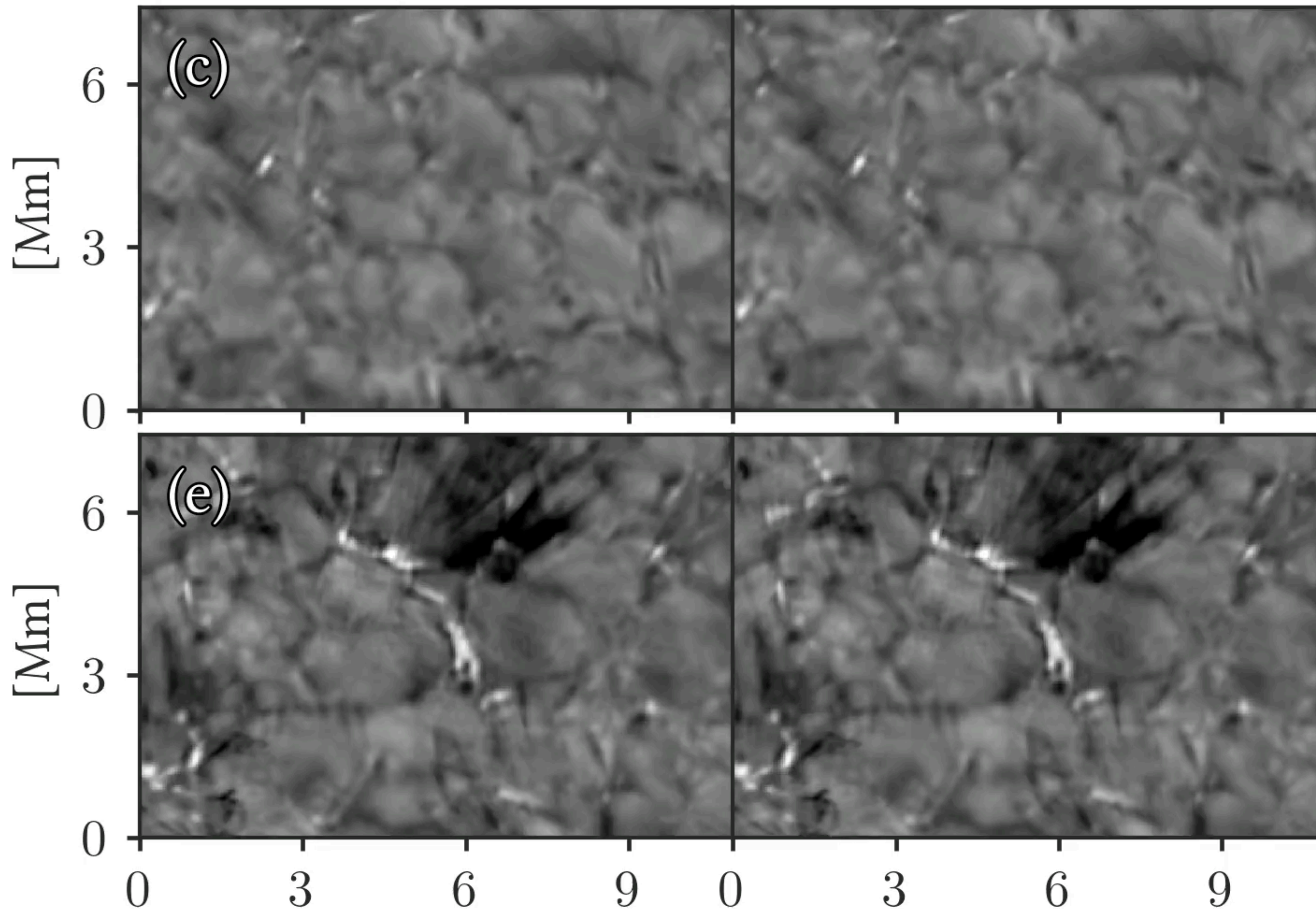
Some (15%) can be associated with brightenings in SJI 1400 and have Si IV 1394Å emission
 $\rightarrow$ *impact on overall atmosphere is limited*

2019-06-06 08:41:14 UT



Large numbers of
Ellerman bombs in
quiet Sun:

>120 QSEBs

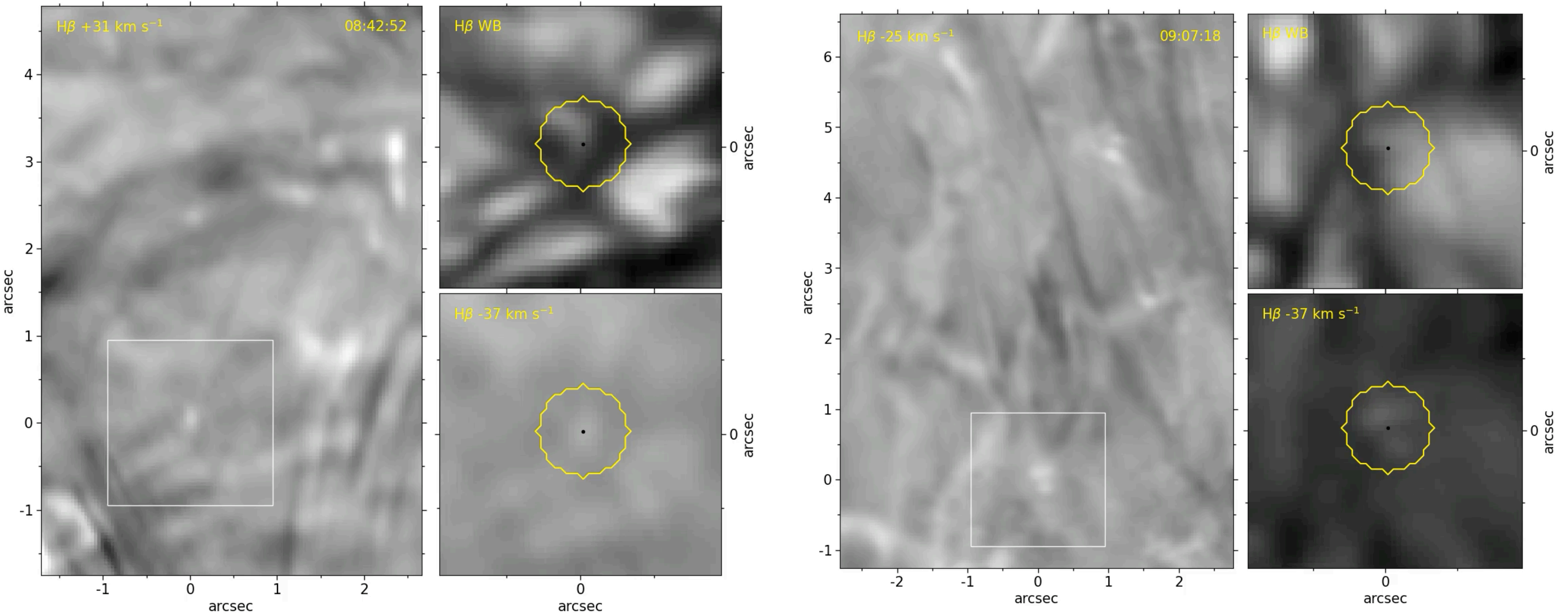


Large numbers of
Ellerman bombs in
quiet Sun:

>120 QSEBs

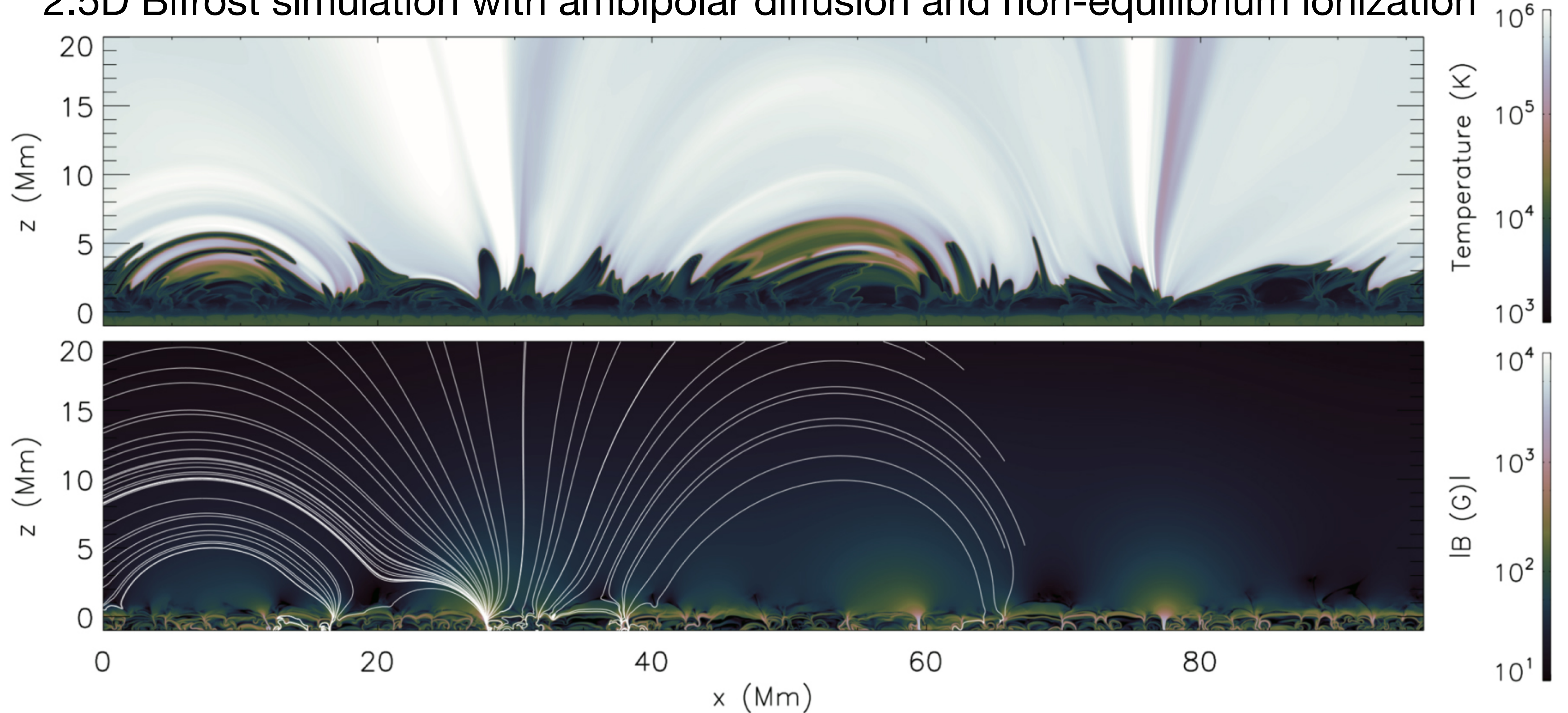
→ >750,000 over
whole Sun

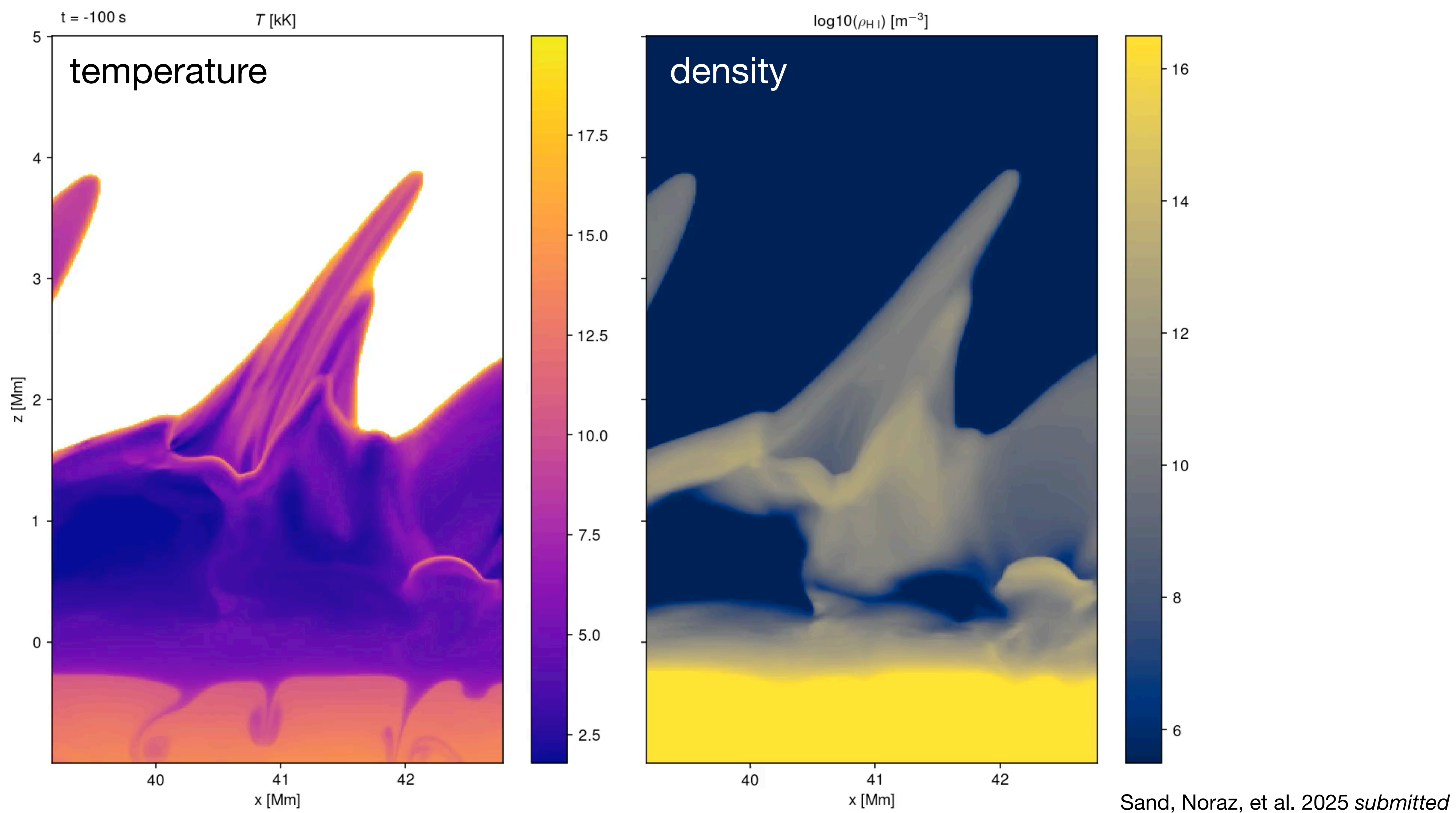
Connection between Quiet Sun Ellerman bombs and spicules?



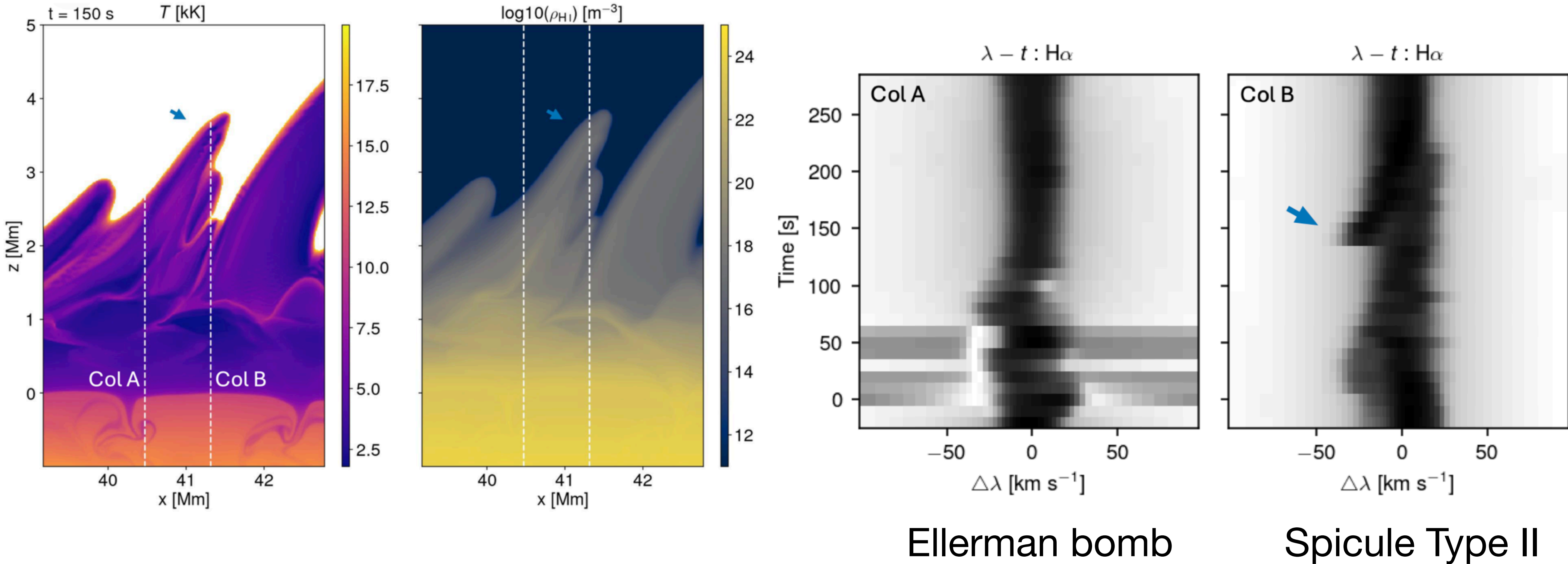
Some suggestive cases of QSEBs with spicule activity

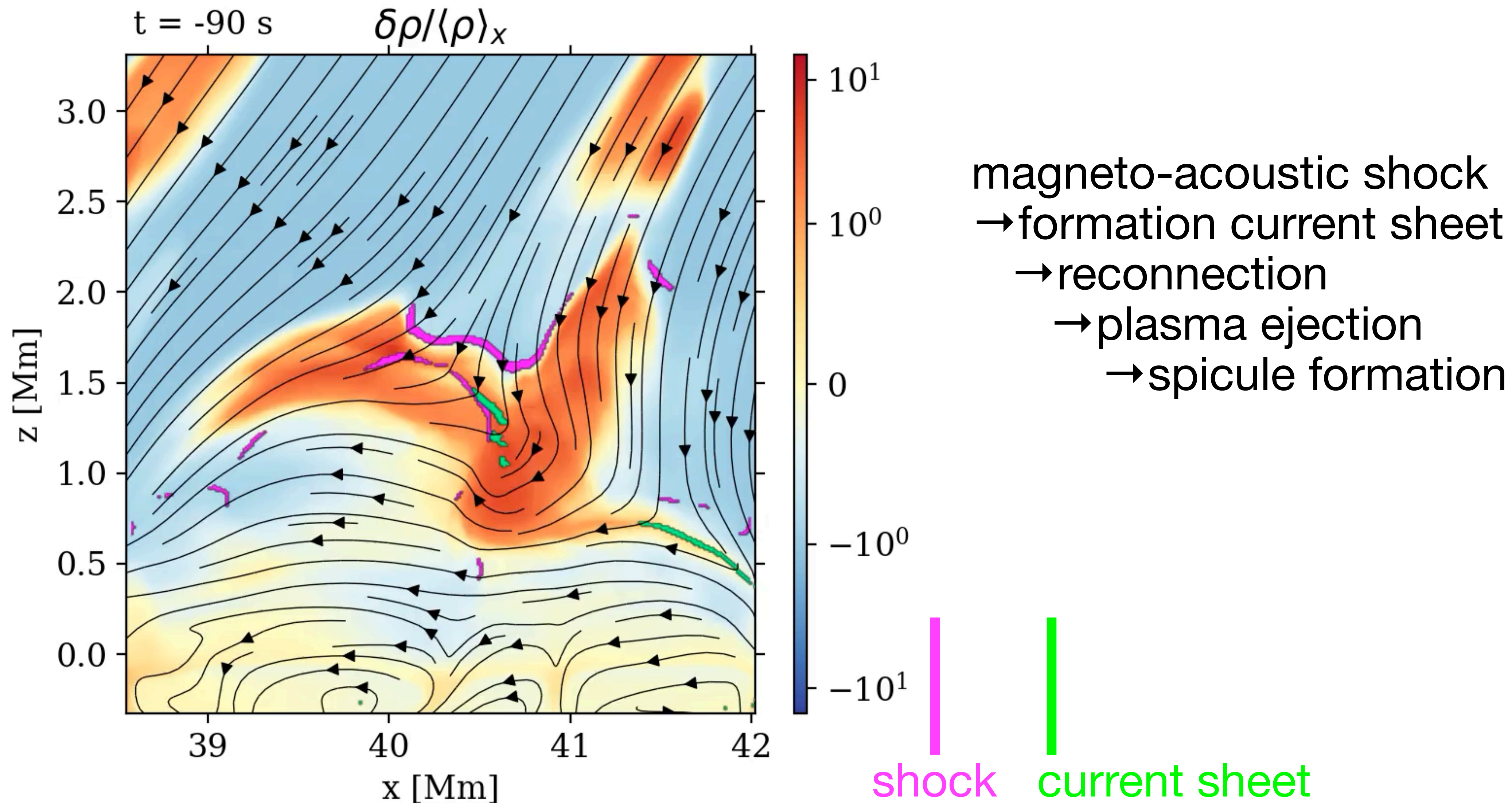
2.5D Bifrost simulation with ambipolar diffusion and non-equilibrium ionization





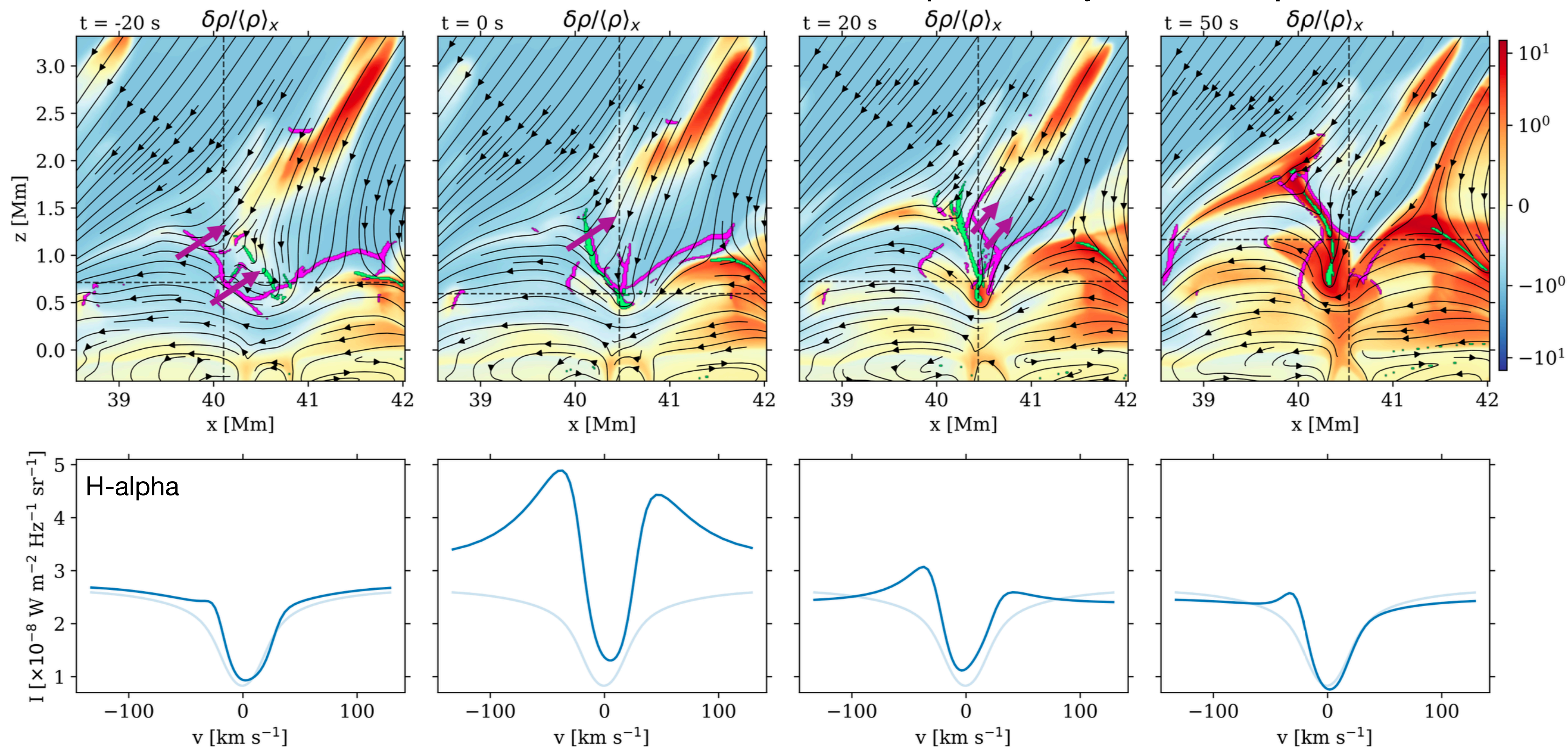
RH1.5D H-alpha synthetic spectra

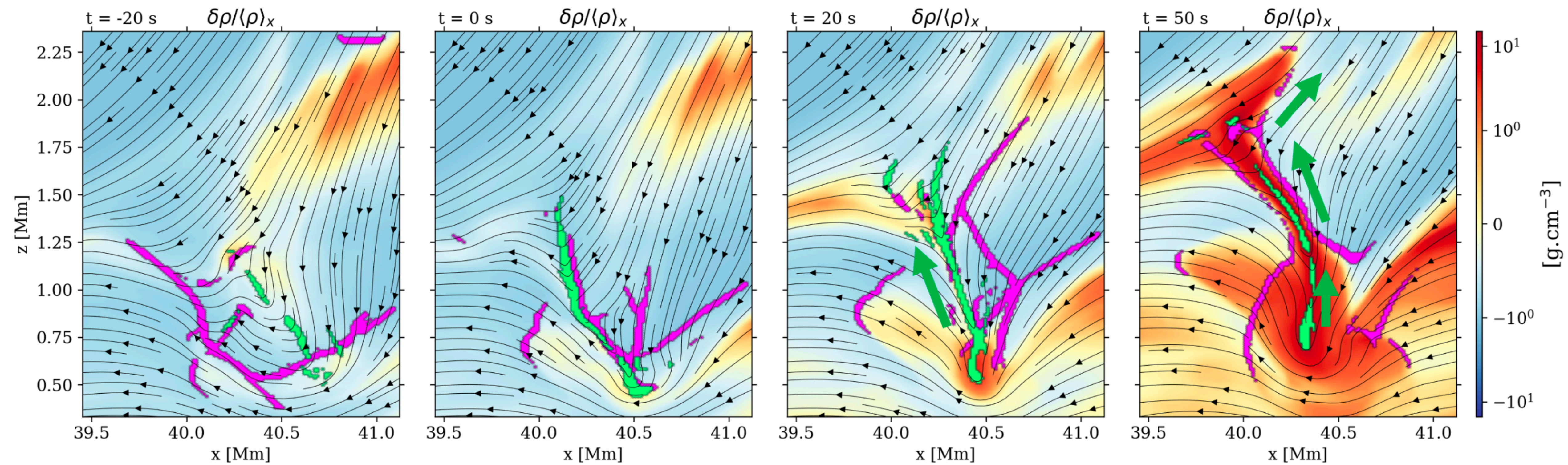




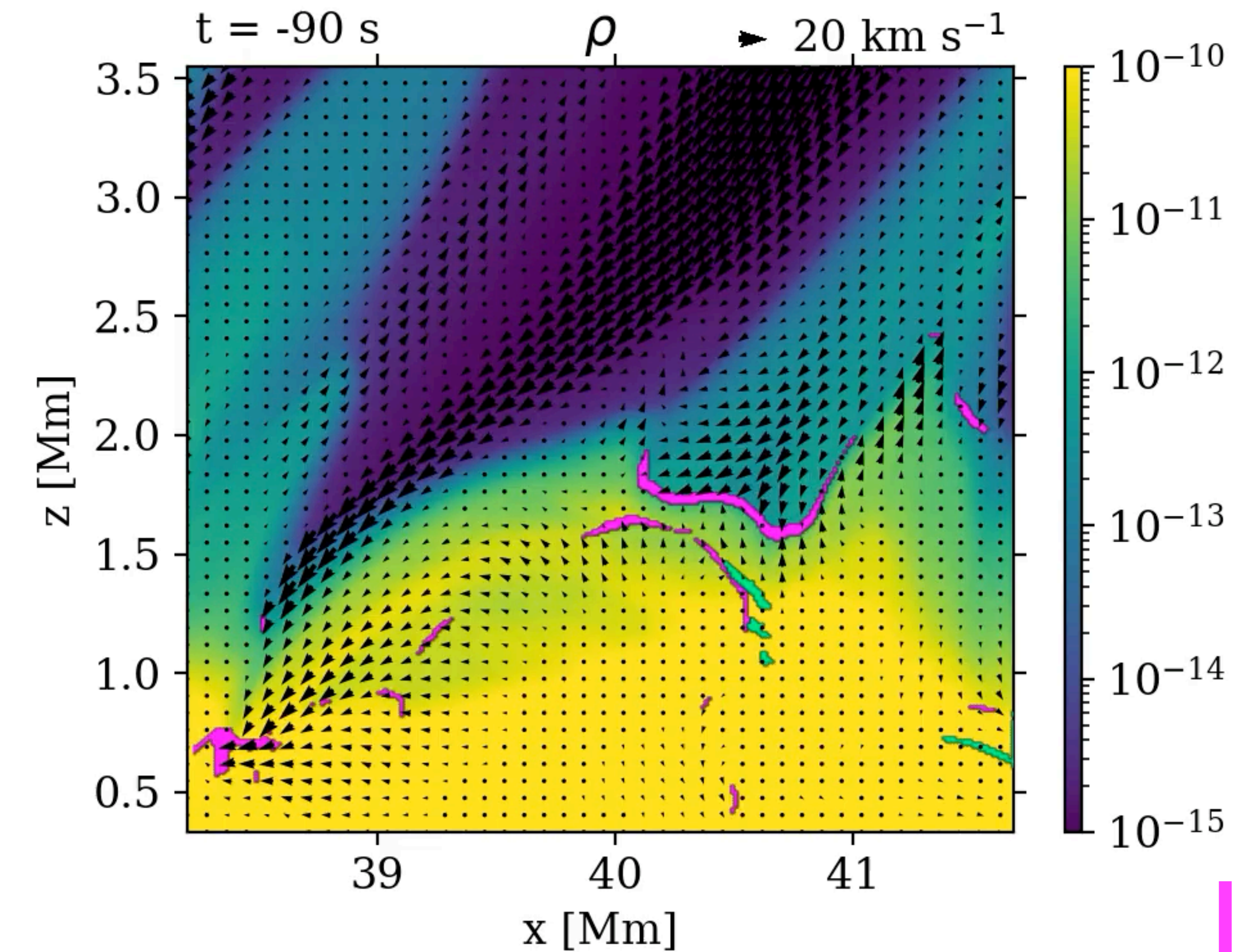
normalised density fluctuation map

shock → formation current sheet → reconnection → plasma ejection → spicule formation



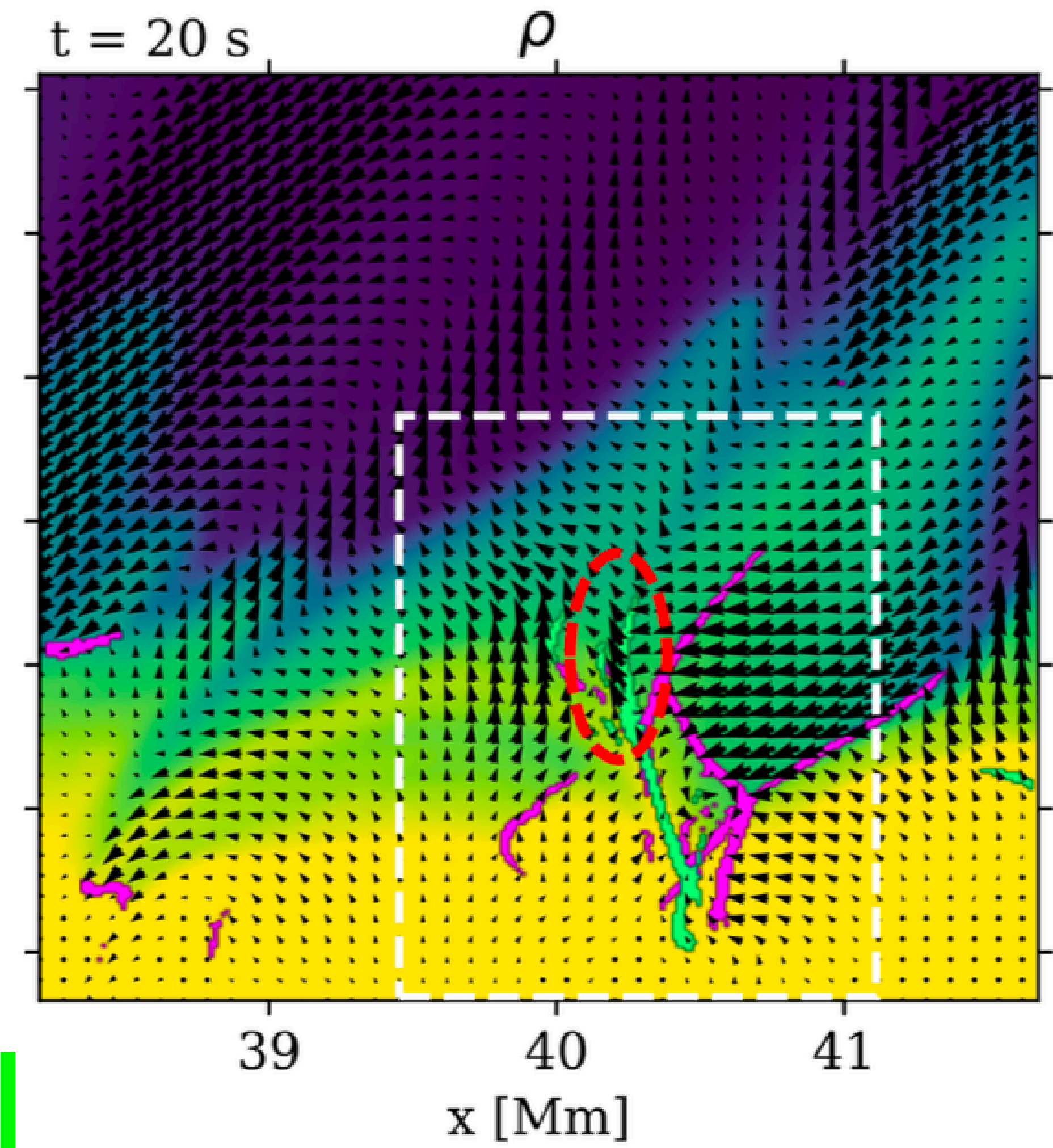
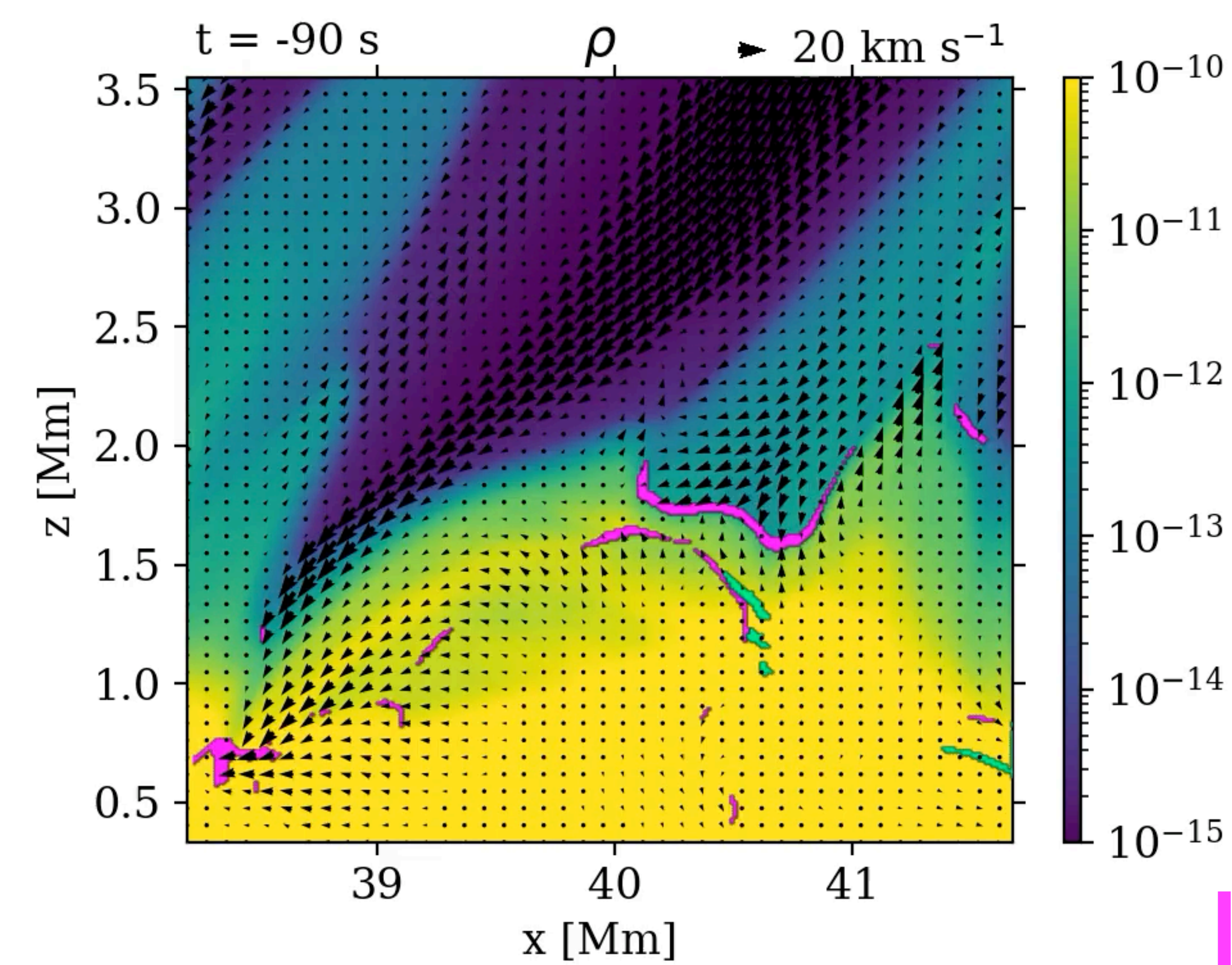


| shock
| current sheet

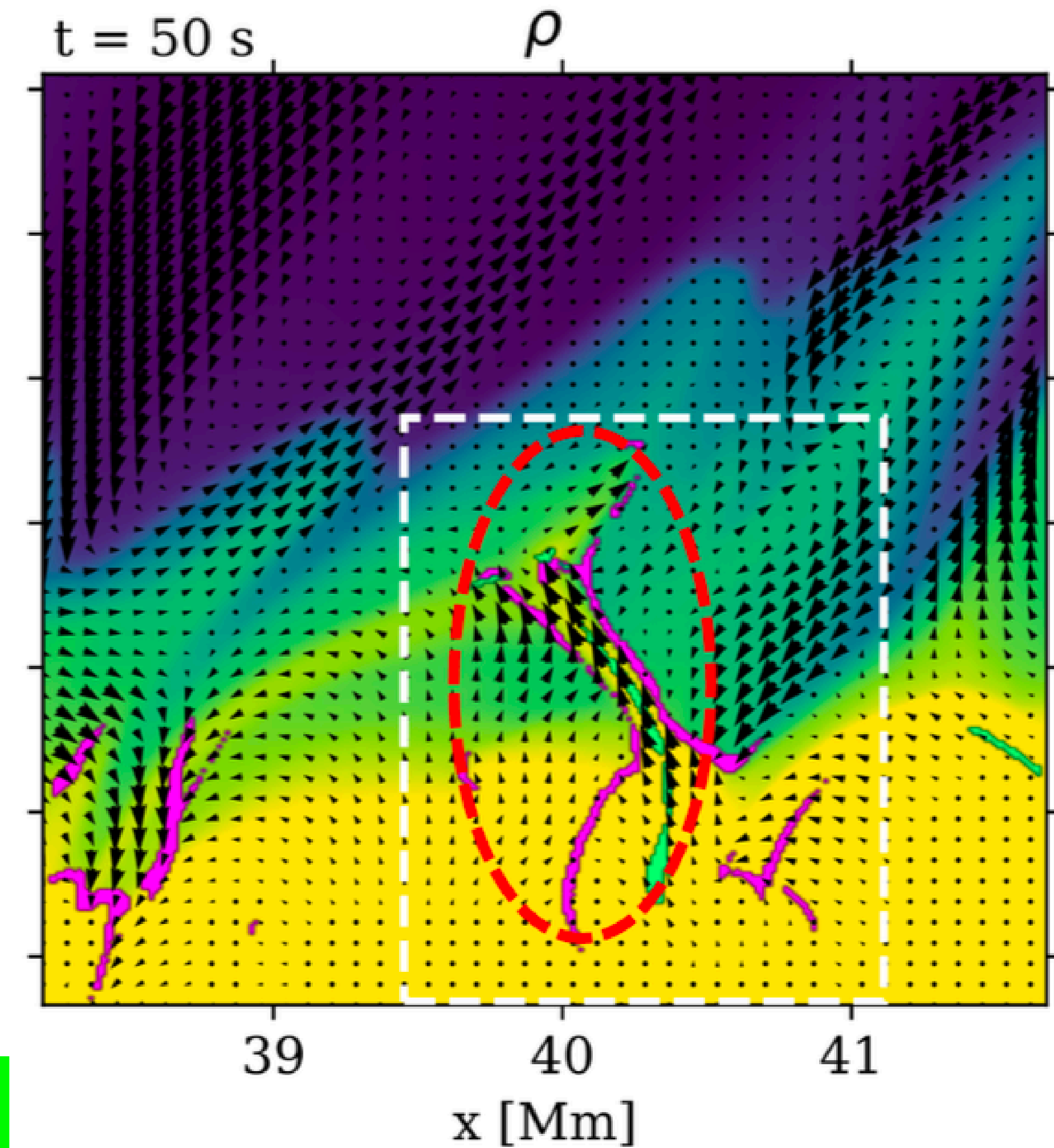
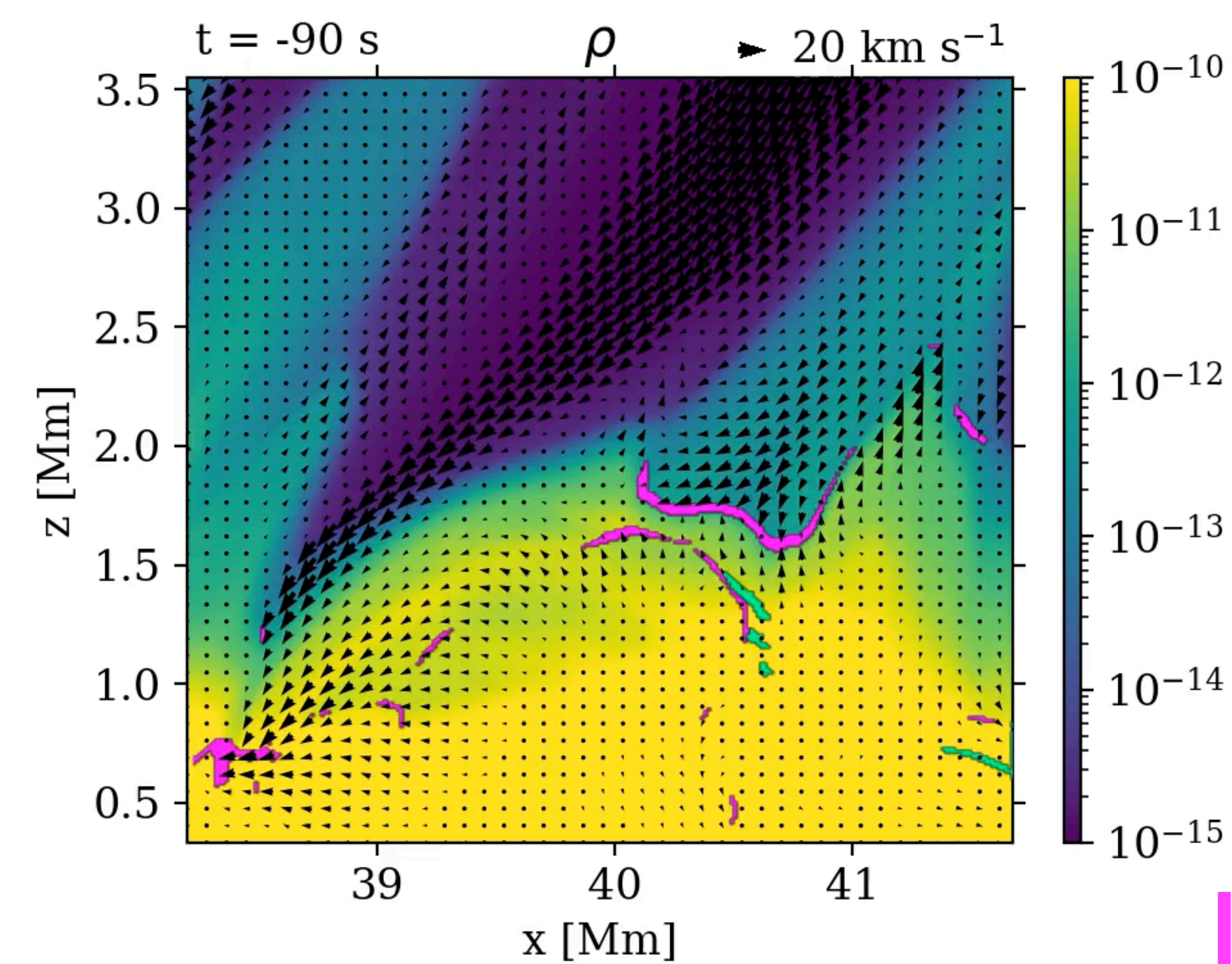


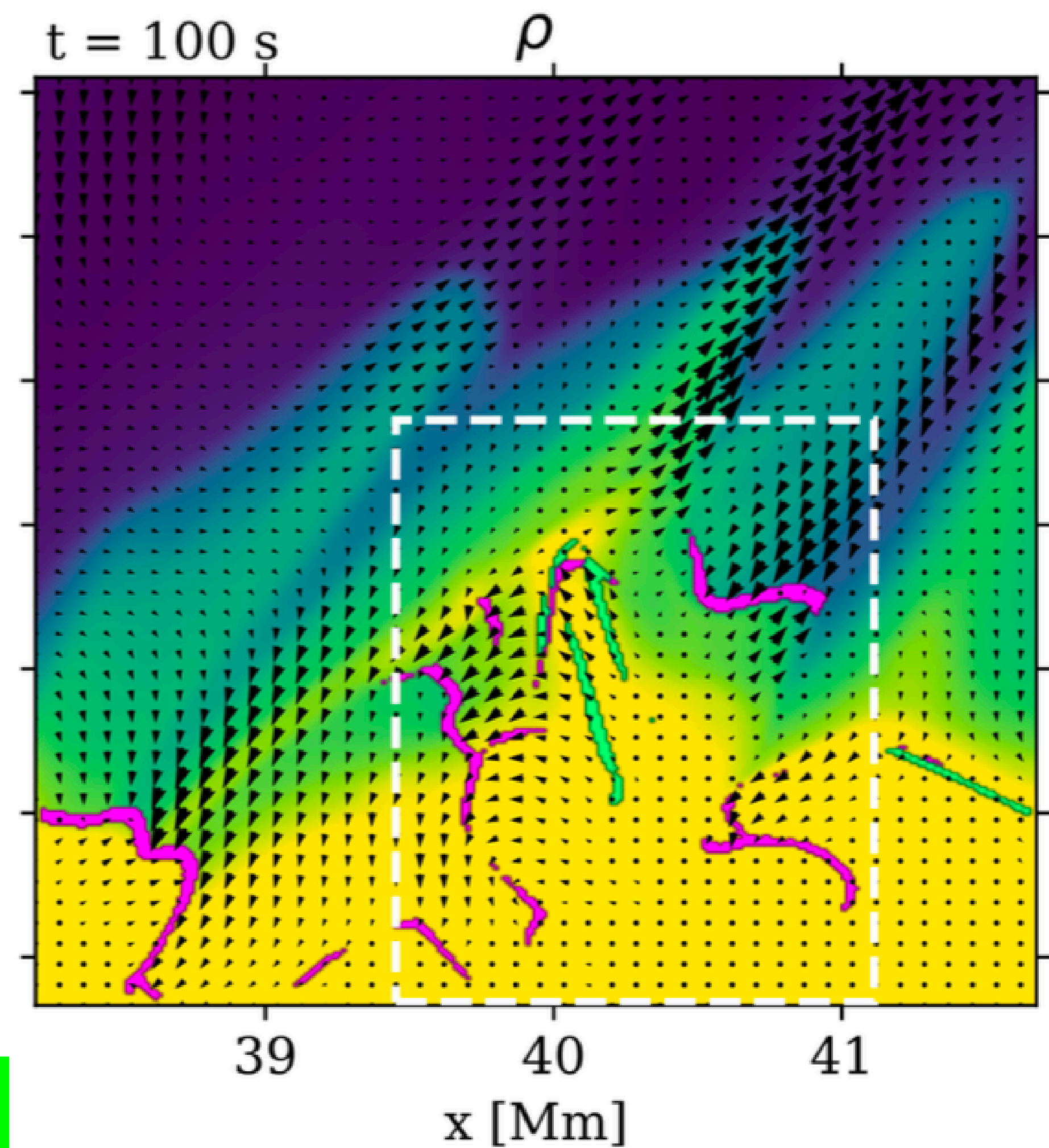
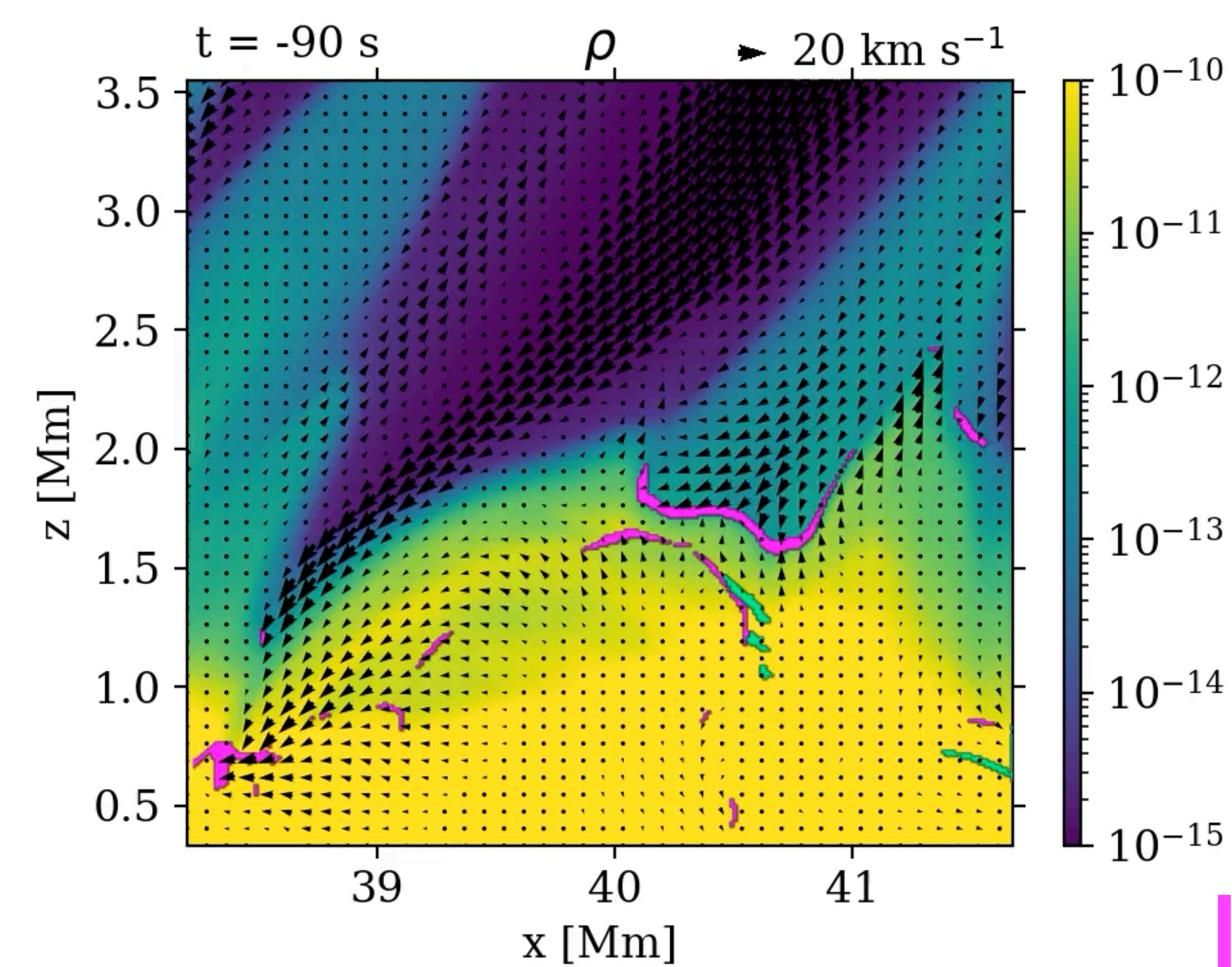
shock

current sheet



| shock
 | current sheet

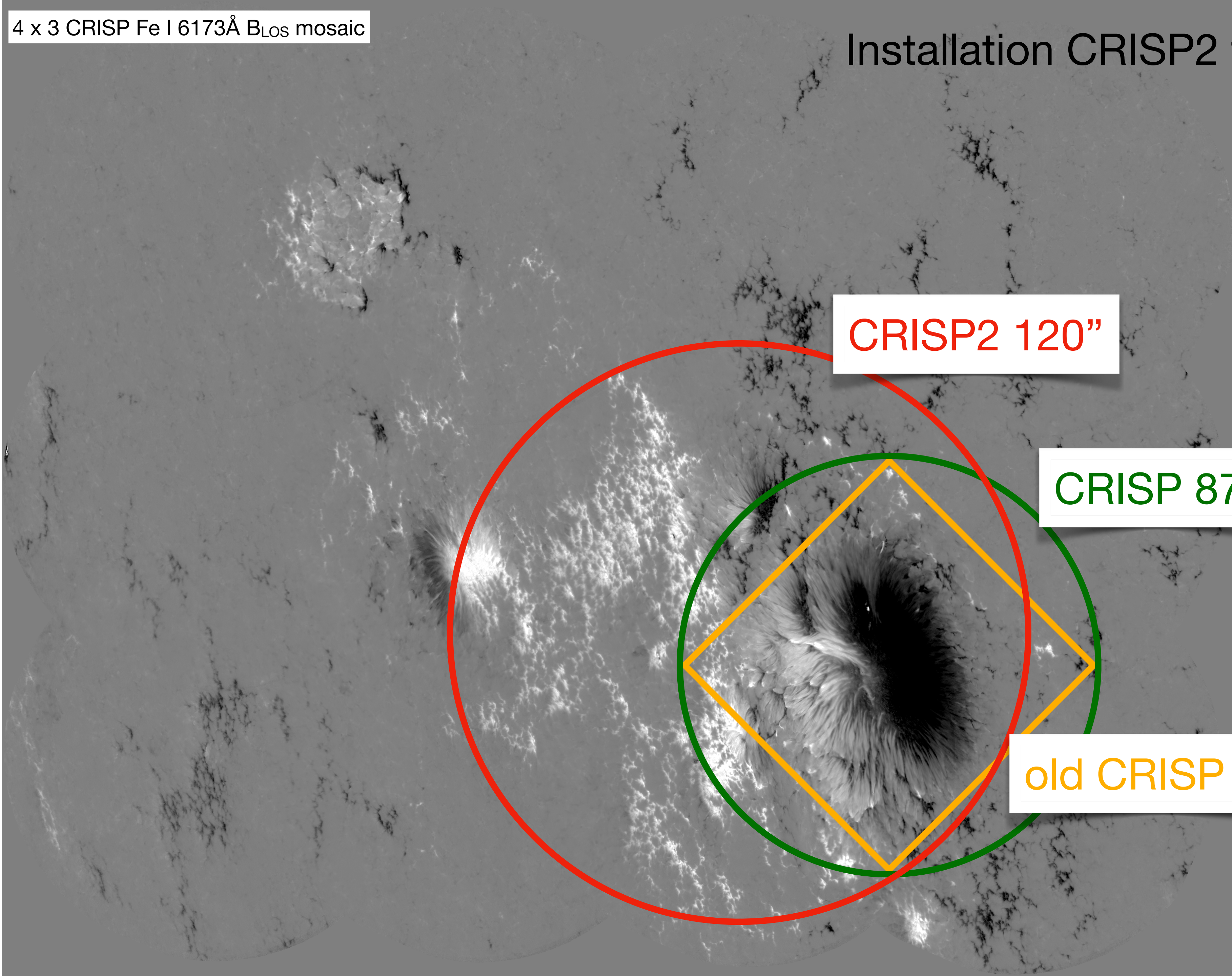




| shock
| current sheet

Conclusions

- Large number of Ellerman bombs on the Sun: $>750,000$
- Some local heating (IRIS SJI 1400 and Si IV emission)
- Some Ellerman bombs can be connected with spicules
- Simulation: scenario of shock-wave induced reconnection leading to spicule formation



CRISP2 120''

CRISP 87''

old CRISP 60''

4 x 3 CRISP Fe I 6173Å B_{LOS} mosaic

CRISP2 120''

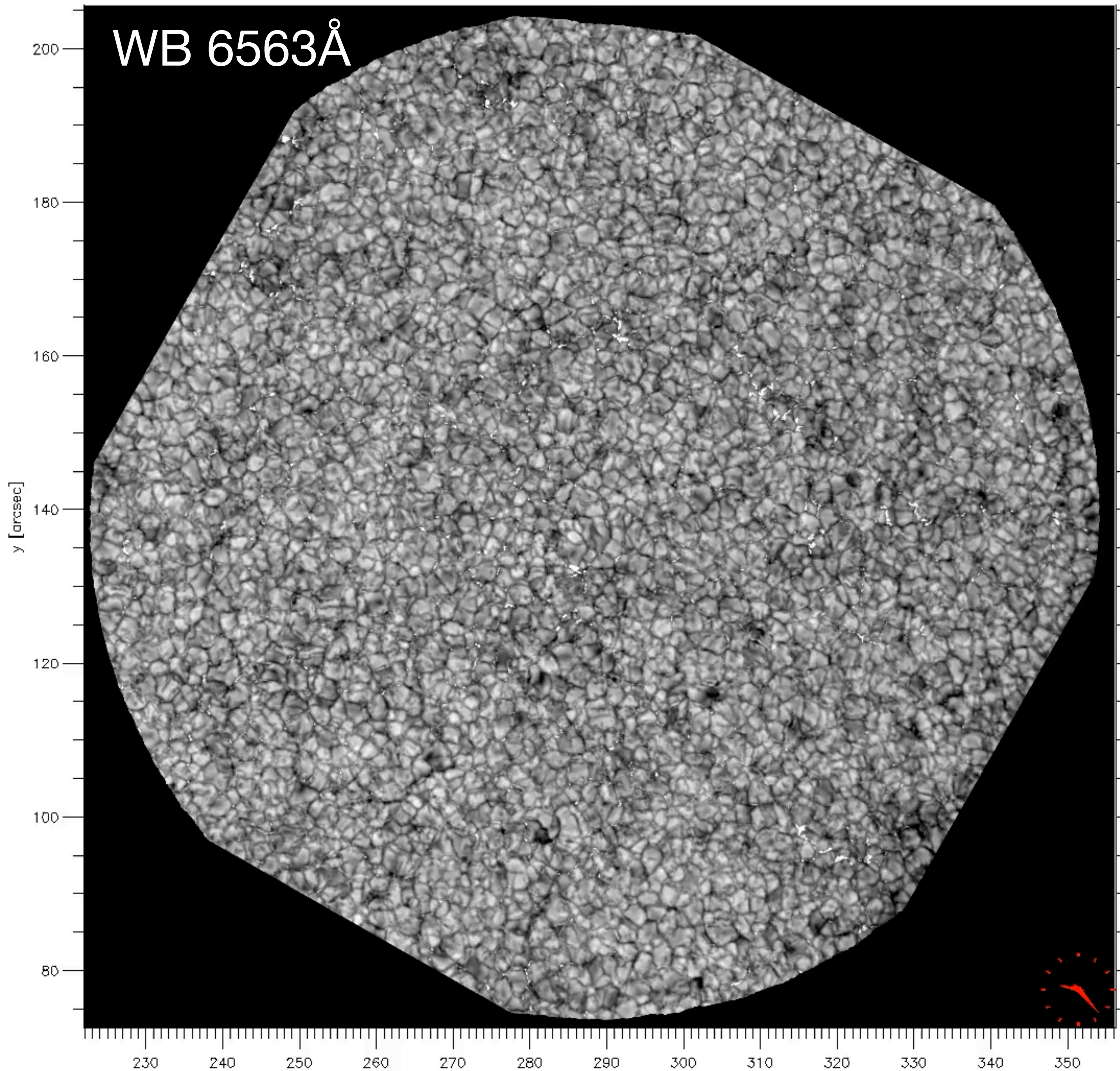
CHROMIS 90''

MUSE

CRISP2 120''

CHROMIS 90''

WB 6563Å



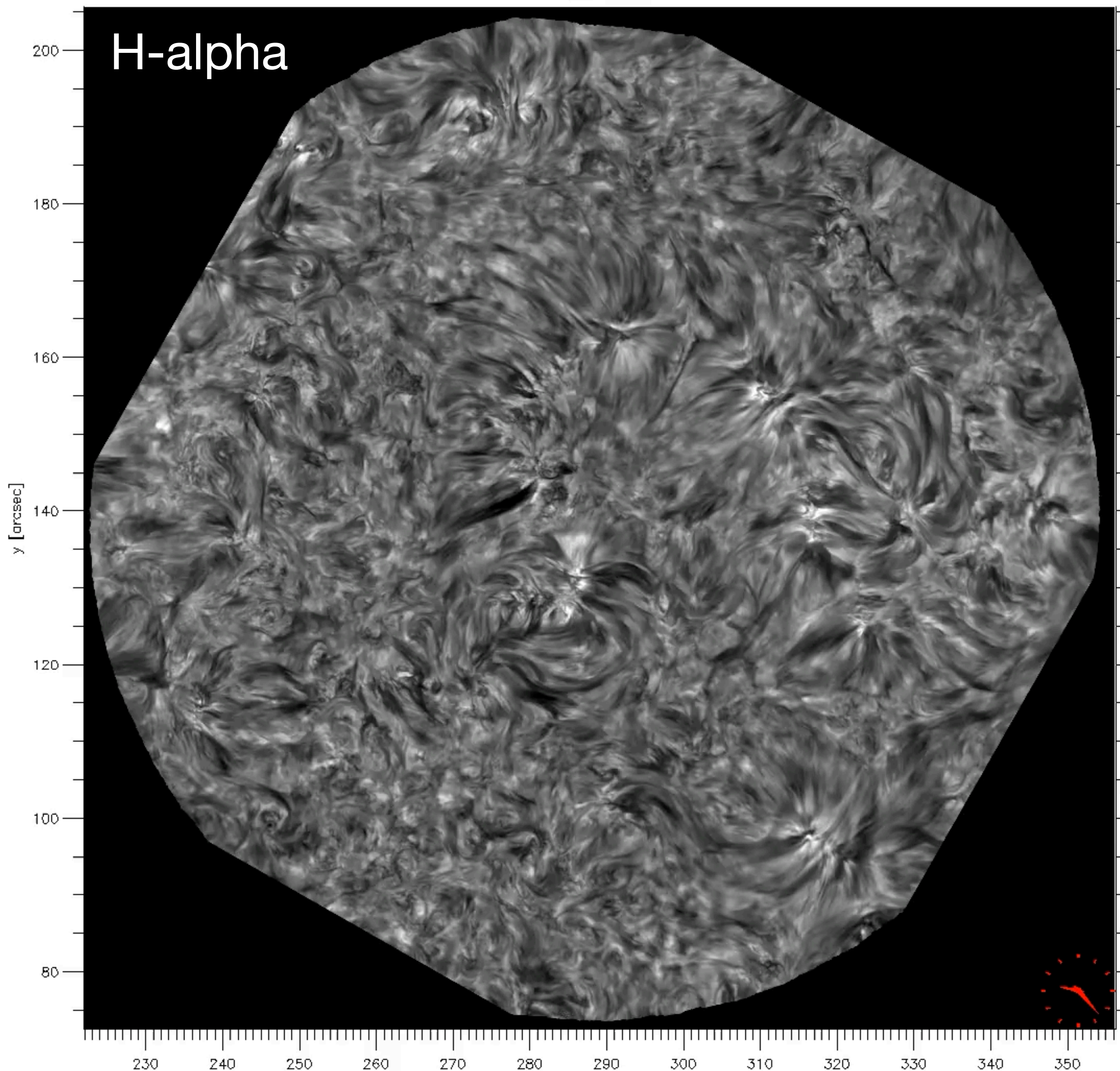
CRISP2 FOV 120''

10-Oct-2025

31 min

H-alpha +0.000 A

H-alpha

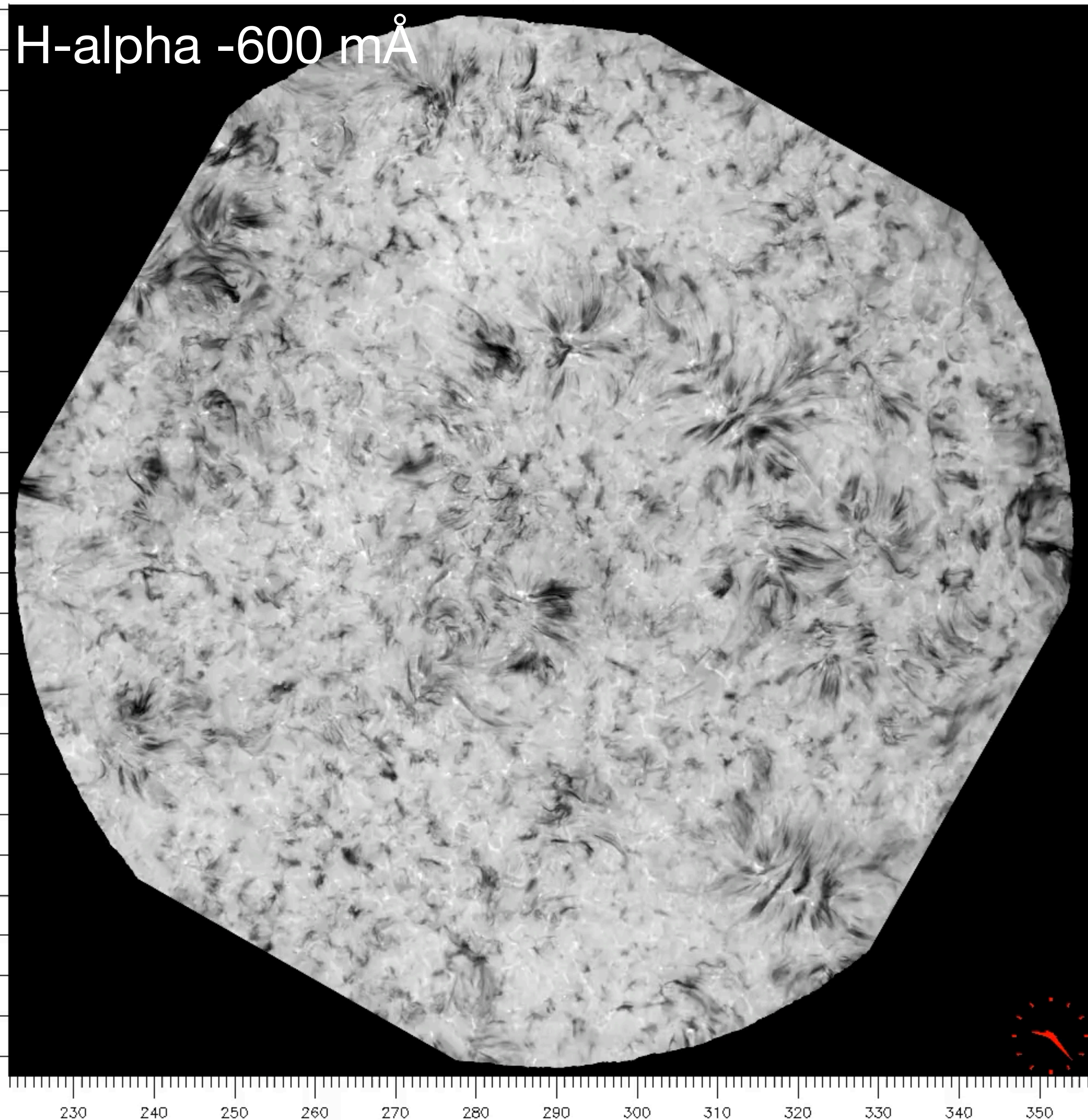


CRISP2 FOV 120''

10-Oct-2025

31 min

H-alpha -0.600 Å



CRISP2 FOV 120"

10-Oct-2025

31 min