Stockholm University

Chromospheric condensation and magnetic field from He I D3 inversions

T. Libbrecht, **J. de la Cruz Rodríguez**, S. Danilovic, J. Leenaarts & H. Pazira

arXiv:1806.06880

European Research Council
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Contributed Talk

4. Eruptions in the solar atmosphere

What do non-LTE inversions tell us about flares in the upper chromosphere?

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Solar fares have long been studied observationally and theoretically with radiation-MHD simulations. However, both approaches have struggled to fully explain the observed line profiles in chromospheric lines. In this talk we present and discuss time-series of 3D empirical models derived from non-LTE inversions performed simultaneously in Ca II H&K, Ca II 8542 and, for some targets, including also Mg II h&k from IRIS.

Previous studies involving depth-stratified inversions have focused in the Ca II 8542 line, that samples the lower chromosphere. By including Ca II H&K and Mg II h&k we can reach the upper chromosphere, and better constrain velocity and temperature gradients in the entire chromosphere.

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(some) chromospheric diagnostics

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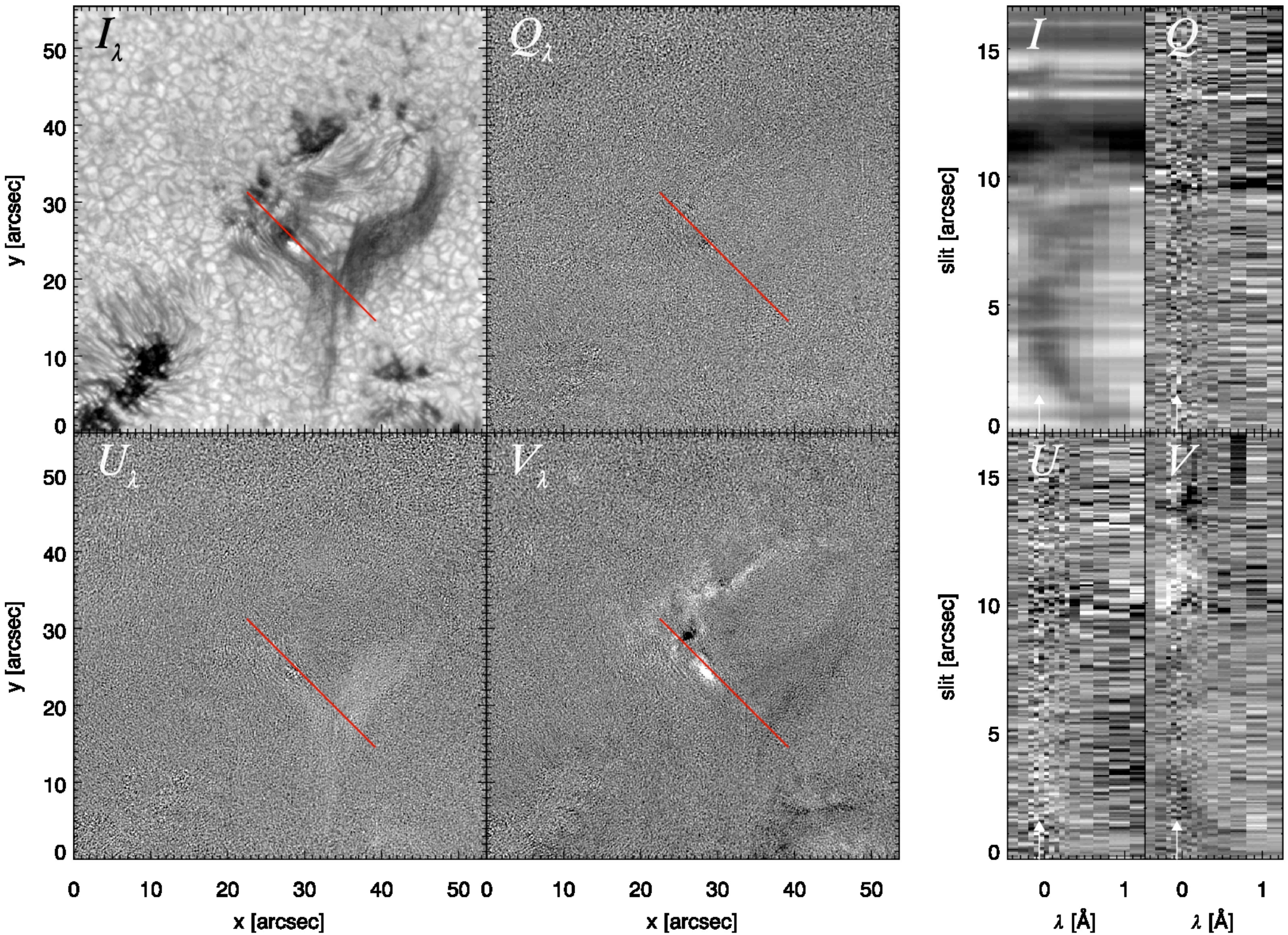
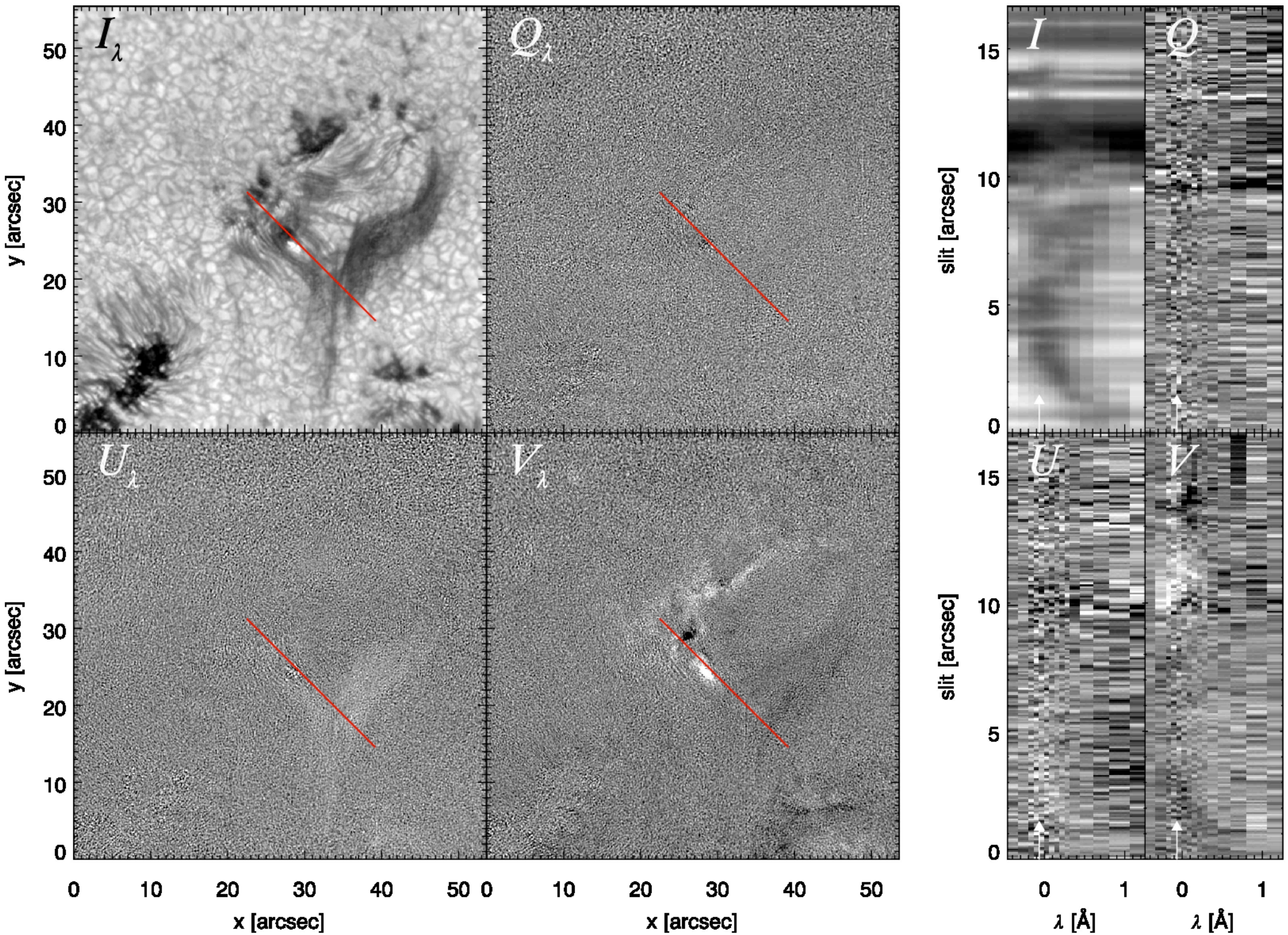
He I D_3 and 10830: magnetic fields in the mid-upper chromosphere

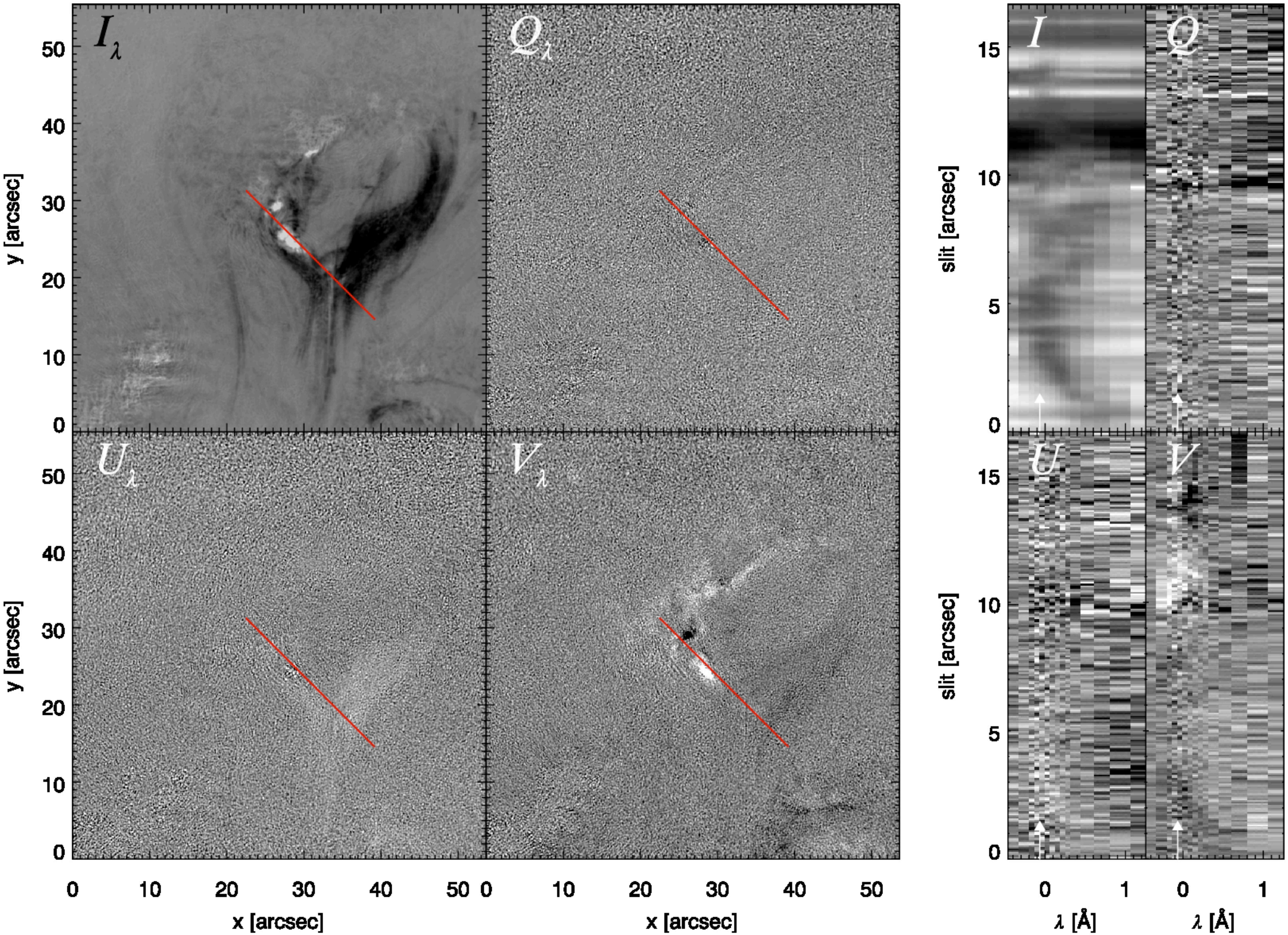
He I D_3 flare observations at the Swedish 1-m Solar Telescope



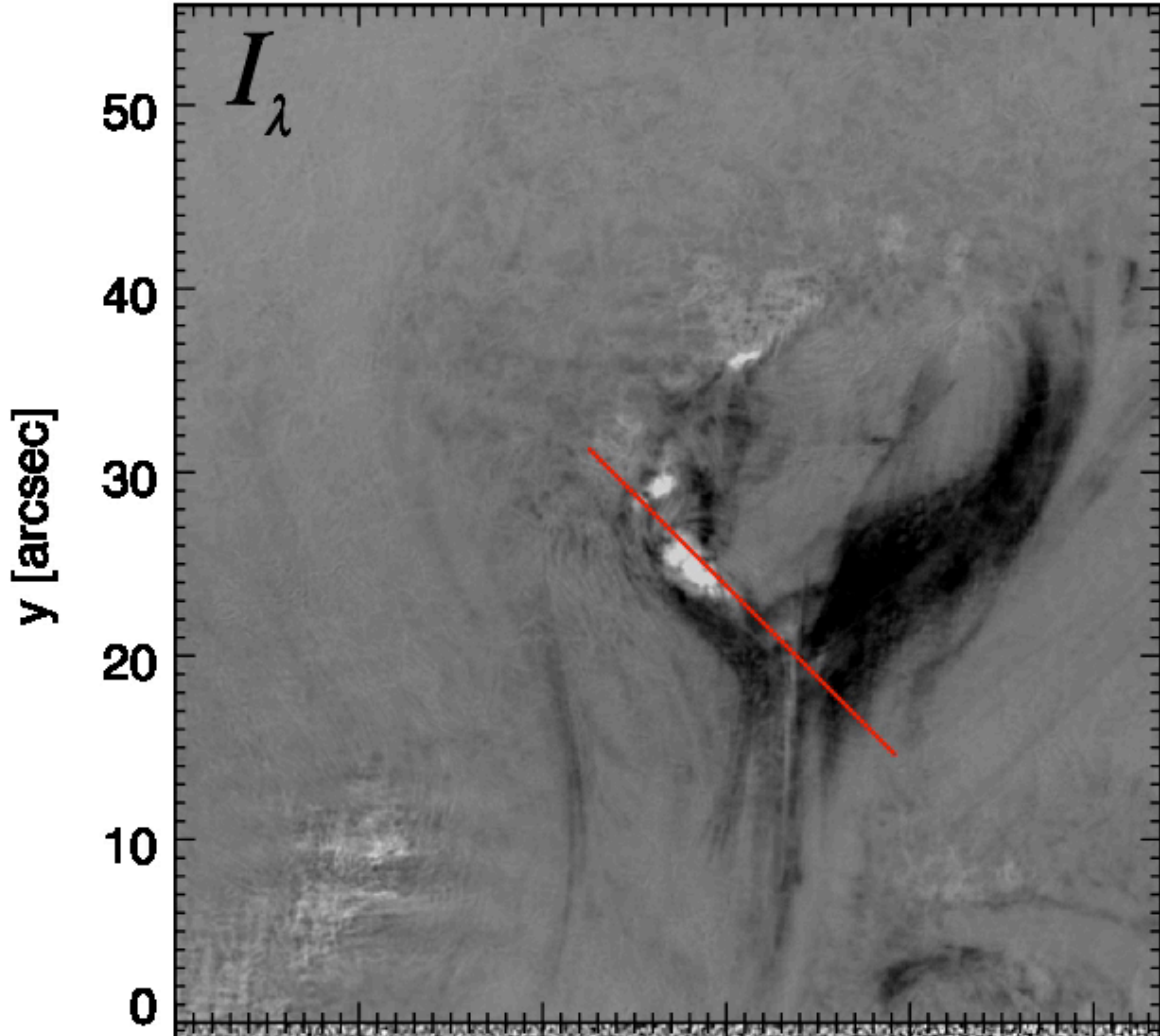
I_λ
Q_λ
U_λ
V_λ
I
Q
U
V
y [arcsec]
x [arcsec]
slit [arcsec]
λ [Å]



I_λ
Q_λ
U_λ
V_λ
I
Q
U
V
y [arcsec]
x [arcsec]
slit [arcsec]
λ [Å]

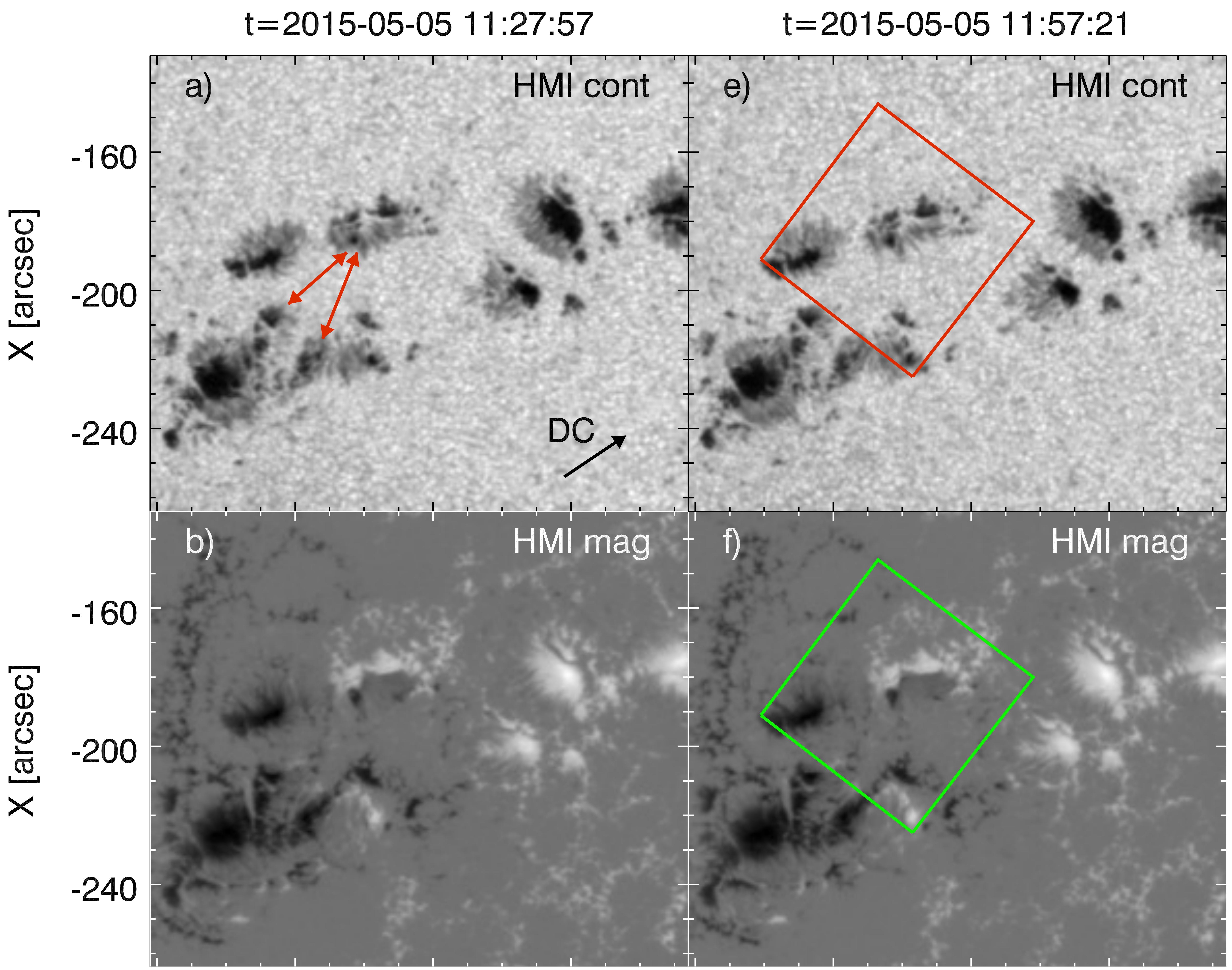


I_λ
Q_λ
U_λ
V_λ
I
Q
U
V
y [arcsec]
x [arcsec]
slit [arcsec]
λ [Å]

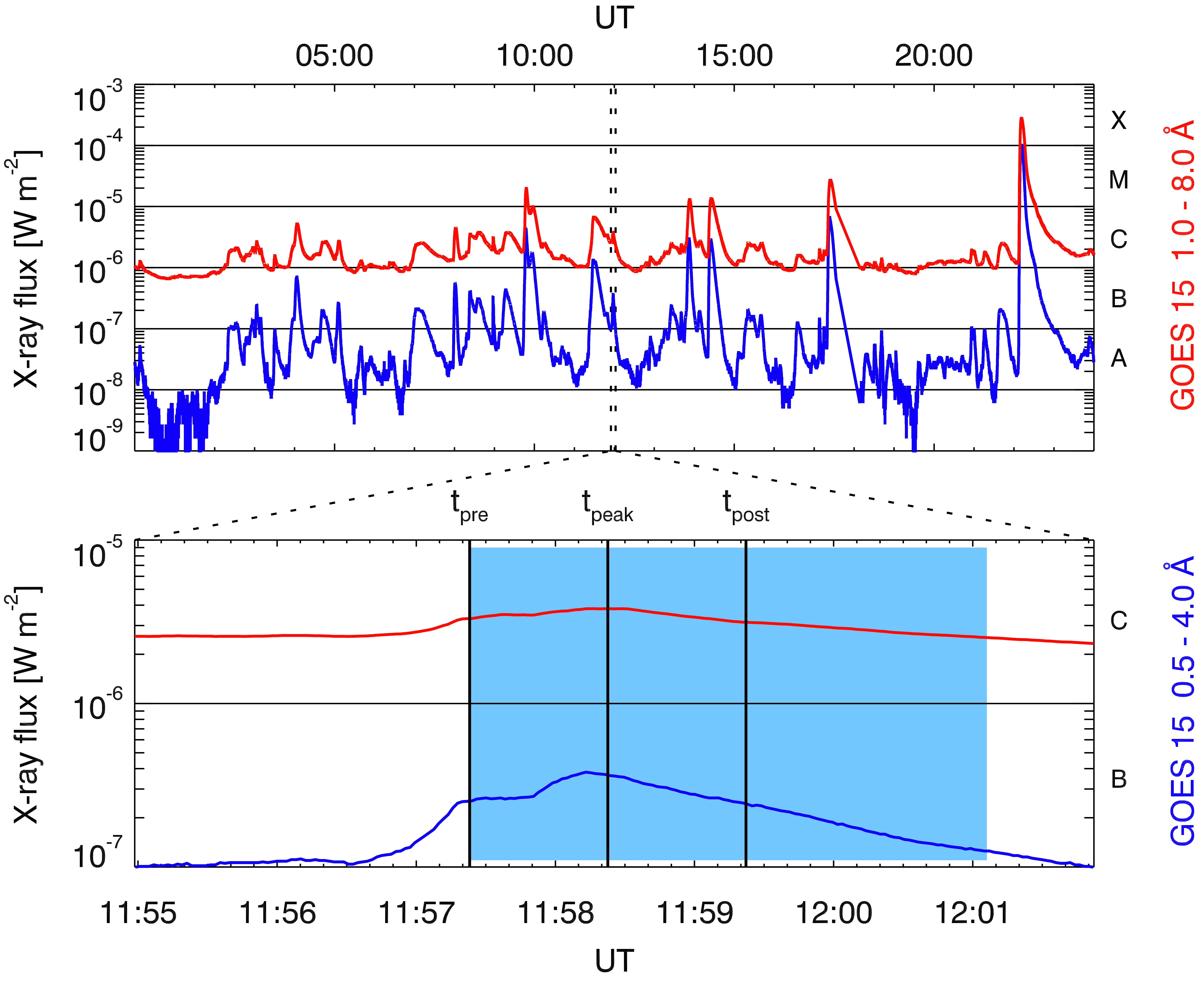


I_λ
y [arcsec]
50
40
30
20
10
0

Observations with SDO/HMI



X-ray flux during the observation

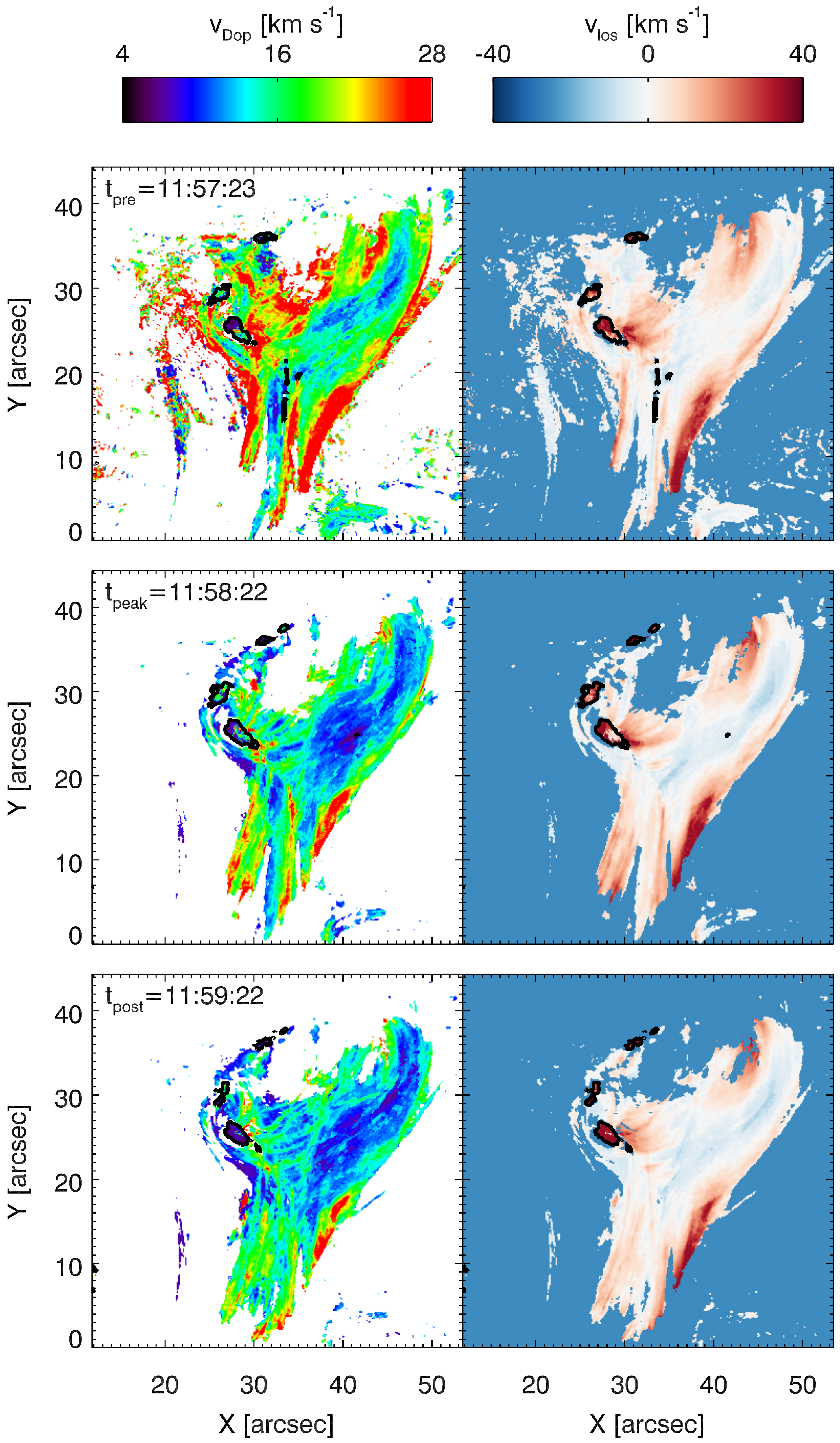


Inversions

Hazel-1 (Asensio Ramos et al. 2008)

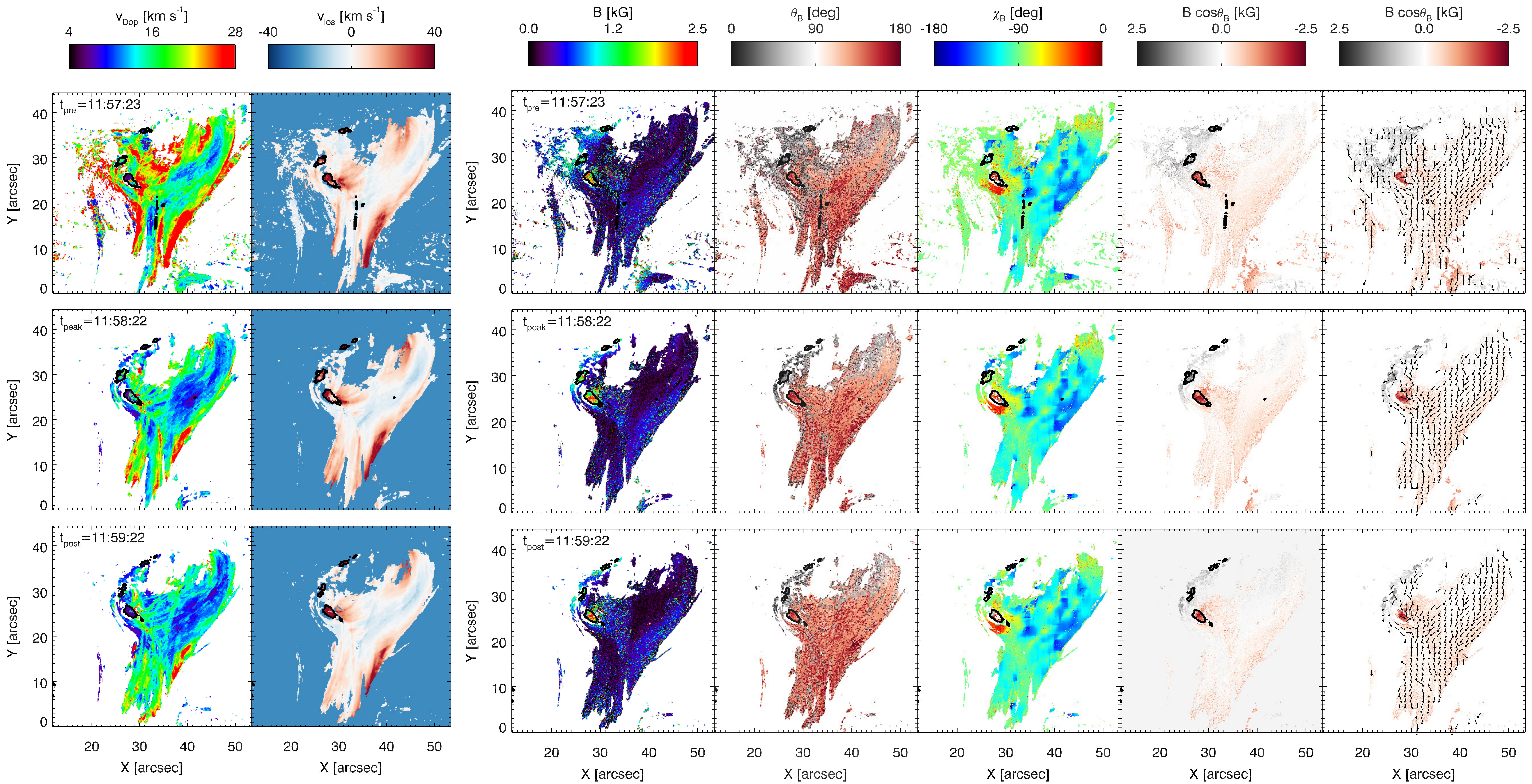
- Single slab model in flare loops.
- Two slabs at the foot points.

Flare loops



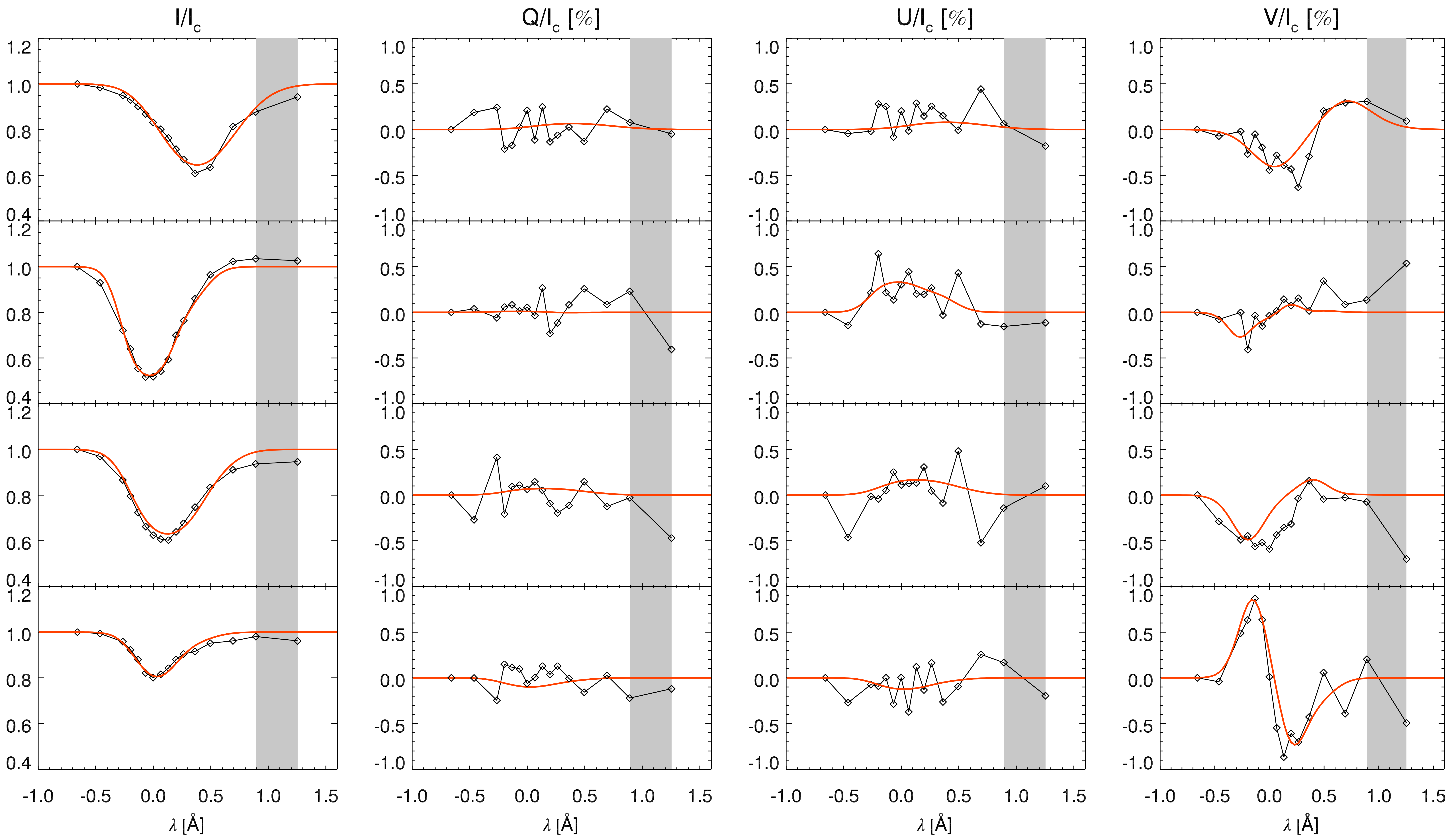
v_{Dop} [km s^{-1}]
4
16
28
v_{los} [km s^{-1}]
-40
0
40
t_{pre}=11:57:23
t_{peak}=11:58:22
t_{post}=11:59:22
Y [arcsec]
X [arcsec]

Flare loops

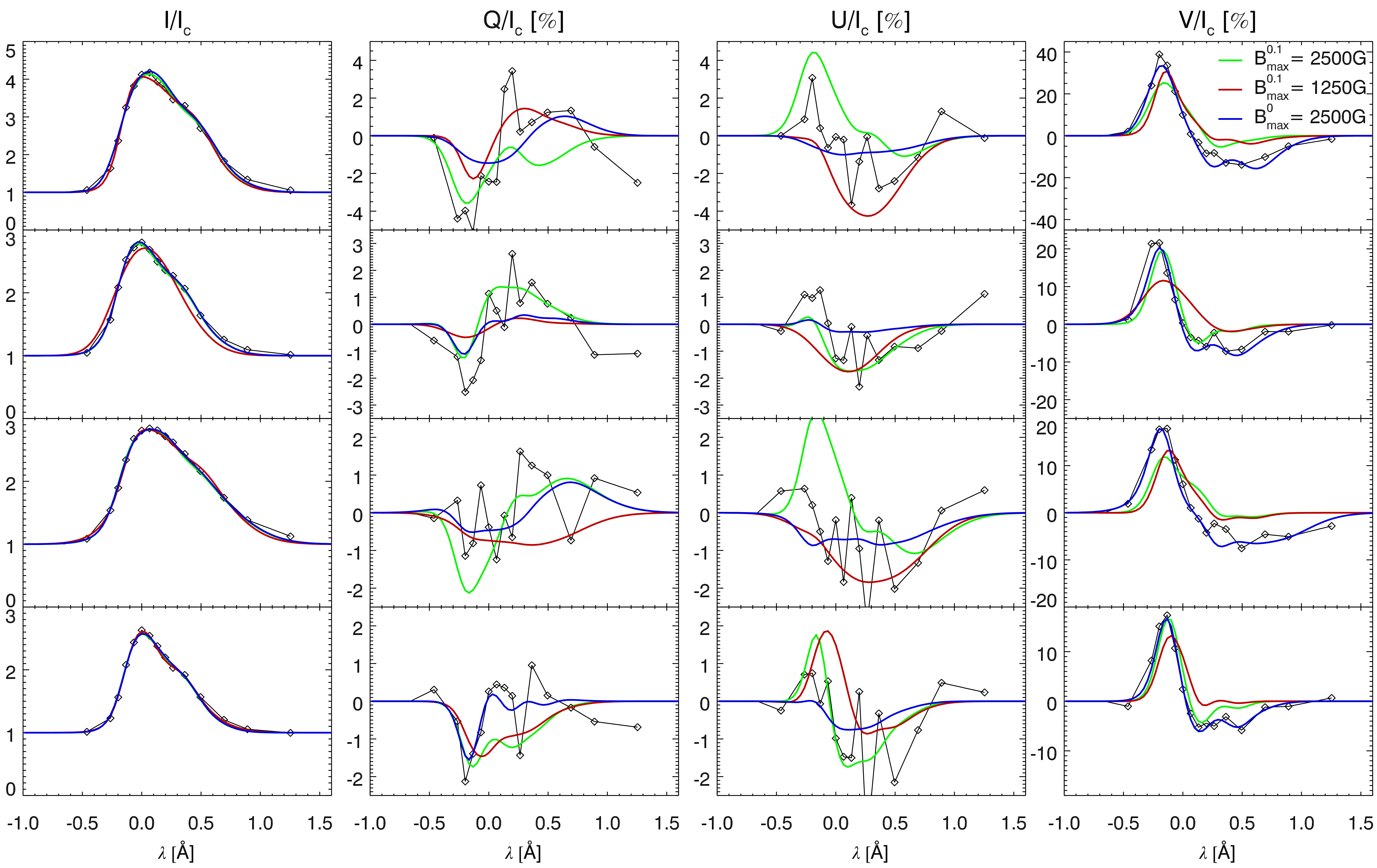


v_{Dop} [km s^{-1}]
v_{los} [km s^{-1}]
B [kG]
θ_B [deg]
χ_B [deg]
B cosθ_B [kG]
B cosθ_B [kG]
t_{pre}=11:57:23
t_{peak}=11:58:22
t_{post}=11:59:22
Y [arcsec]
X [arcsec]

Flare loops

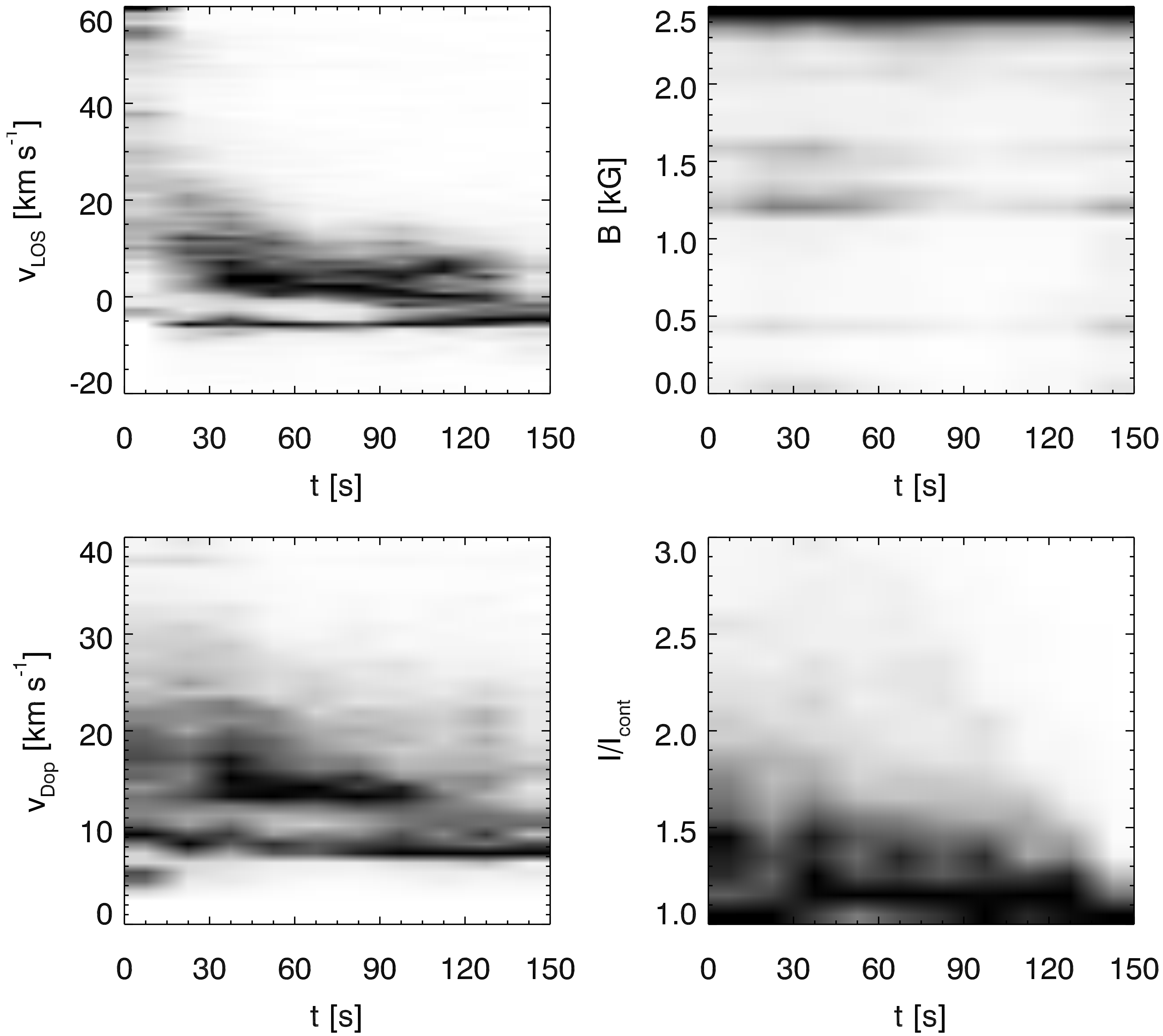


Footpoints



I/I$_c$
Q/I$_c$ [%]
U/I$_c$ [%]
V/I$_c$ [%]
$B^{0.1}_{max}$ = 2500G
$B^{0.1}_{max}$ = 1250G
B^{0}_{max} = 2500G
λ [Å]

Footpoints

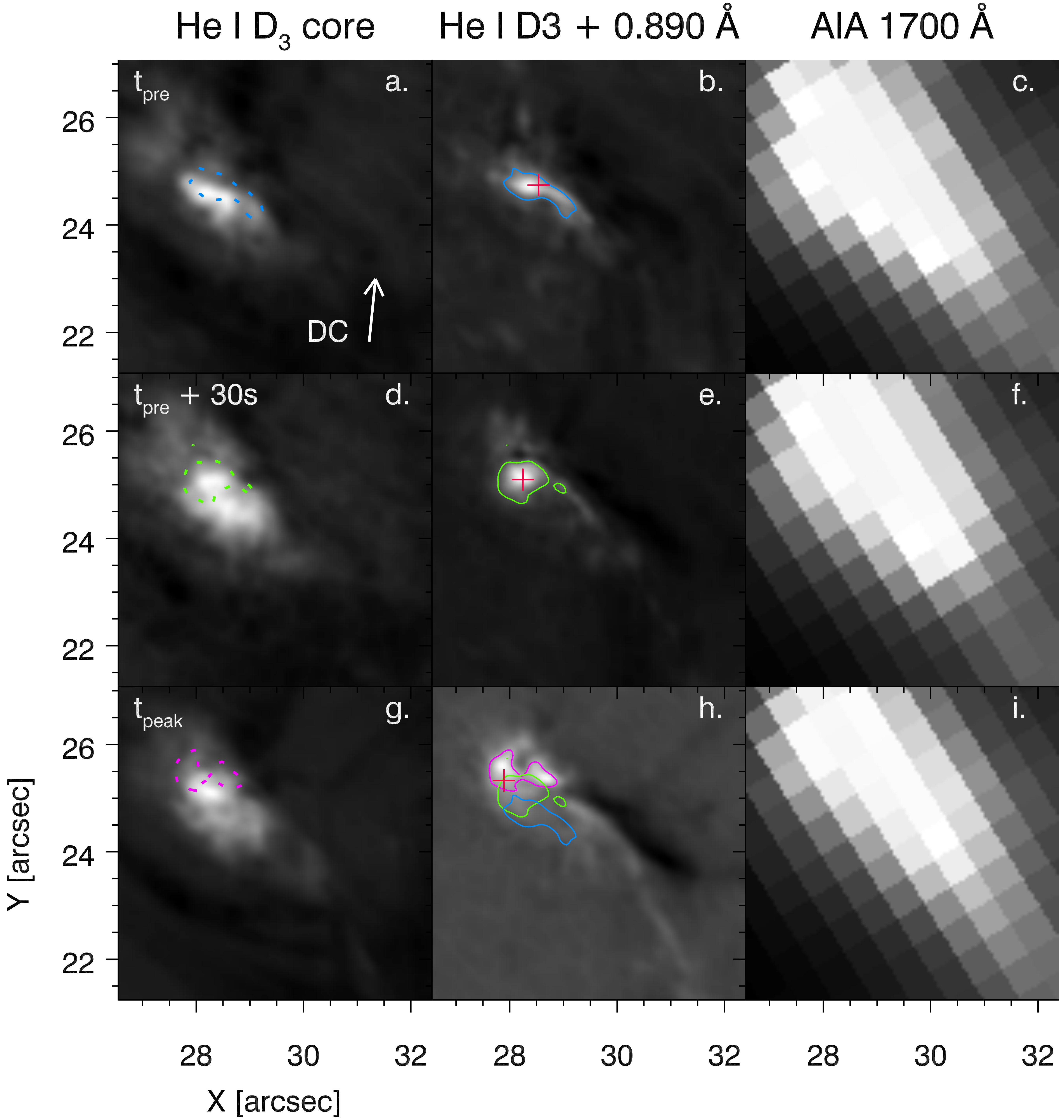


- Very similar velocity behaviour as Graham & Cauzzi (2015).
- But also a blue-shifted population.
- Vdop and I also may show similar correlations.

Footpoints

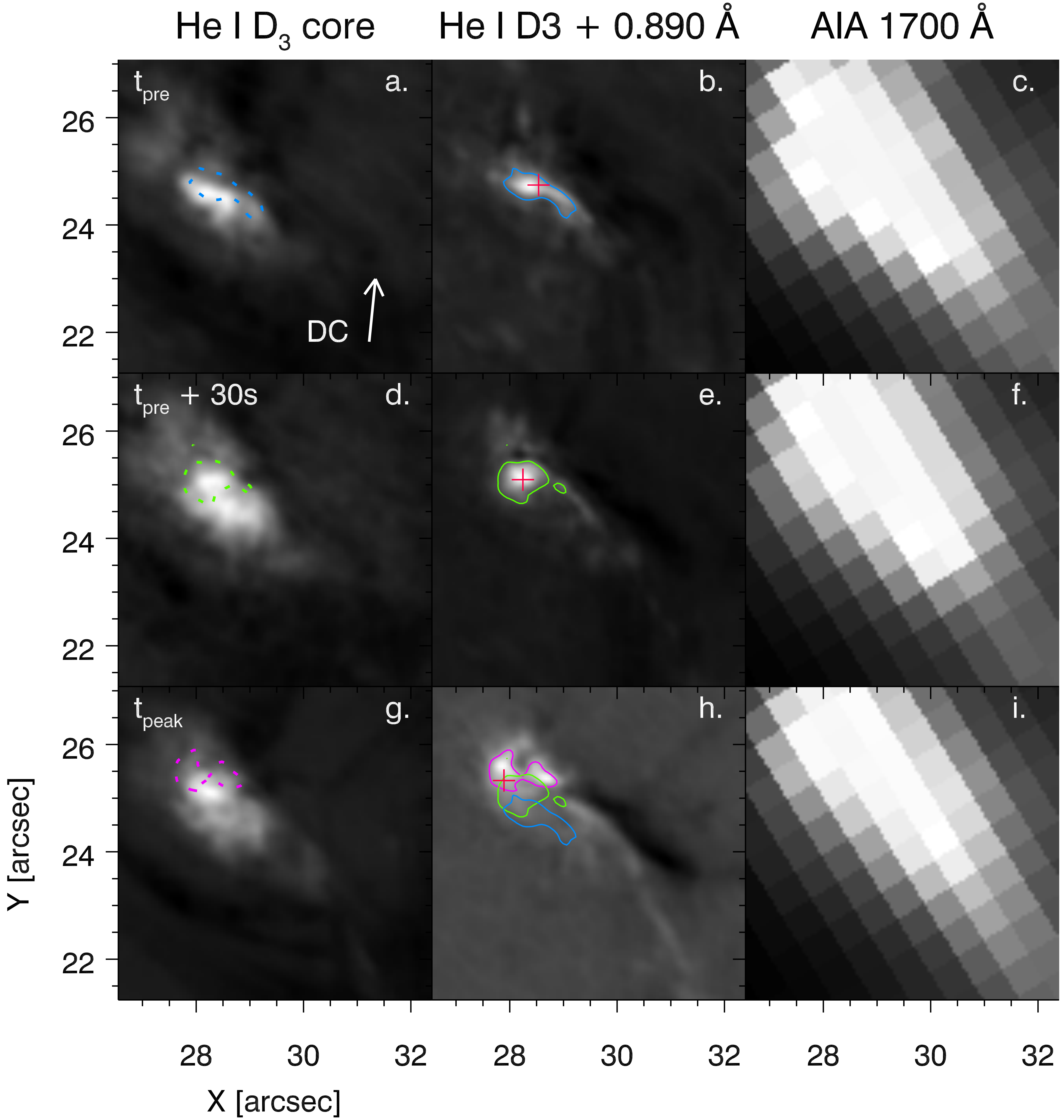
x=28.6", y=24.7"
x=28.3", y=25.1"
x=27.9", y=25.4"
Stokes I
Stokes V
12:00:06
11:59:52
11:59:37
t_post=11:59:22
11:59:07
11:58:52
11:58:37
t_peak=11:58:22
11:58:07
11:57:52
11:57:37
t_pre=11:57:23
-1.0 -0.5 0.0 0.5 1.0
λ [Å]

Footpoints

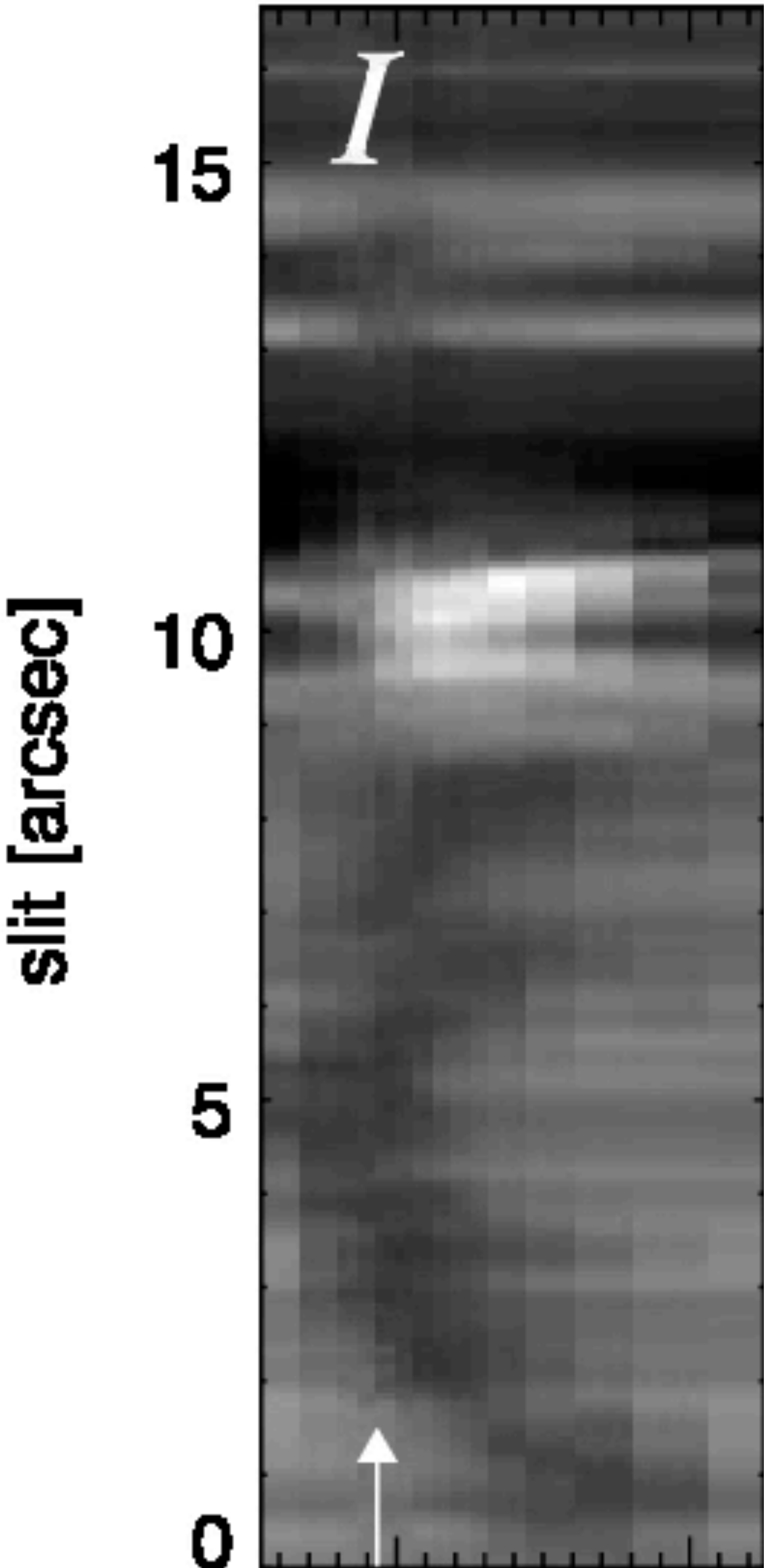


He I D$_3$ core
He I D3 + 0.890 Å
AIA 1700 Å
t$_{pre}$
a.
b.
c.
DC
t$_{pre}$ + 30s
d.
e.
f.
t$_{peak}$
g.
h.
i.
26
24
22
Y [arcsec]
28
30
32
X [arcsec]

Footpoints

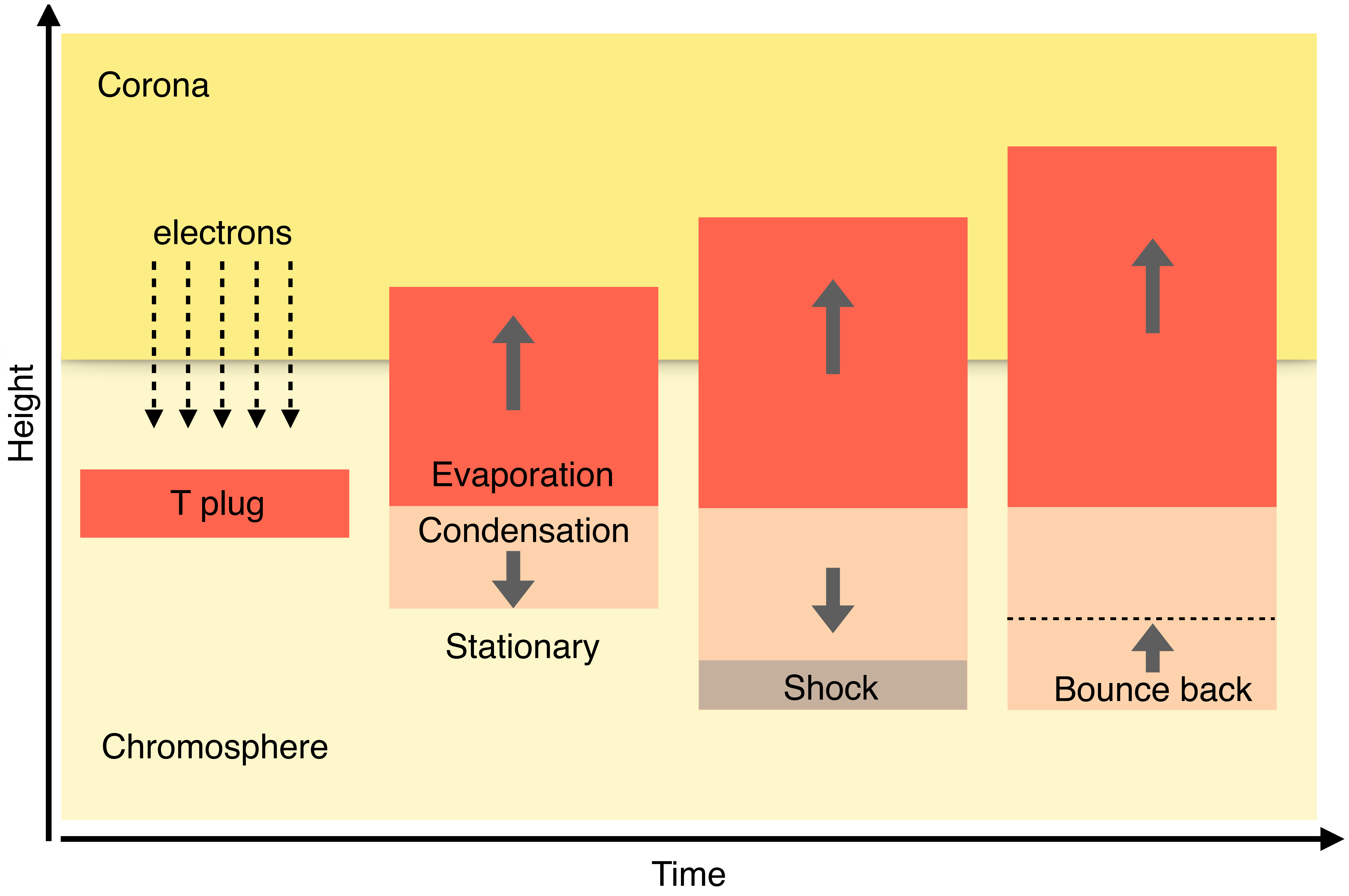


He I D_3 core
He I D3 + 0.890 Å
AIA 1700 Å
t_{pre}
t_{pre} + 30s
t_{peak}
a.
b.
c.
d.
e.
f.
g.
h.
i.
DC
Y [arcsec]
X [arcsec]
26
24
22
28
30
32



I
slit [arcsec]
15
10
5
0

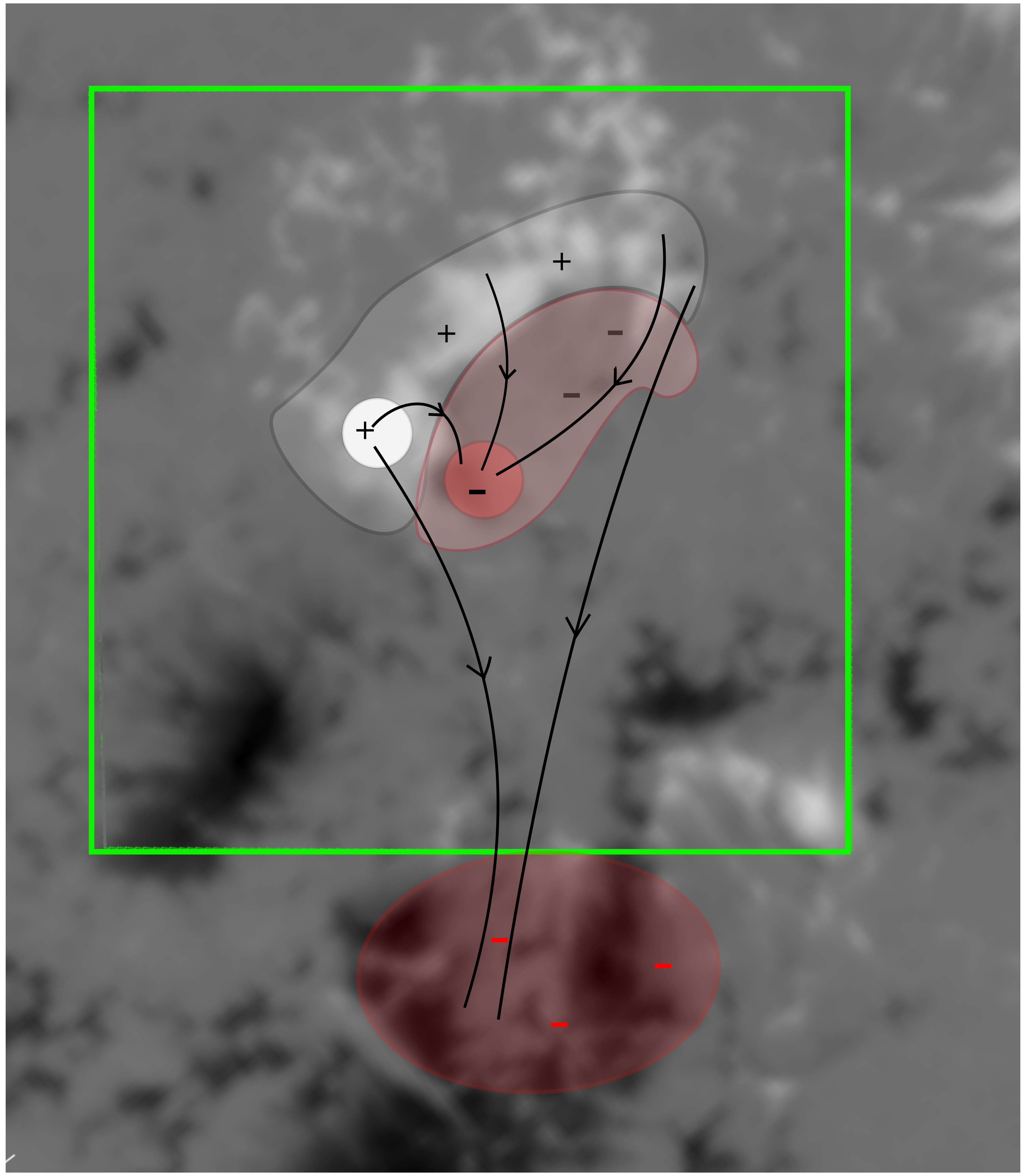
Footpoints


Corona
electrons
T plug
Evaporation
Condensation
Stationary
Shock
Bounce back
Chromosphere
Height
Time

Conclusions

- He I D_3 excellent $V_{l.o.s}$ and **B** diagnostic capabilities.
- The derived magnetic field orientation is compatible with the loops orientation.
- Very good diagnostic for chromospheric condensation!

Conclusions



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