Small-scale impulsive EUV emission enhancements along network loops

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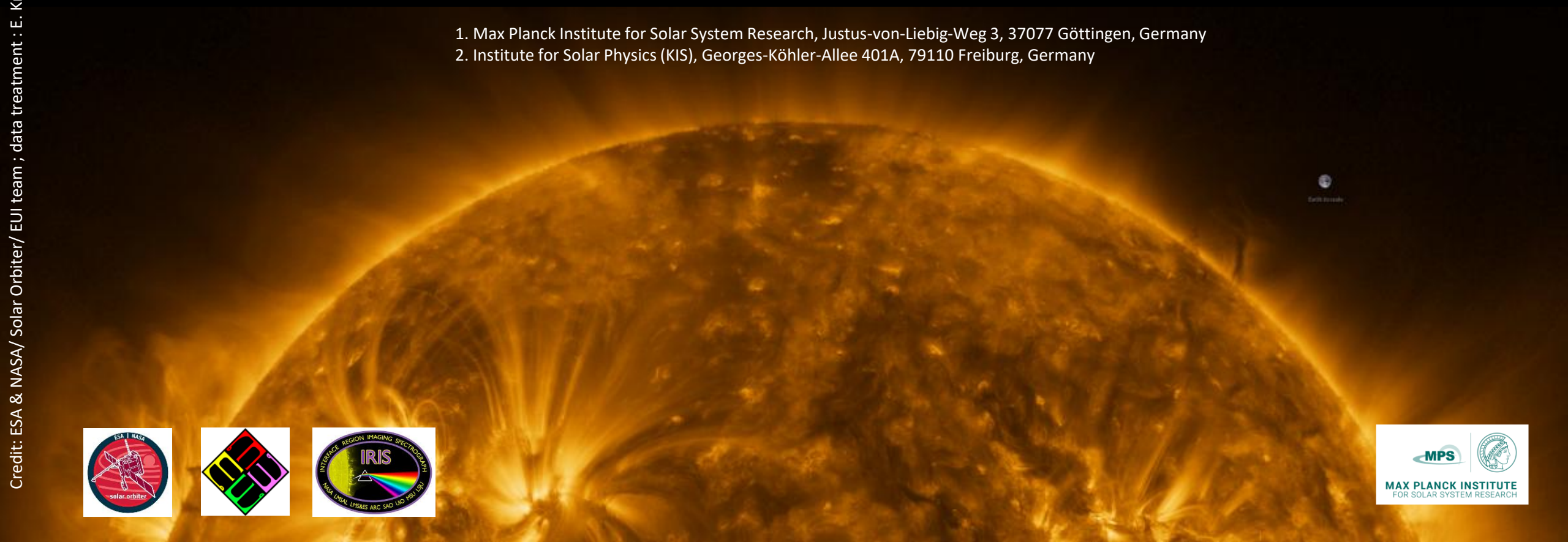


Credit: ESA & NASA/ Solar Orbiter/ EUI team ; data treatment : E. Kraaikamp (ROB).

The plasma response to a local energy deposition

Coronal heating: The main hypothesis it is impulsive and happens mainly at the smallest scales.

➔ Aim to focus on **signatures** of small-scale energy depositions.

Radiative cooling, here seen in EUI & AIA

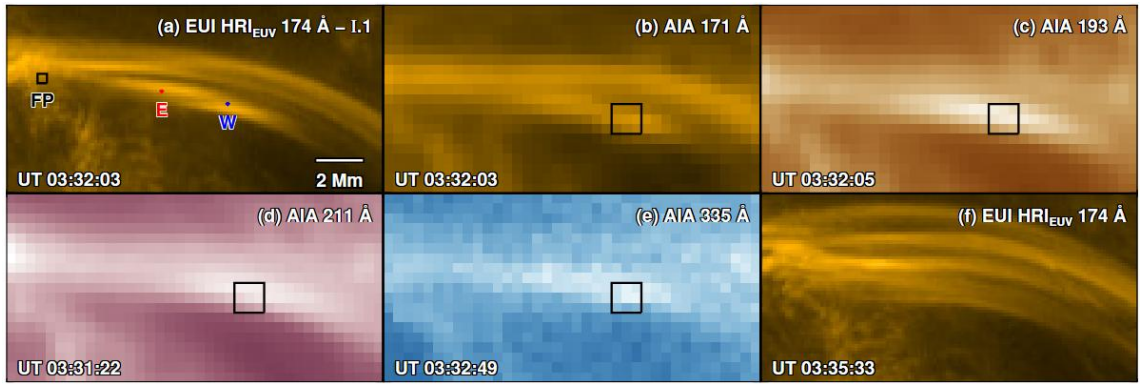
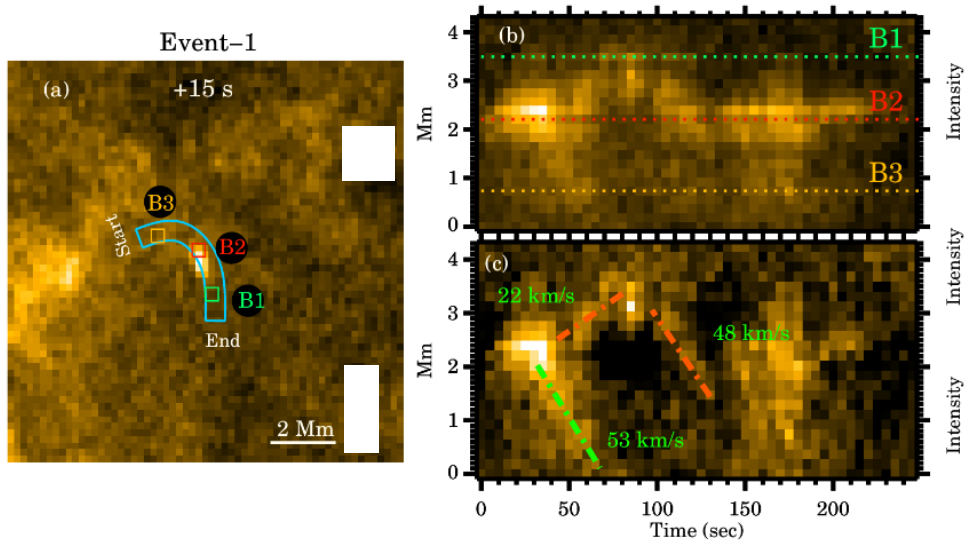


Fig. 2 of Chitta+2022

Intensity peak motions, here seen in EUI (possibly associated with emission of flows/plamoid jets)



Adapted from Fig.2 of Mandal+2022

The multi-instrumental approach

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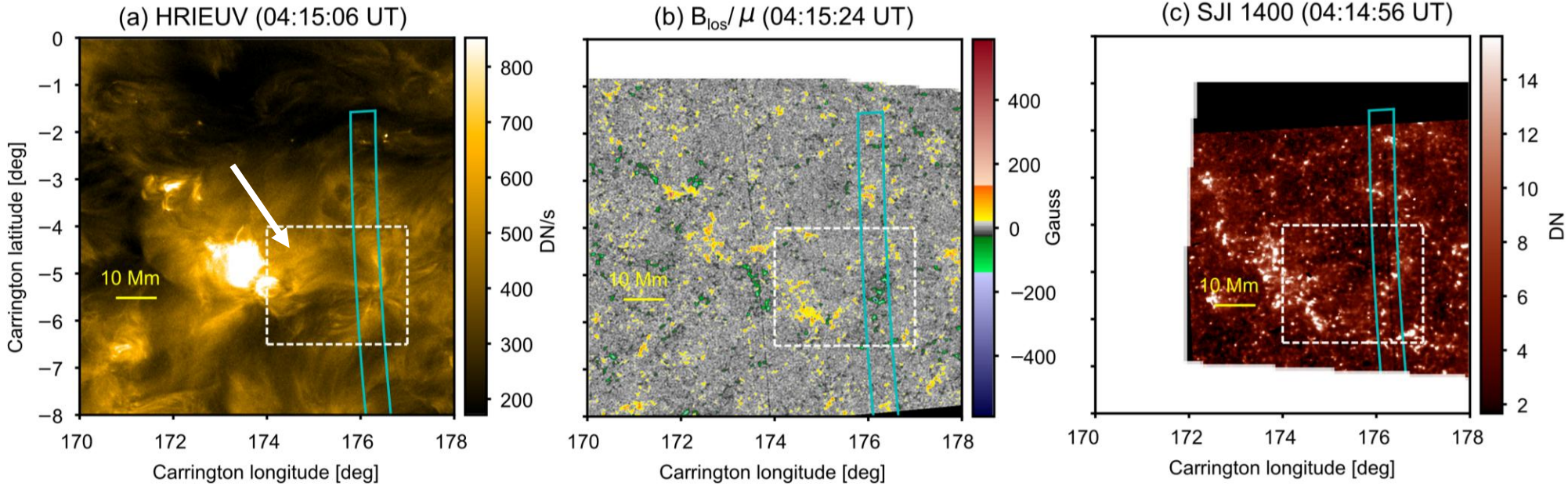
We aim to measure the plasma response following local energy depositions on a network loop bundle.

Main challenges we aim to solve with a multi-instrumental approach :

- Intensity peak motions does not necessarily plasma motion.
  ➔ **We use FUV/NUV spectroscopy to find evidence of up/downflows along the line of sight.**

- Similar observational signatures in UV Imaging/spectroscopy can have a wide variety of physical origin.
  ➔ **Photospheric magnetic field measurements to find evidence of flux emergence/cancellation.**

Quiet Sun observation on 2023 April 10th (03:30 – 09:30 UT)



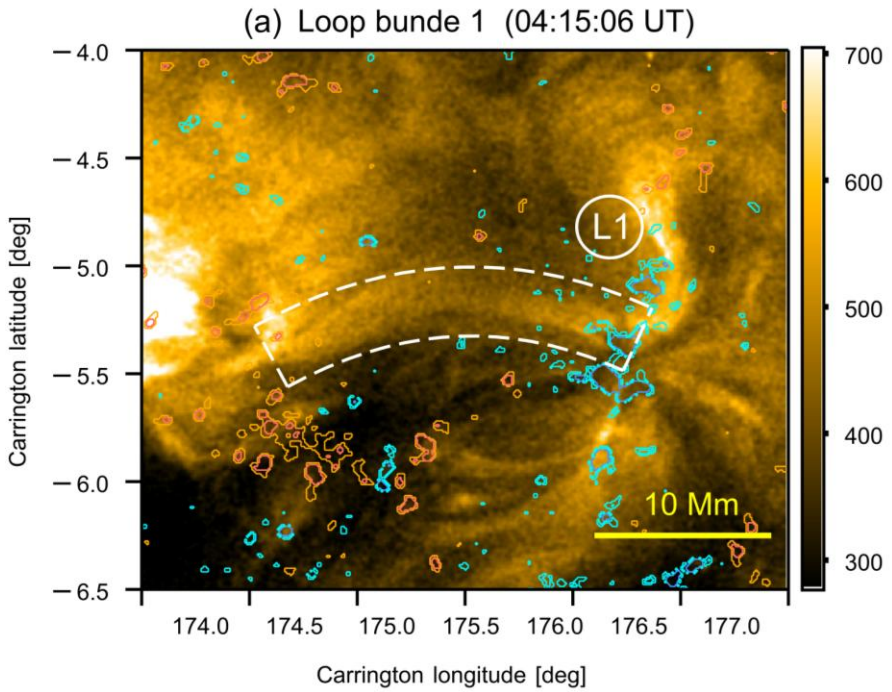
SOOP: R_BOTH_HRES_HCAD_NANOFLARES (coordinated by L. R. Bellot Rubio). It includes :

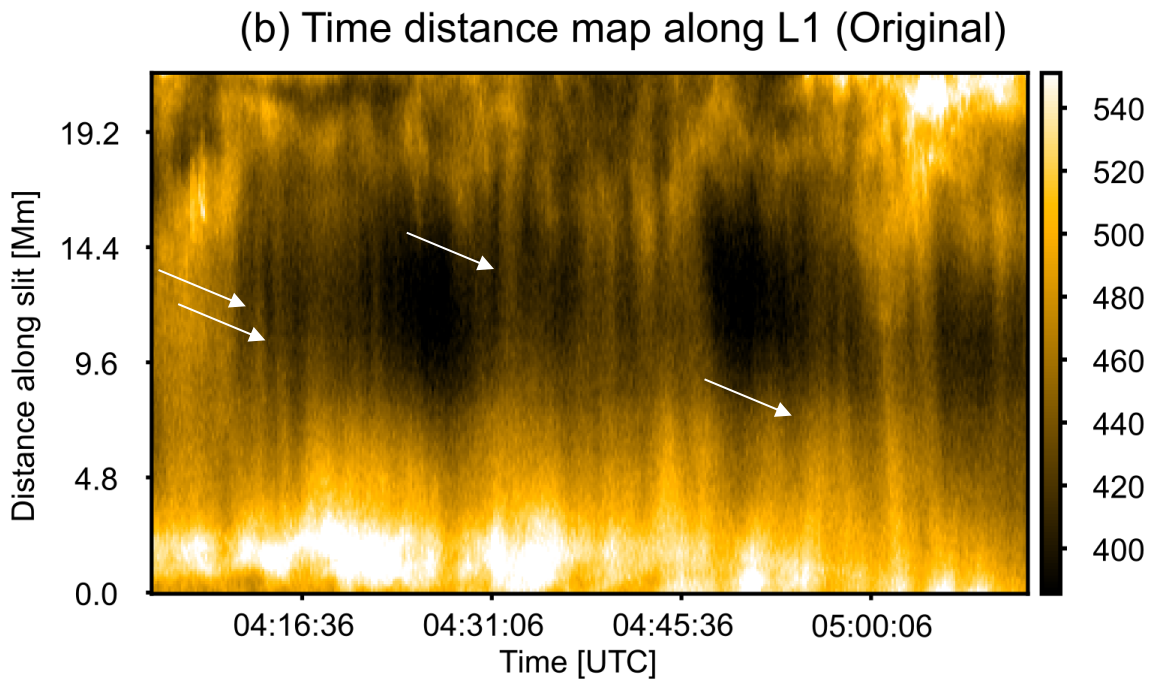
- EUI/HRIEUV at very high spatial resolution (103 km) and 10 s.
- PHI/HRT at 1 min cadence.
- IRIS SJI and spectrograph (8-step sparse raster of 70s, **cyan FOV**).

This network loop bundle (white dotted rectangle) has its right footpoint within the IRIS spectrograph FOV.

Detection of the intensity enhancements along the network loop

We aim to detect EUV enhancements along the network loops and measure their PoS velocity.

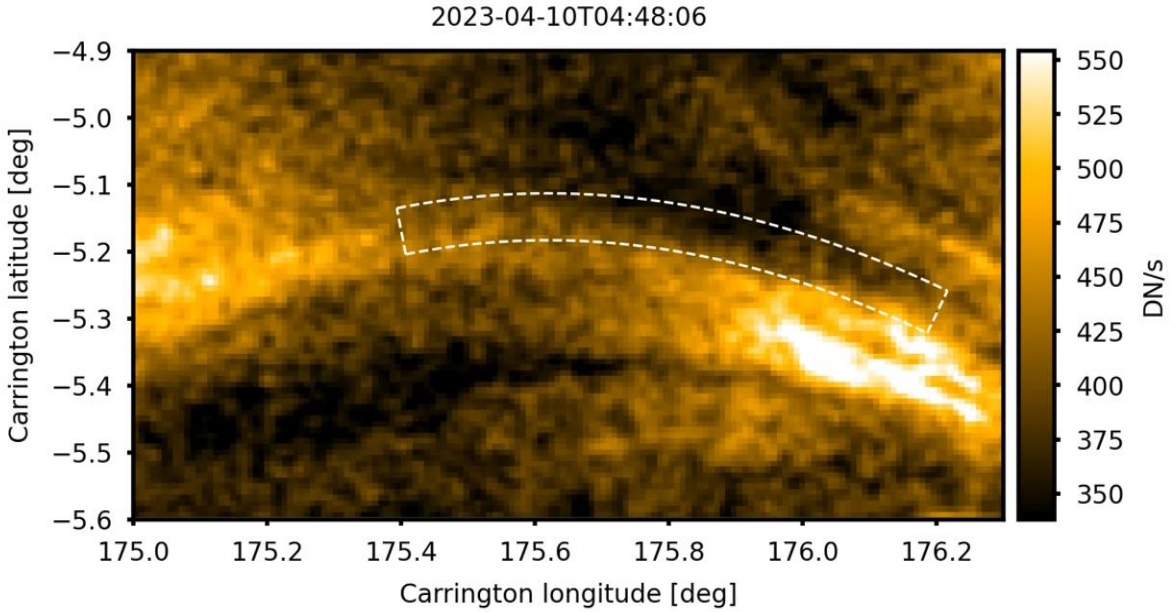


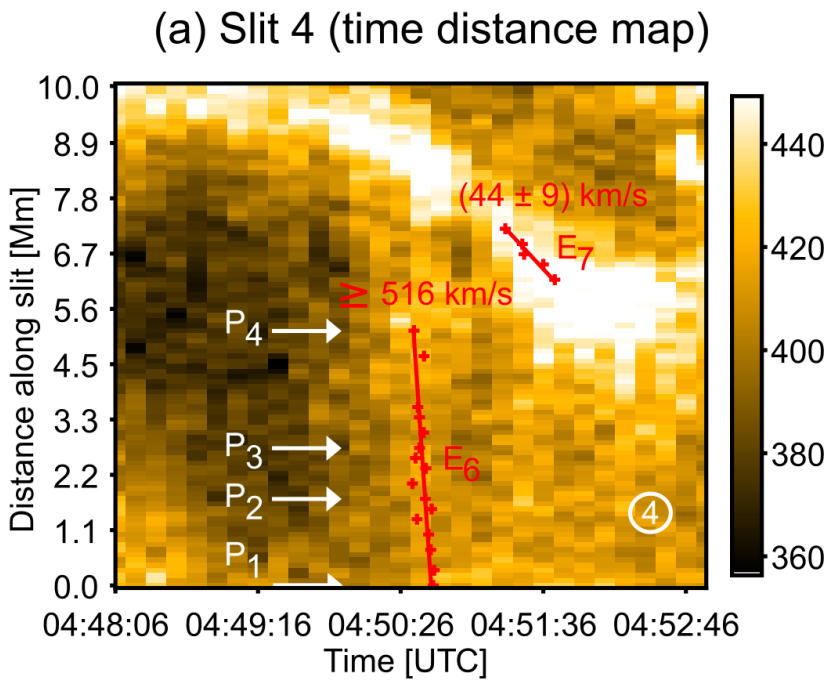


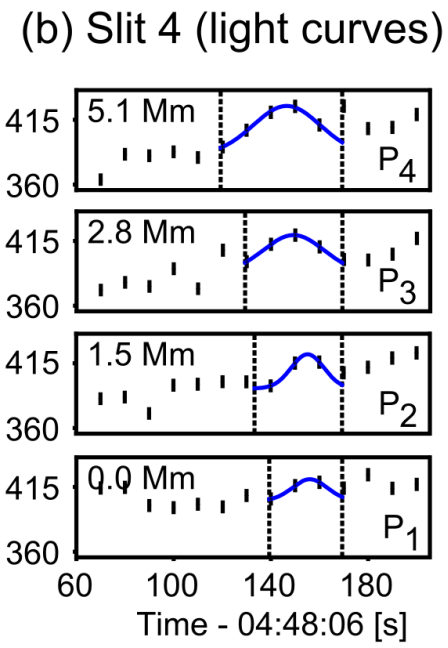
- We detect regular EUV emission enhancements along the loop (two dozens/hour).
- Happen during the whole time interval of one hour.

➔ **Consequence of local energy deposition ? Look for four of them in more details.**

Example of one specific EUV emission enhancement :







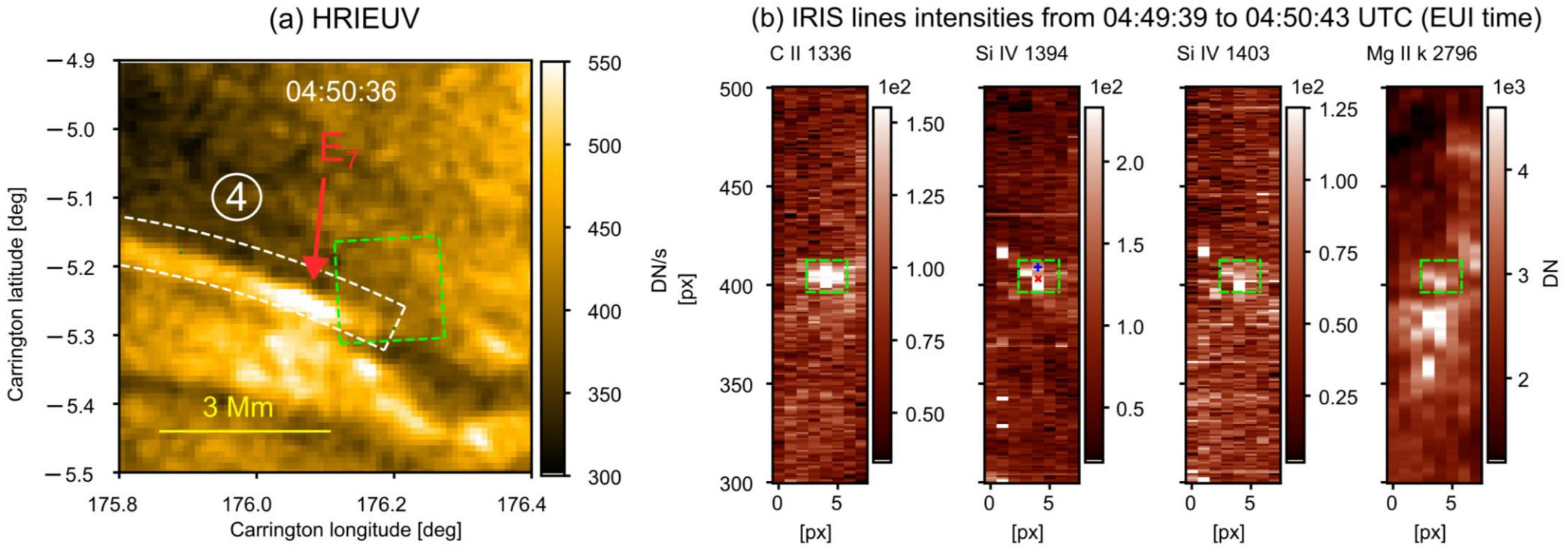
Two distinct co-temporal features:

- E6 : The strand appears to brighten instantaneously (v_{cad} > 516 km/s).
- E7 : An intensity peak motion with a PoS velocity (44 ± 9) km/s.

➔ **Now we look if one of the intensity peak motion is associated with plasma flows.**

Evidence of plasma motion with IRIS Doppler shift measurement (1)

Doppler shifts in the IRIS SI IV spectra can indicate plasma motion.



- **Intensity peak in multiple IRIS lines** at the time of E_7 (44 ± 9 km/s) and at its spatial location.
- Location at the right footpoint of the loop bundle.

We averaged the spectra of Si IV 1394 (logT = 4.8) over the region in **green**,

Evidence of plasma motion with IRIS Doppler shift measurement (2)

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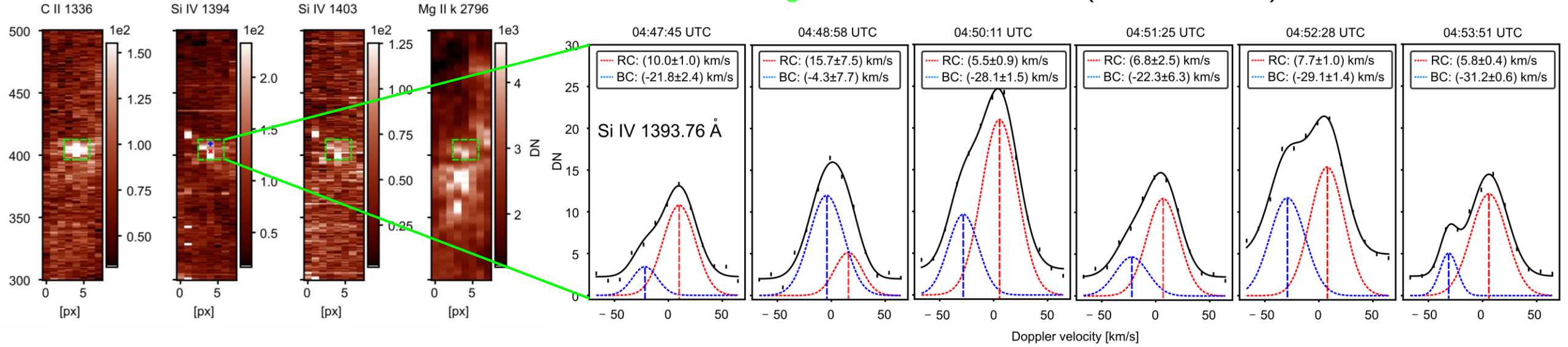
Green region : evolution with time (E7 at 04:50 UT)



Main IRIS results :

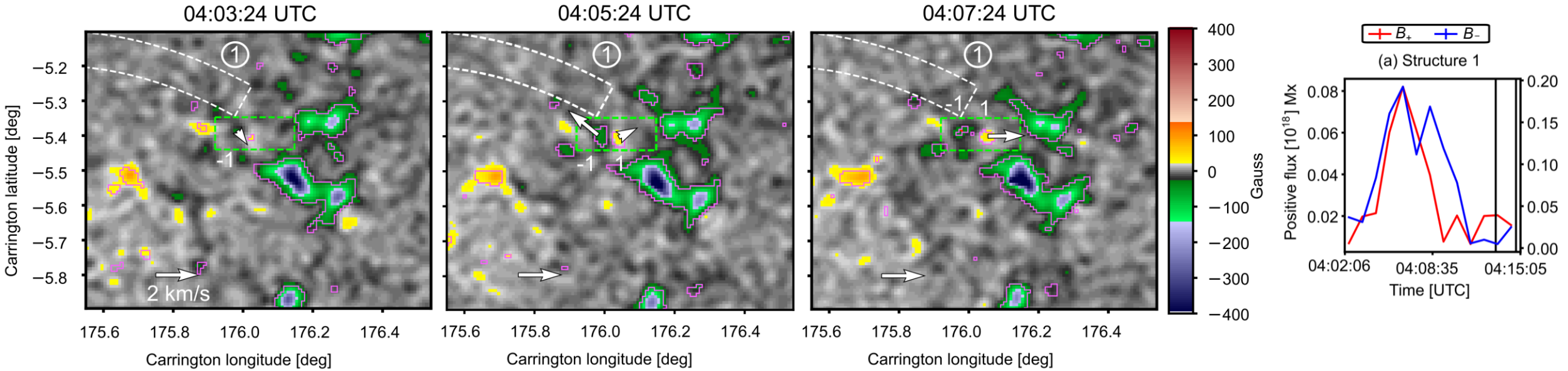
- Intensity peak in EUI associated with **upflows (32 km/s**) in the lower part of the loop.
- Bi-directional flows can be the consequence **of local energy deposition in the lower part of the loop.**

➔ **We now for possible signatures of magnetic reconnexion in the photosphere.**

Magnetic field measurement near the negative-polarity footpoint

We look for evidence of magnetic reconnection near the loop right footpoint of the network loop.

Slit 1 : E1/E2 seen in HRIEUV (04:13 UT)



Main PHI-HRT results :

- **Small-scale flux emergence and variations** at the loop bundle footpoint.
- Small-scale positive-polarity structures moving toward the negative polarity footpoint minutes before EUV enhancements seen in HRIEUV.

Take-away points

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Main take away points (Dolliou *et al* 2026, A&A):

- **Regular EUV emission enhancements along network loops**
- PoS velocity by EUI cadence (v_{cad} > 220 km/s), and co-temporal slow component (< 80 km/s).
- Upflows (32 km/s) and downflows (18 km/s) with Si IV Doppler shifts.
- Detection small-scale flux emergence and fluctuation near loop footpoint.

Main hypotheses involving reconnection :

- Reconnection of the loop with smaller structures.
- “Internal” braiding between the field lines of the network loops (Breu+2022).