

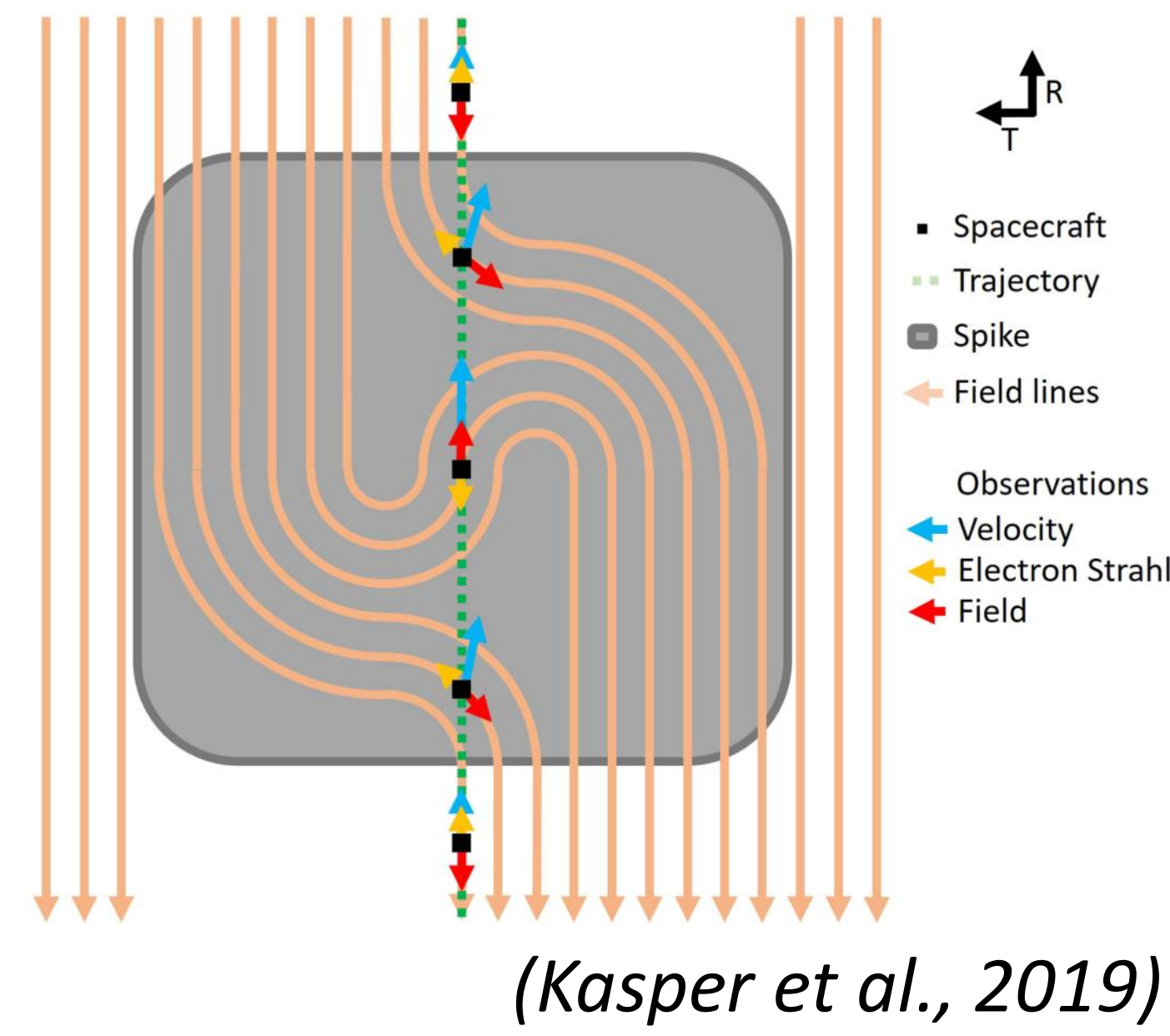
# Magnetic Reconnection as an Erosion Mechanism for Magnetic Switchbacks

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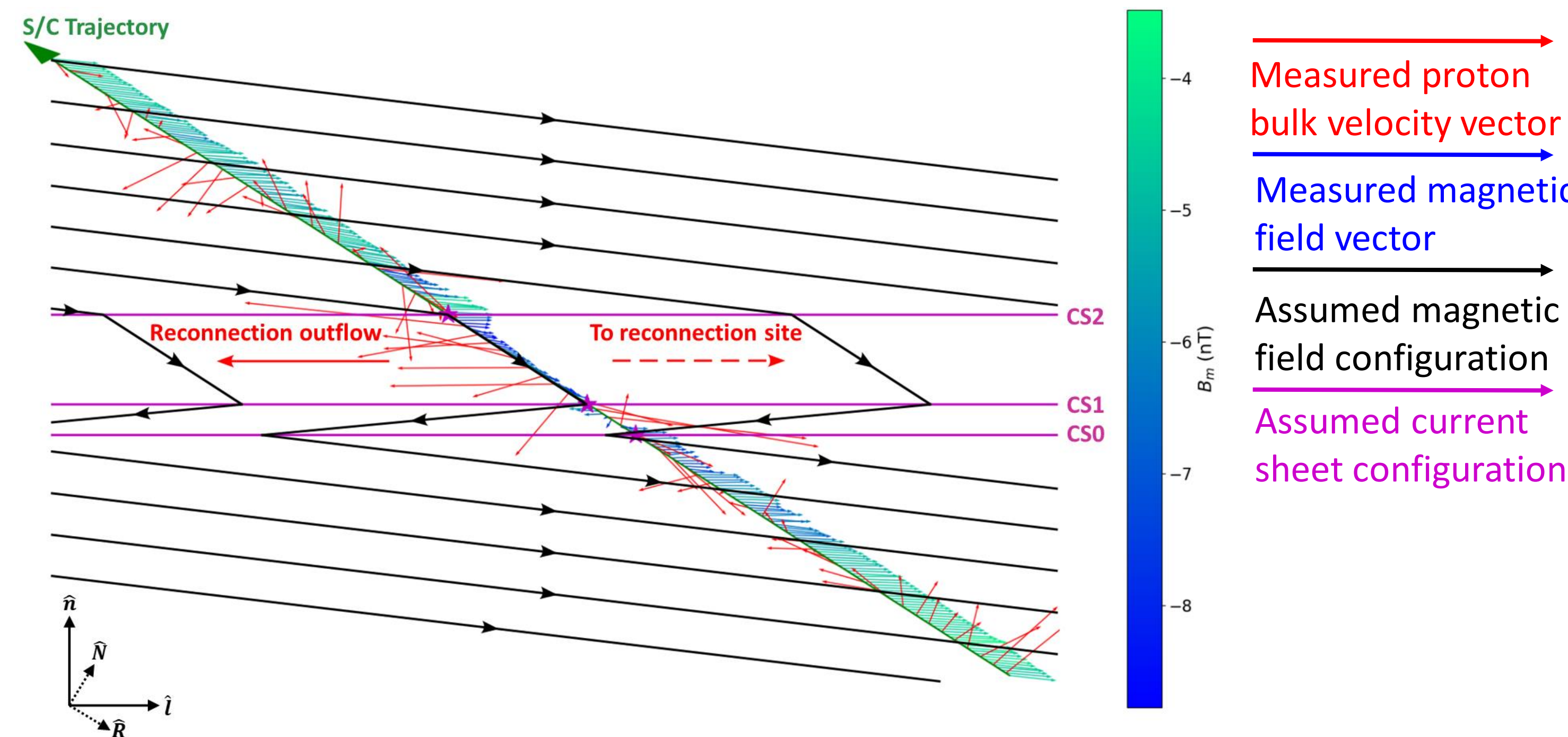
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## I. Magnetic switchbacks

- Localised polarity reversals in the radial component of the heliospheric magnetic field (HMF).
- Commonly observed in the near-Sun solar wind but are rarely seen at 1 au from the Sun and beyond.
- Magnetic reconnection** may occur at **switchback boundaries** (Froment et al., 2021).

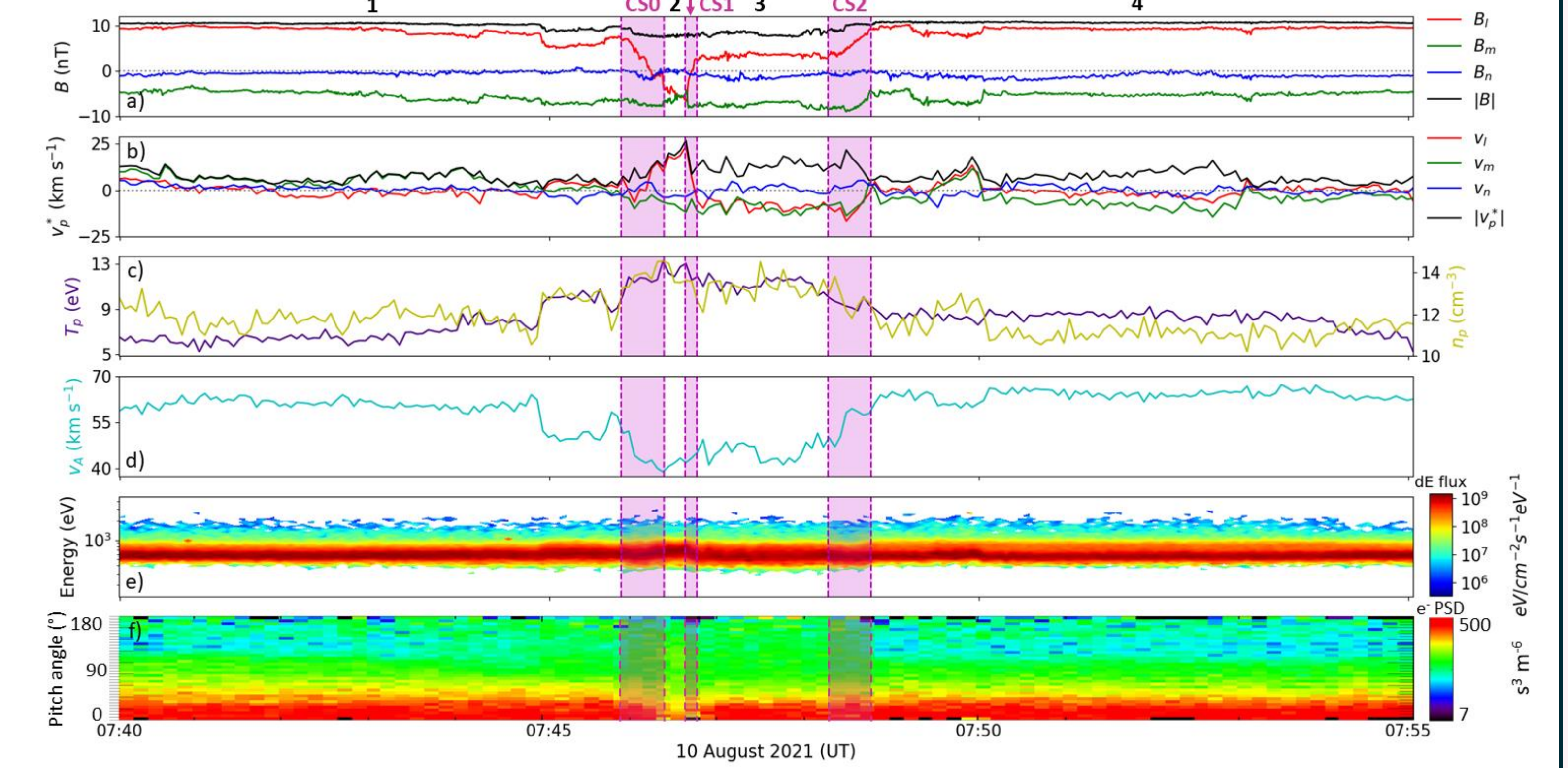
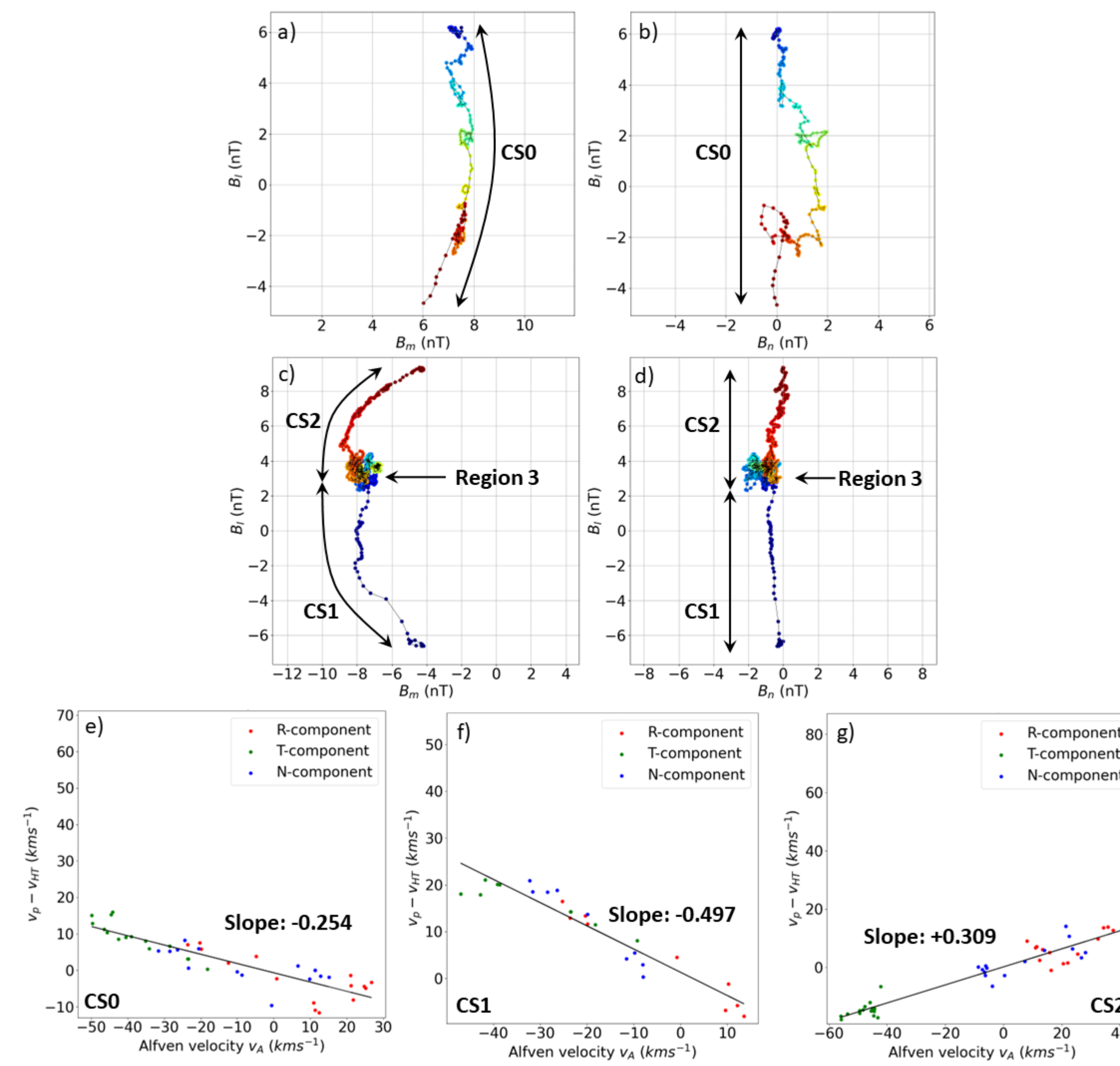


## III. Switchback and reconnection geometry



- Feather plot of the magnetic field and proton velocity measurements, interpretation of switchback geometry overlaid.
- Magnetic tension causes newly reconnected field lines to recoil away from the reconnection site, unwinding switchback in the process.
- Current sheets CS1 and CS2 form a bifurcated current sheet** bounding the reconnection outflow.
- Interpretation similar to one proposed by Fedorov et al., 2021, predicts that a **portion of the switchback is converted to a flux rope**.

## II. Observations



- Data obtained from the MAG and SWA instruments on *Solar Orbiter*.
- Switchback identified 0.71 au from the Sun on 10 August 2021 between 0745 – 0750 UT.
- Embedded within region of slow solar wind flow with **predominant HMF polarity in the anti-sunward (+R) direction**.
- Strong evidence of magnetic reconnection at the trailing edge boundary.**

## IV. Estimating the erosion timescale

Event	$\Lambda$ (km)	Dist. From Sun (au)	$\tau$ (min)	$D$ (au)
1	3570	0.72	40	0.005
2	10100	0.61	126	0.02
3	31700	0.61	2005	0.4

- Three events identified in August 2021, at heliocentric distances of 0.6 – 0.7 au.
- Switchback erosion timescale  $\tau$**  by reconnection given by:

$$\tau = \frac{\phi_{SB}}{\dot{\phi}_{out}} = \frac{B_{l,SB}\Lambda}{B_{n,out}v_{l,out}}$$

- $D \approx |\langle v_p \rangle| \tau$  is the **remaining convection distance** until complete erosion of the switchback.
- $\tau$  ranges from a **few minutes to a few hours**. Estimates for  $D$  suggest complete erosion of switchbacks occurs **before they reach 1 au**.

## V. Conclusions

- Reconnection occurs infrequently** at switchbacks but can **efficiently erode** them when it occurs.
- May explain why fewer switchbacks observed further away from the Sun compared to near the Sun.
- Study limited to **single-spacecraft measurements**; scenario presented here is **one possible configuration consistent with observations**.
- In future, repeat timing analysis on switchbacks observed by PSP, compare with results shown here.

## VI. References

- Fedorov, A. et al. (2021) [doi.org/10.1051/0004-6361/202141246](https://doi.org/10.1051/0004-6361/202141246)  
 Froment, C. et al. (2021) [doi.org/10.1051/0004-6361/202039806](https://doi.org/10.1051/0004-6361/202039806)  
 Kasper, J.C. et al. (2019) [doi.org/10.1038/s41586-019-1813-z](https://doi.org/10.1038/s41586-019-1813-z)  
 Suen, G.H.H. et al. (2023) Submitted to A&A

