MMS Spring 2021 Science Working Team Meeting

Flux transfer event with an electron-scale substructure observed by the MMS

Marcos Silveira

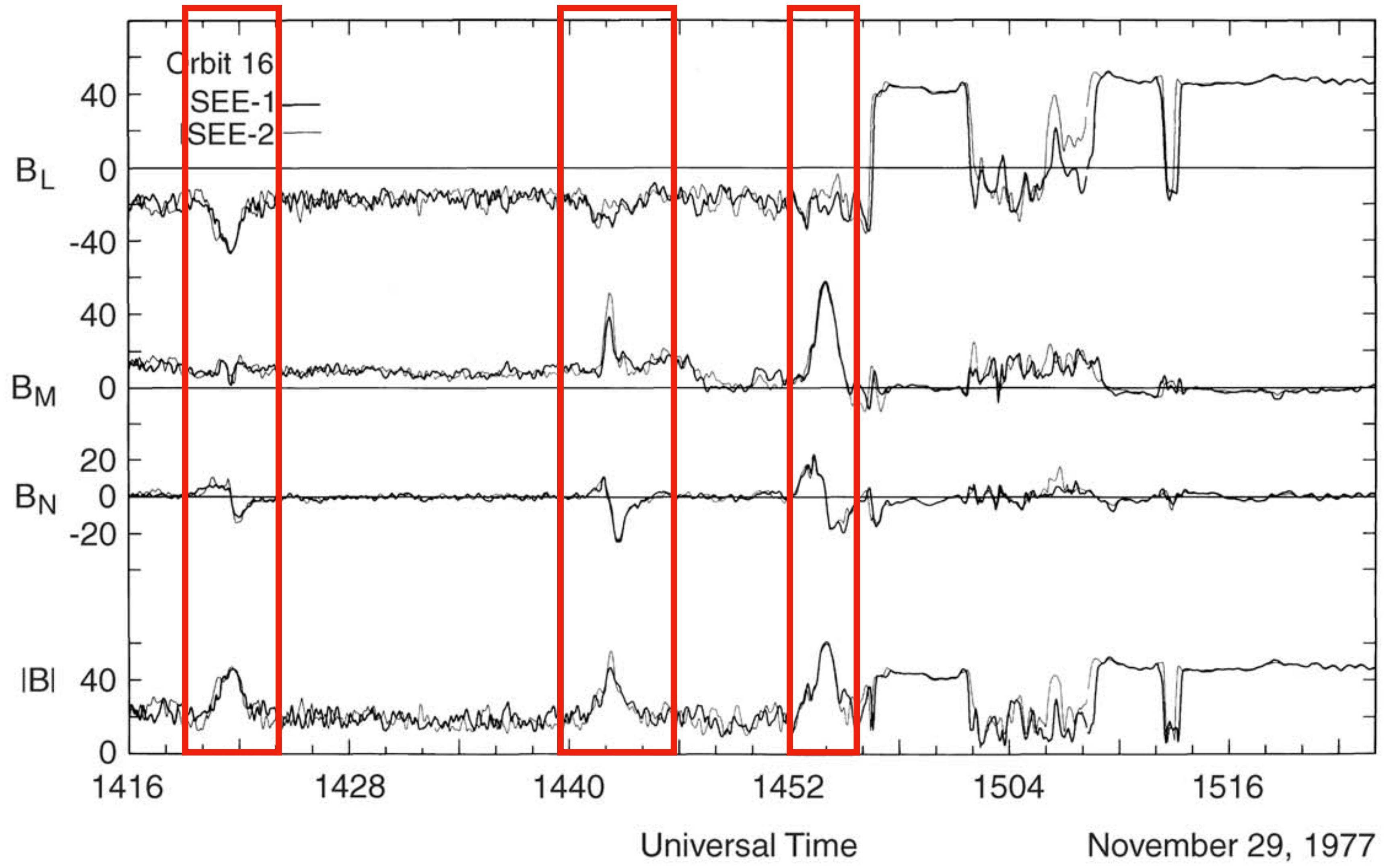
marcosvdsilviera@gmail.com

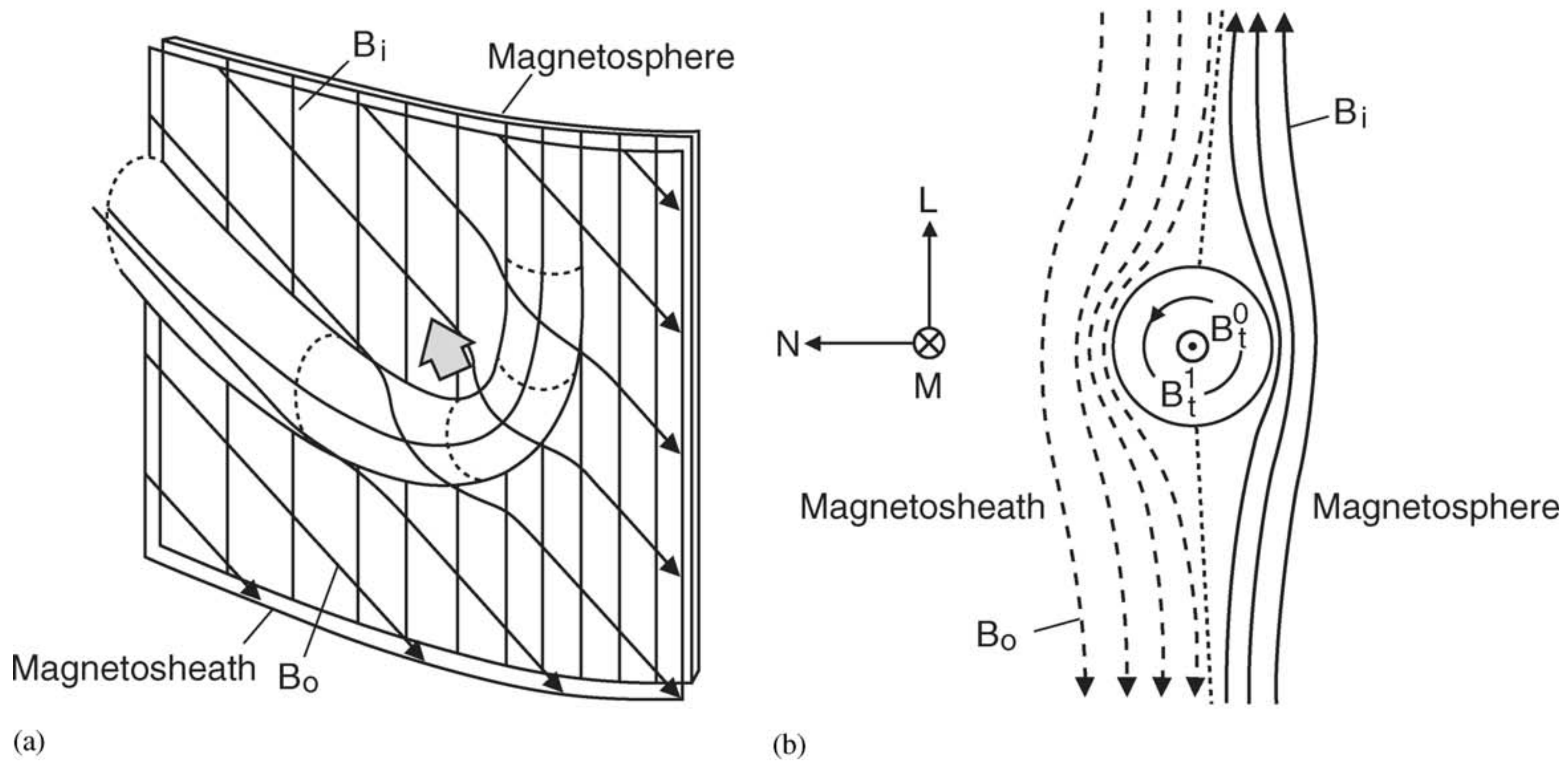
The Catholic University of America, DC, United States.

Silveira, M. D., Sibeck, D. G., Lee, S. H., Koga, D., Souza, V. M., Gonzalez, W. D., & Russell, C. T. (2020). Flux transfer event with an electron-scale substructure observed by the Magnetospheric Multiscale mission. *Journal of Geophysical Research: Space Physics*, 125, e2019JA027308. https://doi.org/10.1029/2019JA027308

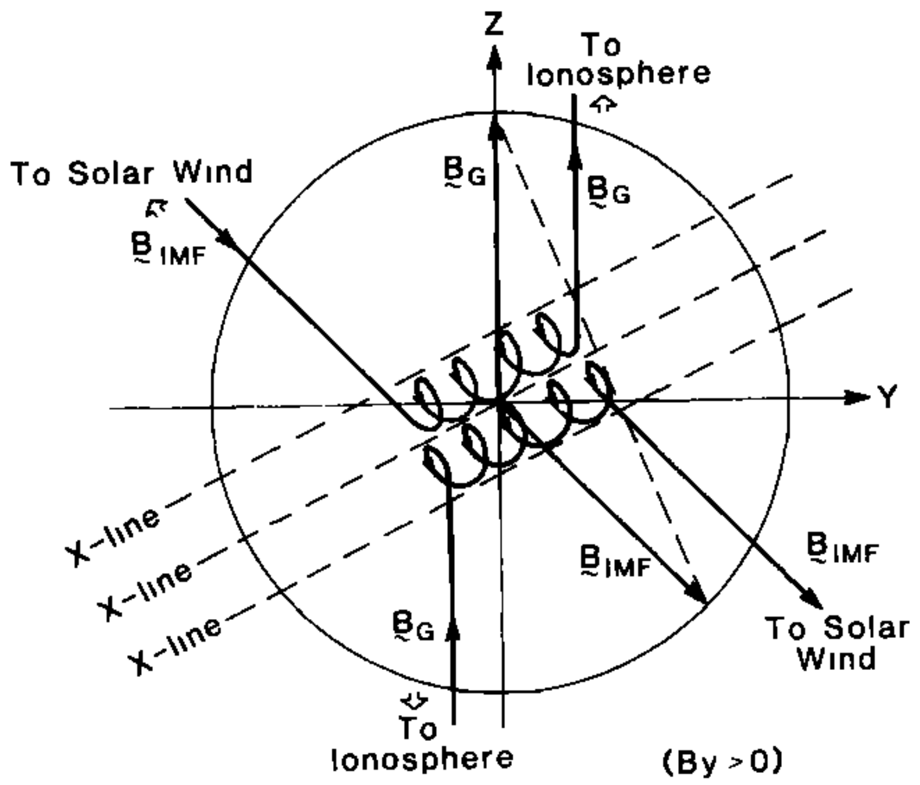
Overview

Russell and Elphic 1978,1979

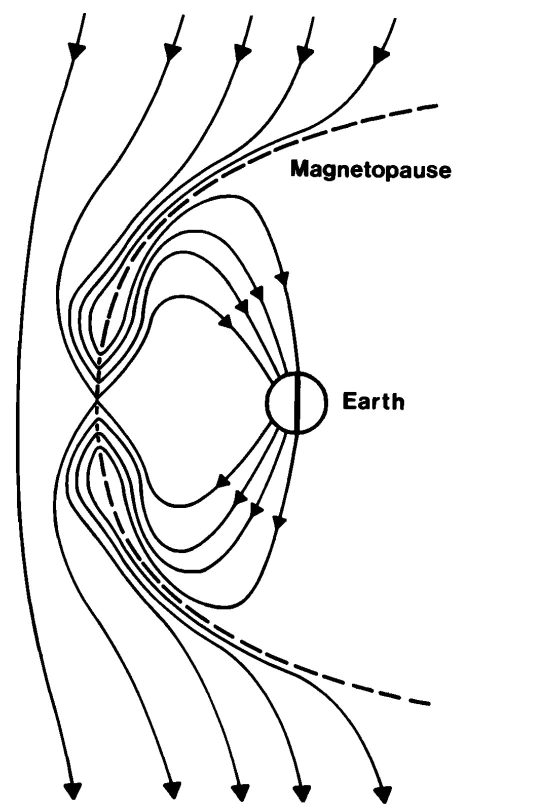




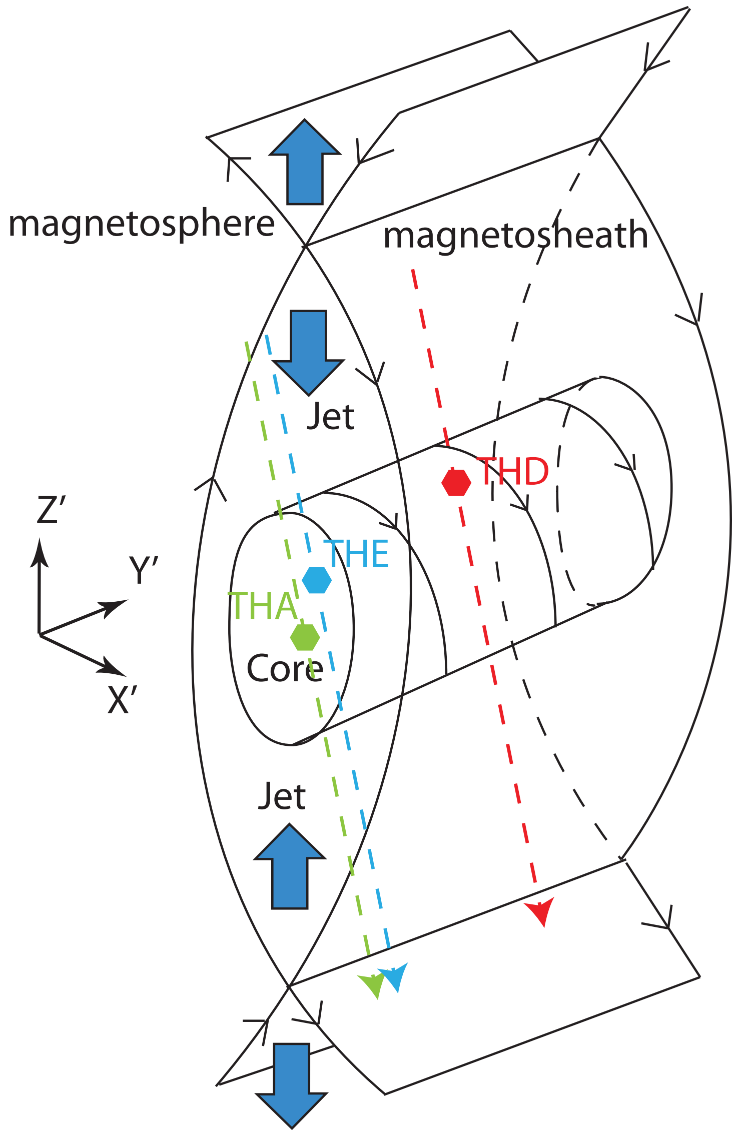
Lee and Fu 1985



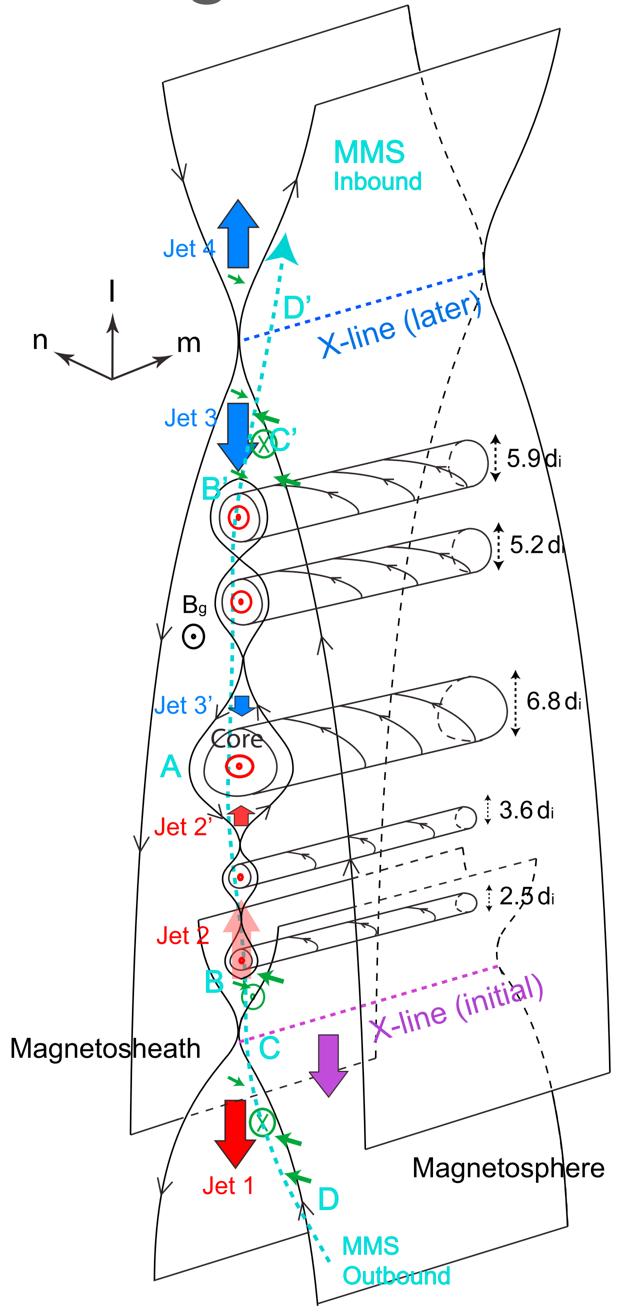
Scholer 1988
Southwood 1988



Øieroset et al. 2011



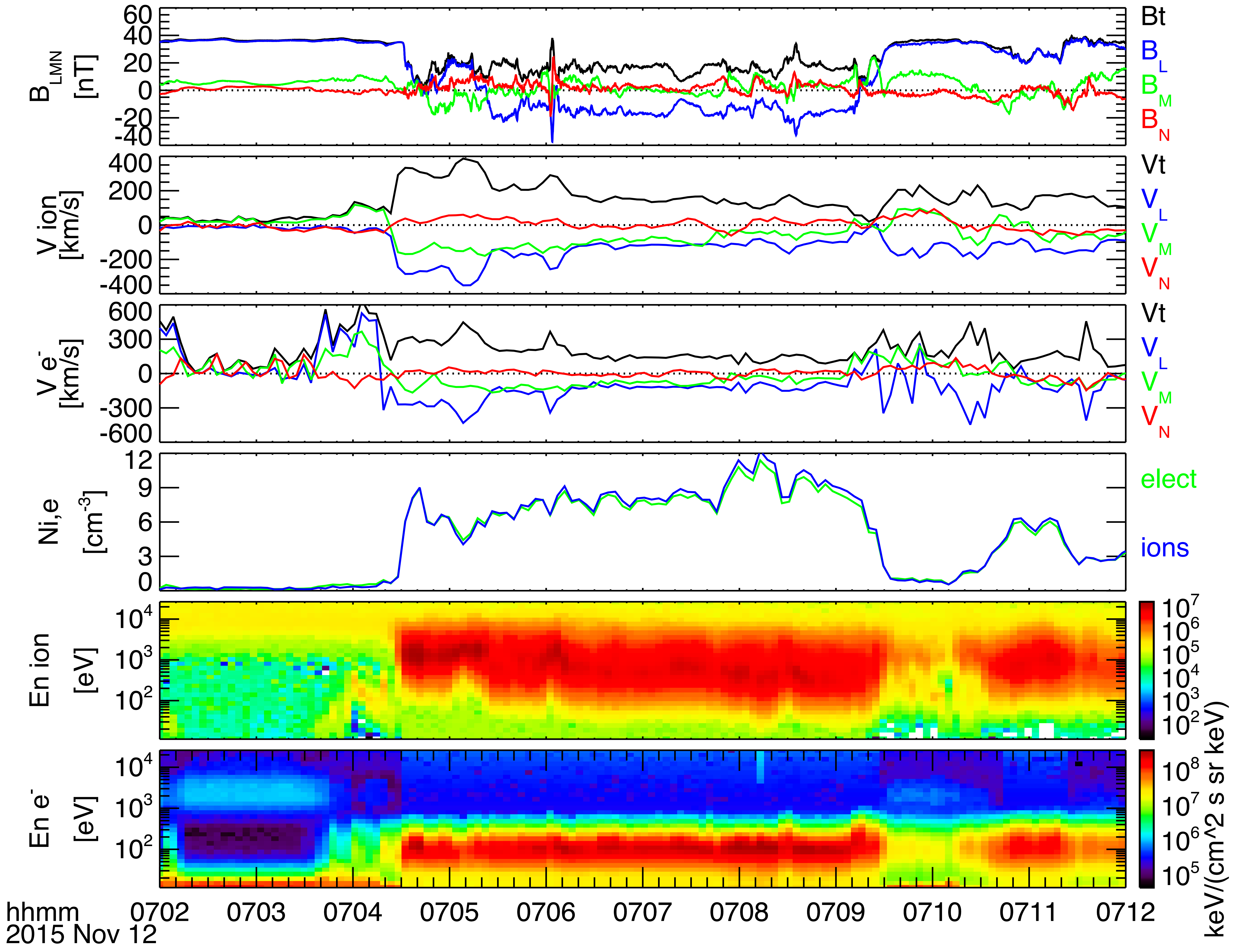
Hwang et al. 2018



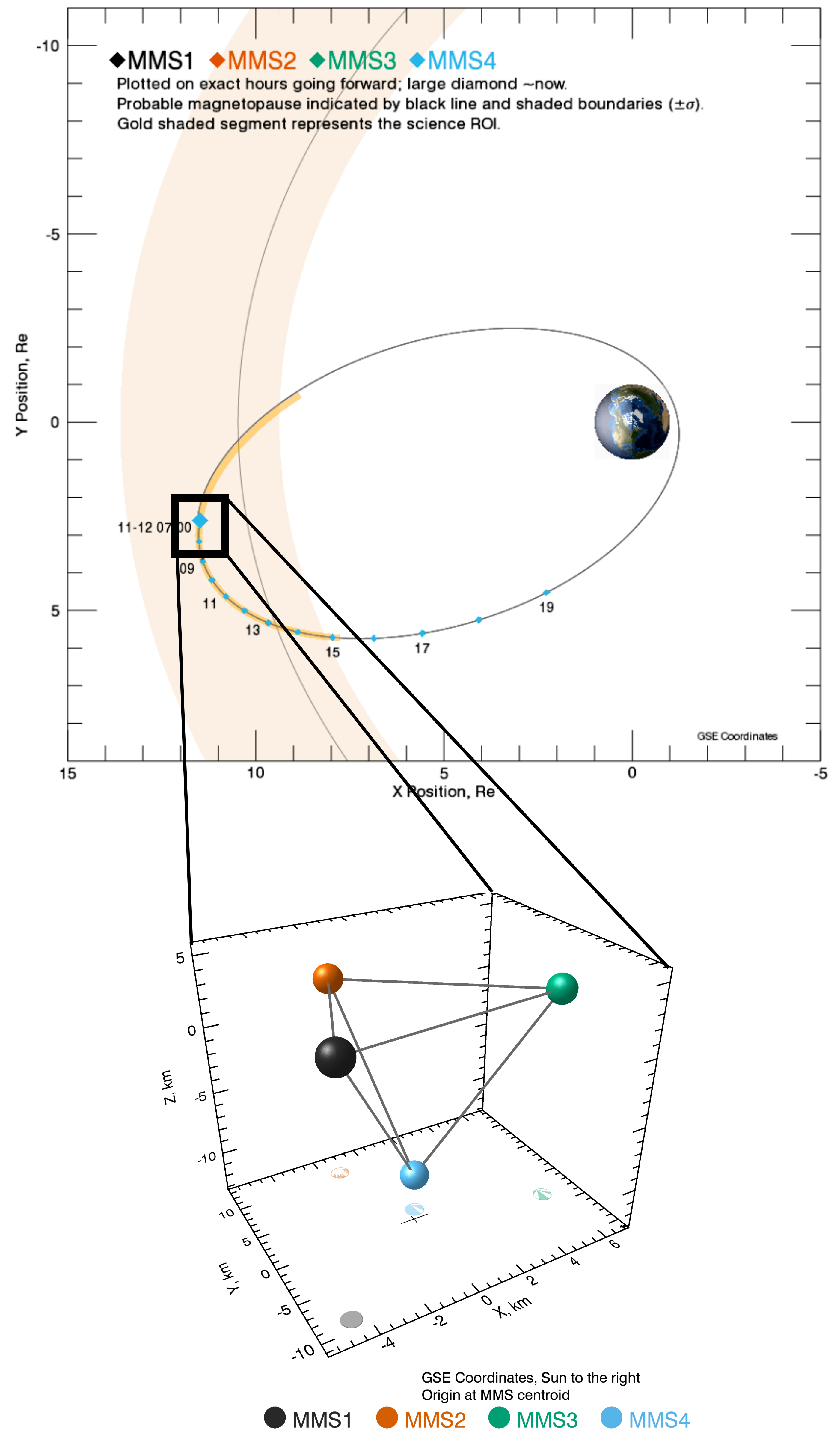
Why should we care about flux transfer events?

- ☞ Transient reconnection could be the dominant process in the magnetopause.
- ☞ Computational simulations (Drake et al., 2006, Fermo et al., 2011) have suggested that FTEs can be smaller (and not detected) than previously reported.
- ☞ High time resolution of MMS instruments and the small distances between the spacecraft enable observations of structures like small FTEs as never before.
- ☞ New results about FTEs have been reported by Eastwood et al. [2016], Hwang et al. [2016], Akhavan-Tafti et al. [2018], Qi et al. [2020], Kieokaew et al. [2021] and more.
- ☞ We present evidences of magnetic reconnection and a tiny FTE on the magnetosheath side of the magnetopause boundary layer during an outbound magnetopause crossing observed by MMS.

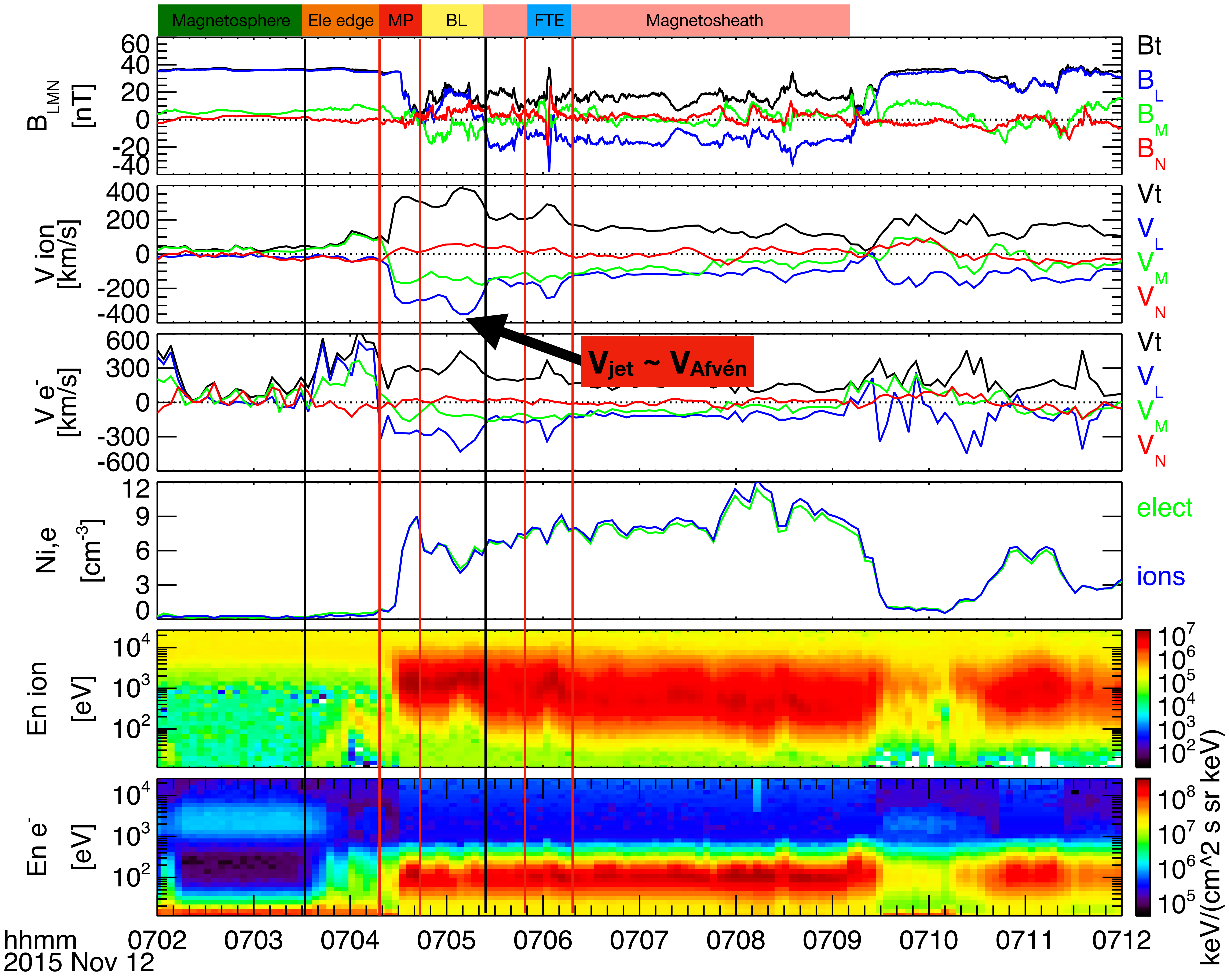
MMS Observation

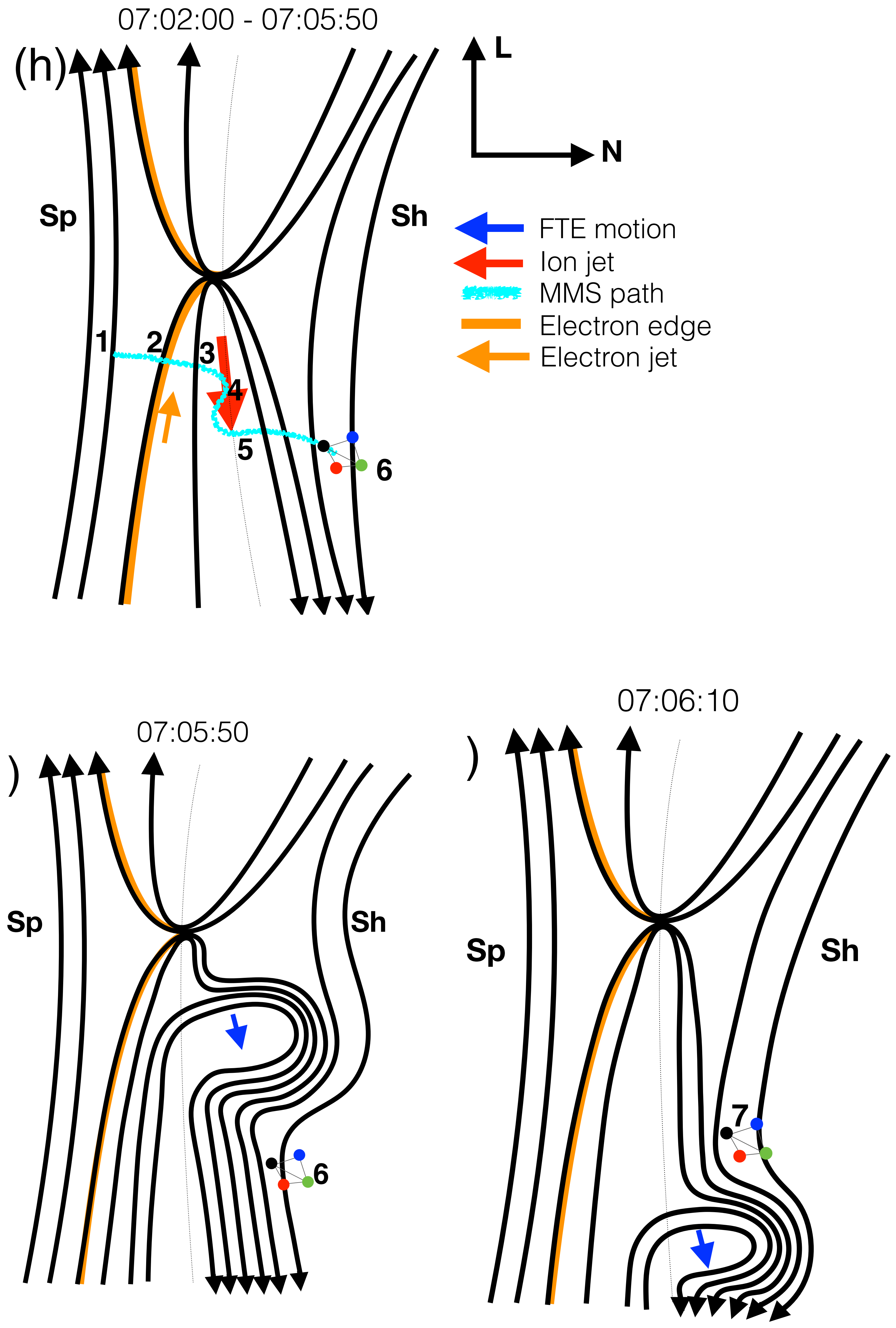


MMS Formation/Orbit



MMS Observation





FTE structure

Bt enhancement

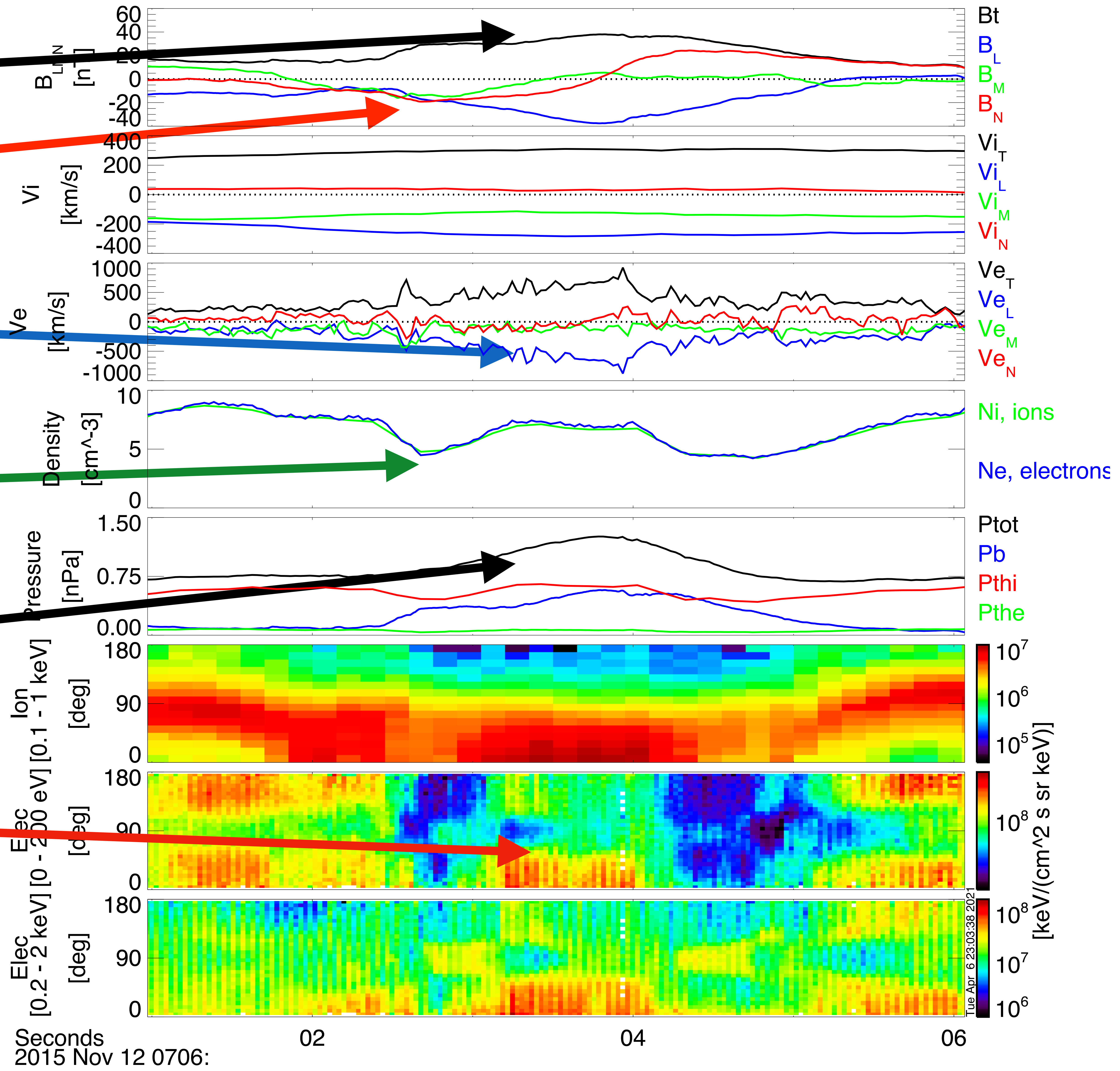
Bipolar B_N

Accelerated bulk flow

Density changes

Pressure imbalance

Particle signature

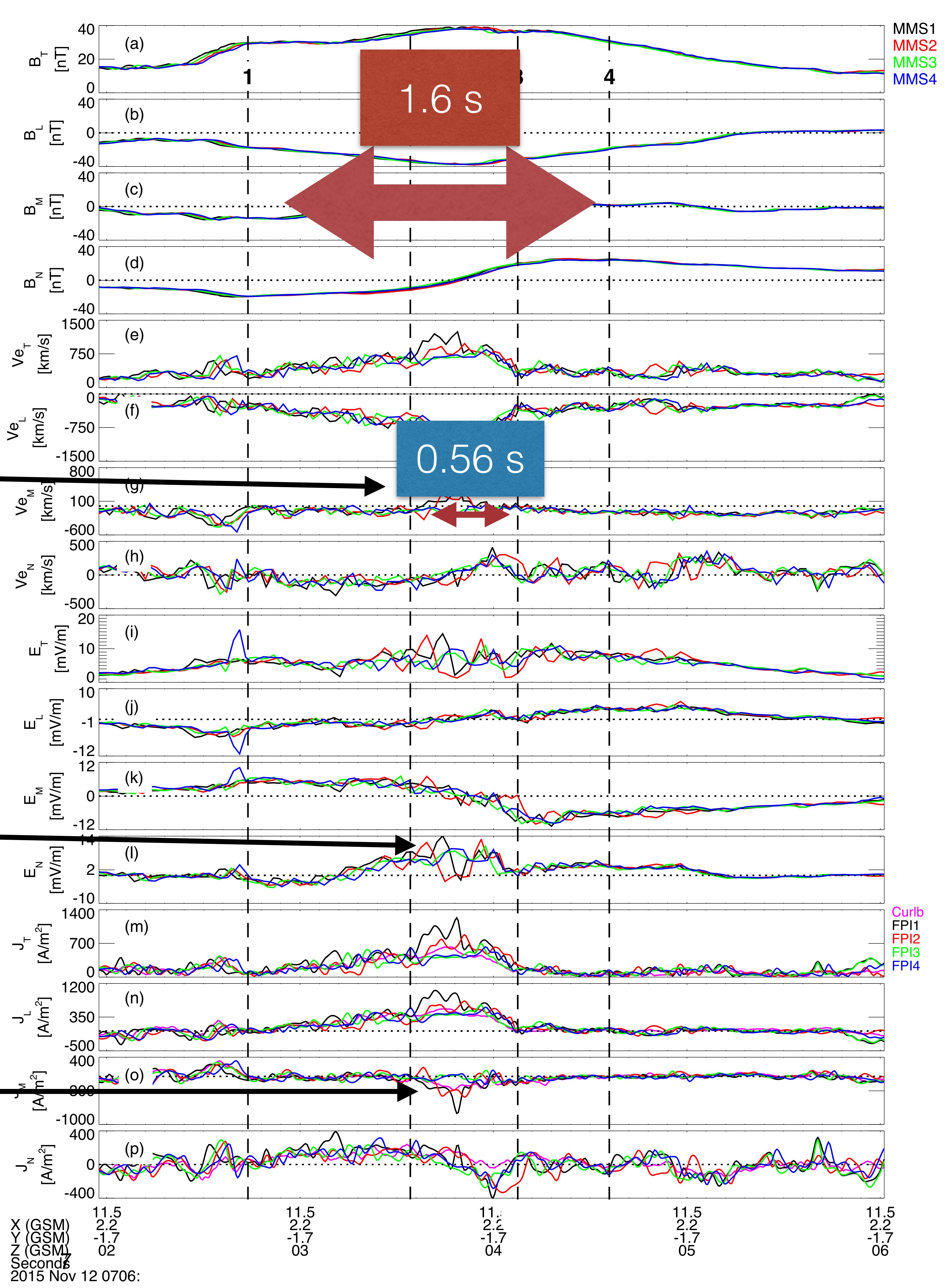


All 4 MMS observed similar B

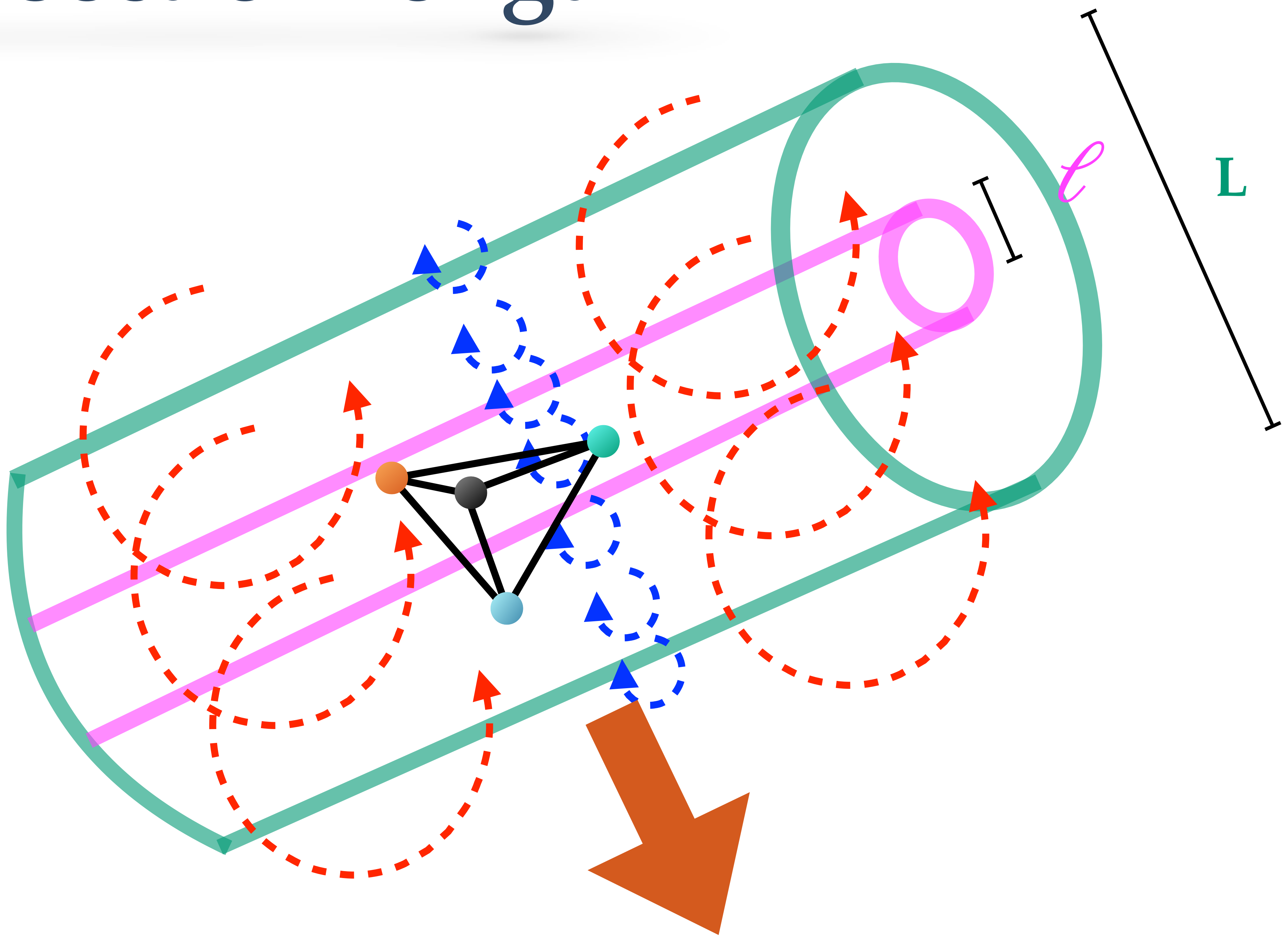
Difference in Ve

Difference in E

Difference in Current density



FTE cross-section length



Propagation direction:

v = [-0.039, 0.14, -0.98]

Speed

V = 324 km/s

External structure

Δt = 1.6s
L = 518 km (0.08 R_E)

4.42 ion gyro-radii

631 electron gyro-radii

Internal structure

Δt = 0.56s
ℓ = 181 km (0.03 R_E)

1.5 ion gyro-radii

221 electron gyro-radii

Conclusion

We presented MMS observations of an outbound magnetopause crossing and magnetic reconnection evidence. About 1.5 min after MMS crossed the magnetopause all spacecraft observed one very small FTE.

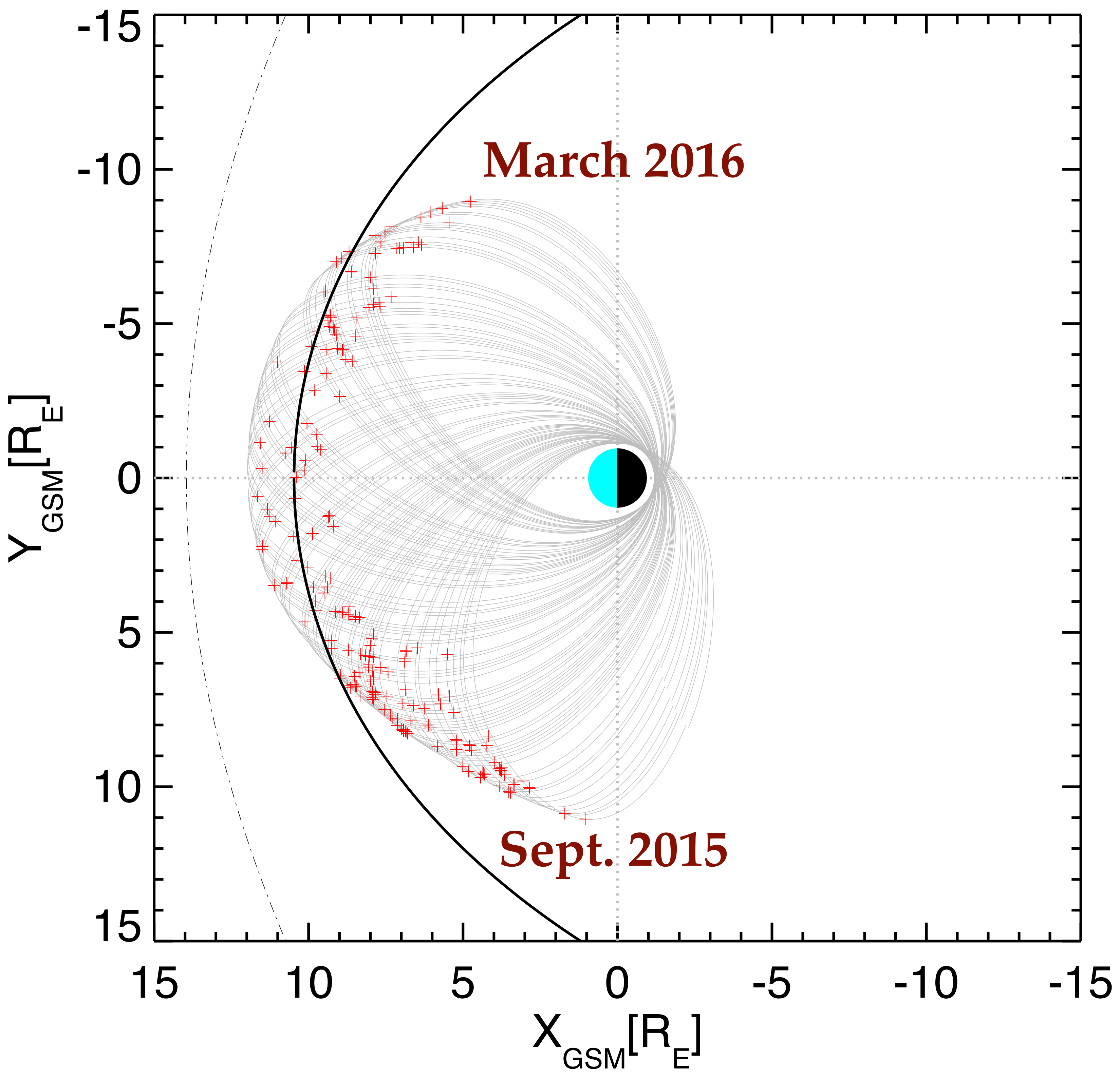
The observation indicates that the FTE was generated by an intensification of reconnection at a preexisting reconnection line, which became bursty.

A slight difference in the V_E components is observed, which may indicate that MMS1 and MMS2 crossed the FTE closer to its core than MMS3 and MMS4.

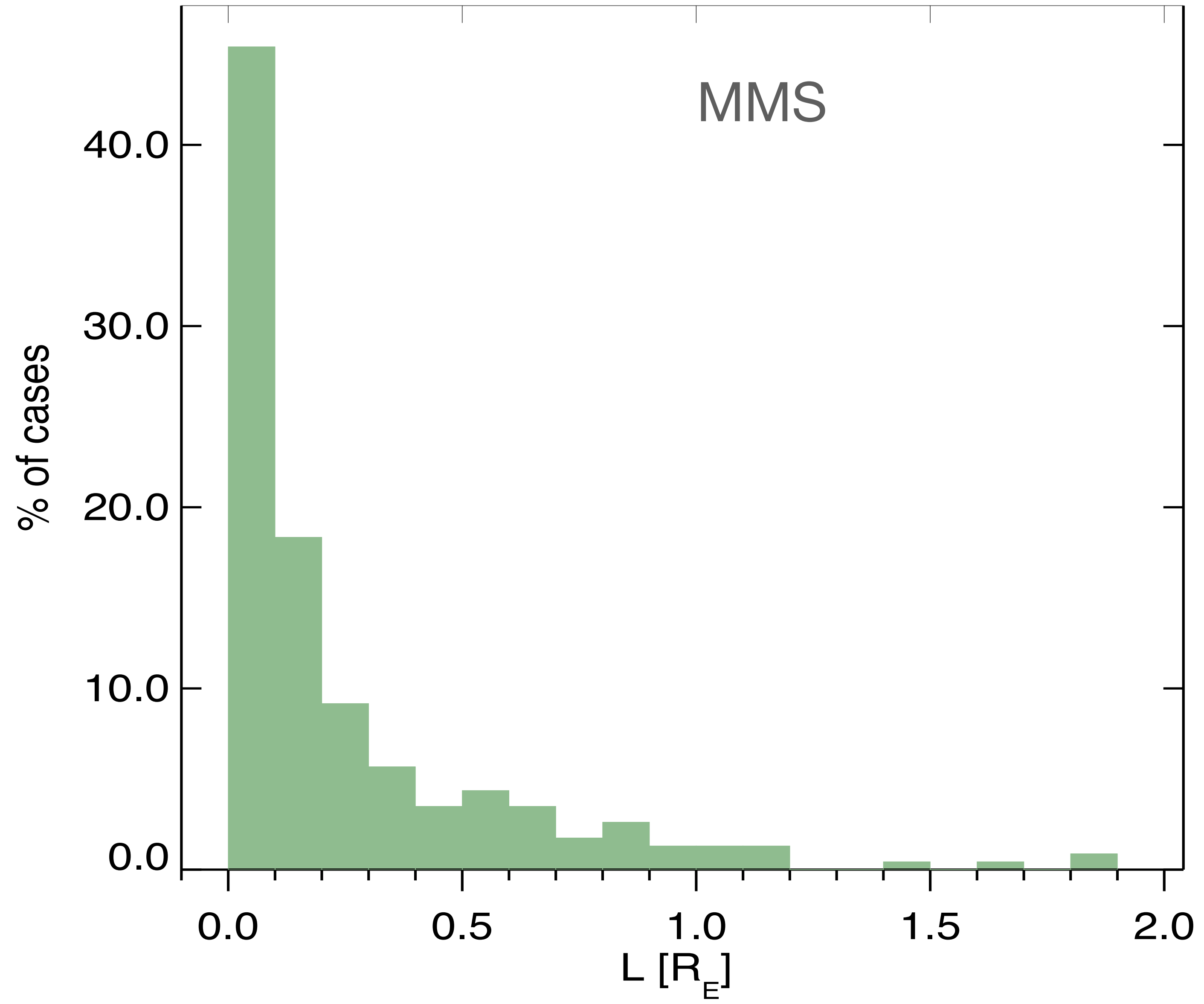
We estimate the FTE size in the transverse direction as 4.42 ion gyroradii. The internal layer, where the electron bulk flow velocity exhibits different behaviors, corresponding to 1.5 ion gyroradii.

It is evident that the region is not large enough to affect the ion behavior, but it does for the electrons, showing that the FTE's core is an electron-scale structure.

What is next?



$L = V_{FTE}\, \tau$



Fermo et al. 2011