Signatures of Magnetic Reconnection in 3D Electric Field MMS Data: Elucidating Particle Energization Throughout the Diffusion Region

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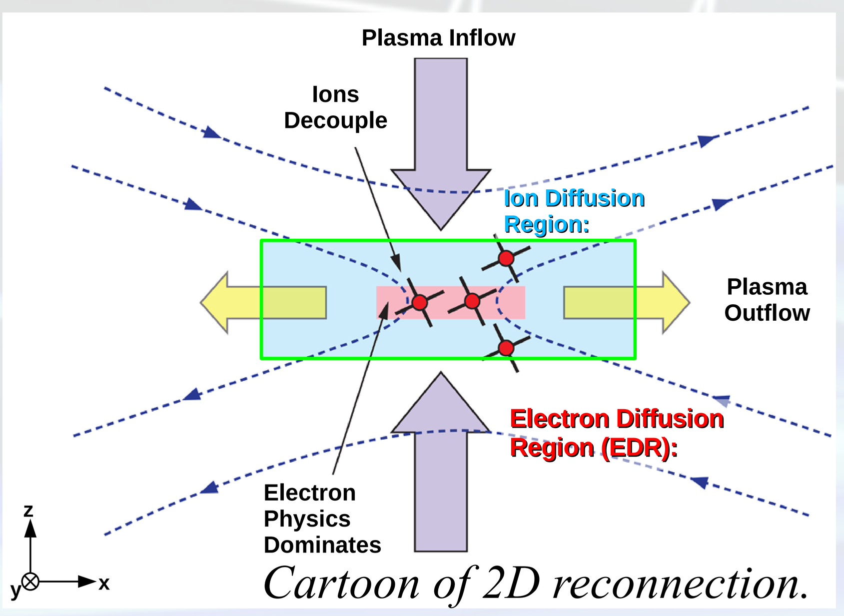
#R-24

Background

Motivation and Context

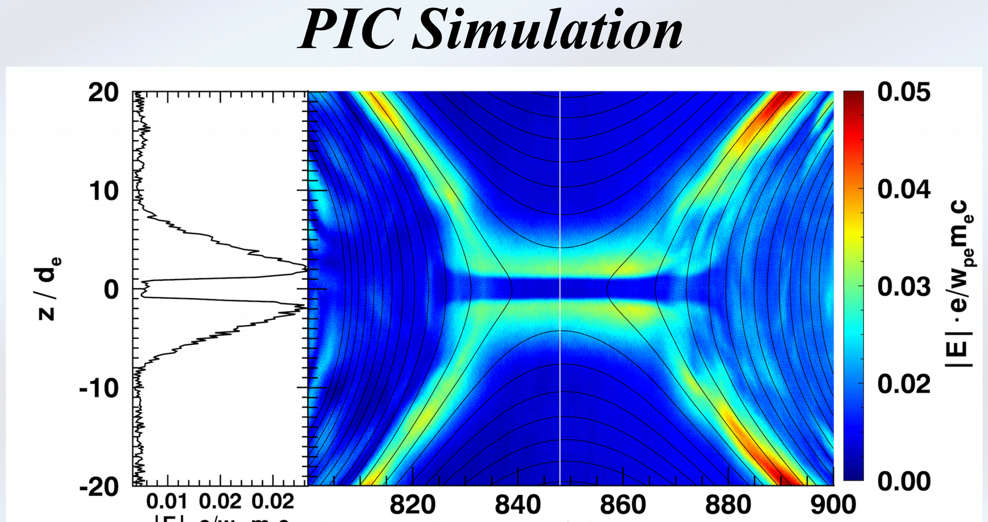
How can magnetic reconnection occur in a collisionless plasma? This outstanding mystery fueled the successful launch of NASA's Magnetospheric Multiscale (MMS) mission. The primary science goal of MMS is to reveal the small-scale, 3D structure and dynamics of the elusive electron diffusion region (EDR) believed to hold the key to the reconnection puzzle.



Cartoon of 2D reconnection.

The unprecedented time resolution of the 3D electric field measurements made by the FIELDS suite [1,2] onboard the MMS spacecraft motivates a comprehensive study of the electric field signatures of magnetic reconnection and their implications for particle energization. The three-axis electric field measurements from the spin-plane and axial double probes (SDP and ADP), combined with high time resolution (~1 millisecond) ambient electron flux from EDI, enable MMS to resolve electron-scale reconnection structures. Here, we present our first efforts to organize the initial MMS electric field measurements for comparison with previous observational and theoretical reconnection studies [*e.g.* 3,4,5,6].

PIC Simulation

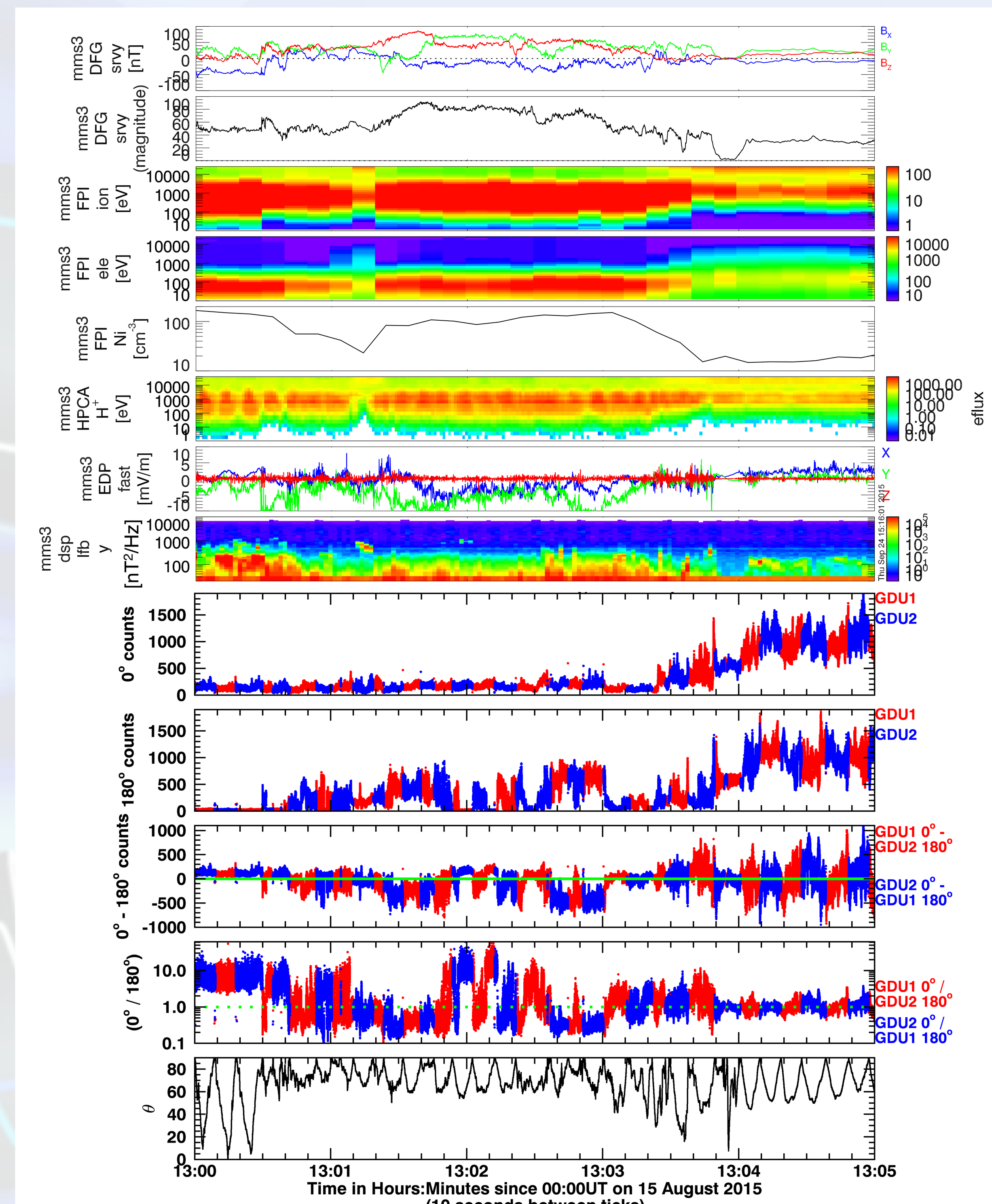


Magnitude of the electric field in and around the diffusion region in the PIC simulation reported in [7].

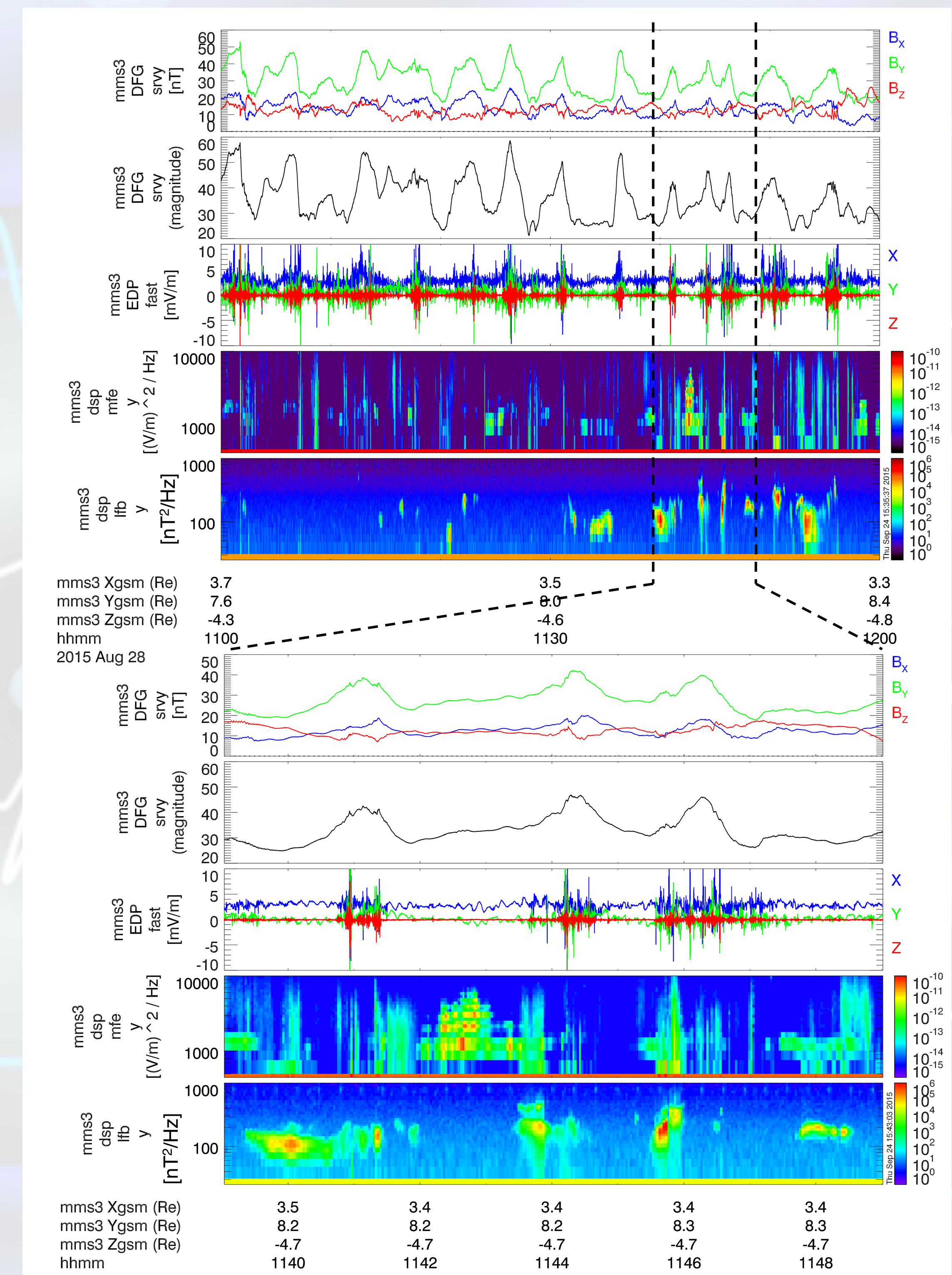
- 2.5D, symmetric, collisionless, undriven, open boundaries
- antiparallel ($B_g = 0$), $m_i / m_e = 400$, domain: $80d_i \times 20d_i$

Results

8/15/2015: 13:00UT to 13:05UT



8/28/2015: 11:00UT to 12:00UT



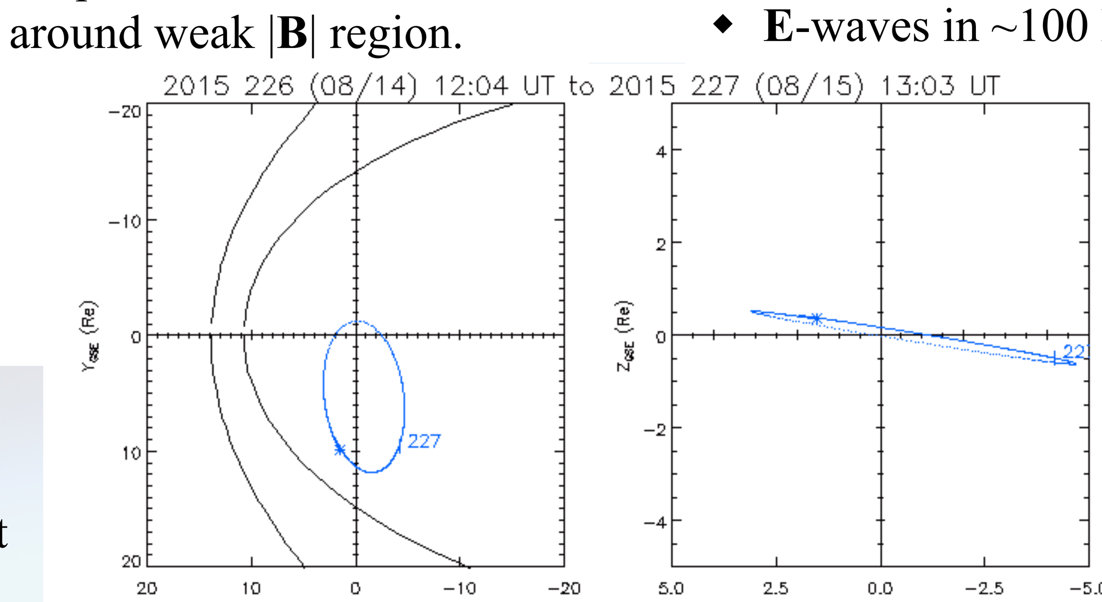
FIELDS: *E-signatures*

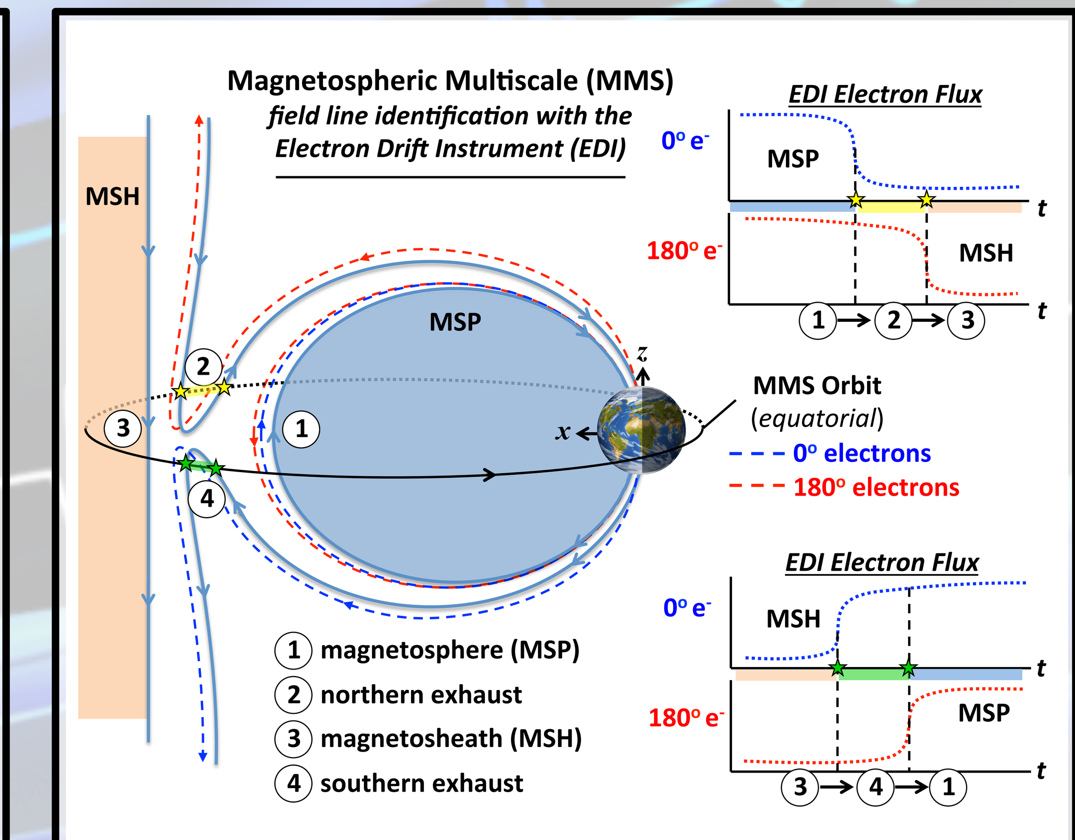
- "magnetic "bubble", |**B**| ~ 1nT, quiet **E** consistent with PIC.
- e- & H+ energization in and around weak |**B**| region.
- EDI 180° flux increases *before* 0° flux, indicating spacecraft encountered field lines connected to the *northern* hemisphere.
- periodic $E_{//}$ wave signatures with increasing |**B**|
- **E**-waves in ~100 Hz to ~1 kHz range

MMS Orbit:

8/14 to 8/15

Spacecraft are in +Z, consistent with interpretation from EDI.



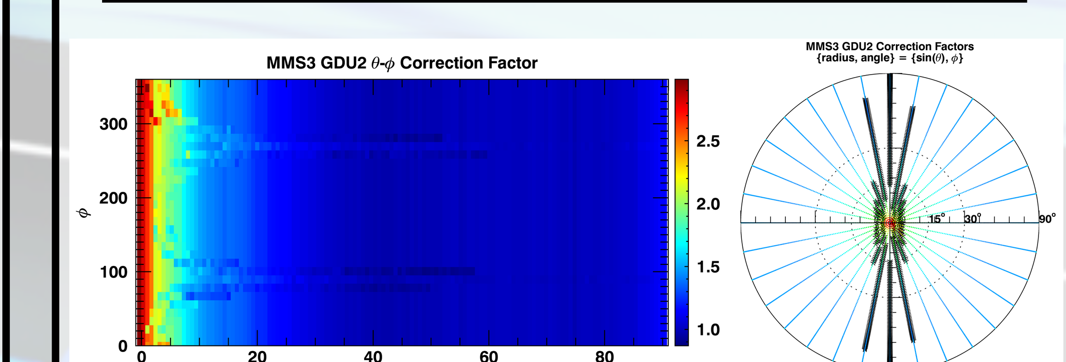


Where are we?

- High to low e- flux: MSP to MSH
- Low to high e- flux: MSH to MSP

Case 1: 0° remaining: southern exhaust

Case 2: 180° remaining: northern exhaust



EDI GDU Ambient Calibration

- Determine θ-φ dependent relative correction factors for each GDU.
- Absolute calibration with FPI on 8/15/2015.

Conclusions

- Frequent observation of $E_{//}$ signatures.
- Relative (θ-φ) and absolute (with FPI) calibration of EDI GDUs.
- Field-line determination based on anisotropic 0° vs. 180° electron fluxes.

Future Work:

- Comparison of MMS and PIC to better understand electric field signatures & particle distribution structures.
- Calibrate remaining EDI GDUs.

References

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