

Identifying magnetic reconnection events using the FOTE method

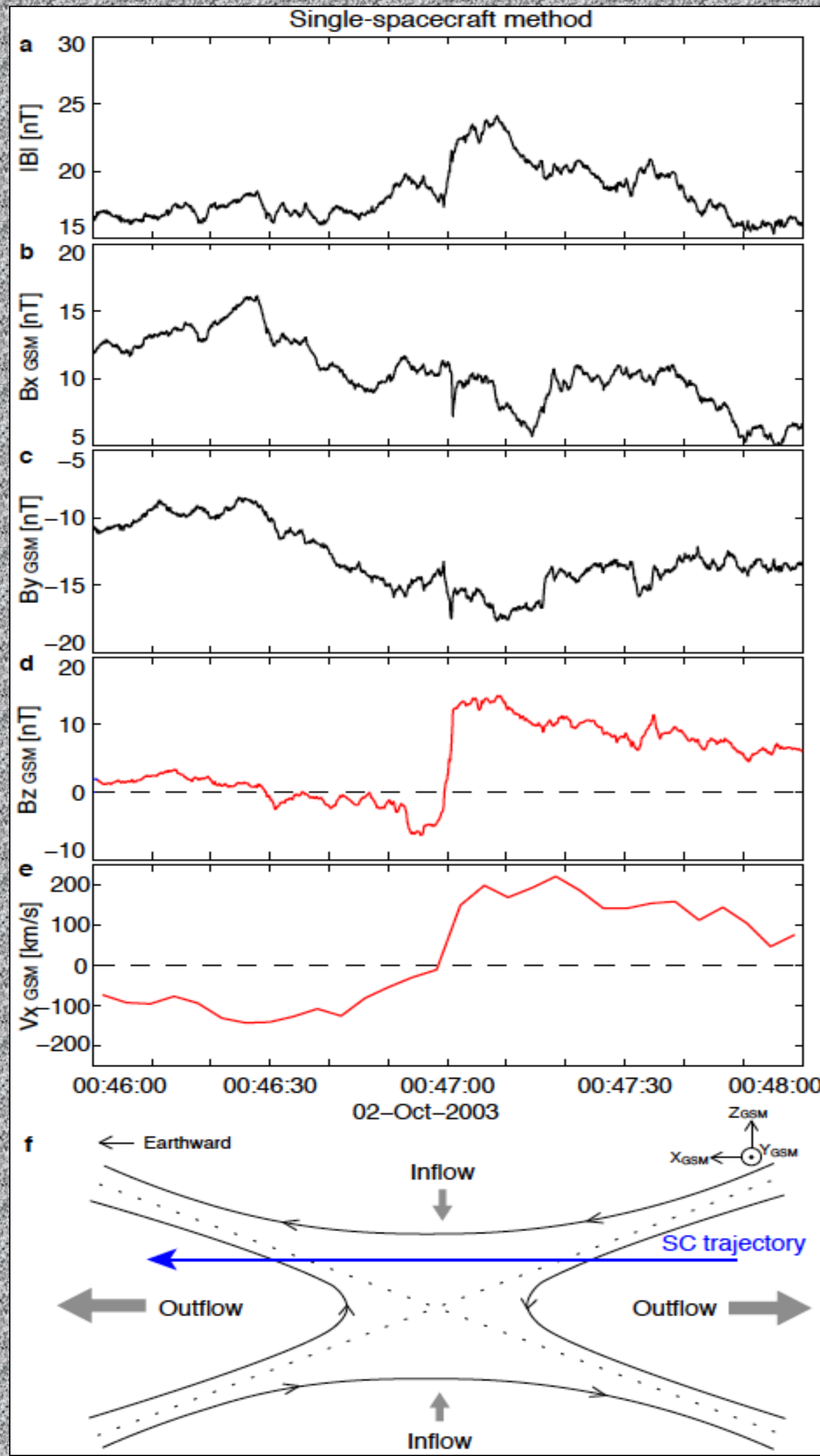
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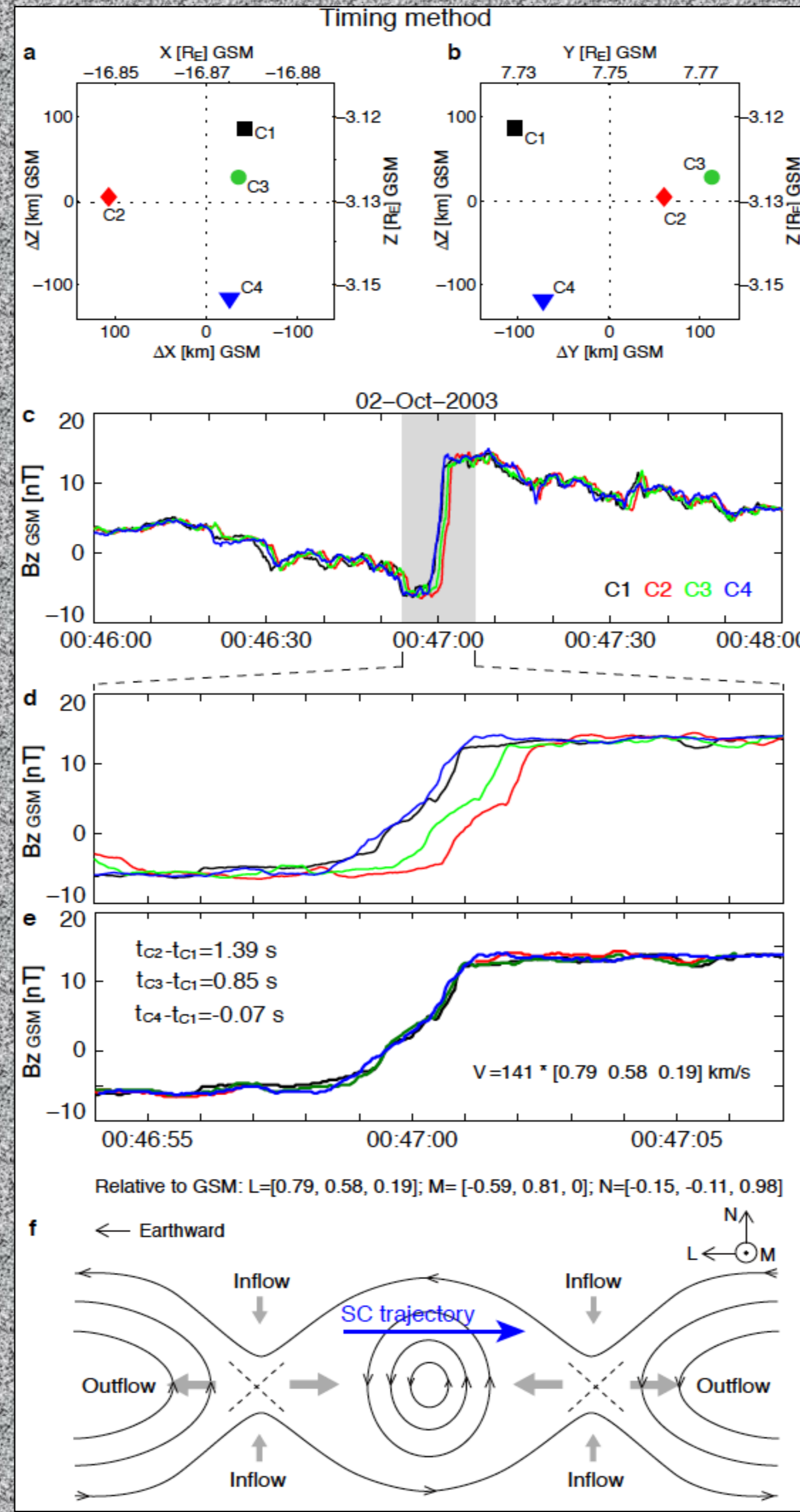
Abstract

A magnetic reconnection event detected by Cluster is analyzed using three methods: single-spacecraft inference, multi-spacecraft timing, and the first-order Taylor expansion (FOTE). Using single-spacecraft method, we find that the structure is a reconnection X-line; while using timing and FOTE analyses, we find it is a magnetic island (O-line). We conclude that the most efficient way to identify a reconnection event is FOTE, and therefore suggest using this method with the data from the forth-coming MMS mission.

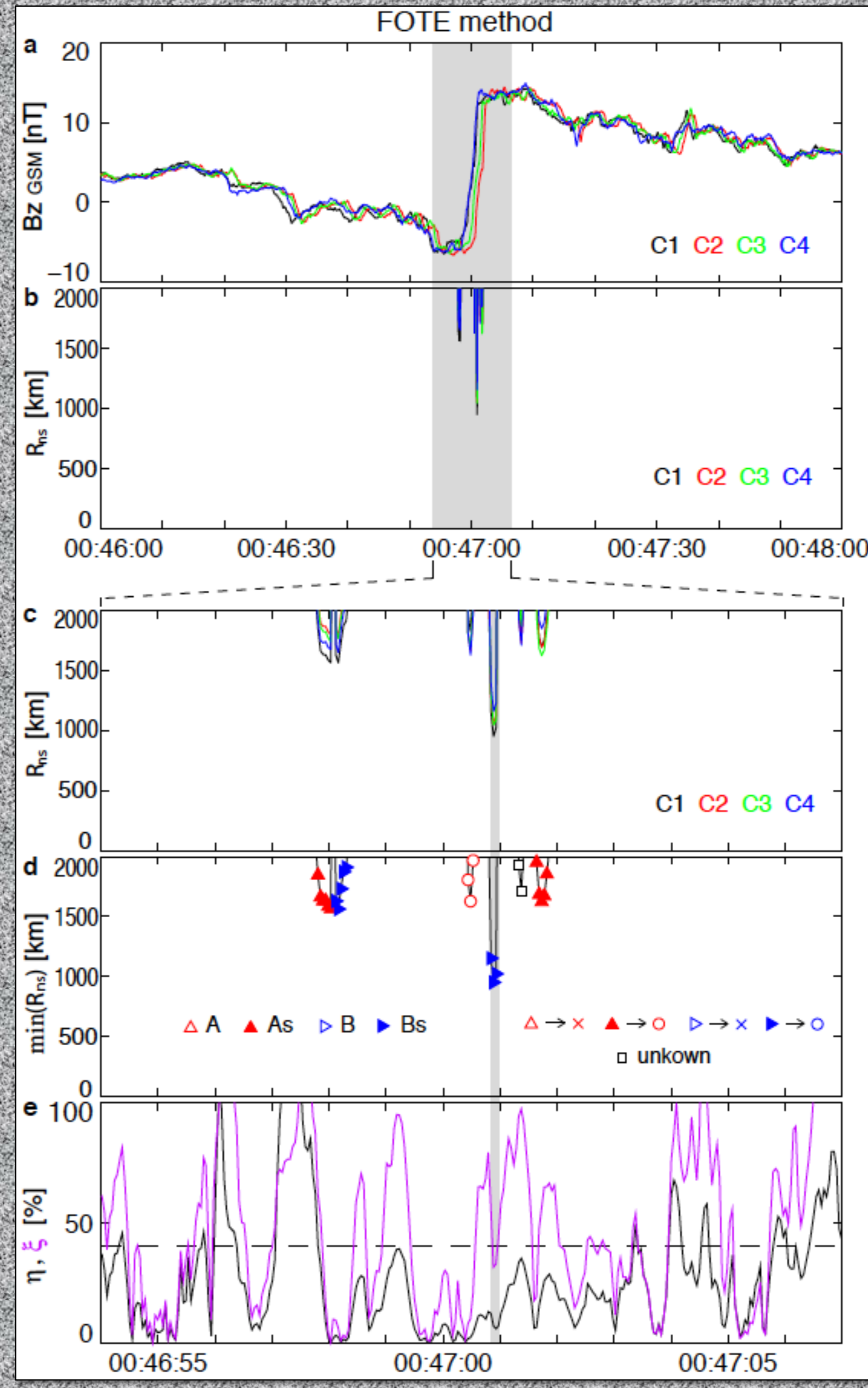
Single-spacecraft inference



Multi-spacecraft timing



First-order Taylor expansion



Single-spacecraft inference:

A reconnection X-line moving tailward

Timing method:
 A magnetic island or flux rope flowing earthward

FOTE method:
 A spiral-type null or correspondingly magnetic island

Comparison:

1. FOTE and timing methods are consistent.
2. However, FOTE is much faster and more accurate than timing.
3. We can survey the time-series data using FOTE but not timing.
4. For the reconnection without clear structure, only FOTE is valid.

During 00:46-00:48 UT on 2 October 2003, Cluster 1 was located at $X_{GSM} \approx -16.9 R_E$, $Y_{GSM} \approx 7.7 R_E$, $Z_{GSM} \approx -3.1 R_E$ in the Earth's magnetotail with a separation of ~ 200 km. It observed a simultaneous reversal of the high-speed flow with the normal magnetic field.

Conclusions:

1. Three methods for identifying reconnection are compared
2. We conclude that FOTE is the most efficient approach
3. We suggest using this approach with the MMS data

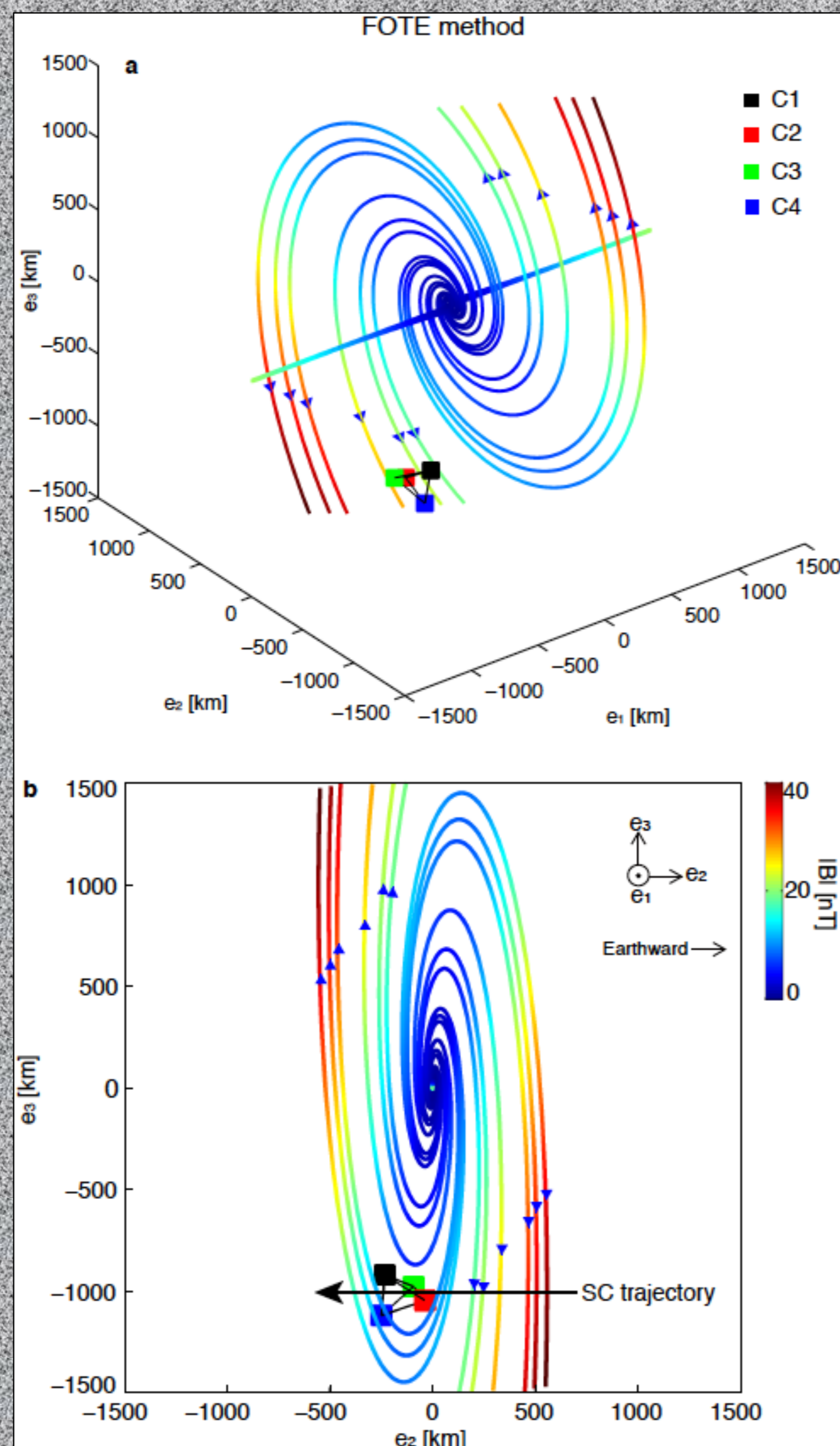
Related Publication:

Fu, H. S., et al. (2015), Identifying magnetic reconnection events using the FOTE method, *submitted*.

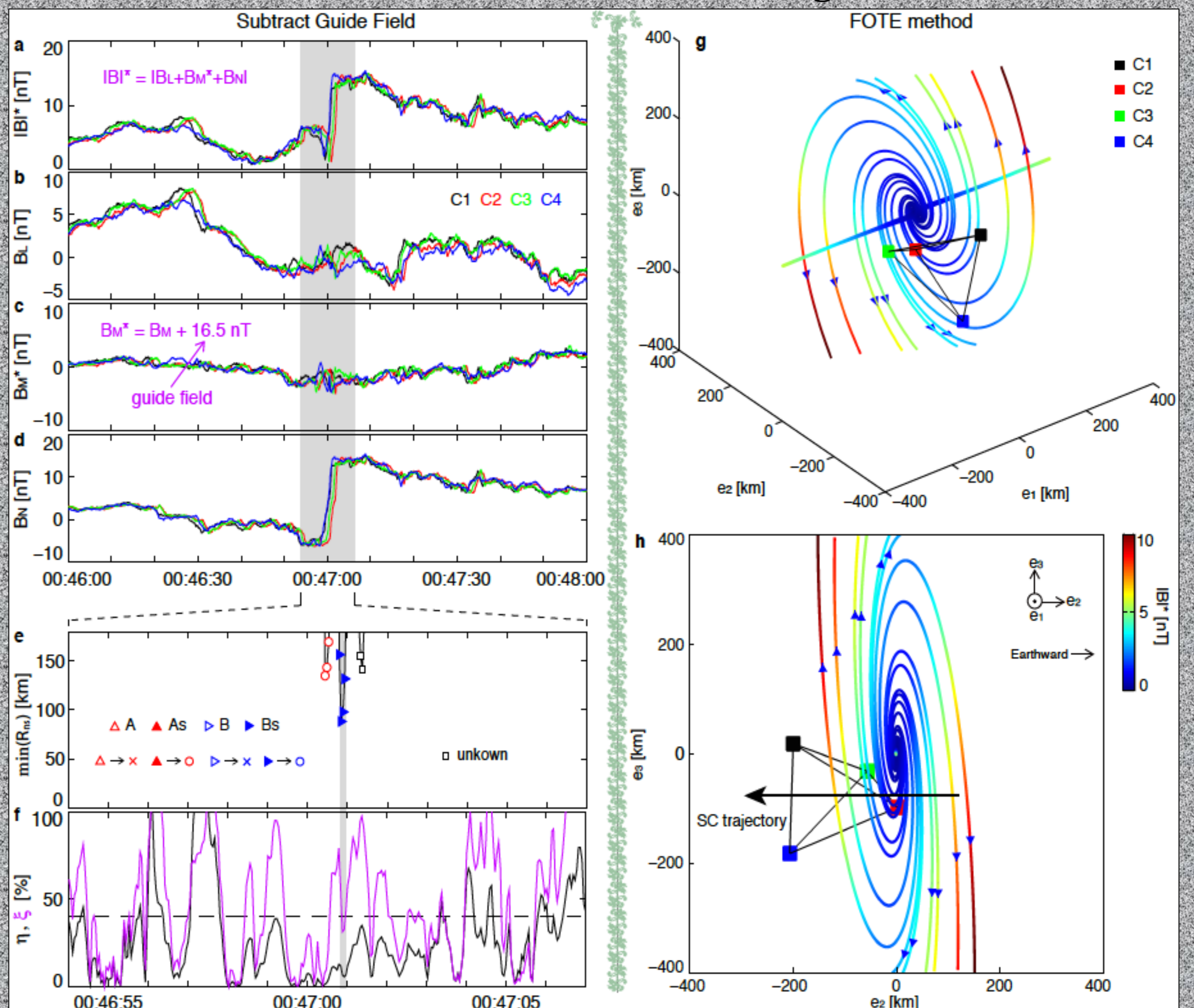
References:

Eastwood, J. P., et al. (2005), Observations of multiple X-line structure in the Earth's magnetotail current sheet: A Cluster case study, *Geophys. Res. Lett.*, 32, L11105.
 Fu, H. S., et al. (2015), How to find magnetic nulls and reconstruct field topology with MMS data?. *J. Geophys. Res.*, 120, 3758–3782.

Reconstruction using raw data



Reconstruction after removal of "guide field"



No guide-field situation: we reconstruct the null topology and find both the bipolar feature and compression feature of the structure.
Guide-field situation: we subtract "guide field" and then reconstruct the topology. Same topology, except the null-SC distance is small.