

Detection of a solar wind reconnection exhaust with small-scale non-planar geometry

submitted to *Journal of Geophysical Research*

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1st Solar Orbiter Summer School

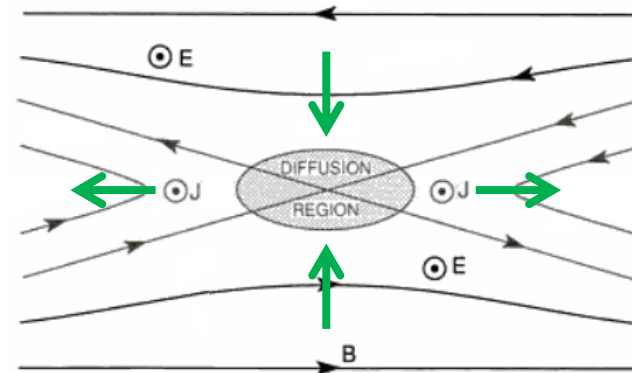
JP Eastwood¹, H Hietala¹

22nd September 2014

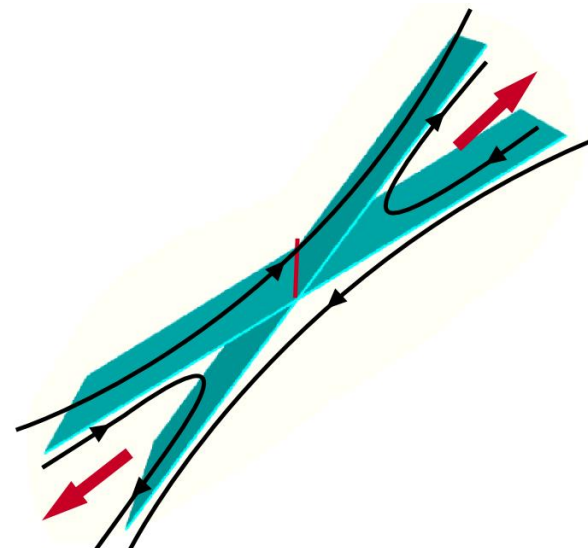
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Magnetic Reconnection

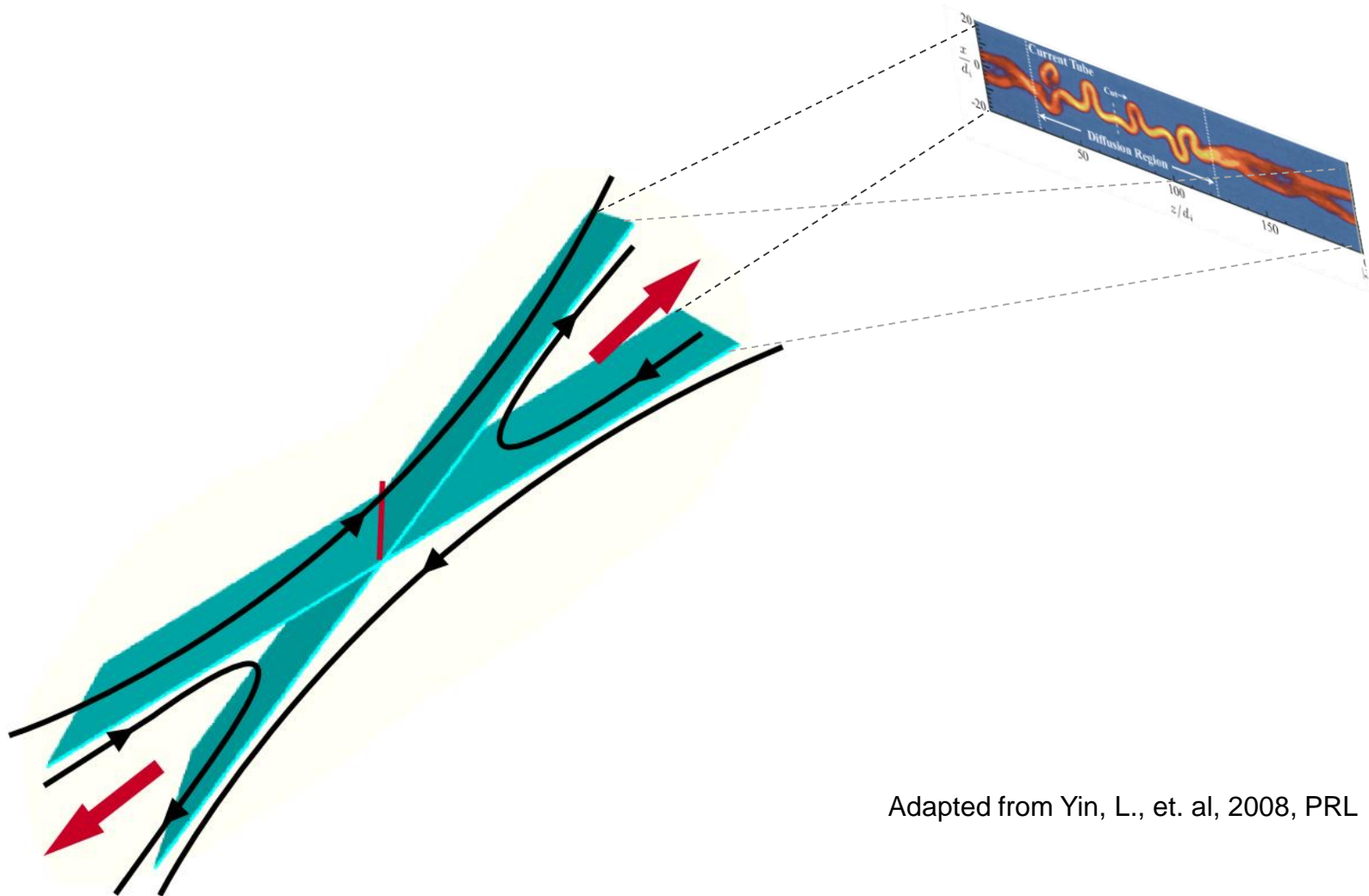
- Changes magnetic topology
- Partition of magnetic and kinetic energy
- Solar wind
 - Planar
 - Large scale



Adapted from Hughes, 1995

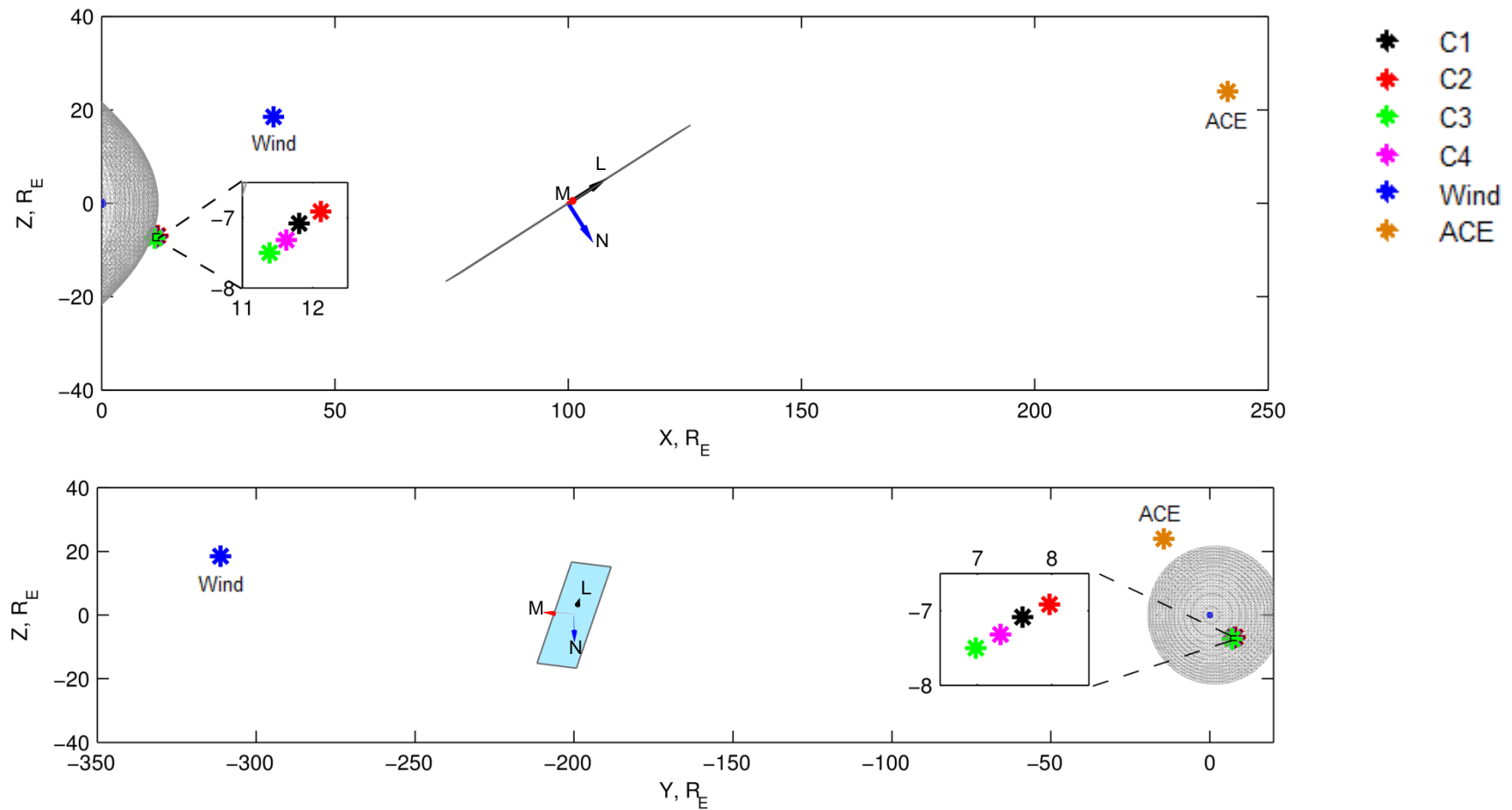


What about smaller scale structure?



Adapted from Yin, L., et. al, 2008, PRL

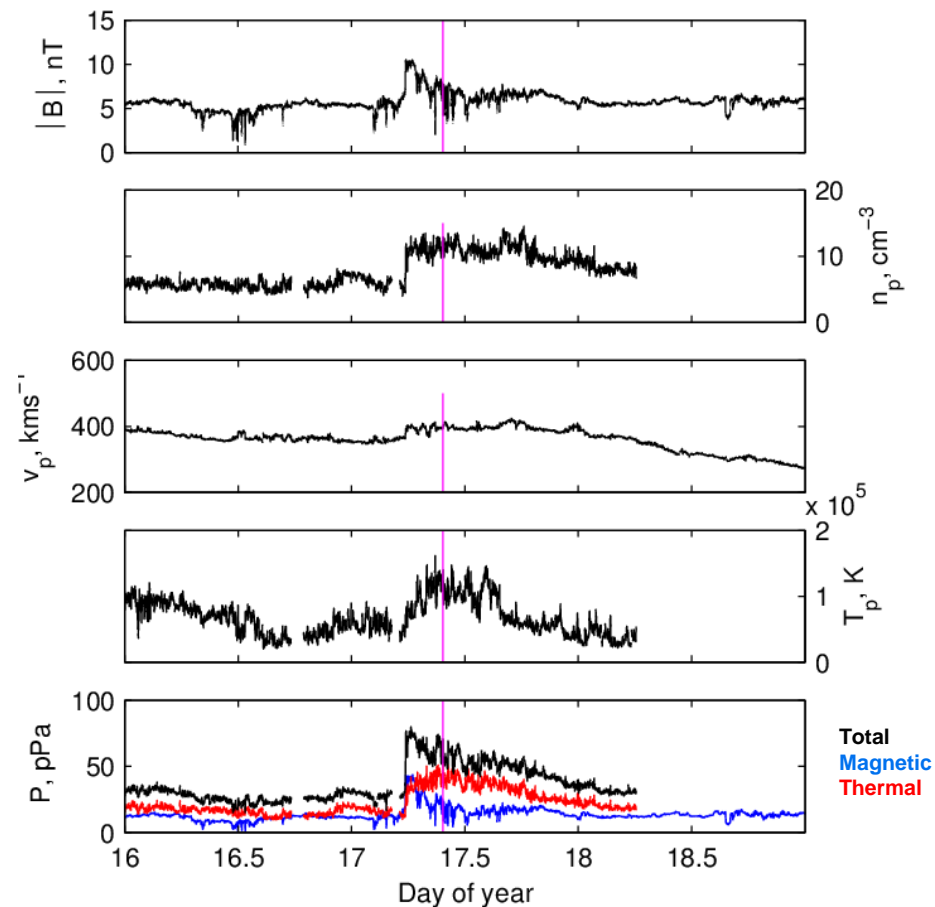
Orientation of the Current Sheet



17th January 2002

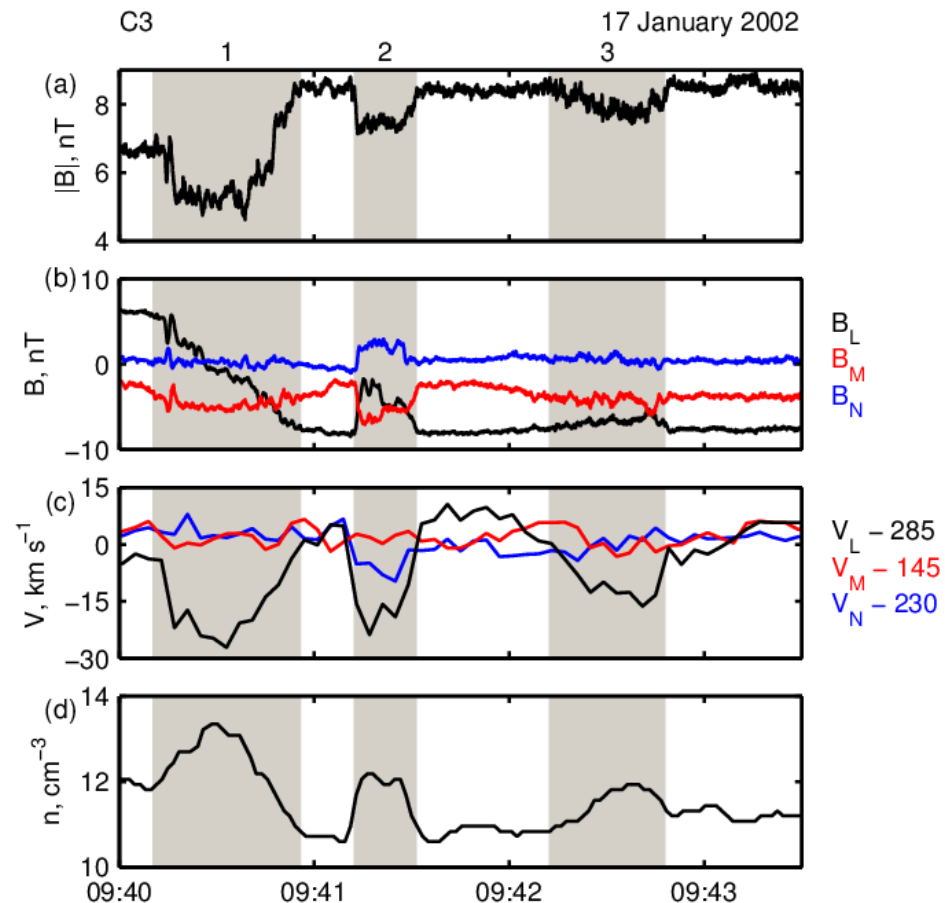
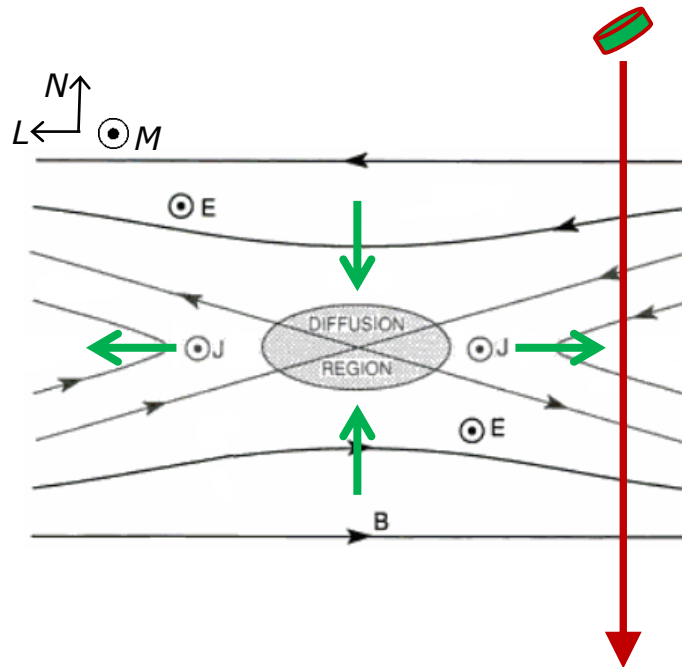
Observations at ACE and Wind

- ACE SWE 64s cadence – unable to resolve exhaust
- Wind 3DP 3s cadence – exhaust is not clear
- ACE: current sheet is located within an interplanetary shock sheath region
- Same orientation at ACE, Wind, Cluster
 - Planar over large scales



Observations from C3

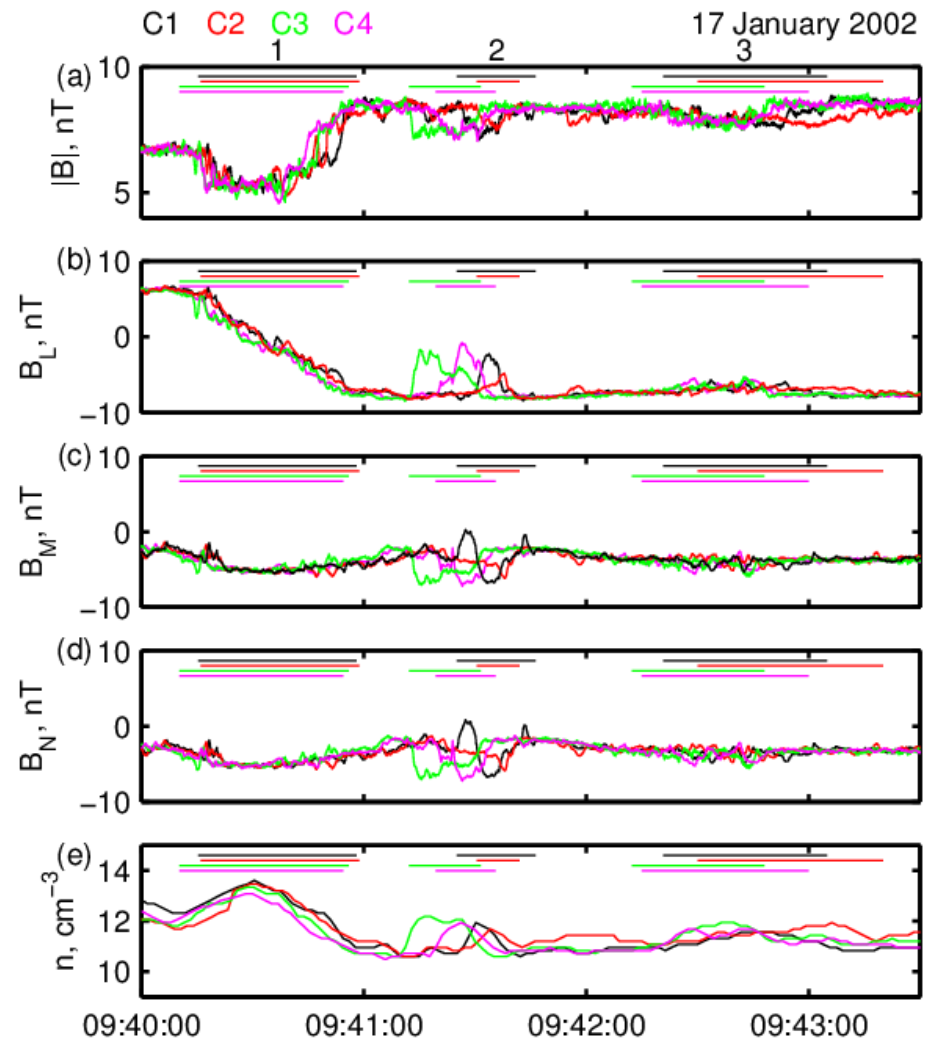
- Current sheet normal coordinates
- Magnetic shear 122°



Magnetic field from C1-C4

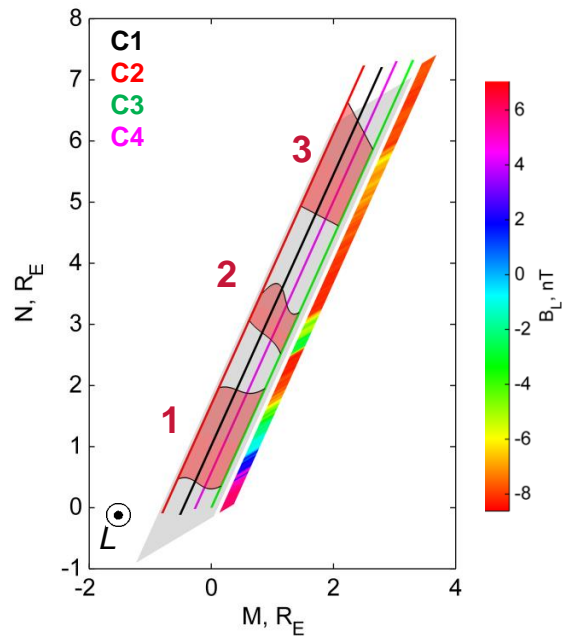
Four spacecraft observe

- Main current sheet simultaneously
- Intervals 2 & 3 at distinct times

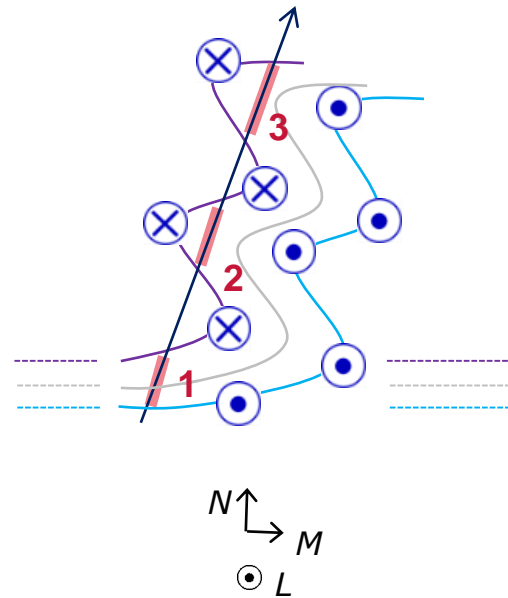


Folds in the exhaust boundary

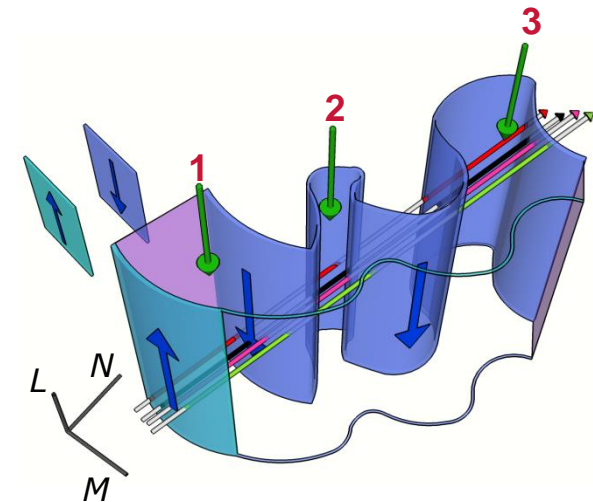
- curvature on scale $\sim 230 d_i$ ($2.5 R_E$)
- 'thin' exhaust width $\sim 135 d_i$ ($1.5 R_E$)
- observation time $\sim 57 \tau_i$



Data



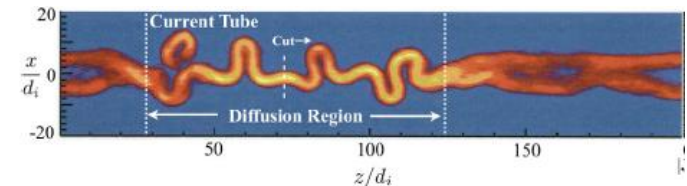
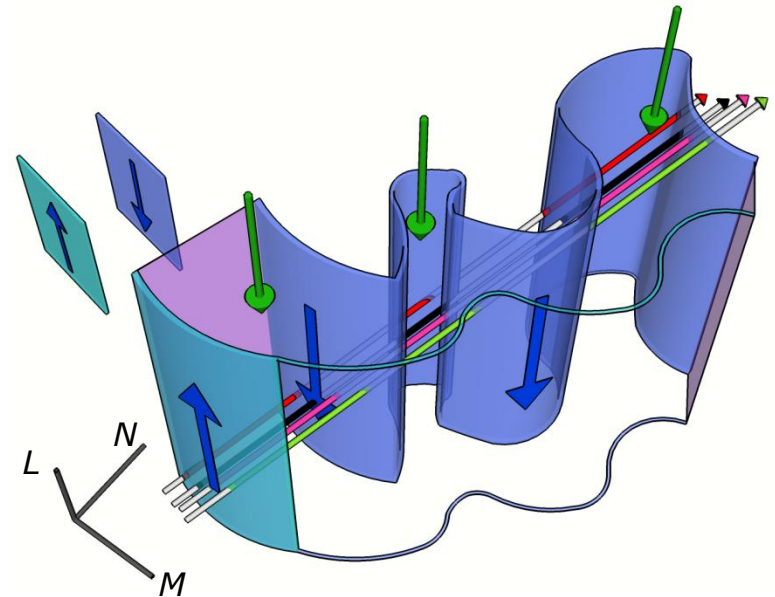
Cartoon



3D interpretation

Conclusions

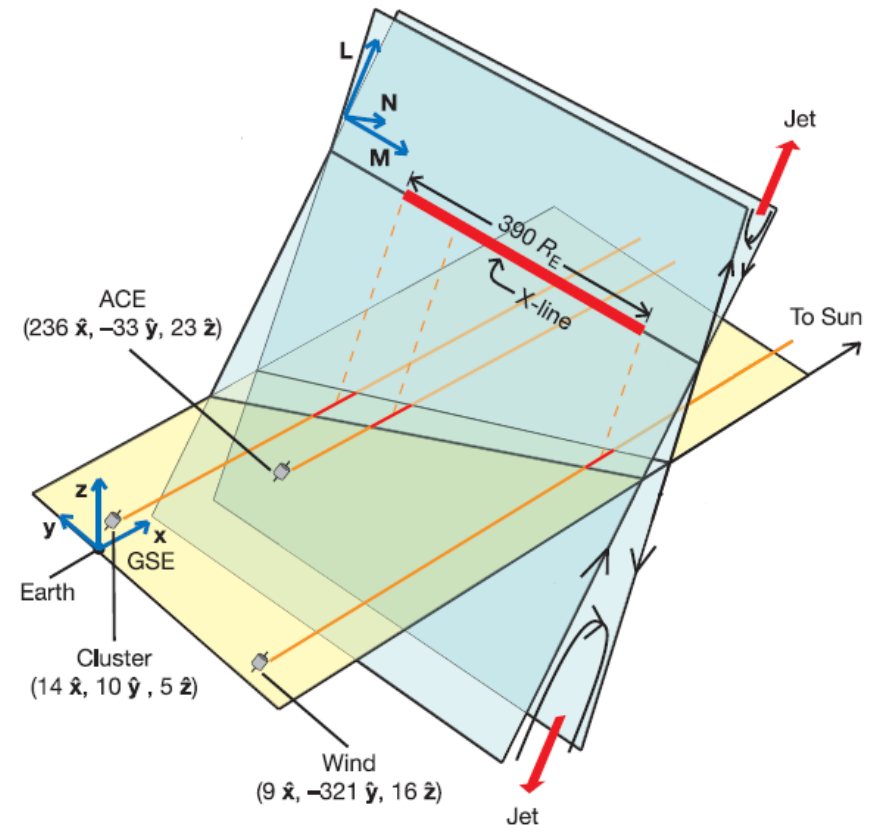
- Large-scale planar current sheet ($>320 R_E$)
- (localised) reconnection exhaust
- Locally exhaust is non-planar, with features $\sim 230 d_i$ ($2.5 R_E$)
- Unlikely to observe small-scale structure
- Why is it non-planar?
 - Instabilities
 - Variable boundary conditions



Yin, L., et. al, 2008, PRL

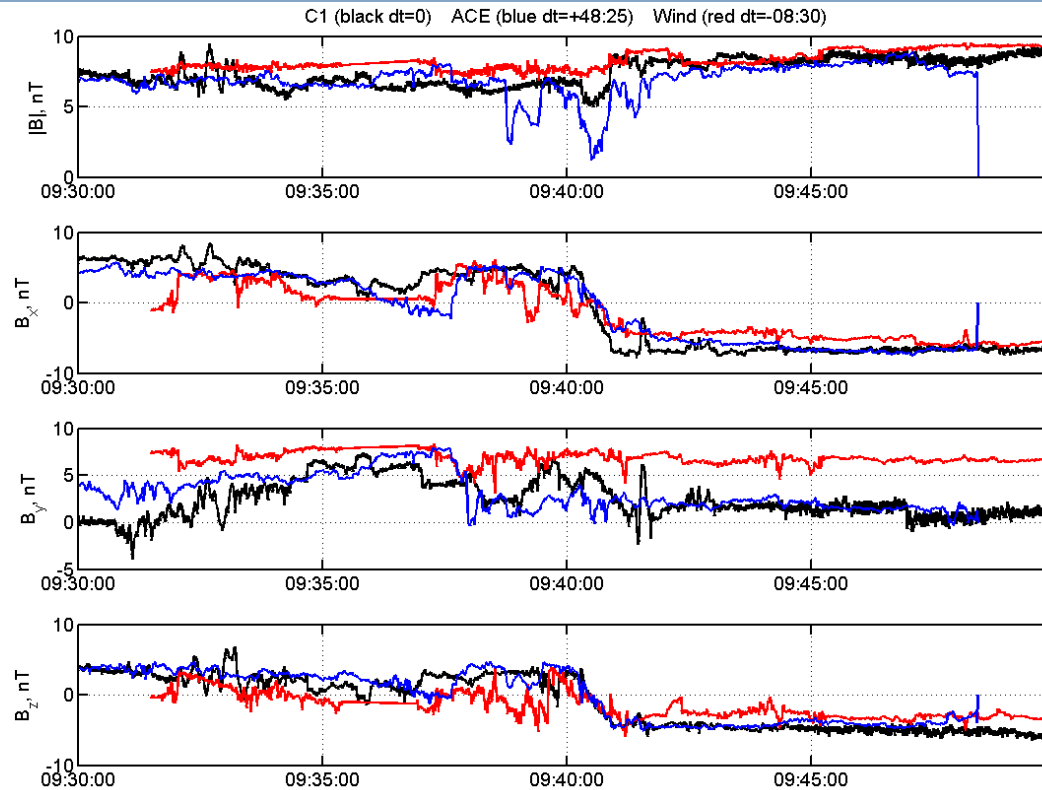
Previous Observations

- Multi-spacecraft observations
 - Planar
 - Quasi-steady
 - Extended X-lines
- High cadence instruments
 - Thin exhausts dominate
 - Low magnetic shear
 - Multi-point observations have not been made



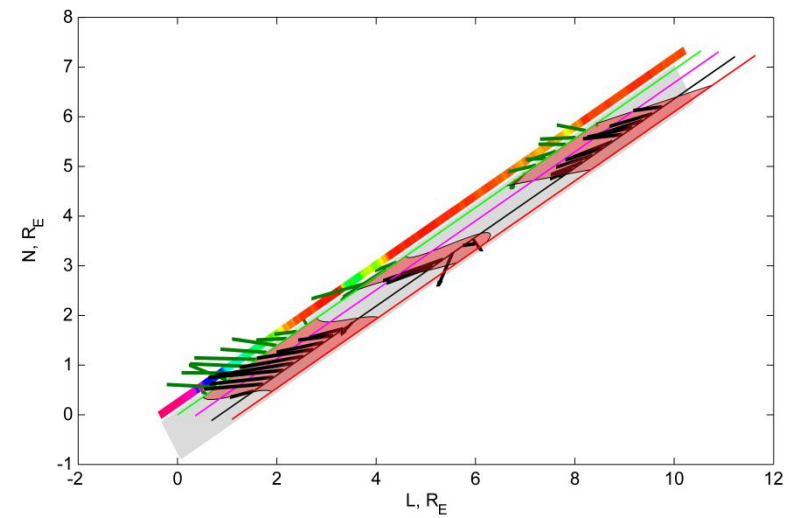
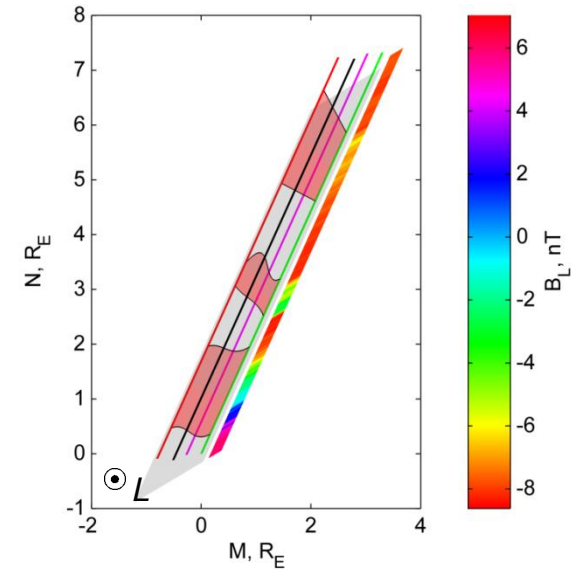
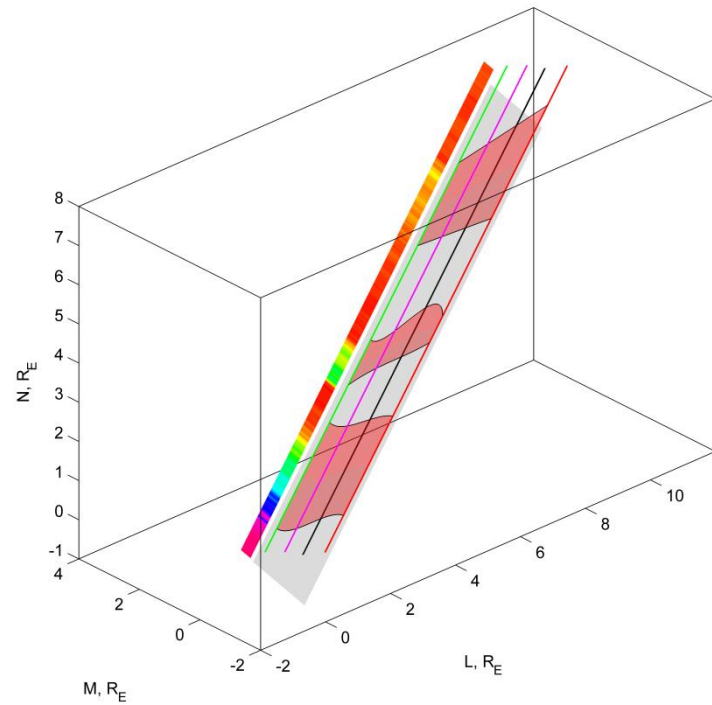
Adapted from Phan, 2006, Nature

Observations at ACE and Wind



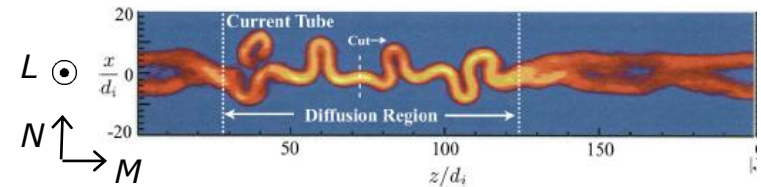
	Cluster			ACE			Wind		
	Before CS	In CS	After CS	Before CS	In CS	After CS	Before CS	In CS	After CS
$ B $ (nT)	6.7	5.8	7.3	7.0	2.0	8.0	8.0	7.5	9.3
n (cm ⁻³)	9.5	9.2	7.6	~11, poor temporal resolution			9.5	9.5	5.8
V_x (km s ⁻¹)		-397			-402			-410	
CS duration (s)		46			48			94	

Constraints from Timing Analysis



Driving Mechanisms

- Turbulent inflow
- MHD-scale instabilities
- Lower Hybrid Drift Instability drives Kelvin-Helmholtz in simulations
- Growth of kinetic instabilities downstream in exhaust?



Yin, L., et. al, 2008, PRL

