Magnetosheath high speed jets observed simultaneously by Cluster and MMS

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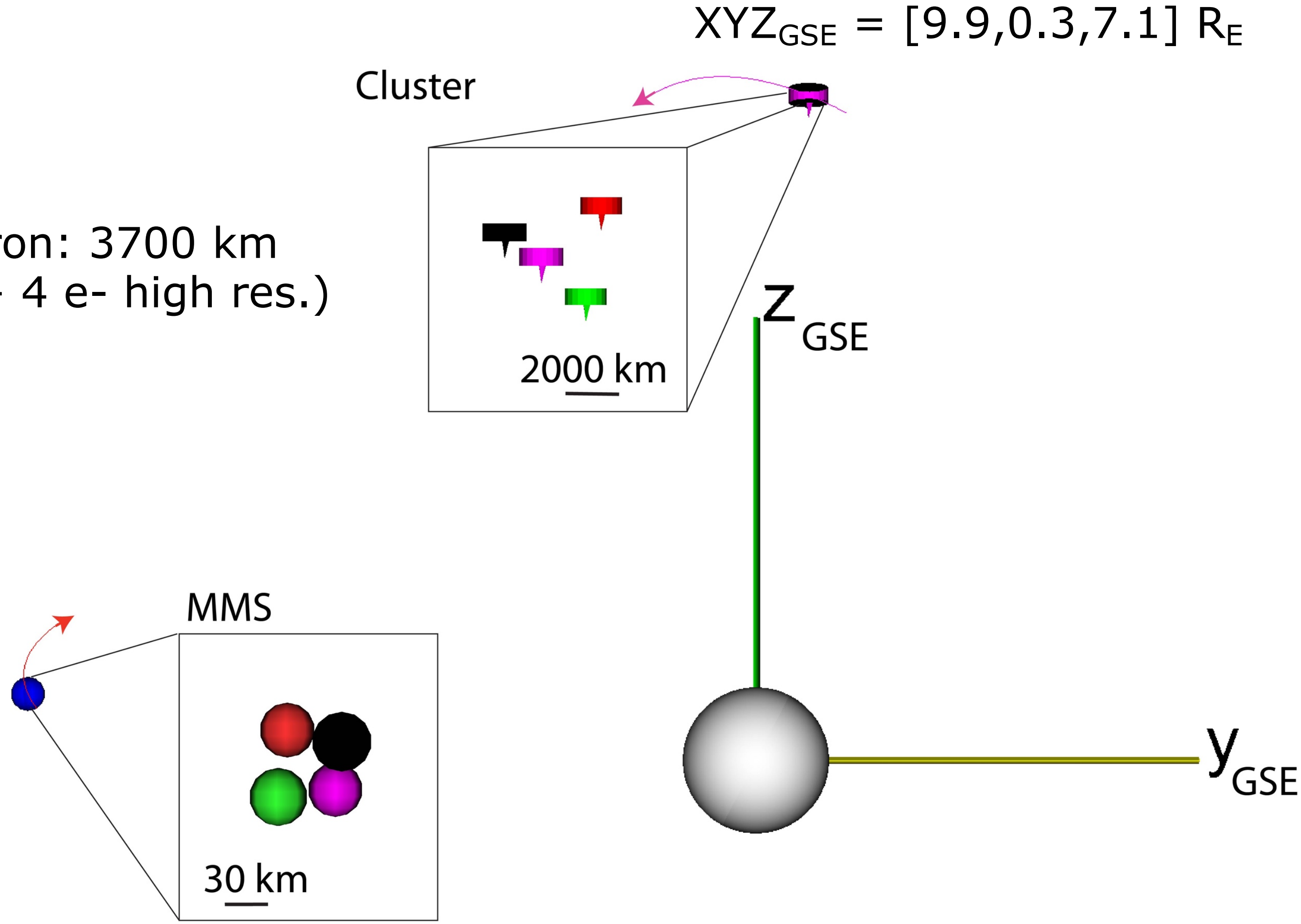
High Speed jet questions

- Origin (discontinuities, bow shock ripples, nanodust)
- Shape, size and frequency
- Effect on the magnetopause

=> Cluster-MMS conjunction in magnetosheath/magnetopause to address these questions

Cluster-MMS positions on 7 Feb. 2017

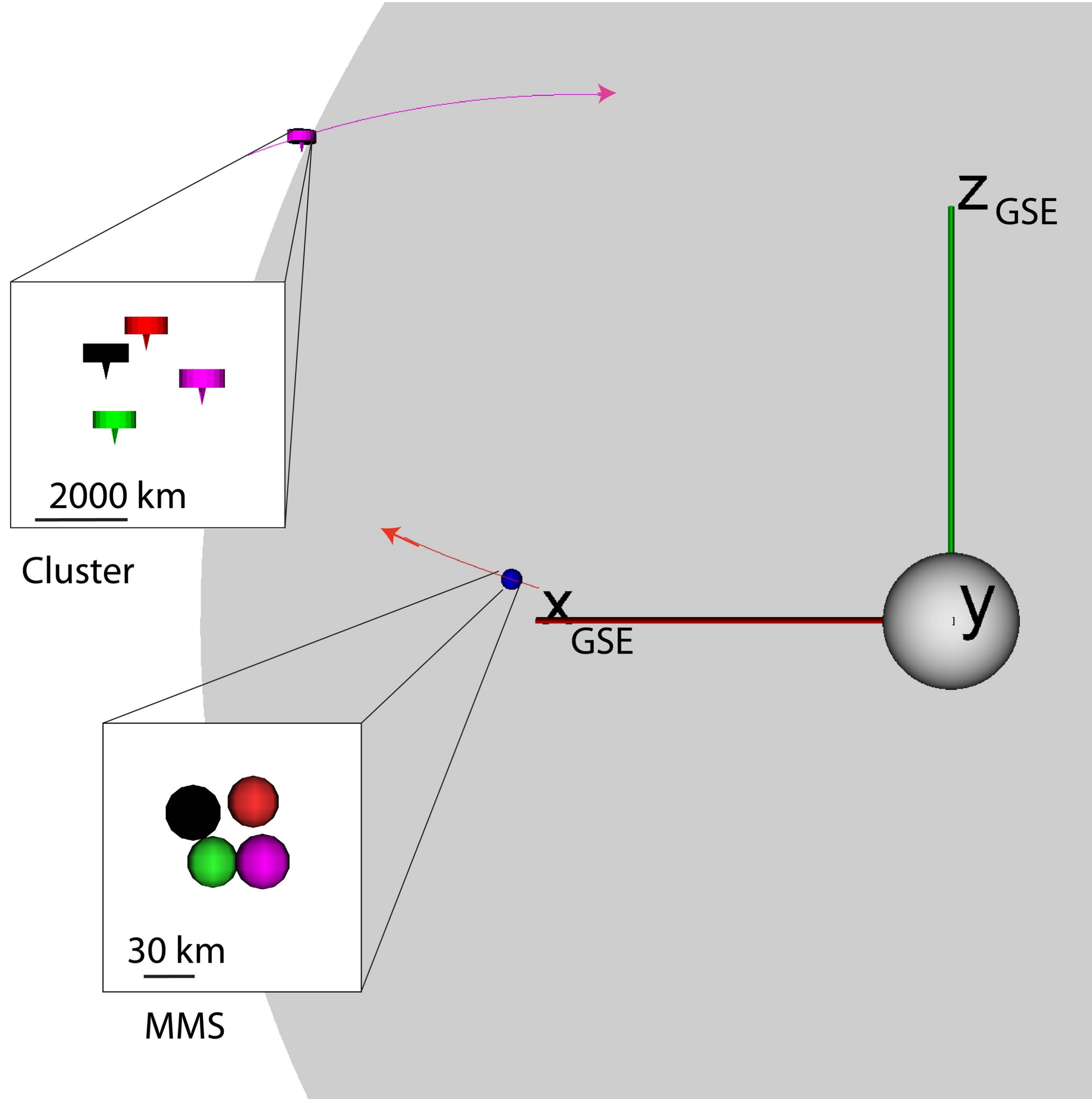
Cluster Tetrahedron: 3700 km
4h BM1 (2 ions + 4 e- high res.)

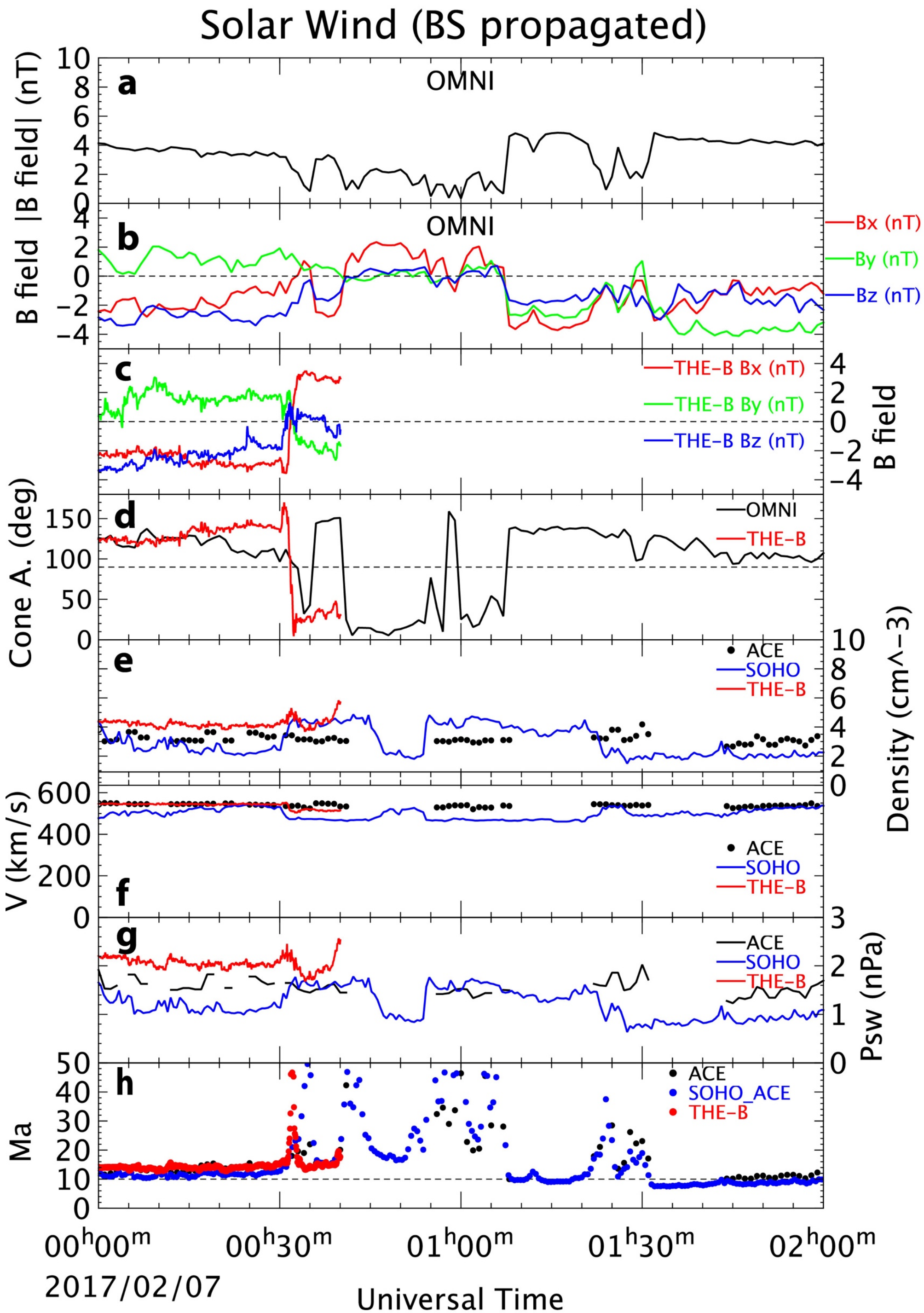


XYZ_{GSE} = [7.7,−8.0,0.7] R_E

MMS Tetrahedron: 50 km
4x10 min. BM intervals on Mpause crossings

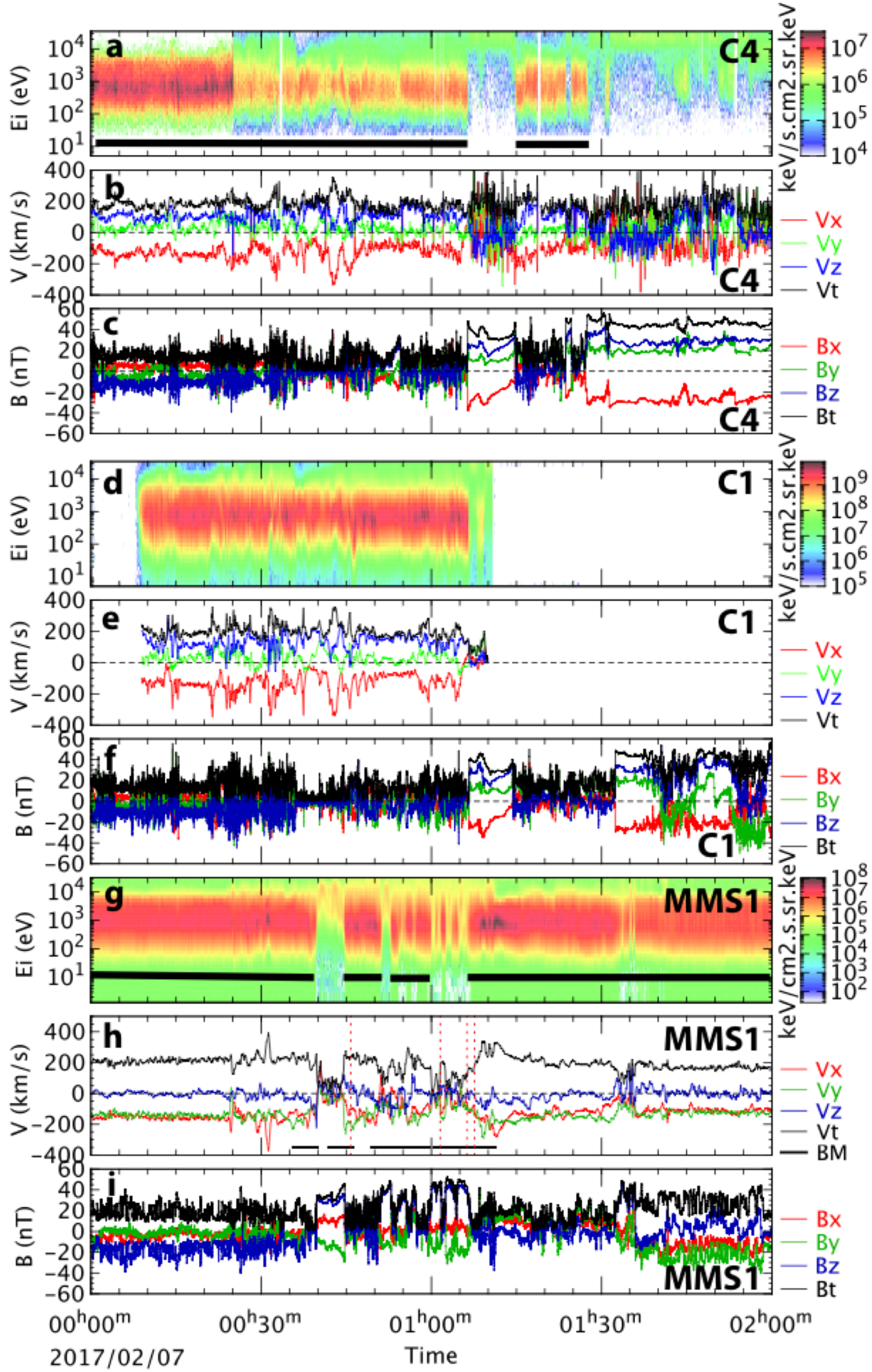
Cluster-MMS positions on 7 Feb. 2017





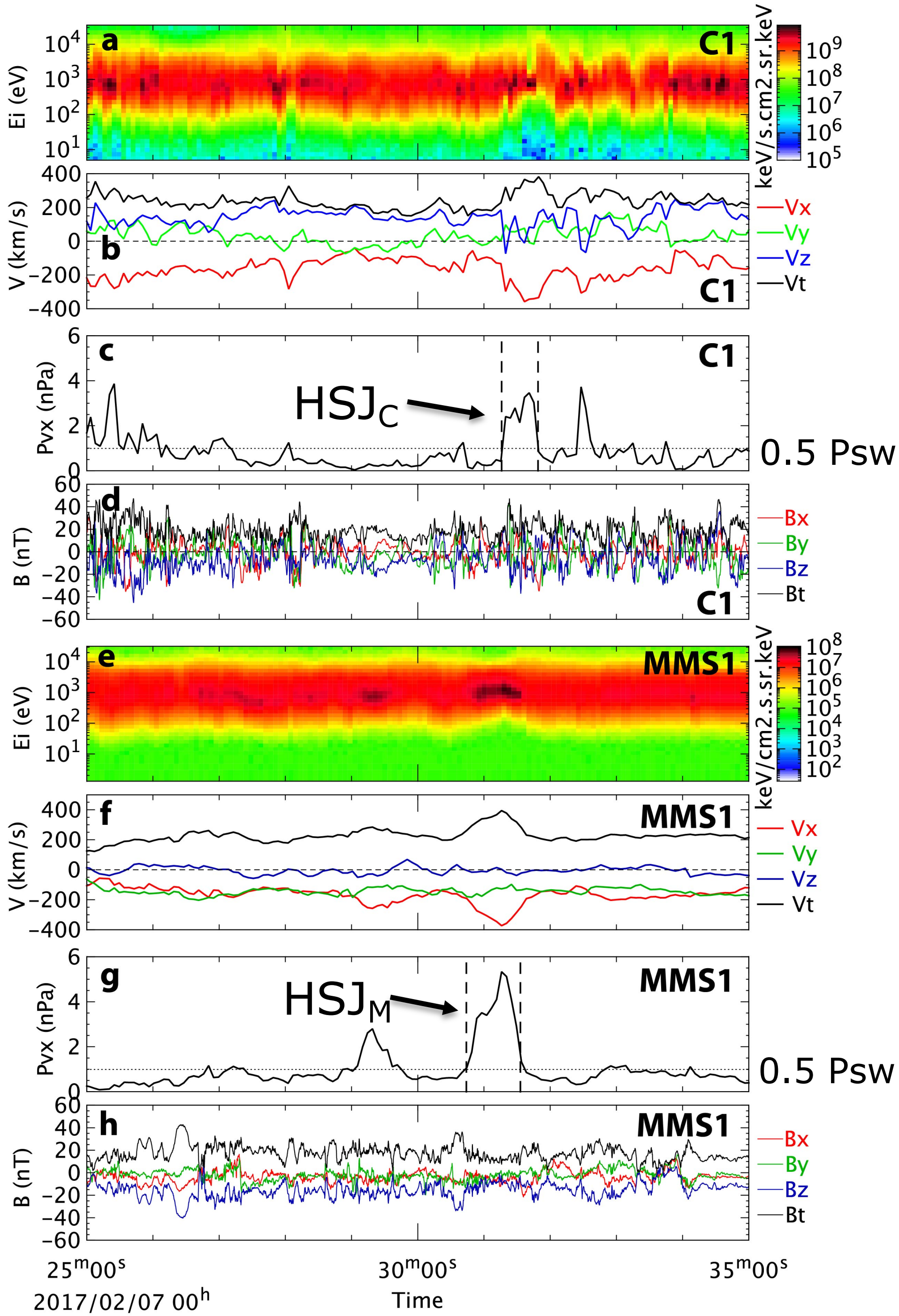
OMNI shifted to BS

- IMF around 4 nT at beginning and end of interval, decreased and very small (0.4 nT at 01 UT) in the middle
- Pure Bx component(2 nT) between 00:40-01:10 => dayside quasi parallel shock
- SOHO and THEMIS-B data added for complementarity



Cluster-MMS data

- Cluster and MMS most of time in magnetosheath (black bar)
- Magnetosheath is turbulents with strong Vx negative flows (red line)
- High speed jets shown in Vx in panels b, e and h
- A few magnetopause crossings
- In panel h:
  - Dust impacts in red dashed lines
  - Burts mode in black line



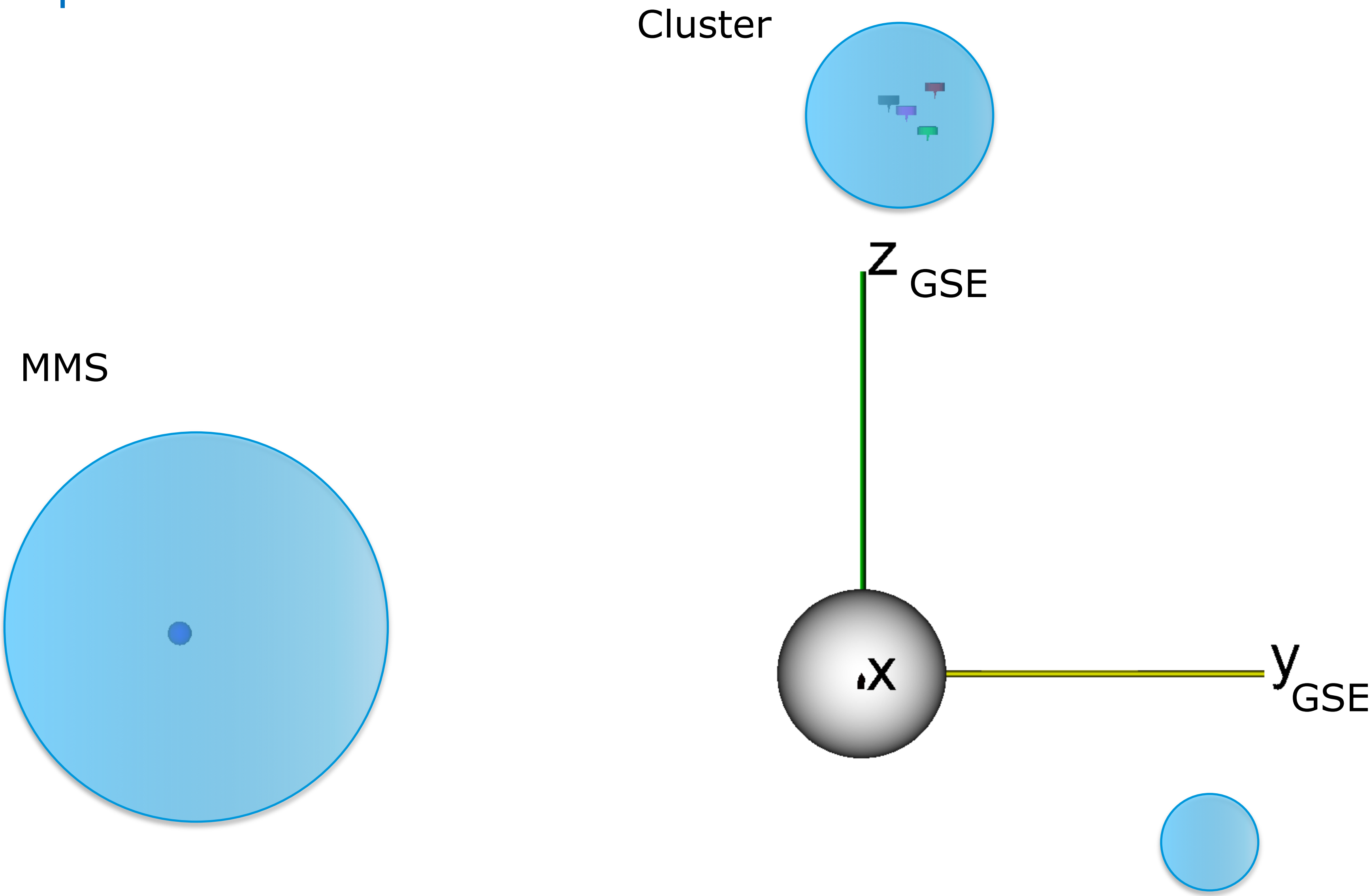
High Sped Jet:

- around same time on Cluster and MMS (24 s overlap)
- size:
  - Cluster : 1.9 Re
  - MMS: 2.8 Re

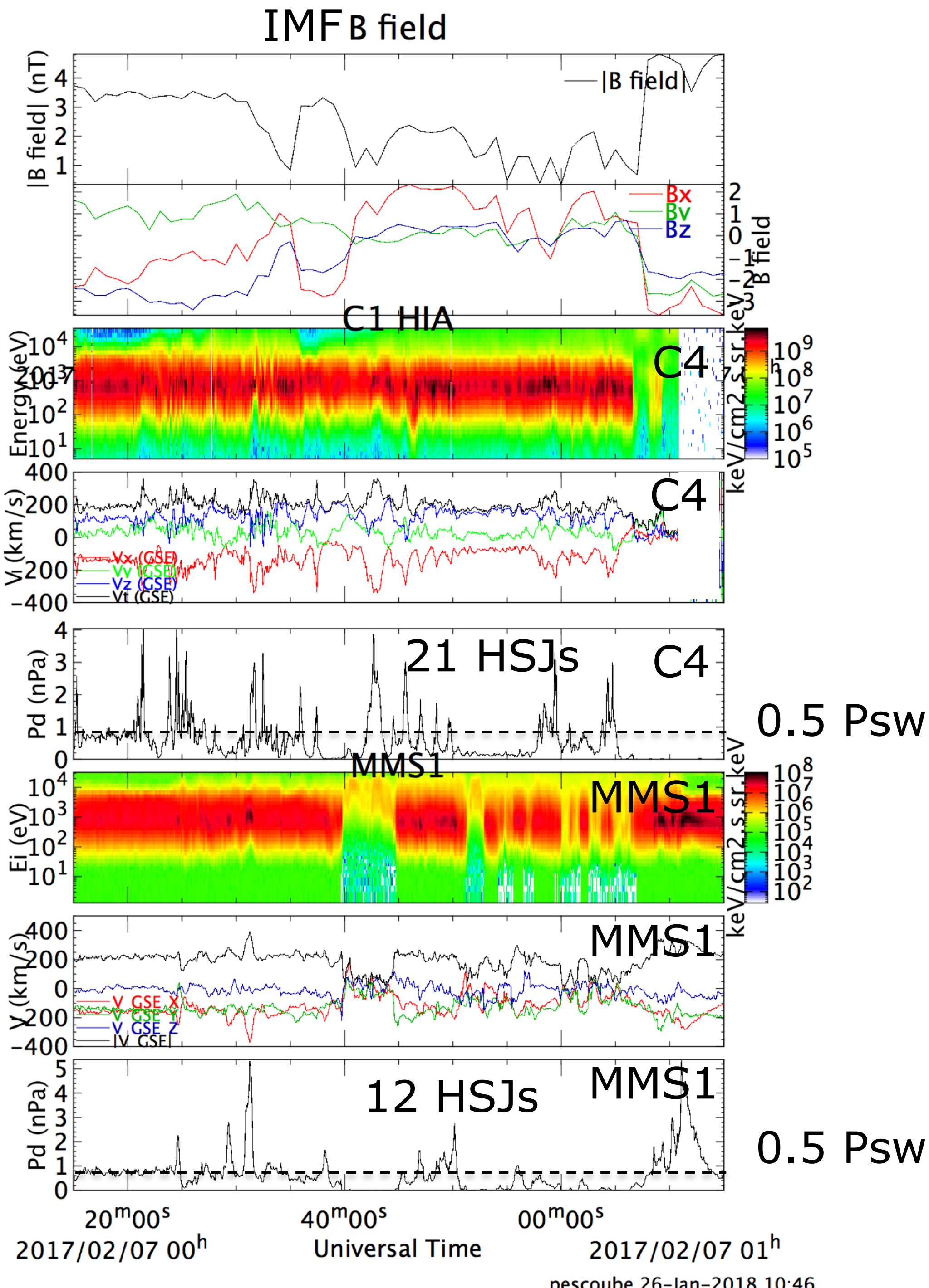
=> Larger at MMS due to higher speed and longer event

- If assume ratio para/perp of 0.5 from Plaschke et al. 2016, we get:
  - Cluster: 1.9 x 3.8 Re
  - MMS: 2.8 x 5.6 Re

HSJ position and size: two different at Cluster and MMS



HSJ average: 1.3Re
(Plaschke et al., 2016)



Cluster-MMS data

- C1: 21 HSJs in 65 min.
- MMS1: 12 HSJs, but intervals of magnetosphere and boundary layers

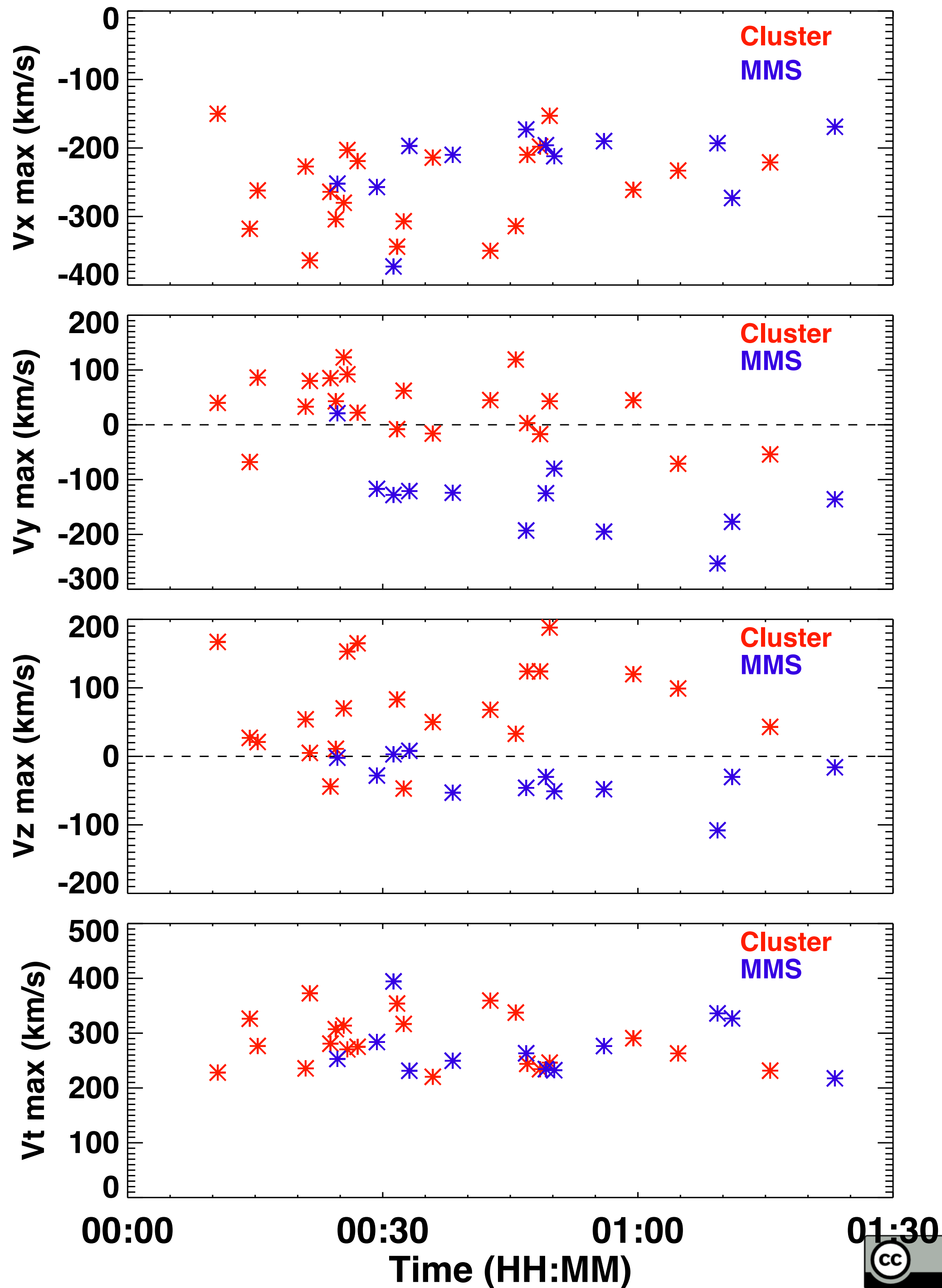
HSJs characteristics 1

Vx (max Vx)

Vy (max Vx)

Vz (max Vx)

Vt (max Vx)

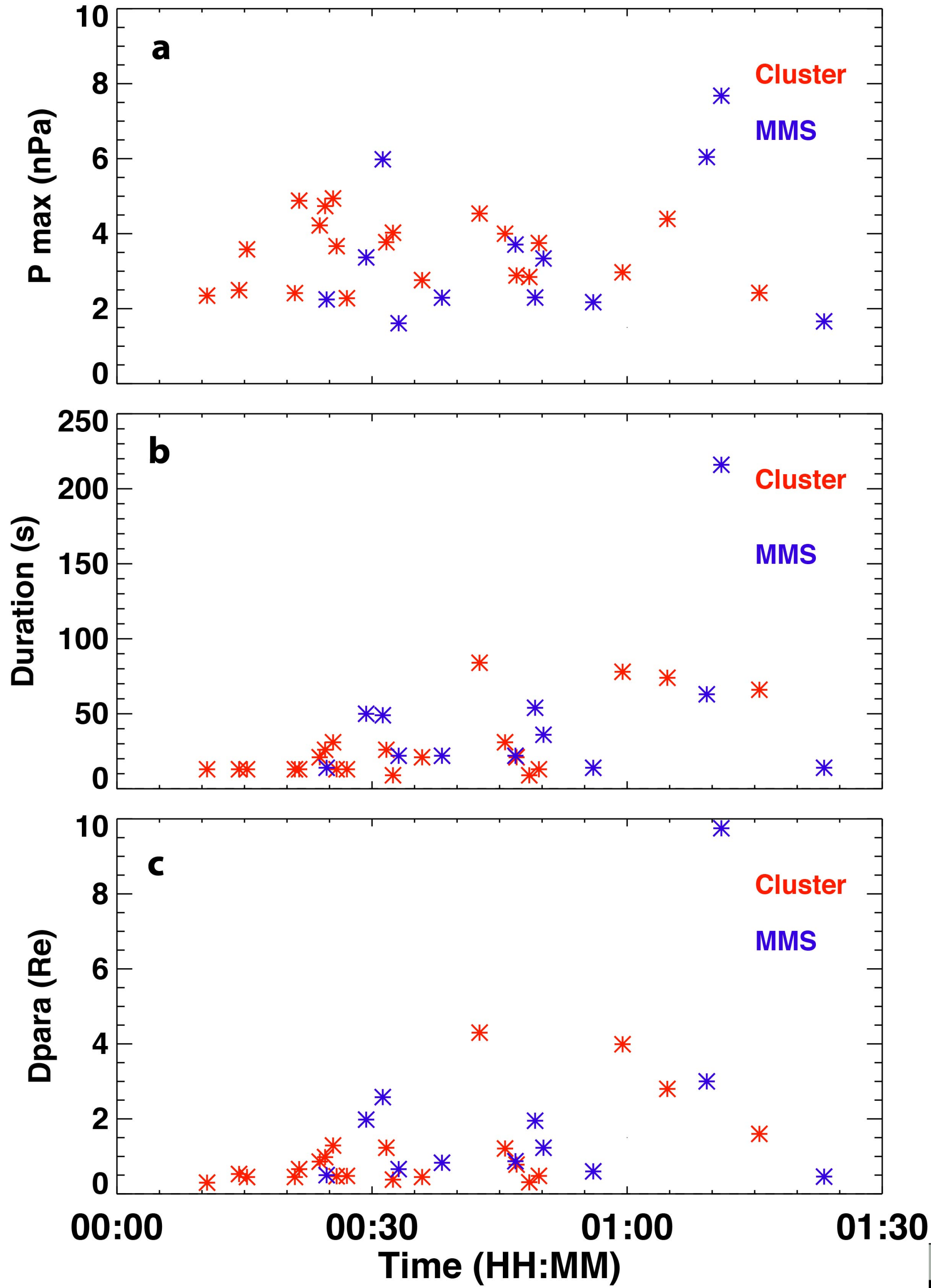


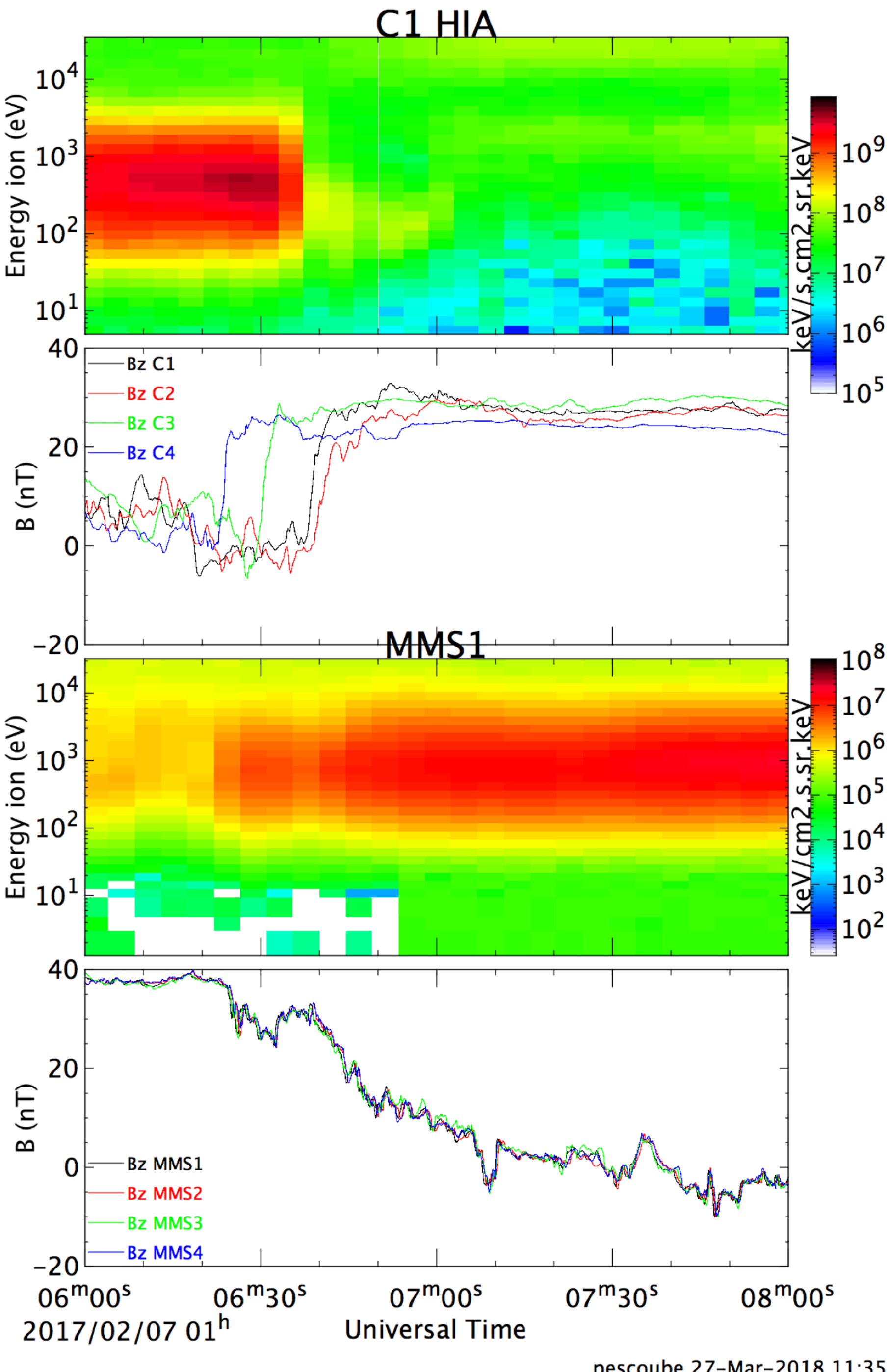
HSJs characteristics 2

P_{Vx} (max Vx)

Duration (s)

Size parallel (R_E)





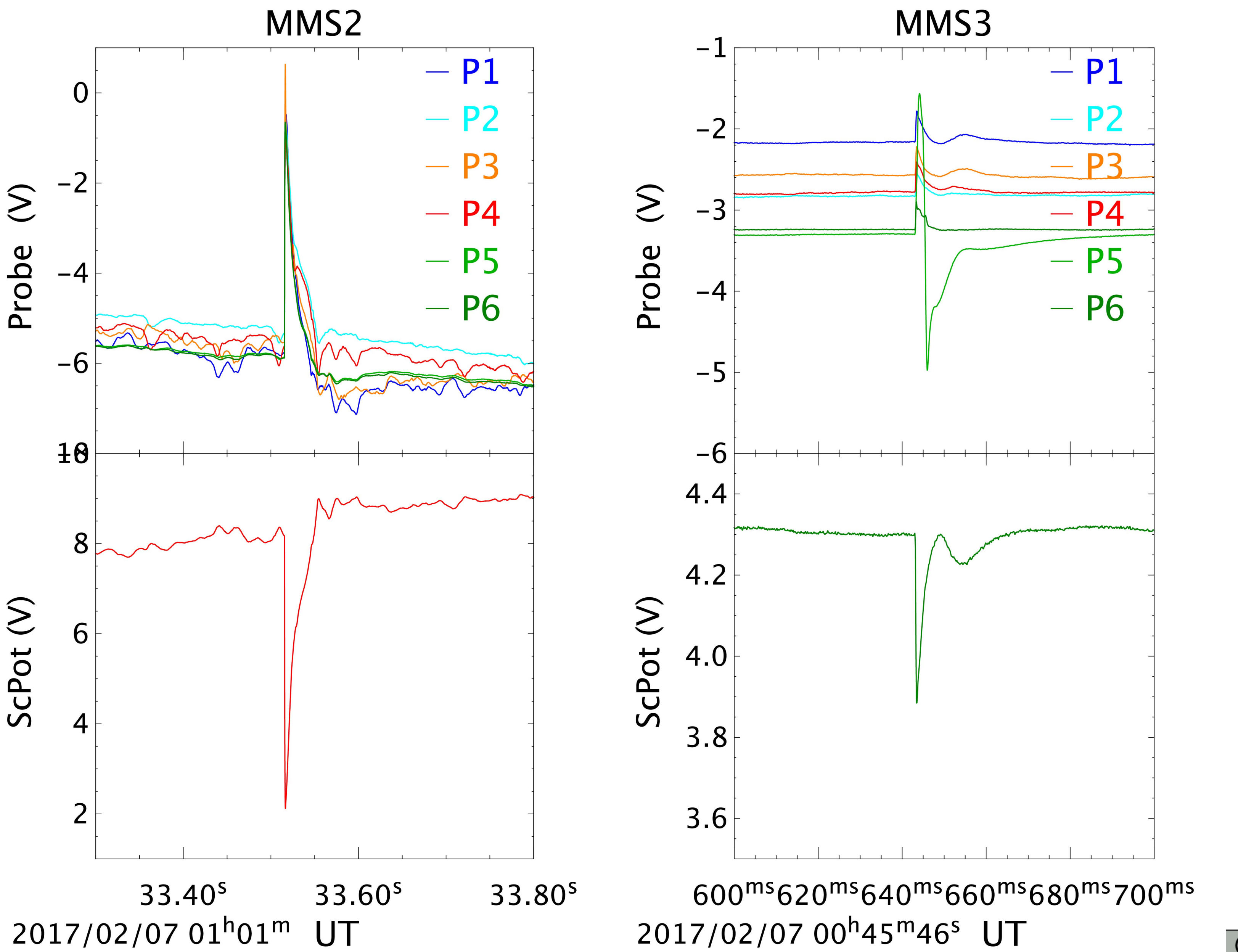
Cluster-MMS magnetopause crossing

- Opposite crossing:
  - Cluster inbound
  - MMS outbound
- Cluster: sharp and short MP (4s)
- MMS wide and long (70s)
- C1 and MMS1: low B field on sheath side (asymmetry)

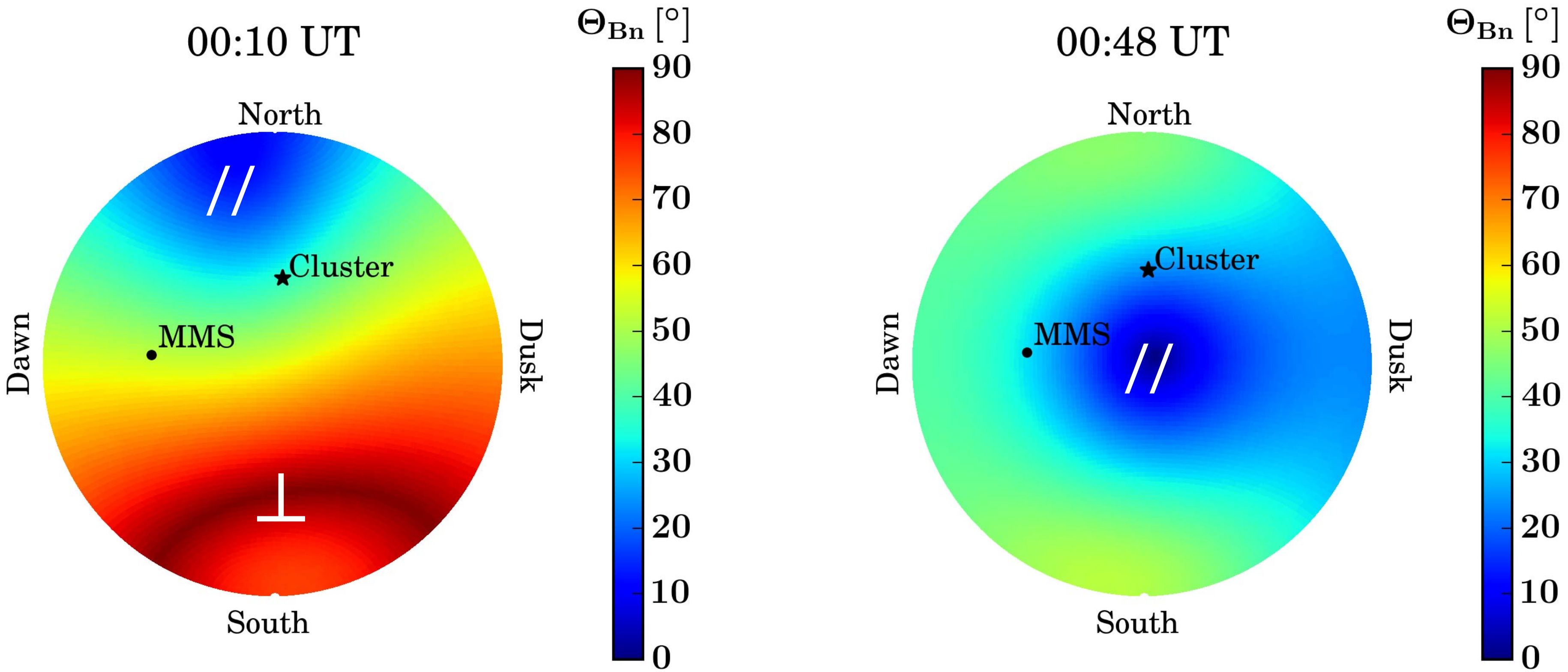
SAT	Time (UT) Inbound/ Outbound	Method	Speed (km s^{-1})	Normal X,Y,$Z_{(GSE)}$	Normal model X,Y,$Z_{(GSE)}$	Angle data-model (°)
MMS	01:06:24 O	4 S/C timing	-83	0.99, -0.03, 0.10	0.79, -0.61, 0.06	35
		MVAB MMS1	-37	0.95, -0.30, 0.11	"	22
		MMS2	-43	0.95, -0.27, 0.14	"	25
		MMS4	-42	0.95, -0.27, 0.13	"	25
		MFR+MVAV 1	21	0.27, -0.94,-0.22	"	37
		MMS2	2	0.15, -0.95, 0.27	"	47
		MMS4	36	0.00, -0.89,-0.45	"	55
CL	01:06:24 I	4 S/C timing	142	0.53, 0.23, 0.82	0.84, 0.02, 0.53	28
		MVAB C1	41	0.76, -0.04, 0.65	"	11
		C4	120	0.54, -0.03, 0.84	"	26
		MFR+MVAVC1	36	0.75, 0.54, 0.39	"	32
		C4	108	0.59, 0.17, 0.79	"	23

Speed very different at Cluster and MMS
Large angle between observations and model of magnetopause normal

Four dust impacts (two shown)



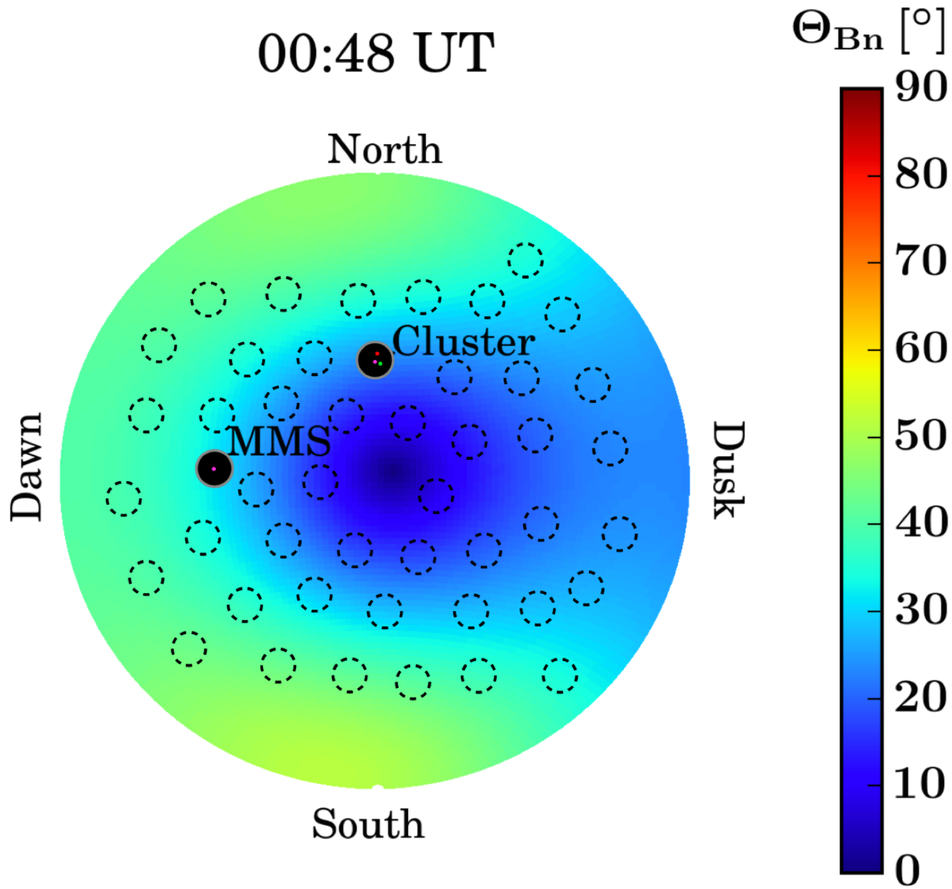
Angle Θ_{Bn}: IMF – shock normal

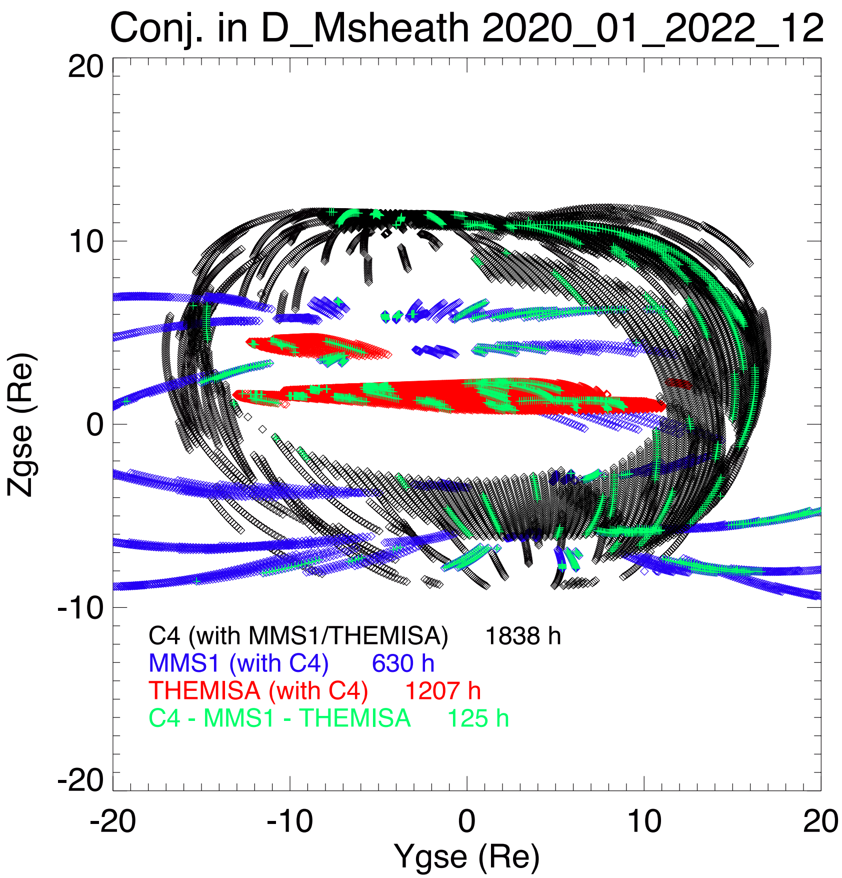


Cluster: HSJs observed
MMS: no HSJ

Cluster: HSJs
MMS: HSJs

HSJs possible extent





Summary and conclusions

- Many HSJs were observed at two very large separation over the dayside of the magnetosheath;
- Two HJSs were observed simultaneously at Cluster and MMS and given their characteristics and size, they would most likely be two separated HSJs;
- Strong indentation of the magnetopause in the 8 crossings;
- One inbound magnetopause crossing observed by Cluster was observed simultaneous to an outbound magnetopause crossing of MMS;
- Four dust impacts were observed as a short pulse of the spacecraft potential between 00:45 UT and 01:10 UT on MMS2 and MMS3. None of these impacts are occurring simultaneously with the observation of HSJs.
- Quasi parallel shock more favorable for generation of HSJs
- Future conjunctions between 2021-2022 should give more double and triple simultaneous measurements with Cluster, MMS and THEMIS