Magnetosheath jets using MMS

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Dayside Kinetic Processes | mini-GEM 2021
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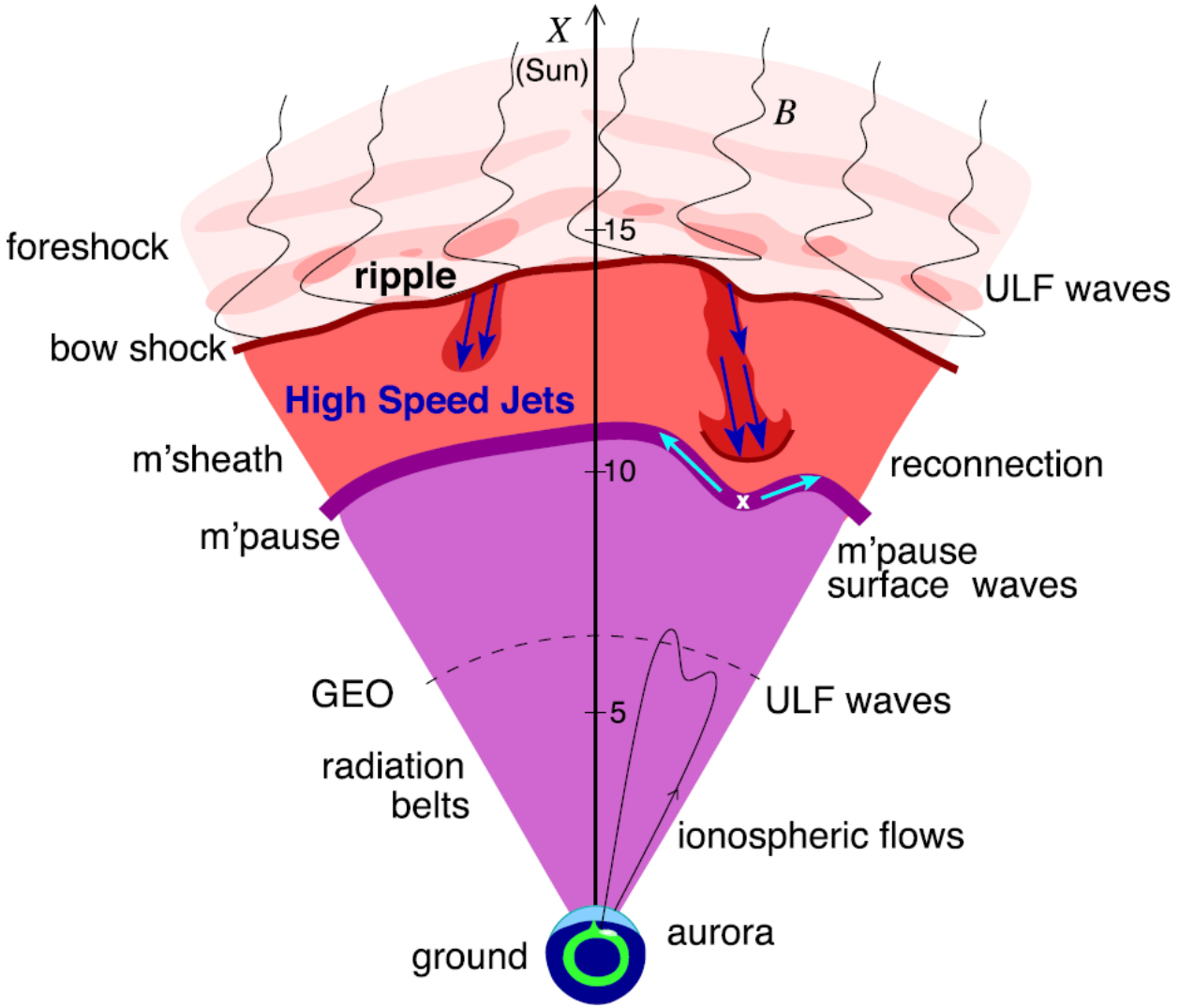
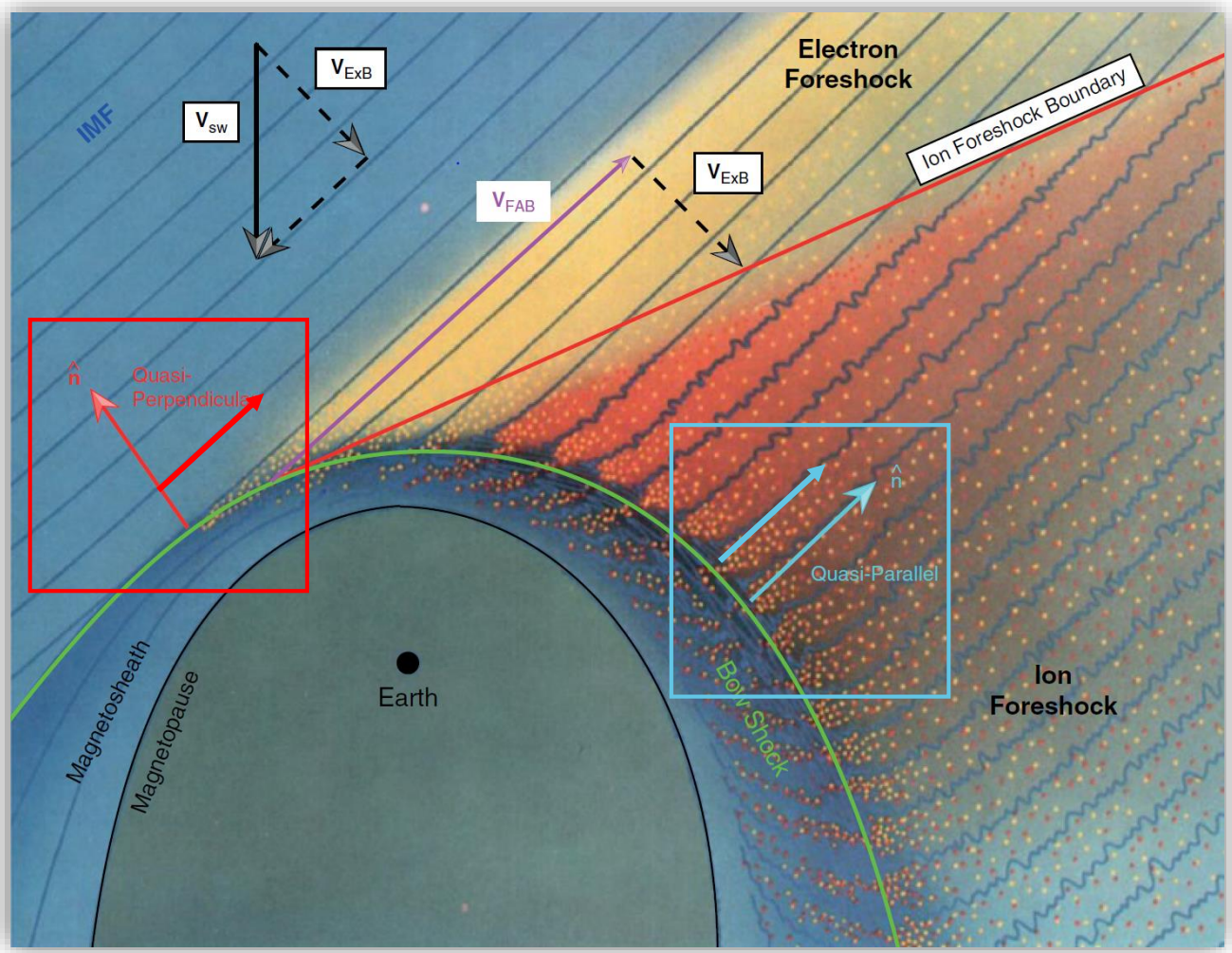
Introduction – Magnetosheath Jets



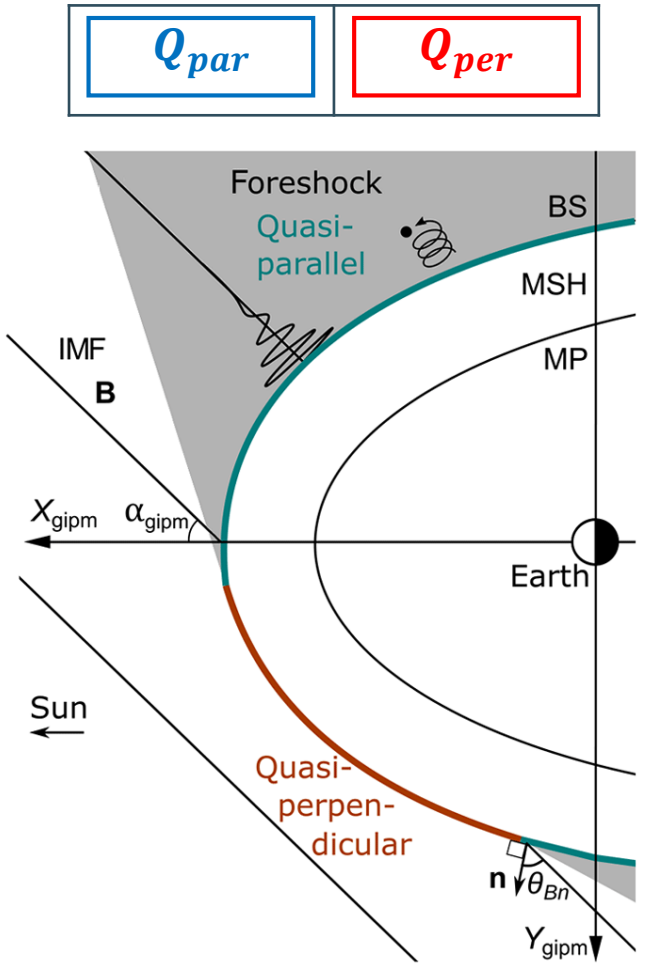
Plaschke F. et al. (2018); sketch by H. Hietala | Space Sci. Rev

Motivation – Main Subcategories



L. B. Wilson (2016) | Geophysical Monograph Series

”Found ~9 times more often behind the Qpar bow shock”



Vuorinen, et al. (2019) | Annales

Classification Procedure in progress

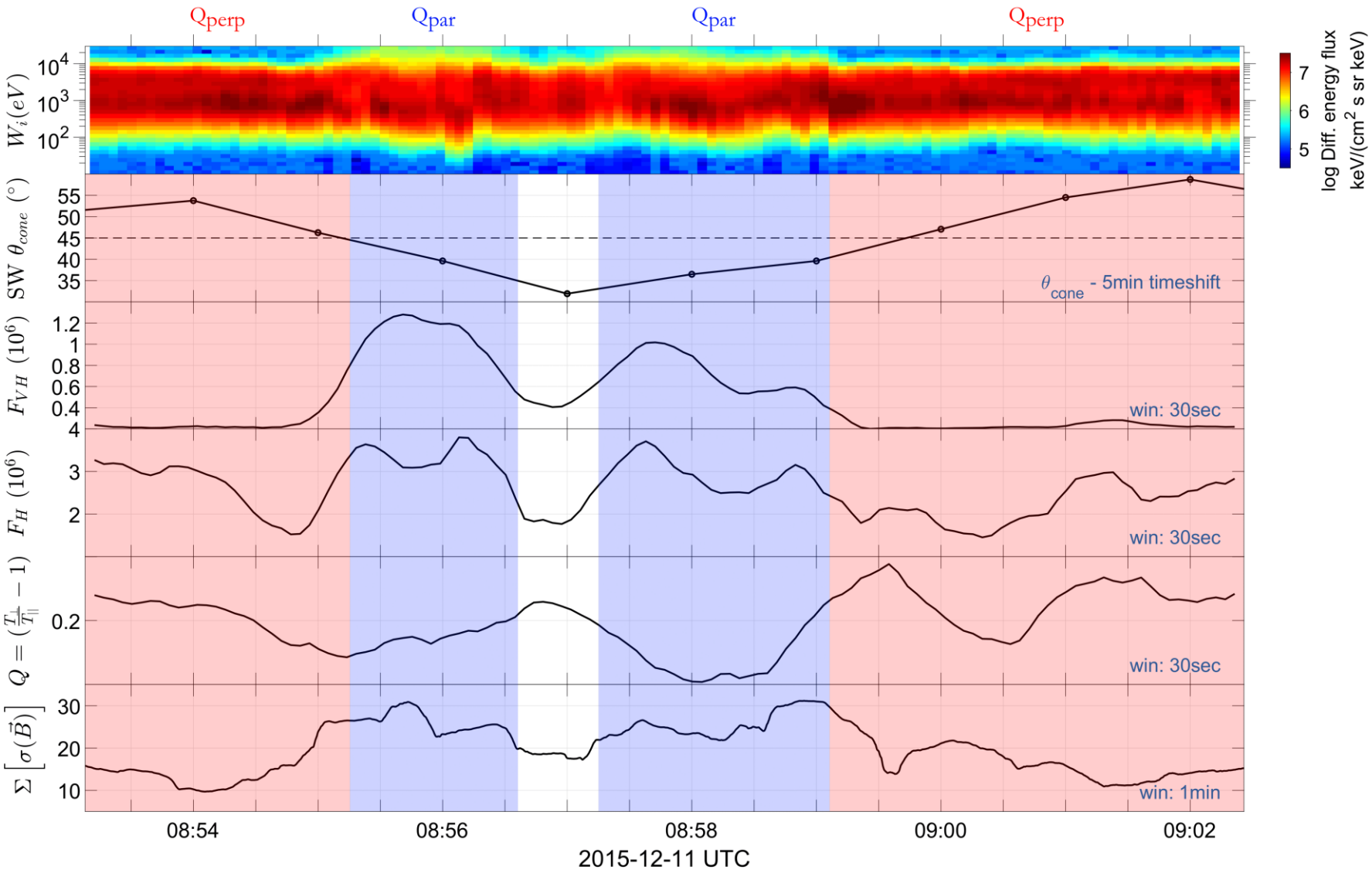
Cone Angle

Very High Energy Flux

High Energy Flux

Anisotropy

Magnetic Field stdev



Raptis, Karlsson, et al. (2020) | JGR
Karlsson, **Raptis**, et al. (2020) | Ongoing

Multispacecraft Classification using Cluster

Energy Spectrum Magnetosheath (eV)

Energy Spectrum Solar Wind (eV)

Magnetic Field (nT)

Magnetic Field (nT)

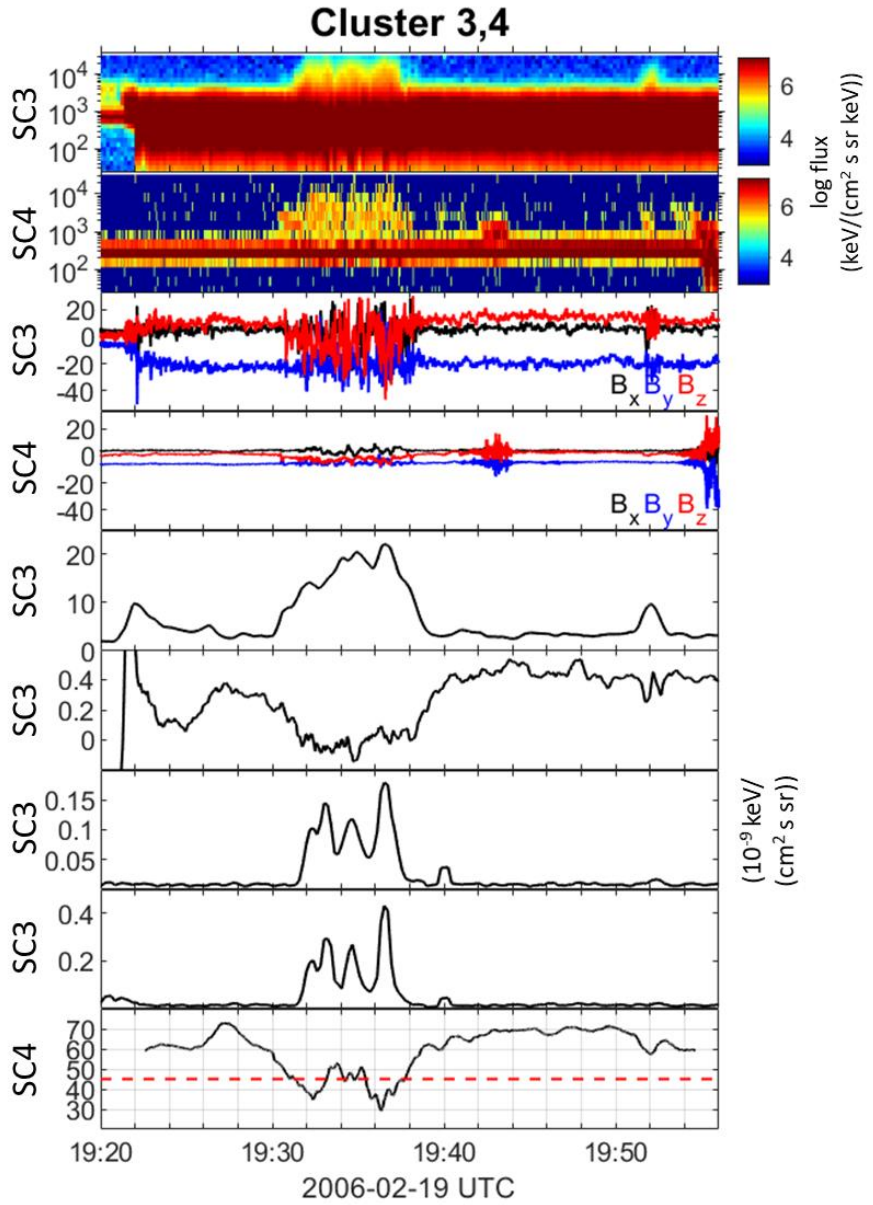
Magnetic Field Stdev (nT)

Anisotropy(Q)

High Energy Flux

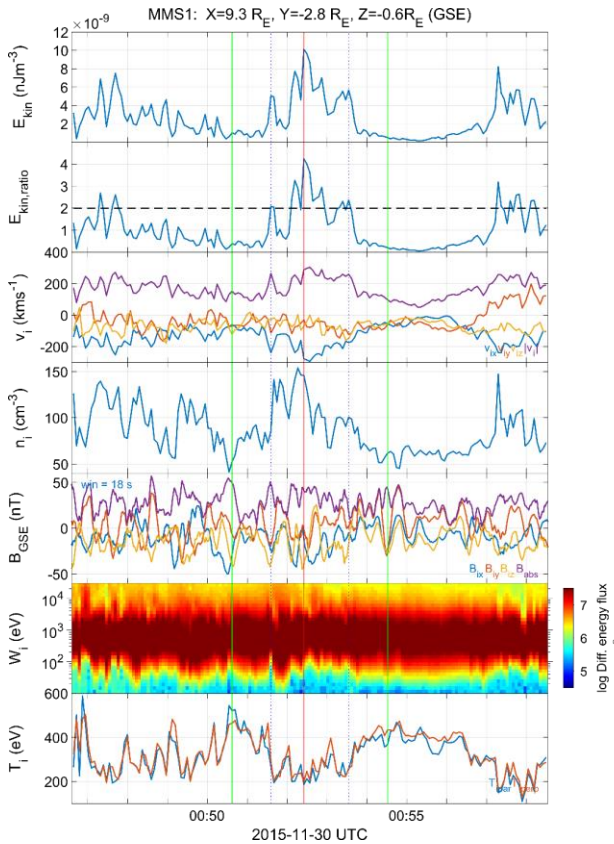
Energy Flux Ratio

Theta Bn



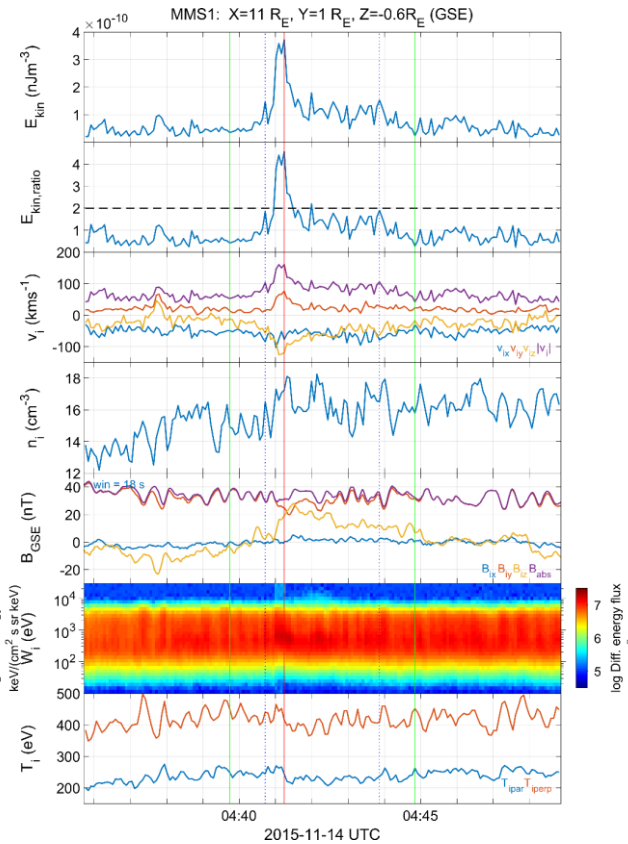
Karlsson, **Raptis**, et al. (2020) | Ongoing

Main Categories of Jets



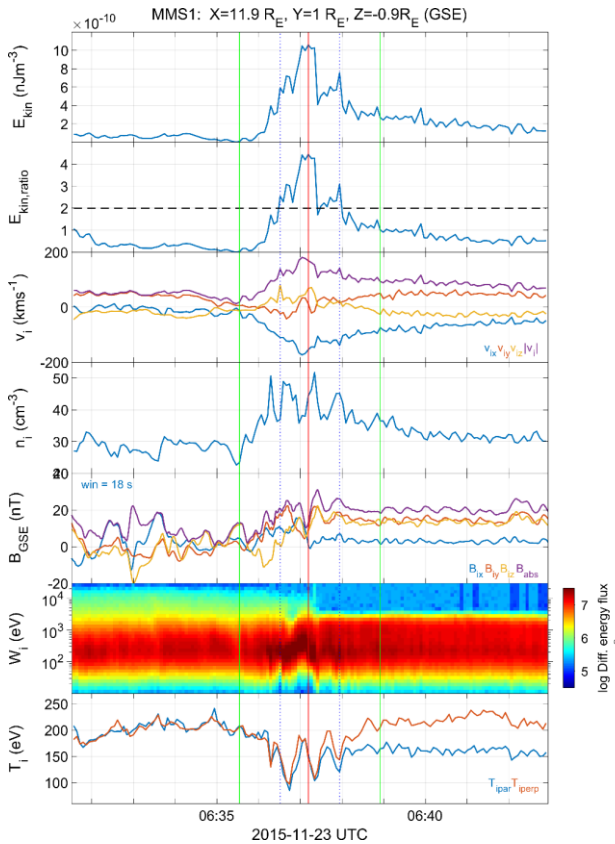
Qpar Jet

Jets found in $Q_{\parallel}$ MSH



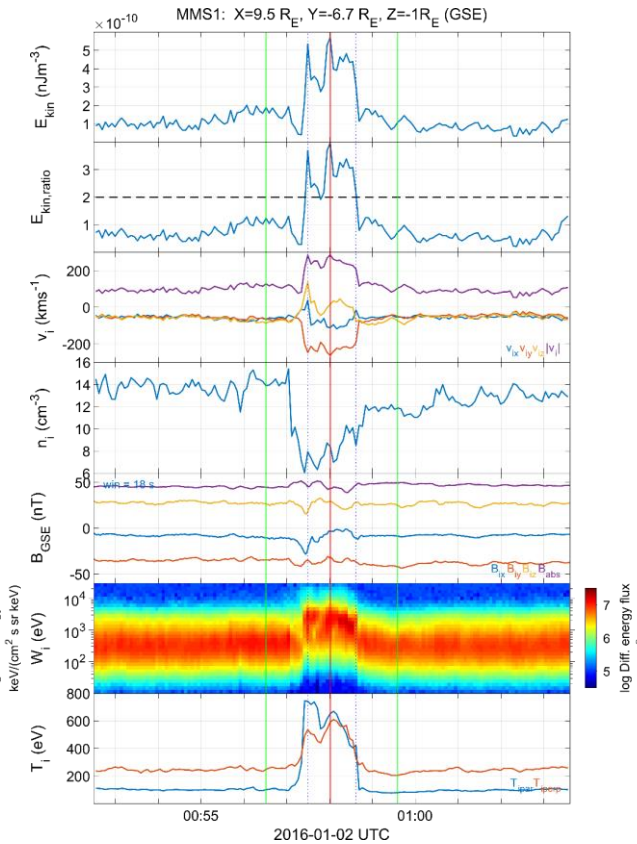
Qperp Jet

Jets found in $Q_{\parallel}$ MSH



Boundary Jet

Jets found in the boundary between $Q_{\parallel}$ and $Q_{\perp}$ MSH



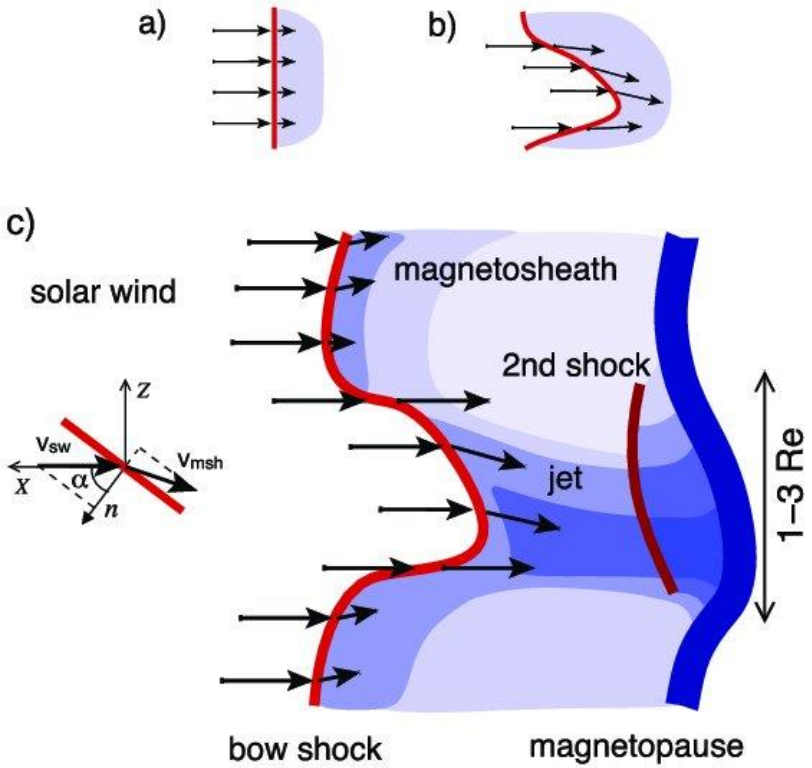
Encapsulated Jet

Jets corresponding to $Q_{\parallel}$-like MSH plasma enclosed in $Q_{\perp}$ MSH

Raptis S., Karlsson T., et al. (2020) | JGR
Raptis S., Aminalragia-Giamini S., et al. (2020) | Frontiers

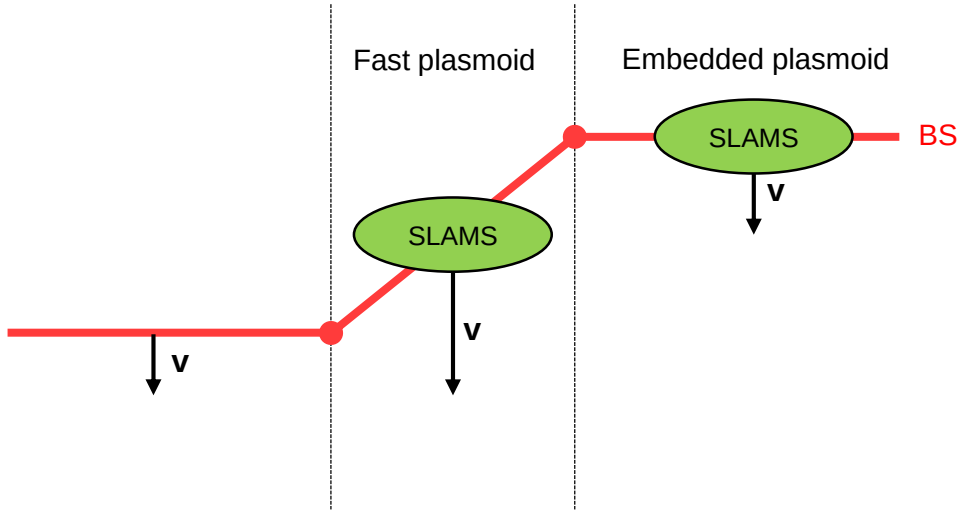
Connecting to existent mechanisms

Bow shock ripples



Faster flow (ΔV) → Less heated (ΔT)

SLAMS penetration



Steepened wave (ΔB) → Density enhancement (Δn)

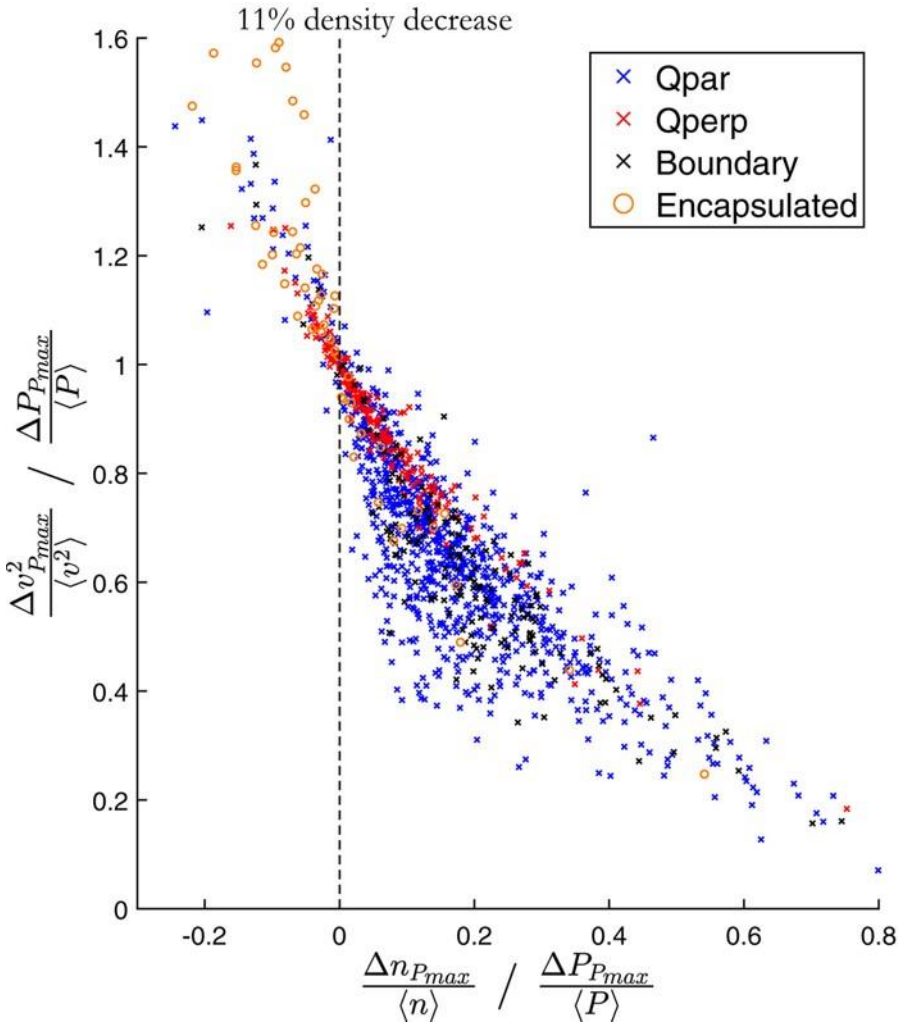
Qpar : Hietala et al., (2009,2012) | Qperp : Johlander et al. (2016)

Hietala et al., (2009,2012), Karlsson et al. (2015)

Recent Results

Raptis S., Karlsson T., et al. (2020) | JGR
Raptis S., Aminalragia-Giamini S., et al. (2020) | Frontiers
Palmroth M., **Raptis S**., et al. (2020) | Annales (under review)

Current main results (1)



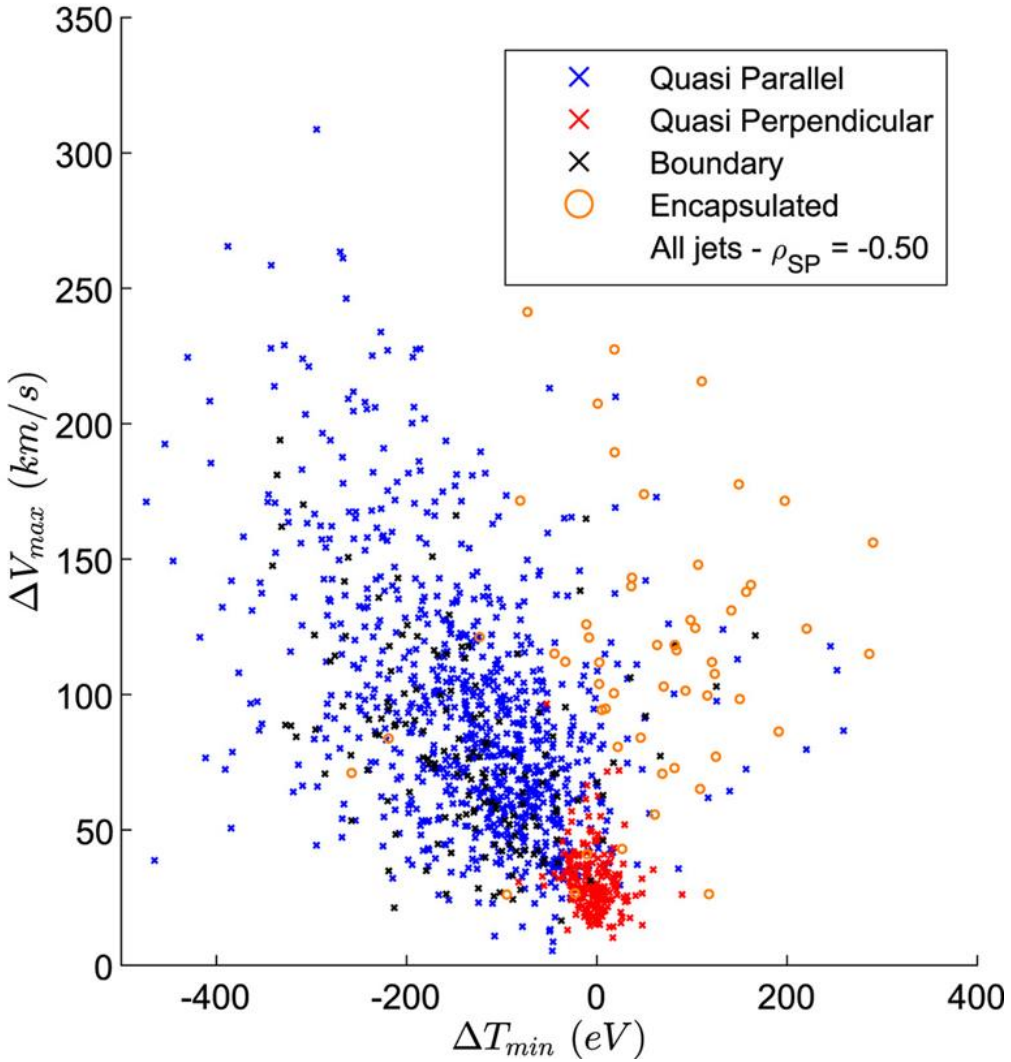
Raptis S., Karlsson T., et al. (2020) | JGR
Raptis S., Aminalragia-Giamini S., et al. (2020) | Frontiers

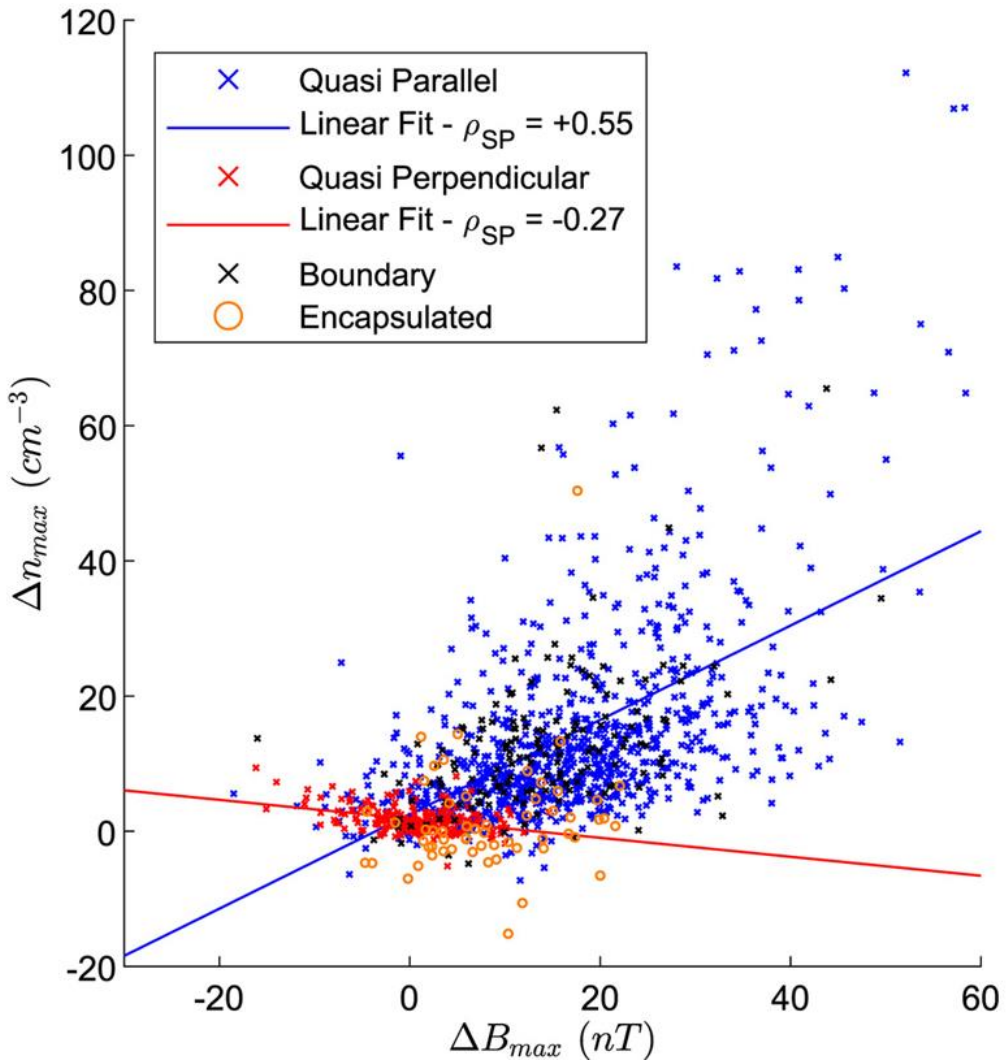
Current main results (2)

"Ripples"

$\Delta X = \mathrm{X_{jet}} - \langle \mathrm{X_{BG}} \rangle_{5\mathrm{min}}$

"SLAMS"

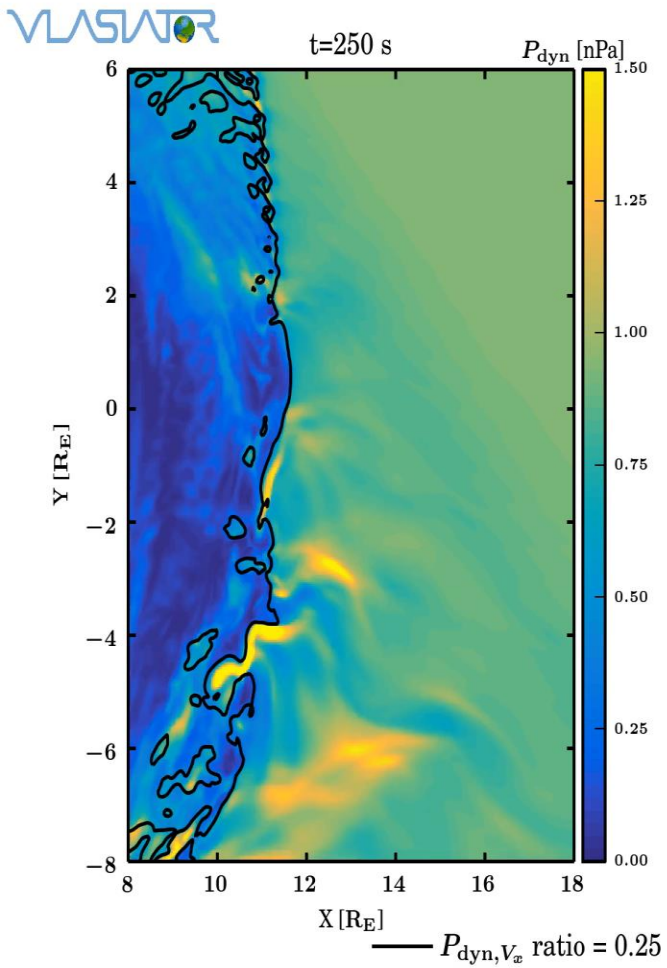


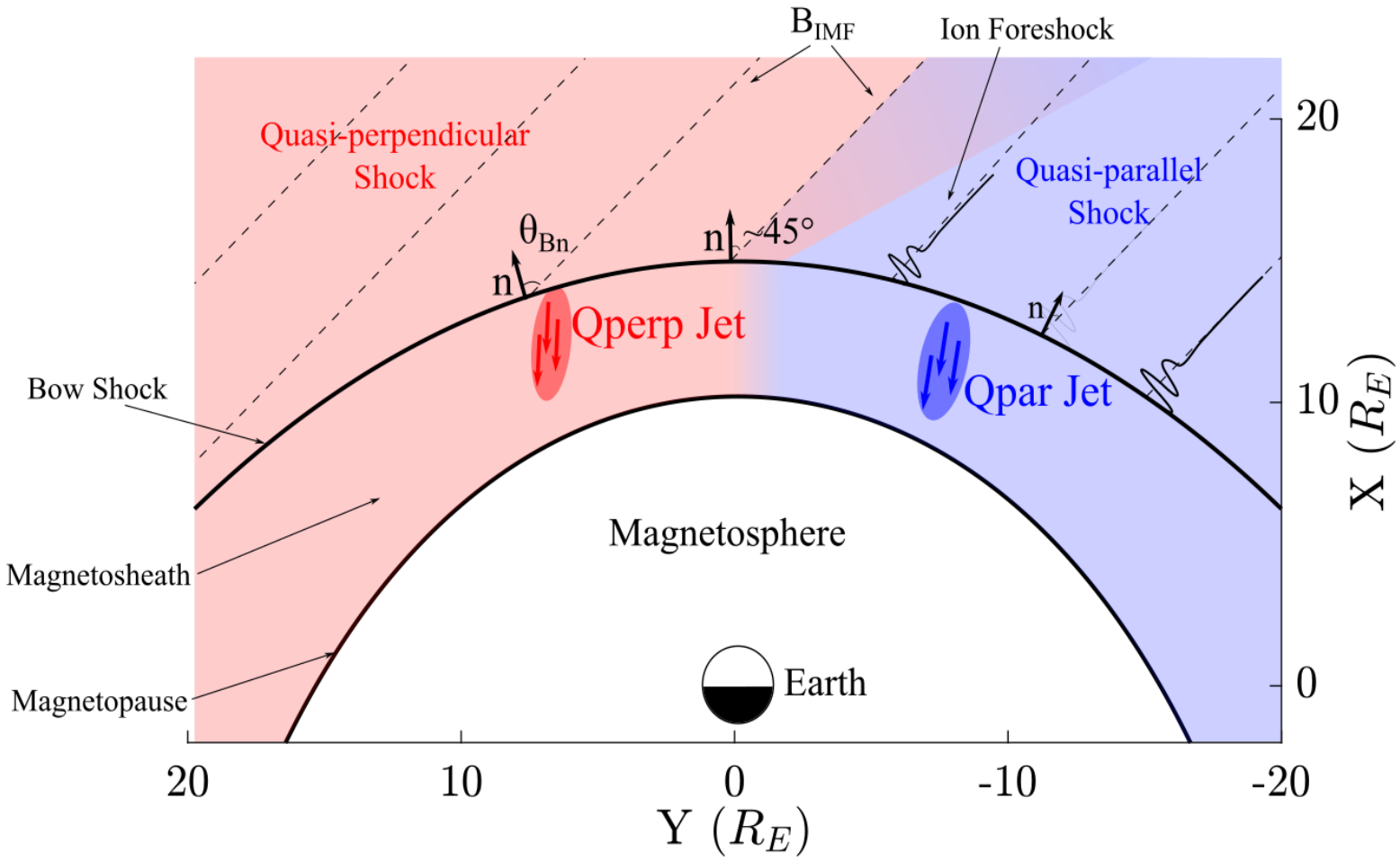


Raptis S., Karlsson T., et al. (2020) | JGR

Ongoing Work

Ongoing work – Approaching the shock





Palmroth M., **Raptis S**., et al. (2020) | Annales (under review)
Palmroth M., et al. (2018) | Annales

Raptis S., Aminalragia-Giamini S., et al. (2020) | Frontiers

Updated database of jets

Initial: N = 8499

Subset	Number	Percentage (%)
Quasi-parallel	2284	26.9
Final cases	**860**	10.1
Quasi-perpendicular	504	5.9
Final cases	**211**	2.5
Boundary	744	8.8
Final cases	**154**	1.8
Encapsulated	77	0.9
Final cases	**57**	0.7
Other	4890	57.5
Unclassified/Uncertain	3499	41.2
Border	1346	15.8
Data Gap	45	0.5

09/2015 - 04/2019

Raptis S., Karlsson T., et al. (2020) | JGR
Raptis S., Aminalragia-Giamini S., et al. (2020) | Frontiers
Palmroth M., **Raptis S**., et al. (2020) | Annales (under review)

Updated: N = 9196

Subset	Number	Percentage (%)
Quasi-parallel	2458	26.7
Final cases	**901**	10.1
Quasi-perpendicular	542	5.9
Final cases	**214**	2.3
Boundary	781	8.5
Final cases	**191**	2.1
Encapsulated	80	0.9
Final cases	**60**	0.7
Other	5335	58.0
Unclassified/Uncertain	3789	41.2
Border	1500	16.3
Data Gap	46	0.5

9/2015 - 9/2020

~**300** close to the bow shock

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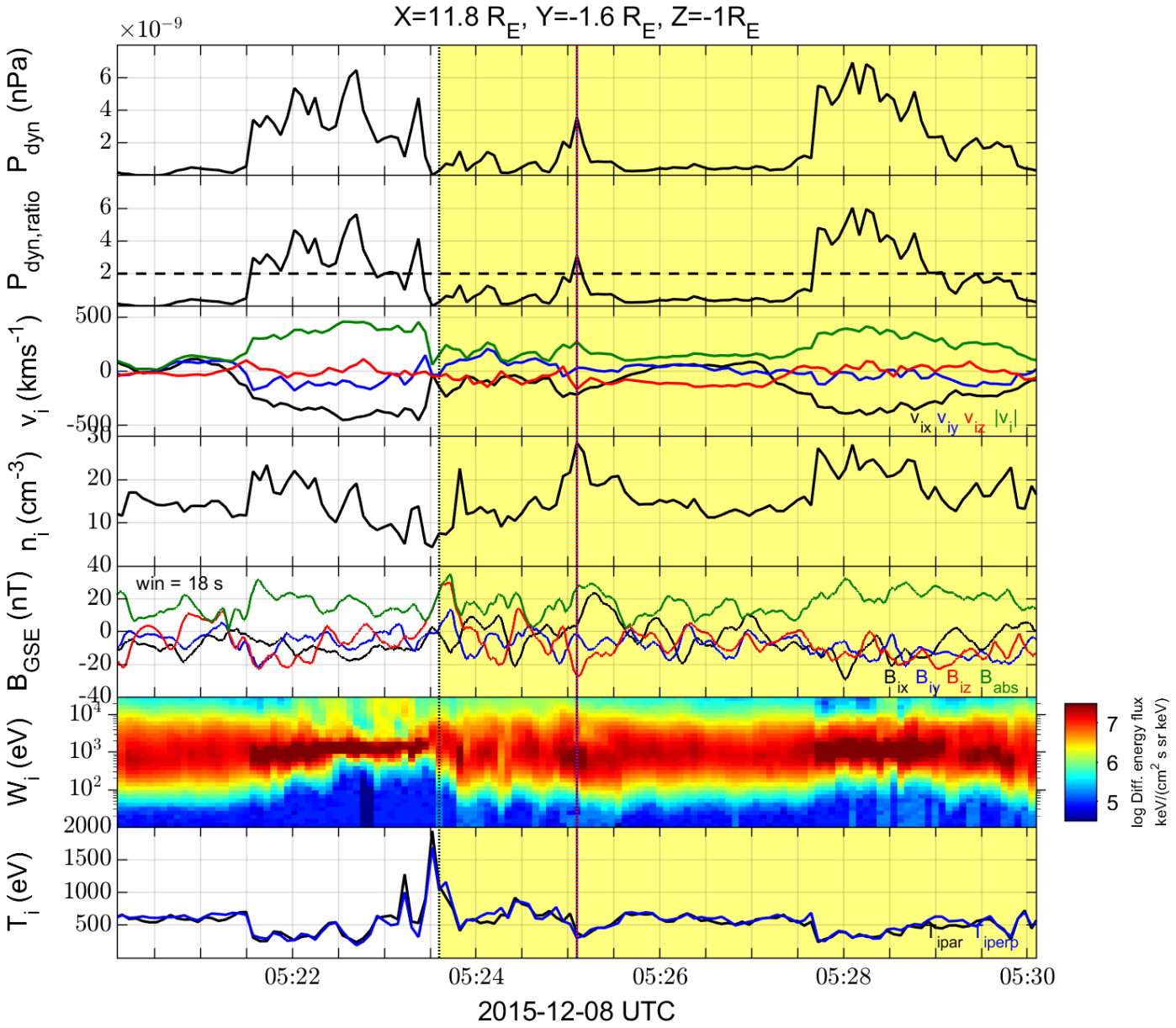
Example: close to the bow shock jet



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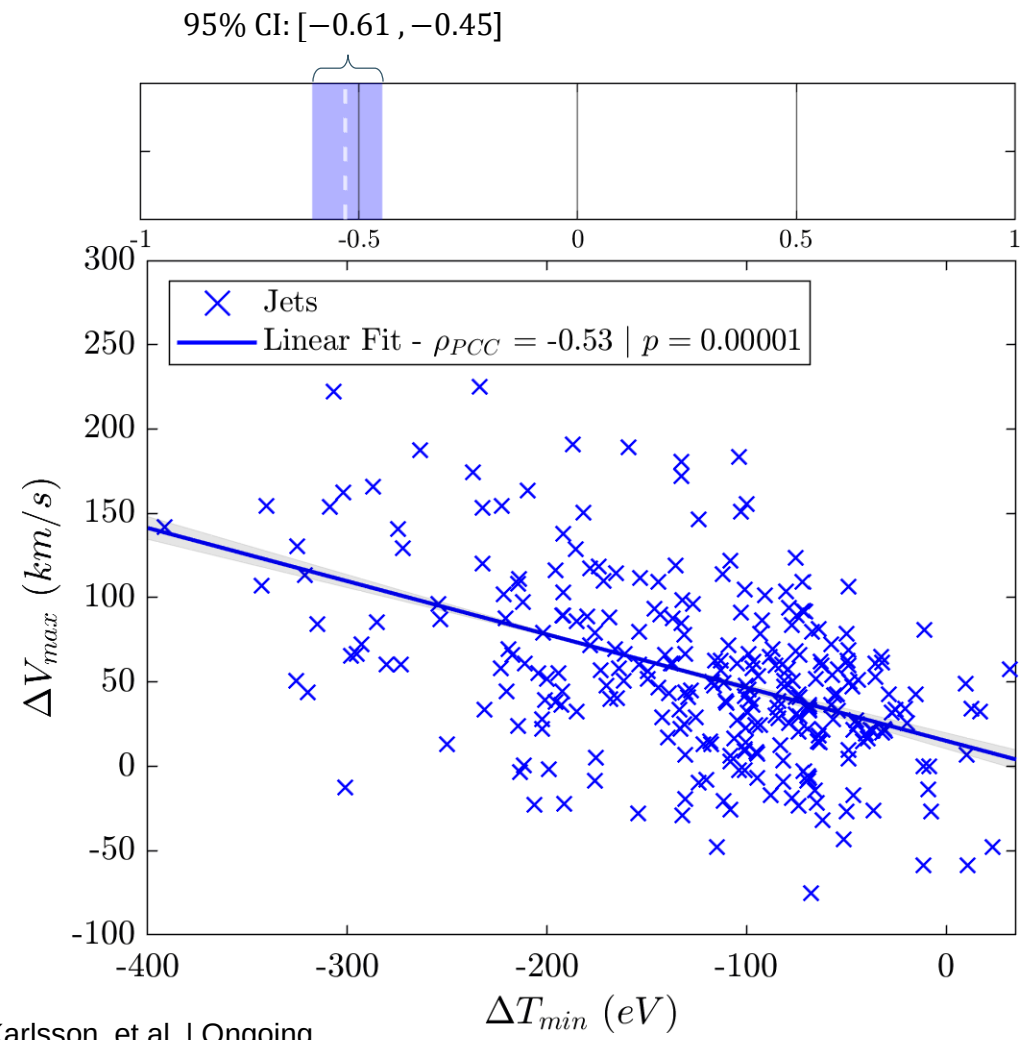
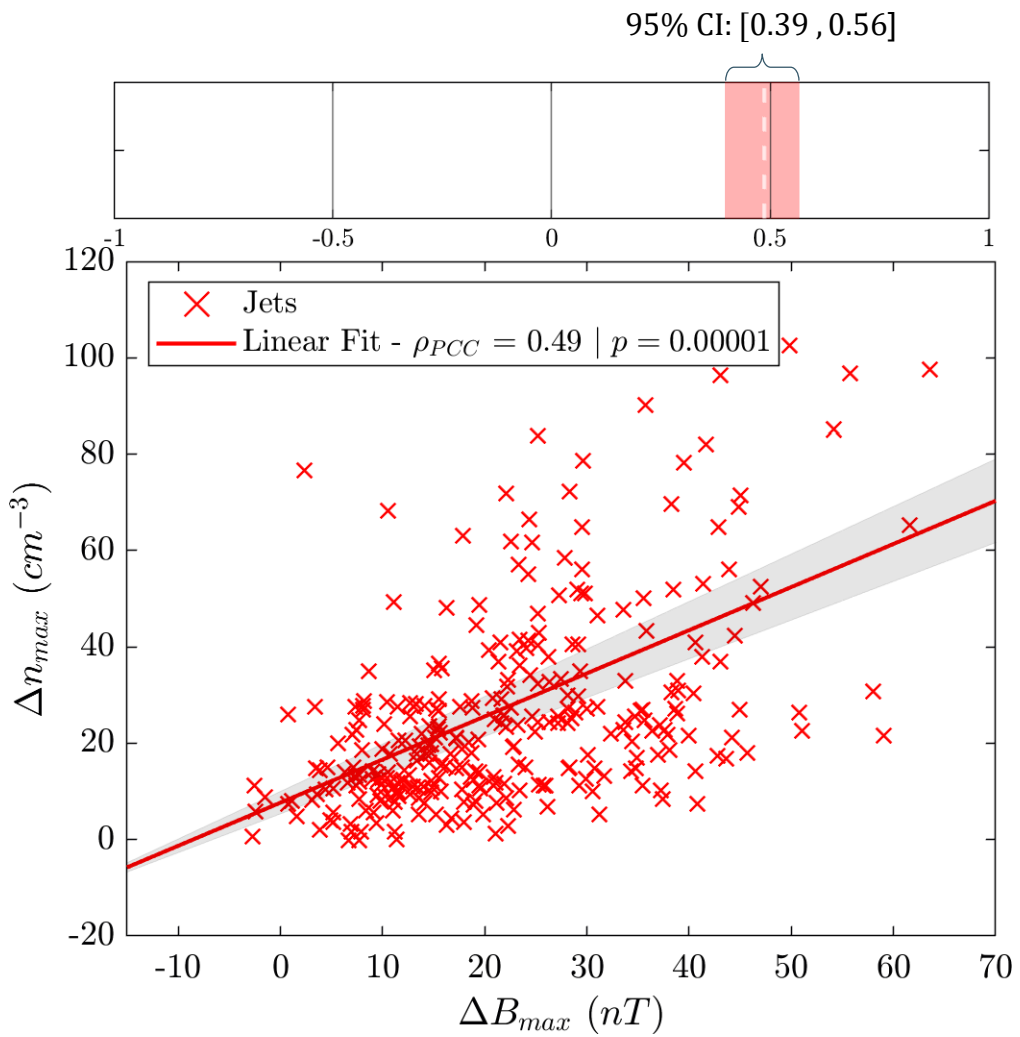
Ongoing Correlation Results

“Ripples” $n = 310$ “SLAMS”





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Summary & Conclusion

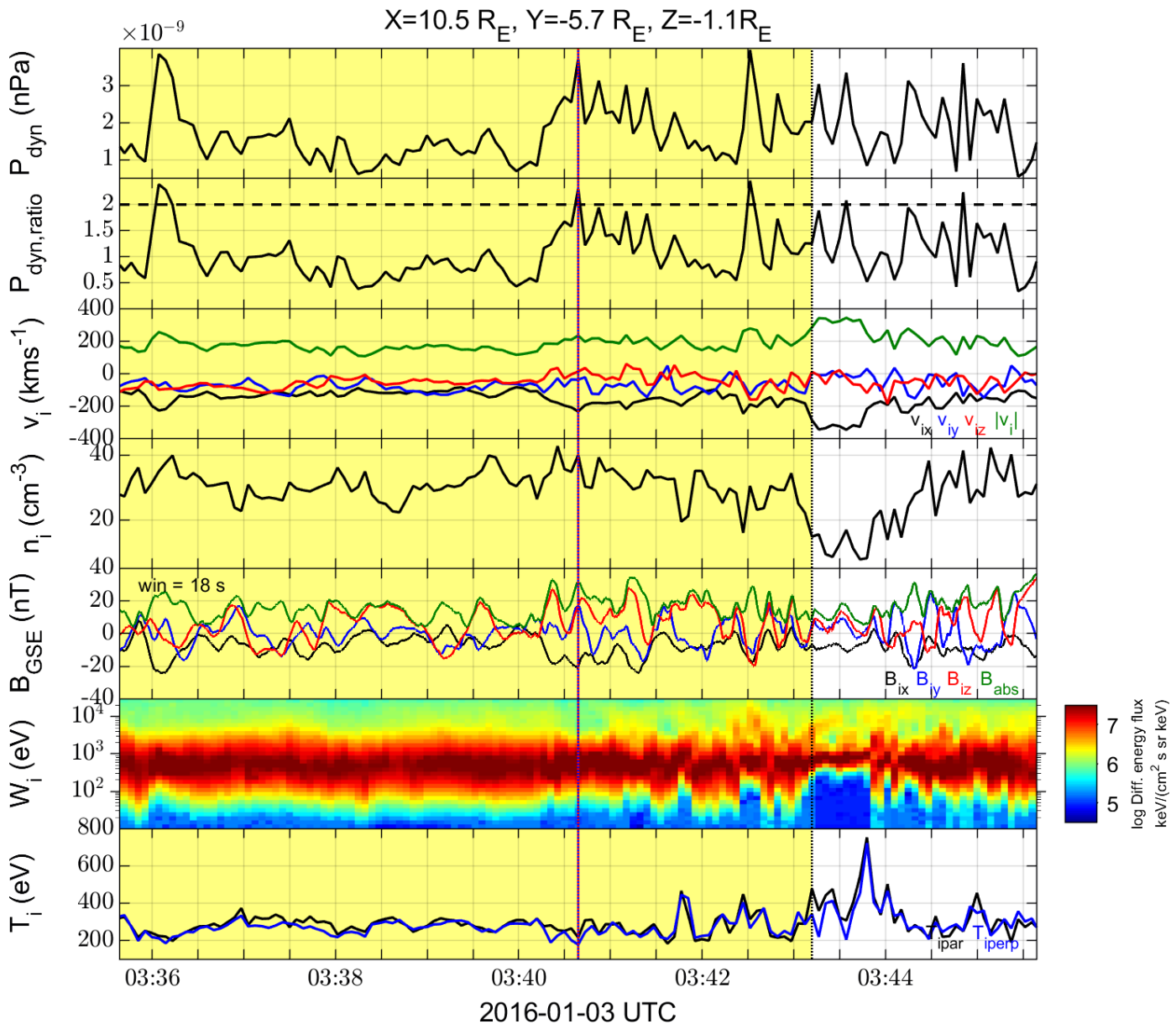
Good indication that existent mechanism are at least partially responsible for what we see.

Quite a few things to be done:

- See class specific correlations close to the bow shock.
- Check burst data availability and see if this provides new insight.
- Check other tools of connecting mechanisms (time series analysis, mutual information (MI), prediction power scores (PPS), machine learning (ML), analytical prediction etc.)
- Quantification of other possible mechanisms (e.g. reconnection “plasmoids”, Preisser et. al. 2020 | ApJL).
- Inspect for statistical artifacts (e.g. partial shock crossings, foreshock, other irregularities etc.)

Extra

Background – Fully automated



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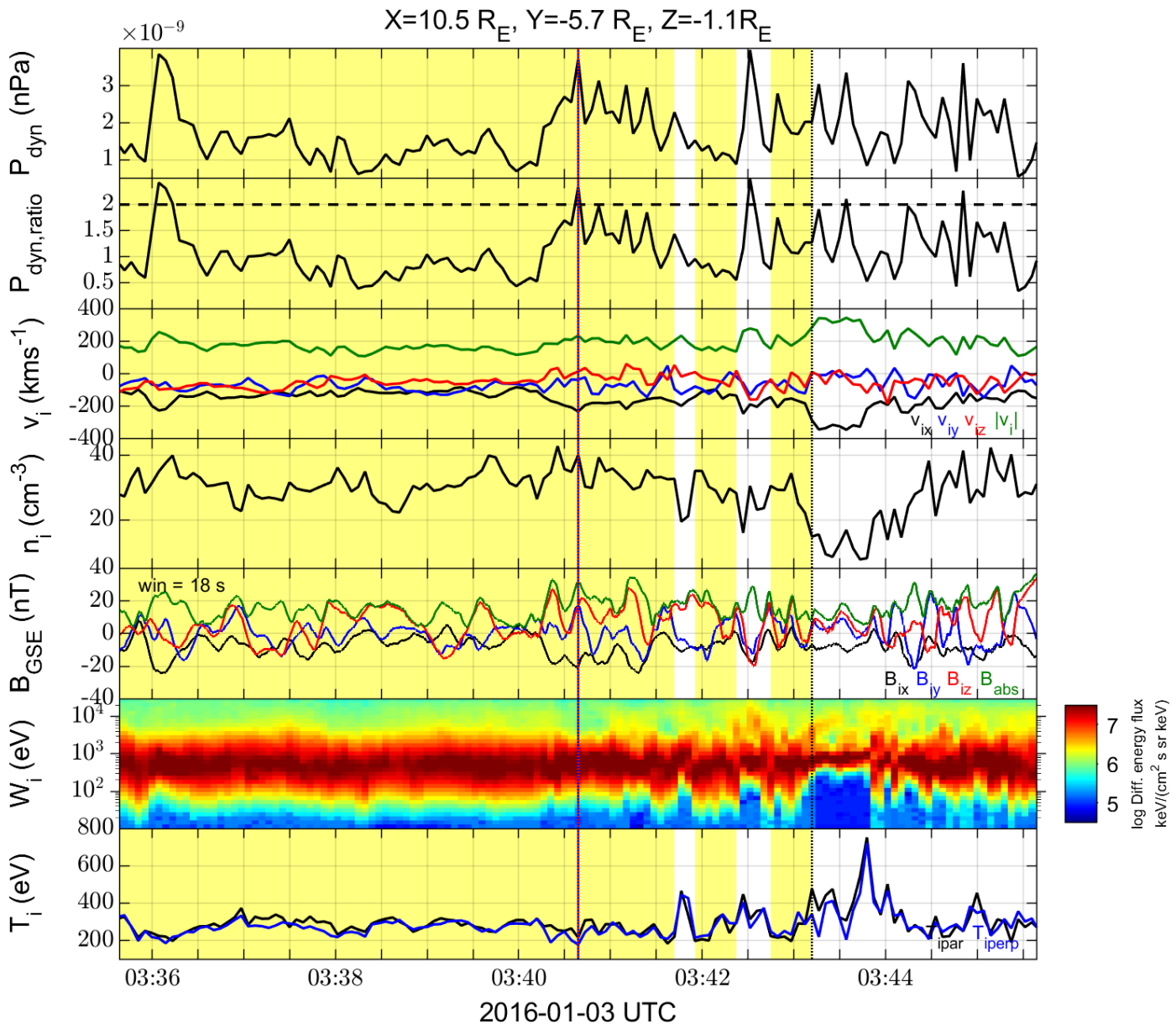
Background – Manual Addition



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