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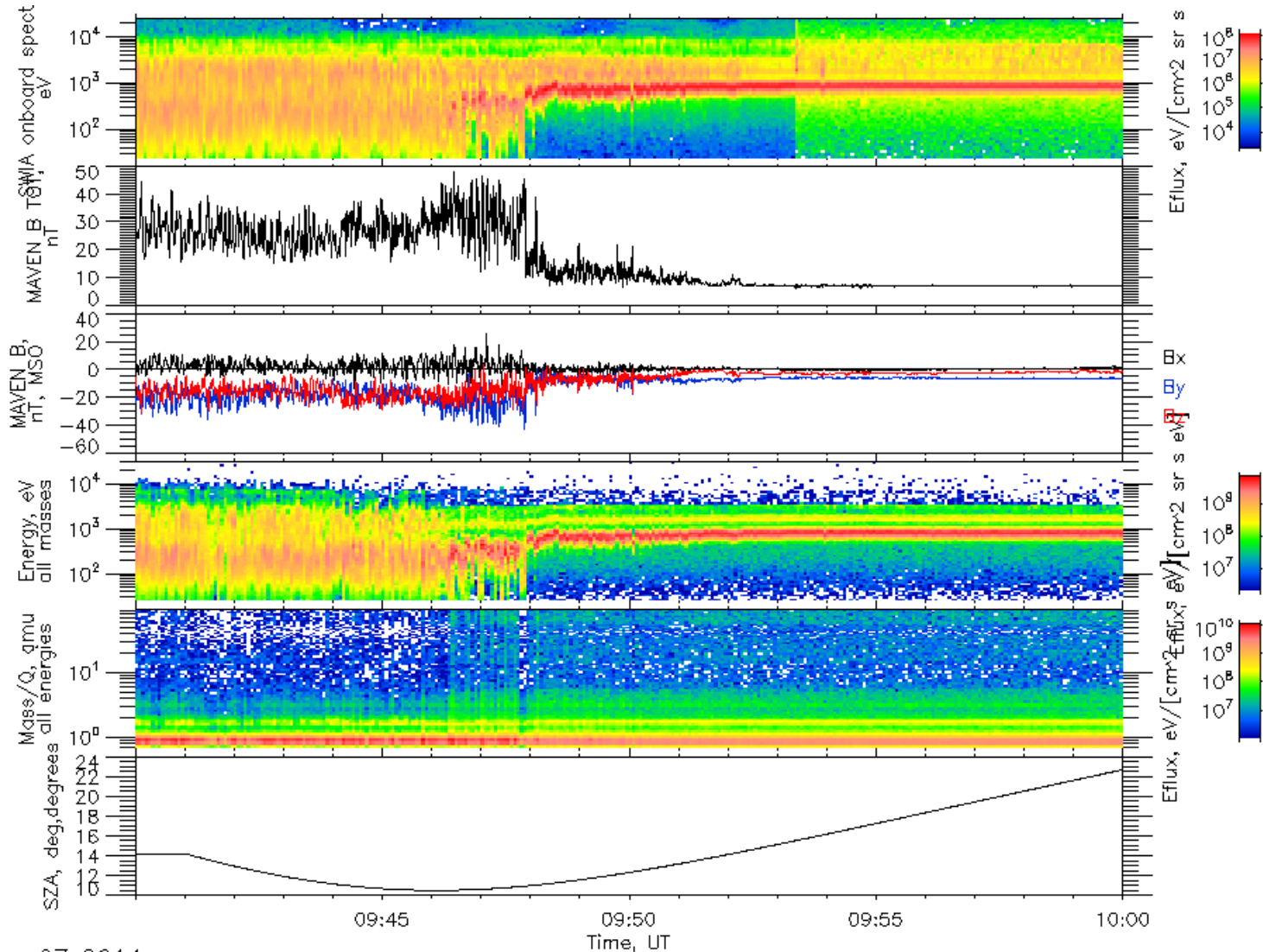
Mass loading influence on the structure of Martian bow shock

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Task definition

- Martian shock structure shows different properties while exposed to different conditions
- The goal of the work is to check whether mass loading can produce a cometary-like shock at Mars

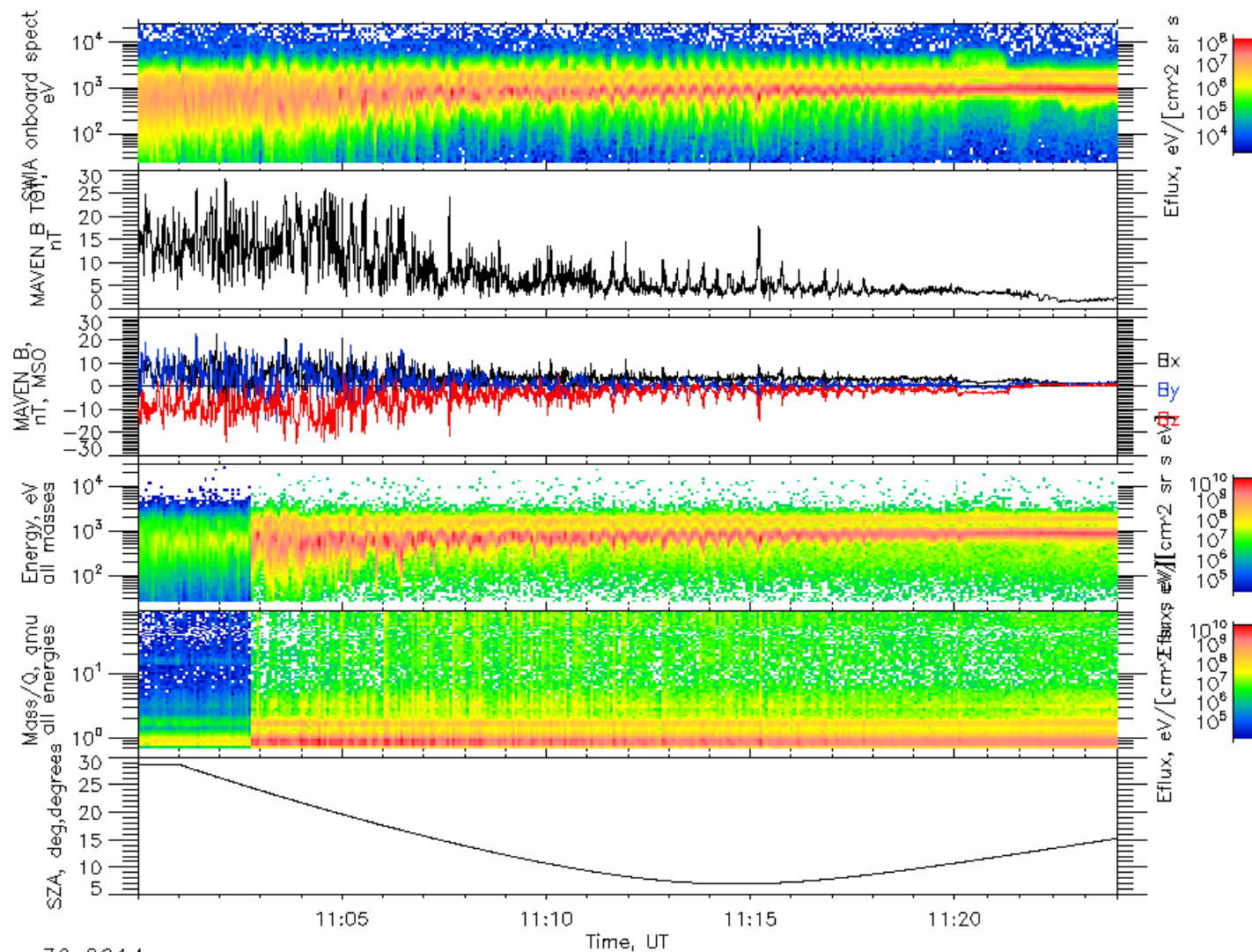
Example: low mass-loading



$$\frac{n_{O^+} + n_{O_2^+}}{n_{H^+}} = 0.08$$

$$\theta_{Bn} = 79^\circ$$

Example: high mass-loading



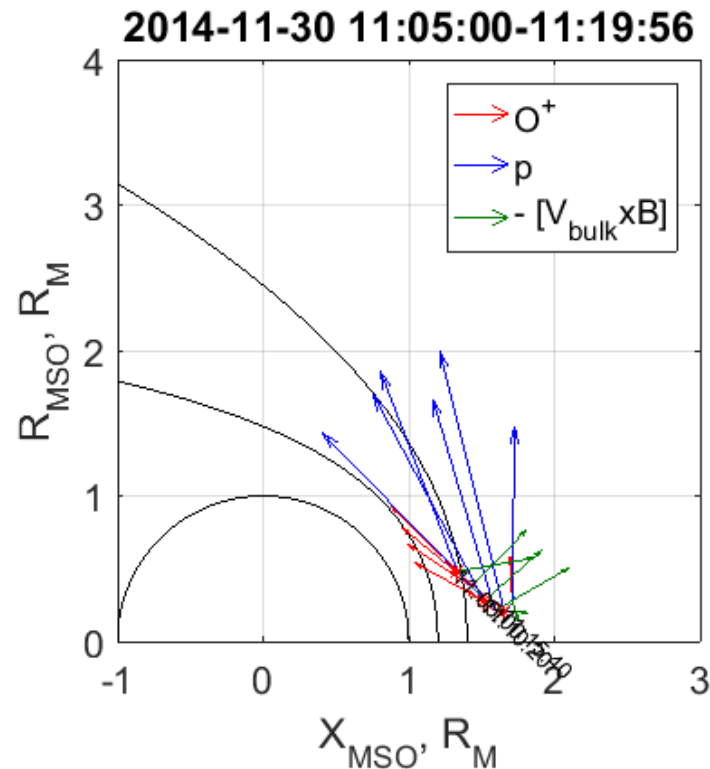
$$\frac{n_{O^+} + n_{O_2^+}}{n_{H^+}} = 0.16$$

$$\theta_{Bn} = 38^\circ$$

Factors that influence mass loading

- Pick-up process:
 - Oxygen corona density
 - Solar UV radiation
- Plume:
 - IMF orientation

Conservation of momentum during plume mass-loading



Protons and heavy ions are deflected to the same direction

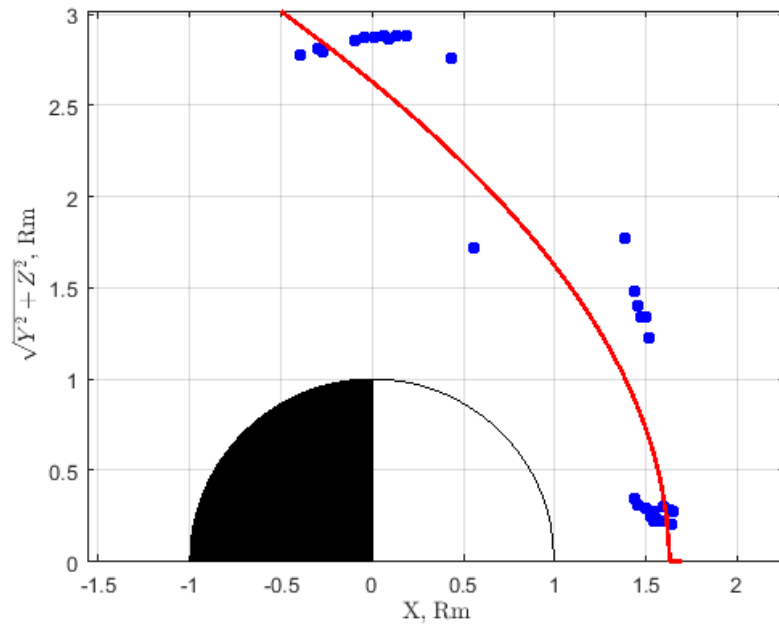
O.L. Vaisberg, V.N. Ermakov, S.D. Shuvalov, L.M. Zelenyi, A.S. Znobishchev, E.M. Dubinin (2017). Analysis of dayside magnetosphere of Mars: High mass loading case as observed on MAVEN spacecraft. *Planetary and Space Science*, 147. <https://doi.org/10.1016/j.pss.2017.09.005>

Dubinin, E., Fraenz, M., Pätzold, M., Halekas, J. S., Mcfadden, J., Connerney, J. E. P., et al. (2018). Solar wind deflection by mass loading in the Martian magnetosheath based on MAVEN observations. *Geophysical Research Letters*, 45. <https://doi.org/10.1002/2017GL076813>

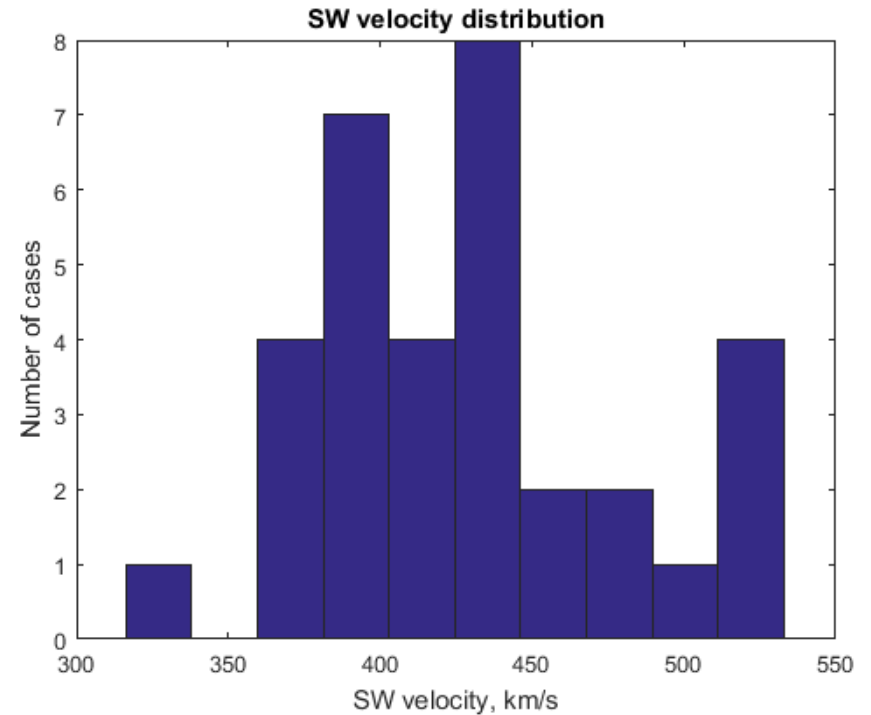
Investigation plan

- Select a number of shock crossings and set an upstream/downstream interval without perturbations
- Calculate upstream mass loading parameter, θ_{Bn} by model/MF rotation
- Explore dependencies between mass loading, θ_{Bn} and shock parameters such as: M_a , M_s , M_{ms} , MF dispersion

Selected shock crossings

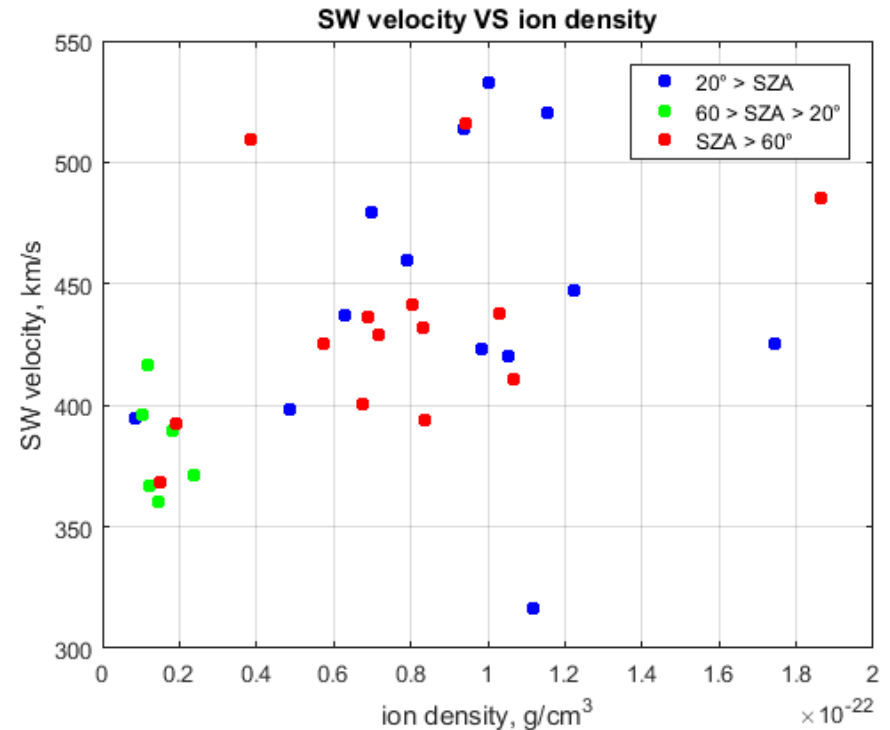
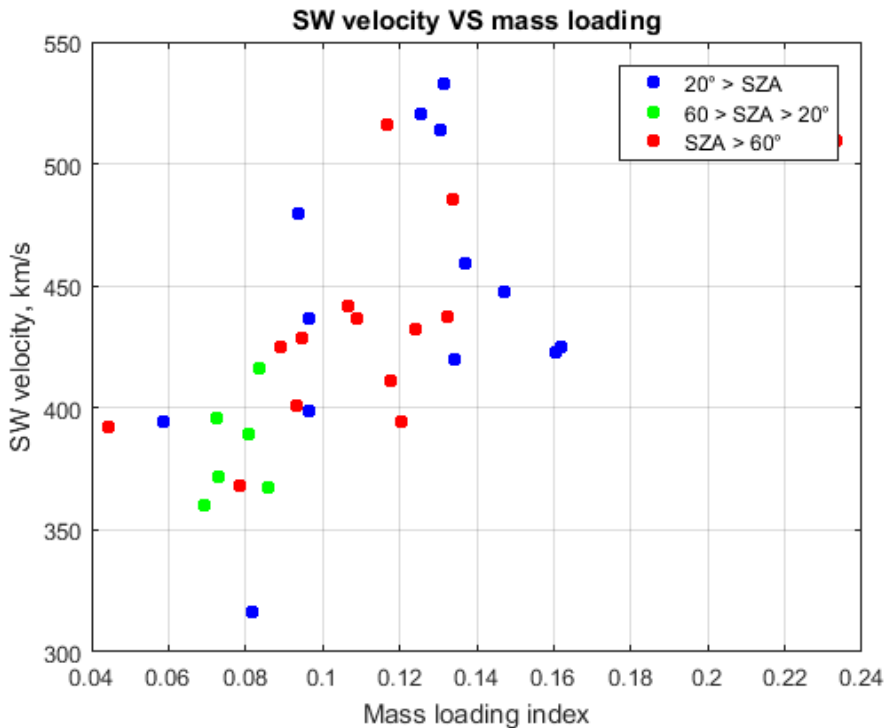


— Average bow shock (Trotignon, 2006)



33 Bow Shock crossings in total

Preliminary results: Mass-loading VS Solar wind velocity

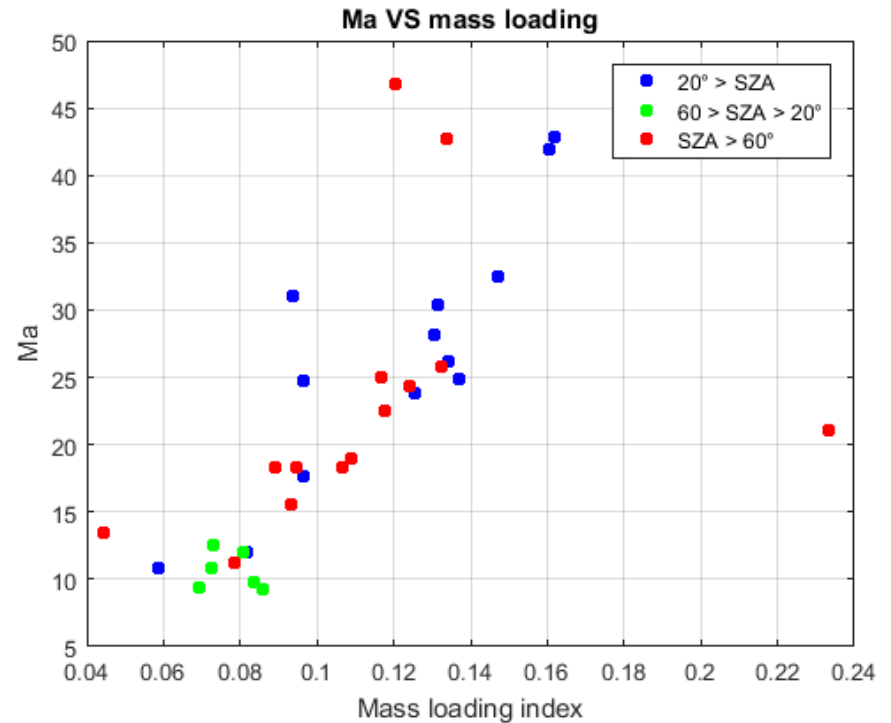
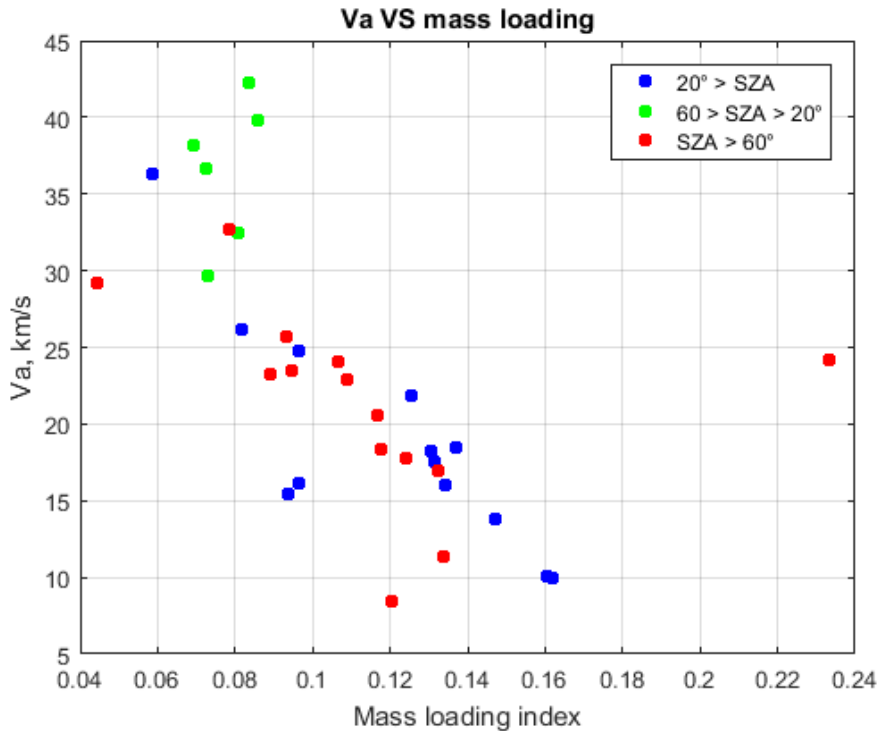


$$\alpha = \frac{n_{O^+} + n_{O_2^+}}{n_{H^+}}$$

Factors that drive mass-loading:

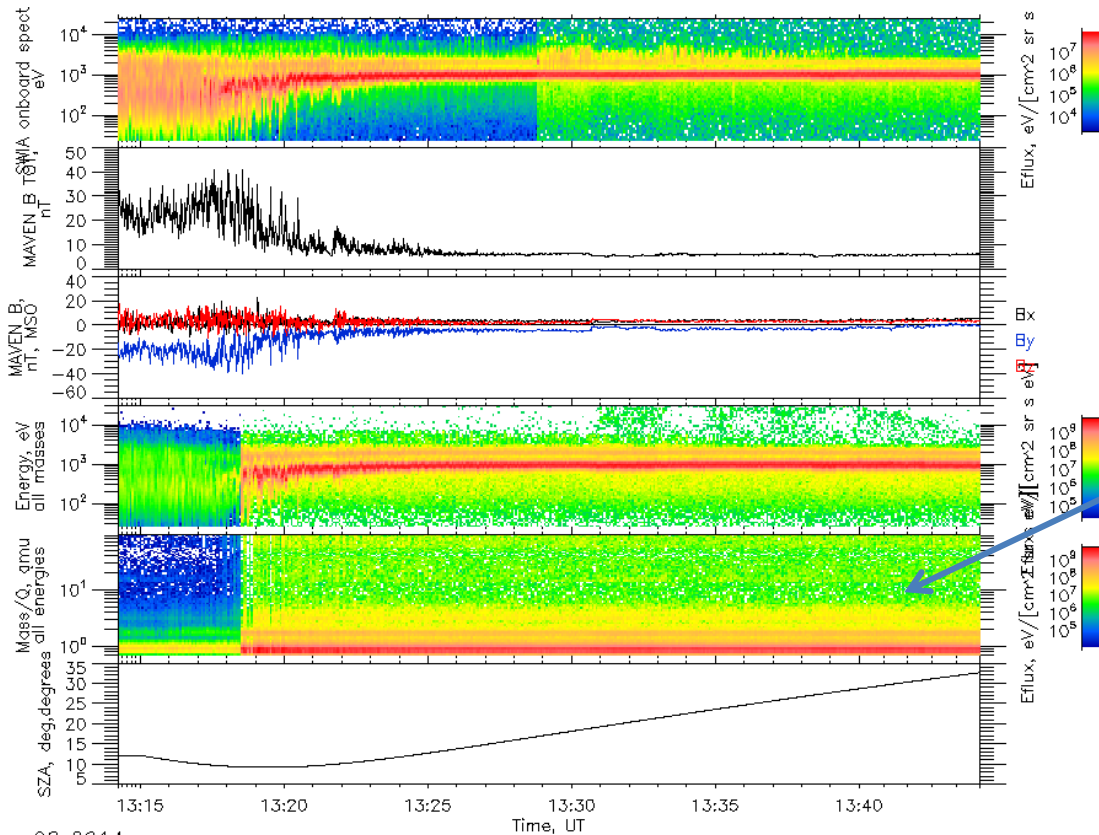
- Solar UV radiation
- Oxygen corona density
- Angle between solar wind and magnetic field
- Plume

Preliminary results: Mass loading influence on Alfvén velocity



$$v_a = \frac{B}{\sqrt{4\pi\rho}}$$

Possible sources of error in mass-loading calculation



High count rate may cause noisy mass-spectra data

It may affect calculated ion parameters

Nov 28 2014

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Conclusion

1. The flow at Martian Bow Shock may be more disturbed when mass-loading parameter is high
2. Martian Bow Shock can show both cometary-like and Earth-like features
3. Calculations of ion parameters may need corrections for possible noise