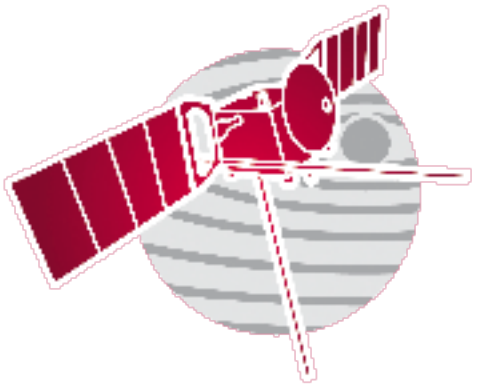


Mars Express and ASPERA-3 celebrates 15 years at Mars

Mats Holmström
Swedish Institute of Space Physics

IRF Seminar
May 24, 2018

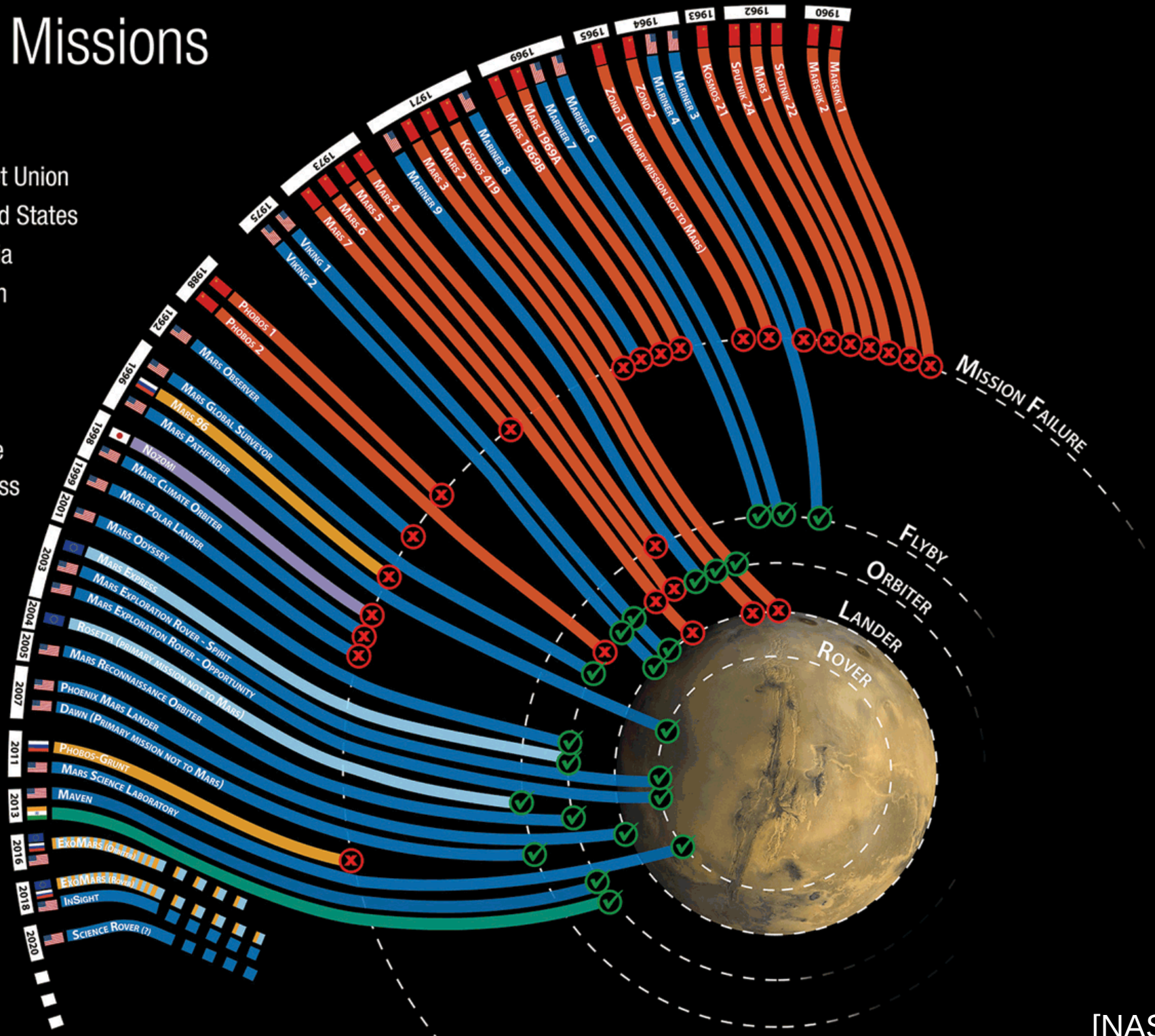
matsh@irf.se
www.irf.se/~matsh/
www.irf.se/program/sspt/

[Hubble, 2003]

30 Years of IRF Mars Exploration

Mission	Sensor	Launch	Comment
Phobos 1	ASPERA	1988	Lost en route
Phobos 2	ASPERA	1988	Two months in orbit
Mars 96	ASPERA-C	1996	Launch failure
Nozomi	IMI	1998	Failed MOI in 2003
Mars Express	ASPERA-3	2003	MOI 25 December 2003
Rosetta	ICA, LAP	2004	Flyby 2007
Phobos Grunt	DIM	2011	Stranded in Earth orbit
Yinghuo 1	YPP	2011	Stranded in Earth orbit

Robotic Missions to Mars



[NASA]

Upcoming Mars missions

Mission	Launch	Notes	Organization
Emirates Mars Mission	July 2020 [22][23][24]	Orbiter	MBRSC, UAE
Mars 2020	July 2020	Rover, helicopter	NASA, USA
ExoMars 2020	July 2020[25]	Lander, rover	ESA/ASE, EU
2020 Chinese Mars Mission	July/August 2020[26]	Orbiter, lander, rover	CNSA, PRC
Mars Terahertz Microsatellite[27]	July 2020[28]	Orbiter, lander	NICT, ISSL, Japan
Mars Orbiter Mission 2 (*Mangalyaan 2*)	2022[29][30]	Orbiter	ISRO, India
Martian Moons Exploration (MMX)	2024[31][32]	Orbiter, Phobos lander	JAXA, Japan

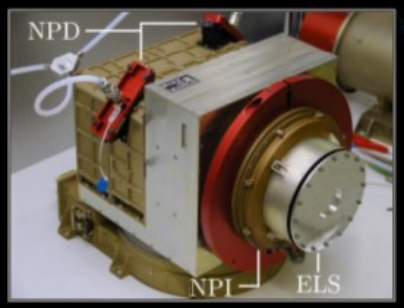
[Wikipedia]

Baikonur

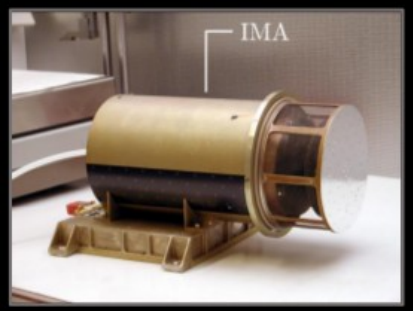
2 juni 2003
17:45 UTC

ASPERA-3 on Mars Express

Main Unit (MU)



Ion Mass Analyzer (IMA)



ASPERA = Analyzer of Space Plasmas and Energetic Atoms

A few ASPERA-3 Science Topics

Science statistics

Until 2017, there are in total 200 peer reviewed publications based on ASPERA-3 data. This is second only to the camera on MEX. The number of publications as a function of time is shown in Fig. 1.

In 2017 there were two PhD dissertations based on ASPERA-3 data:

- Dr. Ben Hall, University of Leicester, 2017
- Dr. Robin Ramstad, IRF and Umeå University, 2017

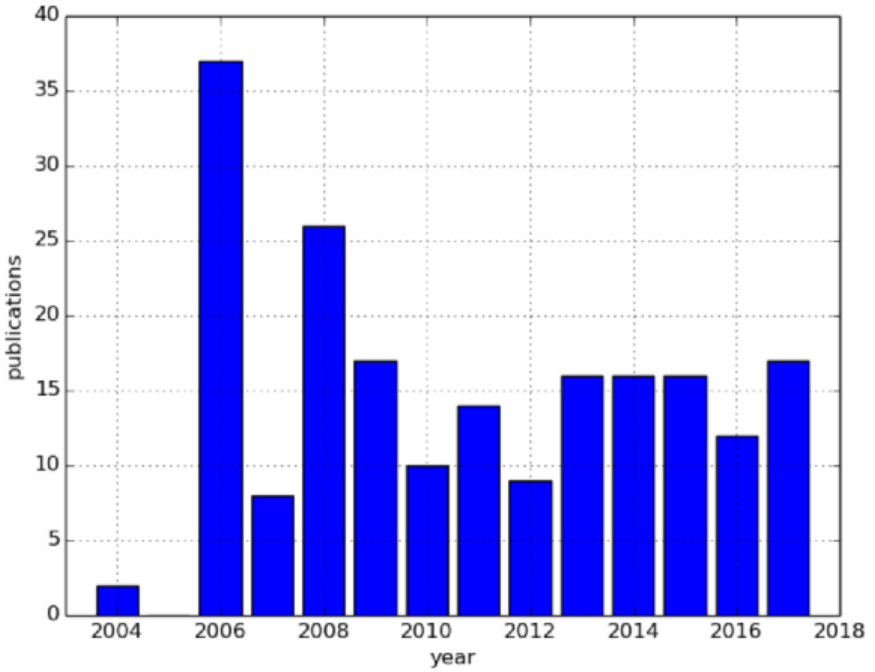
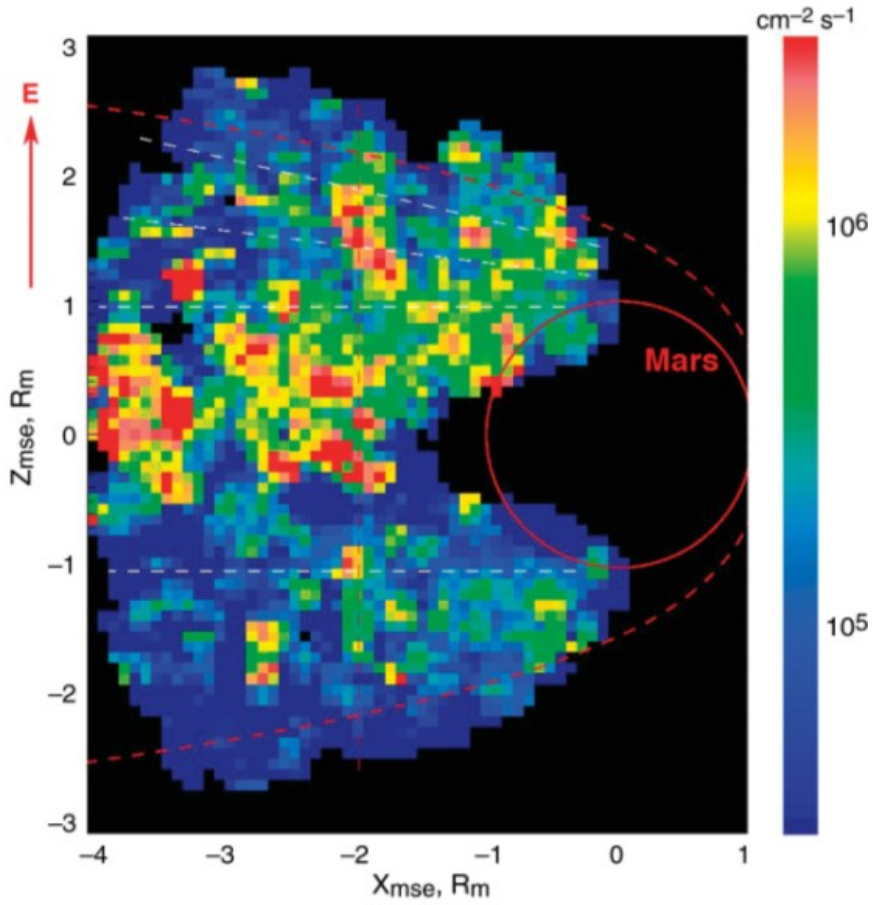
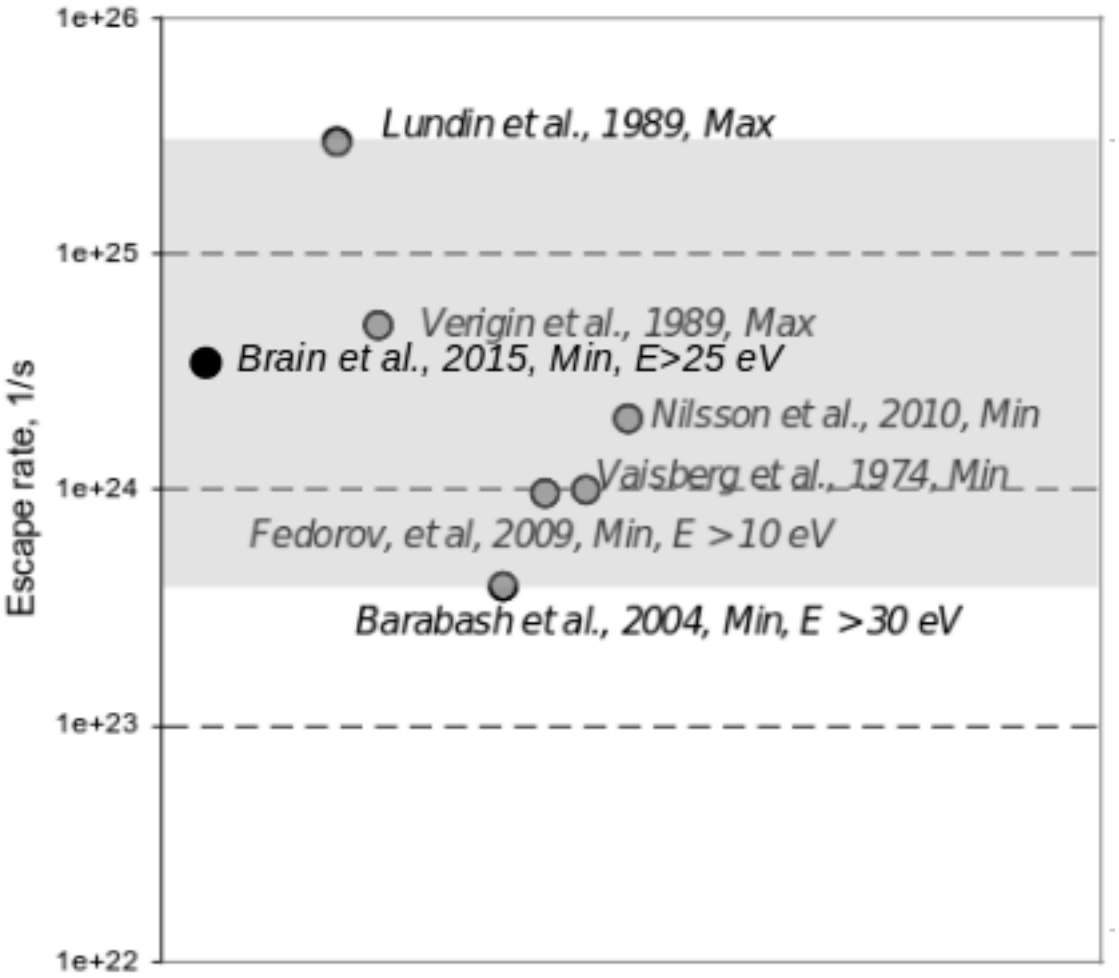


Figure 1. Yearly number of publications using ASPERA-3 data, until 2017.
A full list of the included publications is available at http://tinyurl.com/zn3a4ho

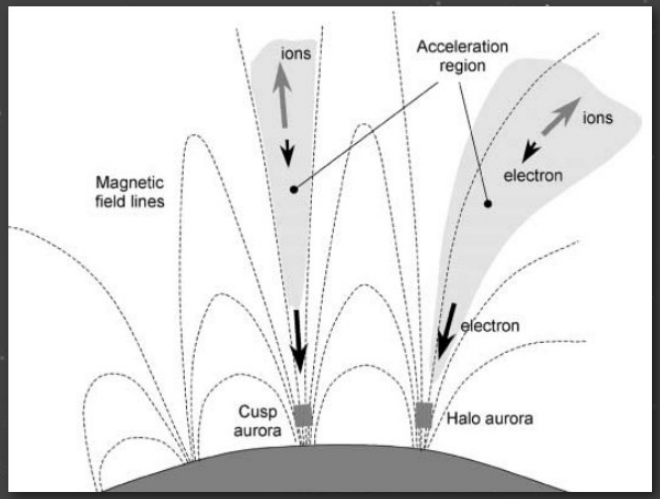
Escape of heavy ions





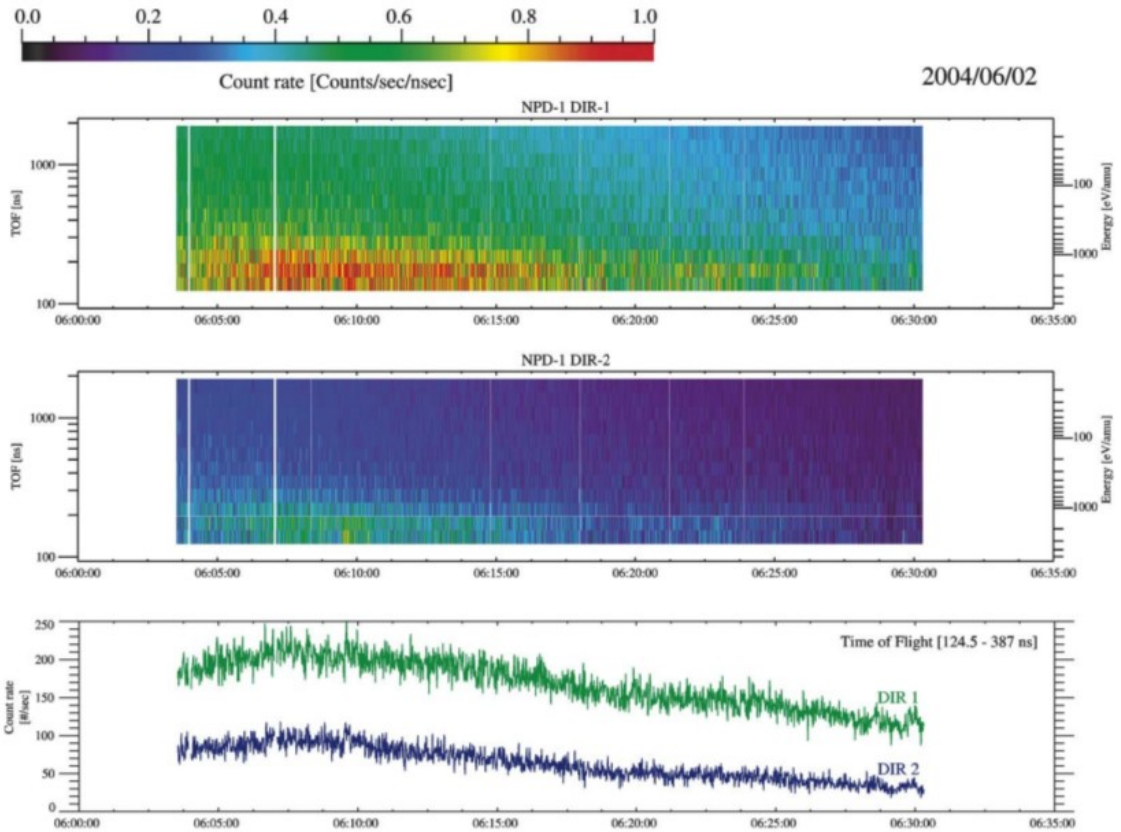
[Barabash et al., Science, 2007]

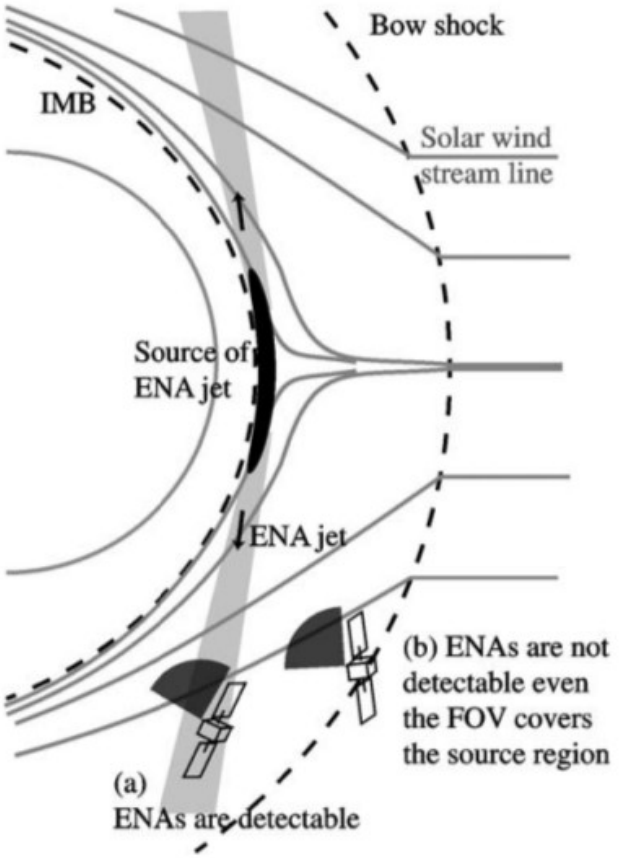
Aurora



[Lundin et al., Science, 2006]

First ENA Observations at Mars

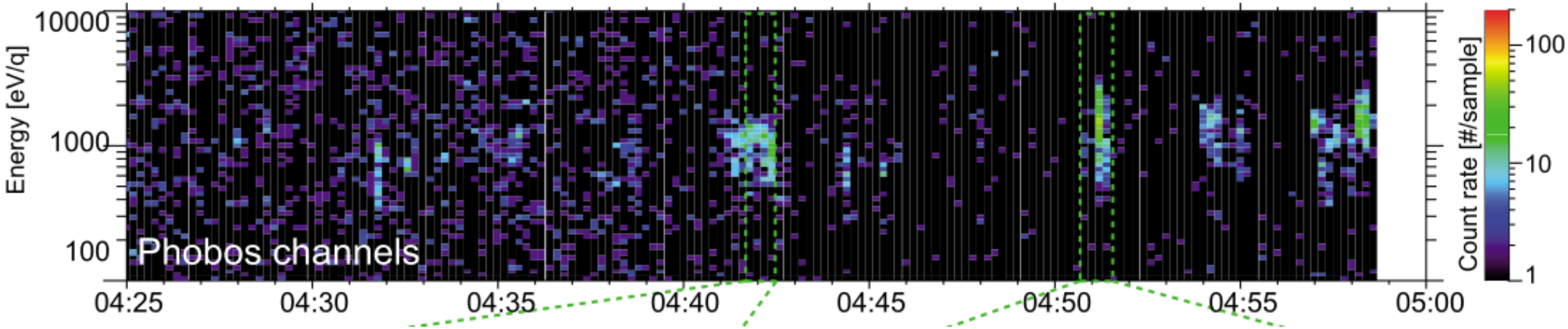




[Futaana et al., Icarus, 2006]

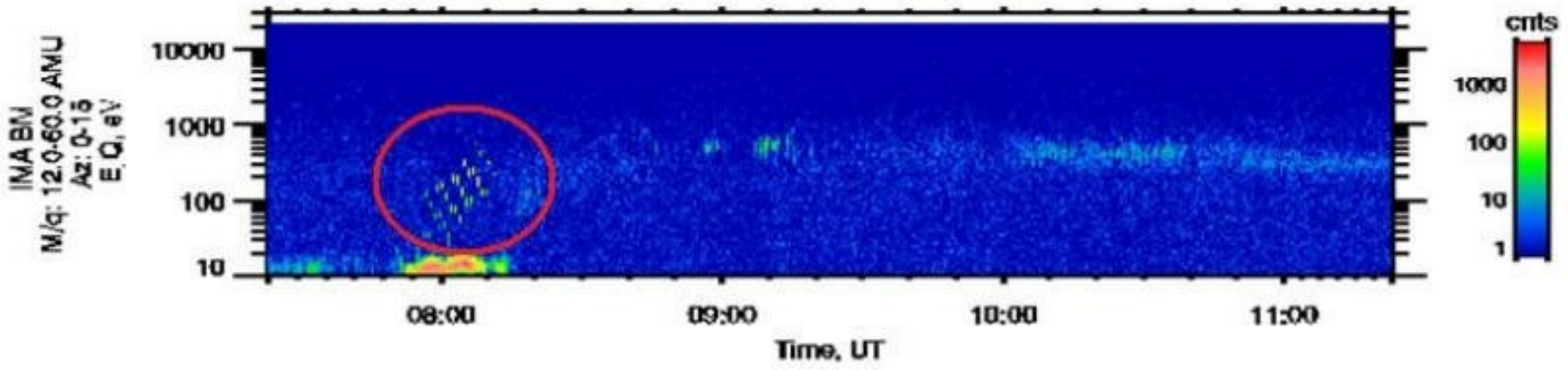
Phobos studies

- We have observed ions, potentially reflected from Phobos, twice in July 2008 [Futaana et al., 2010].
  However, we did not see such ions in December 2013 (58 km).
- For the 2016-01-14 flyby at 53 km we also saw ion fluxes that could be Phobos related
- To rule out s/c deflected solar wind protons, we repeated the slew three times: 2017-05-17T03:51:33, 2017-05-19T05:03:03, 2017-05-21T05:47:40.
  Analysis is on-going



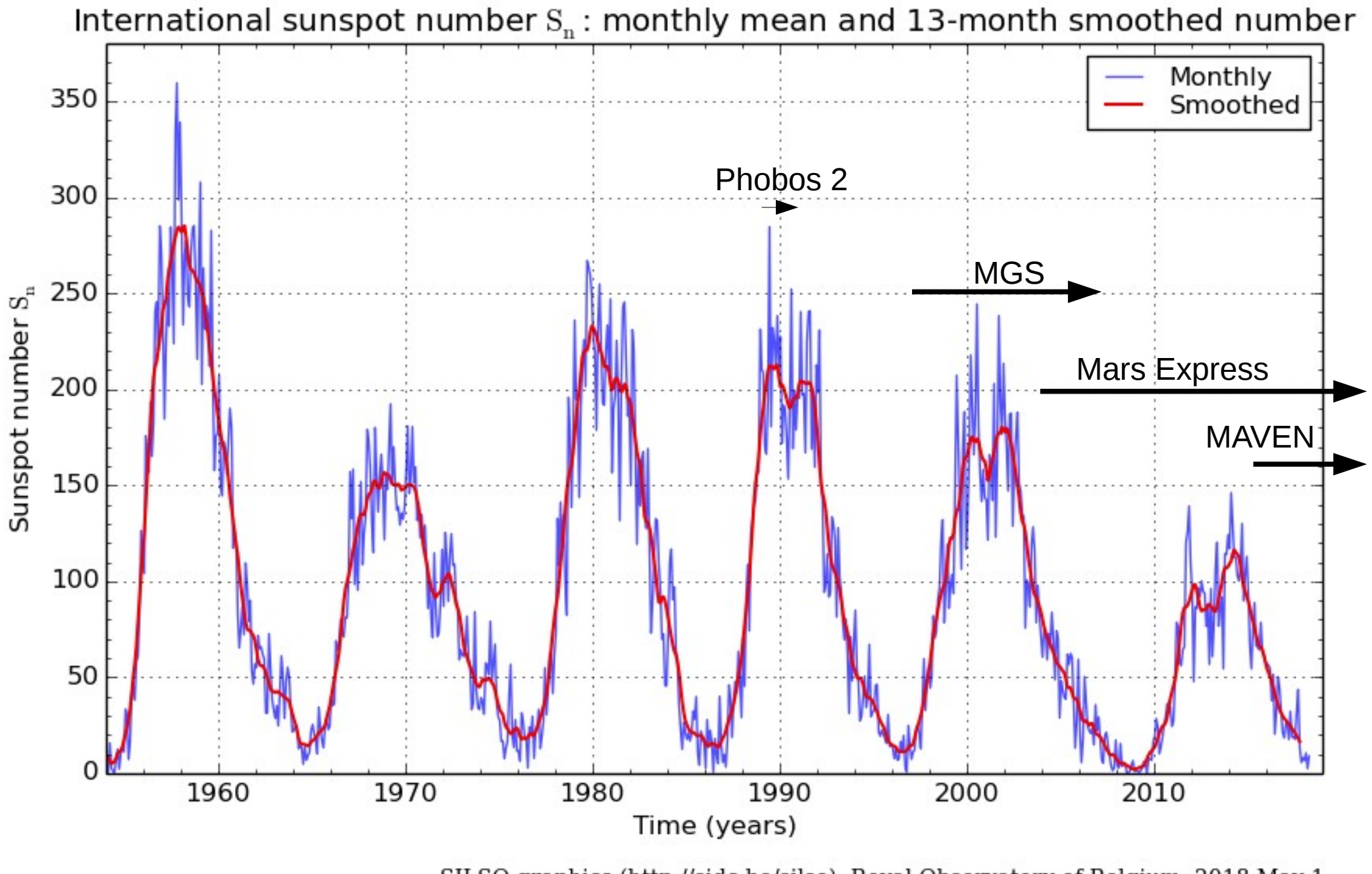
ASPERA-MARSIS active experiment

- Investigation of the “MARSIS effect”. Accelerated ions seen by IMA.

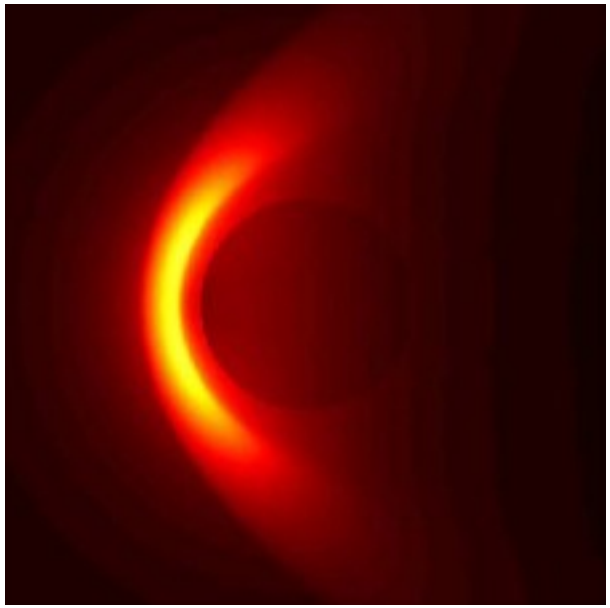


- Study by Andrii Voschchepynets
- Timing of IMA observations in relation to MARSIS pulses becomes important

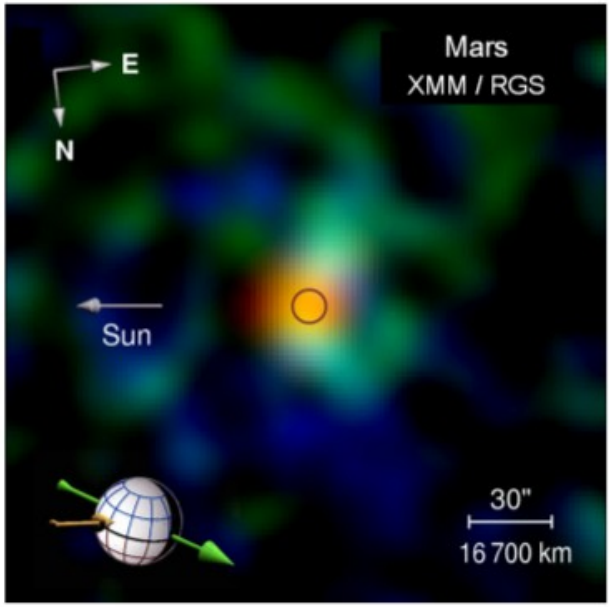
Mission Solar Cycle Coverage



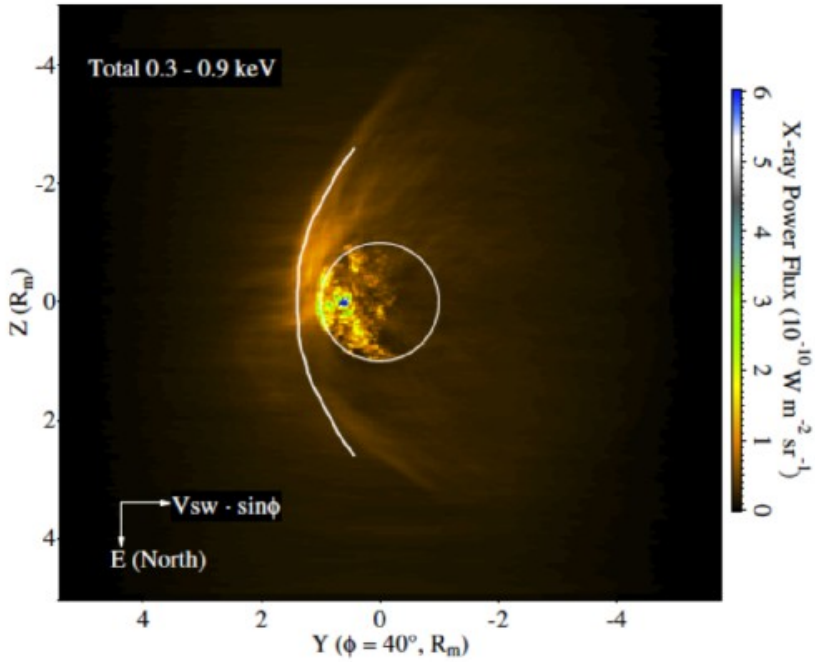
Soft X-ray emissions from Mars



Model
[Holmstrom et al., 2001]



Observation
[Dennerl et al., 2006]



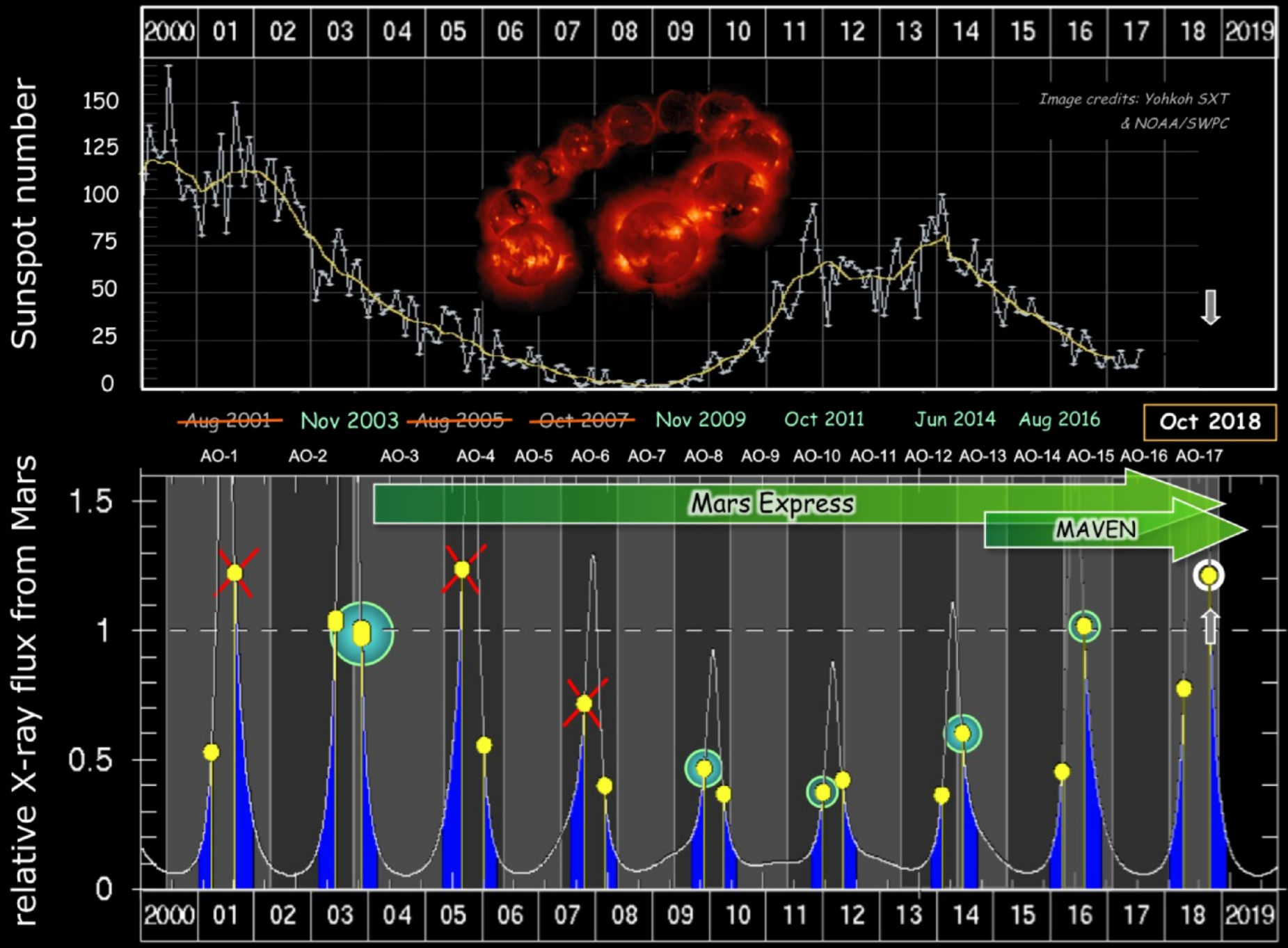
Model
[Koutroumpa et al., 2012]

$$O^{6+} + H \rightarrow \left(O^{5+}\right)^{*} + H^{+}$$

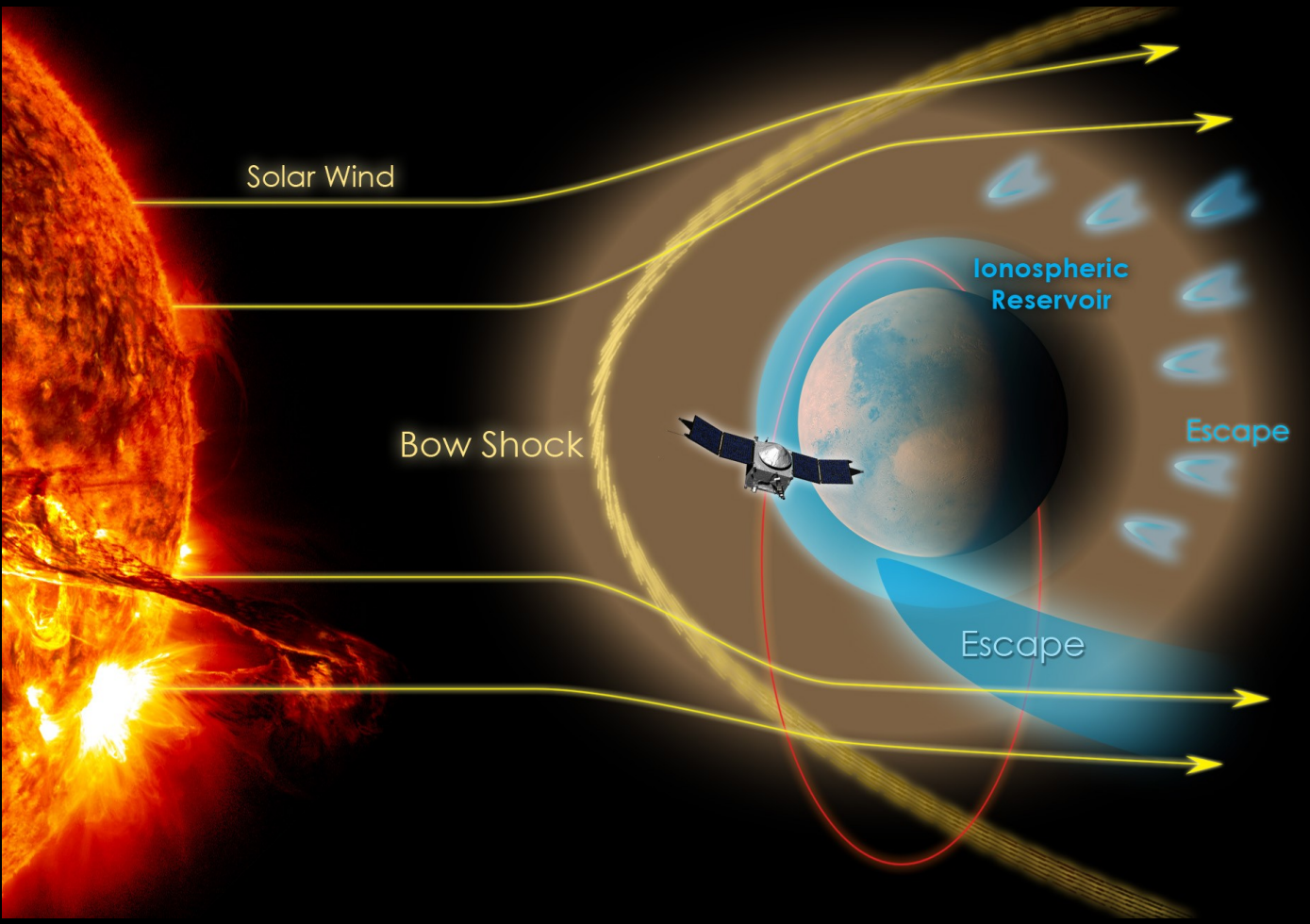
$$\left(O^{5+}\right)^{*} \rightarrow O^{5+} + \text{X-rays}$$

Wanted:
X-ray and
in situ solar wind
observations by
MEX and MAVEN

XMM proposal for October 2018 accepted
PI: Konrad Dennerl, MPI

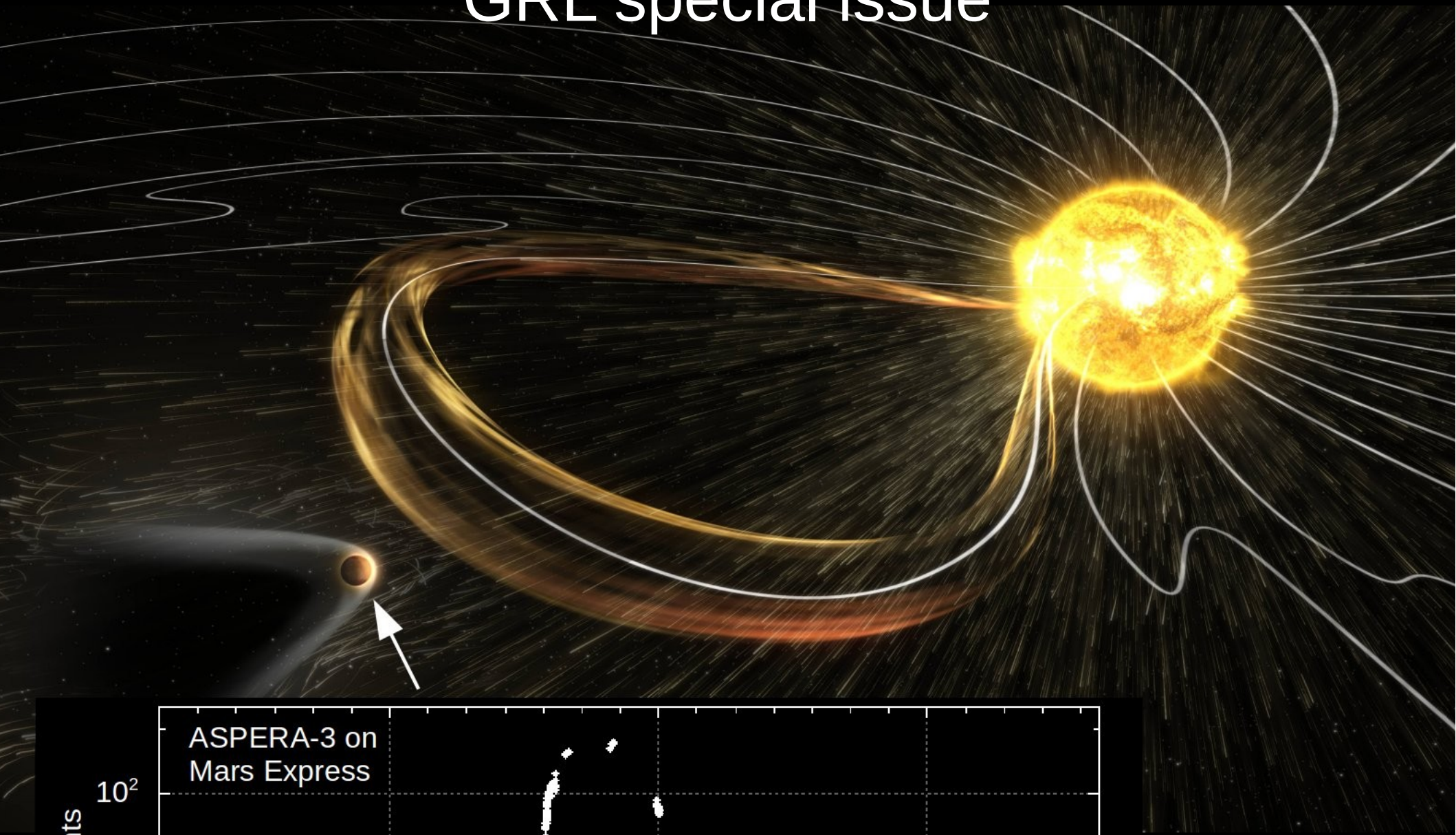


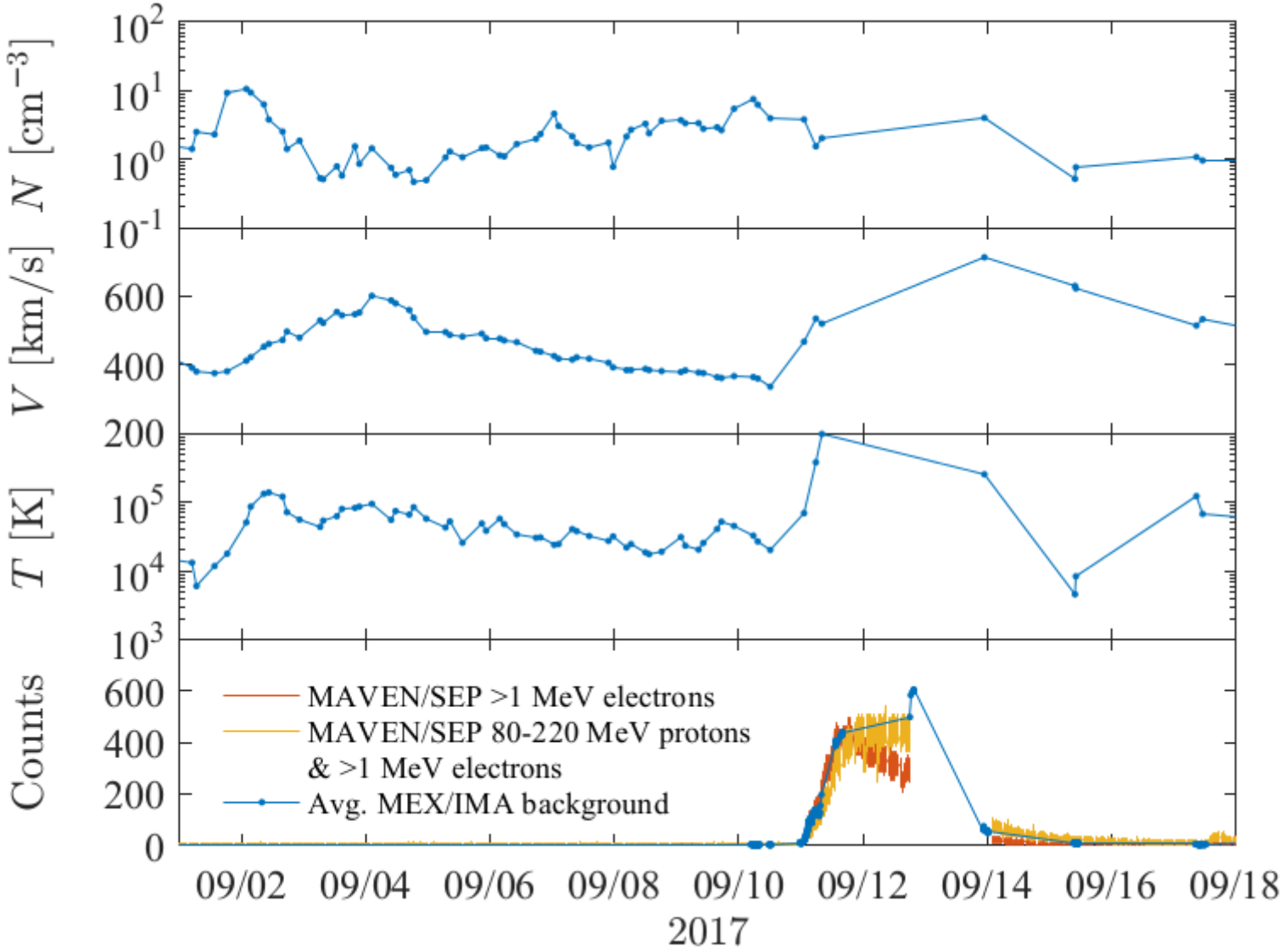
NASA's MAVEN Mission



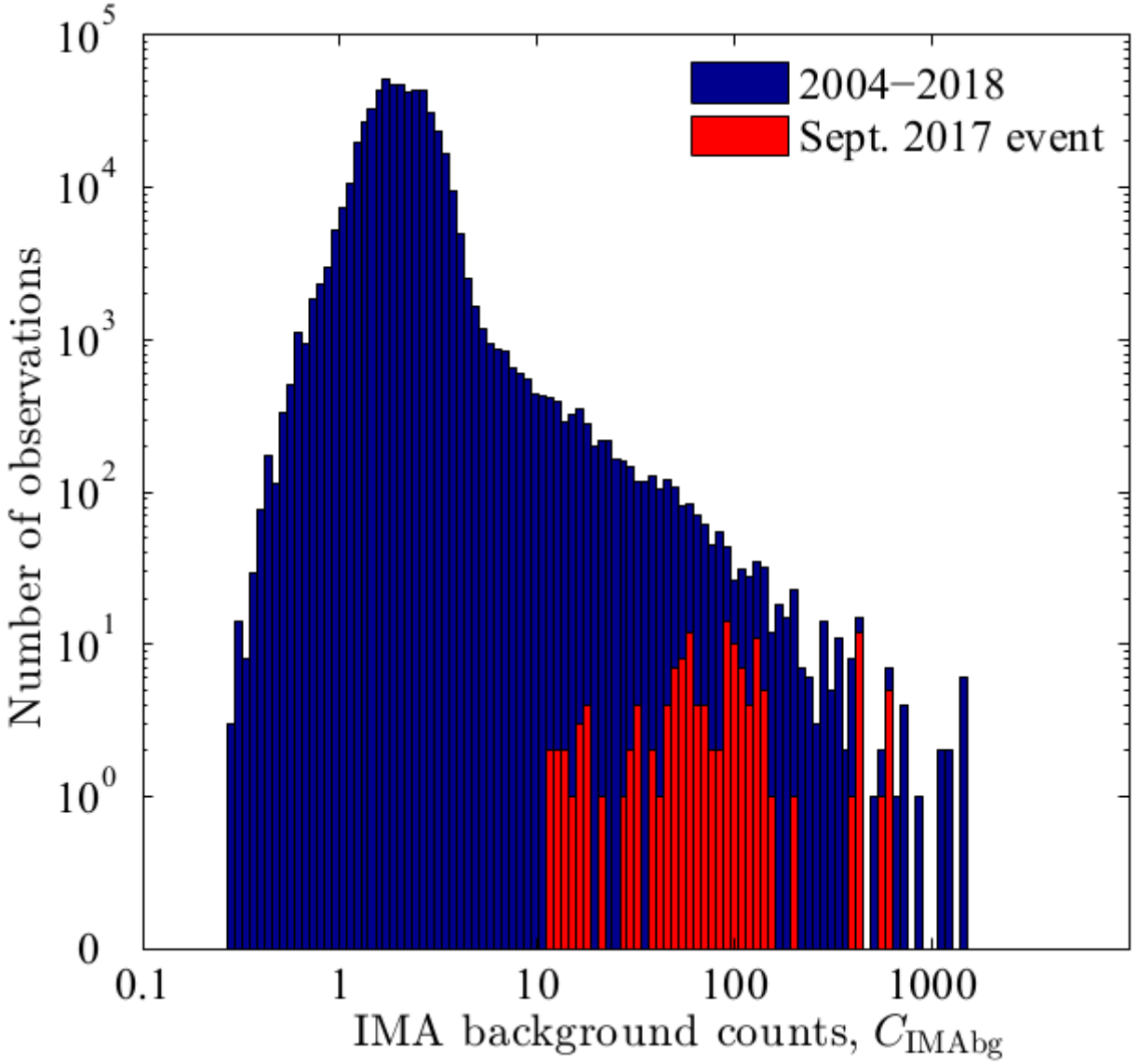
Launch November 2013

September 10 event 2017
GRL special issue





[Ramstad et al., GRL, 2018]



[Ramstad et al., GRL, 2018]

Mars Express status

- **Spacecraft, operations and archiving are nominal**
  - *15 years of MEX operations in orbit*
  - *Successful implementation of "gyroless" AOCS mode*
- **Mission extension**
  - *extension till the end of 2020 is indicatively approved, to be confirmed in 2018 on the basis of MEOR*
  - *2018: technical evaluation and science case for the mission extension 2021-2022*
- **Archiving of high level science products**
  - *MEX legacy archive (led by IDSs)*
  - *project supported activities*
- **Publications:** 1120 papers and 144 PhD theses

ASPERA-3 status

- ESA funded project to archive solar wind moments at PSA for MEX and VEX still ongoing. Data delivered to PSA
- Application for ASPERA-3 operation funding 2019-2020 (and 2021-2022) to Swedish Space Agency submitted in March
- ESA 15 year celebration on July 5 at ESOC
- December celebration in Paris (TBC)
- Battery degradation is probably the limit on lifetime for Mars Express