The Advanced Small Analyzer for Neutrals

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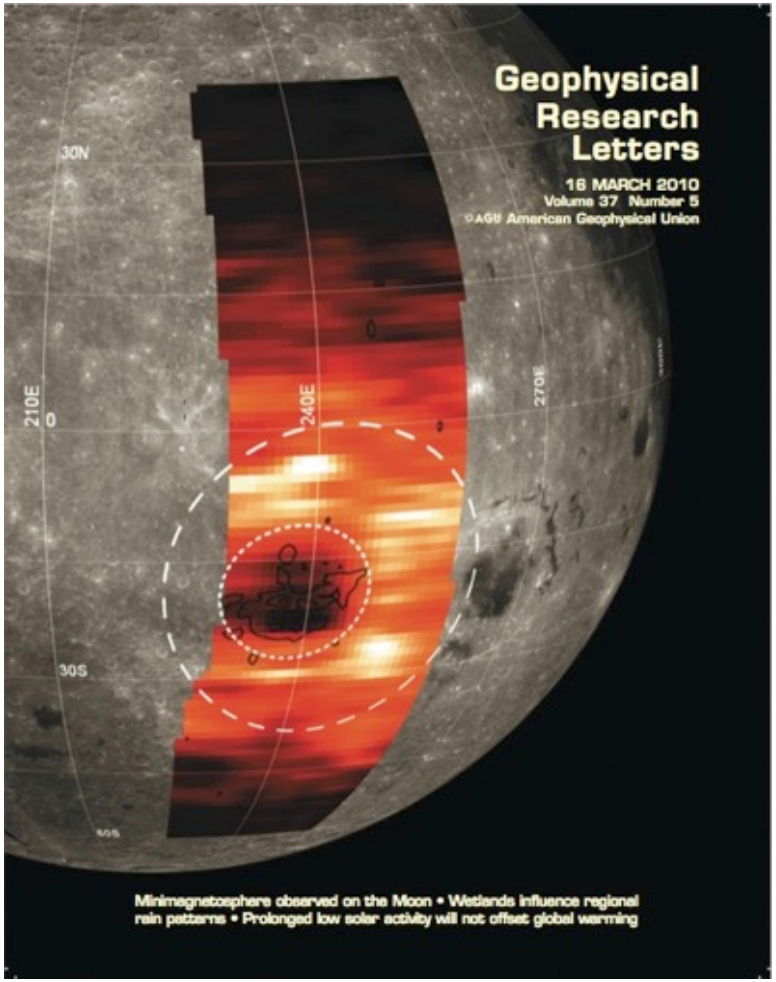
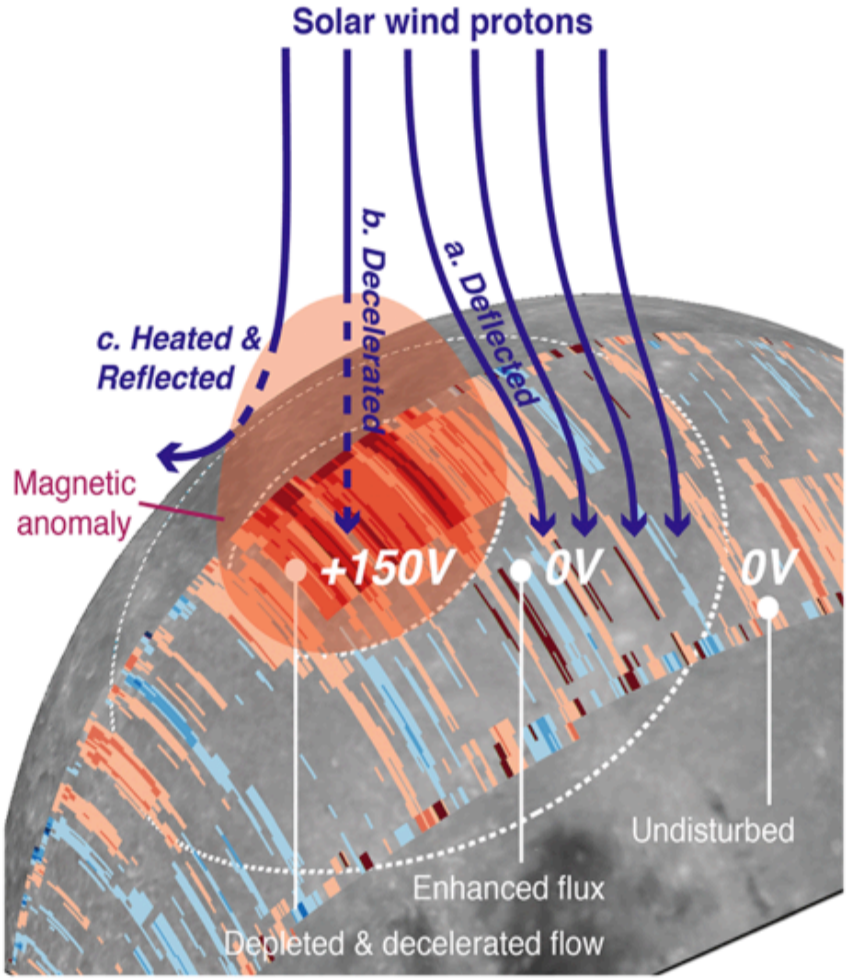
The moon after Chandrayaan-1



[Wieser et al., 2010]



[*Futaana et al.*, 2013].

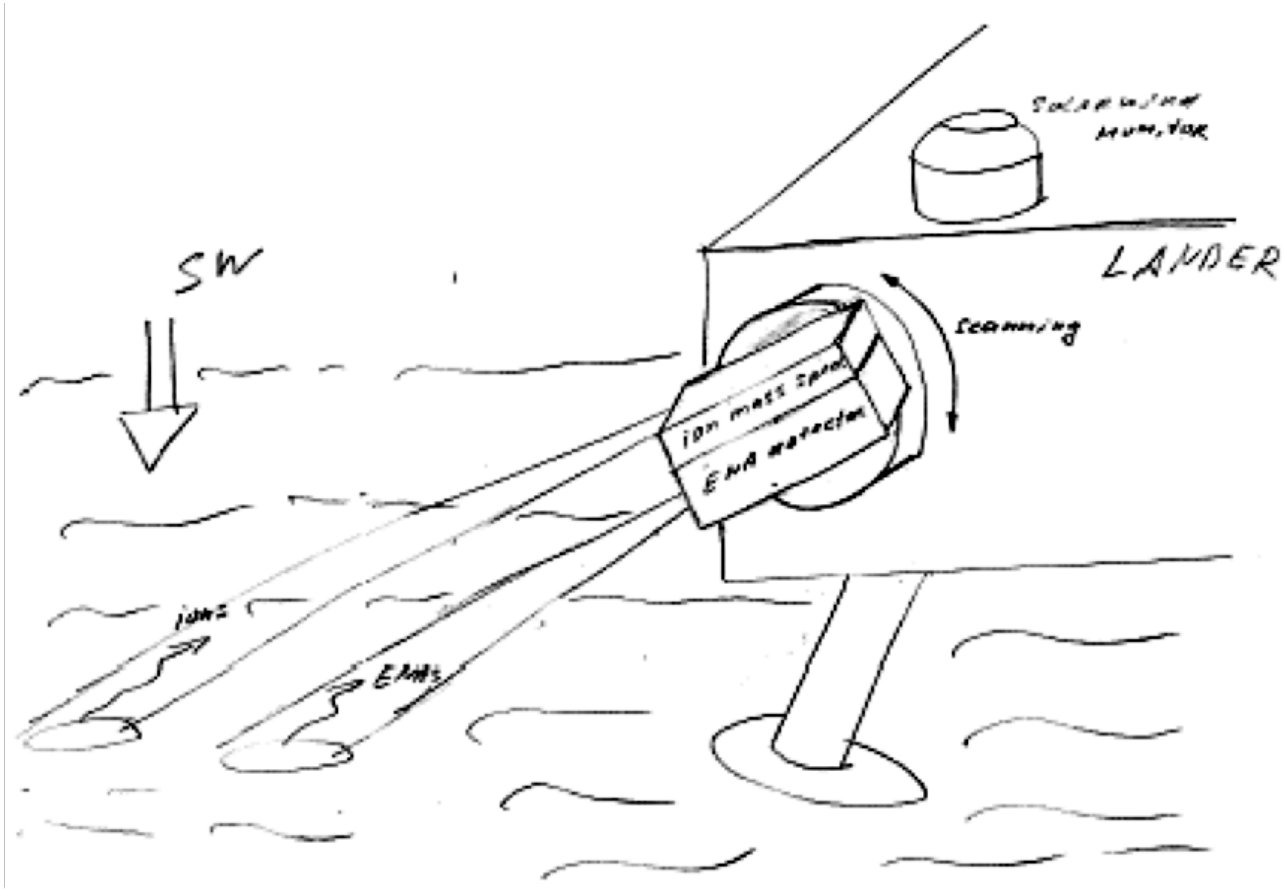
Some open problems after Chandrayaan-1

- How is the **near-surface environment** (neutral and plasma) look like **at 1-m scale**?
- **Why is the apparent scattering/reflection rate** for the solar wind-surface interaction is so **high**?
- **How does the solar wind interact with porous lunar regolith** and does it differ from laboratory experiments?

Earliest concept drawing

Earliest unnamed concept from 2009:

Single pixel ion and ENA instrument



The Advanced Small Analyzer for Neutrals

- Collaboration Swedish Institute of Space Physics and National Space Science Center/Chinese Academy of Sciences
- 650g “single pixel” ENA and ion instrument with fixed viewing direction mounted on the Chang’ e 4 rover.
- 8th member of the “SWIM family” (Wieser et al. 2016) with strong heritage from the XSAN instrument on LunaGlob.
- Surface interaction based time-of-flight design
- Uses COTS components wherever possible

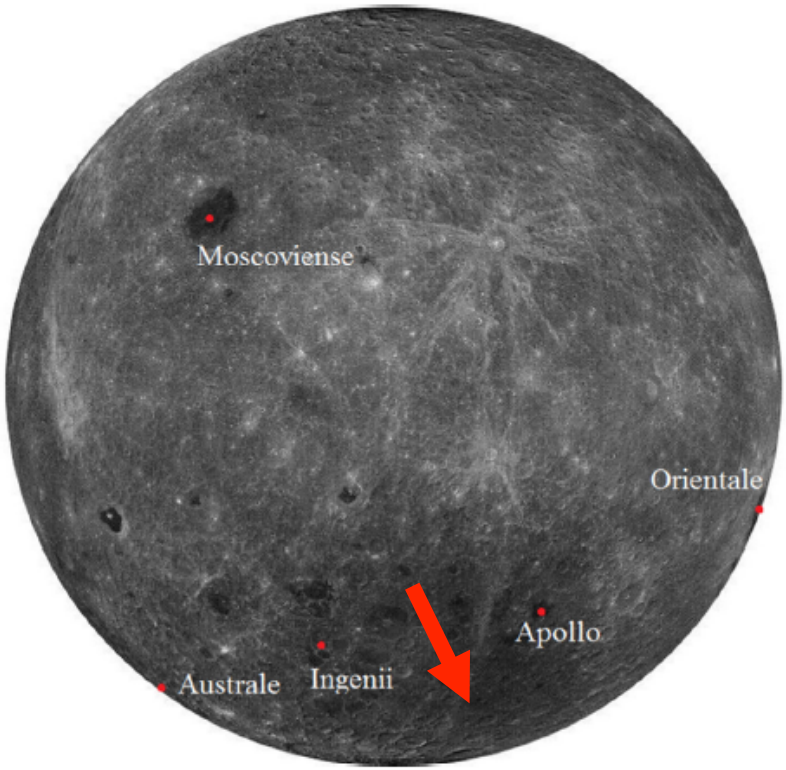
ASAN Measurement Objectives

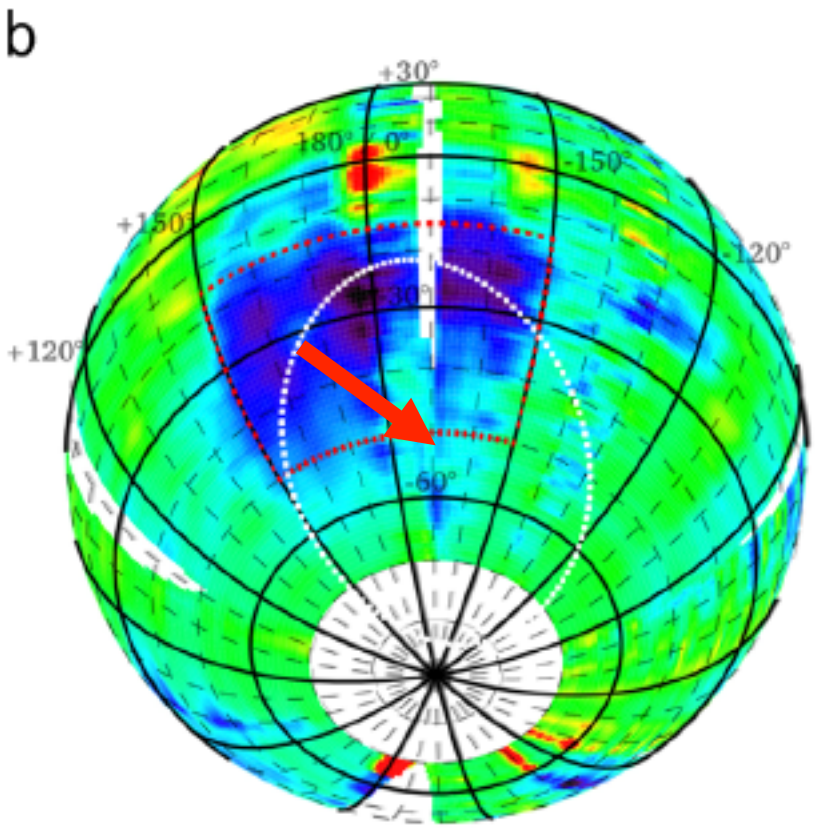
- **Determine the distribution function of solar wind backscattered as ENAs and ions** measured directly at the lunar surface (**ground truth**).

- **Determine the dependence** of the distribution function of the backscattered ions and ENAs **on topography and local time**.

ASAN will do the first ENA measurements direct on the lunar surface.

Chang'e 4 landing site





Wang and Liu (2016)

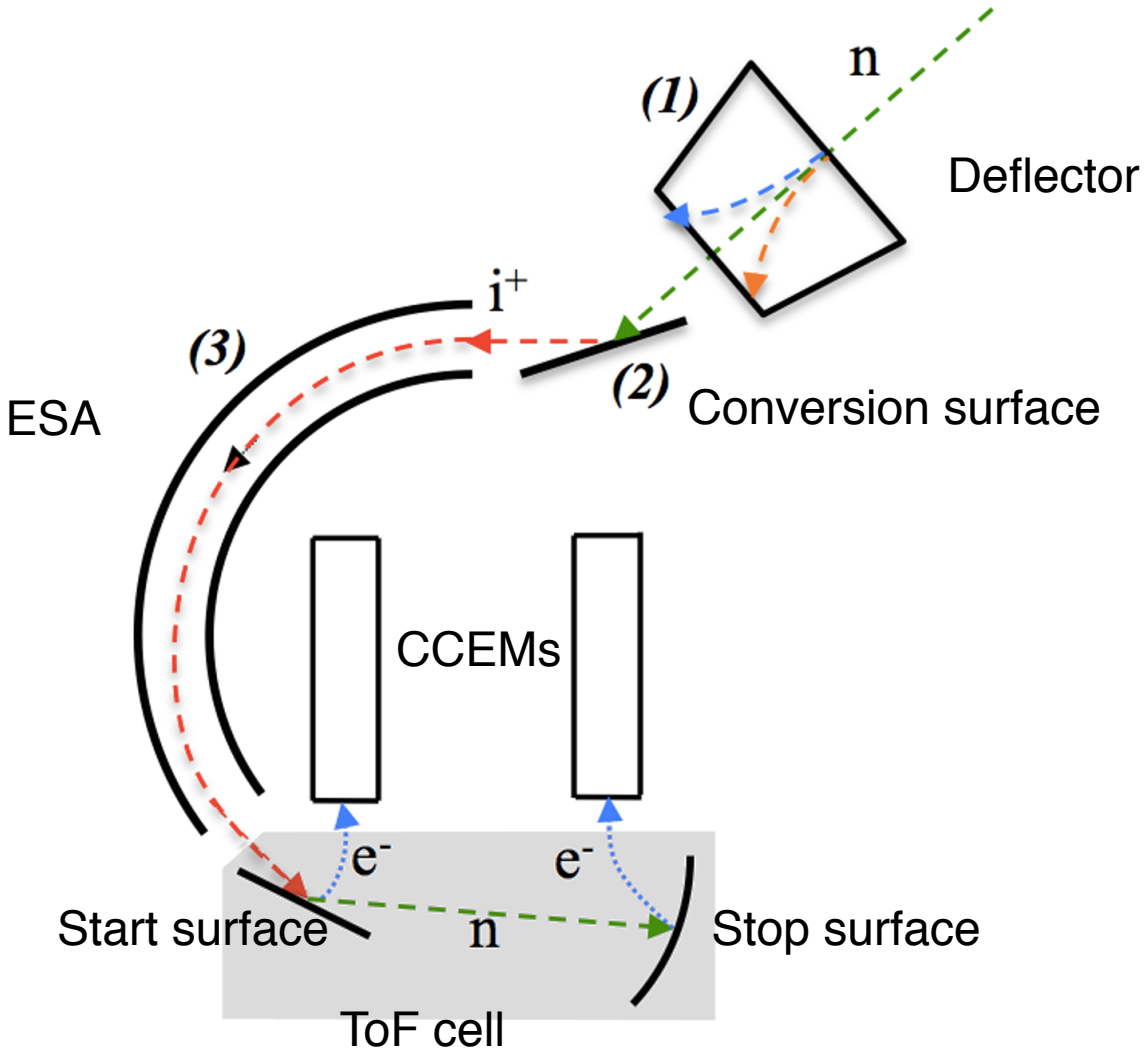
ENA reflection map, Vorburger et al. (2015)

ASAN Characteristics

Measures	ENAs, positive ions
Energy range	10eV - 10keV (ENA, ions)
Mass resolution	Ions: m/q groups: 1,2,4,8,16,32 ENA: H, heavy
Energy resolution	7% (ions), <30% (ENA)
Geometric factor	~10^{-5} cm2 sr eV/eV
Time resolution	Combined ENA/ion energy spectrum: 10s
Mass	650g (+70g mounting structure)
Power	+28V 3.4W (7W cover opening)
Dimensions	108mm x 151mm x 100mm
Telemetry	<1000 bps
Operation temperature	-25 to +55 °C (-50 to +70 °C nonop)
Actuators	One-time cover
Operations	continuous, minimum 14days, max 1 year

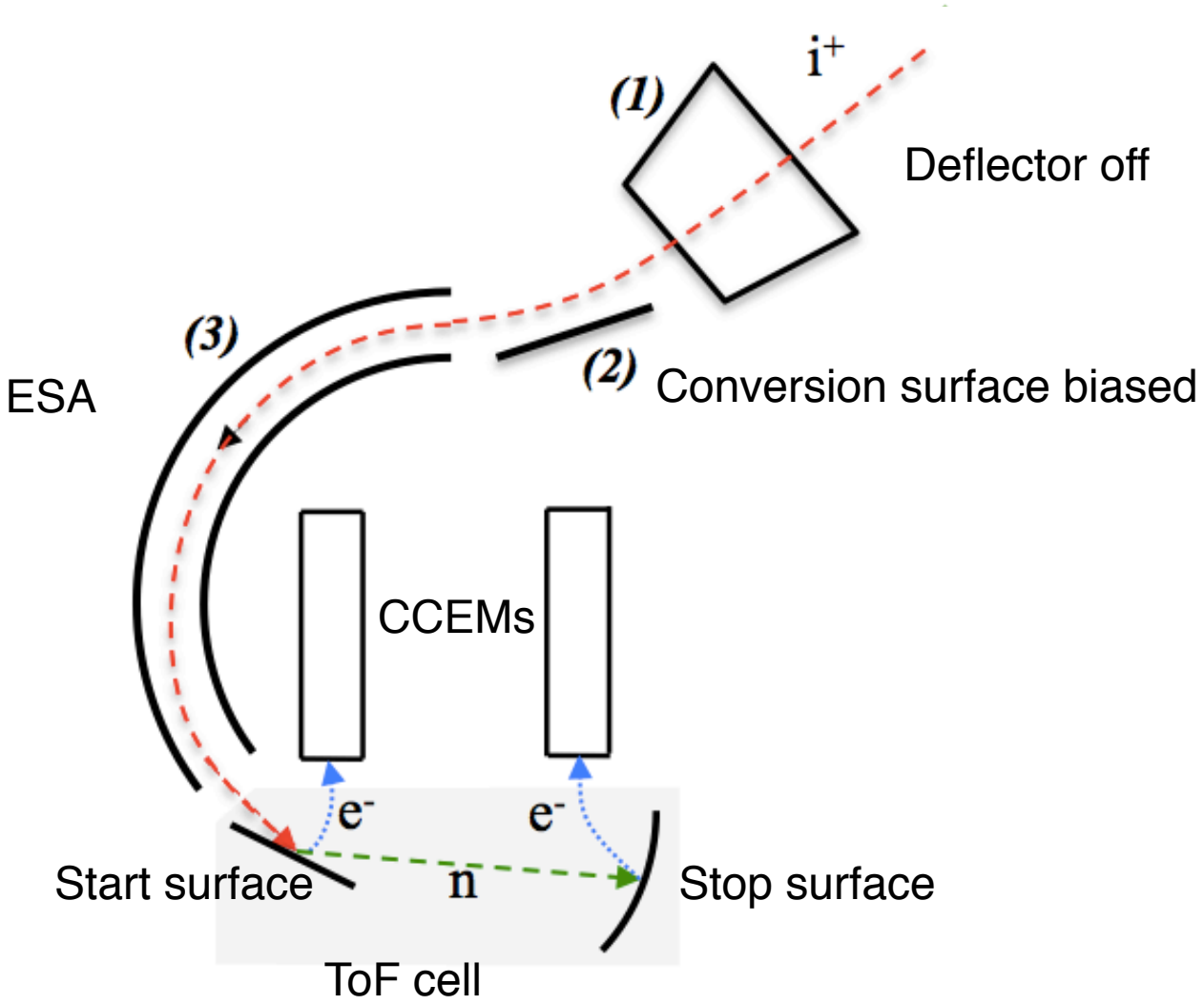
ASAN ion optics (ENA mode)

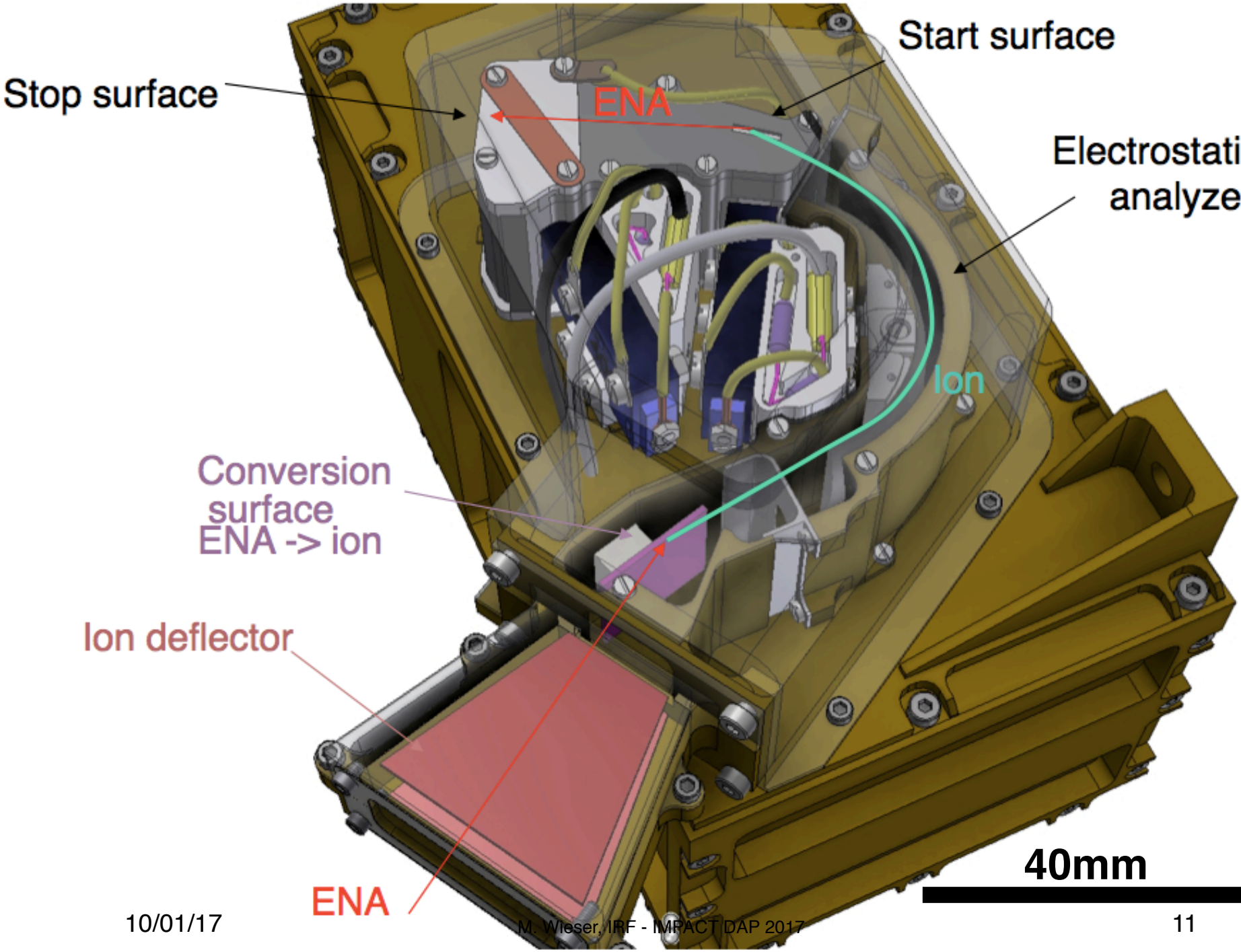
Surface interaction based time-of-flight design:



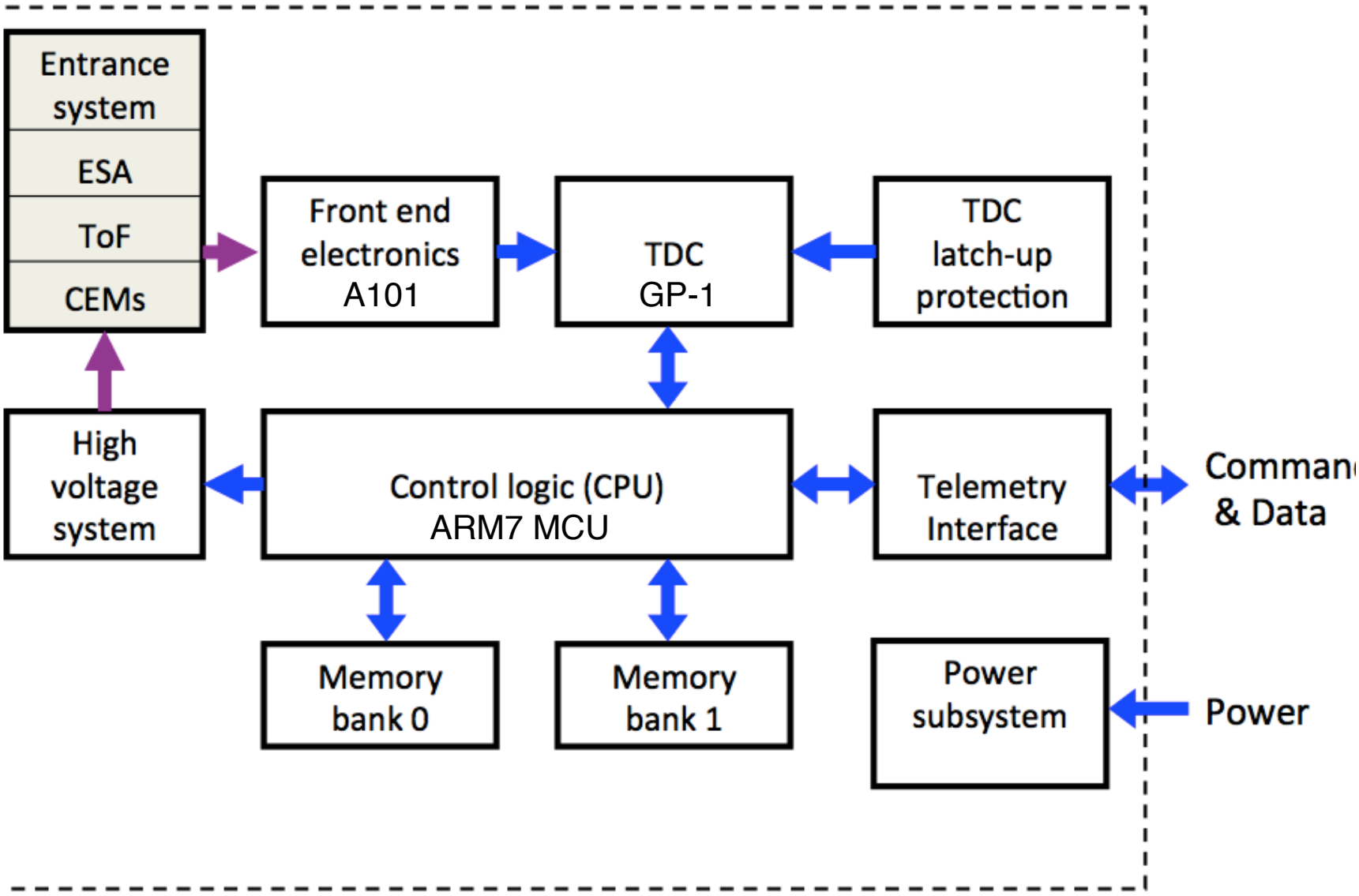
ASAN ion optics (ion mode)

Surface interaction based time-of-flight design:

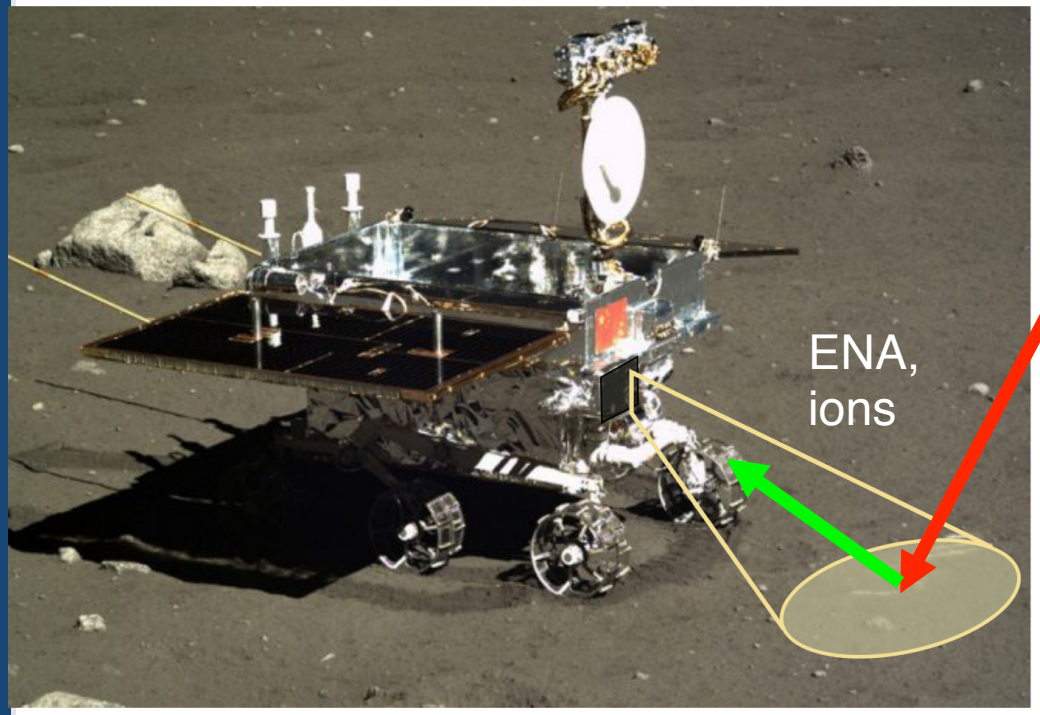



Stop surface
Start surface
ENA
Electrostati
analyze
Ion
Conversion
surface
ENA -> ion
Ion deflector
ENA
40mm

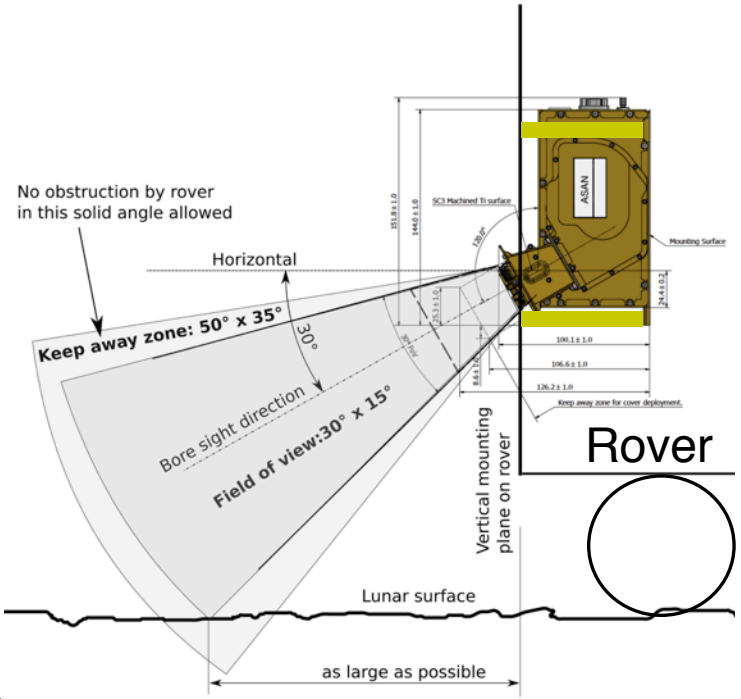
ASAN electronics



ASAN accommodation



CE-3 rover

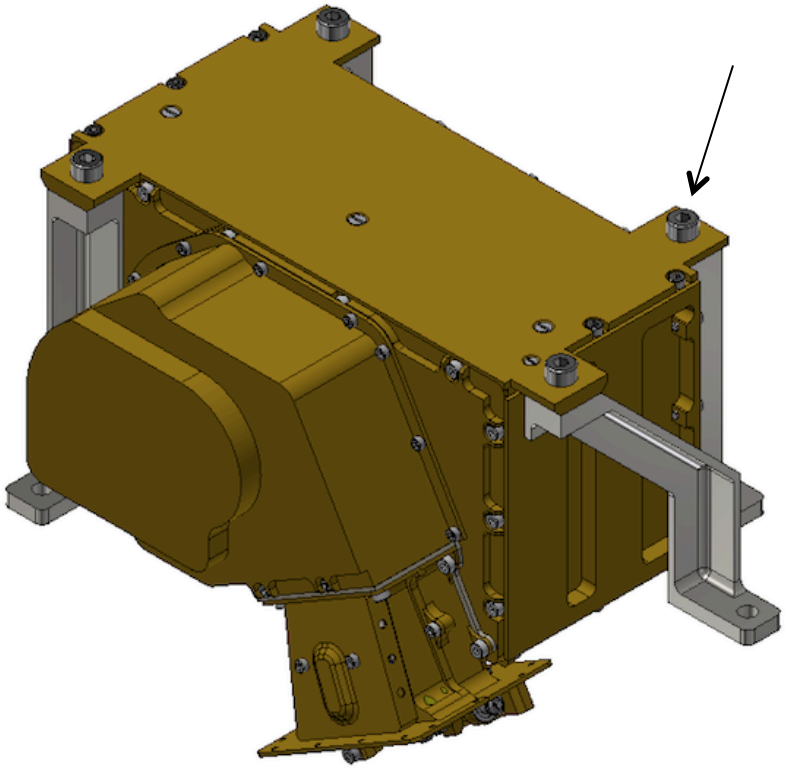


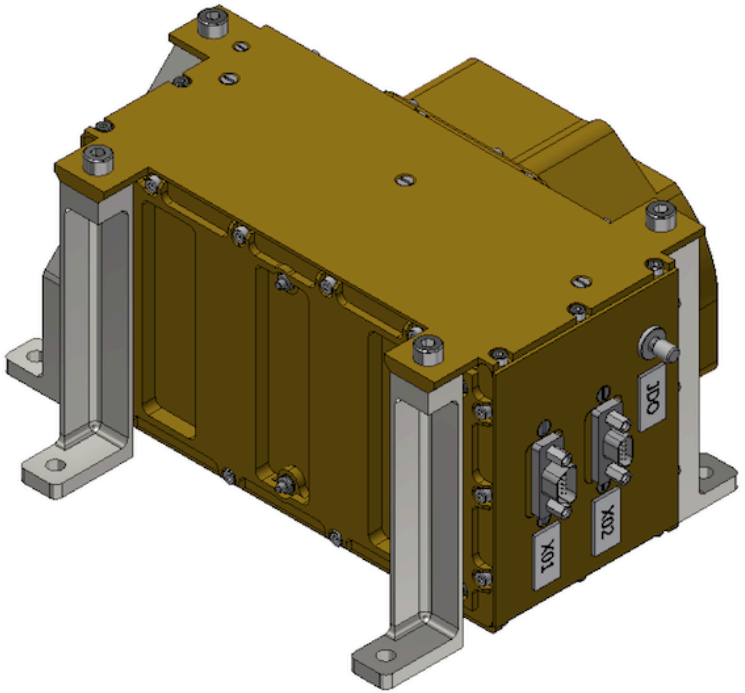
Thermal design

ASAN is only radiatively coupled to the rover payload bay.

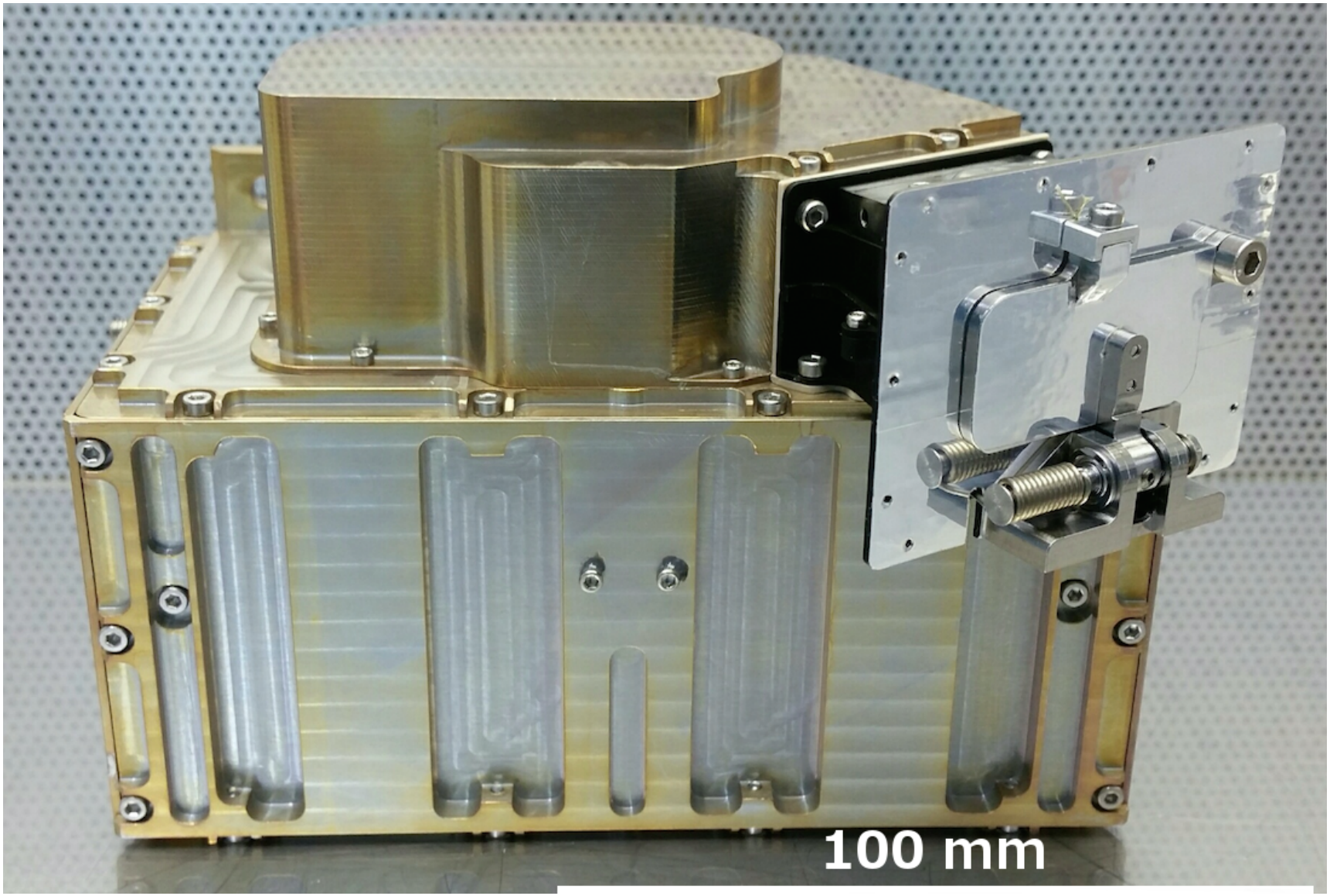
Heritage problem: Feet on the wrong side!

Solution: Ti-supports serving as thermal insulators.





ASAN PFM (w/o thermal finish and feet)



One-time cover test

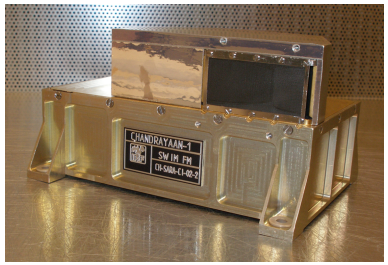
One-time cover test

MOV

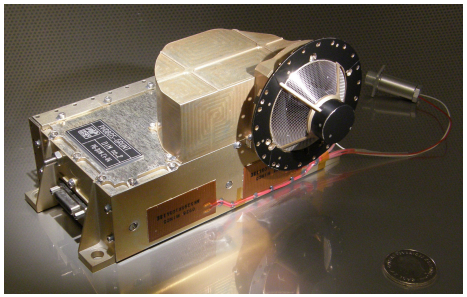
ASAN schedule

November 2016	Engineering model delivered
March 2017	Flight model calibration
End of March 2017	Flight model delivery
End of 2018	Chang' e-4 Launch
Landing + first lunar day	Threshold ASAN science
Landing +1 year	End of nominal Chang'e 4 mission

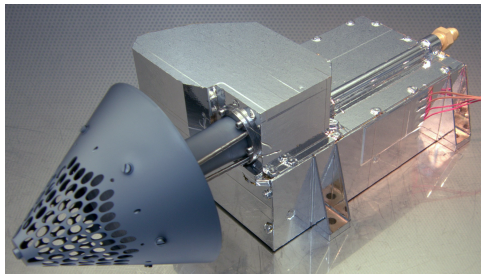
Group photo of the *SWIM family*



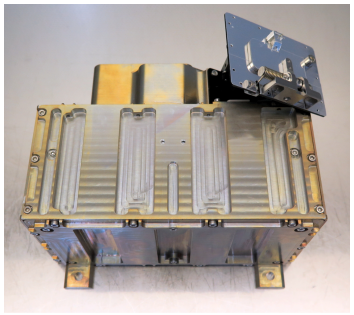
SWIM/Moon 2008



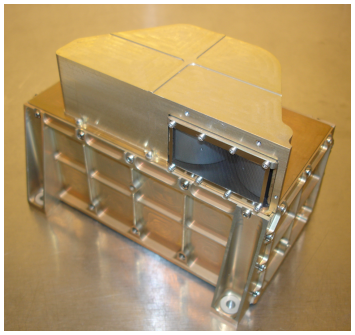
DIM/Mars 2011



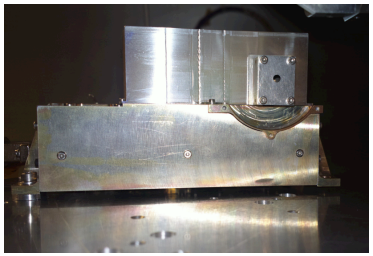
MIPA/Mercury 2018



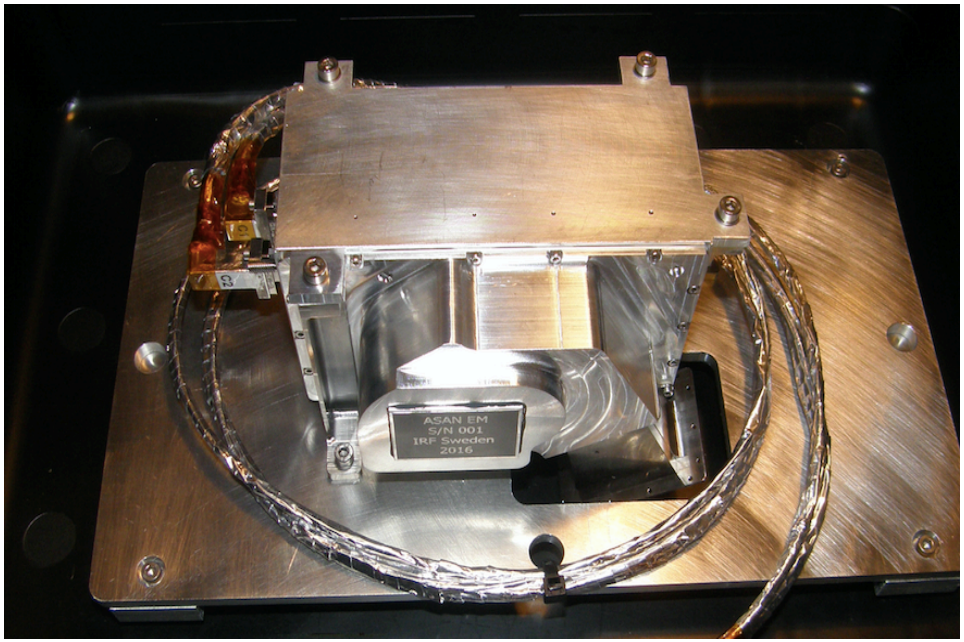
XSAN/Moon 2019



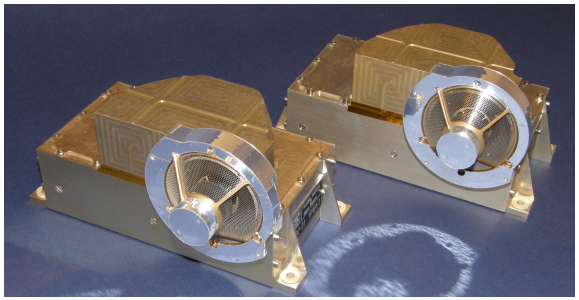
PRIMA/Earth 2010



LISA/Laboratory 2015



ASAN/Moon 2018



YPPi1/YPPi2/Mars 2011

(Wieser and Barabash, 2016)

Summary

- ASAN is a payload on the Chang'e 4 rover.
- ASAN will do the first ENA measurements direct on the lunar surface.
- ASAN will use the rovers mobility to sample undisturbed regolith.
- ASAN program is on track for flight model delivery in March 2017.