Properties of the solar wind measured by moon satellite Chang'E-1

ECU 2021 - 1° Electronic Conference on Universe

Francesco Nozzoli
Pietro Richelli
INFN-TIFPA

Space Science Data Center

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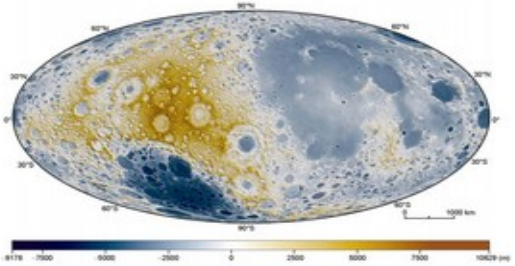
Solar System Exploration @ SSDC

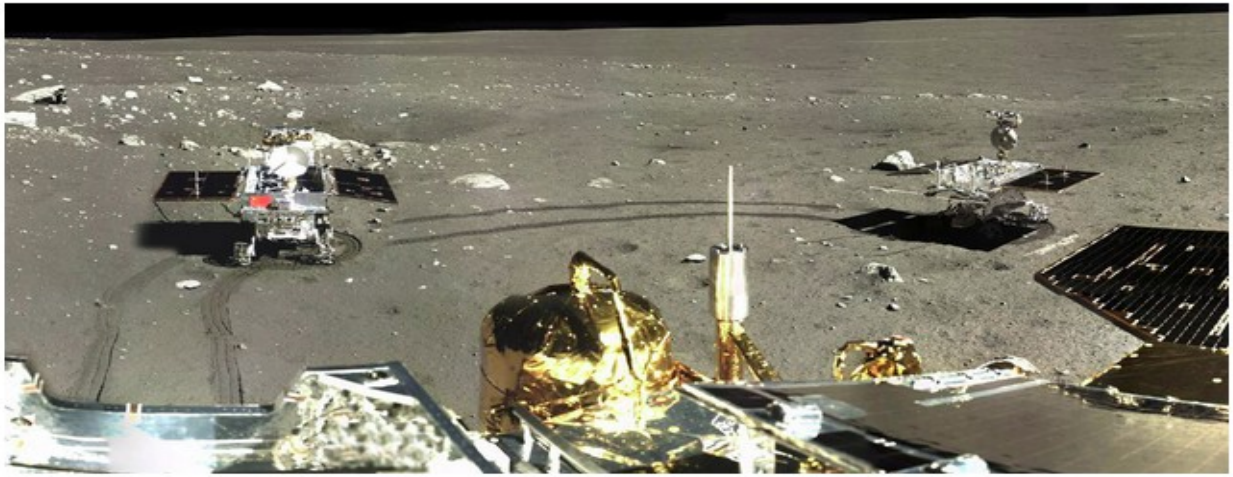
SSDC Solar System Home | Moon Mapping Workshop

https://solarsystem.ssdc.asi.it/change/



MOON MAPPING PROJECT | CHANG'E PROGRAM | DATA HUB

MOON MAPPING PROJECT



Latest Solar System News

- **(Jun 11, 2018)** MATISSE v1.5 online with a better 3D online visualization method

Center of Space Exploration (COSE)

Agenzia Spaziale Italiana (ASI)

5 topics on Moon Mapping with Chang'e satellite data

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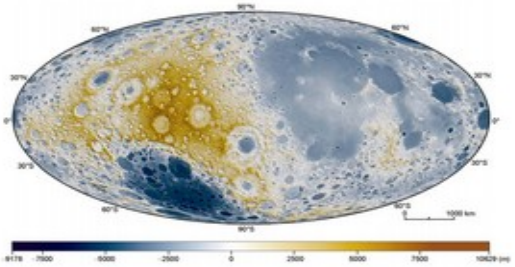
MOON MAPPING PROJECT | CHANG'E PROGRAM | DATA HUB

SSDC stores and provides access to a large part of Chang'e 1 dataset, and to some data acquired by Chang'e 2.

All available data can be accessed by external users using the web-tool MATISSE after registration and only for user part of the Moon Mapping project are:

- 188 Digital Elevation Models (DEMs) computed on the basis of Chang'e 1 observations (250 m per pixel)
- 188 Ortophoto computed on the basis of Chang'e 1 observations (150 m per pixel)
- K, Th, U Elemental Abundance Maps (at 5^{0} resolution) from Chang'e 1
- 187 Ortophoto from Chang'e 2 (50 m per pixel)
- 3244 Chang'e 1 CCD observations (Nadir, Backward, Frontward)
- 425 Chang'e 1 IIM imaging spectrometer observations



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@ ASI - SSDC
stored data of Chinese lunar orbiters:
Chang'e-1 (2007)
Chang'e-2 (2010)

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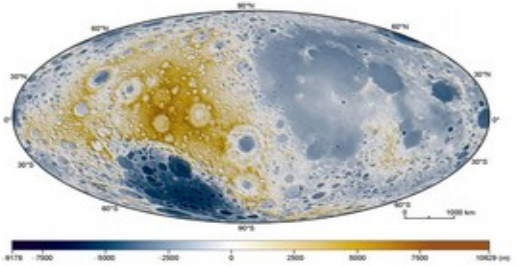

MOON MAPPING PROJECT | CHANG'E PROGRAM | DATA HUB

CHANG'E-1

- Chang'E-1 was launched on 24 October 2007 with a Long March 3A carrier rocket from the Xichang Satellite Launch Center in Soutwest China, traveling 13 days to arrive at the Moon's orbit.
- Its nominal mission was 1 year, but it correctly worked for 1 year and 4 months, when, On Mar. 1st 2009ï¼Œit was controlled to crash on the Mare Fecunditatis after 494 days of orbital operation.
- Chang'E-1 was equipped with eight scientific instruments, namely: a CCD stereo camera, a Sagnac-based Interferometer Spectrometer, a Laser Altimeter, a Microwave Radiometer, a Gamma-Ray Spectrometer, a High-Energy Particle Detector and a Solar Wind Ion Detector.
- It obtained a 120m-resolution global lunar map, an elevation map, abundance and distribution maps of various chemical elements.

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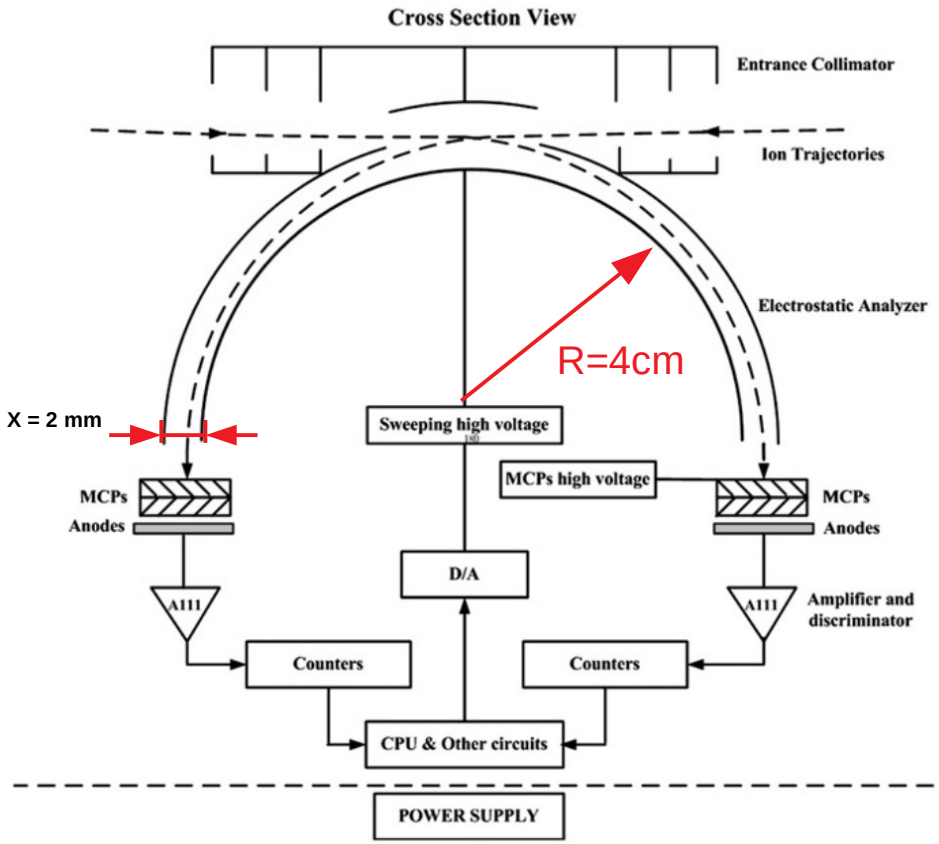
Chang'e-1
measure Solar Wind Ions @moon orbit ("outside" Earth geomagnetic field)
Data taken in the periods:
26/11/2007 - 06/02/2008
15/05/2008 - 07/07/2008
(minimum of Sun activity)

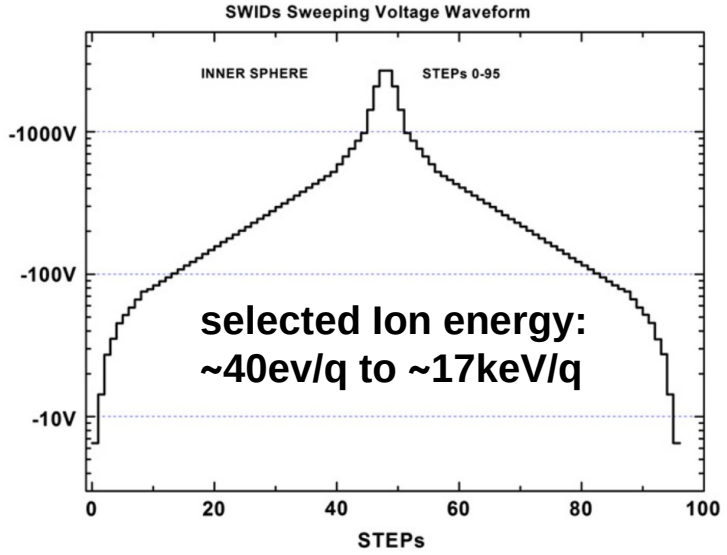
Solar Wind Ion Detector

Half-sphere electrostatic spectrometer



MCPs anode segmented in 12 channels (within 180°x6° FoV of entrance collimator)

48 voltage logarithmic-step from 6.5V to 2690V
sweep duration: 2.9 seconds, 61ms/step

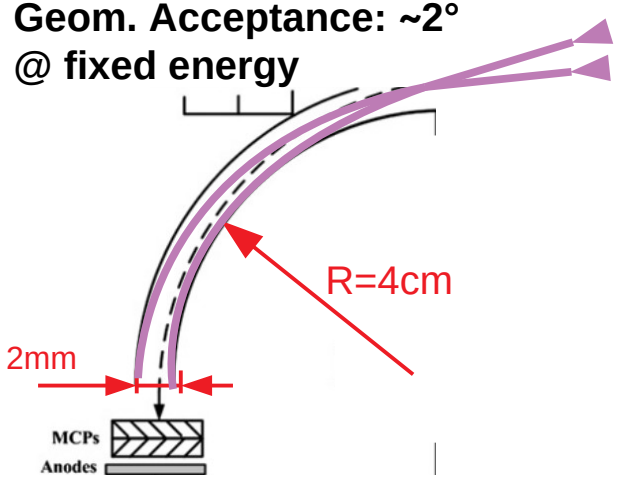


$E_k = 1/2mv^2$, $mv^2/R = Vq/x$

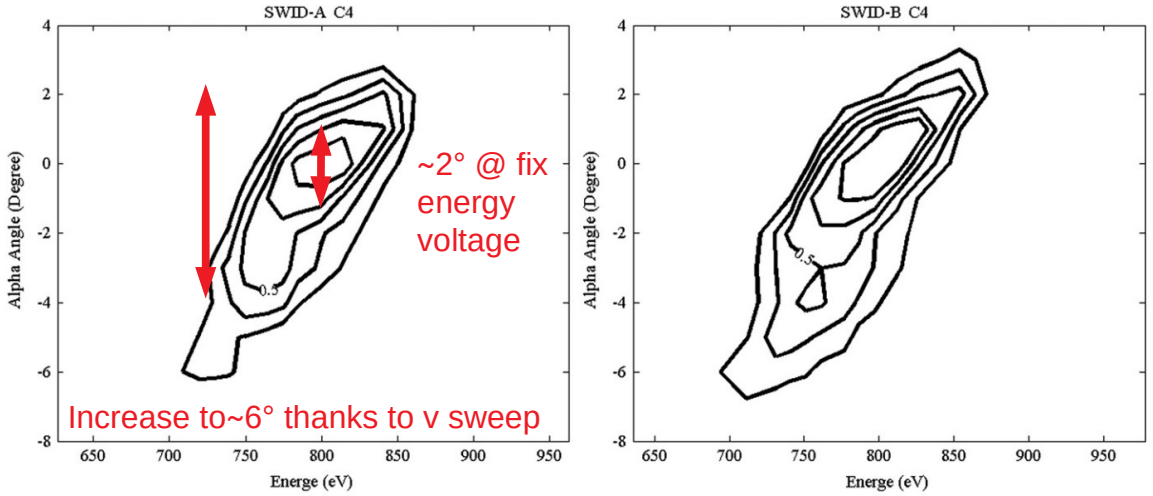
$E_k/q = V*R/(2x) = 10.375*V$

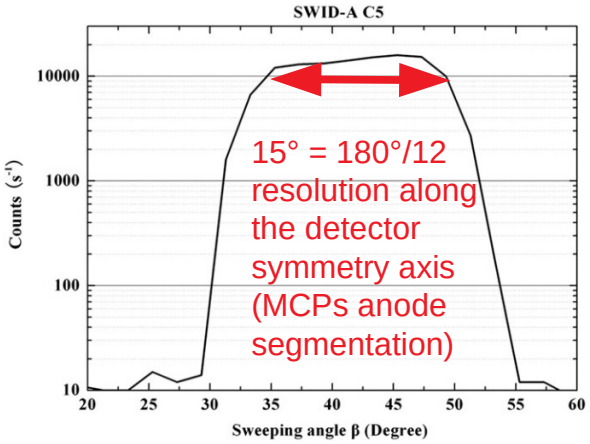
Solar Wind Ion Detector resolution

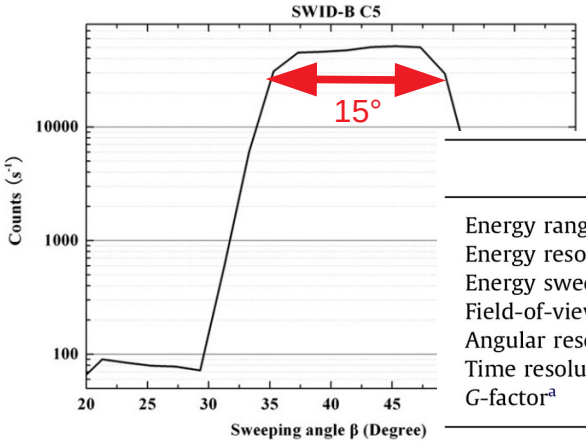
Geom. Acceptance: ~2° @ fixed energy



detector response calibrated @ 5eV-800eV ion beam

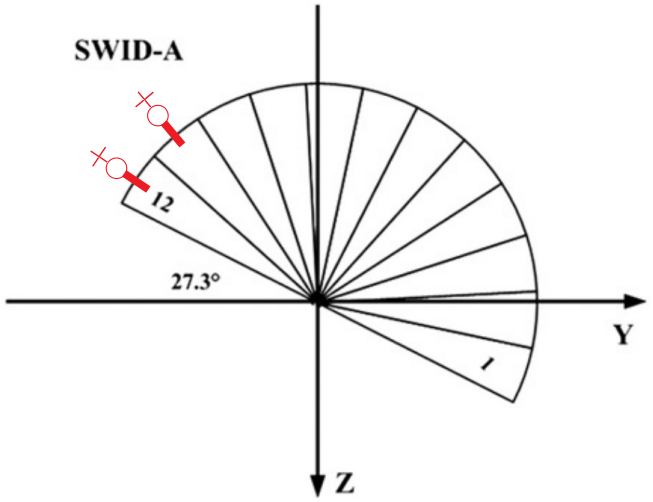


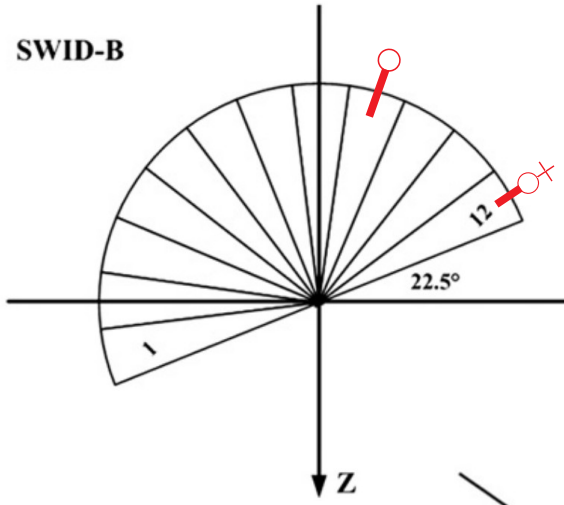




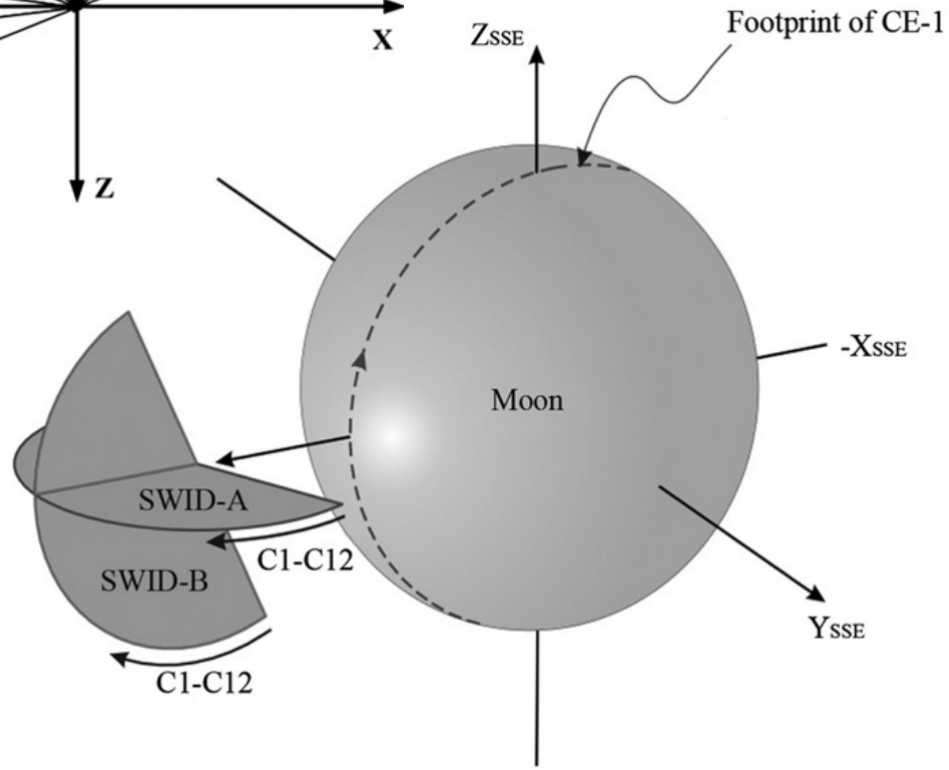
	SWID-A	SWID-B
Energy range	40 eV/q–16.48 keV/q	44 eV/q–17.98 keV/q
Energy resolution	8.1% (FWHM)	8.3% (FWHM)
Energy sweep steps	48	48
Field-of-view	180° × 5.7° (FWHM)	180° × 6.6° (FWHM)
Angular resolution	15° × 5.7° (FWHM)	15° × 6.6° (FWHM)
Time resolution	2.9 s	2.9 s
G-factor[a]	4.6×10^{-4} cm^2 sr eV/eV	5.7×10^{-4} cm^2 sr eV/eV

Solar Wind Ion Detector FoV





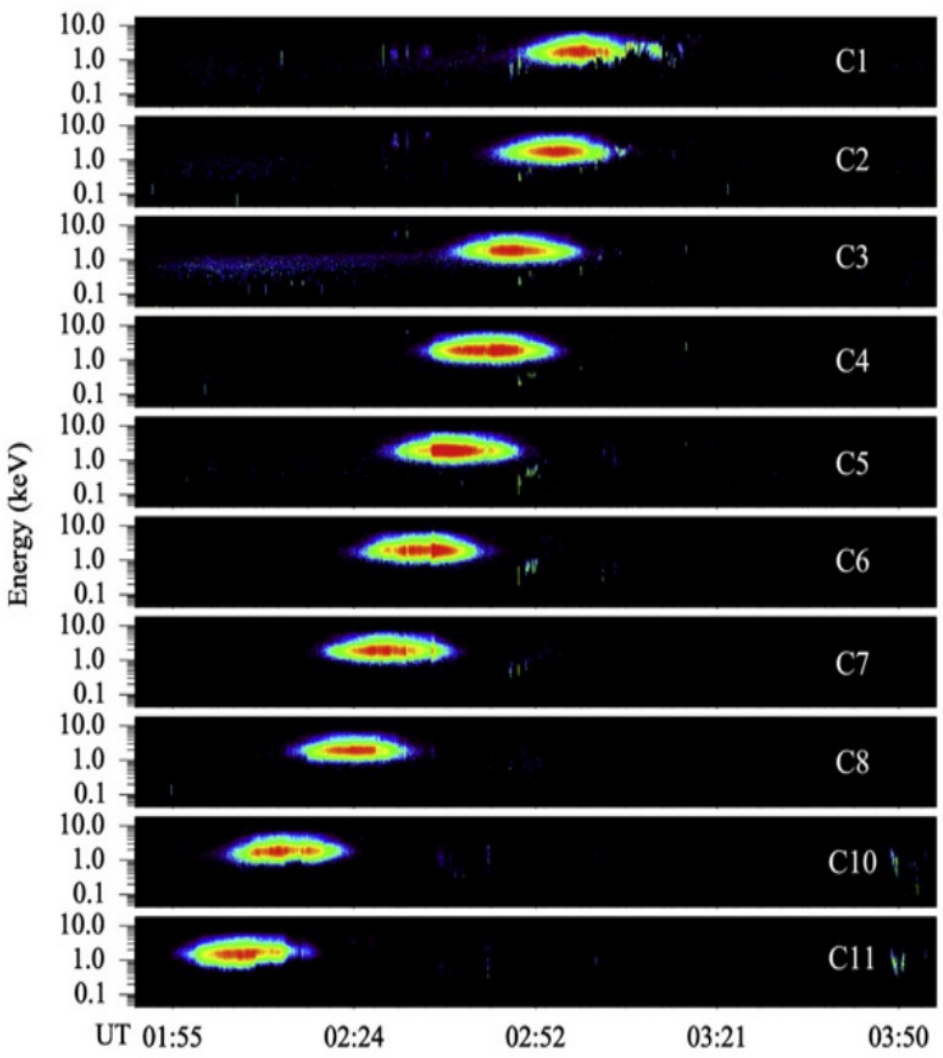
For each Chang'e-1 orbit (2h): SWID-A scan most of the sky and all SWID-B channels scan the "same" 6° slice but with 15° & 5minute redundancy/delay (+Moon is moving wrt the Sun)

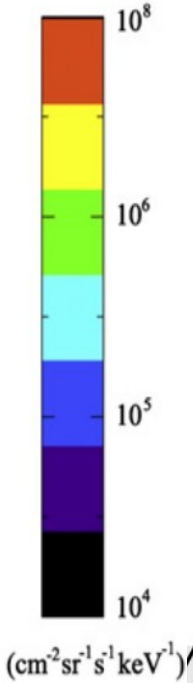


KNOWN PROBLEMS:
-SWIDA-11
-SWIDA-12
-SWIDB-12
Channels are blocked by the satellite body

SWIDB-9 amplifier is broken (gain 1/10)

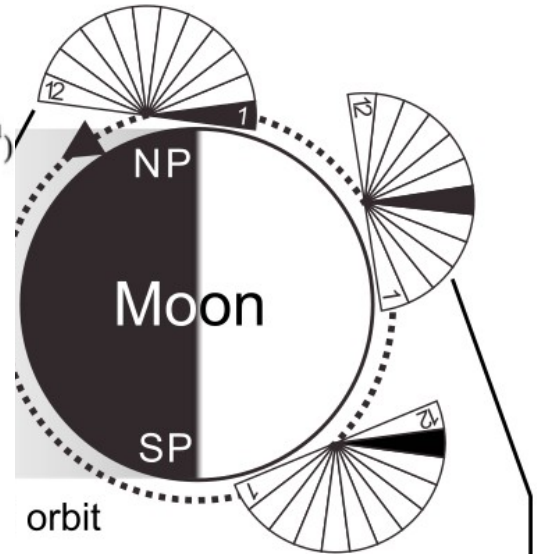
Typical SWID-B flux measurement in one orbit





When the SUN (i.e. the solar wind) enter in the acceptance of a given channel, a large flux is measured.

"SUN Imaging" with ions (thanks to the small magnetic field) This would be not possible within Earth Magnetosphere.



multi-messenger view of the Sun

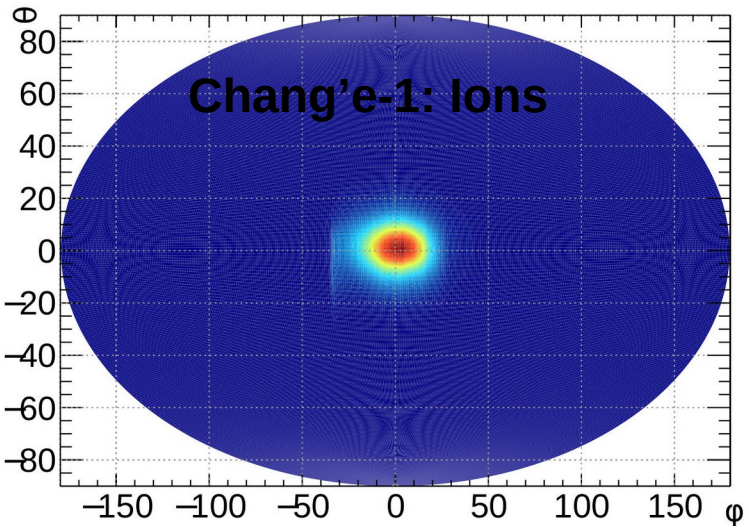
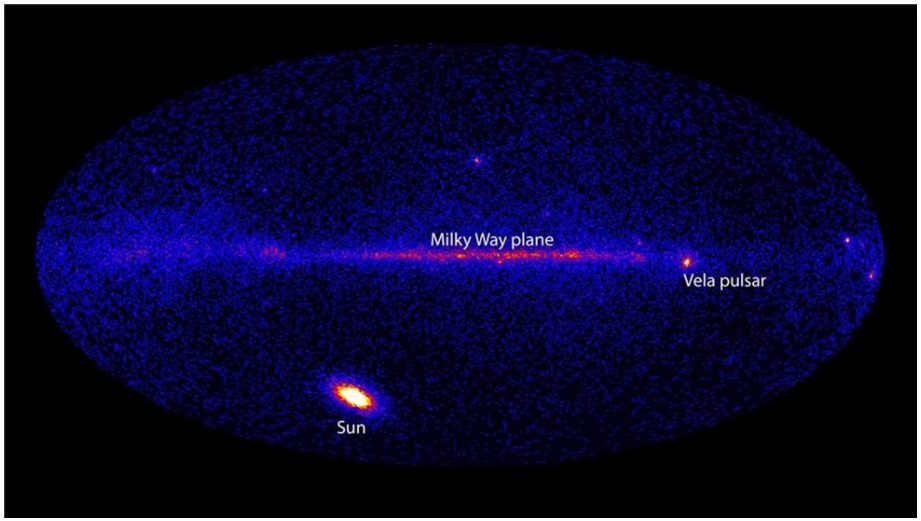
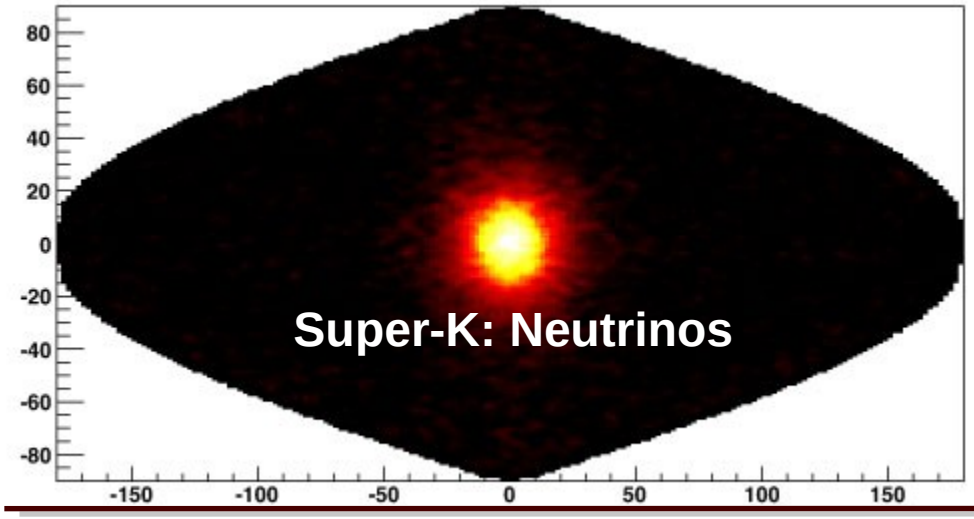


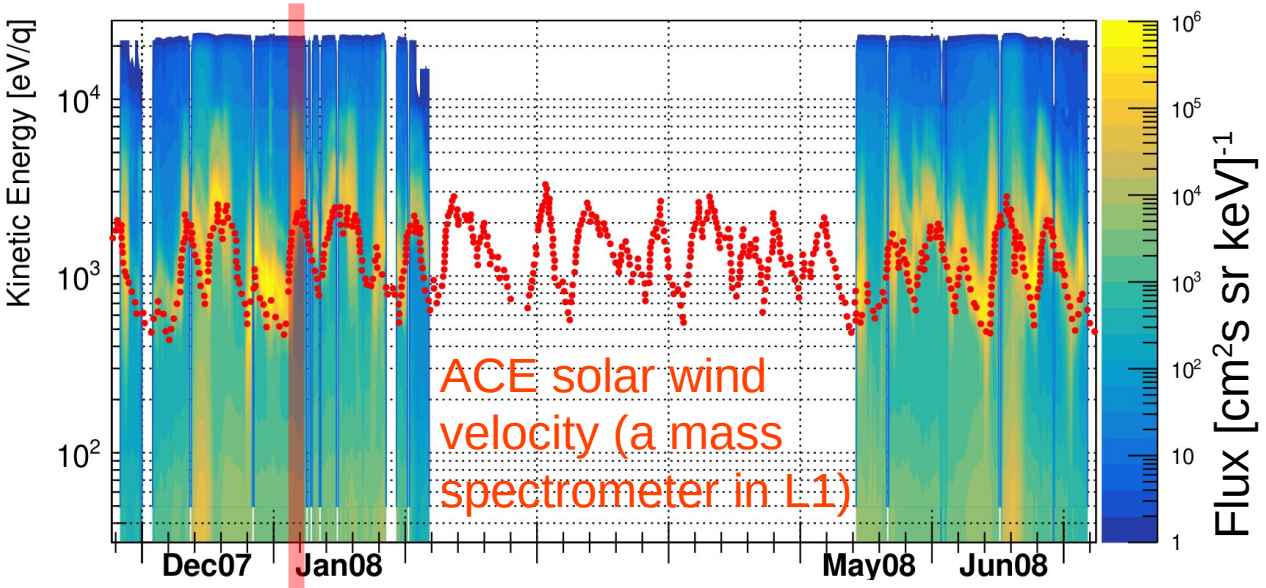
Image of the Sun with charged particles (merging all the good SWIDs channels)



Fermi-LAT 07/03/2012 Solar Flare
E_gamma > 100 MeV



Flux vs time (Sun activity & solar wind composition)



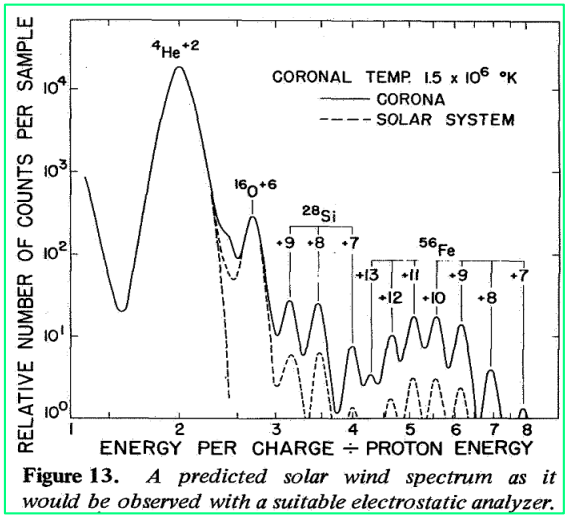
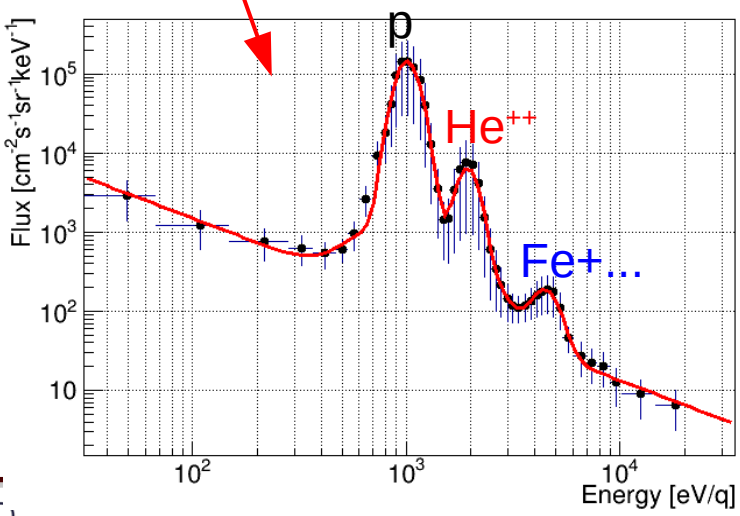
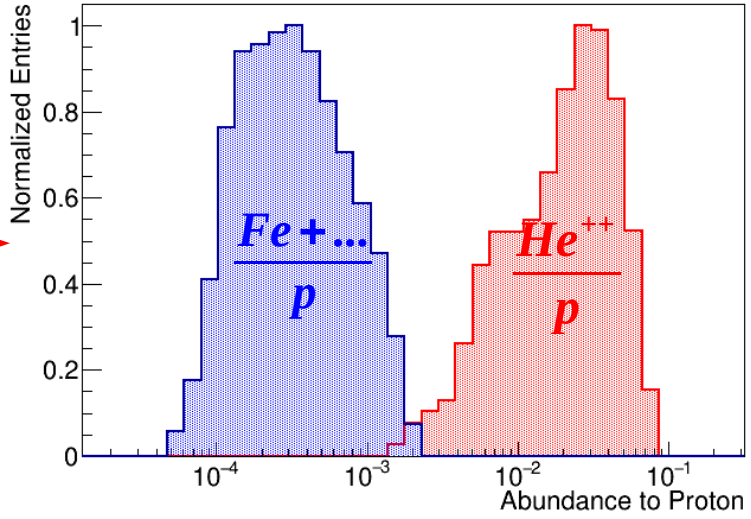


Figure 13. *A predicted solar wind spectrum as it would be observed with a suitable electrostatic analyzer.*





summary

Chang'e-1 Solar Wind Ion Detectors:
- multi-messenger view of the Sun
- complementary information of solar activity/space weather @ 1AU
- study of exotic plasma effects on Moon surface

DATA HUB from Moon-Mapping project:
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