

Hydrogen/Water distribution at Lunar Poles according to LEND / LRO Data

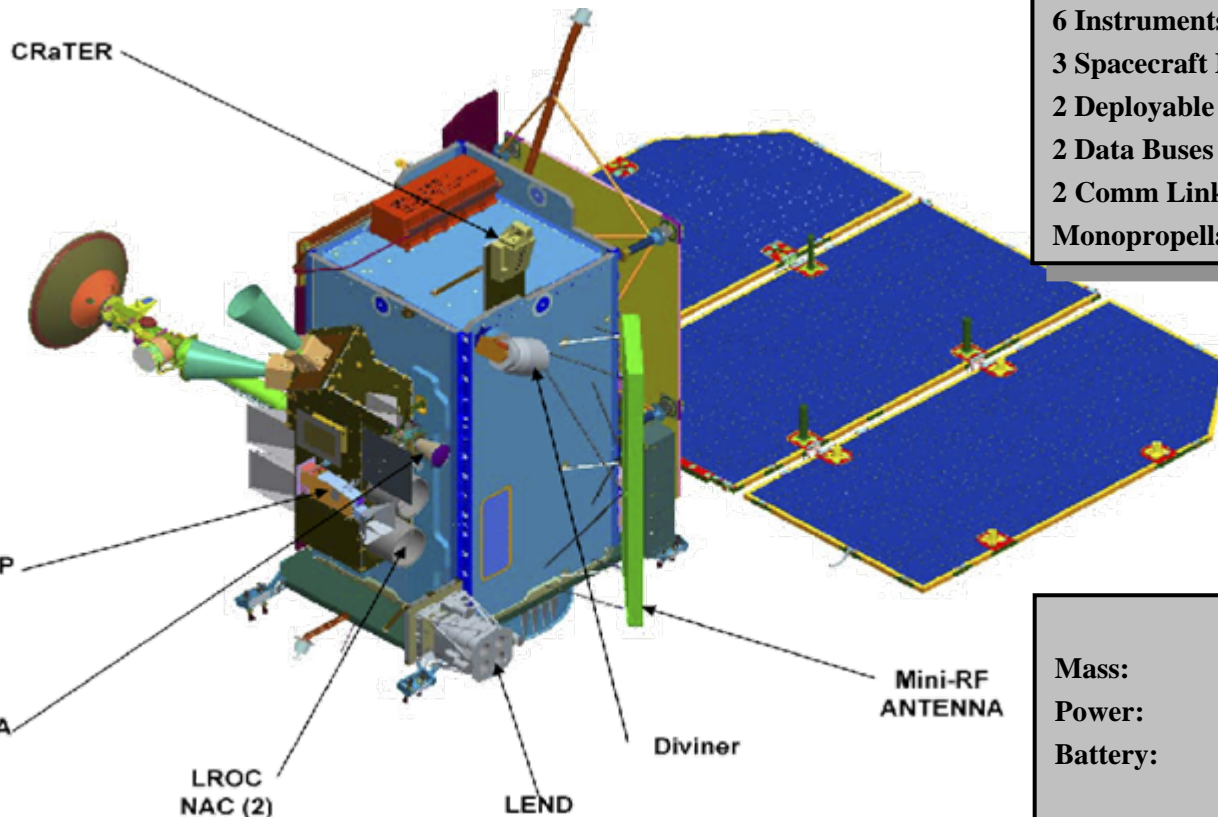
Anton Sanin

on behalf of the LEND Team

LRO Spacecraft Systems Capabilities

LRO Overview

- 6 Instruments and 1 Technical Demonstration
- 3 Spacecraft Modules – Instrument, Propulsion, Avionics
- 2 Deployable Systems – High Gain Antenna, Solar Array
- 2 Data Buses – Low Rate 1553, High Rate Spacewire
- 2 Comm Links – S Band, Ka Band
- Monopropellant System – Hydrazine, Single Tank design



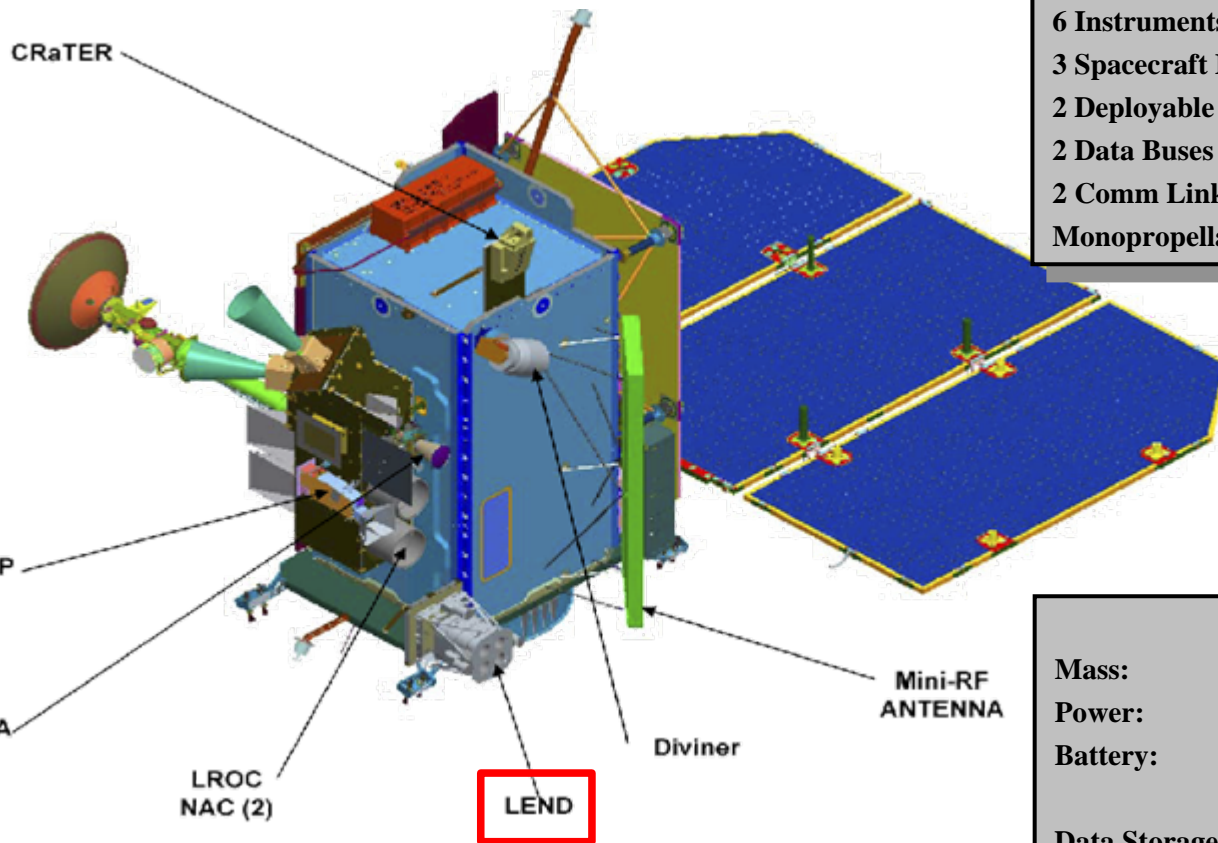
LRO Capability Highlights

- Mass: 1480 kg
- Power: 823 W orbit average @ 35V
- Battery: Lithium Ion Chemistry
80 Amp-Hour Capacity
- Data Storage Capacity: 400 Gb
- Data Rate: 100 Mbps Down – Ka Band
2.186 Mbps Up/Down – S Band
- Timing relative to UTC: 3ms
- Delta V Capability: 1326 m/sec

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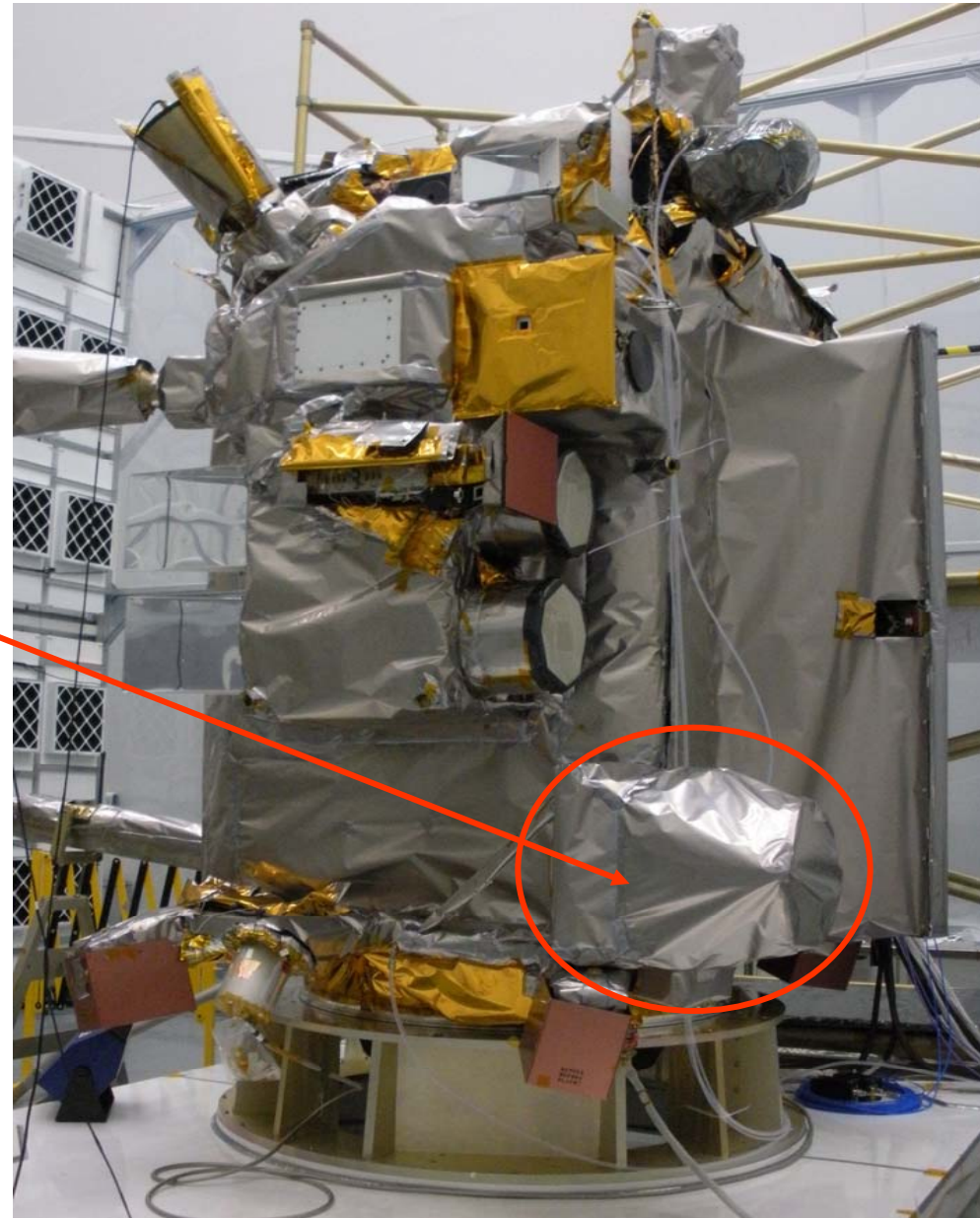
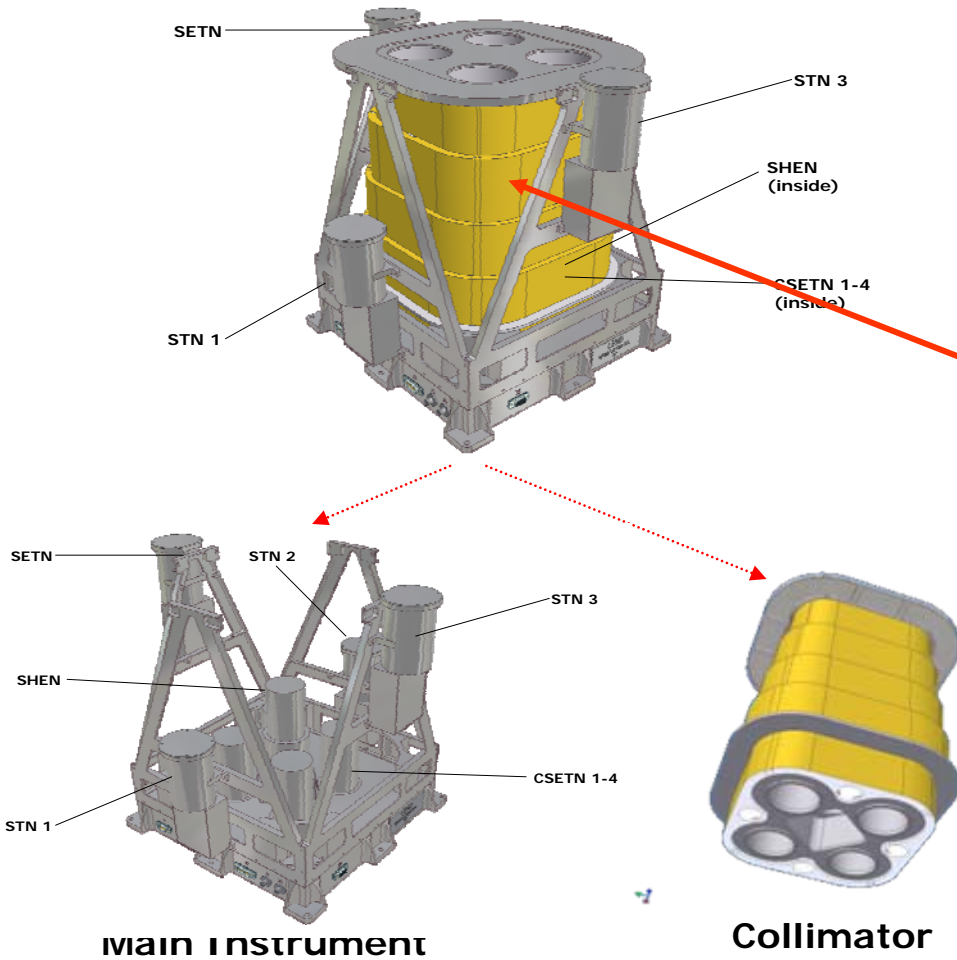


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LEND Instrument Overview

LEND consists of nine detectors to measure fluxes of thermal, epithermal, and fast neutrons.





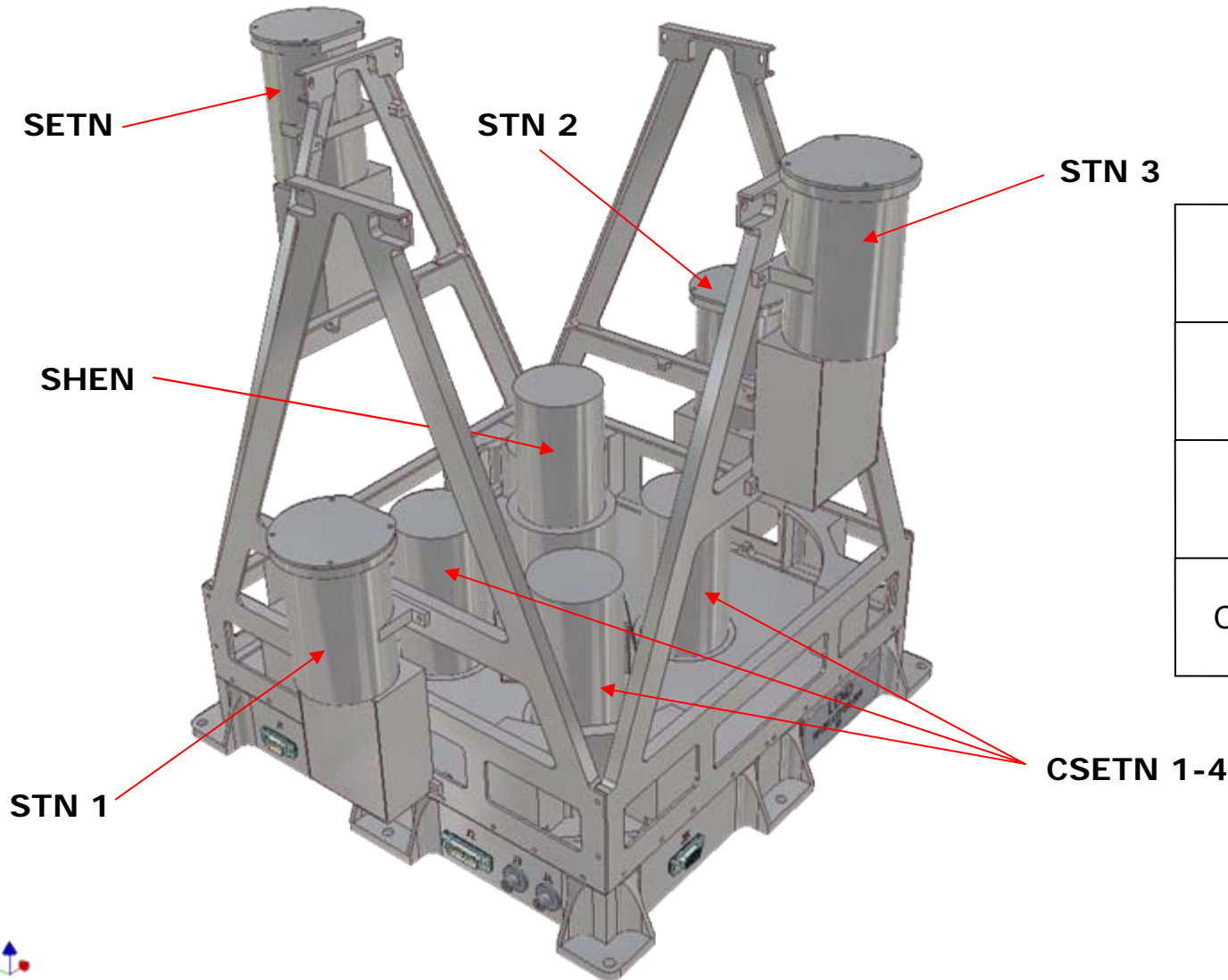
Lunar Exploration Neutron Detector



LEND General Properties

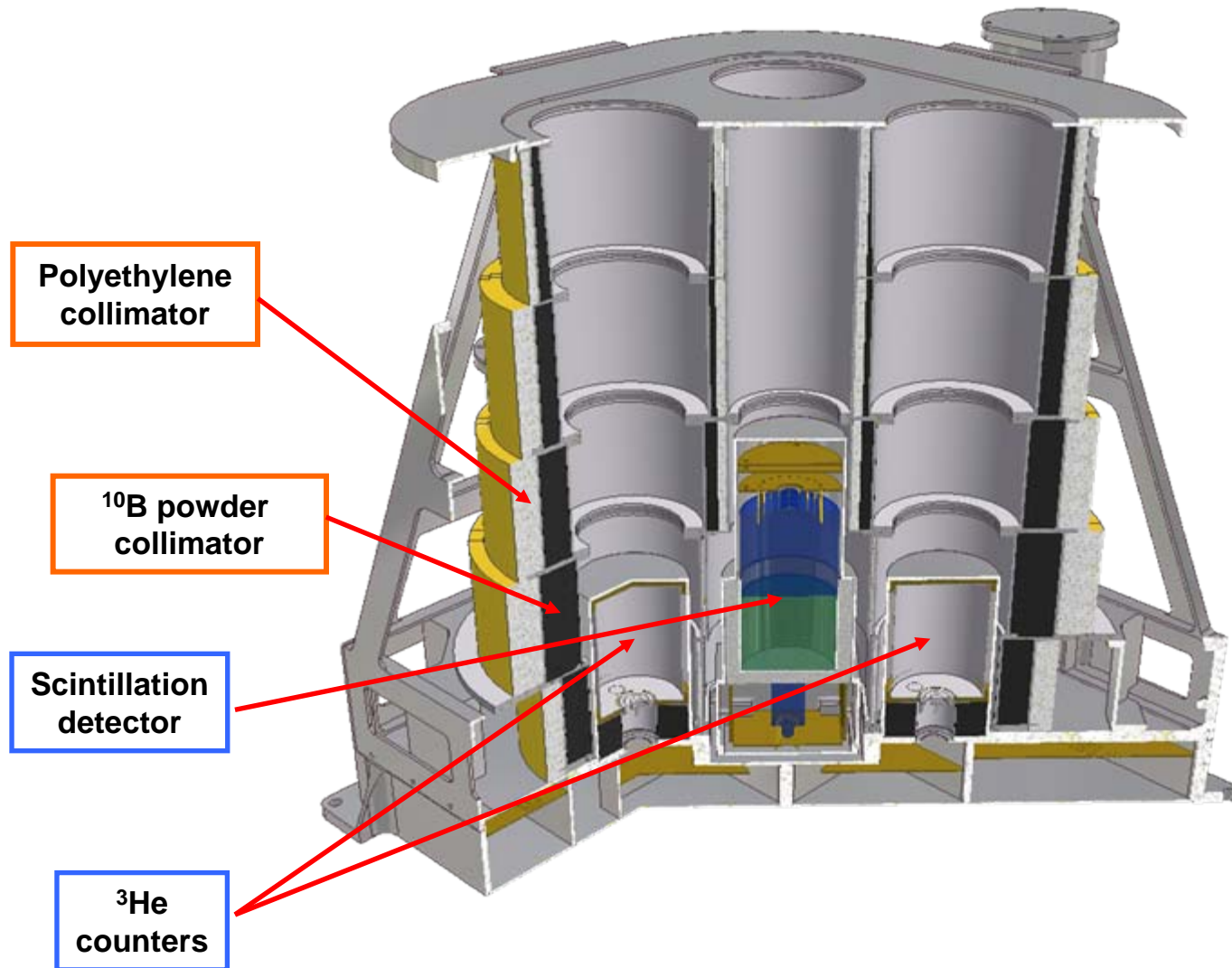
Instrument parameter	LEND
Mass (with MLI, kg)	26.3
Sizes (mm)	460 x 460 x 440
Operational power (W)	8.6
Heating power (W)	3.7
Telemetry rate	3 kbps
Total daily telemetry	250 Mb
Number of commands	7
Energy ranges of neutron measurements	1) < 0.4 eV, 2) 0.4 eV – 1.0 MeV, 3) 1.0 – 15.0 MeV 4) > 15.0 MeV
Time resolution (sec)	≥ 1.0
Spatial resolution (from ~50 km altitude)	Radius ~5 km

LEND Instrument Overview



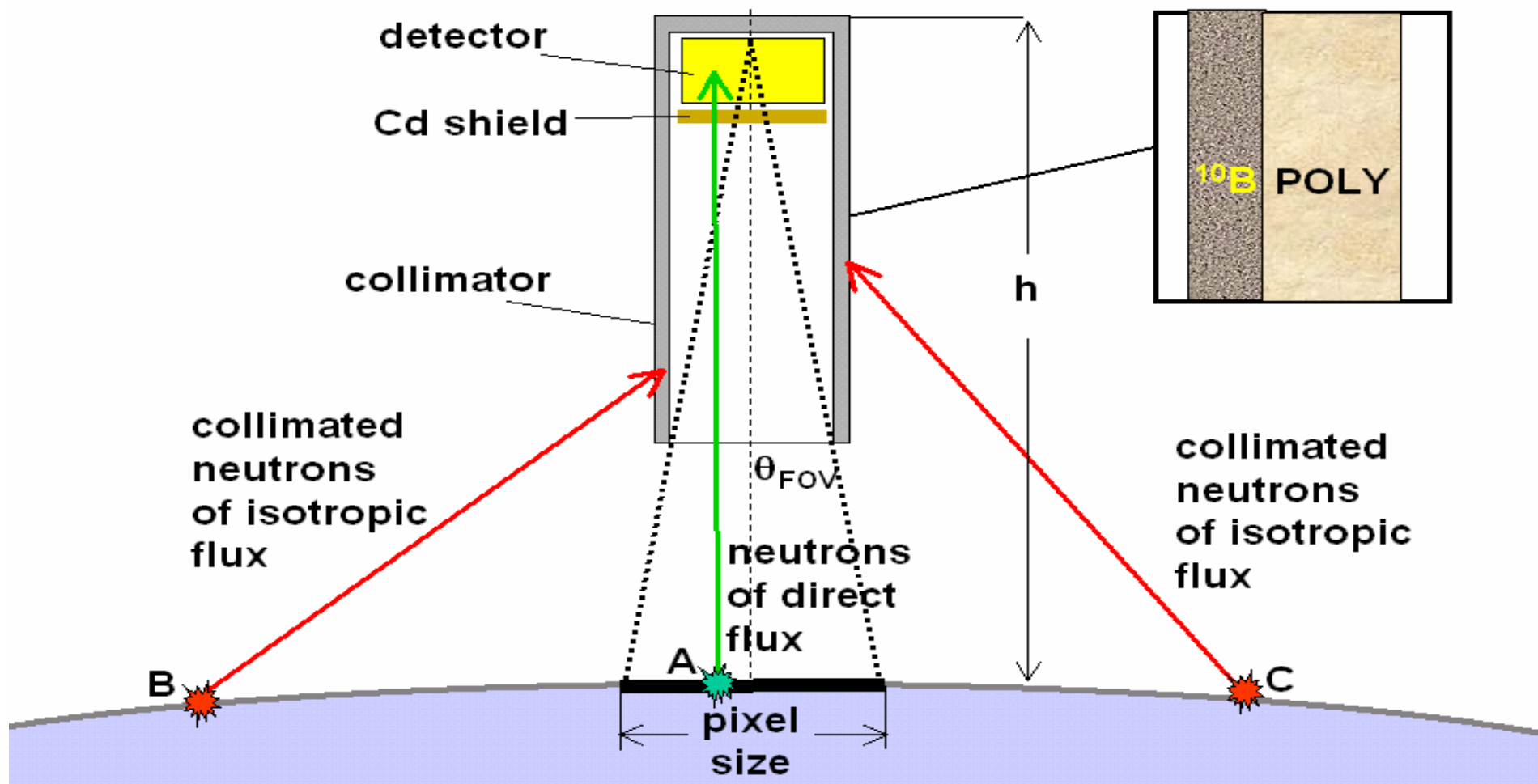
STN 1 - 3	Omnidirectional detectors for thermal neutrons
SETN	Omnidirectional detector for epithermal neutrons
SHEN	Collimated detector for high energy neutrons
CSETN 1 - 4	Collimated detectors for epithermal neutrons

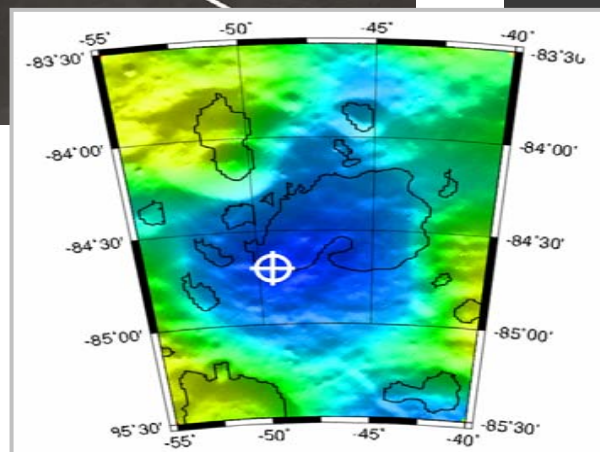
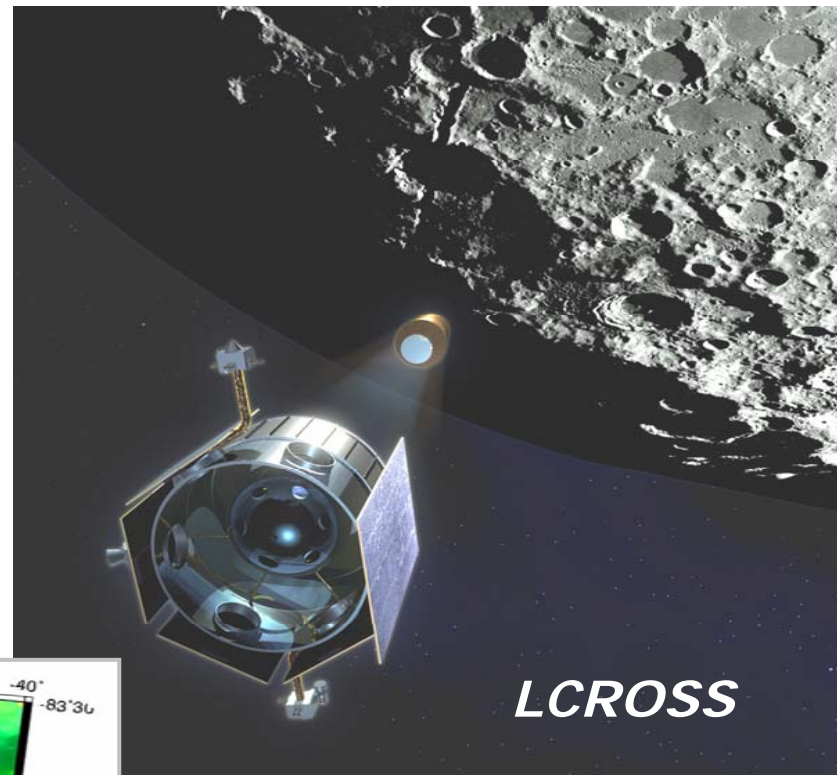
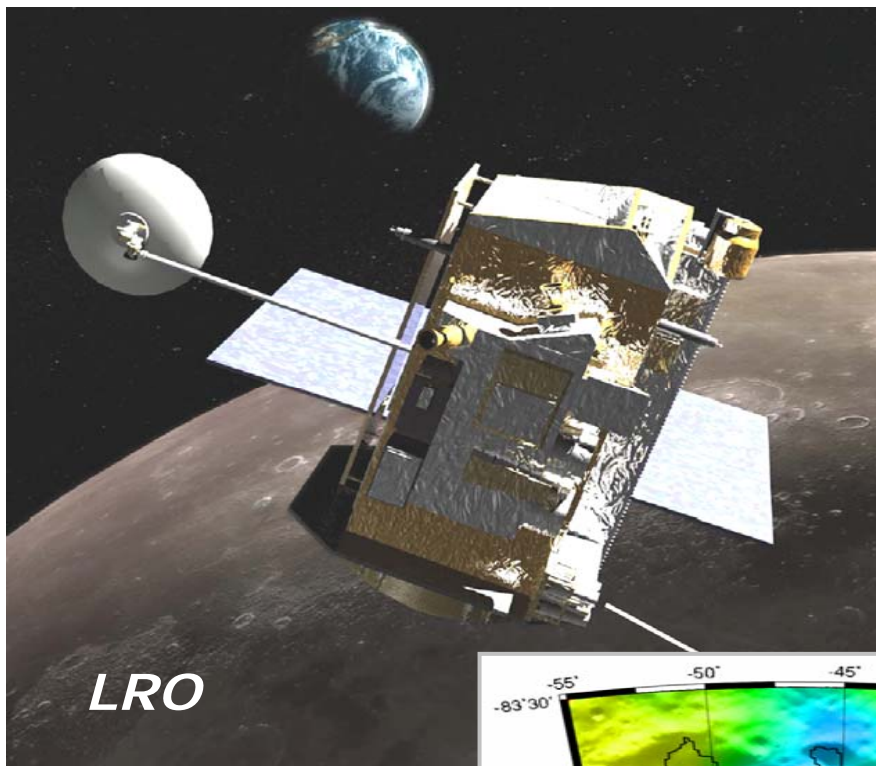
LEND Instrument Overview



LEND Instrument Overview

Principal scheme of neutron registration by collimated detector



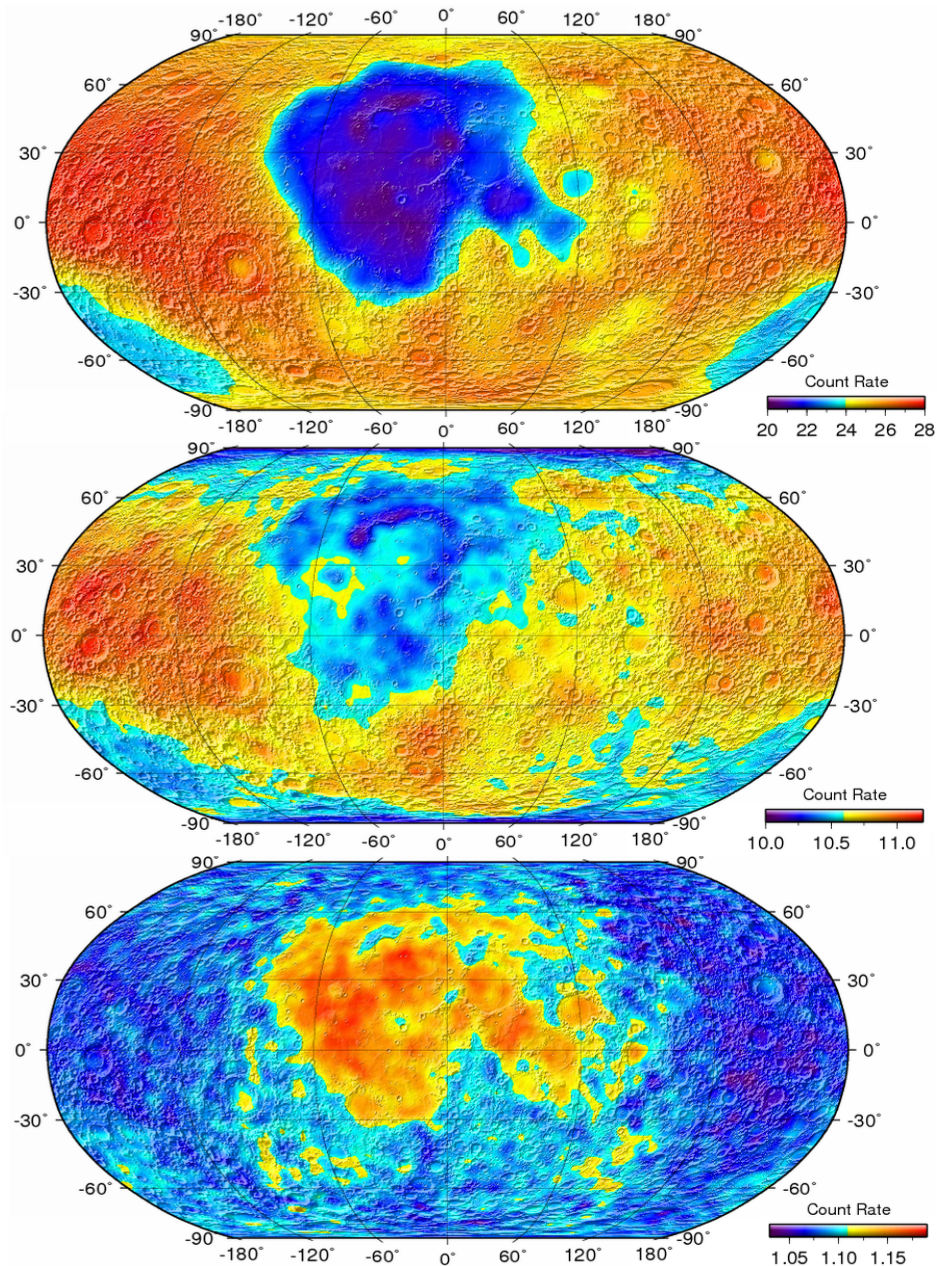


Cabeus was suggested by LEND team from the instrument data analysis, as the best impact target for LCROSS

First results of LEND data analysis and PSR water concentration has been published at:

I. G. Mitrofanov, et al.; Science, 2010, Volume 330, Issue 6003, pp. 483

Global lunar neutrons map



Thermal neutrons

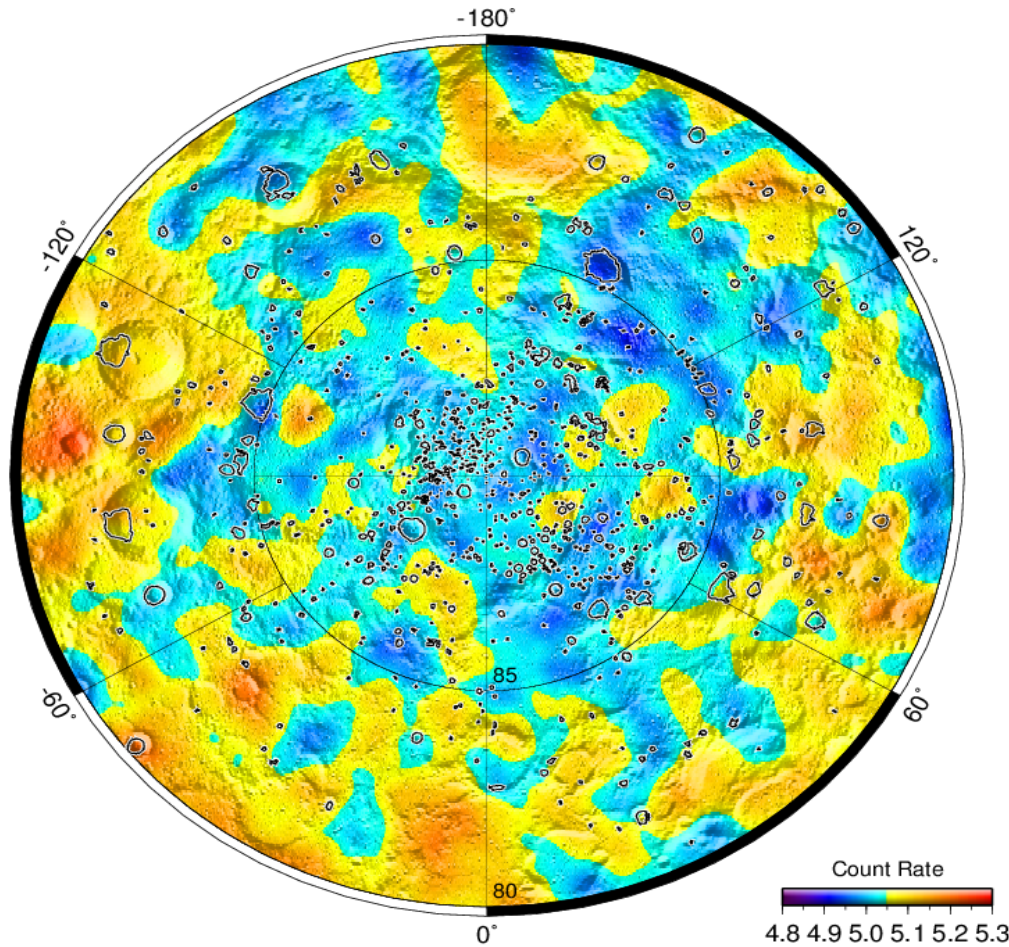
Epithermal neutrons

Fast neutrons

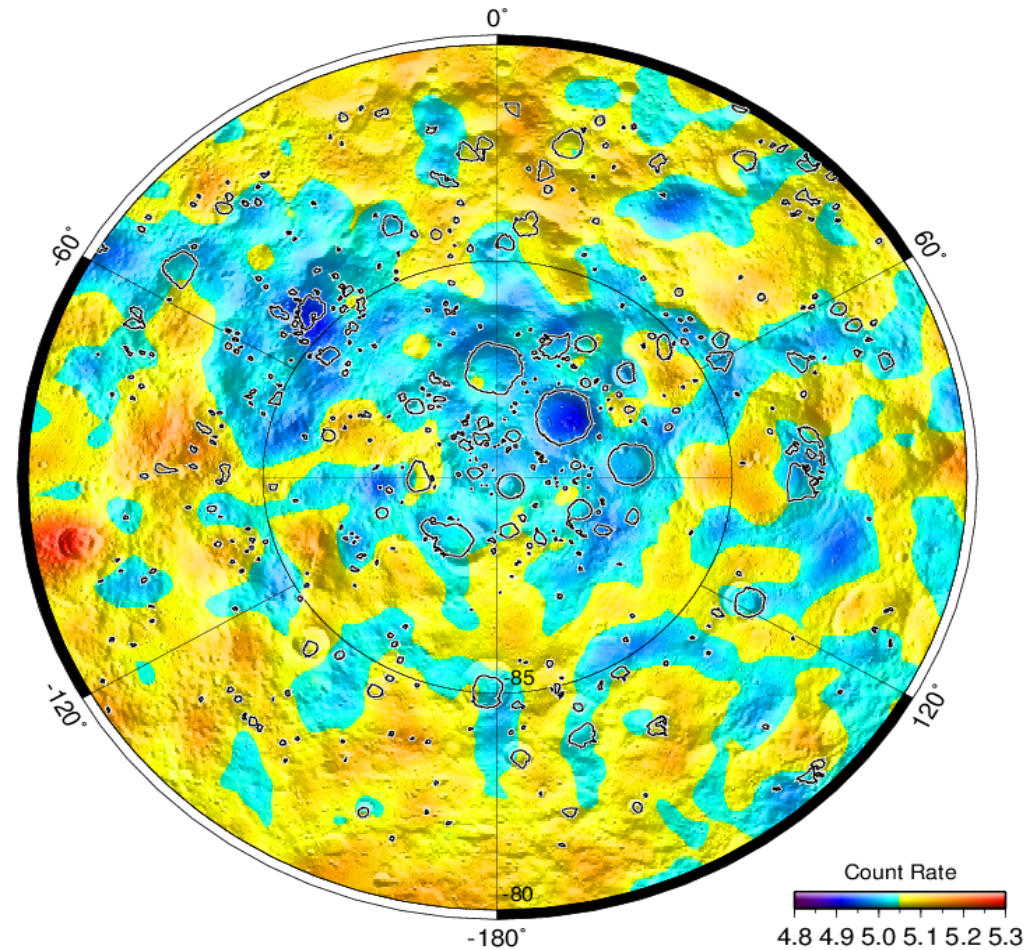
Lunar relief is shown according to LOLA altimetry

LEND maps of epithermal neutrons at North and South poles above 80° latitude

North



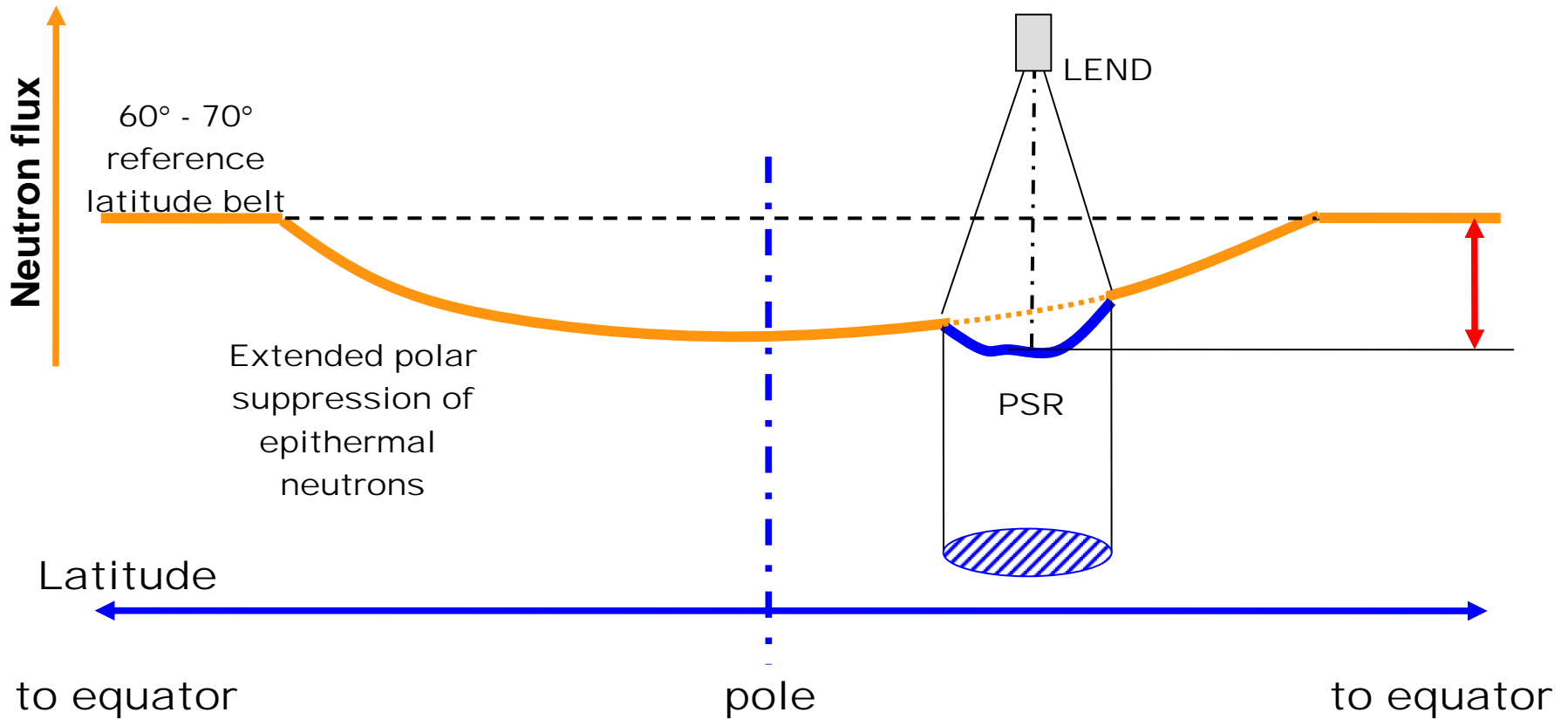
South

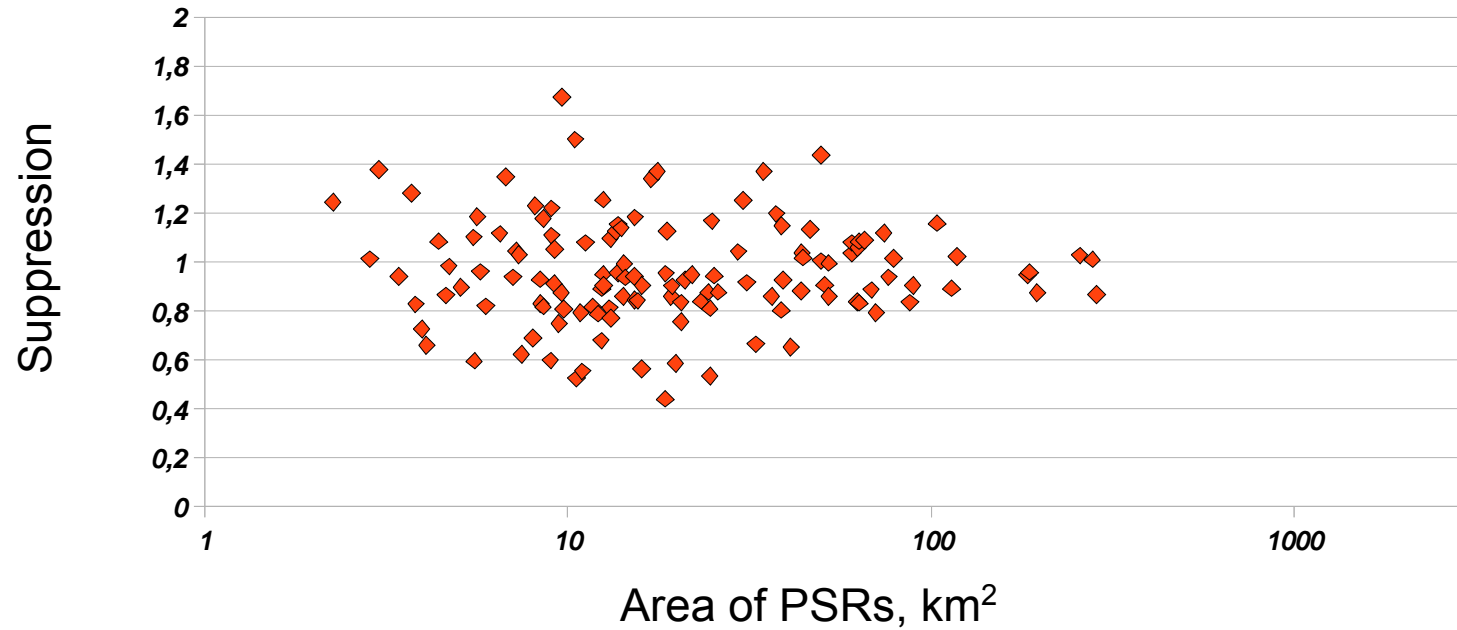


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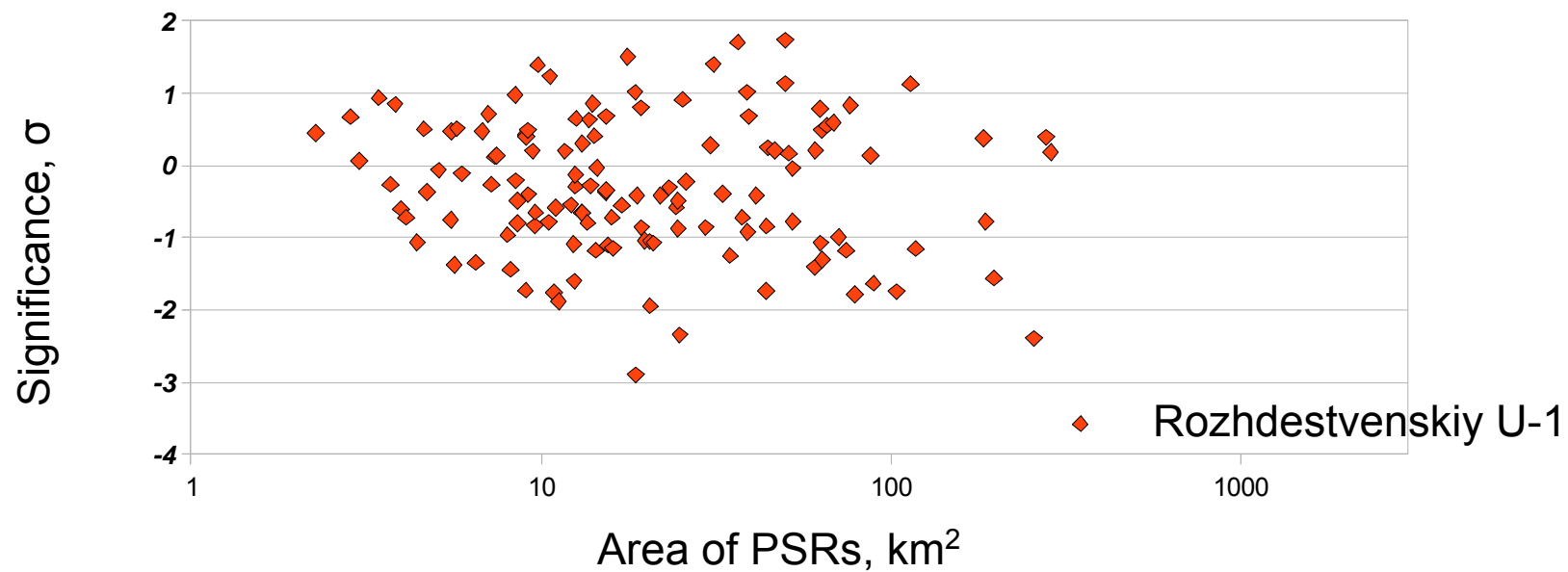
Testing PSRs:

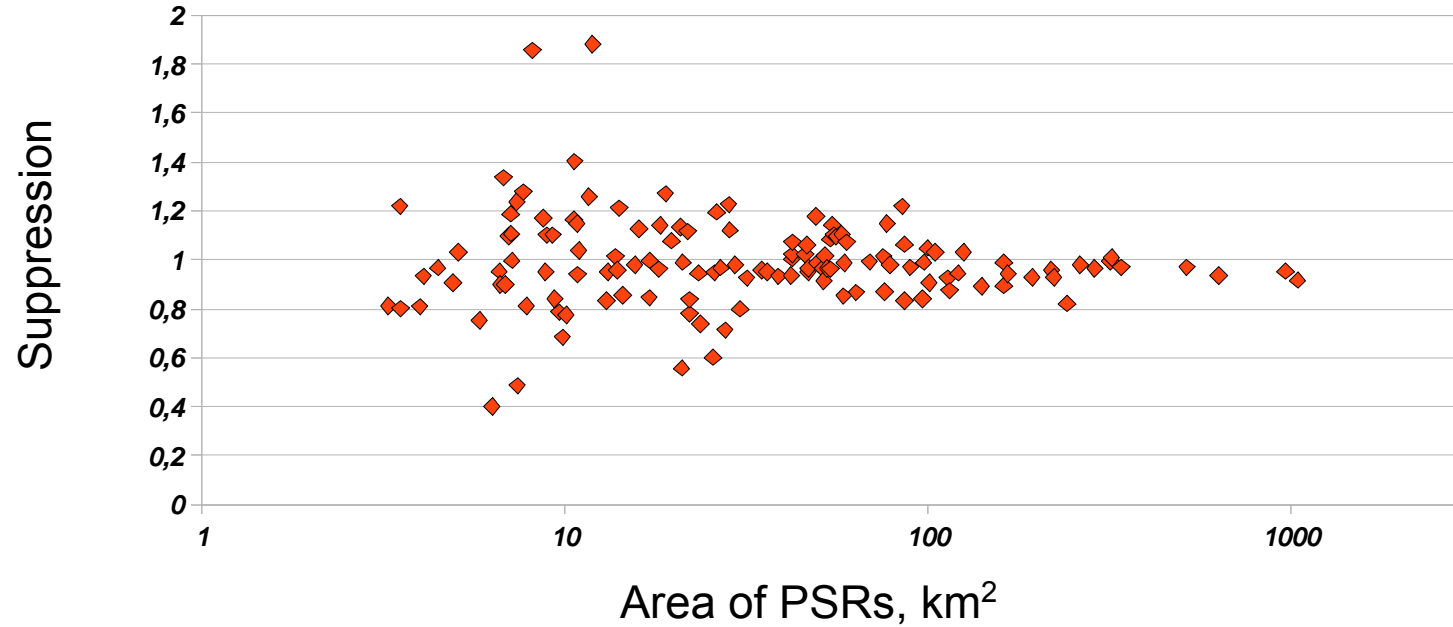
- above $\pm 80^\circ$ latitude
- with area $> 3.5 \text{ km}^2$
- total observation time $> 5 \text{ s}$



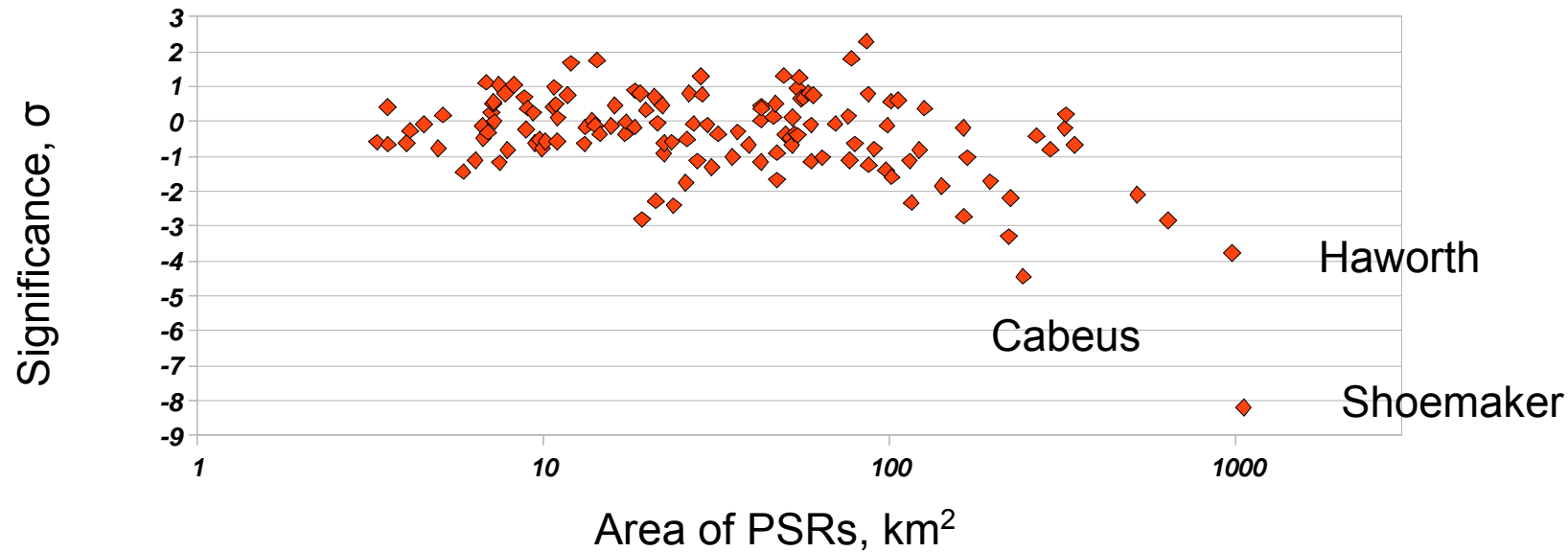


PSR analysis on North pole





PSR analysis on South pole



CONCLUSIONS:

- Analysis of LEND data points out that observable effect of extended polar suppressions of emission of lunar epithermal neutrons is not produced by integrated contributions of large *Permanently Shadowed Regions* (PSRs) with deep local suppressions.
- LEND data shows that *Permanently Shadowed Regions* with areas $> 3.5 \text{ km}^2$ have no appreciable enhancement of Hydrogen in regolith in comparison with illuminated areas at the same latitudes. Many PSRs are shown to have practically the same content of Hydrogen, as the surrounding illuminated areas. The largest enhancement of Hydrogen $\Delta \sim 0.5 \text{ wt}\%$ of water equivalent is detected for PSR in Cabeus.
- Several local *Neutron Suppression Regions* (NSRs) were resolved by LEND at illuminated polar area of the Moon. These regions are probably interesting as landing sites.
- LEND data based suggestions for landing sites will be presented today by A. Varenikov.