

SELMA: a mission to study lunar environment and surface interaction

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SELMA (Surface, Environment, and Lunar Magnetic Anomalies) is a mission to study how the Moon environment and surface interact. SELMA addresses four overarching science questions:

- What is the origin of water on the Moon?
- How do the “volatile cycles” on the Moon work?
- How do the lunar mini-magnetospheres work?
- What is the influence of dust on the lunar environment and surface?

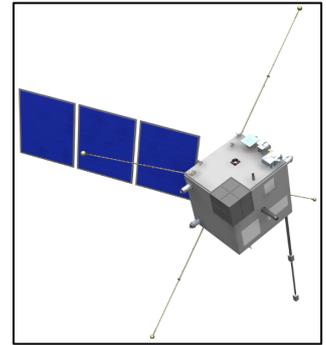
SELMA uses a unique combination of remote sensing via UV, IR, and energetic neutral atoms and local measurements of plasma, exospheric gasses, and dust. It will also conduct an impact experiment to investigate volatile content in the soil of the permanently shadowed area of the Shekleton crater. SELMA carries an impact probe to sound the Reiner-Gamma mini-magnetosphere and its interaction with the lunar regolith from the SELMA orbit down to the surface. The SELMA science objectives and respective measurements are summed up below.

SELMA science objectives	SELMA measurements
Establish the role of the solar wind and exosphere in the formation of the water bearing materials	IR and UV spectroscopy, solar wind monitoring, proton flux at the surface via scattered hydrogen, exospheric gasses composition and density
Investigate the process of the solar wind surface interaction	Measurements of scattered H ⁰ , H ⁺ , H ⁻ ; secondary ions
Determine the water content in the regolith of the permanently shadowed region and its isotope composition	Mass spectroscopy measurements of the plume created by an impactor.
Establish variability, sources and sinks of the lunar exosphere Investigate how the lunar exosphere content is related to impact events	Exosphere gasses densities and composition with simultaneous monitoring of the solar wind, meteor impact, particle releases processes from the surface
Investigate a mini-magnetosphere interaction with the solar wind Establish structure and topology of the magnetic field at the surface	Ions and electrons, waves and field with a time resolution <0.5 sec corresponding to the electron gyro-radius from 10s down to the surface
Investigate the long-term effects of mini-magnetospheres on the local surface	IR and UV spectroscopy, plasma and fields, proton flux at the surface via backscattered scattered hydrogen
Investigate how the impact events affect the lunar dust environments	Dust and meteor impact monitoring
Investigate how the plasma effects result in lofting the lunar dust	Dust, plasma, field and wave measurements

SELMA is a flexible and short (15 months) mission including the following elements SELMA orbiter, SELMA Impact Probe for Magnetic Anomalies (SIP-MA), passive Impactor, and Relaying CubeSat (RCS). It launches on January 1, 2029 (flexible) by Souyz-Fregat launcher and perform direct transfer to the Moon. After 5 days it reaches it nominal quasi-frozen polar working orbit 30 km x 200 km with the pericenter over the South Pole. Approximately 9 months after the launch SELMA releases SIP-MA to sound the Reiner-Gamma magnetic anomaly with very high time resolution <0.5 s to investigate small-scale structure of the respective mini-magnetosphere. At the end of the mission the passive impactor impacts the permanently shadowed region of the Shekleton crater >10 sec before SELMA and SELMA orbiter flies through the resulted plume to perform high resolution mass spectroscopy of the released

volatiles. The data are downlinked to ground and RCS. RCS stays on orbit for 2 more days to downlink the complete data set.

SELMA uses a common 3-x stabilized nadir pointing platform of 627 kg dry-mass, carrying 106 kg payload, SIP-MA, passive impactor, and RCS with 20% margin. The total mass at launch 1302 kg. SIP-MA is 42 kg 3-x stabilized free-flyer carrying 7.6 kg payload. SIP-MA powered by batteries operates only for about 29 min before the impact. SIP-MA communicates with SELMA via one-way 1 Mbps link. RCS is a 6U CubeSat equipped with a S-band communication package and a simple camera to monitor the SELMA impact. The SELMA instruments are summed up below.



Remote sensing instruments	In-situ instruments
Infrared and visible spectrometer <i>Spectral range 400 – 3600 nm</i>	Lunar ion spectrometer <i>M/DM > 80</i>
Wide angle and transient phenomena camera <i>Visible, FoV 120 x 60°</i> <i>Meteoroid impact (>100 g)</i>	Lunar scattered proton and negative ion experiment: <i>Energy range: 10 eV – 10 keV</i>
Moon UV imaging spectrometer <i>Spectral range 115 - 315 nm</i>	Lunar electron spectrometer
ENA telescope <i>Energy range 10 eV – 3 keV</i> <i>Angular resolution < 10°</i>	Moon magnetometer
SELMA Impact Probe for Magnetic Anomaly sounding (SIP-MA)	Lunar exospheric mass spectrometer: <i>M/DM > 1000</i>
Waves and electric field instrument	Plasma wave instrument
Impact probe ions and electrons spectrometer <i>Time res. < 0.5 s/3D</i>	Lunar dust detector: $M > 10^{-15}$ kg
Impact probe magnetometer	Passive 10 kg copper spherical impactor
Context camera	

SELMA was proposed to ESA as a M5-class mission in October 2016.