

MeO improvements for Lunokhod 1 tracking

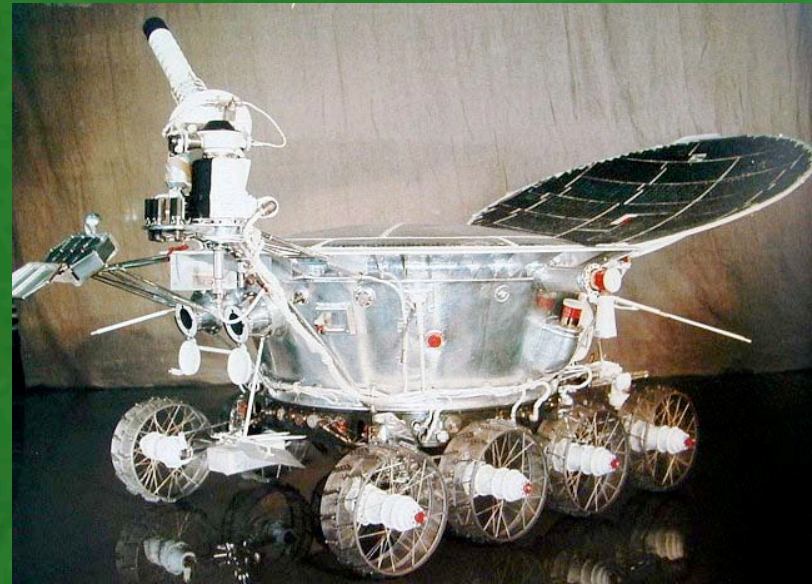
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- Introduction
- Lunokhod 1 mission and target constitution
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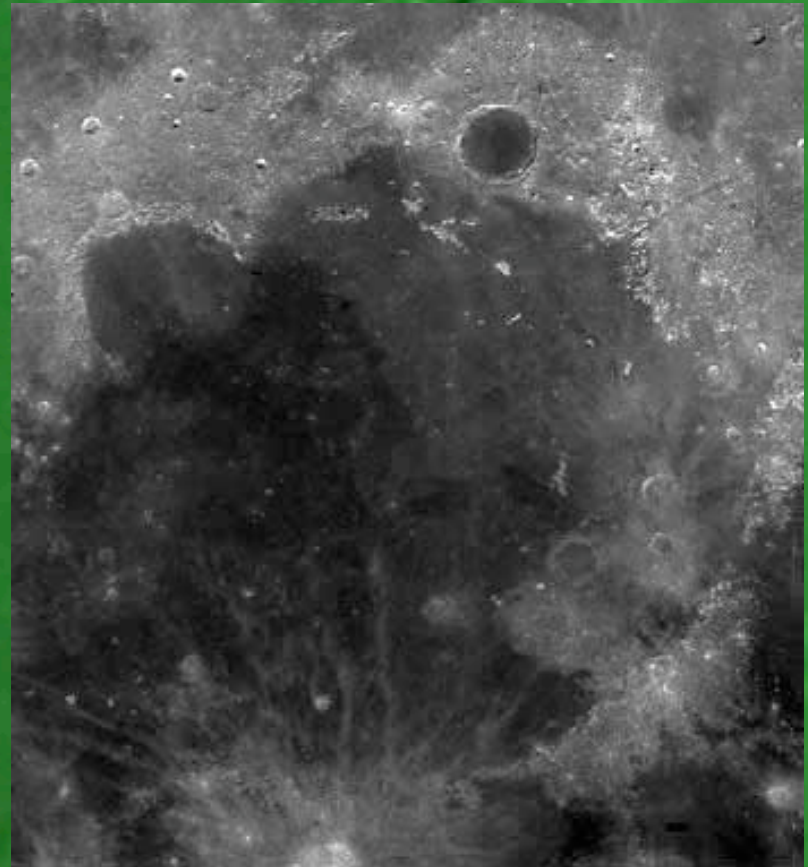
Introduction

- LUNA 17 mission
- LUNOKHOD 1 rover



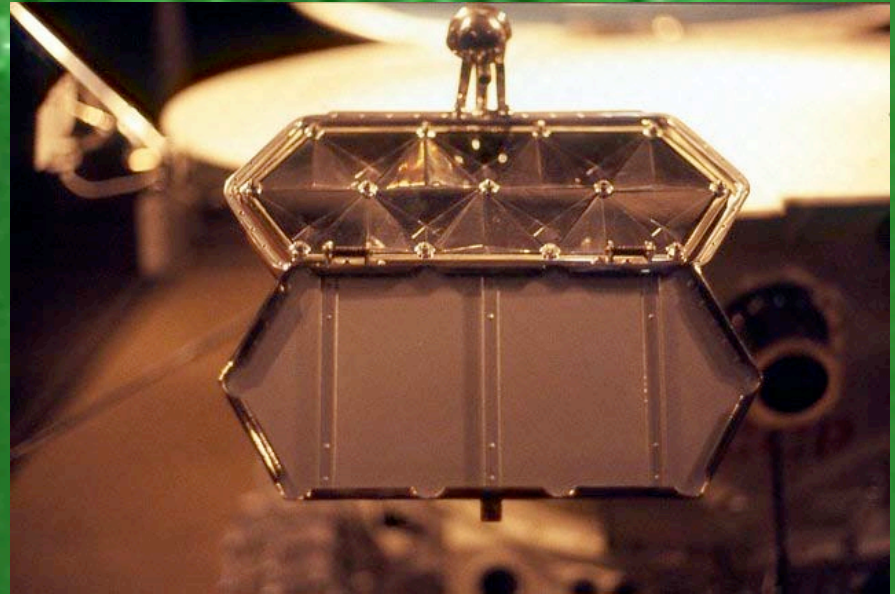
Lunokhod 1 mission

- Landing 1970/11/17,
50 km south of
Héraclides Cape (Mare
Imbrium)
- Lat : 38.17°
Long : -35.00°
- Active 7 lunar days
- End of activity:
1971/06/17



Lunokhod 1 target constitution

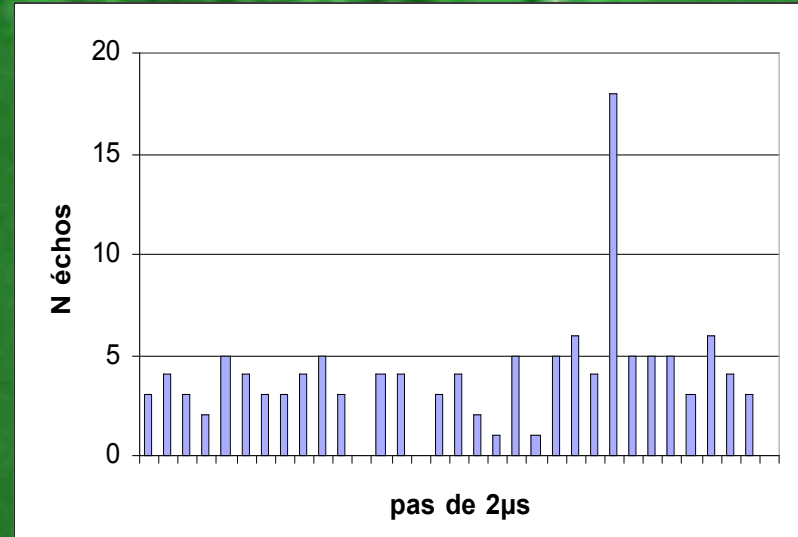
- 44 cm x 19 cm panel
- 14 corner cubes (side : 10.6 cm)
- Silver coating
- Optimized for ruby laser
- Good efficiency from 0° to 25° incidence angle
- Bad behaviour with temperature increase



i	Night	90°	85°	71°	42°	23°
\square	0.82	0.74	0.44	0.16	0.09	0.045

Previous campaigns

- Pic du Midi (France),
December 1970
Noise probability : 3×10^{-6}
- Lunokhod 1 moving
- Few echoes in USSR
- In 1975 and 1998, some attempts at MacDonald (USA)
and Grasse (France) without result



Tracking constraints

- Reflector coordinates
 - Bad positioning knowledge
 - Uncertainty estimates:
 - 1000 m for longitude, 600 m for latitude
 - 4 μ s for distance
 - 45 ns/hour range rate
- Good ranging period
 - From four days after the new Moon to two days after the first quarter
 - Between January and June

MeO improvements

- New SPAD
 - Very low temperature
 - Lower noise
 - Lower efficiency
 - Decreased accuracy
- New laser
 - Pulse width : 7 ns
 - Pulse rate : 10 Hz
 - Pulse energy : 650 mJ

Slightly less efficient, but 8 μ s ranging gate possible and 4 times more powerful laser

Scientific interests

- Physical librations:
 - north-south spread increase of 36%
 - east-west spread increase of 20%
- Tides:
 - displacement
- Accurate location on the Moon

Jim Williams source

2004 campaign

- March : 6 nights - 17 attempts
- April : 6 nights - 6 attempts
- May : 6 nights - 0 attempt

Sky quality		Very clear	Clear	Hazy	Cloudy
AXV echoes		$N > 50$	$50 > N > 10$	$N < 10$	0
Nights or attempts	March	0	8 attempts	9 attempts	3 nights
	April	0	0	6 attempts	3 nights
	May	0	0	0	6 nights

Conclusions

- We began the campaign too late, in March (originally scheduled for January)
- We have only installed the nanosecond laser in April
- **We have not yet had good weather**
- We will try again next year with new improvements