French LLR Station and New Project

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19th International Workshop on Laser Ranging, Annapolis, MD, USA , October 27-31, 2014

History

French LLR station

- Telescope diameter : 1.54 m
- Altitude : 1270 m
- Laser : Nd-YAG frequency-doubled 532nm
  70ps pulse width
  220mJ in green
  10Hz pulse rate
- Detection : APD in Single photon mode

History

- 2003:
  - Lunar Laser Ranging (LLR station)
  - Satellite Laser Ranging (SLR station)
  - French Transportable Laser Ranging System (FTLRS)
- 2008:
  - MéO station (Moon, satellites and other experiments)
  - French Transportable Laser Ranging System
- 2013:
  - MéO station
  - New station being studied

New considerations

- Tracking difficult for targets from LEO to the Moon
- Impossible to develop an automatic station
- Other projects :
  - Adaptive optic
  - Time transfer by laser link
  - Telecommunications by laser link

SLR Global Performance Report Card

July 1, 2013 through June 30, 2014

Location	LEO pass	LAGEOS pass	High pass	Total passes	LEO NP Total	LAGEOS NP Total	High NP Total	Total NP	Min. of Data	Cal. RMS	LAG RMS
Baseline	1000	400	100	1500							
Zim	6874	1375	4549	12798	111578	19974	18612	150164	116511	5.2	11.0
Wettzell	5404	851	4140	10395	54789	6073	14957	75819	50269	6.8	13.4
Graz	4310	697	3171	8178	78445	5651	18606	102702	58017	2.0	5.0
Herst	3294	740	2189	6223	41520	7134	6647	55301	41768	7.2	15.3
Matera	2802	1080	1167	5049	33966	9379	5208	48553	48106	1.2	3.9
Potsdam	2679	298	269	3246	47611	3147	2102	52860	31236	7.3	12.9
Grasse	895	559	877	2331	34406	6624	3343	44373	32069	9.0	16.2

LLR Data Report Card

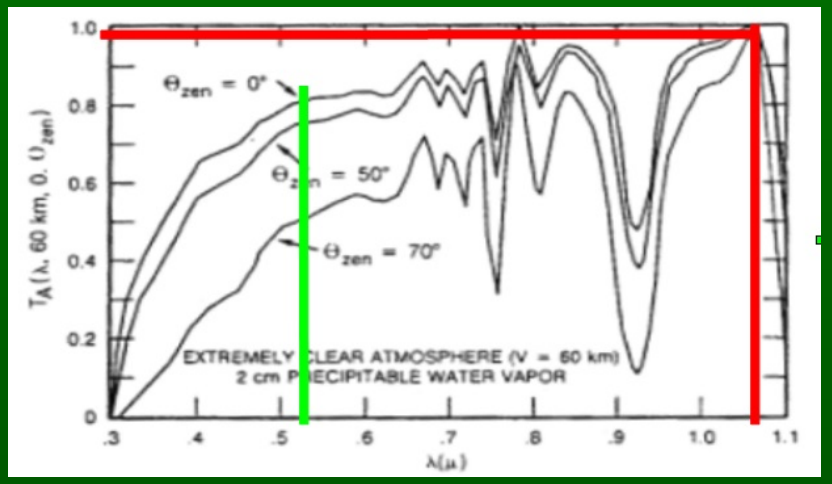
Site Information		Data Information			
Column L1	L2	L3	L4	L5	L6
Location	Station Number	num nights tracking last 12 mon	num npt last 12 mon	num npts last 3 mon	ave npt rms last 3 mon
Grasse_MEO	7845	94	362	50	37.1
McDonald	7080	7	15		
Matera_MLRO	7941	6	10		

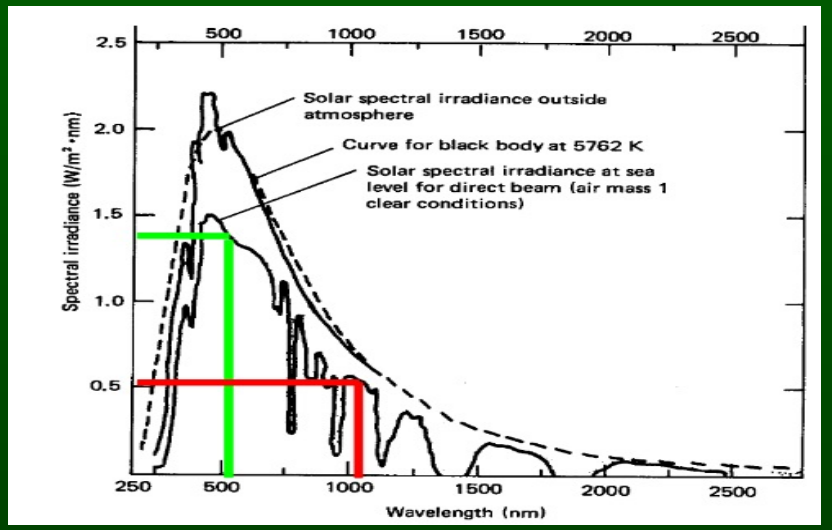
New priorities

- First priority on the Moon tracking
- Geodetic satellites tracking (Lageos, Etalon)
- Time transfer on Jason 2 (T2L2)
- LRO tracking
- Short campaigns on HEO satellites
- Other experiments…

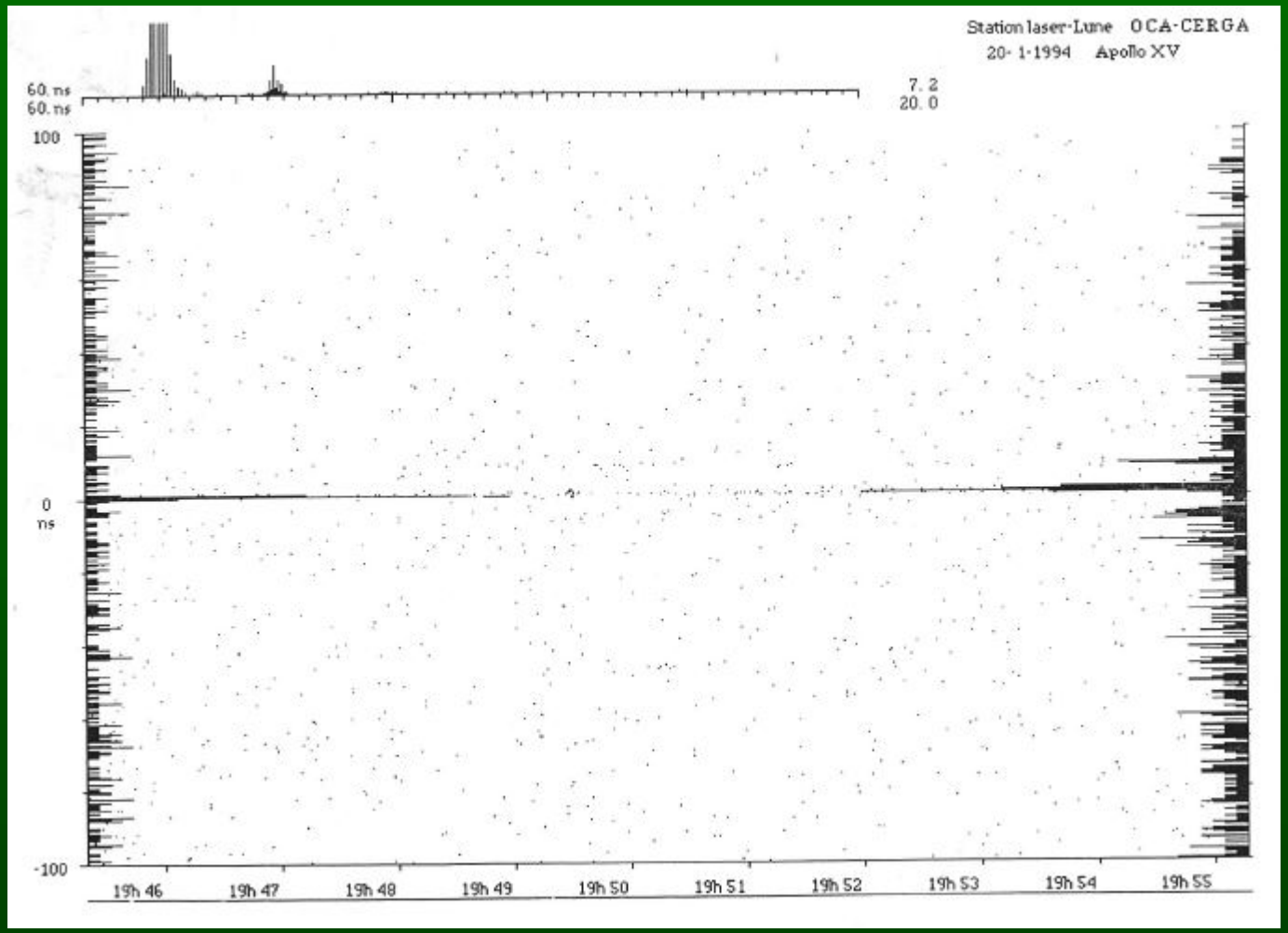
Infrared detection

- Tests of different APD
- Positive points:
  - More powerful laser
  - Better transparency of the sky
  - Less noise
- Negative points:
  - Lower accuracy
  - Dark noise more important

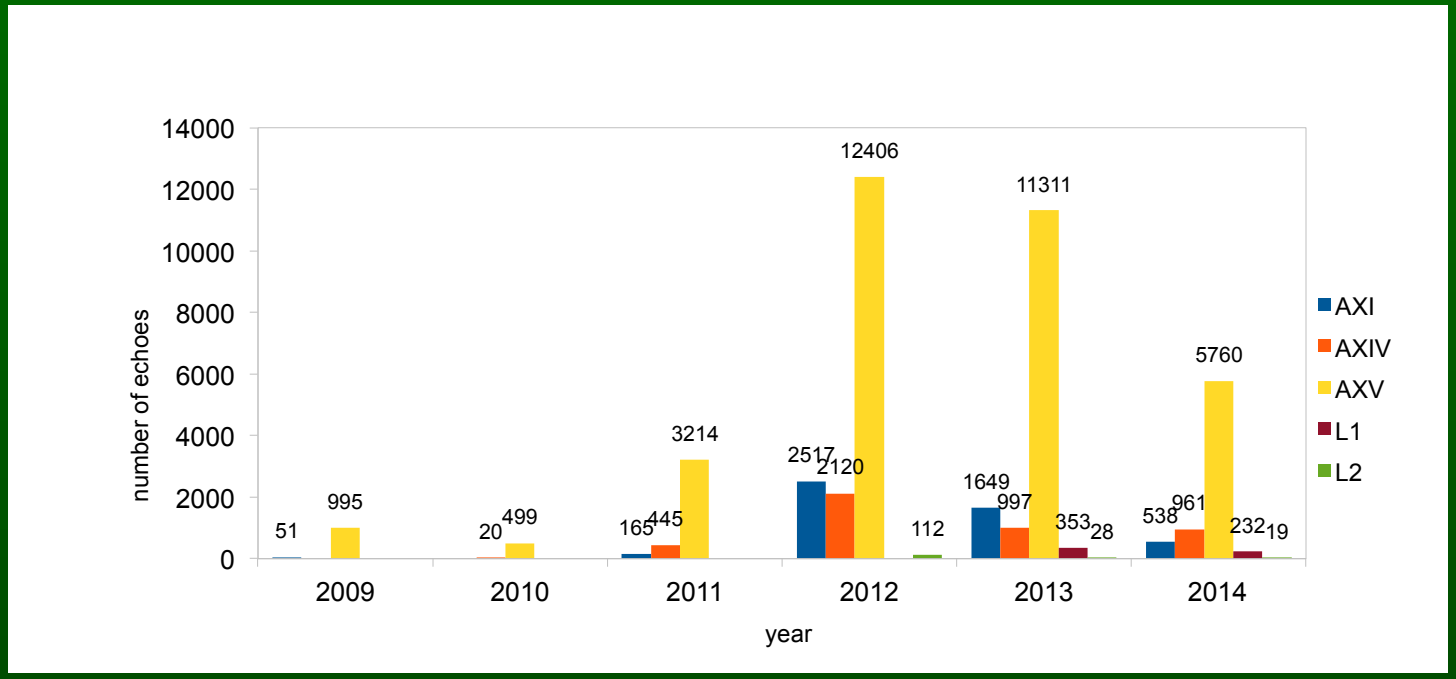




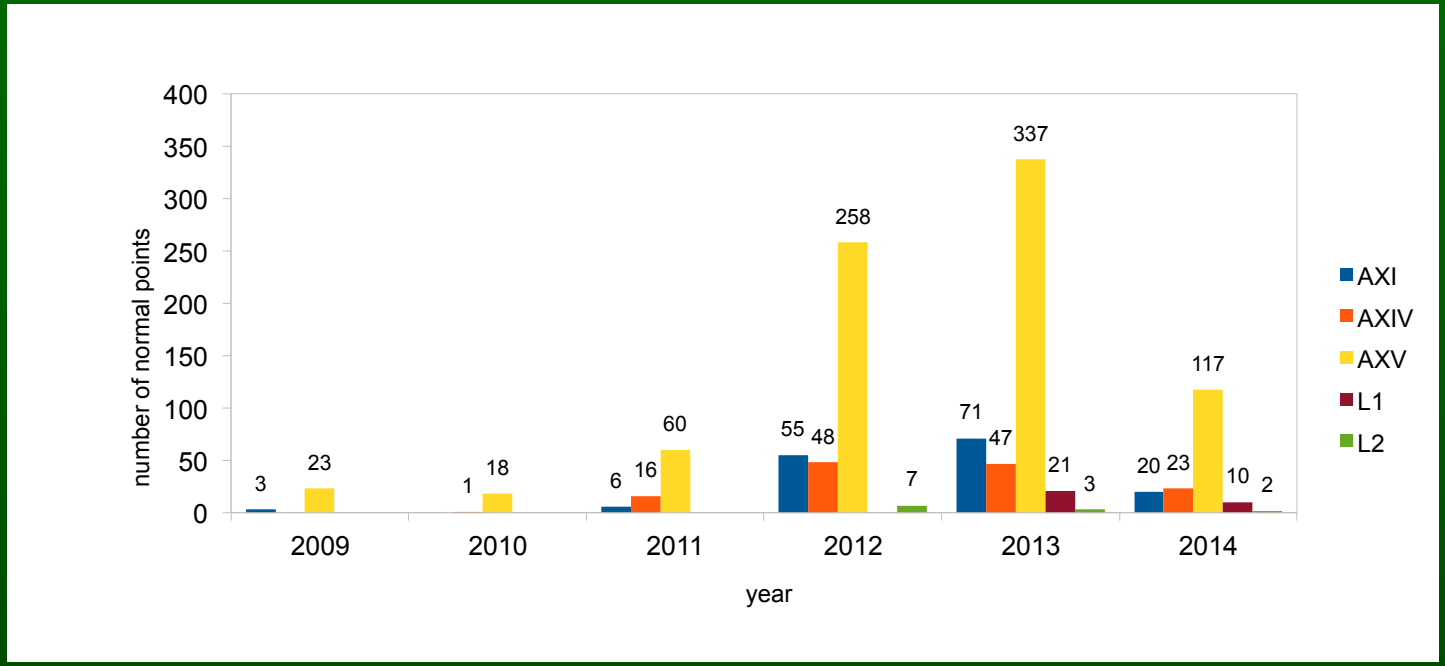
Infrared detection



Statistics: Number of echoes



Statistics: Number of normal points



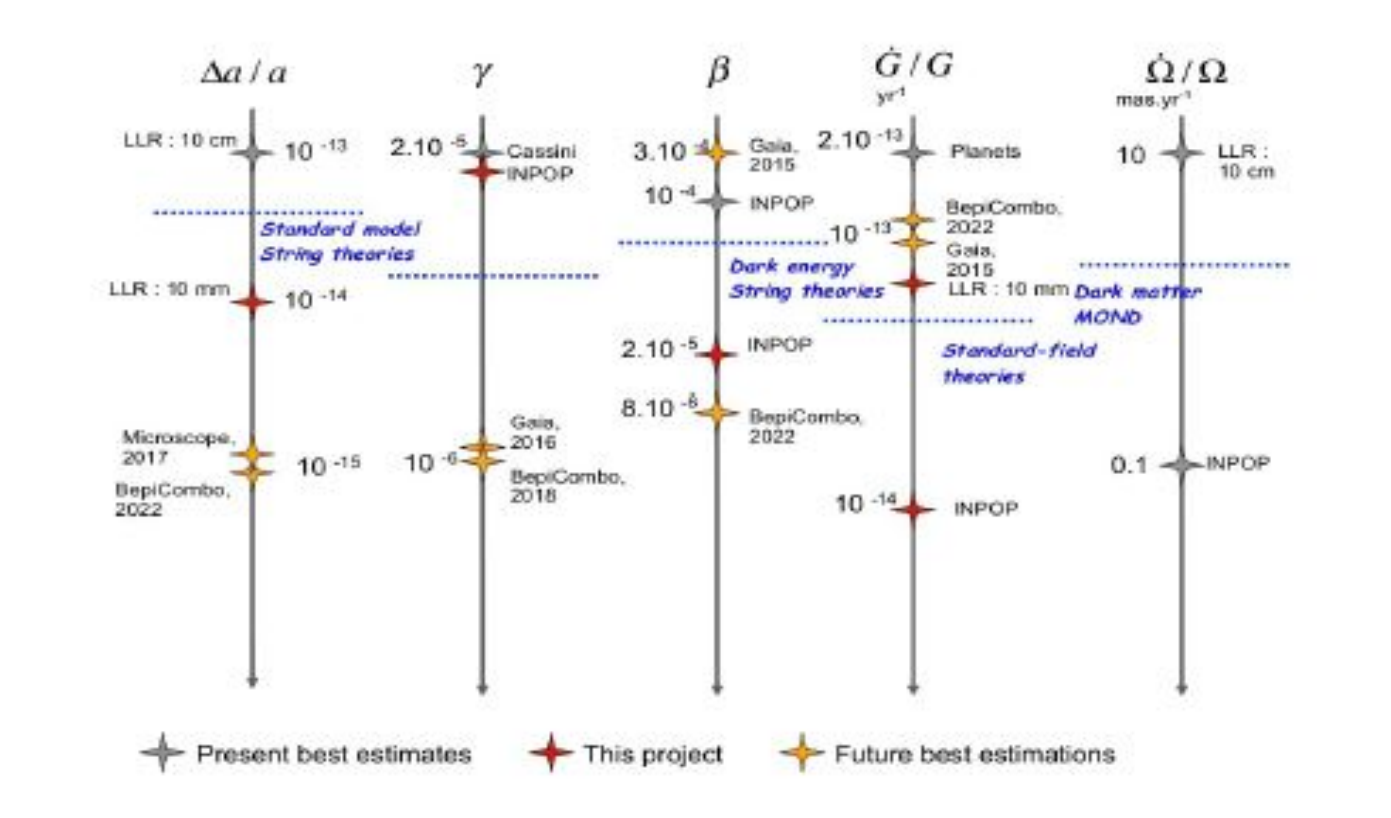
New Project

- S.HE.L.L.I.:
  - Southern Hemisphere Lunar Laser Instrument
  - NTT telescope, La Silla, Chile (ESO)
  - Telescope diameter : 3.60 m
  - Altitude : 2375 m

New Project, abstract

SHELLI is a Lunar Laser instrument to be installed at the Nasmith of NTT. With such instrumentation important, the scientific communities of fundamental physics and solar system formation will highly benefit of the only LLR station in the Southern Hemisphere. The quality of the NTT 3.6 meter telescope will also greatly complement the LLR 3.6 meter APOLLO instrument in the Northern Hemisphere (USA). Finally, about 50% of the observations will be operated during the day and during small sessions of about one or two hours.

Present and expected results of gravity tests realized in the solar system



Improvements in Moon dynamical and internal parameter estimations obtained by including simulated Southern Hemisphere observations (with a simulated accuracy of 2 cm) and 3.6m Southern Hemisphere observations (with a simulated accuracy of 0.5 cm)

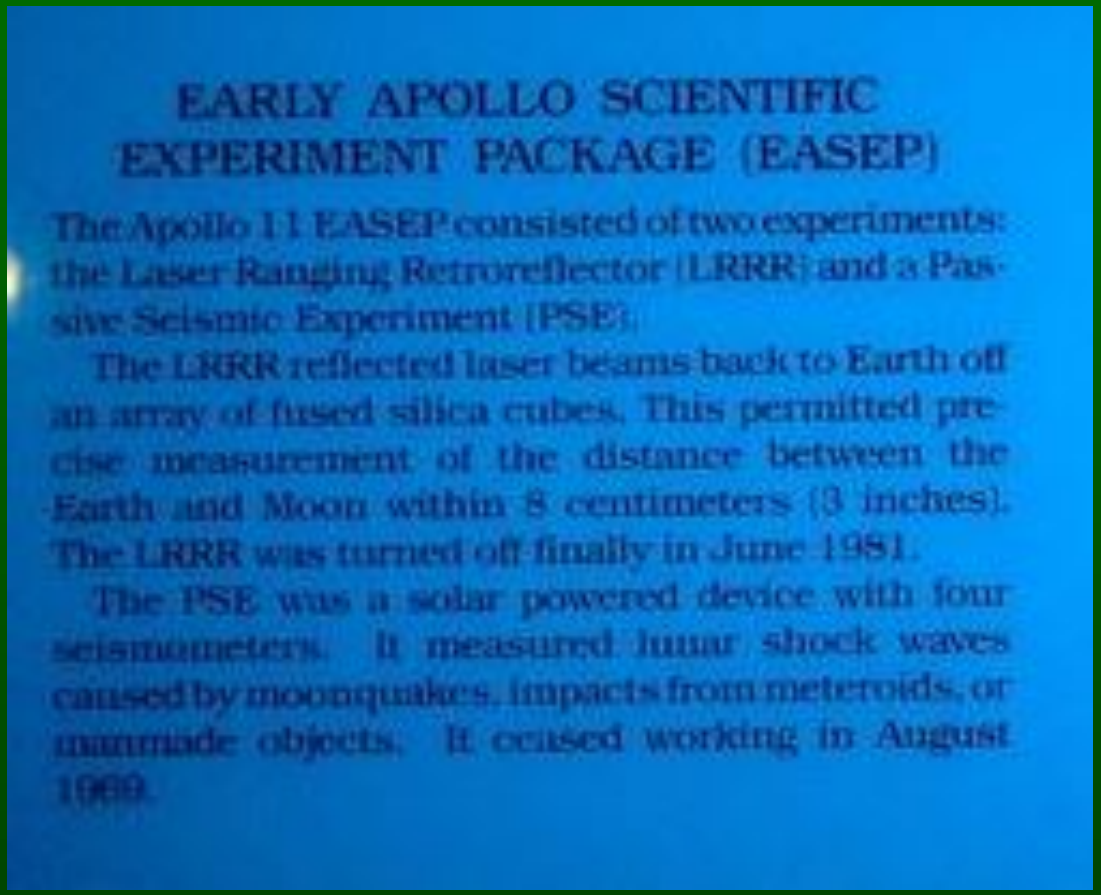
Parameter	Southern station	3.6 m Southern station	What for ?
Geocentric position and velocity of the Moon	10 to 30%	25 to 40%	Dynamics, Tests of GR
Gravity Field coefficients	2 to 30%	15 to 30%	Dynamics, Libration
C/MR^2 ratio	15%	25%	Inner core size and density
Love Numbers	10%	25%	Elastic properties of the Moon
τ parameters	5%	25%	Q of dissipation
Mass of the Moon-Earth system	10%	30%	Dynamics, Tests of Gravity
Positions of the reflectors at the Moon surface	5%	20%	Dynamics, Libration, Tests of GR

New Project, conclusion

"the science case of SHELLI is quite remote from that of the ESO community, and SHELLI requires using the telescope during day time, which may be problematic for subsequent night observing"

- Thanks for all the people of this community who help us for the proposal of this experiment
- In the future, if we want to succeed we need to find a new telescope in an new observatory !
- Fortunately Hartebeesthoek will provide LLR data from the Southern Hemisphere

Curiosity


EARLY APOLLO SCIENTIFIC
EXPERIMENT PACKAGE (EASEP)
The Apollo 11 EASEP consisted of two experiments: the Laser Ranging Retroreflector (LRRR) and a Passive Seismic Experiment (PSE).
The LRRR reflected laser beams back to Earth off an array of fused silica cubes. This permitted precise measurement of the distance between the Earth and Moon within 8 centimeters (3 inches). The LRRR was turned off finally in June 1981.
The PSE was a solar powered device with four seismometers. It measured lunar shock waves caused by moonquakes, impacts from meteroids, or manmade objects. It ceased working in August 1969.

Thanks !!!