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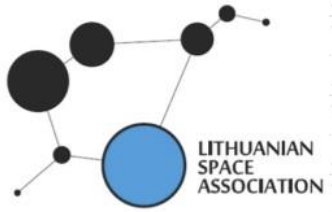

PIEZO-ACTIVE SUSPENSION SYSTEM FOR SPACE INTERFEROMETRY AND BROADBAND COMMUNICATIONS

Algis Karpavicius

2014

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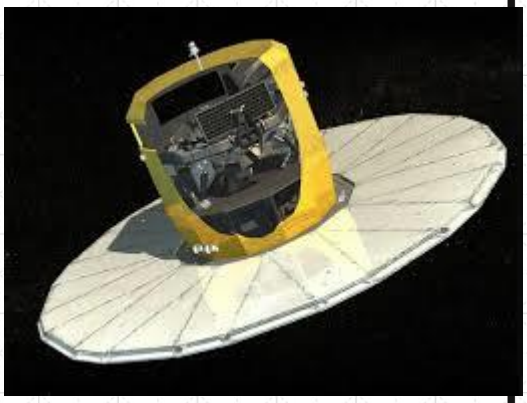
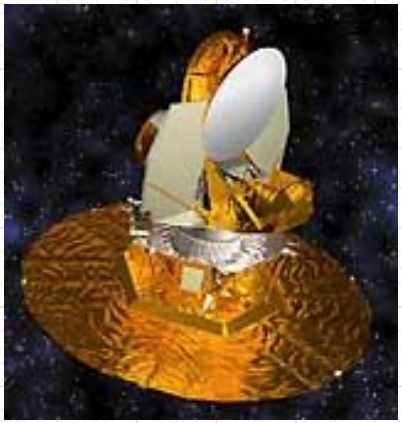
CONTENT

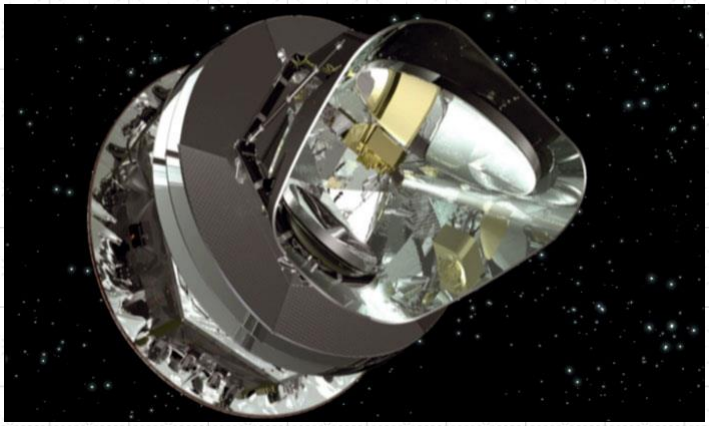
- Introduction (heritage)
- Targeted missions
- Mission goals and concept
- Target parameters
- Space segment
- Piezo-active suspension
- Laser-communication
- Orbits
- Time plan and threats

INTRODUCTION (HERITAGE)

- Wilkinson Microwave Anisotropy Probe
- ESA Planck mission
- Infrared Hershel mission
- Gaia space telescope







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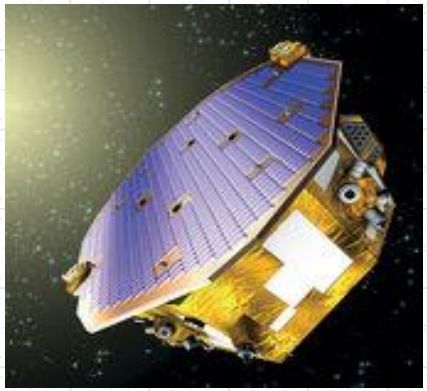
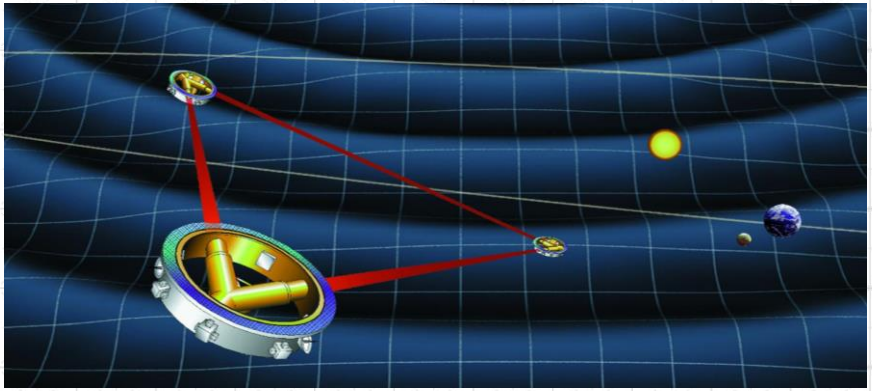
TARGET MISSIONS

- Future ESA Laser Interferometer Space Antenna (LISA) in 2034.
- Japanese DECI-Hertz Interferometer Gravitational wave Observatory (DECIGO) in 2027.





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MISSION GOALS

- Increase the accuracy of the measurement and communication pointing systems
- Compensate the vibrations of the satellite platform by means of piezo –active suspension to less than $<10^{-12}$ rad
- Establish Duplex 1.55 μm Laser link between the Spacecraft and Ground terminal
- Test the accuracy of Attitude control of the Spacecraft provided by Field–emission electric propulsion (FEEP) or Colloid thrusters

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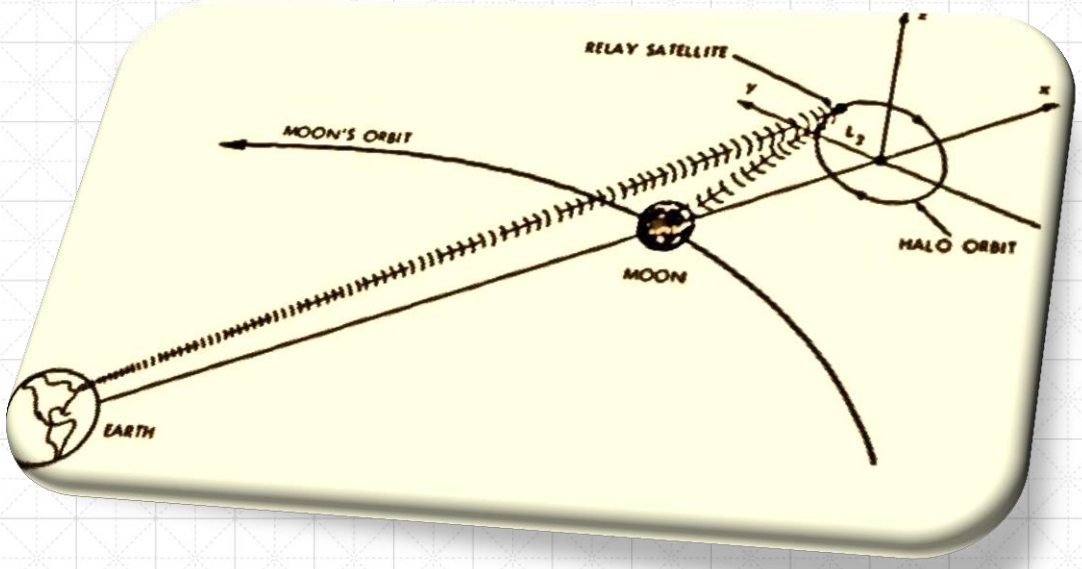
MISSION CONCEPT

- Size <50 kg
- Intermediate orbit~200 km LEO or GTO
- With additional propulsion module to Halo EML-2 / HEO



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MISSION CONCEPT

- S-band TT&C
- The pointing accuracy and optical communication through output will be measured by 1.55 μm Laser duplex system
- Joint operation of Piezo-active suspension system with Field-emission electric propulsion (FEEP)/Colloid thrusters

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TARGET PARAMETERS

- Gaia mission achieved is in the range of 24 μ arcsec corresponding 1.2 x 10^{-10} rad.

	Distance from Earth, 10^9 m	Wavelength, 10^{-6} m	Resolution angle θ, rad 10^{-15}	Actuator resolution*, 10^{-15} m	Delta V from LEO, km/s**
Earth – Sun L2	1.5	1	0.33	0.033	3.4/7.4
Earth – Sun L2	1.5	1 000	330	33	3.4/7.4
Earth – Moon L2	0.45	1	1.1	0.11	3.0/7.0
Earth – Moon L2	0.45	1 000	1 100	110	3.0/7.0

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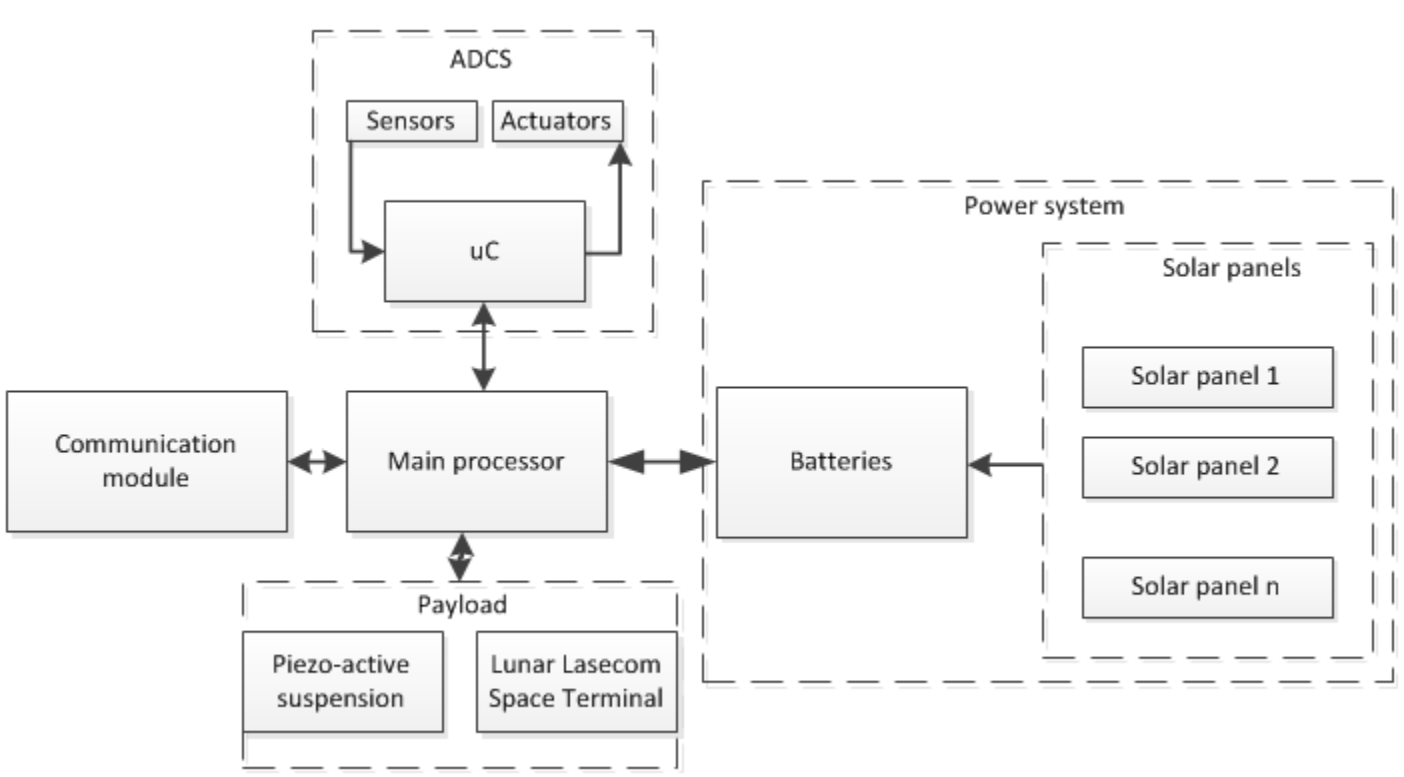
SPACE SEGMENT DESCRIPTION



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PAYLOAD

- Piezo-active suspension
- Lunar Laser-communication Space terminal

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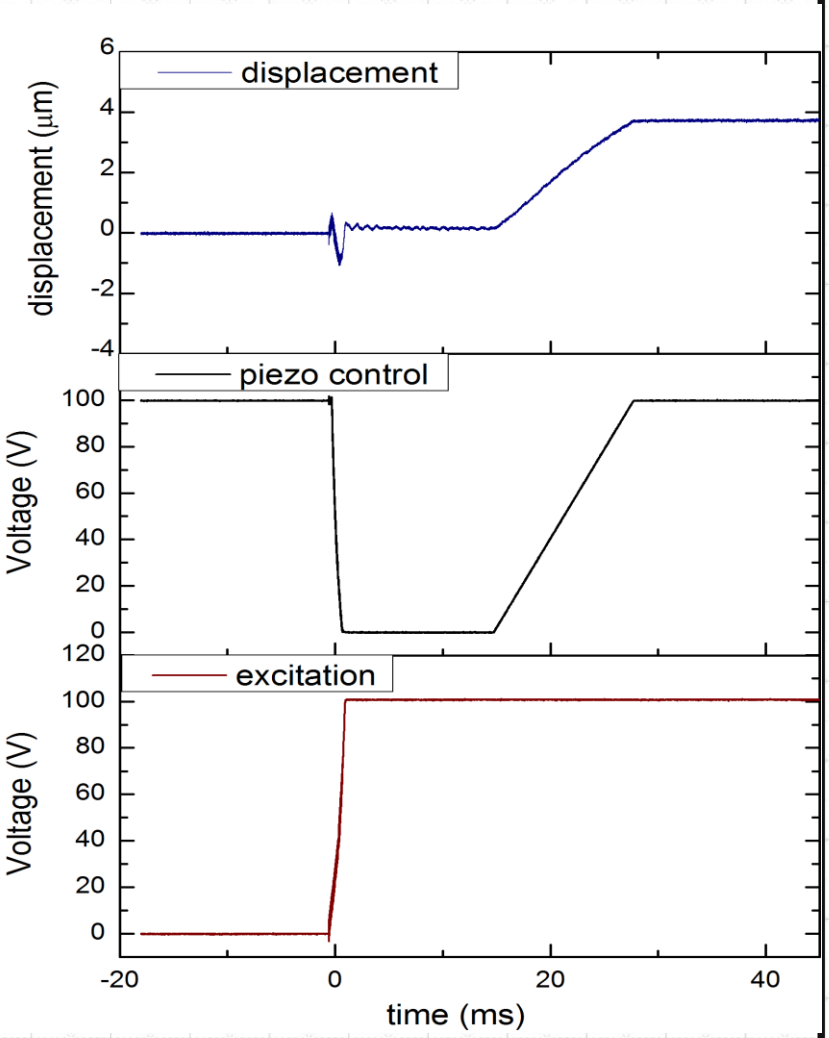
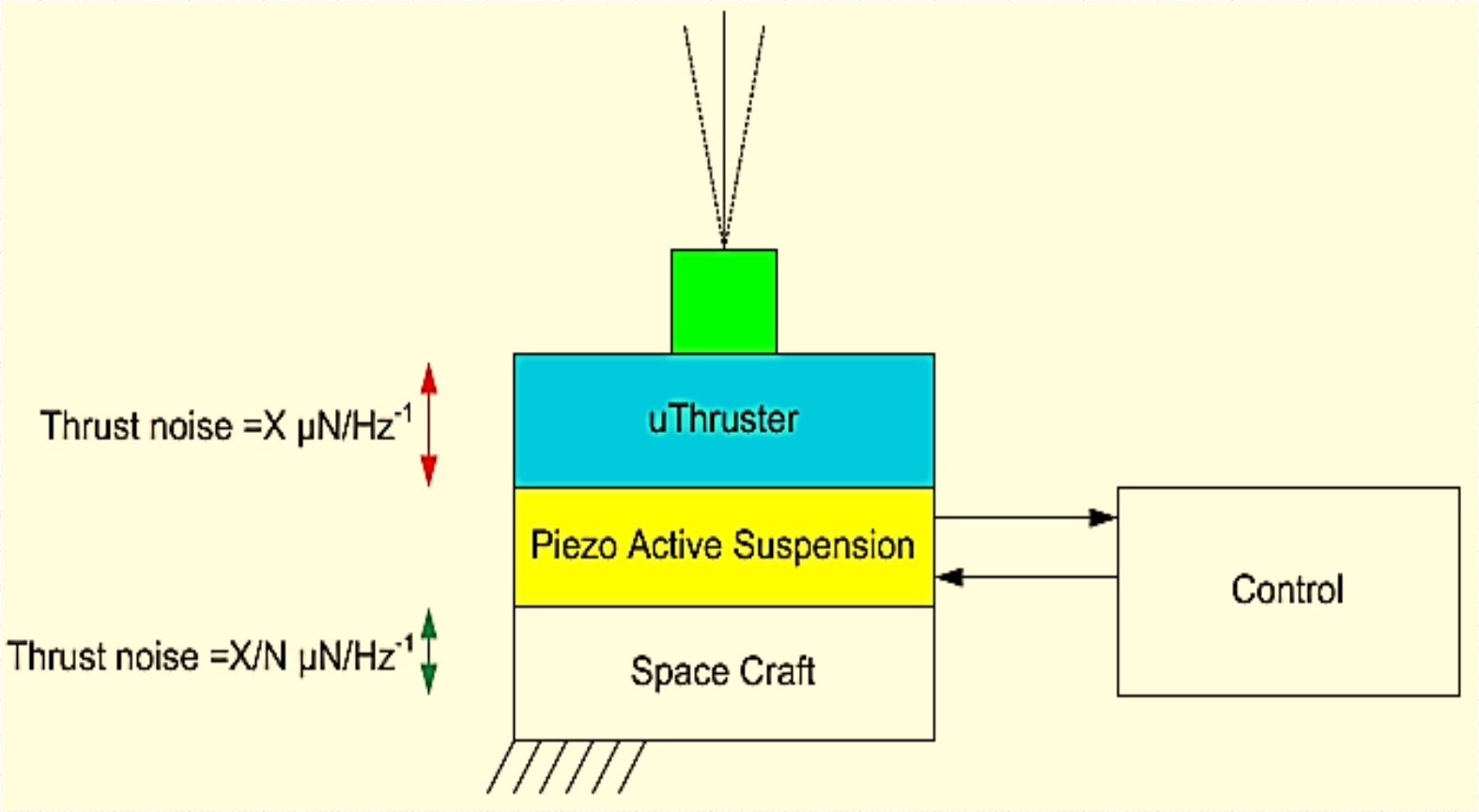
PIEZO-ACTIVE SUSPENSION

- Passive (semi-passive) energy dissipation experiments
- Implement a soft thruster response control
- Test the suspension system



PIEZO-ACTIVE SUSPENSION



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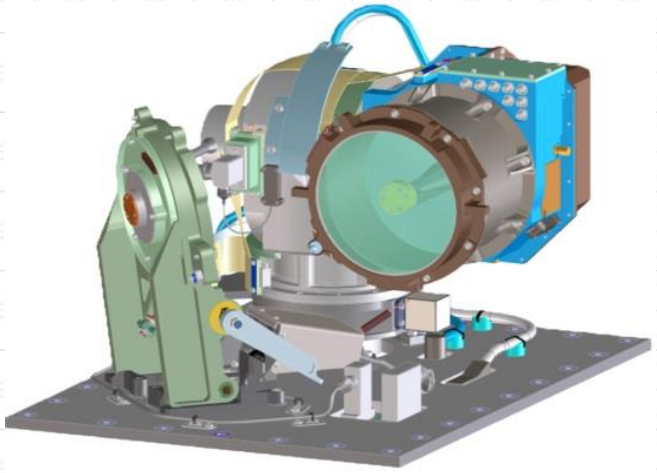
LASER COMMUNICATION

- Lunar Laser Communication Demonstration (LLCD) 2013
- Lasercom space terminal
- Downlink: 40–622 Mbit/s
- Interferometry



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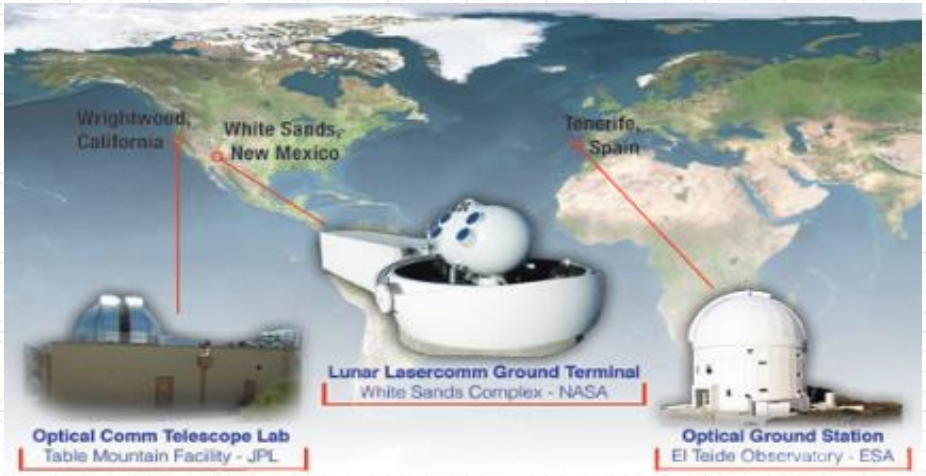
GROUND TERMINAL

- For the satellites laser communication ground terminal it is planned to use the existing infrastructure and collaborate with the related three ground telescopes based in New Mexico, California or Spain.



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OPERATION

For the spacecraft telemetry and payload downlink and uplink communication the S-Band Transmitter of 4W will be combined with a 10W patch antenna . The expected data rate is 100-200bps. After establishing the laser communication additionally broadband laser data communication channel could be used.

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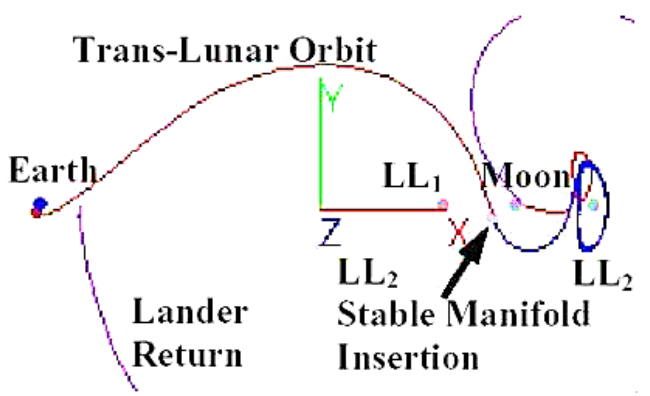
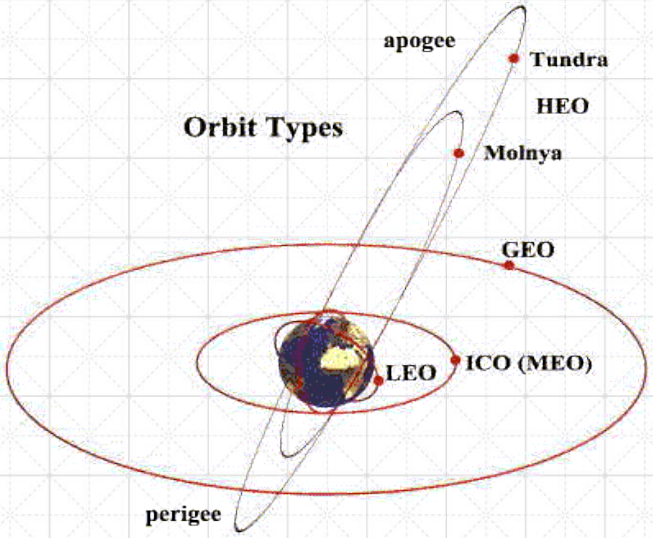
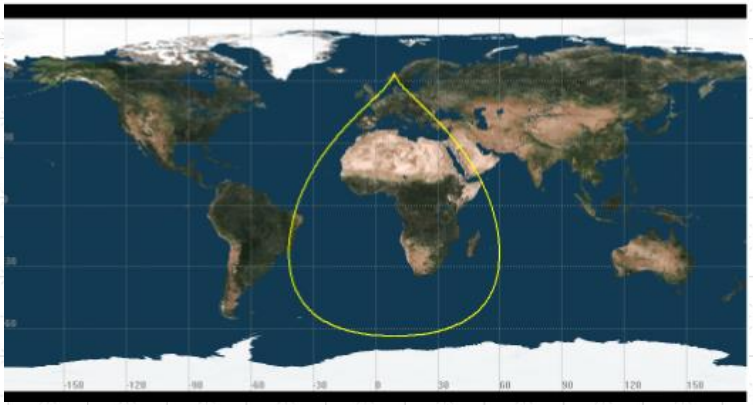
ORBITS

- **EML-2:**Δv=1700m/s, 365days.
- $\Delta v1$= 3122m/s, $\Delta v2$= 570m/s, Δt=11 days.
- **HEO:**$\Delta V = \tilde{}3.64$km/s







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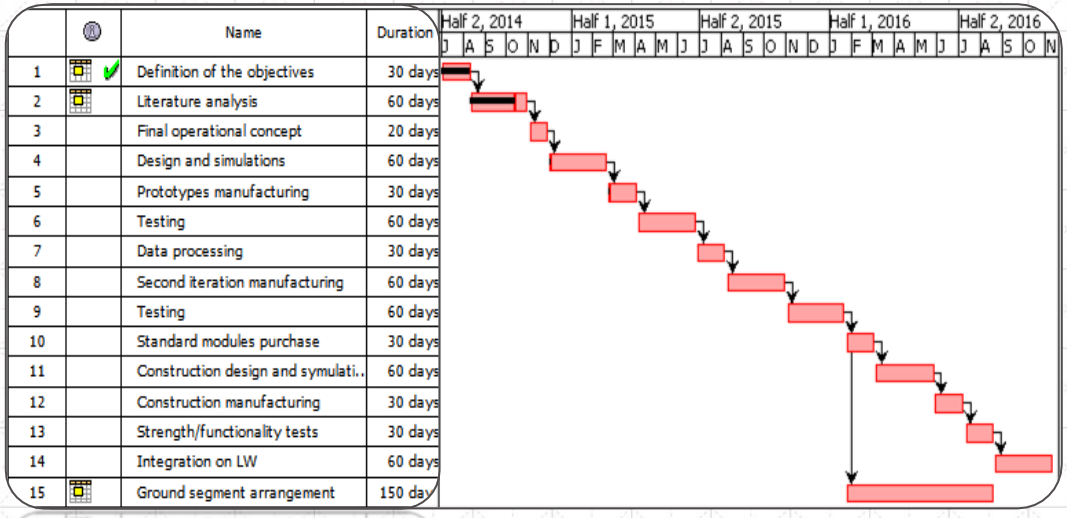
IMPLEMENTATION PLAN

KTU & LSA



	Name	Duration
1	Definition of the objectives	30 days
2	Literature analysis	60 days
3	Final operational concept	20 days
4	Design and simulations	60 days
5	Prototypes manufacturing	30 days
6	Testing	60 days
7	Data processing	30 days
8	Second iteration manufacturing	60 days
9	Testing	60 days
10	Standard modules purchase	30 days
11	Construction design and symulati..	60 days
12	Construction manufacturing	30 days
13	Strength/functionality tests	30 days
14	Integration on LW	60 days
15	Ground segment arrangement	150 day

Future collaboration with ESA

NASA ARC spacecraft platforms in the middle of 2016

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TOP RISKS

- Development of piezoelectric closed control loop positioning system for 1- and 3-axis piezoelectric actuators at subnanometer level;
- Testing of positioning system in 1g gravitational environment will not allow to reproduce the microgravity conditions in full scale;
- Optical communication module is planned to be provided by subcontractor;
- The success of the mission depends on launch or ridesharing availability;
- Insertion into the Moon-Earth Lagrange point raising special requirements for launcher.