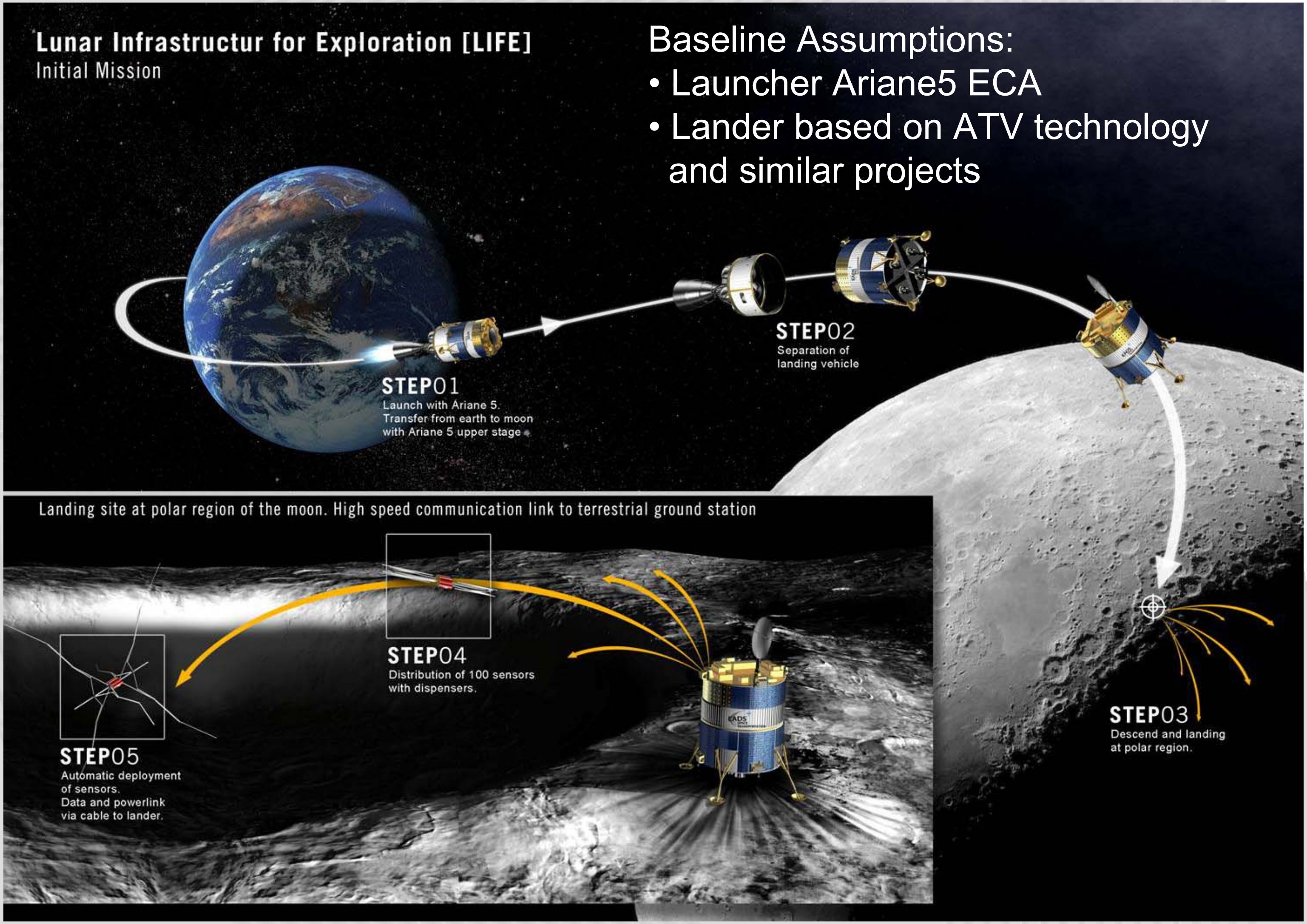
ASTRIUM

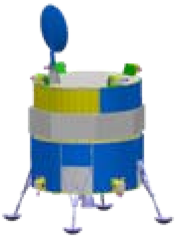
Lunar Lander Concept for LIFE

Hansjürgen Günther TOB 11

Bremen, 23/24.11.2006

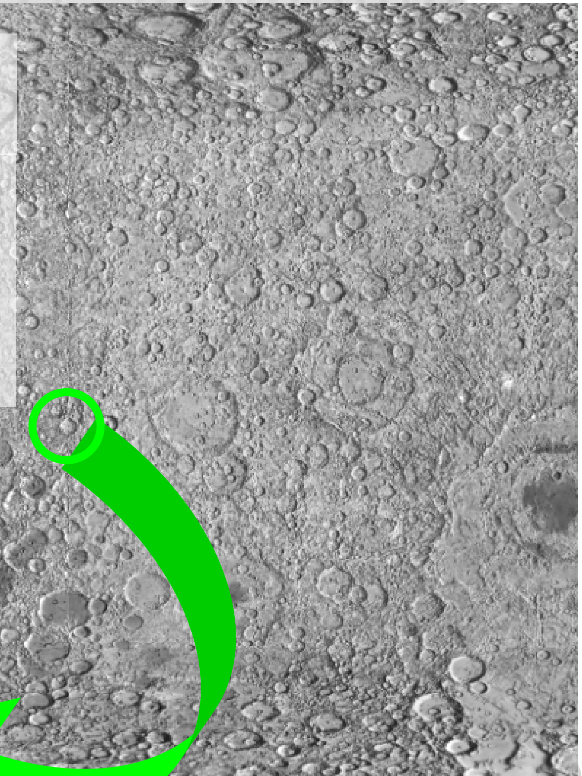
System Approach

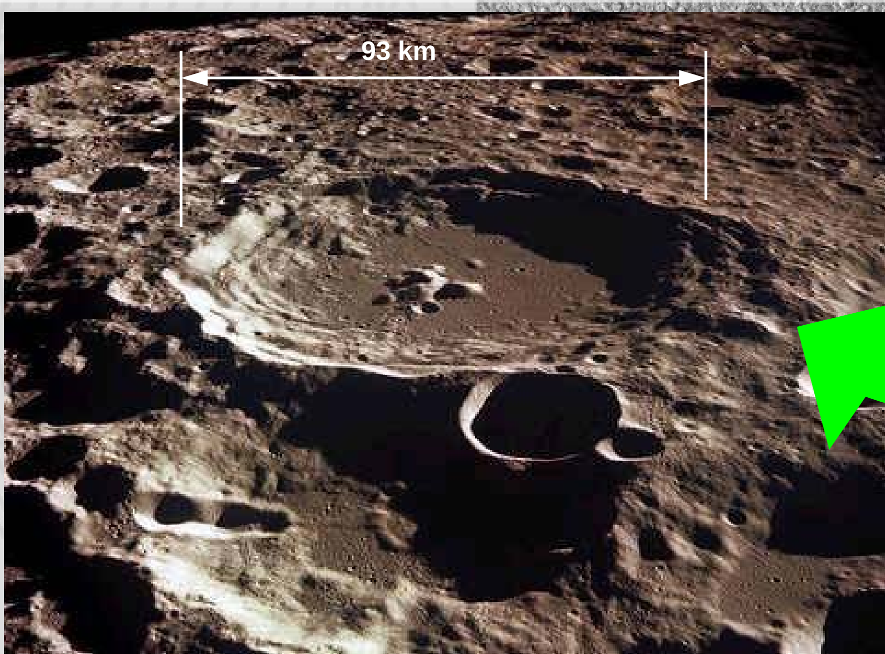




System Aspects: Lunar Far Side

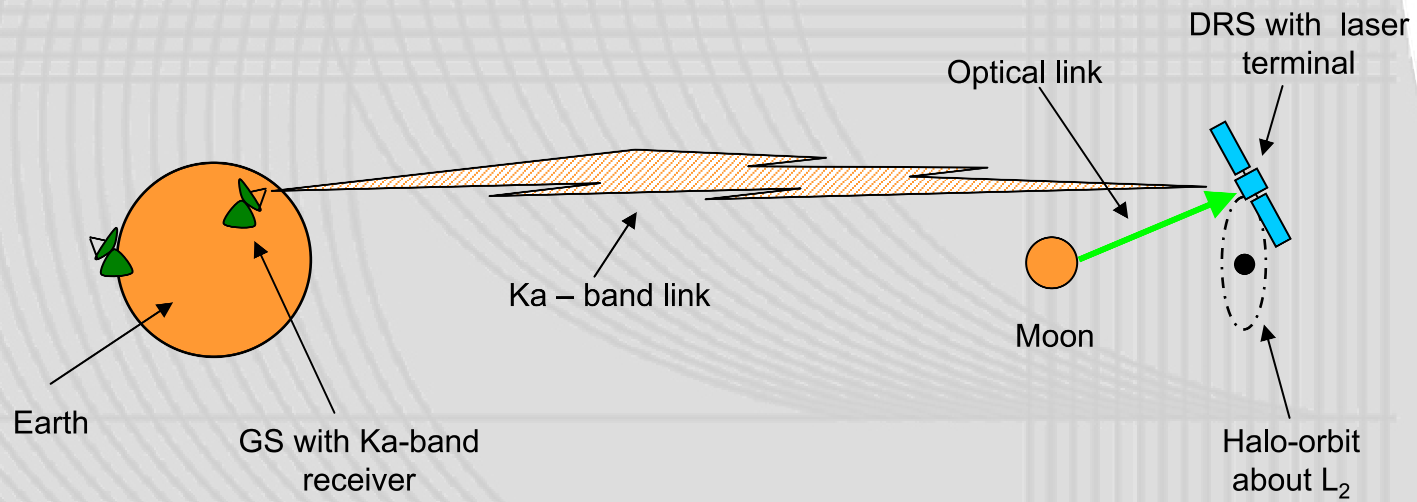
- Primary landing site on lunar far side:
  - Deadalus crater at 179° E, 5° S
- Best shielding from terrestrial RF spillage
- Best shielding from solar RF bursts at lunar night



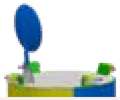


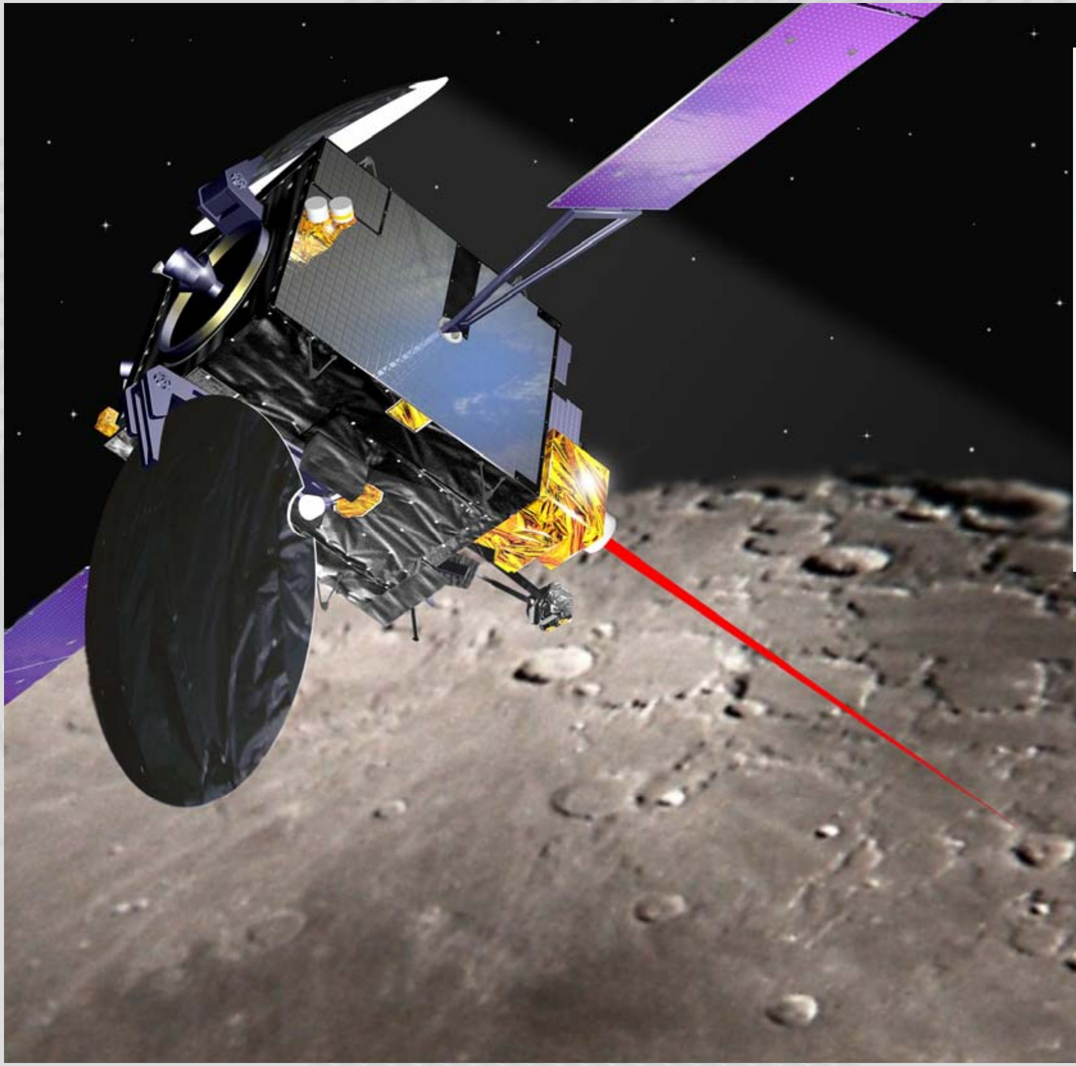
System Aspects: Payload Data Transfer (1)

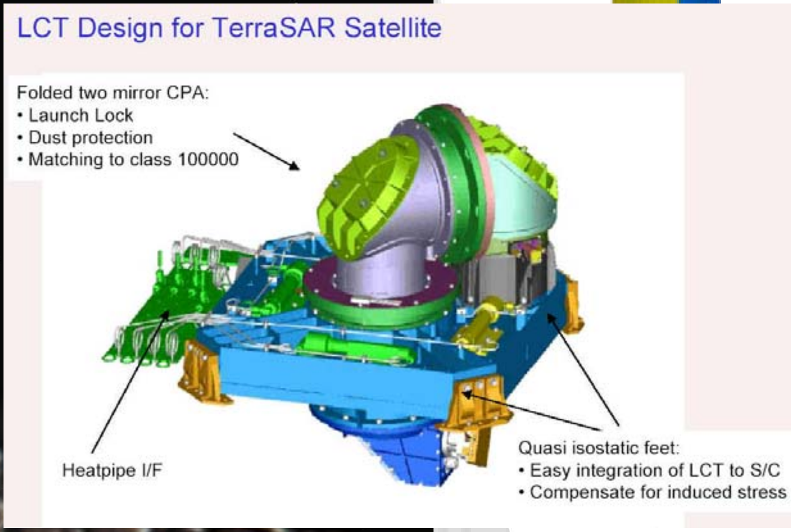
- High data rate to be transferred from lunar far side to earth via data relay satellite
- Propose to use one data relay satellite DRS in halo orbit around L2 of Earth/Moon System
- EMI considerations suggest optical link to DRS, Ka-band link to earth GS (baud rate ≥ 100 Mbit/s)



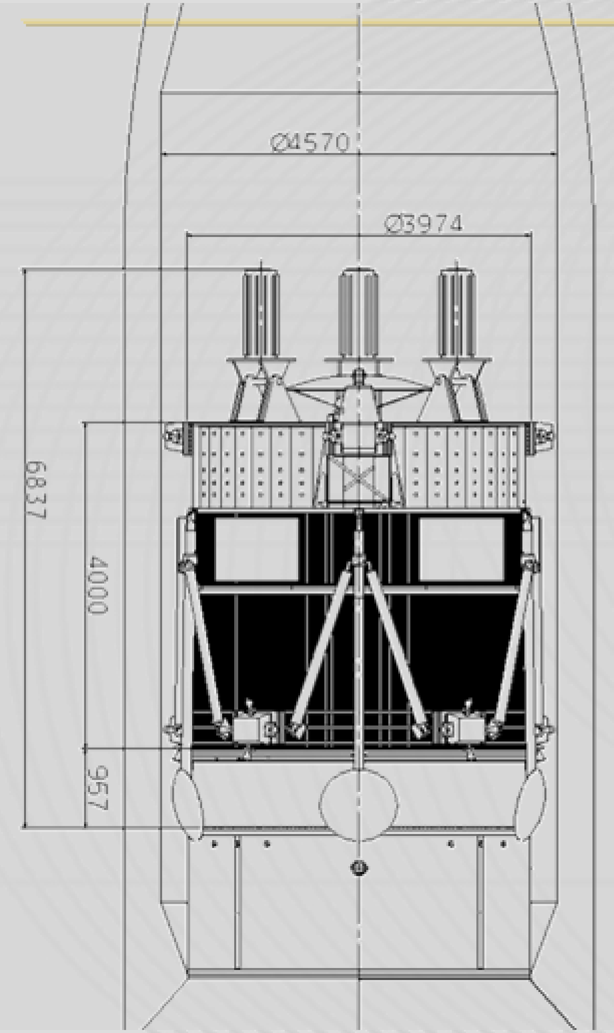
System Aspects: Payload Data Transfer (2)



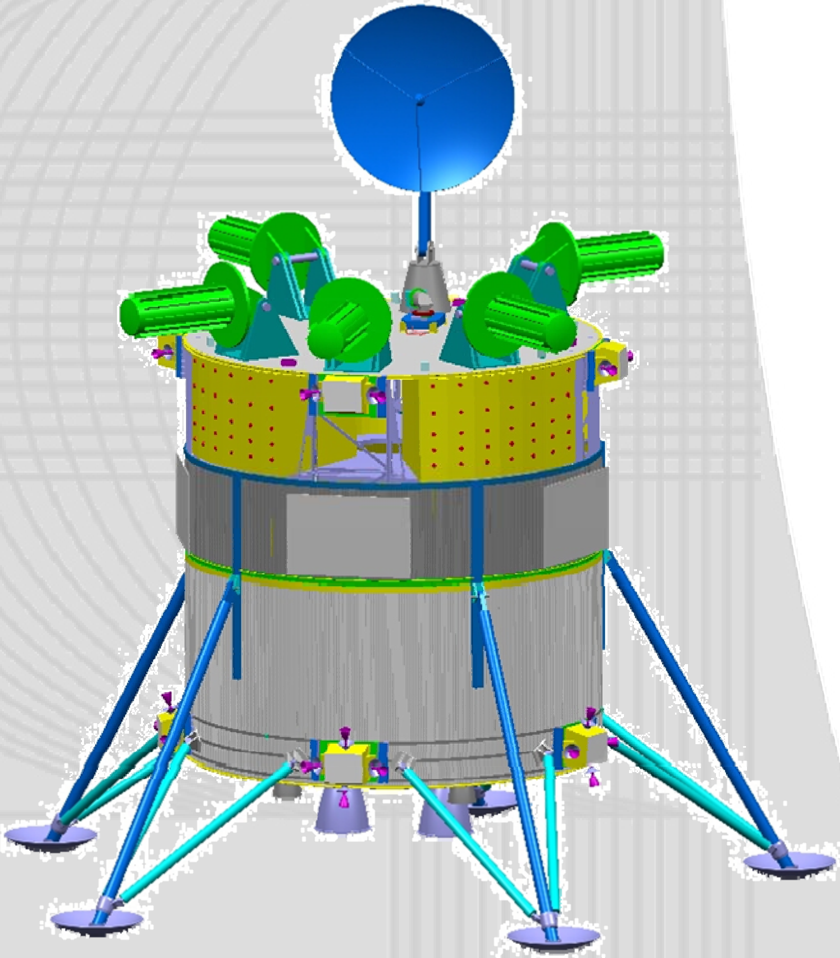




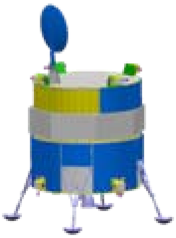
System Aspects: Lander Configuration



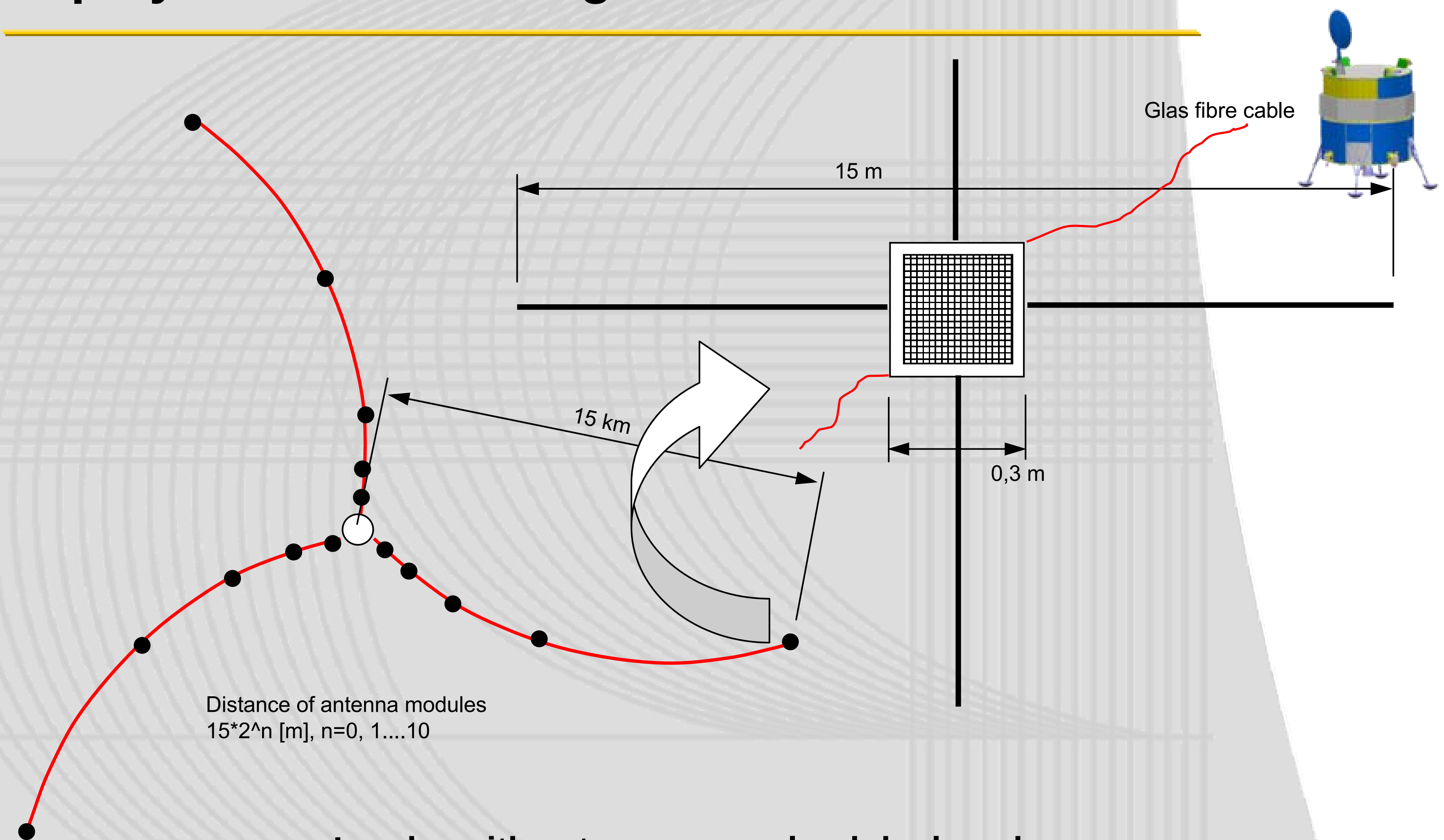
Launch Configuration



Landed Configuration

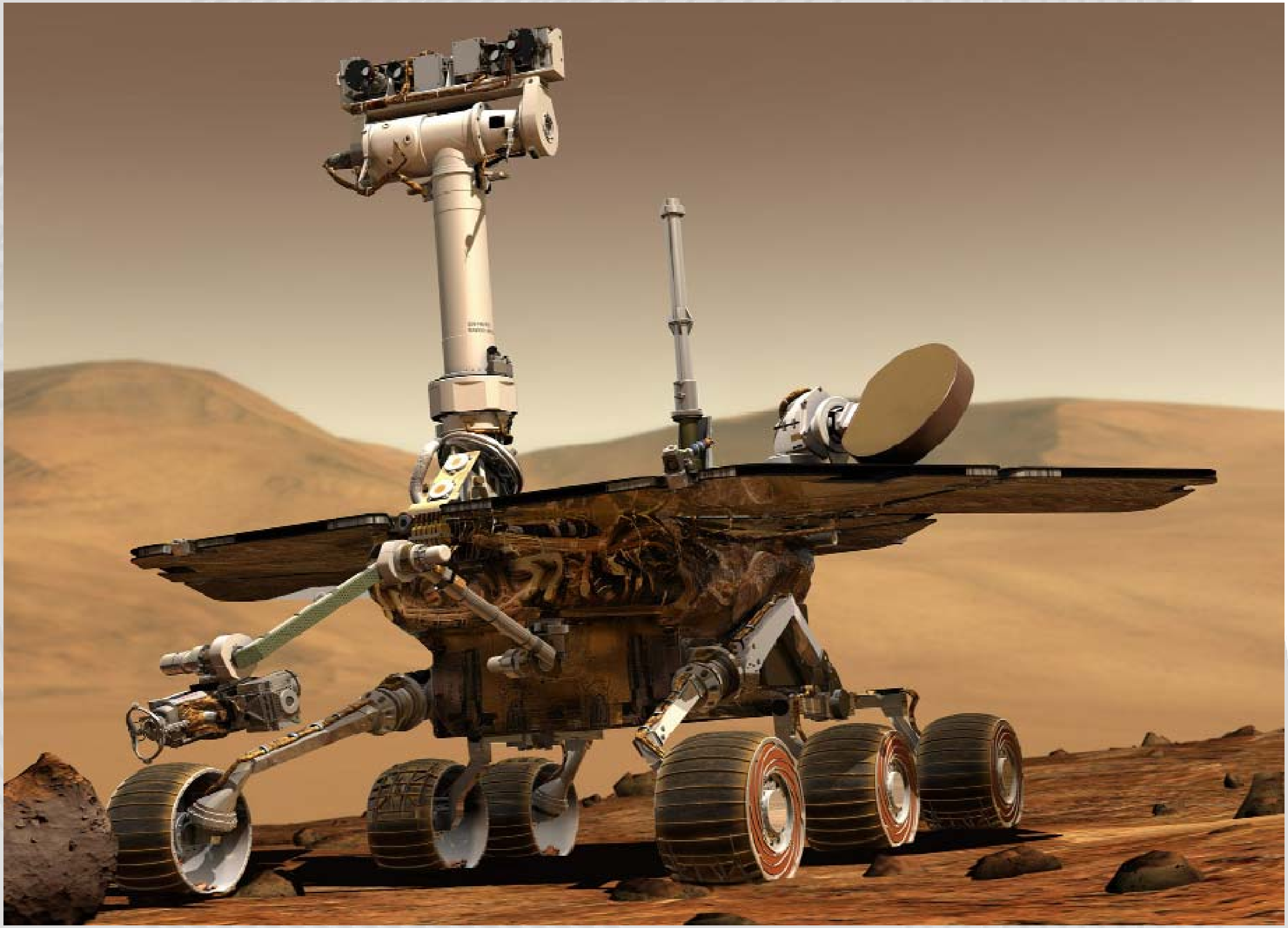


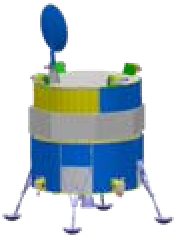
Deployed Sensor Configuration



Lander with astronomy payload deployed

Sensor Deployment by Rover(s)





(Courtesy NASA MER)

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System Mass Budget

	kg
AR5 ECA capability	**7800**
Adapter mass	200
BOL Mass in LTO	**7600**
Mass in LLO	
Mass on LS	**2863**
Unusable prop static	45
Unusable prop dynamic	30
Unusable prop trimm	65
Pressurant	22
Dry Mass	**2701**
Structure/Mechanisms	480
Propulsion	440
Power	220
GNC	50
Avionics	110
Communication	28
Thermal control	32
System margin	136
Lunar Lander Subsystems	**1496**
Payload incl. margin	**1205**
Payload w/o margin	**1341**

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Payload Mass Budget

Antenna module			
dipole	0.2		
no off dipole	4		
electronics	0.2		
solar generator	0.4		
box	0.3		
Module	1.7		
no off Module	33		
Total Ant Modules		**56.1**	**kg**
Payload on Lander			
Silex terminal	150		
Ant data acquisition	45		
Miscell	50		
Remaining on Lander		**245**	**kg**
cable kg/km	2		
km	45		
total cable		**90**	**kg**
Rover:			
Power	60		
Propulsion	80		
Structures	50		
Avionics	30		
total Rover x 3		**660**	**kg**
Mechanisms, Ramps		**150**	**kg**
Payload		**1201**	**kg**

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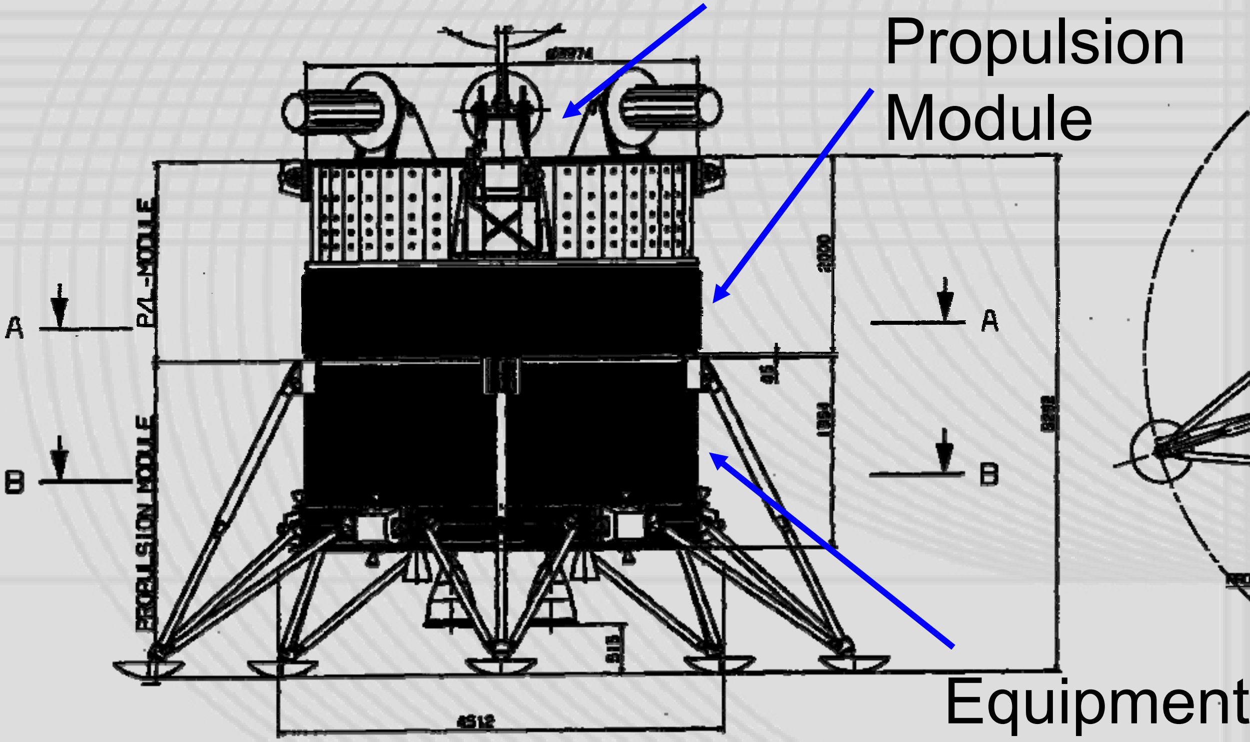
Payload Power Budget

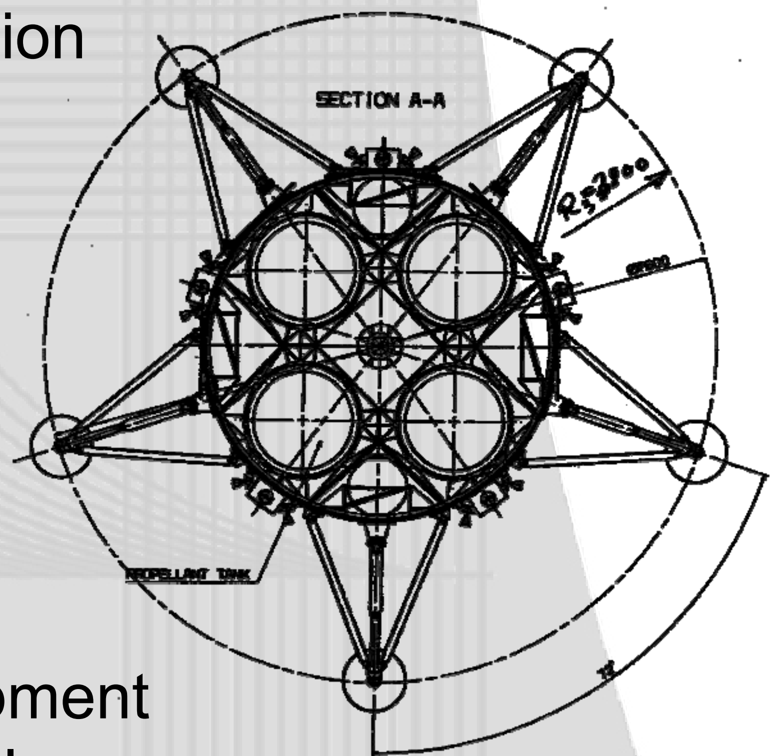
Antenna Module Power			
No of arm	3		
ant mod per arm	11		
feeds per ant mod	2		
PWR ADC/feed	0.1		
RCU/feed	0.2		
Safety factor	2		
Total ant mod.		**1.2**	**W**
Solar generator W/m²	170		
min. area cm²		70.59	
Area required for ops above 6°		705.9	cm²
Array size (n cm by n cm)	26.6		
Duty cycle		46.7	% overall
		93.3	% daytime
		0	% nighttime
Payload on Lander			
No off FPGA	57		
Power / FPGA	5 W		
Total power	285 W		
other	50 W		
Silex terminal	130 W		
Total Payload		**465**	**W**

Structure/Mechanism: Design Concept

Design Concept

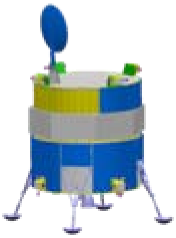
- Payload Module
- Propulsion Module
- Equipment Module

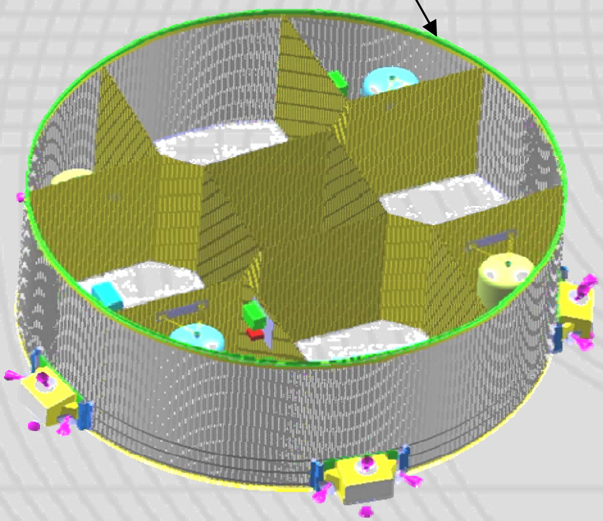


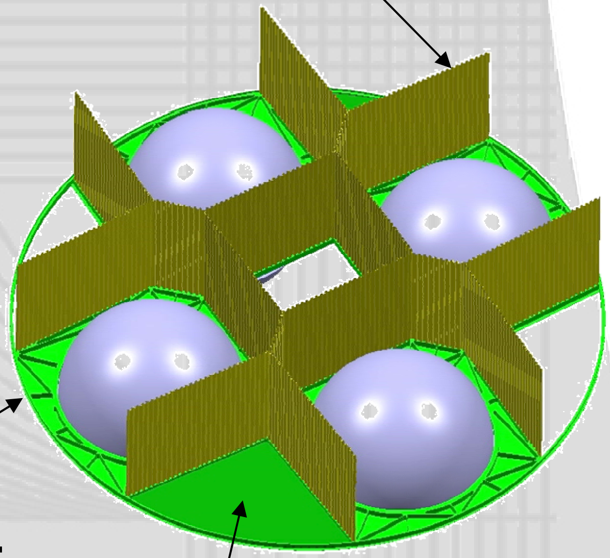


Structure/Mechanism: Design Concept

Propulsion Module

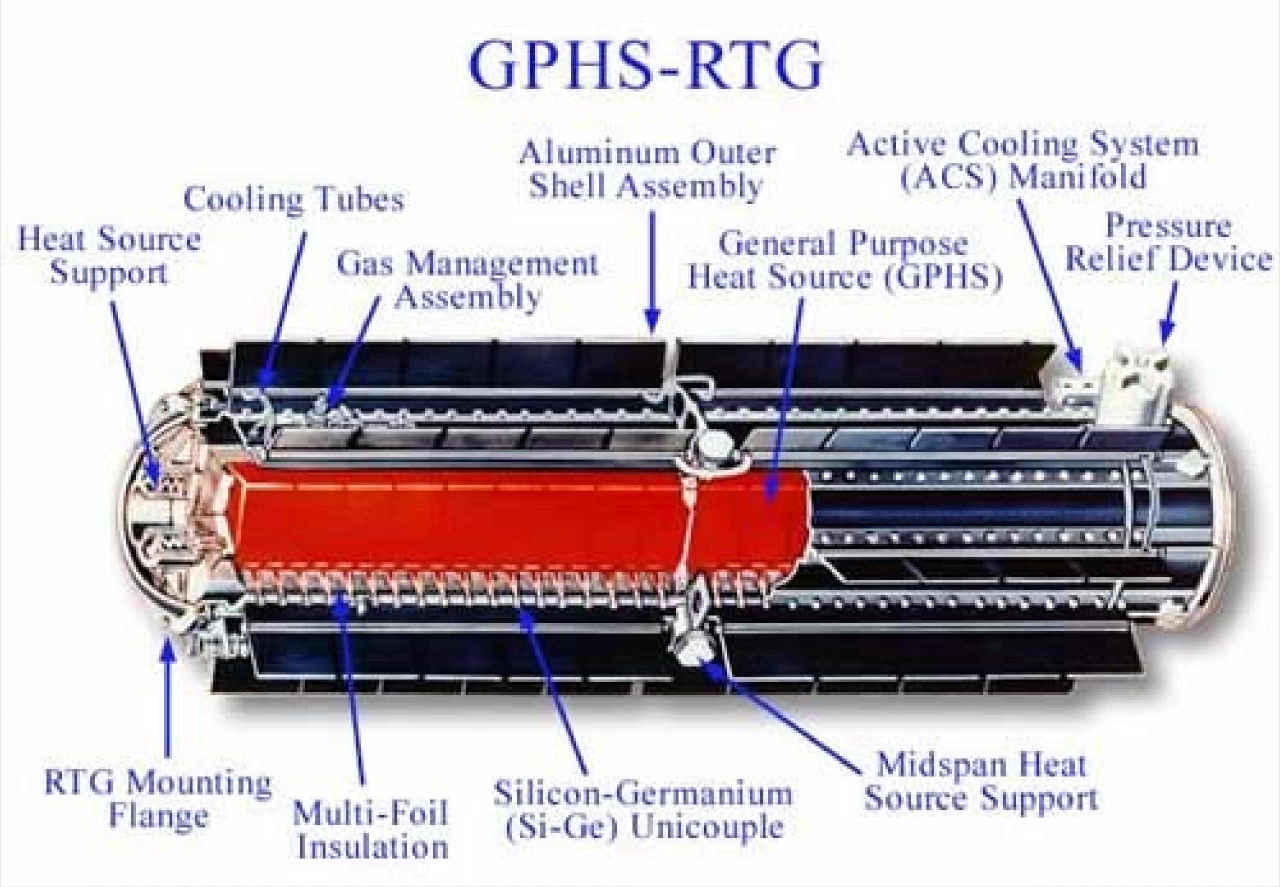


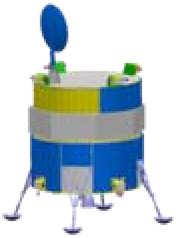




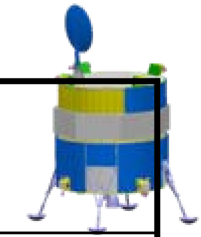
Power Generation & Storage

Radioisotope Thermolectric Generator (RTG)



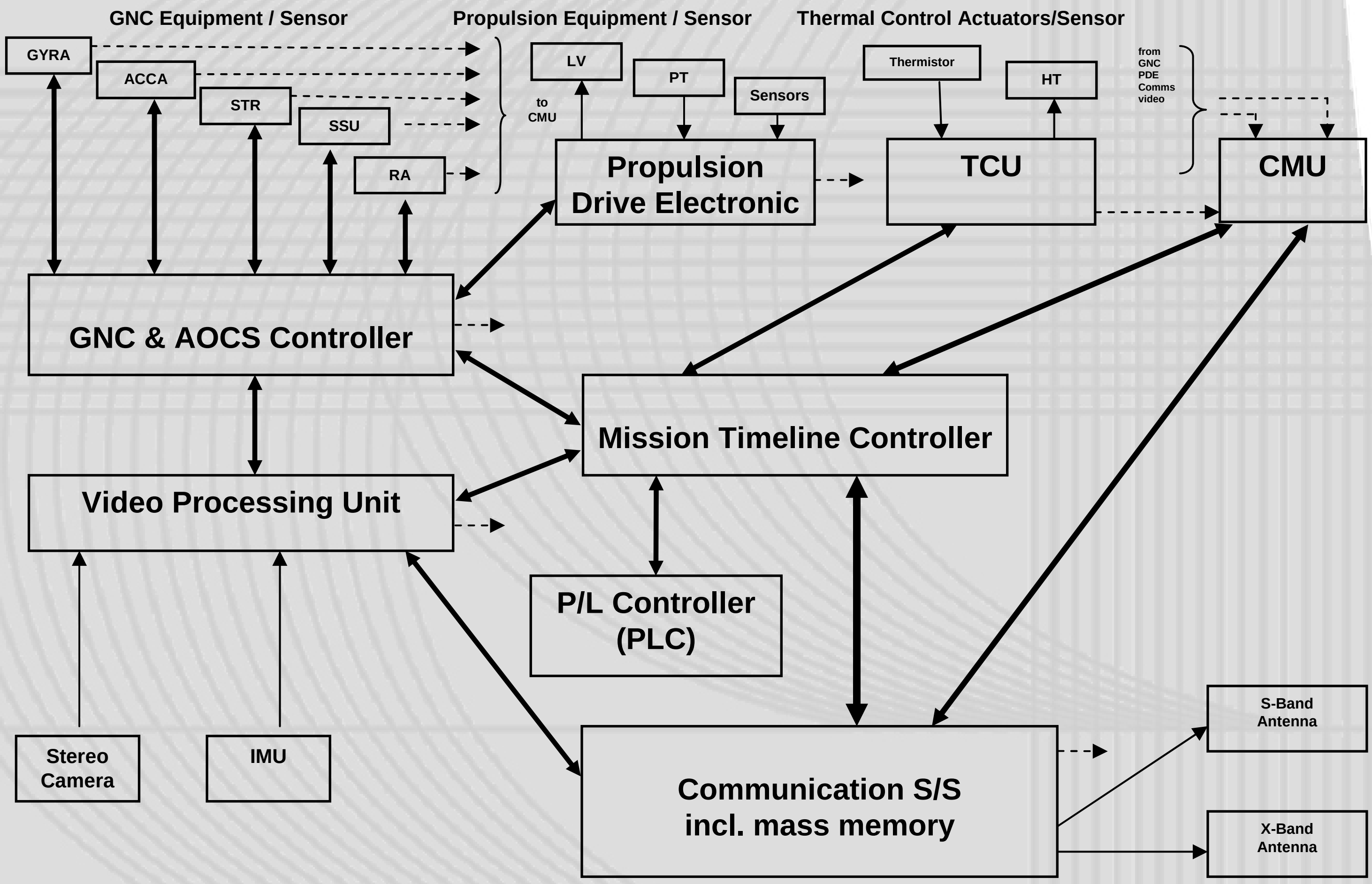


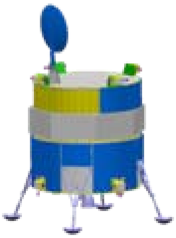
Power Generation & Storage



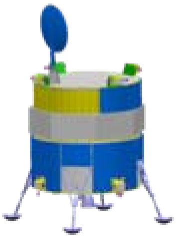
	PV-Battery system (Li-Ion)	RFC Regenerative Fuel Cells	RTG Radioisotope Thermoelectr.	SPS Solar Power Satellite
Mass required for energy storage	~ 7500kg	~ 170kg (H_2O)	~ 400kg	N/A But dedicated Solar Power Satellite
Solar Array Area	~ 41m²	~ 58m²	N/A	SA on the SPS ~ 27m²
Waste Heat / Dissipation	Moderate ~ 280W peak	Moderate ~ 600W average	very high ~ 31kW continuesly	low
Technology Readiness	State of the Art	FC available Electrolyzer to be developed	State of the Art	Laser Power transmission to be developed
Risks		Development of electrolyzer lifetime	Availability of RTG Safety aspects during ground handling	Development of Solar Power Satellite and laser transmission

Data Management - De-Centralized Design Concept

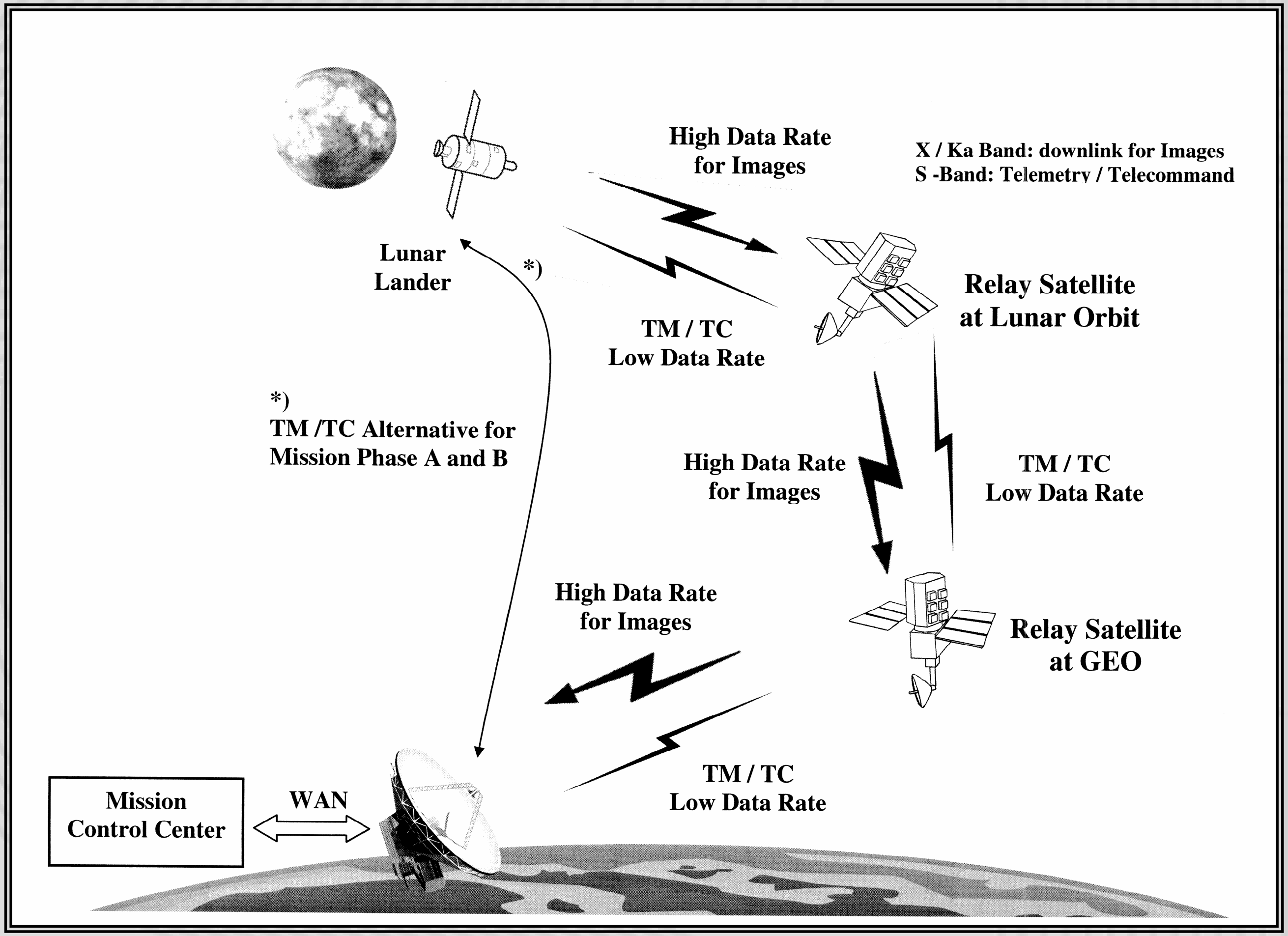




Communications



Overall COM Architecture



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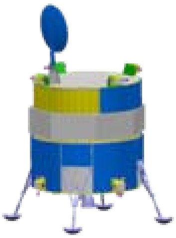
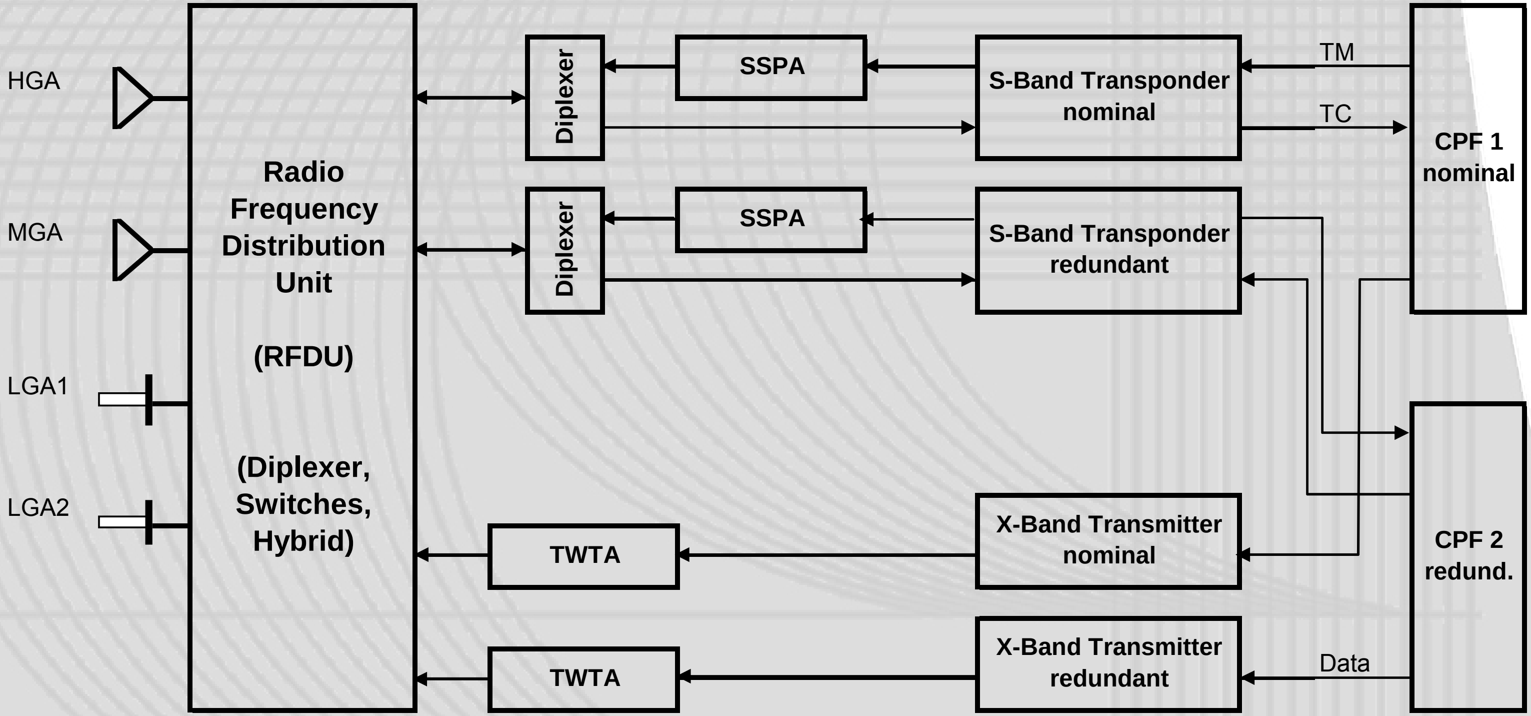
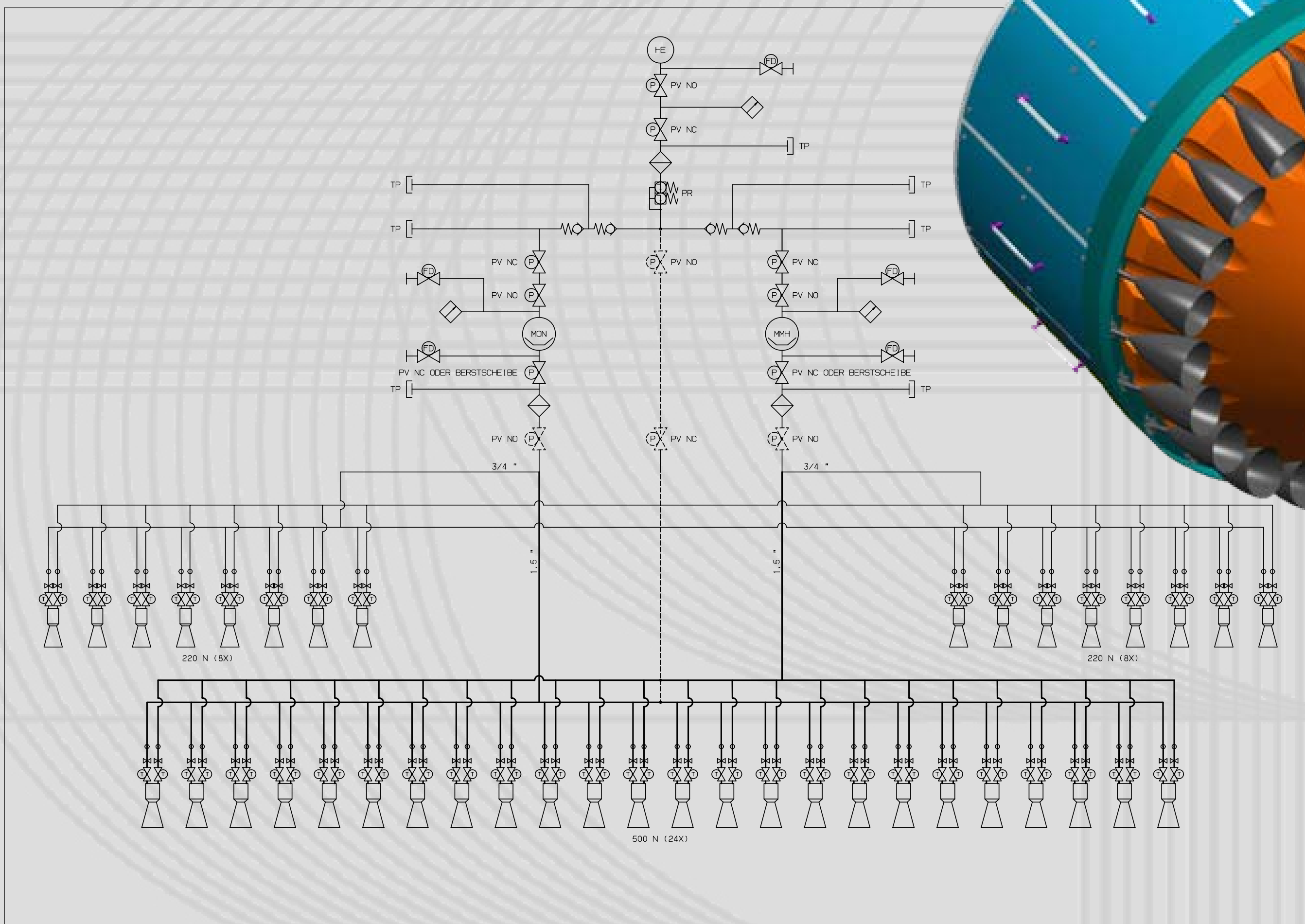


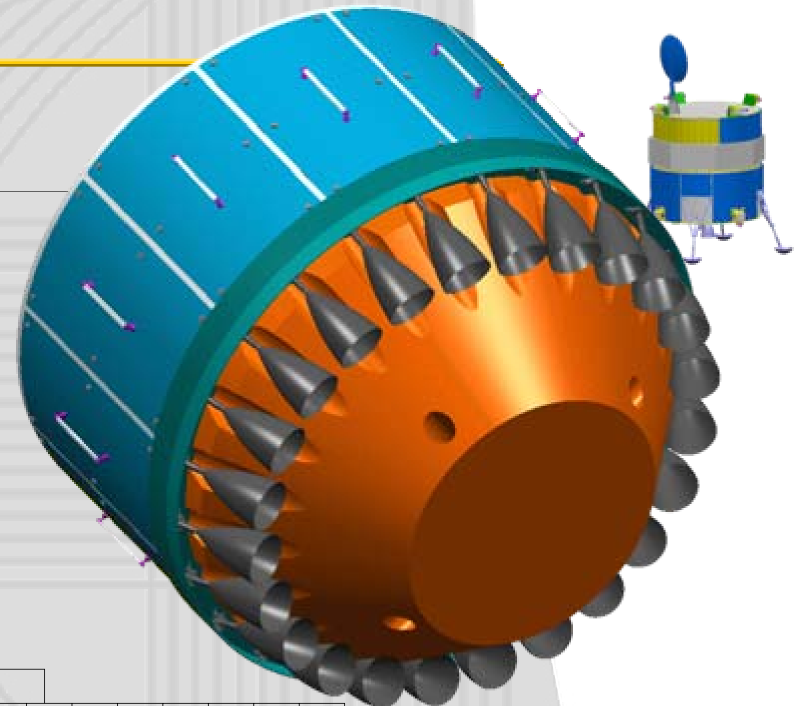
COM Functional Architecture – Layout Onboard Lunar Lander



Propulsion

Clustered / Plugged Nozzle Layout



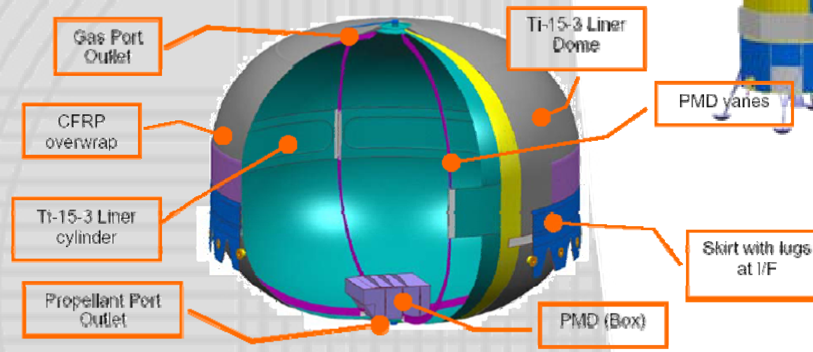


Propulsion

Tanks

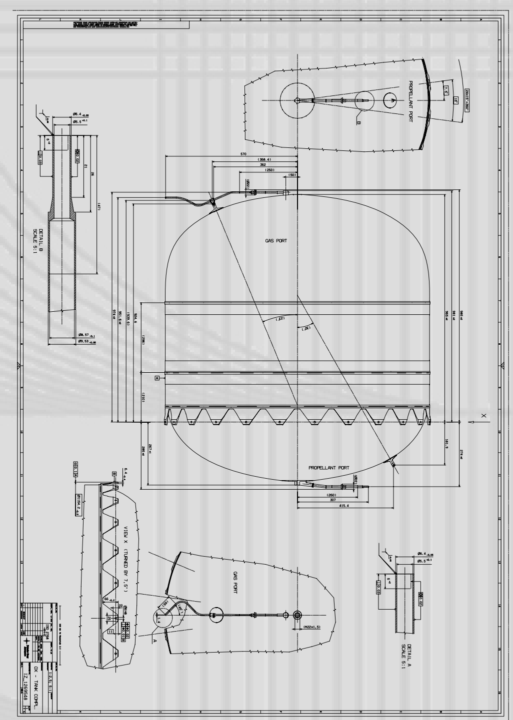
2-Tank Concept:

- Alphabus propellant tank
- V=1911 dm^3
- MEOP 24 bar
- thin titanium liner with CFRP overwrap
- new development of MT Aerospace
- Diameter x Height: 1154.2 mm x 1372 mm

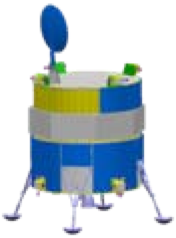


4-Tank Concept:

- Spacebus propellant tank
- V = 1000 dm^3
- MEOP 19.5 bar
- titanium tank
- EADS-ST
- Diameter x Height: 1154.2 mm x 1259 mm



Conclusion



Within the LIFE scenario, the Lunar Lander is a very challenging project:

- With todays technology, only RTGs can fulfill the power require-ments during lunar night – the power demand is a serious challenge (considering the RTG procurement problems)
- It is therefore proposed to refrain from night time operations
- The data transfer requirements and the unique location on lunar far side necessitate additional infrastructural elements (e. g. optical laser link, data relay satellites)
- Compared to the above, the remaining technical challenges can be covered with moderate development effort