ISOLDE

In-Space Outgassing Laboratory Distant from Earth

The 4th Mission Idea Contest For Micro/Nano-satellite Utilization

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21.10.2016

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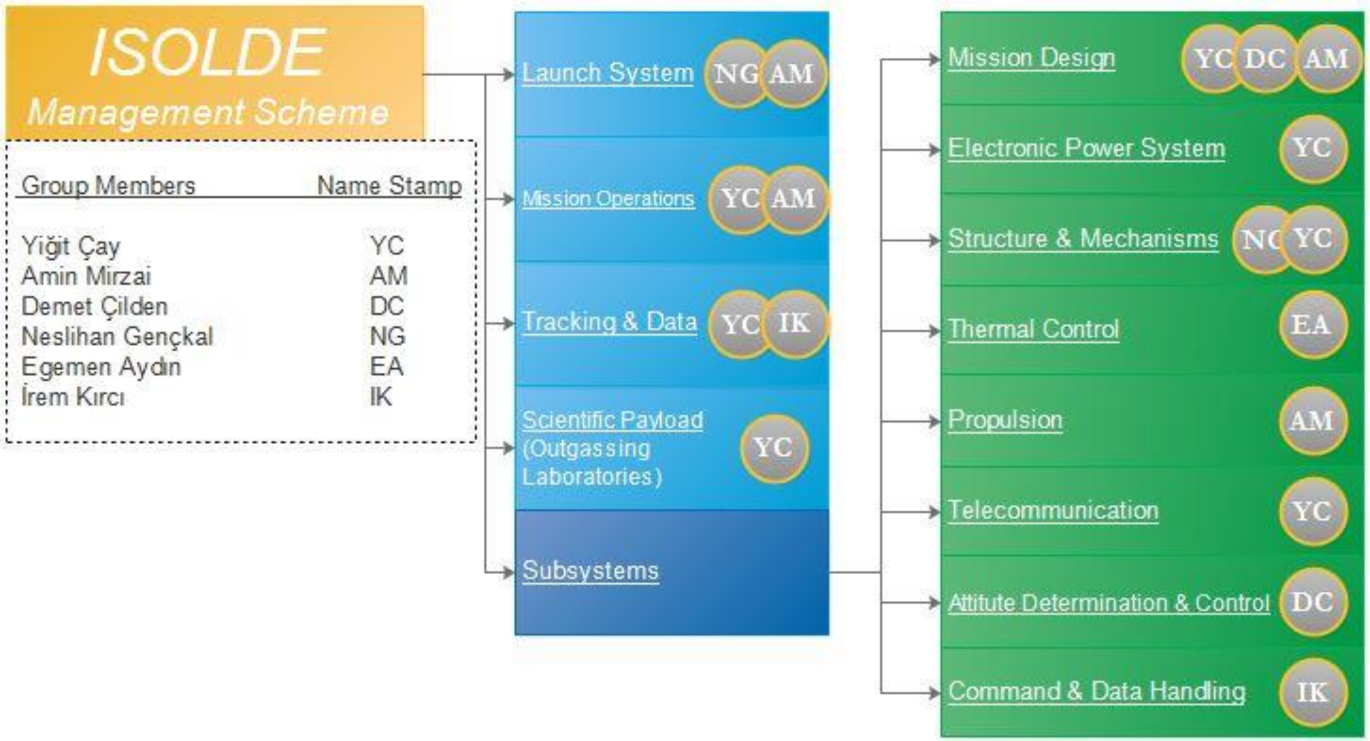
Team Structure



Management scheme of project team

Acknowledgement

- Prof. Dr. Zerefşan Kaymaz
- Prof. Dr. Alim Rüstem Aslan
- Assoc. Prof. Dr. Cuma Yarım
- Prof. Dr. Cengiz Hacızade
- Assoc. Prof. Dr. T. Berat Karyot
- Istanbul Technical University's Upper Atmosphere & Space Weather Laboratory
- Space Systems Test & Integration Laboratory

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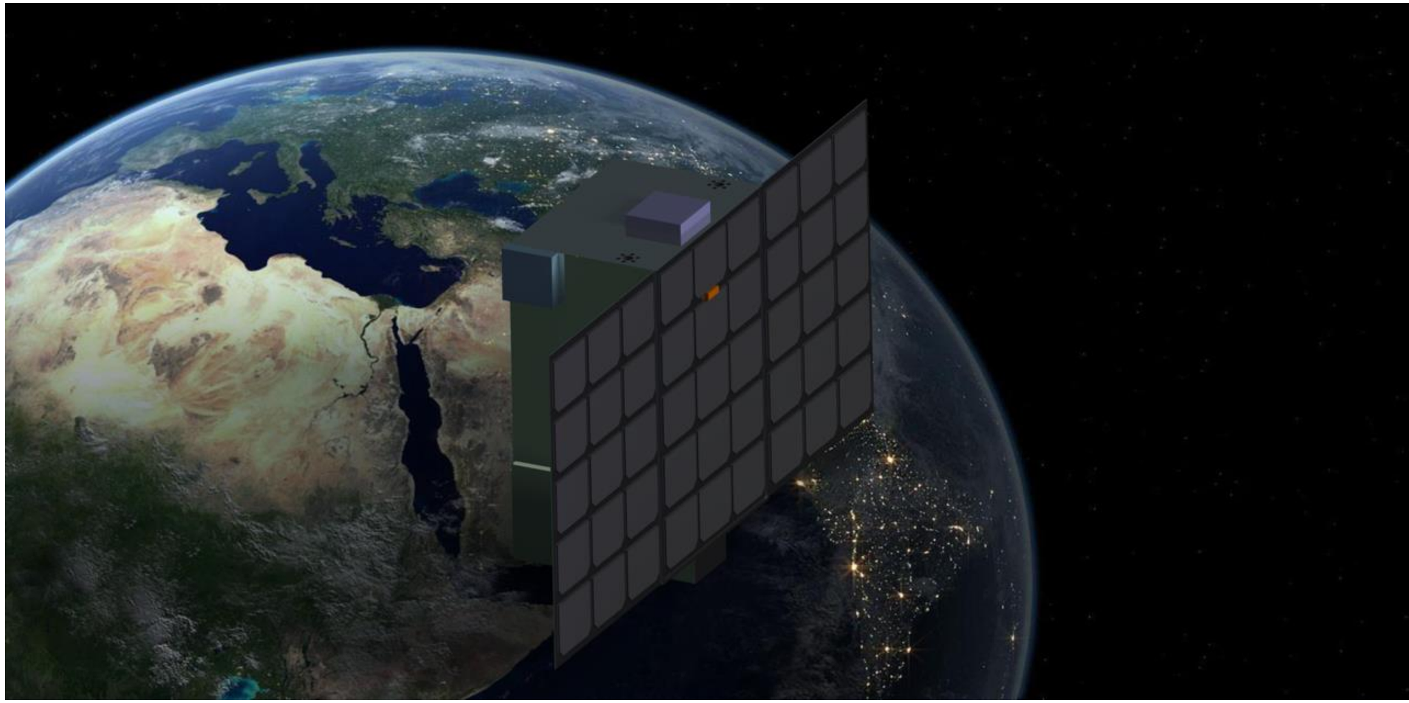

Introduction

‘Outgassing is the release of gasses that dissolved, trapped, frozen or absorbed in materials.’

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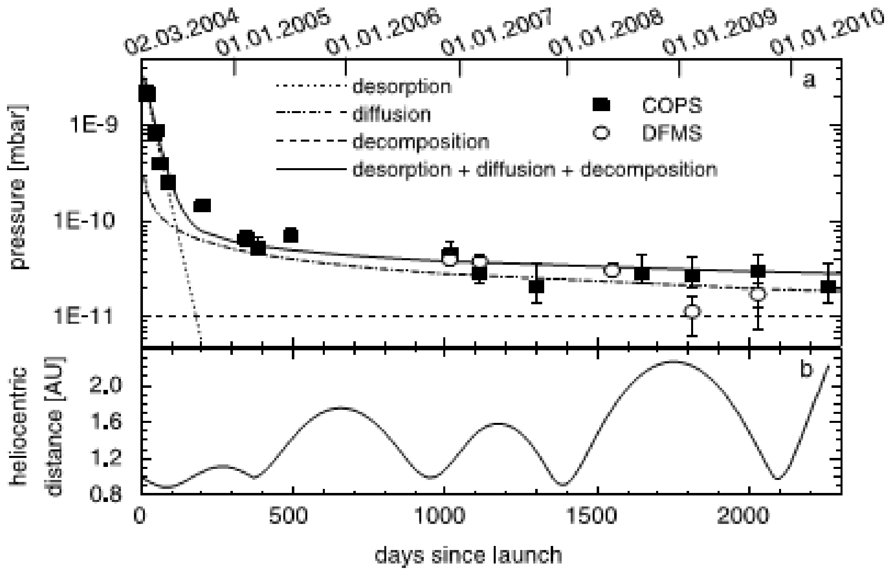
Ground experiments in vacuum tanks
- Lower vacuum
- Costly

UHV > between 10^{-6} and 10^{-10} Pa
XHV > below 10^{-10} Pa

Mission idea of ISOLDE
- Outgassing measurements
- XHV conditions of space



Spacecraft Outgassing (SCHLÄPPI et al.)

Introduction

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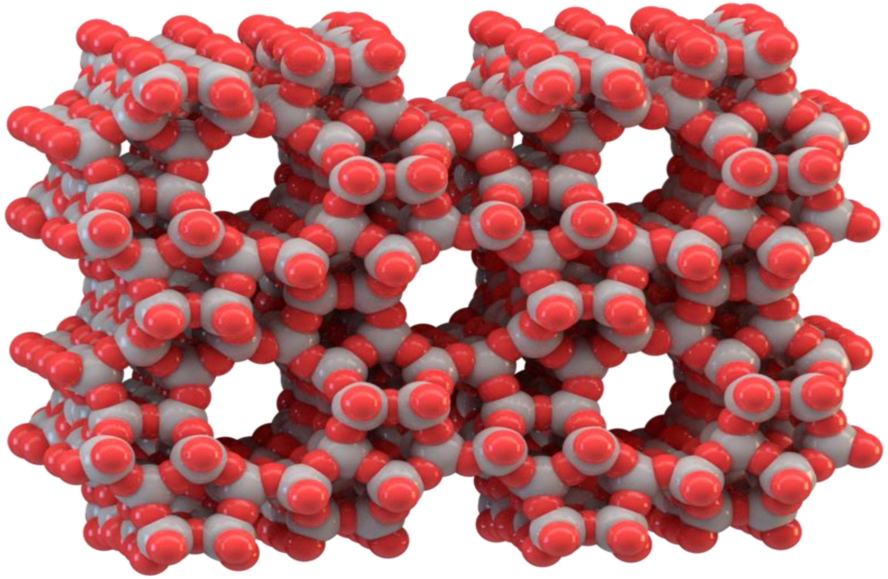
ISOLDE's payload

- Measure outgassing rate
- Contaminants from a sample material
  - Copper

Zeolite is also used in the laboratories to understand its effect to the outgassing characterization of the copper sample.



The molecular structure of a zeolite, ZSM-5

Photo courtesy of wikimedia.org

Mission Objectives

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1. To conduct the standard outgassing measurement processes in the laboratory units with XHV conditions
2. To test the contamination reliability when the payload operations are going on
3. To measure the effect of gas absorbing material, zeolite
4. To provide precise data of a common spacecraft material for improving the prevention techniques of return flux hazards.

Concept of Operation

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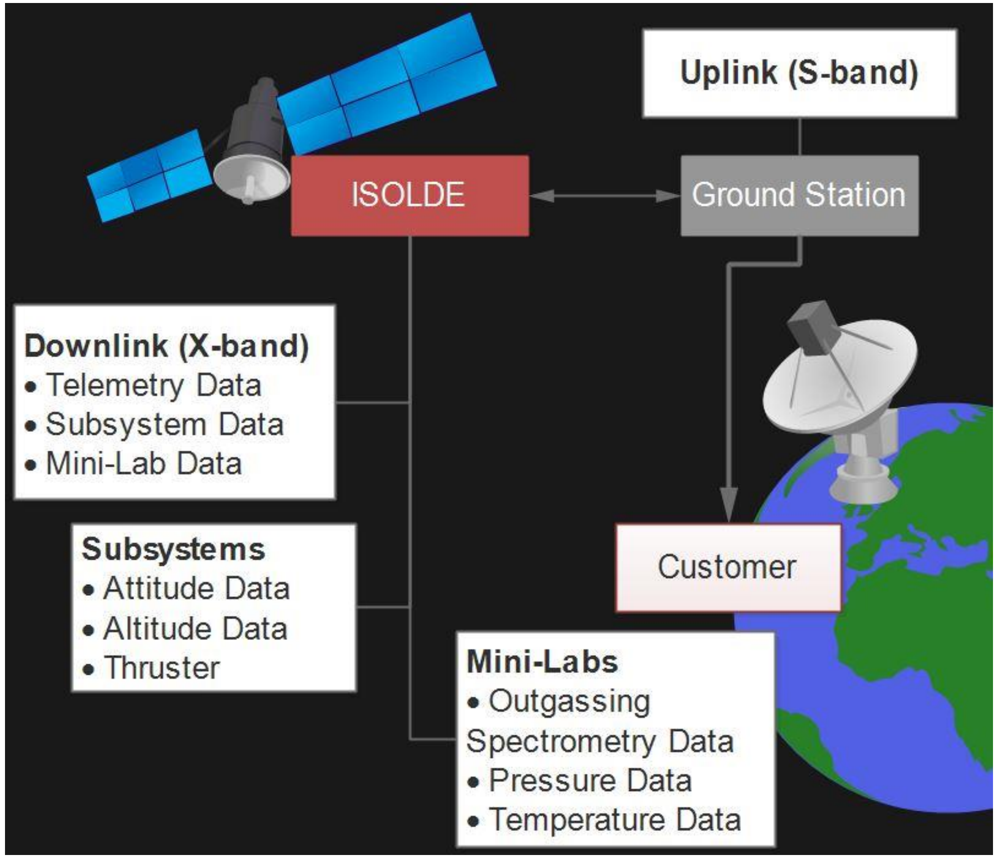
Pre-Mission

Launch
↓
Orbit Insertion
↓
Solar Panel Deployment
↓
The Pressure and Temperature Detection
↓
Mission Start Signal

Mission

XHV Condition Confirmation
↓
Experiments

De-Orbiting Phase



Key Performance Paramaters

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1. Attitude control system to provide the three-axis stabilization and to point the spacecraft to sun in order to keep the laboratory units at the same temperature
2. Successful heating to 0°C the subsystem carrier segment that is shadowed during all mission
3. Achieving the data storage from sensors with 16-bit microcontroller platform
4. Successful data transfer of 10 Mbps to the ground station
5. Activating thruster successfully for de-orbiting phase

Payload

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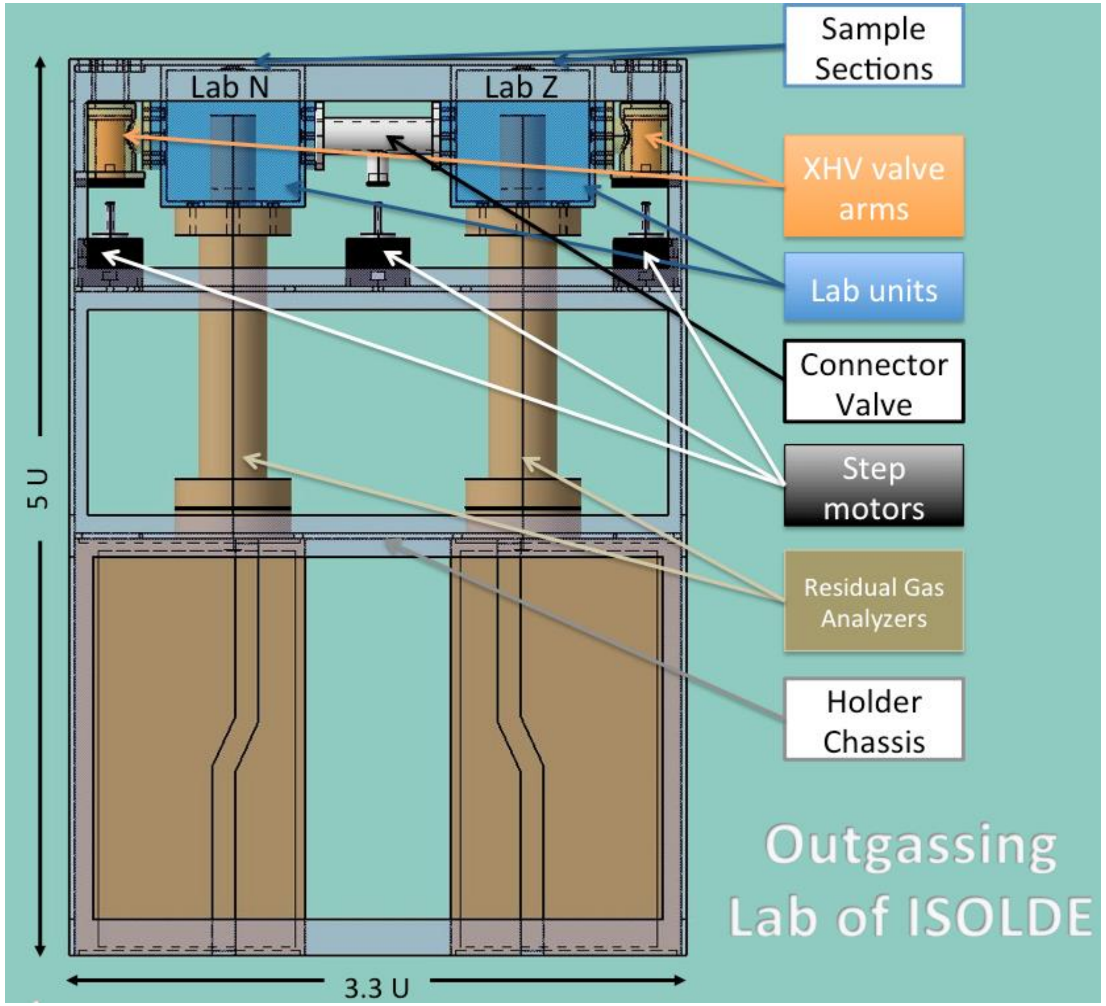

Payload

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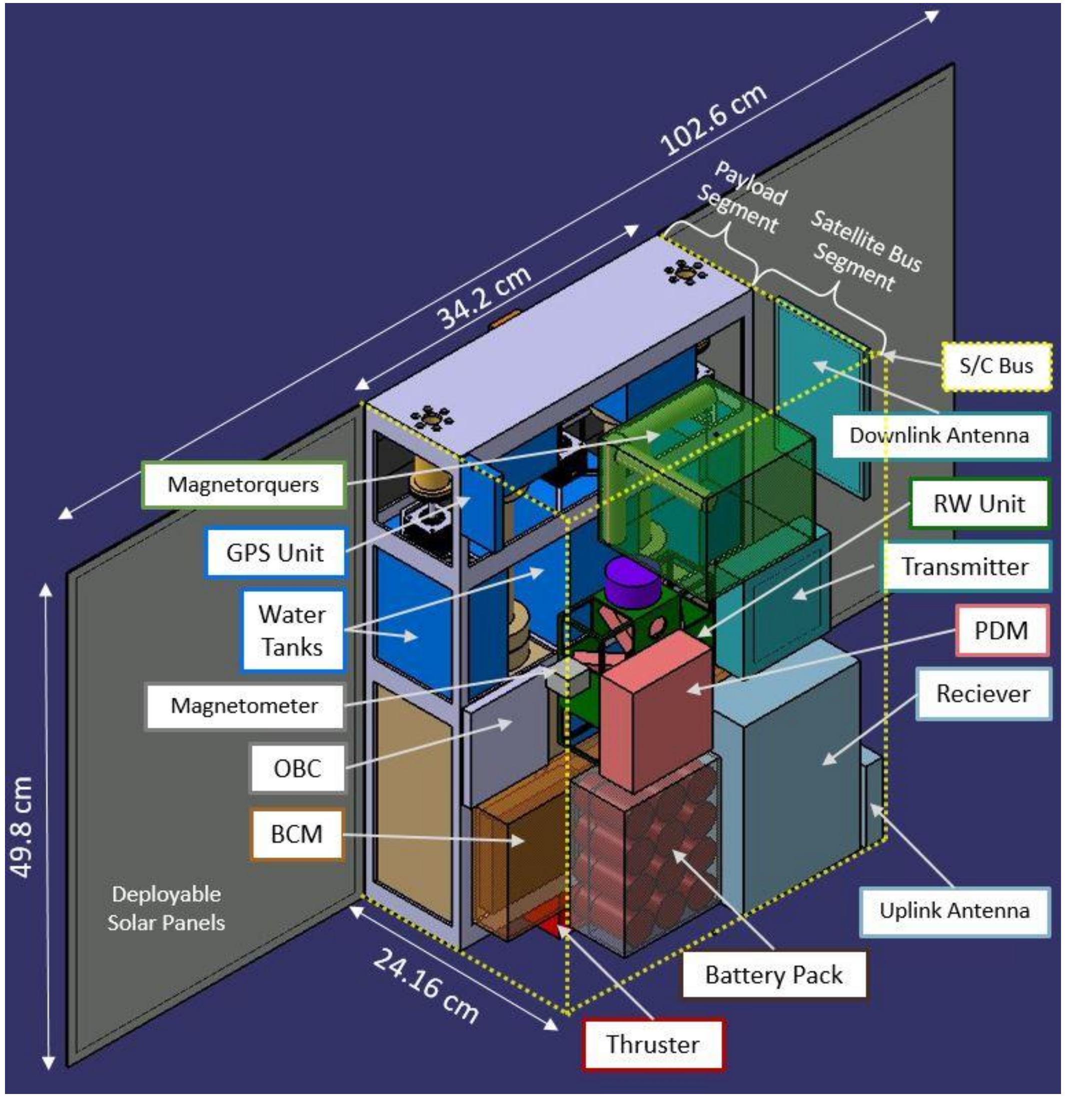

Subsystems and allocations.

Space Segment Overview

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ISOLDE Budgets	%	Mass [kg]	%	Power [W]
Structure and Mechanisms	10.2	2.2	1.13	2.0
Thermal Control System	0.0	0.0	0.00	0.0
Attitude Determination and Control System	8.9	1.7	6.51	11.5
Power System	32.8	6.1	0.00	0.0
Cabling	5.3	1.0	0.00	0.0
Propulsion System	14.6	2.7	3.68	6.5
Telecommunication System	10.2	1.9	20.66	36.5
Command and Data Handling	0.7	0.3	0.11	0.2
Payload	16.7	3.1	67.91	120.0
Total Dry Mass & Power		**19.1 kg**		**56.70 W (w/o payload)**
Propellant Mass		**4.1 kg**		-
Total Dry Mass & Power (Margin Included)		**27.8 kg**		**179.35 W**
Maximum		**50 kg**		**179.39 W**

Maximum allowable mass

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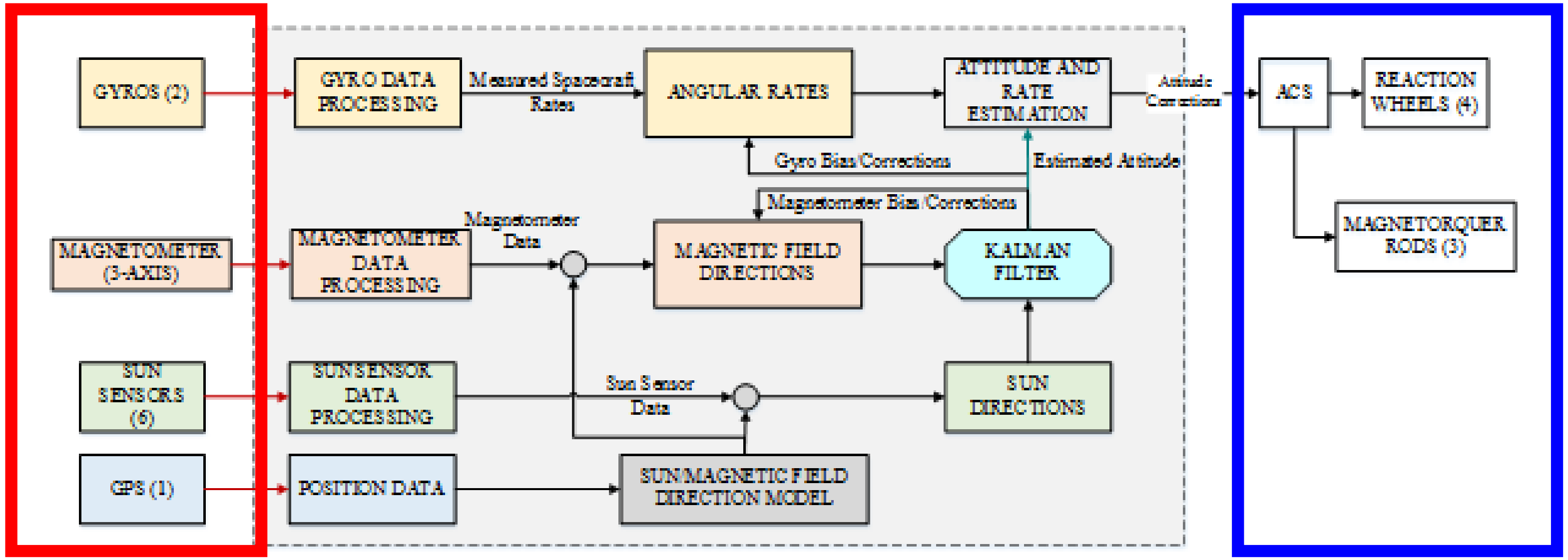
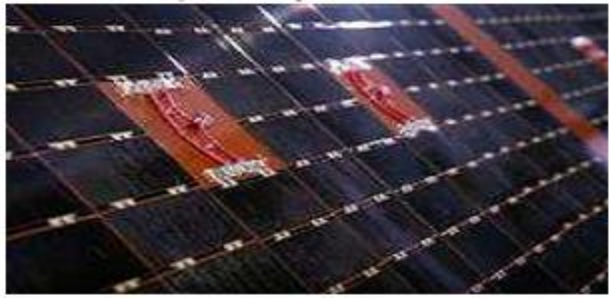
1. Attitude Determination and Control System



2. Electrical Power System

- 48 GaAs/Ge solar cells
- 179 W



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3. Command and Data Handling

- 29 GB payload data for six days of active mission
- 74 MB engineering data
- Two 16 GB SD Card

OBC
in the courtesy of CubeSatShop

4. Operating Modes

- Normal Mode
- Step Mode
- Emergency Mode
- Communication Window Mode
- Recovery Mode

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5. Propulsion

- For De-orbiting Phase
  - Electrolysis of water to generate oxygen and hydrogen propellants to feed its bipropellant thruster
- 3.87 kg Water

6. Telecommunication

- The Uplink frequencies
  - 2030 MHz (S band)
- The Downlink frequencies
  - 8400 MHz (X band)
- Near Earth Network for Ground Network

Link Budget of ISOLDE	*X band downlink*	*S band uplink*
Frequency [GHz]	**8.4**	**2.0**
EIRP [dbW]	29.7	57.0
Transmitter Power [W]	25.0	3.6
[dBW]	14.0	5.6
Transmit Antenna Gain [dBi]	16.5	41.2
Transmitter Line Loss [dB]	-0.8	-3.6
Transmit Antenna Pointing Loss [dB]	0.6	-28.8
Free Space Path Loss [dB]	**179.1**	**166.8**
Atmosphere Absoption Loss [dB]	**1.1**	**1.1**
Polarization Loss [dB]	**0.2**	**0.2**
Other Loss [dB]	**0.1**	**0.1**
G/T	**23.4**	**-22.2**
Receive Antenna Gain [dBi]	52.2	6.0
Receiver Line Loss [dB]	4.2	1.8
Receiver Antenna Pointing Loss [dB]	37.3	0.6
Effective Noise Temperature [K]	289.0	435.0
System Noise Temperature [dBK]	-24.6	-26.4
Carrier-to-Noise Density Ratio (S/N_0)	**63.3**	**65.8**
Required Carrier-to-Noise Density Ratio [dB]	**56.8**	**46.3**
Required E_b/N_0 [dB]	4.3	10.5
Implementation Loss [dB]	3.0	3.0
Data Rate [kbps]	478.7	42.2
[dB-Hz]	56.8	46.3
Margin [dB]	**2.2**	**9.0**

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7. Thermal Control

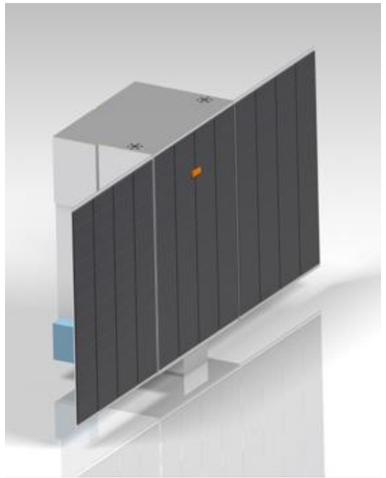
- Passive control system
  - Hughson Black Paint H322
  - 19°C and 22°C range

Subsystem	Min. Temperature (°C)	Max. Temperature (°C)
Payload	-20	+70
ADCS	-20	+50
Battery(s)	-20	+60
Antenna(s)	-40	+70
Receiver	-20	+50
Transmitter	-40	+50
OBC	-40	+85
Range	-20	+50

Temperature Ranges of ISOLDE

8. Structure and Mechanisms

- 34.2 x 49.8 x 24.2 cm
- 27.8 kg
- Aluminum alloy 6061-T6
- Step Motors
- Nichrome burn wire release mechanism



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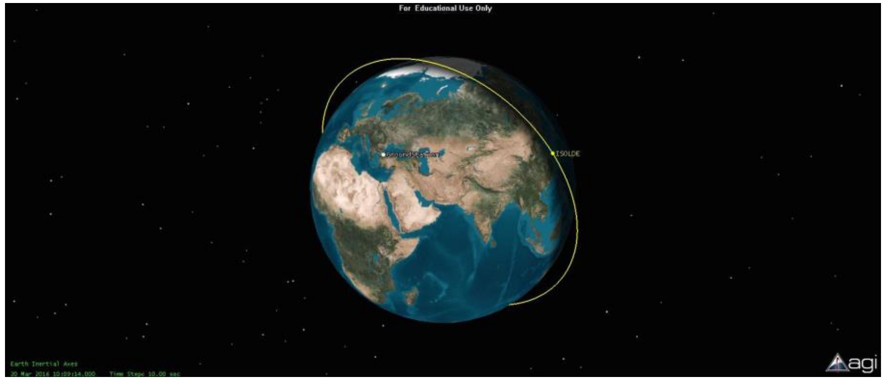
9. Orbit/Constellation Description



3D view of the orbit

World map view.

- Sun-synchronous polar orbit
  - Energy generation
  - Easy to put orbit
- 700 km of altitude
  - De-orbit

- 90.4° of RAAN
- 98.18° of inclination

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Component	Estimated Cost [$]	Remarks
Equipments	**261.375**	**Including margin**
Structure & Mechanism	15.000	
Thermal Control System	1.000	
Attitude Determination and Control System	12.000	
Power System	50.000	
Propulsion System	35.000	
Telecommunication System	35.000	
Command and Data Handling	11.100	
Payload	50.000	
Manufacture	**100.000**	**3 models to manufacture**
Tests	**100.000**	**Held in ITU**
Personnel	**1.010.400**	**22Stu.x800$ + 7Prof.x3500$ for 24m**
Operations	**50.000**	**May increase by other GS usage**
Utilities	**100.000**	**For back-up utilities**
Other	**200.000**	**For unpredictable costs**
Total	**1.821.775**	
Total with Launch	**3.821.775**	**Approximate (Transfer costs inc.)**

Project budget of ISOLDE.

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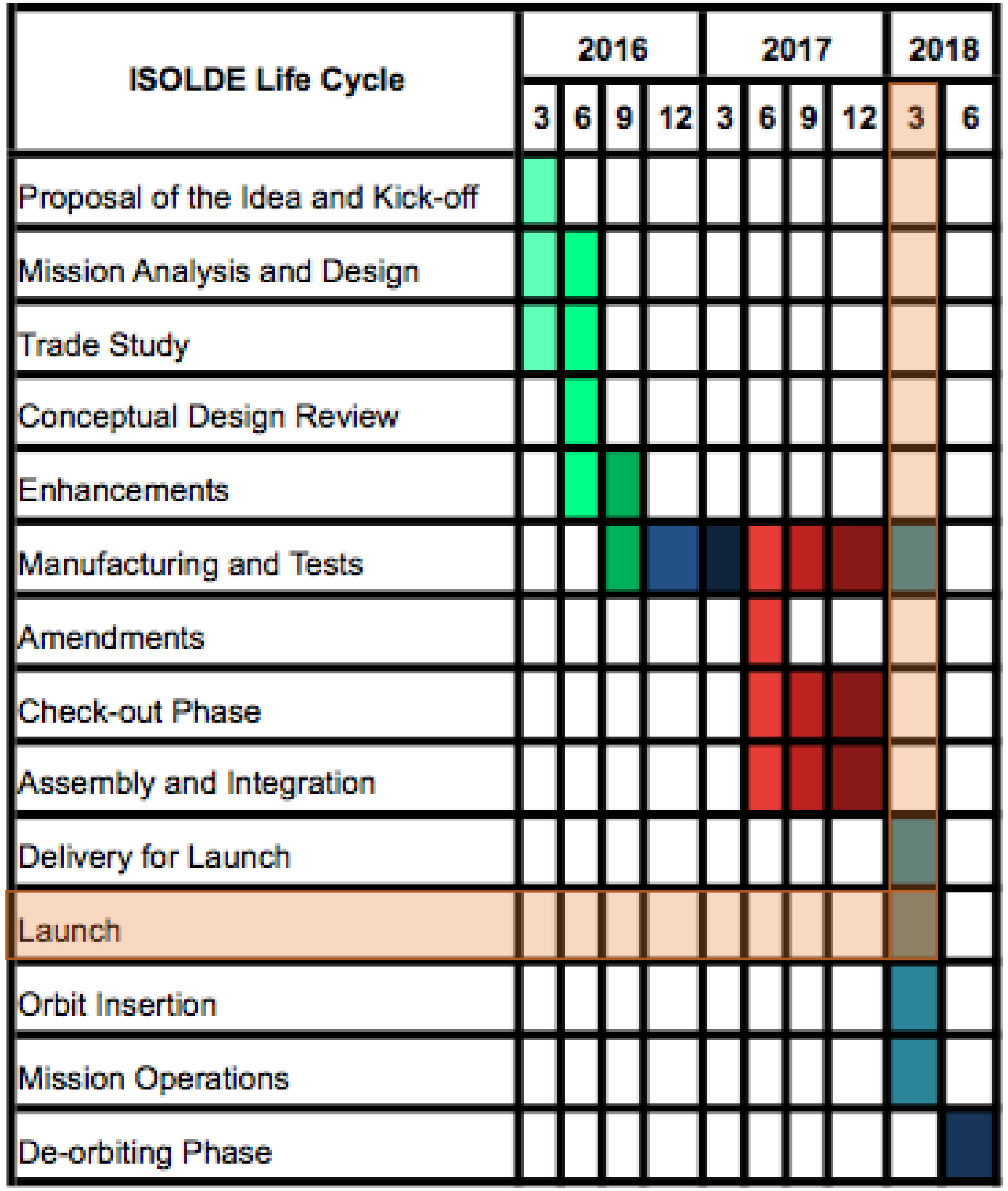

Project timeline.

Project Risks

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1. Any malfunction of ADCS system can be resulted in telecommunication loss or experiment failure due to lack of power generation.
   - Fault Tolerant Control System

2. Any possible leakage from the water tank can be hazardous for the payload electronics and spacecraft hardware.
   - Ground Tests

3. X-ray emissions in space are negatively affecting the quality of the mass spectrometry experiments.
   - Data Correction
   - Radiation Studies

4. Any launch delay can increase the cost of the project.
   - Another Shuttle

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Thank You For Listening

Questions?