THESEUS Workshop, Napoli, October 5, 2017

theseus
TRANSIENT HIGH ENERGY SKY AND EARLY UNIVERSE SURVEYOR

GP ADVANCED PROJECTS

OHB ITALIA

Preliminary THESEUS Configuration - Emiliano Capolongo (OHB-I)

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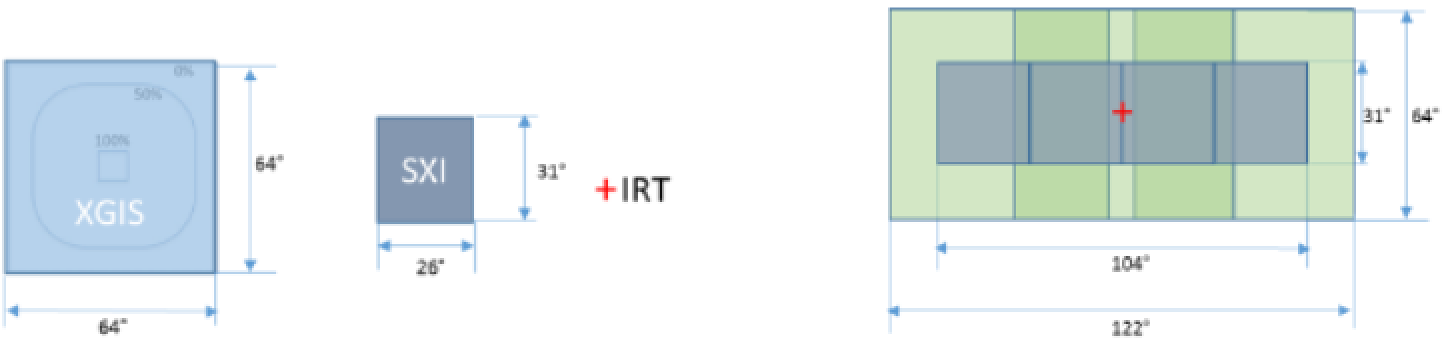
THESEUS Summary of Main Requirements

Requirement ID	Description	Reference
Top level Requirements		
REQ-SCI-010	GRBs census	Explore the early Universe with a complete census of GRBs in the 1st billion years
REQ-SCI-020	GW and cosmic neutrino	Identify and study GW and cosmic neutrino astrophysical sources through an unprecedented exploration of the time-domain Universe in X-rays
Science Requirements		
REQ-SCI-030	Number of GRB	30 GRBs with measured z > 8
REQ-SCI-040	New transient/variable	Hundreds of new transient / variable high energy sources per year
REQ-SCI-050	Sources position	X-ray positions at <1' (soft band) and at< 5' (hard band)
REQ-SCI-060	Triggers range	0.3 keV -10 MeV
REQ-SCI-070	Transient light curves	Transient light curves over seconds to months
Istrument requirements		
REQ-INS-100	Soft X-ray	• 1 sr FOV • 1000s sensitivity 1x10-10 cgs in 0.3-5 keV) • PSF FWHM 4.5' • 150 eV FWHM @ 6 keV • On-board multi-timescale image trigger
REQ-INS-200	Hard X-ray	• 1.5 sr FOV • 1s sensitivity 300 mCrab in 2-30 keV • 300 eV FWHM @ 6 keV • On-board multi-timescale image trigger
REQ-INS-300	Optical/IR	• Imaging, lo-res & hi-res spectra • 10'x10' FOV • Positions <1" • H = 20.6 in 300s @ SNR 5

Mission Requirements		
REQ-MIS-010	Identificaiton of bursts/transients	THESEUS wide field instruments, SXI and XGIS, will monitor a wide area of the sky, and when detecting a burst will generate an Burst/transient alert. Providing to the spacecraft the data about position (quaternion) and time occurrence.
REQ-MIS-020	Orbit	• Circular Low Earth Orbit Altitude: 535 to 600 km (TBC) • Inclination ≤6 deg This orbit granting a low and stable background level in the high-energy instruments, allowing a successfully observation of faint X-ray sources.
REQ-MIS-030	Satellite LoS	The Satellite Line of Sight (LoS) is assumed to be the boresight direction of the IRT. The driver of this requirement is the high pointing accuracy of IRT.
REQ-MIS-040	Sky accessibility	Theseus Field of Regards (FoR) is 64% of the sky. The FoR driver is the achievement of a large Sky accessibility taking into account the constraints, e.g. Sun, Earth, GC.
REQ-MIS-050	Alignment	The Theseus Payload design and performance shall be compatible with an alignment of XGIS and SXI Detector Assembly (each composed by a group of individual Detector Unit) with respect to the IRT LoS. The combined Field of view is shown in Figure 21 .
REQ-MIS-060	Pointing	See Table 14. The pointing requirement are driven by the IRT telescope which has the higher angular resolution and needs also stability for the spectroscopy.
REQ-MIS-070	On-board time management	To guarantee the precise time tagging in every condition, the S/C will be able to provide to each Instrument a Pulse Per Second (PPS) with an accuracy ≤1μs at 3 sigma.
REQ-MIS-080	Satellite slewing capability	In the occurrence of a Burst/Transient alert the satellite shall activate, autonomously from the ground control, a slewing manoeuvre to point the burst/transient identified direction with an agility better than ~60°/10min

THESEUS instruments FoV & pointing Requirements

Instrument	Single Detector FoV	Overall FoV
SXI (4 DU)	26°x31°	104°x31°
XGIS (3 DU – 35 ° off-set)	64°x64°	124°x64°
IRT (max Fov)	10'x10'	10'x10'



Pitch & yaw [roll]	SXI	XGIS	IRT
APE (3 sigma, arcsec)	120 [270]	120 [270]	120 [270]
AMA (3 sigma, arcsec)	3 [90]	3 [90]	3 [90]
APD (3 sigma, arcsec) on observation time of 30 minutes	N.A.	N.A.	10 (TBC)
RPE/Jitter(3 sigma, arcsec) on exposure time of 10 seconds	N.A.	N.A.	1 [1]

THESEUS Satellite Configuration Drivers (1/2)

- The IRT LoS is the main reference of the overall payload.
- No single/total FOV obstructions
- SXI and XGIS alignment have to take into account the LoS and FoV of each individual DU. The alignment accuracy of each SXI/XGS Detector Unit with respect to the IRT LoS should be within 1-2 arcmin.
- Payload instruments are distributed around the longitudinal axis of the satellite and mounted as close as possible to it in order to:
  - Minimize S/C MoI
  - Support efficient load transfer from the spacecraft to the launch vehicle
- Embedding part of the IRT into the S/C structure, with S/C symmetry axis aligned to IRT LoS, increases the S/C compactness

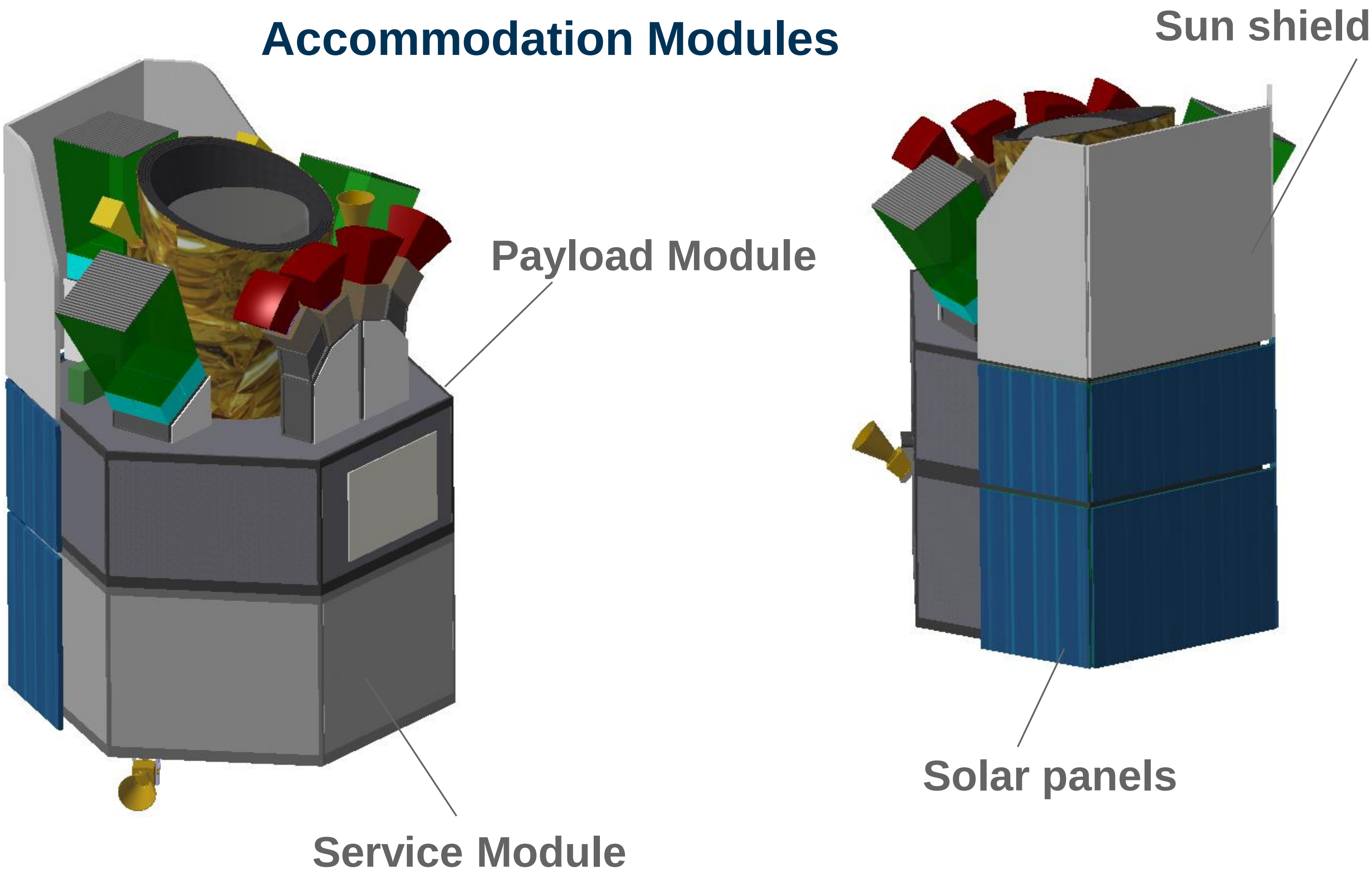
THESEUS Satellite Configuration Drivers (2/2)

- The 4 SXI modules are nominally mounted close to IRT on the opposite side of the solar panels; this will ensure to keep them in the coldest side of the satellite and to have the largest area of the observable sky when THESUES lies between Sun and Earth

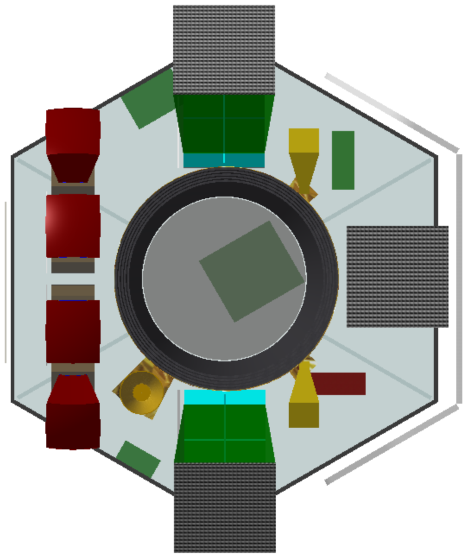
- The SXI DUs positions and orientations are determined in such a way that:
  - no X-rays reflected by IRT tube or any other structure can enter into SXIs FOV,
  - single FOVs do not interfere to each other,
  - the SXI FOV surrounds the smaller IRT FOV.

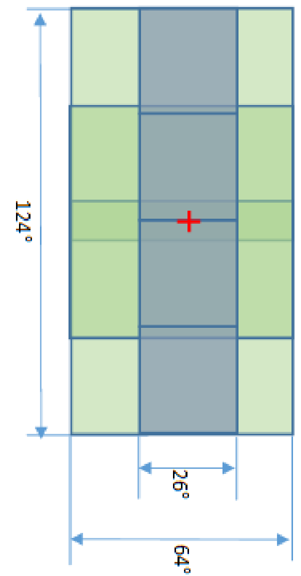
- The accommodation of a IRT cryocooler have to take care of radiator position and micro-vibration minimization

THESEUS Baseline Configuration

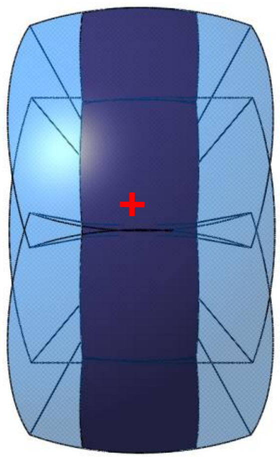


Instruments Combined FoVs

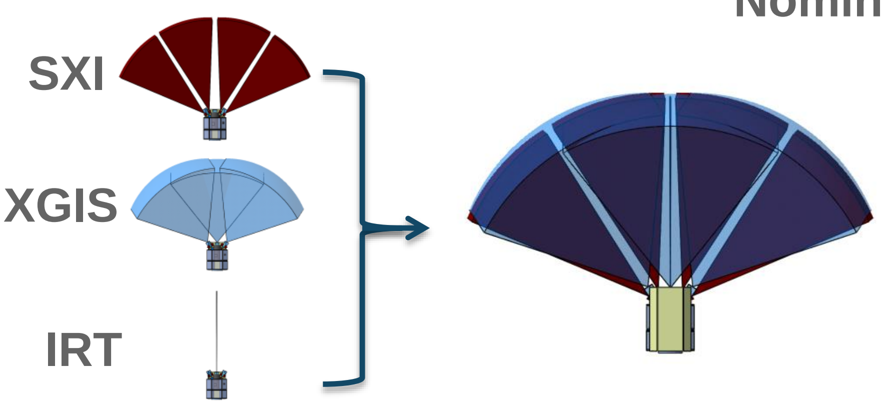


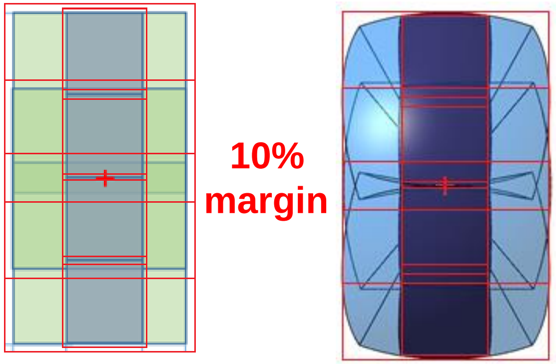


Nominal FoV



Total FoV from Accomodation



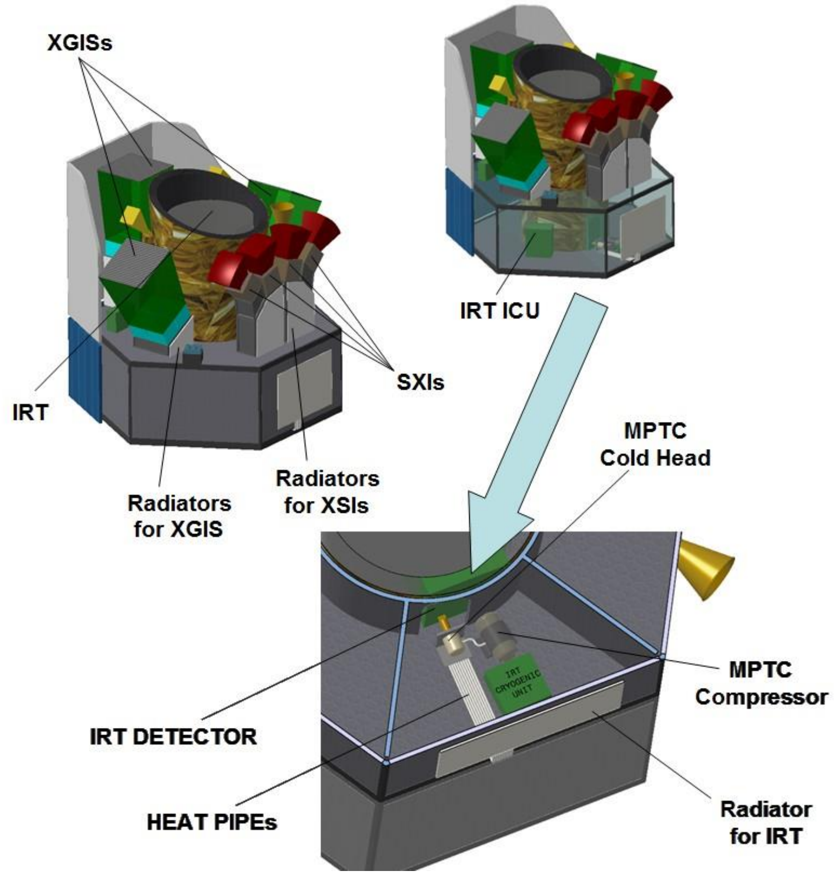


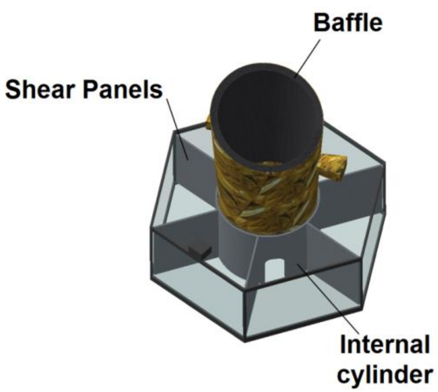
THESEUS Payload Module

Thermal Design:
- Radiators
- MLI
- MPTC

Structure:
- Shear Panels
- Internal Cylinder

Instrument Element	Operative range (°C)	Cooling
SXI- structure/optics	-20 ÷ +20	passive
SXI- detectors	-65	active
XGIS-detectors	-20 ÷ +10	passive
IRT-structure	-30	active
IRT-optics	-83	active





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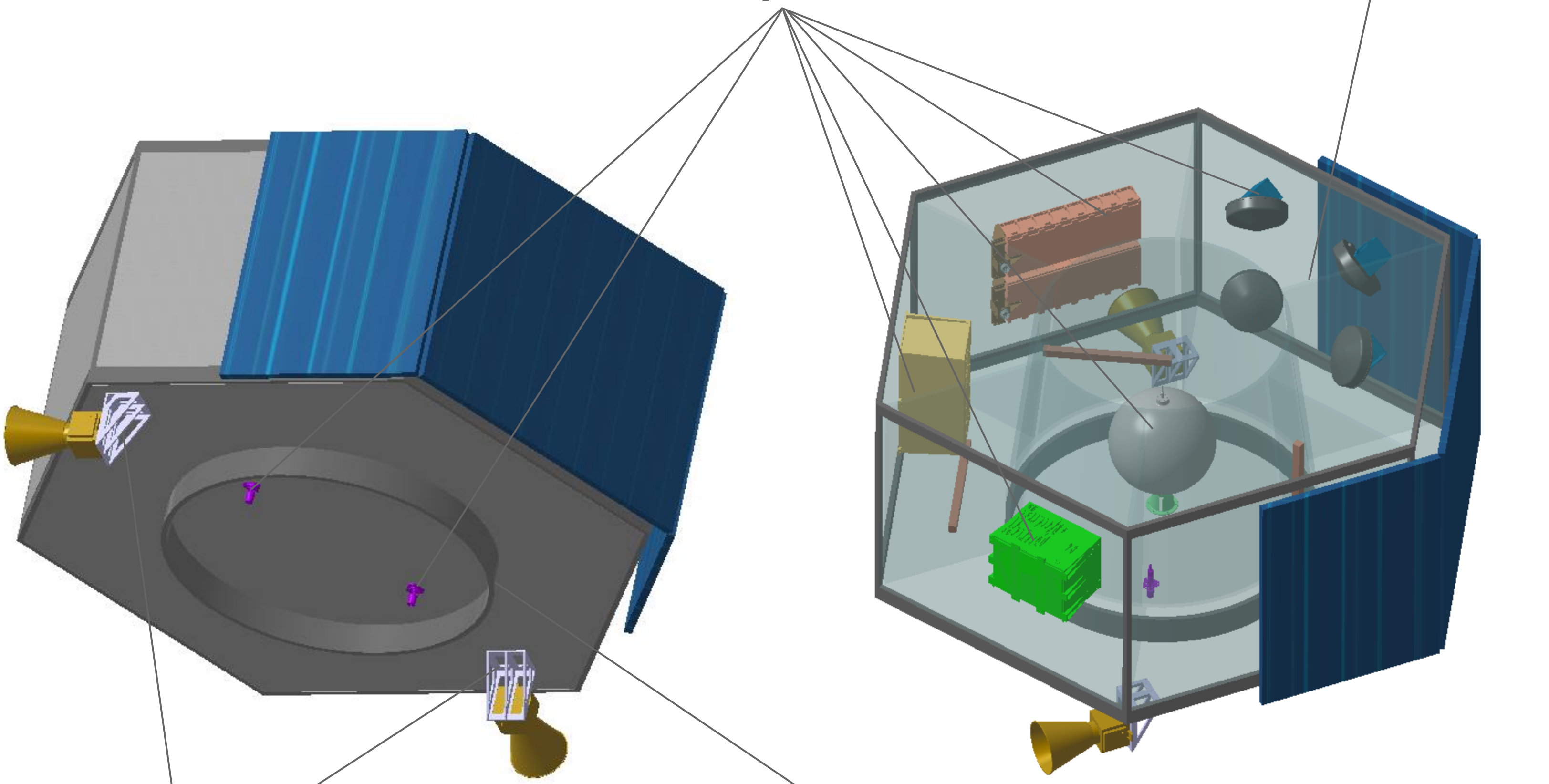
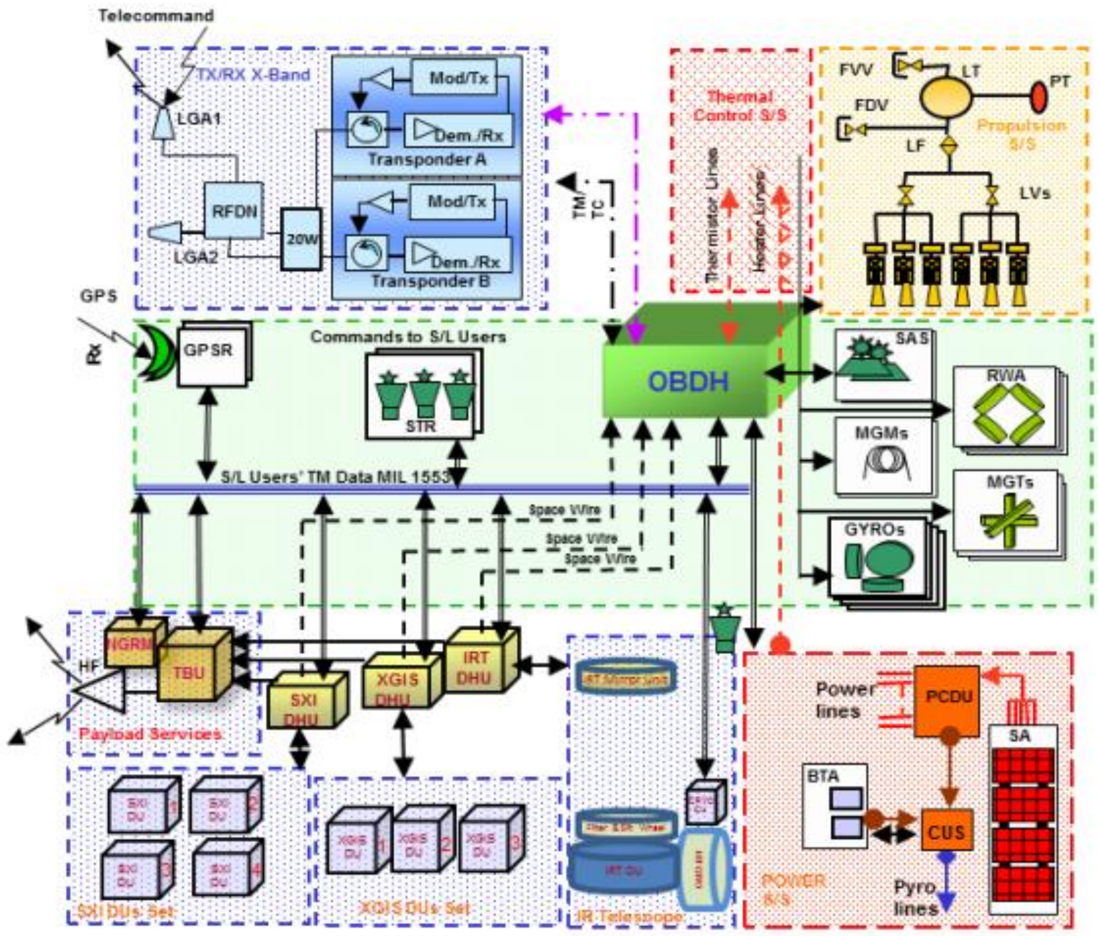
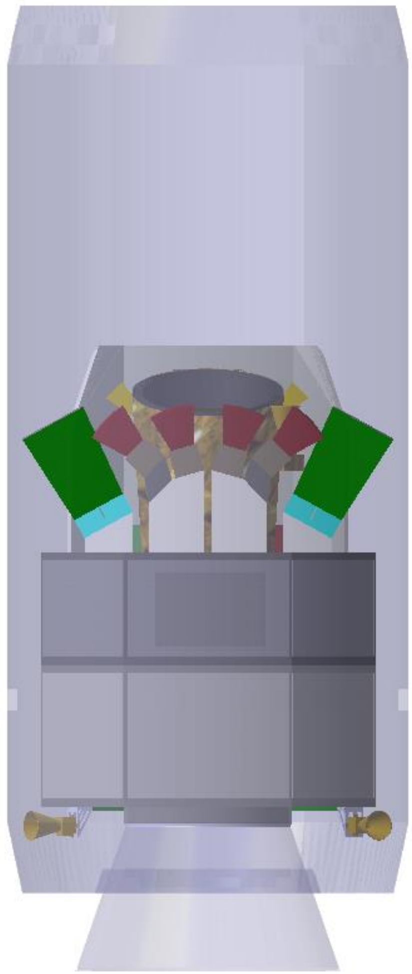
THESEUS Service Module



THESEUS Platform Block Diagram



THESEUS Accommodation within VEGA-C Fairing



Preliminary Mass & Power Budgets

FUNCTIONAL SUBSYSTEMS	Basic Mass (kg)	Margin (%)	Margin (kg)	Current Mass (Kg)
SERVICE MODULE				
AOCS (gyro, RW, SAS, ST)	115,1	10%	11,5	126,6
PDHU + X BAND	31,4	10%	3,1	34,5
DATA HANDLING	24,4	5%	1,2	25,6
EPS (PCU, Battery, SA)	85,1	10%	8,5	93,6
SYSTEM STRUCTURE	129,1	10%	12,9	142,0
PROPULSION	17,0	15%	2,5	19,5
THERMAL CONTROL (heaters+blankets)	14,2	10%	1,4	15,6
HARNESS	46,0	20%	9,2	55,2
Total Service Module Mass	462,3	11%	50,5	512,8
PAYLOAD MODULE				
SXI	100,0	20%	20,0	120,0
XGIS	93,0	20%	18,6	111,6
IRT	94,2	20%	18,8	116,0
i-DHU + i-DU + NGRM + TBU + harness (TBC)	23,1	20%	4,6	27,7
Total P/L Module Mass	310,3		62,1	375,3

Total Service Module Mass (kg)	512,8
Total Payload Module Mass (kg)	375,3
System level margin (20%)	177,6
Dry Mass at launch (kg)	1065,6
Propellant	100,0
Launcher adapter	31,7
Total mass at launch (kg)	1197,3

FUNCTIONAL SUBSYSTEMS	Nominal Avg Power (Watt)	Margin (%)	Margin (Watt)	Current Avg Power (Watt)
SERVICE MODULE				
AOCS	*79*	*10%*	*8*	*87*
DATA HANDLING	*37*	*10%*	*4*	*41*
EPS	*39*	*10%*	*4*	*43*
PROPULSION	*1*	*10%*	*0*	*1*
THERMAL CONTROL (incl. PLM)	*83*	*20%*	*17*	*100*
PDHU + X BAND	*42*	*10%*	*4*	*46*
Total Service Module Power	*282*	*13%*	*36*	*318*
PAYLOAD MODULE				
SXI	*93*	*20%*	*19*	*111*
XGIS	*75*	*20%*	*15*	*90*
IRT	*96*	*20%*	*19*	*115*
NGRM+TBU	*93*	*20%*	*19*	*111*
I-DHU + i-DU (TBC)	*25*	*20%*	*5*	*30*
Total Payload Module Power	*381*	*20%*	*76*	*457*

Satellite Nominal Power (W)	
Service Module	282
Payload Module	381
20% System Margin	132
Harness Loss	18
Total power with losses and margin	813

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The End

Thank you for your attention.

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