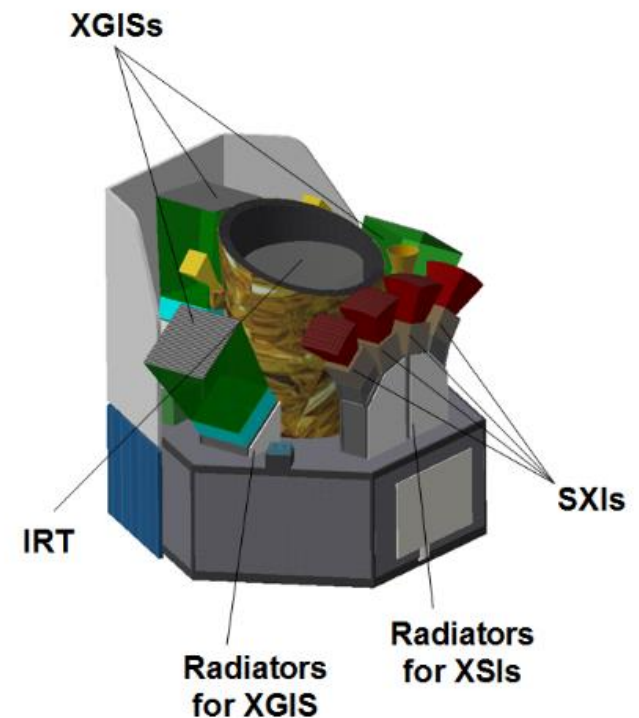


# The THESEUS Ground Segment

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## INTEGRAL (1996-20XX)

Leading the Science Ground Segment operations (software development & maintenance, data processing, archiving, distribution, quick-look, help desk)



## PLANCK (2005-2012)

Developed the Level 1 data processing system for the low-frequency instrument (LFI) to be run at the PLANCK Data Processing Centre in Trieste.



## GAIA (2008-20XX)

Leads the set up of the “Variability data processing unit” (software development & maintenance, periodic data processing and ingestion in the archive, data validation)



## EUCLID (2010-20XX)

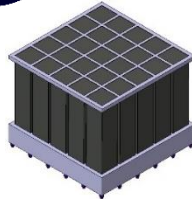
Software development for the distance determination derived from the photometric measurements.





### Astro-H (2009-2016)

Leading the ESSC, which tasks are focused on supporting the European scientific community with respect to the utilization of ASTRO-H.



### POLAR (2005-2017)

Participation to the Science Ground Segment operations



### CHEOPS (2014-20XX)

Leading the overall mission Science Operation Center.



### LOFT (2010-2014)

Led the design of the Science Ground Segment and the definition of the operation chain and data-flow



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### XIPE (2015-20XX)

Leads the design of the Science Ground Segment and the definition of the operation chain and data-flow

Athena, EUSO, eXTP, SPICA, etc...



The University of Geneva has a long standing experience (still expanding) in:

- ✓ **Overall SDC management and engineering**
- ✓ **data processing**
- ✓ **Distribution**
- ✓ **archive management**
- ✓ **quick-look analysis & data validation**
- ✓ **software development** (science software and processing pipelines)
- ✓ **community support** for scientific space missions

For the THESEUS ESA M5 proposal, a sketch of the GS organization has been prepared based on the experience gained in previous running missions and on M3/M4 projects.

A revised and refined GS structure and organization will be achieved at the end of the assessment phase (i.e. most of the current assumptions are still TBD).

The current sketch of the THESEUS ground segment has been **designed to maximize the science return of the mission** and taking into account that:

- GRBs, transient sources, and ToOs are the key ingredients of the mission → **QLA concept and data processing strategy**
- The position of GRBs and transient sources will be communicated rapidly (<30 s) to the ground. Prompt diffusion of these information to the science community at large are of paramount importance → **integration of the TBAGS in the THESEUS SGS**

## Data products

**Raw telemetry:** science telemetry + (preliminary) auxiliary data. Few Gbit per orbit are expected.

**Level 0:** binary FITS files for each instrument. On-board calibrations are applied to all instrument data.

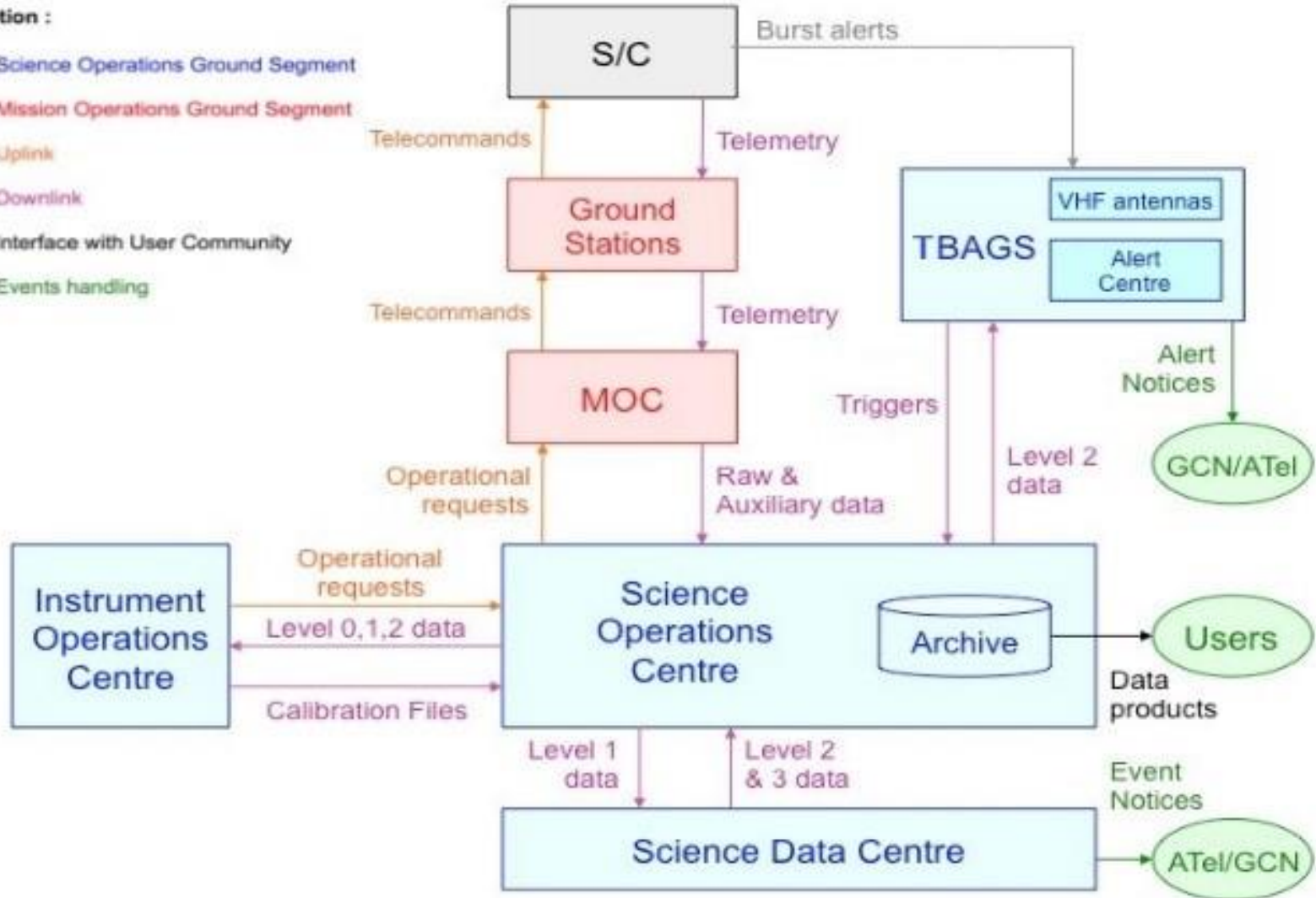
**Level 1:** all corrections (such as aspect correction, time calibration, barycentric corrections) and instrument-specific calibrations (such as detector gains and good-timing information) are applied to level 0 data to obtain cleaned event files.

**Level 2:** pre-defined science products (NOTE: level 2 products are also used for the QLA).

**Level 3:** enhanced, higher level, scientific products derived from Level 2 data

Table caption :

- Science Operations Ground Segment
- Mission Operations Ground Segment
- Uplink
- Downlink
- Interface with User Community
- Events handling



## Operational Ground Segment

- Ground Stations: Malindi, Alcántara
  
- Mission Operation Center (MOC):
  - commanding of the spacecraft and instruments
  - ensuring the spacecraft safety and health
  - provision of Flight Dynamics support
  - all communications with the satellite through the ground stations (upload of the platform and payload telecommands, reception of telemetry)
  - collecting the science data and the transmission to the SOC
  - providing the raw telemetry, housekeeping and auxiliary data to the SOC
  - Providing the telecommand history and other auxiliary data (including attitude history, time calibrations and barycentric corrections) to the SOC



## Science Ground Segment

- Science Operation Center
- Instrument Operation Centers
- Science Data Center
- THESEUS Burst Alert Ground Segment (TBAGS)
  
- Science Operation Center (SOC):
  - Mission planning and proposals handling
  - Automatically process lower level data (Raw to Level 0 and Level 0 to Level 1 data processing)
  - Science Data Archive (data and software distribution to the users)
  - Observation and performance simulator
  - User Support and mission outreach

## Science Ground Segment

- Science Operation Center
- Instrument Operation Centers
- Science Data Center
- THESEUS Burst Alert Ground Segment (TBAGS)
  
- Instrument Operations Centers (IOCs, one per instrument):
  - through national funding
  - deep expertise of the payload
  - support to ESA for payload system integration on the spacecraft, maintenance, operations and calibration
  - characterize and calibrate the instrument responses (provide calibration data)
  - monitor the science performance of the instruments, long-term trend analysis of instrument performance
  - maintain the on-board software (OBSW)
  - maintain the on-board database
  - raise anomaly reports
  - support the investigations of anomalies

## Science Ground Segment

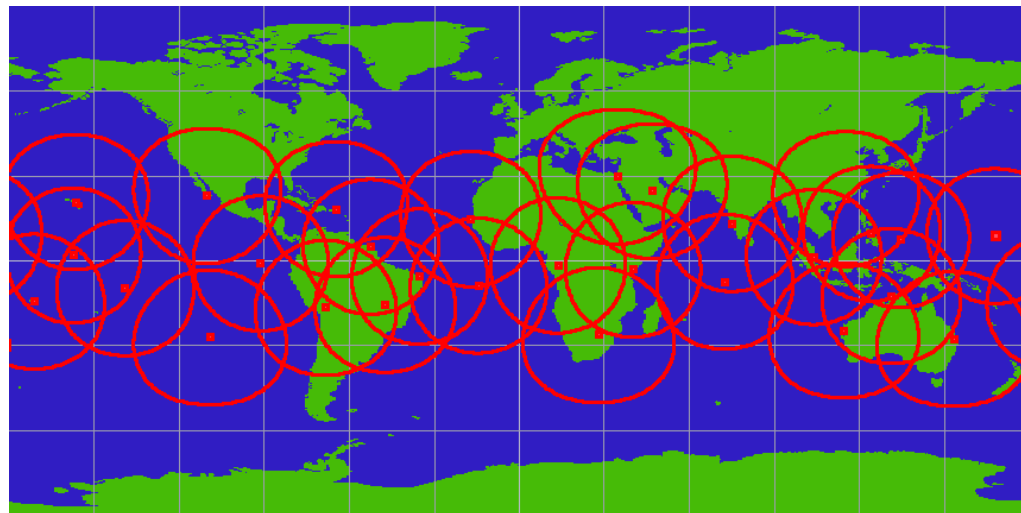
- Science Operation Center
- Instrument Operation Centers
- Science Data Center
- THESEUS Burst Alert Ground Segment (TBAGS)
  
- Science Data Center (SDC):
  - established through national funding and built as a consortium of institute with a leading agency
  - providing interactive and pipeline data analysis software, Quick-Look Analysis (QLA) software, pre-processing software
  - perform pipeline processing of higher level data (Level 1 to 3)
  - lead the data processing software maintenance task
  - perform sky monitoring and provide the publicly available results to the community
  - support the IOC in the instrument calibration activities
  - User support related to analysis software, data processing and quality
  - workshops for training in data analysis and software usage
  - contributes to the testing and validation of the overall SGS operational system



## Science Ground Segment

- Science Operation Center
- Instrument Operation Centers
- Science Data Center
- THESEUS Burst alert Ground Segment (TBAGS): LAC+VHF stations
- TBAGS:
  - ~40 VHF SVOM ground stations
  - THESEUS Alert Center (TAC): personnel monitoring the on-board generated alerts and support/feedback to the community.

## The VHF system of ground antennas

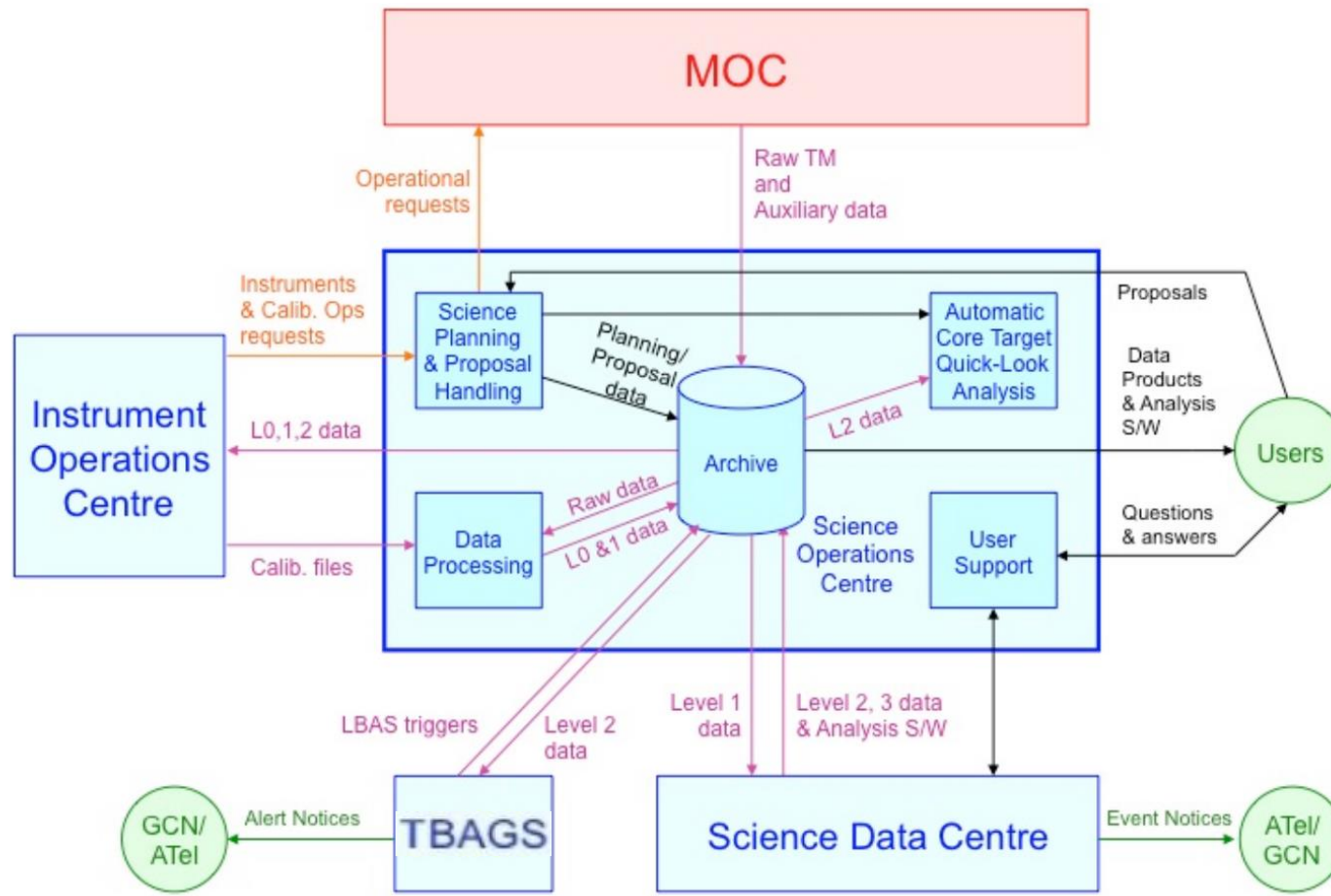


*The VHF network foreseen for SVOM.*



*An example of the old HETE 2 VHF equipment: antenna + workstation.*

## Data flow



Processing of raw telemetry into level 0 and 1 data → done automatically at SOC as soon as telemetry is provided by MOC

Processing of level 1 data into level 2 and 3 data: done by SDC through the TSDA

Calibrations ingested by IOCs into the TSDA

## Conclusions

- Relatively standard ground segment and SGS operations, but SGS will need increased capacity due to the need of fast re-planning and many ToOs.
- Based on the heritage of previous missions
- Optimized shared of tasks between ESA and the THESEUS Consortium
- Relatively small data rate (for the late 2020 scenario) and manageable data products
- **NB**: all assumptions are TBD during the assessment phase (2018/2019)