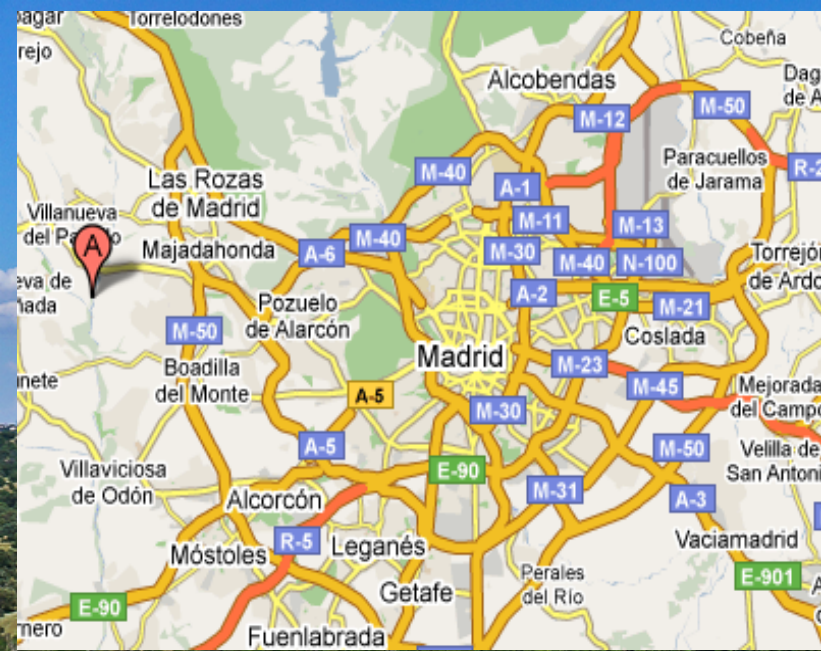


## SCIENCE OPERATIONS 2013

"Working Together in Support of Science"





# European Space Astronomy Centre: History and Current Activities



- 1978: Villafranca Satellite Tracking Station, **VilSpa**,
- 1970s, 1980s, 1990s: Support astronomy missions,
- Early 2000s: Expansion to planetary missions,
- 2008: VilSpa renamed **ESAC**.

➤ **ESAC activities now include:**

- Satellite Communications & Tracking,
- SMOS Data Processing Ground Segment,  
(SMOS = Soil Moisture and Ocean Salinity)
- Space Situational Awareness (SSA),
- Communication and Education,
- Centro de Astrobiologia (CAB ESAC) Lab.



- **Science Operations Centres for astronomy and planetary missions,**
- **Science Archives.**

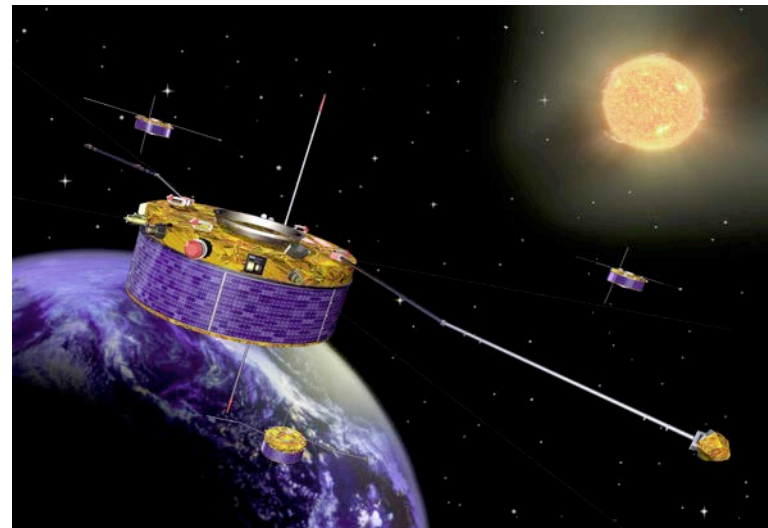
## **SCIENCE OPERATIONS 2013**

**"Working Together in Support of Science"**

Conference Purpose

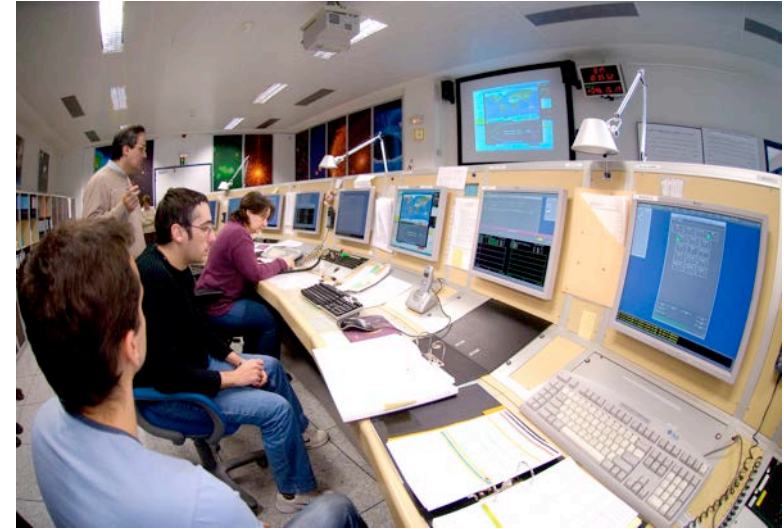
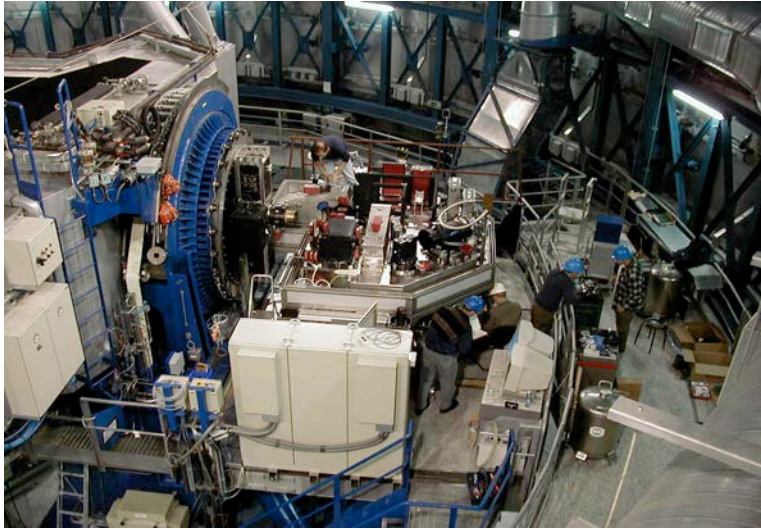
M. Kessler, ESA  
pp. Organisers

## Ground-Based / Space-Based



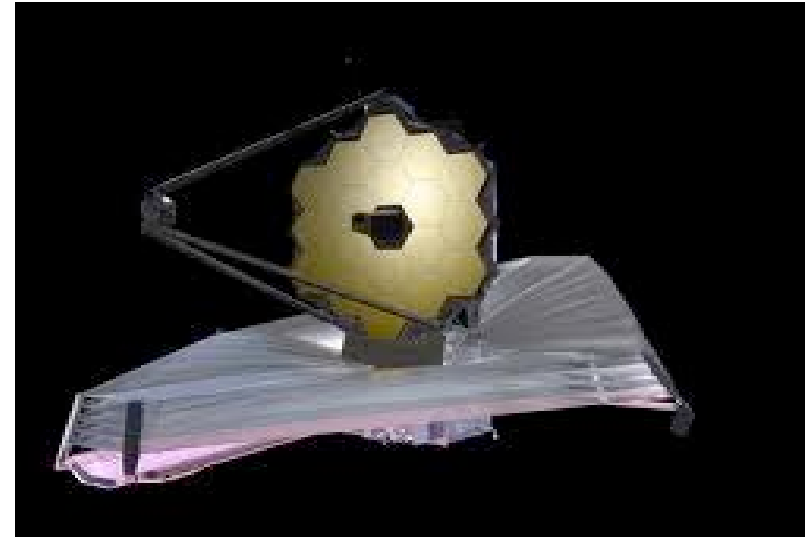
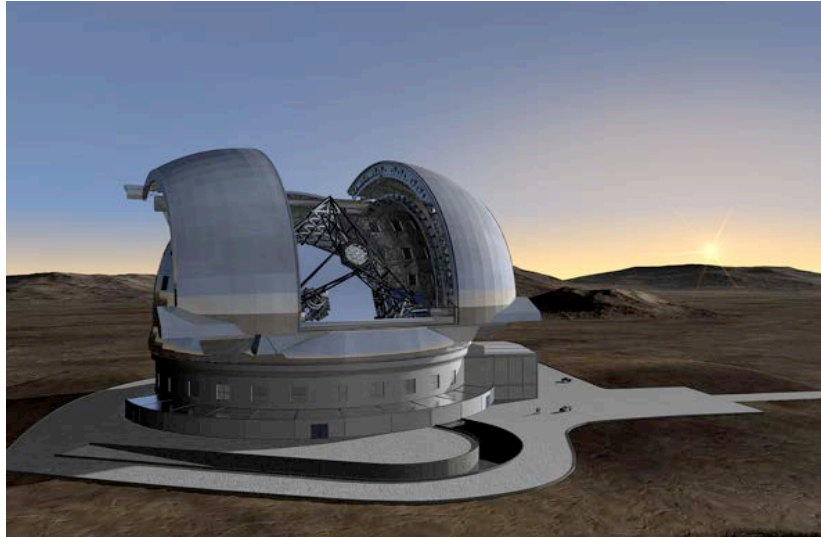
- Working at the interface of Science, Engineering, Operations & Management
- Lack of focus on Science Operations especially during early project phases
- Heterogeneous repository of concepts, tools, processes and terminology
- Strong institutional competition

## Ground-Based / Space-Based



- Larger, more complex and expensive infrastructures & instrumentation
- Growing expectations in terms of optimized deliveries and services
- Wider spectrum of communities to be served
- Increased demand on usability of combined results in science

## Ground-Based / Space-Based

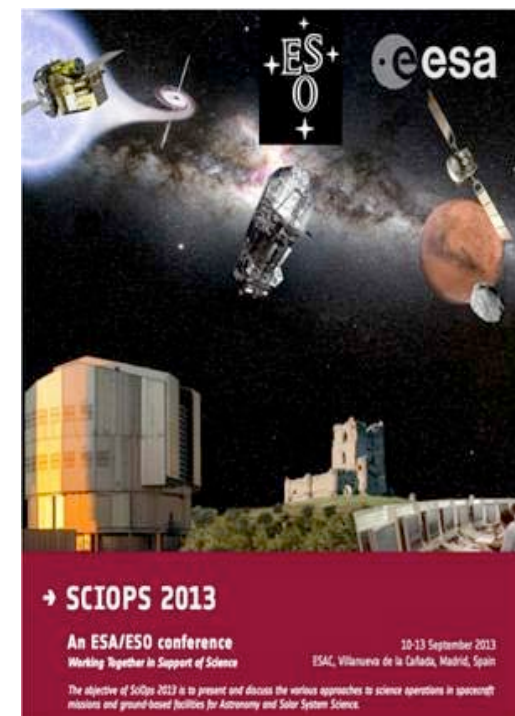


- Increased awareness for science operations as key to enabling science
- Improvements by transferring experience and harmonization
- A vision for the future

# Objectives for a Joint Look at Science Operations

The objective of SCIOPS 2013 is to present and discuss the various approaches to science operations in spacecraft missions and ground-based facilities for Astronomy and Solar System Science by:

- Comparing and improving our processes and approaches
- Fostering innovations
- Enabling a more efficient use of our resources
- Establishing and intensifying collaborations





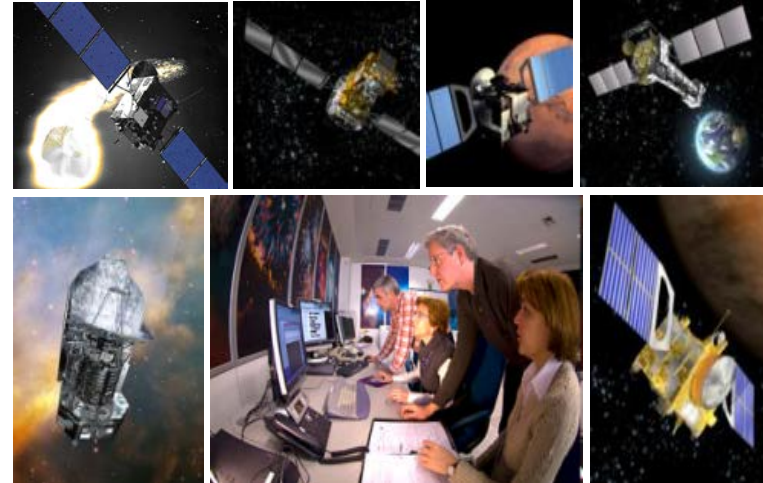
## **SCIENCE OPERATIONS 2013**

**"Working Together in Support of Science"**



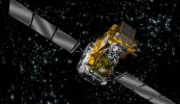



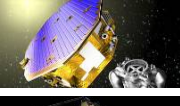

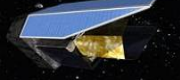
The Space Perspective

M. Kessler, ESA

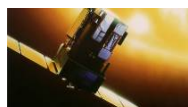
- Currently involved in ~25 missions
  - assessment to long-term archiving
- Most people located at ESAC (~200),
  - also at ESTEC, STScI and GSFC
  - mix of **scientists** and **engineers**.



# ESA Astronomy Missions in Operations and Development

	1990	Hubble Space Telescope (ESA SciOps at STScI)
	1999	XMM-Newton
	2002	INTEGRAL
	2009	Herschel Space Observatory
	2009	Planck
	2013	Gaia
	2015	LISA Pathfinder
	2018	James Webb Space Telescope (ESA SciOps at STScI)
	2020	Euclid

New missions under study: EChO, LOFT, Plato, STE-QUEST



1995 Solar and Heliospheric Observatory (SOHO)



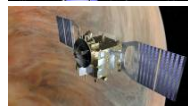
2000 Cluster



2003 Mars Express



2004 Rosetta



2005 Venus Express



2006 Hinode (Japanese-led Solar observatory)



2009 PROBA-2



2015 BepiColombo



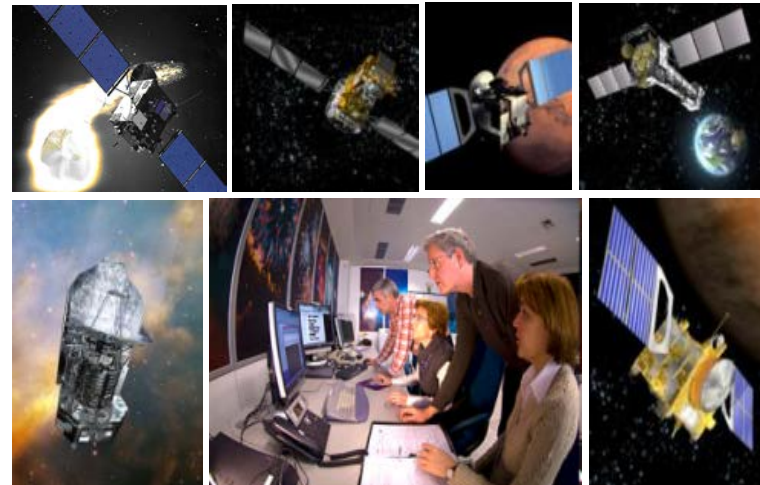
2017 Solar Orbiter

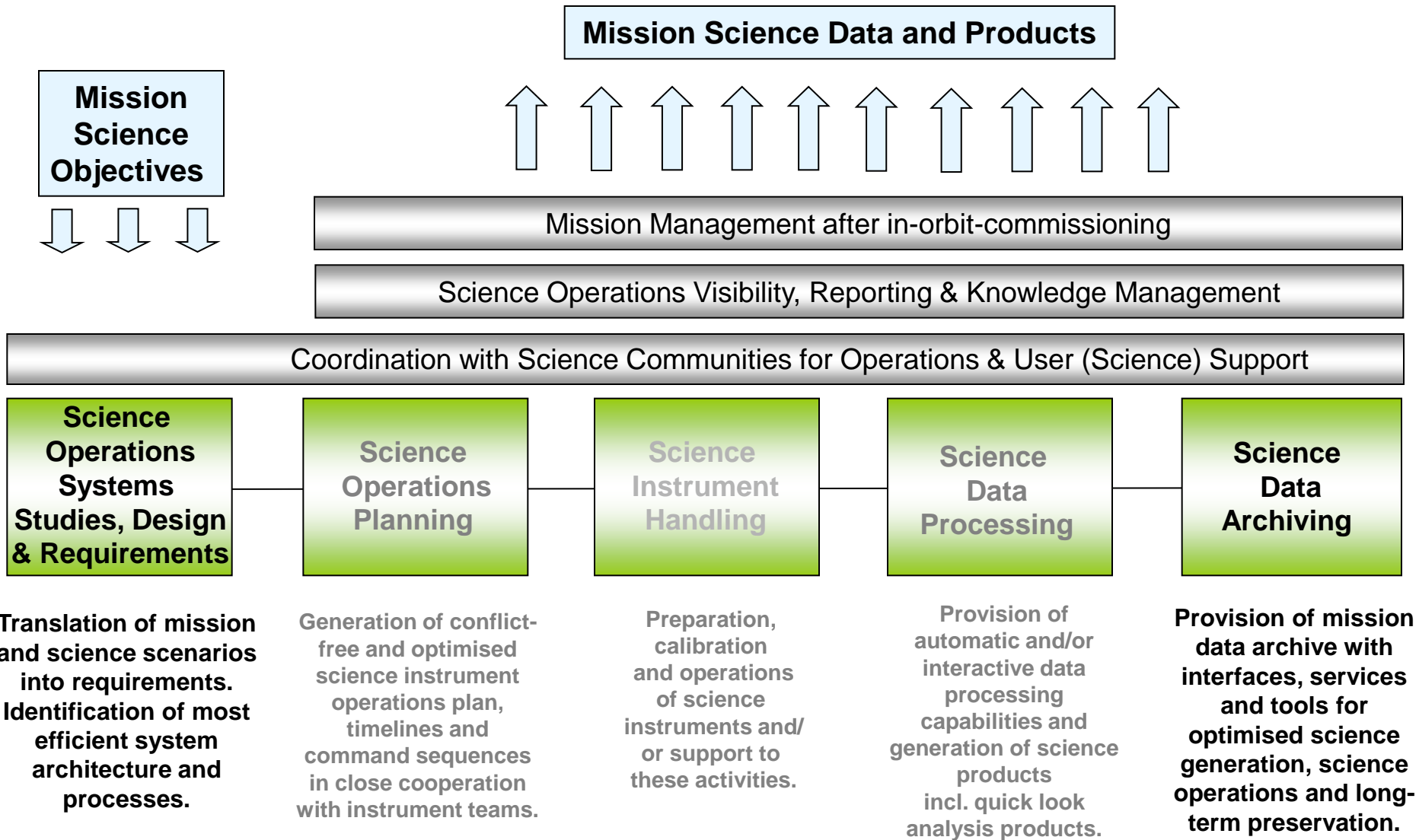


2022 JUICE

New missions under study: Marco-Polo R

- Currently involved in ~25 missions
  - assessment to long-term archiving
- Most people located at ESAC (~200),
  - also at ESTEC, STScI and GSFC
  - mix of **scientists** and **engineers**.
- Provides some/all of following elements:
  - **Interfaces to users:**
    - calls for proposals, information, workshops, training, helpdesk,...
  - **Payload operations:**
    - scientific scheduling and optimisation, payload monitoring, quick-look data analysis, ...
  - **Payload data acquisition, processing, distribution, and archiving:**
    - payload calibration and cross-calibration, data processing (interactive tools and pipelines), archive development, population and maintenance,...





# ESA's Approach to Science Operations

- Top-level requirements per mission defined in 'Science Management Plans', approved by Member States at Science Programme Committee (SPC)
- We carry knowledge, experience and expertise from project to project
- Act as interface between "industrial/agency" and "university" cultures
- ESA-provided elements usually "embedded" in a larger cooperation with multiple Member State entities on Science Ground Segment.



**ESA's Science Operations Centre together with Member State Partners (Instrument Centres, Processing Centres, etc.) form a Science Ground Segment (SGS)**

# Science Operations with ESA and Member States

## ESA Coordination with Science Provider and User Communities



Usually more by ESA



Usually more by Member States



Usually more by ESA



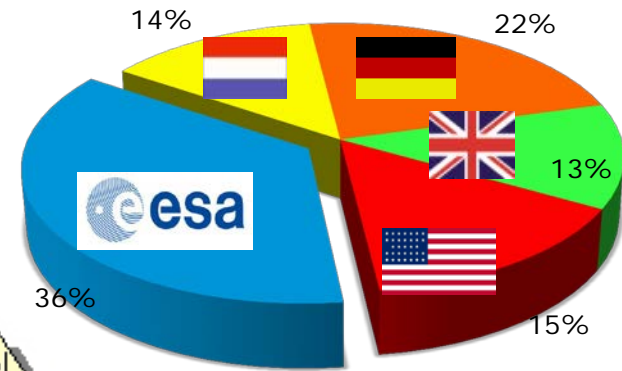
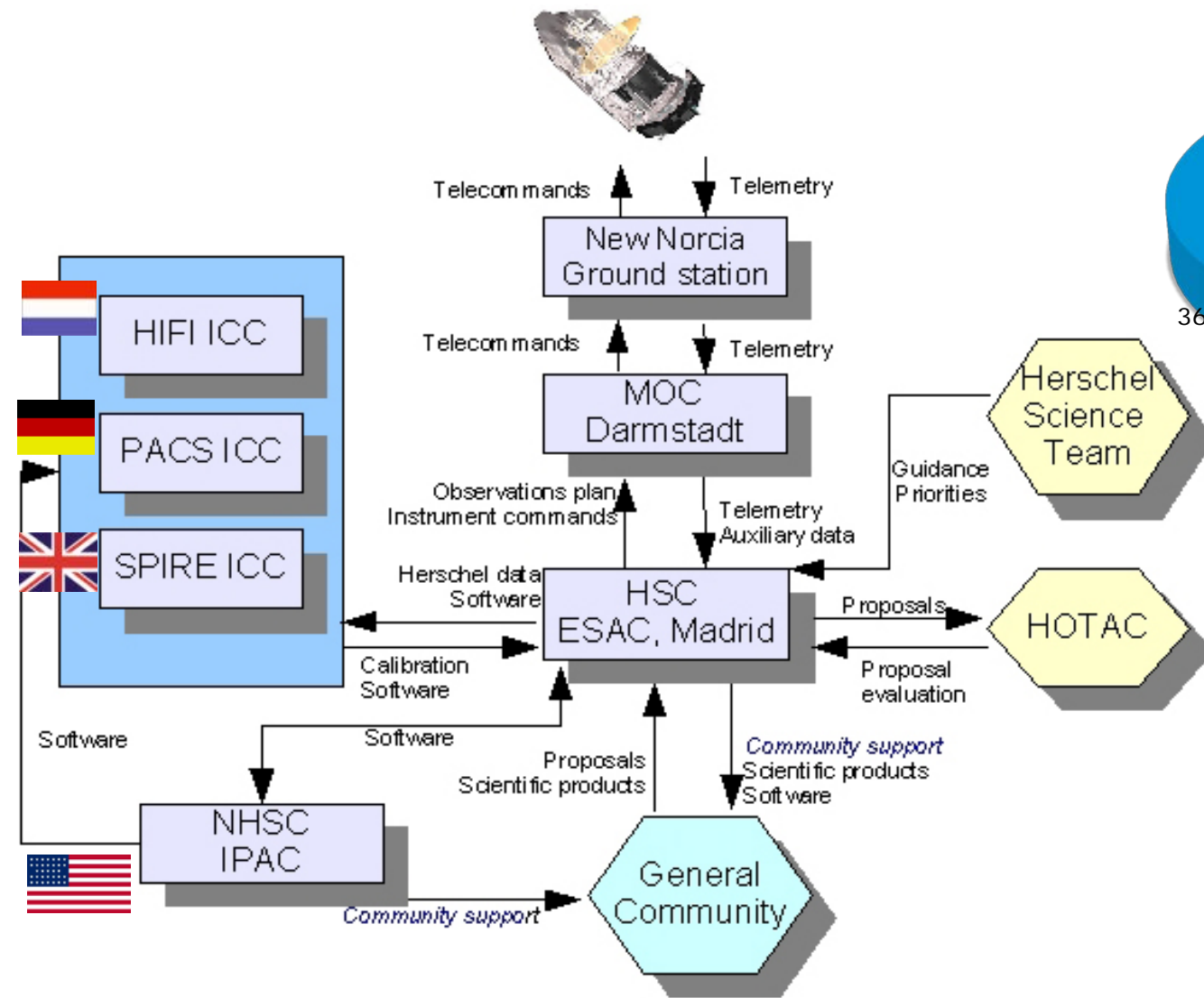
Task distribution between ESA and Member States is mission specific

Member States usually contribute bulk of resources

ESA provides overall coordination (rather than direct management)

ESA has overall responsibility for scientific outputs of the mission





Distributed system.

200 active developers worldwide (mostly Europe, USA, Canada, China)

~4 million lines Java code

~15-20 year lifetime



# Euclid Science Ground Segment



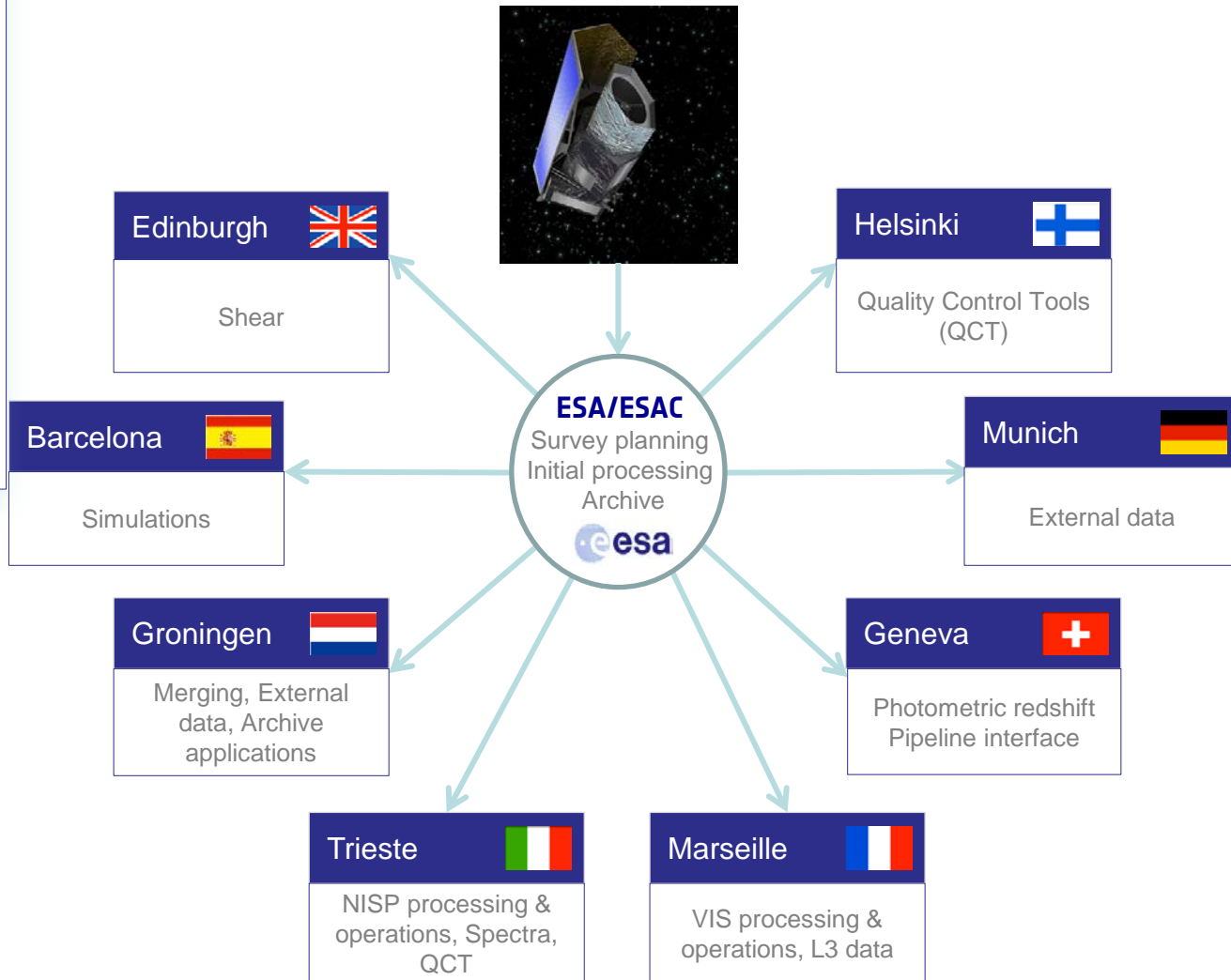
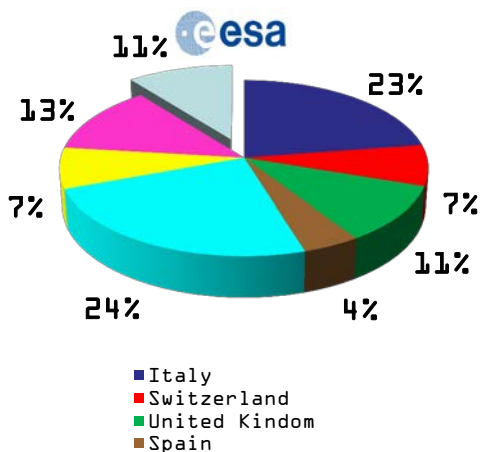
## ESA responsibilities:

- SGS overall design
- Interface to mission operations
- Payload operations coordination
- Archive and community support

## National contributions:

- Science data production
- Pipeline/Infrastructure development
- Data processing facilities
- Management (IT) and engineering support (FR)

Science Ground Segment Manpower Distribution





The European Space Astronomy Centre (ESAC) hosts most of ESA astronomy and planetary missions' archives. This currently includes:

- [Herschel Science Archive](#) → [Herschel Mission](#)
- [XMM-Newton Science Archive](#) → [XMM-Newton Mission](#)
- [ESA Hubble Science Archive](#) → [HST Mission](#)
- [Planck Legacy Archive](#) → [Planck Mission](#)
- [ISO Data Archive](#) → [ISO Mission](#)
- [ESA's Planetary Science Archive](#) → (regrouping data from Rosetta, Mars Express, Venus Express, Huygens, Smart-1 and Giotto for the time being)
- [SOHO Science Archive](#) → [SOHO Mission](#)
- [Ulysses Final Archive](#) → [Ulysses Mission](#)
- [INTEGRAL Science Data Archive](#) → [INTEGRAL Mission](#)
- [EXOSAT Science Archive](#) → [EXOSAT Mission](#)

**Archive data from 15 missions;  
5 more under development**

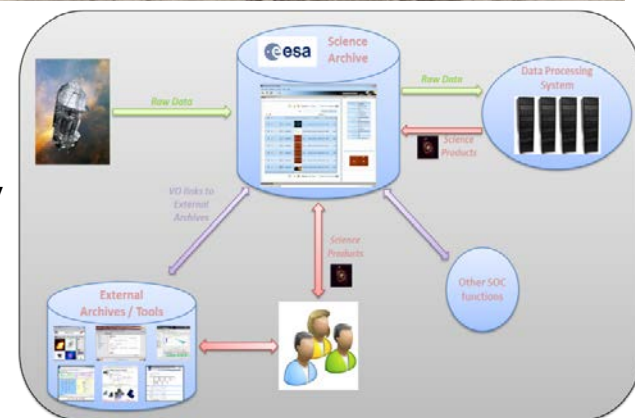
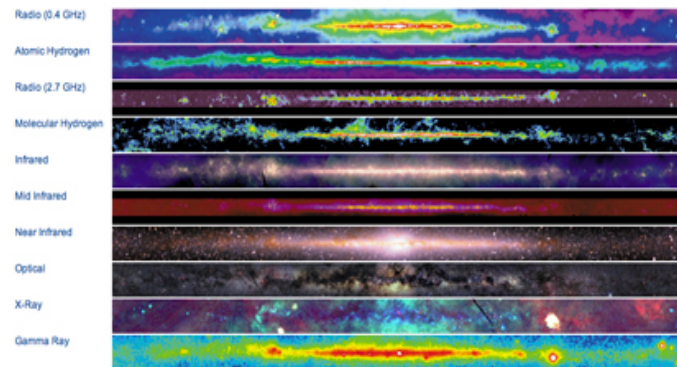
### Latest News

- 23rd July 2013: The XMM-Newton Science Archive v8.0 is released! Highlights: a new web-based interface and the 3XMMi catalogue.
- 21st March 2013: The Planck 2013 results are now available to the world-wide community through the Planck Legacy Archive version 1.0!
- 25th February 2013: The Ulysses Final Archive version 1.0 is released.

In the future Cluster, Gaia, BepiColombo, Solar Orbiter and Euclid will also have their archives located at ESAC.

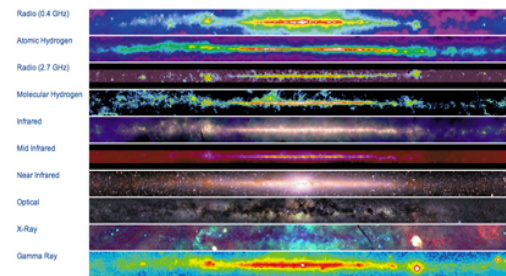
Within the Science Operations Department of ESA's Directorate of Science and Robotic Exploration, all these archives are designed, developed, maintained and operated by the Science Archives Team at ESAC, using common, modular and flexible 3-tier architecture, where the data storage is clearly separated from the data presentation. This ensures automatic operations as well as long-term maintainability and evolution. Through easy-to-use graphical user interfaces or through powerful machine and Virtual Observatory interfaces, they provide instant access to ESA scientific mission data for the science operations centres at ESAC and to the scientific community worldwide.

- Large set of science archives co-located at ESAC are a major research asset for community
- Need to be kept readily available for future users and novel uses
- Thus, must plan now for next 5–20+ years
- Planning based around 3 major goals:
  - Enable maximum scientific exploitation of data sets
  - Enable efficient long-term preservation of data, software and knowledge, using modern technology
  - Enable cost-effective archive production by integration in, and across, projects



# Enable maximum scientific exploitation of data sets

- A key objective is to provide the scientific community with the best possible means to exploit the results obtained from ESA's scientific missions.
- We plan to:
- Develop a powerful multi-mission, multi-instrument, multi-wavelength archive interface to enable the scientific exploitation of the results in the ESAC archives by expert and novice users alike.
- Ensure that our archives are fully-interoperable with those of our partners (including any ground-based facilities) by adopting or developing the necessary, protocols, products and tools to facilitate the broadest possible exploitation of ESA scientific data.
- Provide high-quality user science support (“helpdesk”) services by pooling internal and external science experts.
- Stimulate scientific utilisation of the ESAC archives, together with European partners, to ensure the maximum benefit from added value services.



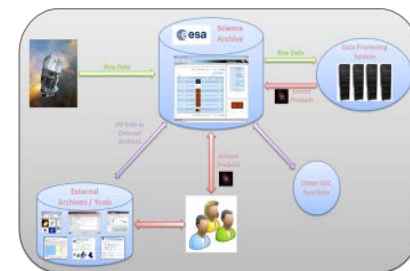
- Key objective to ensure the long term preservation and accessibility of the ESA mission science “Legacy”.
- Contributing to build up of European Legacy of Space Science Data by preserving all mission data (uplink, raw, processed and associated metadata), together with associated software and knowledge and up to date archive access services to enable continued exploitation of ESA science data in the long term
- Implement European partnerships for Long Term Preservation (data, software and knowledge, Archive Technology development)
- Contribute to VO evolution with other Data Centres, PI teams and Community
- Ensure archive technology awareness and motivation for technology migration every 5-7 years to ensure efficient ESA science archives services



# Cost effective archive production by integration with projects

## ➤ Archive integration into Science Operations projects:

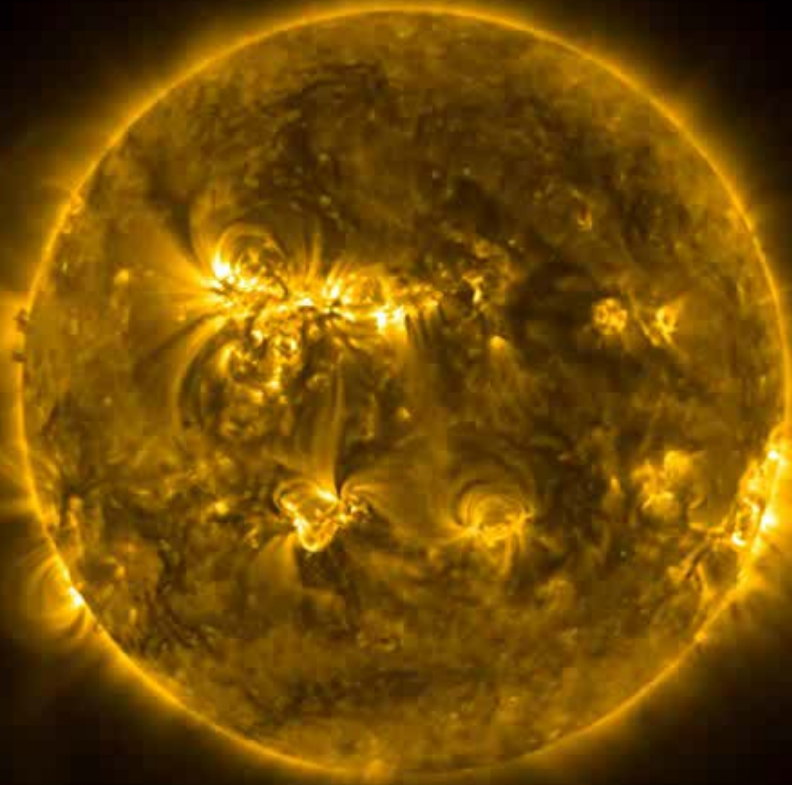
- Archive as a project component which provides crucial feedback into other science operations components of the project
- Archive can incorporate the full operational context of a project
- Allows archive development without duplications and avoids deficiencies due to late implementation



## ➤ Archive horizontal integration into ESAC Archives:

- Exploitation of economy of scale as part of ESAC Archives' operations
- Convenient access to multi-mission ESAC Archive contents
- Archive harmonisation across projects e.g. through common approach to metadata

# PROBA-2: June 2012 Transit of Venus



PROBA2/SWAP 174 2012-06-05T18:25:09.984



# Views from Mars Express



# Herschel and Other Views of the Eagle Nebula (M16)

