



ESA's Science Operations Centre – ESAC

Martin Kessler,

ESAC, 25 May 2018

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European Space Agency

Then: VilSpa

ESA **VIL**lafranca
SPAin Satellite
Tracking Station.



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Now: ESAC – European Space Astronomy Centre



Key dates for VilSpa/ESAC



- 1978: Opening of **VILSPA**.
- 1970s, 80s and 90s: Support for astronomy missions:
 - IUE, ISO, XMM-Newton.
- Early 2000s: Expansion to planetary missions:
 - Rosetta, MEX, VEX.
- 2005: Cebreros DSA inaugurated.
- 2008: VILSPA became **ESAC** the European Space Astronomy Centre.

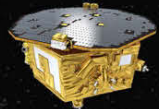


ESAC Main Activities Now

- Satellite tracking,
- Earth Observation:
 - SMOS Spanish National Centre,
- INTA/CSIC Astrobiology Centre (CAB),
- Galileo Navigation Science Office,
- Contribution to Space Situational Awareness,
- ESAC Education activities,
- ESAC Communication activities,
- **ESA's Science Programme:**
 - **Science ops including archives, in-orbit management.**



ESA's Fleet across the Spectrum

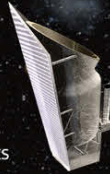


lisa pathfinder

Testing the technology for gravitational wave detection [2015-2017]

iso

Chemical analysis of celestial objects [1995-1998]



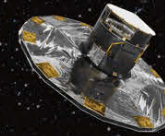
hipparcos

The first astrometry satellite [1989-1993]



gaia

Surveying a billion stars of exoplanets [2013-]



iu

Analysing ultraviolet light from stars [1978-1996]



jwst

Observing the first light



cheops

Sizing and first characterisation of exoplanets



xmm-newton

Seeing deeply into the hot and violent Universe [1999-]



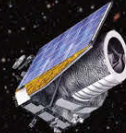
herschel

Unveiling the cool and dusty Universe [2009-2013]



euclid

Exploring the dark Universe



hst

Expanding the frontiers of the visible Universe [1990-]



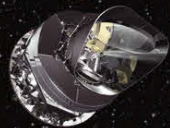
integral

Seeking out the extremes of the Universe [2002-]



planck

Looking back at the dawn of time [2009-2013]



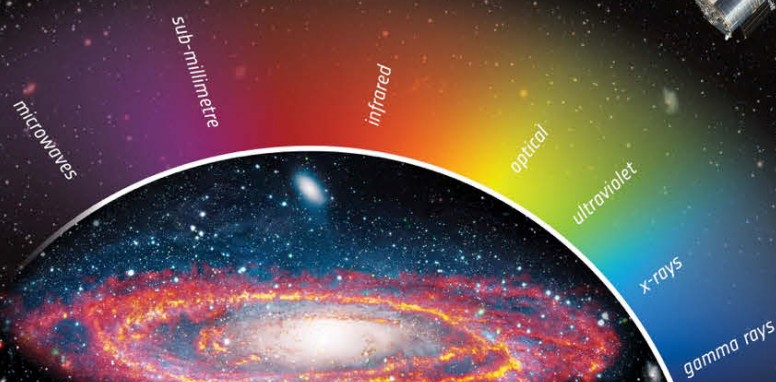
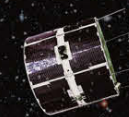
exosat

X-ray survey of high-energy phenomena [1983-1986]



cos-b

Surveying the high energy Galaxy [1975-1982]



ESA's Fleet in the Solar System



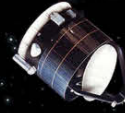
soho
Facing the Sun
[1994-]



proba-2
Observing coronal dynamics
and solar eruptions
[2009-]



giotto
Close encounter with comet Halley
[1986-1992]



bepicolombo
Exploring Mercury



venus express
Studying Venus' atmosphere
[2005-2014]



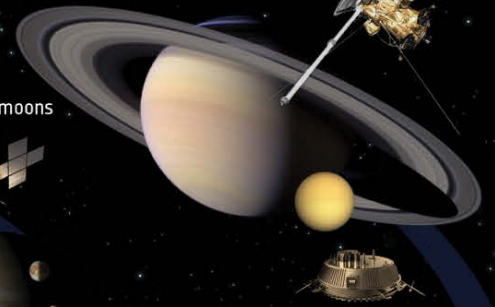
juice
Studying Jupiter's icy moons



exomars
Europe's new era
of Mars exploration
[2015-]



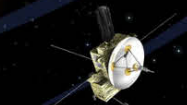
cassini-huygens
Studying the Saturnian
system and landing on Titan
[1997-2017]



smart-1
Exploring our Moon
[2003-2006]



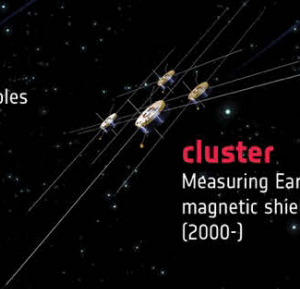
ulysses
Watching over the Sun's poles
[1990-2009]



solar orbiter
The Sun up close



cluster
Measuring Earth's
magnetic shield
[2000-]



mars express
Investigating the Red Planet
[2003-]



rosetta
Chasing and landing
on a comet
[2004-2016]



D/SCI Operations Department

- Overall management of ESA's operational space science missions.
- Science Operations Centres (SOCs) for
 - Astronomy,
 - Heliospheric, and
 - Planetary missions.
- Science Data Archives
 - long-term access to data & information.
- Involved in ~25 missions/studies.
- Over 200 scientists and engineers involved at ESAC and at STScI, GSFC, ESTEC, ...



Science Operations Centres

Provide, usually with member state/international partners, some/all of following elements:

- Interfaces to users,
- Payload operations,
- Payload data acquisition and processing,
- Science data archiving and distribution,
- Plus associated software (and procedures).



EXOSAT Reunion 2018



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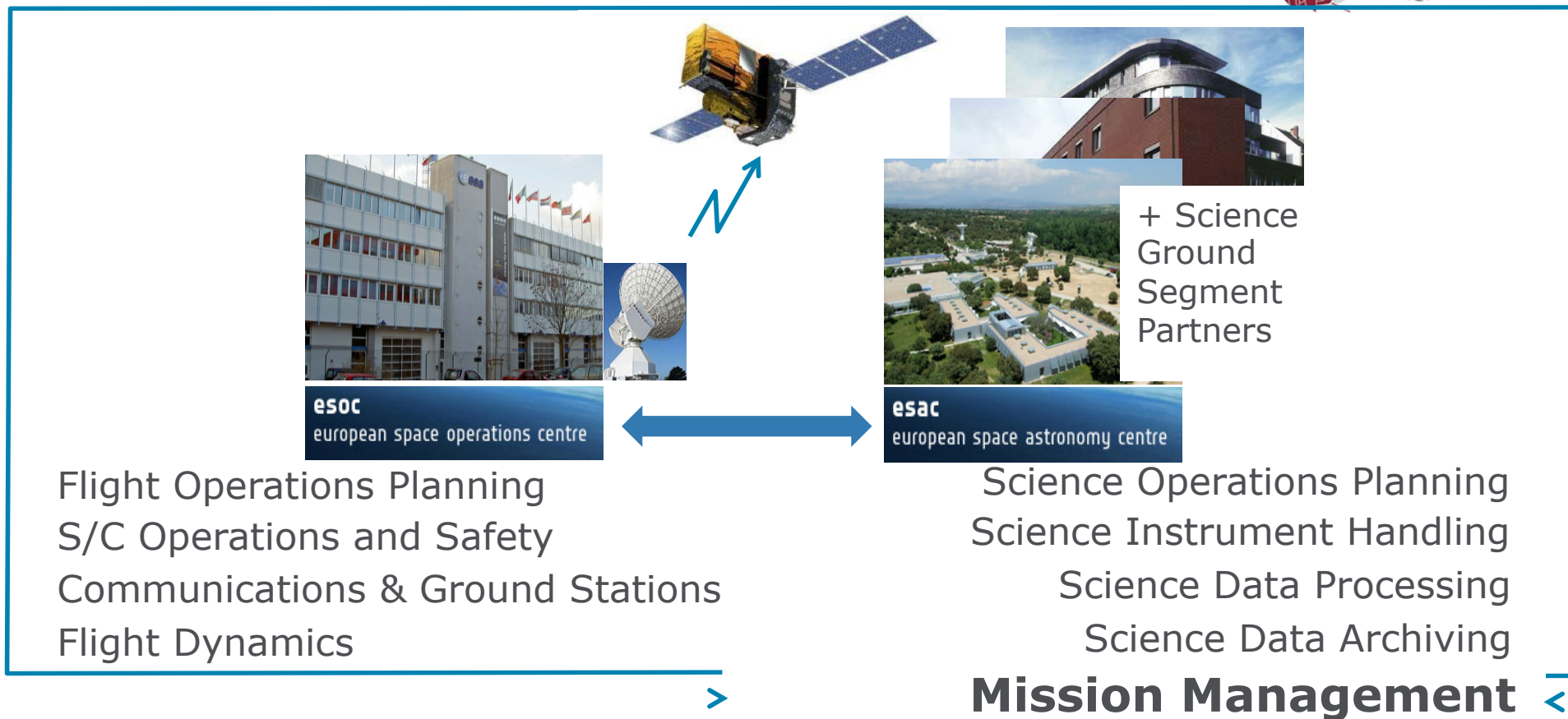
Science Operations Centres

Provide, usually with member state/international partners, 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 and processing,
 - calibration and cross-calibration, interactive and pipeline processing tools, ...
- Science data archiving and distribution,
 - archive development, population and maintenance, ...
- Plus associated software (and procedures).
 - development, integration, test, operation and maintenance.

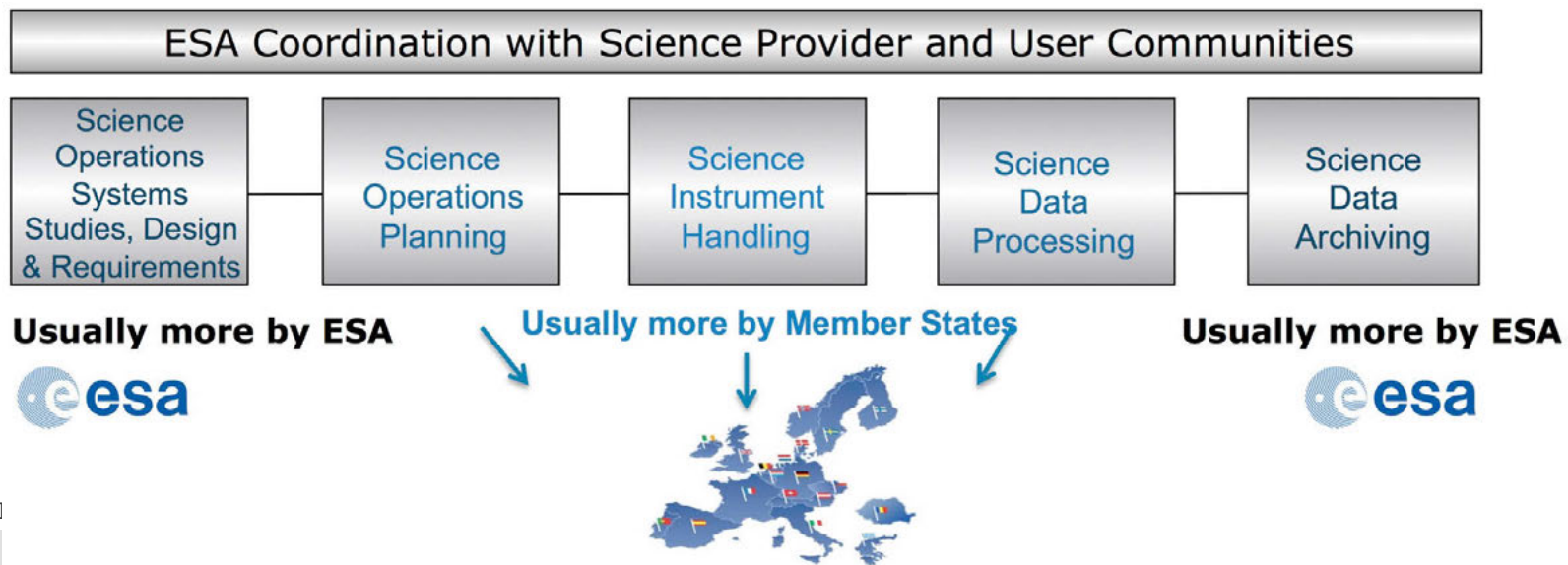


Operations: ESOC and ESAC Tasks



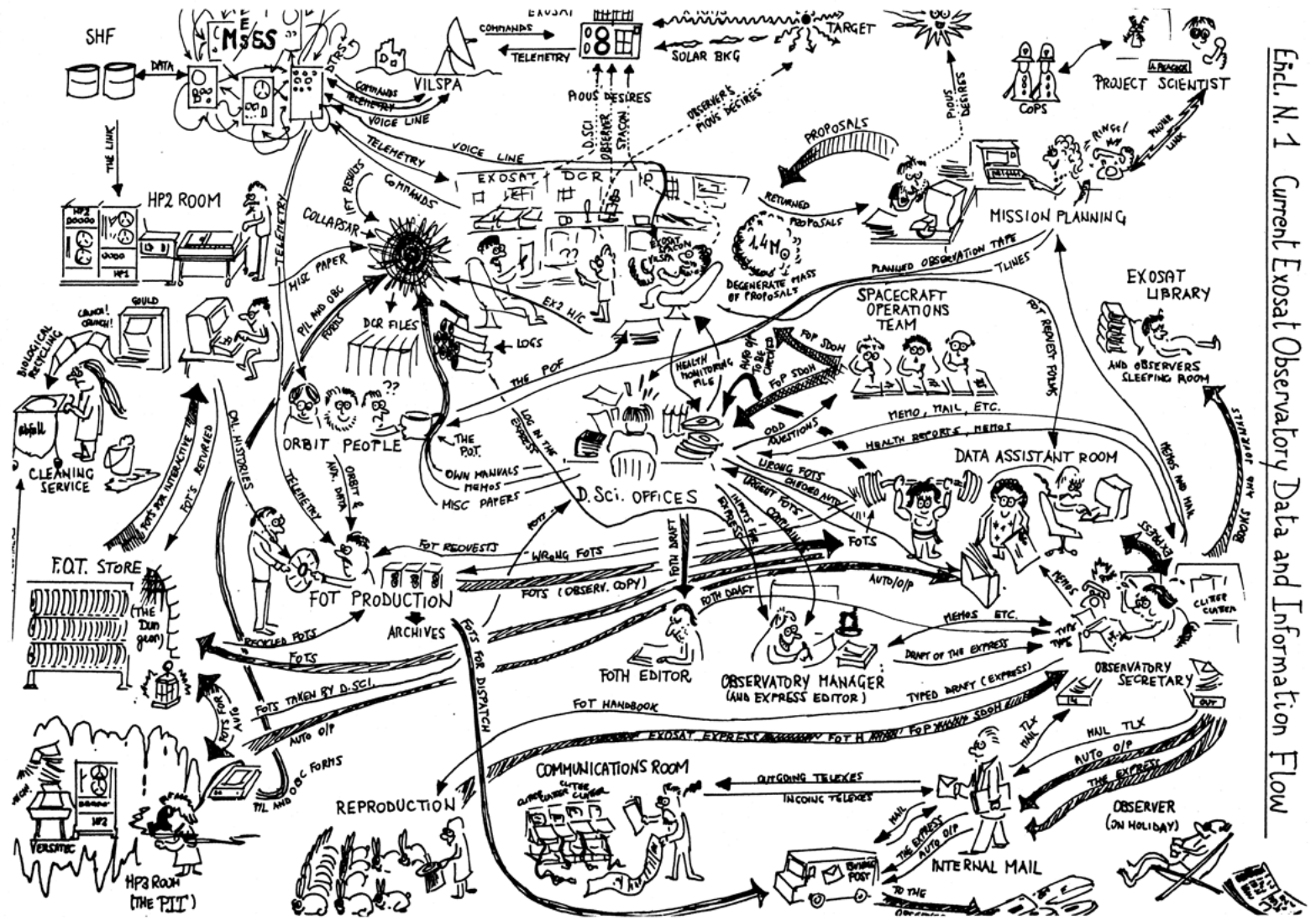
Collaborations with Member States

- Science ground segments now collaborative developments with multiple Member State entities.
- Member States usually contribute bulk of resources.
- ESA provides overall coordination
- ESA has overall responsibility for mission.



Then:

EXOSAT Observatory Data and Information Flow



Encl. N. 1 Current Exosat Observatory Data and Information Flow

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Now → Distributed (Sci-)Ops

- 2017 Collaborative workshop with ESO
- **Aims:**
 - Focus on challenges that distributed science operations present to space and ground based projects,
 - Promote the interchange of ideas and information between ESA, ESO and the broader community.

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SCIOPS 2017

Working together in support of science

17-20 Oct 2017
ESAC - Madrid

Distributed science operations

The objective of SciOps 2017 is to examine the challenges that distributed science operations present to space and ground based projects.

Programme Organising Committee
Olivier Hainaut (ESO)
John Hoar (ESA)
Andreas Kaufer (ESO)
Uwe Lammers (ESA)
Bruno Leibundgut (ESO)
Pedro Garcia Lario (ESA)
Danny Lennon (ESA; Co-chair)
Michael Sterzik (ESO; Co-chair)
Damien Texier (ESA)
Eva Verdugo (ESA)

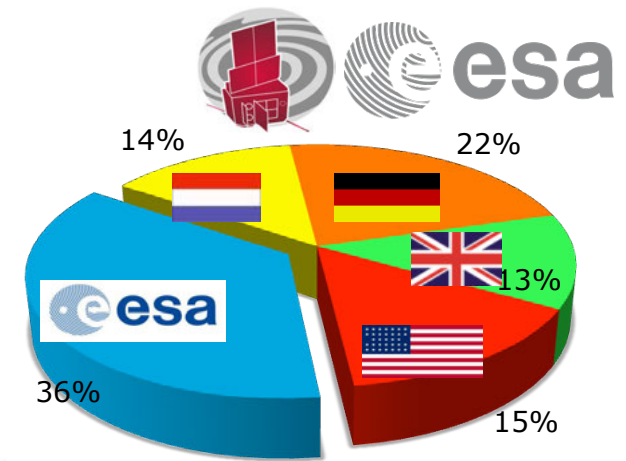
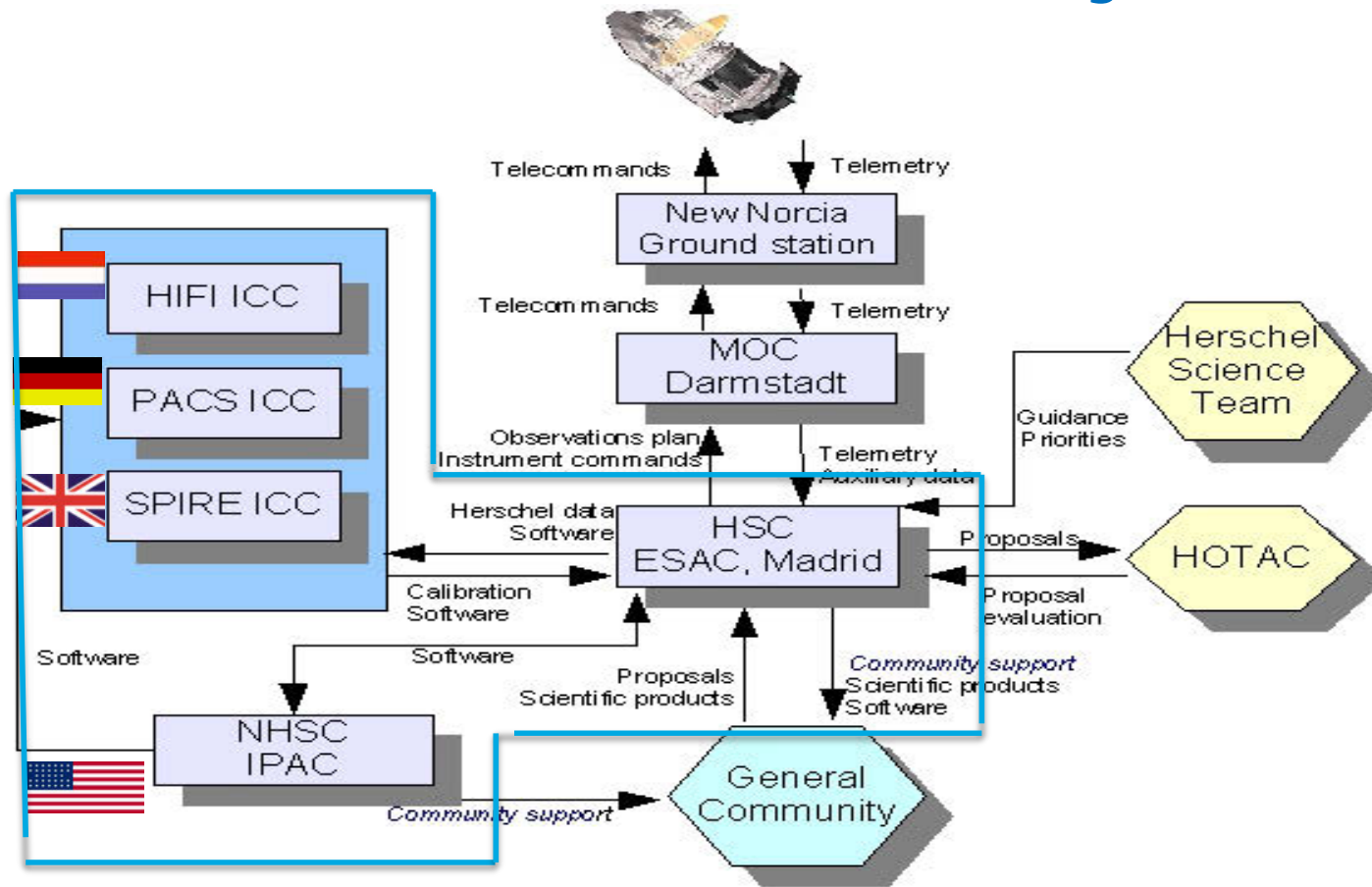
Local Organising Committee
Carlos Gabriel
Rocio Guerra
Eleni Kalfountzou
Danny Lennon
Julia Marin-Yaseli
Frank Trammer
Ana Willis

esa

ESO

www.cosmos.esa.int/web/sciops-2017

Then: Herschel Science Ground Segment



Distributed system.
200 active developers
world-wide (mostly
Europe, USA, Canada,
China.

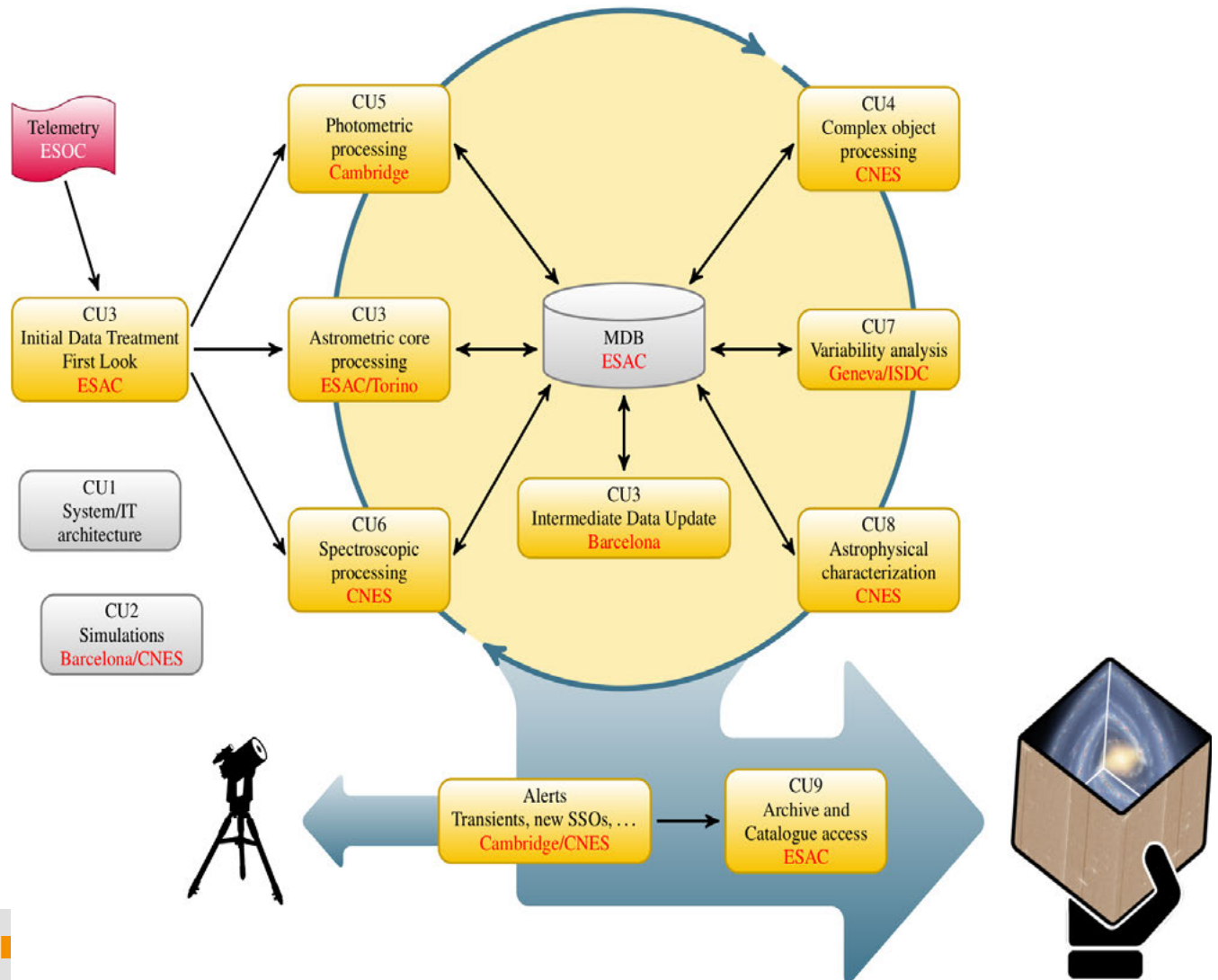
~3 million lines Java code
~15-20 year lifetime

Now: Gaia-DPAC

DPAC = Data Processing Analysis Consortium

- 9 Coordination Units (CUs)
- 6 Data Processing Centres
- 450+ scientists + engineers
- ~20 countries

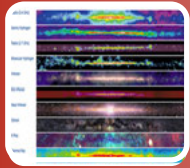
Upstream -----> Downstream



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Science Data Archives



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**

ESAC SCIENCE DATA CENTRE

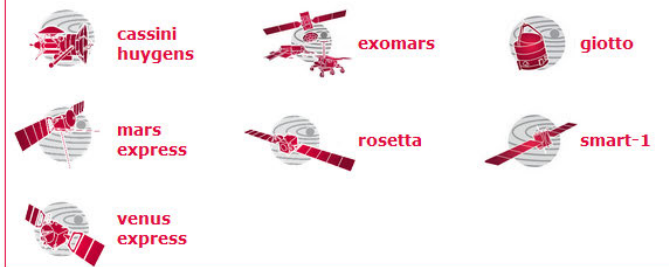
Astronomy Science Archives



Heliophysics Science Archives



The Planetary Science Archive



Future Archives



Archives → inc science-ready products



The Gaia Archive interface includes a search bar, a list of job names, and a detailed view of a specific job. The job details section shows a 3D visualization of the Gaia scanning strategy, along with several 2D histograms representing the distribution of data points in different dimensions.

The Herschel Science Archive interface displays a list of publications with columns for publication ID, target name, RA, Dec, Distance, Instrument, Observation Mode, ID, and Proposal ID. A detailed view of an observation shows the observation ID, observation mode, RA, Dec, and target name.

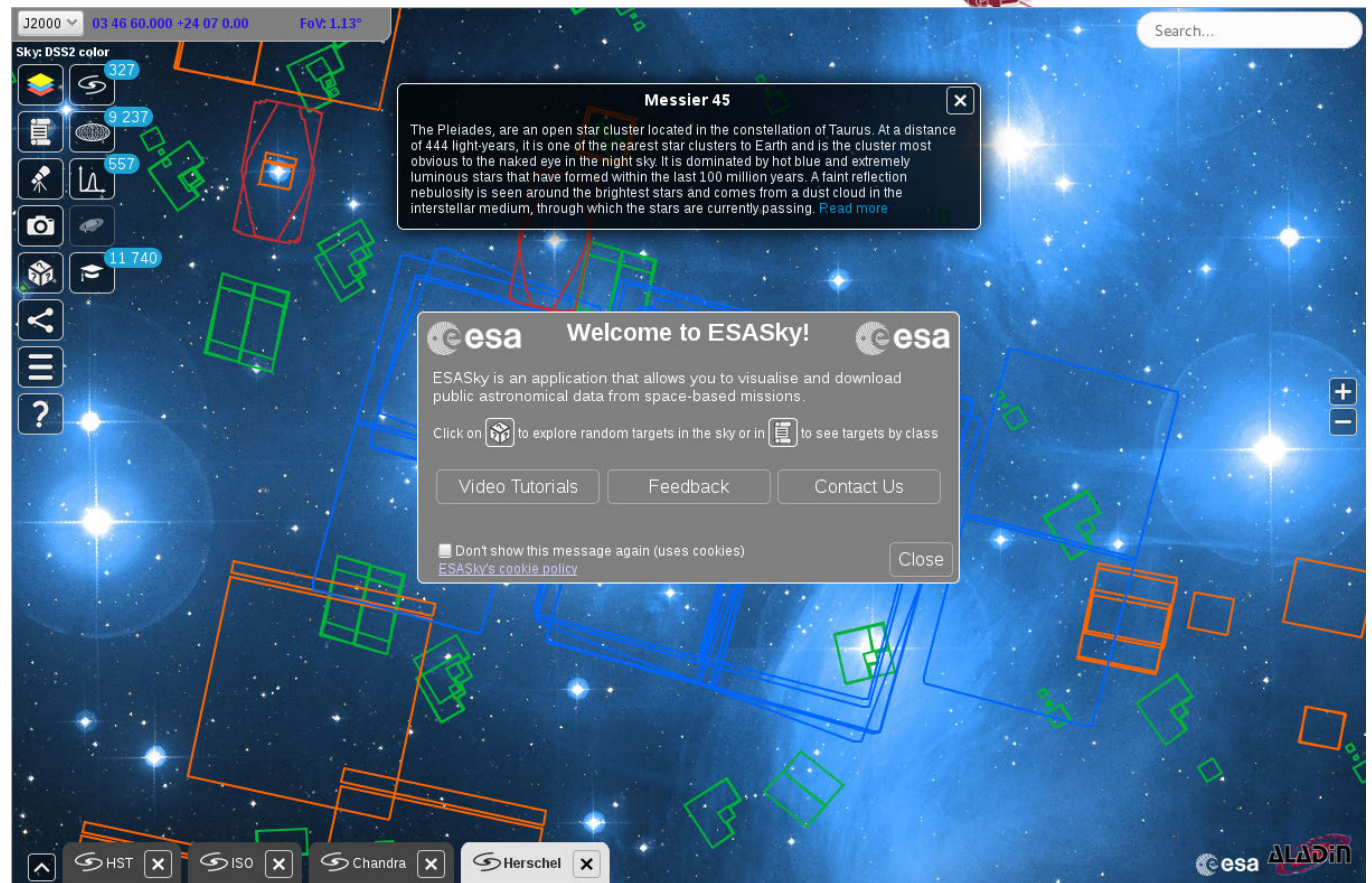
The XMM-Newton Science Archive interface features a table of observations with columns for Observation ID, RA, DEC, Rev, Distance, Start Date, End Date, and Target Type. A detailed view of an observation shows the observation ID, RA, DEC, Rev, Distance, Start Date, End Date, and Target Type.

The Planck Legacy Archive interface displays a table of sources with columns for Source Name, GLON (degrees), GLAT (degrees), RA (degrees), Equinox Supplement, and DEC (degrees). A detailed view of a source shows the source name, GLON, GLAT, RA, and DEC.

Multi- λ data visualisation/exploitation - ESASky



- ESASky:
sky.esa.int
- Facilitate data discovery and archival science for ALL users
 - multi-wavelength,
 - project agnostic,
 - exploration.
- Interface "on top of" all ESA astronomy archives.



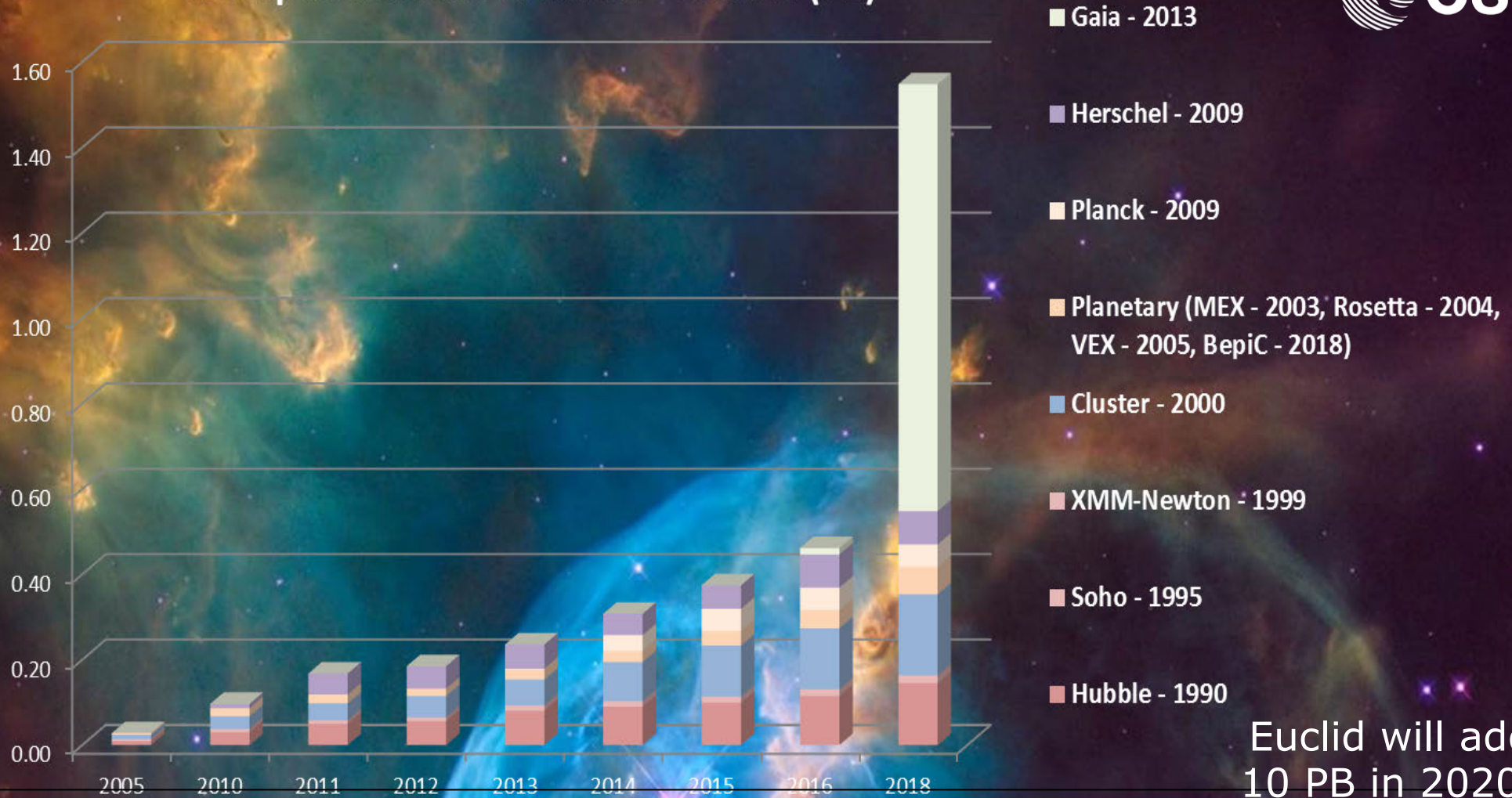
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ESA Space Science Archives - Volume (PB)



Euclid will add
10 PB in 2020s

Users and data

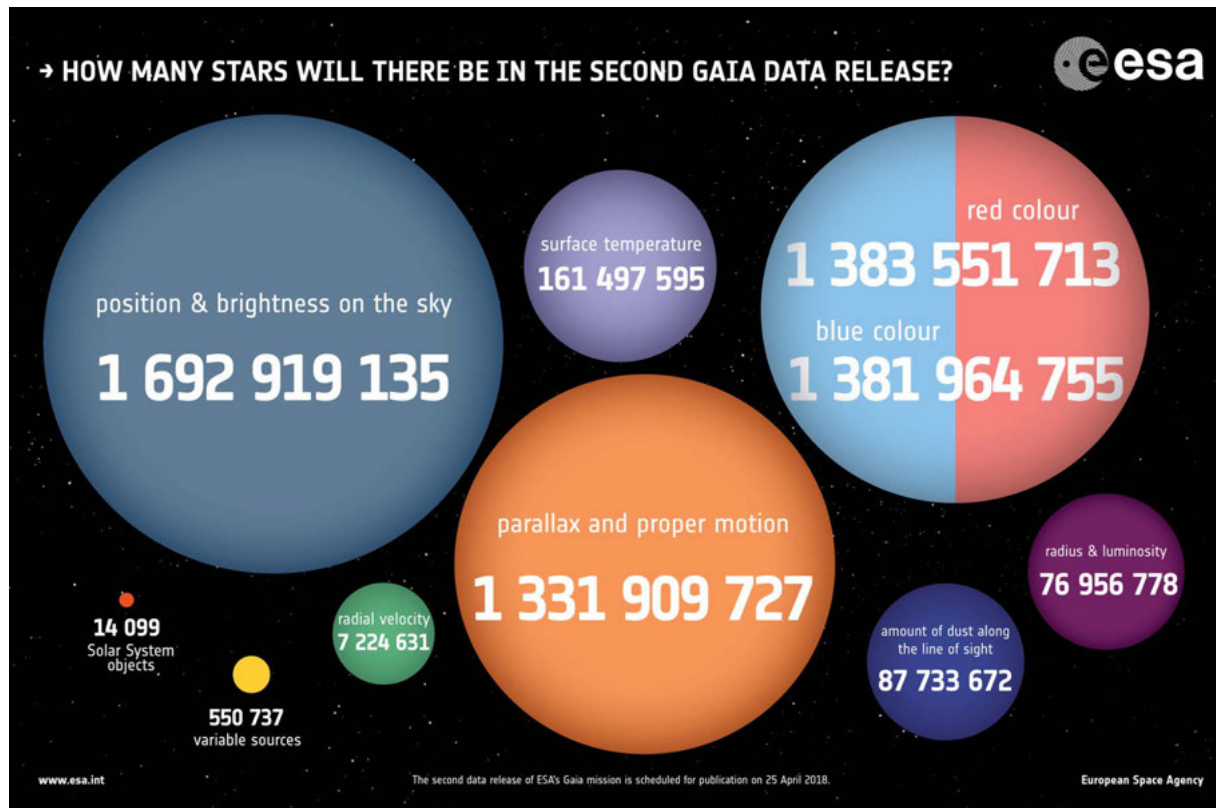


- Then-ish & Now: “Bring the data to the user”,
 - All data available for distribution,
 - Install and run data analysis software locally.
- Now & Future: “Bring user code to the data”,
 - User cannot download all data,
 - Have user workspaces IN the archive,
 - User workspace and code shareable.



User works with the data
WHERE the data is
=> Archive 2.0 concept

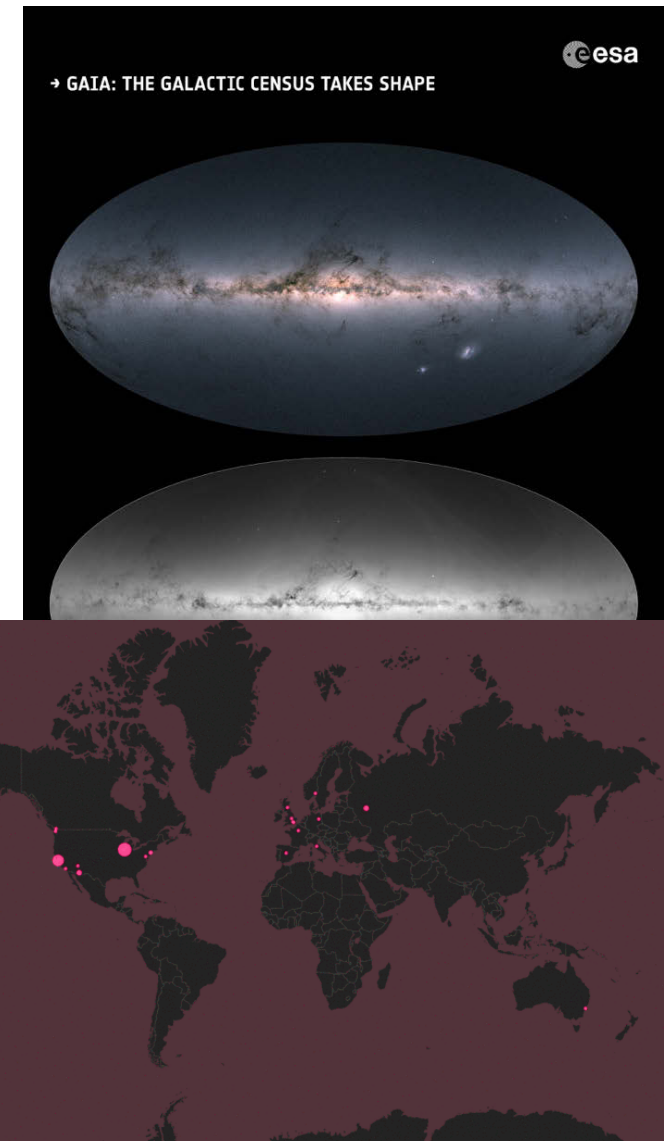
Gaia Data Release 2 – 25 April



“Not perfect but amazing!”

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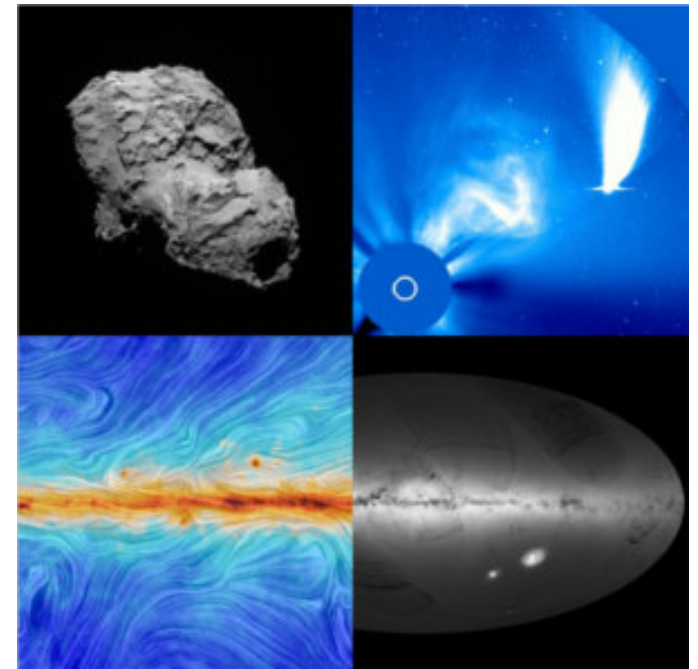
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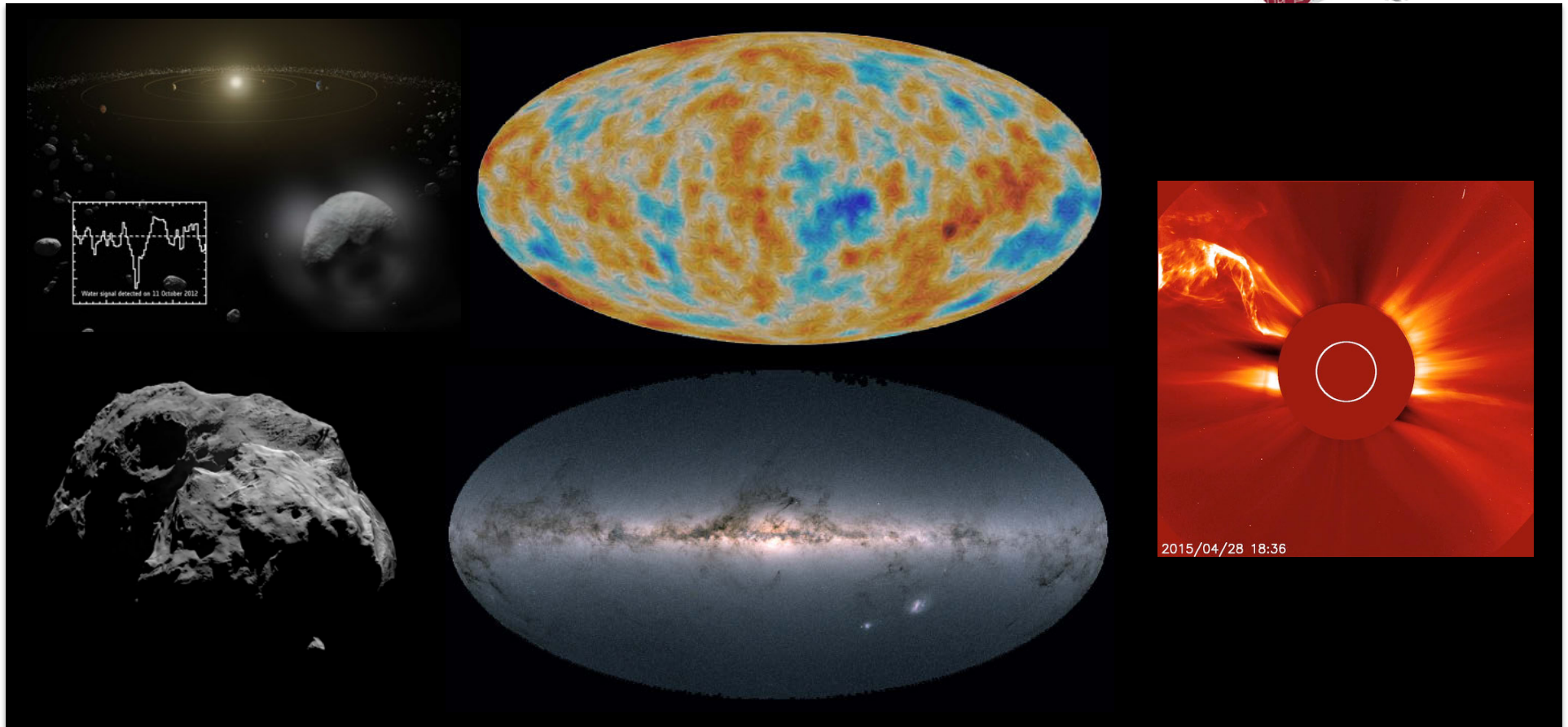
Then → Now: Summary of some Trends



- From centralised → distributed science ground segments
- From 'raw' data → science ready products
- From 'data to users' → 'code to data'
- and others



Then and Now: Why we do (science) operations



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Thank you

