Space Science Data at ESA

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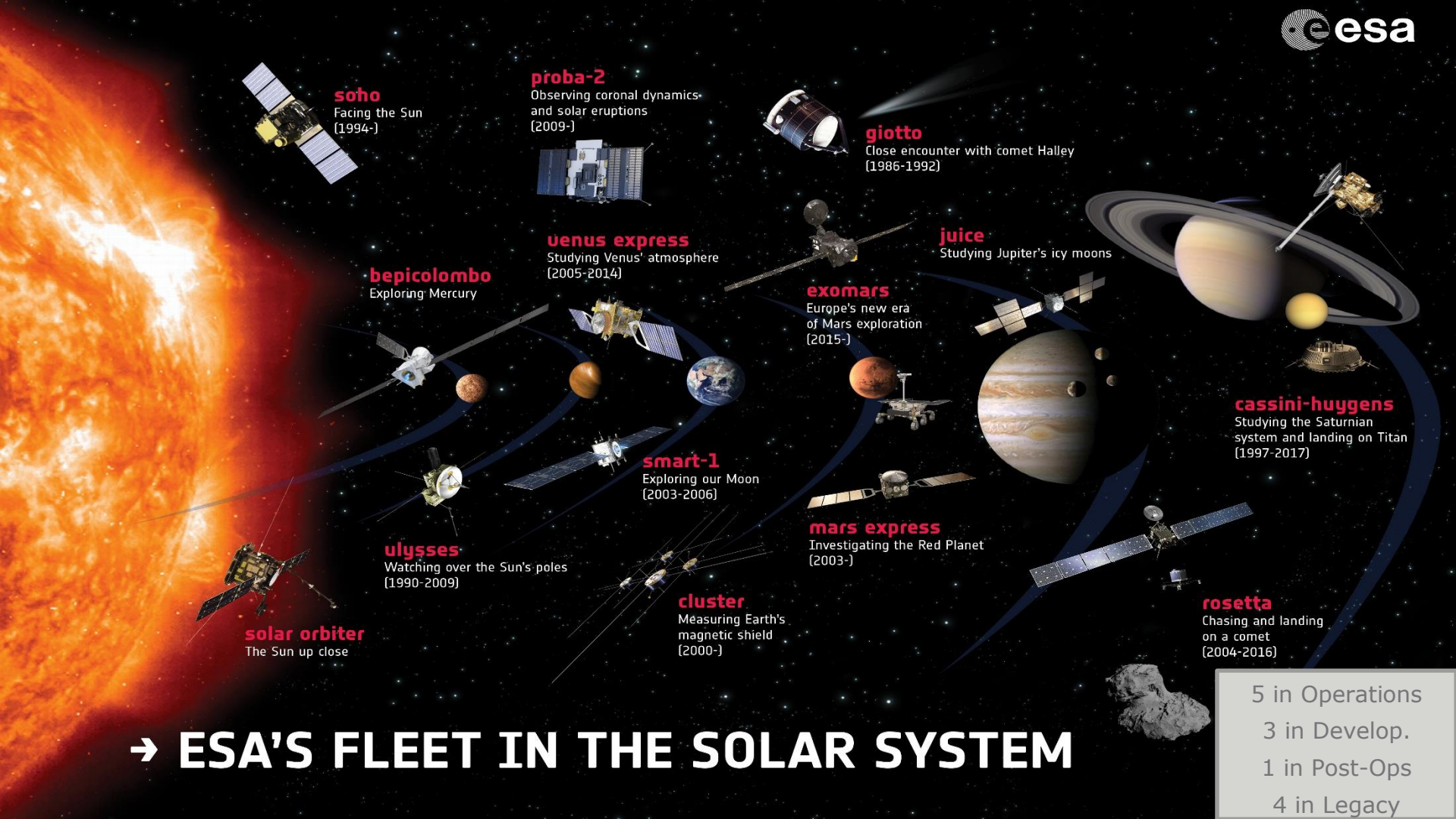
Open Universe Workshop, Vienna, 20-22 Nov 2017

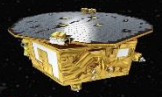


→ ESA'S FLEET IN THE SOLAR SYSTEM

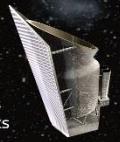
5 in Operations
3 in Develop.
1 in Post-Ops
4 in Legacy

→ ESA'S FLEET ACROSS THE SPECTRUM

5 in Operations
2 in Develop.
2 in Post-Ops
6 in Legacy

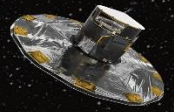


lisa pathfinder
Testing the technology for gravitational wave detection (2015-2017)



iso
Chemical analysis of celestial objects (1995-1998)

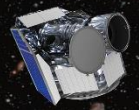
hipparcos
The first astrometry satellite (1989-1993)



gaia
Surveying a billion stars of exoplanets (2013-)

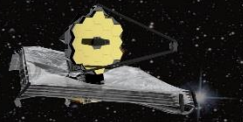
iue
Analysing ultraviolet light from stars (1978-1996)

cheops
Sizing and first characterisation of exoplanets



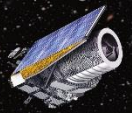
xmm-newton
Seeing deeply into the hot and violent Universe (1999-)

jwst
Observing the first light

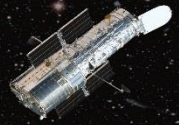


herschel
Unveiling the cool and dusty Universe (2009-2013)

euclid
Exploring the dark Universe

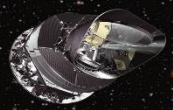


hst
Expanding the frontiers of the visible Universe (1990-)

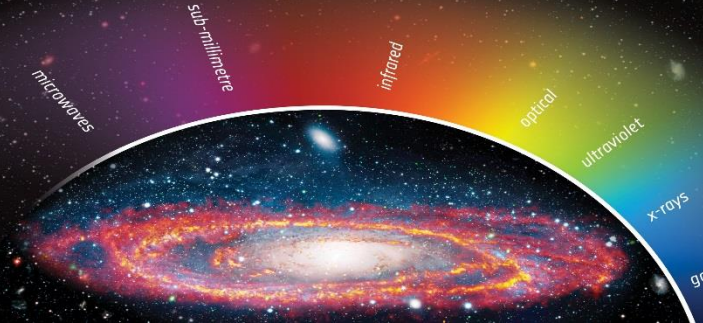


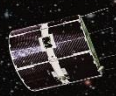
integral
Seeking out the extremes of the Universe (2002-)

exosat
X-ray survey of high-energy phenomena (1983-1986)



planck
Looking back at the dawn of time (2009-2013)





cos-b
Surveying the high energy Galaxy (1975-1982)

ESAC Science Data Centre
The Digital Library of the Universe

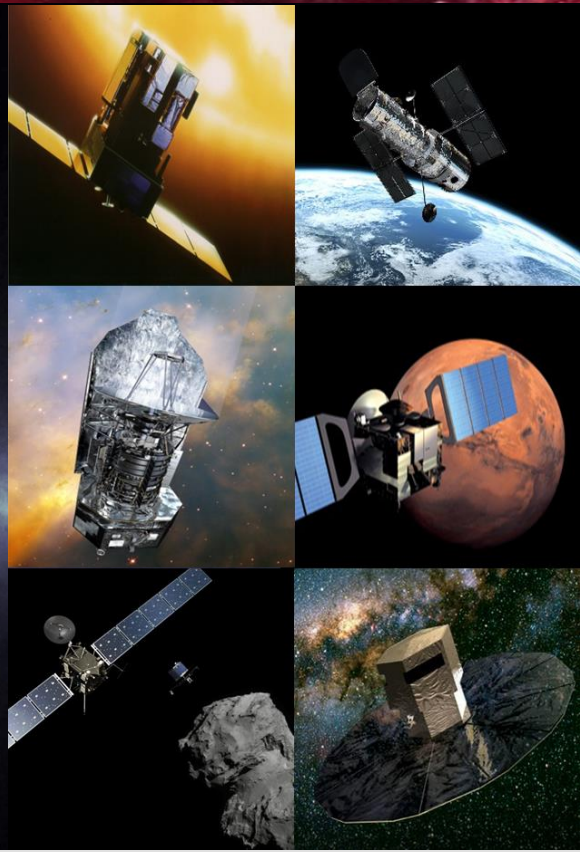
At ESA's European Space Astronomy Centre near Madrid

Science Archives from >15 space missions:

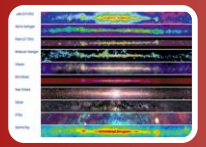
- Astronomy, Planetary, Heliophysics
- From all phases (development, operations, post-ops, legacy)
- http://archives.esac.esa.int/

Different Users:

- Scientific Community (public access)
- Instrument teams and observers (controlled access)
- Science Operations Team (privileged access)



Science Archives at ESAC



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

- esasky
- exosat
- gaia
- herschel
- hubble space telescope
- iso
- lisa pathfinder
- planck
- xmm-newton

Heliophysics Science Archives

- cluster
- double star
- ISS-SolACES*
- proba-2
- soho
- ulysses

The Planetary Science Archive

- cassini huygens
- exomars
- giotto
- mars express
- rosetta
- smart-1
- venus express

Future Archives

- bepicolombo
- euclid
- juice
- solar orbiter

ESA Space Science Open Data Policy

Proprietary period for all science data (~1 year)

- To instrument teams when data is being produced by instrument teams
- To observer for observatory missions

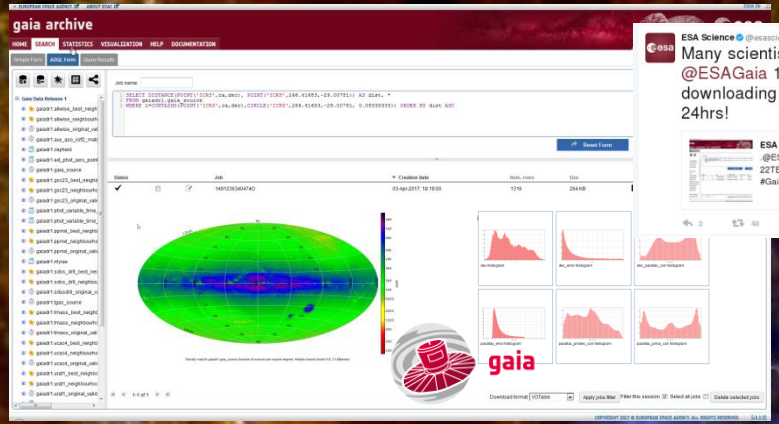
Data then enter the public domain

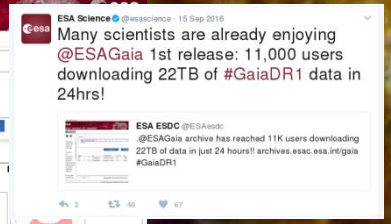
- Freely accessible worldwide
- Being sometimes replicated in non ESA site (European / US data centres)

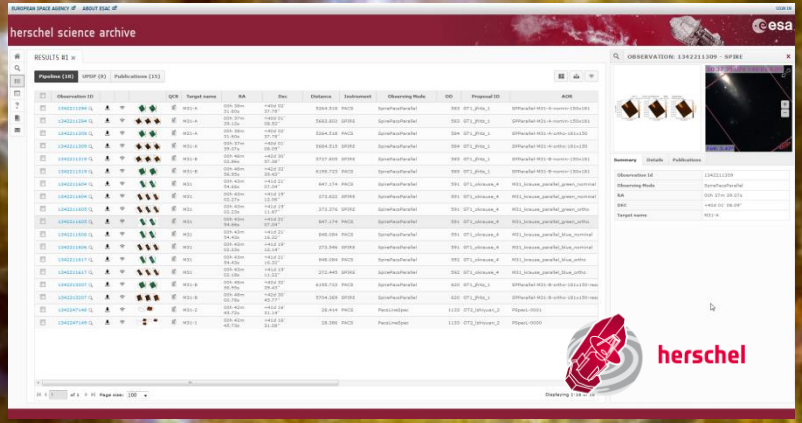
Data is on-line, available to the scientific community and other

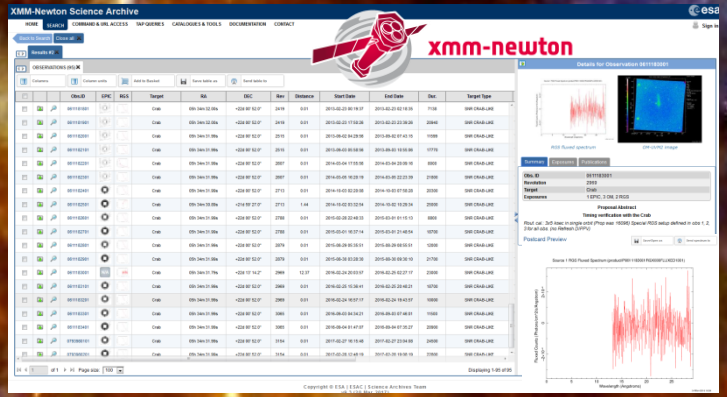
- Through a standard web browser and through scriptable APIs
- Search, preview, select and download

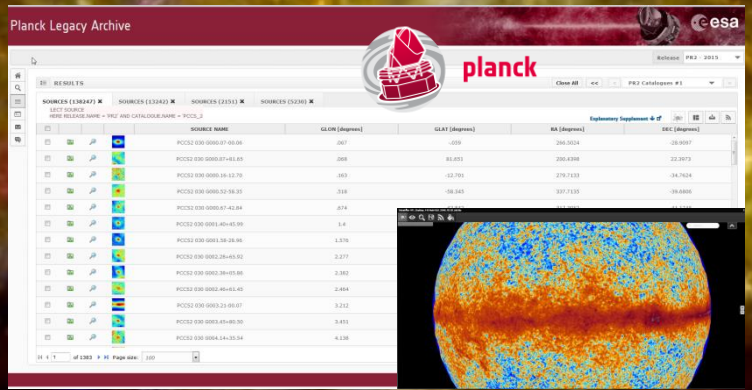
ESA main Astronomy Archives





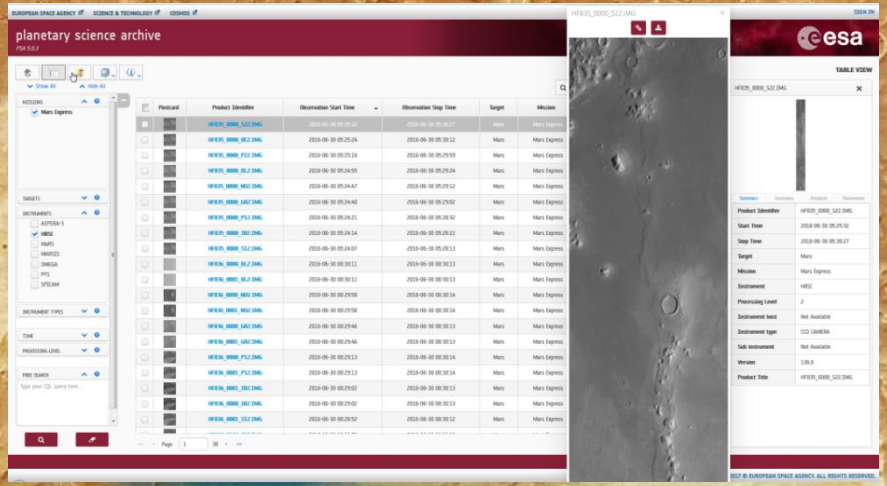


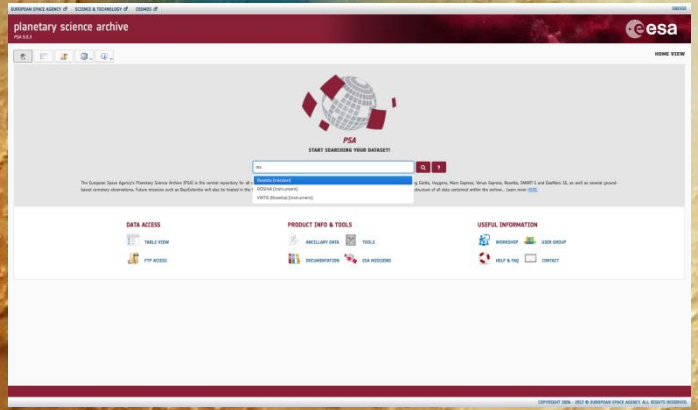


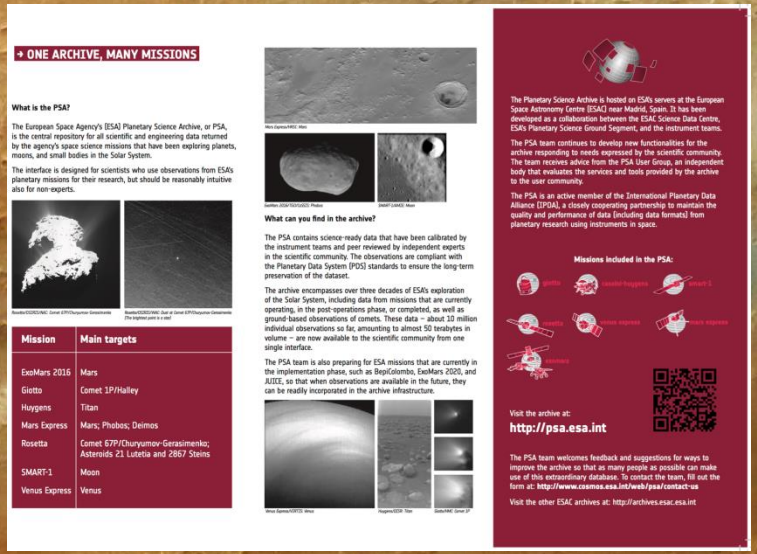


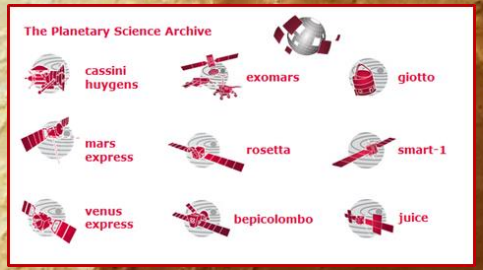
New Planetary Science Archive – psa.esa.int

Planetary Science Archive







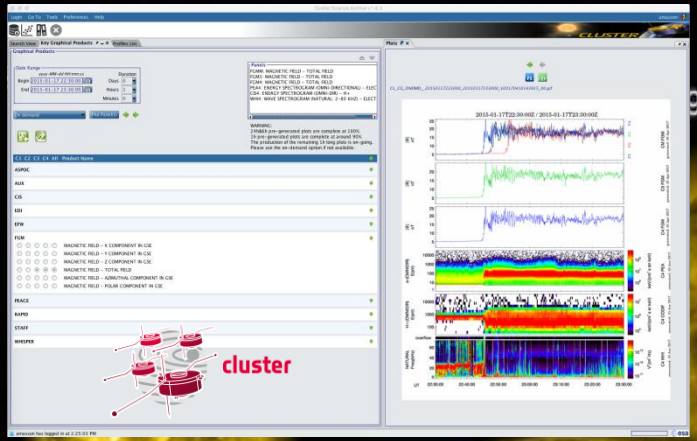


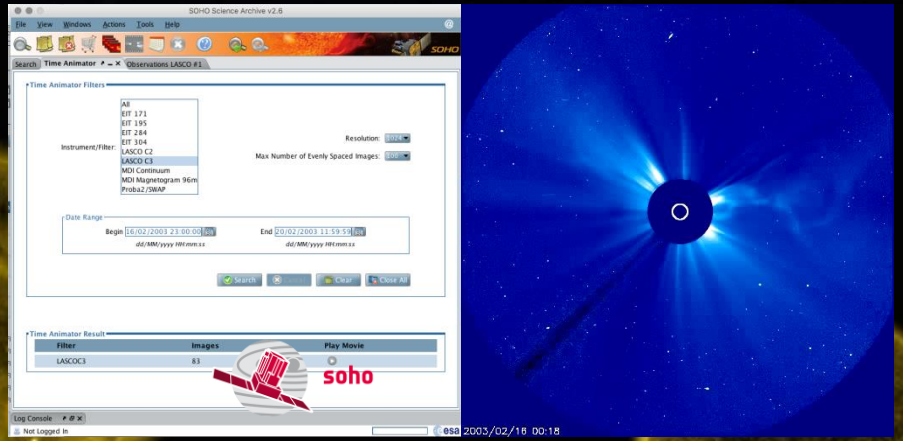
Index of ftp://psa.esac.esa.int/pub/mirror/

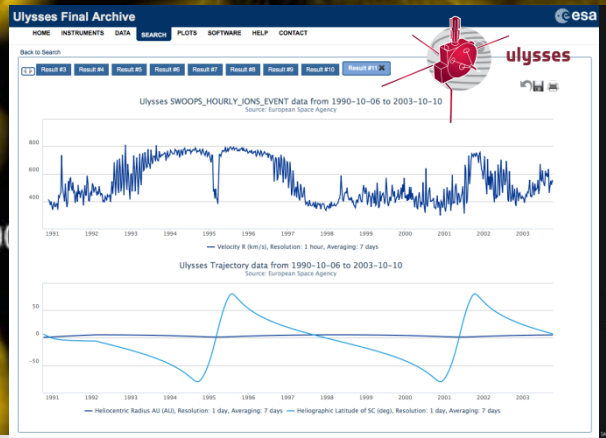
Up to higher level directory

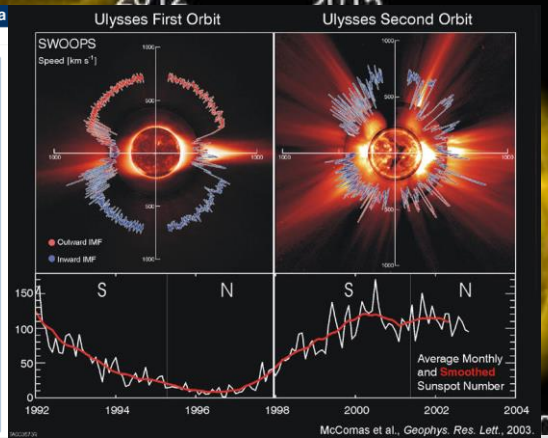
Name	Size	Last Modified
CASSINI-HUYGENS		16/10/07 00:00:00
EARTH		11/09/09 00:00:00
ExoMars2016		09/11/16 18:42:00
GIOTTO		17/10/06 00:00:00
HST		17/10/06 00:00:00
INTERNATIONAL-ROSETTA-MISSION		14/10/16 03:00:00
MARS-EXPRESS		19/05/09 00:00:00
PSA		23/03/17 13:55:00
SMALL-MISSIONS-FOR-ADVANCED-RESEARCH-AND-TECHNOLOGY		20/08/10 00:00:00
VENUS-EXPRESS		15/09/10 00:00:00

ESA Heliophysics Archives









Data Stewardship and Curation

ESA's Digital Agenda for Space commits us to data quality and accuracy

ESAC Science Data Centre mission:

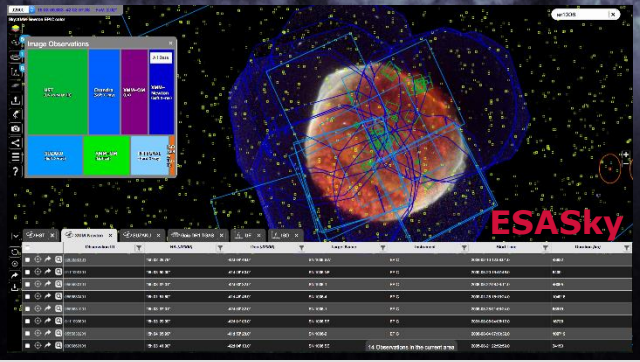
Before transitioning mission data to Legacy Phase, ESDC curation includes:

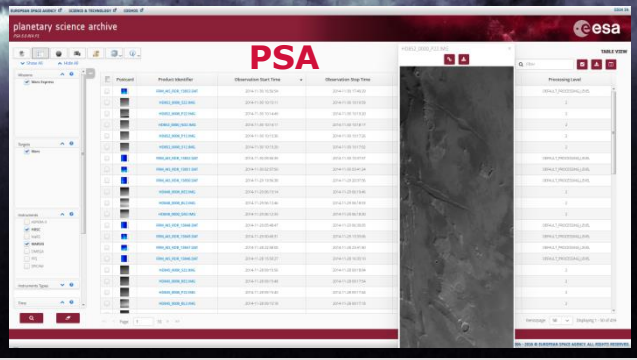
- Working with consortia to ensure data quality and accuracy upon data delivery
- Collecting and organizing all knowledge specific to that mission (data, software, documentation)
- Linking data with research papers they generated (e.g. SAPS)
- Providing links and tools to compare legacy data and data from current missions to augment the research value of the data (e.g. ESASky, PSA, SEPP)
- Involvement in generation of high level science products by community

Long Term Preservation Strategy - 1

Consolidation of all ESA Space Science Archives at ESAC, with strong re-use across projects, ensuring easier and cheaper long term data preservation

- Hardware infrastructure
- Software architecture and code, including technology migration
- Human technical and scientific expertise
- Multi mission, multi instruments science exploitation





Long Term Preservation Strategy - 2

Long term preservation of data processing capabilities (on-going)

- Preserve software coming from various places
- Provide data processing capabilities as a “service”
- Bring the “user software to the data” instead of the “data to the user”

Sharing and preservation of knowledge, including international cooperation

- IVOA, IPDA

Collaboration is key – IVOA in astronomy

Astronomy Science is now multi-wavelengths

Existing collaboration among VO partners worldwide

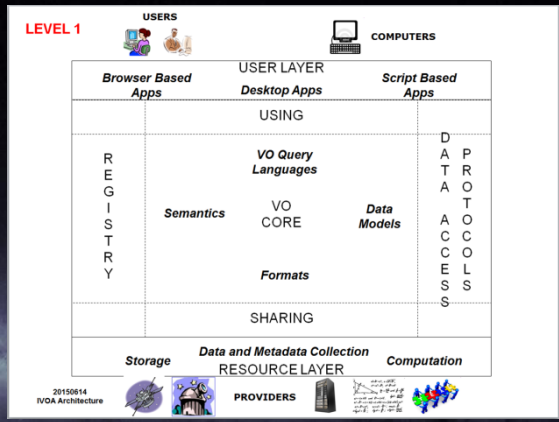
Existing Virtual Observatory (VO) Framework

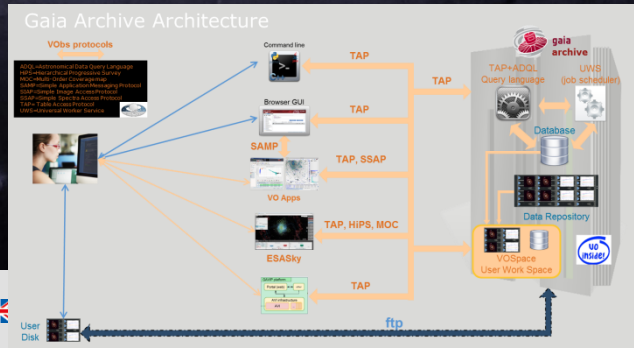
VO initially planned for space and ground based archive interoperability

layer on top of existing archives

VO now also used for data management infrastructure

VO built-in archives at ESA (Gaia, Euclid, …)





Collaboration is key – IPDA in Planetary Science

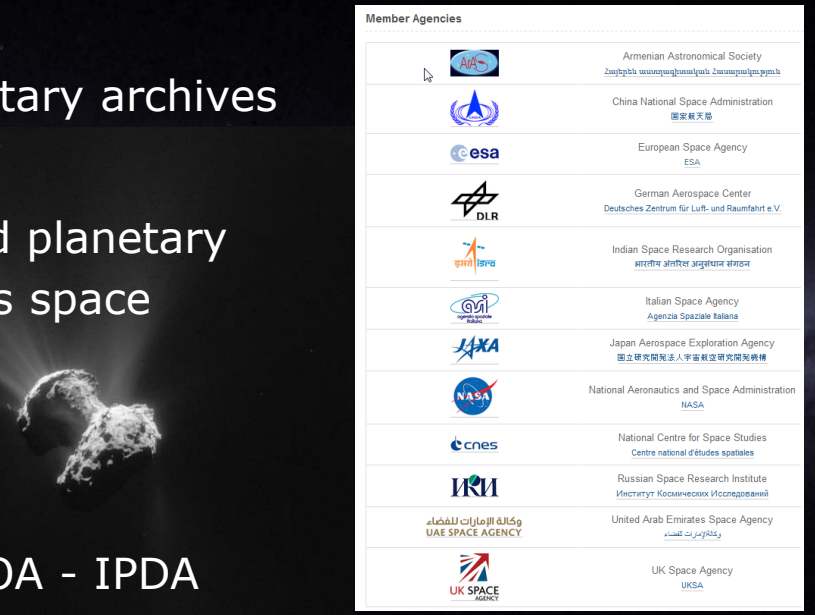
Facilitate global access to, and exchange of, high quality scientific data products managed across international boundaries

- used between ESA, NASA, JAXA, ISRO planetary archives

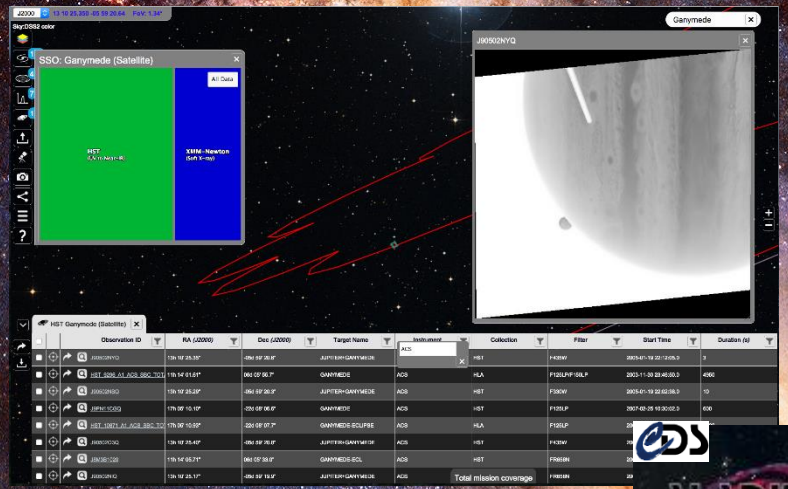
Definition of archiving data standards (PDS) and planetary archiving processes at international level, across space agencies

- used by ESA Planetary Science Archive

Sharing of expertise and standards between IVOA - IPDA



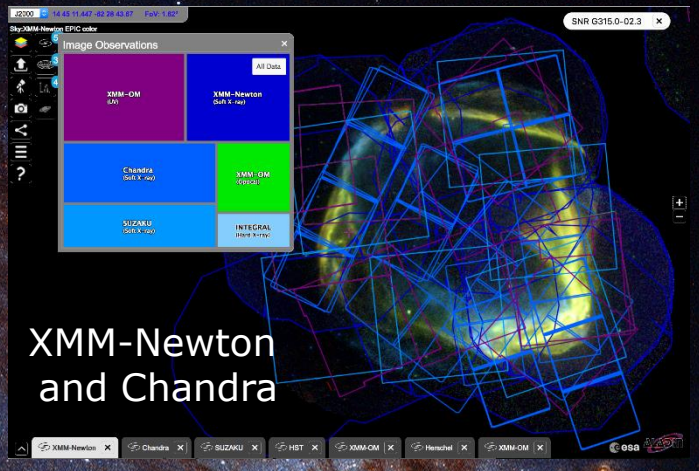
Collaboration is key – ESASky



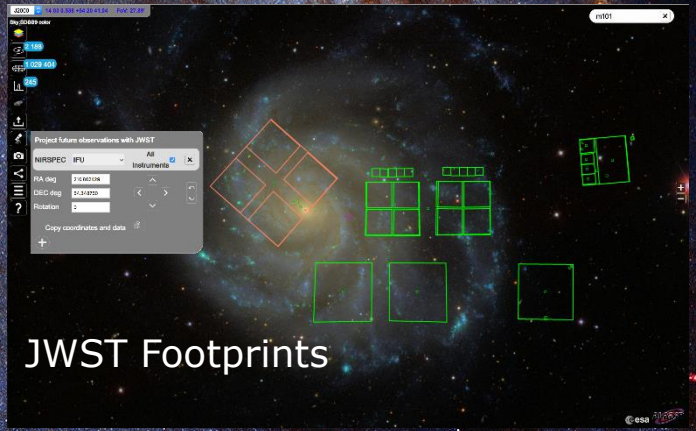
HiPS

SAMP TAP

ObsCoreDM, MOC



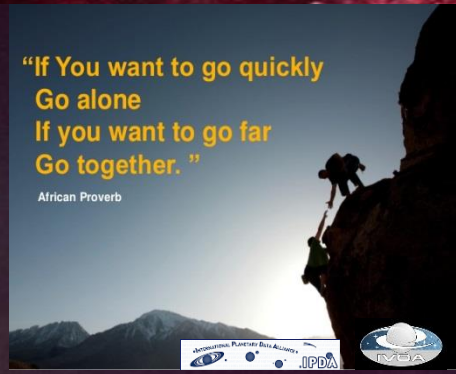
Dedicated Python module to ESASky



Conclusions

Management of ESA Space Science Data

- Heterogeneity of missions and datasets
- Maximize Science Exploitation
- Ensure Long Term Preservation



ESASky, all sky visualization of big data

- Multi-missions, multi-wavelengths tool

Interoperability with other archives worldwide (Virtual Observatory)

- Collaboration between data centres is key
- International collaboration is key (IVOA, IPDA)