Space Science Data at ESA

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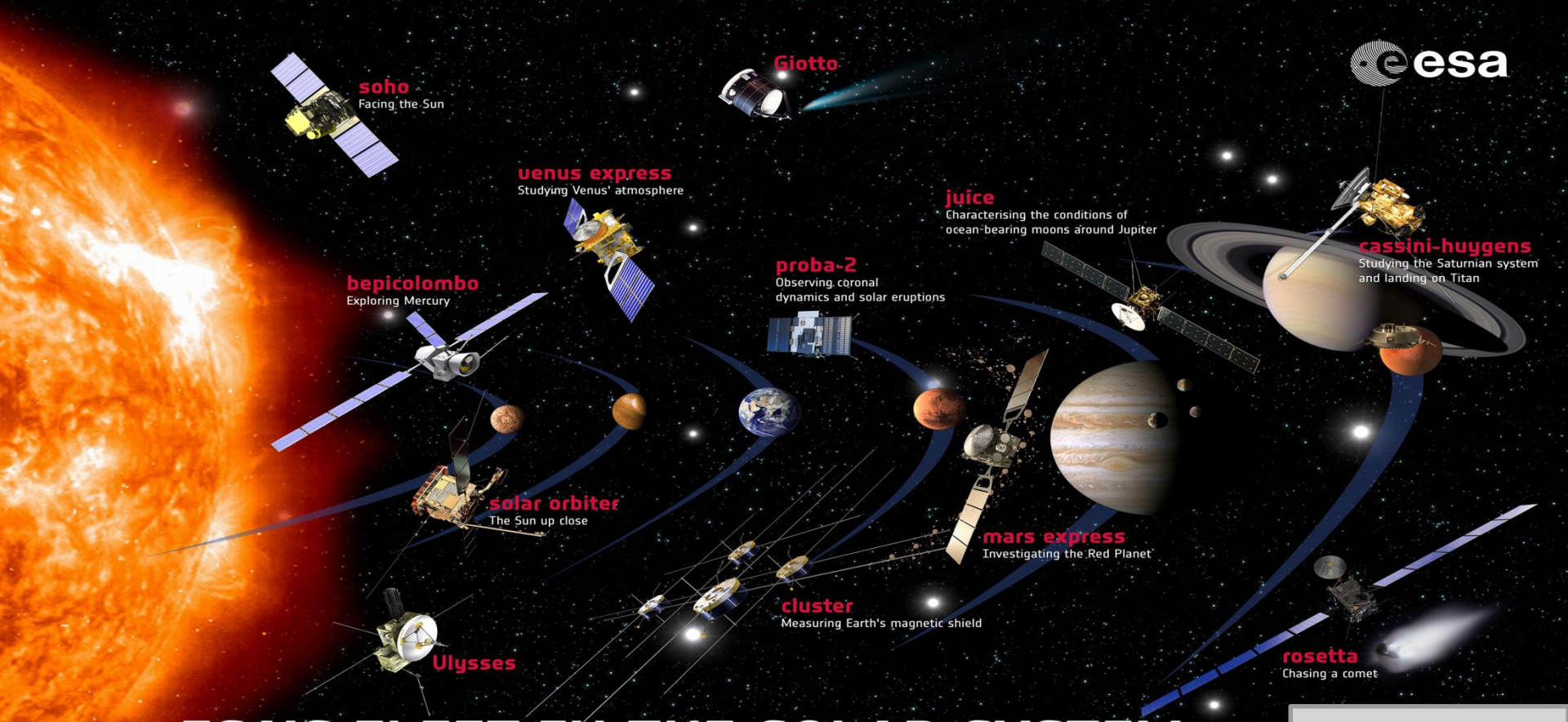
Open Universe Initiative, Experts Meeting, Rome, 11-12/04/2017



➔ ESA'S FLEET IN THE SOLAR SYSTEM

The Solar System is a natural laboratory that allows scientists to explore the nature of the Sun, the planets and their moons, as well as comets and asteroids. ESA's missions have transformed our view of the celestial neighbourhood, visiting Mars, Venus, and Saturn's moon Titan, and providing new insight into how the Sun interacts with Earth and its neighbours. The Solar System is the result of 4.6 billion years of formation and evolution. Studying how it appears now allows us to unlock the mysteries of its past and to predict how the various bodies will change in the future.

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5 in Operations

3 in Develop.

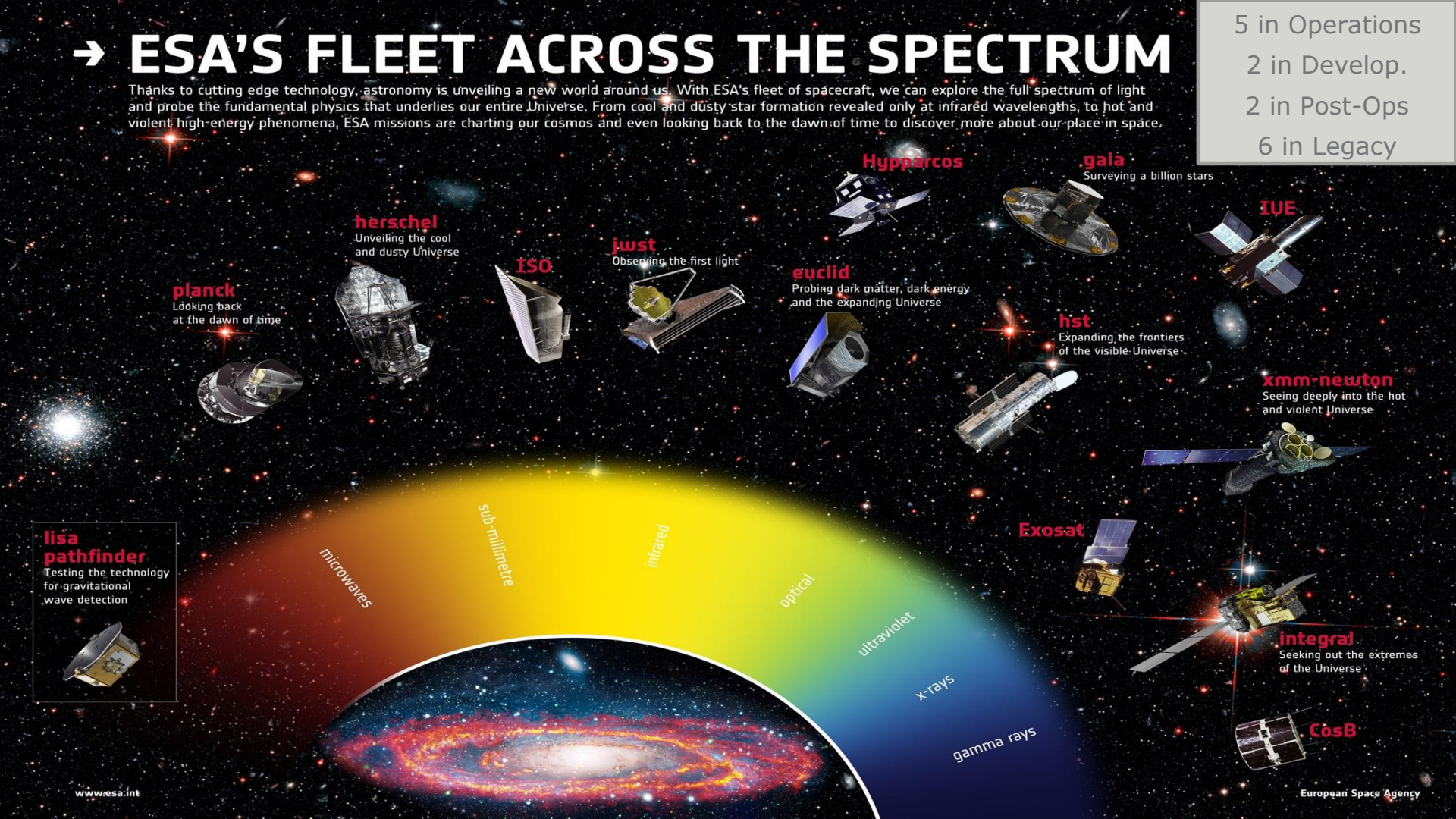
1 in Post-Ops

4 in Legacy

➔ ESA'S FLEET ACROSS THE SPECTRUM

Thanks to cutting edge technology, astronomy is unveiling a new world around us. With ESA's fleet of spacecraft, we can explore the full spectrum of light and probe the fundamental physics that underlies our entire Universe. From cool and dusty star formation revealed only at infrared wavelengths, to hot and violent high-energy phenomena, ESA missions are charting our cosmos and even looking back to the dawn of time to discover more about our place in space.

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



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European Space Agency

ESAC Science Data Centre
The Digital Library of the Universe

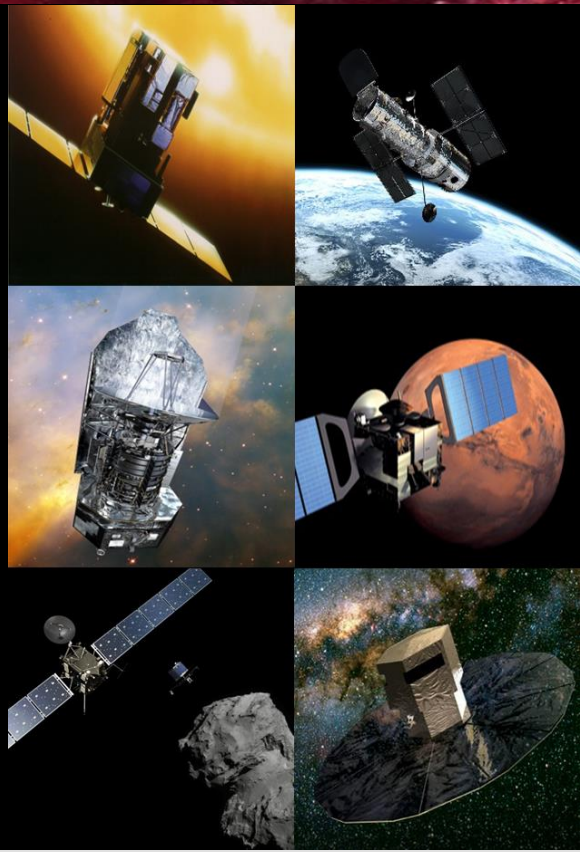
At ESA's European Space Astronomy Centre near Madrid

Science Archives from >15 space missions:

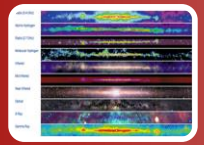
- Astronomy, Planetary, Heliophysics
- From all phases (development, operations, post-ops, legacy)
- http://archives.esac.esa.int/

Different Users:

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



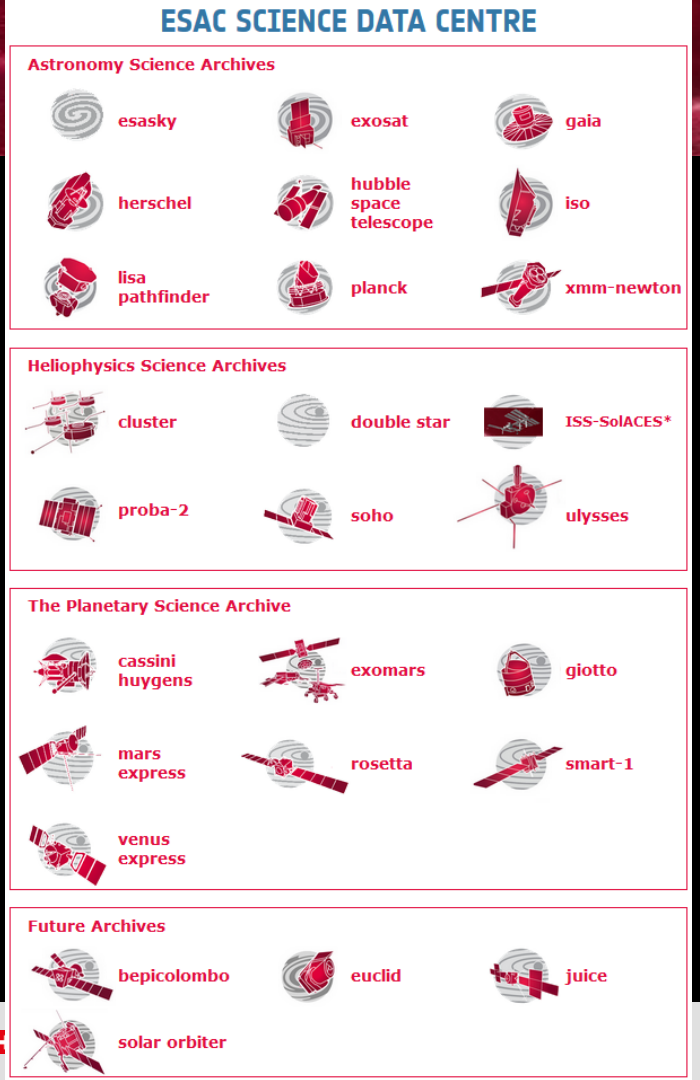
Science Archives at ESAC



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***



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

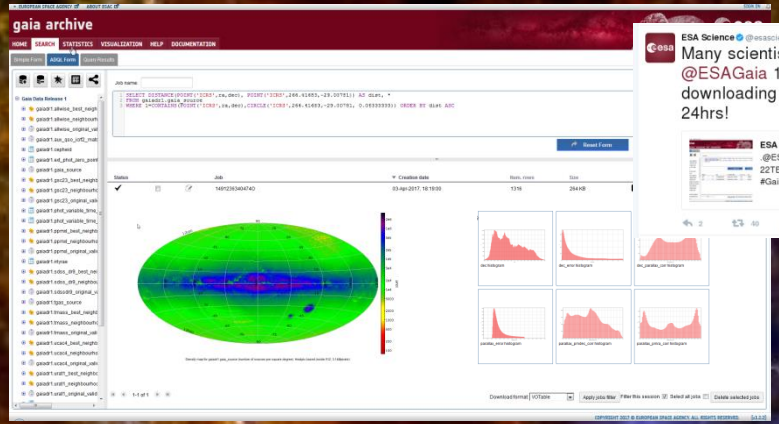
Data then enter the public domain

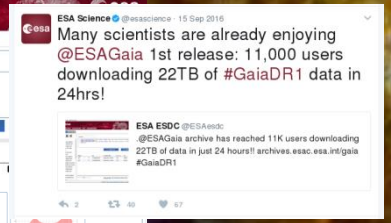
- Freely accessible worldwide
- Being sometimes replicated in non ESA site (European / US data centres)

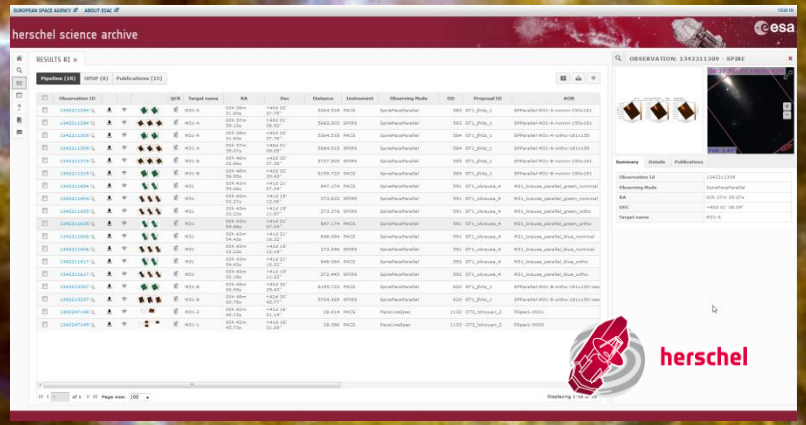
Data is made available to the scientific community through Internet

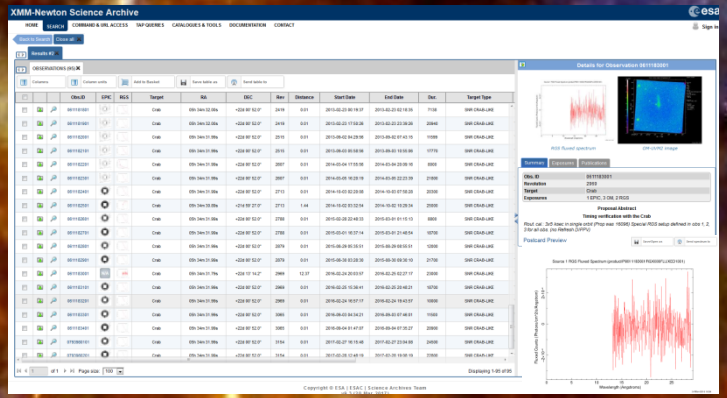
- Through a standard web browser and through scriptable APIs
- Search, preview, select and download

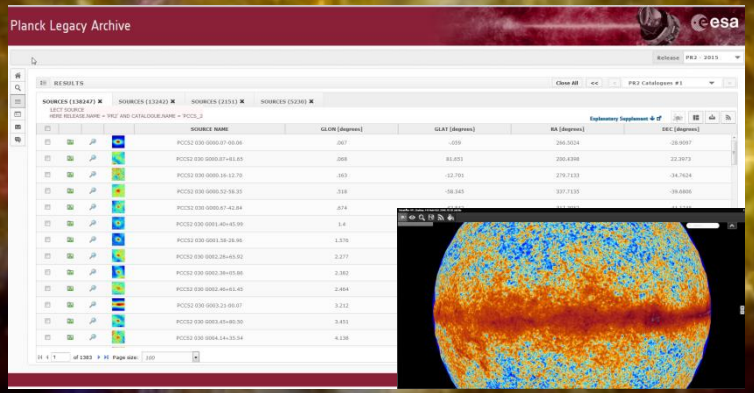
ESA main Astronomy Archives





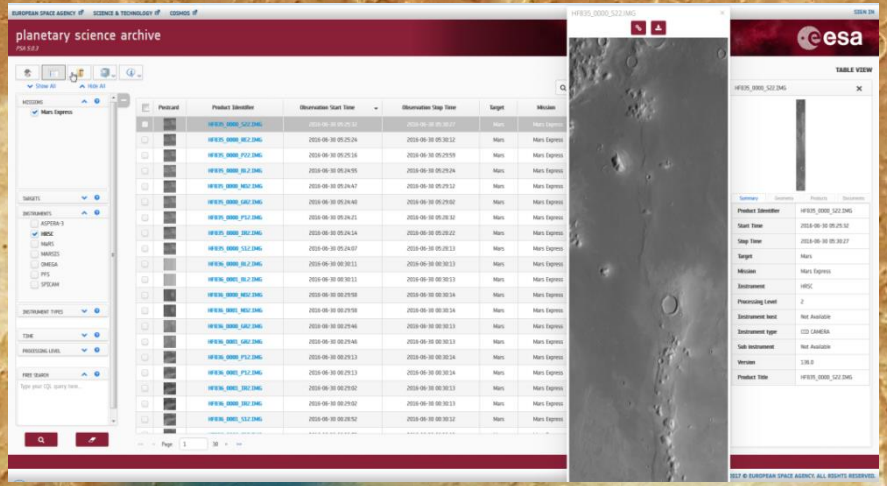


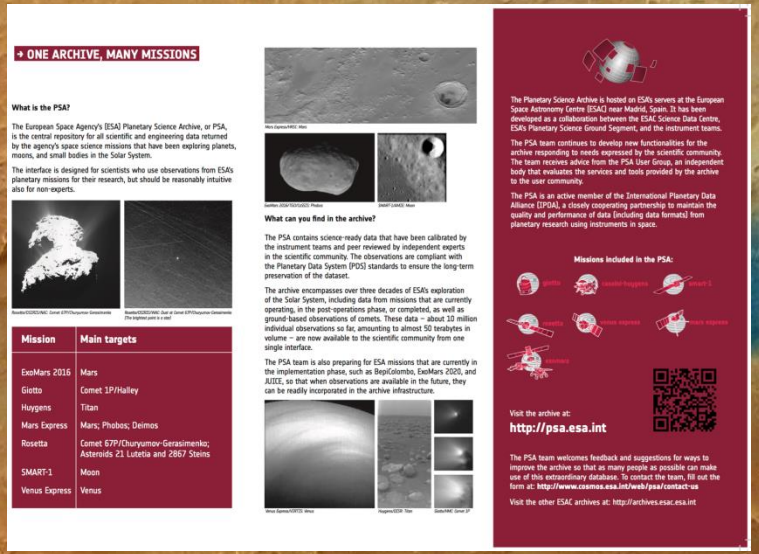


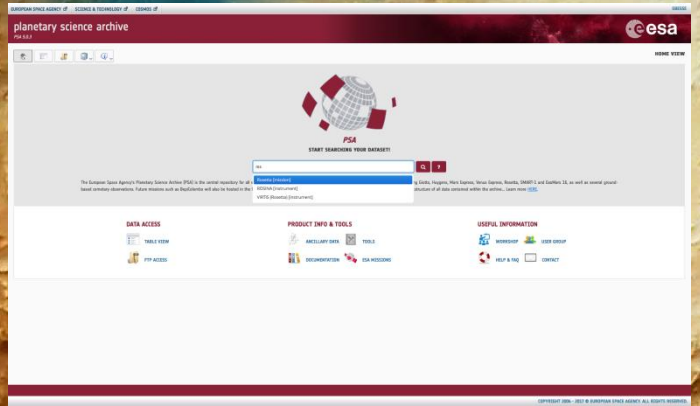


New Planetary Science Archive – psa.esa.int

Planetary Science Archive







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

Up to higher level directory

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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
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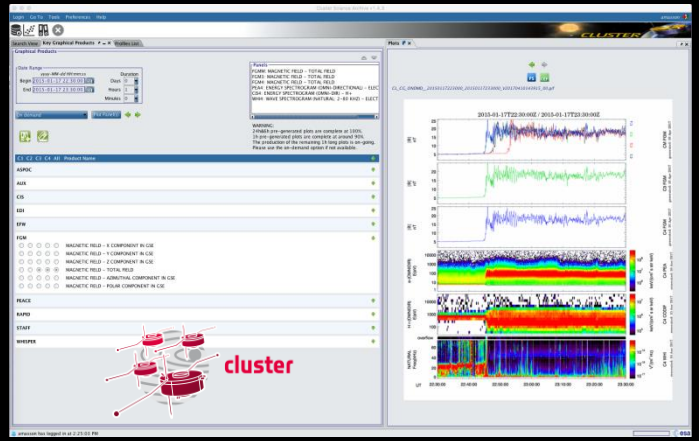
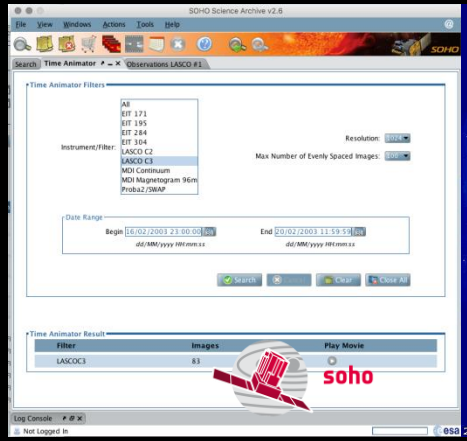
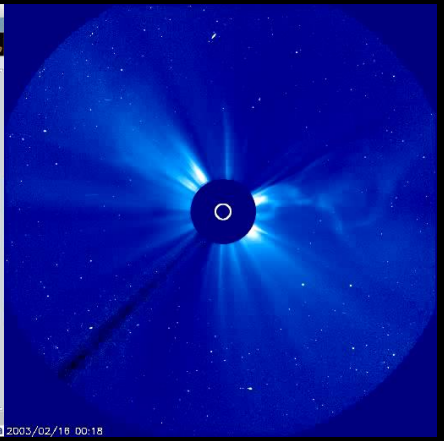
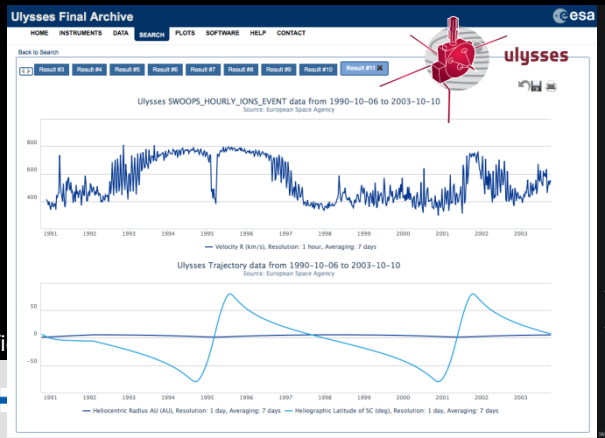
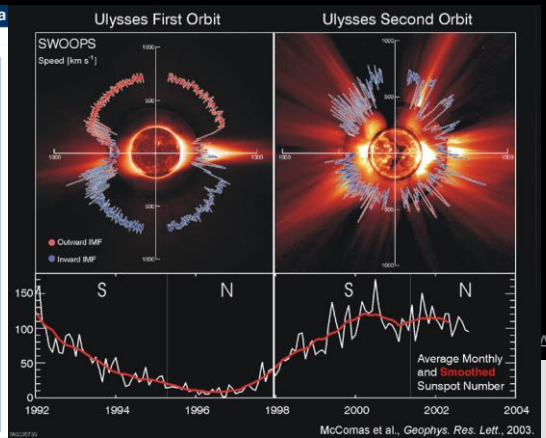
ESA Heliophysics Archives







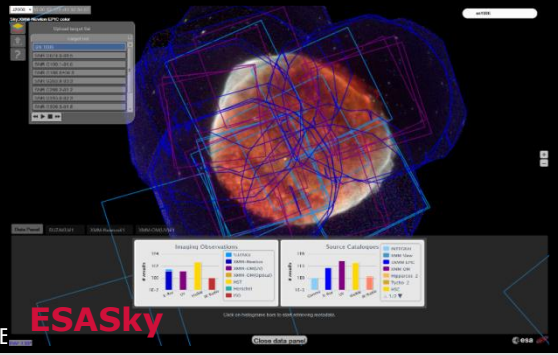


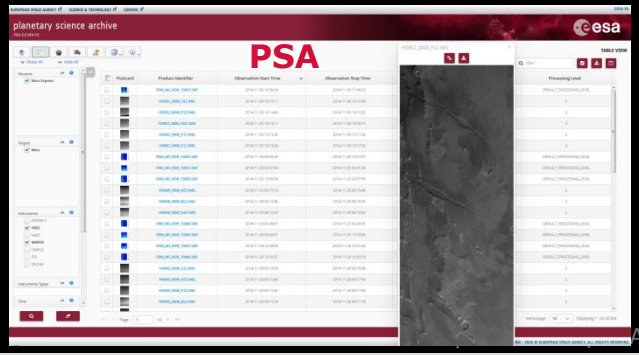


Long Term Preservation Strategy - 1

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

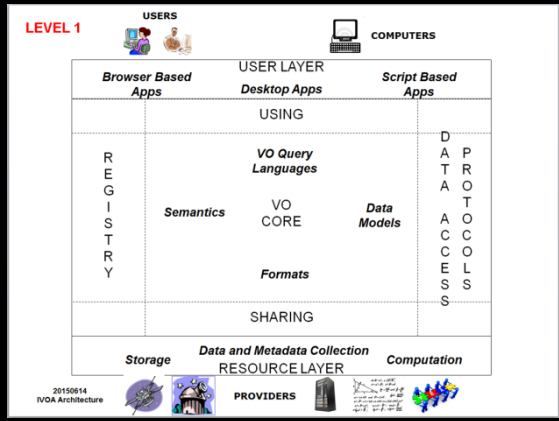
Existing Virtual Observatory (VO) Framework

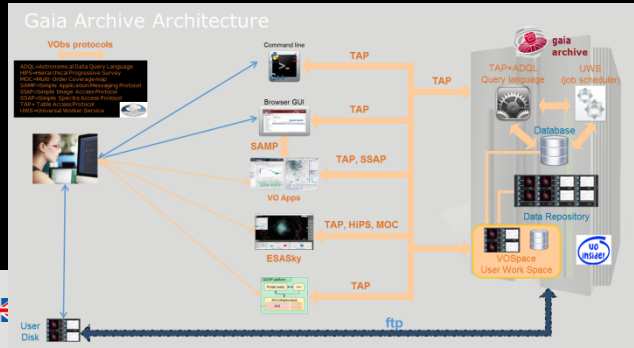
VO initially planned for space and ground based archive interoperability

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

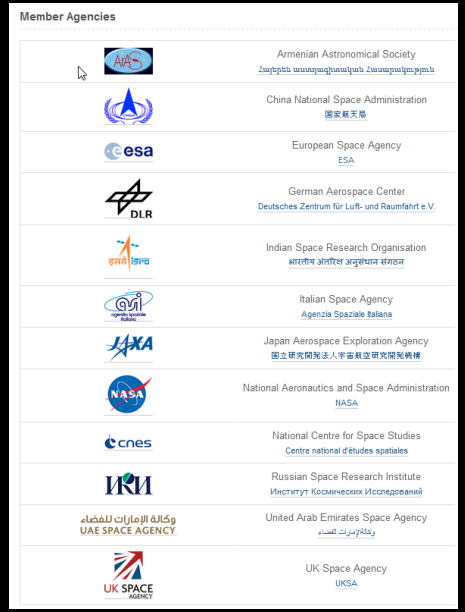
Facilitate global access to, and exchange of, high quality scientific data products managed across international boundaries

- 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



Towards multi wavelengths Science data exploitation

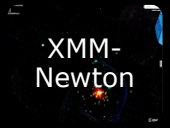
Goal: to facilitate data discovery and archival science for ALL users

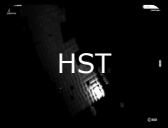
- Multi-wavelength
- Project agnostic
- Exploration

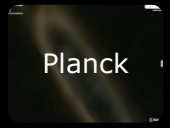
Interface "on top of" all ESA astronomy archives

ESASky – sky.esa.int

Legacy: IUE, ..

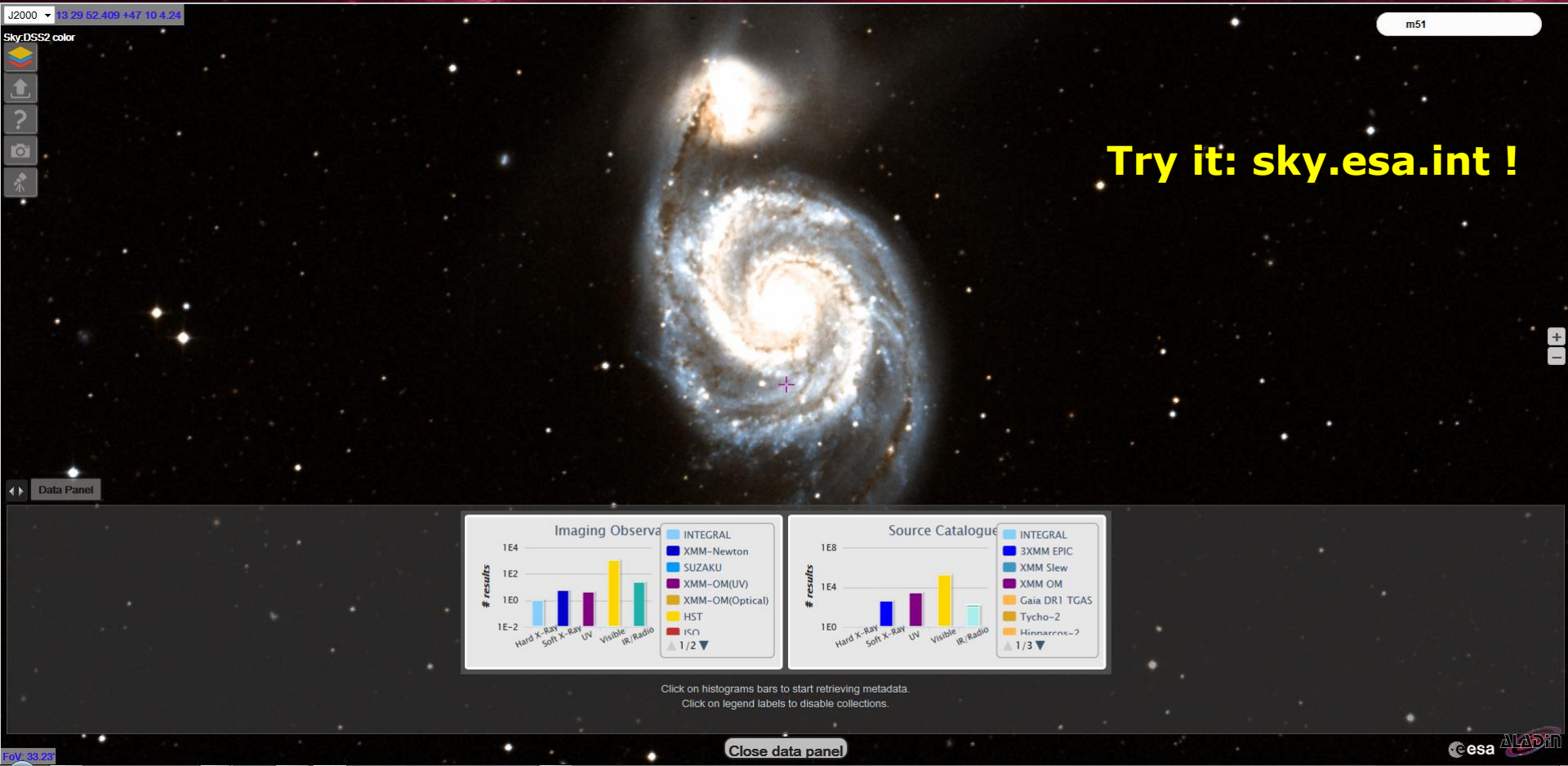




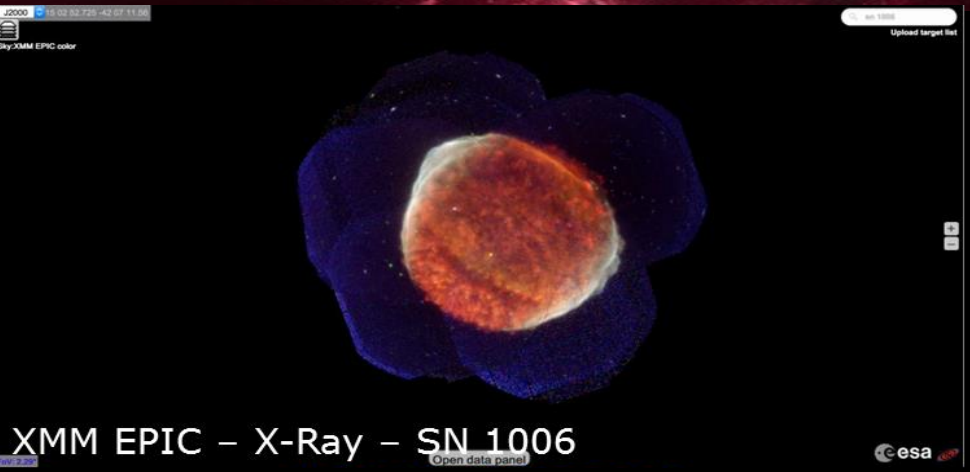


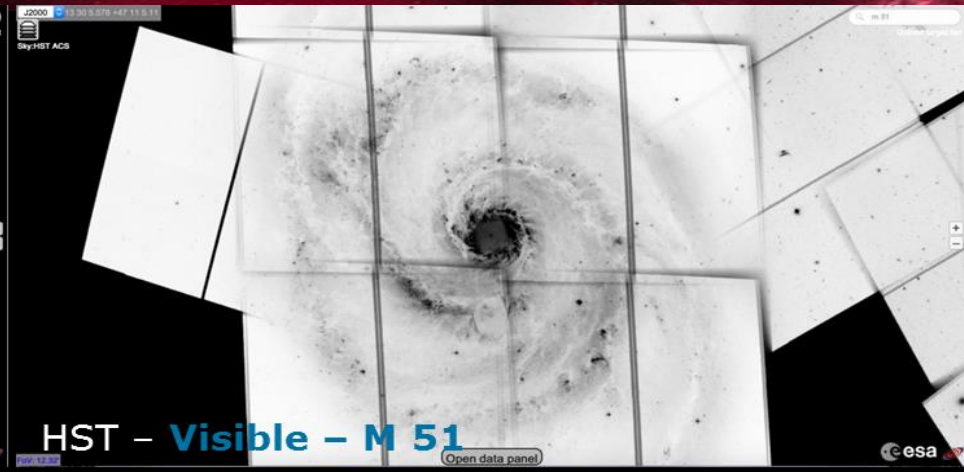
Future: JWST, Euclid, ..

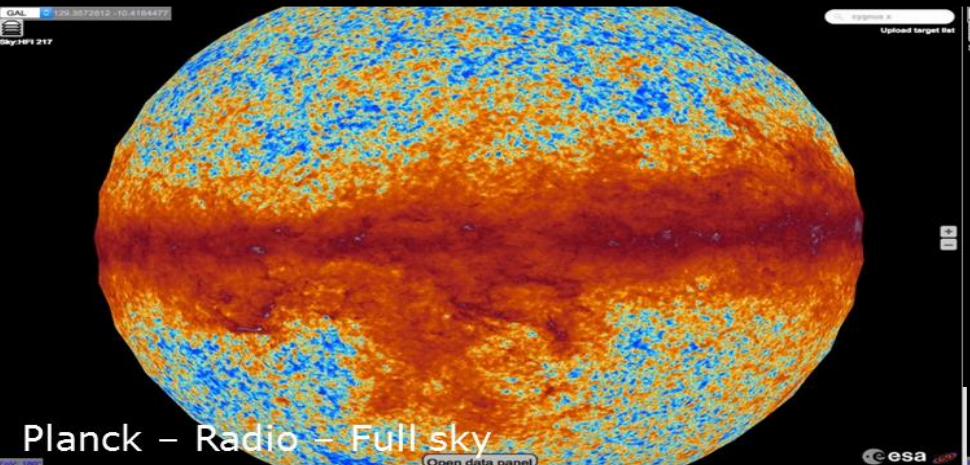
ESASky Concept: Explore, compare, select, download

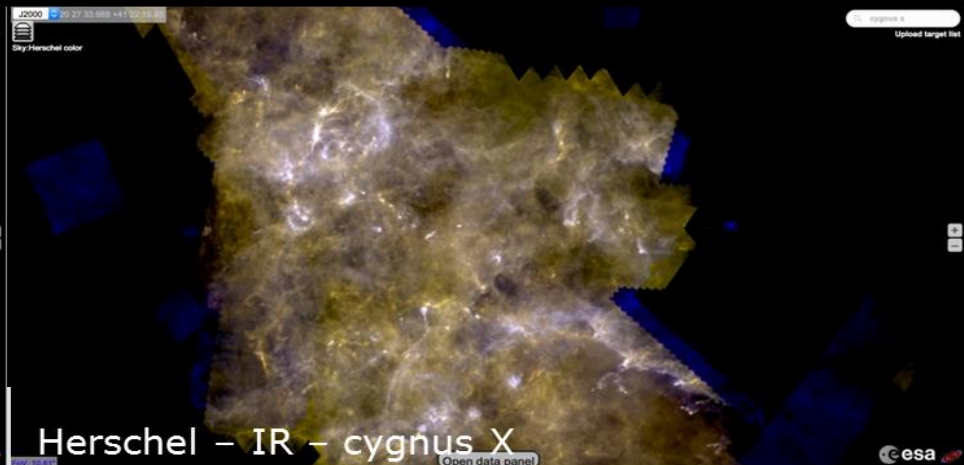


See the sky with different “eyes”









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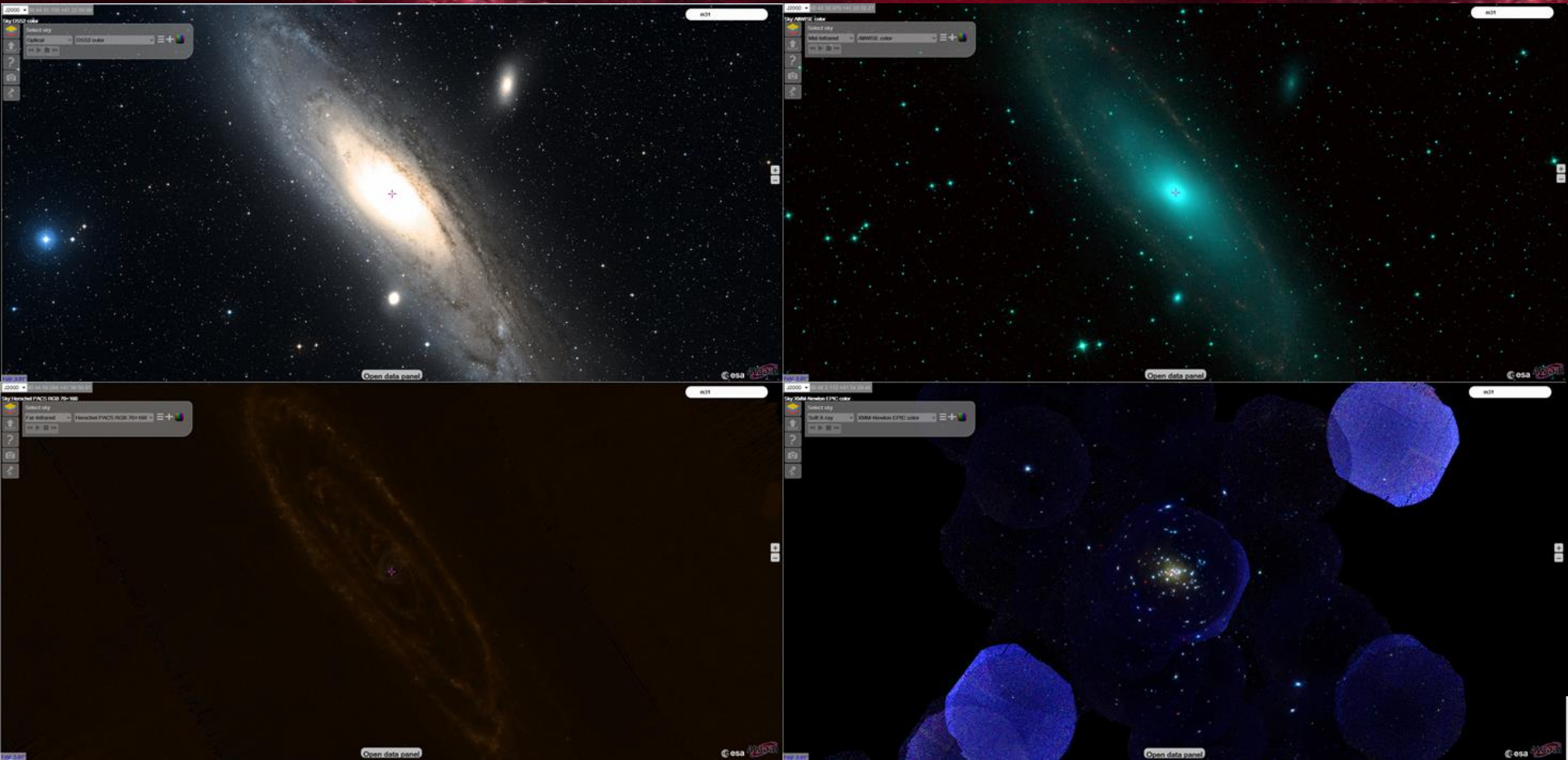
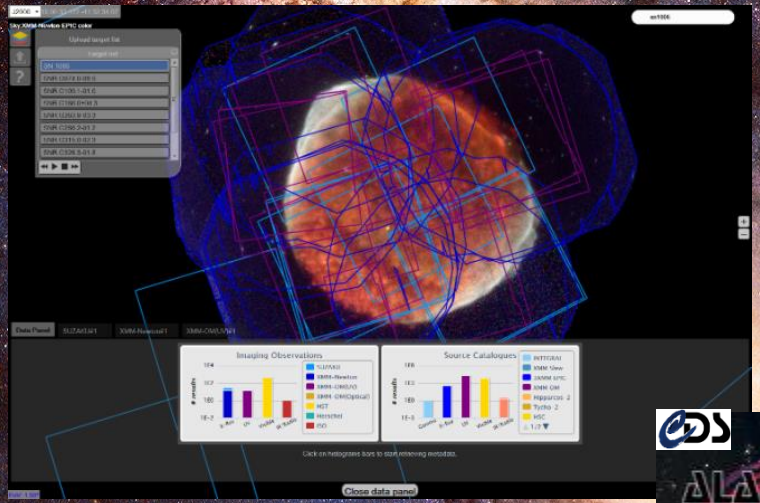


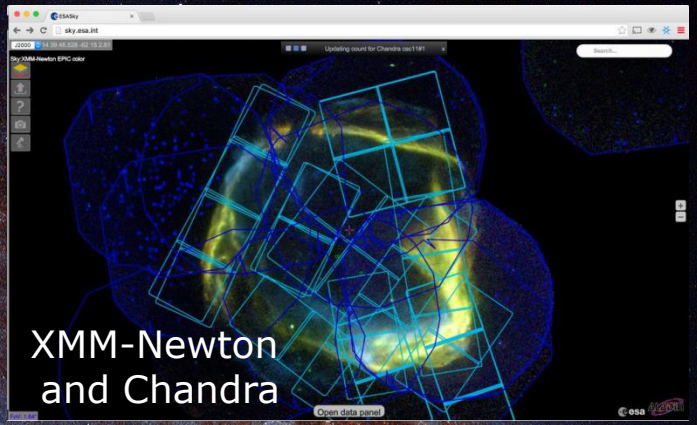
Collaboration is key – ESASky



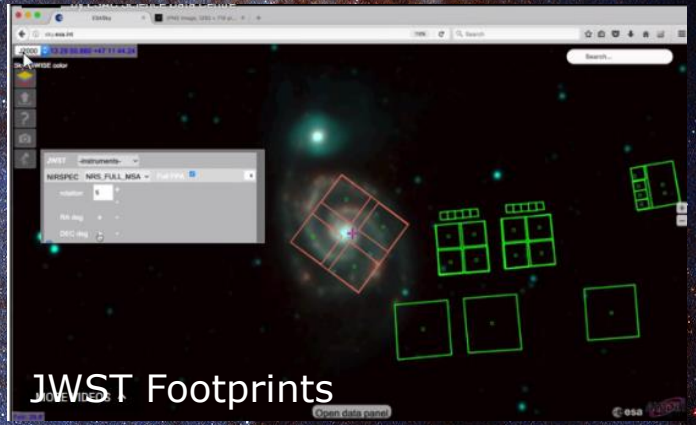
HiPS

SAMP TAP

ObsCoreDM, MOC



XMM-Newton and Chandra



JWST Footprints

Dedicated Python module to ESASky

Need for a new archive usage paradigm

New ways required to access the Gaia catalogue and associated data

- Powerful query mechanism, asynchronicity of results
- One “query interface” for all archive services and VO services

User can not download all catalogue and all data

- Need to have user workspaces IN the Archive
  - User database space, user disk space
- User workspace shareable amongst various users

Bring user code to the data

- Part of the user workspace in the archive
- Share code with other users

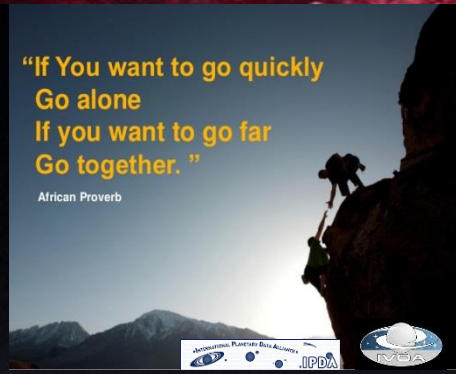
The user works with the data
WHERE the data is

=> Archive 2.0 concept

Conclusions

Management of ESA Space Science Data

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



Visualization of big data : ESASky

Archives 2.0 concept : bring the code to the data

Interoperability with other archives worldwide (Virtual Observatory)

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