

Space Science Data at ESA

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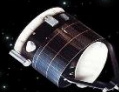
Open Universe Workshop, Vienna, 20-22 Nov 2017



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

uenus 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]

mars express
Investigating the Red Planet
[2003-]

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

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

cluster
Measuring Earth's
magnetic shield
[2000-]

solar orbiter
The Sun up close

→ 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-)

lue

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

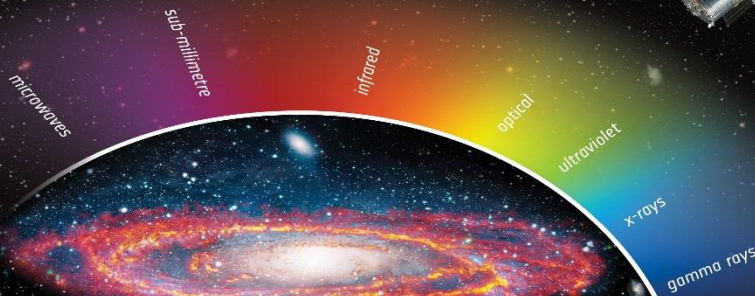
Looking back
at the dawn of time
(2009-2013)

exosat

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

cos-b

Surveying the high
energy Galaxy
(1975-1982)



ESAC Science Data Centre

The Digital Library of the Universe



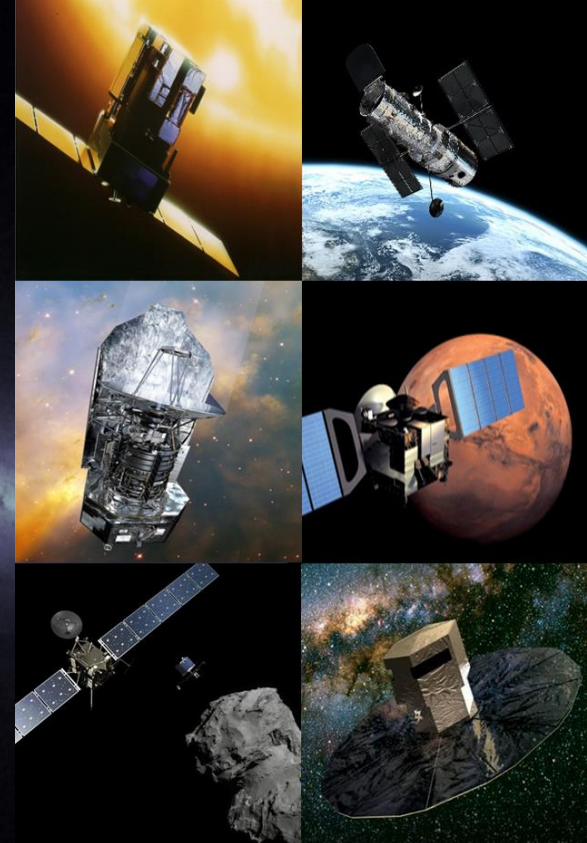
At ESA's European Space Astronomy Centre near Madrid

Science Archives from >15 space missions:

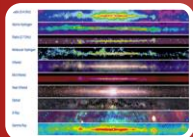
- Astronomy, Planetary, Heliophysics
- From all phases (development, operations, post-ops, legacy)
- <http://archives.esac.esa.int/>

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**

Astronomy Science Archives



esasky



exosat



gaia



herchel



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

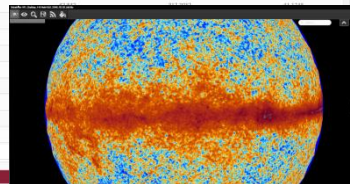
Freely accessible worldwide

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



New Planetary Science Archive – psa.esa.int

Planetary Science Archive



EUROPEAN SPACE AGENCY | SCIENCE & TECHNOLOGY | COSMOS | **planetary science archive** | PSA 001

HOME VIEW

SEARCH

Filter by: Mission, Product, Observation Date, Observation Step, Target, Mission

Product	Product Identifier	Observation Start Time	Observation Stop Time	Target	Mission
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Product 2	198101_0000_1001_0002	2010-01-01 00:00:02	2010-01-01 00:00:03	Mars	Mars Express
Product 3	198101_0000_1001_0003	2010-01-01 00:00:04	2010-01-01 00:00:05	Mars	Mars Express
Product 4	198101_0000_1001_0004	2010-01-01 00:00:06	2010-01-01 00:00:07	Mars	Mars Express
Product 5	198101_0000_1001_0005	2010-01-01 00:00:08	2010-01-01 00:00:09	Mars	Mars Express
Product 6	198101_0000_1001_0006	2010-01-01 00:00:10	2010-01-01 00:00:11	Mars	Mars Express
Product 7	198101_0000_1001_0007	2010-01-01 00:00:12	2010-01-01 00:00:13	Mars	Mars Express
Product 8	198101_0000_1001_0008	2010-01-01 00:00:14	2010-01-01 00:00:15	Mars	Mars Express
Product 9	198101_0000_1001_0009	2010-01-01 00:00:16	2010-01-01 00:00:17	Mars	Mars Express
Product 10	198101_0000_1001_0010	2010-01-01 00:00:18	2010-01-01 00:00:19	Mars	Mars Express
Product 11	198101_0000_1001_0011	2010-01-01 00:00:20	2010-01-01 00:00:21	Mars	Mars Express
Product 12	198101_0000_1001_0012	2010-01-01 00:00:22	2010-01-01 00:00:23	Mars	Mars Express
Product 13	198101_0000_1001_0013	2010-01-01 00:00:24	2010-01-01 00:00:25	Mars	Mars Express
Product 14	198101_0000_1001_0014	2010-01-01 00:00:26	2010-01-01 00:00:27	Mars	Mars Express
Product 15	198101_0000_1001_0015	2010-01-01 00:00:28	2010-01-01 00:00:29	Mars	Mars Express
Product 16	198101_0000_1001_0016	2010-01-01 00:00:30	2010-01-01 00:00:31	Mars	Mars Express
Product 17	198101_0000_1001_0017	2010-01-01 00:00:32	2010-01-01 00:00:33	Mars	Mars Express
Product 18	198101_0000_1001_0018	2010-01-01 00:00:34	2010-01-01 00:00:35	Mars	Mars Express
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Product 21	198101_0000_1001_0021	2010-01-01 00:00:40	2010-01-01 00:00:41	Mars	Mars Express
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Product 23	198101_0000_1001_0023	2010-01-01 00:00:44	2010-01-01 00:00:45	Mars	Mars Express
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Product 25	198101_0000_1001_0025	2010-01-01 00:00:48	2010-01-01 00:00:49	Mars	Mars Express
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Product 42	198101_0000_1001_0042	2010-01-01 00:01:22	2010-01-01 00:01:23	Mars	Mars Express
Product 43	198101_0000_1001_0043	2010-01-01 00:01:24	2010-01-01 00:01:25	Mars	Mars Express
Product 44	198101_0000_1001_0044	2010-01-01 00:01:26	2010-01-01 00:01:27	Mars	Mars Express
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Product 79	198101_0000_1001_0079	2010-01-01 00:02:36	2010-01-01 00:02:37	Mars	Mars Express
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Product 82	198101_0000_1001_0082	2010-01-01 00:02:42	2010-01-01 00:02:43	Mars	Mars Express
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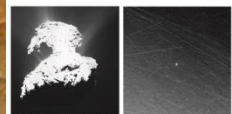
Page 1 of 10

ONE ARCHIVE, MANY MISSIONS

What is the PSA?

The European Space Agency's ESA Planetary Science Archive, or PSA, is the central repository for all scientific and engineering data returned by the agency's space science missions that have been exploring planets, moons, and small bodies in the Solar System.

The interface is designed for scientists who use observations from ESA's planetary missions for their research, but should be reasonably intuitive also for non-experts.



Mission	Main targets
ExoMars 2016	Mars
Giotto	Comet 1P/Halley
Huygens	Titan
Mars Express	Mars; Phobos; Deimos
Rosetta	Comet 67P/Churyumov-Gerasimenko; Asteroids 21 Lutetia and 2867 Steins
SMART-1	Moon
Venus Express	Venus

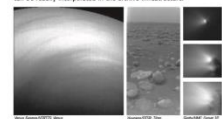


What can you find in the archive?

The PSA contains science-ready data that have been calibrated by the instrument teams and peer-reviewed by independent experts in the scientific community. The observations are compliant with the Planetary Data System (PDS) standards to ensure the long-term preservation of the dataset.

The archive encompasses over three decades of ESA's exploration of the Solar System, including data from missions that are currently operating, in the post-operations phase, or completed, as well as ground-based observations of comets. These data – about 10 million individual observations so far, amounting to almost 50 terabytes in volume – are now available to the scientific community from a single interface.

The PSA team is also preparing for ESA missions that are currently in the implementation phase, such as BepiColombo, Solar Orbiter, and JUICE, so that when observations are available in the future, they can be readily incorporated in the archive infrastructure.



The Planetary Science Archive is hosted on ESA's servers at the European Space Agency Centre (ESAC) near Madrid, Spain. It has been developed as a collaboration between the ESAC Science Data Centre, ESA's Planetary Science Ground Segment, and the Instrument teams.

The PSA team continues to develop new functionalities for the archive responding to needs expressed by the scientific community. The team receives advice from the PSA User Group, an independent body that evaluates the services and tools provided by the archive to the user community.

The PSA is an active member of the International Planetary Data Alliance (IPDA), a closely cooperating partnership to maintain the quality and performance of data (including data formats) from planetary research using instruments in space.

Missions included in the PSA:



Visit the archive at:
<http://psa.esa.int>

The PSA team welcomes feedback and suggestions for ways to improve the archive so that as many people as possible can make use of this extraordinary database. To contact the team, fill out the form at: <http://www.cosmos.esa.int/web/psa/contact-us>

Visit the other ESA archives at: <http://archives.esac.esa.int>

EUROPEAN SPACE AGENCY | SCIENCE & TECHNOLOGY | COSMOS | **planetary science archive** | PSA 001

HOME VIEW

START SEARCHING YOUR DATASET

SEARCH

DATA ACCESS

- TABLE VIEW
- PDF ACCESS

PRODUCT INFO & TOOLS

- ARCHIVAL DATA
- TOOL
- INFORMATION
- DATA ACCESS

USEFUL INFORMATION

- MISSION
- USER GROUP
- HELP & FAQ
- CONTACT

The Planetary Science Archive

missions

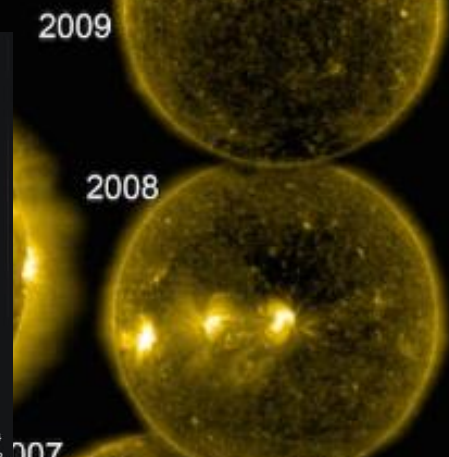
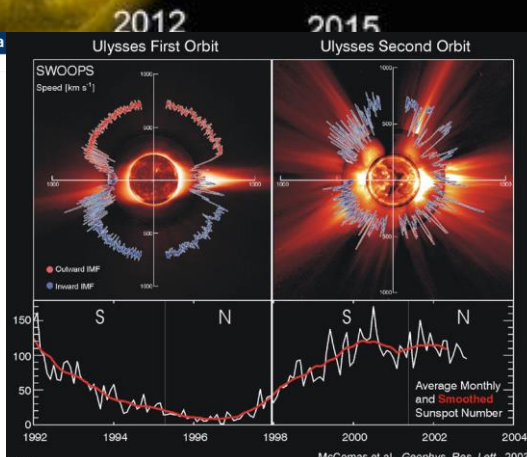
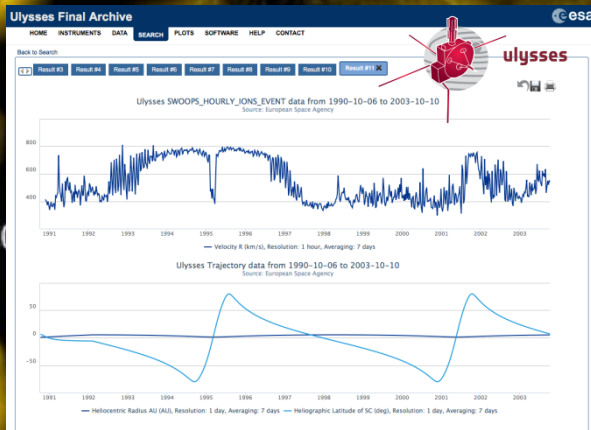
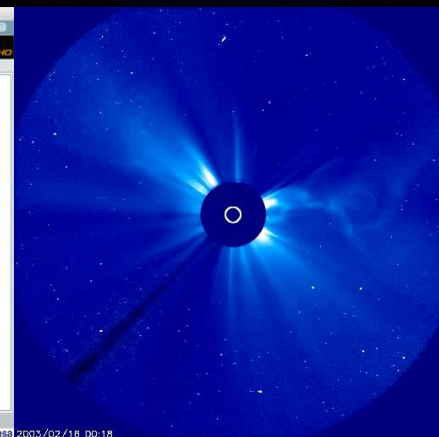
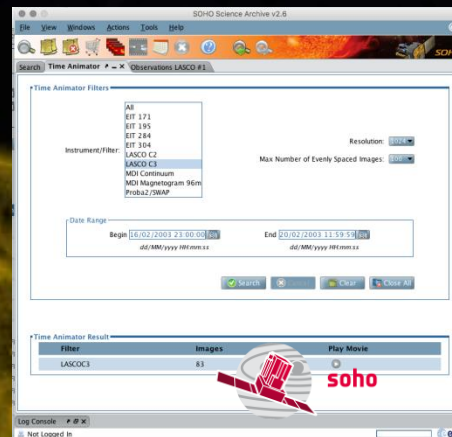
- cassini huygens
- exomars
- giotto
- mars express
- rosetta
- smart-1
- venus express
- bepicolombo
- juice

Index of <http://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



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

ESAC Science Data Centre mission:



PRESENTING AND PRESERVING
RELIABLE SPACE SCIENCE DATA

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



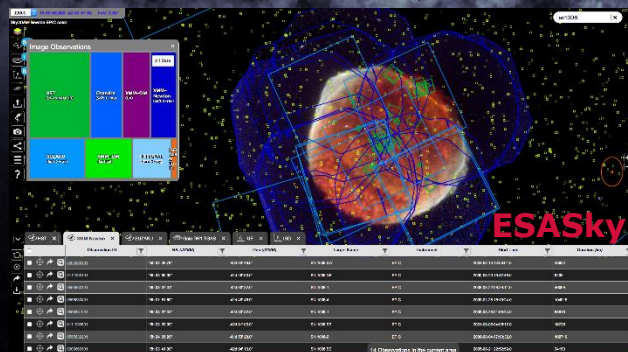
Consolidation of all ESA Space Science Archives at ESAC, with strong re-use across projects, ensuring easier and cheaper long term data preservation

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



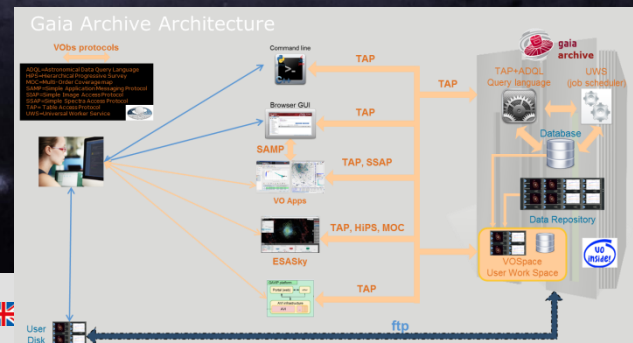
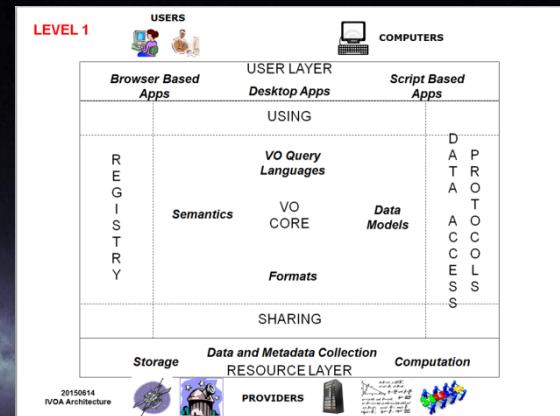
Existing collaboration among VO partners worldwide

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



Member Agencies	
	Armenian Astronomical Society Հայկական աստղագիտական ընկերություն
	China National Space Administration 國家航天局
	European Space Agency ESA
	German Aerospace Center Deutsches Zentrum für Luft- und Raumfahrt e.V.
	Indian Space Research Organisation भारतीय अंतरिक्ष अनुसंधान संगठन
	Italian Space Agency Agenzia Spaziale Italiana
	Japan Aerospace Exploration Agency 独立行政法人宇宙航空研究開発機構
	National Aeronautics and Space Administration NASA
	National Centre for Space Studies Centre national d'études spatiales
	Russian Space Research Institute Институт Космических Исследований
	United Arab Emirates Space Agency وكالة الإمارات للفضاء وكانت لفضاء الامارات
	UK Space Agency UKSA

Collaboration is key – ESASky



HiPS

SAMP

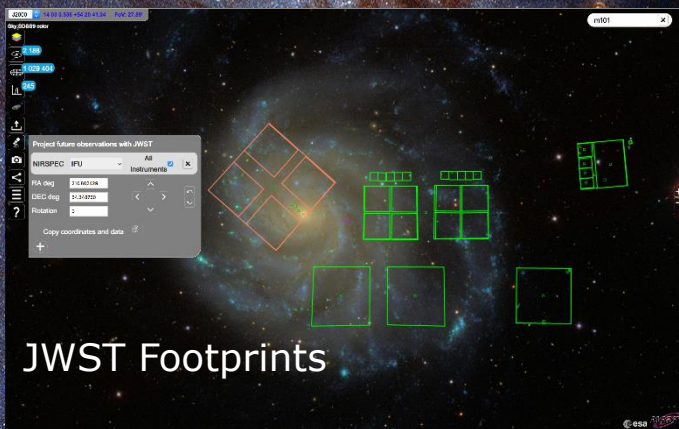
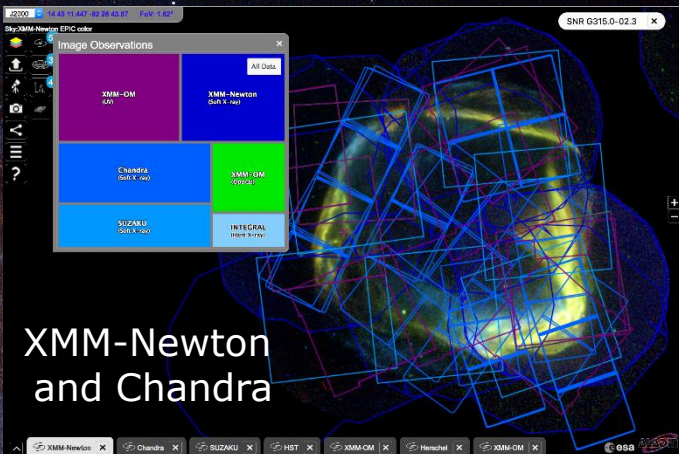


TAP

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)

**"If You want to go quickly
Go alone
If you want to go far
Go together. "**

African Proverb

