

Archival Science with the ESAC Science Archives and Virtual Observatory

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ESA-ESAC, Madrid

- Introduction to the ESAC Science Archives
- What UV data is available in the Astronomical ESAC Science Archives
- Introduction to the Virtual Observatory (VO)
- What UV data is available in the VO
- How to access all this data
- Archival Science and a few examples
- Summary

Introduction: The European Space Astronomy Centre (ESAC)



- ESAC is the ESA centre that hosts the Science Operations Centre (SOC) for ESA's astronomy, heliospheric and planetary missions
- Other Activities:
 - Science Archives
 - Tracking of satellites



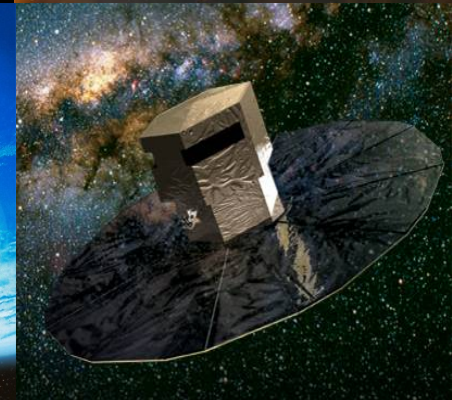
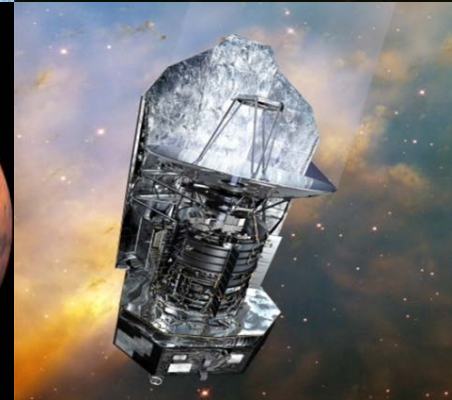
- Located in Villanueva de la Cañada, close to Madrid (Spain).
- Since June 2009, ESAC is formally a new ESA Establishment.

Introduction: The ESAC Science Archives

<http://archives.esac.esa.int>

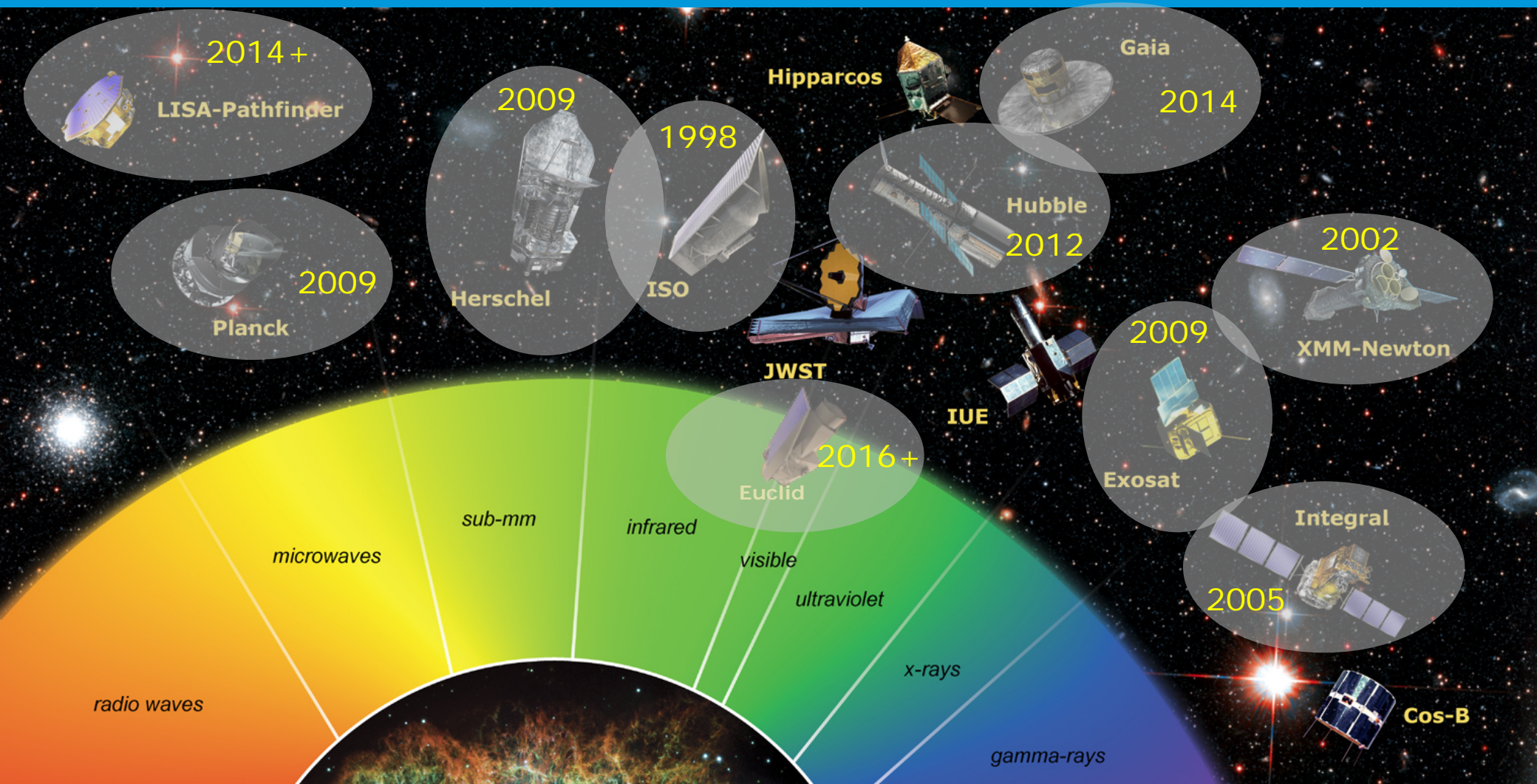


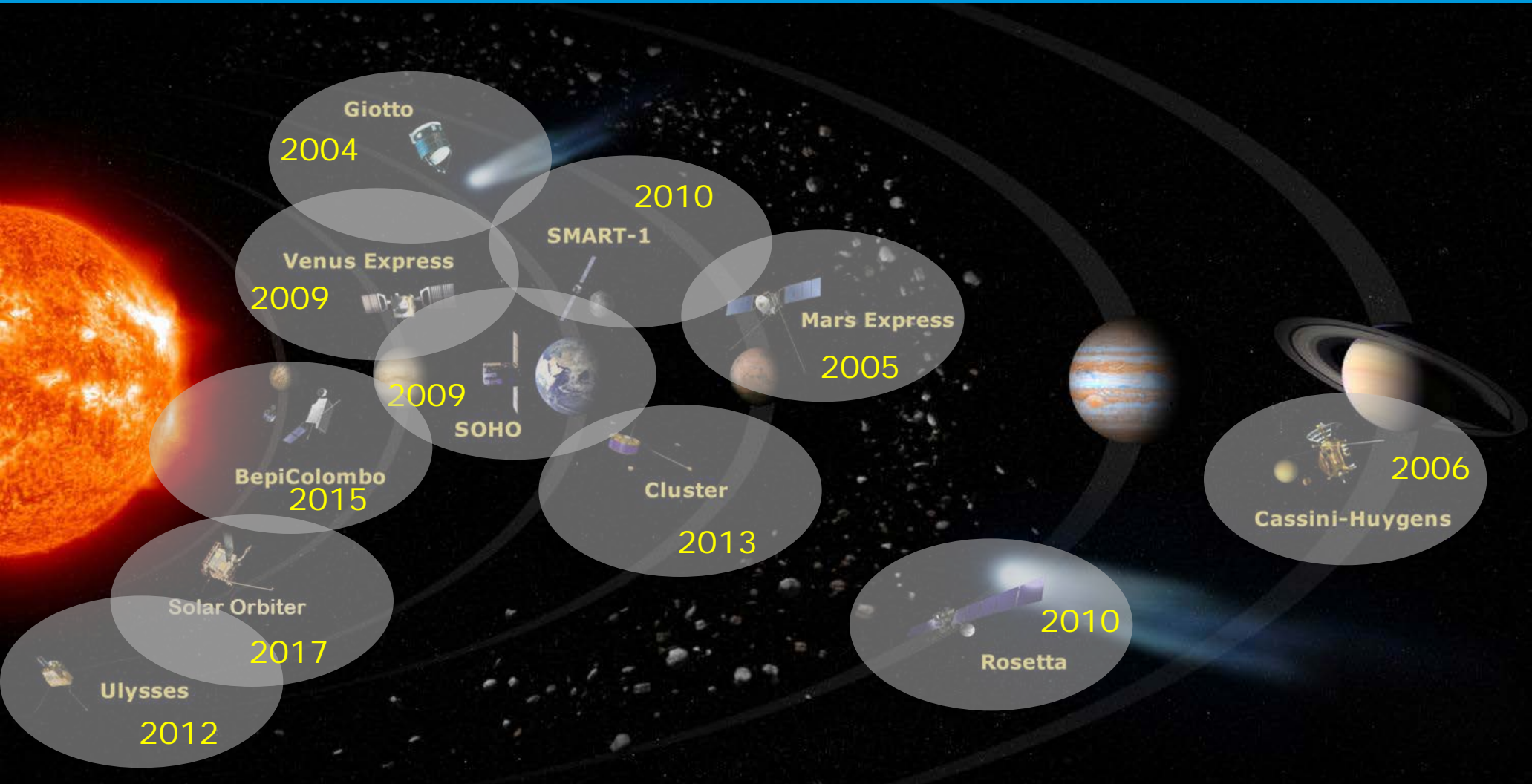
- Different missions:
 - Astronomy, Planetary, Solar System, ...
- Different types of data:
 - Raw data, calibrated processed data, high level data products, ...
- Different Users:
 - Scientific Community (public access)
 - PI team and observers (controlled access)
 - Science Operations Team (privileged access)
- Common Architecture and Look and Feel:
 - Better corporate image for ESA



ESAC Science Archives – Astronomy

<http://archives.esac.esa.int>





Introduction: The ESAC Science Archives

<http://archives.esac.esa.int>



- Archives have gone through 3 generations of updates:
 - 1st Gen (1998): Small apps (Java applets; Web couldn't support user reqs).

The image displays a collage of screenshots from the ESAC Science Archives website, illustrating its evolution and data presentation. The screenshots include:

- Planetary Science Archive 4.3.2:** Shows a search results page with a table of observations, including columns for observation ID, instrument, and date. A 'MEX MAP BROWSER' window is visible at the bottom, displaying a map of Mars.
- XMM-Newton Science Archive 7.0.2:** Shows a search results page with a table of observations, including columns for observation ID, instrument, and date. A 'MEX MAP BROWSER' window is visible at the bottom, displaying a map of Mars.
- ISOC Science Data Archive 3.1.3:** Shows a search results page with a table of observations, including columns for observation ID, instrument, and date. A 'MEX MAP BROWSER' window is visible at the bottom, displaying a map of Mars.
- INFRARED SPACE OBSERVATORY:** Shows a search results page with a table of observations, including columns for observation ID, instrument, and date. A 'MEX MAP BROWSER' window is visible at the bottom, displaying a map of Mars.
- Planetary Science Archive 4.3.2 (MEX MAP BROWSER):** Shows a detailed view of a map of Mars, with a search bar and various options for map display.

Introduction: The ESAC Science Archives

<http://archives.esac.esa.int>



➤ Archives have gone through 3 generations of updates:

- 1st Gen (1998): Small apps (Java applets; Web couldn't support user reqs).
- 2nd Gen (2006): Desktop application (Java webstart; User friendly UI).

The image displays a collage of screenshots from various ESAC Science Archives software interfaces. The interfaces are arranged in a layered, overlapping manner, showcasing different generations of the software. Key elements visible include:

- SOHO Science Archive v2.0:** Shows a table of observations with columns for Instrument, Detector, Observation Type, and Begin Date. A 'Details' window is open, displaying technical parameters like 'Instrument: EIT', 'Observatory: SOHO', and 'Object: Full Sun/Full Disk'.
- EXOSAT Science Archive v1.0.1:** Features a search interface for products by exposure number and observation ID. A 'Product Details' window shows information such as 'Target: BORON', 'Duration: 1.809second', and 'Product Type: image'.
- Planck Legacy Archive v1.0.1:** Displays a 'Maps grouped by' interface with a table of component maps. A 'Postcard' window shows a map titled 'COM_CompMap_DMB-smica_2048_R1.20.png'. Another window shows a 3D visualization of the Planck satellite's scanning path.
- HERSCHEL Science Archive:** Shows a table of observations with columns for Observation ID, Pointers, Target, RA/DEC, and Instrument. A 'Details' window provides specific observation data like 'Observation ID: 134227148' and 'Instrument: PACS'.

Introduction: The ESAC Science Archives

<http://archives.esac.esa.int>



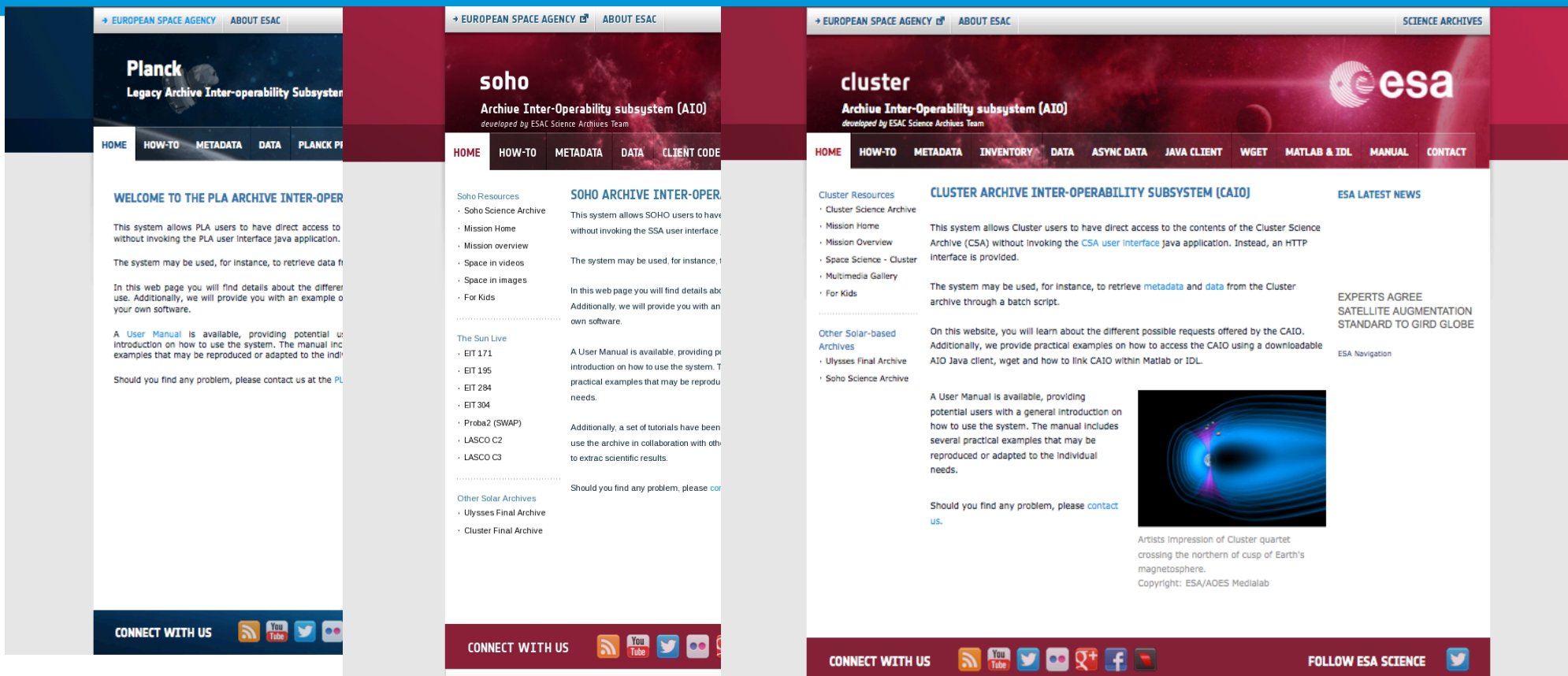
➤ Archives have gone through 3 generations of updates:

- 1st Gen (1998): Small apps (Java applets; Web couldn't support user reqs).
- 2nd Gen (2006): Desktop application (Java webstart; User friendly UI).
- 3rd Gen (2013): Web-based (Google Web Toolkit; User friendly; tablets & mobiles).
- An ESA Multi-Mission Archive interface is also in development

The collage displays four screenshots from the ESAC Science Archives website. The top-left screenshot shows the 'XMM-Newton Science Archive' interface with a search bar and a table of observations. The bottom-left screenshot shows a 'Postcard preview' of a star field with a color scale and a 'Send Image to' button. The middle-left screenshot shows the 'Ulysses Final Archive' search results page with a 'Start Date' dropdown menu. The right side of the collage features two screenshots of data plots: the top one shows 'Ulysses VHM FCM data' as a time-series plot, and the bottom one shows 'Ulysses SWICS data from 1990-10-06 to 2009-06-30' as a line graph with multiple data series.

Introduction: The ESAC Science Archives

<http://archives.esac.esa.int>



➤ Archives can also be directly accessed without launching the User Interface: Archive Inter-Operability (AIO). Complementary way to access content via http access, and batch scripts can be run.

Ultraviolet Data in the ESAC Astronomical Science Archives



XMM-Newton Science Archive:

- Optical/UV Monitor telescope (170 – 650 nm, 6 broad band filters, 3 in UV)
- OM Source catalogue.

XMM-Newton Science Archive

HOME SEARCH AIO SYSTEM CATALOGUES AND TOOLS DOCUMENTATION USER GUIDE CONTACT Sign in

Back to Search

Results #1 X Results #2 X

OBSERVATIONS (1) X EXPOSURES (16) X EPIC PPS SOURCES (48) X OM PPS SOURCES (39) X EPIC PPS SOURCES (39) X

Columns Save table as Send table to

	Obs.ID	Inst	Mode	Exp.ID	Img	Filter	Start Time
	0101640601	EMOS1	Large Window	S002		MEDIUM	2002-03-12 21:00:00
	0101640601	EMOS2	Large Window	S003		MEDIUM	2002-03-12 21:00:00
	0101640601	EPN	Full Frame	S001		MEDIUM	2002-03-12 22:00:00
	0101640601	OM	Image	S007	N/A	GRISM2	2002-03-12 21:00:00
	0101640601	OM	Image	S009		UVM2	2002-03-12 23:00:00
	0101640601	OM	Image	S010		UVW2	2002-03-13 00:00:00
	0101640601	OM	Image	S401		UVM2	2002-03-12 23:00:00
	0101640601	OM	Image	S402		UVM2	2002-03-12 23:00:00
	0101640601	OM	Image	S403		UVM2	2002-03-13 00:00:00

1 of 1 Page size: 100 Displaying 1-16 of 16

Details for Observation 0101640601

Summary Exposures Publications

16 Exposures

ExposureID	S405
Instrument	OM
Mode	Image
Filter	UVW2

XMM-Newton Science Archive:

- Optical/UV Monitor telescope (170 – 650 nm, 6 broad band filters, 3 in UV)
- OM Source catalogue.

ESA Hubble Science Archive:

- Moved to ESAC in June 2012 due to the closure of the Space Telescope European Coordinating Facility (ST-ECF), where the archive was previously located.
- 9 instruments in UV range:
 - **Active:** ACS (Advanced Camera for Surveys, ~120 to 1000 nm)
 - COS (Cosmic Origins Spectrograph, ~115 to 320 nm)
 - STIS (Space Telescope Imaging Spectrograph, ~115 to 1000 nm)
 - WFC3 (Wide Field Camera 3, ~200 to 1700 nm)
 - **Legacy:** FOC (Faint Object Camera, ~120 to 550 nm)
 - FOS (Faint Object Spectrograph, ~115 to 850 nm)
 - GHRS (Goddard High Resolution Spectrograph, ~105 to 300 nm)
 - WFPC & WFPC2 (Wide Field Planetary Cameras 1 & 2, ~115 to 1000 nm)

Other wavelengths:

- **Planck Legacy Archive** (Microwaves, 30 to 857 GHz; Includes Sky maps, catalogues, cosmology products)
- **Herschel Science Archive** (Far-IR & Sub-mm, 55 to 672 μm ; Includes images, photometry, spectra and catalogues)
- **ISO Data Archive** (IR, 2.5 to 240 μm ; Includes images, photometry, spectra and catalogues)
- **ESA Hubble Science Archive** (UV, Optical and near-IR, 105 to 2500 nm; Includes images, spectra, astrometric and photometric data)
- **XMM-Newton Science Archive** (X-ray, 0.15 to 15 keV; Includes images, spectra, light curves and catalogues)
- **EXOSAT Science Archive** (X-ray, 0.05 to 50 keV; Includes images, spectra, light curves and Slew Survey catalogue)
- **INTEGRAL Science Data Archive** (Gamma-ray & X-ray, 15 keV to 10 MeV; Includes images, spectra, light curves and catalogues. Source monitoring in the X-ray, 3-35 keV, and optical V-band, 550 nm).

- **The Virtual Observatory (VO) is the vision that astronomical datasets and other resources should work as a seamless whole.**
 - Many projects and data centres worldwide are working towards this goal.
 - The VO allows astronomers to interrogate multiple data centres in a seamless and transparent way and to utilise astronomical data.
 - Provides analysis and visualization tools within that system.
 - Provides access to science ready data.
 - Gives data centres a standard framework for publishing and delivering services using their data.

- Requires everyone to speak the same language:

*VO standards and protocols defined and adopted within the IVOA
(International Virtual Observatory Alliance)*



- **Ultimate Goal: Aid the work of astronomers and foster new science**

➤ Images:

- Extreme Ultraviolet Explorer (Heasarc)
- GALEX (STScI, Heasarc & MAST)
- HST (MAST & ST-ECF -> ESAC)
- Ultraviolet Imaging Telescope (UIT) on ASTRO-1 mission (MAST)
- XMM-Newton OM (ESAC & MAST) (~100 services covering all wavelengths)

➤ Spectra:

- Extreme Ultraviolet Explorer Merged Spectra (STScI)
- Far Ultraviolet Spectroscopic Explorer (STScI & Obs Paris)
- Galaxy Evolution Explorer (STScI)
- HST STIS, FOS & GHRS (STScI & ST-ECF -> ESAC)
- Hopkins Ultraviolet Telescope (STScI)
- IUE, highly processed, newly extracted (INES) (STScI & CAB)
- ESO Spectrum service: incs UVES (ESO) (~55 services covering all λ s).

➤ Catalogues:

- Source catalogues: GALEX-DR5 AIS & MIS, EUVE, UIT, XMMOMSUSS, Hubble Deep Field ...
- Observation logs: HST, IUE, FUSE, HUT, EUVE, XMM-Newton ...
- Over 230 covering all wavelengths (not including VizieR). Including VizieR -> 11500+ !

How to access all this data



In the ESAC Science Archives:

<http://archives.esac.esa.int>

➤ XSA: <http://archives.esac.esa.int/xsa>

➤ HST: <http://archives.esac.esa.int/hst>

ESA Hubble Science Archive



A classical search interface is available [here](#). The HLA grism data is also available from a dedicated search [interface](#).

Query form **Result table** **Get data** [New](#) [HST@ESAC Webpages](#) [Additional Queries](#) [Contact](#) [Acknowledgement](#) [ESAC/CADC/STScI](#)

Search **Reset** [Query help](#)

Archive HST HLA HLSP **Type** science frames only **Availability** public products only **Members** hidden

One-line query
Constraints entered into this one-line query field are combined with those entered into the form interface below. Keywords can be dragged&dropped from below.

Position	Energy	Time	Observation	Instrument
<input checked="" type="checkbox"/> Target (SIMBAD name) <input type="text"/> <input type="checkbox"/> Target (HST name) <input type="checkbox"/> Target description <input type="checkbox"/> File upload <input type="checkbox"/> RA Dec <input type="checkbox"/> Galactic coordinates <input type="checkbox"/> Ecliptic coordinates <input checked="" type="checkbox"/> Search box <input type="text" value="00:10:00"/> <input type="checkbox"/> Spatial resolution <input type="checkbox"/> Moving objects only	<input type="checkbox"/> Wavelength or band <input type="checkbox"/> Bandwidth <input type="checkbox"/> Filter/Grism/Prism Optical element type <input type="text" value="any"/> <input type="checkbox"/> Spectral resolution <input type="checkbox"/> Spectral resolving power	<input type="checkbox"/> Observation date <input type="checkbox"/> Exposure time <input type="checkbox"/> Time start <input type="checkbox"/> Time end	Data type <input type="text" value="any"/> <input type="checkbox"/> PI name <input type="checkbox"/> Proposal ID <input type="checkbox"/> Proposal title <input type="checkbox"/> Release date <input type="checkbox"/> Dataset name <input type="checkbox"/> Science extension <input type="checkbox"/> Number of members	Instrument <input type="text" value="any"/> WFC3 COS ACS WFPC2 NICMOS STIS FOS HRS FOC WFPC <input type="checkbox"/> Detector <input type="checkbox"/> Photon mode

v8.0 (23-Jul-2013 10:50)

How to access all this data

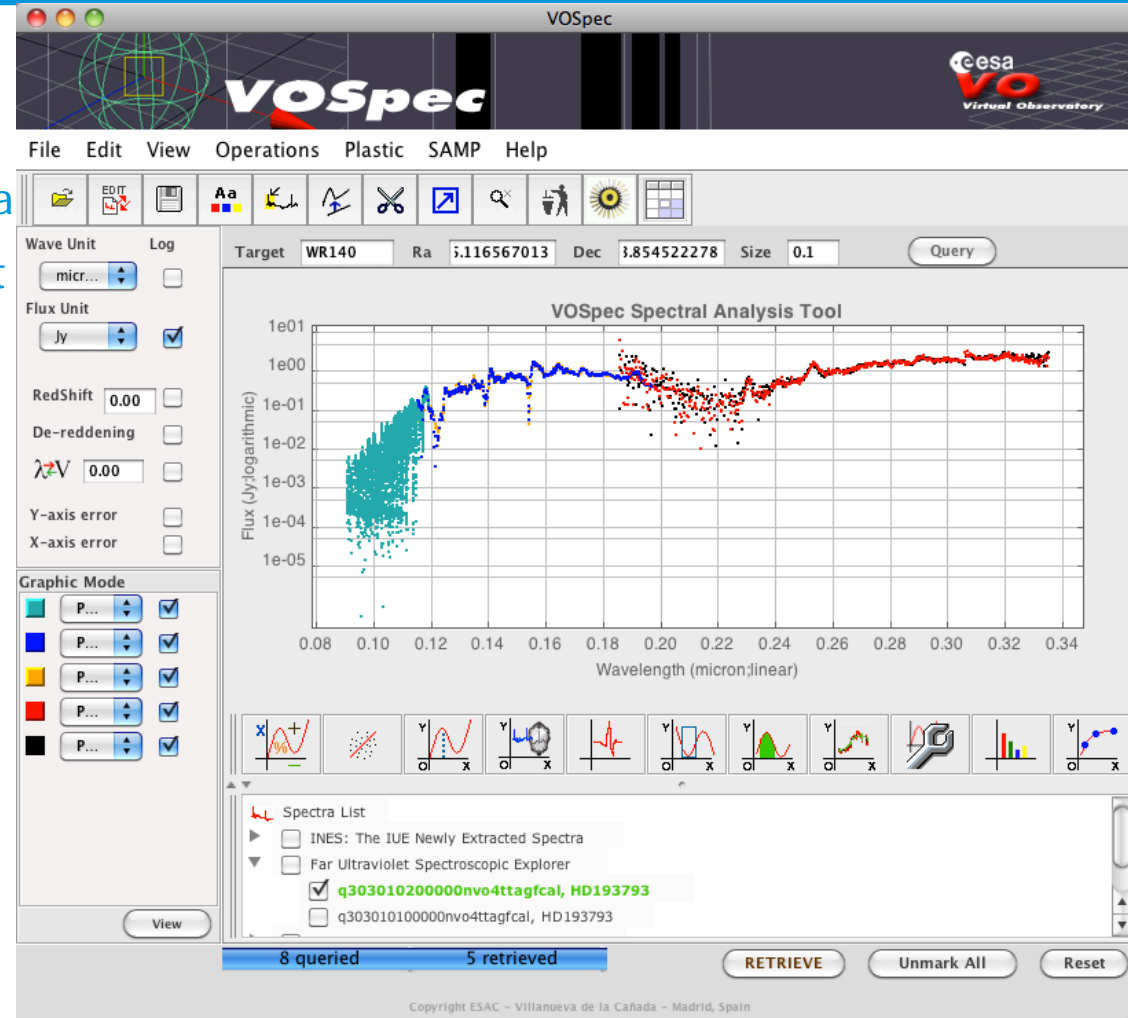
In the ESAC Science Archives:

<http://archives.esac.esa.int>

- XSA: <http://archives.esac.esa.int/xsa>
- HST: <http://archives.esac.esa.int/hst>

In the VO:

- Aladin – interactive software sky atlas to visualise images and superimpose catalogues.
- TOPCAT – interactive graphical viewer and editor for tabular data.
- VOSpec – Multi-wavelength spectral analysis tool.
- All other tools: e.g. IRAF etc. see IVOA and Euro-VO web pages.



How to access all this data



Science

Home

The EURO-VO current project: [EuroVO-CoSADIE](#) Past projects: [VOTECH](#) [EuroVO-DCA](#) [EuroVO-AIDA](#) [EuroVO-ICE](#)

Software

Applications/Services (alphabetical)	Applications/Services (by function)
Aladin	Search for Images: Aladin, Data Discovery Tool, TOPCAT
AstroStat	Search for Spectra: VOSpec, SPLAT, Aladin, Data Discovery Tool, TOPCAT
CDS Cross-Match Service	Search for Catalogues/Tables: Aladin, Data Discovery Tool, TOPCAT, Vizier, Xamin, TAPHandle
Iris	Image Visualisation: Aladin
Seleste	Catalogue/Table Visualisation: TOPCAT, VOPlot
SkyView	Catalogue Cross-matching: Aladin, CDS Cross-Match Service, TOPCAT/STILTS, Cross-Comparison Tool
SIMBAD	Scatter, 3D plots and histograms: TOPCAT, VOPlot, VisIVO
Specview	Statistics: AstroStat
SPLAT	Coverage Maps: Aladin
TAPHandle	Table format conversion: TOPCAT/STILTS, VOConvert
TOPCAT/STILTS	SEDs: Iris, VOSA, VOSpec
VAO Cross-Comparison Tool	Other VO Compliant Tools:
VAO Data Discovery Tool	IRAF, SAOImage DS9
VAO Time Series Search Tool	
VisIVO	
VizieR	

Member of co-funded project

- Home
- Astronomers
- Deployers
- Members
- About

INTERNATIONAL VIRTUAL OBSERVATORY ALLIANCE

VO Applications for Astronomers

In this section, scientists can find available VO-compatible applications for their immediate use to do science. The level of maturity of the applications depends on a high degree on the level of maturity of the corresponding IVOA protocols and standards. As a consequence of the flexibility of the standards, several of the applications might overlap in functionality. **The IVOA does not manage or guarantee these services/tools.**

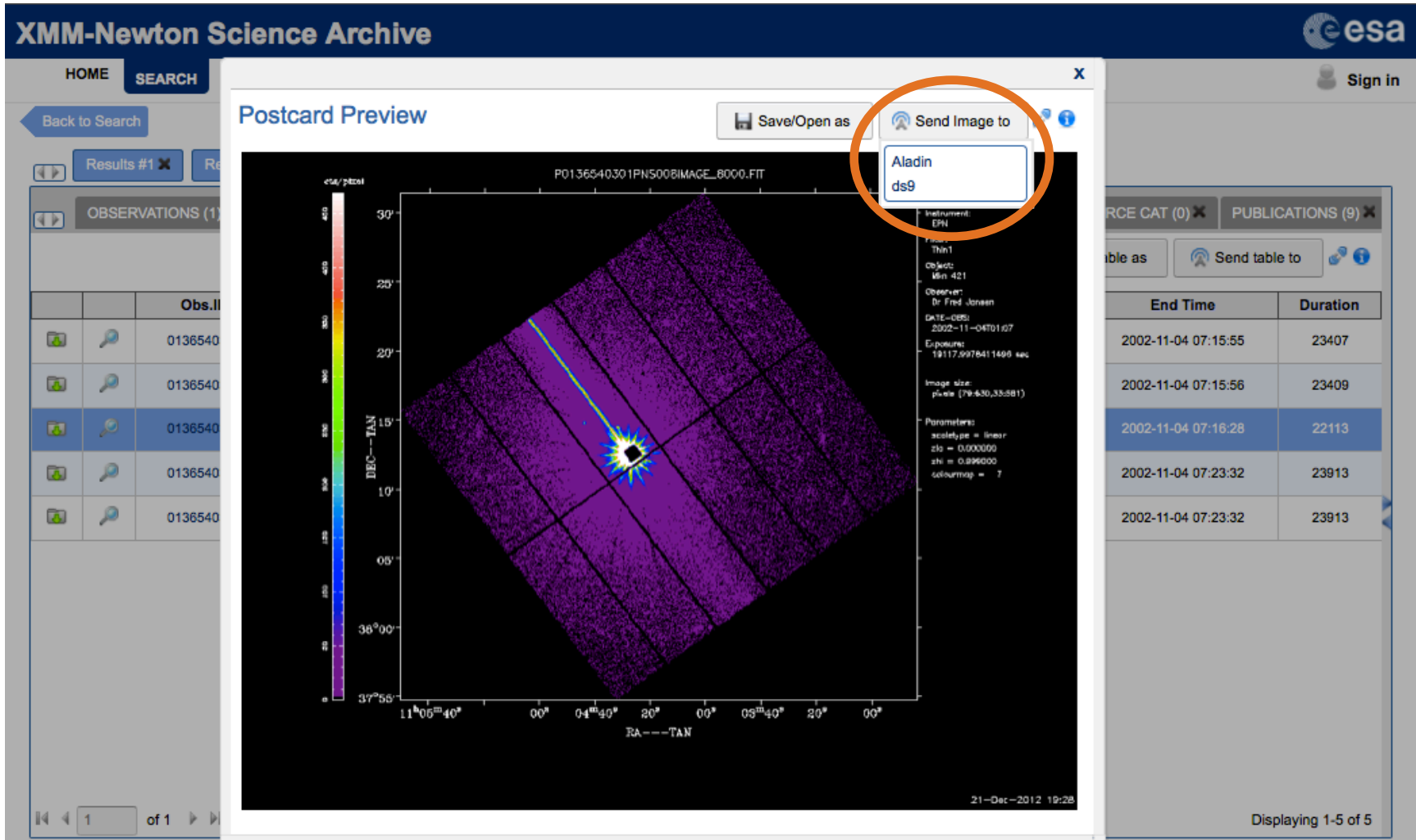


<p>Applications (in alphabetical order)</p> <p>Aladin Applauncher Cross Comparison Tool CDS Xmatch Service Data Discovery Tool Filter Profile Service Iris Montage Octet SkyView Specview SPLAT TAPHandle TAPsh TESELA Time Series Search Tool TOPCAT/STILTS VisIVO VOConvert VODesktop VOPlot VOSat VOSA VOSED VOServices (Footprint, Spectrum, Filters, ...) VOSpec WCSFixer</p>	<p>Functionality</p> <p>Search for Images: Aladin, Datascope, SkyView, VODesktop, Data Discovery Tool</p> <p>Search for Spectra: Aladin, Datascope, SPLAT, Specview, VOServices, VOSpec, Data Discovery Tool</p> <p>Search for Catalogues: Aladin, Datascope, TOPCAT, VODesktop, Data Discovery Tool</p> <p>Search for Time Series Data: Time Series Search Tool</p> <p>Image visualisation: Aladin, SkyView</p> <p>Spectra visualisation: SPLAT, Specview, VOServices, VOSpec</p> <p>Catalogues visualisation: Aladin, TOPCAT, VOPlot</p> <p>Cross-correlation: Aladin, STILTS, TOPCAT, CDS Xmatch Service, Cross Comparison Tool</p> <p>Scatter, 3D plots and histograms: TOPCAT, VOPlot</p> <p>Statistics: AstroStat</p> <p>Footprint Service: Aladin, VOServices</p> <p>Table format conversion: TOPCAT, VOConvert, STILTS</p> <p>Filter curves: VOServices, Filter Profile Service</p> <p>SED building: VOSA, VOSED, VOSpec, Iris</p> <p>Fixing WCS: Aladin, WCSFixer</p> <p>Query Databases Seleste, TOPCAT, TAPHandle,</p>	<p>VO-compliant Tools & Services</p> <p>DS9: Image visualisation GOSSIP: SED fitting VirGO: Search for Images and Spectra IRAF: Image Reduction & Analysis World Wide Telescope Gaia - Graphical Astronomy and Image Analysis SIMBAD TESELA VizieR</p> <p>Browse the Registries RSS Feed of New & Updated Services in the VO Applauncher EURO-VO Registry NVO Registry or use VODesktop</p> <p>Manuals, Tutorials, How-tos ADQL & TAP Tutorial Aladin User manual Cross Comparison Tool Tutorial (video) Datascope how to Data Discovery Tool Tutorial PDF (video) Iris How-to (video) Montage help SkyView documentation Specview examples SPLAT documentation STILTS documentation TOPCAT documentation VisIVO how to VOSpec User manual</p>
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<http://www.ivoa.net/astronomers/applications.htm>

<http://www.euro-vo.org/?q=science/software>

- Simple Application Messaging Protocol (SAMP):



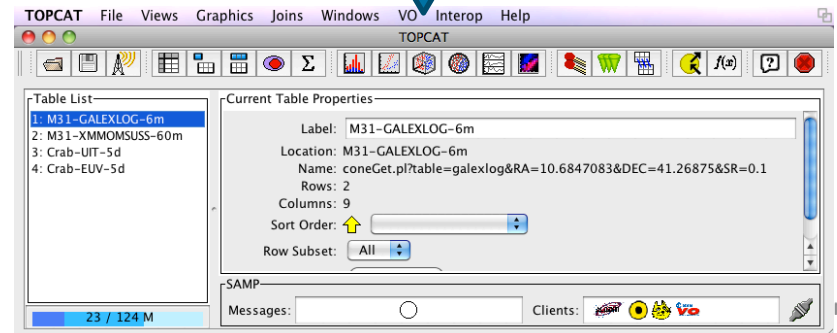
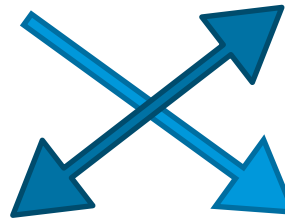
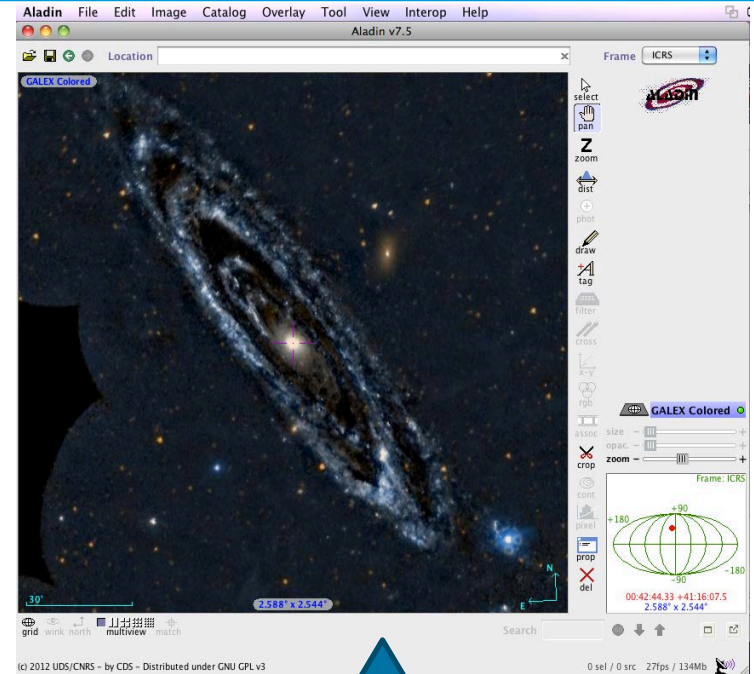
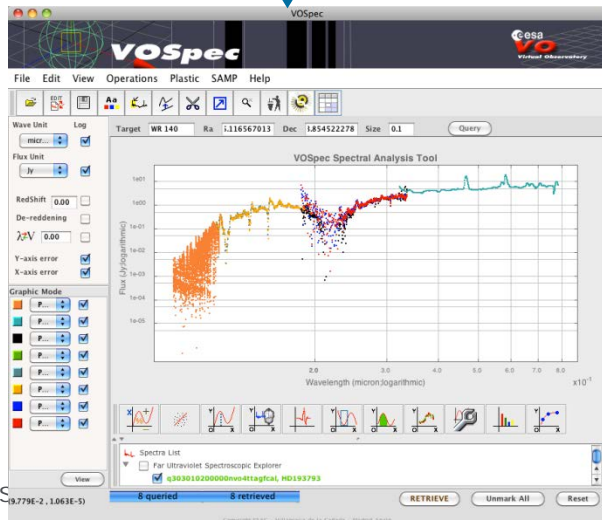
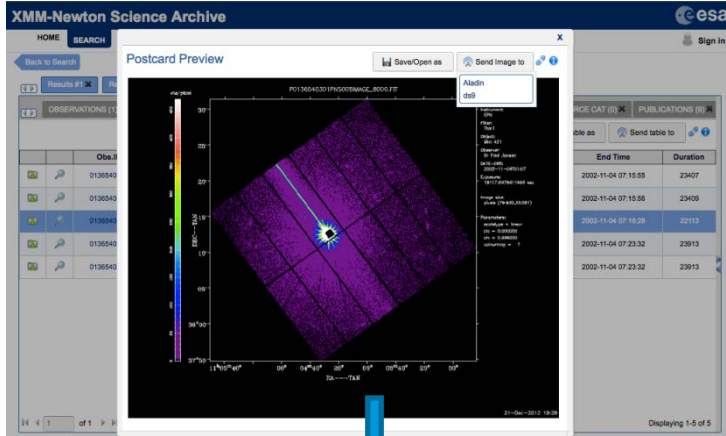
The screenshot displays the XMM-Newton Science Archive interface. A 'Postcard Preview' window is open, showing a color-coded astronomical image of a source. The image is titled 'P0136540301PN5008IMAGE_8000.FIT'. A 'Send Image to' menu is open, with 'Aladin' and 'ds9' highlighted. The background interface shows a search results table with observation IDs and a table of observation parameters.

End Time	Duration
2002-11-04 07:15:55	23407
2002-11-04 07:15:56	23409
2002-11-04 07:16:28	22113
2002-11-04 07:23:32	23913
2002-11-04 07:23:32	23913

Interoperable Tools



Simple Application Messaging Protocol (SAMP):



VizieR catalogues in the VO



TOPCAT File Views Graphics Joins Windows VO Interop Help

TOPCAT

VizieR Catalogue Service

Table List

- 1: J_MNRAS_313_641_table2
- 2: J_MNRAS_313_641_table4
- 3: J_MNRAS_313_641_table6

22 / 124 M

TOPCAT(1): Table Parameters

Name	Value	Description
Name	J/MNRAS/313/641/table2	Table name
Column Count	8	Number of columns
Row Count	777	Number of rows
Description	Detected UV sources	
votable-version	1.97 (28-Nov-2012)	

TOPCAT(1): Table Columns

Visible	Name	ID	Class	Units	Description
<input type="checkbox"/>	Index	\$0	Long		Table row
<input checked="" type="checkbox"/>	recno	\$1	Integer		Record number
<input checked="" type="checkbox"/>	[BBW2000]	\$2	String		Source name
<input checked="" type="checkbox"/>	RAJ2000	\$3	String	"h:m:s"	Right ascension
<input checked="" type="checkbox"/>	DEJ2000	\$4	String	"d:m:s"	Declination
<input checked="" type="checkbox"/>	UVmag	\$5	Float	mag	UV magnitude
<input checked="" type="checkbox"/>	e_UVmag	\$6	Float	mag	rms uncertainty
<input checked="" type="checkbox"/>	FAUST	\$7	Short		? FAUST name
<input checked="" type="checkbox"/>	n_FAUST	\$8	String		Last digit

TOPCAT(1): Table Browser

Table Browser for 1: J_MNRAS_313_641_table2

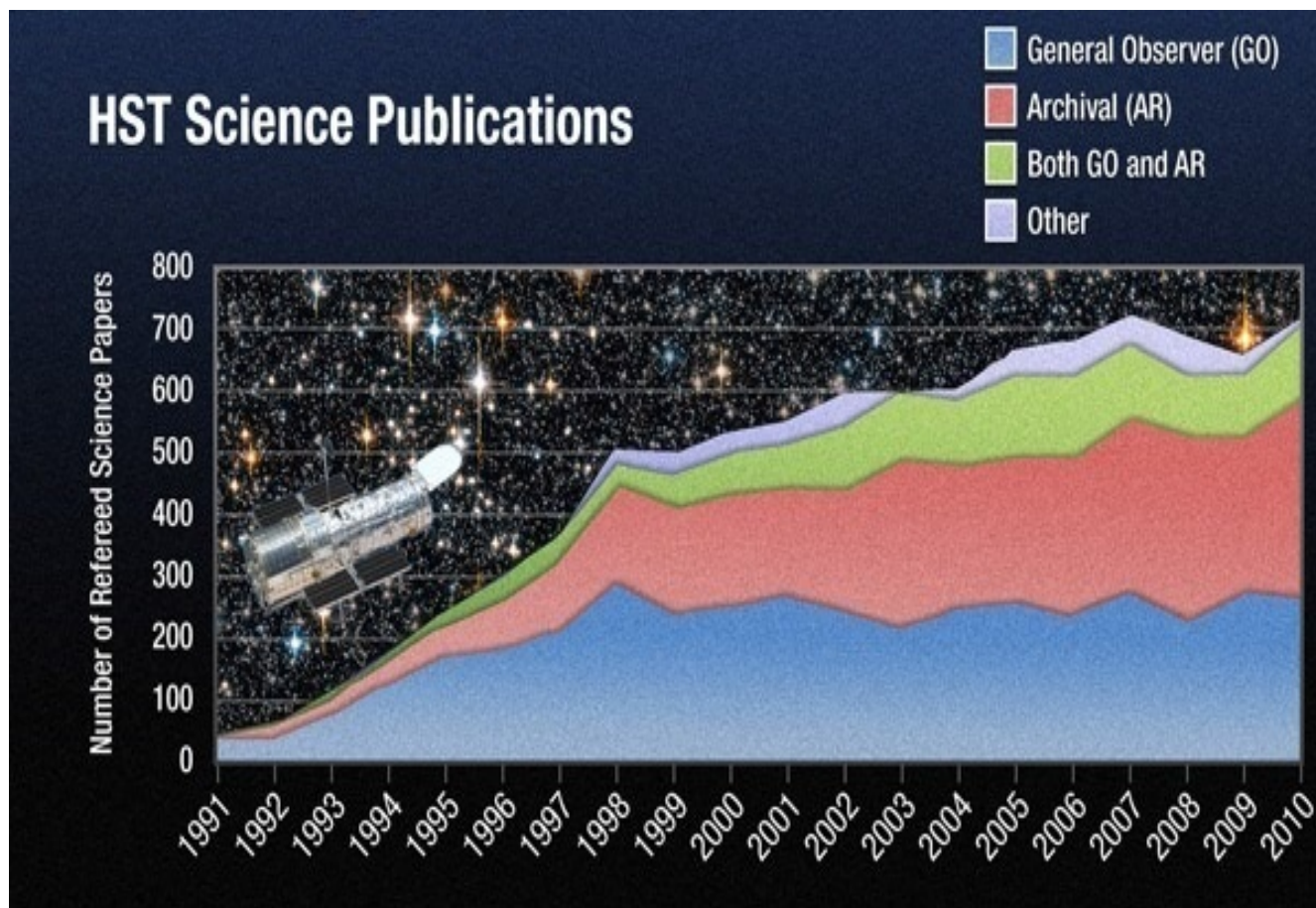
	recno	[BBW20...	RAJ2000	DEJ2000	UVmag	e_UVmag	FAUST	n_FAUST
1	1	FC 1	12 47 36	-37 23 22	11.85	0.4	3466	
2	2	FC 2	12 55 45	-37 17 35	11.26	0.32	3574	
3	3	FC 3	12 40 22	-37 51 52	7.99	0.17	3350	
4	4	FC 4	12 56 32	-37 39 28	11.75	0.29	3580	
5	5	FC 5	12 41 54	-37 53 32	10.07	0.21	3378	
6	6	FC 6	12 42 37	-37 54 09	11.3	0.23	3392	
7	7	FC 7	13 03 21	-37 44 39	10.73	0.29	3654	
8	8	FC 8	12 56 50	-37 57 31	12.19	0.36	3584	
9	9	FC 9	12 52 21	-38 02 20	13.23	0.76	3538	
10	10	FC 10	12 53 32	-38 03 43	12.56	0.45	3548	
11	11	FC 11	12 38 03	-38 15 09	11.5	0.33	3304	
12	12	FC 12	12 49 58	-38 18 24	12.36	0.39	3510	
13	13	FC 13	12 43 48	-38 20 52	11.85	0.34	3410	
14	14	FC 14	12 48 21	-38 22 30	11.4	0.25	3481	
15	15	FC 15	12 39 42	-38 24 46	11.98	0.37	3333	
16	16	FC 16	13 04 38	-38 23 54	9.39	0.19	3665	
17	17	FC 17	12 39 09	-38 44 46	10.08	0.2	3317	
18	18	FC 18	12 34 51	-38 49 43	10.39	0.23	3253	
19	19	FC 19	12 59 41	-38 42 32	8.81	0.17	3614	
20	20	FC 20	12 47 45	-38 51 16	10.49	0.2	3467	
21	21	FC 21	12 45 27	-38 51 25	11.19	0.24	3434	
22	22	FC 22	13 00 35	-38 44 38	12.24	0.28	3631	
23	23	FC 23	12 58 01	-38 55 04	7.48	0.16	3599	
24	24	FC 24	12 40 19	-39 02 42	13.07	0.83	3346	
25	25	FC 25	12 51 54	-38 58 24	13.58	0.92	3526	
26	26	FC 26	12 31 48	-38 13 14	10.7	0.2	3208	

OK

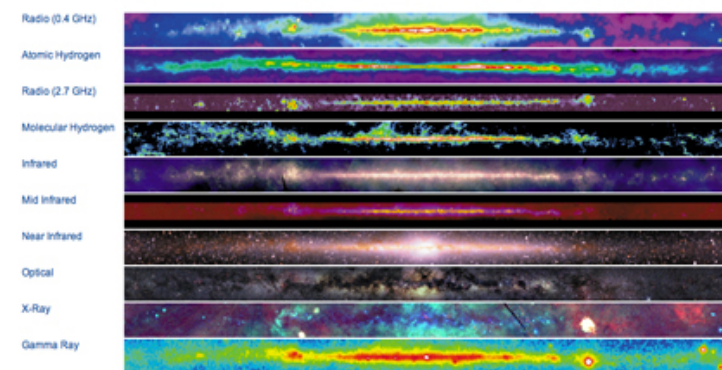
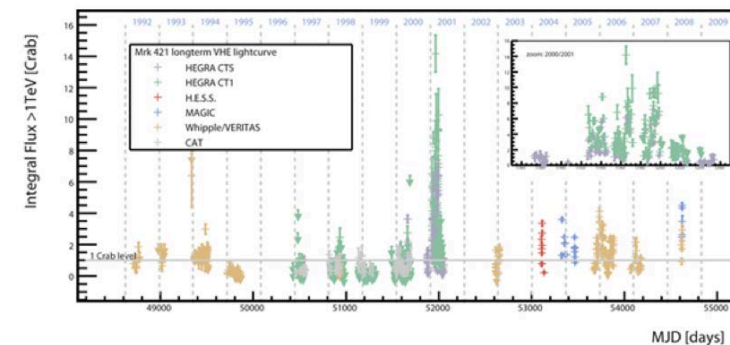
➤ If you have a catalogue or table in VizieR, it is also accessible via the VO.

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- Image from the HST 10,000 science publications press release in June 2011, showing the number of archival papers (AR) increasing whilst General Observer (GO) papers are around the same number from 1997 to 2010:
- One reason for the surge -> the telescope's longevity. Hubble has amassed almost 23 years of data, and astronomers are finding new uses for the data. Projects not imagined when observations were taken.

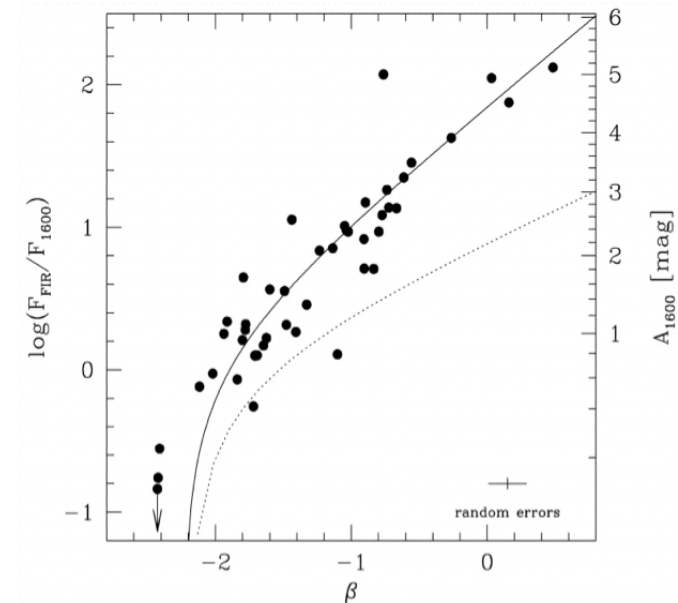


- What kind of science can you do with archival data that you can't, for example, with a short-term observing program?
 - Long-term variability of objects (XMM-Newton science data from 2000 to present, HST science data from 1990 to present, ...).
 - Statistical and correlative studies: obtain data on a large sample of the same types of sources.
 - Multi-wavelength studies using archival data from a number of missions, telescopes and catalogues.
 - Management of large archives for the discovery of rare objects (particularly a VO example).
 - Citizen science: e.g. Galaxy Zoo using SDSS images and Hubble Space telescope images (from the CANDELS survey) to classify galaxies.
 - ...



Dust Absorption and the Ultraviolet Luminosity Density at $z \approx 3$ as Calibrated by Local Starburst Galaxies Meurer, G. R., Heckman, T. M. & Calzetti, D. (1999) *ApJ*, 521, 64

- Highly cited HST Archival science paper (over 490).
- Uses archival data from HST (UV fluxes), IUE (UV fluxes) and IRAS (FIR fluxes).
- Paper refines a technique to measure the absorption-corrected UV luminosity of starburst galaxies using rest-frame UV quantities alone and apply it to Lyman-limit U dropouts at $z \approx 3$ found in the Hubble Deep Field.
- Method is based on an observed correlation between the ratio of far-IR (FIR) to UV fluxes with spectral slope β (a UV colour).
- A fit to this relation allows the UV flux absorbed by dust and reprocessed to the FIR to be calculated, and the dust-free UV luminosity to be determined.
- Summary: demonstrate the close correspondence between local starbursts and high- z Lyman-limit systems, and that there may be a mass-metallicity relationship out to $z \approx 3$.

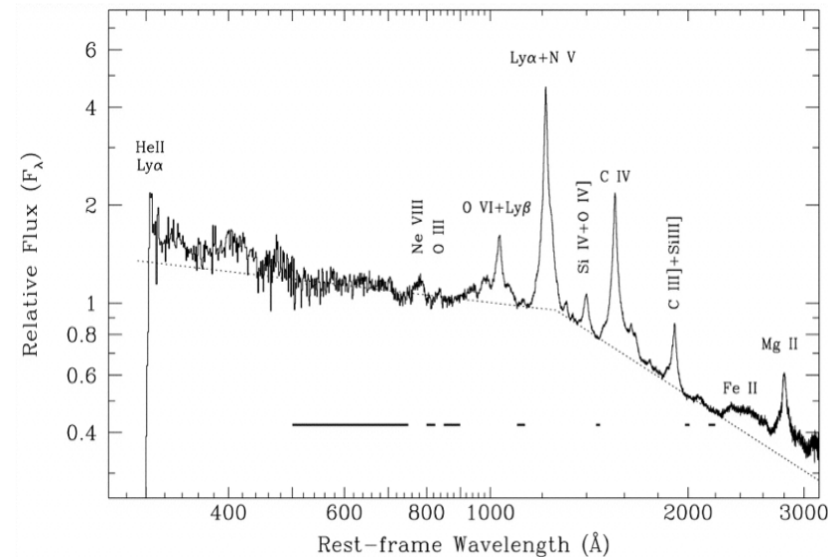


Ratio of FIR to UV fluxes at 1600 Å compared to UV spectral slope β for UV-selected starburst galaxies.

The Rest-Frame Extreme-Ultraviolet Spectral Properties of Quasi-Stellar Objects

Telfer, R. C. et.al. (2002) *ApJ*, 565, 773

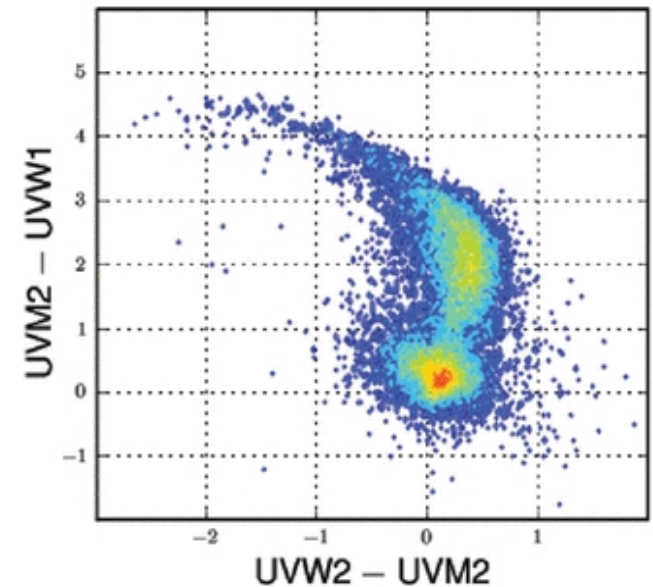
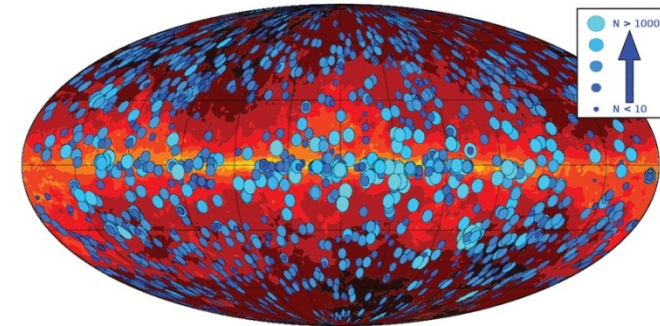
- Highly cited HST Archival science paper (over 320).
- Use a sample of 332 HST spectra of 184 QSOs with $z > 0.33$ to study the typical UV spectral properties of QSOs.
- Sample is twice as large as previous work with a better spectral coverage in the extreme-UV.
- The overall composite continuum can be described by a power law, between 500 to 1200 Å.
- Summary: Find no evidence for evolution of a power law index with redshift for either radio-loud or radio-quiet QSOs.
- Summary: Find marginal evidence for a trend toward harder EUV spectra with increasing luminosity for radio-loud QSOs.



Overall mean composite QSO spectrum in 1 Å bins with some prominent emission lines marked. Dotted line shows best-fit power law continuum (excluding below 500 Å).

XMMOMSUSS – XMM-Newton Optical Monitor Serendipitous UV Source Survey Catalogue
Page, M. J. et.al. (2012) MNRAS, 426, 903

- Contains source detections from 2,417 XMM OM observations in up to 3 broad band UV filters, between February 2000 and March 2007.
- All data publicly available in the Archive since May 2007.
- Net sky area, 29 – 54 deg², depending on UV filter.
- Content: filter-dependent source positions, magnitudes and fluxes. Also profile diagnostics and variability statistics.
- Contains 624,049 unique objects (753,578 UV source detections above 3-sigma). More than 10% of sources visited more than once using the same filter.
- ~1.0 arcsec positional accuracy of catalogue detections.
- Rich in early-type stars and star-forming galaxies out to $z \sim 0.8$.



- There are currently 7 ESAC Astronomical Science Archives with data from microwaves to gamma-rays.
- The ESAC Science archives hold UV data in the XMM-Newton Science Archive and ESA Hubble Science Archive.
- Many of the large data centres have published UV data in the Virtual Observatory, including HST, GALEX, FUSE, IUE, EUVE, XMM-Newton data ...
- VizieR catalogues are also available in the Virtual Observatory.
- The older the mission, the more important Archival data becomes.
- Archival data particularly good for studying long-term variability of objects, large statistical and correlative studies, multi-wavelength studies, discovery of rare objects, ...
- Very valuable science can (and is being) done with Archival data.

<http://archives.esac.esa.int>


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Science Archives at ESAC



Click on a satellite to visit the mission archive homepage.

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

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.

Observations from ISO, XMM-Newton and Integral can also be seen from Google Sky downloading the following KML file.

Latest News

- **11th Sept 2013:** The Herschel Science Archive version 5.0 is released! Highlights include providing access to User Provided Data Products (UPDPs).
- **23rd July 2013:** The XMM-Newton Science Archive v8.0 is released! Highlights include a new web-based interface and the 3XMM catalogue.
- **21st March 2013:** The Planck 2013 results are now available to the world-wide community through the Planck Legacy Archive version 1.0!
- **29th February 2013:** The Ulysses Final Archive version 1.0 is released.

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European Space Agency