

Integral Archive

*A new brand of science-oriented Science Archives at ESAC
Science Data Centre*

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ESA ESAC

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Integral mission: a bit of context

- ESA's International Gamma-Ray Astrophysics Laboratory, launched on October 2002 (still in operations)
- First observatory that observes simultaneously objects in gamma rays, X-rays and visible light
- Mission targets:
 - Galactic black holes, neutron stars, white dwarfs
 - Active galactic nuclei at heart of distant galaxies
 - Gamma-ray bursts and violent explosions
 - Supernova explosions
- Heavy science payload (2 tonnes): large area detectors & huge shield
 - 2 gamma-ray instruments: Imager (IBIS) & Spectrometer (SPI)
 - 2 monitors: X-ray monitor (JEM-X) & Optical camera (OMC)
- 3 days high elliptical orbit around Earth, shorter after 2015 to ensure re-entry
- Planned mission end date: 2029



- ISO: first science archive in ESAC in 1998!
- ESAC is the default ESAC location for scientific archives and VO activities
- ESDC (ESAC Science Data Centre):
 - Design, develop and maintain all the scientific archives to enable maximum scientific exploitation of ESA space science data
 - Optimize personnel resources and expertise
 - Ensure long term data preservation
- State of the art technology in continuous improvement: need to adapt to the trend



ESDC: Archives evolution - architecture



	First Generation 1998 - 2006	Second 2006- 2011	Third 2011 - 2019	Forth 2019 -
Client Layer	Java applet: AWT	Java webStart Swing Jgoodies Infonode	Java: GWT	Javascript: Angular
Server Layer	In-house Java server	Open source Java Server	Open source Java Server	Open source Java Server (IVOA protocols)
Ingestor	Java standalone application			Apache Camel
Data Layer/ Persistence	Sybase, Oracle	Postgresql, Hibernate, Ehcache		Greenplum
	--			UX Design



One step forward in ESDC: UX design

- Term “UX design” invented by Don Norman in 1995: User Experience Design
- Goal: provide meaningful experiences to the application users
- Key to distinguish between UX and UI and usability: UX is a broader concept
 - UI concerns to the product interface
 - Usability is a UI quality attribute
- Involves the entire process of acquiring and integrating the product, covering why, what and how:
 - Why: user’s motivations for adopting a product
 - What: functionality
 - How: design of the functionality in the most high-quality way



UX design in ISLA: why, what, how

Why

- Different and meaningful approach to exploit the Integral Science

What

- Having an efficient and intuitive Integral science archive

How

- Replace old forms-based Science Archives by Science Portals focused on specific scientific topics
- Adding smart search engine (google like form)
- Collaborate with mission scientists to design a science oriented archive
- Use the ESA branding
- Responsiveness
- Balance: up to date on technology trends & long term applications => Angular framework

ISLA UX design How: Angular Framework

- Selected among the three most popular JavaScript frameworks/tools: Angular vs React vs Vue
 - It is a complete framework: very convenient for large teams like ESDC
 - Developed by Google with LTS
 - Based on Typescript
 - Follow Model-View-Controller (MVC) paradigm
 - Large developers community
 - Scalable

- ESDC UI applications:
 - Large applications: Angular is scalable
 - Similar in their core: Angular is modular (reusability)
 - Pretty large team: Angular is a framework
 - ESDC has a strong background in OO language (Java): Angular is based on TypeScript

The result: ISLA

ISLA

Home Search Explorer User Guides SIGN IN ESA

INTEGRAL Exploring the extremes of the universe

Eyes across the high energy sky

POINT SOURCES BLACK HOLES AGN NEUTRON STARS NUCLEOSYTHESIS

MORE MORE MORE MORE MORE

ISLA

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MORE

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Eyes across the high energy sky

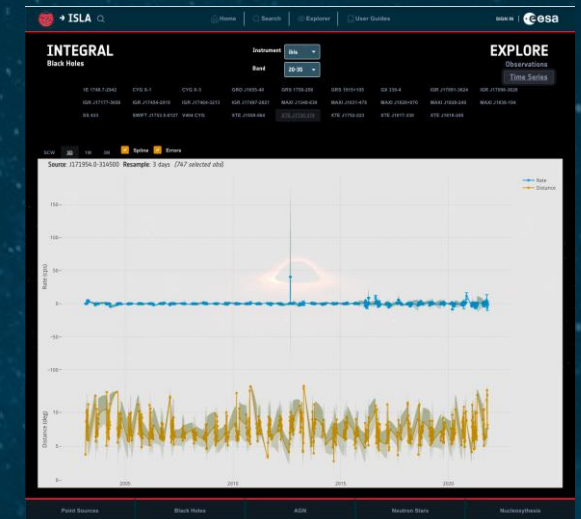
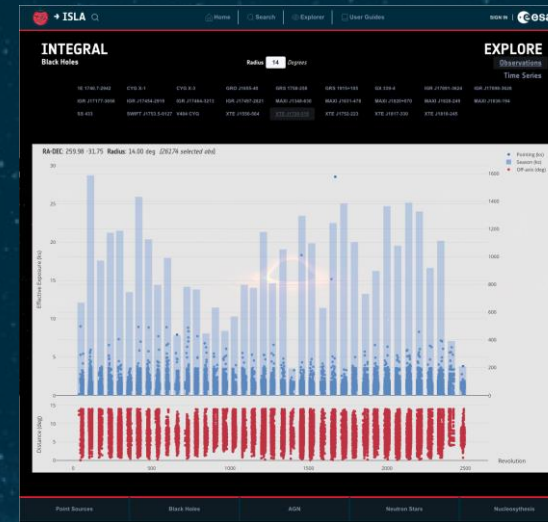
POINT SOURCES BLACK HOLES AGN

MORE MORE MORE

NEUTRON STARS NUCLEOSYTHESIS

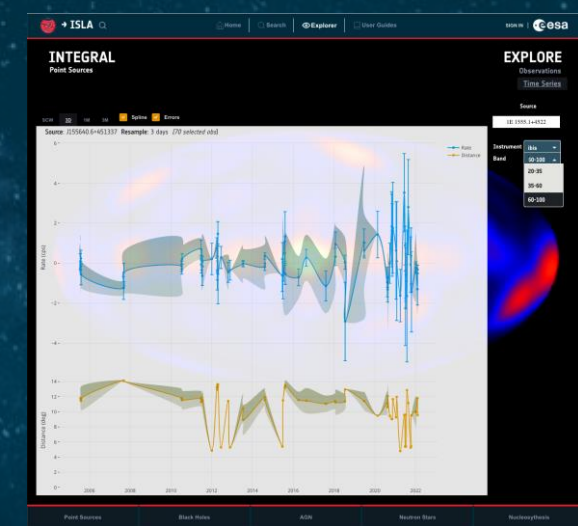
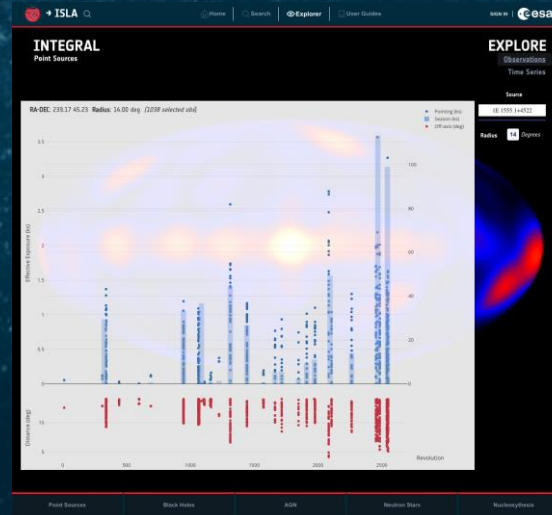
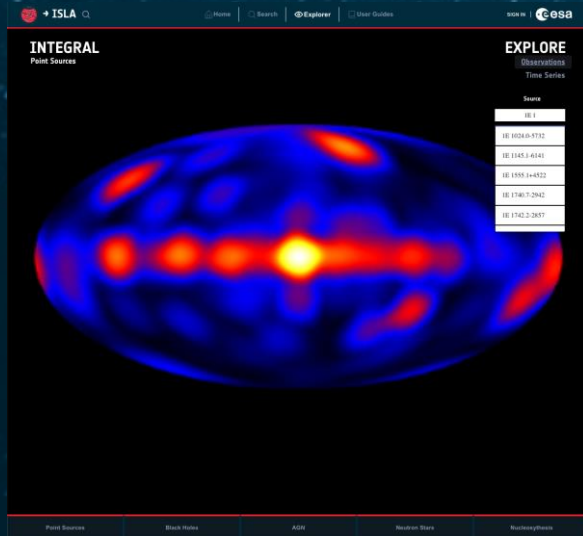
MORE MORE

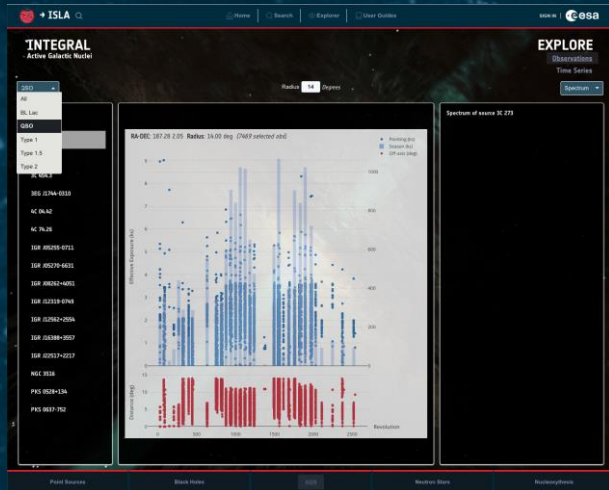
- One of the mission targets
 - Wide field of view (30 by 30 degrees)
 - Observations of up to 3 full days
 - High sensitivity (above 20 keV)
- Centralised access of the Black Holes observed by Integral in the past 20 years
- Capabilities:
 - All the observed Black Holes are explicitly exposed
 - Effective Exposure plot
 - Timeseries graphs corresponding to the different instrument energy bands
 - Optional down sampling



Science Portals: High Energy Point Sources

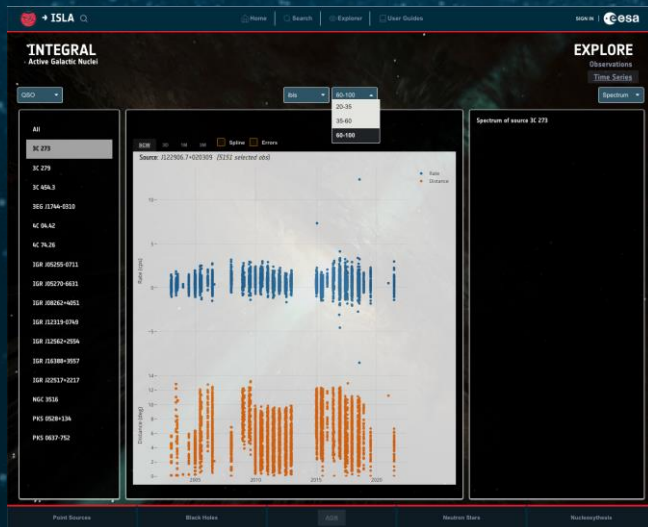
- Portal for quick and easy exploration of point sources detected by INTEGRAL
- Identifiers are SIMBAD compliant
- Last version contains 2410 sources
- Science Portal capabilities:
 - Autocomplete source search
 - Display effective exposure timeline of observations, time series, spectra
 - All instruments: IBIS, JEM-X, SPI, and OMC





➤ AGN (Active Galactic Nuclei) – under construction

- Selection based on AGN type
- Display of observations, time series, spectra
- AGN-specific products for population studies
 - Average spectra
 - LogN – LogS (number per luminosity bin)
 - Comparison of individual to population

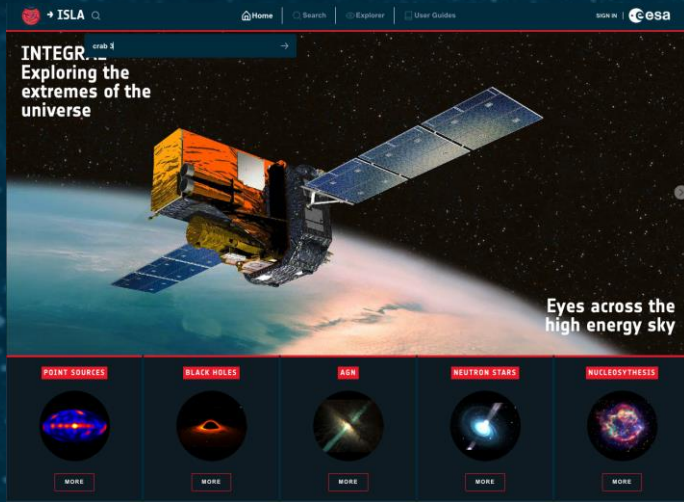


➤ Pulsars (planned)

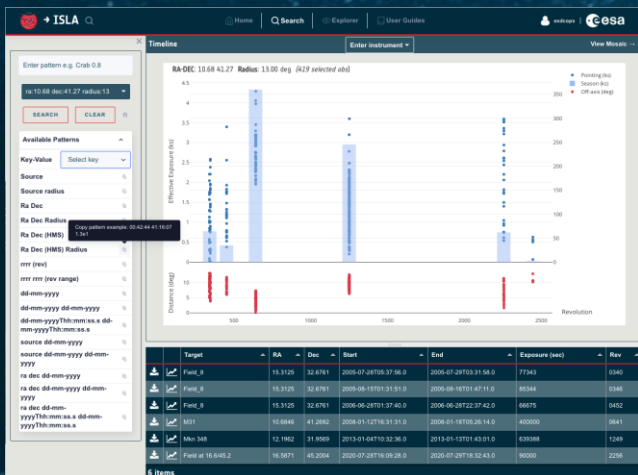
- High resolution products:
 - periodograms
 - Phasograms (folded time series and pulse profile)
 - time resolved spectra

➤ Nucleosynthesis (planned)

Improving user experience: smart search tool



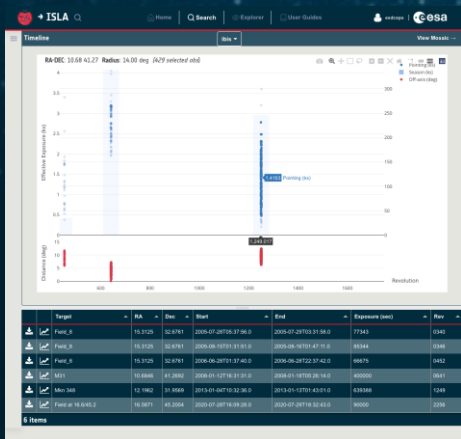
- Quick search in the home page
- Smart google-like search based on a sophisticated grammar
 - Many input patterns
 - Regular expressions approach discarded: difficult to maintain and escalate
 - Solution:
 - Consider the input filters as formal language and define a grammar
 - Use ANTLR (Another Tool for Language Recognition)



- Tabulator JavaScript library to show the results
 - Fast render
 - Extensive features set: filtering, sorting,
 - Interactive tables
 - New releases almost every month

Scientific display tools: JS9 & Plotly

- JS9 : Astronomical visualization tool fully integrated
- JS9 is the DS9 successor
- Display and merge the three energy bands of Integral mosaics
- Idisplay canvas and a menubar full of useful capabilities: zoom, pane, colormap, WCS....



- Plotly: standalone Javascript data visualization library
- Default ISLA display tool
- Built on top of d3.js and WebGL
- Versatile: over 40 chart types, including 3D charts, statistical and SVG maps
- Big community
- Continuous releases
- ...



ISLA: pioneering the next ESDC step

- Truly pioneer
 - Science-oriented
 - UX paradigm
 - Angular framework
 - Smart search



Hubble



Human and Robotics
Exploration Data Archive

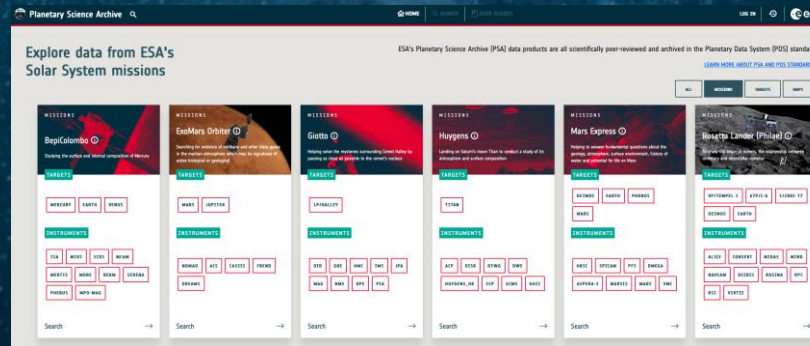


Soho

- Reusability is a MUST
- Increase team efficiency

➤ Coming soon:

- JWST
- XMM
- PSA
- ...



Planetary Science Archive

- Science Archives are the final mission data repository
 - Maximum scientific exploitation
 - Long-term preservation data
- ESDC: Science Archives incubator
 - Up-to-date on technology trends
 - Several generation of archives
- Integral Science Archive: truly pioneer
 - Science-oriented
 - UX design paradigm
 - Angular,
 - Smart search
- Inspiration for other archives: HST, Soho, PSA, JWST...

Thanks!!