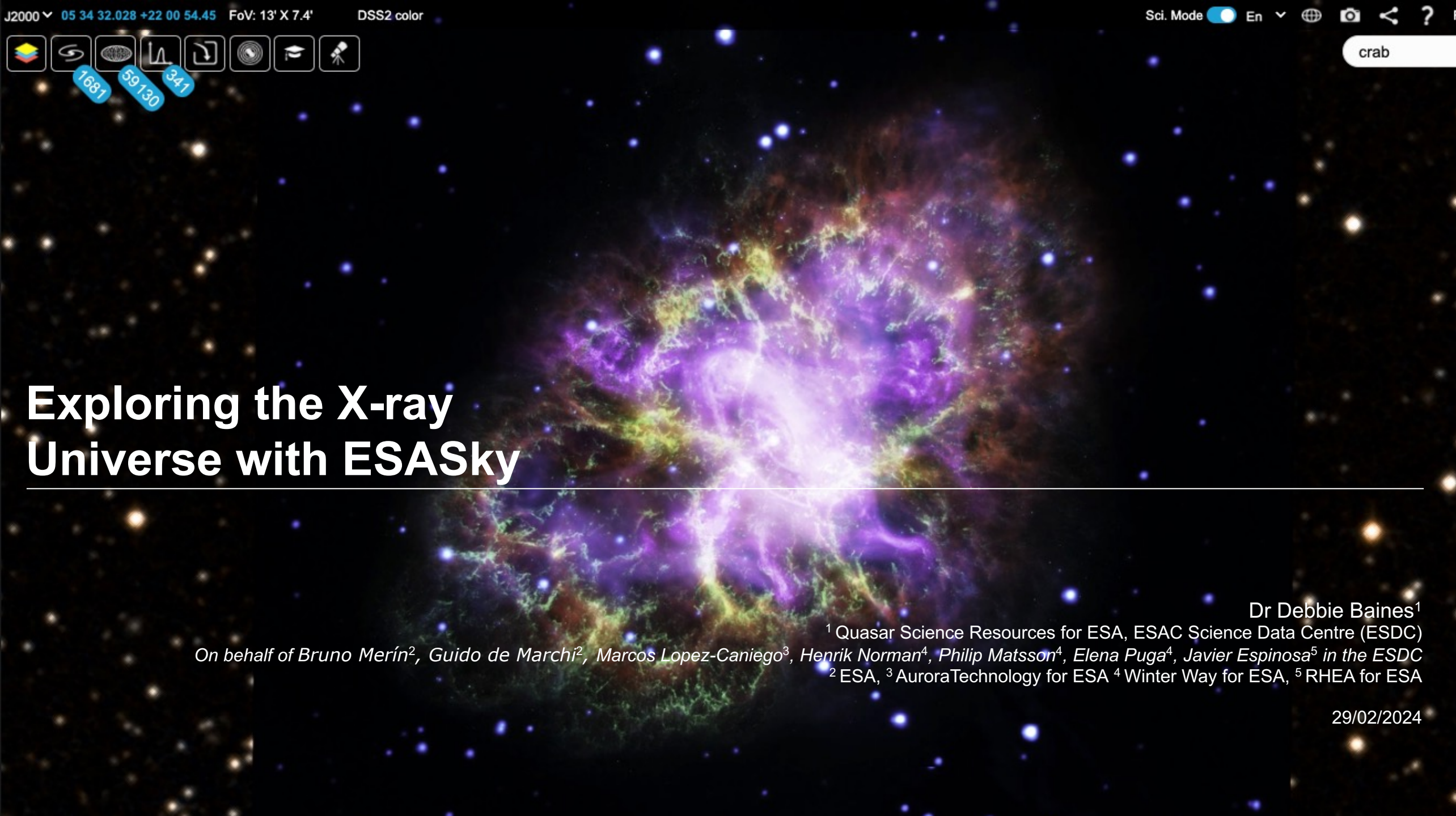

Exploring the X-ray Universe with ESASky

Dr Debbie Baines[1]
[1] Quasar Science Resources for ESA, ESAC Science Data Centre (ESDC)
On behalf of Bruno Merín[2], Guido de Marchi[2], Marcos Lopez-Caniego[3], Henrik Norman[4], Philip Matsson[4], Elena Puga[4], Javier Espinosa[5] in the ESDC
[2] ESA, [3] AuroraTechnology for ESA [4] Winter Way for ESA, [5] RHEA for ESA

29/02/2024

Overview

- Introduction to ESASky
- High-energy data and useful functionalities in ESASky
- Demo
- Future Plans
- Summary

Introduction: ESASky

Goal: a scientific tool to facilitate data discovery and archival science

- Multi-wavelength, -mission, -messenger portal
- Access to ~100 mission metadata & data, 56,000+ catalogues, 1100+ HiPS images.
- Driven by scientific use cases and needs from the scientific community
- Exploration and Data Discovery
- Archival science and unplanned science!

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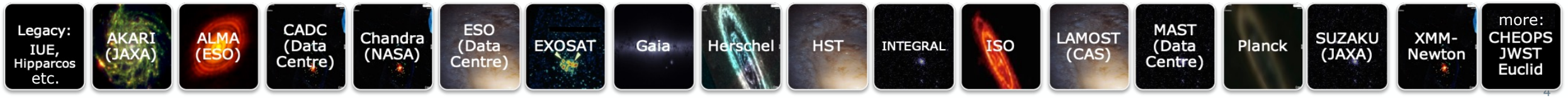
- Interface ‘on top of’ all ESA astronomy archives + others

ESASky https://sky.esa.int



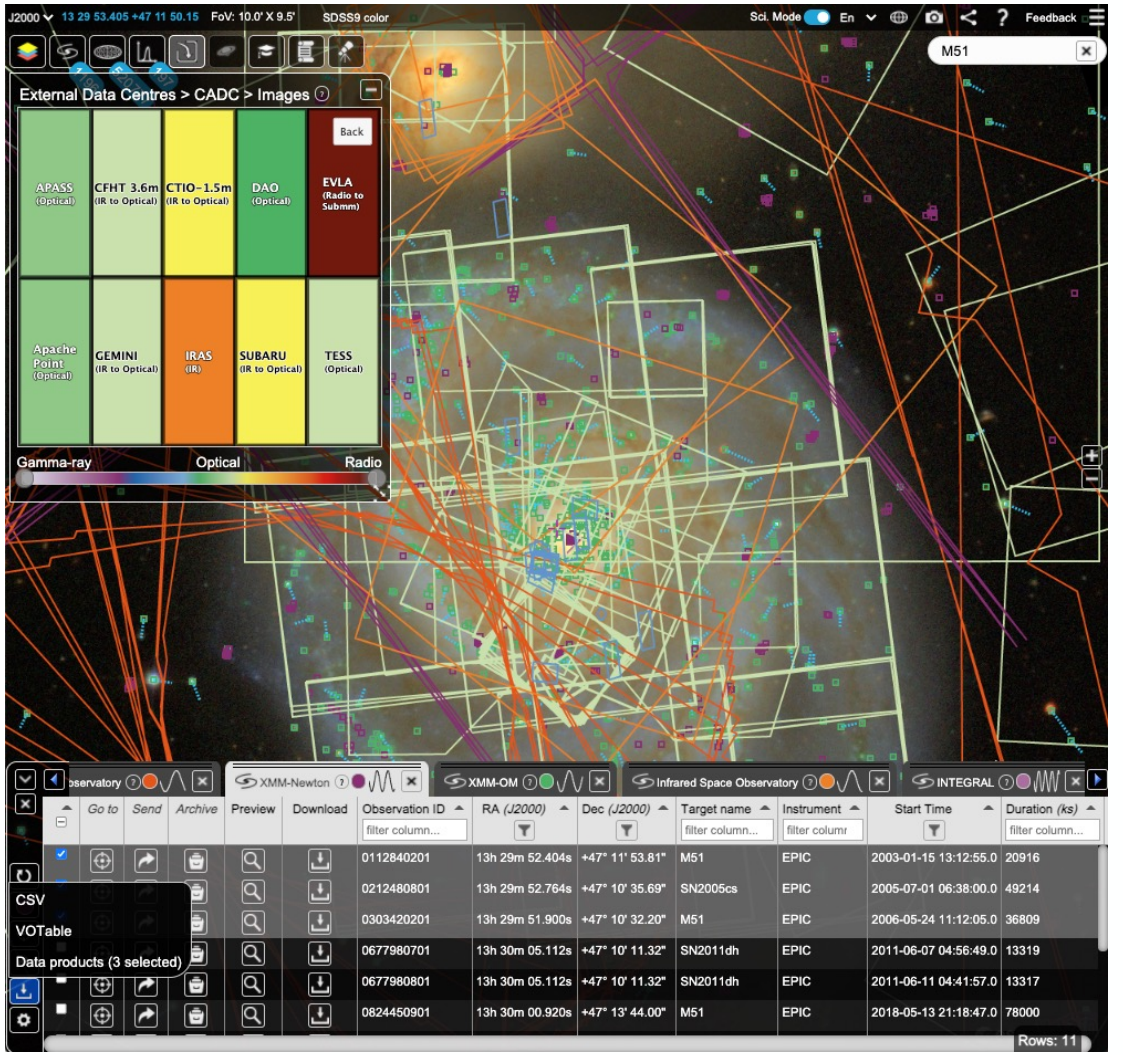
Intro Demo

https://youtu.be/iFFiNN1Iheg

How do users use ESASky for their science?

Main scientific functionalities:

- **Visual inspection** of skies (Hierarchical Progressive Surveys: HiPS), images, catalogues, footprints, probability regions, many in combination.
- **Data mining and downloading** (images, catalogues, spectra, cubes, time series, +), metadata and subsets of results tables.



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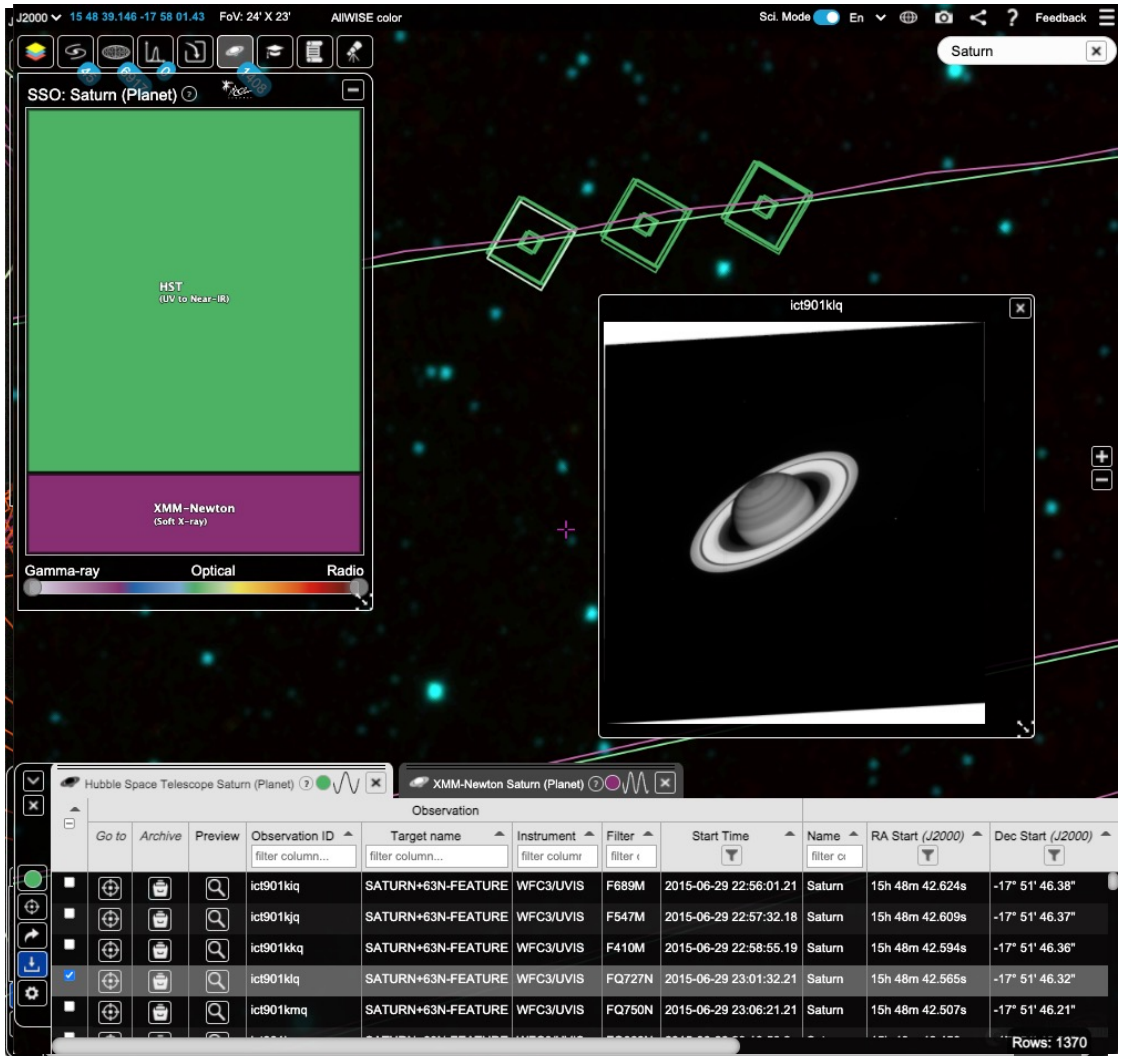

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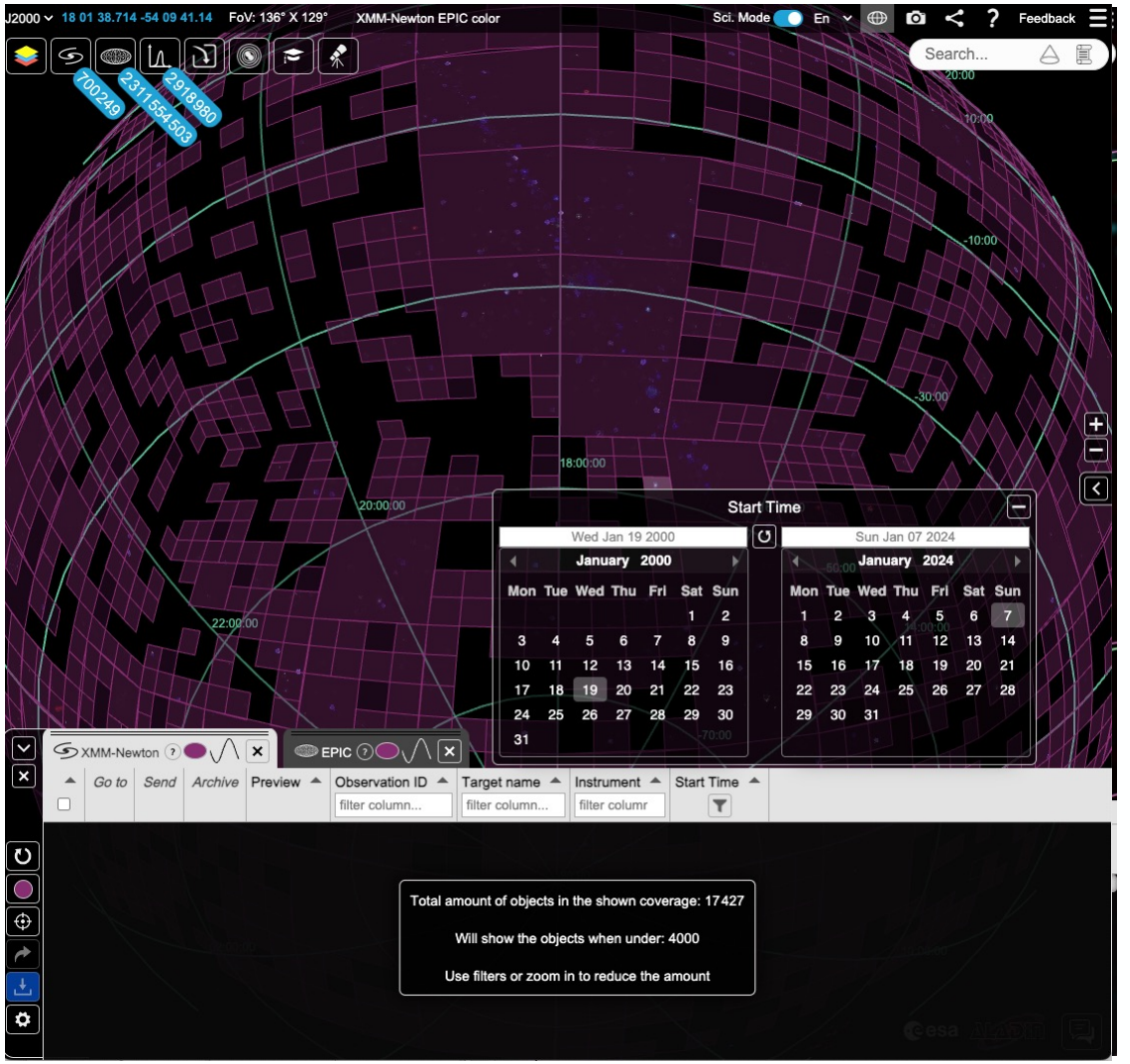

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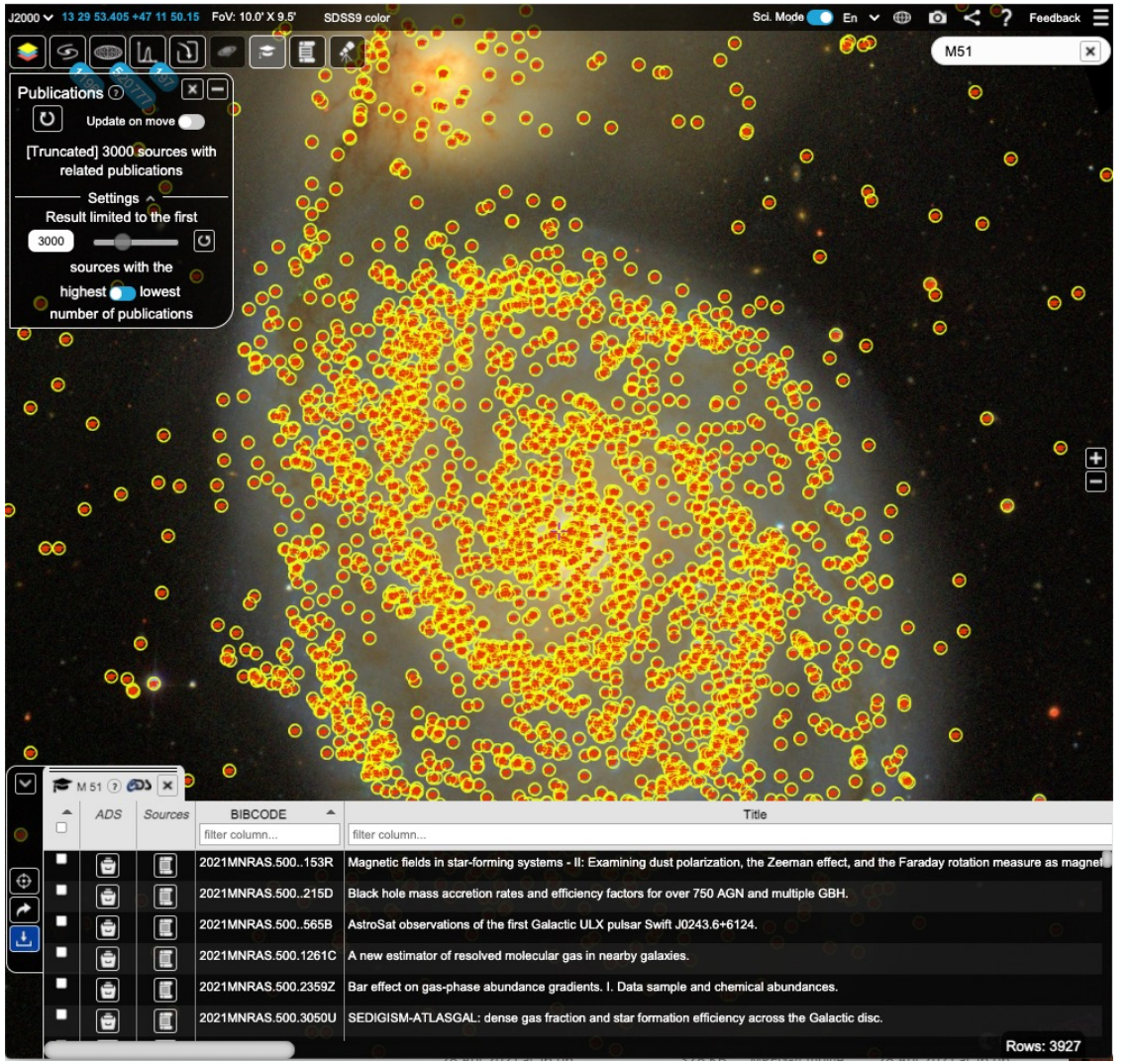

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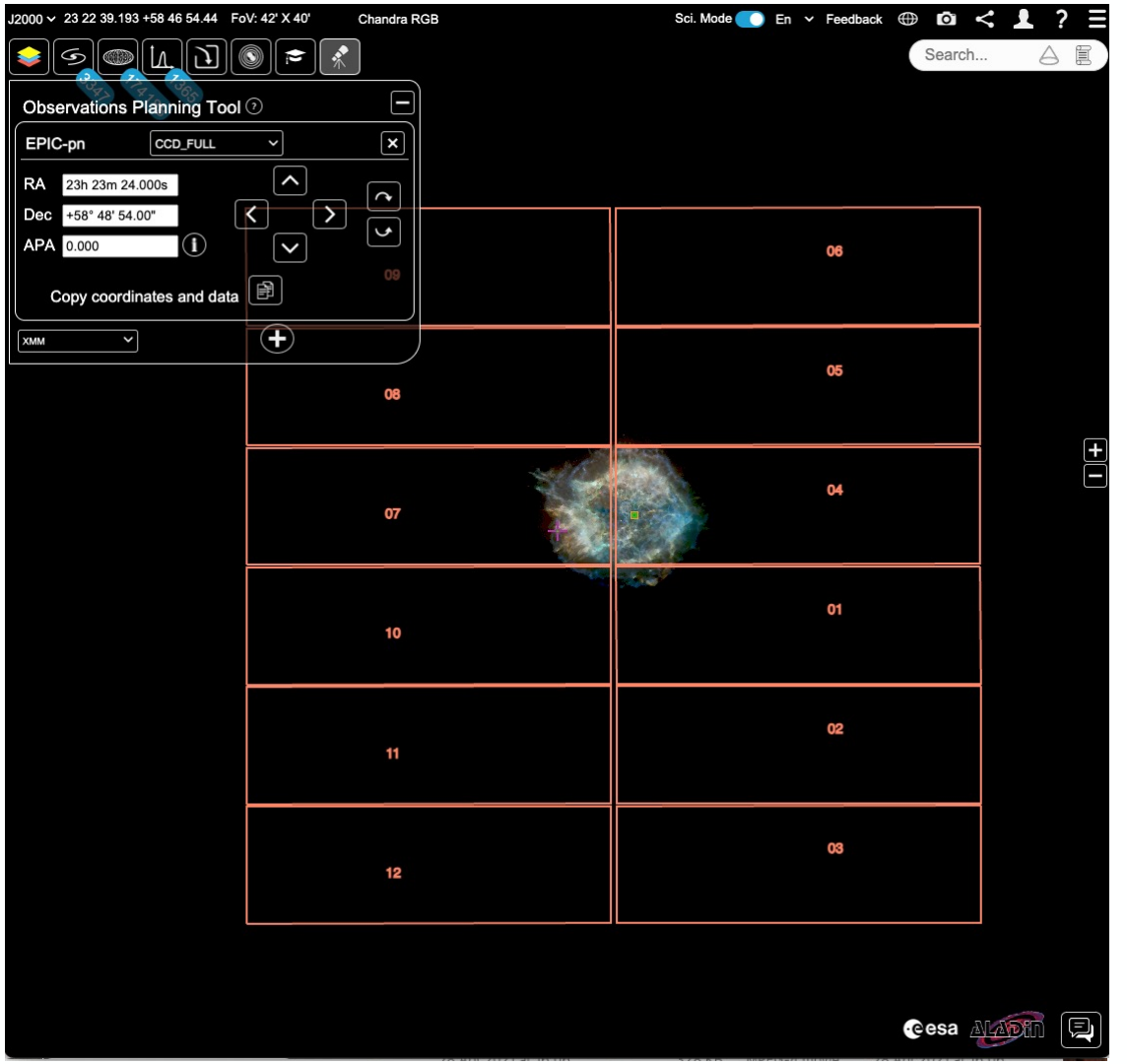

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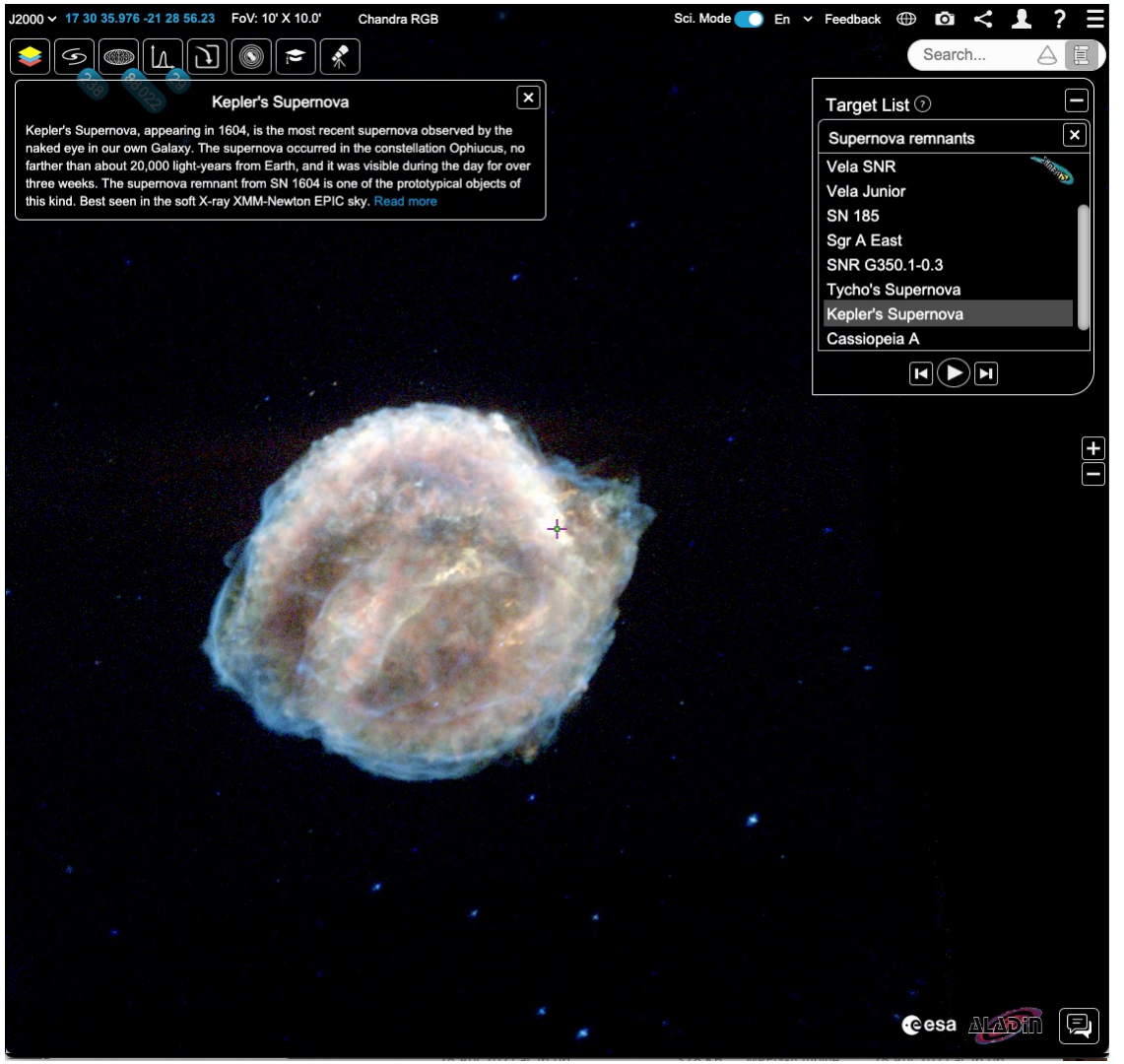
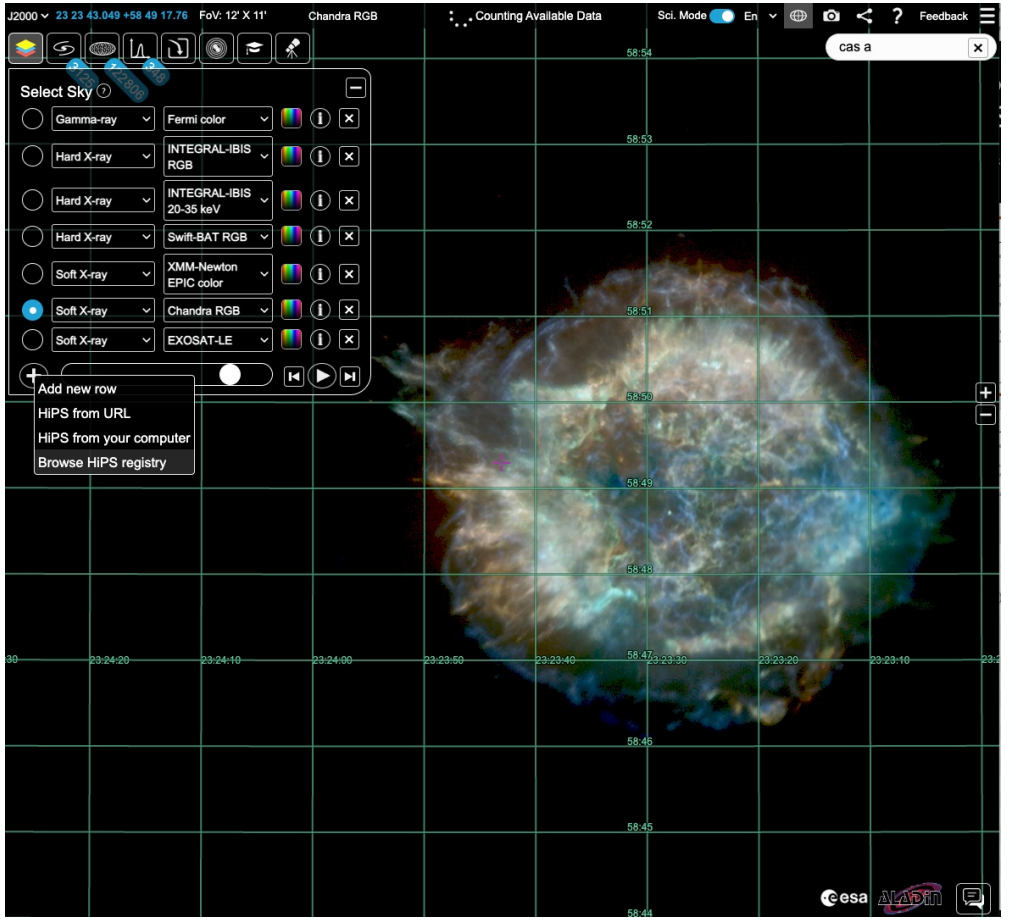


High-energy data and functionalities

High-energy data and useful functionalities for high-energy astronomers:

Data:

- **HiPS: Access to 12 high-energy HiPS and a further 60+ in the HiPS registry:** XMM-Newton EPIC; Chandra; SUZAKU; EXOSAT; eROSITA; INTEGRAL; Swift; Fermi plus ASCA; COMPTEL; EGRET; HGPS; Hitomi; MAXI; ROSAT.



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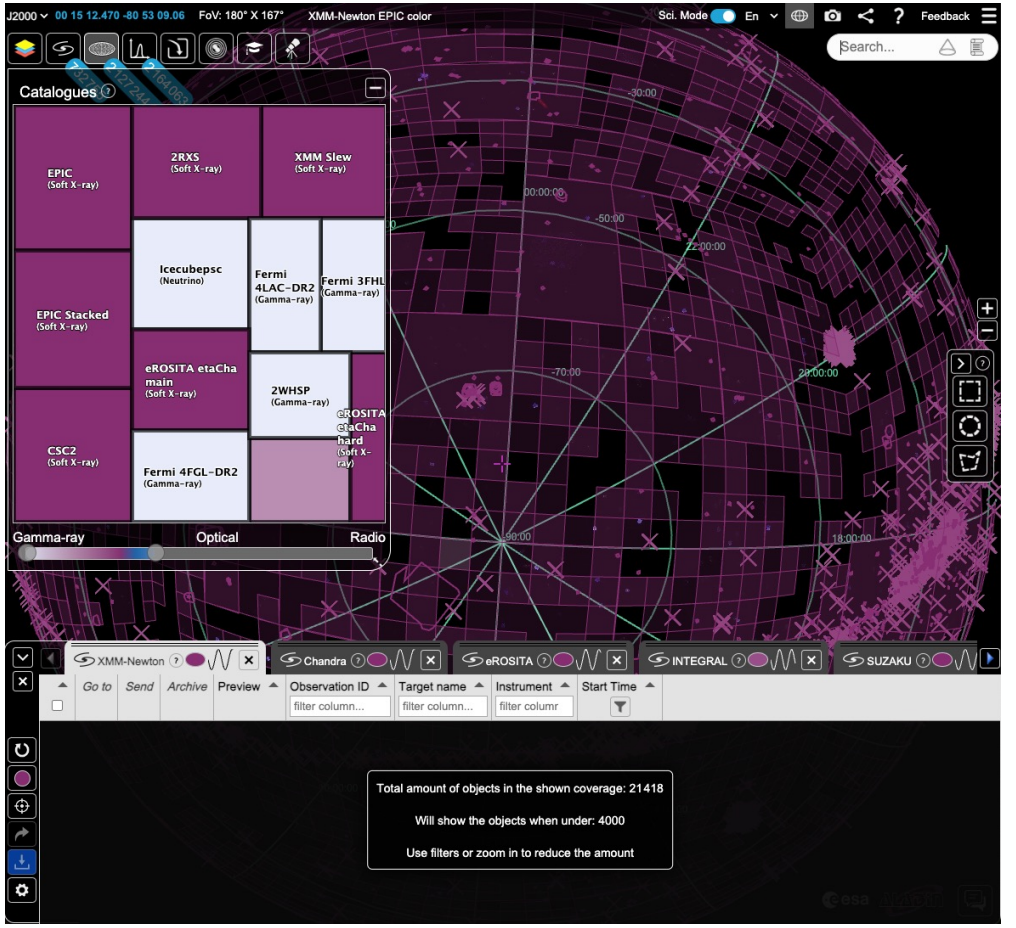

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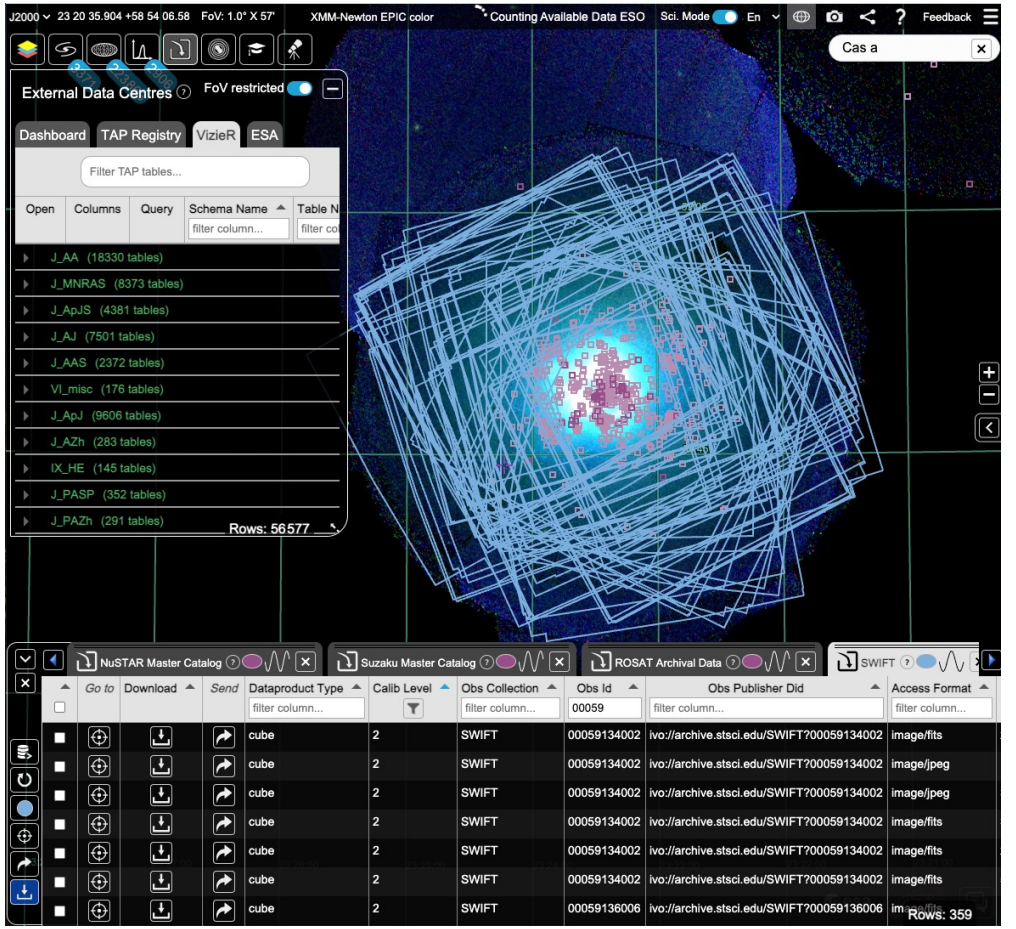
- **Access to high-energy data in the External Data Centres** feature (TAPs):
    - **HEASARC**, XMM-Newton, Chandra TAPs
    - ESASky legacy TAP (with EXOSAT, COS-B tables)
    - **Access to all VizieR catalogues**.



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- **Access to Gravitational Wave events and probability maps:** LIGO-Virgo-KAGRA collaboration
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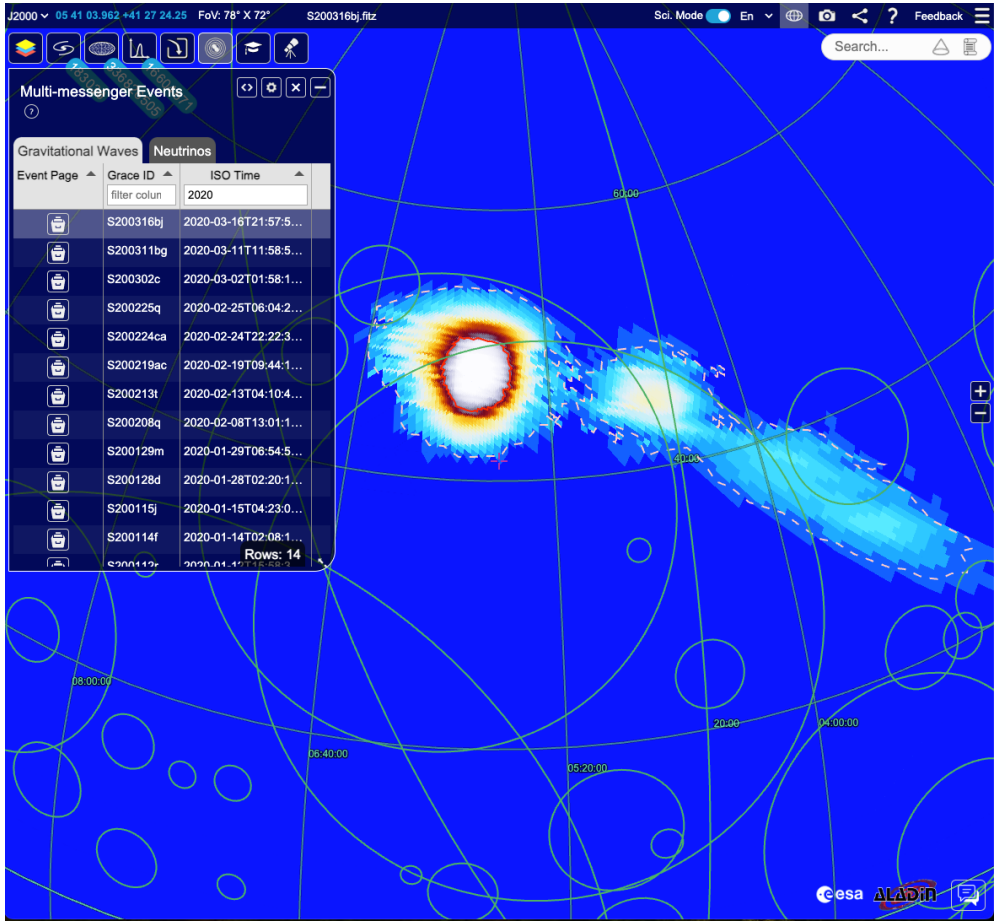

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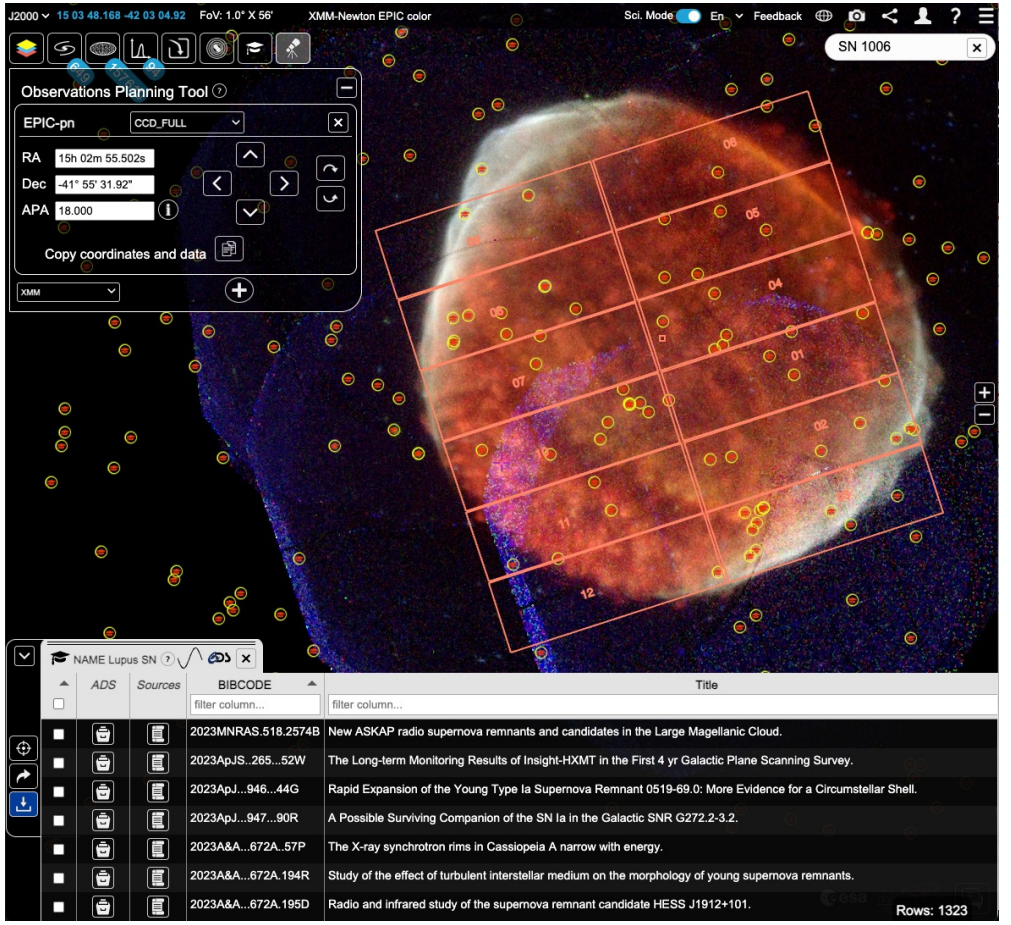
Functionalities:

- Wavelength slider in treemaps (observations, catalogues and External Data Centres).
- XMM-Newton EPIC-pn footprint in planning tool.
- Publications feature.

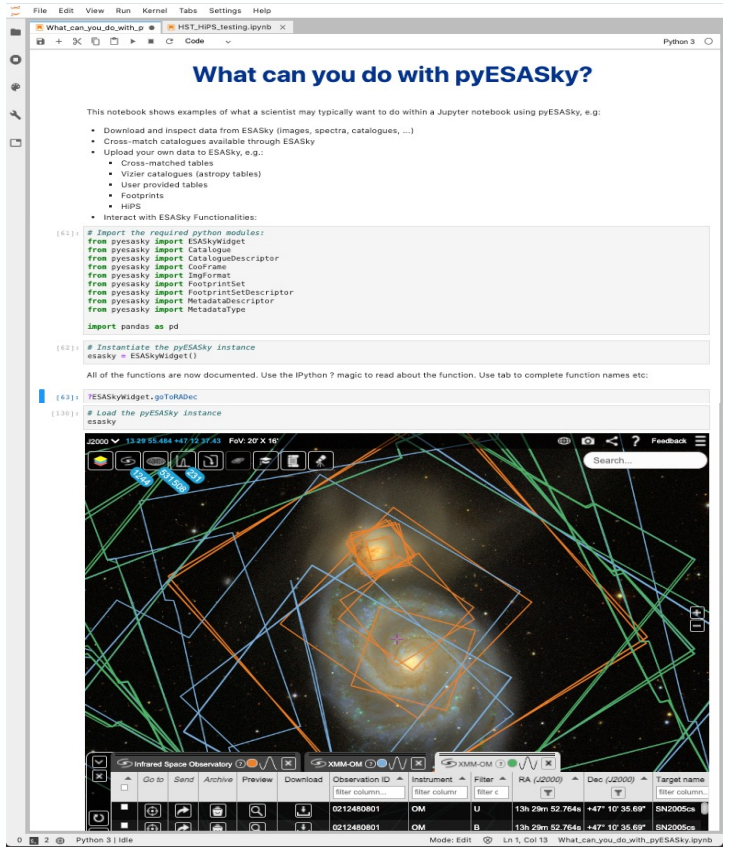


Demo

https://youtu.be/ny2Zu2RUIpk

Other ways to access data in ESASky

pyESASky Jupyter widget



Astroquery module: astroquery.esasky

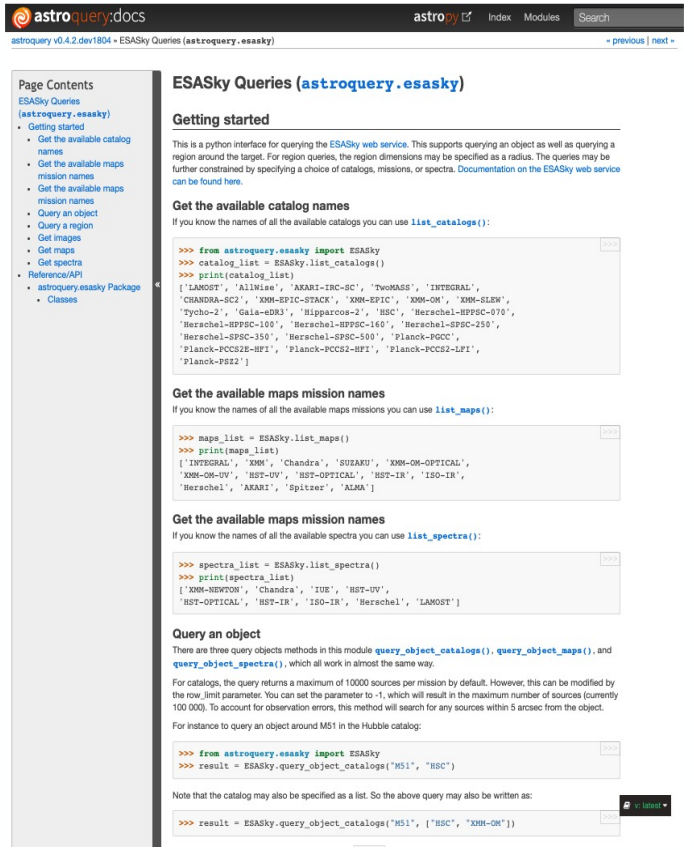
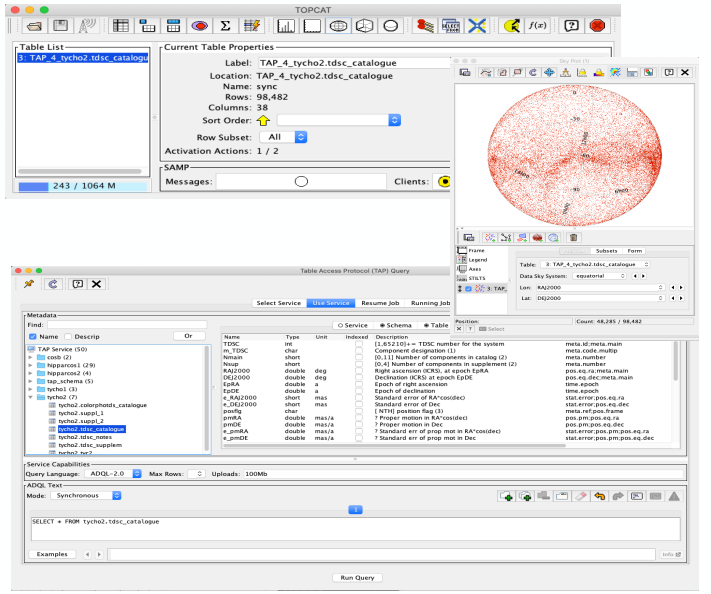


Table Access Protocol (TAP) access

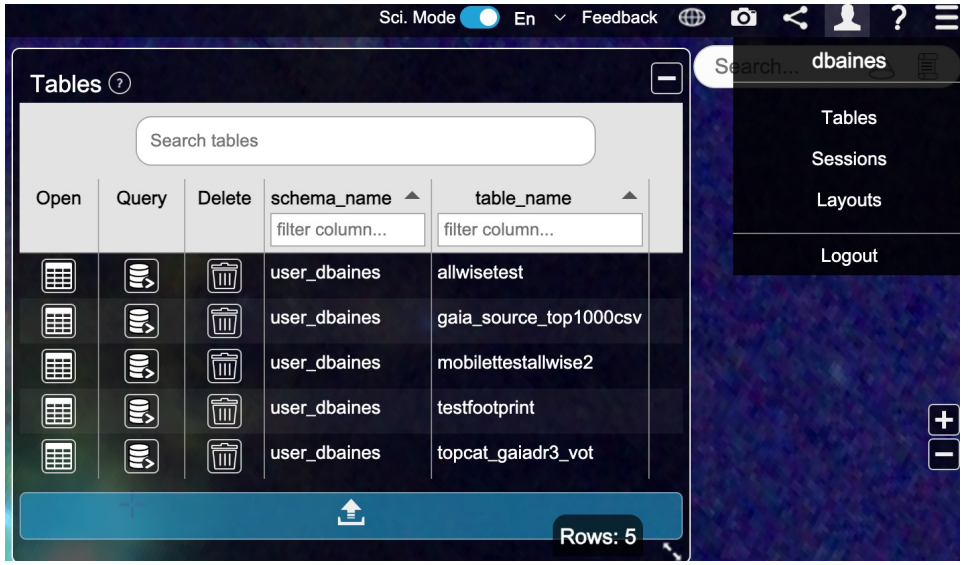


- http://sky.esa.int/esasky-tap/tap
- http://esaskylegacy.esac.esa.int/esasky-legacy-sl-tap/tap

Additional scientific use cases that you can't perform in the main interface.

ESASky (near)-future plans

- **User area** (released last week!): Upload your own tables, save your session, customise the ESASky layout, quotas per user currently 1 GB (more can be requested).
    - Future updates: upload your own images, sharing.



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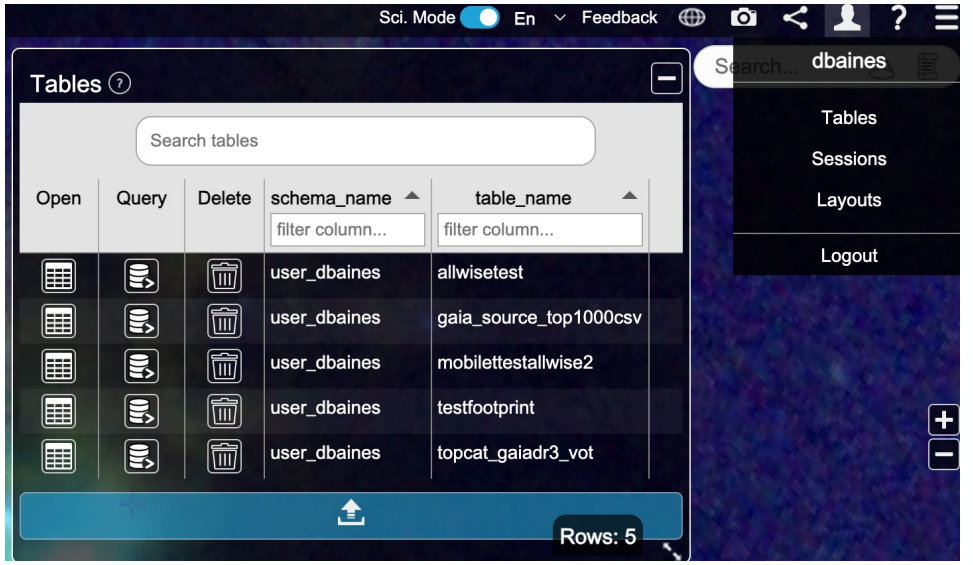
    - Future updates: upload your own images, sharing.
- Access to **eROSITA DR1** data
- Extending the multi-messenger feature to include more types of events (e.g. **GRBs** etc.) reported in NASA GCN.
- Access to **Euclid Early Release Observations**.
- Updating to **AladinLite v3** -> fits image visualisation.
- **Time-series data visualization** functionality.
- And more! (catalogue updates, access to EPIC light curves, HILIGT, …).



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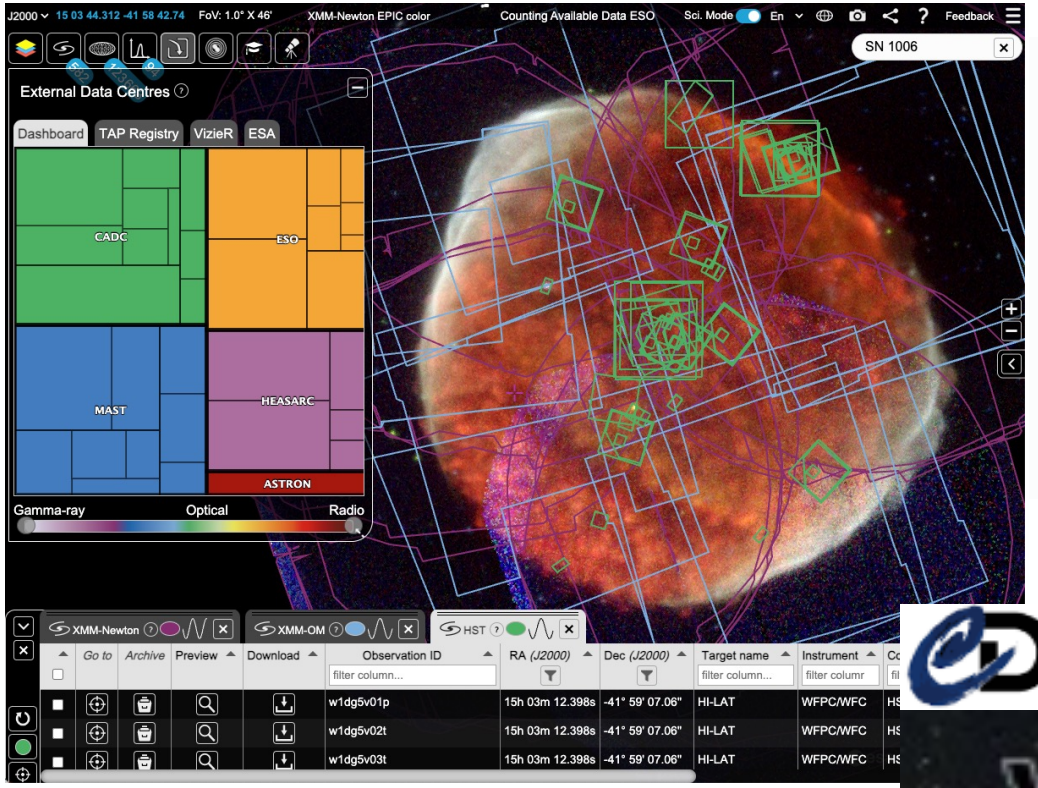

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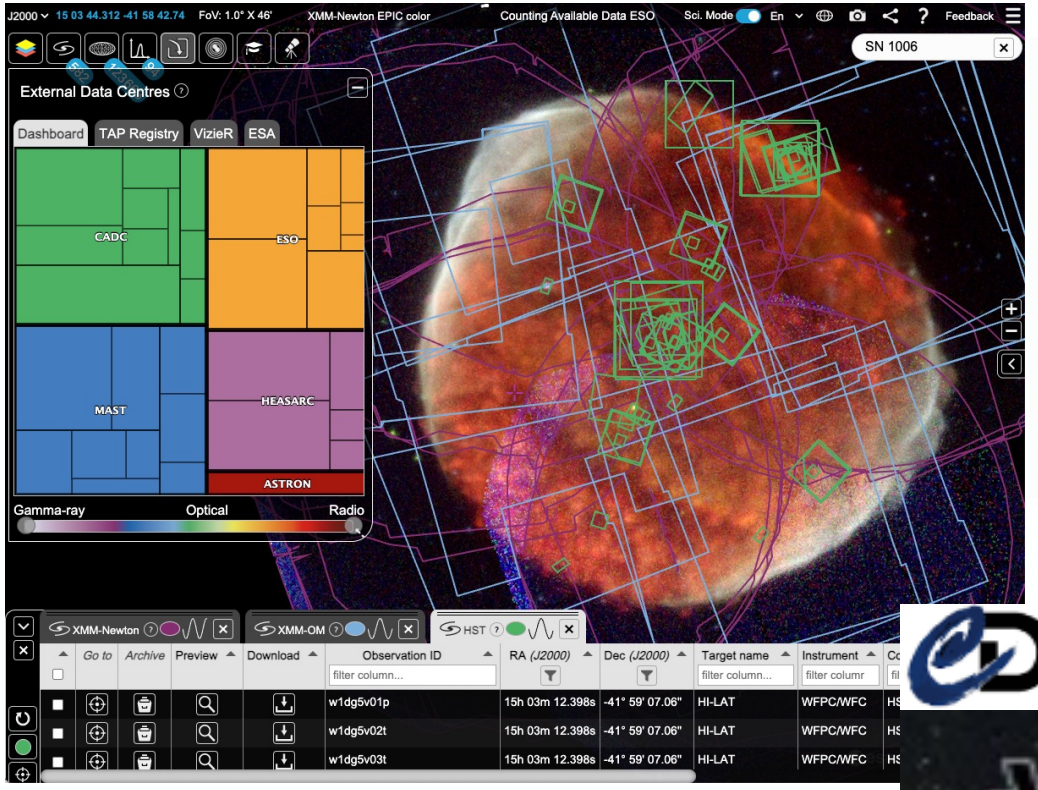


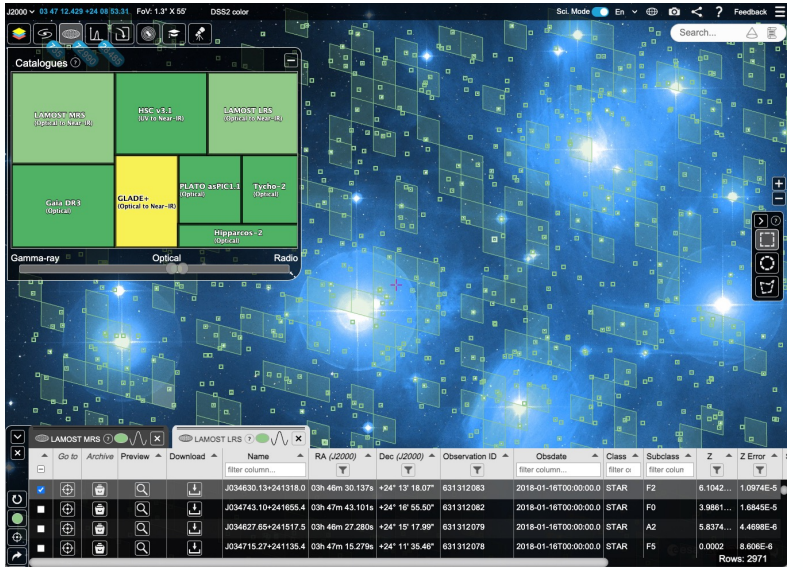
International Virtual Observatory Alliance

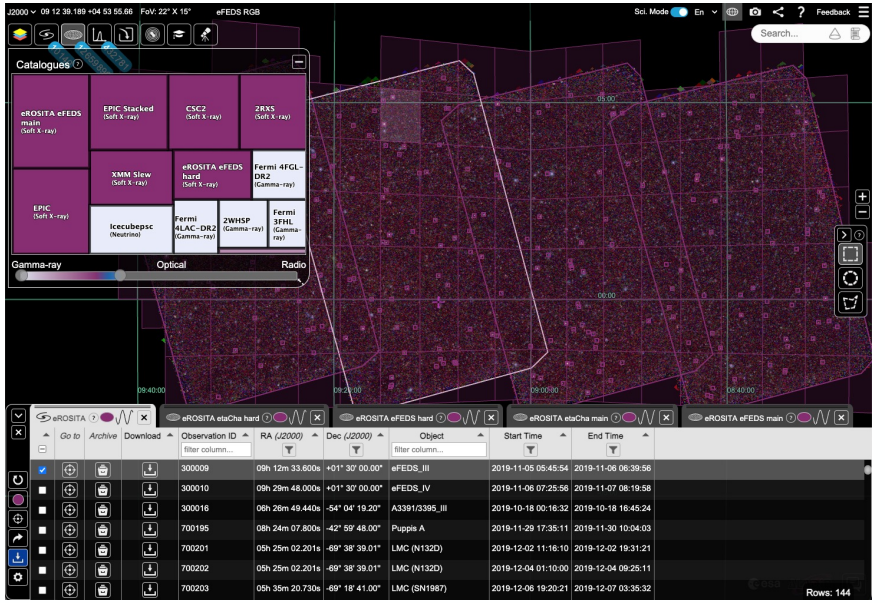
Standards: HiPS

TAP MOC

Datalink ADQL

ObsCore SAMP





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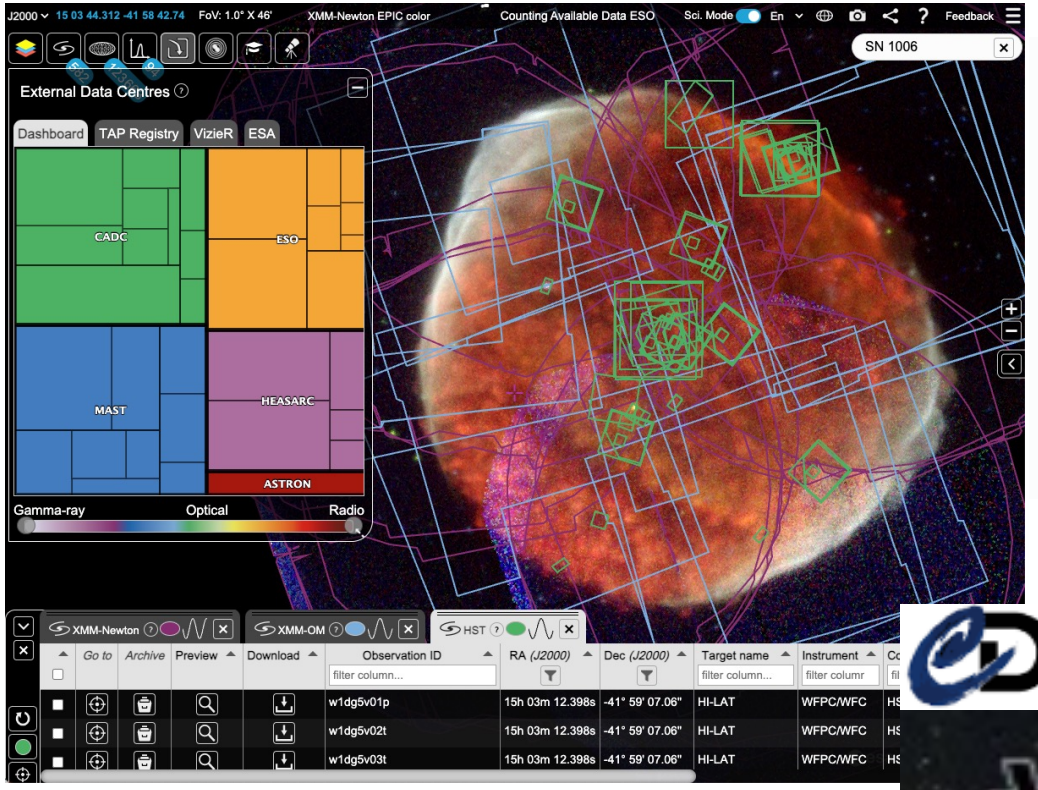

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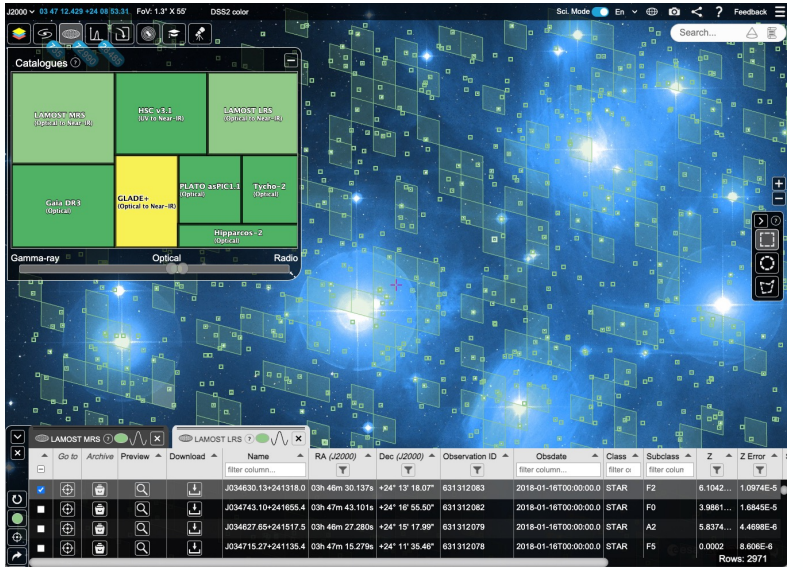

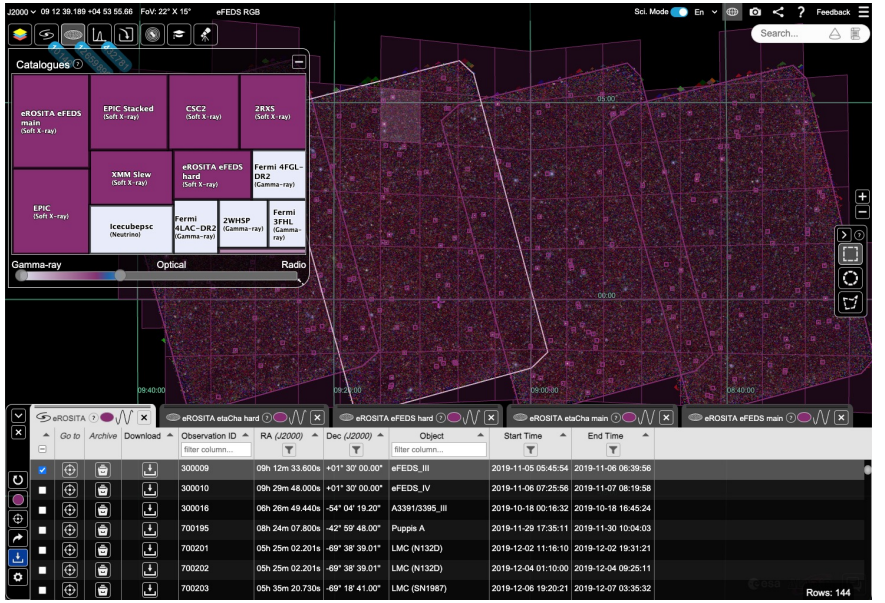

Dedicated Python astroquery module to ESASky and pyESASky Jupyter widget

Credits: a long and growing list of contributors!

- ***Former ESASky team members:*** Belén López Martí, Andy Pollock, Michael Rosa, Fabrizio Giordano, Elena Racero, Mattias Wångblad +more
- ***CDS:*** Pierre Fernique, Thomas Boch, Mark Allen, Anaïs Oberto, Matthieu Baumann, Caroline Bot.
- ***XMM-Newton Science Operations Centre:*** Pedro Rodríguez, Elena Jiménez-Bailón, Maria Santos-Lleo, Matthias Ehle and Norbert Schartel
- ***INTEGRAL Science Operations Centre:*** Guillaume Belanger, Erik Kuulkers, Peter Kretschmar, Jari Kajava.
- ***Planck Science Office:*** Marcos López-Caniego, Xavier Dupac and Jan Tauber.
- ***Gaia Science Operations Centre:*** Jos De Bruijne, Jorgo Bakker, Hector Canovas and Timo Prusti.
- ***Herschel Science Centre:*** Pedro García Lario, Eva Verdugo, Ivan Valtchanov, Miguel Sánchez-Portal, Pilar Esquej and Göran Pilbratt
- ***ESAC Science and Operations IT Unit:*** Alejandro Lorca, Roberto Prieto, Ruben Álvarez +team.
- ***Centre for Astrobiology (CAB), ESAC:*** Enrique Solano, Carlos Rodrigo. • ***Euclid Science Centre:*** Bruno Altieri, John Hoar and René Laureijs.
- ***ASTRON*:** Yan Grange, Mattia Mancini, Nico Vermaas • ***HST:*** Antonella Nota, Chris Evans, Paule Sonnentrucker and Jonas Haase (HST/ESO).
- ***JWST:*** Anthony Marston, Marco Sirianni, Sarah Kendrew, Tim Rawle and Macarena García-Marín.
- ***Hubble/Webb outreach team:*** Bethany Downer, Mahdi Zamani, Javier Enciso • ***MAST/STScI:*** Tom Donaldson • ***HEASARC*:** Tess Jaffe
- ***Canadian Astronomy Data Centre (CADC):*** Daniel Durand, Brian Major, JJ Kavelaars, Patrick Dowler, Séverin Gaudet
- ***ESO:*** Alberto Micol, Felix Stoehr • ***Johns Hopkins University:*** Tamás Budavári • ***CHEOPS*:** Kate Isaak
- ***ISAS, JAXA*:** Ken Ebisawa • ***Jet Propulsion Laboratory, Caltech*:** Krzysztof Górski • ***LIGO Scientific Collaboration:*** Chris North
- ***Chandra, NASA*:** Pepi Fabbiano, Janet Evans, Raffaele D'Abrusco, Yulie Zografou and Arnold Rots • ***OCA, Nice*:** Benoit Carry.
- ***IMCCE, Paris*:** Jérôme Berthier and Jonathan Normand (Solar system ephemeris and name resolver). • ***Smithsonian/NASA ADS*:** Alberto Accomazzi, Michael J. Kurtz, Sergi Blanco-Cuaresma • ***China-VO/CAS:*** Chenzhou Cui, Shanshan Li, Dongwei Fan, Hanxi Yang
- ***eROSITA:*** Andrea Merloni, Jonas Haase, Mara Salvato, Jeremy Sanders, Susanne Friedrich • ***Spitzer, IRSA*:** Steve Groom, Vandana Desai, Harry Teplitz. • **IceCube Neutrino Observatory:** Marcos Santander, Claudio Kopper, Michael Larson, Juan Antonio Aguilar

Summary

- ESASky is developed for scientists to facilitate data discovery and archival science.
- Provides access to ~100+ mission metadata & data, 56,000+ catalogues, 1100+ HiPS.
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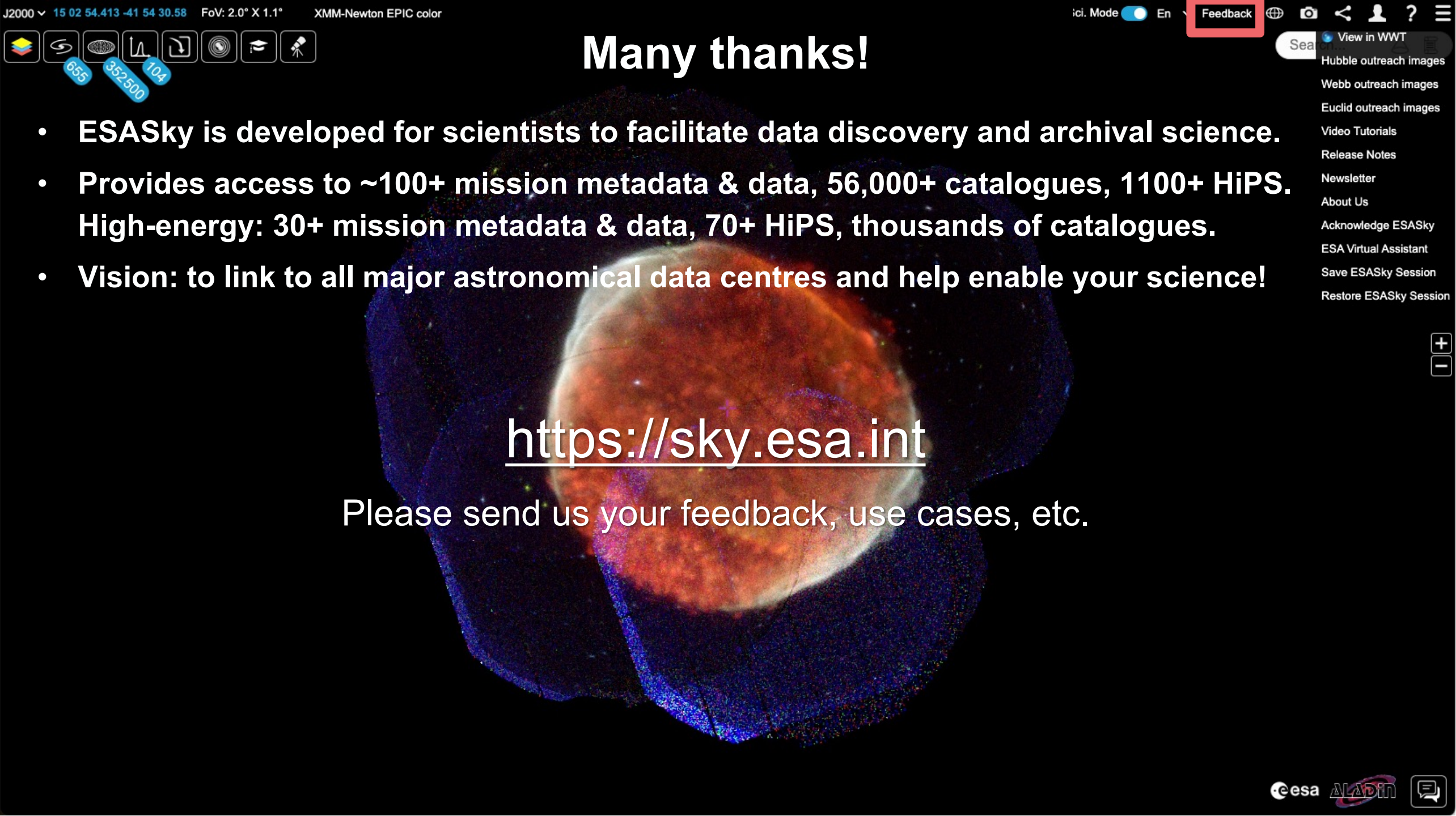
- Vision: to link to all major astronomical data centres and help enable your science!



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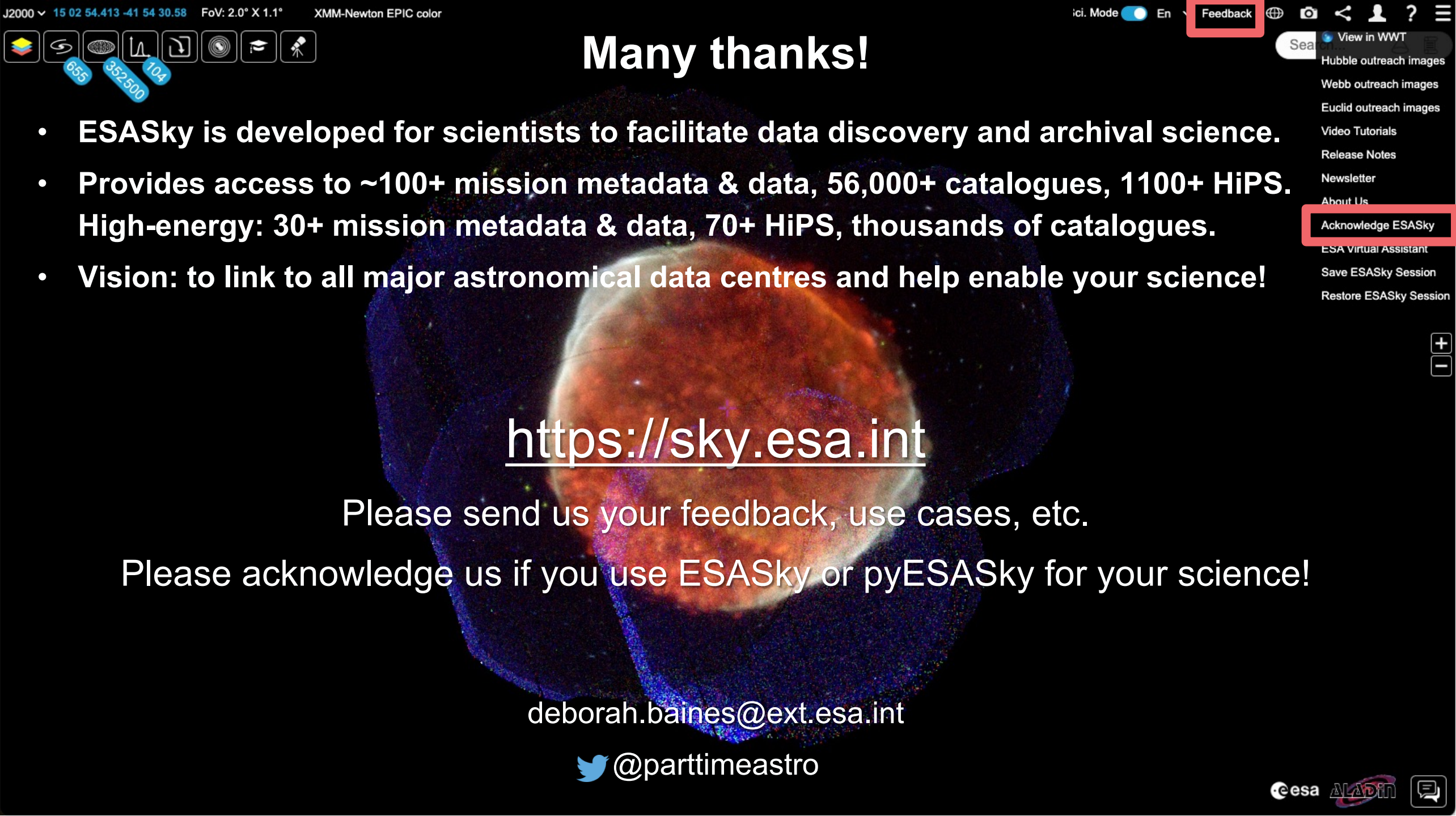

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Please send us your feedback, use cases, etc.

Please acknowledge us if you use ESASky or pyESASky for your science!

deborah.baines@ext.esa.int

@parttimeastro

ESASky Links

- **ESASky:** https://sky.esa.int
- **How to use ESASky, videos and links to help pages:** https://www.cosmos.esa.int/web/esdc/esasky-how-to
- **pyESASky:** https://www.cosmos.esa.int/web/esdc/pyESASky
- **pyESASky notebooks:** https://github.com/esdc-esac-esa-int/pyesasky/tree/master/samples
- **astroquery.esasky:** https://www.cosmos.esa.int/web/esdc/esasky-astroquery-module
- **ESASky TAP:** https://sky.esa.int/esasky-tap/tap
- **ESASky Legacy archive TAP:** https://esaskylegacy.esac.esa.int/esasky-legacy-sl-tap/tap
- **ESASky Javascript API:** https://www.cosmos.esa.int/web/esdc/esasky-javascript-api
- **How to contribute data to ESASky:** https://www.cosmos.esa.int/web/esdc/esasky-contributing
- **Educational activities:** https://www.cosmos.esa.int/web/esdc/esasky-for-education
- **Contact and feedback:** https://esdc.userecho.com