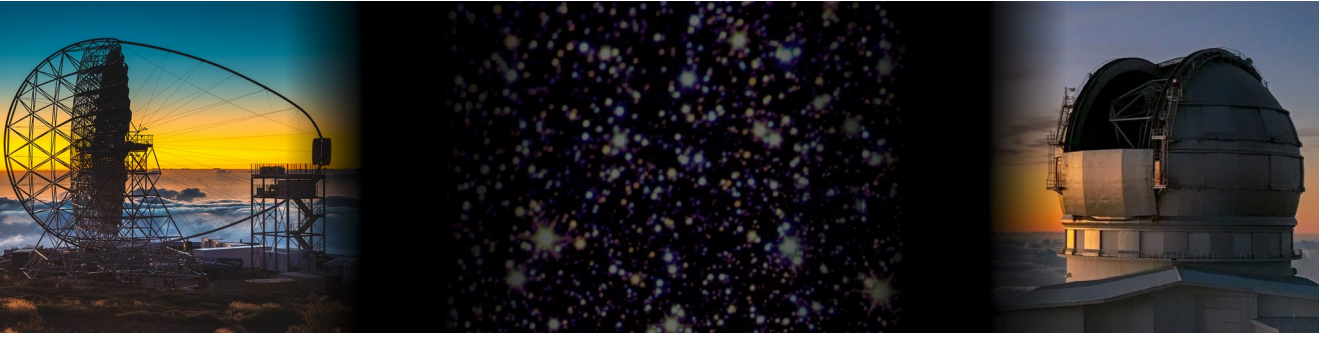
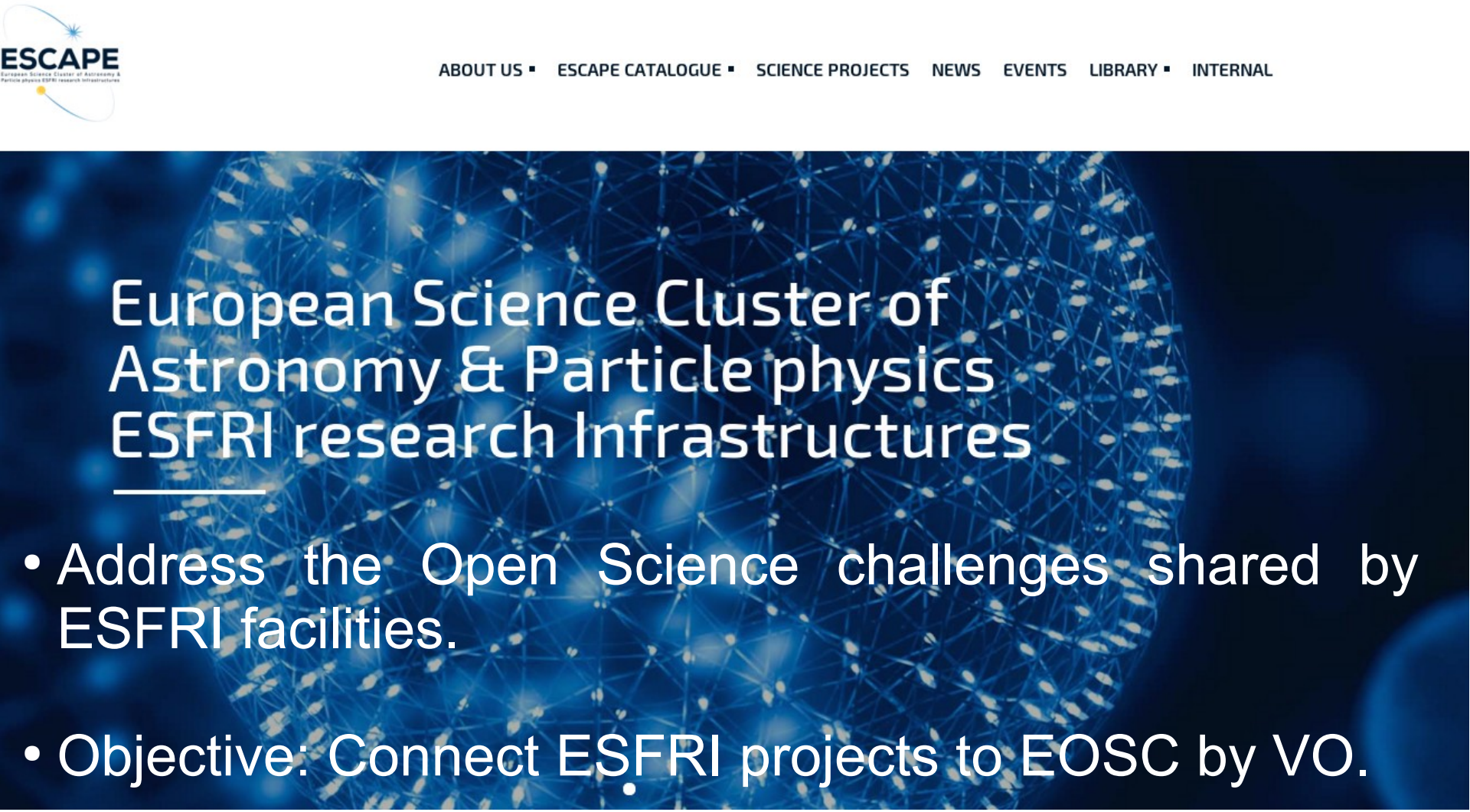


CTA & GTC at VO through ESCAPE

Enrique Solano

Centro de Astrobiología (INTA-CSIC).
Spanish Virtual Observatory, Madrid. Spain.

The ESCAPE project



- Address the Open Science challenges shared by ESFRI facilities.
- Objective: Connect ESFRI projects to EOSC by VO.

ESCAPE in a nutshell

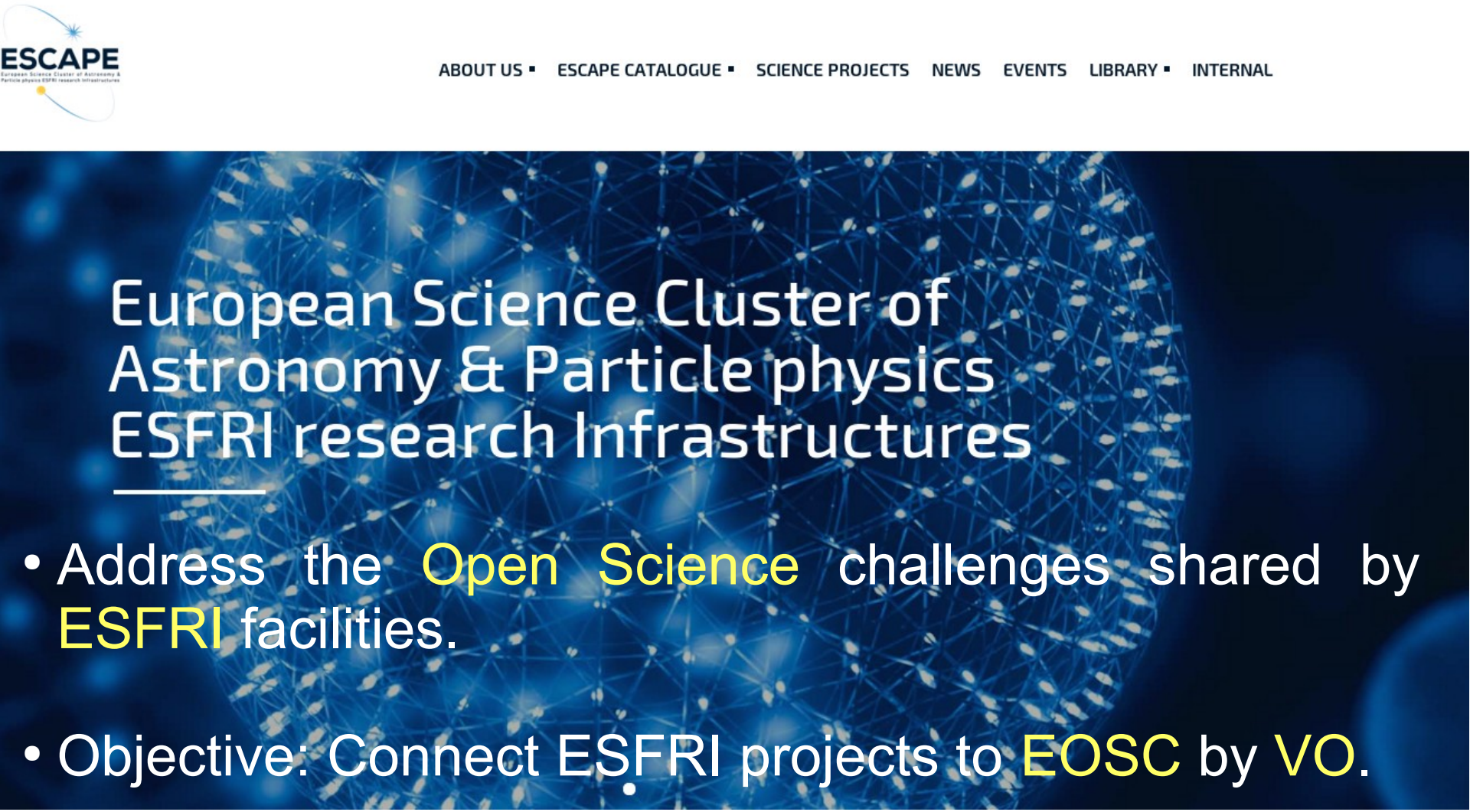
ESCAPE convenes a large scientific community

- **31** partners (including 2 SMEs)
- **7** ESFRI projects & landmarks: CTA, ELT, EST, FAIR, HL-LHC, KM3NeT, SKA
- **2** pan-European International Organizations: CERN, ESO (with their world-class established infrastructures, experiments and observatories).
- **4** supporting ERA-NET initiatives: HEP (CERN), NuPECC, ASTRONET, APPEC
- **1** involved initiative/infrastructure: EURO-VO (Virtual Observatory)
- **2** European research infrastructures: EGO and JIVE-ERIC
- Budget: **15.98 M€**
- Started: **1/2/2019**
- Duration: **42** months (end date 31/7/2022)
- Coordinator: **CNRS (**Centre national de la recherche scientifique**) - LAPP - G. Lamanna**

Home page: https://escape2020.eu ; Twitter: @ESCAPE_EU

Funded by the European Union's Horizon 2020 - Grant N° 824064

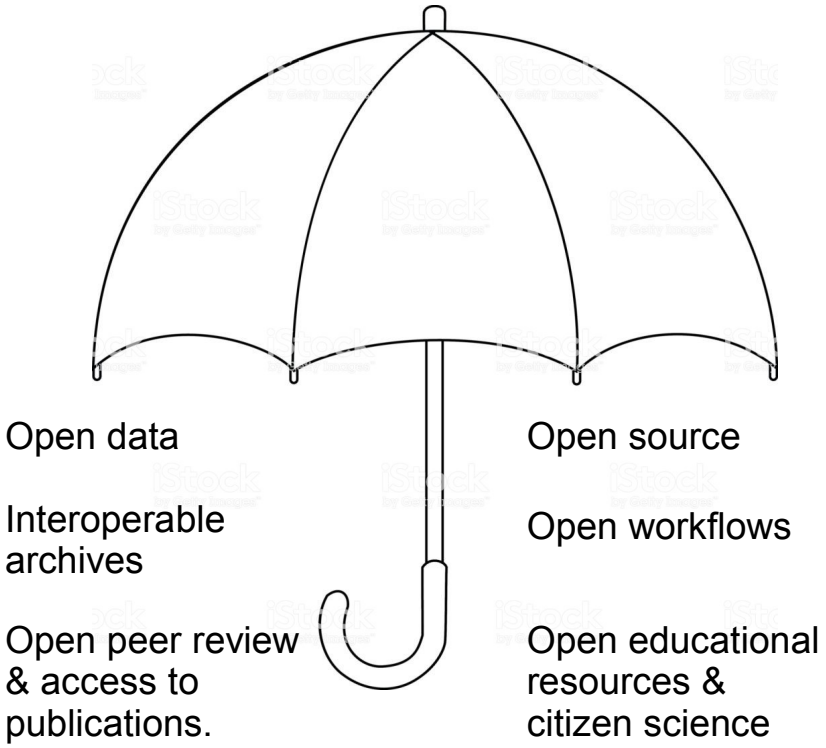
The ESCAPE project



- Address the Open Science challenges shared by ESFRI facilities.
- Objective: Connect ESFRI projects to EOSC by VO.

Open Science

- First step: *"to make the primary outputs of publicly funded research results -publications and data- publicly accessible in digital form with no or minimal restrictions"* (OECD)
- Ultimate goal: Extend the principles of openess to the whole research cycle.

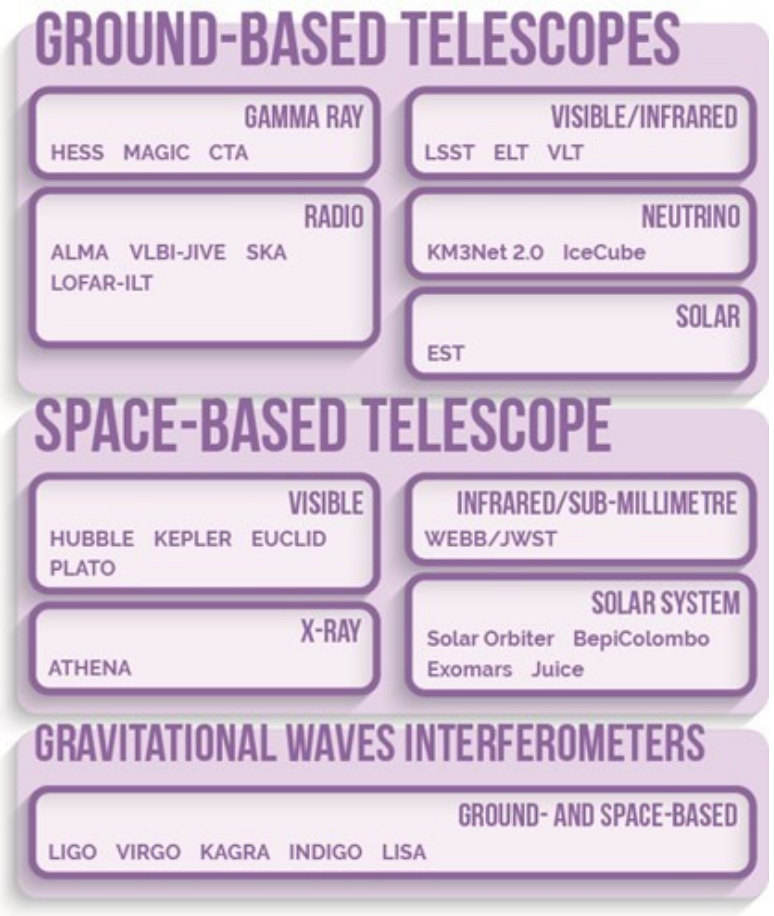


ESFRI

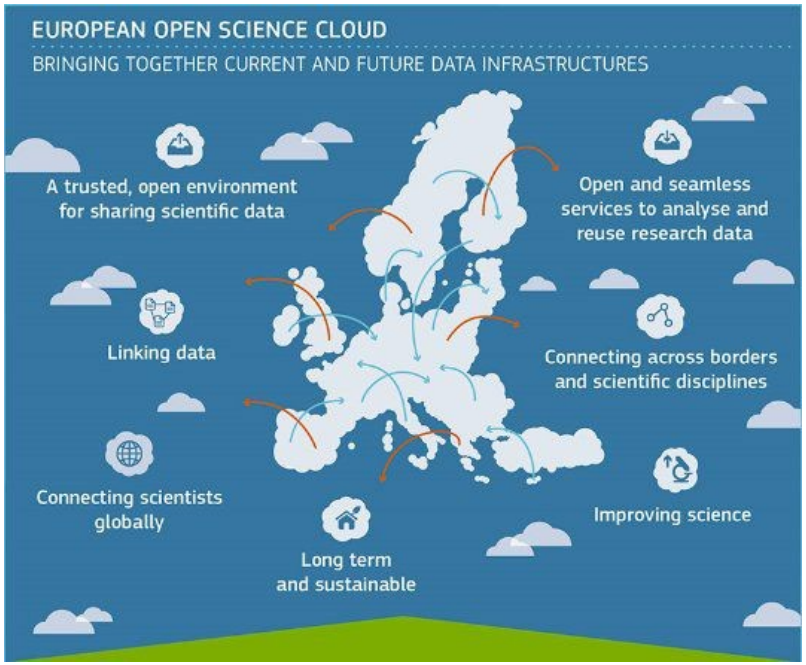
ESFRI

- European Strategy Forum on Research Infrastructures.
- Policy-making to optimize European RIs.

Strategy Report on Research Infrastructures
ROADMAP 2018

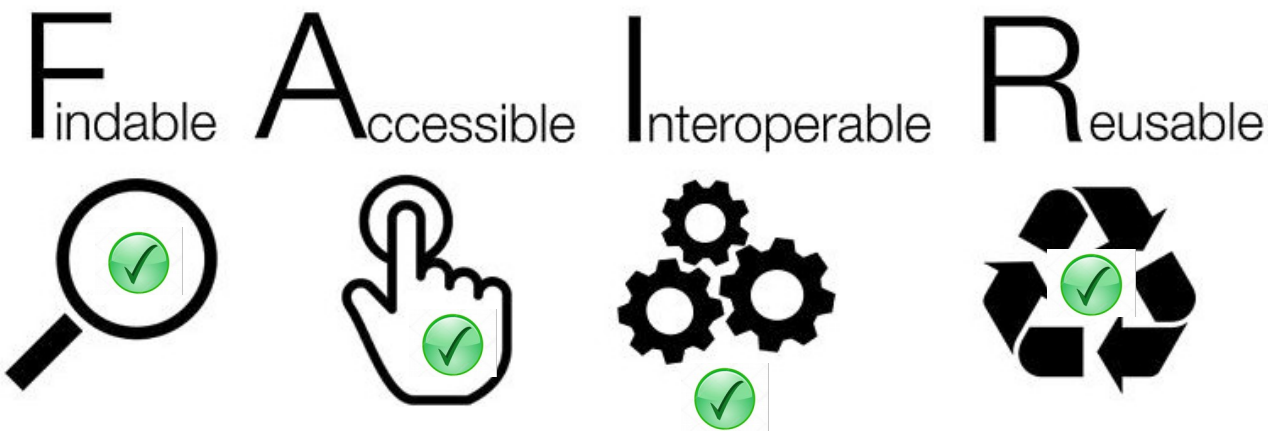


European Open Science Cloud (EOSC)



- European Comission initiative aiming at developing an infrastructure to support and develop open science and open innovation in Europe
- Started in 2015.

The Virtual Observatory (VO)



Technical Specifications

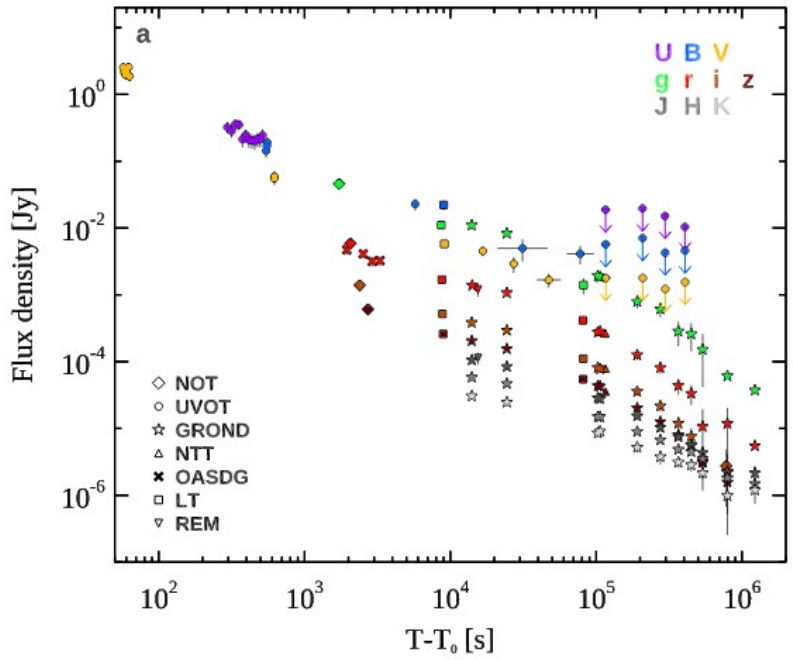
Group	Title	Most stable	In progress	Version history
App	SAMP - Simple Application Messaging Protocol	1.3		1.3 1.3 1.3 1.3 1.3 1.2 1.2 1.2 1.11 1.11 1.10 1.00
	VOTable - VOTable Format Definition	1.4		1.4 1.4 1.4 1.4 1.4 1.4 1.3 1.3 1.3 1.2 1.2 1.2 1.20 1.20 1.10 1.00
	MOC - HEALPix Multi-Order Coverage Map	1.1		1.1 1.1 1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0
	HiPS - Hierarchical Progressive Survey	1.0		1.0 1.0 1.0 1.0 1.0 1.0 1.0
DAL	DALI - Data Access Layer Interface	1.1		1.1 1.1 1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	DataLink	1.0		1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	Simple Cone Search	1.03		1.03 1.02 1.01 1.00
	SIA - Simple Image Access	2.0		2.0 2.0 2.0 2.0 2.0 2.0 2.0 1.0 1.0 1.0 1.01 1.00
	SLAP - Simple Line Access	1.0	2.0	2.0 2.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	SSA - Simple Spectral Access	1.1		1.1 1.1 1.1 1.1 1.04 1.03 1.02 1.01 1.01 1.00
	STC-S: Space-Time Coordinate Metadata Linear String Implementation	1.0		1.0
	TAP - Table Access Protocol	1.1		1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0 1.00
	TAPRegExt - A VOResource Schema Extension for Describing TAP Services	1.0		1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	ADQL - Astronomical Data Query Language	2.00	2.1	2.1 2.1 2.1 2.00 2.00 2.00 1.01 1.00

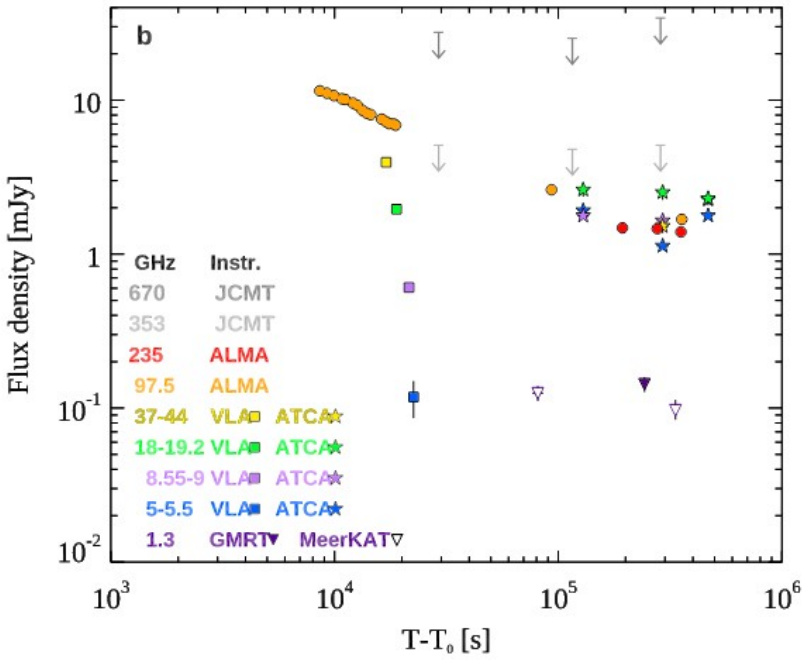
Interoperability is a MUST

Observation of inverse Compton emission from a long γ-ray burst

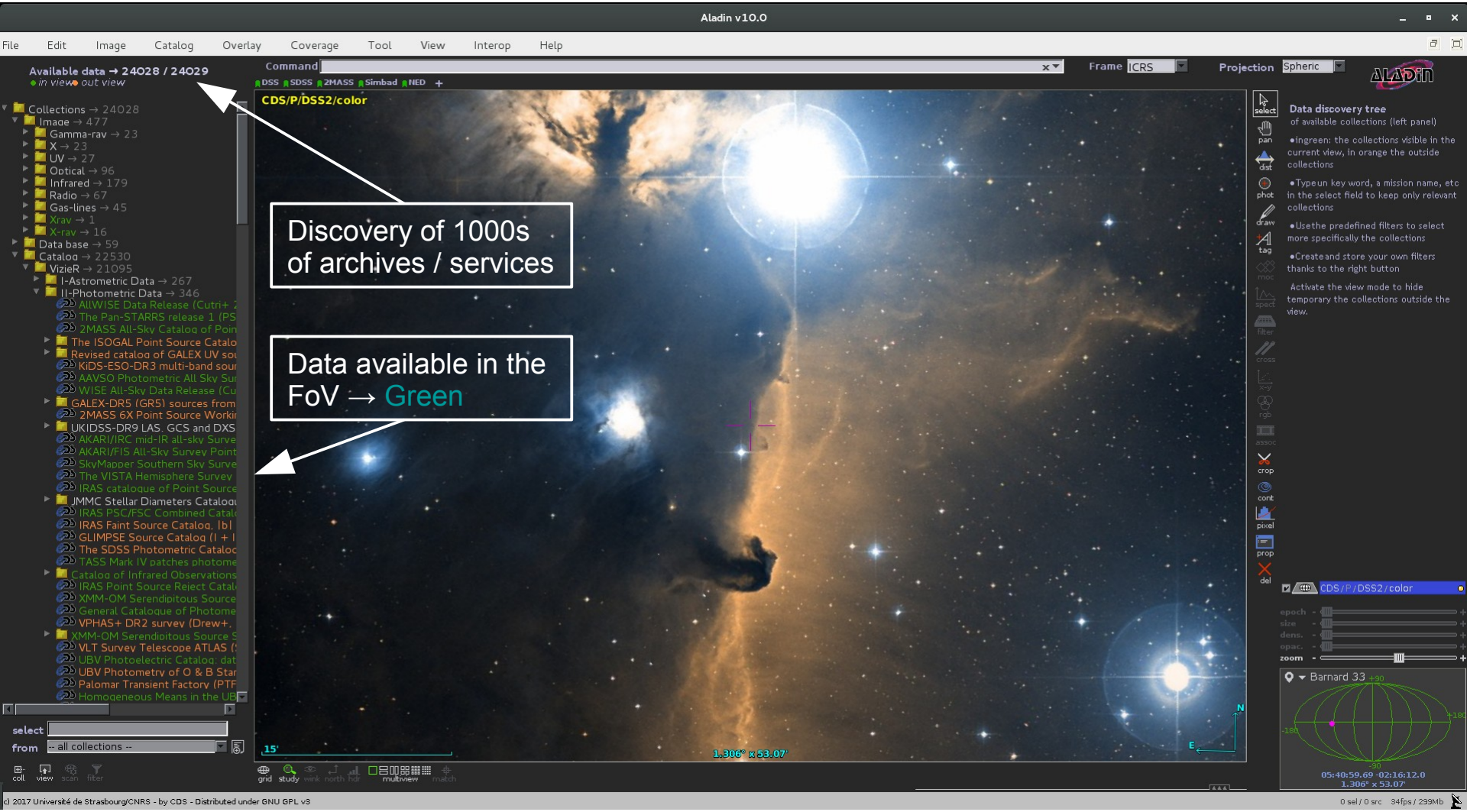
https://doi.org/10.1038/s41586-019-1754-6

A list of authors and affiliations appears at the end of the paper.

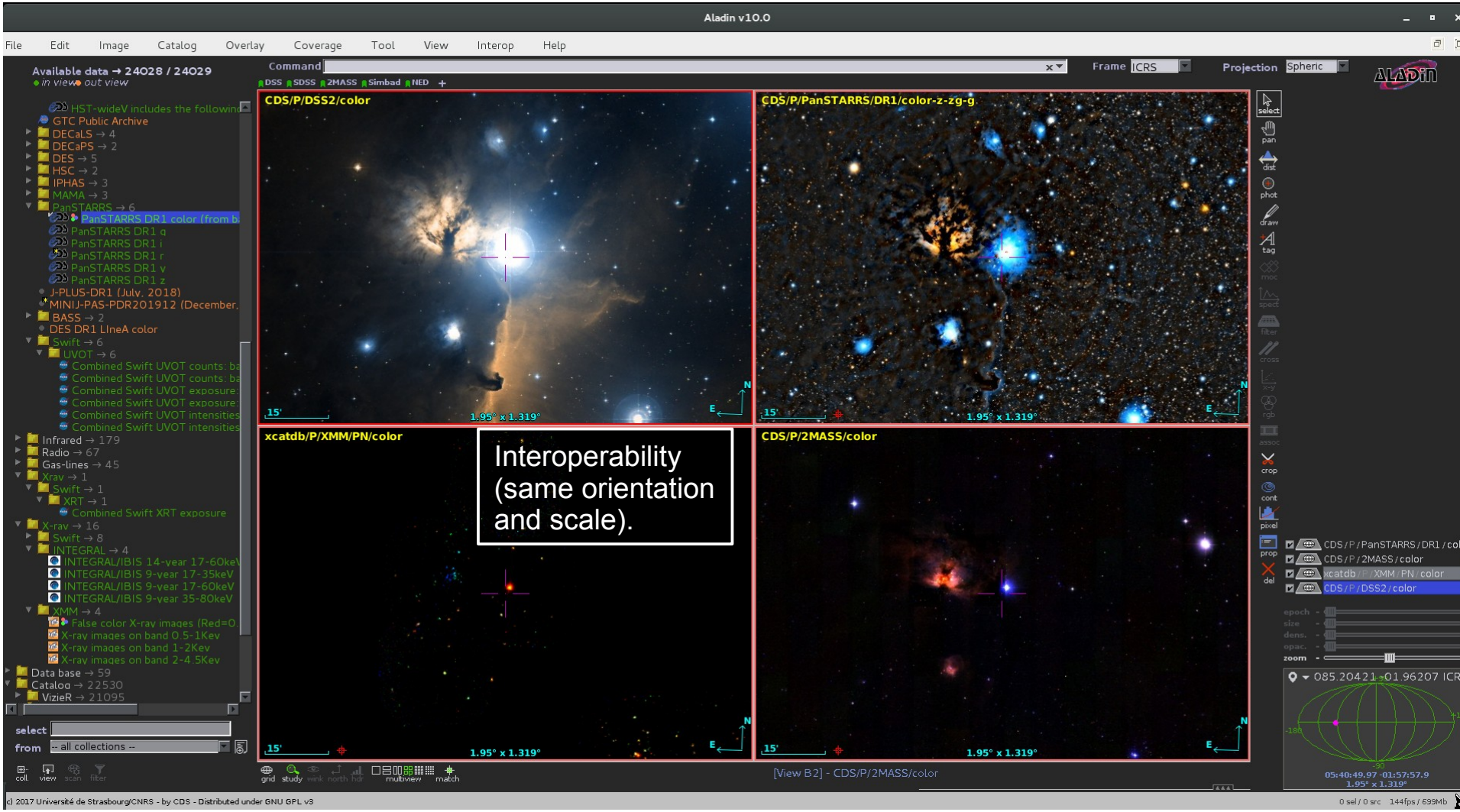




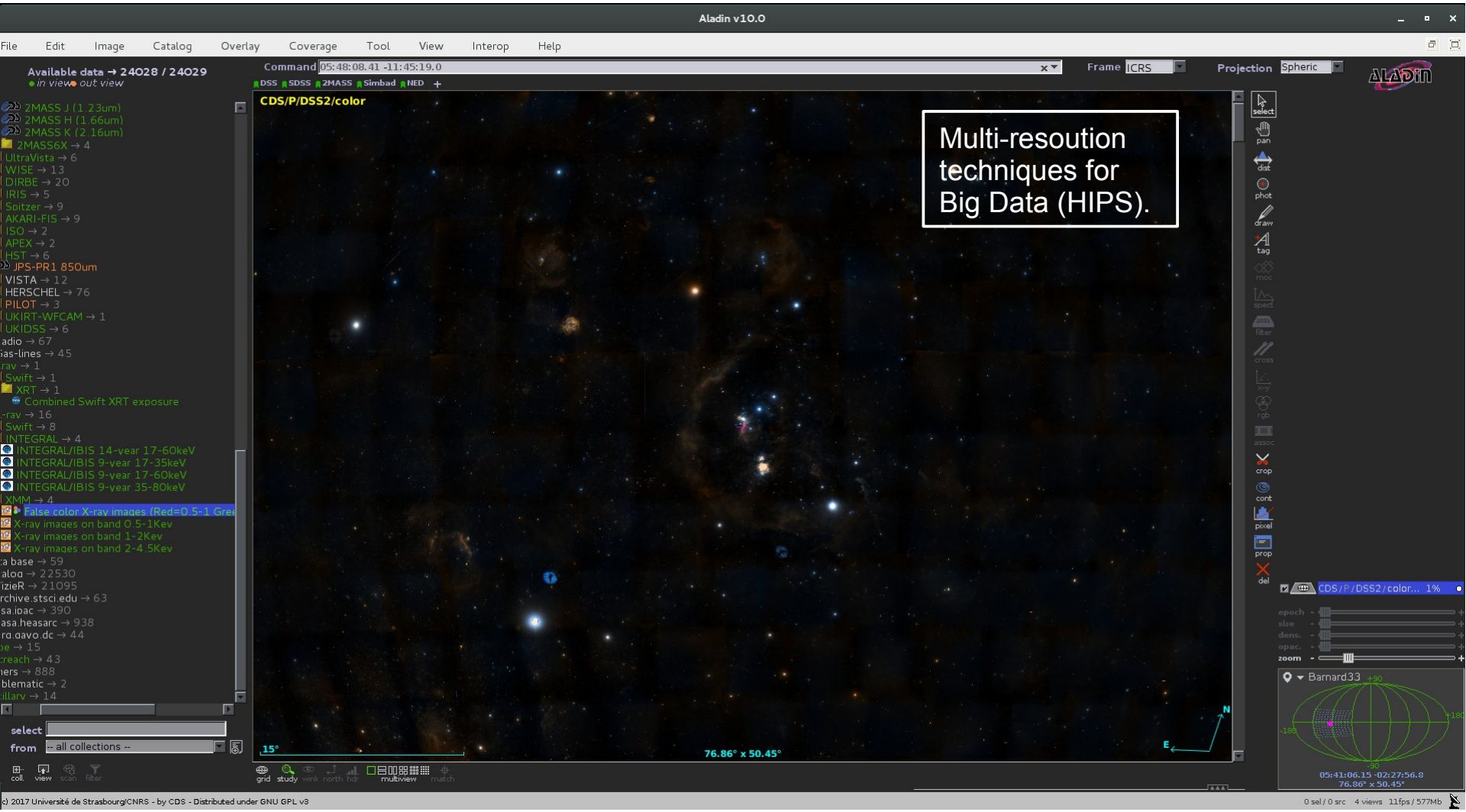
FAIR. The power of VO



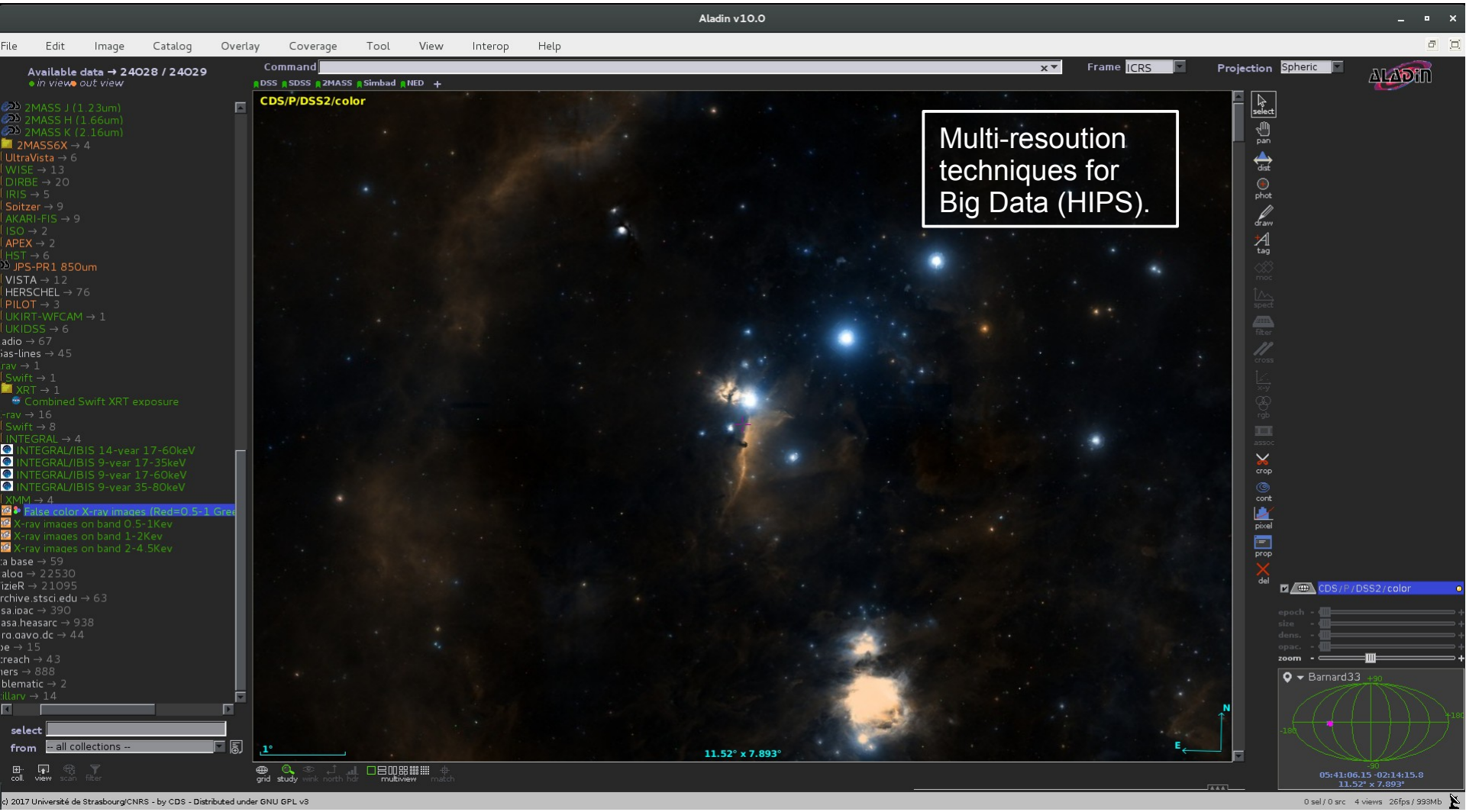
FAIR. The power of VO



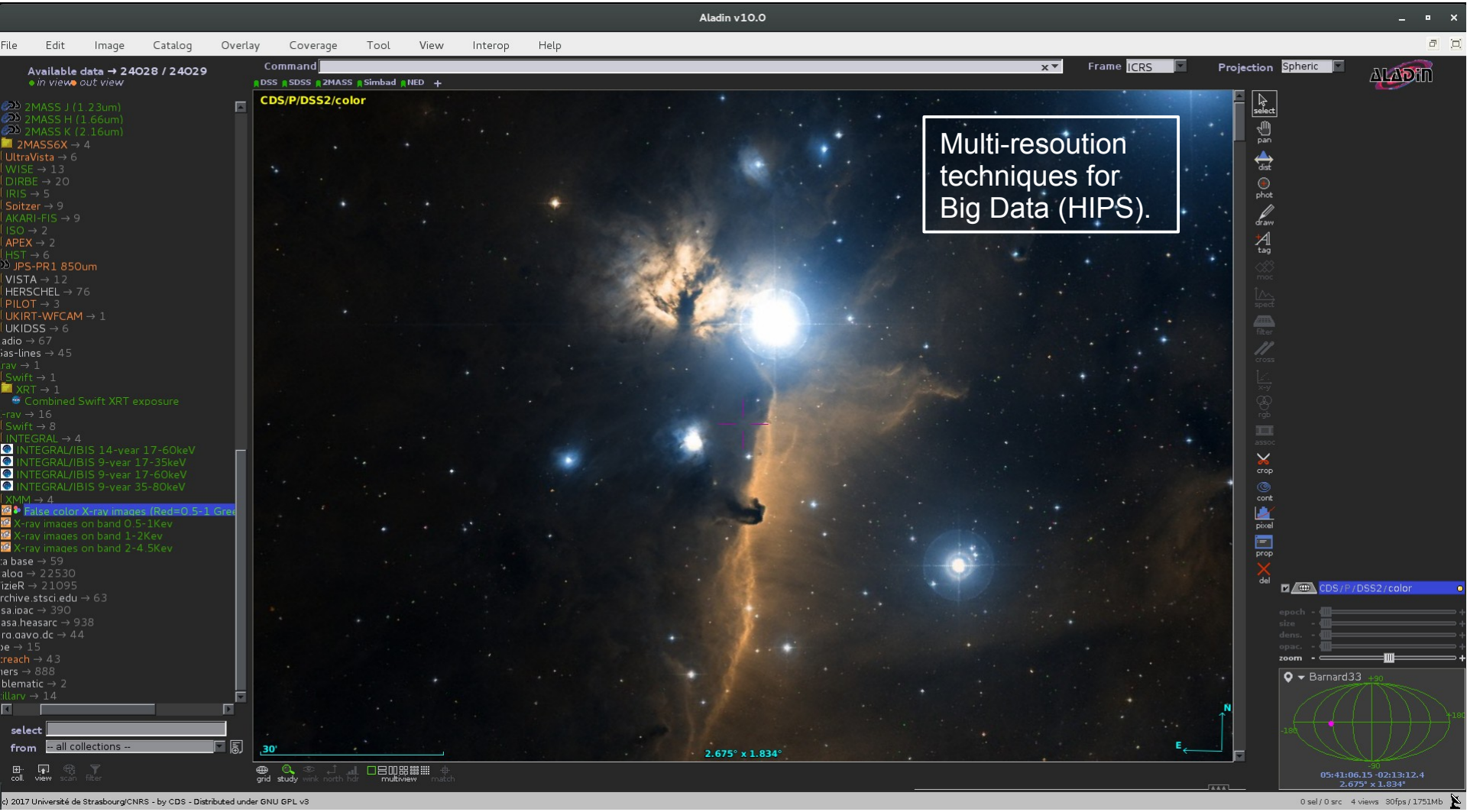
The power of VO



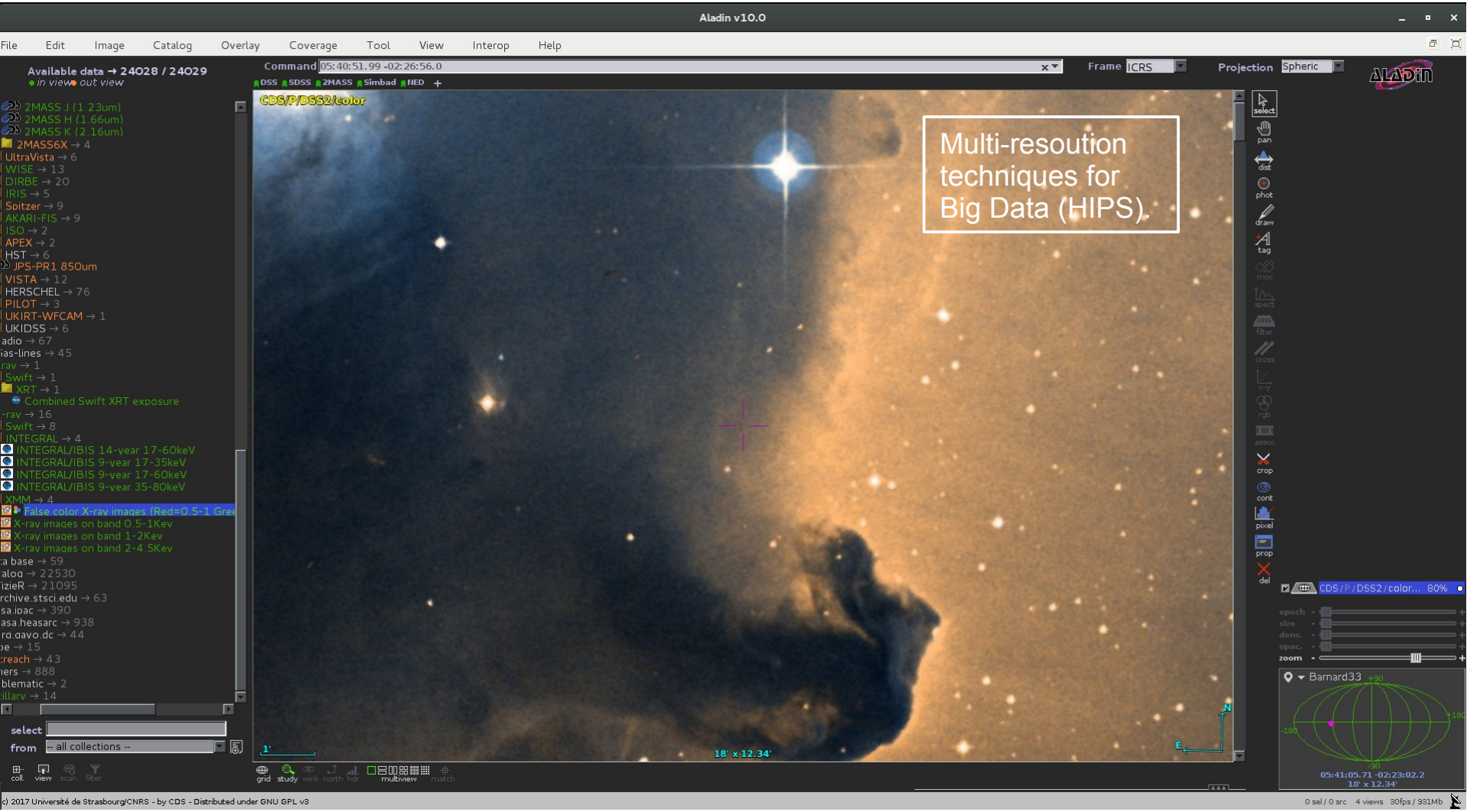
The power of VO



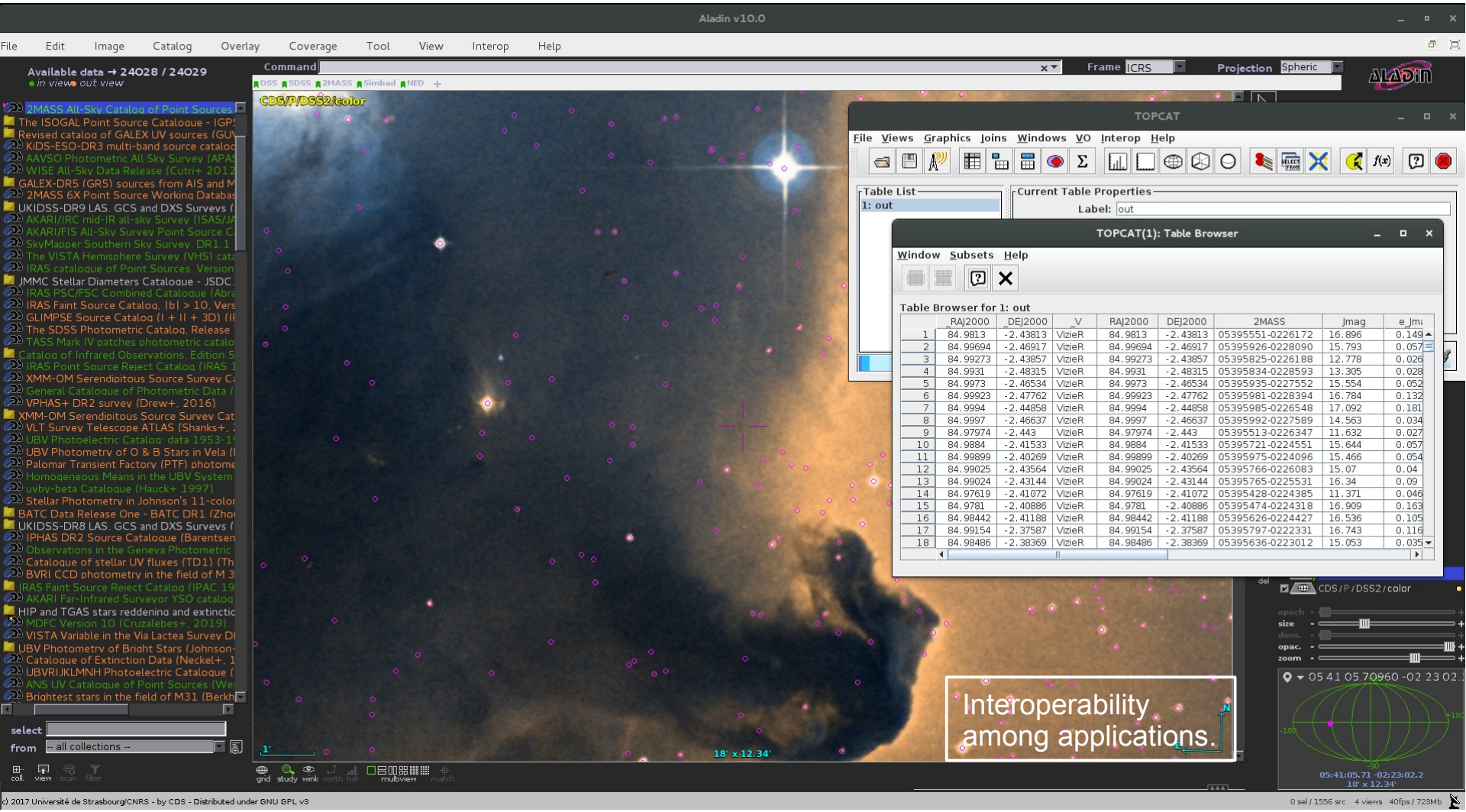
The power of VO



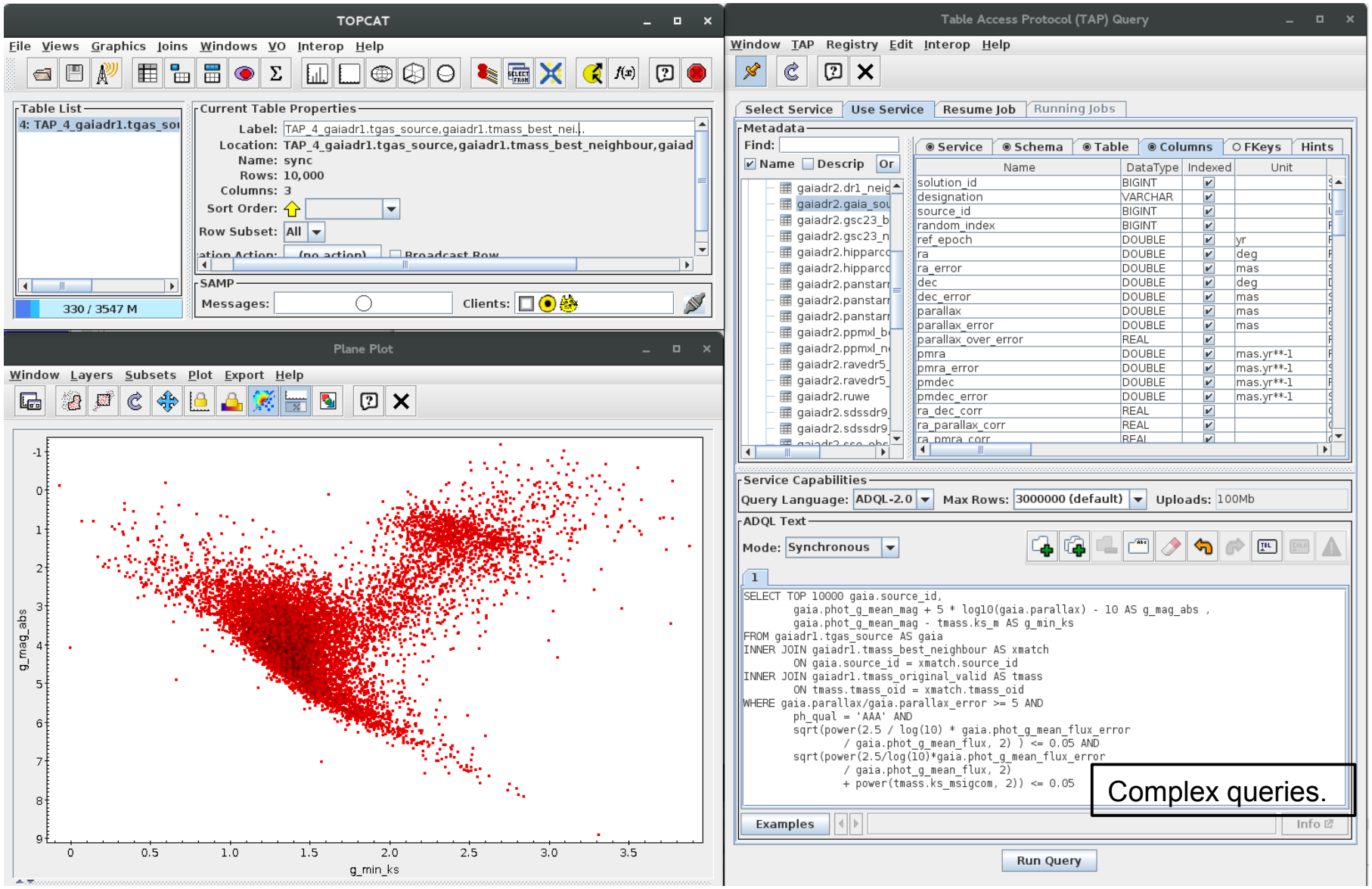
The power of VO



The power of VO



The power of VO



ESCAPE

WP4 : CEVO

Connecting ESFRI projects to EOSC through VO framework

- Inclusion of data of the ESFRI facilities in the VO already started in a previous H2020 project (ASTERICS, 2015-2019.).

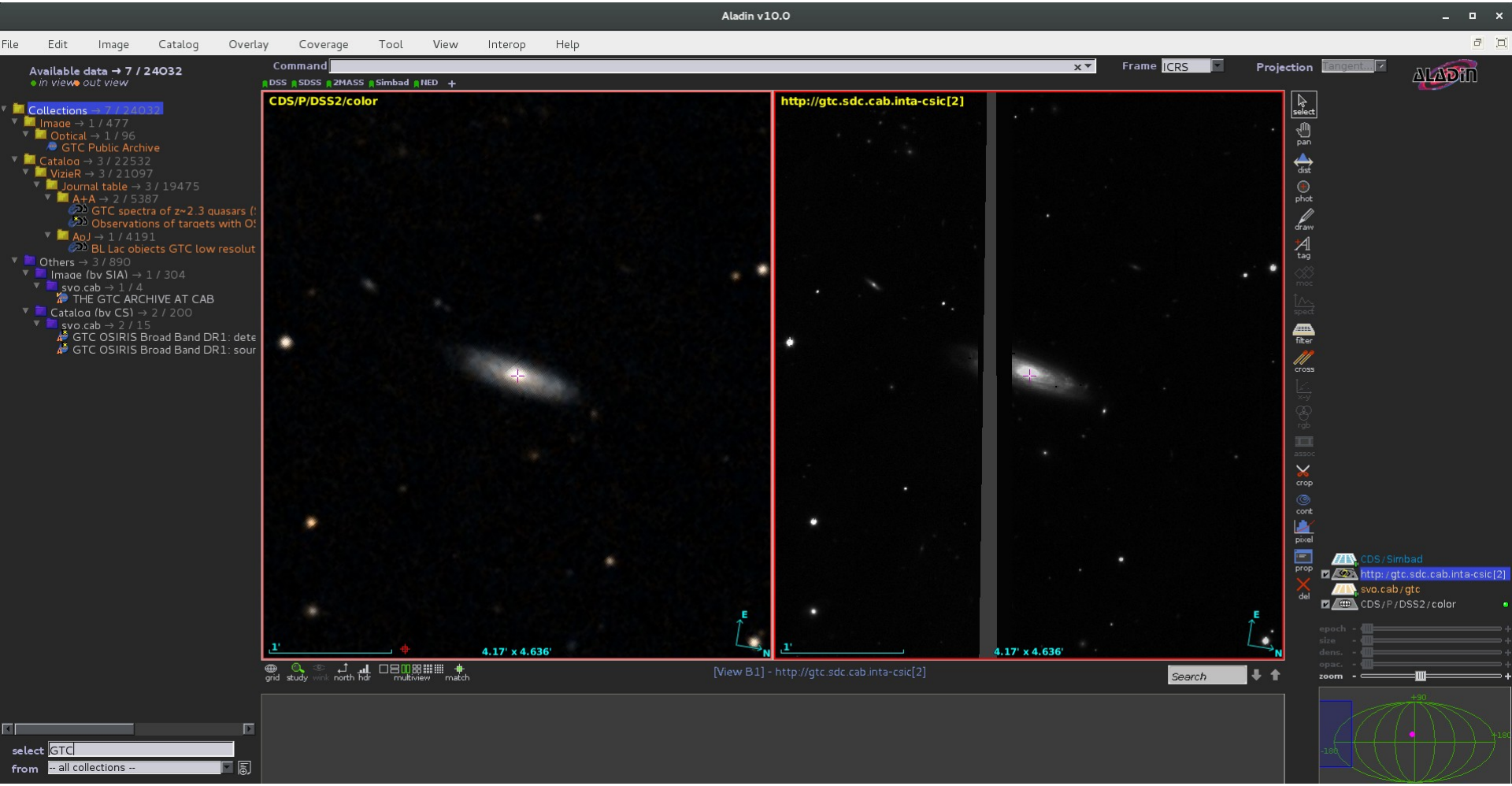
- New in ESCAPE:

  - Cross-disciplinary interoperability
  - From tools to scientific analysis platforms.
  - Connection to computing resources → Big Data
  - Add value to scientific contents of the ESFRI data archives.
    - Machine learning classification of astronomical sources.

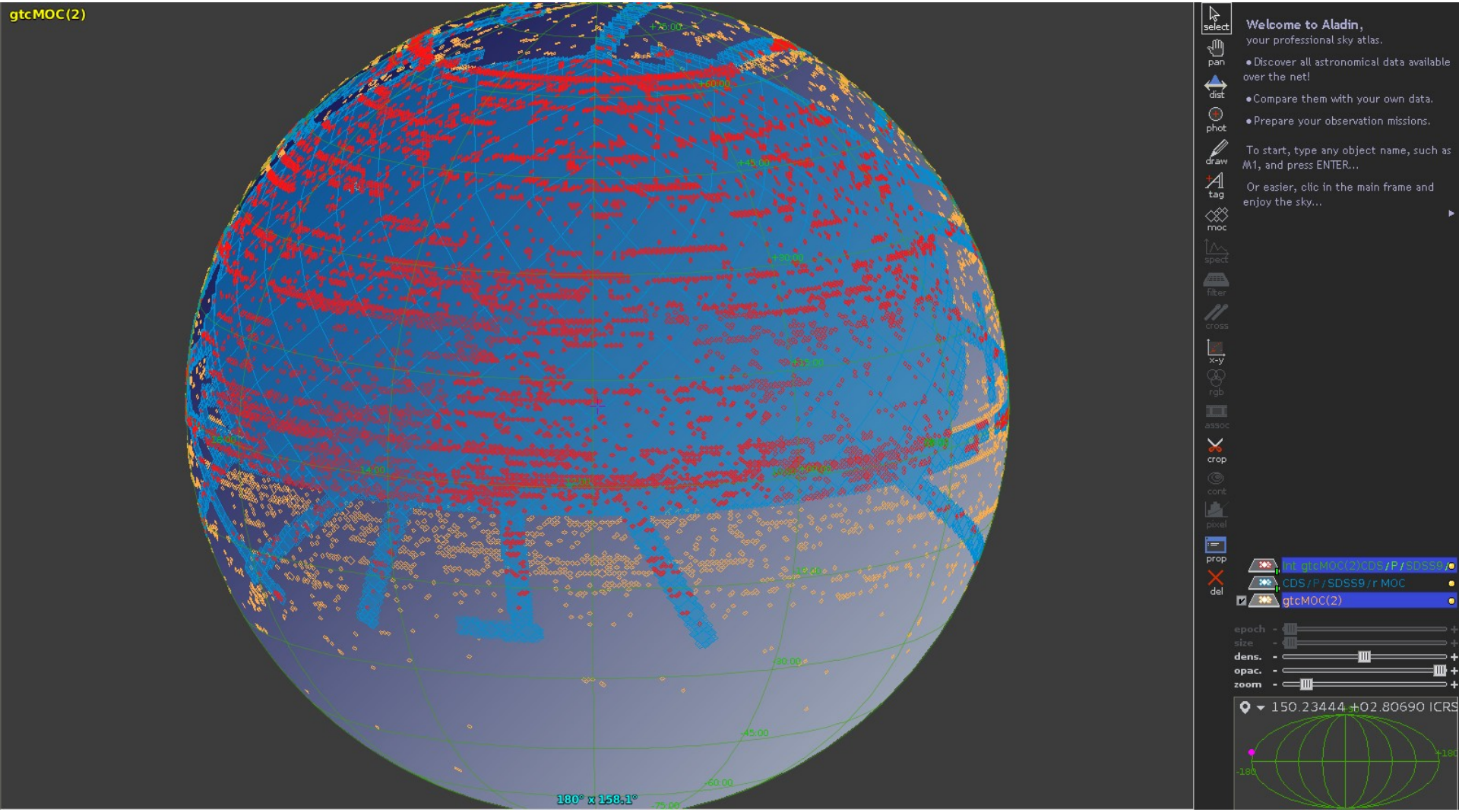
GTC and the VO

- 2003 First GTC-CAB meeting
  - The need of a VO-compliant archive for GTC is identified.
    - Long-term preservation.
    - Optimum scientific exploitation.
- 2011 Operational version of GTC archive

GTC and the VO: SIAP



GTC and the VO: MOC



GTC and the VO: VOSA

Filter Profile Service

A repository of Filter information for the VO

VO Service | Browse | Search | News | Help-Desk | AuthId: | Passw:

2MASS	AAO	AKARI	Astrosat	BOK	CAHA	CFHT	COBE	CTIO	DENIS	Euclid	GAIA	GALEX
Generic	Geneva	GTC	Herschel	Hipparcos	HST	IAC80	ING	INT	IRAS	ISO	IUE	JWST
KPNO	LasCumbres	LaSilla	LBT	LCO	LICK	Liverpool	LSST	McD	Misc	MKO	MMT	MSX
NOAO	NOT	OAF	OAJ	OSN	P200	Palomar	PAN-STARRS	Paranal	SAO	Scorpio	SkyMapper	SLOAN
Spitzer	STELLA	Subaru	Swift	TCS	TD1	TESS	TJO	TNG	TNO	TYCHO	UKIRT	VATT
WISE	WIYN	XMM										

GTC filters: CanariCam | EMIR | OSIRIS

Filter ID	λ_{mean}	λ_{eff}	λ_{min}	λ_{max}	W_{eff}	ZP (Jy)	Obs. Facility	Instrument	Description
GTC/OSIRIS.sdss_g_filter	4847.5	4745.4	3800	5806	1321.2	3906.9	GTC	Osiris	GTC, Osiris, SDSS g (f
GTC/OSIRIS.sdss_g	4910.4	4810.3	3805	5817	1179.7	3878.3	GTC		GTC, OSIRIS, SDSS g

GTC/OSIRIS.sdss_g

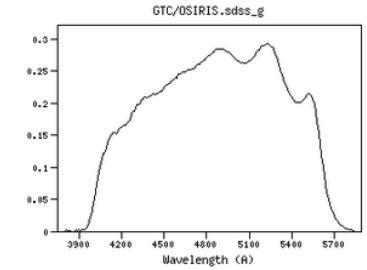
Filter Description

Filter ID (?) :	GTC/OSIRIS.sdss_g
Description (?) :	GTC, OSIRIS, SDSS g filter (full trans)
Phot.System (?) :	OSIRIS
Detector Type (?) :	Photon counter
Band Name (?) :	------
Obs. Facility (?) :	GTC
Instrument (?) :	------
Comments (?) :	------

Mathematical properties

Property	Calculated	Specified	Unit
λ_{mean} (?) :	4910.44	-------	(Angstrom)
λ_{cen} (?) :	4855.81	-------	(Angstrom)
λ_{eff} (?) :	4810.33	-------	(Angstrom)
λ_{peak} (?) :	5230.00	-------	(Angstrom)
λ_{pivot} (?) :	4852.64	-------	(Angstrom)
λ_{phot} (?) :	4849.08	-------	(Angstrom)
λ_{min} (?) :	3805.19	-------	(Angstrom
λ_{max} (?) :	5817.14	-------	(Angstrom
W_{eff} (?) :	1179.72	-------	(Angstrom
FWHM (?) :	1476.58	-------	(Angstrom
A_g/A_V (?) :	1.19	-------	()

Transmission curve



Data file: ascii, VOTable

Reference for filter response: OSIRIS

Calibration properties

Vega System

Property	Specified	Calculated	Unit
Zero Point (?) :	-------	5.025e-9	(erg/c
	-------	3878.29	(Jy)
ZP Type (?) :	Pogson		
PhotCal ID (?) :	GTC/OSIRIS.sdss_g/Vega		

AB System

Property	Specified	Calculated	Unit
Zero Point (?) :	-------	4.704e-9	(erg/c
	-------	3631.00	(Jy)
ZP Type (?) :	Pogson		
PhotCal ID (?) :	GTC/OSIRIS.sdss_g/AB		

ST System

Property	Specified	Calculated	Unit

GTC OSIRIS Broad Band First Data Release: Source catalogue

Home | Data retrieval | News | Documentation | Coverage Map | Credits | Help-desk

RA (?) | DEC (?) | Radius (?) | Search | Clean | 10 results | default verb.

(Example of valid query: RA=351.712, DEC=26.5276) (Maximum Search Radius allowed: 1 degrees)

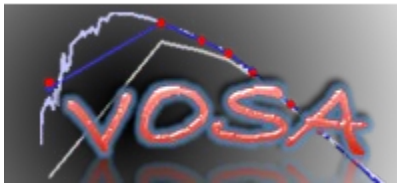
Don't use coordinates as search criterion

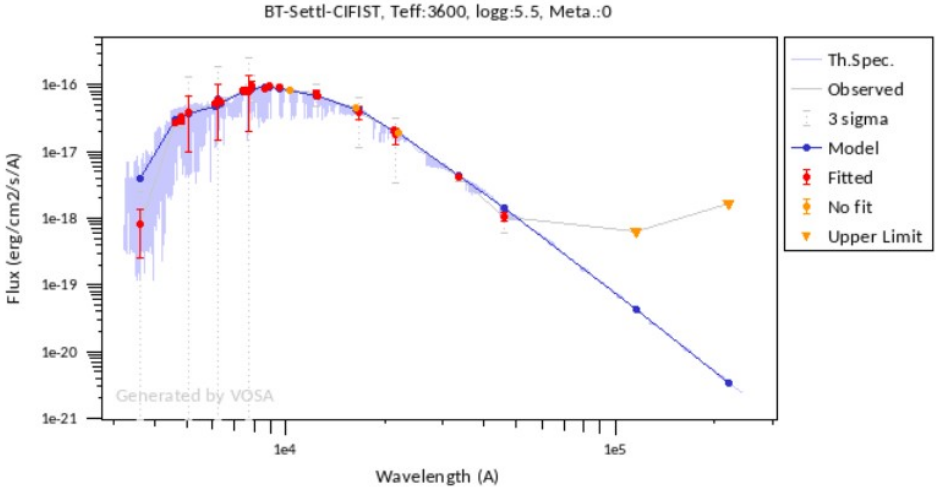
[-] Hide additional search fields

Magnitude ranges (?): rmag_psf : 18 - 18.2

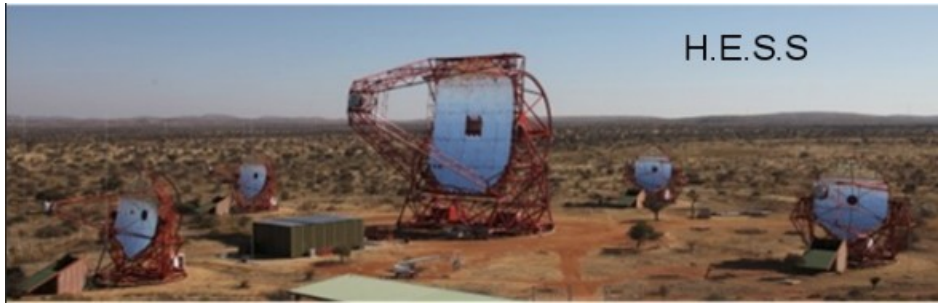
Color ranges (?)

ID_source (?)





VO and the high energies: H.E.S.S.



Euro-VO Registry

RESULTS #1

Search Results (21)

	Short Name	Publisher	Title	Capabilities	Compliance	IVOID	Resource Type	
	CHESSCAT	NASA/GSFC HEASARC	ChaMP Extended Stellar Survey (ChESS) X-Ray Catalog	cs:conesearch, undefined, undefined	Compliant(A++), not applicable, not applicable	ivo://nasa.heasarc/chesscat	vs:catalogservice	The ChaMP Extended Stellar Survey (ChESS) is a sample of X-ray-emitting stars identified in the *(more)*
	HESSCAT	NASA/GSFC HEASARC	HESS (High Energy Stereoscopic System) Source Catalog	undefined, undefined, cs:conesearch	not applicable, not applicable, Compliant(A++)	ivo://nasa.heasarc/hesscat	vs:catalogservice	H.E.S.S. is a system of Imaging Atmospheric Cherenkov Telescopes for the investigation of cosmic gamma rays in the 100 GeV energy range. The name H.E.S.S. stands for High Energy Stereoscopic System, and should also remind us of Victor Hess, who received in 1936 the Nobel Prize in Physics for his discovery of cosmic radiation. The instrument allows us to explore gamma-ray sources with intensities at a level of a few thousandth parts of the flux of the Crab nebula. H.E.S.S. is located in Namibia, near the Gamsberg, an area well known for its excellent optical quality. The first of the four telescopes of Phase I of the H.E.S.S. project went into operation in Summer 2002; all four were operational in December 2003, and were officially inaugurated on September 28, 2004. In recognition of its scientific results, H.E.S.S. was awarded the 2006 Descartes Prize for Research of the European Commission. *(less)*
	HESS DL3 DR1	Paris Astronomical Data Centre - LUTH	H.E.S.S. DL3 public test data release 1	tr:tableaccess	Partially Compliant(C-)	ivo://vopdc./luth/hess-d		
	J/A+A/545/L2	CDS	PSR J0537-6910 gamma-ray emission (HESS+, 2012)	undefined, undefined	not applicable, not applicable	ivo://cds.vizier/j/a+a/545/l2	vs:catalogservice	(associated with N157B) *(more)*
	J/A+A/612/A1	CDS	H.E.S.S. Galactic Plane Survey (HESS+, 2018)	undefined, undefined, cs:conesearch, cs:conesearch, cs:conesearch, cs:conesearch	not applicable, not applicable, Compliant(A++), Compliant(A++), Compliant(A++), Compliant(A++), Compliant(A++)	ivo://cds.vizier/j/a+a/612/a1	vs:catalogservice	The H.E.S.S. Galactic plane survey and of other tables that are *(more)*
	J/A+A/612/A3	CDS	HESS Galactic supernova remnants (Hess+, 2018)	undefined, undefined, cs:conesearch	not applicable, not applicable, Compliant(A++)	ivo://cds.vizier/j/a+a/612/a3	vs:catalogservice	In this study, we selected described in Aharonian et *(more)*
	J/A+A/612/A5	CDS	W49B with H.E.S.S. and Fermi-LAT (HESS+, 2018)	undefined, cs:conesearch, undefined	not applicable, Compliant(A++), not applicable	ivo://cds.vizier/j/a+a/612/a5	vs:catalogservice	File hessmap.fit contains the H.E.S.S. in the direction

1 of 1 Page size: 100

Displaying 1-21 of 21

HESSCAT

Summary | XML | Validation

Title: HESS (High Energy Stereoscopic System) Source Catalog
Type: vs:CatalogService
Short name: HESSCAT
Identifier: ivo://nasa.heasarc/hesscat
AltIdentifier:
Status: active

Curation

Publisher:NASA/GSFC HEASARC
Creator(s): Hofmann
Contributor(s):

1 Contacts declared:

- Contact 1 of 1:
  - **name:** Michael Preciado
  - **address:**
  - **email:** Michael.E.Preciado@nasa.gov
  - **telephone:**

Content

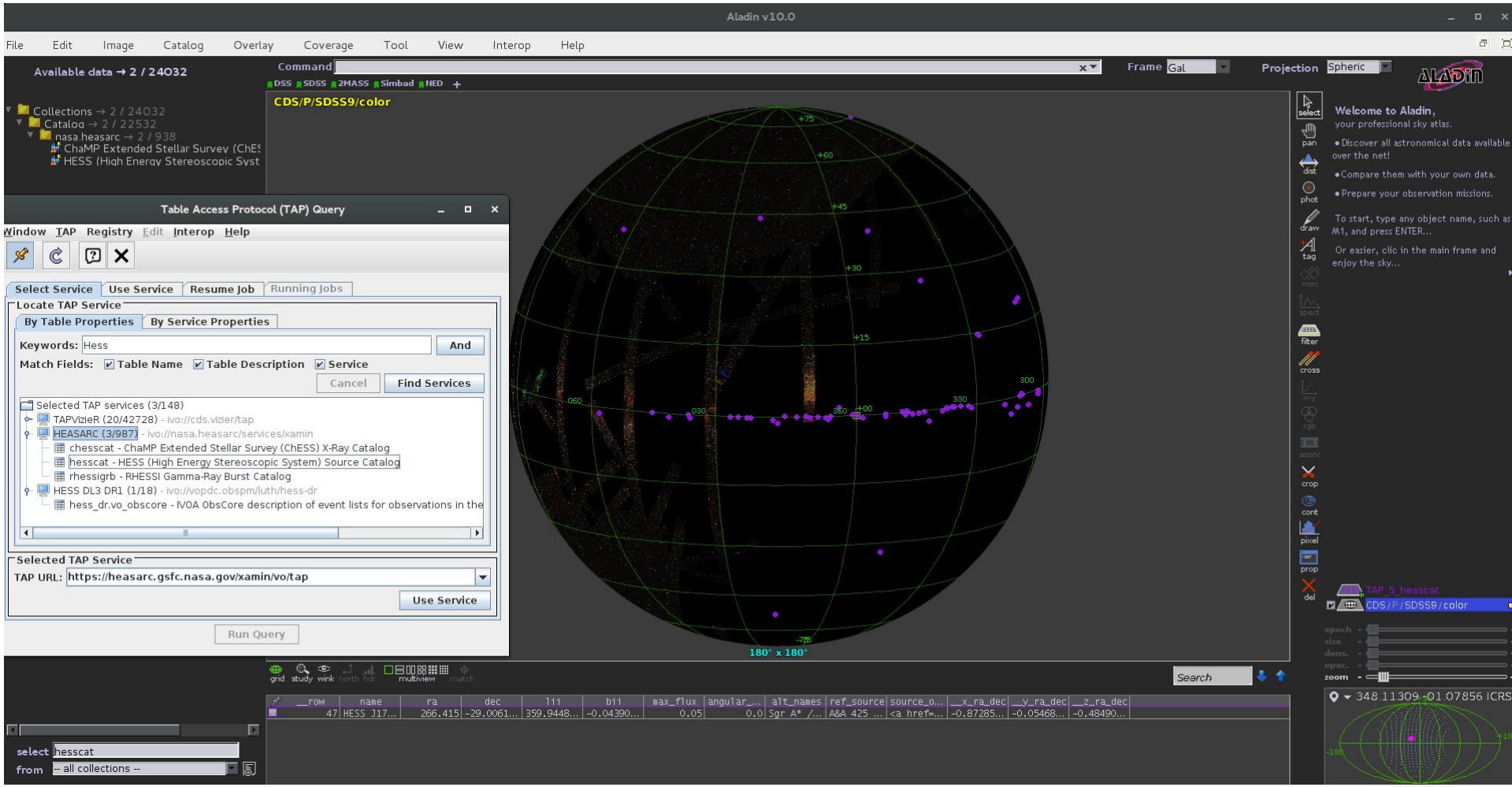
Subject(s): *Survey Source*
Description: H.E.S.S. is a system of Imaging Atmospheric Cherenkov Telescopes for the investigation of cosmic gamma rays in the 100 GeV energy range. The name H.E.S.S. stands for High Energy Stereoscopic System, and should also remind us of Victor Hess, who received in 1936 the Nobel Prize in Physics for his discovery of cosmic radiation. The instrument allows us to explore gamma-ray sources with intensities at a level of a few thousandth parts of the flux of the Crab nebula. H.E.S.S. is located in Namibia, near the Gamsberg, an area well known for its excellent optical quality. The first of the four telescopes of Phase I of the H.E.S.S. project went into operation in Summer 2002; all four were operational in December 2003, and were officially inaugurated on September 28, 2004. In recognition of its scientific results, H.E.S.S. was awarded the 2006 Descartes Prize for Research of the European Commission.

Capabilities

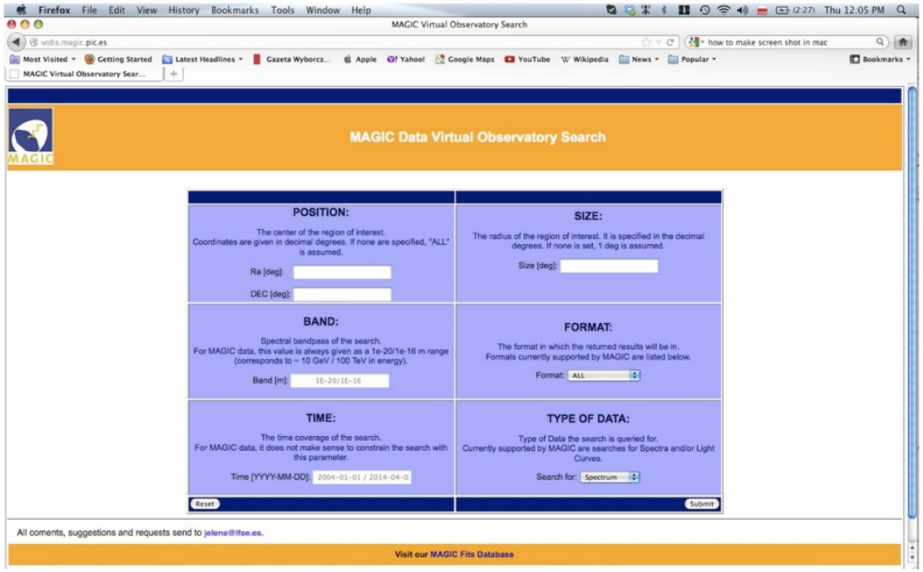
4 Capabilities present:

- Capability 1 of 4:
  - **type:** [cs:ConeSearch]
  - **standardID:** [ivo://ivoa.net/std/ConeSearch]
  - **1 accessURL(s):** [https://heasarc.gsfc.nasa.gov/cgi-bin/vo

VO and the High energies: H.E.S.S



VO and the high energies: MAGIC



Euro-VO Registry

RESULTS #8

Search Results (1)

	Short Name	Publisher	Title	Capabilities	Compliance	IVOID	Resource Type	
	Magic SSAP	BSDC	Magic Public Spectra SSAP Interface	ssap:simplespectra undefined, undefined, undefined, undefined	Partially Compliant(C--), not applicable, not applicable, not applicable, not applicable	ivo://bsdc.icranet.org /magic/q/ssa	vs:catalogservice	The MAGIC project observes the radiation events. The project is c from the Spain-VO team they pr web services. Our goal here is to difference that the data is transfo values in 'erg/(s.cm2)', and phot frequency values. *(less)*

CTA in VO: needs and challenges

Konstancja Satalecka (UCM)

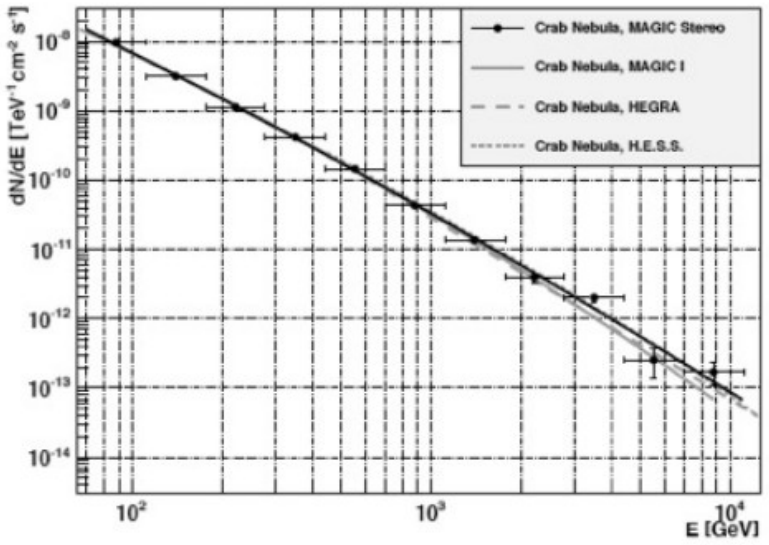
SVO, 8th April 2014

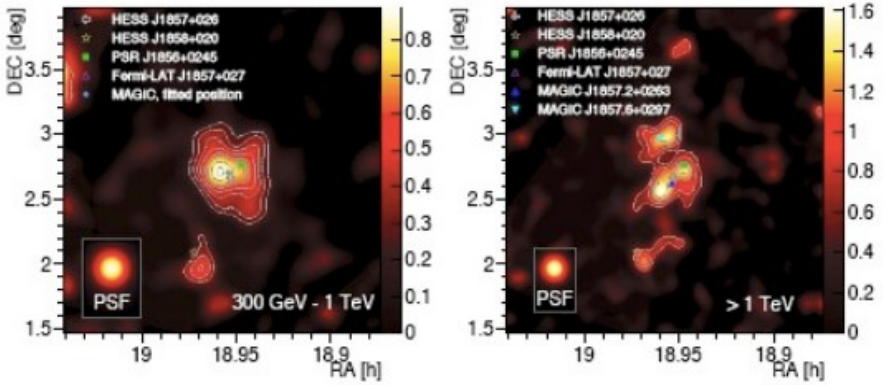
IACT data processing: DL4

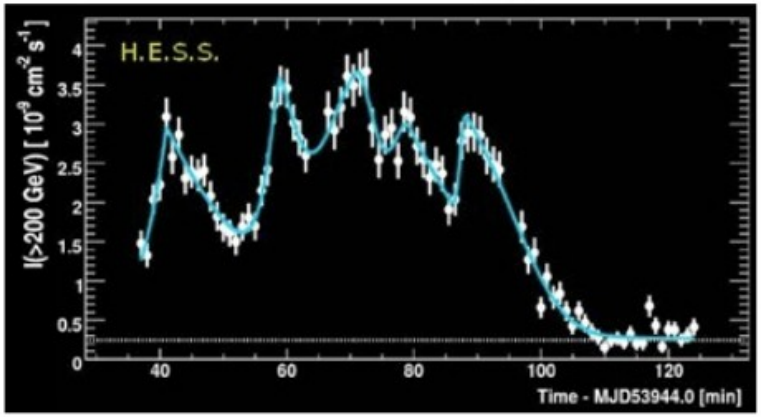
high level data: light curve, spectrum, sky map for each source/observation

IMPORTANT:
- produced from L3 events list using the corresponding IRFs
- might be a combination of data from different observations

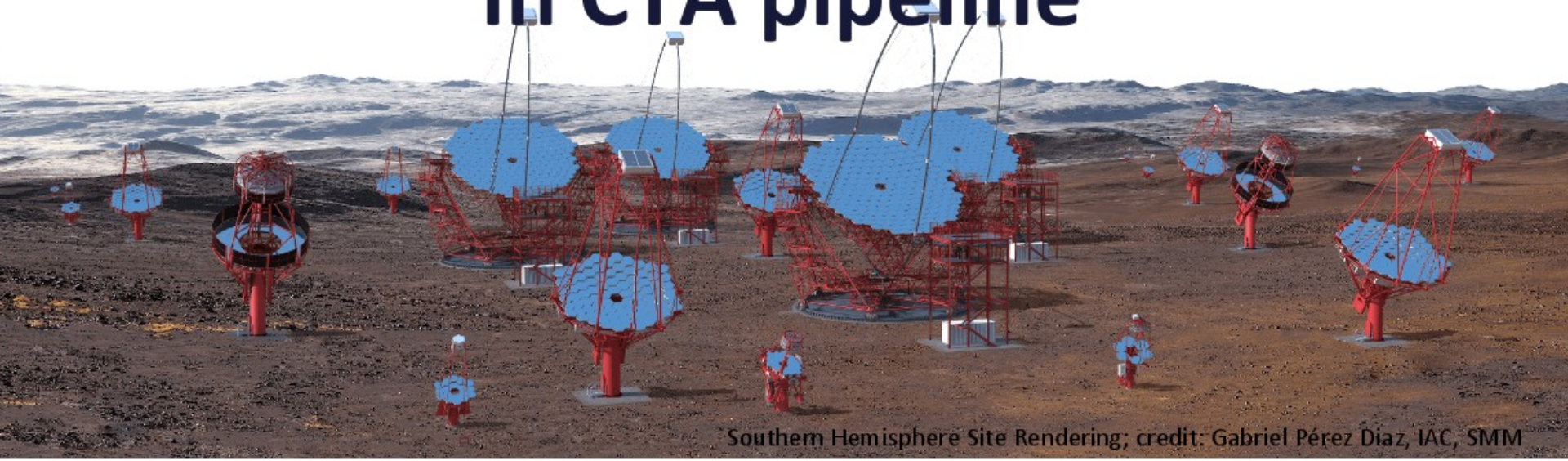
Access: Privileged Users and Guest/Archive Users







Provenance implementation in CTA pipeline



Southern Hemisphere Site Rendering; credit: Gabriel Pérez Diaz, IAC, SMM

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W3C Provenance definition

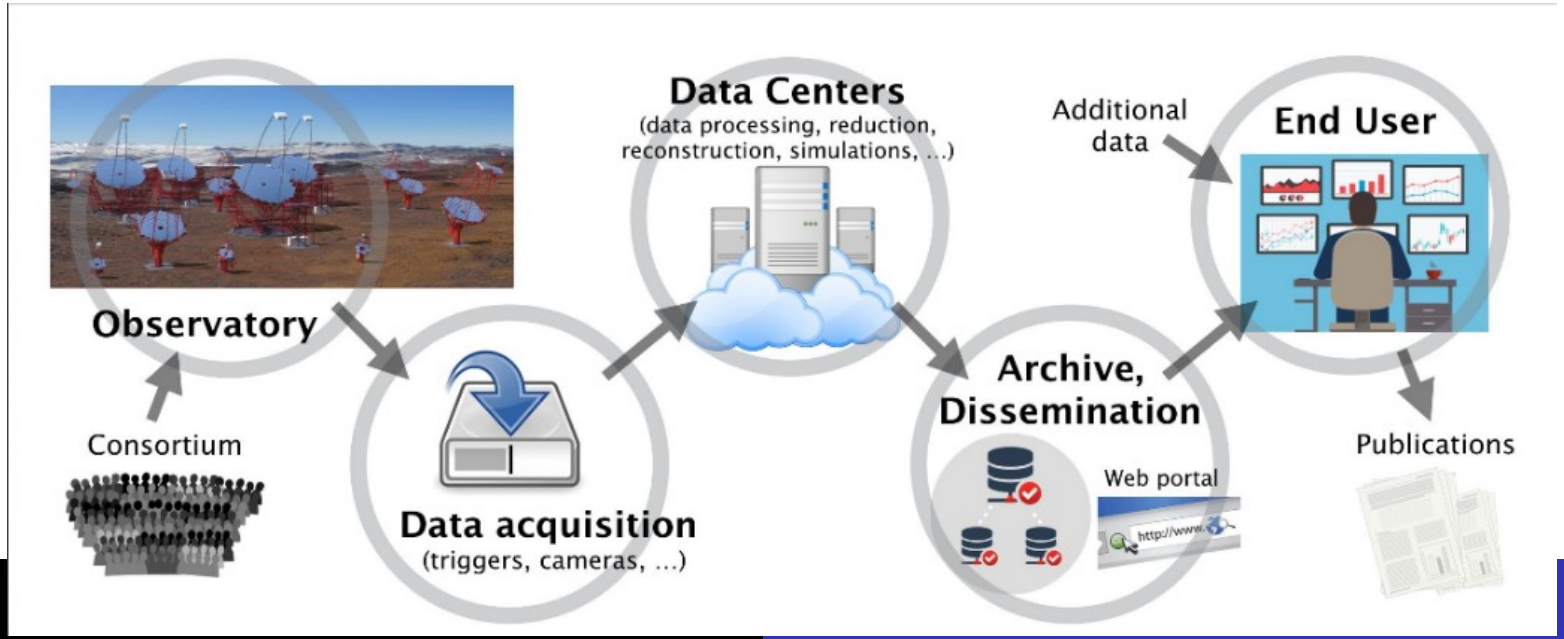
http://www.w3.org/TR/prov-overview/

W3C PROV (PROV-DM, 2013)

Word Wide Web Consortium

Provenance is defined as a **record that describes the people, institutions, entities, and activities** involved in **producing**, **influencing**, or **delivering** a **piece of data or a thing**.

In particular, the provenance of information is crucial in deciding whether information is to be **trusted**, how it should be **integrated** with other diverse information sources, and how to **give credit** to its originators when reusing it.



Use cases adressed

A: Traceability of products

Track the lineage of a product back to the raw material (backwards search), show the workflow or the data flow that led to a product.

Examples:

- Having a dataset, find the main progenitors and in particular locate the raw data.
- Find out what processing steps have been already performed for a given dataset: Is an image already calibrated? What about dark field subtraction? Were foreground stars removed?
- Find out if a filter to remove atmospheric background muons has been applied.

Use cases adressed

B: Acknowledgement and contact information

Find the people involved in the production of a dataset, the people/organizations/institutes that one may want to acknowledge or can be asked for more information.

Examples:

- I want to use an image for my own work – who was involved in creating it? Who can I contact to get information?
- Who was on shift while the data was taken?
- I have a question about column xxx in a data table. Who can I ask about that?

Use cases adressed

C: Quality and Reliability assessment

Assess the quality and reliability of an observation, production step or dataset, e.g., based on detailed descriptions of the processing steps and manipulated entities.

Examples:

- Get detailed information on the methods/tools/software that were involved: What algorithm was used for Cherenkov photon reconstruction? How was the stacking of images performed?
- Check if the processing steps (including data acquisition) went "well": Were there any warnings during the data processing? Any quality control parameters?
- Extract the ambient conditions during data acquisition (cloud coverage? wind? temperature?)
- Is the dataset produced or published by a person/organisation I rely on? Using methods I trust?

Use cases adressed

D: Identification of error location

Find the location of possible error sources in the generation of a product. This is connected to use cases described in section C above, but implies an access to more information on the execution such as configuration or execution environment.

Examples:

- I found something strange in an image. Was there anything strange noted when the image was taken? a warning during the processing?
- Which pipeline version was used, the old one with a known bug for treating bright objects or a newer version?
- What was the execution environment of the pipeline (operating system, system dependencies, software version, etc.)?
- What was the detailed configuration of the pipeline? were the parameters correctly set for the image cleaning step?

VO and CTA

International
Virtual
Observatory
Alliance

IVOA Provenance Data Model

Version 1.0

IVOA Proposed Recommendation 2019-11-21

Working group
DM

This version
http://www.ivoa.net/documents/ProvenanceDM/20191121

Latest version
http://www.ivoa.net/documents/ProvenanceDM

Previous versions
WD-ProvenanceDM-1.0-20190614.pdf
PR-ProvenanceDM-1.0-20181015.pdf
WD-ProvenanceDM-1.0-20180530.pdf
WD-ProvenanceDM-1.0-20170921.pdf
WD-ProvenanceDM-1.0-20161121.pdf
ProvDM-0.2-20160428.pdf
ProvDM-0.1-20141008.pdf

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Conclusion

- The (current) GTC and (future) CTA VO-compliance will guarantee the efficient management of science-ready data products generated by these infrastructures.

- This will boost joint scientific initiatives in the multi-lambda, multi-messenger framework.