



Conference

ESCAPE to the Future | 25-26 October 2022

Royal Belgian Institute of Natural Sciences | Brussels, Belgium

25 October 2022, 13:30 - 14:25

ESCAPE VO - A European Virtual Observatory



Mark Allen
Strasbourg
Astronomical
Data Center



François Bonnarel
Strasbourg
Astronomical
Data Center



Martino Romaniello
ESO



Véronique Delouile
Royal Observatory of Belgium



Giuseppe Greco
INFN





ESCAPE

European Science Cluster of Astronomy &
Particle physics ESFRI research Infrastructures

ESCAPE to the Future

25-26 October 2022
Brussels, Belgium

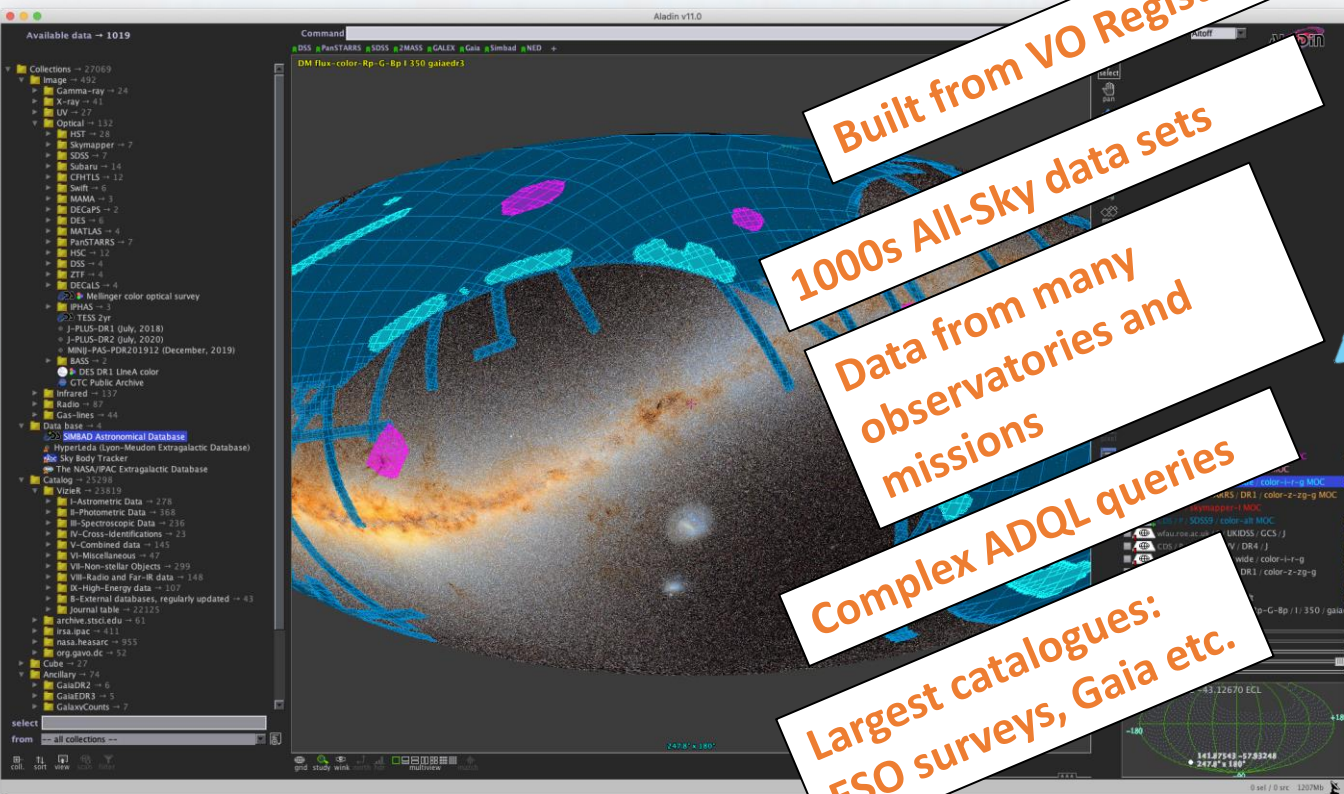
The Virtual Observatory in ESCAPE and EOSC

Mark Allen and François Bonnarel
CDS, Observatoire astronomique de Strasbourg
For WP4, 'CEVO'



ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 824064.

One view of the VO from an application/portal :



Built from VO Registry

1000s All-Sky data sets

Data from many observatories and missions

Complex ADQL queries

Largest catalogues: ESO surveys, Gaia etc.

Enables a *Virtual Research Environment* of interoperable tools and services based on IVOA standards:

```
In [ ]: 1 from ipyaladin import Aladin
2 a = Aladin(target='18 55 24.508 +04 29 46.72', survey='P/Mellinger/color', fov=180)
3 a

In [ ]: 1 a.addTableFromUrl('http://cdsarc.u-strasbg.fr/ftp/cdsarc/all/surveys/18_55_24.508_04_29_46.72', 'color')

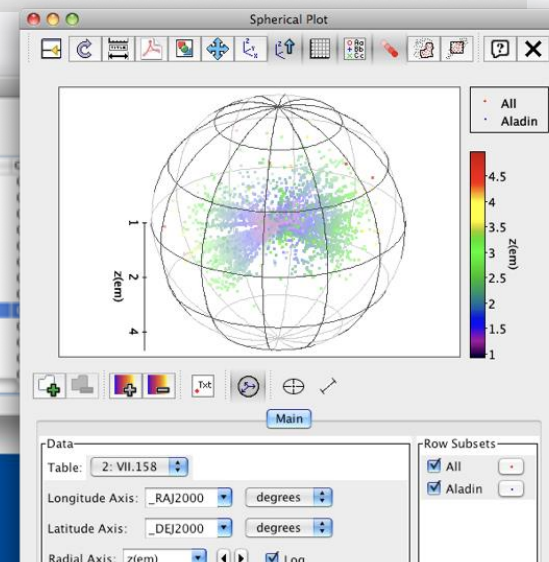
In [ ]: 1 a.survey = 'P/GALEXGR6/AIS/color'; a.target = 'M101'; a.fov = 0.3

In [ ]: 1 nloadTable=outputFormat=vot&filename=vizier_M101_II_328_allwise_20190322', {'color': 'red', 'onClick': 'showTable'})
2
```

TOPCAT(1): Table Browser

Table Browser for 1: III.157

Seq	QSO	Name	z	Vmag	Type	Ns	CalSp
31	1133+704	Mrk 180	0.046	14.49	BLZ	1	CalSp
32	1146+037	PKS	0.341	16.9	QSO	1	CalSp
33	1148+549	PG	0.969	15.82	QSO	1	CalSp
34	1156+295	4C 29.45	0.729	14.41	BLZ	1	CalSp
35	1202+281	PG	0.165	15.51	QSO	1	CalSp
36	1211+141	PG	0.085	14.63	QSO	2	CalSp
37	1219+755	Mrk 205	0.07	14.5	SY1	2	CalSp
38	1225+317	B2	2.219	15.87	QSO	1	CalSp
39	1276+078	3C 273	0.158	12.86	QSO	2	CalSp
40	1229+204	TON 1542	0.064	15.3	SY1	2	CalSp
41	1241+176	PG	1.273	15.38	QSO	1	CalSp
42	1253-055	3C 279	0.538	17.75	BLZ	2	CalSp
43	1302-102	PKS	0.286	14.92	QSO	2	CalSp



Making data FAIR with the Virtual Observatory.

The **V**irtual **O**bservatory is:

- **An operational framework** for interoperable access to world-wide astronomical data and services.
- **A pioneer of FAIR data sharing** - an existing global framework – populated by major data providers (space and ground based) that is heavily used by the community.
- **Built on International Virtual Observatory Alliance (IVOA) standards**
 - *Recognised in the ESFRI roadmap (2021).*
 - *‘... a global implementation of a FAIR disciplinary framework and openly available data, the so-called astronomical Virtual Observatory.’*
 - *Quoted as an example in EOSC SRISA document (Feb 2021).*
- **Supported in Europe** by **Euro-VO** (VO Partners + EC projects since ~2001).
 - *Recognised in ASTRONET roadmap (2008, 2014, 2022).*



Successful formula: Bringing together ESFRI/RIs and VO expert partners

Astronomy ESFRIs, Research Infrastructures and associated partners



Partners bringing experience from European Virtual Observatory
+ many contributions from external collaborators – e.g. Europlanet



The approach:

Integration of astronomy VO data and services into the EOSC

- Interaction with **EOSC** projects based on experience of onboarding via EUDAT

Implementation of FAIR principles for ESFRI data through the Virtual Observatory

- ESCAPE ESFRI and RI priorities represented at the IVOA
- Community training events for *scientists* and *data producers/providers*

Adding value to trusted content in astronomy archives

- Deep learning applied to archive data sets (joint with WP3)

ESCAPE Cross-WP interaction/integration

- VO services in ESAP, VO software in OSSR, explore VO data in Data Lake, VO data/services/tools for citizen science and Test Science Projects



The results:

Integration of astronomy VO data and services into the EOSC

- Interaction with EOSC projects based on experience of onboarding via EUDAT
 - *Analysis reports on VO data and service integration into EOSC*

Implementation of FAIR principles for ESFRI data through the Virtual Observatory

- ESCAPE priorities at IVOA level -- Many standards!!
- Community training events for scientists and data producers/providers:
 - *2 Science with interoperable data schools*
 - *European data providers Forum - Hands-on workshop for data providers*

Adding value to trusted content in astronomy archives

- Results of deep learning applied to archive data sets (joint with WP3)
 - *Prototype demonstrator for value-added archive services*












ESO, CNRS-ObAS,
INTA, INAF, UHEI
UEDIN, HITS

EGO (INFN),
CNRS-ObAS,

JIVE, ASTRON,
SKAO, ESO/ALMA,
UHEI, CNRS-ObAS

CTAO, Obs-Paris,
CNRS (ObAS+CPPM)
UHEI, (FAU)

ORB, KIS, CNRS-
ObAS, INTA, UHEI

ESFRI / RIs	Results for ESCAPE work toward FAIR standards and tools
ESO-ELT 	<ul style="list-style-type: none"> - Data access and visualisation standards and tools - Support of VO standards in ESO archive services – used as exemplary case to help others - Relevant IVOA standards updated
EGO/VIRGO 	<ul style="list-style-type: none"> - Development of MOC2.0 (approved IVOA standard) and mocpy - Tools / libraries integrated into GW community software - Paper published in Astronomy & Computing
SKA, JIVE, ALMA (LOFAR)   	<ul style="list-style-type: none"> - Creation and support of the IVOA Radio Astronomy Interest Group - New TAP services, accessible in VO tools and in the ESCAPE platform - Visualisation capabilities – transferring into SKA SRC prototyping
CTA & KM3NeT   	<ul style="list-style-type: none"> - Data Provenance standards approved by IVOA - Many activities for adoption and implementation (Workshop held) - TAP services – Table Access Protocol for neutrino data - Reference paper published on a: Management System for Provenance Information
EST 	<ul style="list-style-type: none"> - VO metadata developed for Solar Physics - Prototype TAP services for solar data

Example – 2 of the standards led/contributed to by ESCAPE partners



IVOA Provenance Data Model Version 1.0

IVOA Recommendation 2020-04-11

Working group
DM

This version
<http://www.ivoa.net/documents/ProvenanceDM/20200411>

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

Previous versions
PR-ProvenanceDM-1.0-20190719.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

Author(s)
Mathieu Servillat, Kristin Riebe, Catherine Boisson, François Bonnarel, Anastasia Galkin, Mireille Louys, Markus Nullmeier, Nicolas Renault-Tinacci, Michèle Sanguillon, Ole Streicher

Editor(s)
Mathieu Servillat

Provenance Data Model

Finalised and approved April 2020.

Brought to community via
ESCAPE Provenance workshop
September 2020.
- **Published** - Servillat et al. – SPIE

Multi-Order Coverage 2.0

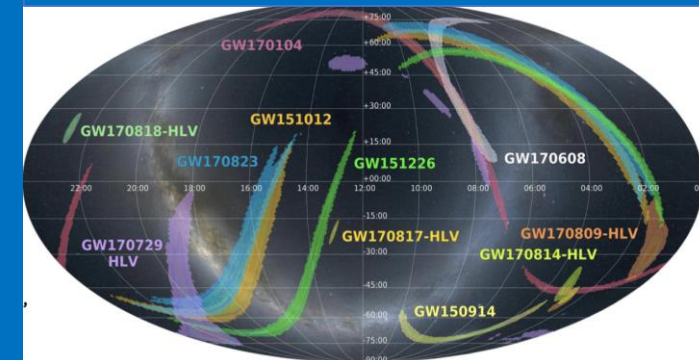
**Space coverage extended with
TIME coverage.**
Approved in April 2022.

Driven by ESFRI/RI needs (EGO,
ESO, Radio astronomy,+++).



MOC: Multi-Order Coverage map Version 2.0

e.g. IVOA metadata for Sky
Coverage maps of Gravitational
Wave detections



Highlight : VO in B2FIND

- Demonstrates 1st level of metadata compatibility
 - Links to the actual service
 - enables feedback to EOSC



IVOA

23,975 datasets found for "IVOA"

Repositories:

IVOA x

Dataset

Communities

The VO @ ASTRON TAP service

The The VO @ ASTRON's TAP end point. The Table Access Protocol (TAP) lets you execute queries against our database tables, inspect various metadata, and upload your own data. It is thus the VO's premier way to access public data holdings.

Tables exposed through this endpoint include: main from the lbcas schema, main, mom0 from the sauron schema, img_main, main from the lofartier1 schema, img_main, main from the tgssadr schema, main, msssvf_img_main from the mvf schema, columns, groups, key_columns, keys, schemas, tables from the tap_schema schema, hetdex_images, img_main from the hetdex schema, img_main from the mss schema, obscure from the ivoa schema.

ADQL

Catalogs

Virtual observatory

Identifier

Source

Metadata Access

Provenance

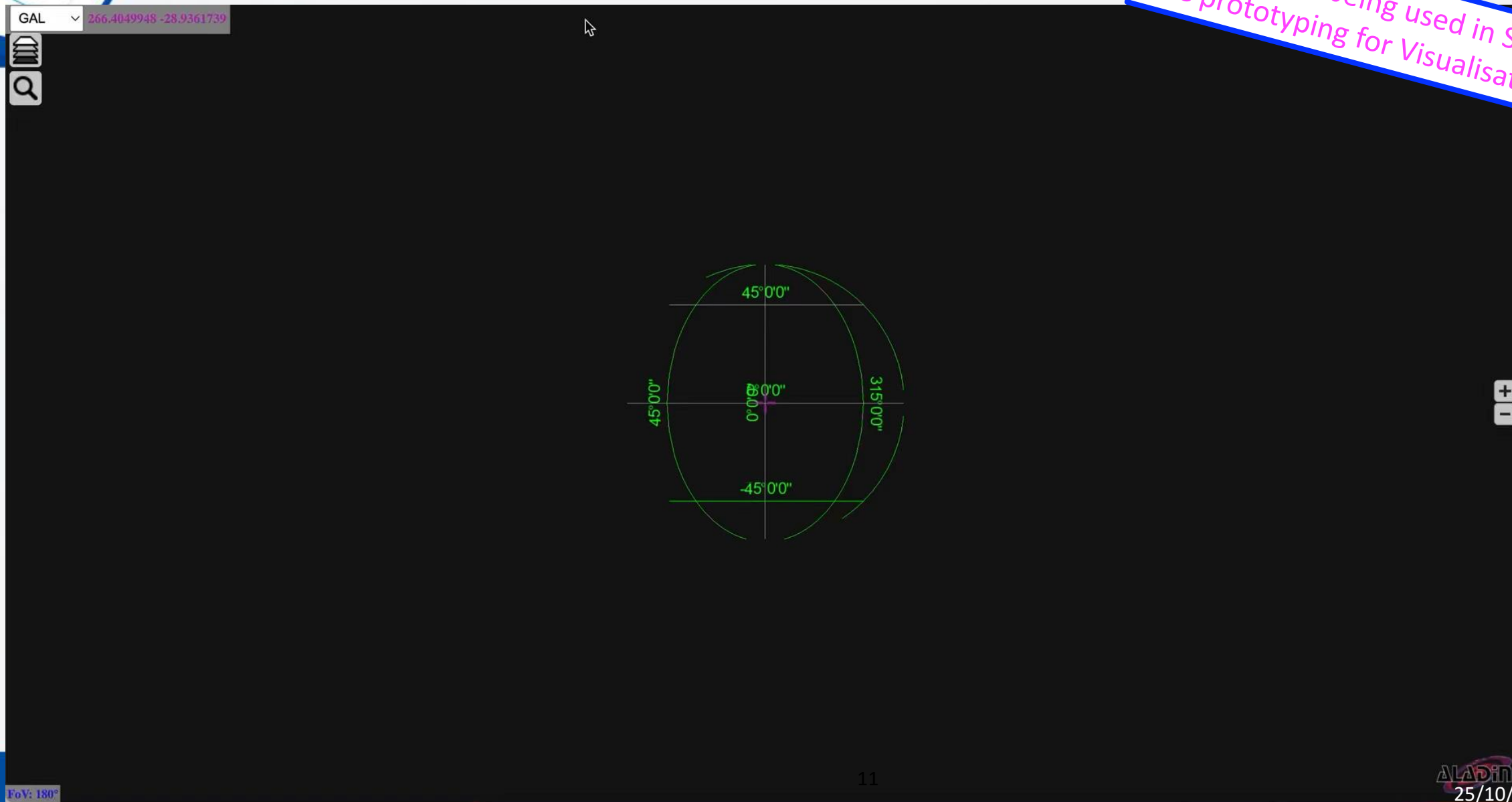
https://vo.astron.nl/__system__/tap/run/info

http://dc.g-vo.org/rr/q/pmb...

verb=GetP...

Example of MeerKAT SKA pathfinder data

ESCAPE work being used in SKA
SRC prototyping for Visualisation



Today - Focus on ESCAPE-enabled interoperable services



Mark Kettenis

JIVE

A VO service for the European VLBI Network



Giuseppe Greco

INFN - Perugia

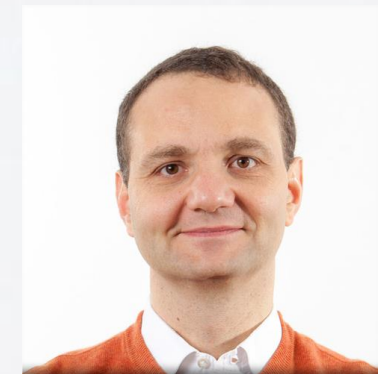
VO interoperability for visualisation of GW sky localizations and strategies of EM follow-up



Martino Romaniello

ESO

The VO at ESO



Vernoique Delouille

Royal Observatory of
Belgium

*ESCAPE VO Impact
on the European
Solar Telescope ESFRI*





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Thanks



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The VO at ESO

Martino Romaniello (ESO)

Head, Back-end Operations Department



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ESO, The European Southern Observatory

- What we do
 - Develop ground-based **astronomical telescopes and observatories** that are not individually achievable by single Member States
 - Secure science community access to high quality data
- Founded in 1962 (60th anniversary!)
- 16 Member States; host state: Chile; strategic partner: Australia



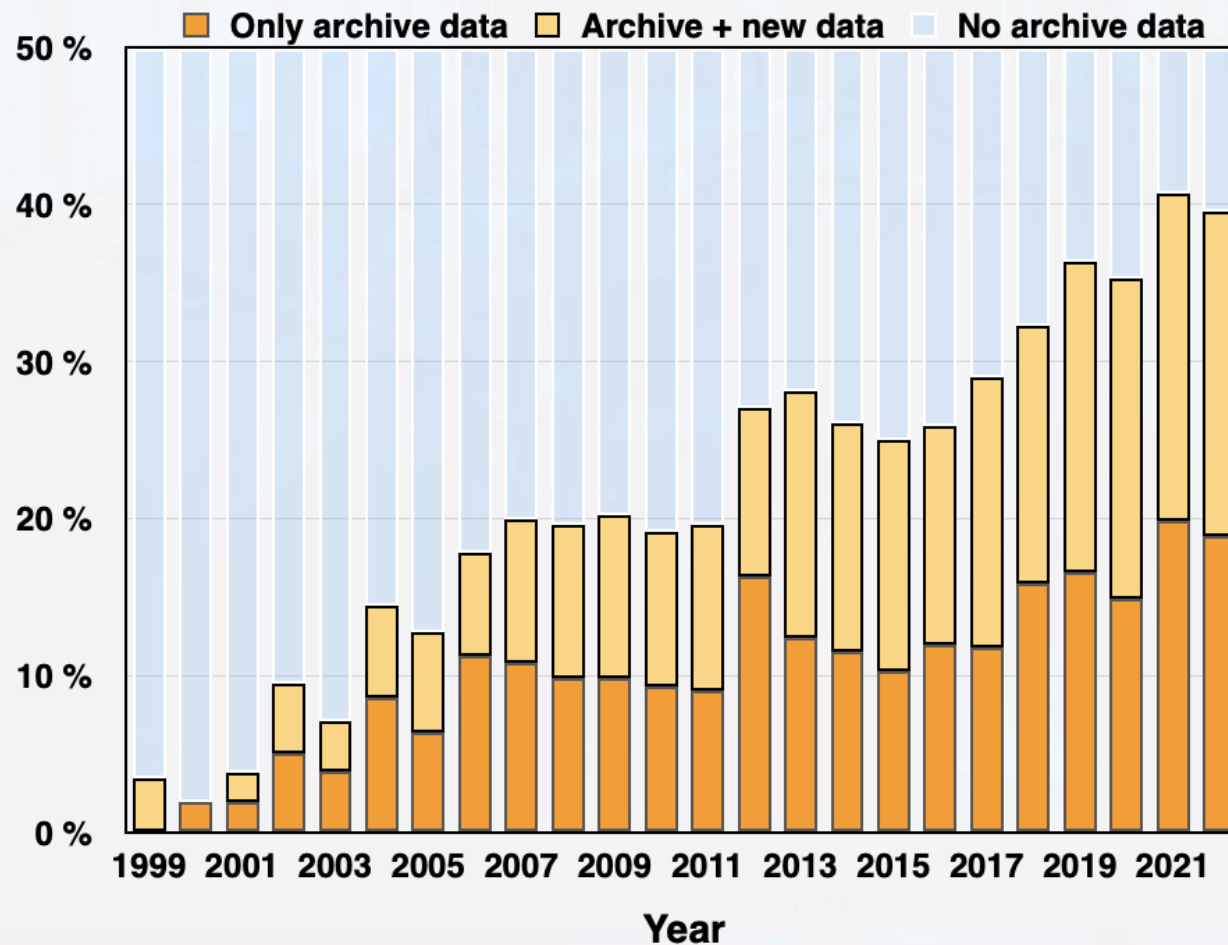
The ESO Science Archive as an essential component to ESO's operations

“The telescopes are operated to optimise scientific excellence, to maximise the scientific return of ESO by undertaking observations that have the potential to yield significant scientific advancements, and to exploit synergies between them as well as with other facilities. **The telescopes are operated within an end-to-end process which starts with proposal solicitation and ends with data preservation and publication [...] ESO supports an open data policy**”

ESO Optical/Infrared Telescopes Science Operations Policies, 2020, Cou-1847

The ESO Science Archive as science machine

- About 40% of the science publications with ESO data use the archive



Source: ESO Telescope Bibliography (telbib.eso.org)

The impact of the ESO Science Archive

- It allows to scrutinize published results: a staple of the scientific method
- It fosters a culture of cooperation and open data in Astronomy and science in general
 - Astronomy has been leading open data
- It broadens ESO's user community
 - Rather large community: ~ 60% of professional astronomers worldwide
 - One third of archive users are new to ESO
 - Larger fraction of early-career scientists than as Principal Investigators
 - Reaches out beyond the ESO Member States
 - Brings in new communities, e.g. earth atmosphere

Data interoperability: the Virtual Observatory

- About 50% of the ESO science results also use data from other observatories (source: ESO Telescope Bibliography + NASA ADS)
- Exchanging data is, then, necessary to make the most out of it
- The Virtual Observatory is the de-facto standard for data interoperability in astronomy ...
 - Standards, protocol, tools
- ... and it needs to keep evolving to keep up with new data types, new instruments and science cases
- CEVO is instrumental in doing so
 - For ESO data itself, and for coordination of European astrophysics interests in the IVOA and EOSC

The Virtual Observatory and the ESO Science Archive

- The ESO Science Archive heavily relies on the Virtual Observatory

- For internal operations, e.g. internal communications

- For user access and services

- ADQL

- Aladin Lite

- DataLink

- HiPS

- ObsCore

- SAMP

- SODA

- SSA

- STC-S (point, circle, multi-polygon)

- TAP (DALI, VOSI, UWS, UCD, UTYPE, ...)

- TOPCAT

- VOTable

- pyvo

- ...

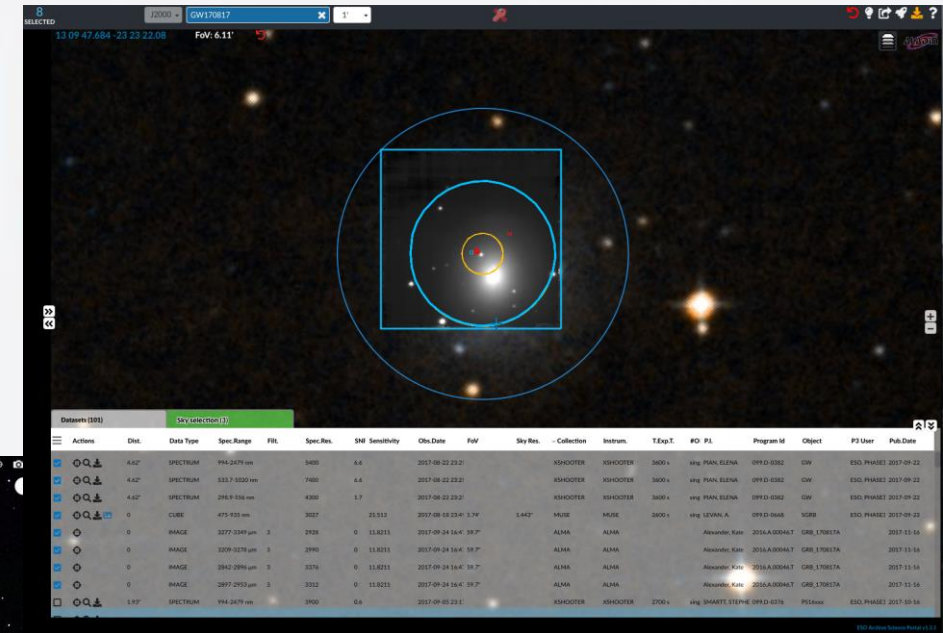


Multi-messenger, multi-wavelength view of neutron star merger GW170817



ESO + LIGO/Virgo

ESO + HST (ESASky)



ESO La Silla Paranal + ALMA



In summary: ESO and CEVO

- The Virtual Observatory is central to the success of the ESO Science Archive
- CEVO provided crucial support to the ESO Science Archive
 - Continued support and development of tools, protocols and standards
 - Coordinated involvement and expansion of the astronomical community
 - Prototyping of new techniques to add-value to archive contents
 - Connection to the EOSC, the common framework for European Open Science
- CEVO also provided training to:
 - Early career researchers on the use of the VO and the development of EOSC
 - Other astronomy data providers for their use of the standards and tools

An outlook to the future

- The Virtual Observatory is a very mature set of tools, protocols, standards/specifications
- It is an essential component of the ESO Science Archive ... and, arguably, of all the major ones, present and future
- A key component to the success of the VO is that its components have constantly evolved with the data ...
- ... this needs to continue, and the ESCAPE Open Collaboration is in an ideal position to contribute coordination of European Virtual Observatory efforts in the development of EOSC, in particular for interoperability

The logo for ESCAPE (European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures) is located in the top left corner. It features a stylized blue starburst above the word "ESCAPE" in bold, dark blue capital letters. Below the word, the full name of the cluster is written in a smaller, lighter blue font. The logo is set against a white circular background with a blue border.

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A large, semi-circular particle detector structure, likely a calorimeter or tracker, is shown in the center of the slide. It is composed of many blue, rectangular segments arranged in a circular pattern. The background is a dark blue space with numerous small, bright white stars.

Thanks!



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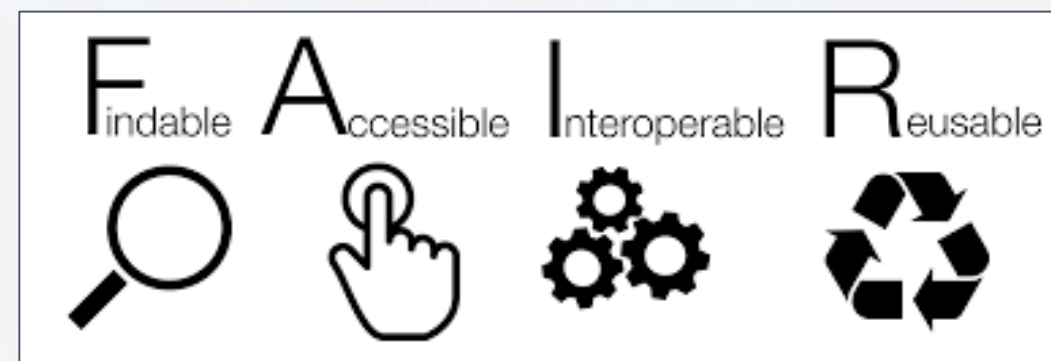
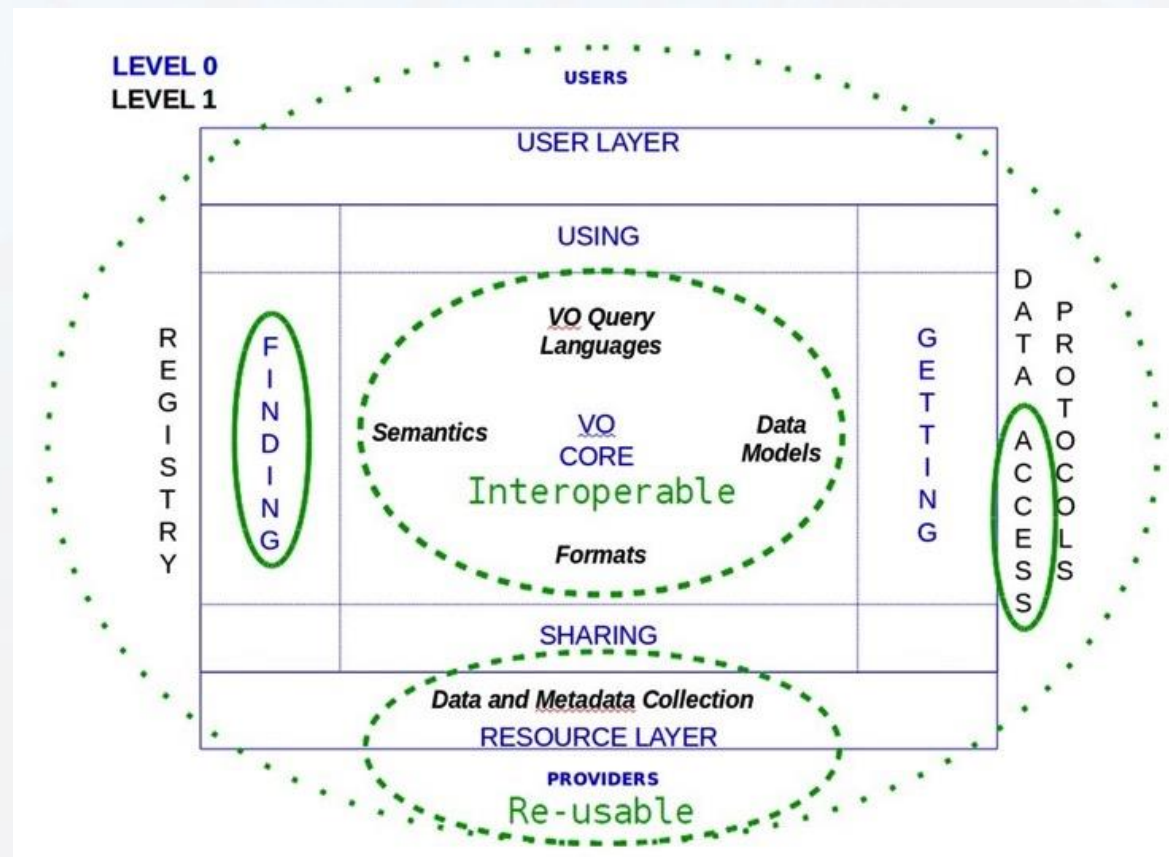
ESCAPE VO Impact on the European Solar Telescope ESFRI

Véronique Delouille, Royal Observatory of Belgium
Nazaret Bello Gonzalez, KIS



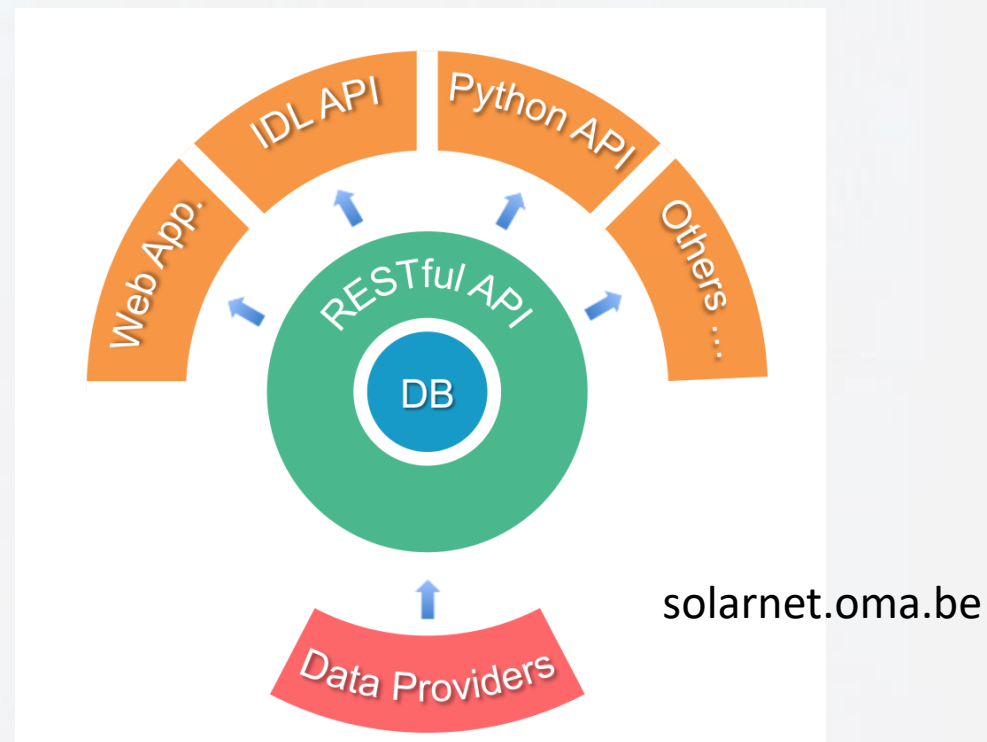
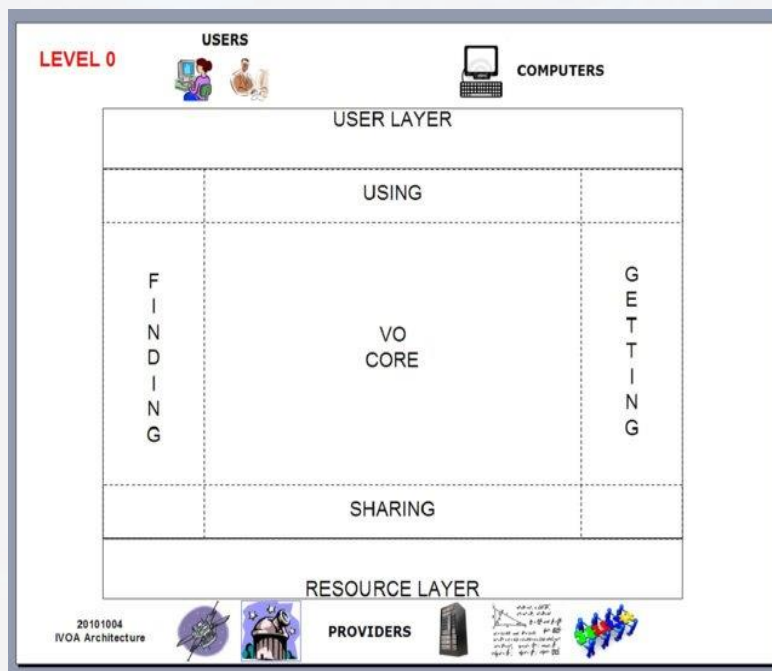
ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 824064.

Goal of Task 4.2: Enable high level data products and archive services to be interoperable in the VO framework, so that they can connect to the EOSC through the VO



What already existed in terms of VO in solar physics?

- SOLARNET VO : few constraints on metadata and on ways to access the data (ftp, https)
- Limited to FITS files
- No standardization, but SOLARNET recommendation for FITS keywords



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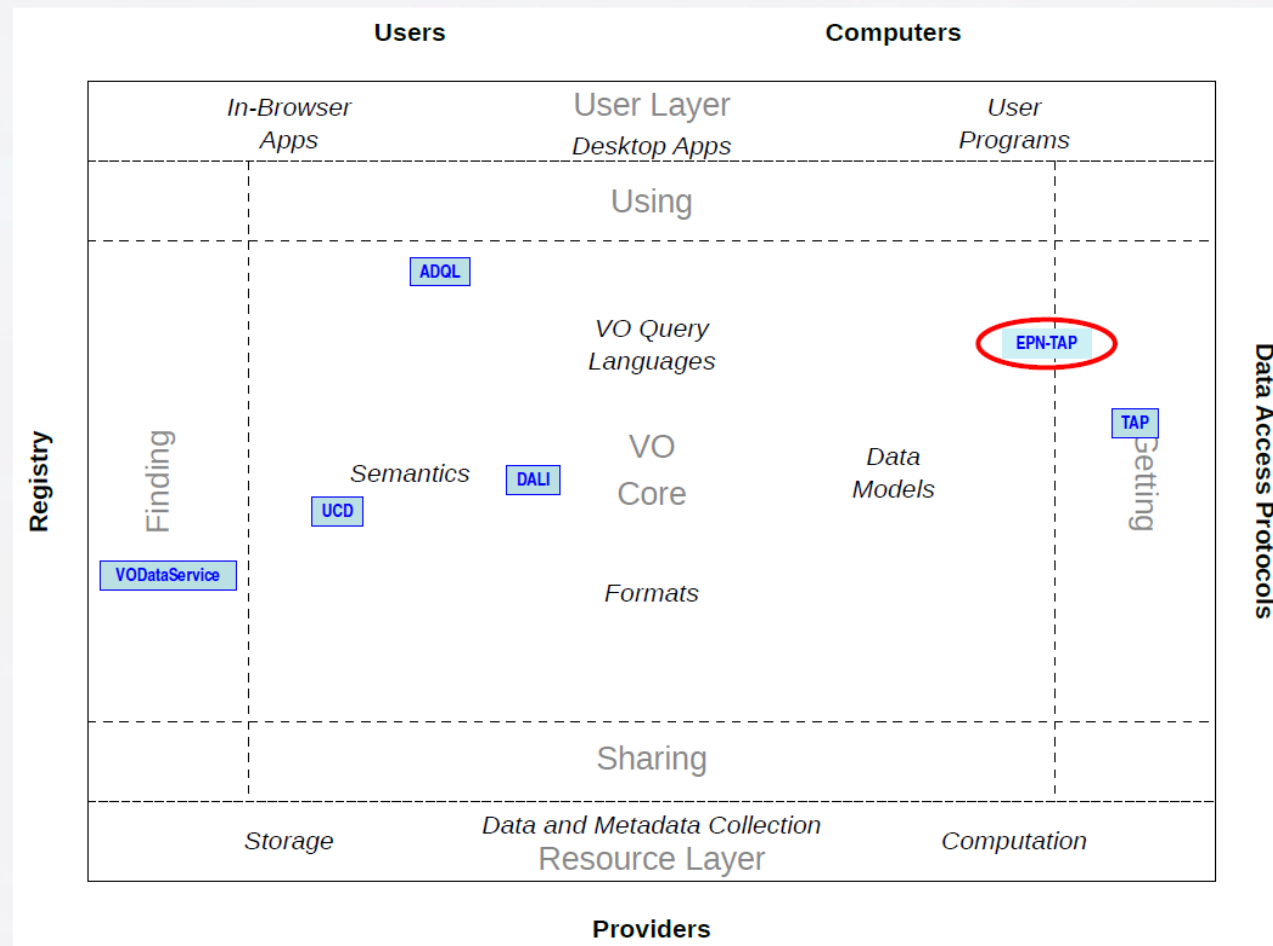
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How to go further ?

EPN-TAP extension to solar physics

- Correspondance between EPN-TAP parameters and SOLARNET FITS keywords
- Review of UCD for the needs of solar physics community
- Comparison with existing databases of solar event (HEK, HFC)
- Addition of UCD terms





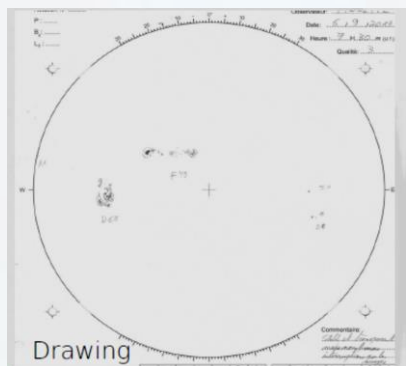
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Data Access Layer for solar physics data sets

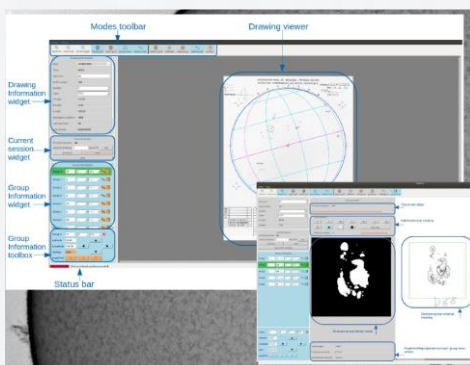
Implementation of EPN-TAP services

uset_sunspot_drawings



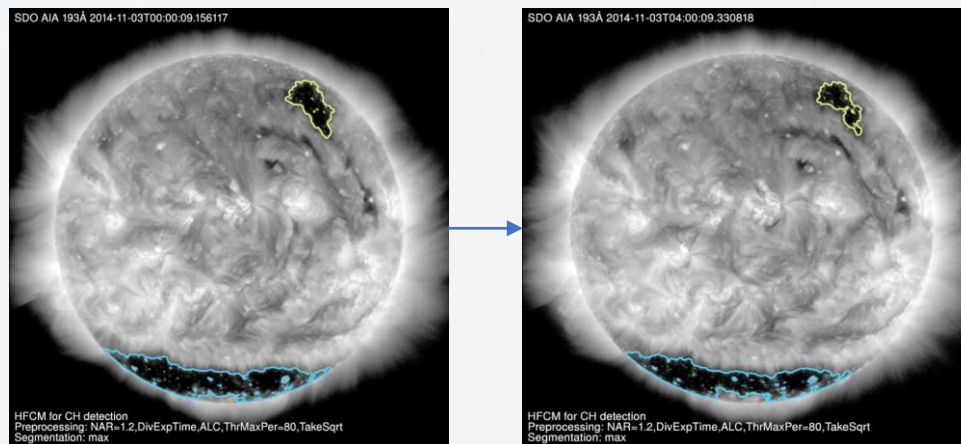
Parameters from the drawings, e.g
Total number of sunspots

uset_sunspot_groups



Individual sunspot group parameters computed from in-house software

Catalog of Coronal Holes, from EUV solar images



rob_spoca_ch : main table with position, area, intensity, etc,...

rob_spoca_ch_tracking : tracking table to follow a same CH over time

uset : EPN-TAP service exists (still need to be registered)

spoca : data ready to be ingested in EPN-TAP

Using SOLARNET as a TAP client

MEDOC – EIT Synoptic maps

<https://solarnet.oma.be>

Filter metadata

Hide

Observation date

Start

End

YYYY-MM-DD hh:mm:ss

YYYY-MM-DD hh:mm:ss

Wavelength

171 Å

195 Å

284 Å

304 Å

Add a filter for the keyword

Search

Settings

1

2

3

4

5

	Download	Observation date	Wavelength (Å)
<input type="checkbox"/>	Download	1996-01-03 00:00:00	304

MEDOC – GAIA-DEM maps

<https://solarnet.oma.be>

Filter metadata

Hide

Observation date

Start

End

YYYY-MM-DD hh:mm:ss

YYYY-MM-DD hh:mm:ss

Map type

Emission measure

Temperature

Thermal width

Chi2

Add a filter for the keyword

Search

Settings

1

2

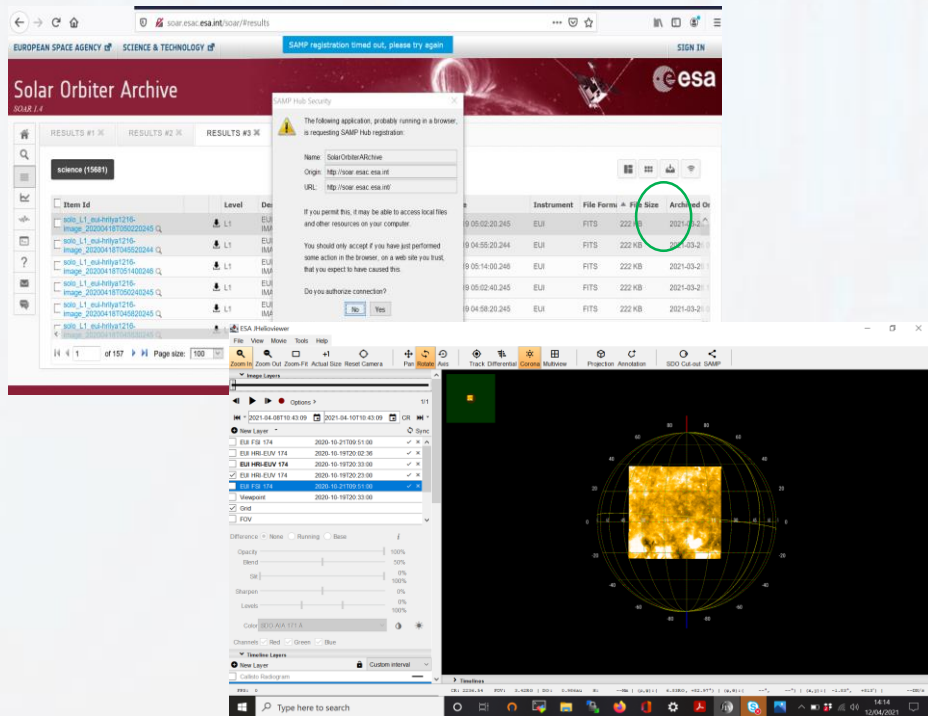
3

4

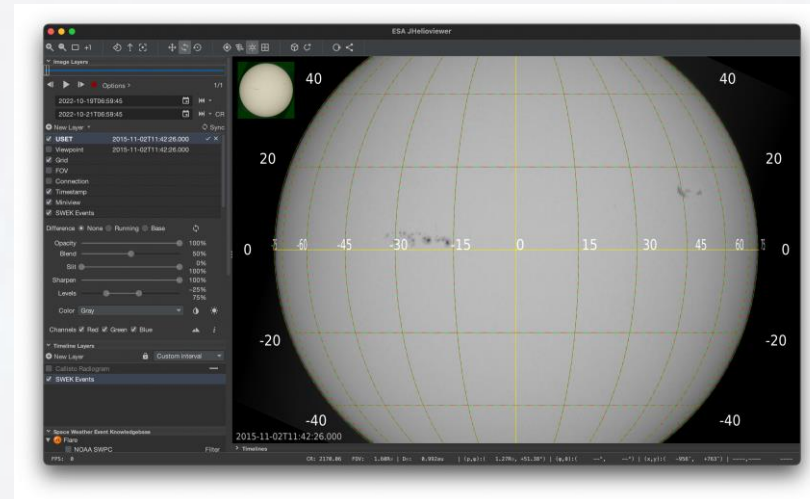
5

	Download	Observation date	Map Type
<input type="checkbox"/>	Download	2010-05-13 00:04:35	Temperature
<input type="checkbox"/>	Download	2010-05-13 00:04:35	Chi2
<input type="checkbox"/>	Download	2010-05-13 00:04:35	Emission measure

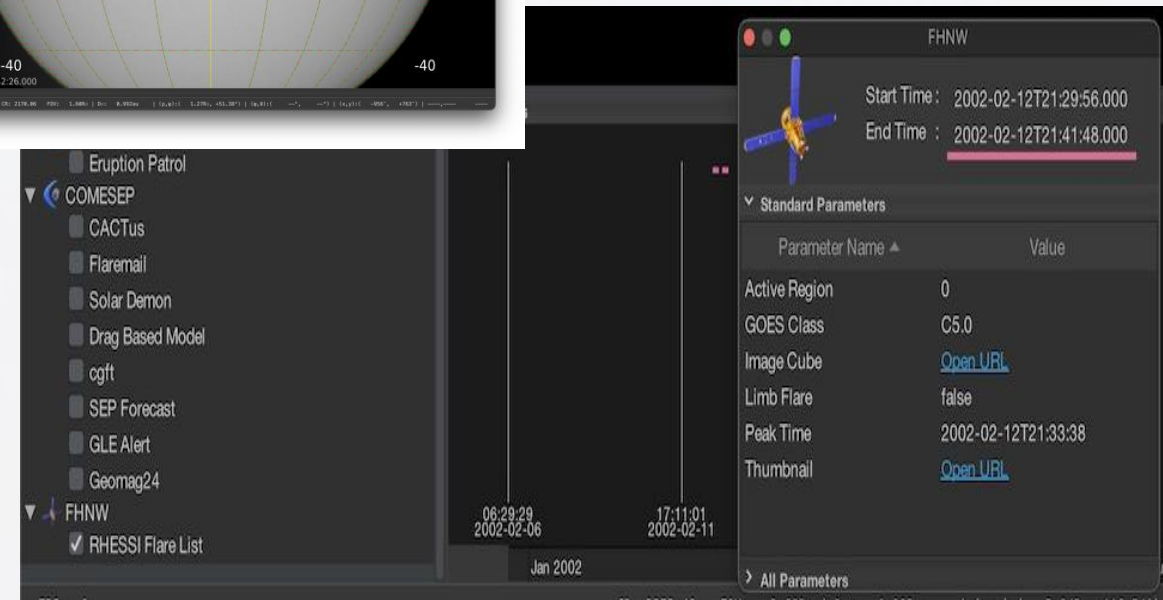
Interoperability with solar visualization tool JHelioviewer



TAP archive of ESA
imported via SAMP
protocol



USET images
imported from
SOLARNET



RHESSI Flare list imported from EPN-TAP

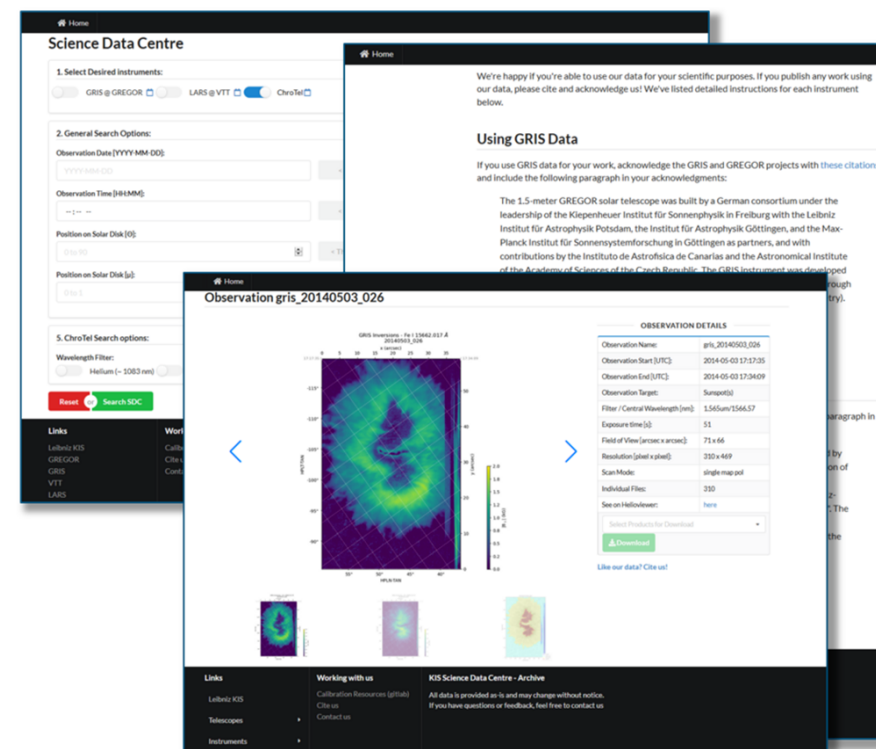
KIS/ in ESCAPE WP4

Thanks to ESCAPE WP4, KIS/EST has achieved the following goals:

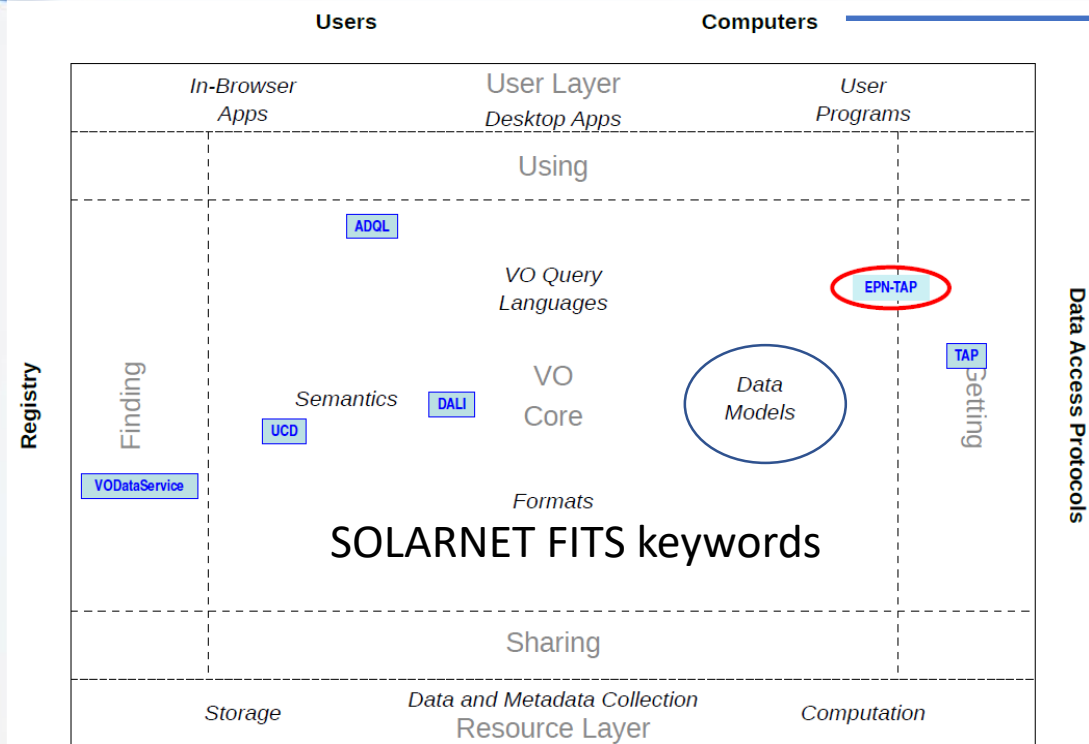
- Curation of highly-inhomogeneous datasets of high-res ground-based spectro-polarimetric solar data starting from 2014
- Creation of an instrument-independent importing framework
- Proper archiving of the data
archive.sdc.leibniz-kis.de
- Implementation of IVOA standards

EPN-TAP publishing of ground-based solar data in the Astronomical VO planned for Nov 2022 in collaboration with M. Demleitner, GAVO (Heidelberg)

This has been a pioneering endeavour within the ground-based high-resolution solar community

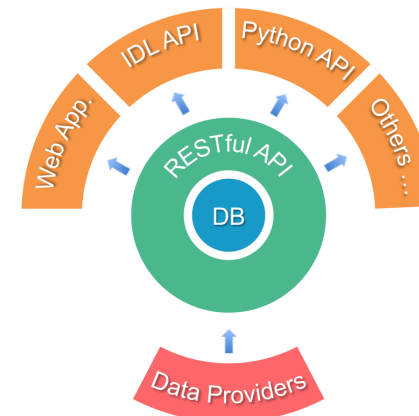


Summary CEVO/EST ... and the future

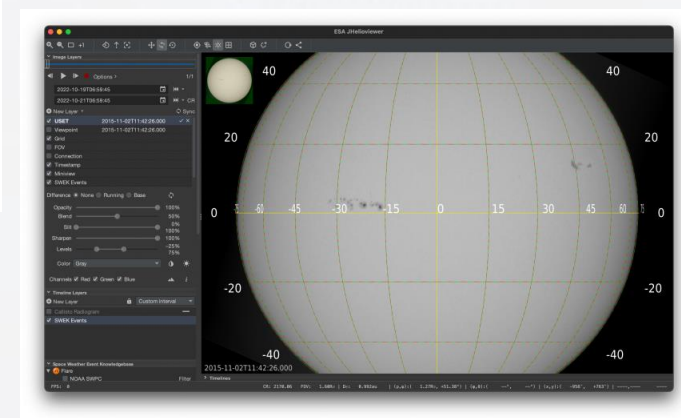


Providers : ground based telescopes
(high resolution, synoptic observations)

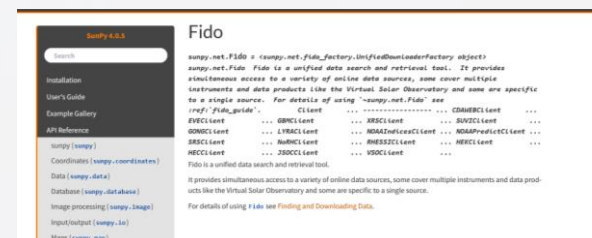
Dedicated VO



Visualization tool



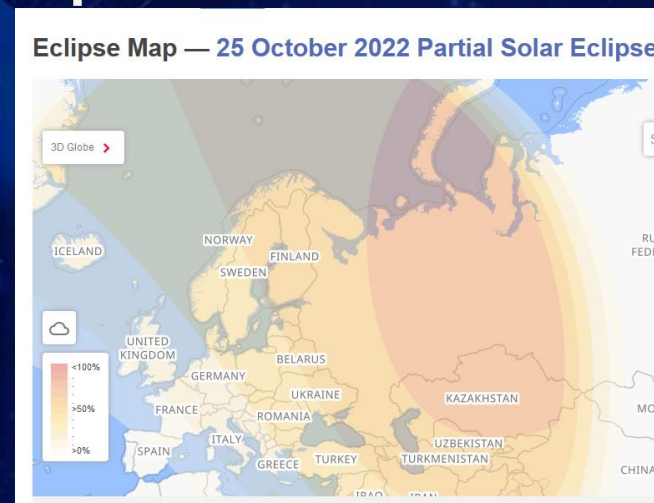
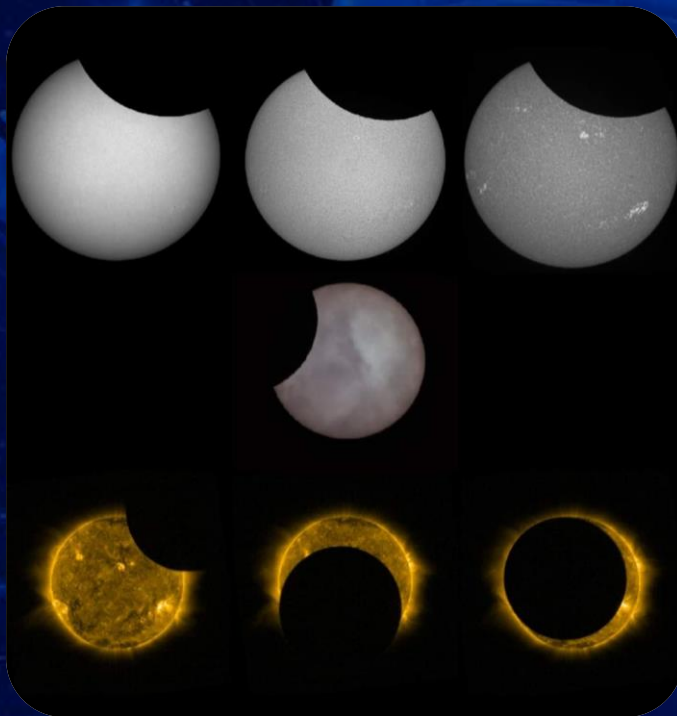
Python access
(pyVo, 'fido' search
function, etc...)



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And enjoy the solar eclipse !





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VO interoperability for visualisation of gravitational-wave sky localisations and strategies of EM follow-up

Giuseppe Greco - INFN Perugia

Mateusz Bawaj, Roberto de Pietri, Marica Branchesi,
Flavio Travasso, Michele Punturo, Helios Vocca and CDS team

EGO  VIRGO



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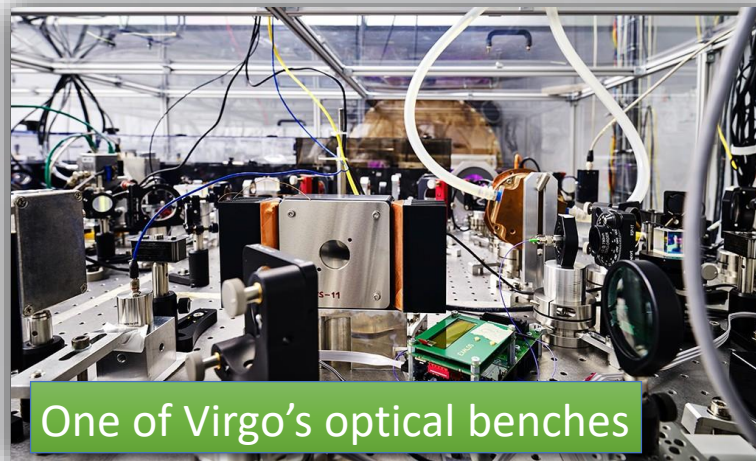
The Virgo interferometer



Aerial view of EGO and Virgo



One of the 3 km long tunnels



One of Virgo's optical benches



One of Virgo's mirrors

Title Here

The Virgo Collaboration works as a community on the building, development and operation of the Virgo gravitational-wave detector, hosted by the European Gravitational Observatory (EGO) at Cascina, near Pisa, Italy. The Virgo Collaboration works together with the scientists of the LIGO Scientific Collaboration and of the KAGRA Collaboration to form the **LIGO-Virgo-KAGRA (LVK) Collaboration** - <https://www.virgo-gw.eu/about/scientific-collaboration/>.

The dawn of Multi-Messenger and Gravitational-Wave Astronomy

- GW150914: first gravitational wave detection, BH-BH merger.
- BH-BH binaries exist, and coalesce within a Hubble time at a detectable rate.
- The observation of tens of BH-BH coalescences has revealed a previously unknown population of stellar-mass BHs, much heavier than those detected through the observation of X-ray binaries.
- GW170817: first NS-NS merger, birth of the multi-messenger with GW.
- Neutron star tidal deformability and equation of state constraints.
- Solved the long-standing problem of the origin (at least some) short GRBs.
- The observations of the associated kilonova revealed that NS-NS mergers are a major formation site of the heaviest elements through r- process nucleosynthesis.
- GW200105 and GW200115: Gravitational Waves from Two Neutron Star–Black Hole Coalescences.
- Speed of GWs is the same as the speed of light to about a part in 10:15.
- The first measurement of the Hubble constant with GWs.
- The tail of the waveform of the first observed event, GW150914, showed oscillations consistent with the prediction from General Relativity.
- Several possible deviations from GR (graviton mass, post-Newtonian coefficients, extra polarizations, etc.) could be tested and bounded.
-

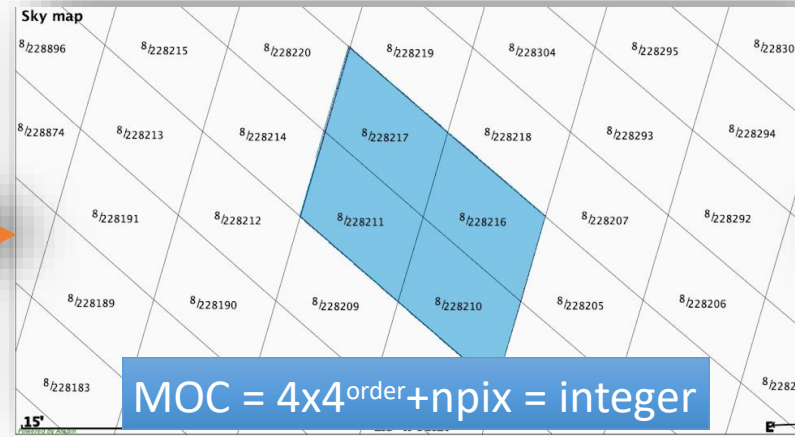
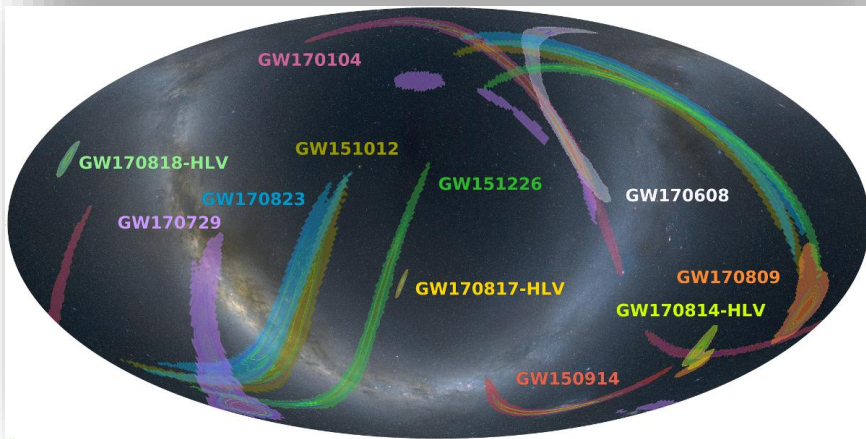
The logo for ESCAPE (European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures) is located in the top left corner. It features a stylized blue starburst above the word "ESCAPE" in large, bold, dark blue capital letters. Below "ESCAPE" is the full name in smaller, lighter blue text. The logo is set against a white circular background with a blue border.

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MOC (Multi Order Coverage) in action

MOC VO Standard to encode GW sky localisations



☀ We demonstrate that these irregularly shaped and complex sky localisations can be encoded as MOC maps, and how they can be used in visualisation tools, and processed (filtered, combined) and also their utility for access to Virtual Observatory services which can be queried ‘by MOC’ for data within the region of interest. The use of MOC maps allows a high level of interoperability to support observing schedule plans.

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A large, semi-circular structure, likely a radio telescope array, is shown in the center of the slide. It is composed of many smaller, curved segments, each with numerous antennas or receivers pointing outwards. The structure is set against a dark blue background filled with stars, suggesting a space or astronomical theme.

Aladin Desktop in action



LIGO-VIRGO-KAGRA Public Alert User Guide

Title Here

Added new sections dedicated to the MOC 2.0



Primer on public alerts for astronomers from the LIGO and Virgo gravitational-wave observatories.

Navigation

- Getting Started Checklist
- Observing Capabilities
- Data Analysis
- Alert Contents
- Sample Code

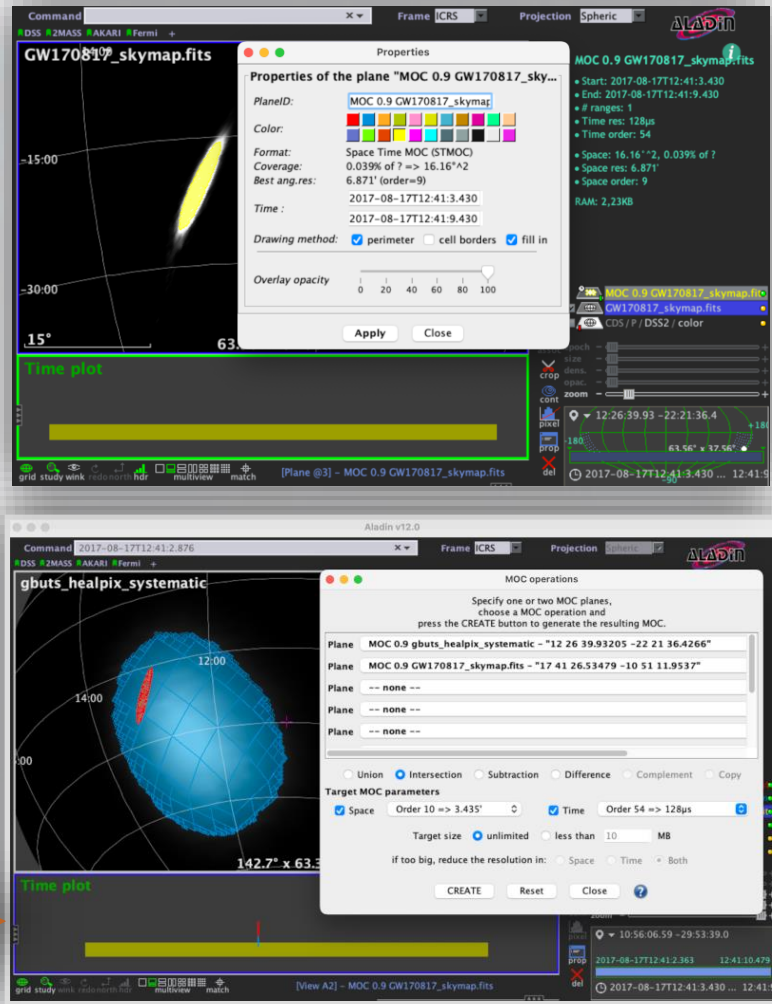
← [ligo.skymap: Advanced Python Tools for Probability Sky Maps](#) | [Mobile Apps](#) →

Sky Map Visualizations and Credible Regions in Aladin

In this section, we demonstrate working with gravitational-wave sky localizations in [Aladin Desktop](#). The following main topics are addressed.

- [MOC and GW Sky Localizations](#)
- [Running Aladin Desktop](#)
- [Loading a GW Sky Localization](#)
- [Building a Credible Region](#)
- [Area Within a Credible Region](#)
- [Querying and Filtering a Galaxy Catalog](#)
- [Thumbnail View Generator](#)

- Building a Spatial and Temporal Credible Region
- Spatial and Temporal Coverage Intersections



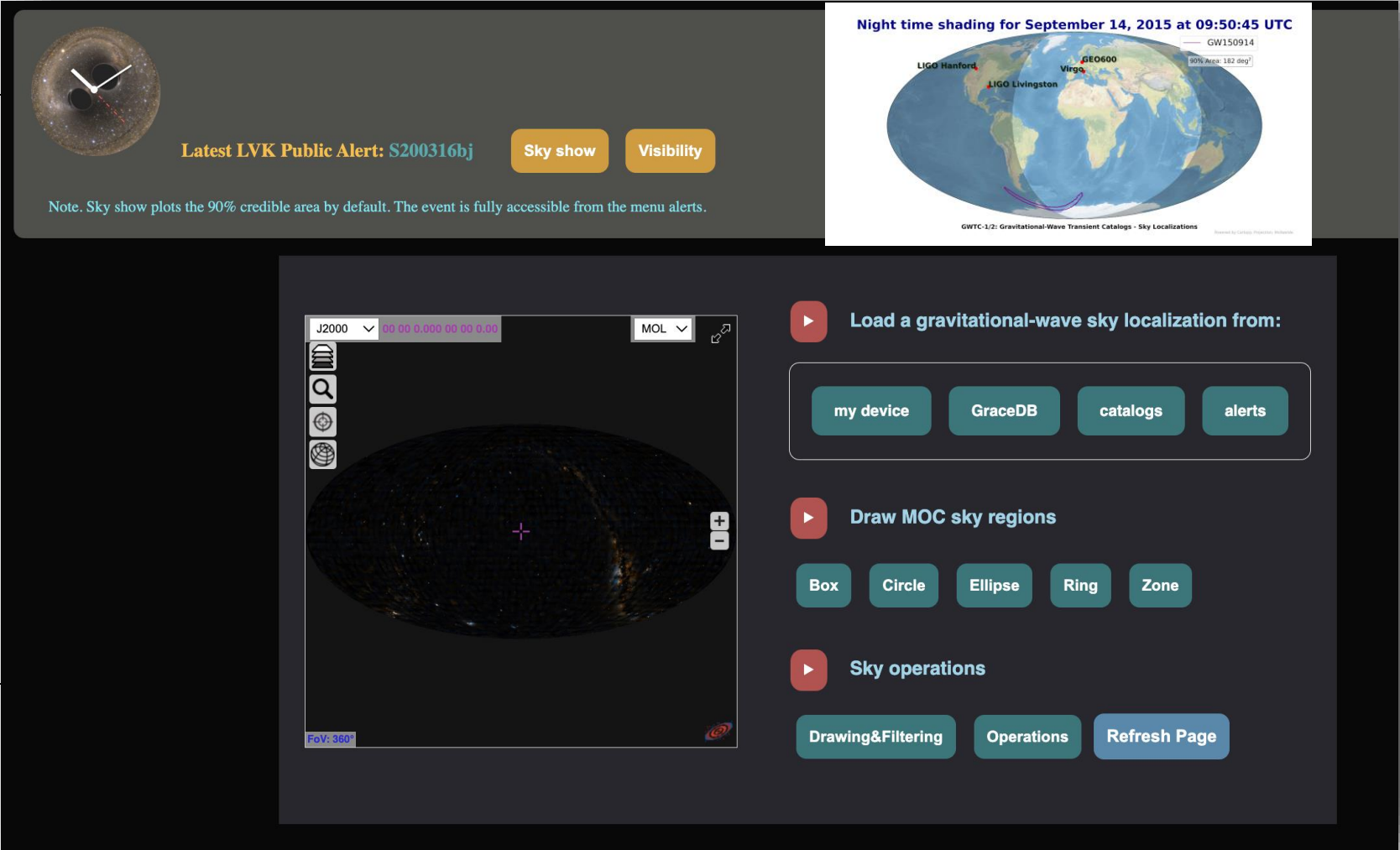
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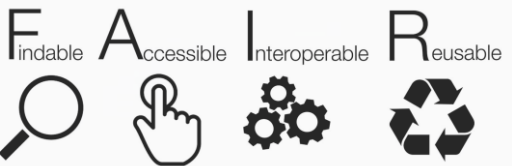
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Aladin Lite “meets” MOCWasm

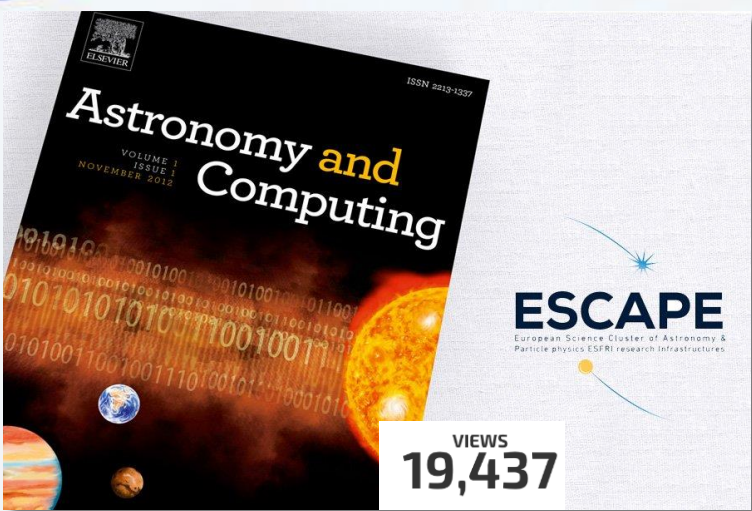
- The webtool organizes all the skymaps released by the LVK collaborations both in low latency and catalog publications.
- Users can locate EM transients and perform dedicated operations.



The screenshot displays the ESCAPE webtool interface. At the top left, there's a circular icon representing a sky map. Next to it, the text reads "Latest LVK Public Alert: S200316bj". To the right are two buttons: "Sky show" and "Visibility". Below this, a note states: "Note. Sky show plots the 90% credible area by default. The event is fully accessible from the menu alerts." On the top right, there's a world map titled "Night time shading for September 14, 2015 at 09:50:45 UTC" showing the locations of LIGO Hanford, LIGO Livingston, and Virgo. The main central area shows a large, detailed sky map with a central crosshair. To the right of the sky map are several interactive controls: a dropdown menu for "J2000" and "MOL", a "Load a gravitational-wave sky localization from:" section with buttons for "my device", "GraceDB", "catalogs", and "alerts", a "Draw MOC sky regions" section with buttons for "Box", "Circle", "Ellipse", "Ring", and "Zone", and a "Sky operations" section with buttons for "Drawing&Filtering", "Operations", and "Refresh Page".



Multi Order Coverage data structure to plan multi-messenger observations



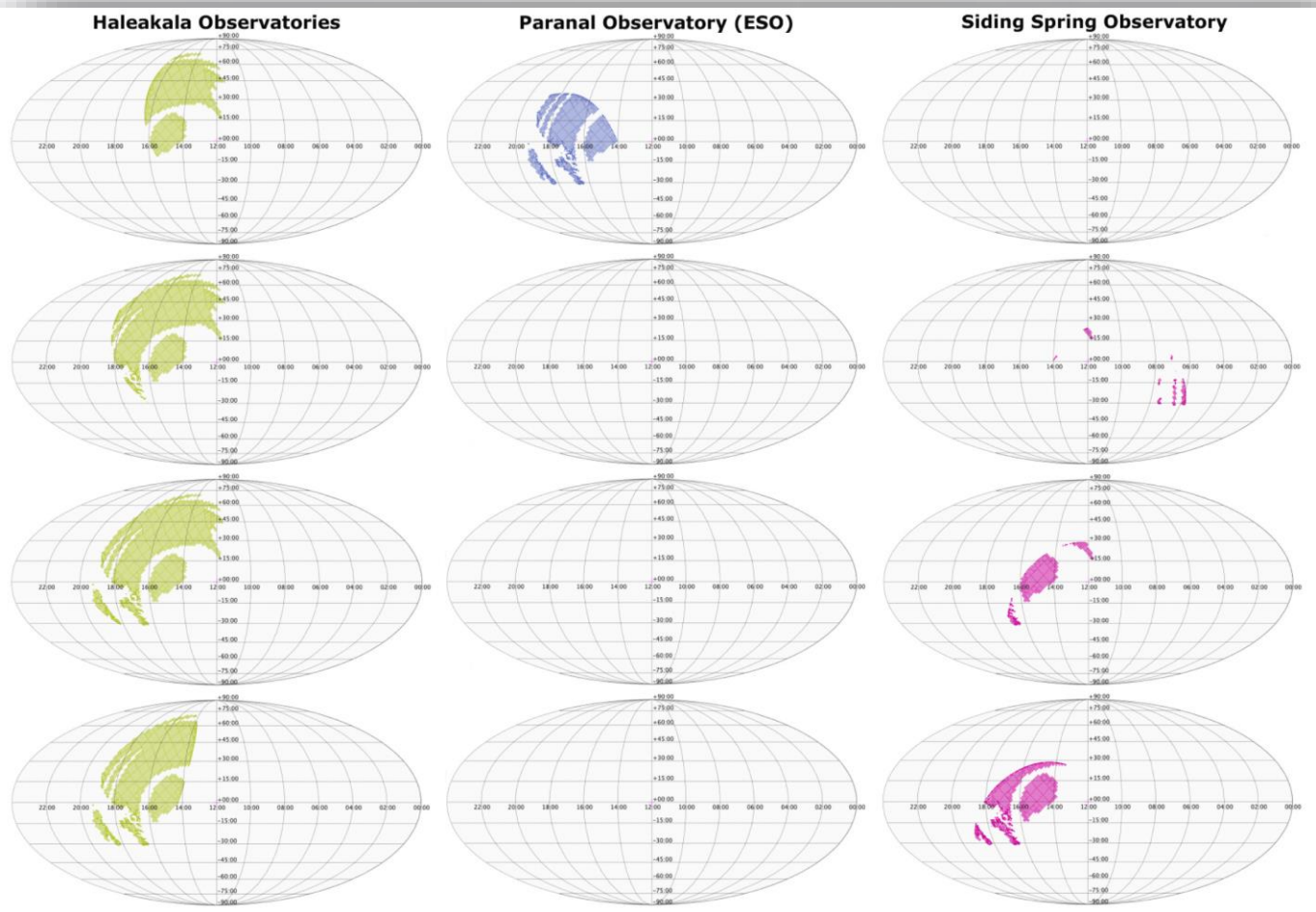
VIEWS
19,437

A new application of multi-messenger observations by ESCAPE and AHEAD2020

Accepted for publication in *Astronomy and Computing Journal* the work led by **Giuseppe Greco** focused on supporting multi-messenger astrophysics with Virtual Observatory standards and tools

[Click for more information](#)

AHEAD 2020



☉ Visibility MOC maps of a gravitational-wave sky localisation.



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Educational and outreach

Universities, training schools, festivals and disseminations

- VO ESCAPE schools.
- LVK Open data workshop.
- Learning activities at the University of Perugia.
- Bachelor's and master's degree theses at the Camerino and Perugia Universities presented to ADASS2021/2022 conferences.
- PhD thesis (UniPG): Evaluation of catalogues completeness by extending the Virtual Observatory framework to estimate the H_0 Hubble constant with dark standard sirens.
- Dissemination material for outreach, news and press releases.
- Science Festivals.

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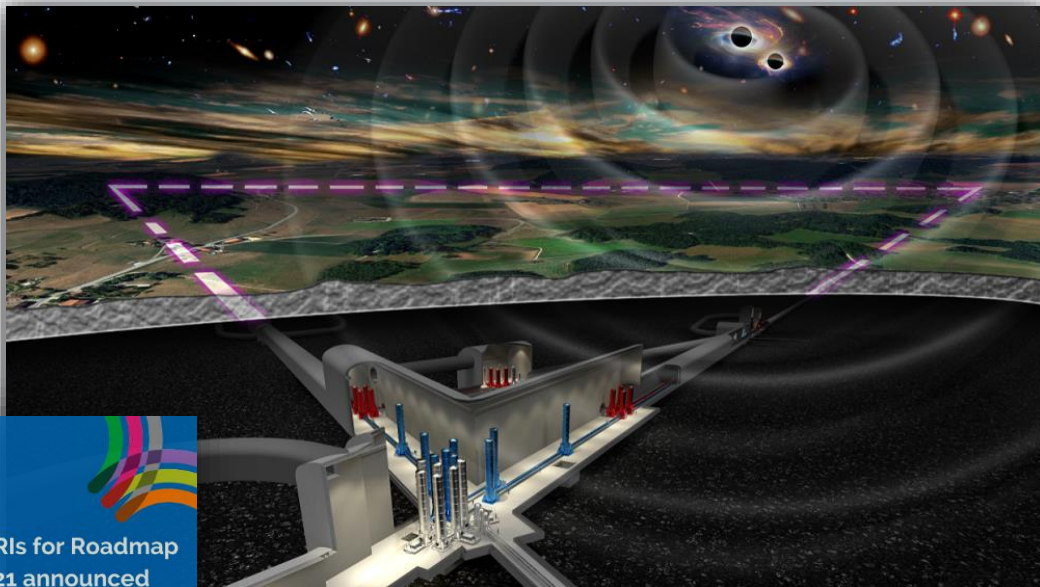
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Einstein Telescope: third-generation gravitational-wave observatory

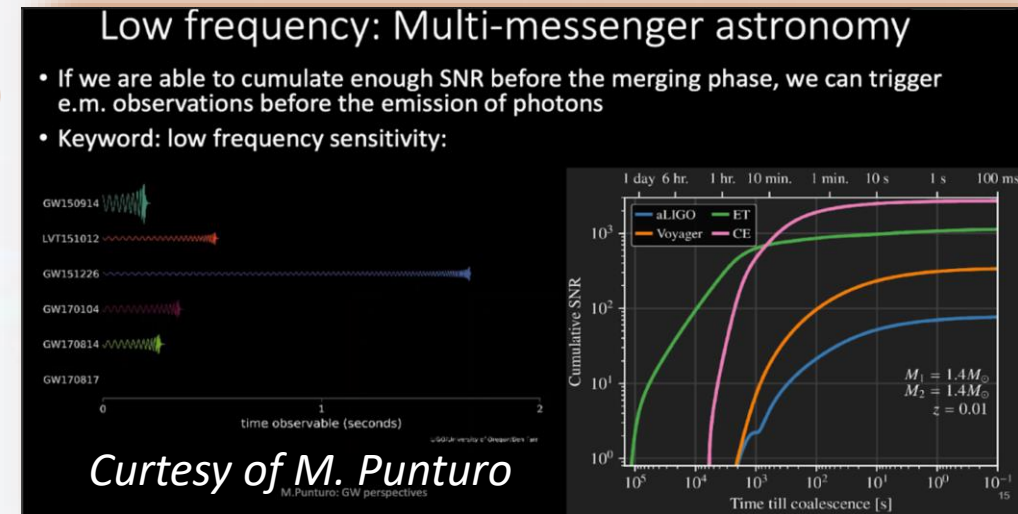
Einstein Telescope approved for ESFRI Roadmap 2021

Looking ahead

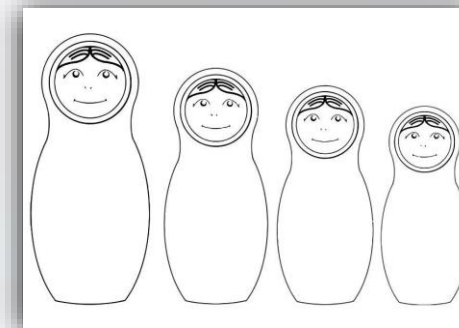


ET - **E**instein **T**elescope, the first and most advanced third-generation gravitational-wave observatory, with unprecedented sensitivity that will put Europe at the forefront of the Gravitation Waves research

<https://www.esfri.eu/latest-esfri-news/new-ris-roadmap-2021>.



MatryoSKY



A Nested skymap system

The logo is located in the top-left corner. It consists of a white circle with a blue border. Inside the circle, there is a stylized blue starburst at the top and a yellow dot at the bottom, connected by a thin blue line. The word "ESCAPE" is written in bold, dark blue capital letters.

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A large, stylized blue starburst or sunburst graphic is centered in the middle of the slide. It has multiple pointed rays extending outwards, creating a sense of radiance. The background is a dark blue space with many small white stars.

THANKS



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ESCAPE to the Future

25-26 October 2022
Brussels, Belgium



A VO service for the European VLBI Network

Mark Kettenis, Software Project Scientist
Joint Institute for VLBI ERIC



ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 824064.



- European VLBI Network (EVN)
 - Very Long Baseline Interferometry
 - High-resolution radio astronomy
 - Europe and beyond!
- Joint Institute for VLBI ERIC
 - operates the EVN correlator
 - provides support to EVN users
 - hosts the EVN Data Archive



- Searchable archive of most EVN observations since 1998
- Most data is public
- Users complain search is slow!

FITS-finder Tool for the EVN Archive
Find FITS files in the EVN Archive matching specified selection criteria, including source name or position.

Show fields		Select values		Sort fields	
<input checked="" type="checkbox"/> P. Investigator	<input checked="" type="checkbox"/> Frequency	P. Investigator	Any	<input type="checkbox"/> P. Investigator	<input type="checkbox"/>
<input checked="" type="checkbox"/> Experiment	<input type="checkbox"/> Channel width	Experiment	Any	<input type="checkbox"/> Experiment	<input type="checkbox"/>
<input checked="" type="checkbox"/> Source name	<input type="checkbox"/> Freq. channels	Source name	Any	<input checked="" type="checkbox"/> Source name	<input type="checkbox"/>
<input checked="" type="checkbox"/> RA	<input type="checkbox"/> Nr bands	Polarization	Any	<input type="checkbox"/> RA	<input type="checkbox"/>
<input checked="" type="checkbox"/> DEC	<input type="checkbox"/> Bandwidth / IF			<input type="checkbox"/> DEC	<input type="checkbox"/>
<input checked="" type="checkbox"/> Equinox	<input type="checkbox"/> Total Width			<input checked="" type="checkbox"/> Observ. date	<input type="checkbox"/>
<input type="checkbox"/> File name	<input type="checkbox"/> Stations			<input checked="" type="checkbox"/> Frequency	<input type="checkbox"/>
<input type="checkbox"/> File length	<input type="checkbox"/> Polarization			<input type="checkbox"/> Total Width	<input type="checkbox"/>
<input type="checkbox"/> File startdate	<input type="checkbox"/> Integr. time			<input type="checkbox"/> Freq. channels	<input type="checkbox"/>
<input type="checkbox"/> File starttime	<input type="checkbox"/> Total time			<input type="checkbox"/> Integr. time	<input type="checkbox"/>
<input type="checkbox"/> File enddate	<input type="checkbox"/> Observ. date			<input type="checkbox"/> Total time	<input type="checkbox"/>
<input type="checkbox"/> File endtime				<input type="checkbox"/> Polarization	<input type="checkbox"/>

Find sources in Circle ☐ Box ☐

Find sources in frequency range:

Any band P-band 90,49 cm Min. frequency 320 MHz

L-band 21,18 cm Max. frequency 50000 MHz

S-band 13 cm

C-band 6,5 cm

X-band 2 cm

K-band 1 cm

RA (hh:mm:ss) 12:00:00

DEC (dd:mm:ss) 00:00:00

Radius (degr) 1

Offset degr RA,DEC 180 90

Show list Plot list Typed Input Info Defaults Reset

Not Secure — jive.nl

JIVE
Joint Institute for VLBI ERIC

Home Contact Us EVN Intranet Wiki Daily Image

JIVE

About JIVE
JIVE management
ERIC council
News
User support
Visiting JIVE

EVN Correlator

Correlator overview
e-VLBI
Operations
Software

EVN Data Archive

Select experiment

EVN Data Archive at JIVE

Select EVN experiment

N19K2

Access to EVN archive

- Show experiment N19K2

Info

- Increase of data since 2000
- Web statistics since June 2004

Select a sourceposition from EVN experiment N19K2

Ra	Dec	Source	Image	Image
164.6234	1.5663	J1058+0133	sdss	evn
179.8826	29.2455	J1159+2914	sdss	evn

Access to VO archives

- Aladin Sky Atlas
- Sloan Digital Sky Survey

- But is it findable?
- Registered with re3data.org

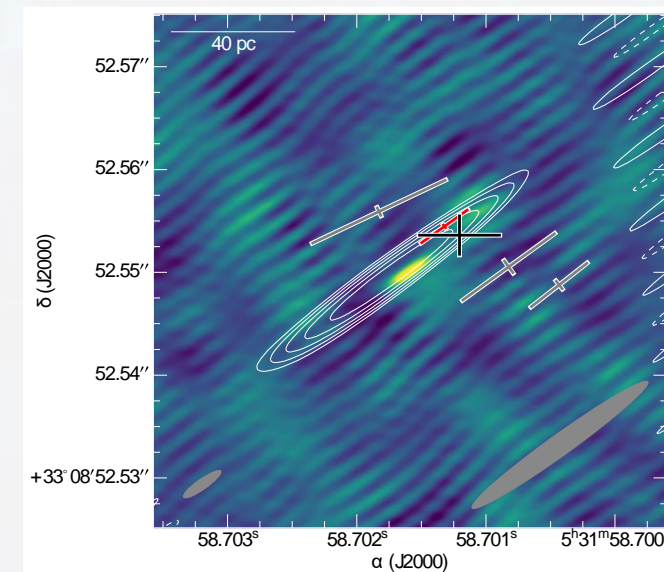
- Access to historic data for high-resolution follow-up

- Gravitational Wave events
- Gamma Ray Bursts
- Fast Radio Bursts

(EOSC Future: The Extreme Universe and Gravitational Waves)

- Standardized access to archival data for science platform

- JupyterLab environment (talk by Aard Keimpema)



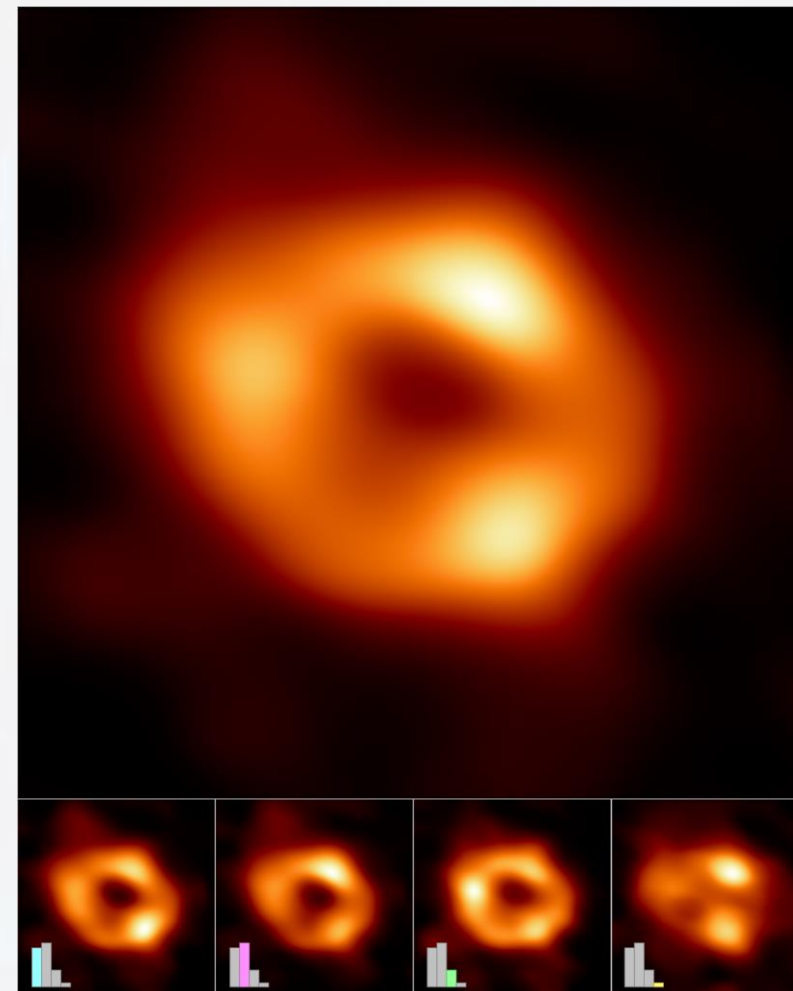
EVN localization of FRB
121102

B. Marcote *et al* 2017 *ApJL* **834** L8

VLBI data is different

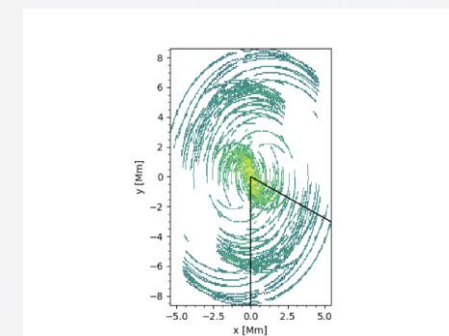
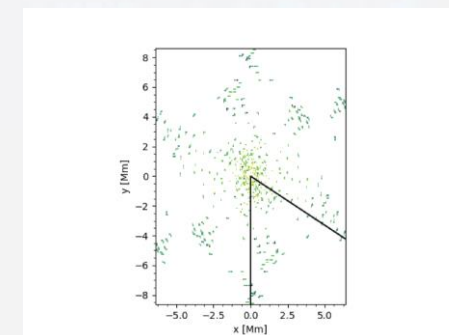
- Visibility data; not images!
 - Requires further processing to make images
 - Algorithms & parameters depend on science goals
- Observation properties not well defined:
 - Footprint depends on desired sensitivity
 - Potential gaps in spectral coverage
- Multiple sources per data set
 - Calibrators are essential for imaging targets

Discussion with ESCAPE CEVO partners and IVOA Radio IG were essential to get metadata right!



Credit: EHT Collaboration

- JIVE participates in the IVOA Radio Interest Group
 - Contributed to Implementation Note
 - Describing JIVE use-case and implementation
 - <https://www.ivoa.net/documents/Notes/RadioVOImp/index.html>
 - Contributes to Radio Obscore Extension
 - Characterization of UV (visibility) coverage
 - excentricity and filling factor
 - Frequency vs. Wavelength
 - <https://github.com/ivoa/ObsCoreExtensionForVisibilityData>

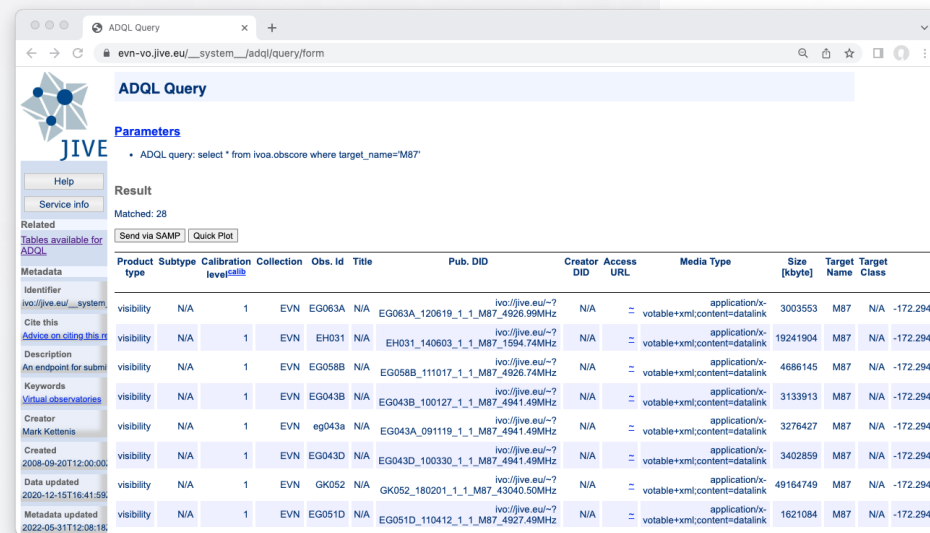


ESCAPE CEVO was instrumental in getting the IVOA Radio IG going!

VO Protocols used in our service

- ObsTAP (Table Access Protocol serving ObsCore metadata)
 - Provides metadata describing observations
- DataLink
 - Used to link together dataset components
 - Used to link to calibration information
 - Will be used to add preview images and diagnostic plots

- Based on DaCHs
 - Customized resource description
- Custom software for ingest (fitscrawler)
 - Extracts metadata from FITS-IDI files
 - Written in Python
 - Open Source: <https://github.com/jive-vlbi/evn-vo> (BSD 3-clause)
- Runs on top of existing archive
 - Datalink URLs point to existing server



ADQL Query

Parameters

ADQL query: select * from ivoa.obscore where target_name="M87"

Result

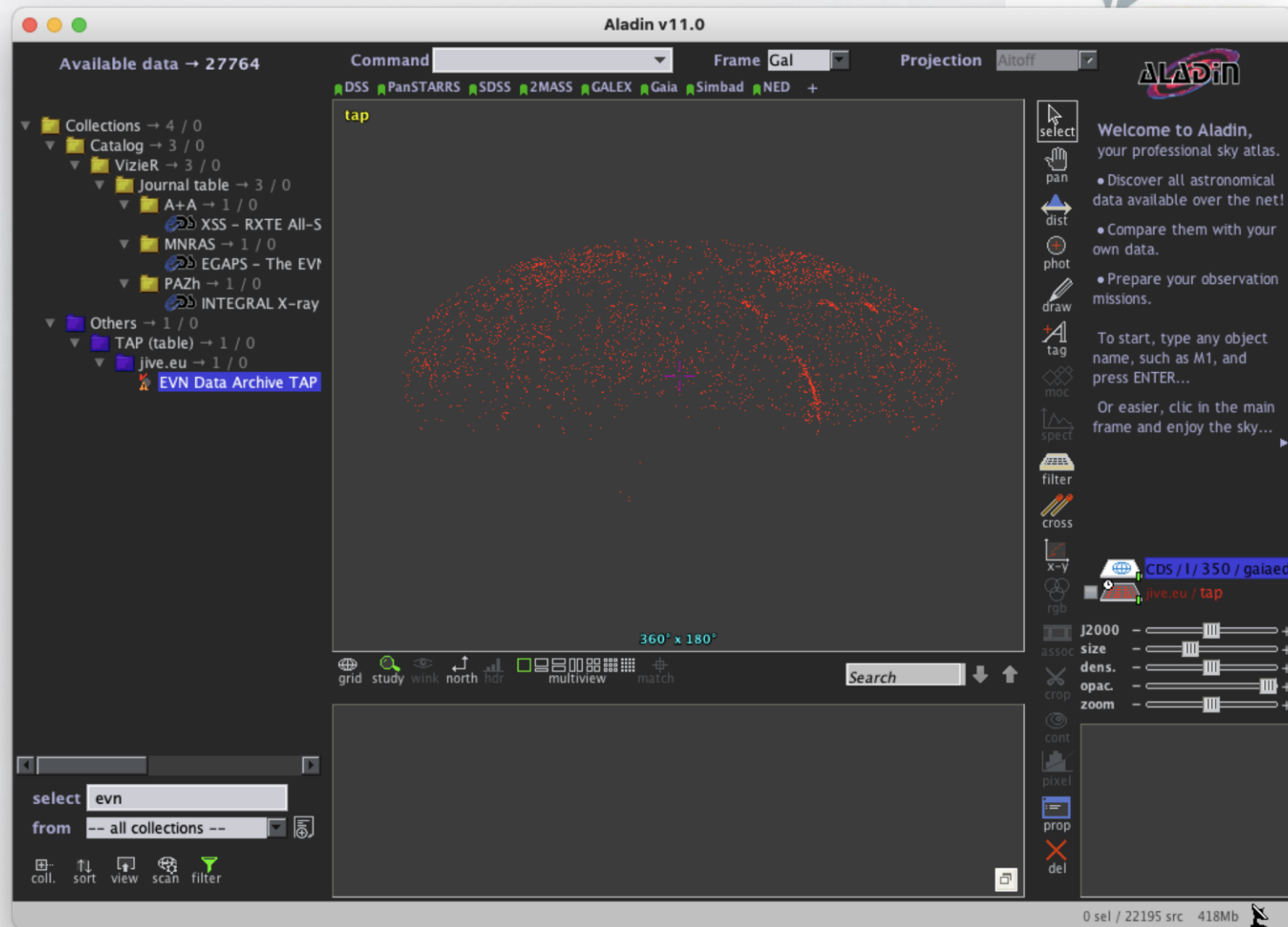
Matched: 28

Send via SAMP Quick Plot

Product type	Subtype	Calibration level	Collection	Obs. Id	Title	Pub. DID	Creator DID	Access URL	Media Type	Size [kbyte]	Target Name	Target Class	R [d]
visibility	N/A	1	EVN	EG063A	N/A	EG063A_120619_1_1_M87_4926.99MHz	ivo://jive.eu/~?	N/A	votable+xml;content=datalink	3003553	M87	N/A	-172.29406
visibility	N/A	1	EVN	EH031	N/A	EH031_140603_1_1_M87_1594.74MHz	ivo://jive.eu/~?	N/A	votable+xml;content=datalink	19241904	M87	N/A	-172.29406
visibility	N/A	1	EVN	EG058B	N/A	EG058B_111017_1_1_M87_4926.74MHz	ivo://jive.eu/~?	N/A	votable+xml;content=datalink	4686145	M87	N/A	-172.29406
visibility	N/A	1	EVN	EG043B	N/A	EG043B_100127_1_1_M87_4941.49MHz	ivo://jive.eu/~?	N/A	votable+xml;content=datalink	3133913	M87	N/A	-172.29406
visibility	N/A	1	EVN	eg043a	N/A	EG043A_091119_1_1_M87_4941.49MHz	ivo://jive.eu/~?	N/A	votable+xml;content=datalink	3276427	M87	N/A	-172.29406
visibility	N/A	1	EVN	EG043D	N/A	EG043D_100330_1_1_M87_4941.49MHz	ivo://jive.eu/~?	N/A	votable+xml;content=datalink	3402859	M87	N/A	-172.29406
visibility	N/A	1	EVN	GK052	N/A	GK052_180201_1_1_M87_43040.50MHz	ivo://jive.eu/~?	N/A	votable+xml;content=datalink	49164749	M87	N/A	-172.29406
visibility	N/A	1	EVN	EG051D	N/A	EG051D_110412_1_1_M87_4927.49MHz	ivo://jive.eu/~?	N/A	votable+xml;content=datalink	1621084	M87	N/A	-172.29406

Registering the service

- DaCHS conveniently implements a registry
- Registering that registry makes published services findable
- EVN Data Archive shows up in Aladin



- The EVN Data Archive is now much more Findable
 - DOIs will be available soon!
 - TAP service is fast
- VO protocols already used to implement other services
 - Science platform
- Help from ESCAPE CEVO and IVOA Radio IG was essential for getting metadata right
- Help from Markus Demleitner (GAVO/Universität Heidelberg) really useful to get DaCHS running (ESCAPE CEVO workshops)
- Further improvements planned!

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A large, semi-circular structure composed of many blue, rectangular segments, resembling a particle detector or a large telescope. It is set against a dark blue background filled with numerous small, bright white stars.

Thanks!



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ESCAPE to the Future

25-26 October 2022
Brussels, Belgium

Future perspectives

Mark Allen and François Bonnarel
CDS, Observatoire astronomique de Strasbourg
For WP4, 'CEVO'



Future outlook of VO in ESCAPE and EOSC

Integration of astronomy VO data and services into the EOSC

- Next big step is to use evaluate/use the new *'enhanced EOSC Resource Catalogue'* for on-boarding of 'data sources'

FAIR principles for data through the Virtual Observatory

- ESCAPE has built capacity within ESFRI/RIs to become actors in defining the standards.
Future : Implementation / Coordination / Innovation / Scaling up
- Continue networked approach – Standards, Data, tools/services, Training

Integration in platforms, virtual research environments

- Within ESCAPE, but also beyond: space agencies and major observatories and data centres
- *Coordination of European efforts necessary to continue global impact*

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