The ESO Science Archive

Martino Romaniello, Alberto Micol

ESO

Public

The ESO Science Archive: your source of data

INTRODUCTION

ESO's raison d'être
Then…

"ESO's *raison d'être* is the provision of telescope time […] the core is the number of nights during which the visiting astronomer has control"

van der Laan 1988, The Messenger, 51, 1

ESO's raison d'être …and now

"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

- ESO Science Archive (today)
- Data processing (tomorrow, but hands-on already today)

Outline for today
The ESO Science Archive

- The ESO Science Archive is **the** access point to your data!

archive.eso.org

- Interactive web access (Martino)
- Direct and scripted database access (Alberto)

archive.eso.org

Science Archive Facility

- Data Portal
- ESO Data
- Hubble Space Telescope Data
- Virtual Observatory Tools
- Catalogues, Plates and DSS
- Tools and Documentation
- Related External Services
- ESO & HST Image Galleries
- News and Updates
- FAQ
- ESO Data Access Policy

Warning!!

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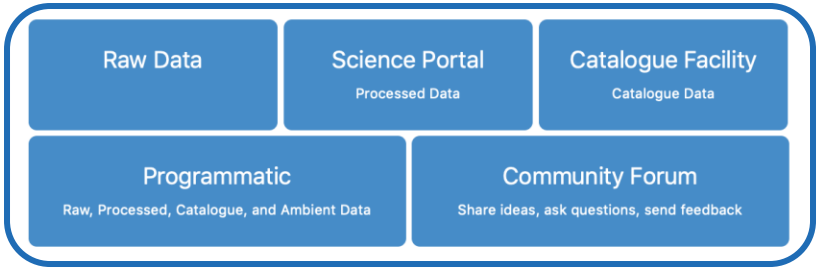
Browsing the archive does not require authentication. Please acknowledge the use of archive data in any publication.

There are three main ways to access the archive, varying for content and presentation/interface: the usual Raw Data query form, the innovative Science Portal to browse and access the processed data, and the novel Programmatic and Tools access which permits direct database access to both raw and processed data, and to the ambient condition measurements, also in a scriptable and VO manner. Other query forms are available in the table at the bottom of this page.



Latest News and Updates

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More news ...

To browse the archive

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Interactive access from a browser

1. RAW DATA
2. PROCESSED DATA
3. SOURCE CATALOGUES
4. COMMUNITY FORUM

Interactive access from a browser

1. RAW DATA

archive.eso.org

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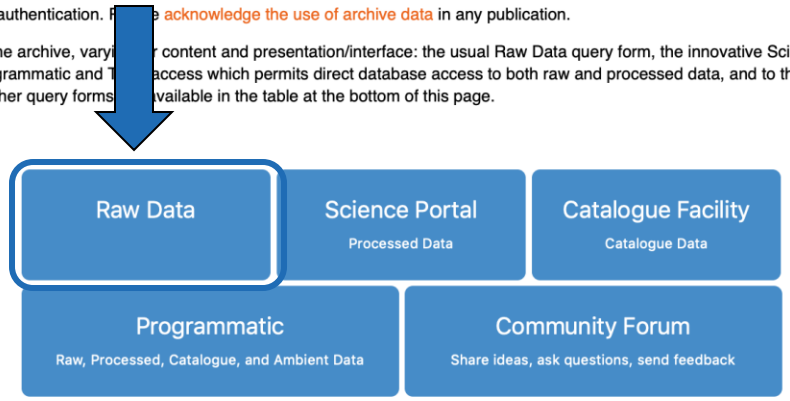

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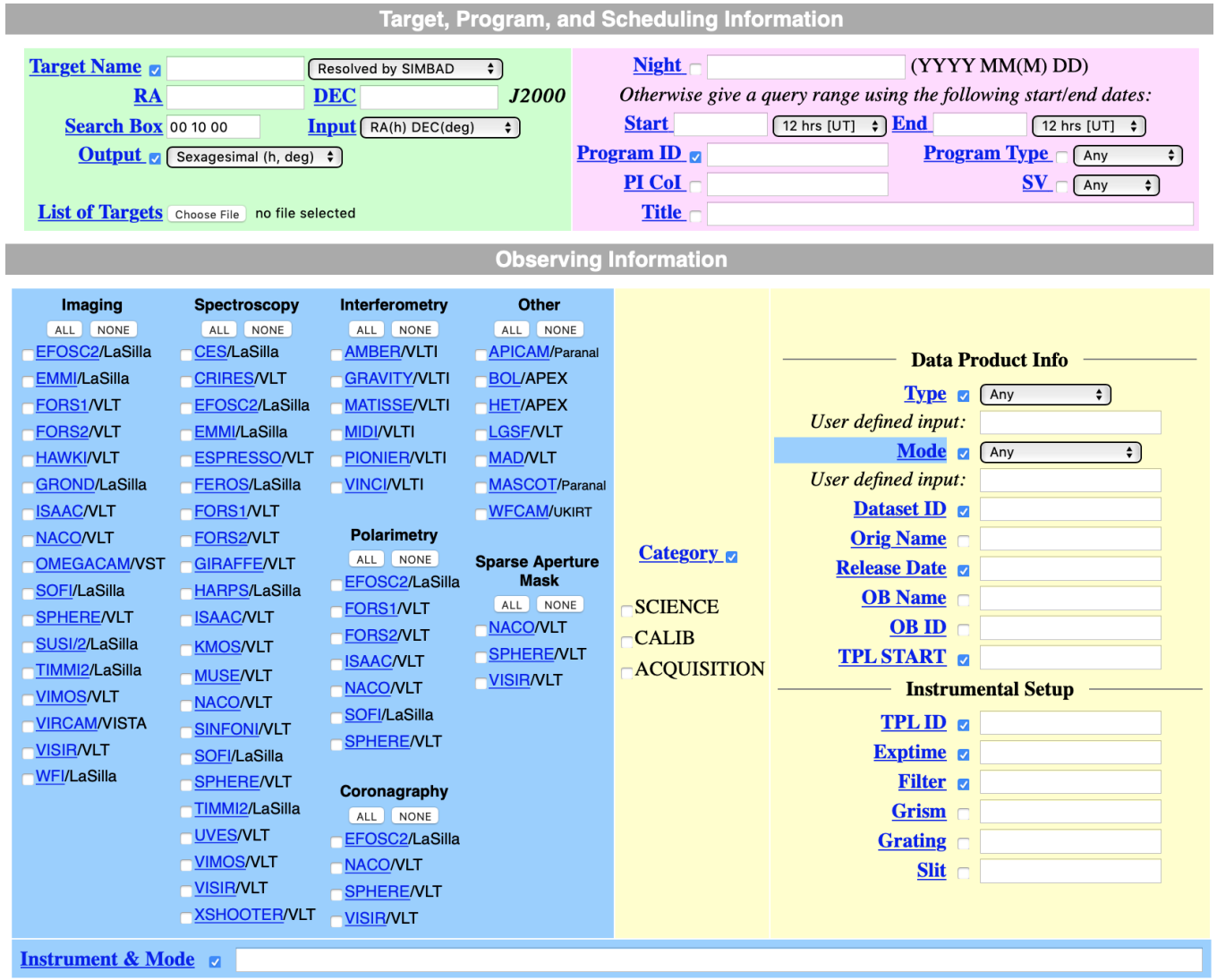
Raw data


Target, Program, and Scheduling Information
Target Name
Resolved by SIMBAD
RA
DEC
J2000
Search Box
00 10 00
Input
RA(h) DEC(deg)
Output
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List of Targets
Choose File
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Night
(YYYY MM(M) DD)
Otherwise give a query range using the following start/end dates:
Start
12 hrs [UT]
End
12 hrs [UT]
Program ID
Program Type
Any
PI CoI
SV
Any
Title
Observing Information
Imaging
ALL
NONE
EFOSC2/LaSilla
EMMI/LaSilla
FORS1/VLT
FORS2/VLT
HAWKI/VLT
GROND/LaSilla
ISAAC/VLT
NACO/VLT
OMEGACAM/VST
SOFI/LaSilla
SPHERE/VLT
SUSI2/LaSilla
TIMMI2/LaSilla
VIMOS/VLT
VIRCAM/VISTA
VISIR/VLT
WFI/LaSilla
Spectroscopy
ALL
NONE
CES/LaSilla
CRIRES/VLT
EFOSC2/LaSilla
EMMI/LaSilla
ESPRESSO/VLT
FEROS/LaSilla
FORS1/VLT
FORS2/VLT
GIRAFFE/VLT
HARPS/LaSilla
ISAAC/VLT
KMOS/VLT
MUSE/VLT
NACO/VLT
SINFONI/VLT
SOFI/LaSilla
SPHERE/VLT
TIMMI2/LaSilla
UVES/VLT
VIMOS/VLT
VISIR/VLT
XSHOOTER/VLT
Interferometry
ALL
NONE
AMBER/VLTI
GRAVITY/VLTI
MATISSE/VLTI
MIDI/VLTI
PIONIER/VLTI
VINCI/VLTI
Polarimetry
ALL
NONE
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FORS1/VLT
FORS2/VLT
ISAAC/VLT
NACO/VLT
SOFI/LaSilla
SPHERE/VLT
Coronagraphy
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SPHERE/VLT
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Other
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BOL/APEX
HET/APEX
LGSF/VLT
MAD/VLT
MASCOT/Paranal
WFCAM/UKIRT
Sparse Aperture Mask
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NACO/VLT
SPHERE/VLT
VISIR/VLT
Category
SCIENCE
CALIB
ACQUISITION
Data Product Info
Type
Any
User defined input:
Mode
Any
User defined input:
Dataset ID
Orig Name
Release Date
OB Name
OB ID
TPL START
Instrumental Setup
TPL ID
Exptime
Filter
Grism
Grating
Slit
Instrument & Mode

Raw data – Calibration selection

Submit Request

Request Description: Test calibration selection

Media delivery Type: How do you want your files to be delivered?
- Instant Download
- Mailed USB Disk (only for very large requests)

Options: Which files do you want to be delivered?
- Only selected files
- Selected files + associated raw calibrations (if available)
- Selected files + associated processed calibrations (if available)

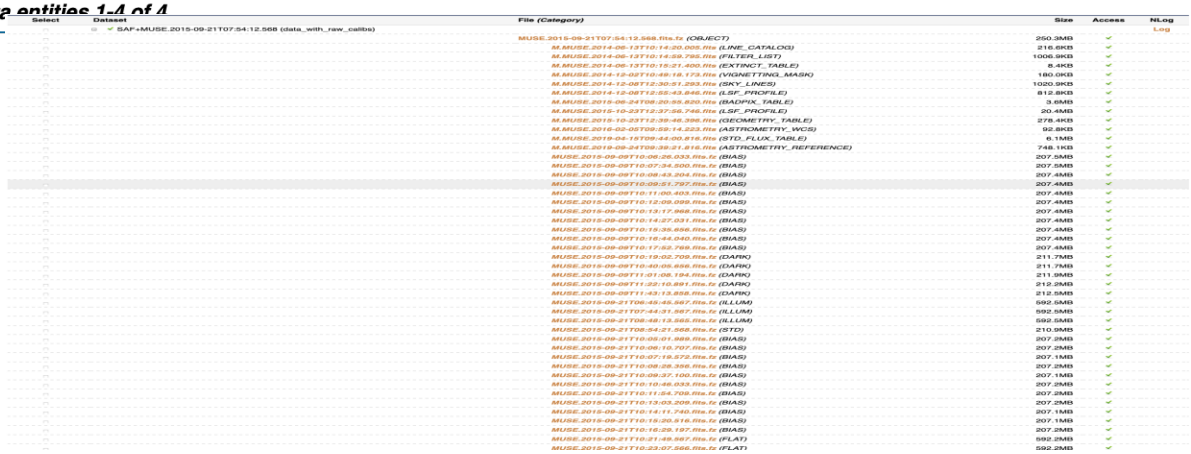
Submit

Requested Datasets • MUSE.2015-09-21T08:28:29.571

Which files do you want to be delivered?
- Only selected files
- Selected files + associated raw calibrations (if available)
- Selected files + associated processed calibrations (if available)

Select	Dataset	File
☐	✔ SAF+MUSE.2015-09-21T07:54:12.568 (data_with_raw_calibs)	
☐	✔ SAF+MUSE.2015-09-21T08:11:21.566 (data_with_raw_calibs)	
☐	✔ SAF+MUSE.2015-09-21T08:28:29.571 (data_with_raw_calibs)	
☐	✔ SAF+MUSE.2015-09-21T08:48:13.565 (data_with_raw_calibs)	

Data entities 1-4 of 4



Interactive access from a browser

2. PROCESSED DATA: THE ARCHIVE SCIENCE PORTAL

archive.eso.org

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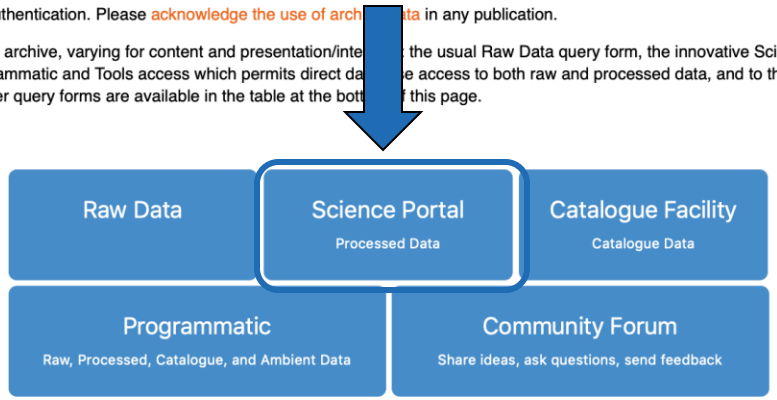

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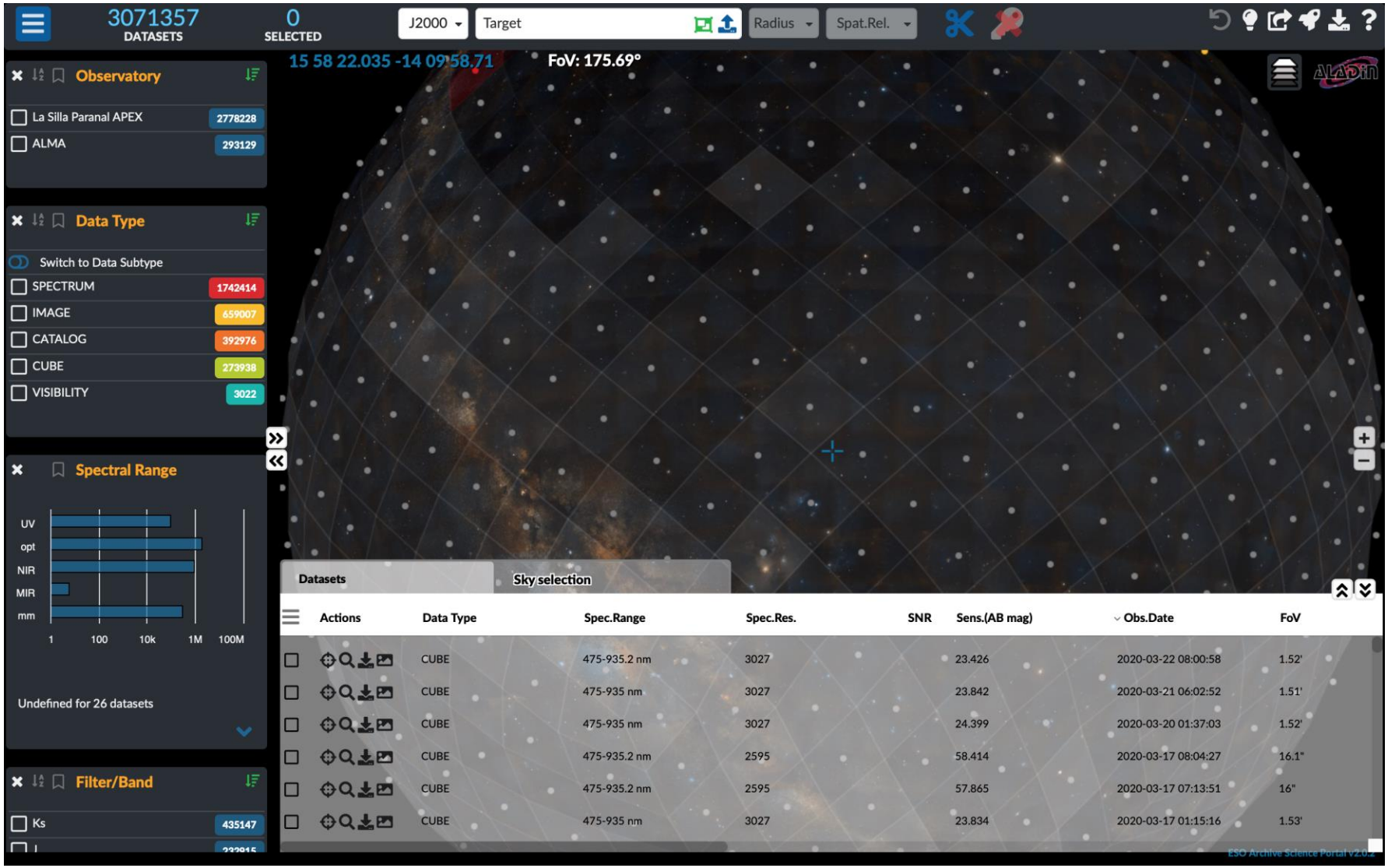
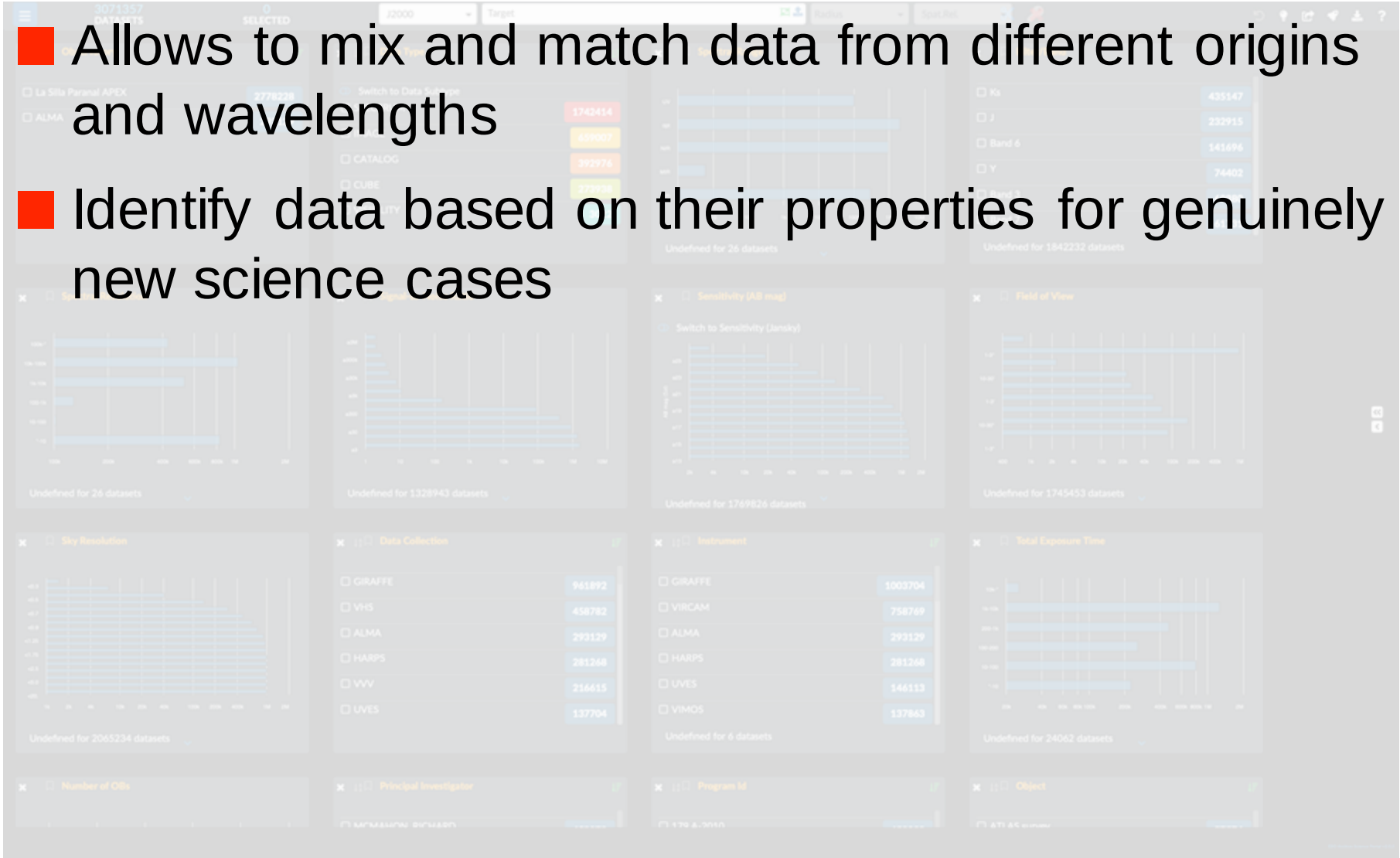


The Archive Science Portal

The Archive Science Portal

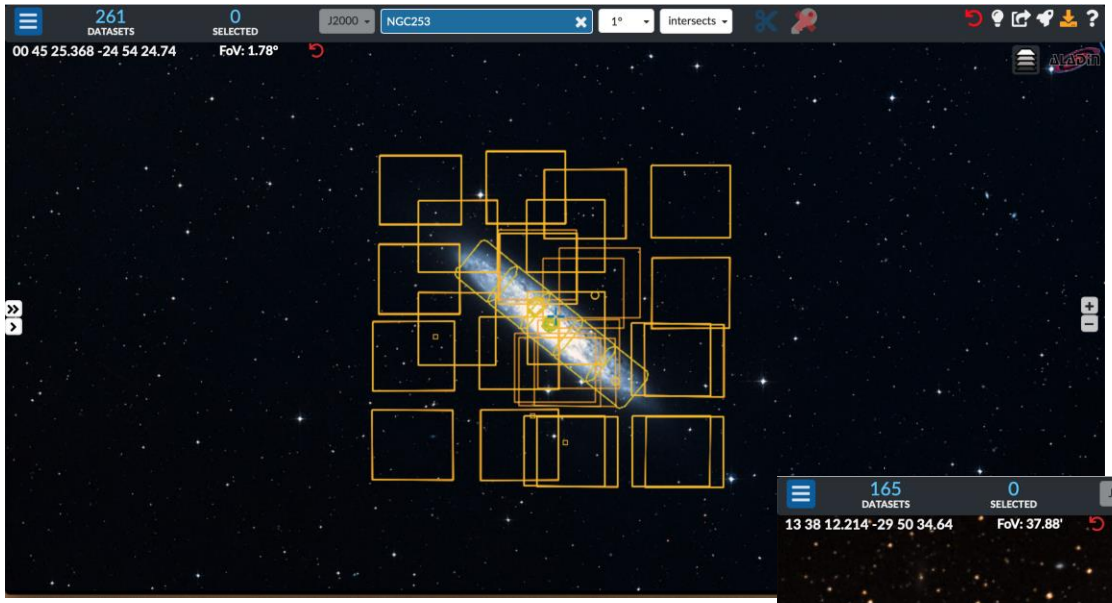
- Allows to mix and match data from different origins and wavelengths
- Identify data based on their properties for genuinely new science cases

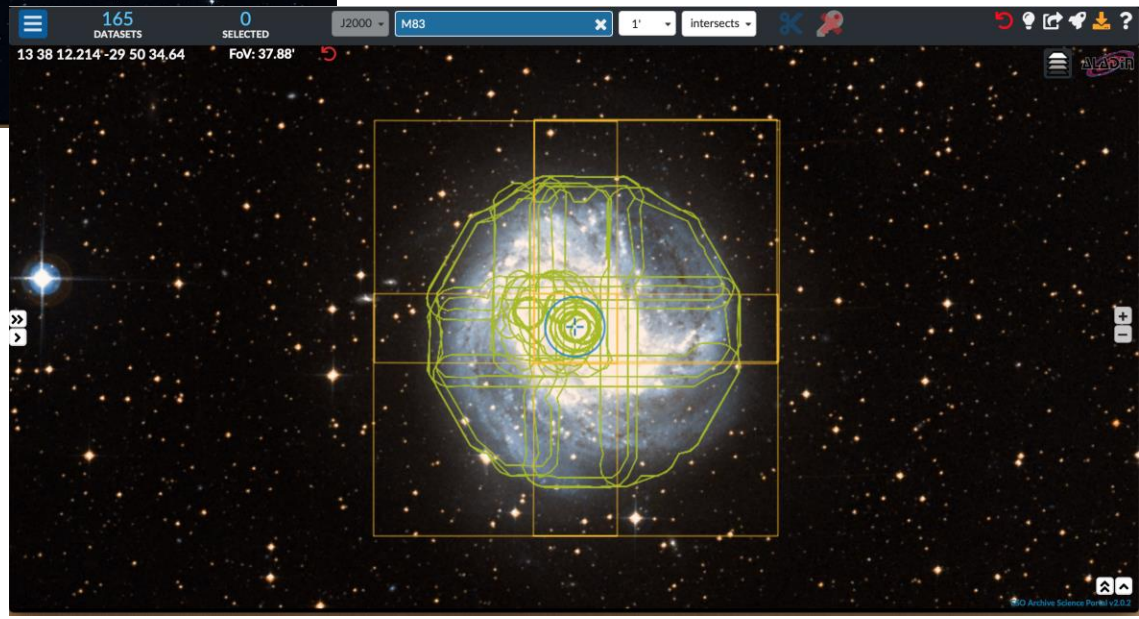


Interactive access from a browser

ARCHIVE SCIENCE PORTAL: CONTENT

La Silla Paranal *and* ALMA data

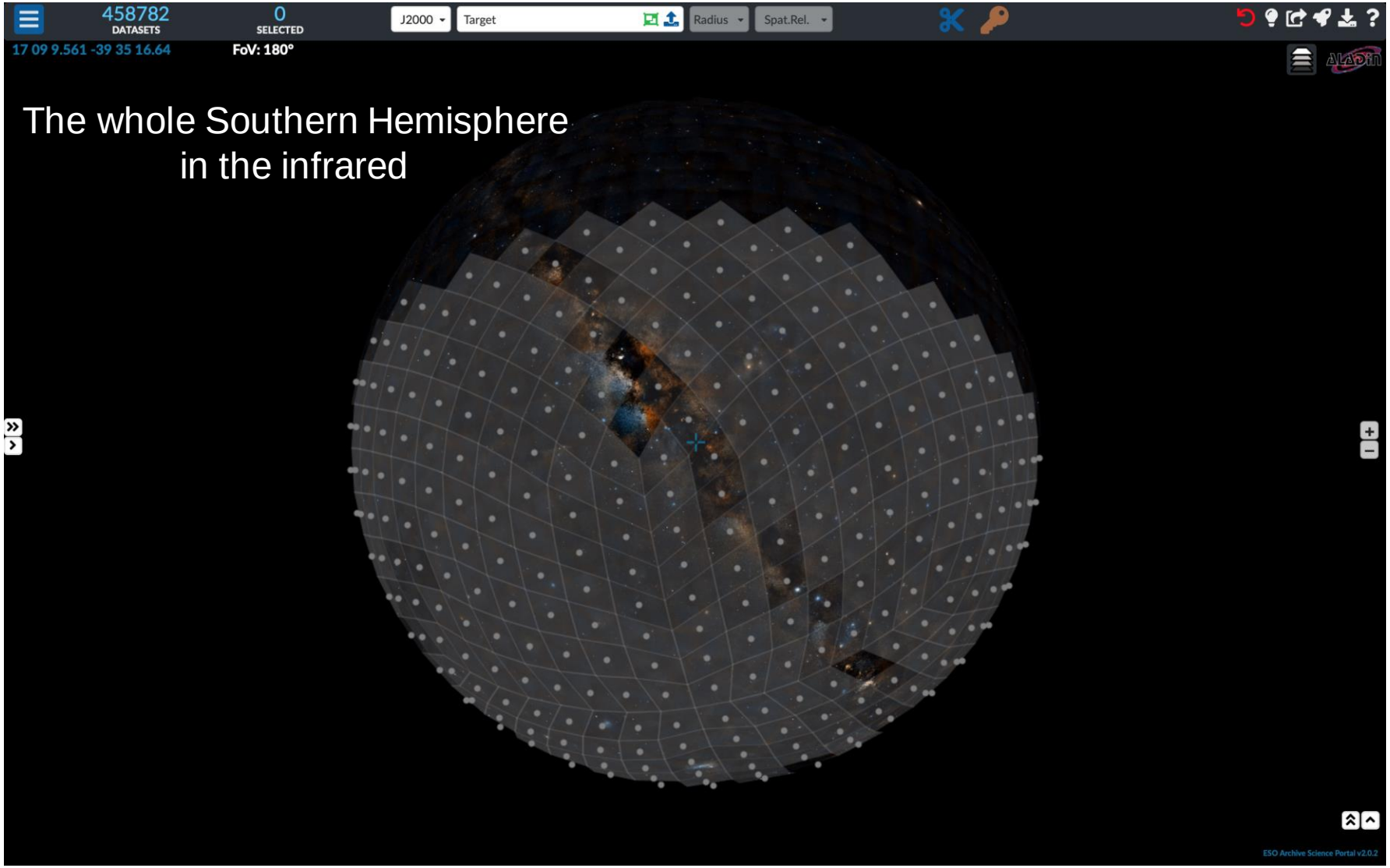




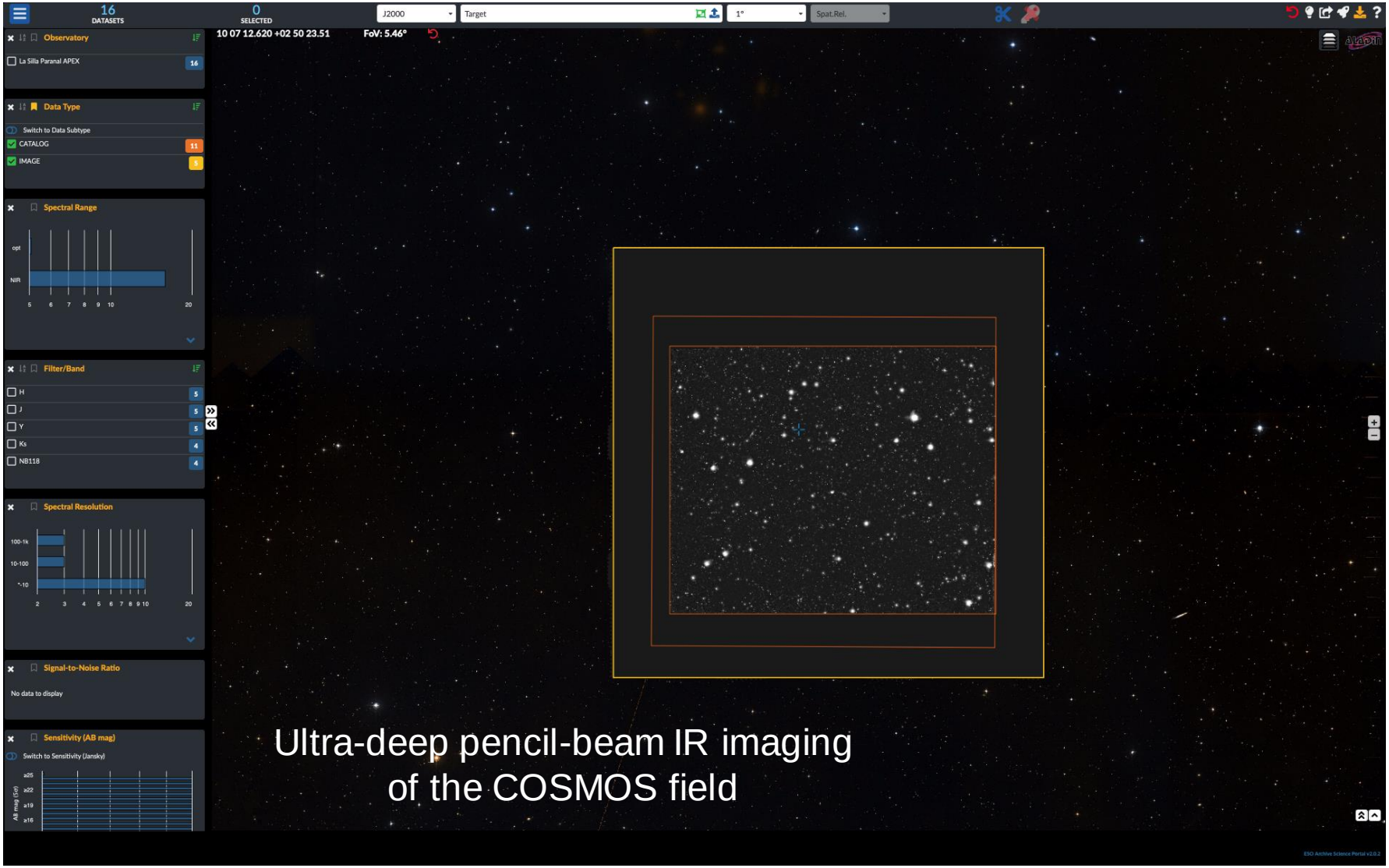
Types of processed data

- Images
- Spectra
- Cubes
- Flux maps
- Visibilities
- Source catalogues
- Light curves

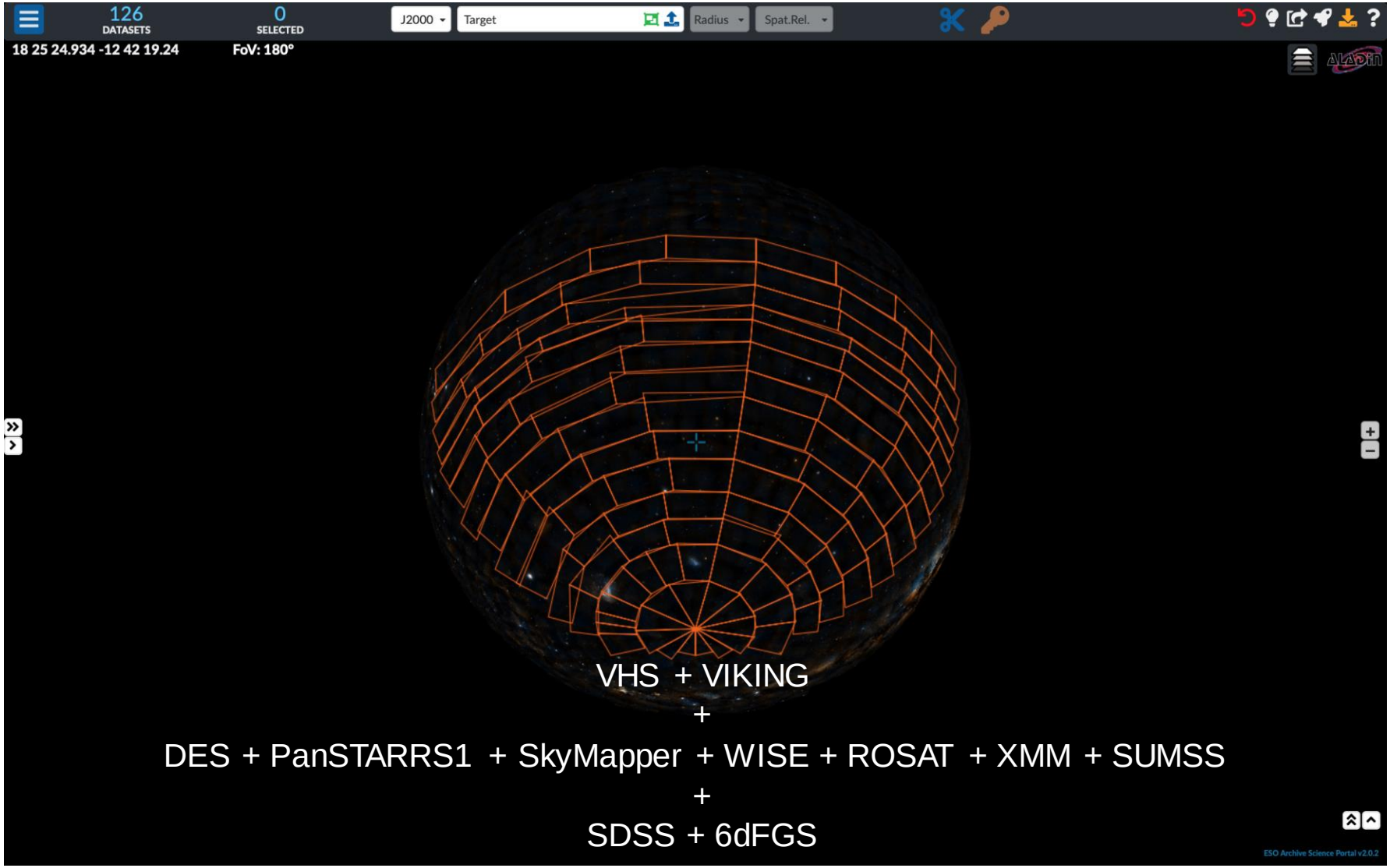
VHS: the VISTA Hemisphere Survey



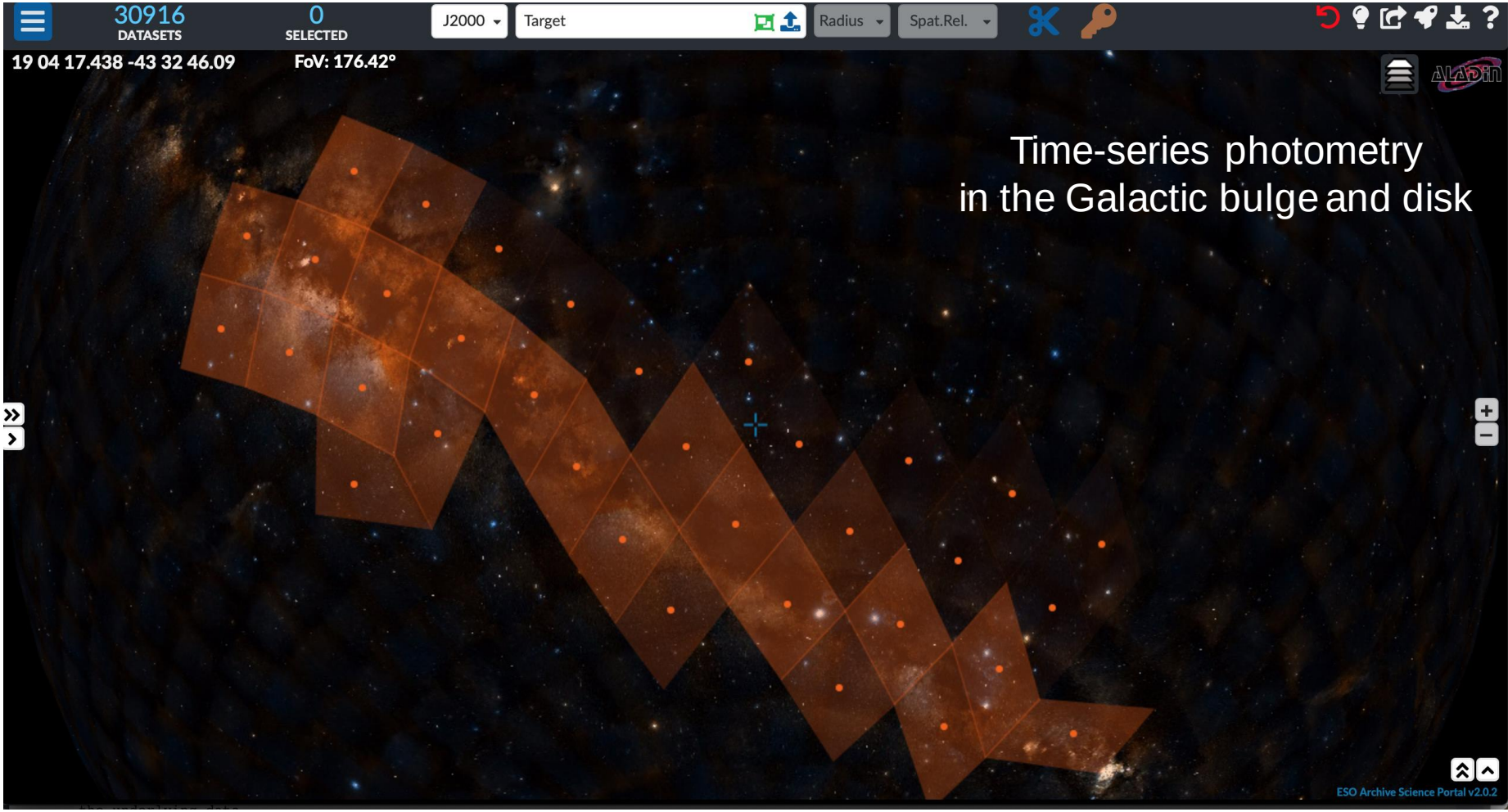
UltraVISTA


16
DATASETS
0
SELECTED
J2000
Target
1°
Spat.Rel.
10 07 12.620 +02 50 23.51
FoV: 5.46°
Observatory
La Silla Paranal APEX
16
Data Type
Switch to Data Subtype
CATALOG
11
IMAGE
5
Spectral Range
opt
NIR
Filter/Band
H
J
Y
Ks
NB118
Spectral Resolution
Signal-to-Noise Ratio
No data to display
Sensitivity (AB mag)
Switch to Sensitivity (Jansky)
Ultra-deep pencil-beam IR imaging
of the COSMOS field

VEXAS: the VISTA EXtension to Auxiliary Surveys

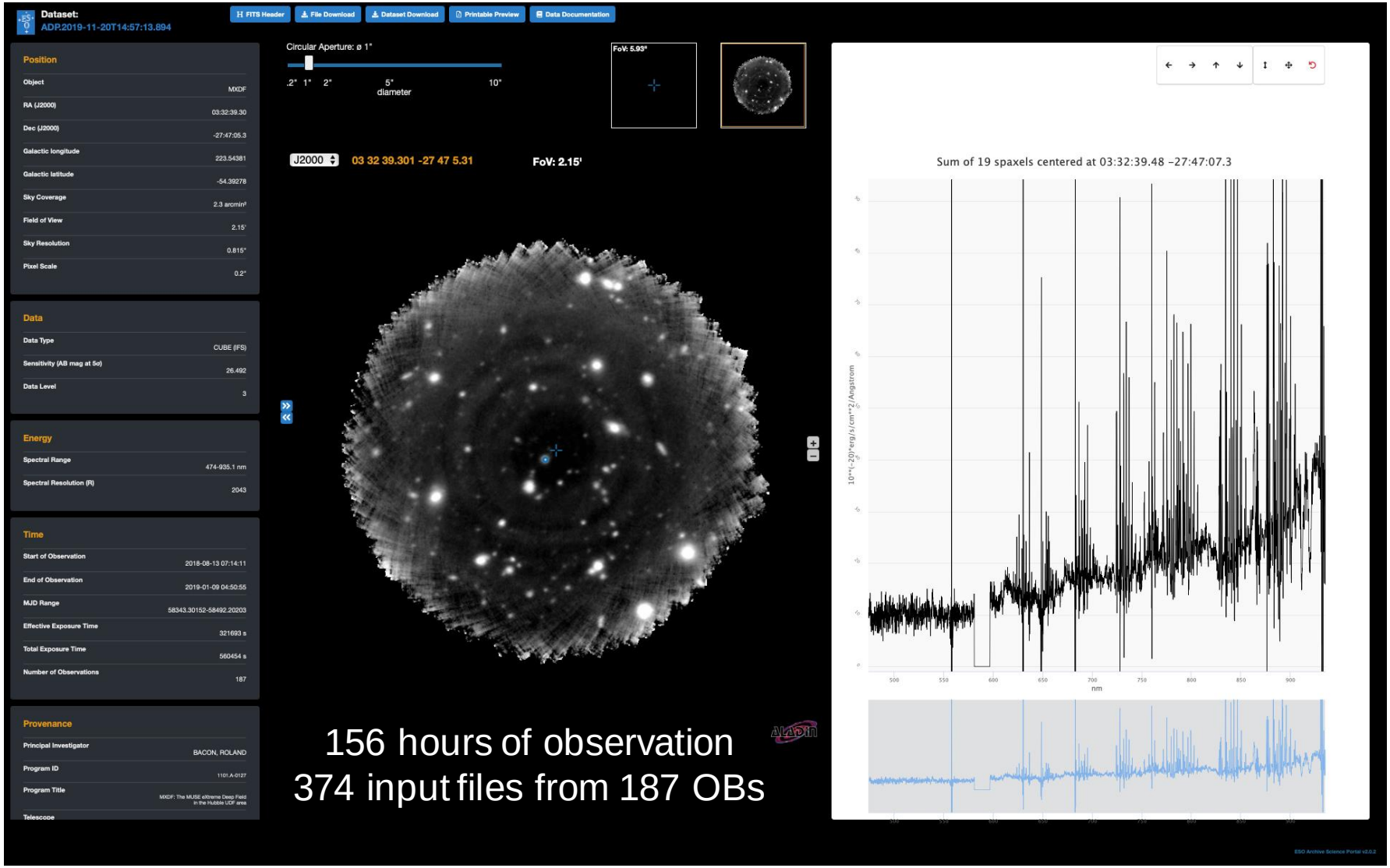


VVV: Variable Stars in the Via Lactea

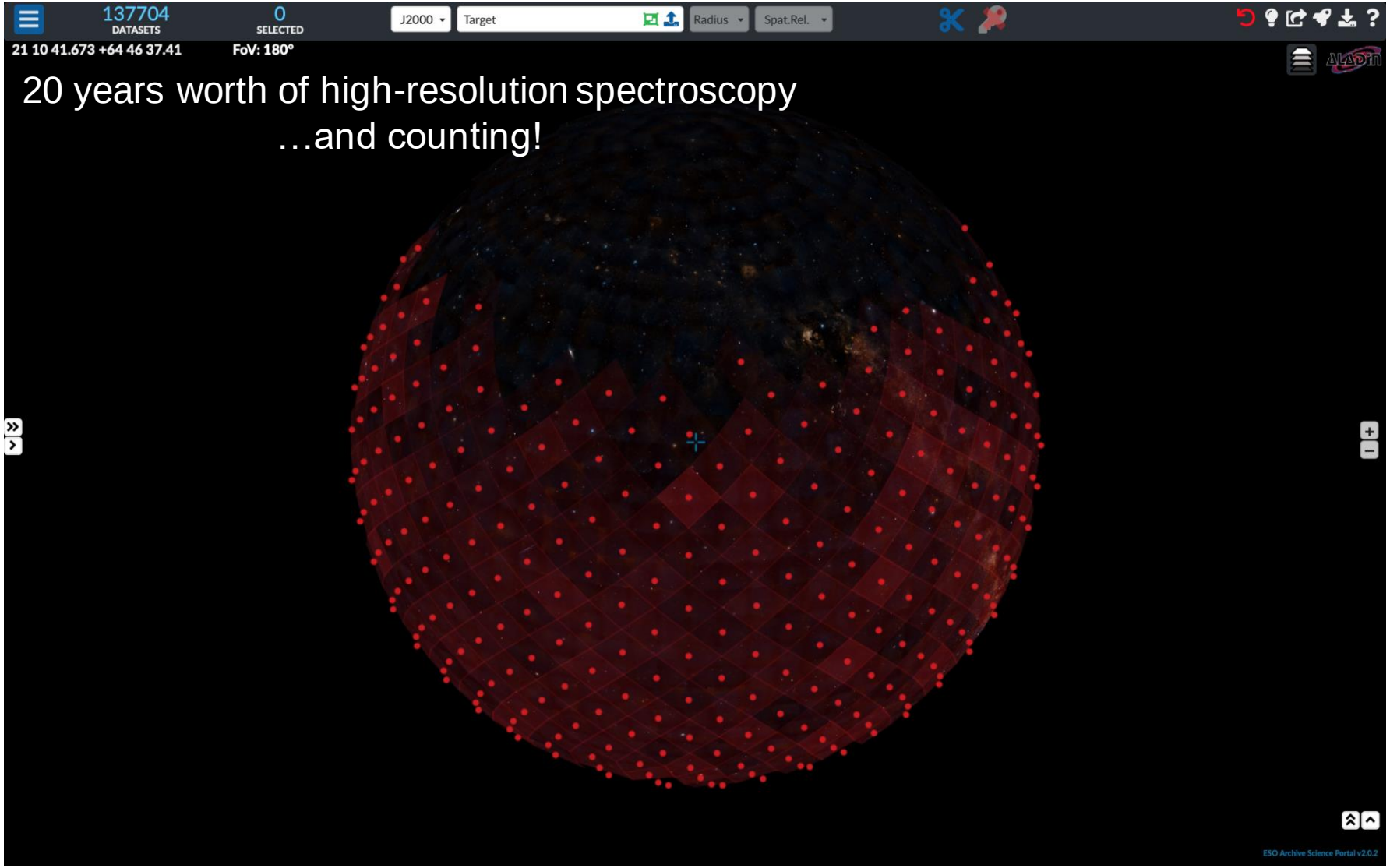


VMC: VISTA Magellanic Clouds

MXDF: The MUSE eXtreme Deep Field in the Hubble UDF area



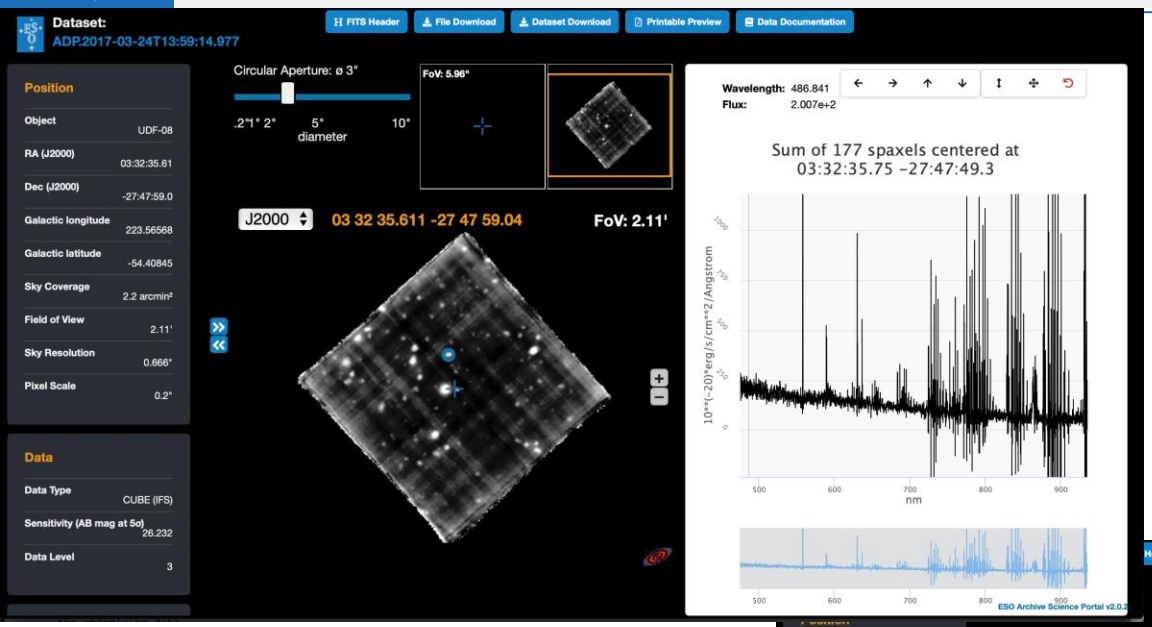
The UVES point-source archive

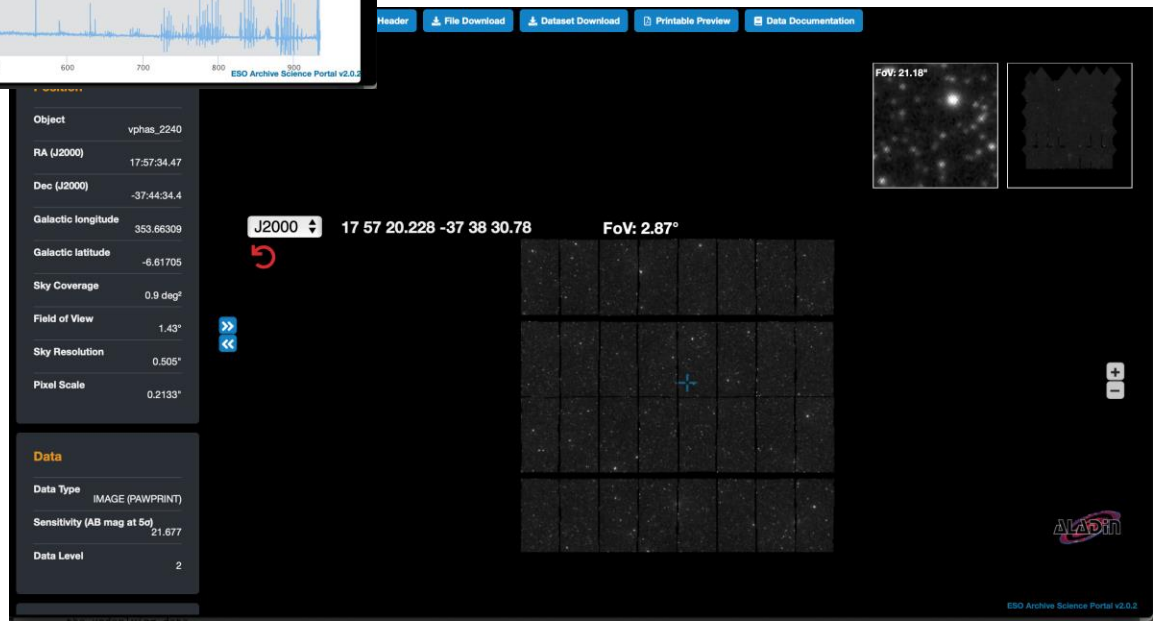


Interactive access from a browser

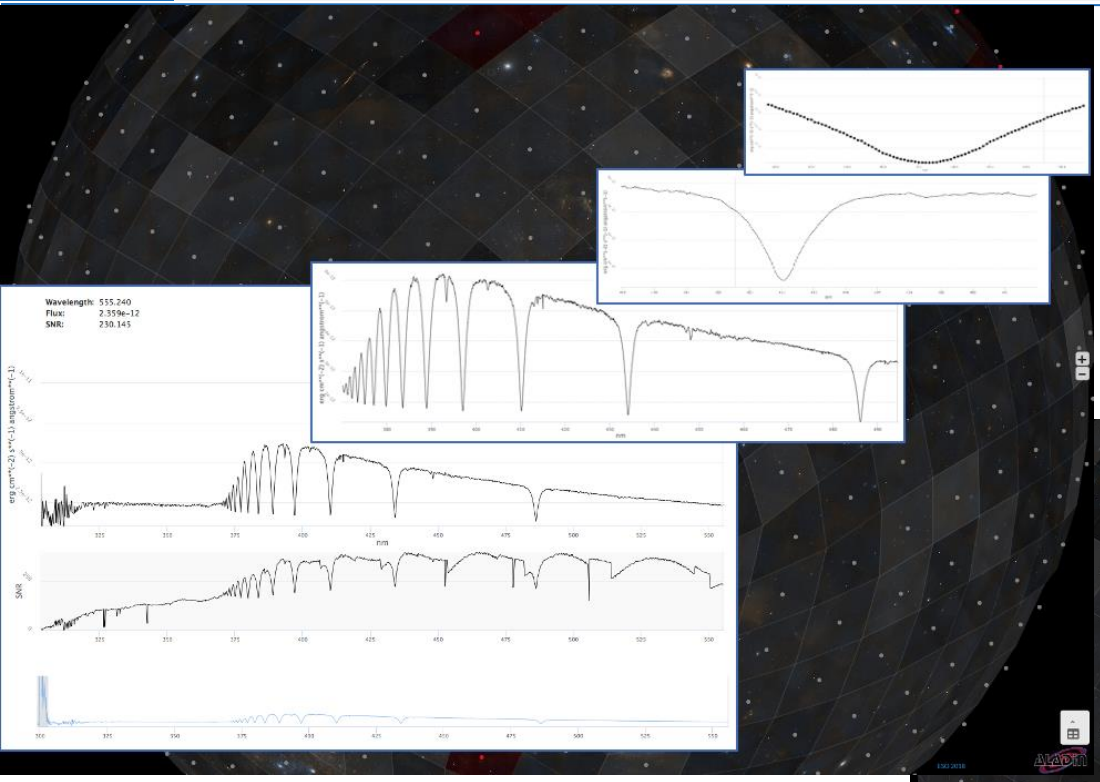
ARCHIVE SCIENCE PORTAL: USER SERVICES

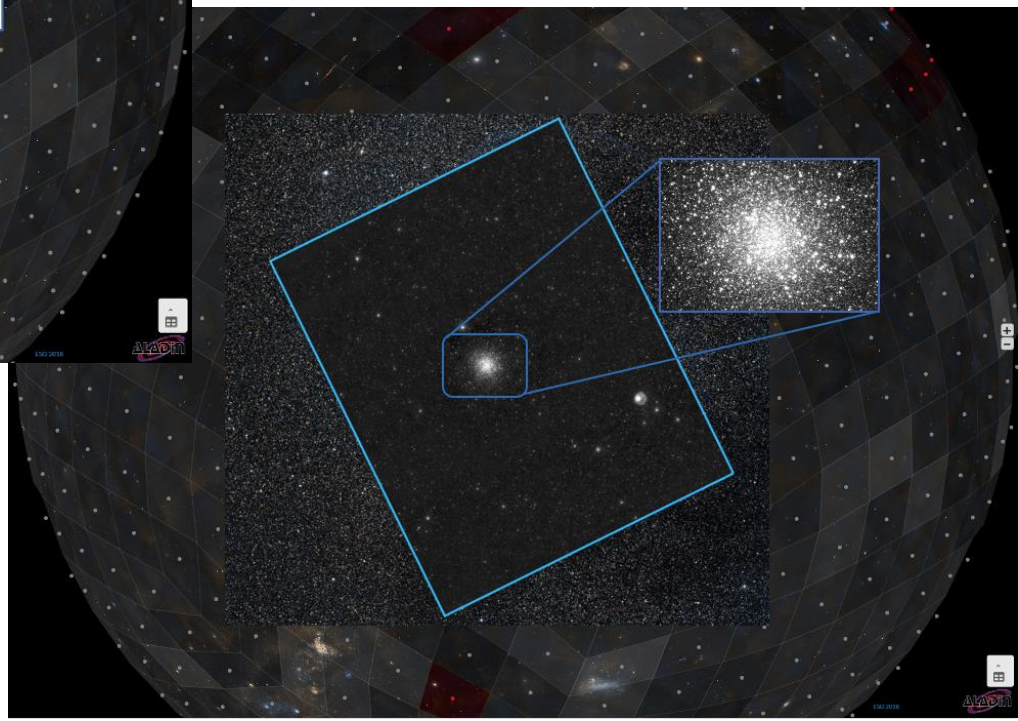
Data previews - I



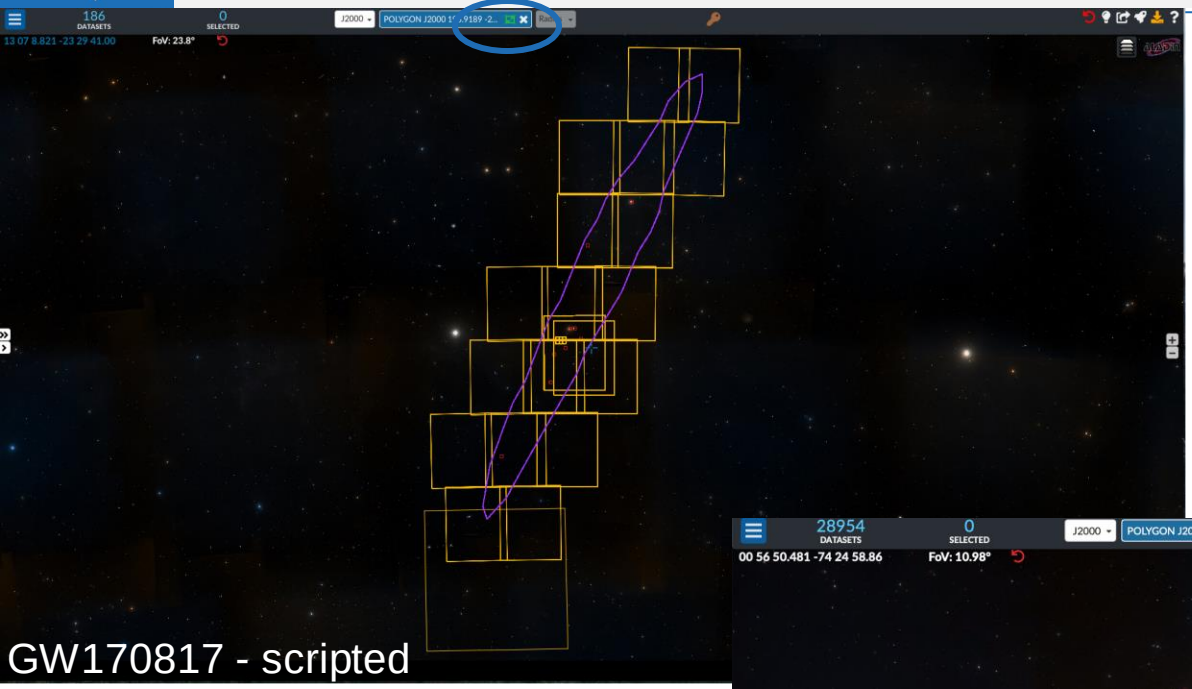


Data previews - II

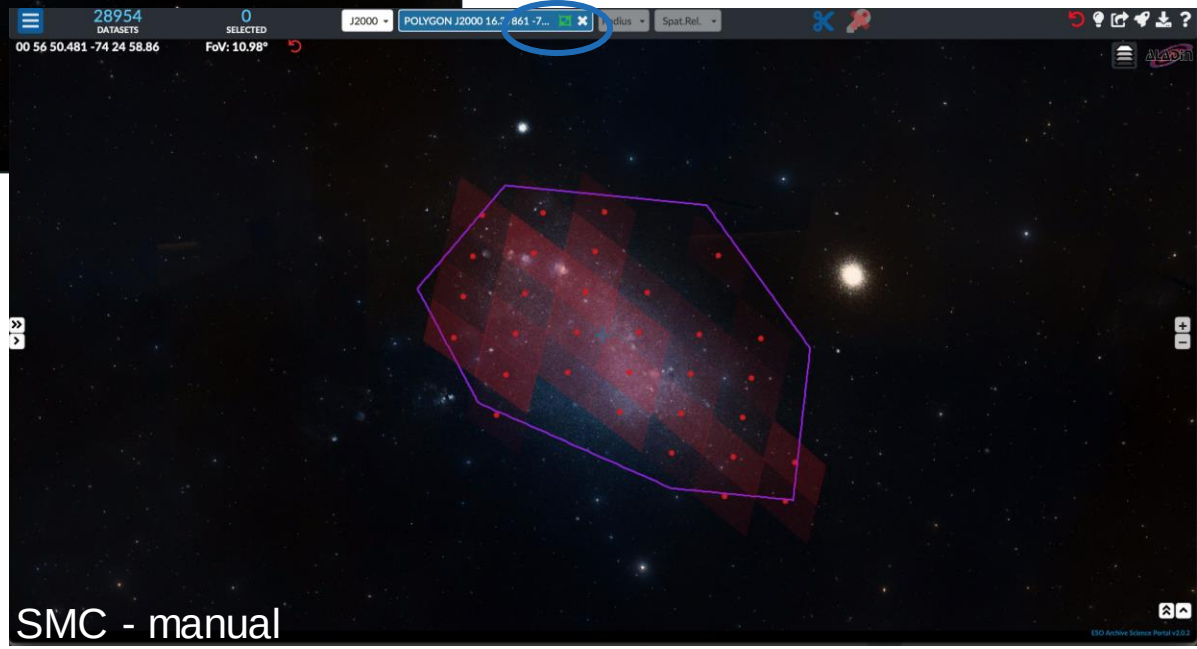




Custom contour queries

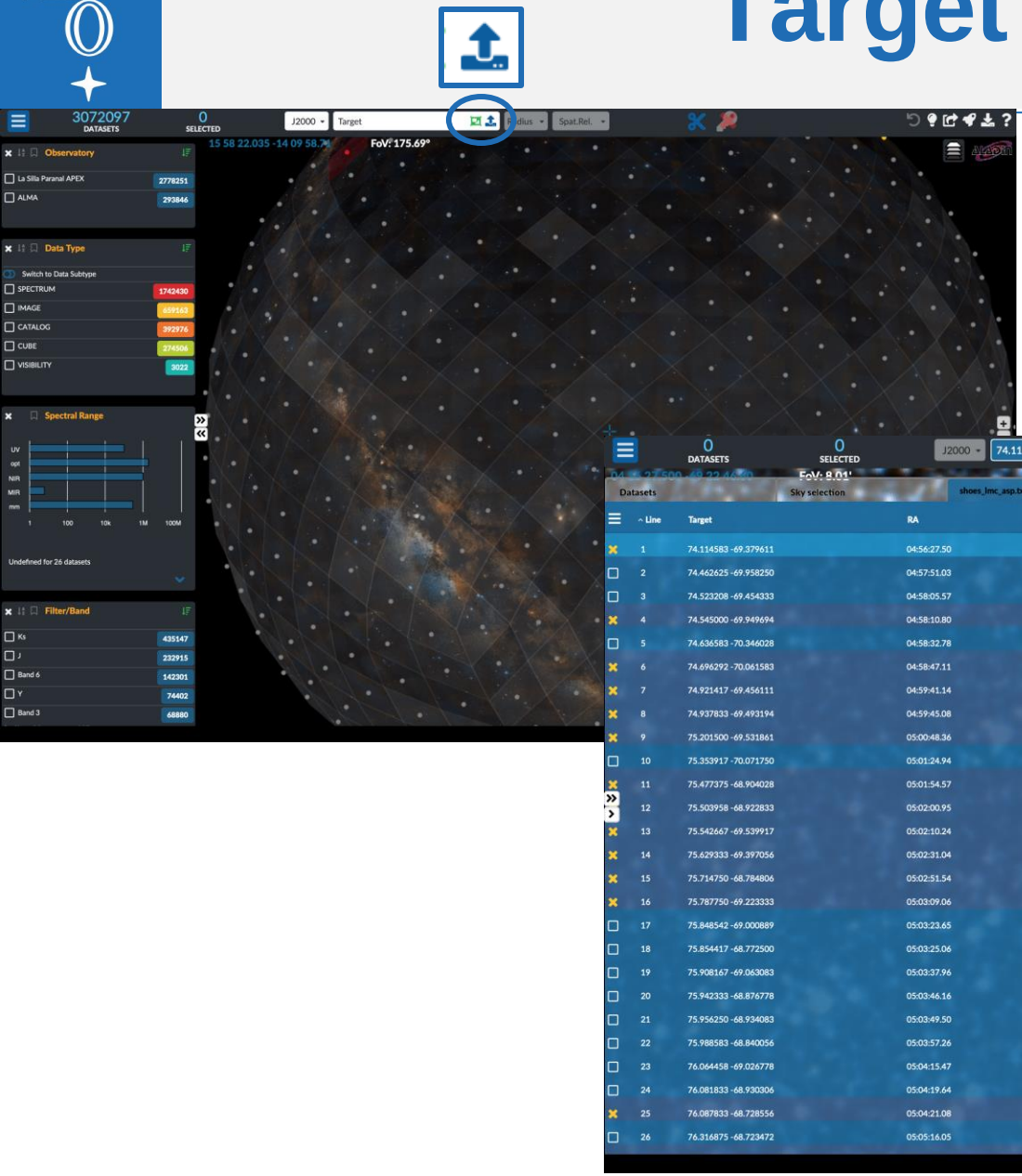


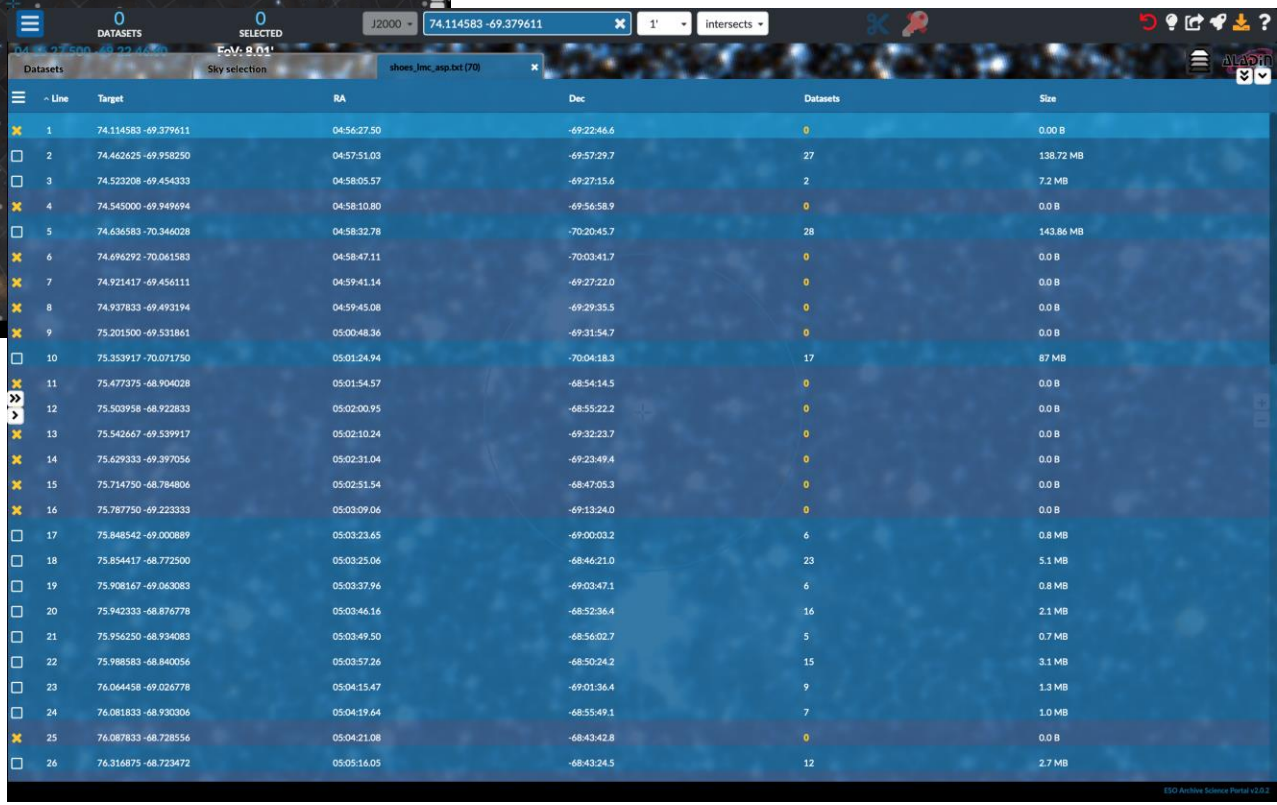
GW170817 - scripted



SMC - manual

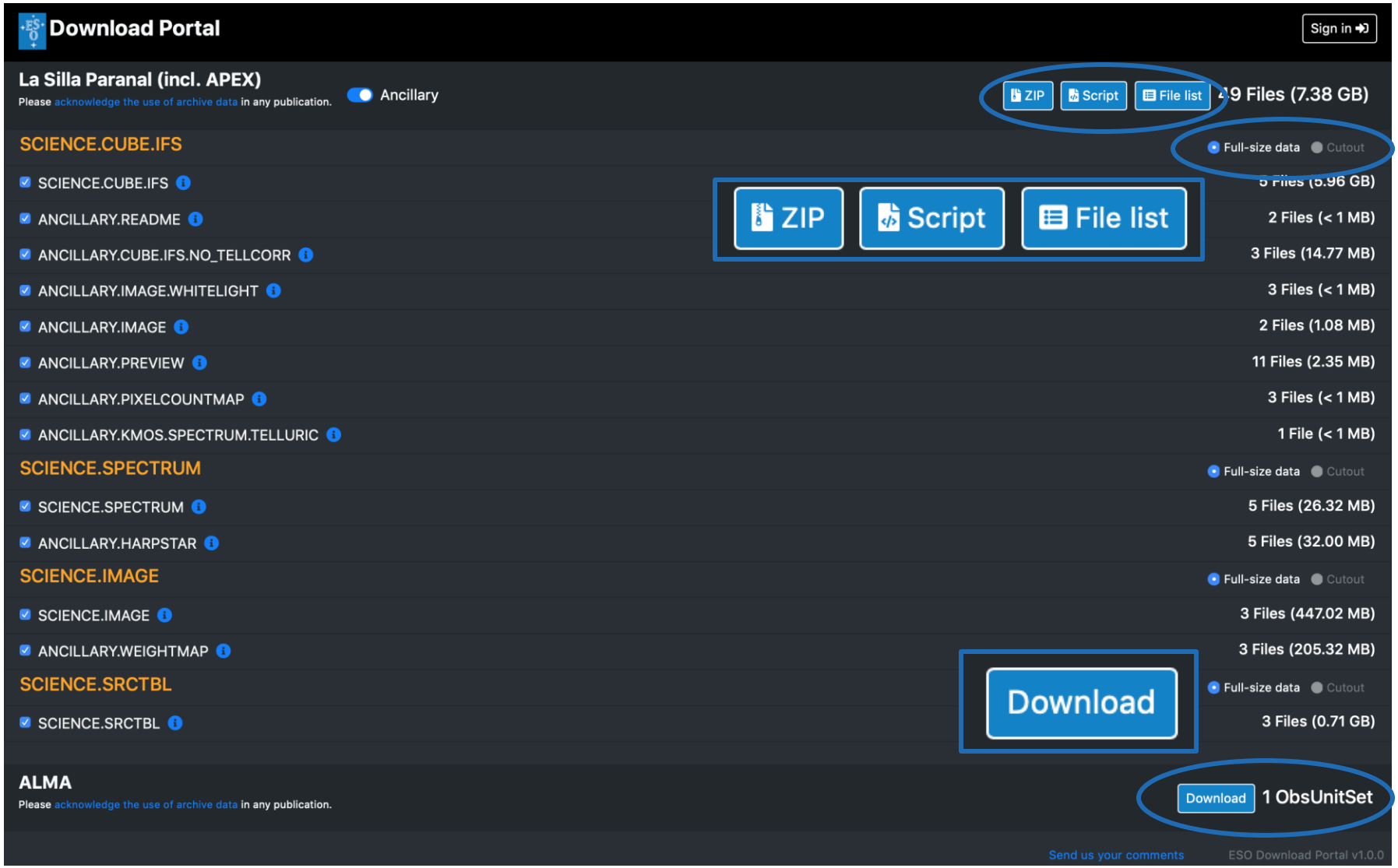
Target lists



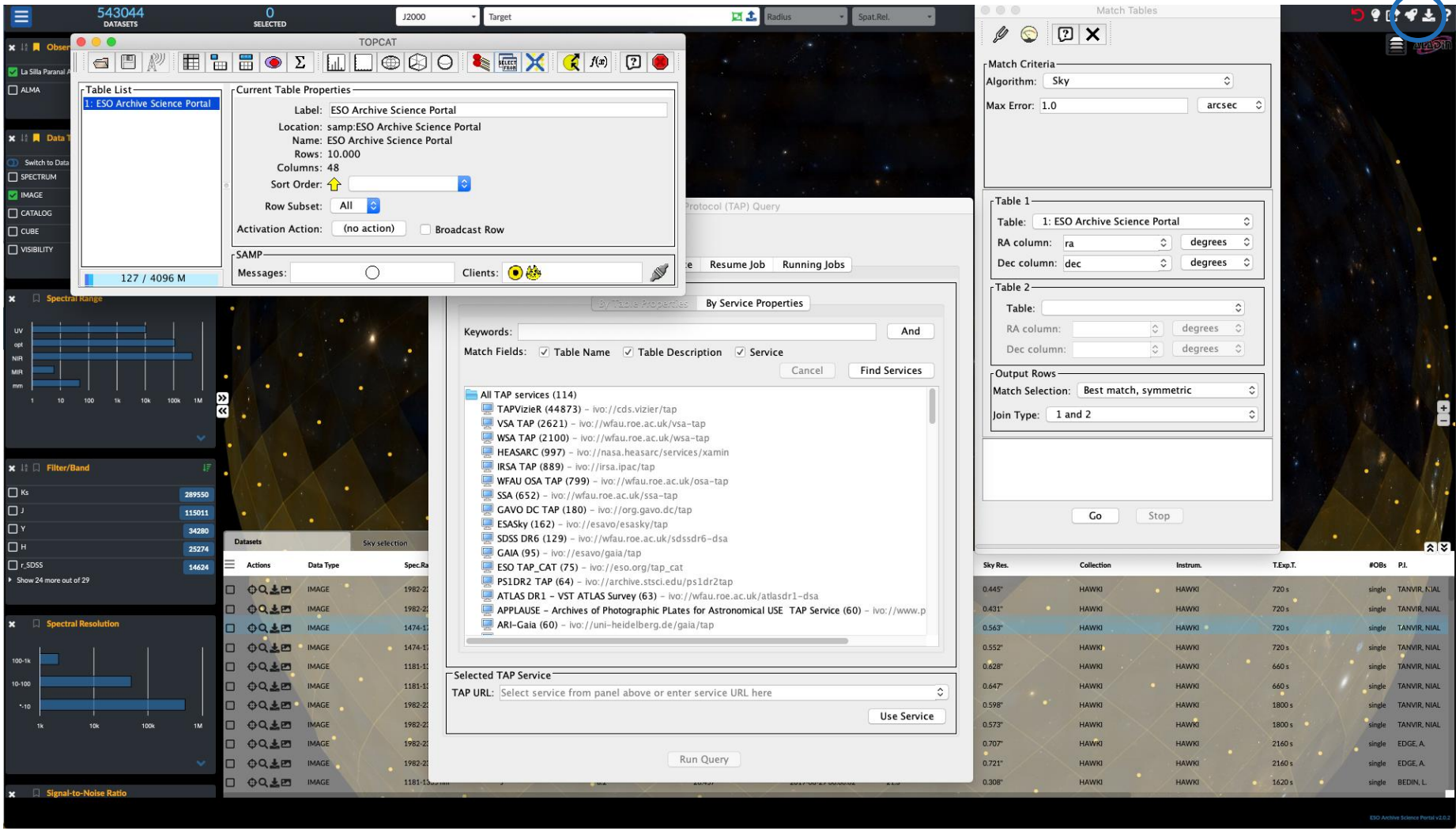


Cutouts: images, spectra, cubes

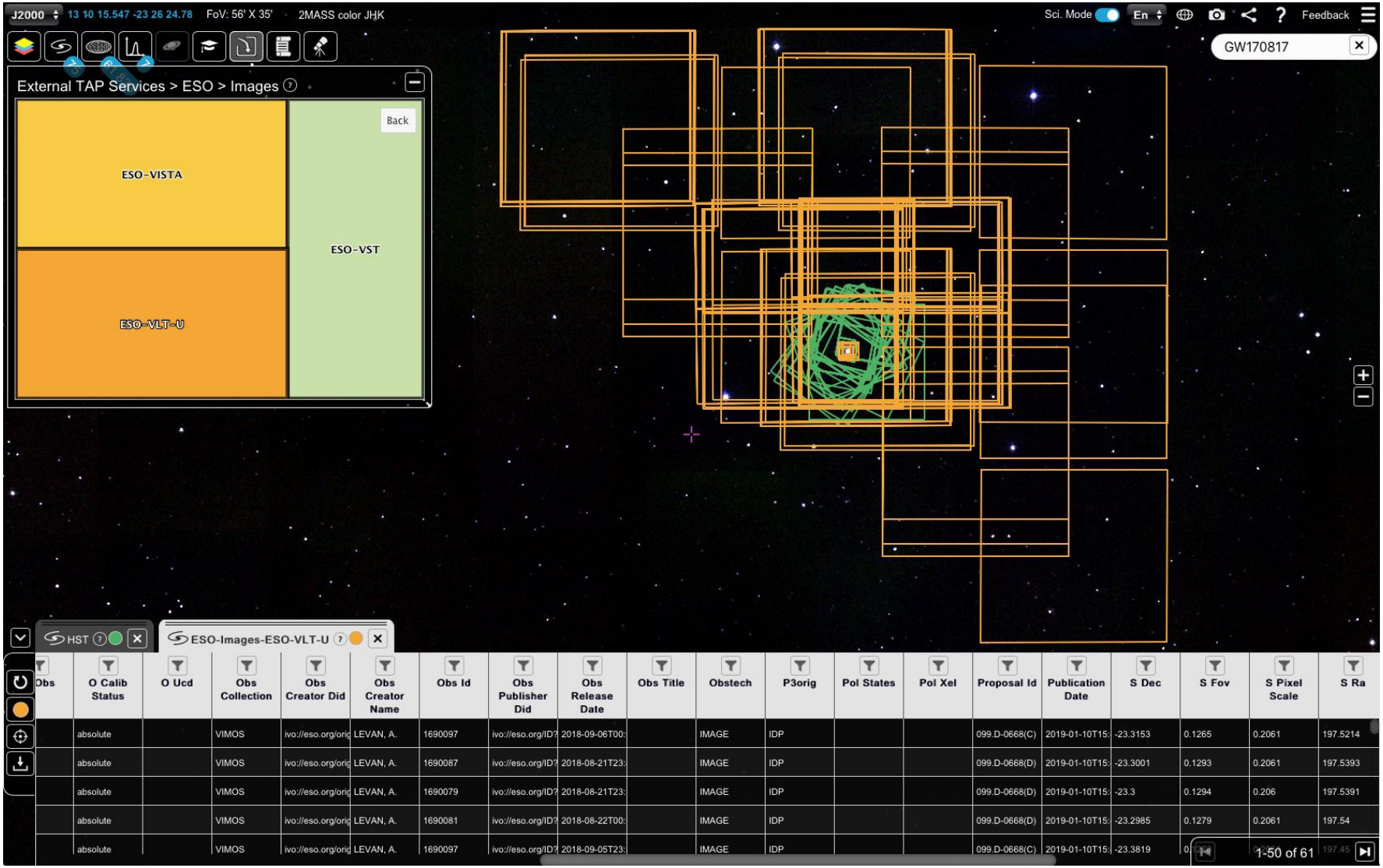
Data download



Virtual Observatory



Digression: ESO data in ESASky



Interactive access from a browser

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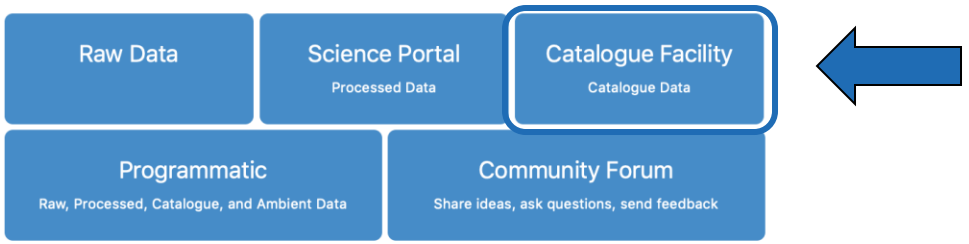

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More news ...

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Currently, **raw data** and various types of **data products** can be reached via different interfaces:

Category	Access Point	Data collection	Data Type	Instruments
LPO Raw Data	**Raw data** query form (all instruments) **Instrument specific** query forms **Direct** retrieval of raw data by file name	All ESO raw data	Various	Many La Silla Paranal instruments
LPO Processed Data	**Science Portal** (Processed Data) **Type specific** query forms (generic, spectral, imaging, VISTA) **Direct** retrieval of reduced data by file name	Processed Data (ESO public surveys; ESO pipeline-reduced products; Large programs: GOODS, zCOSMOS; etc.)	Imaging, Spectroscopy, Catalogs, etc.	Various

Source catalogues

ESO public survey

PROGRAMME	TITLE (*click on title for querying*)	INSTRUMENT	FILTER SET	VERSION	PUBLICATION DATE	INFO	REQUEST
UltraVISTA	COSMOS2015 catalogue: photometric redshifts and stellar masses (Laigle et al. 2016)	VIRCAM	Y,J,H,Ks	1	2016-12-20	(i)	(r)
UltraVISTA	Deep/Ultra-Deep Near-IR Survey of the COSMOS Field (Ultra-VISTA)	VIRCAM	Y,J,H,Ks,NB118	3	2019-03-11	(i)	(r)
GCAV	GCAV catalogue for RXCJ1514.9-1523 cluster	VIRCAM	Y,J,Ks	1	2018-12-20	(i)	(r)
GCAV	GCAV catalogue for RXCJ2129.6+0005 cluster	VIRCAM	Y,J,Ks	1	2018-12-20	(i)	(r)
GAIAESO	Gaia-ESO spectroscopic survey	GIRAFFE,UVES		2	2016-12-05	(i)	(r)
LEGA-C	Large Early Galaxy Census Spectroscopic Survey	VIMOS		2	2018-06-21	(i)	(r)
PESSTO	PESSTO Multi-epoch Photometry	MULTI		2	2017-08-25	(i)	(r)
PESSTO	PESSTO Public ESO Spectroscopic Survey of Transient Objects	EFOSC		2	2017-08-25	(i)	(r)
KIDS	The Kilo-Degree Survey 9-band ugriZYJHKs source catalogue	OMEGACAM, VIRCAM	u_SDSS,g_SDSS,r_SDSS,i_SDSS,Z,Y,J,H,Ks	4	2020-05-20	(i)	(r)
KIDS	The Kilo-Degree Survey: Weak lensing shear mesurements	OMEGACAM	u_SDSS,g_SDSS,r_SDSS,i_SDSS	1	2017-01-03	(i)	(r)
VANDELS	VANDELS High-Redshift Galaxy Evolution: Spectroscopic and Photometric Redshifts in the CANDELS UDS and CDFS Fields	VIMOS		3	2019-11-11	(i)	(r)
VIDEO	VISTA Deep Extragalactic Observations Survey (VIDEO) - CDFS field	VIRCAM	Z,Y,J,H,Ks	2	2016-09-09	(i)	(r)
VIDEO	VISTA Deep Extragalactic Observations Survey (VIDEO) - ES1 field	VIRCAM	Z,Y,J,H,Ks	2	2016-09-09	(i)	(r)
VIDEO	VISTA Deep Extragalactic Observations Survey (VIDEO) - XMM field	VIRCAM	Z,Y,J,H,Ks	3	2016-09-09	(i)	(r)
VHS	VISTA Hemisphere Survey band-merged multi-waveband catalogues (VHS)	VIRCAM	Y,J,H,Ks	3	2020-03-17	(i)	(r)
VIKING	VISTA Kilo-degree Infrared Galaxy Survey (VIKING)	VIRCAM	Z,Y,J,H,Ks	4	2020-03-17	(i)	(r)

Large programme

PROGRAMME	TITLE (*click on title for querying*)	INSTRUMENT	FILTER SET	VERSION	PUBLICATION DATE	INFO	REQUEST
ATLASGAL	ATLASGAL - APEX Large Area Survey of the Galaxy	APEXBOL	870u	1	2016-01-20	(i)	(r)
196.D-0214	EREBOS source catalogue	FORS2		1	2018-03-19	(i)	(r)
196.D-0214	EREBOS spectroscopic catalogue	FORS2		1	2018-03-19	(i)	(r)
GOODS_FORS2	GOODS/FORS2 Spectroscopic Survey	FORS2		1	2014-07-11	(i)	(r)
GOODS_ISAAC	GOODS/ISAAC imaging	ISAAC		1	2014-12-12	(i)	(r)
GOODS_VIMOS_SPEC	GOODS/VIMOS Spectroscopic Survey	VIMOS		1	2014-12-12	(i)	(r)
HUGS	K band Image of the GOODS-South field	HAWKI	Ks	1	2014-09-29	(i)	(r)
HUGS	K band Image of the UDS field	HAWKI	Ks	1	2014-09-29	(i)	(r)
XQ-100	Quasars and their absorption lines: a legacy survey of the high-redshift universe (XQ-100)	XSHOOTER		1	2016-07-18	(i)	(r)
VIPERS	VIPERS - VIMOS Public Extragalactic Redshift Survey	VIMOS		1	2016-12-15	(i)	(r)
HUGS	Y band Image of the UDS field	HAWKI	Y	1	2014-09-29	(i)	(r)
ZCOSMOS	zCOSMOS Spectroscopic Redshift Survey	VIMOS		2	2015-11-04	(i)	(r)

Other

PROGRAMME	TITLE (*click on title for querying*)	INSTRUMENT	FILTER SET	VERSION	PUBLICATION DATE	INFO	REQUEST
AMBRE	Atmospheric Parameters and Chemical Abundances from Stellar Spectra	FEROS		1	2013-07-15	(i)	(r)
MW-BULGE-PSFPHOT	Milky Way Bulge PSF Photometry	VIRCAM	J,Ks	1	2019-08-21	(i)	(r)
NGTS	Next Generation Transit Survey - light curve catalogue	NGTS	VIS/NIR_NGTS	2	2020-07-20	(i)	(r)

Sort	Column	Constraint	Unit	Description	UCD
	IAUNAME			IAU Name (not unique)	meta.id
	SOURCEID			UID of this merged detection as assigned by merge algorithm	meta.id;meta.main
	RA2000		Degrees	Celestial Right Ascension	pos.eq.ra;meta.main
	DEC2000		Degrees	Celestial Declination	pos.eq.dec;meta.main
	MERGEDCLASS			Class flag,1|0|-1|-2|-3|-9=gal|noise|star|probStar|probGal|saturated	meta.code
	EBV			The galactic dust extinction value measured from the Schlegel maps	phys.absorption.gal
	ZMYPNT		mag	Point source colour Z-Y (using aperMag3)	phot.color;em.opt.I;em.IR.NIR
	ZMYPNTERR		mag	Error on point source colour Z-Y	stat.error;em.opt.I;em.IR.NIR
	ZMYEXT		mag	Extended source colour Z-Y (using aperMagNoAperCorr3)	phot.color;em.opt.I;em.IR.NIR
	ZMYEXTERR		mag	Error on extended source colour Z-Y	stat.error;em.opt.I;em.IR.NIR
	YMJPNT		mag	Point source colour Y-J (using aperMag3)	phot.color;em.IR.NIR;em.IR.J
	YMJPNTERR		mag	Error on point source colour Y-J	stat.error;em.IR.NIR;em.IR.J
	YMJEXT		mag	Extended source colour Y-J (using aperMagNoAperCorr3)	phot.color;em.IR.NIR;em.IR.J
	YMJEXTERR		mag	Error on extended source colour Y-J	stat.error;em.IR.NIR;em.IR.J
	JMHPNT		mag	Point source colour J-H (using aperMag3)	phot.color;em.IR.J;em.IR.H
	JMHPNTERR		mag	Error on point source colour J-H	stat.error;em.IR.J;em.IR.H
	JMHEXT		mag	Extended source colour J-H (using aperMagNoAperCorr3)	phot.color;em.IR.J;em.IR.H
	JMHEXTERR		mag	Error on extended source colour J-H	stat.error;em.IR.J;em.IR.H
	HMKSPNT		mag	Point source colour H-Ks (using aperMag3)	phot.color;em.IR.H;em.IR.K
	HMKSPNTERR		mag	Error on point source colour H-Ks	stat.error;em.IR.H;em.IR.K
	HMKSEXT		mag	Extended source colour H-Ks (using aperMagNoAperCorr3)	phot.color;em.IR.H;em.IR.K

Interactive access from a browser

4. COMMUNITY FORUM

archive.eso.org

Science Archive Facility

- Data Portal
- ESO Data
- Hubble Space Telescope Data
- Virtual Observatory Tools
- Catalogues, Plates and DSS
- Tools and Documentation
- Related External Services
- ESO & HST Image Galleries
- News and Updates
- FAQ
- ESO Data Access Policy

Warning!!

Due to planned maintenance, there will be a disruption of some archive services on the weekend of 5-6 September 2020. Full services won't be guaranteed before Monday 7 September. We apologize for any inconvenience.

Please be informed that due to measures on COVID-19 pandemic adopted at ESO, Science Operations have been paused at all sites in Chile since 23rd March 2020. More detail...

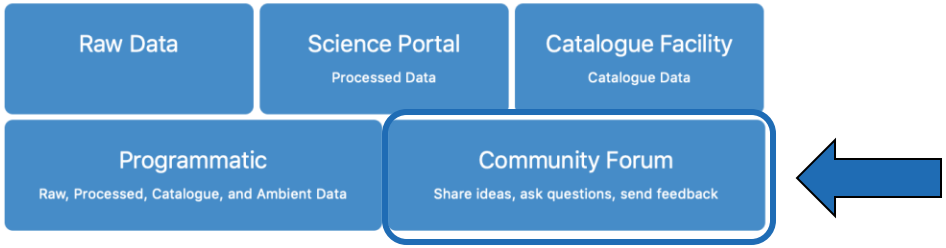
Welcome to the ESO Science Archive Facility

The ESO Science Archive Facility contains data from ESO telescopes at La Silla Paranal Observatory, including the APEX submillimeter telescope on Llano de Chajnantor. In addition, the raw UKIDSS/WFCAM data obtained at the UK Infrared Telescope facility in Hawaii are available.

The Principal Investigators of successful proposals for time on ESO telescopes have exclusive access to their scientific data for the duration of a proprietary period, normally of one year, after which the data becomes available to the community at large. Please read the ESO Data Access Policy statement for more information, along with the relevant FAQs.

Browsing the archive does not require authentication. Please acknowledge the use of archive data in any publication.

There are three main ways to access the archive, varying for content and presentation/interface: the usual Raw Data query form, the innovative Science Portal to browse and access the processed data, and the novel Programmatic and Tools access which permits direct database access to both raw and processed data, and to the ambient condition measurements, also in a scriptable and VO manner. Other query forms are available in the table at the bottom of this page.



Latest News and Updates

- ESPRESSO commissioning data release (03 Sep 2020)
- Second data release of the Next Generation Transit Survey (20 July 2020)
- Release of pipeline processed and telluric corrected KMOS 3D data cubes (16 Jul 2020)
- ESO Science Data Products standard version 6 published (23 Jun 2020)

More news ...

To browse the archive

Currently, **raw data** and various types of **data products** can be reached via different interfaces:

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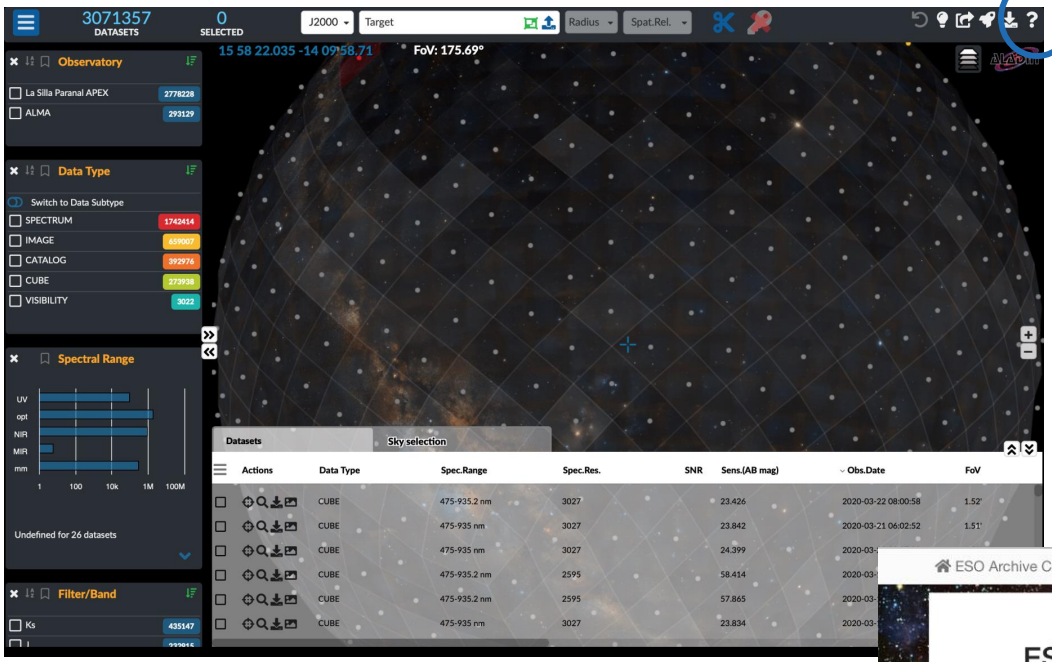
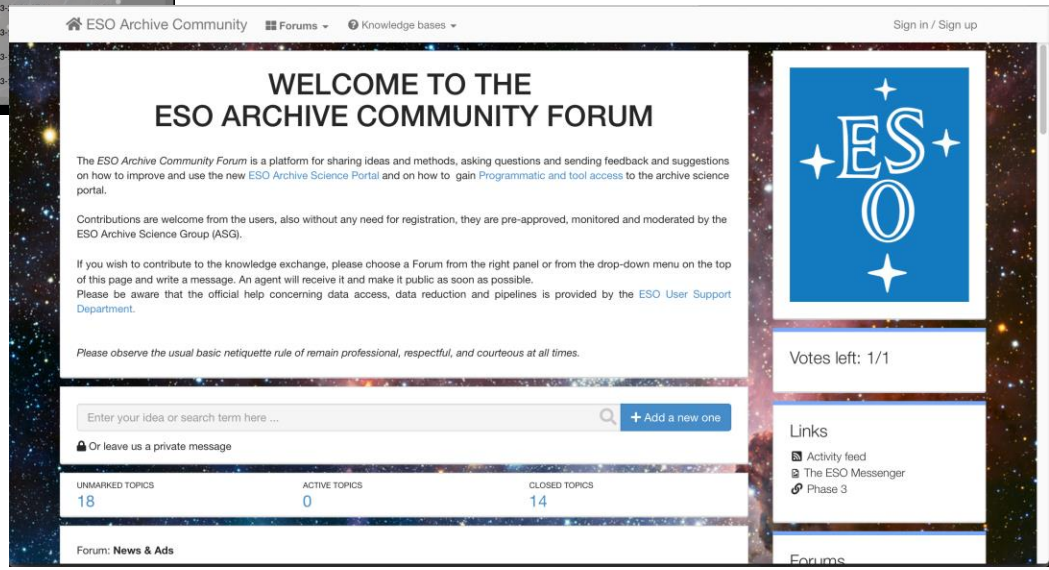
Archive Community Forum



- User feedback/questions
- Knowledge database



Programmatic, tool and Virtual Observatory

DIRECT AND SCRIPTED DATABASE ACCESS

Motivations

- *Programmatic access*
  - Query and download data from scripts programmed and run by the user, allowing for long/repetitive sequences of queries
  - Complex queries, going beyond what a user interface, with its fixed query model, allows
- *Tool access*
  - Discover and access data through standalone community-built(*) tools with powerful generic capabilities, or with specific capabilities that cannot be implemented in a general interface.

    in the community (Aladin, Topcat, …)

    (*) Benefitting of the expertise and resources available
- *VO standards and protocols*
  - Use established standards and protocols from the Virtual Observatory, to make the ESO science archive data discoverable through VO services and tools. Benefit: we used existing VO s/w libs

What's demoed here today

- *Programmatic access to **tabular data and metadata***
  - Queries written in a standard language: *Astronomical Data Query Language (***ADQL**, VO standard), and executed via a standard protocol: Table Access Protocol (**TAP**, VO standard)
    - To search for **raw, processed, and ambient data (tap_obs),** and to query the community-provided Phase 3 **catalogues (tap_cat)**
- *Programmatic access to **data files** (or part of them)*
  - **File download** anonymous and authenticated (JWT tokens, OAuth2.0)
  - **Datalink**
    - VO standard protocol to access data and related files (ancillary files, previews, etc.) and to navigate the provenance information (originating files the data were derived from, derived products)
  - **Cutout** to download user-defined slices of images, cubes, spectra, catalog tiles, and source tables (SODA, VO standard)
- *Putting in it all together*
  - Using **tools, scripts,** and **jupyter notebooks** (python)

http://archive.eso.org/programmatic

Science Archive Programmatic and Tools Access Demo page

The purpose of this page is to help you to learn:

1. *how to compose URLs to interact with the different ESO science archive services, either programmatically or via tools;*
2. *how to construct queries to interrogate the various database tables of the ESO science archive, using ADQL and TAP;*
3. *how to put it all together and script your access to the ESO science archive, using the pyvo python module.*

If some terms in this page are not familiar to you, please read the overview page first.

In this page: [open] click here to read the page description...

Query a TAP Service | async Query Manager | Script your access | Configure tools | Learn dataset actions | VO standards & software | Change Log

Click on a tab to see its contents here.

Would you like to provide your feedback?

Last modification: 3 September 2020 (see change log)

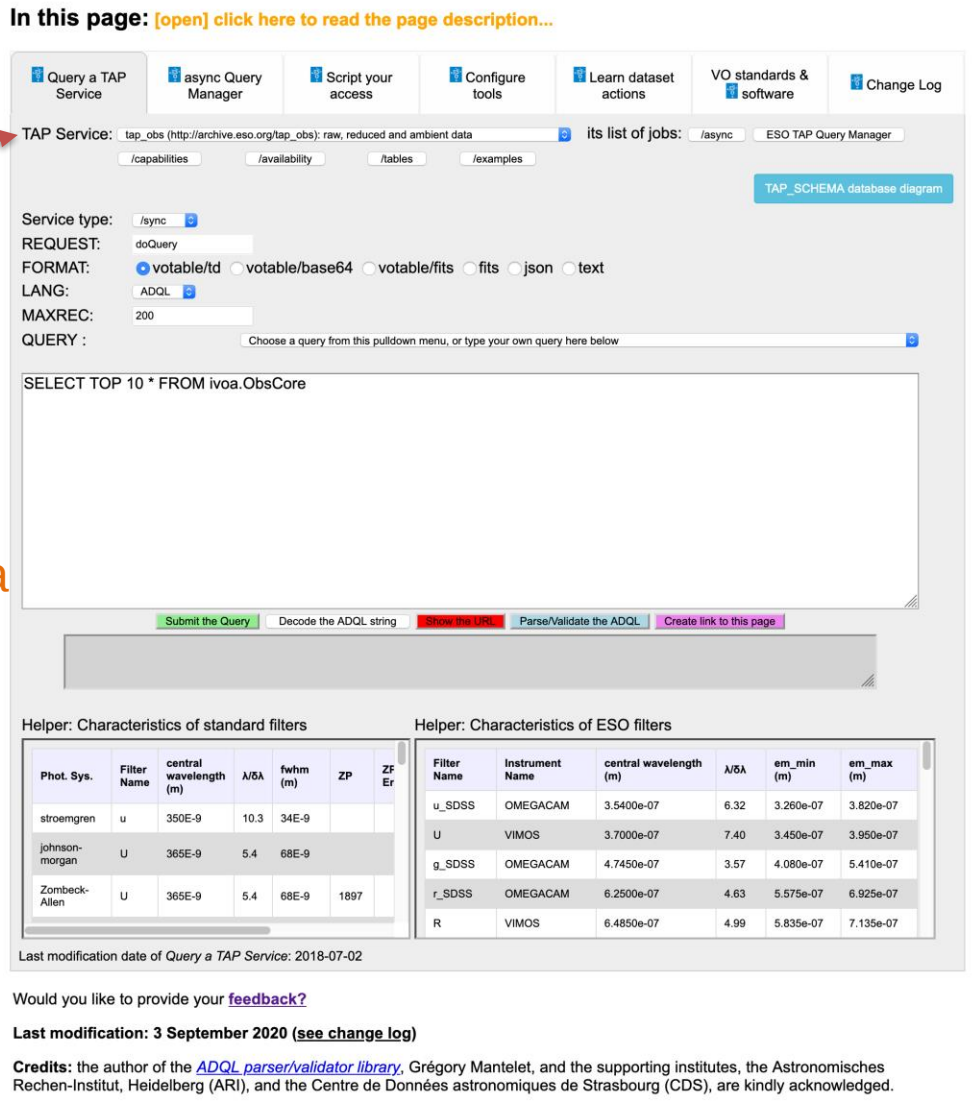
ADQL Queries via TAP (1)

Pulldown menu with a list of TAP services to choose from.

First two are:

TAP_OBS
- To query for ESO observational data (ambient, raw, processed data, provenance information)

TAP_CAT
- To query the ESO community-generated catalogs (phase 3)



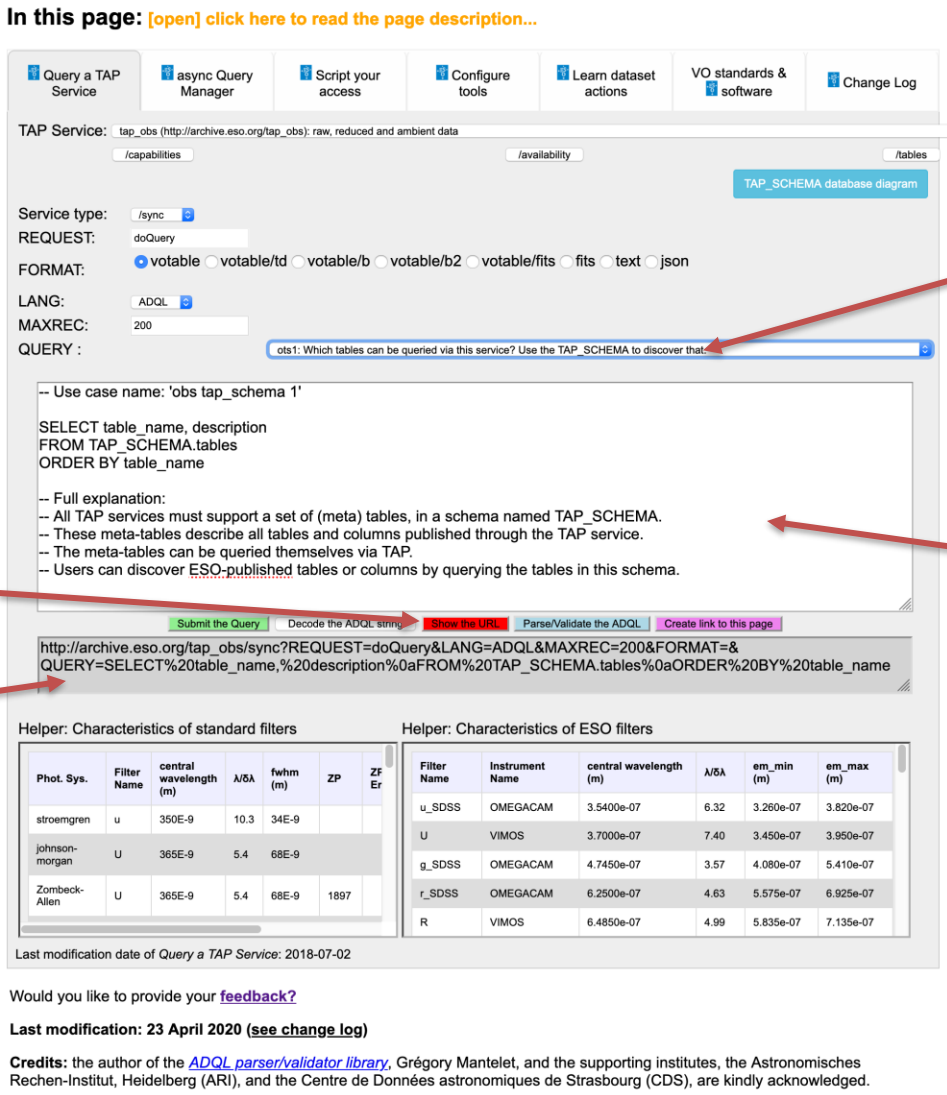
ADQL Queries via TAP (2)

- *“Cool, but… Which tables are available? What are their names?”*
- In TAP, also the descriptors of the tables and their columns are stored in the database, and are therefore queryable:

QUERY:

```
SELECT table_name, description
FROM TAP_SCHEMA.tables
ORDER BY table_name
```

ADQL Queries via TAP (3)



"Show the URL" button click on it to see which URL will be invoked

The first example from this pulldown menu provides you that query

Comments start with -- (a double minus)

ADQL Queries via TAP (4)


```
−<VOTABLE version="1.3" xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.3 http://www.ivoa.net/xml/VOTable/v1.3">
  −<RESOURCE type="results">
     <INFO name="QUERY_STATUS" value="OK"/>
     <INFO name="PROVIDER" value="ESO">TAP service for the science archive</INFO>
     <INFO name="QUERY" value=" SELECT table_name, description FROM TAP_SCHEMA.tables ORDER BY table_name "/>
    −<TABLE name="result_S1599209365261">
      −<FIELD arraysize="*" datatype="char" name="table_name">
         <DESCRIPTION>the fully qualified table name</DESCRIPTION>
       </FIELD>
      −<FIELD arraysize="*" datatype="char" name="description">
         <DESCRIPTION>describes tables in the tableset</DESCRIPTION>
       </FIELD>
      −<DATA>
       −<TABLEDATA>
         −<TR>
            <TD>asm.dimm_paranal</TD>
           −<TD>
              Table containing the ambient measurements of the Differential Image Motion Monitor (DIMM) channel of the MASS-DIMM instrument. DIMM operates in an extended range of
              atmospheric conditions which overlap science operation. It provides, along with other measurements, the Paranal reference seeing. Time coverage: 2016-APR-04 12:00:00 UTC
              onwards. More info at: http://archive.eso.org/wdb/help/eso/ambient_paranal.html#dimm_2016
            </TD>
          </TR>
         −<TR>
            <TD>asm.lhatpro_paranal</TD>
           −<TD>
              Table containing the ambient measurements of the Low Humidity And Temperature PROfiling microwave radiometer (LHATPRO) resolves the low levels of precipitable water
              vapour (PWV) that are prevalent on Paranal (median ~2.4 mm). The instrument consists of a humidity profiler (183-191 GHz), a temperature profiler (51-58 GHz), and an infrared
              camera (~10 micrometers) for cloud detection. Time coverage: 2016-APR-04 12:00:00 UTC onwards.More info at: http://archive.eso.org/wdb/help
              /eso/ambient_paranal.html#lhatpro
            </TD>
          </TR>
         −<TR>
            <TD>asm.mass_paranal</TD>
           −<TD>
              Table containing the ambient measurements of the Multi-Aperture Scintillation Sensor located in Paranal. Included measurements like; vertical profile of the turbulence Cn2(h) (6
              layers), Isoplanatic angle, Coherence time, etc. More info at: http://archive.eso.org/wdb/help/eso/ambient_paranal.html#mass
            </TD>
          </TR>
         −<TR>
            <TD>asm.meteo_lasilla</TD>
           −<TD>
              Table of the ambient measurements of the Vaisala meteorological station installed at La Silla. The following measurements are provided: temperature, relative humidity, wind speed
              and direction, at various heights. The sampling intervals are 2 seconds for digital sensors (wind speed and direction) and one minute for analog sensors (T, Rh, P). One minute
```

Currently available TAP_OBS tables

- asm.dimm_paranal
- asm.lhatpro_paranal
- asm.mass_paranal
- asm.meteo_lasilla
- asm.meteo_paranal
- asm.slodar_paranal
- TAP_SCHEMA.columns
- **dbo.raw** **(raw data)**
- dbo.ssa

- **ivoa.ObsCore** **(processed data)**
- TAP_SCHEMA.key_columns
- TAP_SCHEMA.keys
- phase3v2.files
- provenance
- TAP_SCHEMA.schemas
- TAP_SCHEMA.tables

More to come…

Ivoa.ObsCore: VO standard table

- ObsCore is a standard VO service:
  - column names, formats, units are fixed by the standard
  - all sites running an ObsCore service can be queried with one and the same query
  - E.g., this ”cone-search” query around Eta Car for spectra can be sent unchanged to all existing ObsCore services:

```
SELECT target_name, s_dec, s_ra, t_exptime, em_res_power, em_min,
dataproduct_type, instrument_name
FROM   ivoa.Obscore
WHERE  CONTAINS(s_region,CIRCLE('ICRS',161.265, -59.684,
100./3600.)) = 1
AND em_res_power > 27000
```

Ivoa.ObsCore: VO standard table

- ObsCore is a standard VO service:
  - column names, formats, units are fi… dard
  - all sites running an ObsCor… queried with one and the same que…
  - E.g., this "cone-s… ound Eta Car for spectra can be ser… all existing ObsCore services:

Remember: use the ESO ObsCore only for processed products !

S… e, s_dec, s_ra, t_exptime, em_res_power, em_min, … pe, instrument_name

… Ivoa.Obscore

WHERE CONTAINS(s_region,CIRCLE('ICRS',161.265, -59.684, 100./3600.)) = 1

AND em_res_power > 27000

- *“I’m interested in processed data; what are the columns of the ivoa.ObsCore table?”*

Query a TAP Service | async Query Manager | Script your access | Configure tools | Learn dataset actions | VO standards & software | Change Log

TAP Service: tap_obs (http://archive.eso.org/tap_obs): raw, reduced and ambient data its list of jobs: /async ESO TAP Query Manager

/capabilities /availability /tables /examples

TAP_SCHEMA database diagram

Service type: /sync

REQUEST: doQuery

FORMAT: votable/td votable/base64 votable/fits fits json text

LANG: ADQL

MAXREC: 200

QUERY : ots3: I am interested in reduced data. What are the column names of the ivoa.obscore table?

```
-- Use case name: 'obs tap_schema 3'

SELECT column_name, datatype, unit, ucd, utype -- add description to know more
from TAP_SCHEMA.columns
where table_name='ivoa.ObsCore'

-- WHAT ARE THE COLUMNS OF THE DATA PRODUCT TABLE called ivoa.ObsCore?
-- The TAP_SCHEMA.columns table contains all column names, units,
-- UCDs, description, etc., of all the published ESO tables.
```

Submit the Query | Decode the ADQL string | Show the URL | Parse/Validate the ADQL | Create link to this page

Columns of the ivoa.ObsCore table

column_name	datatype	unit	ucd	utype
"abmaglim"	"DOUBLE"	"mag"	"phot.mag;stat.max"	"mag"
"access_estsize"	"BIGINT"	"kbyte"	"phys.size;meta.file"	"obscore:Access.size"
"access_format"	"VARCHAR"		"meta.code.mime"	"obscore:Access.format"
"access_url"	"CLOB"		"meta.ref.url"	"obscore:Access.reference"
"bib_reference"	"VARCHAR"		"meta.bib.bibcode"	"obscore:Curation.reference"
"calib_level"	"INTEGER"		"meta.code;obs.calib"	"obscore:ObsDataset.calibLevel"
"dataproduct_subtype"	"VARCHAR"		"meta.code.class"	"obscore:ObsDataset.dataProductSubtype"
"dataproduct_type"	"VARCHAR"		"meta.code.class"	"obscore:ObsDataset.dataProductType"
"dp_id"	"VARCHAR"		"meta.id"	
"em_max"	"DOUBLE"	"m"	"em.wl;stat.max"	"obscore:Char.SpectralAxis.Coverage.Bounds.Limits.HiLimit"
"em_min"	"DOUBLE"	"m"	"em.wl;stat.min"	"obscore:Char.SpectralAxis.Coverage.Bounds.Limits.LoLimit"
"em_res_power"	"DOUBLE"		"spect.resolution"	"obscore:Char.SpectralAxis.Resolution.ResolPower.refVal"
"em_xel"	"BIGINT"		"meta.number"	"obscore:Char.SpectralAxis.numBins"
"facility_name"	"VARCHAR"		"meta.id;instr.tel"	"obscore:Provenance.ObsConfig.Facility.name"
"filter"	"VARCHAR"		"meta.id;instr.filter"	
"gal_lat"	"DOUBLE"	"deg"	"pos.galactic.latitude"	"galactic:Char.SpatialAxis.Coverage.Location.Coord.Position2D.Value2.C2"
"gal_lon"	"DOUBLE"	"deg"	"pos.galactic.longitude"	"galactic:Char.SpatialAxis.Coverage.Location.Coord.Position2D.Value2.C1"
"instrument_name"	"VARCHAR"		"meta.id;instr"	"obscore:Provenance.ObsConfig.Instrument.name"
"multi_ob"	"CHAR"		"meta.code.multip;obs"	
"n_obs"	"INTEGER"		"meta.number;obs"	
"o_calib_status"	"VARCHAR"		"meta.code.qual"	"obscore:Char.ObservableAxis.calibrationStatus"
"o_ucd"	"VARCHAR"		"meta.ucd"	"obscore:Char.ObservableAxis.ucd"
"obs_collection"	"VARCHAR"		"meta.id"	"obscore:DataID.collection"
"obs_creator_did"	"VARCHAR"		"meta.id"	"obscore:DataID.creatorDID"
"obs_creator_name"	"VARCHAR"		"meta.id"	"obscore:Da
"obs_id"	"VARCHAR"		"meta.id"	"obscore:Da
"obs_publisher_did"	"VARCHAR"		"meta.ref.ivoid"	"obscore:Cu
"obs_release_date"	"TIMESTAMP"		"time.release"	"obscore:Cu
"obs_title"	"VARCHAR"		"meta.title;obs"	"obscore:Da
"obstech"	"VARCHAR"		"instr.setup"	
"p3orig"	"VARCHAR"		"meta.ref"	
"pol_states"	"VARCHAR"		"meta.code;phys.polarization"	"obscore:Ch
"pol_xel"	"BIGINT"		"meta.number"	"obscore:Ch
"proposal_id"	"VARCHAR"		"meta.id;obs.proposal"	"obscore:Pr
"publication_date"	"TIMESTAMP"		"time.publiYear"	
"s_dec"	"DOUBLE"	"deg"	"pos.eq.dec"	"obscore:Ch
"s_fov"	"DOUBLE"	"deg"	"phys.angSize;instr.fov"	"obscore:Ch
"s_pixel_scale"	"DOUBLE"	"arcsec"	"phys.angSize;instr.pixel"	"obscore:Ch
"s_ra"	"DOUBLE"	"deg"	"pos.eq.ra"	"obscore:Ch
"s_region"	"REGION"		"pos.outline;obs.field"	"obscore:Char.SpatialAxis.Coverage.Support.Area"
"s_resolution"	"DOUBLE"	"arcsec"	"pos.angResolution"	"obscore:Char.SpatialAxis.Resolution.Refval.value"
"s_xel1"	"BIGINT"		"meta.number"	"obscore:Char.SpatialAxis.numBins1"
"s_xel2"	"BIGINT"		"meta.number"	"obscore:Char.SpatialAxis.numBins2"
"snr"	"DOUBLE"		"stat.snr"	
"t_exptime"	"DOUBLE"	"s"	"time.duration;obs.exposure"	"obscore:Char.TimeAxis.Coverage.Support.Extent"
"t_max"	"DOUBLE"	"d"	"time.end;obs.exposure"	"obscore:Char.TimeAxis.Coverage.Bounds.Limits.StopTime"
"t_min"	"DOUBLE"	"d"	"time.start;obs.exposure"	"obscore:Char.TimeAxis.Coverage.Bounds.Limits.StartTime"
"t_resolution"	"DOUBLE"	"s"	"time.resolution"	"obscore:Char.TimeAxis.Resolution.Refval.value"
"t_xel"	"BIGINT"		"meta.number"	"obscore:Char.TimeAxis.numBins"
"target_name"	"VARCHAR"		"meta.id;src"	"obscore:Target.name"

Standard ObsCore colmuns have a utype prefixed with the namespace “obscore:”

→ ESO-specific columns don’t!

Example of a Complex Query: overlapping H & J HAWKI tiles

```
SELECT count(distinct H.dp_id) num_H, min(H.s_resolution) H_minfwhm, max(H.s_resolution) H_maxfwhm,
       count(distinct J.dp_id) num_J, min(J.s_resolution) J_minfwhm, max(J.s_resolution) J_maxfwhm
FROM
(select * FROM ivoa.Obscore WHERE dataproduct_subtype ='tile' AND obs_collection = 'HAWKI'
       AND (gal_lat < -10 OR gal_lat > 10)
       AND obs_release_date < getdate()
       AND em_min < 1.265E-6 AND em_max > 1.265E-6 ) J,

(select * FROM ivoa.Obscore WHERE dataproduct_subtype ='tile' AND obs_collection = 'HAWKI'
       AND (gal_lat < -10 OR gal_lat > 10)
       AND obs_release_date < getdate()
       AND em_min < 1.66E-6 AND em_max > 1.66E-6 ) H

WHERE INTERSECTS( J.s_region , H.s_region)=1
AND ESO_INTERSECTION( J.s_region , H.s_region) > 0.8*AREA( J.s_region )
```

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       AND (gal_lat < -10 OR gal_lat > 10)
       AND obs_release_date < getdate()
       AND em_min < 1.66E-6 AND em_max > 1.66E-6 ) H
WHERE INTERSECTS( J.s_region , H.s_region)=1
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WHERE INTERSECTS( J.s_region , H.s_region)=1
AND ESO_INTERSECTION( J.s_region , H.s_region) > 0.8*AREA( J.s_region )
```

How many high latitude HAWKI H & J tiles, and which spatial resolution?

```
num_h|h_minfwhm|h_maxfwhm|num_j|j_minfwhm|j_maxfwhm
-----|---------|---------|-----|---------|--------
 337 |   0.321 |   4.298 | 331 |   0.331 |  2.137
```

- *Nice, but how do I get to know that I need to set the query constraint:*

  dataproduct_subtype = 'tile' ?

You can always check the various types and subtypes using a query like:

```
SELECT count(*), dataproduct_type, dataproduct_subtype
FROM ivoa.obscore
where obs_collection='HAWKI'
group by dataproduct_type, dataproduct_subtype
order by 2,3
```

```
COUNT_ALL|dataproduct_type|dataproduct_subtype
---------|----------------|-------------------
5861     |"image"         |"pawprint"         |
5830     |"image"         |"tile"             |
11691    |"measurements"  |"srctbl"           |
```

Overlapping H & J HAWK-I: distinct J

```
SELECT * FROM ivoa.ObsCore WHERE dp_id in

(select distinct J.dp_id  FROM

  (select * FROM ivoa.Obscore WHERE dataproduct_subtype ='tile' AND obs_collection = 'HAWKI'

          AND (gal_lat < -10 OR gal_lat > 10)

          AND obs_release_date < getdate()

          AND em_min < 1.265E-6 AND em_max > 1.265E-6 ) J,


  (select * FROM ivoa.Obscore WHERE dataproduct_subtype ='tile' AND obs_collection = 'HAWKI'

          AND (gal_lat < -10 OR gal_lat > 10)

          AND obs_release_date < getdate()

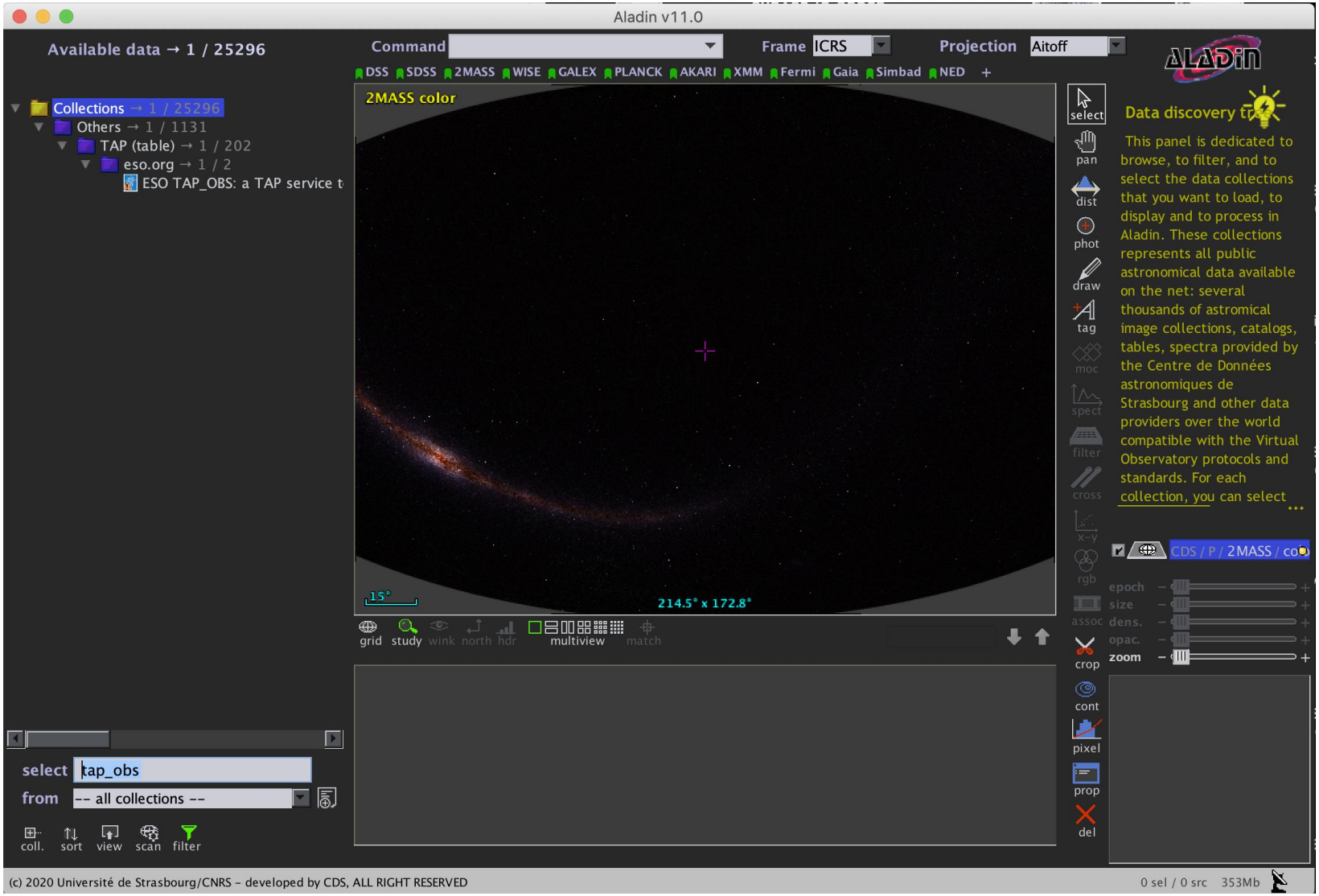
          AND em_min < 1.66E-6 AND em_max > 1.66E-6 ) H


  WHERE INTERSECTS( J.s_region , H.s_region)=1

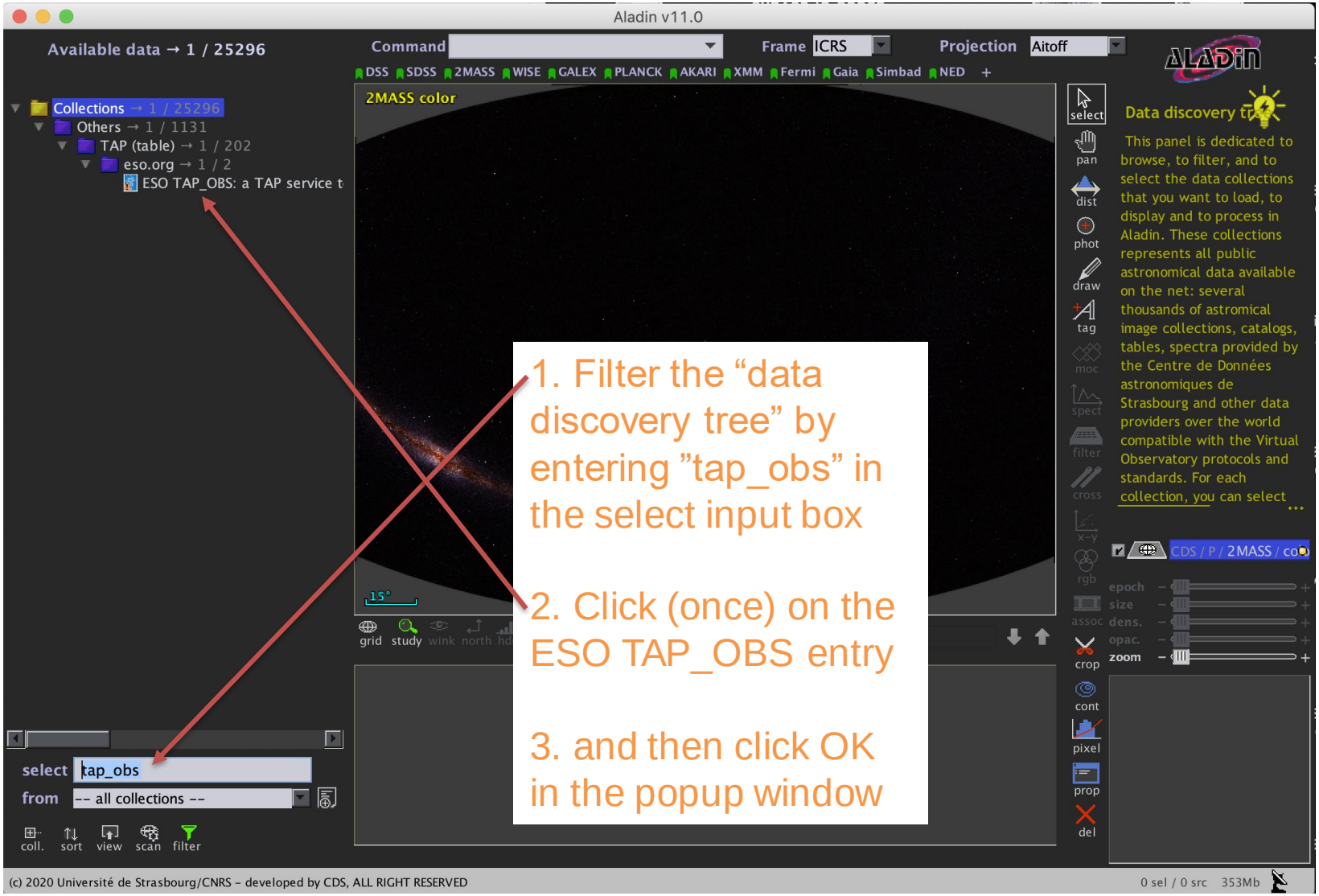
  AND ESO_INTERSECTION( J.s_region , H.s_region) > 0.8*AREA( J.s_region )

)
```

Using a tool to send the query and visualise results: Aladin (CDS)



Using a tool to send the query and visualise results: Aladin (CDS)

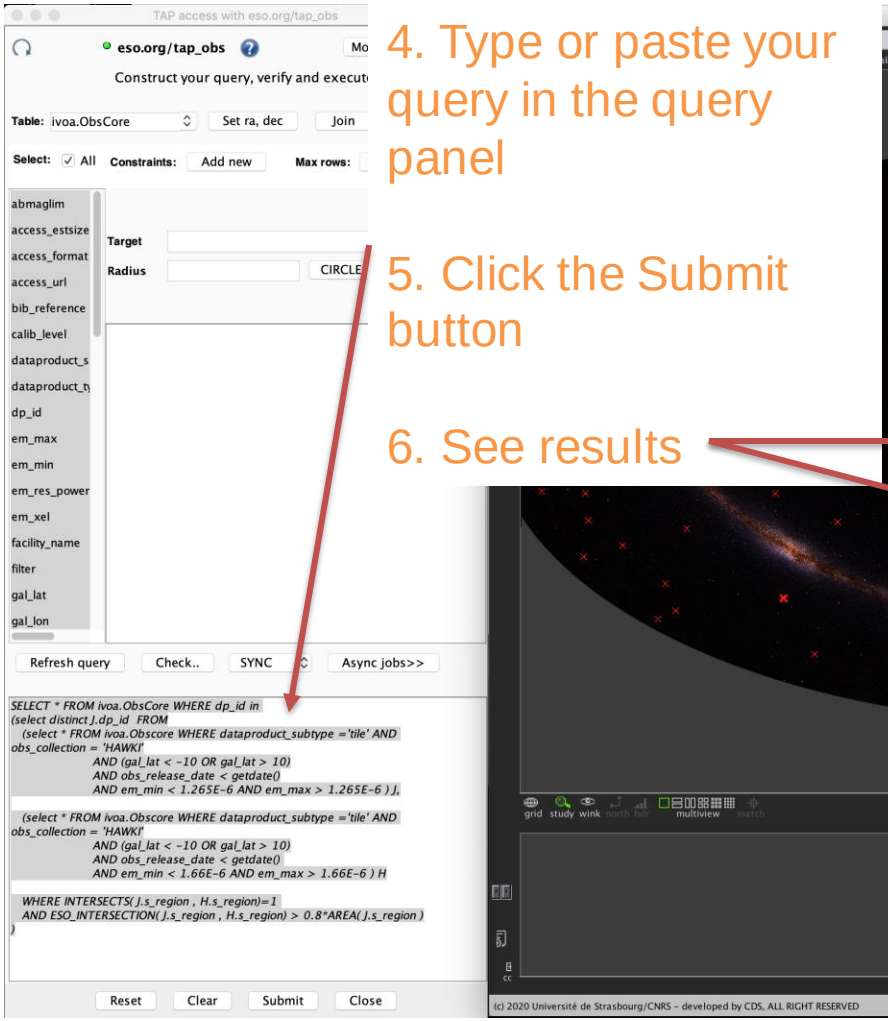


Running the query in Aladin (CDS)

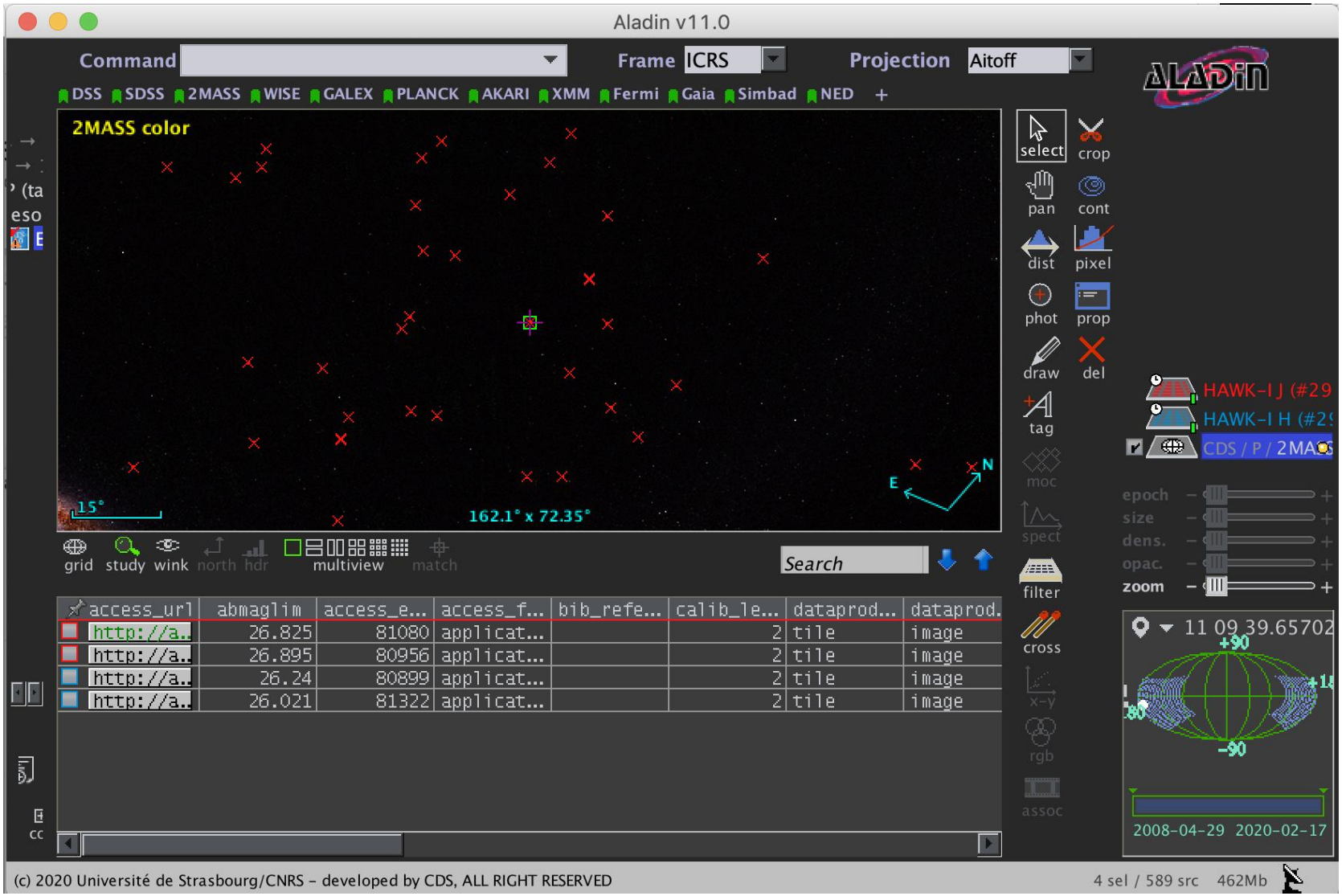
4. Type or paste your query in the query panel

5. Click the Submit button

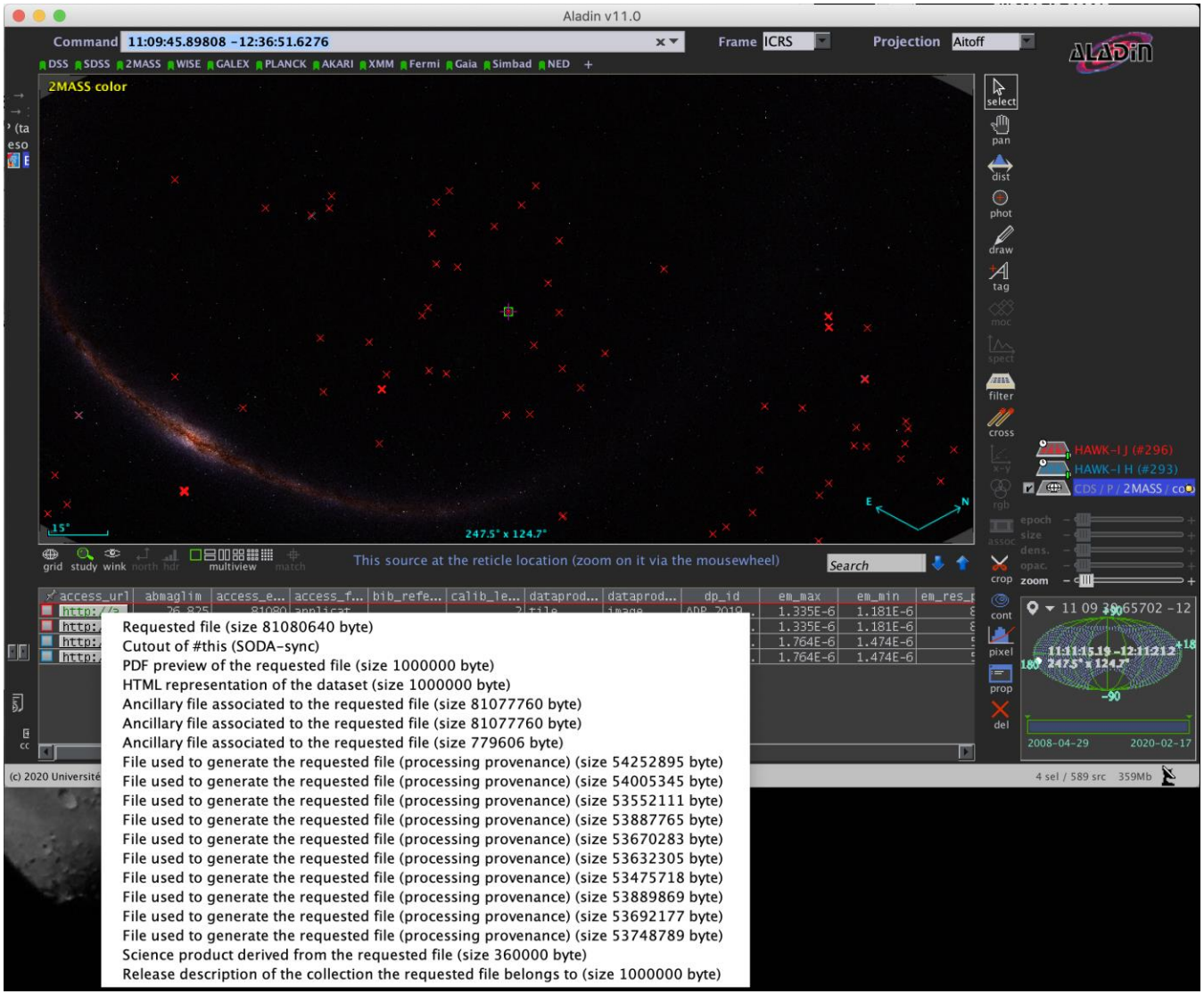
6. See results



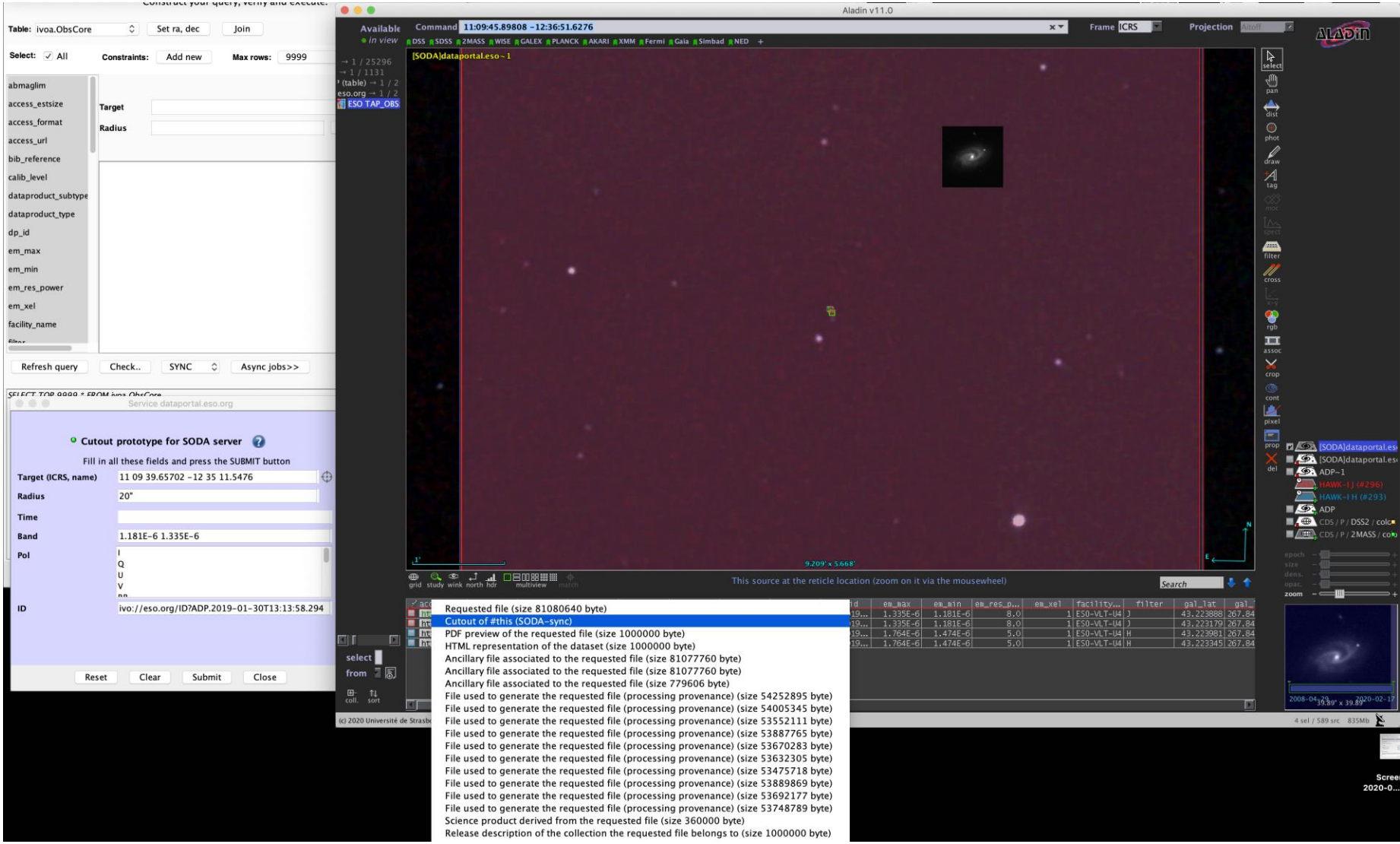
Query results visualised in Aladin



Datalink visualised by Aladin



Cutouts in Aladin (CDS, Strasbourg)



Script your access

In this page: [open] click here to read the page description...

Query a TAP Service | async Query Manager | Script your access | Configure tools | Learn dataset actions | VO standards & software | Change Log

Scripted access to the archive

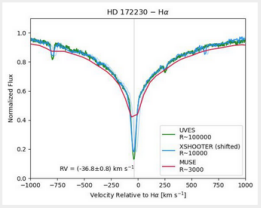
2018-07-02: The eso_ssa.py script illustrates how a python 3 script using the pyvo module can perform queries to the ESO Simple Spectral Access Protocol (SSAP), and retrive the spectra with a SNR grater than a certain threshold.

2018-09-17: The eso_raw.py script illustrates how to query and download raw science frames for a given object.
2019-02-13: New version to reflect a change to the dbo.raw table.

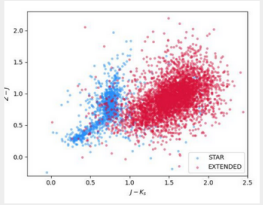
2019-11-25: The eso_download_raw_and_calibs.py script illustrates how to query and download public (i.e. non-proprietary) raw science frames along with the files necessary to calibrate them (via the DataLink and calSelector services).

2020-04-23: More python examples are available as Jupyter Notebooks at: ESO Science Archive Programmatic: HOWTOs

2020-09-03: More python jupyter notebook examples are available in the ESO Archive Community Forum. Currently available:



Access to Spectroscopic Data: Example #1



Access to Catalogues: Example #1

Jupyter Notebooks available (small but growing collection)

How to download data

This section of the "ESO Science Archive Programmatic: HOWTOs" shows how to programmatically download ESO data, either anonymously (for public data) or with authentication (for proprietary data), using Python.

**Usage**: You can access this file either as a static HTML page (download it here), or as an interactive jupyter notebook (download it here) which you can download and run on your machine (instructions). To interact with the jupyter notebook: move up and down the various cells using the arrow keys, execute the code by pressing CTRL+ENTER; you can also modify the code and execute it at will.

Let's start by setting up the python modules:

In [ ]:
```
import os
import sys

import requests
import cgi
import json

import getpass
```

Let's define a couple of utility functions, useful to write the files on disk using the ESO file name (provided in the response http header, via the Content-Disposition field.

In [ ]:
```
def getDispositionFilename( response ):
    """Get the filename from the Content-Disposition in the response's http header"""
    contentdisposition = response.headers.get('Content-Disposition')
    if contentdisposition == None:
        return None
    value, params = cgi.parse_header(contentdisposition)
    filename = params["filename"]
    return filename

def writeFile( response ):
    """Write on disk the retrieved file"""
    if response.status_code == 200:
        # The ESO filename can be found in the response header
        filename = getDispositionFilename( response )
        # Let's write on disk the downloaded FITS spectrum using the ESO filename:
        with open(filename, 'wb') as f:
            f.write(response.content)
        return filename
```

How to retrieve a file anonymously

Without the need to authenticate, any user can anonymously download public files, that is, files that are out of the proprietary period (of usually one year from the moment the observation takes place).

In [ ]:
```
file_url = 'https://dataportal.eso.org/dataportal_new/file/ADP.2016-11-17T12:51:01.877'

response = requests.get(file_url)
filename = writeFile( response )
if filename:
    print("Saved file: %s" % (filename))
else:
    print("Could not get file (status: %d)" % (response.status_code))
```

How to retrieve a file with authentication

Notebooks on How to Access the ESO Scientific Catalogues

HOW TO obtain data given parameters extracted from an ESO catalogue

The ESO Archive provides access to reduced or fully calibrated data sets, and derived catalogs, that were contributed by PIs of ESO programmes or produced by ESO (using ESO calibration pipelines with the best available calibration data), and then integrated into the ESO Science Archive Facility (see for instance the ESO catalogue facility and the Archive Scienc

A powerful way to access this
are python wrappers part of th

In [1]:
```
from ESOAsg.ancillary
from ESOAsg import arc
from ESOAsg import arc

from astropy.coordinat
from astropy.io import
import astropy.units a
import matplotlib.pypl
import numpy as np
```

In [2]:
```
%matplotlib notebook
```

Get all archival sp

In this example we will show h

Query the GAIA-ESO

To begin, you need to know
astropy table of all catalogues

```
archive_catalogues.
```

In [3]:
```
all_catalogues = archi
```

Find metal poor stars:

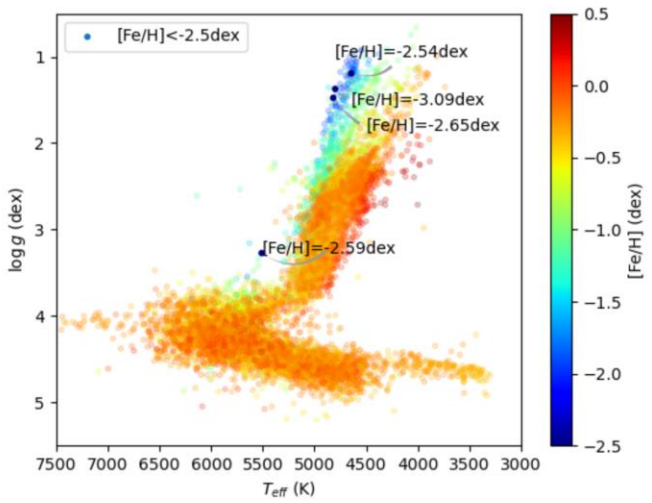
Now the GAIAESO catalogue is ready to be explored. As an example, we queried a larger fraction of the catalogue to find the most metal poor stars (with $[Fe/H] < -2.5\,dex$) and to see their location in the T_{eff} vs. $\log g$ plane:

In [9]:
```
METAL_LIMIT = -2.5 # limit in Fe/H to select

GAIAESO = archive_catalogues.get_catalogues(

# extract the info
TEFF = GAIAESO['TEFF'].data
LOGG = GAIAESO['LOGG'].data
META = GAIAESO['FEH'].data
# remove nans
filter_nans = np.isfinite(TEFF) & np.isfinit
TEFF, LOGG, META = TEFF[filter_nans], LOGG[f


# plot the result
plt.figure()
plt.xlim(7500.,3000.)
plt.ylim(5.5,0.5)
plt.scatter(TEFF, LOGG, c=META, alpha=0.2, m
            cmap='jet')
plt.scatter(TEFF[(META<METAL_LIMIT)], LOGG[(
            cmap='jet', label=r'[Fe/H]<{}dex
plt.clim(-2.5,0.5)
cbar = plt.colorbar()
cbar.set_label(r'[Fe/H] (dex)')
plt.xlabel(r'$T_{eff}$ (K)')
plt.ylabel(r'$\log\,g$ (dex)')
plt.legend()
for idx in range(len(TEFF[(META<METAL_LIMIT)
    plt.annotate(r'[Fe/H]={:.2f}dex'.format(META[(META<METAL_LIMIT)][idx]),
                 xy=(TEFF[(META<METAL_LIMIT)][idx], LOGG[(META<METAL_LIMIT)][idx]),
                 xytext=(-(idx-2)*10, (idx-2)*10), textcoords='offset points',
                 arrowprops=dict(arrowstyle="wedge,tail_width=0.2",
                                 fc="0.6", ec="none",
                                 connectionstyle="arc3,rad=-0.4"))
plt.show()
plt.savefig('gaiaeso.jpg', format='jpg', quality=99, bbox_inches='tight')
```



In the GAIAESO catalogue there are thus 5 metal poor stars (note that 19101103-5955405 does

Now `all_catalogues` contains all the latest version of the catalogues currently present at ESO and you can now look for that `table_name` associated with the

Change Log for any news/improvements/new tables…

In this page: [open] click here to read the page description...

Query a TAP Service | async Query Manager | Script your access | Configure tools | Learn dataset actions | VO standards & software | Change Log

Change Log of the programmatic and tool interfaces

The table below, in reverse chronological order, lists all the changes to the programmatic and tool interfaces that could affect your scripts or anyway your way of accessing the ESO science archive via TAP, SSAP, or via one of the URLs specified in the Learn dataset actions. Keep an eye on it, to make sure to be up-to-date with this newly born and still evolving functionality of the ESO Science Archive.

Date	Context	Description of change
2020-09-04	**scripted access**	added demo script to illustrate how to download science raw frames with authentication, allowing to download proprietary files if authorised. *eso_authenticated_download_raw_and_calibs.py*
2020-09-03	**Jupyter Notebooks**	More python jupyter notebook examples are available in the ESO Archive Community Forum. Currently available: • Access to Spectroscopic Data: Example #1 • Access to Catalogues: Example #1 and #2
2020-04-23	**Jupyter Notebooks**	The new page: ESO Science Archive Programmatic: HOWTOs offers a series of Jupyter Notebooks to learn how to script your access in python. Currently available: • How to download data (both anonymously and via authentication) • How to query for reduced data (including queries to find areas of the sky covered in different bands for multiband photometry) • More to come soon... When new notebooks will be available, they will be announced in this page.
2020-04-23	**Authentication**	Programmatic authenticated access to proprietary data is now fully supported via both basic authentication and JWT tokens (OAuth2.0). (Read more...)
2020-04-23	**Cutout service**	Positional and spectral cutouts of science data products is now available. The service is fully compliant to the IVOA Server-side Operations for Data Access (SODA) protocol. (Read more...)
2020-04-23	**DataLink**	The ESO DataLink service now supports: • proprietary data • the SODA protocol, to allow an easy programmatic access to the VO-compliant ESO cutout services (Read more...)
2020-04-23	**tap_obs ObsCore table**	The ivoa.ObsCore table now supports the **ALMA data**, along with the already served reduced data from La Silla Paranal Observatory (including APEX) [LPO]. **Pros**: • Integrated data discovery experience for both ALMA and LPO processed data • Full support for powerful spatial queries • Ability to cross-match LPO and ALMA data **Limitations**: • Currently, new ALMA data are published here manually about twice a month. We are

Archive Community Forum

- For any questions or suggestions while developing your scripts, building or optimising ADQL queries, etc, please contact us using:

  https://esocommunity.userecho.com/

  (which supports also anonymous questions)

We will be eager to learn about your needs and provide suggestions, if not, possibly, solutions!

archive.eso.org