The Virtual Observatory

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Federal Ministry of Education and Research

- What it's (not) – and why
- An illustrated journey through...
- ...registry,
- ...simple services,
- ...TAP,
- ...and SAMP.

What This Is About

The Virtual Observatory's goal is to make

as **much** astronomical data as possible

discoverable

and **usable**

ideally in an **ad-hoc** fashion

ideally **moving a minimum** of data

ideally under **maximum user control**.

The VO is not. . .

. . . a program.

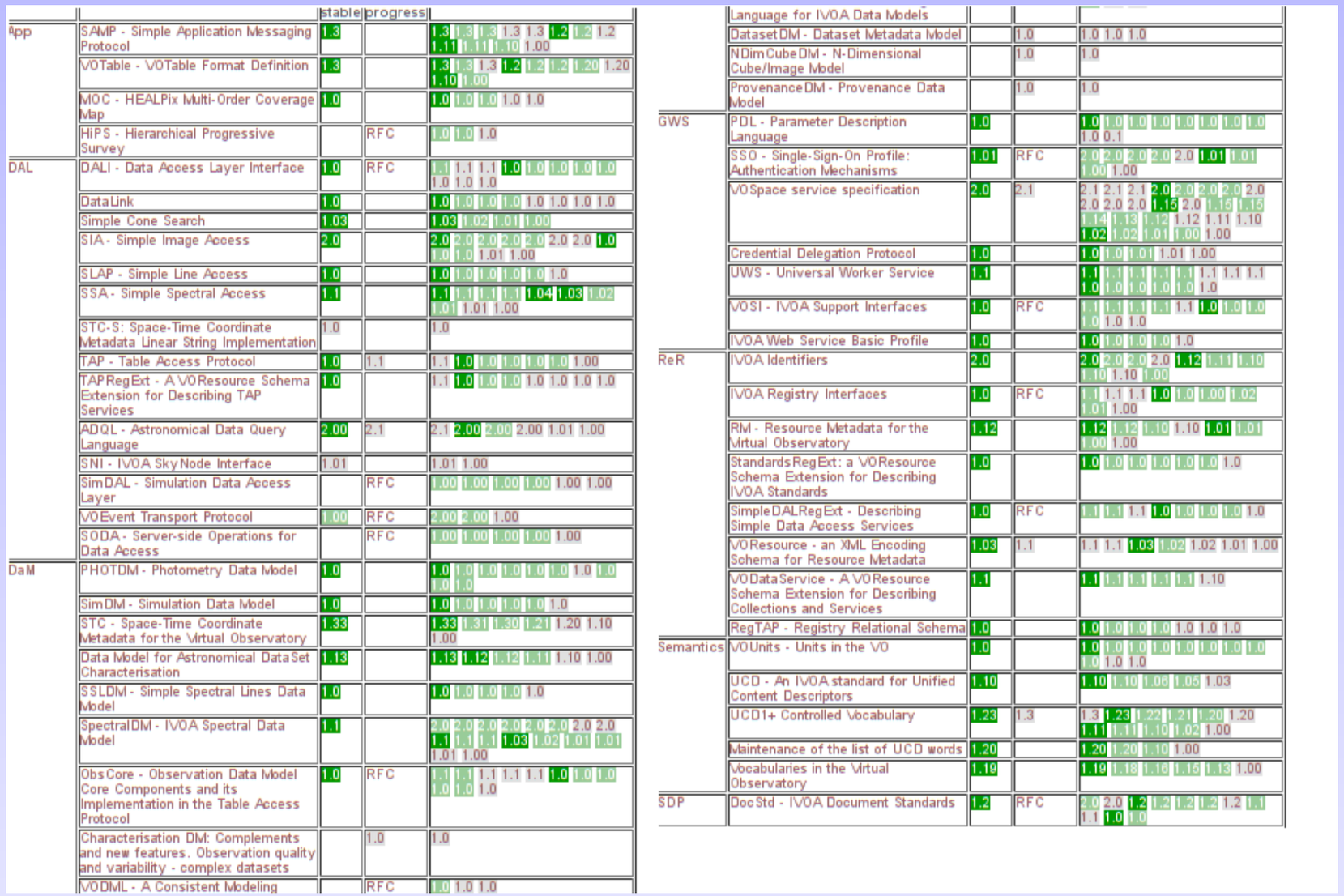
The VO is not. . .

. . . a “platform”.

The VO is not. . .

. . . a cabal of wise guys.

The VO is. . .



		stable	progress	
App	SAMP - Simple Application Messaging Protocol	1.3		1.3 1.3 1.3 1.3 1.3 1.2 1.2 1.2 1.11 1.11 1.10 1.00
	VOTable - VOTable Format Definition	1.3		1.3 1.3 1.3 1.2 1.2 1.2 1.20 1.20 1.10 1.00
	MOC - HEALPix Multi-Order Coverage Map	1.0		1.0 1.0 1.0 1.0 1.0
	HiPS - Hierarchical Progressive Survey		RFC	1.0 1.0 1.0
DAL	DALI - Data Access Layer Interface	1.0	RFC	1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	DataLink	1.0		1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	Simple Cone Search	1.03		1.03 1.02 1.01 1.00
	SIA - Simple Image Access	2.0		2.0 2.0 2.0 2.0 2.0 2.0 2.0 1.0 1.0 1.0 1.01 1.00
	SLAP - Simple Line Access	1.0		1.0 1.0 1.0 1.0 1.0 1.0
	SSA - Simple Spectral Access	1.1		1.1 1.1 1.1 1.1 1.04 1.03 1.02 1.01 1.01 1.00
	STC-S: Space-Time Coordinate Metadata Linear String Implementation	1.0		1.0
	TAP - Table Access Protocol	1.0	1.1	1.1 1.0 1.0 1.0 1.0 1.0 1.00
	TAPRegExt - A VOResource Schema Extension for Describing TAP Services	1.0		1.1 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	ADQL - Astronomical Data Query Language	2.00	2.1	2.1 2.00 2.00 2.00 1.01 1.00
	SNI - IVOA SkyNode Interface	1.01		1.01 1.00
	SimDAL - Simulation Data Access Layer		RFC	1.00 1.00 1.00 1.00 1.00 1.00
	VOEvent Transport Protocol	1.00	RFC	2.00 2.00 1.00
	SODA - Server-side Operations for Data Access		RFC	1.00 1.00 1.00 1.00 1.00
DaM	PHOTDM - Photometry Data Model	1.0		1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	SimDM - Simulation Data Model	1.0		1.0 1.0 1.0 1.0 1.0 1.0
	STC - Space-Time Coordinate Metadata for the Virtual Observatory	1.33		1.33 1.31 1.30 1.21 1.20 1.10 1.00
	Data Model for Astronomical DataSet Characterisation	1.13		1.13 1.12 1.12 1.11 1.10 1.00
	SSLDM - Simple Spectral Lines Data Model	1.0		1.0 1.0 1.0 1.0 1.0
	SpectralDM - IVOA Spectral Data Model	1.1		2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 1.1 1.1 1.1 1.03 1.02 1.01 1.01 1.01 1.00
	ObsCore - Observation Data Model Core Components and its Implementation in the Table Access Protocol	1.0	RFC	1.1 1.1 1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0 1.0
	Characterisation DM: Complements and new features. Observation quality and variability - complex datasets		1.0	1.0
	VODML - A Consistent Modeling Language for IVOA Data Models		RFC	1.0 1.0 1.0
	DatasetDM - Dataset Metadata Model		1.0	1.0 1.0 1.0
	NDimCubeDM - N-Dimensional Cube/Image Model		1.0	1.0
	ProvenanceDM - Provenance Data Model		1.0	1.0
GWS	PDL - Parameter Description Language	1.0		1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.1
	SSO - Single-Sign-On Profile: Authentication Mechanisms	1.01	RFC	2.0 2.0 2.0 2.0 2.0 1.01 1.01 1.00 1.00
	VOSpace service specification	2.0	2.1	2.1 2.1 2.1 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 1.15 2.0 1.15 1.15 1.14 1.13 1.12 1.12 1.11 1.10 1.02 1.02 1.01 1.00 1.00
	Credential Delegation Protocol	1.0		1.0 1.0 1.01 1.01 1.00
	UWS - Universal Worker Service	1.1		1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0 1.0
	VOSI - IVOA Support Interfaces	1.0	RFC	1.1 1.1 1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0 1.0
	IVOA Web Service Basic Profile	1.0		1.0 1.0 1.0 1.0 1.0
ReR	IVOA Identifiers	2.0		2.0 2.0 2.0 2.0 1.12 1.11 1.10 1.10 1.10 1.00
	IVOA Registry Interfaces	1.0	RFC	1.1 1.1 1.1 1.0 1.0 1.00 1.02 1.01 1.00
	RM - Resource Metadata for the Virtual Observatory	1.12		1.12 1.12 1.10 1.10 1.01 1.01 1.00 1.00
	StandardsRegExt: a VOResource Schema Extension for Describing IVOA Standards	1.0		1.0 1.0 1.0 1.0 1.0 1.0 1.0
	SimpleDALRegExt - Describing Simple Data Access Services	1.0	RFC	1.1 1.1 1.1 1.0 1.0 1.0 1.0 1.0
	VOResource - an XML Encoding Schema for Resource Metadata	1.03	1.1	1.1 1.1 1.03 1.02 1.02 1.01 1.00
	VODataService - A VOResource Schema Extension for Describing Collections and Services	1.1		1.1 1.1 1.1 1.1 1.1 1.10
	RegTAP - Registry Relational Schema	1.0		1.0 1.0 1.0 1.0 1.0 1.0 1.0
Semantics	VOUnits - Units in the VO	1.0		1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
	UCD - An IVOA standard for Unified Content Descriptors	1.10		1.10 1.10 1.06 1.05 1.03
	UCD1+ Controlled Vocabulary	1.23	1.3	1.3 1.23 1.22 1.21 1.20 1.20 1.11 1.11 1.10 1.02 1.00
	Maintenance of the list of UCD words	1.20		1.20 1.20 1.10 1.00
	Vocabularies in the Virtual Observatory	1.19		1.19 1.18 1.16 1.15 1.13 1.00
SDP	DocStd - IVOA Document Standards	1.2	RFC	2.0 2.0 1.2 1.2 1.2 1.2 1.2 1.1 1.1 1.0 1.0

. . . a load of boring standards.

The VO is. . .

. . . about 15000 services compliant with these standards.

- 10^4 cone search services and tables,
- 10^2 each of image and spectral services,
- 10^2 database (TAP) services with 10^4 tables with 10^{12} rows combined

. . . 10^2 software programs, web services, and libraries that can locate and access these services

(cf. http://ivoa.net/astronomers/applications.html)

The VO is. . .

. . . two "interoperability" conferences a year, open to all interested parties

. . . about 10^2 national or regional projects forming the IVOA that organises all this.

In the EU, there's currently Asterics, with a Tech Forum in Strasbourg March 22 and 23.

The User Perspective. Finally.

Consider the deliberately somewhat whacky use case:

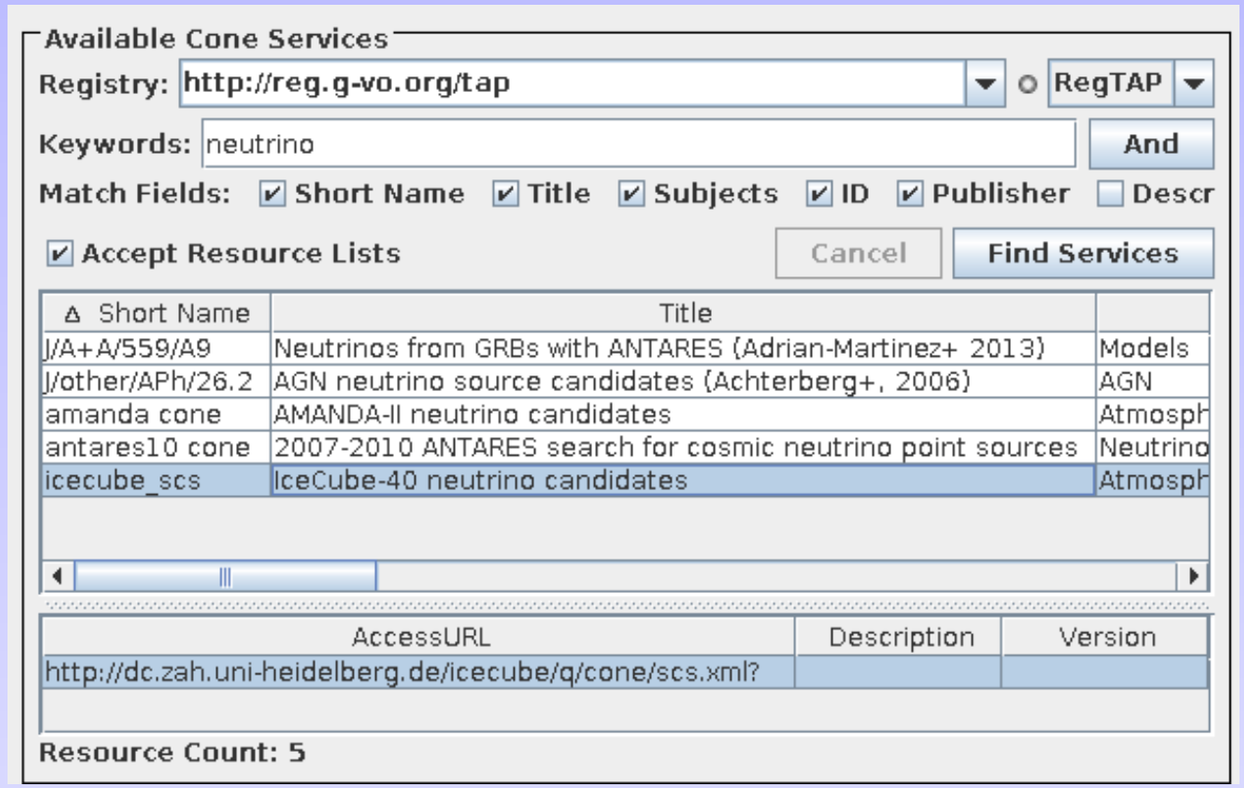
"Are there any conspicuously blue objects close to OH masers that are within the detection cones of high energy neutrinos?"

The default client for the VO: ⟨TOPCAT⟩.

Locating a Neutrino Catalog

The Registry is a set of structured metadata on services in the VO.

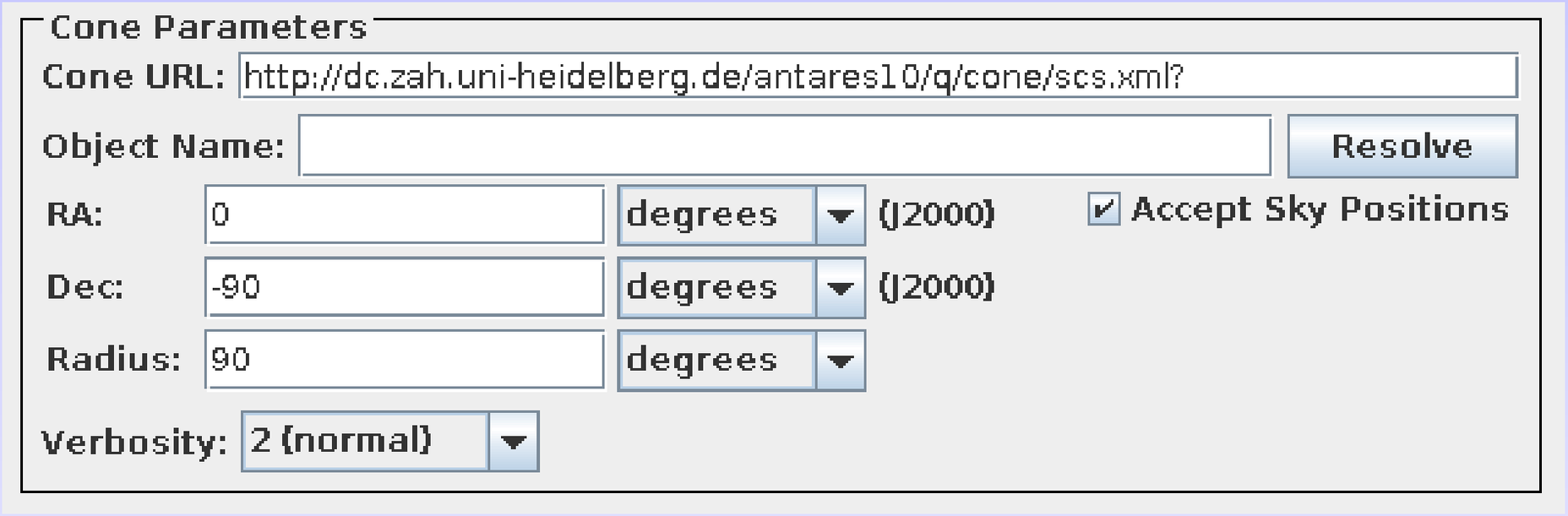
Concrete implementations these days come as a 13-table RDBMS schema. It's normally used via some UI:



This is using Registry and TAP standards.

Pulling the Catalog

In this case, we retrieve the entire southern sky (you'll usually try to avoid this in the VO).



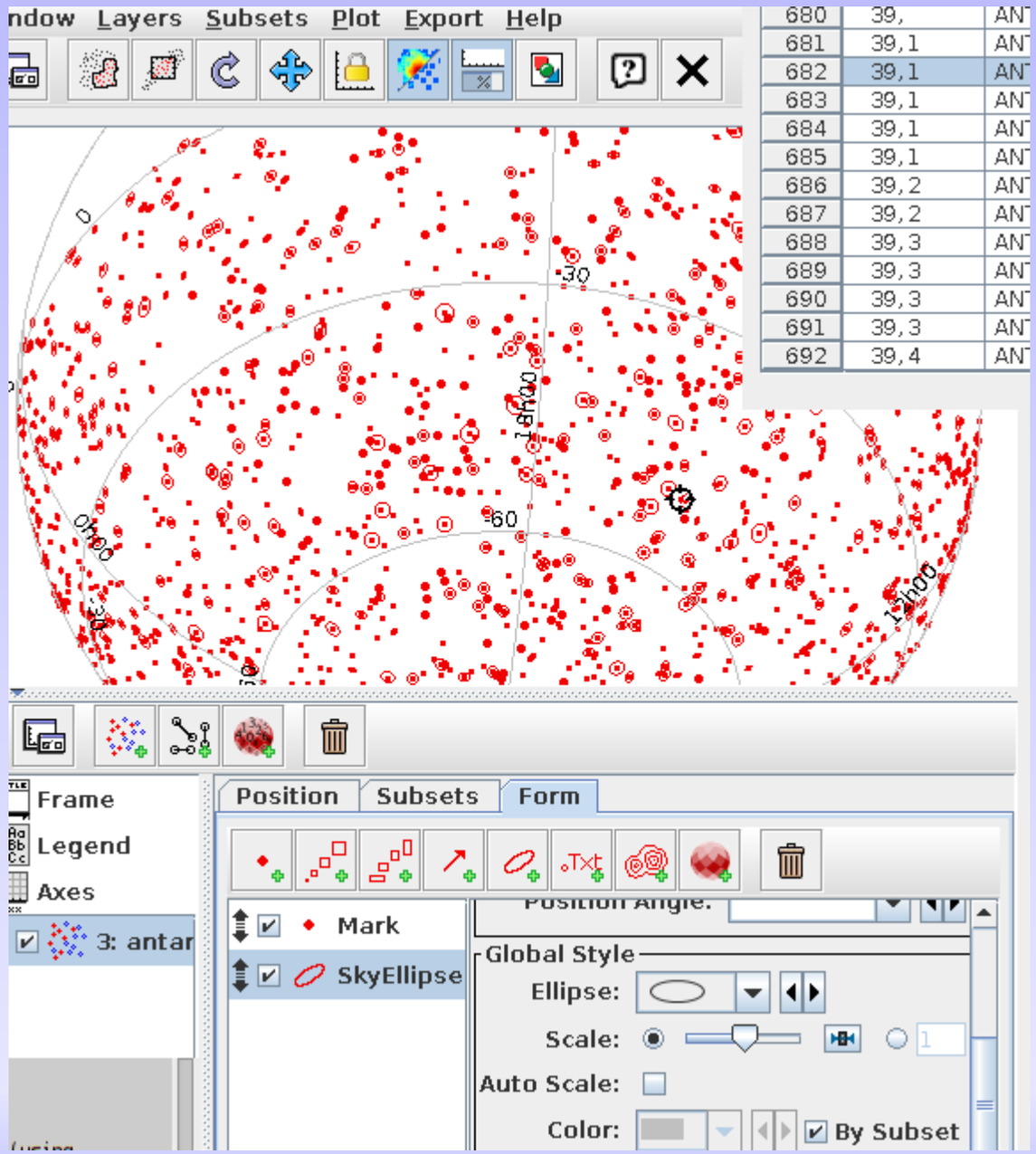
That's using the Cone Search (SCS) protocol.

Let's have a look

VO data should come with rich metadata.

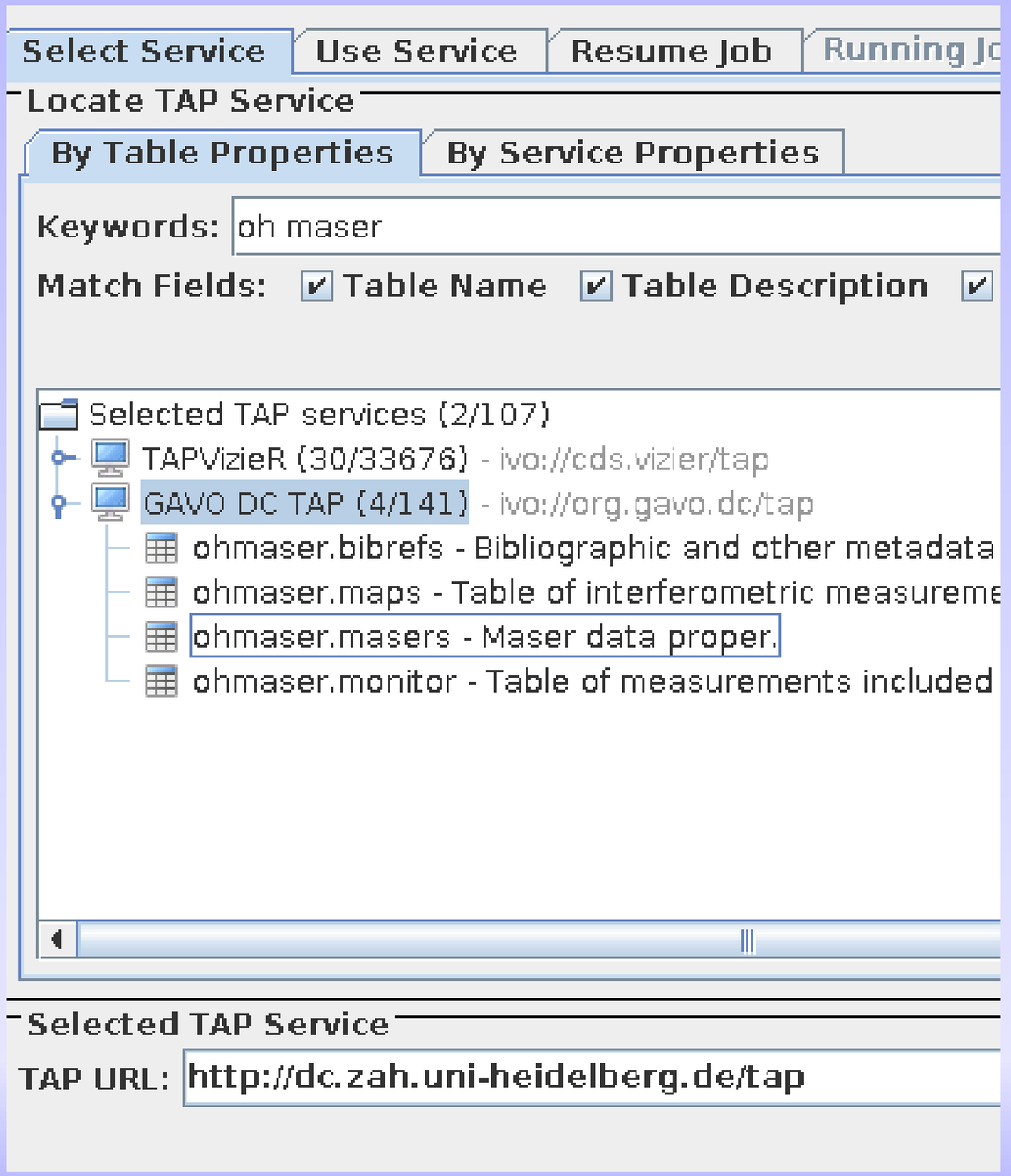
In this case, TOPCAT can work out by itself how to do a sky plot (using the UCD standard).

Also see Views/Column Info.



OH Masers In Our Cones

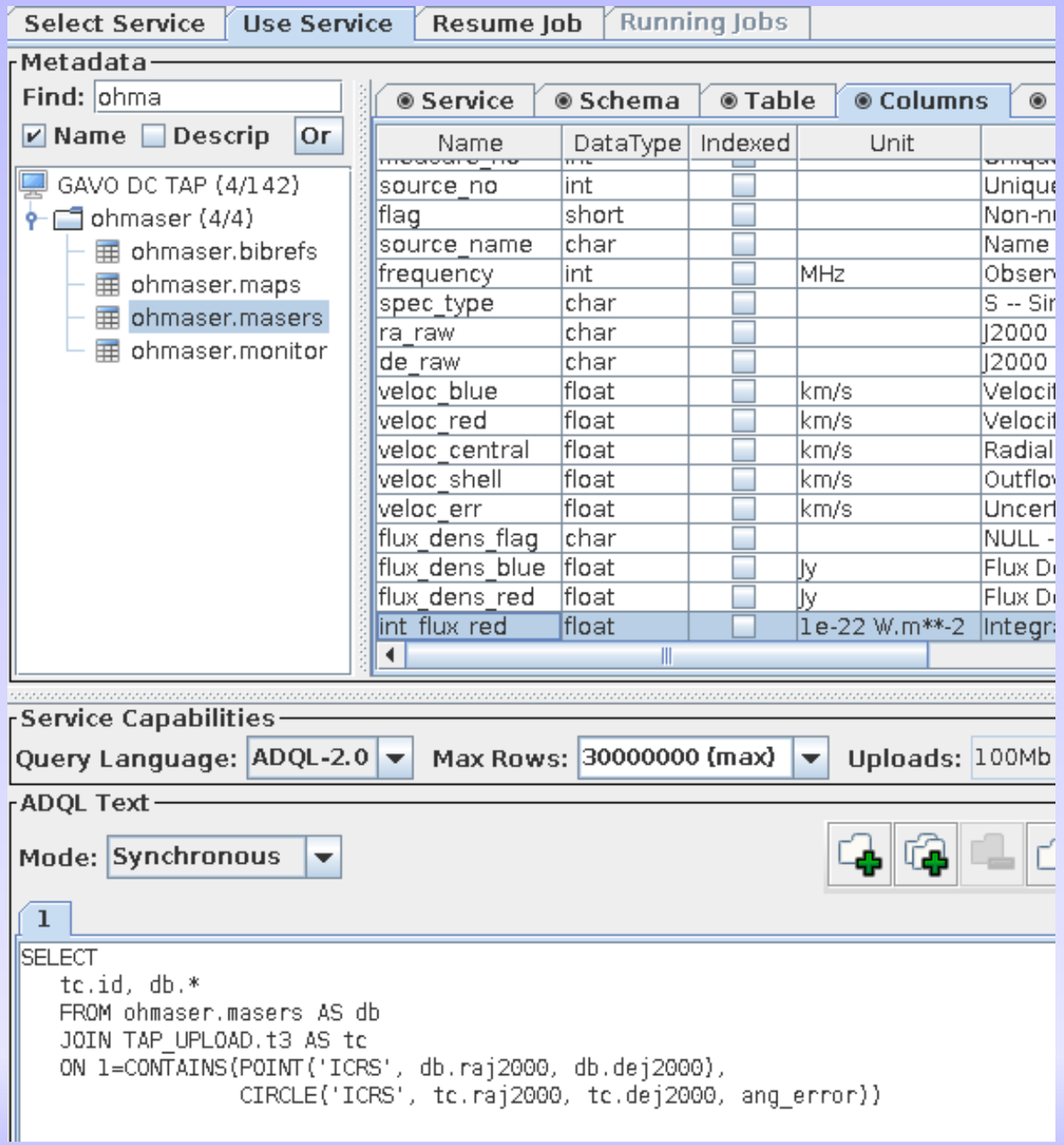
Can we find OH masers within our $\sim$ 2000 cones? Easy with TAP. Again, a Registry query:



Writing the Remote Query

TAP lets you run database queries against remote tables and upload your own tables there.

Our query is a bit edited from Examples/Upload/Upload Join (this uses TAP, ADQL, and DALI):



Obtaining Photometry

We now have 500 OH Masers that might plausibly related to our mystic sources. Let's use the tricks we learned to pull Gaia and 2MASS photometry.

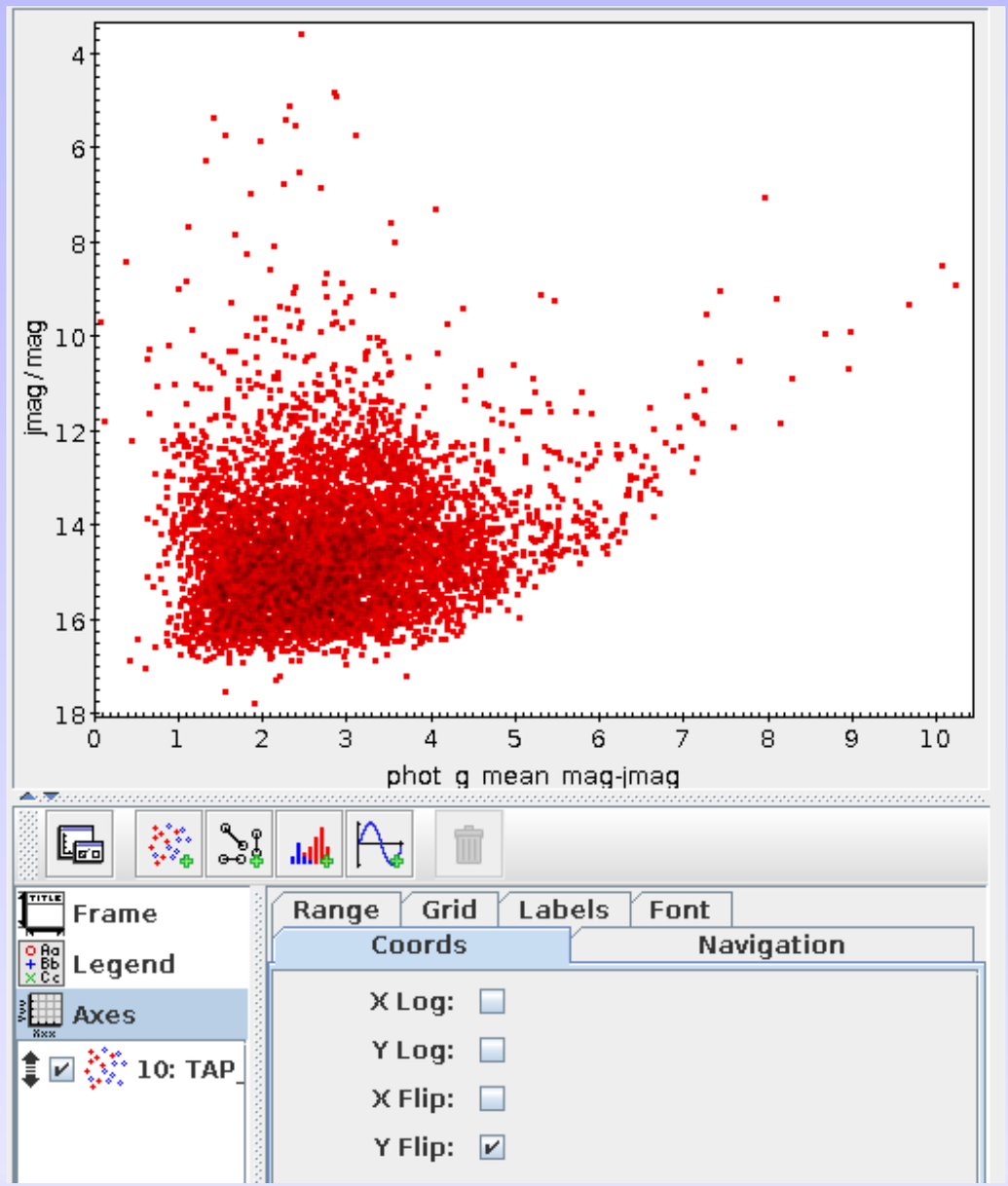
We'll do it in two steps (these could come from different services). First step: 2MASS objects in a 30' circle:

```
SELECT DISTINCT
   tc.id, db.raj2000, db.dej2000, jmag, hmag, kmag
   FROM twomass.data AS db
   JOIN TAP_UPLOAD.t6 AS tc
   ON 1=CONTAINS(POINT('ICRS', db.raj2000, db.dej2000),
                 CIRCLE('ICRS', tc.ra, tc.dec, 30./3600.))
```

Match against Gaia left as an exercise for the reader.

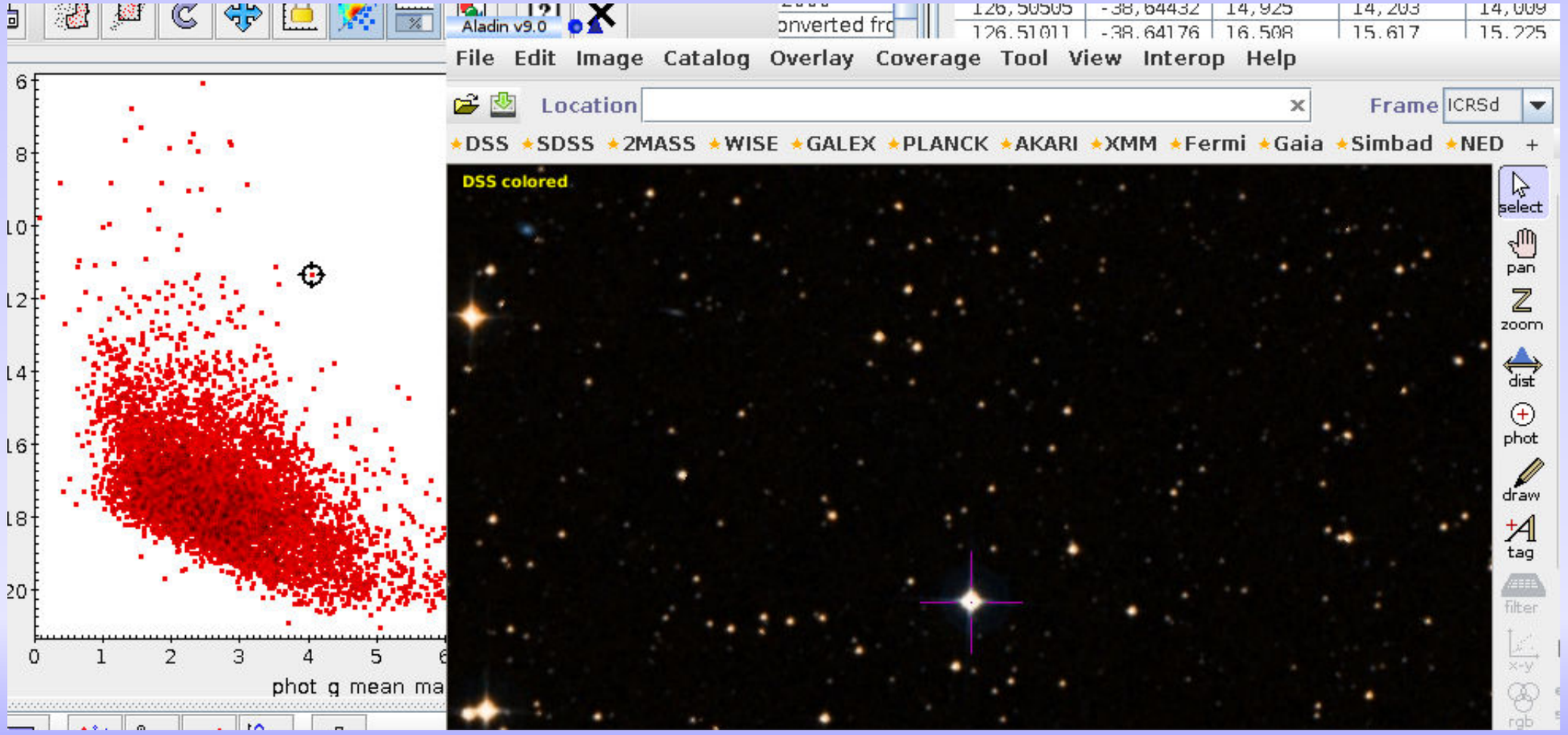
A CMD

Now plot, say, phot_g_mean_mag-jmag against jmag.



Viewing Things

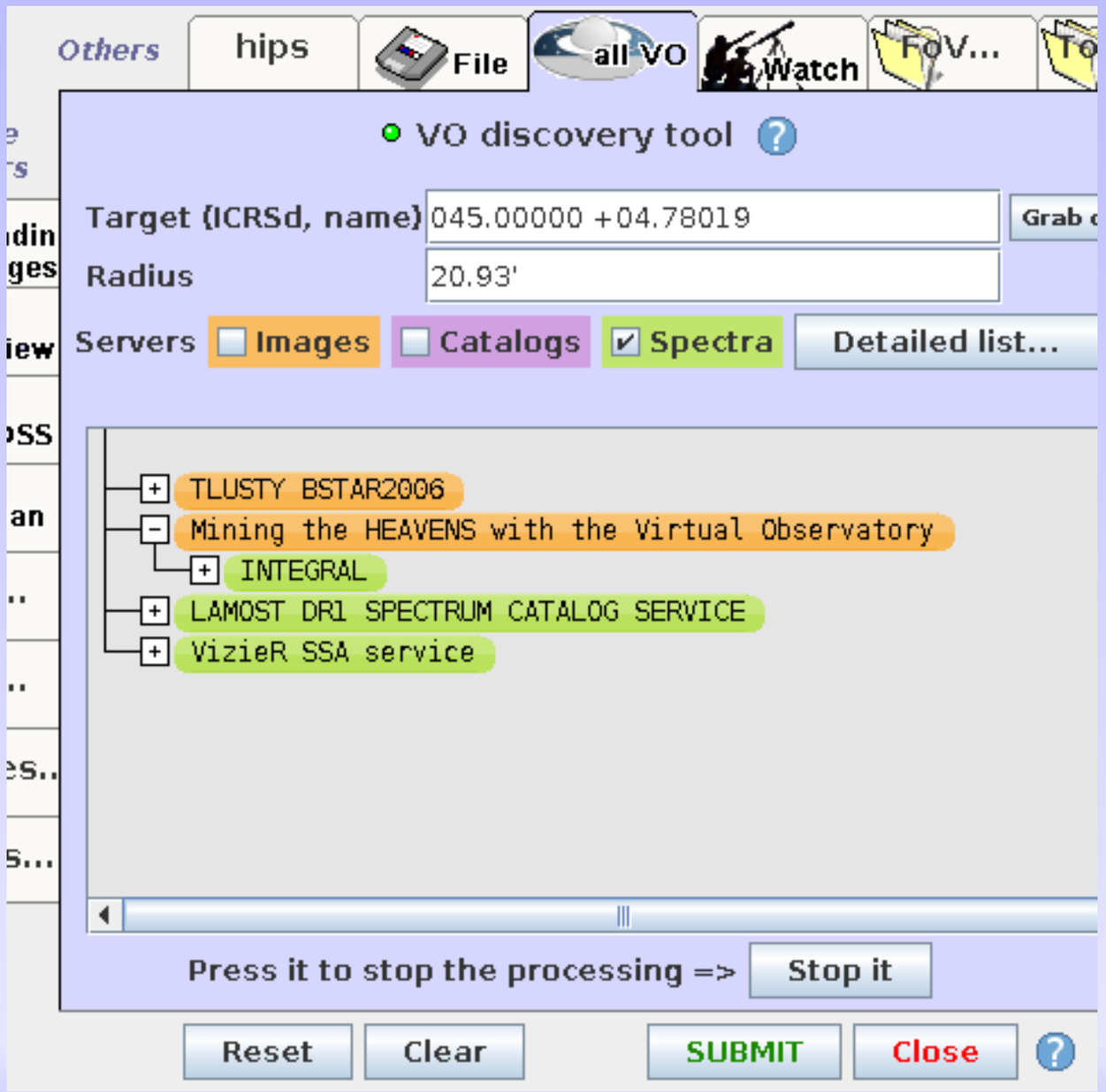
In TOPCAT, configure “Transmit coordinates” as activation action and start Aladin (a different client from a different vendor!). Choose a data source and zoom in.



Further Investigations

From this, you can do an all-VO search for spectra of this object from within Aladin.

This uses SSAP, so (ideally) all spectra services can be uniformely queried.



The Point I Tried to Make

- The VO has come up with a load of standards...
- ...that produce a fairly nicely integrated environment...
- ...that's distributed in space, responsibilities, maintenance, development...
- ...suitable for quite a few sorts of data use and dissemination.

And You?

As a user: GAVO gladly does house calls. Talk to me to schedule a VO day teaching all this at your institute.

As a developer: Try to avoid sinking too much work into web pages, however much the PIs clamor for them. Join us for the Asterics Tech Forum.

As a scientist: Publish your data. VO-compatibly. Soon. And pressure your consortia to do so, too. All this only works because others did so before you.

Oh, and...

If you have data to publish

by all means contact us

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