

SKYMAPPER IN THE VIRTUAL OBSERVATORY:
HOW WILL YOU ACCESS THE TERABYTES?

SIMON MURPHY (HEIDELBERG)

FEAT. **JON SMILLIE** (ANU), **YESHE FENNER** (AAL)
& THE **ALL SKY VIRTUAL OBSERVATORY** PROJECT



OUTLINE

- Introduction to the Virtual Observatory
- SkyMapper data products
- Complex queries using TAP/ADQL
- Federating data
- Interoperability with SAMP (*if time permits*)
- Feedback - you are the users!

THE VIRTUAL OBSERVATORY

- What is the Virtual Observatory?
“all astronomy data products on your computer”
- A set of globally-agreed standards for:

- *Describing resources*
- *Publishing resources*
- *Finding resources*
- *Accessing resources*



- **Interoperability** is the key concern

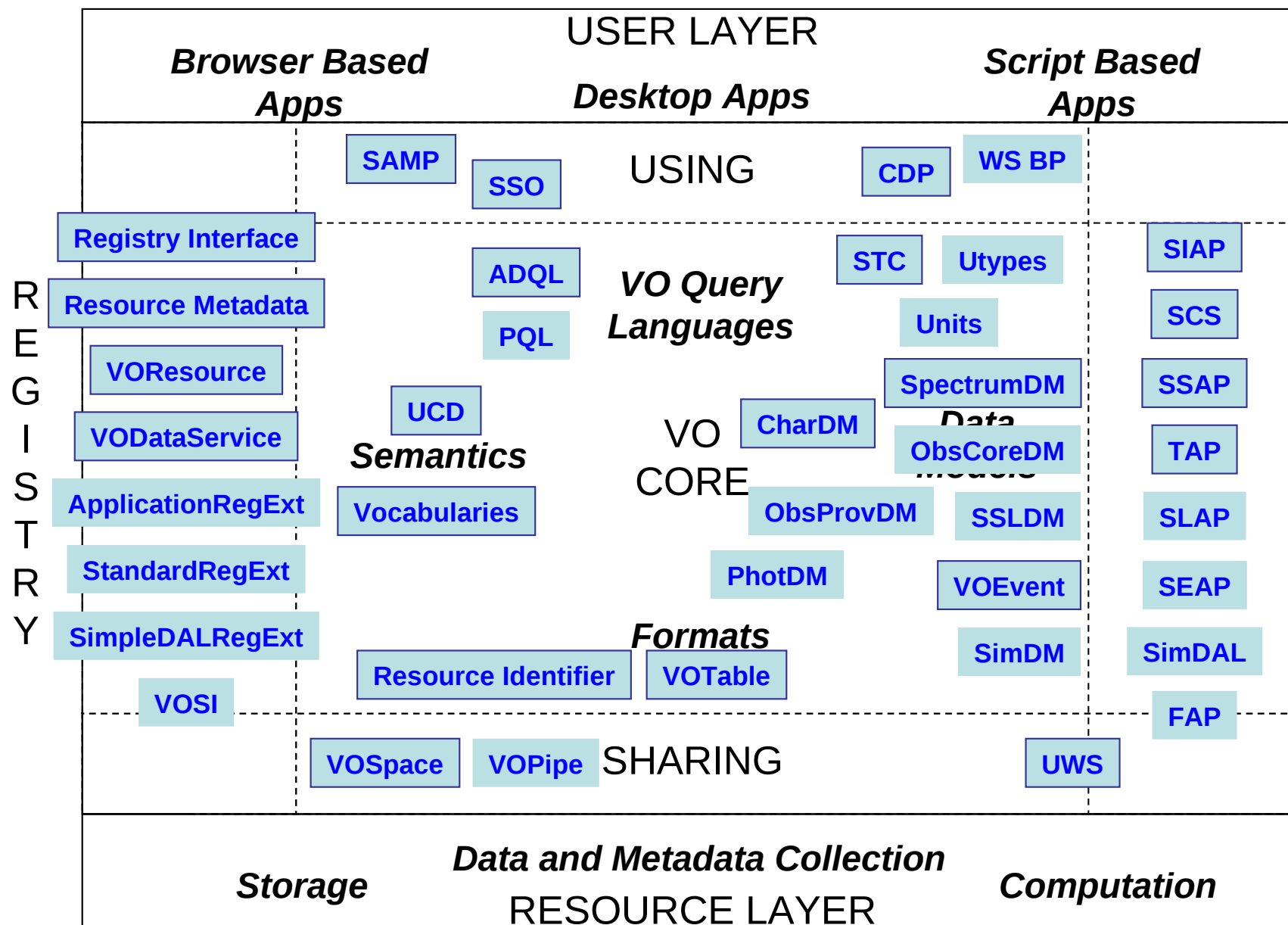
THE VIRTUAL OBSERVATORY

LEVEL 2

USERS



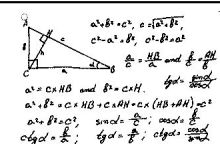
COMPUTERS



20101004
IVOA Architecture



PROVIDERS



The background of the image is a deep space photograph. It features a dense field of stars of various colors (white, blue, orange) against a dark, textured cosmic background. A faint, glowing nebula with reddish and bluish hues is visible in the lower right quadrant. The text is centered horizontally and vertically.

YESHE FENNER
ASTRONOMY AUSTRALIA LIMITED



What is the All Sky Virtual Observatory?

Platform for connecting Australian datasets with users and the world-wide VO network, via IVOA standards and services, and customised web interfaces.

History:

2011: Mid-Term Review of the Decadal Plan 2006-2015 recommended:

"Astronomy should build an astronomical data fabric that links high-performance resources through appropriate data middleware and networks to create new opportunities for discovery by Australian researchers based on data flowing from telescopes like SkyMapper, ASKAP and the MWA. A path forward to achieving this goal is for the community to actively engage in the Government's eResearch initiatives, such as NeCTAR and RDSI"

2012: AAL commissioned an eResearch software development company *Intersect* to conduct a design study into a "Federation of National Astronomy Datasets"

2012: AAL secured NeCTAR funds to take a first step towards this vision, by building the \$3.5M All Sky Virtual Observatory

Sponsors:



Partners:



Astronomy
Australia
Ltd.

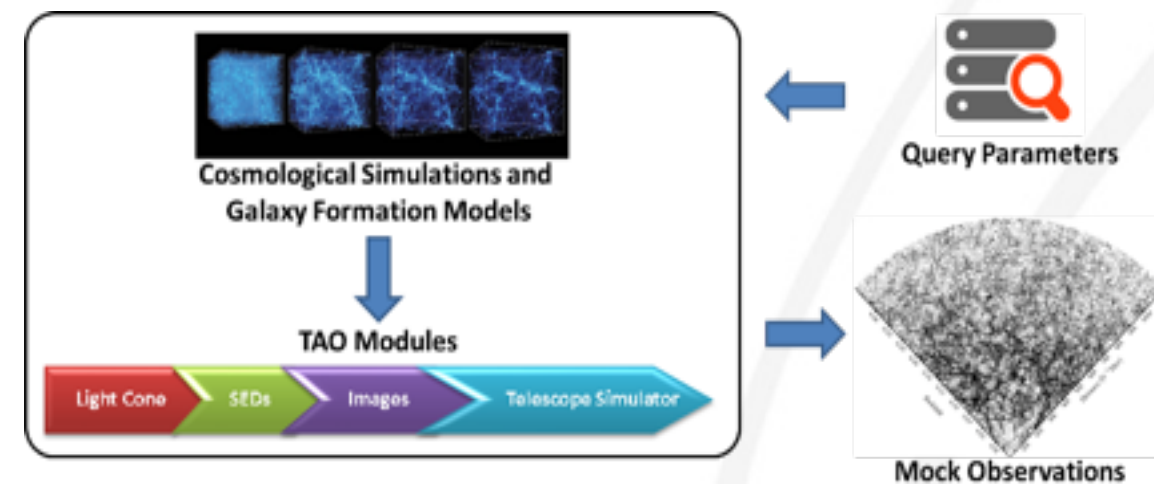




ASVO v1.0

Initial ASVO datasets chosen in consultation with AAL's eResearch Advisory Committee and the community:

1. The **Theoretical Astrophysical Observatory** (TAO <https://tao.asvo.org.au>) builds virtual universes based on simulation and model datasets. Developed at Swinburne. Launched 24th March 2014.
2. Optical data from ANU's **SkyMapper Southern Sky Survey** (+ WiggleZ spectroscopic survey). Housed at NCI. First ASVO-SkyMapper public data release ~2015.



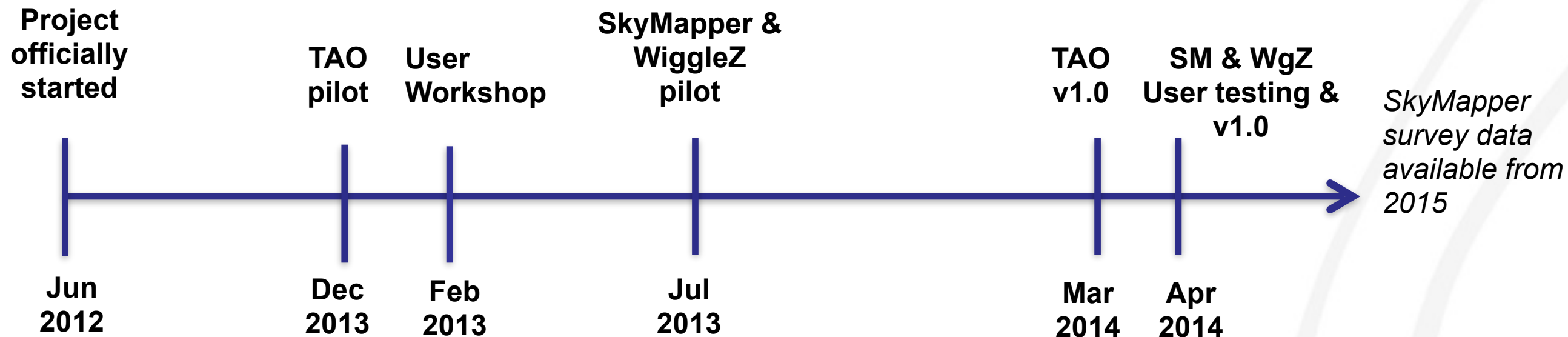
TAO schematic



SkyMapper telescope



Timeline and next steps



Future possibilities:

- More functionality for TAO and SkyMapper Nodes
- Data access services for other Australian datasets, e.g. next-gen radio telescopes

THE VIRTUAL OBSERVATORY

- **How is this relevant to science with SkyMapper?**
 - *VO tries to make science as easy as possible*
 - *SkyMapper access primarily through the (AS)VO*
 - *A lot of other data are already in the VO
(catalogues, images, spectra, simulations, ...)*



Multi-wavelength, multi-dataset science

SKYMAPPER DATA PRODUCTS

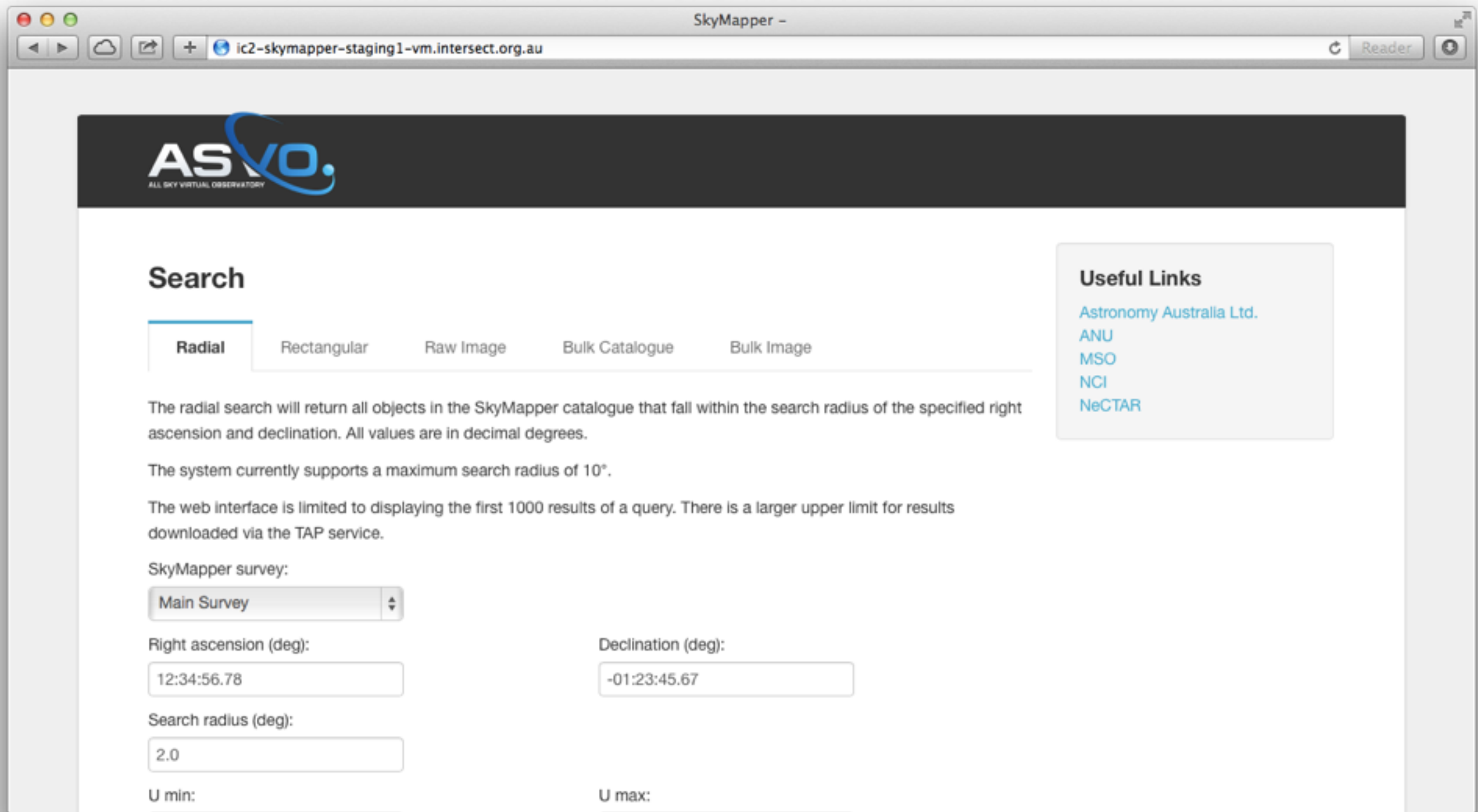
- Shallow and Main Survey data releases (from late 2015?)
- **Catalogue access** first priority, then images
- 10 tables x 10^9 rows x $\sim 10^2$ cols → **50-100 TB database**
c.f. SDSS-DR7: 18 TB (4×10^8 srcs); DR9: 60 TB (10^9 srcs)
- **Raw + reduced images (1-2 PB)**, plus cutouts, mosaics, RGB, photometry service?
- **Transient alerts**
(things that go bump in the night)



SKYMAPPER DATA PRODUCTS

- Under development within the ASVO project:
 - **High Performance Data Archive** (*internal+release*)
 - Cloud Analysis (*near data, BYO-software*)
 - **Data Exploration Tools**
 - ▶ Web forms (simple queries)
 - ▶ Direct database access (local SQL)
 - ▶ **VO services (images, catalogues)**

WEB ACCESS: CONE SEARCH



The screenshot shows a web browser window titled "SkyMapper -" with the address bar displaying "ic2-skymapper-staging1-vm.intersect.org.au". The page features the ASVO logo at the top left. The main content area is titled "Search" and includes a tabbed interface with "Radial" selected. Below the tabs, there is explanatory text about the radial search and its limitations. The form includes a dropdown for "SkyMapper survey:" set to "Main Survey", input fields for "Right ascension (deg):" (12:34:56.78) and "Declination (deg):" (-01:23:45.67), a "Search radius (deg):" field (2.0), and fields for "U min:" and "U max:". A "Useful Links" sidebar on the right lists links to Astronomy Australia Ltd., ANU, MSO, NCI, and NeCTAR.

ASVO.
ALL SKY VIRTUAL OBSERVATORY

Search

Radial Rectangular Raw Image Bulk Catalogue Bulk Image

The radial search will return all objects in the SkyMapper catalogue that fall within the search radius of the specified right ascension and declination. All values are in decimal degrees.

The system currently supports a maximum search radius of 10°.

The web interface is limited to displaying the first 1000 results of a query. There is a larger upper limit for results downloaded via the TAP service.

SkyMapper survey:

Main Survey

Right ascension (deg): 12:34:56.78 Declination (deg): -01:23:45.67

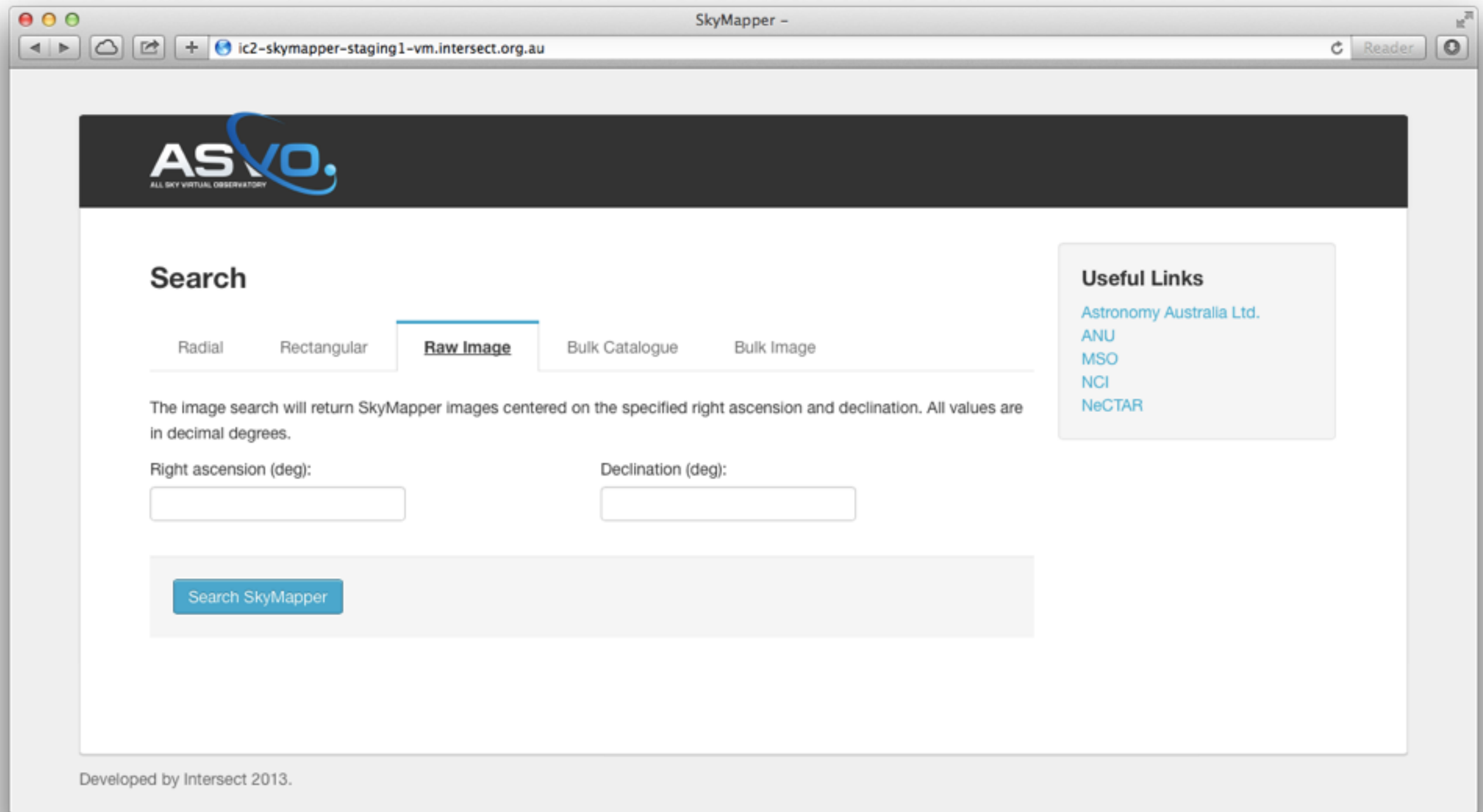
Search radius (deg): 2.0

U min: U max:

Useful Links

- [Astronomy Australia Ltd.](#)
- [ANU](#)
- [MSO](#)
- [NCI](#)
- [NeCTAR](#)

WEB ACCESS: IMAGES



The screenshot shows a web browser window titled "SkyMapper -" with the address bar displaying "ic2-skymapper-staging1-vm.intersect.org.au". The page features the ASVO logo at the top left. Below the logo is a "Search" section with five tabs: "Radial", "Rectangular", "Raw Image" (which is selected), "Bulk Catalogue", and "Bulk Image". A text box explains: "The image search will return SkyMapper images centered on the specified right ascension and declination. All values are in decimal degrees." Below this, there are two input fields labeled "Right ascension (deg):" and "Declination (deg):". A blue button labeled "Search SkyMapper" is positioned below the input fields. To the right of the search section is a "Useful Links" box containing links to "Astronomy Australia Ltd.", "ANU", "MSO", "NCI", and "NeCTAR". At the bottom left of the page, it says "Developed by Intersect 2013."

ASVO.
ALL SKY VIRTUAL OBSERVATORY

Search

Radial Rectangular **Raw Image** Bulk Catalogue Bulk Image

The image search will return SkyMapper images centered on the specified right ascension and declination. All values are in decimal degrees.

Right ascension (deg):

Declination (deg):

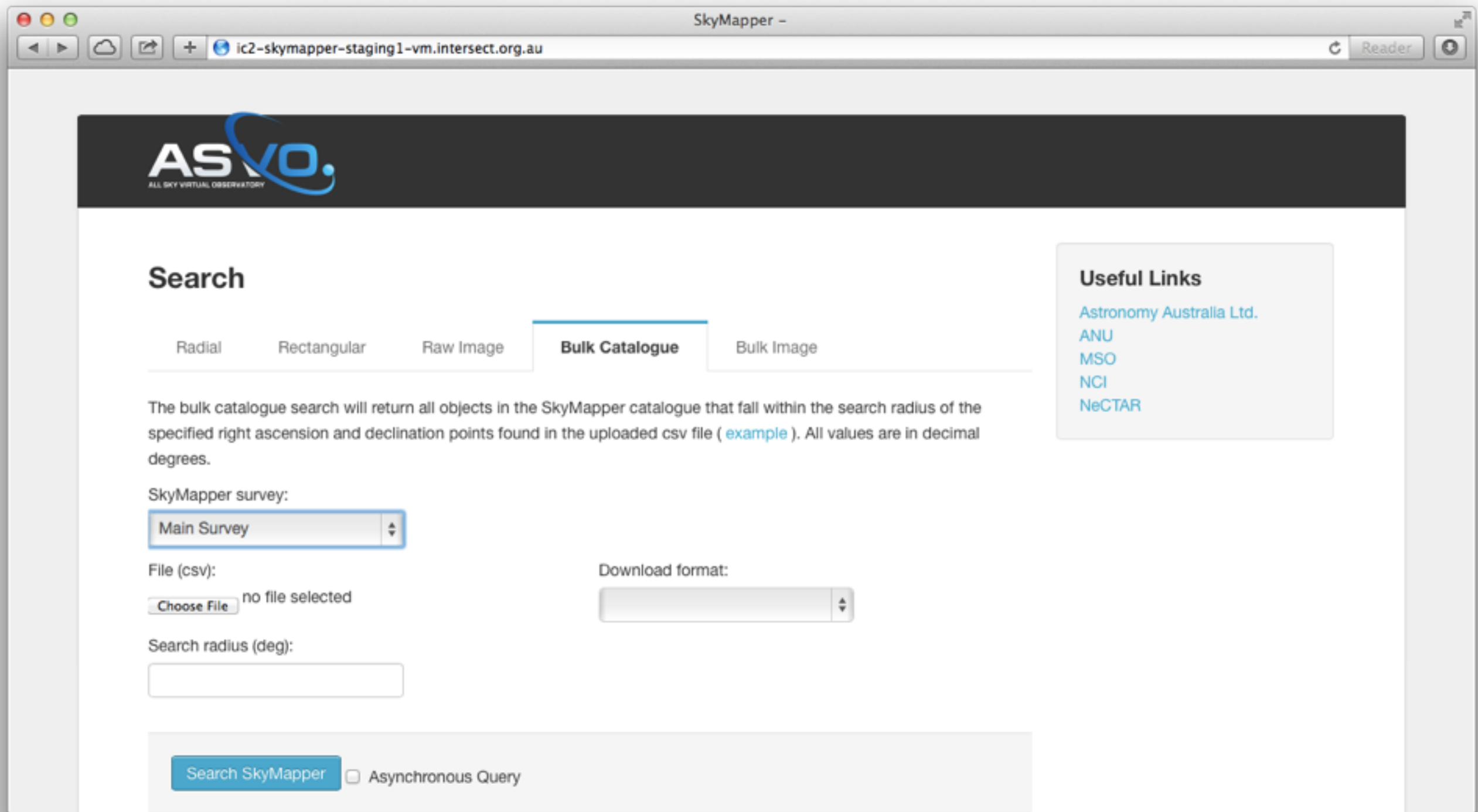
[Search SkyMapper](#)

Useful Links

- [Astronomy Australia Ltd.](#)
- [ANU](#)
- [MSO](#)
- [NCI](#)
- [NeCTAR](#)

Developed by Intersect 2013.

WEB ACCESS: CROSS MATCH



The screenshot shows a web browser window titled "SkyMapper -" with the address bar displaying "ic2-skymapper-staging1-vm.intersect.org.au". The page features the ASVO logo at the top left. The main content area is titled "Search" and includes five tabs: "Radial", "Rectangular", "Raw Image", "Bulk Catalogue" (which is selected), and "Bulk Image". Below the tabs, a text block explains that the bulk catalogue search returns objects within a specified radius of points in an uploaded CSV file. It includes a dropdown menu for "SkyMapper survey:" set to "Main Survey", a "File (csv):" section with a "Choose File" button and "no file selected" text, and a "Download format:" dropdown menu. A "Search radius (deg):" input field is also present. At the bottom, there is a "Search SkyMapper" button and an unchecked "Asynchronous Query" checkbox. On the right side, a "Useful Links" box lists "Astronomy Australia Ltd.", "ANU", "MSO", "NCI", and "NeCTAR".

ASVO.
ALL SKY VIRTUAL OBSERVATORY

Search

Radial Rectangular Raw Image **Bulk Catalogue** Bulk Image

The bulk catalogue search will return all objects in the SkyMapper catalogue that fall within the search radius of the specified right ascension and declination points found in the uploaded csv file ([example](#)). All values are in decimal degrees.

SkyMapper survey:
Main Survey

File (csv):
Choose File no file selected

Download format:

Search radius (deg):

Search SkyMapper ☐ Asynchronous Query

Useful Links
[Astronomy Australia Ltd.](#)
[ANU](#)
[MSO](#)
[NCI](#)
[NeCTAR](#)

DEMO

SKYMAPPER CONE SEARCH
WITH TOPCAT

Cone Search

Available Cone Services

Registry: http://registry.astrogrid.org/astrogrid-registry/services/RegistryQueryv1_0

Keywords: And

Match Fields: ☒ Short Name ☒ Title ☒ Subjects ☒ ID ☒ Publisher ☐ Description

☒ Accept Resource Lists

Cancel Query Submit Query

Query registry for Cone services:
enter keywords like "2mass qso" and click Submit Query.

Alternatively, enter Cone URL in field below.

AccessURL	Description	Version
-----------	-------------	---------

Cone Parameters

Cone URL: http://asvo.nci.org.au/skymapper/ms_distilled/conesearch

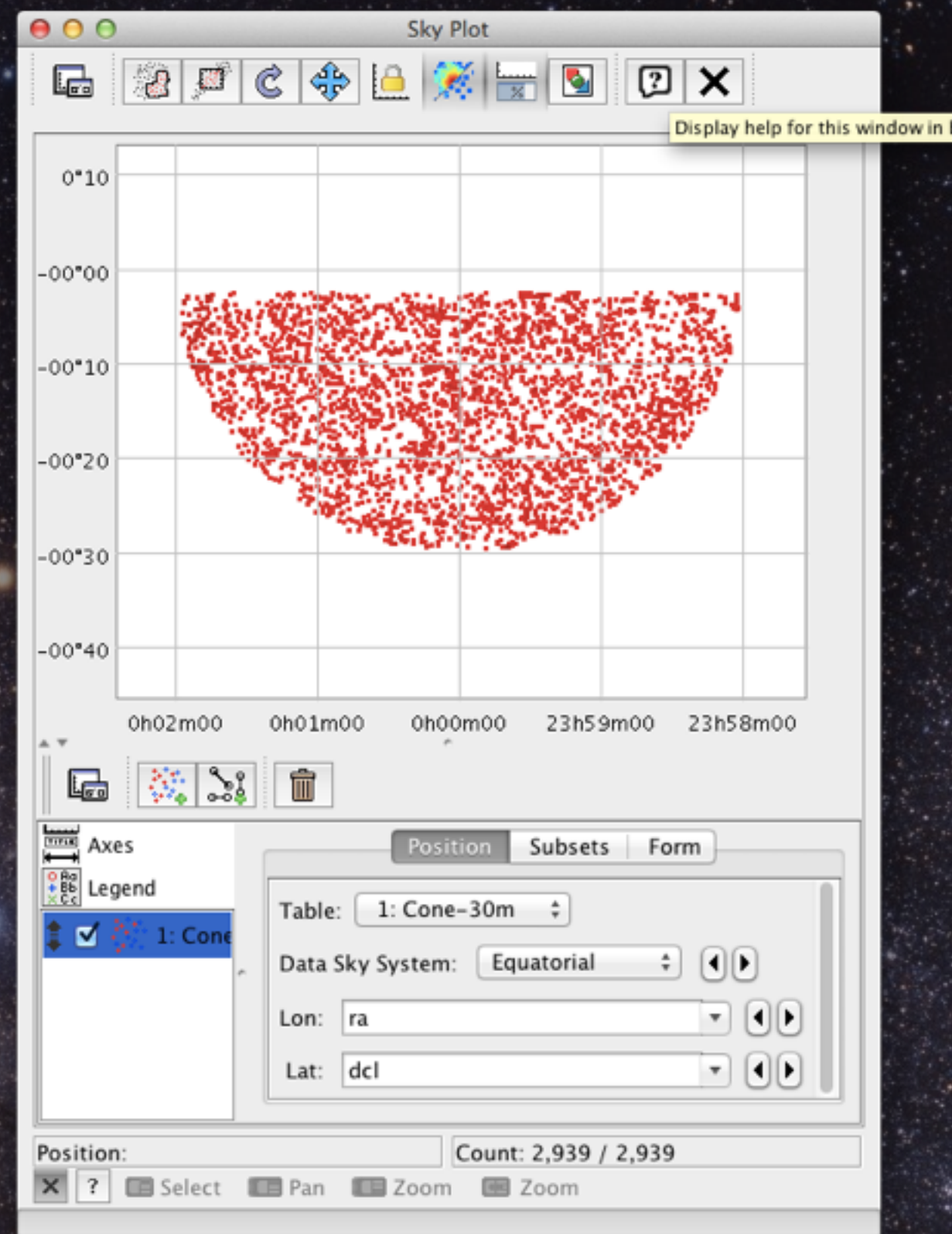
Object Name: Resolve

RA: degrees (J2000) ☒ Accept Sky Positions

Dec: degrees (J2000)

Radius: degrees

OK



Cone Search URL (in registry mid-2014):
http://asvo.nci.org.au/skymapper/ms_distilled/conesearch

COMPLEX TABULAR QUERIES

**SHOW ME BLUE
VARIABLE STARS AT HALO
DISTANCES**

**WHAT OBSERVATIONS
WENT INTO THIS CATALOGUE
ENTRY?**

**FIND ALL HIGH PROPER
MOTION OBJECTS WITHOUT
2MASS PHOTOMETRY**

**CONSTRUCT THE SED OF THIS
GALAXY FROM UV TO RADIO**

**IS THERE A DWARF
GALAXY IN THIS REGION?**

**IDENTIFY HIGH-Z QUASARS IN THIS
IRREGULAR SKY AREA**

COMPLEX TABULAR QUERIES

- VO standard: **TAP (Table Access Protocol)**
- SQL-like access to multi-table databases:
ADQL (Astronomical Data Query Language)
- Complex spatial queries
(*cross matching, radial/polygonal, set geometry*)
- User uploaded tables
- Asynchronous job handling
- **Services & clients already available**



ADQL IN ONE SLIDE

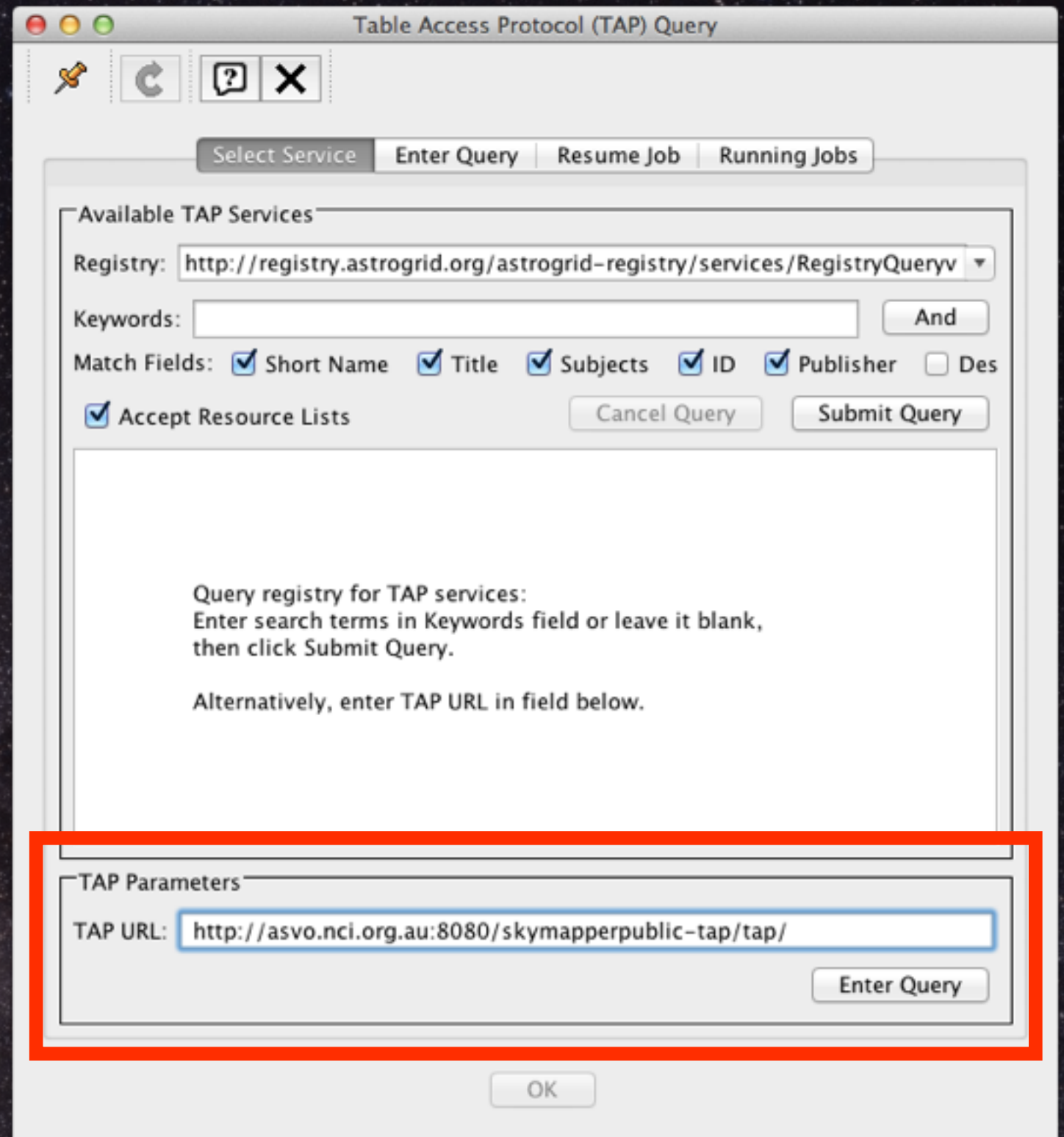
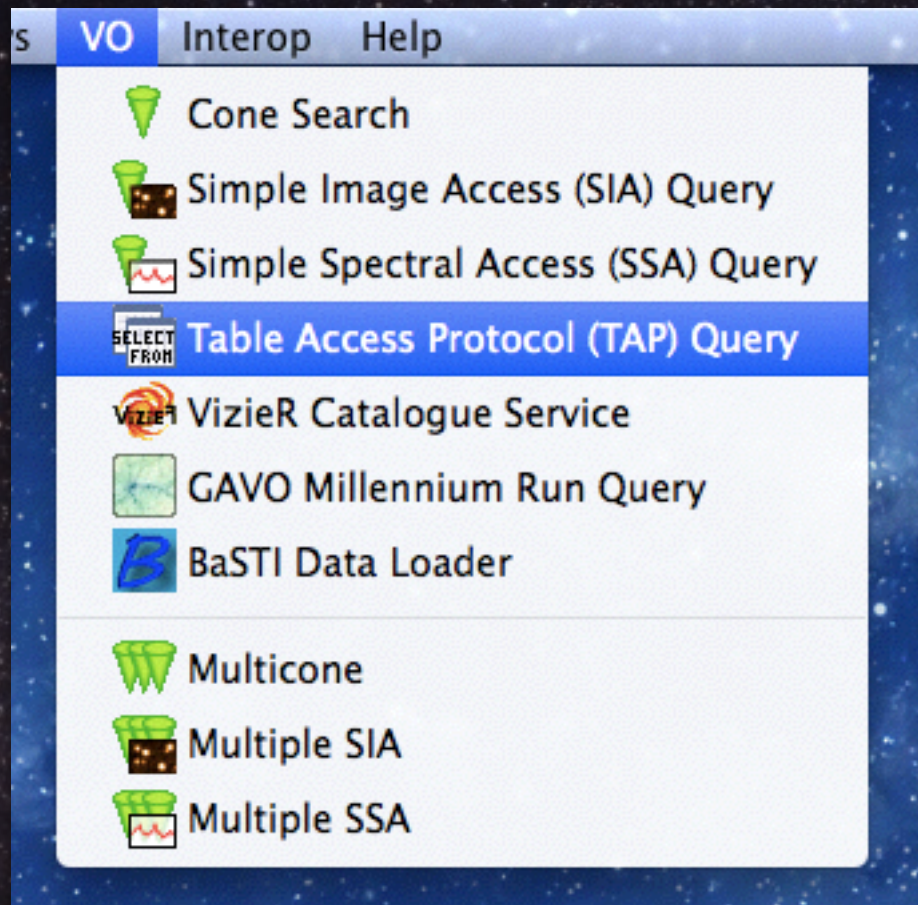
- Similar syntax to SQL (commercial DBs, CASJobs):

```
SELECT new_object_id,ra,dcl,a/b  
FROM public.ms_distilled  
WHERE sigma_g/mean_g BETWEEN 0.1 AND 0.2  
      AND class_star>0.9  
      AND transient='false'
```

- Mathematical, logical operators, joins, sub queries,...
- See [**is.gd/ADQLTutorial**](https://is.gd/ADQLTutorial) and [**is.gd/ADQLTutorial2**](https://is.gd/ADQLTutorial2)
for a range of example queries

DEMO

ADQL ACCESS TO SKYMAPPER
USING TOPCAT



TAP URL (in registry mid-2014):

<http://asvo.nci.org.au:8080/skymapperpublic-tap/tap/>

Table Access Protocol (TAP) Query



Select Service

Enter Query

Results

Table Metadata

Service: <http://asvo.nci.org.au:8080/skymapper>Table: **public.ms_distilled**

Columns:

Name	DataType	Indexed	Unit	Description
new_object_id	VARCHAR	☒		
mean_epoch	INTEGER	☐		
ra	DOUBLE	☐	deg	
dcl	DOUBLE	☐	deg	
pi	DOUBLE	☐		
sigma_pi	DOUBLE	☐		
mu_x	DOUBLE	☐		

Foreign Keys:

Target Table	Links	Description	Type
--------------	-------	-------------	------

Service Capabilities

Query Language: **ADQL-2.0** Max Rows: Uploads: **unavailable**

ADQL Text

☒ Synchronous

Examples

Clear

Parse Errors

```
SELECT *
FROM public.ms_distilled
WHERE class_star>0.9
AND transient='true'
```

OK

TOPCAT(2): Table Browser



Table Browser for 2: TAP_1_public.ms_distilled

	petro_sigma_i	petro_sigma_z	variability	transient	class_star	a	b	theta
1	0.54694	1.85437	0.35469	true	0.99	0.35063	4.35618	138.09
2	0.70363	2.91083	0.4383	true	0.99	0.66424	13.28489	82.19
3	0.75712	3.28075	1.22263	true	0.99	0.63432	6.06462	73.33
4	0.54283	2.79581	0.05908	true	0.99	0.20918	4.18355	152.09
5	0.98691	2.07157	0.14864	true	0.99	0.00979	1.7948	26.74
6	0.80781	1.94733	0.18541	true	0.99	0.59671	2.06907	103.84
7	0.52152	1.60454	0.28639	true	0.99	0.66414	13.28274	50.29
8	0.45397	1.50415	0.35469	true	0.99	0.99201	1.61614	134.62
9	0.4872	1.31406	0.4383	true	0.99	0.23055	4.61099	56.39
10	0.79725	2.69053	0.66406	true	0.99	0.66413	13.28257	115.24
11	0.59495	2.84734	0.07545	true	0.99	0.34325	6.865	142.53
12	0.51523	2.08333	0.18541	true	0.99	0.95232	1.77515	66.86

Cone Search

```
1=CONTAINS ( POINT ( ' ICRS ' , mean_ra , mean_dcl ,  
CIRCLE ( ' ICRS ' , 0.0 , 0.0 , 0.5 ) )
```

Name	DataType	Indexed	Unit	Description	UCD	Utype
new_object_id	VARCHAR	☒			meta.id;meta.main	
mean_epoch	INTEGER	☐				
ra	DOUBLE	☐	deg		pos.eq.ra;meta.main	
dcl	DOUBLE	☐	deg		pos.eq.dec;meta.main	
pi	DOUBLE	☐				
sigma_pi	DOUBLE	☐				
mu x	DOUBLE	☐				

Foreign Keys:

Target Table	Links	Description	Utype

Service Capabilities

Query Language: Max Rows: Uploads:

ADQL Text

☒ Synchronous

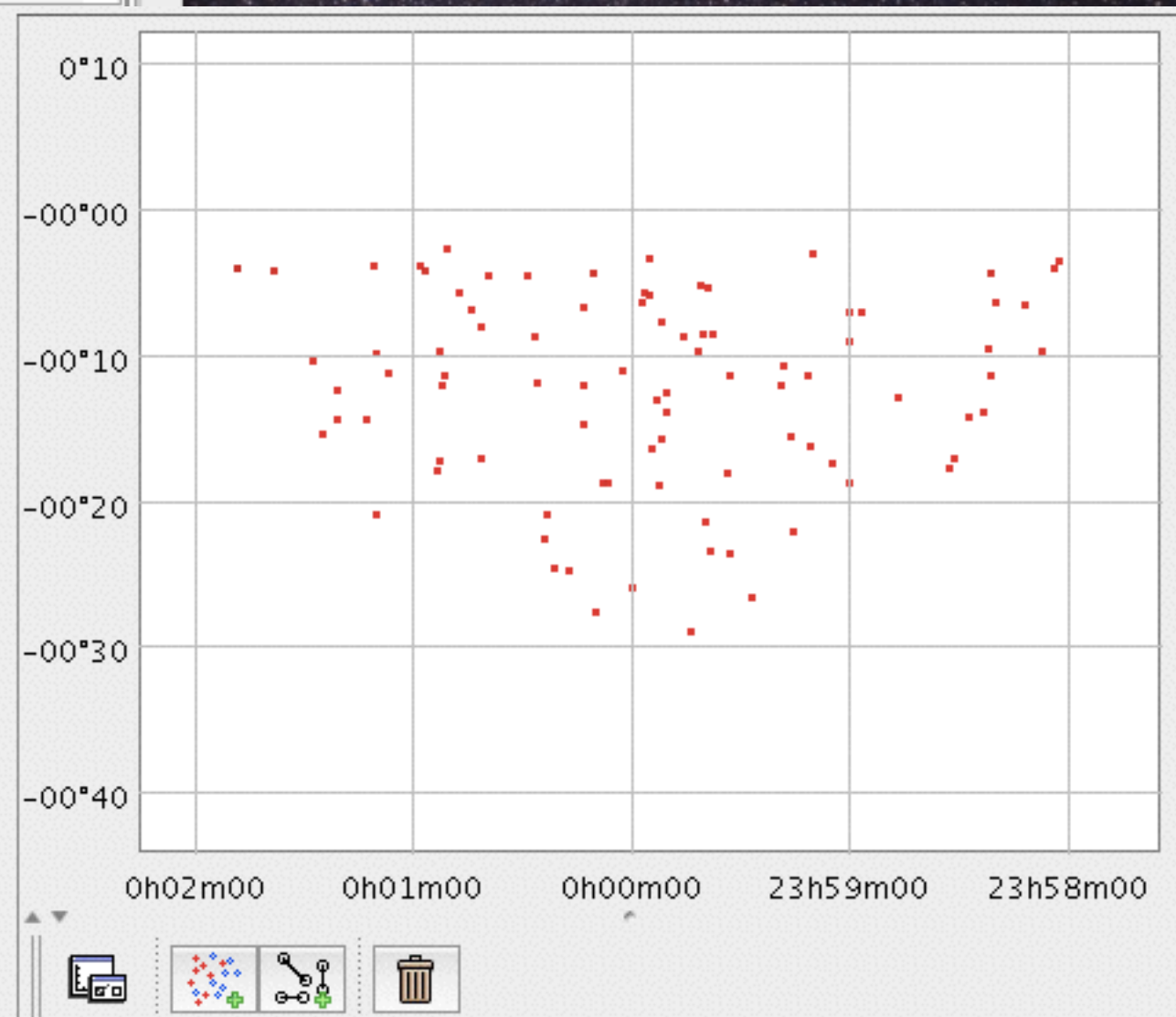
Examples

Clear

Parse E

```
SELECT *  
FROM public.fs_distilled  
WHERE 1=CONTAINS(POINT('ICRS', mean_ra, mean_dcl), CIRCLE('ICRS', 0, 0, 0.5)  
AND sigma_flux_u/flux_u<0.1 AND n_epochs=3
```

OK



Simple Joins

```
SELECT *  
FROM public.fs_photometry AS f  
JOIN public.image AS i  
ON f.image_id=i.image_id
```

Cross match - a join using CONTAINS

```
SELECT *  
FROM public.fs_distilled AS f  
JOIN public.ms_distilled AS m  
ON 1=CONTAINS(POINT('ICRS',f.mean_ra,f.mean_dcl),  
              CIRCLE('ICRS',m.ra,m.dcl,5./3600.))  
WHERE f.n_epochs>3 AND m.a/m.b<0.5
```


FEDERATING DATA

- **Datasets more powerful when brought together**
- ASVO already hosts *HiPASS, WiggleZ, MACHO*
- Coming soon: *SkyMapper, GALAH, TAI PAN, FunnelWeb, ASKAP, ..., Gaia, SKA, **others?***
- Allow user to upload/reference their own data
- **TAP can already do much of this**
- The dream: **distributed queries**
(coming soon to TAP standard, possible to hack now)

NEW: CDS X-MATCH SERVICE

The screenshot shows the CDS XMatch Service web interface in a browser window. The browser's address bar displays `cdsxmatch.u-strasbg.fr/xmatch`. The page features a navigation bar with links to Portal, Simbad, Vizier, Aladin, X-Match, Other, and Help. The main content area is titled "CDS X-Match Service" and includes buttons for X-match, Tables management, and Documentation. A "Choose tables to cross-match" section contains two input fields with placeholder text "e.g. VII/260/dr7qso, or select in list" and "e.g. VII/233/xsc, or select in list". Below these fields are buttons for "VizieR", "SIMBAD", and "My store". A "Show options" button is also present. A "Begin the X-Match" button is located below the input fields. The "Visualize and manage your cross-match jobs" section contains a table titled "List of X-match jobs". The table has columns for Table 1, Table 2, Options, Begin, Status, Actions, and a checkbox. The table is currently empty, showing "No job in list". A "Delete" button is located at the bottom right of the table.

CDS XMatch Service

Portal Simbad Vizier Aladin X-Match Other Help

CDS X-Match Service X-match Tables management Documentation

Login Preferences Register

Choose tables to cross-match

e.g. VII/260/dr7qso, or select in list X e.g. VII/233/xsc, or select in list

VizieR SIMBAD My store VizieR SIMBAD My store

Show options

Begin the X-Match

Visualize and manage your cross-match jobs

List of X-match jobs

Table 1	Table 2	Options	Begin	Status	Actions	
No job in list						

For the selected job(s): Delete

© UDS/CNRS
Contact

cdsxmatch.u-strasbg.fr/xmatch

DEMO

QUERYING THE GAVO DATA CENTRE

Table Access Protocol (TAP) Query

Available TAP Services

Registry: <http://registry.astrogrid.org/astrogrid-registry/>

Keywords:

Match Fields: ☒ Short Name ☒ Title ☒ Subjects ☒

☒ Accept Resource Lists

Cancel Query

Short Name	Title	Subjects
GAVO DC TAP	GAVO Data Center TAP service	Virtual observa

TAP Parameters

TAP URL:

OK

Table Access Protocol (TAP) Query

Select Service Enter Query Resume Job Running Jobs

Table Metadata

Service: GAVO Data Center TAP service (122 tables)

Table:

Column

Name	Type	Indexed	Unit	Description
nualpha	ucac3.main		deg	Neutrino arrival direction, RA
nudelta	ucac3.ppmxlcross		deg	Neutrino arrival direction, Declination
nch	ucac3.icrscorr			Number of optical modules hit in an event
angular	ucac4.main		deg	Angular resolution of a neutrino event
mjd	usnob.plates			Observation time, Modified Julian Day
atmonu	usnob.data			Subset of candidates used in AMANDA's seven-ye

Foreign Keys:

Target Table	Links	Description	Utype
--------------	-------	-------------	-------

Service Capabilities

Query Language: Max Rows: Uploads:

ADQL Text

☒ Synchronous

Examples Clear Parse Errors

OK

TOPCAT

Table List

1: Top Secret Candidates

Current Table Properties

Label: Top Secret Candidates

Location: Top Secret Candidates

Name: Top Secret Candidates

Rows: 52

Columns: 24

Sort Order: ↑

Row Subset: All

Activation Action: (none)

SAMP

Messages:

6 / 124 M

Table Access Protocol (TAP) Query

Select Service Enter Query Resume Job Running Jobs

Table Metadata

Service: GAVO Data Center TAP service (122 tables)

Table: ppmxl.main PPMXL is a catalog of positions ...

Columns:

Name	DataType	Indexed	Unit	Description
ipix	long	☒		Identifier (Q3C ipix of the USNO-B 1.0 object)
raj2000	double	☒	deg	Right Ascension J2000.0, epoch 2000.0
dej2000	double	☒	deg	Declination J2000.0, epoch 2000.0
e_raepra	float	☐	deg	Mean error in RA*cos(delta) at mean epoch

Foreign Keys:

Target Table	Links	Description	Utype
--------------	-------	-------------	-------

Max Rows: 2000 (default) Uploads: 1b

☒ Synchronous Examples Clear Parse Errors

```
SELECT *
FROM ppmxl.main AS p
JOIN TAP_UPLOAD.t1 AS epscha
ON 1=CONTAINS(POINT('ICRS', p.raj2000, p.dej2000),
              CIRCLE('ICRS', epscha.RAJ2000, epscha.DEJ2000, 5./3600.))
WHERE epscha.SpT like 'M%' AND p.nobs>2
```

OK

Table upload and join

JOIN TAP_UPLOAD.t1 **AS** mytable

A slightly more complicated query...

```
SELECT *
FROM (
  SELECT ALL *
  FROM wise.main AS w
  JOIN sdssdr7.sources AS s
  ON 1=CONTAINS(
    POINT('ICRS',s.ra,s.dec),
    CIRCLE('ICRS',w.raj2000,w.dej2000,20./3600.))
  JOIN twomass.data AS t
  ON 1=CONTAINS(
    POINT('ICRS',t.raj2000,t.dej2000),
    CIRCLE('ICRS',w.raj2000,w.dej2000,20./3600.))
  WHERE 1=CONTAINS(
    POINT('ICRS',w.raj2000,w.dej2000),
    CIRCLE('ICRS',125.0,15.0,5))
    AND 0=CONTAINS(
      POINT('ICRS',t.raj2000,t.dej2000),
      CIRCLE('ICRS',w.raj2000,w.dej2000,1./3600.))
    AND NOT EXISTS (
      SELECT *
      FROM supercosmos.sources AS sc
      WHERE 1=CONTAINS(
        POINT('ICRS',sc.raj2000,sc.dej2000),
        CIRCLE('ICRS',w.raj2000,w.dej2000,1./3600.))))
AS bigtable
```

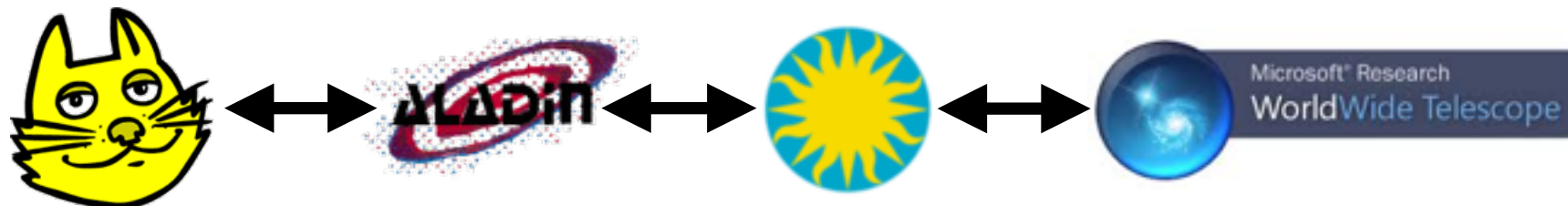


```
WHERE w1mag-w2mag>0.5
      AND w2mag<15.5
      AND w2mag-w3mag<2.5
      AND g>22.2
      AND r>22.2
      AND (i>21.3 OR i-z>3)
      AND z<20.5
      AND aflag='0'
      AND xflag='0'
      AND qflag NOT LIKE 'U%'
      AND jmag>9
      AND jmag-w2mag>1.8
      AND z-jmag>2.5
```

See [**is.gd/ADQLTutorial2**](https://is.gd/ADQLTutorial2) for more details

INTEROPERABILITY

- Tools can exchange data using **SAMP**
(Simple Application Messaging Protocol):
 - tables, row selections, images, sky positions, ...
- **Wide support:**
 - Desktop tools (TOPCAT, Aladin, ds9, WWT, SPLAT...)
 - **Languages (Python, Java[script], C,...)**
 - Web pages (VizieR, MAST, Web Profile)





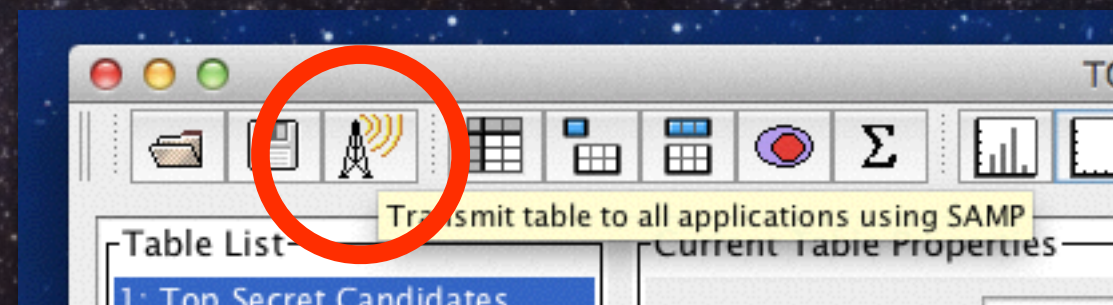
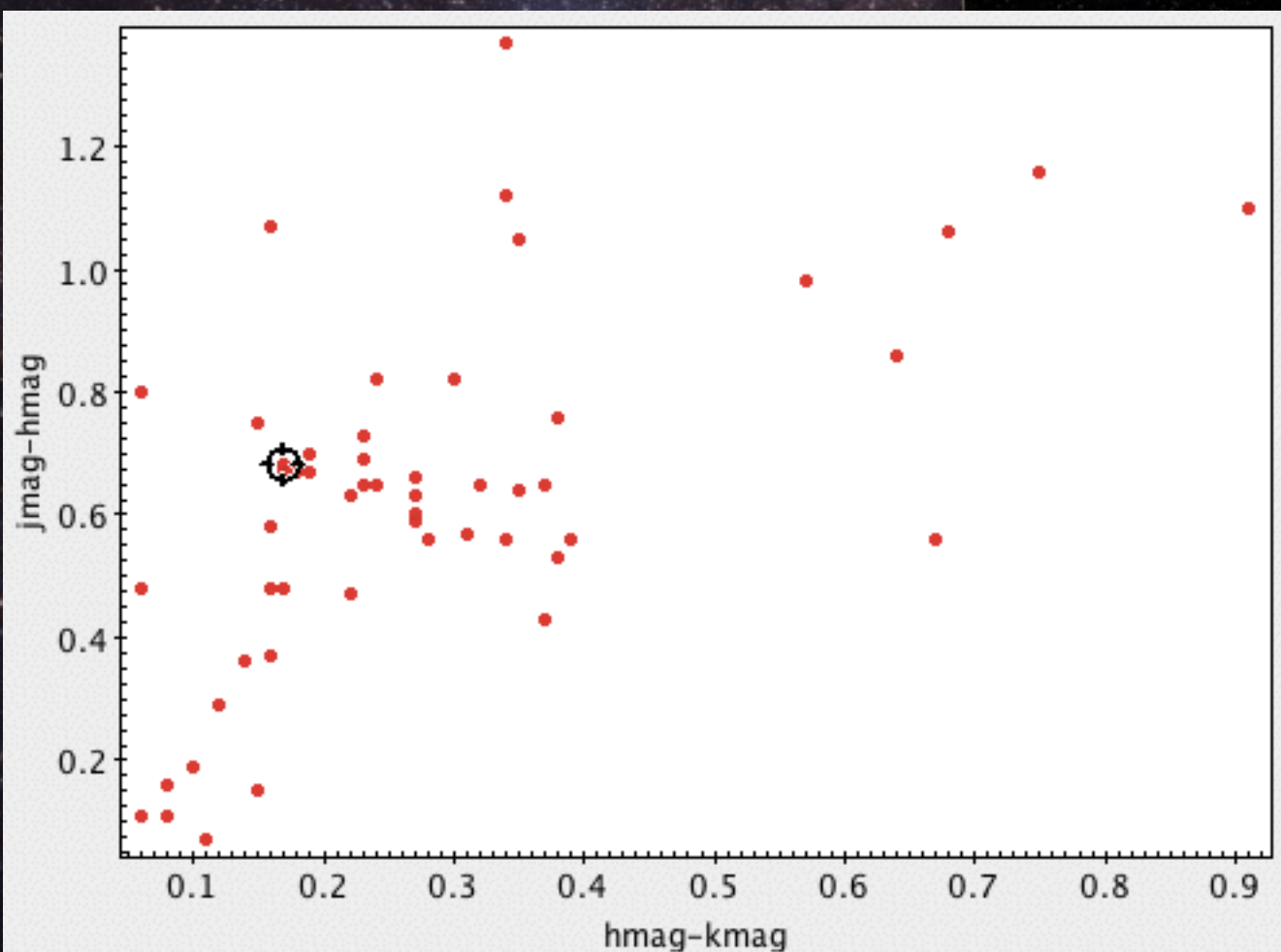
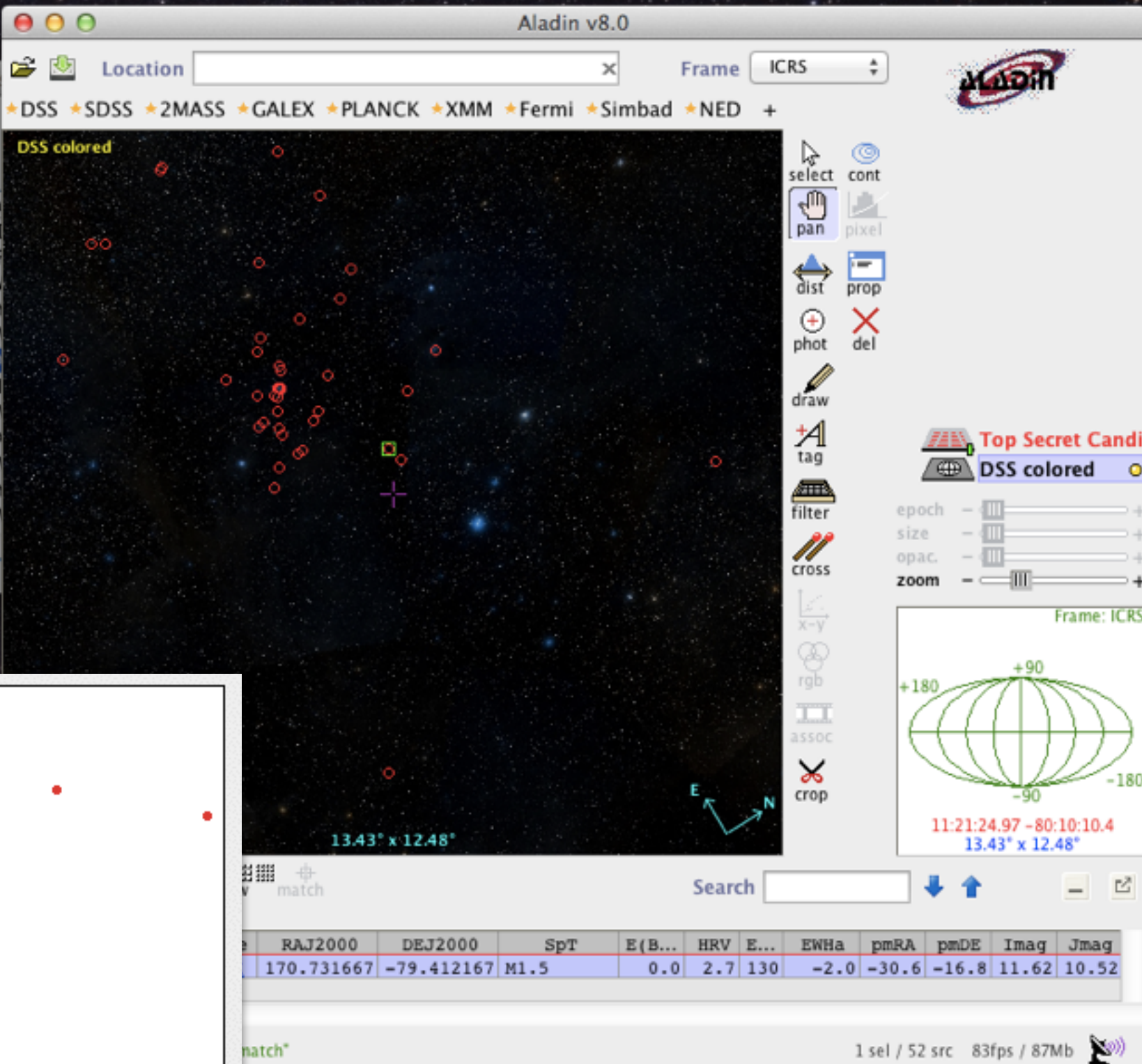
DEMO

INTEROPERABILITY WITH SAMP

TOPCAT(1): Table Browser

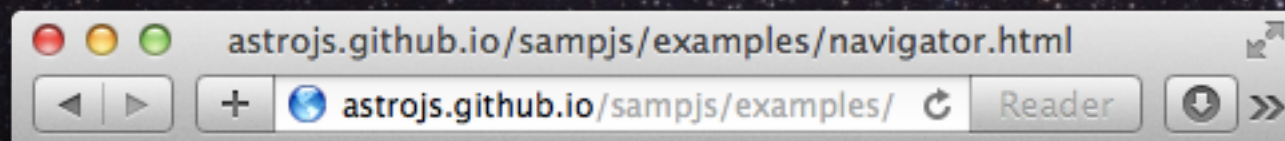
Table Browser for 1: Top Secret Candidates

	_RAJ2000	_DEJ2000	recno	ID	Mm	Na
1	142.08792	-78.25972	1			HI
2	164.45542	-69.23333	2		C	CF
3	167.00625	-77.70806	3			VV
4	169.12083	-78.42244	4		p	TY
5	169.64875	-79.59856	5	13	C	2M
6	170.73167	-79.41217	6	14		RX
7	171.32542	-84.95444	7			HI
8	173.45542	-76.31108	8	15		2M
9	174.38042	-76.79972	9			RX
10	175.20708	-74.99428	10	16	C	2M
11	175.36542	-73.78417	11			TY
12	175.86125	-78.07928	12	17	C	2M



sampjs

<http://astrojs.github.io/sampjs/>



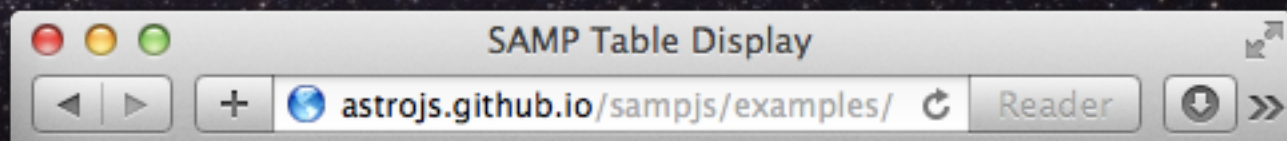
When registered and the sliders are moved, they send appropriate `coord.pointAt.sky` messages. If Aladin is running in all-sky mode, this will change the view position accordingly.

Registered: Yes

RA:

Dec:

Pos: 116.75, 41



This client can receive a VOTable (TABLEDATA only) from another SAMP client (`table.load.votable`) and receive row highlight messages from it (`table.highlight.row`, `table.select.rowList`). If you click on a row in the loaded table, it will broadcast a `table.highlight.row` message.

This is a proof of concept only - it is not very robust or scalable. You probably shouldn't try to send a table with more than a few hundred rows.

Registered: Yes

Table

_RAJ2000	_DEJ2000	recno	ID	Mm	Name
142.087917	-78.259722	1	-32768		HD 82879
164.455417	-69.233333	2	-32768	C	CP-68 1388
167.00625	-77.708056	3	-32768		VW Cha
169.120833	-78.422444	4	-32768	p	TYC 9414-191-1
169.64875	-79.598556	5	13	C	2MASS J11183572-793554
170.731667	-79.412167	6	14		RX J1123.2-7924
171.325417	-84.954444	7	-32768		HIP 55746
173.455417	-76.311083	8	15		2MASS J11334926-761839
174.380417	-76.799722	9	-32768		RX J1137.4-7648
175.207083	-74.994278	10	16	C	2MASS J11404967-745939
175.365417	-73.784167	11	-32768		TYC 9238-612-1

SUMMARY

- **Working knowledge of the VO vital** in the age of tera/peta/exabyte surveys
- Variety of ways to access SkyMapper data in ASVO:
 - **Desktop** (web, VO clients)
 - **Programmatically** (share your workflows!)
 - *Later:* **In the cloud** (custom, BYO software)
- ASVO SkyMapper Node live in **mid-2014**
(*ready for DR1 in 2015*)

SUMMARY

- **More information:**

All Sky Virtual Observatory: **www.asvo.org.au**

International VO Alliance: **www.ivoa.net**

TOPCAT: **www.star.bris.ac.uk/~mbt/topcat/**

ADQL Tutorials: **[is.gd/ADQLTutorial\(2\)](http://is.gd/ADQLTutorial(2))**

Questions, comments, suggestions?

