Visibility data discovery and access prototype based on ObsTAP + DataLink

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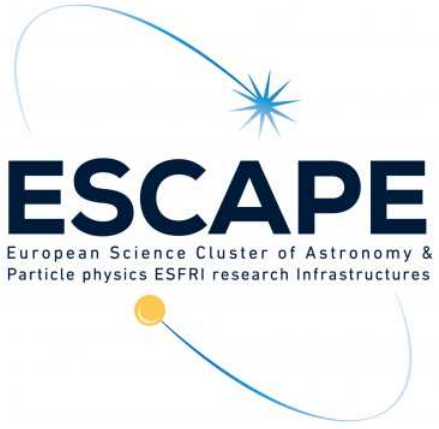


Our GOAL

- Demonstrate how we can use existing standards to expose visibility data in the VO and highlight what is missing by :
- Try to expose a small collection of visibility data observations (measurement sets) in an ObsTAP service
- Solve the Observation / dataset issue
  - Visibilty data observations are generally gathering several datasets
- Provide additional information useful for data selection by adding « ad hoc » columns in ObsCore table and various information via DataLink
- *Initiate a discussion on how we can standardize this additional information*

Small MS collection

- Various measurement sets provided by Katharina Lutz and Yelena Stein (post docs at CDS) and Alan Loh (Nançay)
  - 7 ATCA MS
    - Single and multi-fields : 1-2 Ghz, 4-5 Hhz, 6-7Ghz, 40-50 Ghz bands
  - 2 EVLA MS
    - Single and multi_fields 1-2 Ghz band
  - 1 LOFAR MS
    - 50-60 Mhz band
  - 1 NENUFAR MS
    - 50-60 Mhz band

Processed Metadata : listobs output

- For each measurement set we extract metadata using the casa « listobs » command
- Algorithm to split measurement sets into several datasets and extract ObsCore metadata for them developped by one of us (A.Egner) as an internship project.

```
================================================================================
           MeasurementSet Name:  /home/klutz/Interns/Anais_Radio-Data-Archive/Measurement_Sets/HI_data_narrow_channels.ms      MS Version 2
================================================================================
   Observer: TB,KL     Project: C2705
Observation: ATCA
Data records: 18900       Total elapsed time = 3229.86 seconds
   Observed from   10-Sep-2015/02:13:20.0   to   10-Sep-2015/03:07:09.9 (UTC)

   ObservationID = 0         ArrayID = 0
  Date        Timerange (UTC)          Scan  FldId FieldName             nRows     SpwIds   Average Interval(s)    ScanIntent
  10-Sep-2015/02:13:20.0 - 02:53:29.9     0      0 eso208-g026             14460  [0,1,2,3]  [9.86, 9.86, 9.86, 9.86]
              02:54:10.0 - 02:59:09.9     1      1 0823-500                 1800  [0,1,2,3]  [9.86, 9.86, 9.86, 9.86]
              02:59:50.0 - 03:07:09.9     2      0 eso208-g026              2640  [0,1,2,3]  [9.86, 9.86, 9.86, 9.86]
            (nRows = Total number of rows per scan)
Fields: 2
  ID   Code Name                RA               Decl           Epoch   SrcId      nRows
  0         eso208-g026         07:35:21.099994 -50.02.34.99996 J2000   0          17100
  1         0823-500            08:25:26.868994 -50.10.38.49003 J2000   1           1800
Spectral Windows:  (4 unique spectral windows and 1 unique polarization setups)
  SpwID  Name   #Chans   Frame   Ch0(MHz)  ChanWid(kHz)  TotBW(kHz) CtrFreq(MHz)  Corrs
  0             2049   TOPO    3124.000     -1000.000   2049000.0   2100.0000   XX  XY  YX  YY
  1            17409   TOPO    1410.500        -0.488      8500.5   1406.2500   XX  XY  YX  YY
  2             2049   TOPO    3124.000     -1000.000   2049000.0   2100.0000   XX  XY  YX  YY
  3            17409   TOPO    1410.500        -0.488      8500.5   1406.2500   XX  XY  YX  YY
Sources: 2
  ID   Name               SpwId RestFreq(MHz)  SysVel(km/s)
  0    eso208-g026        any   1420.40575     0
  1    0823-500           any   1420.40575     0
Antennas: 6:
  ID   Name  Station   Diam.    Long.         Lat.                Offset from array center (m)               ITRF Geocentric coordinates (m)
                                                                      East         North     Elevation            x                   y                z
  0    CA01  ANT1      22.0 m   +149.33.56.6  -30.08.43.7       1499.9977       0.7721       -1.6135 -4751674.967380  2791612.460760 -3200482.268996
  1    CA02  ANT2      22.0 m   +149.33.50.3  -30.08.43.7       1331.6239       0.6974       -1.7741 -4751589.523380  2791757.543760 -3200482.252996
  2    CA03  ANT3      22.0 m   +149.33.48.0  -30.08.43.7       1270.4069       0.6539       -1.8330 -4751558.449380  2791810.287760 -3200482.260996
  3    CA04  ANT4      22.0 m   +149.33.32.6  -30.08.43.7        857.1470       0.4463       -2.2224 -4751348.704380  2792166.364760 -3200482.244996
  4    CA05  ANT5      22.0 m   +149.33.28.0  -30.08.43.7        734.6957       0.3678       -2.3296 -4751286.549380  2792271.868760 -3200482.258996
  5    CA06  ANT6      22.0 m   +149.31.08.2  -30.08.43.8      -2999.9964      -0.8846       -4.6136 -4749390.961380  2795489.734760 -3200482.194996
```

A few hints on the choice we made

- A dataset is defined as a subset of contiguous or overlapping SpectralWindows of same Channel Width for a given Field
- obs_id, facility_name, instrument_name built or extracted from generic measurement set information (Observer, project, Observation name, etc..)

```
================================================================================
   Observer: TB,KL     Project: C2705
Observation: ATCA
Data records: 18900       Total elapsed time = 3229.86 seconds
   Observed from   10-Sep-2015/02:13:20.0   to   10-Sep-2015/03:07:09.9 (UTC)
```

A few hints on the choice we made

- target_name , s_ra, s_dec, obs_publisher_did extracted from the field table for each datasets we create :

```
Fields: 2
  ID   Code Name                 RA                Decl              Epoch   SrcId      nRows
  0         eso208-g026          07:35:21.099994 -50.02.34.99996 J2000   0          17100
  1         0823-500             08:25:26.868994 -50.10.38.49003 J2000   1           1800
```

- f_min, f_max, em_min, em_max, em_res_power, em_xel, pol_states, pol_xel, s_fov, s_region extracted from the SpectralW indow table

```
Spectral Windows:  (4 unique spectral windows and 1 unique polarization setups)
  SpwID  Name   #Chans   Frame   Ch0(MHz)  ChanWid(kHz)  TotBW(kHz) CtrFreq(MHz)  Corrs
  0             2049   TOPO    3124.000     -1000.000   2049000.0   2100.0000   XX  XY  YX  YY
  1            17409   TOPO    1410.500        -0.488      8500.5   1406.2500   XX  XY  YX  YY
  2             2049   TOPO    3124.000     -1000.000   2049000.0   2100.0000   XX  XY  YX  YY
  3            17409   TOPO    1410.500        -0.488      8500.5   1406.2500   XX  XY  YX  YY
```

s_fov is estimated as 1.02 * (central lambda / Antenna Diameter)* (180/ pi)

(f_min, f_max non ObsCore columns)

A few hints on the choice we made

- t_min, t_max, t_exptime extracted from « scan table »

```
Date        Timerange (UTC)          Scan  FldId FieldName             nRows     SpwIds   Average Interval(s)    ScanIntent
10-Sep-2015/02:13:20.0 - 02:53:29.9     0      0 eso208-g026           14460  [0,1,2,3]  [9.86, 9.86, 9.86, 9.86]
            02:54:10.0 - 02:59:09.9     1      1 0823-500               1800  [0,1,2,3]  [9.86, 9.86, 9.86, 9.86]
            02:59:50.0 - 03:07:09.9     2      0 eso208-g026            2640  [0,1,2,3]  [9.86, 9.86, 9.86, 9.86]
        (nRows = Total number of rows per scan)
```

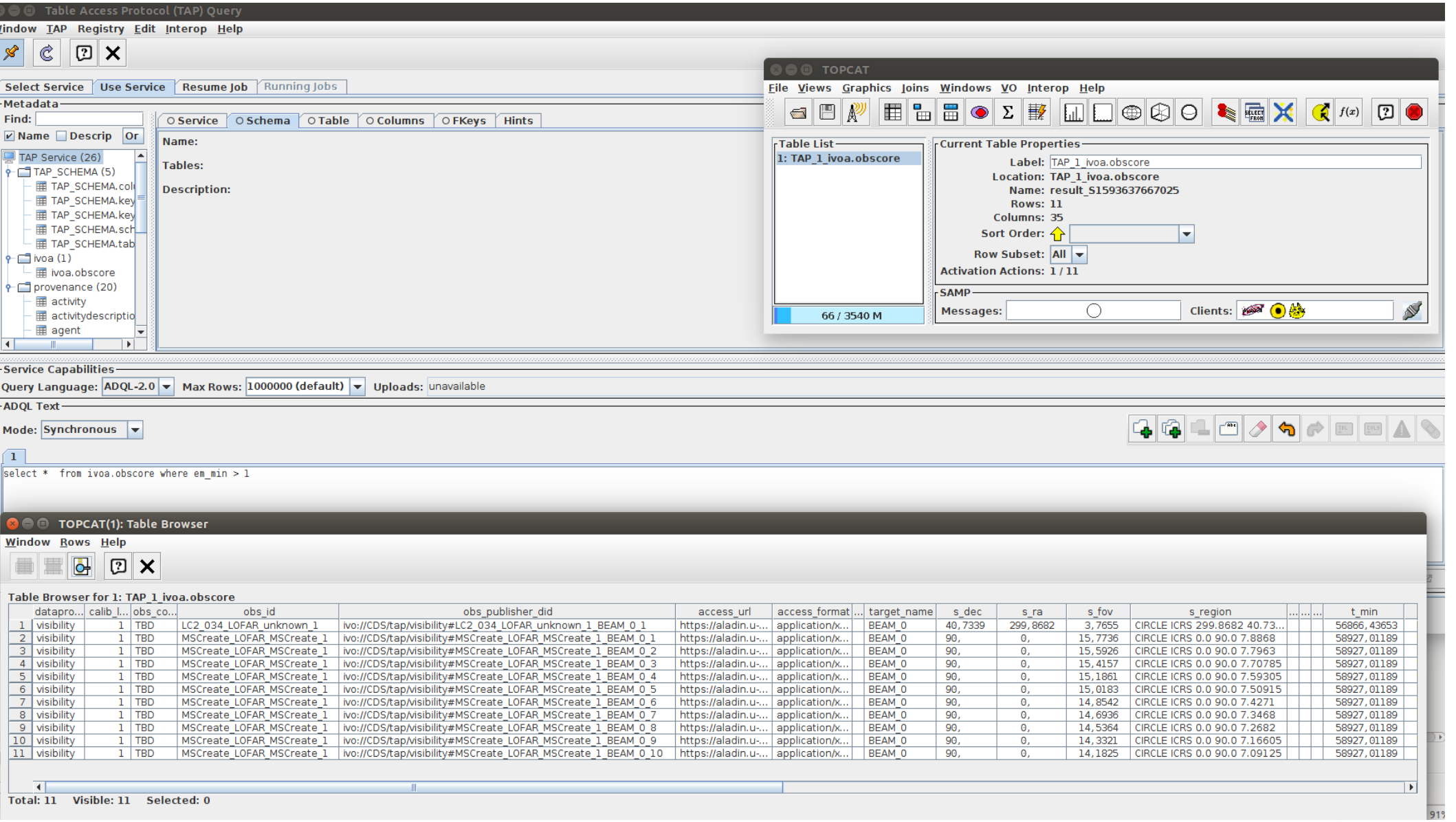
- Antenna diameter from Antenna table (common value)
- Still unsolved :
    - s_resolution, s_xel1,s_xel2
    - t_resolution, t_xel
    - obs_collection

Visibility data ObsTAP CDS prototype

- A service with 374 different datasets from 11 observations
- access_url gives a DataLink response VOTable providing links to
  - Full listobs result file
  - MS zip file
  - Various plots (uv coverage, antennae, etc...)

Prototype queried via TOPCAT

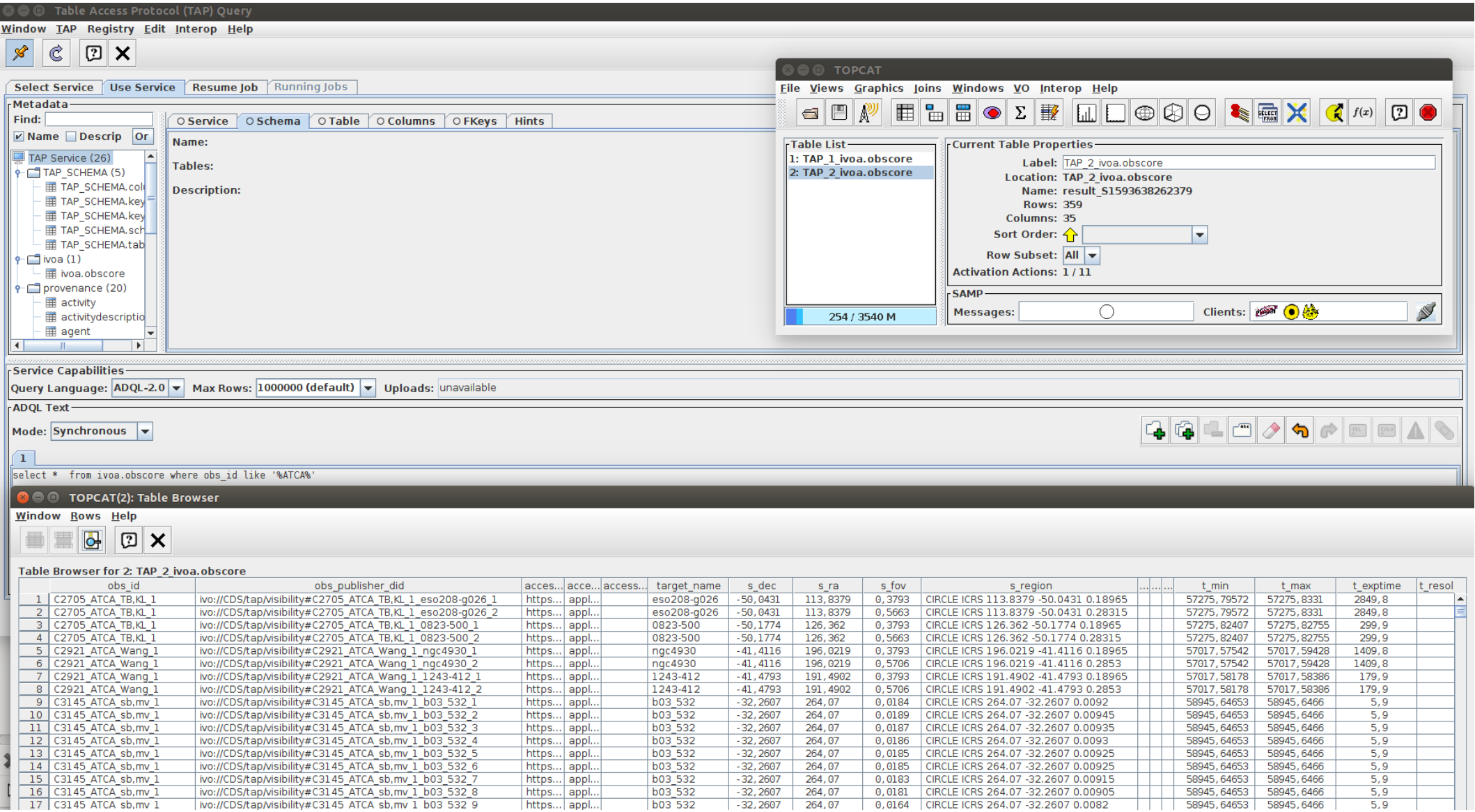
« select * from ivoa.obscore where em_min > 1 »



	datapro...	calib_l...	obs_co...	obs_id	obs_publisher_did	access_url	access_format	...	target_name	s_dec	s_ra	s_fov	s_region	...	...	...	t_min
1	visibility	1	TBD	LC2_034_LOFAR_unknown_1	ivo://CDS/tap/visibility#LC2_034_LOFAR_unknown_1_BEAM_0_1	https://aladin.u-...	application/x...		BEAM_0	40,7339	299,8682	3,7655	CIRCLE ICRS 299.8682 40.73...				56866,43653
2	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_1	https://aladin.u-...	application/x...		BEAM_0	90,	0,	15,7736	CIRCLE ICRS 0.0 90.0 7.8868				58927,01189
3	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_2	https://aladin.u-...	application/x...		BEAM_0	90,	0,	15,5926	CIRCLE ICRS 0.0 90.0 7.7963				58927,01189
4	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_3	https://aladin.u-...	application/x...		BEAM_0	90,	0,	15,4157	CIRCLE ICRS 0.0 90.0 7.70785				58927,01189
5	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_4	https://aladin.u-...	application/x...		BEAM_0	90,	0,	15,1861	CIRCLE ICRS 0.0 90.0 7.59305				58927,01189
6	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_5	https://aladin.u-...	application/x...		BEAM_0	90,	0,	15,0183	CIRCLE ICRS 0.0 90.0 7.50915				58927,01189
7	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_6	https://aladin.u-...	application/x...		BEAM_0	90,	0,	14,8542	CIRCLE ICRS 0.0 90.0 7.4271				58927,01189
8	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_7	https://aladin.u-...	application/x...		BEAM_0	90,	0,	14,6936	CIRCLE ICRS 0.0 90.0 7.3468				58927,01189
9	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_8	https://aladin.u-...	application/x...		BEAM_0	90,	0,	14,5364	CIRCLE ICRS 0.0 90.0 7.2682				58927,01189
10	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_9	https://aladin.u-...	application/x...		BEAM_0	90,	0,	14,3321	CIRCLE ICRS 0.0 90.0 7.16605				58927,01189
11	visibility	1	TBD	MSCreate_LOFAR_MSCreate_1	ivo://CDS/tap/visibility#MSCreate_LOFAR_MSCreate_1_BEAM_0_10	https://aladin.u-...	application/x...		BEAM_0	90,	0,	14,1825	CIRCLE ICRS 0.0 90.0 7.09125				58927,01189

Prototype queried via TOPCAT

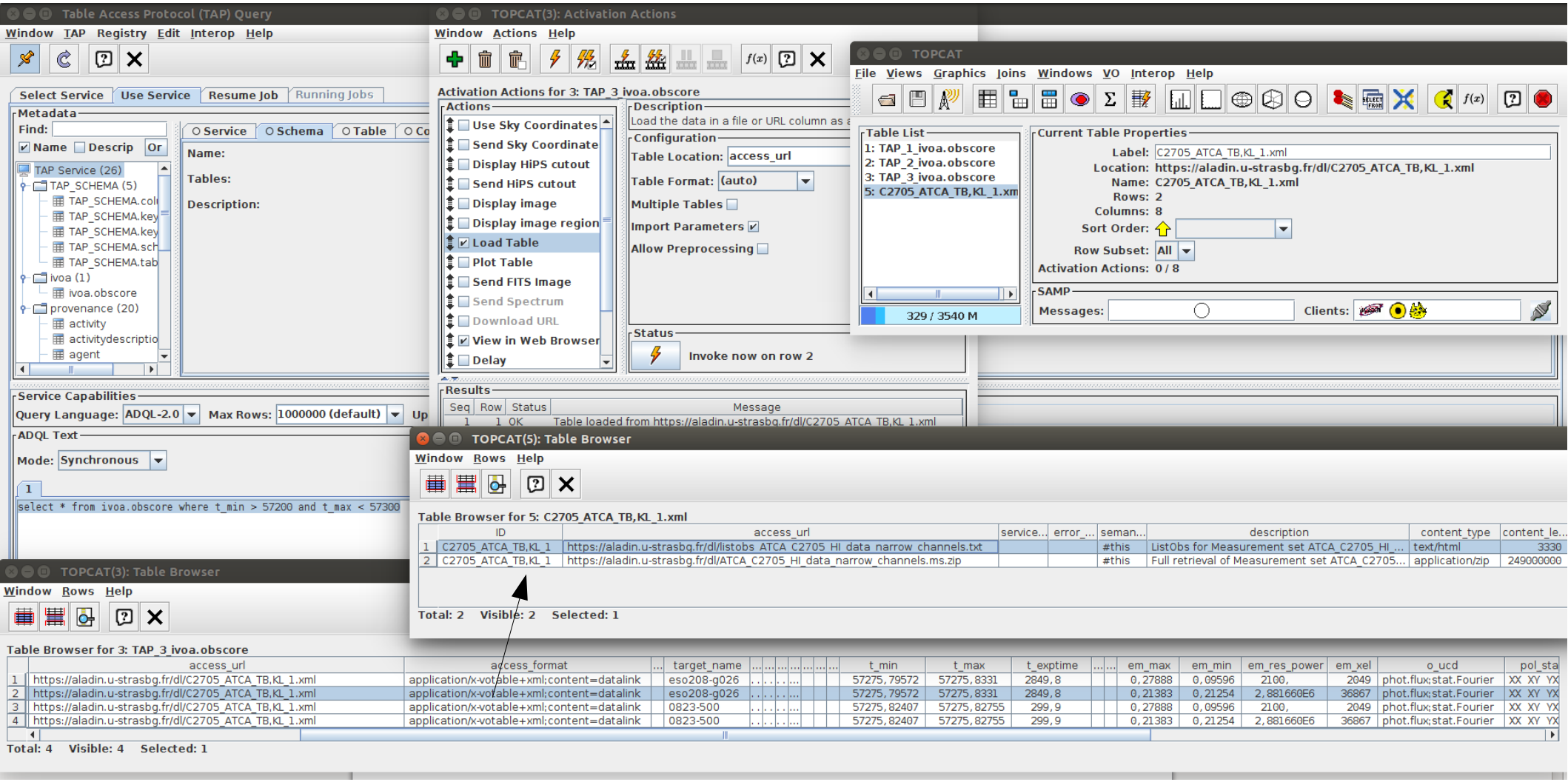
« select * from ivoa.obscore where obs_id like '%ATCA%'»



	obs_id	obs_publisher_did	acces...	acce...	access...	target_name	s_dec	s_ra	s_fov	s_region	...	...	...	t_min	t_max	t_exptime	t_resol
1	C2705_ATCA_TB,KL_1	ivo://CDS/tap/visibility#C2705_ATCA_TB,KL_1_eso208-g026_1	https...	appl...		eso208-g026	-50,0431	113,8379	0,3793	CIRCLE ICRS 113.8379 -50.0431 0.18965				57275,79572	57275,8331	2849,8	
2	C2705_ATCA_TB,KL_1	ivo://CDS/tap/visibility#C2705_ATCA_TB,KL_1_eso208-g026_2	https...	appl...		eso208-g026	-50,0431	113,8379	0,5663	CIRCLE ICRS 113.8379 -50.0431 0.28315				57275,79572	57275,8331	2849,8	
3	C2705_ATCA_TB,KL_1	ivo://CDS/tap/visibility#C2705_ATCA_TB,KL_1_0823-500_1	https...	appl...		0823-500	-50,1774	126,362	0,3793	CIRCLE ICRS 126.362 -50.1774 0.18965				57275,82407	57275,82755	299,9	
4	C2705_ATCA_TB,KL_1	ivo://CDS/tap/visibility#C2705_ATCA_TB,KL_1_0823-500_2	https...	appl...		0823-500	-50,1774	126,362	0,5663	CIRCLE ICRS 126.362 -50.1774 0.28315				57275,82407	57275,82755	299,9	
5	C2921_ATCA_Wang_1	ivo://CDS/tap/visibility#C2921_ATCA_Wang_1_ngc4930_1	https...	appl...		ngc4930	-41,4116	196,0219	0,3793	CIRCLE ICRS 196.0219 -41.4116 0.18965				57017,57542	57017,59428	1409,8	
6	C2921_ATCA_Wang_1	ivo://CDS/tap/visibility#C2921_ATCA_Wang_1_ngc4930_2	https...	appl...		ngc4930	-41,4116	196,0219	0,5706	CIRCLE ICRS 196.0219 -41.4116 0.2853				57017,57542	57017,59428	1409,8	
7	C2921_ATCA_Wang_1	ivo://CDS/tap/visibility#C2921_ATCA_Wang_1_1243-412_1	https...	appl...		1243-412	-41,4793	191,4902	0,3793	CIRCLE ICRS 191.4902 -41.4793 0.18965				57017,58178	57017,58386	179,9	
8	C2921_ATCA_Wang_1	ivo://CDS/tap/visibility#C2921_ATCA_Wang_1_1243-412_2	https...	appl...		1243-412	-41,4793	191,4902	0,5706	CIRCLE ICRS 191.4902 -41.4793 0.2853				57017,58178	57017,58386	179,9	
9	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_1	https...	appl...		b03_532	-32,2607	264,07	0,0184	CIRCLE ICRS 264.07 -32.2607 0.0092				58945,64653	58945,6466	5,9	
10	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_2	https...	appl...		b03_532	-32,2607	264,07	0,0189	CIRCLE ICRS 264.07 -32.2607 0.00945				58945,64653	58945,6466	5,9	
11	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_3	https...	appl...		b03_532	-32,2607	264,07	0,0187	CIRCLE ICRS 264.07 -32.2607 0.00935				58945,64653	58945,6466	5,9	
12	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_4	https...	appl...		b03_532	-32,2607	264,07	0,0186	CIRCLE ICRS 264.07 -32.2607 0.0093				58945,64653	58945,6466	5,9	
13	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_5	https...	appl...		b03_532	-32,2607	264,07	0,0185	CIRCLE ICRS 264.07 -32.2607 0.00925				58945,64653	58945,6466	5,9	
14	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_6	https...	appl...		b03_532	-32,2607	264,07	0,0185	CIRCLE ICRS 264.07 -32.2607 0.00925				58945,64653	58945,6466	5,9	
15	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_7	https...	appl...		b03_532	-32,2607	264,07	0,0183	CIRCLE ICRS 264.07 -32.2607 0.00915				58945,64653	58945,6466	5,9	
16	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_8	https...	appl...		b03_532	-32,2607	264,07	0,0181	CIRCLE ICRS 264.07 -32.2607 0.00905				58945,64653	58945,6466	5,9	
17	C3145_ATCA_sb,mv_1	ivo://CDS/tap/visibility#C3145_ATCA_sb,mv_1_b03_532_9	https...	appl...		b03_532	-32,2607	264,07	0,0164	CIRCLE ICRS 264.07 -32.2607 0.0082				58945,64653	58945,6466	5,9	

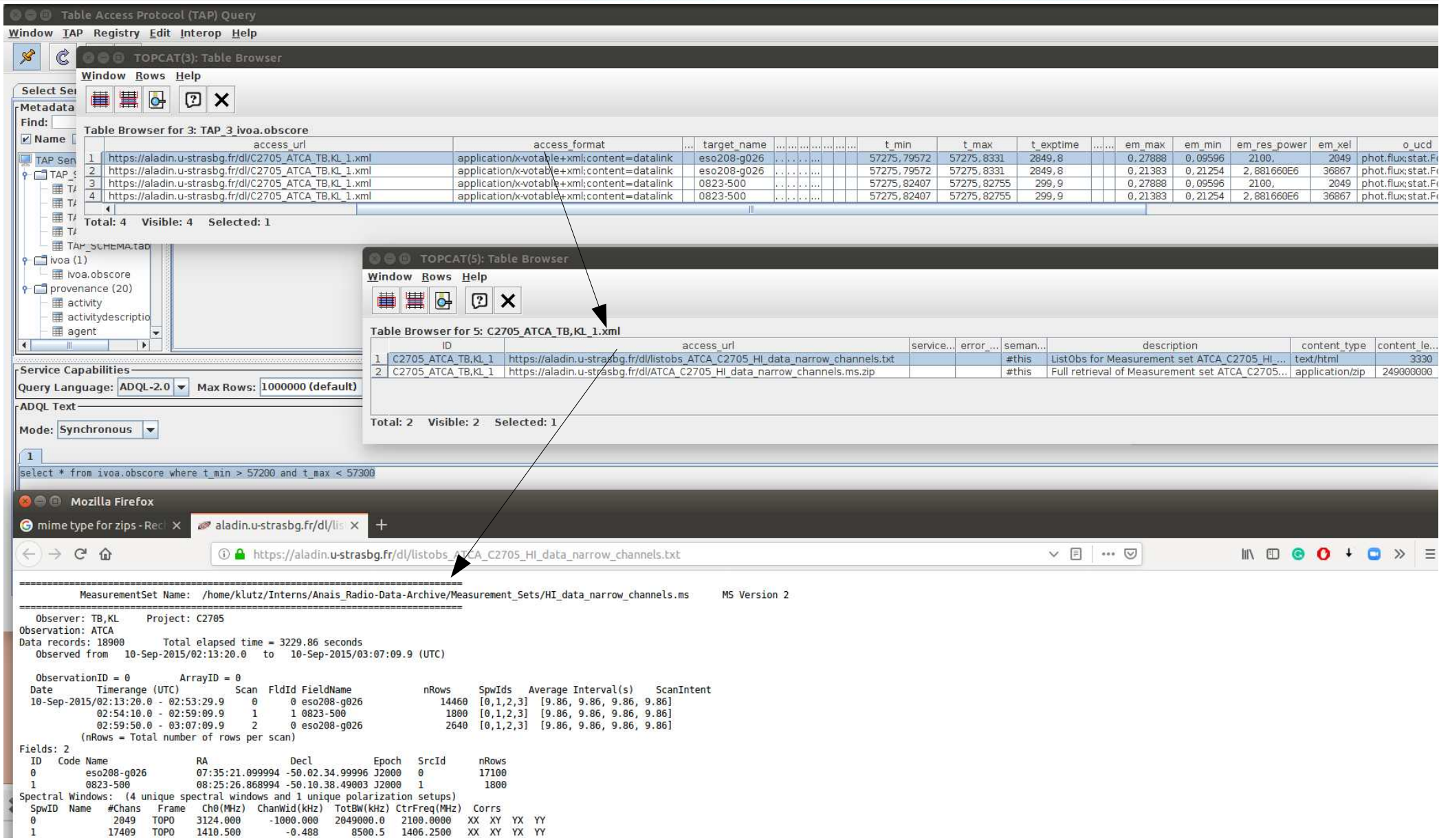
Prototype queried via TOPCAT

« select * from ivoa.obscore where t_min > 57200 and t_max < 57300»
+ DataLink acces to listobs result - 1

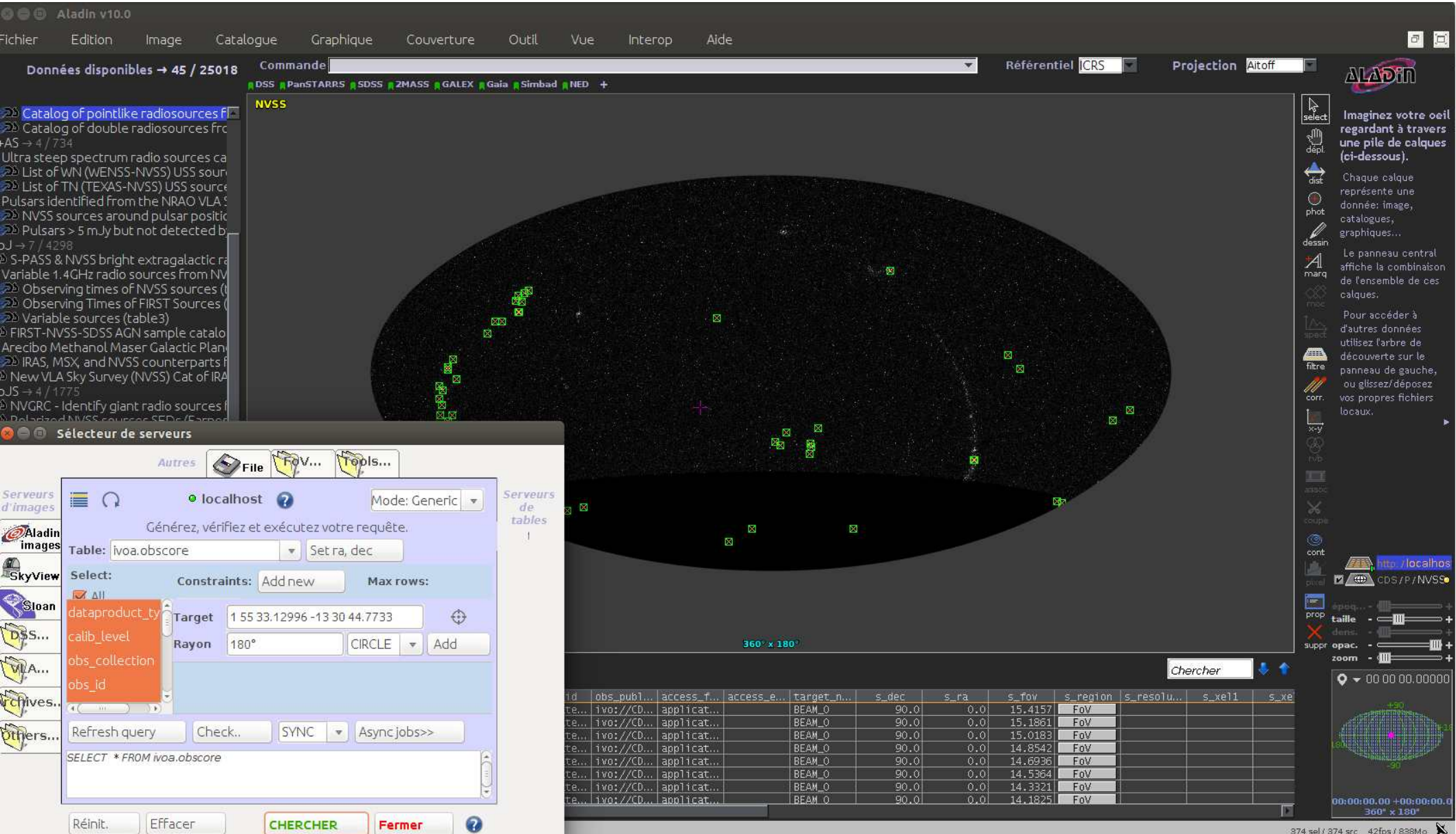


Prototype queried via TOPCAT

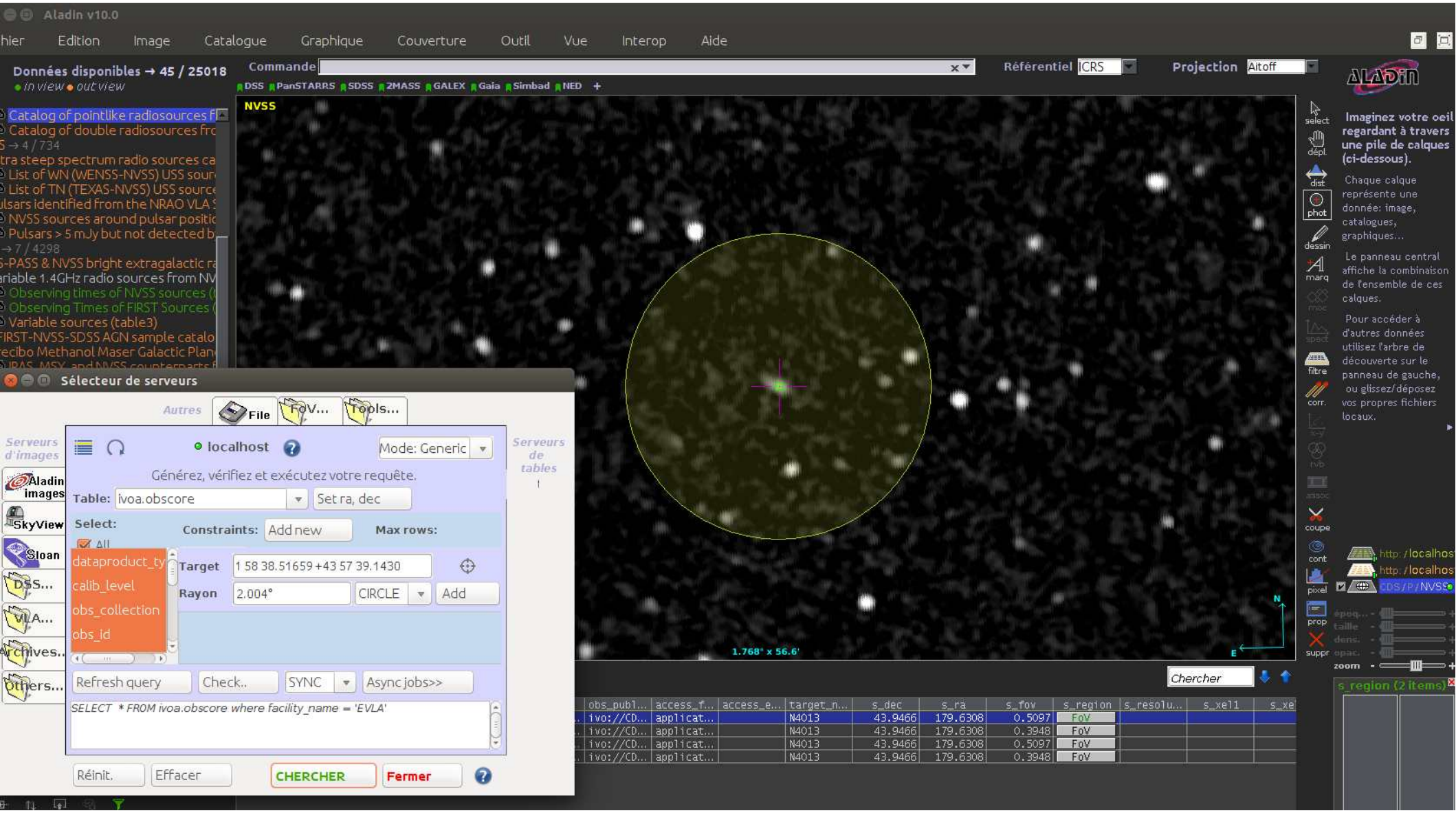
« select * from ivoa.obscore where t_min > 57200 and t_max < 57300»
+ DataLink acces to listobs result - 2



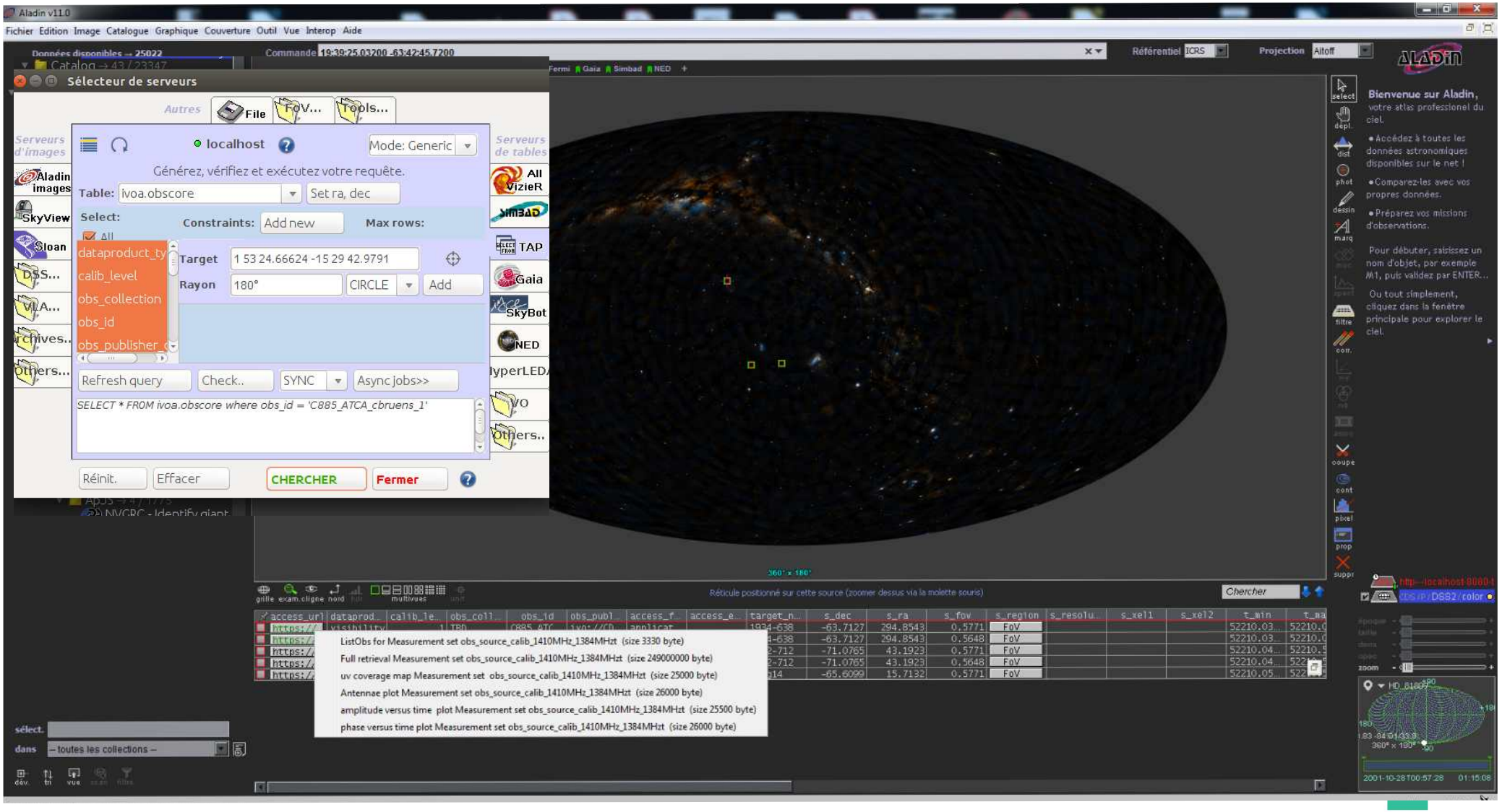
Prototype queried via Aladin
Overal distribution of datasets



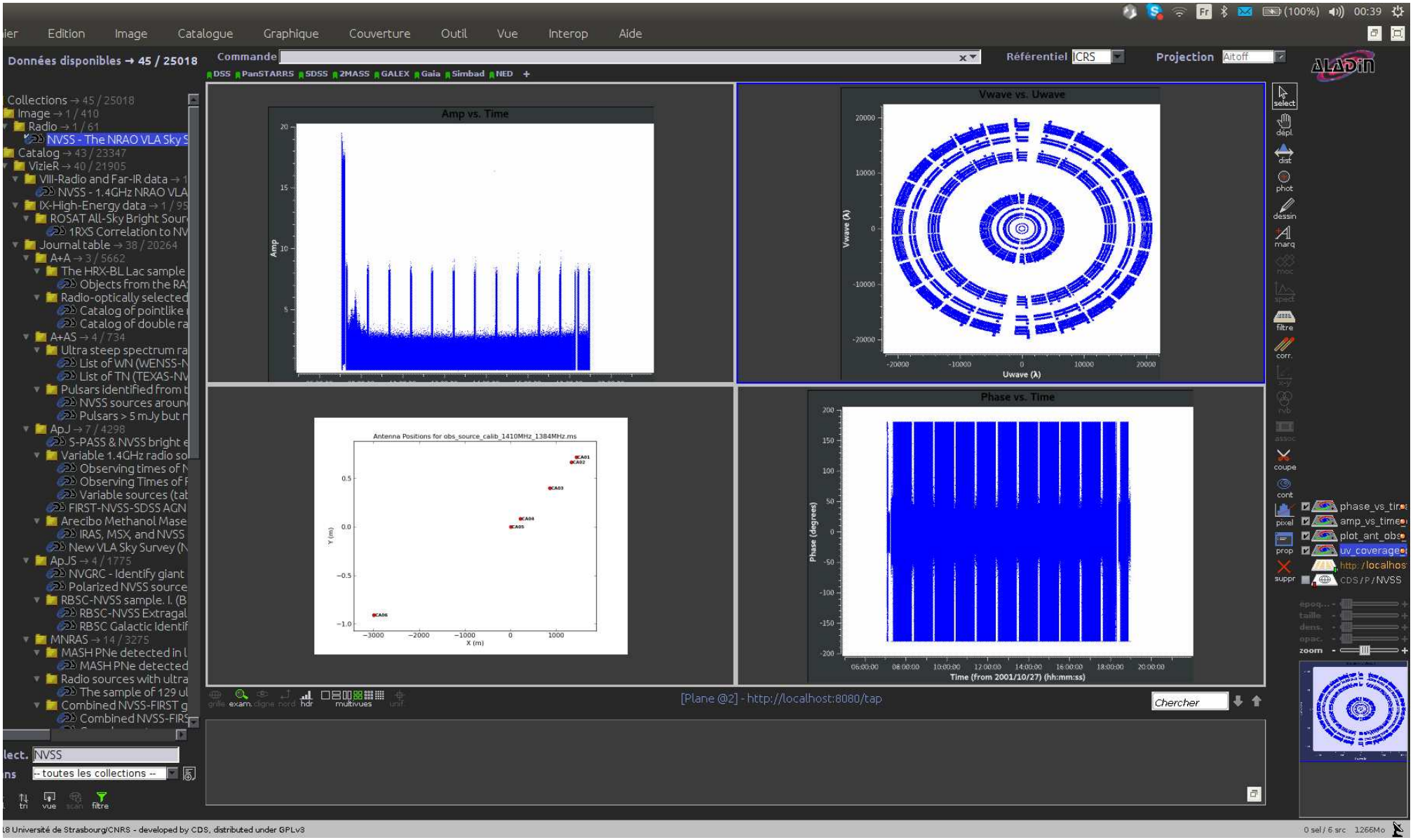
Prototype queried via Aladin
EVLA MS field of view on top of NVSS



Prototype queried via Aladin
ASCA MS with DataLinks



Prototype queried via Aladin
ASCA MS linked plots



Work coming next

- Add other MS (JIVE, LOFAR, ALMA???)
- Add other free metadata columns in ObsCore
  - uv characterisation, number of antennae,
- Add new descriptive metadata in DataLink
- Make an attempt of standardizing metadata = Characterisation and Provenance extension
- Collaborations ?