

Radio and millimetric Data in the Virtual Observatory : State of the art and open questions



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On behalf of ... many Interop Partners



Summary

- 0) political context
- I) science ready data / visibility data
- III) relevant VO achievements or ongoing work
 - Discovery : obstap/Siap2
 - Access : DataLink and SODA
 - Interfaces : Aladin, TOPCAT
 - Discovery + Access + View : MOC and HiPS
- IV) working implementations
 - HiPS cubes distributed by CDS
 - ALMA implementations
 - ASKAP data : CASDA implementations
- V) What next ?
 - « extend » « science ready data » implementations
 - Discovery of visibility data
 - « fine grain » characterisation of visibility data
 - Integrating Visibility data processing in VO landscape
 - Visibility data representation ?



Radio cubes in the VO political context

- « Multi-D » IVOA priority driver
 - Set of protocols
- ALMA, LOFAR, ASKAP in VO landscape.
 - First IVOA standards implementations
 - Asterics discussions in Europe
- SKA perspective
- ESCAPE CEVO in Europe : ESFRI projects / VO experts
 - Asterics/Escape meeting in Strasbourg



Radio data in the VO

Science ready data (imaging cubes)

versus

Visibility / raw data



Radio data Cubes (science ready)

- ALMA
- LOFAR, ASKAP, JIVE
 - Towards SKA
- various surveys at CADC or CDS
- Two different strategies :
 - 2 steps strategy
 - data discovery by selecting criteria on metadata
 - Data acces : extraction of « useful » data in discovered « datasets »
 - AllSky discovery, access and visualisation : HiPS



Data discovery : ObsTAP

- Data discovery by selecting criteria on description attribute (metadata)
- ObsCore 1.1 (addition to ObsCore 1.0):
 - Size in pixels
 - Polarisation
- Served by TAP → ObsTAP
- ObsTAP : allows to select datasets on criteria such as `dataprodct_type= cube` and characterisation of axes
- REC may 2017



Data discovery : SIAP 2.0

- SIAP 2 : allows queries for image and cubes with PARAMETERS such as : DPTYPE = cube
- POS = « STC shape», BAND = 0.0005 0.0006, TIME = 52618 53700 etc.
- REC december 2015



Towards access :

→ DataLink

- Full data retrieval via `access_reference` column in ObsCore
- Or access to DataLink ... an SODA cutouts



DataLink

- {links} endpoint :
link a list of RESOURCES (metadata, other formats, associated data, services...) to a DataSet via a small VOTable giving url, media type, sémantics, etc..
- DataLink « service descriptor »
A « resource » to describe a service (included in main DAL service or {links} endpoint response)
- REC June 2015
- DataLink 1.1 proposal (july 2019)



Data access

- Data access : extracting useful data from the datasets
 - Full retrieval cumbersome (radio cubes are « huge »)
 - Cutouts : SODA 1.0 REC may 2017
 - Eventually regridding, reprocessing -> SODA -next (virtual data)
 - More metadata/modelling for finer description ?



Interface : Aladin

- Recent developments : discovery tree, SIA interface, DataLink and SODA interface
- TAP interface
 - ADQL control and assistance
 - Synchronous, asynchronous modes
 - JOINS
 - UPLOAD

The screenshot displays the Aladin web interface. On the left, a 'Server selector' dialog box is open, showing a query editor with the following SQL query:

```
Select TOP 9999 main_id, ra, dec, pmra, pmdec, SQRT(POWER(pmra,2)+POWER(pmdec,2)) as pm from basic WHERE SQRT(POWER(pmra,2)+POWER(pmdec,2)) > 20
```

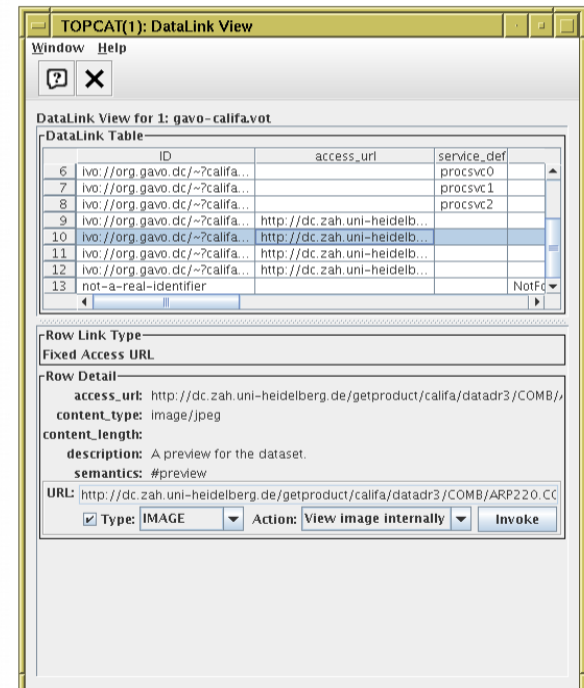
Below the query editor, a table of results is displayed with the following columns: main_id, ra, dec, pmra, pmdec, pm. The table contains 10 rows of data:

main_id	ra	dec	pmra	pmdec	pm
UCAC2_33429...	269.990821	4.598942	-1.47	-1.41	20.369094
TYC_994-1499...	266.809109	8.844841	-1.799	-39.197	39.238262
TYC_994-240.1	266.814408	8.847392	-5.633	-43.158	43.524058
2MASS J1812558	272.231908	11.692548	-29.3	24.1	34.941379
2MASS J1846107	281.544764	10.551941	-1.6	-27.4	31.933055
2MASS J1846209	281.587148	10.503709	-1.4	-33.1	38.366261
2MASS J1846460	281.681769	11.09897	-21.2	-16.8	27.049584
UGCS J174207.6	265.531882	5.172271	9.85	-38.68	39.91444
UGCS J174348.2	265.951045	5.703928	-18.43	-8.57	21.23605
UGCS J174349.1	265.954572	4.976473	-2.0	-22.0	22.090722

At the bottom of the interface, a search bar and a table of results are visible. The table has columns for main_id, ra, dec, pmra, pmdec, pm, and a search bar.

Interface : TOPCAT

- TOPCAT is an ObsTAP interface
 - Discovery, SAMP to other tools
- TOPCAT takes into account DataLink
 - Feedback
 - Improvement proposals



VO data modelling

1) Obscore : metadata for discovery

obs_collection	unitless	String	Name of the data collection
obs_id	unitless	String	Observation ID
obs_publisher_did	unitless	String	Dataset identifier given by the publisher
access_url	unitless	String	URL used to access (download) dataset
access_format	unitless	String	File content format (see in App. BB.5.2)
access_estsize	kbyte	integer	Estimated size of dataset in kilo bytes
target_name	unitless	String	Astronomical object observed, if any
s_ra	deg	double	Central right ascension, ICRS
s_dec	deg	double	Central declination, ICRS
s_fov	deg	double	Diameter (bounds) of the covered region
s_region	unitless	String	Sky region covered by the data product (expressed in ICRS frame)
s_xel1	unitless	integer	Number of elements along the first spatial axis
s_xel2	unitless	integer	Number of elements along the second spatial axis
s_resolution	arcsec	double	Spatial resolution of data as FWHM
t_min	d	double	Start time in MJD
t_max	d	double	Stop time in MJD
t_exptime	s	double	Total exposure time
t_resolution	s	double	Temporal resolution FWHM
t_xel	unitless	integer	Number of elements along the time axis
em_min	m	double	Start in spectral coordinates
em_max	m	double	Stop in spectral coordinates
em_res_power	unitless	double	Spectral resolving power
em_xel	unitless	integer	Number of elements along the spectral axis



VO data models

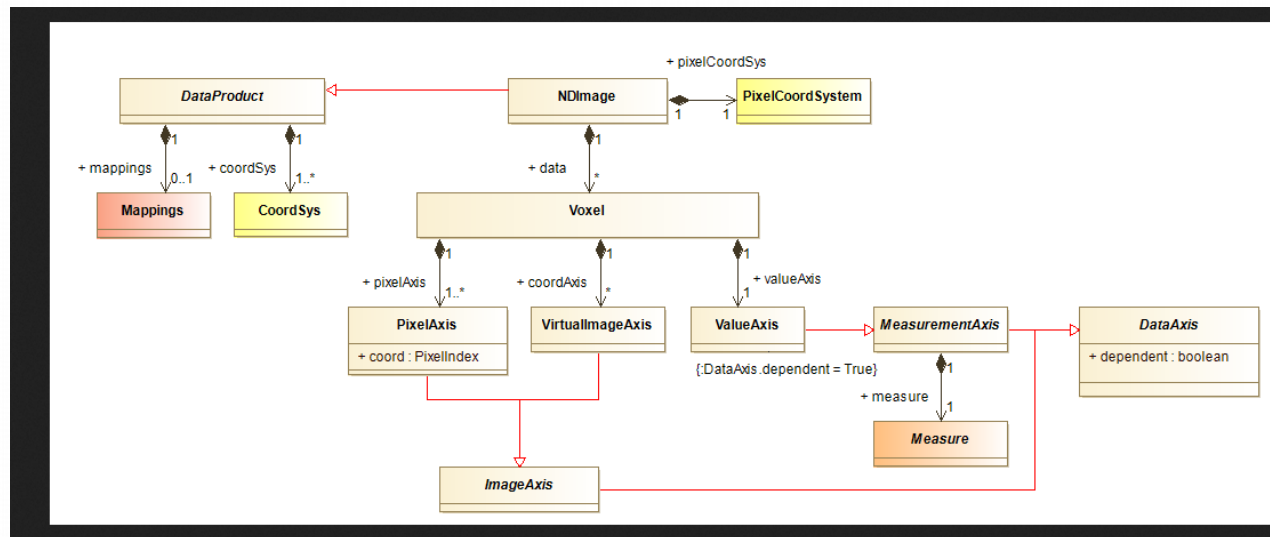
2) Other existing datamodels

- STC : useful concepts, currently in major revision
 - > Coords, Measurements and Transformations – see below
- PhotDM : mainly for optical domain
- Characterisation 1.0 : generic model reused by other models (Obscore, Cube) . In revision
- Spectral Line Data Model : From observations to Physics
- Simulation data model and SimDAL protocol.
 - Observation/Simulation comparison



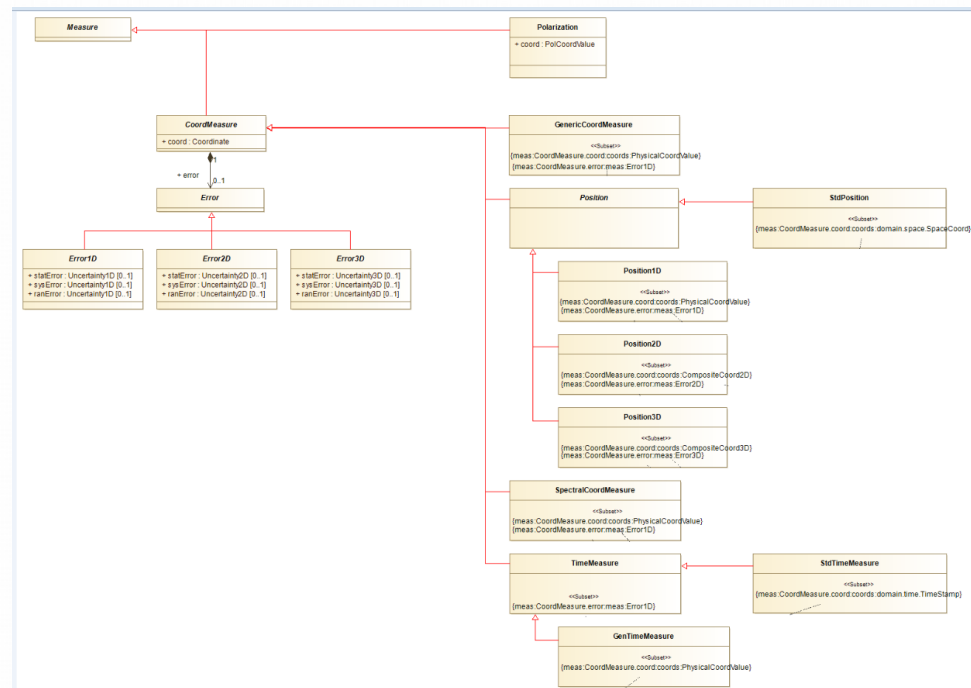
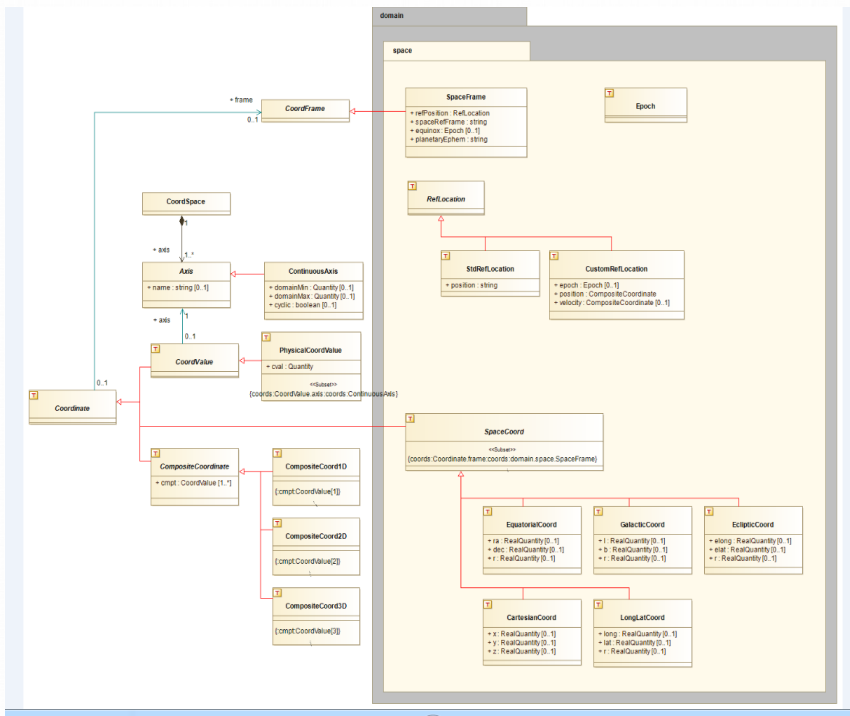
VO data modelling

3) Cube datamodel (in progress) : ND Image



VO data modelling

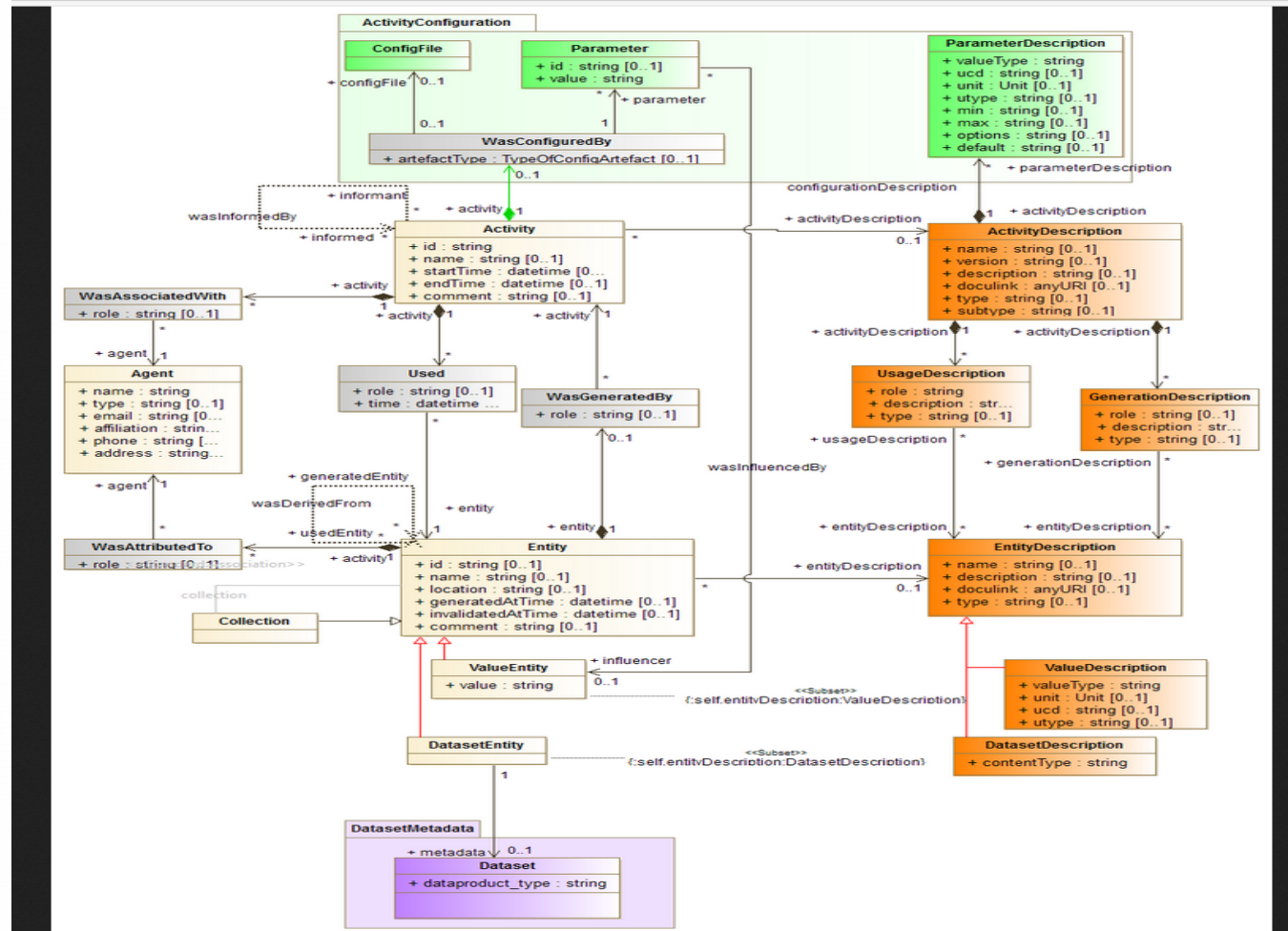
4) Coords and measurements (work in progress)



VO data modelling

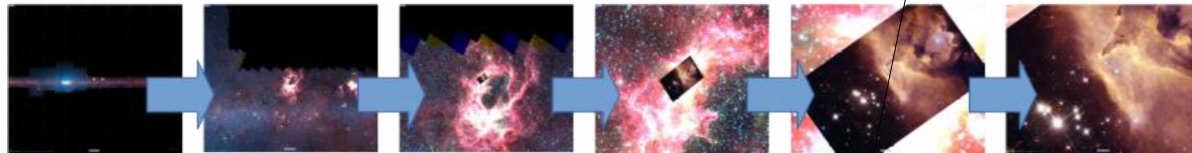
5) Provenance (work in progress)

ActivityAndConfigurationDescriptionForPR2_1502.png



□ HiPS ? What is it ?

- **H**ierachical **P**rogressive **S**urvey
“The more you zoom in on a particular area, the more details show up”
- Multi-resolution **HEALPix** data structure
- for **Images**, **Catalogues**, 3-dimensional data **cubes**, ...
- **Conserves scientific** data properties alongside visualisation considerations
- No databases or dedicated servers are required, just http



3

And MOC for discovery :
indexation by HEALPIX cell

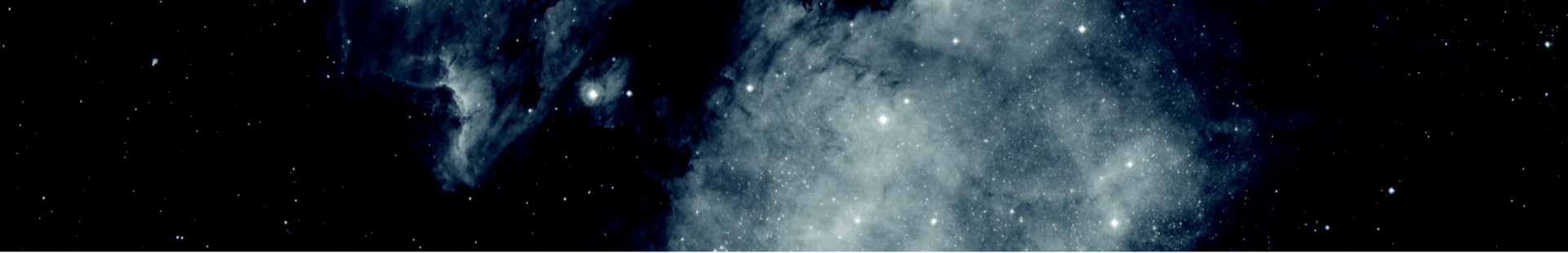
View, Access, Discovery of DataCube



Don't forget

- SAMP for Desktop applications
- UWS : standard interface to manage VO Web Services
- VOSpace : for data storage
- Registry



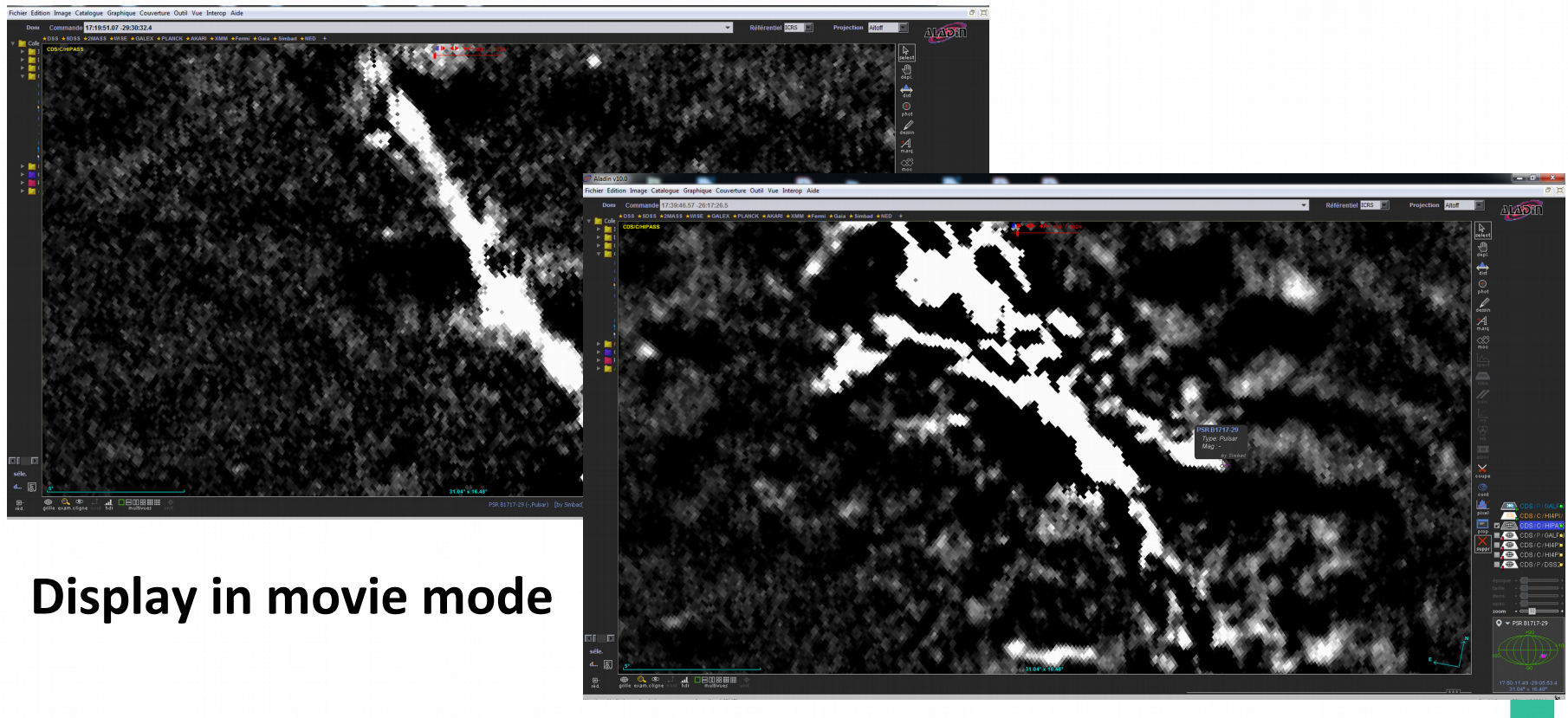


Existing « science ready »
radio data VO services



HiPS Cubes

- HI4PI (Effelsberg), GALFAHI (Arecibo), and HIPASS (Australia)



Display in movie mode

ALMA science archive

- ALMA provides interferometric data in millimetric domain
- Native interface available
- Imaging cubes not yet available for all observations
(but in progress)
- ALMA archive delivers step by step VO interface elements:
 - ObsTAP service available (next slides)
 - SAMP in client
 - MOC available
 - Integrated in ESA Sky (with AladinLite)
 - Projects : DataLink, SIAV2
 - UWS web service for reprocessing planned



ALMA science archive ObsTAP service in Aladin

10.0 *** BETA VERSION (based on v10.073) ***

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Available data → 21973 / 219' Command: 06:05:41.72100 -86:37:55.0200 Frame: ICRS Projection: Aitoff

Available servers: DSS, SDSS, 2MASS, WISE, GALEX, PLANCK, AKARI, XMM, Fermi, Gaia, Simbad, NED

DSS2 color

Server selector

beta.cadc-ccda.hia-ih-a-nrc-cnrc.gc.ca Mode: Generic

Construct your query, verify and execute.

Table: alma.obscore Set ra, dec

Select: All Constraints: Add new Max rows:

access_format Target: 6 05 41.72100 -86 37 55.0200

calib_level Radius: 128.7° CIRCLE Add

s_ra s_dec s_fov

Refresh query Check.. SYNC Async jobs>>

SELECT TOP 100 * FROM alma.obscore

Reset Clear SUBMIT Close

15° 112.9° x 61.7°

Search

	calib_level	s_ra	s_dec	s_fov	s_region	t_min	t_max	Observation En...	t_exptime	t_ra
text/html	2	91.423837500...	-86.63195	26.564235597...	FoV	2.2102533595...	57145.964021	2015-05-03T23:57:145.895432	1300.32	
text/html	2	91.423837500...	-86.63195	26.564235597...	FoV	2.2102533595...	57145.964021	2015-05-03T23:57:145.895432	1300.32	
text/html	2	91.423837500...	-86.63195	26.564235597...	FoV	2.2102533595...	57145.964021	2015-05-03T23:57:145.895432	1300.32	
text/html	2	91.423837500...	-86.63195	26.564235597...	FoV	2.2102533595...	57145.964021	2015-05-03T23:57:145.895432	1300.32	
text/html	2	73.14289725	-85.588400972...	26.564235597...	FoV	2.2840199243...	57145.964021	2015-05-03T23:57:145.895432	151.2	
text/html	2	73.14289725	-85.588400972...	26.564235597...	FoV	2.2840199243...	57145.964021	2015-05-03T23:57:145.895432	151.2	
text/html	2	73.14289725	-85.588400972...	26.564235597...	FoV	2.2840199243...	57145.964021	2015-05-03T23:57:145.895432	151.2	
text/html	2	73.14289725	-85.588400972...	26.564235597...	FoV	2.2840199243...	57145.964021	2015-05-03T23:57:145.895432	151.2	

Click on it to show/hide the associated footprint

select from: all collections

ALMA science archive

url in the ObsCore response points to a native interface page in the browser

ALMA Science Archive

Query Form Results Table

Submit download request

Close Viewer Results Bookmark Export Table Results Help

J2000 06:05:41.721 -86:37:55.02

RA: 2.22°

Project code	Source name	RA	Dec	Band	Integration	Release date	Velocity resolution	Frequency support
2013.1.00623.S	ES0005-G004	06:05:41.72	-86:37:55.0	6	1300.320	2016-12-12	38006.03	227.81_246.51GHz

ord	em	res	power	access	url	access	estsize	obs	publisher	obs	collecto
H2	7353.7783250			http://almascienc				ADSJAO	ALMA#2	ALMA	
H2	7888.0240400			http://almascienc				ADSJAO	ALMA#2	ALMA	
H2	7820.3918826			http://almascienc				ADSJAO	ALMA#2	ALMA	
H2	7423.7358826			http://almascienc				ADSJAO	ALMA#2	ALMA	
H2	7353.7783250			http://almascienc				ADSJAO	ALMA#2	ALMA	
H2	7423.7358826			http://almascienc				ADSJAO	ALMA#2	ALMA	
H2	7820.3918826			http://almascienc				ADSJAO	ALMA#2	ALMA	
H2	7888.0240400			http://almascienc				ADSJAO	ALMA#2	ALMA	

select: [input type="text"]

From: -all collections--

12:02:55820 -86:36:44.43
112.9° x 61.7°

ASKAP data : CASDA services

- CASDA implemented
 - MOC
 - ObsTAP, and SIA services available
 - DataLink with Cutouts
 - SODA interface
 - VO Scripts available



CASDA (= ASKAP data) (availability of cube data on the sky)

The screenshot displays the Aladin software interface, a professional sky atlas. The main window shows a wide-field astronomical image with several red rectangular selection boxes overlaid on it. A dialog box is open in the center, titled "CSIRO ASKAP Science Data Archive Image Access Service ...". The dialog contains the following information:

- no preview
- Coverage: 433.2^{sq}
- Access mode & derived prod. in view custom space cov.
- au.csiro/casda/sia2
- Load button

The interface includes a menu bar (File, Edit, Image, Catalog, Overlay, Coverage, Tool, View, Interop, Help), a command line, and a toolbar on the right with various icons for navigation and data manipulation. At the bottom, there is a search bar with "casda" entered and a "select" button. The status bar at the bottom right shows coordinates: 55:57.72658 -60:28:06.65 and 360° x 180°.

ASKAP data : CASDA services

SIAP 2.0

v10.0 *** BETA VERSION (based on v10.073) ***

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Available data → 4
 in view out view

Command 16:29:08.41 -18:02:00.0

DSS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED

DSS2 color

Actions → 4 / 22454
 Filters → 4 / 1248
 IA2 (image|cube) → 1 / 6
 au.csiro → 1
 CSIRO ASKAP Science I
 SA (spectrum) → 1 / 115
 au.csiro → 1
 CSIRO ASKAP Science I
 S (table) → 1 / 565
 au.csiro → 1 / 2
 CSIRO ASKAP Science I
 AP (table) → 1 / 224
 au.csiro → 1 / 3
 CSIRO ASKAP Science I

Server selector

Generic SIAv2 query

Target (ICRS, name) rho oph
 Radius 14'
 Server IVOID or ba... au.csiro/casda/sia2
 Data set identifier
 Collection name
 Telescope name
 Instrument name
 Target
 Calibration level (0...
 Maximum number ... 99999

Reset Clear SUBMIT Close

access url	dataprodu	calb level	obs collection	obs id	obs publisher	access format	access estsize	target name	s ra
https://data.csiro.au/casda/vo/prox/vo/datalink/links?ID=cube-729	cube	3	P248	P248	cube-729	application/x-vot	54467		246.2870972
https://data.csiro.au/casda/vo/prox/vo/datalink/links?ID=cube-778	cube	3	P248	P248	cube-778	application/x-vot	54456		247.2850553

select casda
 from -all co...

Search

Rho Oph

16:25:35.12 -23:26:49.8
 1.491° x 46.2'

2 sel / 2 src 375Mb

ASKAP data : CASDA services dataset field of view

v10.0

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Command: 16:25:08.90 -26:02:00.0

Frame: ICRS Projection: Aitoff

ALADIN

Available data → 4
 in view out view

DSS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED +

DSS2 color

select results

- Field: access_url
- Value:
- UCD: meta.ref.url
- Utype:
- URL used to access (download) dataset

epoch - +
 size - +
 dens. - +
 opac. - +
 zoom - +

Rho Oph

15:41:00.69 -25:47:21.1
 83.29° x 47.17°

select casda

from all co...

coll. sort view scan

grid study wink north hdr multiview match

results

access_url	calib_level	obs_id	target name	s_ra	s_dec
https://data.csiro.au/casda/vo/prox/vo/datalin/...	3	P248	cube-729	246.28709726...	-26.03332860...
https://data.csiro.au/casda/vo/prox/vo/datalin/...	3	P248	cube-778	247.28505537...	-18.03333018...

Click on it to load the corresponding archive data in the stack

ASKAP data : CASDA services DataLink

The screenshot displays the ALADIN software interface, a tool for astronomical data visualization and management. The main window shows a large-scale astronomical image with a zoomed-in inset of a specific region. The interface includes a menu bar (File, Edit, Image, Catalog, Overlay, Coverage, Tool, View, Interop, Help), a toolbar with various icons, and a sidebar with a tree view of data collections. A search results table is visible at the bottom, listing data products with their access URLs and sizes.

*** BETA VERSION (based on v10.073) ***
Aladin v10.0 *** PROTOTYPE VERSION (based on v10.098) ***

Command: 18:19:23.82 -29:05:24.8
Frame: ICRS
Projection: Altoff

Available data → 4
in view out view
DSS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED

639675.618
147 / 1024

15°
94.06' x 50.27'

access url	dataprodu	calib level	obs collection	obs id	obs publisher	access format	access estsize	target name	s ra	s dec
https://										
https://										

Download data product via web (size 55774208 byte)
Download data at Pawsey Centre. Note: Only users from within PSC network can access the data through this link. Only use if you currently have access to Pawsey facilities. (size 55774208 byte)
Scripted file access via Web (size 55774208 byte)
Scripted file access via Pawsey Centre. Note: Only users from within PSC network can access the data through this link. Only use if you currently have access to Pawsey facilities. (size 55774208 byte)
Scripted cut-out service
Scripted spectrum generation service

select casda
from --all co...

2.sel / 2.src 527Mb

ASKAP data : CASDA services SODA interface

The screenshot displays the SODA interface with a central star field image. A dialog box titled "Service casda.csiro.au" is open, showing a "Cutout prototype for SODA server" form. The form includes fields for Target (ICRS, name), Radius, Time, Band (0.21015484916529545 0.220026116655881), Pol, and ID (IAwjdlcT1HIEq7251deobNLMEEsqZ3bmz). A dropdown menu for "ASync" is also visible. The interface includes a menu bar (File, Edit, Image, Catalog, Overlay, Coverage, Tool, View, Interop, Help), a command line (16:25:08.90334 -26:01:59.9830), and a toolbar with various tools like select, pan, dist, phot, draw, tag, moc, filter, cross, crop, cont, pixel, prop, and del. A table at the bottom lists data products with columns for access url, dataproduct t..., calib level, obs collection, obs id, obs publisher, access format, access estsize, target name, s ra, and s dec. A search bar and zoom controls are also present.

Available data → 4
in view out view
DSS SDDS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED +

Command 16:25:08.90334 -26:01:59.9830

Frame ICRS Projection Aitoff

Service casda.csiro.au

○ Cutout prototype for SODA server ?

Fill in all these fields and press the SUBMIT button

Target (ICRS, name)

Radius

Time

Band 0.21015484916529545 0.220026116655881

Pol

ID IAwjdlcT1HIEq7251deobNLMEEsqZ3bmz

ASync

Reset Clear Submit Close

access url	dataproduct t...	calib level	obs collection	obs id	obs publisher ...	access format	access estsize	target name	s ra	s dec
https://casda.csiro.au/askap/...										
https://casda.csiro.au/askap/...										

select casda
from --all co...

Download data product via web (size 55774208 byte)
Download data at Pawsey Centre. Note: Only users from within PSC network can access the data through this link. Only use if you currently have access to Pawsey facilities. (size 55774208 byte)
Scripted file access via Web (size 55774208 byte)
Scripted file access via Pawsey Centre. Note: Only users from within PSC network can access the data through this link. Only use if you currently have access to Pawsey facilities. (size 55774208 byte)
Scripted cut-out service
Scripted spectrum generation service

Search

2 sel / 3 src 449Mb

ASKAP data : CASDA services

SODA : ready for query

*** BETA VERSION (based on v10.073) ***

Aladin v10.0 *** PROTOTYPE VERSION (based on v10.098) ***

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Available data → 4 Command 13:58:08.23 -60:42:26.6 Frame ICRS Projection Aitoff

DSS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED +

DSS2 color

Service casda.csiro.au

● Cutout prototype for SODA server ?

Fill in all these fields and press the SUBMIT button

Target (ICRS, name) 16 34 13.5 -25 43 46.0

Radius 0.73°

Time

Band 0.21015484917063945 0.2200261166617463

Pol

ID T21AwjdlcT1HiEpZLk-AQYke0t5LMtVlqiUX

ASYNC

Reset Clear Submit Close

access url	dataprodu	calib level	obs collection	obs id	obs publisher	access format	access estsize	target name	s ra	s dec
https://casda	cube	3	P248	P248	cube-729	application/x-vot	54467		246.28709726...	-26.03332860...
https://casda	cube	3	P248	P248	cube-778	application/x-vot	54456		247.28505537...	-18.03333018...

select casda

from all co...

Job controller

ASKAP data : CASDA services

SODA asynchronous task completed

Aladin v10.0 *** BETA VERSION (based on v10.073) ***

Aladin v10.0 *** PROTOTYPE VERSION (based on v10.098) ***

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Available data → 4 Command [16:29:08.41329 -18:01:59.9887] Frame [ICRS] Projection [Aitoff]

Service casda.csiro.au

• Cutout prototype for SODA server ?

Fill in all these fields and press the SUBMIT button

Target (ICRS, name) [16 34 13.5 -25 43 46.0]

Radius [0.73°]

Time []

Band [0.21015484917063945 0.2200261166617463]

Pol []

ID [T21AwjdlcT1HIepZLk-AQYke0t5LMtVlqiUX]

Job controller

Asynchronous jobs of current session:

- COMPLETED, Start time: 2019-01-10T02:00:39.680+0800 (server: [SODA]casda.csiro.au)

Or choose an already submitted job:

Job URL [] GO

Load from /results/result ABORT DELETE Delete on closing Aladin

Job details:

Load on Aladin: <http://3A%2F%2Fcasda.csiro.au%2Fdownload%2Fweb%2F2a0b425e-9fc8-43fb-b58e-e0474563cb0b%2Fcutout-12881-imagecube-729.fits> LOAD

Job ID: 2a0b425e-9fc8-43fb-b58e-e0474563cb0b

Run ID: null

URL: https://casda.csiro.au/casda_data_access/data/async/2a0b425e-9fc8-43fb-b58e-e0474563cb0b

URL	cube	size	type	application/x-vot	size	date	time
https://casda.csiro.au/casda_data_access/data/async/2a0b425e-9fc8-43fb-b58e-e0474563cb0b	cube-729	3	P248	54487	246.29709726...	-26.03332860...	1.20
https://casda.csiro.au/casda_data_access/data/async/2a0b425e-9fc8-43fb-b58e-e0474563cb0b	cube-778	3	P248	54456	247.28505537...	-18.03333018...	1.20

select casda

from --all co...

2.sel / 3.src 676Mb

ASKAP data : CASDA services extracted subcube displayed

Aladin v10.0 *** BETA VERSION (based on v10.073) ***

Aladin v10.0 *** PROTOTYPE VERSION (based on v10.098) ***

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Command Frame **CRS** Projection **Aitoff**

Available data → 4
in view out view

DSS SDSS ZMASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED +

ctions → 4 / 22641
ners → 4 / 1258
A2 (image)cube → 1 / 8
au.csiro → 1
CSIRO ASKAP Science
SA (spectrum) → 1 / 114
au.csiro → 1
CSIRO ASKAP Science
S (table) → 1 / 566
au.csiro → 1 / 2
CSIRO ASKAP Science
AP (table) → 1 / 219
au.csiro → 1 / 3
CSIRO ASKAP Science

-534351.977

054 / 1024

2.622° x 1.094°

30'

Search

access url	dataprodu	calib level	obs collection	obs id	obs publisher	access format	access estsize	target name	s ra	s dec
https://data.csiro.au/casda	cube		P248	P248	cube-728	application/x-vot	54467		246.28709726...	-28.03332860...
https://data.csiro.au/casda	cube		P248	P248	cube-778	application/x-vot	54456		247.28505537...	-18.03333018...

select casda
from --all co...

epoch -
size -
dens. -
opac. -
zoom -

39 csiro / casda / sia2~1
CDS/P/DSS2/ color

1.583° x 1.583°

2 sel / 3 src 820Mb

ASKAP data : CASDA services extracted spectrum

ALADIN v10.0 *** BETA VERSION (based on v10.073) ***

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Available data → 4 Command 16:28:09.05 -25:58:01.6 Frame ICRS Projection Aitoff

● In View ● out view DSS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad HED +

DSS2 color

Service casda.csiro.au

○ Cutout prototype for SODA server ?

Fill in all these fields and press the SUBMIT button

Target (ICRS, name) 16 27 46.15903 -25 44 54.2702

Radius 25.26'

Time

Band 0.21015484916529545 0.220026116655881

Pol

ID |AwjdlcT1HiEg7251deobNLMEEsqZ3bmz

ASync

Reset Clear Submit Close

23.42° x 13.87°

Search

select casda from --all co...

epoch - site - desc. - objac. - zoom -

16:25:35.11766 -23:26:49.8150
23.42° x 13.87°

0 sel / 8 src 945Mb

ASKAP data : CASDA services extracted spectrum

The screenshot displays the Aladin v10.0 software interface, which is used for astronomical data visualization and analysis. The main window shows a 'Cutout prototype for SODA server' dialog box with the following fields:

- Target (ICRS, name): 16 25 18.95162 -26 02 18.7137
- Radius: 2.704'
- Time: [empty]
- Band: 0.21015484917063945 0.2200261166617463
- Pol: [empty]
- ID: ERxaCEZ6GfBcQEBVu8wpW4ALYUAttPIA
- ASync: [dropdown menu]

Buttons at the bottom of the dialog include 'Reset', 'Clear', 'Submit', and 'Close'. The 'job controller' window in the foreground shows a list of jobs:

- Completed jobs of current session:
 - Completed, Start time: 2019-01-10T02:00:39.680+0800 (server: [SODA]casda.csiro.au)
 - Completed, Start time: 2019-01-10T02:07:04.558+0800 (server: [SODA]casda.csiro.au)
- Jobs already submitted:
 - Job ID: [input field]
 - Buttons: 'Load from /results/result', 'ABORT', 'DELETE', and a checked 'Delete on closing Aladin' checkbox.
- Job URL: http://casda.csiro.au/casda_data_access/data/async/880a27f9-8ba9-4dc0-8046-7a3a66d58f1c
- Buttons: 'LOAD' and 'GO'.

The 'FITS header' window on the right shows the following parameters:

```
SIMPLE = T / conforms to FITS standard
BITPIX = -64 / array data type
NAXIS = 3 / number of array dimensions
NAXIS1 = 1
NAXIS2 = 1
NAXIS3 = 1024
DATAMIN = -8.0000000E+00
DATAMAX = 3.2000000E+01
BMAJ = 2.583334E-01
BMIN = 2.583334E-01
BPA = 0.0000000E+00
BUNIT = 'Jy' / Brightness (pixel unit)
EPOCH = 2.000000000000E+03
LONPOLE = 1.800000000000E+02
CTYPE1 = 'RA--SIN'
CRVAL1 = 2.462500000000E+02
CDELTA1 = -6.666667014360E-02
CROTA1 = 0.000000000000E+00
CRPIX1 = 3.
CUNIT1 = 'deg'
CTYPE2 = 'DEC--SIN'
CRVAL2 = -2.600000000000E+01
CDELTA2 = 6.666667014360E-02
CROTA2 = 0.000000000000E+00
CRPIX2 = 3.
CUNIT2 = 'deg'
CTYPE3 = 'VELO--HEL'
CRVAL3 = -4.024387640672E+05
CDELTA3 = 1.319132129105E+04
CROTA3 = 0.000000000000E+00
CRPIX3 = 68.
CUNIT3 = 'km/s'
```


CADC and others

- CADC has a couple of Radio cube surveys such as
 - CGPS
 - ALMA
 - VLASS
- Plans at NRAO (collab with CADC?)
- Italian
- Others ? Sorry if any !!!



SIAV2 + DataLink + SODA at CADC

The screenshot displays the ALadin software interface for astronomical data analysis. The main window shows a star field with a central cutout window. A 'Server selector' dialog is open, allowing users to configure a cutout for the SODA sync server. The dialog includes fields for Target (ICRS, name), Radius, Time, Band, Pol, and ID, along with a 'SUBMIT' button.

Server selector dialog details:

- Tab: **Cutout**
- Section: **Cutout prototype for SODA sync server**
- Instruction: Fill in all these fields and press the SUBMIT button
- Fields:
 - Target (ICRS, name): 05 32 57.25 -11 57 20.5
 - Radius: 2.904°
 - Time: [empty]
 - Band: 8.424999999999999E-5 1.1576E-4
 - Pol: I, Q, U
 - ID: adIRIS/1170B4H0
- Buttons: Reset, Clear, **SUBMIT**, Close, ?

ALadin interface details:

- Location: 05:32:35.25 -11:09:55.8
- Frame: ICRS
- Projection: Sinus
- Layers: DSS, SDSS, 2MASS, WISE, GALEX, PLANCK, AKARI, XMM, Fermi, Gaia, Sirlbad, NED
- Selected layer: CDS/P/DSS2/color
- Basic controls: select, edit, link, print, draw, tag, zoom, cross, rgb, assoc, crop, font, pixel, prop, del
- Search: [empty]
- Coordinates: 28.03° x 16.05°



Time Domain ?

See Ada's talk on Saturday



What else ?

- A) extend « science ready data » availability in the VO .
 - Create new ObSTAP/SIAV2/DataLink/SODA services
 - Create HiPS for moment/continuum maps and access « original data »
- B) Visibility data (=VD) – what should be investigated/done :
 - Use ObsTAP/SIAP2 for VD rough discovery
 - VD fine grain characterisation and discovery
 - Integrate VD processing in VO landscape
 - VD VO representation/data modelling ?
- C) Others ? (Rotation measures, ...)



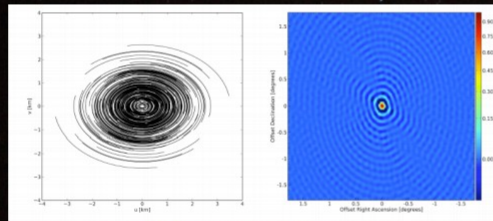
Visibility data?

(courtesy LOFAR/ASTRON partners)

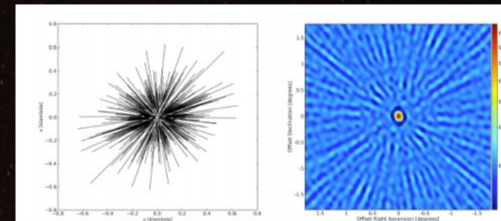
Data Types: Visibilities

ASTRON

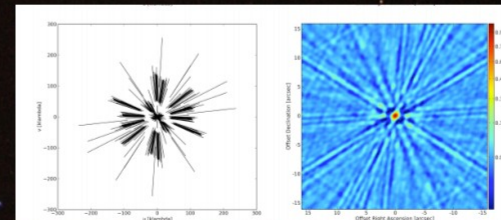
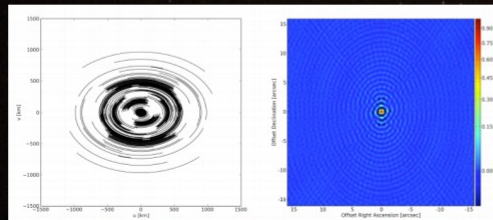
- Interferometer: Creating virtual aperture up to $\sim 2000\text{km}$ (λ/D)
- Incomplete coverage
- Typical use of Radio Telescopes: imaging depending on science
- LOFAR: Projection effects (No moving dish/mirror)



6 hours



1 second



Use ObsTAP/SIAP2 for VD rough discovery

- ObsCore has « visibility » dataproduct type
- Visibility data have rough spatial position/extension, time range, spectral range, polarisation
 - *roughly fit in ObsCore*
- Complex data structure can be searched via CAOM extensions ?

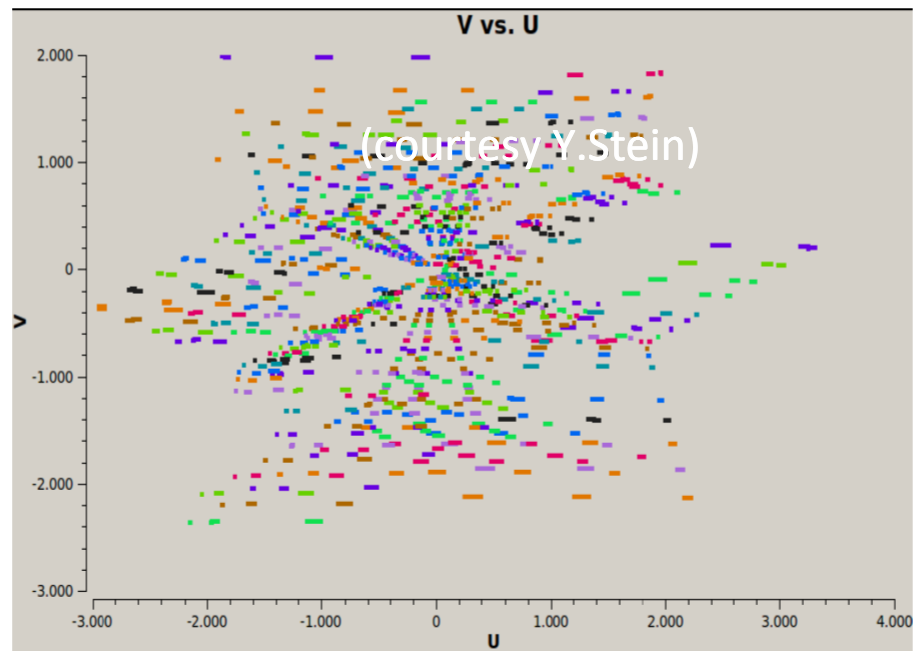


VD fine grain characterisation and discovery

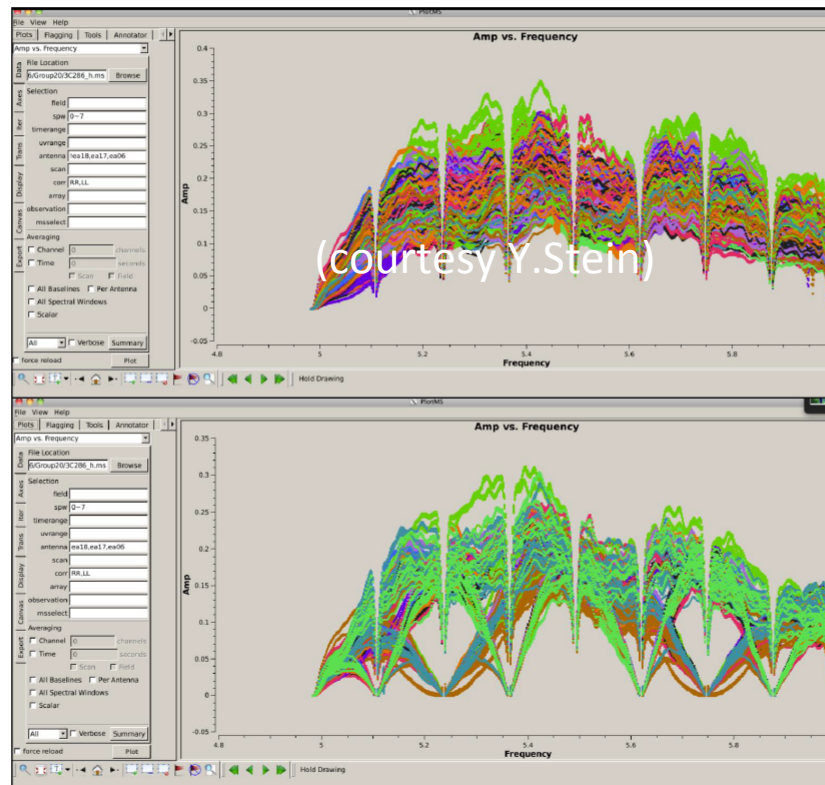
- « coarse grain » discovery via ObsCore + DataLink for additional metadata
 - UV plots
 - frequency/amplitude or phase/amplitude plots
 - Beam size and shape
 - Number of antennas, instrumental details
 - should we integrate this in « characterisation » DM ?
- Dynamic characterisation according to scientific goals : VO Web Service or VO application ?



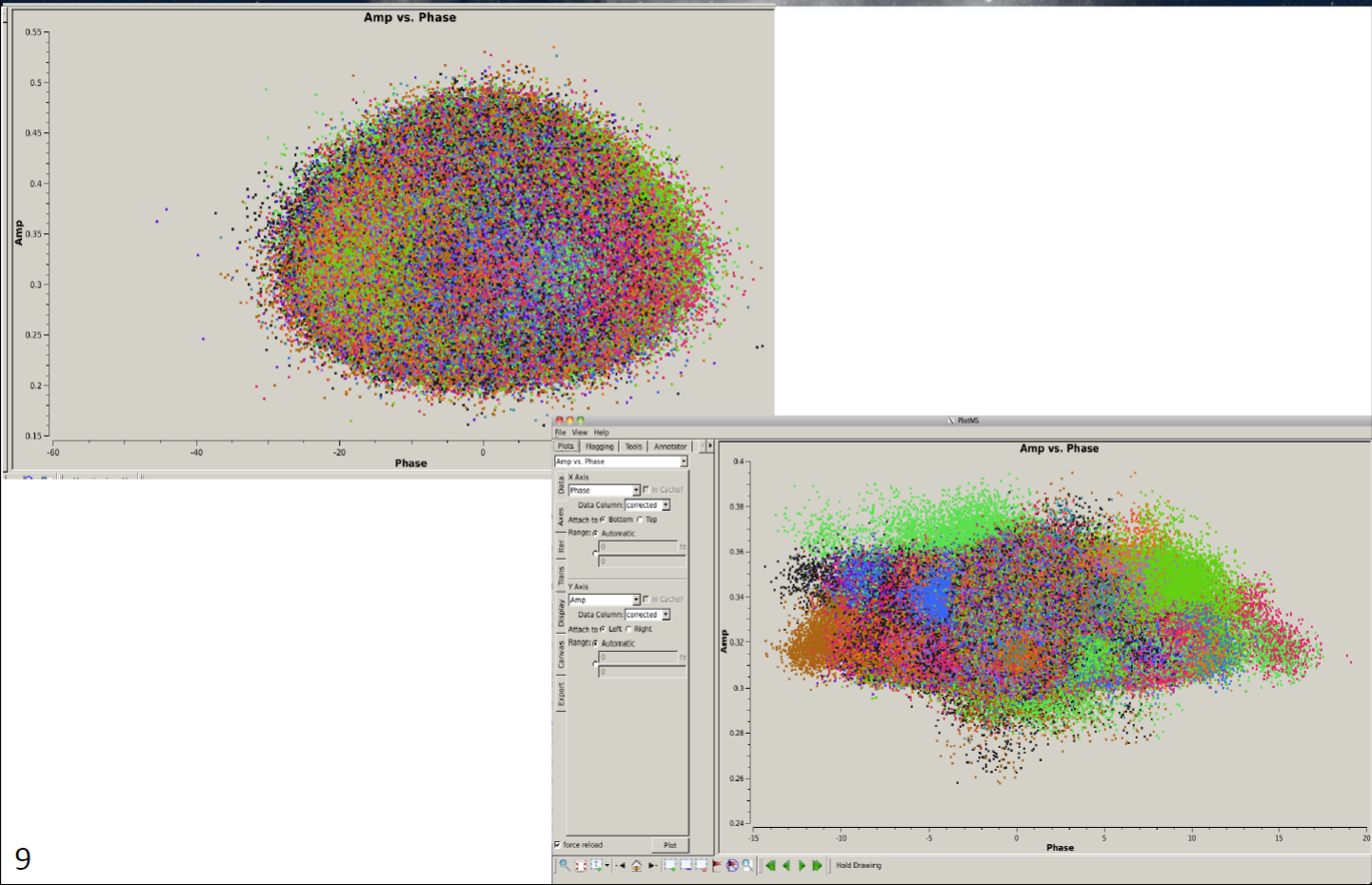
□ Uv coverage



□ Amp vs. Freq



□ Amp vs. phase



Integrate VD processing in VO landscape

- Use « provenance » to go back to original data
- Store and Make available science data reduced by individual scientists
- Propose a black box service providing « science ready data » according output characterisation
- Launch CASA code remotely close to the data
- Bring code to the data (docker/ jupiter notebook / platform)



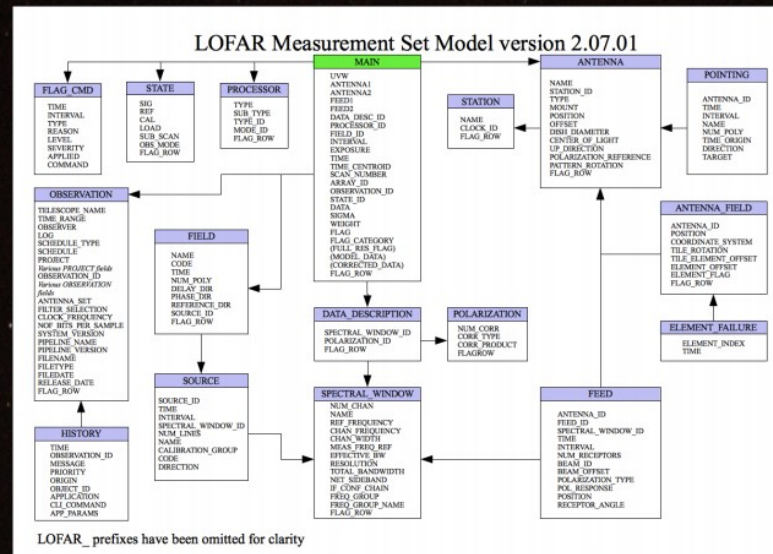
Visibility data modelling/representation

« measurement sets » are all what we need ?

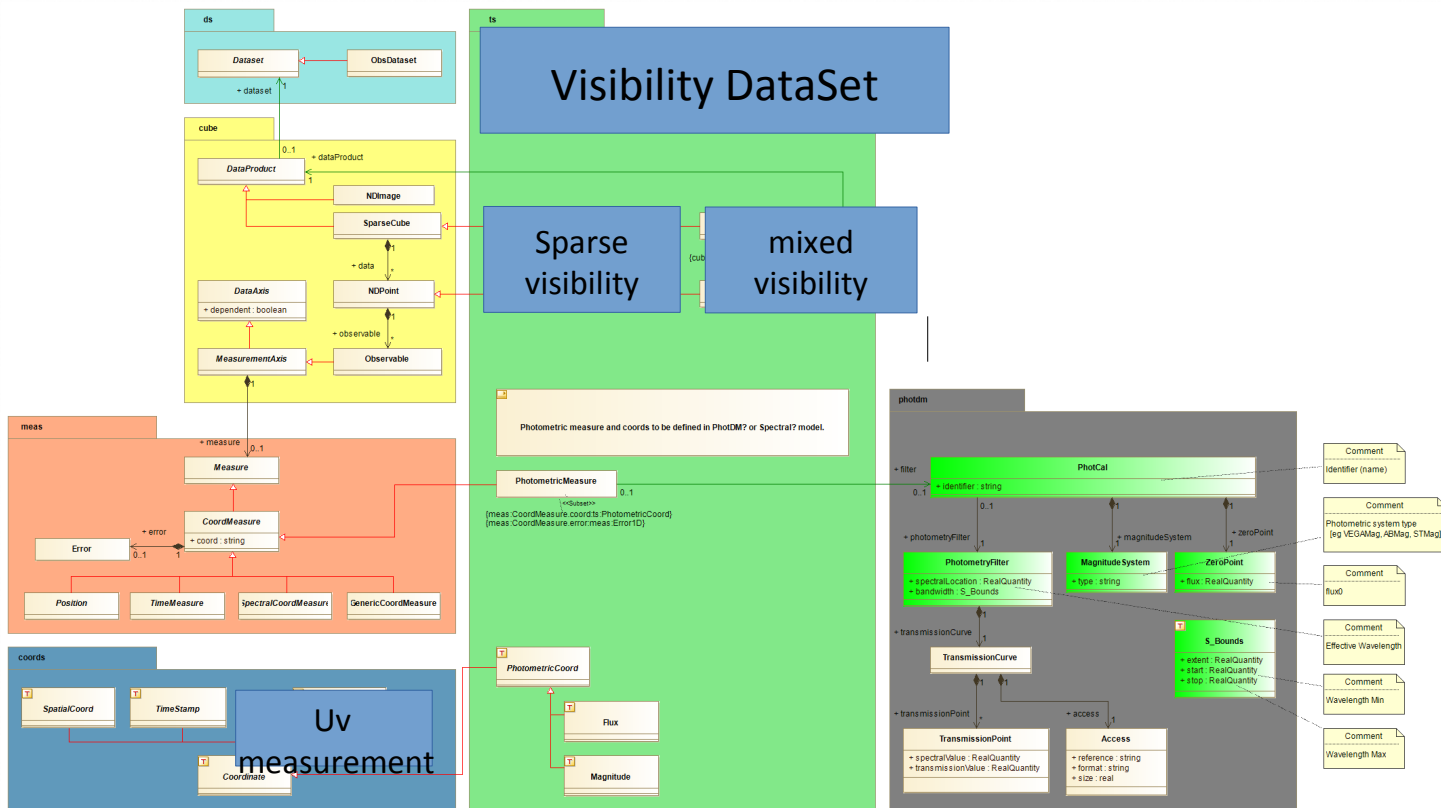
Data Types: Visibilities

ASTRON

- Stored as CASA Measurement Sets
 - 10 MB - 100 GB in size, per 192 kHz frequency band
 - Usually 400-488 per observation
 - Relational structure
 - Each cell can have multiple dimensions (pol x freq)



IVOA Visibility data model as an extension of CubeDM ?



Why : transform into time series, event lists, etc ? Combination with other spectral domains

