

**INAF**  
ISTITUTO NAZIONALE  
DI ASTROFISICA

Access from visualisation tools to SKA science images and cubes  
stored in a rucio DataLake through IVOA discovery and access  
services

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# People involved

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# SKA and the SRCnet

- SKA in two words
  - Low and mid frequency radio astronomy project
  - South Africa and Australia
  - International project : Australia, South Africa, Europe, China, Canada
  - First light : end 2024
  - Fully operational 2028
  - 700 Pbytes/year of reduced data
  - SKAO (headquarters Manchester UK) is the international organization building and operating the project and producing the the science data products



# SKA and the SRCnet

- The SRCnet is an alliance of national/regional nodes working together for
  - Distributed Data storage
  - Advanced data reduction
  - Currently a dozen of prototyping teams prepare the system : should be working by first light
- 3 teams have been prototyping access and visualisation of data in the context of a DataLake operating Rucio

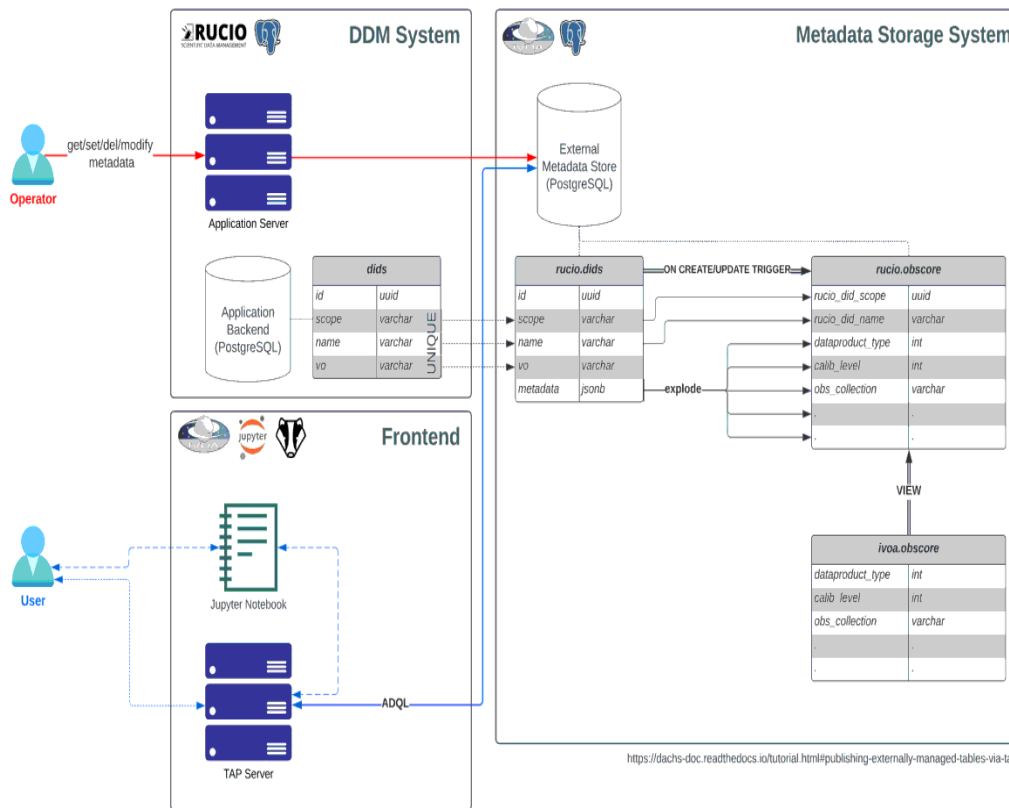


# Rucio : dataset storage, metadata management an VO discovery service

- Load datafiles in Rucio storage elements  
(here the spanish one)
- Set « ObsCore » metadata for these datasets in the database operated by the SKAO (magenta) team by a set of rucio commands
- ObsTAP/SIA/SCS service (implemented with Dachs) on top of the rucio database + DataLink
- SODA service (developed by orange team) operated on the spanish node (by the coral team)



# Rucio : dataset storage, metadata management an VO discovery service



# Discovery, access and visualisation of datasets

- Several steps
  - Data discovery service (ObsCore + API = SCS currently)
  - DataLink service
    - Full retrieval of the data
    - SODA sync and async services close to the data
      - SODA service is developed by INAF from Vialactea project
    - Visualisation servers (VisIVO, CARTA, Yafits) close to the data
    - Recursive Datalink for further advanced discovery facility
  - Visualisation (orange team): VisIVO, Aladin (Desktop, Lite), later : CARTA, Yafits, ...



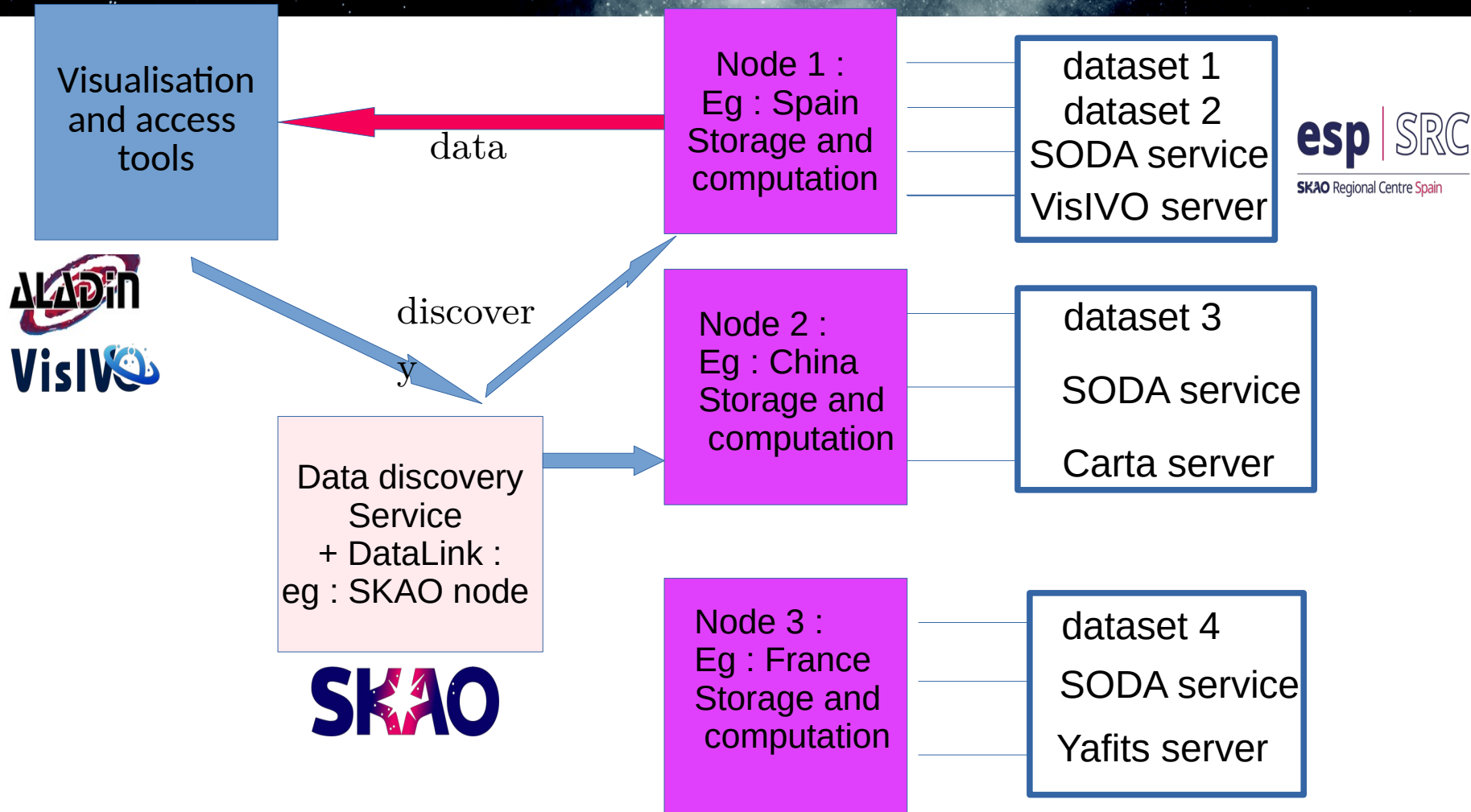
# Discovery, access and visualisation of datasets

- Introduction of recursive datalink
  - For advanced discovery
    - Additional documentation
    - Derived data (moment maps, spectral indexes, spectra, etc ...)
    - → HiPS of derived data for fast access to region of interest





# Discovery, access and visualisation of data



# Pathfinder and simulation datasets for the prototype

- 16 datasets from
  - MEERKAT
  - ASKAP
  - VLASS
  - LOFAR
  - Apertif
  - + SDC1, SDC2, SDC3
- Various spectral range and resolution, field of view, sizes (up to 40 gigabytes)



# VisIVO Discovery service interface

## NGC 1431 Meerkat cube ObsCore

### Cone Search

#### Cone Parameters

Cone URL:

RA (deg):

Dec (deg):

Radius (deg):

Verbosity:

#### Table

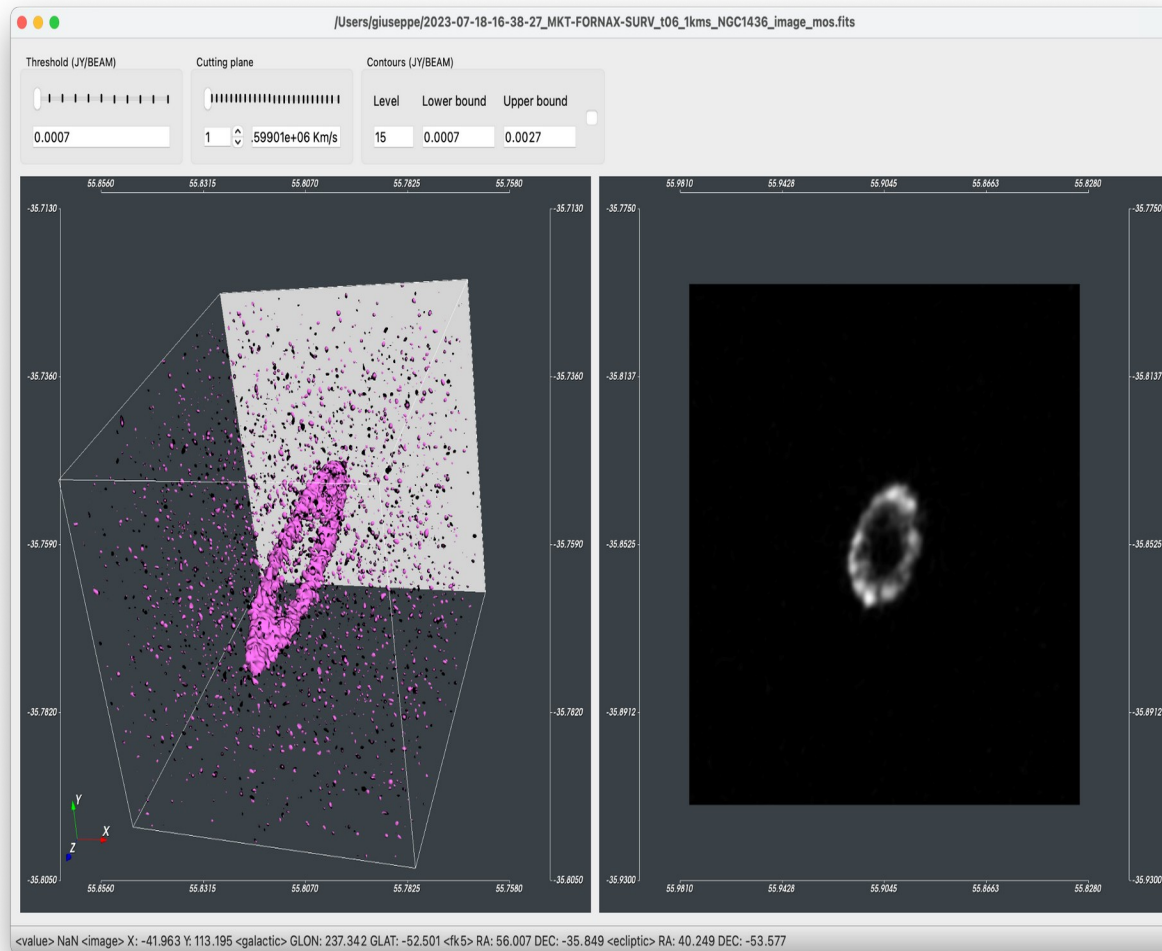
|   | _r                   | obs_publisher_id  | obs_title | obs_creator_id | target_name | target_class | t_exptime | t_min | t_max | s_region | em_min      | em_max      | em_res   | power | em_ucd | datapro |
|---|----------------------|---|-----------|----------------|-------------|--------------|-----------|-------|-------|----------|-------------|-------------|----------|-------|--------|---------|
| 1 | 0.004740542485292875 | ivo://test.skao/~?sp3531_soda:2023-09-22-14-04-00_MKT-FORNAX-SURV_t06_1kms_NGC1436_image_mos.fits |           |                | NGC 1436    |              | --        | --    | --    |          | 0.212056998 | 0.212333965 | 217700.0 |       |        | cube    |
| 2 | 0.004740542485292875 | ivo://test.skao/~?sp3531_soda:2023-07-18-16-38-27_MKT-FORNAX-SURV_t06_1kms_NGC1436_image_mos.fits |           |                | NGC 1436    |              | --        | --    | --    |          | 0.212056998 | 0.212333965 | 217700.0 |       |        | cube    |

SODA cutout



# VisIVO

## NGC 1431 Meerkat cutout display



# Aladin Desktop querying the service around NGC 1436

## ObsCore response : Meerkat Fornax survey cube found

The screenshot shows the Aladin v12.0 desktop interface. A 'Server selector' dialog box is open, displaying the 'SRC Discovery Service Simple Cone Search interface'. The search parameters are:

- Target (ICRS, name): 03 43 37.0574100 -35 51 54.135500
- Radius: 44.46'

The 'SUBMIT' button is highlighted in green. The main Aladin window shows a star field with a blue nebula at the center, marked with a red crosshair. The 'Aladin Java measurements frame' at the bottom displays a table of search results.

| access url          | r              | obs publisher d... | obs t | obs c | target name | target t | exp t | mi... | t m... | s reg | em min      | em max      | em res power | em | dataproduct ty... | dataproduct sub... | calib level | obs collection   |              |
|---------------------|----------------|--------------------|-------|-------|-------------|----------|-------|-------|--------|-------|-------------|-------------|--------------|----|-------------------|--------------------|-------------|------------------|--------------|
| https://voa.data... | 0.000043498428 | ivo://test.skao/~? |       |       | NGC 1436    |          |       |       |        | RA    | 0.212056998 | 0.212333965 | 217700       |    | cube              | HI spectral cube   | 3           | MIKT-FORNAX-SURV | application/ |
| https://voa.data... | 0.000043498428 | ivo://test.skao/~? |       |       | NGC 1436    |          |       |       |        | RA    | 0.212056998 | 0.212333965 | 217700       |    | cube              | HI spectral cube   | 3           | MIKT-FORNAX-SERV | application/ |



# AladinDesktop querying the service around NGC 1436 – DataLink response

The screenshot displays the Aladin v12.0 desktop application. The main window shows a star field with a central blue object. The interface includes a menu bar (File, Edit, Image, Catalog, Overlay, Coverage, Tool, View, Interop, Help), a command line, and a toolbar. A sidebar on the left lists available data collections. A search bar is located at the bottom right. A table at the bottom of the window displays the DataLink response, showing query URLs and their results.

| access url  | r              | t                   | obs | publisher d. |
|---|----------------|---------------------|-----|--------------|
| <a href="https://voa.data.link/scdev/skaointr/col/link/stid=orange/2023-07-10-17-23-27_106_1kms_NGC1436_image_mos.fits">https://voa.data.link/scdev/skaointr/col/link/stid=orange/2023-07-10-17-23-27_106_1kms_NGC1436_image_mos.fits</a>   | 0.012010241625 | ivo://rest.skaop/~? |     |              |
| <a href="https://voa.data.link/scdev/skaointr/col/link/stid=sp5531_soda/2023-07-18-16-38-27_MKT-FORNAX-SURV_t06_1kms_NCC1436_image_mos">https://voa.data.link/scdev/skaointr/col/link/stid=sp5531_soda/2023-07-18-16-38-27_MKT-FORNAX-SURV_t06_1kms_NCC1436_image_mos</a>             |                |                     |     |              |
| <a href="https://voa.data.link/0.0000434984281_ivo://rest.skaop/~?sp5531_soda/2023-07-18-16-38-27_MKT-FORNAX-SURV_t06_1kms_NCC1436_image_mos">https://voa.data.link/0.0000434984281_ivo://rest.skaop/~?sp5531_soda/2023-07-18-16-38-27_MKT-FORNAX-SURV_t06_1kms_NCC1436_image_mos</a> |                |                     |     |              |
| <a href="https://voa.data.link/0.0000434984281_ivo://rest.skaop/~?orange/2023-07-10-17-23-27_106_1kms_NGC1436_image_mos">https://voa.data.link/0.0000434984281_ivo://rest.skaop/~?orange/2023-07-10-17-23-27_106_1kms_NGC1436_image_mos</a>   |                |                     |     |              |

# AladinDesktop querying the service around NGC 1436 – SODA interface

The screenshot displays the AladinDesktop interface. The main window shows a star field with a central cluster (NGC 1436) highlighted. The interface includes a menu bar (File, Edit, Image, Catalog, Overlay, Coverage, Tool, View, Interop, Help), a toolbar, and a sidebar with a tree view of available data. A 'Command' window is open, showing a table of query results. A 'Service' window is also open, displaying a 'Cutout service' form with fields for ID, CIRCLE, and BAND.

Available data → 33598  
● in view ● out view

Command

DSS PanSTARRS SDSS 2MASS GALEX Gaia Simbad NED +

DSS2 color

Imagine your eye looking through a stack of planes (below). Each plane contains its own data set: image, catalog, graphical overlays... You see the combination of them in the main panel. For accessing to other data, use the discovery tree in the left panel, or clic & drag your own local files.

| t max | t exptime | t resolution | t xel | em min      | em max      | em res. p |
|-------|-----------|--------------|-------|-------------|-------------|-----------|
|       |           |              | 1     | 0.212056998 | 0.212333965 | 21        |

Service spsrc33.laa.csic.es

● Cutout service ?  
Fill in all these fields and press the SUBMIT button

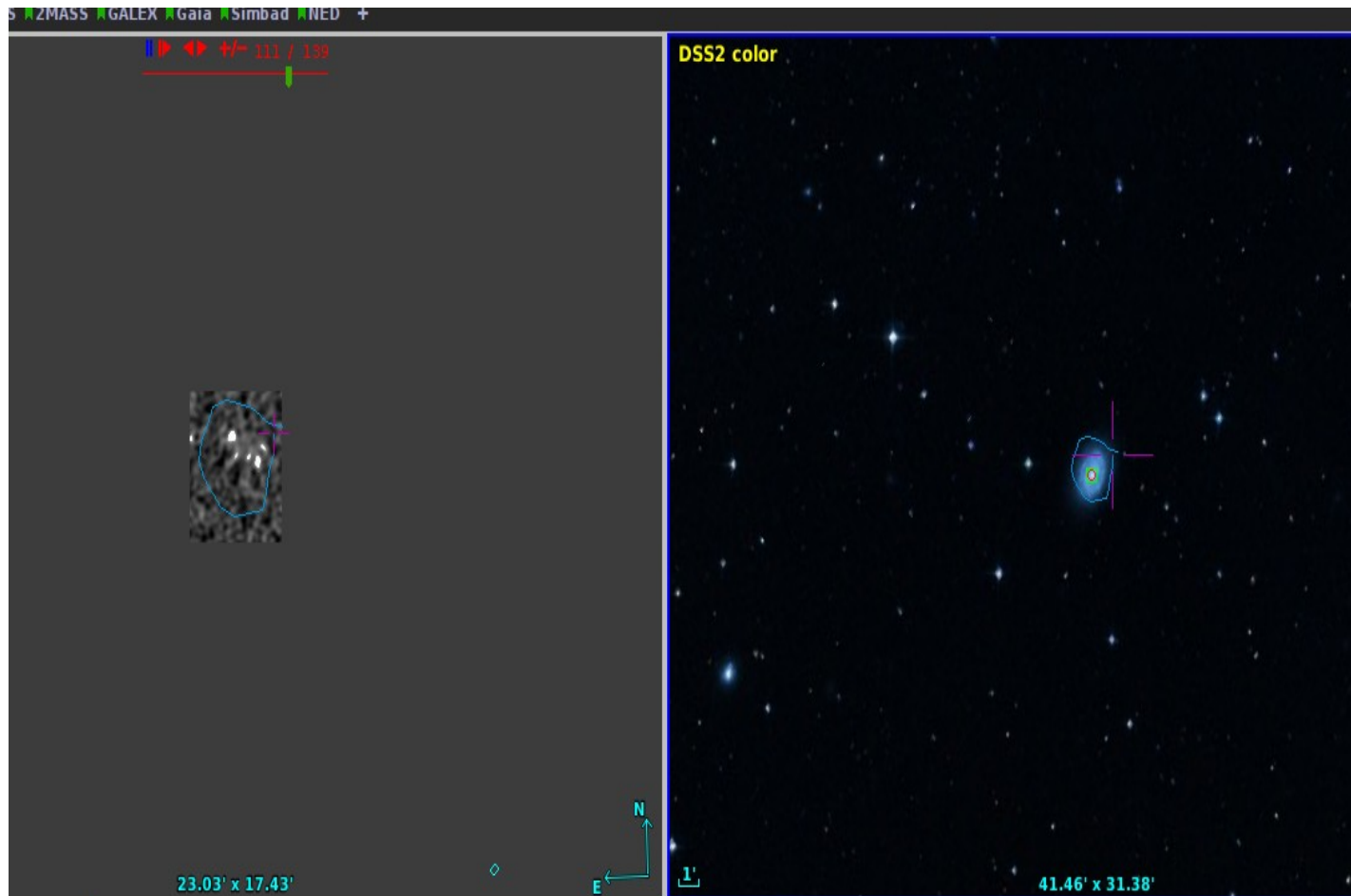
ID: RV t06 1kms NGC1436 image mos.fits  
CIRCLE: 055.904500000 -35.853028000 0.05  
BAND: 0.212056998 0.212333965

select  
from: all collections

1 sel / 15 src 50fps / 428Mb

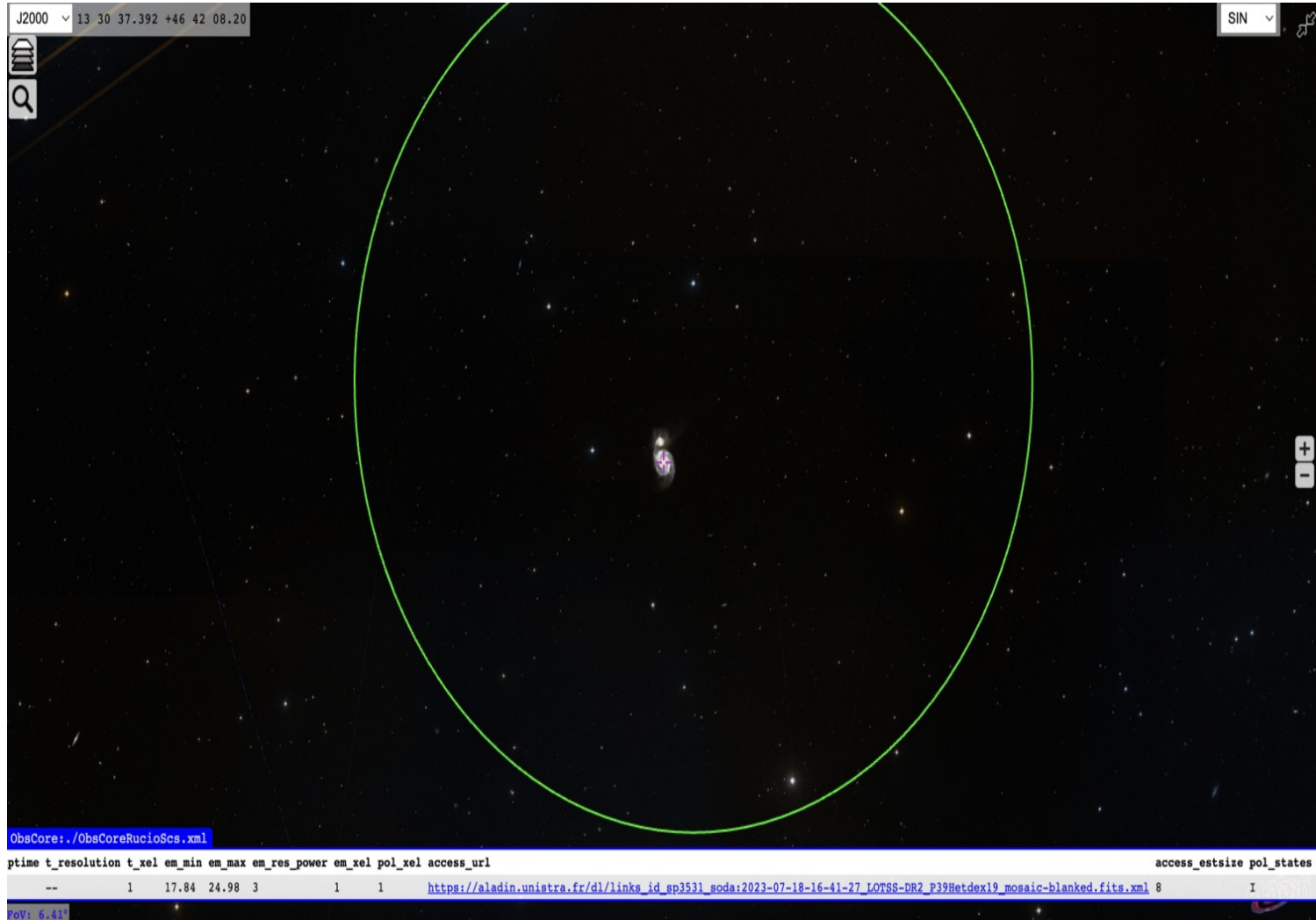


# AladinDesktop querying the service around NGC 1436 – SODA result - channel 111





# AladinLite ObscOre result for M51 : LOFAR continuum image found



# AladinLite ObsCore result for M51 : DataLink response

The screenshot displays the AladinLite web interface. At the top, there is a search bar with the text "J2000" and coordinates "13 29 52.885 +47 11 39.09". A "SIN" dropdown menu is visible in the top right corner. The main area shows a star field with a large green circle centered on a bright, multi-colored object. Below the star field, there is a table with the following columns: "service\_def", "error\_message", "semantics", and "description".

| service_def  | error_message | semantics | description  |
|--|---------------|-----------|--|
| <a href="#">ministic/sp3531_soda/52/b2/2023-07-18-16-41-27_LOTSS-DR2_P39Hetdex19_mosaic-blanked.fits</a> | --            | --        | #this P39Hetdex19  |
| soda-sync  | --            | #cutout   | SODA-sync cutout of ivo://auth.example.org/datasets/fits?sp3531_soda/52/b2/2023-07-1 |
| soda-async   | --            | #cutout   | SODA-async cutout of ivo://auth.example.org/datasets/fits?sp3531_soda/52/b2/2023-07- |

At the bottom left, the text "FoV: 6.41'" is visible. The interface also includes a "Datalink" field with the URL "https://aladin.unistra.fr/d..." and a search icon in the top left corner.

# AladinLite – SODA interface for M51 LOFAR image

J2000 13 30 57.150 +47 05 46.95 SIN

**Cutout Query Window**

ID  
ID:

CIRCLE

ra[deg]:

dec[deg]:

rad[deg]:

BAND

fmin[m]:

fmax[m]:

Datalink: <https://aladin.unistra.fr/d...>

| service_def  | error_message | semantics | description   |
|--|---------------|-----------|---|
| <a href="#">ministic/sp3531_soda/52/b2/2023-07-18-16-41-27_LOTSS-DR2_P39Hetdex19_mosaic-blanked.fits</a> | --            | --        | #this P39Hetdex19   |
| soda-sync  | --            | #cutout   | SODA-sync cutout of ivo://auth.example.org/datasets/fits?sp3531_soda/52/b2/2023-07-18-16-41-27_LOTSS-DR2_P39Hetdex19_mosaic-blanked.fits  |
| soda-async   | --            | #cutout   | SODA-async cutout of ivo://auth.example.org/datasets/fits?sp3531_soda/52/b2/2023-07-18-16-41-27_LOTSS-DR2_P39Hetdex19_mosaic-blanked.fits |

PoV: 6.41°

# AladinLite – M51 LOFAR cutout image overlaid on top of DSS

J2000 13 34 34.298 +48 10 47.19

SIN

**Cutout Query Window**

ID  
ID

CIRCLE

ra[deg]

dec[deg]

rad[deg]

BAND

fmin[m]

fmax[m]

Datalink:<https://aladin...>

| service_def  | error_message | semantics | description          |
|--|---------------|-----------|----------------------|
| <a href="#">/dev/deterministic/sp3531_soda/52/b2/2023-07-18-16-41-27_LOTSS-DR2_P39Hetdex19_mosaic-blanked.fits</a> | --            | --        | #this P39Hetdex19    |
| soda-svnc  | --            | --        | #cutout SODA-svnc cu |

# Abell 194 datasets discovery (see recursive DataLink link)

The screenshot displays the Aladin v12.0 software interface, which is used for astronomical data visualization and discovery. The main window shows a field of galaxies with a central reticle. The interface includes a menu bar, a toolbar, and a sidebar with various tools and filters. A table at the bottom lists the discovered datasets.

Command: 021.4458000000 -01.3730000000

Frame: ICRSd Projection: Aitoff

Available data → 33603

Command: 021.4458000000 -01.3730000000

DSS PanSTARRS SDSS 2MASS GALEX Gaia Simbad NED +

DSS2 color

1.383° x 42.9'

| access url  | calib level | s.ra    | s.dec  | s.fov | s.region | obs.publisher.d.           | obs.collection | facility.name | instrument.name | obs.id      | da |
|---|-------------|---------|--------|-------|----------|----------------------------|----------------|---------------|-----------------|-------------|----|
| <a href="http://aladin.unistra.fr/links/abell_194_poln.fits.gz">http://aladin.unistra.fr/links/abell_194_poln.fits.gz</a> |             | 21.4458 | -1.373 | 2     | ENV      | ivo/test/slooh-2/MKT-MGCLS | M55PKAT        |               | Lband-4kcorr    | Abell_194_I | cu |
| <a href="http://aladin.unistra.fr/links/abell_194_poln.fits.gz">http://aladin.unistra.fr/links/abell_194_poln.fits.gz</a> |             |         |        |       |          |                            |                |               | Lband-4kcorr    | Abell_194_Q | cu |

Abell\_194\_I recursive DataLink

SODA-sync cutout of ivo://auth.example.org/datasets/fits?sp3531\_soda/a8/58/2023-07-18-16-34-27\_MKT-MGCLS\_Abell\_194\_I\_Poln.fits.gz

SODA-async cutout of ivo://auth.example.org/datasets/fits?sp3531\_soda/a8/58/2023-07-18-16-34-27\_MKT-MGCLS\_Abell\_194\_I\_Poln.fits.gz

2 sel / 15 src 764Mb

# Abell 194 recursive DataLink (moment 0 and spectral index HiPS links)

Activités cds-aladin-Aladin 25 août 07:34 Aladin v12.0 \*\*\* BETA VERSION (based on v12.033) \*\*\*

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Available data → 33609  
in VIEW out VIEW

Command: 01:25:46.9920000 - 01:22:22.8000000 Frame: CRS Projection: Atoff

DSS PanSTARRS SDSS ZMASS GALEX Gaia Simbad NED +

DSS2 color

30' 2.21' x 1.12'

ska.scmnet.org/italy/galacticCenter

| access url  | calib level | s ra          | s dec     | s fov     | s region      | obs publisher d... | obs collection | facility name | instrument |
|---|-------------|---------------|-----------|-----------|---------------|--------------------|----------------|---------------|------------|
| <a href="http://www.abell194.com">http://www.abell194.com</a> |             | 7-18-16-34-27 | MKT-MGCLS | Abell_194 | IPoln.fits.gz | MEERKAT            | Lband-4K       |               |            |
| <a href="http://www.abell194.com">http://www.abell194.com</a> |             |               | -1.373    | 2         | Fov           | MEERKAT            | Lband-4K       |               |            |

select from --all collections--

epoch size dens opac zoom

01:26:01:30-01:26:01:30 2.21' x 1.12' 80 sky 2018-05-01 ... 2020

2 sel / 15 src 620Mb

http://aladin.unistra.fr/d/links\_id\_sp3531\_soda:2023-07-18-16-34-27\_MKT-MGCLS\_Abell\_194\_IPoln.fits.gz.xml

# Abell 194 moment 0 HiPS

Aladin v12.0 \*\*\* BETA VERSION (based on v12.033) \*\*\*

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Available data → 33609  
● in view ● out view

Command  X Frame **ICRS** Projection **Aitoff**

▼ DSS ▼ PanSTARRS ▼ SDSS ▼ 2MASS ▼ GALEX ▼ Gaia ▼ Simbad ▼ NED ▼

Abell\_194HiPS

16.3' x 8.259'

Data are being downloaded... look at the "stack"

| access url            | calib level | s.ra    | s.dec  | s.fov | s.region | obs.publisher.d...  | obs.collection | facility name | instrument |
|-----------------------|-------------|---------|--------|-------|----------|---------------------|----------------|---------------|------------|
| http://aladin.univ... | : '3        | 21.4458 | -1.379 | 2     | Fov      | ivo://test.skao/~?E | MKT-MCCLS      | MEERKAT       | Lband-4k   |
| http://aladin.univ... | : '3        | 21.4458 | -1.379 | 2     | Fov      | ivo://test.skao/~?E | MKT-MCCLS      | MEERKAT       | Lband-4k   |

select   
from -- all collections --

Welcome to Aladin, your professional sky atlas.

- Discover all astronomical data available over the net!
- Compare them with your own data.
- Prepare your observation missions.

To start, type any object name, such as M1, and press ENTER...

Or easier, clic in the main frame and enjoy the sky...

ObsCoreRucio5  
Abell\_194HiPS  
DSS/P/DSS2

epoch -  
size -  
dens. -  
apar. -  
zoom -

01:25:47.02 -01:2  
16.3' x 8.259'

# Abell 194 spectral index HiPS

Aladin v12.0 \*\*\* BETA VERSION (based on v12.033) \*\*\*

File Edit Image Catalog Overlay Coverage Tool View Interop Help

Available data → 33609  
 ● in view ● out view

Command  Frame [CRS] Projection [Aitoff]

Abell\_194SpecindexHiPS

DSS  PanSTARRS  SDSS  2MASS  GALEX  Gaia  Simbad  NED +

Collections → 33609  
 Image → 581  
 Data base → 4  
 Catalog → 31631  
 Cube → 24  
 Ancillary → 79  
 Outreach → 52  
 Others → 1230  
 Deprecated → 8

select  
 pan  
 dist  
 phot  
 draw  
 tag  
 mac  
 spect  
 filter  
 cross  
 rpb  
 assoc  
 crop  
 cont  
 pvel  
 prop  
 del

**Tips & tricks**  
 Pixel mapping controller:  
 Tip: The pixel mapping may be adjusted directly in the main panel thanks to a clic&drag action with the right-mouse button. The mouse pointer position determines the contrast and the luminosity of the view (a la "DS9").  
 Also, the usage of the hdr button in the main panel allows you to switch from the preview mode (256 levels) to the full dynamic mode offering the full dynamicity of the image.

ObsCoreRucidS  
 Abell\_194Spe  
 Abell\_194HiPS  
 GDS/P/DS2

Search

| access_url  | calib_level | s_ra    | s_dec  | s_fov | s_region | obs_publisher_d...     | obs_collection | facility_name | instrument |
|---|-------------|---------|--------|-------|----------|------------------------|----------------|---------------|------------|
| <a href="http://aladin.univ...">http://aladin.univ...</a> | :+3         | 21.4458 | -1.373 | 2     | FoV      | ivo://test.skao/~?i... | MKT-MGCLS      | MEERKAT       | Lband-4K   |
| <a href="http://aladin.univ...">http://aladin.univ...</a> | :+3         | 21.4458 | -1.373 | 2     | FoV      | ivo://test.skao/~?i... | MKT-MGCLS      | MEERKAT       | Lband-4K   |

select   
 from --all collections--

epoch -   
 size -   
 dens. -   
 opac. -   
 zoom -   
 01:25:46.08 - 01:25:46.08  
 1.2° x 36.49°  
 80  
 -90 80  
 2010-05-24 20:30