

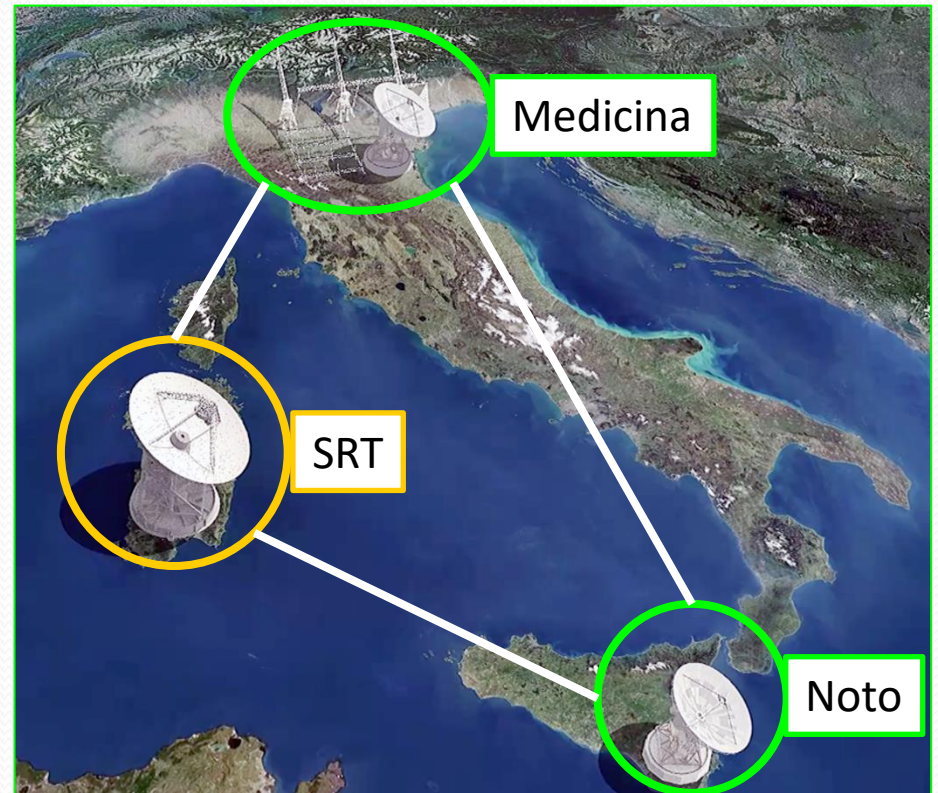
# The Italian radio telescopes archive and the VO perspective

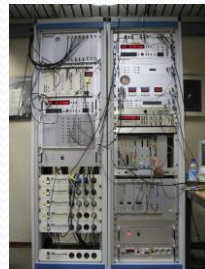
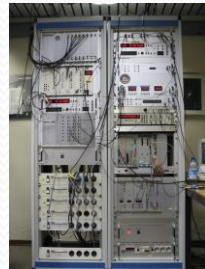
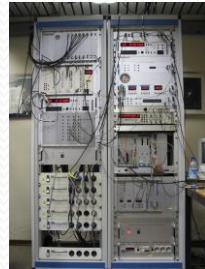


Alessandra Zanichelli  
*INAF – Istituto di Radioastronomia*

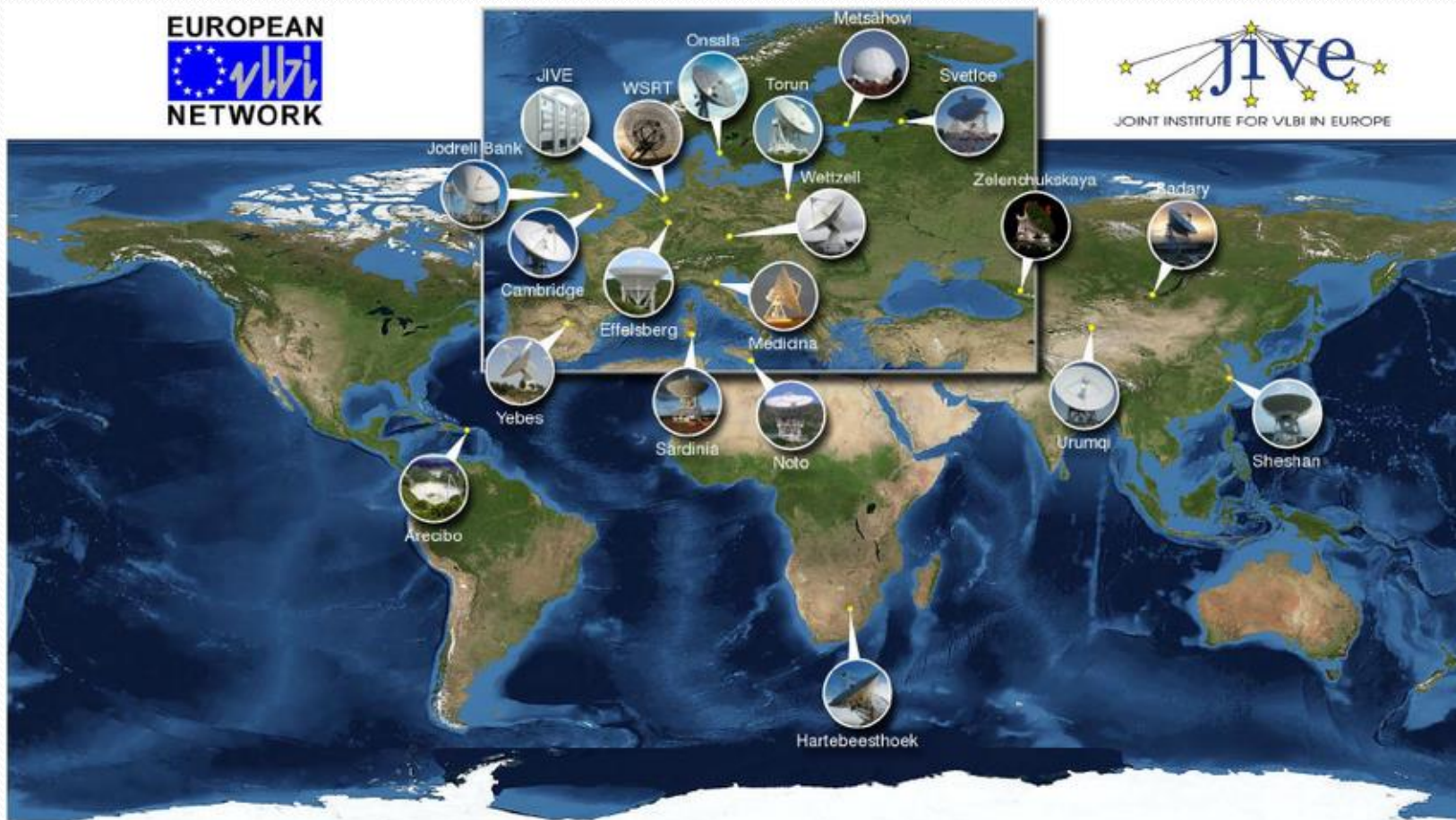
# The Italian Radio Telescope Network

- INAF currently manages three fully-steerable radio telescopes
- Harmonization and coordination of efforts and resources on a national basis





# Single Dish



# Very Long Baseline Interferometry

# The present @ SRT, Medicina, Noto



- Common Single-Dish Control System (DISCOS): integrated backends, common data format



- «Italian» VLBI Network experiments (EVN subarrays + others) quite common



➔ A public radio archive

# Data formats @ SRT, Med, Noto

**MBFITS**

```
alex@honeysbee: ~/escs/mbfits/medicina/20121008/20121008-120852-140526-libardi_3C286$ ls -la
total 12
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 .
drwxr-xr-x 2 alex alex 4096 2013-02-21 13:01 ..
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0002
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0003
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0004
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0005
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0006
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0007
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0008
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0009
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0010
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0011
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0012
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 0013
-rw-rw-r-- 1 alex alex 17280 2013-02-21 13:01 CCC-Backend-FEBEPAR.fits
-rw-rw-r-- 1 alex alex 23040 2013-02-21 13:01 GROUPING.fits
-rw-rw-r-- 1 alex alex 17280 2013-02-21 13:01 MONITOR.fits
```

```
alex@honeysbee: ~/escs/mbfits/medicina/20121008/20121008-120852-140526-libardi_3C286$ ls -la 0002
total 4
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 CCC-Backend-ARRAYDATA-01.fits
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 CCC-Backend-ARRAYDATA-02.fits
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 CCC-Backend-DATAPAR.fits
-rw-rw-r-- 2 alex alex 4096 2013-02-21 13:01 MONITOR.fits
```

**FITS**

```
File Edit Tools
Search for: Find Case sensitive? No Help
T / file does conform to FITS standard
3 / number of bits per data pixel
0 / number of data axes
T / FITS dataset may contain extensions
ible Image Transport System) format is defined in 'Astronomy
physics', volume 376, page 259; bibcode: 2001AA...376..359H
ed by S. Rajani, M. Bartolini, & A. Crist
output standard for Italian radiotelescopes
ays column in data table replaced with the Text table, it re
ys measurement for each input of each section
section table has been splitted into two tables: sections and
able
f the flux column in section table
onyType added as primary header; keyword
few table to store position of subreflector a primary focus
SERVO table
MPT10.50.31 / File creation date (YYYY-MM-DDThh:mm:ss UT)
se = '020506' / Name of the project
/ Name of the observer
de = 0.16135848187879 / Longitude of the site (radians)
de = 0.609293579621821 / Latitude of the site (radians)
= 650. / Slant of the site (meters)
1 / Number of beams
2 / Total number of sections
e = 4 / Number of bytes of a data
de = 'OCB' / Keyword that identifies the receiver
ion = 0.117895724509617 / Source right ascension at J2000 (c
= 0.65213155421545 / Source declination at J2000 (radians)
0 / Source radial velocity
NIEKANG Azimuth Offset = 0 / Longitude offset in horizontal frame
NIEKANG Elevation Offset = 0 / Latitude offset in horizontal frame
NIEKANG RightAscension Offset = 0 / Longitude offset in equatorial frame
NIEKANG Declination Offset = 0 / Latitude offset in equatorial frame
NIEKANG Galactocentric Offset = 0 / Longitude offset in galactic frame
NIEKANG Galactolactic Offset = 0 / Latitude offset in galactic frame
SCANID = 1 / Scan Identifier
NIEKANG SubScanID = 0 / Subscan Identifier
NIEKANG ScheduleName = '020506_20140308-105305'
NIEKANG LogFileBase = '020506_20140308-105305_Log'
NIEKANG SubScanType = 'RA' / describes the scan type based on telescope a
```

Index	Extension	Type	Dimension	Header	Hist	Plot	All	Select
0	Primary	Image	0	Header				
1	SECTION TABLE	Binary	5 cols X 2 rows	Header				
2	RF INPUTS	Binary	9 cols X 2 rows	Header				
3	FEED TABLE	Binary	4 cols X 1 rows	Header				
4	DATA TABLE	Binary	12 cols X 364 rows	Header				
5	ANTENNA TEMP TABLE	Binary	2 cols X 364 rows	Header				
6	SERVO TABLE	Binary	8 cols X 364 rows	Header				

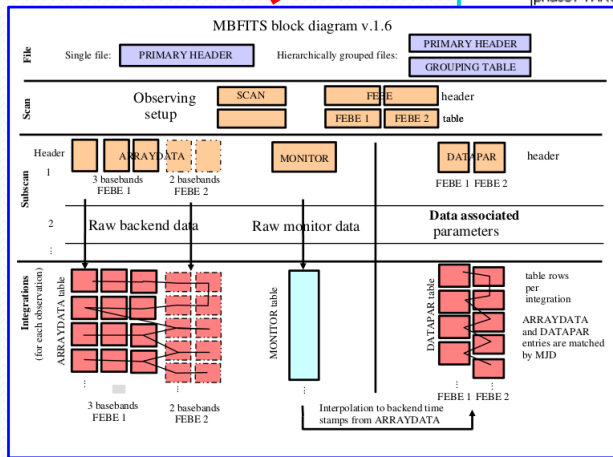
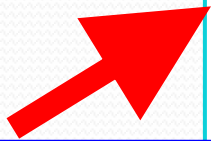
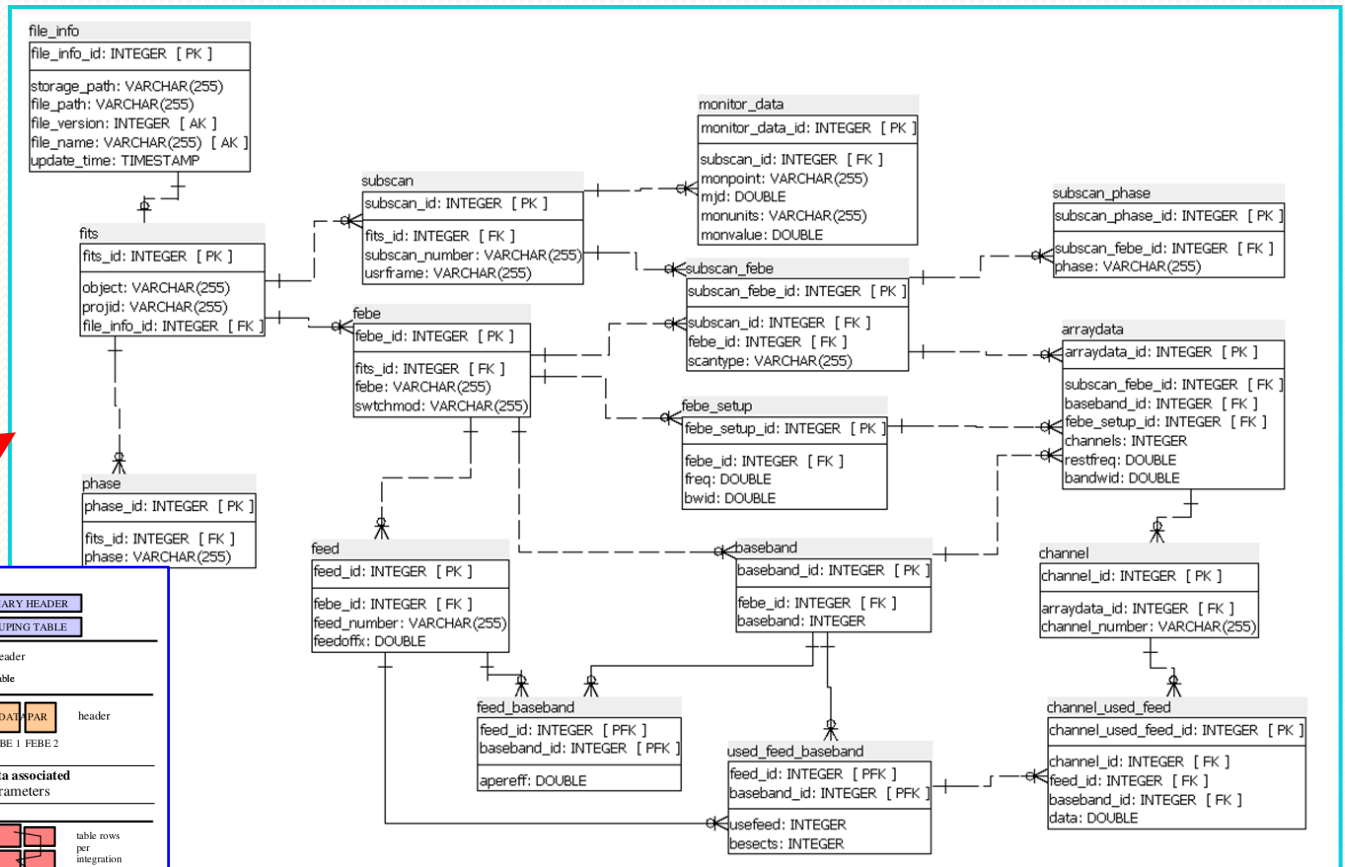
**VLBI FITS**

```
<table>
<PROJID>1313f</PROJID>
<TELESCOP>VLBIT</TELESCOP>
<PNAME>Marcello Girolletti</PNAME>
<OBJECT>0222+73</OBJECT>
<RA>30.2918926036</RA>
<DEC>73.8257282611</DEC>
<START>2014-03-28 14:19:43</START>
<ANTENNAS>NT-Md-Mc</ANTENNAS>
<FREQ>4966.49</FREQ>
<OBS_MODE>16x8MHz</OBS_MODE>
<RATE>512.0</RATE>
<ONTIME>4430</ONTIME>
</table>
<table>
<PROJID>1313f</PROJID>
<TELESCOP>VLBIT</TELESCOP>
<PNAME>Marcello Girolletti</PNAME>
<OBJECT>0304+362</OBJECT>
<RA>45.7247090019</RA>
<DEC>36.3701193225</DEC>
<START>2014-03-28 14:19:43</START>
<ANTENNAS>NT-Md-Mc</ANTENNAS>
<FREQ>4966.49</FREQ>
<OBS_MODE>16x8MHz</OBS_MODE>
<RATE>512.0</RATE>
<ONTIME>4430</ONTIME>
</table>
<table>
<PROJID>1313f</PROJID>
<TELESCOP>VLBIT</TELESCOP>
<PNAME>Marcello Girolletti</PNAME>
<OBJECT>0304+362</OBJECT>
<RA>45.7247090019</RA>
<DEC>36.3701193225</DEC>
<START>2014-03-28 14:19:43</START>
<ANTENNAS>NT-Md-Mc</ANTENNAS>
<FREQ>4966.49</FREQ>
<OBS_MODE>16x8MHz</OBS_MODE>
<RATE>512.0</RATE>
<ONTIME>4430</ONTIME>
</table>
-- INSERT --
```

Index	Extension	Type	Dimension	View
0	Primary	Image	0	Header Image Table
1	ARRAY_GEOMETRY	Binary	7 cols X 2 rows	Header Hist Plot All Select
2	SOURCE	Binary	26 cols X 4 rows	Header Hist Plot All Select
3	ANTENNA	Binary	15 cols X 18 rows	Header Hist Plot All Select
4	FREQUENCY	Binary	6 cols X 1 rows	Header Hist Plot All Select
5	INTERFEROMETER_MODEL	Binary	20 cols X 210 rows	Header Hist Plot All Select
6	CALC	Binary	11 cols X 5 rows	Header Hist Plot All Select
7	MODEL_COMPS	Binary	21 cols X 210 rows	Header Hist Plot All Select
8	UV_DATA	Binary	13 cols X 8410 rows	Header Hist Plot All Select
9	SYSTEM_TEMPERATURE	Binary	10 cols X 0 rows	Header Hist Plot All Select
10	PHASE-CAL	Binary	17 cols X 378 rows	Header Hist Plot All Select

Pulsar data (PSRFITS)

# A common data model



# Astronomical data preservation

Observations comprise:

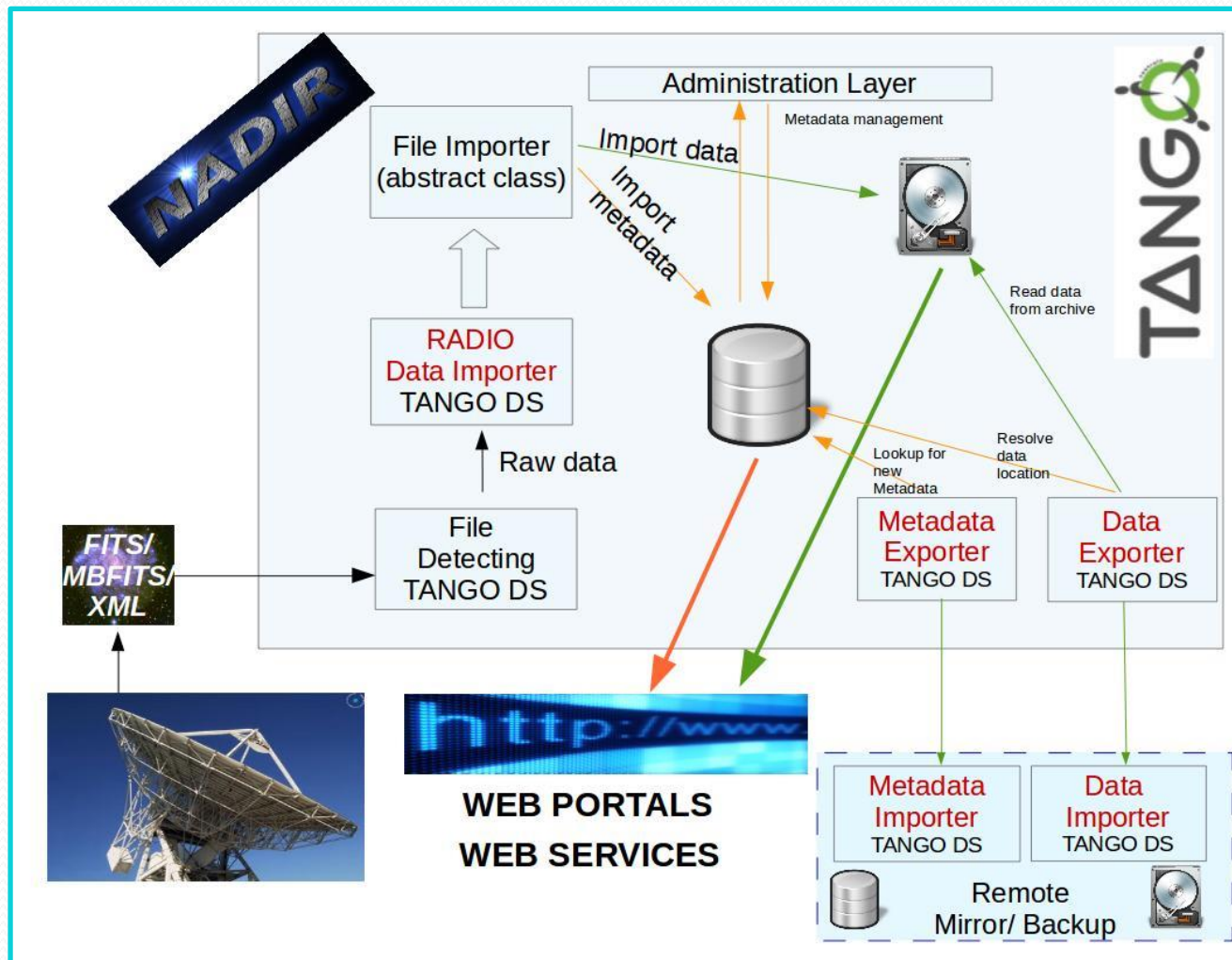
- The scientific exposures
- The [data+instrument+site] metadata
- The observing schedule
- The observing and telescope(s) logs

All this information is archived to guarantee data reuse, preservation and curation

 **scientific exploitation**



# The radio archive architecture



# Web interface

The image displays the web interface of the INAF Radio Archive. At the top, there are navigation links for 'New search' and 'Help', and a user status indicator 'Currently not logged in' with a 'Login' button. Below this, there are search filters: 'Simple search' (highlighted with a red circle), 'VLBI-IT search', 'SD search', and 'Pulsar search'. The main search area includes a 'File name' input field, a 'Name resolver' section with 'Object name' and 'Resolve' buttons, and checkboxes for 'RA' and 'Dec' with corresponding coordinate input fields. There are also date range filters for 'Obs date', 'Frequency [MHz]', and 'Project id'. A 'Radius (arcmin)' input field is set to 0.0. A 'Search' button and a 'Reset' button are located at the bottom right of the search area. Below the search area, there is a 'Rows displayed' dropdown menu set to 20. The bottom of the page shows 'Total results: 0' and a 'Powered by IA2' logo with a link to the 'Privacy policy'.

A red starburst highlights the 'Login' button in the top right corner, with a red arrow pointing to the 'Remote Authentication Portal' screenshot below.

The 'Remote Authentication Portal' screenshot shows the following content:

- Header: Remote Authentication Portal
- Section: Login to Radio Archive
- Logos and instructions for: eduGAIN, Facebook, LinkedIn, X.509, and IA2.
- Footer: Powered by IA2

We

[New search](#) [Help](#) 🇺🇸 Your files 0 Currently not logged in [Login](#)

[Simple search](#) **VLBI-IT search** [SD search](#) [Pulsar search](#)

**File name**

**Name resolver**  [Resolve](#)

**RA**   **Dec**  **Radius (arcmin)**

**Obs date** **From**   **To**

**Frequency [MHz]** **From**  **To**

**Project id**

**Telescope**

**Antennas**

**Data rate [Mbit/s]**

**Spectral channels**

**Spectral resolution [MHz (\*)]**

New search Help Your files 0 Currently not logged in Login

Simple search VLBI-IT search **SD search** Pulsar search

File name

Name resolver

RA   Dec  Radius (arcmin)

Equinox

Obs date From   To

Frequency [MHz] From  To

Project id

Telescope

Frontend

Bandwidth [MHz]

Exposure time [s]

LST Min  Max

Scan type

Scan geometry

Scan speed [deg/min]

New search Help Your files 0 Currently not logged in Login

Scan geometry

Scan speed [deg/min]

Switch mode

Spectral resolution [Hz (%)]

Frequency bins

Wobbler

Observer

Creator

Format version

Scan frame

Rest frequency [MHz]

Rows displayed

<input checked="" type="checkbox"/>	File name	Policy	Obs date
<input type="checkbox"/>	<a href="#">20100128-221111-3C286.tar.gz</a>	FREE	2010-01-28T22:11:11
<input type="checkbox"/>	<a href="#">20150129-221111-3C286.tar.gz</a>	FREE	2015-01-29T22:11:11
<input type="checkbox"/>	<a href="#">20180207-131557-31-17-Skydip.tar.gz</a>	PRIV	2018-02-07T13:15:58
<input type="checkbox"/>	<a href="#">20180207-132738-31-17-NGC7027.tar.gz</a>	PRIV	2018-02-07T13:27:39
<input type="checkbox"/>	<a href="#">20180207-154640-31-17-3C123.tar.gz</a>	PRIV	2018-02-07T15:46:41
<input type="checkbox"/>	<a href="#">20180210-174520-25-17-TXS0506+058.tar.gz</a>	PRIV	2018-02-10T17:45:21



[Simple search](#)

[VLBI-IT search](#)

[SD search](#)

[Pulsar search](#)

File name

Name resolver

Object name

[Resolve](#)

RA

hh:mm:ss.ss

Dec

dd:mm:ss.ss

Radius (arcmin)

0.0

Obs date

From

yyyy-MM-dd



To

yyyy-MM-dd



Project id

Backend

Observation mode

PSR

Observer

[Search](#)

[Reset](#)

Rows displayed

20

Total results: 0

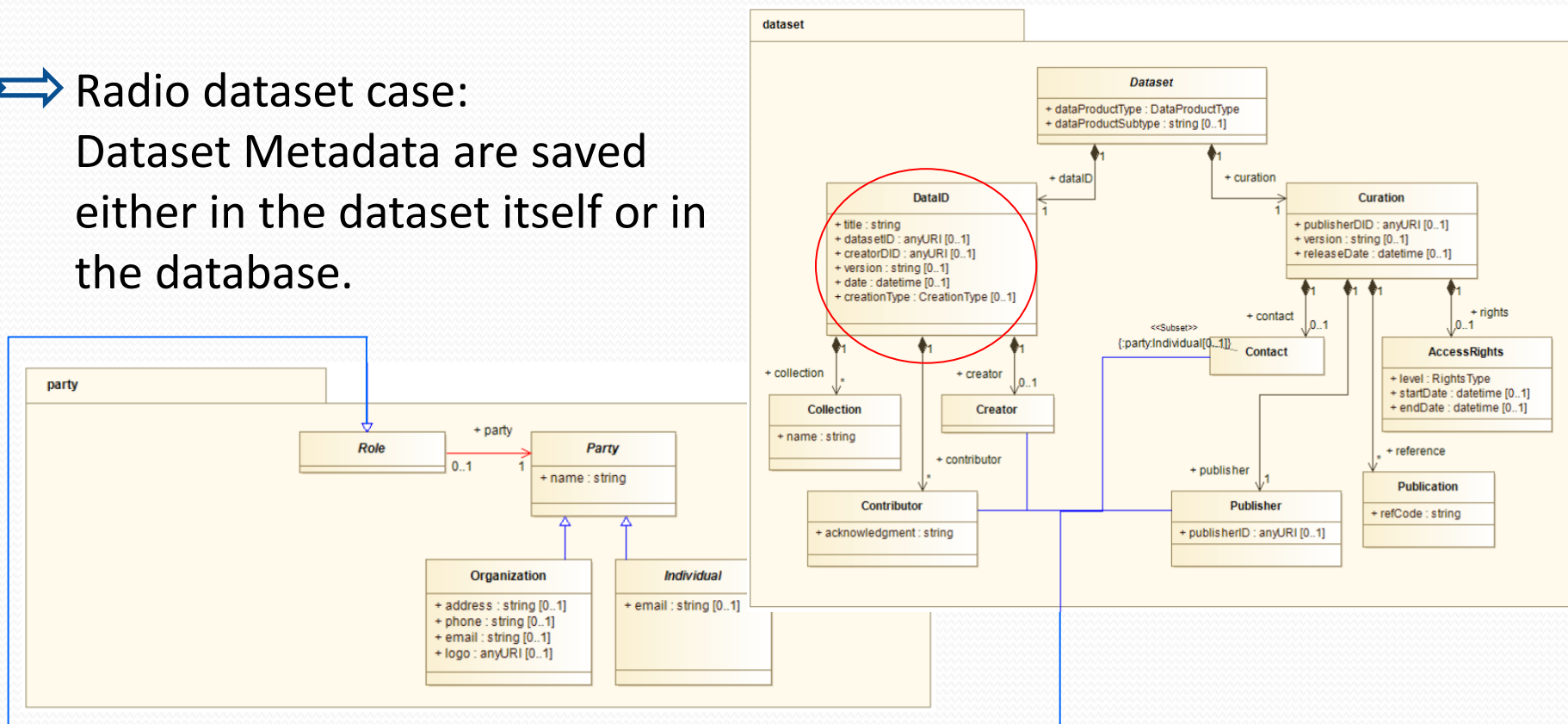
# The VO perspective

- Analysis of VO Dataset Metadata Model
- Analysis of VO ObsCore mandatory components
- A look at the CAOM model
- TAP service and data access via DataLink

# VO Dataset Metadata Model

Generic high-level metadata needed to describe a file or files which are considered to be a single deliverable (IVOA Dataset).

⇒ Radio dataset case:  
Dataset Metadata are saved either in the dataset itself or in the database.

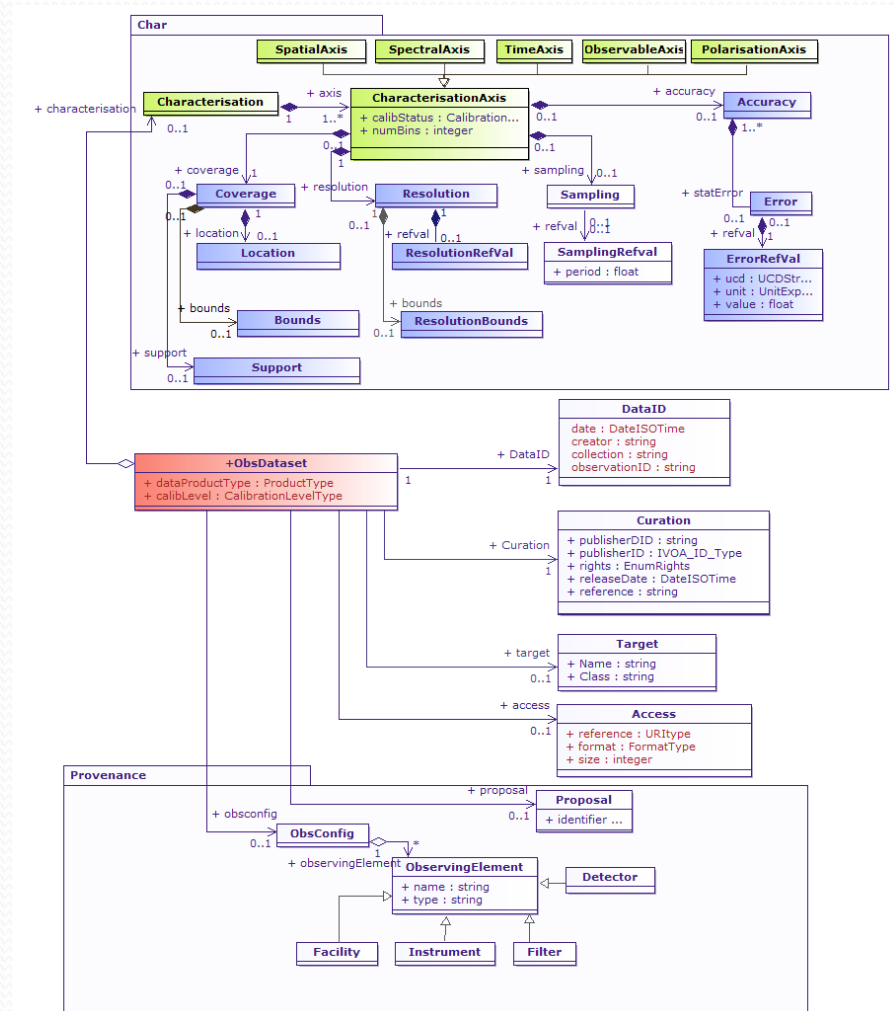


# VO ObsCore

Global data discovery and access requires to expose a uniform, standard data model.

Analysis of the VO ObsCore **mandatory** components.

For data discovery purposes, all the required metadata core components are present in the radio data model.





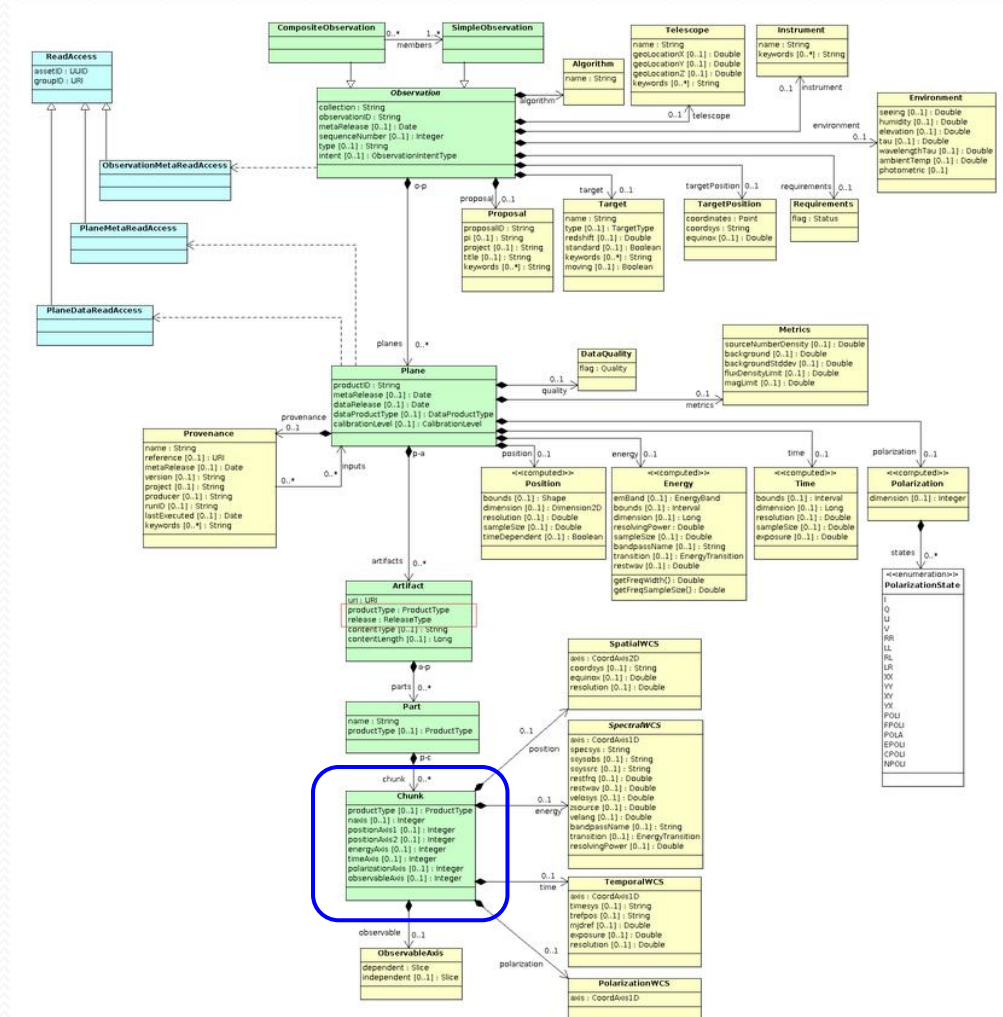
# The CAOM Model

Common Archival Observation Model @ CADC

CompositeObservation  
-> Observing Project

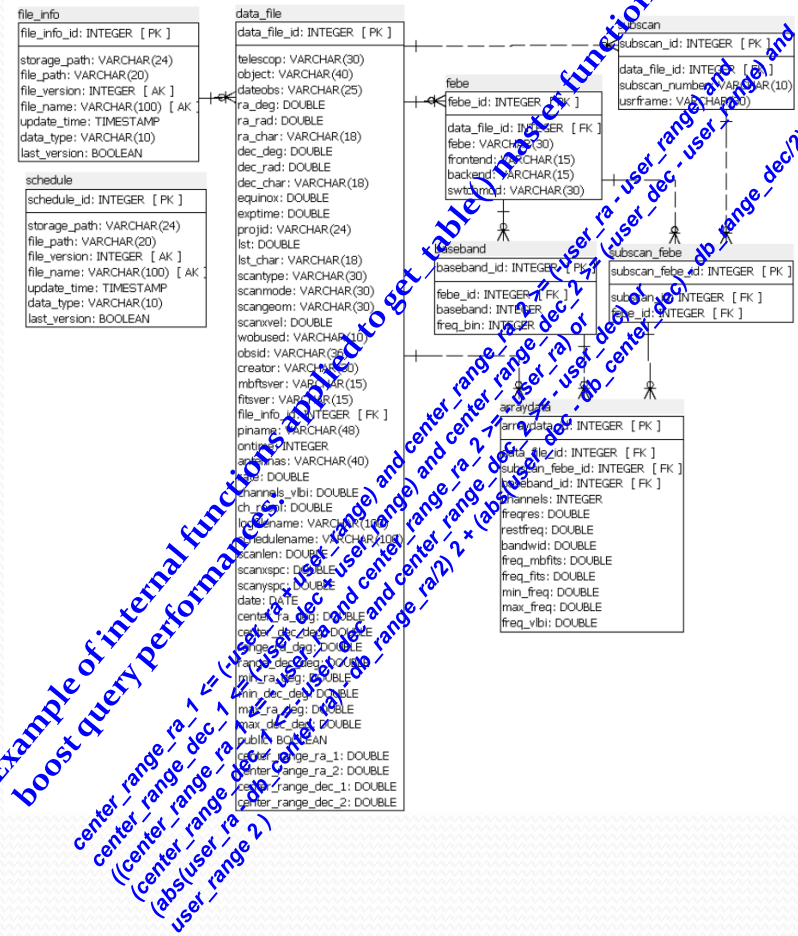
Artifacts -> tar files / MBFits

Chunk -> single subscan or file  
denormalized



# TAP and DataLink

- TAP service:
  - IA2 implementation
  - custom User Defined Functions to improve query performance  
 $get\_table = f(pos, freq, \dots);$   
 $pos = f(ra, dec, rad, \dots);$
- DataLink access to datasets
  - Access to complex datasets: content list, ancillary resources (related datasets)
  - additional metadata (provenance, data quality, etc.)



# Conclusions



- Public Archive for the Italian radio telescopes: definition of a common data model, flexible architecture
- Web interface: definition of query parameters, A&A
- The Radio Archive and the VO: what's next?