A VO service for the European VLBI Network

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EDP Workshop, November 2021

JIVE

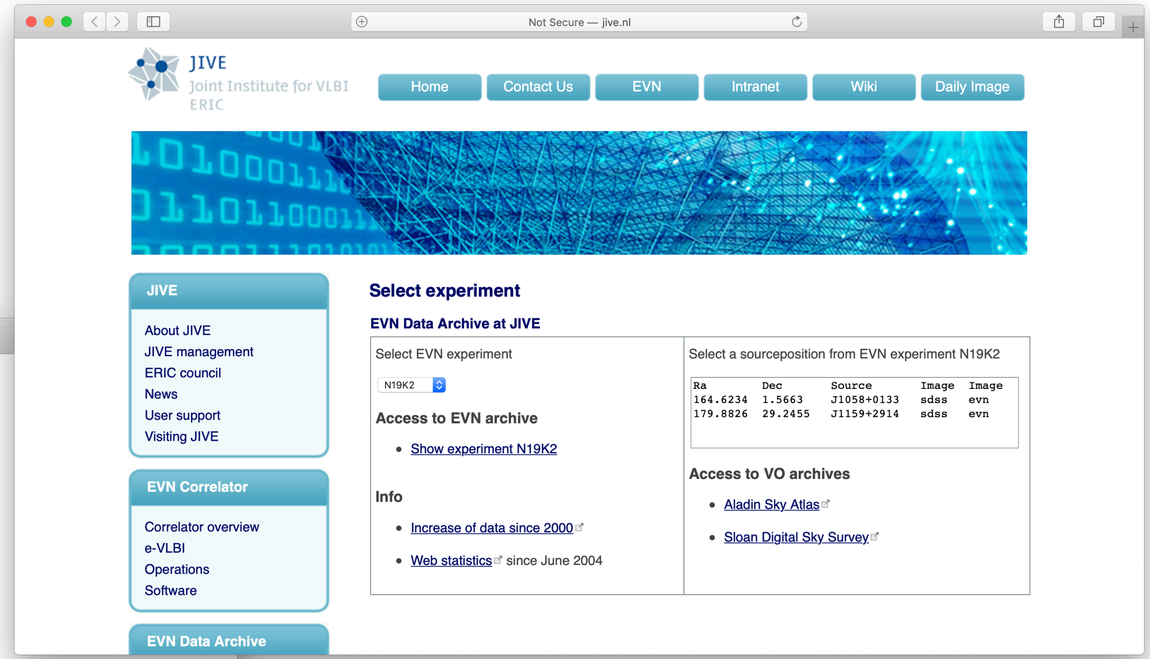
Joint Institute for VLBI ERIC

ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n° 824064.

EVN & JIVE

- EVN: European VLBI Network
  - Collaboration between radio observatories in Europe and beyond (South-Africa, Puerto-Rico, China, Korea)
  - Heterogeneous array
  - PI driven
- JIVE: Joint Instutute for VLBI ERIC
  - Support institute for the EVN
  - Operates the EVN correlator and hosts the EVN data archive

EVN Archive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Operations
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EVN Data Archive
Select experiment
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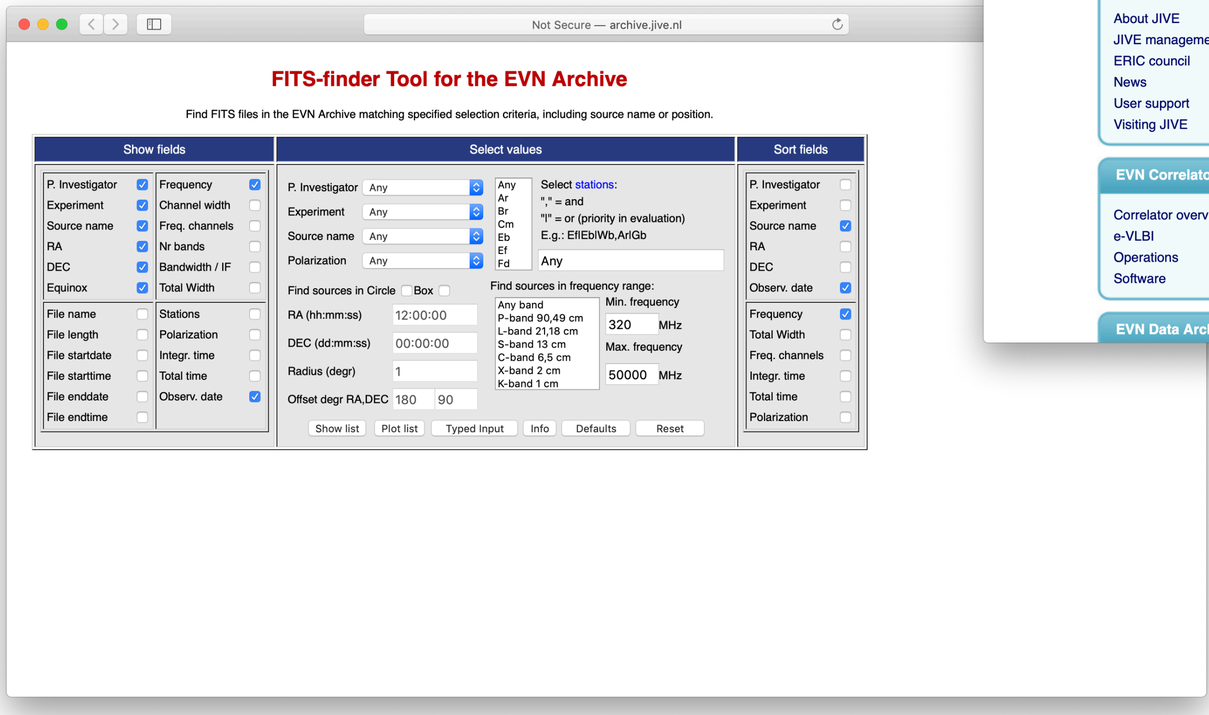
N19K2
Access to EVN archive
Show experiment N19K2
Info
Increase of data since 2000
Web statistics since June 2004
Select a sourceposition from EVN experiment N19K2
Ra Dec Source Image Image
164.6234 1.5663 J1058+0133 sdss evn
179.8826 29.2455 J1159+2914 sdss evn
Access to VO archives
Aladin Sky Atlas
Sloan Digital Sky Survey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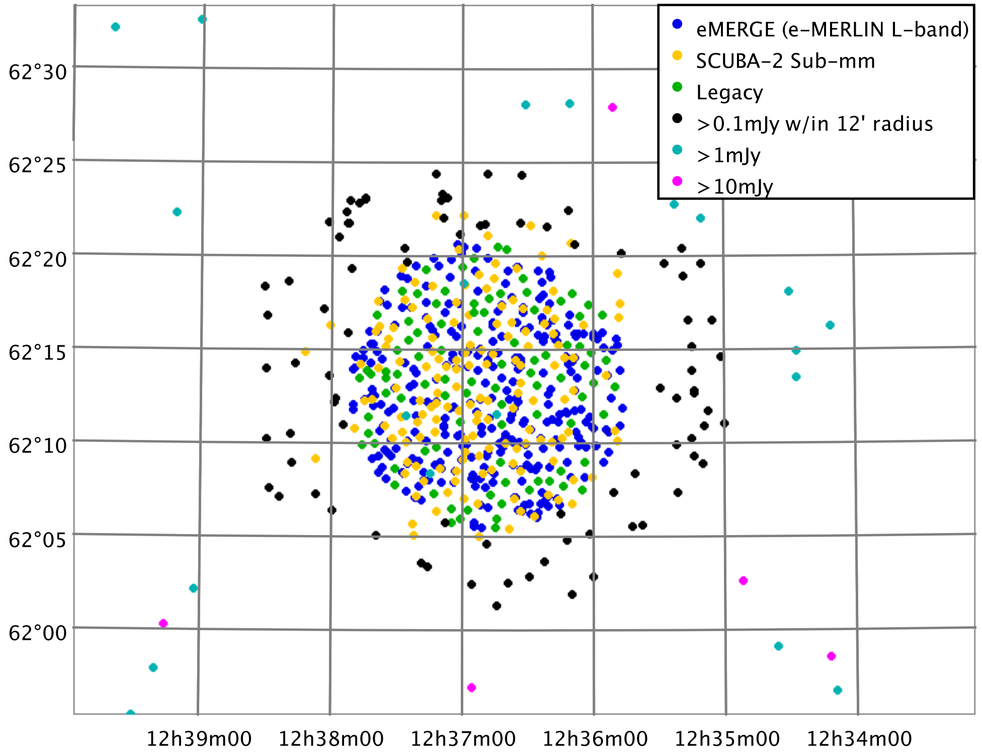
FITS-finder Tool for the EVN Archive
Find FITS files in the EVN Archive matching specified selection criteria, including source name or position.
Show fields
Select values
Sort fields
P. Investigator
Experiment
Source name
RA
DEC
Equinox
Frequency
Channel width
Freq. channels
Nr bands
Bandwidth / IF
Total Width
File name
File length
File startdate
File starttime
File enddate
File endtime
Stations
Polarization
Integr. time
Total time
Observ. date
Any
Select stations:
"," = and
"|" = or (priority in evaluation)
E.g.: Ef|Eb|Wb,Ar|Gb
Find sources in Circle
Box
RA (hh:mm:ss)
12:00:00
DEC (dd:mm:ss)
00:00:00
Radius (degr)
1
Offset degr RA,DEC
180
90
Find sources in frequency range:
Any band
P-band 90,49 cm
L-band 21,18 cm
S-band 13 cm
C-band 6,5 cm
X-band 2 cm
K-band 1 cm
Min. frequency
320
MHz
Max. frequency
50000
MHz
Show list
Plot list
Typed Input
Info
Defaults
Reset

Data products

- Visibility data (“UV data”; FITS-IDI)
  - No in-beam calibrators -> Multiple sources per observation
  - Continuum and spectral line data
  - Pulsar observations: multiple bins
  - MPC observations: multiple field centers
- Filterbank data (Pulsars, FRBs; PSR-FITS/filterbank, not yet archived)
  - Time-series
- Calibration data
  - Flagging, amplitude calibration, observation schedule, observation logs
- Diagnostic plots (from pipeline)

Multiple Phase Centers



Radcliffe et. al.

699 sources in GOODS-N

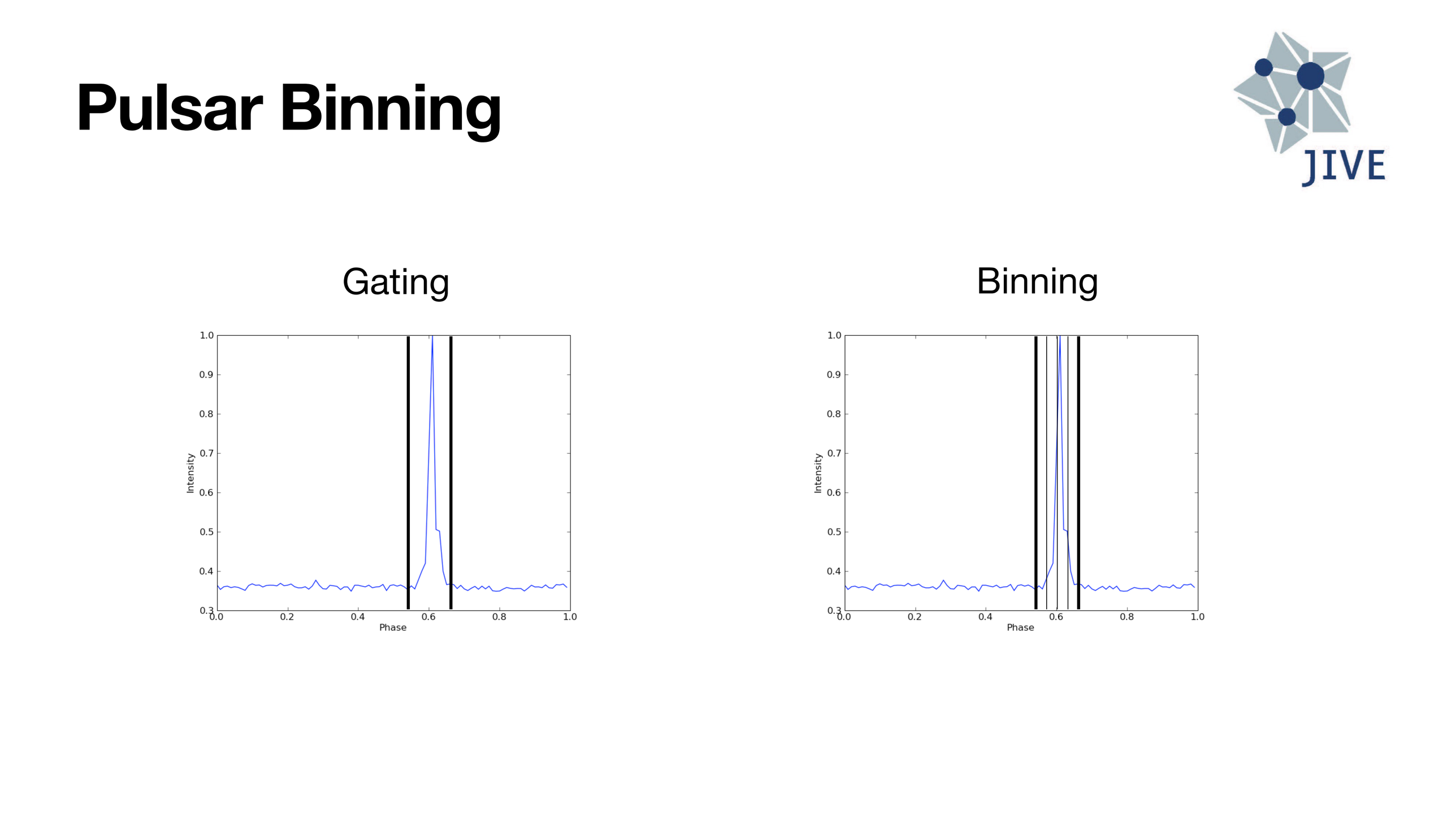
Two areas:

- 15’ central area
- 20’ outer annulus

Multi-source Self Calibration

arXiv:1601.04452

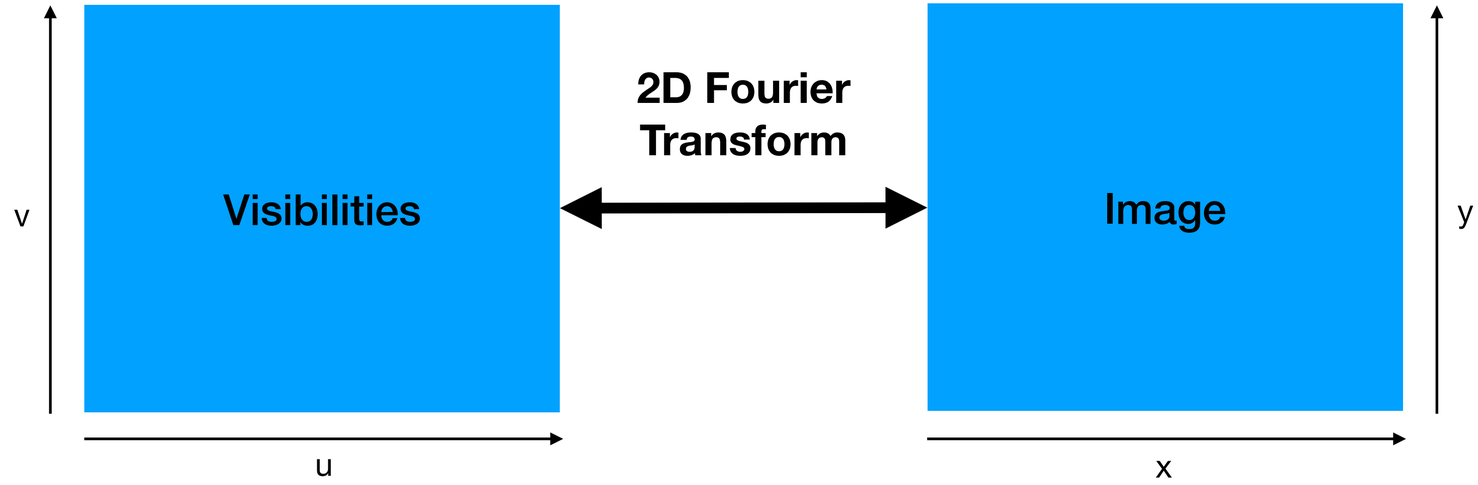
Pulsar Binning



Gating

Binning

Visibilities & Images



- UV plane is not completely filled
- Visibilities have to be (partly) self-calibrated
- Imaging algorithm choices depend on scientific goal

VO use case

1. Access historic data (“before picture”) for high-resolution follow-up of:
    - Gravitational Wave events
    - Gamma Ray Bursts
    - Fast Radio Bursts

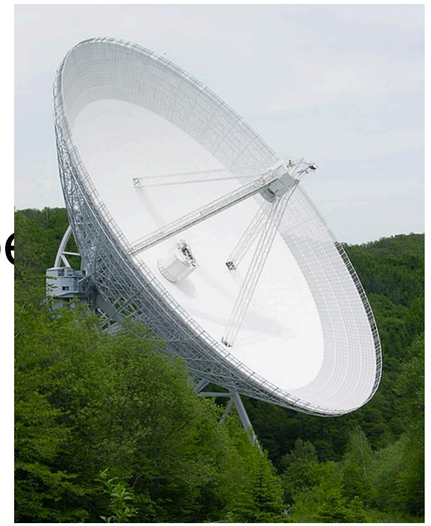
2. Standardized acces to archive data for science platform
    - JupiterLab environment

VO protocols that match: ObsTAP and Datalink

Implementation using DaCHS

- Why DaCHS?
  - Some in-house knowledge (at ASTRON)
  - Python
  - Visit by Markus (to ASTRON)
  - Implements TAP and Datalink service
- DaCHS runs alongside existing Archive interface
  - Linking to data products in Existing archive
- DaCHS ingests CSV data generated by separate Python “fitscrawler” Tool
  - FITS-IDI stores Important metadata in (large) binary tables

ObsCore representation of visibility data



- Spatial extent determined by several factors:
  - FoV of individual telescopes (in particular the largest telescope)
  - Time and frequency smearing
  - Projected longest baseline (distance between telescopes)
- Approximated assuming maximal amplitude loss of 50% and ignoring projection effects

ObsCore representation of visibility data

- **s_resolution** based on longest baseline
  - Approximation; should be based on synthesised beam (from UV coverage)
- **t_exptime** is calculated by summing integration time
  - Each source in the observation becomes separate ObsCore dataset
- **em_min** and **em_max** calculated based on minimum and maximum observed frequency
  - Dual S/X band observations should probably be split into separate ObsCore datasets

ObsCore representation of visibility data

- Multiple targets per observation
  - Multiple ObsCore “rows” with the same **access_url** (but different **obs_publisher_did**)
- Some observations are correlated multiple times with different parameters
  - “continuum” and “spectral line” get its own **access_url** and **obs_publisher_did**
- MPC correlations result in multiple sets of output files
  - Each phase centre gets its own **access_url** and **obs_publisher_did**
- Pulsar binning/gating
  - Each bin gets its own **access_url** and **obs_publisher_did** (including “off-pulse” bin)
- **access_url** is a Datalink

Datalink for FITS-IDI

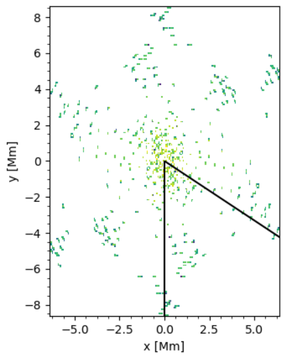
- Single observation split into several FITS-IDI files of ~2GB
  - Return Datalink table with rows for each chunk
- Calibration data will be added in the future
- Considering adding pipeline images as previews
  - These are often very rough!
- Considering adding diagnostic plots as secondary datalink

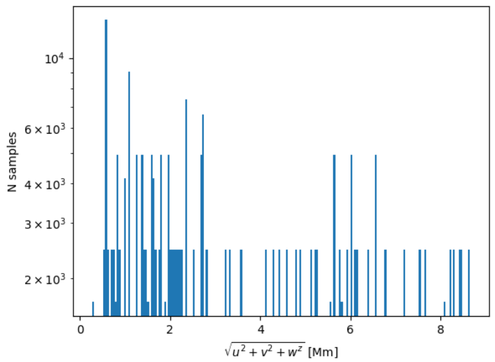
Extending ObsCore

- Ongoing discussion within the IVOA radio IG of common extensions:
  - Characterization of UV coverage (eccentricity, filling factor)
  - Largest spatial scale
  - Frequency-based characterisation of observed spectrum

- Plan to add DataCite DOIs for each observation in the EVN archive
  - Which ObsCore field should be used?

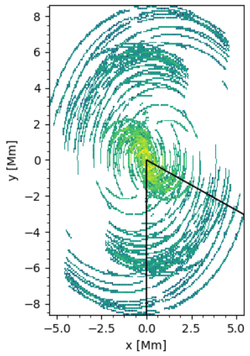
UV space characterization

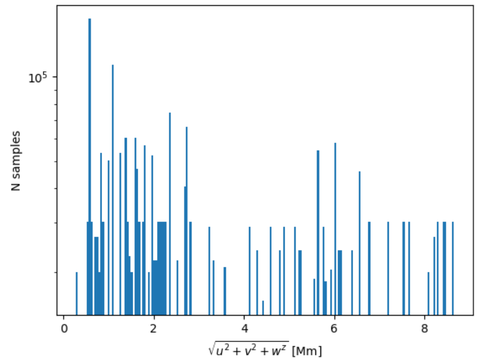




$e = 0.74$
$f = 0.03$

calibrator source

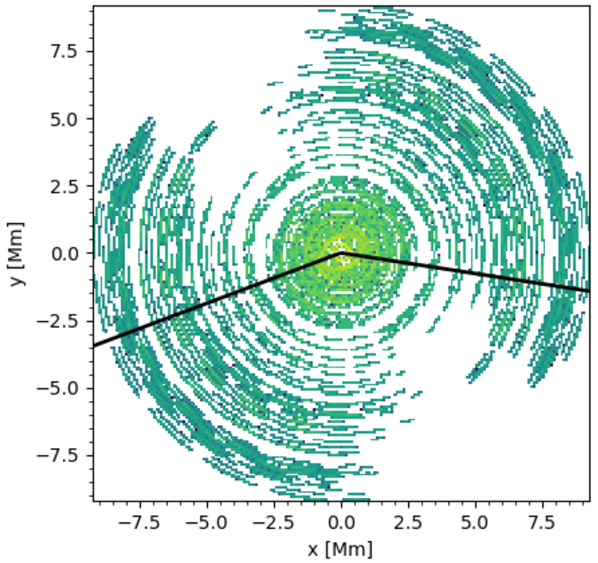




$e = 0.63$
$f = 0.25$

target source

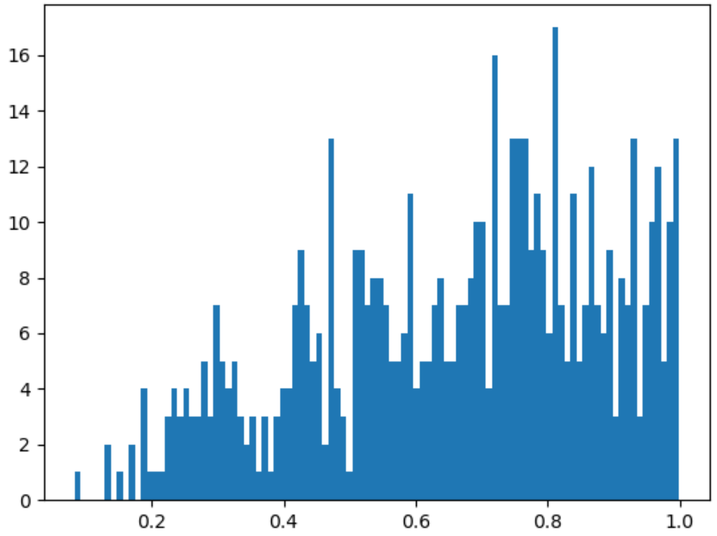
Plots derived from software developed by Mattia Mancini (ASTRON)



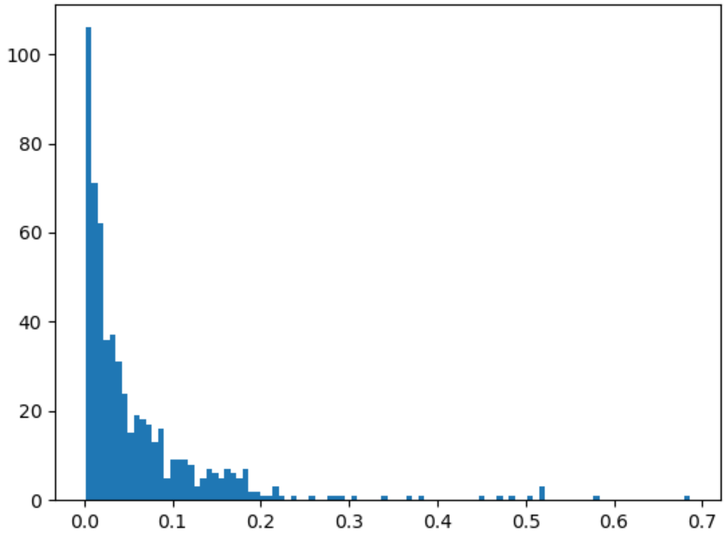
e = 0.97
f = 0.34

All EVN observations in 2017

eccentricity (e)



filling factor (f)



Preliminary service

- TAP interface URL: https://evn-vo.jive.eu/tap
- Almost 23K ObsCore datasets (for 150 TB of data)
  - From ~2000 observations
- Global metadata for the service still needs to be

Some initial feedback

- em_min, em_max and em_res_power given in wavelengths
  - This is unatural for radio astronomy
  - Posible solution: add f_min, f_max and f_resolution?

- Datalink acess_url initially surprises users

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