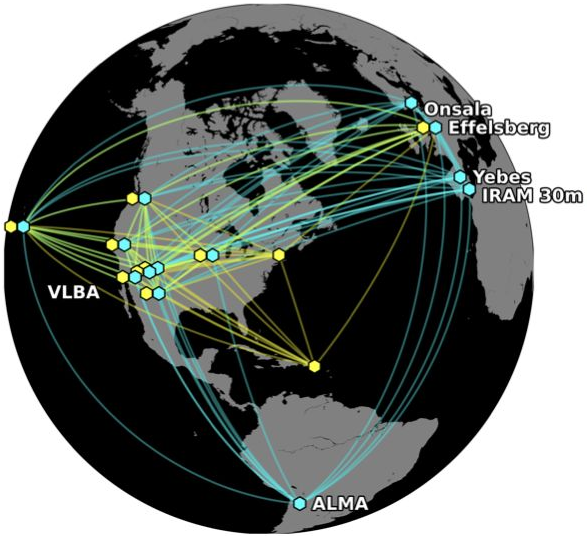
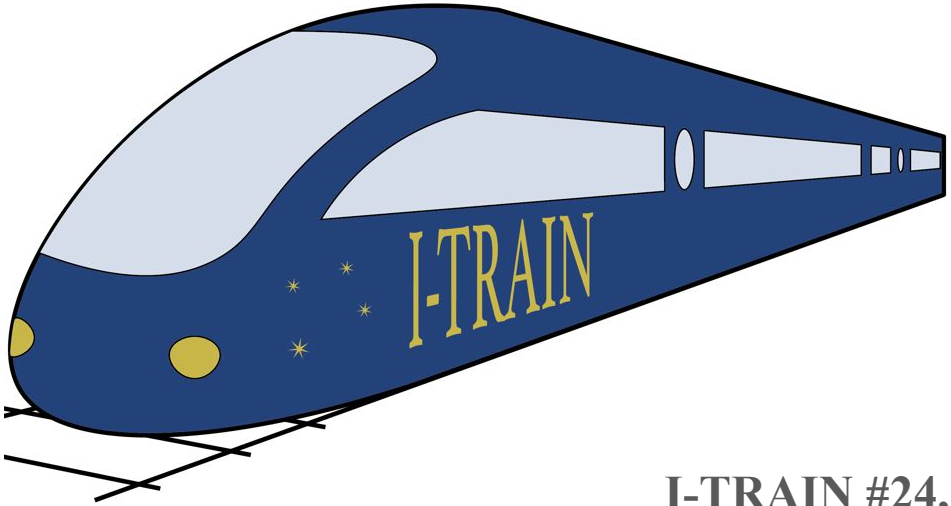
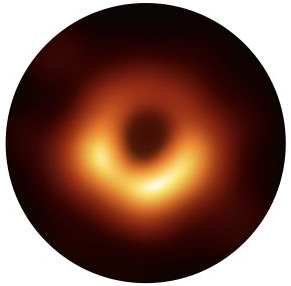
VLBI part II: Accessing and calibrating data







I-TRAIN #24, 16 May 2025

Interactive Training in Reduction and Analysis of INterferometric data with the European ARC network

ALMA
EUROPEAN ARC
ALMA Regional Centre

Design: Katharina Immer and Megan Lewis

I-TRAIN with the European ARC Network

24: VLBI Part II: Obtaining and calibrating VLBI data with phased ALMA

Tutors: Michael Janssen, Georgios-Filippos Paraschos, Kazi Rygl

ALMA

EUROPEAN ARC
ALMA Regional Centre

IN·DEI·NOMINE·FELICITER

Max-Planck-Institut
für Radioastronomie

INAF IRA

I-TRAIN on VLBI with ALMA

Introduction to VLBI: Science and Proposals (Part 1)

- mm VLBI science with ALMA
- proposal opportunities
- planning an ALMA VLBI proposal
- ALMA OT for a VLBI proposal

Working with ALMA VLBI data: Accessing and calibrating data (this talk)

- Phased ALMA data and what is in the ALMA Science Archive
- Obtaining GMVA
- Obtaining EHT data
- Calibrating GMVA and EHT data

Phased ALMA participates to VLBI networks as large single dish thanks to the ALMA Phasing System

ALMA Phasing system

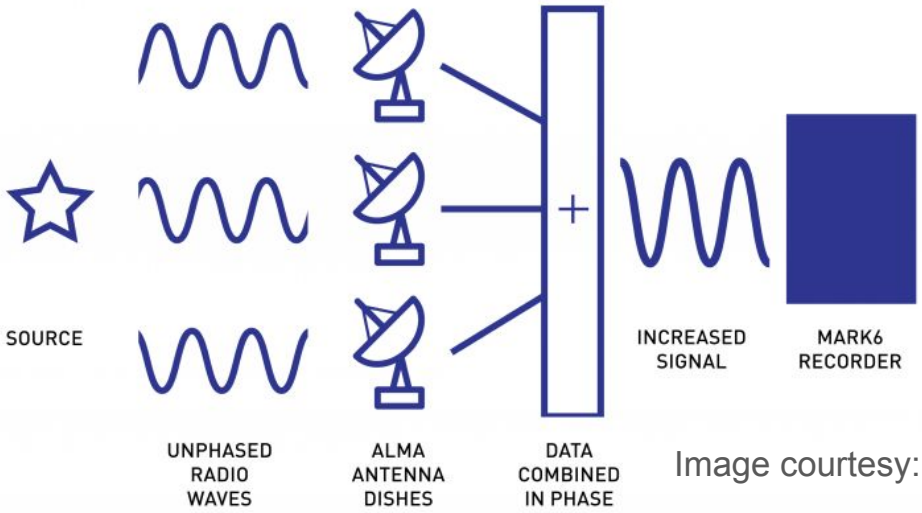
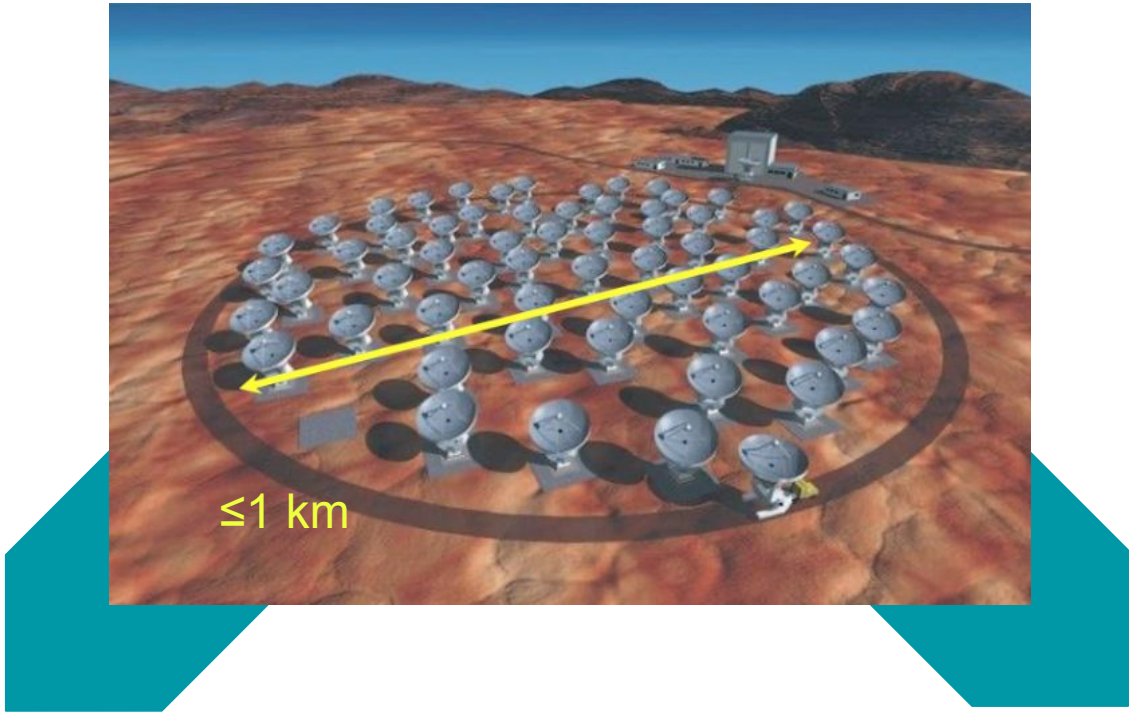


Image courtesy: MIT Haystack

APS computes the phase adjustments relative to a reference antenna. The phased signals are then summed in the ALMA correlator to create the (virtual) summed antenna.

See Matthews et al. 2018 for more details

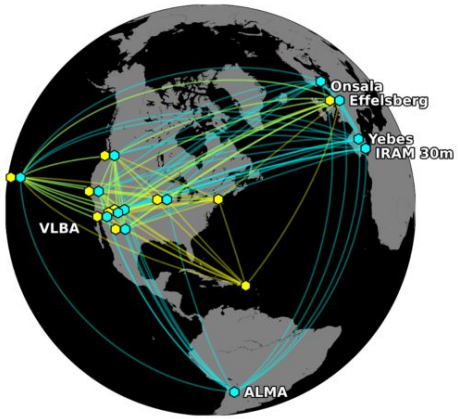
Data collected during phased ALMA observations



~77m single dish to be correlated with VLBI antennas

ALMA 12-m Array interferometer

Quality assessment of phased ALMA observations



ALMA: linear polarisation (X,Y)
VLBI antennas: circular polarisation (L,R)

$$V_{+\odot} = \begin{pmatrix} V_{XR} & V_{XL} \\ V_{YR} & V_{YL} \end{pmatrix}$$

QA2 +

PolConvert

$$V_{\odot\odot} = \begin{pmatrix} V_{RR} & V_{RL} \\ V_{LR} & V_{LL} \end{pmatrix}$$

See Goddi et al. 2019, Marti-Vidal 2016 for more details

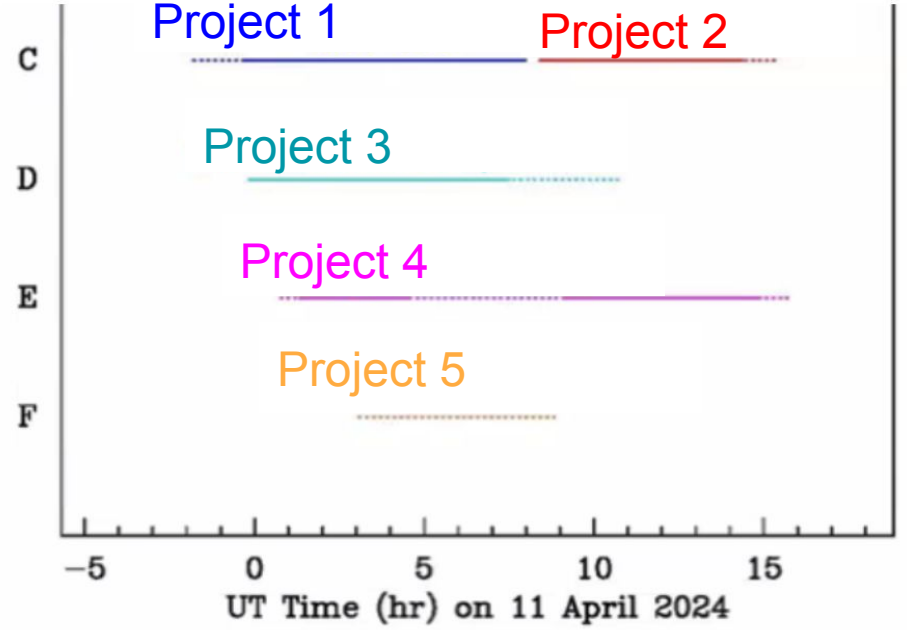
Quality assessment of phased ALMA observations

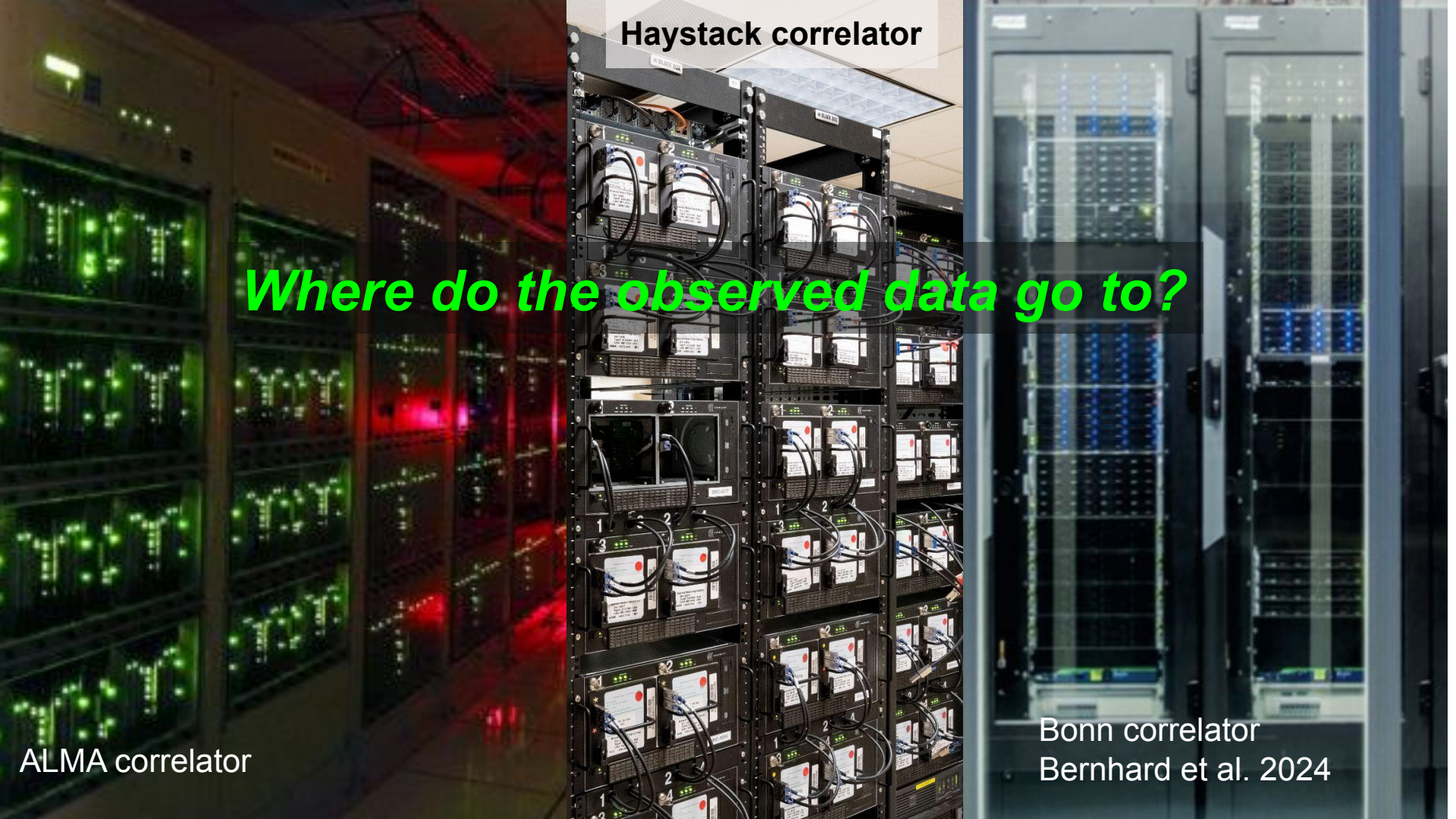
Goals:

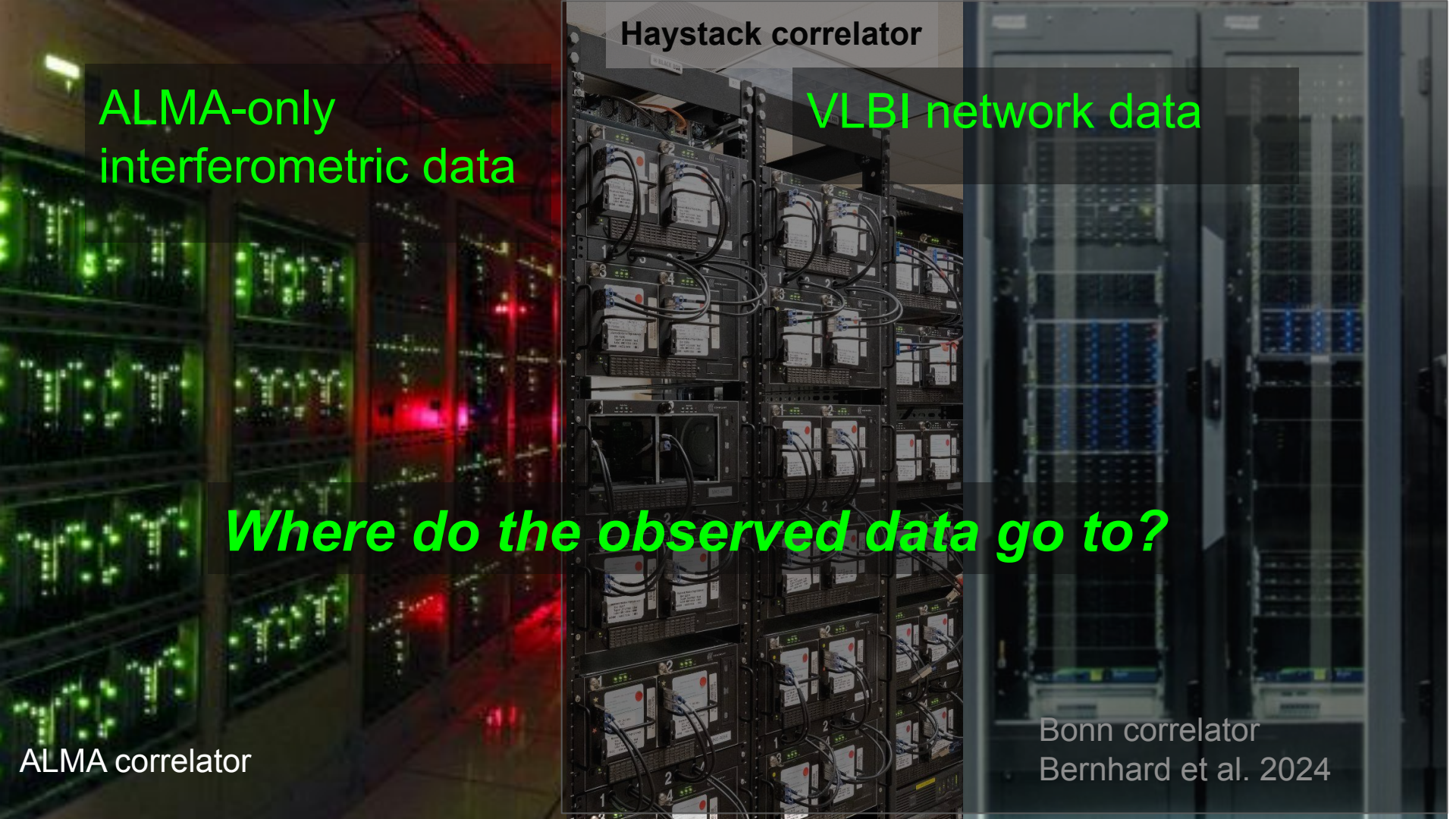
- polarisation conversion of mixed XY/LR visibilities to circular only to allow VLBI data calibration
- deliver ALMA interferometer data to ALMA Science Archive (project based)

QA2 for ALMA VLBI data entails a regular polarisation calibration with a few exceptions:

- done track-based rather than project based; calibrators can be shared
- full details in Goddi et al. 2019

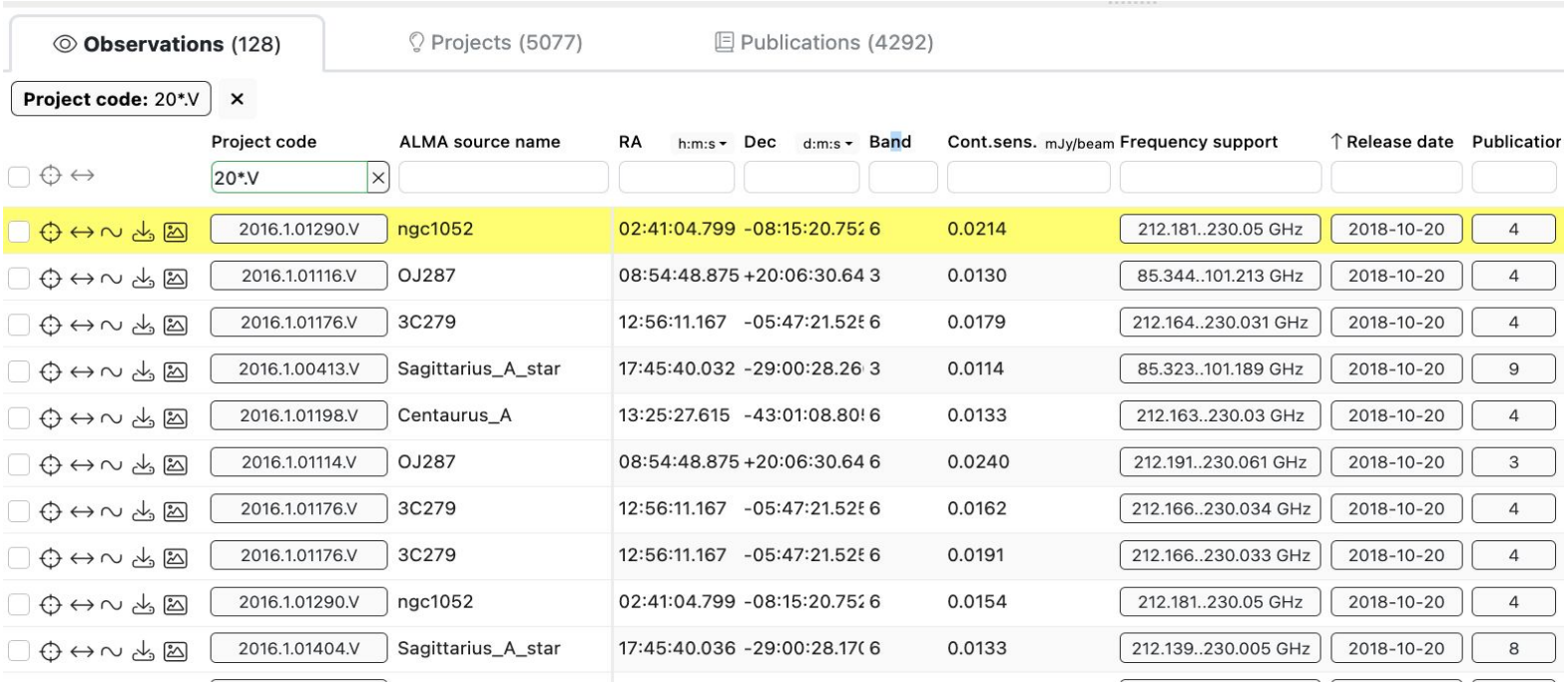



Haystack correlator
Where do the observed data go to?
ALMA correlator
Bonn correlator
Bernhard et al. 2024


Haystack correlator
ALMA-only interferometric data
VLBI network data
Where do the observed data go to?
ALMA correlator
Bonn correlator
Bernhard et al. 2024

ALMA Science Archive

Searching on project code “20*.V” gives all VLBI projects (20xx.1.xxxxx.V)



Observations (128) | Projects (5077) | Publications (4292)

Project code: 20*.V

Project code	ALMA source name	RA h:m:s	Dec d:m:s	Band	Cont.sens. mJy/beam	Frequency support	Release date	Publication
20*.V								
2016.1.01290.V	ngc1052	02:41:04.799	-08:15:20.752	6	0.0214	212.181..230.05 GHz	2018-10-20	4
2016.1.01116.V	OJ287	08:54:48.875	+20:06:30.64	3	0.0130	85.344..101.213 GHz	2018-10-20	4
2016.1.01176.V	3C279	12:56:11.167	-05:47:21.525	6	0.0179	212.164..230.031 GHz	2018-10-20	4
2016.1.00413.V	Sagittarius_A_star	17:45:40.032	-29:00:28.26	3	0.0114	85.323..101.189 GHz	2018-10-20	9
2016.1.01198.V	Centaurus_A	13:25:27.615	-43:01:08.80	6	0.0133	212.163..230.03 GHz	2018-10-20	4
2016.1.01114.V	OJ287	08:54:48.875	+20:06:30.64	6	0.0240	212.191..230.061 GHz	2018-10-20	3
2016.1.01176.V	3C279	12:56:11.167	-05:47:21.525	6	0.0162	212.166..230.034 GHz	2018-10-20	4
2016.1.01176.V	3C279	12:56:11.167	-05:47:21.525	6	0.0191	212.166..230.033 GHz	2018-10-20	4
2016.1.01290.V	ngc1052	02:41:04.799	-08:15:20.752	6	0.0154	212.181..230.05 GHz	2018-10-20	4
2016.1.01404.V	Sagittarius_A_star	17:45:40.036	-29:00:28.17	6	0.0133	212.139..230.005 GHz	2018-10-20	8

ALMA-only VLBI data in the archive

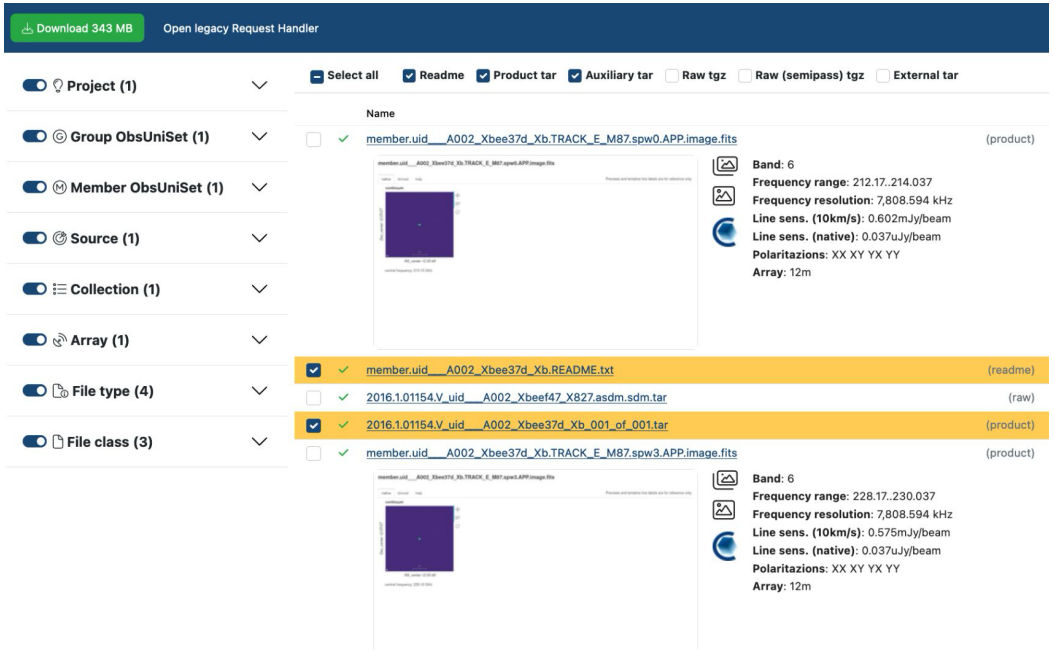
Raw data

Calibration script and the calibration tables from QA2

Image products:

- MFS full Stokes images, one per spectral window
- No cubes, no combined continuum image
- No calibrator images (these can be the target of another project in the same track)

Public 1 year after confirmed successful correlation at the VLBI correlator



VAPOLA

VLBI AGN POLarization data with ALMA

Welcome to VAPOLA — the first ALMA AGN sources archive observed in APS mode,
containing multi-epoch multi-band full Stokes data products ready for science.

Introduction to VAPOLA project

VAPOLA is a user friendly repository of ALMA data observed in APP mode. It is located in the Italian Astronomical Archives Center (INAF) servers (Trieste, Italy). It contains, ready-for-science heigh order products and to the whole community. Every year it will be updated with observations of the current and new sources observed in the different bands.

What to find in this webpage repository?

In this wabepage you will find an interactive portal to the data. Left side menu (hamburger icon in top left margin) contains the redirection for the Home (actual page), Download (where you will have access to the data), Documentation (paper, technical memo) and my contact email for any kind of question or problems you may have.

How to download the data

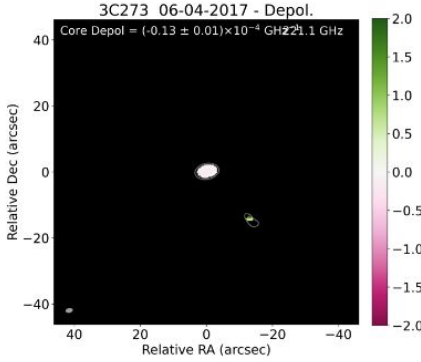
To download the data, you need to click the menu, and select the Download page. You will have access to the tree data structure. Data is organized as follows:

1. in the root folder, there are three folders VLBI, non-VLBI, documentation
2. VLBI contains the data per Source, Year, Band, Day_Month
3. non-VLBI contains the (generally short) observations of ALMA in non APP mode DURING the Global Campaings
4. documentaiton. Folder that contains csv files that summariz the data.

You can download the data in three ways: individually, by wishing list (selecting one or more files), and filtering by different criteria ("Download by Selection")

Note for PI's of private data that have kindly shared with us

To access to protected data, you need to login in the Download page.



Contact

webpage: http://vapola.ia2.inaf.it/

- Alejandro Mus: alejandro.musmejias@unica.it
- Ciriaco Goddi: ciraco.goddi@unica.it
- Vincenzo Galluzi: vincenzo.galluzzi@inaf.it
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- Douglas Ferreira Carlos: douglas.carlos@usp.br

Piano Nazionale di Ripresa e Resilienza (PNRR) – Missione 4 "Istruzione e Ricerca" – Componente 2 "Dalla Ricerca all'Impresa" Investimento 1.1 "Fondo per il Programma Nazionale di Ricerca e Progetti di Rilevante Interesse Nazionale (PRIN)". PI: Ciriaco Goddi

Credit: Alejandro Mus

VAPOLA repository

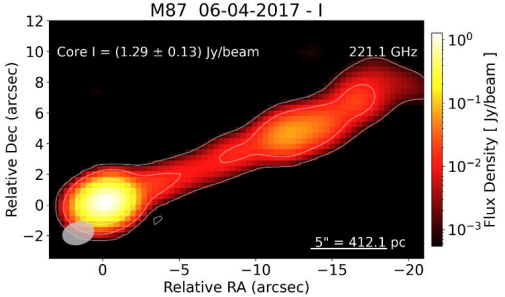
Organised per source, per band, per observing run

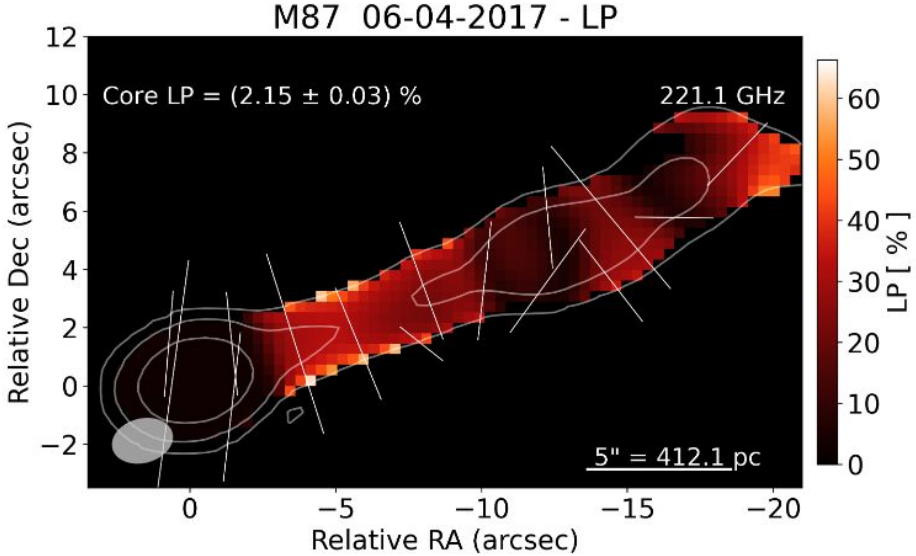
Advanced polarisation data products (FITS)

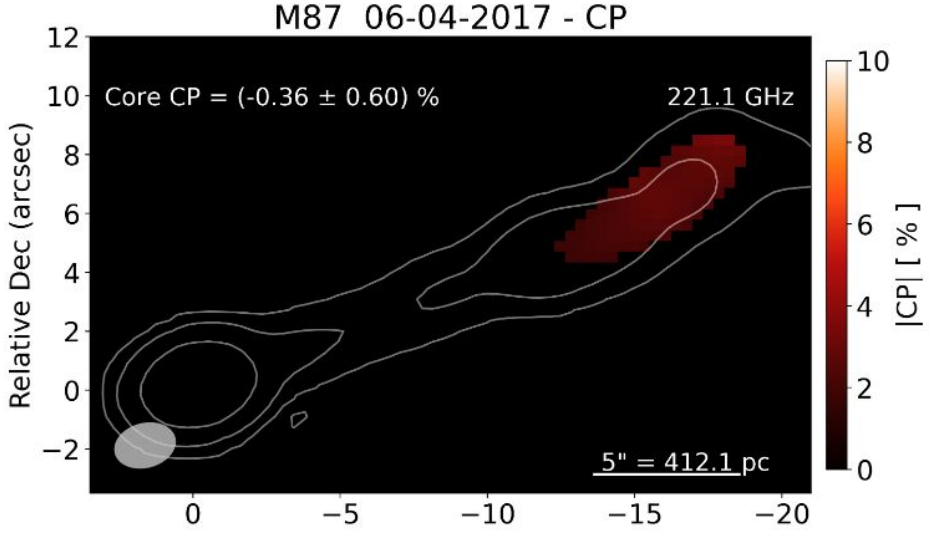
Plots (PNG) of advanced data products plus spectral index and RM maps.

Calibrated visibilities (without channel smoothing)

Example: M87 in polarisation







Example: M87 RM and spectral index