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mm-VLBI workshop, Bologna

Eduardo Ros (MPIfR)

# GMVA AND ALMA

# The team

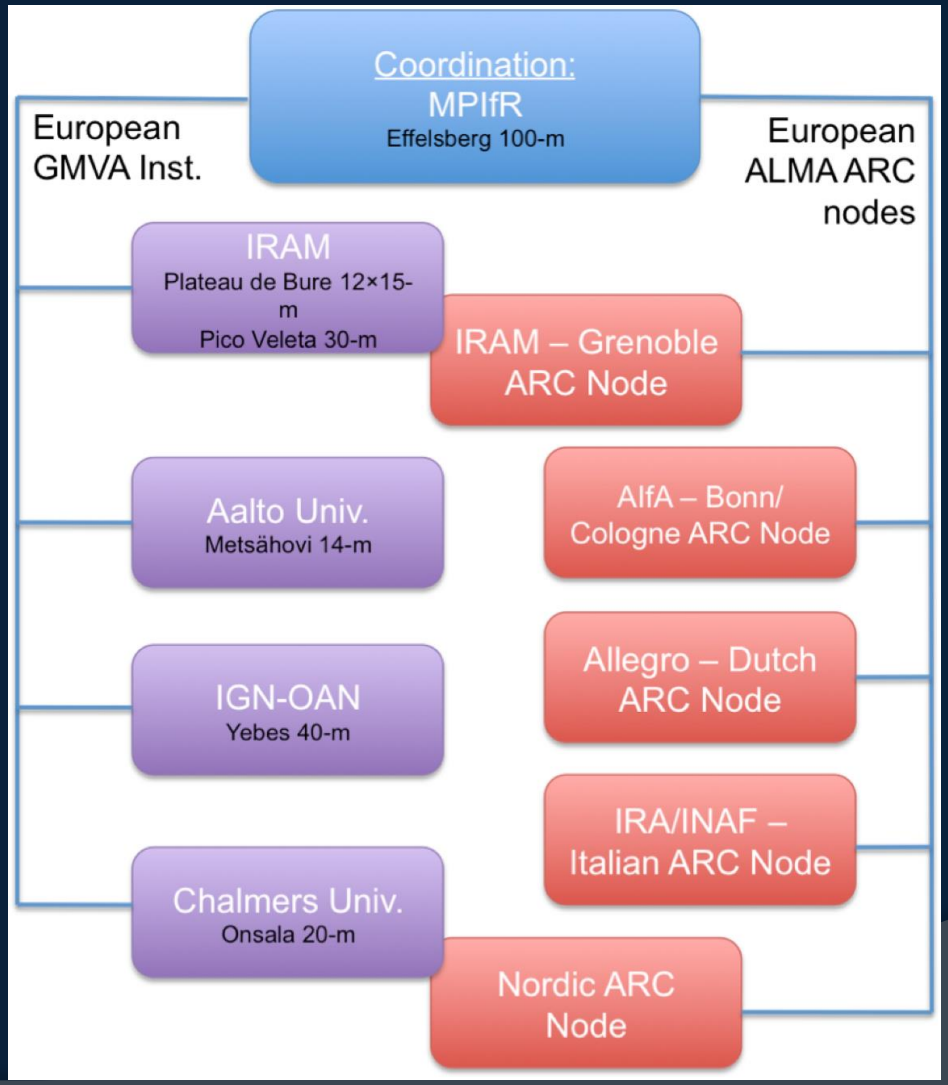
Laing
Testi

Bremer

Tornikoski

Bachiller
Colomer

Lindqvist
Martí-Vidal
Vlemmings




Alef
Bertarini
Krichbaum
Rottmann
Ros
Zensus

Mühle

Tilanus

Brand
Liuzzo
Massardi

# The science

- Study of the immediate vicinity of the central engine in AGN
  - Schwarzschild-radius size imaging
  - Collimation and acceleration region in jets
- Spectral-line VLBI of absorbing systems for nature constant determination
- VLBI of masers in stellar objects and AGN
- Astrometry in the Milky Way and beyond

# Background

1. ALMA upgraded by implementing a beamformer for phasing up ALMA for VLBI and PSR observations
2. The Event Horizon Telescope Experiment will perform 1-mm observations of SgrA* and M87
3. Preparing operation of ALMA in a VLBI network
   - GMVA operates at 3mm wavelength
4. Joint observations ALMA with VLBI networks

# Why?

- ALMA was de-scoped in the development phase
- Hooks for phasing are in the correlator, ... for VLBI at a later date
- That “later date” is NOW!  Further additions:
  - H-Maser
  - Phasing system & Software
  - VLBI formatting, data transport & Recorders

# Indeed, why?

- 7mm VLBI: EVN+KVN tests performed
- 3mm VLBI: GMVA, including KVN
  - Regular observations, though more difficult than at cm
  - Sensitivity sufficient for observing a few 100 sources
- Tests at 2 and 1 mm, lack sensitivity – EHT observes 1× per year
  - Increase sensitivity with broader bandwidth (aim: 64 Gbps : 2×2×4 GHz) and with **phased arrays** !
    (Add signals of antennas of a local array coherently)
  - Done at Plateau de Bure for mm-VLBI (GMVA)
    - Only for 2×128 MHz=256 MHz; still ~95% efficient at 1 mm
    - New NOEMA correlator on the horizon
  - CARMA, SMA, LMT, NOEMA...
- ALMA !!  (also offers very long **north-south** baselines)
  - EHT (1mm), GMVA (3mm), VLBA (7&3mm), EVN (7mm),...

# Ongoing activities

- ALMA Phasing Program (phasing 2015/Q2)
- Science case for ALMA beamformer (Fish et al. 2013, arXiv:1309.3519)
- White paper on implementation (Tilanus et al. 2014, arXiv:1406.4650)
- ERC granted a Synergy Proposal (BlackHoleCam) to several European partners to achieve scientific goals
- This proposal to define operations with ALMA
- ALMA Cycle 4 call in Spring 2016 (GMVA calls in Aug15, Feb16, …)

# Layout

- Network procedures
- Proposal handling
- Scheduling
- Disk logistics, correlation, archiving
- Data rights
- User support
- Resources & funding

# Network procedures

- Formal agreement between participating sites: MoU
- User-oriented infrastructure
- Open skies, peer reviewed at each network site (or joint TAC if agreed)

# Proposal handling

GMVA

Scheduler

NRAO

TAC

Max-Planck-Institut für Radioastronomie

TAC

iram

TAC

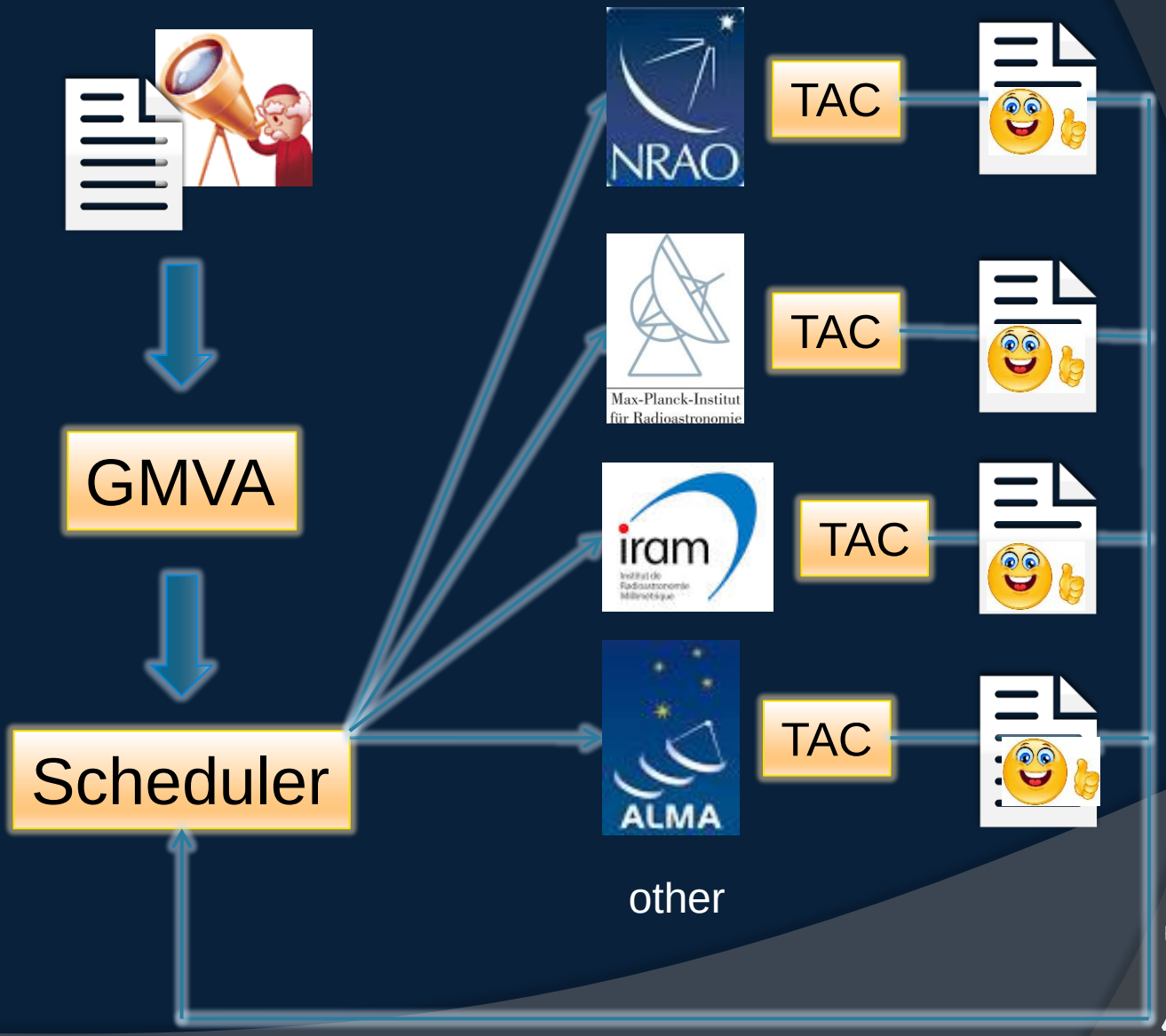
other

ALMA

TAC

ALMA PT includes VLBI option
Feeding information?

# Proposal handling (alternative)



# Scheduling

- Considerations:
  - weather statistics for all sites for planning
  - weather decision (triggered observations)
  - telescope constrains (frequency agility)
- ALMA observing:
  - manual scheduling possible
  - $0^{th}$-order approach: all stations use frequency and bit rate setup of ALMA
- Suggestion:
  - agreement on a ‘window of observation’, with weather-triggered observation at a given GST range for several optional days

# Disk logistics, correlation, archiving, and data rights

- Telescopes commit to ship the necessary media and to make available additional, if needed
- Small data portions sent per internet for fringe verification during observation
- Expert support avalaible in the stations (friend of VLBI)
- Data will be correlated and stored at the MPIfR, with an archival copy at NRAO

# Data rights

- Present policy:
  - calibrator data are public
  - proprietary data: 1 yr after the observer gets the IDI-FITS file, after that, available at NRAO archive interface
- Suggestion: similar policy for ALMA data and VLBI data including ALMA

# Technical and user support

- GMVA: limited at present (open sky but expertise needed)
  - Schedule made for observers
  - Observing in correlation in absentia
  - Amplitude calibration checked for quality and consistency
  - Further support based on collaborations
- Potential ARC support at
  - Technical advice at proposal stage
  - ALMA calibration, availability of ALMA visibilities
  - Monitoring of VLBI calibrators
  - Support with data reduction (AIPS, CASA, etc.)

# Funding

- Proposal handling
- Data recording at telescopes
- Correlation and data proof
- Archiving and user support
- VLBI-specific equipment maintenance
- Media

- Typically covered locally (≈ $10^4$ €/yr)
- ALMA should fund it partially – Issue: friend of VLBI

# Key issue:
# Friend of VLBI at ALMA

Funding?

- Media shipping and organisation
- Conversion VEX into field system
  - schedules
  - check list
  - scan list
- Phasing/pointing
- Coordination with tech. staff/groups in telescope
- Post processing support: log files, calibration data, failure report

- Potential duties:
  - Station software, maintenance & upgrade VLBI hardware, network management, testing, of equipent/firmware/hardware
- Knows the institution from inside, it is not a “parachutist”
- Guarantees the success of VLBI observation by monitoring all the aspects involved

# Summary

- Proposal of upgrading ALMA for VLBI observing procedures: exercise towards a global mm-VLBI array
- Getting all stakeholders and involving the whole ALMA community
- Immediate goal: proposal-based joint observations at the ALMA Cycle 4 (associated with the GMVA call for Feb16)
- Discussion of details on proposing/scheduling/data rights/user support involving the whole ALMA community