Eating VLBI: history, status, and perspectives

Marcello Giroletti
INAF Istituto di Radioastronomia

EAVN workshop, Ibaraki Univ., 25 September 2019
People

Prof. Giovannini
M. Orienti
F. D’Ammando
C. Migoni
A. Melis
E. Egron
R. Lico (now Bonn)
G. Principe
E. Kravchenko
…and more…
…and Kazuhiro Hada!
Outline

• Status in Italy
• Status in Europe (P. Colomer’s talk)
• History and status of Eating VLBI ***MoA and Call for proposal!!!***
• Science with Eating VLBI - so far and what’s next
VLBI in Italy

• National Institute for Astrophysics: operates two 32-m and one 64-m single dish (Medicina, Noto, Sardinia)

• Baseline length in range 580-893 km

• Frequency range between 1.4 and 43 GHz, potentially 86
  • currently able to do 1.6, 7 and 22 GHz for all three stations

• All connected electronically in real time to Bologna

• Bologna hosting data storage and software correlator facility
## Status tables, 2017

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<td><strong>e-VLBI</strong></td>
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* same as T6-Ky!

**K-band 5σ sensitivity (mJy) [5min @1Gbps]**
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### KVN-Ta

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Challenges and opportunities

• Stations active primarily in regular European VLBI Network activity and as single dish

• Few resources for coordination and support of nation-wide scale activities

• Other limits: three stations, low-mid frequency

• Science opportunities: mostly non-imaging: surveys, transients, alerts

• Great potential in sensitivity and angular resolution to be combined with other stations/networks:
  - Europe, East Asia, Africa, space

P. Colomer’s talk
The whole is more than the sum of its parts

- From Italy-Japan to “East Asia To Italy: Nearly Global VLBI”
- Science, technology, and outreach activities
  - Frequency and baseline range
  - Science topics (high energy, NLS1, astrometry, transients; geodesy and time)
  - From one baseline to tens
  - Role of Nanshan, and other stations…
Fermi Large Area Telescope

- PMN J0948+0022, global e-VLBI, first collaboration with East Asia
- 3C 84, bright Fermi source, collaboration with Nagai-san, and later the Radioastron Giovannini paper; also an Eating VLBI target (test and science)
- TXS 0506+056: flares, ToOs, Eating VLBI data - and now more neutrinos and more opportunities for science collaboration (and joint observations?)
- OJ287 (see P18 by Jee Won Lee), and FR0 radio galaxies, stellar evolution, and more…
The global e-VLBI campaign on NLSy1 0948+0022

- First global e-VLBI campaign
- Australia, Japan, China, Europe (pre-KVN!)
- $\nu=22$ GHz, full pol, 3 epochs
- Important early constraints on new class of gamma-ray sources
3C 84, from GENJI to Radioastron

• A compact radio source, young/restarted, bright and interesting to model

• Turned out to be a bright gamma-ray source, too

• Target of dense monitoring with VERA, up to Space VLBI

• Subject of 2018 Noto IAU symposium “Perseus in Sicily”, with important Italy-East Asia leadership (SOC: Giroletti, Nagai, Asada, Bower, Yung)
Towards multi-messenger astrophysics

• Renewed interest in blazar parsec scale jets after claim of association to astrophysical neutrino from TXS 0506+056

• Observed with Eating VLBI, KVN, VLBA, and other MWL data

• More sources reported later: complex framework, important to obtain data for more sources

• Other multi-messenger (GW) and transient-related opportunities for collaboration
Astrometry and high frequency

- Italian stations add east-west angular resolution to EAVN imaging of M87
- Multi-epoch observations in 2017-18-19: some technical challenges but promising results and progress
- Part of a larger picture ranging from EVN to EHT
- Astrometry in Mrk501 (Koyama et al.)
Other milestones

• Meetings

• Visits, students

• Outreach activities: video, exhibits

• Upgrade of INAF stations to high frequency (part of )

• MoA INAF-KASI, 30 hours per semester for joint observations. CALL NOW!!!

• goal of making it full “Eating VLBI” array

• IAU LoI for GA 2021 focus meeting “Physics of relativistic jets on all scales” (SOC Chairs: Orienti, Sohn)”
Eating VLBI workshops

- 2012, 2014, 2017, 2019; Bologna, Jeju
- Growth in attendance and diversity in age, provenance, gender, and science interests
- April ’19: 60 participants, 40 talks, 10 sessions, from transients to measurements of time
Outreach activities and added social value

Cultural/social aspects of the project

• Fruitfulness of a worldwide cooperation (and wonders in some of its aspects, such as the observations schedules)
• Diversity and contact points of cultural backgrounds

The charm of the scientific contents

• Black holes!
• Creation or adaptation of educational materials

A public outreach event in Bologna fair on “Astronomy beyond… culture, tradition, and borders” (02/18)
According to the MoA between INAF and KASI up to 30 hours of observing time in VLBI mode are allocated to approved EATING VLBI projects. These projects have to be submitted both to the Italian and Korean TACs with the standard form selecting "EATING VLBI" mode in the project type. Approved projects will be observed up to 30 hours/semester. Projects exceeding 30 hours will be scheduled together with all other projects according to their relative grades. PIs of these proposals must be associated with INAF or KASI.
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| **baseline length (km)** |              |            |               |
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| Mc               | 893*         | 592        | 8401          |        |
| Nt               | 13.5         | 580        | 8639          |        |
| Sr               | 5.5          | 6          | 8783          |        |

* same as T6-Ky!

K-band 5σ sensitivity (mJy) [5min @1Gbps]
What’s next? The revolution of transients

- Fast radio bursts (FAST???)  
  - Li’s talk

- Gamma-ray bursts: EAVN ToO an interesting experience and an important scientific result
  - An’s talk

- GW - a challenge to the sensitivity of MWL observations
Challenges

• Wide field instruments offering immense possibilities and demanding huge resources

• What’s VLBI to offer? T. An’s talk

• What’s Eating VLBI to offer?
  • High frequency niche - needs developments
  • Real time on long baselines - coordination is key (recent steps forward)
  • Training and broadening of horizons - here we are!