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# The Global VLBI Alliance

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For more than 50 years, Very Long Baseline Interferometry (VLBI) has studied the Universe with the greatest detail. Radio telescopes around the world have joined forces to create formal VLBI networks, long standing international collaborations which also regularly cooperate to form combined arrays. A Global VLBI Alliance (GVA) has been set up to facilitate the flow of information between these VLBI networks, including sharing strategies, technical developments for compatibility, logistics, operations, and user support. The GVA also promotes and coordinates common observational campaigns with these existing networks, fosters and supports new VLBI activities, while increasing the visibility, scientific and societal impact of VLBI.

The GVA moreover facilitates the interaction with the users, and serves as contact point and framework of collaboration of the VLBI networks and other astronomical facilities, in view of the growing need of multi-messenger studies. For example, the GVA is preparing the collaboration with the Square Kilometre Array Observatory (SKAO) to include the SKA as a very sensitive element in VLBI networks, as well as a mechanism to add long baselines to the SKA Phase 1 (SKA1) telescopes. The consortium will provide the VLBI equipment for the SKA telescopes and assist the coordination of VLBI Networks for joint observations with the SKA.

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## 1. Introduction

Very Long Baseline Interferometry (VLBI), by its very nature, has always depended on international collaborations. Nowadays several formal VLBI networks exist, which in turn regularly form combined arrays. A Global VLBI Alliance (GVA, http://www.gvlbi.org/) facilitates the flow of information between VLBI networks, including sharing strategies, technical developments for compatibility, logistics, operations, and user support. It also promotes and coordinates common observational campaigns with these existing networks, fosters and supports new VLBI activities, while increasing the visibility, scientific and societal impact of VLBI. The GVA moreover facilitates the interaction with the users, and serves as contact point and framework of collaboration of the VLBI networks and other astronomical facilities, in view of the growing need of multi-messenger studies.

## 2. VLBI networks in the GVA

The Global VLBI Alliance is open to every VLBI network, at this moment (December 2021) it includes those who can operate at some common frequencies, these are:

- The European VLBI Network (EVN),
- The East-Asian VLBI Network (EAVN), comprised of the Chinese VLBI Network (CVN), Korean VLBI Network (KVN) and Japanese VLBI Exploration by Radio Astronomy (VERA), the last two also operating together as KaVa,
- The Very Long Baseline Array (VLBA) in USA,
- The southern hemisphere Long Baseline Array (LBA), with radio telescopes in Australia and South Africa.

The joint operation of the EVN and VLBA has historically been known also as “global VLBI”.


Fig 1: Map of the networks in the Global VLBI Alliance.

## 3. Structure of the GVA

The Global VLBI Alliance is structured in the:

- GVA Director´s Forum (GVAD): VLBI network directors or representatives (up to 2 per network) to discuss any aspect of the global cooperation.
- Science Forum (GVAS): evaluates and fosters the unique and complementary contribution of VLBI to astrophysical research. Members are active scientists, not necessarily linked to any of the VLBI networks in the GVA.
- Technical R&D Forum (GVAT): discusses opportunities and coordinates the development of new instrumentation or procedures,
- Operations and Logistics Team (GVAO): facilitates and coordinates observations scheduled with several VLBI networks, or with participation of third-party instruments (e.g. multi-wavelength/multi-messenger).
- Communication and outreach Team (GVAC): coordinates activities and tools to increase the scientific and societal impact of VLBI.

The GVAS, GVAT, GVAO and GVAC, all report to the GVAD.

### 3.1 The GVA Science Forum

The GVA Science Forum (GVAS) evaluates and fosters the unique and complementary contribution of VLBI to astrophysical research. Members are active scientists, not necessarily linked to any of the VLBI networks in the GVA.

The GVAS provides the opportunity for scientists to identify needs and engage in discussions on how to keep the VLBI facilities responding to the latest astronomical challenges, participating and providing input to roadmap exercises. Recent examples are the excellent review of VLBI in the *EVN science vision 2020-2030* document [1], *"VLBI20-30: a scientific roadmap for the next decade – The future of the European VLBI Network"*, to optimise its unique role in the context of a rapidly evolving set of global astronomical facilities as planned for the next few decades. In the USA, the NSF *Decadal Survey on Astronomy and Astrophysics 2020* (Astro2020) [2] aims to support funding the design and cost studies and prototyping for the next-generation Very Large Array (ngVLA), a potential replacement for the Jansky Very Large Array and the Very Long Baseline Array radio astronomy facilities.

The scientists involved can evaluate not only the synergies between VLBI facilities, but also exploit the unique and complementary characteristics that enhance the contribution of VLBI to astrophysical research, such as different frequency coverage, angular resolution, sensitivity, availability for studies that require observations with different cadences, real time capabilities, access to different regions of the sky, etc. Moreover, the incorporation of VLBI to roadmap exercises such as the *Astronet Science Vision and Infrastructure Roadmap for European Astronomy* [3] will facilitate the coordination of VLBI networks with other astronomical instruments.

The GVAS is also a forum for cross-fertilisation where scientists, regular users of some regional VLBI network can meet with other colleagues and start global collaborations, in line with the true international nature of VLBI.

### 3.2 The GVA Technical R&D Forum

The GVA Technical Research and Development Forum (GVAT) discusses opportunities and coordinates the development of new instrumentation or procedures. A primary goal is to make the VLBI networks sufficiently compatible as to allow joint observations, which requires capability for observing at common frequencies, using the same data transport and formatting protocols, storage, etc. Users also benefit of similar proposal tools, and data reduction platforms.

The role of the GVAT is also to evaluate the best way to answer the expectations of the VLBI users, as described in the science vision documents, from the development of state-of-the-art instrumentation to the logistics of how the observations are made. Joint efforts to achieve increased sensitivity, survey speed, agility, frequency range and post-processing capabilities are beneficial for all VLBI networks. For example, expected increases in correlator and data imaging capacity, possibly combined with Phased Array Feeds (PAFs) on the larger VLBI telescopes, would make imaging over large fields of view a standard capability, and flexible VLBI arrays and real-time capabilities will also allow follow-ups of transient events detected either in large field of view radio surveys or by instruments operating in other parts of the electromagnetic spectrum.

Currently there are several instances in which the staff responsible of R&D, scheduling and logistics from VLBI networks regularly meet; the GVAT will extend the scope to the global scale, and facilitate the exploration of not only the synergies but also the complementarity of the network characteristics, to fulfil the requirements of the user science cases.

### 3.3 GVA Operations and Logistics Team

The GVA Operations and Logistics Team (GVAO) takes care of identifying and solving the details that facilitate coordinated observations with several VLBI networks, and/or with participation of third-party instruments (e.g. multi-wavelength/multi-messenger).

The team is composed by the officers responsible of operations, scheduling, in close collaboration with the chairs of the Time Allocation Committees (TACs) to discuss aspects such as proposal submission tools and deadlines, evaluation criteria and other data policies which need to be consistent among the networks.

### 3.4 GVA Communications and Outreach

The results of VLBI, and its capacity to complement the information obtained in studies with other astronomical techniques, are made visible by the Communication and Outreach Team (GVAC), whose important mission is to promote the visibility of VLBI, its networks, making joint advocacy of VLBI. This is done by the maintenance of the GVA web portal [4], presence in social networks [5], organisation or participation in conferences, workshops, schools and other events, etc.

## 4. The SKA-VLBI Consortium

The Global VLBI Alliance is preparing the collaboration with the Square Kilometre Array Observatory (SKAO) to include the SKA as a very sensitive element in VLBI networks, as well as a mechanism to add long baselines to the SKA Phase 1 (SKA1) telescopes. The model describes the science and engineering operations for the VLBI capability in the SKA1 Observatory (SKA-VLBI), and the mechanisms to access the data and resources. These mechanisms will enable the implementation of high-level policies and agreements between the different stakeholders.

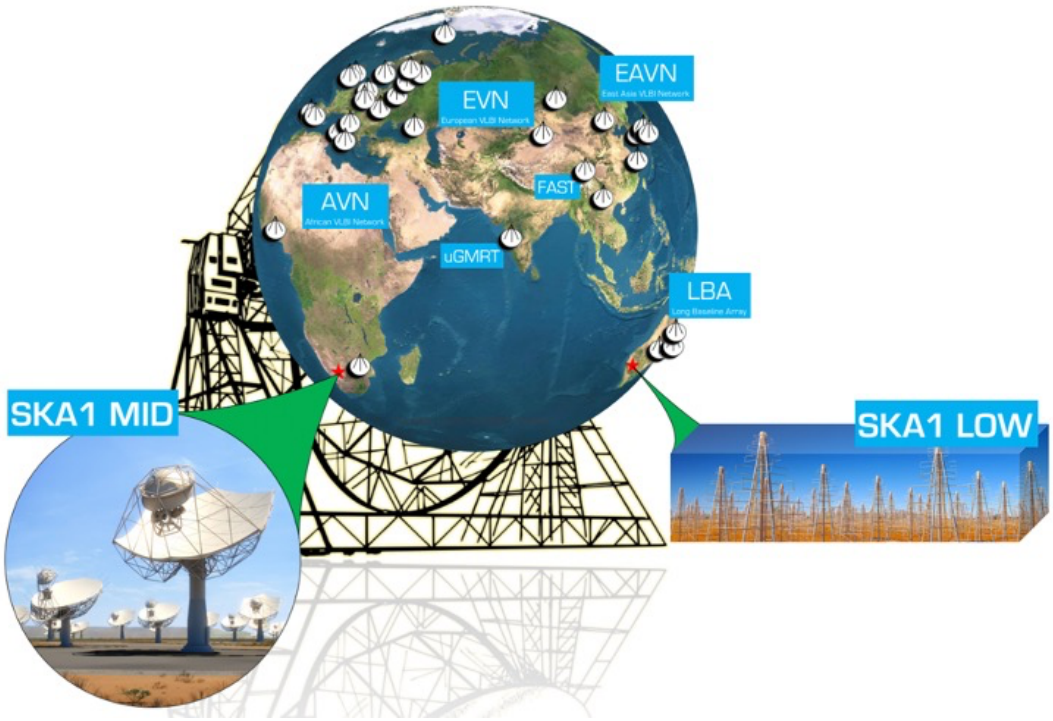


Fig 2: SKA-VLBI, a collaboration of the GVA with the Square Kilometre Array Observatory.

As part of the "JUMPING JIVE" project in the Horizon2020 program of the European Commission, JIVE, SKAO and partners have developed the "Details on VLBI interfaces to SKA consortia" (D10.1), "Operational model for inclusion of SKA in Global VLBI" (D10.2), "Portfolio of SKA-VLBI Science cases with details on science requirements" (D10.3) and the "Report on SKA-VLBI Key Science Projects" (D10.4), all available in the project website [6].

These deliverables assume that the SKA-VLBI Consortium will provide the VLBI equipment for the SKA telescopes and assist the coordination of VLBI Networks for joint observations with the SKA. This Consortium will comprise radio observatories and VLBI networks interested in observations with the SKA1 telescopes (SKA1-MID and SKA1-LOW) in their respective frequency ranges, as well as representation from the SKA Observatory. Coordination between the VLBI networks will be based on the long-proven model adopted nowadays for VLBI global observations. The different VLBI stakeholders will properly define the scope, responsibilities and potential associated costs for the SKA-VLBI Consortium.

## 5. How to engage with the GVA?

The GVA Science and R&D Forums are open for participation by any scientist interested in developing and/or taking advantage of the VLBI technique.

A working group in the Commission B4 of the International Astronomical Union has been established on the subject of the Global VLBI Alliance [7]. Astronomers can participate in the GVA Science Forum by formally joining this IAU working group; moreover, and for those not members of the IAU, by participating in any of the events announced in the web [5].

## References

[1] T. Venturi, M. Lindqvist, Z. Paragi et al., *VLBI20-30: a scientific roadmap for the next decade – The future of the European VLBI Network*, arXiv:2007.02347 (2020), https://arxiv.org/abs/2007.02347

[2] USA NSF *Decadal Survey on Astronomy and Astrophysics 2020* (Astro2020), see: https://nap.edu/resource/26141/interactive/ and https://www.aip.org/fyi/2021/astro2020-decadal-survey-arrives-priorities-major-facilities

[3] *Astronet Science Vision and Infrastructure Roadmap for European Astronomy* (2021), https://www.astronet-eu.org/forums/roadmap-community-consultation

[4] Website of the Global VLBI Alliance: http://www.gvlbi.org/

[5] The Global VLBI Alliance in Twitter: @globalvlbi

[6] EC H2020 "JUMPING JIVE" project, see: https://jumping.jive.eu/results.html

[7] The Global VLBI Alliance, a working group in the International Astronomical Union, Commission B4, see: https://www.iau.org/science/scientific_bodies/working_groups/324/

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