International VLBI Service for Geodesy and Astrometry (IVS)

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Chair of Directing Board: Rüdiger Haas (Sweden)
Coordinating Center Director: Dirk Behrend (USA)

IVS website - https://ivscc.gsfc.nasa.gov/

1 Overview

This report summarizes the activities and events of the International VLBI Service for Geodesy and Astrometry (IVS) from mid-2023 through mid-2025. Benedikt Soja succeeded John Gipson as the IVS Analysis Coordinator. Rüdiger Haas was re-elected for a second term as IVS Chair for the period from February 2025 through February 2029. Work is underway to restructure the Intensive observing program and to increase the VGOS portion of the overall program. The VGOS network has grown to 16 stations (19 when accounting for three twin telescope sites).

2 Structure

The International VLBI Service for Geodesy and Astrometry (IVS) is an approved service of the International Association of Geodesy (IAG) since 1999 and of the International Astronomical Union (IAU) since 2000. The goals of the IVS, which is an international collaboration of organizations that operate or support Very Long Baseline Interferometry (VLBI) components, are:

- to provide a service to support geodetic, geophysical and astrometric research and operational activities;
- to promote research and development activities in all aspects of the geodetic and astrometric VLBI technique; and
- to interact with the community of users of VLBI products and to integrate VLBI into a global Earth observing system.

They are realized through seven types of components (Network Stations, Operations Centers, Correlators, Analysis Centers, Data Centers, Technology Development Centers, and the Coordinating Center). The structure of the IVS and the interaction among the various components and external organizations is shown in Figure 1.

Being tasked by IAG and IAU with the provision of timely and highly accurate products (Earth Orientation Parameters, EOP; Terrestrial Reference Frame, TRF; Celestial Reference Frame, CRF), but having no funds of its own, IVS strongly depends on the voluntary support of individual agencies that form the IVS.

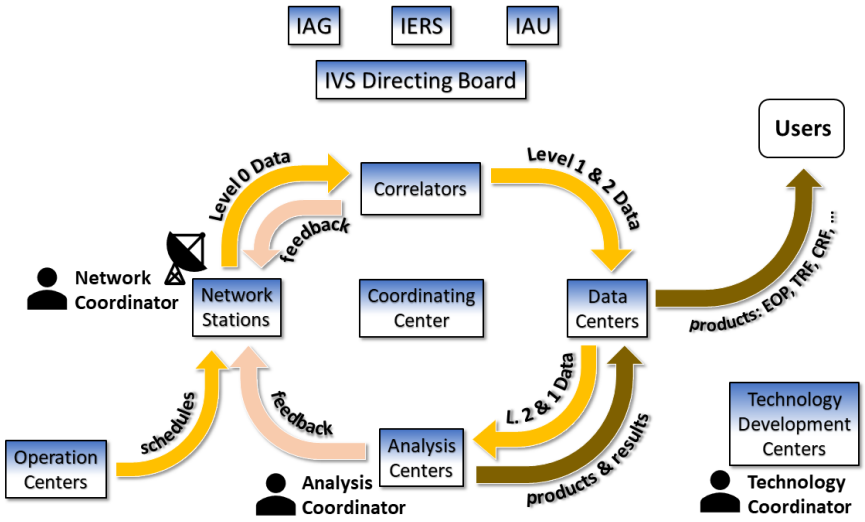

Fig. 1. Organizational structure of the IVS and general data flow between its various component types.

3 Activities

3.1 Meetings and Organization

The IVS organizes biennial General Meetings and biennial Technical Operations Workshops. Other workshops such as the Analysis Workshops and technical meetings are held in conjunction with larger meetings and are organized once or twice a year. Table 1 gives an overview of the IVS meetings during the report period.

Table 1. IVS meetings during the report period (July 2023 – June 2025).

Time	Meeting	Location
4–9 March 2024	13th IVS General Meeting	Tsukuba, Japan
6 March 2024	IVS 25th Anniversary Celebration	Tsukuba, Japan
8 March 2024	24th IVS Analysis Workshop	Tsukuba, Japan
20–23 October 2024	9th International VLBI Technology Workshop	Westford, MA, USA
6–11 April 2025	EVGA Working Meeting 2025	Matera, Italy
10 April 2025	25th IVS Analysis Workshop	Matera, Italy
4–8 May 2025	13th IVS Technical Operations Workshop	Westford, MA, USA
8–9 May 2025	VGOS Correlation Workshop	Westford, MA, USA

In 2023, the IVS fully returned to in-person meetings only. While in the aftermath of the coronavirus pandemic it was essential to organize virtual and/or hybrid events to avoid a complete lapse of community engagement, the experience also showed that such events did not register as adequate replacements for in-person gatherings. This holds in particular true for hands-on workshops and training schools.

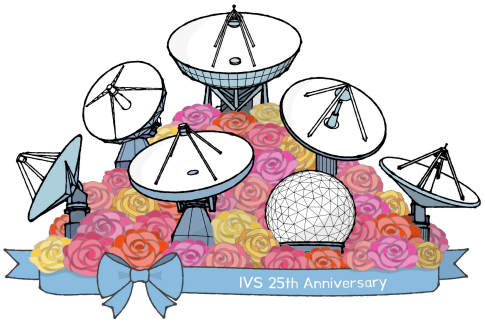

Fig. 2. Logo of the IVS 25th Anniversary.

The Thirteenth IVS General Meeting (GM) was held almost exactly 25 years after the foundation of the service (1 March 1999). Thus, in conjunction with the GM a celebratory

event was organized to commemorate the IVS 25th Anniversary. It was also the first time in IVS history that a venue was repeated; Tsukuba, Japan was also the host location for the Second IVS General Meeting back in 2002.

Table 2. Current members (June 2025) of the IVS Directing Board. Listing in alphabetical order by last name.

Member Name	Institution, Country	Function	Recent Term
Dirk Behrend	NVI, Inc./NASA, USA	Coordinating Center Director	—
Patrick Charlot	Bordeaux Observatory, France	IAU Representative	—
Susana García-Espada	Norwegian Mapping Authority, Norway	Networks Representative	Feb 2025 – Feb 2029
Rüdiger Haas	Chalmers University of Technology, Sweden	IERS Representative, Chair	—
Phillip Haftings	U.S. Naval Observatory, USA	Correlators and Ops Centers Representative	Feb 2023 – Feb 2027
Masafumi Ishigaki	GSI, Japan	At Large Member	Feb 2025 – Feb 2027
Nancy Kotary	Haystack Observatory, USA	Office for Outreach and Communications	—
Hana Krásná	TU Vienna, Austria	At Large Member	Feb 2025 – Feb 2027
Lucia McCallum	University of Tasmania, Australia	Networks Representative	Feb 2023 – Feb 2027
Alexander Neidhardt	TU Munich, Germany	Network Coordinator	—
Chet Ruszczyk	Haystack Observatory, USA	Technology Development Centers Representative	Feb 2023 – Feb 2027
Matthias Schartner	ETH Zurich, Switzerland	Analysis and Data Centers Representative	Feb 2025 – Feb 2029
Fengchun Shu	Shanghai Astronomical Observatory, China	At Large Member	Feb 2025 – Feb 2027
Benedikt Soja	ETH Zurich, Switzerland	Analysis Coordinator	—
Gino Tuccari	IRA/INAF, Italy	Technology Coordinator	—
Alet de Witt	SARAO, South Africa	IAG Representative	—
Minghui Xu	GFZ Potsdam, Germany	Analysis and Data Centers Representative	Jul 2024 – Feb 2027

The Directing Board determines policies, adopts standards, and approves the scientific and operational goals for IVS. The Directing Board exercises general oversight of the activities of IVS including modifications to the organization that are deemed appropriate and necessary

Table 3. Outgoing members of the IVS Directing Board in the period 2023–2025. Listing in alphabetical order by last name.

Member Name	Institution, Country	Function	Recent Term
Johannes Böhm	TU Vienna, Austria	IAG Representative	—
John Gipson	NVI, Inc./NASA, USA	Analysis Coordinator	—
Hayo Hase	BKG/AGGO, Argentina	At Large Member	Feb 2023 – Feb 2025
Oleg Titov	Geoscience Australia, Australia	Analysis and Data Centers Representative	Feb 2021 – Feb 2025
Pablo de Vicente	Instituto Geográfico Nacional, Spain	Networks Representative	Feb 2021 – Feb 2025
Anastasiia Walenta	BKG, Germany	Analysis and Data Centers Representative	Apr 2022 – Jul 2024

to maintain efficiency and reliability. The current and outgoing Board members are listed in Tables 2 and 3.

After eleven years in the function of IVS Analysis Coordinator (March 2013 to March 2024), John Gipson of NVI, Inc./NASA Goddard Space Flight Center completed his tenure at the GM in Tsukuba. The Board elected Benedikt Soja from ETH Zurich as the new Analysis Coordinator. In the fourth quarter of 2024, the IVS held Directing Board elections. The new Board re-elected, at its first meeting in 2025, Rüdiger Haas from Chalmers University of Technology, Onsala Space Observatory as IVS Chair for a second four-year term from February 2025 to February 2029.

3.2 Observing Program

The IVS observing program is gradually undergoing a transformation owing to the growth of the VGOS system and the slow fading of the legacy S/X system. While the S/X system remains the main production system, VGOS has gained traction in particular in the 1-hour Intensive observation arena. A major challenge for a larger increase of 24-hour VGOS sessions lies in the large amount of raw data that needs to be transferred and stored. The observing program for 2023–2025 can be summarized as follows:

- EOP: Several 1-hour UT1 Intensive measurements per day on legacy S/X baselines (IVS-INT-1, IVS-INT-2, IVS-INT-3, IVS-INT-00, IVS-INT-S) and VGOS baselines (VGOS-INT-A, VGOS-INT-B, VGOS-INT-C, VGOS-INT-G, VGOS-INT-M, VGOS-INT-S, VGOS-INT-Y). After establishing a sufficient time series and proper error estimates, VGOS-INT-A became the first VGOS Intensive series to be used operationally by the IERS Rapid Service/Prediction Center (since May 2023). Further VGOS Intensive series (see Figure 3) are being evaluated by the IERS. The Intensive observing program has reached some 1000 sessions per year in recent observing years. Two legacy S/X rapid-turnaround 24-hour sessions each week (IVS-R1, IVS-R4) designed to measure all components of EOP. Data is available within 15 days after each session ends. One VGOS 24-hour session roughly each week (VGOS-OPS) with data availability at 30 days after observing. While the VGOS-OPS sessions were observed 18 UT – 18 UT until the end of 2023, they were observed 12 UT – 12 UT since January 2024. Starting in 2025, the VGOS-OPS are observed 00 UT – 00 UT in order to better align with other space-geodetic services.

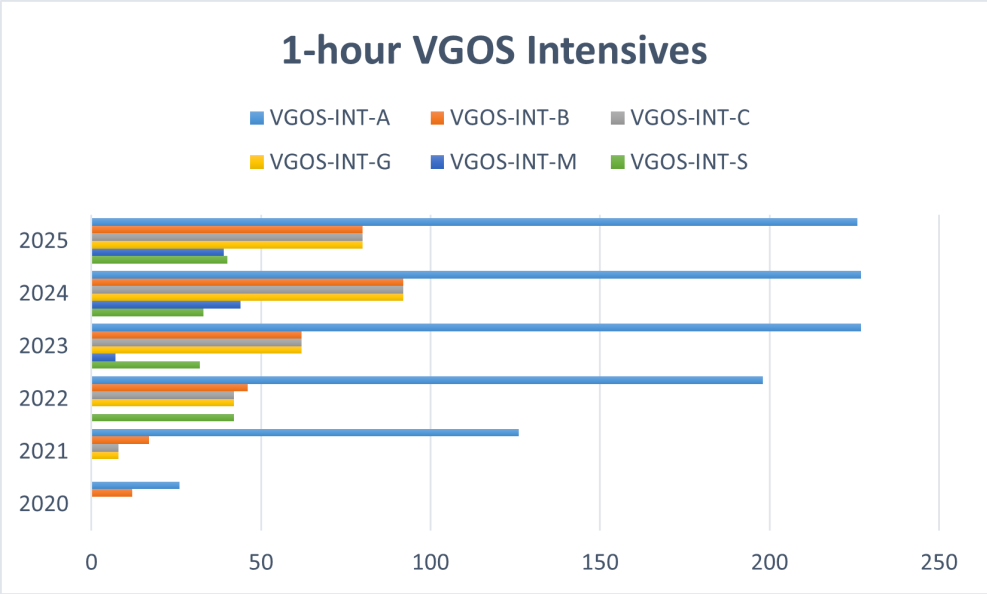

Fig. 3. Number of VGOS Intensive sessions since 2020.

- TRF: Bi-monthly TRF sessions with 14–18 stations using all stations at least two times per year.
- CRF: Bi-monthly sessions using the Very Long Baseline Array (VLBA) and up to eight geodetic stations, plus astrometric sessions to observe mostly southern sky sources.
- R&D sessions: 6–8 VGOS and 10 S/X sessions per year to investigate instrumental effects, research the network offset problem, and study ways for technique and product improvement.

Although certain sessions have primary goals, such as CRF, all sessions are scheduled so that they contribute to all geodetic and astrometric products. Efforts are underway to restructure the Intensive observing program to better accommodate the needs of our sister services. The general idea is to align the program with the IGS Rapids. The transition will take time and can only be done in steps. Limitations include station and correlator resources.

3.3 Analysis

ITRF2020 Updates ITRF2020-u2023 and ITRF2020-u2024

Previously the ITRF was updated with a cadence of roughly once every 5–6 years, with the most recent update in this cycle being ITRF2020. As the geodetic community requested more frequent updates, the IVS together with the other geometric services (IDS, IGS, ILRS) agreed to provide data for annual updates. The IVS contributed data to the first ITRF2020 update, named ITRF2020-u2023, submitting the combination of sessions from 2021 through the end of 2023 (as far as the sessions were available) provided by 12 Analysis Centers. The second update (ITRF2020-u2024) used the results from 14 IVS Analysis Centers and data through the end of 2024, if available.

IVS Working Group on VLBI Scale

When the realization ITRF2020 of the International Terrestrial Reference System became available in April 2022, it showed a significant change in the behavior of the scale defined by VLBI after 2013.75. The IVS Directing Board initiated in 2022 the creation of an IVS Task Force, chaired by John Gipson until June 2023 and then by Karine Le Bail (Chalmers University of Technology), with the goal of identifying possible reasons for this apparent VLBI scale drift. The IVS Task Force worked on testing various potential reasons for the VLBI scale drift (e.g., VLBI station events, non-linear VLBI station motion, network effects) and on quantifying their impact on the VLBI scale factors. At its 51st meeting at MIT Haystack Observatory, the IVS Directing Board decided to establish IVS Working Group 9 on the VLBI Scale (WG9) with the mission to continue and intensify the work of the Task Force. WG9 has a lifetime of four years and is led by Karine Le Bail.

IVS Working Group on Satellite Observations with VLBI

Also at the 51st IVS Directing Board meeting, the Board decided to revive IVS Working Group 7 on Satellite Observations with VLBI (WG7). This is to a large extent a response to the recent missions by the European Space Agency (ESA), Genesis, and NASA, GRITSS, but not restricted to the two. ESA's Genesis mission is designed to be a co-location satellite for all four space-geodetic techniques, involving an onboard artificial VLBI sender. NASA's GRITSS mission is planned to retransmit GPS signals to VLBI stations. WG7 has a lifetime of four years and will be led my Lucia McCallum. The task is to study such co-location missions and to prepare the IVS for including satellite observations in future operations. A close cooperation with, for example, the ESA Genesis working group on VLBI is foreseen.

3.4 Technology Development

The S/X VLBI network has been the production system of the IVS since the Service's inception in 1999. In 2020, after a visionary journey from designing to prototyping to system rollout, the next-generation, broadband VLBI system called VGOS (VLBI Global Observing System) was declared operational and a (geographically) limited VGOS network of some eight (northern-hemisphere) stations started to contribute operationally to IVS products. That VGOS network has increased to 16 more (19 when considering the three twin telescope sites) globally distributed stations, and it continues to grow with further stations planning to join in 2025 (see Figure 4). The current operational VGOS observing program includes two 24-hour session series (known as VGOS-OPS and VGOS-RD) for EOP determination and a 1-hour (Intensive), weekdaily series (VGOS-INT-A) for dUT1 determination. Further VGOS Intensive series are being validated (see above).

Beyond the network buildout activities, other infrastructure components of the VLBI processing chain have been developed further (e.g., VGOS correlation and post-processing, VGOS analysis). During 2023–2025, research and development work has concentrated on, for instance, optimizing VGOS scheduling, optimizing the VGOS frequency setup, preparing to develop imaging capability with operational VGOS, and reducing the amount of recorded VGOS data per observing session.

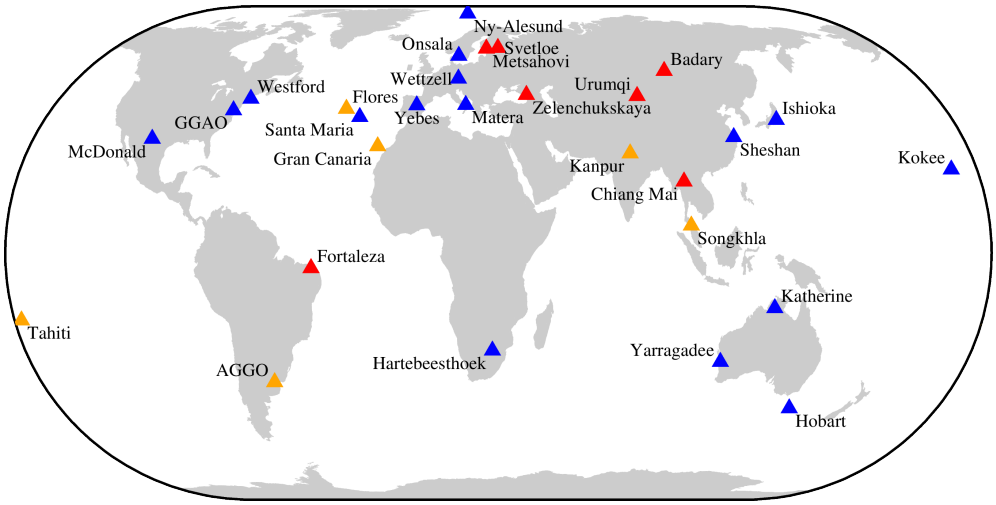

Fig. 4. Rollout status of the VGOS station network: ▲ operational station, ▲ antenna built, signal chain work in progress, and ▲ in planning stage.