Ny-Ålesund Geodetic Observatory

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Abstract During 2023–2024, Ny-Ålesund Geodetic Observatory in Svalbard (Norway), operated by the Norwegian Mapping Authority (NMA), continued to contribute to the VLBI network as the northernmost VLBI station. The Ny-Ålesund north (Nn) 13-m telescope at the new geodetic observatory joined officially as a core VGOS station in November 2022. During 2023–2024, Nn continued its regular contributions to the VGOS IVS observation schedule by running VGOS sessions and contributing in the legacy IVS network by running legacy sessions (R1, R4, RV) using the so-called mixed mode. The Ny-Ålesund south (Ns) 13-m telescope contributed as a core station in the legacy IVS network from November 2021 until June 2024. Ns ran parallel sessions with the old 20-m telescope (Ny) in order to estimate the VLBI tie-vector between sites Ny-Ns with the best accuracy possible. Ny was dismantled in August 2023 when its operations were officially shut down and all VLBI operations in Ny-Ålesund were moved to the 13-meter telescopes at the new Earth Geodetic Observatory at Brandal. On the other hand, since the end of 2024, efforts are focused on the Ns new VGOS capabilities with the installation of an updated VGOS receiver and the commissioning of its complete VLBI chain. The Ns telescope is planned to start contributing to the VGOS VLBI network during the first half of 2025.

Norwegian Mapping Authority, Geodetic Institute

Ny-Ålesund Network Station

IVS 2023+2024 Biennial Report

1 General Information

The Geodetic Observatory of the Norwegian Mapping Authority (NMA) is situated at 78.9° N and 11.9° E in Ny-Ålesund, Kings Fjord, on the west side of the island Spitsbergen. This is the largest island in the Svalbard archipelago. The geodetic observatory features fast-slewing VGOS twin telescopes (Nn, Ns) at the new facility at the Earth Geodetic Observatory (see Figure 1) and until August 2023 a 20-meter legacy VLBI radio telescope (Ny) at the Rabben site (see Figure 2).

Fig. 1 The geodetic observatory's Brandal site with 13-m twin telescopes. From left to right: Ny-Ålesund 13-m North antenna (Nn), SLR dome, operations building, and Ny-Ålesund 13-m South antenna (Ns). (Image: Bjorn-Owe Holmberg)

In addition to the 13-m twin telescopes, the geodetic observatory has three Global Navigation Satellite System (GNSS) receivers in the International GNSS Service (IGS) system and two Super Conducting Gravimeters (SCGs) which are part of the International Geodynamics and Earth Tide Service. One SCG is installed at the Rabben site, and the second SCG is installed at the Brandal site. They are approximately

Fig. 2 The geodetic observatory's Rabben site with the Ny 20-m telescope which ended operations in August 2023. (Image: Esther Horvath)

1.5 km away from each other. A fourth GNSS receiver, from the German Research Center for Geosciences (GFZ), is hosted at the Rabben site. A solar radio burst monitor is set up in Rabben, and a tide gauge is in operation in the harbor of Ny-Ålesund.

The observatory also hosts an accelerograph from the Instituto Geográfico Nacional in Spain and a GPS Ionospheric Scintillation and TEC Monitor (GISTM) receiver, which is operated in the frame of ISACCO, an Italian research project on ionospheric scintillation observations, led by the Italian Institute of Volcanology and Geophysics (INGV). Another Real-Time Ionospheric Scintillation (RTIS) Monitor has been set up and operated by the NMA since November 2012. A DORIS station is located approximately 350 m from the new geodetic observatory in Brandal and is hosted by the French-German AWIPEV research base.

NMA is working on the installation of a Satellite Laser Ranging (SLR) system in the new geodetic observatory. The SLR dome was installed in April 2022 (see Figure 1). Gimbal and telescope assembly was installed during 2023. In 2026, laser installation is planned to start, and the SLR technique will be fully operational by the end of the year.

2 Component Description

The fast-slewing VGOS twin telescopes at Brandal Geodetic Observatory (designated as Nn and Ns) are 13.2-m in diameter. Both the Nn and the Ns telescopes have installed a broadband receiver (2–14 GHz), with a DBBC3 and Flexbuff as the backend. A T4Science iMaser 3000 provides the frequency signal at Brandal.

The Ny-Ålesund 20-m diameter radio telescope was shut down in August 2023, and all VLBI operations in Ny-Ålesund were moved to the two 13-meter telescopes at the Geodetic Observatory. Since October 1994 the 20-m diameter antenna was used for geodetic purposes and regularly participated in legacy S/X VLBI sessions, contributing to many scientific studies. Its location in the Arctic, in the vicinity of several large glaciers, has been valuable and demanding at the same time. An accelerating uplift has confirmed that Svalbard's glaciers are losing mass due to climate change; this has created a challenge for the stability of the reference frame. Its design and construction was similar to those at Green Bank (West Virginia, USA) and Kokee Park (Hawaii, USA). NMA donated parts of the telescope and spare parts from the Ny-Ålesund 20-m antenna to Green Bank Observatory (GBO). Our colleagues from GBO spent two weeks in Ny-Ålesund salvaging parts such as panels, gearboxes, and electrical components. The demolishing work was completed in less than two weeks (see Figure 3).

Fig. 3 A Norwegian company was contracted to finish the demolishing work in September 2023. (Image: Dag S. Roland)

3 Staff

The staff at Ny-Ålesund consists of five people employed at 75%; 3.75 full-time positions are currently covered (see Figure 4 for an overview). Station staff are part of the Geodesy Division at the Geodetic Insti-

tute of the Norwegian Mapping Authority, which has its main office in Hønefoss, Norway (near Oslo).

Susana Garcia-Espada and Rubén Bolaño González joined the operations team in April 2020. Susana has served as the station leader since November 2022. During 2023, Axel Meldahl and Thomas Gasmoe finished their contract in Ny-Ålesund Geodetic Observatory. Antoine Protin, Earl Sullivan Lester, and Jon Leithe joined the operations team in the first half of 2024 (see Figure 4).

Fig. 4 Core team in 2024 from left to right: Susana Garcia-Espada (station leader), Rubén Bolaño González, Antoine Protin, Earl Sullivan Lester, Jon Leithe.

The staff in Ny-Ålesund work closely with colleagues located on the mainland at NMA's Hønefoss and Oslo offices: Ann-Silje Kirkvik (VLBI data analyst), Leif Morten Tangen (VLBI instrument responsible), Gro Grinde (project leader for the new geodetic observatory), Lars Olsson (department director), and Per Erik Opseth (head of the Geodesy department) (see Table 1 for an overview).

Table 1 Staff related to VLBI operations in Ny-Ålesund.

Head of Department	Per Erik Opseth
Department Director	Lars Olsson
Project Leader (new observatory)	Gro Grinde
Station Leader	Susana Garcia-Espada
Operations Engineer	Rubén Bolaño González
Operations Engineer	Antoine Protin
Operations Engineer	Earl Sullivan Lester
Operations Engineer	Jon Leithe
VLBI Instrument Responsible	Leif Morten Tangen
VLBI Data Analyst	Ann-Silje Kirkvik

4 Current Status and Activities

In 2023, until its dismantling in August, the 20-m Ny and Ns telescopes in Ny-Ålesund were scheduled for 46 24-hour VLBI sessions, including R1, R4, EURO, RD, T2, and RDV sessions, for 13 one-hour sessions within the Intensives program, and for 17 sessions in the NYTIE local-tie program.

The legacy 20-m telescope at Rabben (Ny) was operative until August 2023. In late 2022, the Ny antenna started having lower performance than usual, and it had a period off for a couple of months. A DBBC2 was borrowed from the Instituto Geográfico Nacional (Spain), and once it was installed, operations resumed at the beginning of 2023. Several technical issues were encountered during spring 2023, including a receiver warming up due to a leaking dewar degraded pumping system and helium compressor. Finally it was shut down in August 2023.

The original plan was to dismantle Ny during summer 2022, but due to the importance of the parallel sessions between Ny-Ns, Ny operations were extended until August 2024.

The Ny telescope contributed to the IVS during almost 30 years of geodetic VLBI operations. In the last few years, it was challenging to keep the 20-m Ny telescope operational, and more efforts were put into the new Ns and Nn antennas at Brandal (see Figure 5).

During 2023–2024, the 13-m Ns and Nn telescopes were scheduled in 174 24-hour VLBI sessions, including R1, R4, EURO, RD, T2, and RDV sessions, for 25 one-hour VLBI sessions within the Intensive program, and for 17 sessions in the NYTIE local-tie program (see Figure 6).

Most of the scheduled sessions were run in parallel at both the Ny and Ns telescopes to estimate the VLBI local-tie. In order to get best possible estimations and results for the parallel time series between Ns-Ny, 17 24-hour VLBI local-tie short baseline sessions between the Ny and Ns telescopes (NYTIE) were observed from August 2022 until August 2024. Colleagues from the Onsala Space Observatory supported the correlation and analysis of the NYTIE sessions. During this period, most of the Ny scheduled sessions were run in parallel with the Ns telescope (see Figure 7).

The 13-m Nn telescope has been scheduled as a core station in the VGOS VLBI network since November 2022. During 2023–2024, Nn was scheduled in 45

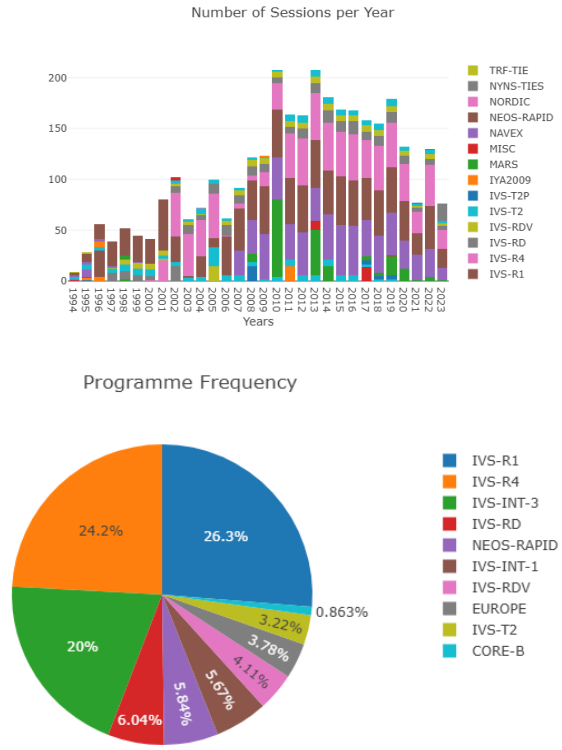

Fig. 5 The two figures above show how the 20-m telescope (Ny) contributed to the IVS during almost 30 years of geodetic VLBI operations. Plots from ETH Zürich website.

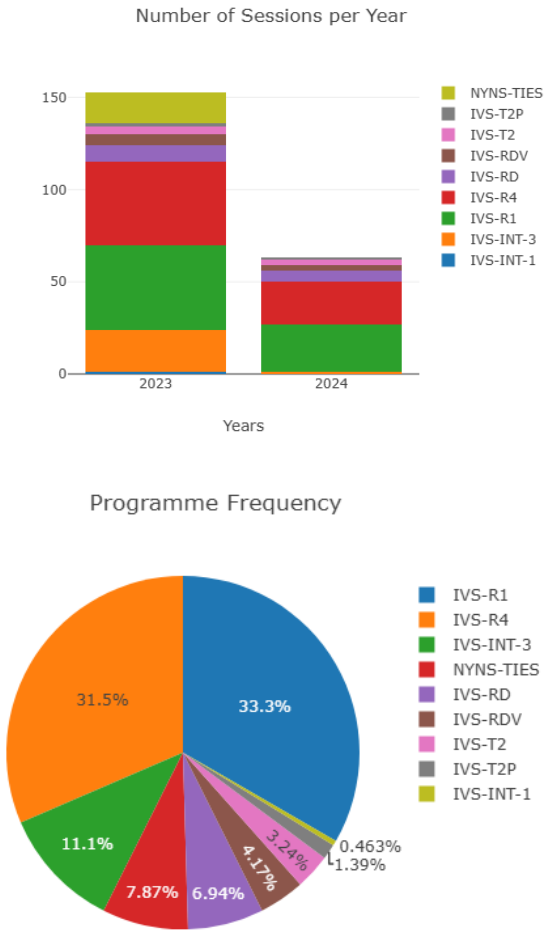

Fig. 6 The two figures above show the 13-m telescope (Ns) session contributions during 2023–2024. Plots from ETH Zürich website.

Fig. 7 The distance from the Ny telescope at Rabben to the Ns and Nn telescopes was around 1.5 km.

24-hour VGOS sessions, for 39 one-hour VLBI sessions within the VGOS Intensive program, and for 76 24-hour VLBI legacy sessions, including R1 and R4 (see Figure 8).

On the other hand, the VGOS receiver (installed in November 2021 in the Nn telescope) was upgraded during mid-2021 at the Yebes Observatory (Instituto Geográfico Nacional, Spain). Its Low Noise Amplifier (LNA) configuration was upgraded from single ended to balanced configuration. Installation of the upgraded VGOS receiver in the Nn telescope was done in November 2021. The second VGOS receiver for Ns was upgraded during 2024 in the same way as the Nn VGOS receiver and was installed by December 2024. The Ns telescope is planned to start contributing to the VGOS VLBI network during the first half of 2025.

Local tie measurements were carried out at Brandal in the summers of 2023 and 2024, continuing with the stability measurements time series.

The DORIS beacon continued to be connected to the common frequency standard at the Brandal new Geodetic Observatory since July 2022. The duct cable from Brandal to DORIS houses an RF cable providing a 5 MHz reference signal from the hydrogen maser at Brandal to the DORIS beacon. It ensures all

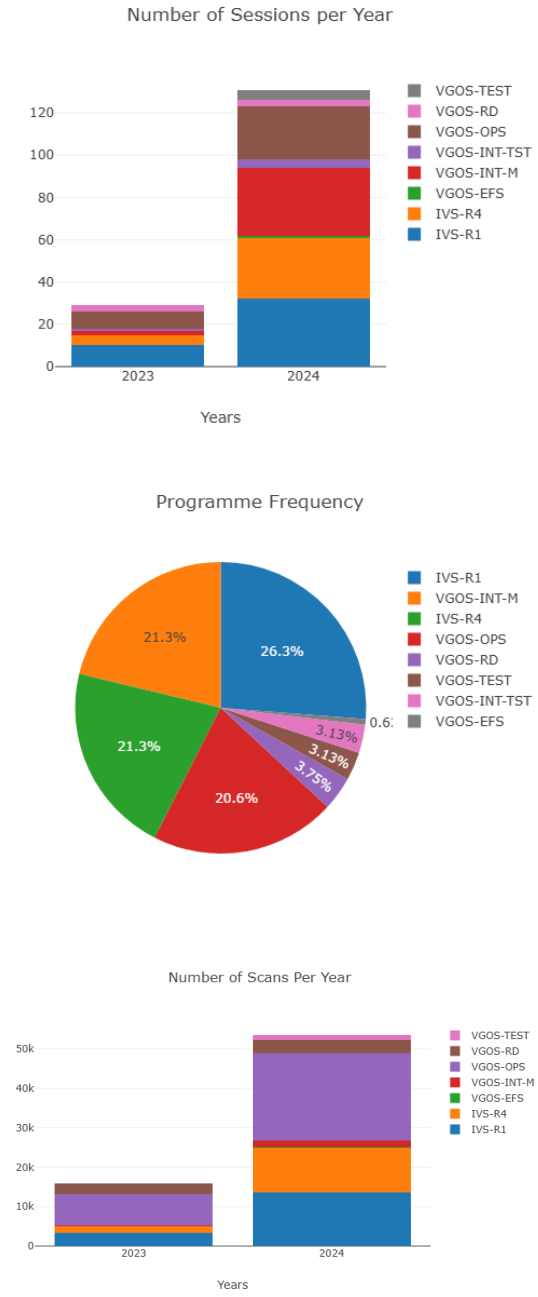

Fig. 8 The three figures show the 13-m telescope (Nn) session contributions during 2023–2024. Plots from the ETH Zürich website.

space geodetic techniques at Brandal use a common frequency standard.

Installation of the first components of the SLR system at the Brandal site started in April 2022, with the installation of the SLR construction laser technical room roof. The installation of the GTA telescope was done in February 2024 (see Figure 9).

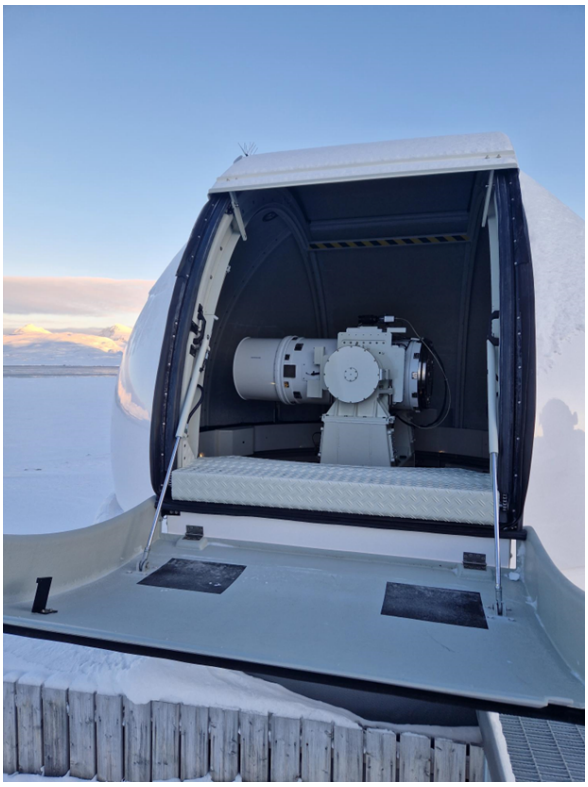

Fig. 9 SLR GTA telescope installation was done in February 2024.

5 Future Plans

Full operationalization of the twin telescopes (Ns and Nn) at the new Geodetic Observatory remains a focus of the station staff.

The Nn telescope will continue contributing to the VGOS VLBI network by running VGOS sessions and the legacy VLBI network by running legacy sessions (R1, R4, RV) using the so-called mixed mode. The Nn telescope has participated in 2024 and will continue to participate in further VGOS frequency tests.

Together with the upgraded broadband receiver and the installation of a DBBC3, the Ns telescope will be ready to start contributing in the IVS VGOS network in mid-2025.

Local tie measurements at Brandal and between Brandal and Rabben won't be carried out in summer 2025 due to construction work planned in summer 2025 in the Brandal building. Due to the permafrost active layer melting during the summer season and freezing again in the autumn/winter, the pillars of the main building and corridors are suffering instabilities, causing some of them to be pushed upwards. It is planned to fix the pillars during the summer and attach them to bedrock. The foundations of all geodetic techniques will no longer be affected by melting permafrost because they will be excavated and attached to bedrock, making them stable long term. The next local-tie measurement campaign will be in summer 2026 to confirm that the fixed pillars are stable and to perform the regular local-tie measurement.

On the other hand, plans for 2025 also include renovation of the office building close to the airport at the Rabben site. The renovation includes reusing the old 20-m telescope backend room to be reconverted into a meeting room, new electrical and network cabling, and a new control room. It is from the Rabben office that VLBI operations are run remotely.

In 2026, the SLR laser system is expected to be installed early in the year and operational by the end of the year.

The Geodetic Observatory is thus planning to become a fundamental station with all space geodetic techniques co-located in 2026.

References

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