

# FINNARP

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## Field Operations 2023–24





# Content

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Editorial.....	3
The Finnish Antarctic research program FINNARP.....	4
Ice load measurements onboard S.A. Agulhas II.....	7
Atmospheric composition trends in Antarctic Peninsula .....	8
Geodetic Installations and Measurements at Aboa .....	9
Seismic measurements at Aboa Research Station .....	10

Basen nunatak. Photo: Aleksi Rimali/ FINNARP



## Editorial



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**The FINNARP 2023 expedition** concluded the fieldwork of the Academy of Finland's Antarctic Research 2021–2024 funding period. The research period was very exceptional. The coronavirus pandemic caused challenges for travel and the organization of a safe work environment in Antarctica.

Due to the world's political situation, existing cooperation networks had to be reorganized. Finding a new flight route and establishing reliable partnerships took some effort, but we succeeded.

The weather conditions during two field seasons were unprecedentedly harsh. The intensities and durations of snowstorms were exceptional considering Aboa's 35-year measurement history. The amount of snow around the station increased significantly. The latest issue to be monitored is the bird flu that has arrived and spread in Antarctica. There are no visible signs of it around Aboa yet.

During the four years period 2021–2024, all planned measurement campaigns were implemented, and a significant amount of new research material was collected. In addition to Aboa, Finnish researchers worked at Marambio station in Argentina, Julio Escudero Base on King George Island in Chile, and Scott Base in New Zealand. Several researchers worked onboard the South African research vessel S/A Agulhas. Cooperation with the American Amundsen-Scott and Italian-French Dome Concordia stations also continued. The important partners in operations and logistics were the Norwegian

Polar Institute, the German Alfred Wegener Institute for Polar Regions and Marine Research, and the Swedish Polar Secretariat.

Aboa's station development work has been continuous. The Land Surveying Institute of Finland updated the GPS measurement equipment that had served at Aboa for 20 years to a GNSS station. Two satellite radar reflectors were installed on Aboa to support remote mapping studies.

The seismic station at Aboa, and the AWS5 weather station, located on the glacier, were updated. The station's solar energy systems were expanded by adding panels and batteries to support year-round measurements. The station's satellite connections have been improved as new technology has become available. The development of instant messaging has been significant, increasing safety, workflow, and comfort.

In the 2024–2025 season, FINNARP operations will organize the transport of fuel and equipment needed at Aboa, and dispose the waste accumulated at Aboa in the previous seasons. Aboa's energy systems are constantly being developed, and in the next season, the station's old generators will be replaced by more economical and environmentally friendly power generators.

In the spring of 2024, the Academy of Finland organizes a call for Antarctic funding with international evaluations. It guarantees a high level of research in the coming years as well. FINNARP and research station Aboa welcome researchers during the next four years.

**Mika Kalakoski**

Manager, Antarctic Operations

FINNARP, Finnish Meteorological Institute



The Finnish Antarctic research program FINNARP carried out FINNARP 2023 research expedition to the Finnish Antarctic Station Aboa between December 2023 and February 2024. Five FINNARP employees and two researchers from the National Land Survey of Finland (NLS) participated in the expedition.

The FINNARP 2023 expedition started its journey to the research station Aboa on 15 December 2023. The expedition team traveled first from Helsinki to Oslo, from where they flew with a flight organized by the Norwegian Polar Secretariat via Cape Town, South Africa, to Norway's Troll Station. From there, the expedition flew by ski-equipped aircraft to Aboa. The FINNARP technicians with their cargo arrived at Aboa on Tuesday evening, 19 December 2023. Part of the expedition's cargo was transported on a container ship by the German Alfred Wegener Institute to the Neumayer III station and from there by ski plane to Aboa. The two NLS researchers joined the expedition one month later, on 21 January 2024. The expedition team consisted of the expedition leader, senior specialist, cook, mechanic, doctor, and two researchers from the National Land Survey's Finnish Geospatial Research Institute (FGI).

Aboa had wintered rather well despite the severe Antarctic winter storms. The damage to the station's structures and technology was minor, although an unusual amount of snow had accumulated in the vicinity of the station. The station start-up went without any difficulties, and the generators were turned on immediately after the team had arrived at Aboa.

The FGI researchers performed geodetic measurements in the vicinity of Aboa and updated the measuring infrastructure, which will now serve the area's geodetic and geophysical research long into the future. Two new reflectors for remote sensing satellites were installed. The reflectors are the largest in Antarctica and will provide a new method for measuring the tectonic shift in the area with satellites. The researchers also replaced the satellite positioning receiver, which had

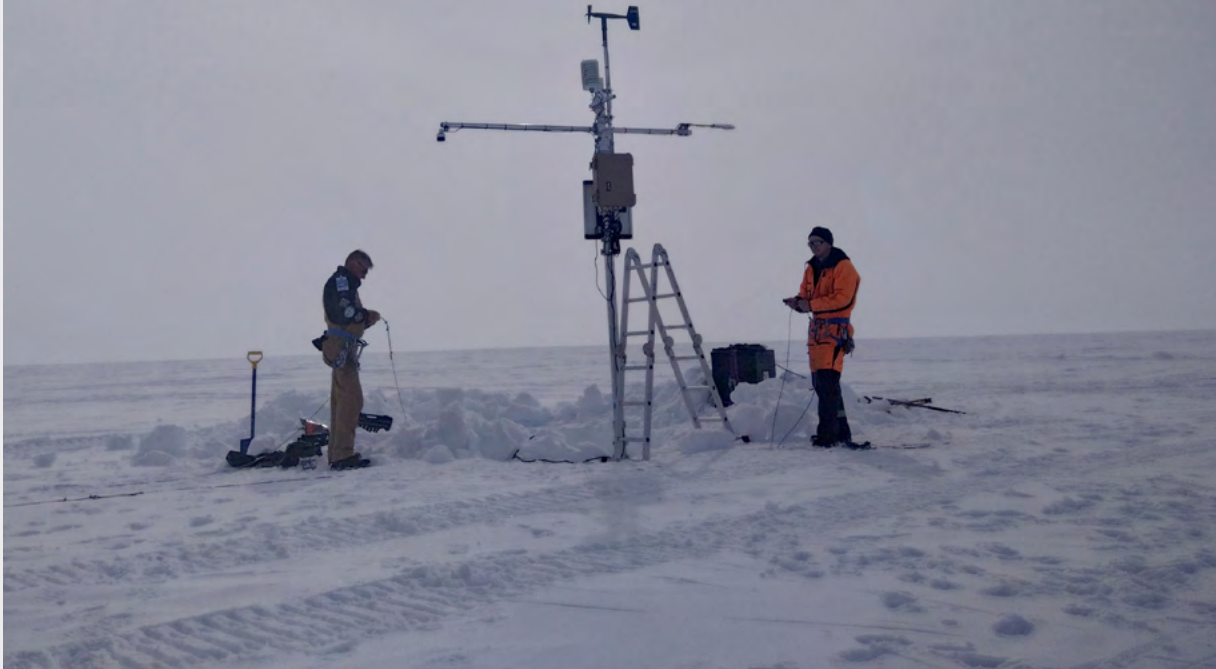


FINNARP 2023 expedition team from left to right: Jyri Näränen (scientist, NLS), Arttu Raja-Halli (scientist, NLS), Tapio Hyppänen (mechanic, FMI), Priit Tisler (senior advisor, FMI), Juho Vehviläinen (medical doctor, FMI), Mika Kalakoski (expedition leader, FMI), Sanna Häkkänen (chef, FMI). Photo: FINNARP



Research station Aboa. Photo: Pasi Ylirisku / FINNARP

Maintenance of the automatic weather station AWS5 10 kms from the Aboa station. Photo: Mika Kalakoski / FINNARP



served the station for 20 years. The new device can receive signals from all satellite positioning systems, including the European Galileo system.

The expedition's technical personnel serviced the station's year-round measuring devices and the data was collected for scientific analysis. The continuously measuring seismometer of the University of Helsinki's Institute of Seismology was also replaced with a new one by the FINNARP team.

In addition, the station was subject to routine maintenance and repair. To carry out demanding research work in Antarctica, the research station must be professionally maintained, and maintenance must be carefully planned. Vehicles at

Aboa, such as snowmobiles, tracked transport vehicles, SUVs, and the station tractor, were serviced and repaired. The expedition was lucky in terms of weather; there were no strong storms in the Aboa area, and all works were completed as planned.

The expedition team closed the research station on Sunday, 11 February 2024. From Aboa, the team flew by ski-equipped aircraft to Norwegian Troll station and continued their journey with a cargo aircraft to Oslo via Cape Town. The expedition team returned to Finland by 21 February 2024. The return was delayed by a few days due to the bad weather in Antarctica. Research station Aboa was occupied for 55 days.

## Finland's Antarctic research station Aboa

- Finland's Antarctic research station Aboa is located on Queen Maud's land about 130 kilometers from the coast and about 5,000 kilometers from Cape Town, South Africa. The research station was built in Antarctica during the summer of 1988–1989. After the construction of its research station, regular research trips to Antarctica have been made from Finland.
- Research expeditions are usually carried out between November and February when it is summer in Antarctica and the temperature stays between 0 and 20 degrees below zero. Antarctic summer is characterized by constant light and strong solar radiation, as well as strong snowstorms.
- Finland's Antarctic operations FINNARP, operating at the Finnish Meteorological Institute, organizes annual research expeditions to Aboa and supports the fieldwork of projects funded by the Academy of Finland in different parts of Antarctica. The research work of the FINNARP expeditions is mainly focused on Queen Maud's land and in the vicinity of the research station Aboa.
- Since 1998, the Finnish Meteorological Institute has operated and maintained an automatic year-round weather station (AWS) at Aboa. The weather station belongs to the WMO International Weather Observation Network. Another automatic weather station (AWS5) is located on a glacier 10 km from Aboa.
- Finland is a member of the Antarctic Treaty. A prerequisite for this is the implementation of significant research activities in the region.



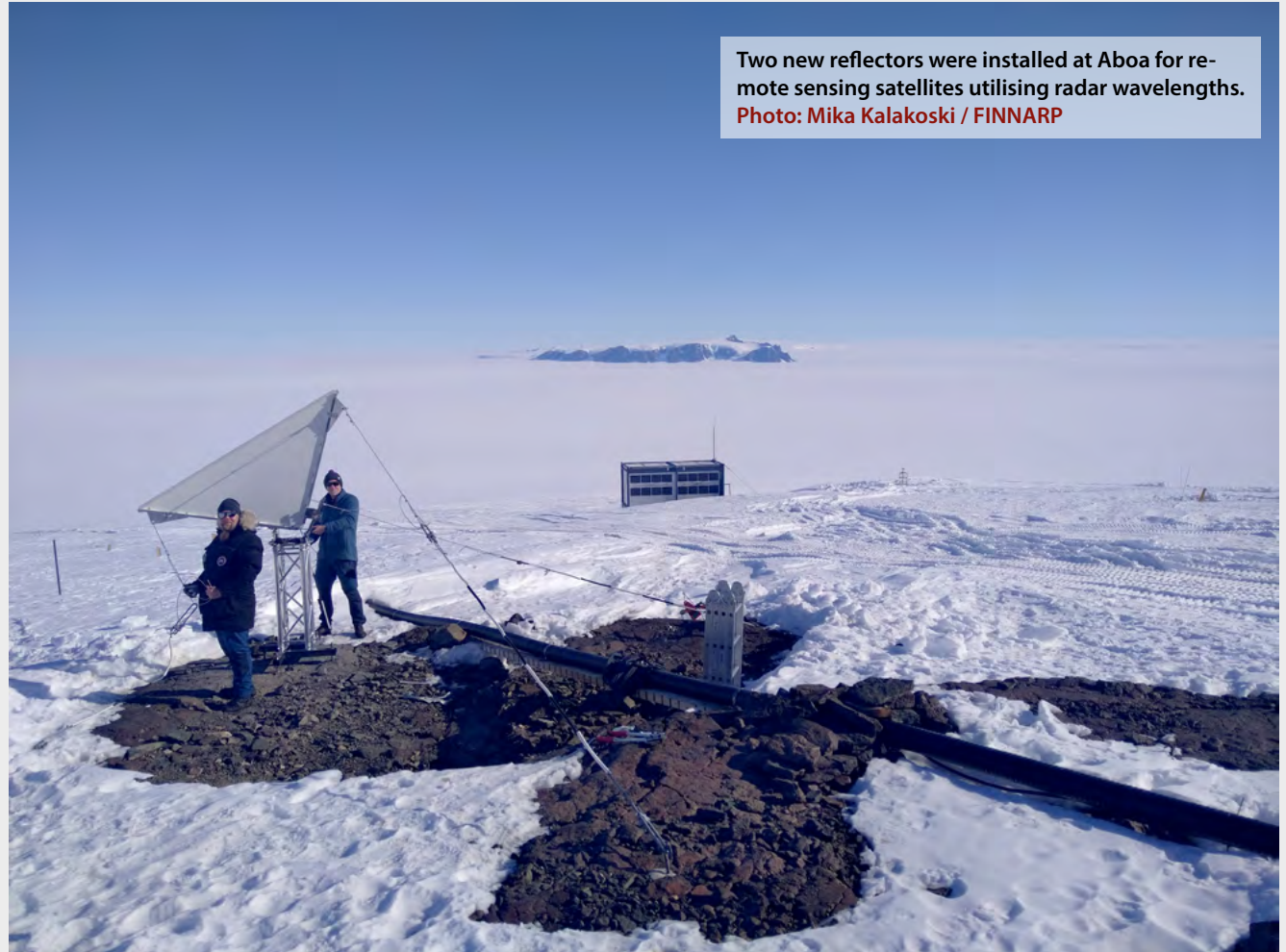
## Measuring devices and campaigns at Aboa during the austral summer 2023/24

### Measuring campaigns:

- Absolute gravity and geodetic measurements by the National Land Survey of Finland (NLS) in the vicinity of Aboa.

### Maintenance of year-round measuring devices and collection of accumulated data:

- Automatic weather station (FMI) at Aboa was maintained.
- Automatic weather station AWS 5 (FMI), 10 km from Aboa, was maintained.
- Continuously measuring seismometer of the University of Helsinki's Institute of Seismology was replaced with a new one.
- Aboa's permanent GPS station was upgraded to a new GNSS station to improve the data coverage and resilience of the station by the National Land Survey of Finland.
- Two passive reflectors were installed for Synthetic Aperture Radar (SAR) satellites at the station area.



Two new reflectors were installed at Aboa for remote sensing satellites utilising radar wavelengths.  
Photo: Mika Kalakoski / FINNARP



Geodetic measurements (RTK-GPS) on the Basen glacier.

Photo: Jyri Näränen / FINNARP



### FINNARP 2023 Expedition

Mika Kalakoski, expedition leader  
Priit Tisler, senior advisor  
Juho Vehviläinen, medical doctor  
Tapio Hyppänen, mechanical engineer  
Sanna Häkkänen, chef  
Jyri Näränen, scientist  
Arttu Raja-Halli, scientist



# Ice load measurements onboard S.A. Agulhas II

**Yaxuan Zhu, Aalto University**

From 24th December 2023 to 20th February 2024, scientist Yaxuan Zhu from Aalto University participated in the SANAE 2023/2024 annual relief voyage onboard the South African research and supply vessel S.A. Agulhas II. Yaxuan Zhu joined a team with three scientists from Stellenbosch University: Gerhard Durandt, Micaela Melim, and Chanté van der Spuy. The team focused on research related to the loads on the ship, induced by sea ice and ocean waves, as well as vibrations of the ship.

For the Aalto part, Yaxuan Zhu collected data on the ice loads, ice conditions, and ship speed during the voyage. The ice loads were measured through strain gauges attached to the hull of S.A. Agulhas II, and the ice conditions (ice concentration, floe size, thickness) were monitored through cameras and visual observations. The data makes it possible to relate each ice load event with the ice floe size and ship speed.

This research is funded by the Research Council of Finland, and it is a collaborative work with Stellenbosch University in South Africa and the Finnish Meteorological Institute.



Aalto/Stellenbosch team onboard S.A. Agulhas II.

Photo: Nicole Catherine Taylor



Ice Shelf at Penguin Bukta.

Photo: Yaxuan Zhu



South African SANAE IV Base.

Photo: Yaxuan Zhu

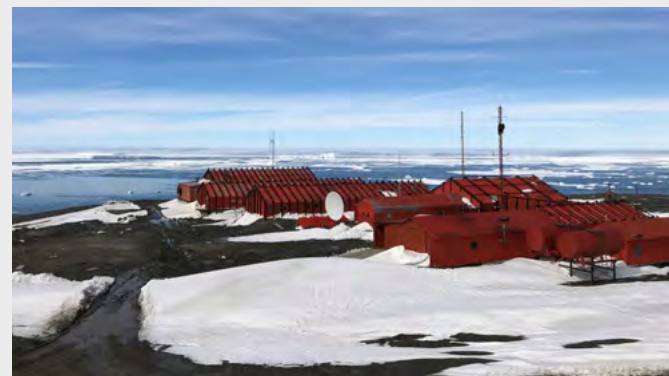


# Atmospheric composition trends in Antarctic Peninsula

## Eija Asmi, Finnish Meteorological Institute

Atmospheric composition measurements, including greenhouse- and trace gases, aerosol particles, and clouds, have continued in the Antarctic Peninsula station Marambio for over 10 years now - thanks to Finnish-Argentinean collaboration. This data series is among the longest, most comprehensive ones in the region to study climate-relevant trends: where Antarctica is going based on this data? This question is asked in the ongoing ACFA project (Antarctic Climate Forcing Aerosol), funded by the Finnish Academy.

Maintaining continuous data flow requires long-term commitment and international collaboration. Finland contributes through instrument purchases and know-how and Argentina contributes through logistics and technical support. Scientific work with data is done together. This year, the daily operation of the instruments in Marambio is carried out by two technicians from the Argentinean Meteorological Service (SMN): Evelyn Lucero and Matias Martonaro. Data is sent near-real-time (NRT) to Buenos Aires and to Helsinki servers, where they are inspected by scientists from SMN, FMI (Finnish Meteorological Institute), and INAR (Institute for Atmospheric and Earth System Research).



Argentinian research station Marambio. Photo: Eija Asmi

Profound maintenance and calibration work was done between 11.-16.03.2024 when Marambio was visited by Eija Asmi (scientist from FMI) and Giselle Marincovich (scientist from SMN), who were assisted by the overwintering team at Marambio and SMN technical expert Francisco Quarin. Asmi and Marincovich arrived on a Hercules C130 cargo plane, while Francisco joined the team by the icebreaker ARA Almirante Irizar, also visiting Marambio.

Marambio has instrumentation to measure aerosol and ion numbers and size distribution, aerosol scattering and absorption, aerosol optical depth, surface greenhouse- and trace gas concentrations, and vertical profiles of ozone. Data are recorded online with approximately 1-min time resolution. Supporting instrumentation monitors meteorological parameters and clouds. Climate change affects the composition of the atmosphere and the interaction between different atmospheric components. This is also evident from Marambio data. During the visit, instruments were prepared for another full year of operation and to assure high quality data. Overwintering personnel were trained for daily operations. Eija Asmi's visit to Argentina and Antarctica was supported by the SCAR Visiting Scholar scholarship.



Giselle and Eija walking towards the measurement container in Marambio. Photo: Giselle Marincovich



Francisco Quarin (SMN) joined the research team from the icebreaker ARA Almirante Irizar, which was visiting Marambio at the same time. Photo: Francisco Quarin



# Geodetic Installations and Measurements at Aboa

**Jyri Näränen ja Arttu Raja-Halli,  
Finnish Geospatial Research Institute,  
National Land Survey of Finland**

The Department of Geodesy and Geodynamics of the Finnish Geospatial Research Institute participated in the FINNARP 2023 expedition with two researchers. During the expedition, Aboa's permanent geodetic measurement infrastructure was renewed and expanded, and geodetic measurements were made. All research requiring geospatial information at or near Aboa will benefit from the improved measurement infrastructure.

A new Global Navigation Satellite Systems (GNSS) receiver was installed to replace the GPS receiver that served well for 20 years. The new receiver continues the 20-year-long time series of the movements of Earth's crust with even more precise measurements, when all satellite positioning systems are in use, including the European Galileo. The receiver can also be used to study the electron content of the ionosphere and to perform so-called GNSS reflectometry to detect changes in the height of the snow surface near the antenna. The continuously measuring GNSS station installed on solid bedrock is one of the few in the entire Queen Maud Land and its time series is one of the longest on the entire continent. Its measurements cover a gap of thousands of square kilometers in the global satellite positioning network. This improves the quality of any research requiring geospatial information in the area.

In addition to the GNSS receiver, two 1.3-meter corner cube reflectors were installed on the slope of Basen nunatak, which serve as bright targets for remote sensing satellites using synthetic aperture radar (SAR). The position of the reference points of the reflectors as well as the exact orientations were precisely measured with so-called local tie measurements. The reflectors

are used to calibrate and validate the operation of SAR remote sensing satellites and they enable the use of a new research method to determine the crustal movements of Basen and its vicinity. In addition to this, they can be used as fixed points in other research besides geodesy, e.g. when determining the movements of nearby glaciers using the SAR method. The reflectors are the largest of their kind in Antarctica and the only permanently installed geodetic reflectors in Queen Maud Land.

In addition to the installation of the research infrastructure, the time series of absolute gravity measurements was also continued at Aboa. The time series of gravity measurements in Aboa is now 30 years long and the second longest in the entire Antarctic.

The so-called RTK-GPS method was used to measure the heights of the ice surface both on the lower slope of Basen and to a distance of about 20 km on the glacier. The measurement results are compared with precision GPS measurements made in the same places during previous seasons, in order to obtain information about changes in the height, and subsequently mass, of the glacier. The information is needed for the interpretation of the gravity time series. Gravity and GPS time series are used to measure movements of the Antarctic crust and are used in modeling the movement. Movements are affected by both the previous ice age and the ongoing change in the mass balance of the glacier. Measurements at Aboa are also important for the creation of global coordinate and gravity systems, as reliable, bedrock-bound, geodetic time series are quite rare in Antarctica. All the field measurements and work at Aboa were finished according to plans. The research and installation work was done with funding from the Department of Geodesy and Geodynamics of the Finnish Geospatial Research Institute.



Arttu and Jyri installing the SAR reflector. Photo: FINNARP



Arttu measuring the local ties of reflectors. Photo: Jyri Näränen



Jyri measuring the height of the glacier with RTK-GPS. Photo: Arttu Raja-Halli

# Seismic measurements at Aboa Research Station

**Kari Komminaho,**  
**University of Helsinki, Institute of Seismology**

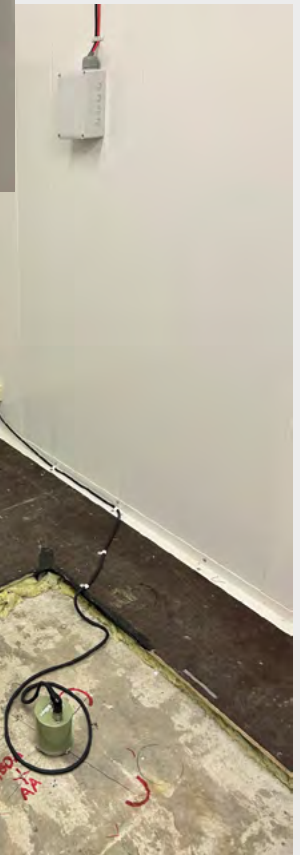
The new continuously measuring seismic equipment was installed at Aboa station by the FINNARP 2023 expedition team. Operated since 2009, the old Reftek 130 digitizer and STS-2 seismometer were replaced with Nanometrics Centaur and Trillium Compact 120s. The new equipment uses 34% less electricity and increases the storage capacity of the hardware.

The new seismic station is situated on a pillar in an absolute gravimetry container in Aboa. It records big earthquakes worldwide and enables calculations of local earth crust thickness. Small local earthquakes are also measured which enables the determination of local seismicity near Aboa station. During seven previous FINNARP expeditions, two temporary seismic stations have been installed at Plogen and Fossilryggen nunataks to get more detailed information on local seismicity.



Nanometrics Centaur digitizer in an absolute gravimetry container in Aboa. Photo: Priit Tisler / FINNARP

Nanometrics Centaur digitizer and Trillium Compact 120s seismometer in an absolute gravimetry container in Aboa. Photo: Priit Tisler / FINNARP



The new seismic station is situated on a pillar in an absolute gravimetry container in Aboa. Photo: Priit Tisler / FINNARP



Trillium Compact 120s seismometer. Photo: Priit Tisler / FINNARP



Sunset at Aboa. Photo: Arttu Raja-Halli / FINNARP

