Recent News

Greenland Telescope Opens New Era of Arctic Astronomy

To study the most extreme objects in the Universe, astronomers sometimes have to go to extreme places themselves. Taking advantage of the excellent atmospheric conditions in Greenland, the Inst. of Astronomy and Astrophysics (ASIAA) of Academia Sinica and the Harvard-Smithsonian Center for Astrophysics (CfA) collaborated to build the Greenland Telescope (GLT).

Over the past year, this team of scientists braved frigid temperatures to successfully set up this new radio telescope in Greenland in 2017. And in April 2018, the team joined the international effort to observe large-scale black holes. In the future, this telescope designed to detect radio waves from stars, galaxies and black holes is expected to make history by taking the very first shadow image of a supermassive black hole.

The Greenland Telescope is currently the only submillimeter wave astronomical observation station in the Arctic Circle. The telescope itself is a 12-meter radio antenna that was originally built as a prototype for the Atacama Large Millimeter/Submillimeter Array (ALMA) project in North America. In 2011, the U.S. National Science Foundation awarded this 12-meter radio antenna to this team of collaborating scientists to deploy and operate in Greenland.

Under the leadership of Academia Sinica's Inst. of Astronomy and Astrophysics, the telescope was refitted to adapt and operate in extreme cold weather and moved to Greenland. Working together with the National Chung-Shan Inst. of Science and Technology (NCIST) of Taiwan, ASIAA refurbished and rebuilt the antenna to prepare it for the cold climate of Greenland's ice sheet. In 2016, the telescope was shipped to the Thule Air Base in Greenland, situated 1,200 km inside the Arctic Circle, where it was customized for this coastal site (Figure 1) and furbished with a special set of the receivers for the antenna by ASIAA (Figure 2).

In the future, the telescope is expected to move from its current location at the Thule Air Base to the summit of the Greenland ice sheet—a site where scientists will be able to take advantage of the lower water vapor in the atmosphere overhead and achieve even better resolution at the higher operating frequencies.

"It is extremely challenging to quickly and successfully set up a new telescope in such a cold environment, where temperatures fall below -30 degrees Celsius," said Ming-Tang Chen, Research Fellow of ASIAA and project manager of the Greenland Telescope. "This is the first submillimeter telescope in the North Pole."

ASIAA scientists began commissioning the telescope on December 1, 2017, and they were able to detect radio emission from the Moon during the same month, an event astronomers refer to

as “first light”.

Then in early 2018, the team combined data from the Greenland Telescope’s observations of a quasar with data from ALMA, and the data from both were synchronized. From these two locations that are nearly 10,000 kilometers apart, the same astronomical targets were observed and interference fringes were successfully obtained.

“This represents a major step in integrating the telescope into a larger, global network of radio telescopes,” said Nimesh Patel from CfA and the lead scientist for the Greenland Telescope. “Finding fringes tells us that the Greenland Telescope is working as we hoped and planned.”

“We can officially announce that we are open for business to explore the cosmos from Greenland,” said Timothy Norton of the CfA and senior project manager for the telescope. “It’s an exciting day for everyone who has worked so hard to make this happen.”

The location of the Greenland Telescope also allows interferometry with various existing arrays. In mid-April 2018, the Greenland Telescope joined the Event Horizon Telescope (EHT) observing campaign (Figure 3). The goal of this project is to connect radio telescopes around the globe to form a global array with high image resolution radio dishes that are linked together to take the first image of a supermassive black hole and to further validate Albert Einstein's theory of relativity.

Compared to existing telescopes, the image resolution of the Greenland Telescope is 1000 times greater than the best optical telescope available on Earth. This type of high resolution is equivalent to clearly seeing an object the size of a baseball on the Moon from Earth.

Also involved in the EHT campaign are two projects located in Hawaii—the Submillimeter Array (SMA), a joint project by the Smithsonian Astrophysical Observatory (SAO) and ASIAA, and the East Asian Observatory’s (EAO) James Clerk Maxwell Telescope (with participation by Academia Sinica)—along with the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile and other arrays located throughout Europe and Antarctica. Together, these projects form a global interferometry array that span almost the diameter of planet Earth.

The Greenland Telescope and ALMA in Chile form the longest baseline (about 10,000 km) covering the north and south ends of the Earth, successfully extending the baseline of this array in the north-south direction.

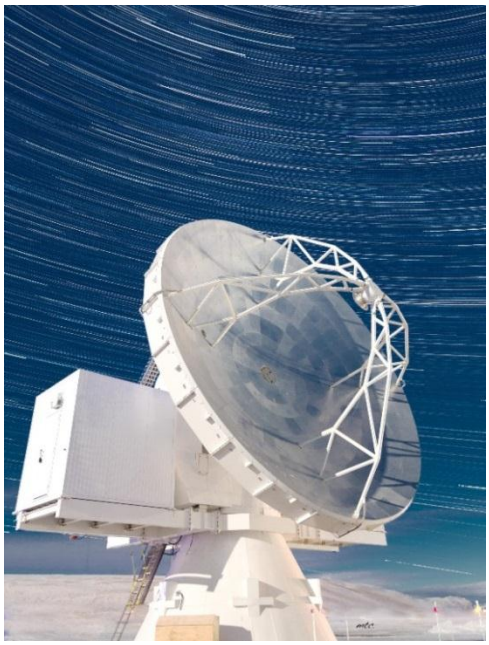
“The Greenland Telescope is a crucial addition to the EHT, allowing for an even greater separation between the radio dishes in the array and hence better resolution,” said Keiichi Asada, Research Fellow from ASIAA and the Greenland Telescope project scientist. “We are very excited that the Greenland Telescope is part of this historic project.”

The Greenland Telescope was sponsored in part by the Ministry of Science and Technology (formerly the National Science Council), which funded Taiwan’s participation in the Atacama Large

Millimeter/Submillimeter Array (ALMA) project.

More information about the Greenland Telescope can be found at the following websites:
http://vlbi.asiaa.sinica.edu.tw/
https://www.cfa.harvard.edu/greenland12m/

For more information about the Event Horizon Telescope (EHT), please visit https://eventhorizontelescope.org.



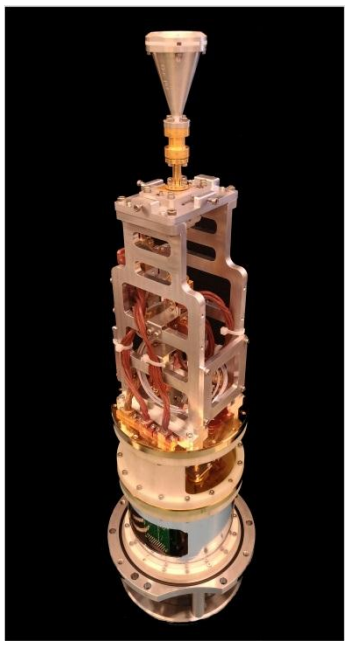


Figure 1 (left): Current image of the Greenland Telescope (GLT) at Thule Air Base, Greenland (image credit: Ming-Tang Chen).

Figure 2 (right): The 86GHz receiver ASIAA built for the Greenland Telescope (image credit: Johnson Han).

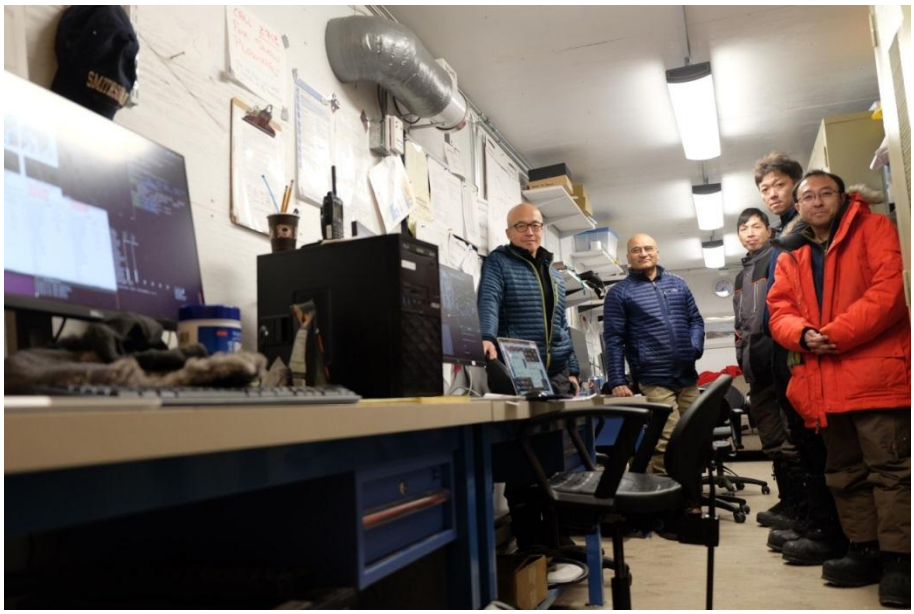


Figure 3: Picture taken at the EHT dress rehearsal in the Greenland Telescope control room at Thule, Greenland. From left to right: Ming-Tang Chen (ASIAA), Nimesh Patel (SAO), Kuan-Yu Liu (ASIAA/EAO), Keiichi Asada (ASIAA), and Hiroaki Nishioka (ASIAA) (image credit: Nimesh Patel).

The Greenland Telescope project was initiated by Dr. Paul Ho, Academician of Academia Sinica. Under his direction, the leading scientists of the project Makoto Inoue, Ming-Tang Chen, Satoki Matsushita, and Keiichi Asada jointly led the engineering and science team that consisted of the following members: Philippe Raffin, Ted Huang, Johnson Han, George Nystrom, Derek Kubo, Shu-Hao Chang, Ta-Shun Wei, Pierre Martin-Cocher, Homin Jiang, Paul Shaw, Hiroaki Nishioka, Chih-Wei Locutus Huang, Chung-Cheng Chen, Shoko Koyama, Masanori Nakamura, Patrick Koch, Peter Oshiro, Kevin Jun Yi Kuo, Chih-Cheng Chang, Ryan Chilson, Chen-Yu Yu, Kuan-Yu Liu, Ranjani Srinivasan, Cheng-Yu Kuo, Hung-Yi Pu, Lupin Lin, Zheng Meyer-Zhao, and Juan-Carlos Algaba Marcos.

Below is a list of the project partners, collaborators, and vendors (domestic and international) of the Greenland Telescope project.

Project Partner:

- Smithsonian Astrophysical Observatory (SAO): Roger Brissenden, Timothy Norton, Nimesh Patel, T.K. Sridharan, and Shep Doeleman

Major Collaborators:

- National Chung-Shan Inst. Science and Technology: former President Guan-chung Chang, President Chung-Hsing Gao, and Vice President Wan-June Ma

- Aeronautical Research Laboratory: Director Li-pin Chi, Chu-Hsiang Chiou, Chun-Hong Chen, Chi-Tai Lee, Ching-Tang Liu and Chi-Den Huang
- International Cooperation Program of the National Chung-Shan Inst. Science and Technology (NCSIST): former General Director Jinchi Han, Director Kuo-Chang Han, Song-Chu Chang, Leo Lu, Fen Yeh and the technical team they led.

Collaborators:

- Radio Receiver Team of Osaka Prefecture Univ.: Hideo Ogawa, Yutaka Hasegawa, and Kimihiro Kimura

National Astronomical Observatory of Japan (NAOJ): Satoru Iguchi and its ALMA team members

Korea Astronomy and Space Science Inst. (KASI): Do-Young Byun and Bong Won Sohn

East Asian Observatory (EAO)/James Clerk Maxwell Telescope: Jessica Dempsey, Craig Walther, Per Friberg, and Dan Bintley

Major Vendors in Taiwan:

- China Steel Structure Co., Ltd., Altogether Enterprise CO., LTD, TCcore Applied Honeycomb Technology Co., Ltd., SAN JIAO COMMERCIAL CO., LTD., Dragon Steel Corporation, and Yuanhong Precision Instrument Company

Major International Vendors:

- Vertex Antennentechnik GmbH and ADS international (Italy)

Special thanks should be extended to the US National Science Foundation, Office of Polar Programs for their effective support in logistics, to the United States Air Force, 821st Air Base Group, Thule Air Base, Greenland for use of the site and access to the Base and logistics chain, to the National Radio Astronomy Observatory, and to the MIT Haystack Observatory for their support in the acquisition of the ALMA-NA prototype in order to repurpose it for Greenland deployment. Special thanks also extended to Autunas for providing arctic clothing for the Greenland Telescope team.