Earth-Venus-Earth (EVE 25) Experiment

The Deep Space Exploration Society

The Plishner Radio Astronomy and Science Center

K0PRT

Haswell, Colorado, October, 2025 (Revised)

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President

The DSES Dish (https://dses.science/)

Background

In the summer of 2022, Ray Uberecken (AA0L) and Paul Sobon (NO0T) discussed potential applications for our 18.3-meter dish antenna in Haswell, Colorado. Uberecken proposed a Venus signal bounce experiment, noting that Venus's comparable size to Earth makes it a favorable target for reflection.

Research revealed precedent: in March 2009, a German AMSAT-DL team had successfully reflected a 13 cm signal off Venus using approximately 6000 watts of continuous wave transmission (under special governmental authorization) with the Bochum Observatory's 18.3-meter dish.

The concept resurfaced in January 2023 when Alex Nersesian (K6VHF) joined The Deep Space Exploration Society. DSES developed a proposal for the DSES Board of Directors, outlining its intention to utilize the amateur radio legal limit of 1,500 watts RF power on the 23 cm wavelength band - significantly less power than in previous experiments. Following thorough deliberation, the Board approved the DSES initiative, marking the start of a race against time. Venus would reach its closest approach to Earth in March 2025, giving the DSES team just one year to secure funding and develop a system capable of generating 1500 watts of continuous RF transmission for the approximately five-minute round-trip signal journey.

Project Proposal

Nersesian, a NASA employee at the time, developed a comprehensive path loss link-budget model incorporating data from NASA, the Bochum team, and other authoritative sources. The model calculated a formidable path loss of 345 dB. DSES evaluated numerous RF modes of weak signal decoding, including the new WSJT-X Q65 digital protocol.

A significant technical obstacle emerged: no commercial amplifiers existed within the amateur radio community capable of delivering 1500 watts of RF power at 23 cm or 13 cm with continuous duty cycle capability. This necessitated a custom design approach. The DSES investigation identified Kuhne, a German manufacturer, producing 1000-watt amplifiers for 23 cm. We determined that combining two such units would provide the requisite 1500 watts of continuous power. Additionally, we faced the engineering challenge of designing a receiving feed system robust enough to withstand the high-power transmission environment without thermal failure.

Project Activities - Teamwork

Transforming concepts into reality required substantial funding for design, fabrication, prototyping, and testing. The DSES team, including DSES Board members and general membership, collaboratively developed a comprehensive funding proposal for the Amateur Radio Digital Communications (ARDC) organization. (https://www.ardc.net/)

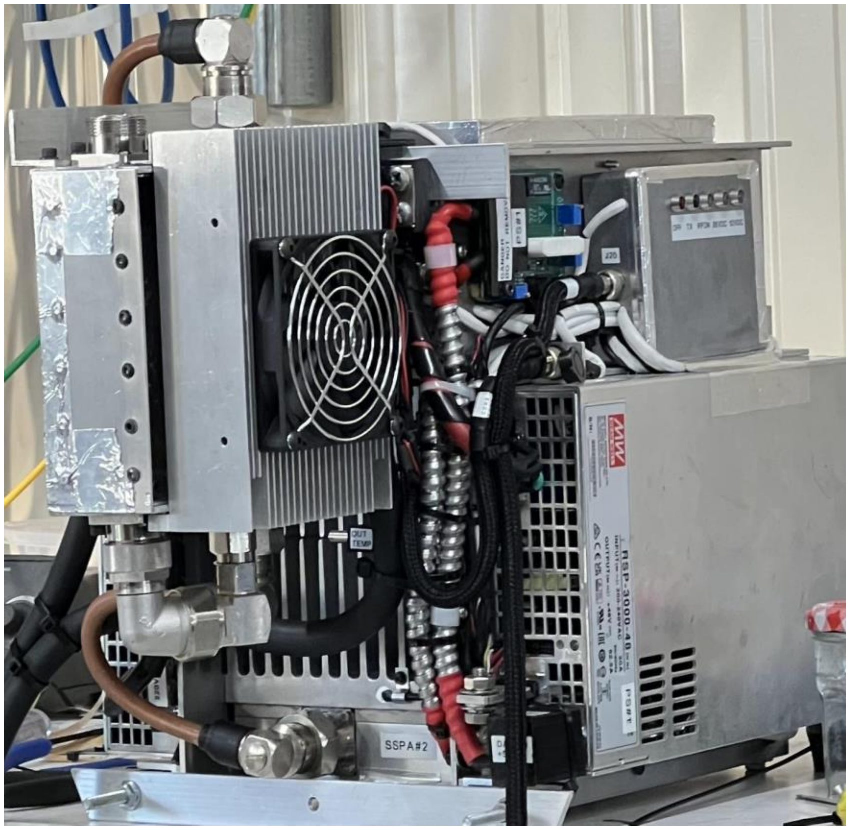
Beyond the radio and amplifier systems, the 18.3-meter dish required significant infrastructure upgrades, including enhanced feed lines, AC power distribution, and fiber optic telemetry links to support the new systems mounted within the dish feed assembly.

With Venus's approach imminent, DSES submitted its proposal to ARDC mid-summer and received funding approval in October 2024. With financing secured, we had merely five months to progress from conceptual design to operational system - an unprecedented endeavor for the team. Given his extensive systems engineering expertise, Nersesian assumed the role of Chief Design Engineer, while Sobon coordinated operations as project manager.

Project Expansion

By January 2025, Nersesian had finalized a viable design, and we had produced their initial prototype. At this juncture, the DSES team initiated collaboration with other large-aperture antenna facilities, establishing connections with Wolfgang Herrmann at Astropeiler in Stockert, Germany, and Dick Harms at Dwingeloo in the Netherlands, both of which operate 25-meter dishes.

Astropeiler Dish at Stockert, Germany
(https://www.astropeiler.de/en/beobachtungen-mit-dem-25-meter-spiegel/)



The Earth-Venus-Earth DSES system before mounting at the dish feed

Dennis Akos from Aerospace Engineering Sciences, University of Colorado at Boulder, at the 18.3m antenna feed cavity with the new EVE 25 system inside

Dwingeloo 25-meter dish in the Netherlands (https://www.camras.nl/en/)

Weekly videoconferences were established, bringing together the Haswell team with the Dwingeloo and Astropeiler teams.

Thomas Telkamp from Dwingeloo independently analyzed the initial path loss link budget and concluded that Earth-Venus-Earth communication was infeasible under the estimated parameters. Telkamp's calculations indicated path losses exceeding initial estimates by at least 24 dB, effectively eliminating any possibility of signal detection using the digital Q65 mode. After a thorough review, DSES concurred with his analysis.

Concurrently, to address the 24 dB shortfall, a Western Australia DSES team member, Mark Drayton, engaged with the Commonwealth Scientific and Industrial Research Organization (CSIRO), which operates the 64-meter radio telescope at Parkes Observatory in Australia. While interest existed, authorization proved unattainable within their timeframe. Planning for a 13 cm experiment in October 2026 is active.

Drayton also established communication with the University of Tasmania's facilities at Hobart and Ceduna, housing substantial radio telescopes. Due to the compressed timeline and limited observation windows, the University was unable to allocate resources for the DSES March experiment but expressed interest in a proposed 13 cm investigation in October 2026.

Using Applied Mathematics and Models

DSES member Michelle Thompson, co-founder and CEO of the Open Research Institute (ORI), and colleague Lee Blanton developed a sophisticated mathematical model reassessing the link budget with additional parameters. (https://github.com/OpenResearchInstitute/documents/blob/master/Engineering/Link_Budget/Link_Budget_Modeling.pdf)

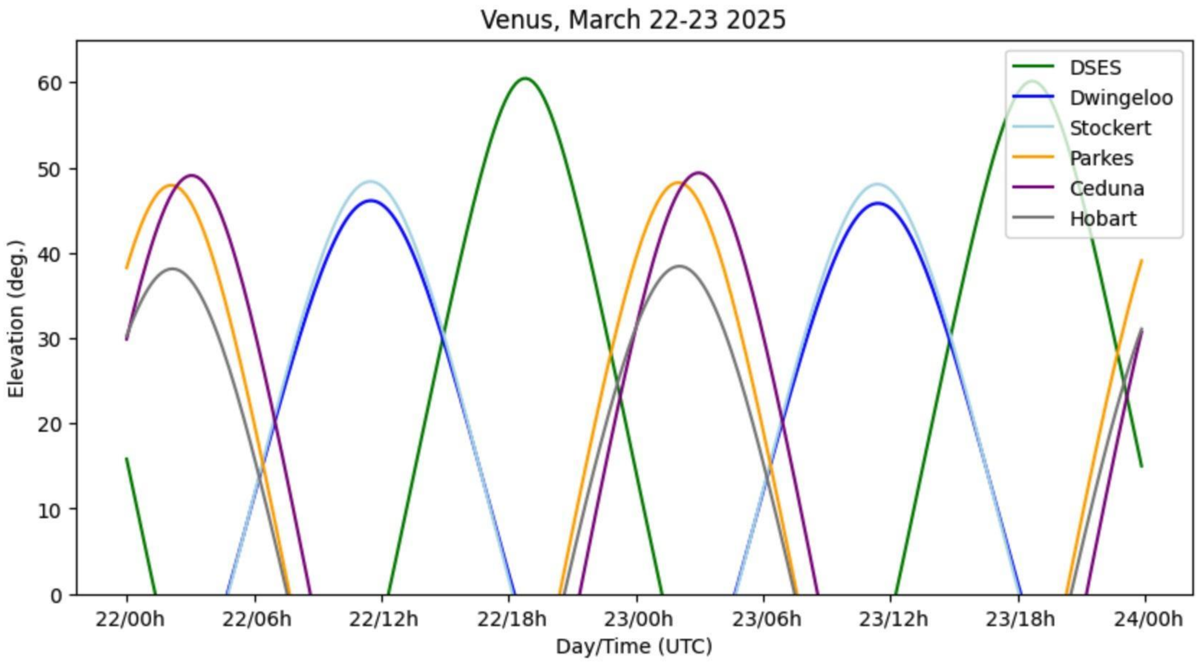
After weeks of collaboration between DSES engineers, ORI and the Dwingeloo team, and running multiple simulation scenarios, it was determined that utilizing a continuous carrier wave with a Rubidium clock frequency stability might enable Venus signal detection.

EVE Experiment — The Day

On March 22, 2025, Haswell and Dwingeloo prepared to transmit 23 cm signals toward Venus. Dwingeloo had secured authorization from the Dutch Authority for Digital Infrastructure (RDI), which determines the frequencies that can be used (their regulatory equivalent to the FCC) to transmit power at one kilowatt within a two-hour window at 1299.5 MHz. Due to recent GNSS navigation system protection protocols, the Dwingeloo team moved their frequency up to 1299.5 MHz, to avoid any chance of interference to the primary user of the 23cm band.

Europe's earlier viewing window with Venus allowed them to commence testing before the USA. The RDI staff was also excited and brought their whole office to see it happen. After four transmission sequences, their time ran out.

Dwingeloo Control Room with the RDI staff watching



Common Windows for Venus at Various Receiver Dishes around the World (courtesy of Dwingeloo)

Deep Space Exploration Society Control Room - Nersesian in the foreground

In Haswell, Colorado, DSES thoroughly tested their 1500-watt system and then integrated a Rubidium frequency standard (on loan from the University of Colorado, Boulder) with an Elecraft K4 transceiver. This precision Rubidium clock provided the frequency stability essential for continuous RF signal transmission.

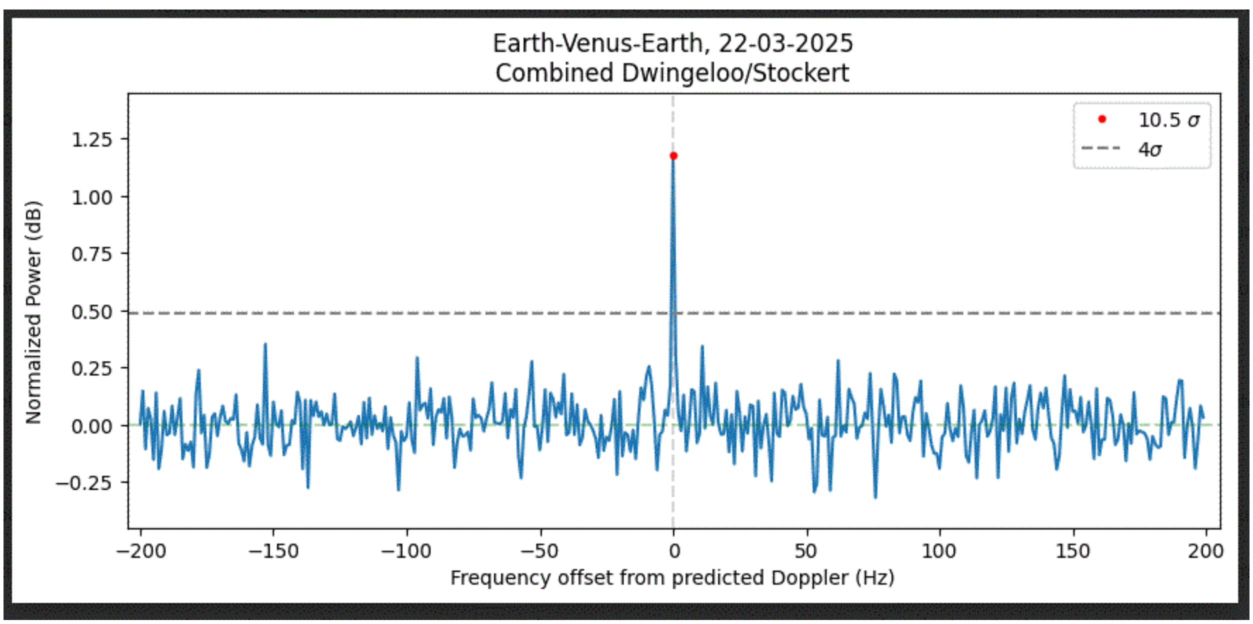
At this critical juncture, DSES encountered technical setbacks. The system experienced intermittent failures within the dish-feed assembly. After conducting extensive component diagnostics, DSES identified the culprit: a DC-powered cooling fan that was shorting the low-voltage power supply. Simultaneously, the Elecraft K4 developed transmission issues that could not be resolved.

By this point, the DSES mutual observation window of Venus with Dwingeloo and Astropeiler was diminishing, limiting their transmission to a three-minute window using a non-GPS-controlled ICOM 705 transceiver. These abbreviated transmissions proved insufficient for European stations to detect a Venus-reflected signal.

Results

Fortuitously, despite equipment failure after four transmissions in the EU, both Dwingeloo and Astropeiler successfully processed their data and confirmed signal detection, with signal strength as the mathematics models had anticipated, given the Doppler spread.

The experiment, conceptualized years earlier, materialized on March 22, 2025, through the dedicated collaboration of numerous individuals across two continents.



Charts courtesy of Dwingeloo, NL, and Astropeiler DL Radio Astronomy

Lessons Learned

The feasibility of a previously unattempted communications methodology was demonstrated from a scientific perspective. It was discovered that collaborative teams, comprising individuals with diverse backgrounds and skill sets, can achieve what appears impossible despite seemingly insurmountable odds. DSES teamwork had paid dividends as the organization grew.

This unprecedented project management experience has strengthened the DSES team's organizational cohesion. The knowledge and expertise acquired will prove invaluable as they progress toward their next endeavor: a 23 and 13 cm Venus bounce experiment planned for October 2026.

We have also learned that the EVE system requires multi-layered protection (both software and hardware) to avoid random failures.

Additionally, we are moving forward to enhance the signal detection and processing software by developing a more robust algorithm.

Steps Since April Interim Report

1. We have developed a new software architecture that addresses all previously identified gaps. We have added new scripts for verification and multi-stage processing

2. We are developing the next-generation design of a dual-band 23 cm/13 cm TX/RX system for the EVE project, which includes a 1,500-watt PA for the 13 cm band.

3. The 18.3-meter dish feed point design has been modified to allow more flexibility in changing feeds for diverse scientific projects and the optimization of the focal point.

4. These new techniques help DSES to support future scientific experiments and interplanetary communications.

In almost every way, EVE25 was a success for DSES and our members. The lessons learned from this activity have resulted in upgrades to the coax cables, electrical wiring, and grounding at the antenna structure, and improved grounding and bonding for the control center. In turn, this resulted in the first ever successful detection by DSES of a sub-1Jy radio source. The team, led by Dan Layne, successfully detected all three types of radio pulses emitted by the Crab pulsar. This success might not have happened without the lessons learned from EVE25.

We also gained confidence in our ability to undertake challenging projects. Examples of such future projects that may be pursued are tracking the Artemis manned mission to the moon, detecting deep space satellites, including the Voyager satellites, and bouncing signals off the Apophis asteroid in 2029.

About

The Deep Space Exploration Society (DSES), with amateur radio station callsign K0PRT, is a Colorado-based 501 (c) (3) nonprofit organization and has been recently recognized as a Colorado Charity dedicated to practical astronomy and space science education for students, the general public, and society members.

Our major project is restoring and operating a 60-foot dish antenna for radio astronomy and amateur radio experimenting. The site is located south of Haswell, a small town in Kiowa County, Colorado.

Since 2009, our volunteer team members have been working hard to restore and modernize the antenna and its support facilities. Additionally, we support radio astronomy and amateur radio projects using smaller antennas.

Through STEM, DSES supports educational outreach to high schools in the underserved Southeast part of Colorado, and we rely on your generous donations to continue our work.