Callisto and LWA Antenna Installation at HAARP, Gakona, Alaska

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A new radio telescope installation was completed at the HAARP facility near Gakona, Alaska in September 2021. In addition to a Long Wavelength Array (LWA) antenna, the installation consists of two Callisto radio spectrometers, a dual up-converter for observations in the HF and lower VHF ranges, LWA Power Coupler and supporting equipment and cabling. The system was installed at the Modular UHF Incoherent Scatter Radar (MUIR) site at 62° 23' 20.66" N, 145° 08' 15.65" W.

First light was achieved at 2302 UTC on 2 October, only two days after the installation was completed, by the reception of weak Type III fast-drift solar radio bursts (figure 1). At the time of the bursts, the Sun was 22° elevation and 204° True azimuth. Additional solar radio bursts were received before the end of the UTC day. The emissions also were received at higher frequencies on a similar system at the Cohoe Radio Observatory about 400 km to the southwest.

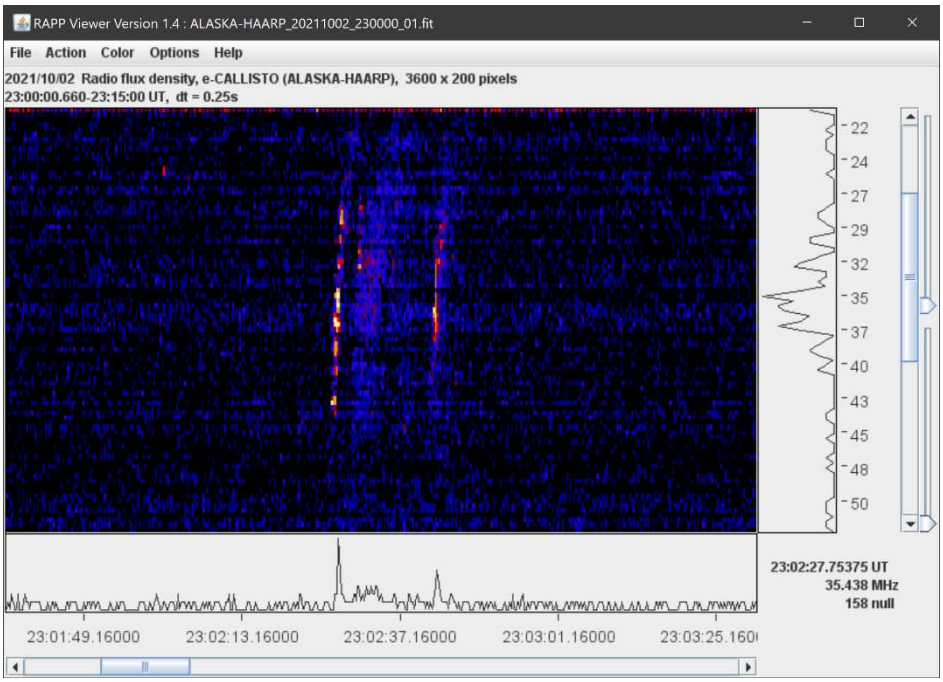

Figure 1 ~ First light! Dim but obvious Type III fast-drift radio bursts observed at 2302 on 2 October between 24 and 45 MHz. Additional radio bursts were received over the next couple hours. Frequency in MHz is shown on the right and time in UTC is along the bottom. The colors indicate relative intensity with black-blue being lower and red-yellow being higher. The text in the lower-right corner indicates the time, frequency and relative intensity of the cursor location when the image was taken (the cursor is not visible in these images).

According to the Space Weather Prediction Center's Events report {SWPC-EVNT}, the radio bursts at 2302 were simultaneously received at Palahua, HI, USA (PAL) and Learmonth, Australia (LEA), where they were classified as a relatively minor intensity Type VI burst. A Type VI consists of a series of Type III bursts over a period of 10 minutes or more with no period longer than 30 minutes without activity. Only a few Type III – components of the Type VI – were detected by the new installation at HAARP, probably due to the low elevation of the Sun and the weak nature of the bursts. See {SOLAR} for information on the types and characteristics of Type III, Type VI and other solar radio emissions.

The antenna (figure 2) and radio spectrometers (figure 3) replace a single Callisto that was previously installed and connected to the TCI-540 antenna about 2 km west-northwest {see (Reeve19}). The earlier installation was

decommissioned in May 2021 when the TCI-540 antenna was converted for transmitter operation and subsequently used for some non-solar radio experiments.

Figure 2 ~ LWA Antenna installed at the Modular UHF Incoherent Scatter Radar (MUIR) site on the HAARP facility. The antenna consists of aluminum, tied-fork, crossed-dipoles supported on a 1.5 m steel mast. Frequency range is approximately 10 to 100 MHz but is usable only to about 85 MHz because of FM broadcast station interference. Image © 2021 W. Reeve

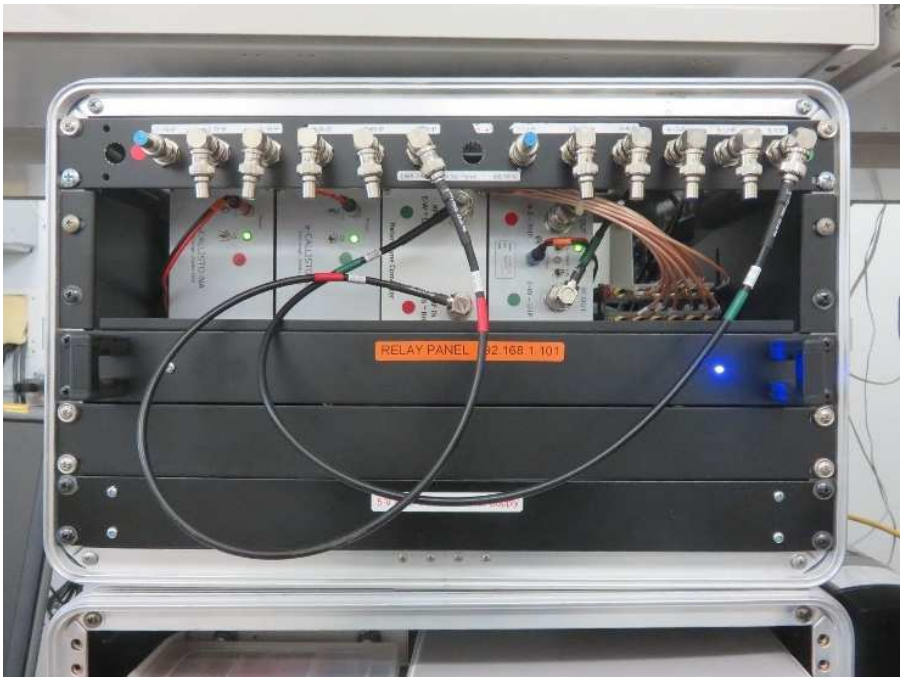

Figure 2 ~ All electronics were installed in an equipment cabinet (of the type used by musicians) and placed in the MUIR enclosure. The two Callistos are at the upper-left. Next to them, and in the middle, is the UPC-590L dual up-converter and to its right is the LWAPC-Q power coupler. The RF patch panel along the top of the cabinet is connected to two 6-port splitters on the far-right next to the LWAPC-Q. Immediately below is the LAN-controlled relay panel for remotely cycling the dc power to the Callistos. At the bottom of the cabinet are the 5, 12 and 15 Vdc power supplies. Not shown are the PC, LAN/WAN components and Uninterruptible Power System.

An LWA Antenna installation was planned prior to converting the TCI-540 antenna but its installation was temporarily stalled until a new site could be found. A survey of potential new sites was completed in May 2021 with selection of the MUIR site and associated heated-cooled equipment enclosure (figure 4). Installation of the LWA Antenna was completed in early September and required only a couple days for site preparation and installation. All electronic equipment was preinstalled in a cabinet and tested in Anchorage before deployment.

Figure 3 ~ MUIR equipment enclosure and associated radar antenna array (left-background). All electronics for the Callisto-LWA Antenna installation were placed in the enclosure at the end of September. A protected coaxial cable entrance facility was installed on the back of the enclosure (not visible in this picture). This picture was taken the day before the weather station and lightning sensor was installed on the enclosure. Image © 2021 W. Reeve

A block diagram of the new installation shows the RF components (figure 4). The two crossed-dipole antenna polarizations are connected through 6-port splitters to an RF patch panel that allows connection of the up-converters and Callistos as well as other receivers. Power is provided to the LWA Antenna Front-End Electronics (FEE) by an LWA Power Coupler with Quadrature Coupler (LWAPC-Q). The quadrature coupler provides right-hand and left-hand circular polarized outputs from the LWA Antenna's linear polarized dipoles.

The Callisto instruments have an instantaneous bandwidth of approximately 300 kHz and an integration time of 1 ms. The Callisto software collects data as Flexible Image Transport System (FITS) files, which are stored locally. The files also are uploaded automatically to Fachhochschule Nordwestschweiz (FHNW) University of Applied Sciences & Arts website for permanent archiving. Data from the HAARP Callisto installation as well as other stations within the e-CALLISTO network are located at {e-CALLISTO}. Callisto data uploads and local archiving are controlled by System Scheduler software using an FTP script developed by Christian Monstein.

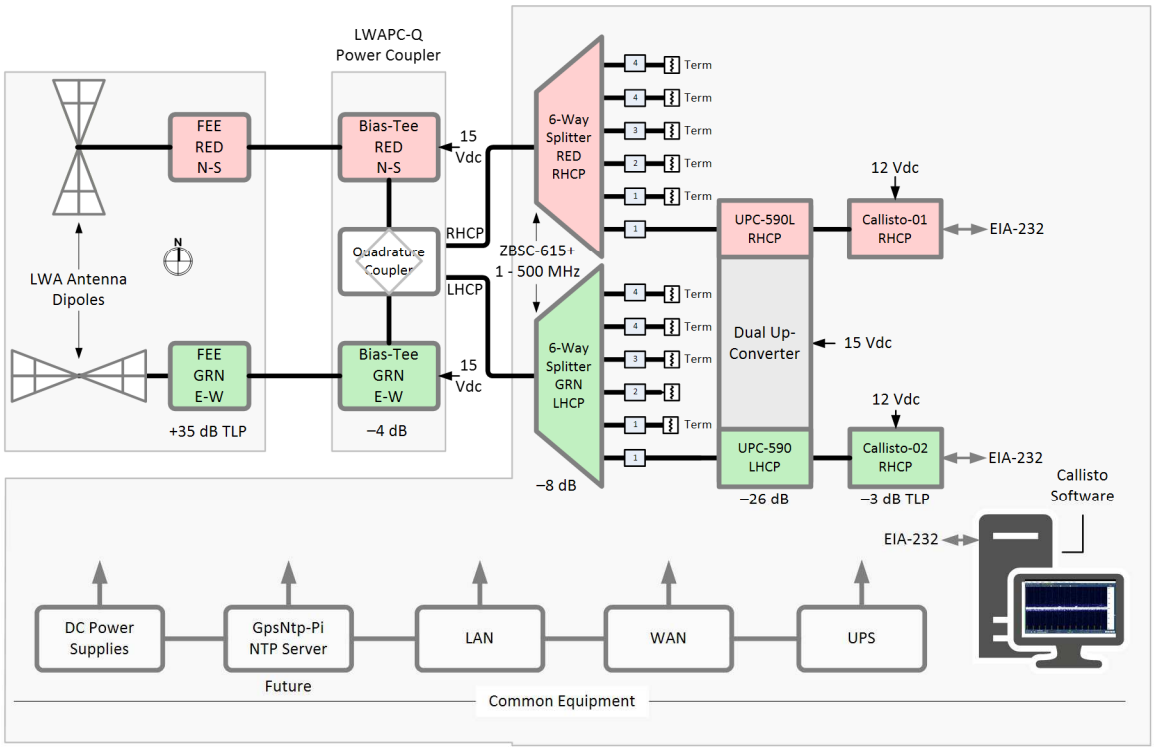

Figure 4 ~ System block diagram shows the components associated with the LWA Antenna and Callisto instruments and the common equipment shared across the observatory. Polarizations are color-coded: Red, RHCP; Green, LHCP. To offset the high gain of the LWA Antenna FEE, the up-converter has an internal 20 dB attenuator in each channel to provides an overall conversion loss of 26 dB. The splitter and quadrature coupler losses add up to 12 dB, resulting in a Transmission Level Point (TLP) at the Callisto RF input of –3 dB. Image © 2021 W. Reeve

References & Weblinks:

{e-CALLISTO} http://soleil.i4ds.ch/solarradio/callistoQuicklooks/

{Reeve19} Reeve, W., New Radio Observatory Established at HAARP in Gakona, Alaska, 2019, available at: https://www.reeve.com/Documents/Articles%20Papers/Reeve_HAARP-System.pdf

{SOLAR} http://www.reeve.com/Solar/Solar.htm

{SWPC-EVNT} ftp://ftp.swpc.noaa.gov/pub/indices/events/

Document Information

Author: Whitham D. Reeve

Revisions: 0.0 (Original draft started, 03 Oct 2021)
0.1 (Revised layout, 06 Oct 2021)
0.2 (Completed 1st draft, 07 Oct 2021)
0.3 (Distribution, 08 Oct 2021)

Word count: 1100
File size (bytes): 1667469