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Final Report: Acquisition of a Portable Interferometric Radio Imaging System \\ for Ionospheric and Atmospheric Research and STEM Education

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7. PERFORMING ORGANIZATION NAMES AND ADDRESSES
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Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not contrued as an official Department of the Army position, policy or decision, unless so designated by other documentation.

14. ABSTRACT

15. SUBJECT TERMS

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a. REPORT	b. ABSTRACT	c. THIS PAGE			Brett Isham
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RPPR Final Report
as of 12-Jul-2022

Agency Code: 21XD

Proposal Number: 74274RTREP **Agreement Number: W911NF-19-1-0486**
INVESTIGATOR(S):

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Report Date: 02-Jun-2022 Date Received: 30-May-2022
Final Report for Period Beginning 03-Sep-2019 and Ending 02-Mar-2022
Title: Acquisition of a Portable Interferometric Radio Imaging System \\ for Ionospheric and Atmospheric Research and STEM Education
Begin Performance Period: 03-Sep-2019 **End Performance Period:** 02-Mar-2022
Report Term: 0-Other

Submitted By: Brett Isham Email: bisham@bayamon.inter.edu
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Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees: 0 **STEM Participants:**

Major Goals: The major goal of the project was the acquisition of a portable 0.1 to 30-MHz interferometric radio imaging system. The system is for use in ionospheric and atmospheric research projects in Puerto Rico and worldwide. Key features of the equipment are full polarization, high time resolution, wide frequency band, portability, flexibility, and cableless phase coherence. The components of the system can be operated individually or together. When operated with pairs or groups of antennas, interferometric radio direction-finding and radio imaging measurements are possible. For interferometric observations phase must be maintained. This can be done via cable connections for short separations between components, and, for short or long separations, each component has a rubidium-GPS clock able to maintain phase without a cable connection. In both cases phase and polarization can be calibrated.

The equipment has wide application in space weather research. When used with a compatible radar transmitter, the radar imaging capabilities of the system can provide a 3-D view (in latitude, longitude, and altitude) of radar scattering. Multiple bistatic radar observations can also provide information over a large area. Both can add to our knowledge of space weather on all scales, including local phenomena and connections between the equator and mid-latitudes. The equipment can also provide insights into ionospheric radio emissions, such as those stimulated by high-power high-frequency research transmitters as a result of inducing ionospheric plasma turbulence. The sideband radio emissions produced by the turbulence which can be imaged by the proposed equipment, something never done before, which promises new discoveries and new insights into space and basic plasma processes.

Accomplishments: The equipment was successfully purchased and delivered.

Training Opportunities: The vendor provided training to the PI both remotely and at the vendor location.

Results Dissemination: There was no development or research associated with this award, so there is no dissemination to report.

RPPR Final Report
as of 12-Jul-2022

Honors and Awards: There was no development or research associated with this award, so there are no honors or awards to report.

Protocol Activity Status:

Technology Transfer: This was a purchase of equipment, so there is no technology transfer to report. However, the vendor responded to requests by the PI for features to be included in the equipment specific to the research envisioned by the PI, including phase coherence between separate units, and long time series recording for radio data.

PARTICIPANTS:

Participant Type: PD/PI
Participant: Brett Isham
Person Months Worked: 2.00 **Funding Support:**
Project Contribution:
National Academy Member: N

Partners

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I certify that the information in the report is complete and accurate:
Signature: Brett Cameron Isham
Signature Date: 5/30/22 9:11PM

FINAL REPORT FOR CONTRACT NUMBER W911NF1910486
ACQUISITION OF A PORTABLE INTERFEROMETRIC RADIO IMAGING SYSTEM FOR IONOSPHERIC AND ATMOSPHERIC 2 OF RESEARCH AND STEM EDUCATION

Dates Covered: 3 Sep 2019 to 2 Mar 2022

Brett Isham, PI

30 May 2022

MAJOR PROJECT GOALS

The major goal of the project was the acquisition of a portable 0.1 to 30-MHz interferometric radio imaging system. The system is for use in ionospheric and atmospheric research projects in Puerto Rico and worldwide. Key features of the equipment are full polarization, high time resolution, wide frequency band, portability, flexibility, and cableless phase coherence. The components of the system can be operated individually or together. When operated with pairs or groups of antennas, interferometric radio direction-finding and radio imaging measurements are possible. For interferometric observations phase must be maintained. This can be done via cable connections for short separations between components, and, for short or long separations, each component has a rubidium-GPS clock able to maintain phase without a cable connection. In both cases phase and polarization can be calibrated.

The equipment has wide application in space weather research. When used with a compatible radar transmitter, the radar imaging capabilities of the system can provide a 3-D view (in latitude, longitude, and altitude) of radar scattering. Multiple bistatic radar observations can also provide information over a large area. Both can add to our knowledge of space weather on all scales, including local phenomena and connections between the equator and mid-latitudes. The equipment can also provide insights into ionospheric radio emissions, such as those stimulated by high-power high-frequency research transmitters as a result of inducing ionospheric plasma turbulence. The sideband radio emissions produced by the turbulence which can be imaged by the proposed equipment, something never done before, which promises new discoveries and new insights into space and basic plasma processes.

PROJECT ACCOMPLISHMENTS

The equipment was successfully purchased and delivered.

TRAINING OPPORTUNITIES

The vendor provided training to the PI both remotely and at the vendor location.

TECHNOLOGY TRANSFER

This was a purchase of equipment, so there is no technology transfer to report. However, the vendor responded to requests by the PI for features to be included in the equipment specific to the research envisioned by the PI, including phase coherence between separate units, and long time series recording for radio data.