Low-Frequency Observations of the Radio Sky from Marion Island

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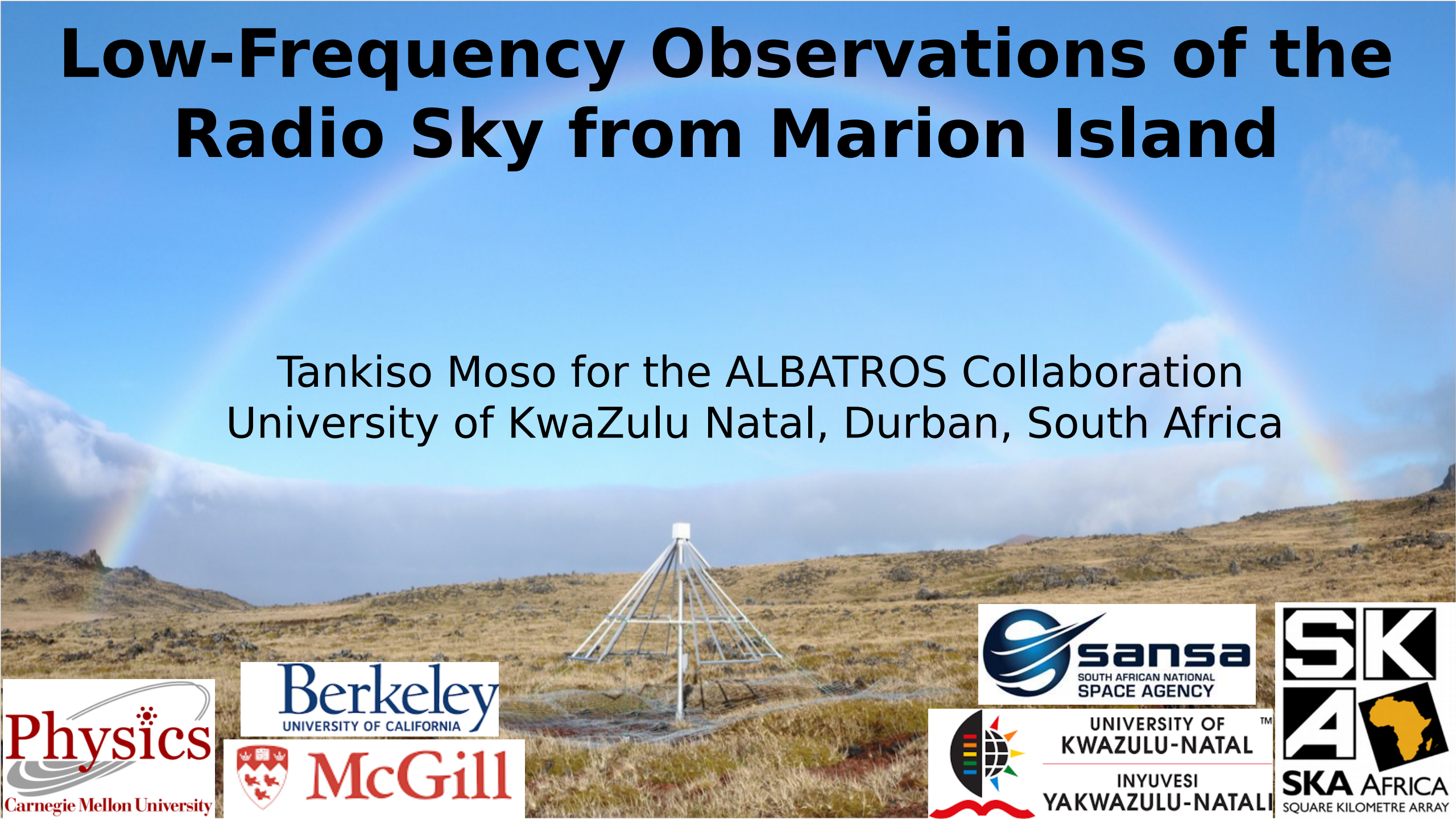
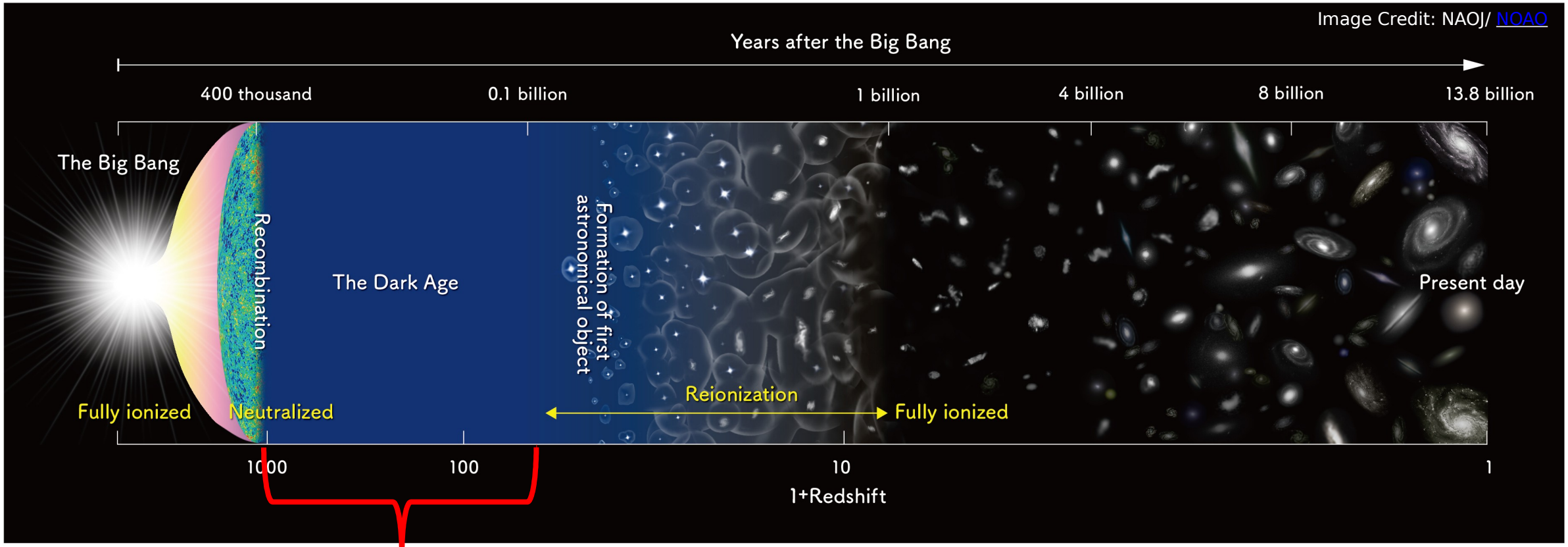


History of the Universe



The final goal is to lay groundwork for exploring the dark ages.

For now we're taking steps towards mapping the foregrounds and the frequencies of interest are from ~1.3 MHz to ~46 MHz ($z \sim 1100 - z \sim 30$).

The State of Art at Low Frequencies

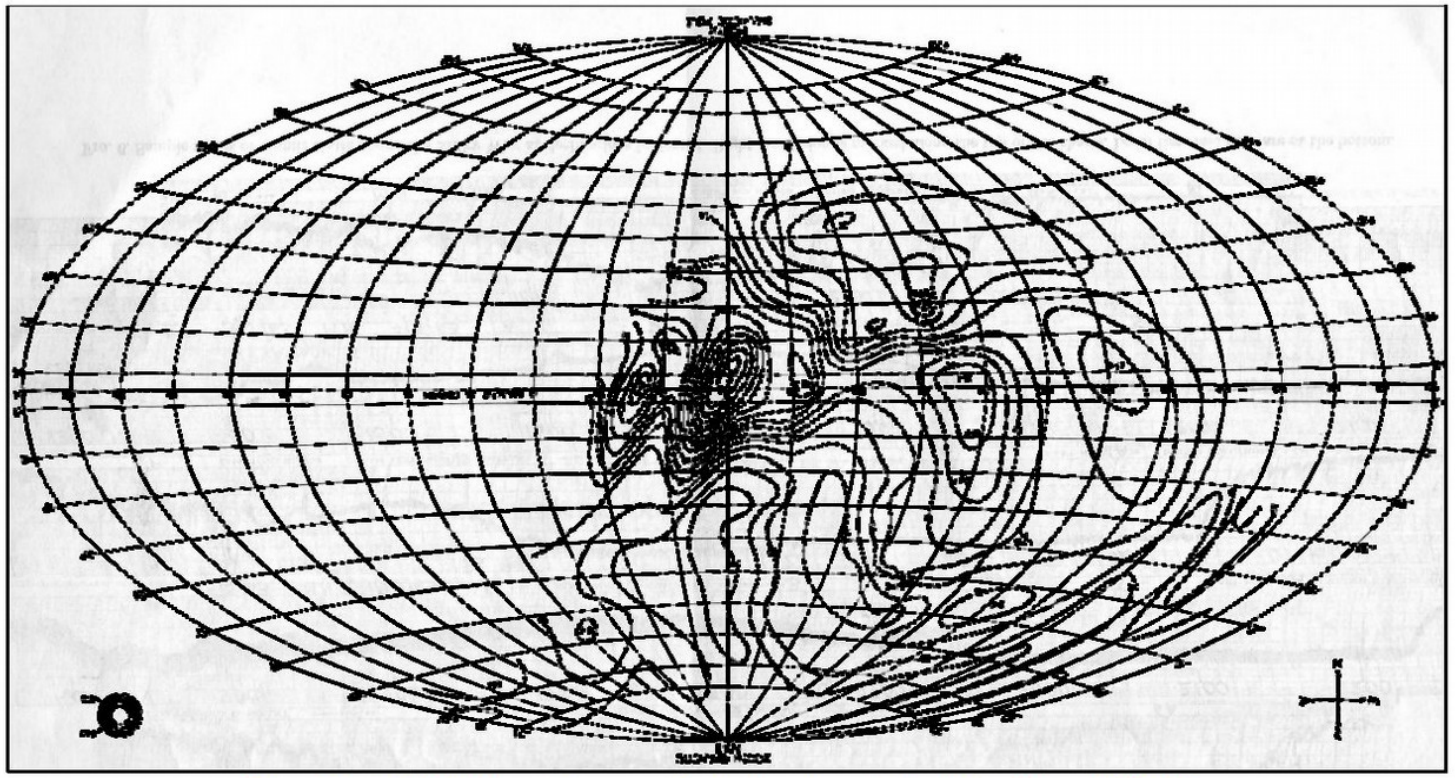
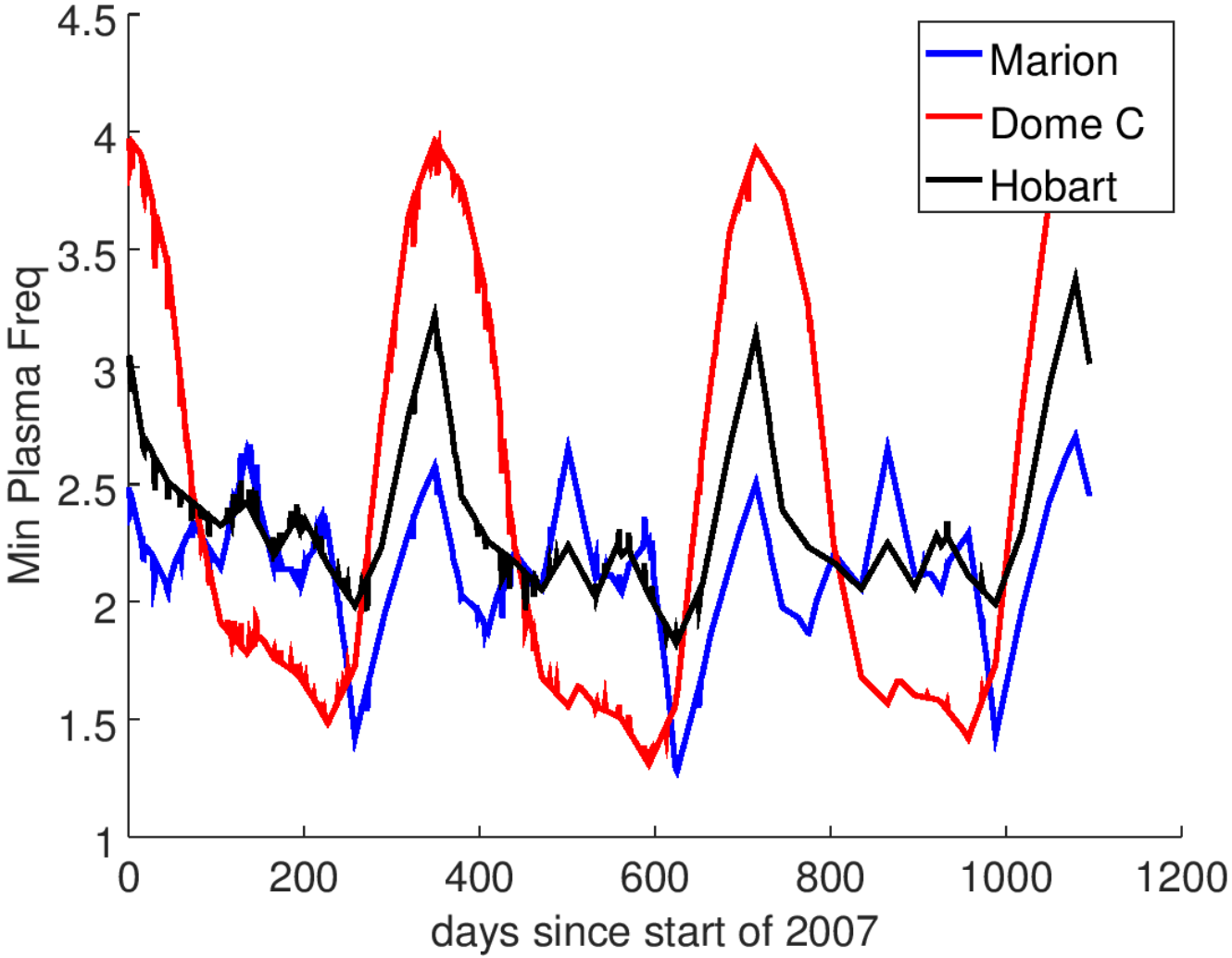


Figure 11: A 2.085 MHz contour map of galactic radio emission (after Reber, 1968: 10).

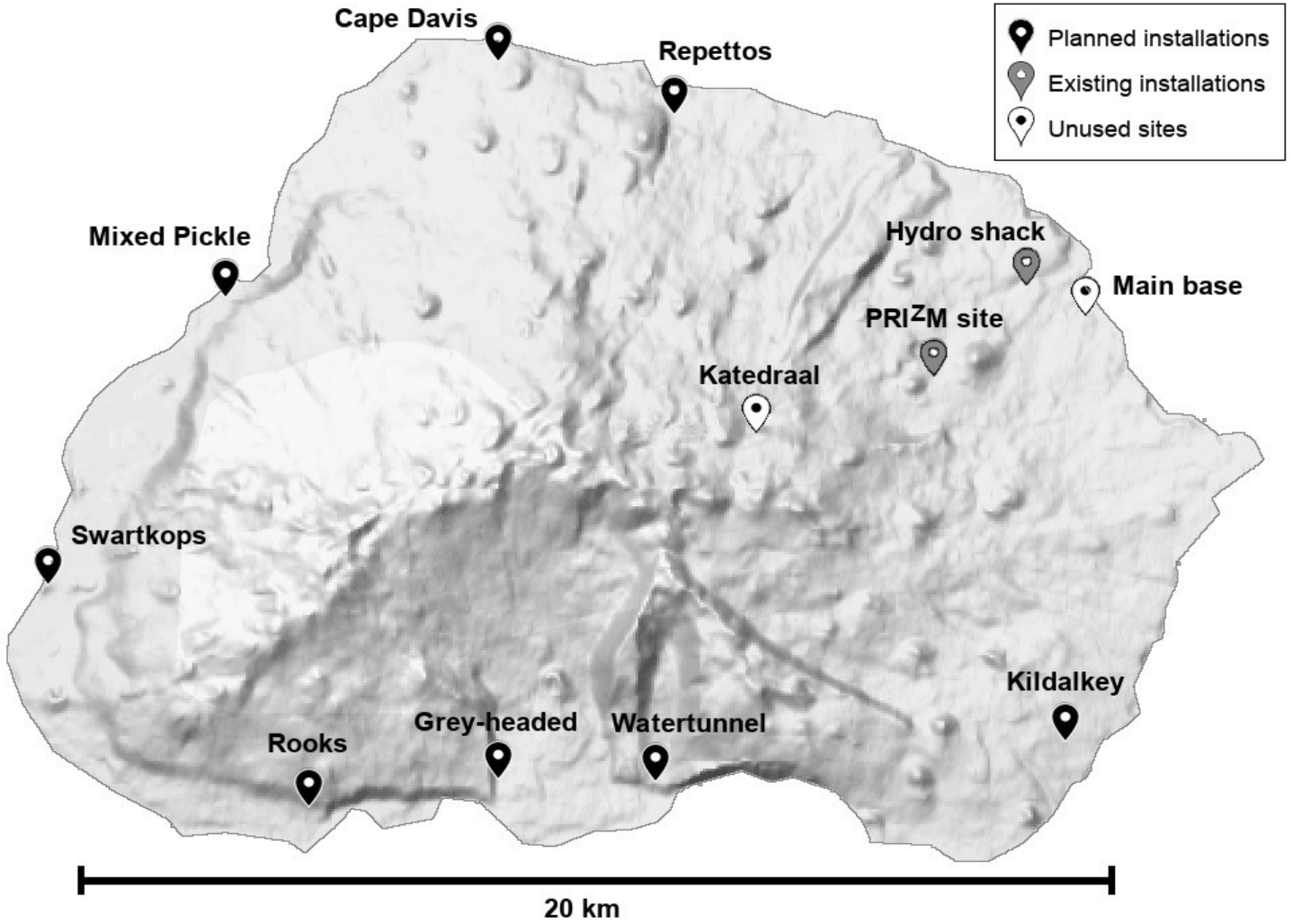
Experiment	Frequency	Resolution	Year
DRAO Penticton	≈10 MHz	≈2 deg	1967
Grote Reber	≈2.1 MHz	≈5 deg	1968
RAE-B Satellite	≈4.7 MHz	≈10 deg	1978
DRAO	≈22 MHz	≈1.1 – 1.7 deg	1999
LWA	≈36 MHz	≈15 arcmin	2017

How low can we go on Marion

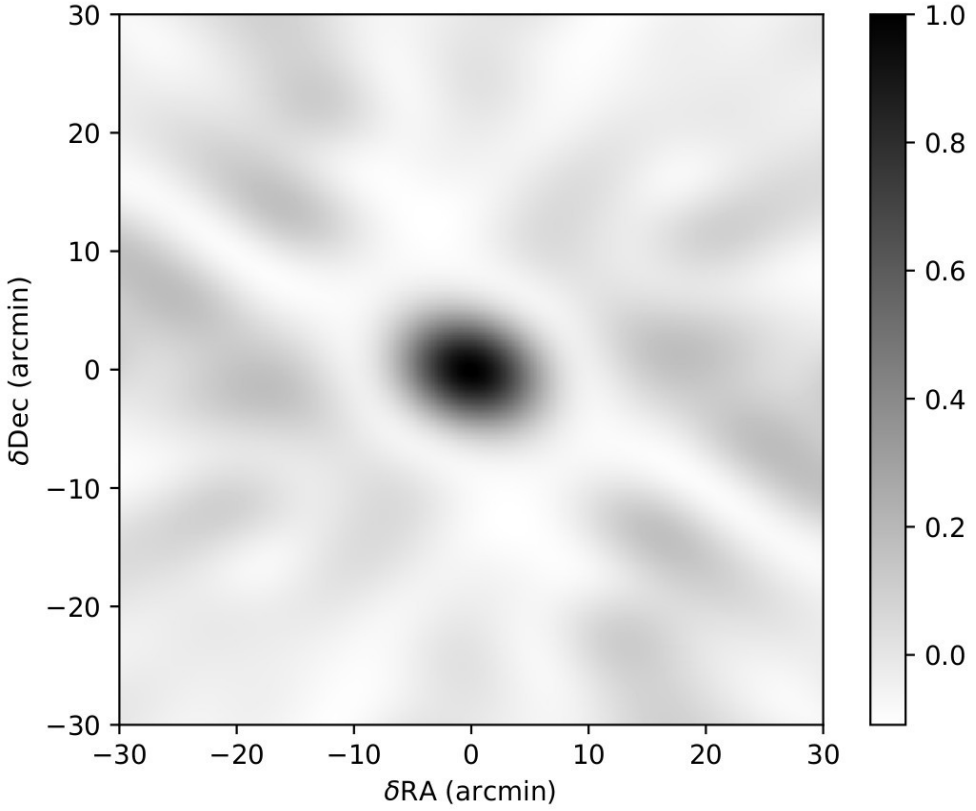


- The International Reference Ionosphere model predictions illustrating the ionospheric plasma cutoff frequency at ~ 1.5 MHz during last solar minima.

Autonomous Stations

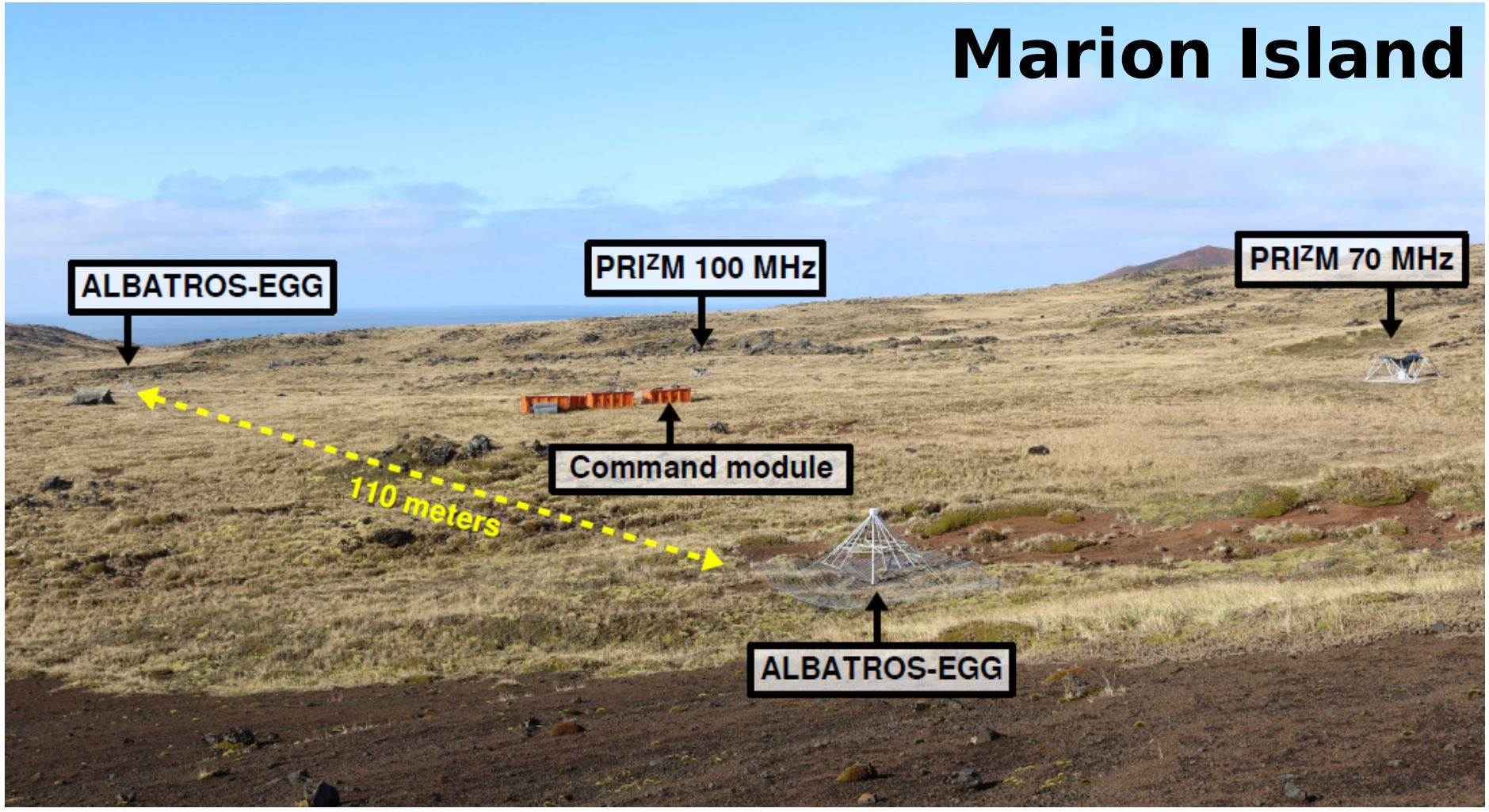


- Will be the final project which will consist of autonomous antenna stations separated by baselines of ≈20 km.

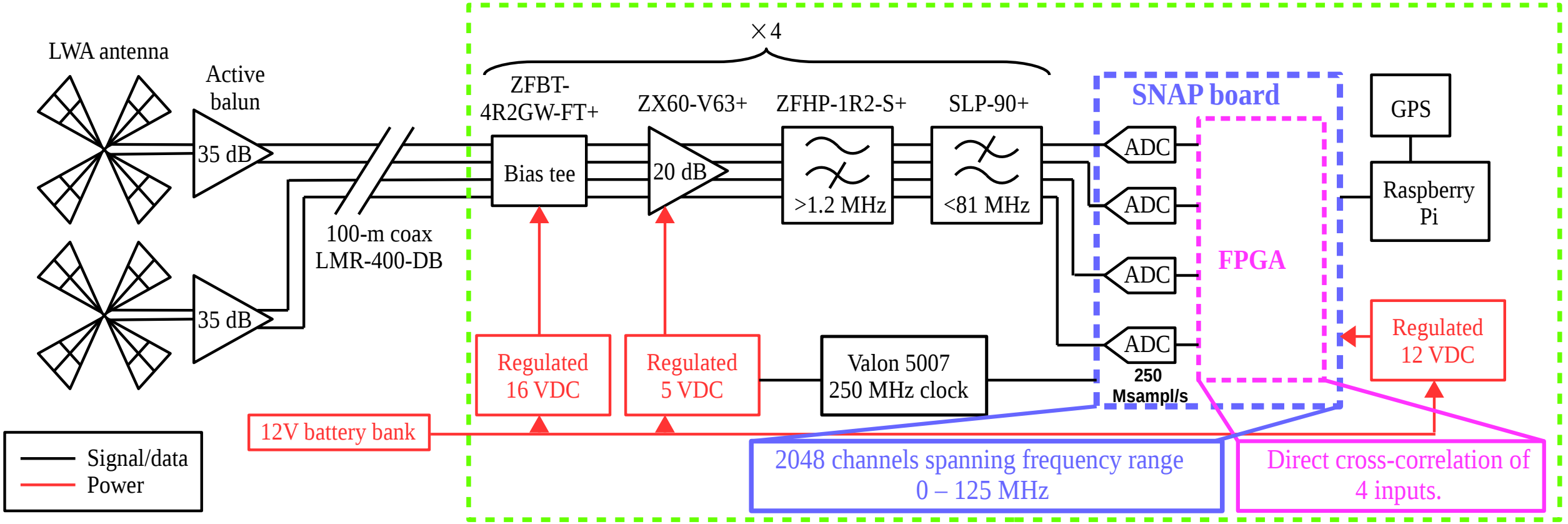


- Marion Island huts which are potential stations for the ALBATROS have a ring-like pattern which is appropriate for imaging and produces an angular resolution of ~ 7’ for a synthesized beam at 5 MHz

Array of Long Baseline Antennas for Taking Radio Observations from the Sub-Antarctic (ALBATROS) - Pathfinder

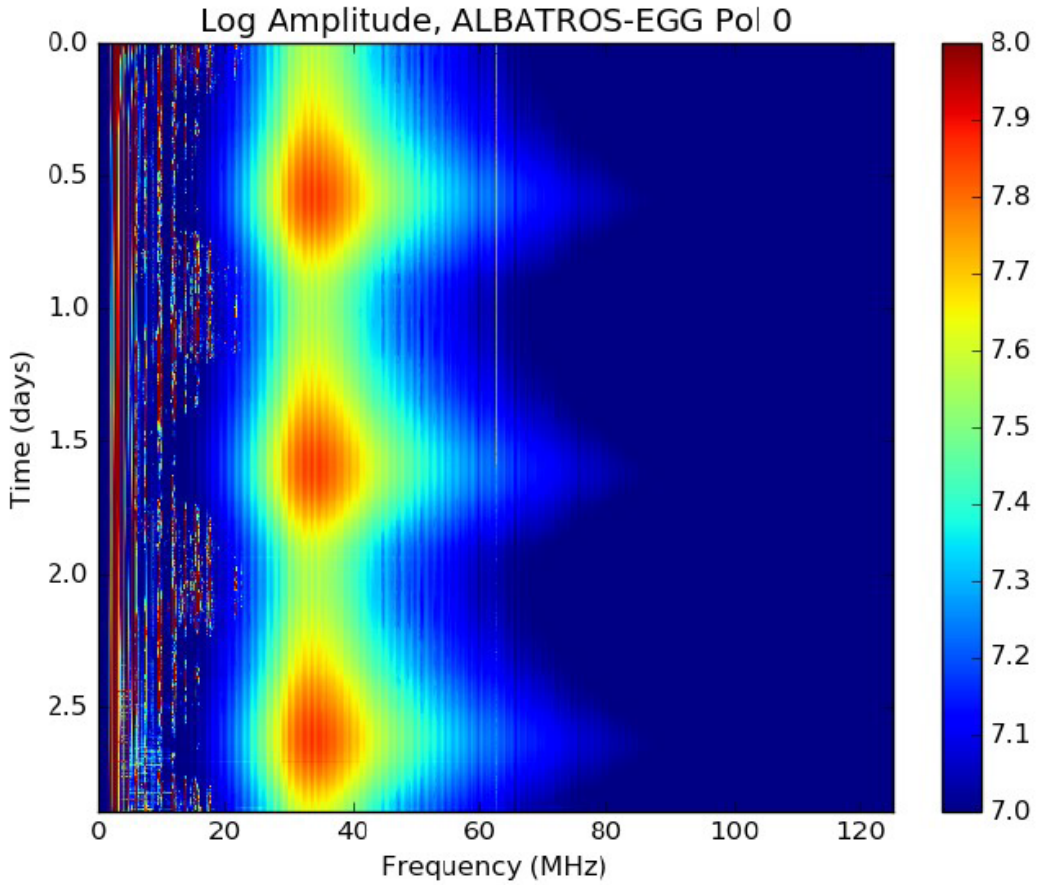


Pathfinder Block Diagram



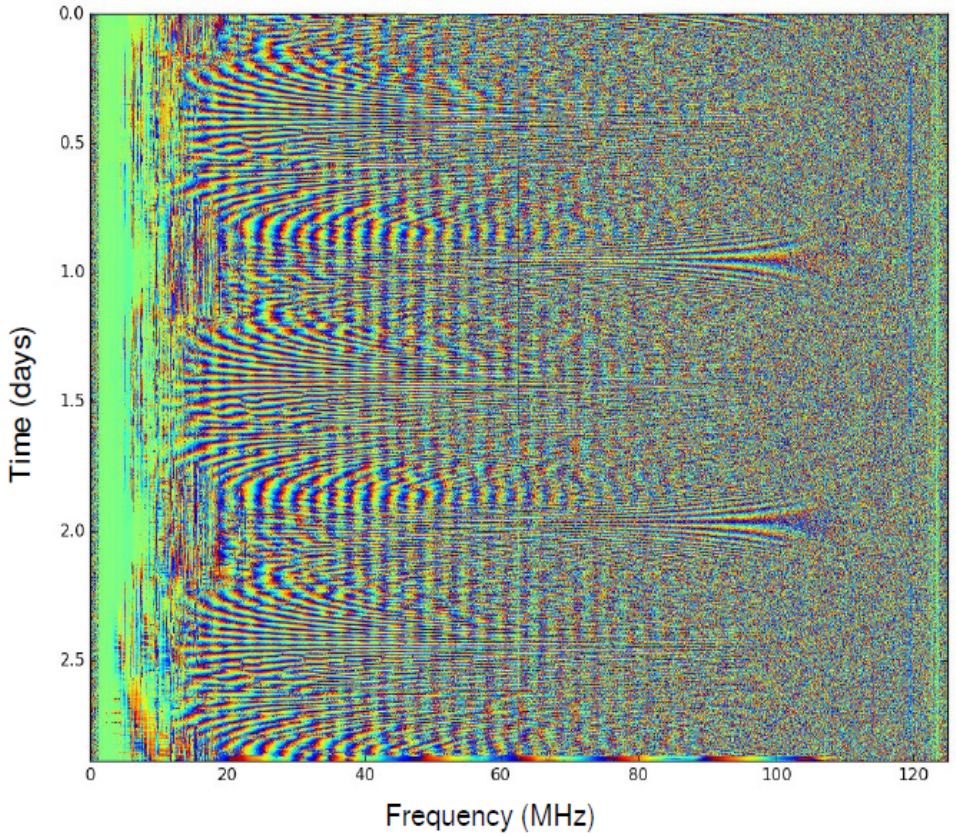
Pathfinder Results

Auto spectra



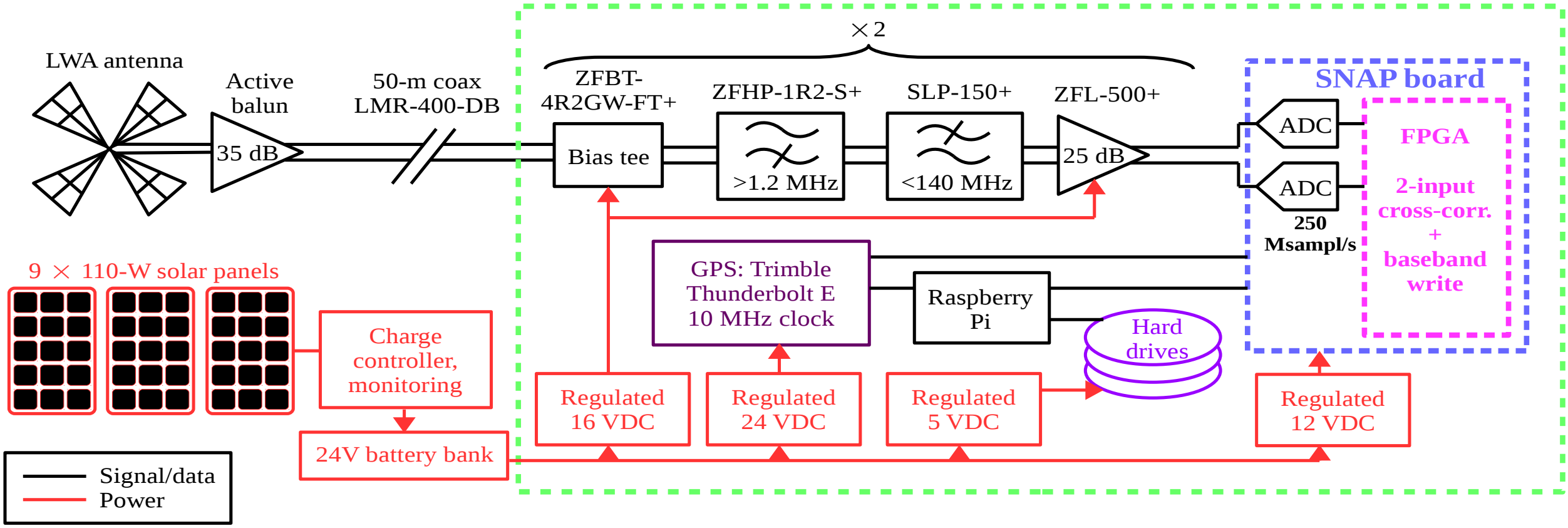
- Waterfall runs for 3 days
- Galaxy rising clearly visible.
- Ripples in frequency because of uncalibrated data

Cross Correlation



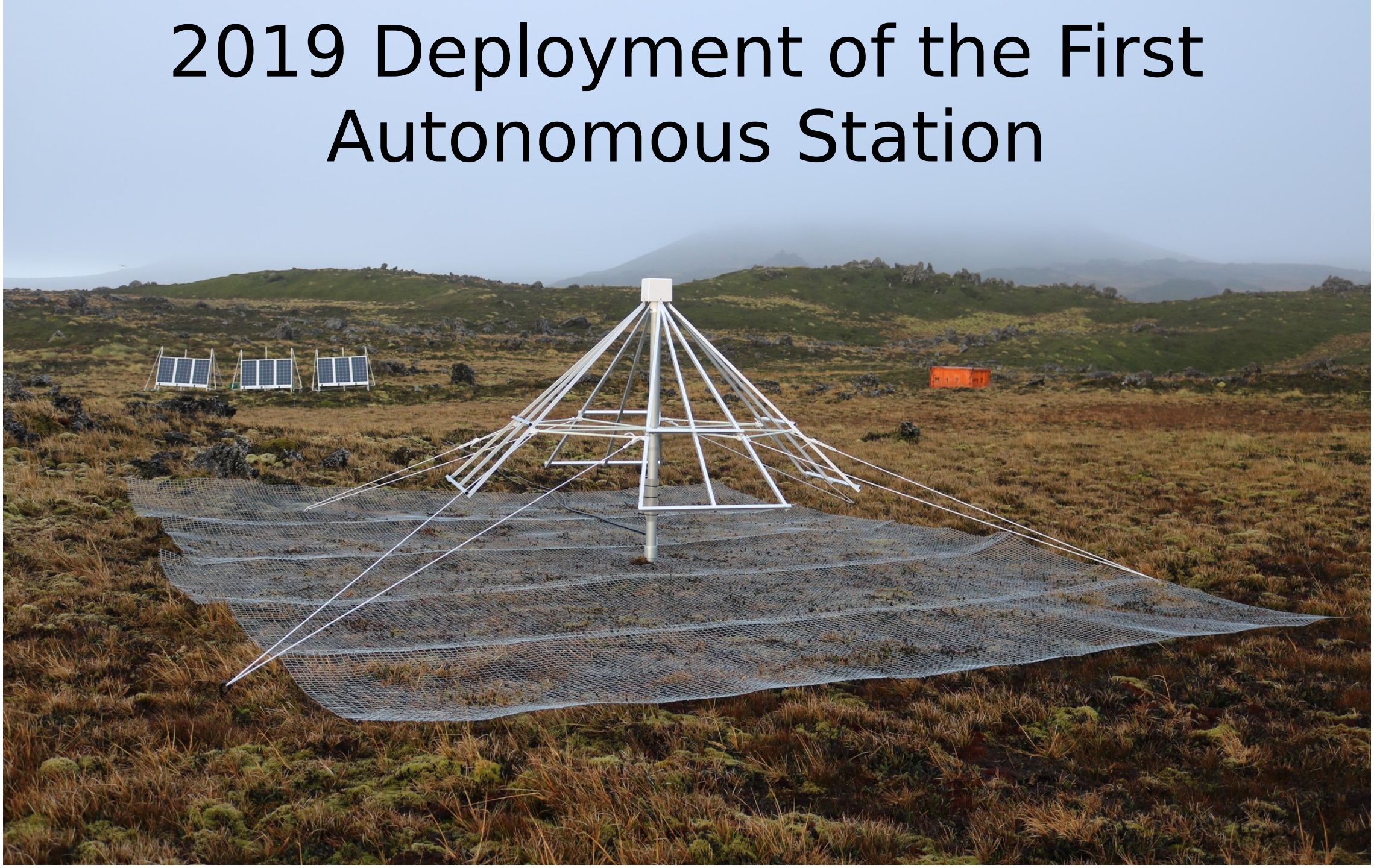
- Fringes clearly visible
- Repeatable structures at ≈10 MHz without data processing or cuts

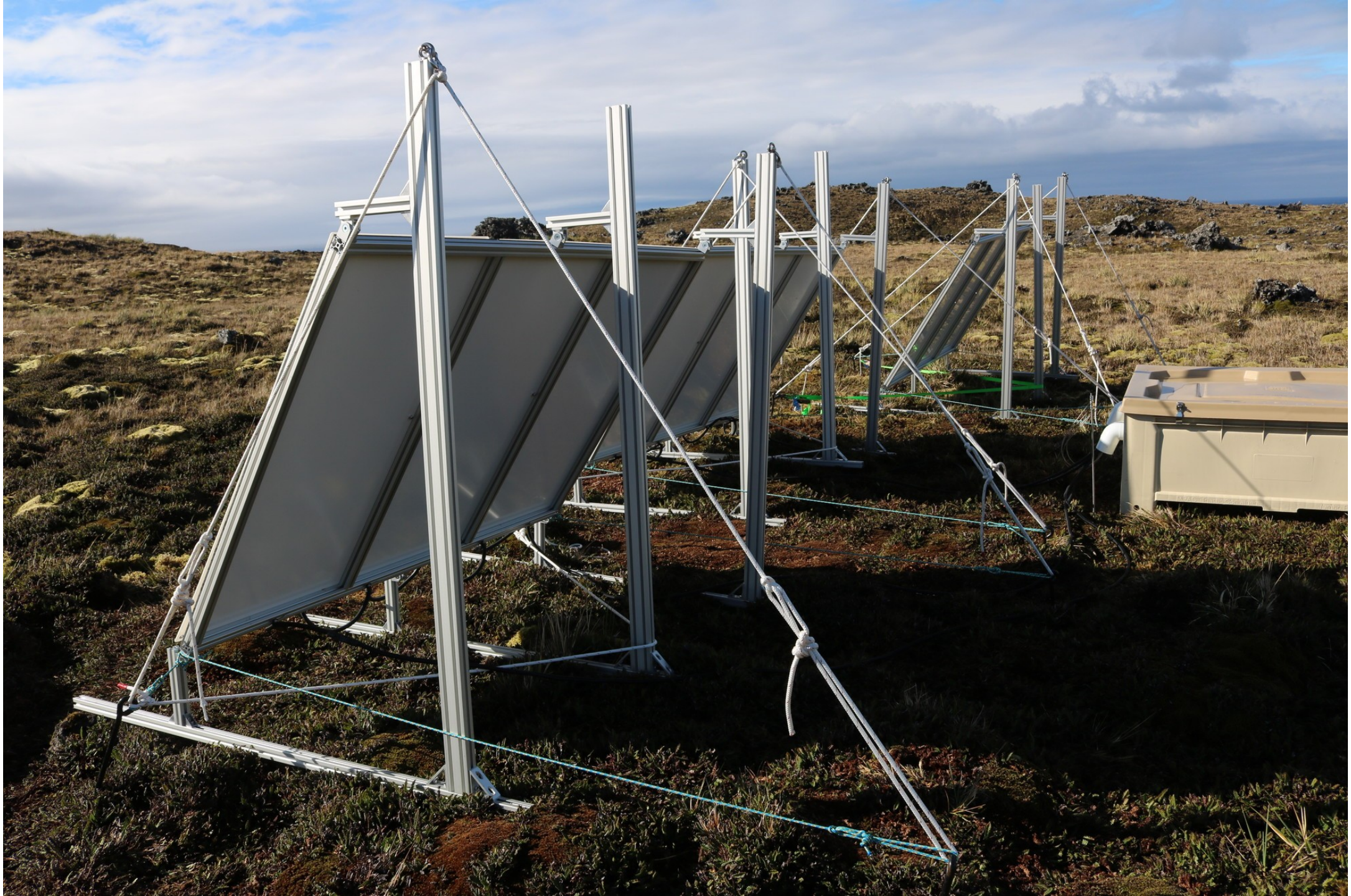
Autonomous Stations

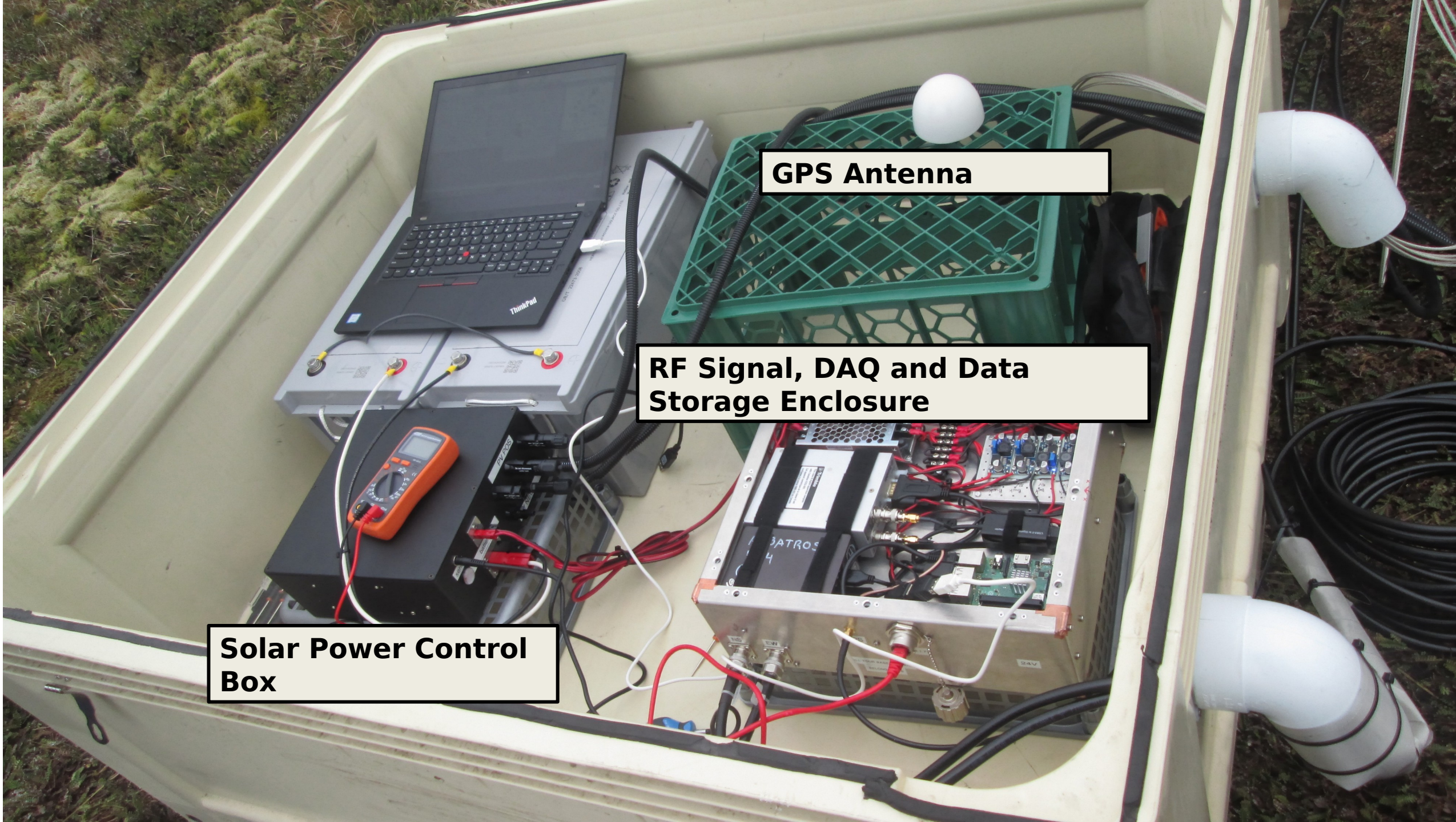


- Current firmware capable of 1-, 2-, 4-bit baseband.

2019 Deployment of the First Autonomous Station





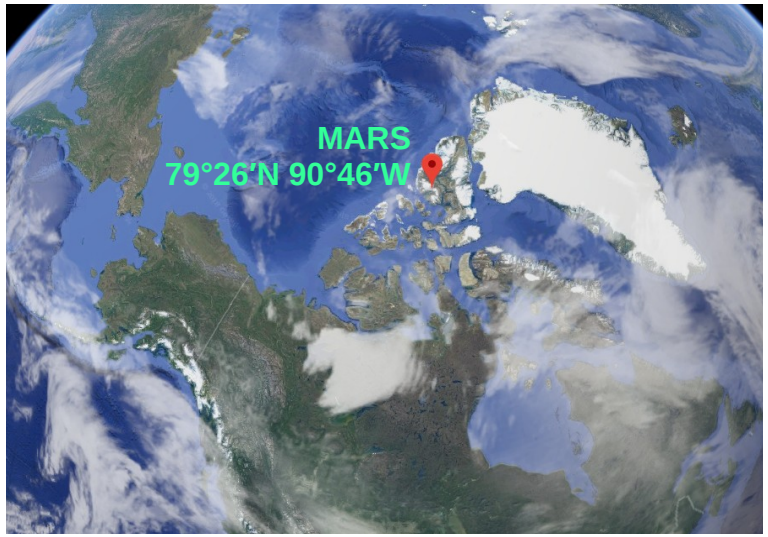

GPS Antenna
RF Signal, DAQ and Data Storage Enclosure
Solar Power Control Box

ALBATROS Baseband Recording

- Random shortwave station broadcasting around 13 MHz
- Audio was recovered using 4-bit baseband
- The higher the number of bits, the higher the signal fidelity.

Conclusion and Future Plans

- Next Marion deployment scheduled for April 2021 (2020 voyage cancelled because of COVID-19).
- Tentative plan of installing two new autonomous stations in 2021 and we will gradually install the rest.
- ALBATROS autonomous stations installation at the McGill Arctic Research Station (MARS)



- Analysis of our available data
- ALBATROS instrument paper in progress

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