Observing the low-frequency sky with ALBATROS

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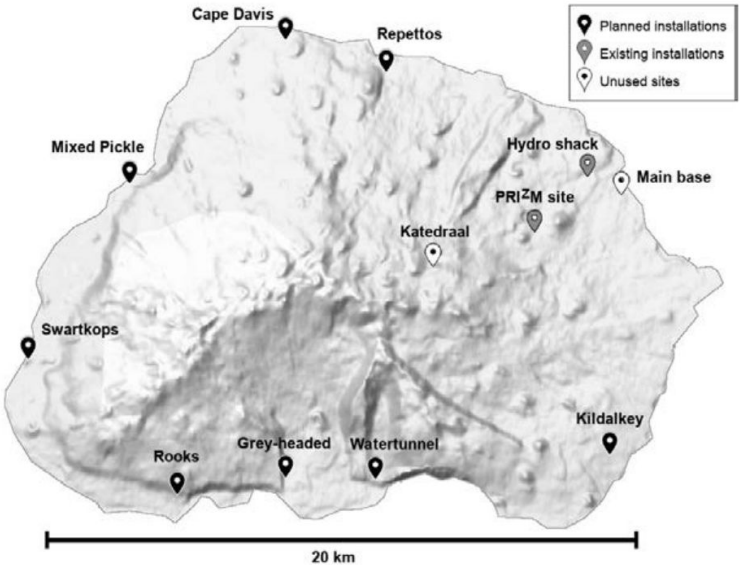
ALBATROS Overview

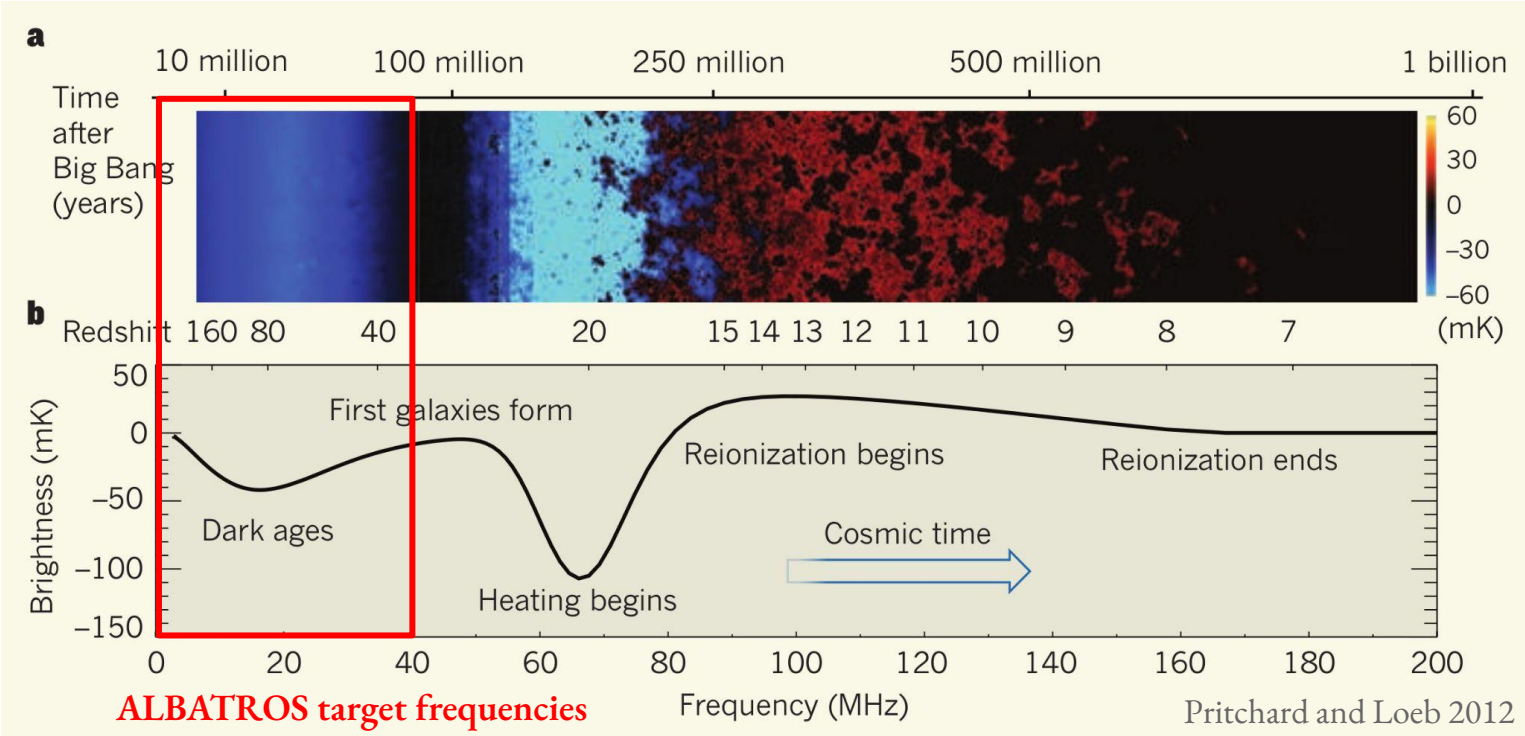
- The **A**rray of **L**ong **B**aseline **A**ntennas for **T**aking **R**adio **O**bservations from the **S**ub-antarctic/**S**eventy-ninth parallel
- Goal: map the sky below 30 MHz
- Remote locations to minimize RFI
- Autonomous antenna stations with ~10 km baselines



Chiang et al 2020

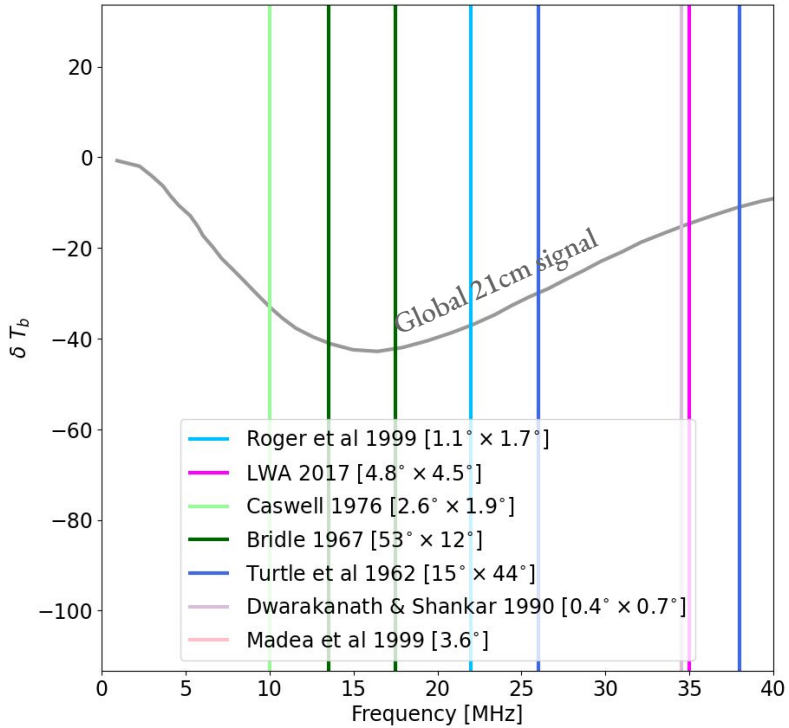
ALBATROS Overview

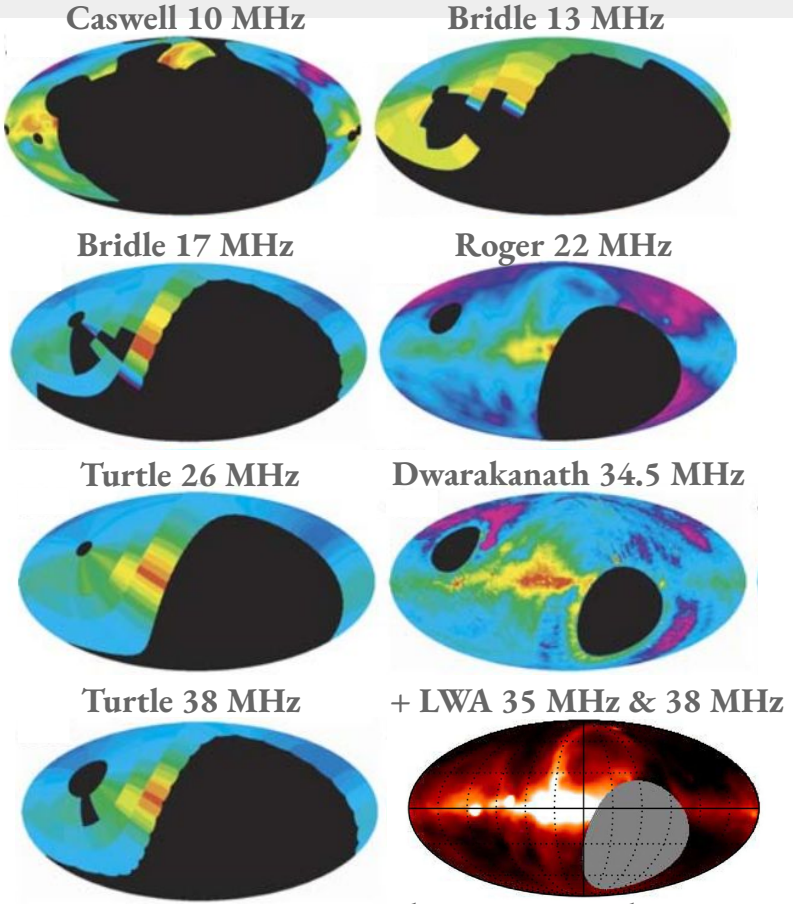
- 21cm emissions from the Cosmic Dark Ages are redshifted to <30 MHz
- Ultimate goal: map 21cm brightness temperature fluctuations from the Dark Ages. **First step: understand foregrounds.**



Our current understanding of the sub 40 MHz sky

Data at low frequencies is both **sparse** and **low-resolution**





De Oliveira-Costa et al 2008, GSM

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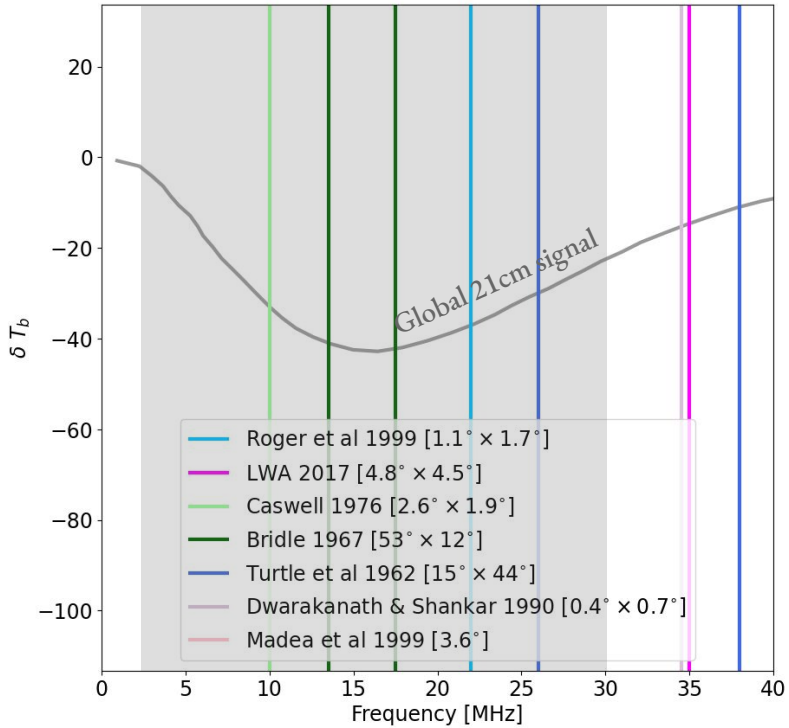
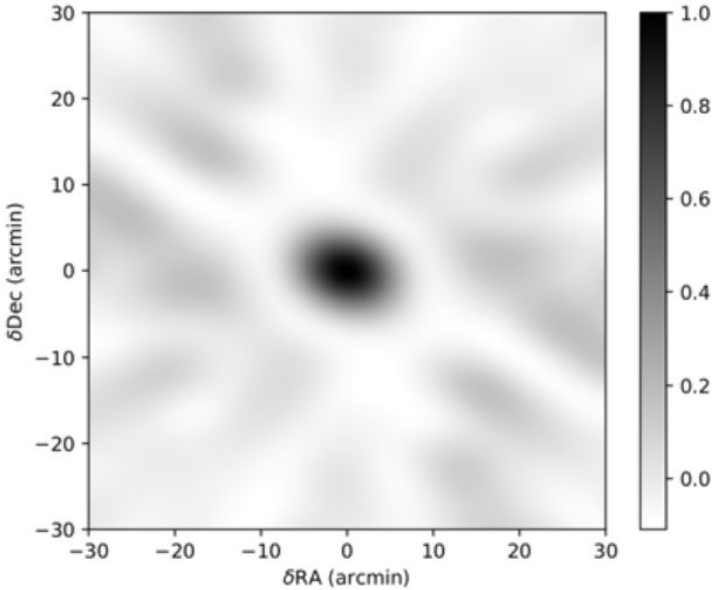


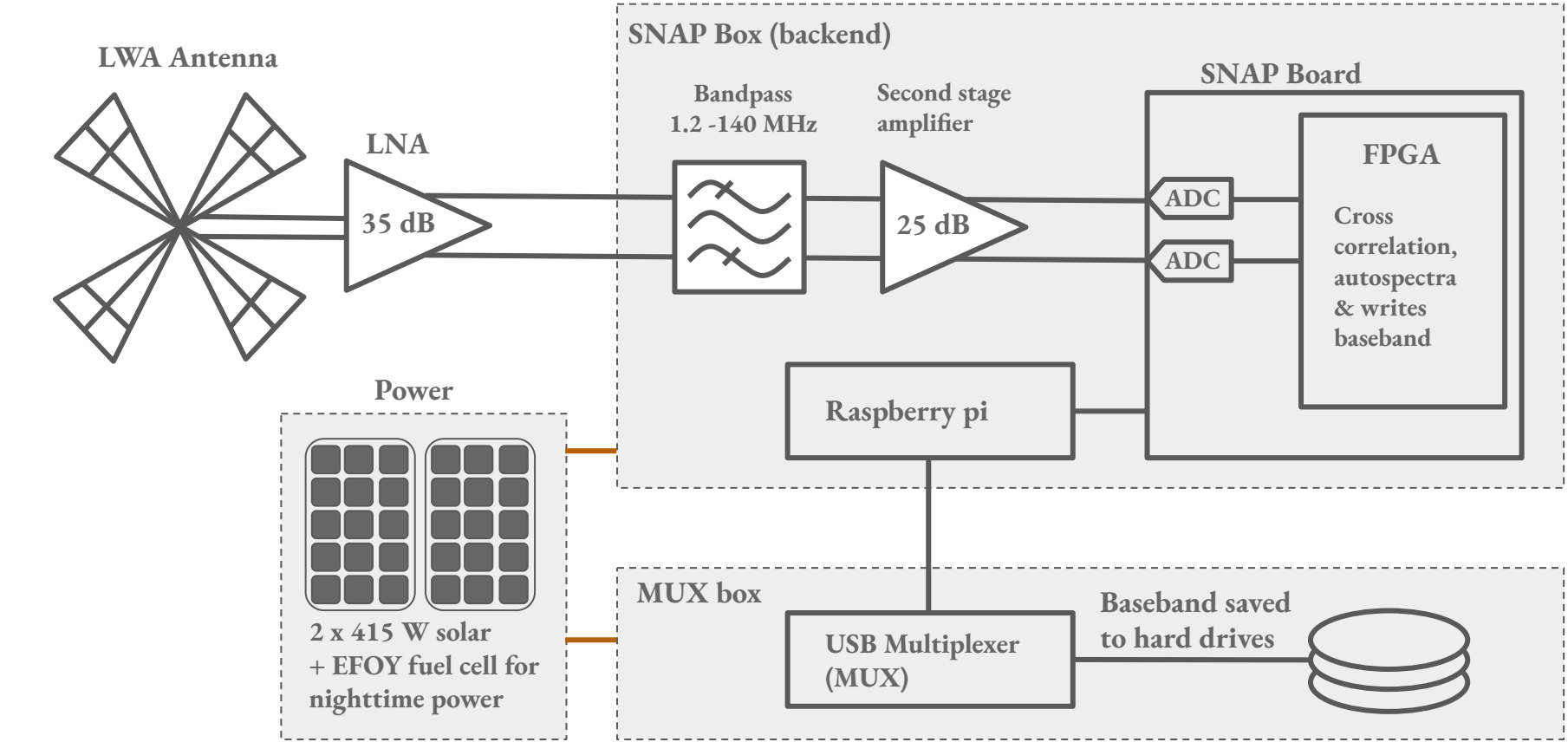
ALBATROS Synthesized beam at 5 MHz



ALBATROS will map the sky below 30 MHz at arcminute resolution

Chiang et al 2020

Simplified ALBATROS block diagram



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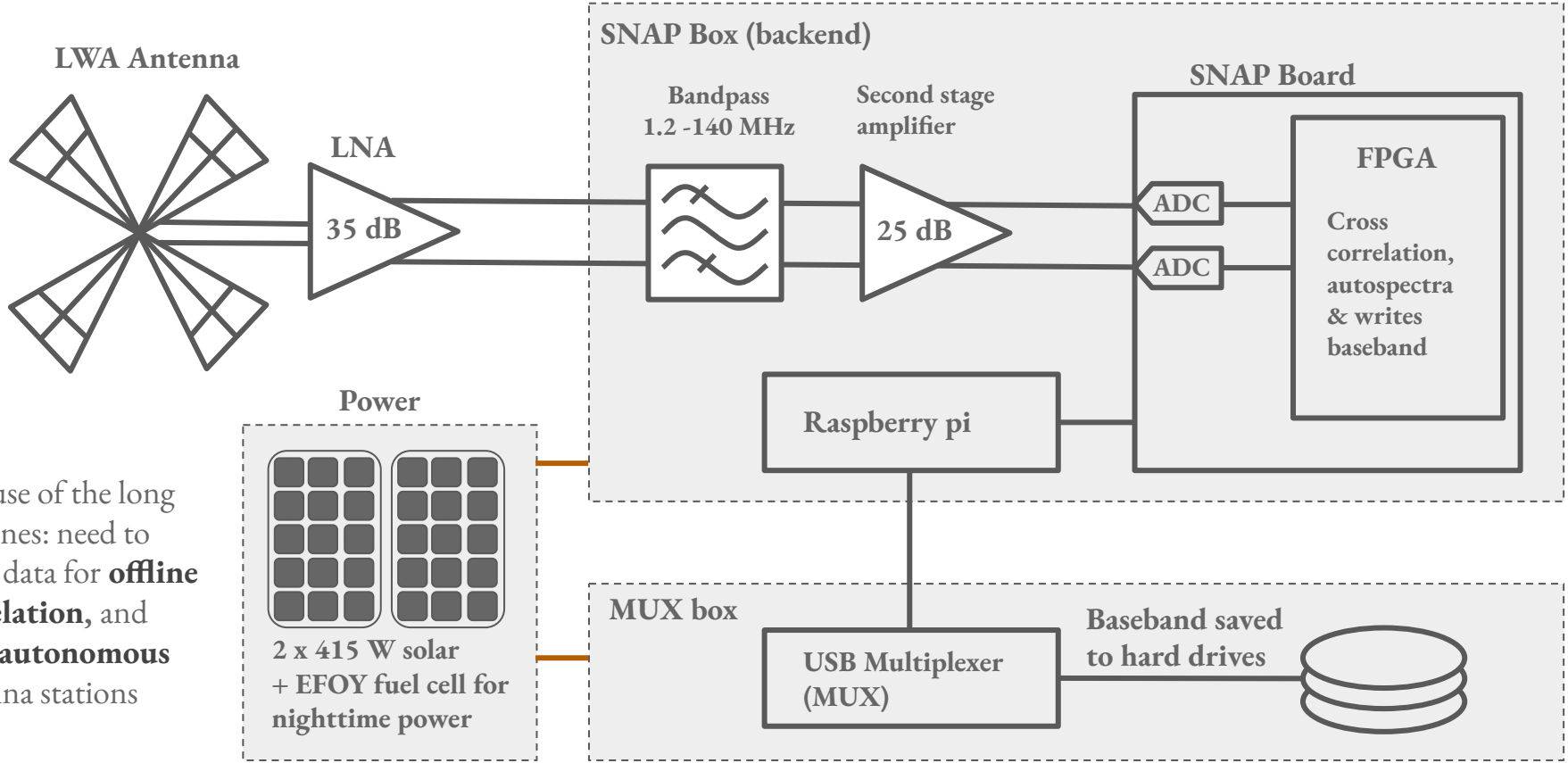
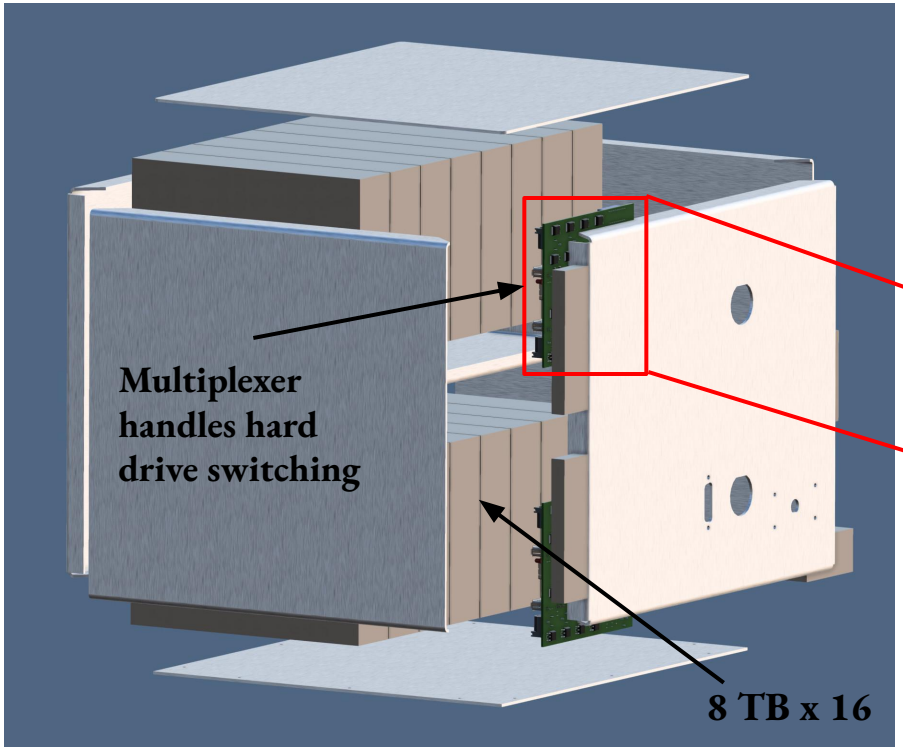
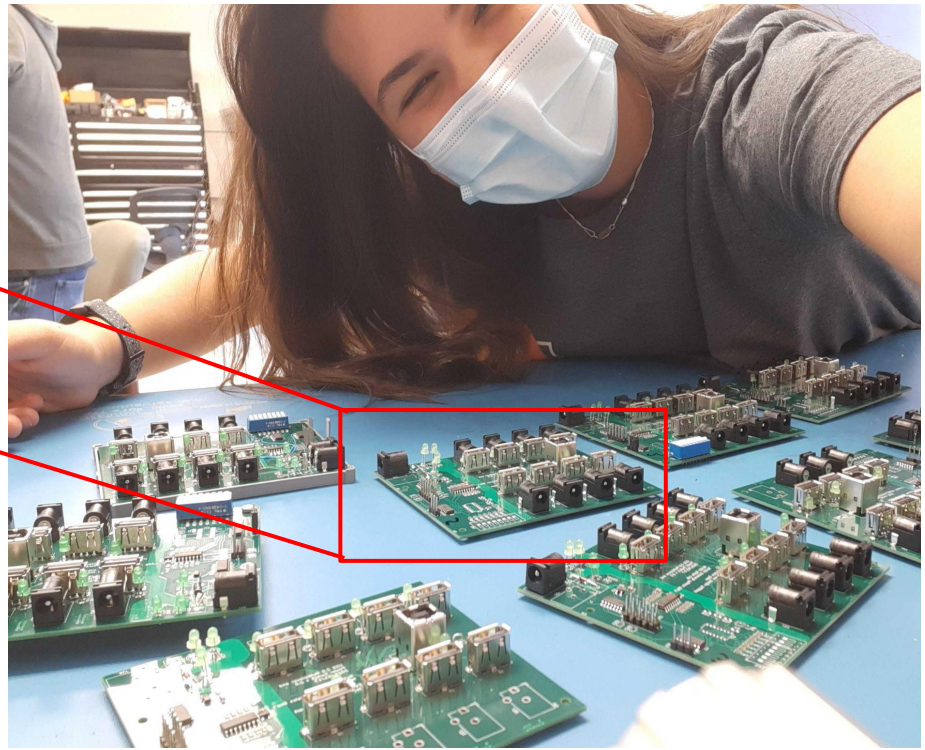


Because of the long baselines: need to write data for **offline correlation,** and need **autonomous** antenna stations

Data storage

- Store 1 bit of baseband data for ~1 year of autonomous operation





Power systems

- Hybrid solar & methanol fuel cell

Power systems

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SNAP Box (backend)

Power systems

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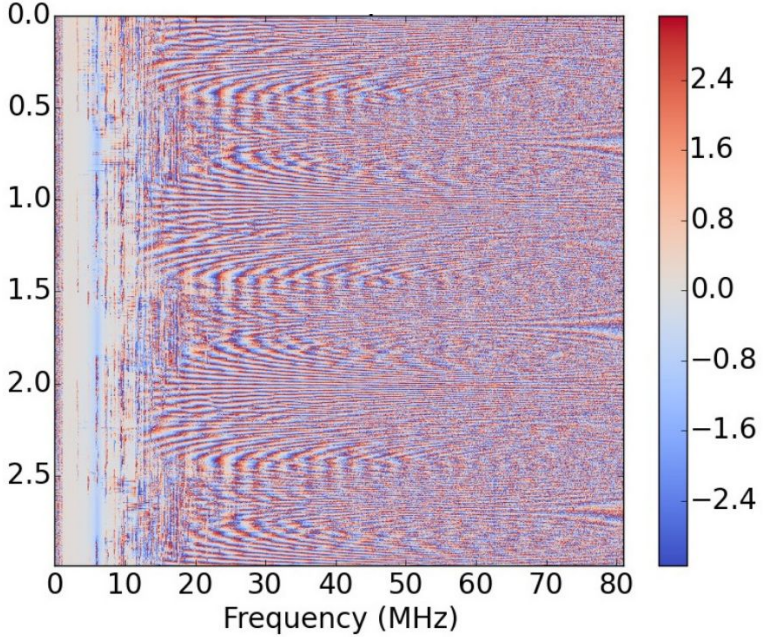
Front end amplifier and antenna response

- Currently using LWA systems: large impedance mismatch at low frequencies causes a drop in gain

Cross spectra of 2-antenna pathfinder at Marion island (LWA)



Chiang et al 2020

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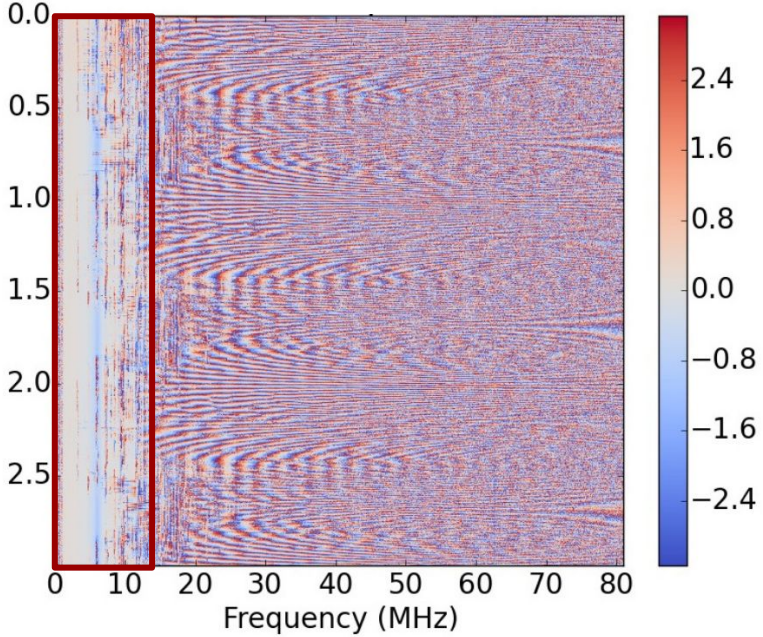

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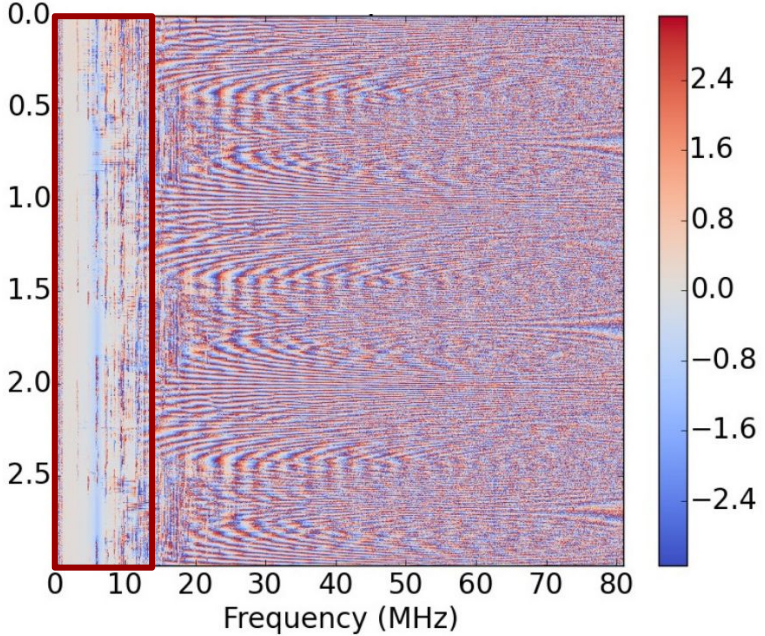
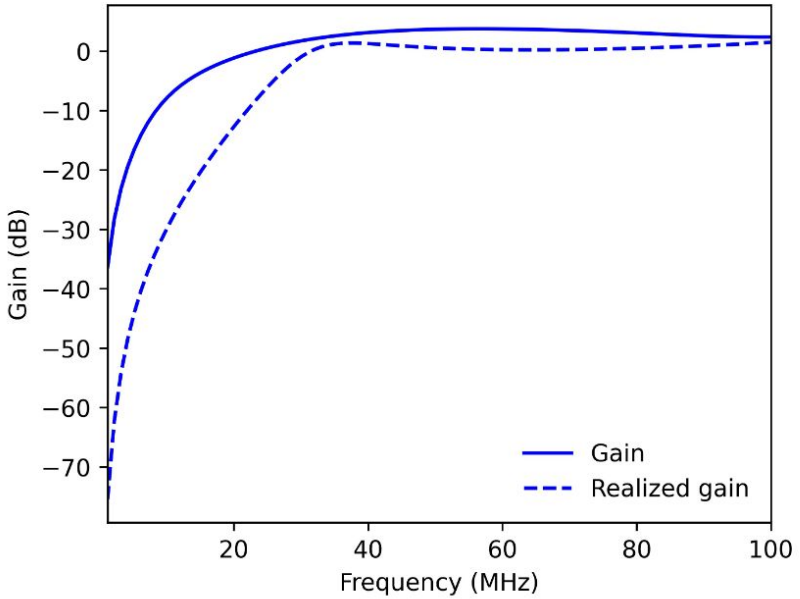


LWA gain and realized gain



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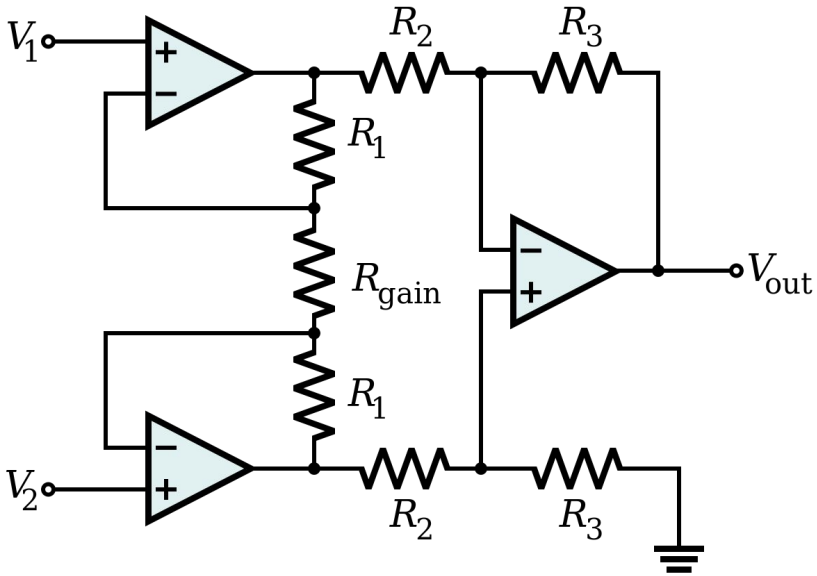
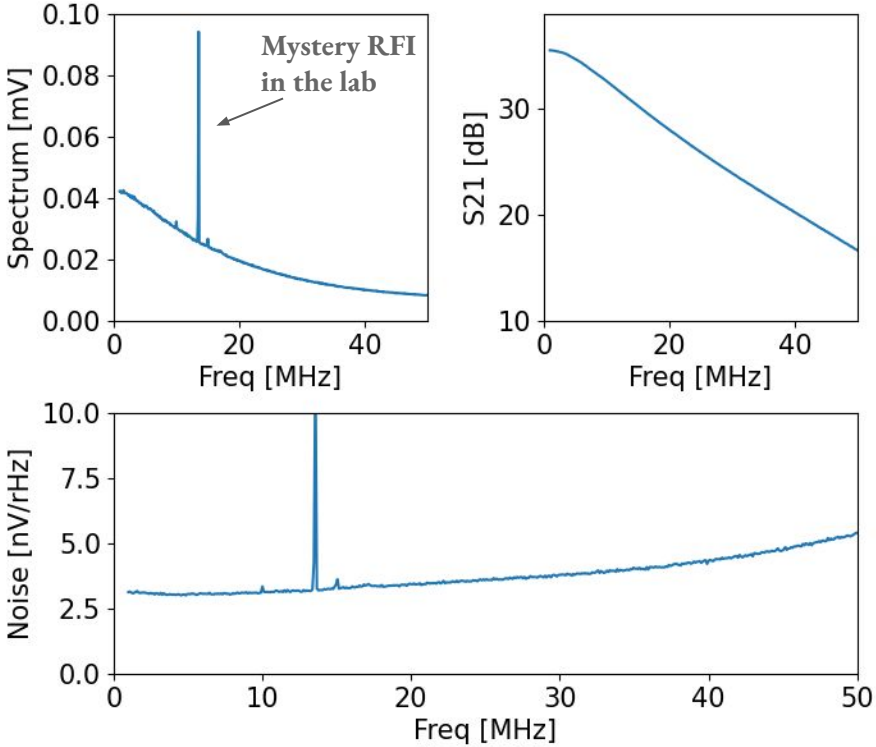
New antenna & front-end electronics (FEE)

- Inverted-V dipole antenna
  - Easily scalable to modify resonant frequency
- High-impedance differential low-noise amplifier



First tests of performance

Spectrum, S21, and noise of latest FEE revision



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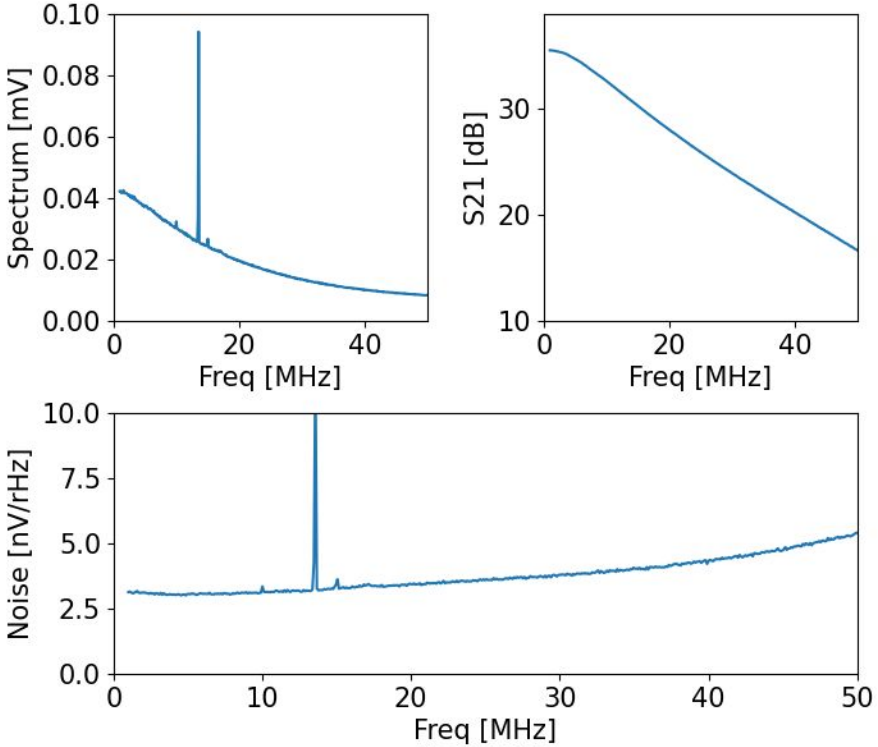

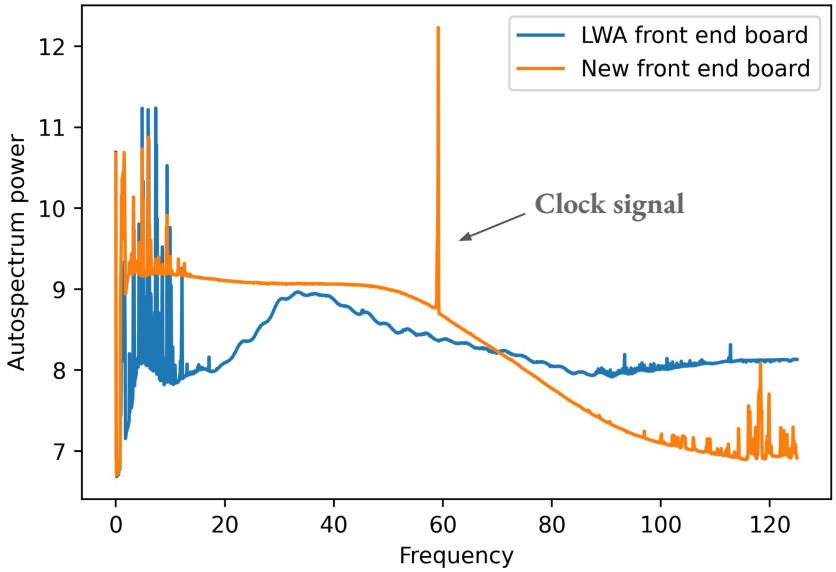

Comparison of new FEE and LWA FEE autospectra at Uapishka Station, taken on LWA antenna

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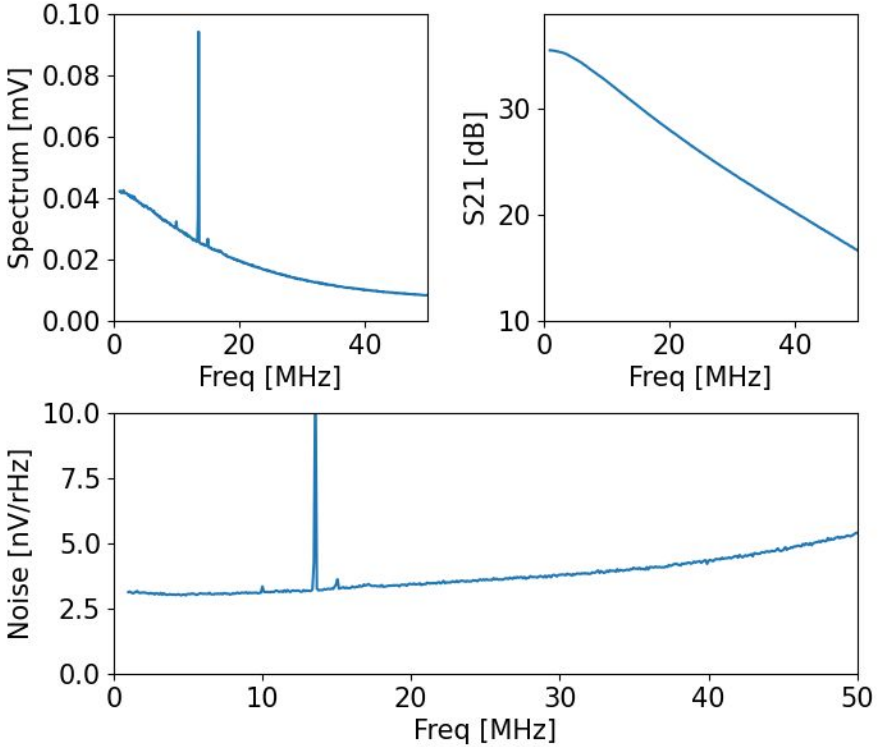

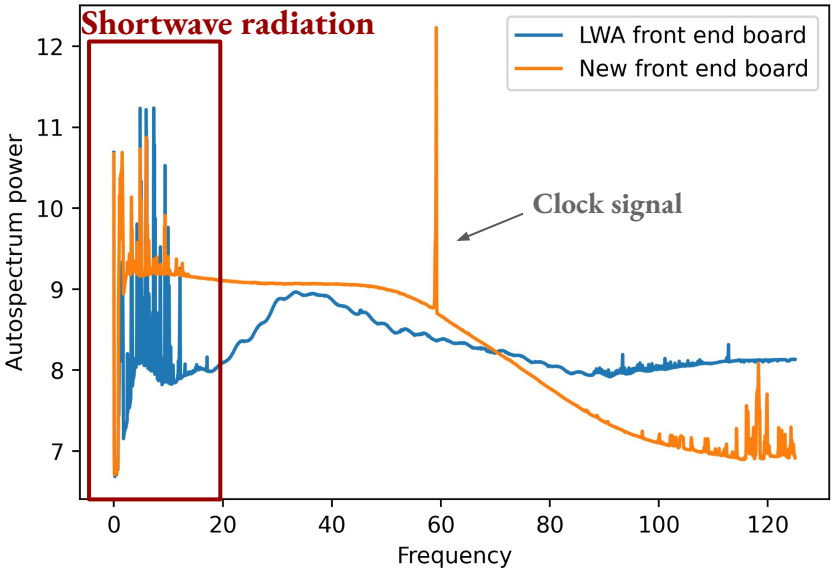

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Summary

- ALBATROS status:
  - First test of full system still running at Uapishka Station
  - Summer 2022: first installation on site at McGill Arctic Research Station + sending new parts to Marion
- New antenna & amplifier development:
  - Continued development to improve noise properties and response
  - Will be tested in radio-quiet sites in the coming months
- ALBATROS maps will provide a new view of the low frequency sky