

MIST project @ MARI site

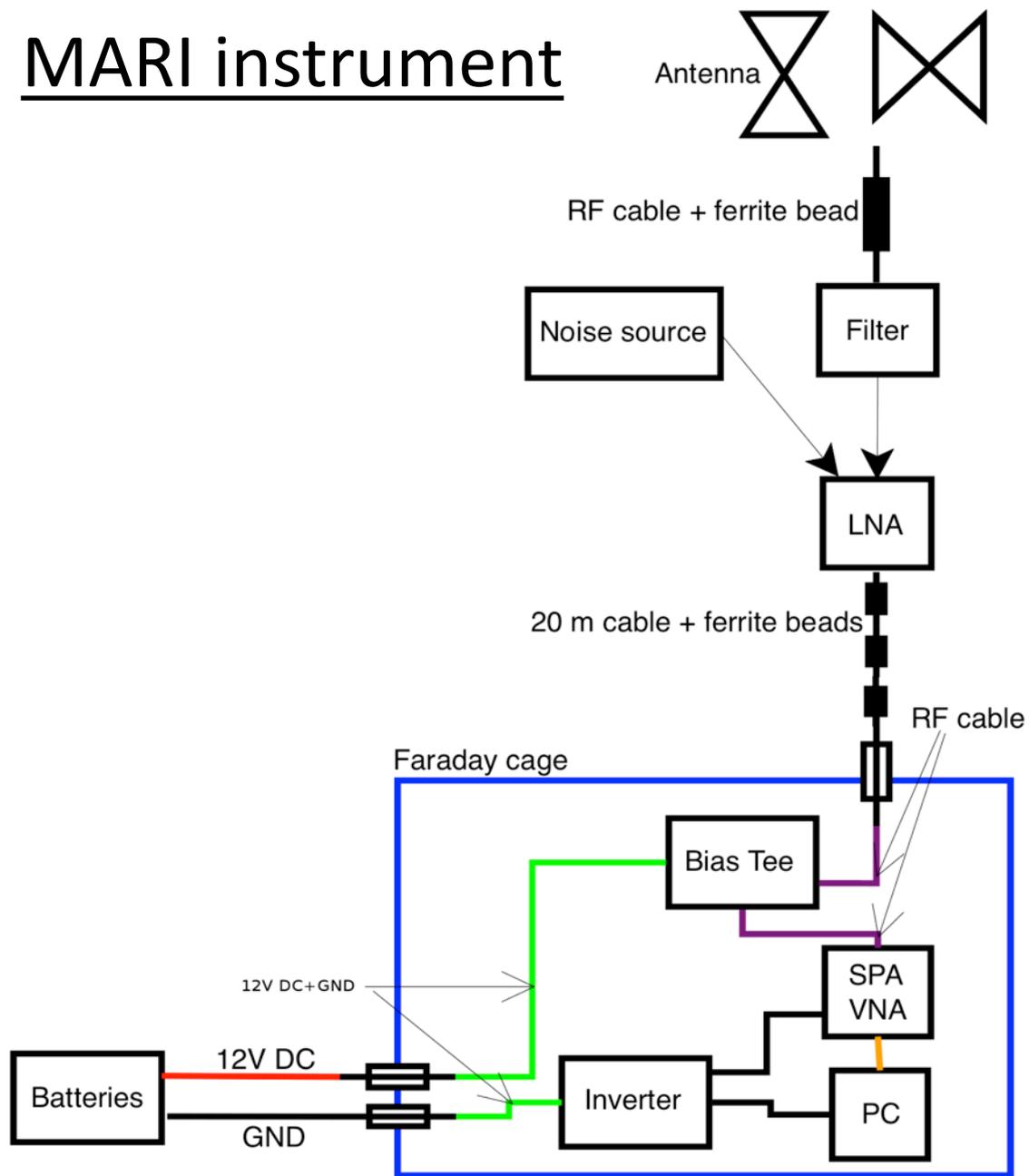
Ricardo Bustos

Universidad Católica de la Santísima Concepción

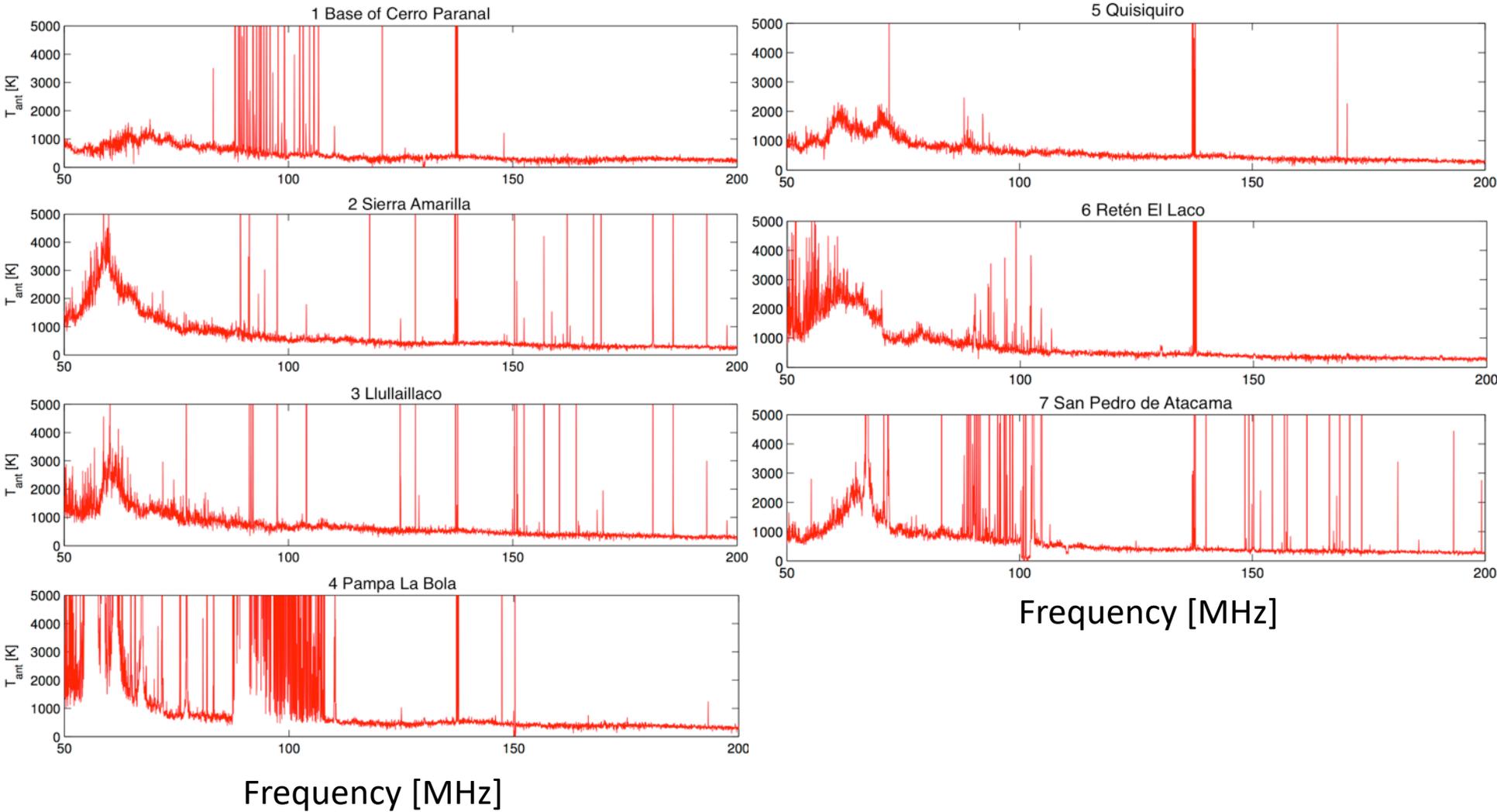
MARI Project

- **MARI: Medidor Autónomo de Radio-Interferencia.**
- Goal: Find a site with low RFI levels for redshifted 21cm observations.
- Measured RFI levels between 50 - 250 MHz in the north of Chile.
- Team:
 - Ricardo Bustos (PI, UCSC)  **UCSC**
 - Raúl Monsalve (ASU at the time, now at McGill) 
 - Judd Bowman (ASU)
 - Alexandra Suárez (UdeC) 
 - Students (Electrical Engineering from UCSC)

MARI instrument



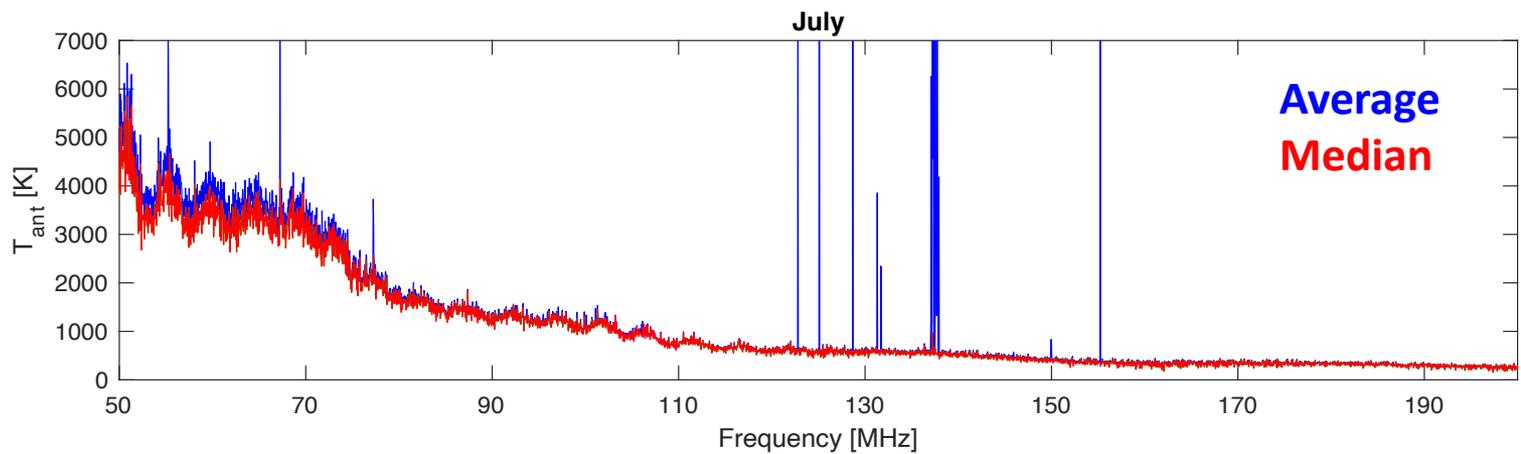
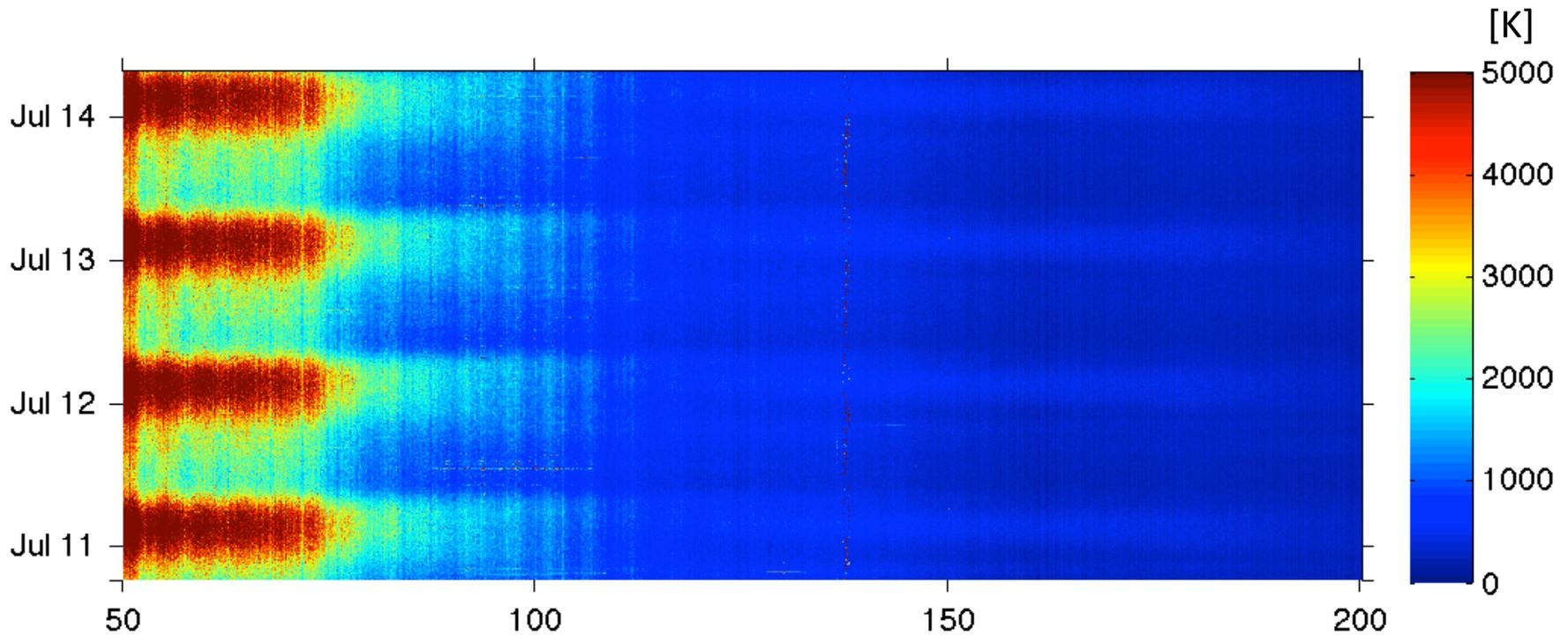
MARI Stage I results: vertical antenna, 1-hr integration



MARI Stage II - Characteristics

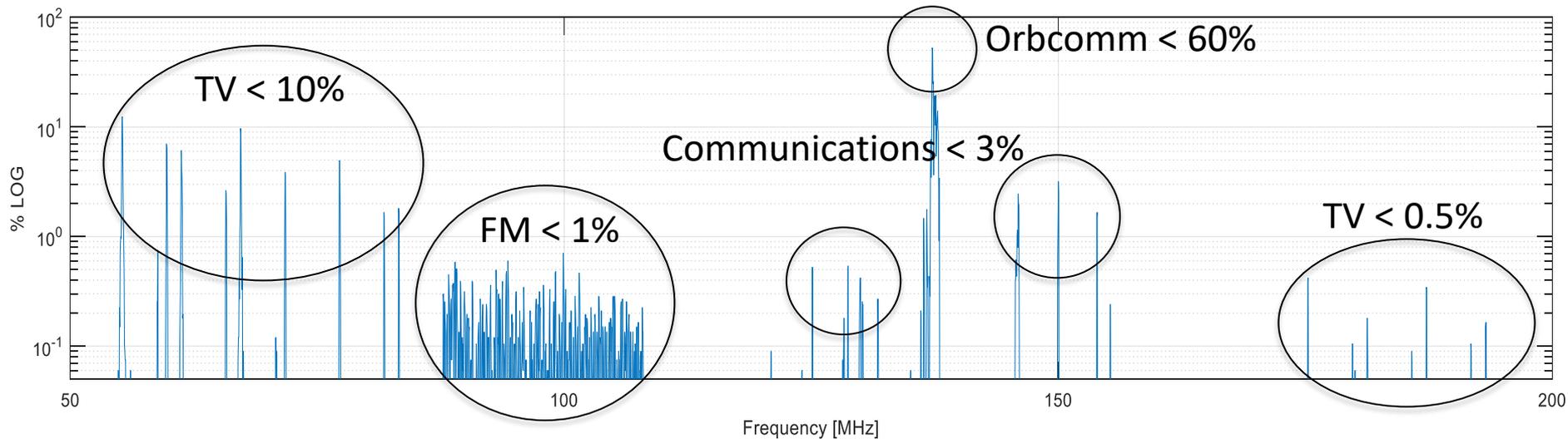
- Deeper observations at the site with lowest RFI levels.
- At a plateau we called the **MARI site**: west side of the Andes, blocking RFI from Chilean cities, at 4380 masl.

MARI Stage II results: July 2015, MARI site



MARI site

Occupancy in [%] for 6677 spectra: 5 continuous days each month
May, July, November



Bustos R., et al, 2019: In preparation

MARI site – PWV studies

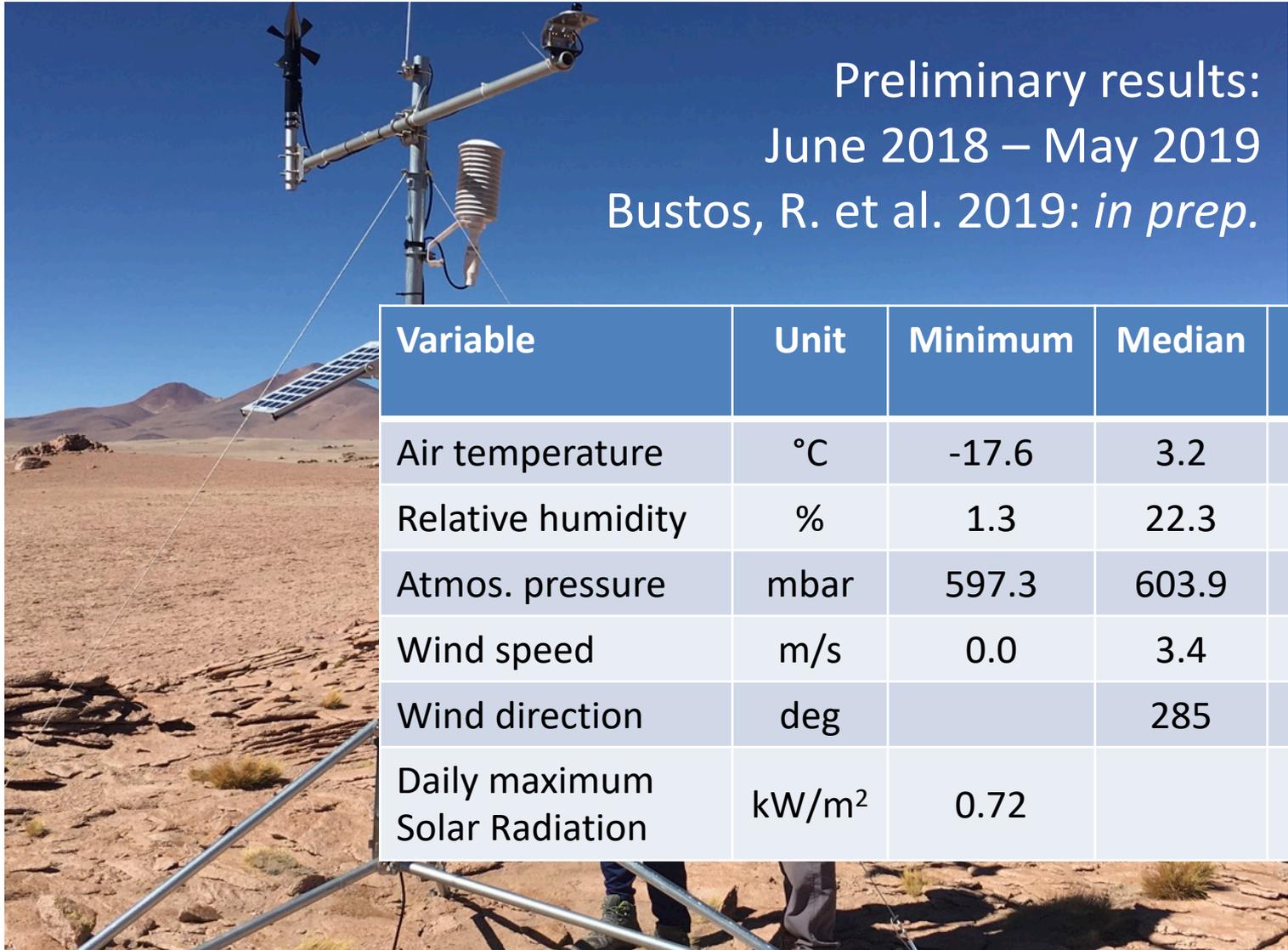
183 GHz radiometer - Oct. 2017

To evaluate the site for microwave frequencies, we measured PWV. We found 40% higher than the ALMA site, being 700 m lower. Still a competitive site at those frequencies



MARI - June 2018

Weather station to characterize the MARI site (ESO funding)



Preliminary results:
June 2018 – May 2019
Bustos, R. et al. 2019: *in prep.*

Variable	Unit	Minimum	Median	Maximum
Air temperature	°C	-17.6	3.2	20.7
Relative humidity	%	1.3	22.3	99.9
Atmos. pressure	mbar	597.3	603.9	609.2
Wind speed	m/s	0.0	3.4	33.2 (*)
Wind direction	deg		285	
Daily maximum Solar Radiation	kW/m ²	0.72		1.3

Legal status MARI site

Government permission:

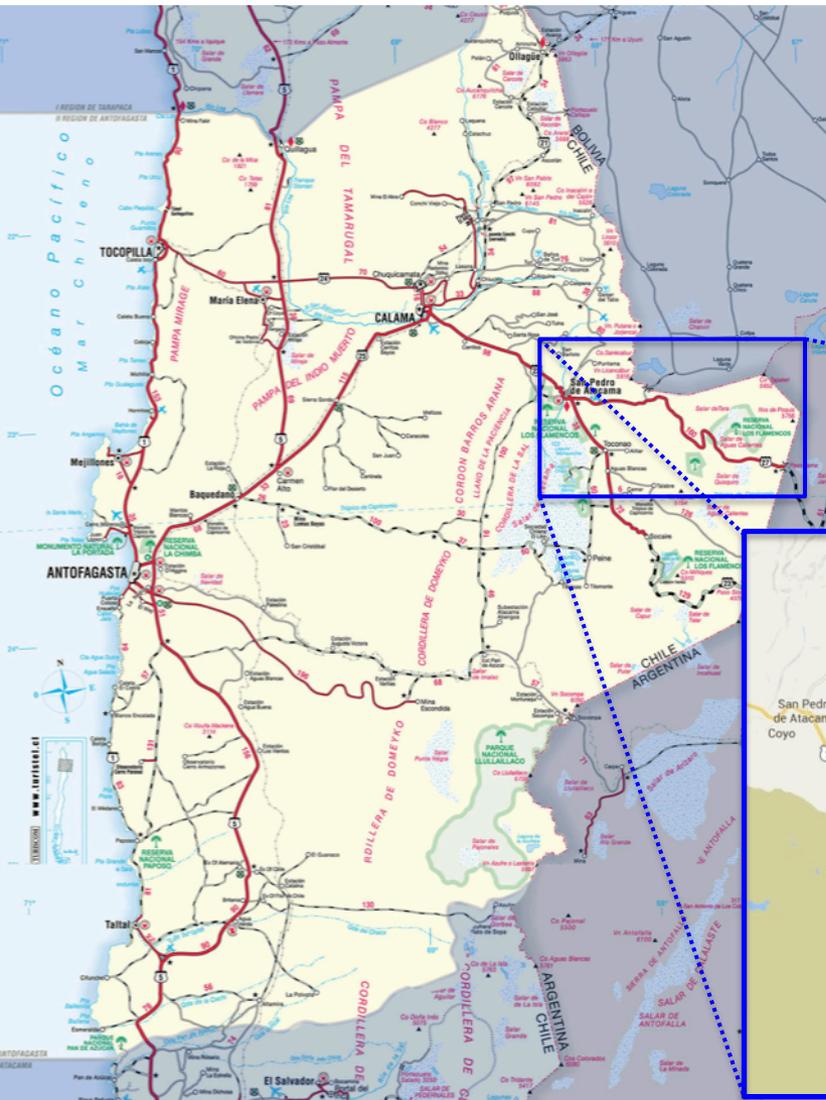
2015: Initial enquiries.

2018: Obtained an official temporary permission to operate in the area.

2019: Applied for a permit extension.

2020: Apply for a 3-year concession and to protect for scientific use.

Altitude: 4380 m. Area: 8.000 ha.

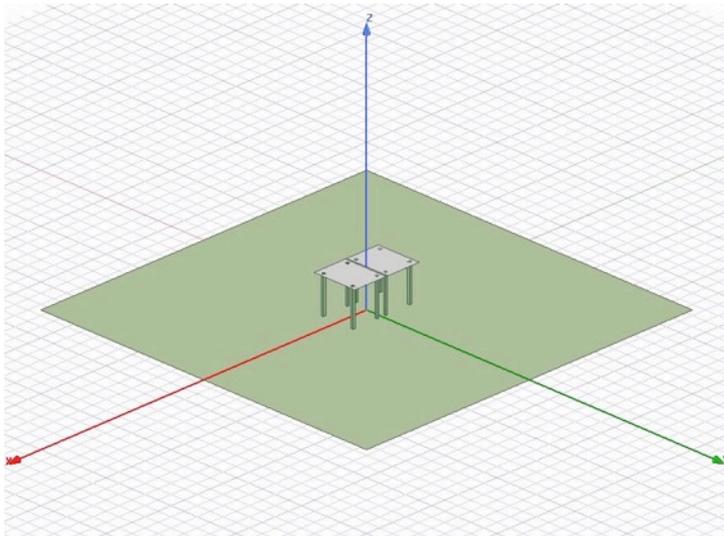


Antenna beam comparison

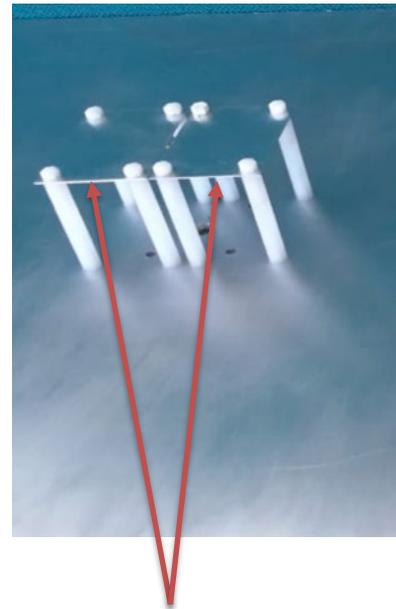
Simulation v/s measurements

- Oscar Restrepo, PhD Student, Universidad de Chile.

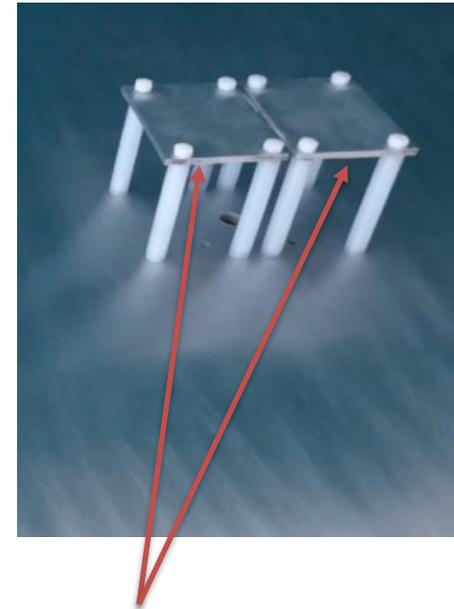
EDGES Blade antenna scaled from
100 - 200 MHz to 1 - 2 GHz



Antenna simulation



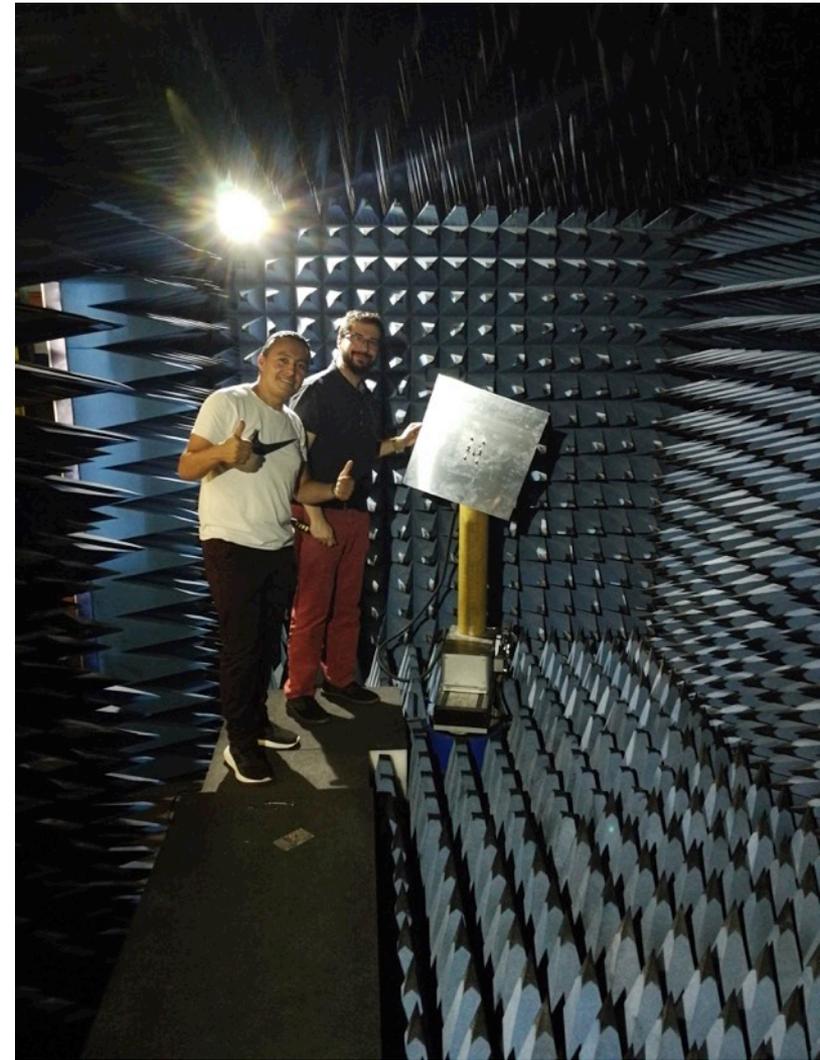
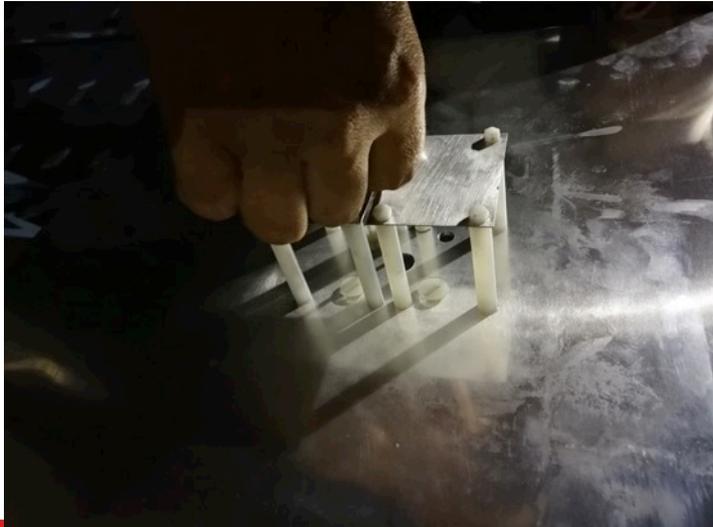
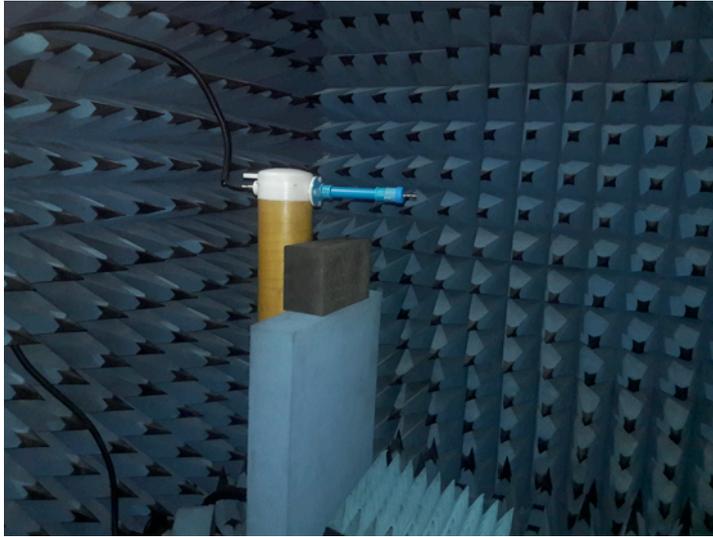
Antenna panels: 0.6 mm



Antenna panels: 3.0 mm

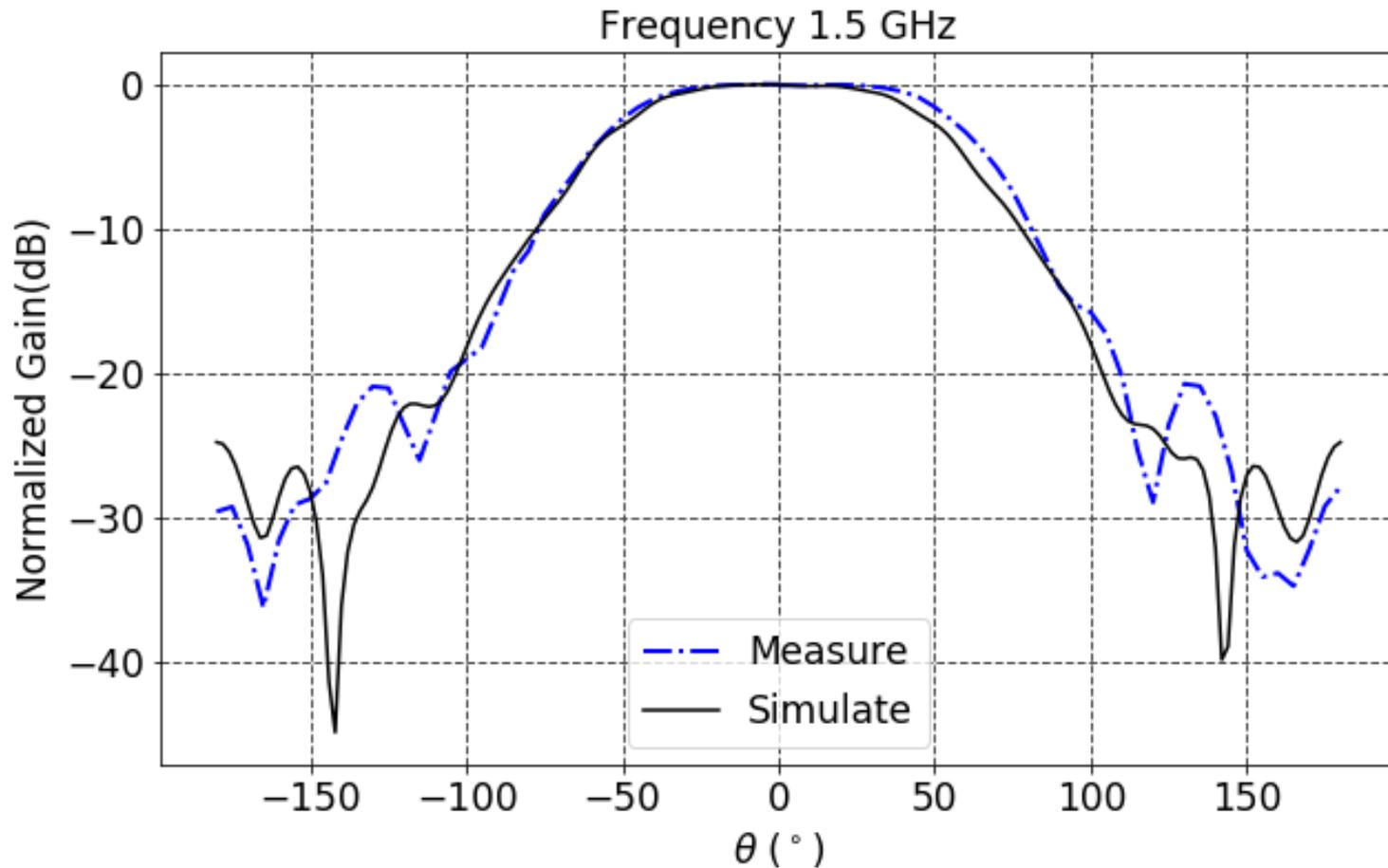
Anechoic chamber measurements

At UTFSM, Valparaíso.



Example from First Try

More refined measurements in progress.



(b) Plano $\phi = 90^{\circ}$

MIST: Mapper of the IGM Spin Temperature

Goal:

- try to verify and measure with high precision global 21 cm signal.
- deployed and observing in 2020.

Team: Mauricio Díaz, Ricardo Bustos (UCSC), Raúl Monsalve, Jon Sievers, Cynthia Chiang (McGill), Nithyanandan Thyagarajan (NRAO), McGill, U. Chile, UCSC students.

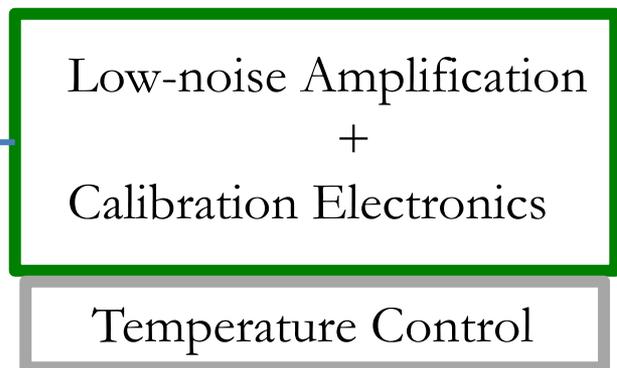
Students from McGill: Christian Bye, Matheus Pessoa.

Block Diagram

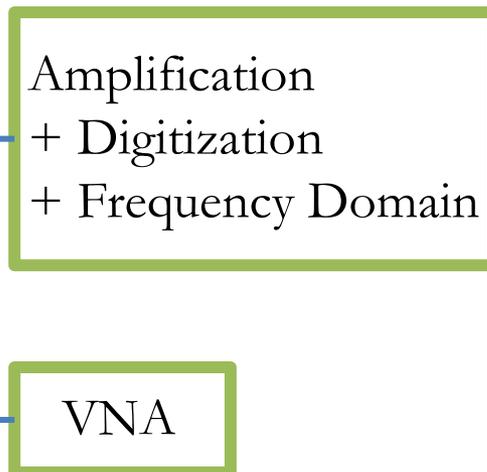
Antenna



Receiver



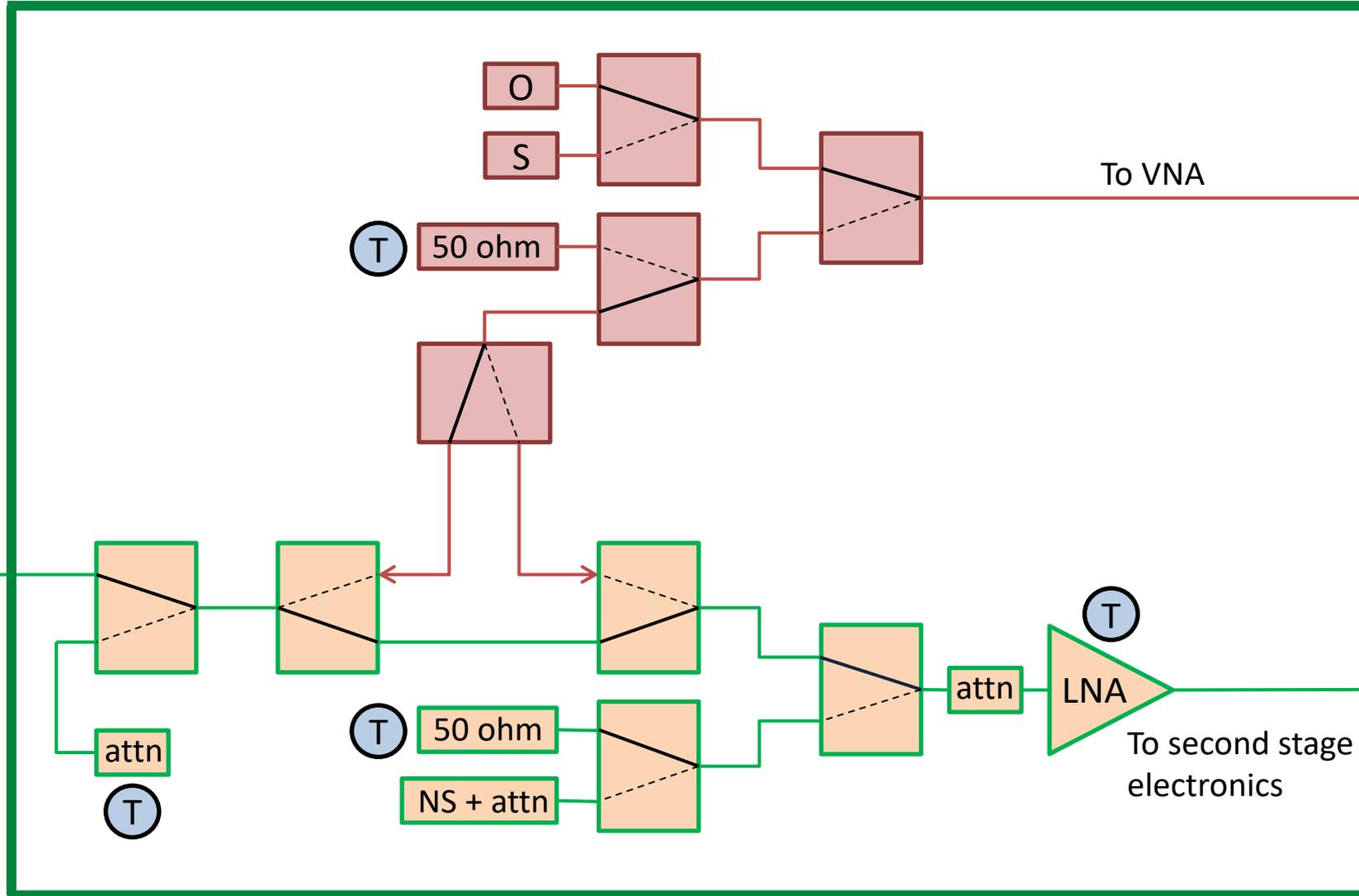
Back-End



- Design based on EDGES-2, and somewhat similar to EDGES-3.
- All components different from EDGES
- Initial focus is on instrument, antenna not defined yet.
- Observation site not defined yet.

Receiver

Antenna



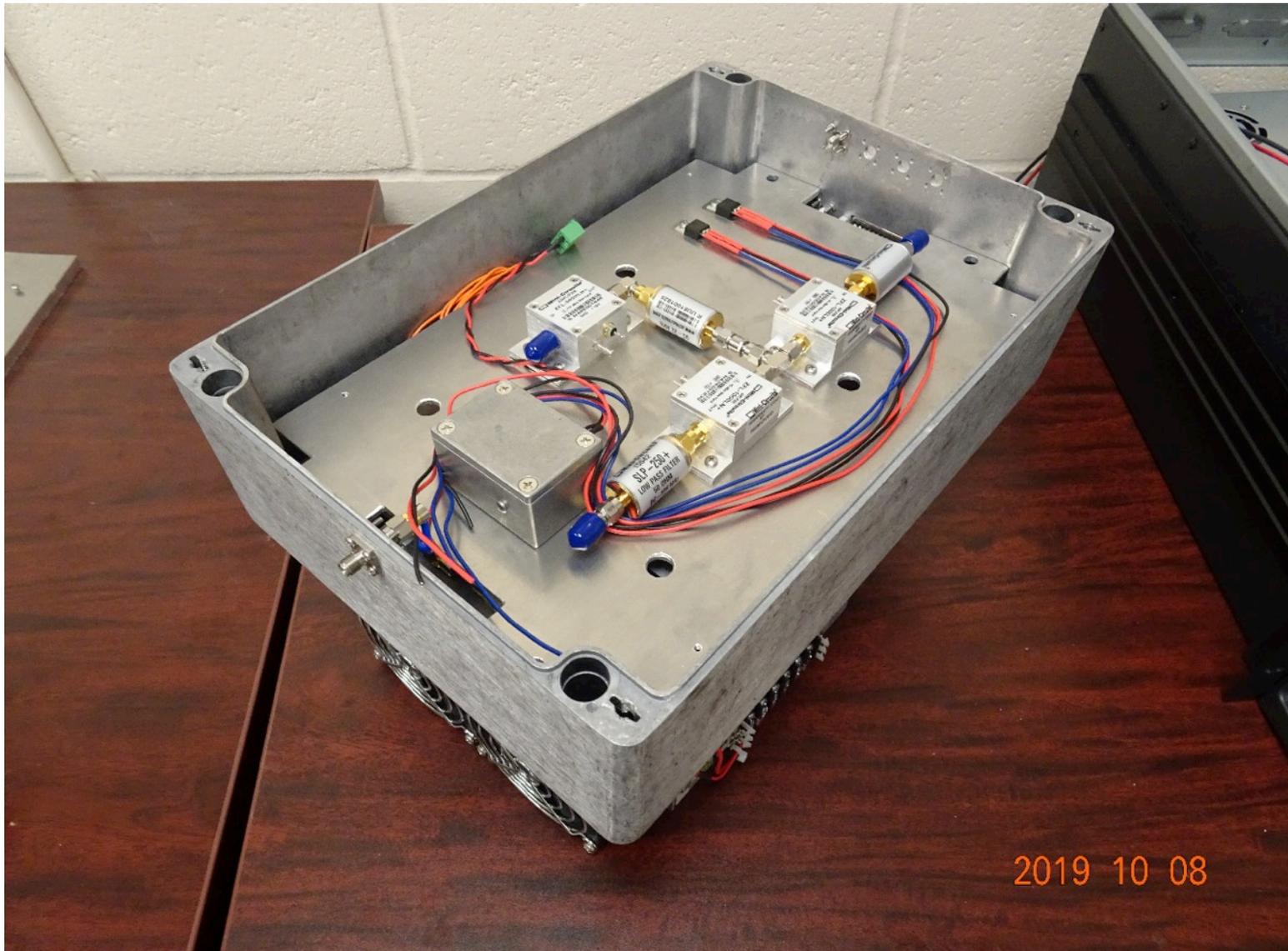
Temperature Control

Receiver Pictures



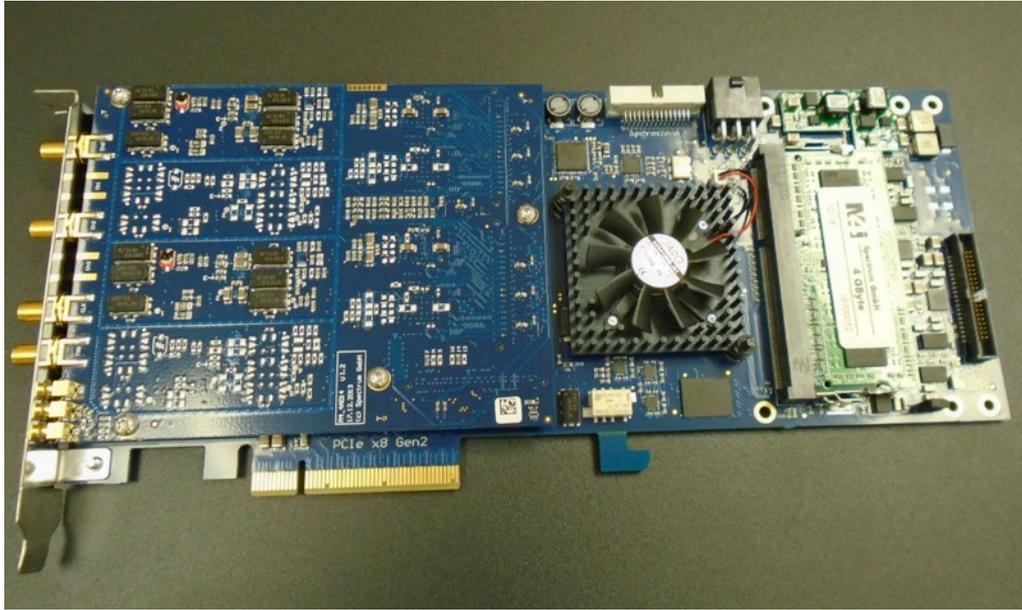
2019 10 08

Receiver Pictures



2019 10 08

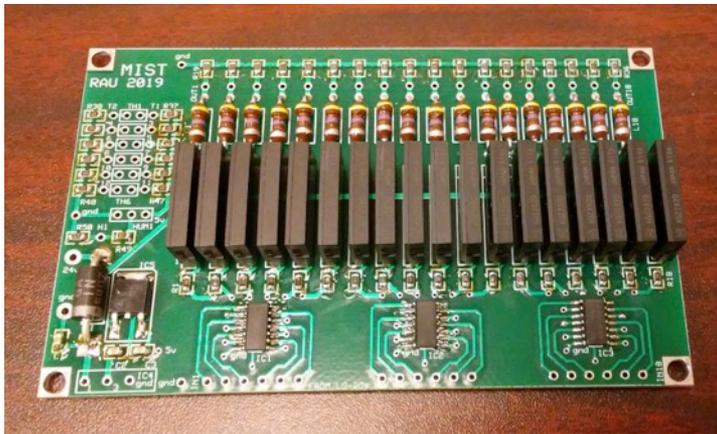
Back End Pictures



Analog-to-Digital Converter



Vector Network Analyzer



Switch Driver Board

Most of the Instrument



Work Ahead

1) Instrument and Calibration

- Finish assembly of the instrument.
- Finish the control program.
- Deep integration to test digitizer.
- Build receiver calibration unit.
- Lab receiver calibration at different temperatures.

2) Antenna Design

- Simple antenna with smooth frequency response, sacrificing reflections and losses.

3) Smaller is Better

- In parallel, continue development of portable version of MIST, “mini MIST”.
- Small profile and low power, with enough performance for 21-cm science.



<http://mari-ucsc.blogspot.cl>



@Lab_Astro_UCSC

Many thanks!

MARI Stage I - Characteristics

- Antenna: Biconical dipole in horizontal (NS and EW) and vertical orientations.
- Frequency resolution: 36.3 kHz.
- Scan time: 3 min over range 50 - 250 MHz.
- Observing time per antenna orientation: 1-hour.
- Noise per scan:

