New Receiver System for 21cm Global Spectrum Field Experiment

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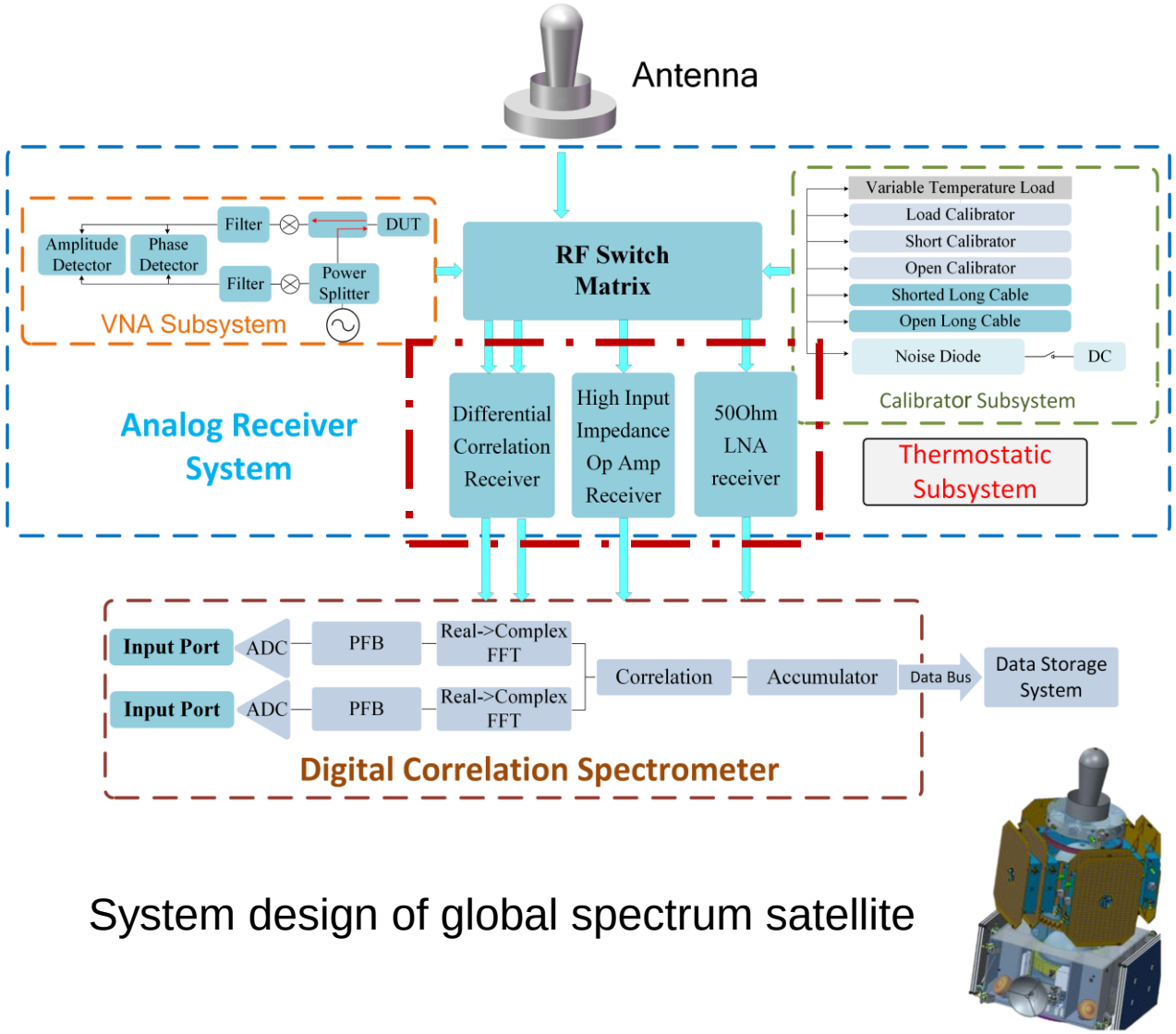
NATIONAL ASTRONOMICAL OBSERVATORIES, CAS

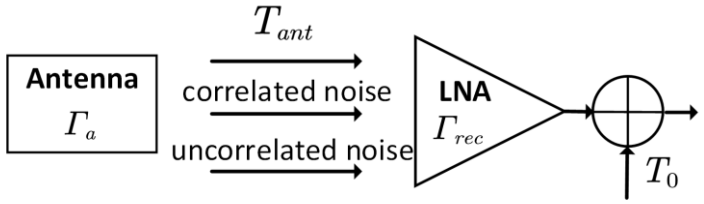
Introduction

Introduction

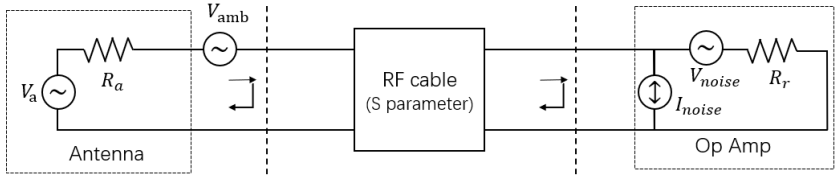


System design of global spectrum satellite

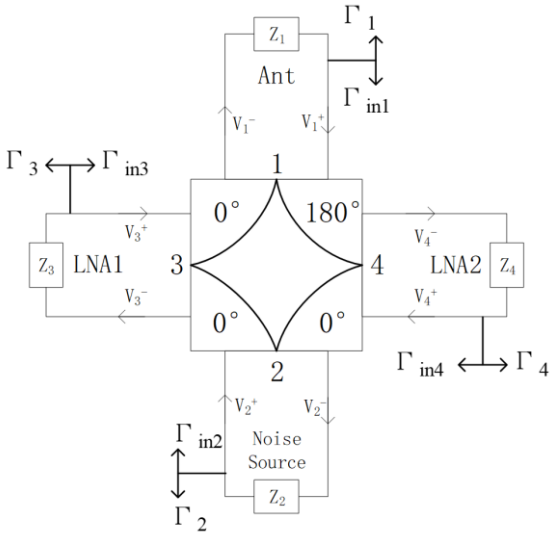
One-way matched LNA receiver



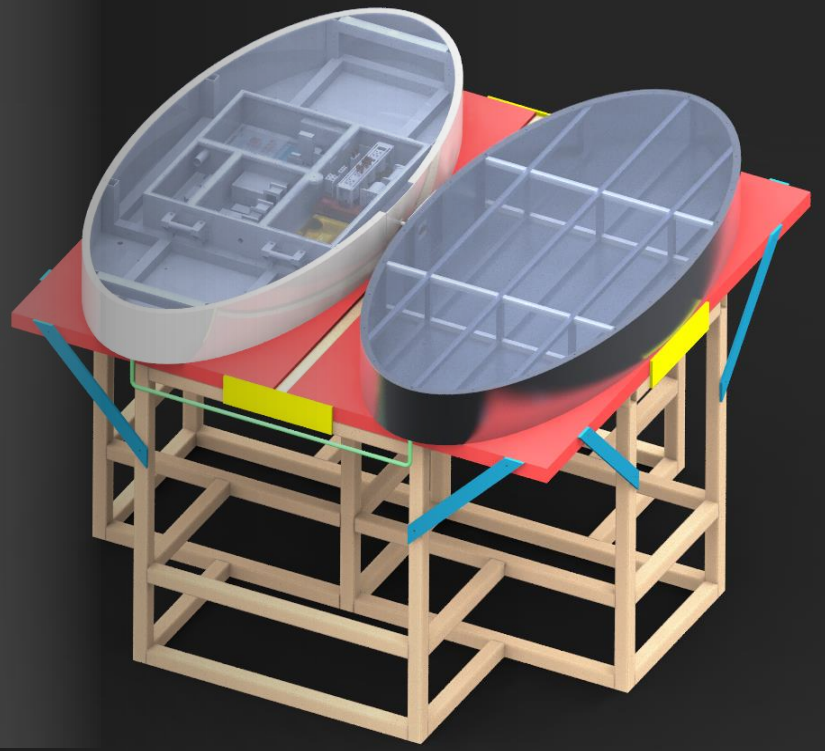
High input impedance receiver



Two-way differential receiver

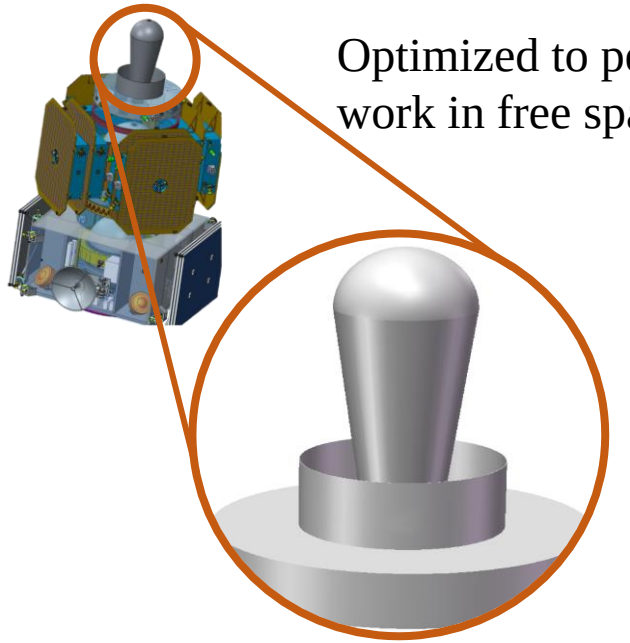


Elliptical Cylinder Dipole Antenna

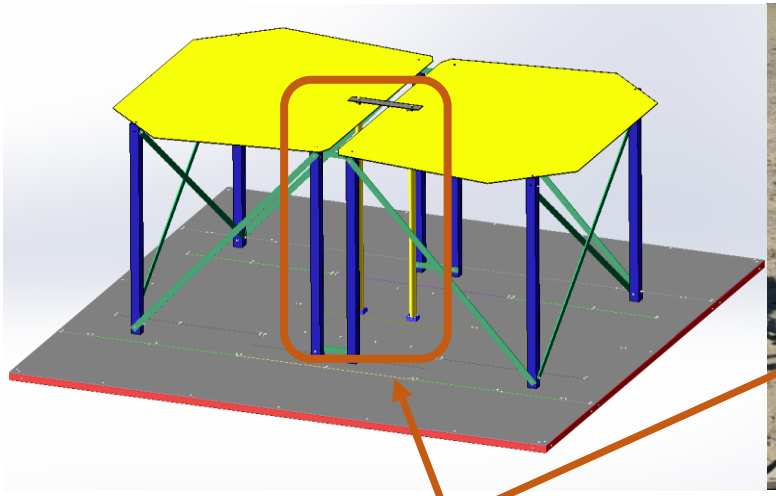


As a verification of the satellite system

Elliptical Cylinder Dipole Antenna

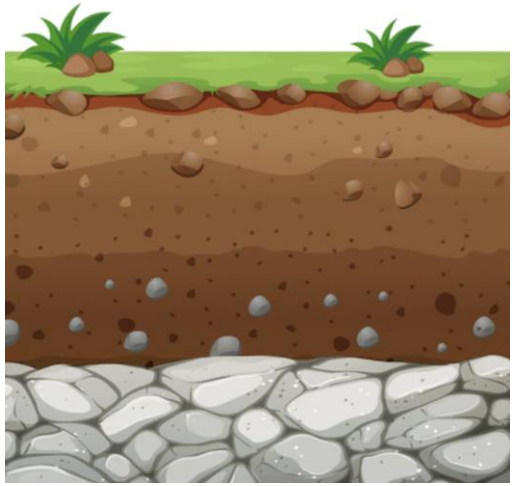


Optimized to perfectly work in free space



Balun: Difficult to Calibrate

Receiver under the ground

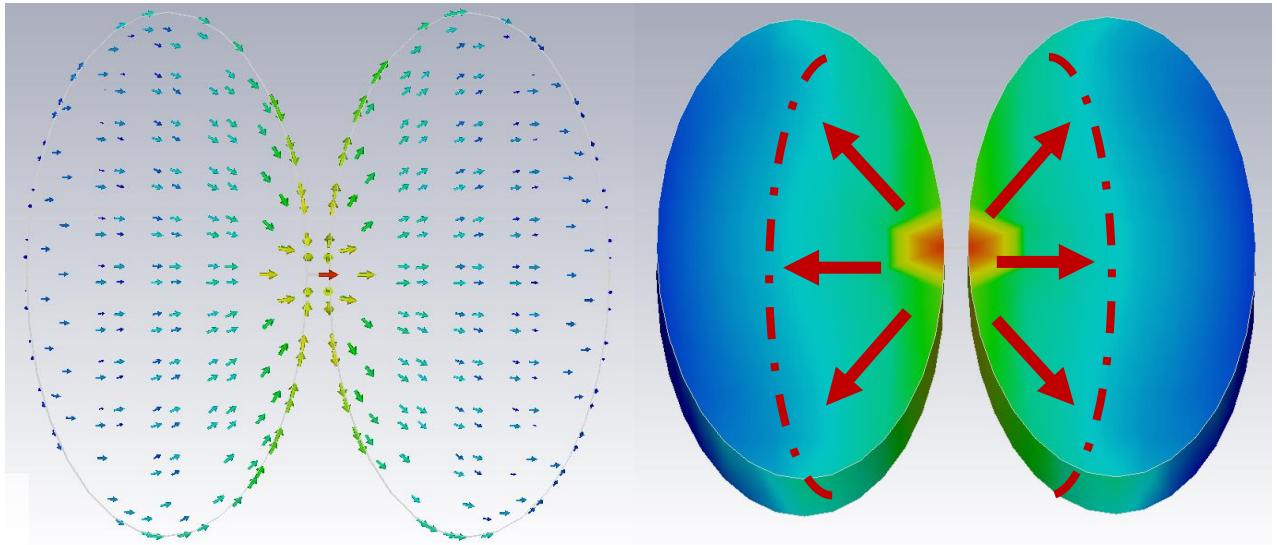


Ground Effect

- Ground net
- Surface of a lake

- **Impedance match** between the Antenna and Receiver
- **Frequency-independent** Beam Pattern

Elliptical Cylinder Dipole Antenna

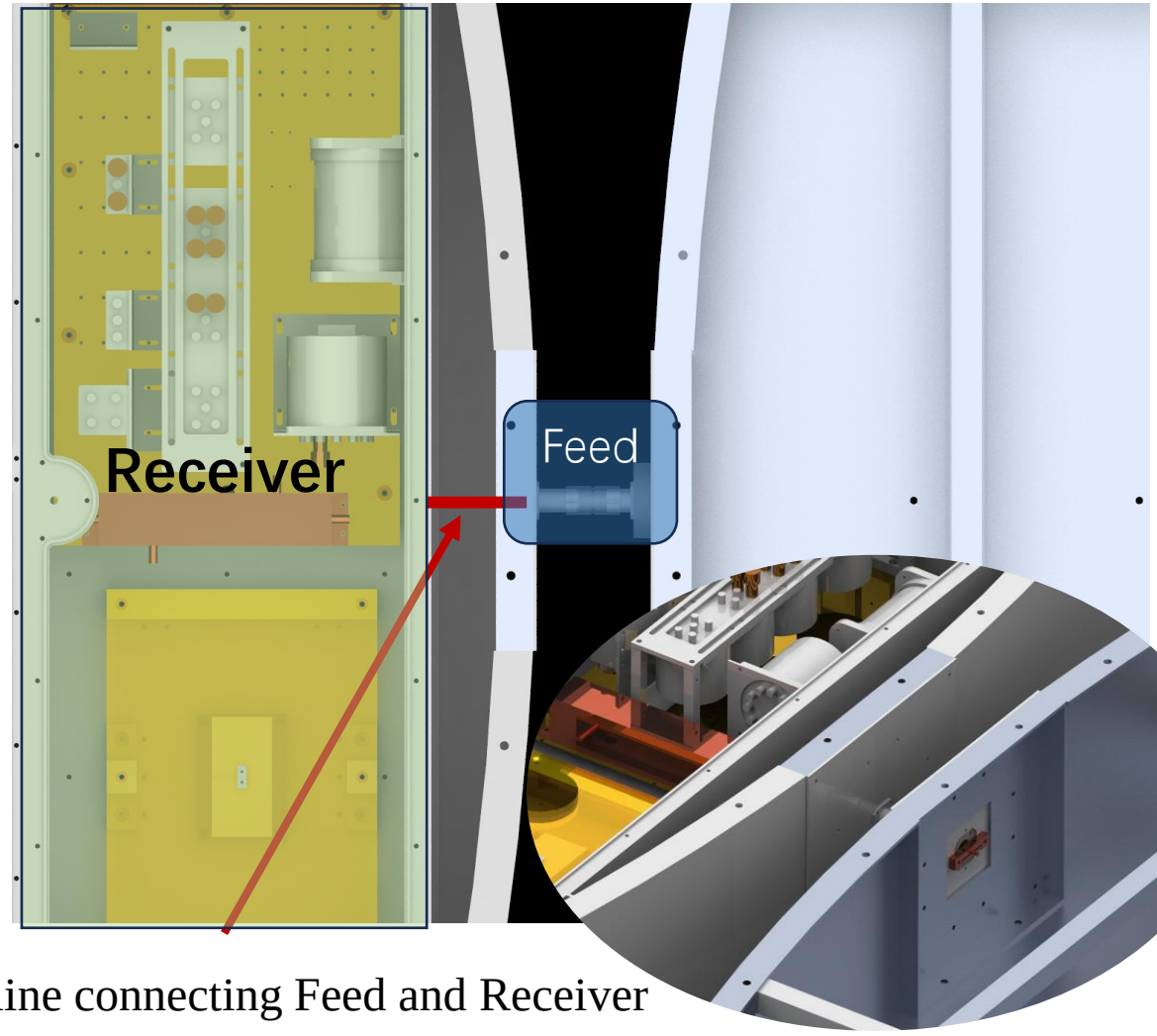


The surface current tends to be an elliptic radiant

Outside → Inside

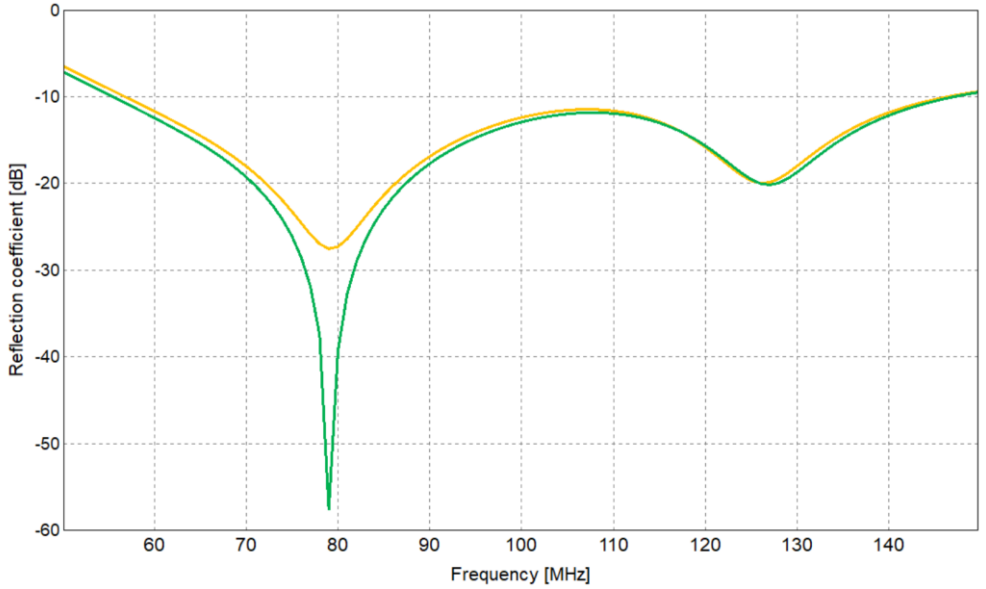
Plane → Solid

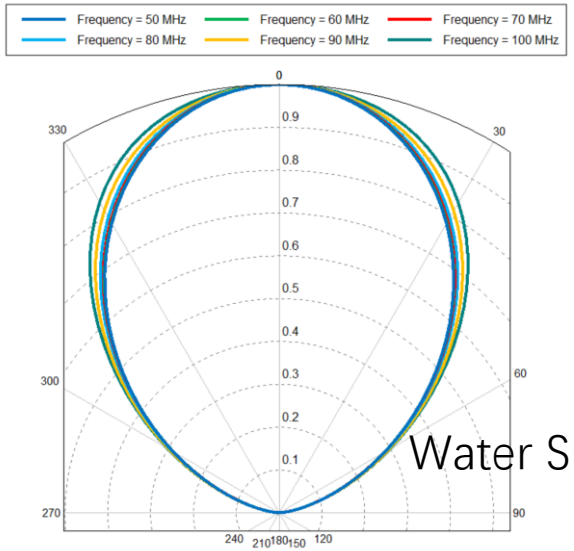
Hexagon → Ellipse



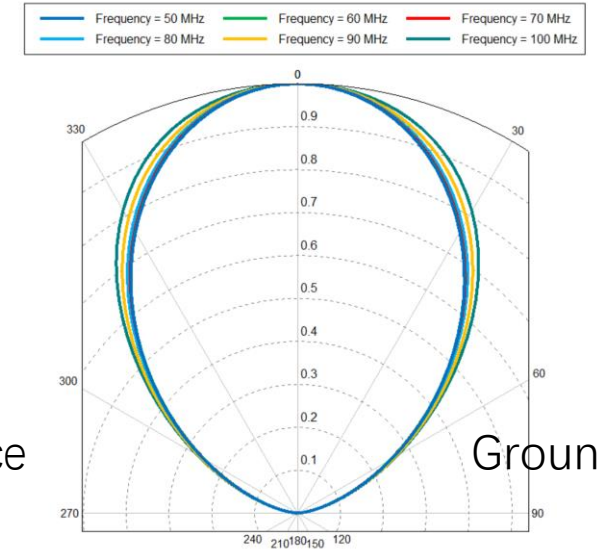
A short coaxial line connecting Feed and Receiver

Elliptical Cylinder Dipole Antenna





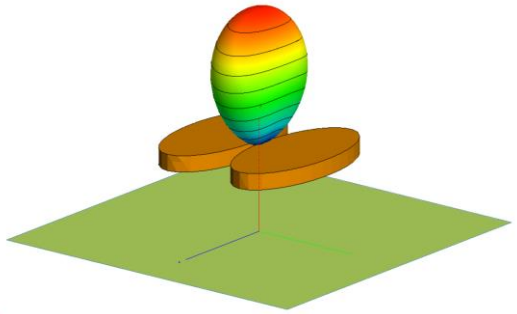
Water Surface



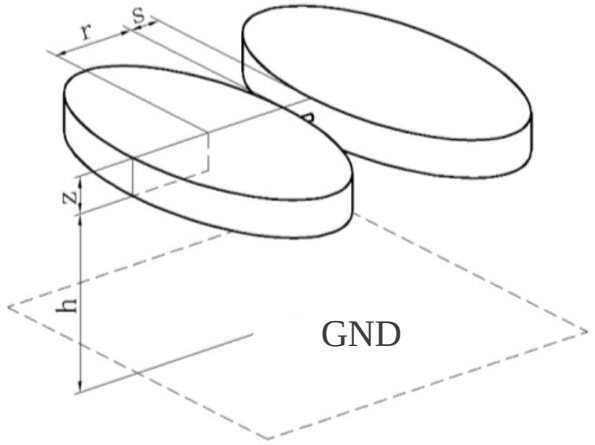
Ground Net

Band Width(S11<-10dB):**56Mhz-143Mhz**

HPBW_max – HPBW_min **< 1.8°**



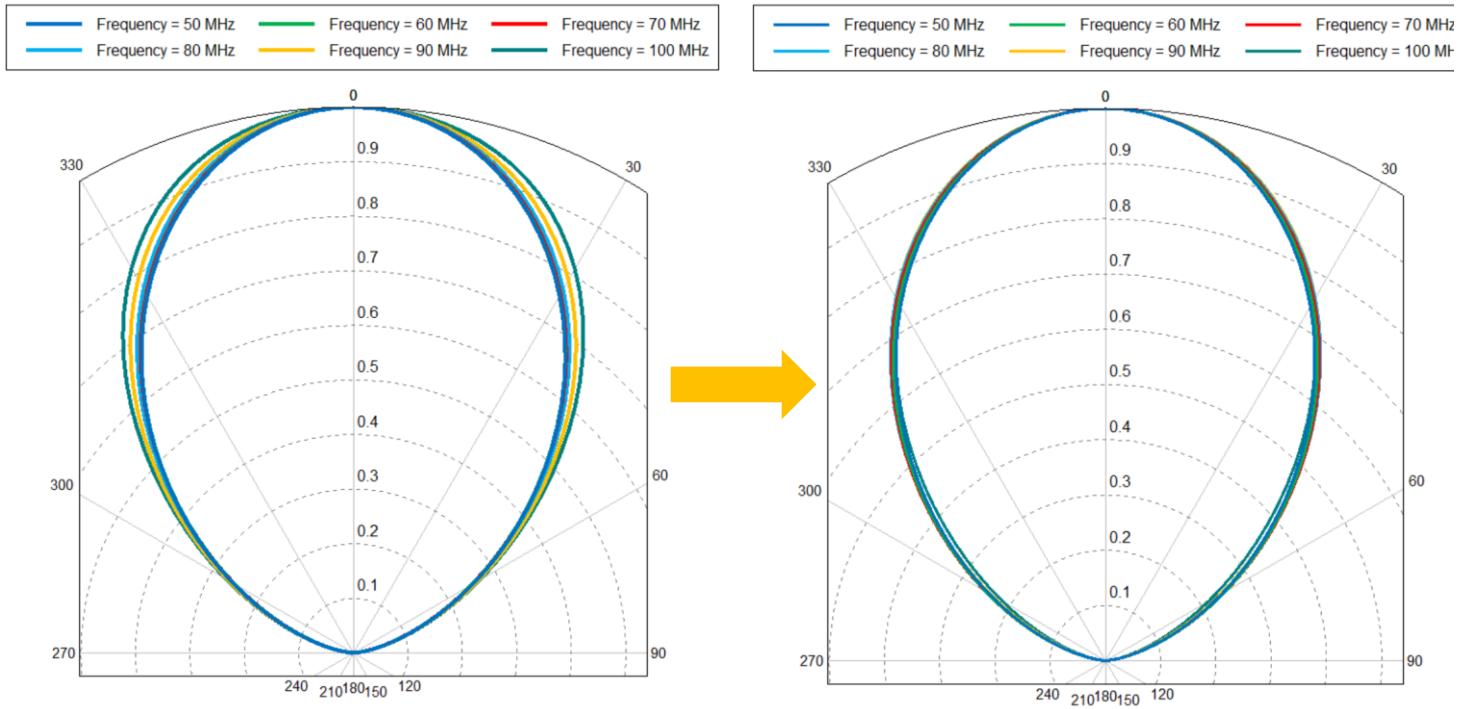
Get a well matched model of almost triple octave bandwidth with an achromatic beam pattern

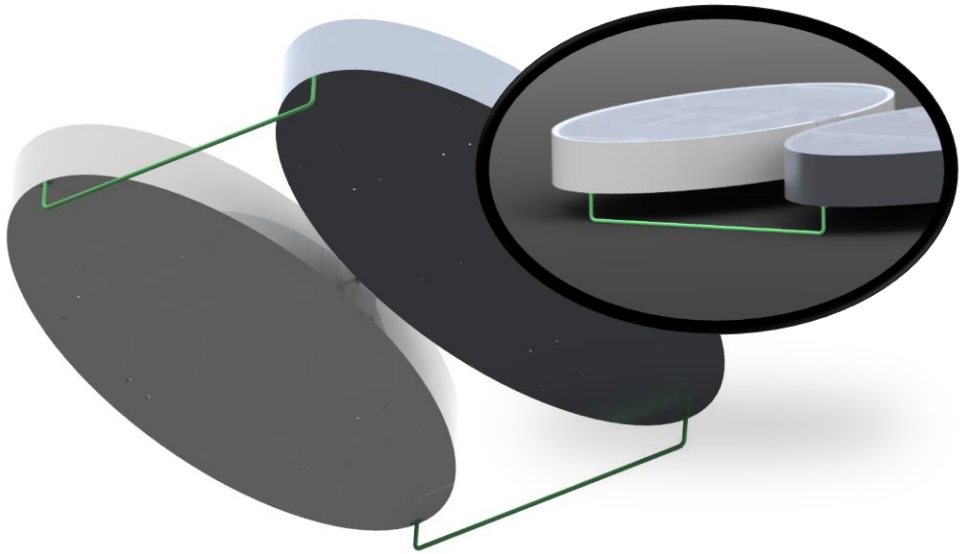


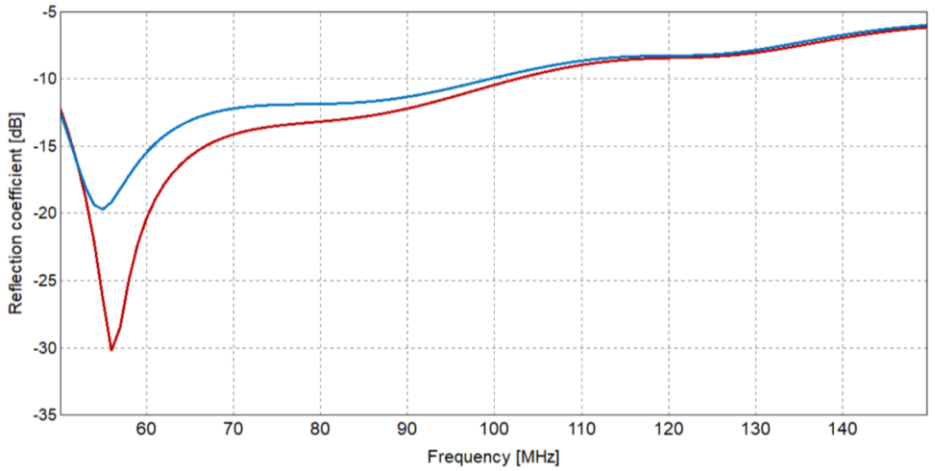
a	Aspect ratio
r	Radius of minor axis
s	Distance between two antenna
z	Thickness of antenna
h	Height from ground

Elliptical Cylinder Dipole Antenna

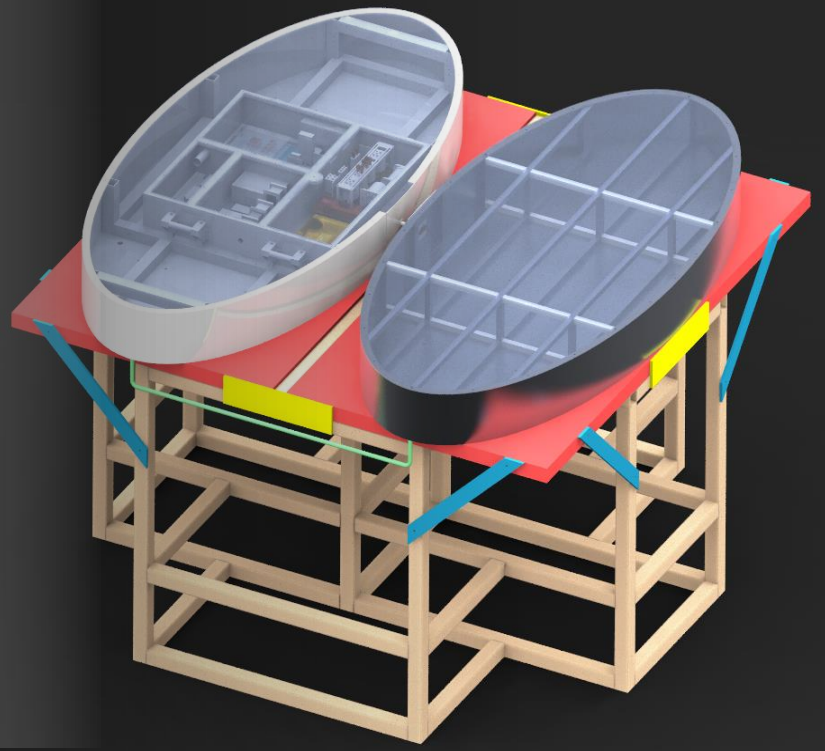
Folded Arm







Multi-Receiver



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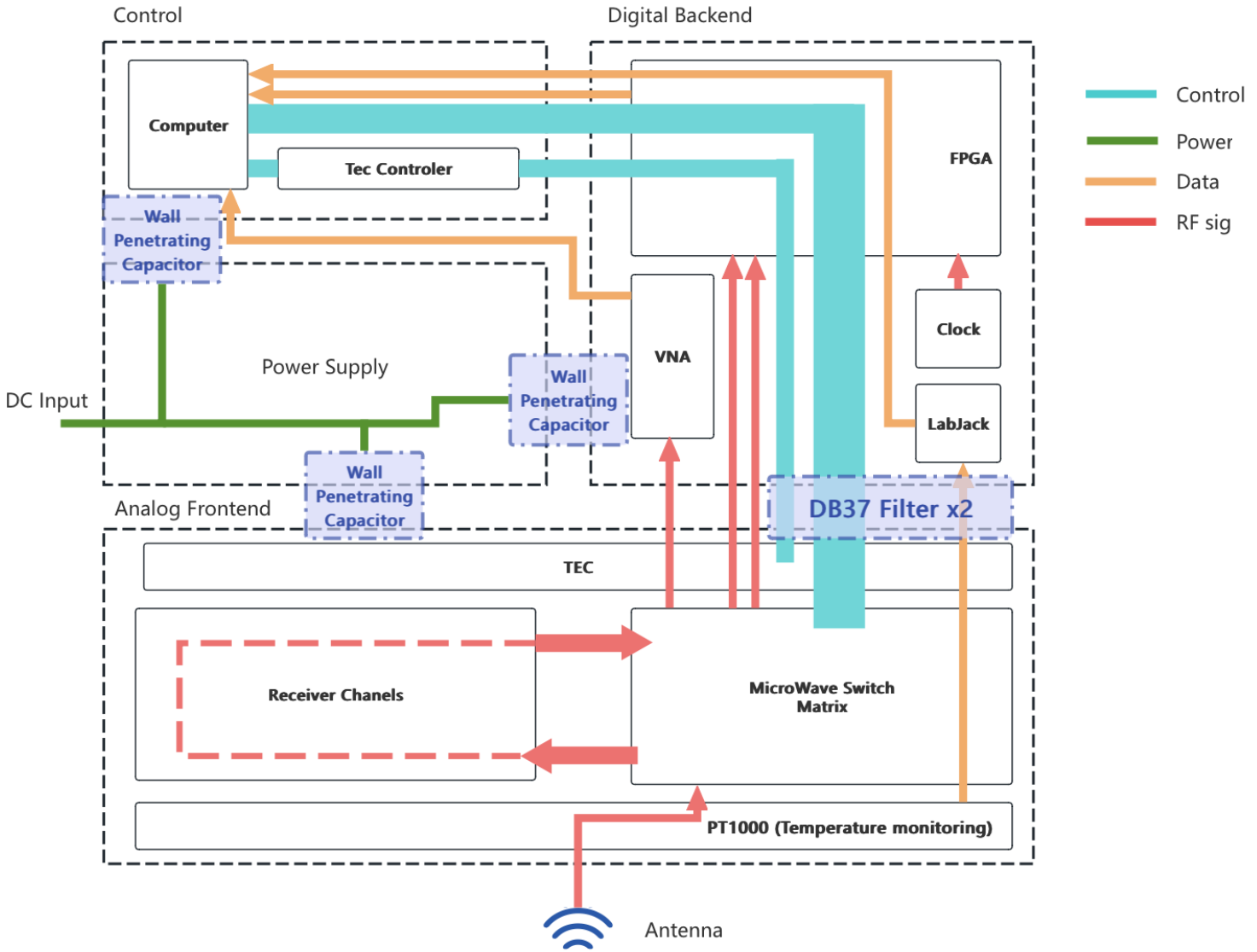
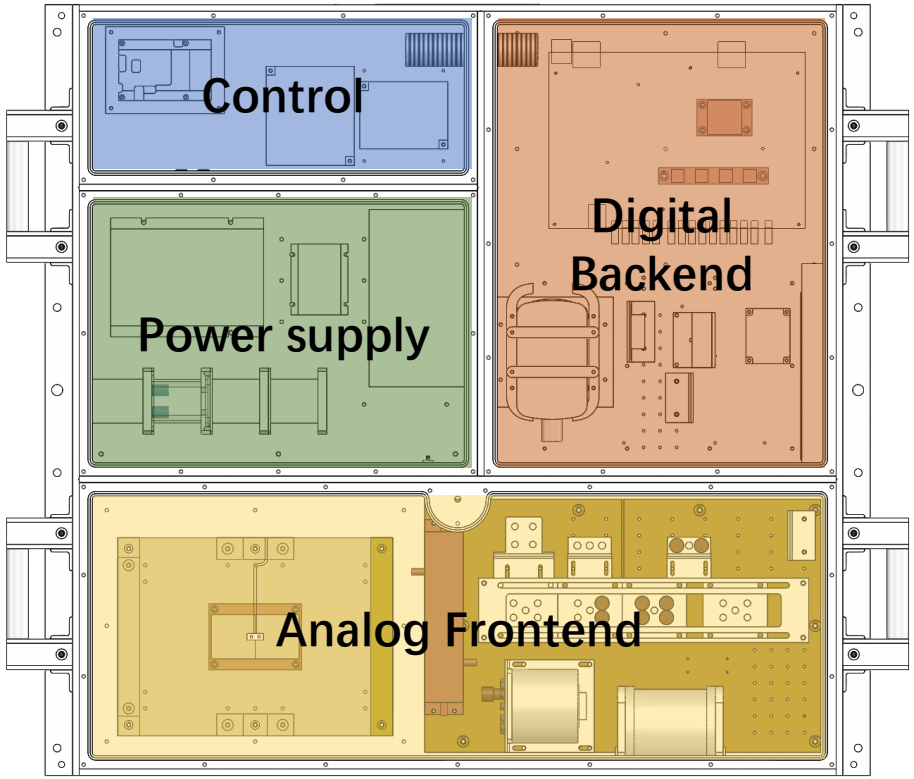
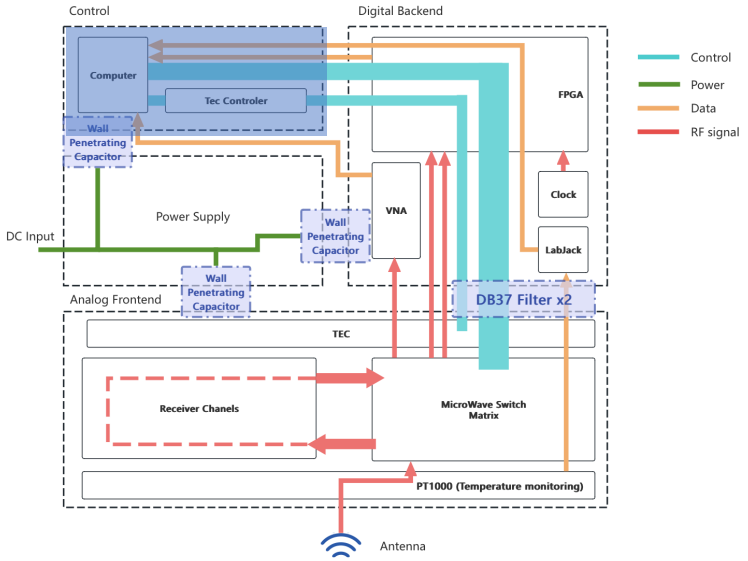
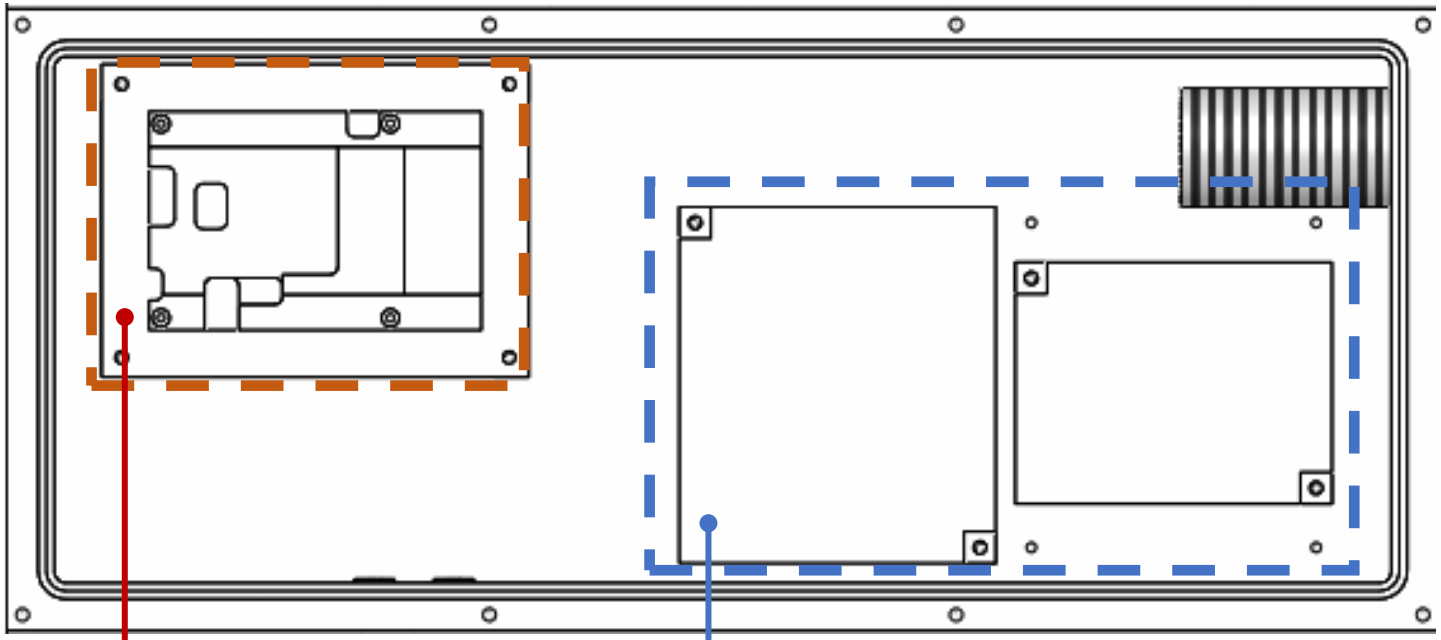
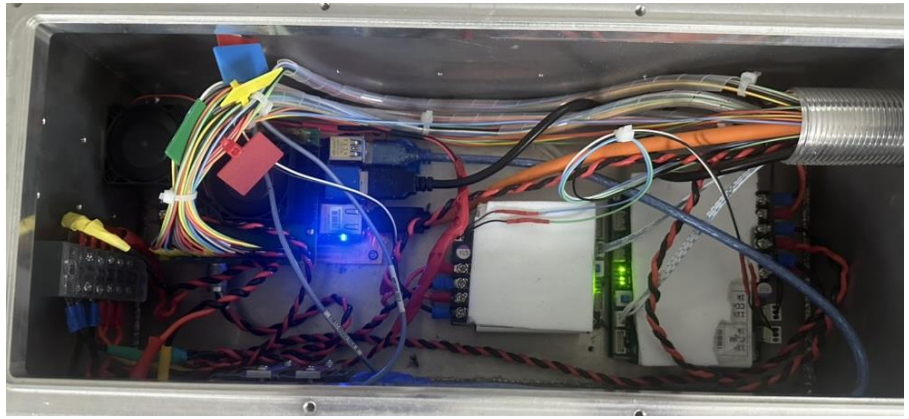




Multi-Receiver





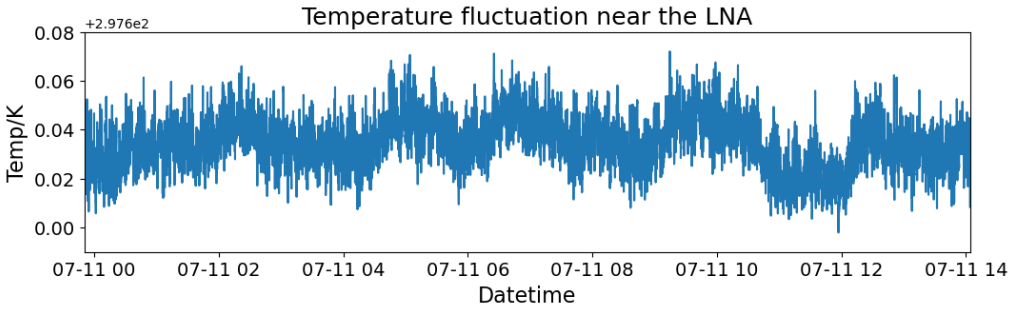


Tec-Controller

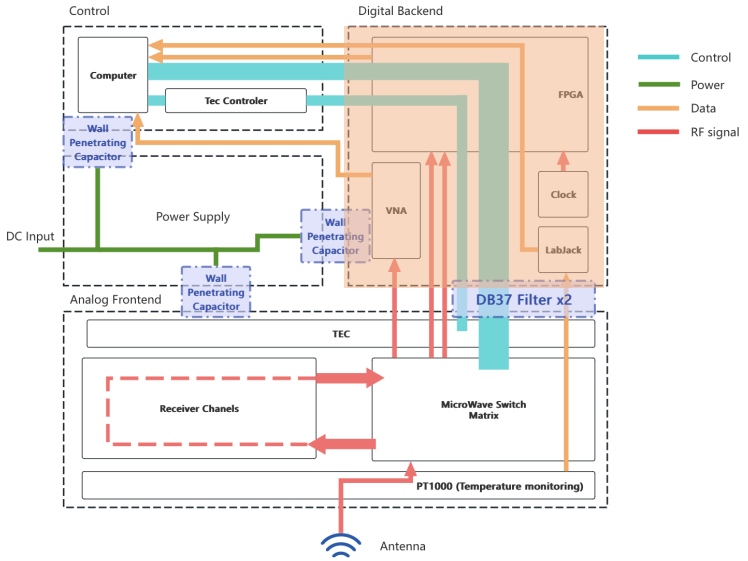
- Keep constant temperature

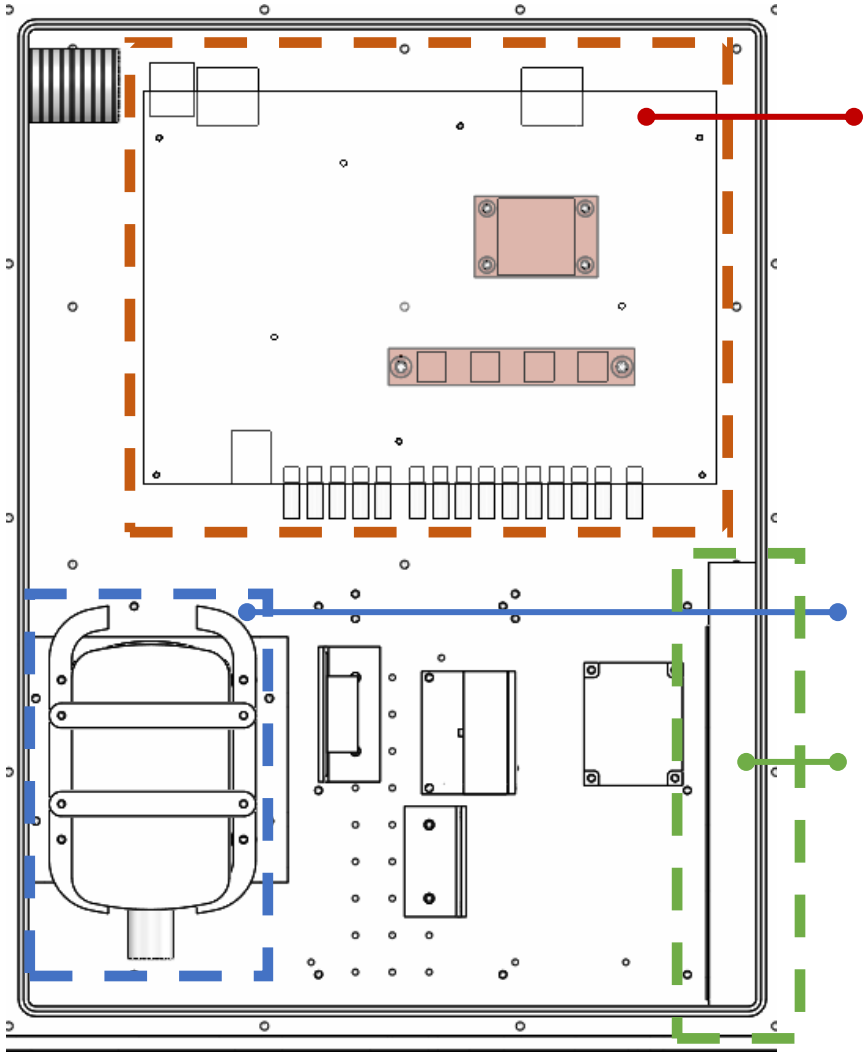
UpBoard-Nezha

- Control
- Data storage



Multi-Receiver





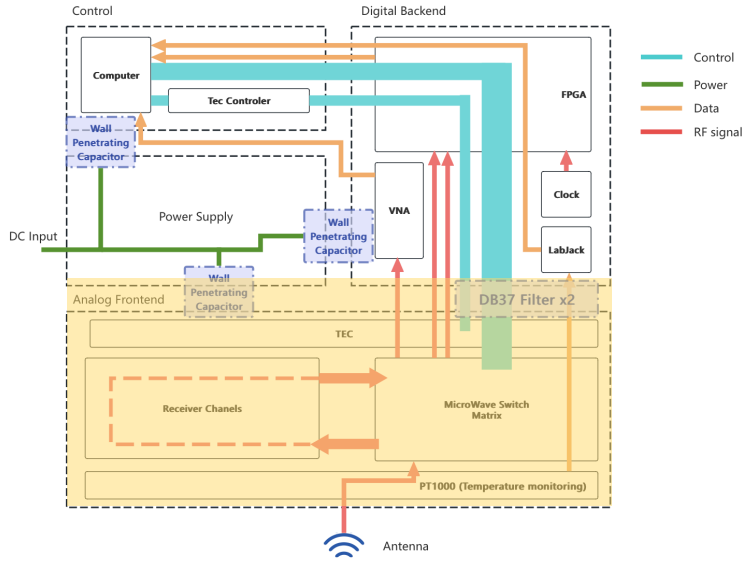
FPGA correlation board

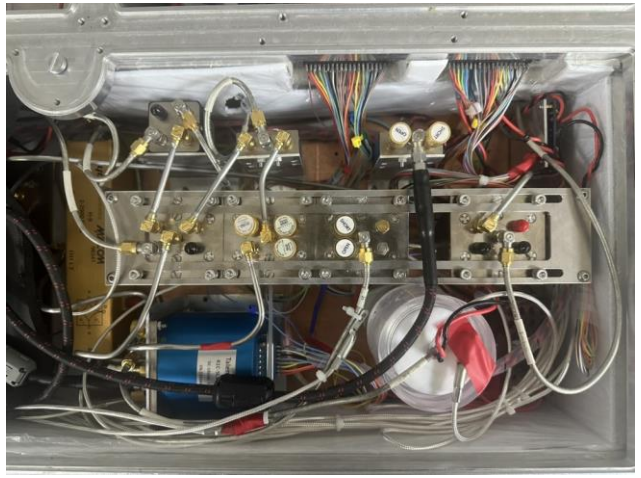
- 12-bits ADCs
- 500 million samples per second

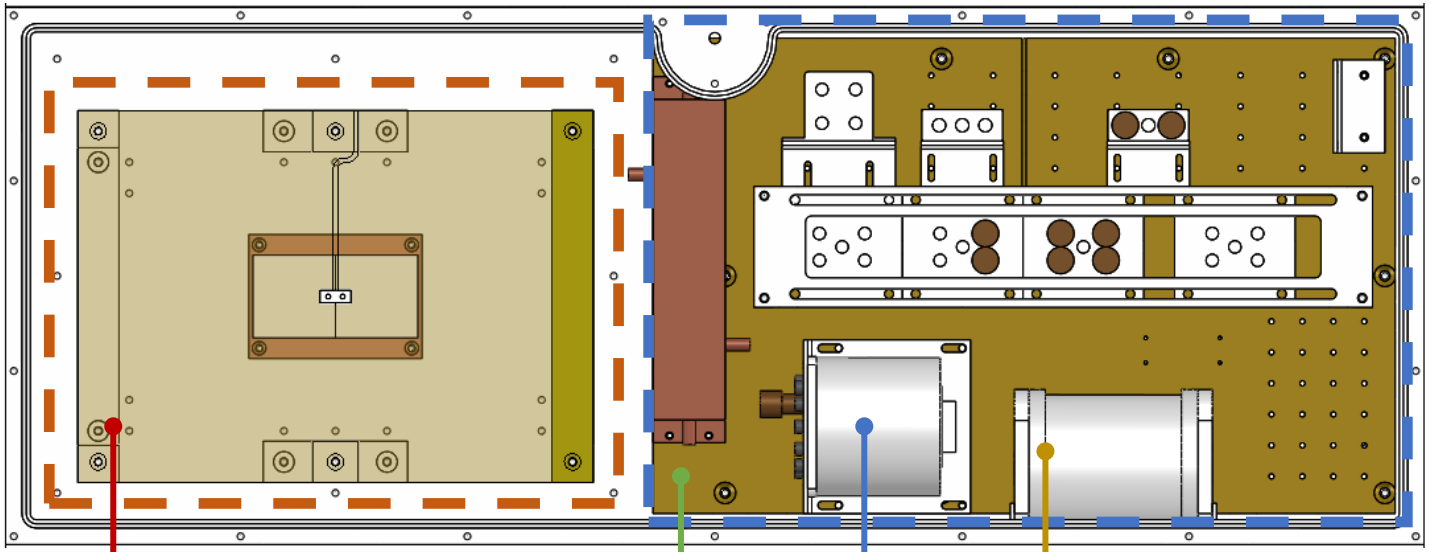
Vector Network Analyzer

Temp Data collecting module

Multi-Receiver







Analog Receiver units

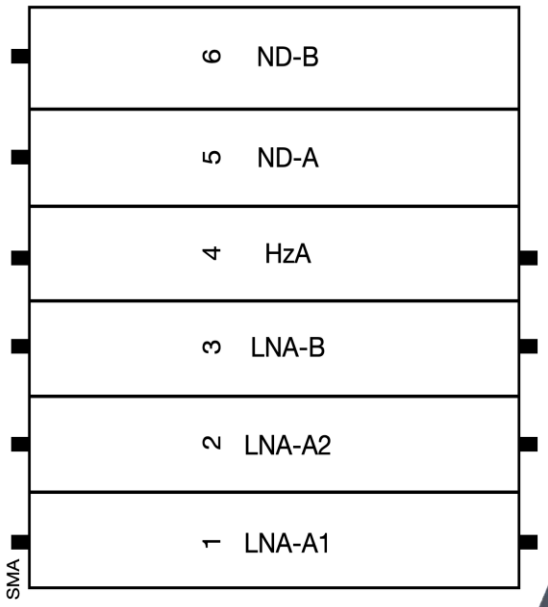
- Three 50Ohm LNAs
- One high input impedance Amplifier
- Two Noise Sources

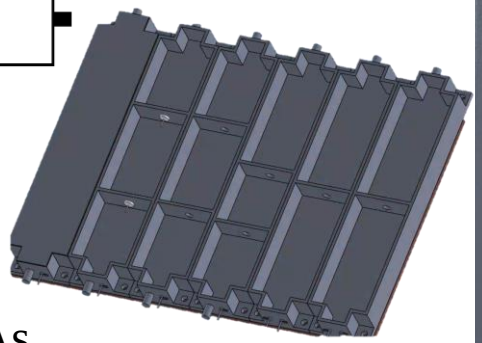
Hot Load

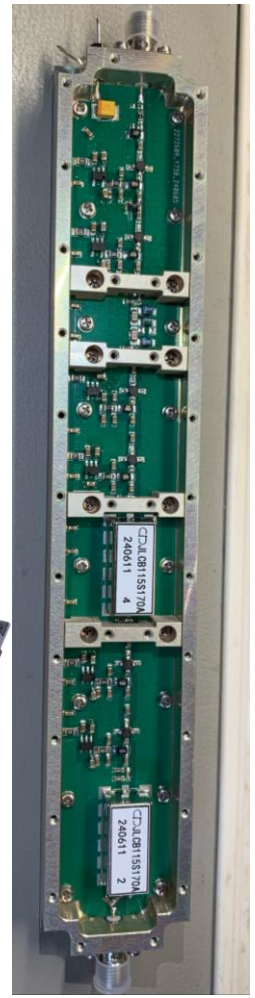
Microwave switch Matrix

Temperature Control and Monitor module

Multi-Receiver







Prototype of 50Ohm LNA
(65dB,30-200MHz)

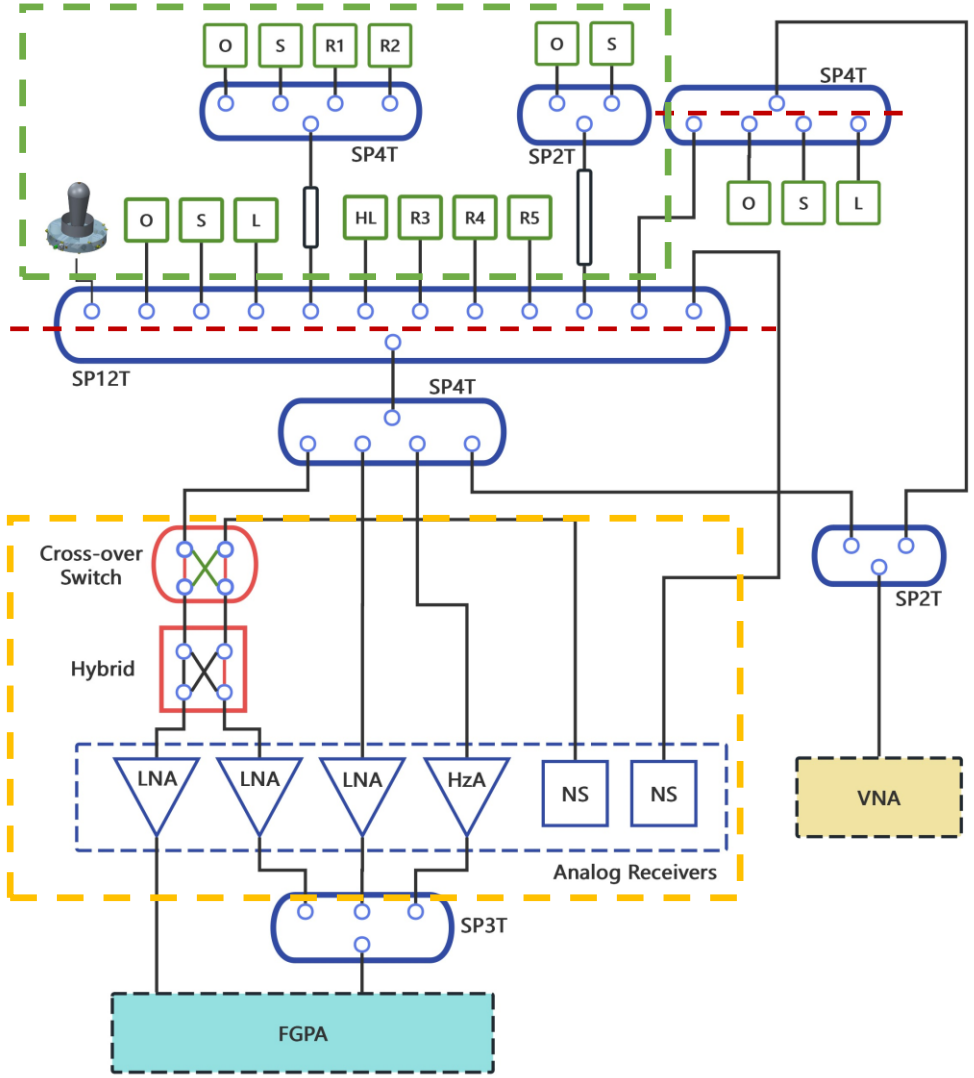
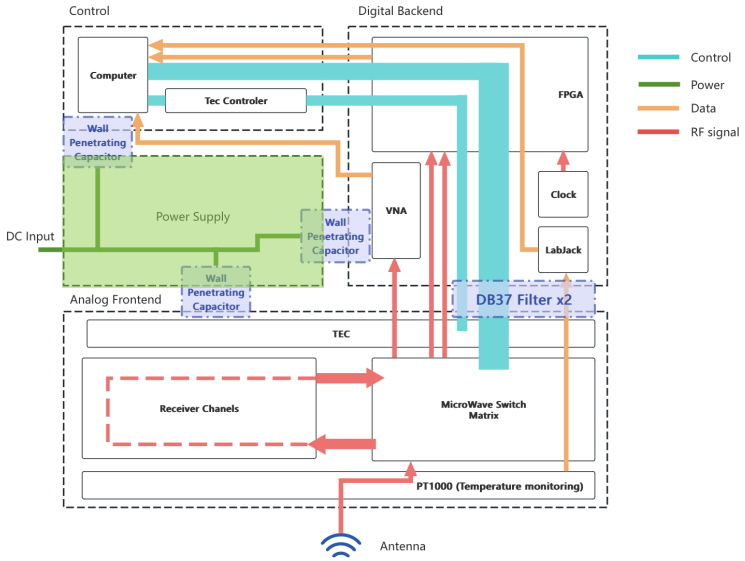


Diagram of Signal Chain

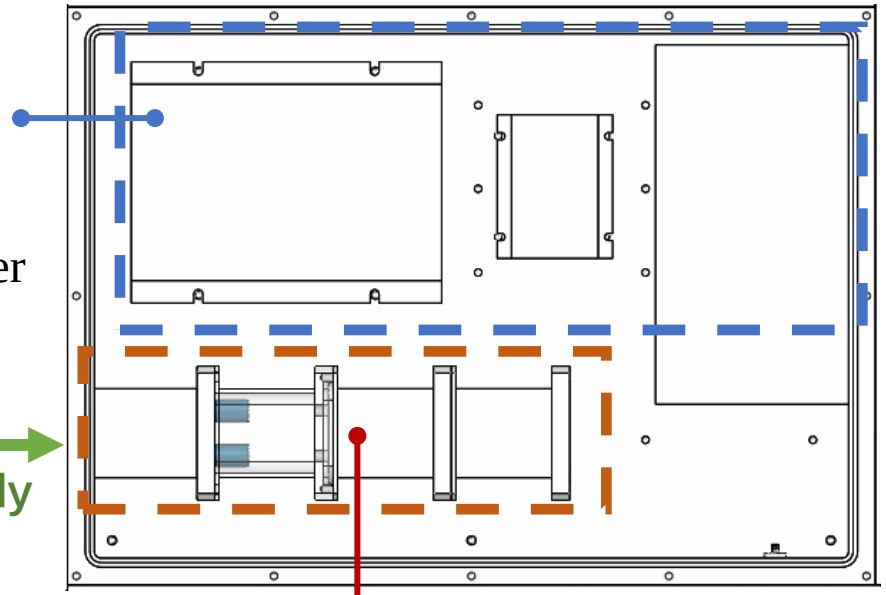
- Three 50Ohm LNAs
- One high input impedance Amplifier
- Two Noise Sources

Multi-Receiver



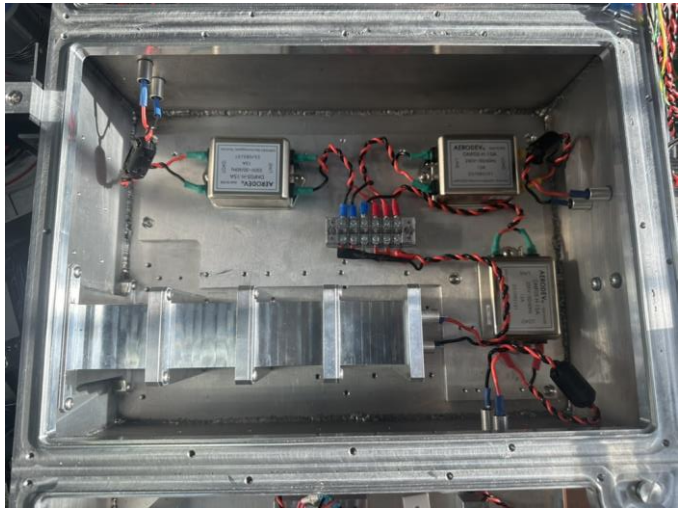
DC-DC/DC-AC Converter

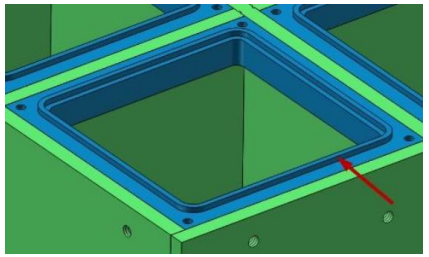
- If using solar power

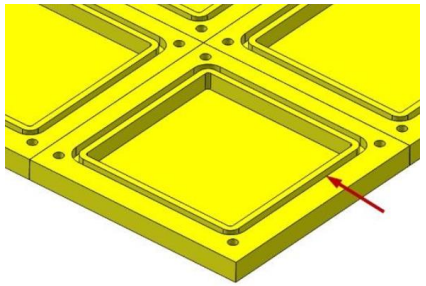


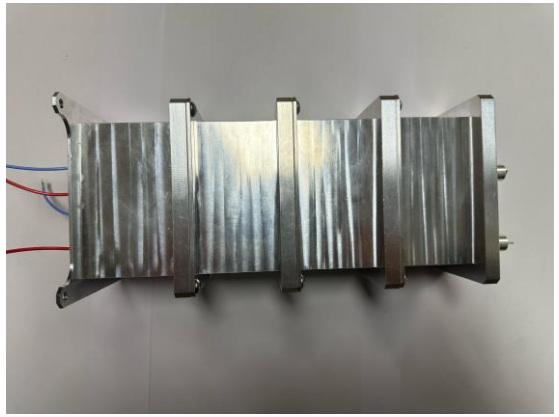
External Power Supply

mechanical structures



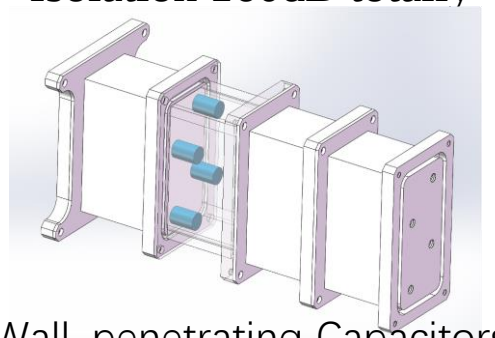






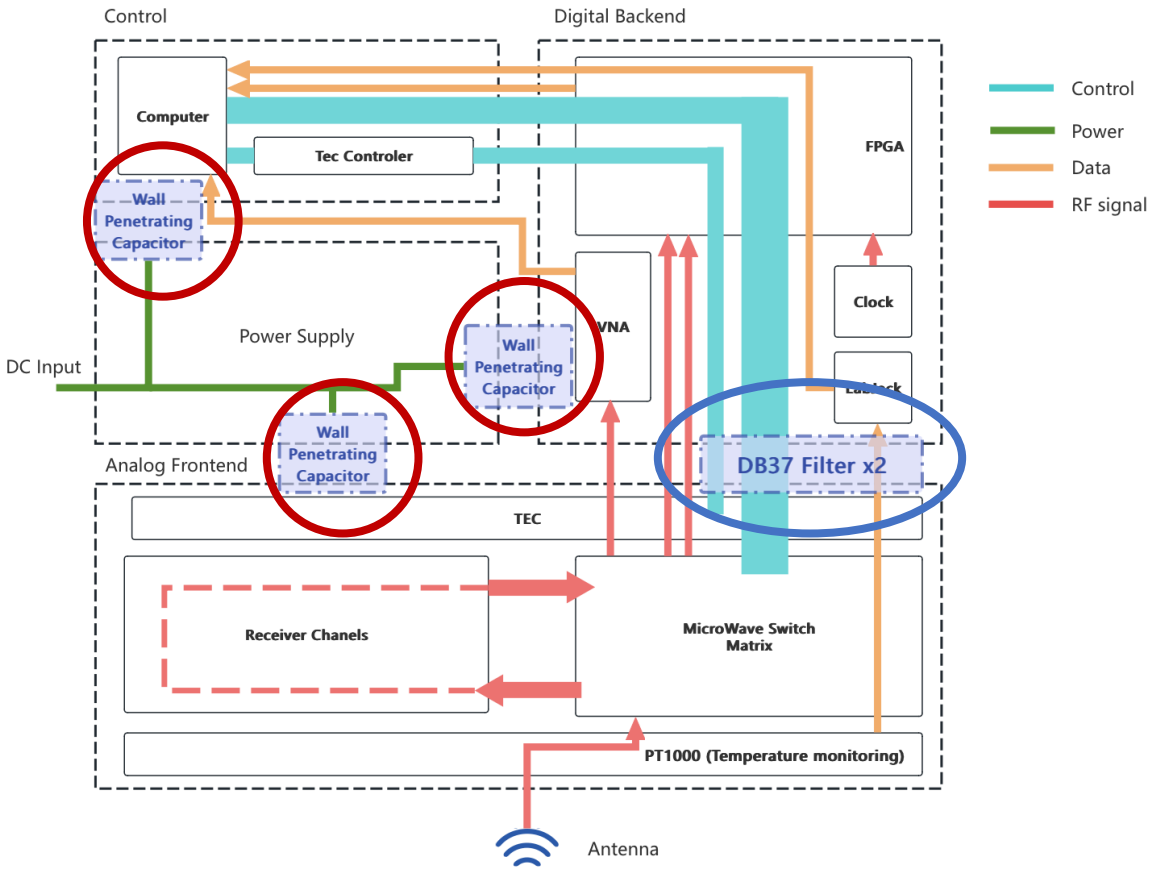
RFI shielding cavities

- Isolation 160dB totally

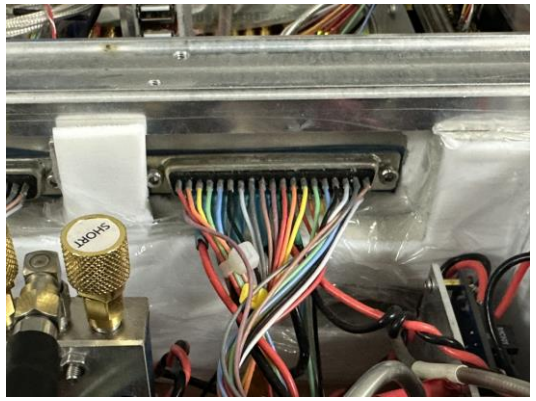


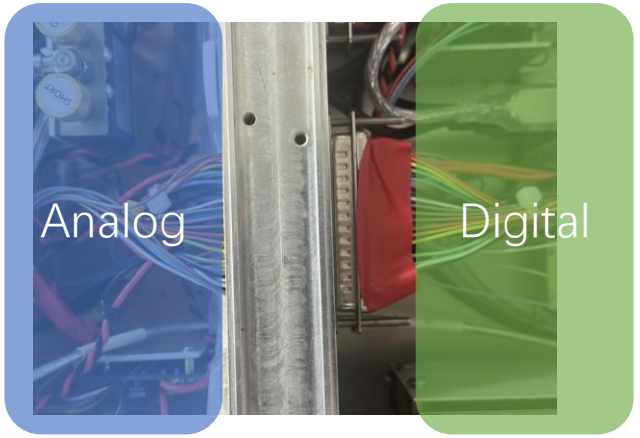
Wall-penetrating Capacitors

Multi-Receiver



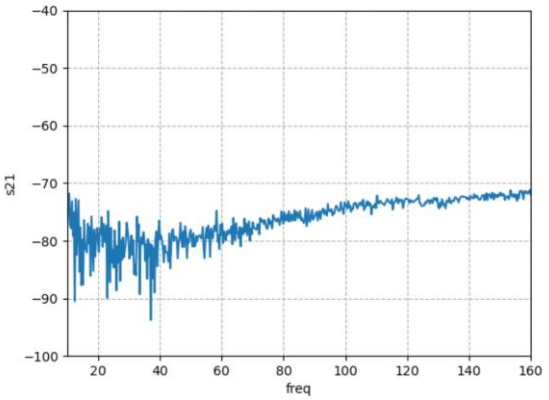
DB37 Filters





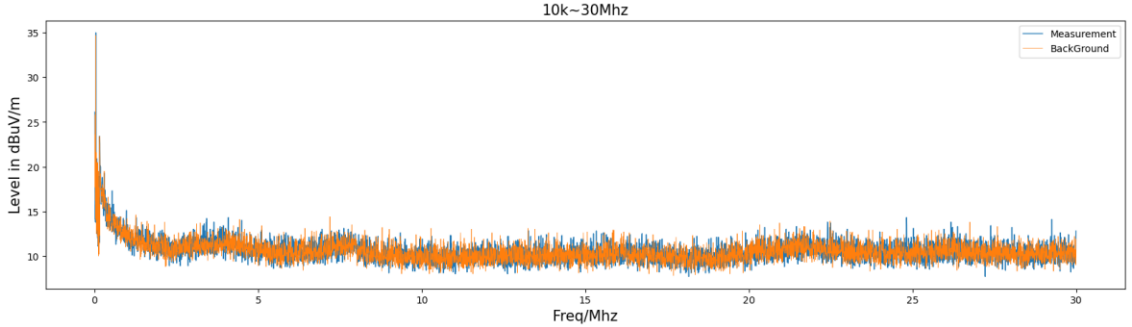
Wall-Penetrating Capacitors

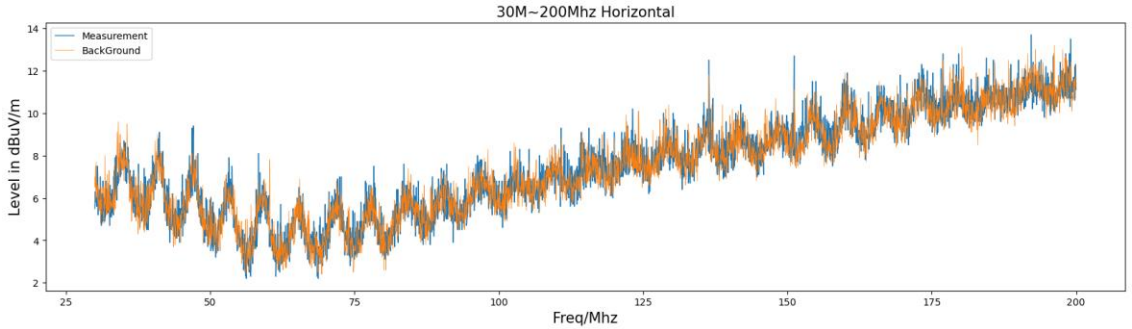
Isolation of a single Capacitor

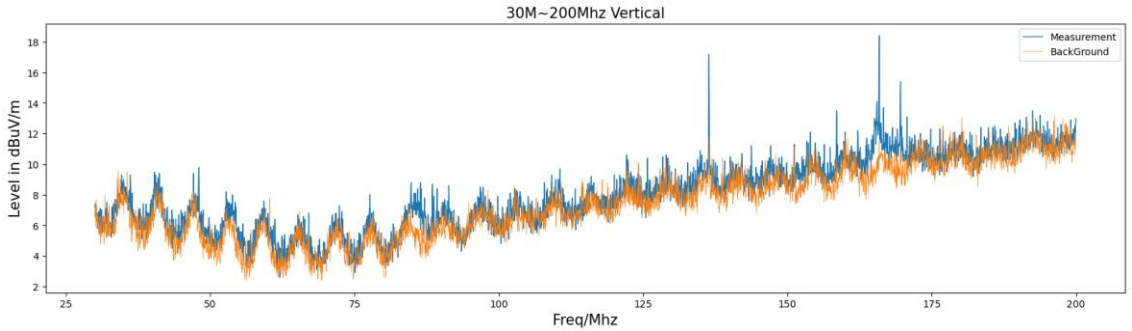


Multi-Receiver

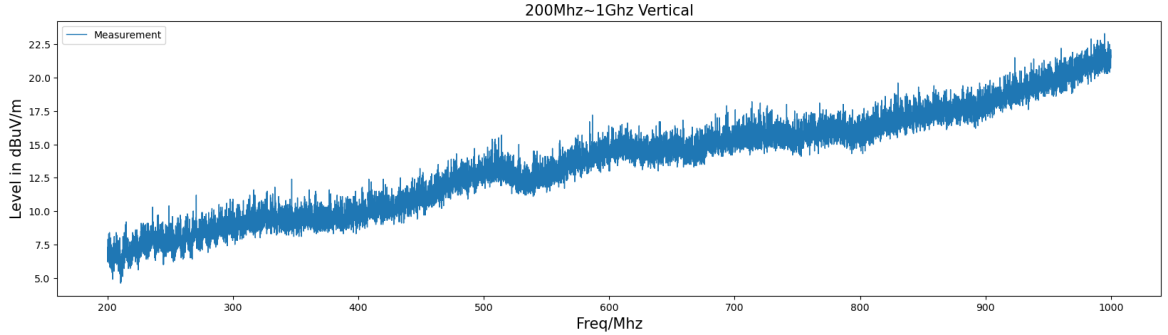
Freq below 200Mhz

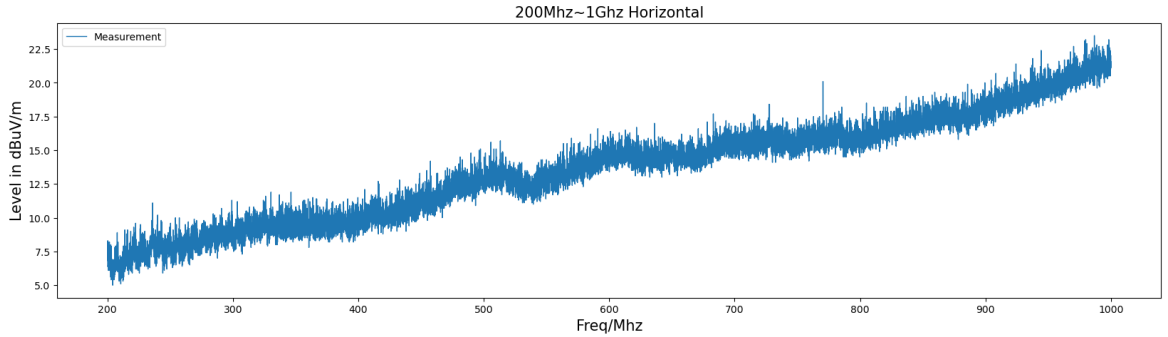


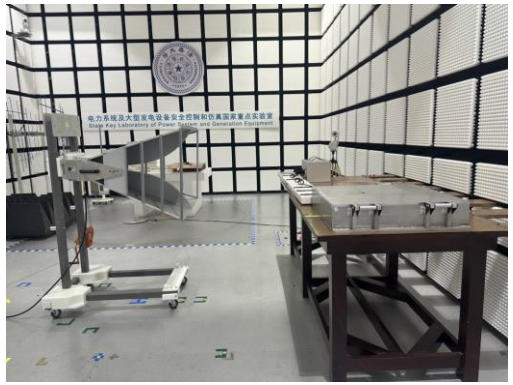




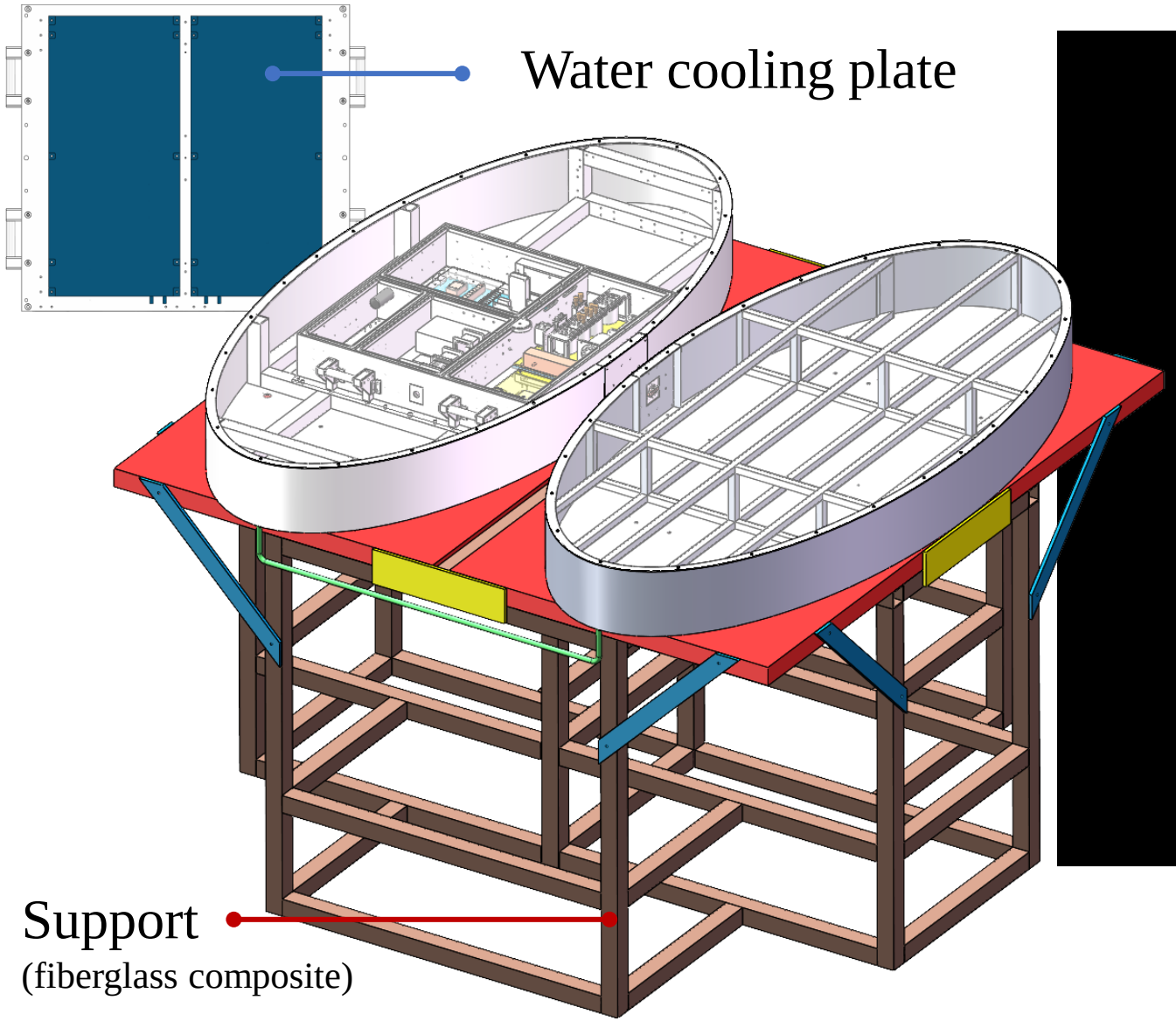
Freq above 200Mhz

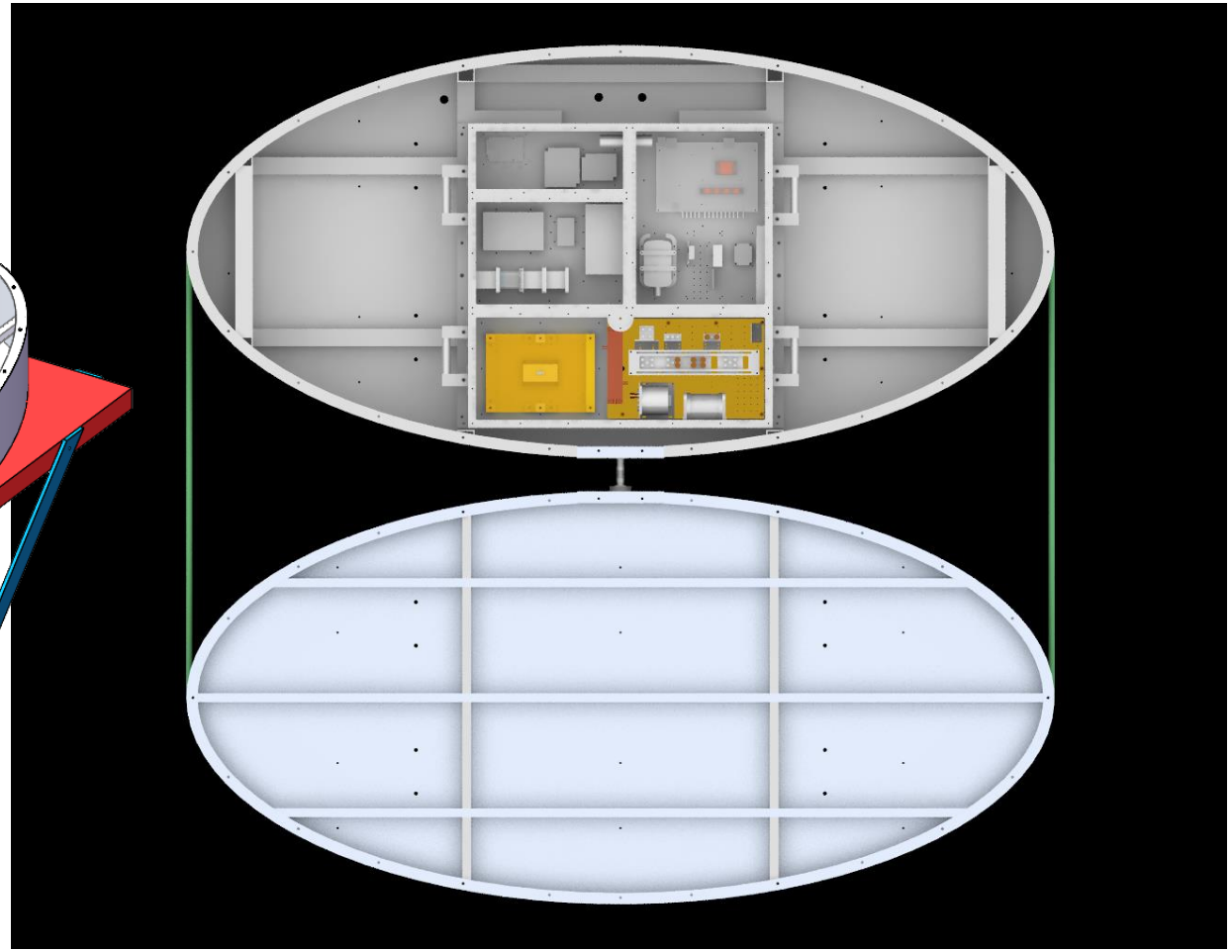






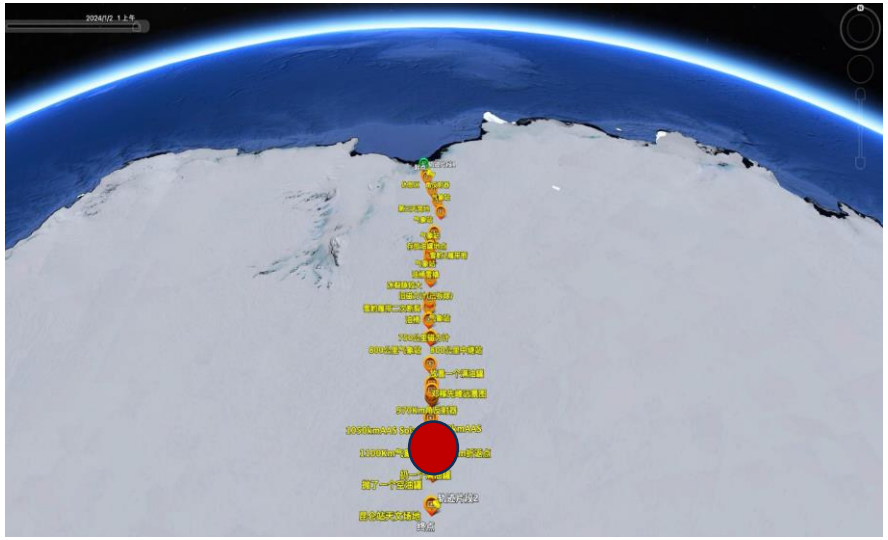
Overall System



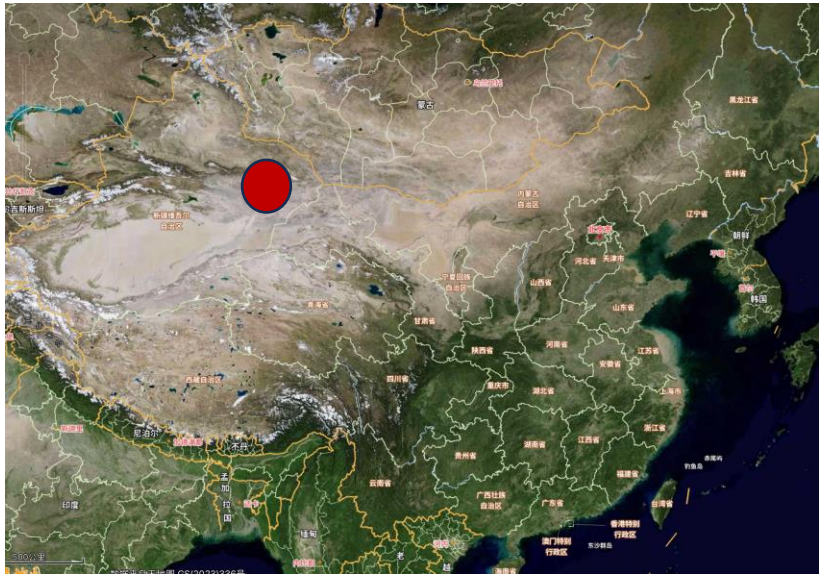


Overall System

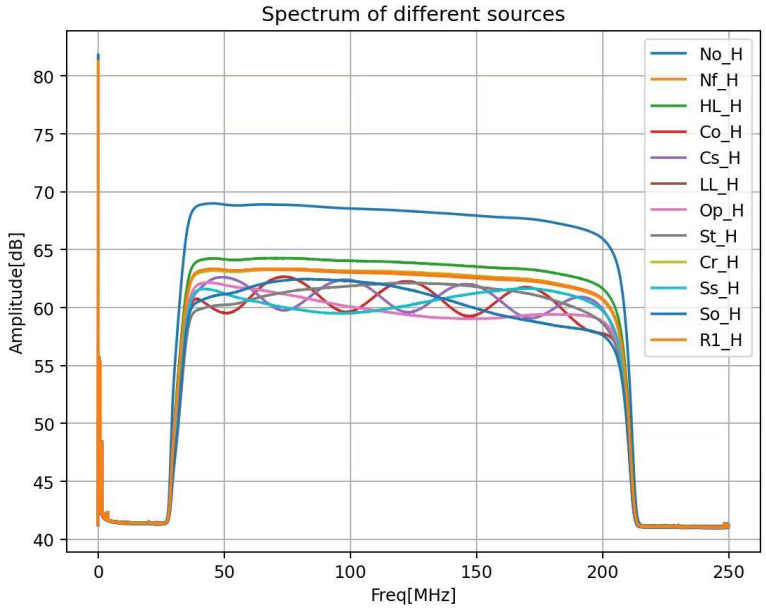
Antarctica

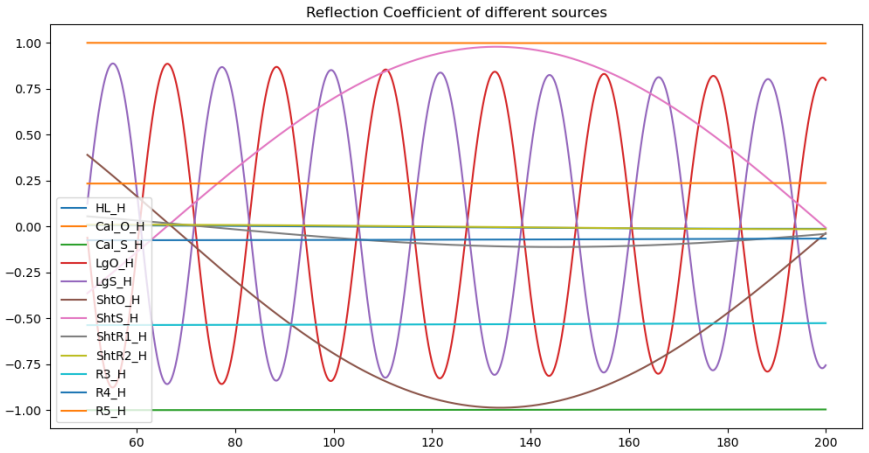


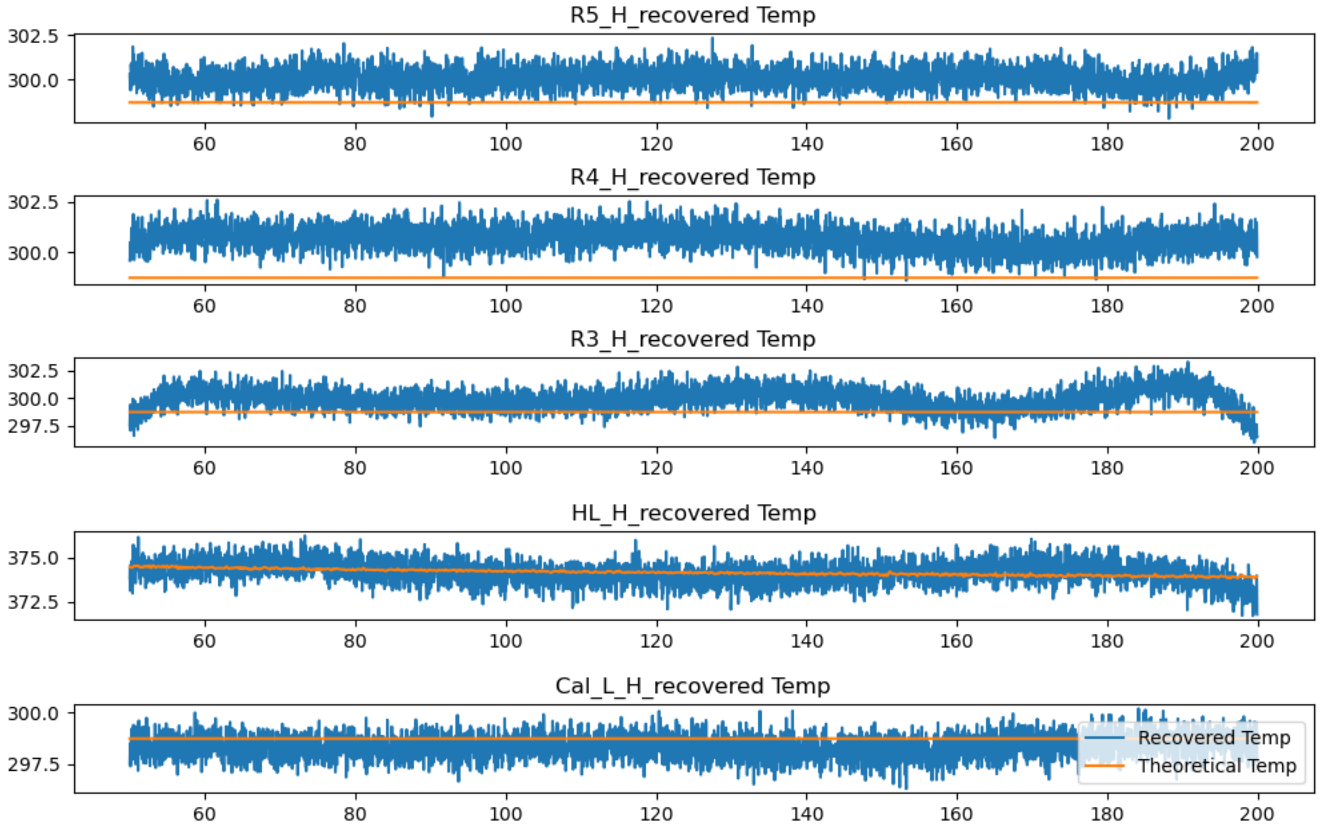
Hongliuxia,
Xinjiang, P.R.C.



Preliminary Calibration Results







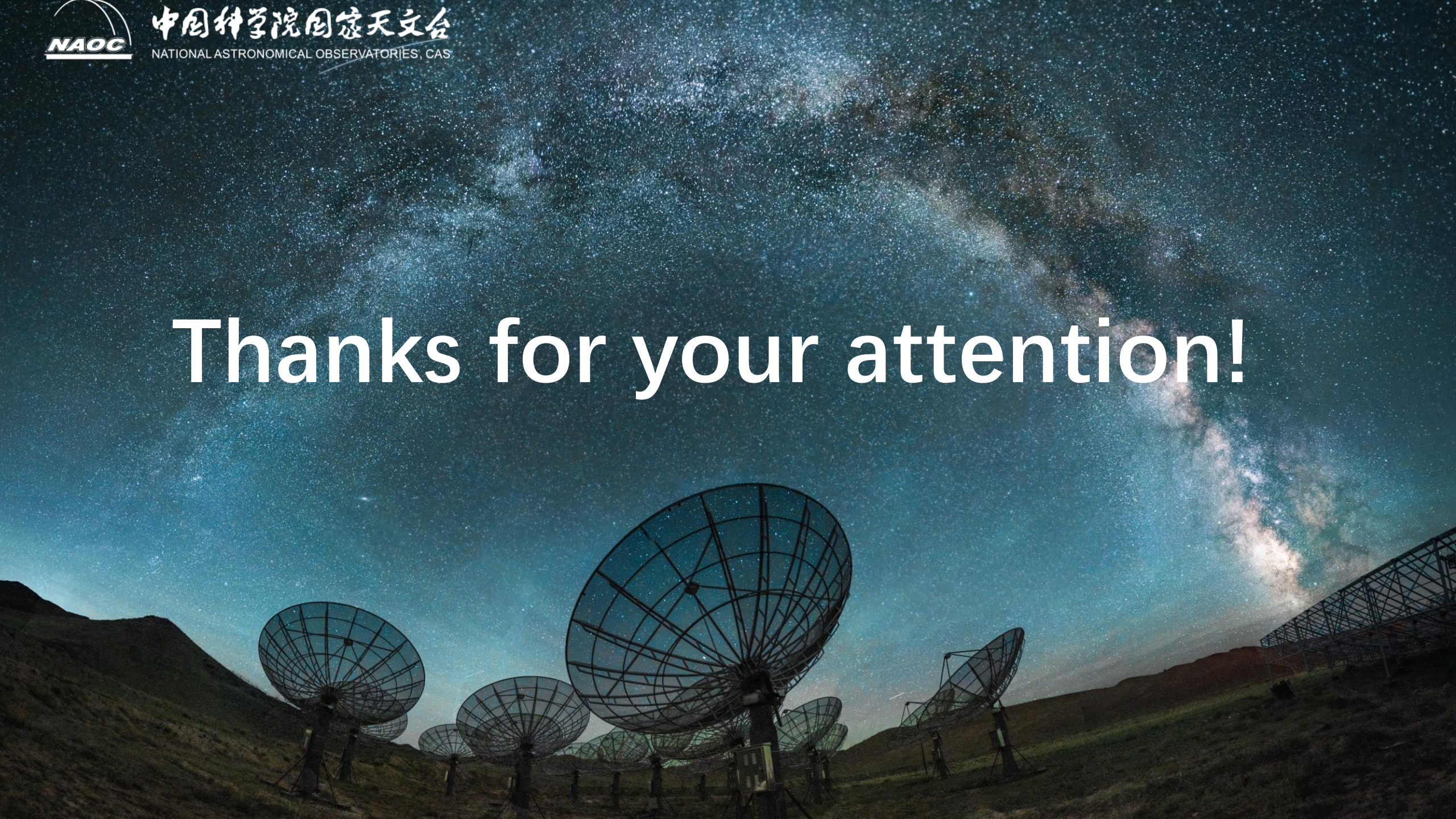
Recovered Temp (Integrated14hour data)

Conclusion:

1. A verification platform for the inside-antenna-multi receiver system.

2.Receiver with great EMC performance.

3.The overall system is under test.

4.Preparing for the water surface/ice surface/ground net experiment.

Thanks for your attention!