



A Wideband Receiver for FAST



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Receiver for the FAST Telescope

- Frequency range .27 to 1.62 GHZ
- Dual-linear polarization QRFH feed-uncooled
- Front end Receiver Cooled to 11K
 - Integrated Noise Sources for Stable Calibration
 - High pass filter for RFI mitigation
- Warm Back end electronics
 - 2 Bands-Full Band .27 to 1.62 GHZ-Reduced Band 1.3-1.62 GHZ
(Requirement has chaged-Youling Yue)
 - Linear/Circular Polarization Selected by Switched Hybrid
 - 2 GHZ Fiber Optic Transmitters
 - RF Power Monitors
 - 5 bit Attenuators-1 dB/Step 31 dB total
 - Spectrum Analyzer-Rigol DSA1030
 - Warm Electronics Temperature Controller
 - Software control over Ethernet

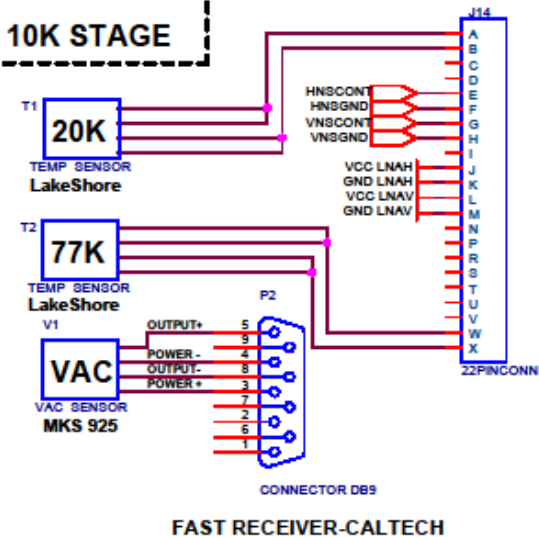
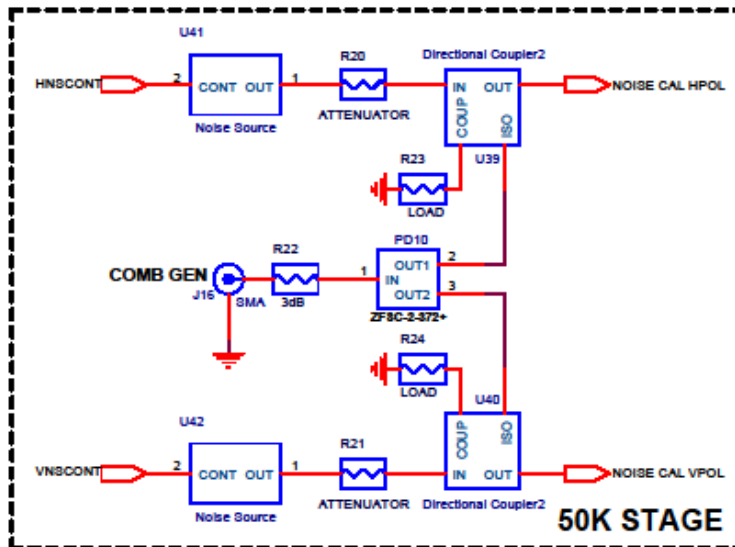
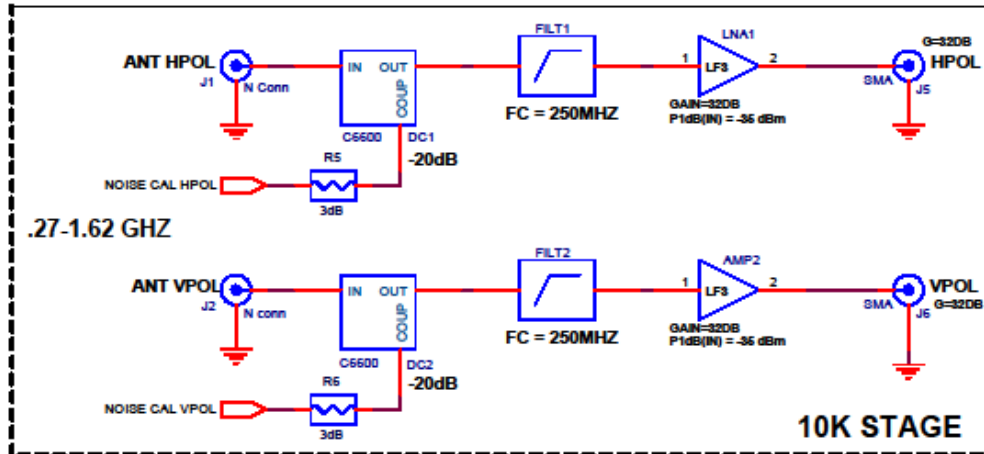


Receiver Design Goals

Frequency Band .27 to 1.62 GHz

- Feed Aperture Efficiency-Greater than 60% for F/D 0.46
- Feed Spillover Noise-Less than 10K
- System Noise Temperature < 35 Kelvin
(including 9K Spillover and 6K sky noise)
- System Gain 65 dB Typ
- P 1dB Gain Compression >-35 dBm
- Noise Calibration Signal = 20 +/- 5 K
- System Mass < 100 Kg
- Feed Size = 1.45 m Square X 1.2 m long

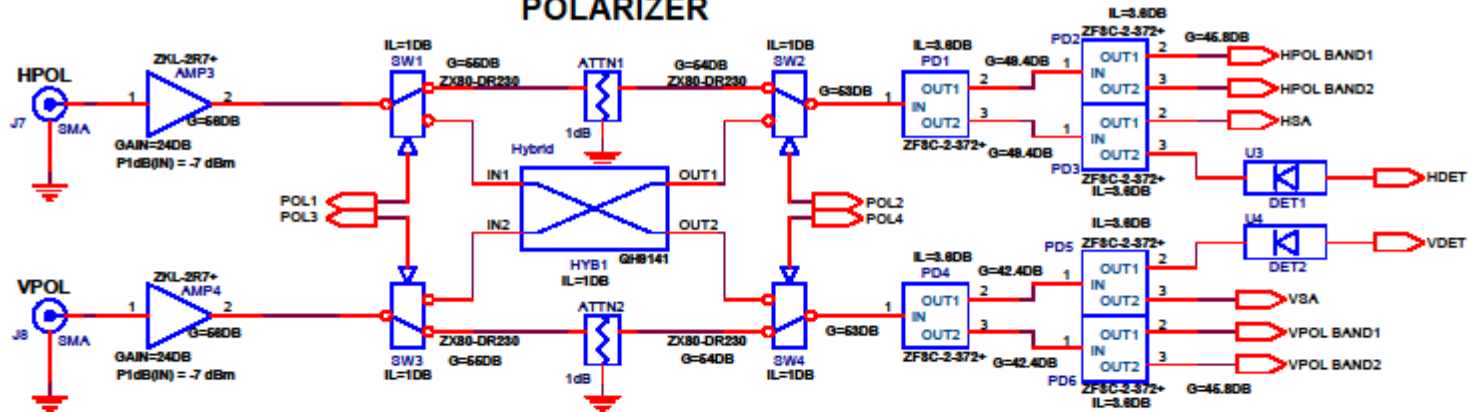
Cryogenics Dewar





Warm Electronics

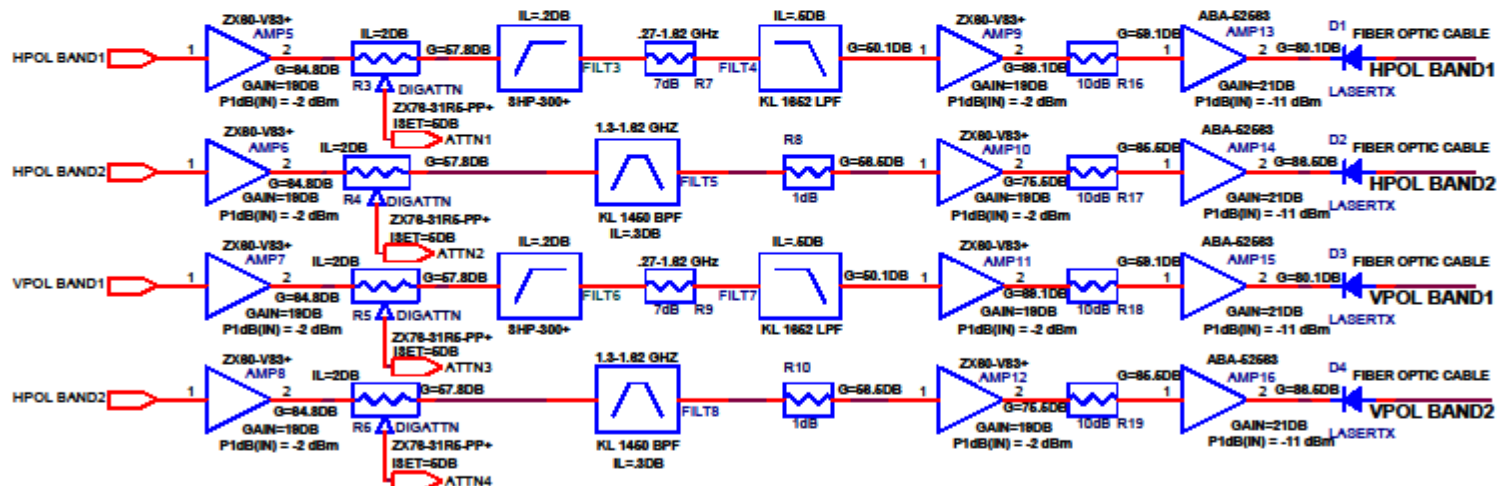
POLARIZER



DIGITAL ATTN

FILTER

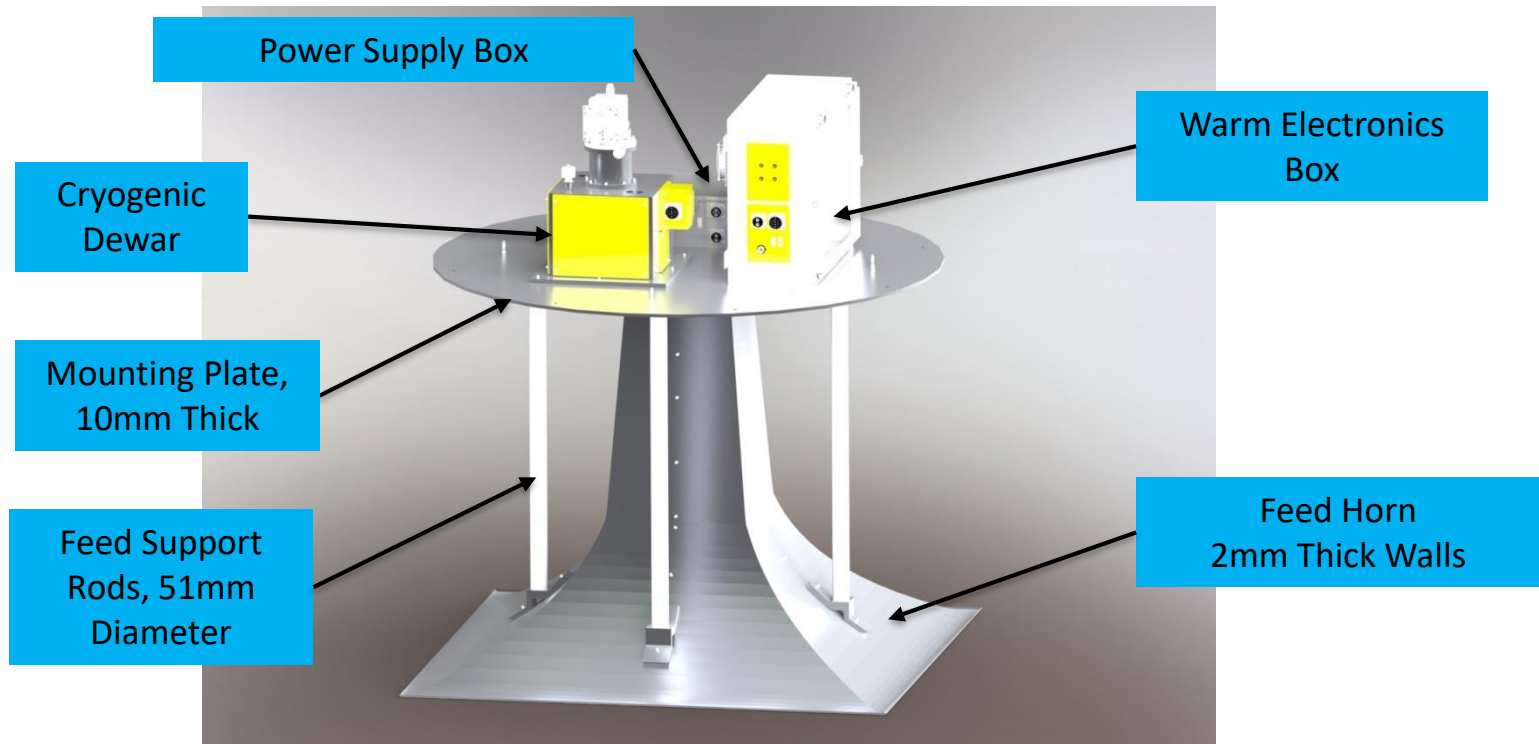
FIBER OPTIC TX



FAST RECEIVER-CALTECH



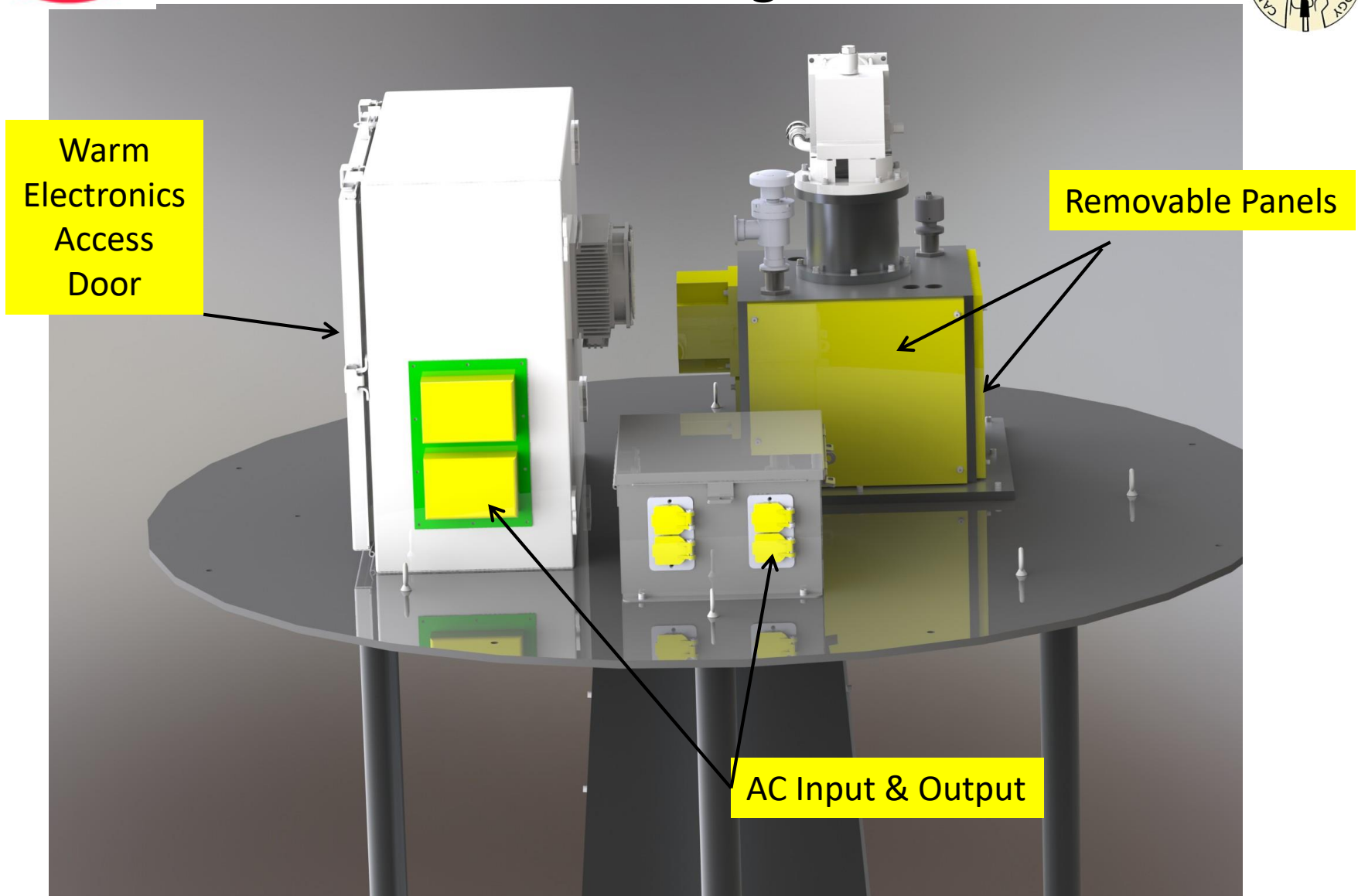
Overall View of the FAST Receiver

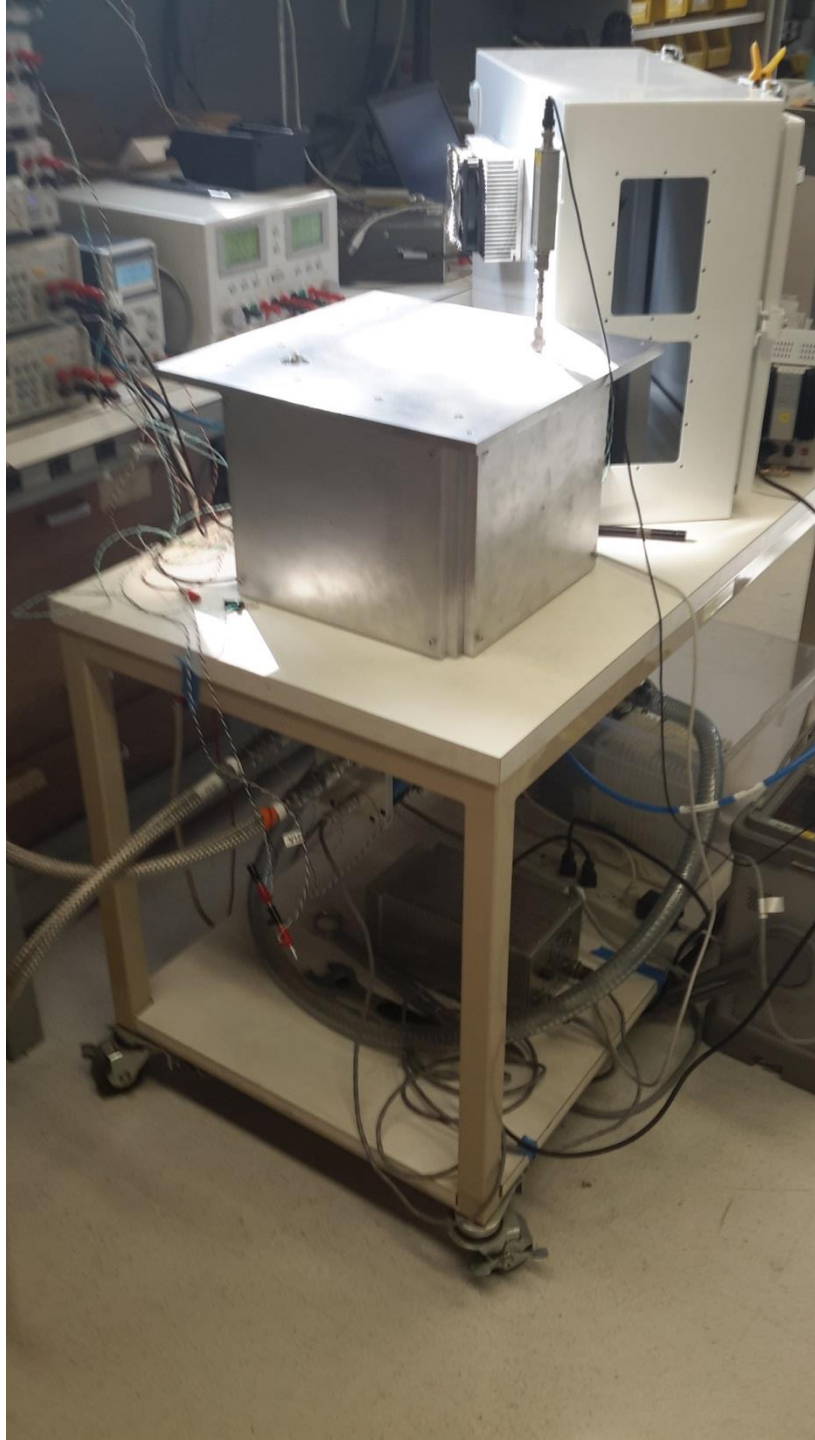


- Round mounting plate has diameter of 1.5m
- Feed is 1.453m square at the bottom
- Total height is 1.706m
- All boxes are RFI sealed and water sealed
- Weight estimate is 189 kg

Designed by Steve Smith

Another View Showing Access Panels



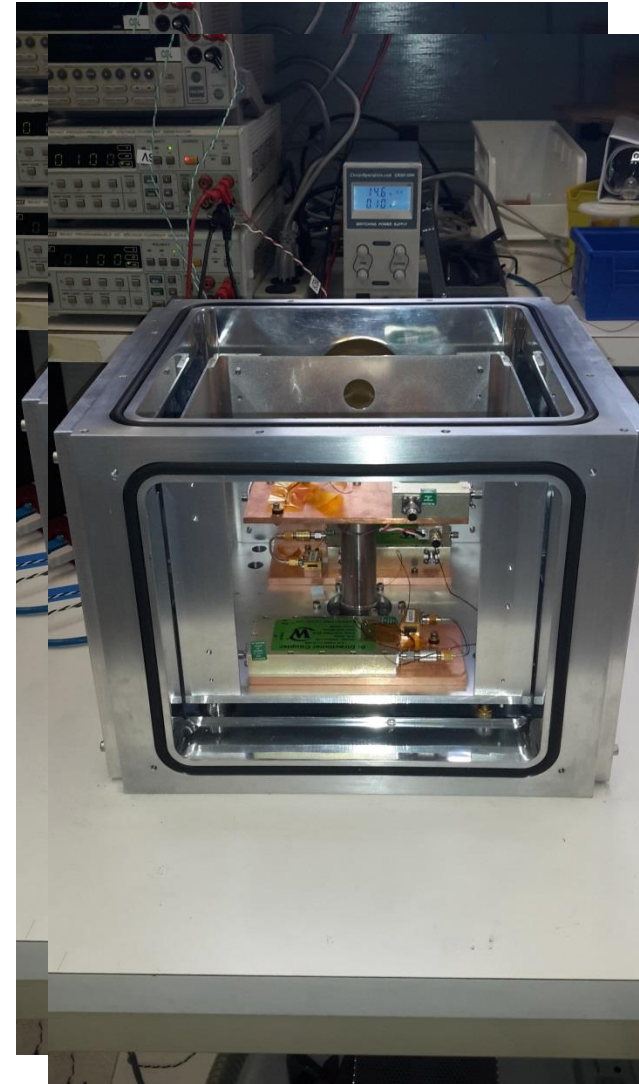




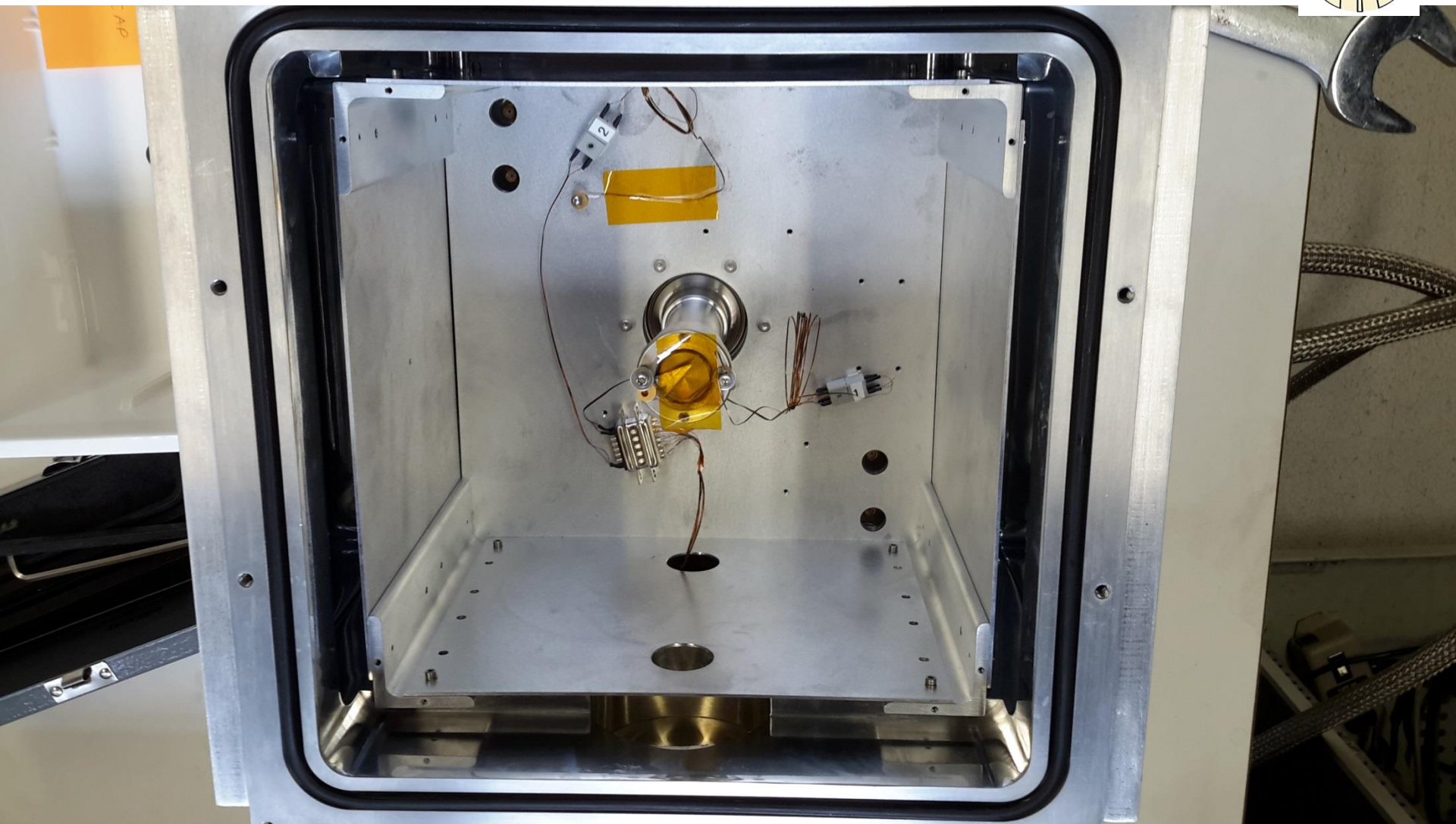


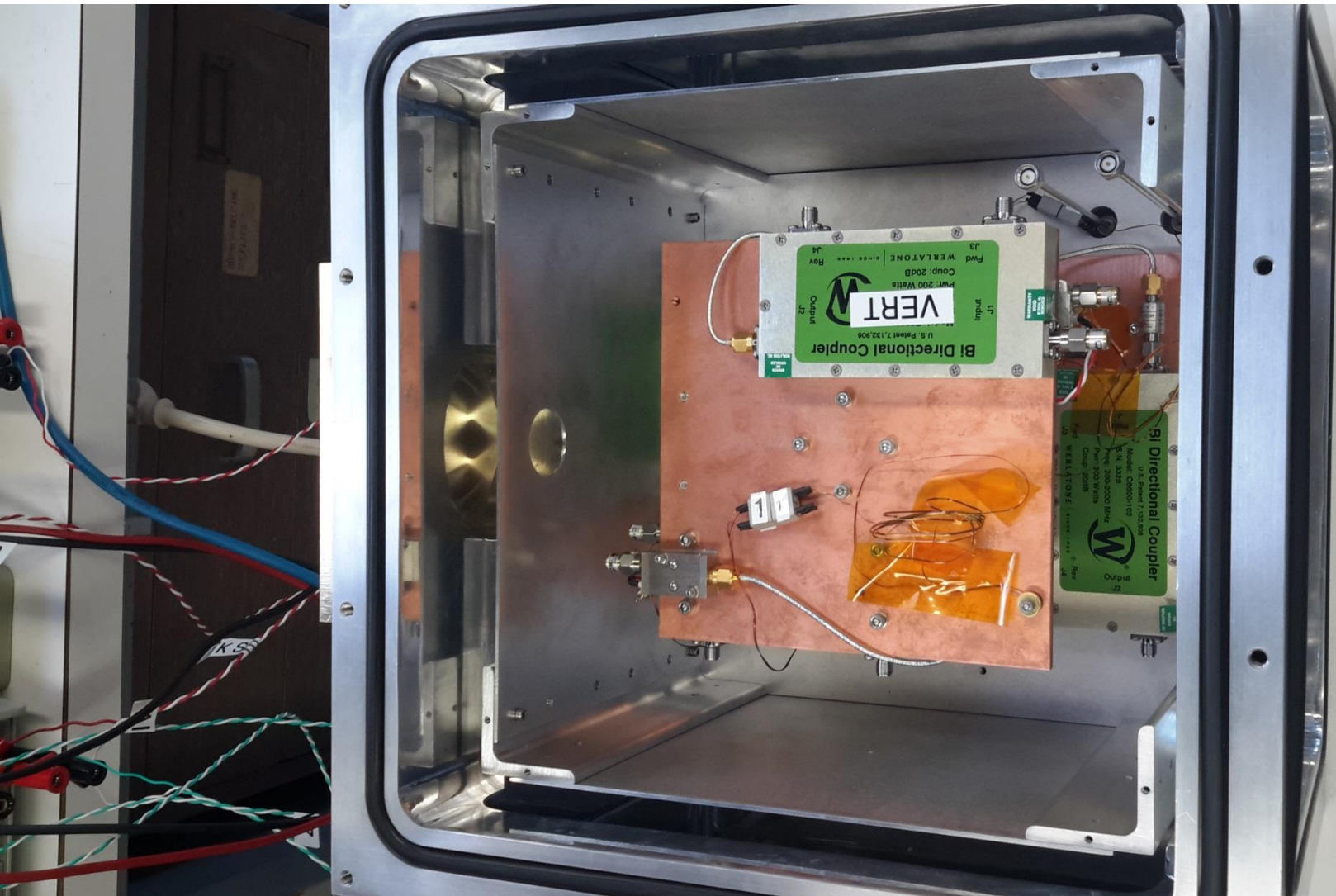
Cryogenic Dewar

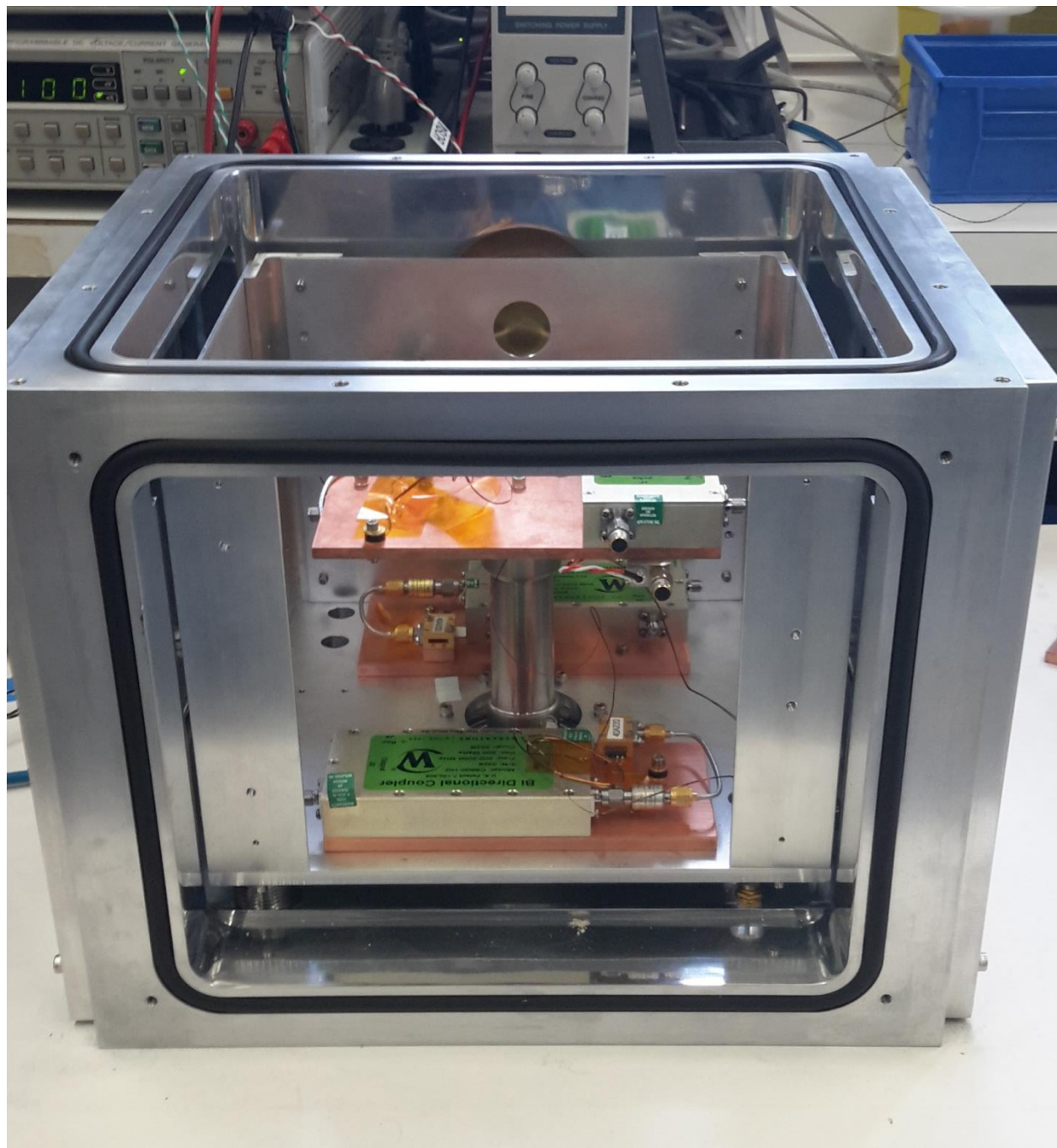
- CTI 350 2 stage Cryogenic Cooler
- 50K 1st Stage, 11K 2nd Stage
- Removable access panels on 3 sides of the Dewar for easy access
- Direction Couplers, High Pass Filters, LNAs on 2nd Stage
- Noise Sources, Directional Couplers on 1st Stage
- N Connector Input (2) from Feed
- SMA Connector Outputs (2) to Warm Electronics
- SMA Comb Generator Calibration Input (1)



Designed by Steve Smith

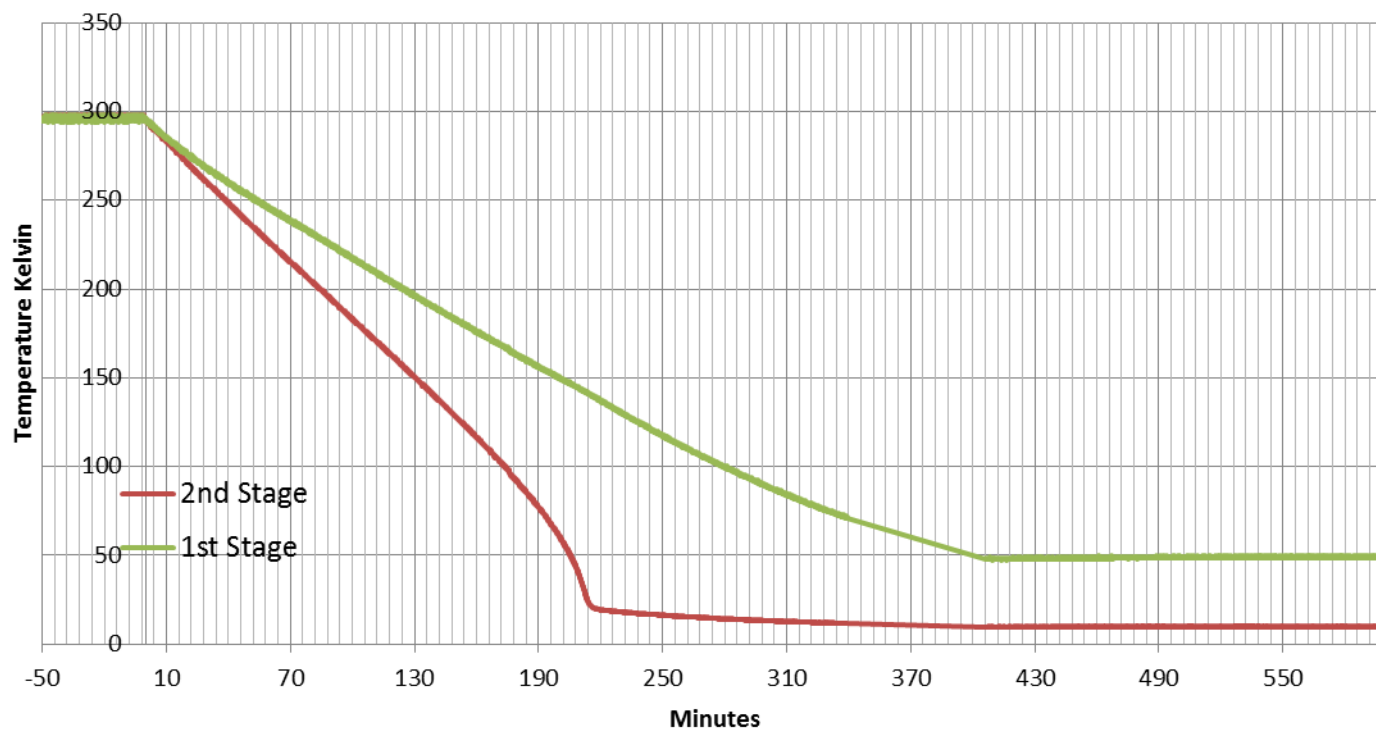




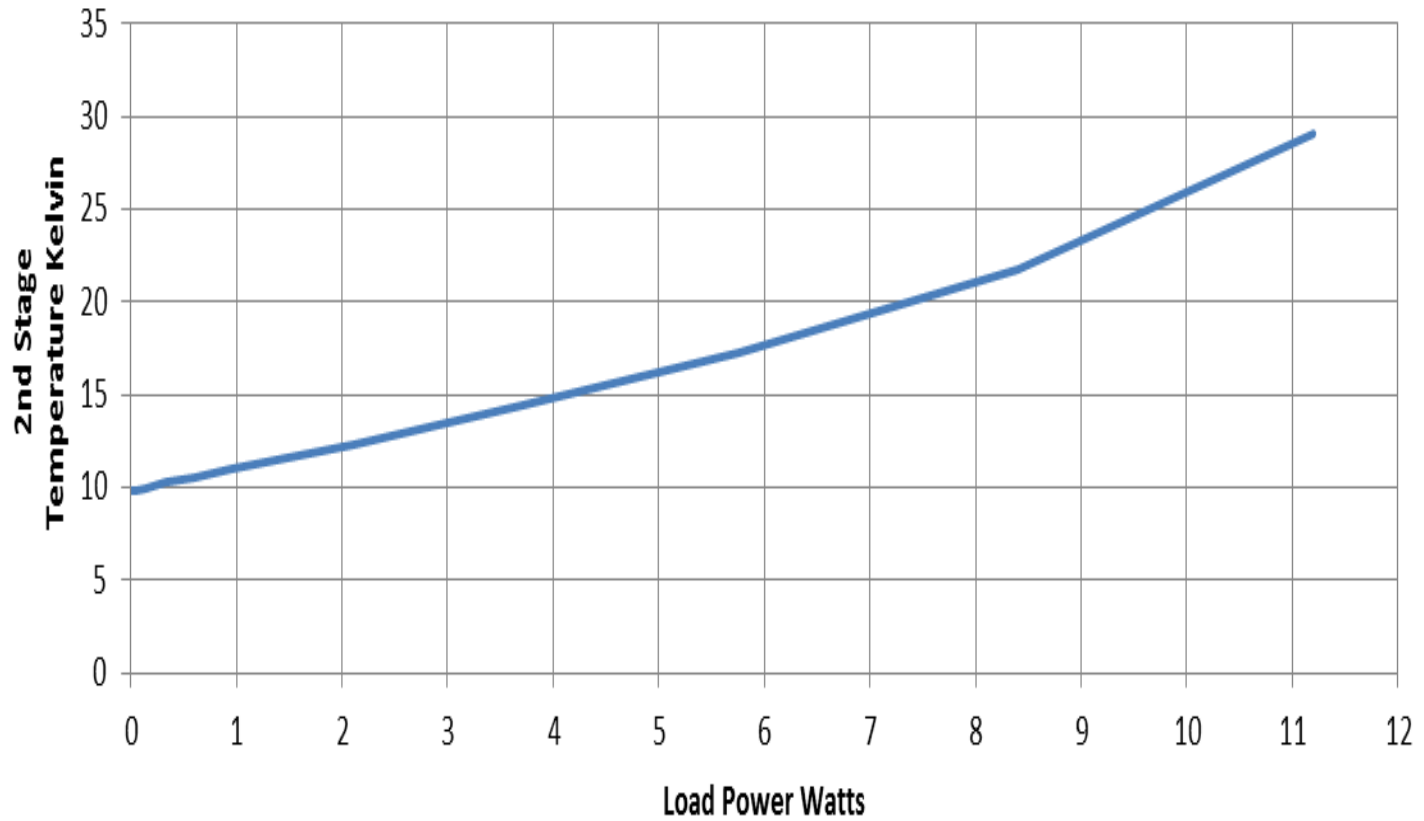


Temperature Profile

Components installed, DC Wired, No RF Connections

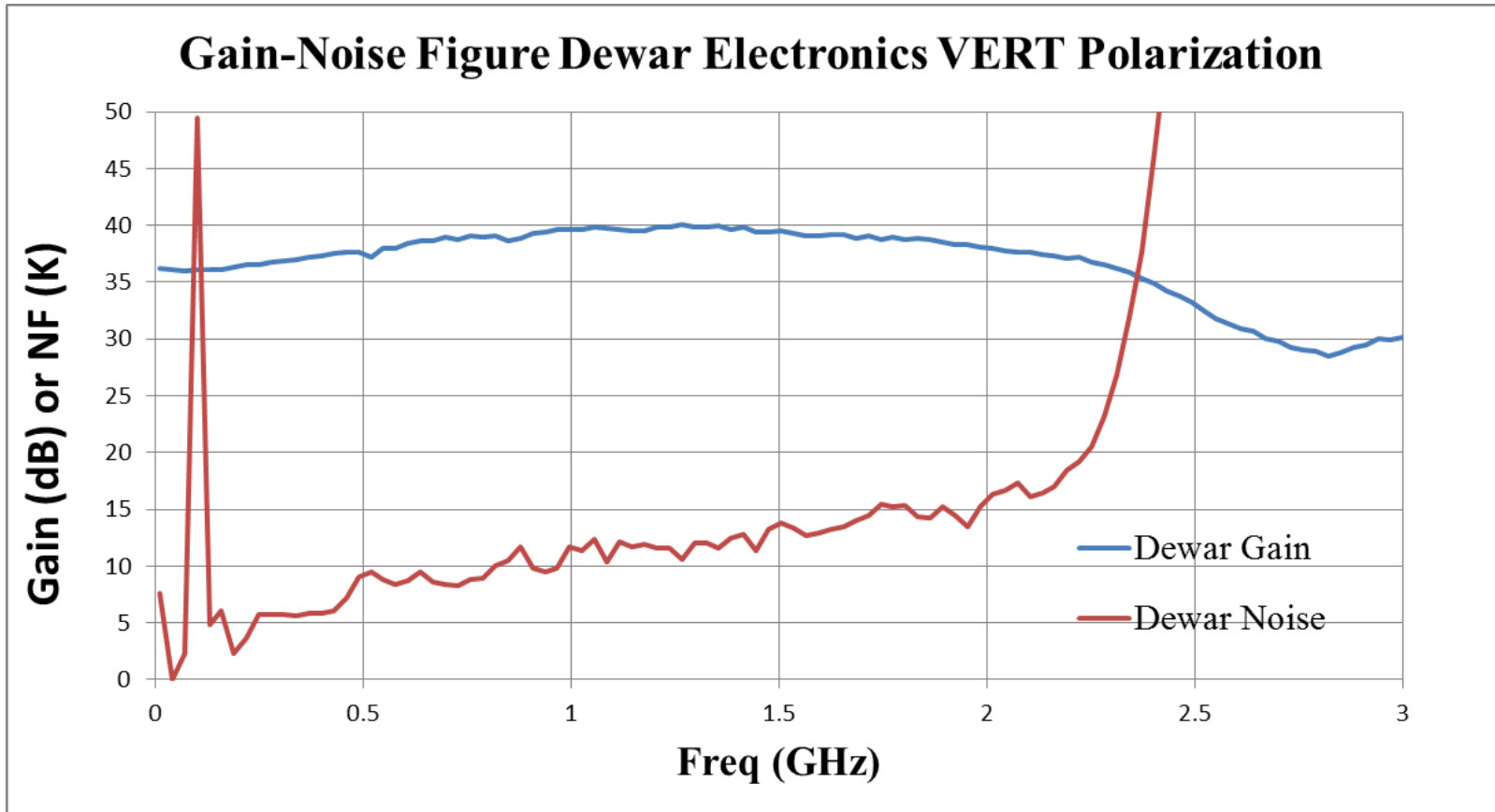


CTI350 Cooler Heat Loading





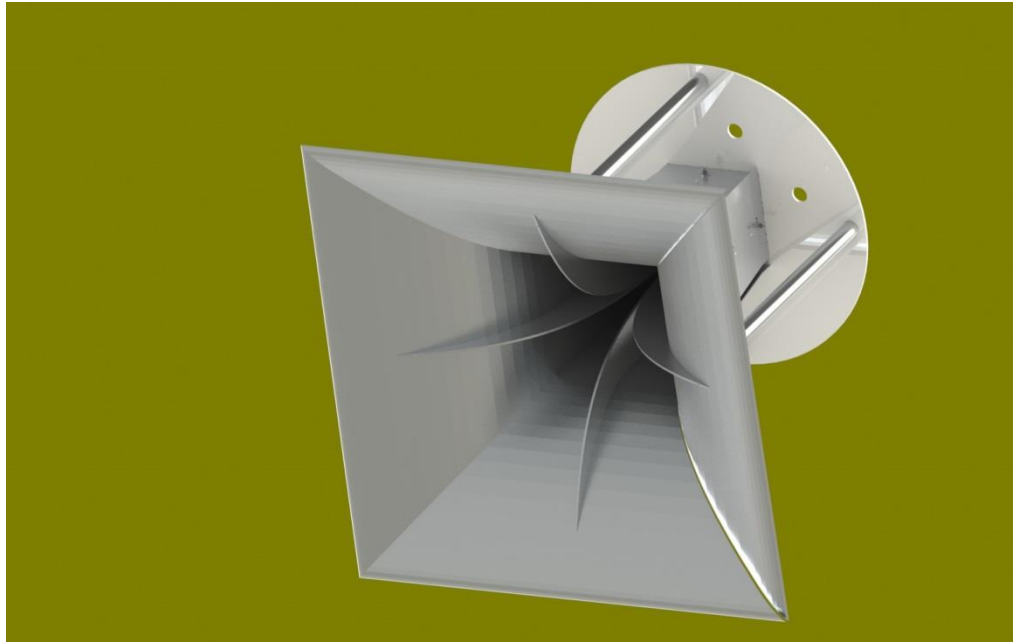
Measured Dewar Performance





Antenna Feed

QRFH-Quad Ridge Flared Horn



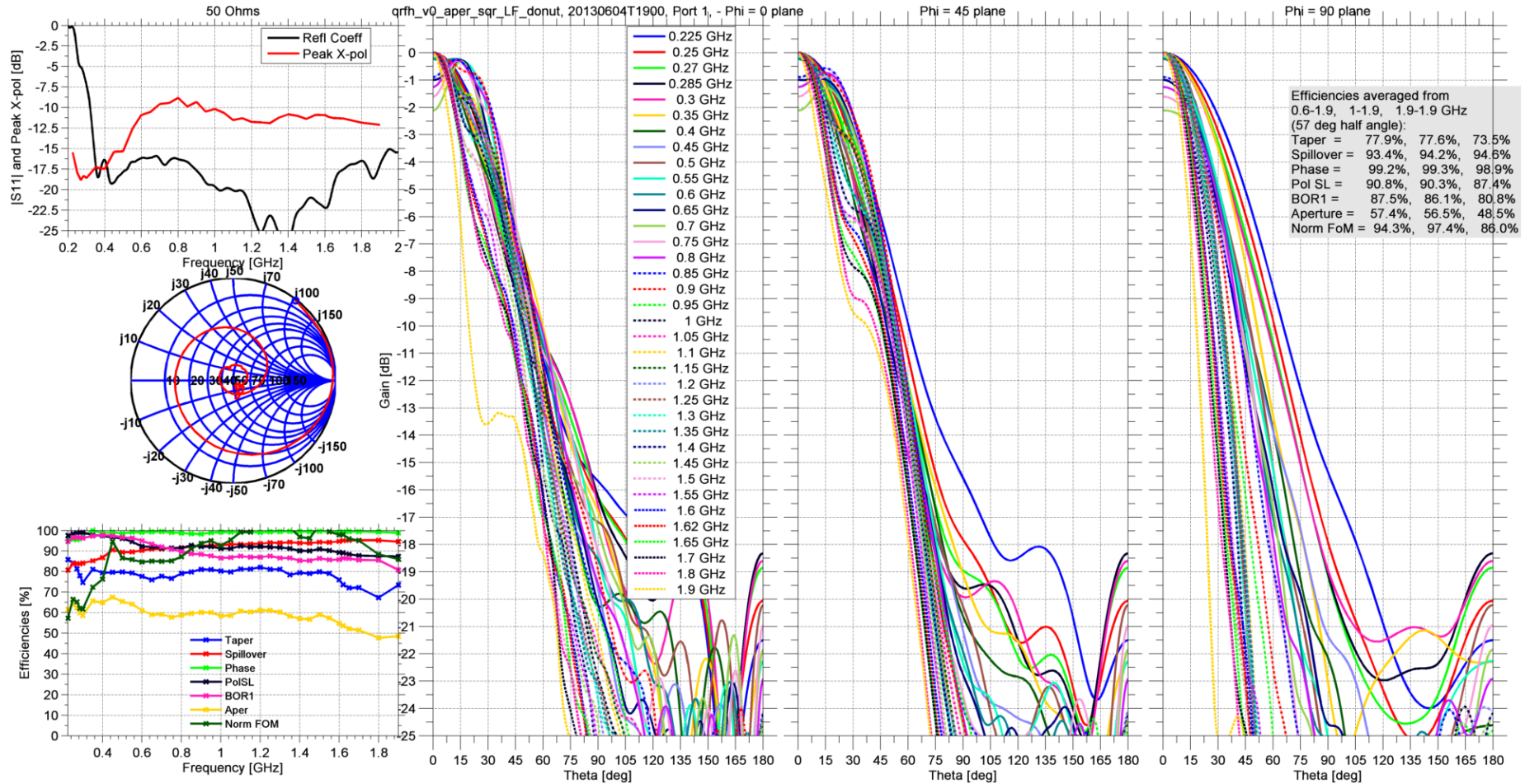
- Quad Ridge Flared Horn
- Constant Phase Center
- 3:1 Bandwidth
- 1.45m X 1.45m X 1.2m

Designed by Ahmed Akgiray, Caltech PHD Graduate
Fabrication Designed by Cao Yang, BAO

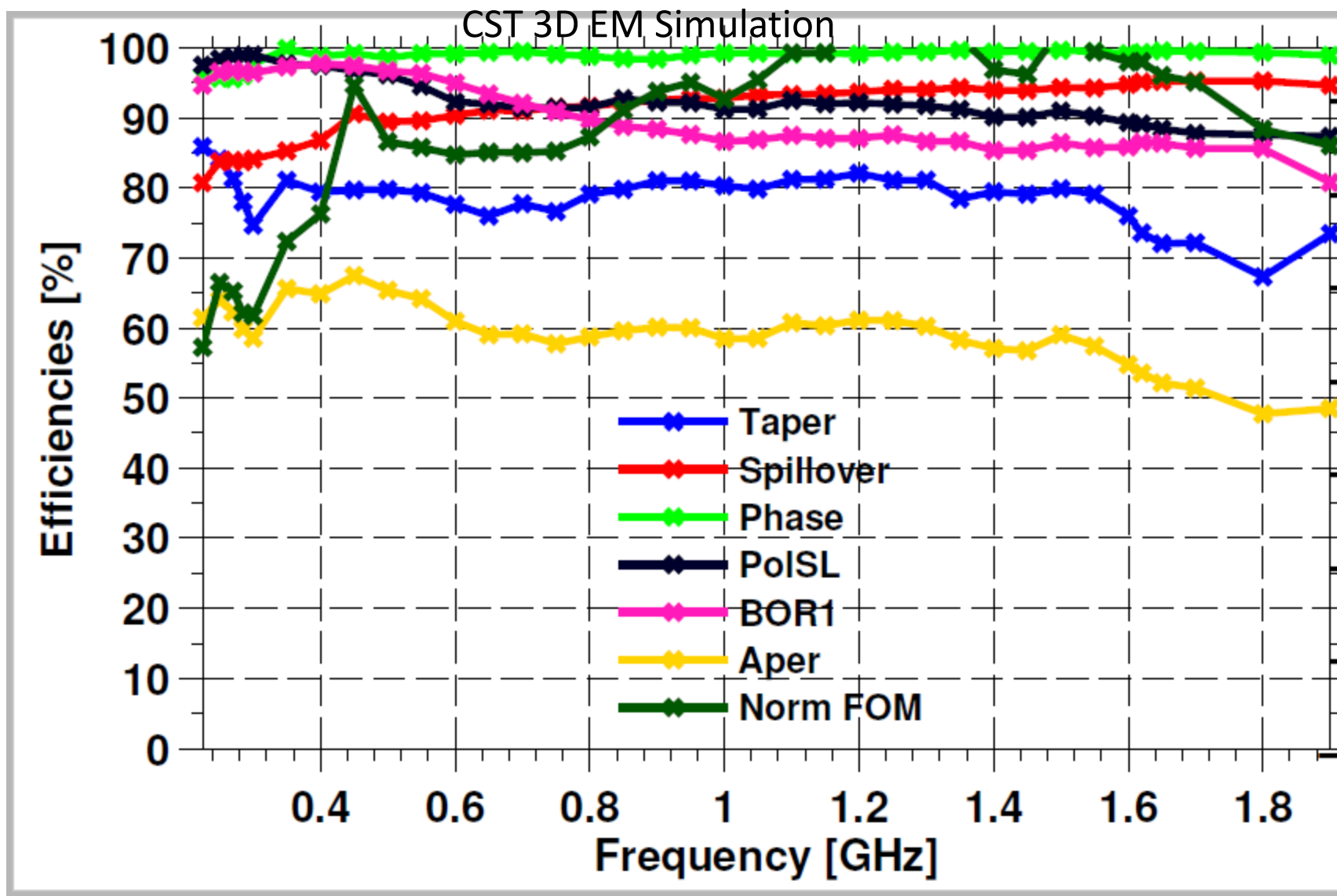


Antenna Feed

CST 3D EM Simulation



Antenna Feed





LF3 Cryogenic Low Noise Amp

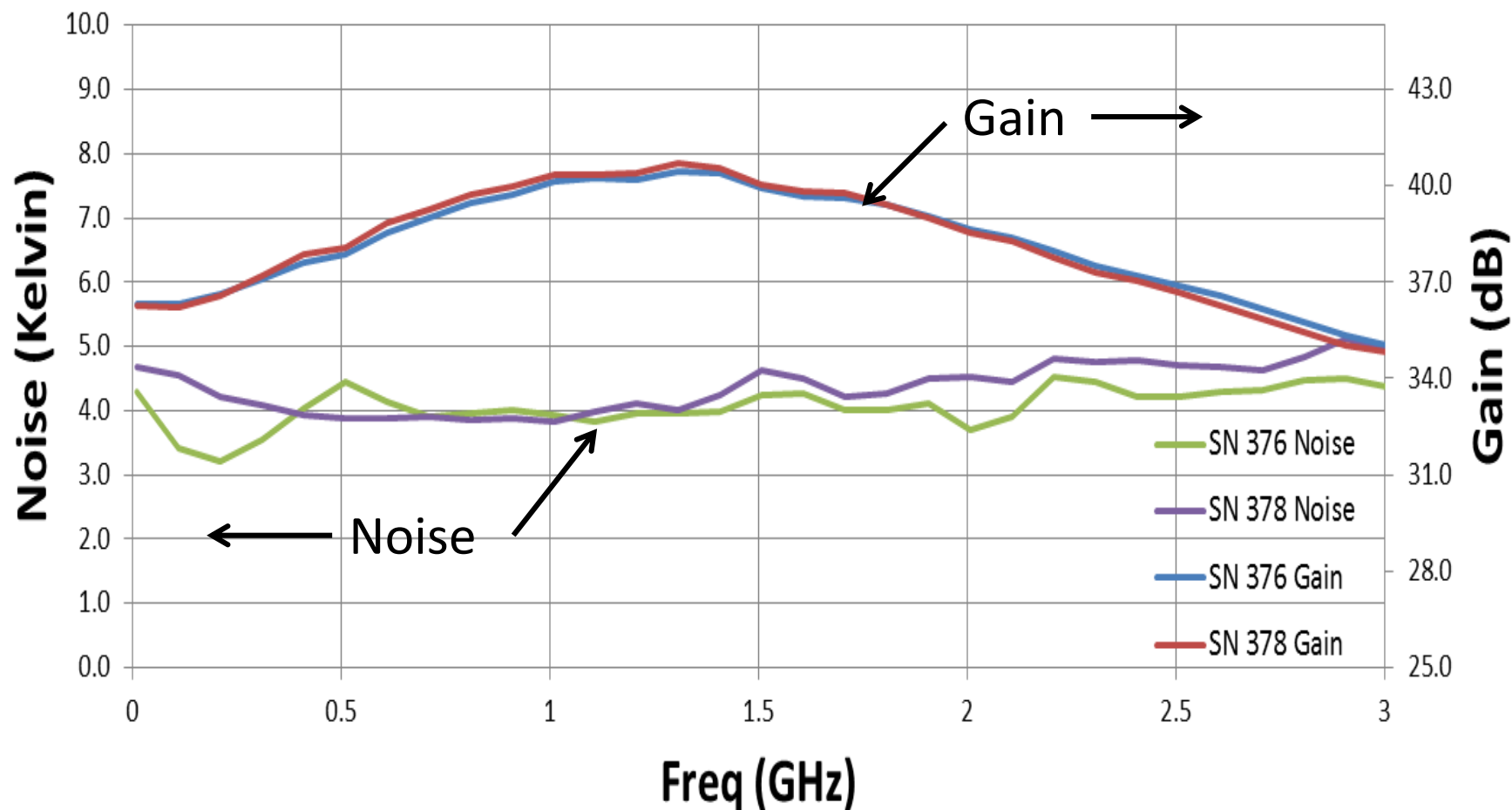


Designed by Sandy Weinreb

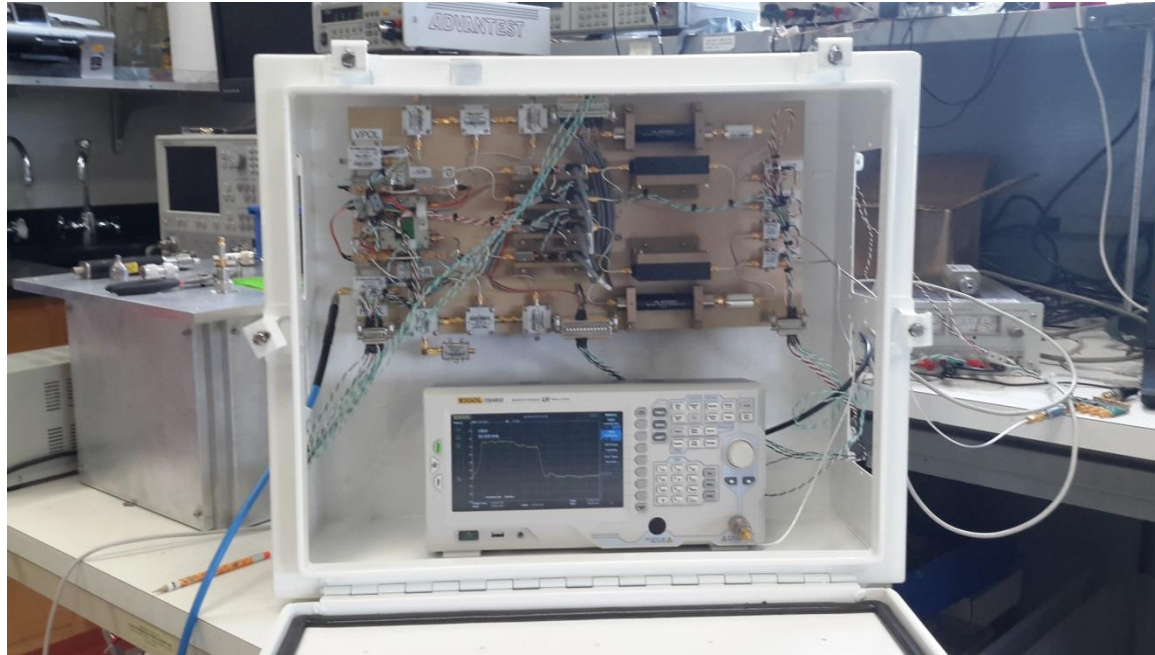


Measured Cryogenic Performance of the LNA's

CITLF3 Noise and Gain at 20K

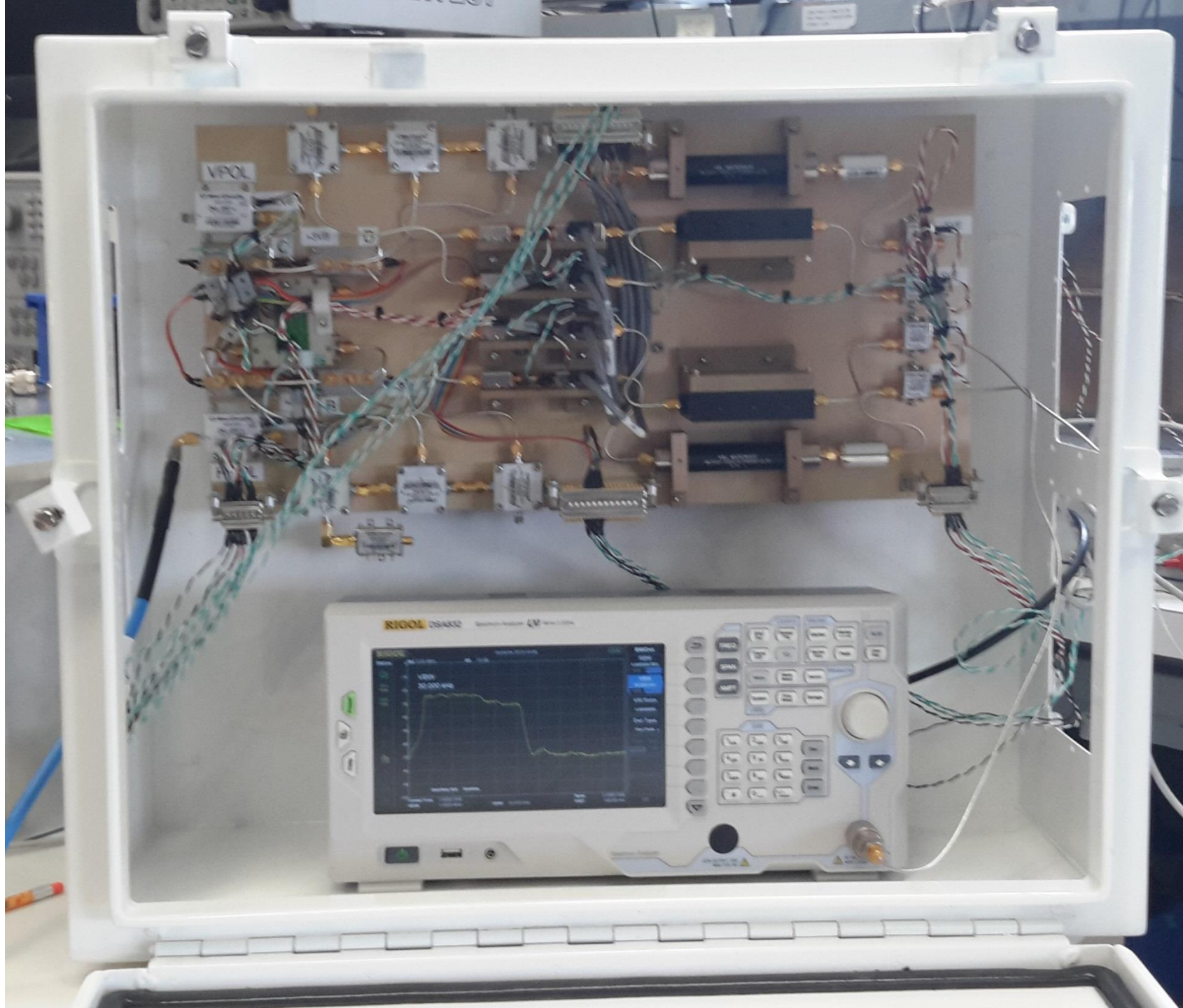


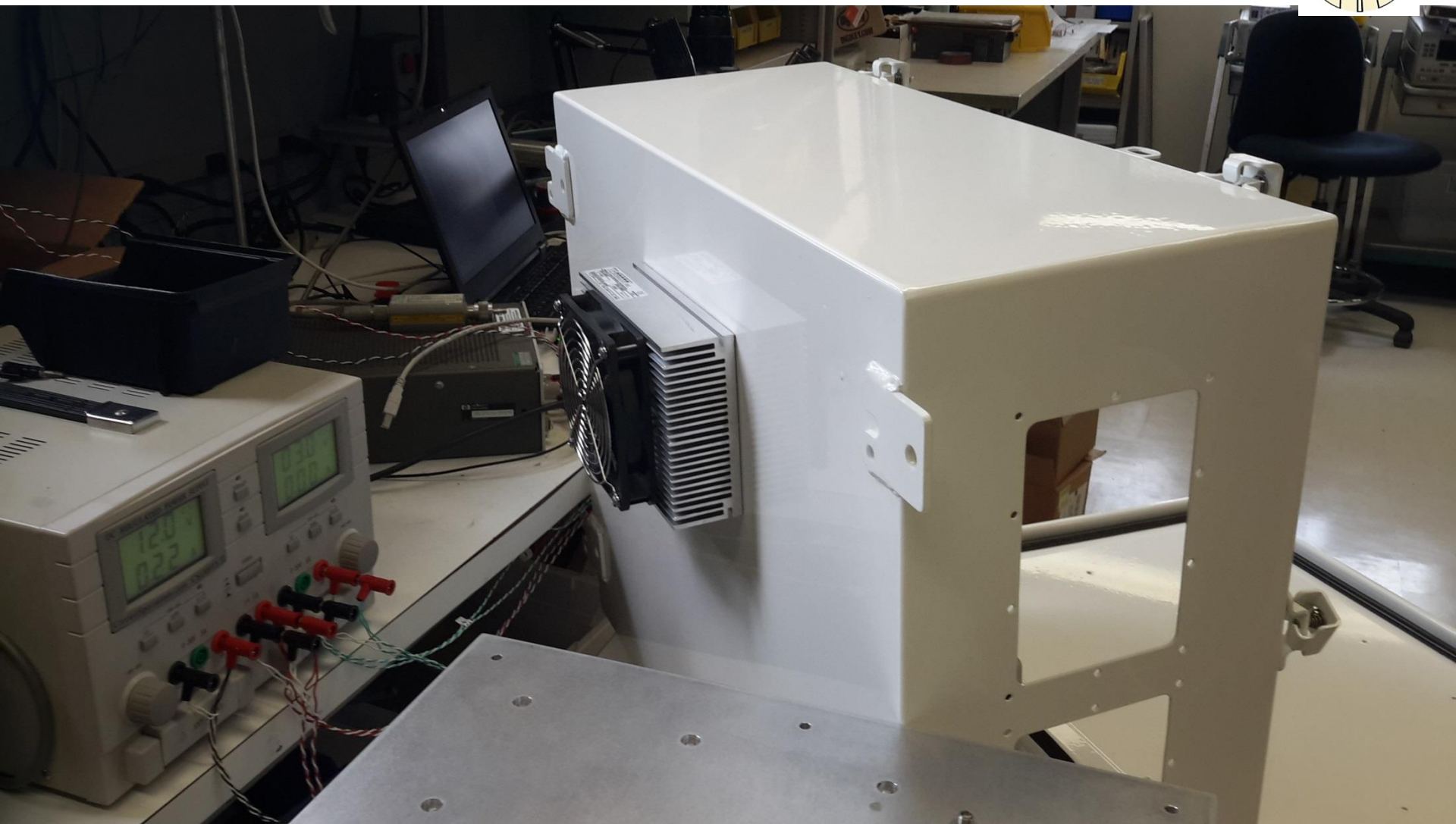
Warm Electronics



- Replaceable, Off-the shelf Components
- Components are field replaceable without a Soldering Iron
- TEC Thermal Electric Cooler keeps component temperature @ 40C
- 2 GHz Laser Pair (Designed by Sandy) for IF Output
- Rigol Spectrum Analyzer for RFI monitoring (SA has Ethernet interface)
- Voltage, Current Monitors
- Control of Receiver thru Ethernet

Designed by Steve Smith, Sandy Weinreb

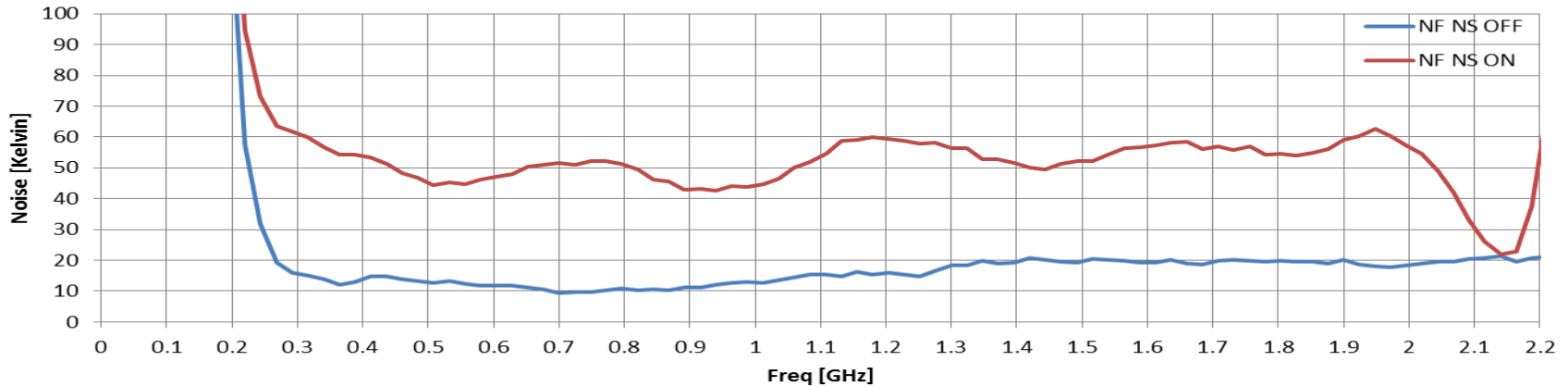




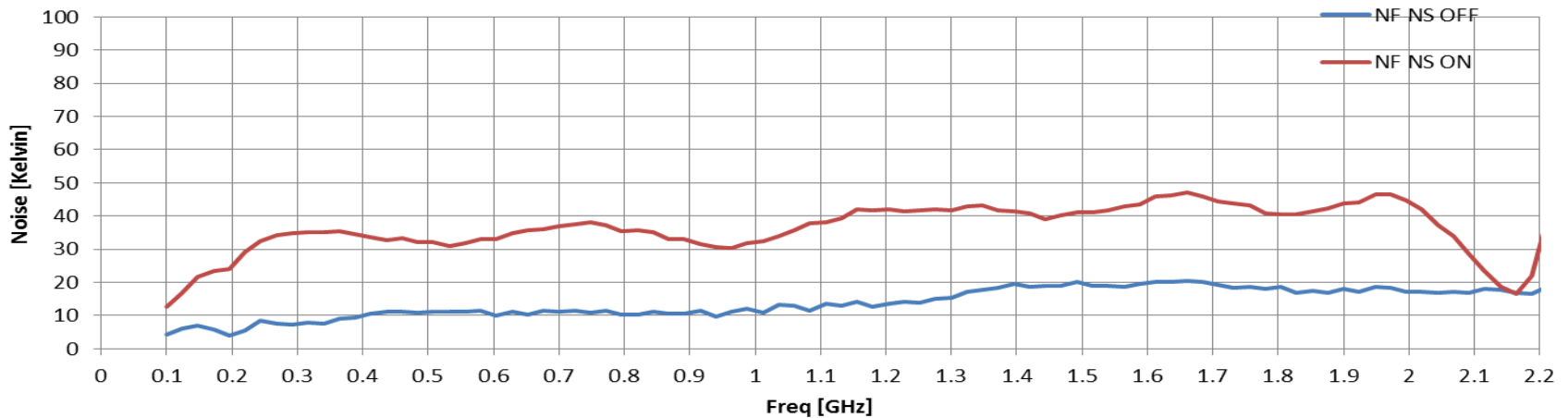


Measured Dewar Performance

Horizontal Polarization Total Noise
with High Pass filter



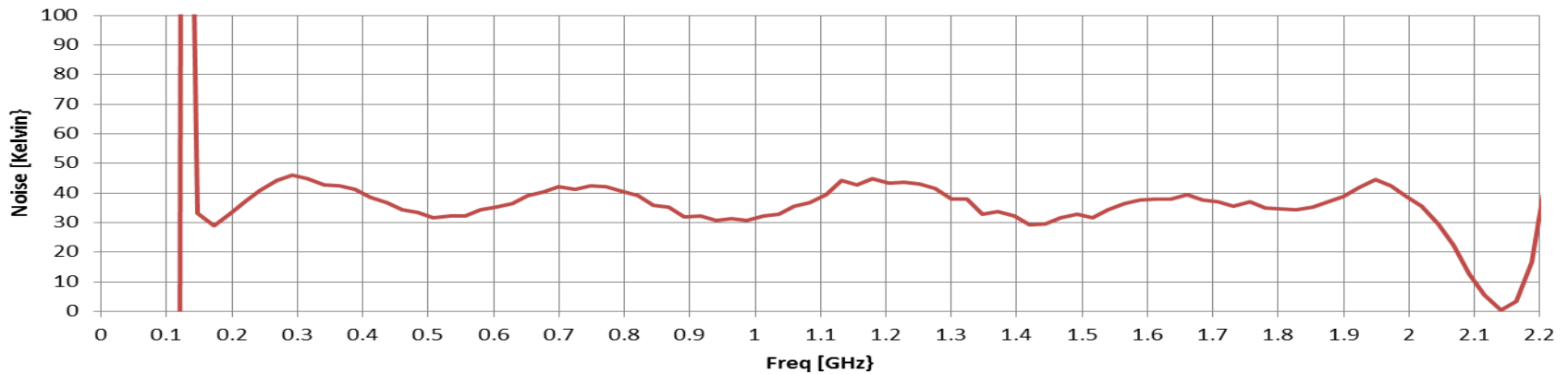
Vertical Polarization Total Noise
without High Pass filter



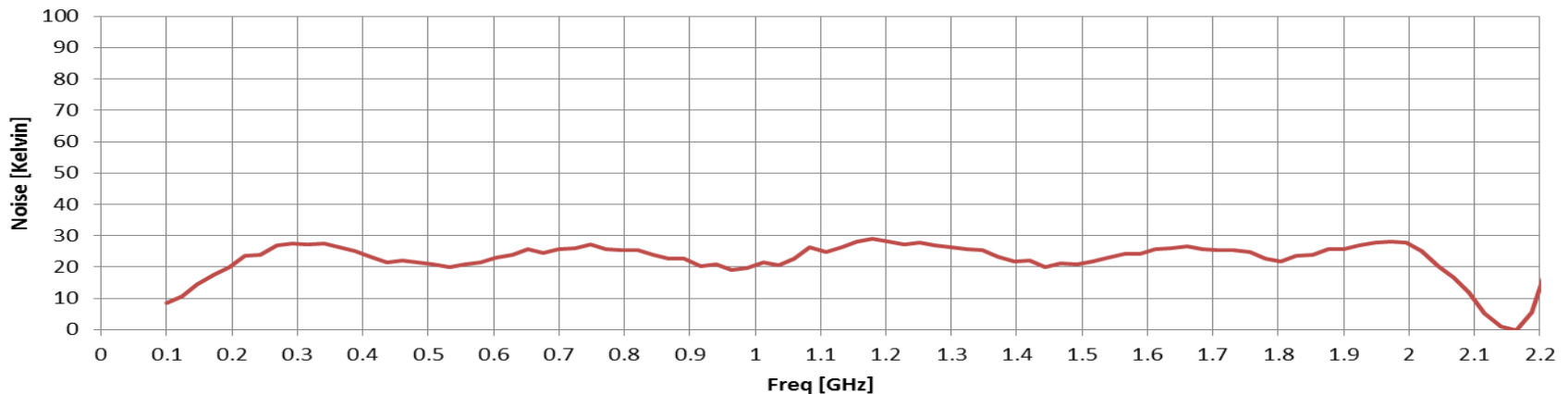


Measured Dewar Performance

Horizontal Polarization Noise Source
with High Pass filter

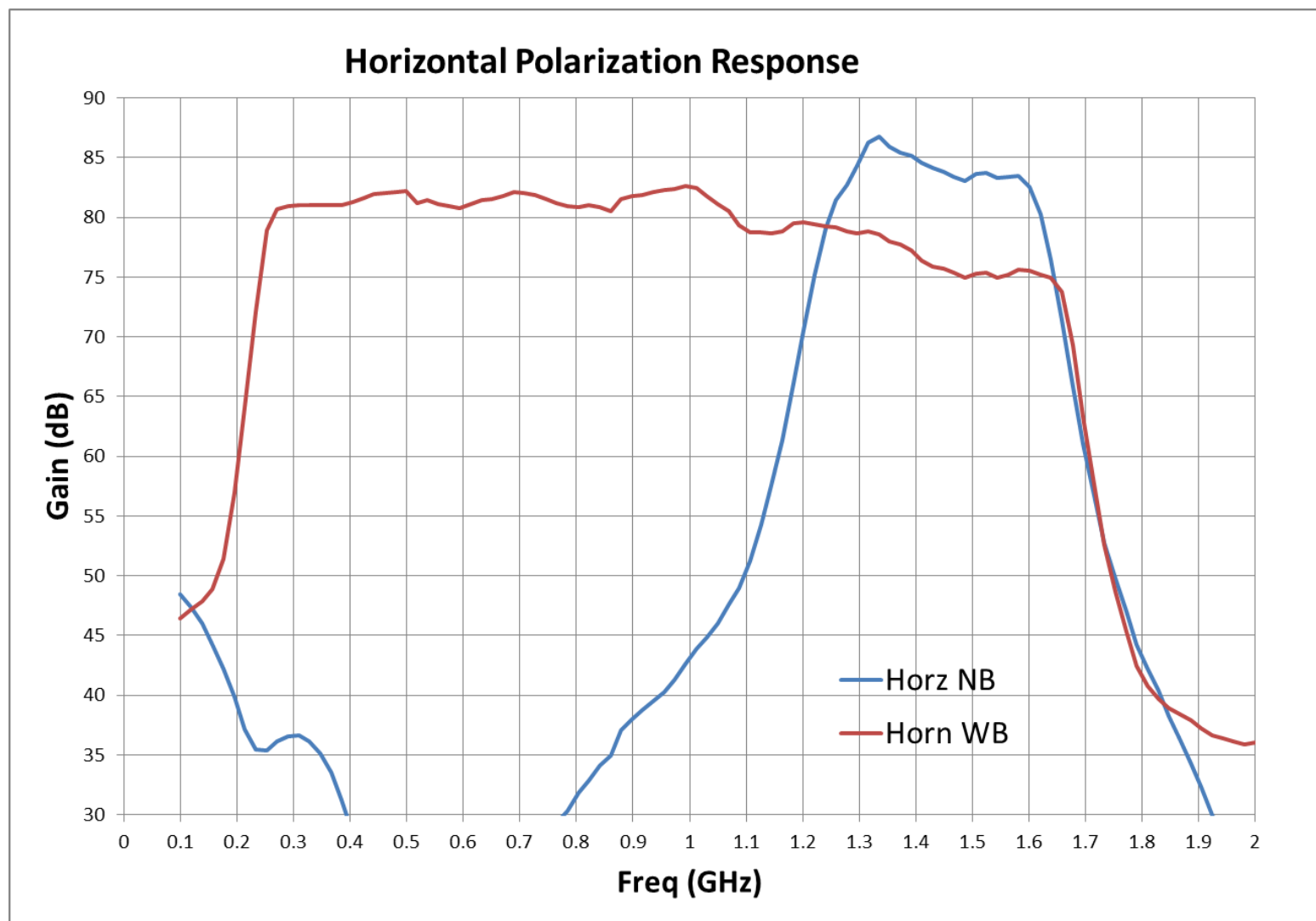


Vertical Polarization Noise Source
without High Pass filter



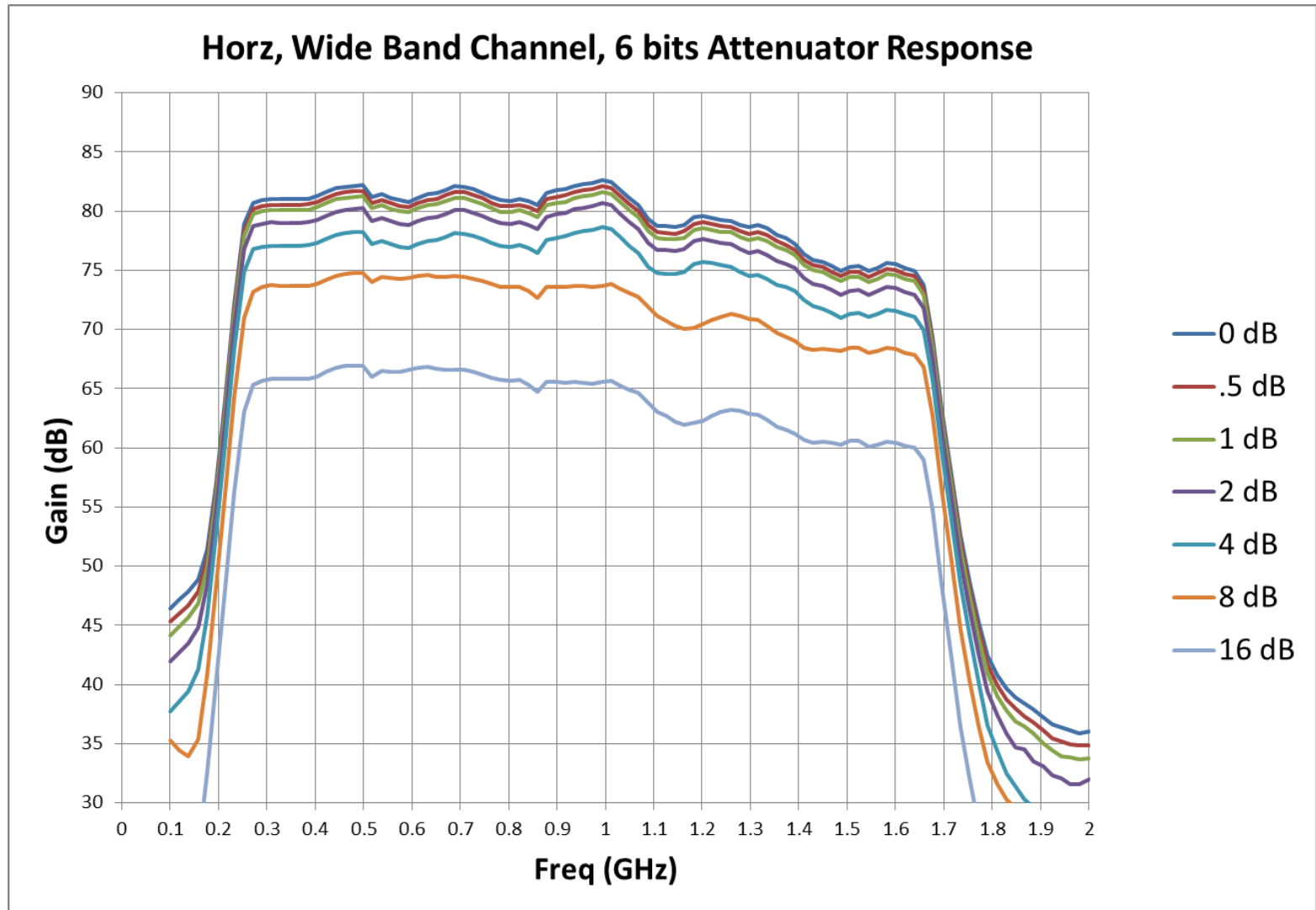


Measured System Performance



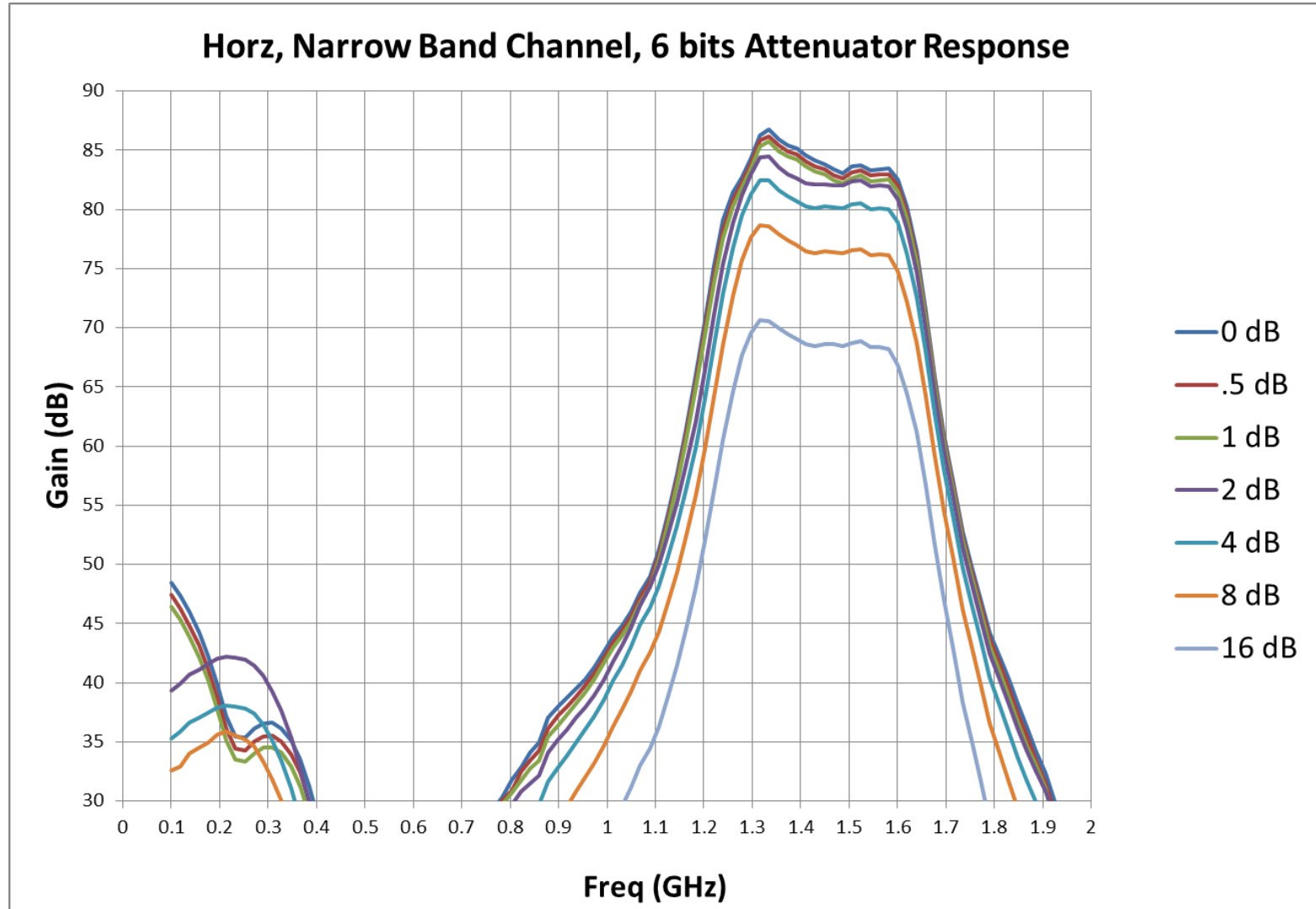


Measured System Performance



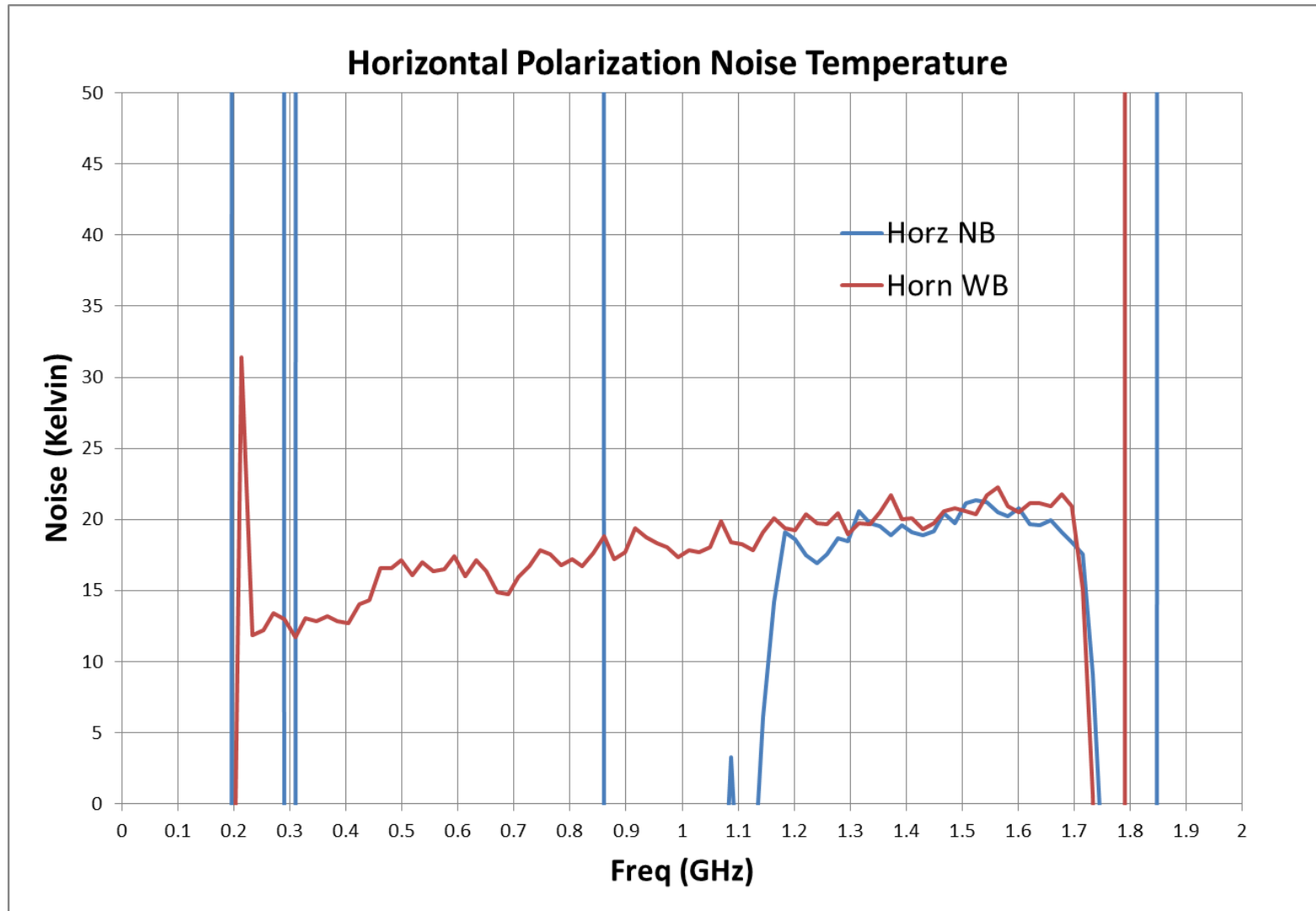


Measured System Performance





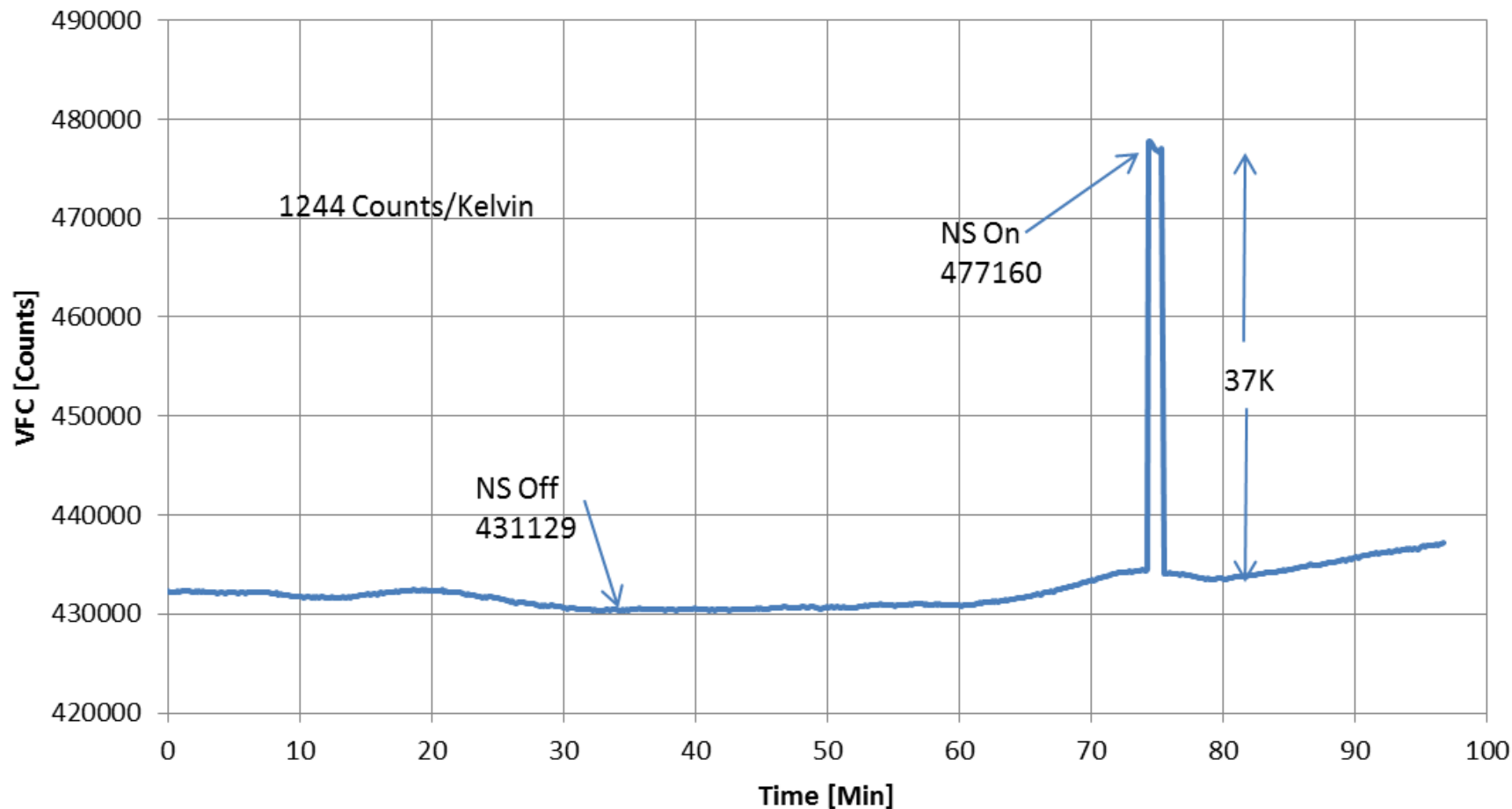
Measured System Performance





Measured System Performance

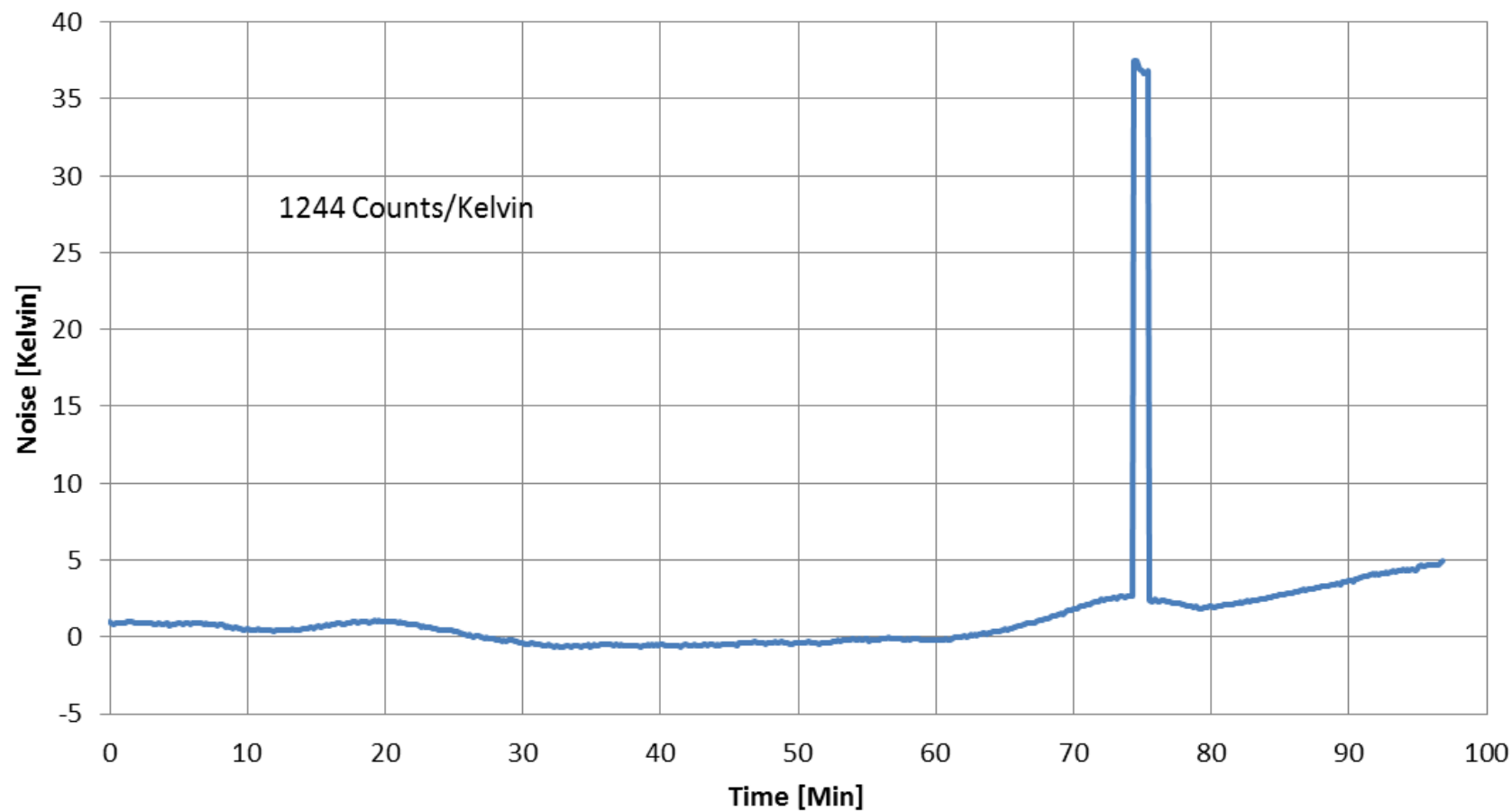
8 Sec Integration Horz Channel Wide Band





Measured System Performance

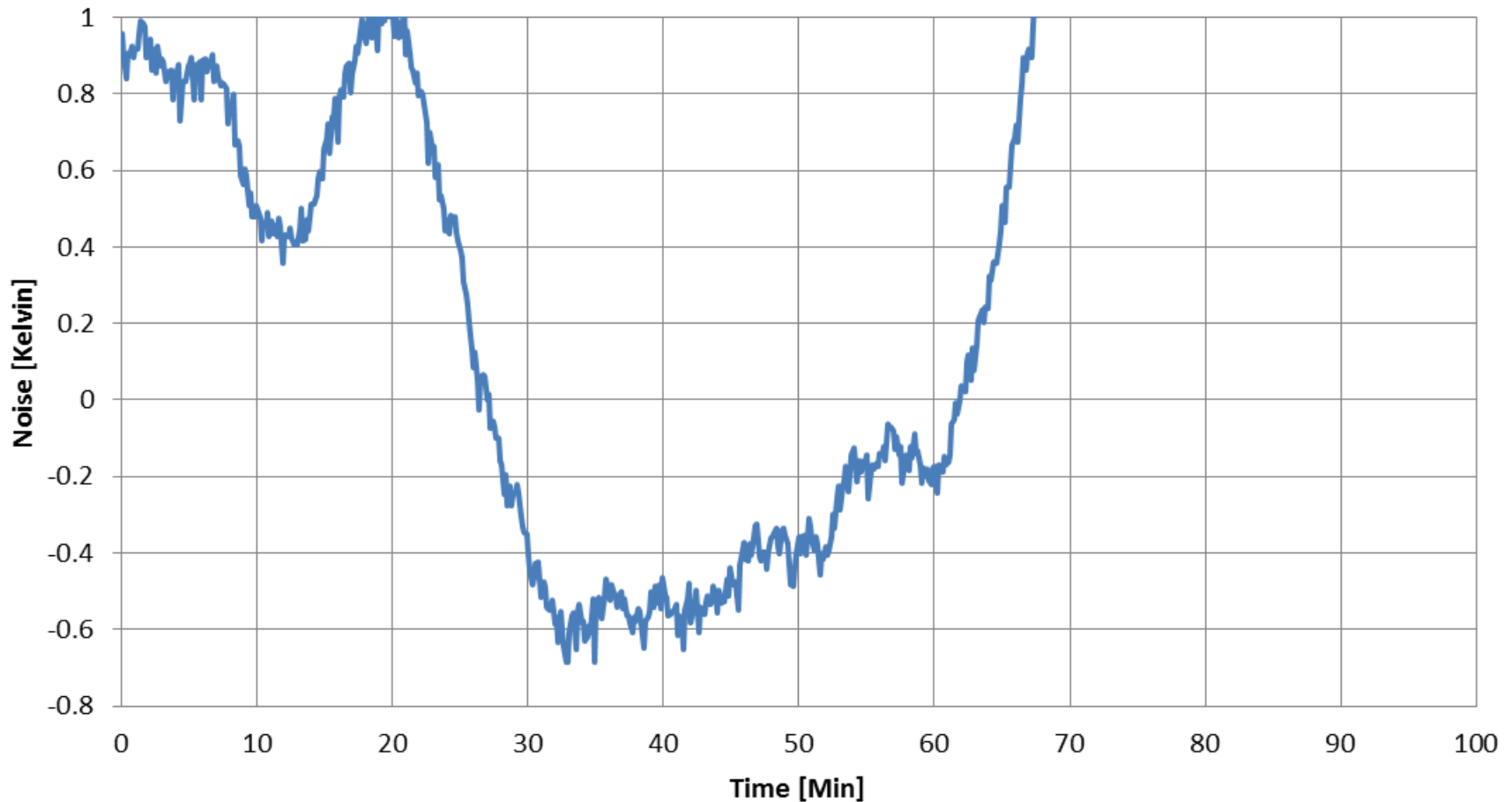
8 Sec Integration Horz Channel Wide Band





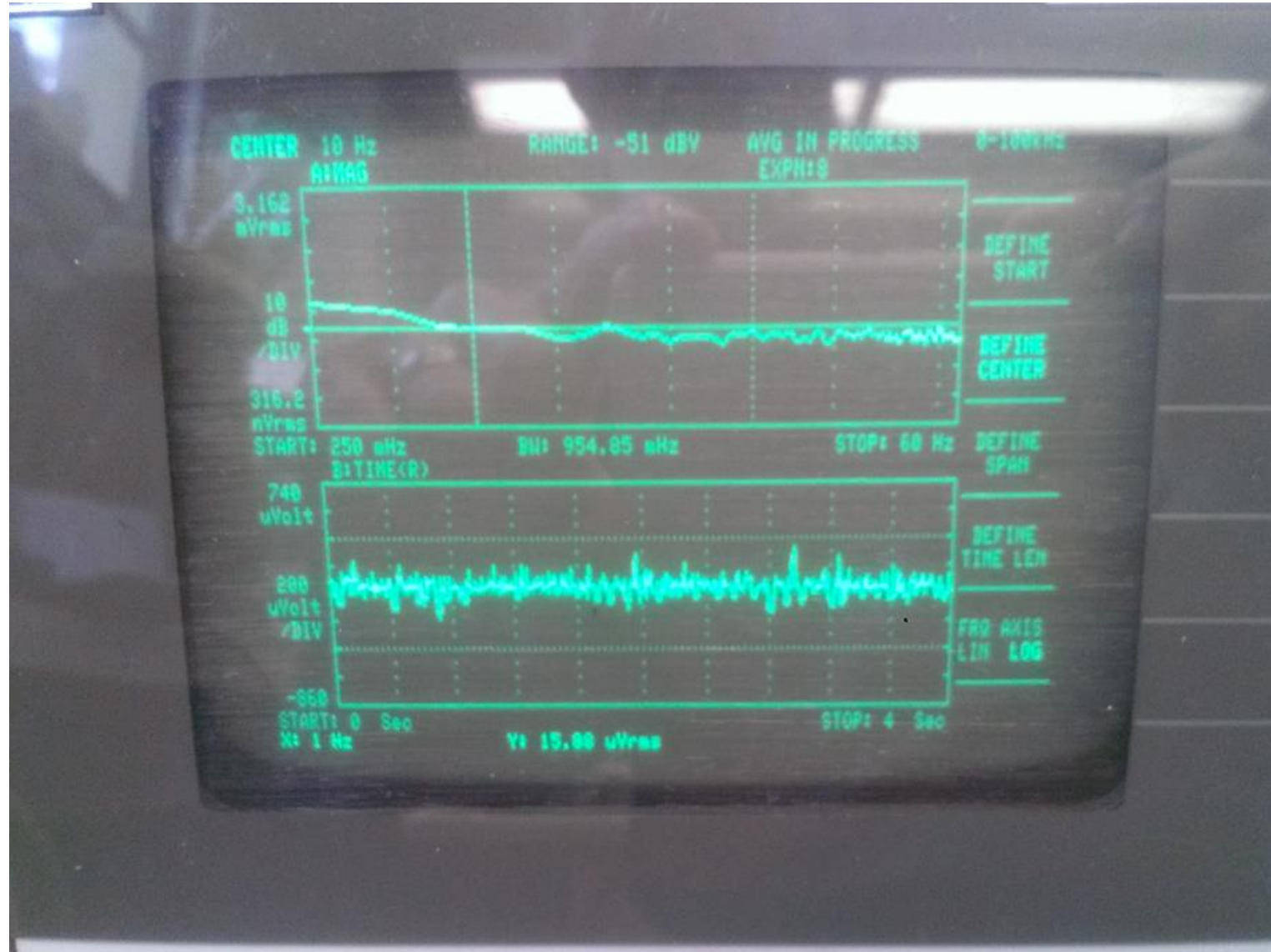
Measured System Performance

8 Sec Integration Horz Channel Wide Band





Measured System Performance





Control Software

- Python Language
- Controls all Receiver functions
- Voltage and Current Monitor
- Monitor for 1st and 2nd stage Cooler Temperature
- Monitors Warm Electronics Temperature
- Total Power Detectors
- Spectrum Analyzer
- Control Receiver with Ethernet Connection



Five hundred meter **A**perature **S**pherical radio **T**elescope as of Oct 10, 2015

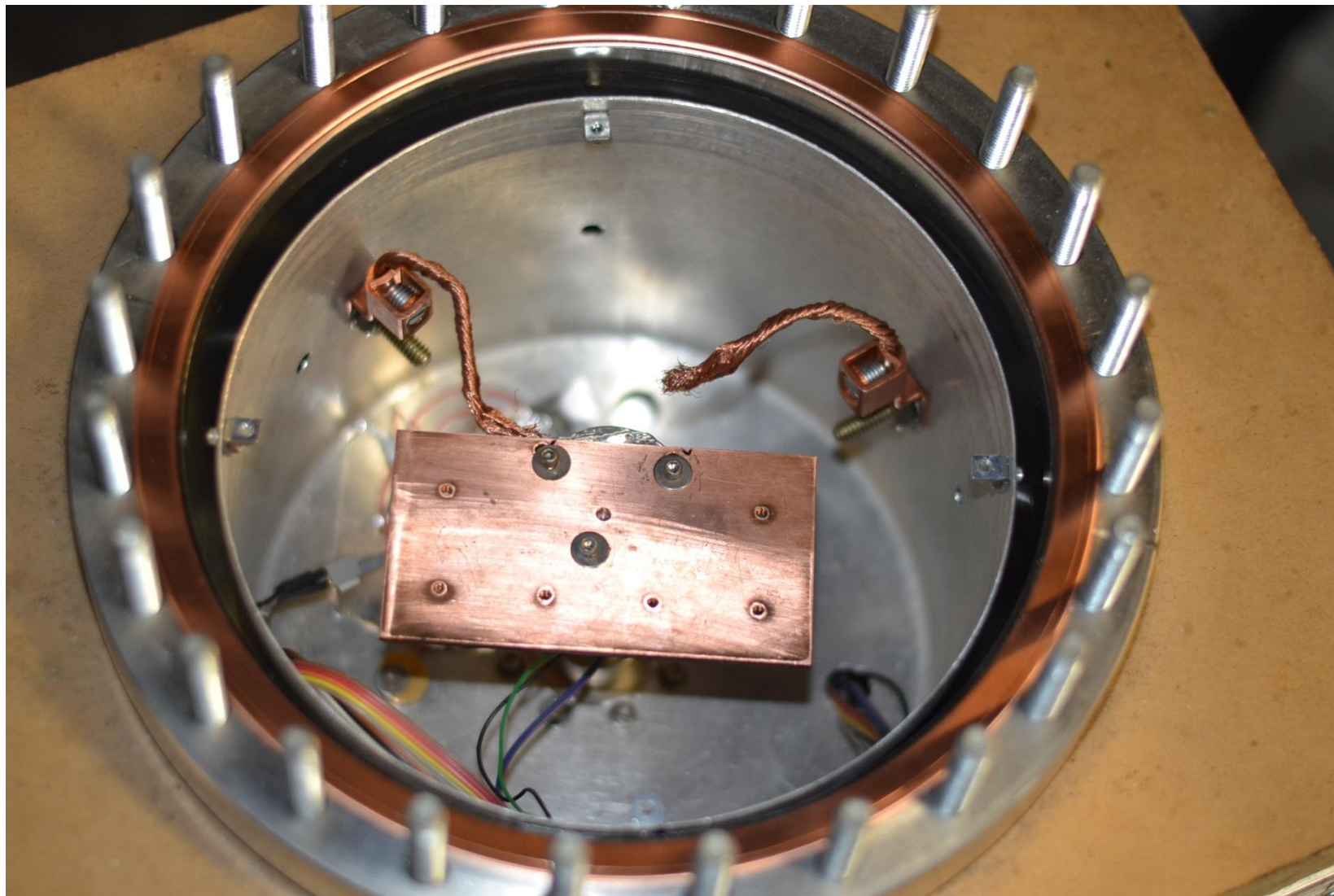




CMT Dewar



CMT Dewar



CMT Dewar



CMT Dewar

Cosmic Microwave Dewar

