

Report on the new VGOS 12m radio telescope at Kokee Park Geophysical Observatory

Chris Beaudoin, Alan Whitney, Arthur Niell, Brian Corey, Chet Ruszczyk,
Chris Eckert, Mark Derome, Russ McWhirter, Jason SooHoo, Mike Titus,
Alan Rogers, Peter Bolis, Roger Cappallo, Jon Byford - **MIT Haystack Observatory**

Chopo Ma, Larry Hilliard, Tom Clark – **NASA GSFC**

Ed Himwich – **GSFC/NVI**

Bill Petrachenko – **Natural Resources Canada**

Javier Gonzalez Garcia – **Yebes Astronomical Observatory**



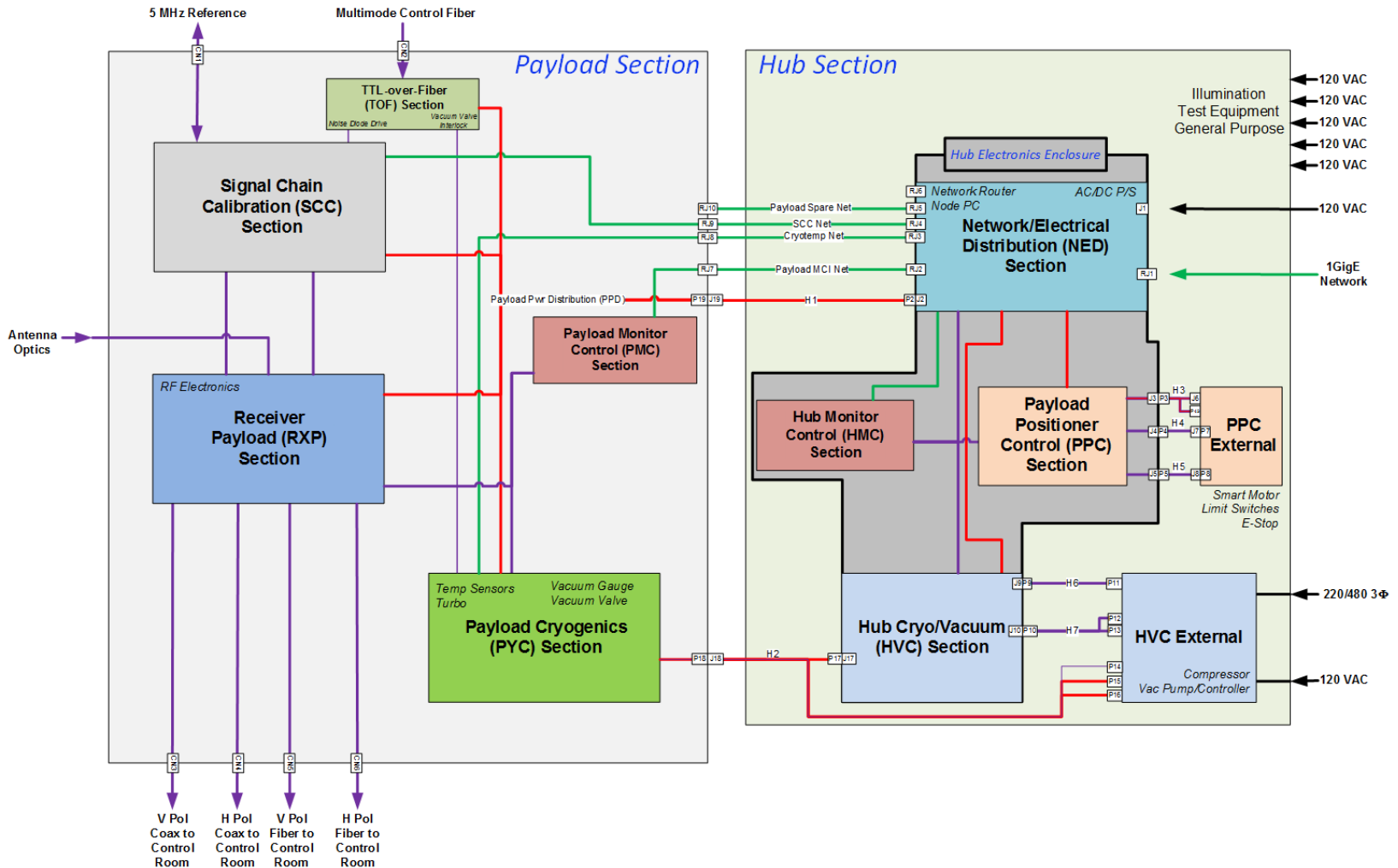
- ◆ Frontend
 - Block Diagram
 - RF Design
 - Antenna/Mechanical Design

- ◆ Backend
 - Block Diagram
 - Equipment Rack Layout
 - VGOS UDC w/ baseband output
 - RDBE-G v3.0

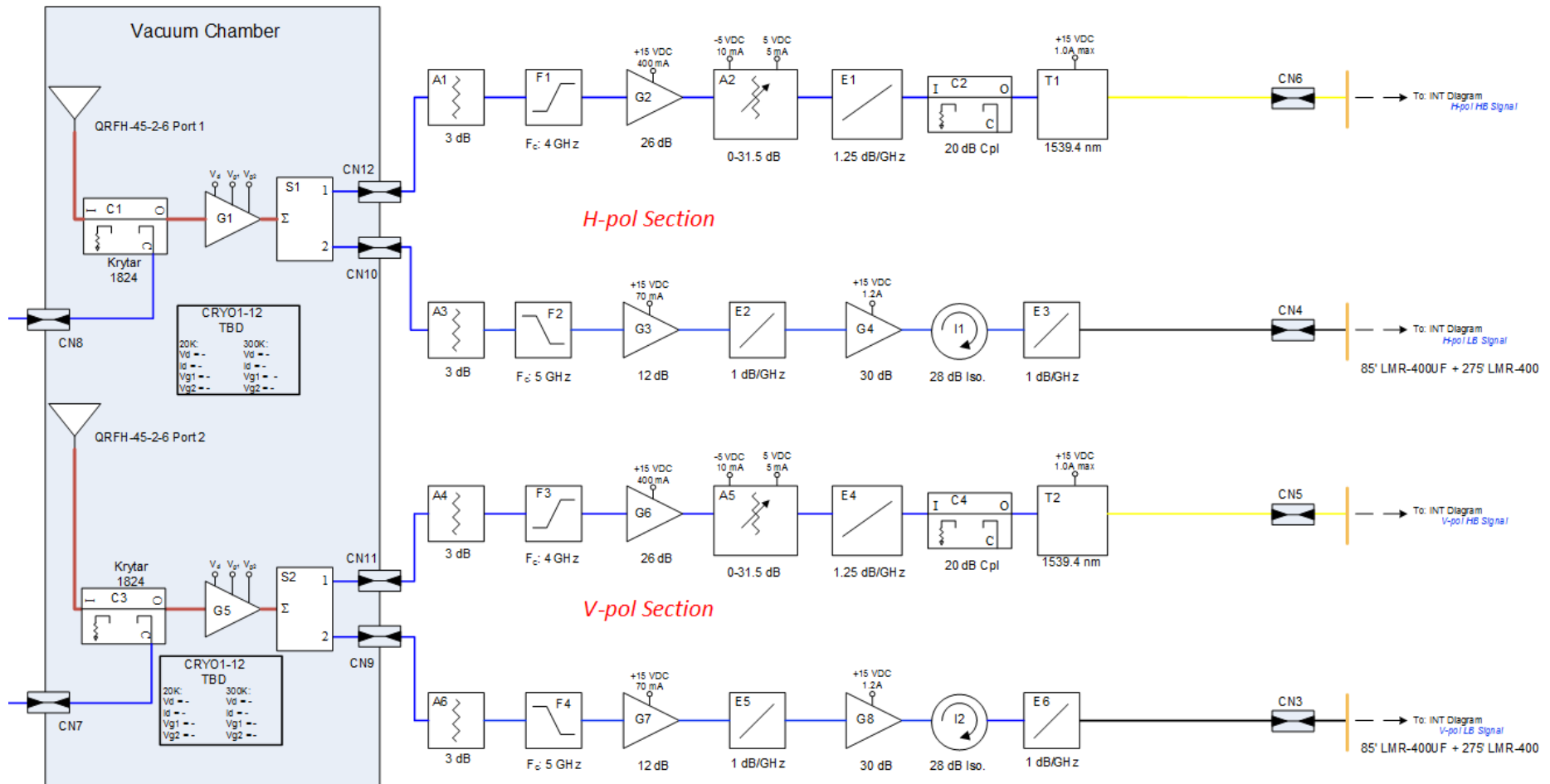
- ◆ Signal Chain Calibration Subsystem
- ◆ Monitor/Control VLBI Data AcQuisition (VDAQ) Module
- ◆ Schedule



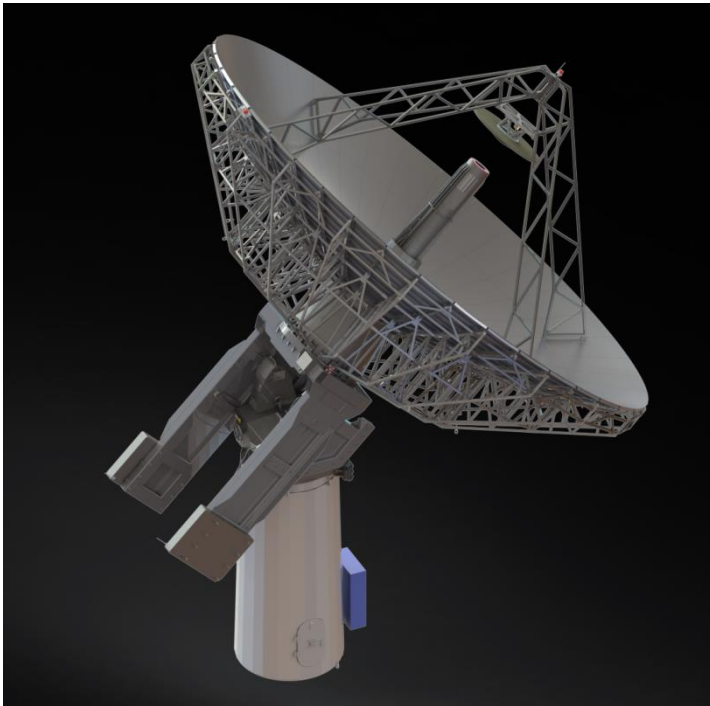
Frontend – Block Diagram



Frontend – RF Design



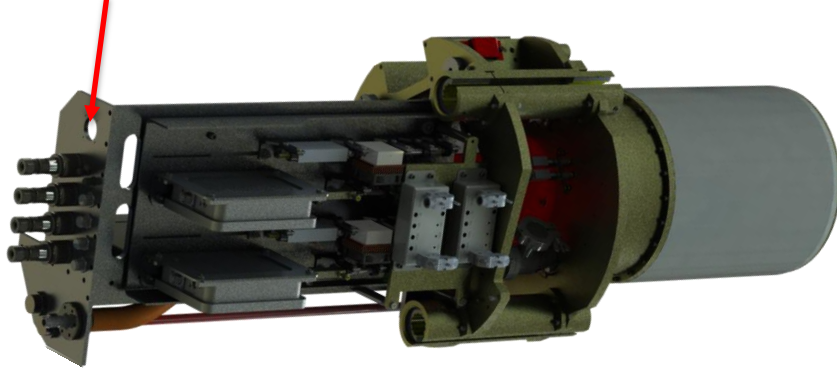
High accuracy, high slew speed, full motion 12m Antenna System



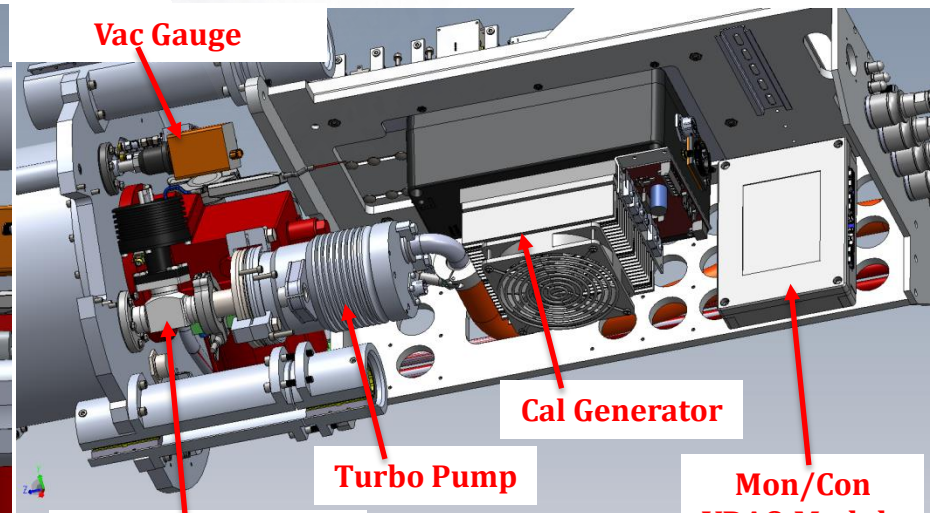
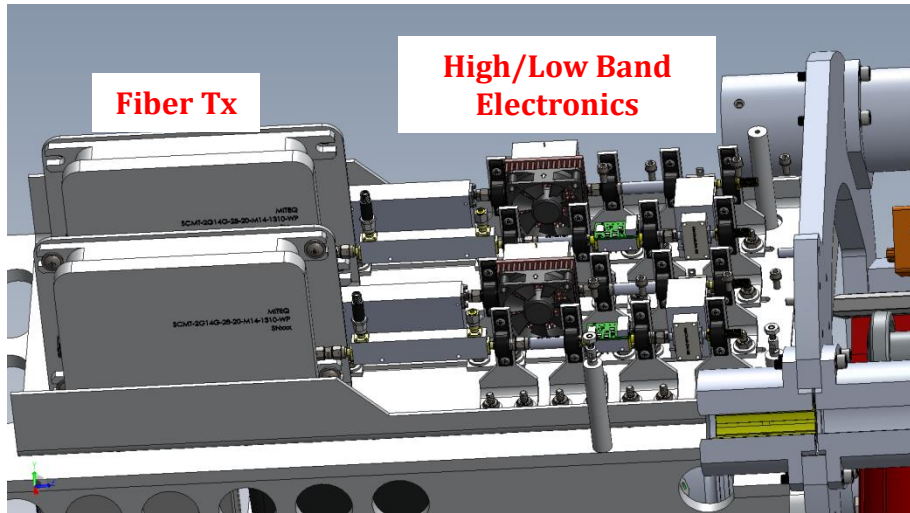
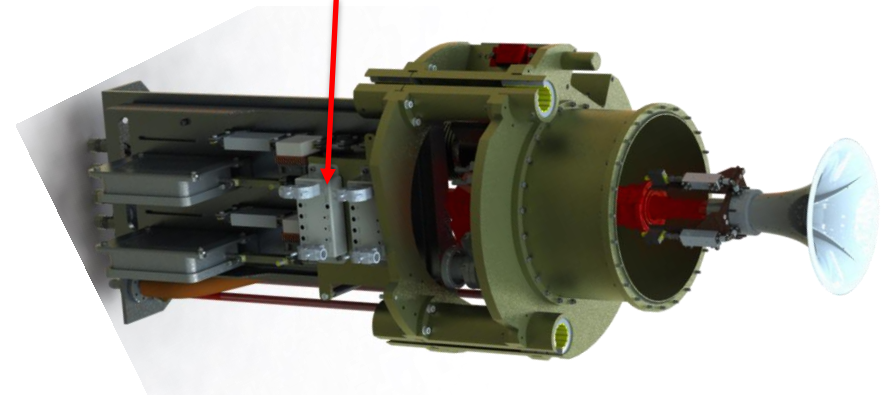
- Main reflector surface comprises 100 precision adjustable stretch formed aluminum panels,
- Carbon fiber composite sub-reflector with optional high accuracy hexapod adjustment mechanism
- Precision zero backlash torque biased mechanisms based on COTS motors and controllers
- Extensively galvanized and painted to assist with corrosion protection, galvanic protection built in by design
- Meets **all** the VLBI2010 specifications
- Suitable for array applications
- Passed CDR in July 2014

Frontend – Mechanical Design

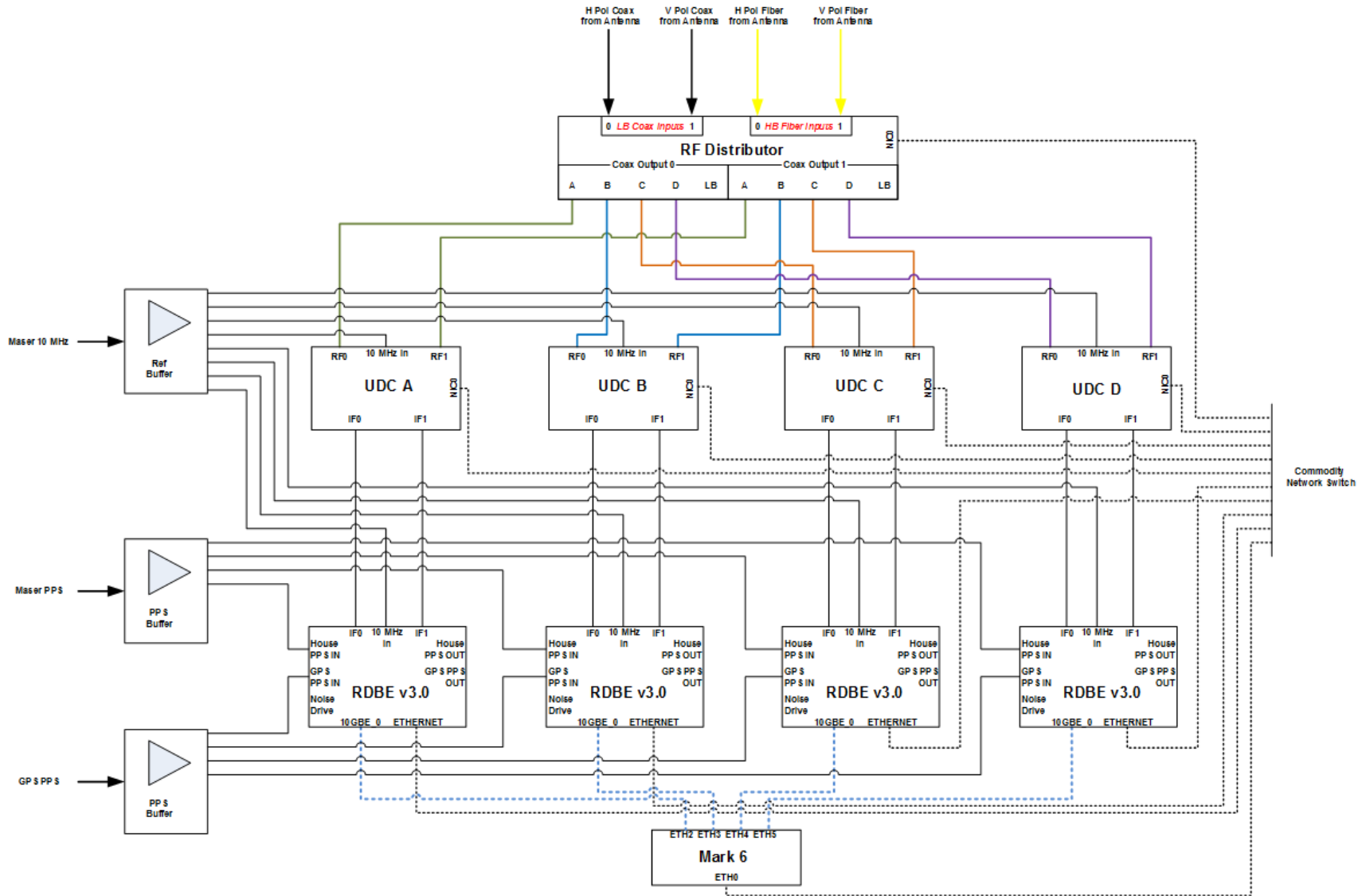
Payload Interface



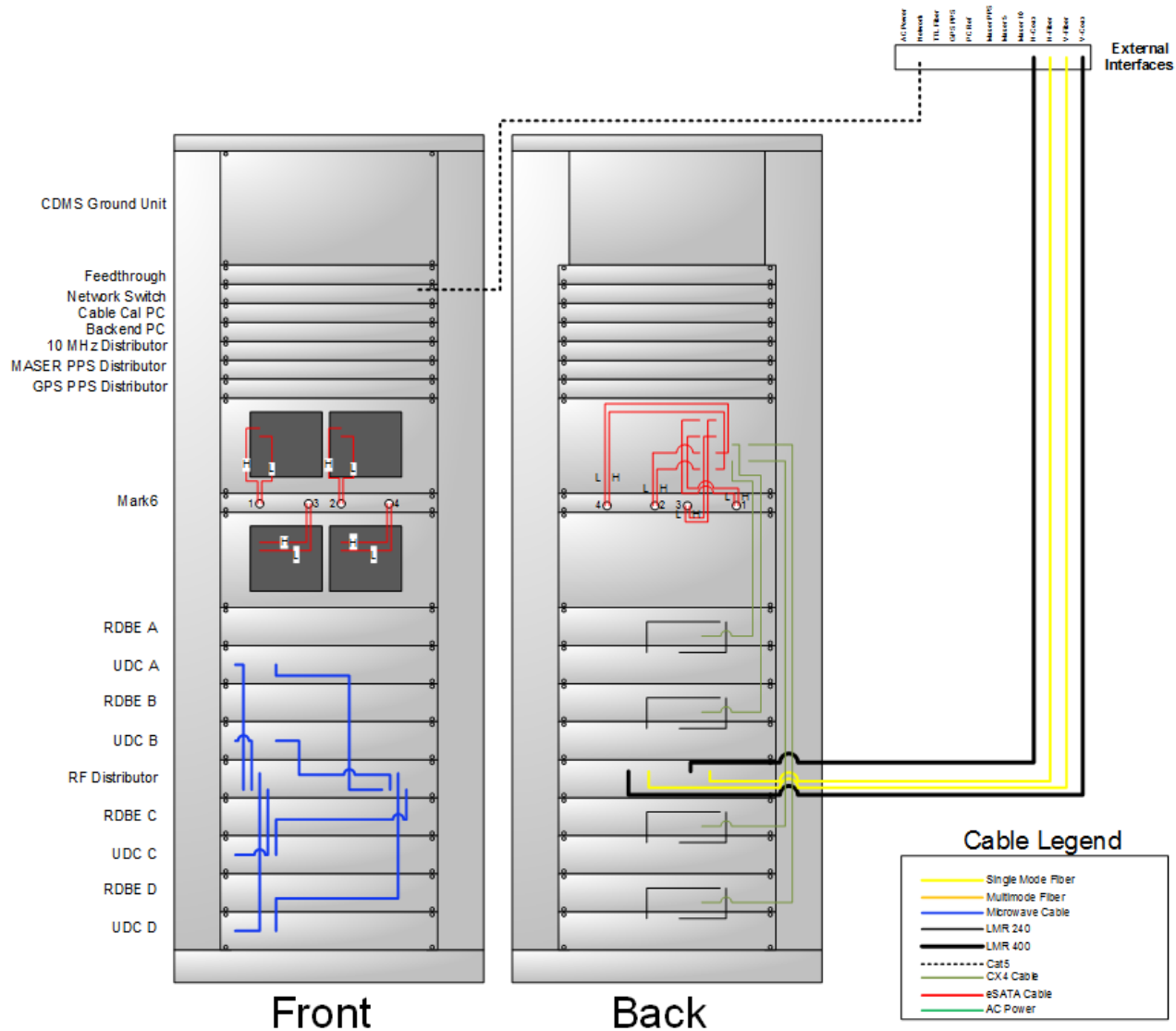
LNA Bias Supplies



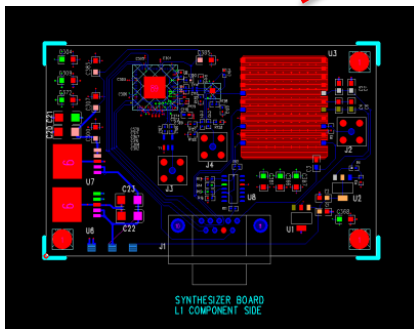
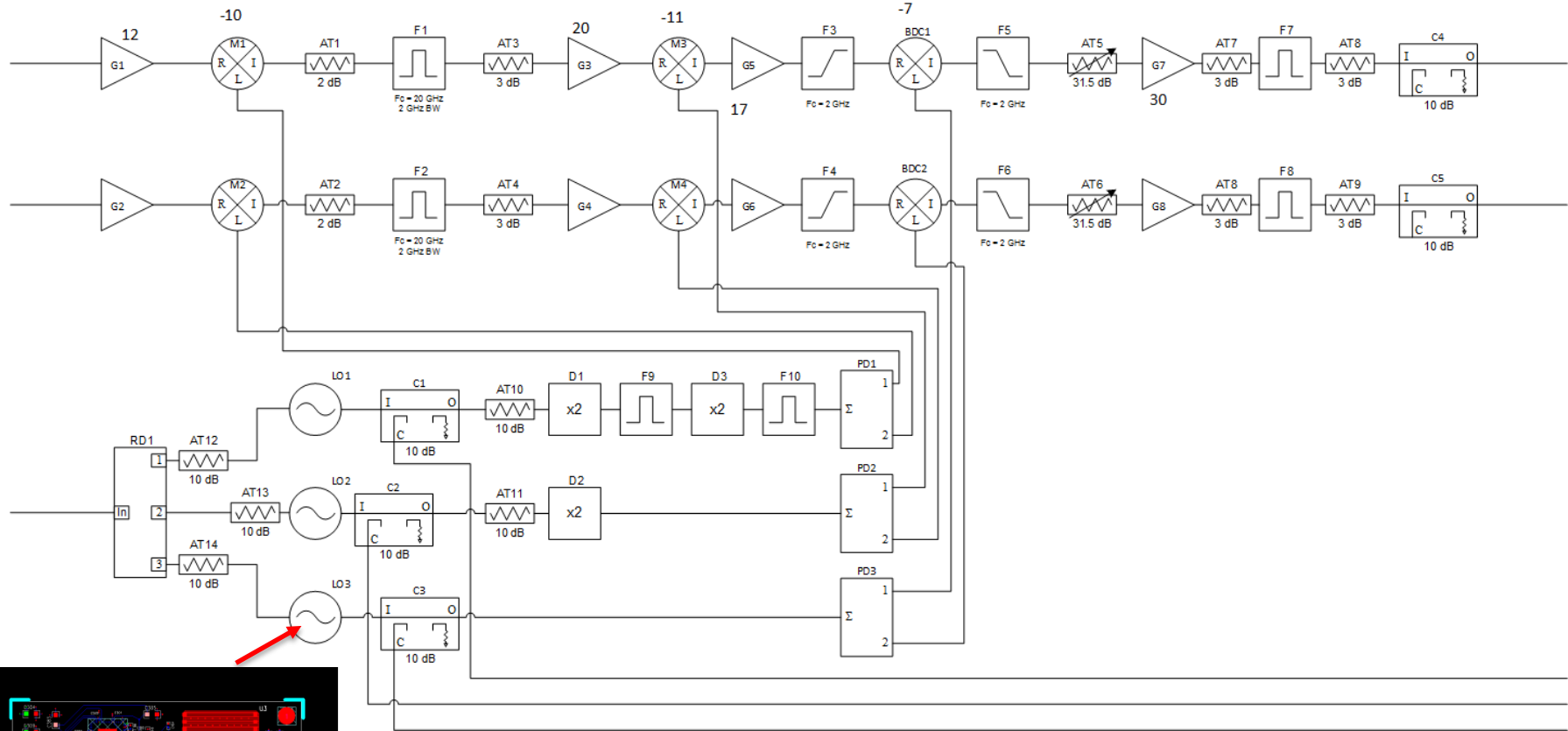
Backend – Block Diagram



Backend – Equipment Rack Layout



Backend – VGOS UDC

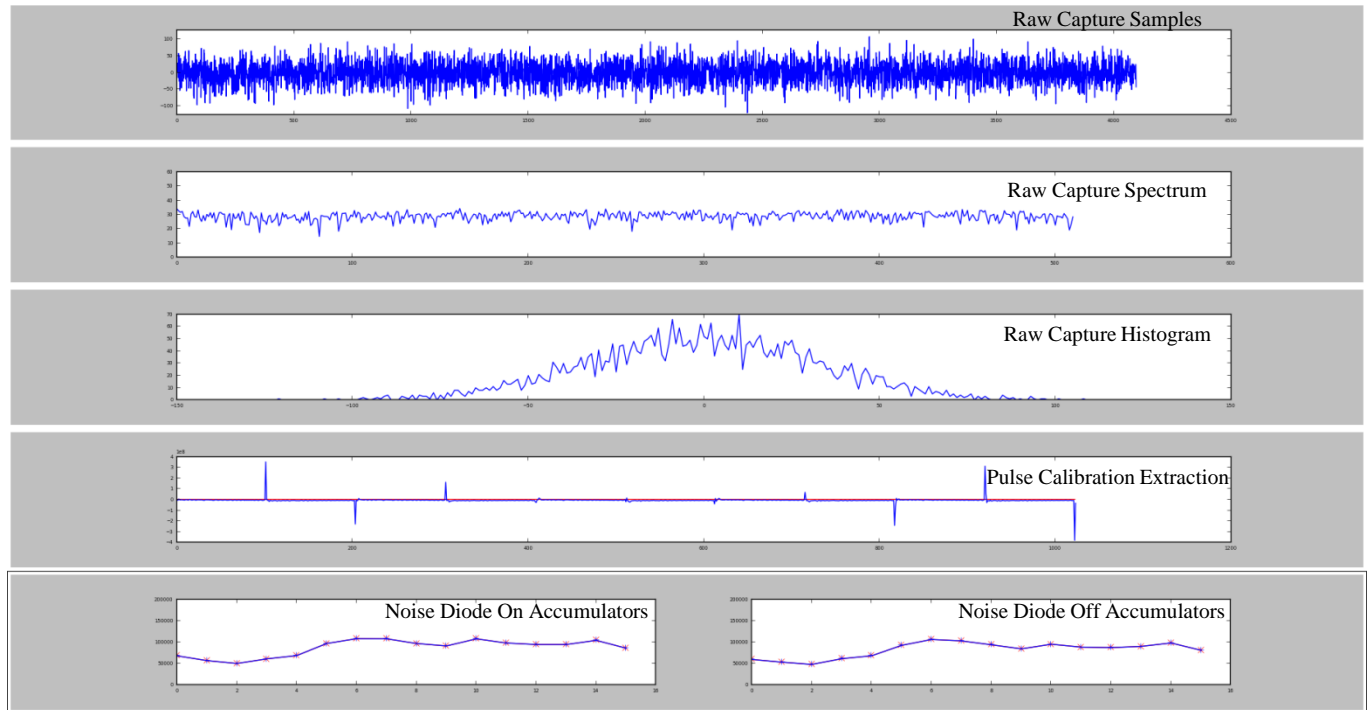


- Supports 2-14 GHz input RF Frequency
- Provides 2 GHz baseband output
- Net LO tuning resolution < 1 Hz

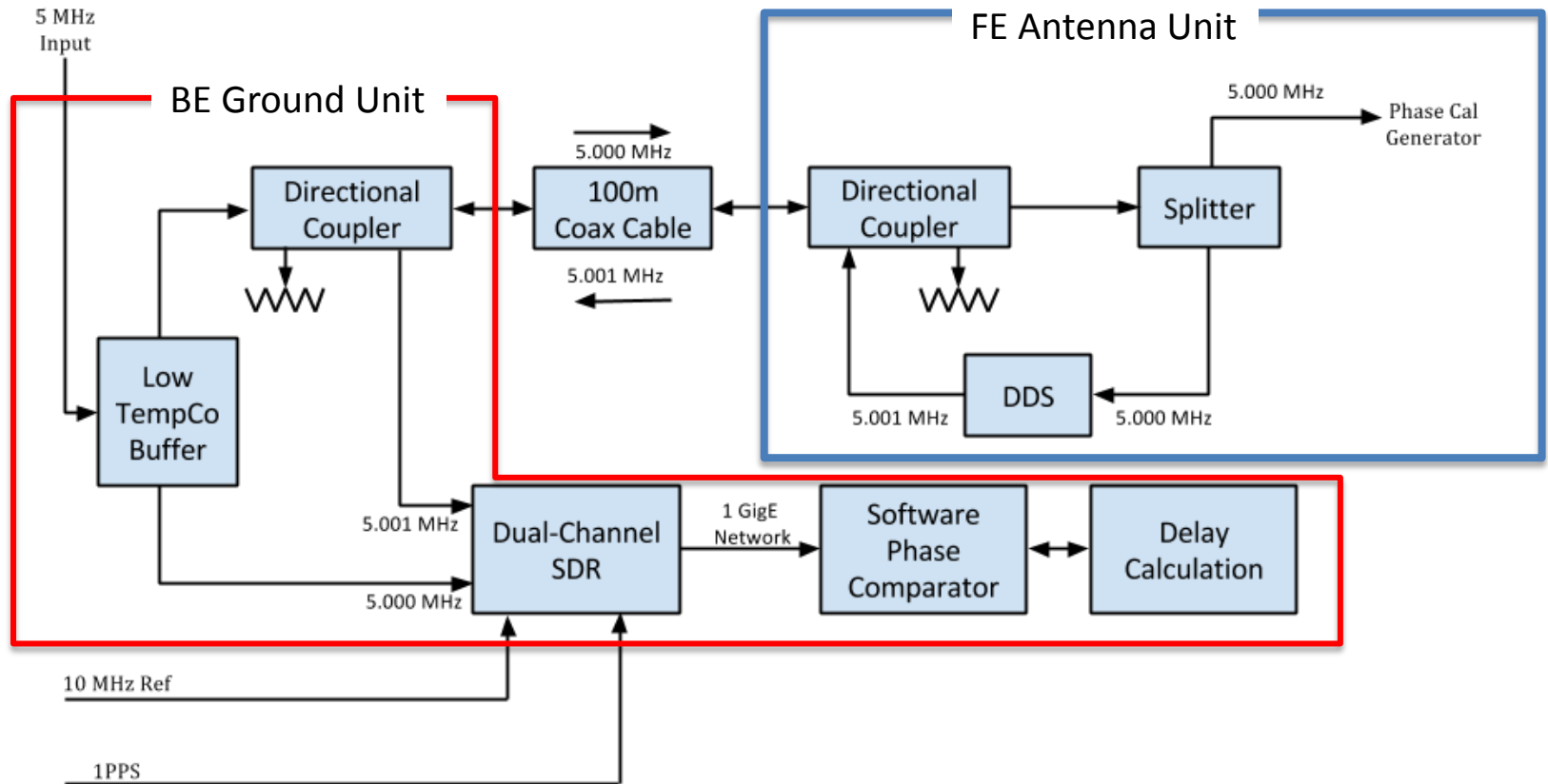
Backend - RDBE-G v3.0 Firmware



- Synchronous with 1PPS
- Broadcast over network



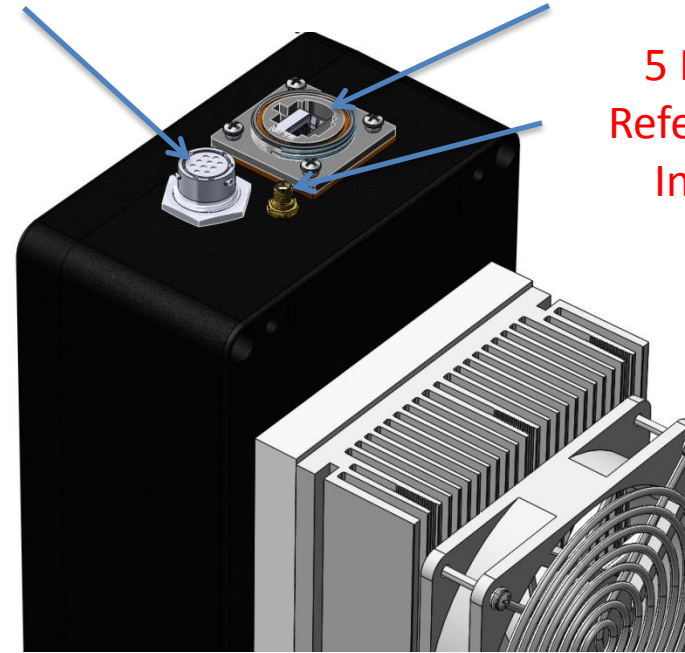
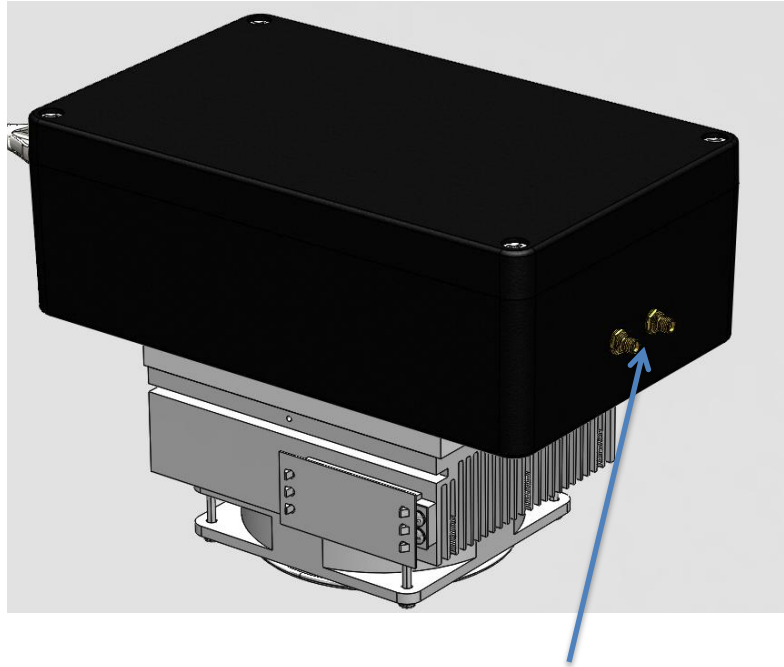
Signal Chain Calibration Subsystem



Signal Chain Calibration – Antenna Unit

Main Supply and drive signals

Ethernet/PoE Interface

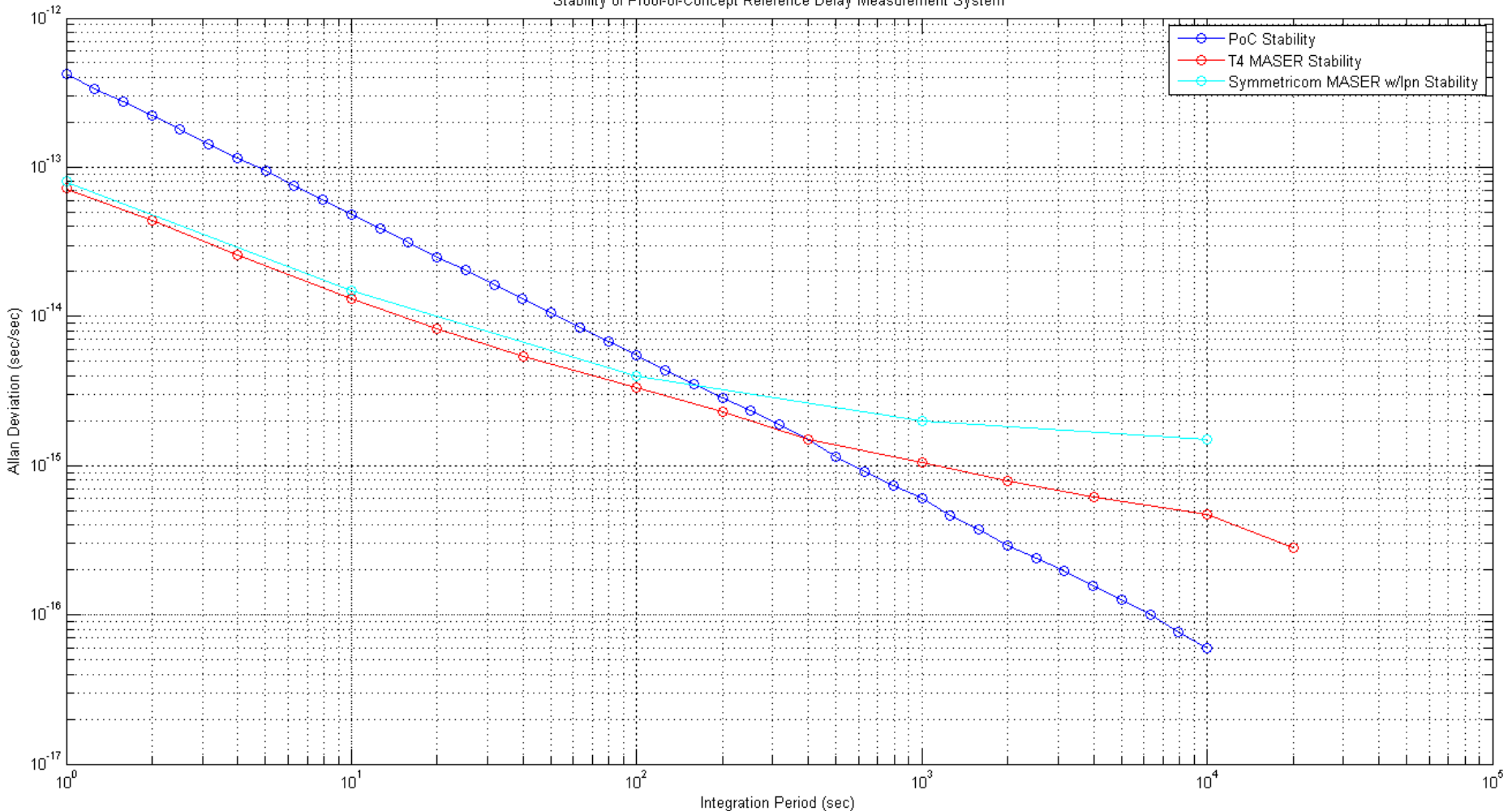


5 MHz
Reference
Input

Dual Phase/Noise Calibration Signal Outputs

Signal Chain Calibration – CD Stability

Stability of Proof-of-Concept Reference Delay Measurement System



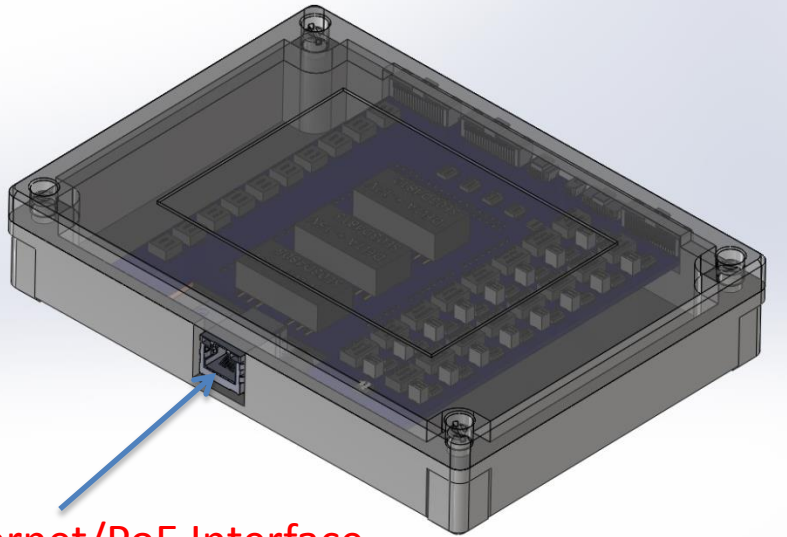


- ◆ VLBI Data Acquisition (VDAQ) module
 - Open-source hardware development
 - Hot-Swappable
 - Deployable Temperature, Pressure, Humidity Sensing
 - On-board temperature sensor
 - Logging to SD card

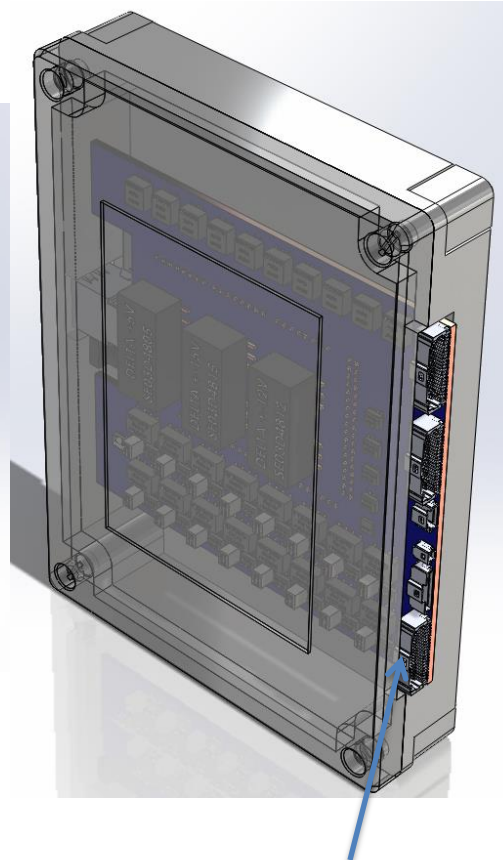
- ◆ Interface
 - Ethernet Communications
 - Powered over Ethernet
 - Isolated DC Power Sources
 - 16 Analog Monitors
 - Single-ended or Differential
 - Isolated or Non-Isolated
 - Configurable signal conditioning
 - 40 Digital Monitors or Controls
 - 10 Isolated Monitors
 - 10 Isolated Controls
 - 20 Non-isolated Monitors and/or Controls
 - RS232 and I²C Communications

VLBI Data Acquisition Module

Dimensions: 13 x 10 x 2.5 cm



Ethernet/PoE Interface



Monitor/Control Signal Interface



- ◆ March 2015: Calibration Subsystem Fab Complete
- ◆ April 2015: Frontend/Backend Subsystems Fab Complete
- ◆ May 2015: MCI and Integration Complete
- ◆ May-July 2015: Integrated Testing at Haystack
- ◆ August 2015: Ship to KPGO
- ◆ August-Sept 2015: Installation/Testing
- ◆ Early October 2015: Complete System Test
- ◆ Oct-Dec 2015: Commissioning
- ◆ Jan 2016 and beyond: IVS Integration