



ACADEMIA SINICA  
Institute of Astronomy and  
Astrophysics

HARVARD-SMITHSONIAN  
Center for Astrophysics



# *Electronics Instrumentation for the Greenland Telescope*

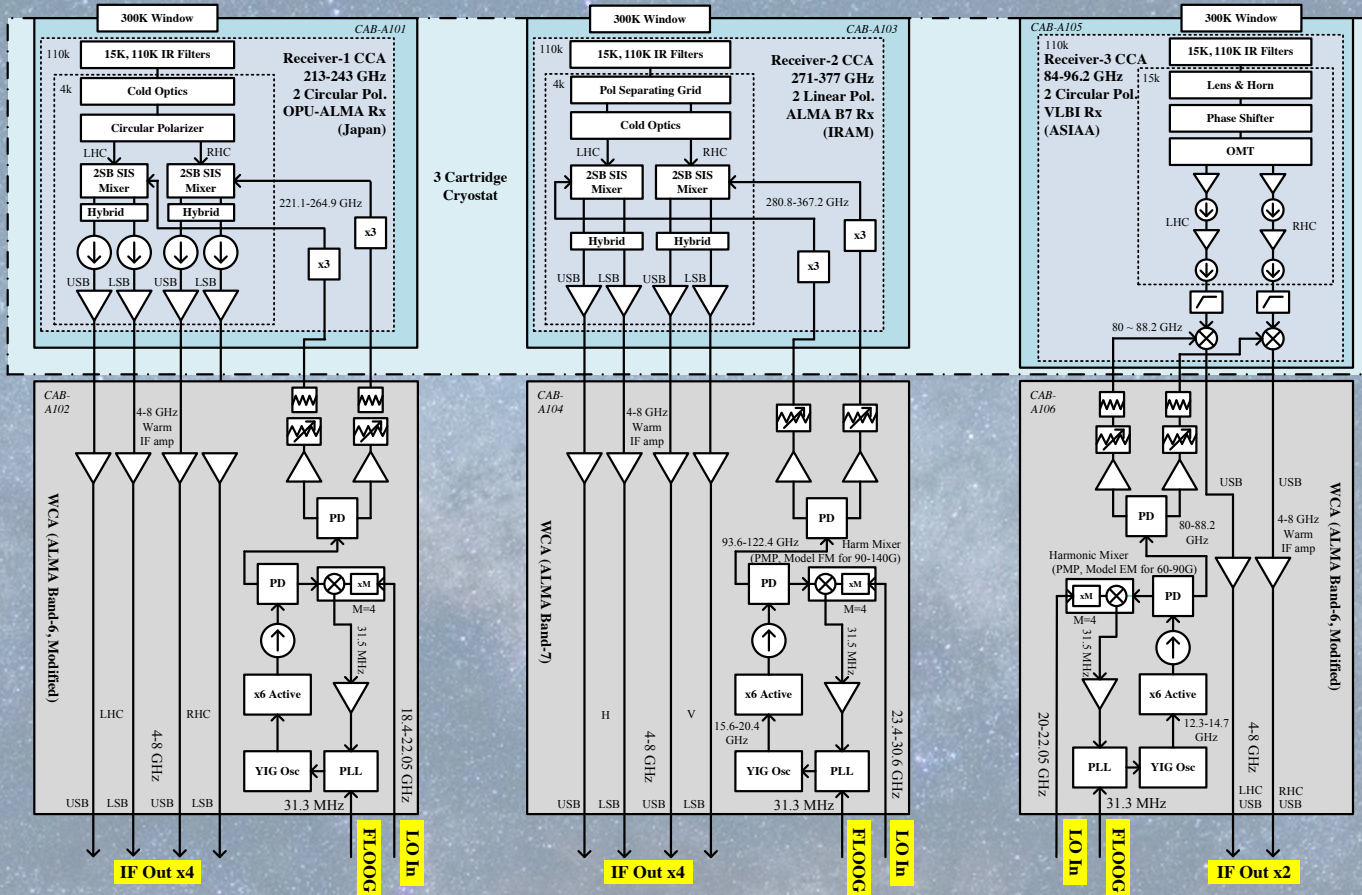
Photo courtesy of M.T. Chen

June 10-15, 2018

SPIE Astronomical Telescopes and Instrumentation

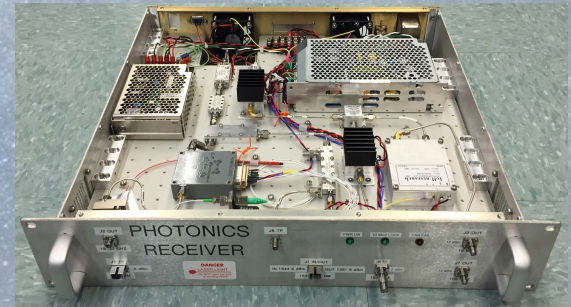
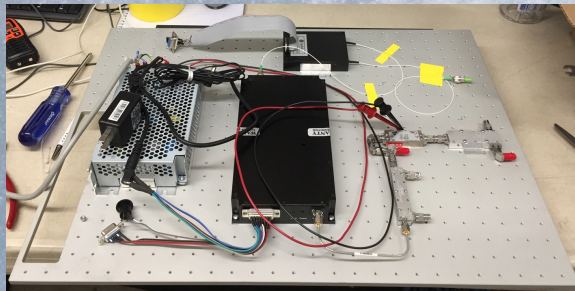
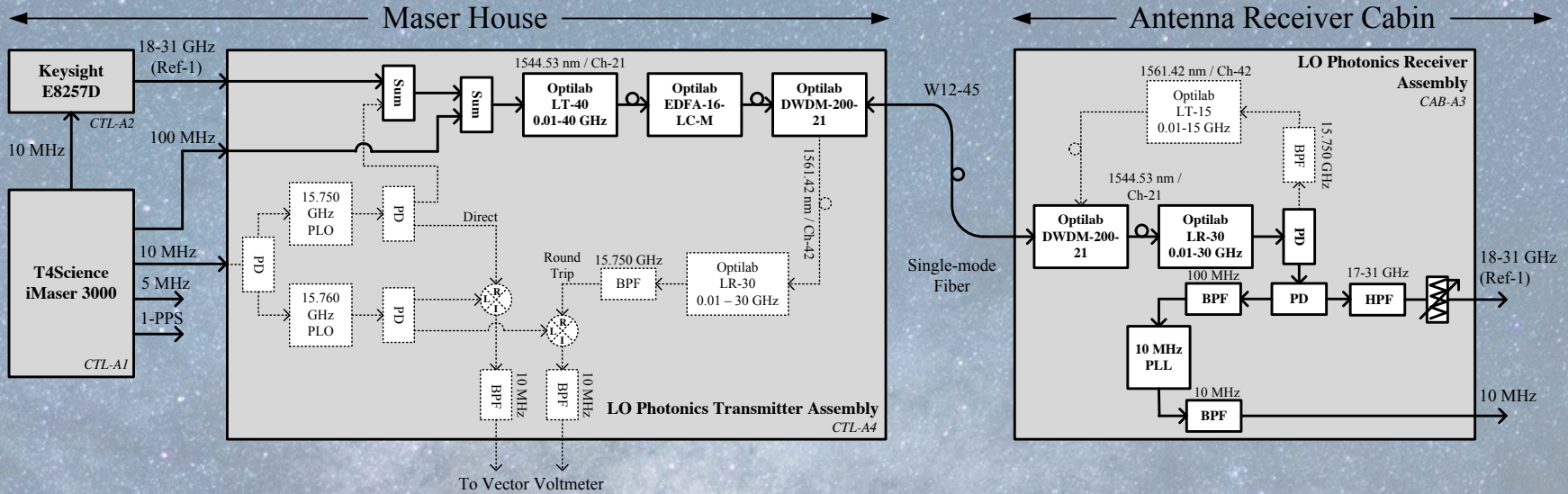
Derek Kubo  
ASIAA  
SPIE 10708-40

# Millimeter Wave Receivers



First Light Receivers for the Greenland Telescope SPIE 10708-149

# Local Oscillator Generation and Distribution



# *Local Oscillator Generation and Distribution*

- Maser House*



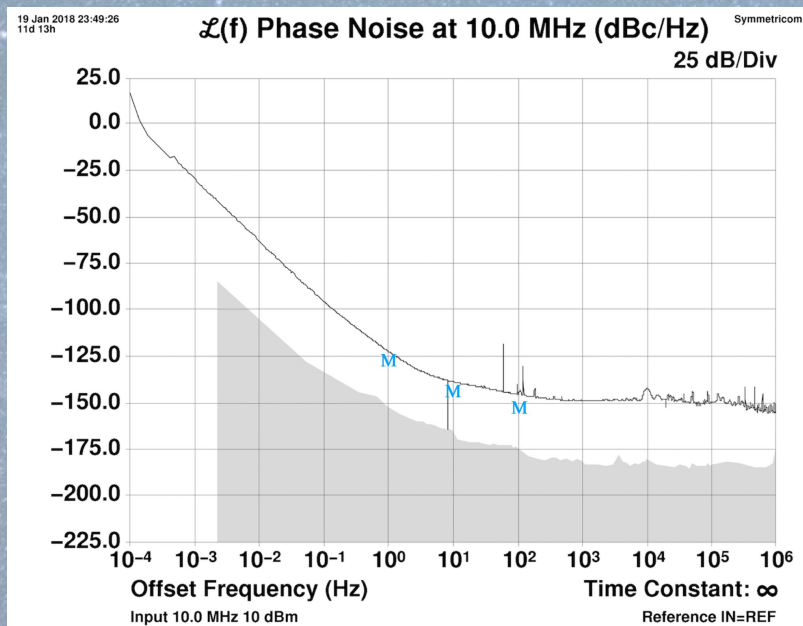
Equipment Rack and Maser Unit



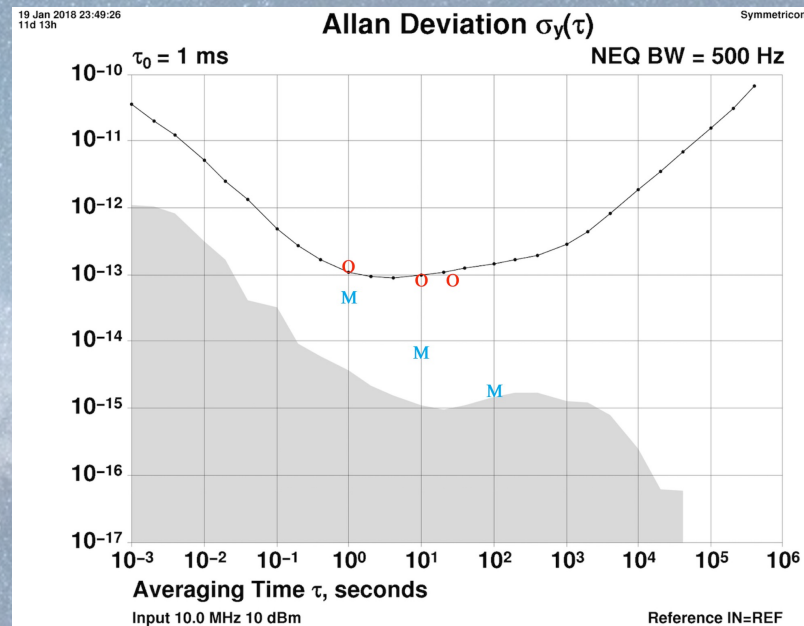
T4 Science iMaser 3000

# Local Oscillator Generation and Distribution

- *iMaser Performance at Thule (relative to Oscilloquartz 8607 OCXO)*
- *Dominated by Oscilloquartz test reference source*



iMaser S/N 118 vs Oscilloquartz Phase Noise

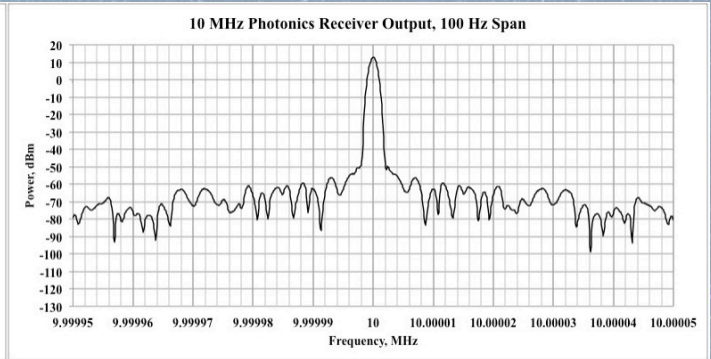
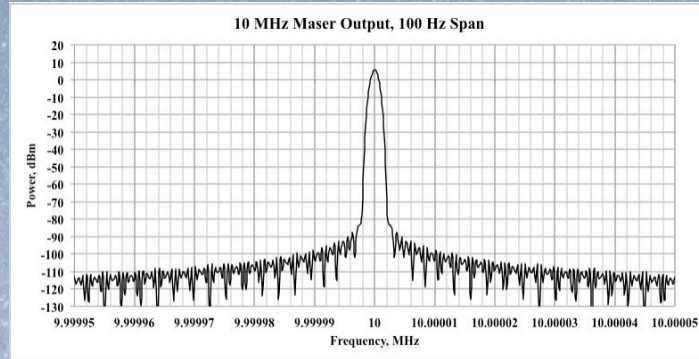


iMaser S/N 118 vs Oscilloquartz Allan Deviation

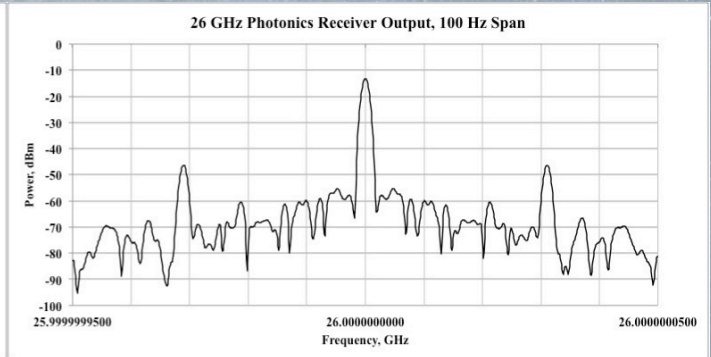
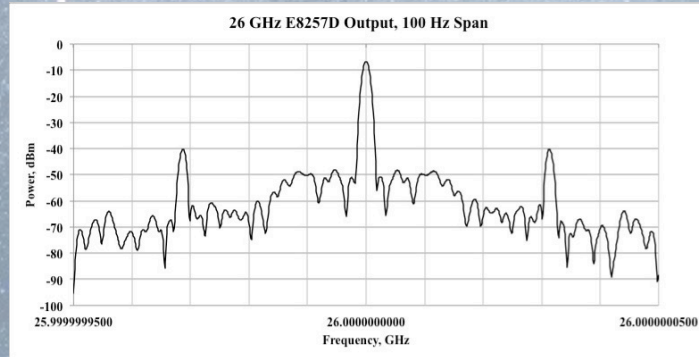
# Local Oscillator Generation and Distribution

- *LO Photonics Transmitter and Receiver Performance*

10 MHz  
Reference



18-31 GHz LO  
Reference

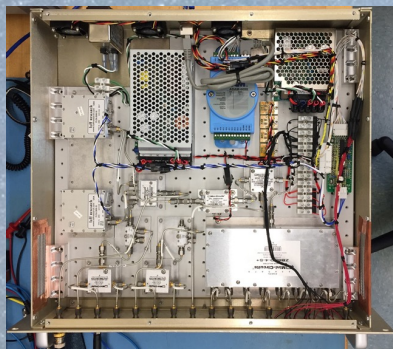


Before Optical Transmission

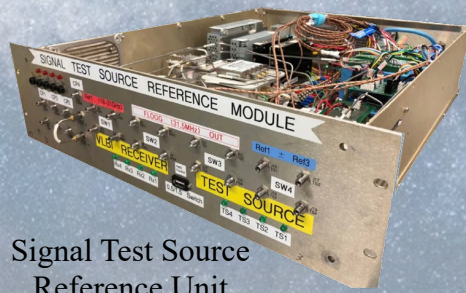
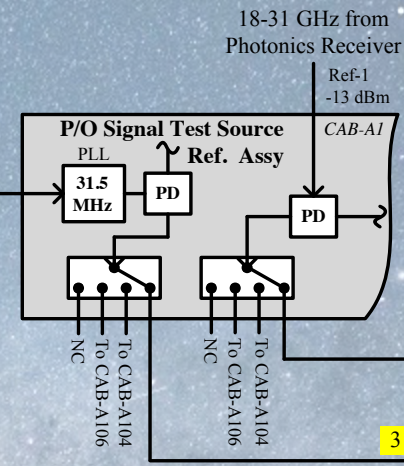
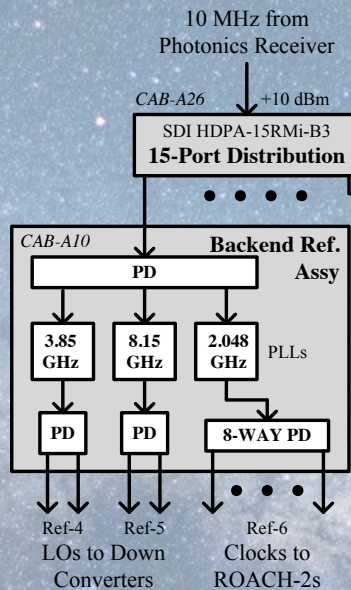
After Optical Transmission

# Local Oscillator Generation and Distribution

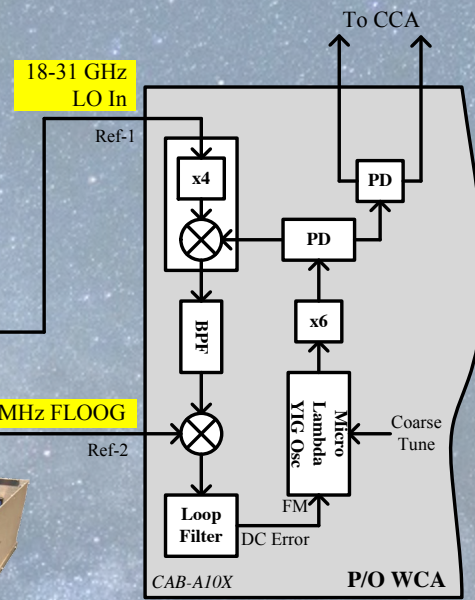
- Secondary LO Generation and Distribution



Backend Reference Unit

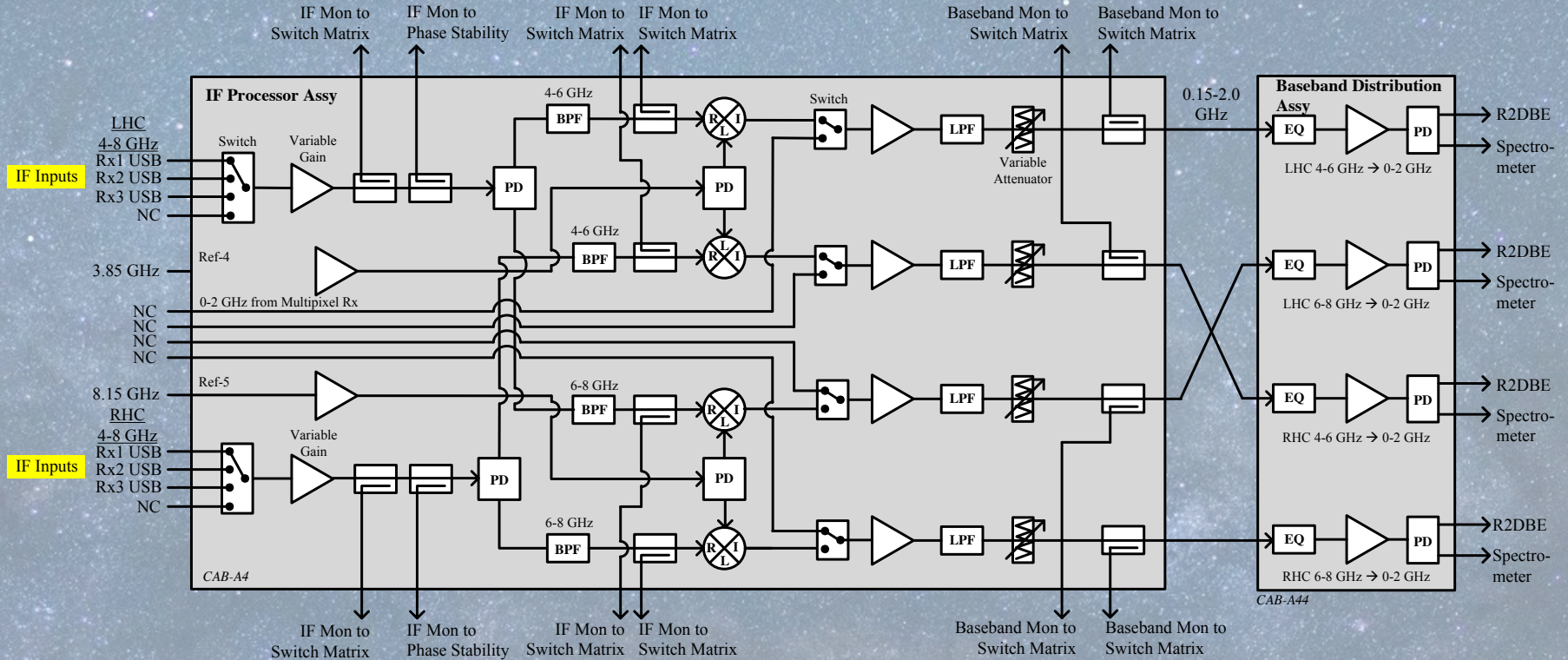


Signal Test Source Reference Unit



# IF Down Conversion, Digitization and Recording

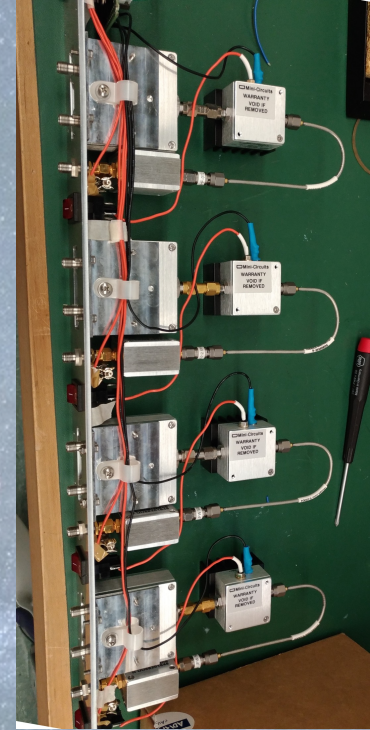
- *Down Conversion to Baseband provided by IF Processor Units (x2)*





# *IF Down Conversion, Digitization and Recording*

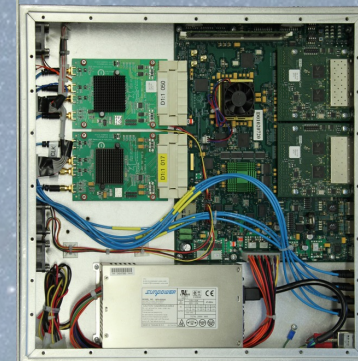
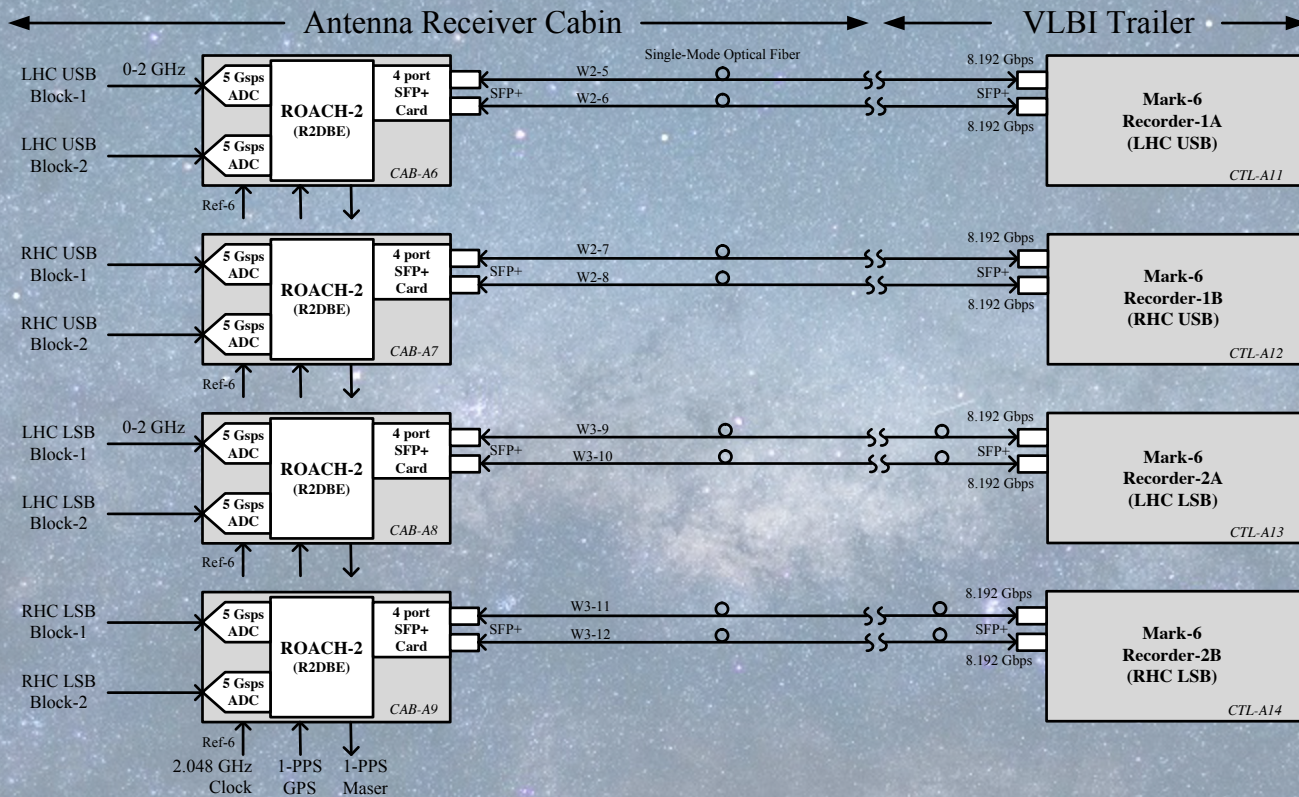
- *IF Processor Units (x2)*



Baseband Distribution Plate

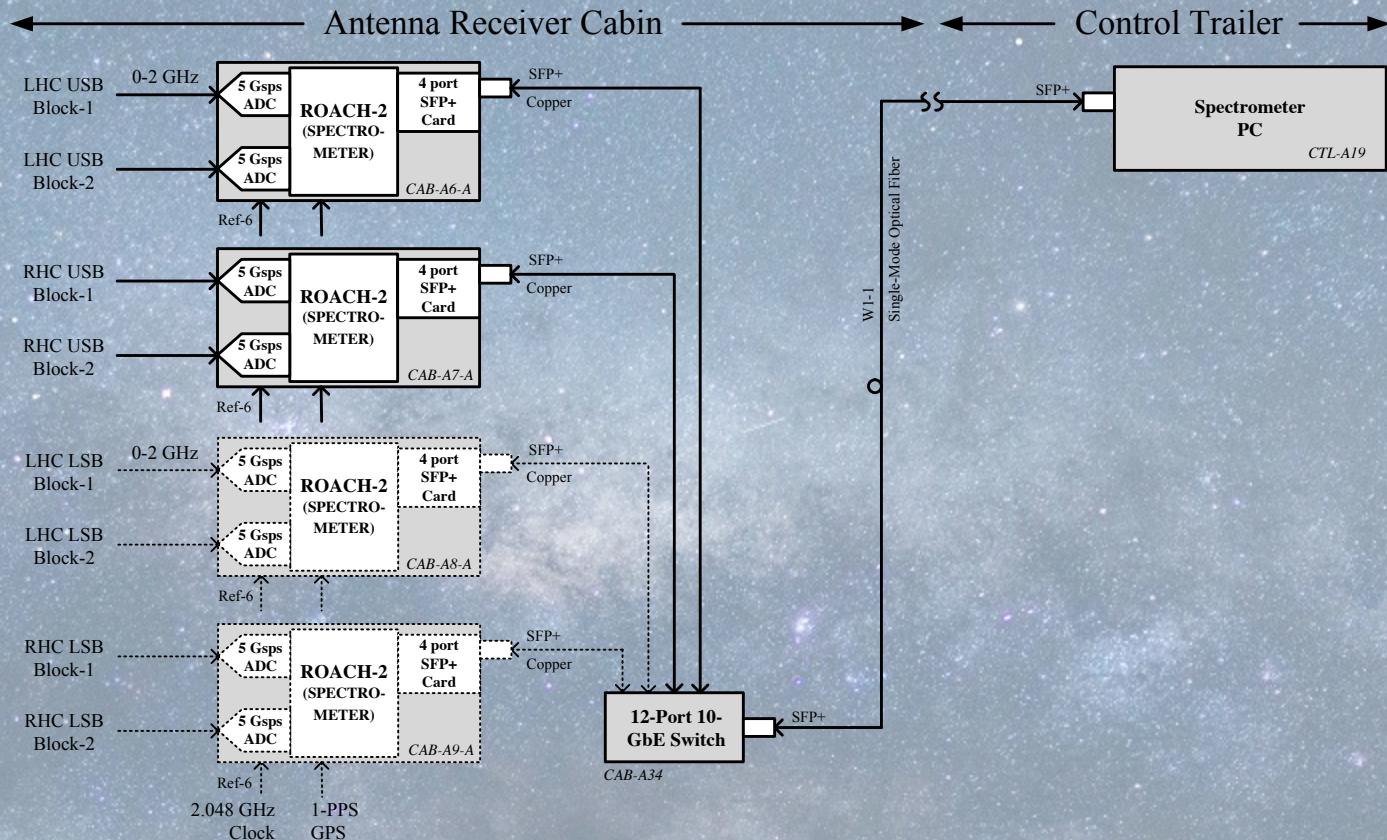
# Down Conversion, Digitization and Recording

## • Digital Backend



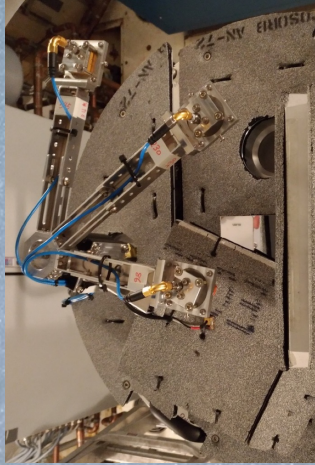
# Down Conversion, Digitization and Recording

- Spectrometer**

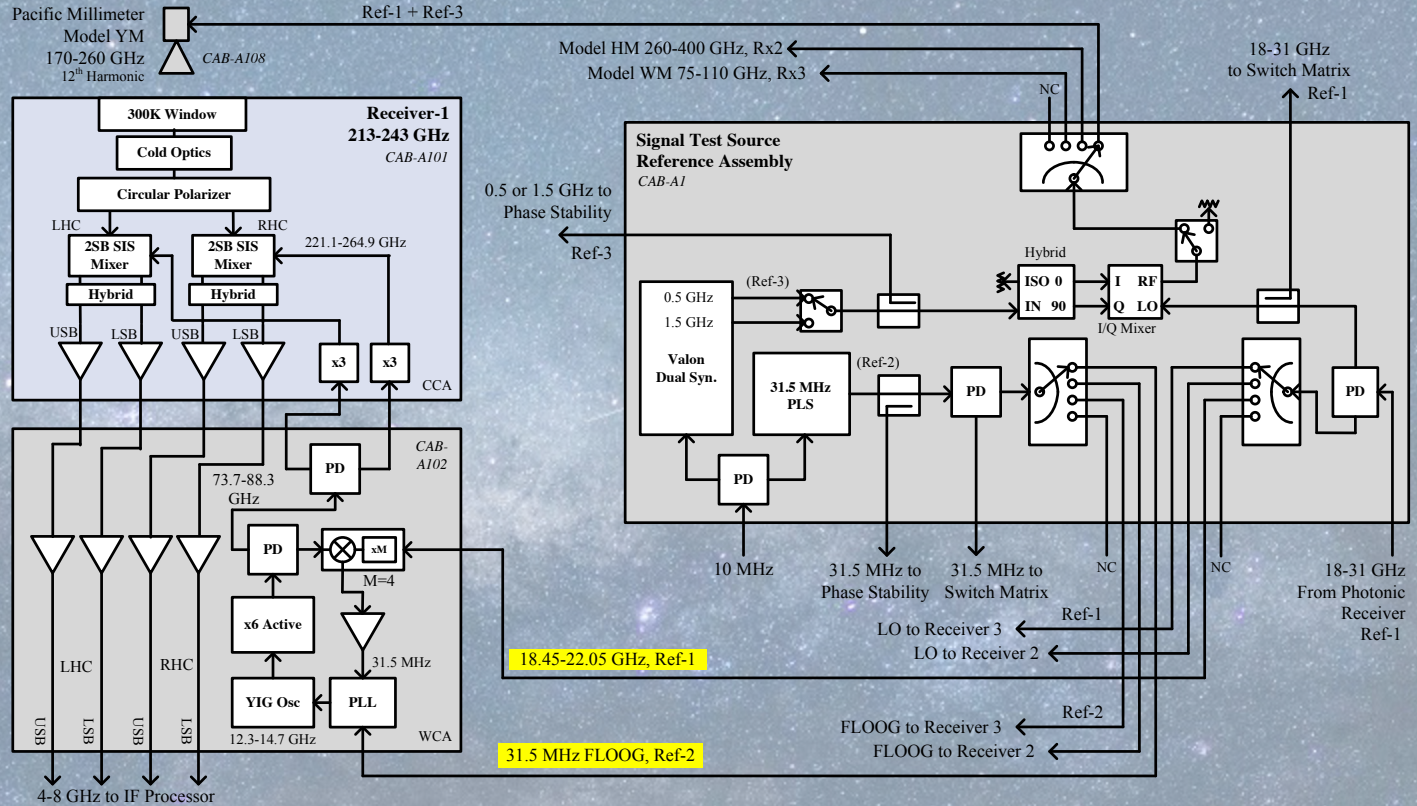


# Calibration and Diagnostics

## • Millimeter Wave Test Tone Generation

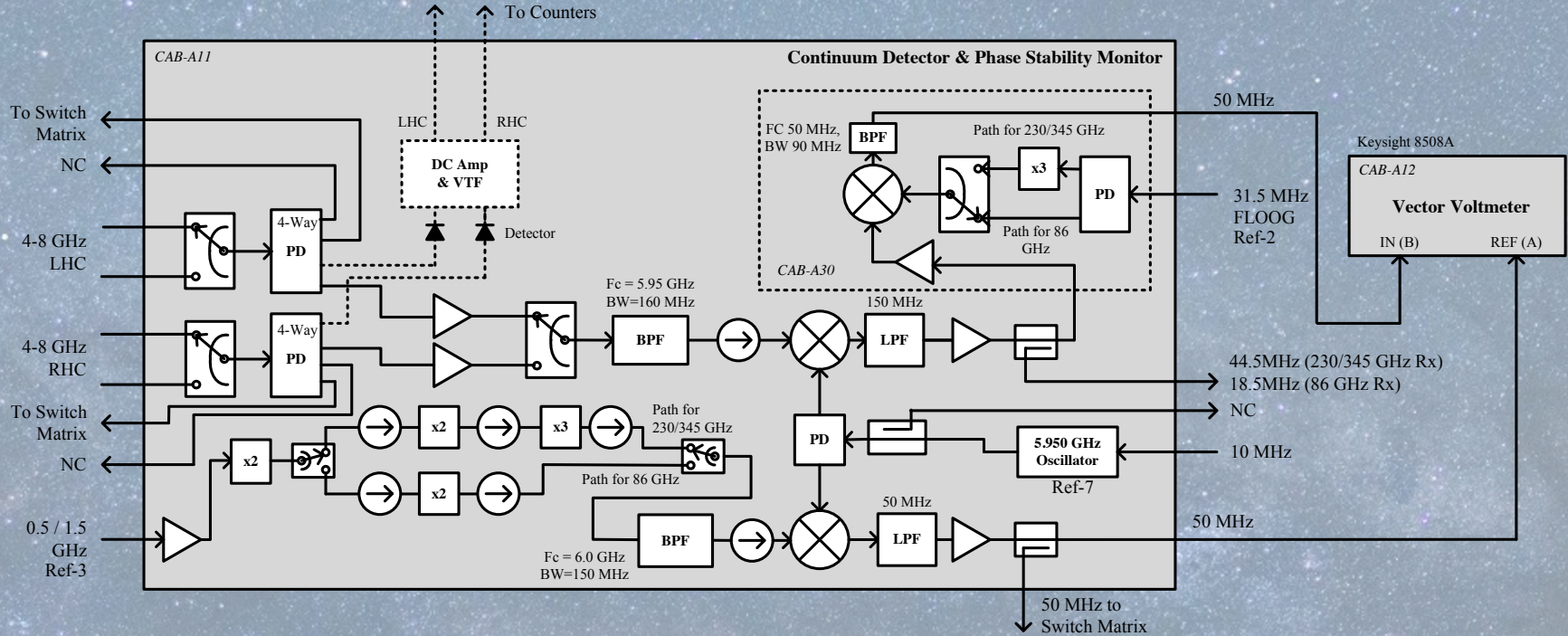


Ambient Load and Harmonic Mixers



# Calibration and Diagnostics

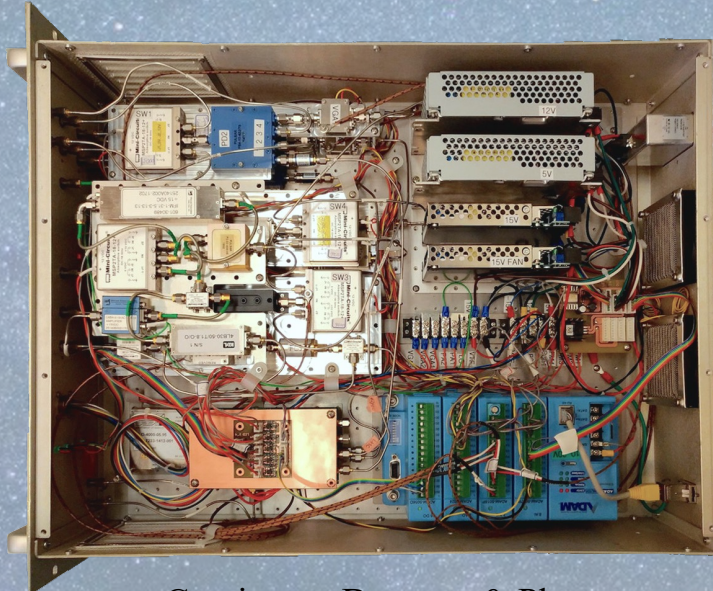
- *Test Tone Phase Stability Monitor*



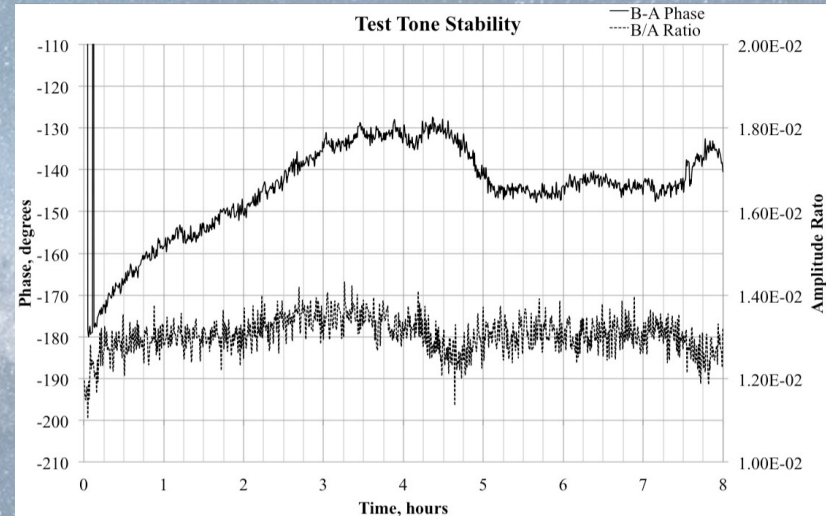
# Calibration and Diagnostics

- *Millimeter Wave Test Tone Generation*

- *LO = 221.1 GHz, Test Tone = 227.0055 GHz*
- *See +12.5 degrees/hour worst-case → 0.2 degrees/minute*  
→ *Allan Deviation 1e-14 @ 1 sec, 2e-15 @ 10 sec*



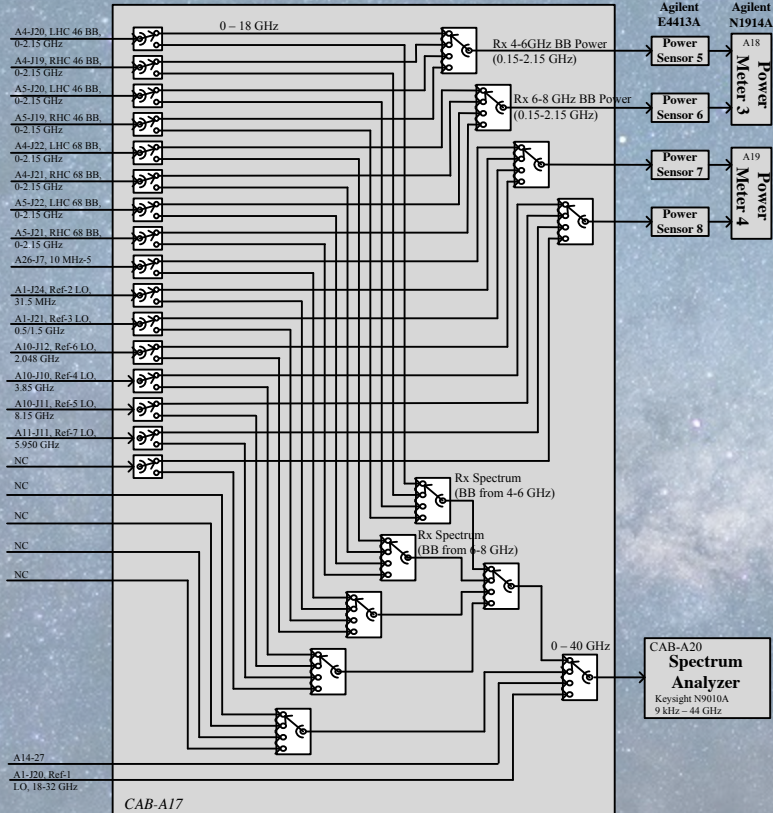
Continuum Detector & Phase  
Stability Monitor Unit



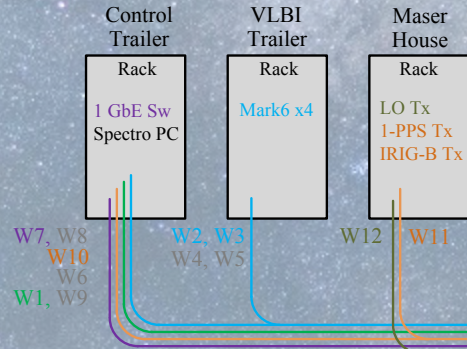
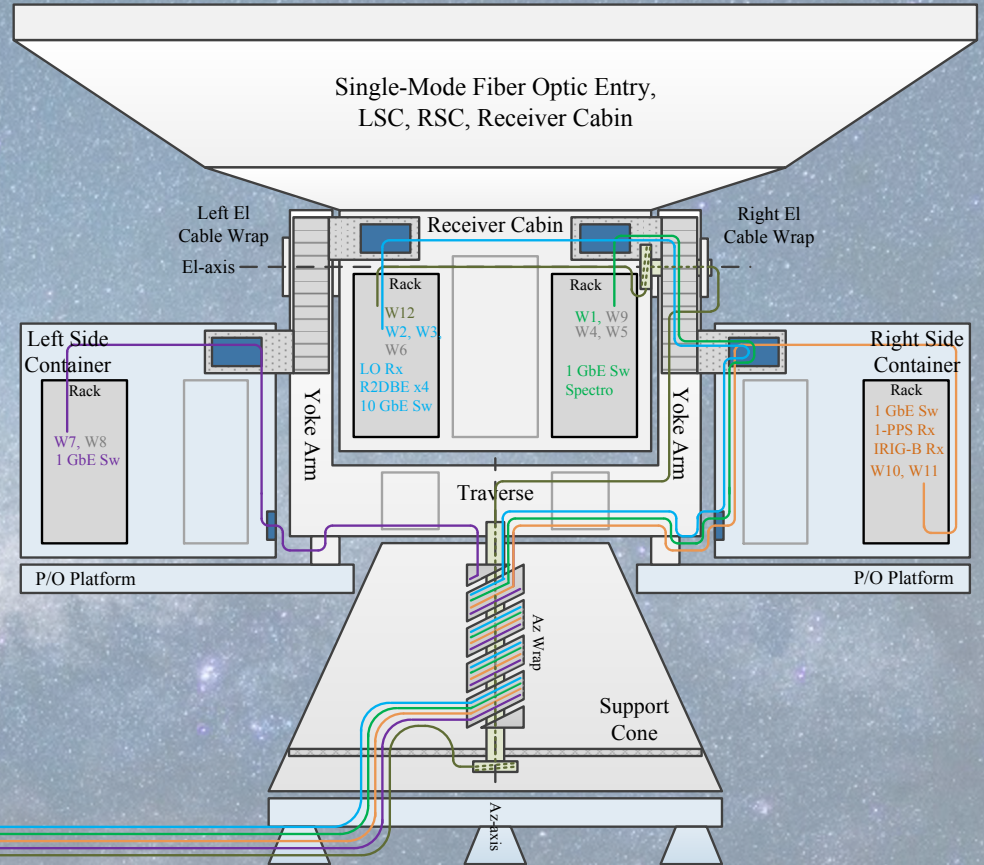
Phase/Amplitude vs Time  
(Apr 21, 2018)

# Calibration and Diagnostics

- Remote Monitoring – Switch Matrix Unit (x2)



# Lower Temperature Fiber Optics







## *Acknowledgements*



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