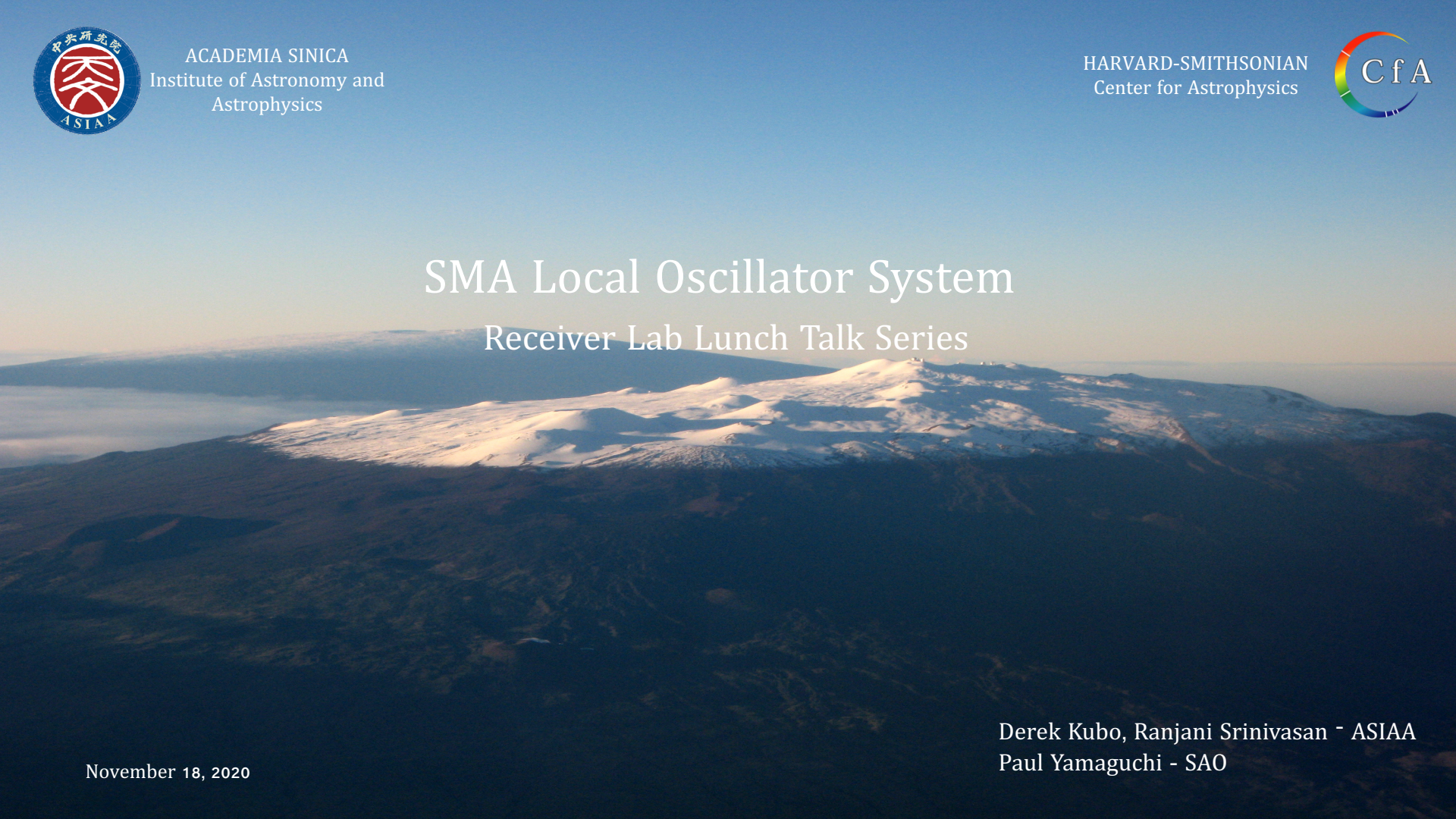


ACADEMIA SINICA
Institute of Astronomy and Astrophysics

HARVARD-SMITHSONIAN
Center for Astrophysics

SMA Local Oscillator System

Receiver Lab Lunch Talk Series

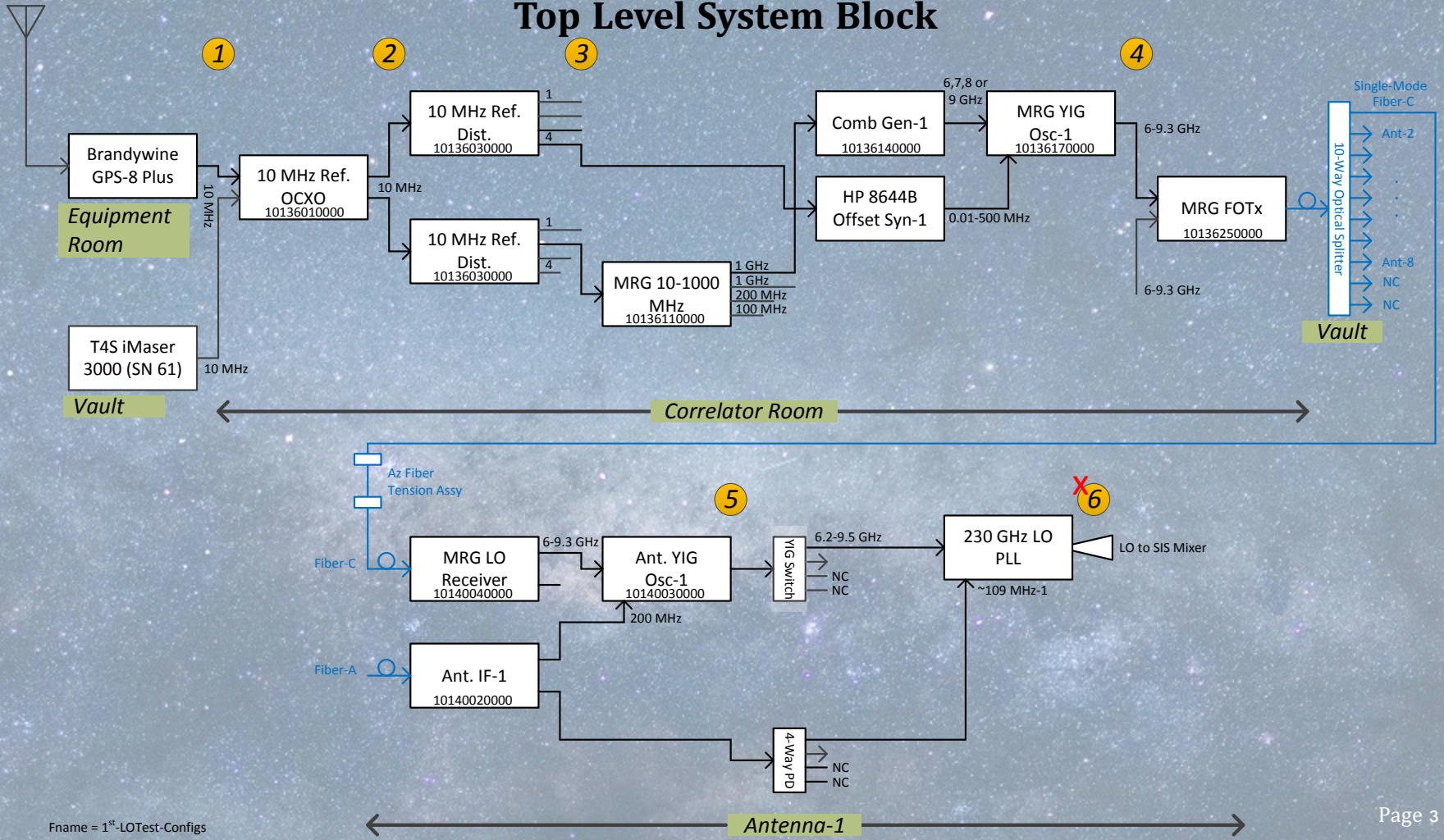
Derek Kubo, Ranjani Srinivasan - ASIAA
Paul Yamaguchi - SAO

November 18, 2020

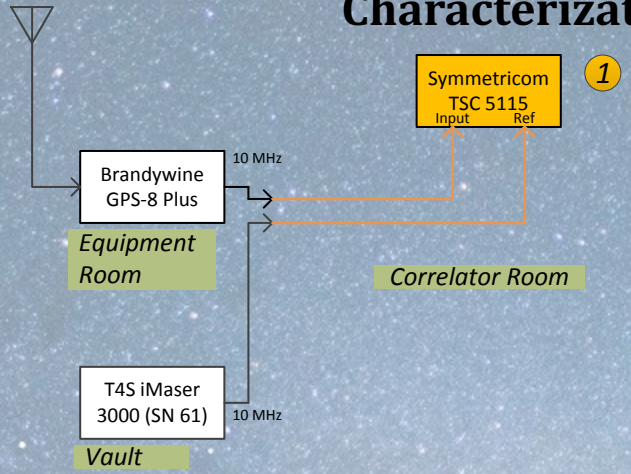
Today's Topics

- Overview of MRG LO system
- Test results of 10 MHz phase noise quality
- Test result MRG YIG phase noise and stability
- Planned tests for Antenna YIG phase noise and stability
- Utilizing CWDM for multiplexing additional common signals
- Scheme for round-trip phase monitoring

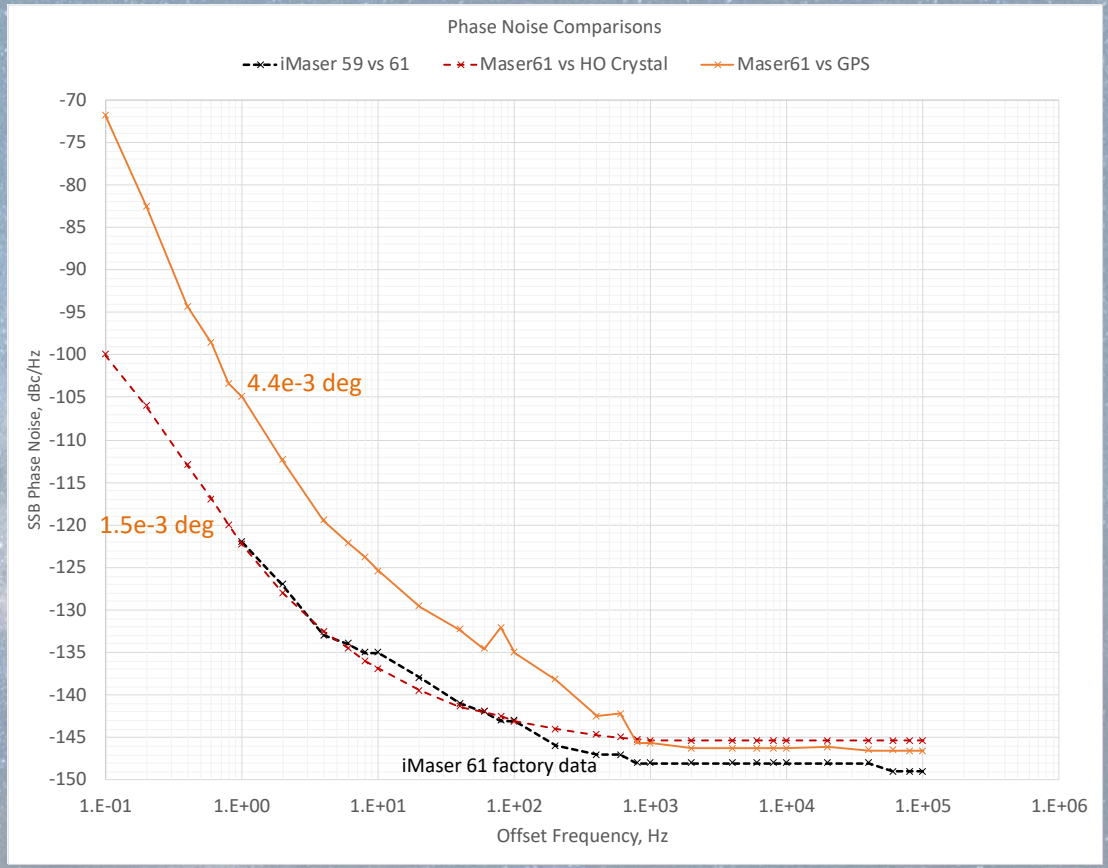
Top Level System Block



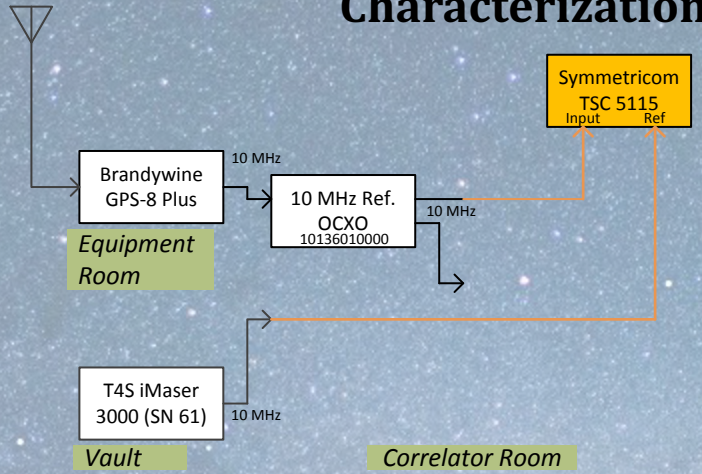
Characterization of 10 MHz Source Phase Noise (1)



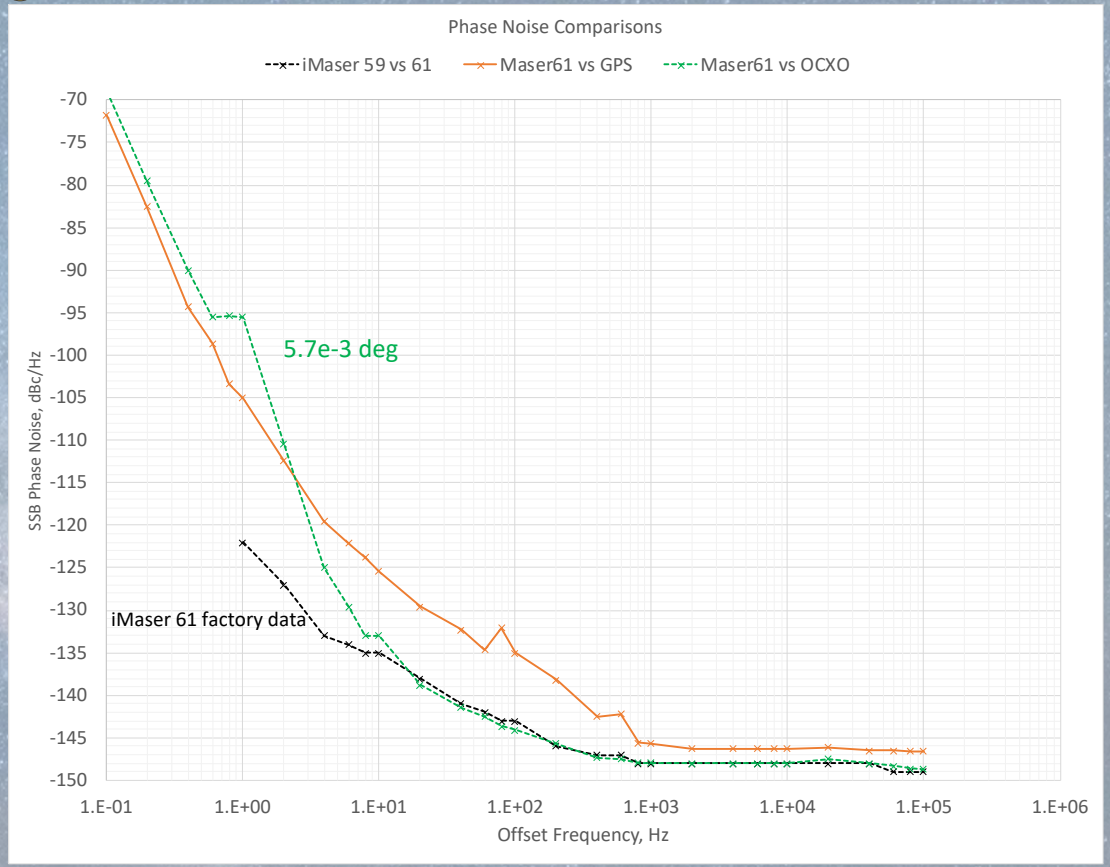
- Differential phase noise measurement between maser and GPS
  - Integrated phase noise 4.4e-3 degrees RMS, 0.1 – 100,000 Hz
- Maser vs HO Crystal shown for reference
  - Integrated phase noise 1.5e-3 degrees RMS, 0.1 – 100,000 Hz



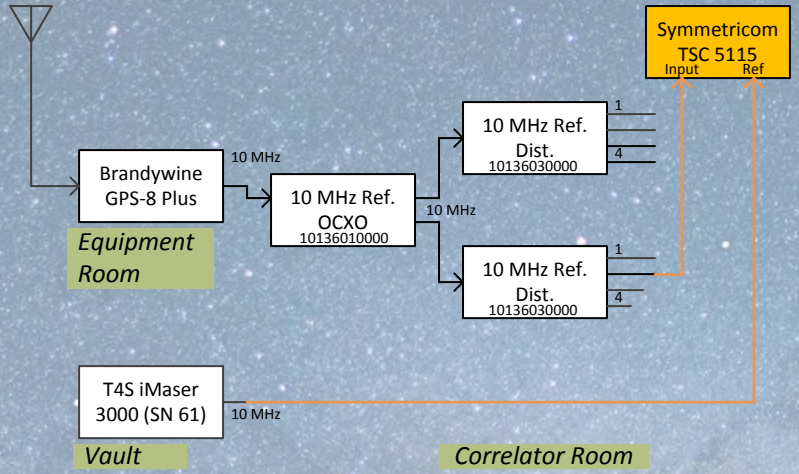
Characterization of 10 MHz Source Phase Noise (2)

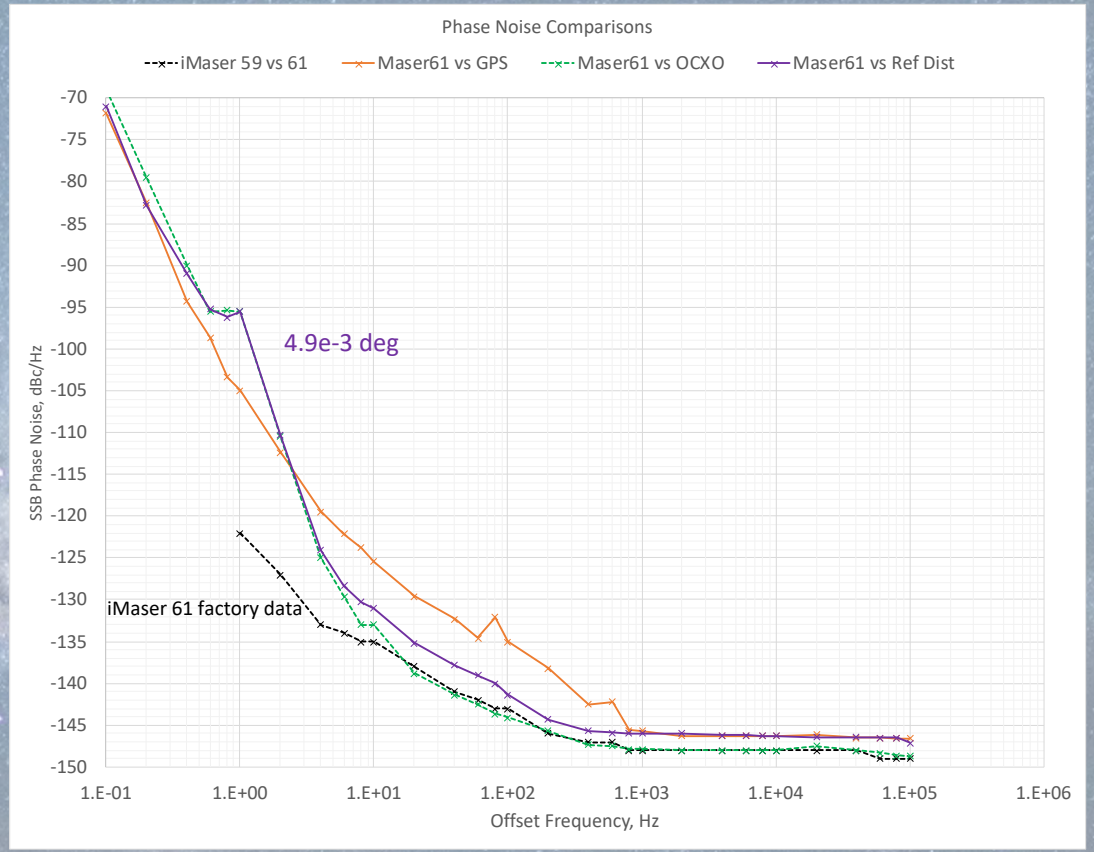


- GPS 10 MHz after OCXO drawer
  - One sided loop BW ~1 Hz
- Integrated phase noise 5.7e-3 degrees RMS, 0.1 – 100,000 Hz



Characterization of 10 MHz Source Phase Noise (3)





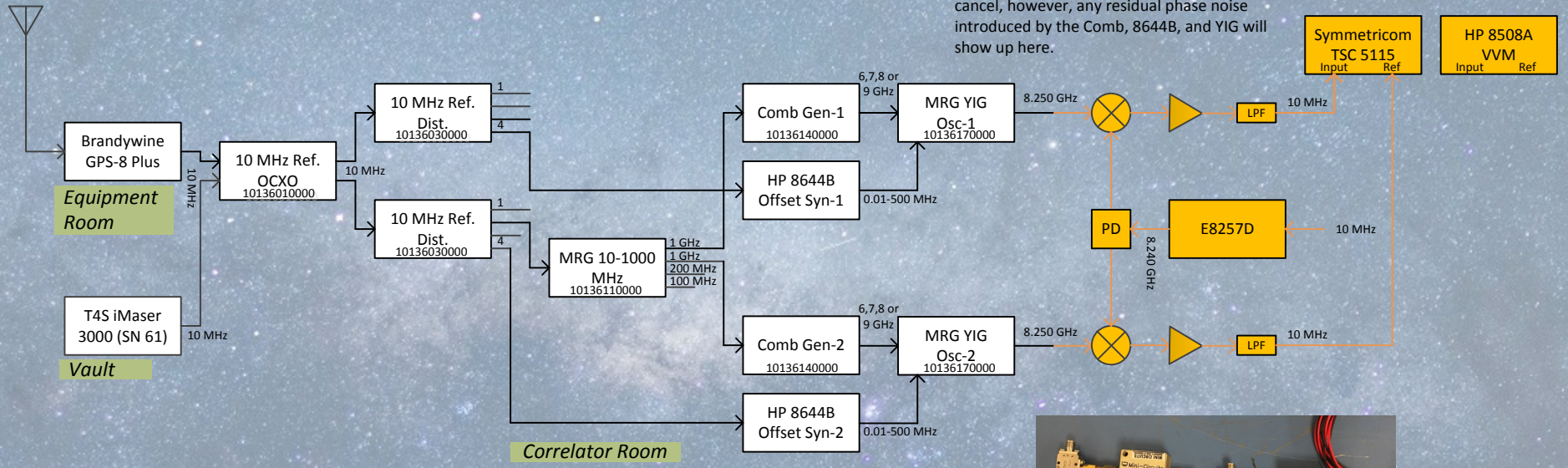
- 10 MHz after Reference Distribution drawer
- Integrated phase noise 4.9e-3 degrees RMS, 0.1 – 100,000 Hz
- Small scatter in results probably from differences in test setup
  - (1) 4.4e-3 degrees (Maser vs GPS)
  - (2) 5.7e-3 degrees (Maser vs OCXO)
  - (3) 4.9e-3 degrees (Maser vs Ref Dist)

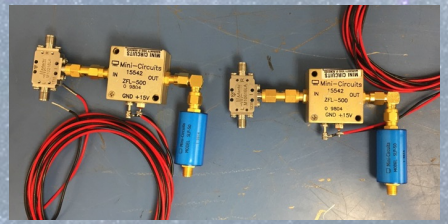
Characterization of MRG YIG Oscillator Phase Noise & Stability (4a)

- MRG YIG-1 & YIG-2 both tuned to 8.250 GHz
  - Anomalous frequency setup (two YIGs are never set to same frequency)
  - Physical configuration is symmetrical

Both MRG YIG-1 and -2 tuned to 8.250 GHz. Ideally the phase noise of the two LOs should cancel, however, any residual phase noise introduced by the Comb, 8644B, and YIG will show up here.

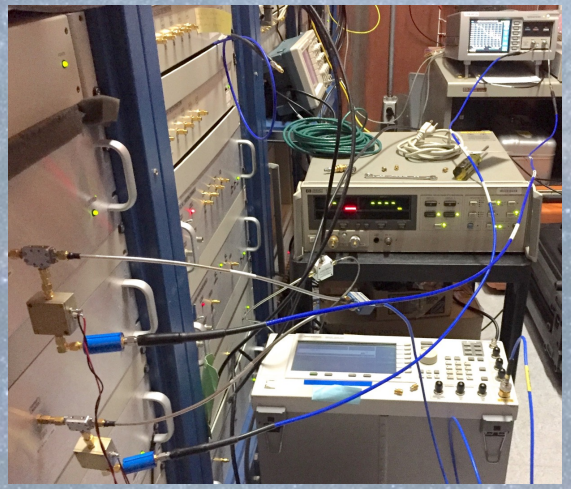
4a

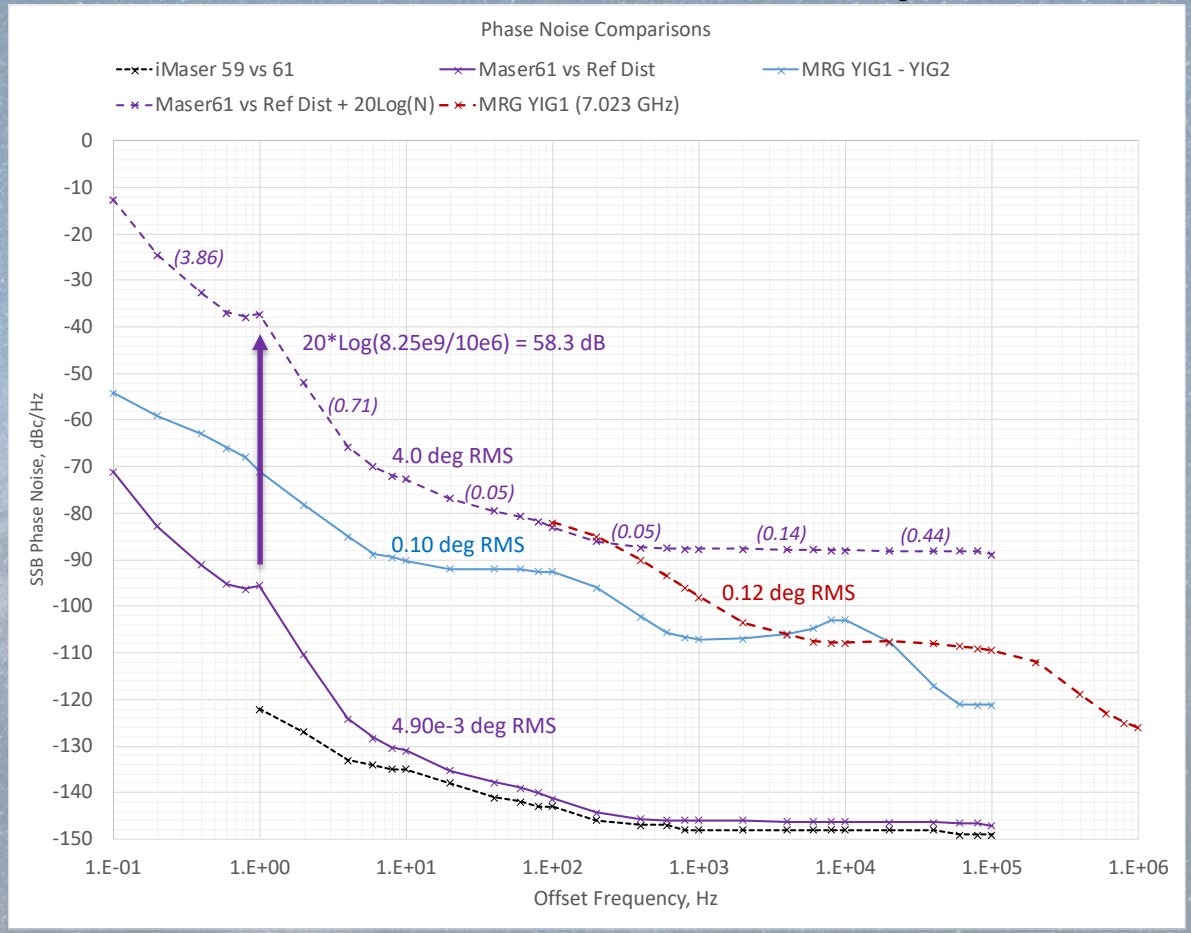




Characterization of MRG YIG Oscillator Phase Noise & Stability (4a)

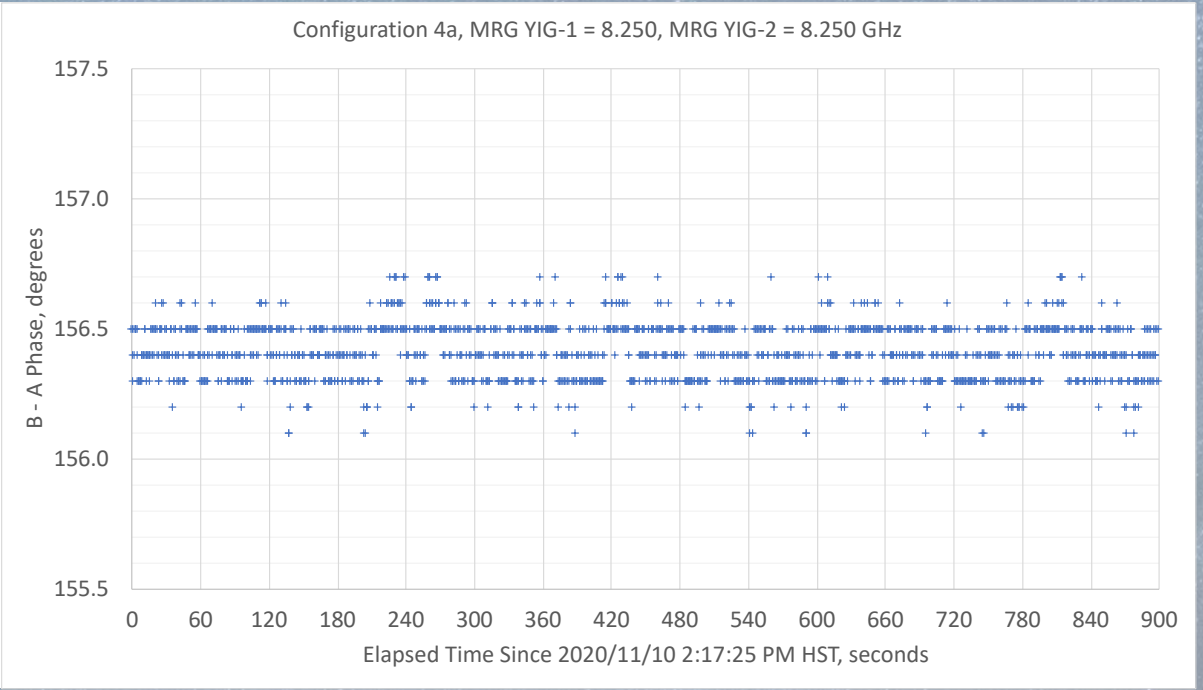
- Phase noise of MRG YIG-1 – YIG-2
  - Common mode phase noise should cancel
  - Represents residual phase noise generated by comb, 8644, and YIG oscillator
- Integrated phase noise 0.10 degrees RMS, 0.01 – 100,000 Hz



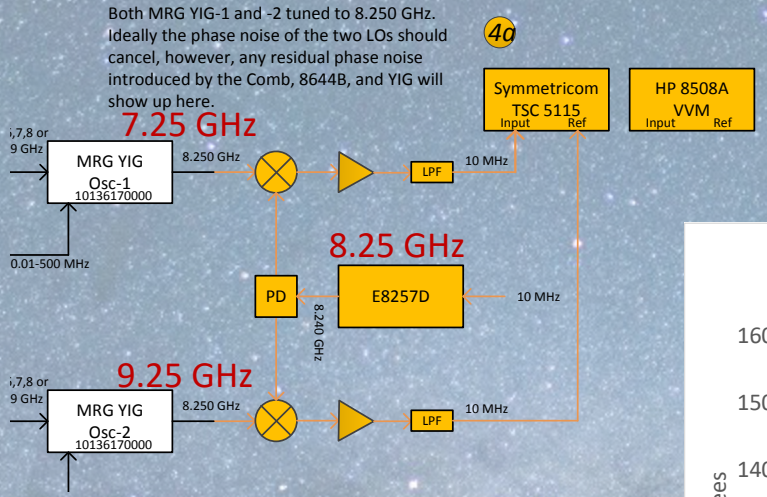


Characterization of MRG YIG Oscillator Phase Noise & Stability (4a)

- Phase stability of MRG YIG-1 – YIG-2
  - 2 samples per second
  - 15 minutes duration
- Standard deviation from 360 – 420 seconds is <u>0.11 degrees</u>



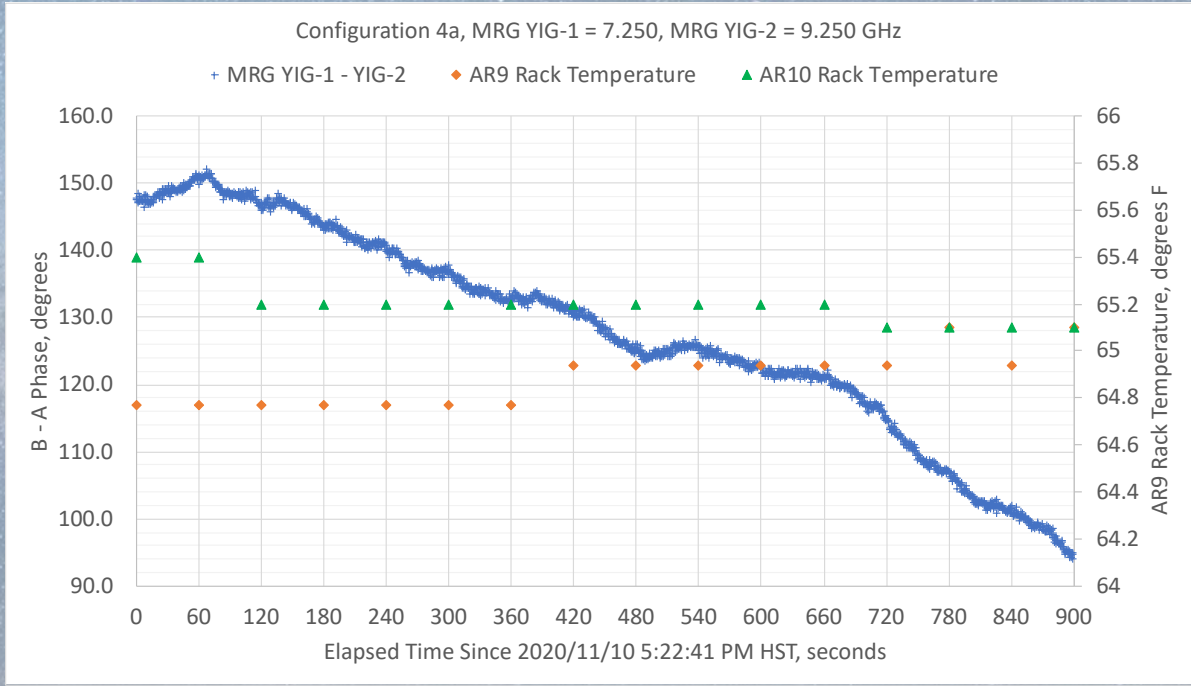
Characterization of MRG YIG Oscillator Phase Noise & Stability (4a)



- Source of phase slope
  - MRG Comb Generator?
  - External D/C Synthesizer?

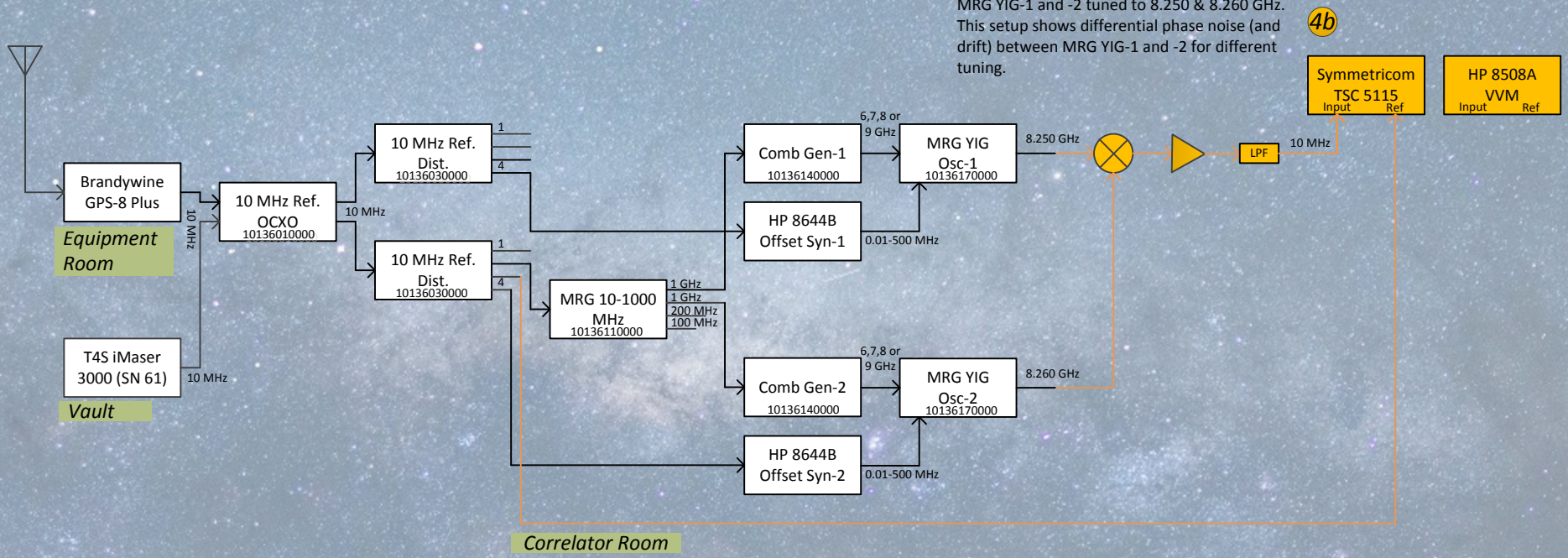
- Configuration 4a
  - MRG YIG-1 = 7.250 GHz
  - MRG YIG-2 = 9.250 GHz
  - D/C LO = 8.250 GHz

- Produced a pair of IFs at 1.000 GHz
  - Run directly into VVM
  - 2 samples per second
  - 15 minute duration



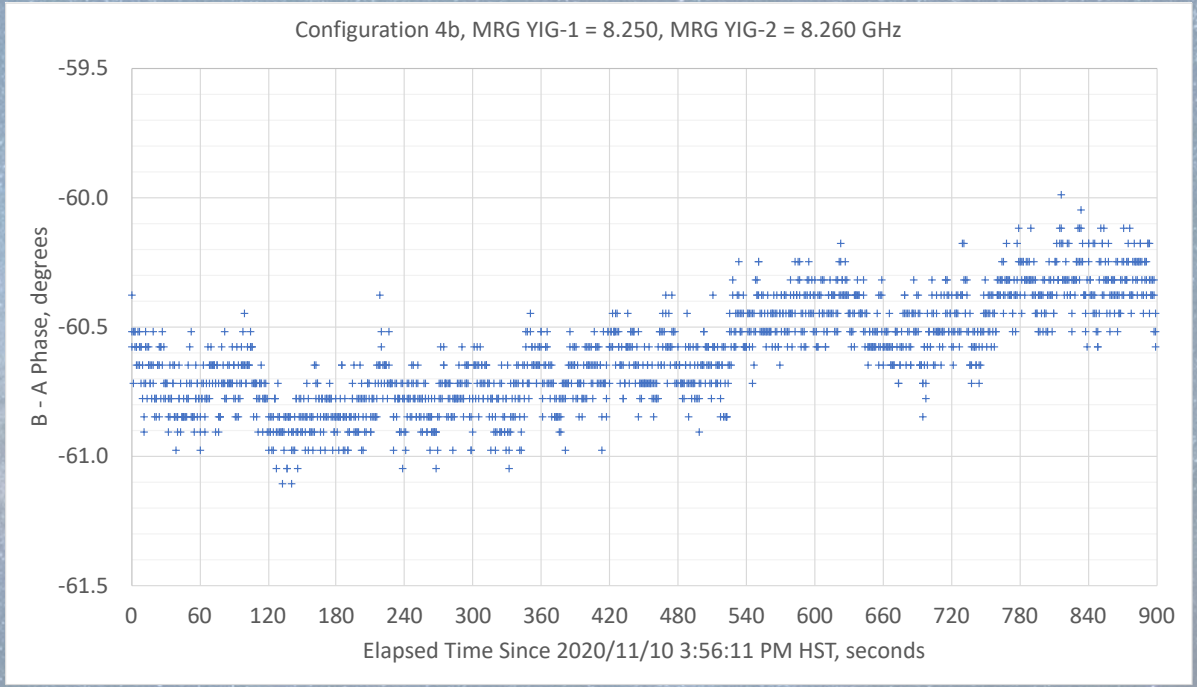
Characterization of MRG YIG Oscillator Phase Noise & Stability (4b)

- MRG YIG-1 tuned to 8.250 GHz and MRG YIG-2 tuned to 8.260 GHz
  - Anomalous frequency setup (delta F is normally > 500 MHz)
  - Physical setup is asymmetrical



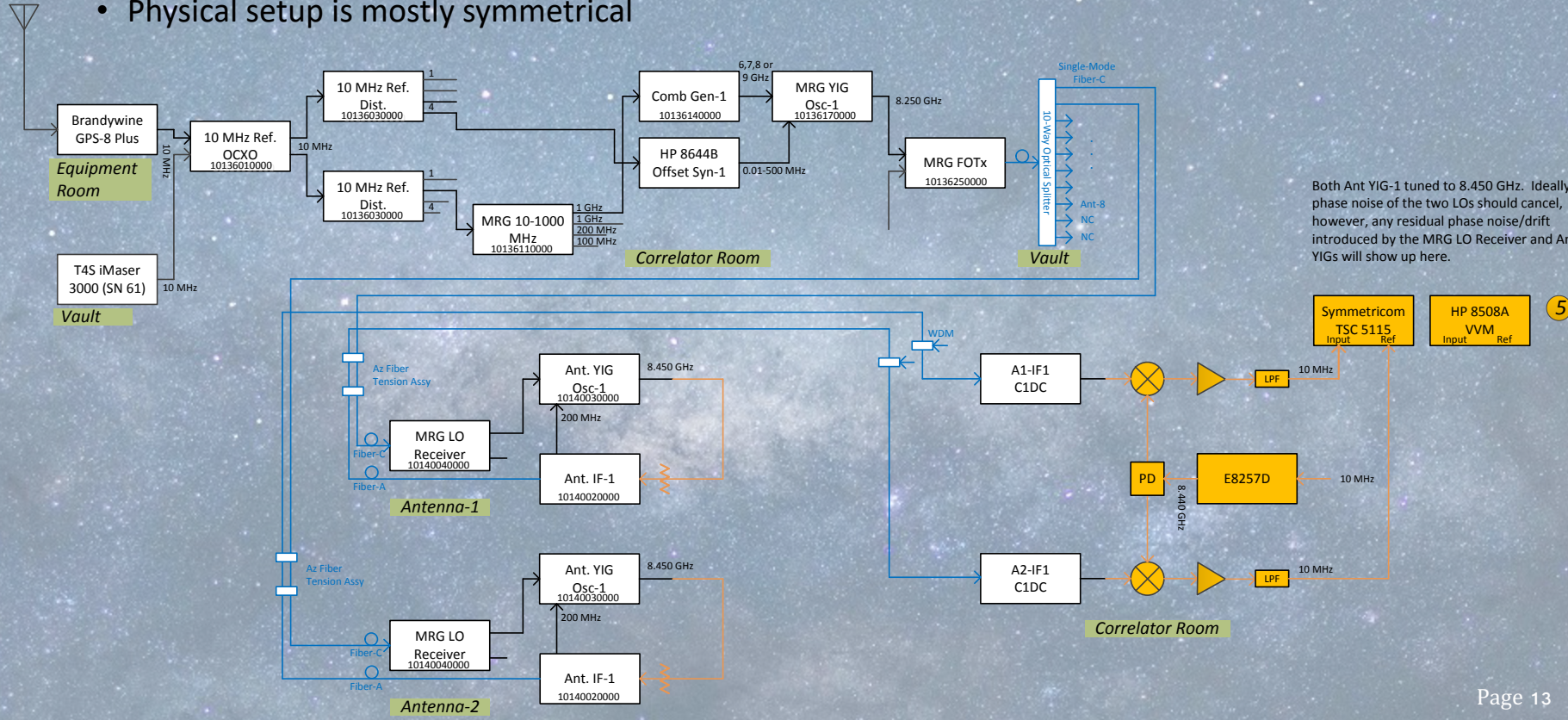
Characterization of MRG YIG Oscillator Phase Noise & Stability (4b)

- Phase stability of MRG YIG-1 – YIG-2
  - 2 samples per second
  - 15 minutes duration
- Standard deviation from 360 – 420 seconds is 0.10 degrees
- See much larger variation in phase
  - 0.5 degrees over 15 minutes
  - Asymmetrical setup?
  - Different MRG frequencies?
- 8.25 x (14 x 2) = 231.0 GHz
  - 14 degrees movement over 15 minutes



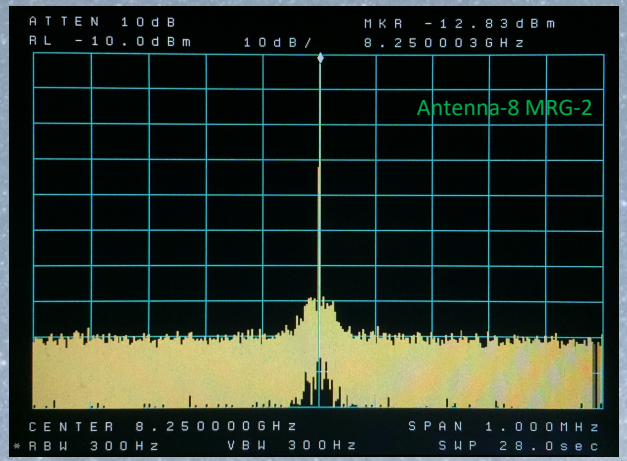
Characterization of Antenna YIG Oscillator Phase Noise & Stability (5)

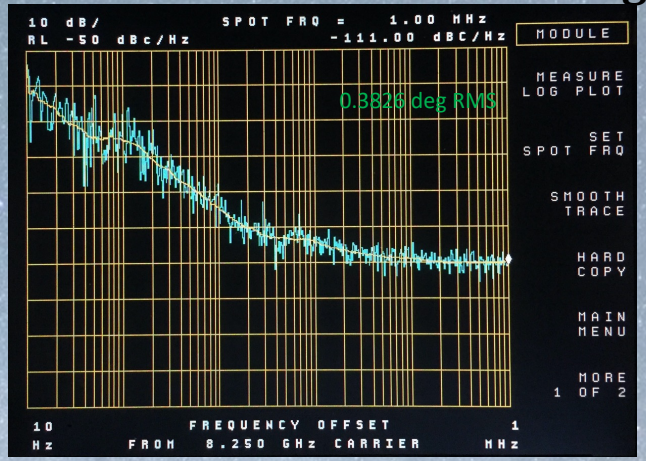
- Paul Y's suggested test setup for characterizing entire MRG LO system
  - Anomalous frequency setup (delta F is normally > 500 MHz)
  - Physical setup is mostly symmetrical

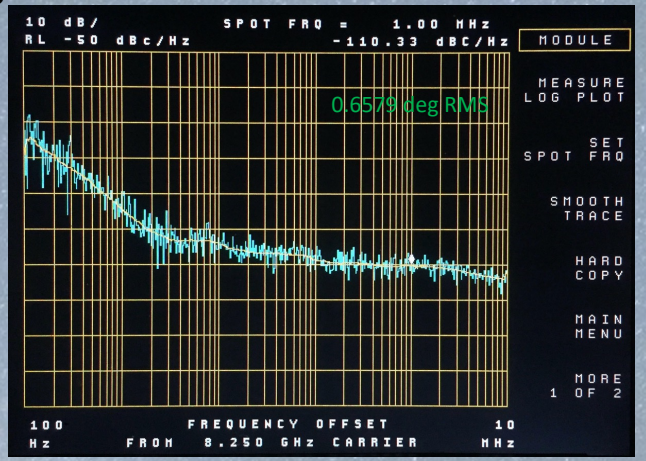


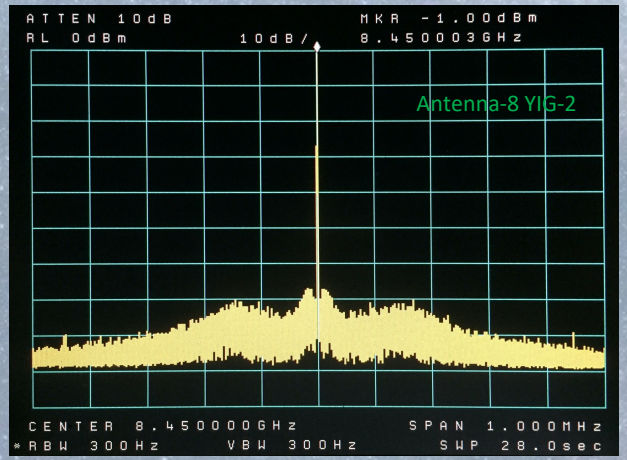
Both Ant YIG-1 tuned to 8.450 GHz. Ideally the phase noise of the two LOs should cancel, however, any residual phase noise/drift introduced by the MRG LO Receiver and Ant. YIGs will show up here.

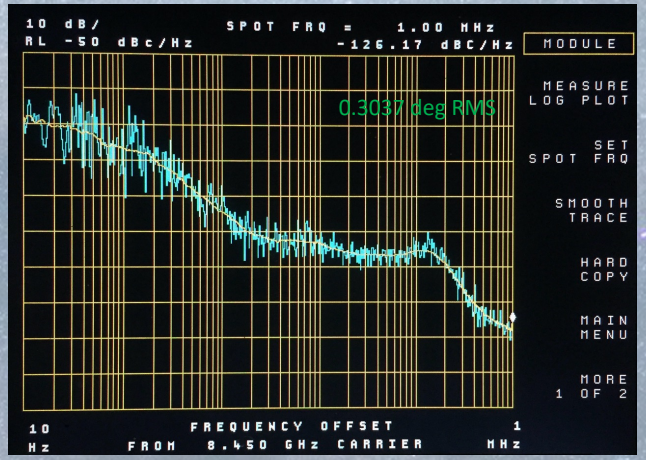
Characterization of Ant-8 MRG-2 & YIG-2 Signals in Cabin (5a)

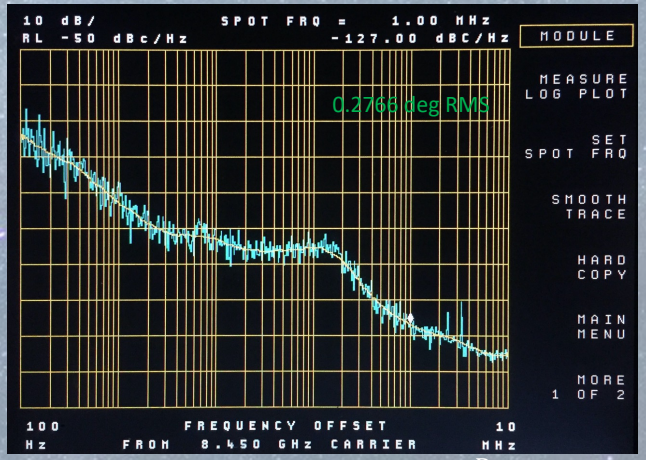




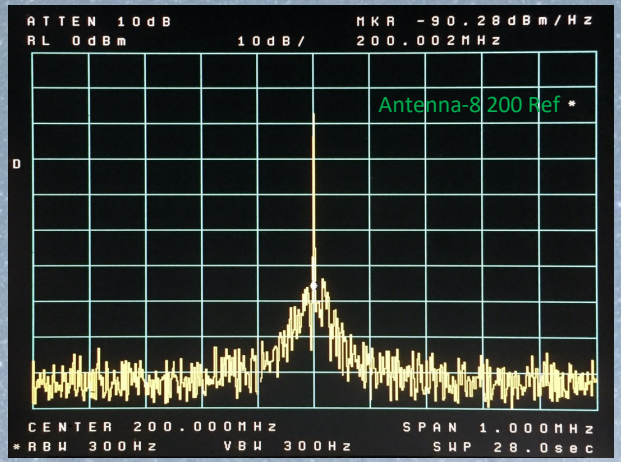


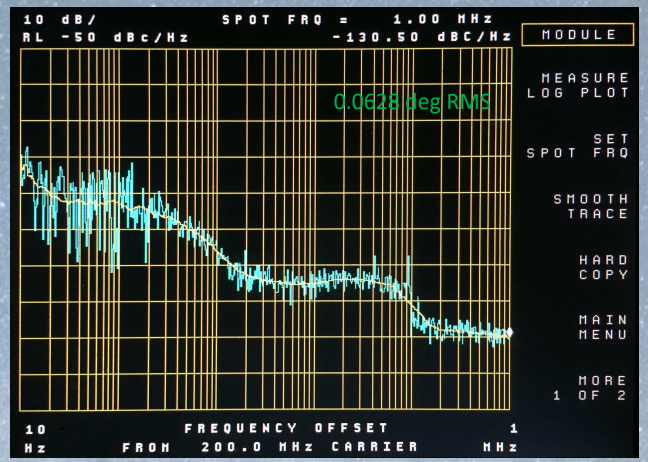


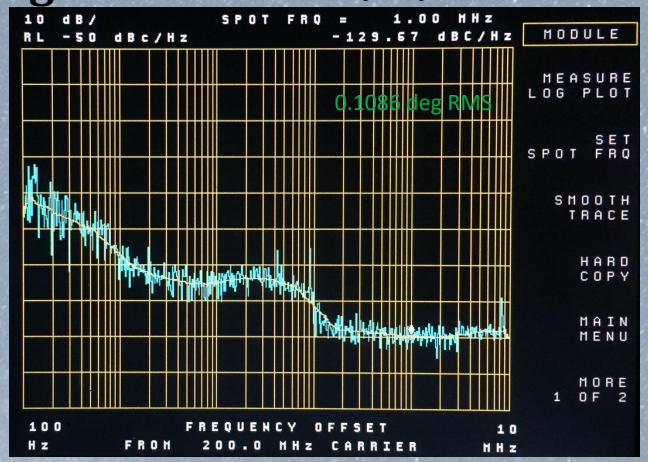


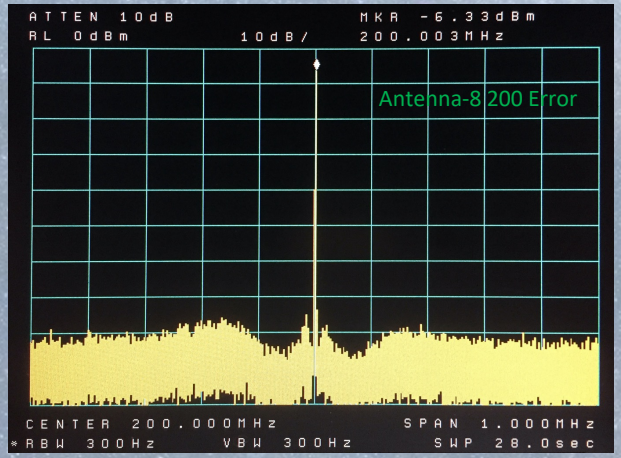


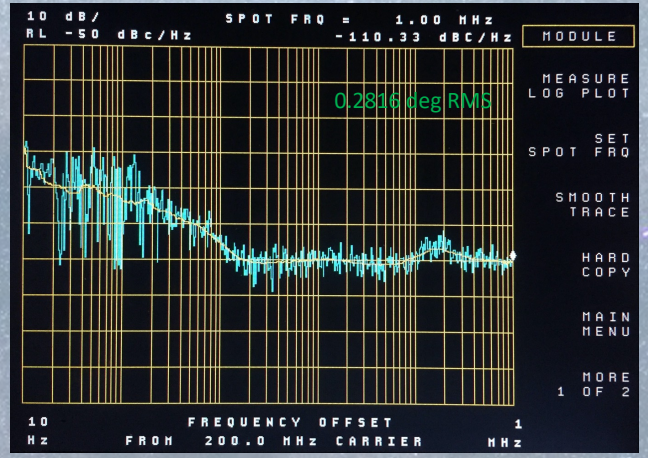
Characterization of Ant-8 200 Ref & 200 Error Signals in Cabin (5a)

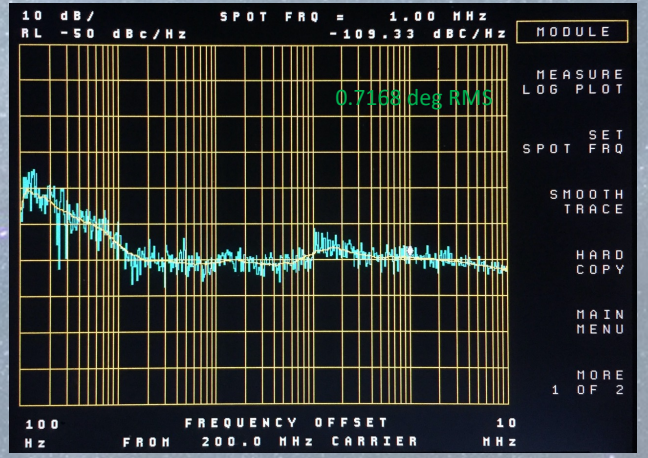




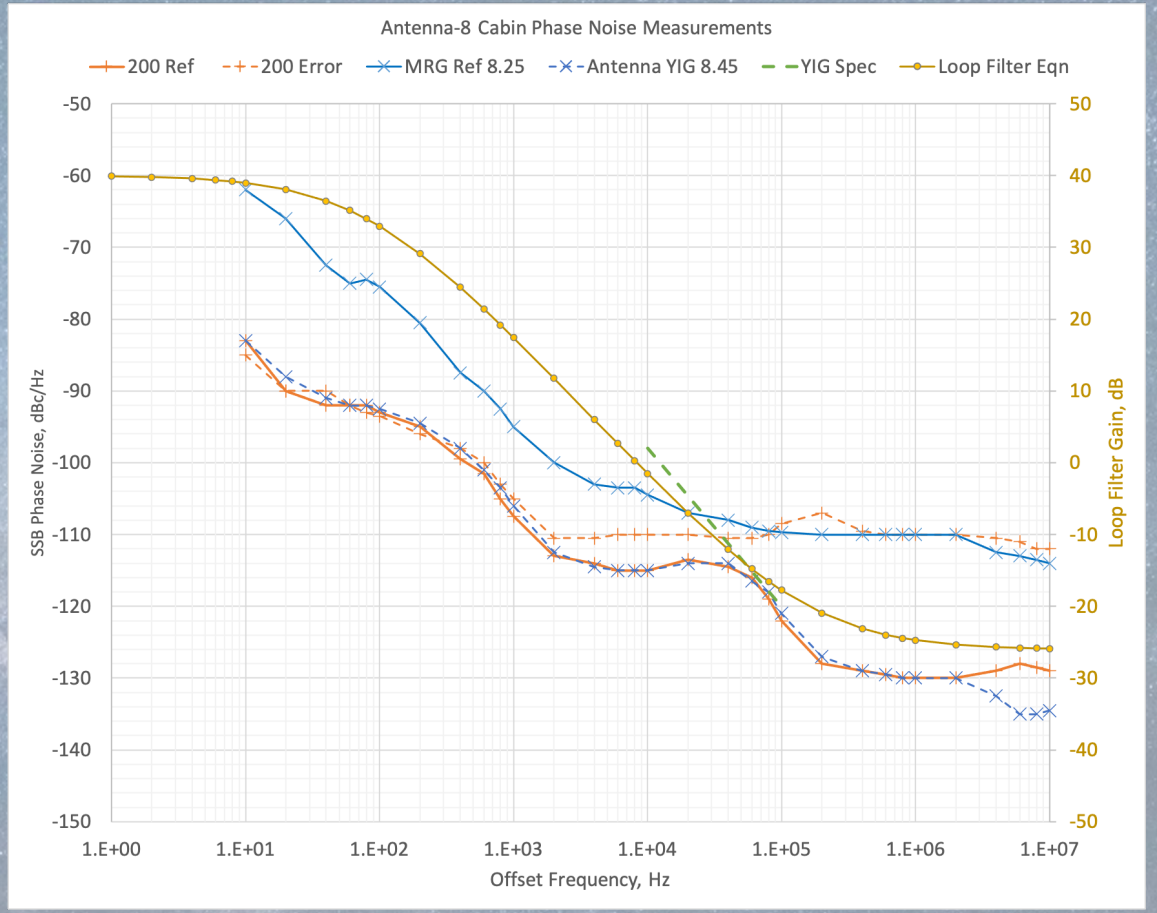






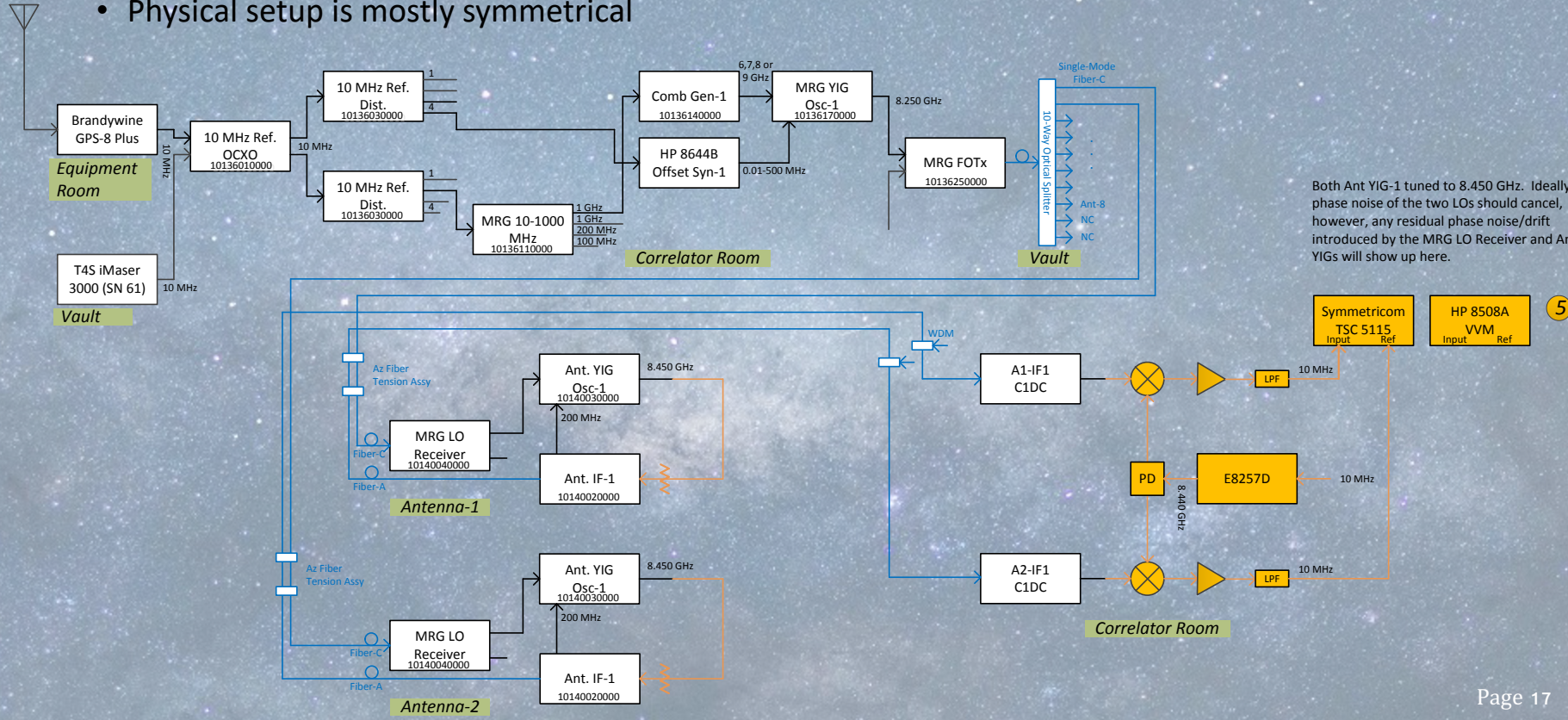


Characterization of Antenna-8 YIG-2 Phase Noise

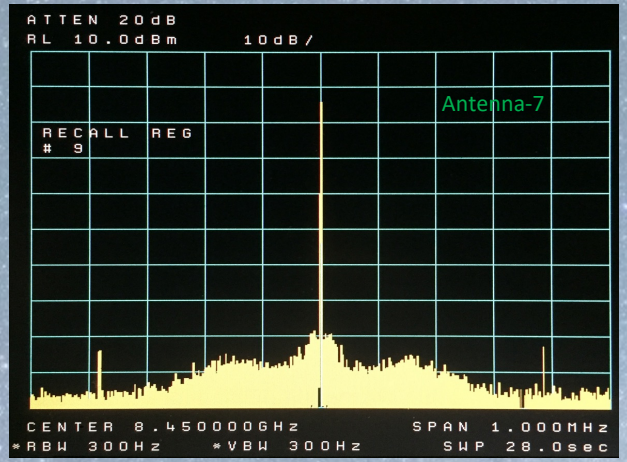


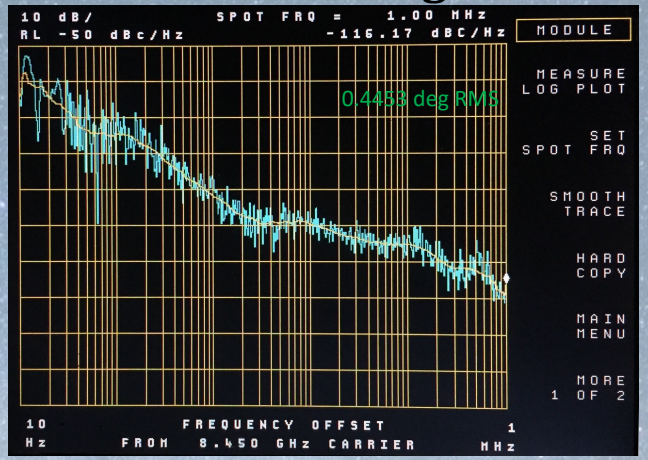
Characterization of Antenna YIG Oscillator Phase Noise & Stability (5)

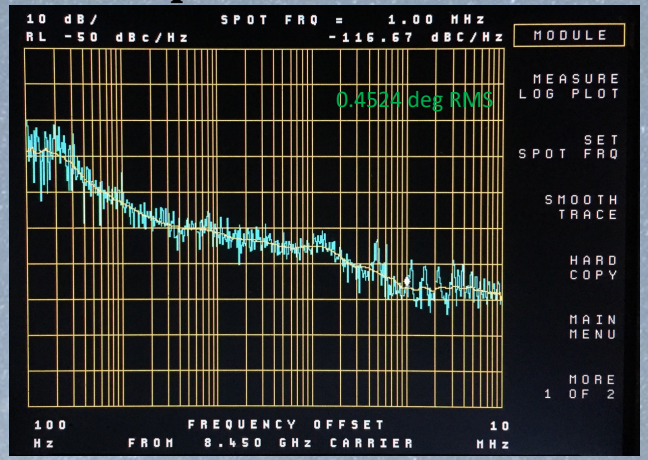
- Paul Y's suggested test setup for characterizing entire MRG LO system
  - Anomalous frequency setup (delta F is normally > 500 MHz)
  - Physical setup is mostly symmetrical

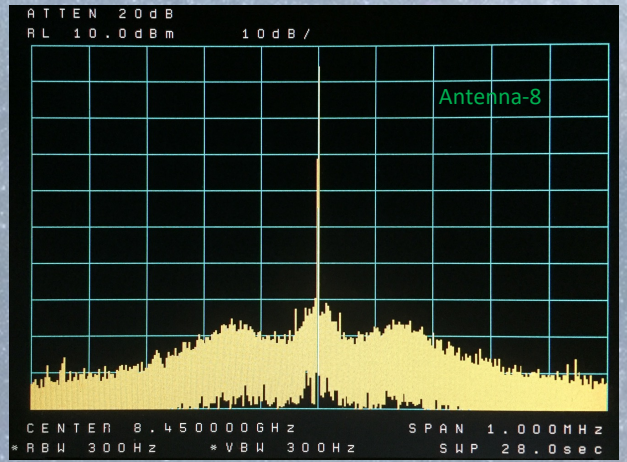


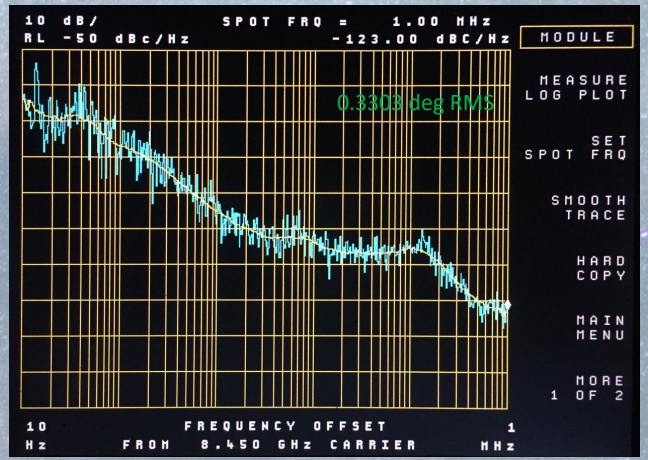
Characterization Ant-7/8 YIG-2 Signals at C1DC Outputs (5b)

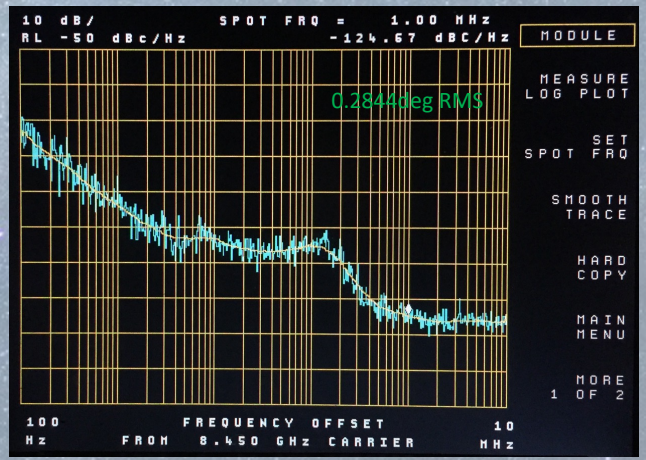




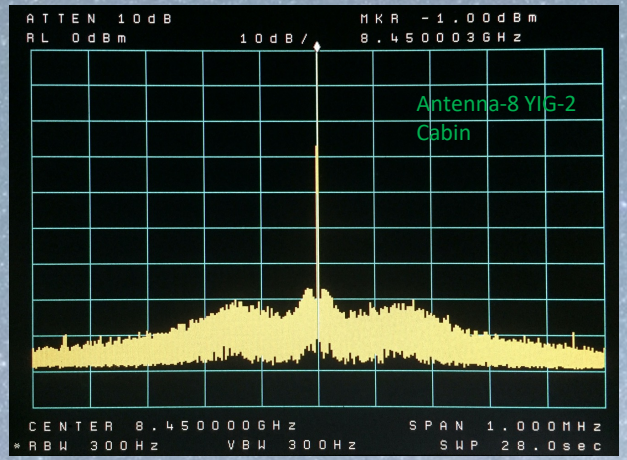


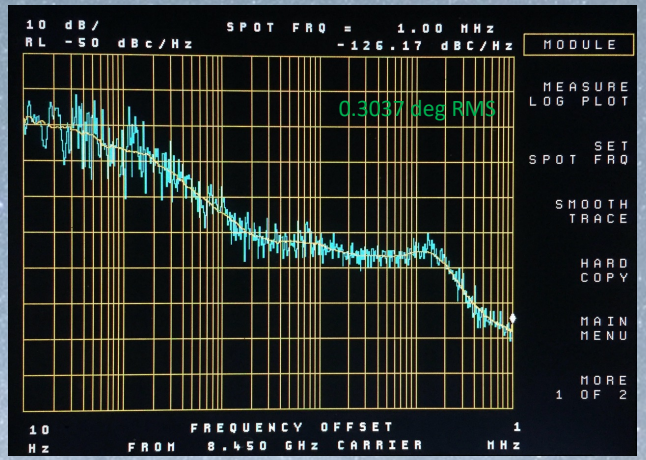


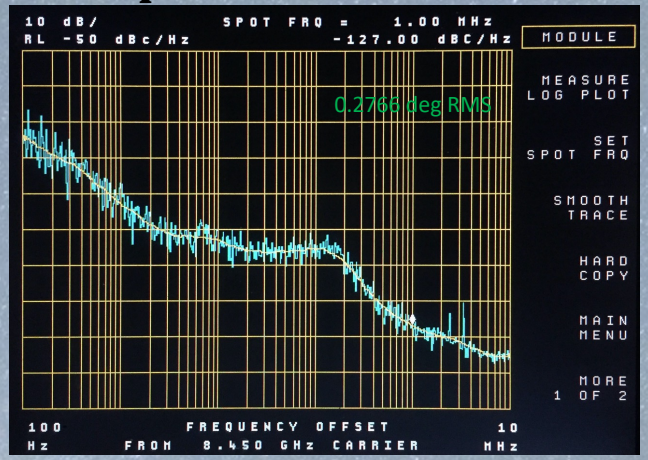


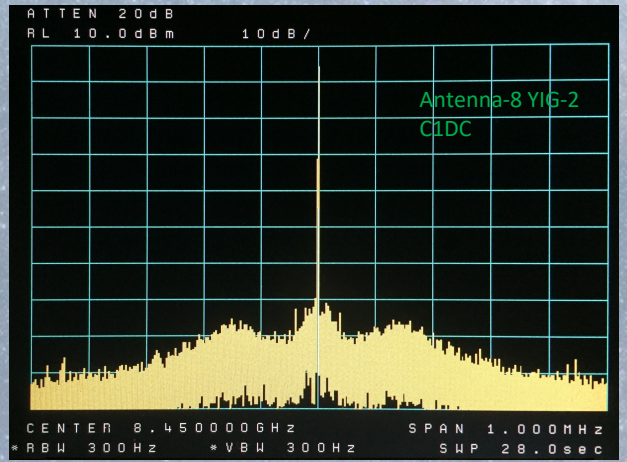


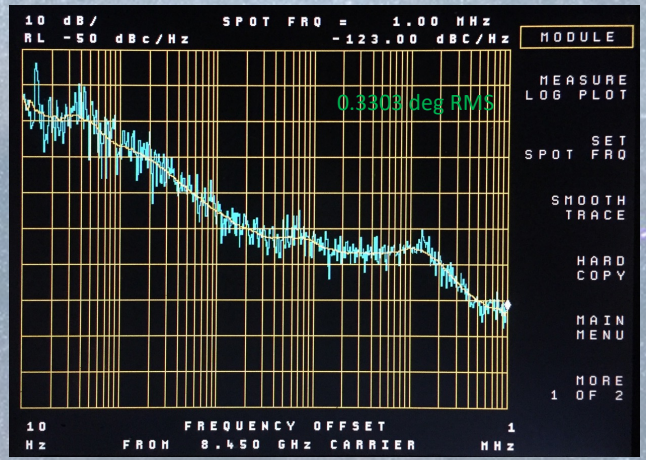
Characterization Ant-8 YIG-2 Cabin vs C1DC Outputs (5b)

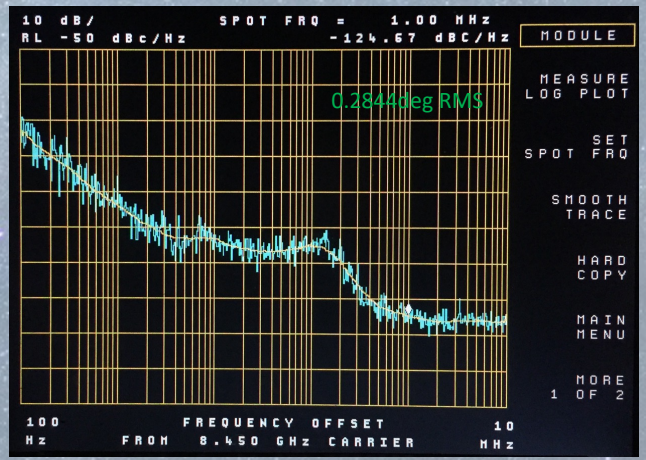






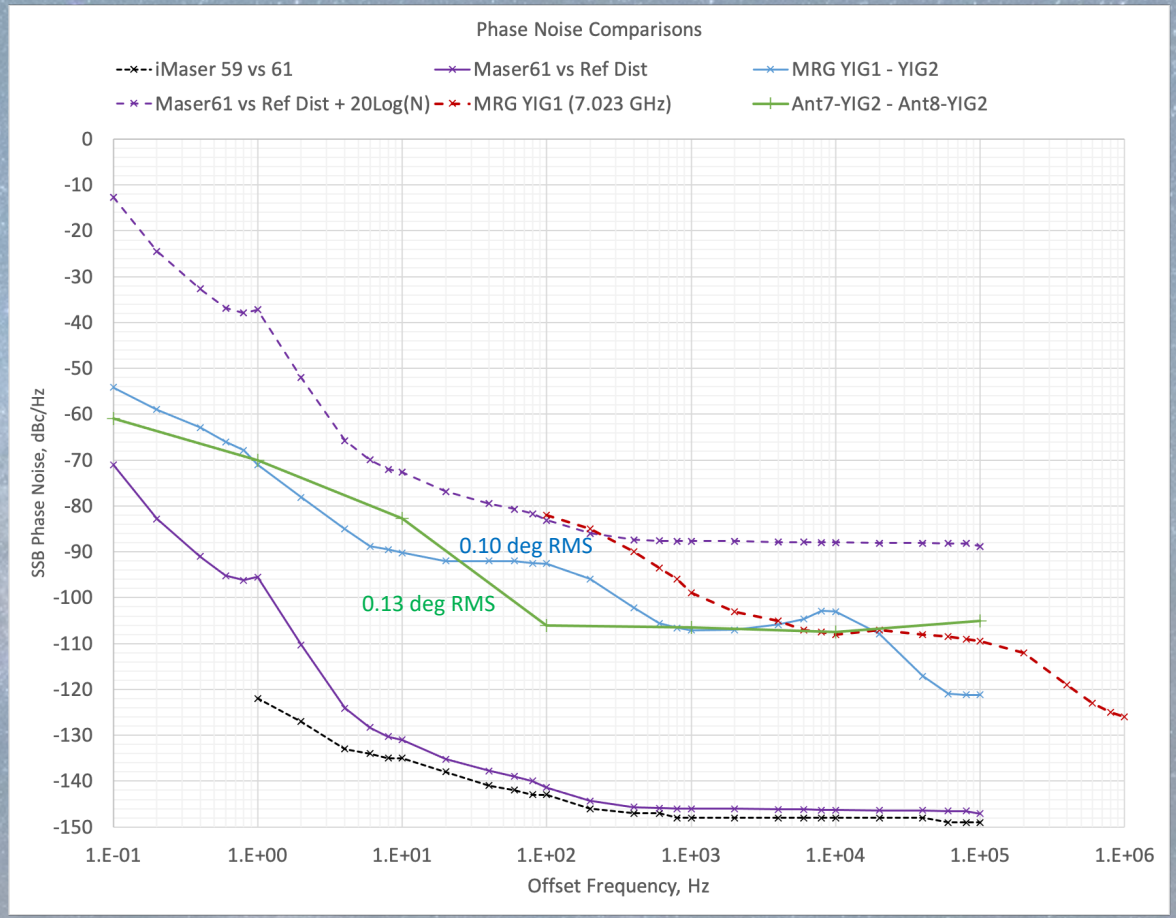






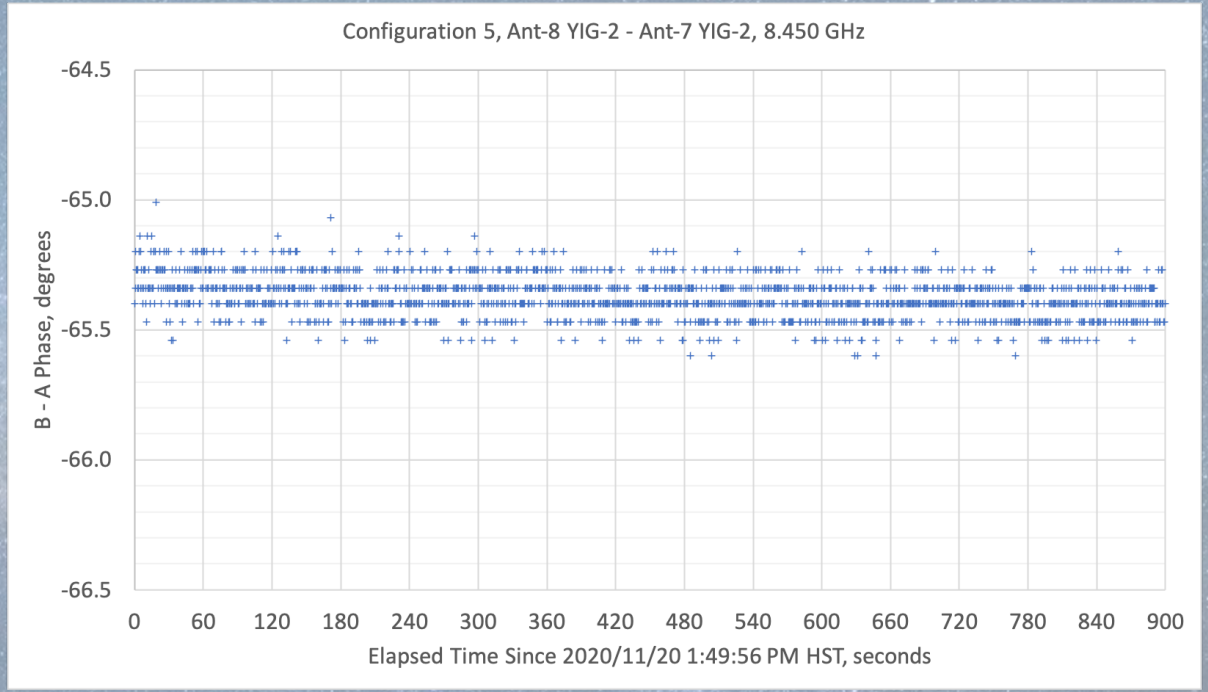
Characterization of Antenna YIG Oscillator Phase Noise & Stability (5b)

- Phase noise of Ant8-YIG2 – Ant7-YIG2 (F_{antyig} = 8.450 GHz)
  - After transmission to back to correlator room on IF2
  - Represents differential phase noise between Ant8 and 7
- Integrated phase noise <u>0.13 degree RMS</u>, 0.01 – 100,000 Hz
  - 3.64 degree RMS at 236.6 GHz
  - 0.20% loss in sensitivity



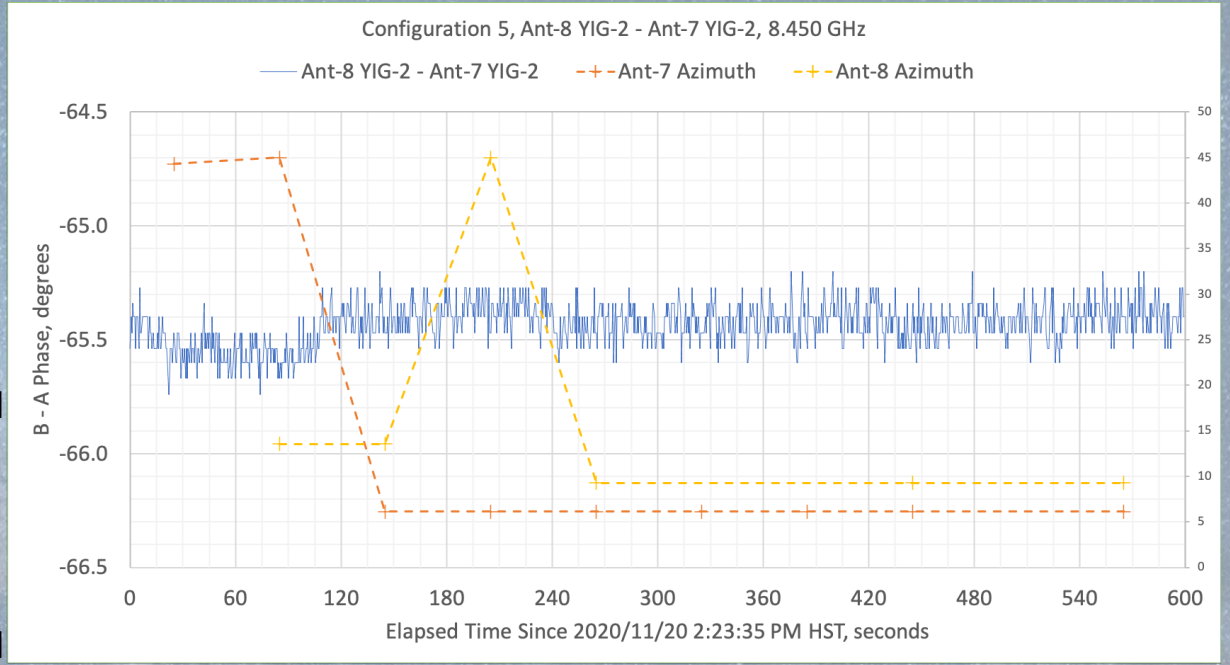
Characterization of Antenna YIG Oscillator Phase Noise & Stability (5b)

- Phase stability of Ant-8 YIG-2 – Ant-7 YIG-2
  - 2 samples per second
  - 15 minutes duration
- Standard deviation from 360– 420 seconds is 0.07 degrees RMS
  - 1.96° RMS @ 236.6 GHz LO
  - 0.06% sensitivity loss
- Small falling drift of ~0.05 degrees over 15 minutes
  - 0.05 x 14 x 2 = 1.4 degrees @ 236.6 GHz LO



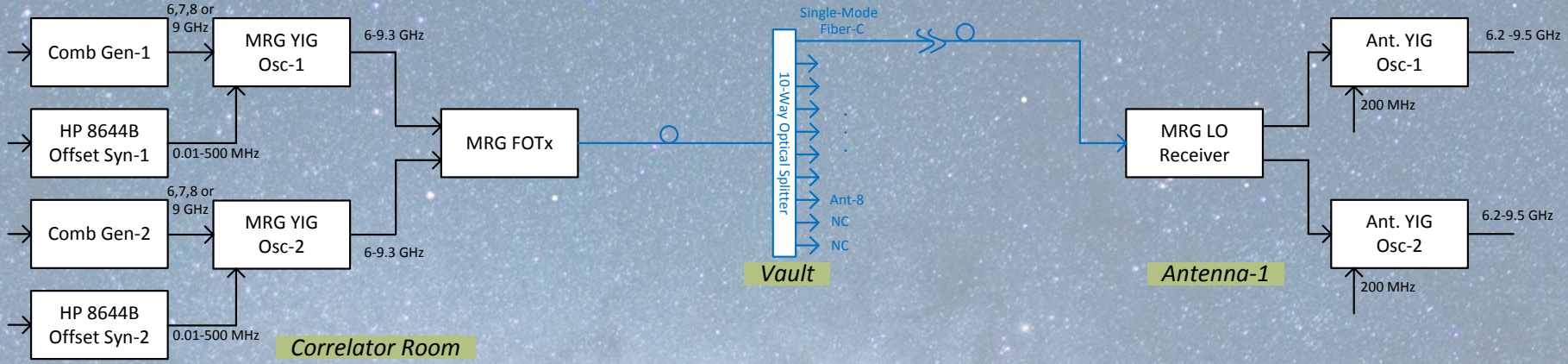
Characterization of Antenna YIG Oscillator Phase Noise & Stability (5b)

- Phase stability of Ant-8 YIG-2 – Ant-7 YIG-2
  - 2 samples per second
  - 15 minutes duration
- Standard deviation from 360 – 420 seconds is <u>0.08 degrees RMS</u>
- Moved both antennas in azimuth
  - Ant-7 39° Az movement caused ~0.15 degree phase shift
    - 3.8 m-deg/deg Az
    - 106 m-deg/deg Az @ 236.6 GHz LO
  - Ant-8 32° Az movement caused ~0.10 degree phase shift
    - 3.1 m-deg/deg Az
    - 86.8 m-deg/deg Az @ 236.6 GHz LO

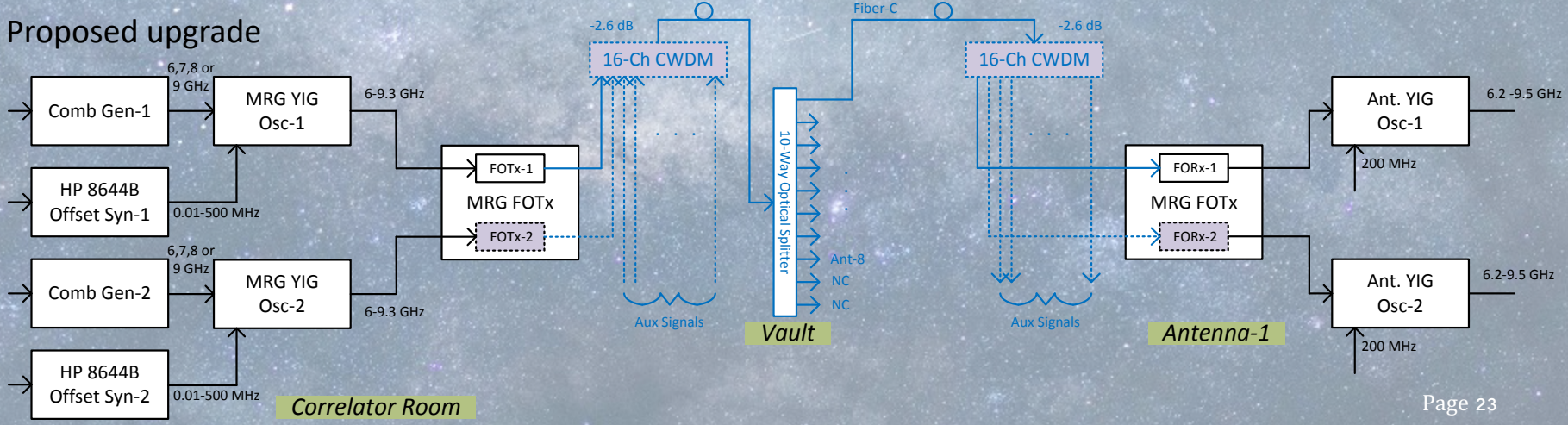


CWDM Expansion for Future Upgrades

- Current configuration

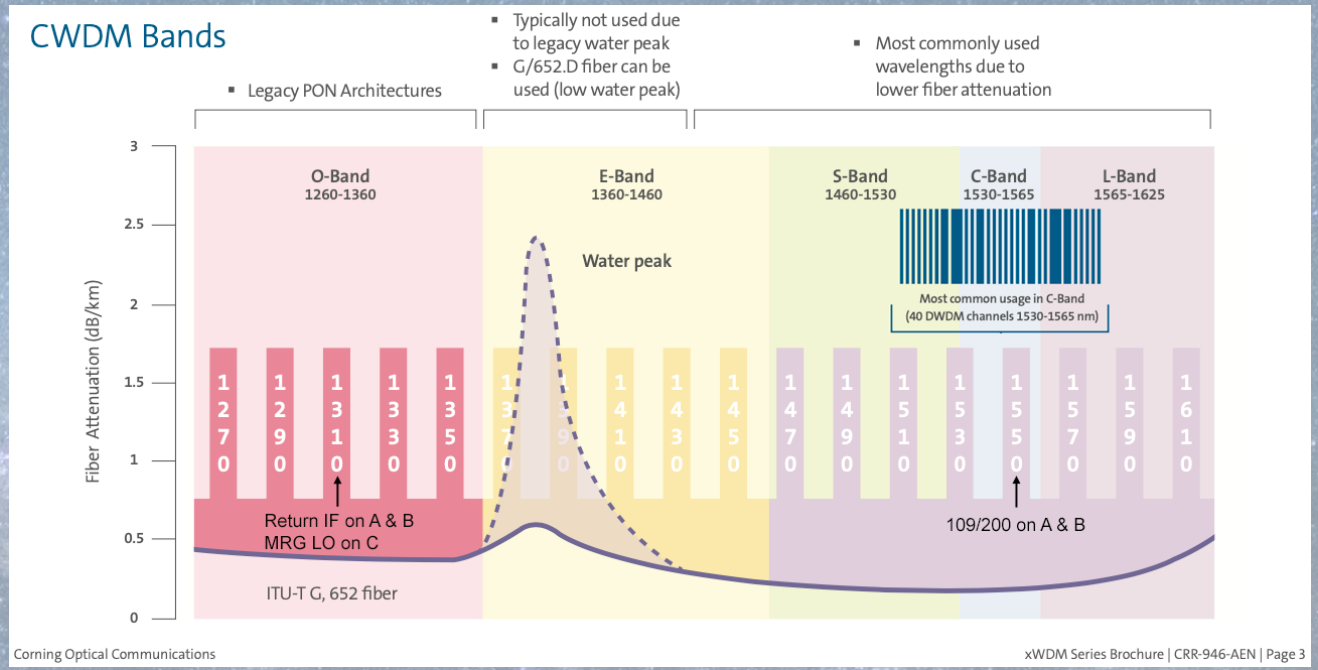


- Proposed upgrade



CWDM Expansion for Future Upgrades

- Prelim Ch assignments
  - 1270 – 100 Hz HB
  - 1290 –
  - **1310 – MRG LO-1**
  - 1350 –
  - 1370 – ADC Clock
  - 1390 – Skip
  - 1410 – Skip
  - 1430 – 10 MHz
  - 1450 – D/C LO-1
  - 1470 – D/C LO-2
  - 1490 – Round-Trip LO
  - 1510 -
  - **1550 – MRG LO-2**
  - 1570 -
  - 1590 – 1-PPS
  - 1610 – Start of Walsh



CWDM Expansion for Future Upgrades

Click to open expanded view



Customized Compact CWDM Mux Demux, 2.6dB Max IL, Dual Fiber #73959

★★★★★ 354 Reviews | 6 Questions | Share

US$ 681.00

Import Fees included

FS P/N: CCWDM-DF

Choose Specifications:	○ Default ◉ Customize
Channels:	16CH
Wavelength:	1270-1610nm (Skip 1390, 1410nm)
Connector:	FC/APC
Housing:	ABS Pigtailed Module
Cable Diameter:	0.9mm
Fiber Length:	1m (Default)

Installation: FMU Plug-in Module fits inFMU-1UFMX-N chassis.

Customized, **Asia Warehouse**

Deliver to New York, 10010

Free Shipping via FedEx IP, get it by Mon. Nov. 30

Round-Trip LO Phase Monitor

- Limited tests conducted in the past have shown evidence of LO phase dependency on azimuth position for some antennas