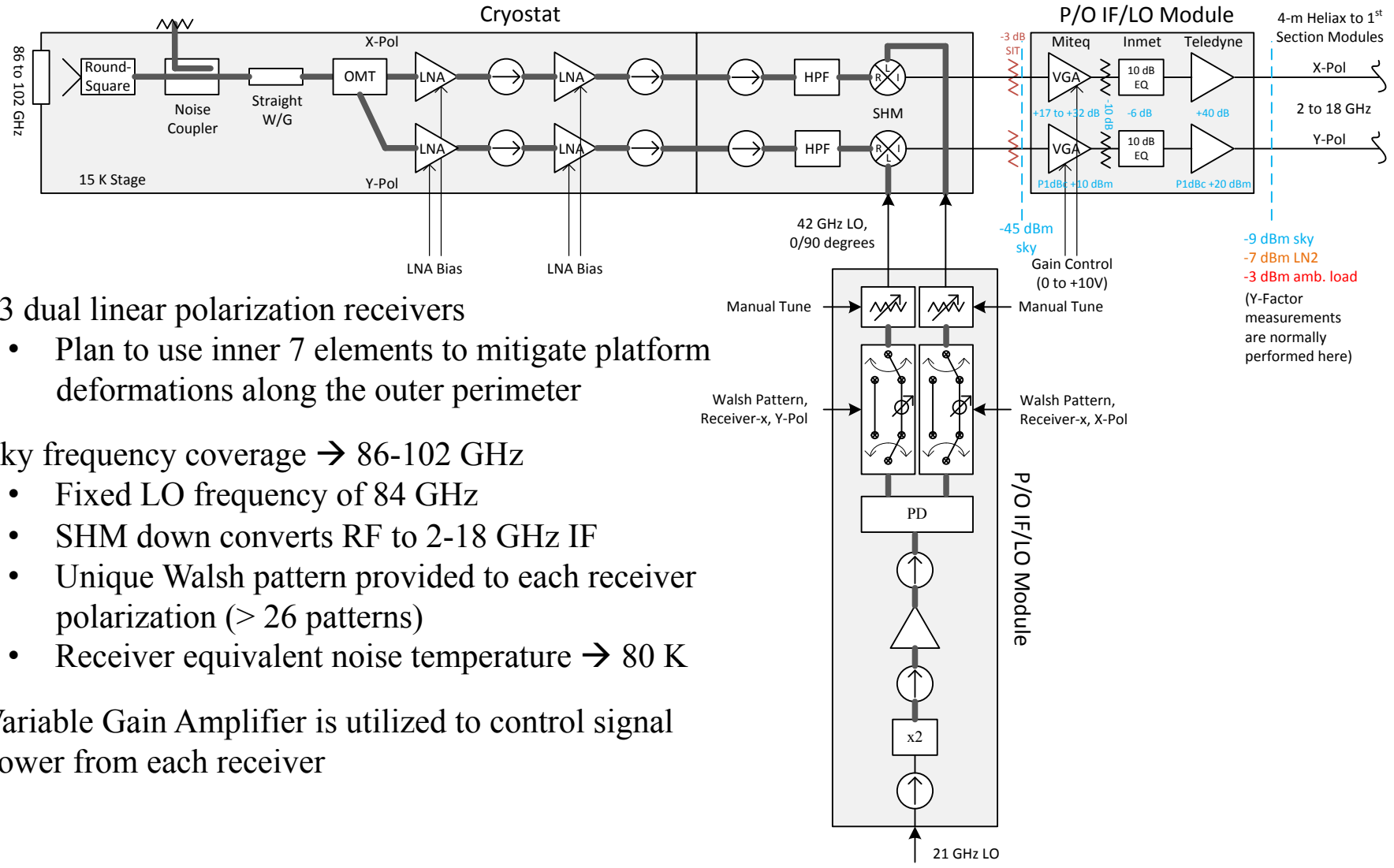
Technical Status, Upgrades & Modifications

Derek Kubo
Chief Engineer
dkubo@asiaa.sinica.edu.tw

Contents

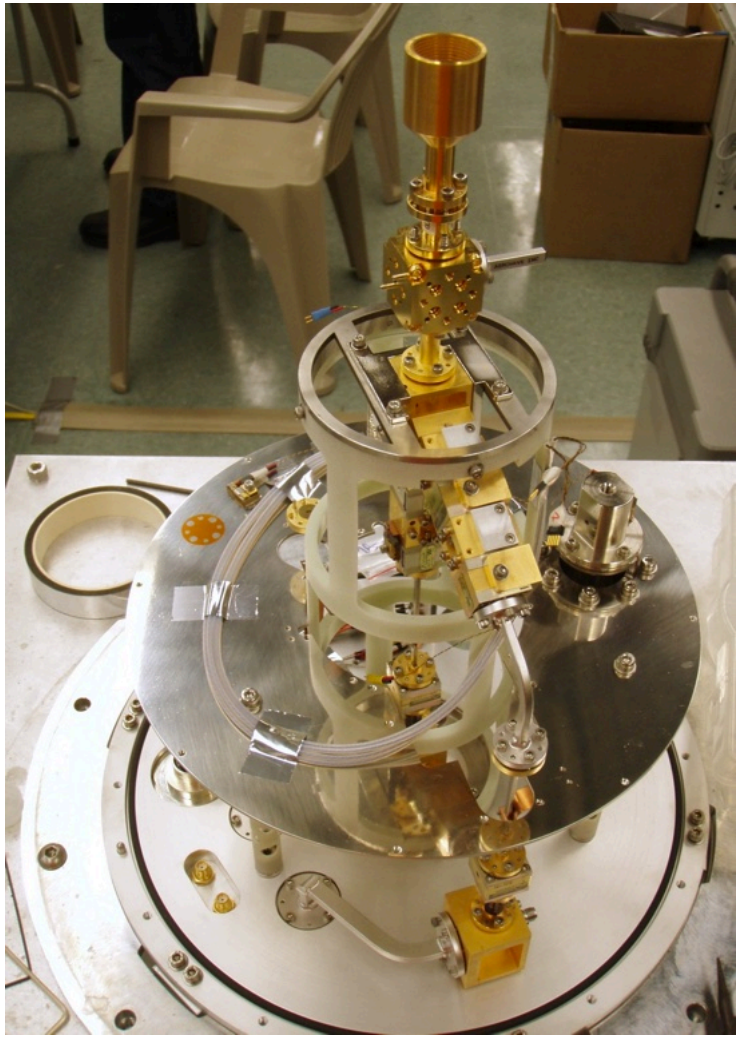
- Existing Hardware
- Modifications for 4-Element Single Polarization Prototype
- Plans for 7-Element Dual Polarization System

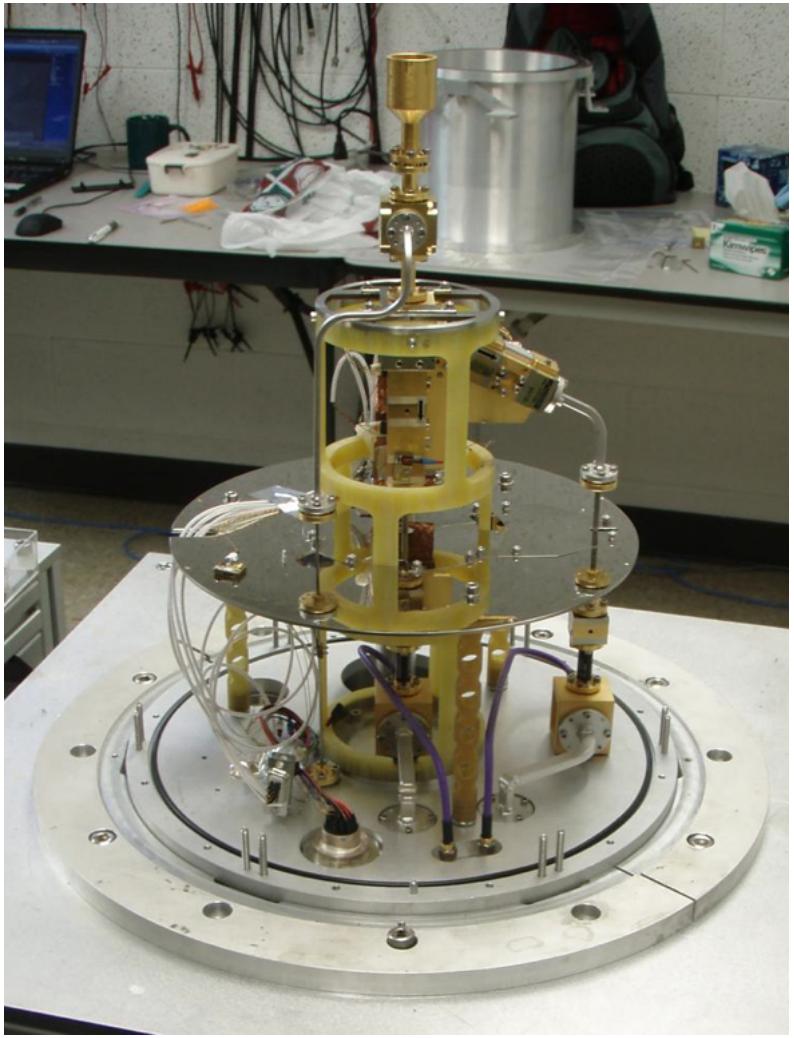
Receiver and IF/LO Description (preexisting hardware)



- 13 dual linear polarization receivers
  - Plan to use inner 7 elements to mitigate platform deformations along the outer perimeter
- Sky frequency coverage → 86-102 GHz
  - Fixed LO frequency of 84 GHz
  - SHM down converts RF to 2-18 GHz IF
  - Unique Walsh pattern provided to each receiver polarization (> 26 patterns)
  - Receiver equivalent noise temperature → 80 K
- Variable Gain Amplifier is utilized to control signal power from each receiver

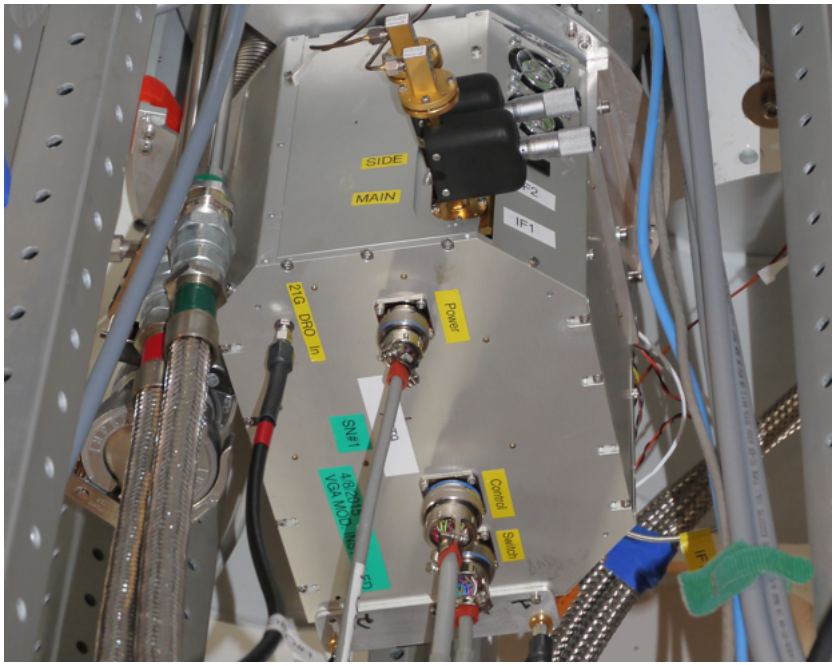
Receiver Photos (preexisting hardware)





Phase Switcher (preexisting hardware)

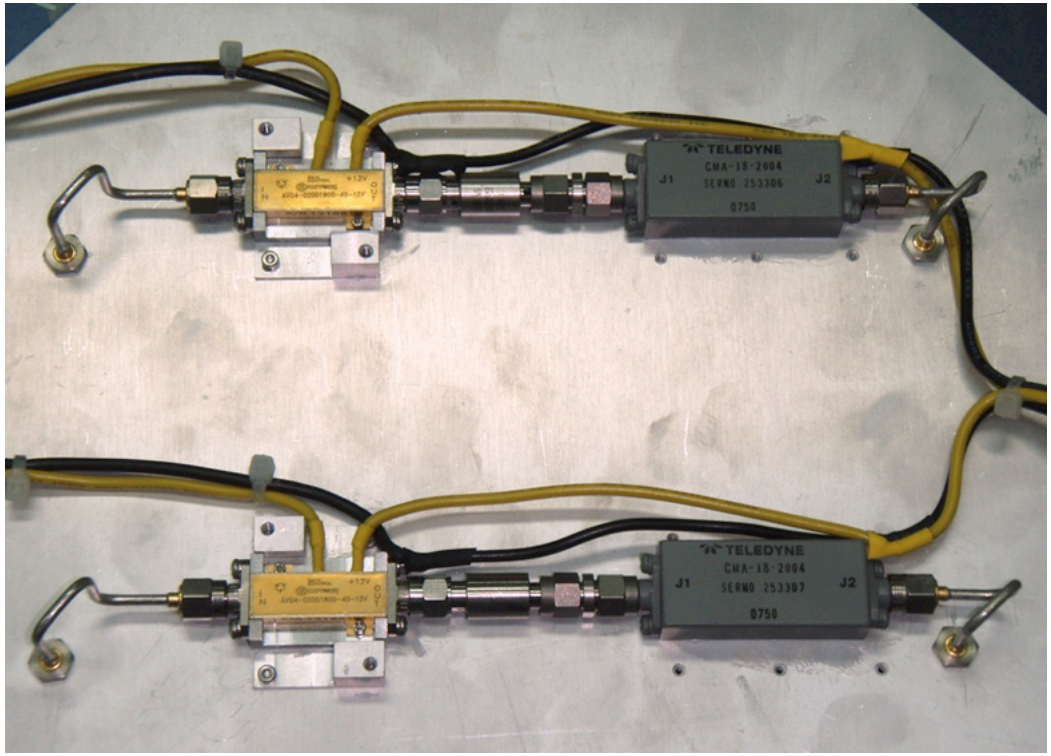
- Existing phase shifter design produces undesirable AM-ing of LO signal to SHM
  - LO AM-ing ranges from approximately 0 dB to 2 dB depending on receiver
  - Causes AM-ing of IF and Baseband signal
- Currently mitigating AM-ing by fine tuning the LO drive into the SHM
  - Driving SHM into saturation minimizes AM-ing at IF
  - Optimum drive, however, depends on temperature
  - We may attempt to servo the LO drive to minimize AM-ing
- AM-ing of Baseband signal affects Analog Correlator DC offset systematics
  - How does AM-ing of the Baseband signal affect Digital Correlator?



IF Portion (preexisting hardware)

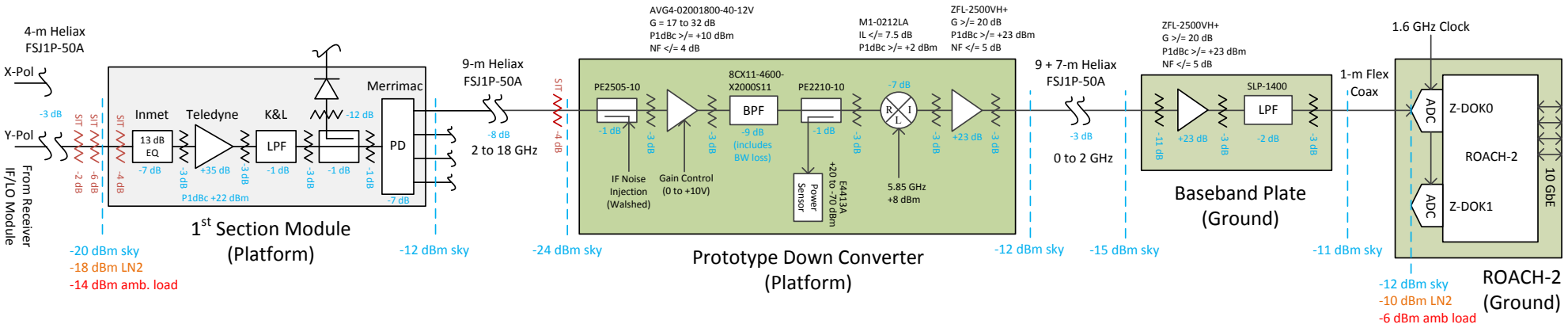
- 2-18 GHz IF signal
  - VGA controlled by ADAM-5000/ TCP controller

  - Slope equalizer provides 10 dB of pre-emphasis to compensate for cable and component losses with respect to frequency



In VGA Slope EQ Fixed Gain Amp Out

1st Section (preexisting), Prototype Down Converter and ROACH-2 Hardware (new)

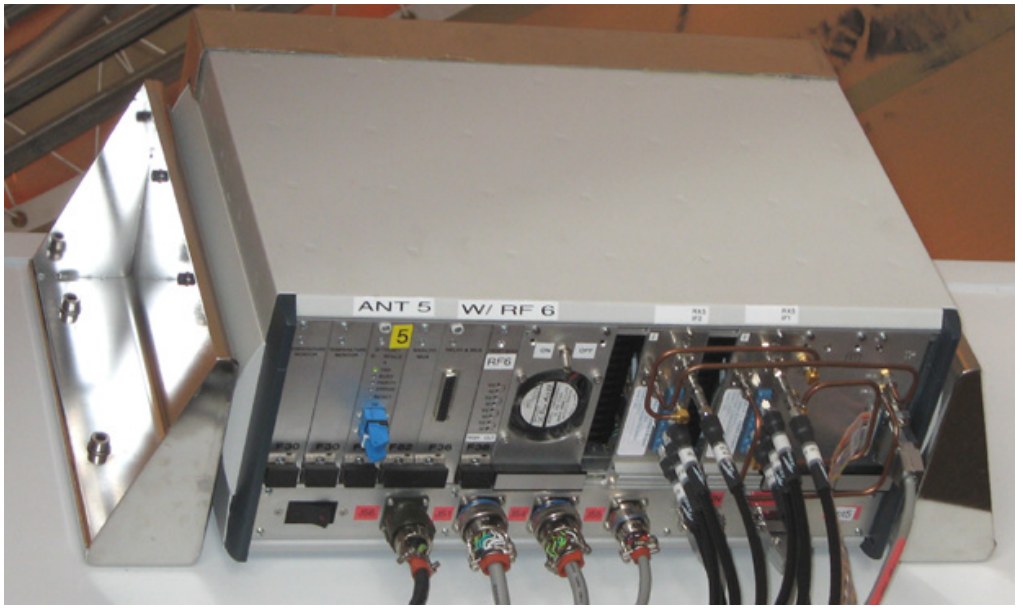


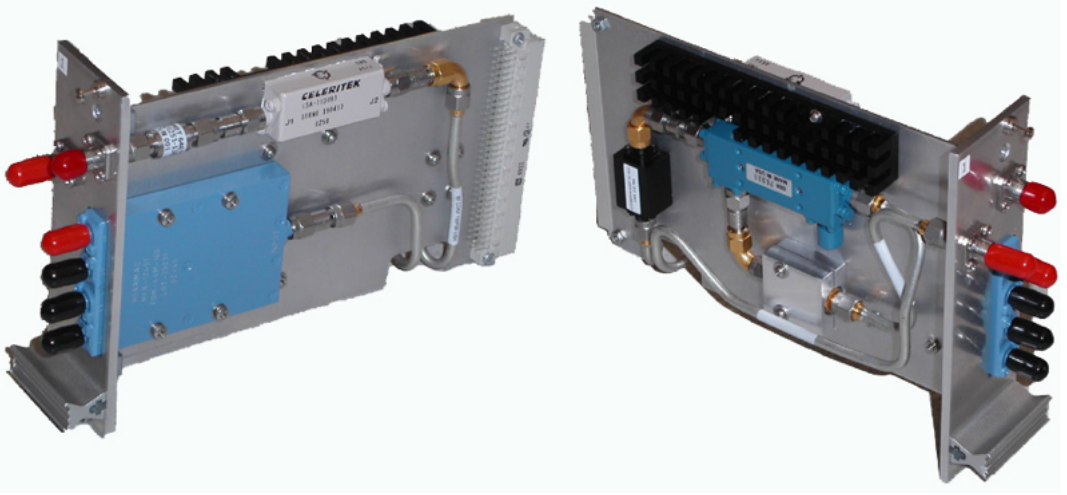
- A 4-channel prototype down converter was deployed in 2014
  - Fixed frequency, 3.6 to 5.6 GHz IF is mixed with 5.85 GHz LO to produce 0.25 to 2.25 GHz baseband (spectrally inverted)
  - Represents 87.6 to 89.6 GHz portion of sky

- 8-bit ADCs are currently clocked at 1.6 GHz with an effective sample rate of 3.2 GSps
  - Final goal after optimization of bit code is 2.24 GHz clock, 4.48 GSps
  - Present Nyquist bandwidth into ADC is restricted to 1.6 GHz
  - Present sky coverage is 88.25 to 89.6 GHz (0.25 to 1.6 GHz baseband)

1st Section Module (preexisting)

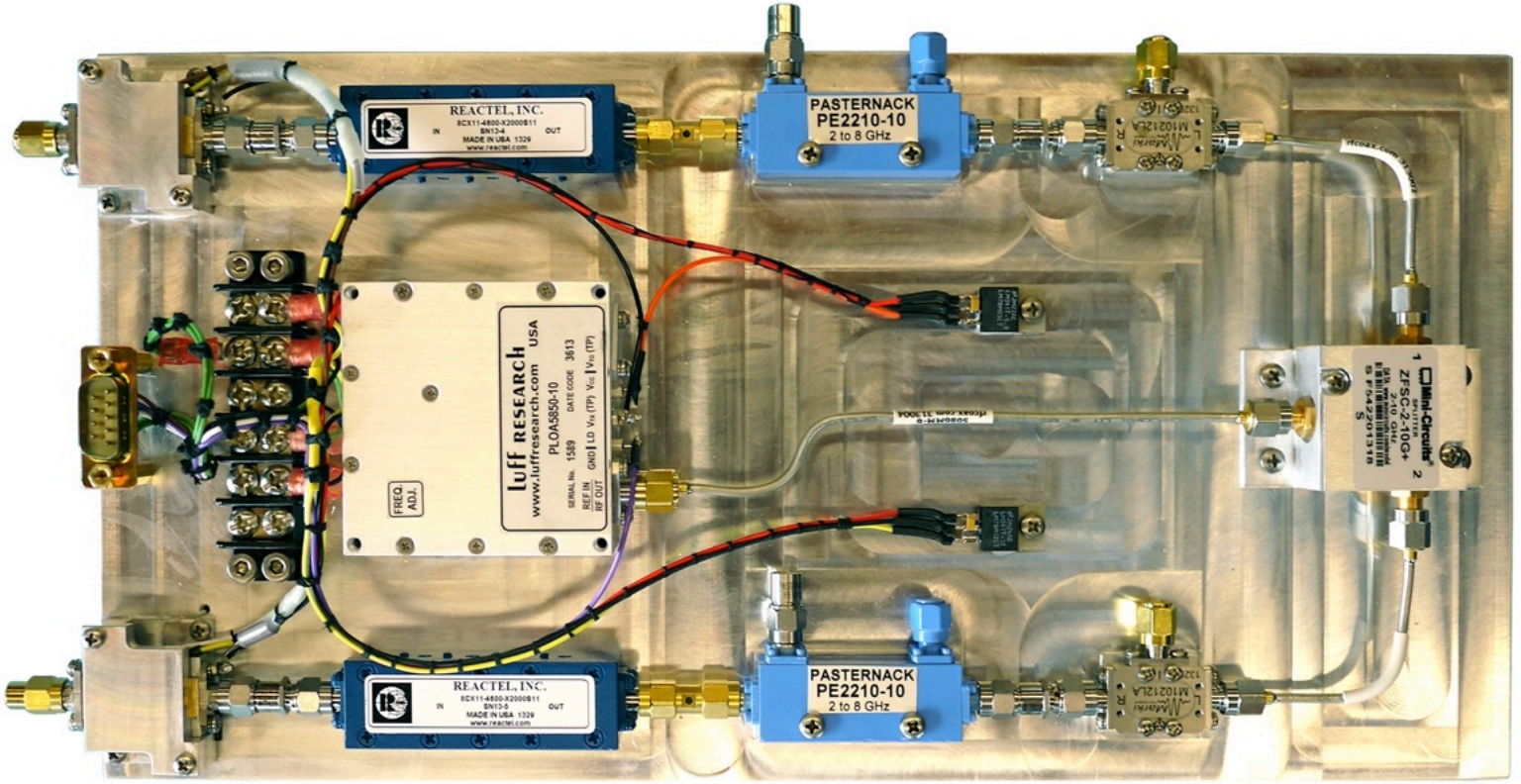
- One Electronic Box per Receiver (13 total), located along perimeter of platform
  - Temperature monitor module (x2)
  - Communication (x1)
  - LNA bias (x2)
  - 1st Section module (x2)
  - X-Y module (x1)
  - Total power detector module (x1)
- 1st Section Module
  - Plan to remove 13-dB Inmet slope equalizer





Down Converter Plate (new for 4-element prototype)

- Dual channel Down Converter plate
  - Two plates are currently installed on the platform
  - Fixed frequency filters (3.6-5.6 GHz) and LO (5.85 GHz)
  - Baseband amplifiers not shown



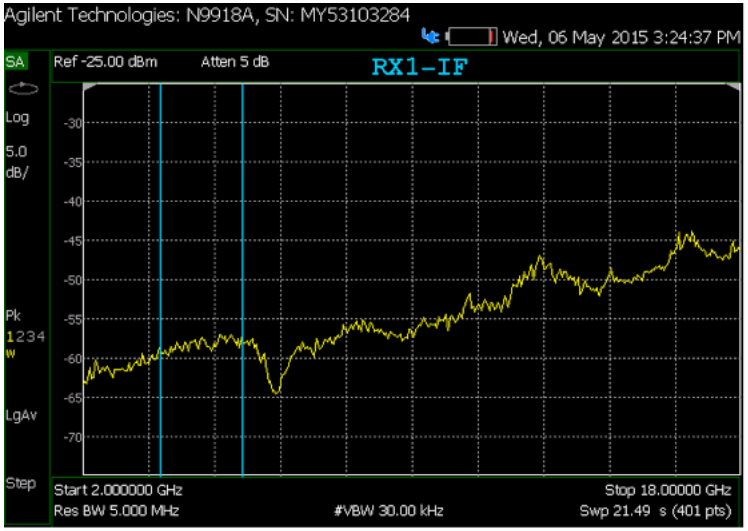
YUAN-TSEH LEE ARRAY TELESCOPE

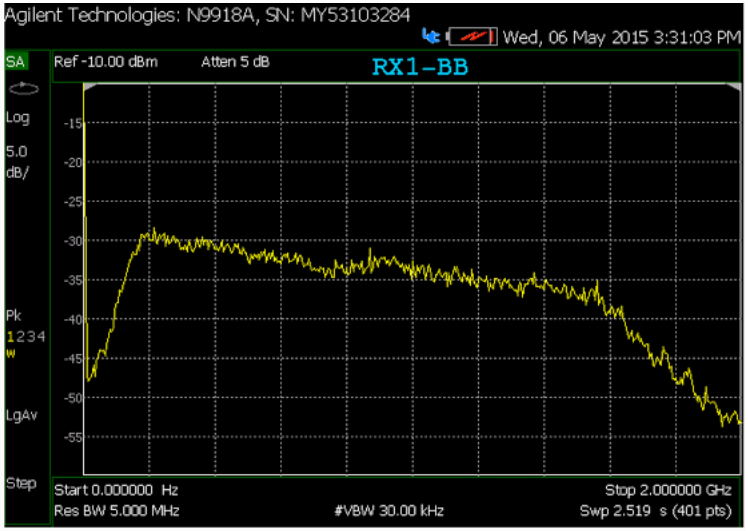
1st Section input (2-18 GHz) | ROACH-2 input (0-2 GHz)

Rx1 Spectra

-Left plot 2-18 GHz
-Blue portion
3.85-5.85 GHz

-Right plot 0-2 GHz
-Input SNR = 21 dB
@ -12 dBm

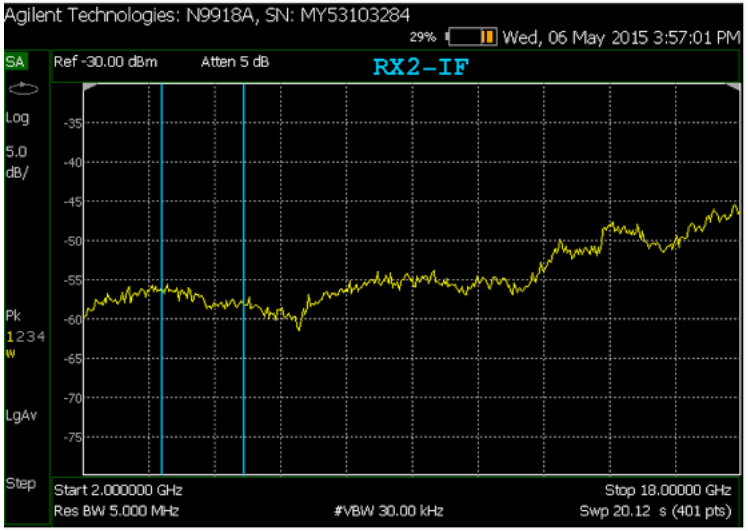


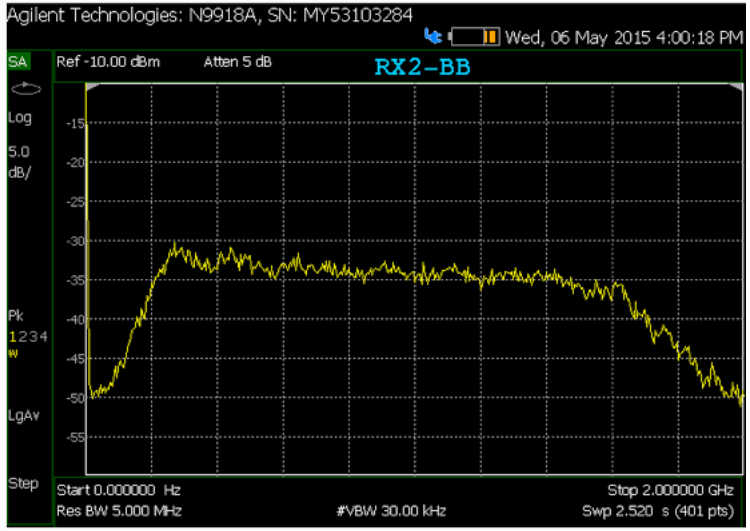


Rx2 Spectra

-Left plot 2-18 GHz
-Blue portion
3.85-5.85 GHz

-Right plot 0-2 GHz
-Input SNR = 23 dB
@ -12 dBm





YUAN-TSEH LEE ARRAY TELESCOPE

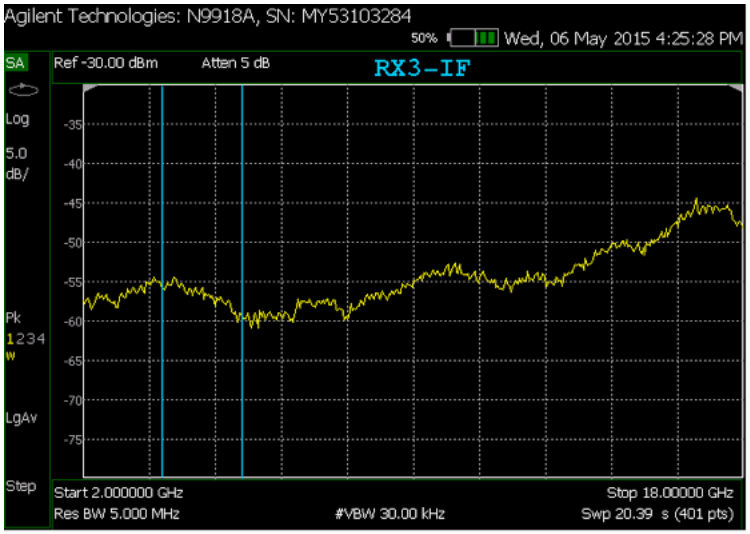
1st Section input

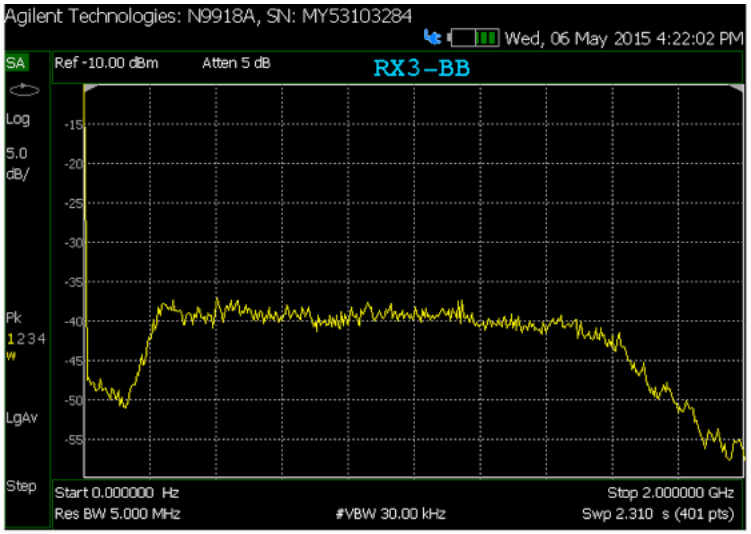
ROACH-2 input

Rx3 Spectra

-Left plot 2-18 GHz
-Blue portion
3.85-5.85 GHz

-Right plot 0-2 GHz
-Input SNR = 31 dB
@ -12 dBm

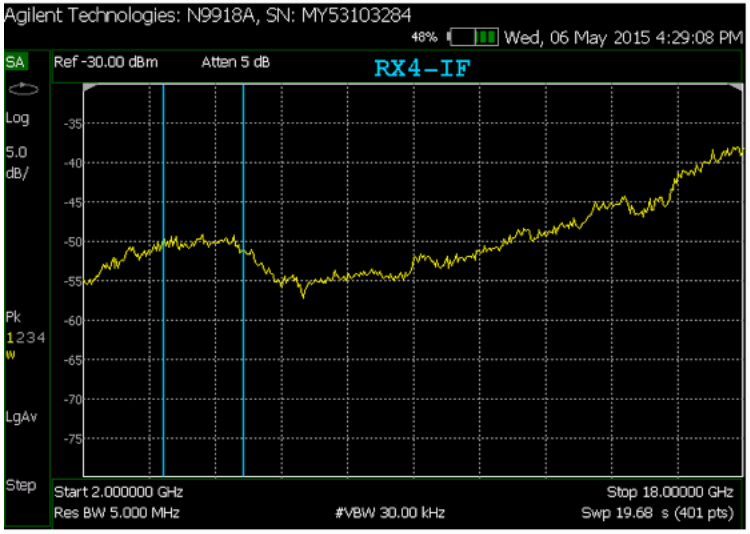


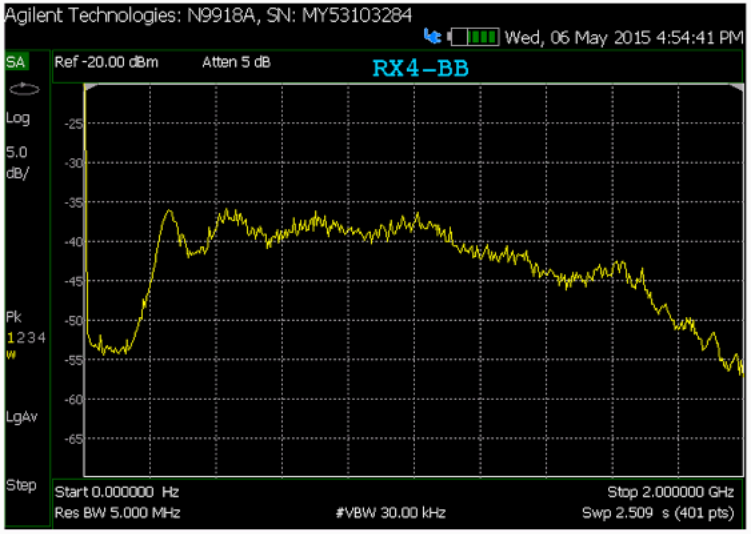


Rx4 Spectra

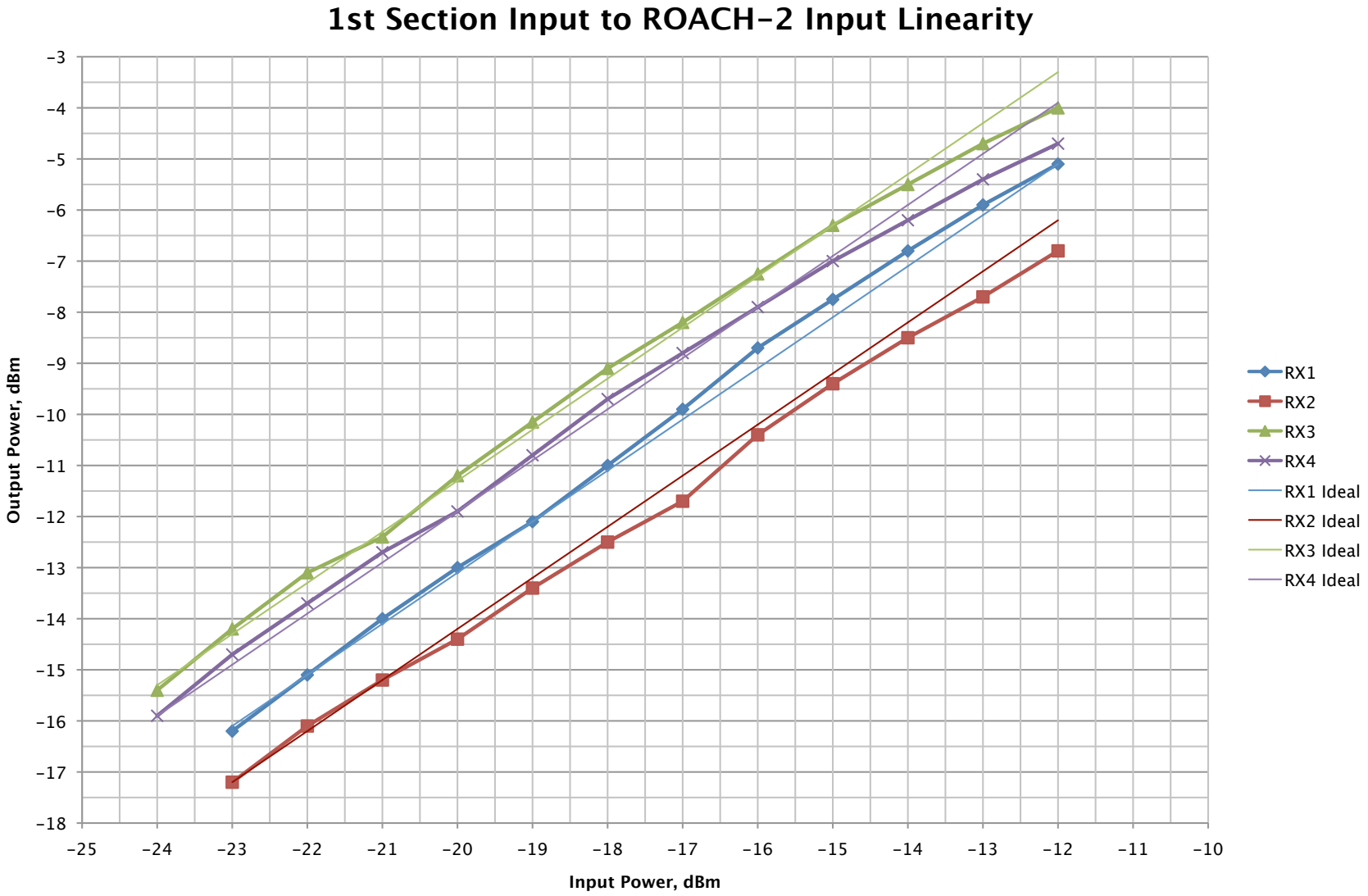
-Left plot 2-18 GHz
-Blue portion
3.85-5.85 GHz

-Right plot 0-2 GHz
-Input SNR = 25 dB
@ -12 dBm

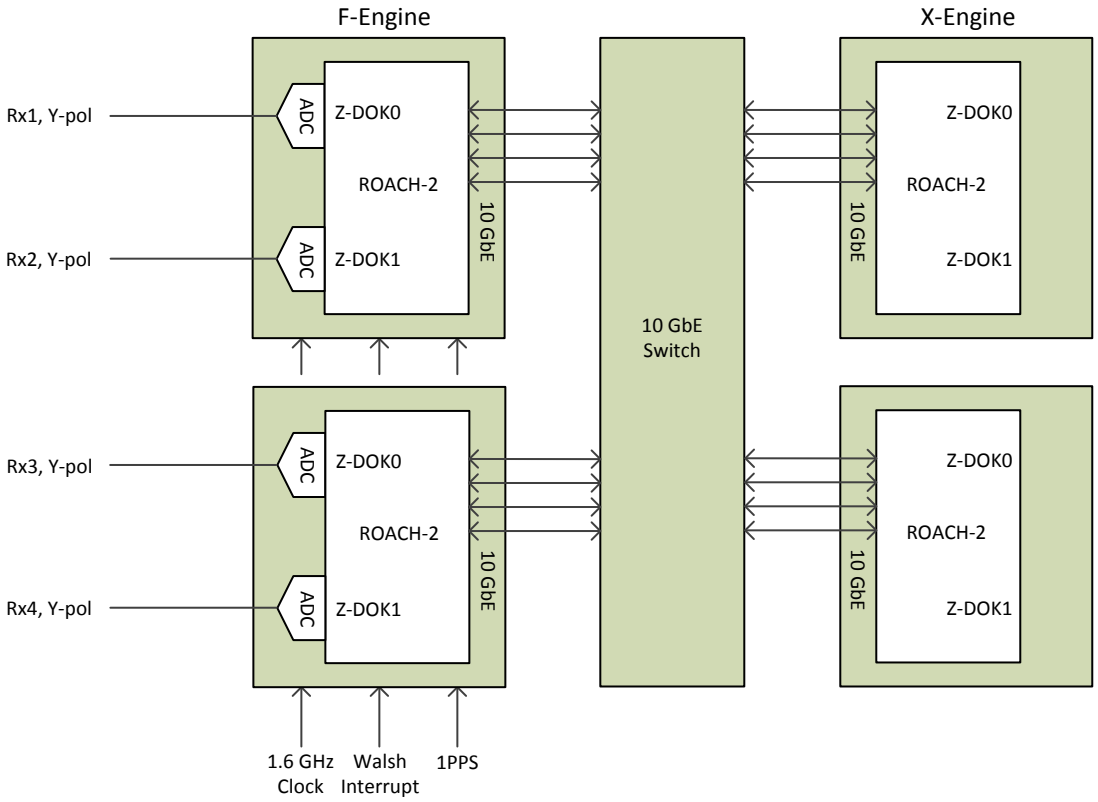


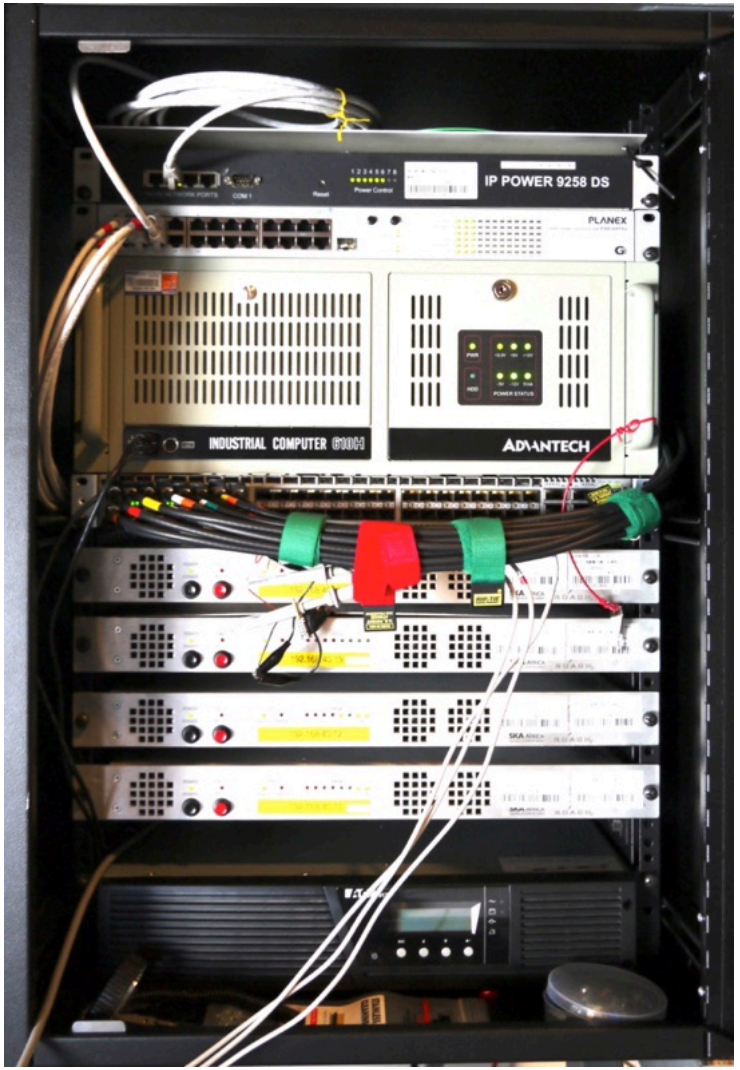


Power Linearity from 1st Section Input to ROACH-2 Input



ROACH-2 (new for 4-element prototype)





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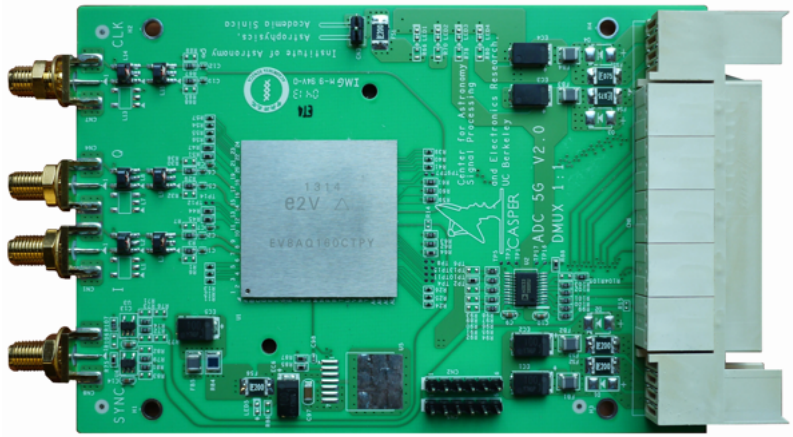
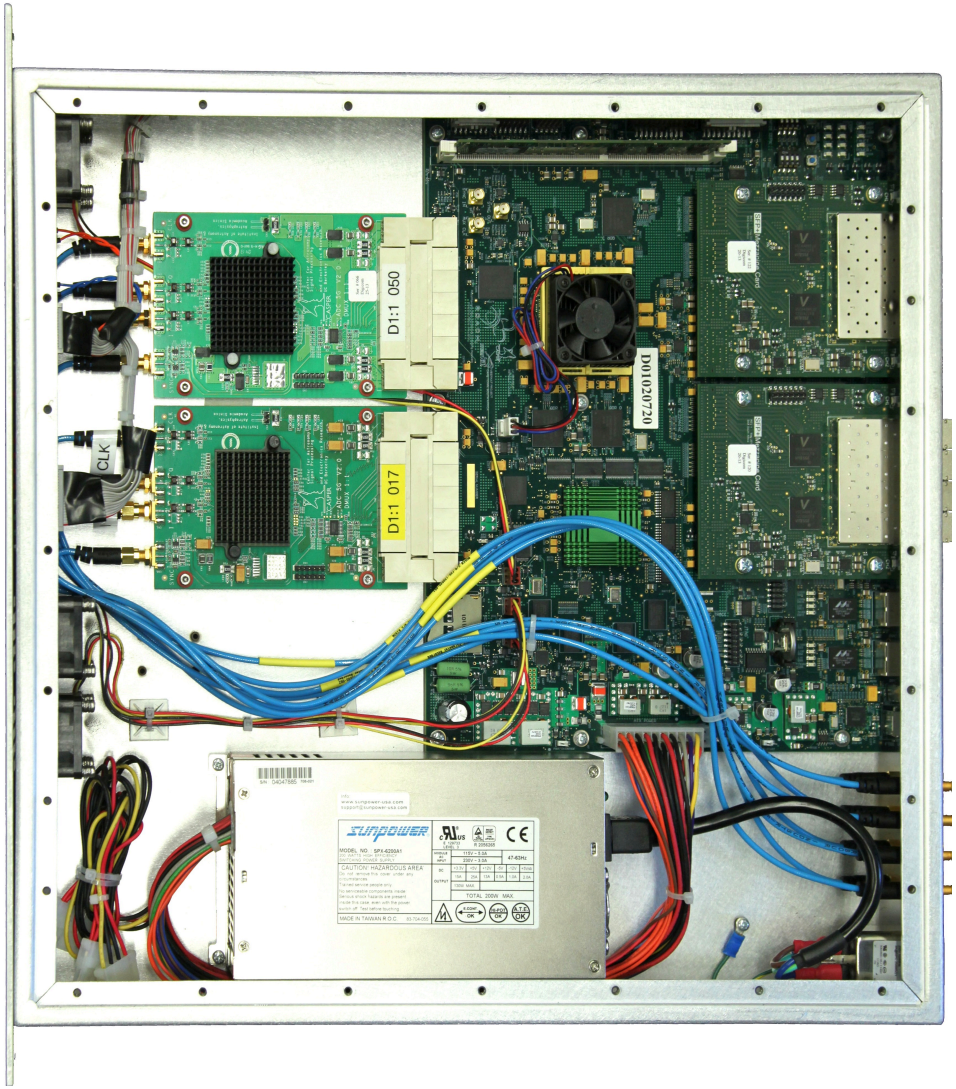
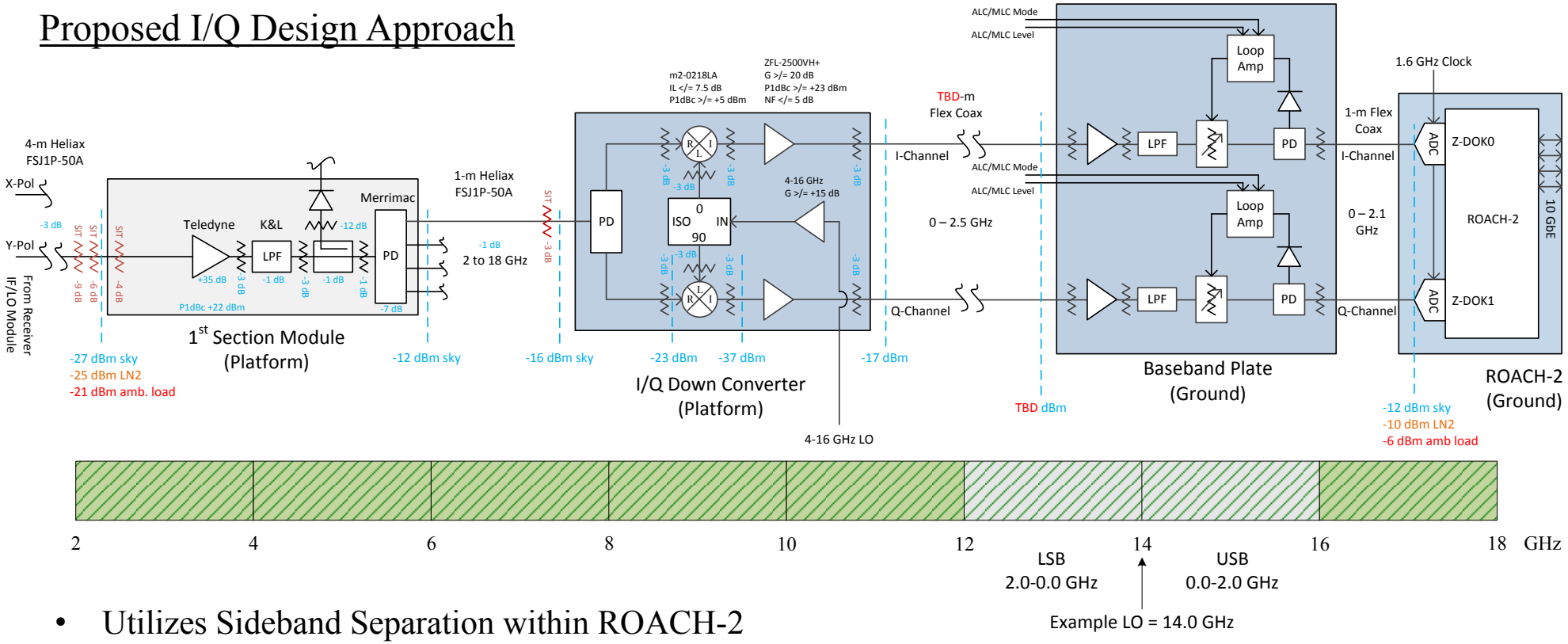




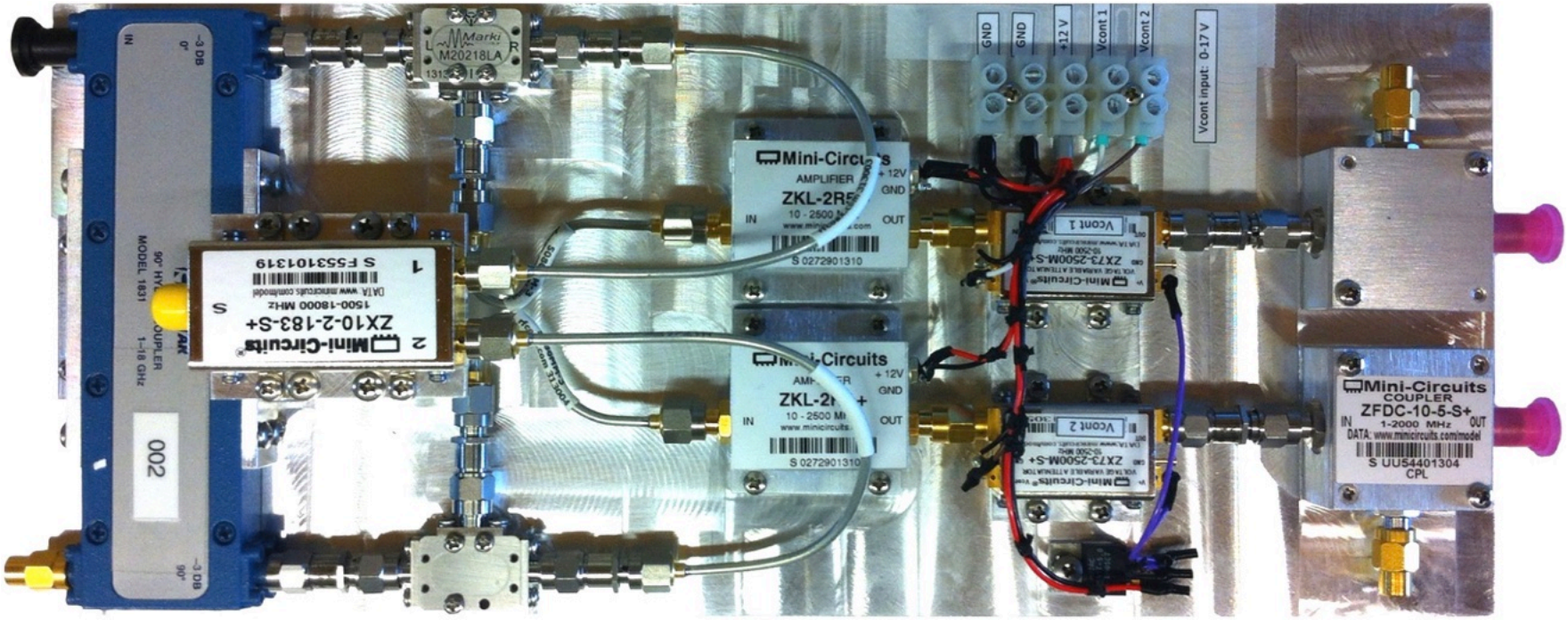
Proposed I/Q Design Approach



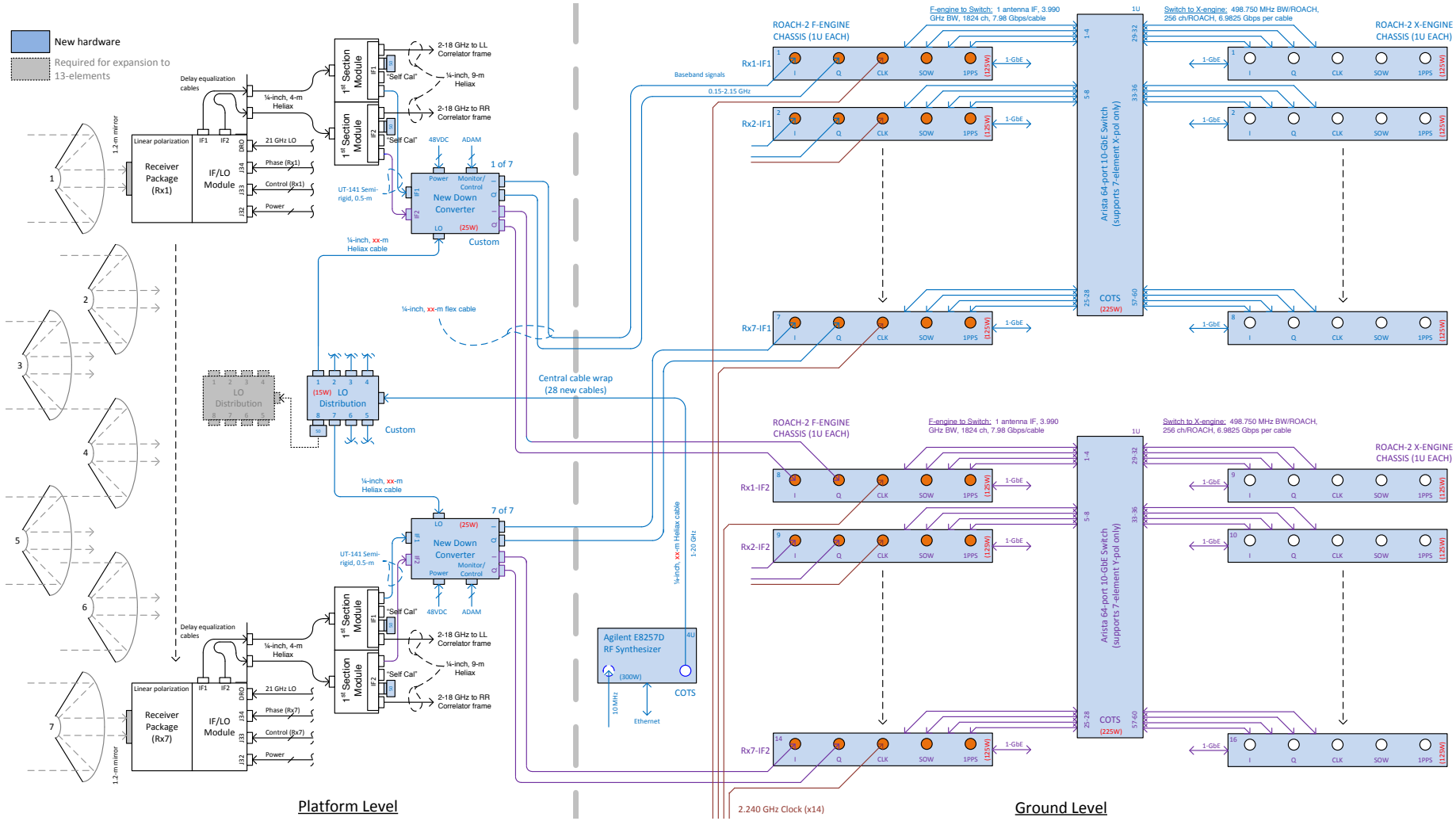
- Utilizes Sideband Separation within ROACH-2
  - Can down convert any 4 GHz portion of the 2-18 GHz IF spectra
  - No IF filter bank required
  - Demonstrated > 25 dB sideband separation in lab
- Requires one F-engine ROACH-2 per IF
  - 14 F-engine ROACH-2s required for 7-element dual polarization

Prototype I/Q down converter

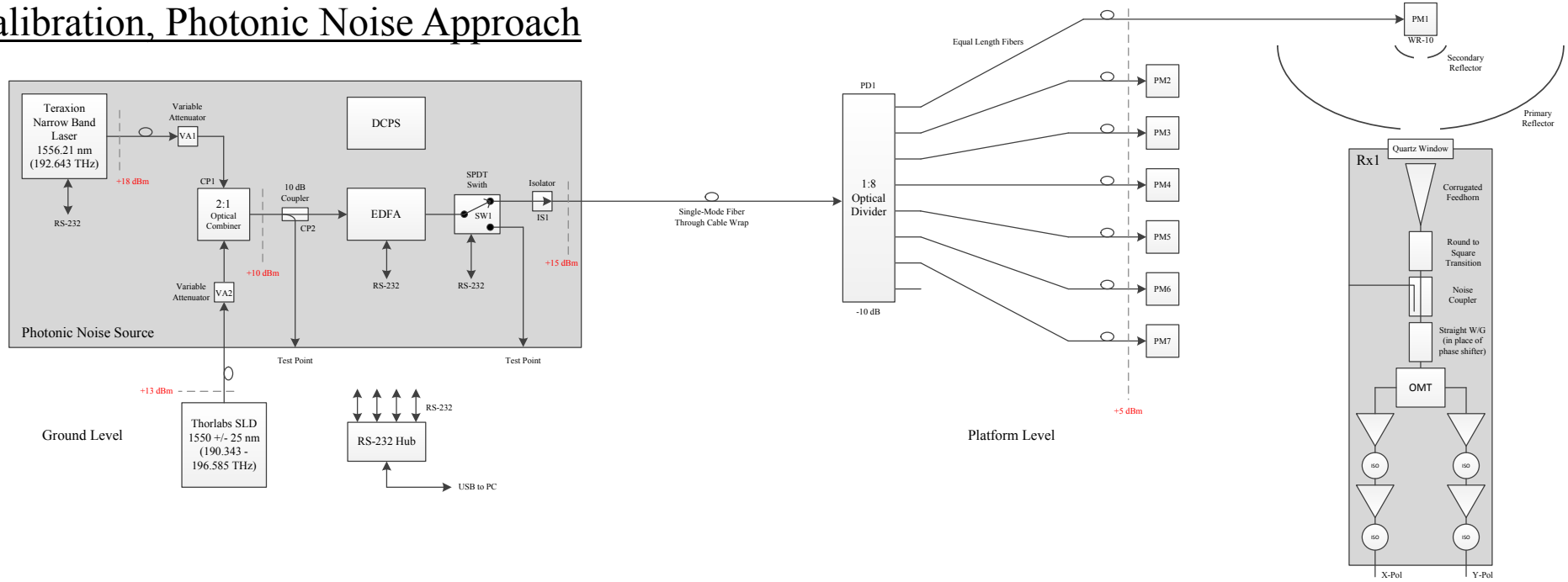
- Single channel I/Q Down Converter plate
  - Currently have 2 plates
  - Plan to demonstration 1-baseline sideband separation and fringes on sky
  - With current 3.2 GSps ADC sample rate, will process 3.2 GHz of sky bandwidth



Overall Block Diagram for Proposed I/Q Approach

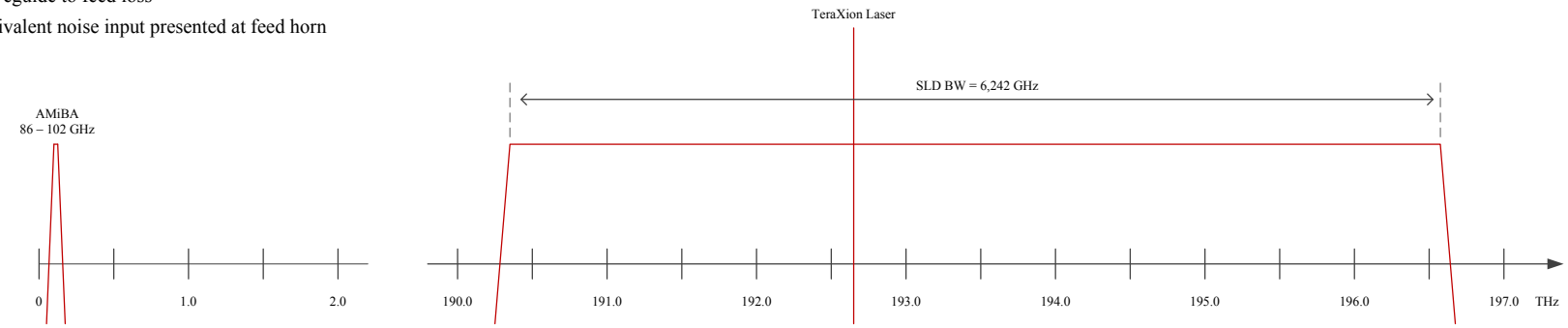


Calibration, Photonic Noise Approach

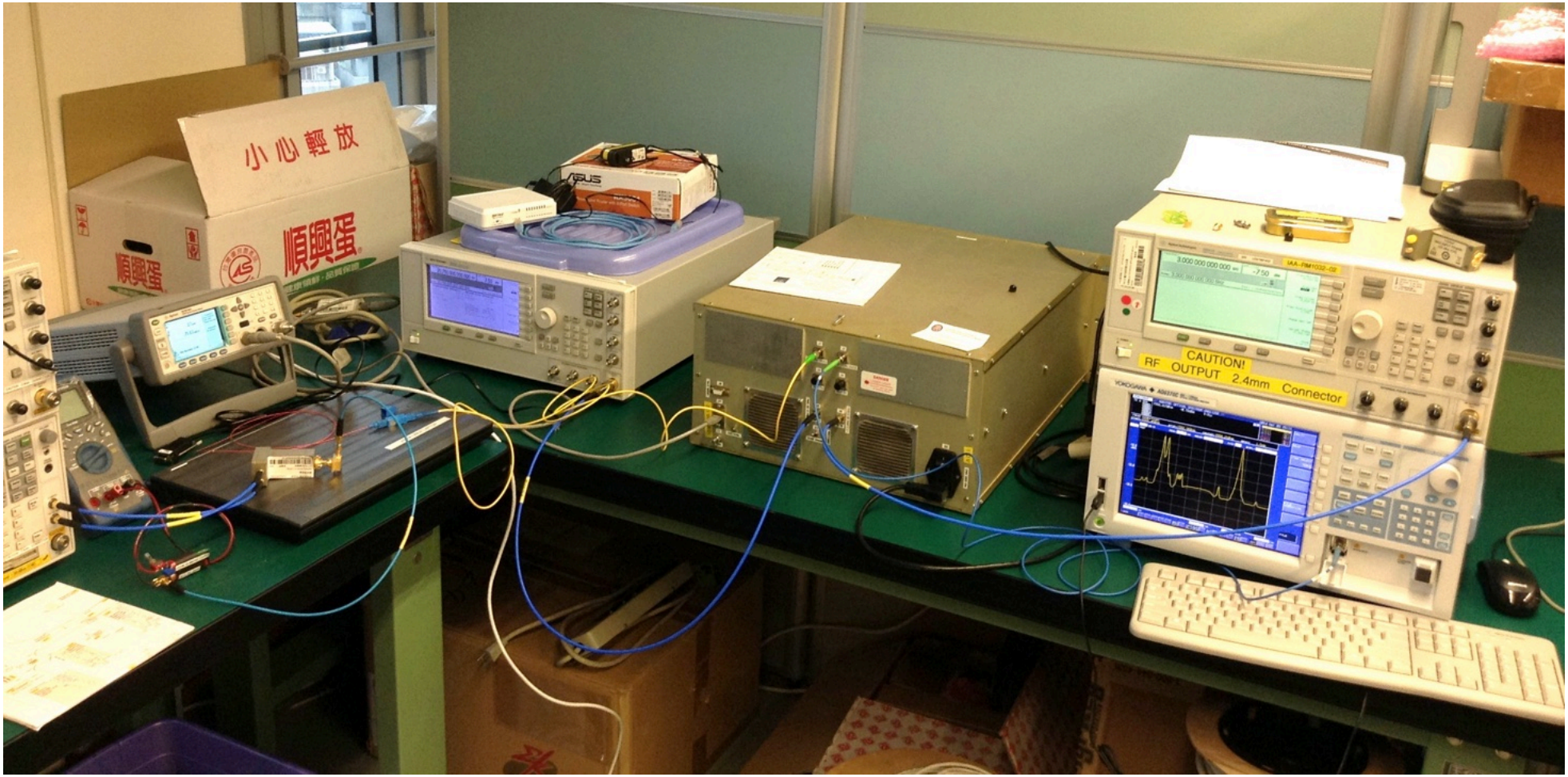


Fraction of SLD noise translated down to 86 to 102 GHz = 10*Log(16/6242) = -25.9 dB

-20.0 dBm	Typical PM output
-25.9 dB	Bandwidth ratio loss
-45.0 dB	Waveguide to feed loss
-90.9 dBm	Equivalent noise input presented at feed horn



Example of Photonic LO



Schedule

Version - 2015 May 11

7-ELEMENT, SINGLE POLARIZATION SCHEDULE					May					June				July				August					September				October				November					December			
Item	Task	Staff		Task Dur. Weeks	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	6	13	20	27
1	**Rack Installation (2 more)**	PO	SH																																		
	Construct wood frames																																				
	Paint																																				
	Install racks																																				
2	**Order ROACH-2 (x15 + 2 spare)**	HM																																			
	Ship to Hilo																																				
	Modify F-Eng w/ clk PD																																				
3	**Order 10 GbE cables (x60 + 6 spares)**	HM																																			
	Ship to Hilo																																				
4	**Install ROACH-2s in rack, cable up**	PO	SH																																			
5	**ID and order Clock Synthesizer**	PO																																			
6	**Clock Distribution Chassis**	SH																																			
	Design																																				
	Order Parts																																				
	Fabrication																																				
	Assembly/Test																																				
5	**I/Q Plate (x7)**	JK																																			
	Finalize EE & ME design																																				
	Order parts																																				
	Plate fabrication details																																				
	Assembly																																				
	Test																																				
6	**Install I/Q Plates on Electronic Boxes (x7)**	PO	SH																																			
7	**Baseband Chassis (x7 channels)**	RC																																			
	Finalize design																																				
	Order parts																																				
	Plate fabrication details																																				
	Assembly																																				
	Test																																				
8	**Loop Amplifier Board (P/O BB Chassis)**	RC																																			
	Design/schematic																																				
	Order parts																																				
	Board fabrication details																																				
	Assembly																																				
	Test																																				
9	**Install Baseband Chassis in Rack & Cable**	PO	SH																																			
10	**LO Distribution Plate**	DK																																			
	Finalize design																																				
	Order parts																																				
	Plate fabrication details																																				
	Assembly																																				
	Test																																				
11	**ID and order 4-16 GHz synthesizer**	PO																																				
12	**ID and order long flex cables**	DK																																				
13	**Modify 1st Section Modules (x7)**	PO	SH																																				
	Modification																																				
	Test S21 Response																																				
14	**ADAM controller (may combine w/ BB Ch)**	RC	JK																																				
	Plate & power supply design																																				
	Fabrication																																				
	Assembly																																				
	Cable harnesses																																				