EVLA Front-End CDR

L-Band (1-2 GHz)

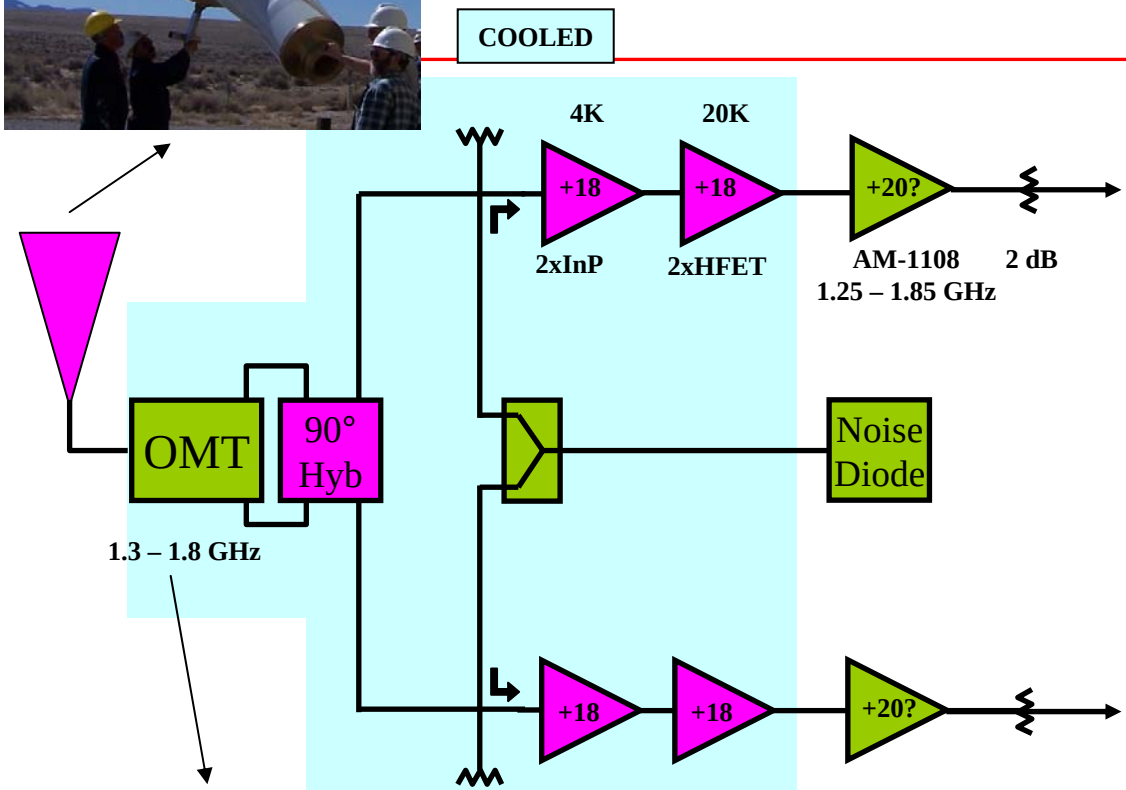
EVLA Receiver

Contents

- Interim L-Band Receiver
  - Block diagram, photos, axial ratio, Trx, Gain, Input return loss
- Prototype L-Band Receiver
  - Block diagram, LNA info, construction, thermal hurdles, window selection, Trx, Gain, axial ratio

EVLA Interim L Band

Block Diagram



First EVLA antennas were outfitted with modified VLA receivers:

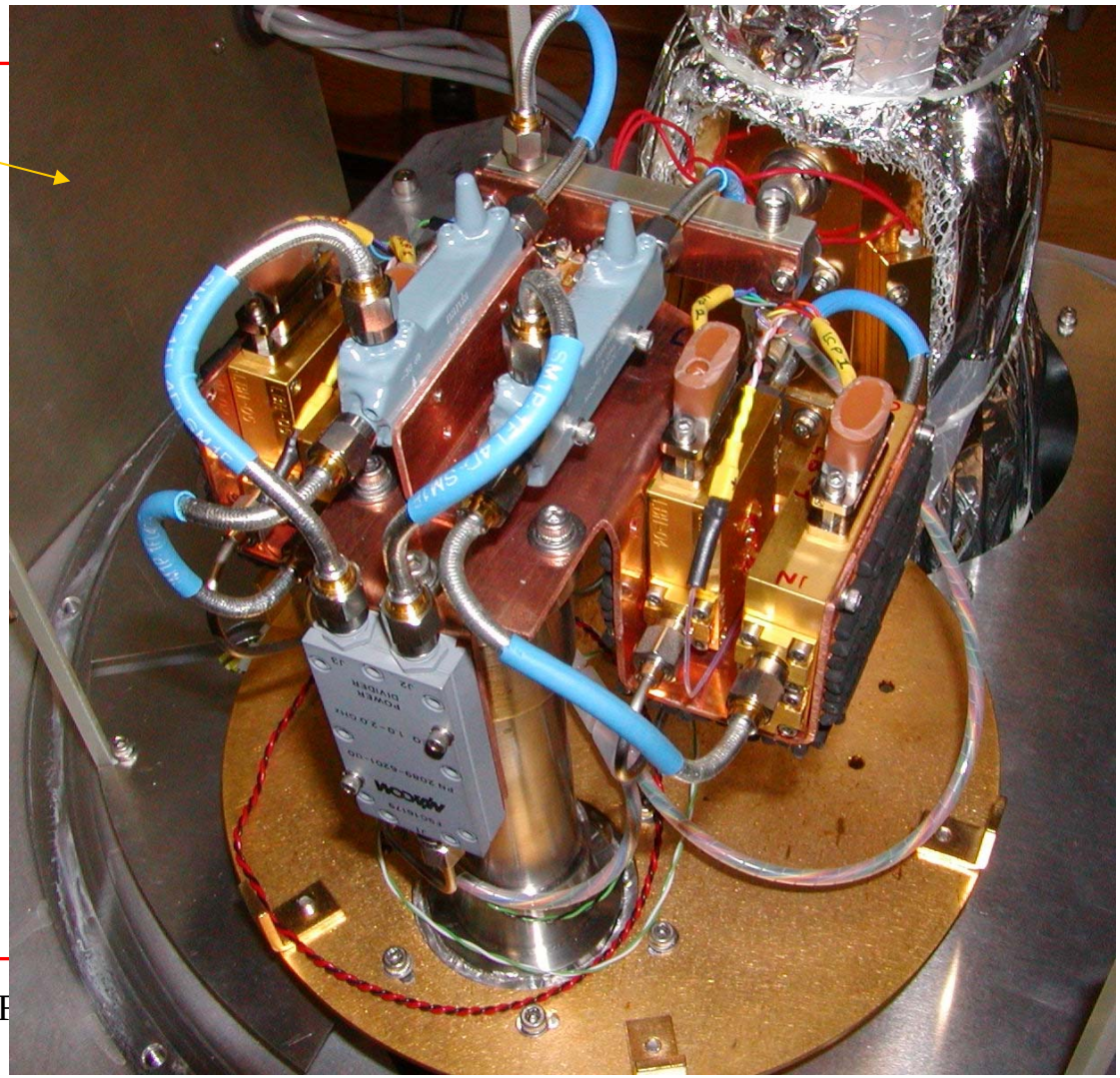
- new feed
- added 90 degree hybrid coupler
- replace single LNA with low-noise / high power balanced amplifiers

EVLA Interim L-Band

Photos

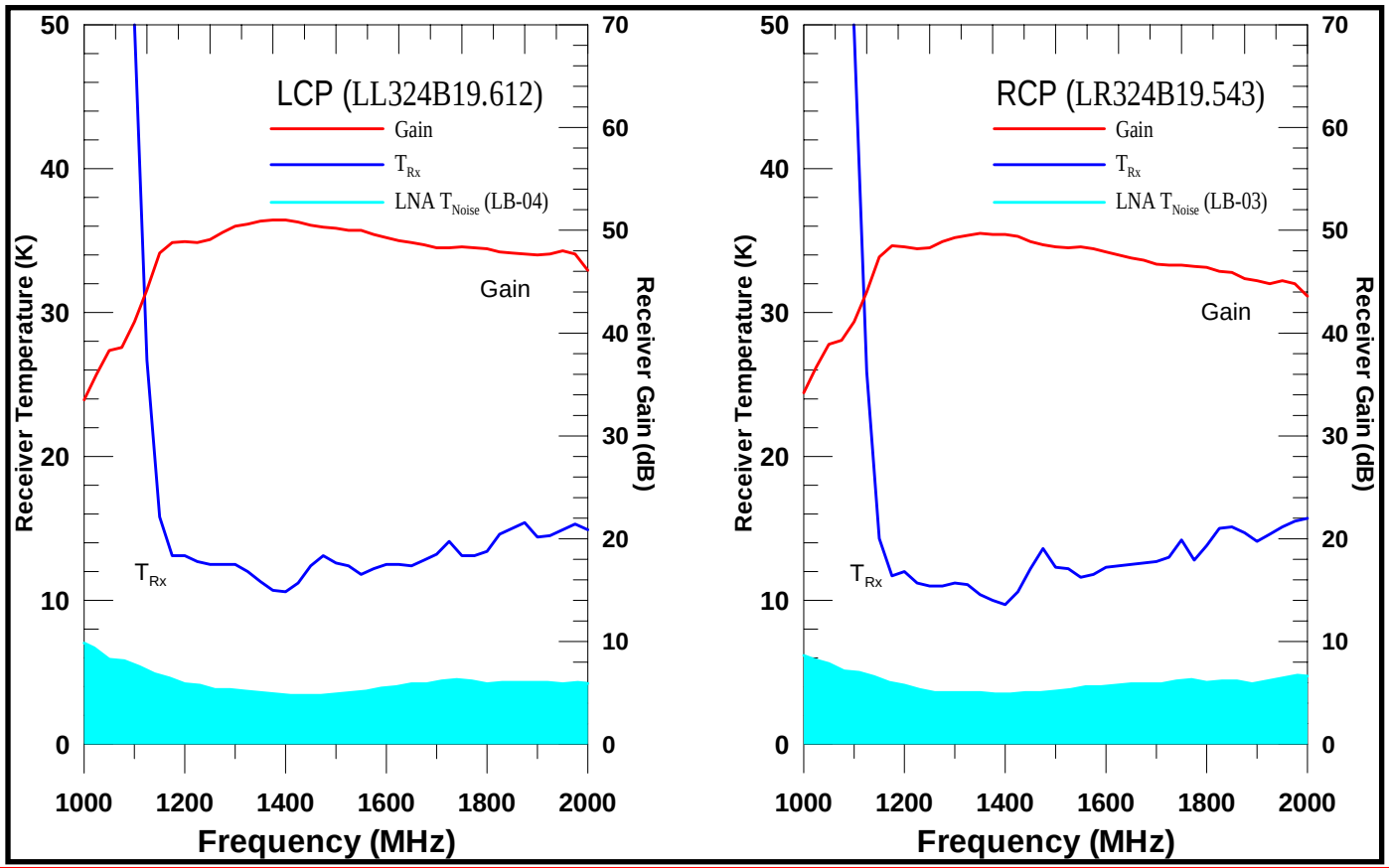
RF inside

window

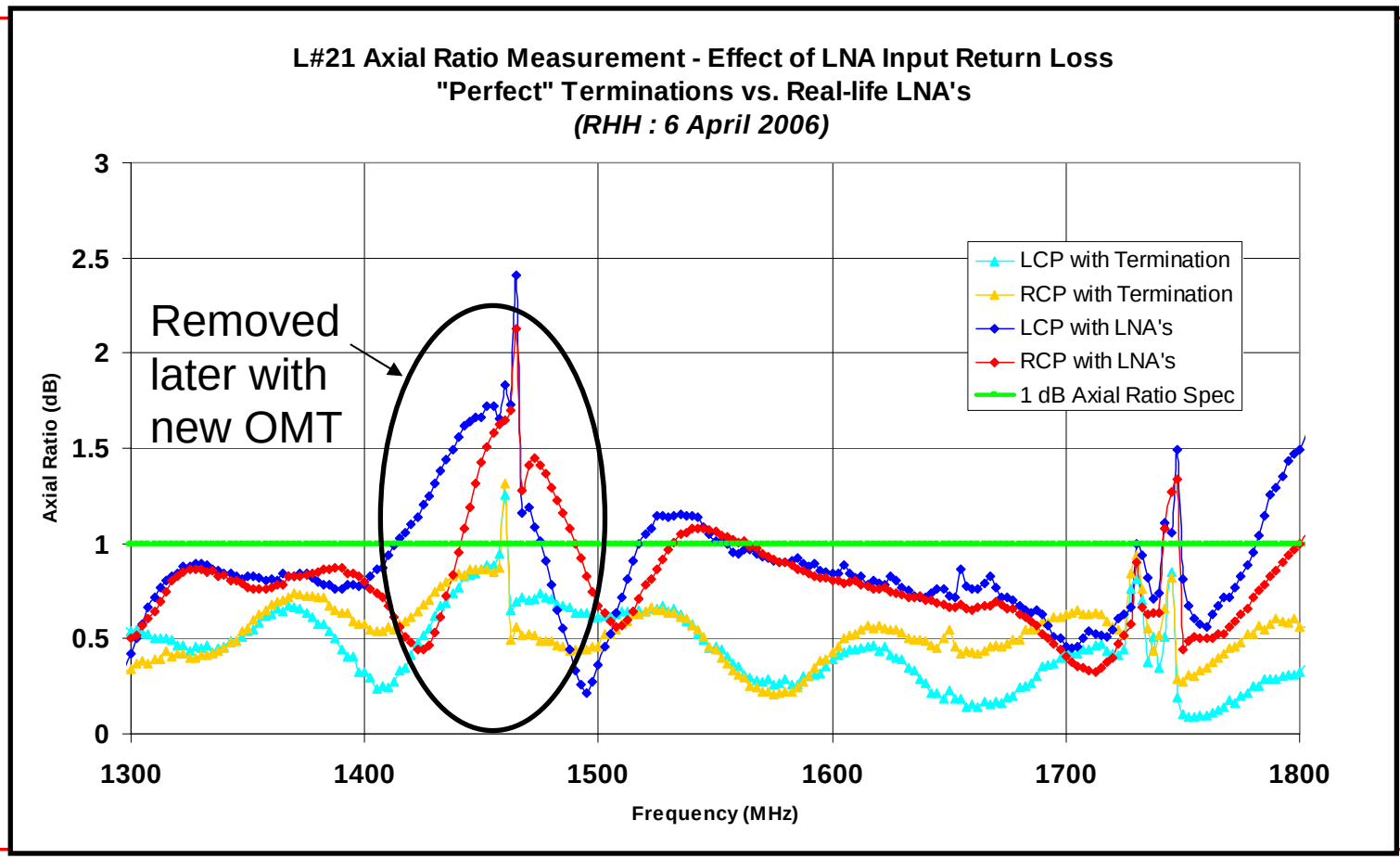


L-Band SN 32 - Antenna 14 Interim L-Band Performance

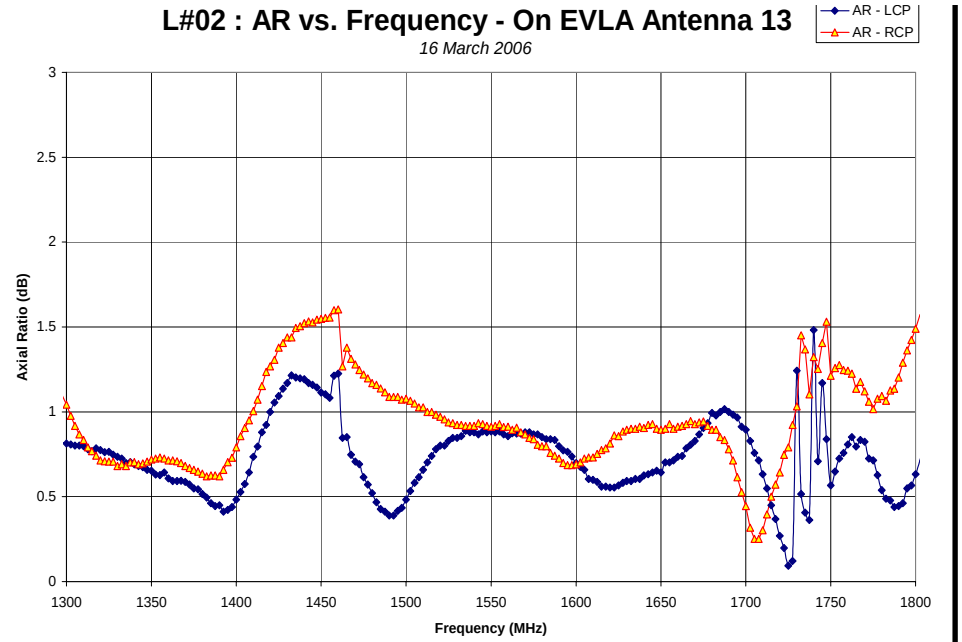
(RHH : 17 April 2006)

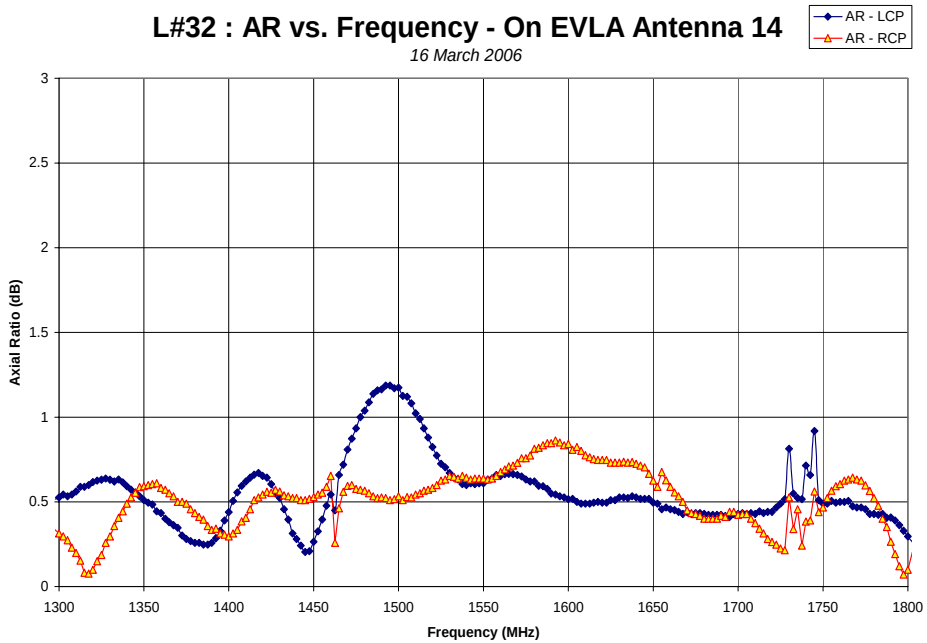


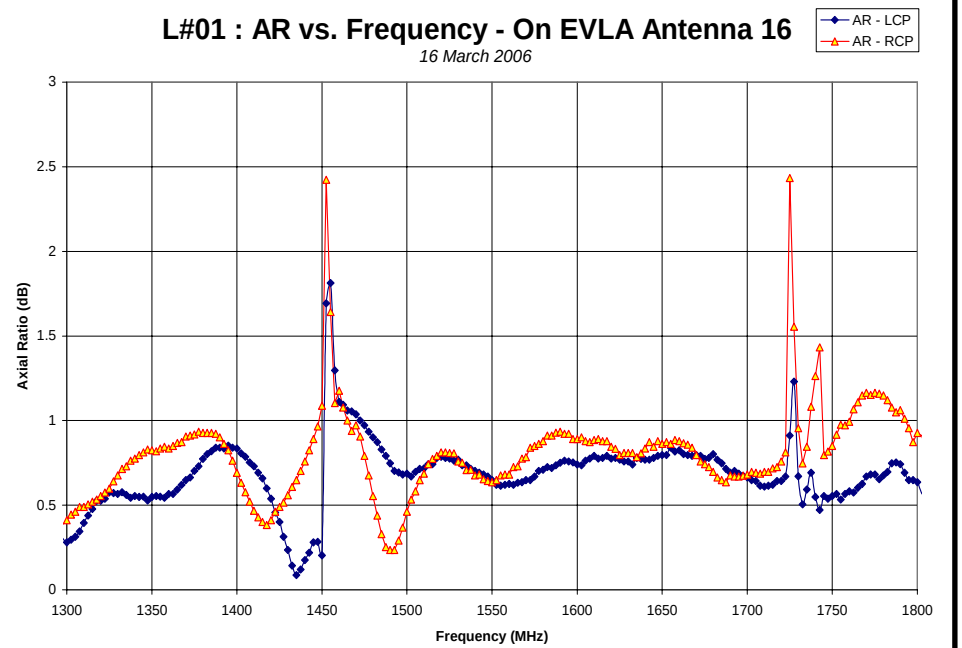
Effect of LNA Input Return Loss on Axial Ratio (L#21)

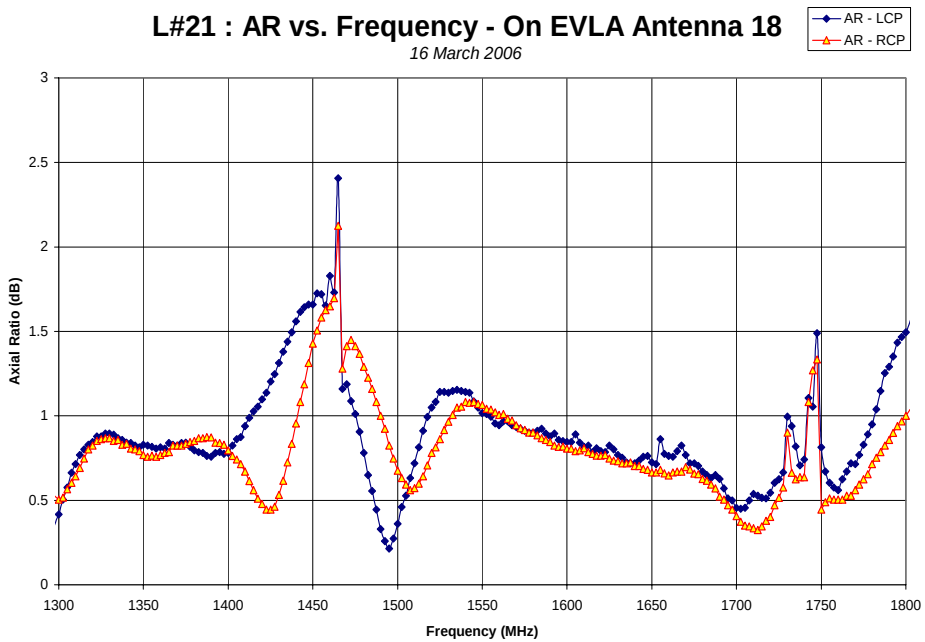


Axial Ratios on EVLA Interim L-Band Receivers





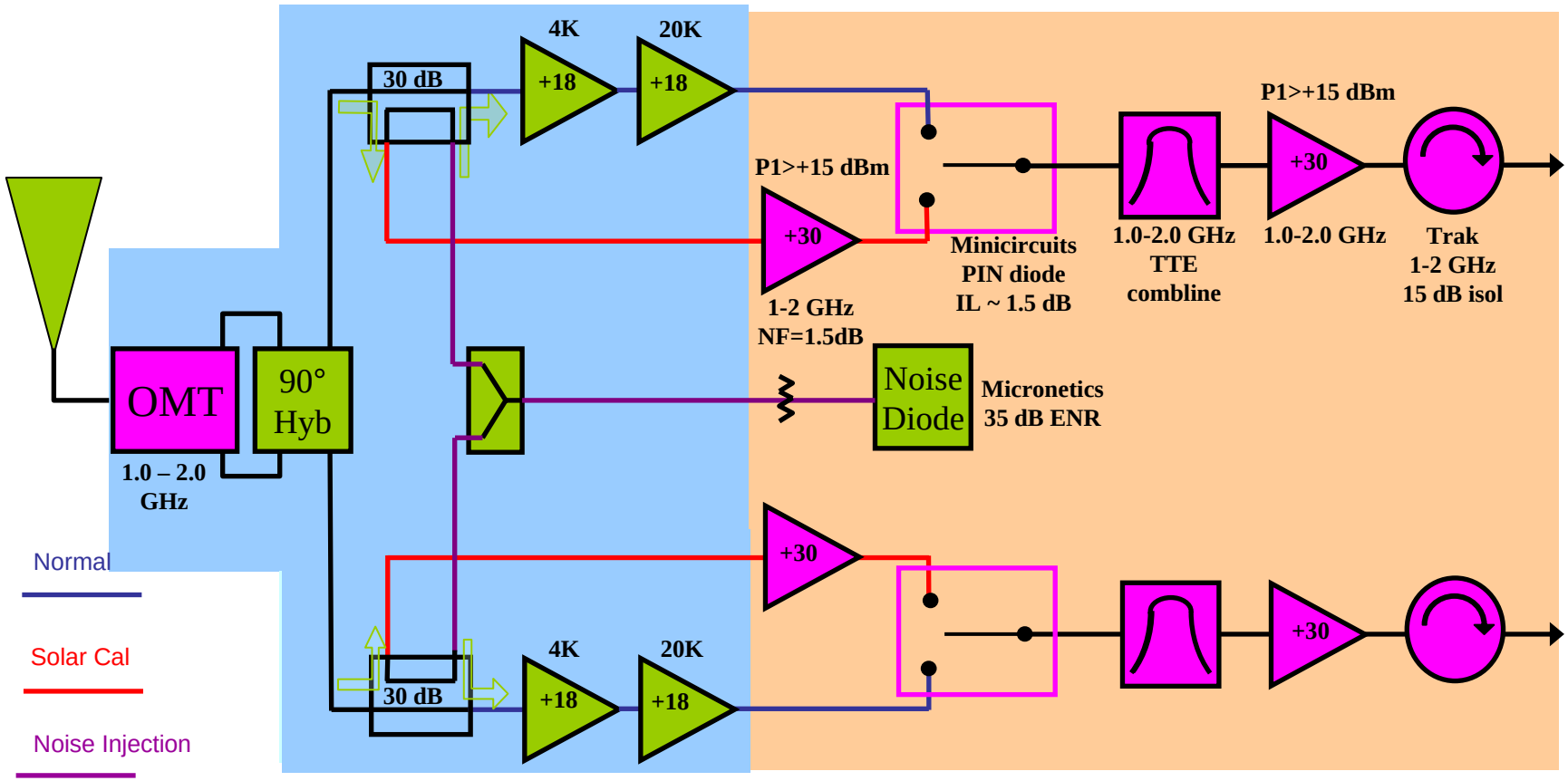




EVLA L-Band Design

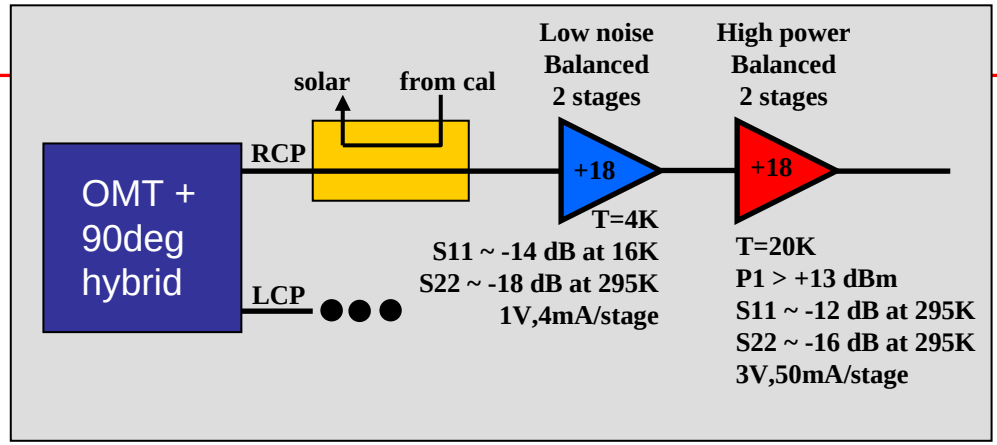
EVLA L Band

Block Diagram



EVLA L-Band

Low noise / high power LNAs

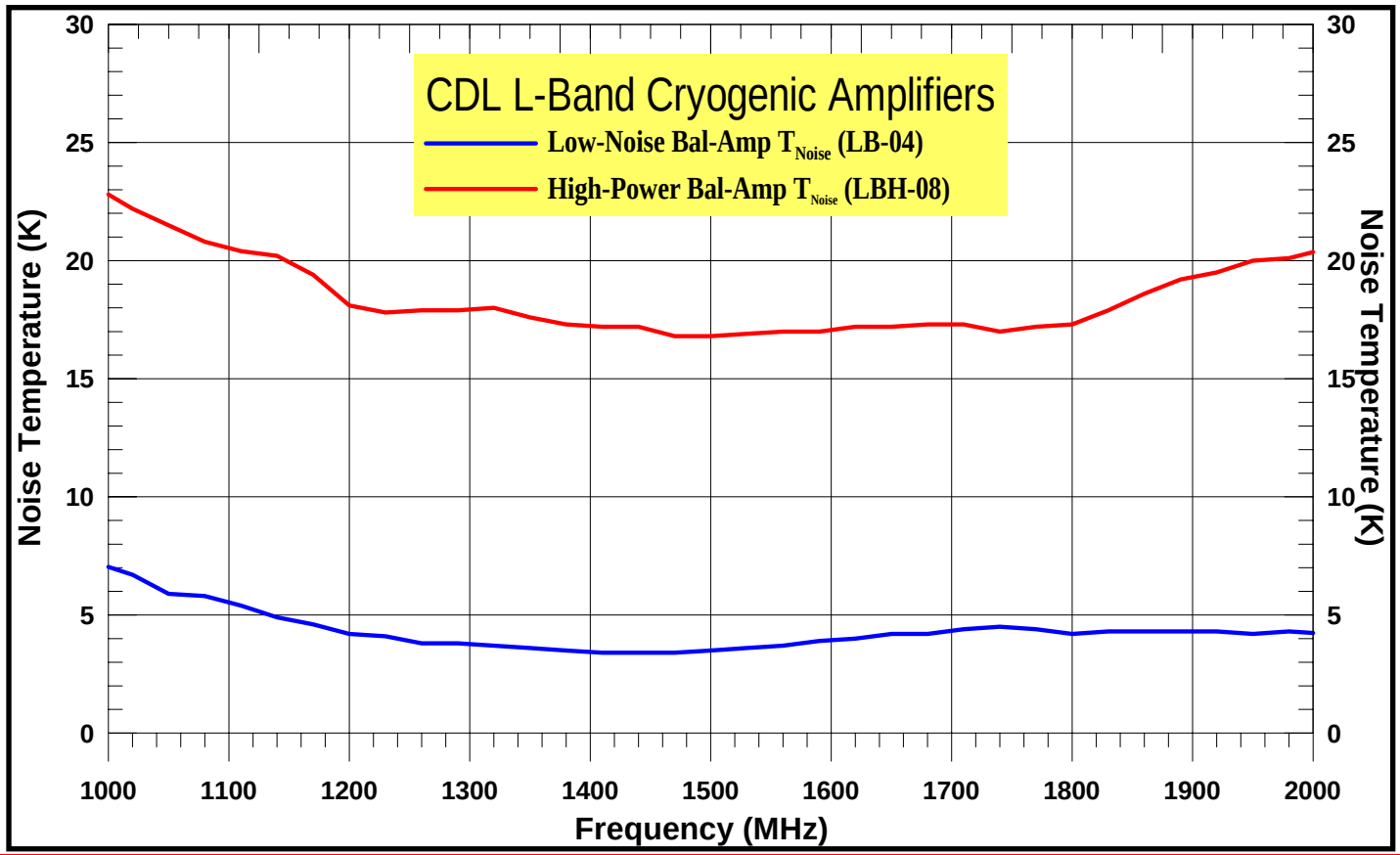


- In absence of a broadband cryogenic isolator...
- Split LNAs allows for future cooled filter if RFI situation warrants
- Compromise between low noise and dynamic range

- Balanced low noise block
  - provides decent S11 to prevent reflections through OMT & S22 to possible filter
  - two InP stages give 4K noise temp.
- Balanced high power block
  - provides good S11 to possible filter
  - 2 stage commercial HFET gives 20K noise temp.

CDL L-Band LNA

Low-Noise & High-Power Balanced Amplifier Gain Blocks



Estimated EVLA L-Band T_{Rx}, Output Power & Headroom

<u>Best Case</u> - With Low-Loss Vacuum Window and OMT Cooled to 50°K

EVLA L-Band Rx (RHH : 28 March 2006)	P (1dB) (dBm)	P (1%) (dBm)	Temp (K)	NF/C (dB)	Loss/Gain (dB)	Loss/Gain (linear)	Delta T (K)	Trx (K)	BW (MHz)	Pnoise (dBm)	Pnoise dBm/GHz	Headroom (dB)
										for Tsky of		
										12.0		
										(K)		
									2000	-94.8	-97.8	
Weather Window			300		-0.02	0.9954	1.385			-94.3		
Feed Horn			300		-0.05	0.9886	3.490			-93.4		
Vacuum Window			300		-0.001	0.9998	0.070			-93.4		
Quad-Ridge OMT			50		-0.1	0.9772	1.184			-93.2		
Coax Cable			32.5		-0.05	0.9886	0.391			-93.1		
Hybrid Phase Shifter			15		-0.2	0.9550	0.744			-93.2		
Coax Cable			15		-0.05	0.9886	0.191			-93.2		
Cal Coupler (IL)			15		-0.2	0.9550	0.788			-93.2		
Cal Coupler (Branch)			300	-30	0	1.0000	0.300			-93.1		
Isolator			15		0	1.0000	0.000			-93.1		
Balanced LNA (16-20 d	-5	-17	4		18	63.0957	4.668	13.21		-74.2		57.2
Coax Cable			15		-0.1	0.9772	0.006			-74.3		
Transfer Switch			15		0	1.0000	0.000			-74.3		
Filter Hi-Q/Notch			15		0	1.0000	0.000			-74.3		
Coax Cable			15		0	1.0000	0.000			-74.3		
Balanced LNA (16-20 d	13	1	20		18	63.0957	0.379			-56.3		57.3
Stainless Steel Coax			157.5		-2	0.6310	0.028	13.62		-58.3		
Coax Cable			300		-1	0.7943	0.037			-59.3		
Switch			300		0	1.0000	0.000			-59.3		
Isolator			300		-0.5	0.8913	0.022			-59.8		
Filter (0.8-2.2 GHz)			300		-1	0.7943	0.052		1400	-62.3		
Post-Amp	15	3	229.6	2.5	30	1000.0000	0.194			-32.3		35.3
Isolator			300		-0.5	0.8913	0.000	13.93		-32.8		

Estimated EVLA L-Band T_{Rx}, Output Power & Headroom

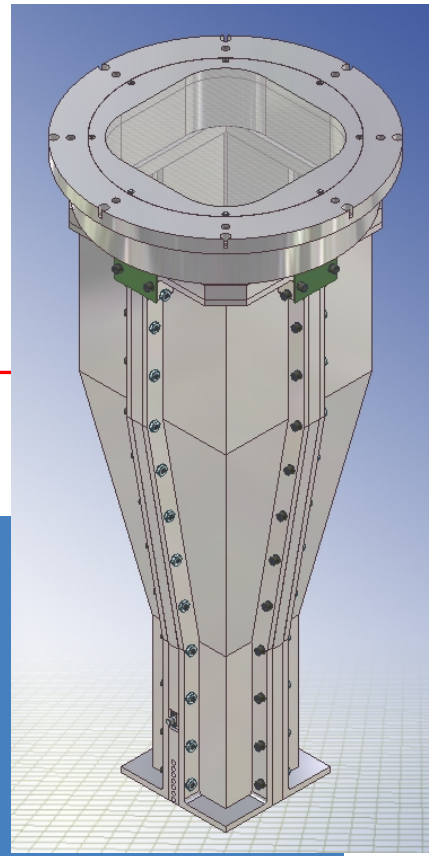
Worst Case - With Lossy Vacuum Window and OMT Cooled to only 100°K

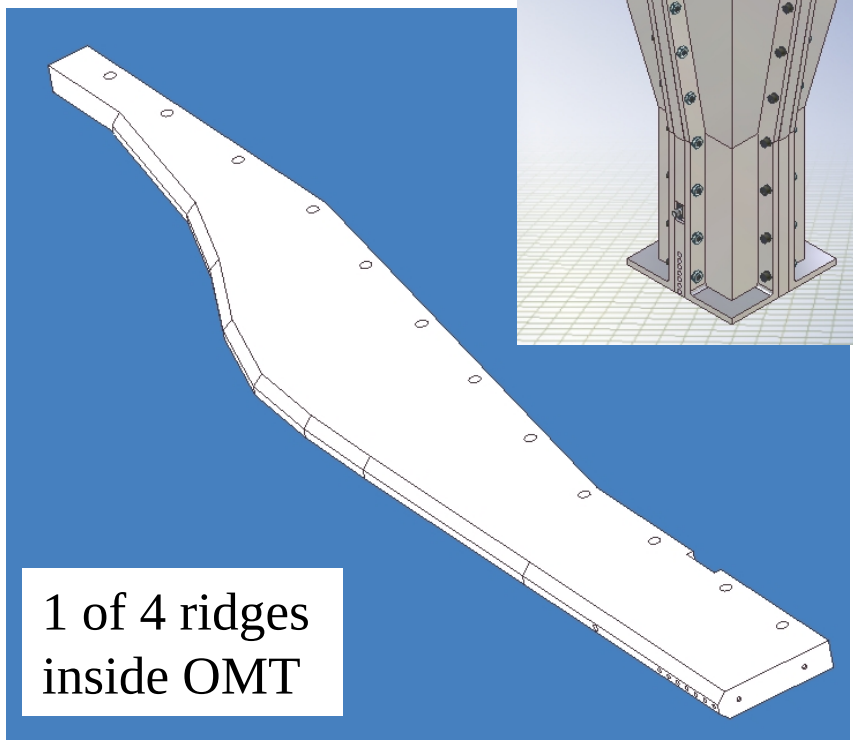
EVLA L-Band Rx (RHH : 28 March 2006)	P (1dB) (dBm)	P (1%) (dBm)	Temp (K)	NF/C (dB)	Loss/Gain (dB)	Loss/Gain (linear)	Delta T (K)	Trx (K)	BW (MHz)	Pnoise (dBm)	Pnoise dBm/GHz	Headroom (dB)
										for Tsky of		
										12.0		
										(K)		
									2000	-94.8	-97.8	
Weather Window			300		-0.02	0.9954	1.385			-94.3		
Feed Horn			300		-0.05	0.9886	3.490			-93.4		
Vacuum Window			300		-0.1	0.9772	7.101			-92.0		
Quad-Ridge OMT			100		-0.1	0.9772	2.422			-91.6		
Coax Cable			60		-0.05	0.9886	0.739			-91.6		
Hybrid Phase Shifter			20		-0.2	0.9550	1.015			-91.6		
Coax Cable			20		-0.05	0.9886	0.261			-91.6		
Cal Coupler (IL)			20		-0.2	0.9550	1.075			-91.7		
Cal Coupler (Branch)			300	-30	0	1.0000	0.300			-91.6		
Isolator			20		0	1.0000	0.000			-91.6		
Balanced LNA (16-20 d	-5	-17	4		18	63.0957	4.776	22.56		-73.0		56.0
Coax Cable			20		-0.1	0.9772	0.009			-73.1		
Transfer Switch			20		0	1.0000	0.000			-73.1		
Filter Hi-Q/Notch			20		0	1.0000	0.000			-73.1		
Coax Cable			20		0	1.0000	0.000			-73.1		
Balanced LNA (16-20 d	13	1	20		18	63.0957	0.387			-55.0		56.0
Stainless Steel Coax			160		-2	0.6310	0.029	22.99		-57.0		
Coax Cable			300		-1	0.7943	0.038			-58.0		
Switch			300		0	1.0000	0.000			-58.0		
Isolator			300		-0.5	0.8913	0.022			-58.5		
Filter (0.8-2.2 GHz)			300		-1	0.7943	0.053		1400	-61.1		
Post-Amp	15	3	229.6	2.5	30	1000.0000	0.199			-31.0		34.0
Isolator			300		-0.5	0.8913	0.000	23.30		-31.5		

EVLA L-Band

Polarizer

- Quad-ridge OMT + 90 degree hybrid
- Increased frequency range
- Improved performance
- Details discussed by Paul Lilie



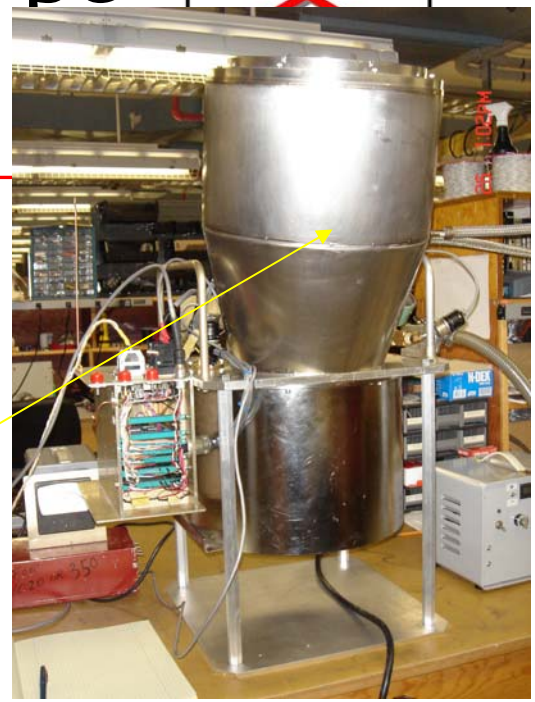


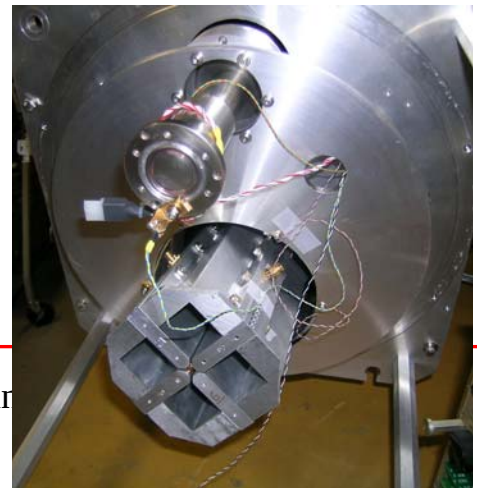
EVLA L Band Prototype

EVLA L-Band Prototype

Construction

- Modify a VLA L-Band dewar to evaluate OMT performance
  - reused mounting plate bottom can
  - new can over OMT
  - 350 fridge replaced with 1020 from A-rack

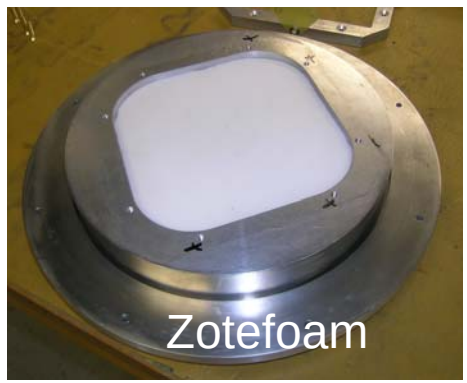




EVLA L-Band Prototype

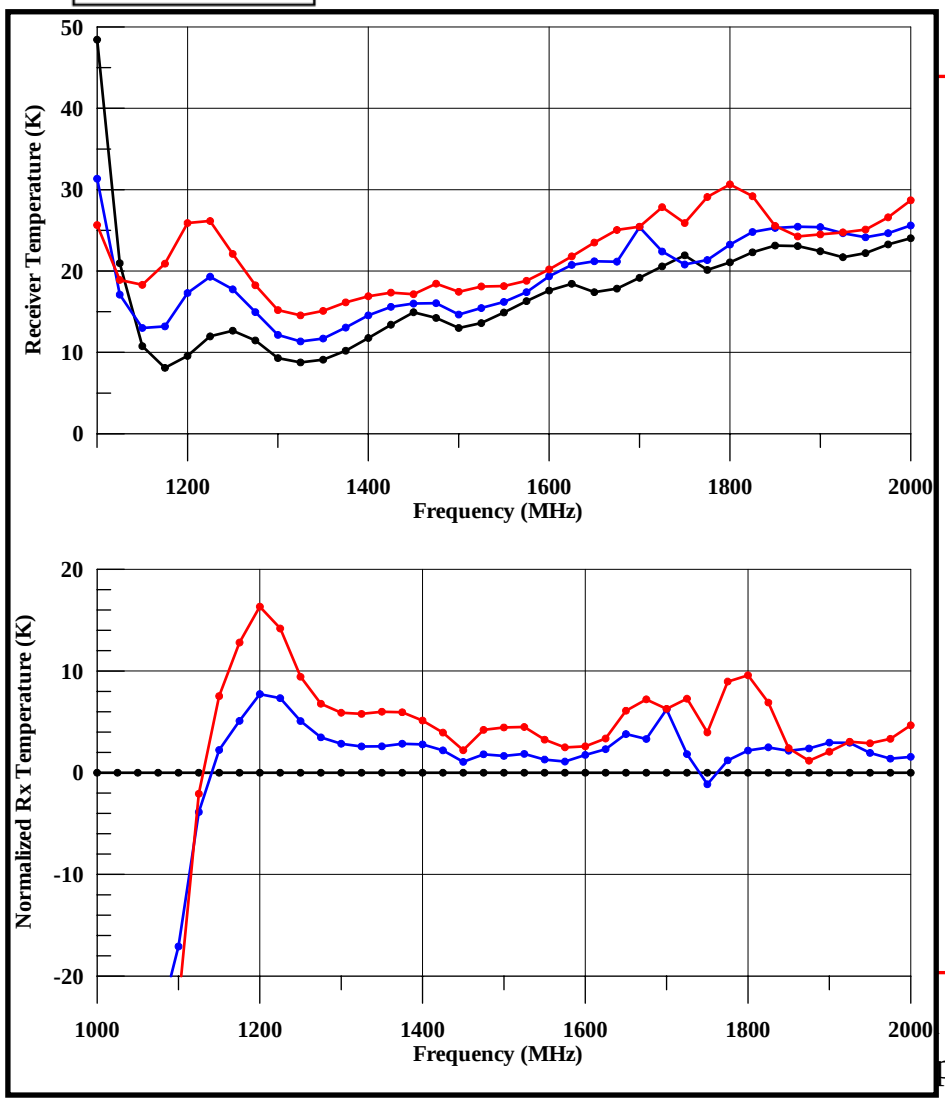
Vacuum Windows

- Blue Eccofoam
  - classic foam used in older receviers
  - RF: excellent
  - strength: good
  - thermal: excellent
  - has been deteriorating, replacing with Zotefoam
- Zotefoam HD30
  - used in smaller (L,C) windows for years
  - RF: excellent
  - strength: good
  - thermal: excellent
- Nidacore
  - new honeycomb material
  - RF: moderate
  - strength: excellent
  - thermal: poor



EVLA L-Band Prototype

Vacuum Window Test



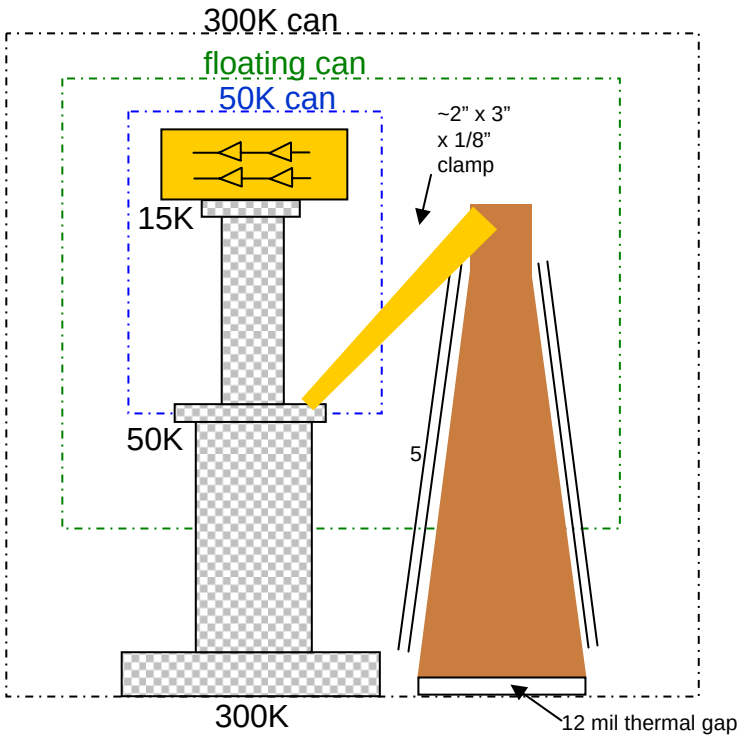
Dewar Vacuum Window
Nidacore Honeycomb Plug
vs. Zotefoam Plug alone

Effect on TRx

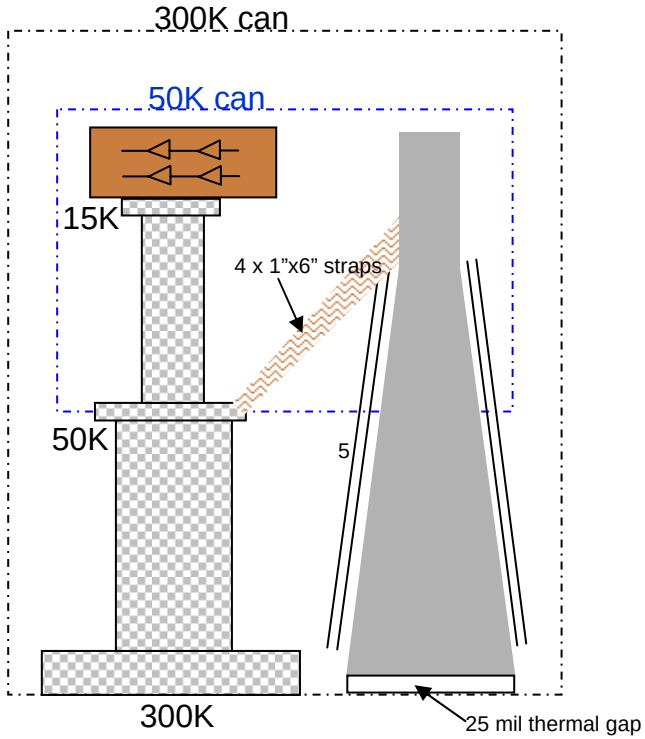
L-Band (SN 11) Measurements with Nidacore Honeycomb Plug using Lilie Noise Standard (Off/On = 100/675 K)
14 Feb 2006

- No Plug
- Single 0.5" Honeycomb Plug
- Double 0.5" Honeycomb Plug

Dewar Thermal Designs
VLA vs EVLA



Original VLA = Interim EVLA



Current EVLA prototype

gold-plated (50 microns?) copper

solid copper (OHFC)

braided copper (OHFC)

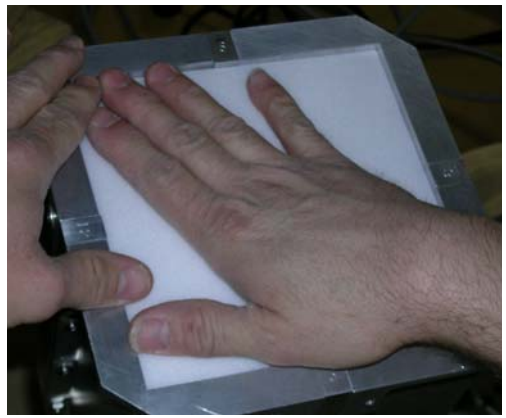
6061 aluminum

n layers of "space blanket"

EVLA L-Band Prototype

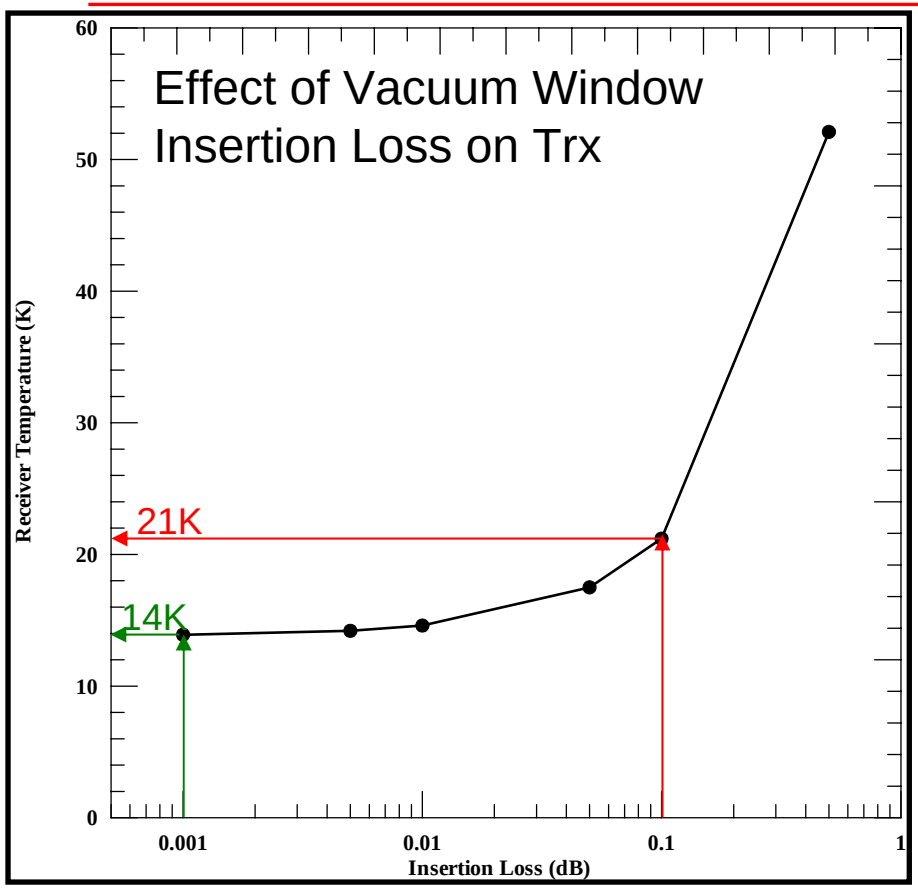
Thermal Progress

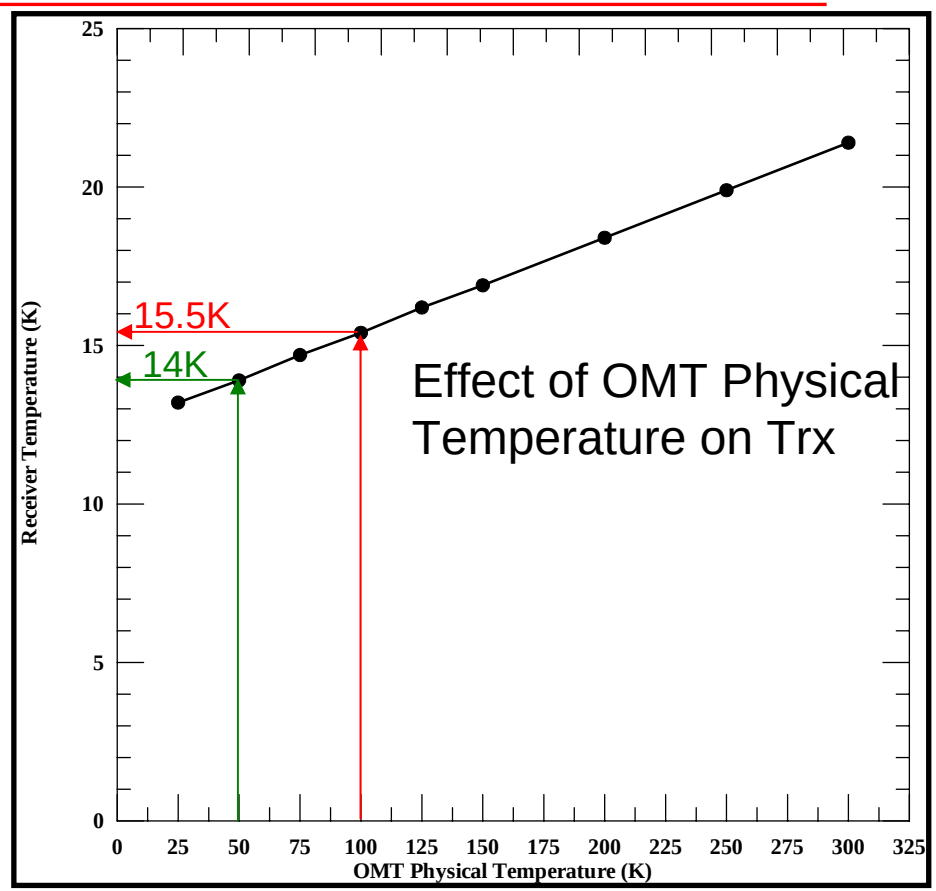
- 50K stage cools to 99K
- 15K stage cools to 20K
- Insulated 50K radiation shield with veil/space blanket layers
- Added Zotefoam to inside of OMT to add thermal insulation.
- Tie OMT to 50K instead of 15K stage
- Replace Nidacore window with Zotefoam



EVLA L-Band Prototype

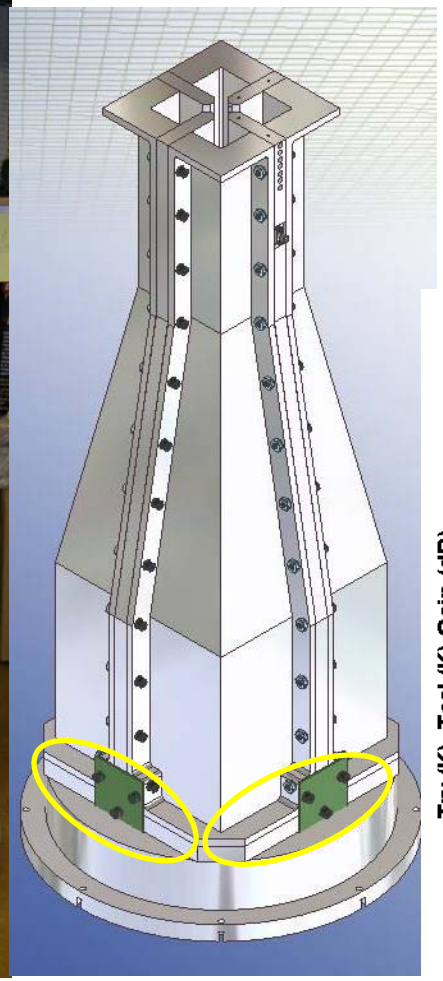
OMT Temp vs Trx
Window Loss vs Trx



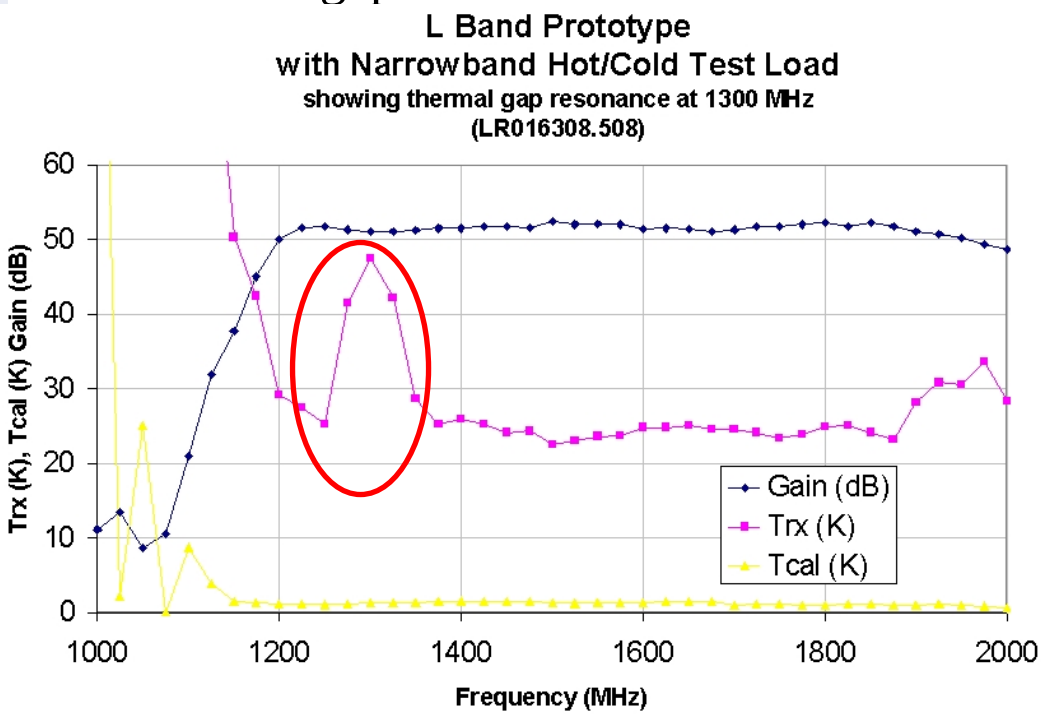


EVLA L-Band Prototype

RF through Thermal Gap

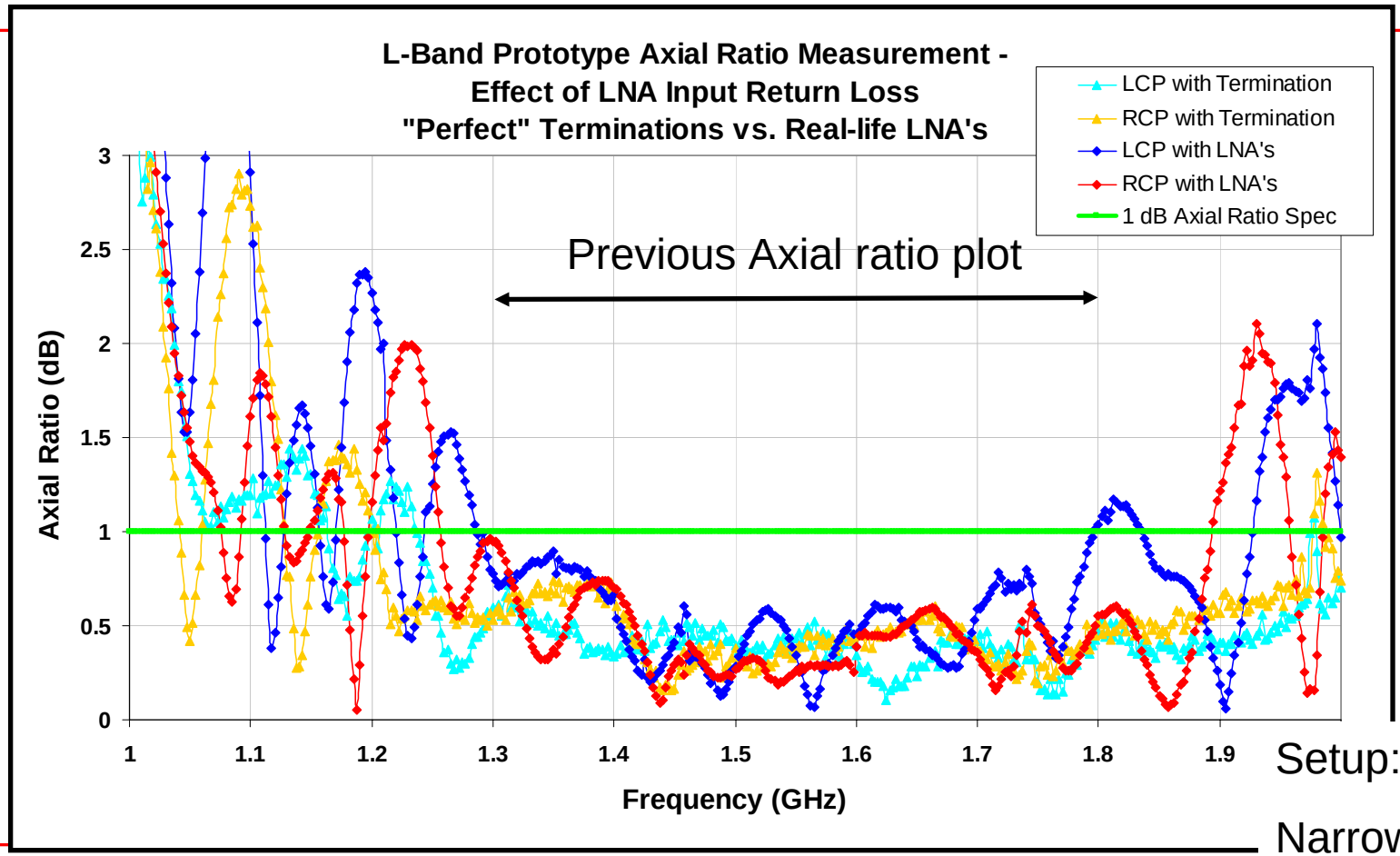


- A “bump” was caused by RF leaking out the thermal gap
- Resonant cavity conditions inside dewar can
- Solved with strip of absorber around thermal gap



EVLA L-Band Prototype

Effect of LNA Input Return Loss on Axial Ratio

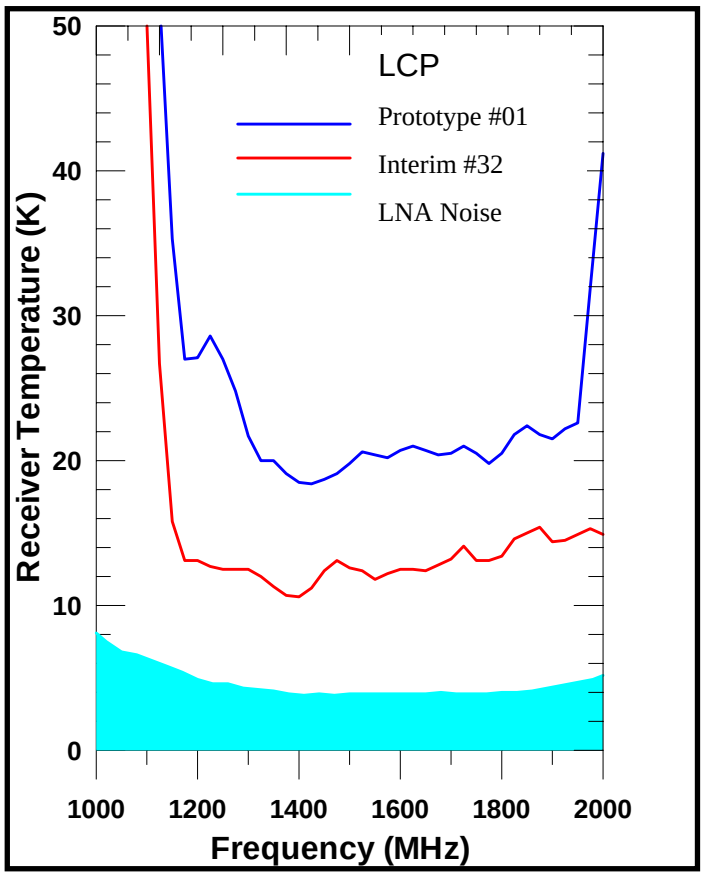


Setup:

Narrowband 1.3 – 1.8 GHz OMT as input

Prototype vs Interim L#32

Preliminary Results with Narrowband Hot/Cold Test Load



- RCP and LCP very similar results
- Interim receiver has physical temperature 45K/15K
- Prototype 99K/15K, needs to be reduced
- Response of receiver below 1300 MHz unknown due to narrowband test OMT

Conclusions

- OMT under continued testing
  - between 1.3 – 1.8 GHz, performance acceptable
  - at band-edges performance to be tested
- Second OMT almost ready for use as a test fixture instead of narrow band OMT
- Re-evaluate dewar thermal design to reduce OMT physical temperature from 100K
- Reduce Trx from 20K to 15K