

HFET Receivers for ALMA Bands ## 1, 2 and 3



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CDL

Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array



Band #1: 31.3 to 45 GHz

Specifications:

Freq (GHz)	Specification		Goal	
	T(SSB) over 80%	T(SSB) at any freq	T(SSB) over 80%	T(SSB) at any freq
31.3 – 45	15 K	23 K	10 K	14 K

Standard waveguide bands:

WR28 26-40 GHz, $F_c=21.2$ GHz

WR22 33-50 GHz, $F_c=26.4$ GHz

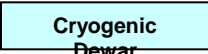

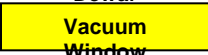

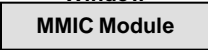

ALMA Band#1 fits a new “WR25” waveguide band

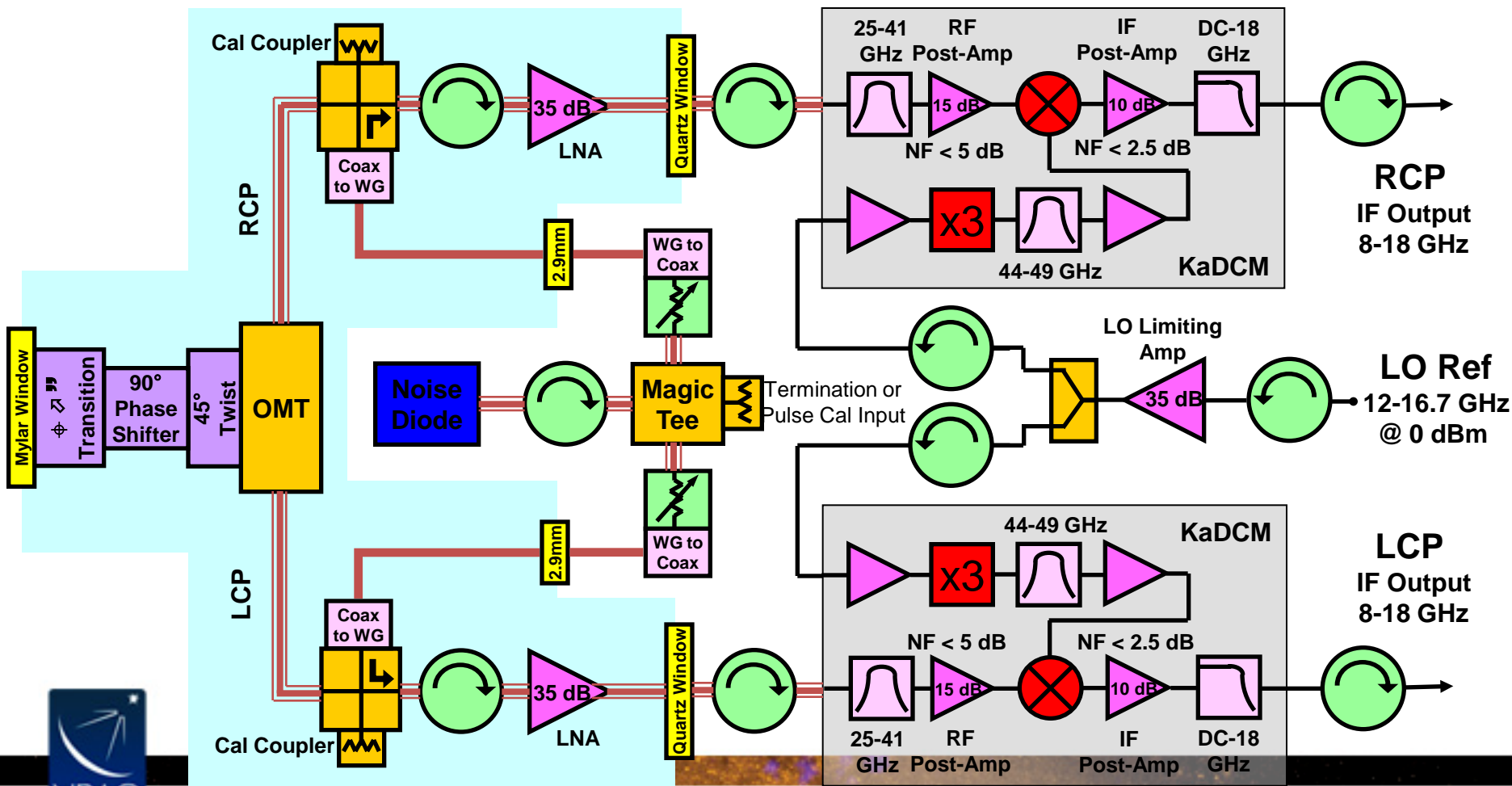


EVLA 26-40 GHz Receiver Block Diagram

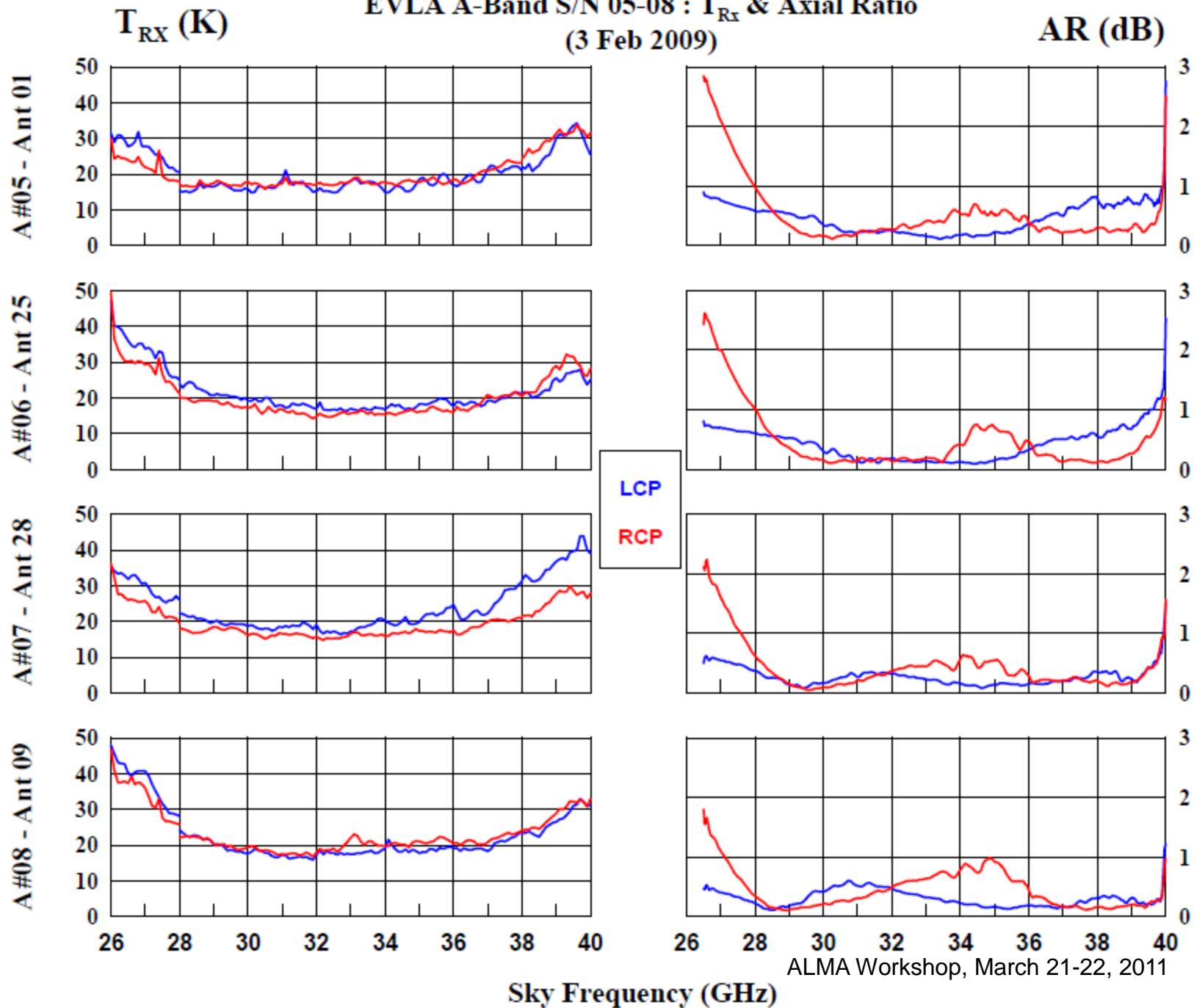
RHH : 18 March 2011 (courtesy R. Hayward)

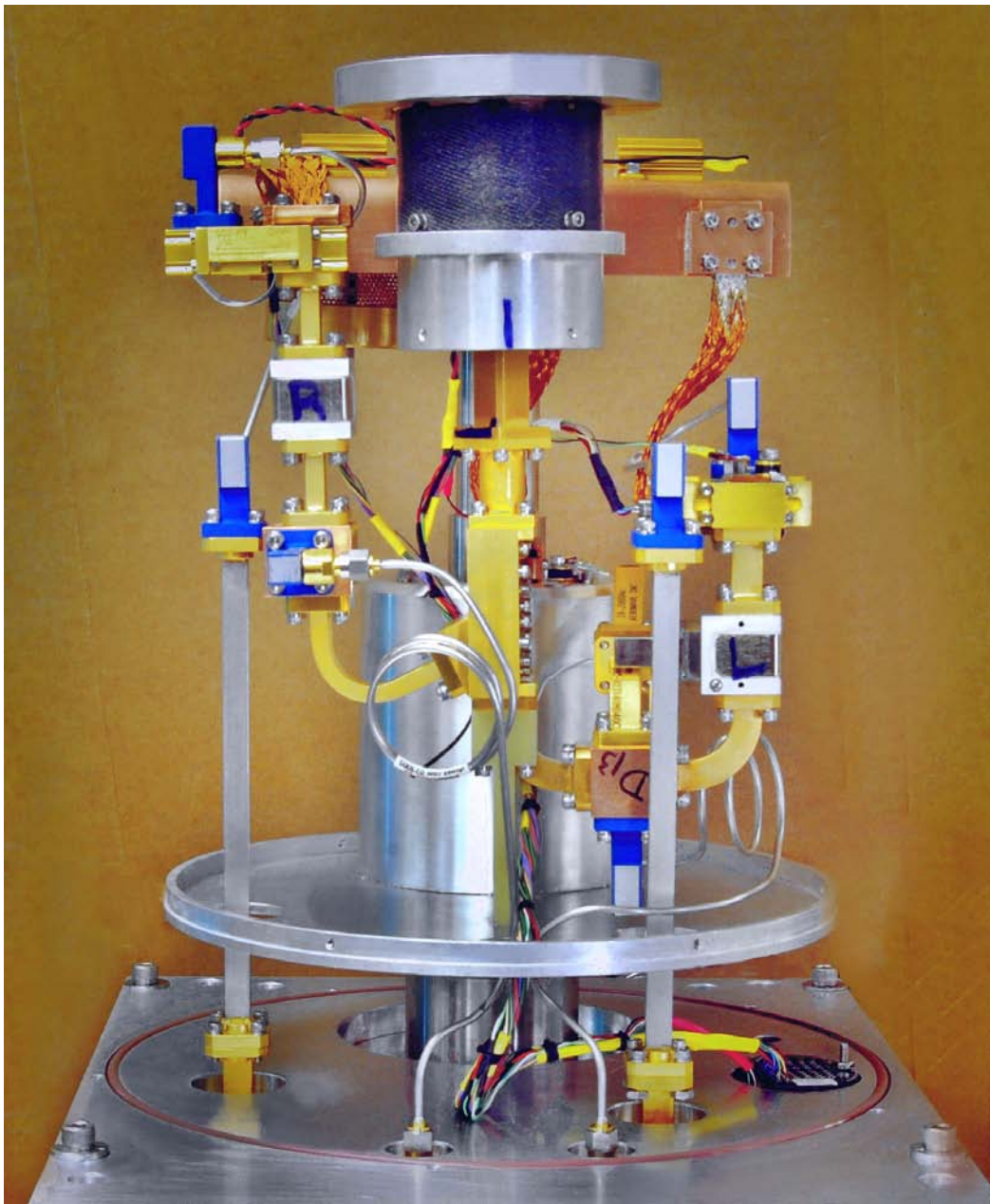
Key:

	Cryogenic Dewar		WR-28 Waveguide
	Vacuum Window		Coaxial Cable, 2.9mm
	MMIC Module		Coaxial Cable, SMA



EVLA A-Band S/N 05-08 : T_{RX} & Axial Ratio
(3 Feb 2009)



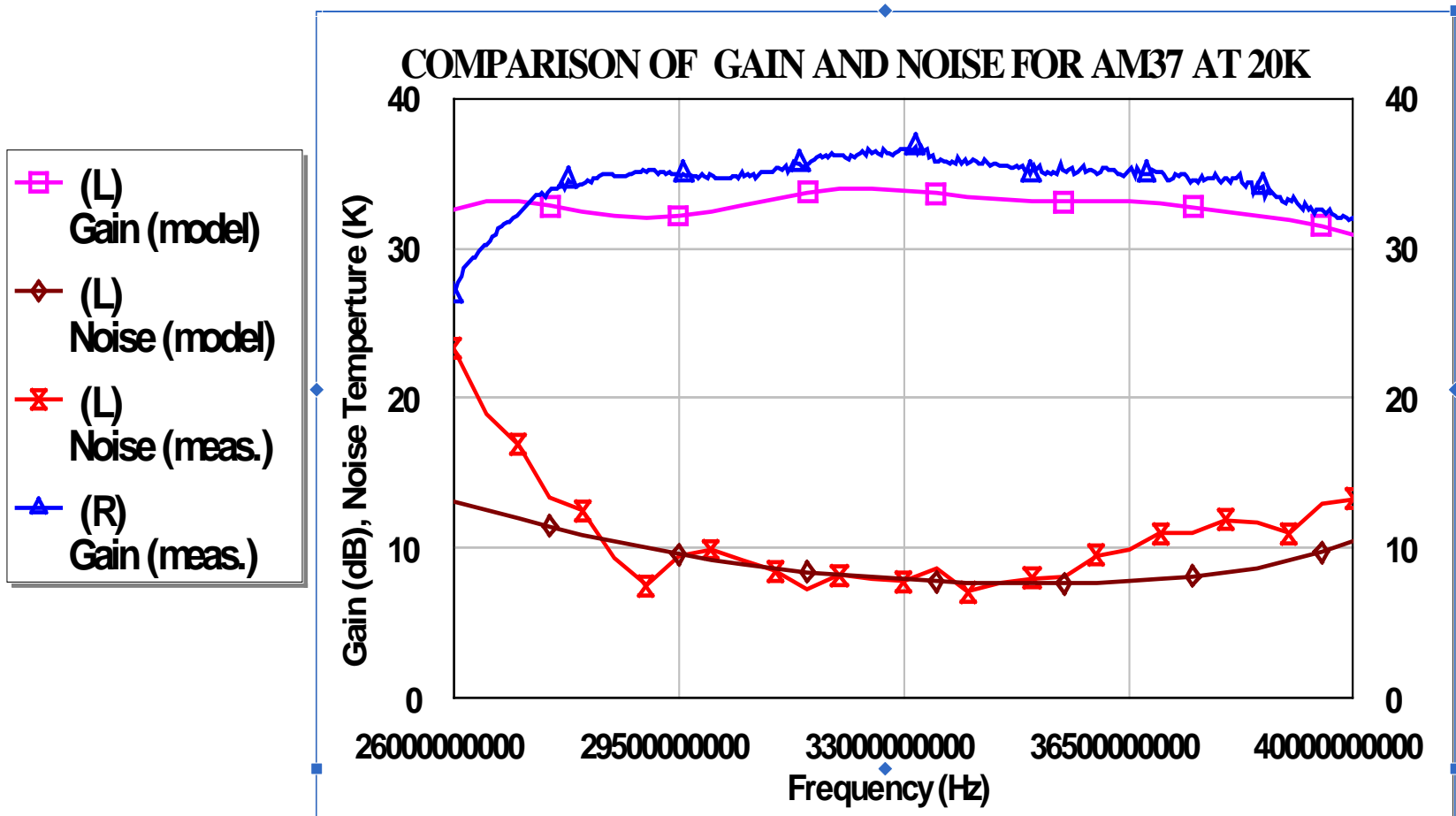


EVLA Receiver
Courtesy: R. Hayward,
P. Harden, NRAO

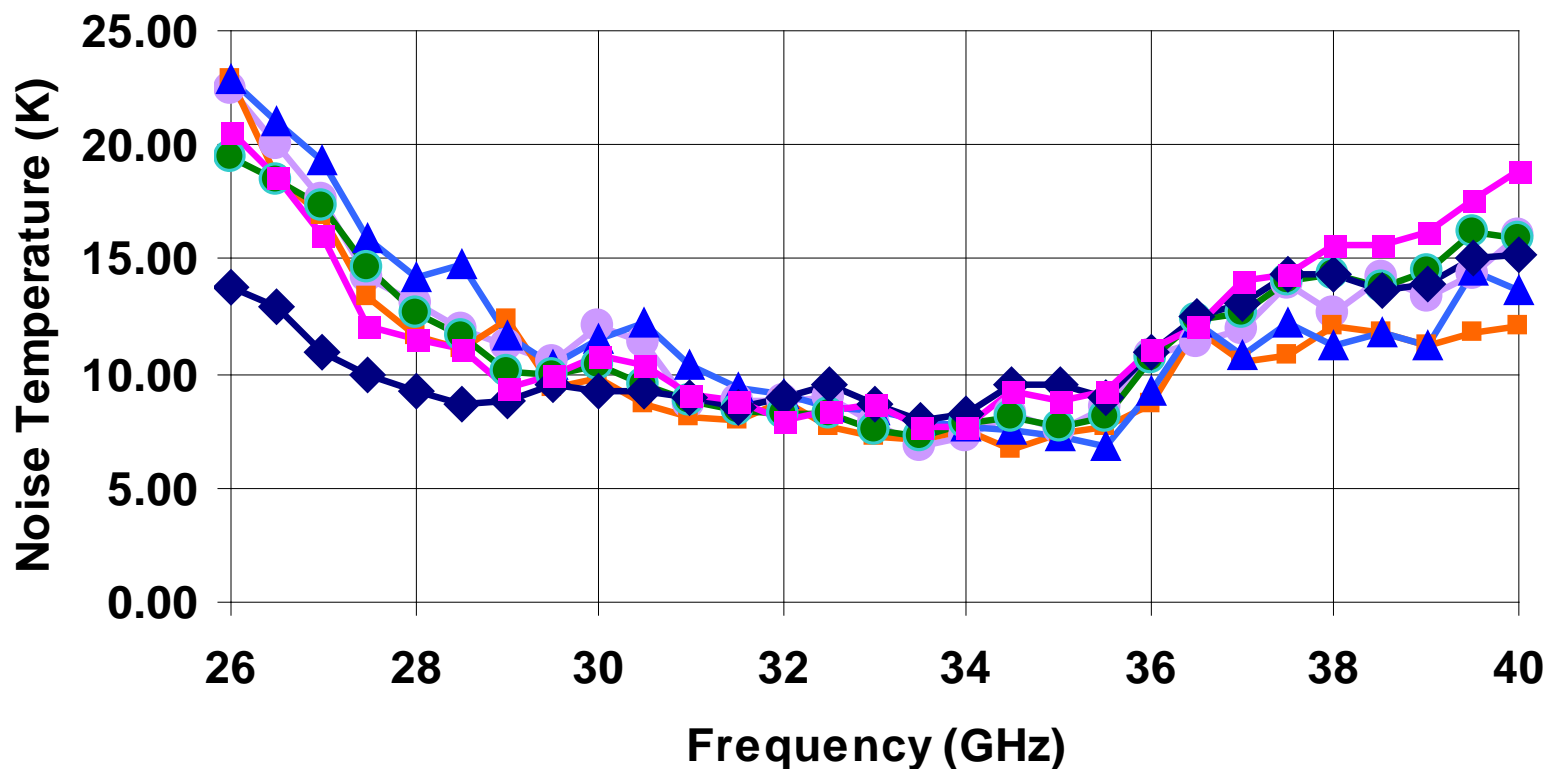
NOISE TESTING OF K-, K_a- and Q-band AMPLIFIERS



EVLA K_a-Band Amplifier



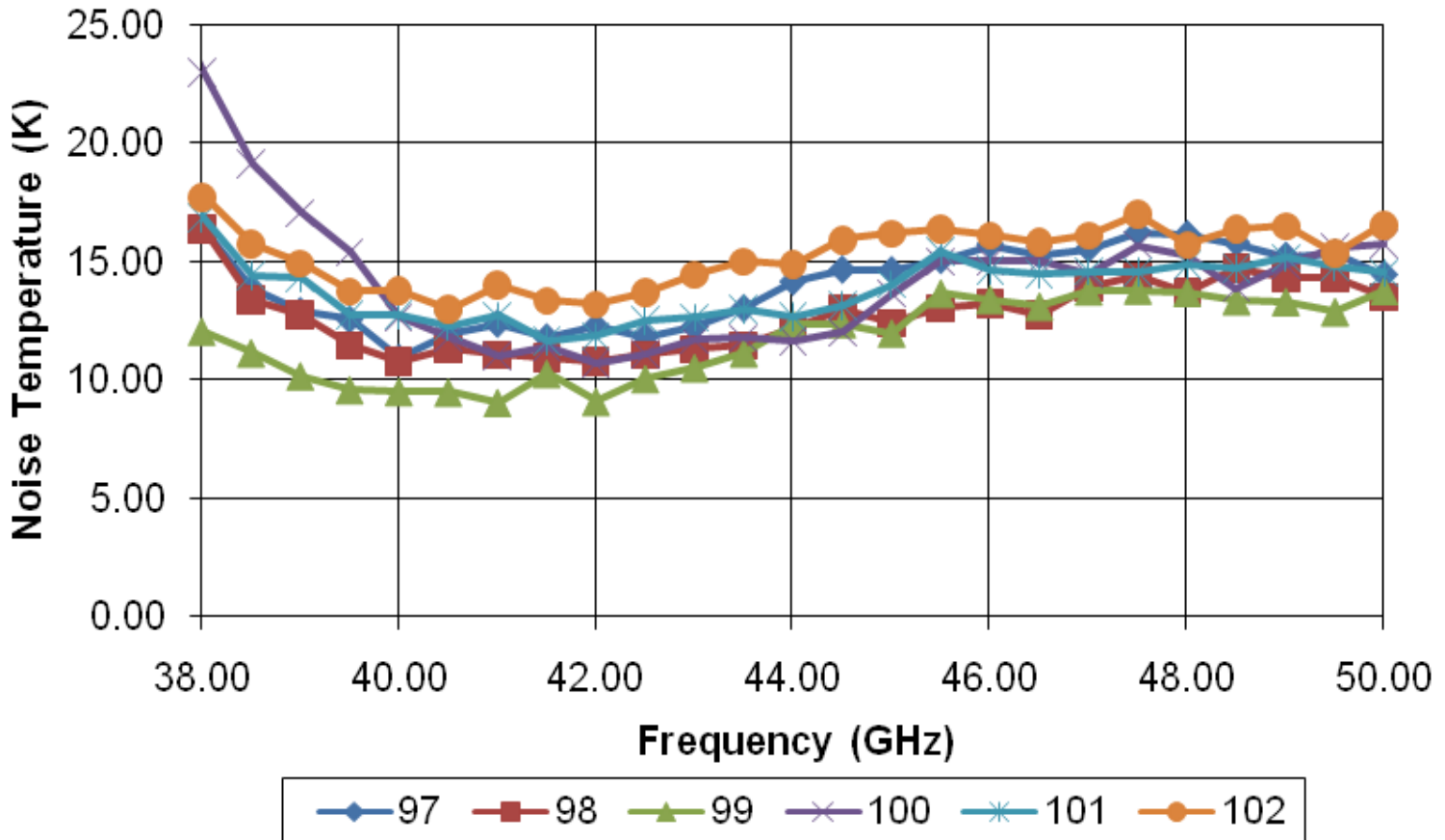
EVLA K_a-Band Amplifiers at 19 K



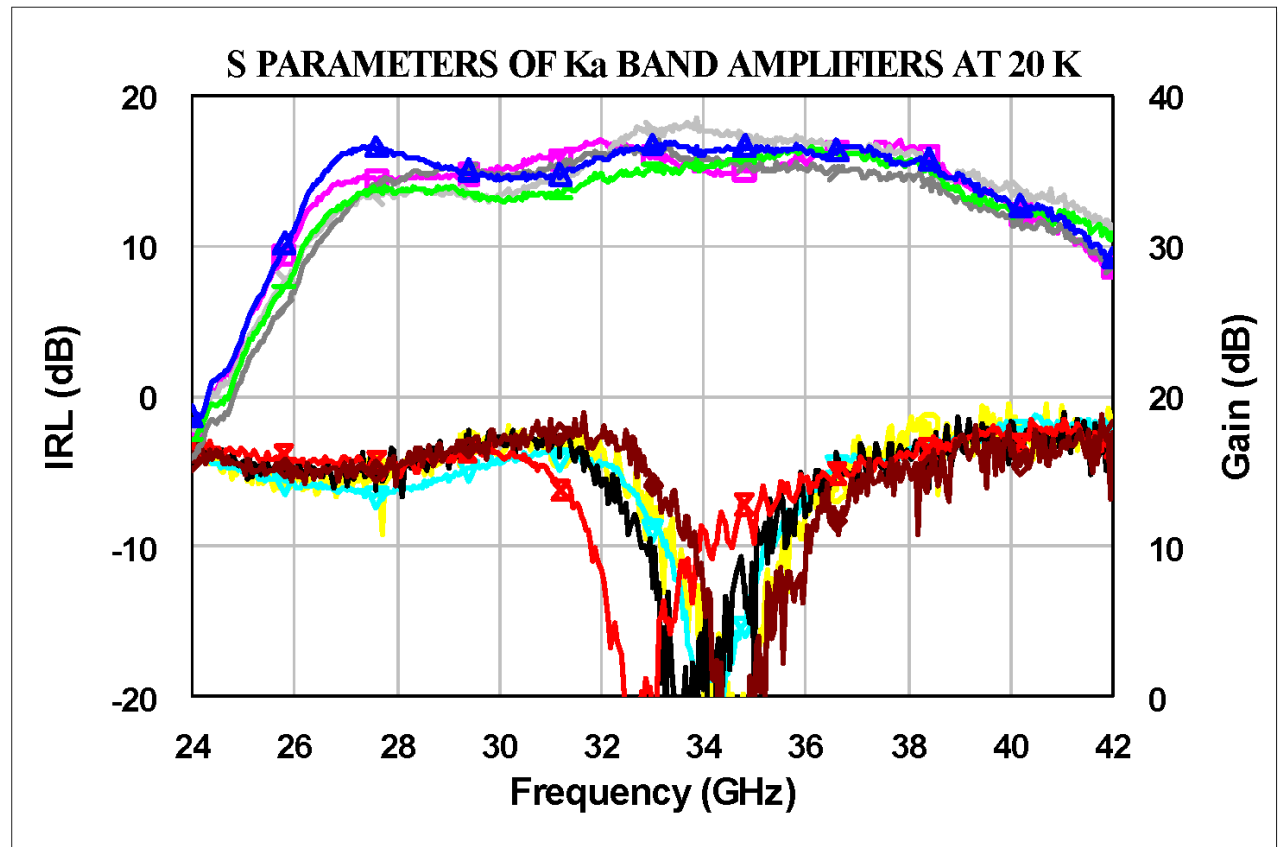
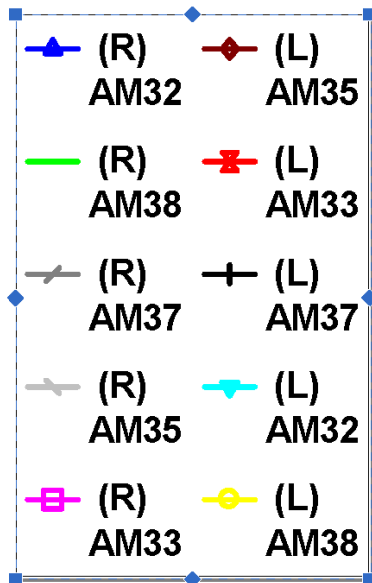
Over 60 amplifiers have been built



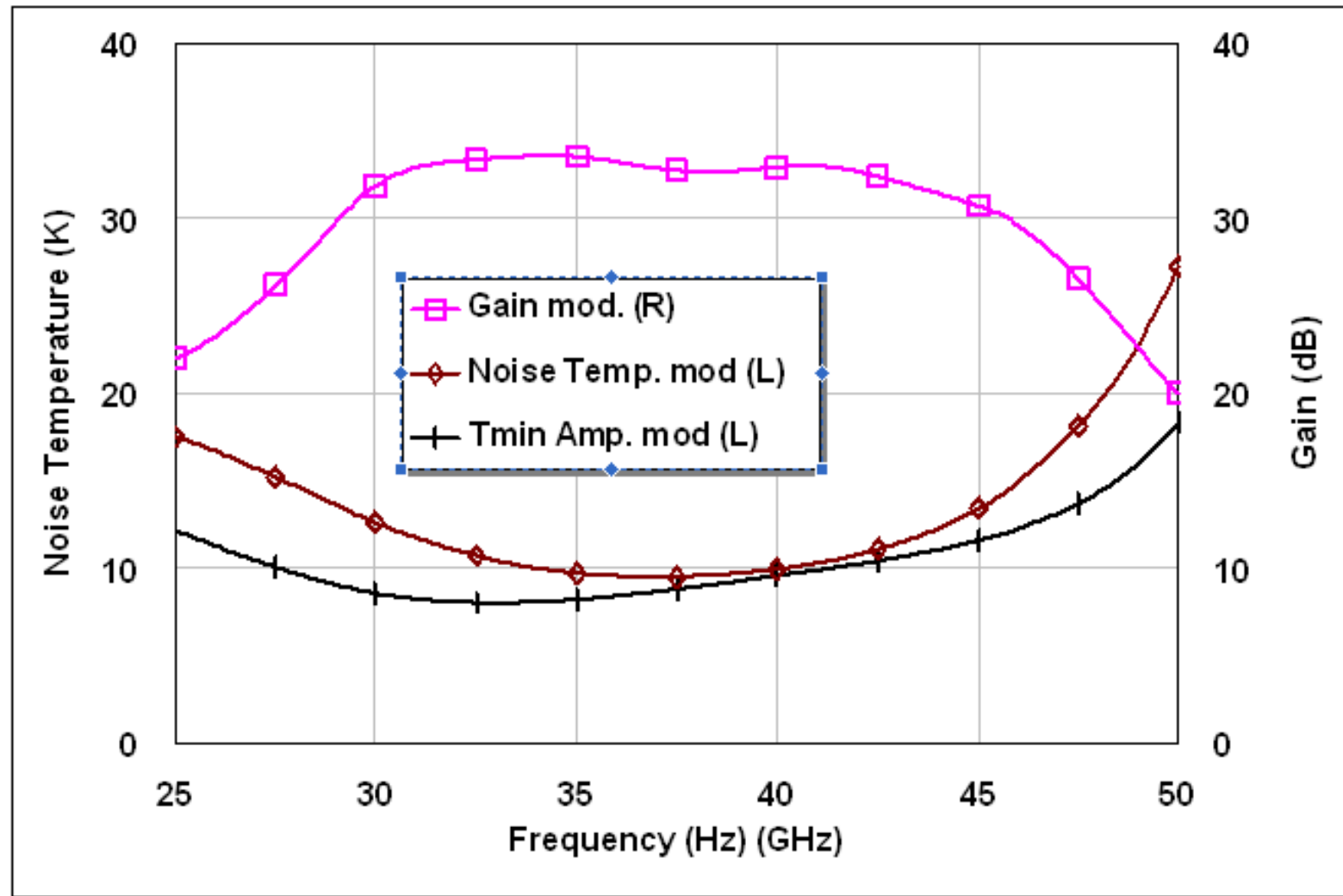
Noise Performance of Q-Band Amplifiers



EVLA K_a-Band Amplifiers



ALMA Band #1 Amplifier Performance



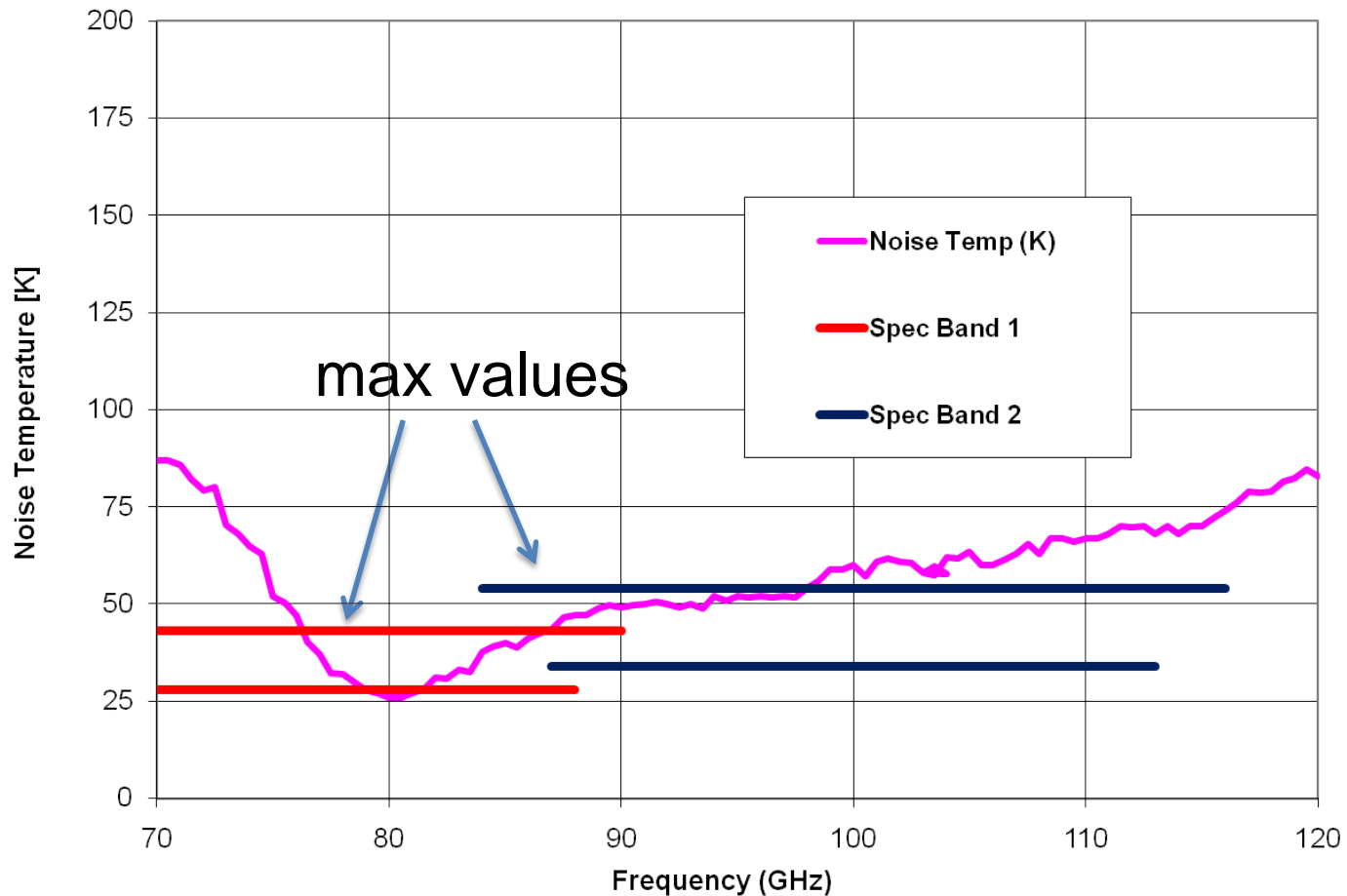
Band #2 and 3

Specifications:

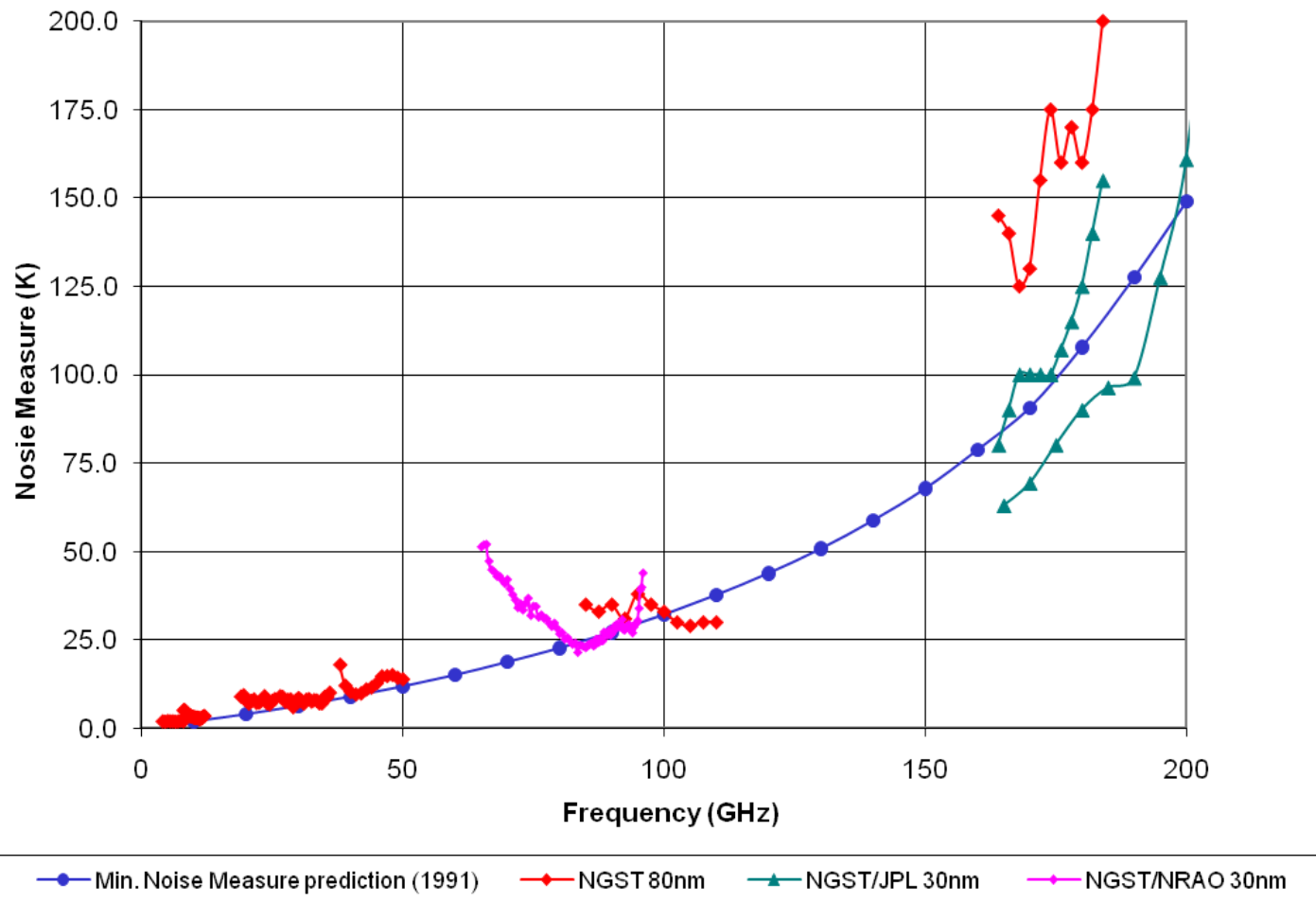
Band	Freq (GHz)	Specification		Goal	
		T(SSB) over 80%	T(SSB) at any freq	T(SSB) over 80%	T(SSB) at any freq
2	67 – 90	28 K	43 K	16 K	24 K
3	84 – 116	34 K	54 K	19 K	29 K

Test Receiver Noise Temperature

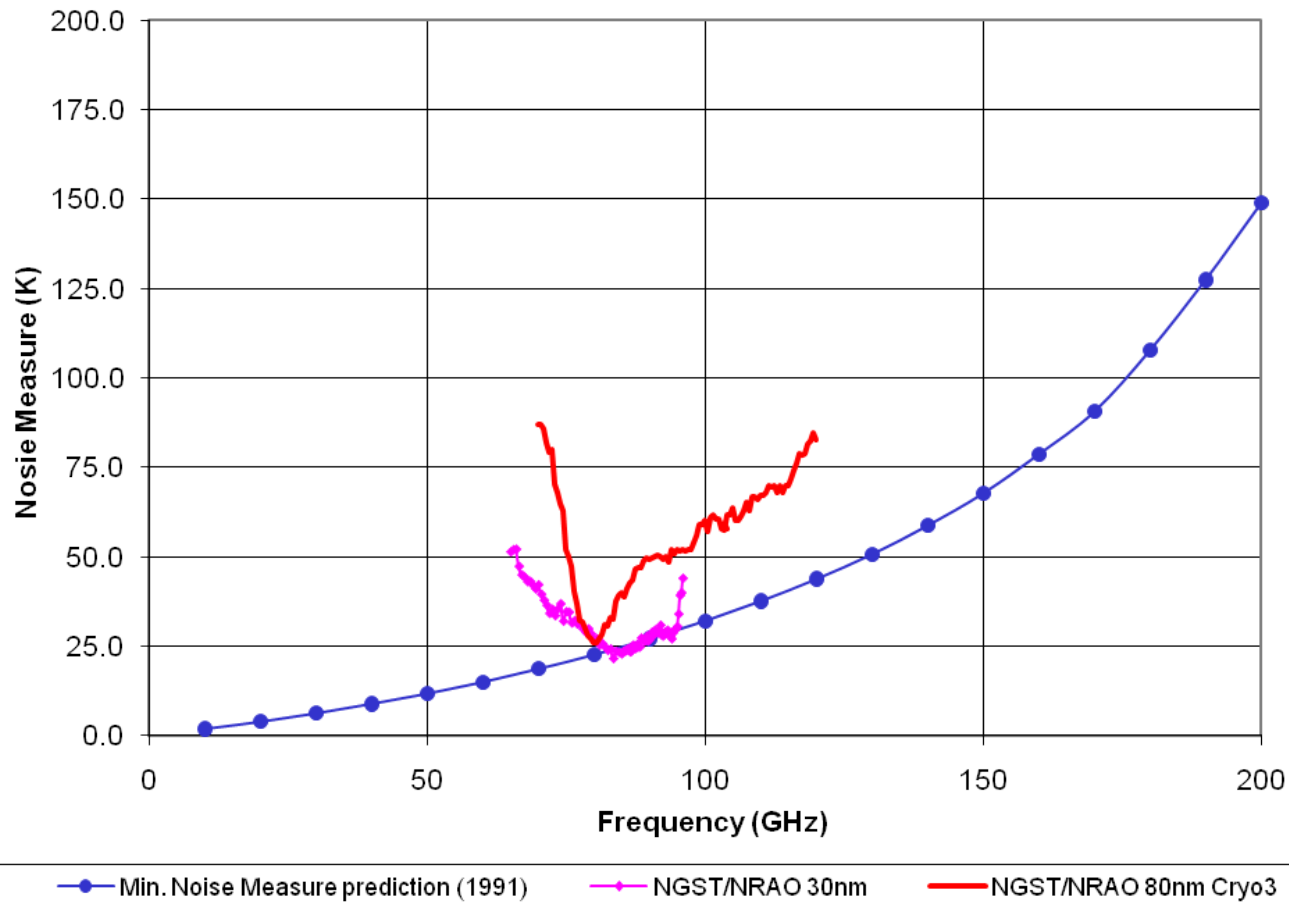
75-115 Test Receiver Noise Temperature



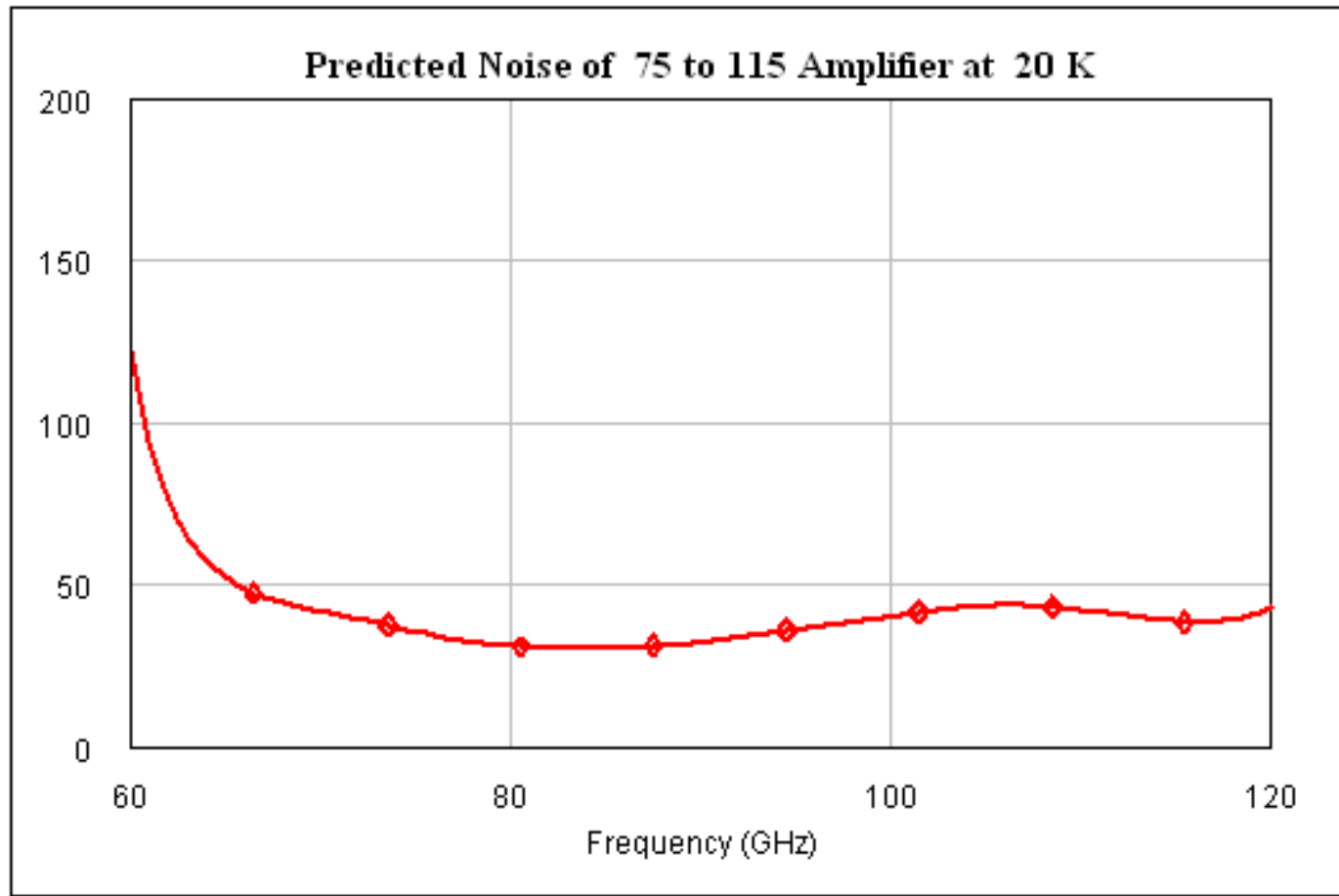
Noise Temperature Summary of Cryogenic HEMTs



Comparison of 80 nm Cryo3 Chip&Wire Amplifier with 35 nm MMIC



Expected Noise of Cryo3 Chip&Wire 75-115 GHz Amplifier



Conclusions

Band #1 amplifiers can be built with cryo3 wafer devices satisfying all T_{rcvr} specifications with good margins

Band # 2 amplifiers can be built with cryo3 wafer devices satisfying all T_{rcvr} (max) specifications and marginally satisfying $T_{\text{rcvr}} < 28 \text{ K}$ (80% of band)

A receiver covering 75-116 GHz (bands ##2&3) is possible with $T_{\text{rcvr}} < 50 \text{ K}$