EVLA Front-End CDR

Plans for
S (2-4), X (8-12) & Ku (12-18 GHz) Receiver Bands

Contents

- S-Band Receiver
  - EVLA Design
- X-Band Receiver
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- Ku-Band Receiver
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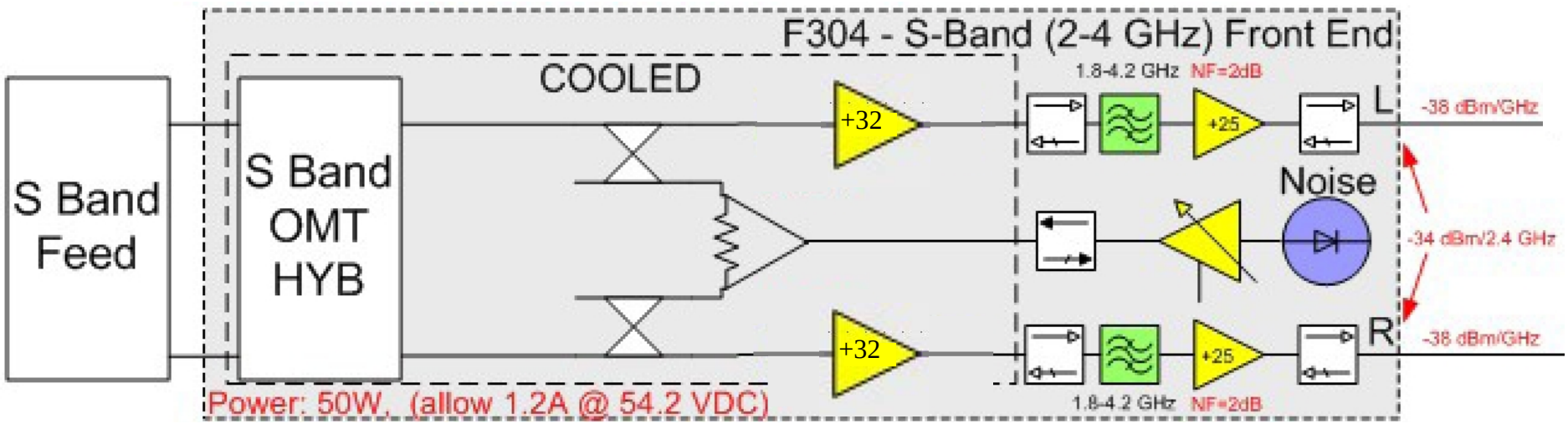
EVLA S-Band

- 2.0 – 4.0 GHz
- Schedule: starting builds in 2008
- Critical design issue
  - OMT scaled from L Band quad-ridge
- Possible reuse L Band dewars
- CTI 350 cryopump is allocated

Block Diagram



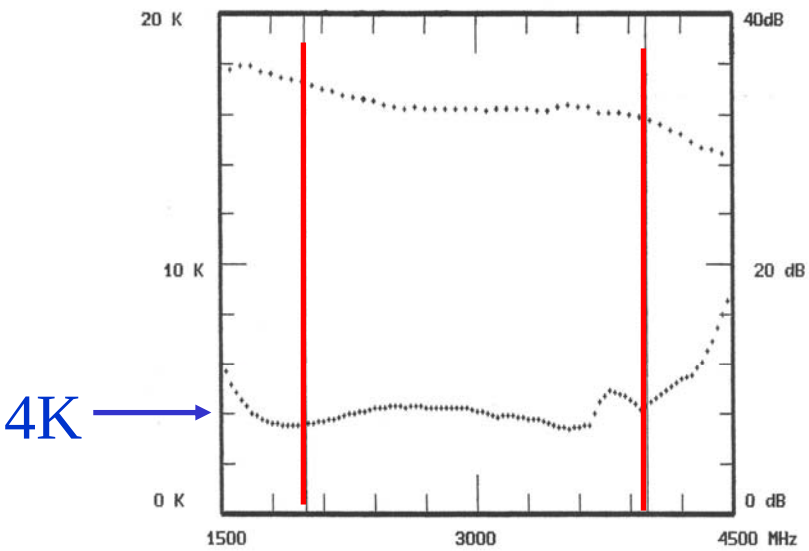
- Quad hybrid OMT
- Cal injection
- 2 stage balanced LNA
- RF Postamp module

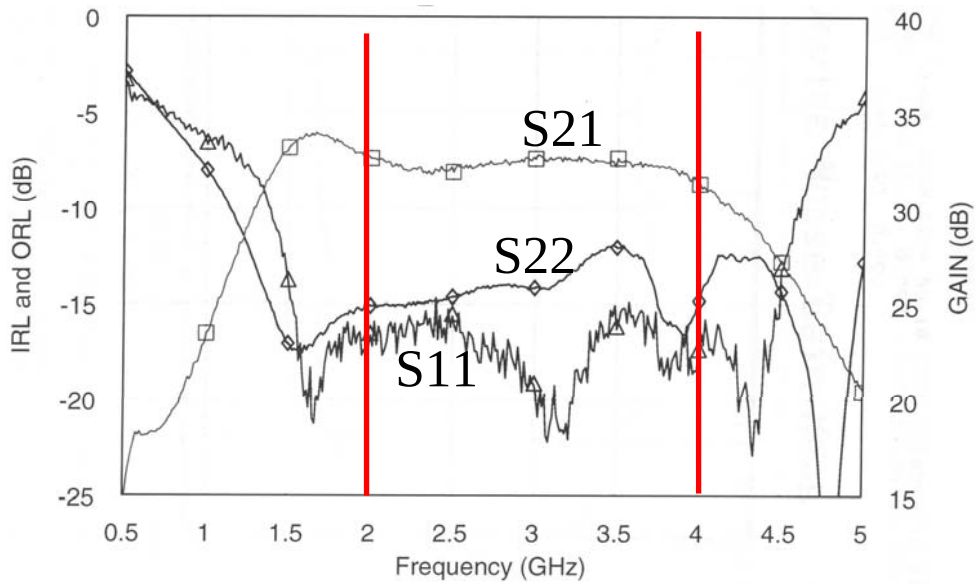
Estimated EVLA T_{Rx}, Output Power & Headroom

EVLA S-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)		
									5000	-90.8	-97.8	
Weather Window			300		-0.02	0.9954	1.385			-90.4		
Feed Horn			300		-0.05	0.9886	3.490			-89.4		
Vacuum Window			300		-0.001	0.9998	0.070			-89.4		
Quad-Ridge OMT			50		-0.1	0.9772	1.184			-89.2		
Coax Cable			32.5		-0.1	0.9772	0.787			-89.1		
Hybrid Phase Shifter			15		-0.2	0.9550	0.752			-89.1		
Coax Cable			15		-0.1	0.9772	0.389			-89.2		
Cal Coupler (IL)			15		-0.2	0.9550	0.806			-89.2		
Cal Coupler (Branch)			300	-30	0	1.0000	0.300			-89.1		
Isolator			15		0	1.0000	0.000			-89.1		
Balanced LNA (2-stage	-5	-17	4		32	1584.8932	4.777	13.94		-56.2		39.2
Stainless Steel Coax			157.5		-2	0.6310	0.069	14.01		-58.2		
Coax Cable			300		-1	0.7943	0.093			-59.2		
Switch			300		0	1.0000	0.000			-59.2		
Isolator			300		-0.5	0.8913	0.055			-59.7		
Filter (1.8-4.2 GHz)			300		-1	0.7943	0.131		2400	-63.9	-67.7	
Post-Amp	15	3	229.6	2.5	30	1000.0000	0.488			-33.8		36.8
Isolator			300		-0.5	0.8913	0.000	14.78		-34.3		

CDL's Low Noise Amplifiers

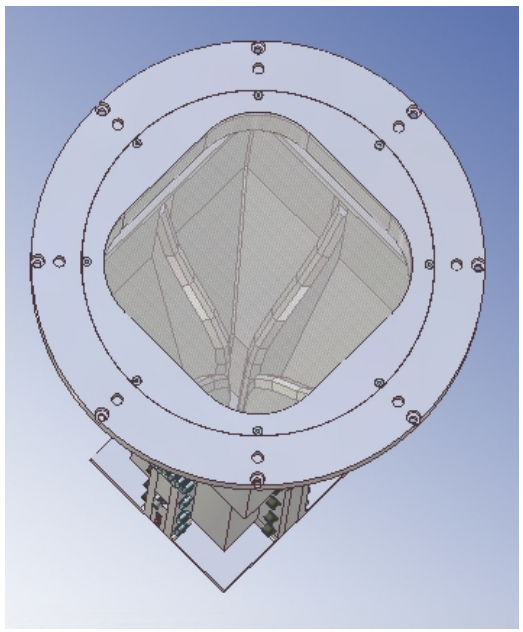
- 16K performance
  - Tamp = 4K
  - Gain = 32 dB
- 295K performance
  - S11: -15dB
  - S22: -13 dB

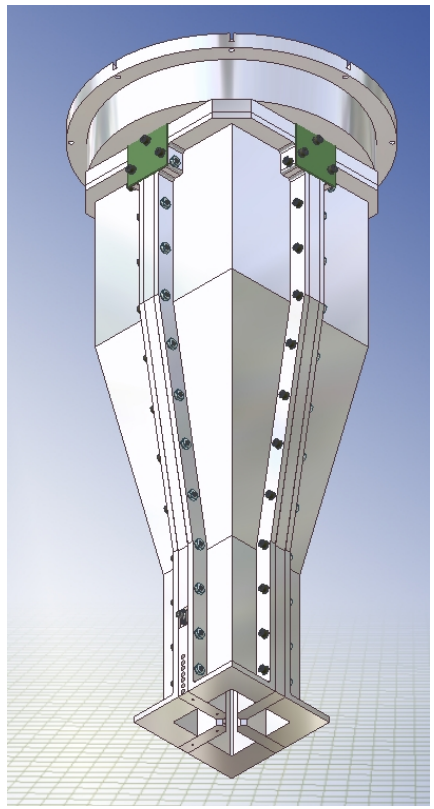




Polarizer Design

- scaled up in frequency from L Band quad-ridge OMT
- full length = 13.25”, ridge width = 0.25”
- .085” coax for probes

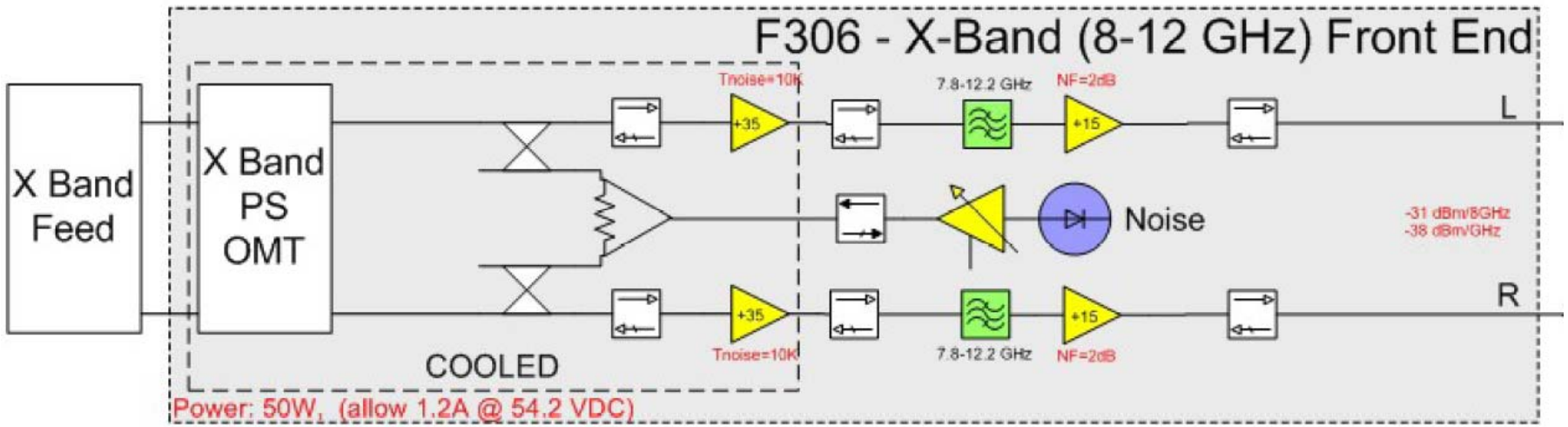




EVLA X-Band

- 8.0 – 12.0 GHz
- Schedule: Transition receivers until 2008, new receivers 2009-2012
- Only critical design issue – Polarizer
- CTI 22 cryopump allocated

Block Diagram



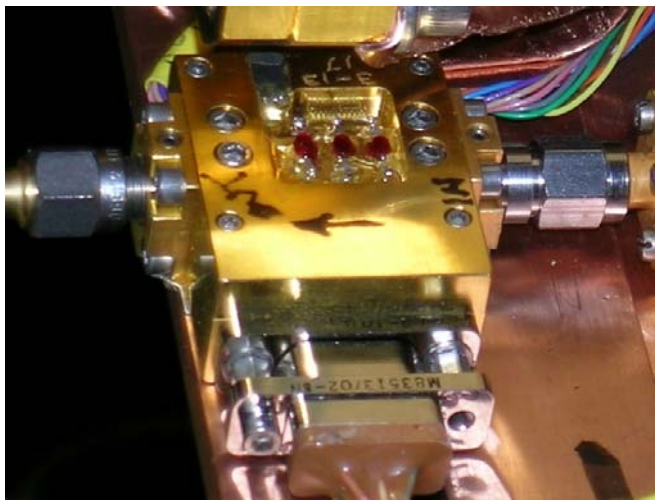
- polarizer undetermined
- cal injection
- cooled isolators
- single LNA
- RF postamp module

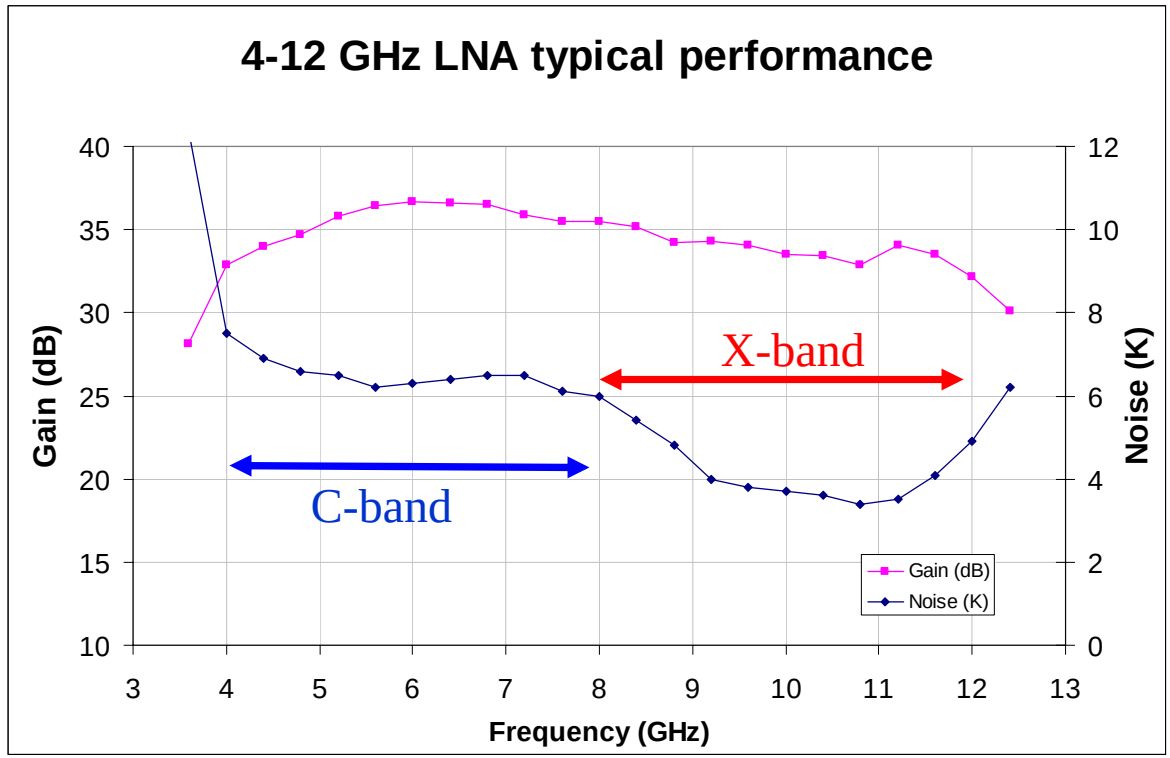
Estimated EVLA X-Band T_{Rx}, Output Power & Headroom

EVLA X-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) for Tsky of 10.0 (K)	Pnoise dBm/GHz	Headroom (dB)
									6000	-90.8	-98.6	
Weather Window			300		-0.03	0.9931	2.080			-90.0		
Feed Horn			300		-0.05	0.9886	3.498			-89.0		
Vacuum Window			300		-0.001	0.9998	0.070			-89.0		
Phase Shifter			18		-0.1	0.9772	0.427			-88.9		
OMT			18		-0.2	0.9550	0.884			-88.9		
Coax Cable			18		-0.1	0.9772	0.458			-88.9		
Cal Coupler (IL)			18		-0.2	0.9550	0.948			-88.9		
Cal Coupler (Branch)			300	-30	0	1.0000	0.300			-88.8		
Isolator			18		-0.5	0.8913	2.569			-88.7		
LNA	-10	-22	6		35	3162.2777	7.875			-52.4		30.4
Stainless Steel Coax			159		-2	0.6310	0.039	19.15		-54.4		
Coax Cable			300		-1	0.7943	0.051			-55.3		
Switch			300		0	1.0000	0.000			-55.3		
Filter (7-13 GHz)			300		-1	0.7943	0.064		6000	-56.3	-64.1	
Isolator			300		-0.5	0.8913	0.038			-56.8		
Post-Amp	13	1	229.6	2.5	25	316.2278	0.269			-31.8		32.8
Isolator			300		-0.5	0.8913	0.000	19.57		-32.3		

CDL's Low Noise Amplifiers

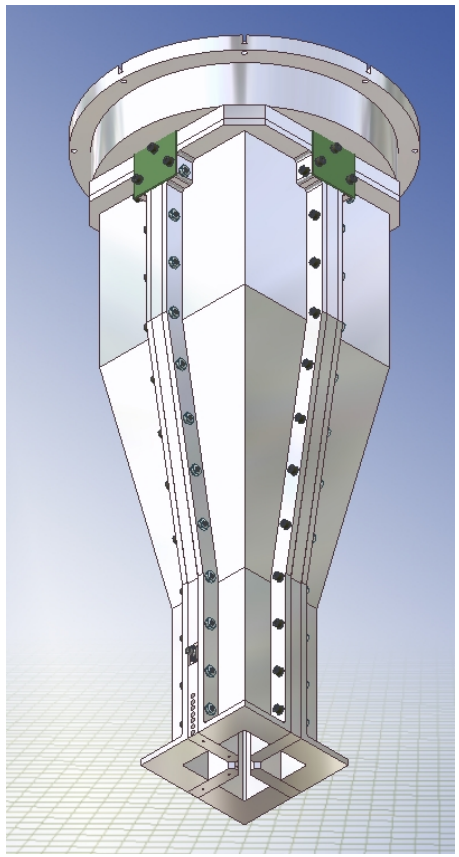
- "CX" 4-12 GHz 3-stage, all InP





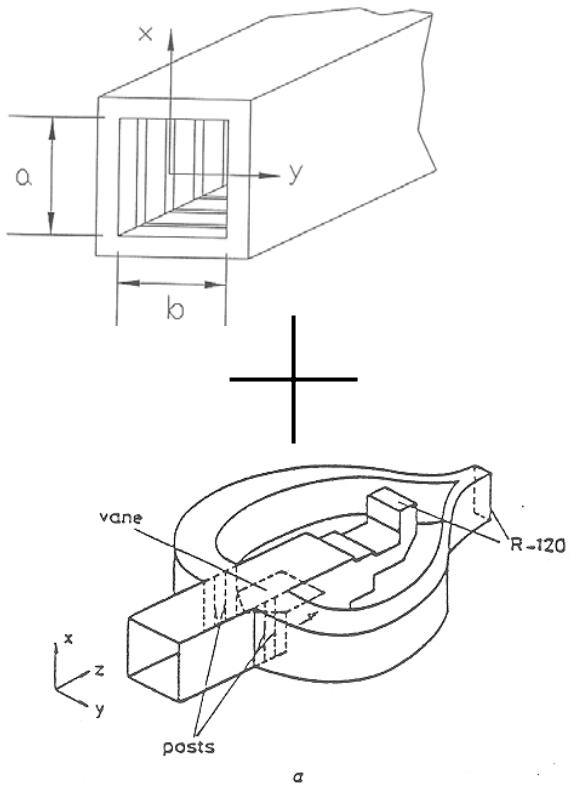
Polarizer Design Options

- Quad-ridge OMT + hybrid
  - full length = 3.975”
  - ridge width = 0.075”
  - .047” coax for probes



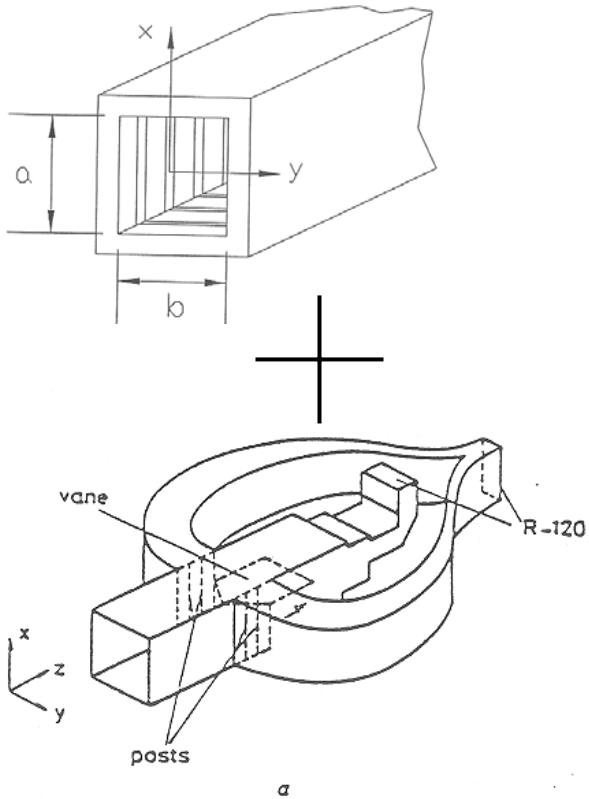
Polarizer Design Options

- Corrugated phase shifter + Bøifot OMT
  - length of phase shifter 9.1”
  - length of Bøifot OMT 8.8”
  - better phase and amp balance than 8-12 hybrid



Polarizer Design Options

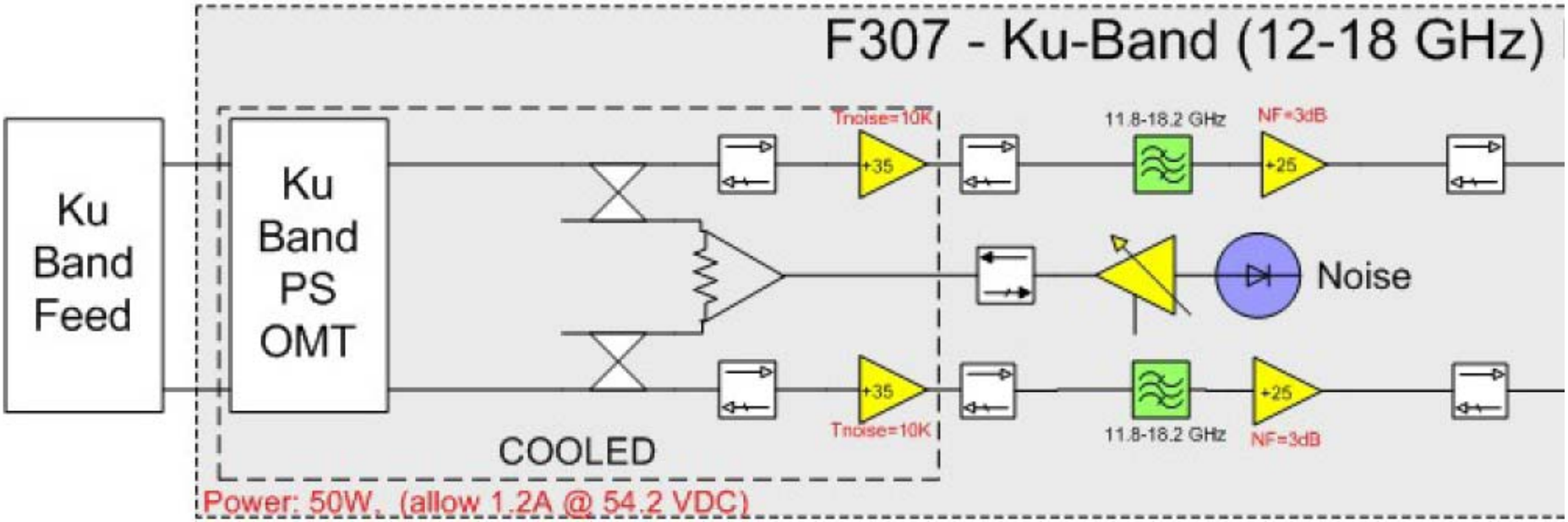
- Cooled dielectric phase shifter + Bøifot OMT
  - length of PS: shorter than corrugated PS
  - better phase and amp balance than 8-12 hybrid



EVLA Ku-Band

- 12.0 – 18.0 GHz
- Schedule: 2007 – 1 prototype, 2010 – 2012 production
- No critical design issues
- Polarizer has been designed

Block Diagram



- cooled phase shifter + Boifot OMT
- cooled isolators
- single LNA
- RF postamp module

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

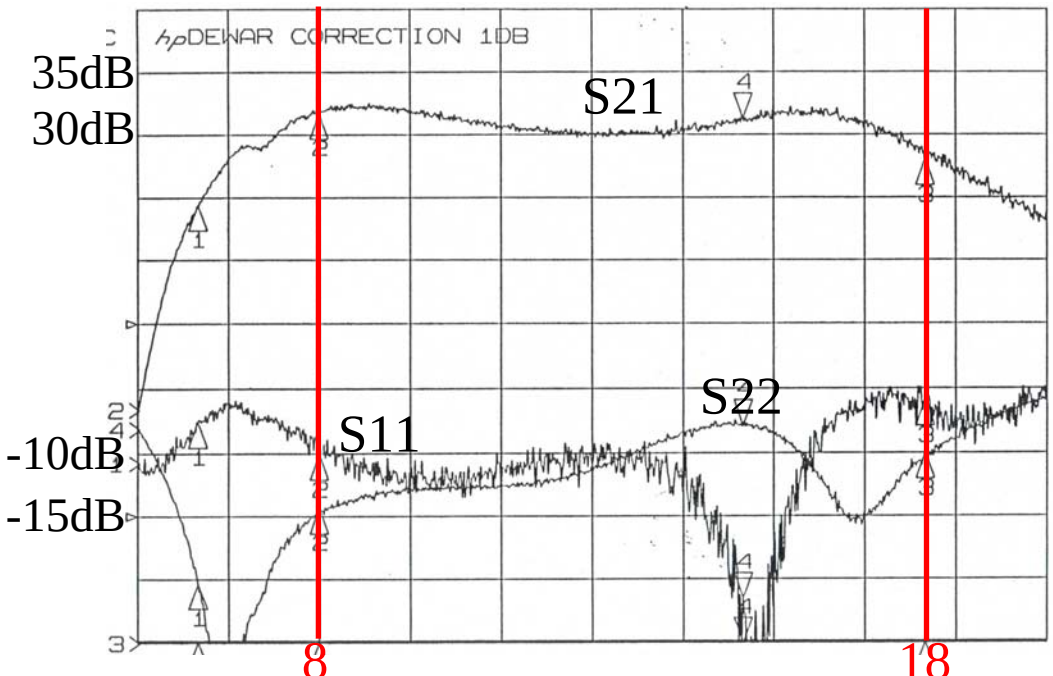
EVLA Ku-Band Rx (RHH : 28 March 2006)	P (1dB) (dBm)	P (1%) (dBm)	Temp (K)	NF/C (dB)	Loss/Gain (dB)	Loss/Gain (linear)	Delta T (K)	Trx (K)	BW (MHz)	Pnoise (dBm) for Tsky of 12.0 (K)	Pnoise dBm/GHz	Headroom (dB)
									8000	-88.8	-97.8	
Weather Window			300		-0.03	0.9931	2.080			-88.1		
Feed Horn			300		-0.05	0.9886	3.498			-87.2		
Vacuum Window			300		-0.01	0.9977	0.704			-87.0		
Phase Shifter			15		-0.1	0.9772	0.357			-87.1		
OMT			15		-0.2	0.9550	0.739			-87.1		
Coax Cable			15		-0.1	0.9772	0.382			-87.1		
Cal Coupler (IL)			15		-0.2	0.9550	0.791			-87.1		
Cal Coupler (Branch)			300	-30	0	1.0000	0.300			-87.1		
Isolator			15		-0.5	0.8913	2.145			-87.1		
LNA	-10	-22	10		35	3162.2777	13.152			-50.2		28.2
Stainless Steel Coax			157.5		-2	0.6310	0.038	24.19		-52.2		
Coax Cable			300		-1	0.7943	0.051			-53.2		
Switch			300		0	1.0000	0.000			-53.2		
Filter (11-19 GHz)			300		-1	0.7943	0.064		8000	-54.2	-63.2	
Isolator			300		-0.5	0.8913	0.038			-54.7		
Post-Amp	10	-2	446.0	4	20	100.0000	0.523			-34.6		32.6
Isolator			300		-0.5	0.8913	0.000	24.86		-35.1		

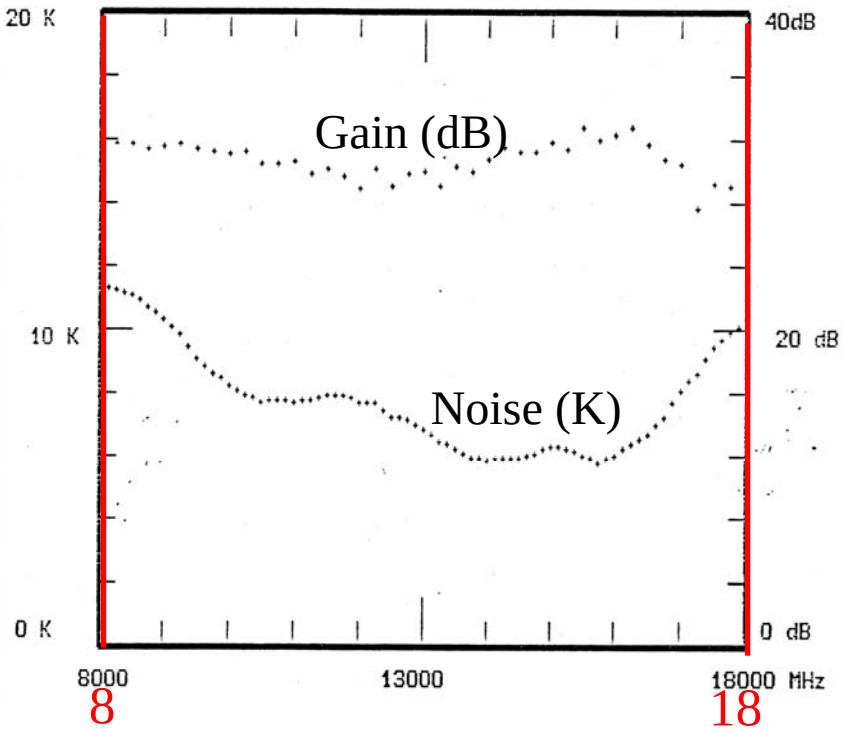
CDL's Low Noise Amplifiers

- CDL model 8-18 GHz
- used in VLBA W Band's second stage

295K performance

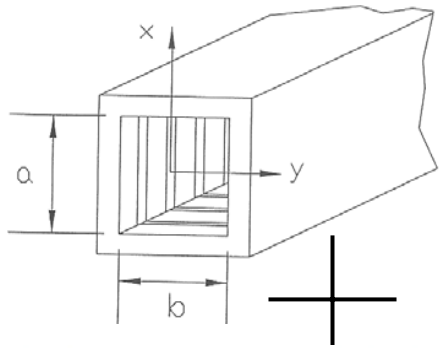
16K performance

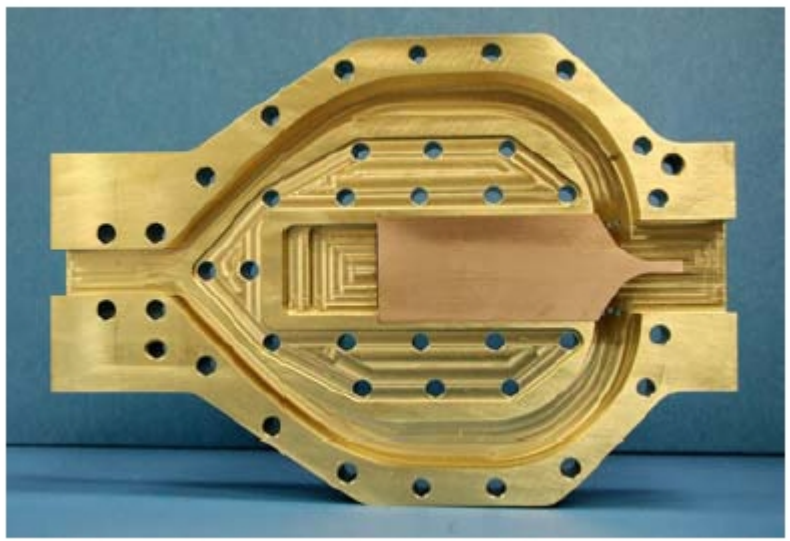




Polarizer Design

- S. Srikanth's corrugated phase shifter shifted down in frequency from K Band model
- Wollack & Gundersen have designed a Ku-Band OMT
- Overall lengths
  - phase shifter: 6.0"
  - OMT: 4.6"





More OMT Information

- Design Band: $1.15 < f/f_c < 1.95$
- Input Guide: 18.5mm ID (0.729")
- Output Guides: WR62.2 (0.622":0.311")
- Side-arm Insertion Loss: <0.05dB
- Main-arm Insertion Loss: <0.04dB
- Return Loss: ~18dB
- Isolation: ~60dB
- Mass: <1000 grams
- Envelope: 118mm x 80mm x 33mm (4.65in x 3.14in x 1.31in)

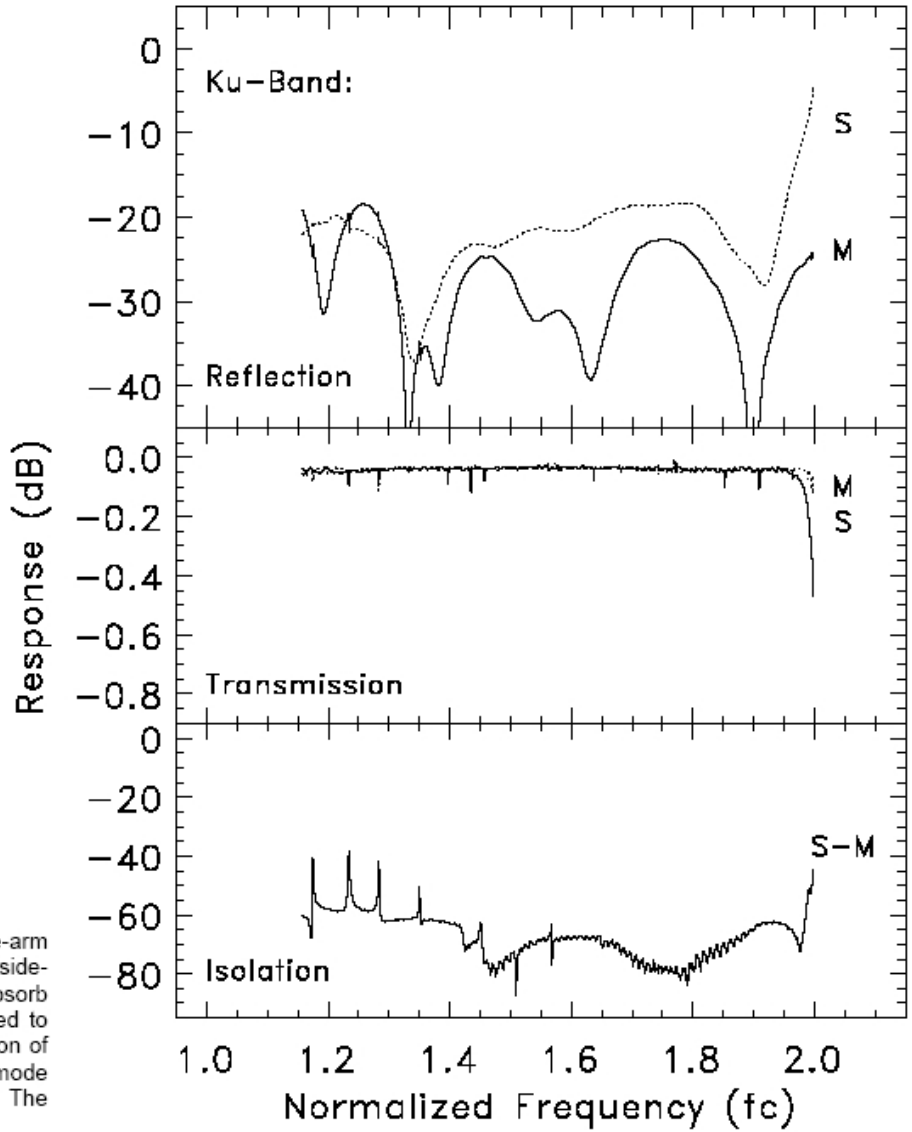


Figure 2: Ku-Band (WR62.2) Orthomode Transducer Performance. The main and side-arm return and insertion losses are indicated by solid and dashed lines respectively. The main-to-side-arm isolation with the common-arm terminated in a cylindrical waveguide with a conical Eccosorb load is indicated by the solid line. Two pins and the nominal septum placement were used to compensate the junction for these measurements. The transition between the square section of the common-arm and the desired circular diameter was realized by a quarter-wave mode converter section [5]. This circular interface is used for the measurements presented. The frequency response is normalized to the WR62.2 cutoff, f_c = 9.494 GHz.

Conclusions

- S Band (2008)
  - needs L Band OMT to scale
- X Band (2009)
  - transition receivers until 2009
  - needs polarizer design resolved
- Ku Band (2007)
  - no design issues