VLBA TEST MEMO NO. 38

90 and 50 cm system status

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A schemetic of the 90 and 50 cm feed, front end and upto input stages in the 327 MHz IF Converter/ 610 MHz Filter Unit is shown in figure 1. Considering very heavy RFI environment around 610 MHz at various stations only about 26 dB (a bare minimum) gain is provided at this band in the front end (located in the FRM tube near the prime focus). Signal bandwidth is limited using a four section 30 MHz bandwidth filter before a signal is further amplified in both 327 MHz Converter unit as well as 610 MHz Filter unit. The bandwidth of the 50 cm band signal had to be limited to 30 MHz because of very heavy RFI on both sides just outside 590-630 frequency range causing (otherwise) compression in the following amplifier.

The schemetic in figure 1 also shows attenuation in cables and various FE components, typical noise calibration signal level, and noise temperatures of the first stage amplifiers. Table 1 shows calculations of the expected system performance at 90 and 50 cm bands for the noise temperatures and attenuation values in figure 1, and assuming antenna efficiency of 50% at 90 cm and 49% at 50 cm as given in the project book. The expected system temperature at both bands are around 168 deg K and expressed in Jy is about 1900 Jy.

Table 2 gives results of measurements made on 1992AUG21 using 7x7 raster. For calculations in the table I have assumed flux density of Cas-A to be 3540 Jy at 611 MHz and 5600 Jy at 327 MHz. Brewester (BR) and Ovens valley (OV) antennas have new dipoles which were constructed using revised trap size of 2.25 inches based on the dielectric constant for the MACOR dielectric material received in 1992 instead of the earlier trap size of 2 inches on the other six antennas (upto HN). Performance of these two antennas (BR and OV) with the new dipole feeds is close to what is expected using revised calculations; namely Tsys (jy)= 1900 +/-150 at both 611 MHz and 327 MHz. Amongst the antennas using old dipoles KP seems to have only slightly poor performance (Tsys ~2300 Jy) at 611 MHz and as expected performance at 327 MHz. At 611 MHz all other antennas (PT, LA, FD, NL, and HN) have considerably poor performance (Tsys = 2300 to 4000 Jy). At 327 MHz performance of these antennas (except LA) is only slightly poor compared to what is expected (increase in Tsys-Jy <~ 20%).

Tables 3 and 4 give results of pointing in azimuth and elevation at 609.99 MHz and 324.99 MHz respectively for nominal subreflector position and the subreflector rotated from its nominal position by 90, 180, and 270 degrees. Pointing observations were made on Cas-A. From T(sys)-Jy at 50 cm and 90 cm it is clear that BR and OV antennas are performing as expected at these frequencies. T(sys)-Jy for various antennas (except LA) at 90 cm is not much worse than what is expected. From the large pointing offset changes(~15 arcmin) with subreflector rotation at 609.99 MHz it is clear that one of the dipole arm on antennas PT, FD, and HN (and perehaps) NL is shorting. KP and LA antennas have old design dipole feeds and may also have tunning/matching problem. It is clear that dipoles on antennas PT, LA, FD, NL, HN, and KP have to be repaired or replaced by new design dipoles as used on antennas at BR and OV. It is also possible that LA and KP have somewhat higher receiver temperatures, though it is not clear from the data. T(cal) values at 90 cm at PT are clearly too high (giving antenna efficieny of .90 to 1.08).

On the two good antennas (BR and OV) efficiency at 50 cm is about 46% to 58%, and at 90 cm is 65% to 72%. The system temperature at 50 cm is about 140 to 200 K, and at 90 cm is about 220 to 250 K. The lower antenna efficiency and lower system temperature seem correlated. Also we donot expect antenna efficiency to be much higher than about 50%. From this it appears that many of the T(cal) values are incorrect.

FIGURE 1 — SCHEMETIC SHOWING 90 AND 50 CM SYSTEM AND VARIOUS LOSS AND NOISE TEMPERATURE VALUES

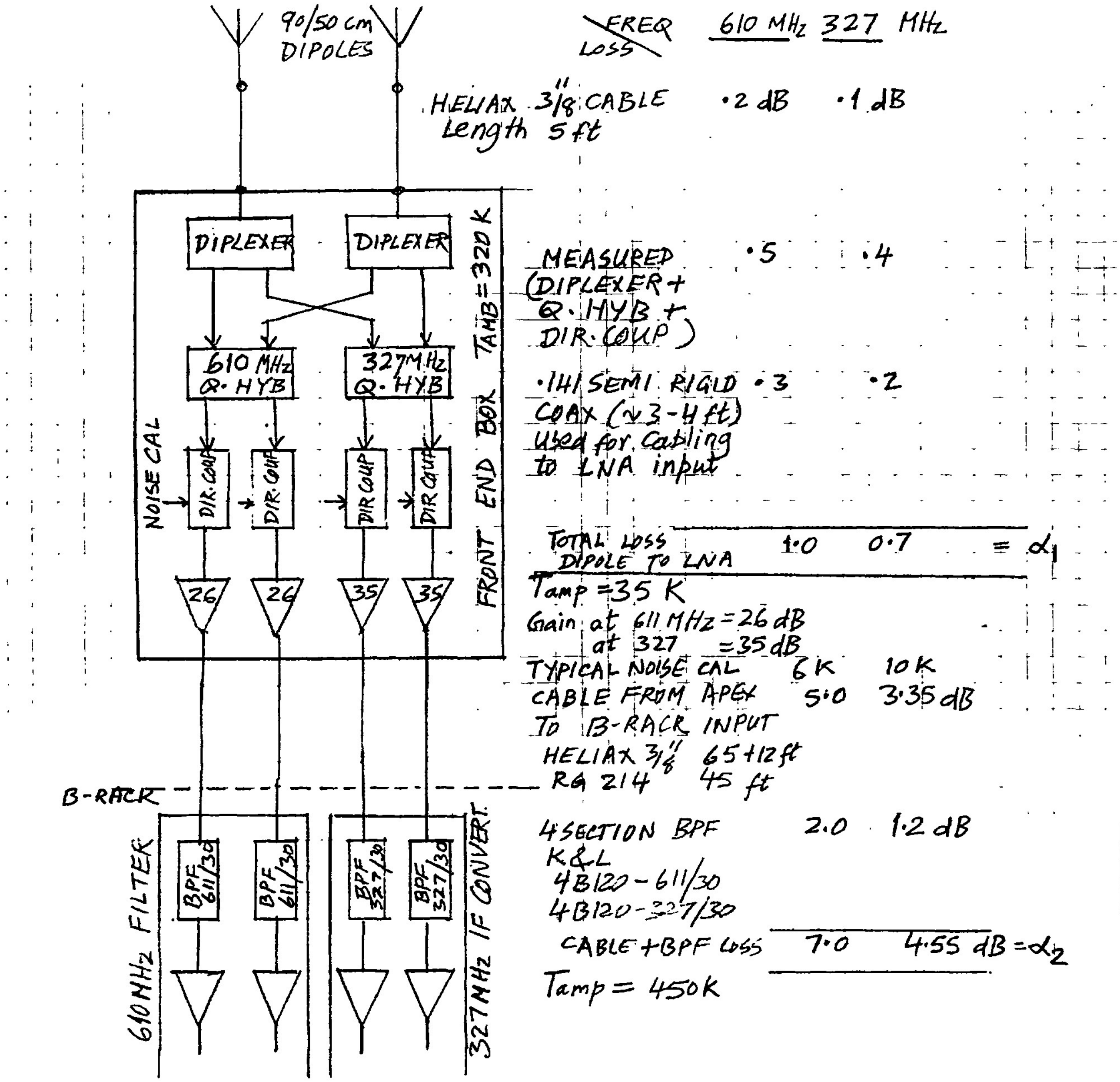

TABLE 1 – EXPECTED SYSTEM TEMPERATURE AT 50 and 90 cm

T_{CONV} = NOISE TEMP OF CONVERTER/FILTER UNIT AT THE OUTPUT OF THE LNA

$$= \frac{(1-\alpha_2)}{\alpha_2}(T_{AMB} + T_{amp}) + T_{amp}$$

$$T_{LNA+AMP} = T_{LNA} + \frac{T_{CONV}}{G_{LNA}} + \frac{T_{CAL}}{2}$$

$$T_{RCV} = \frac{(1-\alpha_1)}{\alpha_1}(T_{FE\text{-}BOX} + T_{LNA+AMP}) + T_{LNA+AMP}$$

$$T_{SYS}(K) = T_{Back\text{-}ground} + T_{spill\text{-}over} + T_{RCV}$$

$$T_{SYS}(Jy) = T_{SYS}(K) / \text{ANTENNA-Efficiency} \times .178$$

	611 MHz	327 MHz	REMARKS
α_1	1.0 dB	0.7 dB	Figure 1
α_2	7.0 dB	4.55 dB	Figure 1
T_{amb}	300 K	300 K	assume
T_{amp}	450 K	450 K	WJ amp A18-1 NF = 4 dB
T_{LNA}	35 K	35 K	ASSUME
G_{LNA}	26 dB	35 dB	TYPICAL
T_{cal}	6 K	10 K	Assume
$T_{FE\text{-}BOX}$	320 K	320 K	
$T_{Back\text{-}ground}$	10 K	50 K	PROJECT Book p 5-10
$T_{spill\text{-}over}$	15 K	15 K	PROJECT Book p 5-10
Antenna eff.	0.49	0.50	PROJECT Book p 5-9
T_{sys} (K)	167	169	
T_{sys} (Jy)	1915	1900	

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TABLE 2 — 90 AND 50 CM PERFORMANCE ON 1992 AUG 21.

ANT.	POL	DIPOLE*	611 MHz Source (CAS)	611 MHz OFF	611 MHz SP	611 MHz Tcal	327 MHz Source (CAS)	327 MHz OFF	327 MHz SP	327 MHz Tcal	611 MHz Tsys Jy	611 MHz Tsys K	611 MHz Ant Eff	327 MHz Tsys Jy	327 MHz Tsys K	327 MHz ANT EFF
BR	R	NEW	152	88	113	4.0	No data			7.2	2049	176	.48			
	L		178	93	98	4.0	No data			7.1	1870	186	.56			
OV	R	NEW	172	96	101	4.0	205	69	97	7.0	1852	180	.54	1885	242	.72
	L		190	95	100	4.0	215	71	88	6.5	1770	190	.60	1849	231	.70
KP	R	OLD	95	63	140	6.9	123	41	145	10.2	2347	217	.52	1867	201	.62
	L		94	61	147	6.7	120	40	149	10.0	2297	204	.50	1867	200	.60
PT	R	OLD	36	36	348	13.8	80	30	212	22.6 (?)	3540	248	.39	2100		
	L		36	40	317	12.1	88	32	185	25.7 (?)	3933	242	.35	2036		
LA	R	OLD	95	78	122	5.7	100	49	146	8.9	2906	222	.43	2744	218	.45
	L		98	72	124	5.7	100	47	145	9.3	2600	205	.44	2632	219	.47
FD	R	OLD	75	70	130	5.6	135	52	120	9.5	3304	196	.33	2157	247	.64
	L		90	73	136	6.0	150	55	110	8.3	2871	219	.43	2053	228	.62
NL	R	OLD	66	68	150	5.6	106	43	136	9.0	3647	190	.29	2272	194	.48
	L		75	72	153	5.1	108	44	154	9.0	3398	184	.30	2261	198	.49
HN	R	OLD	90	78	116	6.0	130	51	119	8.0	3068	234	.43	1904	204	.60
	L		85	81	126	5.7	143	48	120	9.0	3373	231	.38	1880	216	.65

* NEW DIPOLE — REVISED DIMENSIONS (1992 JAN 15) FOR MACOR DIELECTRIC RECEIVED 1992 (TRAP SIZE 2.25")

OLD DIPOLE — USING QUARTER WAVE TRAP OF 2" BASED ON OLD MACOR DIELECTRIC BUT SUSPECTED TO HAVE TUNNING PROBLEM

ANT	SUBREF ROT.	AZIMUTH OFF SET	AZIMUTH BEAM SIZE	ELEVATION OFF SET	ELEVATION BEAM SIZE	T_{ANT} CAS	T_{SYS} (K)	T_{CAL}	ANT. EFF.	T_{SYS} (Jy)	AZIMUTH OFF SET	AZIMUTH BEAM SIZE	ELEVATION OFF SET	ELEVATION BEAM SIZE	T_{ANT} CAS	T_{SYS} (K)	T_{CAL}	ANT. EFF.	T_{SYS} (Jy)
		RCP, FREQ = 609.99 MHz, BW = 2 MHz									LCP, FREQ = 609.99 MHz, BW = 2 MHz								
BR	237.8	-.8	94.5	1.6	93	309	155	4.0	.49	1775	-.9	79	1.2	79	332	186	4.0	.53	1970
	147.8	-2.8	94	2.7	94	290	144		.46	1760	-2.4	79	3.0	78	332	180		.53	1935
	57.8	-3.3	94	1.5	95	290	140		.46	1700	-3.5	79	2.0	79	335	175		.52	1875
	327.8	-1.7	94	-.3	94	290	140		.46	1700	-2.1	79	-.2	79	330	172		.52	1860
OV	314.2	-11.3	77	4	78	330	177	4.0	.52	1920	-8.4	77.6	4.6	78	366	200	4.0	.58	1940
	224.2	-12	77	-.3	78	337	176		.53	1840	-12.6	76.6	2.9	77.4	366	191		.58	1850
	134.2	-8	77	-1.8	78	336	178		.53	1870	-11.2	76.6	-2	77.5	365	190		.58	1880
	44.2	-6.9	78	3.5	78	336	178		.54	1860	-6.2	77.6	-.2	77.6	365	190		.58	1850
KP	88.8	-4.9	76.6	-2.6	78.6	310	220	6.9	.49	2500	-.4	78	-.5	76	305	207	6.7	.48	2380
	178.8	.6	78.3	2.8	77.2	307	220		.49	2520	2.9	77	1.8	78	302	199		.48	2340
	268.8	6.5	77.3	-2.2	77.7	310	208		.49	2380	5.3	78	-4.2	77	302	199		.48	2330
	358.8	.6	78.2	-7.5	76.4	306	210		.49	2420	-1.5	77	-6.8	77.6	300	205		.48	2415
PT	314.1	-1.8	86	8.8	78.8	168	177	10.0	.27	3720	-11	80	8.2	76	190	212	10.3	.30	3900
	224.2	-25.6	84	5.8	81.5	170	177		.27	3690	-22.6	73.8	-3.6	79.5	194	212		.30	3870
	134.1	-20.1	78	-18.7	80.2	181	176		.29	3440	-12.4	77.9	-16.7	77.5	202	218		.31	3850
	44.2	1.5	78	-12.5	84.3	172	174		.27	3530	0.8	78.3	-4.0	80.6	191	215		.30	3980
LA	87.7	-2.6	81	-2.8	77	275	238	5.7	.43	3050	-6.9	78.6	-.4	83.4	270	205	5.7	.43	2650
	177.8	-2.5	76	-6.2	81	273	235		.43	3050	-1	84	-2	79.8	270	208		.44	2750
	267.8	-5.3	81	-7.2	75	277	231		.44	2960	-.5	79	-9	82.5	270	203		.42	2650
	357.7	-6.7	76	-3.8	81.5	278	225		.44	2870	-9.3	81.8	-7.8	78.6	284	190		.45	2360
FD	105.7	-3.7	80.5	-1.9	75.8	233	227	5.6	.37	3450	-2.8	79	-3	77.8	249	223	6.0	.40	3155
	195.8	-6.6	76.1	-13.4	77	232	221		.37	3350	-3.4	78.2	-14.4	75.8	251	224		.40	3165
	285.7	-17.4	75.2	-10.8	75	236	215		.37	3240	-19.3	73	-13.8	75	265	220		.42	2945
	375.8	-15.3	73.1	.6	80.8	235	221		.37	3330	-16.4	74.1	3.1	78.8	250	216		.40	3060
NL	126.3	-2.1	82	-6.4	82.4	161	174	5.2	.25	3830	-4.1	78.6	7.8	82.3	218	204	5.5	.35	3300
	216.3	0	82.2	-3.9	81	162	178		.25	3890	14.0	81.2	6.7	78.5	216	202		.34	3300
	306.3	9.9	80.8	2.3	82.2	163	177		.25	3830	12.3	77.8	-1.2	81.3	218	204		.35	3320
	396.3	8.1	82	-7.1	80.7	156	177.5		.25	3960	-6.4	81.8	-9.5	76.8	215	212		.34	3485
HN	107.4	12.5	75.6	-11.6	80	214	193	4.89	.34	3195	16.4	81	-6	83	216	188	4.6	.34	3090
	197.4	-10.8	79.4	-14.3	74	215	190		.34	3110	-5.8	81.5	-18	80	216	188		.34	3080
	287.4	-12.5	74.8	9.4	81.5	213	191		.34	3170	-16.2	79.4	4.2	82	217	181		.34	2960
	377.4	10.5	80.2	12.1	75.8	213	196		.34	3280	5.4	82.1	15.7	81.5	213	181		.34	2985

TABLE 3 - POINTING RESULTS AT 609.99 MHz FOR VARIOUS SUB-REFLECTOR ROTATION POSITIONS.

ANT	SUBREF ROT.	AZIMUTH		ELEVATION		T_{ANT} CAS	T_{SYS} (K)	T_{CAL}	ANT. EFF.	T_{SYS} (Jy)	AZIMUTH		ELEVATION		T_{ANT} CAS	T_{SYS} (K)	T_{CAL}	ANT. EFF.	T_{SYS} (Jy)
		OFF SET	BEAM SIZE	OFF SET	BEAM SIZE						OFF SET	BEAM SIZE	OFF SET	BEAM SIZE					
		RCP, FREQ = 324.99 MHz, BW = 2 MHz									LCP, FREQ = 324.99 MHz, BW = 2 MHz								
BR	237.8	.5	152	-.6	150	649	230	7.2	.65	1980	1.5	153	-.6	151	680	235	7.1	.69	1900
	147.8	1.5	152	.8	150	640	220		.64	1960	-.6	153	2	148	692	232		.69	1870
	57.8	-.7	150	.6	149	650	224		.64	1940	-1	151	-1.4	150	690	229		.69	1860
	327.8	-1.2	149	-.4	151	635	226		.64	1995	0	150	-2.4	151	675	230		.68	1900
OV	314.2	-62	149	2.2	150	725	248	7.0	.72	1960	-9.5	149	1.8	149	720	241	6.5	.72	1850
	224.2	-10	147	.7	149	730	246		.72	1900	-9.1	148	-2.5	148	715	236		.72	1850
	134.2	-8.7	148	-2.6	151	710	246		.71	1935	-57	149	-3.3	151	710	236		.71	1860
	44.2	-6	151	-1.0	148	711	248		.71	1950	-6	152	.9	149	707	238		.71	1880
KP	88.8	2.2	150	-3.8	149	628	205	10.2	.63	1835	3.5	150	-3.3	149	592	191	10.0	.59	1800
	178.8	.5	149	-3.6	150	620	202		.62	1825	2.2	150	-5	149	582	188		.58	1810
	268.8	1.6	150	-3.4	149	630	202		.62	1835	.2	150	-3	149	581	187		.57	1800
	358.8	2.0	150	-2	150	628	205		.63	1835	.9	150	-1	148	582	188		.58	1810
PT	314.1	-14	147	-2	152	906	335	22.6	.91	2060	-15	148	-7.3	150	1090	409	25.2	1.08?	2110
	224.2	-15	149	-8	149	915	334		.92	2040	-8	149	-8.4	151	1070	411			2150
	134.2	-7	147	-8	150	915	336		.92	2055	-5.8	151	-3.2	149	1085	414			2130
	44.2	-8	148	-2	148	930	338		.93	2035	-12.5	148	-.2	149	1100	421			2140
LA	87.8	-2.2	153	-5.8	148	400	202	9.9	.40	2830	-4.8	154	-4.8	148	412	196	9.3	.41	2640
	177.8	-4.5	147	-6.3	152	405	200		.41	2770	-2	149	-4.8	153	409	195		.41	2650
	267.8	-3.8	151	-6	149	377	212		.38	3150	-2.4	152	-6.7	148	384	206		.39	3000
	357.9	-3.7	148	-4	152	389	205		.39	2950	-4.8	149	-6.4	152	400	202		.40	2820
FD	105.7	-8	146	-9	144	640	244	9.5	.64	2150	-9	150	-7	149	635	230	8.3	.63	2020
	195.7	-11	142	-9.5	146	630	240		.63	2120	-8	146	-9	147	625	230		.62	2045
	285.7	-11.7	144	-6.6	146	640	241		.64	2115	-11	145	-8	150	628	225		.63	2010
	375.8	-8.8	148	-5.0	146	630	243		.63	2160	-12	152	-6	148	615	226		.61	2060
NL	126.3	6	148	-4.6	151	480	186	9.0	.48	2160	6	151	-2.5	150	490	197	9.0	.49	2230
	216.3	2	150	-2.8	149	481	187		.48	2175	6	150	-7	150	483	196		.49	2270
	306.3	5	147	-2.6	151	479	187		.48	2180	3.8	150	-3.6	150	497	196		.50	2210
	396.3	6.6	149	-1.7	147	483	190		.48	2210	5.6	151	-1.8	150	495	200		.50	2260
HN	107.4	4.2	152	-4	153	595	212	8.0	.59	1990	1.9	151	-4.8	149	610	209	9.0	.61	1900
	197.4	1.4	152	-7	151	594	213		.59	2020	-1.2	147	-4.3	151	606	211		.60	1960
	287.4	-1.1	150	-4.4	151	598	214		.60	2005	.2	149	-1.2	147	616	212		.62	1925
	377.4	2.1	152	0	148	606	215		.60	1990	5	148	-2	147	614	213		.62	1940

TABLE 4 – POINTING RESULTS AT 324.99 MHz FOR VARIOUS SUB-REFLECTOR ROTATION POSITIONS.