Summary of DSS28 Efficiency Measurements

Nov 21, 2008

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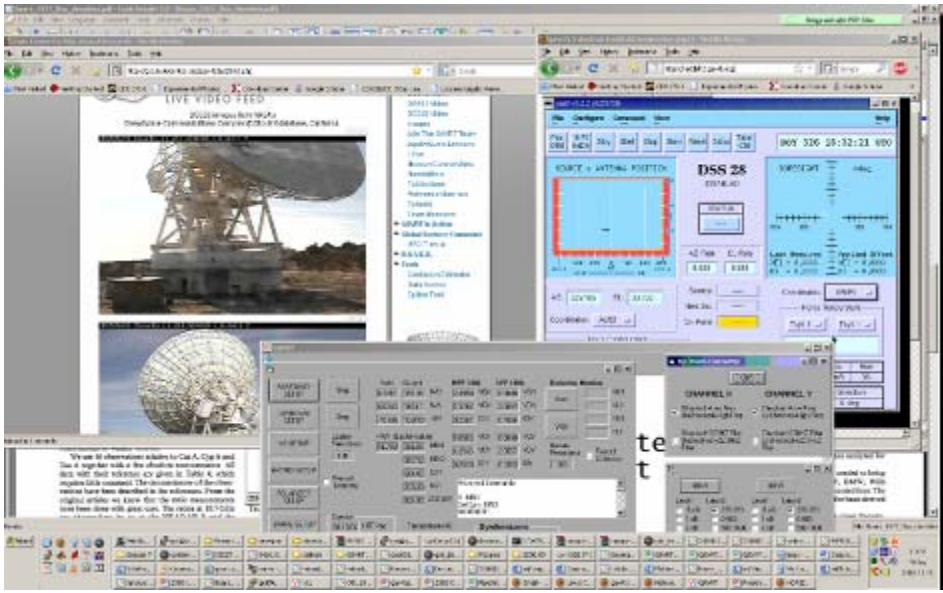
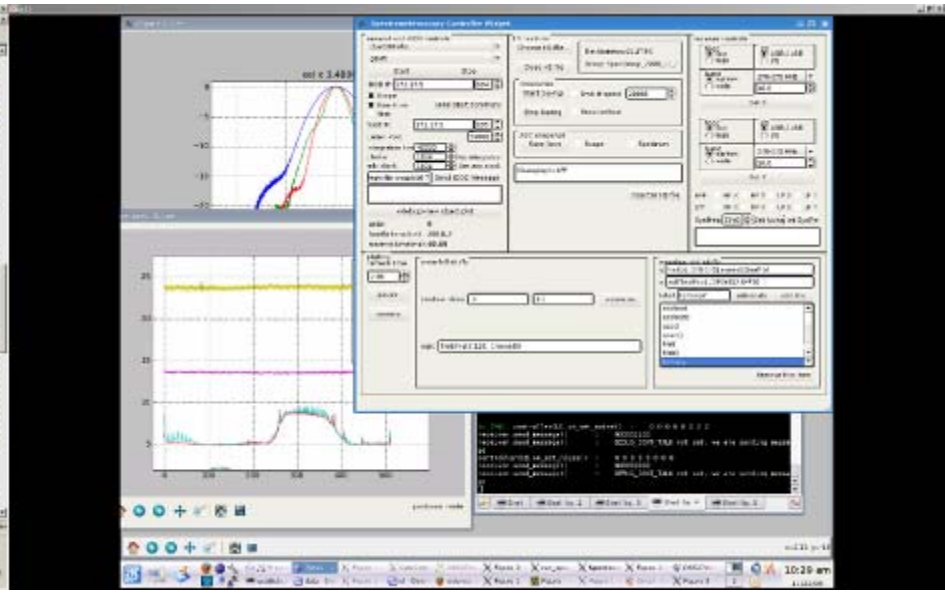
1. Efficiency
2. Beam Patterns
3. Tsys Tipping Curves
4. Tertiary Patterns
5. LFF RFI
6. Conclusions

DSS28 Test Configuration, Nov 21 and Nov 23, 2008

- The telescope, tertiary, receiver, and spectrometer were controlled from Caltech through two computer terminals with screen-shots below
- Ryan Dorcey and an ITT person were in the DSS28 alidade room to start the telescope control system and take control if needed.





DSS28 34m Telescope

Secondary (shadow)

2-14 GHz Cooled Feed

0.5-4 GHz Feed

Receiver Box

Rotatable Tertiary

GAVRT DSS-28 Vertex
Goldstone, CA

DSS28 Efficiency and Tsys Measurements

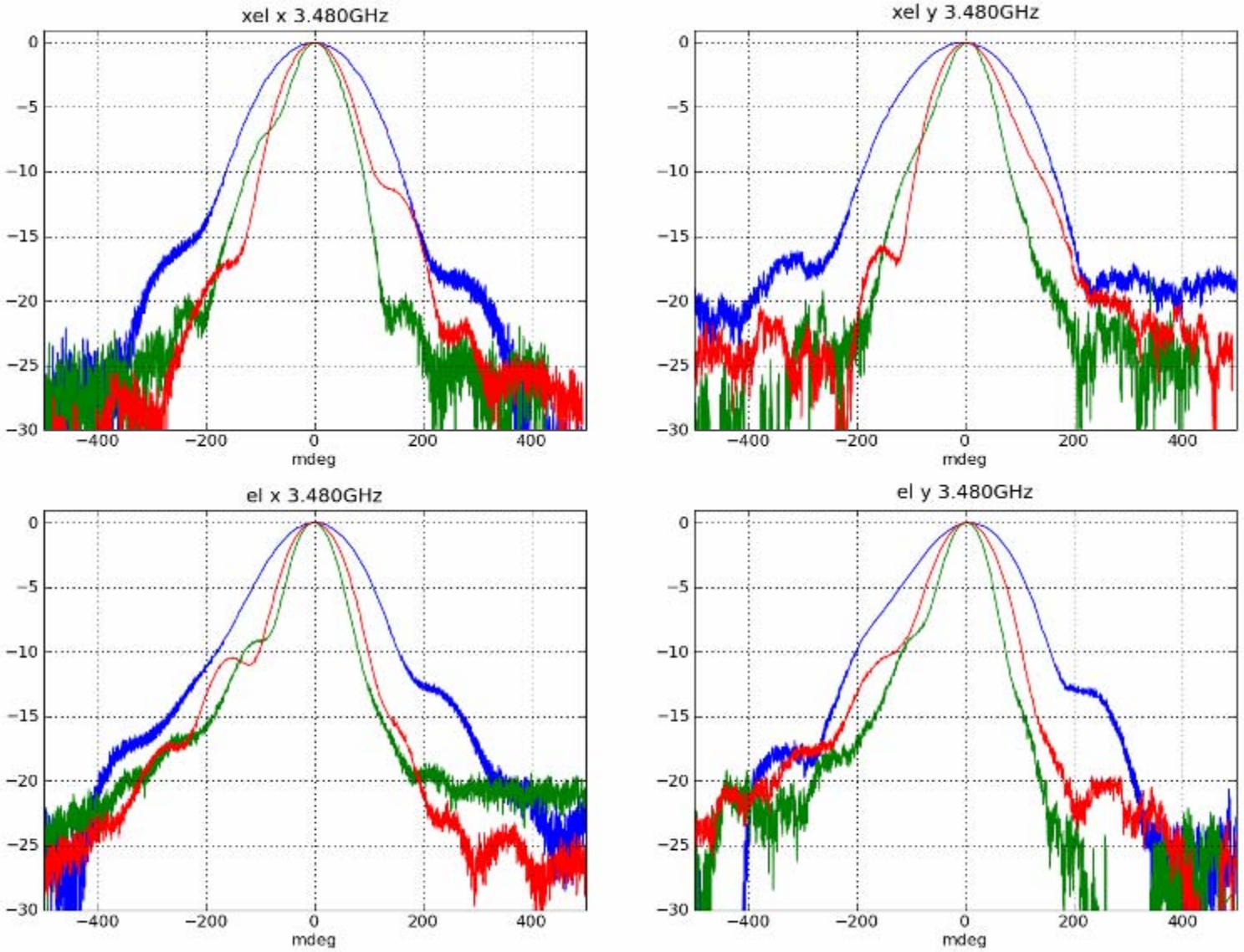
Using Cygnus, 100 MHz bandwidth, spectrometer detector

		Date	19-Nov-08	19-Nov-08	19-Nov-08	19-Nov-08	21-Nov-08	21-Nov-08	21-Nov-08	21-Nov-08	21-Nov-08
		Receiver	HFF	HFF	HFF	HFF	LFF	LFF	HFF	LFF	LFF
Physical Area of 34m reflector			907.922	907.922	907.922	907.922	907.922	907.922	907.922	907.922	907.922
Degrees per Jansky, K/J, 100% Eff			0.329	0.329	0.329	0.329	0.329	0.329	0.329	0.329	0.329
Frequency		**MHz**	**5280**	**7380**	**11480**	**3480**	**3480**	**2222**	**2222**	**1515**	**1440**
Wavelength, cm			5.7	4.1	2.6	8.6	8.6	13.5	13.5	19.8	20.8
Beamwidth, 70*lambda/diameter		Deg	0.117	0.084	0.054	0.177	0.177	0.278	0.278	0.408	0.429
Cygnus angular width, max		Deg	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
Cygnus flux, Ott Table 5, equation			342.0	202.5	101.4	656.8	656.8	1325.4	1325.4	2413.5	2613.1
Cygnus flux, Baars Table 3, equation			338.1	222.9	128.7	567.9	567.9	992.3	992.3	1598.0	1702.1
Tcal, low		K	10.0	6.5	5.0	12.5	12.0	18.0	24.0	35.0	35.0
Pout, off source, cal OFF, tert -35 deg			1.925								
Pout, off source, cal ON, tert -35 deg			2.830								
Gain, Out/K			0.091	0.066	0.029	0.167	0.009	0.014	0.024	0.012	0.009
Tsys, tert -35 deg			21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tertiary peak angle, deg			-6.30	-6.24	-6.05	-6.20	82.00	82.00	-6.20	82.00	82.00
Pout, tert at peak, cal off			2.75	1.85	0.760	5.320	0.818	1.280	1.520	2.270	2.150
Pout, tert at peak, cal on					0.906	7.410	0.931	1.540	2.090	2.700	2.470
Tsys, tert peak, off Cygnus			**30.4**	**28.0**	**26.0**	**31.8**	**86.9**	**88.6**	**64.0**	**184.8**	**235.2**
Pout, tert at peak, on Cygnus,cal ON				3.50							
Pout, tert at peak, on Cygnus			6.14	3.07	0.973	14.900	1.190	3.420	4.720	5.450	4.750
Tsys, tert at peak, on Cygnus			67.8	46.4	33.3	89.1	126.4	236.8	198.7	443.6	519.5
Tant, Cygnus		K	37.5	18.4	7.3	57.3	39.5	148.2	134.7	258.8	284.4
Tant, 100%, Cygnus			111.9	70.0	37.8	196.7	196.7	314.0	314.0	525.7	559.9
Efficiency			**0.335**	**0.264**	**0.193**	**0.291**	**0.201**	**0.472**	**0.429**	**0.492**	**0.508**

GAVRT DSS28 Antenna Patterns, X and Y Polarizations

Cross-Elevation and Elevation Scans through Cygnus, Nov 19, 2008

Blue 3480 MHz, Red 5280 MHz, and Green 7380 MHz

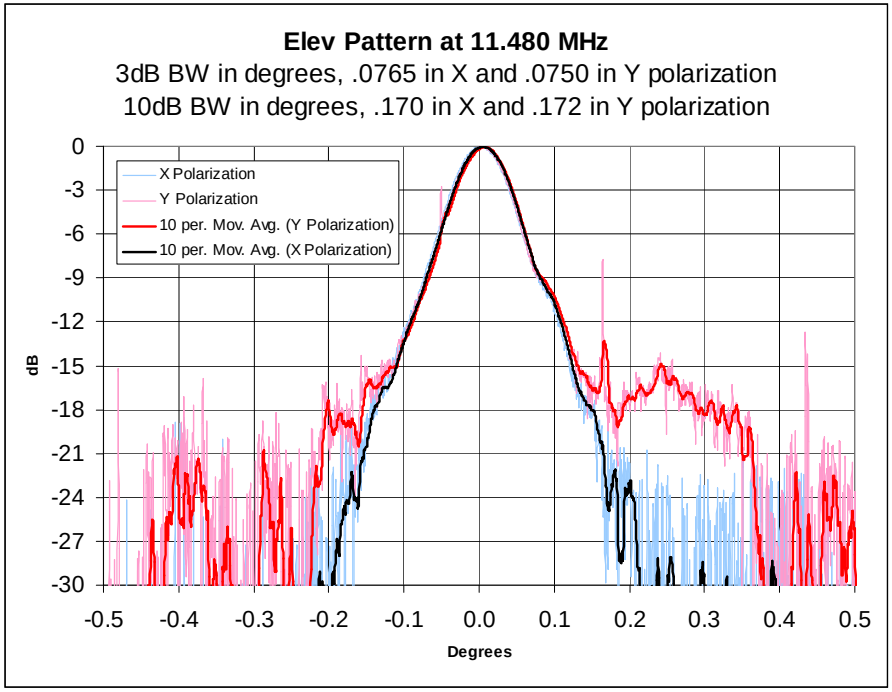


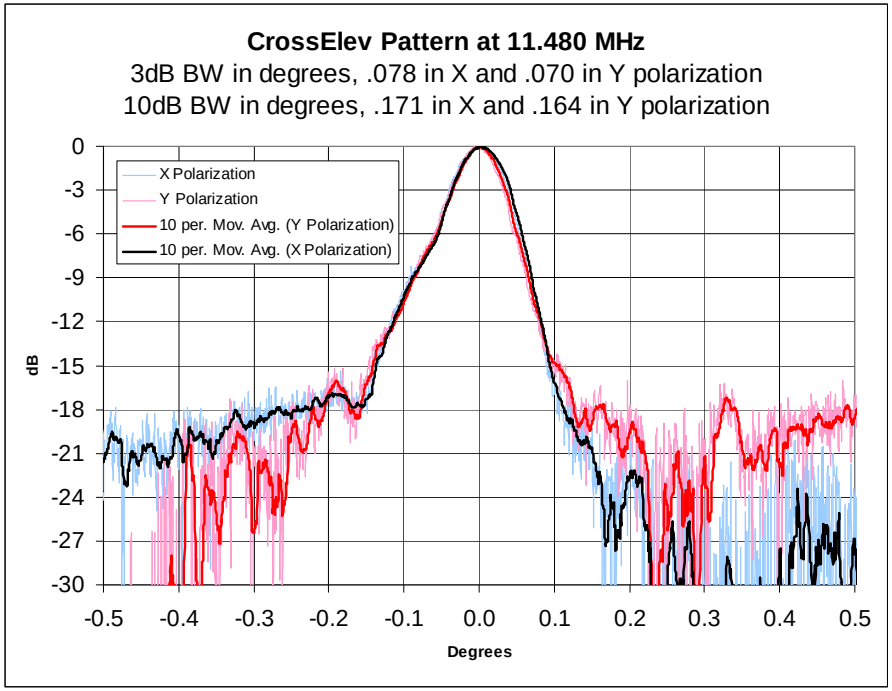
DSS28 Patterns at 11,280 MHz

Cygnus Source, Nov 21, 2008, 1014am PST, Tertiary -6.07 degrees

Elevation 27.8 degrees, Efficiency 19%, Tsys = 26K

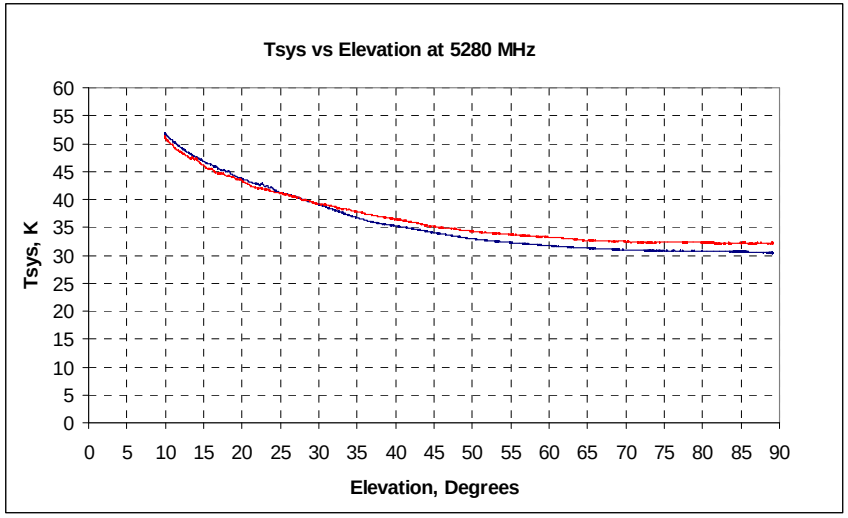
Theoretical Beamwidth at 70*lambda/D = .054 degrees

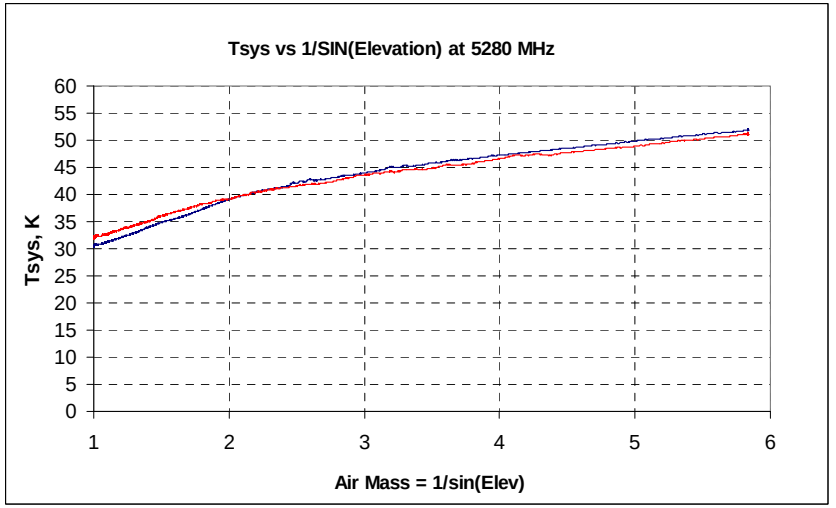




DSS28 Tipping Curve – Tsys of HFF Receiver vs Elevation Angle at 5380 MHz

- Data of Nov 19, 2008 ~630PM. DSS27 off. Tertiary pointed at HFF
- Spectrometer used as detector with 100 MHz bandwidth
- Data calibrated by separate Tsys measurement of ~30K at zenith
- Increase in noise is ~8K from zenith to 30 degrees





Tertiary Scans at 5280 MHz

On Cygnus

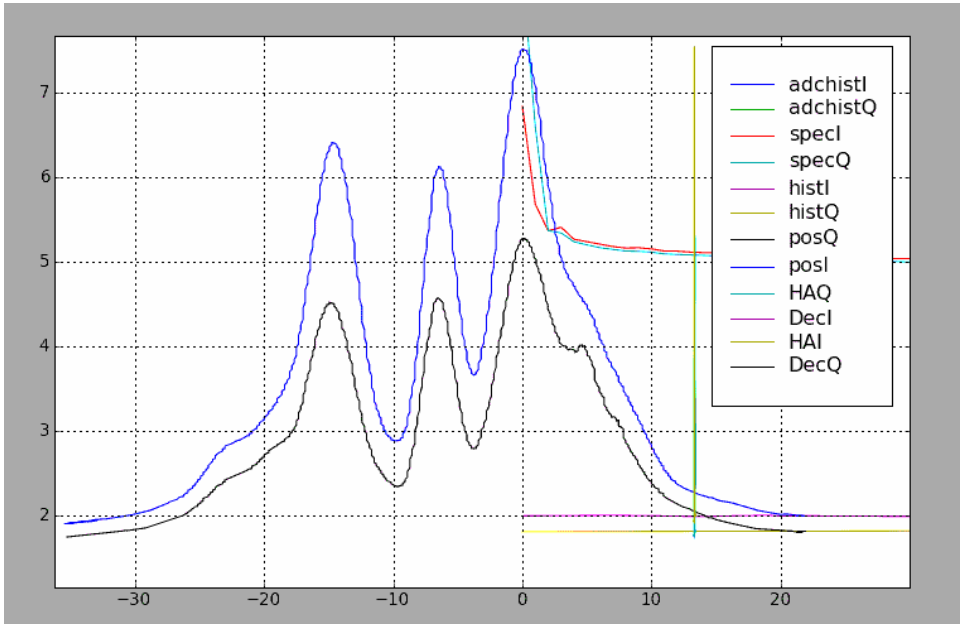
•Peak Cygnus response is at -6.76 degrees from encoder zero.

•Vertical scale is 11K per division.

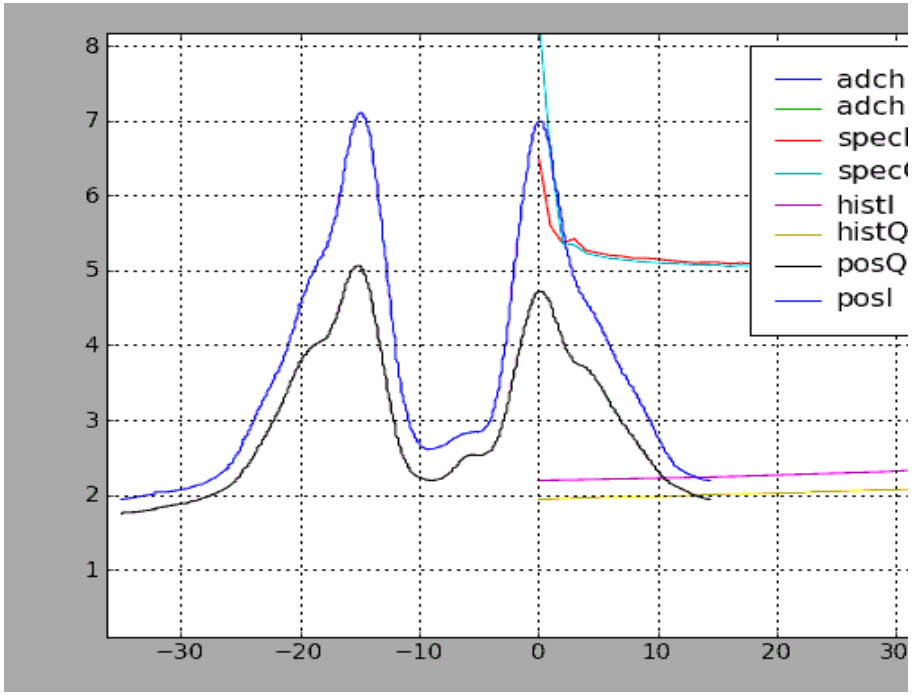
•Top curve is X polarization; bottom curve is Y polarization.

• Spillover noise peaks at about +/- 7 degrees from peak gain point

• With tertiary -20 degrees off peak Tsys = 22K, at peak gain point Tsys = 30K.



Off Cygnus, 1 degree in Az



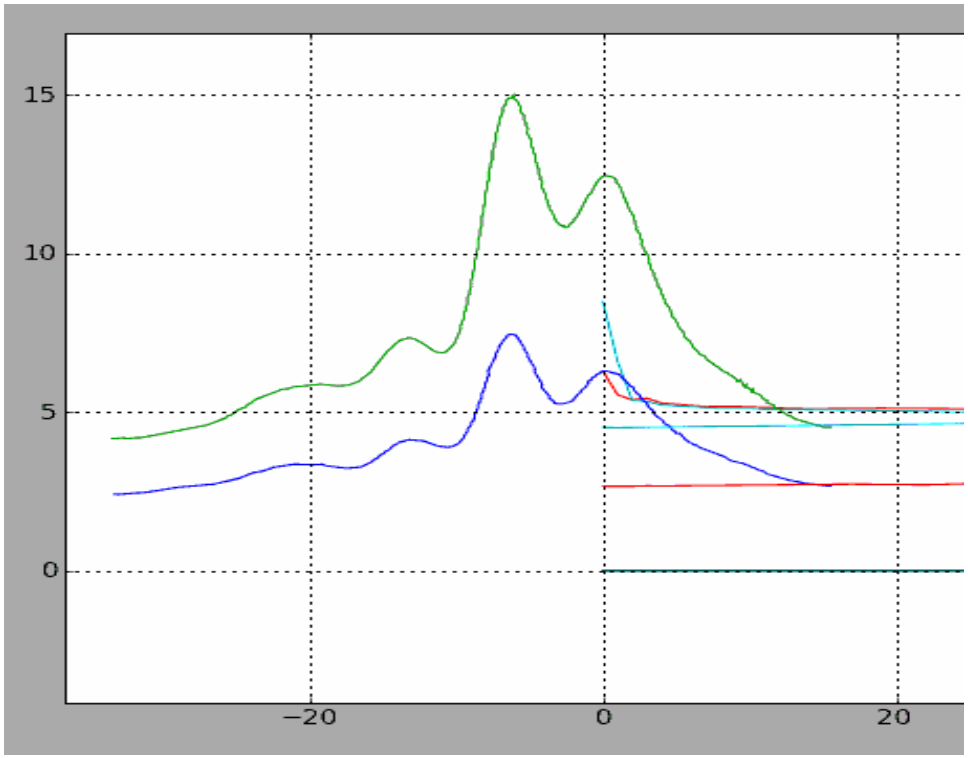
Tertiary Scans on Cygnus

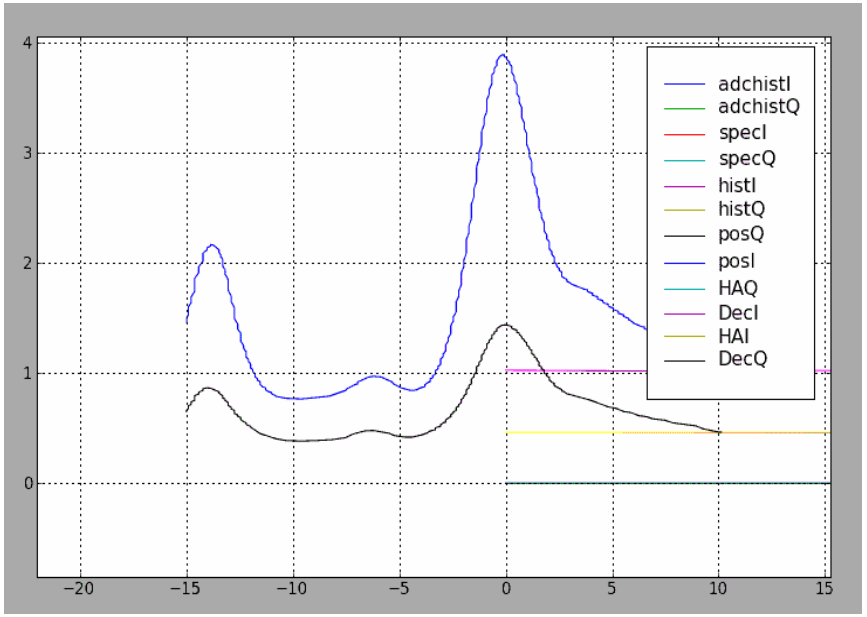
•Top chart is at 3480 MHz. The two traces are the two polarizations.

•Bottom chart is at 11,480 MHz

• Note difference in horizontal and vertical scales.

• The peak at -6.5 degrees is due to Cygnus. Peaks at 0 and -14 degrees are due to spillover.

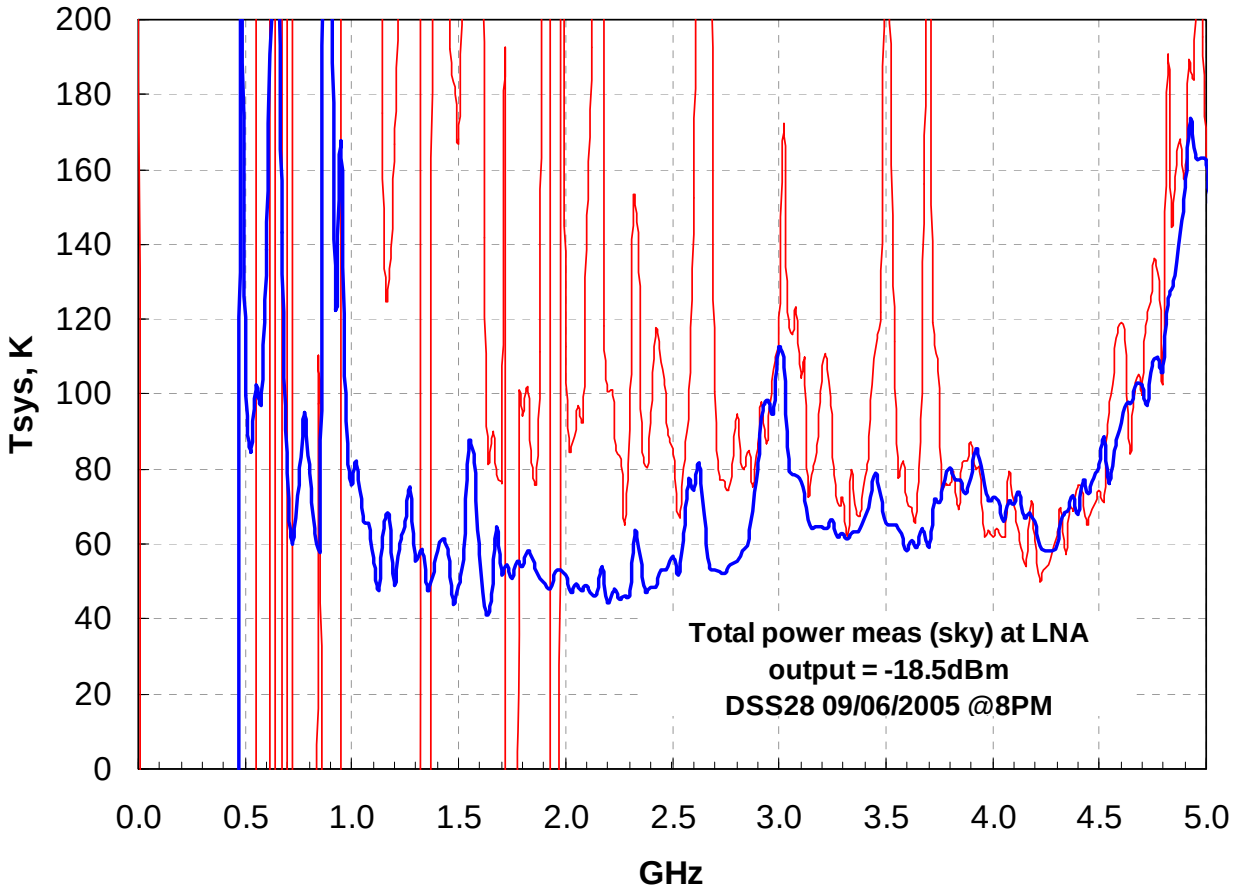




LFF Tsys and RFI

Tsys and RFI level in the 0.5 to 4 GHz range increased significantly when the receiver was moved from the DSS13 pad to the DSS28 vertex

Tsys of LFF X, Blue on Ground Near DSS13, Aug 27, 2008
Red on DSS28, Sep 06, 2008

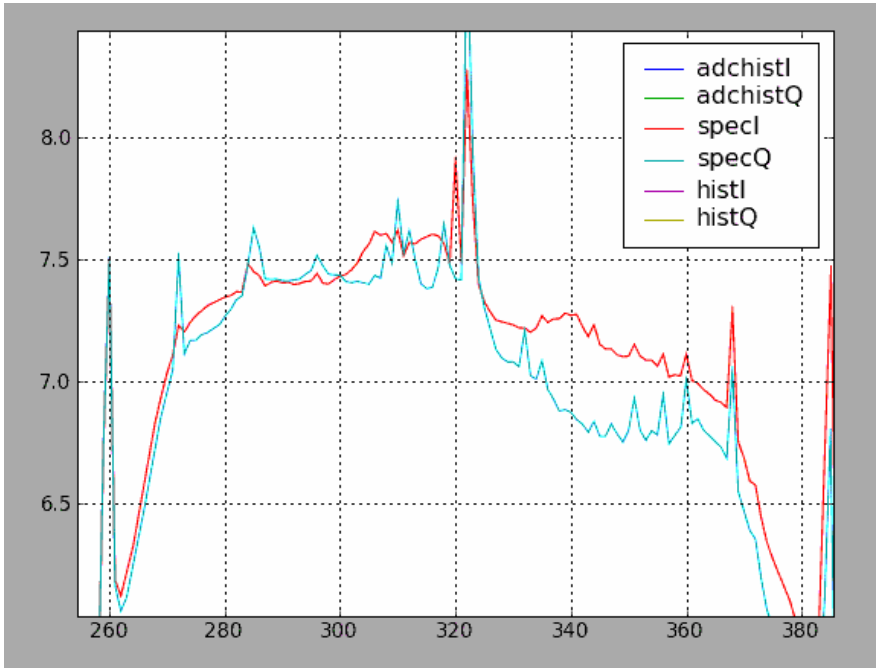


RFI Due to LFF Cryocooler Drive Electronics

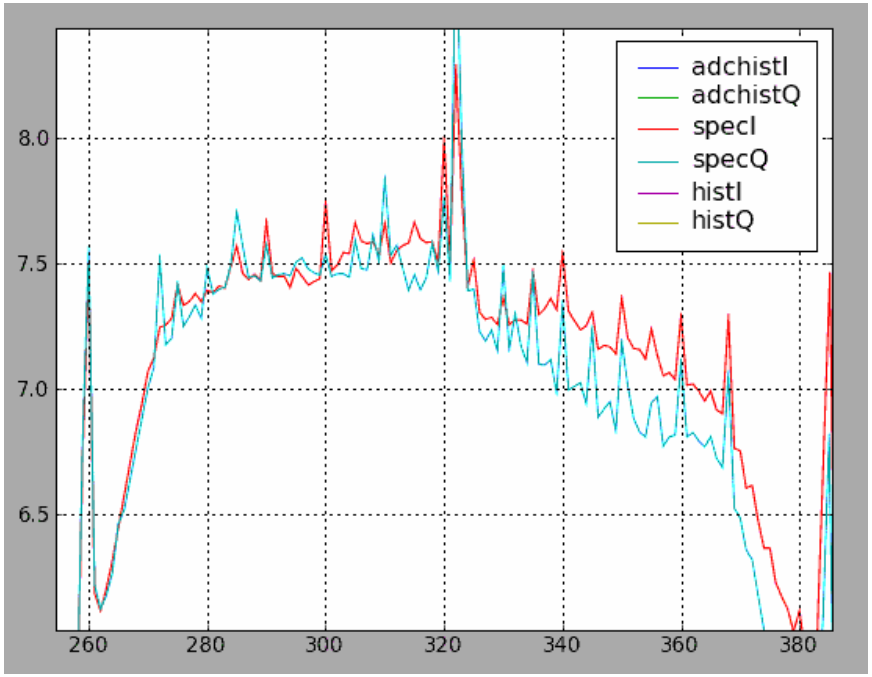
The switch-mode driver generates 5 MHz harmonics in the GHz range

- Data below is for 1540 MHz (left) to 1420 MHz (right), the abscissa is IF frequency
- Red curves are for the LFF receiver and blue curves are for the HFF receiver
- Vertical scale is in log power. Thus 1 div is 5 dB and the 5 MHz harmonics are a few dB above receiver noise
- Other RFI is present

Cryocooler Power Off



Cryocooler Power On



Conclusions

- The measured efficiency using the radio source Cygnus as a calibrator ranged from 51% at 1440 MHz and 19% at 11,480 MHz. Focusing errors are suspected as being the source of the decreased efficiency at high frequencies.

- Tsys of HFF from 3.5 to 11.5 GHz is ~30K at zenith with tertiary peaked for maximum gain. It decreases to 22K if the tertiary is pointed away from the feed and increases to ~38K at elevation of 30 degrees (as measured at 5.3 GHz).

- At 2.2 GHz the HFF efficiency of 43% and Tsys of 64K which is gives better Aeff/Tsys than the LFF (47% and 89K).

- The LFF is picking up much RFI below 2 GHz and the cooler driver has been identified as one source of the RFI. Further tests of the vertex TV camera and receiver power supplies are needed to check for RFI.