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TITLE:

**FM 30GHz RCA27
Data Analysis Report**

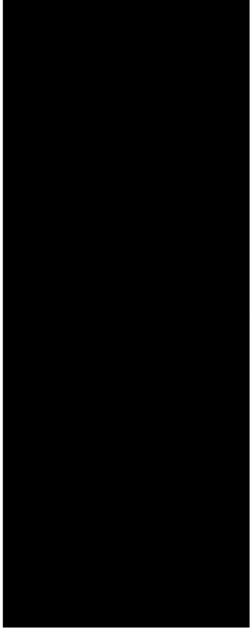

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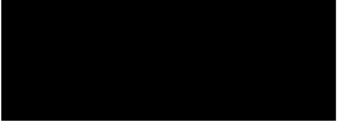
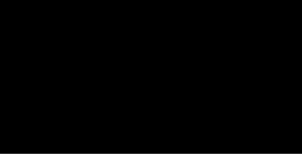


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1 INTRODUCTION AND SCOPE

This document reports on the RCA27 Flight Model on – ground calibration. Tests were performed from 01 April 2006 to 09 April 2006 (including functional tests) at Alcatel Alenia Space – Milano according to the LFI Calibration Plan.

Date	Filename	Notes
01-apr-06	030LFI27_RCA_FM_AMB_200604011426	Warm functional test
03-apr-06	030LFI27_RCA_FM_CRY_200604031224	Cryogenic functional test
03-apr-06	030LFI27_RCA_FM_XXX_200604031528	Phase switch curves (I-V curves)
03-apr-06	030LFI27_RCA_FM_TUN_200604031628	Phase switch tuning
03-apr-06	030LFI27_RCA_FM_TUN_200604031811	VG1 tuning first step
04-apr-06	030LFI27_RCA_FM_TUN_200604041546	VG1 tuning second step
04-apr-06	030LFI27_RCA_FM_TUN_200604041842	VG2 tuning first step
05-apr-06	030LFI27_RCA_FM_TUN_200604050823	VG2 tuning second step
05-apr-06	030LFI27_RCA_FM_XXX_200604051022	Check on spikes, offset, etc.
05-apr-06	030LFI27_RCA_FM_TUN_200604051127	VG2 tuning second step (check after BEM thermalisation)
05-apr-06	030LFI27_RCA_FM_XXX_200604051246	Check on spikes, offset, etc. with environmental parameters acquisition off
05-apr-06	030LFI27_RCA_FM_TUN_200604051457	DAE calibration
05-apr-06	030LFI27_RCA_FM_TUN_200604051515	DAE calibration
05-apr-06	030LFI27_RCA_FM_XXX_200604051608	Test on T ref
05-apr-06	030LFI27_RCA_FM_TUN_200604051734	DAE calibration
05-apr-06	030LFI27_RCA_FM_TNG_200604051756	TNG test with 3 T steps on sky (12.8 -- 19 --- 25K) and 2 T steps on ref (9.5 --- 25K). Offset and PGA gain as from DAE calibration test
06-apr-06	030LFI27_RCA_FM_TNG_200604060233	"
06-apr-06	030LFI27_RCA_FM_OFT_200604061041	OFT test, Tref High Tsky changing to 25 K
06-apr-06	030LFI27_RCA_FM_SPR_200604061449	RCA SPR test
06-apr-06	030LFI27_RCA_FM_XXX_200604061641	Check on DAE BB output channel w.r.t. slow output RCA response to temperature steps on loads (A ---> C, B --> D, C -----> A, D -----> B)
06-apr-06	030LFI27_RCA_FM_SPR_200604061728	SPR test with output channels as in XXX_200604061641
06-apr-06	030LFI27_RCA_FM_XXX_200604061837	Check on output signal on sky T change
06-apr-06	030LFI27_RCA_FM_ST3_200604061922	STn test
07-apr-06	030LFI27_RCA_FM_ST3_200604070402	RACHEL crashed during file closing
07-apr-06	030LFI18_RCA_FM_ELE_200604071241	RCA ELE test. Test erroneously closed
07-apr-06	030LFI27_RCA_FM_ELE_200604071244	RCA ELE test on VG1
07-apr-06	030LFI27_RCA_FM_AMB_200604071354	RCA ELE test on VG2. Note: test name is erroneously named AMB
07-apr-06	030LFI27_RCA_FM_ELE_200604071503	RCA ELE test on Vdrain.
07-apr-06	030LFI27_RCA_FM_XXX_200604071759	Check on PS/SW diodes
07-apr-06	030LFI27_RCA_FM_THF_200604071851	RCA susceptibility test to temperature changes of the FEM
07-apr-06	030LFI27_RCA_FM_ST3_200604071940	STn test
08-apr-06	030LFI27_RCA_FM_ST3_200604080415	"
08-apr-06	030LFI27_RCA_FM_THV_200604081124	RCA susceptibility test to temperature changes of the 3rd VG
08-apr-06	030LFI27_RCA_FM_UNC_200604081247	Noise properties with unchopped radiometer in all the 4 states
08-apr-06	030LFI27_RCA_FM_LIS_200604081545	RCA LIS test with temp. steps on sky and ref
09-apr-06	030LFI27_RCA_FM_LIS_200604090020	"
09-apr-06	030LFI27_RCA_FM_LIS_200604090853	"



09-apr-06	030LFI27_RCA_FM_LIS_200604091726	"
10-apr-06	030LFI27_RCA_FM_LIS_200604100200	"
10-apr-06	030LFI27_RCA_FM_LIS_200604101035	"
10-apr-06	030LFI27_RCA_FM_THB_200604101419	RCA susceptibility test to thermal changes in the BEM
10-apr-06	030LFI27_RCA_FM_XXX_200604101756	RCA susceptibility check to thermal changes in the BEM with PGA gain=1 and offset = 0
10-apr-06	030LFI27_RCA_FM_XXX_200604101804	"
12-apr-06	030LFI27_RCA_FM_AMB_200604121456	RCA SPR check at room temp; 4K target as in test campaign. Test ended due to BEM thermalisation



The following tests have been performed specifically at room temperature to investigate the SPR problems we encountered at cryo temperature.

12-apr-06	030LFI27_RCA_FM_AMB_200604121456	RCA SPR check at room temp; 4K target as in test campaign. Test ended due to BEM thermalisation
12-apr-06	030LFI27_RCA_FM_AMB_200604121605	RCA SPR check at room temp. for sky load polarization investigation
12-apr-06	030LFI27_RCA_FM_AMB_200604121840	"
12-apr-06	030LFI27_RCA_FM_AMB_200604121909	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131021	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131026	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131115	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131124	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131131	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131140	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131520	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131524	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131559	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131601	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131603	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131646	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131721	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131902	"
13-apr-06	030LFI27_RCA_FM_AMB_200604131939	"
14-apr-06	030LFI27_RCA_FM_AMB_200604141357	"
14-apr-06	030LFI27_RCA_FM_AMB_200604141431	"
14-apr-06	030LFI27_RCA_FM_AMB_200604141515	"
14-apr-06	030LFI27_RCA_FM_AMB_200604141524	"
14-apr-06	030LFI27_RCA_FM_AMB_200604141549	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181034	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181058	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181134	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181155	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181426	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181434	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181454	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181518	"
18-apr-06	030LFI27_RCA_FM_AMB_200604181537	"



Termometers:

SKY LOAD: based on the RCA28, a delta T between the back plate sensor (SKY_TEMP) and the eccosorb pyramids (SMON_TMP) is expected.

Based on the RCA28 TNG data the following DT is applied:

SKY_TEMP	SMON_TMP	DIFFERENCE
15.0000 +/- 0.000000	15.4134 +/- 0.00757300	0.4134
9.19999 +/- 3.94658E-005	9.77658 +/- 8.39263 E-005	0.57659
20.0000 +/- 0.000000	20.372 +/- 0.0126364	0.372
AVERAGE		0.454



2 APPLICABLE DOCUMENTS

- [AD 1] M.Bersanelli, *Planck-LFI Calibration Plan*, PL-LFI-PST-PL-008, Issue/Rev 1.0, July 2003
- [AD 2] E.Alippi, P.Guzzi, *Planck LFI 30GHz Radiometer Chain Assembly (RCA) Specification*, PL-LFI-PST-SP-006, Issue/Rev. 2.0, March 2002

3 REFERENCE DOCUMENTS

- [RD 1] A.Mennella, et. al, *Data analysis and calibration matrix of LFI 44 GHz QM receiver (LFI24)*, PL-LFI-PST-AN-003, Issue/Rev 1.0, May 2005
- [RD 2] P. Battaglia, *44GHz RCA #24 FM Test Report*, PL-LFI-LAB-RP-059, Issue 1
- [RD 3] F. Cuttaia, A. D'Arcangelo, D. Lawson, L. Stringhetti, *nonlinearity investigation at 44 GHz using prototype units: BEM44_B3_DC and BEM44_B4_DC*, PL-LFI-PST-TN-073, 1.0
- [RD 4] N. Roddis, D. Lawson, F. Cuttaia D. Kettle et al. *Planck LFI – 44 GHz FM FEM 4F2 Final Performance Test Report*, PL-LFI-JBO-RP-090



4 TUNING

4.1 RADIOMETER TUNING

See [RD 2]

4.2 BACK END MODULE OFFSET

BEM offset is determined by recording each detector output when the FEM is off. The values stored are used in data analysis when required. The values are reported in *Table 5-1*.

Table 5-1: BEM radiometric offset values.

	BEM offset (Volts)
Detector A	0.0322
Detector B	0.0377
Detector C	0.0327
Detector D	0.0377

5 BASIC PERFORMANCES

5.1 RCA_OFT: RADIOMETER OFFSET

It is calculated by measuring the voltage difference at the crossing between the reference and Load temperature.

file considered: 030LFI27_RCA_FM_OFT_200604061041

Channel	offset (V)	Abs Error (V)
Detector A	-0.0274	0.0003
Detector B	-0.0447	0.0008
Detector C	0.029	0.001
Detector D	0.022	0.001

Figure 6-1: Voltage offset derived at crossing point between the REF and SKY

5.2 RCA_LIS: LINEARITY AND ISOLATION

The linearity has been evaluated extensively by changing both the REF and the SKY temperature in several steps.

	T Noise FEM (K)



DETECTOR 1	7.7
DETECTOR 2	7.7
DETECTOR 3	7.9
DETECTOR 4	7.9

Specifically the analysis has been performed on the following datasets:

reference load temperature steps are:

030LFI27_RCA_FM_LIS_200604081545

sky load temperature steps:

030LFI27_RCA_FM_LIS_200604090020

030LFI27_RCA_FM_LIS_200604090853

030LFI27_RCA_FM_LIS_200604091726

030LFI27_RCA_FM_LIS_200604100200

From these datasets the characteristic curves V output Vs. T input were built for each detector and then a parabolic fit has been performed, as reported in next sections.

5.2.1 Reference temperature steps

In the first data set the REF temperature has been varied from 11.98 Kelvin to 30.54 Kelvin and the SKY has been kept to 12.8 Kelvin.

The REF temperature sequence is shown in figure below

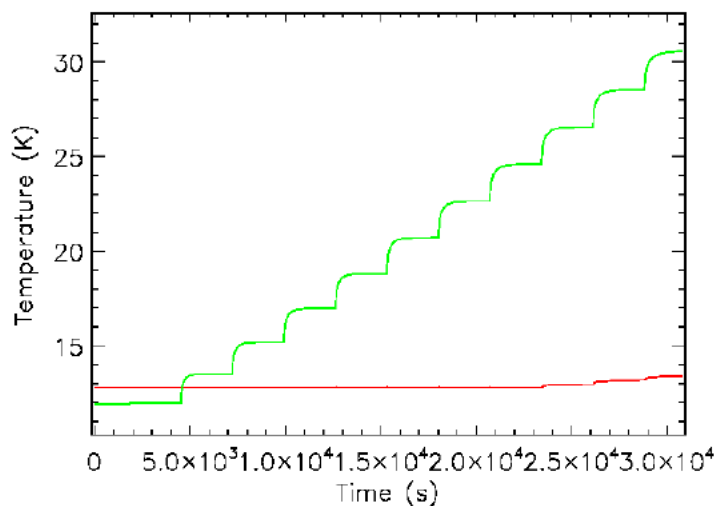


Figure 6-2 Temperature of the Reference load (green line) is taken from R_MON monitor sensor, and of the Skyload temperature (Red line) taken from SKY_TEMP monitor sensor.



The results are reported here. The error is the fit uncertainty and does not includes any systematic error from measurements.

Table 6-1: basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY_TEMP probe as a sky load temperature, and R_MON sensor for the REF load temperature. For isolation the error has not been calculated. It will be reported in the next update of the document.

	Gain [V/K]	Gain [K/V]	Tnoise [K]	Tnoise [K]	Isolation [dB]
	x 1E-02		Linear	Parabolic	
DETECTOR A	4.05±0.02	24.67±0.12	21.9±0.1	12.9±0.3	-13.5
DETECTOR B	4.24±0.02	23.54±0.12	22.0±0.2	12.4±0.2	-13.5
DETECTOR C	3.57±0.01	27.99±0.13	18.2±0.1	5.3±0.1	-15.4
DETECTOR D	4.02±0.02	24.87±0.12	19.4±0.1	5.5±0.1	-15.8

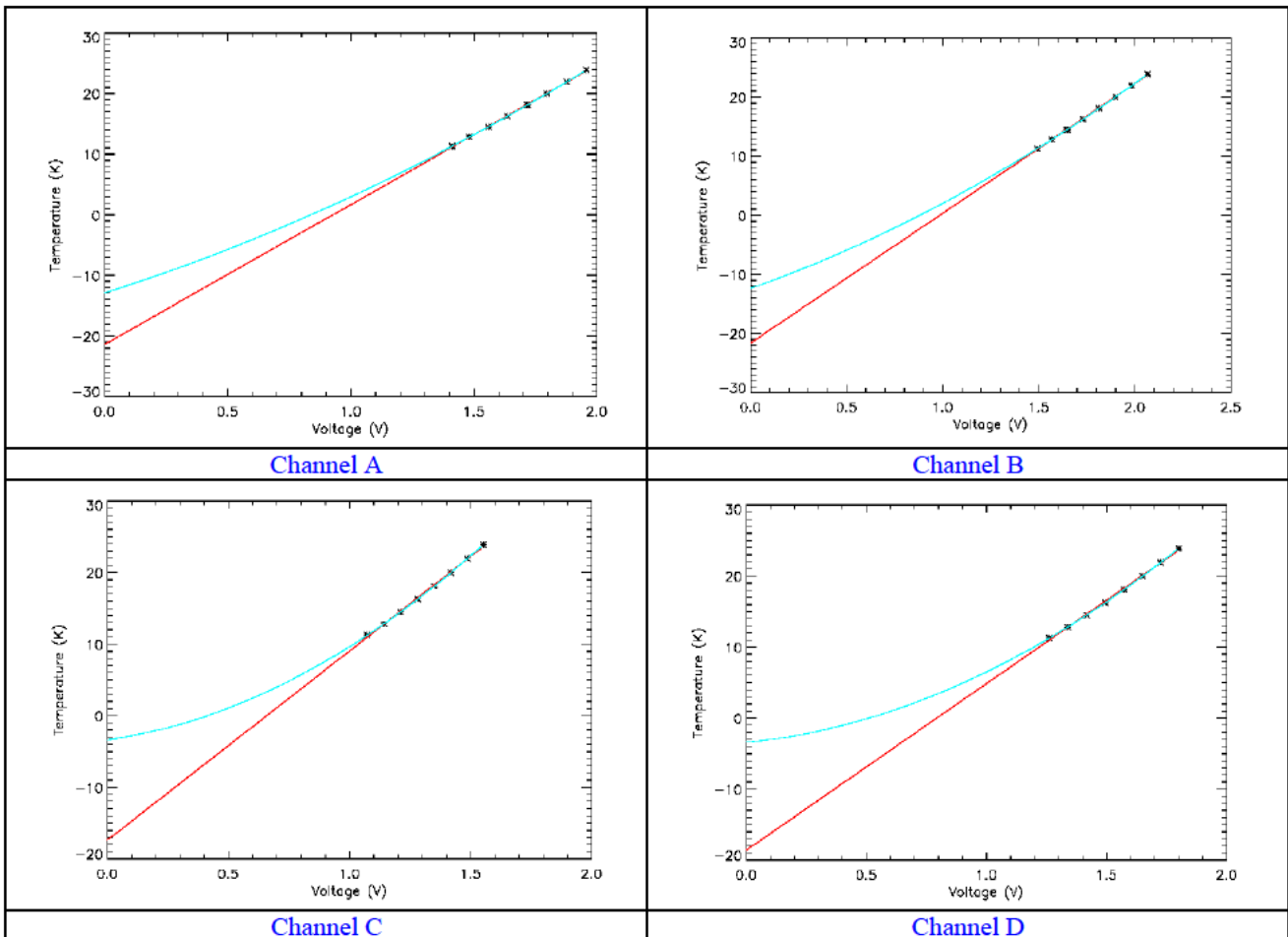


Figure 6-3



The complete RaNA output is reported here (RCA27_LIS_results270406_Rmon_all)

```
=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: A
Changing signal: Load
BEM offset (V): 0.0324000

There are 10 time windows
      tmin      tmax
2497.2600    4412.8398
5693.6602    7178.5200
8345.9502    9773.2900
11270.600    12502.000
14008.700    15209.400
16710.199    17965.400
19448.801    20639.600
22227.301    23392.500
24790.900    26001.699
27494.500    28764.000

      Tchange      Tfixed      Vchange      Vfixed
11.982322    12.800000    1.4105380    1.4251746
13.509169    12.800000    1.4812570    1.4281826
15.186212    12.800000    1.5568790    1.4314597
16.965200    12.800000    1.6357016    1.4351822
18.807430    12.800000    1.7160128    1.4397292
20.705917    12.800000    1.7965322    1.4442323
22.636772    12.800000    1.8770256    1.4489416
24.586245    12.800000    1.9565939    1.4535419
26.557276    12.961075    2.0351867    1.4613251
28.518431    13.179775    2.1124076    1.4733380

=====
OUTPUT
***** Linear fit *****

Parameters
      Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
0.040531575    21.963663    -13.469614    0.0067496200

Statistical uncertainties
      Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
0.00020593050    0.15934146    3.6632220    0.0048521364

***** Parabolic fit *****

Average noise temperature
      Tn (k)      Sigma (K)
12.921948    0.29479409

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
      a0      a1      a2
-12.835060    12.783111    3.0561483

      sigma(a0)      sigma(a1)      sigma(a2)
0.054579956    0.063393886    0.018157849

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
      a0      a1      a2
0.85606163    0.051938677    -0.00024457003

      sigma(a0)      sigma(a1)      sigma(a2)
0.0094998647    0.0011702050    3.3716585e-005

=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: B
Changing signal: Load
BEM offset (V): 0.0377000

There are 10 time windows
      tmin      tmax
2497.2600    4412.8398
5693.6602    7178.5200
8345.9502    9773.2900
11270.600    12502.000
14008.700    15209.400
16710.199    17965.400
19448.801    20639.600
22227.301    23392.500
24790.900    26001.699
27494.500    28764.000

      Tchange      Tfixed      Vchange      Vfixed
11.982322    12.800000    1.4917148    1.4952721
13.509169    12.800000    1.5665141    1.4983287
```



15.186212	12.800000	1.6460691	1.5016040
16.965200	12.800000	1.7292415	1.5057696
18.807430	12.800000	1.8136894	1.5106824
20.705917	12.800000	1.8982015	1.5155882
22.636772	12.800000	1.9825594	1.5207612
24.586245	12.800000	2.0657377	1.5257153
26.557276	12.961075	2.1479642	1.5341149
28.518431	13.179775	2.2285644	1.5467267

```
=====
OUTPUT
***** Linear fit *****

Parameters
Gain (V/K)      Tn (K)      Iso. (dB)    Lin. coeff
0.042476291    22.206567   -13.454329   0.0068696078

Statistical uncertainties
Gain (V/K)      Tn (K)      Iso. (dB)    Lin. coeff
0.00022352514  0.16405984  3.6560878    0.0049954459

***** Parabolic fit *****

Average noise temperature
Tn (k)          Sigma (K)
12.418021      0.27175270

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
          a0          a1          a2
-12.281689     11.349180    2.9788944

          sigma(a0)    sigma(a1)    sigma(a2)
0.058928511    0.064805163  0.017578642

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
          a0          a1          a2
0.90343961     0.055304939  -0.00027707104

          sigma(a0)    sigma(a1)    sigma(a2)
0.0094998647   0.0011702050  3.3716585e-005
=====
```

```
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: C
Changing signal: Load
BEM offset (V): 0.00327000

There are 10 time windows
tmin      tmax
2497.2600 4412.8398
5693.6602 7178.5200
8345.9502 9773.2900
11270.600 12502.000
14008.700 15209.400
16710.199 17965.400
19448.801 20639.600
22227.301 23392.500
24790.900 26001.699
27494.500 28764.000

Tchange    Tfixed      Vchange      Vfixed
11.982322  12.800000   1.0733526    1.1701301
13.509169  12.800000   1.1416276    1.1720702
15.186212  12.800000   1.2110989    1.1737736
16.965200  12.800000   1.2806156    1.1758445
18.807430  12.800000   1.3496331    1.1783184
20.705917  12.800000   1.4180264    1.1809619
22.636772  12.800000   1.4856140    1.1837386
24.586245  12.800000   1.5522061    1.1864666
26.557276  12.961075   1.6182045    1.1918062
28.518431  13.179775   1.6828035    1.2003605
=====
```

```
=====
OUTPUT
***** Linear fit *****

Parameters
Gain (V/K)      Tn (K)      Iso. (dB)    Lin. coeff
0.035721762    18.176724   -15.401536   0.0095725425

Statistical uncertainties
Gain (V/K)      Tn (K)      Iso. (dB)    Lin. coeff
0.00016685559  0.13759650  5.1282361    0.0038499024

***** Parabolic fit *****

Average noise temperature
Tn (k)          Sigma (K)
5.3130860      0.10739157
=====
```




Temperature versus Voltage parabolic fit parameters

Equation: $T = a_0 + a_1 * V + a_2 * V^2$

a0	a1	a2
-4.8187945	7.1049069	7.3169605
sigma(a0)	sigma(a1)	sigma(a2)
0.035482637	0.052931938	0.019411342

Voltage versus temperature parabolic fit parameters

Equation: $V = a_0 + a_1 * T + a_2 * T^2$

a0	a1	a2
0.53171512	0.052914343	-0.00042518128
sigma(a0)	sigma(a1)	sigma(a2)
0.0094998647	0.0011702050	3.3716585e-005

=====

INPUT

Centre frequency (Hz) = 3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (V): 0.0377000

There are 10 time windows

tmin	tmax	Tchange	Tfixed	Vchange	Vfixed
2497.2600	4412.8398	11.982322	12.800000	1.2605763	1.3549547
5693.6602	7178.5200	13.509169	12.800000	1.3376361	1.3568271
8345.9502	9773.2900	15.186212	12.800000	1.4158259	1.3586560
11270.600	12502.000	16.965200	12.800000	1.4941894	1.3609702
14008.700	15209.400	18.807430	12.800000	1.5719327	1.3637776
16710.199	17965.400	20.705917	12.800000	1.6490337	1.3669504
19448.801	20639.600	22.636772	12.800000	1.7250289	1.3700829
22227.301	23392.500	24.586245	12.800000	1.7998794	1.3732380
24790.900	26001.699	26.557276	12.961075	1.8738744	1.3792534
27494.500	28764.000	28.518431	13.179775	1.9465522	1.3890173

=====

OUTPUT

***** Linear fit *****

Parameters

Gain (V/K)	Tn (K)	Iso. (dB)	Lin. coeff
0.040206340	19.457278	-15.582287	0.011057168

Statistical uncertainties

Gain (V/K)	Tn (K)	Iso. (dB)	Lin. coeff
0.00020160157	0.12641129	5.1905093	0.0042757244

***** Parabolic fit *****

Average noise temperature

Tn (k)	Sigma (K)
5.5637705	0.11794025

Temperature versus Voltage parabolic fit parameters

Equation: $T = a_0 + a_1 * V + a_2 * V^2$

a0	a1	a2
-4.9461279	5.4617803	5.8513698
sigma(a0)	sigma(a1)	sigma(a2)
0.041097401	0.052559651	0.016543547

Voltage versus temperature parabolic fit parameters

Equation: $V = a_0 + a_1 * T + a_2 * T^2$

a0	a1	a2
0.64890883	0.059811852	-0.00048510693
sigma(a0)	sigma(a1)	sigma(a2)
0.0094998647	0.0011702050	3.3716585e-005

It is important to notice that at higher temperature the Sky Signal is following the Reference Signal as shown in the figure below.

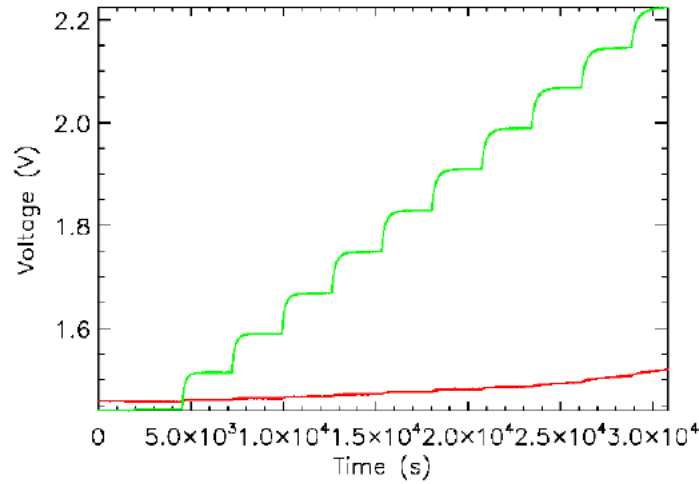


Figure 6-4 Output voltage of the Reference (green), and of the Sky (Red).

The analysis has been repeated considering only the first seven steps where the T-SKY does not change.

	Gain [V/K]	Gain [K/V]	Tnoise [K]	Tnoise [K]	Isolation [dB]
	$\times 1E-02$		<i>Linear</i>	<i>Parabolic</i>	
DETECTOR A	4.41±0.02	24.29±0.17	21.3±0.2	13.1±0.4	-13.4
DETECTOR B	4.32±0.02	23.14±0.15	21.5±0.3	12.6±0.3	-13.5
DETECTOR C	3.66±0.02	27.26±0.17	17.1±0.2	4.3±0.1	-13.5
DETECTOR D	4.13±0.02	24.20±0.14	18.4±0.2	4.5±0.1	-15.6

From the table above it is clear that there is something strange on the Channel C and D where we get the lowest noise temperature from the linear fit and from the parabolic one. The positions of reference temperature sensors with respect the Channel A/B and C/D is shown in the figure below

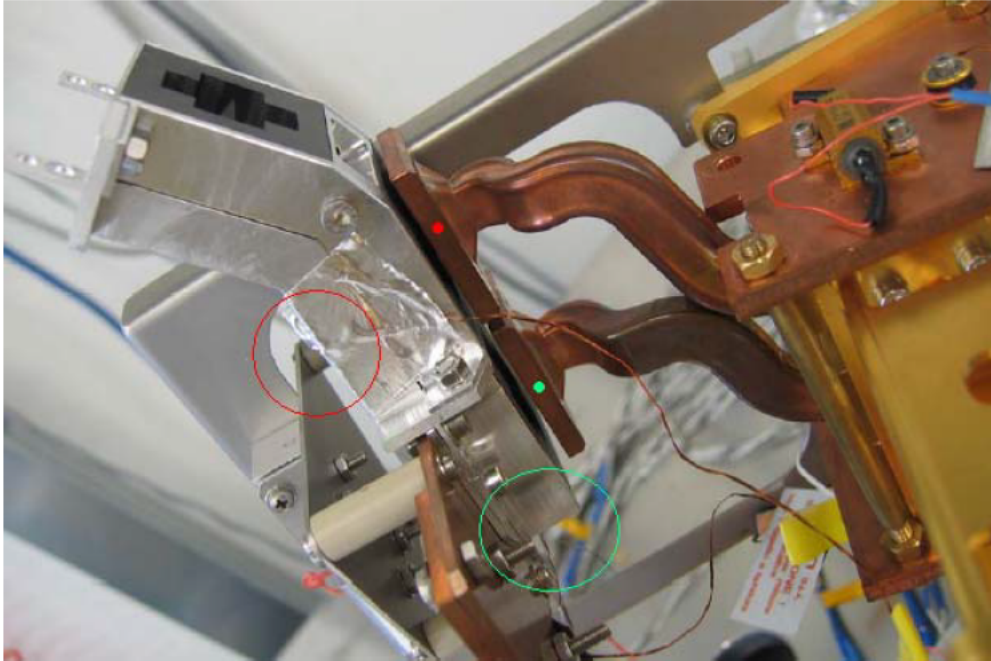


Figure 6-5 The green circle correspond to REF_TEMP and the Reference horn (green spotted) refers to channel C/D. The red circle correspond to R_MON sensor and the reference horn (red spotted) refers to channel A/B.

Doing the analysis in the same time set but using the REF_TEMP we can obtain the following results.

Table XXX : Tnoise with REF_TEMP

	Gain [V/K]	Gain [K/V]	Tnoise [K]	Tnoise [K]	Isolation [dB]
	x 1E-02		Linear	Parabolic	
DETECTOR A	3.38±0.02	29.54±0.21	30.5±0.2	35.1±0.1	-13.5
DETECTOR B	3.55±0.02	28.14±0.18	30.7±0.2	34.1±0.2	-13.5
DETECTOR C	3.01±0.01	33.15±0.20	25.5±0.2	22.3±0.1	-15.3
DETECTOR D	3.39±0.01	29.43±0.17	26.9±0.2	23.5±0.1	-15.6

The complete RaNA output is reported here (RCA27_LIS_results270406_REF_TEMP)

```

=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: A
Changing signal: Load
BEM offset (V): 0.0324000

There are 8 time windows
      tmin      tmax
2497.2600    4412.8398
5693.6602    7178.5200
8345.9502    9773.2900
11270.600    12502.000
14008.700    15209.400
16710.199    17965.400
19448.801    20639.600
22227.301    23392.500

      Tchange      Tfixed      Vchange      Vfixed
11.982322      12.800000      1.4105380      1.4251746
13.509169      12.800000      1.4812570      1.4281826
15.186212      12.800000      1.5568790      1.4314597
16.965200      12.800000      1.6357016      1.4351822
18.807430      12.800000      1.7160128      1.4397292
20.705917      12.800000      1.7965322      1.4442323
  
```



22.636772 12.800000 1.8770256 1.4489416
24.586245 12.800000 1.9565939 1.4535419

=====
OUTPUT

***** Linear fit *****

Parameters
Gain (V/K) Tn (K) Iso. (dB) Lin. coeff
0.041165852 21.286488 -13.468907 0.0048375240

Statistical uncertainties
Gain (V/K) Tn (K) Iso. (dB) Lin. coeff
0.00029037077 0.18405473 4.1198349 0.0049962727

***** Parabolic fit *****

Average noise temperature
Tn (k) Sigma (K)
13.062968 0.36822283

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
a0 a1 a2
-12.933478 12.905680 3.0183310
sigma(a0) sigma(a1) sigma(a2)
0.086254501 0.10406526 0.031094201

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
a0 a1 a2
0.85493403 0.052089511 -0.00024930216
sigma(a0) sigma(a1) sigma(a2)
0.011378848 0.0014411203 4.2903354e-005

=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: B
Changing signal: Load
BEM offset (V): 0.0377000

There are 8 time windows
tmin tmax
2497.2600 4412.8398
5693.6602 7178.5200
8345.9502 9773.2900
11270.600 12502.000
14008.700 15209.400
16710.199 17965.400
19448.801 20639.600
22227.301 23392.500

Tchange Tfixed Vchange Vfixed
11.982322 12.800000 1.4917148 1.4952721
13.509169 12.800000 1.5665141 1.4983287
15.186212 12.800000 1.6460691 1.5016040
16.965200 12.800000 1.7292415 1.5057696
18.807430 12.800000 1.8136894 1.5106824
20.705917 12.800000 1.8982015 1.5155882
22.636772 12.800000 1.9825594 1.5207612
24.586245 12.800000 2.0657377 1.5257153

=====
OUTPUT

***** Linear fit *****

Parameters
Gain (V/K) Tn (K) Iso. (dB) Lin. coeff
0.043208134 21.484348 -13.481771 0.0055526952

Statistical uncertainties
Gain (V/K) Tn (K) Iso. (dB) Lin. coeff
0.00027941433 0.18309243 4.1382248 0.0051538015

***** Parabolic fit *****

Average noise temperature
Tn (k) Sigma (K)
12.575482 0.33984271

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
a0 a1 a2
-12.372842 11.456558 2.9475564
sigma(a0) sigma(a1) sigma(a2)
0.092869539 0.10601582 0.029973245

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2



```

      a0          a1          a2
      0.90192364   0.055507860 -0.00028344317

      sigma(a0)   sigma(a1)   sigma(a2)
      0.011378848 0.0014411203 4.2903354e-005
=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: C
Changing signal: Load
BEM offset (V): 0.00327000

There are      8 time windows
      tmin      tmax
      2497.2600  4412.8398
      5693.6602  7178.5200
      8345.9502  9773.2900
      11270.600  12502.000
      14008.700  15209.400
      16710.199  17965.400
      19448.801  20639.600
      22227.301  23392.500

      Tchange    Tfixed      Vchange      Vfixed
      11.982322  12.800000  1.0733526   1.1701301
      13.509169  12.800000  1.1416276   1.1720702
      15.186212  12.800000  1.2110989   1.1737736
      16.965200  12.800000  1.2806156   1.1758445
      18.807430  12.800000  1.3496331   1.1783184
      20.705917  12.800000  1.4180264   1.1809619
      22.636772  12.800000  1.4856140   1.1837386
      24.586245  12.800000  1.5522061   1.1864666
=====
OUTPUT
***** Linear fit *****

Parameters
      Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
      0.036679950     17.105820   -15.345523     0.0083996614

Statistical uncertainties
      Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
      0.00023094054   0.16517815   5.6858752     0.0043044790

***** Parabolic fit *****

Average noise temperature
      Tn (k)      Sigma (K)
      4.2821680   0.12193271

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
      a0          a1          a2
      -3.1241238   4.4031331   8.3798019

      sigma(a0)   sigma(a1)   sigma(a2)
      0.054578118 0.084797991 0.032546199

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
      a0          a1          a2
      0.52109793  0.054338165 -0.00047000591

      sigma(a0)   sigma(a1)   sigma(a2)
      0.011378848 0.0014411203 4.2903354e-005
=====
INPUT
Centre frequency (Hz) = 3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (V): 0.0377000

There are      8 time windows
      tmin      tmax
      2497.2600  4412.8398
      5693.6602  7178.5200
      8345.9502  9773.2900
      11270.600  12502.000
      14008.700  15209.400
      16710.199  17965.400
      19448.801  20639.600
      22227.301  23392.500

      Tchange    Tfixed      Vchange      Vfixed
      11.982322  12.800000  1.2605763   1.3549547
      13.509169  12.800000  1.3376361   1.3568271
      15.186212  12.800000  1.4158259   1.3586560
      16.965200  12.800000  1.4941894   1.3609702
      18.807430  12.800000  1.5719327   1.3637776
      20.705917  12.800000  1.6490337   1.3669504
```



```

22.636772      12.800000      1.7250289      1.3700829
24.586245      12.800000      1.7998794      1.3732380

=====
OUTPUT
***** Linear fit *****

Parameters
Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
0.041318823     18.389086   -15.573935     0.0096852724

Statistical uncertainties
Gain (V/K)      Tn (K)      Iso. (dB)      Lin. coeff
0.00024843663   0.16484363   5.8185385     0.0045476131

***** Parabolic fit *****

Average noise temperature
Tn (k)      Sigma (K)
4.5483250   0.13774193

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
a0          a1          a2
-3.1887366   3.0656388   6.6581587

sigma(a0)    sigma(a1)    sigma(a2)
0.063528449   0.084531303   0.027807632

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
a0          a1          a2
0.63716730   0.061386254  -0.00053466361

sigma(a0)    sigma(a1)    sigma(a2)
0.011378848   0.0014411203  4.2903354e-005

=====

```

Using the mean temperature between the two sensors we can obtain a different set of values. To run this new calculation that was not foreseen in the RANA software a simple tool in MATLAB has been developed. The tool has been tested with the results already obtained in the case of R_MON variation. We can see that due to a different algorithm to find the best fit there is a slightly difference from the two methods but the error is kept under 0.5K. The results founded are shown in the table below. Only C/D channels are displayed because the A/B should look always at the R_MON sensor.

Table 6-2: Noise temperature and R coefficients for Channel C and D evaluated from linear fits and Parabolic Fit on data with REF step using the average values between R_MON and REF_TEMP sensors.

	Gain [V/K]	Tnoise [K]	R2	Tnoise [K]	R2
	x 1E-02	Linear		Parabolic	
DETECTOR C	3.42	21.46	0.9901	14.44	0.9975
DETECTOR D	3.85	22.80	0.9887	15.18	0.9989

The fit results are the following:

Linear fit:

$$V_C(T) = 0.0342 * T + 0.7339$$

$$V_D(T) = 0.0385 * T + 0.8784$$

Parabolic fit:

$$V_C(T) = -0.0002 * T^2 + 0.0407 * T + 0.6821$$

$$V_D(T) = -0.0002 * T^2 + 0.0460 * T + 0.8189$$



$$T(V_C) = 4.7936 * V^2 + 16.6420 * V - 13.2986$$
$$T(V_D) = 3.8514 * V^2 + 14.1626 * V - 13.8863$$

5.2.2 Sky Temperature Steps

In the data set the SKY temperature has been varied from 12.8 Kelvin to 33.8 Kelvin and the REF has been kept to 12.8 Kelvin.

T Change	T Fixed
12.8	12.0
14.2	12.1
16.0	12.4
19.4	13.0
22.4	13.7
25.6	14.4
28.8	15.2
33.8	-

The results are reported here. The error is the fit uncertainty and does not includes any systematic error from measurements. A linear Fit and a Parabolic Fit has been calculated and their behaviors are shown in the figure below.

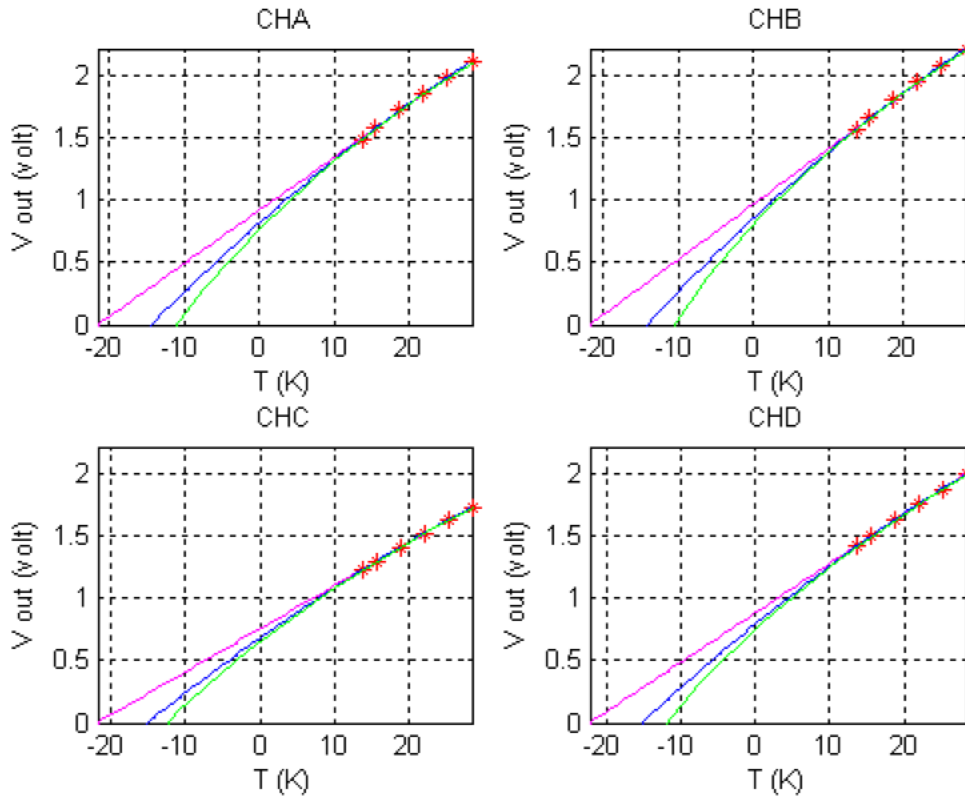


Figure 6-6: Non linearity of the RCA27. The magenta line is the linear best fit. The blue line is the parabolic fit $V(T)$, and the green line is the parabolic best fit for $T(V)$ data.

The noise temperature is then evaluated as the intersection on the T axis and results are reported in **Errore**.
L'origine riferimento non è stata trovata.

Table 6-3: Noise temperature and R coefficients evaluated from linear fits and Parabolic Fit.

Detector Id	Tn from Linear (K)	R2 (Linear)	Tn from Parabolic (K)	R2 (Parabolic)
A	21.52	0.9869	12.80	0.9973
B	21.77	0.9855	12.43	0.9972
C	21.76	0.9905	13.78	0.9980
D	21.27	0.9886	13.71	0.9977

The fit results are the following:

Linear fit:

$$\begin{aligned}
 V_A(T) &= 0.0427 * T + 0.9186 \\
 V_B(T) &= 0.0445 * T + 0.9687 \\
 V_C(T) &= 0.0347 * T + 0.7562 \\
 V_D(T) &= 0.0397 * T + 0.8831
 \end{aligned}$$



Parabolic fit:

$$V_A(T) = -0.000248344 * T^2 + 0.053057288 * T + 0.816806123$$

$$V_B(T) = -0.000276441 * T^2 + 0.056032191 * T + 0.855333121$$

$$V_C(T) = -0.000180869 * T^2 + 0.042301959 * T + 0.652635268$$

$$V_D(T) = -0.000217483 * T^2 + 0.048742725 * T + 0.793997091$$

$$T(V_A) = 3.213100827 * V^2 + 11.82294 * V - 11.19584691$$

$$T(V_B) = 3.160023678 * V^2 + 10.51502 * V - 10.61390596$$

$$T(V_C) = 4.336028988 * V^2 + 16.20976 * V - 11.94399474$$

$$T(V_D) = 3.506887337 * V^2 + 13.23740 * V - 12.18571493$$

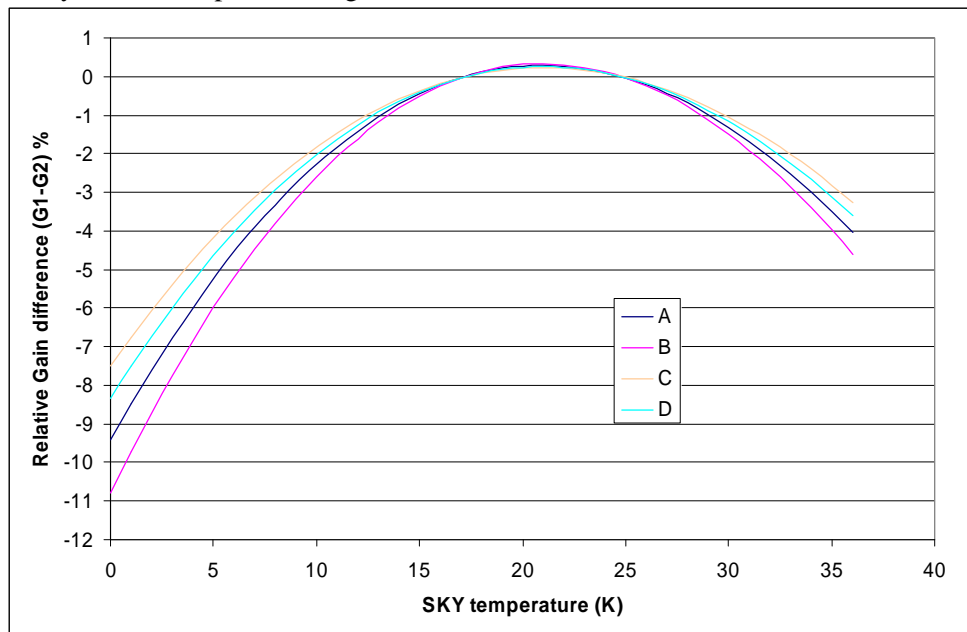
To check for best fit the following exercise has been performed.

From $V=f(T)$ parabolic fit the gain ($G1$ in V/K) has been calculated as $G1=dV/dT$, so that the Gain is the slope of the $f(T)$ function as the temperature varies.

The gain in V/K has been derived in two ways:

- (i) Calculated as $G2 = 1/G1$
- (ii) Calculated from $T=f(V)$ parabolic fit as $G2 = dT/dV$ in K/V

The two gains derived as in (i) and (ii) have been compared and the relative difference (percentage values) as a function of T sky has been reported in figure below:



It should be noted that, without any other assumption on the gain curve, the intrinsic relative error on the gain is less than 1 % within the measured temperature range and goes up to ~10 % near the flight condition (SKY temp ~ 3K). **This evaluation does not include systematics and should be considered as intrinsic error due to knowledge of the Gain function at $T \sim 3K$ based on the parabolic fits.**



5.2.3 Linearity

See Annex A

Table 6-4: Summary of linearity behaviors

Detector Id	Linearity from sky steps	Isolation from sky steps (dB)	Linearity from Ref steps	Isolation from Ref steps (dB)
A	0.008914	-10.77	0.007241	-12.9
B	0.009150	-10.75	0.007769	-12.7
C	0.006114	-11.28	0.003163	-14.7
D	0.009806	-10.97	0.003631	-14.6

5.2.4 Consistency of the Results

The white noise limit has been calculated and compared with the requirement. The white noise limit is defined at a given SKY temperature as follows:

$$\text{Eq. 1:} \quad \Delta T = \sqrt{2} \cdot \frac{T_{SKY} + T_{SYS}}{\sqrt{B}} \cdot 1000 \left[\text{mK} \cdot \sqrt{\text{sec}} \right]$$

where B is the bandwidth [Hz], τ is the integration time [sec], T_{SKY} and T_{SYS} are the Skyload antenna temperature [K] and noise system temperature [K] respectively.

From measurements the white noise limit is calculated as follows:

$$\text{Eq. 2:} \quad \Delta T = G[K/V] \cdot \frac{1}{\sqrt{2}} \cdot WN \cdot \sqrt{\frac{\tau}{\tau - \tau_{BT}}}$$

where WN is the white noise as derived from RaNA, τ is the 122 microSec (1/8KHz) integration time and τ_{BT} is the blanking time (7.5 microSec). G is the gain (K/V) which needs to be know from RCA_TNG tests.

The requirements has been calculated assuming $T_{sys} = 10.7$ Kelvin (see [AD 2]), while the white noise limit form measurements has been derived in three ways:

1. From the T_{sys} and B derived from tests applying the Eq. 1. T_{sys} values were obtained from parabolic values of Table 6-3 and B were obtained from RCA_SPR test from Table 6-7.
2. Table 6-7.
3. Directly From WN measurements applying the Eq. 2 where WN is the white noise level derived from RaNA FFT module when the detector output is calibrated. Firstly the white noise limit has been derived form *RaNA FFT* module selecting a stable (600 sec) calibrated acquisition data chunk. The White noise of differenced calibrated¹ detectors has been selected (A-B and C-D). Then the number has been corrected by the Blanking time.

¹ The calibration has been obtained in the following way:



4. White noise derived from B obtained from WN level (from RaNA FFT) and Tsys from Table 6-3.

Table 6-5: white noise as derived from measurements (Tsys, B from SPR, calibrated WN) compared with the requirements

	Requirement	From Measured Tsys & B	ratio Over requirement	From Data After calibration	Ratio over requirement	Consistency ratio
	mK*Sqrt (s)	mK*Sqrt (s)		mK*Sqrt (s)		
SKY = 14.2 K REF = 9.70 K						
Detector A-B	0.44168860	0.56936877	1.29	0.53865251	1.22	0.95
Detector C-D		0.62486608	1.41	0.54082949	1.22	0.87

Table 6-6: white noise as derived from measurements (Tsys, B from WN, calibrated WN) compared with the requirements

	Requirement	From Measured Tsys & B	ratio Over requirement	From Data After calibration	Ratio over requirement	Consistency ratio
	mK*Sqrt (s)	mK*Sqrt (s)		mK*Sqrt (s)		
SKY = 14.2 K REF = 9.70 K						
Detector A-B	0.44168860	0.41854747	0.95	0.53865251	1.22	1.29
Detector C-D		0.43115791	0.98	0.54082949	1.22	1.25

These calculations have been used to search for best Tnoise and B pairs in order to obtain a consistency ratio near unity (CR = 1). This means to obtain from radiometer equation the WN level as measured from calibrated data.

Required bandwidth for CR = 1 using Tnoise from LIS test:

A-B 4.70 GHz
 C-D 5.07 GHz

Required Tnoise for CR = 1 using B from WN level:

A-B 20.1 K
 C-D 20.7 K

Required Tnoise for CR = 1 using B from SPR test:

A-B 11.2 K
 C-D 10.1 K

5.3 RCA_SPR: BANDPASS MEASUREMENT

The RCA_SPR was performed several times with two different measurement setup. Here we report on the tests performed with the ESA equipment and coax – waveguide WR28 transition of INAF / IRA – Bologna. The following equipment has been used:

- Sweeper: AGILENT Model HP83650B, Synthesized sweeper generator, 10 MHz-50 GHz, output coaxial connector: 2.4 mm, s/n 3844A00889 Option 001²

² Thanks to ESA – ESTEC



- WR28 to Coax Transition: HPU281A S/N 00271 PC2.4 Female ³
- Cable Gore PC24 M-F ⁴

Typical data steam is showed hereafter:

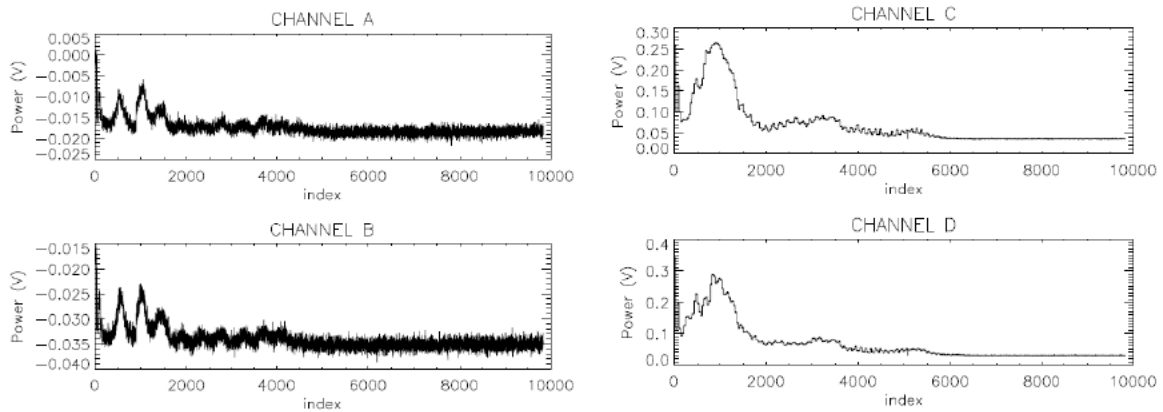


Figure 6-7: typical data steam of the SPR test after trigger removal.

Test has been performed with -34 dBm power level at the sweeper. Data were selected with a BIN = 10, i.e with sampling frequency of 409,6 Hz on the data stream: 030LFI27_RCA_FM_SPR_200604061449

Data set	Trigger sequence [dB] to Power level	Fmin [GHz]	Fmax [GHz]	Step [GHz]	Power level [dBm]
030LFI27_RCA_FM_SPR_200604061449	[+6, 0, +3, 0]@ 27GHz	26.5	40.0	0.05	-34.0

Table 6-7: Bandwidth and centre frequencies as calculated from RCA_SPR tests at different input power levels.

	Power level	
DETECTOR A	Centre frequency [GHz]	31.8
	Bandwidth [GHz]	4.3
DETECTOR B	Centre frequency [GHz]	31.30
	Bandwidth [GHz]	4.11
DETECTOR C	Centre frequency [GHz]	30.70
	Bandwidth [GHz]	3.71
DETECTOR D	Centre frequency [GHz]	30.45
	Bandwidth [GHz]	3.89

The RaNA report is attached.

³ Thanks to Segio Mariotti INAF/IRA - Bologna

⁴ Thanks to ESA – ESTEC

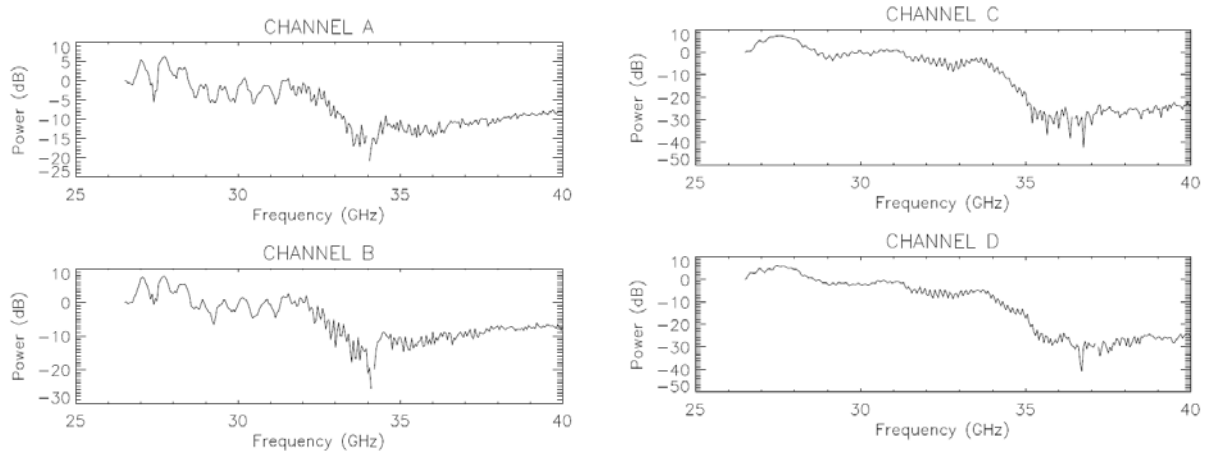


Figure 6-8: Bandpass shape of the all four channels. Obviously the channel A and B show ripples that are not found on channel C and D..

Figure 6-8 shows that for channel A and B a ripple is present with a period of 1 GHz. Moreover the Figure XXX shows that the data stream of these channels are very different with respect to the data stream of the other two channel: the output signal appeared noisy and low in amplitude for A and B, while for channel C and D appeared well defined and clearly visible.

Since for channel A and B results were not satisfactory, the RCA_SPR test was not successfully passed for these two channel. We decided to perform a deeply investigation at warm temperature. Hereafter we report on the results obtained.

5.3.1 Warm tests

Several warm SPR tests have been performed at RCA level, on BEM / waveguide assembly and on BEM stand alone. Specifically at RCA level tests have been performed at different SPR test setup condition, changing the orientation of the waveguide injector w.r.t the OMT arms and SKY load pyramids.

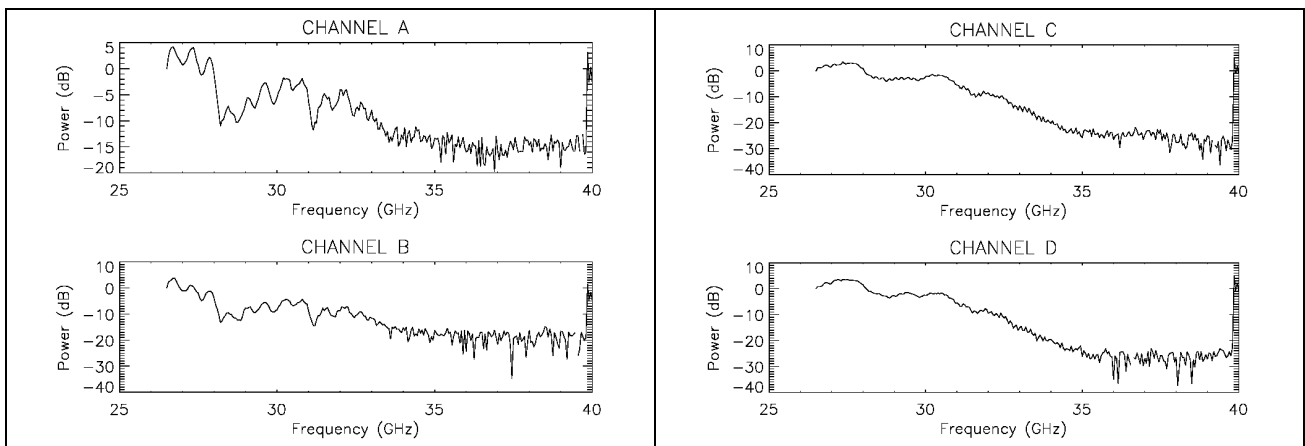
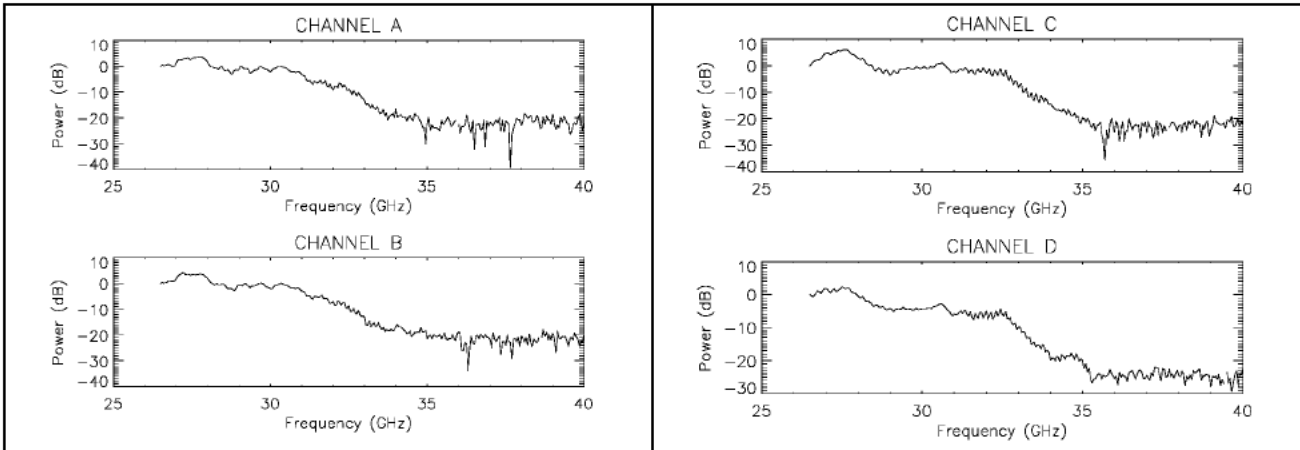


Figure 6-9: Bandpass shape of the all four channels. Obviously the channel A and B show ripples that are not found on channel C and D..



SPR_TEST @ room temperature where the Ripples are quite visible in Channel A/B



SPR_TEST @ Changing the polarization position angle of the launcher waveguide the ripples disappear

The position that minimize the ripple effect in the band is when the Polarization plane of launcher is at 45 DEG respect to the Polarization plane of the Main arm of the OMT (and obviously 45DEG from the polarization plane of the Side arm of OMT).

	Pass Band (GHz)	Pass Band (GHz)
	0 DEG	45 DEG
Detector A	3.55	4.29
Detector B	2.79	4.24
Detector C	3.77	4.07
Detector D	3.69	4.34

The measure values are obtained at room temperature and it is not clear or evident how to compare these results with the one obtained during Cryo tests.

Swept source test on LFI 27 RCA test Campaign.

6 NOISE PROPERTIES

6.1 RCA_STN

Long acquisition time has been performed with the aim to derive noise spectra.

The complete data set of the RCA_STn test with 7.5 uSec Blanking time is composed by the following files:
030LFI27_RCA_FM_ST3_200604071940



030LFI27_RCA_FM_ST3_200604080415
 the temperature step sequence is reported in Table 7-1

Table 7-1: Reference Temperature steps for Noise properties test (STn) with blanking time set at 7.5 uSec

SKY Temperature	REF Temperature	Duration
12.8 K	9.5 K	3 hours
12.8 K	15.0 K	3 hours
12.8 K	20.0 K	3 hours
20.0 K	20.0 K	> 3 hours

6.1.1 One-Over-F Noise

A fourier transform has been applied on data to obtain the 1/f knee frequency and noise properties. In the following table the 1/f characteristics obtained by an optimized fitting is reported. The numbers of point used for the low frequency fit is reported for each detector. BIN = 10 is used (fsampl = 409.600). The following data set have been used:

- 12.8 / 9.5 Selected from 7000 – 10600 sec, bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_ST3_200604071940
- 12.8 / 15.0 Selected from 18000 – 21600 sec, bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_ST3_200604071940
- 12.8 / 20.0 Selected from 26400 – 30000 sec, bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_ST3_200604071940
- 20.0 / 20.0 Selected from 15900– 19500 sec, bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_ST3_200604080415

T sky = 12.8 K T ref = 9.5 K	Detector A	Detector B	Detector C	Detector D
N points	19	24	37	200
1/f knee frequency	0.00674279	0.0100795	0.0248627	0.0310573
R factor	1.0117289	1.0039085	1.0925592	1.0751076
1/f Slope	-1.02472	-1.18724	-1.38526	-0.900950

T sky = 12.8 K T ref = 15 K	Detector A	Detector B	Detector C	Detector D
N points	167	90	16	50
1/f knee frequency	0.052728323	0.040813165	0.022304566	0.0162680
R factor	0.90196009	0.89537801	0.94551358	0.93842167
1/f Slope	-1.0732873	-1.2644164	-1.0548012	-1.36251

T sky = 12.8 K T ref = 20 K	Detector A	Detector B	Detector C	Detector D
N points	134	120	20	50
1/f knee frequency	0.061293342	0.049936296	0.016397661	0.022567225
R factor	0.81677914	0.81158679	0.84400192	0.84295173
1/f Slope	-1.1884388	-1.1765550	-1.3109853	-1.3295316

T sky = 20 K T ref = 20 K	Detector A	Detector B	Detector C	Detector D
N points	35	40	40	35
1/f knee frequency	0.0352489	0.0338384	0.0218724	0.0181386
R factor	0.98492659	0.97730596	1.0207044	1.0126508
1/f Slope	-1.26637	-1.23750	-1.09768	-1.42355



A further check has been done on the following data:

12.8 / 9.5 Selected from **1000 – 4600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940
 12.8 / 15.0 Selected from **12000 – 15600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940
 12.8 / 20.0 Selected from **23000 – 26000** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940

T sky = 12.8 K T ref = 9.5 K	Detector A	Detector B	Detector C	Detector D
N points	60	90	28	45
1/f knee frequency	0.010862375	0.012912768	0.021882927	0.030154401
R factor	1.0113834	1.0113834	1.0921599	1.0747619
1/f Slope	-1.0070003	-1.0234596	-1.0968903	-0.95164386

T sky = 12.8 K T ref = 15 K	Detector A	Detector B	Detector C	Detector D
N points	50	110	50	80
1/f knee frequency	0.0501855	0.0352692	0.0216174	0.0236875
R factor	0.90226751	0.89564600	0.94555593	0.93848066
1/f Slope	-1.52064	-1.63499	-1.20444	-1.07799

T sky = 12.8 K T ref = 20 K	Detector A	Detector B	Detector C	Detector D
N points	140	150	145	50
1/f knee frequency	0.064950925	0.054528675	0.0459296	0.0243880
R factor	0.81689483	0.81169119	0.84403441	0.84299581
1/f Slope	-1.4407961	-1.4718621	-0.598078	-0.991792

Finally, also this data have been analysed:

12.8 / 9.5 Selected from **4000 – 7600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940
 12.8 / 15.0 Selected from **15000 – 18600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940
 12.8 / 20.0 Selected from **25000 – 28600** sec , bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940
 20.0 / 20.0 Selected from **15900– 19500** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604080415

T sky = 12.8 K T ref = 9.5 K	Detector A	Detector B	Detector C	Detector D
N points	50	70	100	50
1/f knee frequency	0.011723189	0.010437344	0.028225476	0.029128471
R factor	1.0115488	1.0037355	1.0924103	1.0749771
1/f Slope	-0.99894215	-1.1217005	-1.0055711	-1.0309422

T sky = 12.8 K T ref = 15 K	Detector A	Detector B	Detector C	Detector D
N points	160	160	60	70
1/f knee frequency	0.048587980	0.0428731	0.0189623	0.0225853
R factor	0.90205405	0.89545550	0.94553092	0.93842245
1/f Slope	-0.94149592	-1.29612	-0.943855	-1.07147



T sky = 12.8 K T ref = 20 K	Detector A	Detector B	Detector C	Detector D
N points	66	123	51	50
1/f knee frequency	0.094050256	0.0731736	0.0244508	0.0258737
R factor	0.81680047	0.81160392	0.84400453	0.84296170
1/f Slope	-0.89563201	-0.830475	-1.10793	-0.947067

6.1.2 White Noise Level and Equivalent Bandwidth

The white noise level has been calculated with the *RaNA_FFT* module using the high frequency part of the amplitude spectrum. From the white noise limit the equivalent bandwidth has been derived. Same data stream as the 1/f calculation has been used. Data were not binned and 10 minutes have been taken for each reference temperature step. For each step the last 600 seconds of the data taken for 1/f noise have been taken for this analysis.

12.8 / 9.5 Selected from **10000 – 10600** sec, bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_ST3_200604071940

12.8 / 15.0 Selected from **21000 – 21600** sec, bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_ST3_200604071940

12.8 / 20.0 Selected from **29400 – 30000** sec , bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_ST3_200604071940

20.0 / 20.0 Selected from **18900– 19500** sec, bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_ST3_200604080415

T sky = 12.8 K T ref = 9.5 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3435988e-005	3.2342572e-005	4.6778515e-005	7.60	7.93	7.77
DETECTOR B	3.5278226e-005	3.4511582e-005	4.9385869e-005	7.54	7.82	7.70
DETECTOR C	2.7727442e-005	2.5396591e-005	3.9143590e-005	7.16	7.15	7.18
DETECTOR D	2.9941649e-005	2.7584003e-005	4.2145125e-005	8.65	8.82	8.73

T sky = 12.8 K T ref = 15 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3644264e-005	3.5675069e-005	4.6557472e-005	7.63	8.34	7.97
DETECTOR B	3.5368858e-005	3.7934642e-005	4.9065764e-005	7.62	8.27	7.92
DETECTOR C	2.8033363e-005	2.9161193e-005	3.9319945e-005	7.10	7.34	7.22
DETECTOR D	3.0140437e-005	3.1397785e-005	4.2073550e-005	8.64	9.05	8.87

T sky = 12.8 K T ref = 20 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3590779e-005	3.8442429e-005	4.6020686e-005	7.76	8.89	8.27
DETECTOR B	3.5403473e-005	4.1253903e-005	4.8691289e-005	7.72	8.64	8.17
DETECTOR C	2.7932176e-005	3.1758679e-005	3.8670899e-005	7.23	7.85	7.54
DETECTOR D	3.0055345e-005	3.4170126e-005	4.1604718e-005	8.78	9.56	9.16

T sky = 20 K T ref = 20 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.9607126e-005	3.9023383e-005	5.5158916e-005	8.34	8.85	8.60



DETECTOR B	4.1667565e-005	4.1447719e-005	5.8092124e-005	8.29	8.77	8.53
DETECTOR C	3.2733853e-005	3.2390443e-005	4.6539301e-005	7.90	7.74	7.82
DETECTOR D	3.5313326e-005	3.4740264e-005	4.9813563e-005	9.43	9.49	9.48

A further check has been done on the following data:

12.8 / 9.5 Selected from **4000 – 4600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940

12.8 / 15.0 Selected from **15000 – 15600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940

12.8 / 20.0 Selected from **25400 – 26000** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940

T sky = 12.8 K T ref = 9.5 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3540639e-005	3.2026162e-005	4.6480214e-005	7.53	8.08	7.85
DETECTOR B	3.5191239e-005	3.4472392e-005	4.9258708e-005	7.56	7.82	7.71
DETECTOR C	2.7836948e-005	2.5248287e-005	3.9130481e-005	7.08	7.22	7.17
DETECTOR D	2.9850261e-005	2.7523769e-005	4.2083530e-005	8.68	8.83	8.73

T sky = 12.8 K T ref = 15 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3480648e-005	3.5779994e-005	4.6427225e-005	7.69	8.27	8.00
DETECTOR B	3.5268394e-005	3.7776802e-005	4.8800127e-005	7.65	8.32	7.99
DETECTOR C	2.8043838e-005	2.9178984e-005	3.9301802e-005	7.08	7.32	7.21
DETECTOR D	3.0022738e-005	3.1586202e-005	4.2169438e-005	8.70	8.92	8.82

T sky = 12.8 K T ref = 20 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3395226e-005	3.8457177e-005	4.5880478e-005	7.85	8.87	8.32
DETECTOR B	3.5391205e-005	4.1121776e-005	4.8622548e-005	7.72	8.68	8.18
DETECTOR C	2.7868565e-005	3.1711425e-005	3.8539880e-005	7.26	7.87	7.59
DETECTOR D	3.0142478e-005	3.4110919e-005	4.1608357e-005	8.72	9.59	9.16

Finally, also this data have been analysed:

12.8 / 9.5 Selected from **7000 – 7600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940

12.8 / 15.0 Selected from **18000 – 18600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940

12.8 / 20.0 Selected from **28000 – 28600** sec, bin 10 for FFT and 1/f from file
 030LFI27_RCA_FM_ST3_200604071940

T sky = 12.8 K T ref = 9.5 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3526986e-005	3.2181533e-005	4.6792230e-005	7.55	8.01	7.75
DETECTOR B	3.5412713e-005	3.4546965e-005	4.9493533e-005	7.47	7.79	7.65
DETECTOR C	2.7870115e-005	2.5301355e-005	3.9074936e-005	7.08	7.19	7.20



DETECTOR D	2.9968213e-005	2.7630755e-005	4.2177082e-005	8.62	8.78	8.71
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T sky = 12.8 K T ref = 15 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3583706e-005	3.5769961e-005	4.6507810e-005	7.65	8.29	7.98
DETECTOR B	3.5224597e-005	3.7896268e-005	4.8769514e-005	7.68	8.27	8.01
DETECTOR C	2.8046126e-005	2.9126792e-005	3.9319864e-005	7.09	7.35	7.21
DETECTOR D	3.0118637e-005	3.1550318e-005	4.2277287e-005	8.65	8.95	8.78

T sky = 12.8 K T ref = 20 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff
DETECTOR A	3.3504507e-005	3.8407273e-005	4.5934878e-005	7.80	8.90	8.30
DETECTOR B	3.5355420e-005	4.1069514e-005	4.8445124e-005	7.74	8.71	8.24
DETECTOR C	2.7863254e-005	3.1719901e-005	3.8608725e-005	7.26	7.87	7.57
DETECTOR D	3.0111617e-005	3.4152561e-005	4.1549893e-005	8.75	9.57	9.19

6.2 RCA_UNC: UNCHOPPED DATA

Noise properties have been derived also from unchopped data, i.e. with all the phase switches off. The following data set has been used:

12.8 / 9.5 Selected from 2075 – 5475 sec, bin 10 for FFT and 1/f from file 030LFI27_RCA_FM_UNC_200604081247

The corresponding RaNA report is reported in [ANNEX], section RaNA_FFT_001.

T sky = 12.8 K T ref = 9.5 K	Detector A	Detector B	Detector C	Detector D
SKY				
N points	38	43	27	40
1/f knee frequency	114.866	393.502	329.784	369.068
1/f Slope	-0.631812	-0.578270	-0.579105	-0.578354
REF				
N points	38	43	27	43
1/f knee frequency	169.265	701.620	133.739	524.124
1/f Slope	-0.610953	-0.551522	-0.627111	-0.562112

The white noise level has been calculated with the *RaNA_FFT* module using the high frequency part of the amplitude spectrum. From the white noise limit the equivalent bandwidth has been derived. Same data stream as the 1/f calculation has been used. Data were not binned and 10 minutes have been taken for each reference temperature step. For each step the last 600 seconds of the data taken for 1/f noise have been taken for this analysis.

The corresponding RaNA report is reported is attached, section RaNA_FFT_002.

T sky = 12.8 K T ref = 9.5 K	White noise level [V/Sqrt(Hz)]			Effective bandwidth [GHz]		
	Sky	Load	Diff	Sky	Load	Diff



DETECTOR A	3.2320391e-005	3.2170511e-005	4.5637558e-005	8.19	8.27	8.22
DETECTOR B	3.5644954e-005	3.5802131e-005	5.0504697e-005	7.68	7.61	7.65
DETECTOR C	2.8233743e-005	2.8231127e-005	3.9929094e-005	7.12	7.12	7.12
DETECTOR D	2.7995929e-005	2.8032187e-005	3.9640900e-005	8.75	8.73	8.73



7 SUSCEPTIBILITY TESTS

Any thermal and electrical variation on the RCA subsystem units produces an variation of the output signal from each of the four detector.

7.1 RCA_THF: SUSCEPTIBILITY TO FEM TEMPERATURE VARIATIONS

The test has been performed by varying the temperature of the FEM keeping constant the temperatures of the other thermal interfaces.

The temperature of the FEM has been set to 20K (nominal), 22K, 24K, and 27K as seen in Figure -1

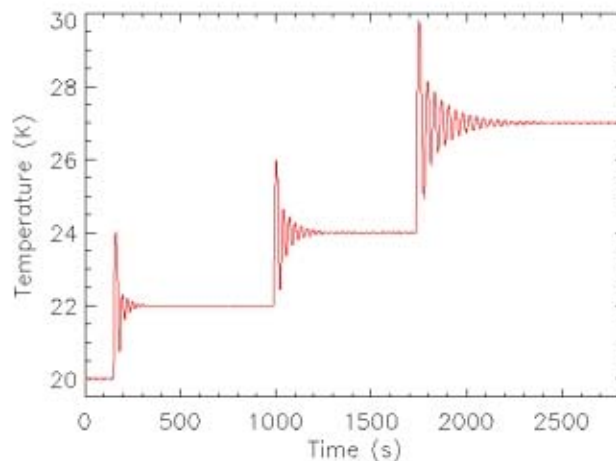


Figure -10: FEM temperature step during the RCA_THF test

The temperature behaviour of the other thermal interfaces are reported in the next figures (Figure -2 and Figure -3) showing the reference load (REF_TEMP and RMON_TMP) and sky load temperatures, and the BEM temperature.

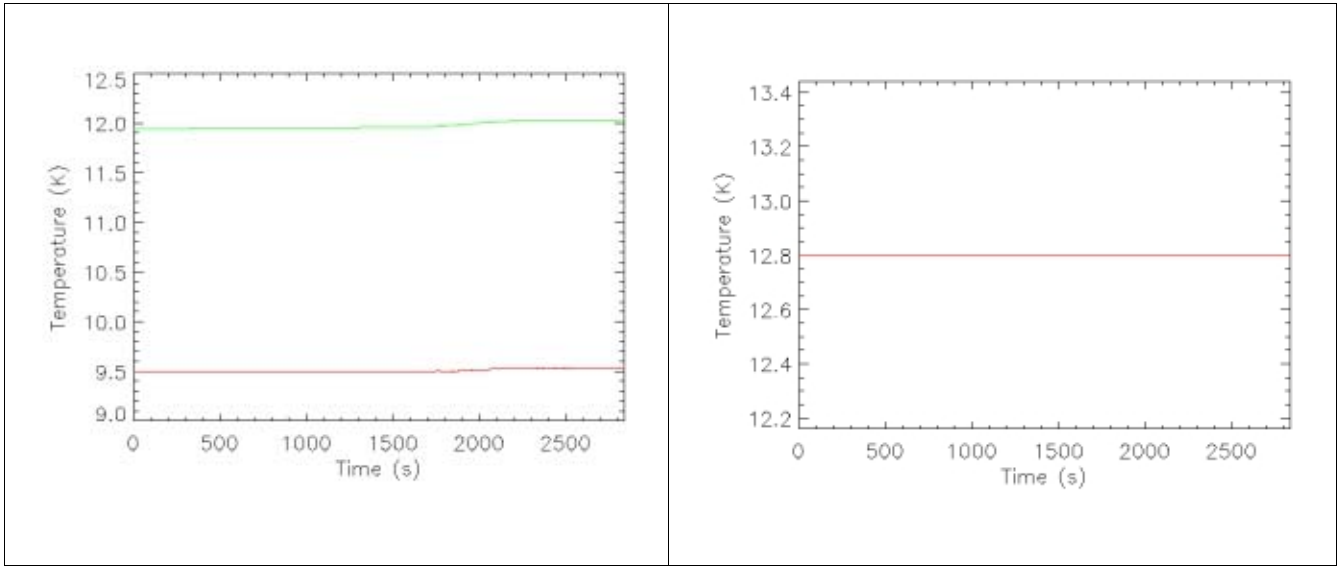


Figure -11: Left – Reference Load (REF_TEMP probe (red) and RMON_TMP probe (green)) temperature behaviour during the RCA_THF test; right – Sky Load SKY_TEMP probe (red)

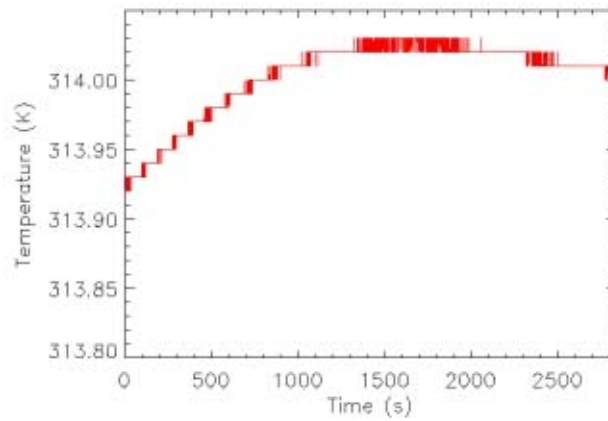


Figure -12: BEM temperature behaviour during the RCA_THF test

To do the analysis, the radiometric output for each channel in the three steps was recorded. We can see the output of the channels in the figures below:

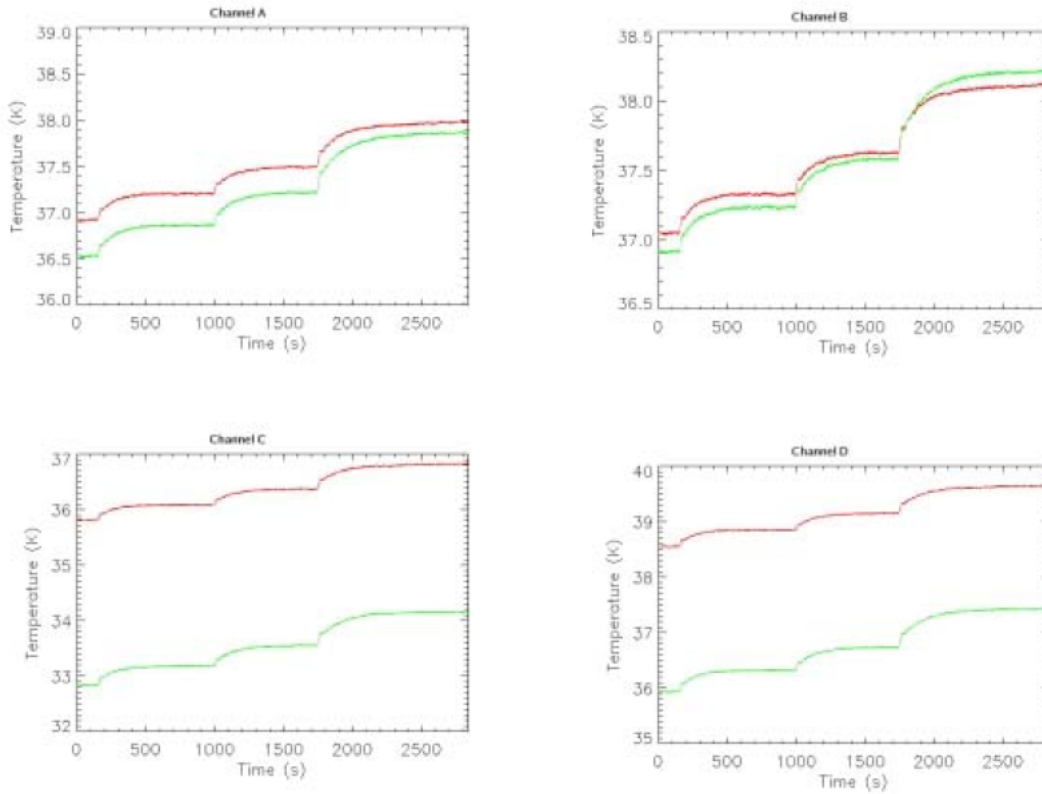


Figure -13: Radiometric output of the 4 detectors during the RCA_THF test. Sky (red) -Reference (green)

Analysis using the SKY_TEMP probe as sky load temperature:

The default parameters for the four channels are:

Table -2: Default input parameters for RCA THF analysis

	Ch. A	Ch. B	Ch. C	Ch. D
Freq (GHz)	30			
L _{feed-OMT} (dB)	0.25			
L _{4k} (dB)	0.2			
r	1.0106878	1.0035895	1.0907821	1.0728292
T _{sky} (K)	12.8			
T _{ref} (K)	9.49988			
G _{F1} ^{dB} (dB)	35			
G _{F2} ^{dB} (dB)	35			
T _{nF1} (K)	20	20	20	20
T _{nF2} (K)	20	20	20	20
$\partial G_{F1}^{dB} / \partial T_{phys}^{FE}$ (dB/K)	-0.05	-0.05	-0.05	-0.05



$\partial G_{F2}^{dB} / \partial T_{phys}^{FE}$ (dB/K)	-0.05	-0.05	-0.05	-0.05
$\partial T_{nF1} / \partial T_{phys}^{FE}$ (K/K)	0.08	0.08	0.08	0.08
$\partial T_{nF2} / \partial T_{phys}^{FE}$ (K/K)	0.08	0.08	0.08	0.08
Gain Calibration Factor (V/K)	0.0399	0.0418	0.03299	0.03651

Calculating the theoretical and the measured transfer functions with RaNA, we obtain:

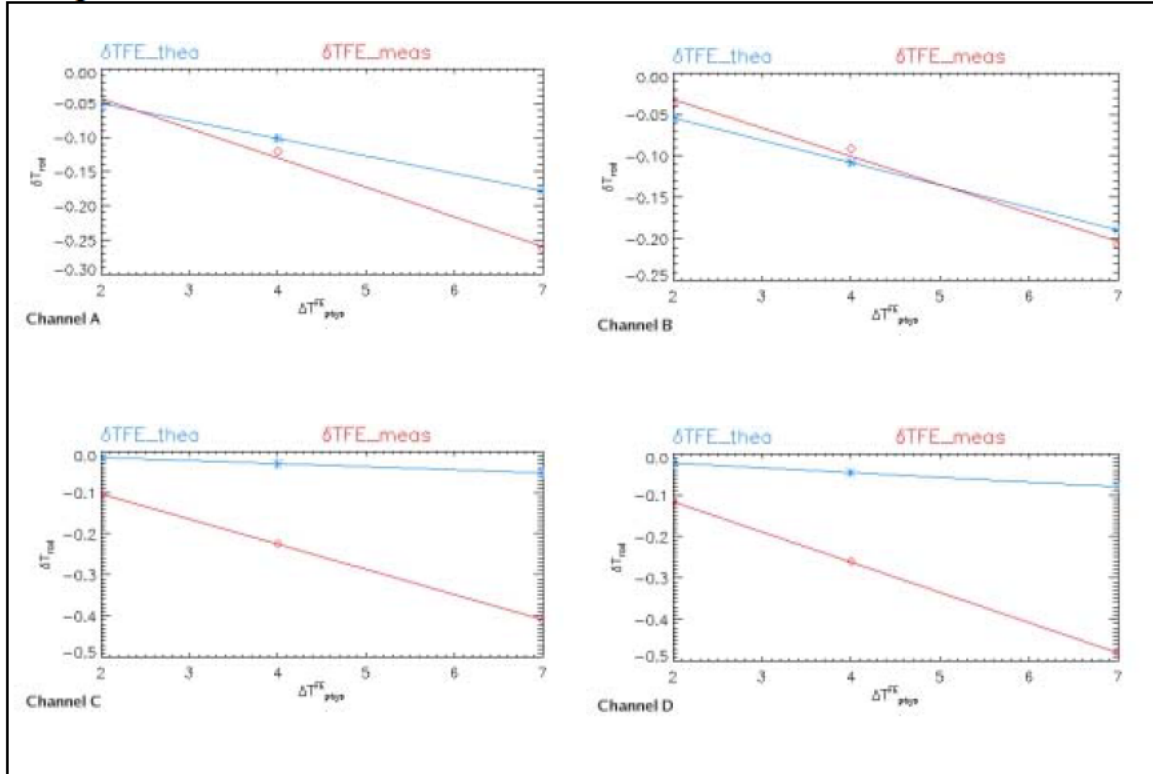


Figure -14: RCA_THF theoretical (blue) Vs measured (red) transfer function

Table -3: RCA_THF Analysis Result based on default parameters

	Channel A	Channel B	Channel C	Channel D
$f_{them}^{front-end}$ (K/K) theoretical	-0.025451	-0.027047	-0.007434	-0.011473
$f_{them}^{front-end}$ (K/K) measured	-0.043035	-0.034227	-0.061077	-0.072906

The complete RaNA output:

FEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : A Load correct : Yes r = 1.0106864 Model: FM Gain calibration factor (V/K) = value of RaNA_View	FEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : B Load correct : Yes r = 1.0035884 Model: FM Gain calibration factor (V/K) = value of RaNA_View
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Table with 2 columns and 4 rows of data. Each row contains technical parameters, sensor data, radiometer outputs, and susceptibility information. The columns are separated by vertical lines.



<pre> OUTPUT ftheo (K/K) fmeas (K/K) -0.007434 -0.061077 </pre>	<pre> OUTPUT ftheo (K/K) fmeas (K/K) -0.011473 -0.072906 </pre>
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To improve the results obtained with the default parameters, I am going to change any of them. In particular, I change the $\partial G_{FE}^{dB} / \partial T_{phys}^{FE}$ and $\partial T_{nFE} / \partial T_{phys}^{FE}$. The best values will be:

Table -4: Optimized parameters of RCA_THF test

	Ch. A	Ch. B	Ch. C	Ch. D
$\partial G_{F1}^{dB} / \partial T_{phys}^{FE}$ (dB/K)	-0.075	-0.059	-0.028	-0.1
$\partial G_{F2}^{dB} / \partial T_{phys}^{FE}$ (dB/K)	-0.075	-0.059	-0.028	-0.1
$\partial T_{nF1} / \partial T_{phys}^{FE}$ (K/K)	0.06	0.08	0.67	0.7
$\partial T_{nF2} / \partial T_{phys}^{FE}$ (K/K)	0.06	0.08	0.67	0.7

and calculating the transfer functions, the new results:

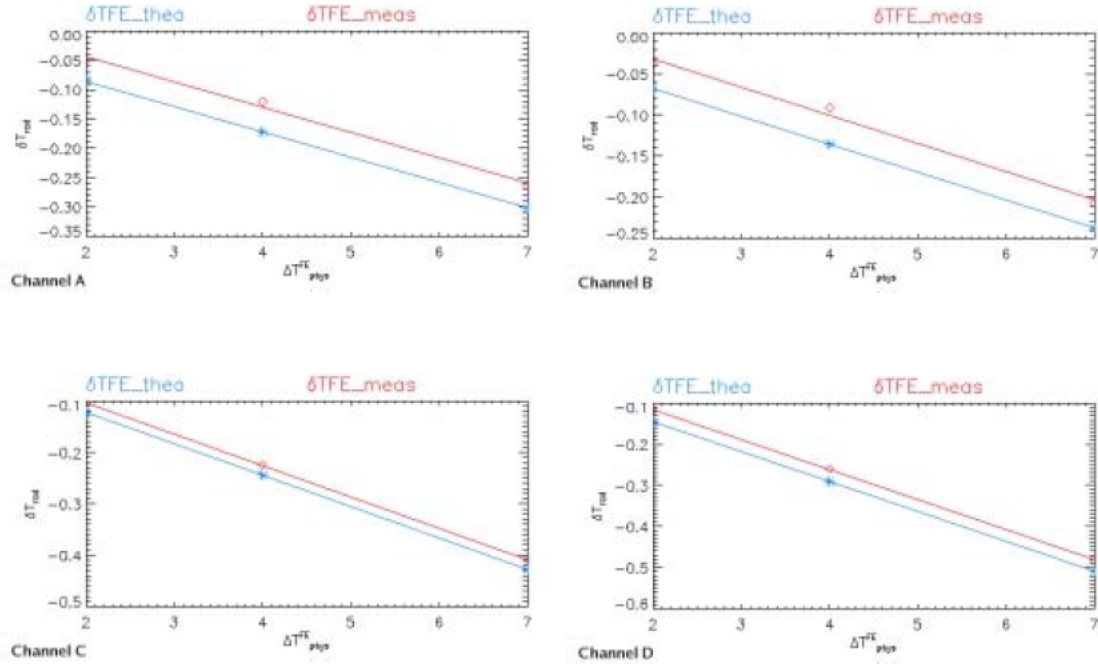


Figure -15: RCA_THF theoretical Vs measured transfer function after optimisation of the parameters.

Table -5: RCA_THF Optimal transfer function Vs. theoretical

		Channel A	Channel B	Channel C	Channel D
$f_{\text{therm}}^{\text{front-end}}$	(K/K) theoretical	-0.043032	-0.033914	-0.061095	-0.072711
$f_{\text{therm}}^{\text{front-end}}$	(K/K) measured	-0.043035	-0.034227	-0.061077	-0.072906

The complete RaNA output:

<pre> FEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : A Load correct : Yes r = 1.0106864 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 dGF1_db_dTFEphys_K = -0.0750000 dGF2_db_dTFEphys_K = -0.0750000 dTn1_dTFEphys_K = 0.0600000 dTn2_dTFEphys_K = 0.0600000 There are 4 time windows tmin tmax 8.00 128.00 419.00 977.00 1369.00 1725.00 2644.00 2836.00 Sky Sensor = SKY_TEMP </pre>	<pre> FEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : B Load correct : Yes r = 1.0035884 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 dGF1_db_dTFEphys_K = -0.0590000 dGF2_db_dTFEphys_K = -0.0590000 dTn1_dTFEphys_K = 0.0800000 dTn2_dTFEphys_K = 0.0800000 There are 4 time windows tmin tmax 8.00 128.00 419.00 977.00 1369.00 1725.00 2644.00 2836.00 Sky Sensor = SKY_TEMP </pre>
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Analysis using the RMON_TMP probe as reference load temperature:

The default parameters for the four channels are:

Table -6: Default input parameters for RCA_THF analysis



	Ch. A	Ch. B	Ch. C	Ch. D
Freq (GHz)	30			
L _{feed-OMT} (dB)	0.25			
L _{4k} (dB)	0.2			
r	1.0106878	1.0035895	1.0907821	1.0728292
T _{sky} (K)	12.8			
T _{ref} (K)	11.944			
G _{F1} ^{dB} (dB)	35			
G _{F2} ^{dB} (dB)	35			
T _{nF1} (K)	20	20	20	20
T _{nF2} (K)	20	20	20	20
$\partial G_{F1}^{dB} / \partial T_{phys}^{FE}$ (dB/K)	-0.05	-0.05	-0.05	-0.05
$\partial G_{F2}^{dB} / \partial T_{phys}^{FE}$ (dB/K)	-0.05	-0.05	-0.05	-0.05
$\partial T_{nF1} / \partial T_{phys}^{FE}$ (K/K)	0.08	0.08	0.08	0.08
$\partial T_{nF2} / \partial T_{phys}^{FE}$ (K/K)	0.08	0.08	0.08	0.08
Gain Calibration Factor (V/K)	0.0399	0.0418	0.03299	0.03651

Table -7: RCA_THF Analysis Result based on default parameters

	Channel A	Channel B	Channel C	Channel D
f _{front-end} f _{therm} (K/K) theoretical	0.003272	0.001474	0.023565	0.019016
f _{front-end} f _{therm} (K/K) measured	-0.0326	-0.023865	-0.049815	-0.061829

The complete RaNA output:

<pre> FEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : A Load correct : Yes r = 1.0106864 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 dGF1_db_dTphys_K = -0.0500000 dGF2_db_dTphys_K = -0.0500000 dTn1_dTphys_K = 0.0800000 dTn2_dTphys_K = 0.0800000 There are 4 time windows tmin tmax 8.00 128.00 419.00 977.00 1369.00 1725.00 2644.00 2836.00 Sky Sensor = SKY_TEMP Ref Sensor = RMON_TEMP FEM Sensor = FEM_TEMP </pre>	<pre> FEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : B Load correct : Yes r = 1.0035884 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 dGF1_db_dTphys_K = -0.0500000 dGF2_db_dTphys_K = -0.0500000 dTn1_dTphys_K = 0.0800000 dTn2_dTphys_K = 0.0800000 There are 4 time windows tmin tmax 8.00 128.00 419.00 977.00 1369.00 1725.00 2644.00 2836.00 Sky Sensor = SKY_TEMP Ref Sensor = RMON_TEMP FEM Sensor = FEM_TEMP </pre>
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<pre> SKY_TEMP RMON_TEMP FEM_TEMP 12.80001068 11.94380093 20.00002289 12.79993534 11.94746971 22.00016212 12.80000973 11.95826912 24.00003052 12.80002499 12.02499008 27.00001335 Radiometer outputs (K) Tsky Tref 36.921345 36.530961 37.201213 36.853079 37.489589 37.198495 37.974078 37.778491 Tsky-r*Tref -0.045692068 -0.10642300 -0.20812776 OUTPUT ftheo (K/K) fmeas (K/K) 0.003272 -0.032600 </pre>	<pre> SKY_TEMP RMON_TEMP FEM_TEMP 12.80001068 11.94380093 20.00002289 12.79993534 11.94746971 22.00016212 12.80000973 11.95826912 24.00003052 12.80002499 12.02499008 27.00001335 Radiometer outputs (K) Tsky Tref 37.047712 36.915245 37.324963 37.225434 37.621944 37.563739 38.113177 38.129077 Tsky-r*Tref -0.034051621 -0.076589261 -0.15272336 OUTPUT ftheo (K/K) fmeas (K/K) 0.001474 -0.023865 </pre>
<pre> FEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : C Load correct : Yes r = 1.0907850 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_dB = 0.250000 L4K_dB = 0.200000 GF1_dB = 35 GF2_dB = 35 TnF1_K = 20 TnF2_K = 20 dGF1_dB_dTFEphys_K = -0.0500000 dGF2_dB_dTFEphys_K = -0.0500000 dTn1_dTFEphys_K = 0.0800000 dTn2_dTFEphys_K = 0.0800000 There are 4 time windows tmin tmax 8.00 128.00 419.00 977.00 1369.00 1725.00 2644.00 2836.00 Sky Sensor = SKY_TEMP Ref Sensor = RMON_TEMP FEM Sensor = FEM_TEMP SKY_TEMP RMON_TEMP FEM_TEMP 12.80001068 11.94380093 20.00002289 12.79993534 11.94746971 22.00016212 12.80000973 11.95826912 24.00003052 12.80002499 12.02499008 27.00001335 Radiometer outputs (K) Tsky Tref 35.817435 32.836384 36.082631 33.171800 36.366584 33.530858 36.821706 34.078624 Tsky-r*Tref -0.10066956 -0.20837232 -0.35074527 OUTPUT ftheo (K/K) fmeas (K/K) 0.023565 -0.049815 </pre>	<pre> FEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : D Load correct : Yes r = 1.0728284 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_dB = 0.250000 L4K_dB = 0.200000 GF1_dB = 35 GF2_dB = 35 TnF1_K = 20 TnF2_K = 20 dGF1_dB_dTFEphys_K = -0.0500000 dGF2_dB_dTFEphys_K = -0.0500000 dTn1_dTFEphys_K = 0.0800000 dTn2_dTFEphys_K = 0.0800000 There are 4 time windows tmin tmax 8.00 128.00 419.00 977.00 1369.00 1725.00 2644.00 2836.00 Sky Sensor = SKY_TEMP Ref Sensor = RMON_TEMP FEM Sensor = FEM_TEMP SKY_TEMP RMON_TEMP FEM_TEMP 12.80001068 11.94380093 20.00002289 12.79993534 11.94746971 22.00016212 12.80000973 11.95826912 24.00003052 12.80002499 12.02499008 27.00001335 Radiometer outputs (K) Tsky Tref 38.553199 35.936036 38.845617 36.314541 39.146076 36.716314 39.644090 37.347765 Tsky-r*Tref -0.11365280 -0.24422789 -0.42365266 OUTPUT ftheo (K/K) fmeas (K/K) 0.019016 -0.061829 </pre>



7.2 RCA_THB: SUSCEPTIBILITY TO BEM TEMPERATURE VARIATIONS

The BEM temperature was cooled continuously from a maximum (306K) to a minimum (304K). In the data analysis, small section of data in which the temperature did not change significantly were used assuming quasi-stationary conditions.

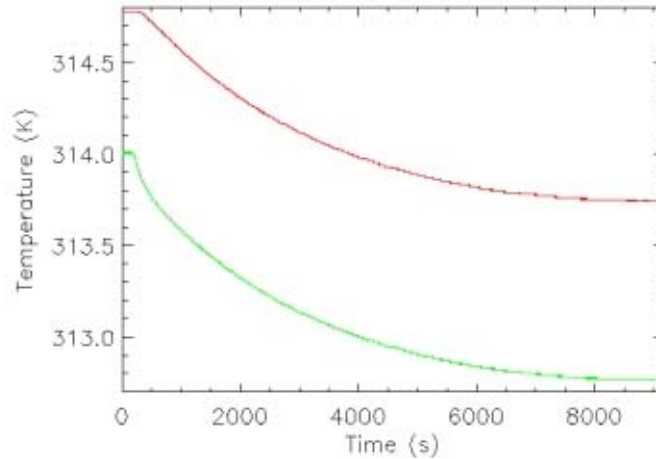


Figure -16: BEM temperature during the RCA_THB test. VG2_TEMP probe (red) and BEM_TEMP probe (green)

The temperature behaviour of the other thermal interfaces are reported in the next figures (Figure -2 and Figure -3) showing the sky load and reference load temperatures (REF_TEMP and RMON_TMP), and the FEM temperature.

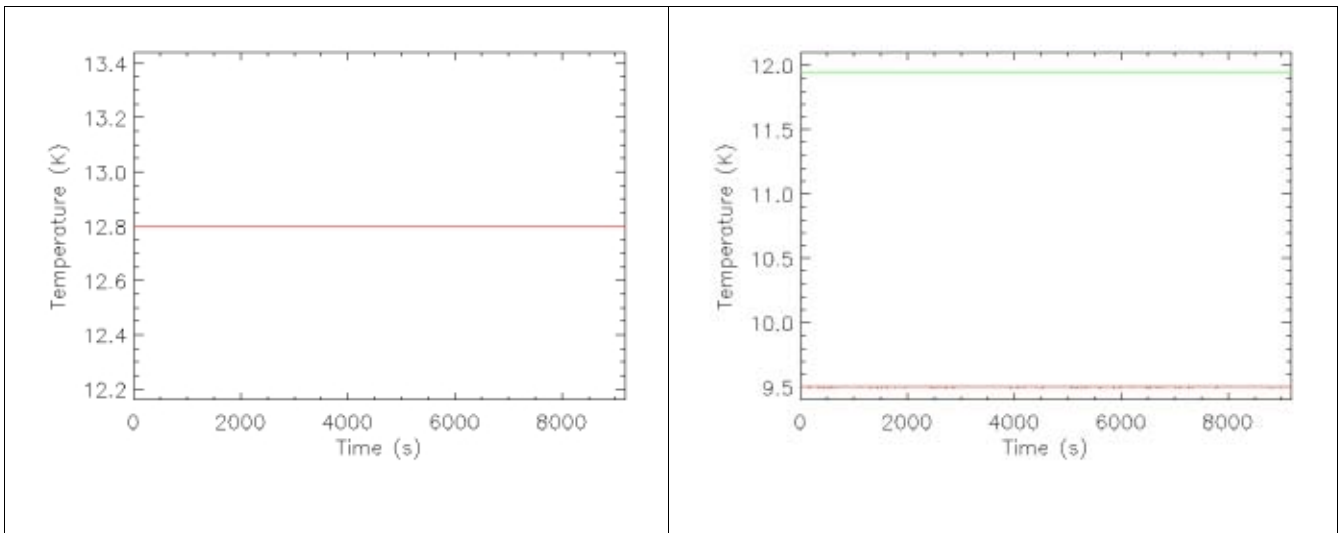


Figure -17: Left – Sky Load temperature behaviour during the RCA_THB test; right – REF_TEMP probe (red) and RMON_TMP probe (green)

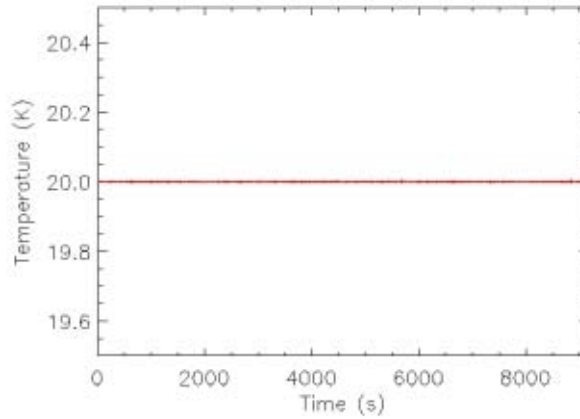
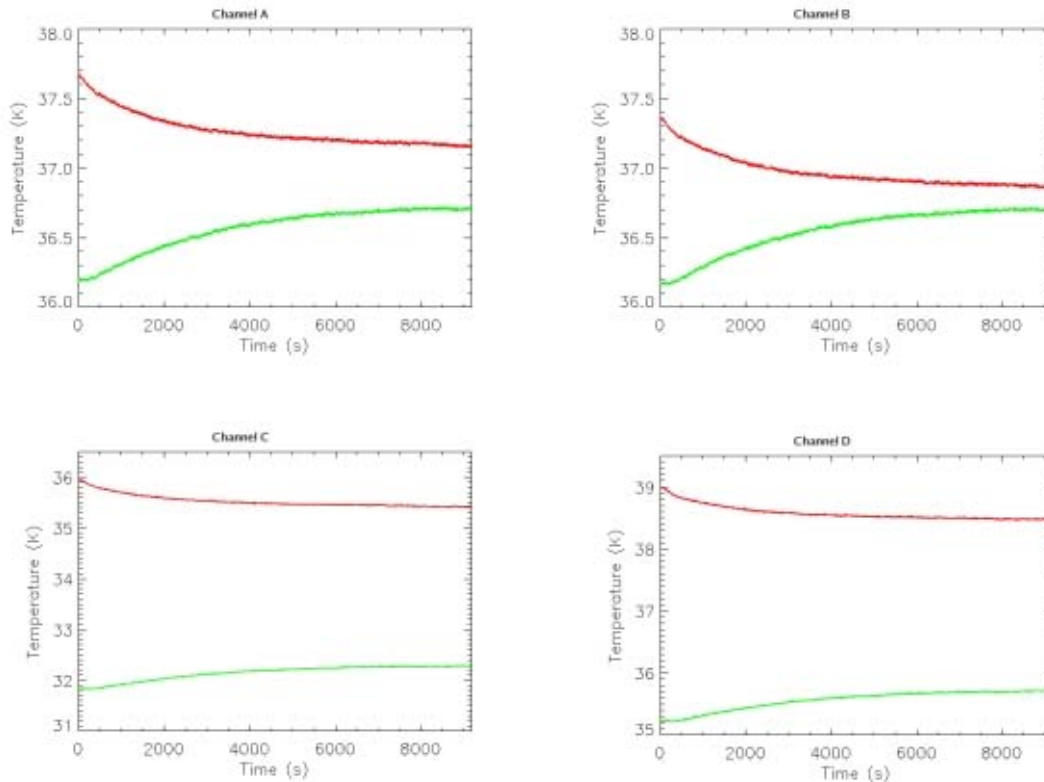


Figure -18: FEM temperature behaviour during the RCA_THB test

To do the analysis, the radiometric output for each channel in the three steps was recorded. We can see the output of the channels in the figures below:

Figure -19: Radiometric output of the 4 detectors during the RCA_THB test. Sky (red) and Reference (green)





The parameters for the four channels are:

	Ch. A	Ch. B	Ch. C	Ch. D
Freq(GHz)	30			
L _{feed-OMT} (dB)	0.25			
L _{4k} (dB)	0.2			
r	1.0389378	1.0312000	1.1273369	1.1051599
T _{FEphys} (K)	20			
G _{F1} ^{dB} (dB)	35			
G _{F2} ^{dB} (dB)	35			
T _{nF1} (K)	20	20	20	20
T _{nF2} (K)	20	20	20	20
$\partial G_{B1}^{dB} / \partial T_{phys}^{BE}$ (dB/K)	-0.034	-0.04	-0.03	-0.027
$\partial G_{B2}^{dB} / \partial T_{phys}^{BE}$ (dB/K)	-0.034	-0.04	-0.03	-0.027
$\partial a^{dB} / \partial T_{phys}^{BE}$ (dB/K)	-0.01	-0.01	-0.01	-0.01
Gain Calibration Factor (V/K)	0.0399	0.0418	0.03299	0.03651

Analysis using the REF_TEMP probe as Reference load temperature and BEM_TEMP probe as BEM temperature:

T _{sky} (K)	12.8
T _{ref} (K)	9.5

Calculating the theoretical and the measured transfer functions with RaNA, we obtain:

	Channel A	Channel B	Channel C	Channel D
f _{therm} ^{back-end} (K/K) theoretical	-0.022414	-0.028246	0.004990	-0.001271
f _{therm} ^{back-end} (K/K) measured	0.789433	0.793694	0.0784877	0.801166

The complete RaNA output:

BEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : A Load correct : Yes r = 1.0389378 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 TnB1_K = 350 TnB2_K = 350 dGB1_db_dTBphys_K = -0.0340000 dGB2_db_dTBphys_K = -0.0340000 da_db_dTBphys_K = -0.01000000	BEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : B Load correct : Yes r = 1.0312000 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 TnB1_K = 350 TnB2_K = 350 dGB1_db_dTBphys_K = -0.0400000 dGB2_db_dTBphys_K = -0.0400000 da_db_dTBphys_K = -0.01000000 There are 2 time windows
---	---



<pre> There are 2 time windows tmin tmax 167.00 195.00 8252.00 9195.00 Sky Sensor = SKY_TEMP Ref Sensor = REF_TEMP BEM Sensor = BEM_TEMP FEM Sensor = FEM_TEMP SKY_TEMP REF_TEMP BEM_TEMP FEM_TEMP 12.79999733 9.49956322 314.00000000 20.00013924 12.79988289 9.49991703 312.76986694 19.99994278 Radiometer outputs (K) Tsky Tref 37.607884 36.198398 37.164082 36.705941 Tsky-r*Tref -0.97110770 OUTPUT ftheo (K/K) fmeas (K/K) -0.022414 0.789433 </pre>	<pre> tmin tmax 167.00 195.00 8252.00 9195.00 Sky Sensor = SKY_TEMP Ref Sensor = REF_TEMP BEM Sensor = BEM_TEMP FEM Sensor = FEM_TEMP SKY_TEMP REF_TEMP BEM_TEMP FEM_TEMP 12.79999733 9.49956322 314.00000000 20.00013924 12.79988289 9.49991703 312.76986694 19.99994278 Radiometer outputs (K) Tsky Tref 37.298530 36.170025 36.870248 36.701509 Tsky-r*Tref -0.97634925 OUTPUT ftheo (K/K) fmeas (K/K) -0.028246 0.793694 </pre>
<pre> BEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : C Load correct : Yes r = 1.1273369 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 TnB1_K = 350 TnB2_K = 350 dGB1_db_dTBephys_K = -0.0300000 dGB2_db_dTBephys_K = -0.0300000 da_db_dTBephys_K = -0.0100000 There are 2 time windows tmin tmax 167.00 195.00 8252.00 9195.00 Sky Sensor = SKY_TEMP Ref Sensor = REF_TEMP BEM Sensor = BEM_TEMP FEM Sensor = FEM_TEMP SKY_TEMP REF_TEMP BEM_TEMP FEM_TEMP 12.79999733 9.49956322 314.00000000 20.00013924 12.79988289 9.49991703 312.76986694 19.99994278 Radiometer outputs (K) Tsky Tref 35.888896 31.835113 35.425349 32.280371 Tsky-r*Tref -0.96550279 OUTPUT ftheo (K/K) fmeas (K/K) 0.004990 0.784877 </pre>	<pre> BEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : D Load correct : Yes r = 1.1051599 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 TnB1_K = 350 TnB2_K = 350 dGB1_db_dTBephys_K = -0.0270000 dGB2_db_dTBephys_K = -0.0270000 da_db_dTBephys_K = -0.0100000 There are 2 time windows tmin tmax 167.00 195.00 8252.00 9195.00 Sky Sensor = SKY_TEMP Ref Sensor = REF_TEMP BEM Sensor = BEM_TEMP FEM Sensor = FEM_TEMP SKY_TEMP REF_TEMP BEM_TEMP FEM_TEMP 12.79999733 9.49956322 314.00000000 20.00013924 12.79988289 9.49991703 312.76986694 19.99994278 Radiometer outputs (K) Tsky Tref 38.927297 35.223225 38.478638 35.709021 Tsky-r*Tref -0.98554114 OUTPUT ftheo (K/K) fmeas (K/K) -0.001271 0.801166 </pre>

Analysis using the RMON_TEMP probe as Reference load temperature and BEM_TEMP probe as BEM temperature:

T _{sky} (K)	12.8
T _{ref} (K)	11.948



Calculating the theoretical and the measured transfer functions with RaNA, we obtain:

		Channel A	Channel B	Channel C	Channel D
$f_{therm}^{back-end}$	(K/K) theoretical	0.003618	0.001115	0.030668	0.022015
$f_{therm}^{back-end}$	(K/K) measured	0.786148	0.790433	0.781312	0.797671

The complete RaNA output:

<pre> BEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : A Load correct : Yes r = 1.0389378 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 TnB1_K = 350 TnB2_K = 350 dGB1_db_dTBphys_K = -0.0340000 dGB2_db_dTBphys_K = -0.0340000 da_db_dTBphys_K = -0.0100000 There are 2 time windows tmin tmax 167.00 195.00 8252.00 9195.00 Sky Sensor = SKY_TEMP Ref Sensor = RMON_TEMP BEM Sensor = BEM_TEMP FEM Sensor = FEM_TEMP SKY_TEMP RMON_TEMP BEM_TEMP FEM_TEMP 20.00013924 12.79999733 11.94810200 314.00000000 12.79988289 11.95234585 312.76986694 19.99994278 Radiometer outputs (K) Tsky Tref 37.607884 36.198398 37.164082 36.702051 Tsky-r*Tref -0.96706620 OUTPUT ftheo (K/K) fmeas (K/K) 0.003618 0.786148 </pre>	<pre> BEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : B Load correct : Yes r = 1.0312000 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 TnB1_K = 350 TnB2_K = 350 dGB1_db_dTBphys_K = -0.0400000 dGB2_db_dTBphys_K = -0.0400000 da_db_dTBphys_K = -0.0100000 There are 2 time windows tmin tmax 167.00 195.00 8252.00 9195.00 Sky Sensor = SKY_TEMP Ref Sensor = RMON_TEMP BEM Sensor = BEM_TEMP FEM Sensor = FEM_TEMP SKY_TEMP RMON_TEMP BEM_TEMP FEM_TEMP 20.00013924 12.79999733 11.94810200 314.00000000 12.79988289 11.95234585 312.76986694 19.99994278 Radiometer outputs (K) Tsky Tref 37.298530 36.170025 36.870248 36.697619 Tsky-r*Tref -0.97233784 OUTPUT ftheo (K/K) fmeas (K/K) 0.001115 0.790433 </pre>
<pre> BEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : C Load correct : Yes r = 1.1273369 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 TnB1_K = 350 TnB2_K = 350 dGB1_db_dTBphys_K = -0.0300000 dGB2_db_dTBphys_K = -0.0300000 da_db_dTBphys_K = -0.0100000 There are 2 time windows tmin tmax </pre>	<pre> BEM susceptibility INPUT Frequency (GHz) = 30 Receiver: LFI Channel : D Load correct : Yes r = 1.1051599 Model: FM Gain calibration factor (V/K) = value of RaNA_View LfeedOMT_db = 0.250000 L4K_db = 0.200000 GF1_db = 35 GF2_db = 35 TnF1_K = 20 TnF2_K = 20 TnB1_K = 350 TnB2_K = 350 dGB1_db_dTBphys_K = -0.0270000 dGB2_db_dTBphys_K = -0.0270000 da_db_dTBphys_K = -0.0100000 There are 2 time windows tmin tmax </pre>



Table with two columns of sensor data and radiometer outputs. Columns include SKY_TEMP, RMON_TEMP, BEM_TEMP, FEM_TEMP, Radiometer outputs (K), and OUTPUT. Values are numerical and include units like (K/K) and (K).

7.3 RCA_THV: SUSCEPTIBILITY TO V-GROOVE TEMPERATURE VARIATIONS

The test consists in three steps in the T_vg3 (the coldest): 66.5, 68.5, 70.5 K respectively. The following graphics show the T_vg3 temperature sensor measurements.

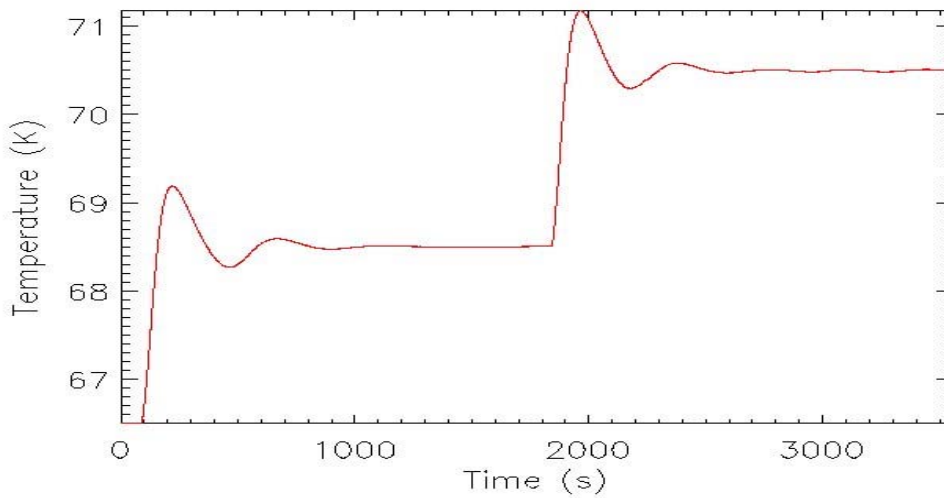


Figure -20: VG3 temperature variation during the RCA_THV test.

Sky load and Reference load were stabilized during the test so that only VG3 temperature was varied.

The T_sky and T_ref behavior during the test is reported in Figure -2

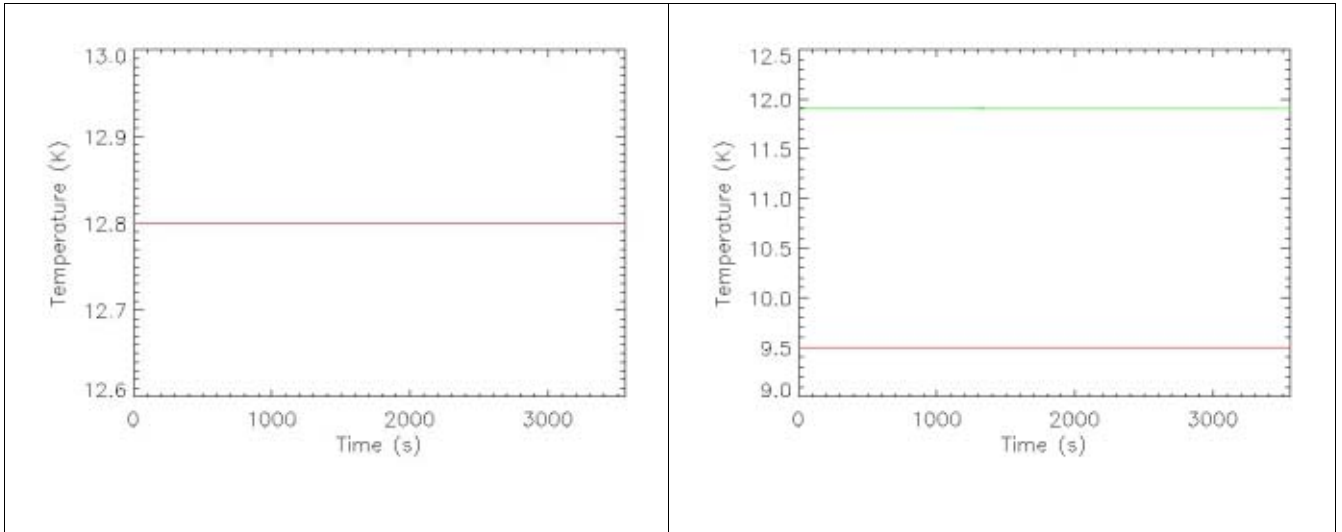


Figure -21: Left – Sky Load: (SKY_TEMP) probe temperature behaviour during the RCA_THF test; right – Reference Load : REF_TEMP probe (red) and RMON_TMP probe (green)

Also the FEM and BEM temperatures were controlled during the test. They are reported in Figure - 3

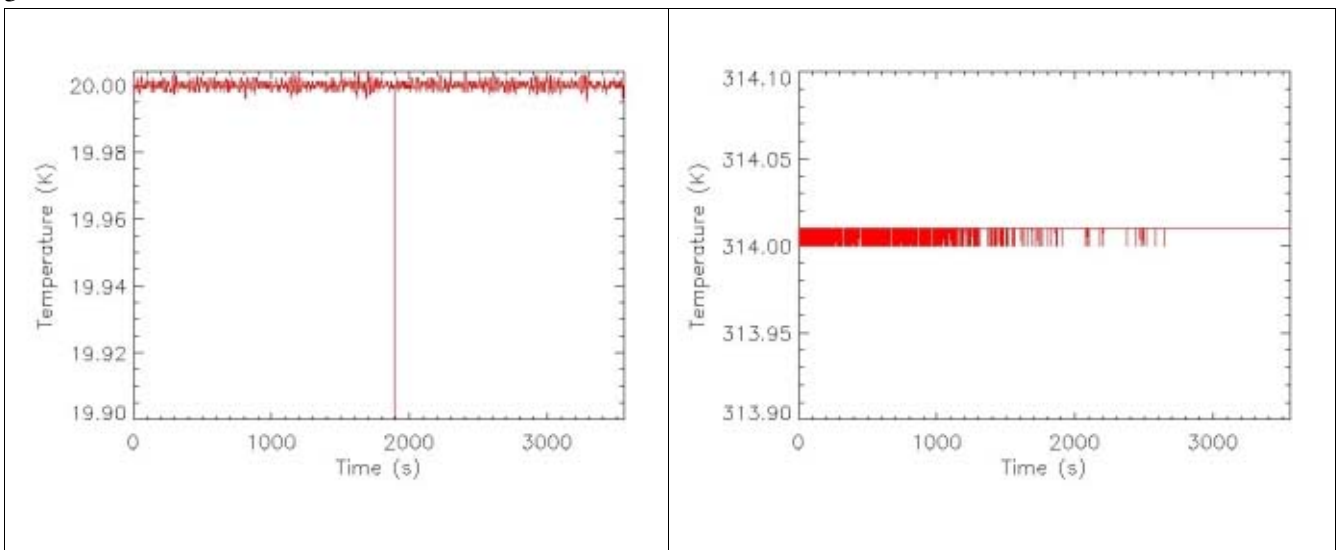


Figure -22: FEM (left) and BEM (right) temperature behaviour during the RCA_THV test

7.3.1 Detector A analysis

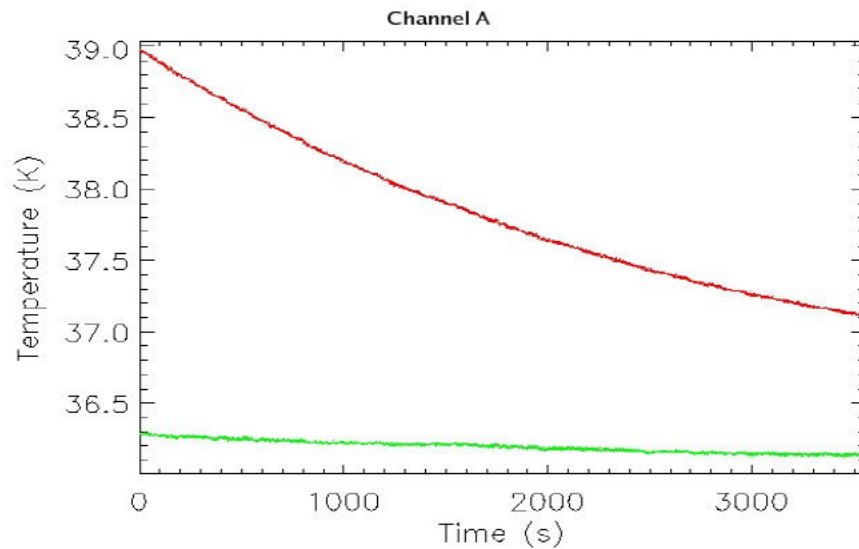


Figure -23: Detector A calibrated output. Sky (red) -Reference (green)

Receiver parameters used in the computation of the theoretical transfer functions:

Frequency (GHz)	30
$L_{\text{feed-OMT}}$ (dB)	0.25
r	1.0732684
G_{P1} (dB)	35
G_{P2} (dB)	35
L_{WG1} (dB)	0.03
L_{WG2} (dB)	1.08
L_{WG3} (dB)	0.11
L_{WG4} (dB)	0.15
L_{WG5} (dB)	0.13
G (V/K)	0.0399

Analysis using the REF_TEMP probe as Reference load temperature:

The transfer functions obtained with RaNA:

F_{meas} (K/K)	-0.31991206
F_{theo} (K/K)	-0.00000389

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : A
Load correct : Yes
```



r = 1.0732684
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB = 0.250000
Vgroove number = 1 coldest
LWG1_dB = 0.0300000
LWG2_dB = 1.08000
LWG3_dB = 0.110000
LWG4_dB = 0.150000
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = REF_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP	REF_TEMP	VG3_TEMP
12.79999161	9.49986649	66.50115204
12.79995251	9.49990845	68.49982452
12.80003452	9.49991322	70.49695587

Radiometer outputs (K)
Tsky Tref
38.942603 36.284125
37.867792 36.207070
37.156871 36.139971

Tsky-r*Tref
-0.99211000
-1.6310164

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000389 -0.31991206

Analysis using the RMON_TEMP probe as Reference load temperature:

The transfer functions obtained with RaNA:

Fmeas (K/K)	-0.32130865
Ftheo (K/K)	-0.00000389

The complete RaNA output:

Vgrooves susceptibility
INPUT
Frequency (GHz) = 30
Receiver: LFI
Channel : A
Load correct : Yes
r = 1.0732684
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB = 0.250000
Vgroove number = 1 coldest
LWG1_dB = 0.0300000
LWG2_dB = 1.08000
LWG3_dB = 0.110000
LWG4_dB = 0.150000
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = RMON_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP RMON_TEMP VG3_TEMP



```
12.79999161 11.91124153 66.50115204  
12.79995251 11.90805435 68.49982452  
12.80003452 11.90546036 70.49695587
```

Radiometer outputs (K)

```
Tsky Tref  
38.942603 36.284125  
37.867792 36.210299  
37.156871 36.145799
```

```
Tsky-r*Tref  
-0.99557573  
-1.6372713
```

OUTPUT

```
ftheo (K/K) fmeas (K/K)  
-0.00000389 -0.32130865
```

7.3.2 Detector B analysis

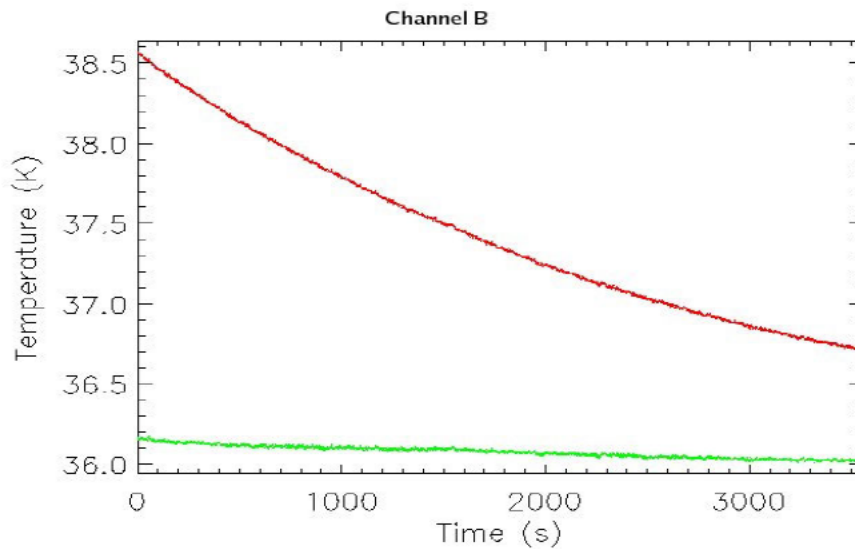


Figure -24: Detector B calibrated output. Sky (red) -Reference (green)

Receiver parameters used in the computation of the theoretical transfer functions:

Frequency (GHz)	30
L _{feed-OMT} (dB)	0.25
r	1.0656175
G _{P1} (dB)	35
G _{P2} (dB)	35
L _{WG1} (dB)	0.03
L _{WG2} (dB)	1.08
L _{WG3} (dB)	0.11
L _{WG4} (dB)	0.15
L _{WG5} (dB)	0.13
G (V/K)	0.0418

**Analysis using the REF_TEMP probe as Reference load temperature:**

The transfer functions obtained with RaNA:

<i>F</i> _{meas} (K/K)	-0.32109367
<i>F</i> _{theo} (K/K)	-0.00000349

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : B
Load correct : Yes
r =      1.0656175
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB =      0.250000
Vgroove number = 1 coldest
LWG1_dB =      0.0300000
LWG2_dB =      1.08000
LWG3_dB =      0.110000
LWG4_dB =      0.150000
LWG5_dB =      0.130000
GF1_dB =      35
GF2_dB =      35

There are      3 time windows
  tmin tmax
      1.00  77.00
     1317.00 1812.00
     3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = REF_TEMP
Vgroove Sensor = VG3_TEMP

  SKY_TEMP REF_TEMP VG3_TEMP
  12.79999161      9.49986649      66.50115204
  12.79995251      9.49990845      68.49982452
  12.80003452      9.49991322      70.49695587

Radiometer outputs (K)
  Tsky Tref
  38.527985      36.155549
  37.464941      36.088300
  36.755504      36.024327

  Tsky-r*Tref
  -0.99138194
  -1.6326482

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000349 -0.32109367
```

Analysis using the RMON_TEMP probe as Reference load temperature:

The transfer functions obtained with RaNA:

<i>F</i> _{meas} (K/K)	-0.3224830
<i>F</i> _{theo} (K/K)	-0.00000349

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : B
Load correct : Yes
r =      1.0656175
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB =      0.250000
Vgroove number = 1 coldest
LWG1_dB =      0.0300000
LWG2_dB =      1.08000
LWG3_dB =      0.110000
LWG4_dB =      0.150000
```



```

LWG5_dB =      0.130000
GF1_dB =       35
GF2_dB =       35

There are      3 time windows
  tmin tmax
    1.00  77.00
 1317.00 1812.00
 3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = RMON_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP  RMON_TEMP  VG3_TEMP
12.79999161  11.91124153  66.50115204
12.79995251  11.90805435  68.49982452
12.80003452  11.90546036  70.49695587

Radiometer outputs (K)
  Tsky Tref
 38.527985  36.155549
 37.464941  36.091529
 36.755504  36.030155

Tsky-r*Tref
-0.99482297
-1.6388585

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000349 -0.32248030

```

7.3.3 Detector C analysis

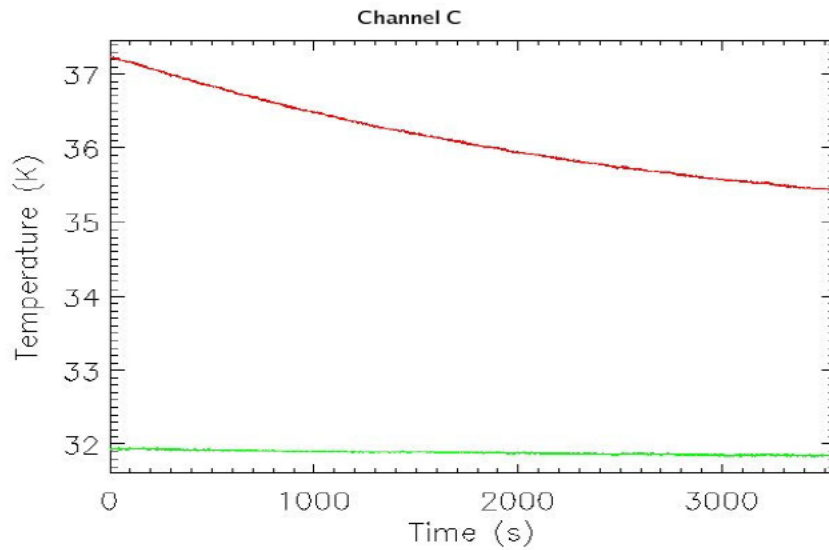


Figure -25: Detector C calibrated output.Sky (red) -Reference (green)

Receiver parameters used in the computation of the theoretical transfer functions:

Frequency (GHz)	30
L _{feed-OMT} (dB)	0.25
r	1.1646563
G _{P1} (dB)	35
G _{P2} (dB)	35



LWG1 (dB)	0.03
LWG2 (dB)	1.08
LWG3 (dB)	0.11
LWG4 (dB)	0.15
LWG5 (dB)	0.13
G (V/K)	0.03299

Analysis using the REF_TEMP probe as Reference load temperature:
The transfer functions obtained with RaNA:

Fmeas (K/K)	-0.31806395
Ftheo (K/K)	-0.00000875

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) = 30
Receiver: LFI
Channel : C
Load correct : Yes
r = 1.1646563
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB = 0.250000
Vgroove number = 1 coldest
LWG1_dB = 0.0300000
LWG2_dB = 1.08000
LWG3_dB = 0.110000
LWG4_dB = 0.150000
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = REF_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP REF_TEMP VG3_TEMP
12.79999161 9.49986649 66.50115204
12.79995251 9.49990845 68.49982452
12.80003452 9.49991322 70.49695587

Radiometer outputs (K)
Tsky Tref
37.203801 31.944016
36.159615 31.894638
35.475483 31.852638

Tsky-r*Tref
-0.98667763
-1.6218931

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000875 -0.31806395
```

Analysis using the RMON_TEMP probe as Reference load temperature:
The transfer functions obtained with RaNA:

Fmeas (K/K)	-0.31957946
Ftheo (K/K)	-0.00000875

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) = 30
Receiver: LFI
Channel : C
Load correct : Yes
r = 1.1646563
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB = 0.250000
```



```
Vgroove number = 1 coldest
LWG1_db = 0.0300000
LWG2_db = 1.080000
LWG3_db = 0.1100000
LWG4_db = 0.1500000
LWG5_db = 0.1300000
GF1_db = 35
GF2_db = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = RMON_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP RMON_TEMP VG3_TEMP
12.79999161 11.91124153 66.50115204
12.79995251 11.90805435 68.49982452
12.80003452 11.90546036 70.49695587

Radiometer outputs (K)
Tsky Tref
37.203801 31.944016
36.159615 31.897868
35.475483 31.858466

Tsky-r*Tref
-0.99043847
-1.6286806

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000875 -0.31957946
```

7.3.4 Detector D analysis

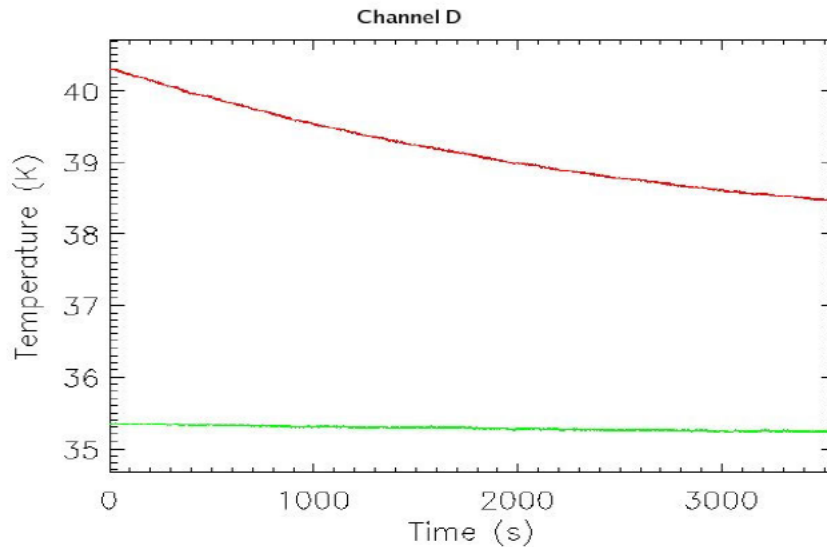


Figure -26: Detector D calibrated output. Sky (red) -Reference (green)

Receiver parameters used in the computation of the theoretical transfer functions:

Frequency (GHz)	30
L _{feed-OMT} (dB)	0.25



r	1.139537
G _{P1} (dB)	35
G _{P2} (dB)	35
L _{WG1} (dB)	0.03
L _{WG2} (dB)	1.08
L _{WG3} (dB)	0.11
L _{WG4} (dB)	0.15
L _{WG5} (dB)	0.13
G (V/K)	0.0365

Analysis using the REF_TEMP probe as Reference load temperature:
 The transfer functions obtained with RaNA:

F_{meas} (K/K)	-0.32517484
F_{theo} (K/K)	-0.00000742

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : D
Load correct : Yes
r =      1.1395370
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_db =      0.250000
Vgroove number = 1 coldest
LWG1_db =      0.0300000
LWG2_db =      1.08000
LWG3_db =      0.110000
LWG4_db =      0.150000
LWG5_db =      0.130000
GP1_db =      35
GP2_db =      35

There are      3 time windows
  tmin tmax
    1.00  77.00
 1317.00 1812.00
 3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = REF_TEMP
Vgroove Sensor = VG3_TEMP

  SKY_TEMP REF_TEMP VG3_TEMP
 12.79999161  9.49986649  66.50115204
 12.79995251  9.49990845  68.49982452
 12.80003452  9.49991322  70.49695587

Radiometer outputs (K)
  Tsky Tref
 40.277087  35.345132
 39.208721  35.292028
 38.506921  35.246059

  Tsky-r*Tref
 -1.0078517
 -1.6572686

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000742 -0.32517484
```

Analysis using the RMON_TEMP probe as Reference load temperature:
 The transfer functions obtained with RaNA:

F_{meas} (K/K)	-0.32665766
F_{theo} (K/K)	-0.00000742

The complete RaNA output:

```
Vgrooves susceptibility
INPUT
Frequency (GHz) =      30
Receiver: LFI
Channel : D
Load correct : Yes
```



```

r = 1.1395370
Model: FM
Gain calibration factor (V/K) = value of RaNA_View
LfeedOMT_dB = 0.250000
Vgroove Number = 1 coldest
LWG1_dB = 0.0300000
LWG2_dB = 1.08000
LWG3_dB = 0.110000
LWG4_dB = 0.150000
LWG5_dB = 0.130000
GF1_dB = 35
GF2_dB = 35

There are 3 time windows
tmin tmax
1.00 77.00
1317.00 1812.00
3225.00 3543.00

Sky Sensor = SKY_TEMP
Ref Sensor = RMON_TEMP
Vgroove Sensor = VG3_TEMP

SKY_TEMP RMON_TEMPV G3_TEMP
12.79999161 11.91124153 66.50115204
12.79995251 11.90805435 68.49982452
12.80003452 11.90546036 70.49695587

Radiometer outputs (K)
Tsky Tref
40.277087 35.345132
39.208721 35.295257
38.506921 35.251887

Tsky-r*Tref
-1.0115314
-1.6639097

OUTPUT
ftheo (K/K) fmeas (K/K)
-0.00000742 -0.32665766

```

8 APPENDIX FOR TRB

8.1 RCA_LIS: LINEARITY AND ISOLATION WITH REFERENCE TEMPERATURE STEPS

Noise temperatures, linearity, and isolation have been computed considering:

1. BEM offset = 0
2. Reference temperature seen by channels C and D simulated by Luca Terenzi

The data set analysed is 030LFI27_RCA_FM_LIS_200604081545. Nine steps have been considered in the computation. The time interval selected in each step is 600 seconds long. The error reported in the tables below is the fit uncertainty and does not includes any systematic error from measurements.

8.1.1 BEM Offset = 0

Table 9-1 Basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY_TEMP probe as a sky load temperature, and R_MON sensor for the REF load temperature. For isolation the error has not been calculated. It will be reported in the next update of the document.

	Gain [V/K]	Gain [K/V]	Tnoise [K]	Tnoise [K]	Isolation [dB]
	x 1E-02		Linear	Parabolic	
DETECTOR A	4.08±0.02	24.5±0.1	22.4±0.2	14.1±0.1	-13.43



Table with 6 columns: Detector (B, C, D), and five numerical values representing measurements and offsets.

The complete RaNA output is reported (RCA27_LIS_results_100506_Rmon_9.txt):

```
-----
INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: A
Changing signal: Load
BEM offset (v) =, 0.000000

There are, 9, time windows
,tmin, tmax
, 3800.00, 4400.00
, 6500.00, 7100.00
, 9200.00, 9800.00
, 12000.00, 12600.00
, 14700.00, 15300.00
, 17400.00, 18000.00
, 20000.00, 20600.00
, 22700.00, 23300.00
, 25400.00, 26000.00

,Tchange, Tfixed, Vchange, Vfixed
, 11.983419418335, 12.800000190735, 1.442863831712, 1.457443225608
, 13.510450363159, 12.800000190735, 1.513649832629, 1.460513550473
, 15.188432693481, 12.800000190735, 1.589175773890, 1.463630553546
, 16.967086791992, 12.800000190735, 1.668228343935, 1.467573307340
, 18.809181213379, 12.800000190735, 1.748639875669, 1.472246842100
, 20.707633972168, 12.800000190735, 1.829081392251, 1.476682181874
, 22.638475418091, 12.800000190735, 1.909555616777, 1.481358057582
, 24.587665557861, 12.800000190735, 1.989164634414, 1.486008527985
, 26.560396194458, 12.966036796570, 2.067890311825, 1.494392018569

OUTPUT
***** Linear fit *****
Parameters
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.040799856796, 22.400856426138, -13.428386025930, 0.005971560426

Statistical uncertainties
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000239777788, 0.156494227351, 3.822651956296, 0.004649178963

***** Parabolic fit *****

Average noise temperature
,Tn (k),Sigma (K)
, 14.053056503690, 0.123721939608

Temperature versus voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
, -13.188189625420, 12.528367130144, 3.069282957142

,sigma(a0),sigma(a1),sigma(a2)
, 0.069660428681, 0.080824948766, 0.023185067035

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.888463232002, 0.051933197810, -0.000244250719

,sigma(a0),sigma(a1),sigma(a2)
, 0.003376643659, 0.000400108753, 0.000011247155
-----

INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: B
Changing signal: Load
BEM offset (v) =, 0.000000

There are, 9, time windows
,tmin, tmax
, 3800.00, 4400.00
, 6500.00, 7100.00
, 9200.00, 9800.00
, 12000.00, 12600.00
, 14700.00, 15300.00
, 17400.00, 18000.00
, 20000.00, 20600.00
, 22700.00, 23300.00
, 25400.00, 26000.00
```



```
,Tchange, Tfixed, Vchange, Vfixed
, 11.983419418335 , 12.800000190735 , 1.529292099949 , 1.532790296498
, 13.510450363159 , 12.800000190735 , 1.604244062961 , 1.535992843862
, 15.188432693481 , 12.800000190735 , 1.683733008725 , 1.539137266210
, 16.967086791992 , 12.800000190735 , 1.767172086159 , 1.543558540796
, 18.809181213379 , 12.800000190735 , 1.851625177445 , 1.548501488260
, 20.707633972168 , 12.800000190735 , 1.936017992035 , 1.553294026849
, 22.638475418091 , 12.800000190735 , 2.020385471888 , 1.558469248013
, 24.587665557861 , 12.800000190735 , 2.103495404693 , 1.563404301564
, 26.560396194458 , 12.966036796570 , 2.186019328322 , 1.572559460051
```

OUTPUT

***** Linear fit *****

Parameters

```
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.042782129934 , 22.612468835761 , -13.396931148718 , 0.006063018995
```

Statistical uncertainties

```
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000249032248 , 0.186607749991 , 3.789583631764 , 0.005352469002
```

***** Parabolic fit *****

Average noise temperature

```
,Tn (k),Sigma (K)
, 13.851486435263 , 0.120433469813
```

Temperature versus Voltage parabolic fit parameters

```
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
, -12.618319376343 , 11.037084746640 , 3.000288585237
,sigma(a0),sigma(a1),sigma(a2)
, 0.075389285270 , 0.082640881983 , 0.022400430326
```

Voltage versus temperature parabolic fit parameters

```
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.941039390684 , 0.055317110117 , -0.000277403501
,sigma(a0),sigma(a1),sigma(a2)
, 0.003376643659 , 0.000400108753 , 0.000011247155
```

INPUT

```
Centre frequency (Hz) =, 3.0000000e+010
Channel: C
Changing signal: Load
BEM offset (v) =, 0.000000
```

There are , 9 , time windows

```
,tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00
```

```
,Tchange, Tfixed, Vchange, Vfixed
, 11.983419418335 , 12.800000190735 , 1.076551973368 , 1.173347073582
, 13.510450363159 , 12.800000190735 , 1.144867297709 , 1.175293276363
, 15.188432693481 , 12.800000190735 , 1.214220150276 , 1.176877361659
, 16.967086791992 , 12.800000190735 , 1.283933045120 , 1.179131631755
, 18.809181213379 , 12.800000190735 , 1.352918417478 , 1.181589383331
, 20.707633972168 , 12.800000190735 , 1.421346614524 , 1.184258395148
, 22.638475418091 , 12.800000190735 , 1.488874645890 , 1.186978879277
, 24.587665557861 , 12.800000190735 , 1.555498772780 , 1.189740570975
, 26.560396194458 , 12.966036796570 , 1.621525835891 , 1.195541282744
```

OUTPUT

***** Linear fit *****

Parameters

```
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.036117461777 , 17.825943119341 , -15.349032729995 , 0.009169856757
```

Statistical uncertainties

```
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000197891215 , 0.150905363410 , 5.347003281768 , 0.004148644499
```

***** Parabolic fit *****

Average noise temperature

```
,Tn (k),Sigma (K)
, 7.392596073342 , 0.055985258341
```

Temperature versus Voltage parabolic fit parameters



```
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
, -4.012704527762 , 5.757491377037 , 7.820221962895

,sigma(a0),sigma(a1),sigma(a2)
, 0.043447741209 , 0.065935926923 , 0.024660812071

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.541136693952 , 0.052277926123 , -0.000409981414

,sigma(a0),sigma(a1),sigma(a2)
, 0.003376643659 , 0.000400108753 , 0.000011247155
=====

INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (v) =, 0.000000

There are , 9 , time windows
,tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

,Tchange, Tfixed, Vchange, Vfixed
, 11.983419418335 , 12.800000190735 , 1.298223213341 , 1.392564401085
, 13.510450363159 , 12.800000190735 , 1.375275348304 , 1.394448960707
, 15.188432693481 , 12.800000190735 , 1.453491858018 , 1.396284414987
, 16.967086791992 , 12.800000190735 , 1.531916913126 , 1.398669659485
, 18.809181213379 , 12.800000190735 , 1.609653893897 , 1.401462855288
, 20.707633972168 , 12.800000190735 , 1.686784565067 , 1.404653020605
, 22.638475418091 , 12.800000190735 , 1.762826699974 , 1.407844626644
, 24.587665557861 , 12.800000190735 , 1.837551938049 , 1.410904094410
, 26.560396194458 , 12.966036796570 , 1.911643160952 , 1.417496814318

OUTPUT
***** Linear fit *****
Parameters
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.040655426197 , 19.867767961453 , -15.524353555743 , 0.010596126088

Statistical uncertainties
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000211309683 , 0.147173837732 , 5.405509310843 , 0.004331423284

***** Parabolic fit *****

Average noise temperature
,Tn (k),Sigma (K)
, 8.141332487364 , 0.068256397563

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
, -4.192266000551 , 3.771914688012 , 6.256560884081

,sigma(a0),sigma(a1),sigma(a2)
, 0.052767365429 , 0.067133808774 , 0.021082245227

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.693289566713 , 0.059128844826 , -0.000468967446

,sigma(a0),sigma(a1),sigma(a2)
, 0.003376643659 , 0.000400108753 , 0.000011247155
=====
```

The same analysis has been done using the REF_TEMP. The results are reported below.



Table 9-2 Basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY_TEMP probe as a sky load temperature, and REF_TEMP sensor for the REF load temperature. For isolation the error has not been calculated. It will be reported in the next update of the document.

	Gain [V/K]	Gain [K/V]	Tnoise [K]	Tnoise [K]	Isolation [dB]
	x 1E-02		Linear	Parabolic	
DETECTOR A	3.40±0.02	29.4±0.2	38.3±0.1	37.76±0.01	-13.41
DETECTOR B	3.56±0.02	28.1±0.2	36.5±0.1	36.22±0.01	-13.38
DETECTOR C	3.00±0.02	33.3±0.2	43.5±0.1	43.5±0.1	-15.32
DETECTOR D	3.38±0.02	29.6±0.2	39.9±0.1	41.07±0.01	-15.49

The complete RaNA output is reported (RCA27_LIS_results_100506_REF_TEMP_9.txt):

```
INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: A
Changing signal: Load
BEM offset (v) =, 0.000000

There are, 9, time windows
, tmin, tmax
, 3800.00, 4400.00
, 6500.00, 7100.00
, 9200.00, 9800.00
, 12000.00, 12600.00
, 14700.00, 15300.00
, 17400.00, 18000.00
, 20000.00, 20600.00
, 22700.00, 23300.00
, 25400.00, 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 9.599903106689, 12.800000190735, -1.044191231535, -1.029611837640
, 11.800000190735, 12.800000190735, -0.973405230619, -1.026541512775
, 14.000000000000, 12.800000190735, -0.897879289358, -1.023424509702
, 16.200000762939, 12.800000190735, -0.818826719312, -1.019481755907
, 18.399999618530, 12.800000190735, -0.738415187579, -1.014808221148
, 20.600000381470, 12.800000190735, -0.657973670997, -1.010372881373
, 22.799999237061, 12.800000190735, -0.577499446471, -1.005697005666
, 25.000000000000, 12.800000190735, -0.497890428833, -1.001046535262
, 27.200000762939, 12.966036796570, -0.419164751423, -0.992663044678

OUTPUT
***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.033950507447, -38.257616603349, -13.408691903651, 0.005468720783

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.000196529367, -0.087109776657, 3.805356471200, 0.004086998591

***** Parabolic fit *****

Average noise temperature
, Tn (k), Sigma (K)
, -37.764540319386, 0.012418027852

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
, 37.150215211043, 24.719256545473, -2.164370657913

, sigma(a0), sigma(a1), sigma(a2)
, 0.012388995333, 0.034841285859, 0.023185067023

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
, a0, a1, a2
, -1.366944232368, 0.034967341380, 0.000032472356

, sigma(a0), sigma(a1), sigma(a2)
, 0.000005403194, 0.000000603664, 0.000000015955

=====
INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: B
Changing signal: Load
```



```

BEM offset (v) =,      0.000000

There are ,          9 , time windows
, tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 9.599903106689 , 12.800000190735 , -1.032910592083 , -1.029412395534
, 11.800000190735 , 12.800000190735 , -0.957958629070 , -1.026209848170
, 14.000000000000 , 12.800000190735 , -0.878469683307 , -1.023065425822
, 16.200000762939 , 12.800000190735 , -0.795030605873 , -1.018644151236
, 18.399999618530 , 12.800000190735 , -0.710577514587 , -1.013701203772
, 20.600000381470 , 12.800000190735 , -0.626184699997 , -1.008908665183
, 22.799999237061 , 12.800000190735 , -0.541817220144 , -1.003733444018
, 25.000000000000 , 12.800000190735 , -0.458707287339 , -0.998798390468
, 27.200000762939 , 12.966036796570 , -0.376183363710 , -0.989643231981

```

```

OUTPUT
***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.035602343942 , -36.540259033702 , -13.377478880095 , 0.004813739735

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.000213657017 , -0.081740277047 , 3.772647850908 , 0.004780780104

***** Parabolic fit *****

```

```

Average noise temperature
, Tn (k), Sigma (K)
, -36.221431773957 , 0.011088931984

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
, 35.737950777591 , 24.152673092588 , -1.700437439647

, sigma(a0), sigma(a1), sigma(a2)
, 0.011062223898 , 0.032513793859 , 0.022400430332

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
, a0, a1, a2
, -1.374761522434 , 0.037177874675 , 0.000021368385

, sigma(a0), sigma(a1), sigma(a2)
, 0.000005403194 , 0.000000603664 , 0.000000015955
=====

```

```

INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: C
Changing signal: Load
BEM offset (v) =, 0.000000

There are ,          9 , time windows
, tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 9.599903106689 , 12.800000190735 , -1.076816022848 , -0.980020922633
, 11.800000190735 , 12.800000190735 , -1.008500698507 , -0.978074719853
, 14.000000000000 , 12.800000190735 , -0.939147845940 , -0.976490634557
, 16.200000762939 , 12.800000190735 , -0.869434951096 , -0.974236364461
, 18.399999618530 , 12.800000190735 , -0.800449578738 , -0.971778612885
, 20.600000381470 , 12.800000190735 , -0.732021381692 , -0.969109601068
, 22.799999237061 , 12.800000190735 , -0.664493350326 , -0.966389116938
, 25.000000000000 , 12.800000190735 , -0.597869223436 , -0.963627425241
, 27.200000762939 , 12.966036796570 , -0.531842160325 , -0.957826713472

```

```

OUTPUT
***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff

```



```
,      0.030044766864 ,    -43.473286535439 ,    -15.316783906761 ,    0.002490791700
Statistical uncertainties
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
,      0.000151474658 ,    -0.070039922702 ,    5.307445807090 ,    0.003928949446
***** Parabolic fit *****
Average noise temperature
,Tn (k),Sigma (K)
,      -45.030738356260 ,    0.016164263940
Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
,      44.486569932234 ,    34.731644832256 ,    1.583770363415
,sigma(a0),sigma(a1),sigma(a2)
,      0.016091630868 ,    0.040558098449 ,    0.024660812068
Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
,      -1.373069423102 ,    0.033591665789 ,    -0.000068904808
,sigma(a0),sigma(a1),sigma(a2)
,      0.000005403194 ,    0.000000603664 ,    0.000000015955
=====
INPUT
Centre frequency (Hz) =,    3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (v) =,    0.000000
There are ,    9 , time windows
,tmin, tmax
,      3800.00 ,    4400.00
,      6500.00 ,    7100.00
,      9200.00 ,    9800.00
,      12000.00 ,    12600.00
,      14700.00 ,    15300.00
,      17400.00 ,    18000.00
,      20000.00 ,    20600.00
,      22700.00 ,    23300.00
,      25400.00 ,    26000.00
,Tchange, Tfixed, Vchange, Vfixed
,      9.599903106689 ,    12.800000190735 ,    -1.086190028999 ,    -0.991848841255
,      11.800000190735 ,    12.800000190735 ,    -1.009137894036 ,    -0.989964281633
,      14.000000000000 ,    12.800000190735 ,    -0.930921384322 ,    -0.988128827353
,      16.200000762939 ,    12.800000190735 ,    -0.852496329214 ,    -0.985743582855
,      18.399999618530 ,    12.800000190735 ,    -0.774759348443 ,    -0.982950387052
,      20.600000381470 ,    12.800000190735 ,    -0.697628677273 ,    -0.979760221735
,      22.799999237061 ,    12.800000190735 ,    -0.621586542366 ,    -0.976568615696
,      25.000000000000 ,    12.800000190735 ,    -0.546861304291 ,    -0.973509147930
,      27.200000762939 ,    12.966036796570 ,    -0.472770081388 ,    -0.966916428022
OUTPUT
***** Linear fit *****
Parameters
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
,      0.033814842763 ,    -39.872895849143 ,    -15.490750779797 ,    0.003089181854
Statistical uncertainties
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
,      0.000166570149 ,    -0.065534342879 ,    5.363846518974 ,    0.004057179417
***** Parabolic fit *****
Average noise temperature
,Tn (k),Sigma (K)
,      -41.071170723029 ,    0.012897117874
Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
,      40.681030574267 ,    30.728492596307 ,    1.373524761037
,sigma(a0),sigma(a1),sigma(a2)
,      0.012844753354 ,    0.033700109488 ,    0.021082245233
Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
,      -1.421203121729 ,    0.038025602046 ,    -0.000083382037
,sigma(a0),sigma(a1),sigma(a2)
,      0.000005403194 ,    0.000000603664 ,    0.000000015955
=====
```



8.1.2 Reference temperature seen by channels C and D simulated by Luca Terenzi

Finally, the temperatures seen by channels C and D have been estimated by Luca Terenzi and used in this analysis. The results are shown in the table below. Only C/D channels are displayed because the A/B should look always at the R_MON sensor.

Table 9-3 Basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY_TEMP probe as a sky load temperature, and the REF load temperature estimated by Luca Terenzi. For isolation the error has not been calculated. It will be reported in the next update of the document.

Table with 6 columns: Gain [V/K], Gain [K/V], Tnoise [K], Tnoise [K], Isolation [dB]. Rows include DETECTOR C and DETECTOR D with their respective values and uncertainties.

The complete RaNA output is reported here (RCA27_LIS_results_100506_LT_9.txt):

```
INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: C
Changing signal: Load
BEM offset (v) =, 0.000000

There are, 9, time windows
, tmin, tmax
, 3800.00, 4400.00
, 6500.00, 7100.00
, 9200.00, 9800.00
, 12000.00, 12600.00
, 14700.00, 15300.00
, 17400.00, 18000.00
, 20000.00, 20600.00
, 22700.00, 23300.00
, 25400.00, 26000.00

, Tchange, Tfixed, Vchange, Vfixed
, 10.762539863586, 12.800000190735, 1.076551973368, 1.173347073582
, 12.609809875488, 12.800000190735, 1.144867297709, 1.175293276363
, 14.545989036560, 12.800000190735, 1.214220150276, 1.176877361659
, 16.540719985962, 12.800000190735, 1.283933045120, 1.179131631755
, 18.575880050659, 12.800000190735, 1.352918417478, 1.181589383331
, 20.639999389648, 12.800000190735, 1.421346614524, 1.184258395148
, 22.725469589233, 12.800000190735, 1.488874645890, 1.186978879277
, 24.827119827271, 12.800000190735, 1.555498772780, 1.189740570975
, 26.941320419312, 12.966036796570, 1.621525835891, 1.195541282744

OUTPUT
***** Linear fit *****

Parameters
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.032651885070, 21.962338266439, -15.330585428090, 0.005460028071

Statistical uncertainties
, Gain (V/K), Tn (K), Iso. (dB), Lin. coeff
, 0.000184697185, 0.150925153342, 5.324339261173, 0.003641960316

***** Parabolic fit *****

Average noise temperature
, Tn (k), Sigma (K)
, 15.532482104038, 0.043448024153

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
, a0, a1, a2
, -12.571996312268, 15.252082758496, 5.354508998666

, sigma(a0), sigma(a1), sigma(a2)
, 0.043447741209, 0.065935926923, 0.024660812071

Voltage versus temperature parabolic fit parameters
```



```
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.685441520064 , 0.040982118724 , -0.000202628188

,sigma(a0),sigma(a1),sigma(a2)
, 0.000004358950 , 0.000000509450 , 0.000000013956
=====

INPUT
Centre frequency (Hz) =, 3.0000000e+010
Channel: D
Changing signal: Load
BEM offset (v) =, 0.000000

There are , 9 , time windows
,tmin, tmax
, 3800.00 , 4400.00
, 6500.00 , 7100.00
, 9200.00 , 9800.00
, 12000.00 , 12600.00
, 14700.00 , 15300.00
, 17400.00 , 18000.00
, 20000.00 , 20600.00
, 22700.00 , 23300.00
, 25400.00 , 26000.00

,Tchange, Tfixed, Vchange, Vfixed
, 10.762539863586 , 12.800000190735 , 1.298223213341 , 1.392564401085
, 12.609809875488 , 12.800000190735 , 1.375275348304 , 1.394448960707
, 14.545989036560 , 12.800000190735 , 1.453491858018 , 1.396284414987
, 16.540719985962 , 12.800000190735 , 1.531916913126 , 1.398669659485
, 18.575880050659 , 12.800000190735 , 1.609653893897 , 1.401462855288
, 20.639999389648 , 12.800000190735 , 1.686784565067 , 1.404653020605
, 22.725469589233 , 12.800000190735 , 1.762826699974 , 1.407844626644
, 24.827119827271 , 12.800000190735 , 1.837551938049 , 1.410904094410
, 26.941320419312 , 12.966036796570 , 1.911643160952 , 1.417496814318

OUTPUT
***** Linear fit *****

Parameters
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.036749201343 , 24.226239443023 , -15.505118539673 , 0.006422456353

Statistical uncertainties
,Gain (V/K),Tn (K),Iso. (dB),Lin. coeff
, 0.000201489079 , 0.168702138197 , 5.381621108663 , 0.004114328063

***** Parabolic fit *****

Average noise temperature
,Tn (k),Sigma (K)
, 17.007350015067 , 0.052767597727

Temperature versus Voltage parabolic fit parameters
Equation: T = a0 + a1 * V + a2 * V^2
,a0,a1,a2
, -13.447603877823 , 12.482321761287 , 4.329471785444

,sigma(a0),sigma(a1),sigma(a2)
, 0.052767365429 , 0.067133808774 , 0.021082245227

Voltage versus temperature parabolic fit parameters
Equation: V = a0 + a1 * T + a2 * T^2
,a0,a1,a2
, 0.856261819240 , 0.046361299480 , -0.000234320759

,sigma(a0),sigma(a1),sigma(a2)
, 0.000004358950 , 0.000000509450 , 0.000000013956
=====
```



8.1.3 Summary Table

Table 9-4 Basic performances obtained varying the Reference load temperature and keeping the SKY load temperature constant. The numbers have been obtained using the SKY_TEMP probe as a sky load temperature, and R_MON sensor for the REF load temperature for A and B channels, and using the REF load temperature estimated by Luca Terenzi for channels C and D. For isolation the error has not been calculated. It will be reported in the next update of the document

	Gain [V/K]	Gain [K/V]	Tnoise [K]	Tnoise [K]	Isolation [dB]
	x 1E-02		Linear	Parabolic	
DETECTOR A	4.08±0.02	24.5±0.1	22.4±0.2	14.1±0.1	-13.43
DETECTOR B	4.28±0.02	23.4±0.1	22.6±0.2	13.9±0.1	-13.40
DETECTOR C	3.27±0.02	30.6±0.2	22.0±0.2	15.53±0.04	-15.33
DETECTOR D	3.67±0.02	27.3±0.1	24.2±0.2	17.01±0.05	-15.51

8.2 RCA_LIS: LINEARITY WITH SKY LOAD TEMPERATURE STEPS

DELTA TC = 200 mK --- Offset not Removed

DETECTOR A --- LINEAR FIT
 $V = 0.95080845 + 0.042680694 * T$
 $V = 0.84900612 + 0.053057288 * T - 0.00024834363 * T^2$
 $T = -11.573214 + 11.616020 * V + 3.2131008 * V^2$
 DETECTOR B --- LINEAR FIT
 $V = 1.0063535 + 0.044481579 * T$
 $V = 0.89303312 + 0.056032191 - 0.00027644146 * T^2$
 $T = -11.005831 + 10.276757 * V + 3.1600237 * V^2$
 DETECTOR C --- LINEAR FIT
 $V = 0.75947810 + 0.034744666 * T$
 $V = 0.68533527 + 0.042301959 * T - 0.00018086914 * T^2$
 $T = -12.469418 + 15.926188 * V + 4.3360290 * V^2$
 DETECTOR D --- LINEAR FIT
 $V = 0.92084882 + 0.039655592 * T$
 $V = 0.83169709 + 0.048742725 * T - 0.00021748289 * T^2$
 $T = -12.679781 + 12.972981 * V + 3.5068873 * V^2$

DELTA TC = 200 mK --- Offset not Removed					
	Tnoise Linear	T noise par V(T)	T noise par T(V)	T noise par AVE	
Detector A	22.28	14.95	11.57	13.26	
Detector B	22.62	14.85	11.01	12.93	
Detector C	21.86	15.21	12.47	13.84	
Detector D	23.22	15.93	12.68	14.31	

DELTA TC = 200 mK --- Offset Removed

DETECTOR A
 $V = 0.91860845 + 0.042680694 * T$
 $V = 0.81680612 + 0.053057288 * T - 0.00024834363 * T^2$
 $T = -11.195847 + 11.822944 * V + 3.2131008 * V^2$
 DETECTOR B --- LINEAR FIT
 $V = 0.96865346 + 0.044481579 * T$



V = 0.85533312 + 0.056032191 * T - 0.00027644146 * T^2
T = -10.613906 + 10.515023 * V + 3.1600237 * V^2
DETECTOR C --- LINEAR FIT
V = 0.72677810 + 0.034744666 * T
0.65263527 + 0.042301959 * T - 0.00018086914 * T^2
T = -11.943995 + 16.209764 * V + 4.3360290 * V^2
DETECTOR D --- LINEAR FIT
V = 0.88314882 + 0.039655592 * T
V = 0.79399709 + 0.048742725 * T - 0.00021748289 * T^2
T = -12.185715 + 13.237401 * V + 3.5068873 * V^2

DELTA TC = 200 mK --- Offset Removed				
	Tnoise Linear	T noise par V(T)	T noise par T(V)	T noise par AVE
Detector A	21.52	14.42	11.20	12.81
Detector B	21.78	14.26	10.61	12.44
Detector C	20.92	14.52	11.94	13.23
Detector D	22.27	15.25	12.19	13.72

Report

RaNA

Mon Apr 10 16:07:47 2006

Chapter 1

**/root/RaNA-Mon-Apr-10-
14:22:47-2006/rana-view**

Chapter 2

**/root/RaNA-Mon-Apr-10-
14:22:47-2006/rana-tn**

Chapter 3

**/root/RaNA-Mon-Apr-10-
14:22:47-2006/rana-oft**

Chapter 4

/root/RaNA-Mon-Apr-10-14:22:47-2006/rana-ling

4.1 rana_ling_mini_report_001

RANA_LING 001

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604081545

Contained in directory: /moredata

INPUT

Channel: A

Sky temperature source: RMON_TEMP

Ref temperature source: SKY_TEMP

Changing voltage channel: Ref

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
11.982578	0.00066796871	12.800000	0.0000000	1.4209387	0.0021535281	1.4355605	0.0000000
13.509188	0.0013647235	12.800000	0.0000000	1.4916528	0.0022109362	1.4385777	0.0000000
15.186900	0.0015477908	12.800000	0.0000000	1.5673083	0.0023210500	1.4418543	0.0000000
16.965250	0.0016629766	12.800000	0.0000000	1.6460962	0.0023835342	1.4455770	0.0000000
18.807276	0.0017292171	12.800000	0.0000000	1.7263672	0.0024650950	1.4500986	0.0000000
20.703377	0.0047018002	12.800000	0.0000000	1.8067493	0.0026095085	1.4545985	0.0000000
22.633661	0.0064634359	12.800000	0.0000000	1.8872256	0.0027163964	1.4593149	0.0000000
24.584471	0.0035923487	12.800000	0.0000000	1.9668155	0.0027759676	1.4638804	0.0000000
26.557478	0.0033608228	12.961092	0.0051455456	2.0456022	0.0028479151	1.4717213	0.0000000
28.513538	0.011756675	13.175012	0.011214501	2.1224890	0.0030078064	1.4831747	0.0000000
30.546484	0.0048519443	13.412120	0.0033968948	2.2013029	0.0030138429	1.4972374	0.0000000

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-13.467028	-0.13559971	0.040164367	0.00018631635

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0075895407	0.0045004748	22.575577	0.14877793

COMMENTS

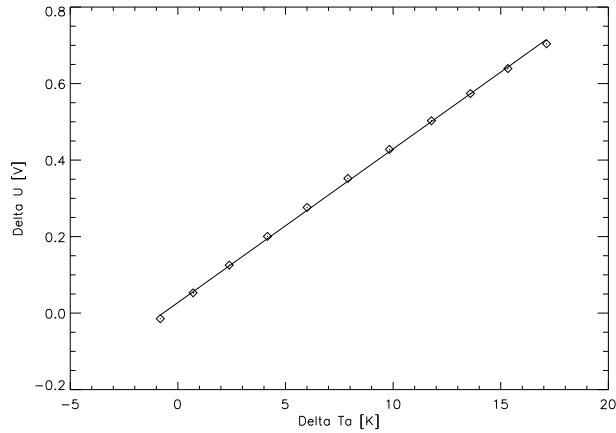


Figure 4.1: Response linearity (differenced values)

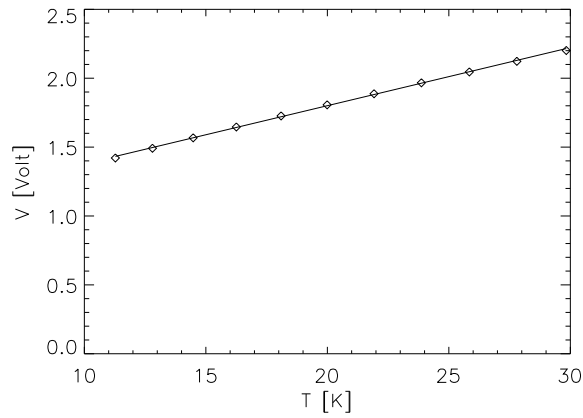


Figure 4.2: Response linearity (changing temperature vs changing voltage)

4.2 rana_ling_mini_report_002

RANA_LING 002

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604081545
Contained in directory: /moredata

INPUT

Channel: B

Sky temperature source: RMON_TEMP

Ref temperature source: SKY_TEMP

Changing voltage channel: Ref

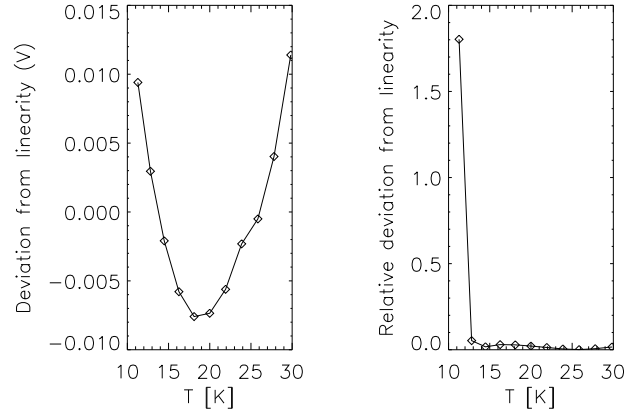


Figure 4.3: Deviation from linearity

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
11.982347	0.00071689778	12.800000	0.0000000	1.5054175	0.0022926114	1.5089695	0.0000000
13.509529	0.00097130542	12.800000	0.0000000	1.5802207	0.0023770129	1.5120145	0.0000000
15.187235	0.0013530200	12.800000	0.0000000	1.6597703	0.0024611853	1.5152448	0.0000000
16.964268	0.0027196549	12.800000	0.0000000	1.7428286	0.0025682056	1.5194170	0.0000000
18.807703	0.0014253096	12.800000	0.0000000	1.8273898	0.0026552156	1.5243730	0.0000000
20.704794	0.0032021415	12.800000	0.0000000	1.9117911	0.0027553566	1.5292517	0.0000000
22.635660	0.0034663822	12.800000	0.0000000	1.9961787	0.0028426470	1.5344513	0.0000000
24.585888	0.0021992659	12.800000	0.0000000	2.0794190	0.0029329682	1.5394163	0.0000000
26.553930	0.0075820000	12.957900	0.0075384169	2.1614101	0.0030779622	1.5474368	0.0000000
28.520657	0.0063672578	13.181936	0.0082141897	2.2424208	0.0031549820	1.5606986	0.0000000
30.541199	0.0098965922	13.409437	0.0056114802	2.3239418	0.0032550974	1.5742642	0.0000000

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-13.449503	-0.13491007	0.042056476	0.00018822718

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0076865760	0.0045168049	22.909080	0.13128681

COMMENTS

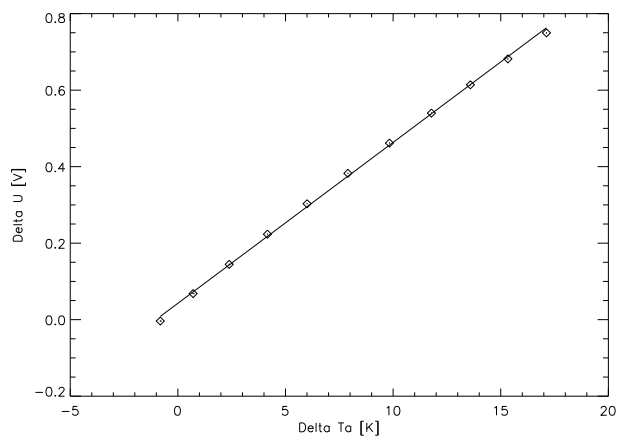


Figure 4.4: Response linearity (differenced values)

4.3 rana_ling_mini_report_003

RANA_LING 003

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604081545

Contained in directory: /moredata

INPUT

Channel: C

Sky temperature source: REF_TEMP

Ref temperature source: SKY_TEMP

Changing voltage channel: Ref

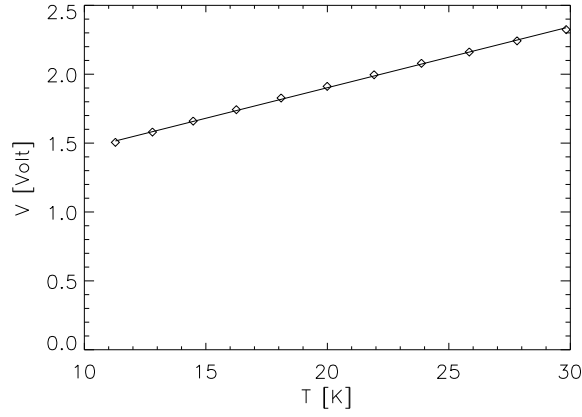


Figure 4.5: Response linearity (changing temperature vs changing voltage)

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
9.5999022	6.6839639e-05	12.800000	0.0000000	1.0555964	0.0016767969	1.1523812	0.0016767969
11.800000	0.0000000	12.800000	0.0000000	1.1238877	0.0017887861	1.1543394	0.0017887861
14.000000	0.0000000	12.800000	0.0000000	1.1934081	0.0018605301	1.1560887	0.0018605301
16.200001	0.0000000	12.800000	0.0000000	1.2628413	0.0019549326	1.1580869	0.0019549326
18.400000	0.0000000	12.800000	0.0000000	1.3319033	0.0020406471	1.1606103	0.0020406471
20.600000	0.0000000	12.800000	0.0000000	1.4002203	0.0021264964	1.1631813	0.0021264964
22.799999	0.0000000	12.800001	0.0000000	1.4677575	0.0022045620	1.1659388	0.0022045620
25.000000	0.0000000	12.800000	0.0000000	1.5343932	0.0022816783	1.1686811	0.0022816783
27.200001	0.0000000	12.958149	0.0065274816	1.6004446	0.0023560188	1.1738289	0.0023560188
29.400000	0.0000000	13.166924	0.015469675	1.6648729	0.0024547950	1.1814923	0.0024547950
31.600002	0.0000000	13.398949	0.0094590932	1.7283325	0.0025166261	1.1909163	0.0025166261

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-15.323569	-0.26511811	0.029811657	0.00012478735

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0035281224	0.0035034611	25.399550	0.13324288

COMMENTS

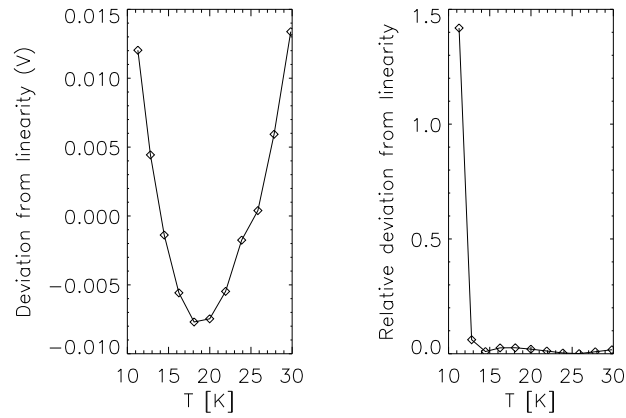


Figure 4.6: Deviation from linearity

4.4 rana_ling_mini_report_004

RANA_LING 004

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604081545
 Contained in directory: /moredata

INPUT

Channel: D

Sky temperature source: REF_TEMP

Ref temperature source: SKY_TEMP

Changing voltage channel: Ref

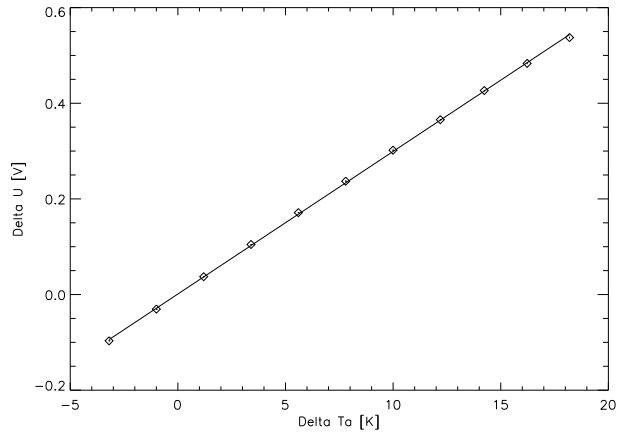


Figure 4.7: Response linearity (differenced values)

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
9.5999022	6.6062283e-05	12.800000	0.000000	1.2732846	0.0018410388	1.3676590	0.000000
11.800000	0.000000	12.800000	0.000000	1.3503327	0.0019517352	1.3695240	0.000000
14.000000	0.000000	12.800000	0.000000	1.4285145	0.0020358699	1.3713513	0.000000
16.200001	0.000000	12.800000	0.000000	1.5068821	0.0021209899	1.3736672	0.000000
18.400000	0.000000	12.800000	0.000000	1.5846124	0.0022005127	1.3764739	0.000000
20.600000	0.000000	12.800000	0.000000	1.6617167	0.0022795654	1.3796544	0.000000
22.799999	0.000000	12.800000	0.000000	1.7376172	0.0023612054	1.3827143	0.000000
25.000000	0.000000	12.800001	0.000000	1.8124754	0.0024467182	1.3858918	0.000000
27.200001	0.000000	12.958264	0.0076941960	1.8865034	0.0025276615	1.3916747	0.000000
29.400000	0.000000	13.175714	0.010735376	1.9591901	0.0025978271	1.4012844	0.000000
31.600000	0.000000	13.398812	0.010492285	2.0301294	0.0026866043	1.4110700	0.000000

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-15.484884	-0.26963822	0.033519697	0.00013195655

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0036199950	0.0036486634	27.935176	0.12856437

COMMENTS

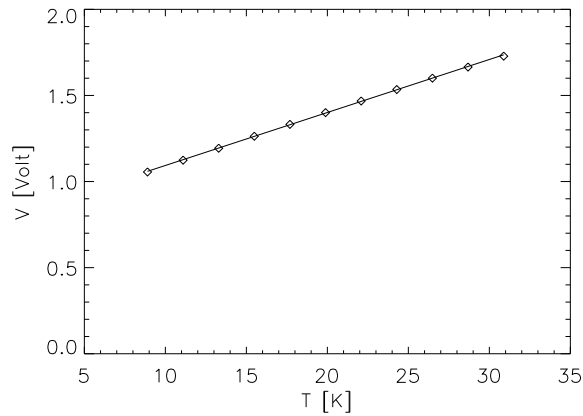


Figure 4.8: Response linearity (changing temperature vs changing voltage)

4.5 rana_ling_mini_report_005

RANA_LING 005

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604081545
 Contained in directory: /moredata

INPUT

Channel: A

Sky temperature source: REF_TEMP

Ref temperature source: SKY_TEMP

Changing voltage channel: Ref

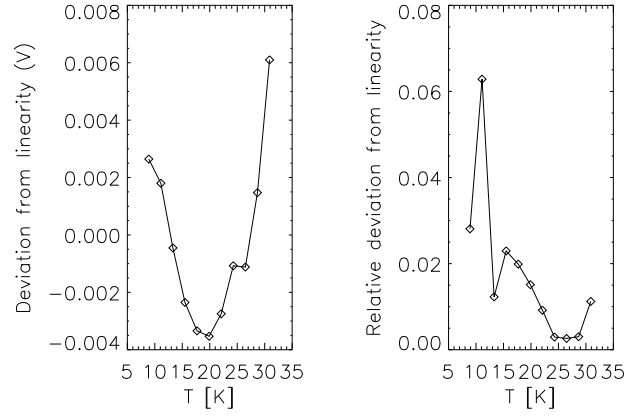


Figure 4.9: Deviation from linearity

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
9.5999022	6.6677218e-05	12.800000	0.0000000	1.4209142	0.0021538318	1.4355180	0.00
11.800000	0.0000000	12.800000	0.0000000	1.4916281	0.0022102136	1.4385289	0.00
14.000000	0.0000000	12.800000	0.0000000	1.5673028	0.0023209889	1.4418419	0.00
16.200001	0.0000000	12.800000	0.0000000	1.6460588	0.0023864211	1.4455650	0.00
18.400000	0.0000000	12.800000	0.0000000	1.7261720	0.0024869987	1.4500236	0.00
20.600000	0.0000000	12.800000	0.0000000	1.8069735	0.0025951705	1.4546474	0.00
22.799999	0.0000000	12.800000	0.0000000	1.8874299	0.0026846734	1.4593411	0.00
25.000000	0.0000000	12.800000	0.0000000	1.9669446	0.0027727446	1.4639282	0.00
27.200001	0.0000000	12.958024	0.0070174984	2.0454048	0.0028672986	1.4713954	0.00
29.400000	0.0000000	13.178581	0.0077455672	2.1227390	0.0029527192	1.4835465	0.00
31.599998	0.0000000	13.405363	0.0060779983	2.2006045	0.0030622754	1.4964363	0.00

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-13.380139	-0.12988374	0.033906725	0.00015705949

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0050573139	0.0040459915	30.658146	0.16810497

COMMENTS

With $T_{\text{ref}} = T_{\text{measured}}$ by the sensor on Cu plate

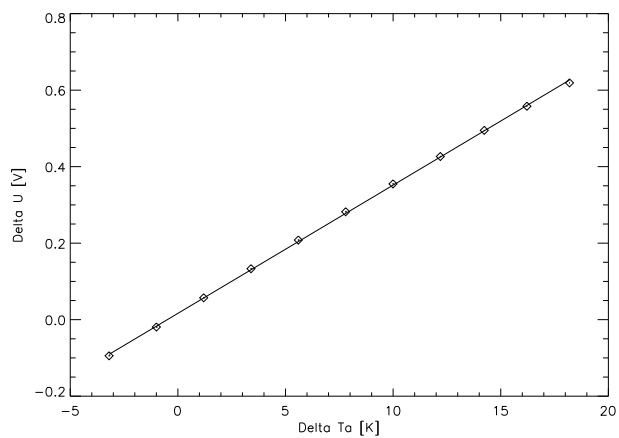


Figure 4.10: Response linearity (differenced values)

4.6 rana_ling_mini_report_006

RANA_LING 006

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604081545

Contained in directory: /moredata

INPUT

Channel: B

Sky temperature source: REF_TEMP

Ref temperature source: SKY_TEMP

Changing voltage channel: Ref

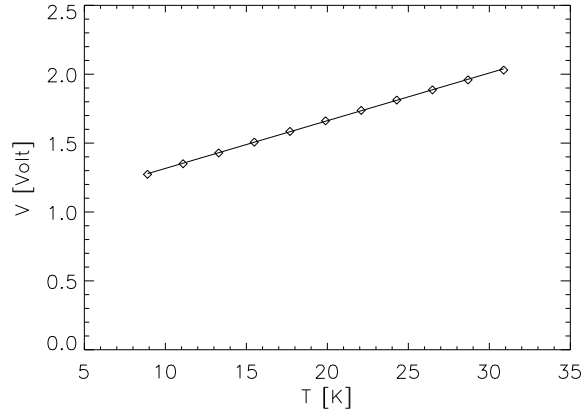


Figure 4.11: Response linearity (changing temperature vs changing voltage)

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
9.5999022	6.5479777e-05	12.800001	0.0000000	1.5054041	0.0022935124	1.5089478	0.0000000
11.800000	0.0000000	12.800000	0.0000000	1.5802373	0.0023770738	1.5120287	0.0000000
14.000000	0.0000000	12.800000	0.0000000	1.6597763	0.0024614655	1.5152916	0.0000000
16.200001	0.0000000	12.800000	0.0000000	1.7429079	0.0025586125	1.5194516	0.0000000
18.400000	0.0000000	12.800000	0.0000000	1.8274309	0.0026510906	1.5243976	0.0000000
20.600000	0.0000000	12.800000	0.0000000	1.9117480	0.0027575097	1.5292502	0.0000000
22.799999	0.0000000	12.800000	0.0000000	1.9962186	0.0028389309	1.5344575	0.0000000
25.000000	0.0000000	12.800000	0.0000000	2.0793468	0.0029381590	1.5394008	0.0000000
27.200001	0.0000000	12.960229	0.0057820906	2.1616024	0.0030485231	1.5476928	0.0000000
29.400002	0.0000000	13.174619	0.0093795089	2.2418880	0.0031789776	1.5597359	0.0000000
31.600000	0.0000000	13.409122	0.0050511207	2.3239233	0.0032466074	1.5742188	0.0000000

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-13.358636	-0.12896226	0.035563895	0.00017179535

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0046087545	0.0041752696	31.086467	0.16799631

COMMENTS

With $T_{\text{ref}} = T$ measured by the sensor on Cu plate

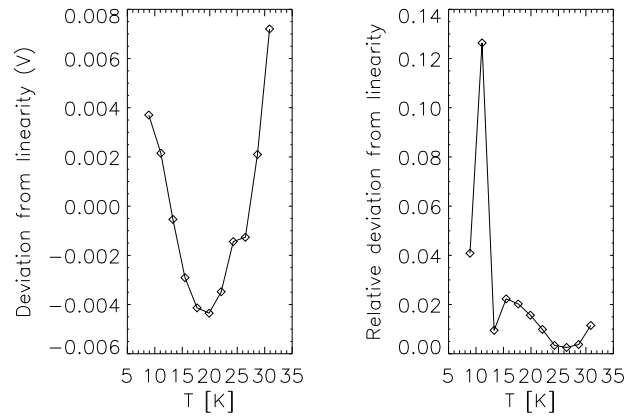


Figure 4.12: Deviation from linearity

4.7 rana_ling_mini_report_007

RANA_LING 007

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604081545
 Contained in directory: /moredata

INPUT

Channel: C

Sky temperature source: RMON_TEMP

Ref temperature source: SKY_TEMP

Changing voltage channel: Ref

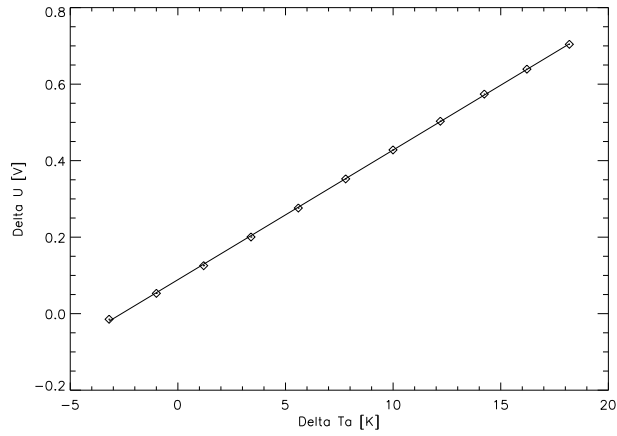


Figure 4.13: Response linearity (differenced values)

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
11.982489	0.00069501746	12.800001	0.0000000	1.0556184	0.0016758161	1.1524026	0.0011342
13.508871	0.0015950449	12.800000	0.0000000	1.1238936	0.0017891768	1.1543396	0.0011342
15.185651	0.0030551120	12.800001	0.0000000	1.1933862	0.0018619660	1.1560650	0.0011342
16.964153	0.0026930780	12.800000	0.0000000	1.2628562	0.0019547193	1.1580978	0.0011342
18.805647	0.0035486810	12.800000	0.0000000	1.3319074	0.0020404005	1.1606024	0.0011342
20.703917	0.0036034249	12.800000	0.0000000	1.4002482	0.0021249699	1.1632013	0.0011342
22.635294	0.0039195488	12.800000	0.0000000	1.4678285	0.0022030339	1.1659717	0.0011342
24.582518	0.0067112655	12.800000	0.0000000	1.5343880	0.0022833480	1.1686819	0.0011342
26.550461	0.011033615	12.955274	0.0082292743	1.6003763	0.0023578529	1.1735860	0.0011342
28.508118	0.016046016	13.170852	0.012670017	1.6649586	0.0024458486	1.1818223	0.0011342
30.525085	0.017809119	13.401829	0.0075325896	1.7283945	0.0025137884	1.1911342	0.0011342

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-15.471828	-0.28523369	0.035278795	0.00014890928

L	σL	T_{noise} [K]	σT_{noise} [K]
0.011215284	0.0037171070	18.078506	0.12122658

COMMENTS

With $T_{\text{ref}} = T_{\text{measured}}$ by the sensor on Al

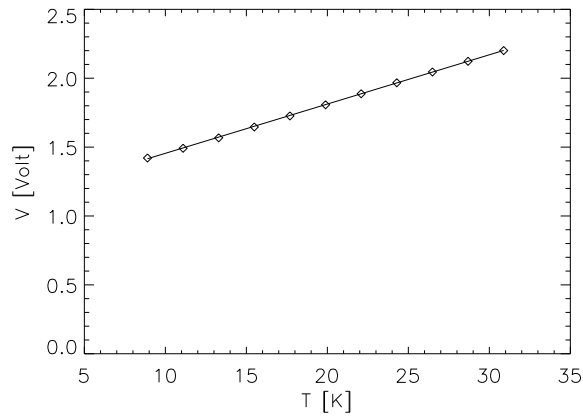


Figure 4.14: Response linearity (changing temperature vs changing voltage)

4.8 rana_ling_mini_report_008

RANA_LING 008

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604081545
 Contained in directory: /moredata

INPUT

Channel: D

Sky temperature source: RMON_TEMP

Ref temperature source: SKY_TEMP

Changing voltage channel: Ref

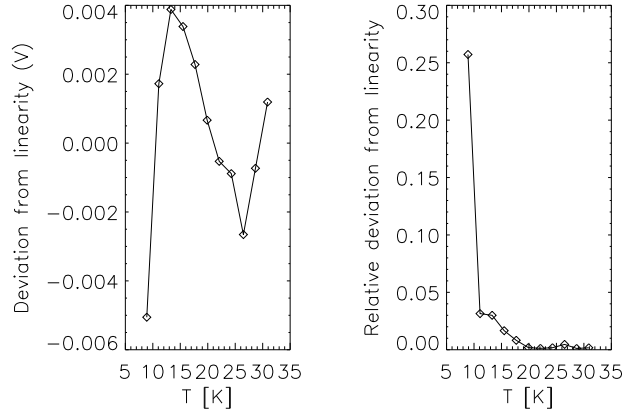


Figure 4.15: Deviation from linearity

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
11.982578	0.00061896961	12.800000	0.0000000	1.2733024	0.0018396107	1.3676787	0.0018396107
13.508640	0.0019545848	12.800001	0.0000000	1.3503613	0.0019531631	1.3695590	0.0019531631
15.185583	0.0026743696	12.800000	0.0000000	1.4285348	0.0020373039	1.3713749	0.0020373039
16.964268	0.0027196549	12.800000	0.0000000	1.5068523	0.0021226241	1.3736436	0.0021226241
18.804974	0.0046042581	12.800000	0.0000000	1.5846053	0.0021996232	1.3764716	0.0021996232
20.700945	0.0081301164	12.800000	0.0000000	1.6616298	0.0022836945	1.3796003	0.0022836945
22.633753	0.0050601116	12.800000	0.0000000	1.7376238	0.0023601788	1.3827165	0.0023601788
24.577927	0.011535820	12.800001	0.0000000	1.8124914	0.0024462621	1.3859043	0.0024462621
26.554150	0.0067312964	12.957669	0.0068794033	1.8865089	0.0025270247	1.3916096	0.0025270247
28.511024	0.012391493	13.172464	0.010841809	1.9591526	0.0025992831	1.4009557	0.0025992831
30.515636	0.027864676	13.398812	0.010492285	2.0301294	0.0026866043	1.4110700	0.0026866043

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-15.642376	-0.29106969	0.039756637	0.00016856968

L	σL	T_{noise} [K]	σT_{noise} [K]
0.012961771	0.0040619396	20.186206	0.11781617

COMMENTS

With $T_{\text{ref}} = T$ measured by the sensor on Al

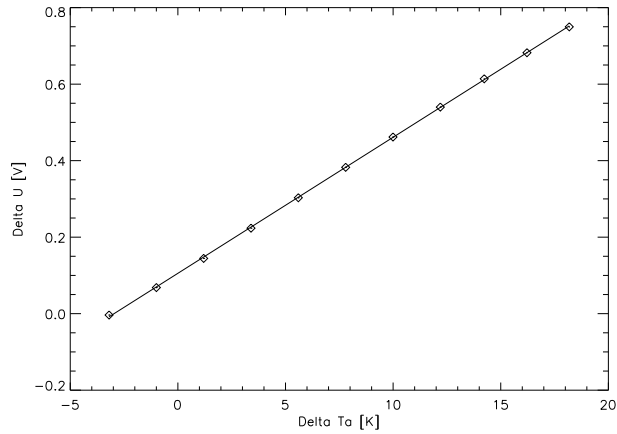


Figure 4.16: Response linearity (differenced values)

4.9 rana_ling_mini_report_009

RANA_LING 009

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604100200
 Contained in directory: /moredata

INPUT

Channel: A

Sky temperature source: SKY_TEMP

Ref temperature source: RMON_TEMP

Changing voltage channel: Sky

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
12.800000	0.0000000	11.982988	0.00062776817	1.4354838	0.0022122709	1.4208905	0.0022122709
14.200000	0.0000000	12.079956	0.0012695900	1.5064351	0.0022756470	1.4329974	0.0022756470
16.000000	0.0000000	12.373691	0.00046188568	1.5918171	0.0024025824	1.4519743	0.0024025824
19.200001	0.0000000	12.987848	0.00087153388	1.7334707	0.0025775087	1.4868075	0.0025775087
22.471905	0.46666265	13.693658	0.011330133	1.8694320	0.0027319676	1.5244722	0.0027319676
25.600000	0.0000000	14.426159	0.00092313456	2.0014689	0.0029487814	1.5647184	0.0029487814
28.799999	0.0000000	15.171201	0.00087432045	2.1309974	0.0030896549	1.6061119	0.0030896549

RESULTS

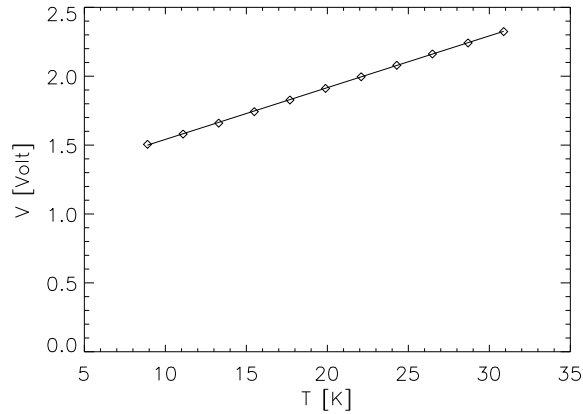


Figure 4.17: Response linearity (changing temperature vs changing voltage)

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-10.775525	-0.034261107	0.039901425	0.00031058169

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0089141274	0.0048405072	21.218289	0.16205646

COMMENTS

4.10 rana_ling_mini_report_010

RANA_LING 010

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604100200

Contained in directory: /moredata

INPUT

Channel: B

Sky temperature source: SKY_TEMP

Ref temperature source: RMON_TEMP

Changing voltage channel: Sky

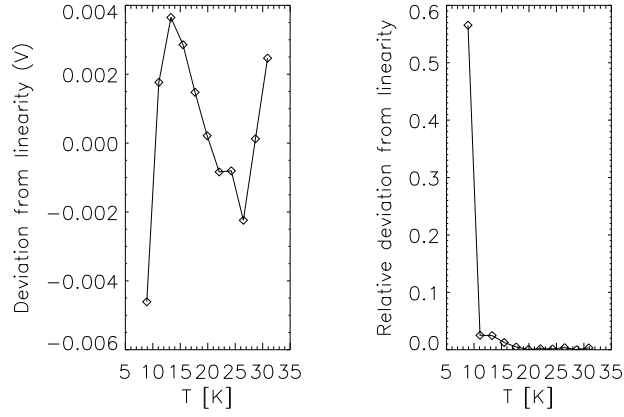


Figure 4.18: Deviation from linearity

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{f}
12.800001	0.0000000	11.982622	0.00078988628	1.5089332	0.0023338605	1.5053927	0.002
14.200000	0.0000000	12.080332	0.0016035779	1.5837529	0.0024312976	1.5184570	0.002
16.000000	0.0000000	12.373694	0.00046069993	1.6730980	0.0025216331	1.5383054	0.002
19.200001	0.0000000	12.988025	0.00089674658	1.8213001	0.0026930201	1.5747814	0.002
22.400000	0.0000000	13.692038	0.00079987670	1.9626478	0.0028770756	1.6136139	0.002
25.600000	0.0000000	14.425656	0.00047452483	2.1007900	0.0030133040	1.6553950	0.002
28.799999	0.0000000	15.171157	0.00091467408	2.2345413	0.0032295055	1.6978219	0.002

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-10.756635	-0.034274439	0.041829548	0.00030441953

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0091501555	0.0056219511	21.403087	0.18853232

COMMENTS

4.11 rana_ling_mini_report_011

RANA LING 011

Linearity, Isolation and Gain

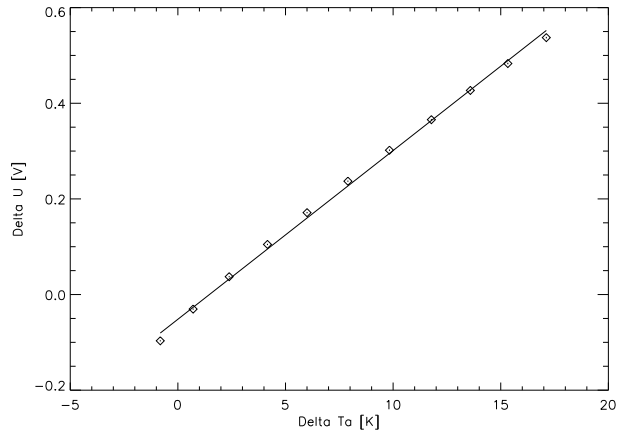


Figure 4.19: Response linearity (differenced values)

Data from file set: 030LFI27_RCA_FM_LIS_200604100200
 Contained in directory: /moredata

INPUT

Channel: C
 Sky temperature source: SKY_TEMP
 Ref temperature source: REF_TEMP
 Changing voltage channel: Sky

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
12.800000	0.0000000	9.5999002	7.0969960e-05	1.1524172	0.0018314532	1.0556397	0.0018314532
14.200000	0.0000000	9.6933165	0.0015294501	1.2091003	0.0019130971	1.0648627	0.0019130971
16.000000	0.0000000	10.091539	0.0010111423	1.2779468	0.0019893987	1.0829606	0.0019893987
19.200001	0.0000000	10.882026	0.0010566262	1.3928412	0.0021243977	1.1162315	0.0021243977
22.400000	0.0000000	11.738089	0.0010492806	1.5035797	0.0022344986	1.1510148	0.0022344986
25.600000	0.0000000	12.619502	0.00078373024	1.6117942	0.0023836430	1.1873016	0.0023836430
28.799999	0.0000000	13.497513	0.00095324096	1.7178234	0.0025082267	1.2237981	0.0025082267

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-11.284475	-0.041505530	0.032990718	0.00025066328

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0061149982	0.0041899044	20.648450	0.16988533

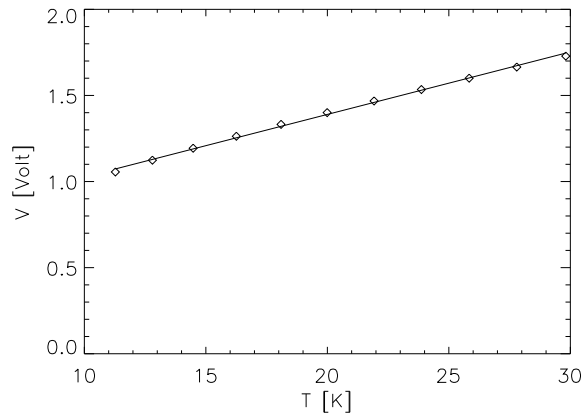


Figure 4.20: Response linearity (changing temperature vs changing voltage)

COMMENTS

4.12 rana_ling_mini_report_012

RANA_LING 012

Linearity, Isolation and Gain

Data from file set: 030LFI27_RCA_FM_LIS_200604100200
 Contained in directory: /moredata

INPUT

Channel: D

Sky temperature source: SKY_TEMP

Ref temperature source: REF_TEMP

Changing voltage channel: Sky

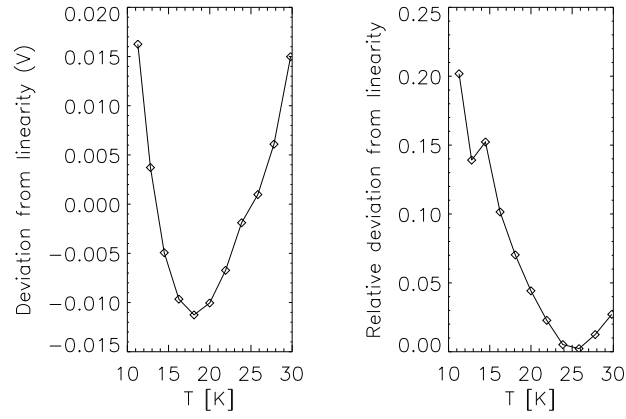


Figure 4.21: Deviation from linearity

30.0 GHz radiometer							
T_{change} [K]	σT_{change} [K]	T_{fixed} [K]	σT_{fixed} [K]	V_{change} [V]	σV_{change} [V]	V_{fixed} [V]	σV_{fixed} [V]
12.800001	0.0000000	9.5999031	6.5880464e-05	1.3676630	0.0019903738	1.2732850	0.0019903738
14.200000	0.0000000	9.6929407	0.0012788934	1.4326905	0.0020663458	1.2841624	0.0020663458
16.000000	0.0000000	10.091534	0.0010268246	1.5115485	0.0021501880	1.3050227	0.0021501880
19.200001	0.0000000	10.882008	0.0010476039	1.6429720	0.0022897912	1.3431714	0.0022897912
22.400000	0.0000000	11.738315	0.0010730720	1.7693073	0.0024342936	1.3828550	0.0024342936
25.600000	0.0000000	12.620363	0.0015990345	1.8922046	0.0025979493	1.4242862	0.0025979493
28.800001	0.0000000	13.497933	0.0012280812	2.0132178	0.0026997870	1.4662501	0.0026997870
33.790051	0.058180261	14.843652	0.00067262113	2.1913474	0.0022590579	1.5302533	0.0022590579

RESULTS

I [dB]	σI [dB]	G [V/K]	σG [V/K]
-10.975075	-0.027857450	0.036507115	0.00022693261

L	σL	T_{noise} [K]	σT_{noise} [K]
0.0098067546	0.0048686898	22.638951	0.17112143

COMMENTS

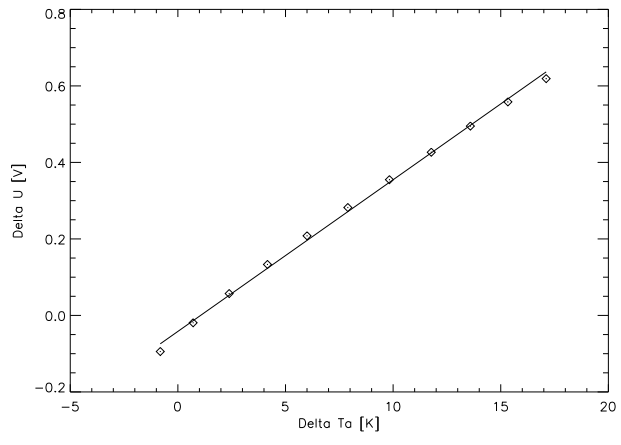


Figure 4.22: Response linearity (differenced values)

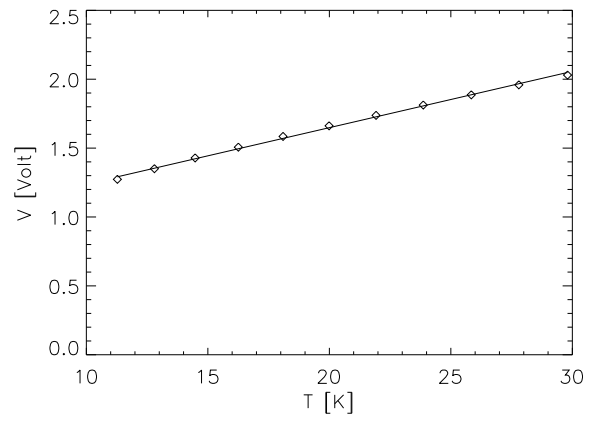


Figure 4.23: Response linearity (changing temperature vs changing voltage)

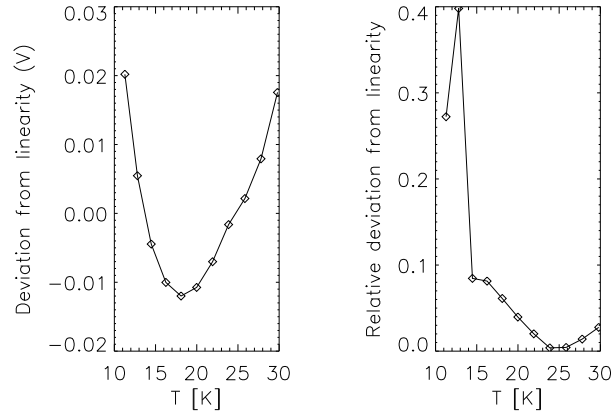


Figure 4.24: Deviation from linearity

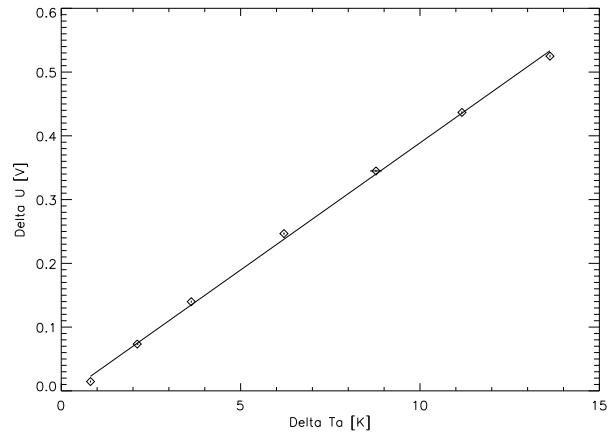


Figure 4.25: Response linearity (differenced values)

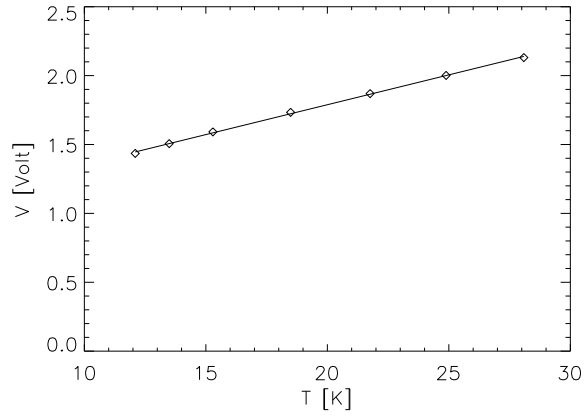


Figure 4.26: Response linearity (changing temperature vs changing voltage)

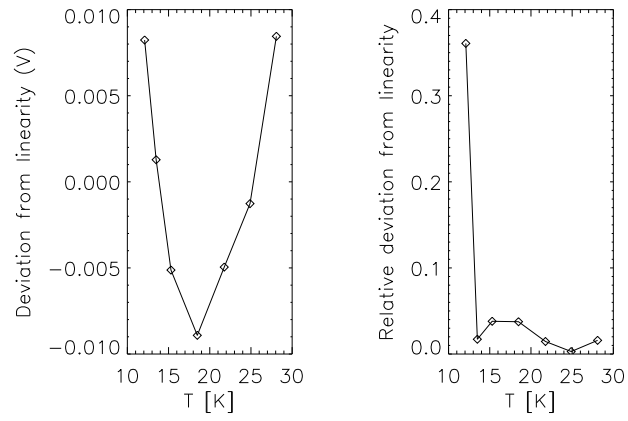


Figure 4.27: Deviation from linearity

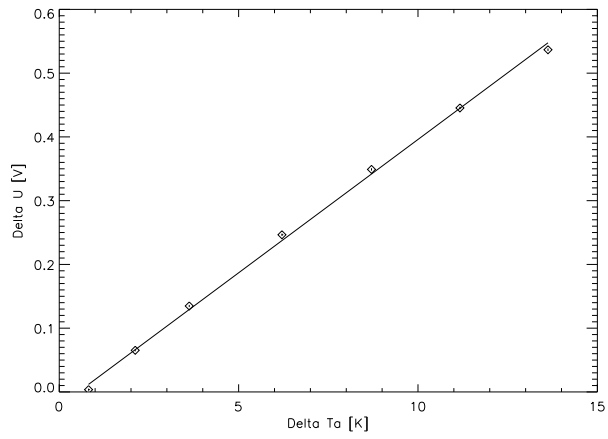


Figure 4.28: Response linearity (differenced values)

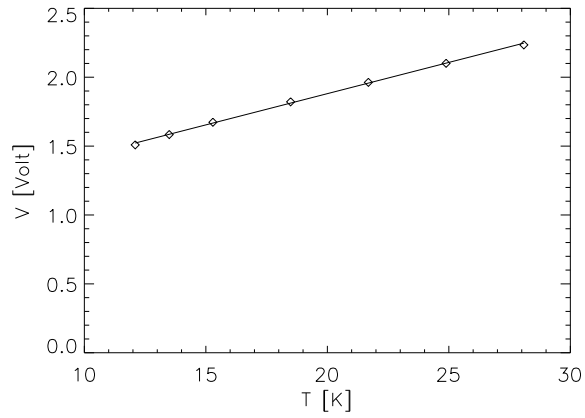


Figure 4.29: Response linearity (changing temperature vs changing voltage)

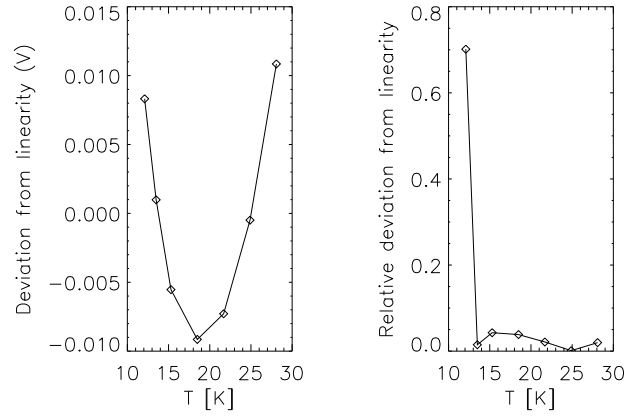


Figure 4.30: Deviation from linearity

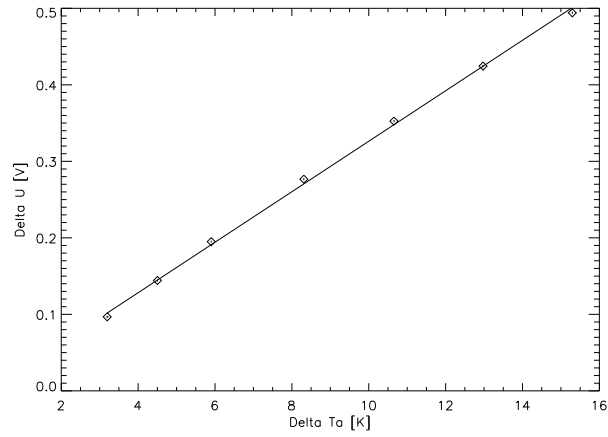


Figure 4.31: Response linearity (differenced values)

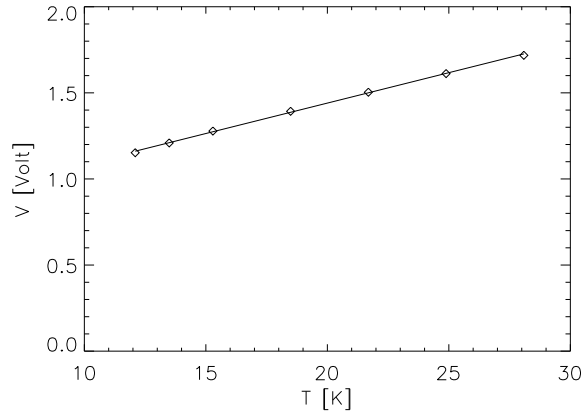


Figure 4.32: Response linearity (changing temperature vs changing voltage)

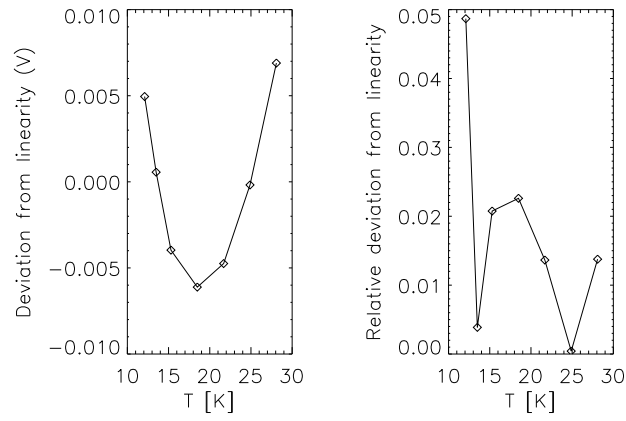


Figure 4.33: Deviation from linearity

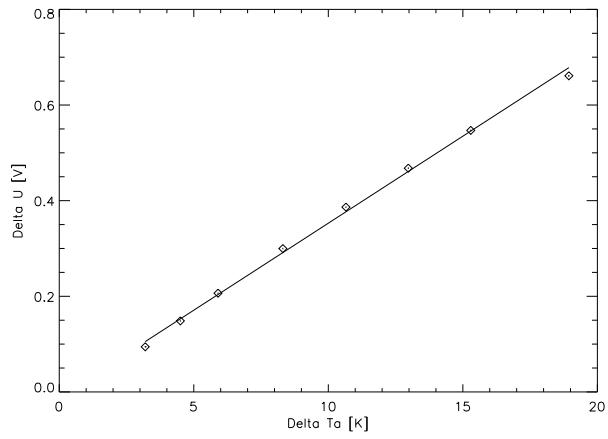


Figure 4.34: Response linearity (differenced values)

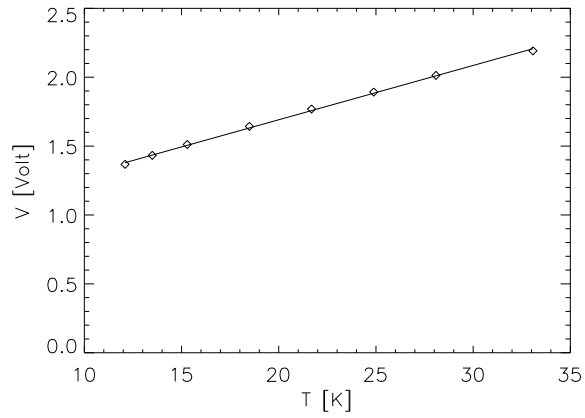


Figure 4.35: Response linearity (changing temperature vs changing voltage)

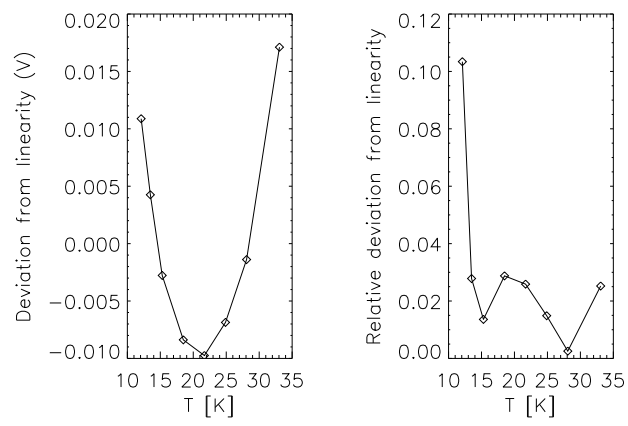


Figure 4.36: Deviation from linearity

Chapter 5

**/root/RaNA-Mon-Apr-10-
14:22:47-2006/rana-fft**

Chapter 6

**/root/RaNA-Mon-Apr-10-
14:22:47-2006/rana-susc**

Chapter 7

**/root/RaNA-Mon-Apr-10-
14:22:47-2006/rana-spr**

Data used in this report are taken from the 030LFI27_RCA_FM_LIS_200604081545 dataset.

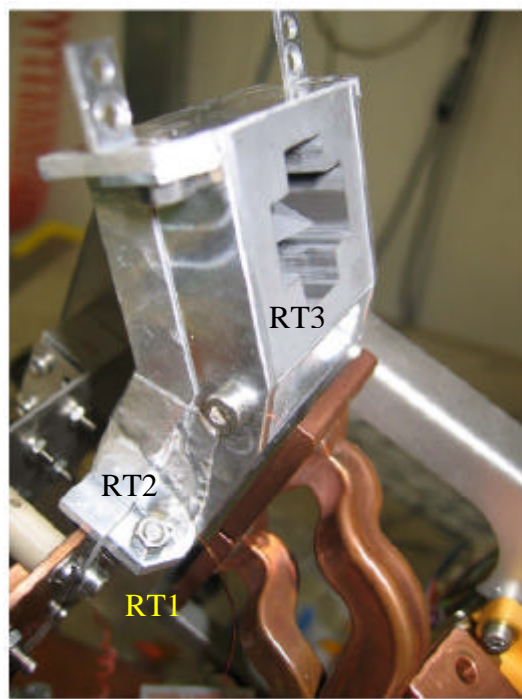


Fig. 1 4K RL mounted on the RCA chamber during RCA27 calibration run.

I assume a thermal contact between the stainless steel support (at about 21.5 K) and the RT2. The temperatures of the RT1 and RT2 will then depend mainly on three thermal conductances:

K1 is the thermal conductance between RT1 and the copper control stage;

K2 is the thermal conductance between RT2 and RT1;

K3 is the contact between support and RT2 envelope.

First step

I want to reproduce the temperature differences, in a steady state between the REFMON sensor, located on the back of RT2, and the REFCTR sensor, mounted on the copper control stage. We can apply the equation:

$$K3 * \Delta T_{SS-RT2} = \frac{1}{\frac{1}{K1} + \frac{1}{K2}} \cdot \Delta T_{RT2-CTR}$$

to estimate the ratio between the two conductances.

I use then four transient steps to fit the measured curve and evaluate the absolute conductance between REFMON and REFCTR sensors.

The curve for simulated RT2 back temperature is compared with the measured curve in Fig. 2. On the lowest steady state the heat flow through the reference load is about 36 mW

Second step

After having fixed a good matching between simulated and measured thermal data, I study the correlation between the temperature curves of RT2 and the RCA outputs A and B. I take as a

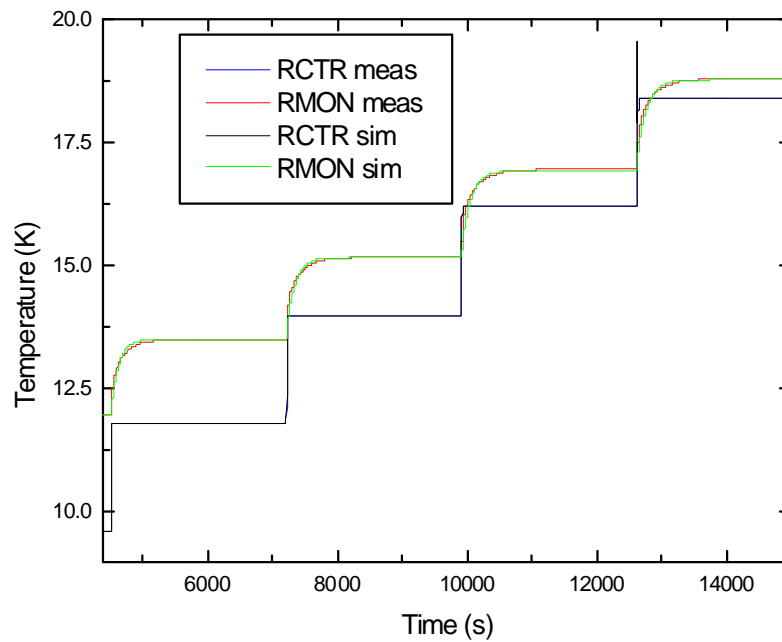


Fig. 2 Comparison between simulated and measured temperatures. RCTR is the input to the simulation so that the simulated and measured curves are not distinguishable

reference a thermal node at half the pyramid height of RT2 and correlate its (antenna) temperature to the BEM voltage. The corresponding Voltage vs Temperature curves are shown in Fig. 3

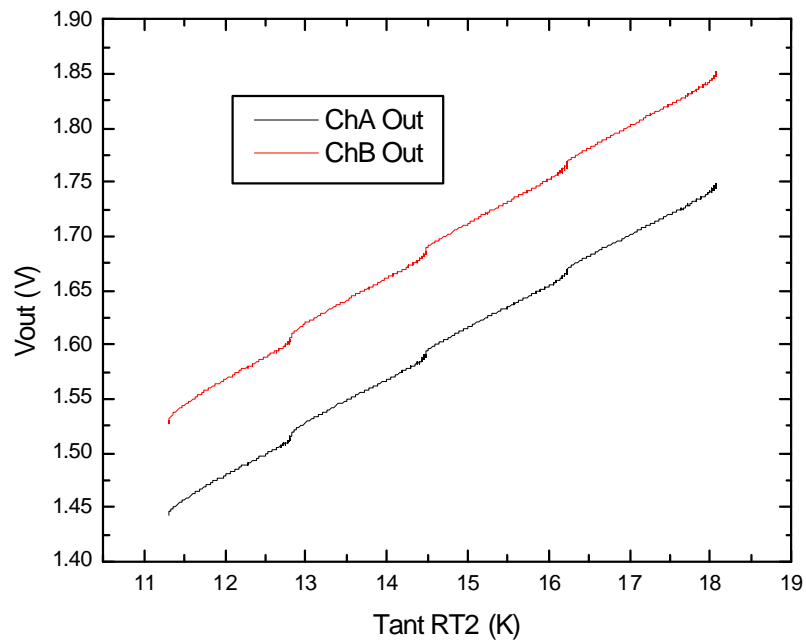


Fig. 3 The V vs T curves whose linear fit is used to estimate the noise temperatures for channels A and B

From a linear fit performed on these curves the noise temperature was calculated (see Conclusions).

Third step

Finally I modulate K1 and K2 in order to have a correlation between RT1 and channels C and D output comparable to the RT2 one, also during transient steps in order to estimate the right RT1 temperature to be used in the data analysis. The result is shown in Fig. 4

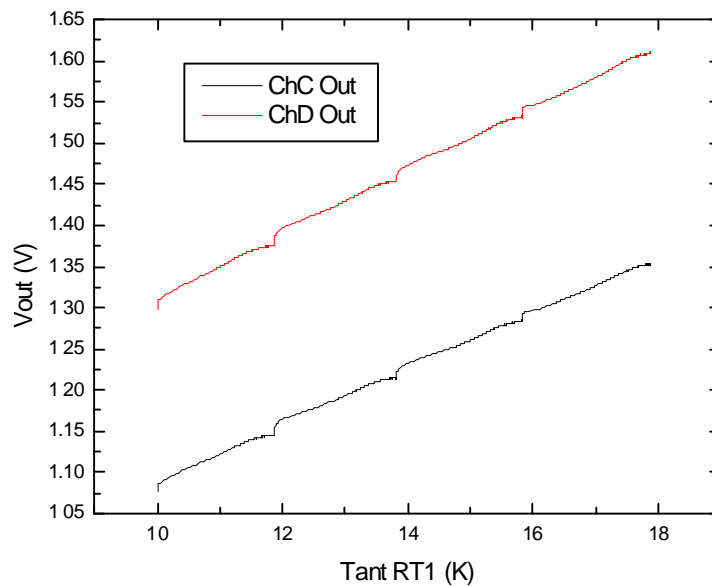


Fig. 4 The V vs T curves whose linear fit is used to estimate the noise temperatures for channels C and D

Conclusions

A thermal model of the 4 K reference load mounted on the RCA cryochamber during the RCA27 test run was developed in order to estimate the reference targets actual temperature observed by the reference horns. The use of a sensor located on the back of one of the targets provided us a good check for the model. A further analysis is foreseen to

- increase the accuracy for the RT1 temperature curve recovery,
- extend the results at all steps of the dataset in order to check the possibility of a parabolic fit
- hopefully extend this study to obtain similar results for the RCA28 data analysis.

In the table below a summary of the RCA parameters evaluated

Ch Id	A	B	C	D
Gain (V/K)	0.04446	0.04683	0.03467	0.03905
Noise Temperature (K) (from linear fit)	21.243	21.455	21.204	23.404

RCA_SPR Rana_Report
Datafile SPR 1449

F.Villa, P.Battaglia, L.Stringhetti

Thu Apr 6 16:20:08 2006

0.0.1 RANA_SPR_001

Data from file set: 030LFI27_RCA_FM_SPR_200604061449

Contained in directory: /moredata

Input Data

Frequency: 30 GHz

Trigger Detector: C

F_min: 26.50 GHz

F_max: 40.00 GHz

Step: 0.05 GHz

Threshold: 0.1000 V/s

Useful Data: 50.00 %

Calibration File: /home/battaglia/LIFE_updated/30_GHz_FM_22032006.dat.txt

Comments

Output Data

Table 1: Central frequency and equivalent bandwidth.

CHANNEL	CENTRAL FREQUENCY (GHz)	EQUIVALENT BANDWIDTH (GHz)
A	31.80	4.30
B	31.30	4.11
C	30.70	3.71
D	30.45	3.89

Derivative Plots

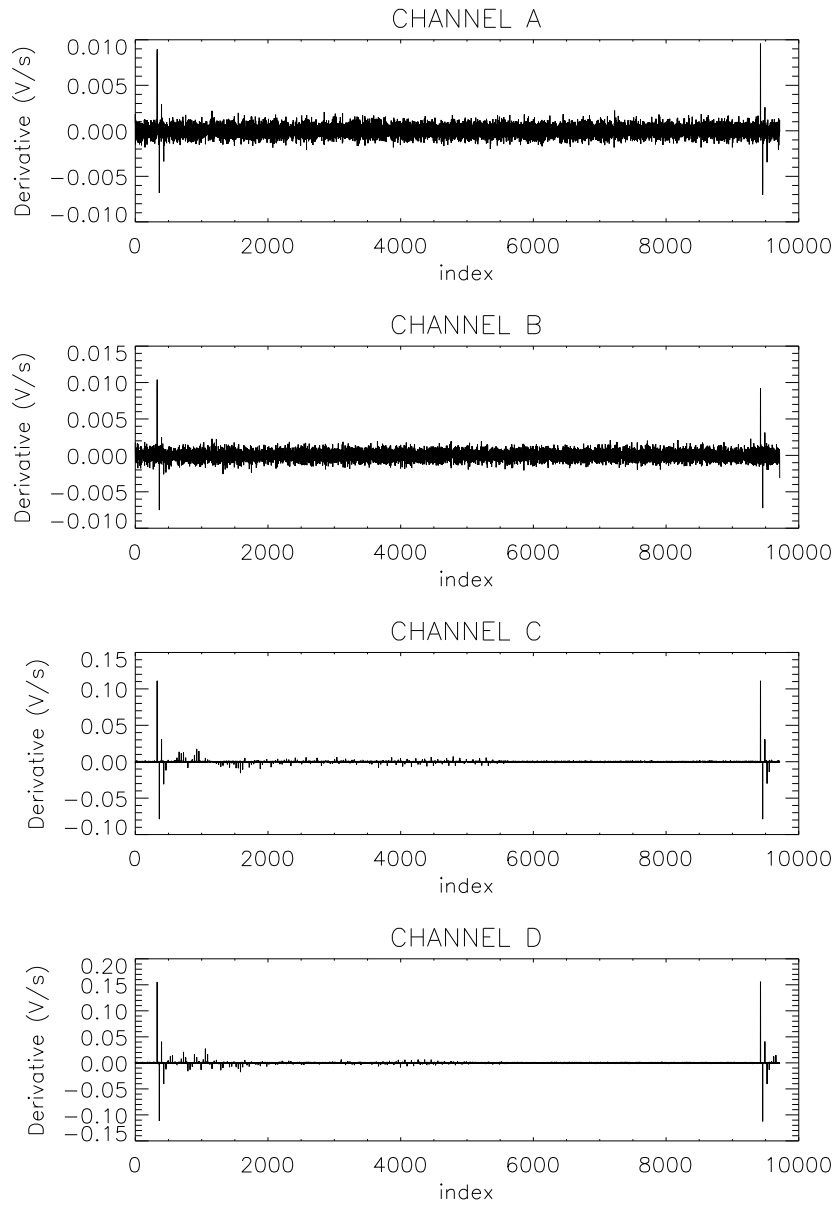


Figure 1: Data binned with a bin equal to 0.

Selected Plots

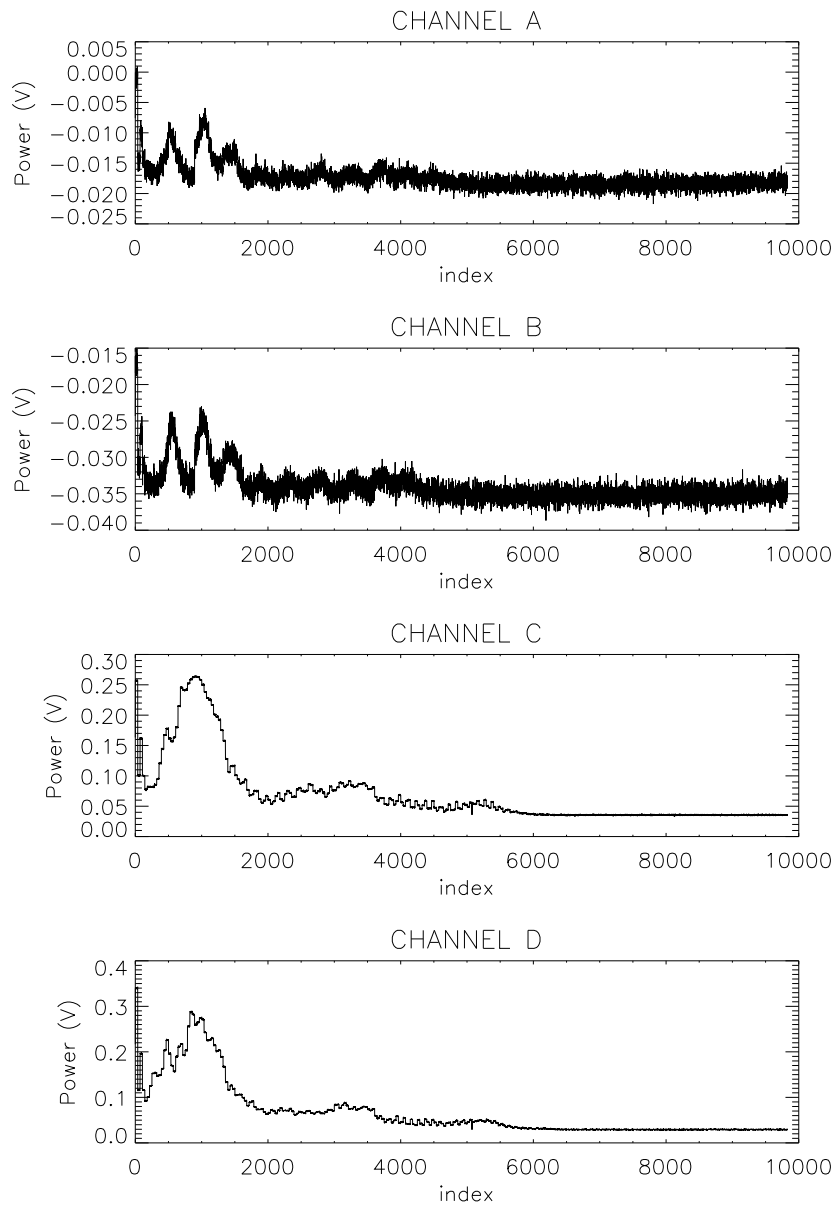


Figure 2: Data binned with a bin equal to 0.

Radiometer Spectral Response

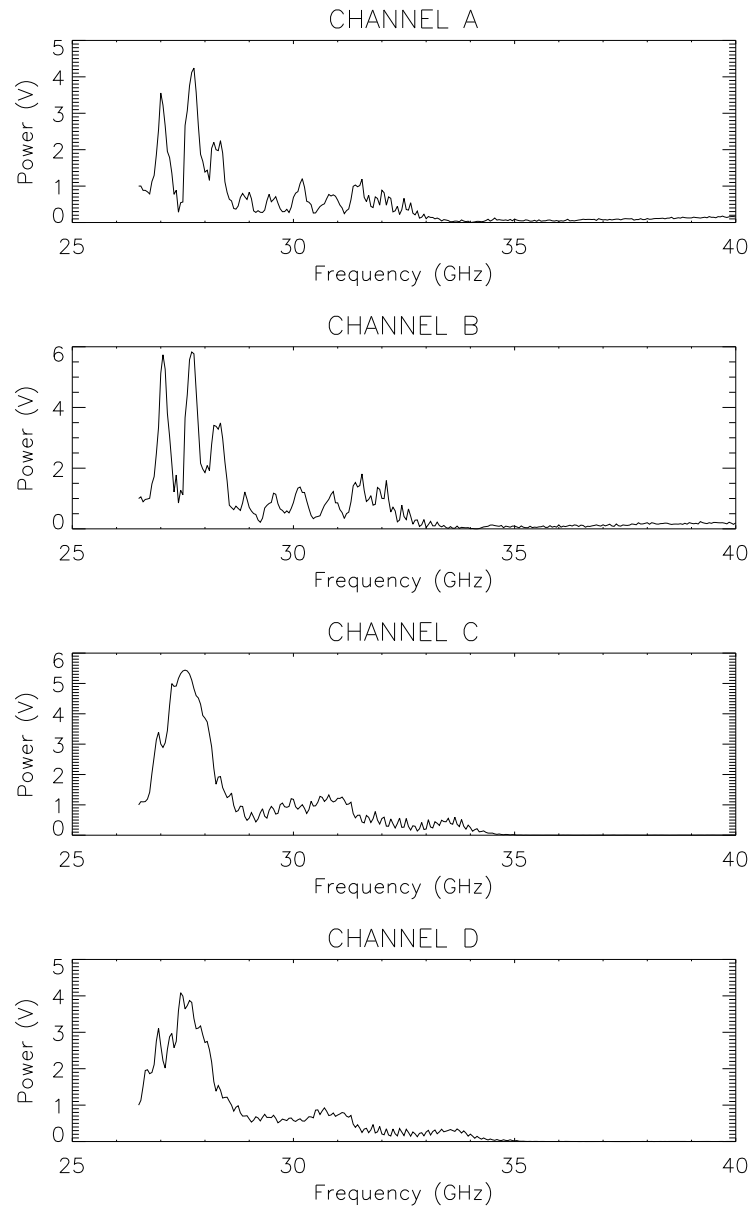


Figure 3: Calibrated data.

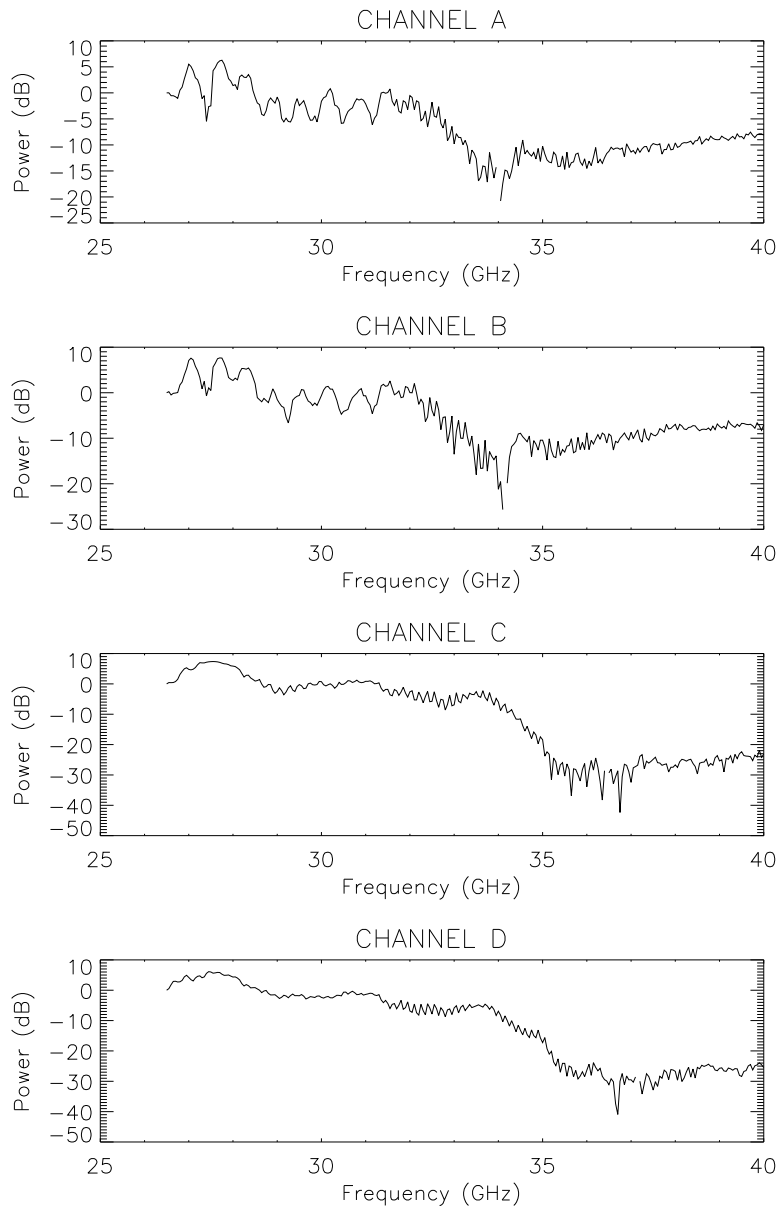


Figure 4: Calibrated data in dB.

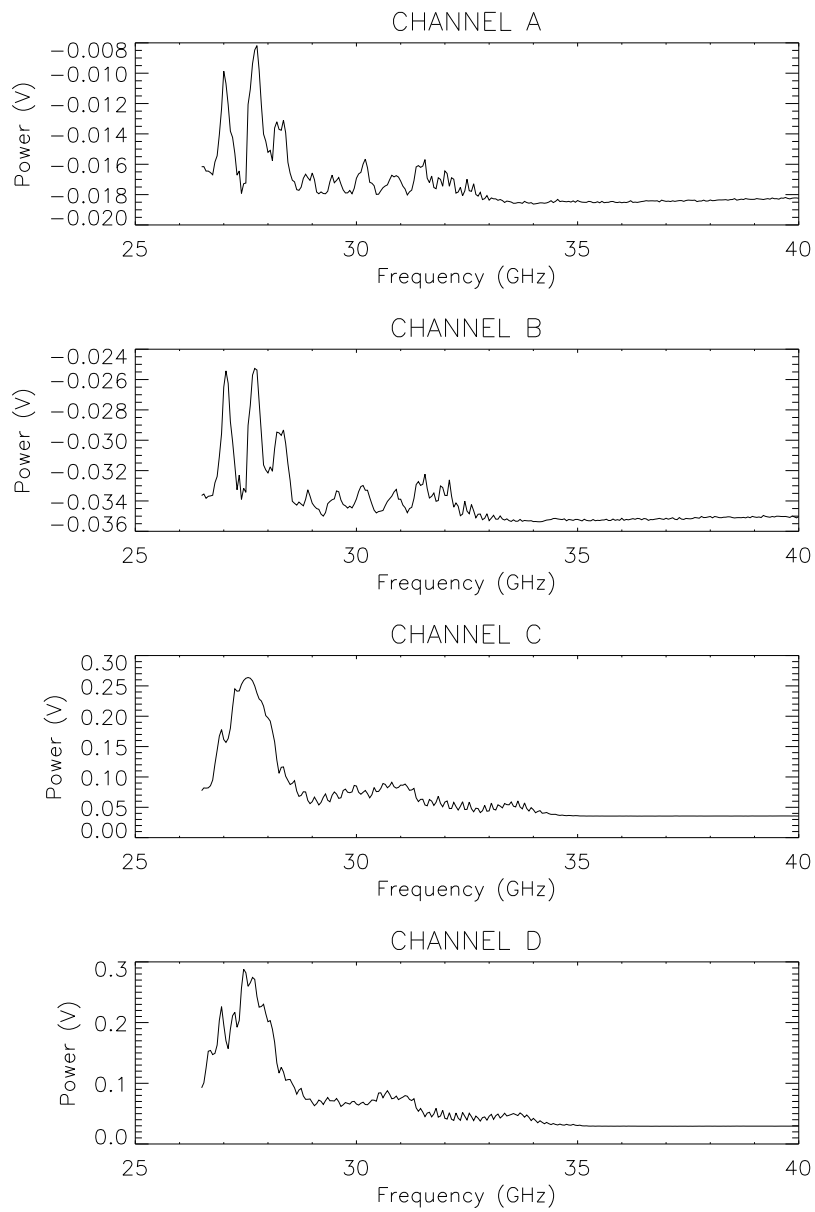


Figure 5: Uncalibrated data.

0.1 rana_spr_mini_report_002

0.1.1 RANA_SPR_002

Data from file set: 030LFI27_RCA_FM_SPR_200604061449

Contained in directory: /moredata

Input Data

Frequency: 30 GHz

Trigger Detector: A

F_min: 26.50 GHz

F_max: 40.00 GHz

Step: 0.05 GHz

Threshold: 0.0075 V/s

Useful Data: 50.00 %

Calibration File: /home/battaglia/LIFE_updated/30_GHz_FM_22032006.dat.txt

Comments

Output Data

Table 2: Central frequency and equivalent bandwidth.

CHANNEL	CENTRAL FREQUENCY (GHz)	EQUIVALENT BANDWIDTH (GHz)
A	31.80	4.30
B	31.30	4.11
C	30.70	3.71
D	30.45	3.89

Derivative Plots

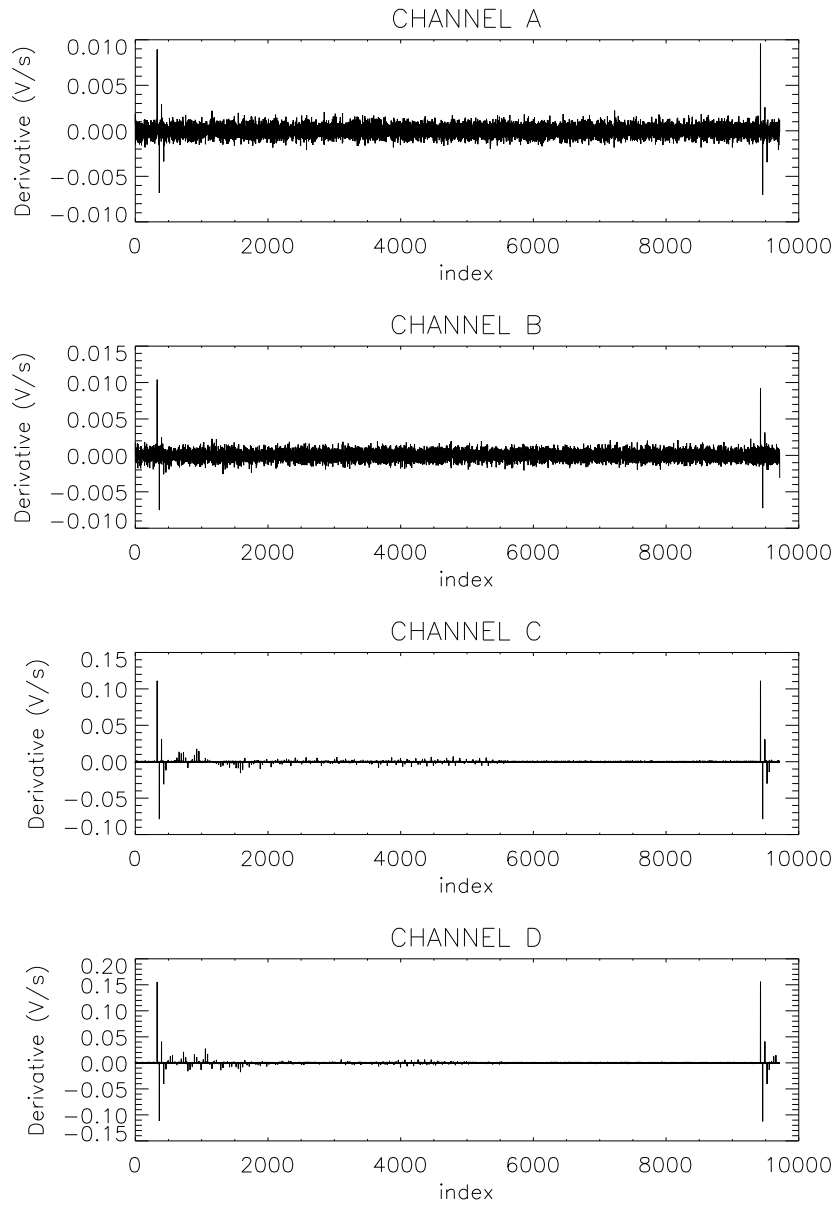


Figure 6: Data binned with a bin equal to 0.

Selected Plots

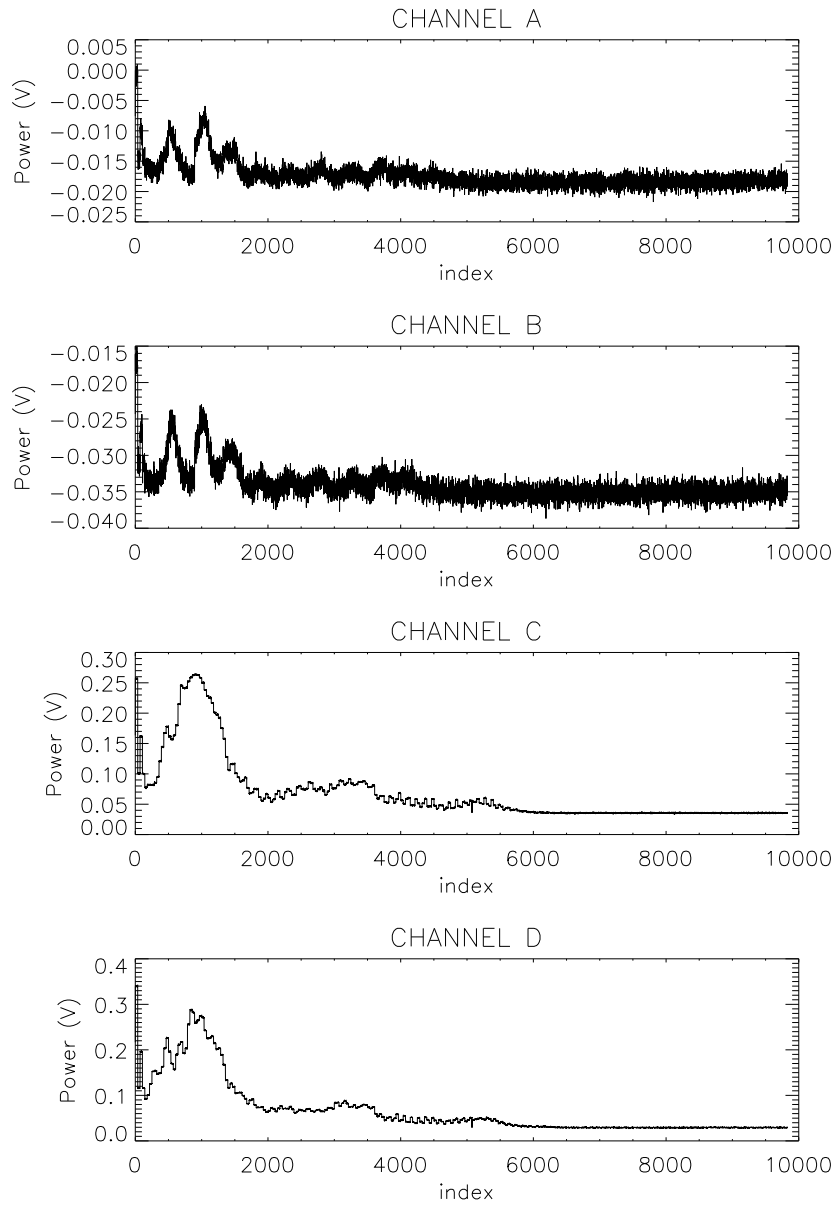


Figure 7: Data binned with a bin equal to 0.

Radiometer Spectral Response

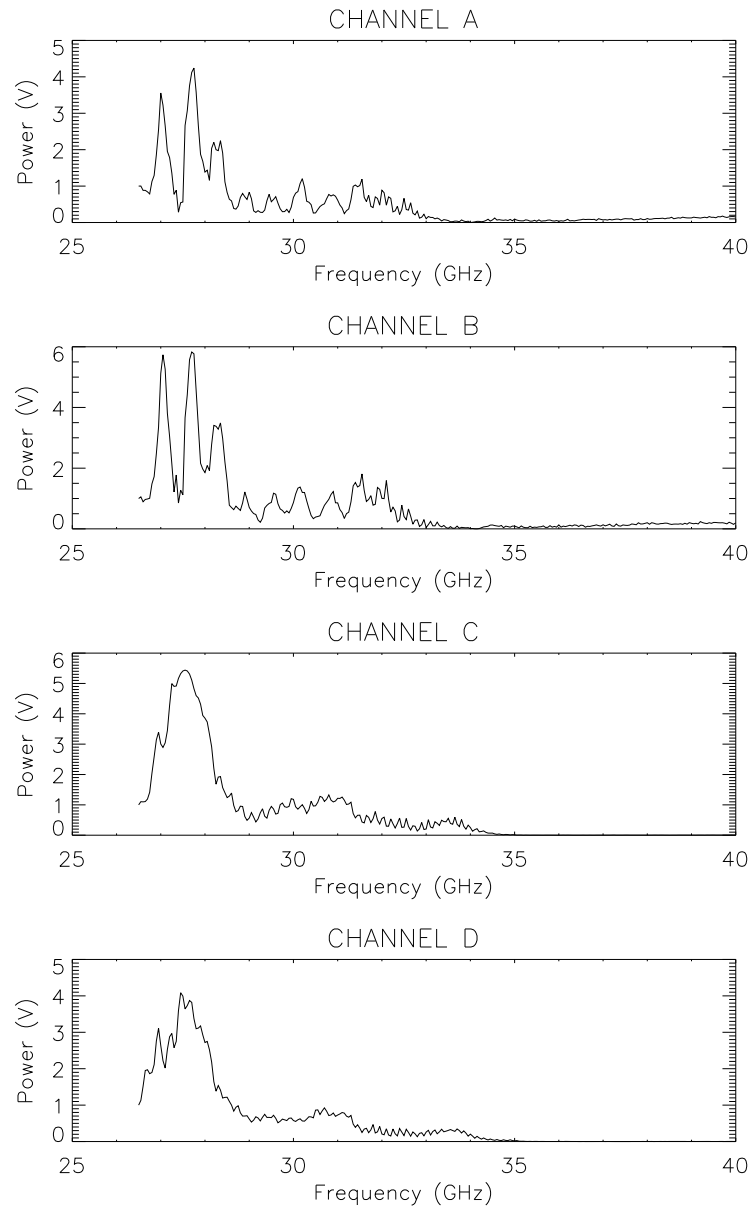


Figure 8: Calibrated data.

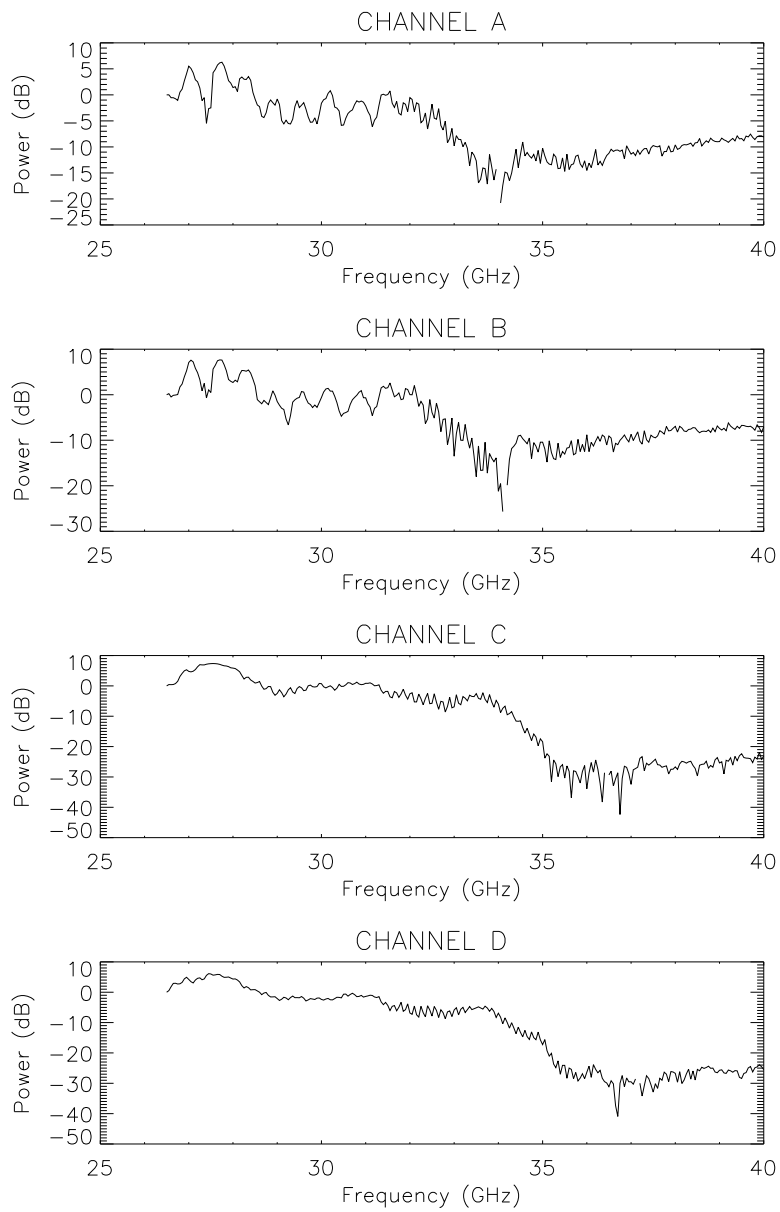


Figure 9: Calibrated data in dB.

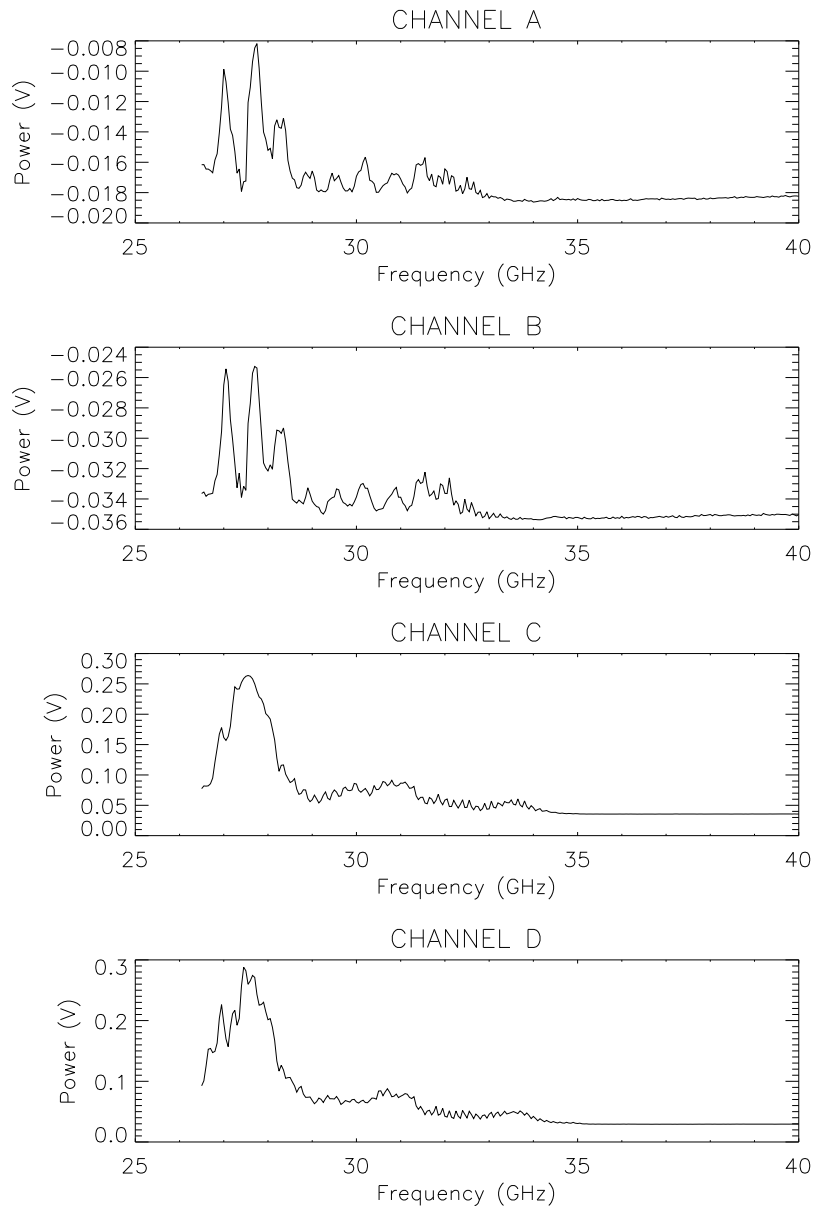


Figure 10: Uncalibrated data.