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*LFI Project System Team*

**Planck LFI**

**TITLE:**

# FM 30GHz RCA27 Data Analysis Report

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# CHANGE RECORD

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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 keep to 12.8 Kelvin.
The REF temperature sequence is shown in figure below

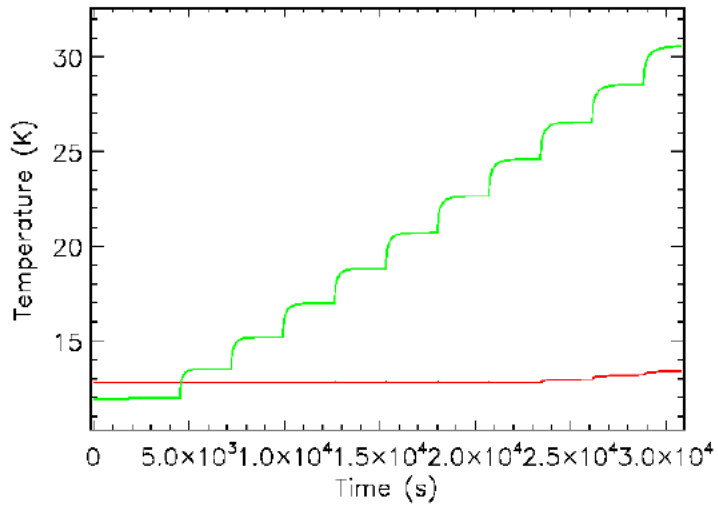
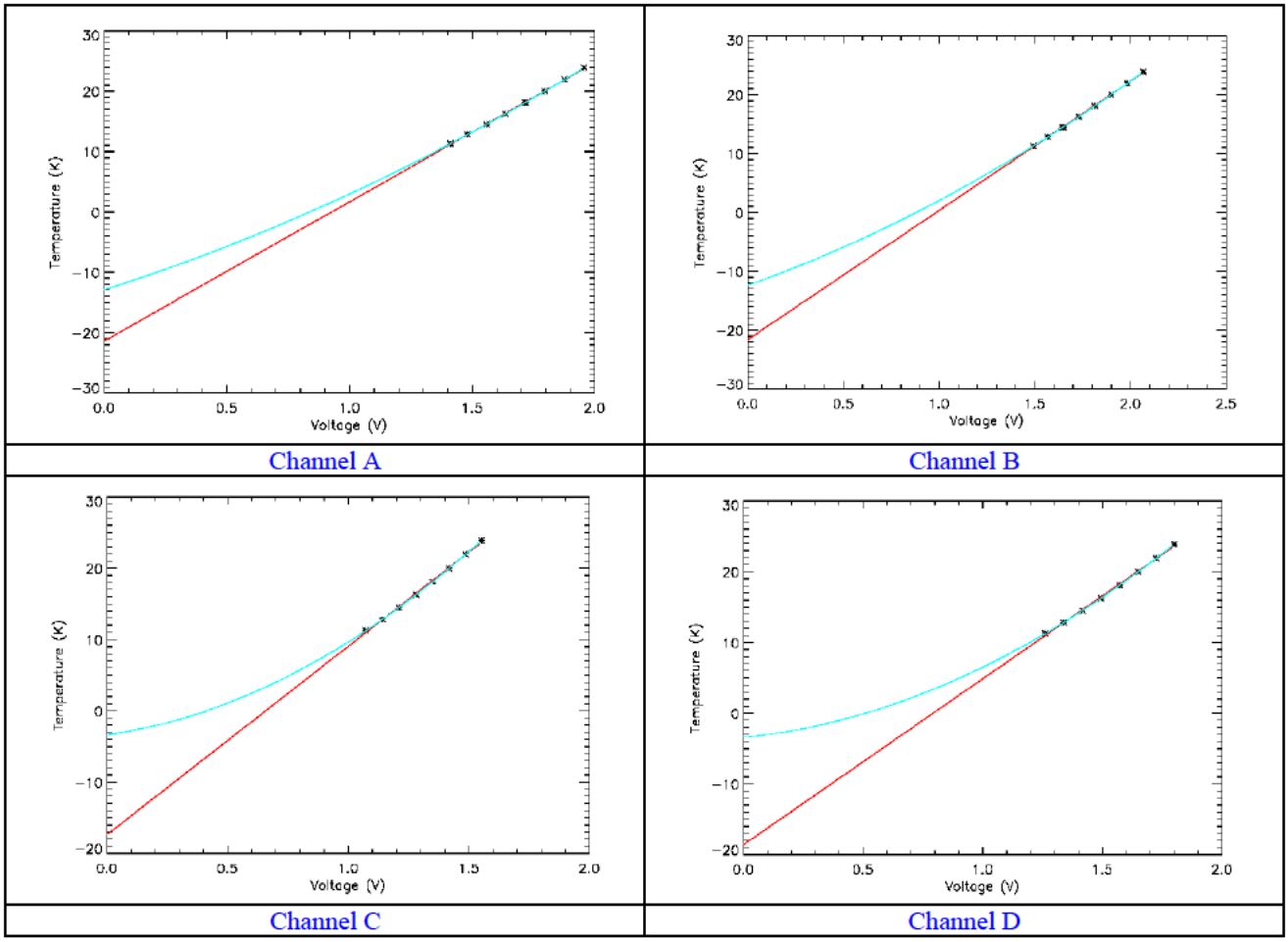



*Figure 6-2 Temperature of the Reference load (green line) is taken form R_MON monitor sensor, and of the Skyload temperature (Red line) taken from SKY_TEMP monitor sensor.*

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 documen1t.*

| | 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 |




Channel A | Channel B

Channel C | Channel D

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 = a0 + a1 * V + a2 * 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 = a0 + a1 * T + a2 * 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
       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       1.2605763       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
       26.557276       12.961075       1.8738744       1.3792534
       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 = a0 + a1 * V + a2 * 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 = a0 + a1 * T + a2 * 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.

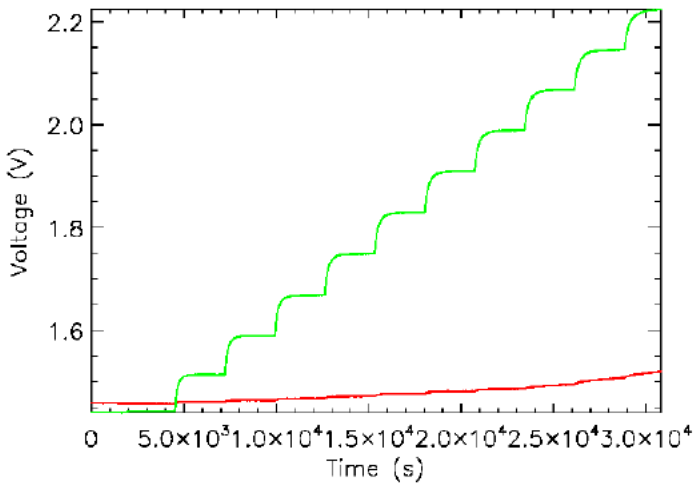



*Figure 6-4 Output voltage of the Reference (green), and of the Sky (Red).*

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] |
|---|---|---|---|---|---|
| | x 1E-02 | | *Linear* | *Parabolic* | |
| **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

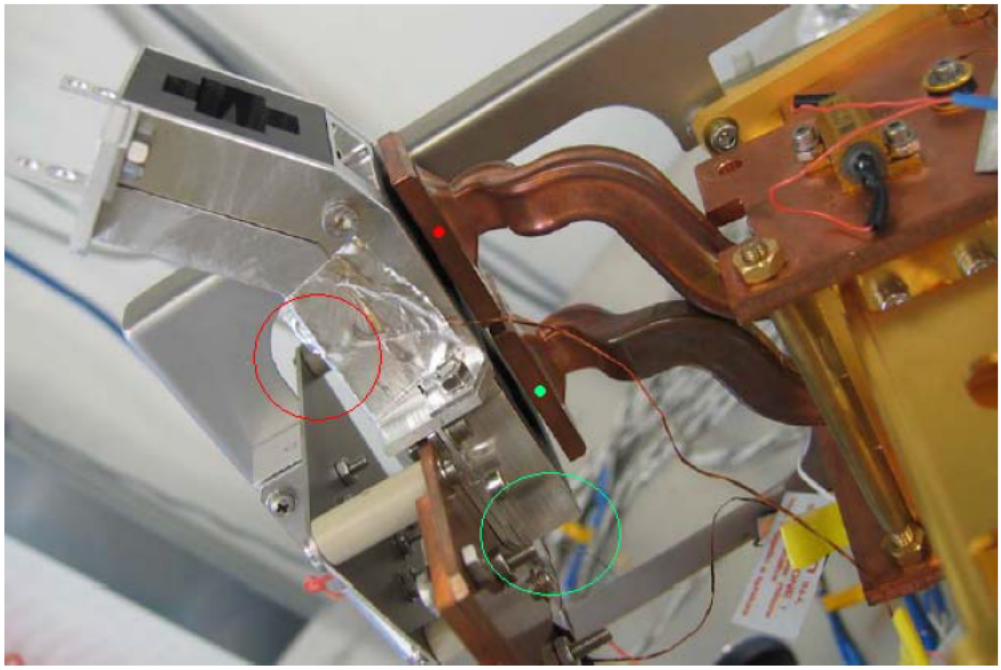


*Figure 6-5 The green circle correspond to REF_TEMP and the Reference horn (green spotted) refers to channel C/D. The red circle correspond to R_MON sensor and the reference horn (red spotted) refers to channel A/B.*

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 keep 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.

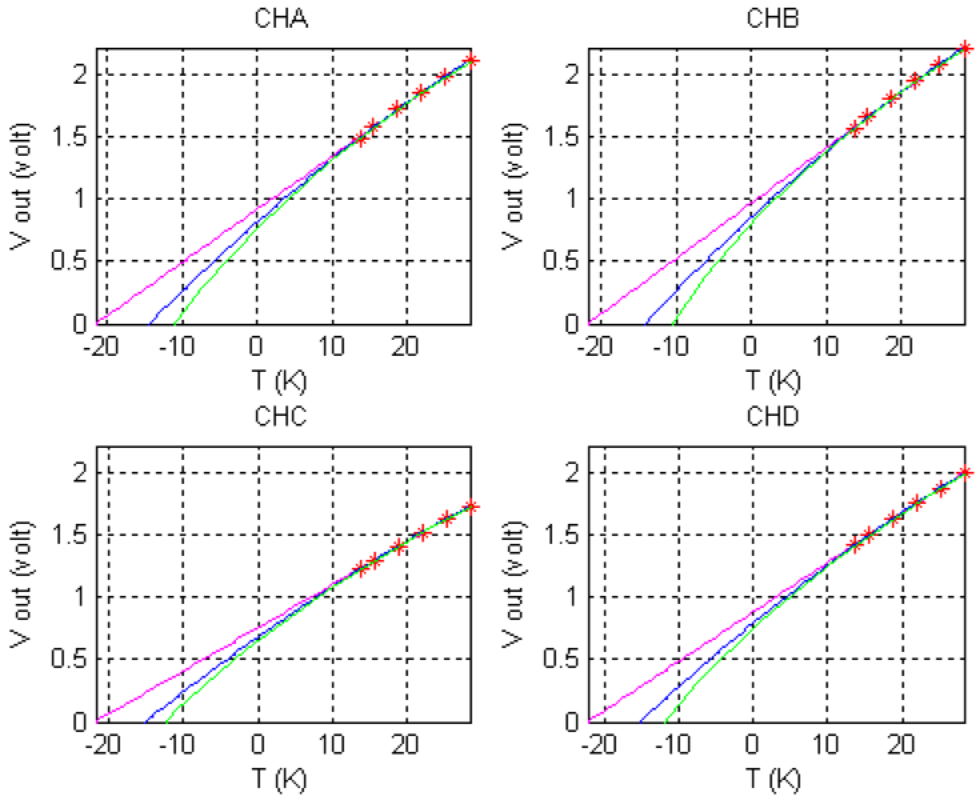



*Figure 6-6: Non linearity of the RCA27. The magenta line is the linear best fi. The blue line is the parabolic fit V(T), and the green line is the parabolic best fit for T(V) data.*

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:

```
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
```

Parabolic fit:

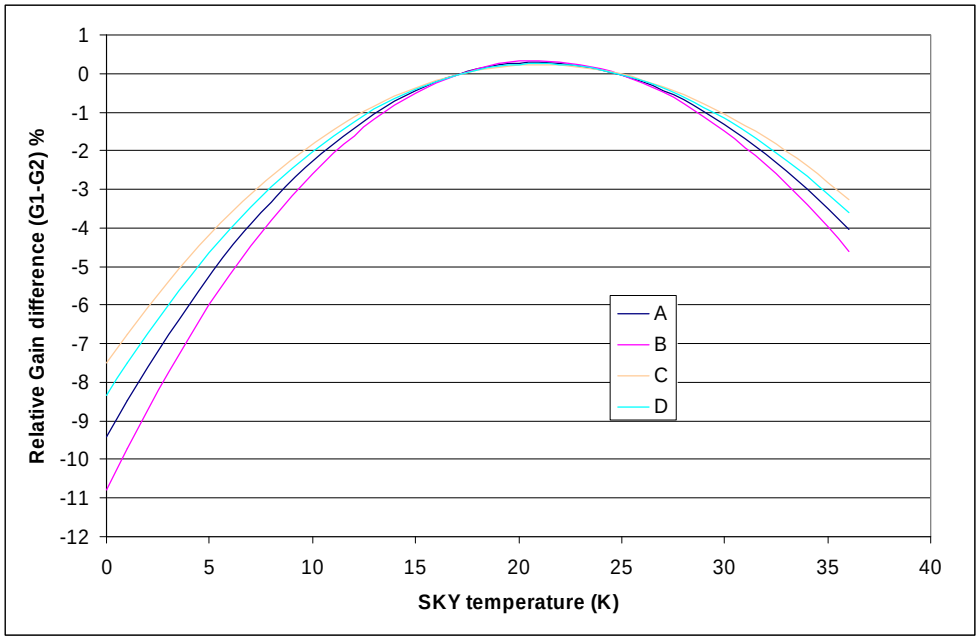
```
V_A(T) = -0.000248344 * T^2 + 0.053057288 * T + 0.816806123
V_B(T) = -0.000276441 * T^2 + 0.056032191 * T + 0.855333121
V_C(T) = -0.000180869 * T^2 + 0.042301959 * T + 0.652635268
V_D(T) = -0.000217483 * T^2 + 0.048742725 * T + 0.793997091

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~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:

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

where B is the bandwidth [Hz], $\tau$ 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:

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

where *WN* is the white noise as derived from RaNA, $\tau$ is the 122 microSec (1/8KHz) integration time and $\tau_{BT}$ 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 Tsys = 10.7 Kelvin (see [AD 2]), while the white noise limit form measurements has been derived in three ways:

1. From the Tsys and B derived from tests applying the Eq. 1. Tsys values were obtained from parabolic values of Table 6-3 and B were obtained from RCA_SPR test from
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 calibrated[1] 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 001 [2]

[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:

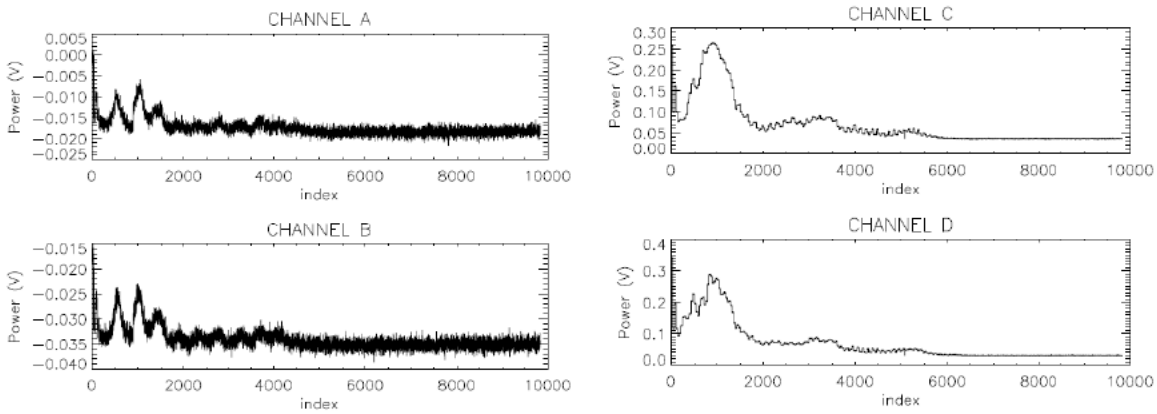



*Figure 6-7: typical data steam of the SPR test after trigger removal.*

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

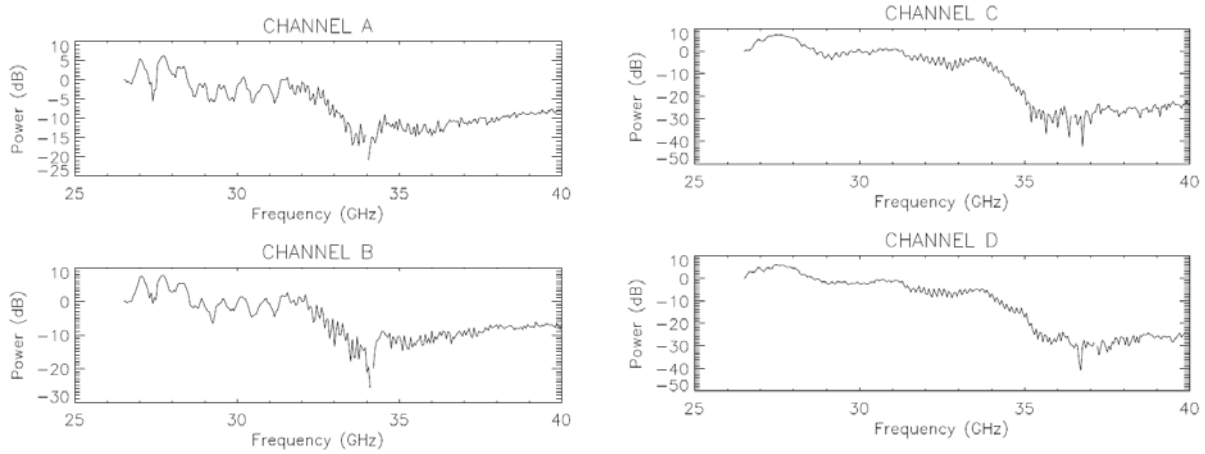



*Figure 6-8: Bandpass shape of the all four channels. Obviously the channel A and B show ripples that are not found on channel C and D..*

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 steam 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.

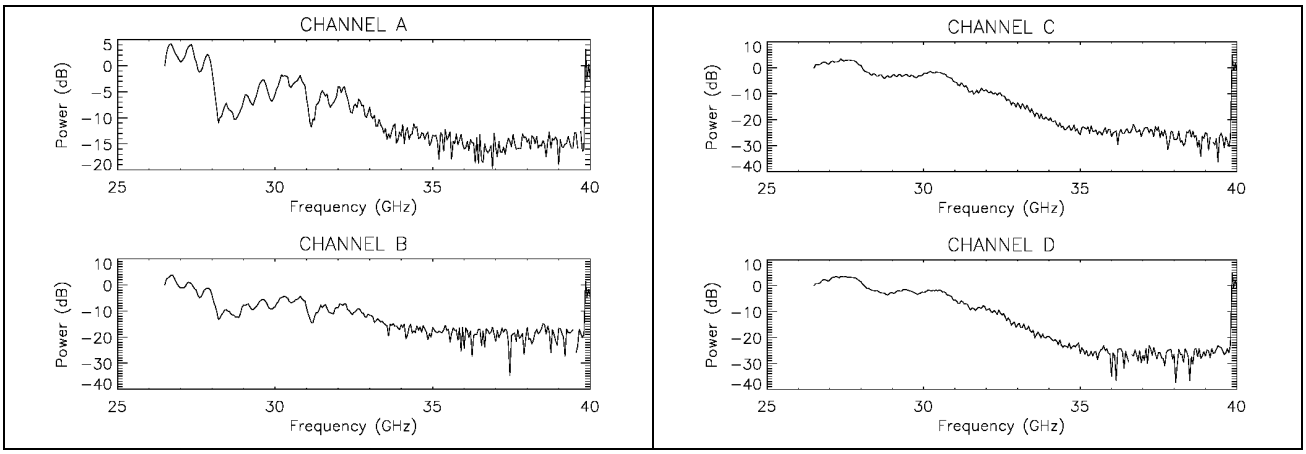
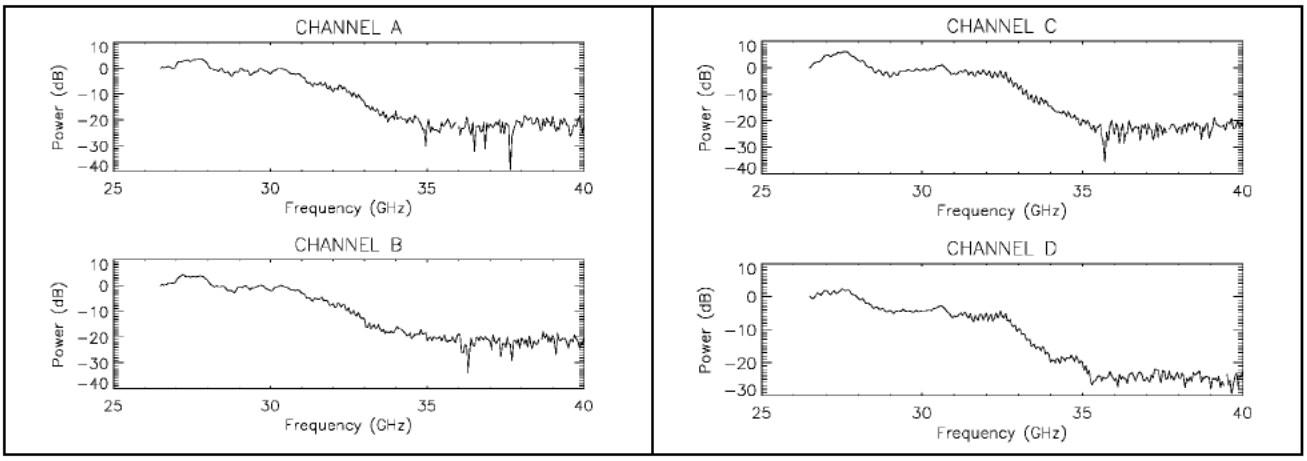



*Figure 6-9: Bandpass shape of the all four channels. Obviously the channel A and B show ripples that are not found on channel C and D..*

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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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**<br>**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**<br>**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<br>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**<br>**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 |

| T sky = 12.8 K<br>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<br>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<br>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<br>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

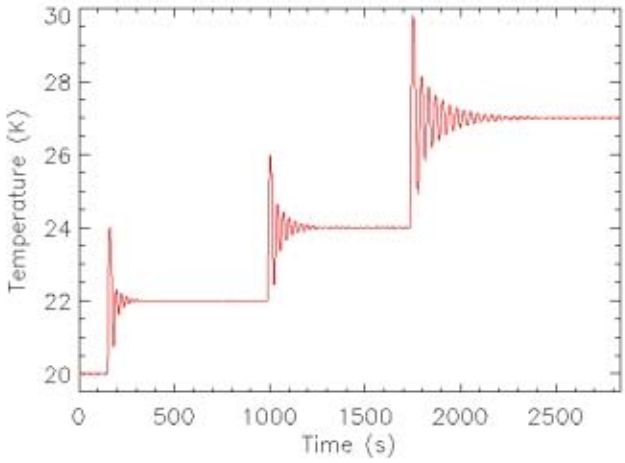



***Figure -10:*** *FEM temperature step during the RCA_THF test*

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.

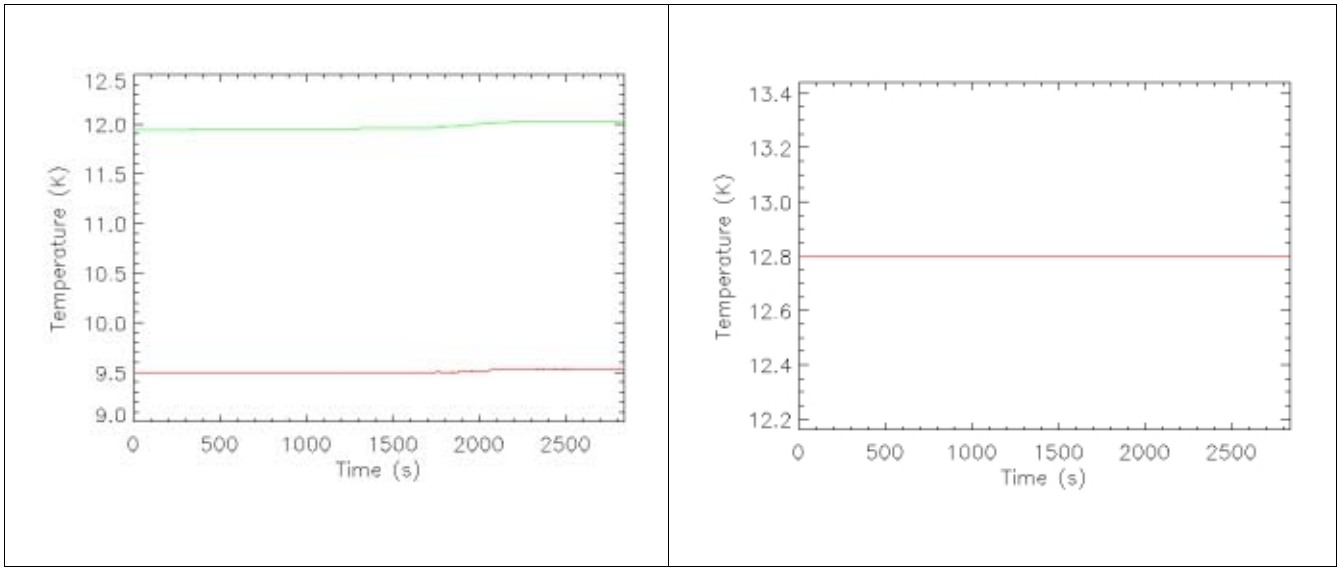



***Figure -11**: Left – Reference Load (REF_TEMP probe (red) and RMON_TMP probe (green)) temperature behaviour during the RCA_THF test; right – Sky Load SKY_TEMP probe (red)*

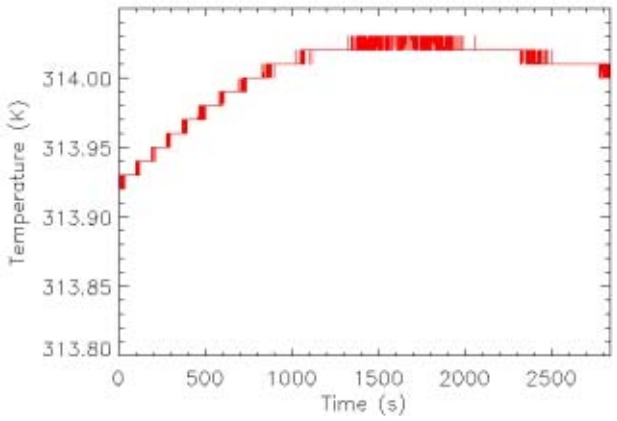



***Figure -12:** BEM temperature behaviour during the RCA_THF test*

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:

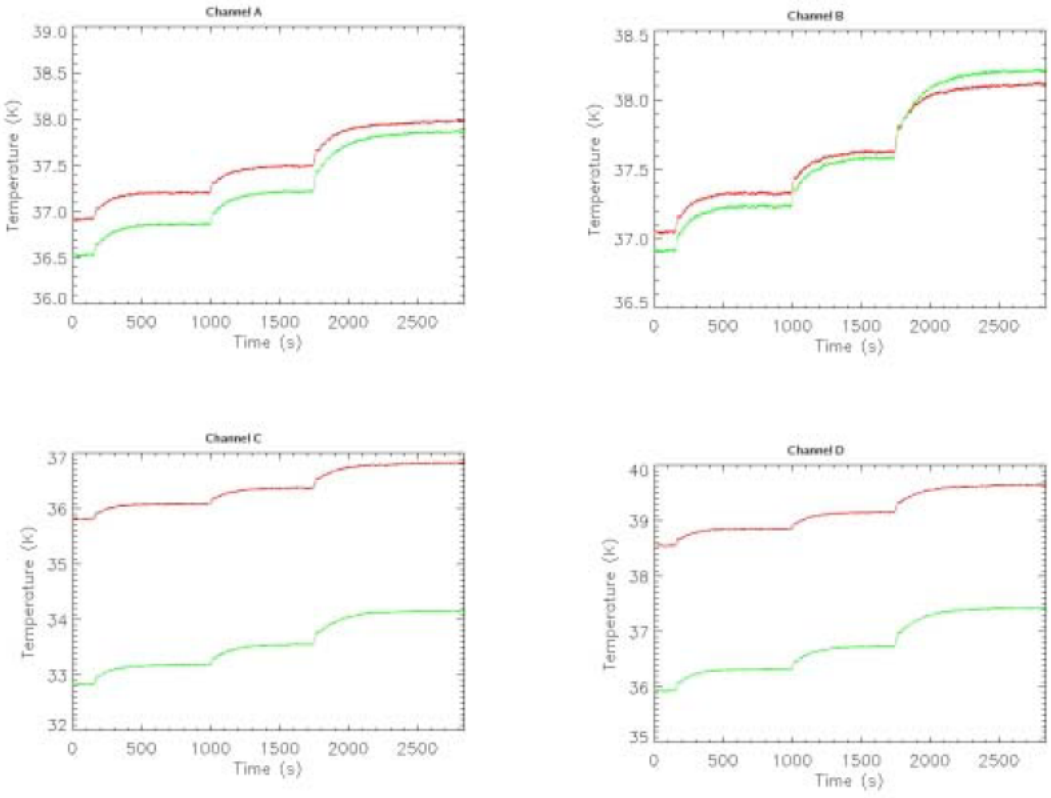



***Figure -13:*** *Radiometric output of the 4 detectors during the RCA_THF test. Sky (red) -Reference (green)*

**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:

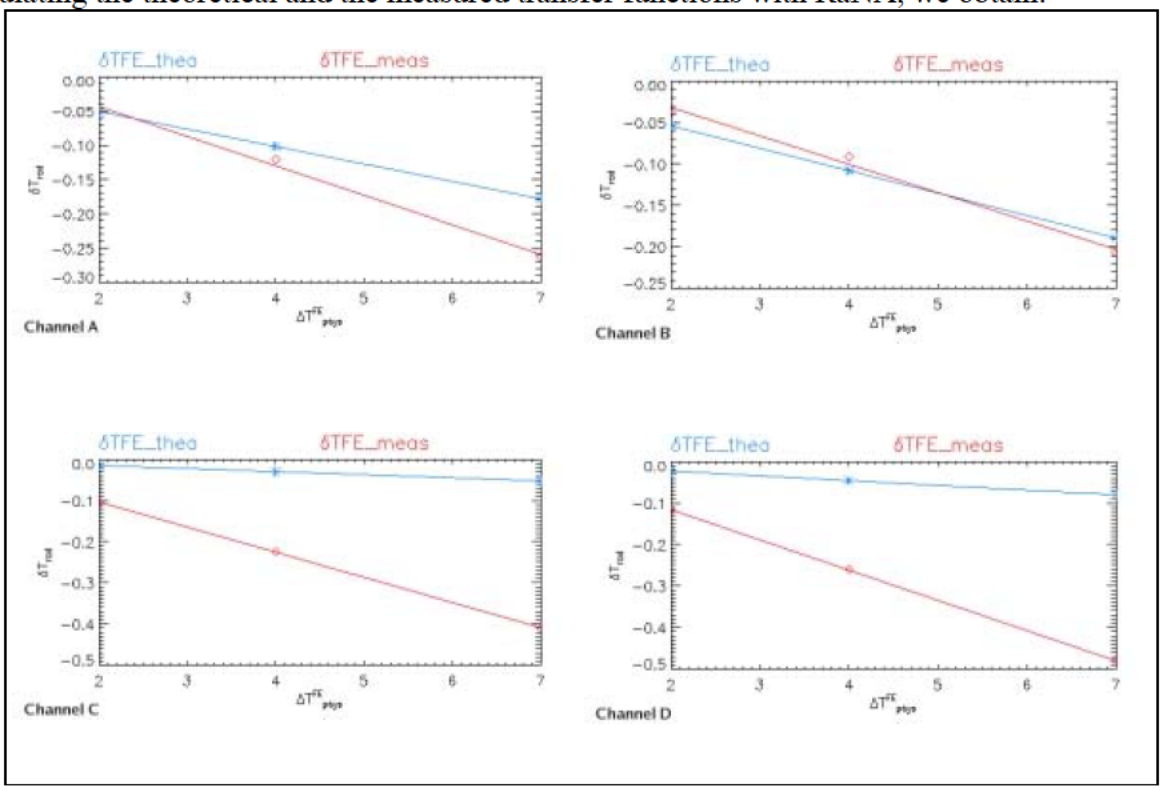



***Figure -14:*** *RCA_THF theoretical (blue) Vs measured (red) transfer function*

***Table -3:*** *RCA_THF Analysis Result based on default parameters*

| | Channel A | Channel B | Channel C | Channel D |
|---|---|---|---|---|
| $f_{therm}^{front-end}$ **(K/K) theoretical** | -0.025451 | -0.027047 | -0.007434 | -0.011473 |
| $f_{therm}^{front-end}$ **(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
```

```
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 =  REF_TEMP
FEM Sensor =  FEM_TEMP

  SKY_TEMP REF_TEMP FEM_TEMP
     12.80001068       9.49986649      20.00002289
     12.79993534       9.49992180      22.00016212
     12.80000973       9.49994278      24.00003052
     12.80002499       9.52705288      27.00001335

Radiometer outputs (K)
   Tsky  Tref
       36.921345        36.530961
       37.201213        36.856692
       37.489589        37.212887
       37.974078        37.832494

   Tsky-r*Tref
     -0.049344155
      -0.12096870
      -0.26270762

OUTPUT
 ftheo (K/K)  fmeas (K/K)
   -0.025451   -0.043035
```

```
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 =  REF_TEMP
FEM Sensor =  FEM_TEMP

  SKY_TEMP REF_TEMP FEM_TEMP
     12.80001068       9.49986649      20.00002289
     12.79993534       9.49992180      22.00016212
     12.80000973       9.49994278      24.00003052
     12.80002499       9.52705288      27.00001335

Radiometer outputs (K)
   Tsky  Tref
       37.047712        36.915245
       37.324963        37.229047
       37.621944        37.578131
       38.113177        38.183080

   Tsky-r*Tref
     -0.037678060
     -0.091032804
      -0.20691991

OUTPUT
 ftheo (K/K)  fmeas (K/K)
   -0.027047   -0.034227
```

```
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 =  REF_TEMP
FEM Sensor =  FEM_TEMP

  SKY_TEMP REF_TEMP FEM_TEMP
     12.80001068       9.49986649      20.00002289
     12.79993534       9.49992180      22.00016212
     12.80000973       9.49994278      24.00003052
     12.80002499       9.52705288      27.00001335

Radiometer outputs (K)
   Tsky  Tref
       35.817435        32.836384
       36.082631        33.175413
       36.366584        33.545250
       36.821706        34.132627

   Tsky-r*Tref
     -0.10461108
     -0.22407079
     -0.40965067
```

```
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 =  REF_TEMP
FEM Sensor =  FEM_TEMP

  SKY_TEMP REF_TEMP FEM_TEMP
     12.80001068       9.49986649      20.00002289
     12.79993534       9.49992180      22.00016212
     12.80000973       9.49994278      24.00003052
     12.80002499       9.52705288      27.00001335

Radiometer outputs (K)
   Tsky  Tref
       38.553199        35.936036
       38.845617        36.318154
       39.146076        36.730706
       39.644090        37.401768

   Tsky-r*Tref
     -0.11752943
     -0.25966793
     -0.48158836
```

```
OUTPUT
 ftheo (K/K)   fmeas (K/K)
   -0.007434    -0.061077
```

```
OUTPUT
 ftheo (K/K)   fmeas (K/K)
   -0.011473    -0.072906
```

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:

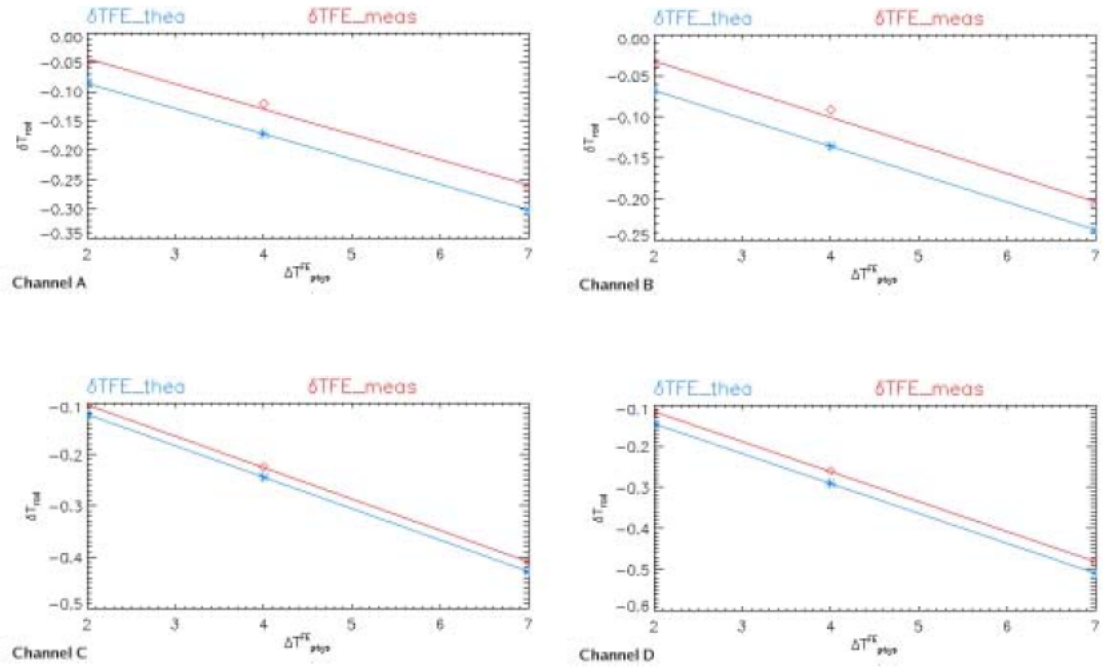



***Figure -15:*** *RCA_THF theoretical Vs measured transfer function after optimisation of the parameters.*

***Table -5:*** *RCA_THF Optimal transfer function Vs. theoretical*

| | Channel A | Channel B | Channel C | Channel D |
|---|---|---|---|---|
| $f^{\text{front-end}}_{\text{therm}}$ (K/K) theoretical | -0.043032 | -0.033914 | -0.061095 | -0.072711 |
| $f^{\text{front-end}}_{\text{therm}}$ (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
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
```

```
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
```

```
Ref Sensor =  REF_TEMP
FEM Sensor =  FEM_TEMP

  SKY_TEMP REF_TEMP FEM_TEMP
      12.80001068       9.49986649      20.00002289
      12.79993534       9.49992180      22.00016212
      12.80000973       9.49994278      24.00003052
      12.80002499       9.52705288      27.00001335

Radiometer outputs (K)
   Tsky  Tref
       36.921345        36.530961
       37.201213        36.856692
       37.489589        37.212887
       37.974078        37.832494

   Tsky-r*Tref
     -0.049344155
      -0.12096870
      -0.26270762

OUTPUT
 ftheo (K/K)  fmeas (K/K)
   -0.043032   -0.043035
```

```
Ref Sensor =  REF_TEMP
FEM Sensor =  FEM_TEMP

  SKY_TEMP REF_TEMP FEM_TEMP
      12.80001068       9.49986649      20.00002289
      12.79993534       9.49992180      22.00016212
      12.80000973       9.49994278      24.00003052
      12.80002499       9.52705288      27.00001335

Radiometer outputs (K)
   Tsky  Tref
       37.047712        36.915245
       37.324963        37.229047
       37.621944        37.578131
       38.113177        38.183080

   Tsky-r*Tref
     -0.037678060
     -0.091032804
      -0.20691991

OUTPUT
 ftheo (K/K)  fmeas (K/K)
   -0.033914   -0.034227
```

```
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 =     -0.0280000
dGF2_dB_dTFEphys_K =     -0.0280000
dTn1_dTFEphys_K =       0.670000
dTn2_dTFEphys_K =       0.670000

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 =  REF_TEMP
FEM Sensor =  FEM_TEMP

  SKY_TEMP REF_TEMP FEM_TEMP
      12.80001068       9.49986649      20.00002289
      12.79993534       9.49992180      22.00016212
      12.80000973       9.49994278      24.00003052
      12.80002499       9.52705288      27.00001335

Radiometer outputs (K)
   Tsky  Tref
       35.817435        32.836384
       36.082631        33.175413
       36.366584        33.545250
       36.821706        34.132627

   Tsky-r*Tref
      -0.10461108
      -0.22407079
      -0.40965067

OUTPUT
 ftheo (K/K)  fmeas (K/K)
   -0.061095   -0.061077
```

```
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 =      -0.100000
dGF2_dB_dTFEphys_K =      -0.100000
dTn1_dTFEphys_K =       0.700000
dTn2_dTFEphys_K =       0.700000

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 =  REF_TEMP
FEM Sensor =  FEM_TEMP

  SKY_TEMP REF_TEMP FEM_TEMP
      12.80001068       9.49986649      20.00002289
      12.79993534       9.49992180      22.00016212
      12.80000973       9.49994278      24.00003052
      12.80002499       9.52705288      27.00001335

Radiometer outputs (K)
   Tsky  Tref
       38.553199        35.936036
       38.845617        36.318154
       39.146076        36.730706
       39.644090        37.401768

   Tsky-r*Tref
      -0.11752943
      -0.25966793
      -0.48158836

OUTPUT
 ftheo (K/K)  fmeas (K/K)
   -0.072711   -0.072906
```

**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 |
|---|---|---|---|---|
| $f_{therm}^{front-end}$ **(K/K) theoretical** | 0.003272 | 0.001474 | 0.023565 | 0.019016 |
| $f_{therm}^{front-end}$ **(K/K) measured** | -0.0326 | -0.023865 | -0.049815 | -0.061829 |

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
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
```

```
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 =     -0.0500000
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
        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
```

```
  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
```

```
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
```

```
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
```

## 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.

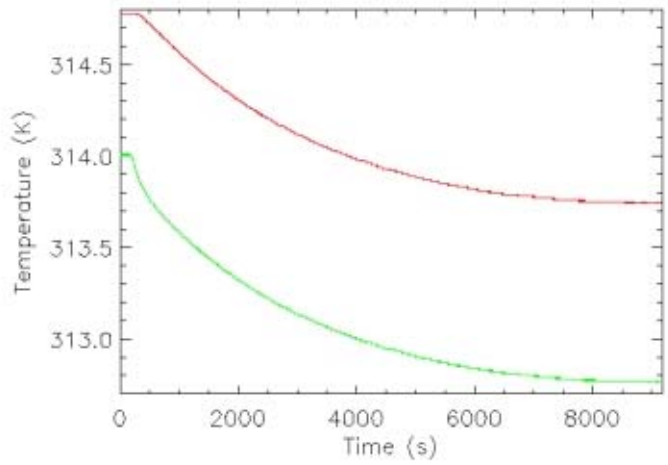



***Figure -16:*** *BEM temperature during the RCA_THB test. VG2_TEMP probe (red) and BEM_TEMP probe (green)*

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.

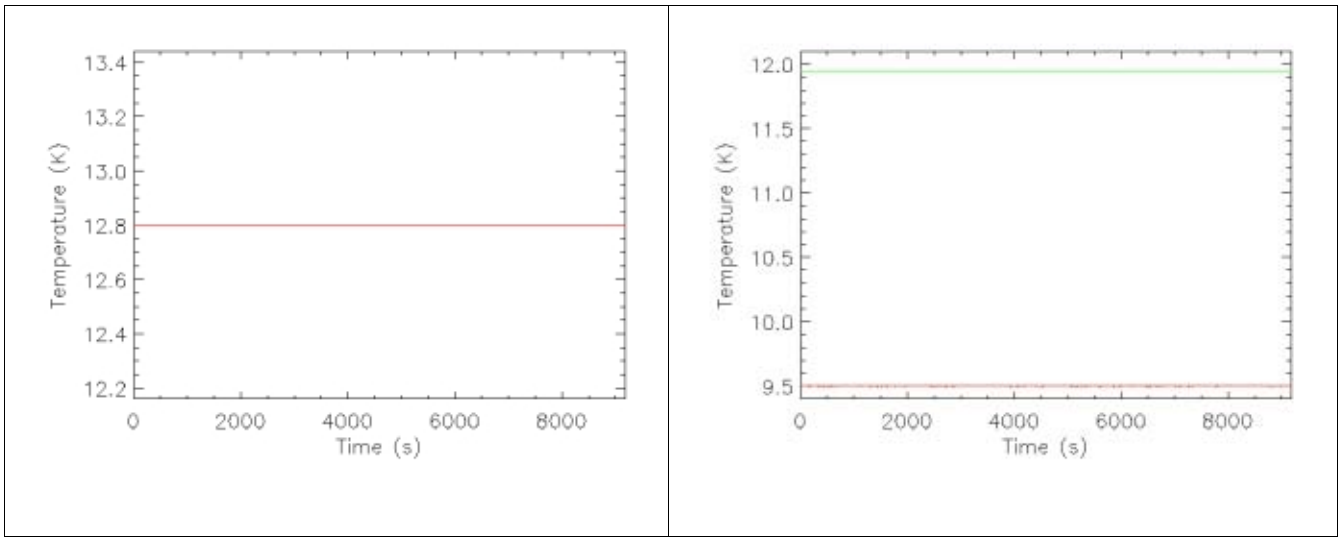



***Figure -17****: Left – Sky Load temperature behaviour during the RCA_THF test; right – REF_TEMP probe (red) and RMON_TMP probe (green)*

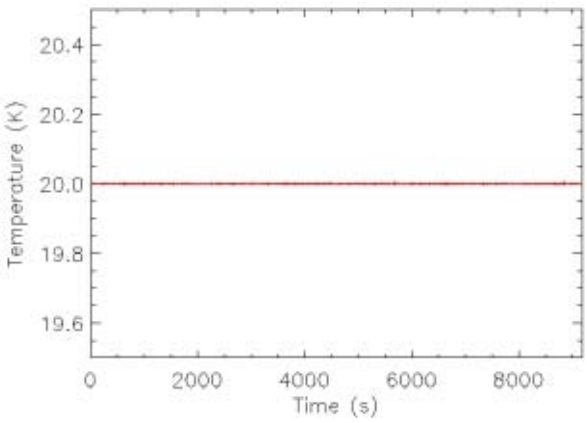
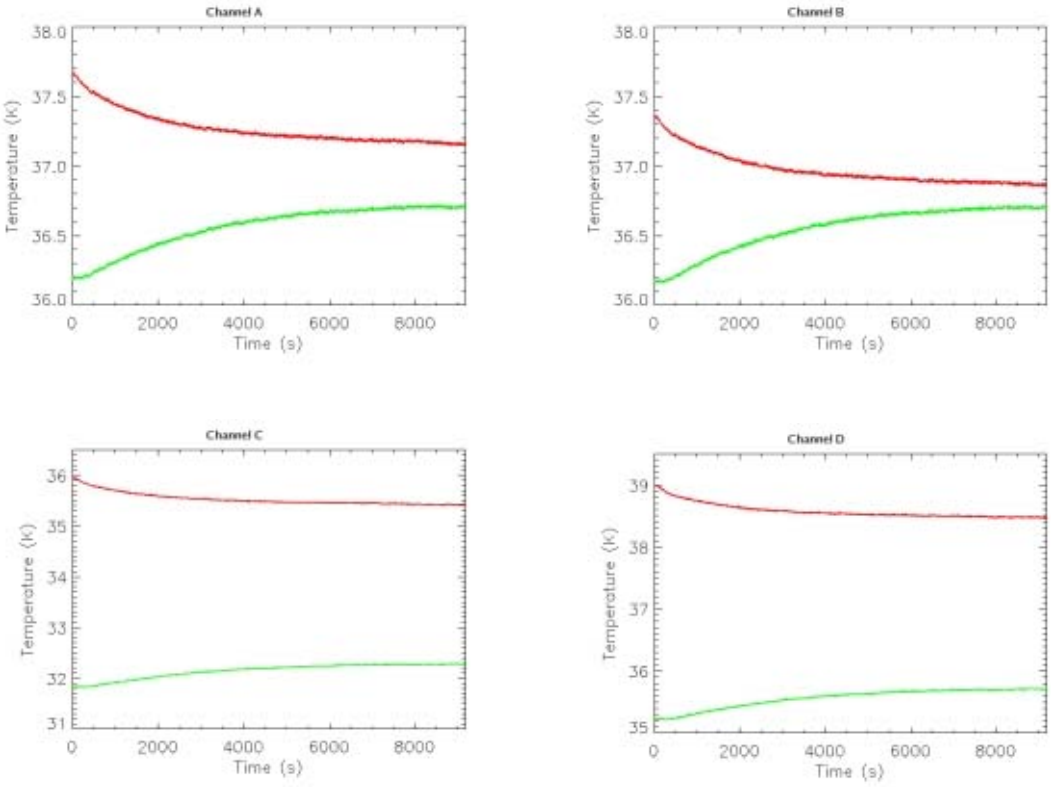



***Figure -18:*** *FEM temperature behaviour during the RCA_THB test*

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 | | | |
| **$L_{feed\text{-}OMT}$ (*dB*)** | 0.25 | | | |
| **$L_{4k}$ (*dB*)** | 0.2 | | | |
| **r** | 1.0389378 | 1.0312000 | 1.1273369 | 1.1051599 |
| **$T_{FEphys}$ (K)** | 20 | | | |
| **$G^{dB}_{F1}$ (*dB*)** | 35 | | | |
| **$G^{dB}_{F2}$ (*dB*)** | 35 | | | |
| **$T_{nF1}$ (*K*)** | 20 | 20 | 20 | 20 |
| **$T_{nF2}$ (*K*)** | 20 | 20 | 20 | 20 |
| **$\partial G^{dB}_{B1}/\partial T^{BE}_{phys}$ (*dB/K*)** | -0.034 | -0.04 | -0.03 | -0.027 |
| **$\partial G^{dB}_{B2}/\partial T^{BE}_{phys}$ (*dB/K*)** | -0.034 | -0.04 | -0.03 | -0.027 |
| **$\partial a^{dB}/\partial T^{BE}_{phys}$ (*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 |
|---|---|---|---|---|
| **$f^{back-end}_{therm}$ (K/K) theoretical** | -0.022414 | -0.028246 | 0.004990 | -0.001271 |
| **$f^{back-end}_{therm}$ (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_dTBEphys_K =      -0.0340000
dGB2_dB_dTBEphys_K =      -0.0340000
da_dB_dTBEphys_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_dTBEphys_K =      -0.0400000
dGB2_dB_dTBEphys_K =      -0.0400000
da_dB_dTBEphys_K =     -0.01000000

There are            2  time windows
```

```
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
```

```
   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
```

```
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 =    -0.01000000

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
```

```
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 =    -0.01000000

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
```

**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 |
|---|---|---|---|---|
| $f^{back-end}_{therm}$ (K/K) theoretical | 0.003618 | 0.001115 | 0.030668 | 0.022015 |
| $f^{back-end}_{therm}$ (K/K) measured | 0.786148 | 0.790433 | 0.781312 | 0.797671 |

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_dTBEphys_K =     -0.0340000
dGB2_dB_dTBEphys_K =     -0.0340000
da_dB_dTBEphys_K =    -0.01000000

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
     12.79999733               11.94810200            314.00000000
20.00013924
     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
```

```
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_dTBEphys_K =     -0.0400000
dGB2_dB_dTBEphys_K =     -0.0400000
da_dB_dTBEphys_K =    -0.01000000

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
     12.79999733               11.94810200            314.00000000
20.00013924
     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
```

```
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 =    -0.01000000

There are             2  time windows
   tmin  tmax
```

```
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 =    -0.01000000

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
     12.79999733               11.94810200            314.00000000
20.00013924
     12.79988289               11.95234585            312.76986694
19.99994278

Radiometer outputs (K)
   Tsky  Tref
       35.888896        31.835113
       35.425349        32.276481

   Tsky-r*Tref
      -0.96111740

OUTPUT
 ftheo (K/K)  fmeas (K/K)
    0.030668    0.781312
```

```
      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
     12.79999733               11.94810200            314.00000000
20.00013924
     12.79988289               11.95234585            312.76986694
19.99994278

Radiometer outputs (K)
   Tsky  Tref
       38.927297        35.223225
       38.478638        35.705131

   Tsky-r*Tref
      -0.98124202

OUTPUT
 ftheo (K/K)  fmeas (K/K)
    0.022015    0.797671
```

## 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.

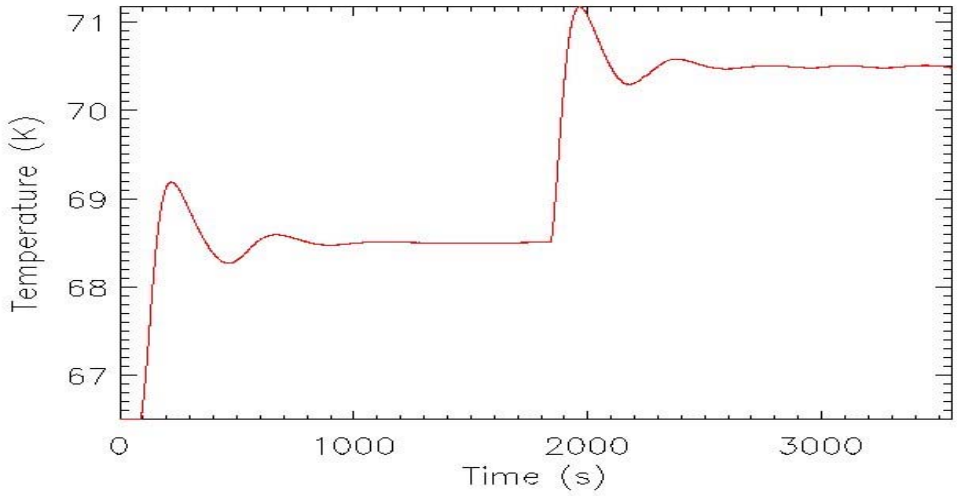



***Figure -20:*** *VG3 temperature variation during the RCA_THV test.*

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

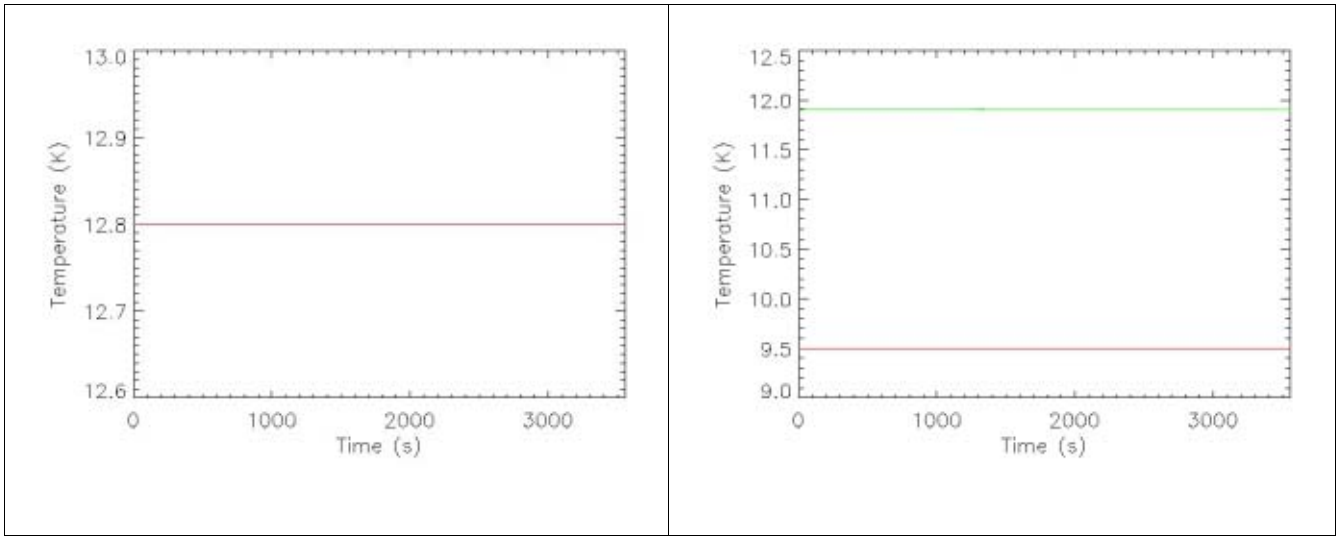



***Figure -21**: Left – Sky Load: (SKY_TEMP) probe temperature behaviour during the RCA_THF test; right – Reference Load : REF_TEMP probe (red) and RMON_TMP probe (green)*

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

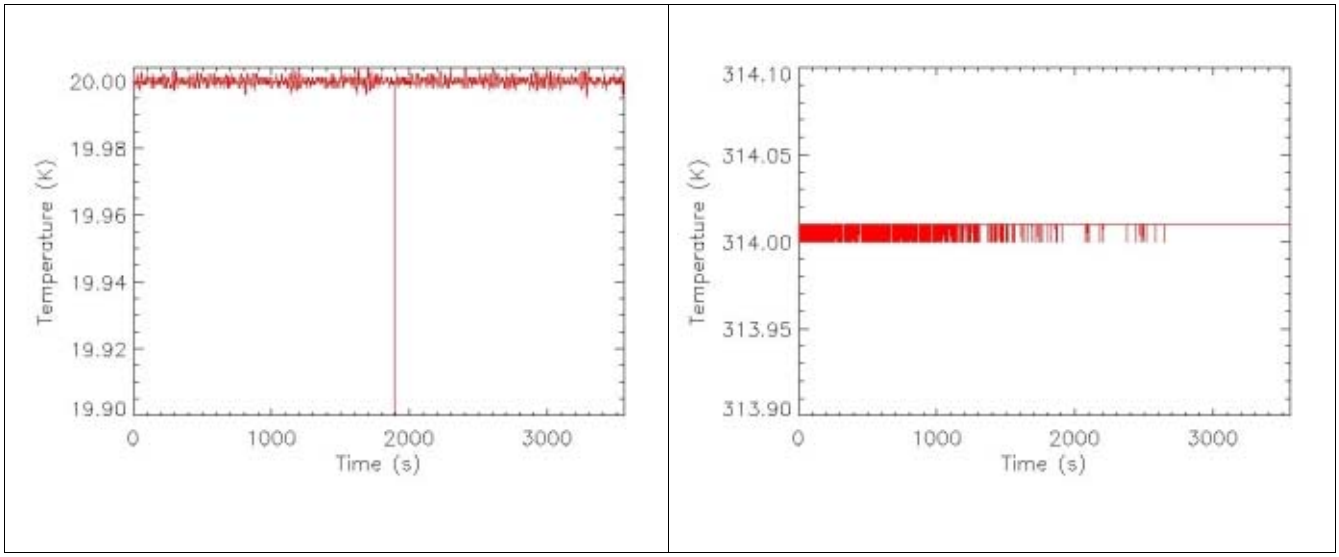



***Figure -22: FEM (left) and BEM (right) temperature behaviour during the RCA_THV test***

### 7.3.1 Detector A analysis

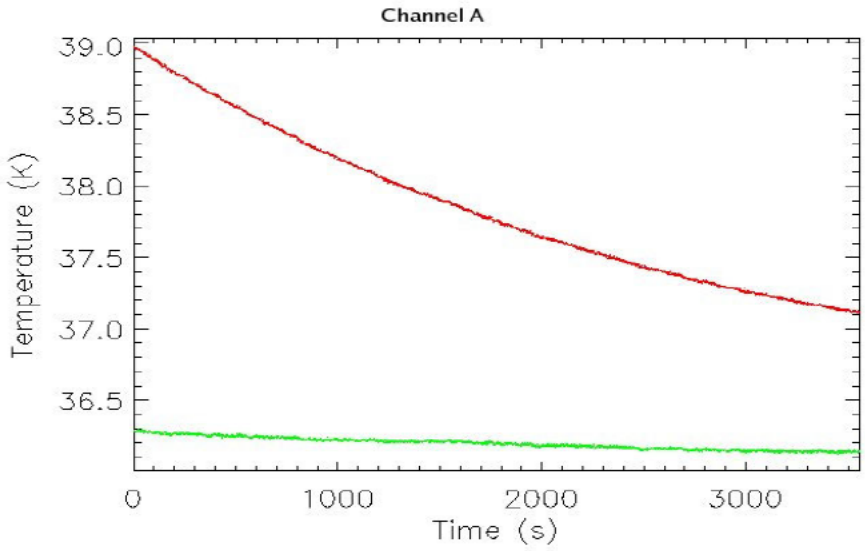



*Figure -23: Detector A calibrated output. Sky (red) -Reference (green)*

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

| | |
|---|---|
| Frequency (GHz) | 30 |
| $L_{feed-OMT}$ (dB) | 0.25 |
| r | 1.0732684 |
| $G_{F1}$ (dB) | 35 |
| $G_{F2}$ (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:

| | |
|---|---|
| *Fmeas (K/K)* | -0.31991206 |
| ***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 =  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

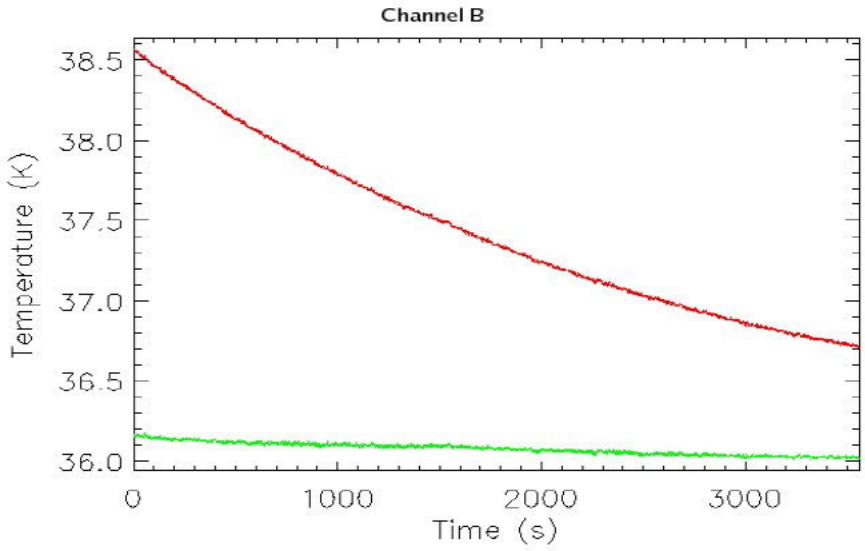



*Figure -24: Detector B calibrated output. Sky (red) -Reference (green)*

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

| | |
|---|---|
| Frequency (GHz) | 30 |
| $L_{feed-OMT}$ (dB) | 0.25 |
| r | 1.0656175 |
| $G_{F1}$ (dB) | 35 |
| $G_{F2}$ (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:

| | |
|---|---|
| *Fmeas (K/K)* | -0.32109367 |
| ***Ftheo (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:

| | |
|---|---|
| *Fmeas (K/K)* | -0.3224830 |
| ***Ftheo (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

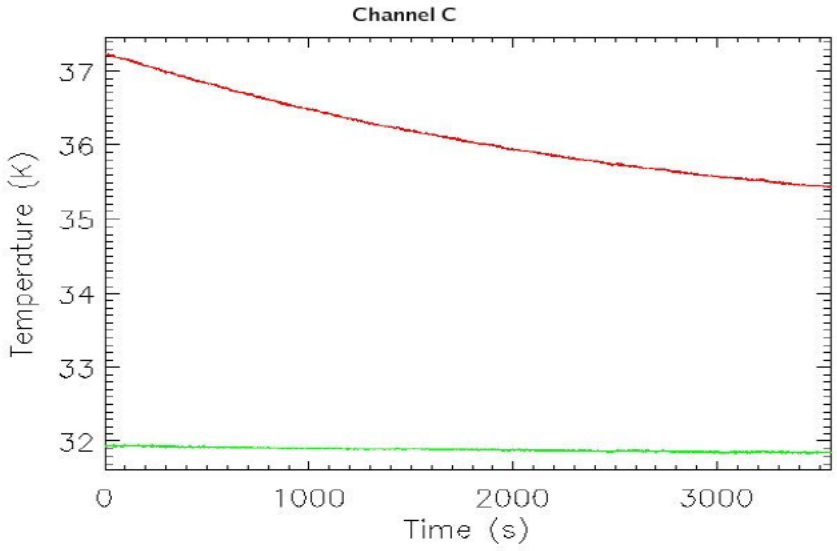



*Figure -25: Detector C calibrated output.Sky (red) -Reference (green)*

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 |

| | |
|---|---|
| $L_{WG1}$ (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) | 0.03299 |

**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 =        1.08000
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
       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

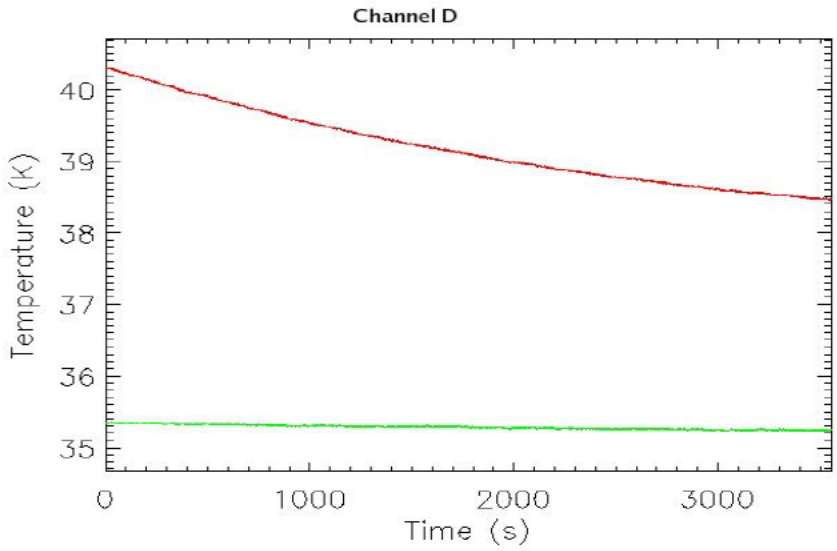



***Figure -26: Detector D calibrated output. Sky (red) -Reference (green)***

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

| | |
|---|---|
| Frequency (GHz) | 30 |
| $L_{feed-OMT}$ (dB) | 0.25 |

| | |
|---|---|
| r | 1.139537 |
| $G_{F1}$ (dB) | 35 |
| $G_{F2}$ (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:

| | |
|---|---|
| *Fmeas (K/K)* | -0.32517484 |
| ***Ftheo (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 =  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:

| | |
|---|---|
| *Fmeas (K/K)* | -0.32665766 |
| ***Ftheo (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 |

| | | | | | |
|---|---|---|---|---|---|
| **DETECTOR B** | 4.28±0.02 | 23.4±0.1 | 22.6±0.2 | 13.9±0.1 | -13.40 |
| **DETECTOR C** | 3.61±0.02 | 27.7±0.2 | 17.8±0.2 | 7.4±0.1 | -15.35 |
| **DETECTOR D** | 4.07±0.02 | 24.6±0.1 | 19.9±0.1 | 8.1±0.1 | -15.52 |

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.*

| | Gain [V/K] | Gain [K/V] | Tnoise [K] | Tnoise [K] | Isolation [dB] |
|---|---|---|---|---|---|
| | x 1E-02 | | *Linear* | *Parabolic* | |
| **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 |

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 | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V$ |
| 11.982578 | 0.00066796871 | 12.800000 | 0.0000000 | 1.4209387 | 0.0021535281 | 1.4355605 | 0.00 |
| 13.509188 | 0.0013647235 | 12.800000 | 0.0000000 | 1.4916528 | 0.0022109362 | 1.4385777 | 0.00 |
| 15.186900 | 0.0015477908 | 12.800000 | 0.0000000 | 1.5673083 | 0.0023210500 | 1.4418543 | 0.00 |
| 16.965250 | 0.0016629766 | 12.800000 | 0.0000000 | 1.6460962 | 0.0023835342 | 1.4455770 | 0.00 |
| 18.807276 | 0.0017292171 | 12.800000 | 0.0000000 | 1.7263672 | 0.0024650950 | 1.4500986 | 0.00 |
| 20.703377 | 0.0047018002 | 12.800000 | 0.0000000 | 1.8067493 | 0.0026095085 | 1.4545985 | 0.00 |
| 22.633661 | 0.0064634359 | 12.800000 | 0.0000000 | 1.8872256 | 0.0027163964 | 1.4593149 | 0.00 |
| 24.584471 | 0.0035923487 | 12.800000 | 0.0000000 | 1.9668155 | 0.0027759676 | 1.4638804 | 0.00 |
| 26.557478 | 0.0033608228 | 12.961092 | 0.0051455456 | 2.0456022 | 0.0028479151 | 1.4717213 | 0.00 |
| 28.513538 | 0.011756675 | 13.175012 | 0.011214501 | 2.1224890 | 0.0030078064 | 1.4831747 | 0.00 |
| 30.546484 | 0.0048519443 | 13.412120 | 0.0033968948 | 2.2013029 | 0.0030138429 | 1.4972374 | 0.00 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -13.467028 | -0.13559971 | 0.040164367 | 0.00018631635 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0075895407 | 0.0045004748 | 22.575577 | 0.14877793 |

COMMENTS

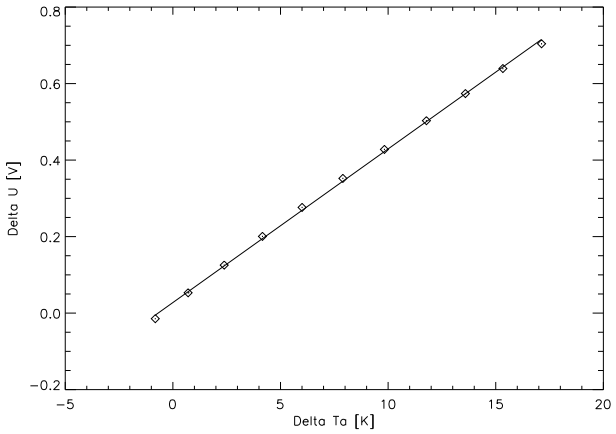



Figure 4.1: Response linearity (differenced values)

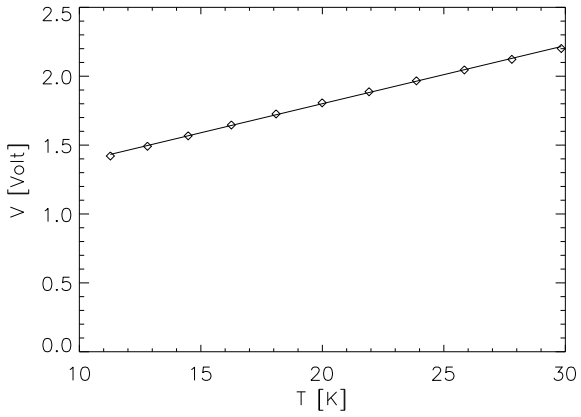



Figure 4.2: Response linearity (changing temperature vs changing voltage

## 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

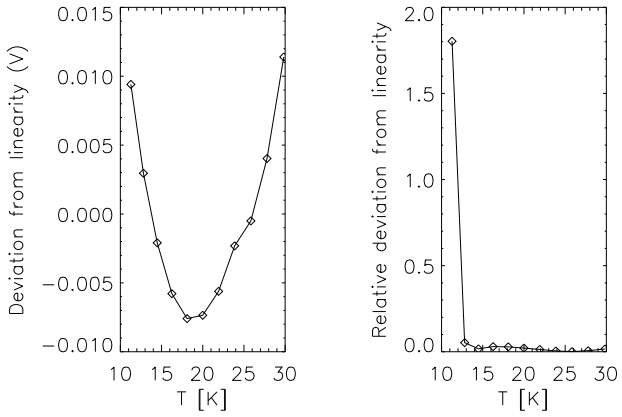



Figure 4.3: Deviation from linearity

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma$ |
| 11.982347 | 0.00071689778 | 12.800000 | 0.0000000 | 1.5054175 | 0.0022926114 | 1.5089695 | 0.00 |
| 13.509529 | 0.00097130542 | 12.800000 | 0.0000000 | 1.5802207 | 0.0023770129 | 1.5120145 | 0.00 |
| 15.187235 | 0.0013530200 | 12.800000 | 0.0000000 | 1.6597703 | 0.0024611853 | 1.5152448 | 0.00 |
| 16.964268 | 0.0027196549 | 12.800000 | 0.0000000 | 1.7428286 | 0.0025682056 | 1.5194170 | 0.00 |
| 18.807703 | 0.0014253096 | 12.800000 | 0.0000000 | 1.8273898 | 0.0026552156 | 1.5243730 | 0.00 |
| 20.704794 | 0.0032021415 | 12.800000 | 0.0000000 | 1.9117911 | 0.0027553566 | 1.5292517 | 0.00 |
| 22.635660 | 0.0034663822 | 12.800000 | 0.0000000 | 1.9961787 | 0.0028426470 | 1.5344513 | 0.00 |
| 24.585888 | 0.0021992659 | 12.800000 | 0.0000000 | 2.0794190 | 0.0029329682 | 1.5394163 | 0.00 |
| 26.553930 | 0.0075820000 | 12.957900 | 0.0075384169 | 2.1614101 | 0.0030779622 | 1.5474368 | 0.00 |
| 28.520657 | 0.0063672578 | 13.181936 | 0.0082141897 | 2.2424208 | 0.0031549820 | 1.5606986 | 0.00 |
| 30.541199 | 0.0098965922 | 13.409437 | 0.0056114802 | 2.3239418 | 0.0032550974 | 1.5742642 | 0.00 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -13.449503 | -0.13491007 | 0.042056476 | 0.00018822718 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0076865760 | 0.0045168049 | 22.909080 | 0.13128681 |

COMMENTS

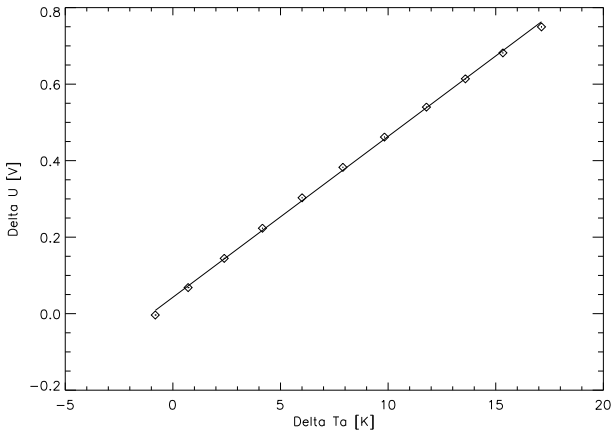



Figure 4.4: Response linearity (differenced values)

## 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

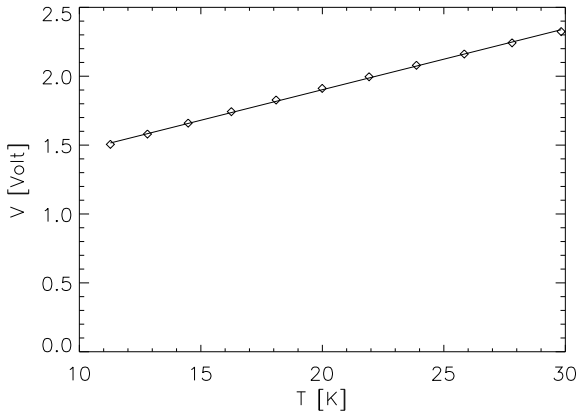



Figure 4.5: Response linearity (changing temperature vs changing voltage

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V$ |
| 9.5999022 | 6.6839639e-05 | 12.800000 | 0.0000000 | 1.0555964 | 0.0016767969 | 1.1523812 | 0.00 |
| 11.800000 | 0.0000000 | 12.800000 | 0.0000000 | 1.1238877 | 0.0017887861 | 1.1543394 | 0.00 |
| 14.000000 | 0.0000000 | 12.800000 | 0.0000000 | 1.1934081 | 0.0018605301 | 1.1560887 | 0.00 |
| 16.200001 | 0.0000000 | 12.800000 | 0.0000000 | 1.2628413 | 0.0019549326 | 1.1580869 | 0.00 |
| 18.400000 | 0.0000000 | 12.800000 | 0.0000000 | 1.3319033 | 0.0020406471 | 1.1606103 | 0.00 |
| 20.600000 | 0.0000000 | 12.800000 | 0.0000000 | 1.4002203 | 0.0021264964 | 1.1631813 | 0.00 |
| 22.799999 | 0.0000000 | 12.800001 | 0.0000000 | 1.4677575 | 0.0022045620 | 1.1659388 | 0.00 |
| 25.000000 | 0.0000000 | 12.800000 | 0.0000000 | 1.5343932 | 0.0022816783 | 1.1686811 | 0.00 |
| 27.200001 | 0.0000000 | 12.958149 | 0.0065274816 | 1.6004446 | 0.0023560188 | 1.1738289 | 0.00 |
| 29.400000 | 0.0000000 | 13.166924 | 0.015469675 | 1.6648729 | 0.0024547950 | 1.1814923 | 0.00 |
| 31.600002 | 0.0000000 | 13.398949 | 0.0094590932 | 1.7283325 | 0.0025166261 | 1.1909163 | 0.00 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -15.323569 | -0.26511811 | 0.029811657 | 0.00012478735 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0035281224 | 0.0035034611 | 25.399550 | 0.13324288 |

COMMENTS

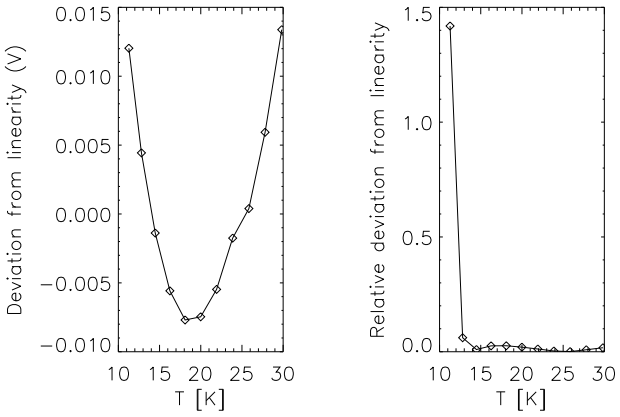



Figure 4.6: Deviation from linearity

## 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

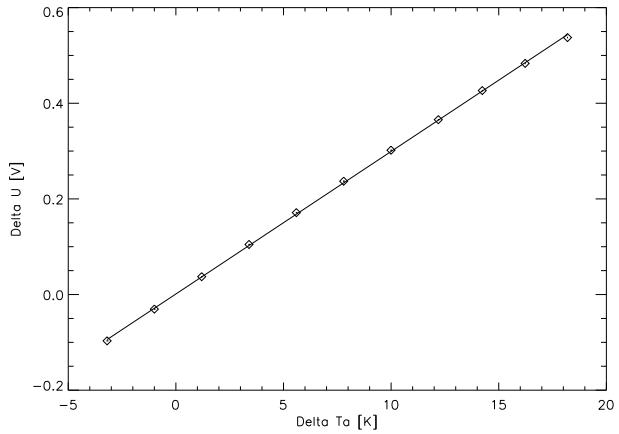



Figure 4.7: Response linearity (differenced values)

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V$ |
| 9.5999022 | 6.6062283e-05 | 12.800000 | 0.0000000 | 1.2732846 | 0.0018410388 | 1.3676590 | 0.00 |
| 11.800000 | 0.0000000 | 12.800000 | 0.0000000 | 1.3503327 | 0.0019517352 | 1.3695240 | 0.00 |
| 14.000000 | 0.0000000 | 12.800000 | 0.0000000 | 1.4285145 | 0.0020358699 | 1.3713513 | 0.00 |
| 16.200001 | 0.0000000 | 12.800000 | 0.0000000 | 1.5068821 | 0.0021209899 | 1.3736672 | 0.00 |
| 18.400000 | 0.0000000 | 12.800000 | 0.0000000 | 1.5846124 | 0.0022005127 | 1.3764739 | 0.00 |
| 20.600000 | 0.0000000 | 12.800000 | 0.0000000 | 1.6617167 | 0.0022795654 | 1.3796544 | 0.00 |
| 22.799999 | 0.0000000 | 12.800000 | 0.0000000 | 1.7376172 | 0.0023612054 | 1.3827143 | 0.00 |
| 25.000000 | 0.0000000 | 12.800001 | 0.0000000 | 1.8124754 | 0.0024467182 | 1.3858918 | 0.00 |
| 27.200001 | 0.0000000 | 12.958264 | 0.0076941960 | 1.8865034 | 0.0025276615 | 1.3916747 | 0.00 |
| 29.400000 | 0.0000000 | 13.175714 | 0.010735376 | 1.9591901 | 0.0025978271 | 1.4012844 | 0.00 |
| 31.600000 | 0.0000000 | 13.398812 | 0.010492285 | 2.0301294 | 0.0026866043 | 1.4110700 | 0.00 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -15.484884 | -0.26963822 | 0.033519697 | 0.00013195655 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0036199950 | 0.0036486634 | 27.935176 | 0.12856437 |

COMMENTS

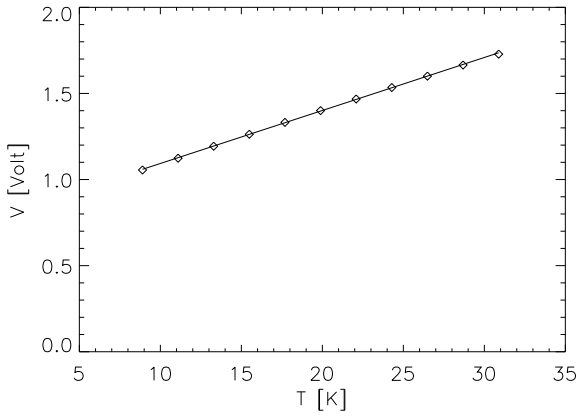



Figure 4.8: Response linearity (changing temperature vs changing voltage

## 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

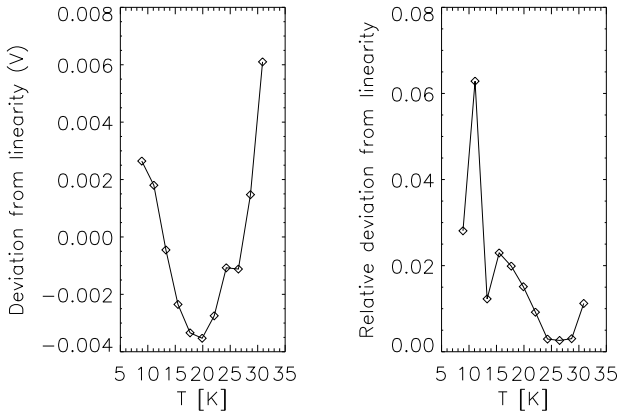



Figure 4.9: Deviation from linearity

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V$ |
| 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] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -13.380139 | -0.12988374 | 0.033906725 | 0.00015705949 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0050573139 | 0.0040459915 | 30.658146 | 0.16810497 |

COMMENTS
With T ref= T measured by the sensor on Cu plate

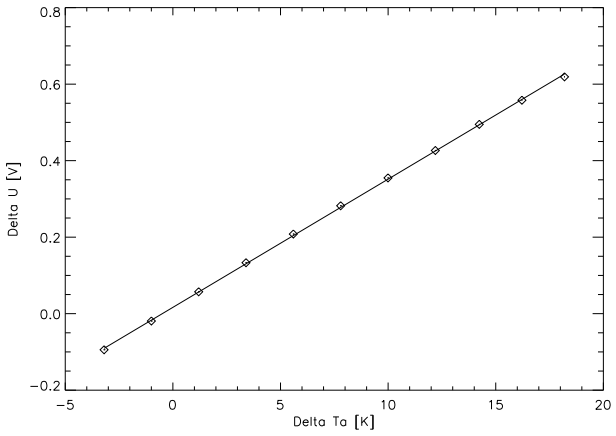



Figure 4.10: Response linearity (differenced values)

## 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

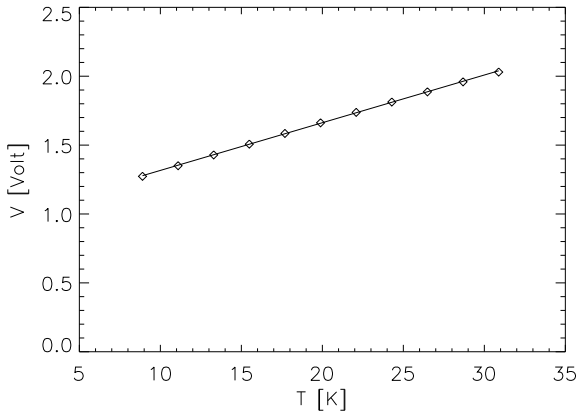



Figure 4.11: Response linearity (changing temperature vs changing voltage

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V$ |
| 9.5999022 | 6.5479777e-05 | 12.800001 | 0.0000000 | 1.5054041 | 0.0022935124 | 1.5089478 | 0.00 |
| 11.800000 | 0.0000000 | 12.800000 | 0.0000000 | 1.5802373 | 0.0023770738 | 1.5120287 | 0.00 |
| 14.000000 | 0.0000000 | 12.800000 | 0.0000000 | 1.6597763 | 0.0024614655 | 1.5152916 | 0.00 |
| 16.200001 | 0.0000000 | 12.800000 | 0.0000000 | 1.7429079 | 0.0025586125 | 1.5194516 | 0.00 |
| 18.400000 | 0.0000000 | 12.800000 | 0.0000000 | 1.8274309 | 0.0026510906 | 1.5243976 | 0.00 |
| 20.600000 | 0.0000000 | 12.800000 | 0.0000000 | 1.9117480 | 0.0027575097 | 1.5292502 | 0.00 |
| 22.799999 | 0.0000000 | 12.800000 | 0.0000000 | 1.9962186 | 0.0028389309 | 1.5344575 | 0.00 |
| 25.000000 | 0.0000000 | 12.800000 | 0.0000000 | 2.0793468 | 0.0029381590 | 1.5394008 | 0.00 |
| 27.200001 | 0.0000000 | 12.960229 | 0.0057820906 | 2.1616024 | 0.0030485231 | 1.5476928 | 0.00 |
| 29.400002 | 0.0000000 | 13.174619 | 0.0093795089 | 2.2418880 | 0.0031789776 | 1.5597359 | 0.00 |
| 31.600000 | 0.0000000 | 13.409122 | 0.0050511207 | 2.3239233 | 0.0032466074 | 1.5742188 | 0.00 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -13.358636 | -0.12896226 | 0.035563895 | 0.00017179535 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0046087545 | 0.0041752696 | 31.086467 | 0.16799631 |

COMMENTS
With T ref= T measured by the sensor on Cu plate

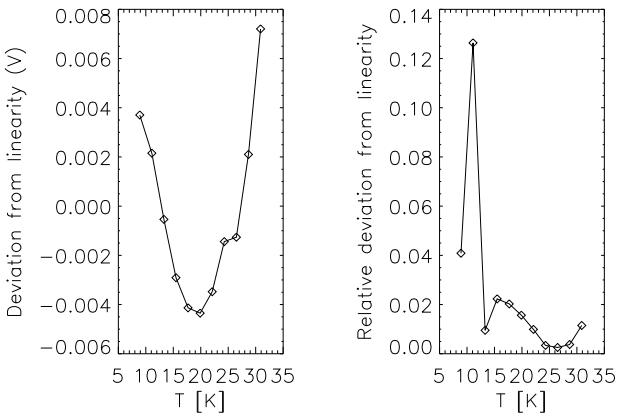



Figure 4.12: Deviation from linearity

## 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

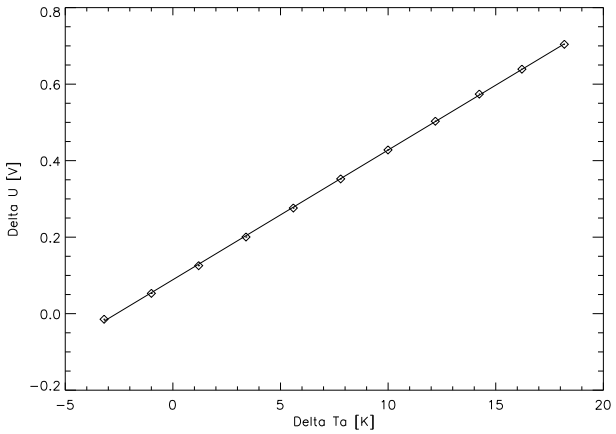



Figure 4.13: Response linearity (differenced values)

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma$V |
| 11.982489 | 0.00069501746 | 12.800001 | 0.0000000 | 1.0556184 | 0.0016758161 | 1.1524026 | 0.00 |
| 13.508871 | 0.0015950449 | 12.800000 | 0.0000000 | 1.1238936 | 0.0017891768 | 1.1543396 | 0.00 |
| 15.185651 | 0.0030551120 | 12.800001 | 0.0000000 | 1.1933862 | 0.0018619660 | 1.1560650 | 0.00 |
| 16.964153 | 0.0026930780 | 12.800000 | 0.0000000 | 1.2628562 | 0.0019547193 | 1.1580978 | 0.00 |
| 18.805647 | 0.0035486810 | 12.800000 | 0.0000000 | 1.3319074 | 0.0020404005 | 1.1606024 | 0.00 |
| 20.703917 | 0.0036034249 | 12.800000 | 0.0000000 | 1.4002482 | 0.0021249699 | 1.1632013 | 0.00 |
| 22.635294 | 0.0039195488 | 12.800000 | 0.0000000 | 1.4678285 | 0.0022030339 | 1.1659717 | 0.00 |
| 24.582518 | 0.0067112655 | 12.800000 | 0.0000000 | 1.5343880 | 0.0022833480 | 1.1686819 | 0.00 |
| 26.550461 | 0.011033615 | 12.955274 | 0.0082292743 | 1.6003763 | 0.0023578529 | 1.1735860 | 0.00 |
| 28.508118 | 0.016046016 | 13.170852 | 0.012670017 | 1.6649586 | 0.0024458486 | 1.1818223 | 0.00 |
| 30.525085 | 0.017809119 | 13.401829 | 0.0075325896 | 1.7283945 | 0.0025137884 | 1.1911342 | 0.00 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -15.471828 | -0.28523369 | 0.035278795 | 0.00014890928 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.011215284 | 0.0037171070 | 18.078506 | 0.12122658 |

COMMENTS
With T ref= T measured by the sensor on Al

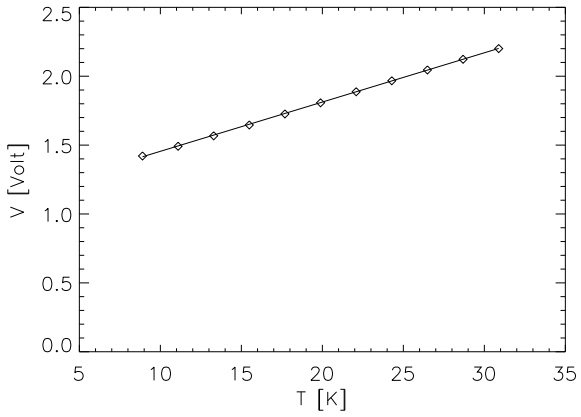



Figure 4.14: Response linearity (changing temperature vs changing voltage

## 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

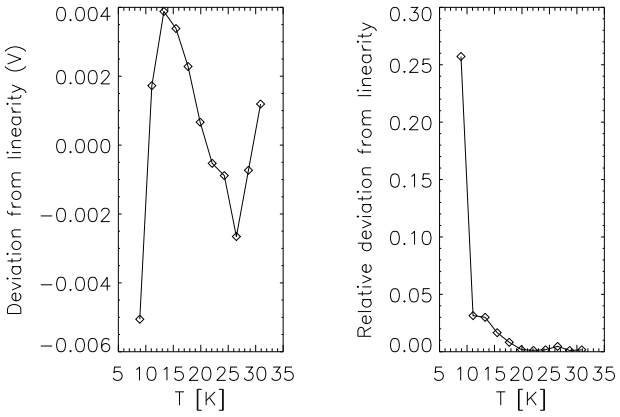



Figure 4.15: Deviation from linearity

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma$ |
| 11.982578 | 0.00061896961 | 12.800000 | 0.0000000 | 1.2733024 | 0.0018396107 | 1.3676787 | 0.00 |
| 13.508640 | 0.0019545848 | 12.800001 | 0.0000000 | 1.3503613 | 0.0019531631 | 1.3695590 | 0.00 |
| 15.185583 | 0.0026743696 | 12.800000 | 0.0000000 | 1.4285348 | 0.0020373039 | 1.3713749 | 0.00 |
| 16.964268 | 0.0027196549 | 12.800000 | 0.0000000 | 1.5068523 | 0.0021226241 | 1.3736436 | 0.00 |
| 18.804974 | 0.0046042581 | 12.800000 | 0.0000000 | 1.5846053 | 0.0021996232 | 1.3764716 | 0.00 |
| 20.700945 | 0.0081301164 | 12.800000 | 0.0000000 | 1.6616298 | 0.0022836945 | 1.3796003 | 0.00 |
| 22.633753 | 0.0050601116 | 12.800000 | 0.0000000 | 1.7376238 | 0.0023601788 | 1.3827165 | 0.00 |
| 24.577927 | 0.011535820 | 12.800001 | 0.0000000 | 1.8124914 | 0.0024462621 | 1.3859043 | 0.00 |
| 26.554150 | 0.0067312964 | 12.957669 | 0.0068794033 | 1.8865089 | 0.0025270247 | 1.3916096 | 0.00 |
| 28.511024 | 0.012391493 | 13.172464 | 0.010841809 | 1.9591526 | 0.0025992831 | 1.4009557 | 0.00 |
| 30.515636 | 0.027864676 | 13.398812 | 0.010492285 | 2.0301294 | 0.0026866043 | 1.4110700 | 0.00 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -15.642376 | -0.29106969 | 0.039756637 | 0.00016856968 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.012961771 | 0.0040619396 | 20.186206 | 0.11781617 |

COMMENTS
With T ref= T measured by the sensor on Al

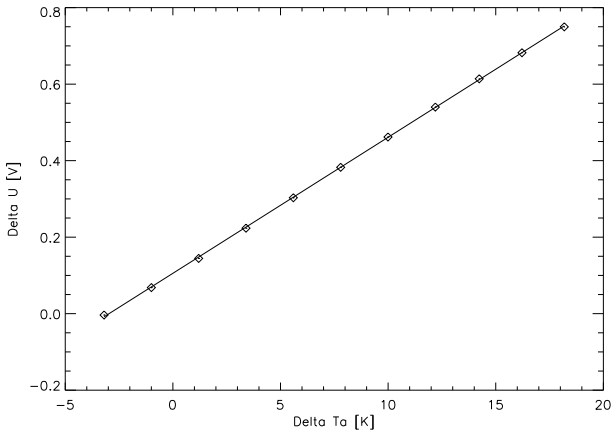



Figure 4.16: Response linearity (differenced values)

## 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 | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\rm change}$ [K] | $\sigma T_{\rm change}$ [K] | $T_{\rm fixed}$ [K] | $\sigma T_{\rm fixed}$ [K] | $V_{\rm change}$ [V] | $\sigma V_{\rm change}$ [V] | $V_{\rm fixed}$ [V] | $\sigma V_{\rm f}$ |
| 12.800000 | 0.0000000 | 11.982988 | 0.00062776817 | 1.4354838 | 0.0022122709 | 1.4208905 | 0.002 |
| 14.200000 | 0.0000000 | 12.079956 | 0.0012695900 | 1.5064351 | 0.0022756470 | 1.4329974 | 0.002 |
| 16.000000 | 0.0000000 | 12.373691 | 0.00046188568 | 1.5918171 | 0.0024025824 | 1.4519743 | 0.002 |
| 19.200001 | 0.0000000 | 12.987848 | 0.00087153388 | 1.7334707 | 0.0025775087 | 1.4868075 | 0.002 |
| 22.471905 | 0.46666265 | 13.693658 | 0.011330133 | 1.8694320 | 0.0027319676 | 1.5244722 | 0.002 |
| 25.600000 | 0.0000000 | 14.426159 | 0.00092313456 | 2.0014689 | 0.0029487814 | 1.5647184 | 0.002 |
| 28.799999 | 0.0000000 | 15.171201 | 0.00087432045 | 2.1309974 | 0.0030896549 | 1.6061119 | 0.002 |

RESULTS

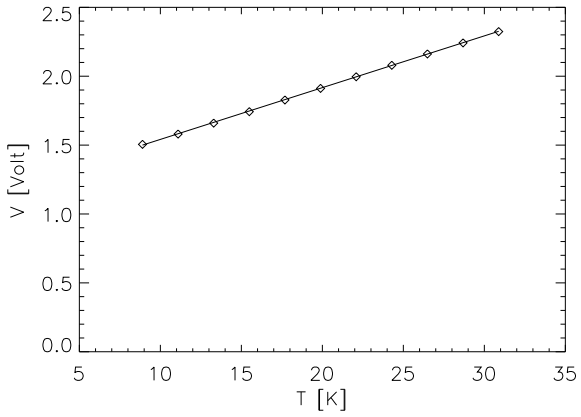



Figure 4.17: Response linearity (changing temperature vs changing voltage

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -10.775525 | -0.034261107 | 0.039901425 | 0.00031058169 |

| $L$ | $\sigma L$ | $T_{\rm noise}$ [K] | $\sigma T_{\rm noise}$ [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

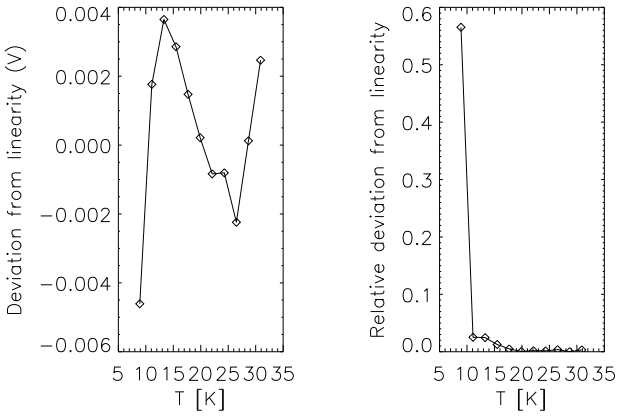



Figure 4.18: Deviation from linearity

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{f}}$ |
| 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] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -10.756635 | -0.034274439 | 0.041829548 | 0.00030441953 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0091501555 | 0.0056219511 | 21.403087 | 0.18853232 |

COMMENTS

## 4.11 rana_ling_mini_report_011

### RANA_LING 011

Linearity, Isolation and Gain

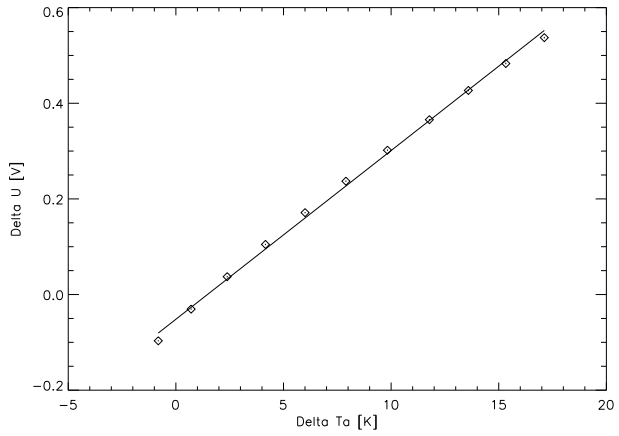



Figure 4.19: Response linearity (differenced values)

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 | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{f}}$ |
| 12.800000 | 0.0000000 | 9.5999002 | 7.0969960e-05 | 1.1524172 | 0.0018314532 | 1.0556397 | 0.001 |
| 14.200000 | 0.0000000 | 9.6933165 | 0.0015294501 | 1.2091003 | 0.0019130971 | 1.0648627 | 0.001 |
| 16.000000 | 0.0000000 | 10.091539 | 0.0010111423 | 1.2779468 | 0.0019893987 | 1.0829606 | 0.001 |
| 19.200001 | 0.0000000 | 10.882026 | 0.0010566262 | 1.3928412 | 0.0021243977 | 1.1162315 | 0.001 |
| 22.400000 | 0.0000000 | 11.738089 | 0.0010492806 | 1.5035797 | 0.0022344986 | 1.1510148 | 0.001 |
| 25.600000 | 0.0000000 | 12.619502 | 0.00078373024 | 1.6117942 | 0.0023836430 | 1.1873016 | 0.001 |
| 28.799999 | 0.0000000 | 13.497513 | 0.00095324096 | 1.7178234 | 0.0025082267 | 1.2237981 | 0.001 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -11.284475 | -0.041505530 | 0.032990718 | 0.00025066328 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0061149982 | 0.0041899044 | 20.648450 | 0.16988533 |

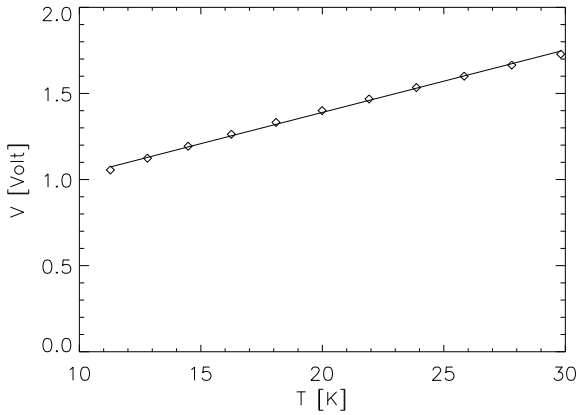



Figure 4.20: Response linearity (changing temperature vs changing voltage

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

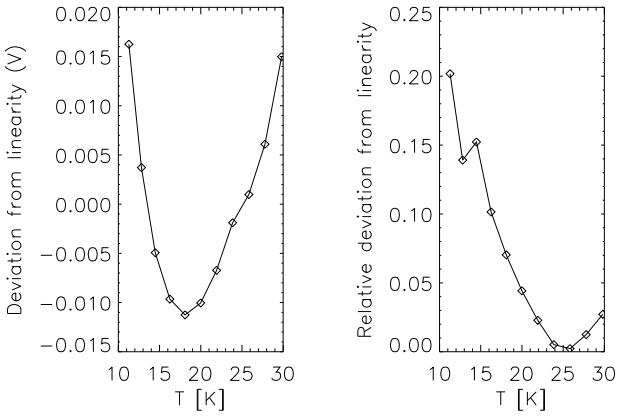



Figure 4.21: Deviation from linearity

| 30.0 GHz radiometer | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_{\text{change}}$ [K] | $\sigma T_{\text{change}}$ [K] | $T_{\text{fixed}}$ [K] | $\sigma T_{\text{fixed}}$ [K] | $V_{\text{change}}$ [V] | $\sigma V_{\text{change}}$ [V] | $V_{\text{fixed}}$ [V] | $\sigma V_{\text{f}}$ |
| 12.800001 | 0.0000000 | 9.5999031 | 6.5880464e-05 | 1.3676630 | 0.0019903738 | 1.2732850 | 0.001 |
| 14.200000 | 0.0000000 | 9.6929407 | 0.0012788934 | 1.4326905 | 0.0020663458 | 1.2841624 | 0.001 |
| 16.000000 | 0.0000000 | 10.091534 | 0.0010268246 | 1.5115485 | 0.0021501880 | 1.3050227 | 0.001 |
| 19.200001 | 0.0000000 | 10.882008 | 0.0010476039 | 1.6429720 | 0.0022897912 | 1.3431714 | 0.001 |
| 22.400000 | 0.0000000 | 11.738315 | 0.0010730720 | 1.7693073 | 0.0024342936 | 1.3828550 | 0.001 |
| 25.600000 | 0.0000000 | 12.620363 | 0.0015990345 | 1.8922046 | 0.0025979493 | 1.4242862 | 0.002 |
| 28.800001 | 0.0000000 | 13.497933 | 0.0012280812 | 2.0132178 | 0.0026997870 | 1.4662501 | 0.002 |
| 33.790051 | 0.058180261 | 14.843652 | 0.00067262113 | 2.1913474 | 0.0022590579 | 1.5302533 | 0.002 |

RESULTS

| $I$ [dB] | $\sigma I$ [dB] | $G$ [V/K] | $\sigma G$ [V/K] |
|---|---|---|---|
| -10.975075 | -0.027857450 | 0.036507115 | 0.00022693261 |

| $L$ | $\sigma L$ | $T_{\text{noise}}$ [K] | $\sigma T_{\text{noise}}$ [K] |
|---|---|---|---|
| 0.0098067546 | 0.0048686898 | 22.638951 | 0.17112143 |

COMMENTS

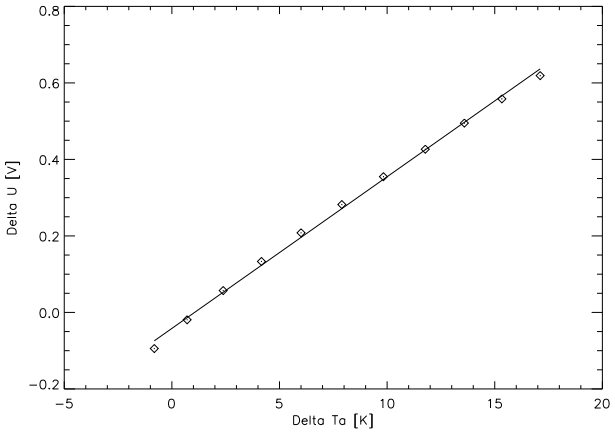



Figure 4.22: Response linearity (differenced values)

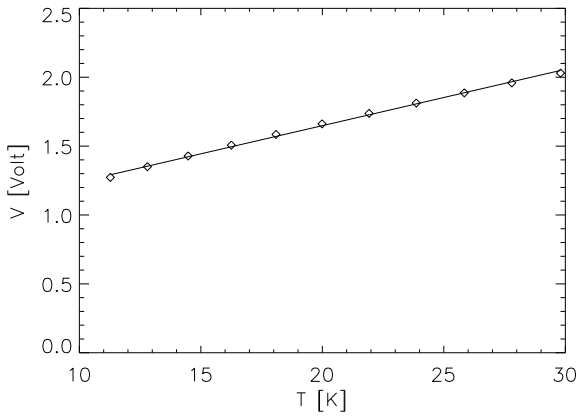



Figure 4.23: Response linearity (changing temperature vs changing voltage

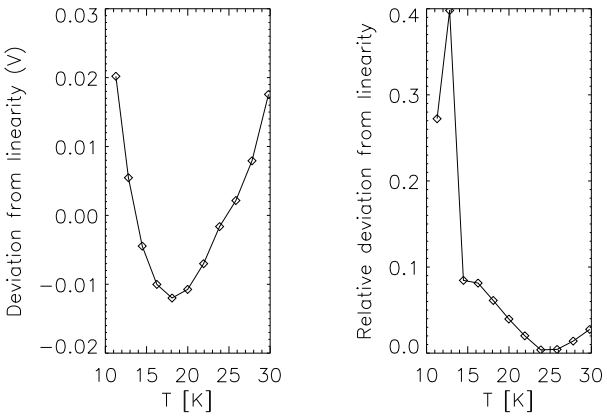



Figure 4.24: Deviation from linearity

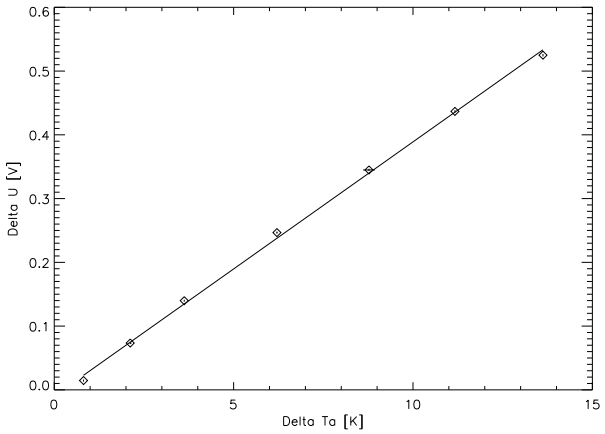



Figure 4.25: Response linearity (differenced values)

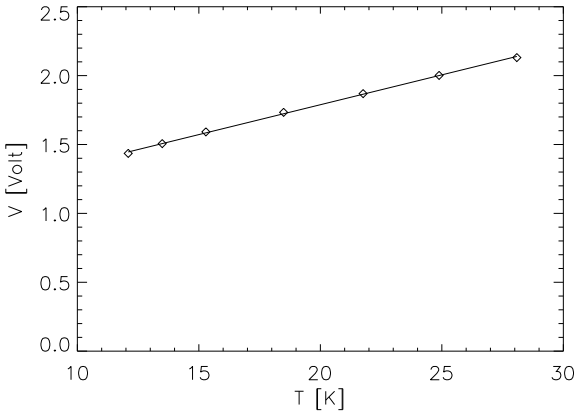



Figure 4.26: Response linearity (changing temperature vs changing voltage

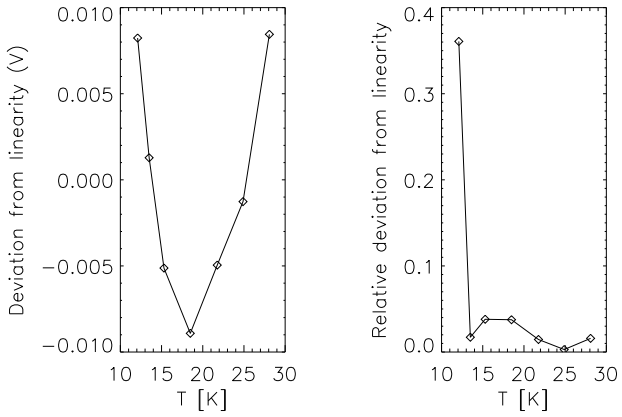



Figure 4.27: Deviation from linearity

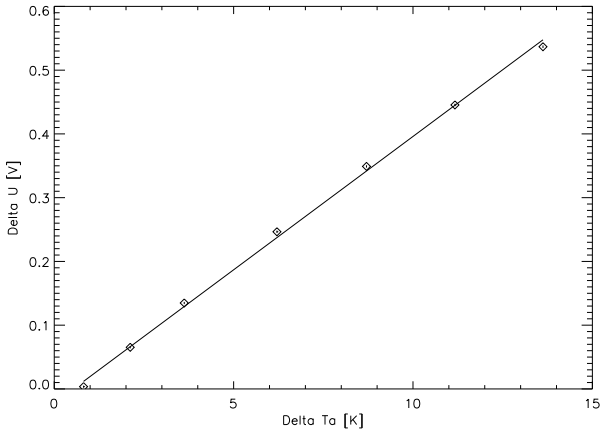



Figure 4.28: Response linearity (differenced values)

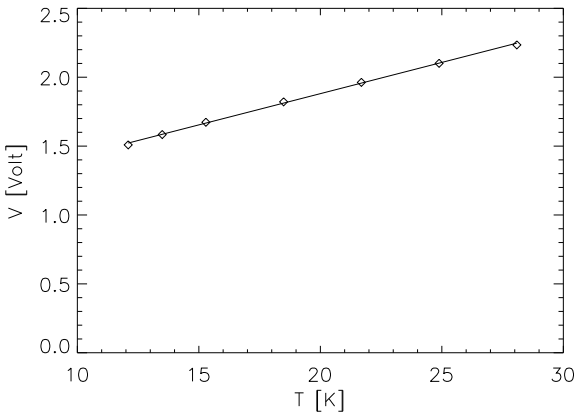



Figure 4.29: Response linearity (changing temperature vs changing voltage

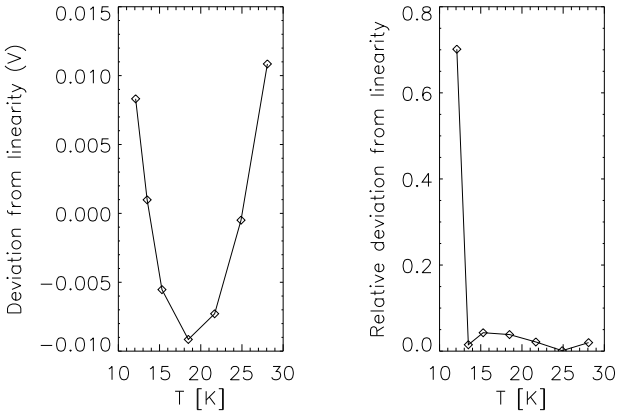



Figure 4.30: Deviation from linearity

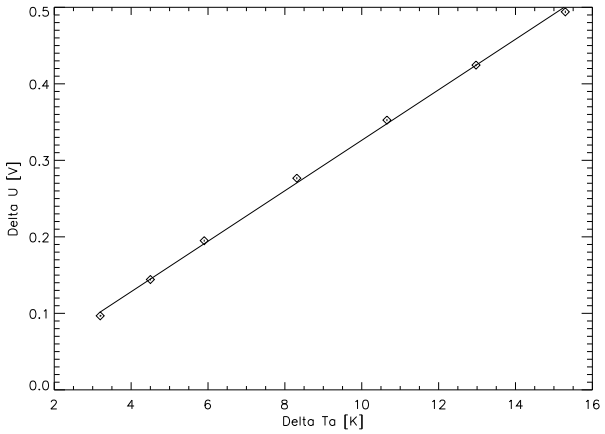



Figure 4.31: Response linearity (differenced values)

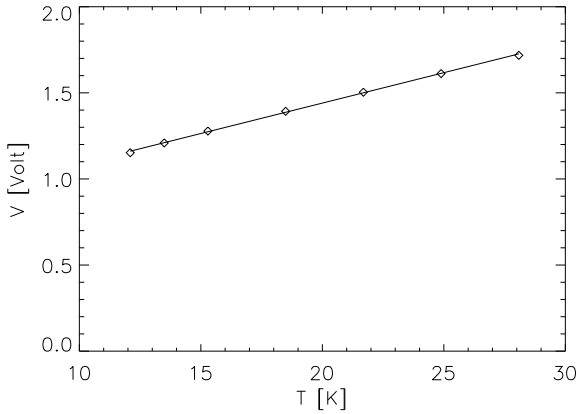



Figure 4.32: Response linearity (changing temperature vs changing voltage

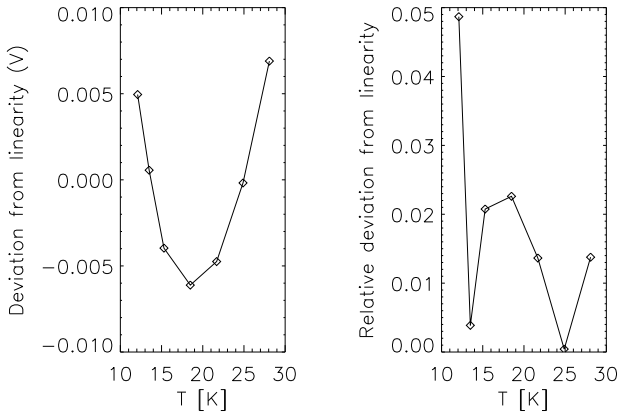



Figure 4.33: Deviation from linearity

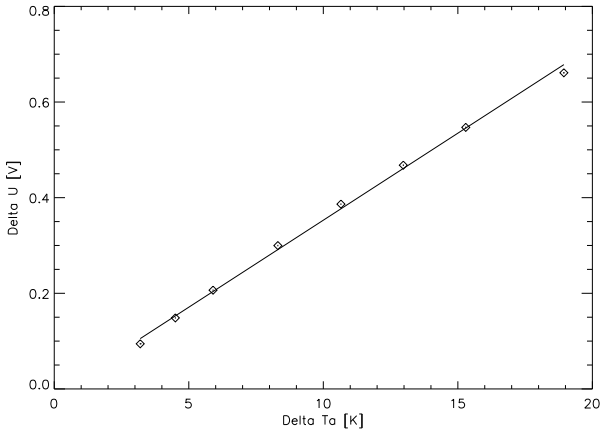



Figure 4.34: Response linearity (differenced values)

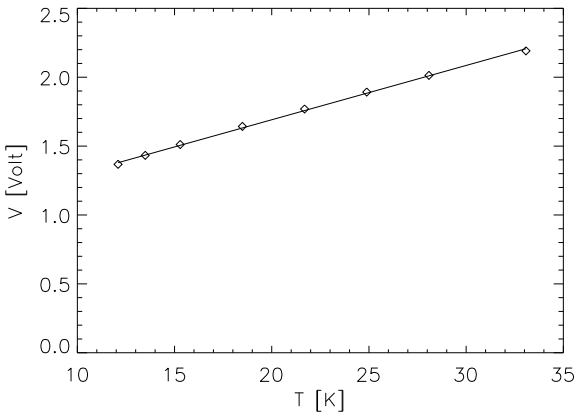



Figure 4.35: Response linearity (changing temperature vs changing voltage

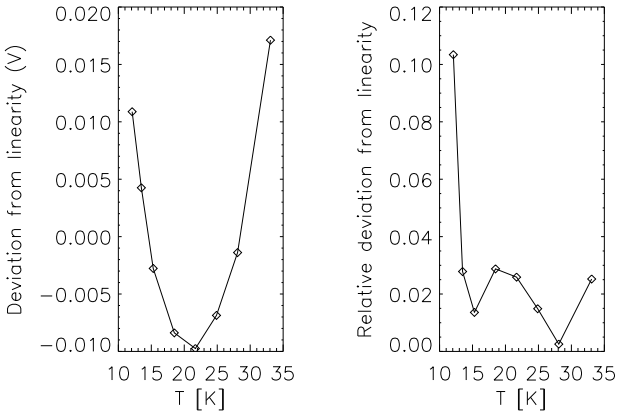



Figure 4.36: Deviation from linearity

# 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

L. Terenzi - 8 May 2006

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

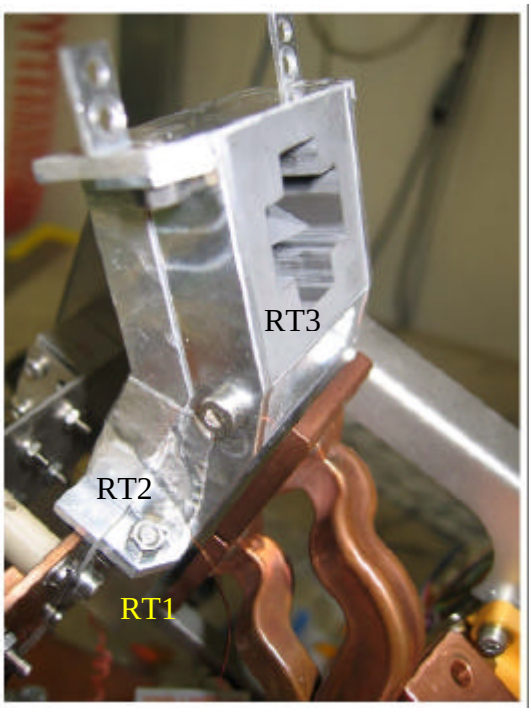



Fig. 1 4K RL mounted on the RCA chamber during RCA27 calibration run.

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

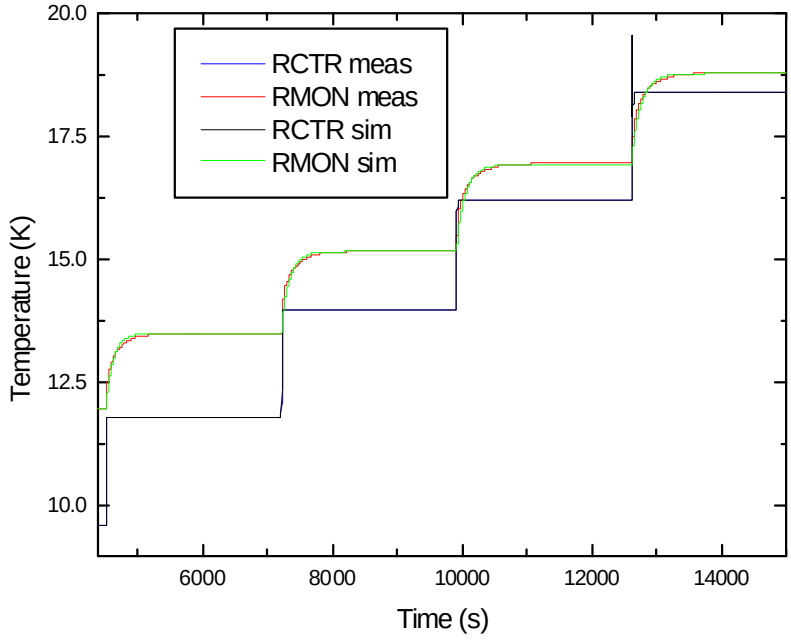



Fig. 2 Comparison between simulated and measured temperatures. RCTR is the input to the simulation so that the simulated and measured curves are not distinguishable

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

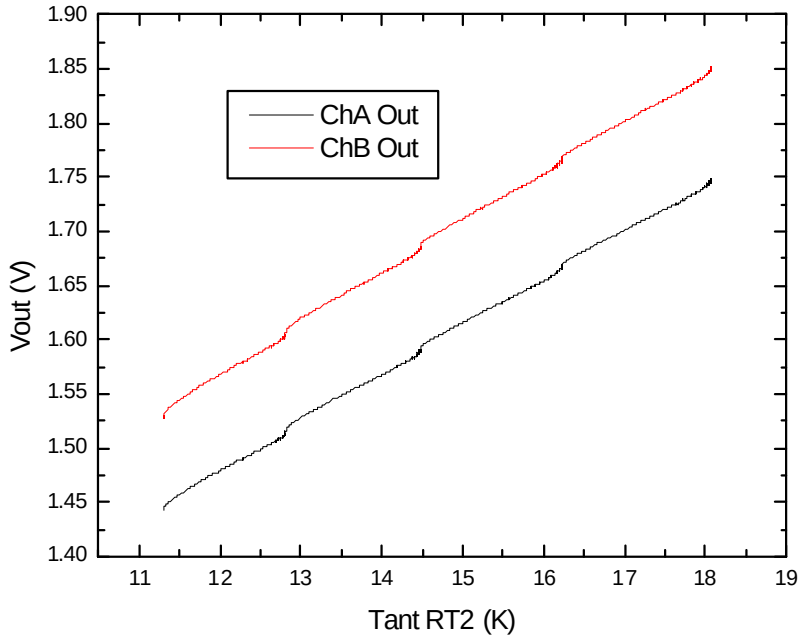



Fig. 3 The V vs T curves whose linear fit is used to estimate the noise temperatures for channels A and B

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

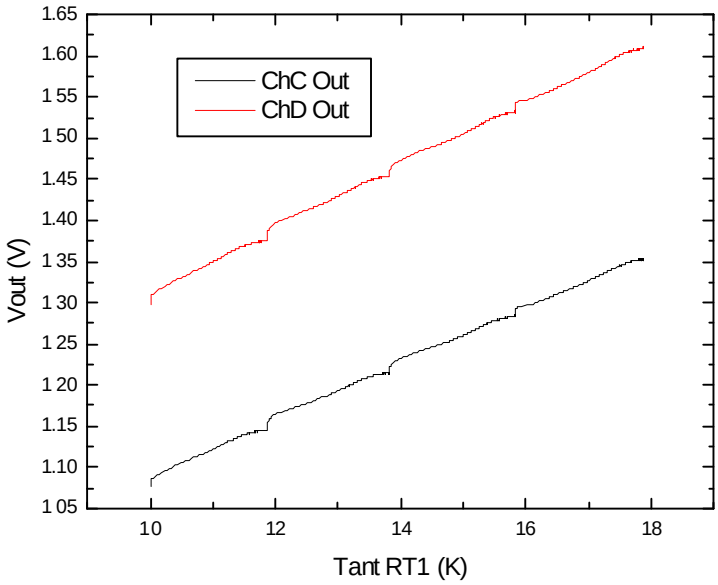



Fig. 4 The V vs T curves whose linear fit is used to estimate the noise temperatures for channels C and D

## 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**

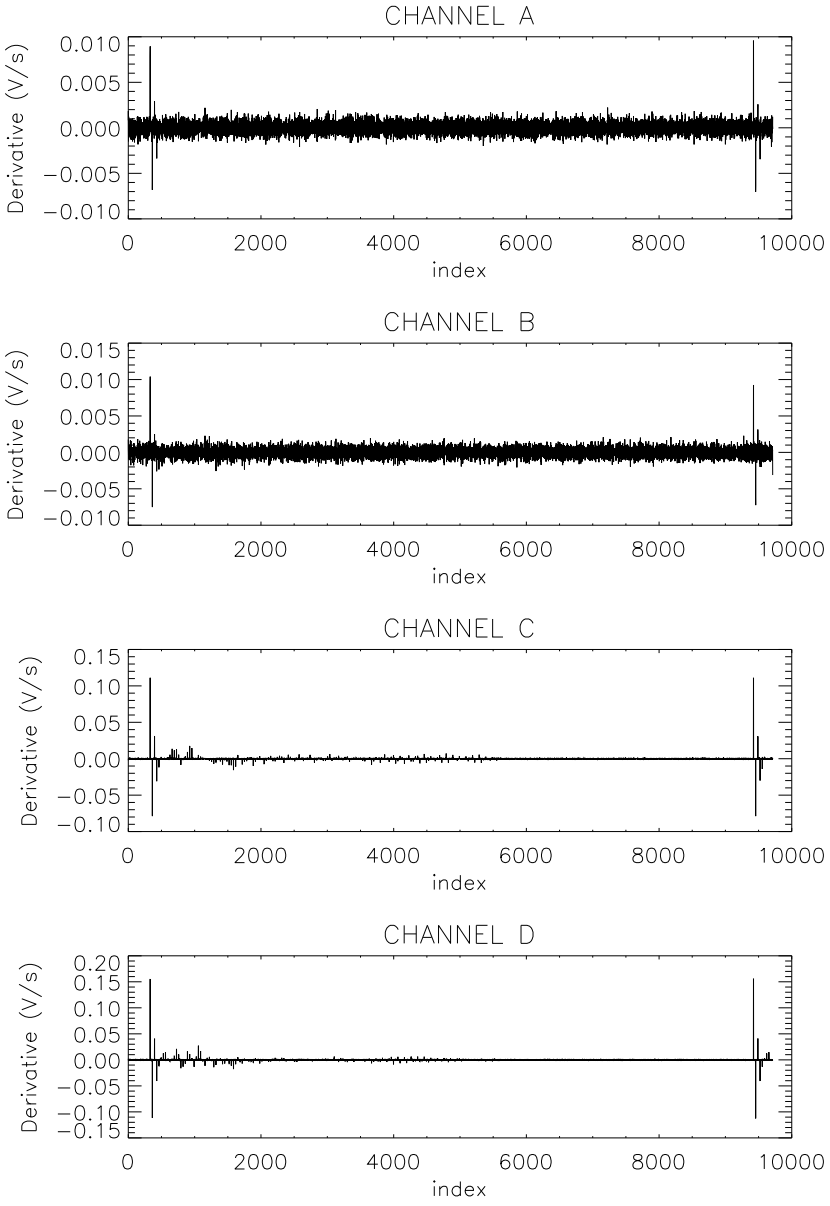



Figure 1: Data binned with a bin equal to 0.

**Selected Plots**

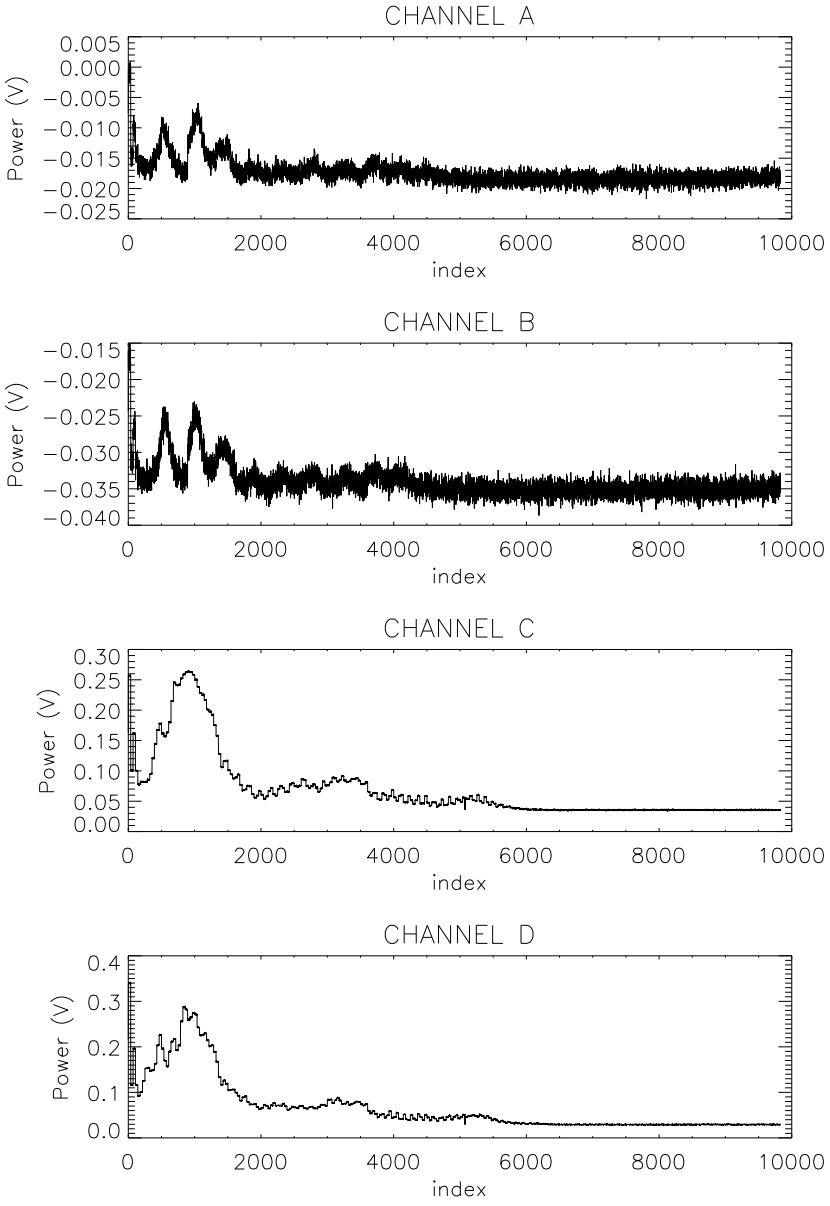



Figure 2: Data binned with a bin equal to 0.

**Radiometer Spectral Response**

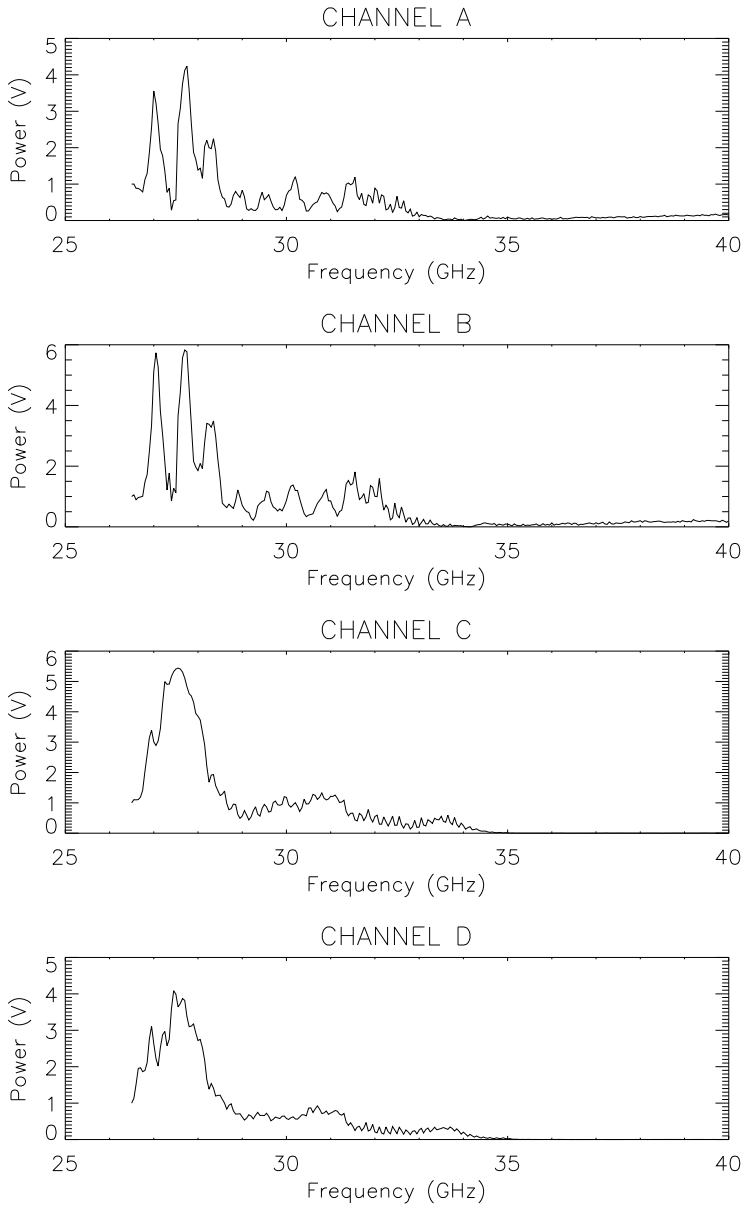



Figure 3: Calibrated data.

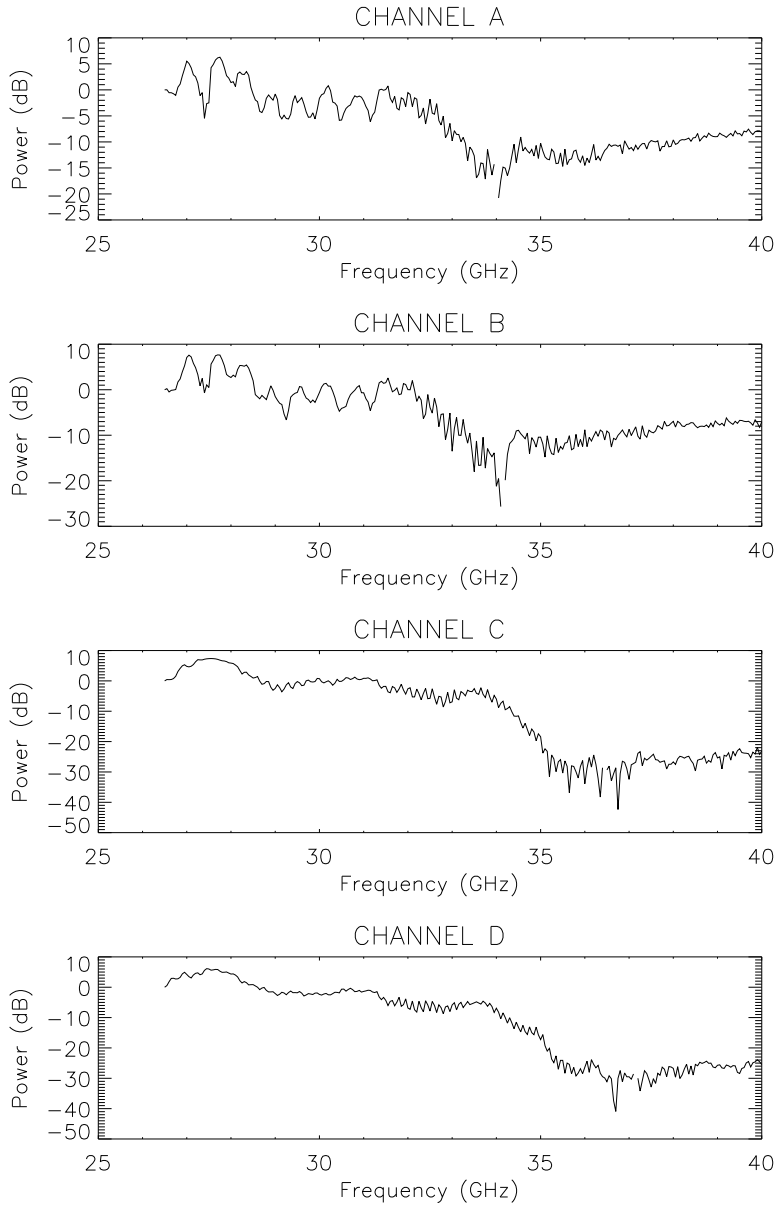



Figure 4: Calibrated data in dB.

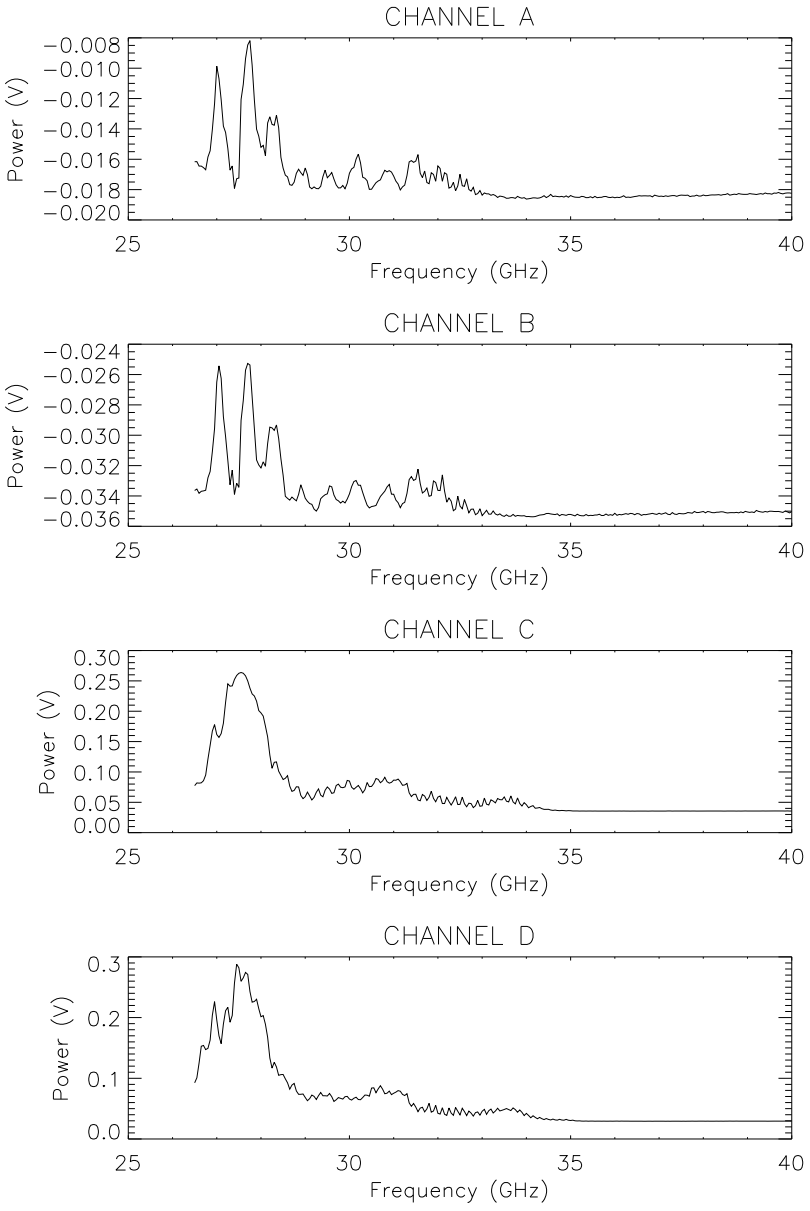



Figure 5: Uncalibrated data.

## 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**

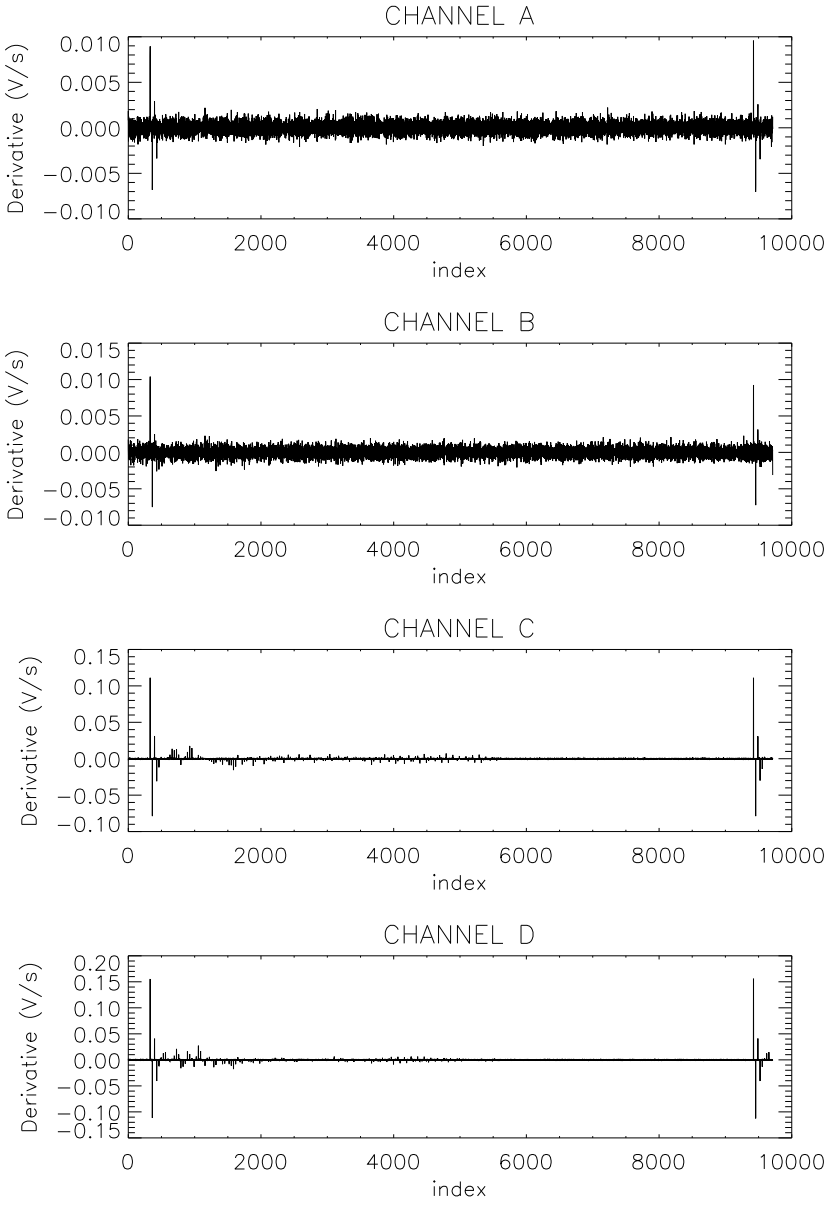



Figure 6: Data binned with a bin equal to 0.

**Selected Plots**

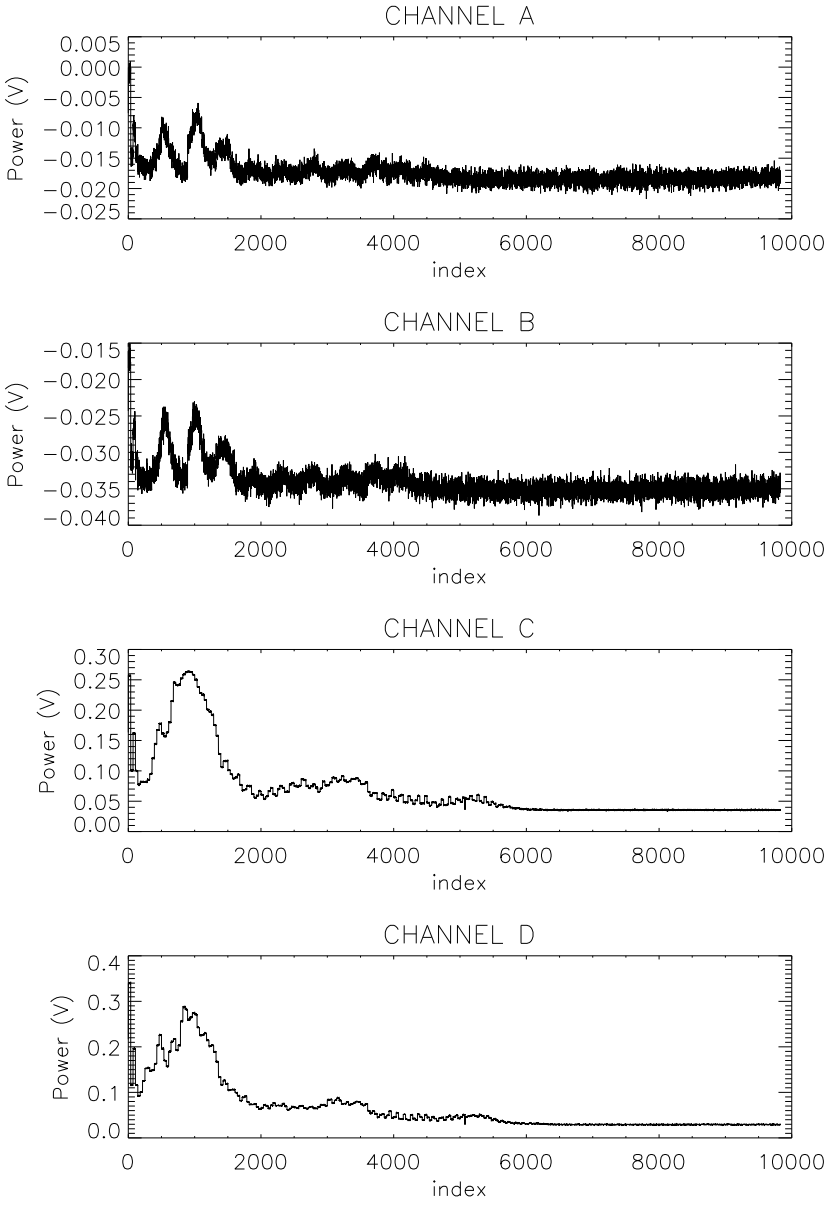



Figure 7: Data binned with a bin equal to 0.

**Radiometer Spectral Response**

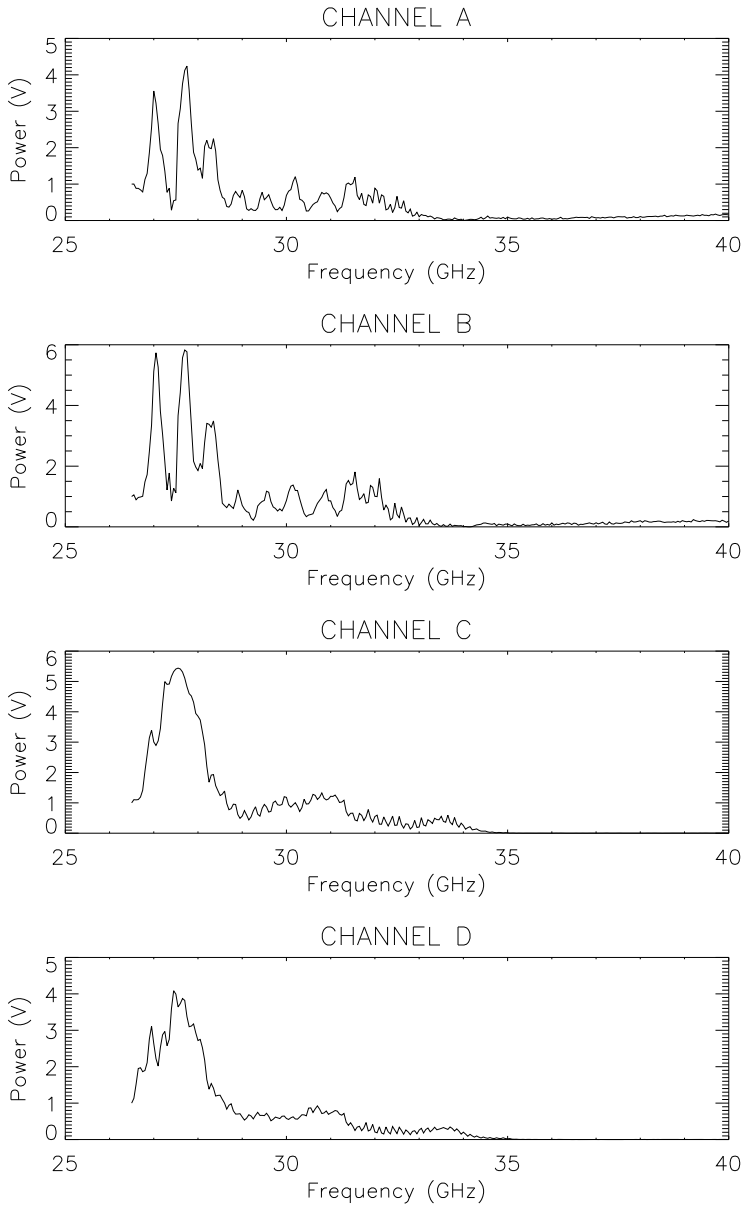



Figure 8: Calibrated data.

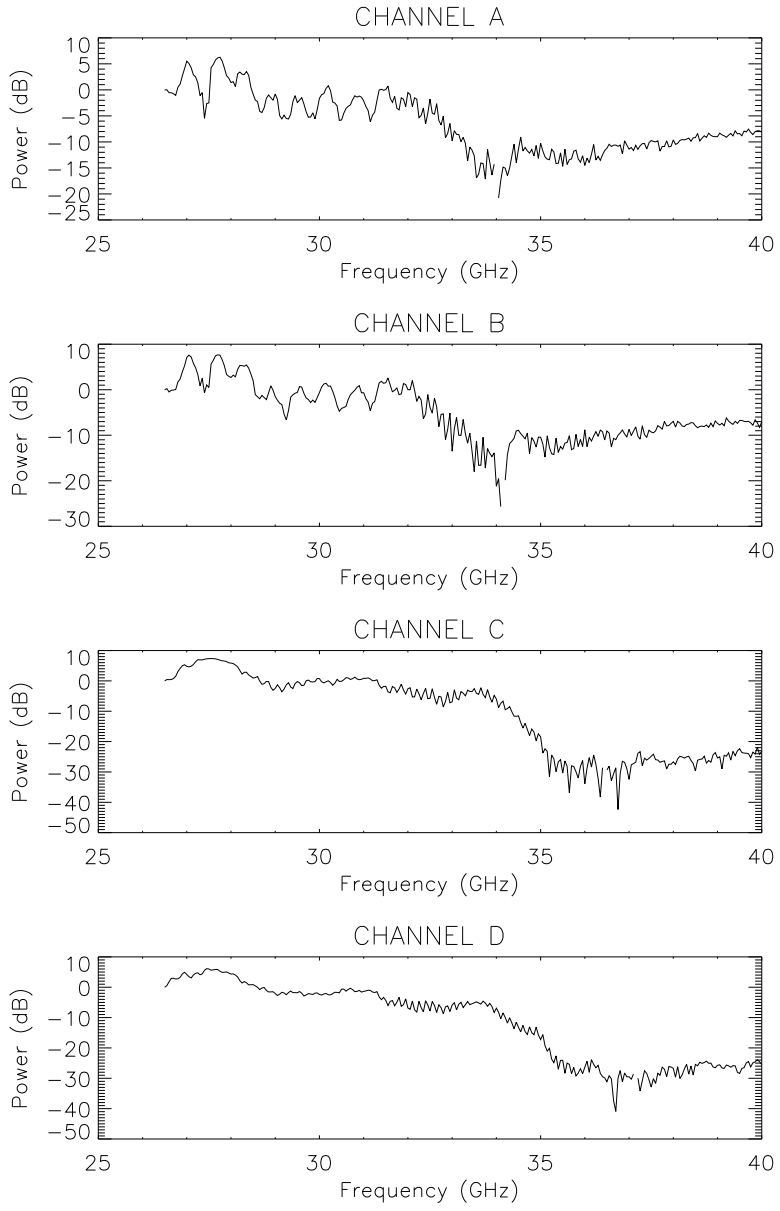



Figure 9: Calibrated data in dB.

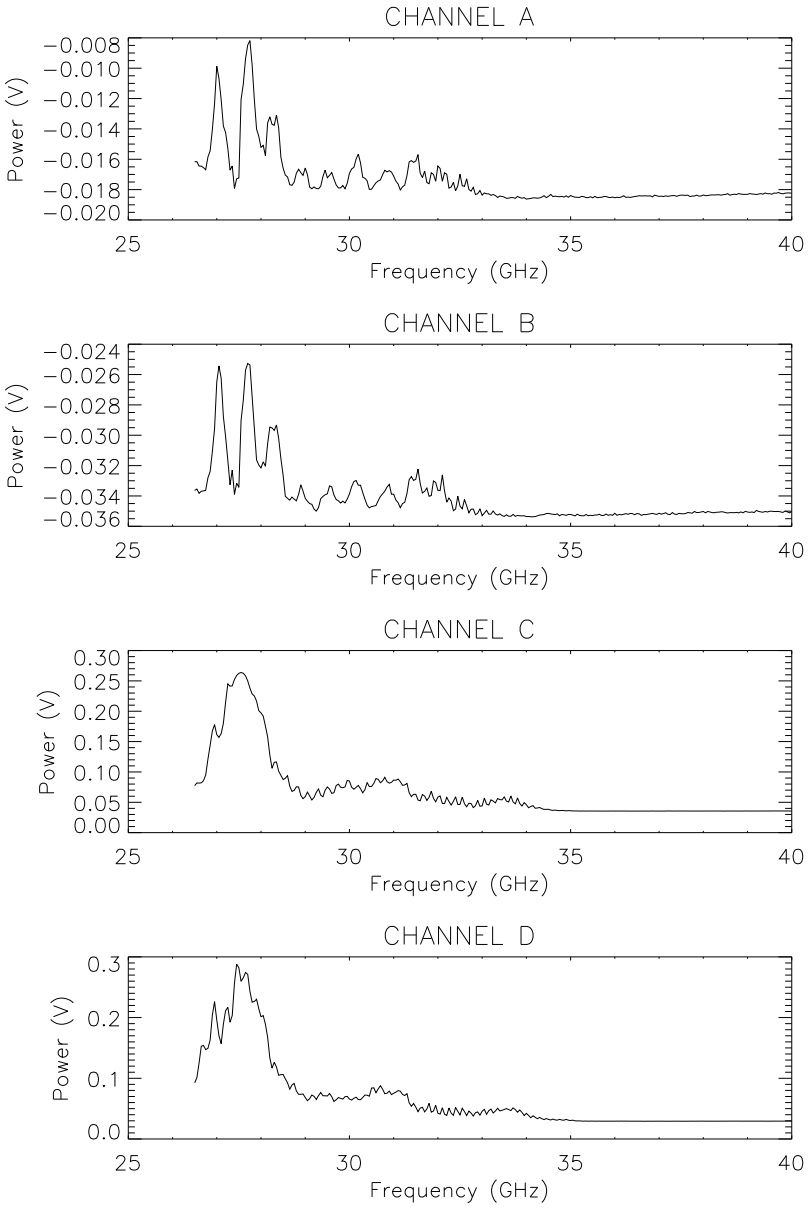



Figure 10: Uncalibrated data.