Bolometer characteristics

CRTBT_Grenoble
test 23rd of April 1999
Archeops cryostat
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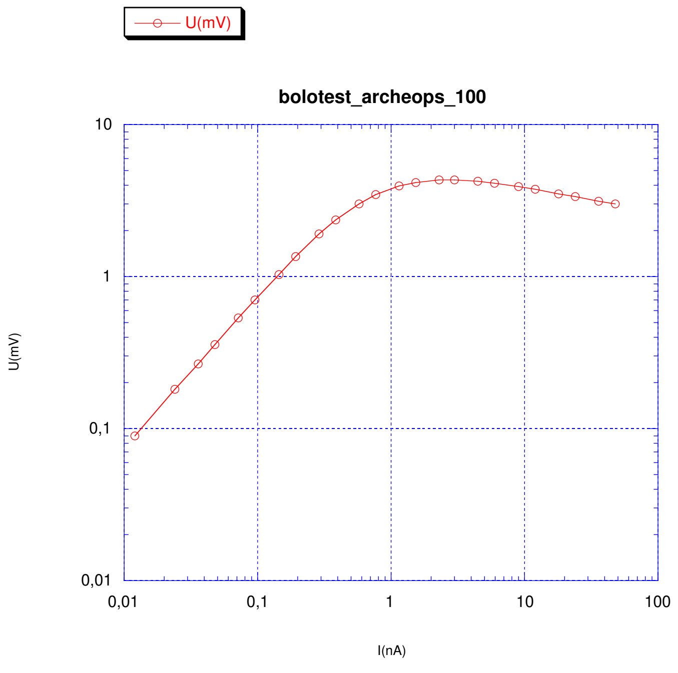
The test bolometer delivered by Ravinder Bhatia is blinded by an aluminum tape during the tests. It is situated on the bolometer platform of the cryostat.This platform is weakly thermalised to a mid platform where the thermal regulation fixed (made with a high precision Dumoulin thermometer and a heating 11kΩ resistance).The time constant of the thermal link is about 20s.

The mid platform is weakly thermalised to the 100mK platform containing the dilution box. It is on the dilution box that we measure the absolute temperature given by a Germanium thermometer.

U=f(I) curve

This curve is obtained at 100mK



With this curve we detrermined the optimal running conditions; which seem to be:

slope at the origin : 7.5MΩ
=> optimal running conditions: 3.75 mV/nA
Z=dU/dI

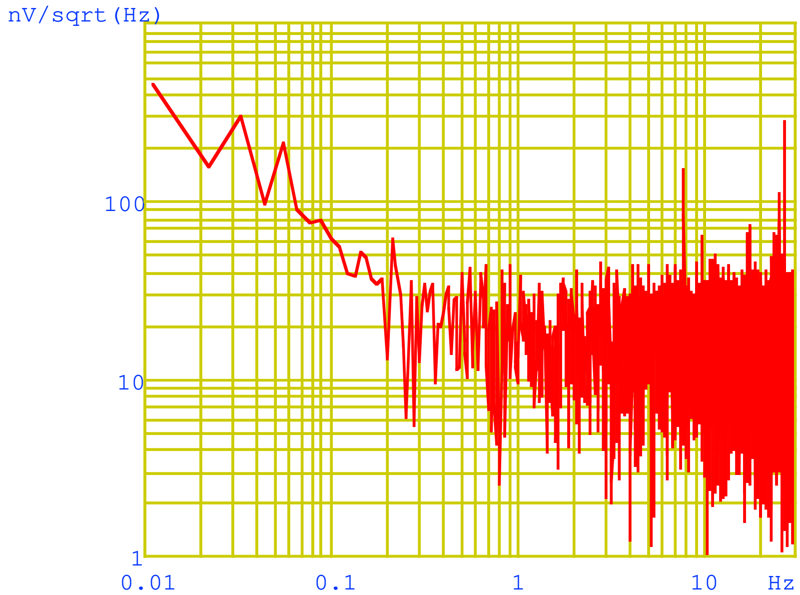
which corresponds to Rbolo=5.251 MΩ
I= 0.575nA

responsivity: $S = \frac{|Z - R|}{2RI}$=2.95 10^8 V/W

$$NEP_{el} = \frac{noise}{S}$$

The noise curve is optained by a Fourier Transform after deglitching with 17000 data points acquired at the sampling frequency of 160 Hz . We used the noise value averaged around 1Hz to calculate the NEP

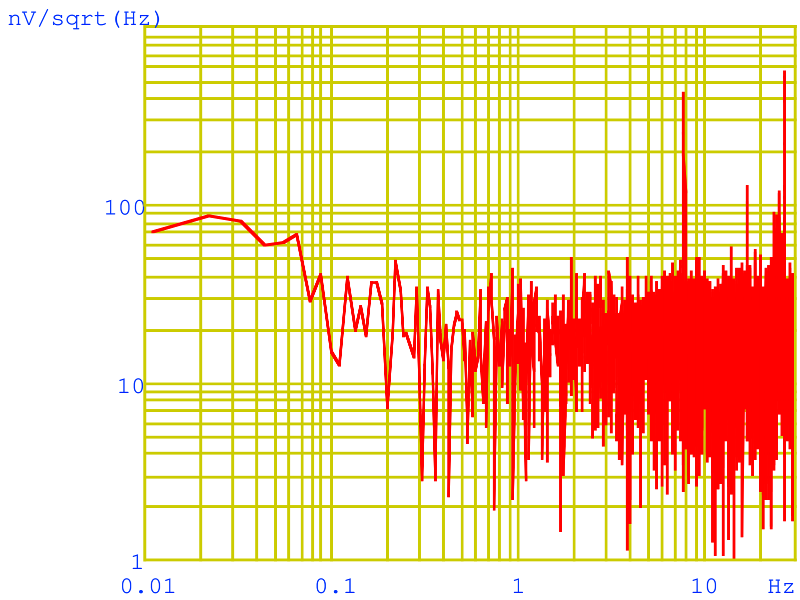
Noise of the blind bolometer for I=0.767 nA U=3.457 mV at 100 mK



average noise 18 nV/ sqrt(Hz)

NEP_el= 6.1 10^{-17} W/sqrt(Hz)

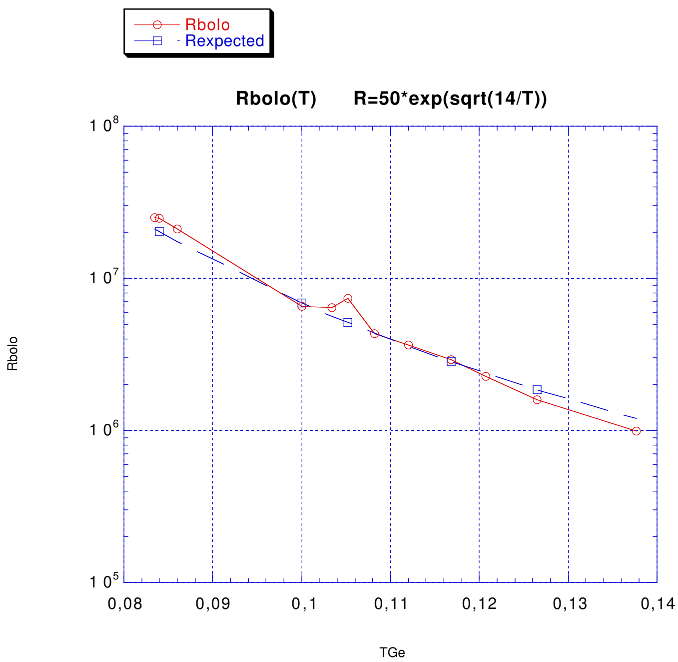
At low frequecy the noise is dominated by temperature fluctuations (as one can see in the next plot obtained with a weak current of 0.012 nA), the white noise at high frequency may be too high by a factor 2 because of unoptimised FET noise.



R=f(T) curve

This curve is obtained by measuring the bolometer's impedance at different temperatures, using a very weak current (0.1 nA).

The temperature is measured by a Germanium thermometre



R in Ohm on the y-axis

We fitted the R_∞ parametre in the following equation :

$$R = R_\infty \exp\left(\left(\frac{T_r}{T_1}\right)^\beta\right)$$

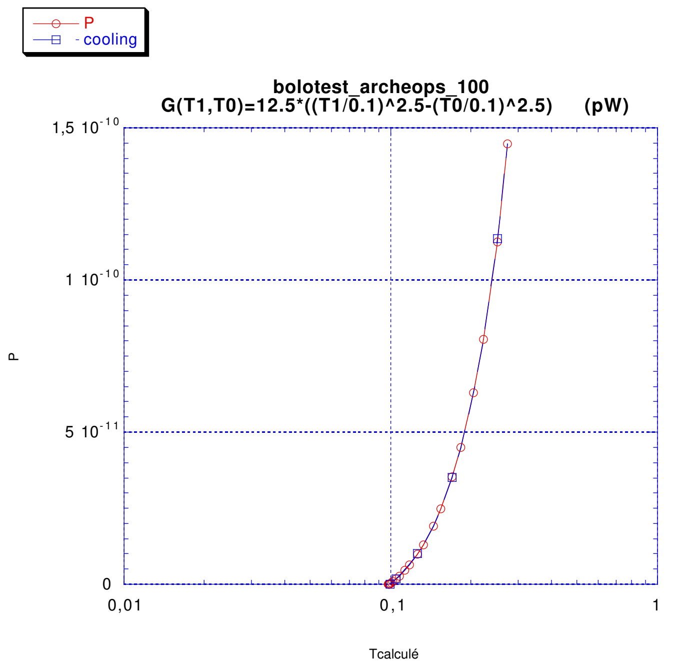
the best value is R_∞ =50Ω (dashed blue curve)

fixing beta= 0.5
Tr= 14K

We can notice a difference with the value R_∞ given to us by Ravinder Bhatia. We found 50Ω instead of 132Ω for R_∞. This may be due to a slight error in temperature measurement. 10 mK is needed to bring the values in agreement wich cannot be accounted for by the thermal links between the bolometre platform and the 100 mK platform.

Cooling function

This curve is obtained with the previous IV curve and by calculating the temperature with the formula above.
The power on the y-axis is th Joule electrical dissipation in Watt.
The temperature at the dilution box was 100 mK



The bolometer equation is UI+Pr= G(T1,T0) wich represents the total power received by the bolometre.

During the tests the bolometre is blinded so radiative power: Pr=0. Therefore we can determine the coefficients of the cooling function of the bolometer :

$$G(T_0,T_1) = g\left(\left(\frac{T_1}{T_g}\right)^{\alpha} - \left(\frac{T_0}{T_g}\right)^{\alpha}\right)$$

We tried to find the best g and alpha to fit the experimental curve (dashed blue curve):

$g = 12.5pW$

$T_g = 0.1K$

$T_0 = 0.098K$

$\alpha = 2.5$

The sensitivity to the bolometer platform temperature is S*dG/dT = 0.094 µV/µK.

The bolometer platform temperature noise can thus be characterised by

$$106nKHz^{-\frac{1}{2}}\left(\frac{f}{1Hz}\right)^{-1}$$

These are preliminary encouraging results, several improvements are planned in the near future.