Characterization and modelling of high impedance connecting links below 1 Hz

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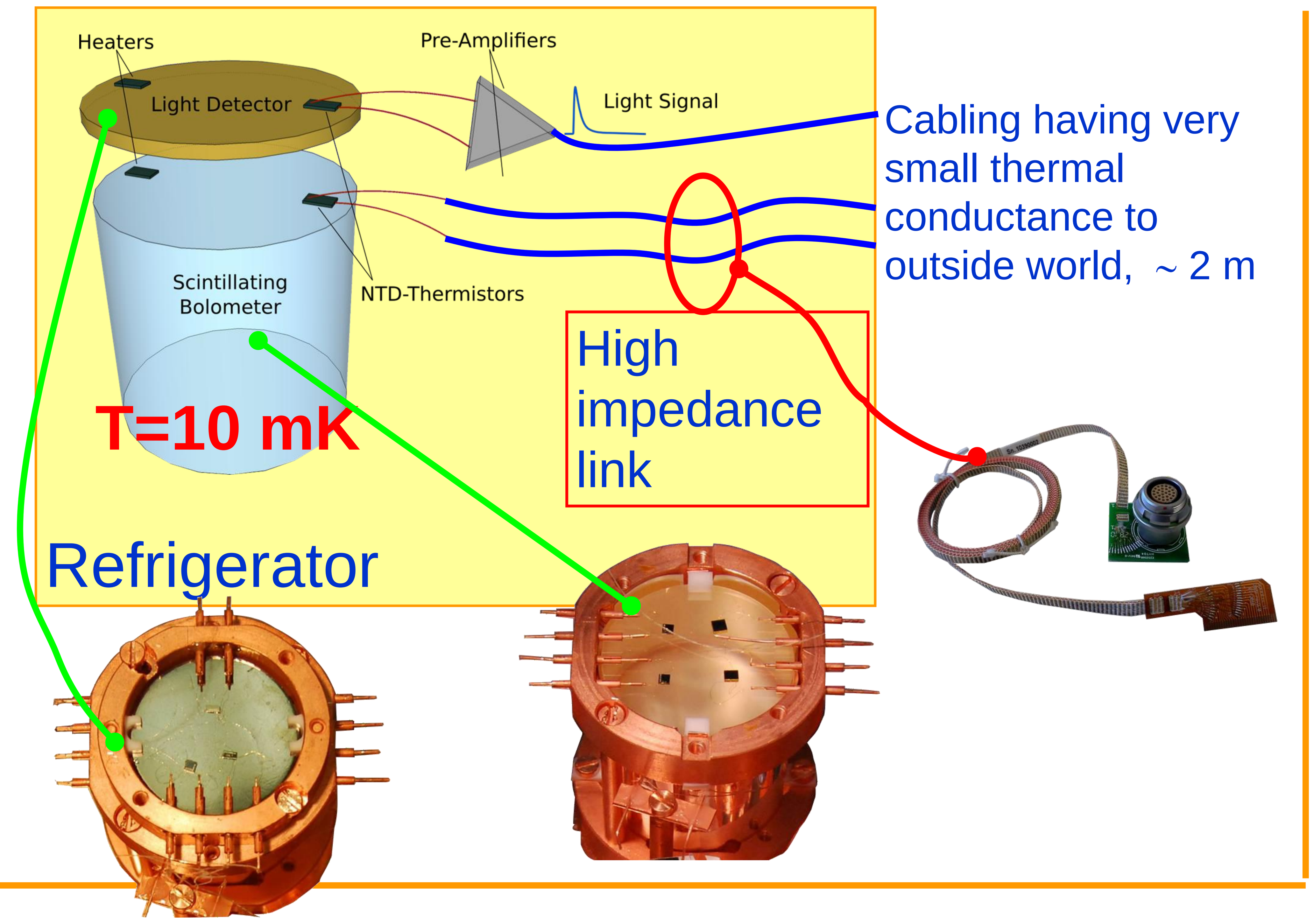
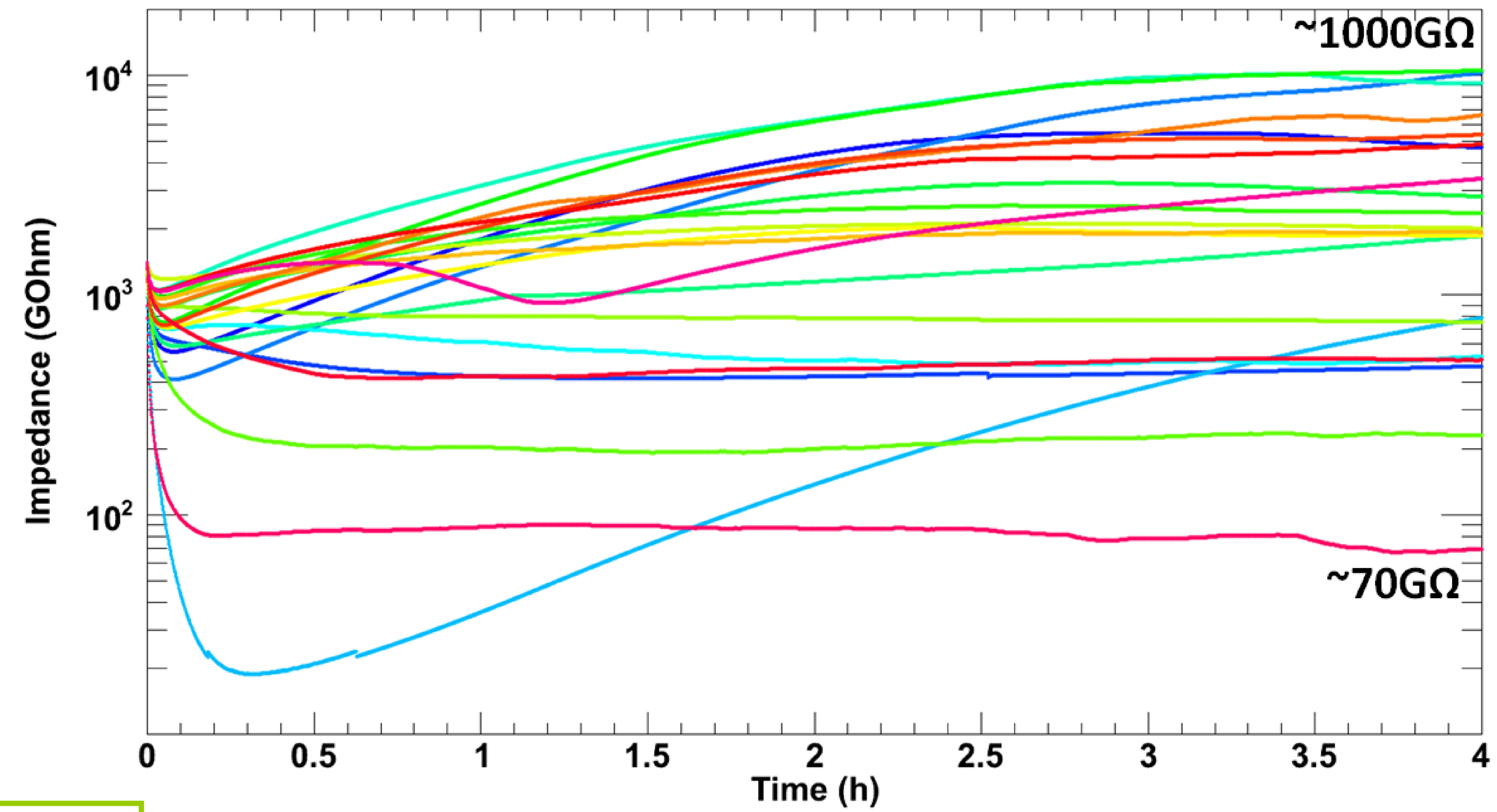
LUCIFER will study the neutrinoless $\beta\beta$ decay in an array of crystals held at very low temperatures. Particles interacting with a crystal increase its temperature measured by a thermistor. The rejection of signals coming from α-particles contamination from the surrounding materials is done exploiting the difference in crystal's light yield, readout with a second detecting device.

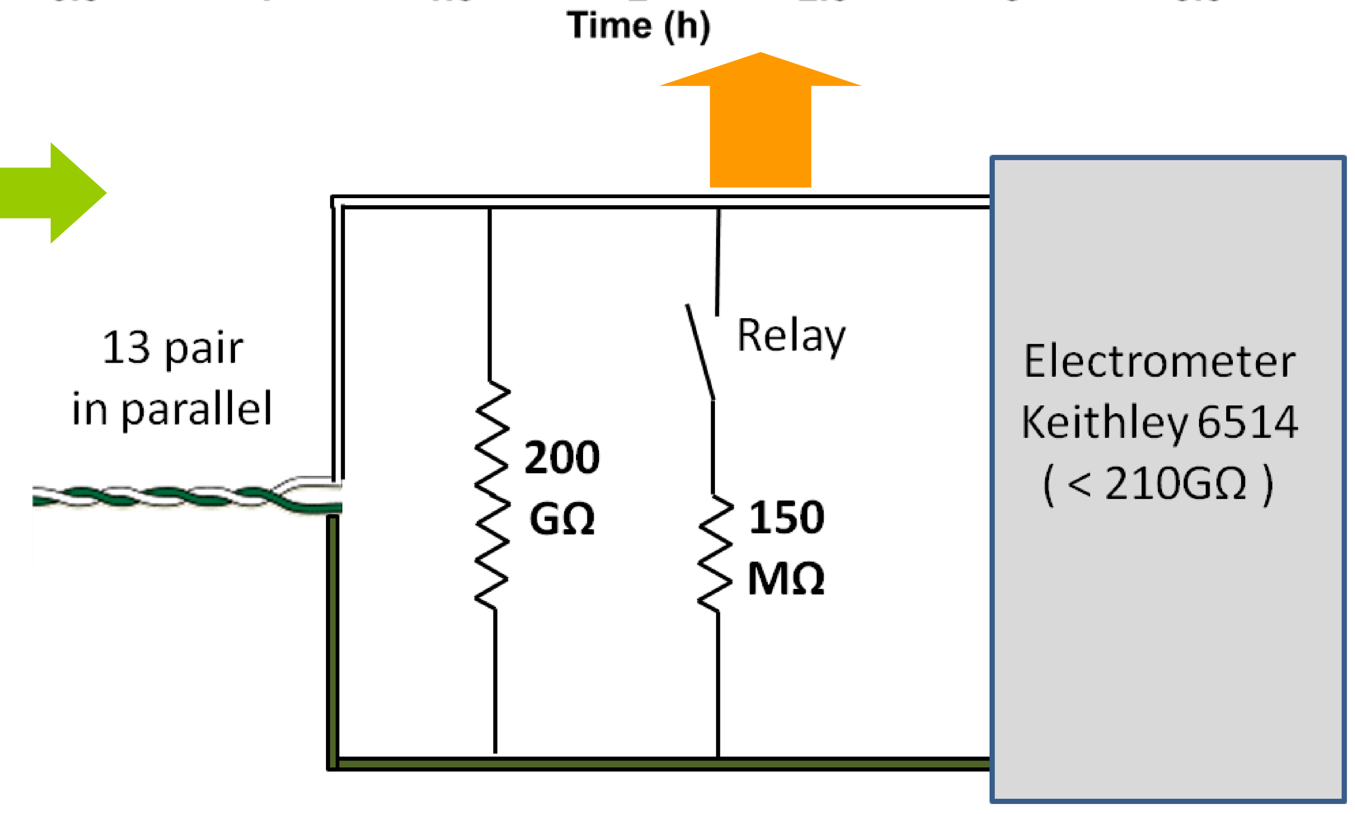
Here we focus on the characterization and modelling of the high impedance connecting link to the thermal sensor that, being very slow (tens of Hz bandwidth), can be readout simply with a room temperature stage.



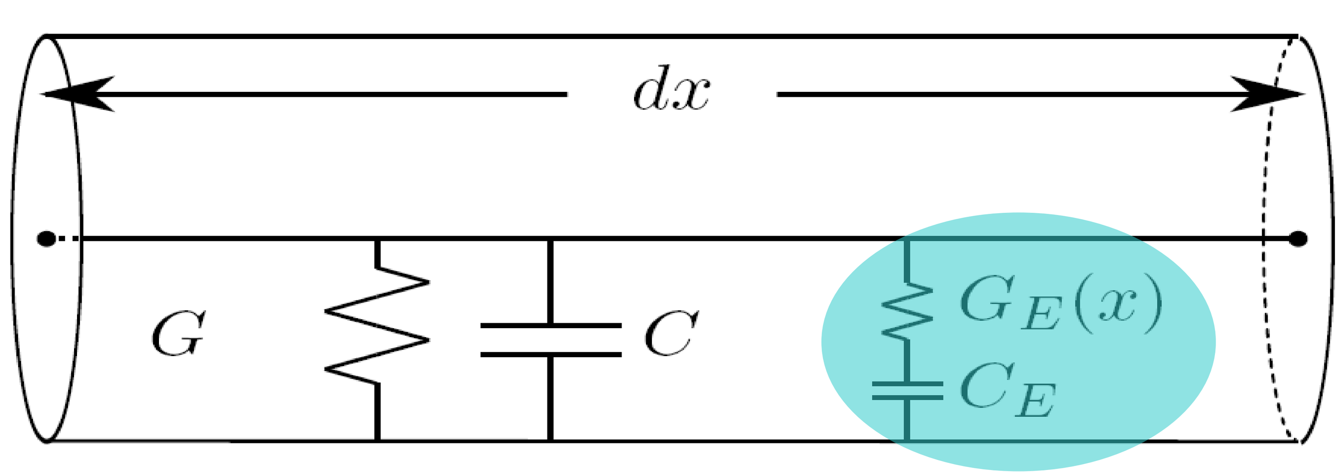
The cables in question are tissue twisted pairs. Each wire is Nb-Ti Nomex, 100 μm diameter. In the present solution each cable is composed by 13 pairs. To measure the isolation we connect the 13 pairs in parallel and measure their DC impedance with an electrometer. Here some results:



To speed up, we first connect in || to the cable 150 MΩ that the electrometer charges with 1 μA, then we open the relay and let 200 GΩ, driven now with 1 nA. From the final value we extrapolate the impedance.



The full scale of the electrometer is 200 V and the measuring current 1 nA. We measured with an LCR-meter about 5 nF the capacitance of the cable. Nevertheless the measuring time resulted about 4 times that expected. The model we found is this (http://arxiv.org/abs/1205.2848):



In || to the expected, "high" frequency impedances G and C we put a series of $G_E(x)$ and C_E, with $G_E(x)$ randomly distributed along the cable, assuming a not perfect dielectric:

$$Z_C^{-1} = G_C + sC_C + sC_E \int_0^L \frac{1}{1 + s\tau(x)} dx$$

$$Z_C^{-1} = G_C + sC_C + \frac{C_E}{\tau} \ln(1 + s\tau)$$

Fit results:

C=4.8 nF

C_E=11.4 nF

τ=2.02 s