NTD-Ge production in the LUMINEU experiment using cryogenic detectors for Rare Event searches

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Abstract

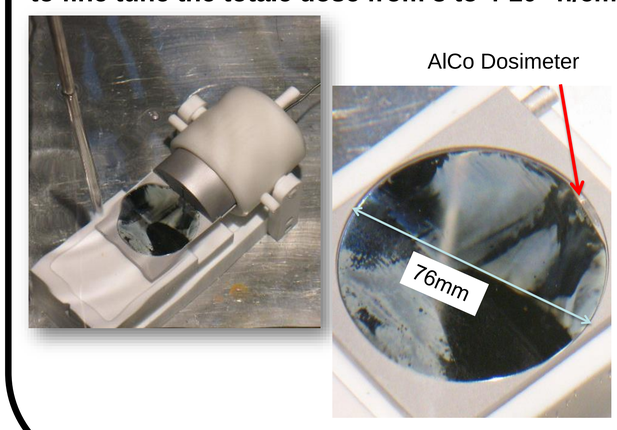
Experiments such as Cupid-Mo and Edelweiss-3 plan to use **Neutron Transmutation Doped Germanium sensors (NTD)** as thermistors on their detectors for Neutrinoless Double Beta Decay and light-mass-WIMP search respectively. Such a choice is motivated by their robustness, reliability, ease of use over a large range of temperature and large dynamic range in energy. To cope this future large demand on NTDs, our groups in LUMINEU started a new production line for Ge-NTDs.

In this poster, we present the synthesis of irradiation dose of the different irradiations of HPGe wafers and parameters of metallization. Some wafers have been selected on the basis of their R(T) at very low temperature and first signals obtained from LUMINEU's detectors equipped with sensors made from these wafers. The performance in term of noise and signal to noise ratio are equivalent to the best previously available NTD sensors.

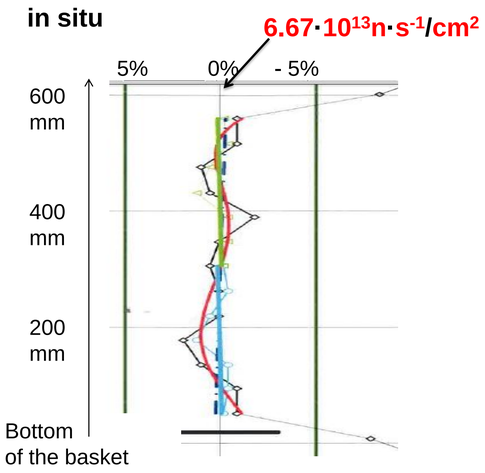
=> **This demonstrates our ability to produce NTD sensors for the desired range of working temperature and for different applications.**

Irradiation and metallization

A complementary irradiation by thermal neutrons in Orphée reactor
to fine tune the totale dose from 3 to 4·10^{18}n/cm^2



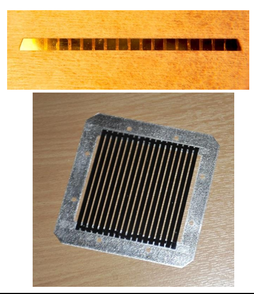
Measurement with a collectron in situ

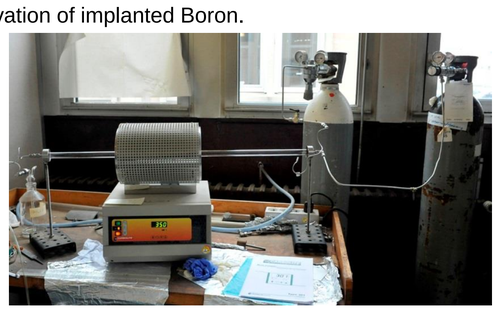


Metallization

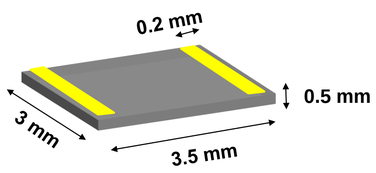
- Implantation of Boron at CSNSM (5, 15 and 25 keV)
- 6nm Pd + 300 nm Au evaporation in High Vacuum at Minerve technological platform (C2N)

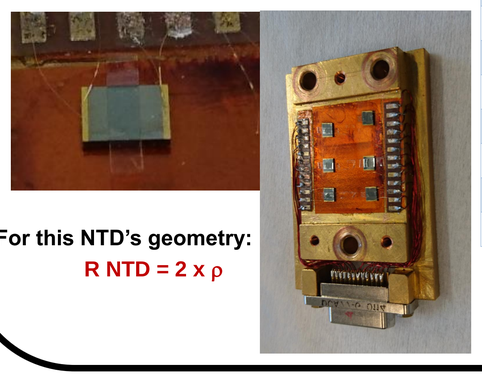
Annealing at SPEC (CEA)
Two different annealing (at 600 and 250°C) have been realized before and after metallization recrystallization and activation of implanted Boron.





R(T) at low temperature

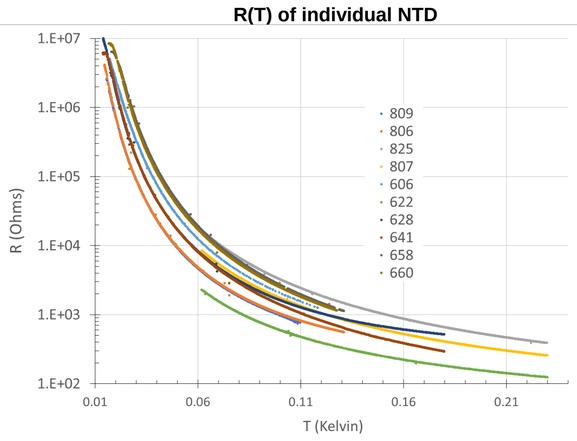




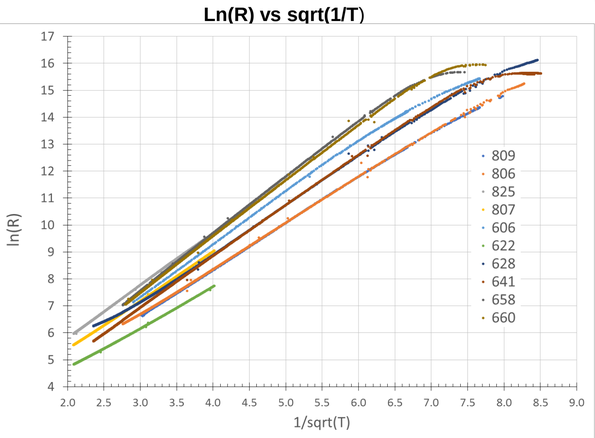
For this NTD's geometry:
R NTD = 2 x ρ

Wafer	Total fluence in 10^18 n.cm-2	R0 in Ohms	T0 in K	R @ 20mK in Mohms
606	3.48	3.45	4.23	7.1
622	3.51	5.44	2.34	2.76
628	3.54	3.35	3.62	2.3
641	3.55	3.52	3.56	2.2
658	3.44	3.48	4.43	10
660	3.53	3.52	4.31	8.3
806	3.56	3.99	2.98	0.79
807	3.48	5.70	3.28	2.08
809	3.51	4.25	3.11	1.1
825	3.44	7.42	2.41	4.34

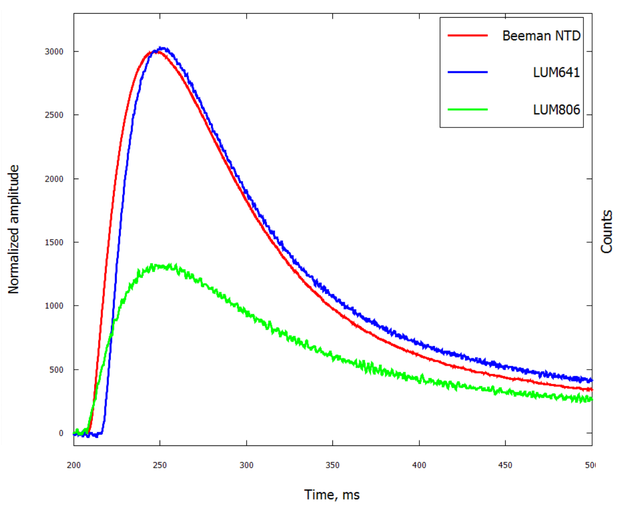
R(T) of individual NTD

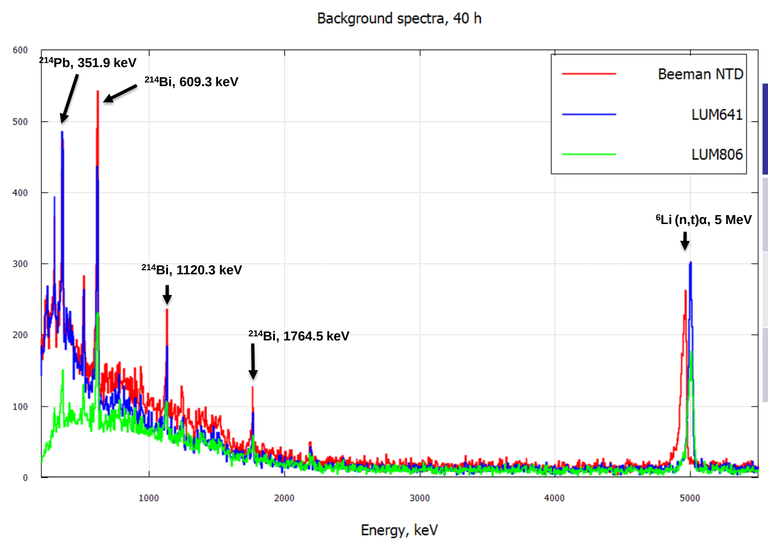


Ln(R) vs sqrt(1/T)



NTD glued on LMO crystal above ground





NTD	Sensitivity, nV/keV	Baseline FWHM, keV	^{214}Bi, 609.3 FWHM	^{214}Bi, 1764.5 FWHM
Haller Beeman	68.8	6.4	10.6(7)	12(1)
641	68.8	6.0	10.1(7)	10(1)
806	30.2	12.2	12(2)	13(3)

LUMINEU = Luminescent Underground Molybdenum Investigation for NEUtrino mass and nature

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