Measurement of the LC of bare HPGe detectors operated in LAr in response to γ radiation … Part III

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Conclusion – GERDA meeting LNGS November 2007

1) Gamma irradiation of the bare prototype detector in liquid argon results in an increase of the leakage current

2) The passivation layer is not being damaged irreversibly by the gamma radiation : irradiation without HV and the methanol bath end of July '07 together with a PTFE/Cu/PTFE cap led to ~10-20 pA

3) The LC depends on the energy deposition (and following charge collection) in the LAr volume facing the groove/borehole side of the crystal

4) The field created by the shifted bias scheme (ground outside, -HV signal) results in a much stronger increase of the LC than the standard bias scheme (+HV outside, signal contact ground) ?

5) The energy deposition in the argon volume inside the groove is, if at all, a minor effect ?

6) Covering the full surface with a PTFE/Cu/PTFE disk strongly suppresses the radiation induced LC increase. The Cu disk is grounded and closes the field lines.

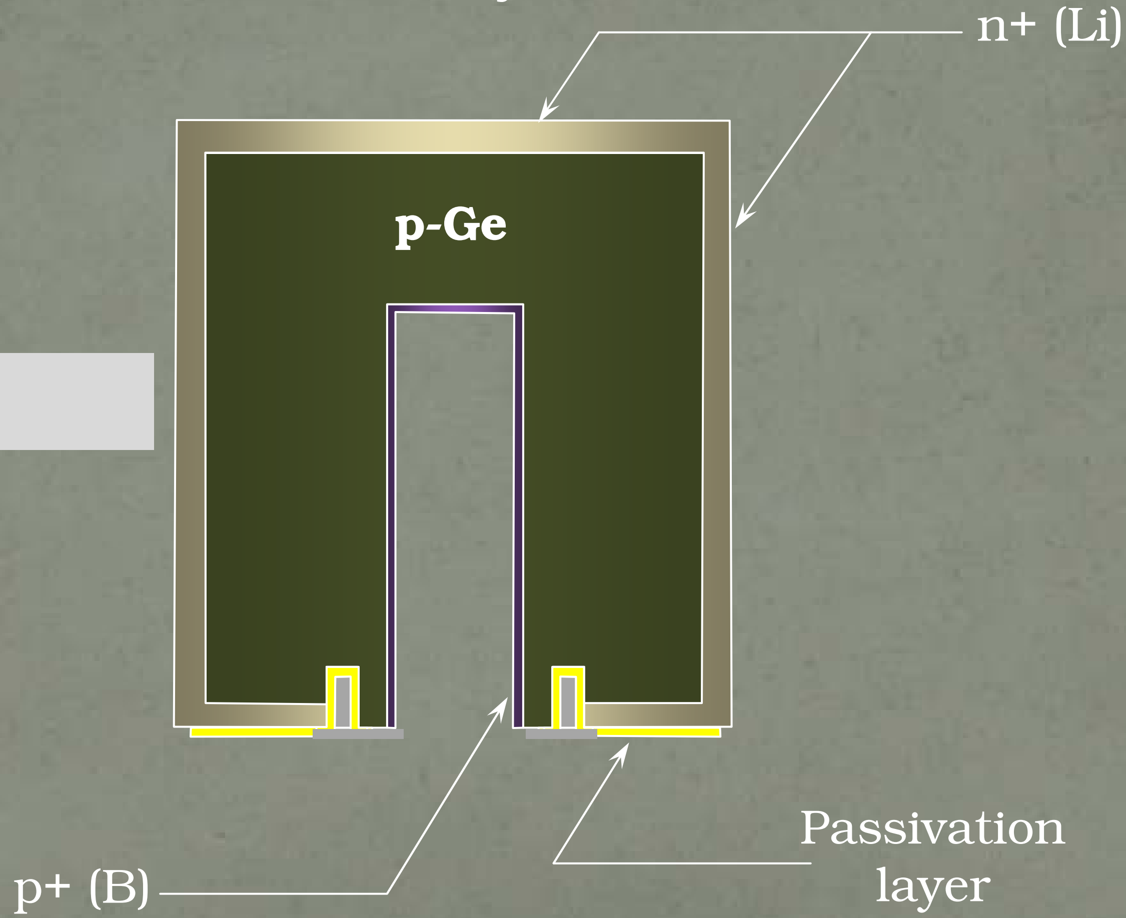
7) The most likely scenario is that the charge collected and trapped on the passivation layer on the inner and/or outer side of the groove is responsible for the increase of the LC. ?

Outlook – GERDA meeting LNGS November 2007

- More measurements planned to test hypothesis explaining the LC response to γ radiation, including

- Irradiations using others diodes with different passivation layers
  - 2 Genius-TF detectors ready to be tested in GDL

Genius-TF 44



- UV irradiations of the detector assembly without applying HV √
- Irradiations of the detector assembly submerged in purified LAr
- Irradiations of the detector assembly submerged in LN √

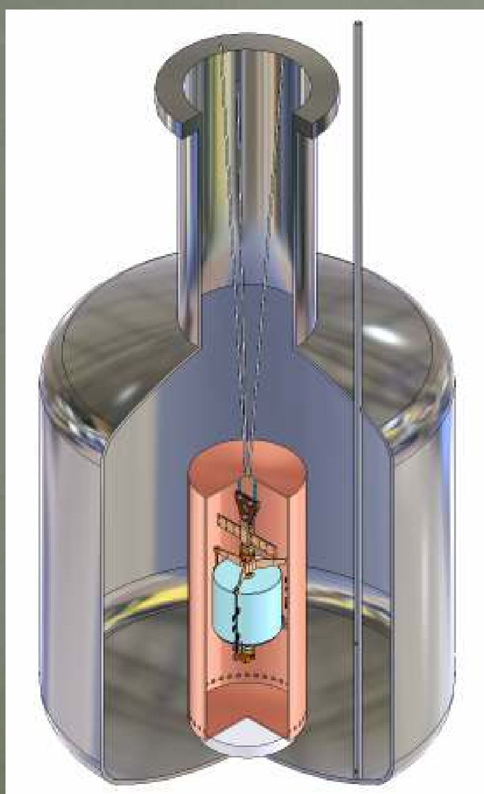
Outline

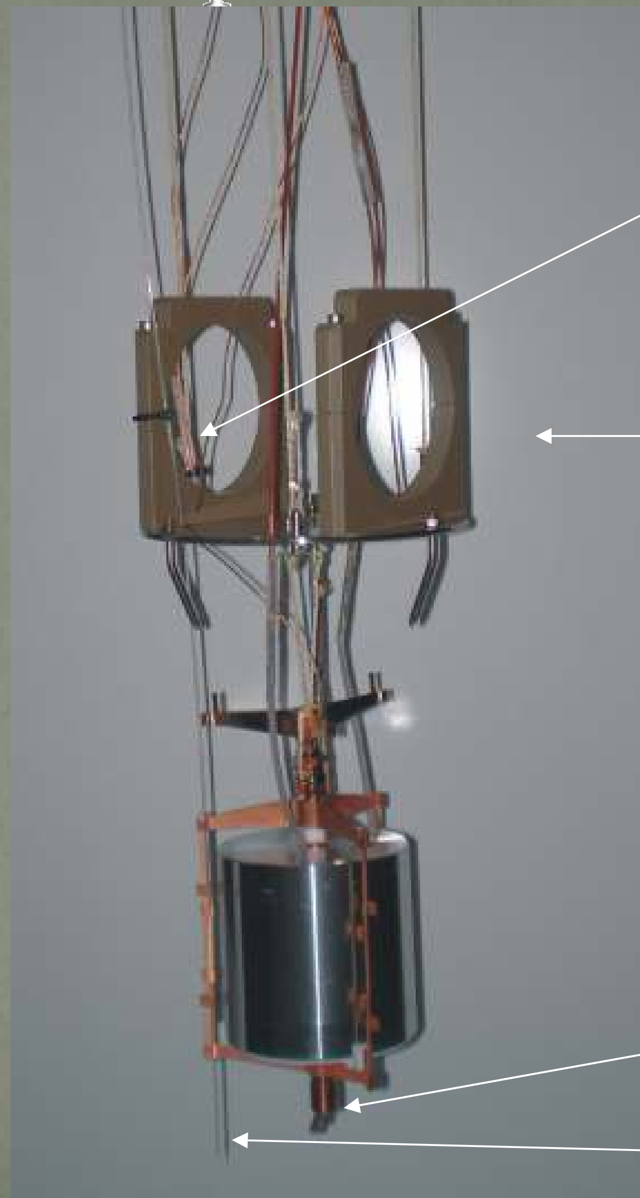
- GTF_42
  - Original LC: 5 pA
  - Irradiation with +/- HV
  - Irradiation with LED
  - ΔLC between +/- HV
- Prototype detector
  - Irradiation with PTFE/Cu/PTFE disk
  - Irradiation without disk
  - ΔLC between +/- HV
  - In LN2: Original LC (~5 pA) and irradiation
- GTF_44
  - Original LC: 28 pA
  - Irradiation with +HV

2 test benches operational in GDL

2nd test bench setup

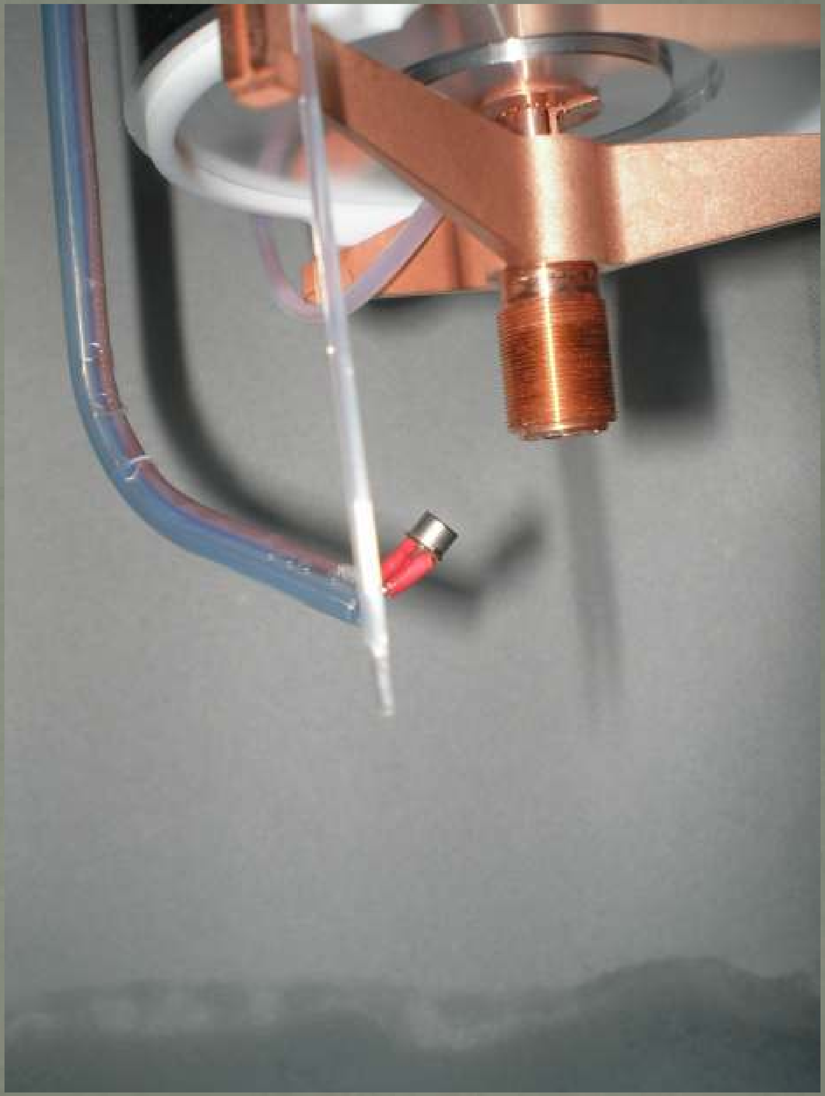
Like test bench_1
-IR shield
-Tube for
irradiation source
…





UV LED

- λ=375 nm $\rightarrow$ 3.3 eV
- 1 s with LED ~ 10^3 x 1 day with UV from LAr with ^{60}Co in pos.1



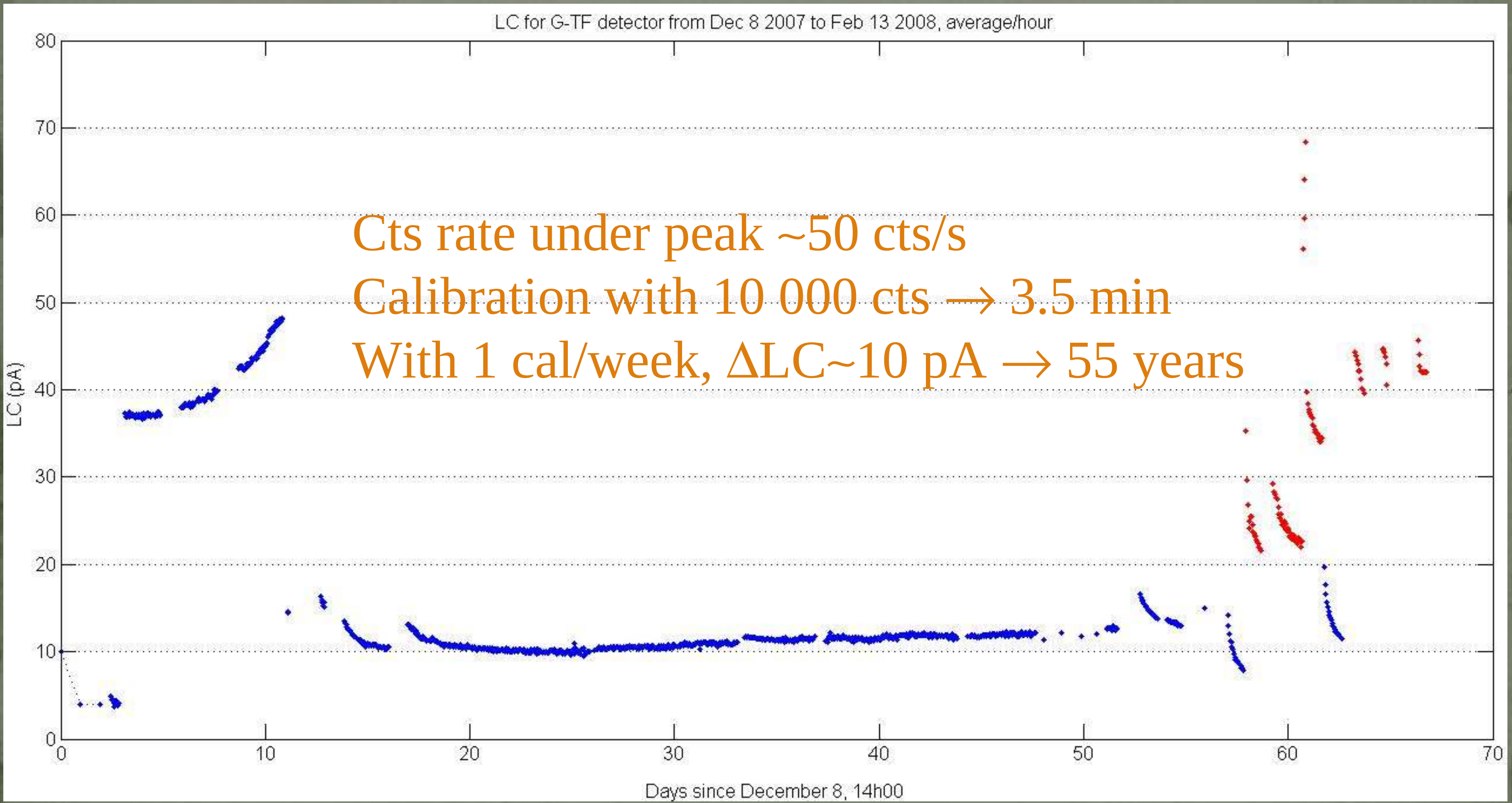
G-TF P41042A

- Refurbished October 2007 by Canberra Semiconductor N.V.
  - Passivation layer just inside the groove
- Mass: 2467 g
- Full depletion voltage: 1500 V
- Cooled down in 2nd test best December 8, 2007

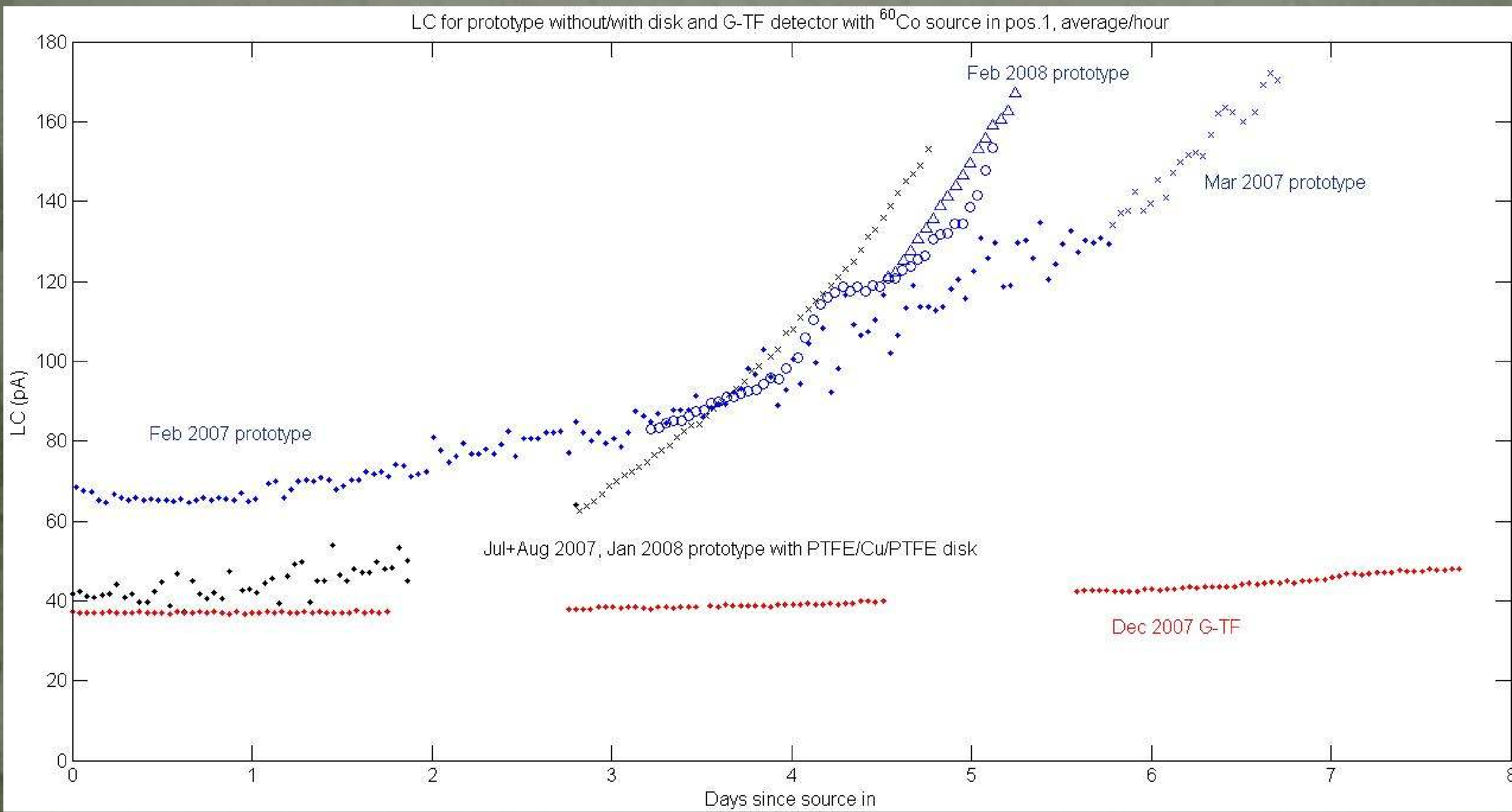
G-TF P41044A

- Refurbished October 2007 by Canberra Semiconductor N.V.
  - No passivation layer
- Mass: 2465 g
- Full depletion voltage: 2500 V
- Cooled down in 1st test best February 10, 2008

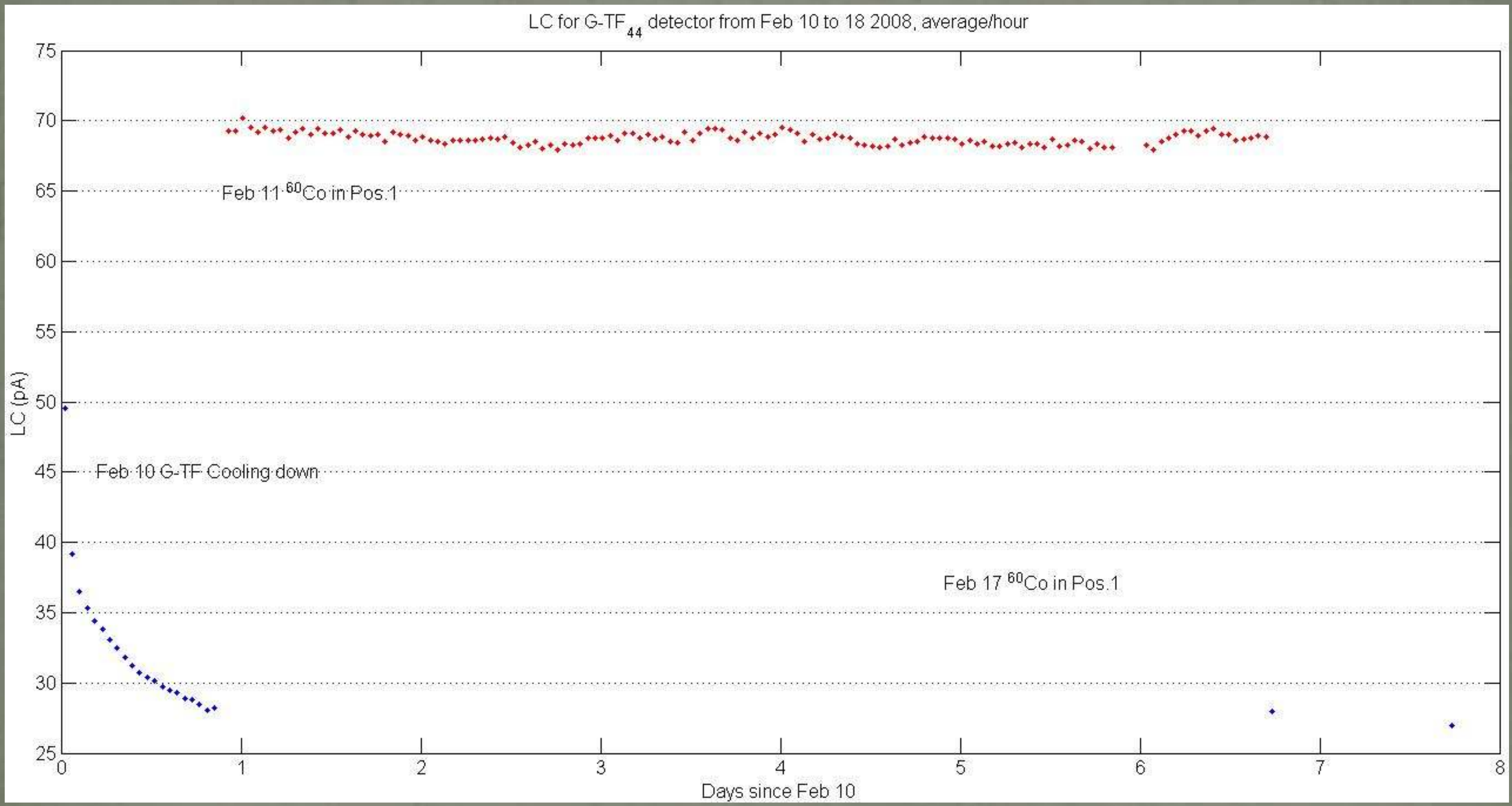
GTF_42 – With passivation layer just in the groove



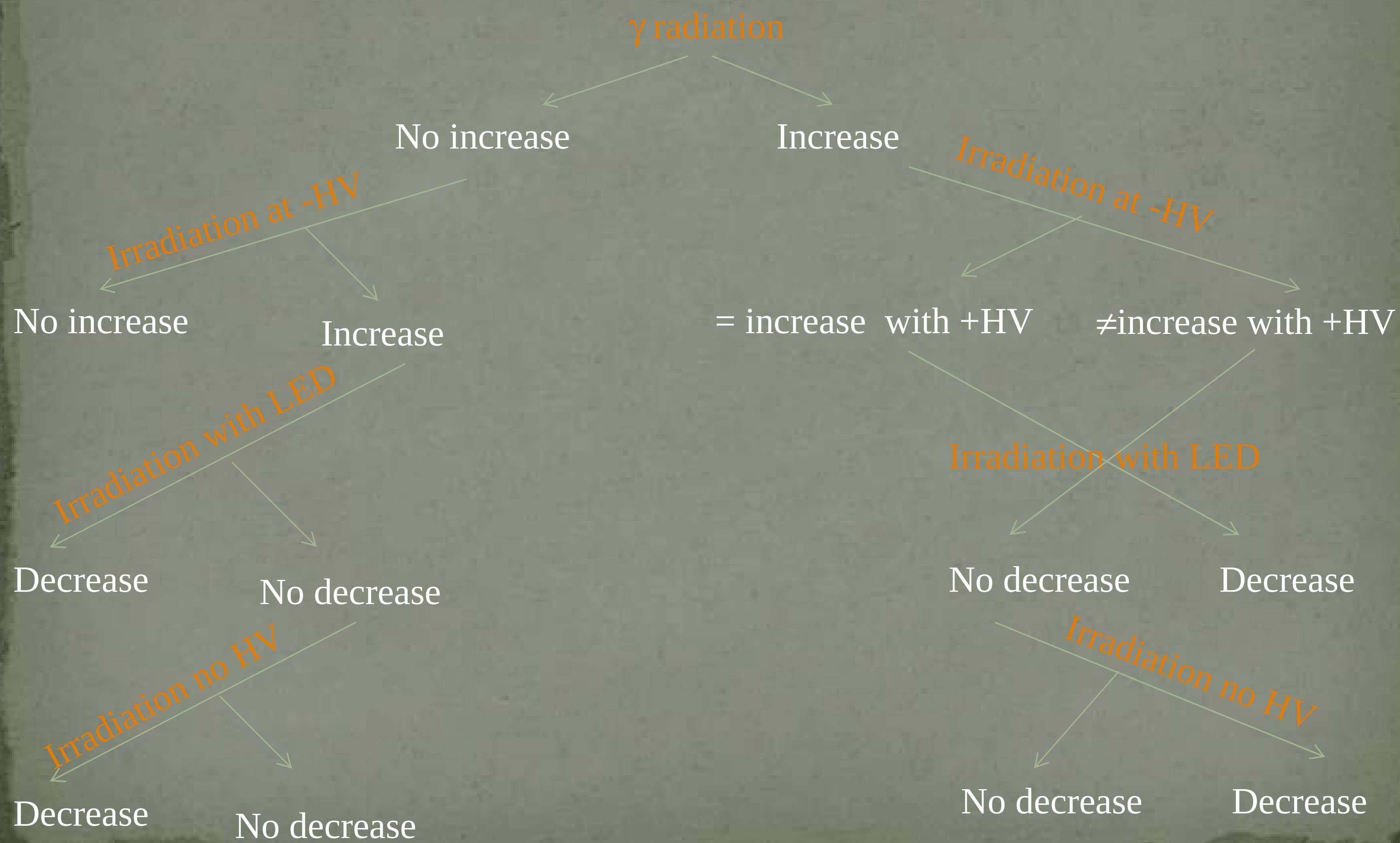
Prototype detector – With passivation layer inside and outside the groove



GTF_44 – Without passivation layer



Next step with prototype in LN_2



Next step with GTF_44 (no passivation layer)

Summary

- Radiation induced LC increase in LAr should not be a problem for GERDA experiment
- 1 year of operation at low LC in LAr with prototype detector
  - Detector parameters are not deteriorated (10 pA$\rightarrow$ 10 pA)
- Reducing the passivation layer area strongly suppresses the radiation induced LC increase
- More results are needed to explain
  - the shifted bias scheme results in a much stronger increase of the LC than the standard bias scheme also for the detector with a passivation layer only inside the groove.
  - ΔLC between + and – HV
  - Strong increase of radiation induced LC with PTFE/Cu/PTFE