Effect of IR- & UV-light on naked Germanium detector

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- Introduction to GERDA experiment
- Test stand for GERDA with naked Ge detector
- Results with IR- & UV-light
- Outlook

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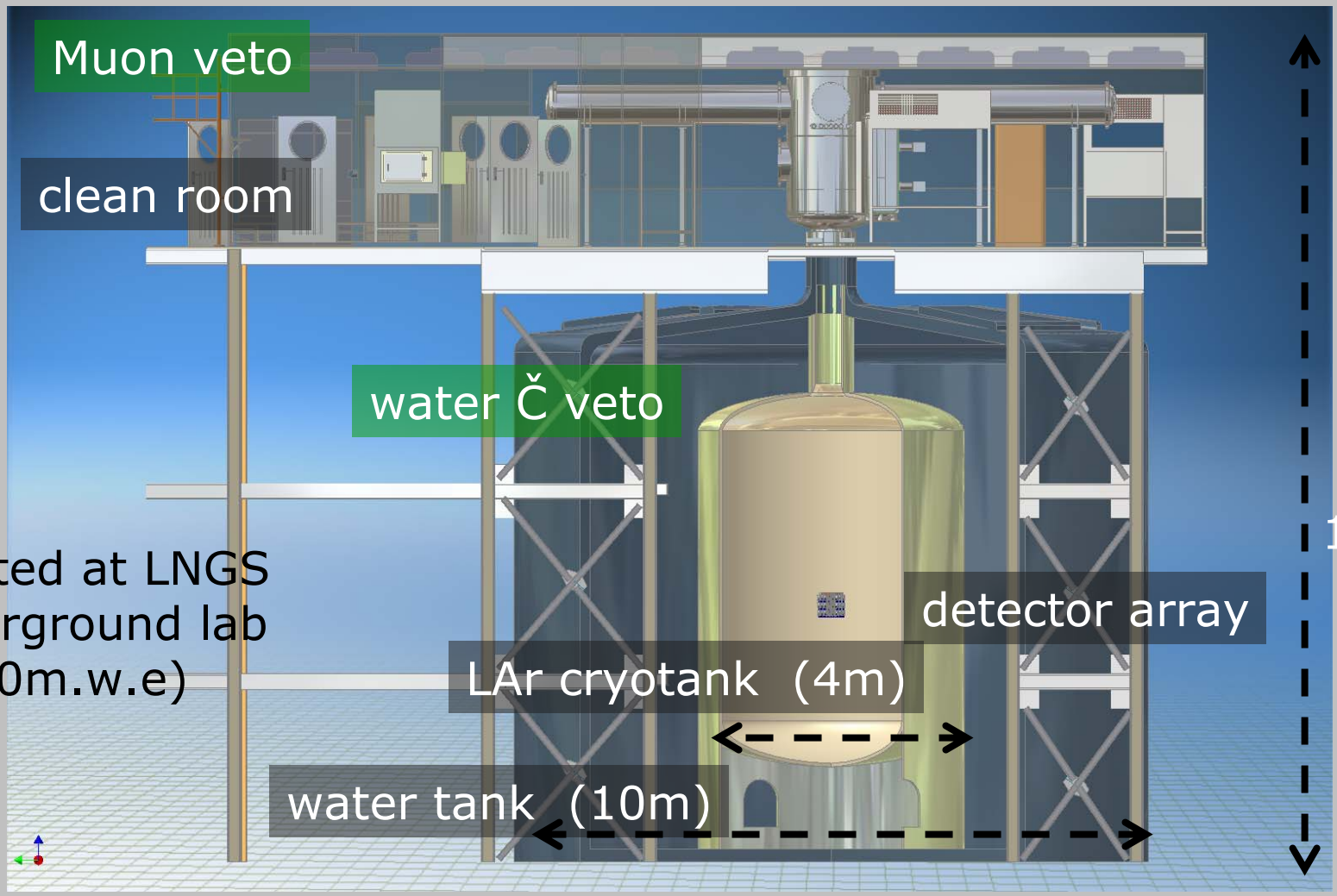
GERmanium Detector Array (GERDA) search for $0\nu\beta\beta$ decay in ^{76}Ge

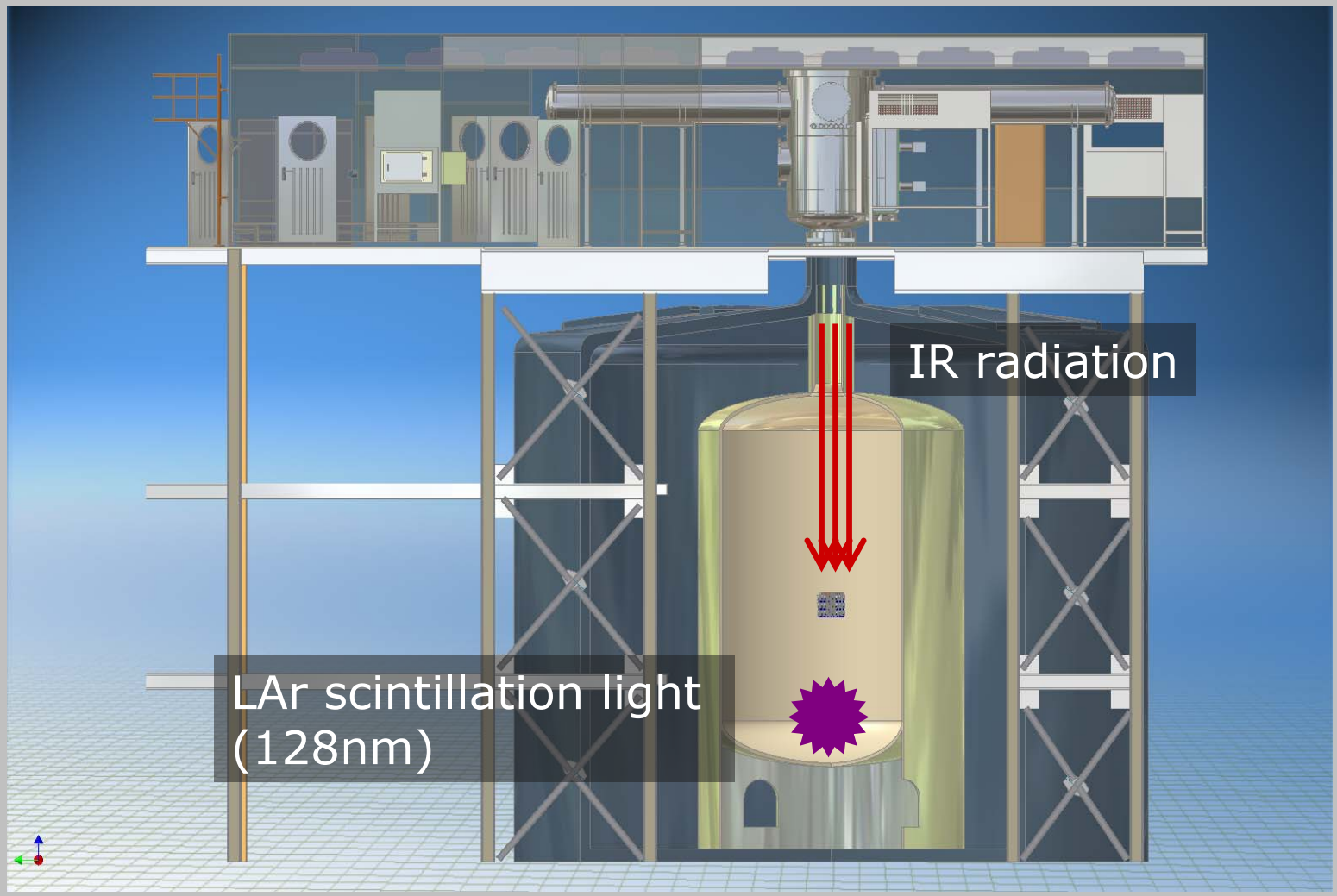


Located at LNGS underground lab (3500m.w.e)

Ge detectors directly submerged in LAr

new segmented detectors (phase-II)

Ge detectors see IR- & UV-light



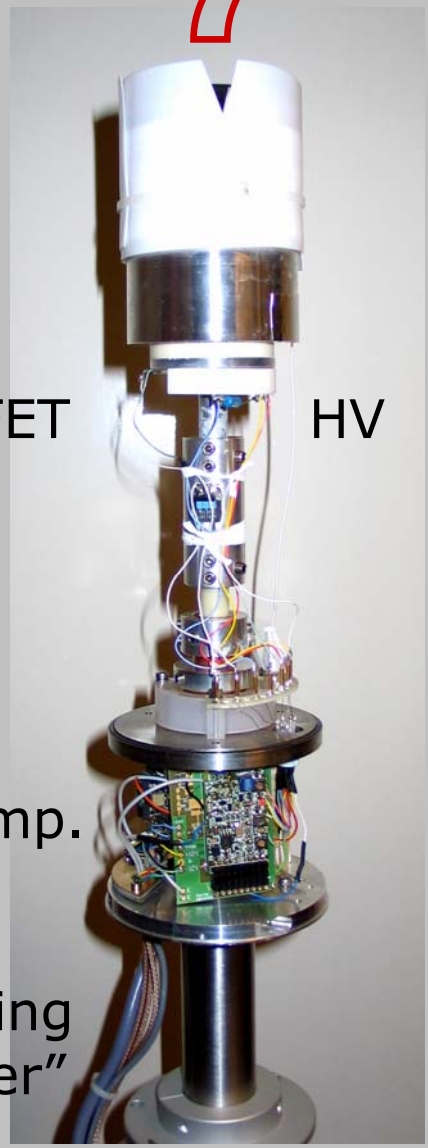
→need to understand Ge detector reaction to IR- & UV-light.
(UV light from LAr not an issue, due to low energy deposit.)

n-type non-segmented detector

- ✓From Canberra France.
- ✓65mm diameter, 77mm high.
- ✓Operated 61x in LN2, 4x in LAr, no obvious deterioration.

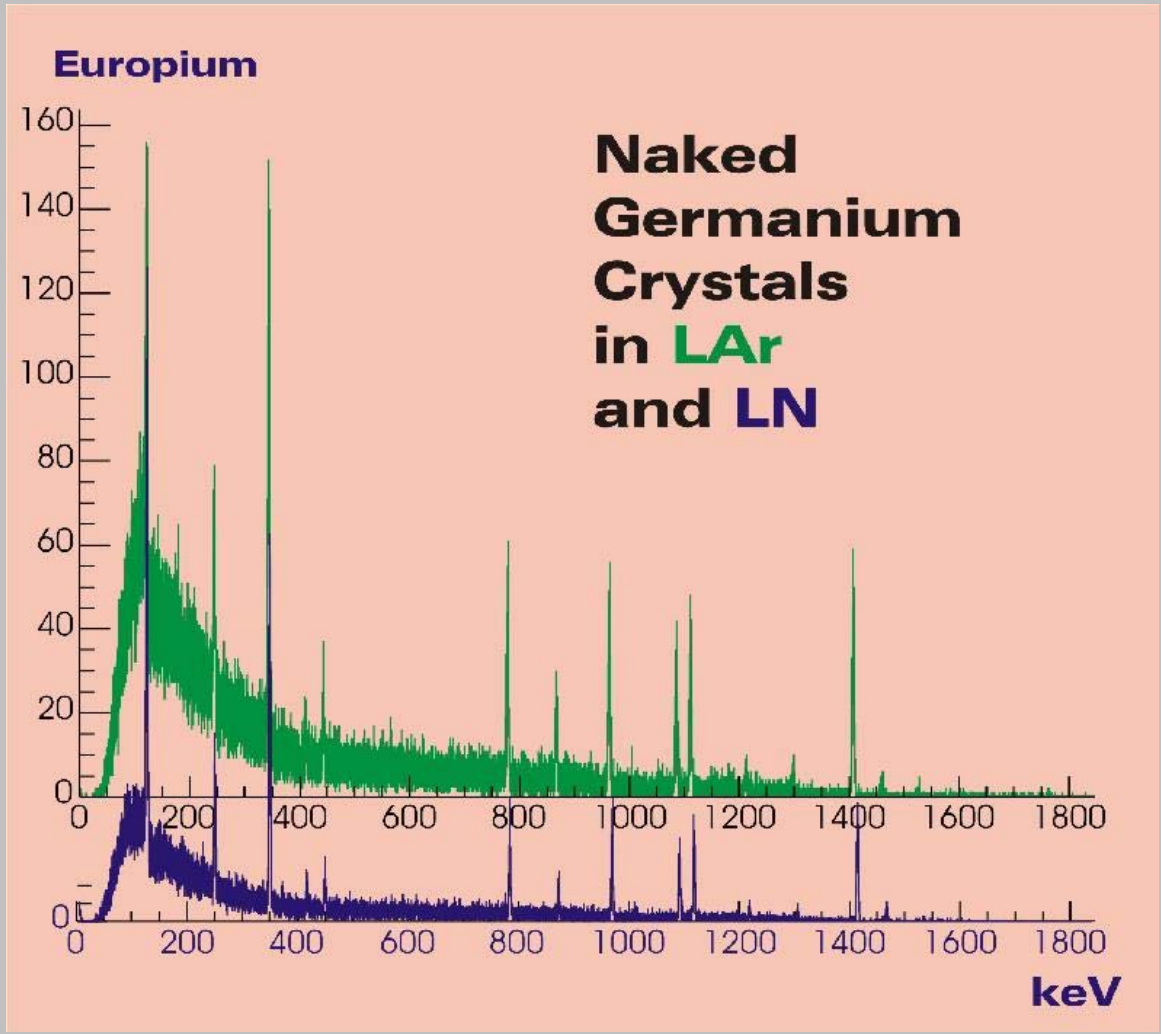
Ge crystal

Teflon layer for protection



detector cooling

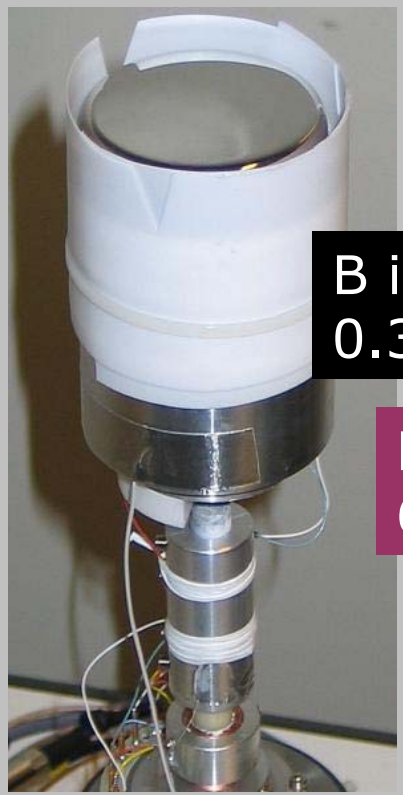
Eu152 energy spectra



- ✓FWHM 3.5-4keV at 1.3MeV (dominated by electronic noise).
- ✓Leakage current (LC) <20pA at -3500V.

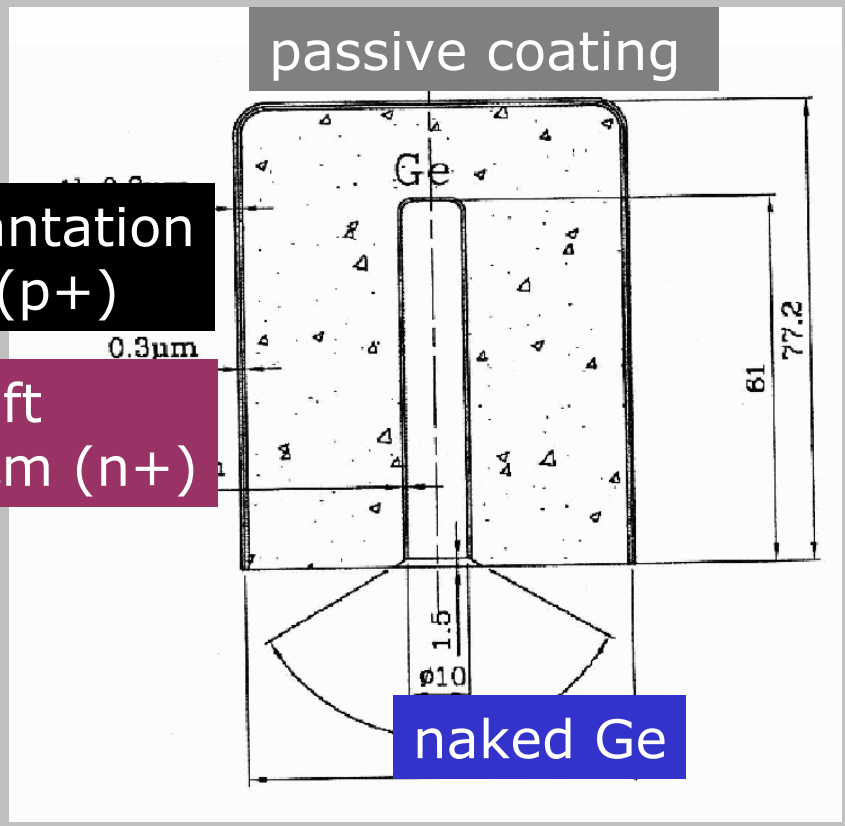
Detector n+ & p+ layer

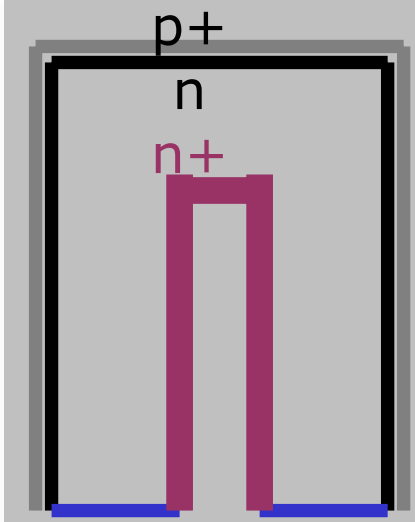
Depleting voltage (-3500V) applied to the outer surface



B implantation
0.3μm (p+)

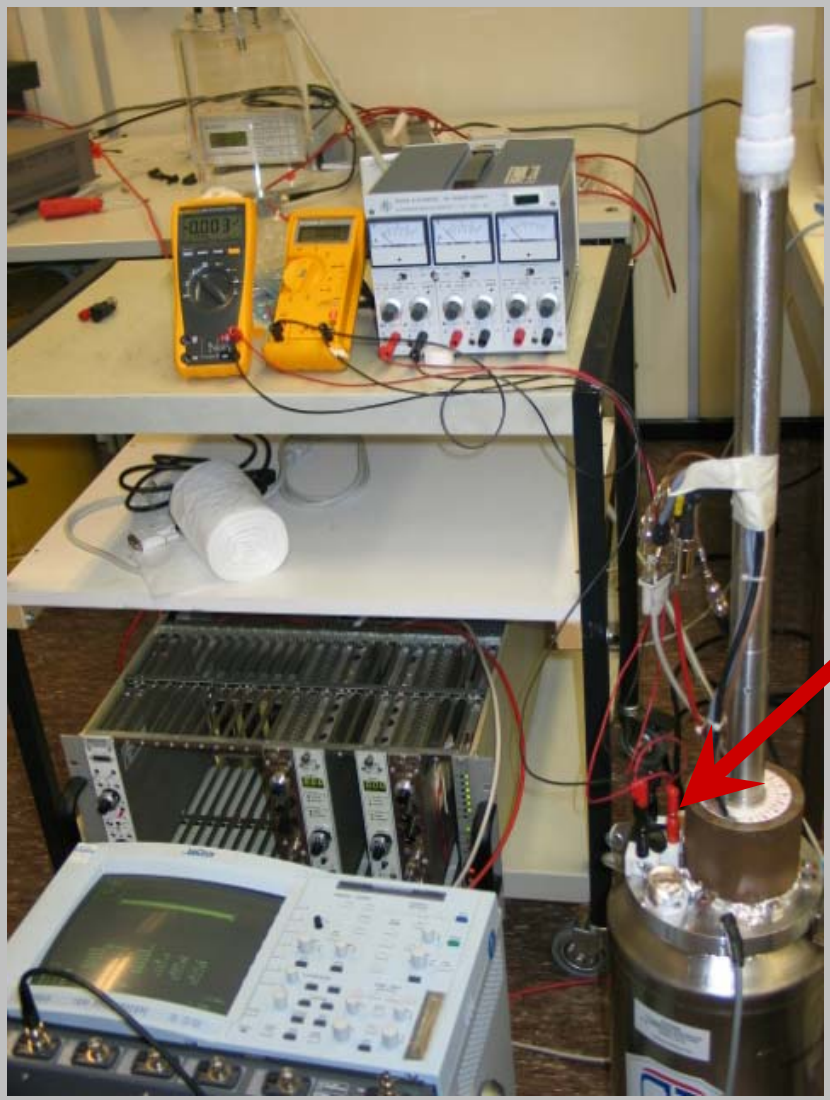
Li drift
600μm (n+)

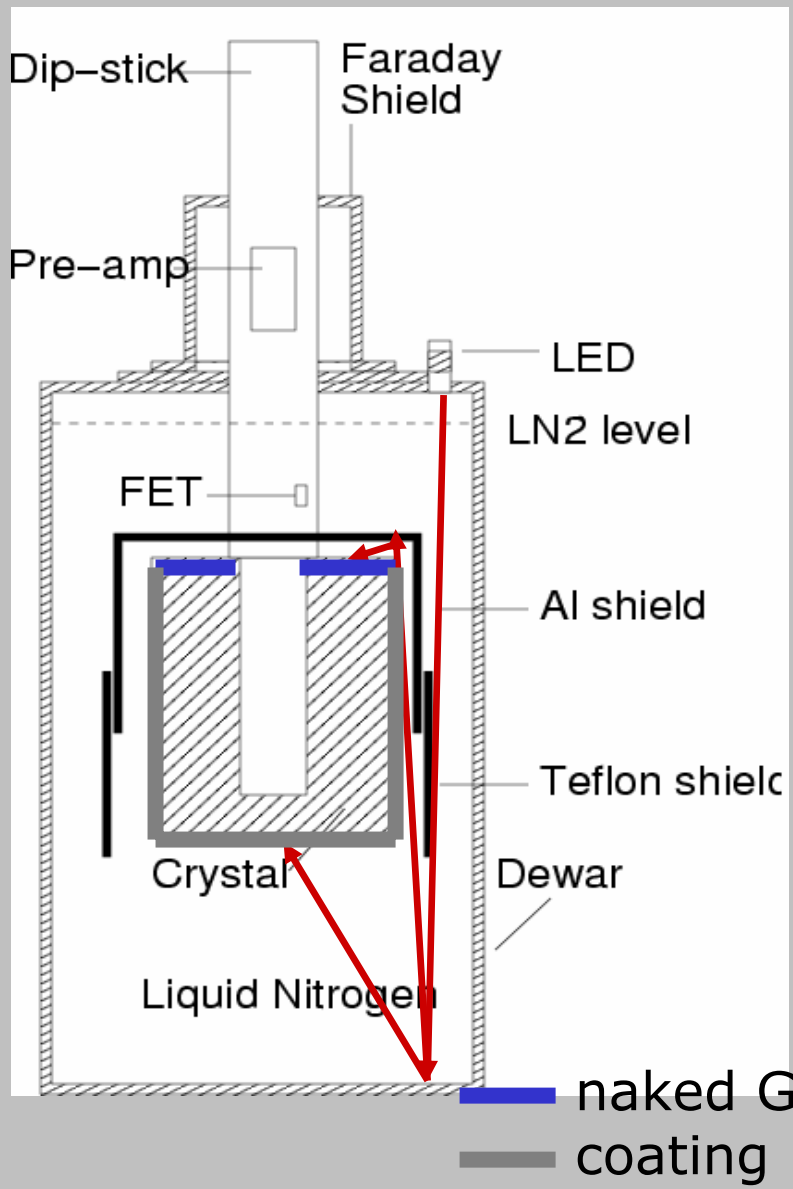




p-n junction
at outer surface

detector exposed to IR- UV-light

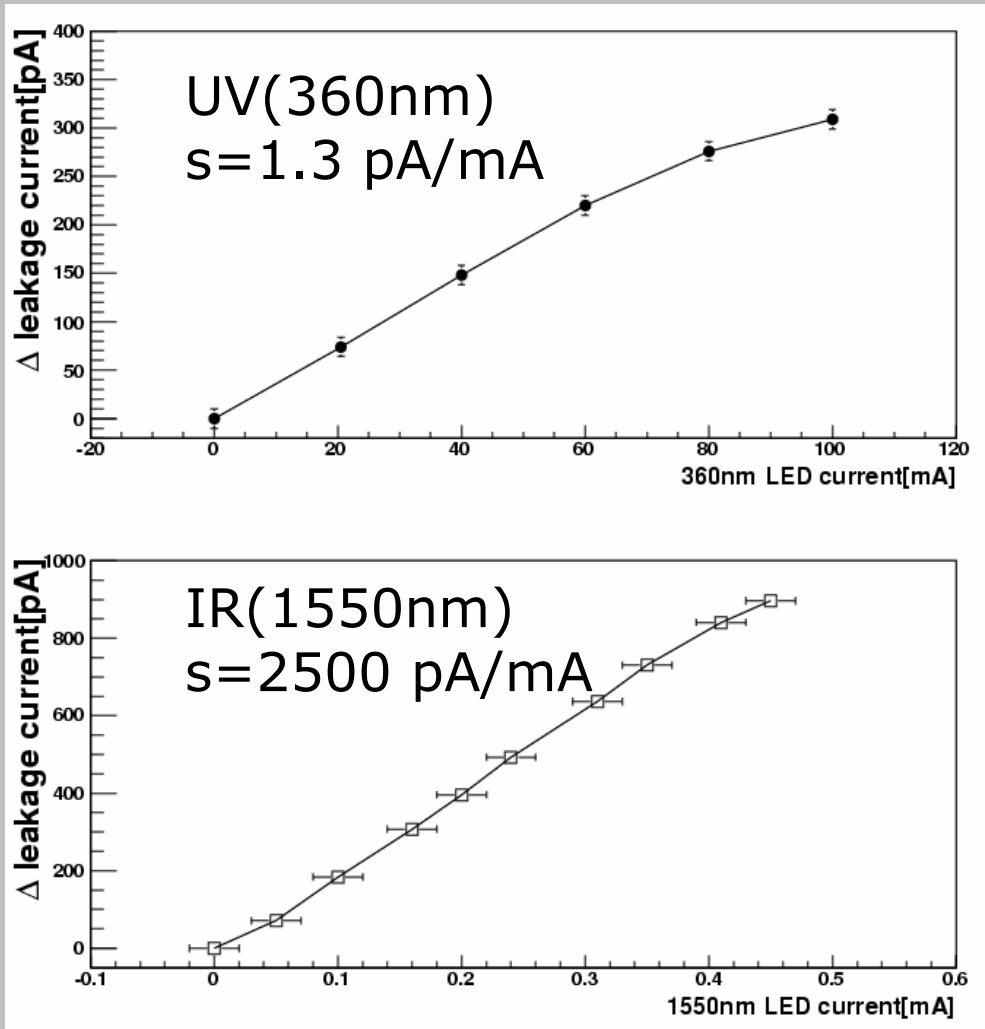




Photons could reach active detector in two different ways.

Leakage current (LC)↑ when IR- UV-light ↑

slope = ΔLC / ΔI_LED [pA/mA]



(Bias Voltage -3500)

- ✓Why IR & UV have different slopes?
- ✓How does slope depend on bias voltage?

Bias V dependence: LC induced on surface vs. LC induced in bulk

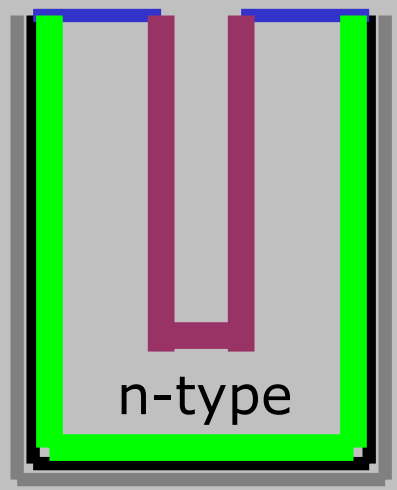
Germanium optical property:

λ [nm]	α [cm^{-1}]	$1/\alpha$	induce LC at	expected slope dependence on bias V
360	0.6E6	0.02μm	surface	weak
1550	9	1mm	surface & bulk	strong

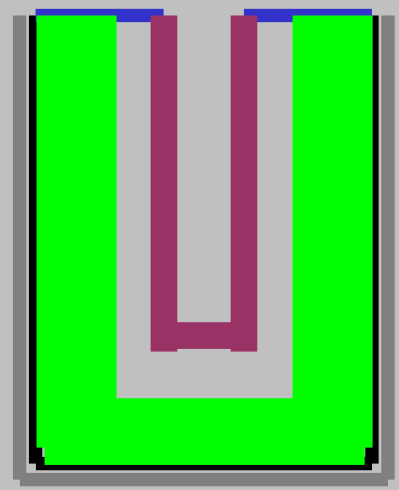
Li drift
600μm (n+)

B implantation
0.3μm (p+)

depleted volume
(active volume)

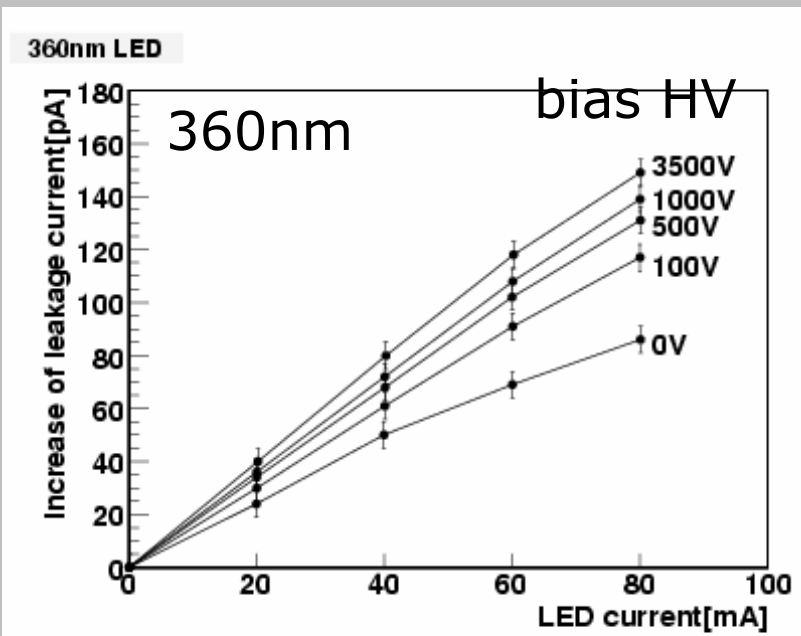


Bias V =0

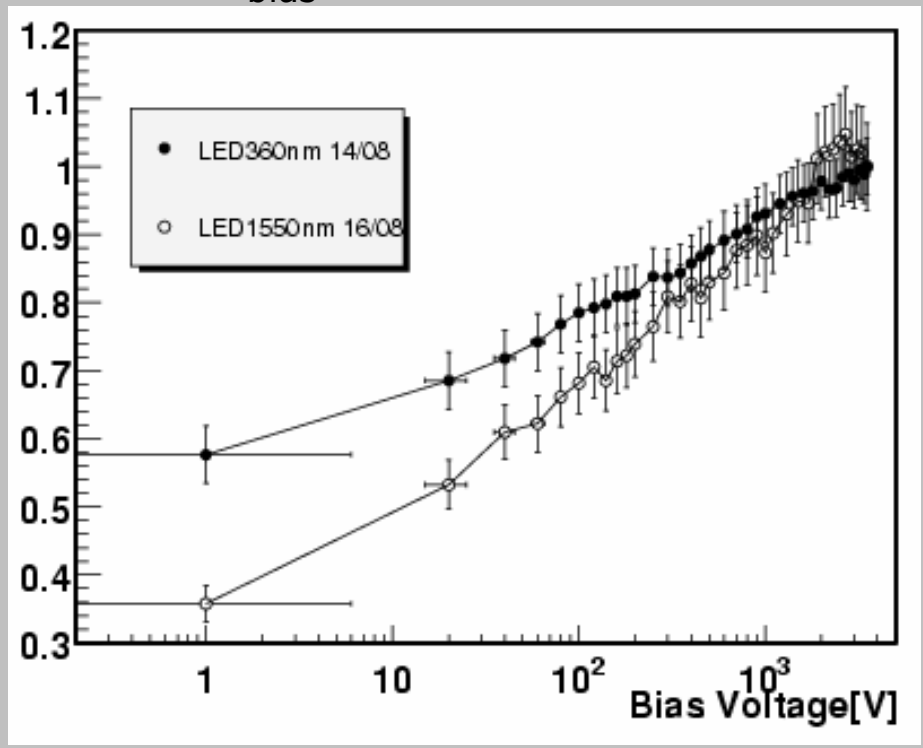


Bias V increase

slope = ΔLC / ΔI_LED at different bias voltage



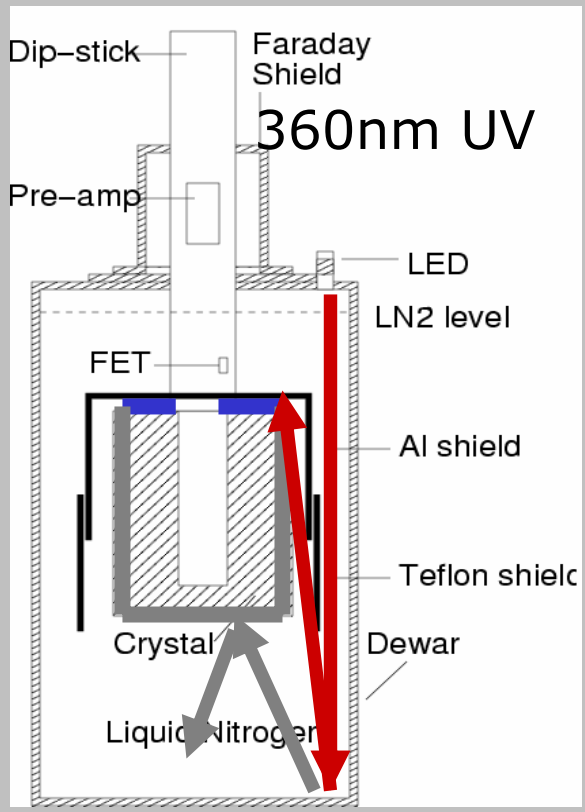
$$\frac{s(V_{bias})}{s(V_{bias}=-3500V)}$$

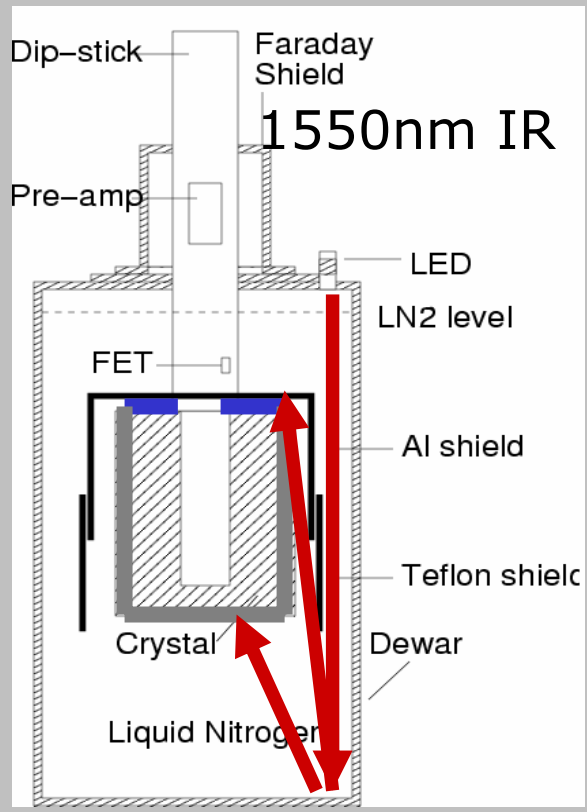


→ as expected

Why IR slope >> UV slope?

Main reason:
coating reflects more UV than IR.
→
Most UV lights reach active volume through the naked Ge surface.





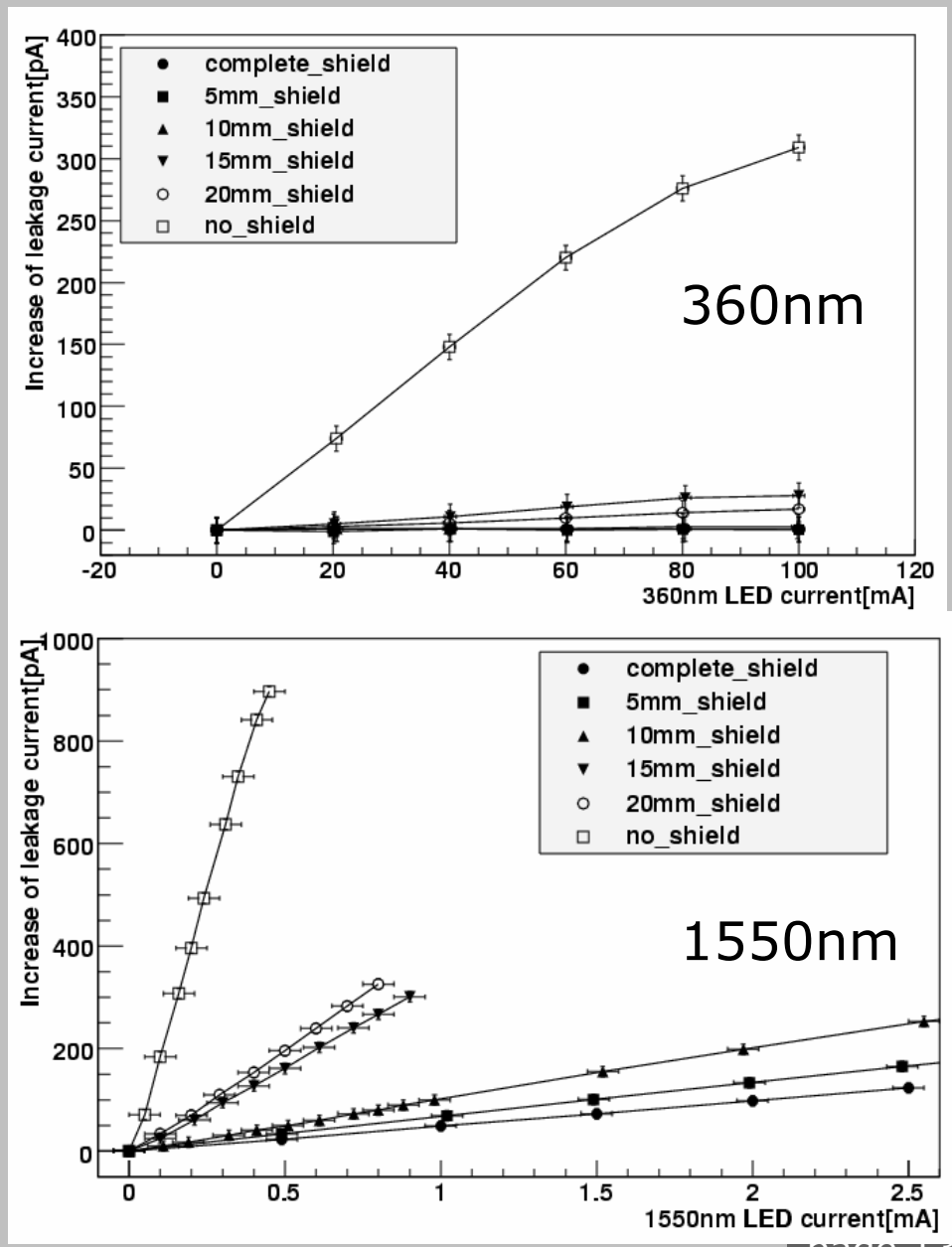
naked Ge
coating

material	λ [nm]	1/α	n
coating	360	6.7nm	0.397
coating	1550	7.7nm	1.44
LN2	IR-UV		1.21

(total reflection at 19°)

To prove that UV gets in through naked Ge surface

✓Detector shielded with extra 2mm-thick Al-plate.
✓Center hole with different sizes, Φ=0, 5, 10, 15, 20mm.



→ UV slope almost independent on hole size.

Conclusion & outlook

- ✓UV- & IR-light effect on n-type naked Ge detector as expected.
- ✓Only qualitative study possible with current test stand.
- ✓New test stand appropriate for this study under construction.
  → 3D scan with γ, α and laser.