The GERDA Phase II detector assembly

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for the GERDA collaboration

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Outline

- Introduction to Phase II of the GERDA experiment
- Phase II detector mount
- Contacting solution
- Integration test
- Conclusion

GERDA Phase II

- New custom-made detectors of ~20 kg total mass
- Background index aim 10 times lower than Phase I: < 0.001 cts/(keV·kg·yr)
- Active & passive reduction of background events
  - Pulse Shape Discrimination (PSD) (T 109.4, T 110.2)
  - Instrumented liquid argon volume (T 109.1/2)
  - Passive shielding by rock, copper, water & argon
  - Radio pure & low mass components e.g. holder structure, front-end electronics, cables, etc

Phase I detectors and contacting scheme

- Refurbished HdM & IGEX semi coaxial HPGe detectors with ~17 kg mass
  - HV contact copper screw (torque 60 N·cm; critical for energy resolution)
  - Signal contact by “chinese hat” pushed by silicon spring
  - Contacts require high mechanical stability of holder (80 g copper per detector)
  - Background index contribution approx. ≤ 0.001 cts/(keV·kg·yr)

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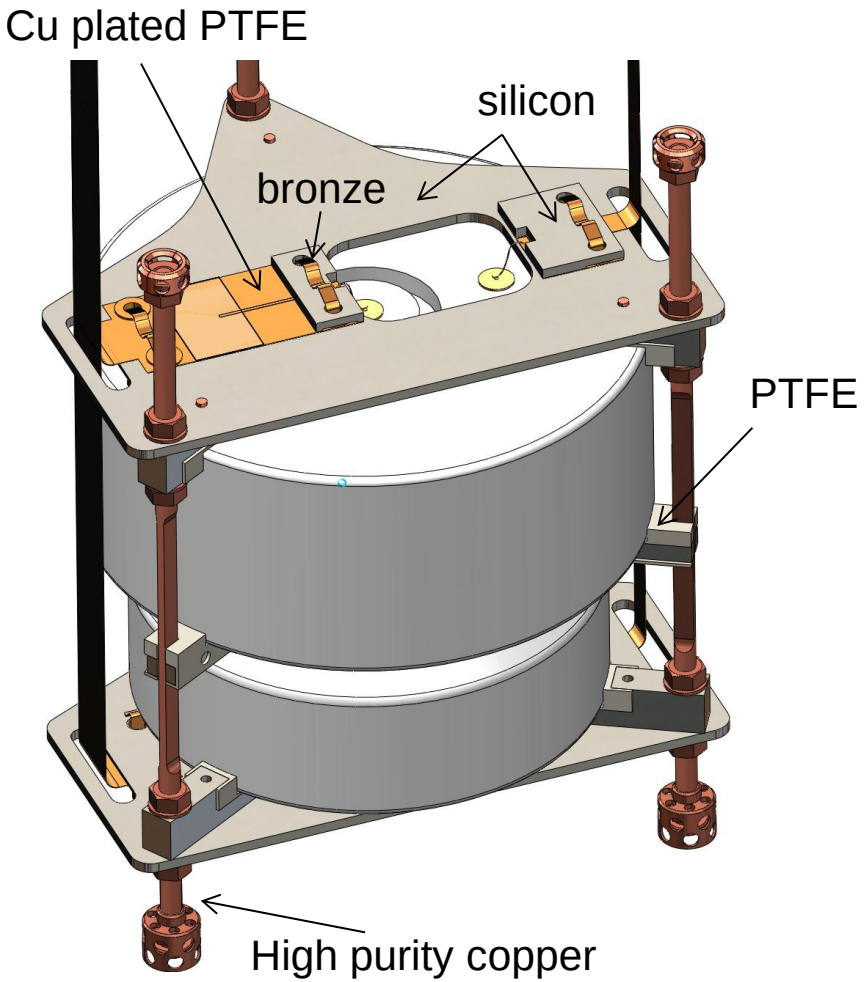
Marginal for Phase II

Phase II detector mount

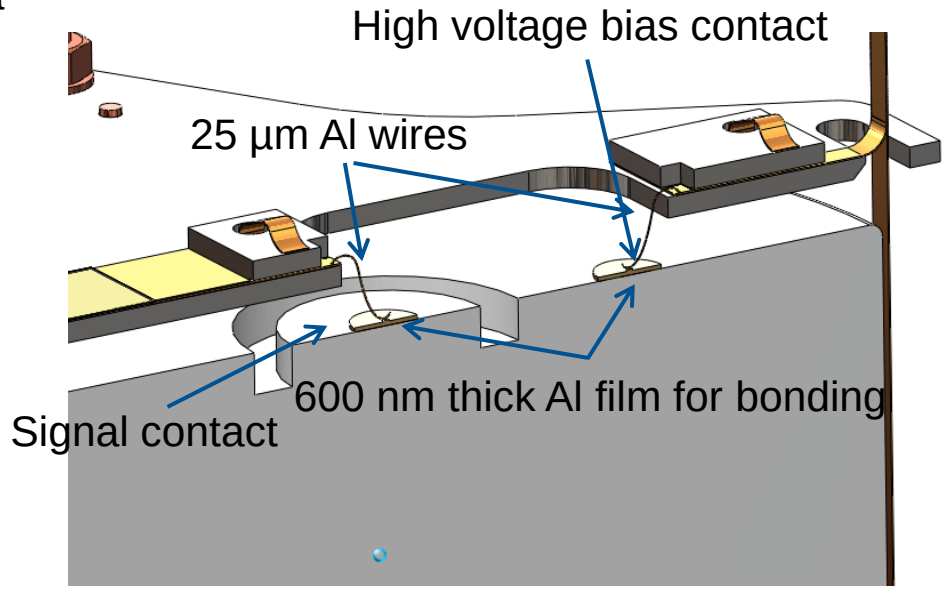
The Phase II detector mount

- Reduction of holder mass per kg detector mass necessary
  - Phase I holder: Cu 30 g/kg; PTFE 3.1 g/kg; Si 0.4 g/kg
  - Phase II holder: Cu 19 g/kg; PTFE 1.4 g/kg; Si 29 g/kg; 0.7 g/kg bronze
- Replace as much copper as possible with intrinsically pure mono crystalline silicon
- Current design achieves factor ~1.5 reduction copper & PTFE mass per kg detector mass
- New contacting scheme allows holder with reduced mass



The Phase II detector mount

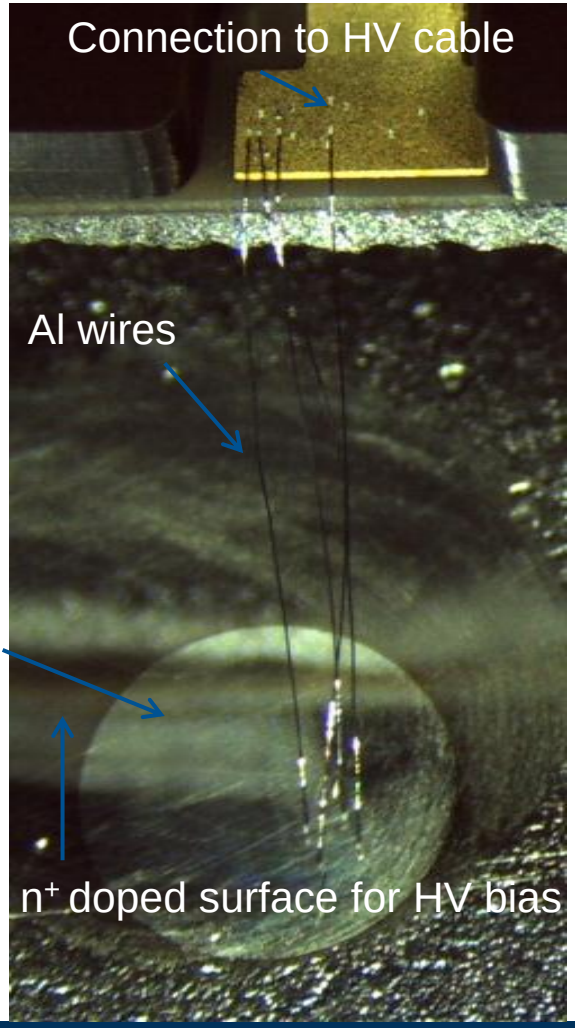
- Ultrasonic wire bonding identified as a low-mass, reliable electrical contact between detector, amplifying electronics and HV supply
- Modification of germanium diodes necessary to allow bonding



Contacting solution

Wire bonding on germanium detectors

- Ultrasonic wire bonding
- Wire bonding used extensively in the chip manufacturing industry
- Current detectors need additional aluminium thin film of 600nm to allow bonding
- In GERDA bonding wires must be stable in liquid argon and survive warming/cooling cycles
- Damage to sensitive p^+ contact must be prevented
- Small background contribution ensured by small contact masses



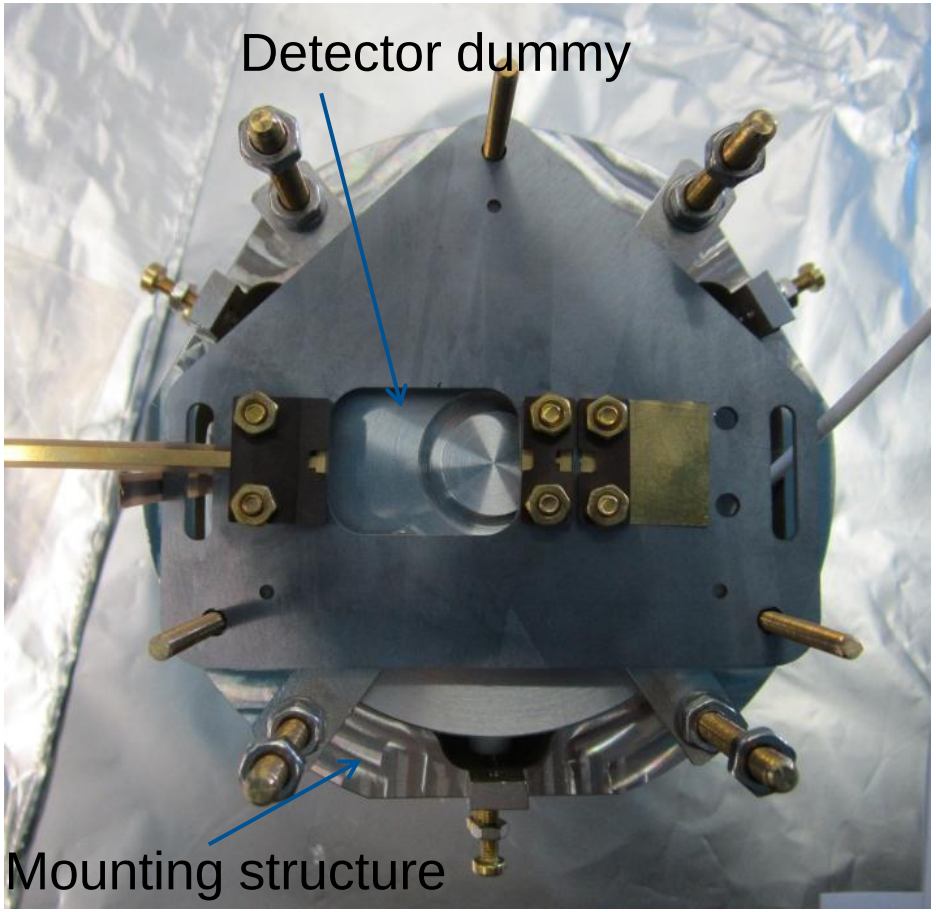
Deposition of aluminium

- Need of metallic surface for ohmic contact and good bonding
- Evaporation of material to produce a cloud of atoms e.g. e-beam evaporator
- Process development at TUM
- Integration into production process of manufacturer, Canberra Semiconductor NV
- Coating at manufacturer‘s site
- Minimization of above ground time to avoid cosmic activation of detectors

Integration test

Test of integrated detector pair

- Two test detectors with Al films mounted in Phase II holder
- Bonded to make electrical contact
- Test of newly designed Phase II electronics
- Test of assembly in liquid argon cryostat (Noise, microphonics, handling in glove box, stability)
- Test in LNGS underground laboratory on going



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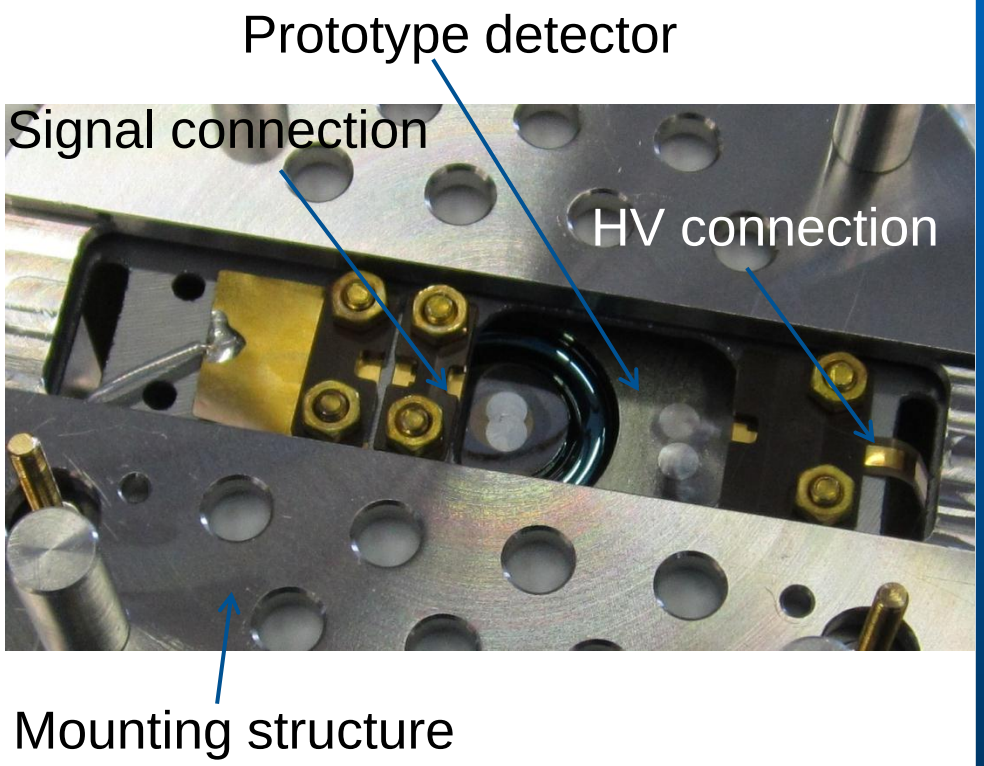
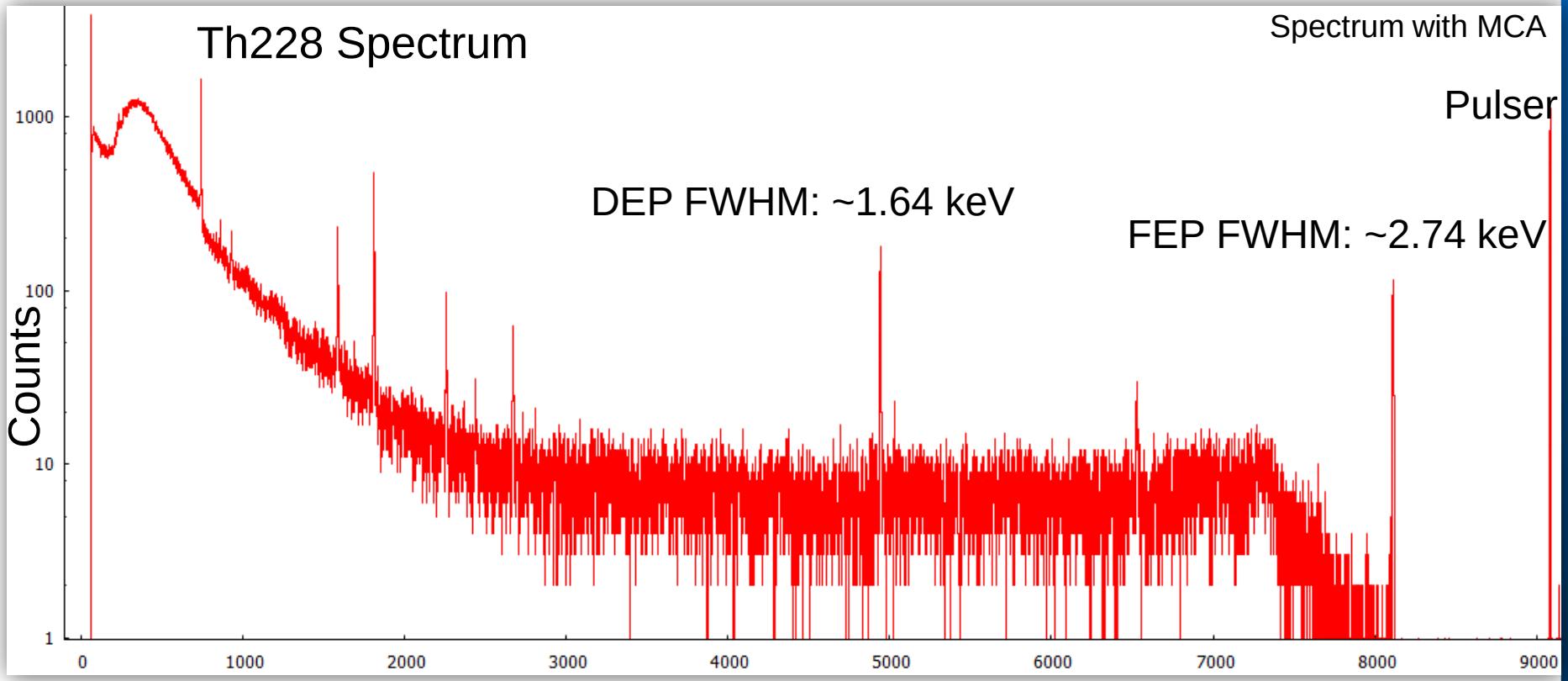


First spectrum with bonded germanium detector operated in LAr



Conclusion

- GERDA Phase II will use active & passive reduction of radioactive backgrounds
- Decrease mass of detector assembly components
- New contacting solution (wire bonding) allows reduction of holder mass
- Steps of bonding on germanium detectors investigated
- Successful process integration achieved
- Integration & operational tests of Phase II prototypes on going
- Evaporation on enriched Ge detectors will start in May

Thank you for your attention