

The GERDA Calibration System



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for the GERDA-Collaboration



DPG Frühjahrstagung 2012 in Göttingen

Outline

Hard- and software description

- Lowering system
- Position measurement
- Control

Analysis

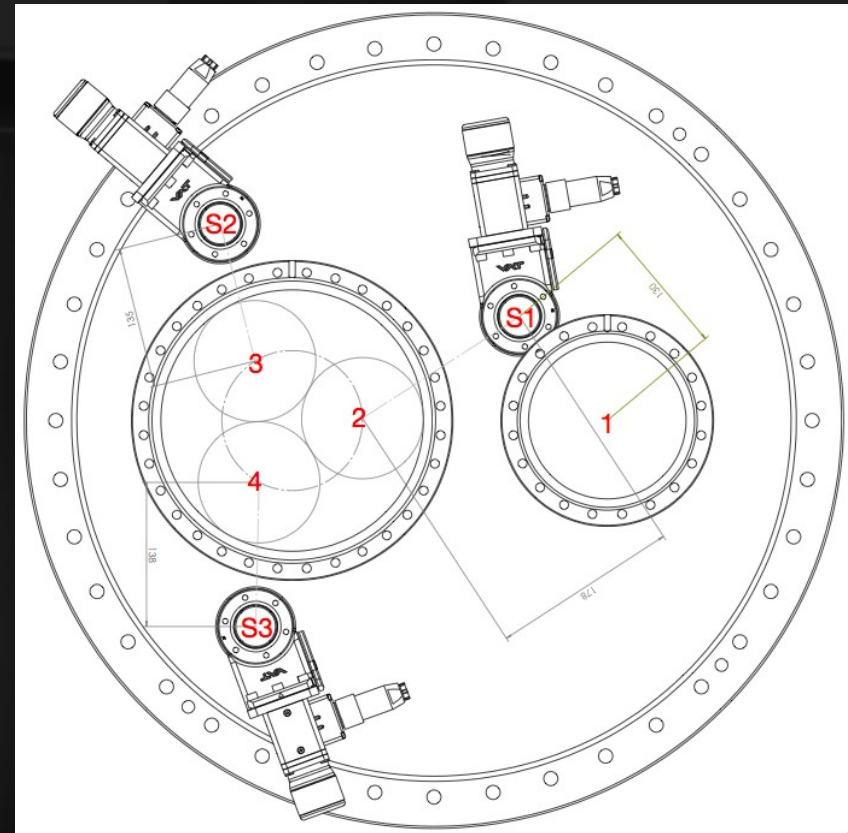
- Calibration algorithm
- Energy resolution
- Linearity

Background induced by sources in parking position (simulation)

Overview

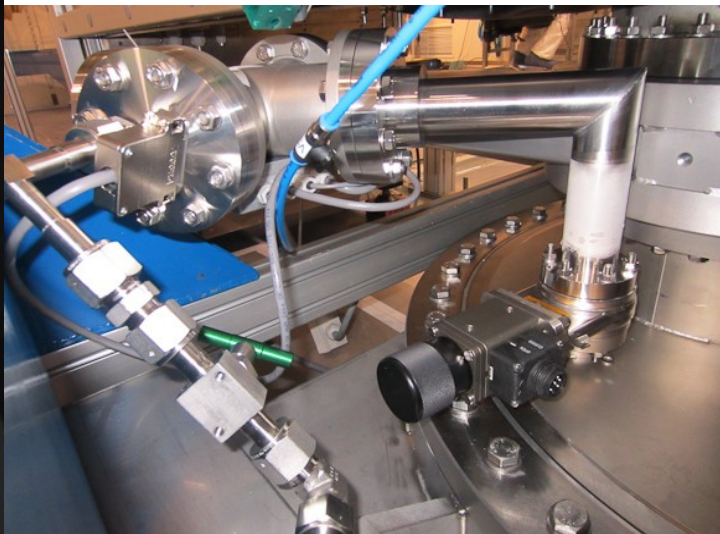
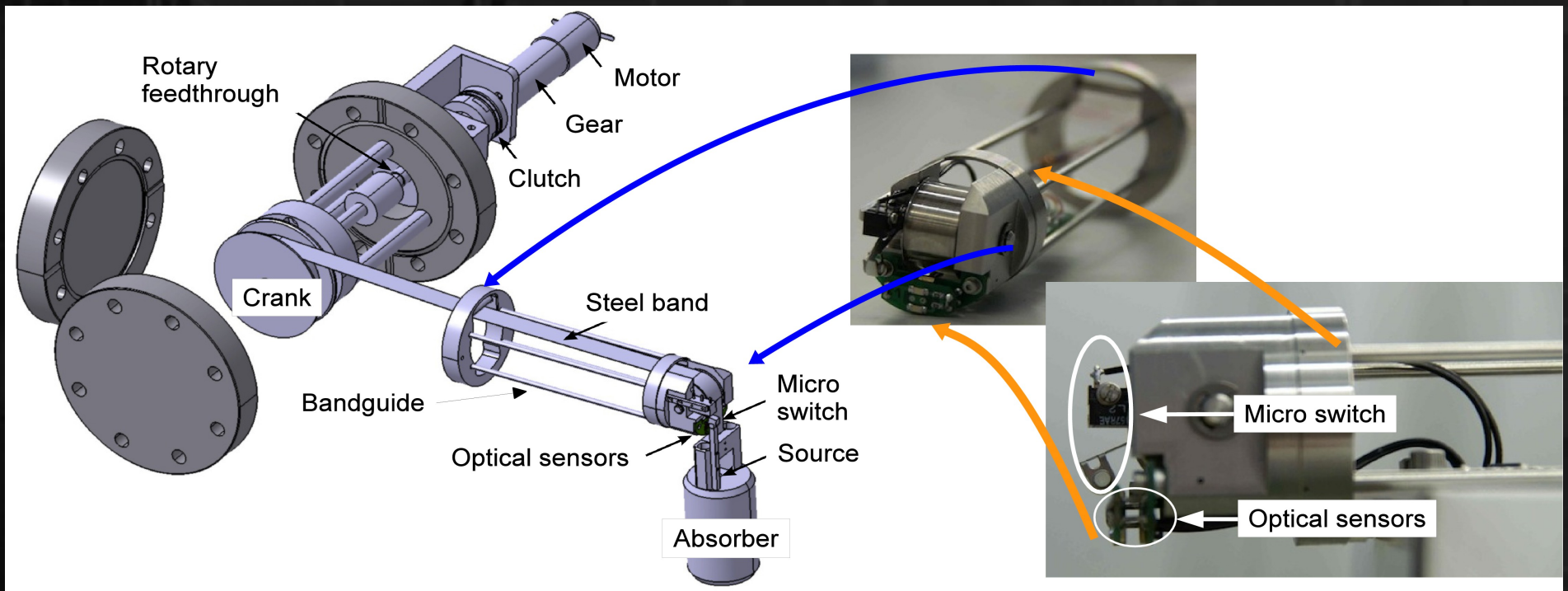


Scheme of the experiment (not to scale).



Top view showing the positions of the Ge diodes and the ^{228}Th calibration sources.

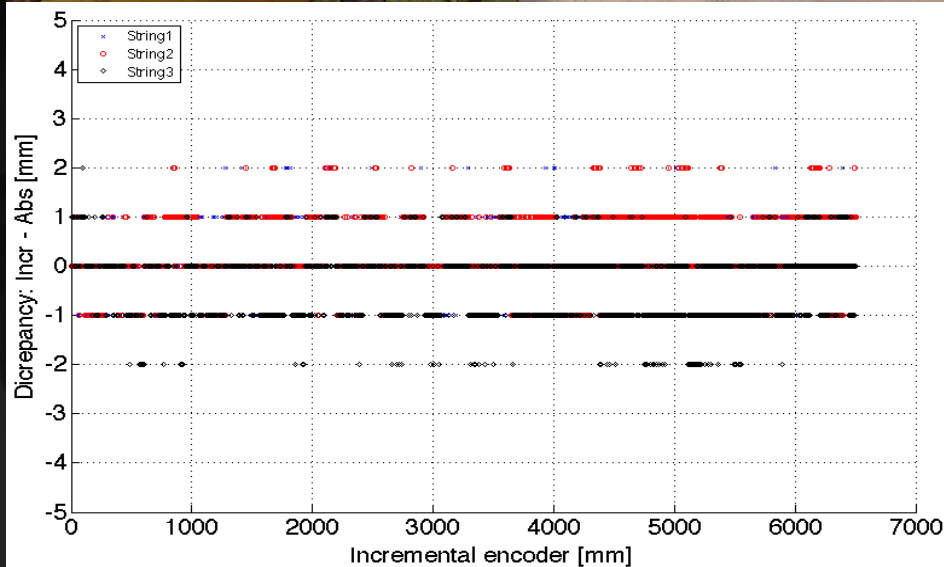
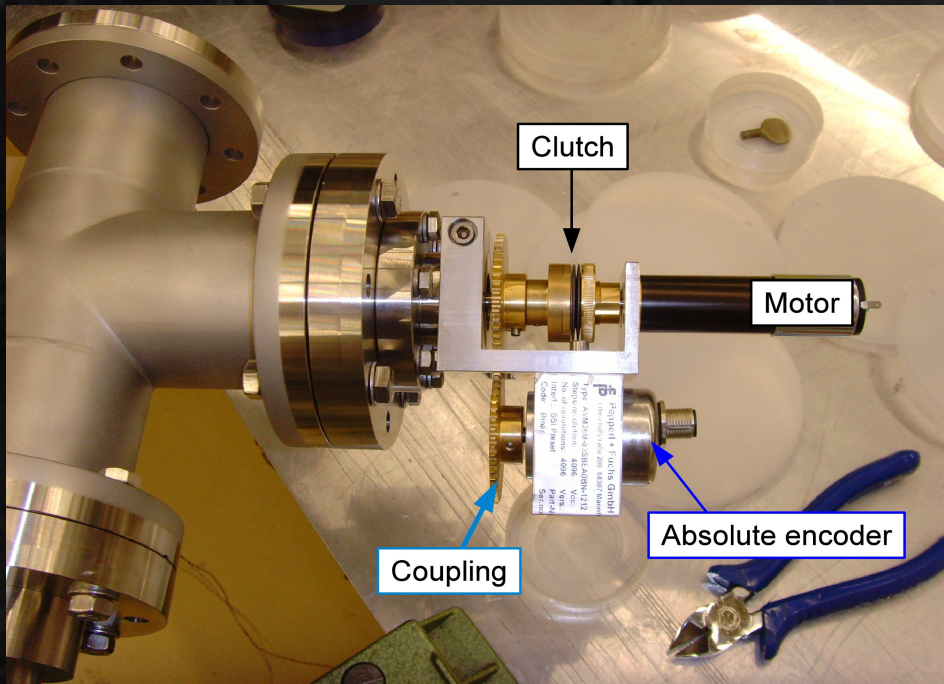
The Source Insertion System



Incremental position measurement:

- Perforated steel band (pitch 4 mm).
- Two pairs of an LED and an optical sensor, resolution ± 1 mm.
- Direction from phase shift.

The Source Insertion System



Second independent position measurement, Pepper+Fuchs AVM36M multi-turn absolute encoder:

- Measures position even if not powered.
- Angular position determined by magnetic sampling with 8 bit resolution (< 1 mm).
- Calibrated using the incremental encoder.

Positions are corrected for thermal expansions.

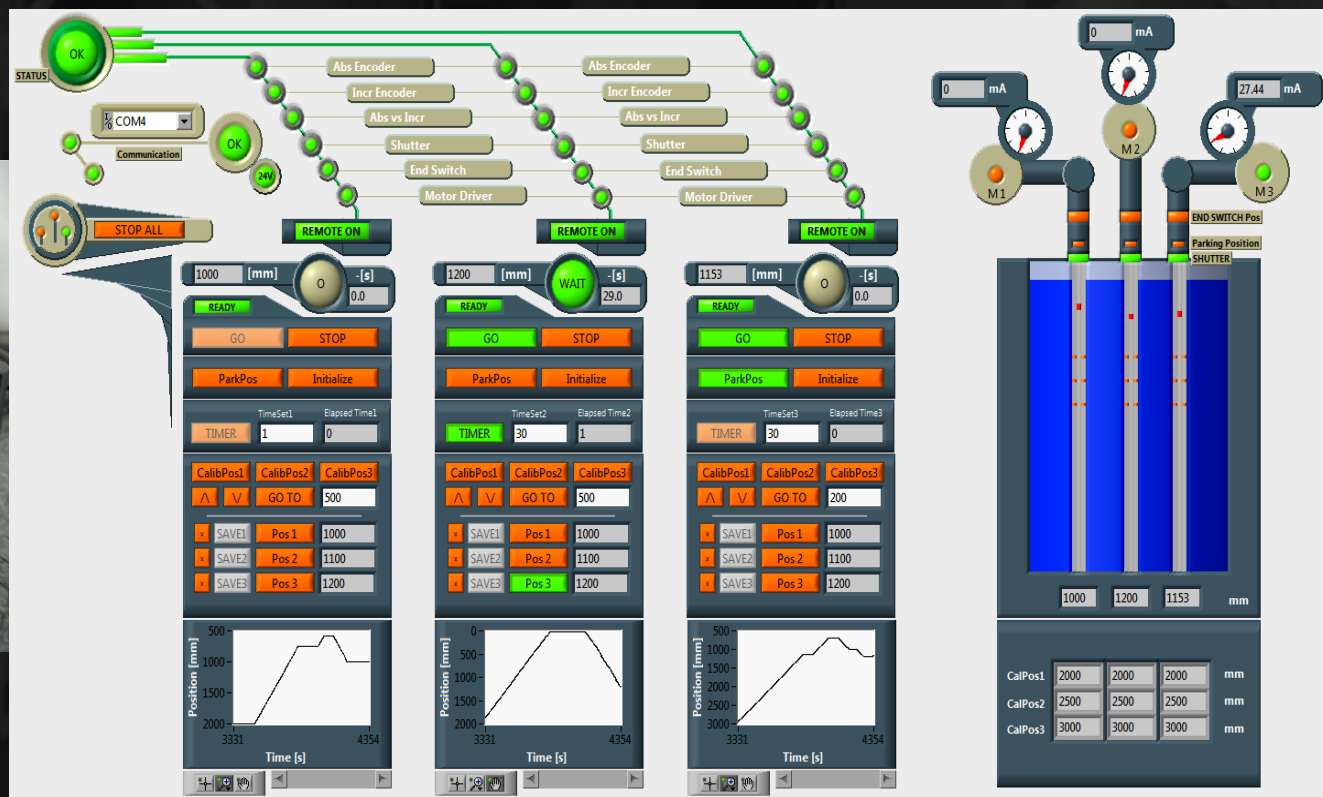
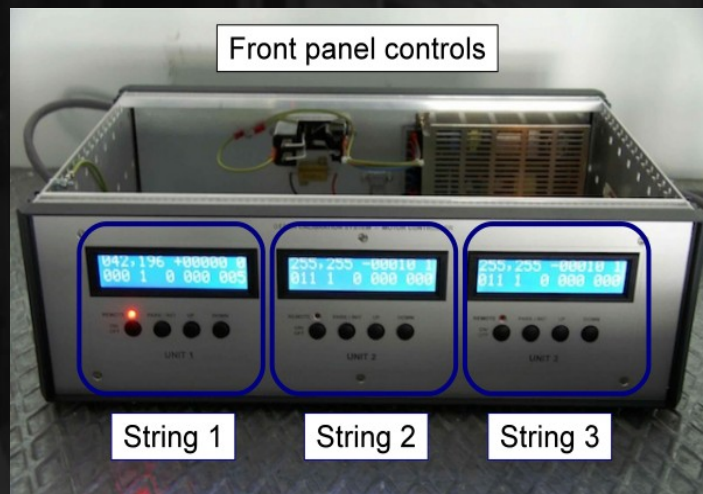
Crank and motor are coupled by a friction clutch.

Control

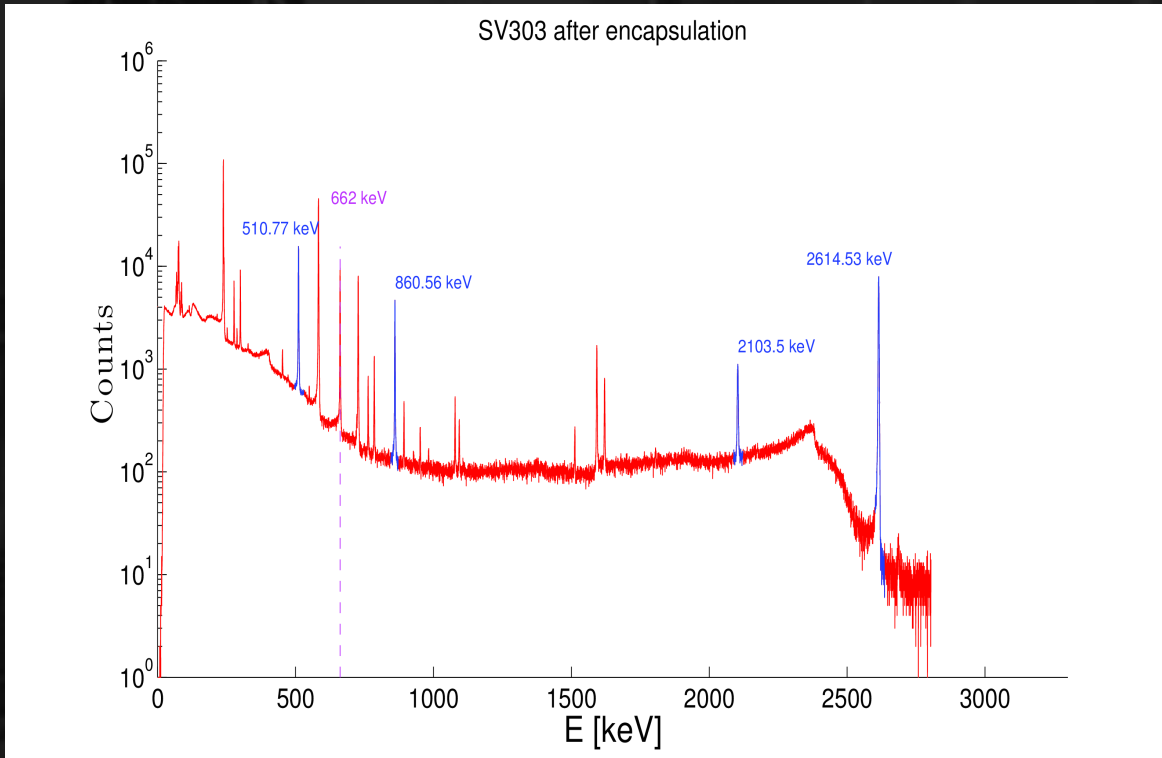
Complete control of the SIS and signal processing in one unit.

Full (optional) remote control and display using LabVIEW:

- Move to pre defined positions, program movement cycles, read shutter status, apply position calibrations, ...

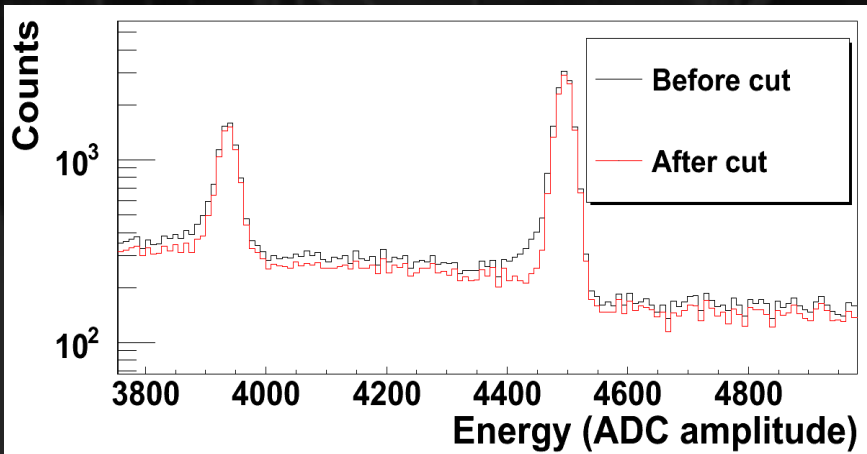


Calibration procedure



Iterative algorithm:

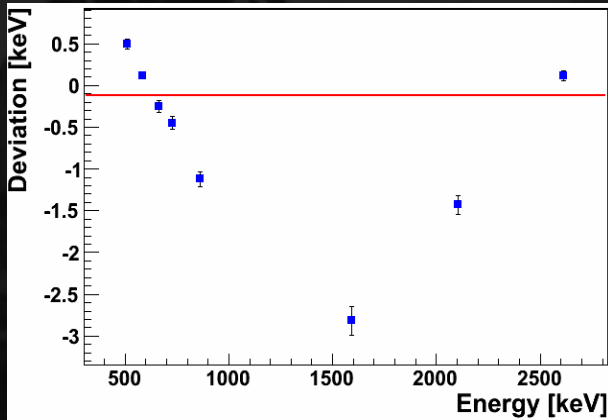
- Find peaks using moving differentiation.
- Identify the 583 keV and 2614 keV peak by ratio of the positions.
- Use these peaks to make a first linear calibration.
- Tries to identify up to 12 peaks for the final quadratic calibration function.



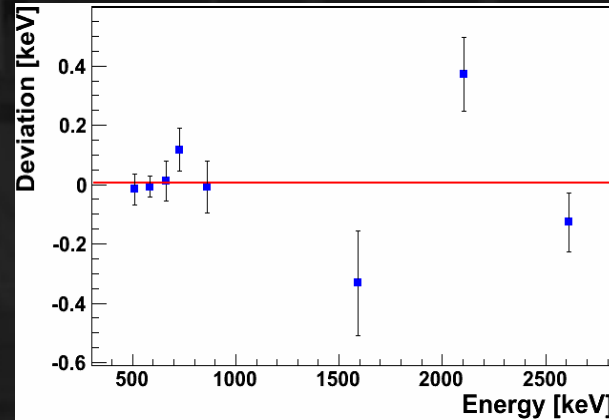
Parameter for pile-up rejection :

- Decay time of exponential fit to baseline.
- Number of leading edges.

Calibration parameters



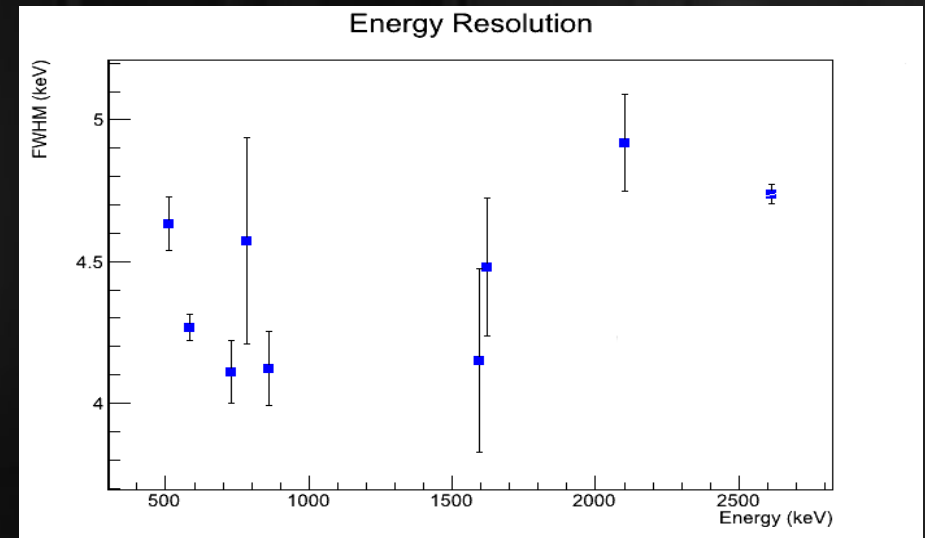
linear calibration



quadratic calibration

Deviation of peak position from true energy for the detector with largest non-linearity (RG2).

FWHM at different energies for ANG2



FWHM in keV at 2.6 MeV:

ANG 2	ANG 3	ANG 4	ANG 5	RG 1	RG 2	GTF 112	GTF 45	GTF 32
4.7	4.7	4.4	4.4	4.6	5.3	4.2	5.3	4.6

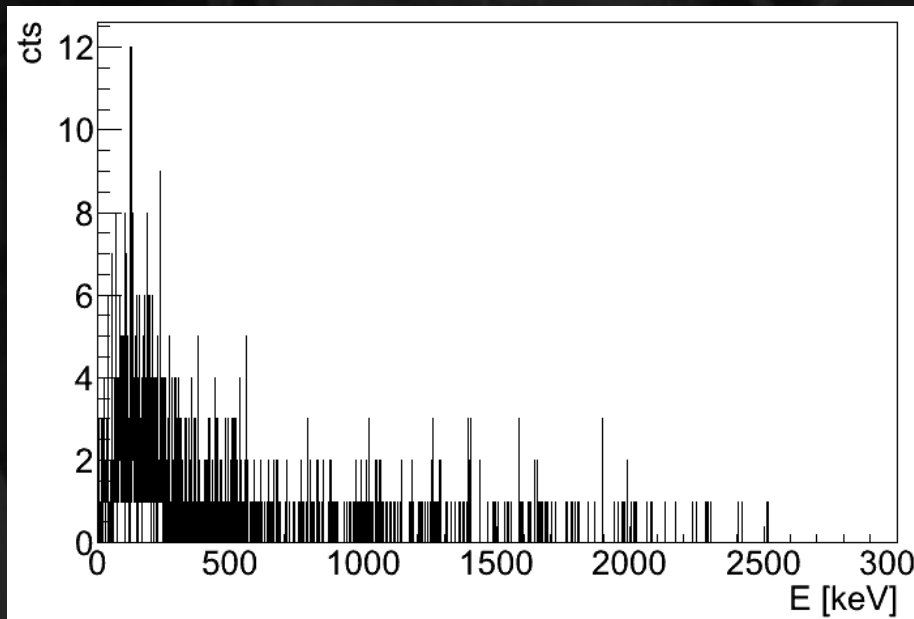
Background induced by sources in parking position

Full MC simulation using MaGe.

3.4 m above the detector array, $1.05 \cdot 10^{12}$ of 2.6 MeV γ 's were created in 2π (corresponds to ≈ 3 years).

Result: $(1.98 \pm 0.62(\text{stat}) \pm 0.2(\text{sys})) \cdot 10^{-4}$ counts/(keV·kg·y) in energy range 1839-2239 keV. Phase I goal: $1 \cdot 10^{-2}$ Phase II: $1 \cdot 10^{-3}$ counts/(keV·kg·y).

Ta absorber not included (reduction factor ≈ 50).

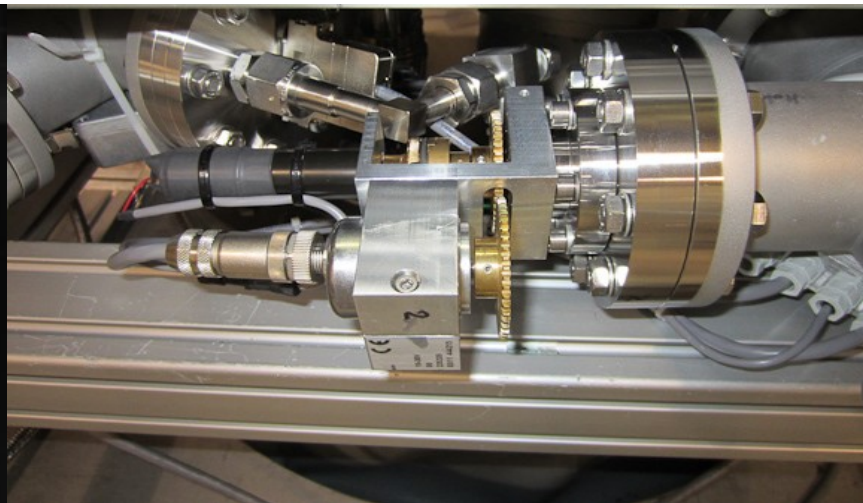
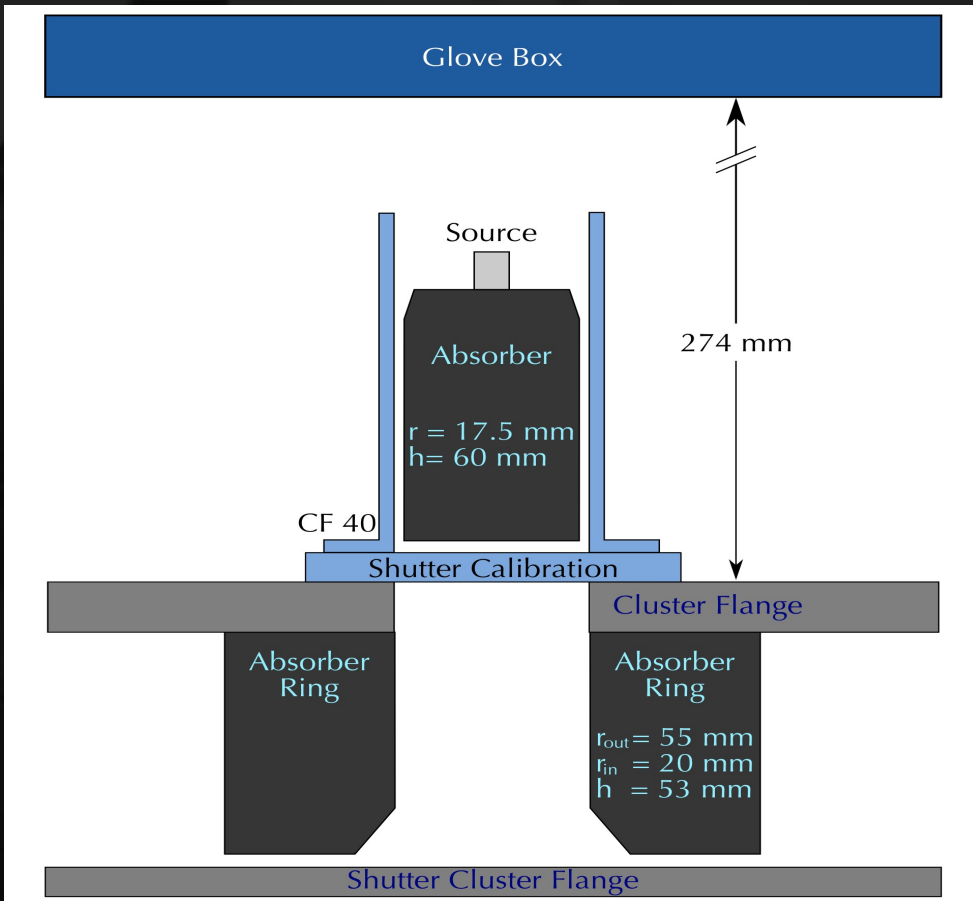


Resulting γ energy spectrum in the Ge diodes.

Neutron induced background:
 $(3.0 \pm 0.1(\text{stat})^{+0.3}_{-0.4}(\text{sys})) \cdot 10^{-4}$
counts/(keV·kg·y)



Thank you for your attention.



ISOTOPE	SERIAL NUMBER	CERTIFICATE	ENCAPSULATION	DATE OF PRODUCTION	DATE OF ACTIVITY MEASUREMENT	ORIGINAL ACTIVITY [KBQ]	CURRENT ACTIVITY [KBQ]	INSTALLATION DATE	STRING
^{228}Th	SV303	PDF	VZ3474	2010-04-09	2010-04-09	25	12.6	2011-06-20	S1
^{228}Th	SV304	PDF	VZ3474	2010-04-09	2010-04-30	17.7	9.1	2011-06-20	S2
^{228}Th	SK393	PDF	VZ3474	2010-01-15	2010-02-01	26.5	12.5	2010-11-08	S3

