Summary of TG1 (joint session with TG2,10)

- Characterization measurements and status of KI detectors @ LNGS
  - part 1:(K. Gusev)
  - part 2:(M. Shirchenkov)
- Empirical reconstruction of background index of the HdM exp. with radioactive sources (O. Chkvorets)
- Data taking with Padova flash-adc system (E. Farnea -> Carla's report)
- Detector support/contact design, underground detector lab.installation, LArGe system, (S. Schoenert)
- LArGe-ino setup @ MPIK: measurement and results (P. Peiffer)
- MaGe physics validation and simulation of liquid argon test stand (D. Franco)

Characterization of KI detectors

November, 2004, in LENS barrack
(prior to barrack refurbishment)

Detectors moved to LUNA - I

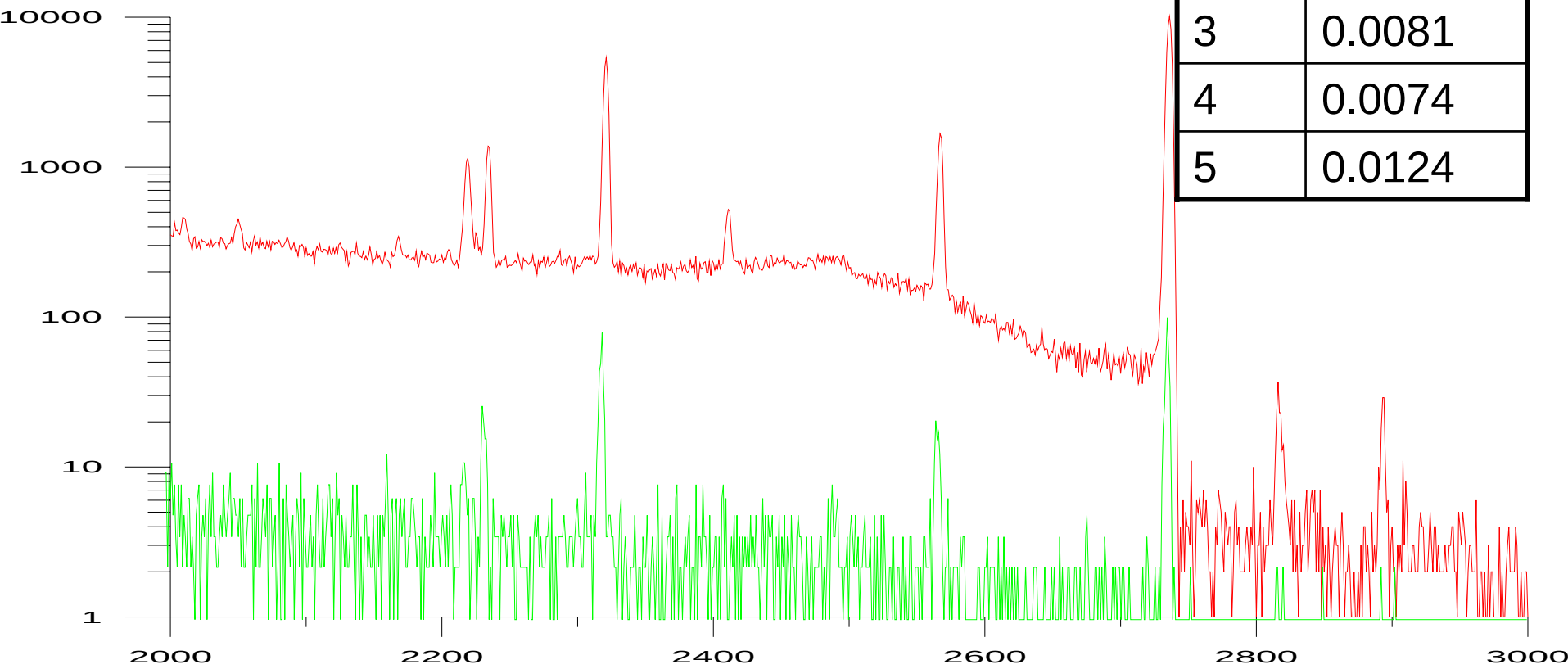
Tests done:

- Resolution
- Stability
- Deadlayer
- Summation peak analysis
- Flash-ADC data taking

	Detector 1	*Detector 2*	*Detector 3*	*Detector 4*	*Detector 5*
Full mass, kG	0.98	2.906	2.446	2.4	2.781
Depletion voltage, V		3000	3200	2900	1900
Bias voltage, V (recommended)	4000	4000	4000	3500	2500
FWHM, keV at 1332 keV (specifications)		1.98	1.91	1.97	2.06
FWHM, keV at full HdMo Set-up	2.22	2.43	2.71	2.14	2.55
Test at February 2005					
FWHM, keV at 1332 keV	2.7	2.27	2.53	2.35	2.75
New measurements					
Bias voltage, V	**3700**	**4000**	**4000**	**3500**	**2500**
FWHM, keV at 1332 keV	**2.88**	**2.5**	**3.0**	**2.76**	**3.05**

Background measurements with simple lead shield: check for gross contaminations

1	0.0063
2	0.0075
3	0.0081
4	0.0074
5	0.0124



Summary KI detector status

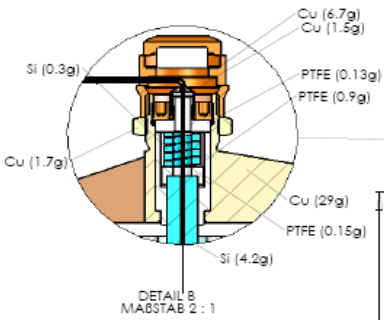
- All detectors are prepared for work, all crystals are good but their spectrometric performance are not ideal (especially for detectors 1, 3 and 5)
- Next steps: (for achieving the best performance of KI detectors)
  - Good measurement conditions -> LArGe barrack;
  - determination of various detector parameters (V-I characteristics);
  - Precision pulse generator;
  - Devices for pump and heat processes.
- Make all available procedures before refurbishment

Summation peak analysis

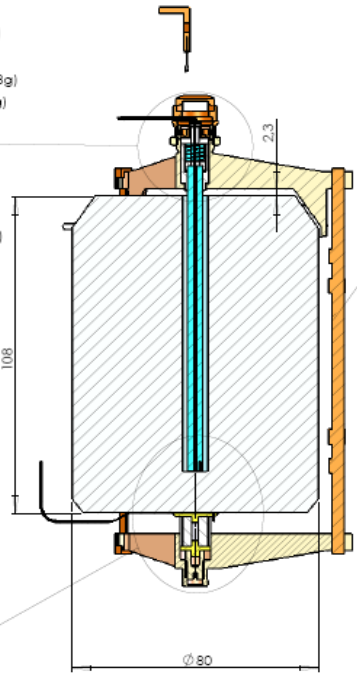
- Measurement of Bi-214 summation spectrum with ANG3
- Intensities of summation lines for different source position
- Conclusion: Good news: dominant Ra-226 (Bi-214) bgd is located at about 5 cm away from the detector – not on detector surface!

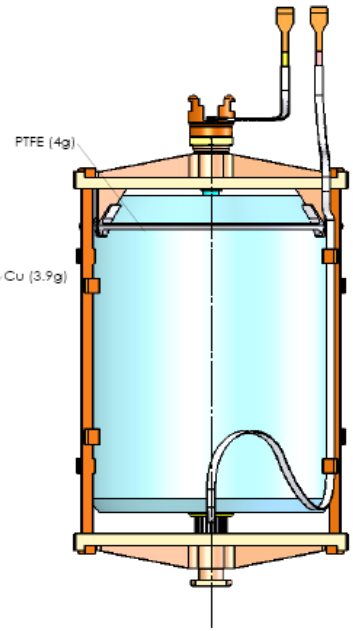
Specifications for new detector support and contacts

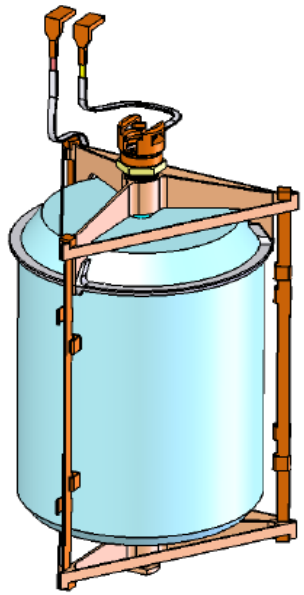
- Low-mass ($\Rightarrow$bgd index $<10^{-2}$ /(keV kg y))
- Use only screened materials with known radioimpurities (NOSV copper, PTFE, Silicon)
- Meets specific Ortec-type of contact (bottom of borehole)
- Mount and test each crystal individually
- Simple connection to string
- Dimensions according to Iris' specs of suspension system (cables some worrisome)

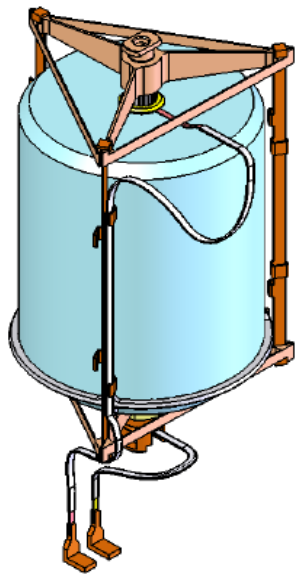


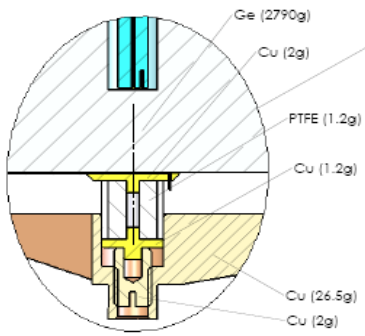
DETAIL B
MAßSTAB 2 : 1



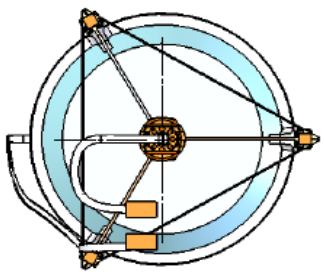






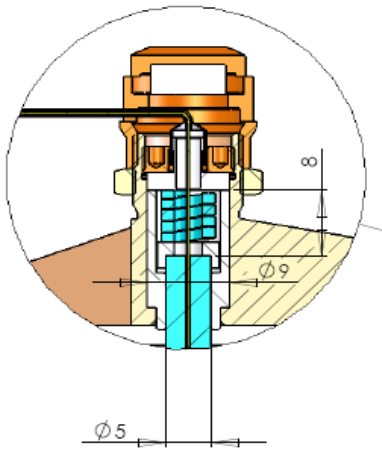


DETAIL C
MAßSTAB 2 : 1

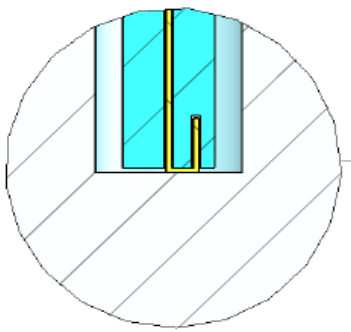


Bemerkung:		Projekt: GERDA	Projekt-Nr.: 116
		Abschnitt: Detector Support Phase 1	Abschnitt-Nr.: 001
		Benennung: Detektor Aufhaengung (Variante 2)	Teil-Nr.:
Erstellt am: 29.10.2002 10:56	Max-Planck-Institut für Kernphysik Heidelberg	Werkstoff:	Anzahl: 1 / Maßstab: 1:1
Auftraggeber: Schoenert		Datum der letzten Änderung: Mittwoch, 18. Mai 2005 10:27:20	
Koordinator: -			
Konstrukteur: Kanklanyan			
Zeichner: Kanklanyan	Zentrale Konstruktion	Zeichn.-Paket: 001 / Blatt-Nr.: 1 / Zeichn.-Nr.: 116001-Detektor Aufhaengung (Variante 2)	
Änderung vorbehalgt nicht dem Änderungsdienst			

Dateiname: L:\Solidworks\Radon Detektor\116001-Detector Support Phase I Variante 2.slddrw | Format: A2 | Blatt 1 von 3 | Geändert durch: Klakr

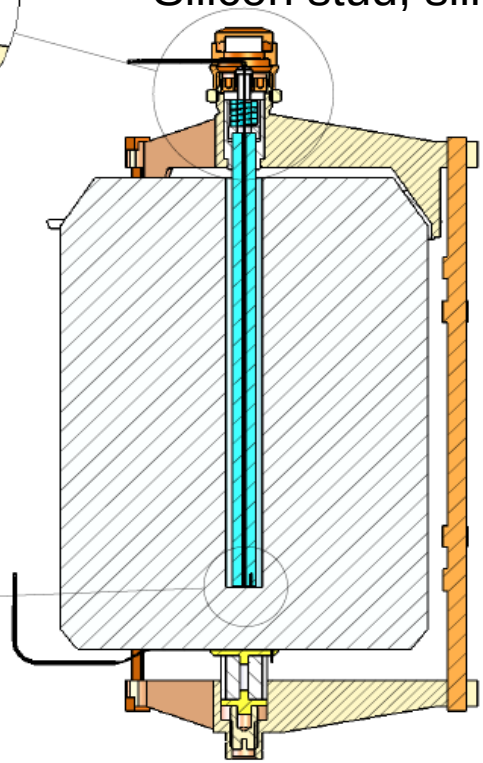


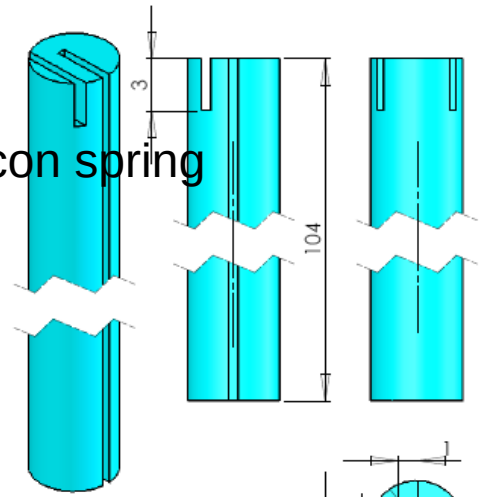
DETAIL E
MAßSTAB 2 : 1

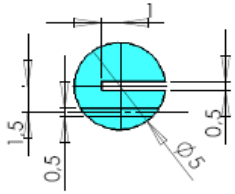


DETAIL F
MAßSTAB 4 : 1

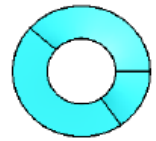
Silicon stud, silicon spring

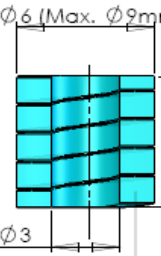






Si Stift (Variante 3)
Machbar ????



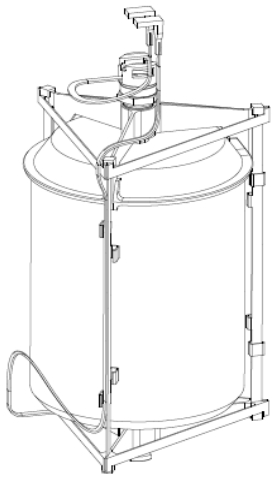


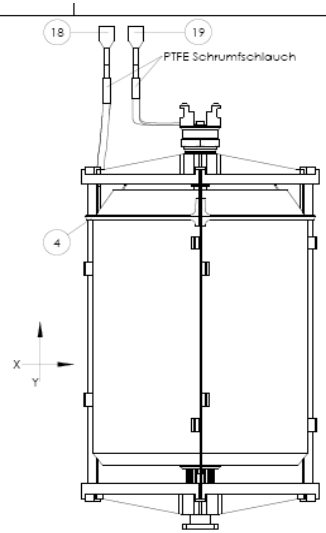
Profil? Form? Staerke ?
Max. Kraft 2N(restweg 1mm+)?

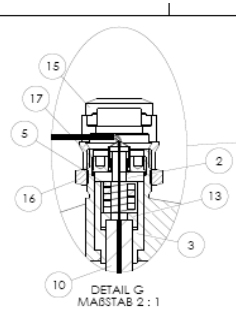
Bemerkung:	
Projekt:	GERDA
Projekt-Nr.:	116
Abschnitt:	Detector Support Phase 1
Abschnitt-Nr.:	001
Benennung:	Detektor Aufhaengung (Variante 2)
Teil-Nr.:	
Werkstoff:	
Anzahl:	1
Maßstab:	1:1
Datum der letzten Änderung	Mittwoch, 18. Mai 2005 10:27:20
Erstellt am:	29.10.2002 10:54
Auftraggeber:	Schoenert
Koordinator:	.
Konstrukteur:	Kankanyan
Zeichner:	Kankanyan
Zeichnung unterliegt nicht dem Änderungsdienst	
Max-Planck-Institut für Kernphysik Heidelberg	
Zentrale Konstruktion	
Zeichn.-Paket:	001
Blatt-Nr.:	2
Zeichn.-Nr:	116001-Detektor Aufhaengung (Variante 2)

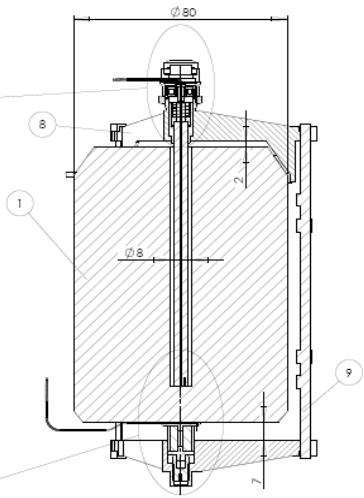
Dateiname: L:\SolidWorks\Radon Detektor\116001-Detector Support Phase I Variante 2.slddrw | Format: A3 | Blatt 2 von 3 | Geändert durch: kbkr

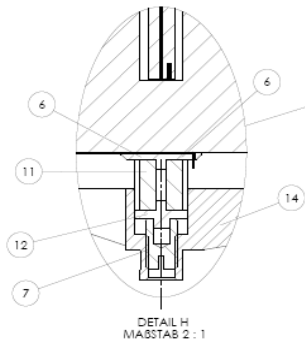
List of parts and masses

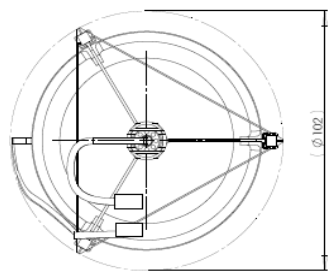












POS-NR.	Name	Anmerkung	MATERIAL	GEWICHT	Y	X	St.
1	Ge-Kristall 2	Z.Nr: 116001-039 Variante 2	Ge	2790g	0	0	1
2	Druckstueck 1	Z.Nr: 116001-080	PTFE	0.13g	73	0	1
3	Fuehrung 1	Z.Nr: 116001-078	PTFE	0.9g	63	0	1
4	Teller	Z.Nr: 116001-077 Variante 2	PTFE	4g	44	0	1
5	Si Feder	Z.Nr: 116001-082	Si	0.3g	69	0	1
6	Kontakt 1	Z.Nr: 116001-087	Cu	2.15g	-55	0	1
7	Gewindestift 1	Z.Nr: 116001-083	Cu	2g	-72	0	1
8	Stern 1 Variante 2	Z.Nr: 116001-075 Variante 2	Cu	29g	61	0	1
9	Streife 1 Variante 2	Z.Nr: 116001-092	Cu	3.9g	-2	46	3
10	Si Stift Variante 2	Z.Nr: 116001-081 Variante 2	Si	4.2g	0	0	1
11	Isolator 3	Z.Nr: 116001-098	PTFE	1.2g	-60	0	1
12	Druckstueck 2	Z.Nr: 116001-099	Cu	1.2g	-66	0	1
13	Isolator 1	Z.Nr: 116001-111	PTFE	0.15g	64	0	1
14	Stern 2	Z.Nr: 116001-132	Cu	26.5g	-67	0	1
15	Spezialmutter 3	Z.Nr: 116001-133	Cu	6.75g	80	0	1
16	Spezialmutter 2	Z.Nr: 116001-134	Cu	1.7g	72	0	1
17	Spezialmutter 1	Z.Nr: 116001-088	Cu	1.5g	75	0	1
18	Leitung 1	116001-Leitung 1	Cu	3.3g	58	30	1
19	Leitung 2	116001-Leitung 2	Cu	2.8g	87	17	1

Bemerkung:

Projekt: GERDA — Projekt-Nr.: 116

Abschnitt: Detector Support Phase 1 — Abschnitt-Nr.: 001

Benennung: Detektor Aufhaengung (Variante 2) — Teile-Nr.:

Werkstoff: — Ansicht: - — Modellabs: 1:1

Erstellt am: 29.10.2002 10:05:51 — Max-Planck-Institut für Kernphysik Heidelberg — Zentrale Konstruktion

Auftraggeber: Schoenert

Koordinator:

Konstrukteur: Kankanyan

Zeichner: Kankanyan

Datum der letzten Änderung: Mittwoch, 18. Mai 2005 10:27:20

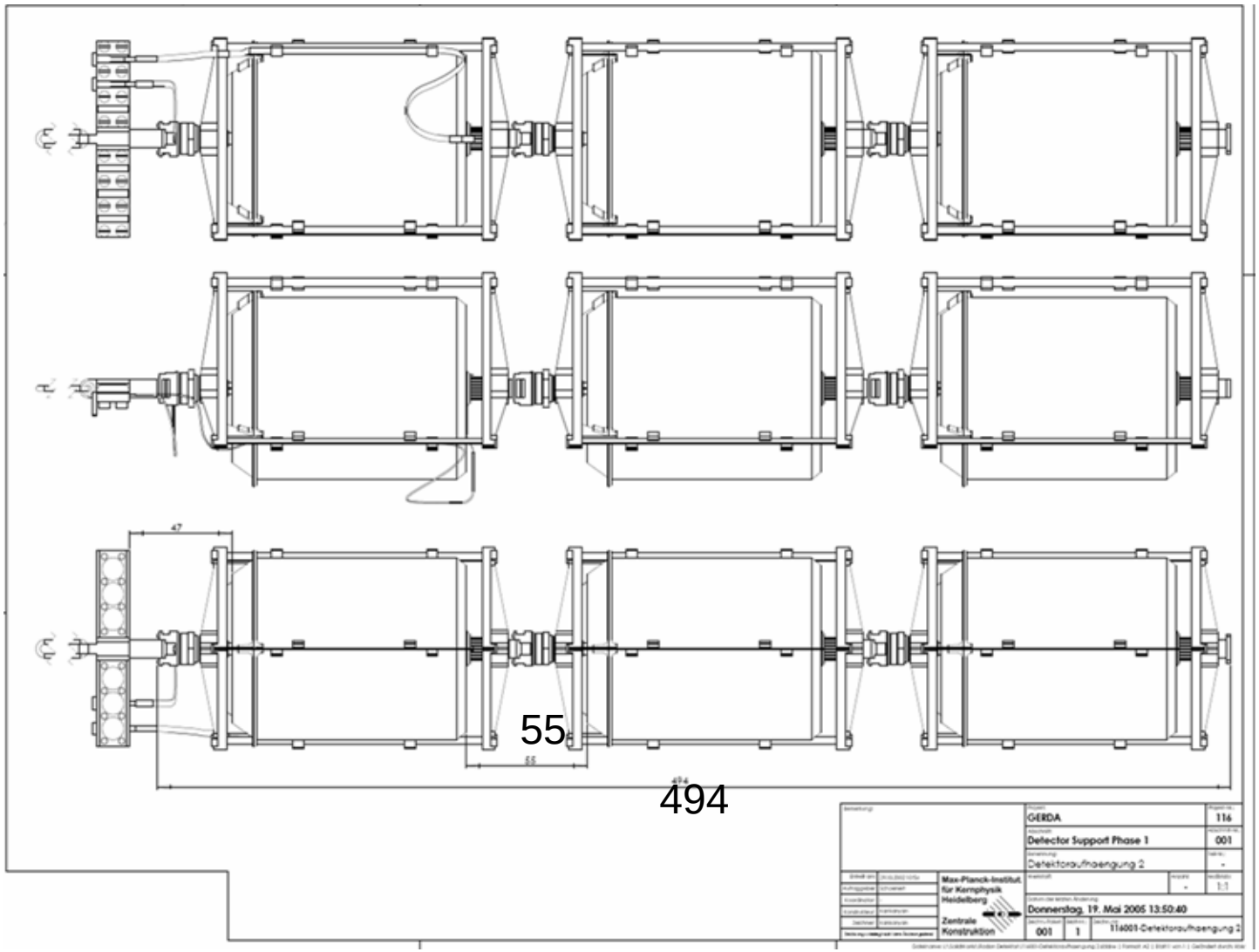
Zeichn.-Paket: 001 — Blatt-Nr.: 3 — Zeichn.-Nr.: 116001-Detektor Aufhaengung (Variante 2)

Dateiname: L:\SolidWorks\Radon Detektor\116001-Detector Support Phase 1 Variante 2.slddrw | Format: A2 | Blatt 3 von 3 | Geändert durch: Klokr

List of parts and masses

POS-NR.	Name	Anmerkung	MATERIAL	GEWICHT	Y	X	St.
1	Ge-Kristall 2	Z.Nr: 116001-039 Variante 2	Ge	2790g	0	0	1
2	Druckstueck 1	Z.Nr: 116001-080	PTFE	0.13g	73	0	1
3	Fuehrung 1	Z.Nr: 116001-078	PTFE	0.9g	63	0	1
4	Teller	Z.Nr: 116001-077 Variante 2	PTFE	4g	44	0	1
5	Si Feder	Z.Nr: 116001-082	Si	0.3g	69	0	1
6	Kontakt 1	Z.Nr: 116001-087	Cu	2.15g	-55	0	1
7	Gewindestift 1	Z.Nr: 116001-083	Cu	2g	-72	0	1
8	Stern 1 Variante 2	Z.Nr: 116001-075 Variante 2	Cu	29g	61	0	1
9	Streife 1 Variante 2	Z.Nr: 116001-092	Cu	3.9g	-2	46	3
10	Si Stift Variante 2	Z.Nr: 116001-081 Variante 2	Si	4.2g	0	0	1
11	Isolator 3	Z.Nr: 116001-098	PTFE	1.2g	-60	0	1
12	Druckstueck 2	Z.Nr: 116001-099	Cu	1.2g	-66	0	1
13	Isolator 1	Z.Nr: 116001-111	PTFE	0.15g	64	0	1
14	Stern 2	Z.Nr: 116001-132	Cu	26.5g	-67	0	1
15	Spezialmutter 3	Z.Nr: 116001-133	Cu	6.75g	80	0	1
16	Spezialmutter 2	Z.Nr: 116001-134	Cu	1.7g	72	0	1
17	Spezialmutter 1	Z.Nr: 116001-088	Cu	1.5g	75	0	1
18	Leitung 1	116001-Leitung 1	Cu	3.3g	58	30	1
19	Leitung 2	116001-Leitung 2	Cu	2.8g	87	17	1

String configuration

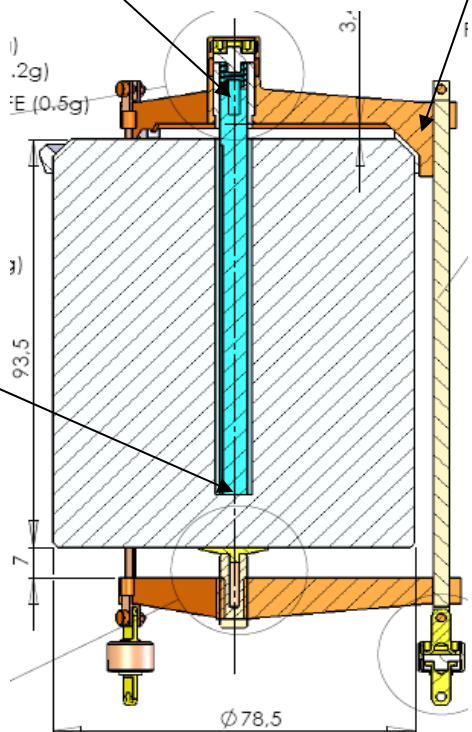


Analysis of bkgd contributions from support structure

MaGe Geant4 MC: probabilities per decay to deposit energy at $Q_{\beta\beta}$ in 1 keV energy bin

Co-60: $3.1 \cdot 10^{-5}$
Bi-214: $1.3 \cdot 10^{-5}$
Tl-208: $7.5 \cdot 10^{-5}$

Co-60: $1.6 \cdot 10^{-5}$
Bi-214: $1.2 \cdot 10^{-5}$
Tl-208: $5.8 \cdot 10^{-5}$



Co-60: $1.4 \cdot 10^{-4}$
Bi-214: $5.1 \cdot 10^{-5}$
Tl-208: $1.4 \cdot 10^{-4}$

Using our limits for Cu, PTFE and Si
Rate in roi:
$<1.5 \cdot 10^{-3}$ / (keV kg year)

Next steps

- Construction of mechanical mockup (ongoing)
- Test with (non-HP) Ge crystal (thermal and electrical)
- Prototype with non-enriched HP diode (only DSG and Canberra type available!)
- Extensive testing/characterization
- Ready for starting refurbishment of enriched detectors

LArGe Facility @ LNGS

Underground laboratory for detector refurbishment and testing of phase-I detectors

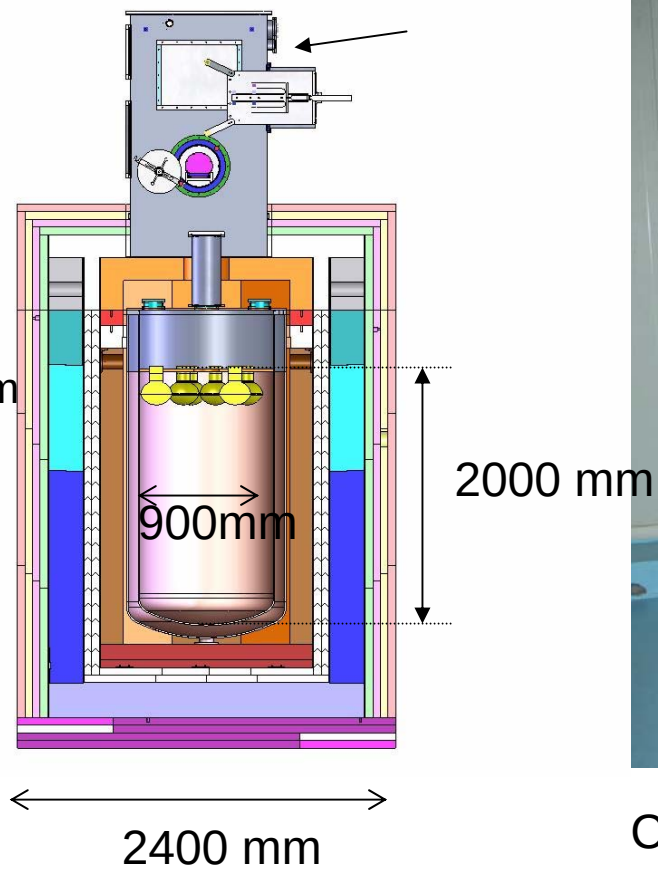
Washstand with high-purity water supply

Fume hood with charcoal filter and vent

(June 05)

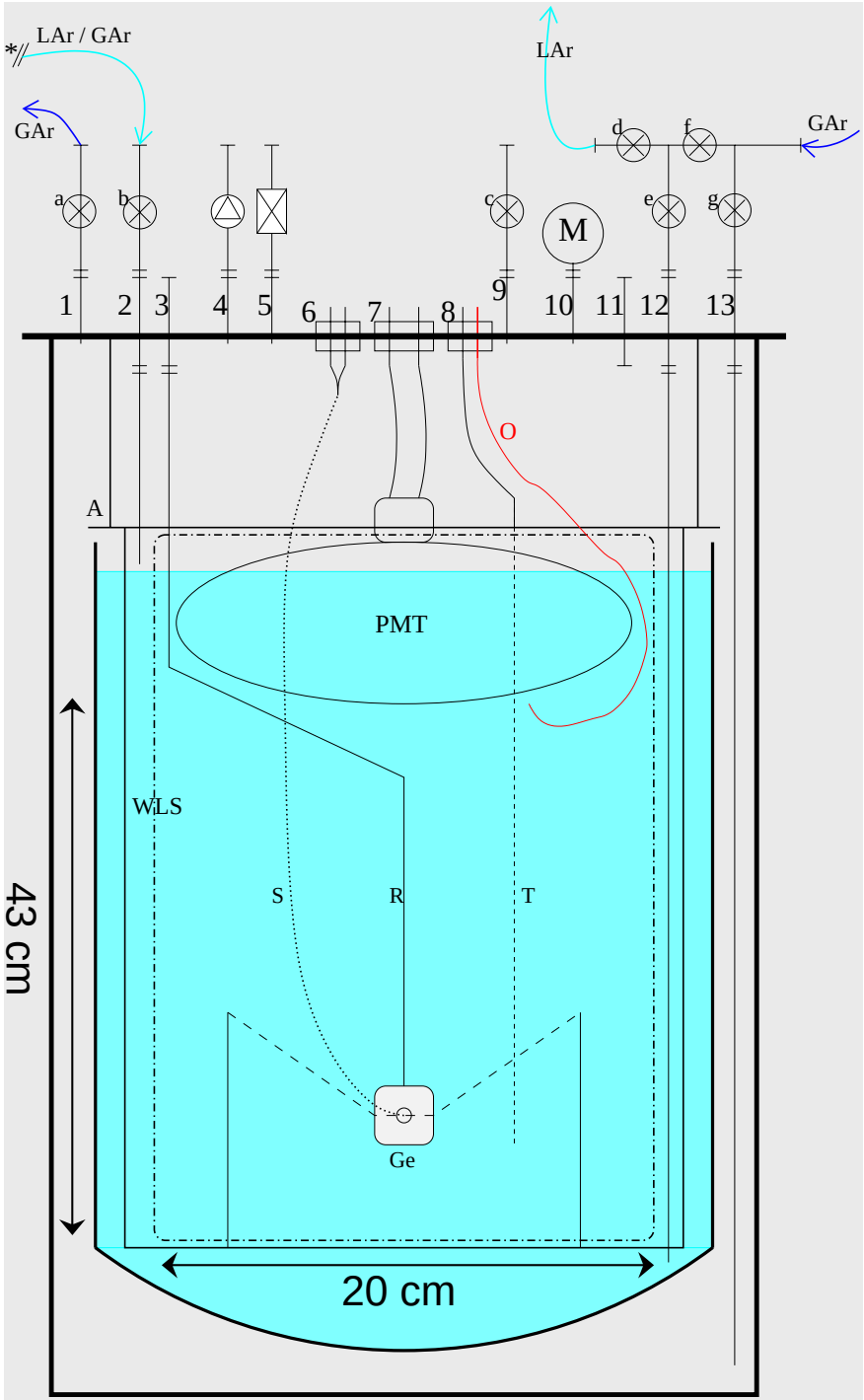
Mounting of LArGe shield

Graded shield:
Copper 150 mm
Lead 100 mm
Steel 230 mm
PE 200 mm



Copper & lead: < 20 μBq/kg (Th-228)

measurements in III



Aim of the measurements:

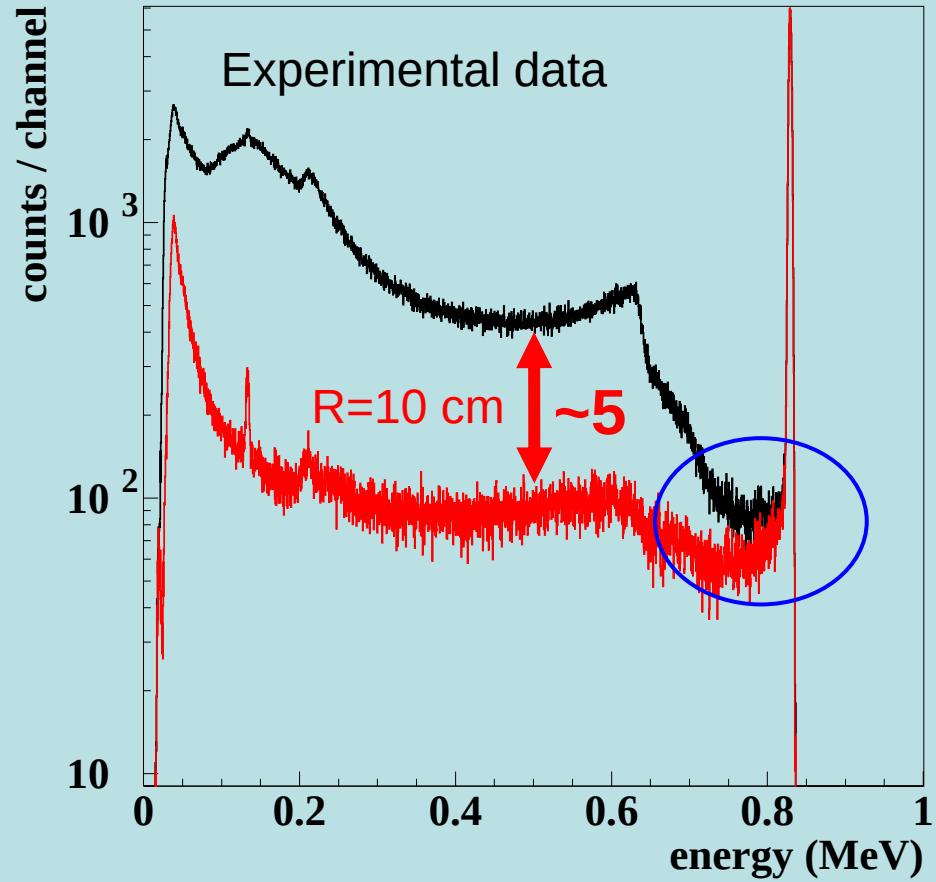
- Experimental demonstration of the new concept
- Determination of relevant parameters

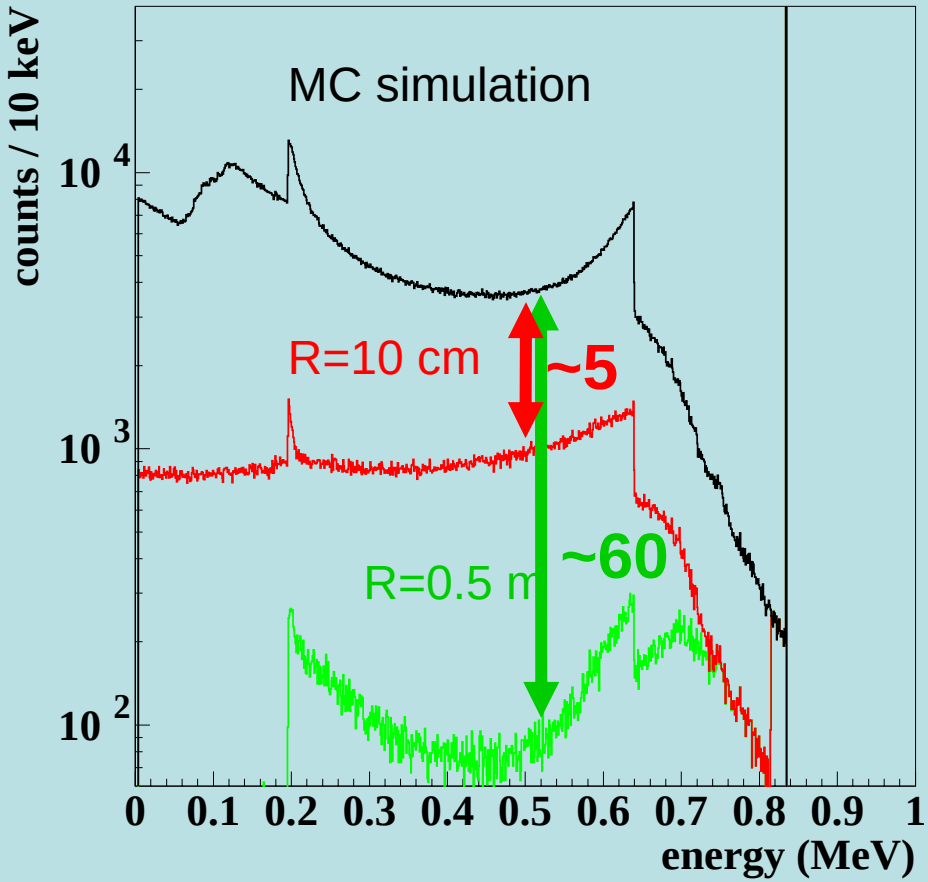
- 168 g and 2 kg p-type HPGe diode
- shielding: u/g lab (15 mwe) + 5 cm Pb
- light detection with wave-length-shifter (WLS) and PMT (ETL 9357KFLB)
  calibration of PMT: UV-LED on optical fibre
- LAr active volume: R = 10 cm, h = 43 cm
  filling-level: array of Pt100 temperature sensors
- complex system because of PMT:
  rather long exposure to ambient air during mounting; when unmounting, crystal at LAr T exposed to room T ⇒ condensation of water (and CO2?) possible

LArGe-ino test stand @ MPIK

Comparision MC/measured data

Source: ^{54}Mn, single-γ-line, E_γ = 835 keV





^{54}Mn-spectrum without suppression

- with LAr-scintillation-veto

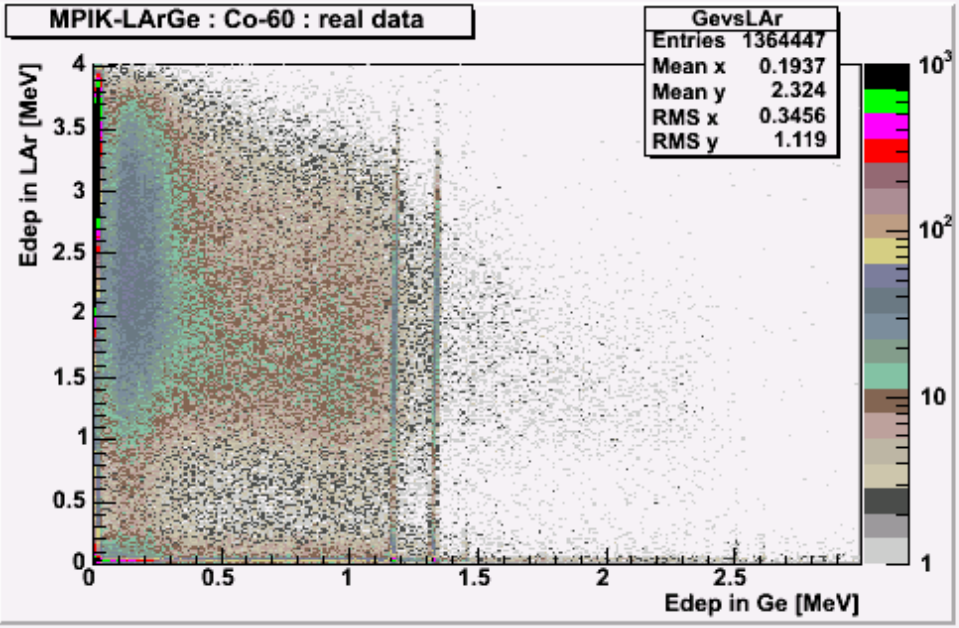
energy-threshold: 20-40 keV

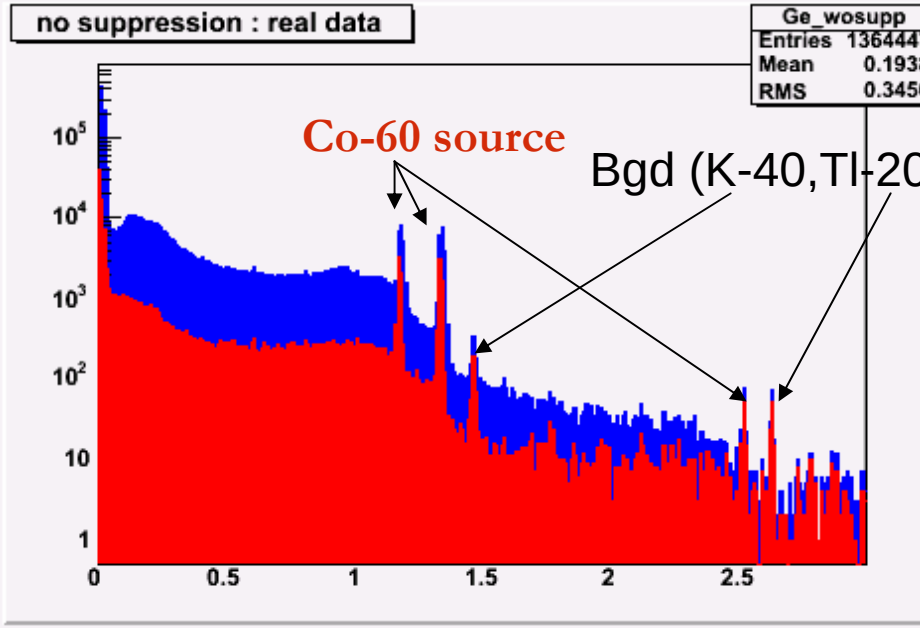
Suppression factor limited by:

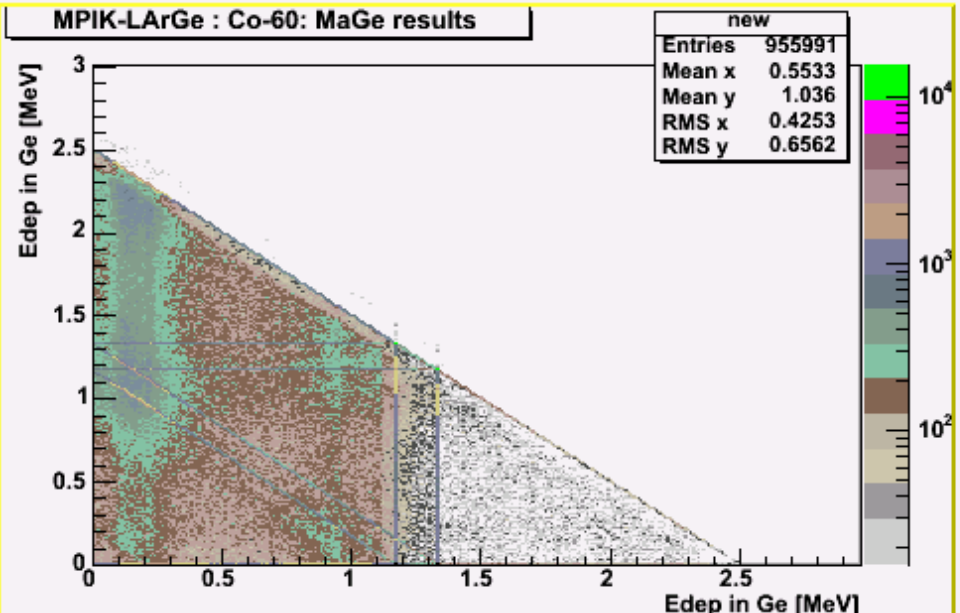
- escape-events (R = 10 cm)

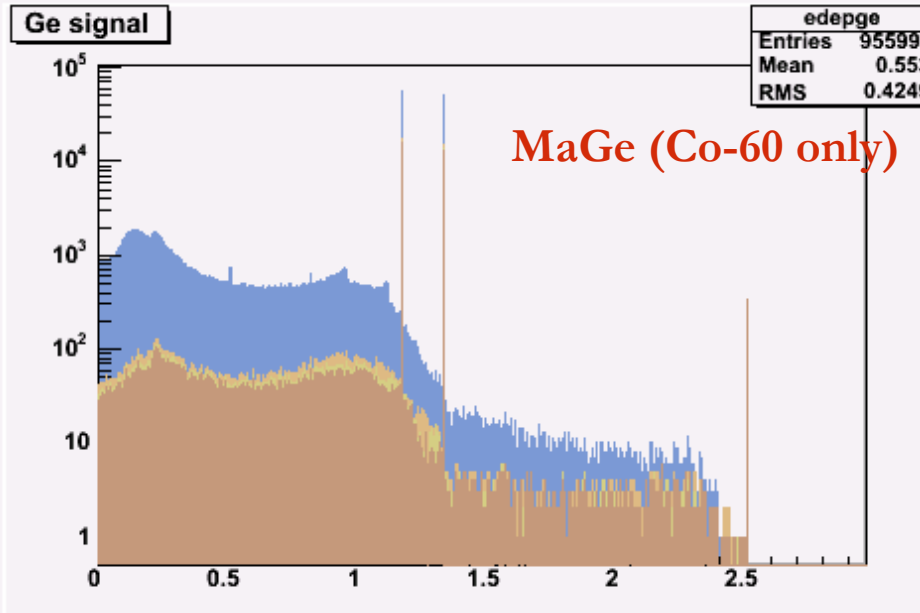
- dead layer of the diode (R = 1 m)

measurements in III: Co-60









quantitative comparison between MaGe and measurements in III

definition:

survival probability
=
nb of Ge evts after LAr veto
raw nb of Ge evts

⇒ the lower the better

Psurv	line (keV)	mc (%)	real (%)	real/mc
Cs 137	662	100,1 ± 0,5	85,2 ±0,7	0,85
Co 60	1173	27,7 ± 0,2	29,0 ± 0,5	1,05
	1333	25,7 ± 0,2	28,6 ± 0,4	1,11
	summ	100,0 ± 6,4	108,9 ± 11,0	1,09
Bi-214	609	24,9 ± 0,3	27,1 ± 0,6	1,09
	1120	17,7 ± 0,5	21,3 ± 1,2	1,21
	1764	92,6 ± 1,2	76,8 ± 2,6	0,83

calculated in flat region around 2038 keV

ROI	mc (%)		real (%)		real/mc
Co-60	23	2	31	2	0,76
Ra-226	48	5	27	5	1,78

quantitative comparison between MaGe and measurements in LL-Lab

definition:

$$\text{peak efficiency} = \frac{\text{nb of Ge evts in given peak}}{\text{nb of desintegrations}}$$

NB.: Detector high leakage current; not fully depleted

peak eff	line (keV)	mc (%)	real (%)	real/mc
Cs 137	662	0,606 ± 0,003	0,678 ± 0,004	1,12
Co 60	1173	0,507 ± 0,002	0,493 ±0,005	0,97
	1333	0,471 ±0,002	0,460 ± 0,004	0,98
	summ	0,002 ± 0,001	0,002 ± 0,001	0,96
Bi-214	609	0,327 ± 0,002	0,242 ± 0,004	0,74
	1120	0,077 ± 0,001	0,062 ± 0,002	0,80
	1764	0,063 ± 0,001	0,044 ± 0,001	0,70

peak ratios	line (keV)	mc	real	real/mc
Co 60	1173	1,08	1,07	1,01
	1333	1,00	1,00	1,00
	summ	0,005	0,005	1,02
Bi-214	609	1,00	1,00	1,00
	1120	0,24	0,25	0,94
	1764	0,19	0,18	1,04

peak / compton	line (keV)	mc (keV)	real (keV)	real/mc
Cs 137	662	123	94	1,3
Co 60	1173	120	95	1,3
	1333	111	88	1,3