LArGe-MPIK
progress report

- physics validation of MaGe
- comparison with LArGe-MPIK: (preliminary) results

GERDA collaboration meeting
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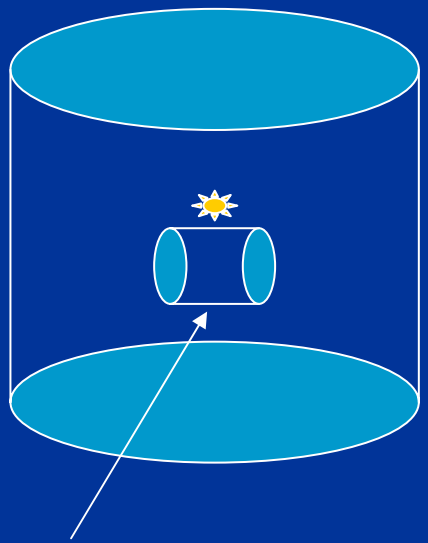
M. Di Marco, D. Franco, L. Pandola, P. Peiffer, S. Schönert

MaGe progress: physics validation

- 2 data sets from:
  - ^{60}Co source + 168 g bare crystal in LN (stat: 5.2e10)
  - ^{226}Ra source with a 830 g conventional crystal
    - 2 positions: in the center (statistics 8.5e7) & 60mm away (statistics 4.0e8)
- LArGe-MPIK: ^{60}Co, ^{226}Ra, ^{137}Cs
- Three tests:
  - Comparison of the spectral shapes
  - Efficiency (# of events in a gamma peak/disintegration)
  - Ratio (# of events in a gamma peak/# of events in the gamma peak of reference)

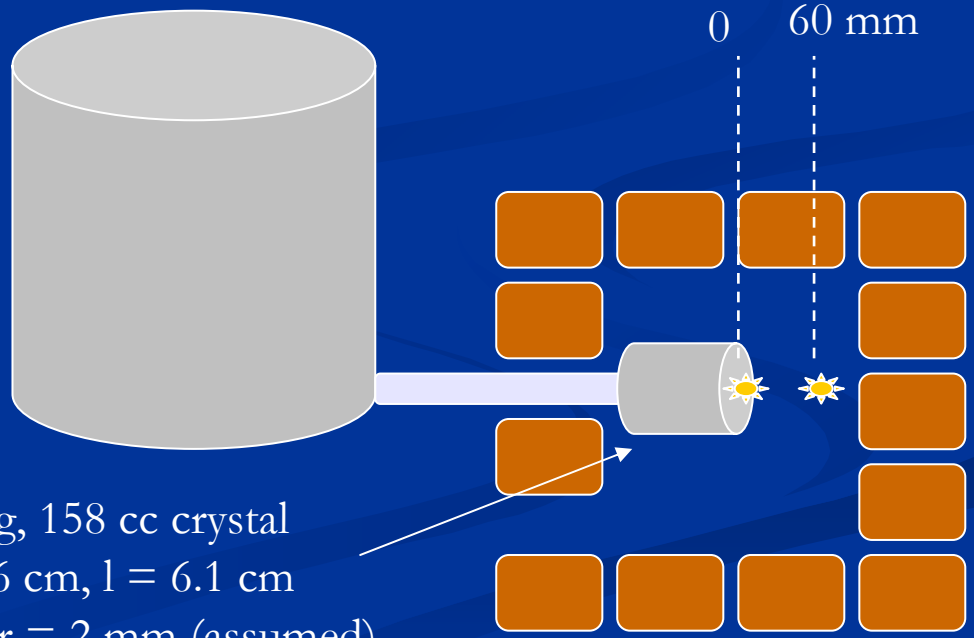
MaGe progress: physics validation

^{60}Co



168 g refurbished crystal
ψ = 3.9 cm, l = 2.4 cm
dead layer = 0.75 mm (assumed)

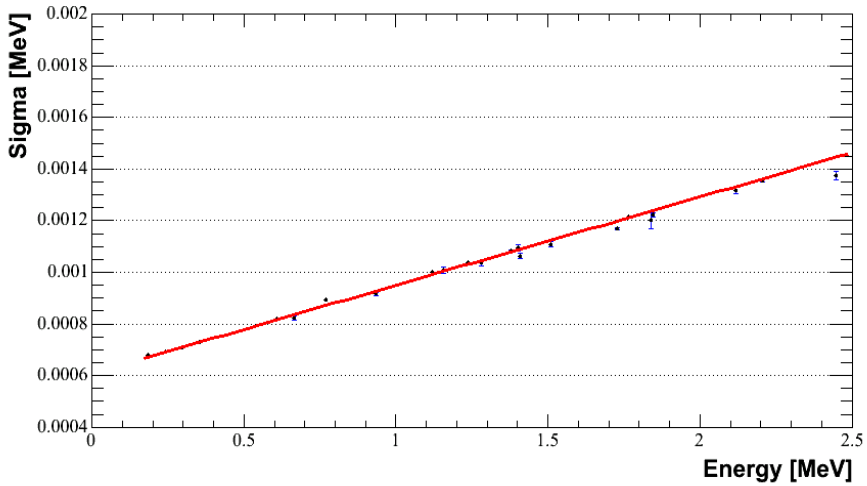
^{226}Ra



830 g, 158 cc crystal
ψ = 6 cm, l = 6.1 cm
dead layer = 2 mm (assumed)

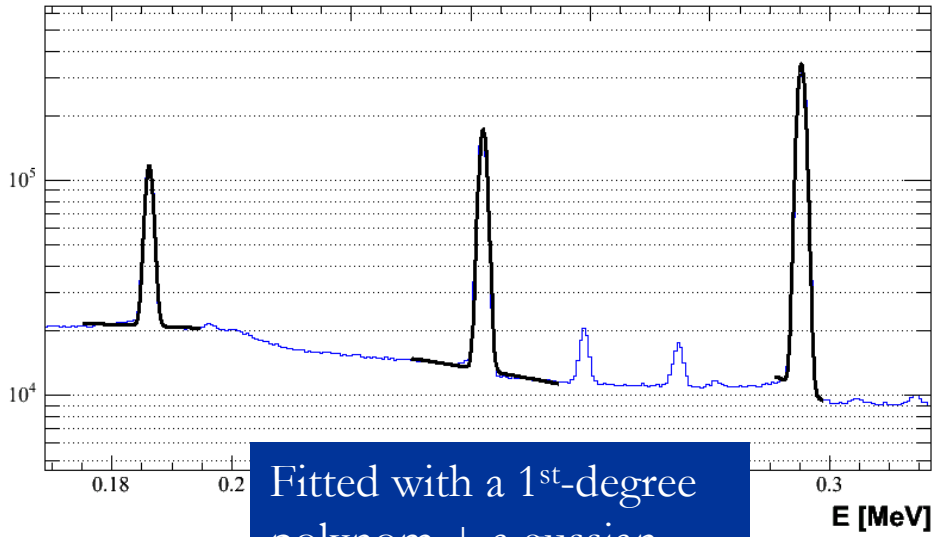
MaGe progress: physics validation

energy resolution

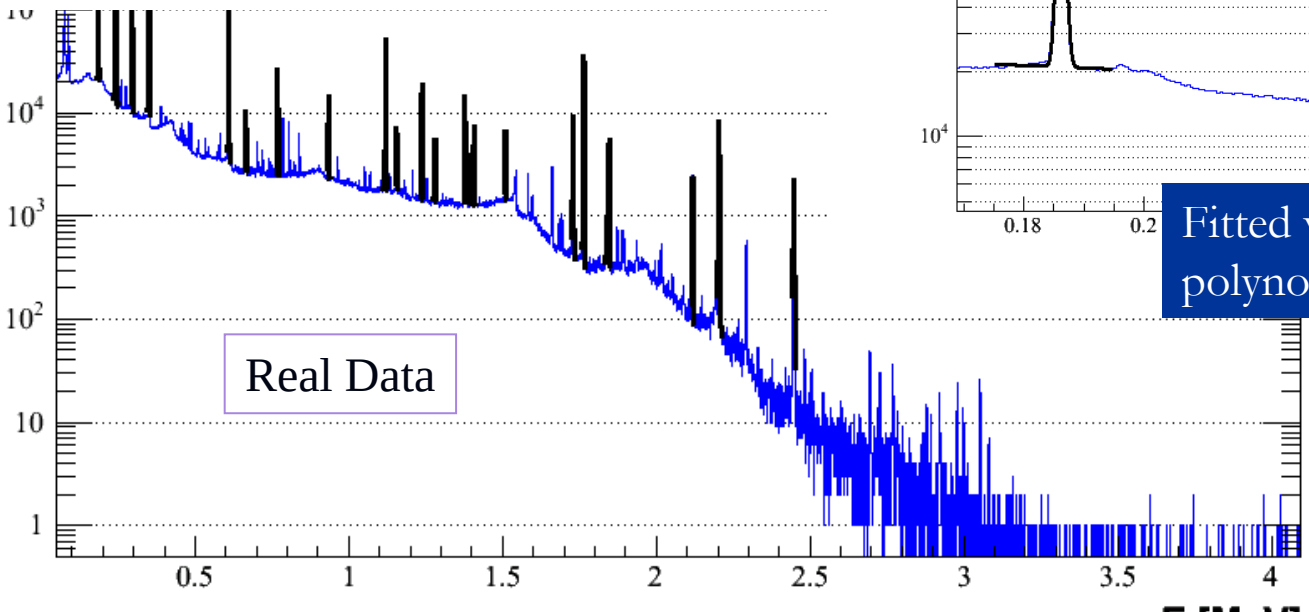


$$\sigma(E) = p1 + p2 * E$$

$$\sigma(E) \neq p1 + p2 * \sqrt{E}$$

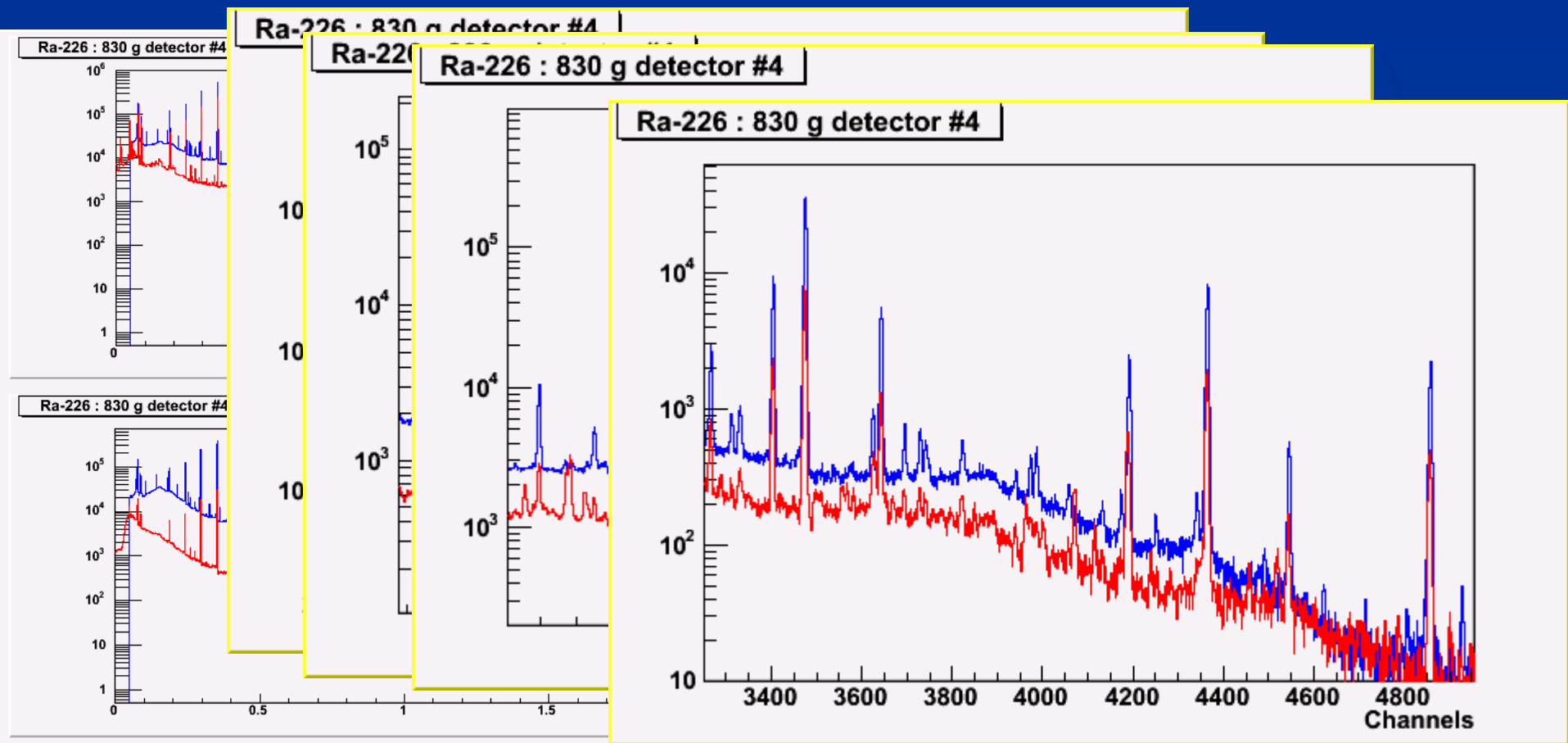


Fitted with a 1st-degree polynom + a gussian



MaGe progress: physics validation

Ra-226 calibration of conventional crystal



MaGe progress: physics validation

Ra-226 calibration of conventional crystal efficiencies

statistical errors << 1%

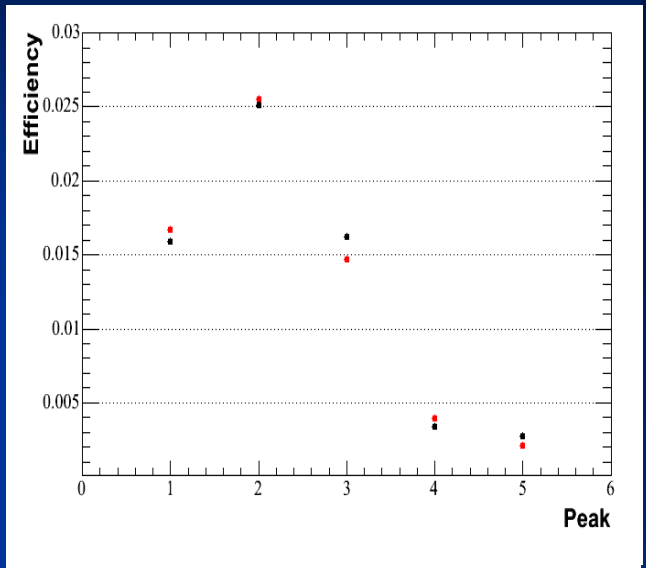
γ lines (center) [keV]	MaGe	RD	MaGe/ RD	γ lines (60mm) [keV]	MaGe	RD	MaGe /RD
295	1.67×10^{-2}	1.59×10^{-2}	1.05	295	2.21×10^{-3}	2.35×10^{-3}	0.94
352	2.55×10^{-2}	2.51×10^{-2}	1.02	352	3.27×10^{-3}	3.67×10^{-3}	0.89
609	1.47×10^{-2}	1.62×10^{-2}	0.91	609	2.45×10^{-3}	2.78×10^{-3}	0.88
1120	3.95×10^{-3}	3.42×10^{-3}	1.15	1120	5.57×10^{-4}	5.92×10^{-4}	0.94
1764	2.08×10^{-3}	2.72×10^{-3}	0.76	1764	3.45×10^{-4}	4.15×10^{-4}	0.83

MaGe progress : physics validation : Ra-226

efficiencies & ratios

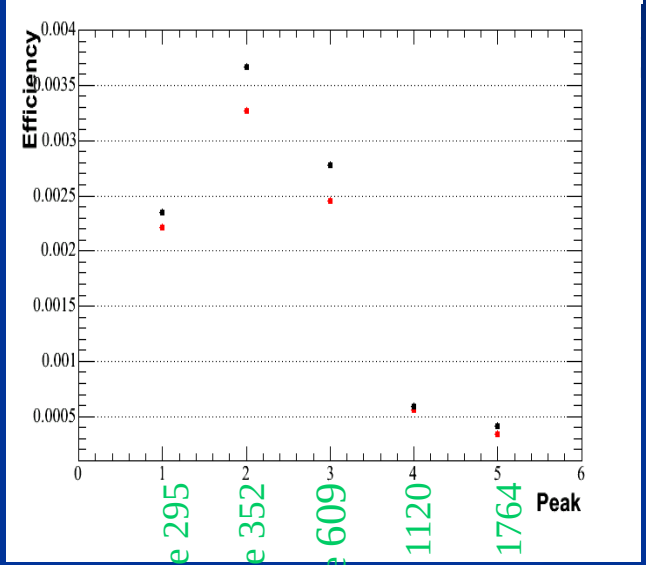
in the center:

Real Data (stat. 8.5e7)
MonteCarlo (stat. 1.0e7)



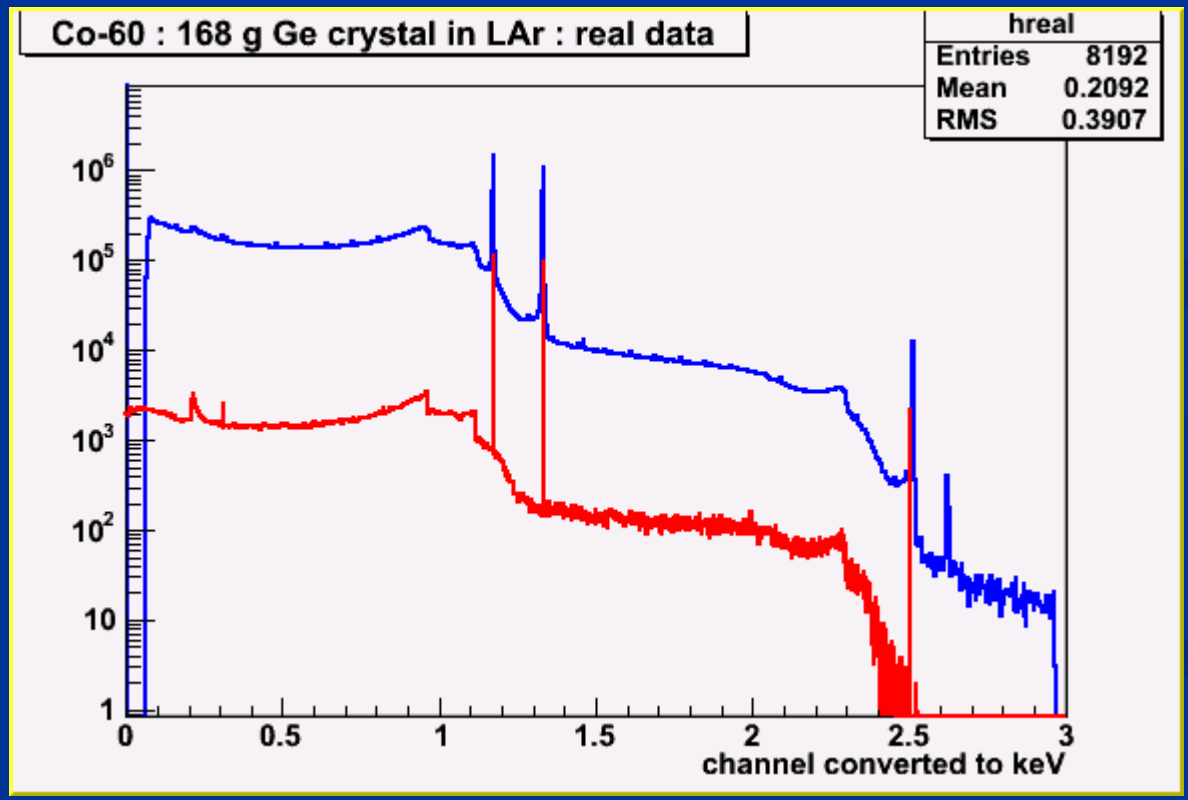
60mm away:

Real Data (stat. 4.0e8)
MonteCarlo (stat. 1.4e7)



MaGe progress: physics validation

Co-60 calibration of 168g bare crystal in LN

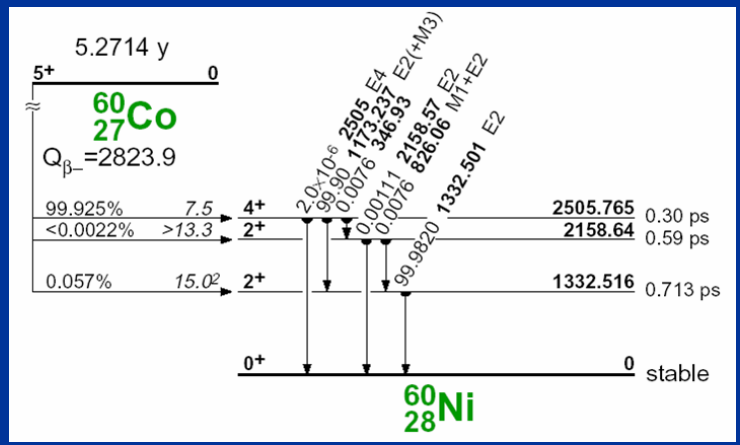


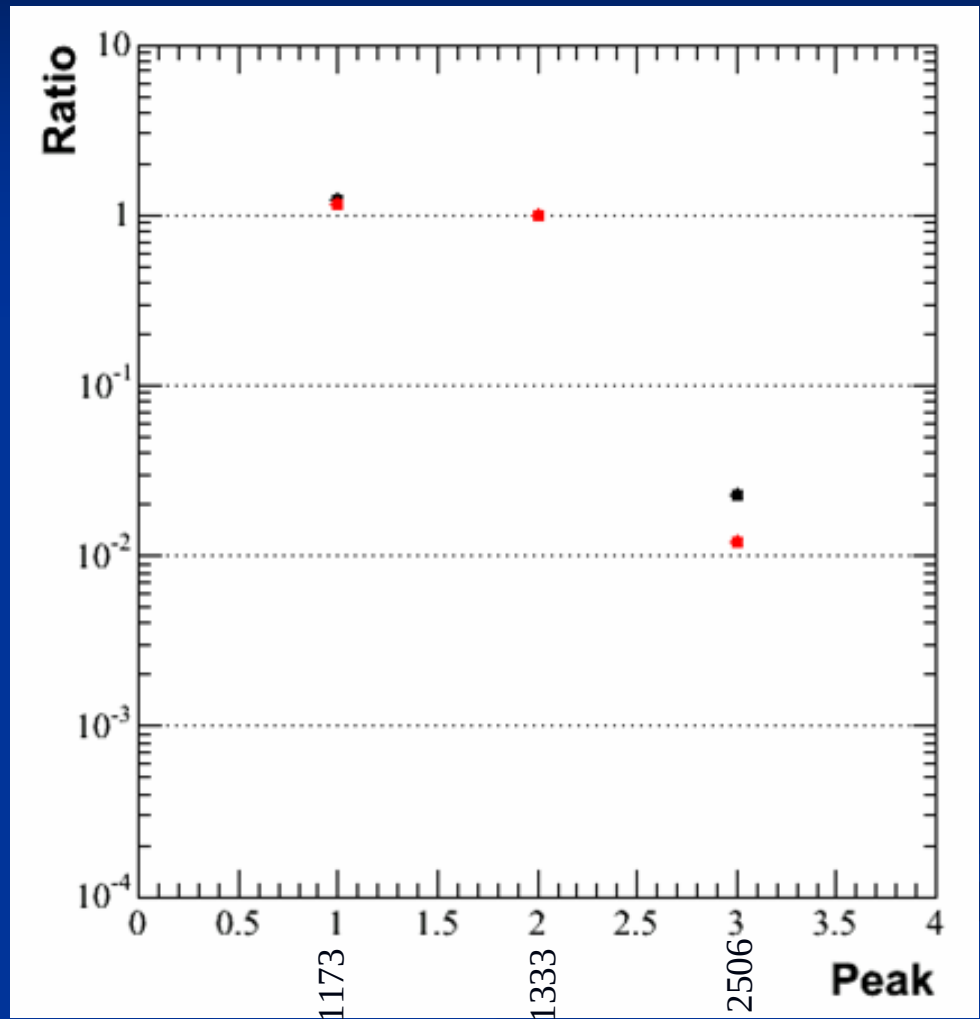
MaGe progress : physics validation : Co-60

efficiencies & ratios

summation peak off by a factor of 2

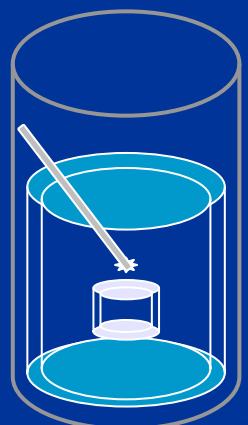
… but very simplified geometry for simulations





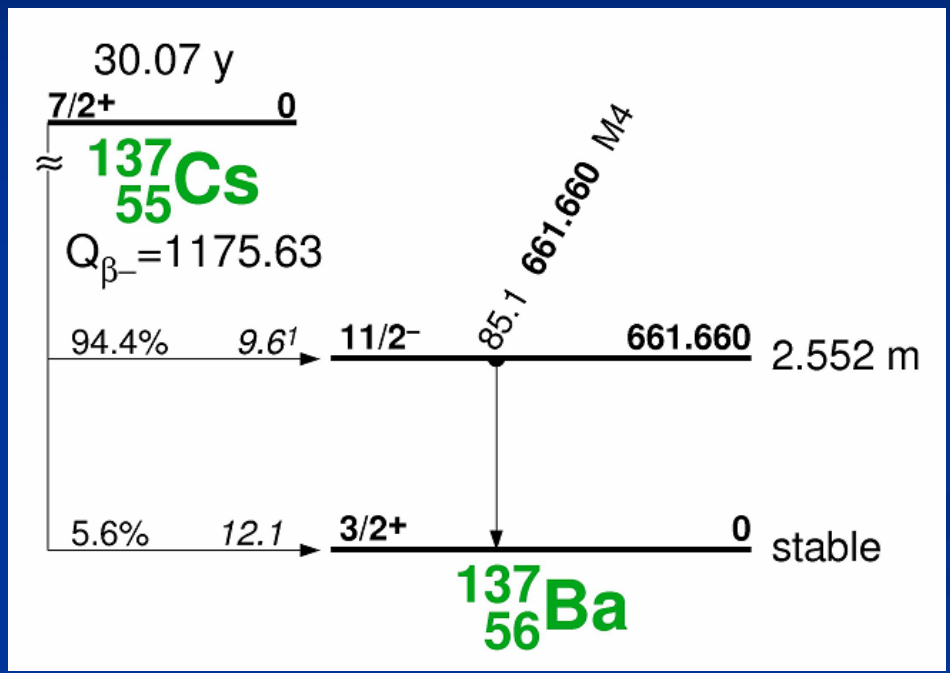
measurements in low-level lab: data with LAr veto

- 2 kg refurbished crystal in LAr covered with VM 2000 foil
- calibrations with encapsulated sources, positioned next to crystal
- all data shown here ~ 1h30 runs:
  meant to be quick test
- full depletion not reached:
  1400 V instead of 2400 V
- high leakage current ⇒bad resolution
  effect ~ bigger dead layer
  1.3 cm for MaGe simulations



measurements in lll: Cs-137

interesting because single gamma line



MaGe reproduces the spectrum quite well:

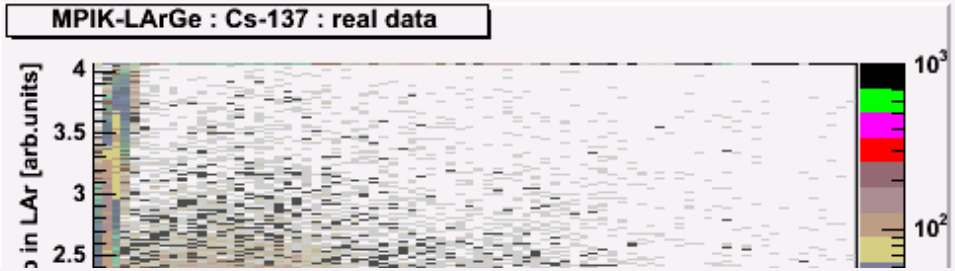
full E peak, Compton edge

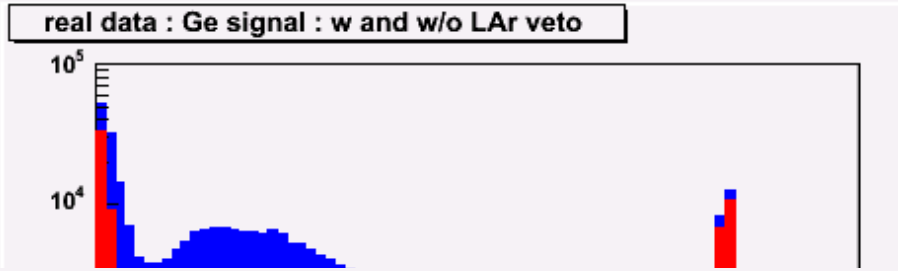
... except at low E: electronic noise, leakage current

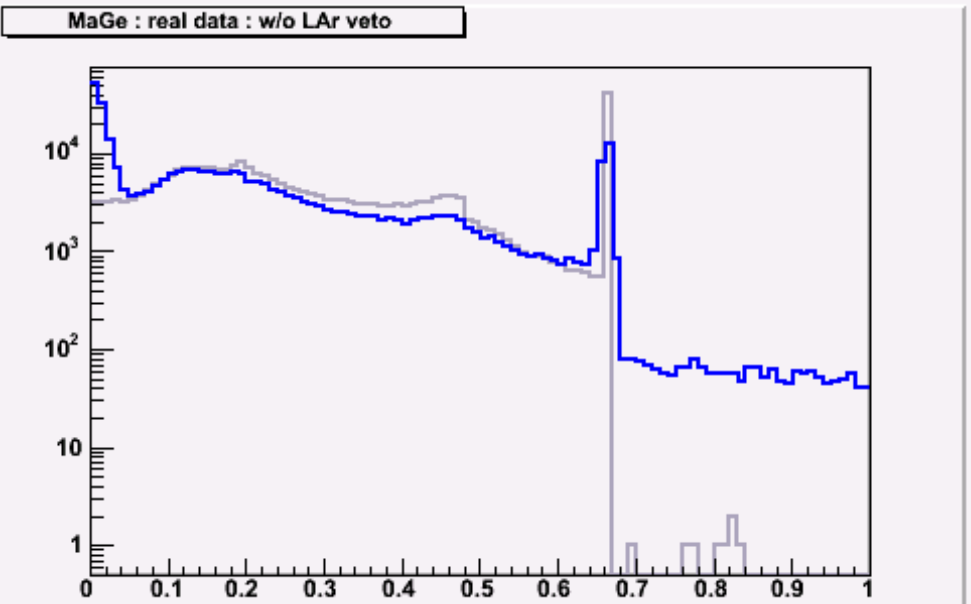
PMT threshold can be determined from shape of spectrum:

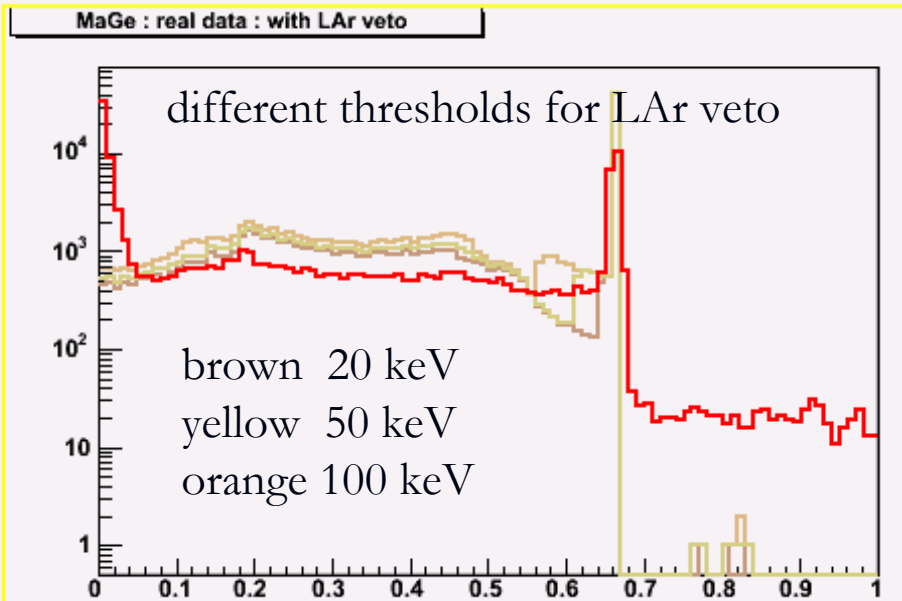
at full E peak and from structure (Compton edge)

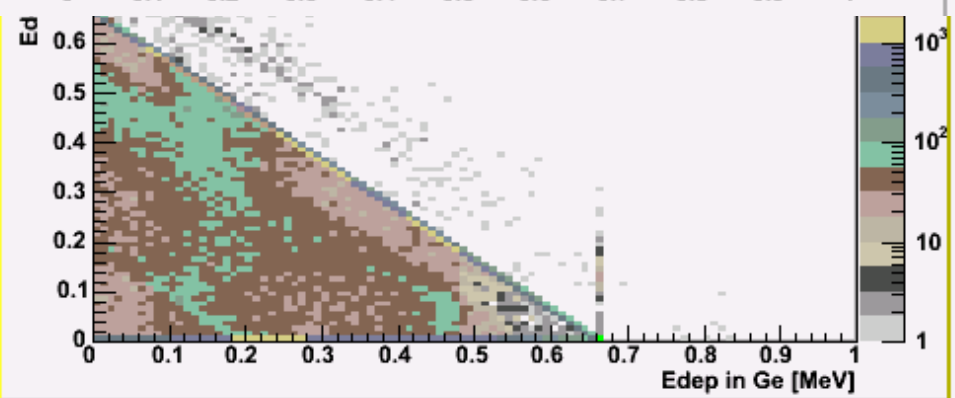
measurements in lll: Cs-137

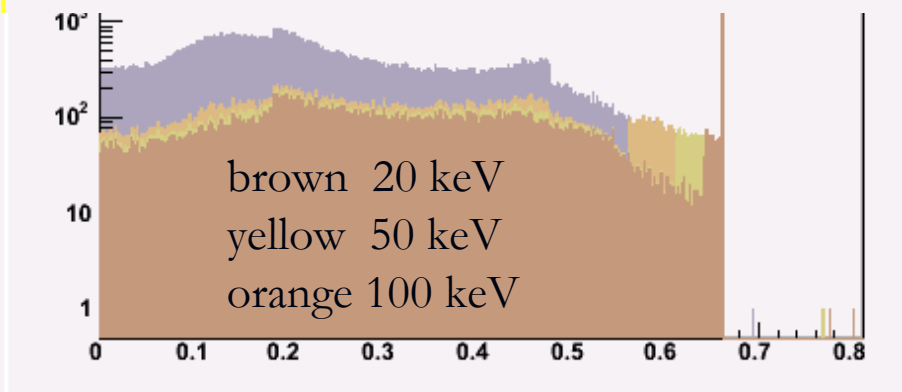






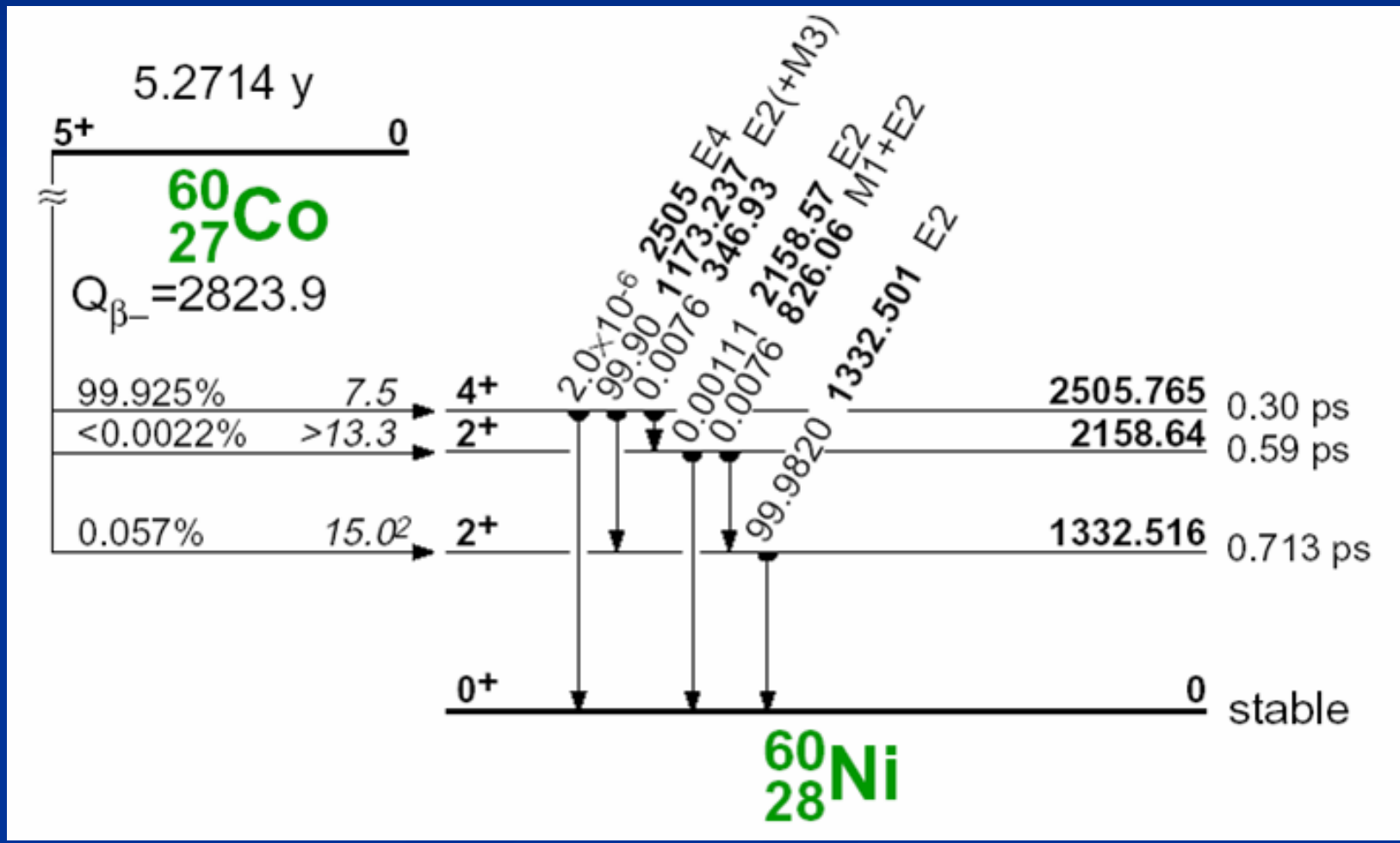




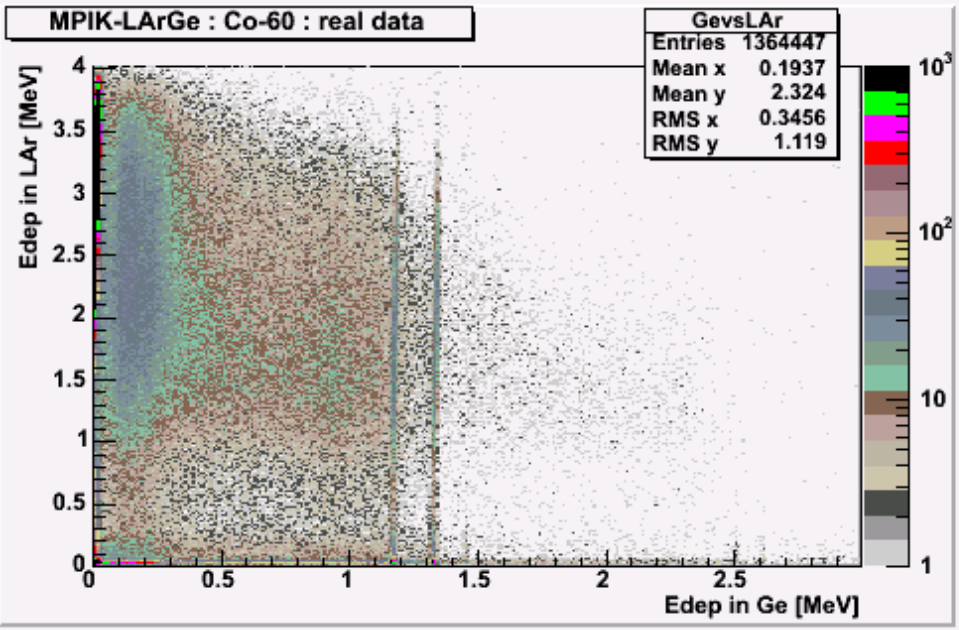


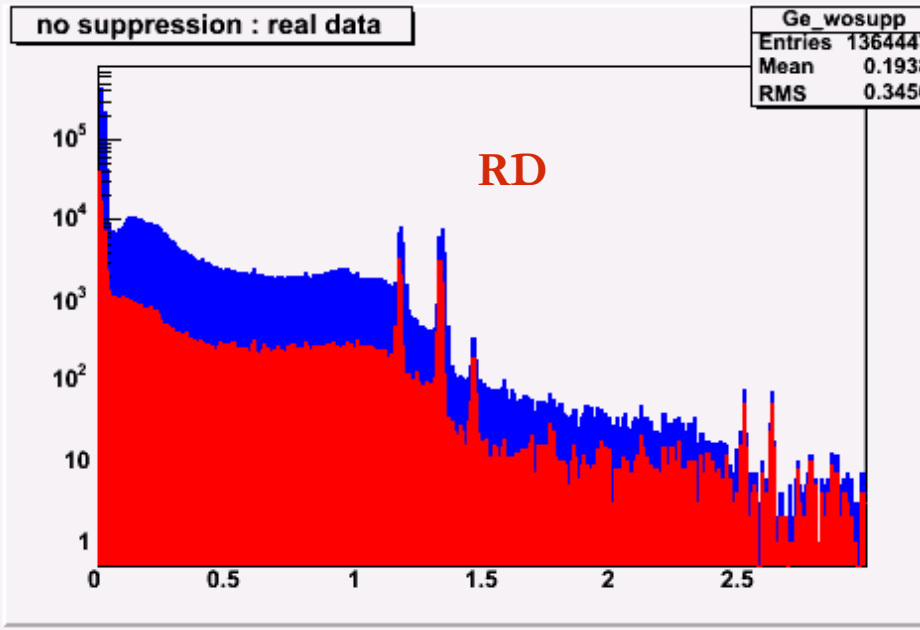
measurements in lll: Co-60

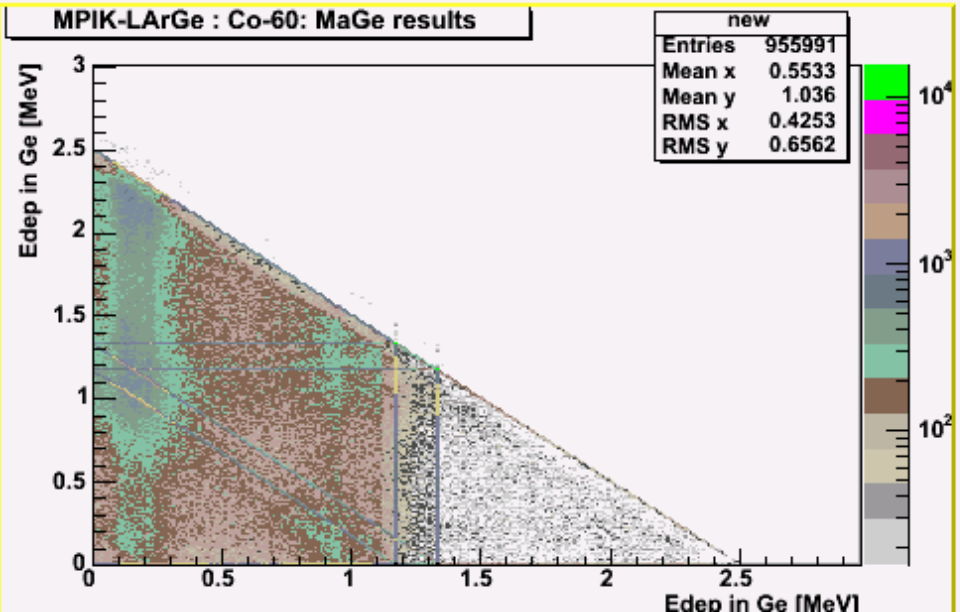
trickier: cascade of 2 gammas

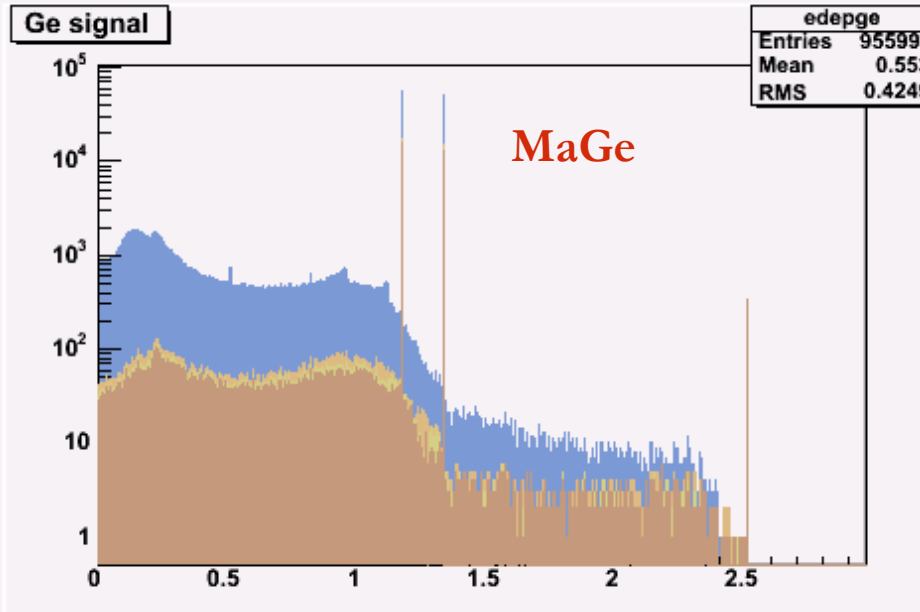


measurements in lll: Co-60





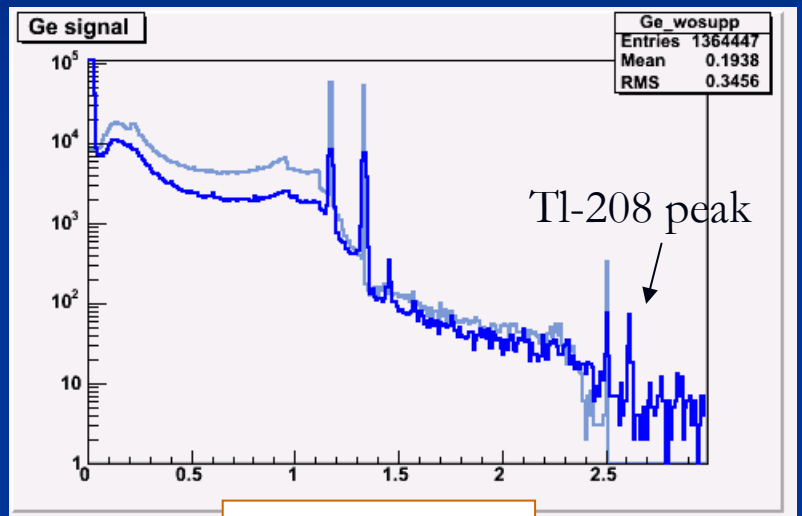




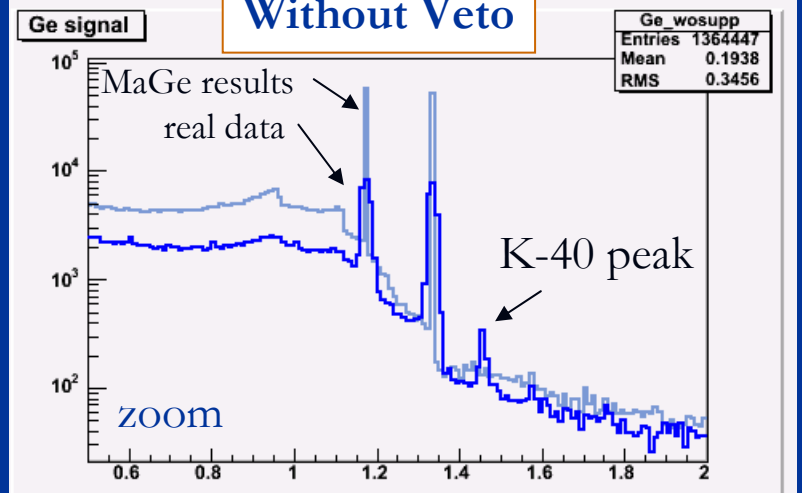
measurements in lll: Co-60

MaGe reproduces the shape of spectrum quite well:
single gamma peaks, double Compton edges

note: even with r-a source, bkgd not negligible

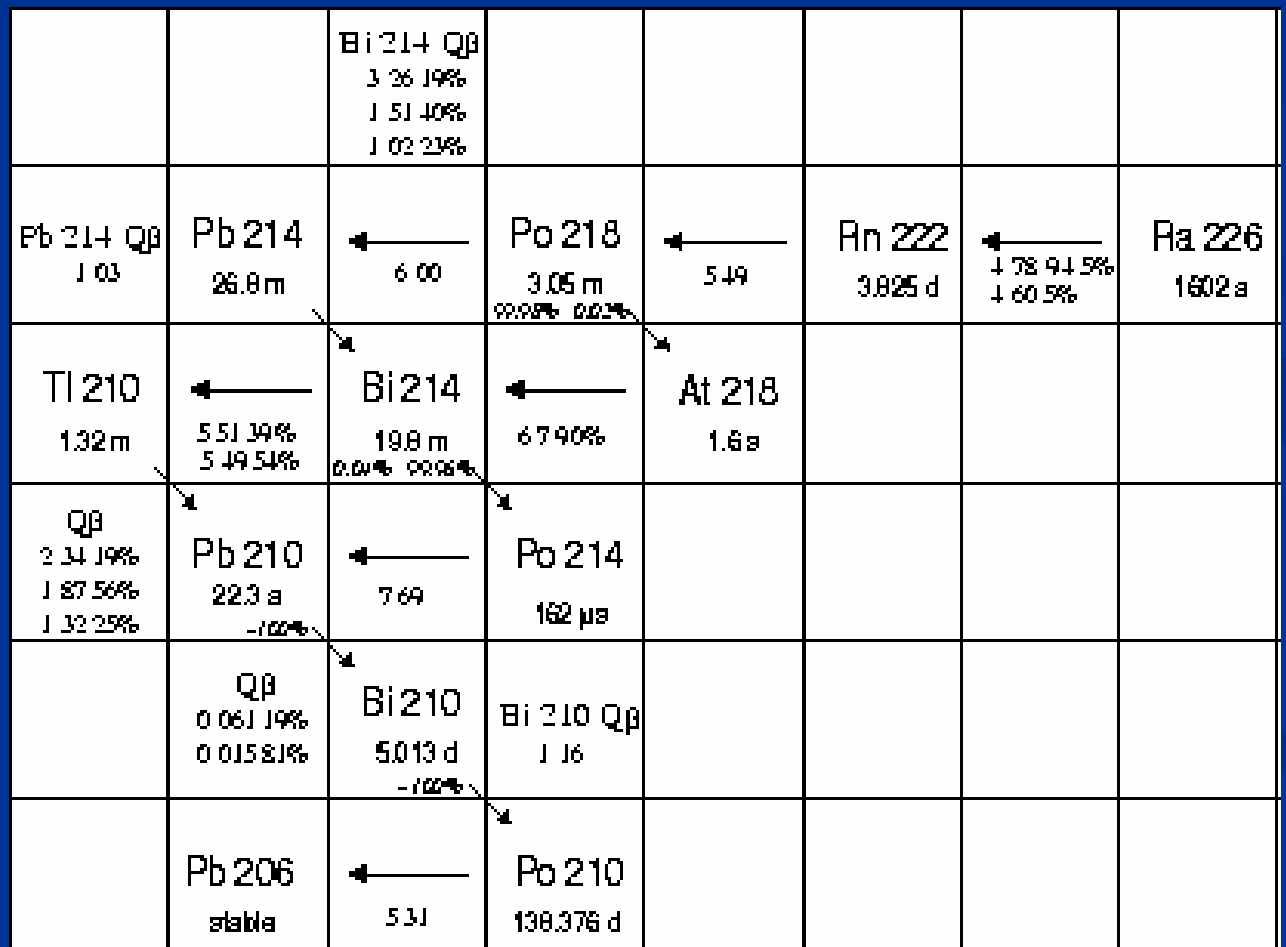


Without Veto

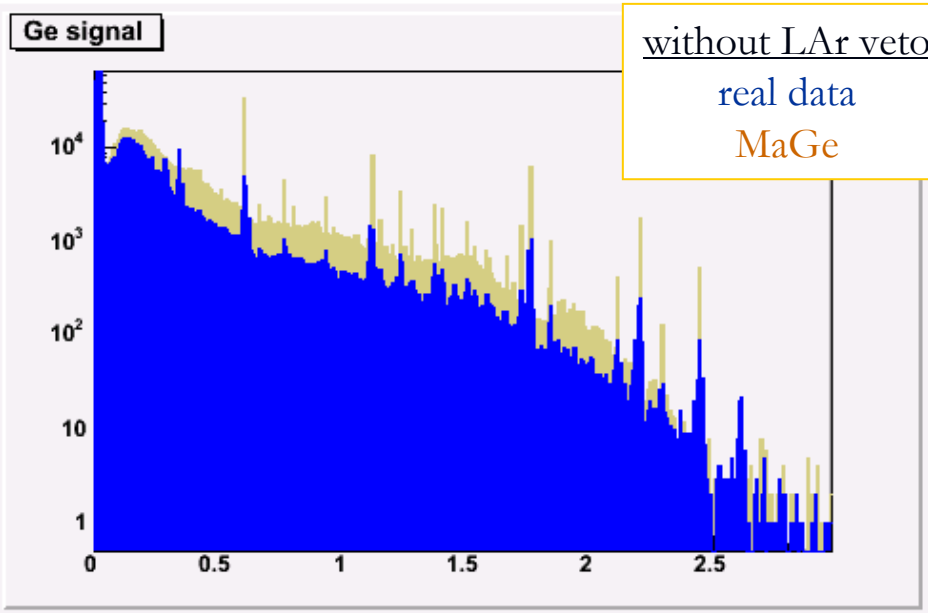


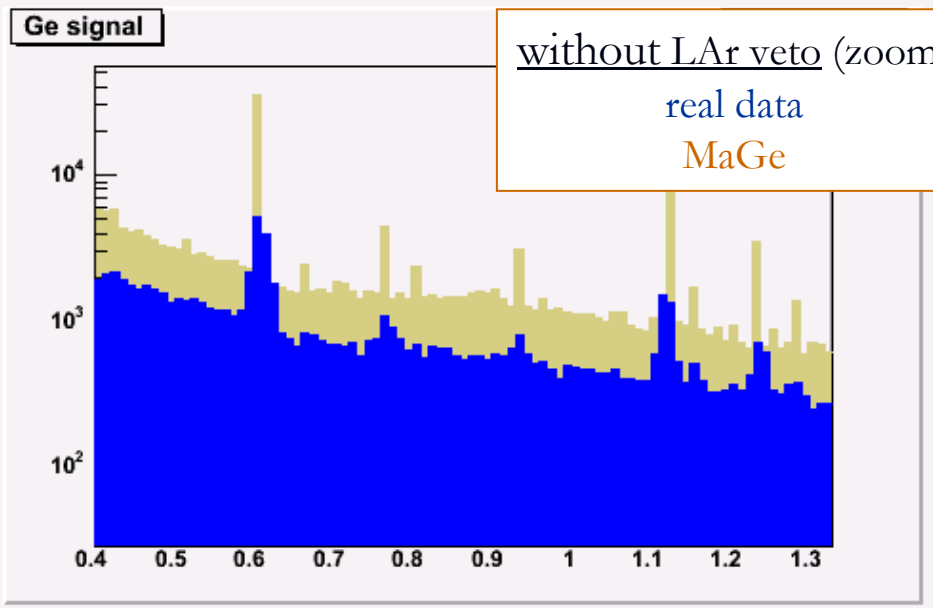
measurements in lll: Ra-226

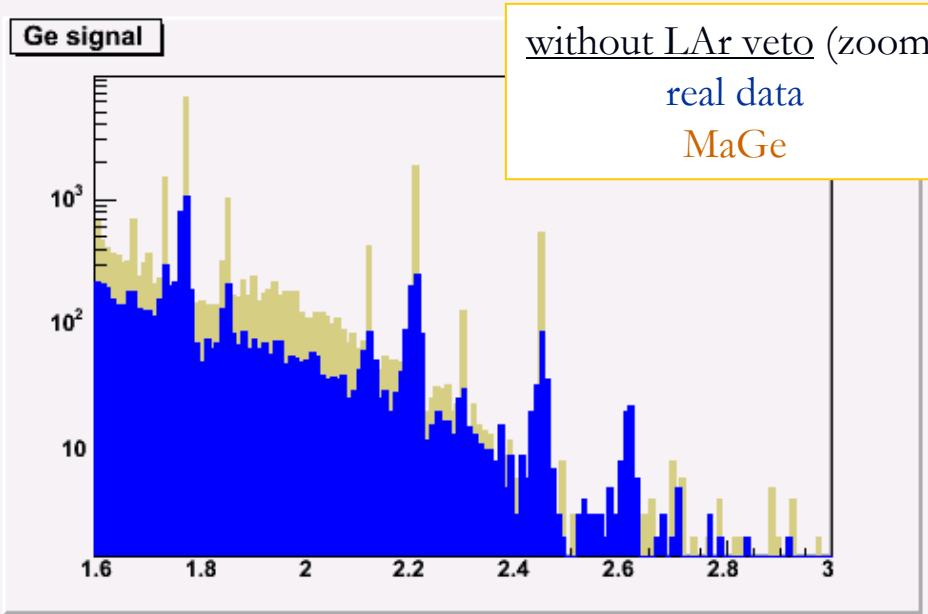
much trickier: whole Ra chain follows main gamma lines are present in both MaGe simulations and real data... but maybe with different ratios, depends on the equilibrium of the Ra chain

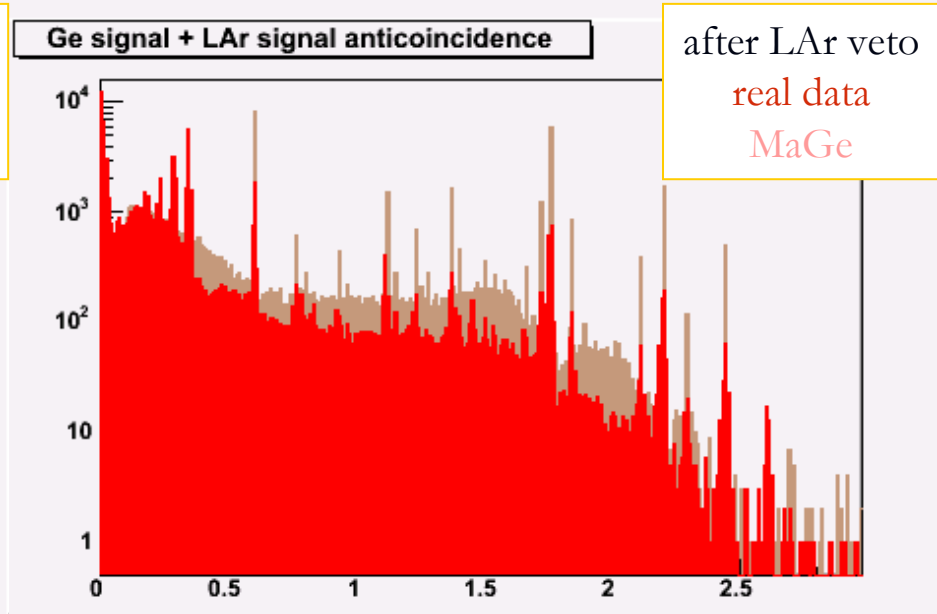


measurements in lll: Ra-226, MC: Bi-214









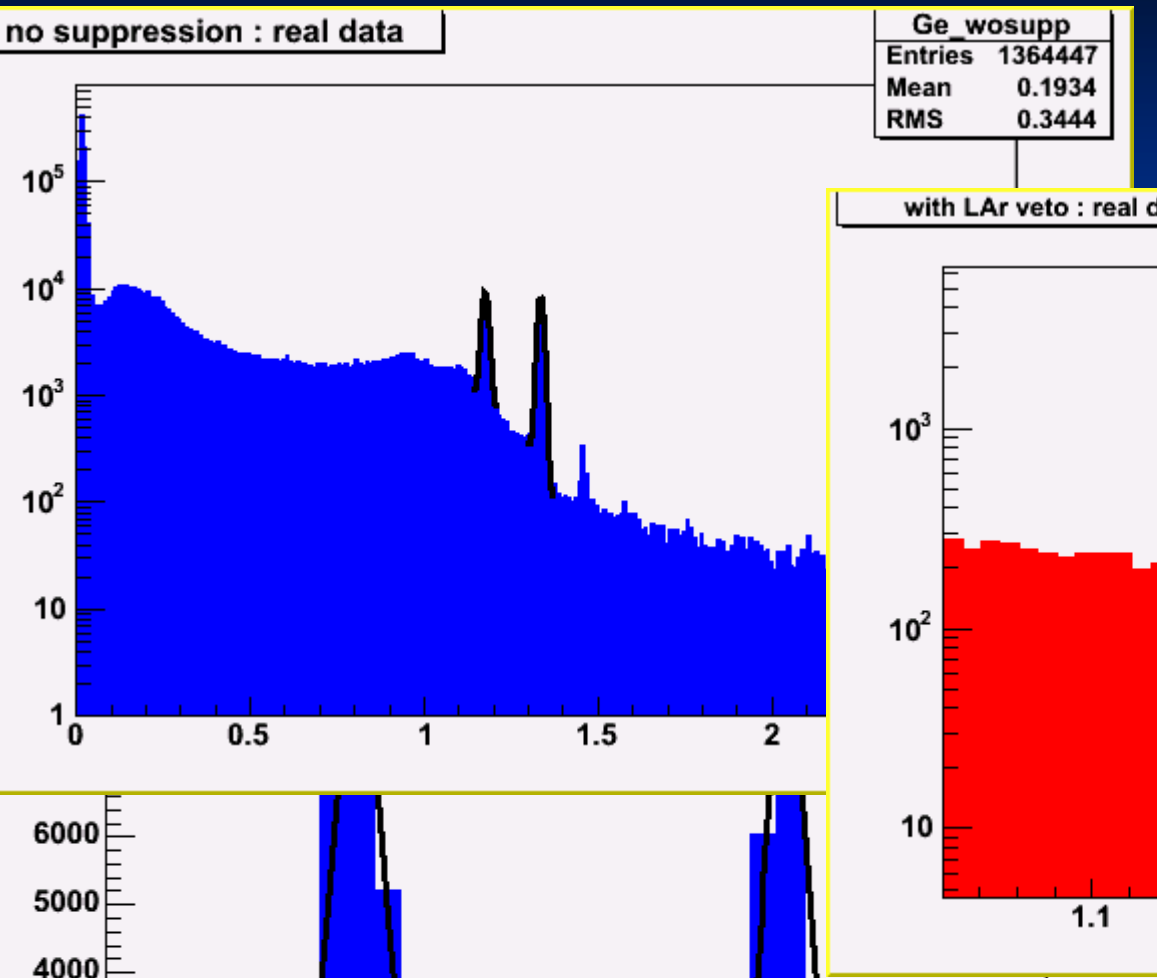
quantitative comparison between MaGe and measurements in lll

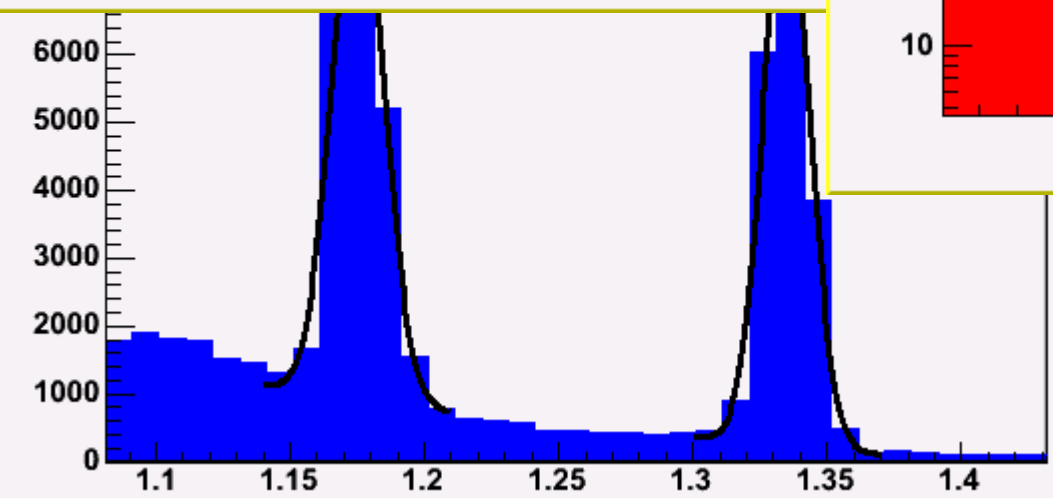
- peak efficiency
- peak to peak ratios
- peak to Compton valley ratio
- cut efficiency

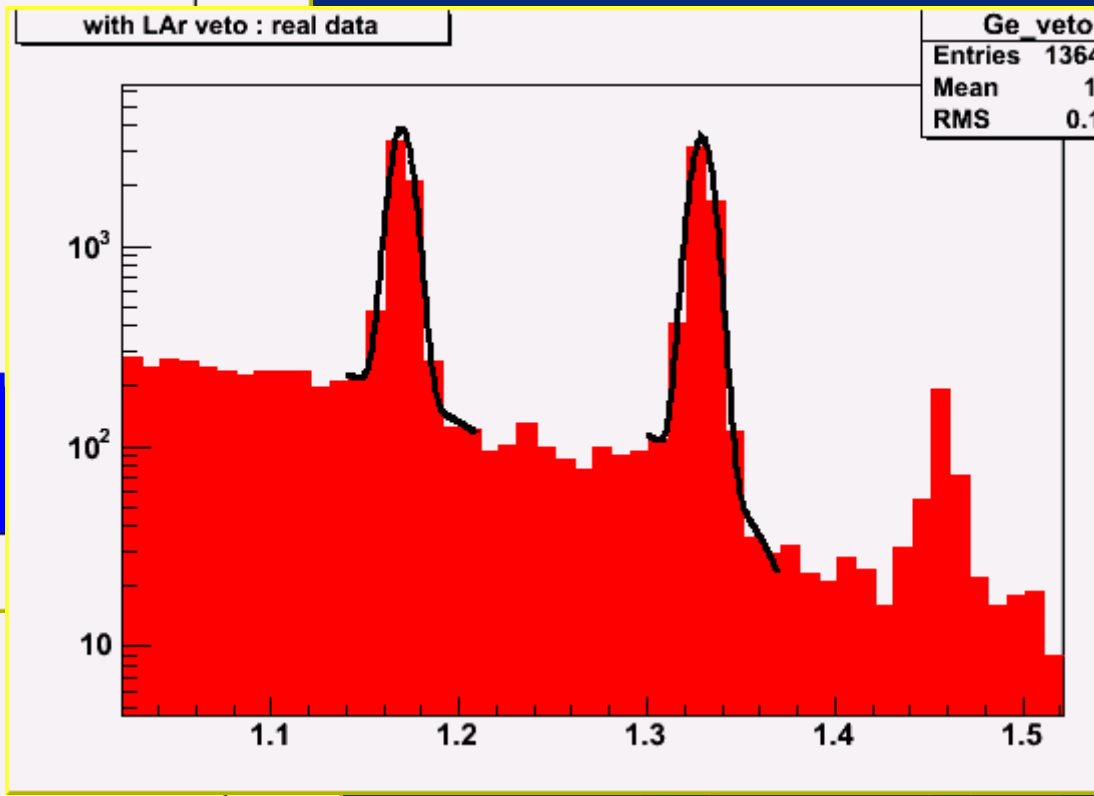
caveats:
- geometry for Monte-Carlo quite basic
- need much higher statistics and better resolution to study Ra-226 data

measurements in lll: Co-60

fitting the peaks in real data







quantitative comparison between MaGe and measurements in lll

definition:

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

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

quantitative comparison between MaGe and measurements in lll

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

measurements in lll: conclusions

analysis presented in this talk is preliminary
data with bad resolution and poor statistics

but: we show that LAr suppression works
MaGe reproduces the spectra fairly well

next : get crystal running !