Method for background localization using cascades

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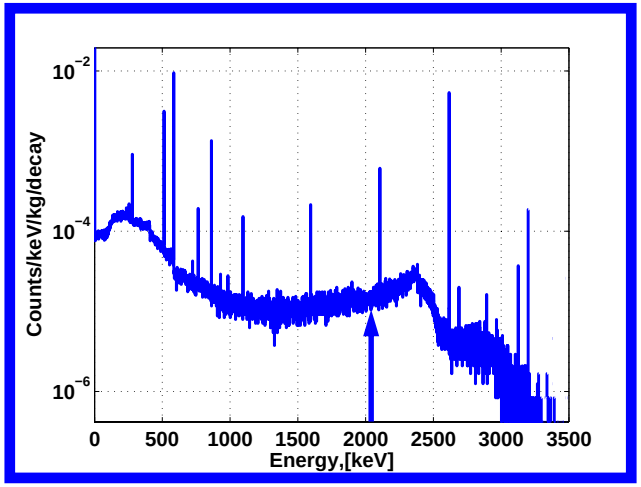
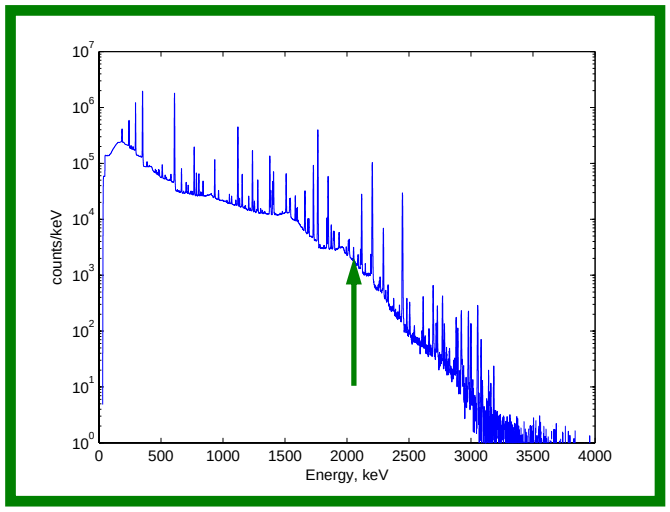
Overview

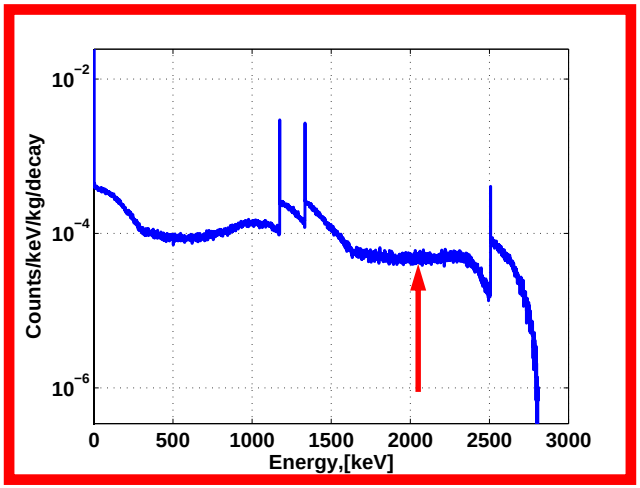
- How to make cascades useful
- Cascades in natural backgrounds
- Estimation of backgrounds location in the Heidelberg-Moscow experiment
- Implication for GERDA

Major background components around Q value of bb decay of 76Ge

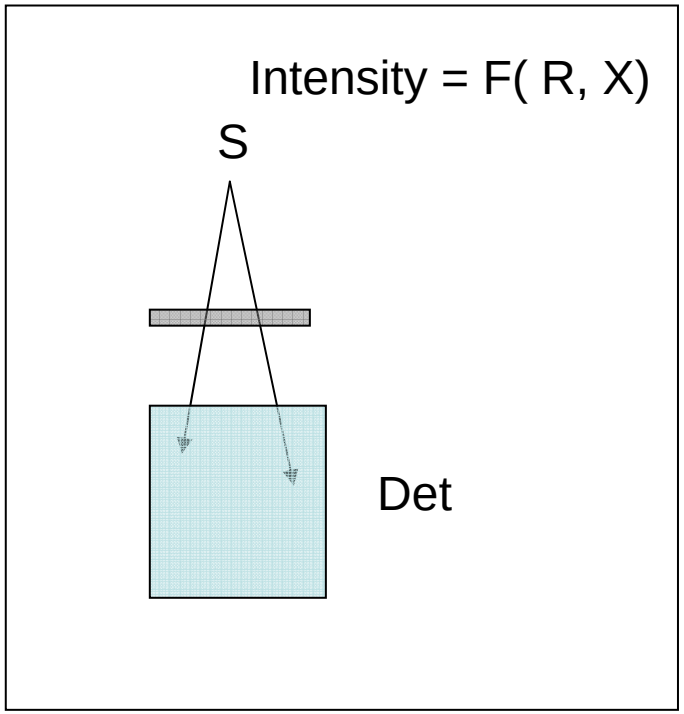
- Daughters of Th-232
- Daughters of U-238
- Summation of Co-60

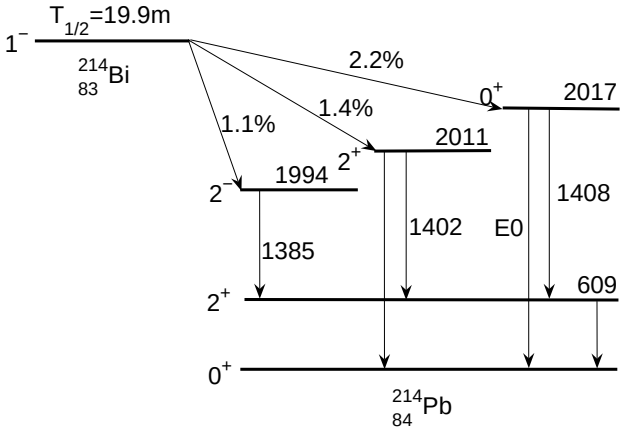


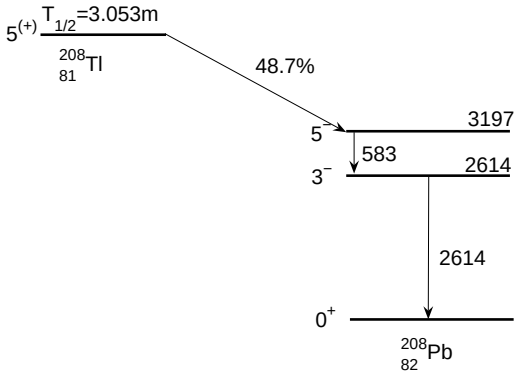




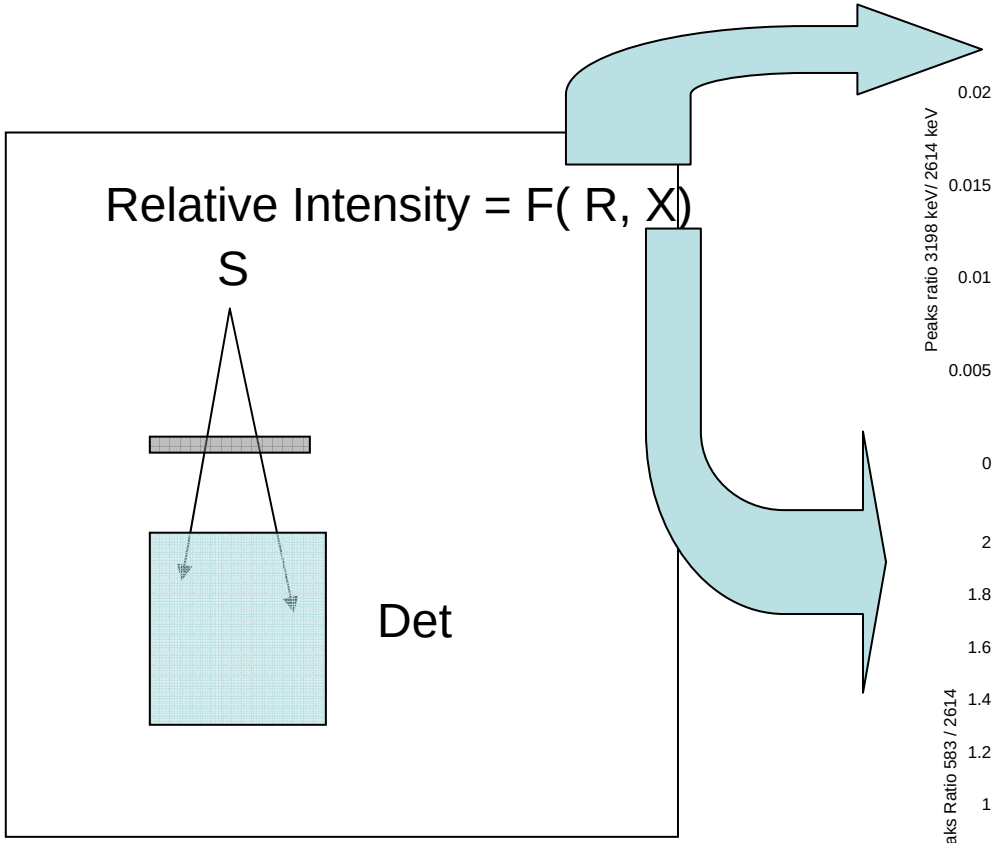
How to use cascades

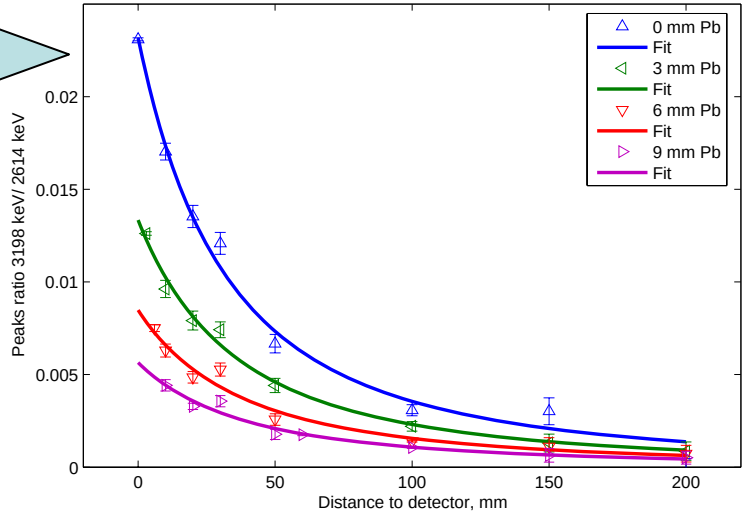


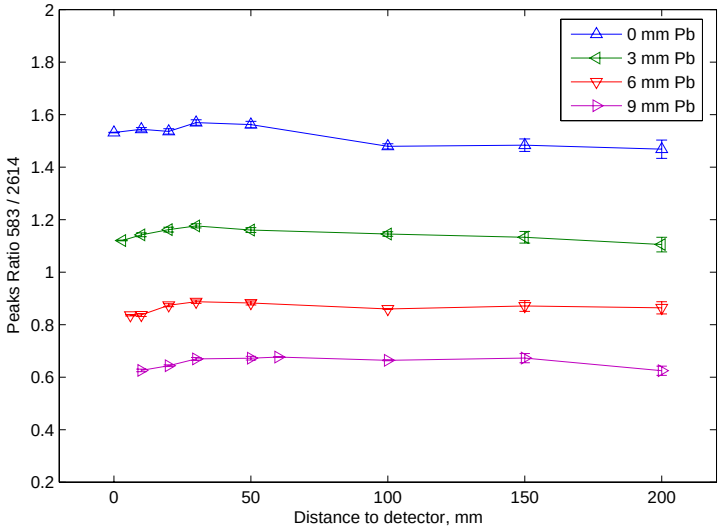




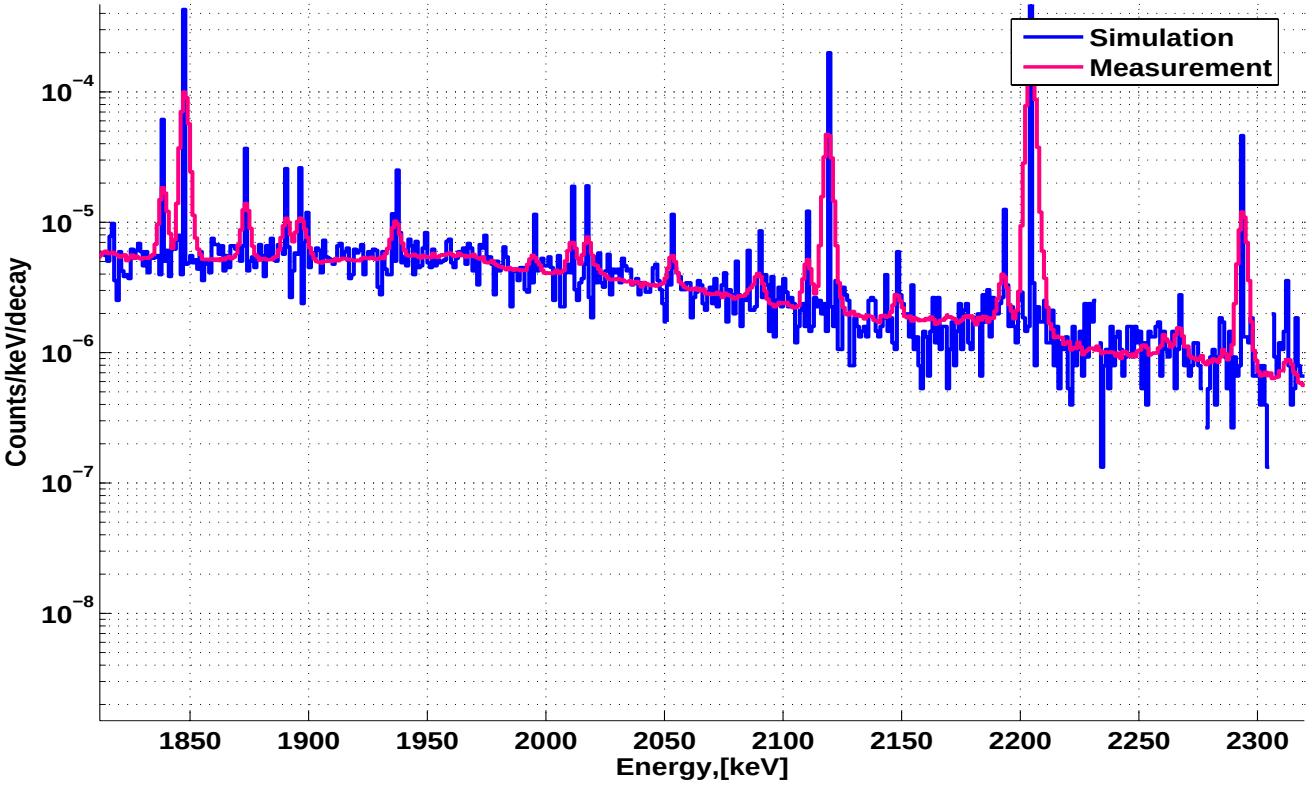
How to use cascades







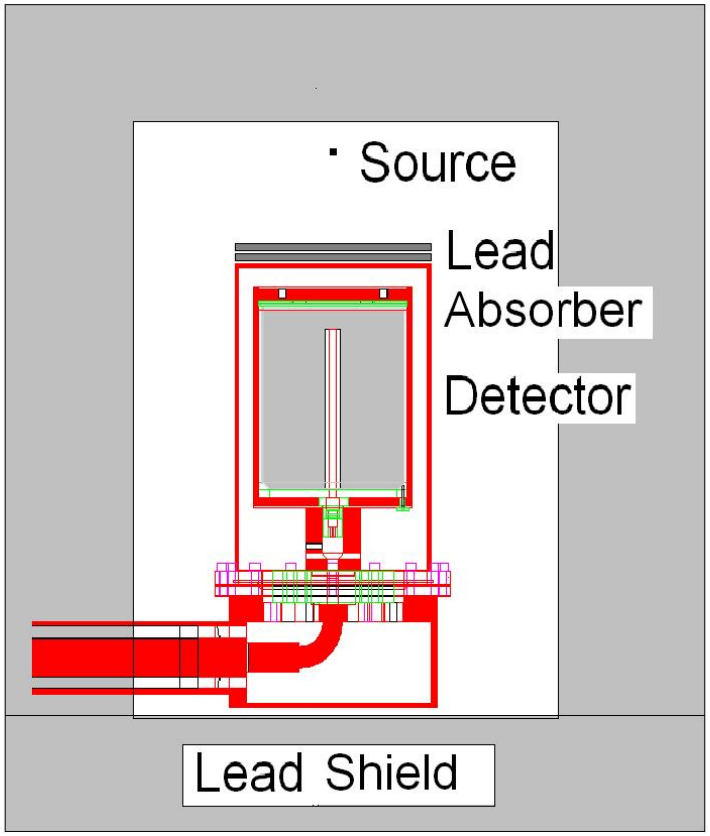
Why do not use simulation?



Pro: GEANT4 Geometries of crystals and cryostats are accurate
GEANT4 decay generator correctly handles cascades

Cons: Months of simulation time for each point is needed to get high statistics for the week Bi-214 lines (~10E9 events) (10E7events/day is the best I get in LNGS or MPIK).

Measurements of sources with Hd-Mo detectors



Sources of Ra226: 936 Bq and 95 kBq,

Th232: 17kBq, Co60: 6kBq

Random coincidences: <1%

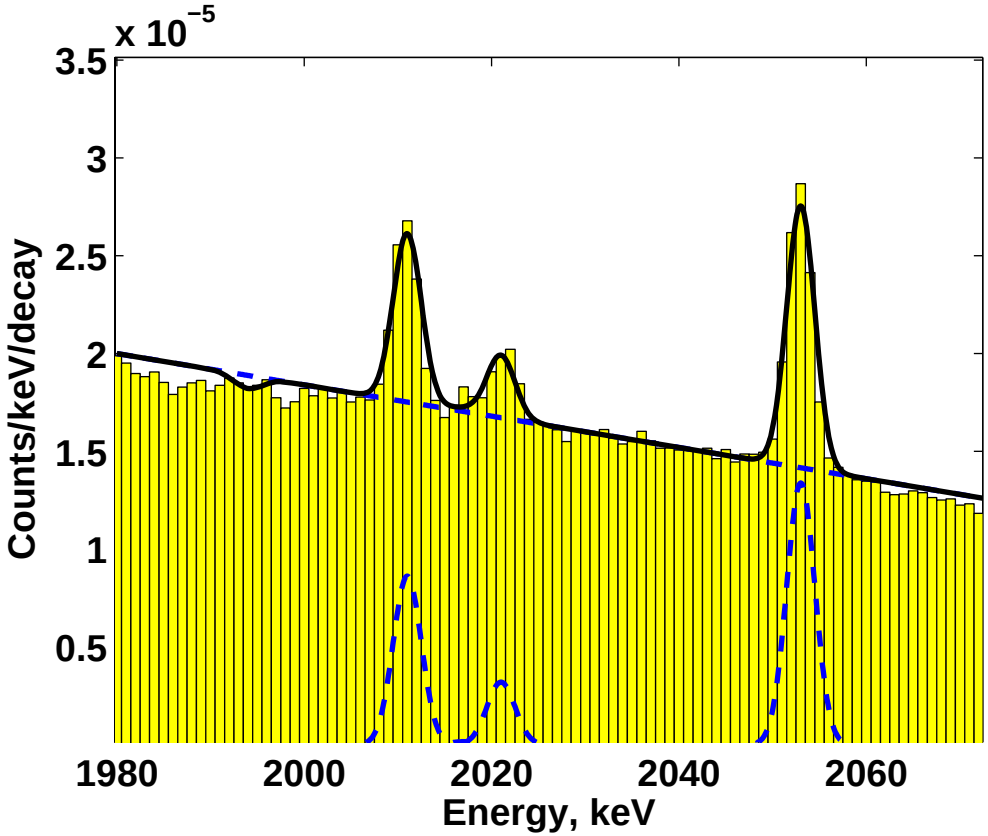
Rn and external background: <1%

Detectors was shielded by 10 cm of Lead

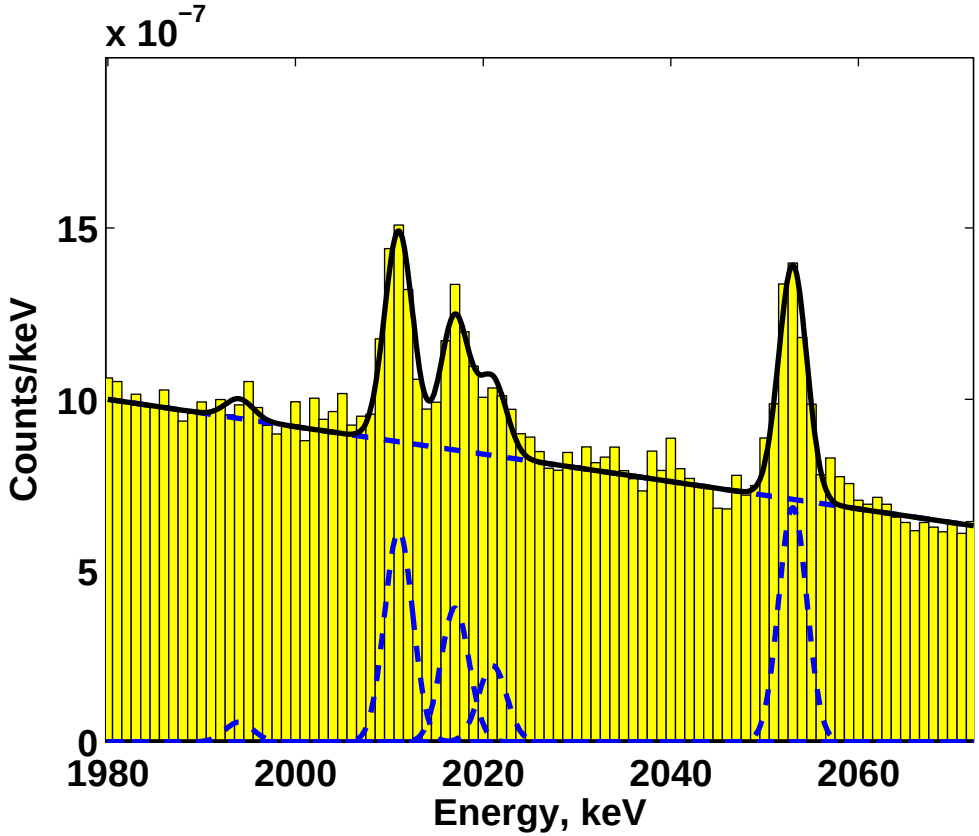
Live time for each point: ~ several days , 10^8 – 10^9 decays

Total number of decays: 1.3*10^11

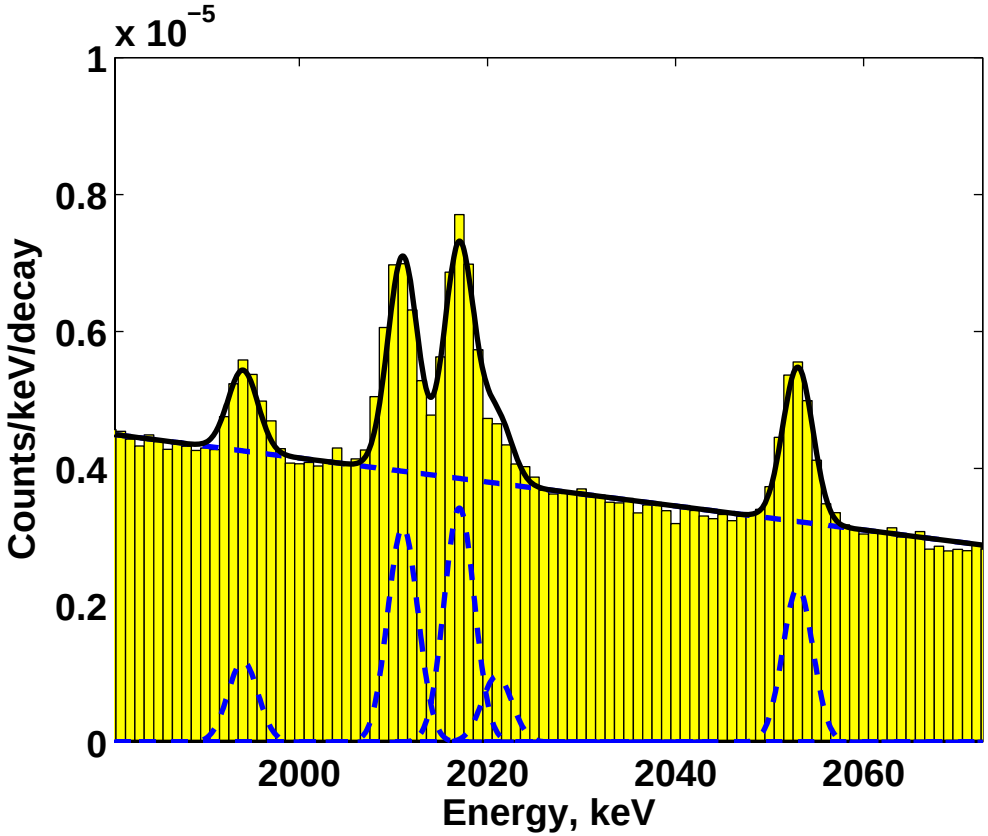
Ra-226 is 20 cm from detector



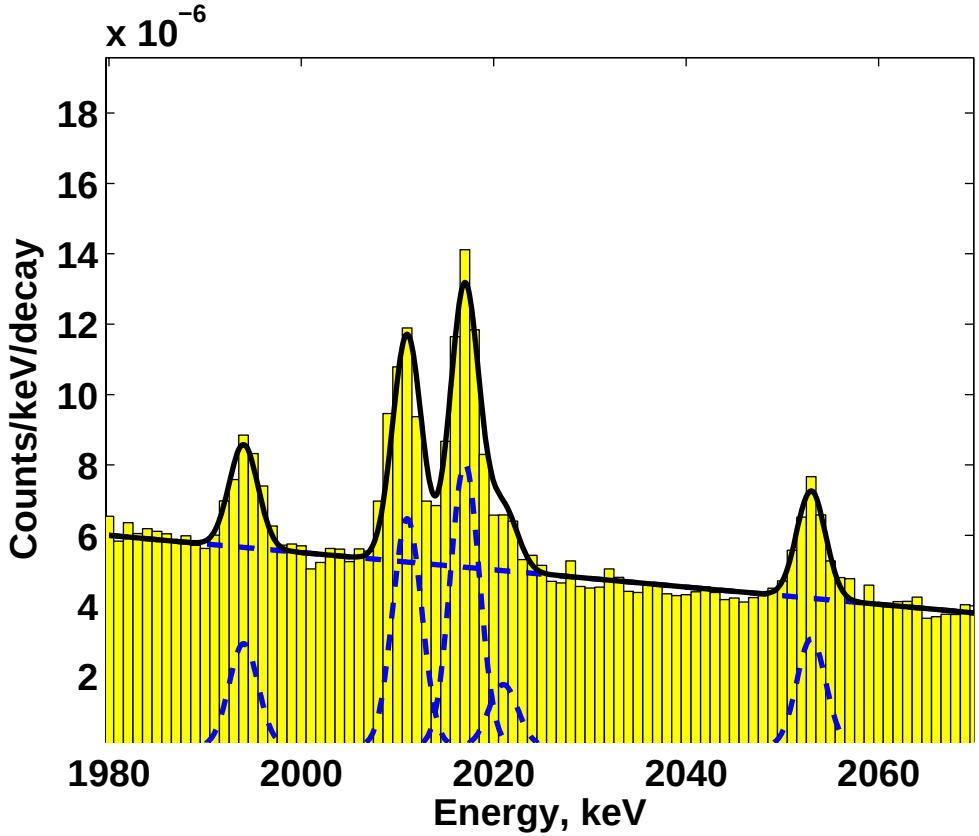
Ra-226 is 5 cm from detector



Ra-226 is 3 cm from detector



Ra-226 is 2 cm from detector

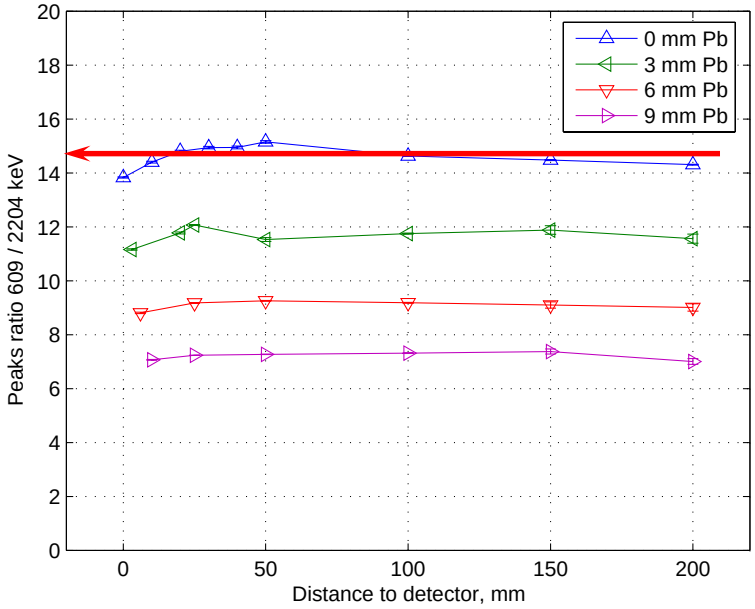


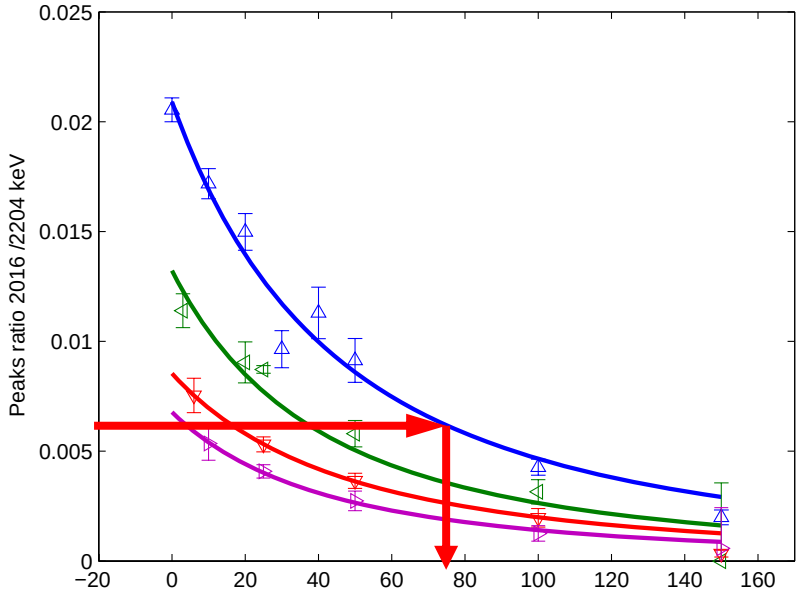
- To disentangle dependence of true summation from position and absorber thickness the series of measurements were performed with radium thorium and cobalt sources using lead absorbers
- Thus it is enough to calculate:
- 1) the ratio of major peaks in low and high energy part of spectrum
- 2) the ratio of summation peak and major peak

Application of method
Location of Uranium in Hd-Mo setup

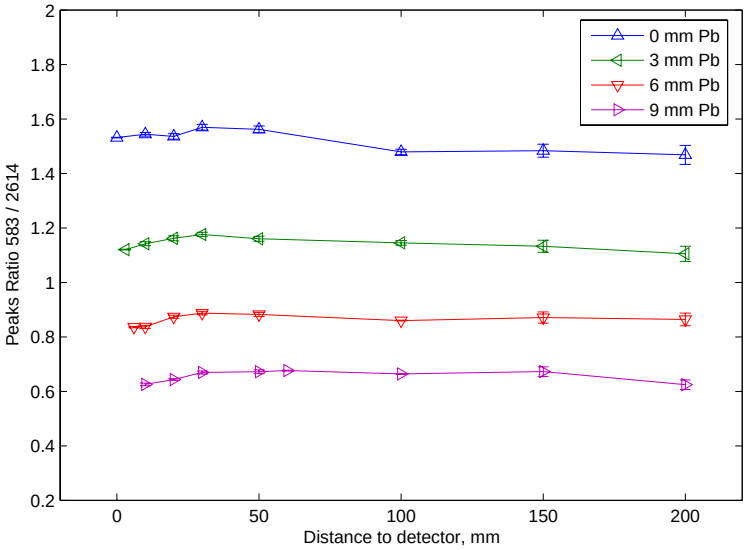
1) There is no additional absorber between U and detector

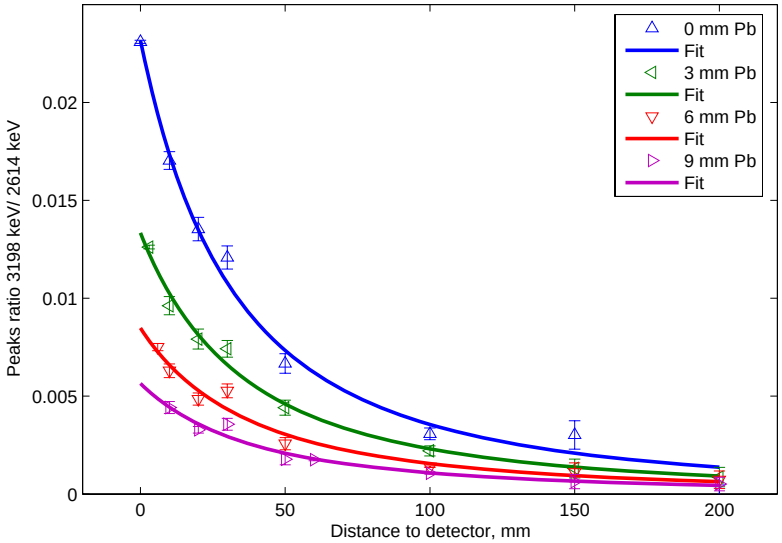
2) Distance to source ~50mm => outside cryostat





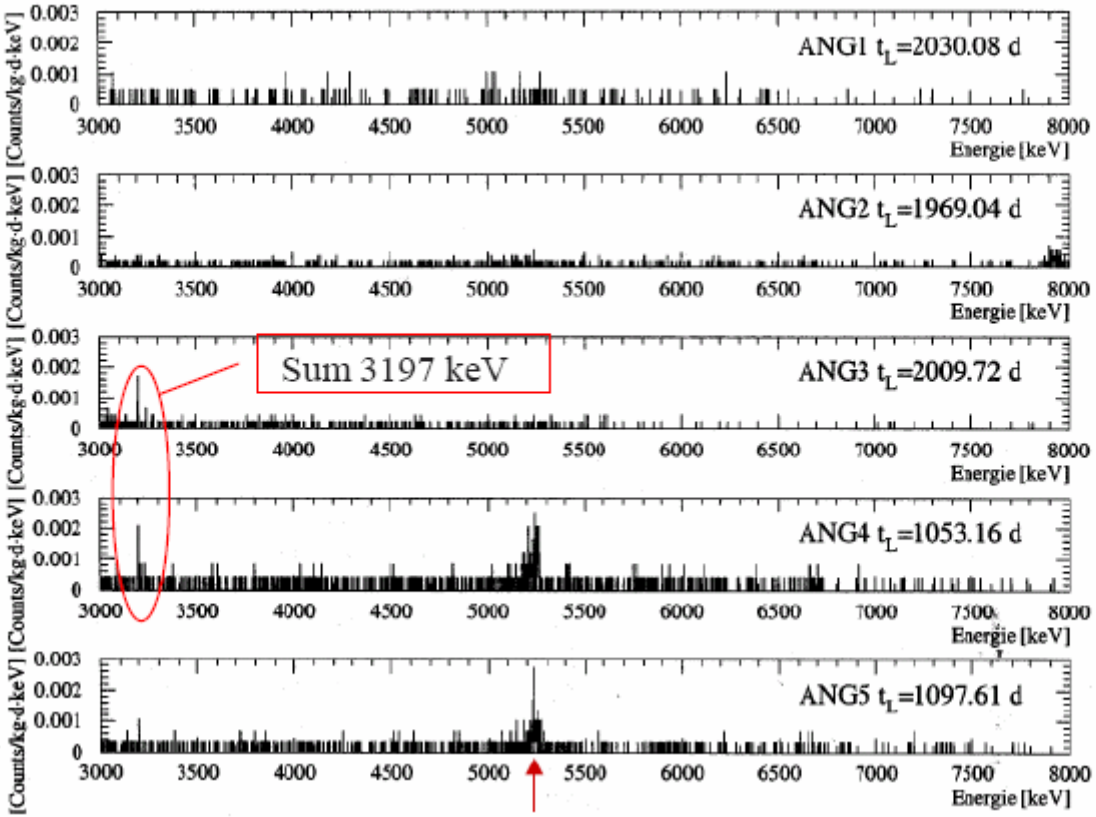
Application of method
Location of Thorium in Hd-Mo setup





Tl-208 summing: simulation and Hd-Mo data

583 keV + 2614 keV = 3197 keV



Ratio of the 3197 keV line to 2614 keV one

Source on top: 0.035 (simulation)

Ratio in the sum Hd-Mo spectrum:

0.041+/-0.004

ANG1: < 0.01

ANG2: < 0.01

Dipl. Thesis
A. Dietz

ANG3: 0.11 +/- 0.01

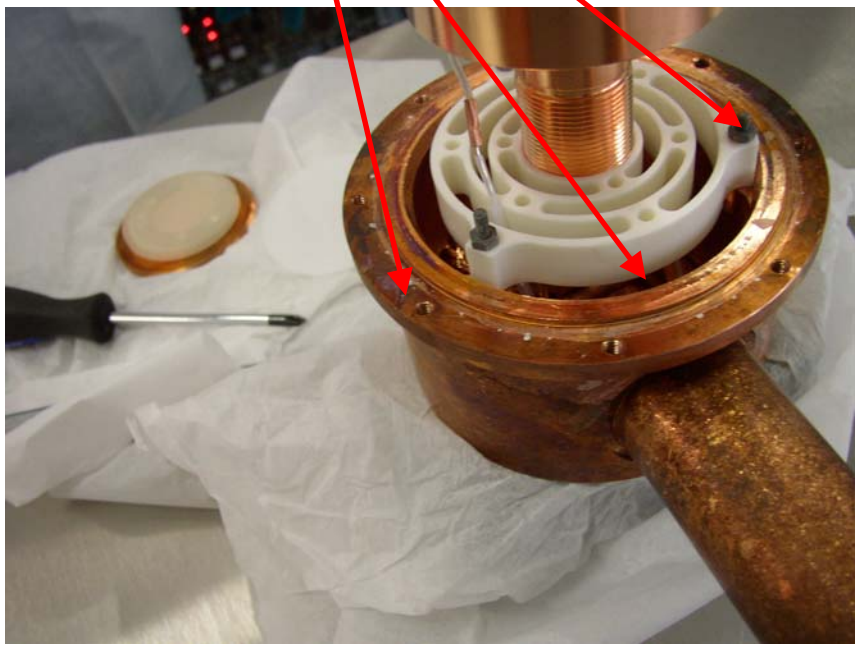
ANG4: 0.13 +/- 0.01

ANG5: 0.04 +/-0.01

Tl-208 source in the Hd-Mo are located mainly in the ANG3 and ANG4 inner contacts

Contribution to Hd-Mo background from U – daughters. Where does it come from?

Mass of cupper cap and holder is ~ 2kg with Activity ~ 10 μBq/kg, total 20 μBq
Total mass of **old ships iron** screws is small ~70-100g, its activity is ~1 mBq/kg.
This screws are indeed in ~5cm distance from crystal



Most probably these screws contribute
to a significant part of background

Conclusions

- Identified location for major contamination of GERDA detectors using the ‘true summation method’.
- Uranium contamination is out of crystals
- Some of detectors (ANG 4 and ANG 5) will require additional surface treatment to reduce Th contaminations.