Estimate of the Internal Gamma Background of the GERDA-Experiment

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Overview

Theory Introduction and Experimental Setup of Gerda

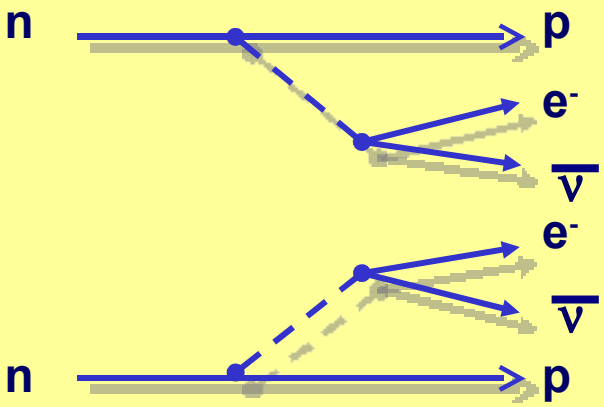
Typical Backgrounds and Reduction

Monte Carlo Simulation

Results and Outlook

Theory Introduction to Double Beta Decay

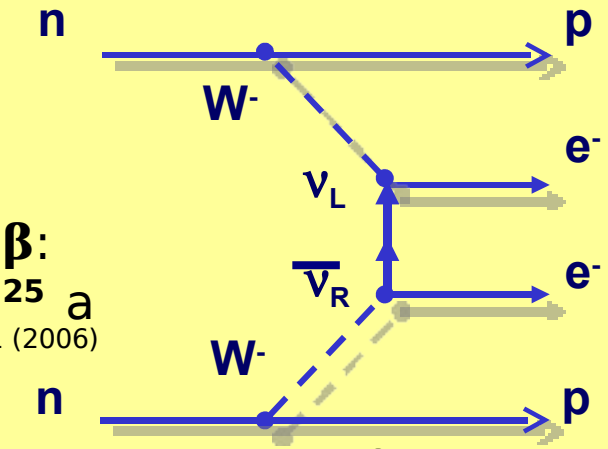
Second order weak process=> rare



^{76}Ge **2νββ**:

$T_{1/2} = 1.55 * 10^{21}$ a

J. Phys. G 33, 1 (2006)

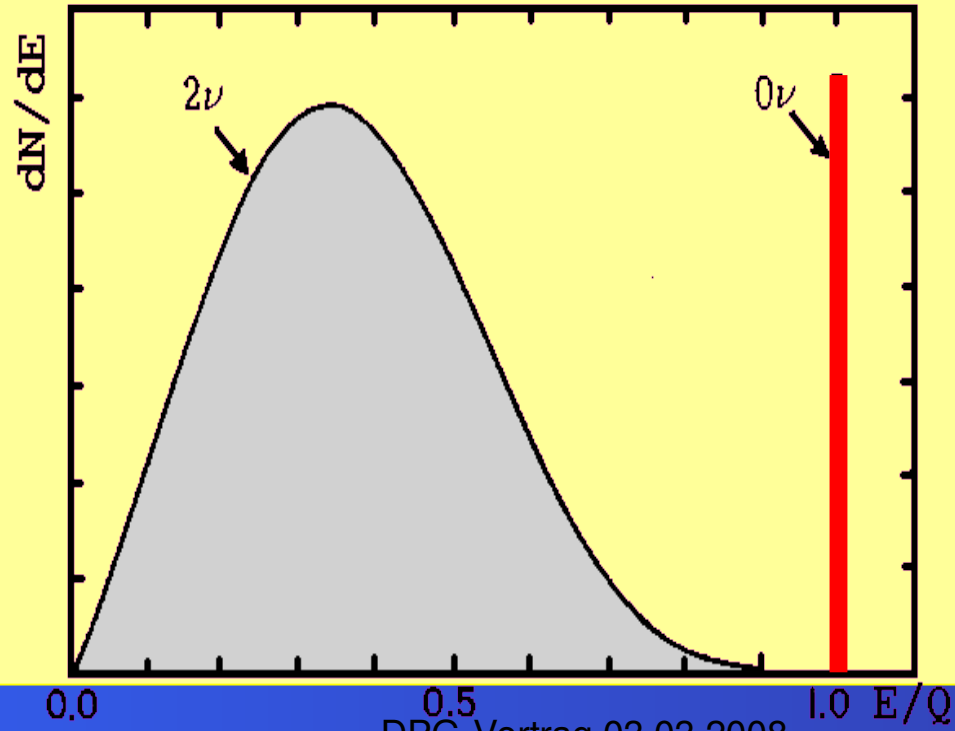


^{76}Ge **0νββ**:

$T_{1/2} > 1.9 * 10^{25}$ a

J. Phys. G 33, 1 (2006)

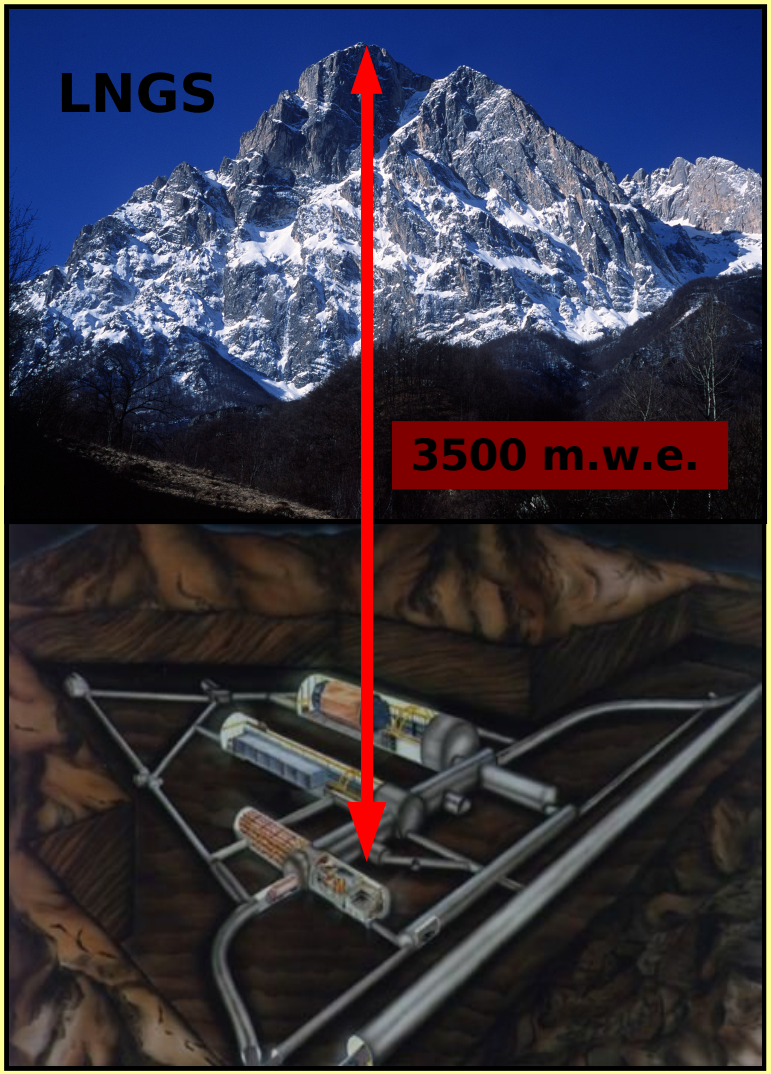
- allowed in SM
- $\Delta L \neq 0$
- **only if $\nu = \bar{\nu}$ && $m_\nu > 0$**

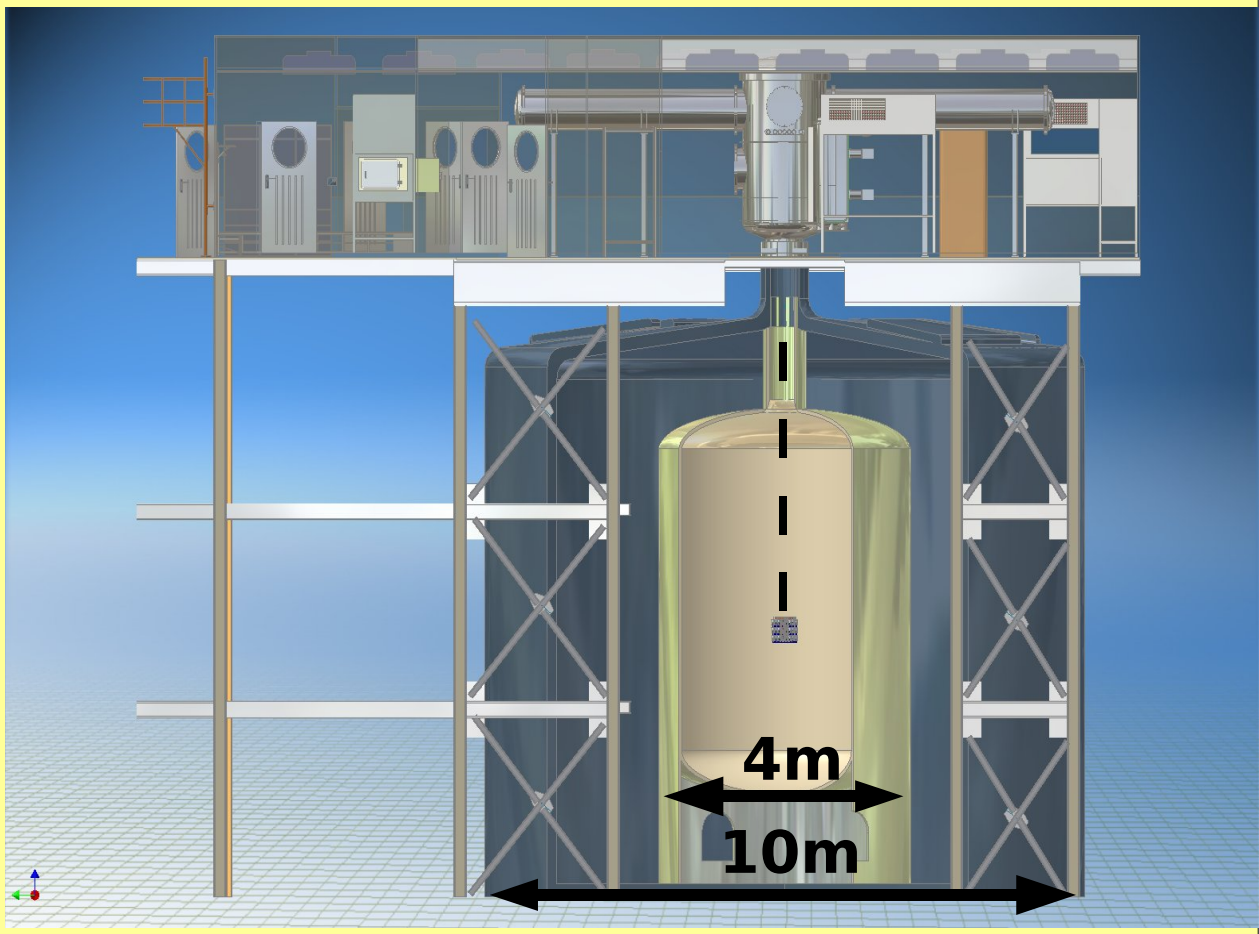


search in energy window around $Q_{\beta\beta}$

$Q_{\beta\beta}(^{76}\text{Ge}) = 2039$ keV

Experimental Setup





Phase I: 8 enriched unsegmented detectors

Targeted background rate:
$1*10^{-3}$ (cts/kg keV y)
in **ROI**

Phase II: 21 enriched detectors (33.9 kg)
18 fold segmented

Typical Backgrounds

- **Cosmogenic production** of isotopes in germanium
- **Cosmic Muons**
- **Neutrons**
  - muon induced
  - from decays in the rock
- **Radioactive** isotopes in surrounding
  - electrons
  - alphas (on surfaces)
  - gammas

Typical Backgrounds + Means of Reduction

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minimize exposure above ground

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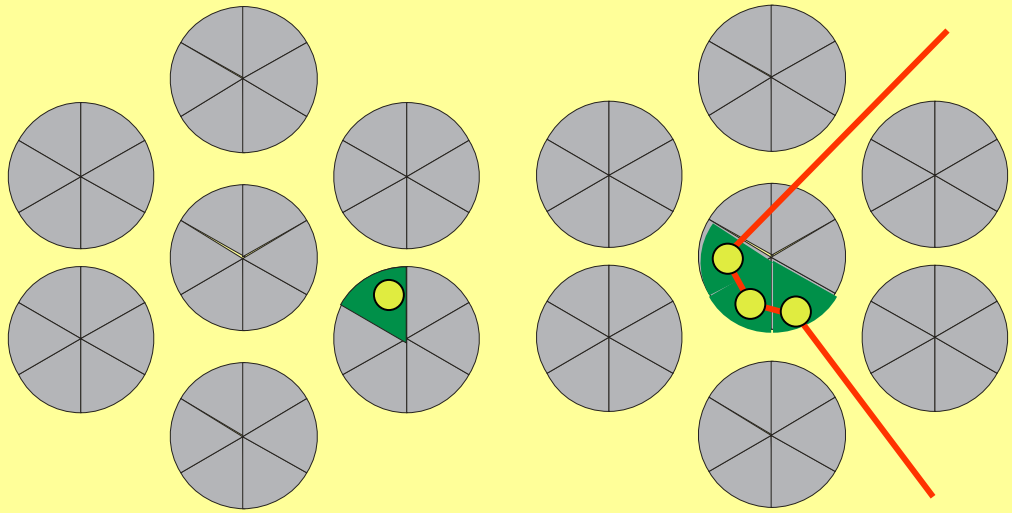
Background Reduction

~ 2MeV **gamma** deposits energy predominantly through Compton-Scattering
mean free path (Ge) : ~ 5cm

Signal (electrons) deposit energy very locally

Signal: **Background:**



energy cut: $Q_{\beta\beta}$ **+-** 10 keV

segment anti-coincidence cut to reduce gamma background

Monte Carlo Simulation

- Use Monte Carlo simulation framework **MaGe** (**Ma**jorana **Ge**rda) arXiv:0802.0860v1
  - **MaGe**:
    - Geant4 based
    - includes decay generators,..

Simulation takes into account:

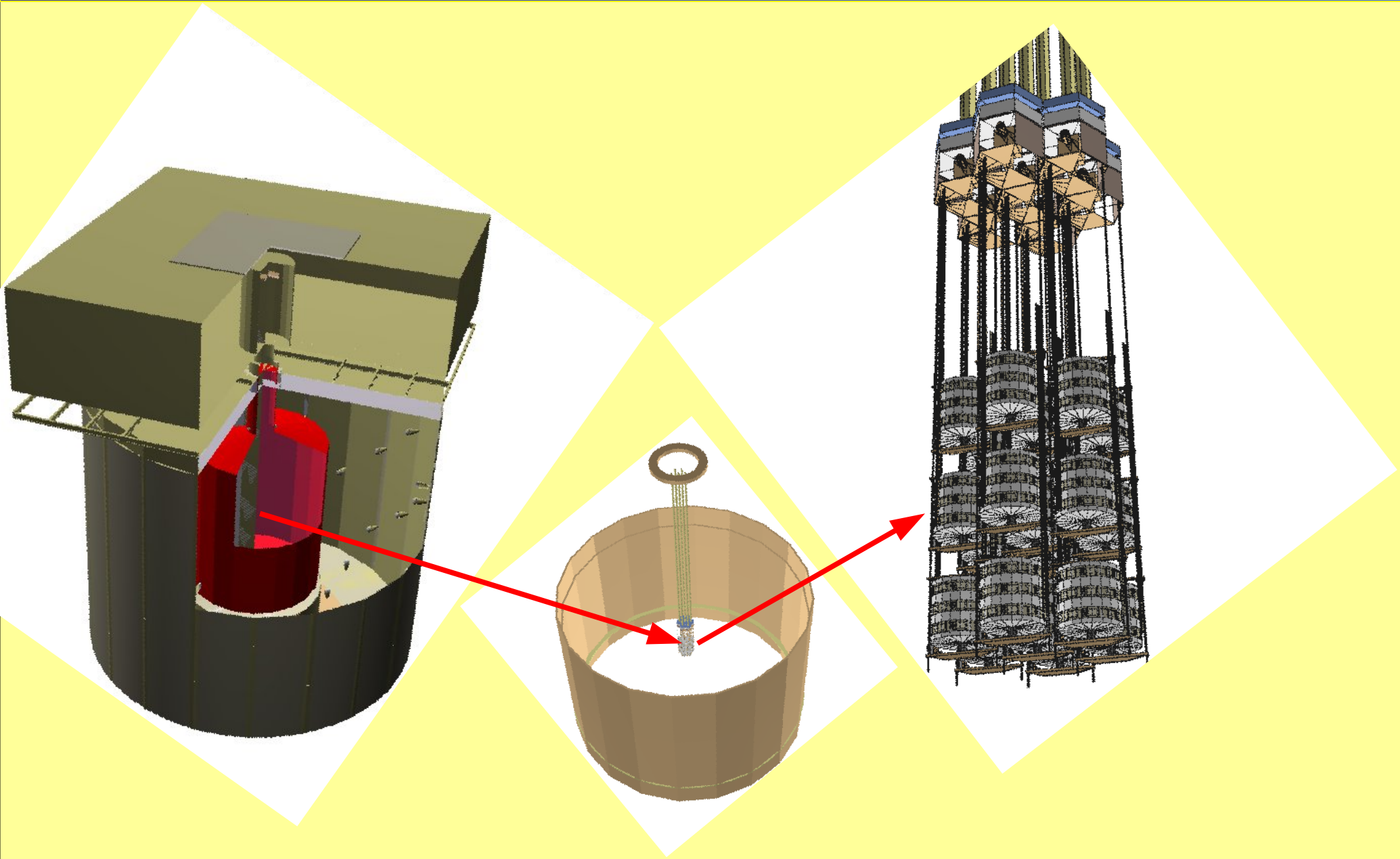
- **natural radioactivity**:
  - ^{232}Th
    - ^{228}Ac: 2029.4 keV
    - ^{208}Tl: 2614.5 keV
  - ^{238}U
    - ^{234}Pa: 2072.2 keV
    - ^{214}Bi: many
    - ^{210}Tl: several
  - ^{40}K: 1460.8 keV
- **“man made“ radioactivity**
  - ^{137}Cs: 661.6 keV
- **cosmogenic activation**
  - ^{60}Co: 2158.5 keV
    2505. keV

Earlier Simulation

Evaluation: Energy cut + segment anticoincidence cut, applying measured activity

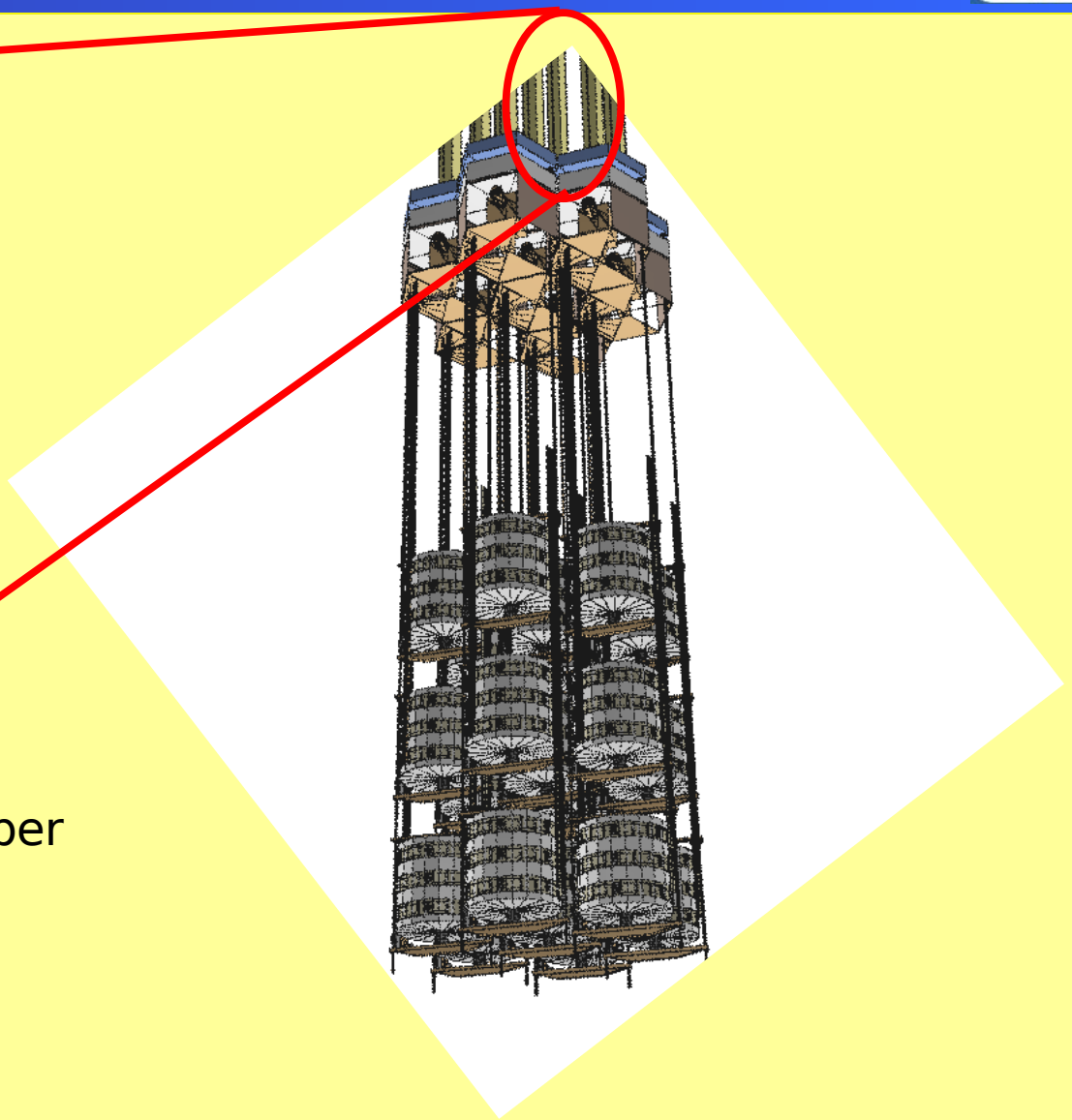
Part		Background contribution [10^{-4} counts/(kg·keV·y)]
Detector	**^{68}Ge**	**4.3** → after 2 years
	^{60}Co	0.3
	Bulk	3.0
	Surf.	**3.5** → further reduction through PSA expected
Holder	Cu	1.4
	Teflon	0.3
Cabling	Kapton	1.5
Electronics		**3.5**
LAr		1.0
Infrastructure		0.2
Muons and neutrons		2.0
Total		21.0

String Setup in Monte Carlo



String Setup in MC

41 cm
above crystals



Cable Chain:

- last meter made from copper
- above stainless steel

Cables:

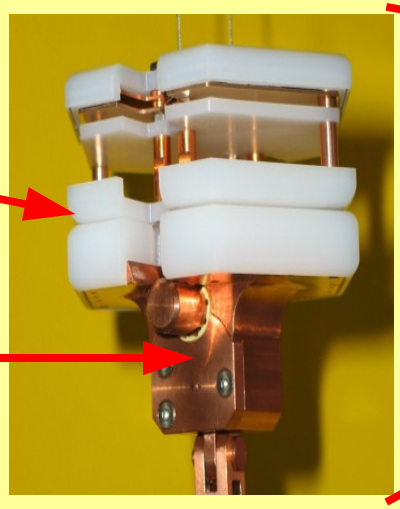
- woven ribbon signal cable

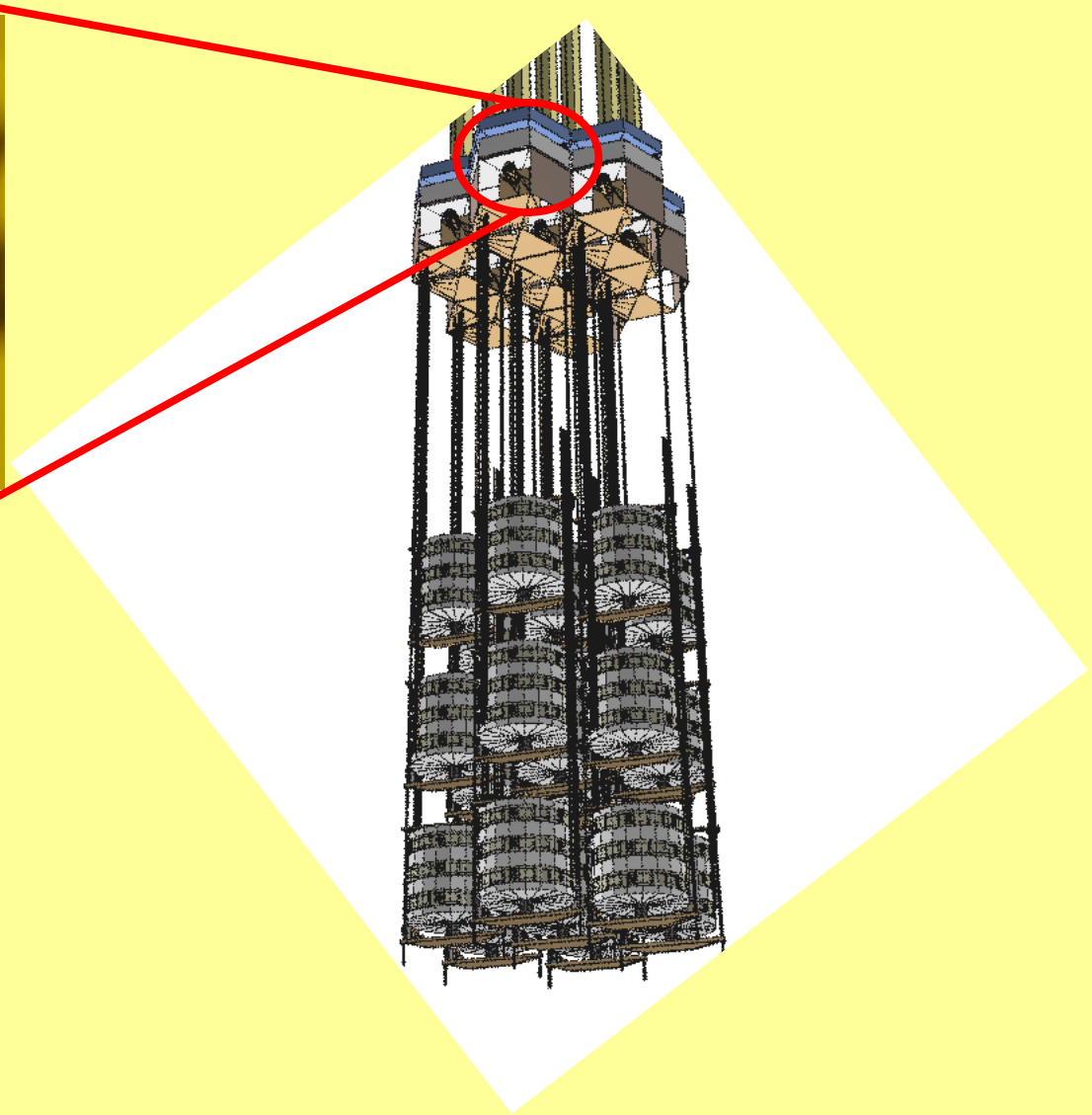
String Setup in MC

murdfeld plastic

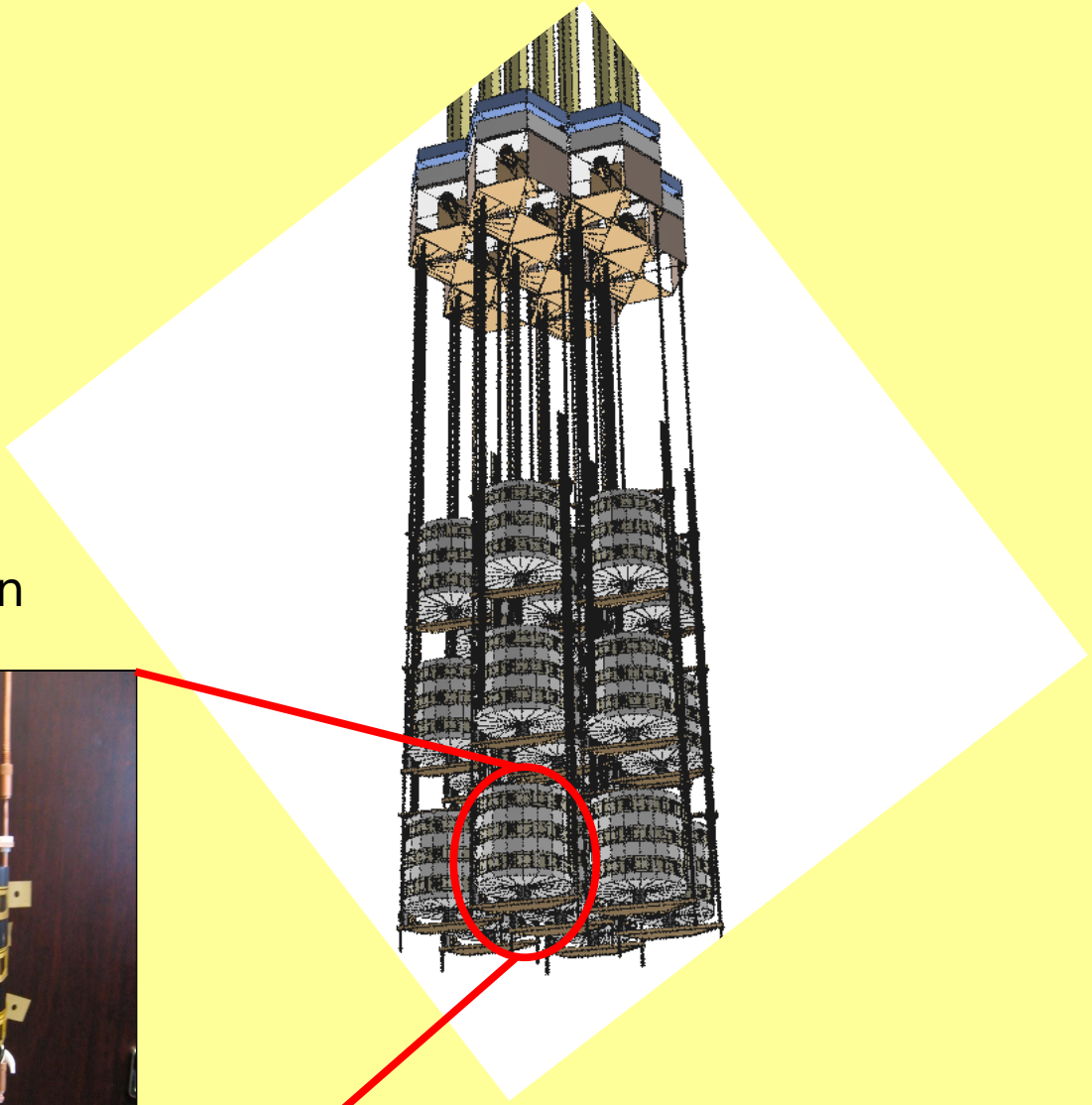
most material copper

30 cm
above crystals





String Setup in MC

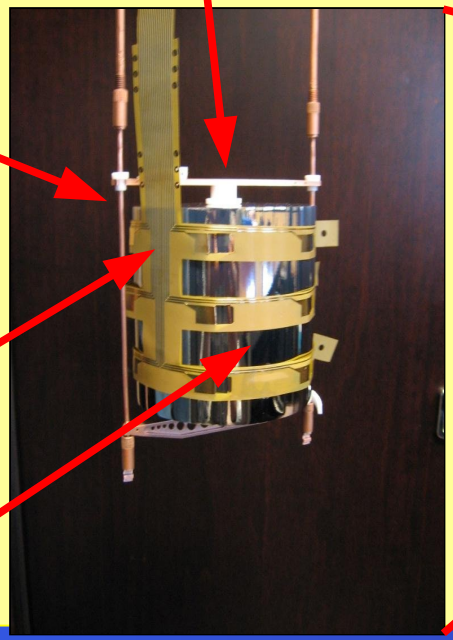


7g teflon

31g copper holder

2.5g Kapton cable

1.62kg Ge



Outlook

Rerun simulation with realistic setup

Take into account other background contribution

Produce Reference Energy Spectrum