Estimate of the Internal Gamma Background of the GERDA-Experiment

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Overview

Theory Introduction and Experimental Setup of Gerda

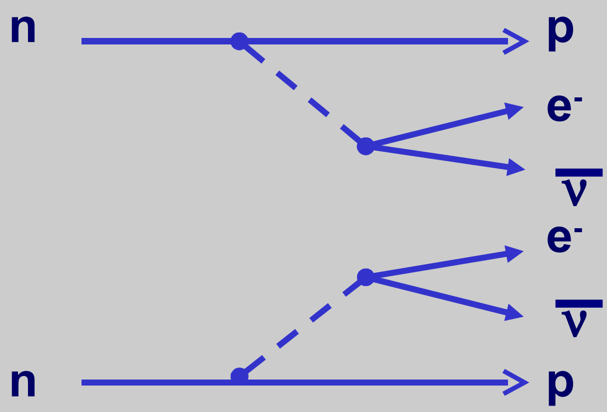
Typical Backgrounds and Reduction

Monte Carlo Simulation

Results and Outlook

Theory Introduction to Double Beta Decay

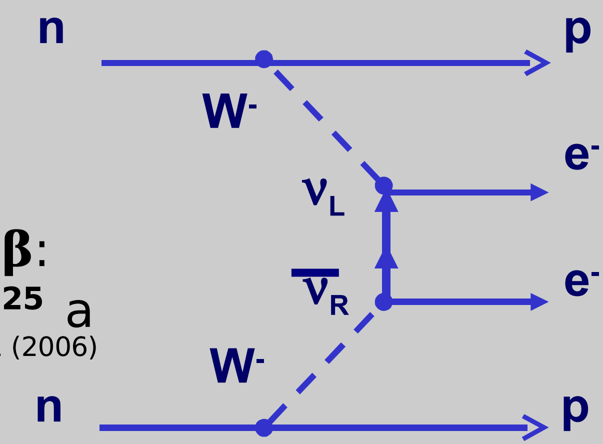
Second order weak process=> rare



^{76}Ge **2νββ**:

$T_{1/2}$= 1.55 * 10^{21} a
J. Phys. G 33, 1 (2006)

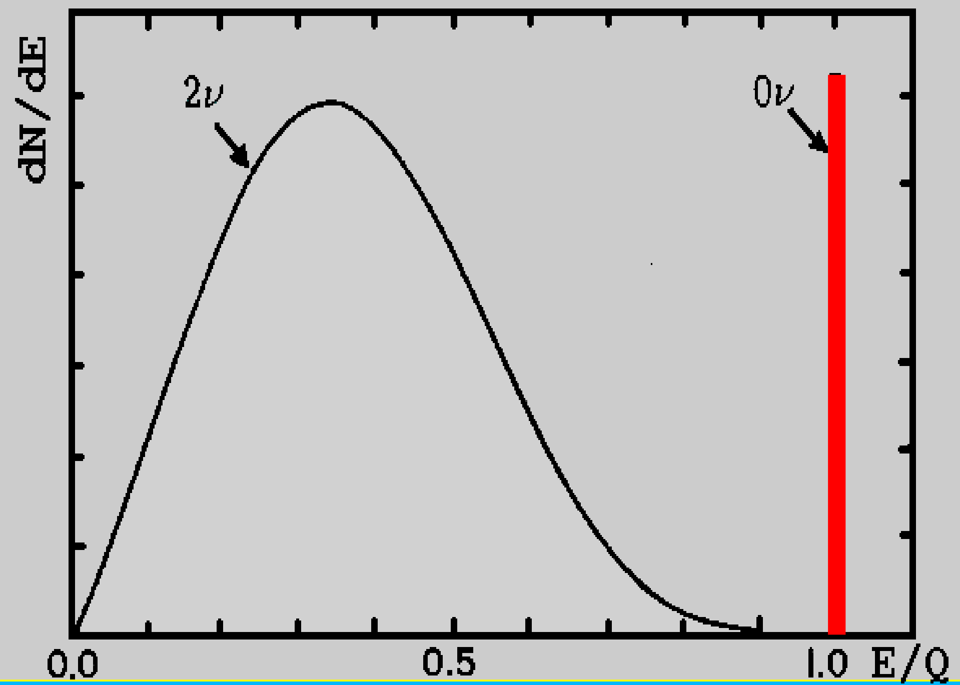
- allowed in SM



^{76}Ge **0νββ**:

$T_{1/2} > 1.9 * 10^{25}$ a
J. Phys. G 33, 1 (2006)

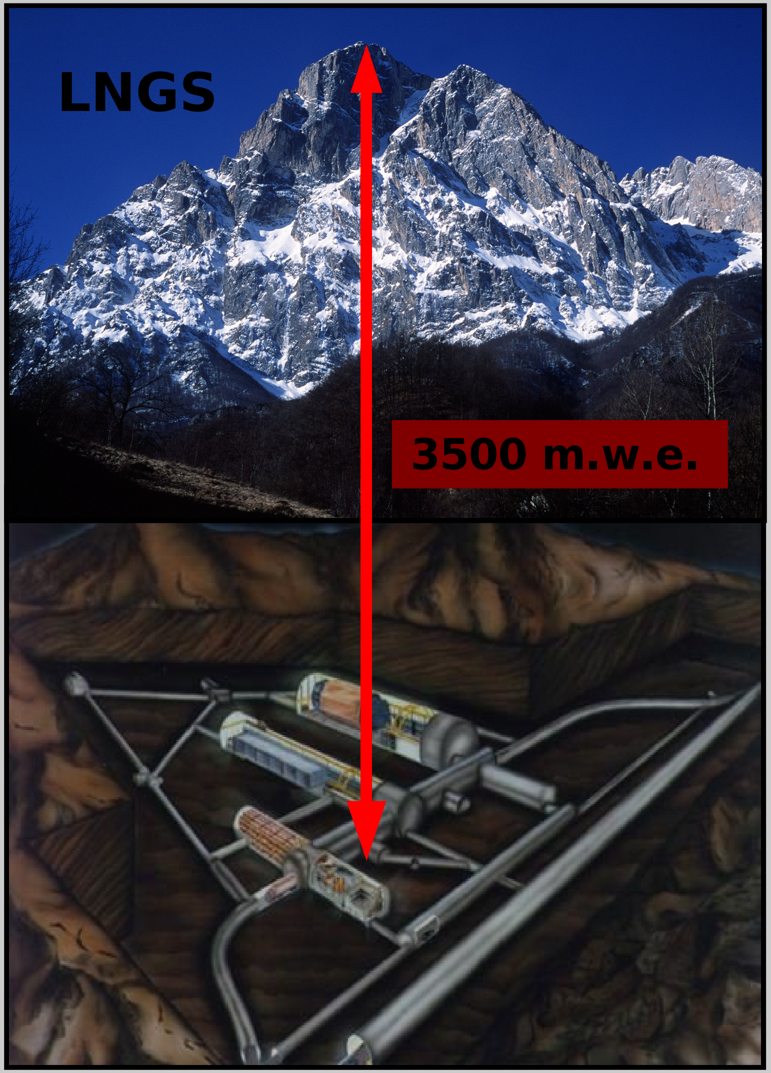
- $\Delta L \neq 0$
- **only if $\nu = \bar{\nu}$ && m_ν>0**

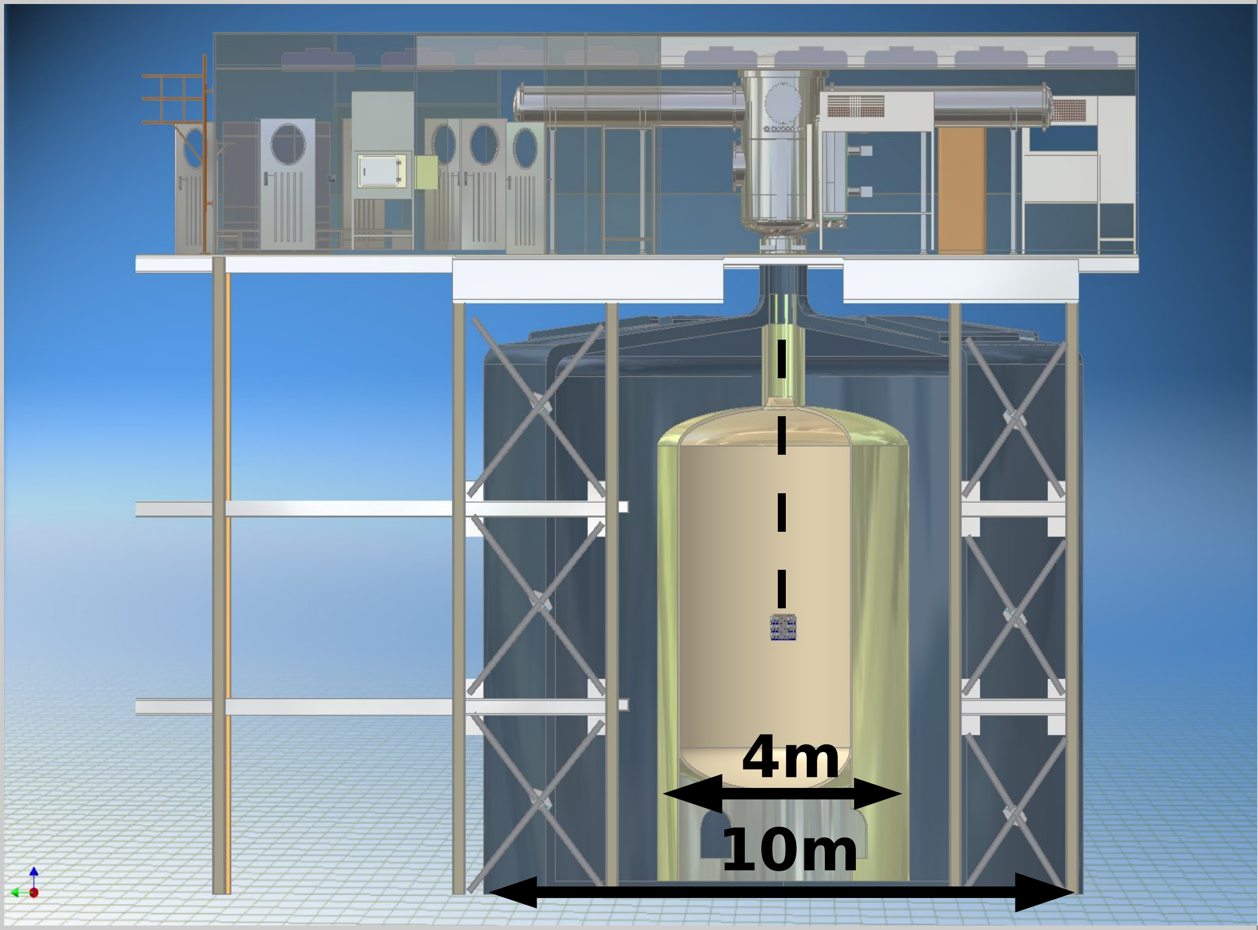


search in energy window around $Q_{\beta\beta}$

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

Experimental Setup





Phase I: 8 enriched unsegmented detectors

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

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

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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treat crystal in clean env
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  - **gammas**

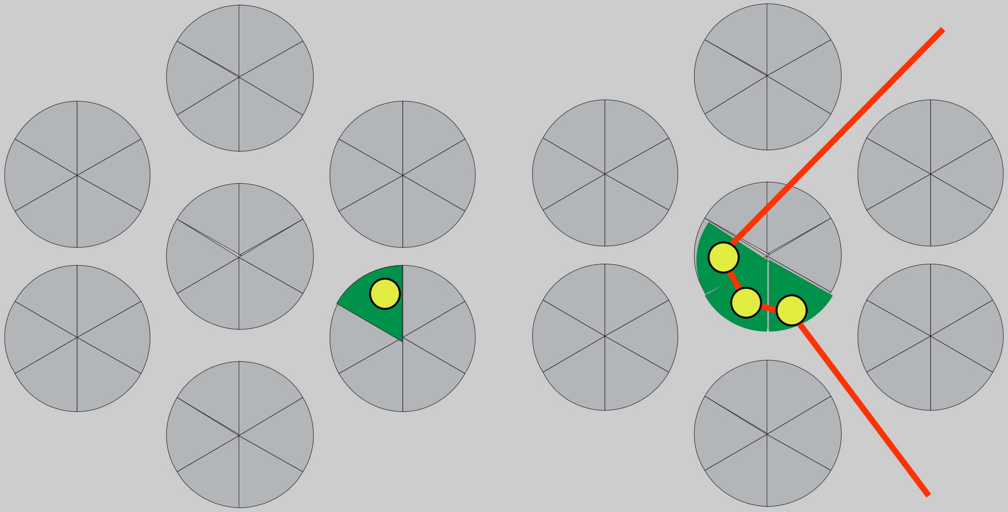
choice of material close to detectors shielding

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:

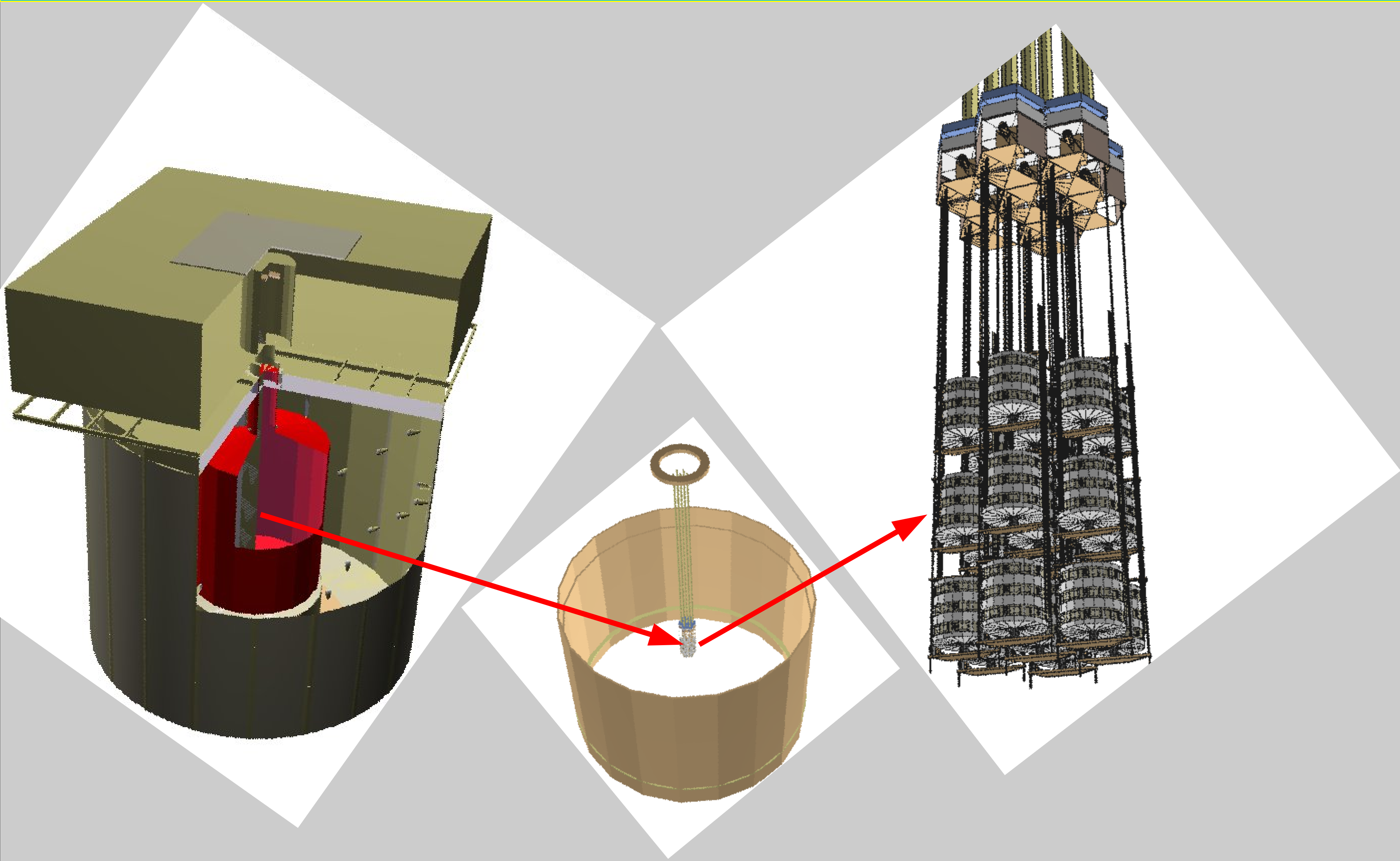
- **natural radioactivity**:
  - ^{232}Th → ^{208}Tl: 2614.5 keV
  - ^{238}U →
    - ^{234}Pa: 2072.2 keV
    - ^{214}Bi: many
    - ^{210}Tl: several
  - ^{40}K: 1460.8 keV
- **“man made“ radioactivity**
  - ^{137}Cs: 661.6 keV
- **cosmogenic activation**
  - ^{60}Co: 2158.5 keV
    2505. keV

Earlier Simulation

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

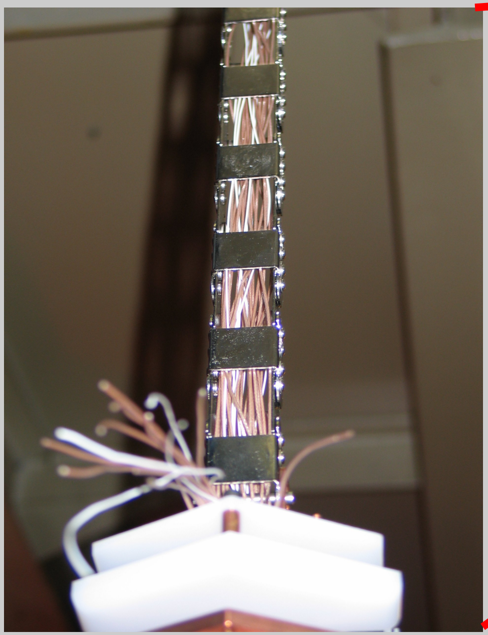
Part		Background contribution [10^{-4} counts/(kg·keV·y)]
Detector	**^{68}Ge**	**4.3** → after 2 years
	^{60}Co	0.3
	Bulk	3.0
	Surf.	**3.5** → further reduction through PSA expected
Holder	Cu	1.4
	Teflon	0.3
Cabling	Kapton	1.5
Electronics		**3.5**
LAr		1.0
Infrastructure		0.2
Muons and neutrons		2.0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

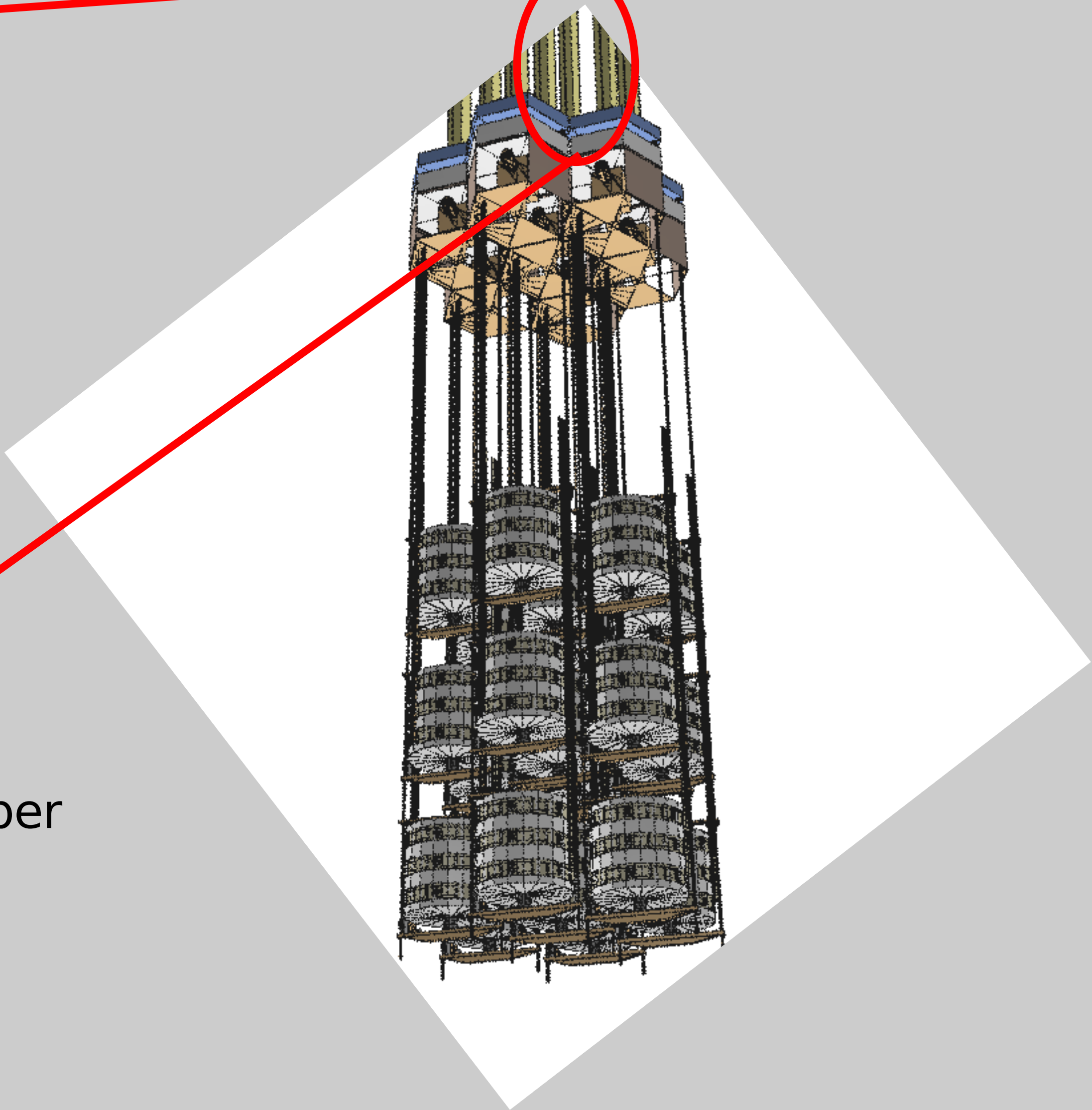
String Setup in Monte Carlo



String Setup in MC

41 cm
above crystals





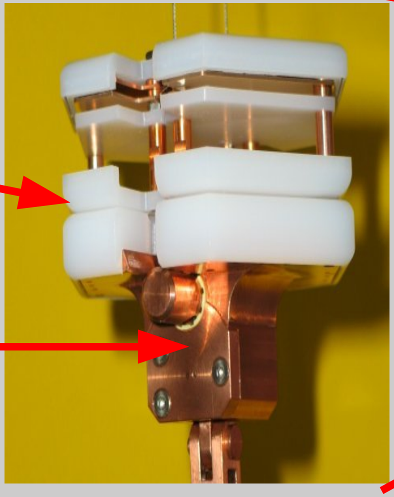
Cable Chain:

- last meter made from copper
- above stainless steel

Cables:

- woven ribbon signal cable

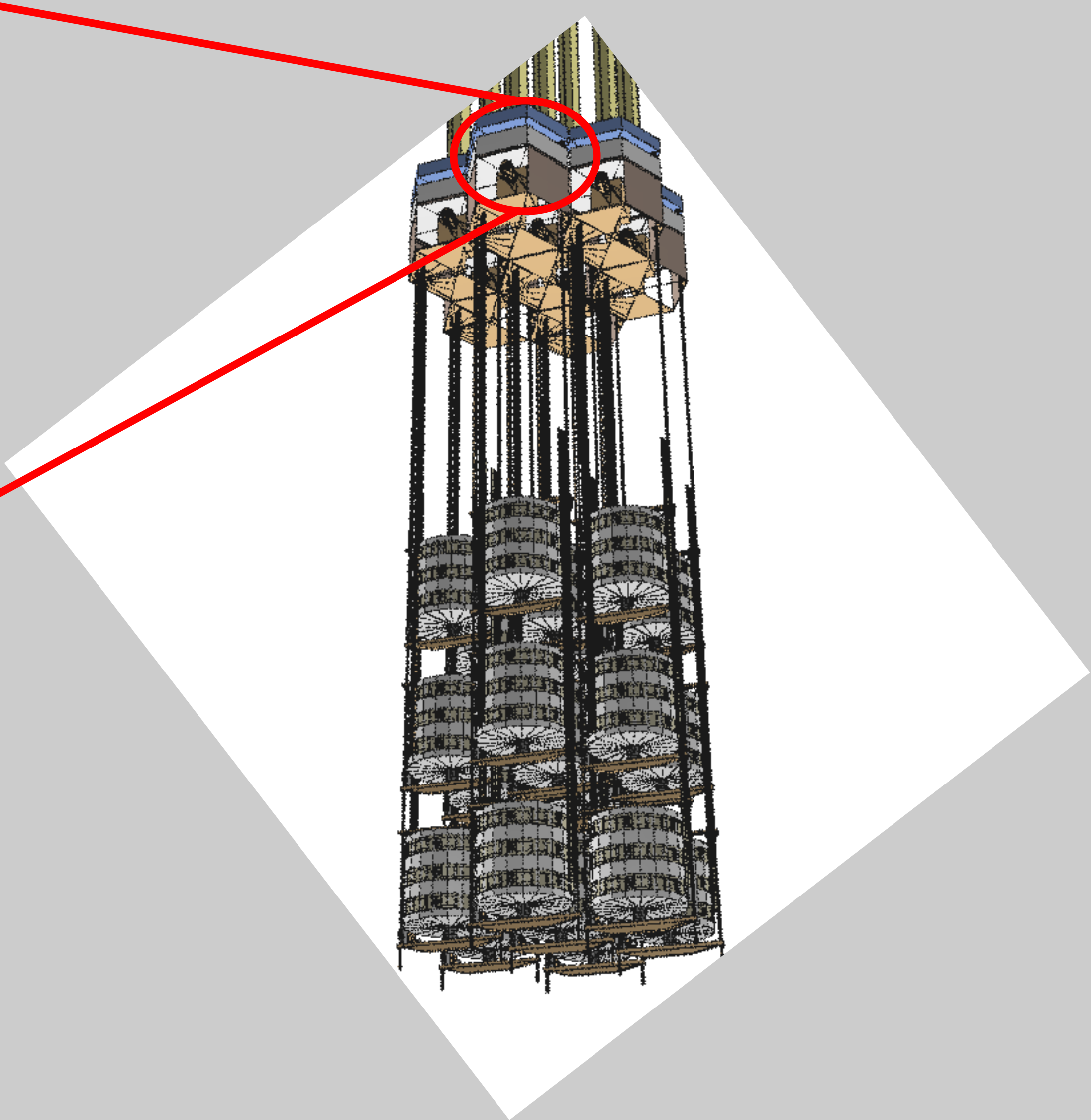
String Setup in MC



murtfeldt plastic
teflon, iglidur

most material copper

30 cm
above crystals

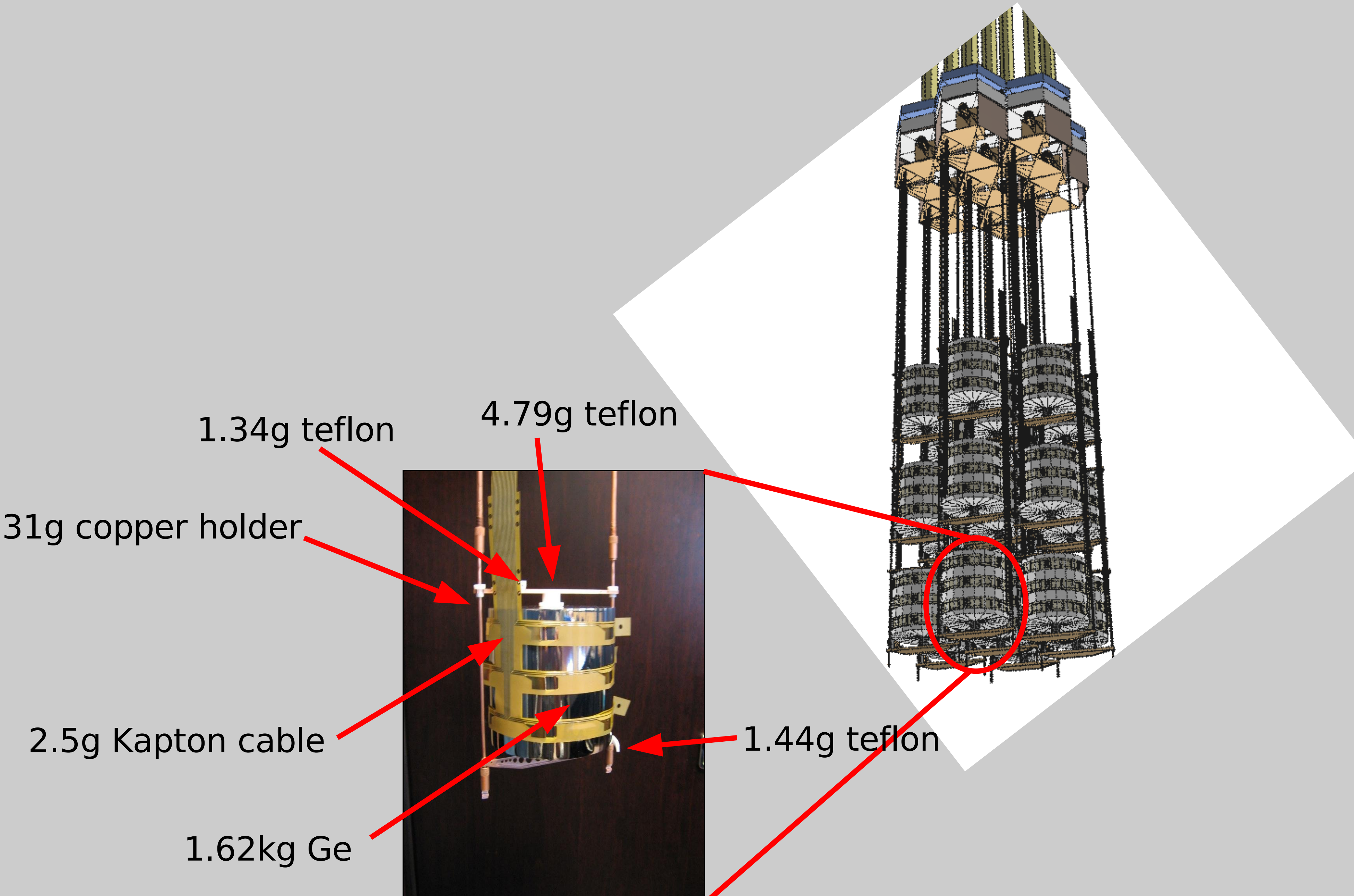


mass:

1.074 kg copper

0.105 kg “plastic“

String Setup in MC



Outlook

Finish analysis

Rerun simulation with realistic setup

Take into account other background contribution

Produce Reference Energy Spectrum