# First results from the background model of the LEGEND-200 experiment

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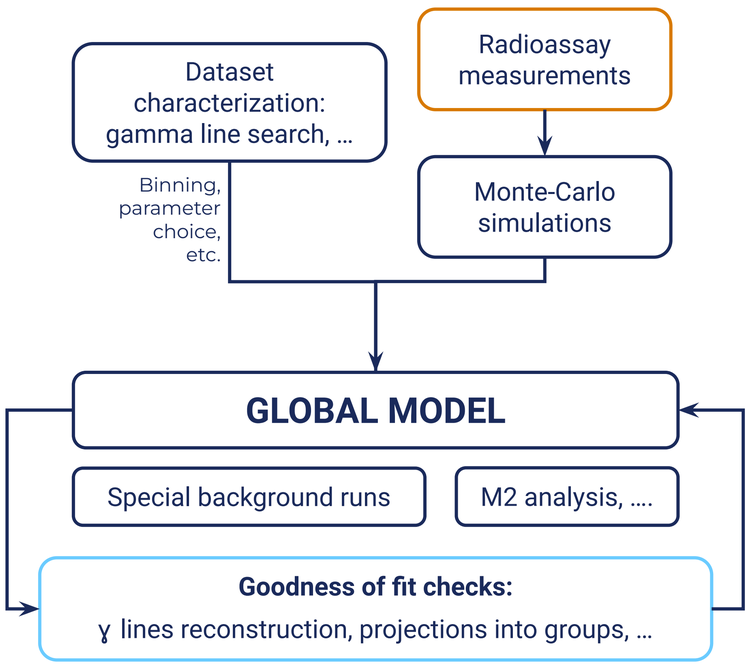
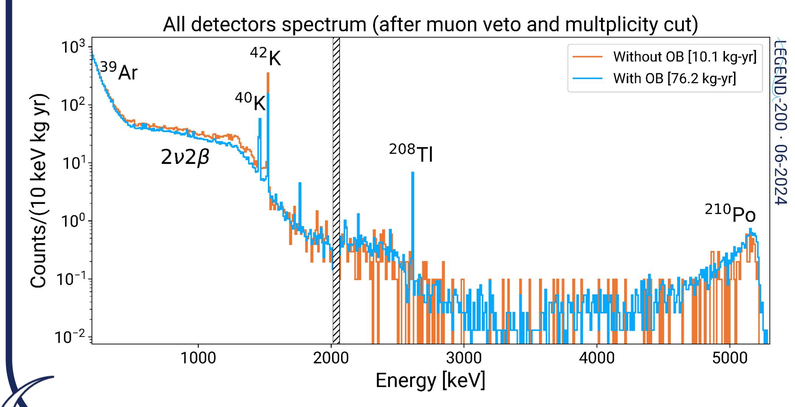
LEGEND Large Enriched Germanium Experiment for Neutrinoless ββ Decay

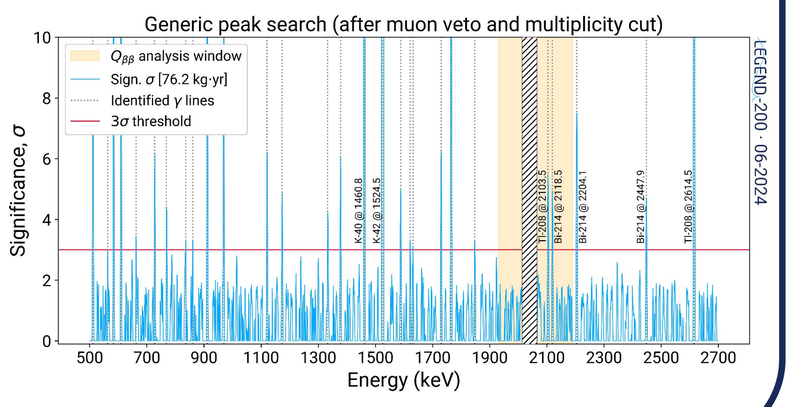
The **LEGEND** project [1] searches for neutrinoless double beta decay (0νββ) with the final **3σ discovery sensitivity aim of > $10^{28}$ yr**.
The first phase (**LEGEND-200**) is currently running and will be installed with 200 kg of $^{76}$Ge.
With 2x$10^{-4}$ cts/keV/kg/yr background and 1 t-yr of exposure: ⟹ **3σ discovery sensitivity, $10^{27}$ yr or $m_{\beta\beta}$ < 33 - 71 meV**
**At this conference:** 0νββ limit from the first year of data and **background model** of these data.

## Data

- Spectra with:
  - **quality cuts:** only physical signals
  - **multiplicity cuts**: # of Ge detectors with E>25 keV
- Dataset based on **two hardware configurations**
- Exposure of **76 & 10 kg-yr** accumulated with & without the outer barrel (OB) of the LAr instrumentation
- Bayesian **generic peak search**
- Identified significant ɣ peaks used to inform the ***global model*** parameter choice and binning

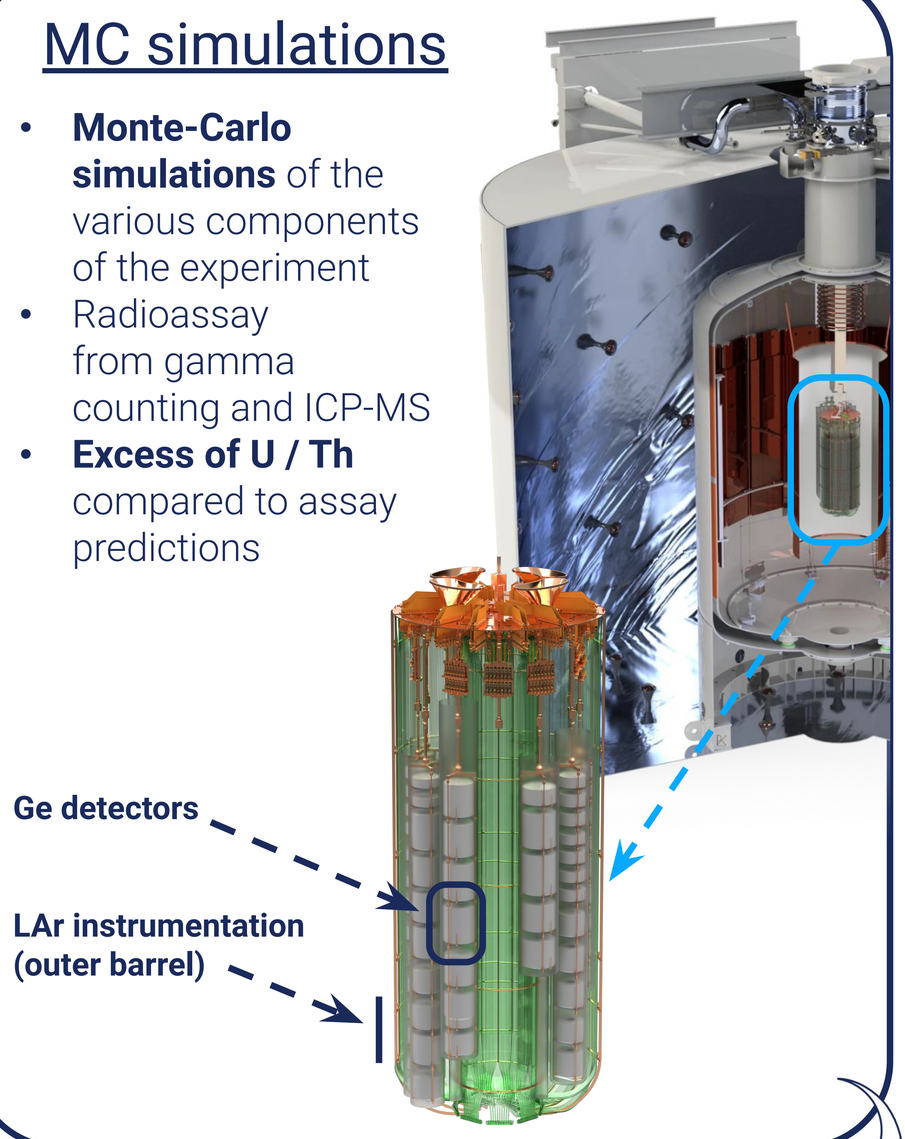



## MC simulations

- **Monte-Carlo simulations** of the various components of the experiment
- Radioassay from gamma counting and ICP-MS
- **Excess of U / Th** compared to assay predictions




## Global Model

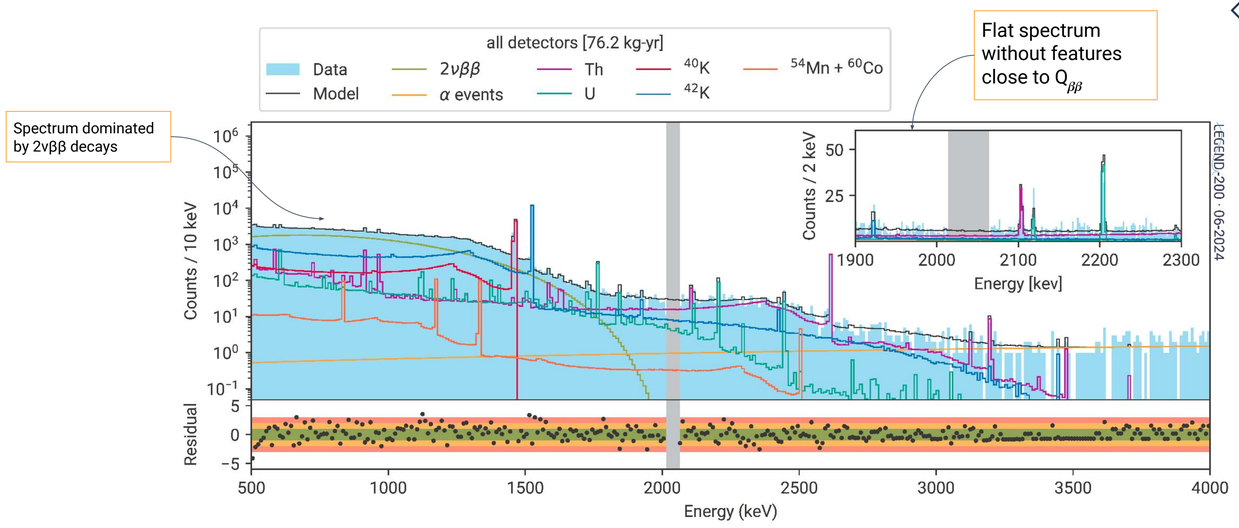
- Binned likelihood fit with BAT [2] similar to Ref. [3]

**GLOBAL MODEL**

M1 spectra by detector type | 4 M2 categories | X | Two hardware configurations (with / without OB)

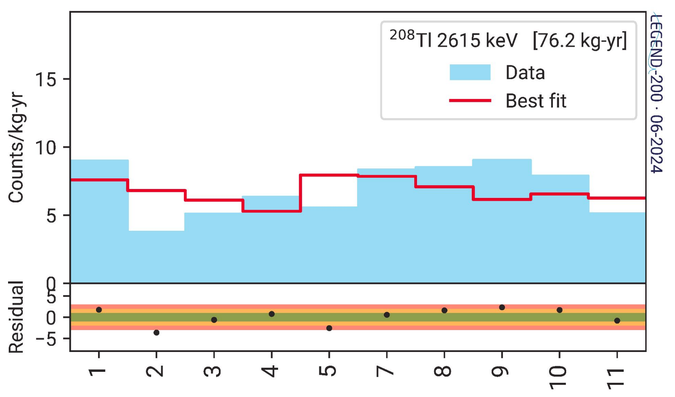
68 parameters: activities in different components

- **Good reproduction** of all 16 data spectra
- Shown on right, multiplicity one (M1) data summed over all detector types




## Model projections

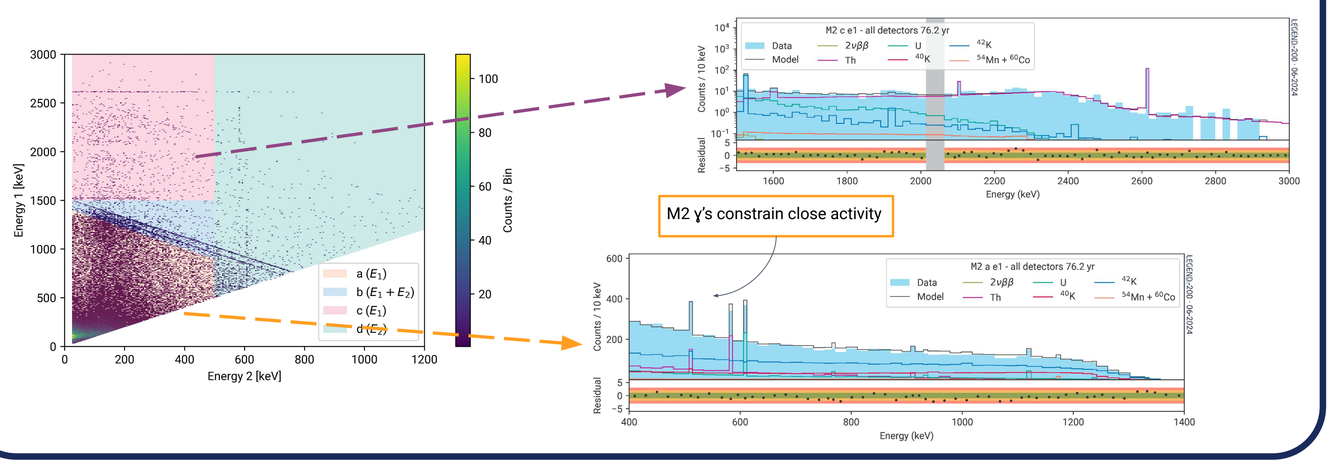
- Reconstructed counts in γ lines for different **groupings of detectors**
  - *By channel*
  - *Detector type*
  - *String*
  - *Z-groups*
  - *Run etc.*
- Show **example** of 2615 keV counts by detector string




Sensitivity to **spatially localised** background sources

## Multiplicity two analysis

- Use **multiplicity two (M2)** events to constrain model
- Divide 2D M2 data into four regions (show two)
- **Improves sensitivity** to the location of U/Th background


- We can **model well** the data from LEGEND-200, before LAr & PSD cuts
- Specific focus on **goodness of fit**: projections into subsets, gamma lines etc.
- Model can rule out some hypotheses (eg. excess activity all close or far etc)
- **Next steps:** Including LAr and PSD response into model

References
[1] *LEGEND Collaboration*. N. Abgrall et al (arxiv:2107.11462)
[2] A. Caldwell, D. Kollar, and K. Kroninger, Comput. Phys. Commun. 180, 2197 (2009),
[3] Modelling of GERDA Phase II data. GERDA collaboration. JHEP 03 (2020), 139

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Full list of LEGEND institutions