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SFB 1258

Neutrinos  
Dark Matter  
Messengers



DFG

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für Physik



TUM

# Suppressing and Tagging $^{42}\text{Ar}/^{42}\text{K}$ Surface Beta Events in LEGEND Using Semi-Supervised Latent Density Estimation

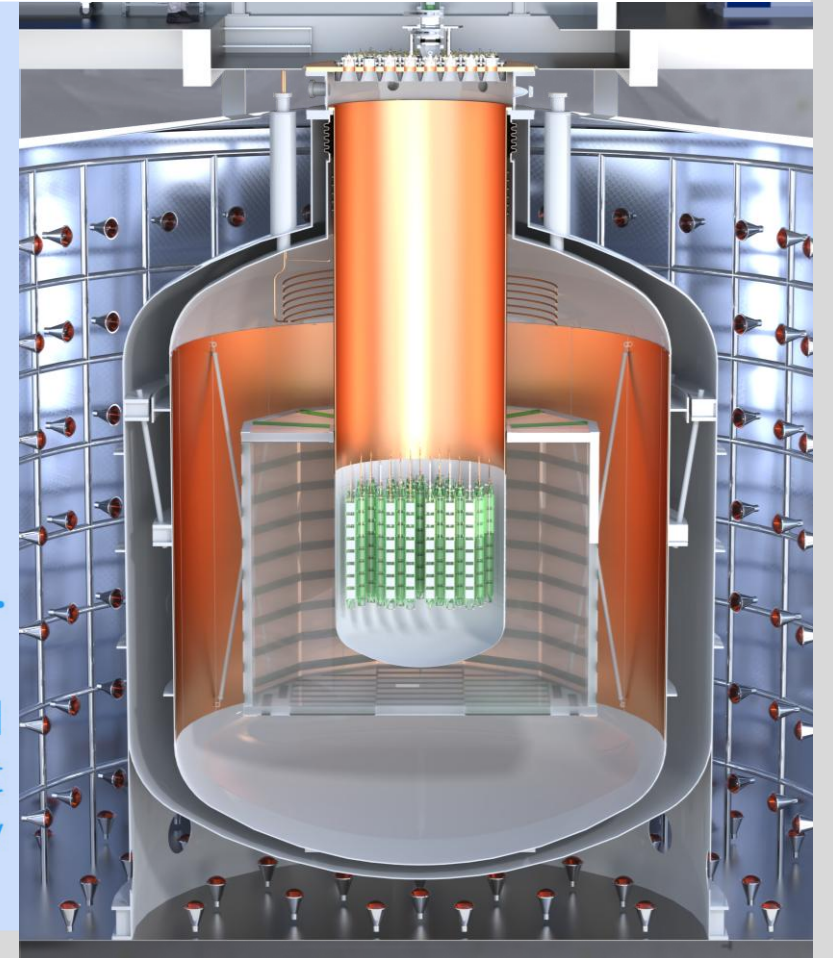


Niko Lay<sup>1</sup>

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Large Enriched  
Germanium Experiment  
for Neutrinoless  $\beta\beta$  Decay



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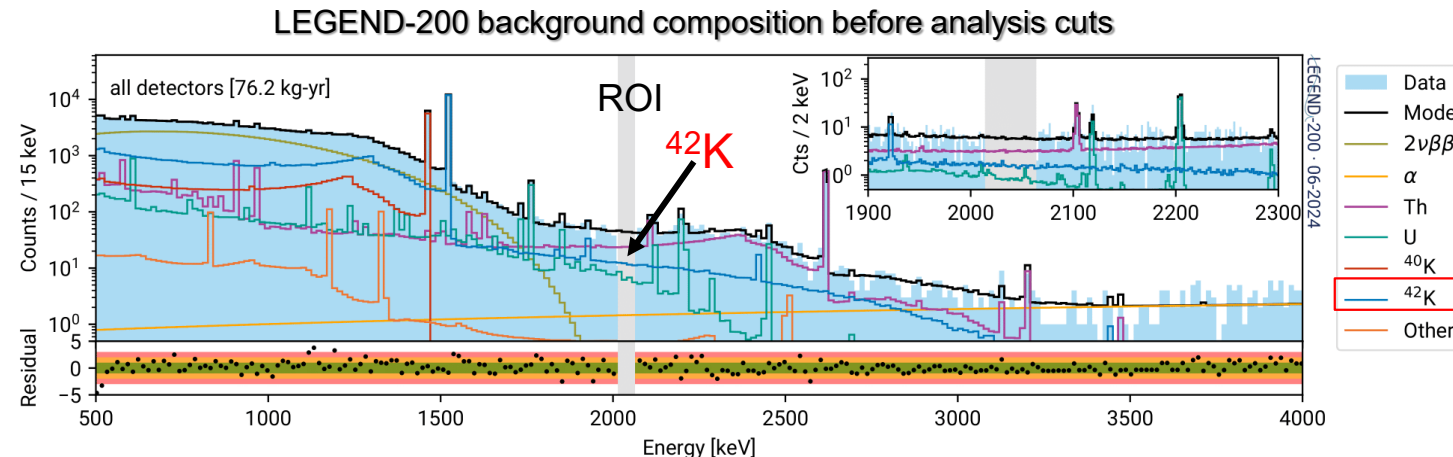
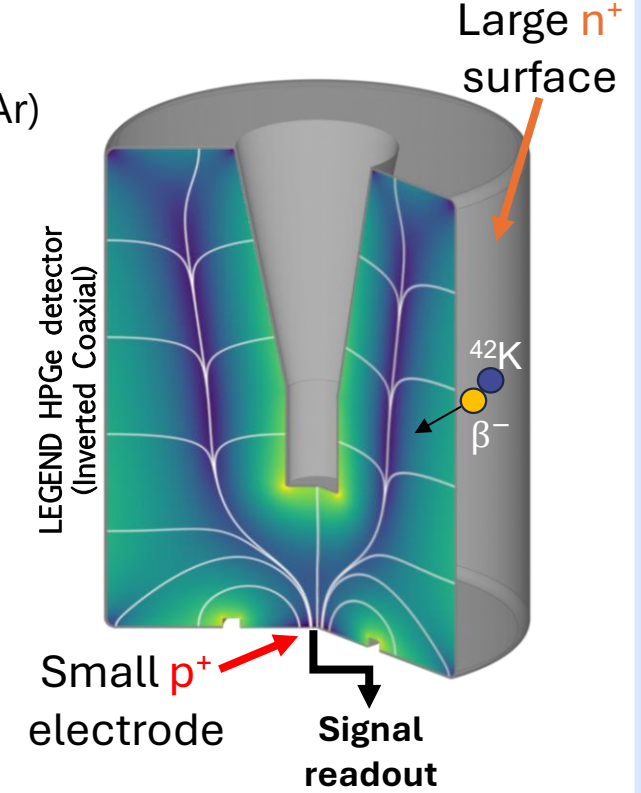
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SCAN ME

# $n^+$ Surface Events: A Challenge for LEGEND-1000

- Large Enriched Germanium Experiment for Neutrinoless  $\beta\beta$  Decay ( $0\nu\beta\beta$ )
  - 2<sup>nd</sup> phase: one-ton high-purity germanium (HPGe) detectors immersed in liquid argon (LAr)
  - Background index goal:  $< 10^{-5}$  cts / (keV kg yr) at ROI
- Without additional measures,  $^{42}\text{K}$   $n^+$ -surface events would be the **dominant background** in LEGEND-1000
- Baseline mitigation: underground-sourced LAr (UGLAr) is depleted in  $^{42}\text{Ar}$
- In case UGLAr is not available, combined detector enclosures and machine learning for HPGe pulse-shape classification offer a promising alternative
- The challenge:
  - $n^+$  surface events are **challenging to simulate**
  - In real LEGEND-200 data: **very few labeled examples** to train on



# Suppressing and Identifying $n^+$ Surface Betas without Labels

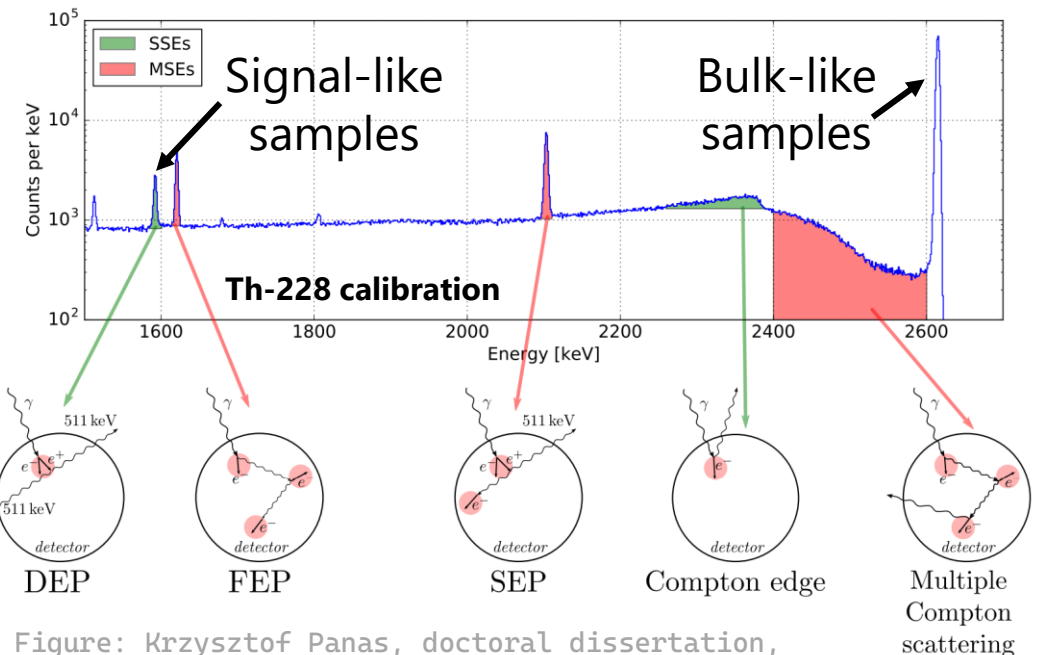
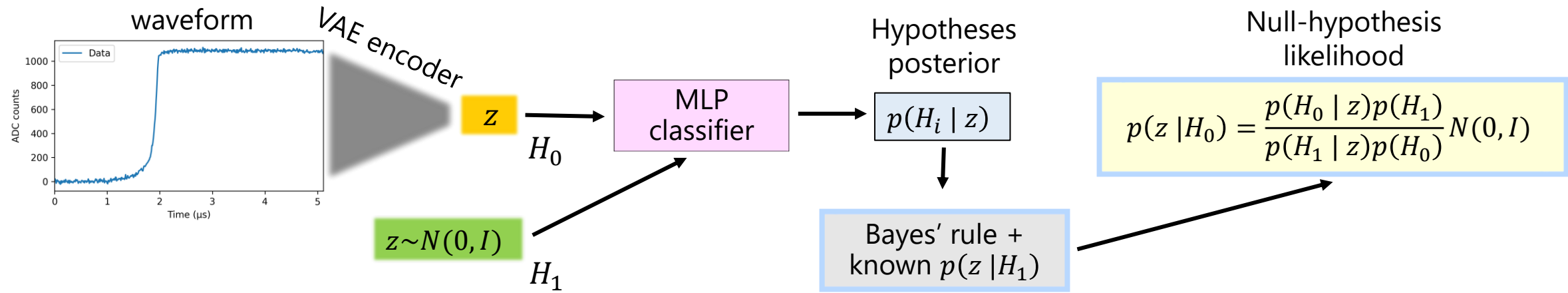
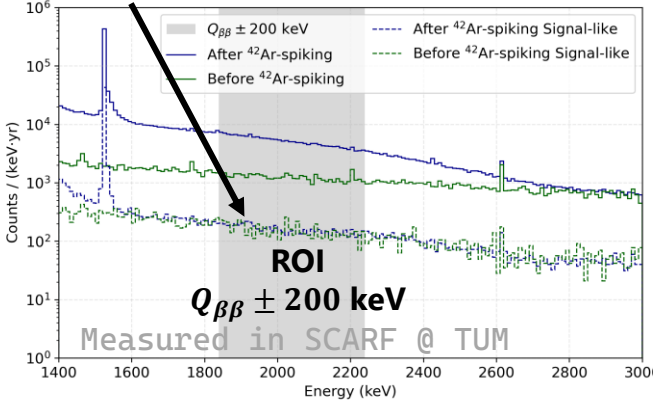


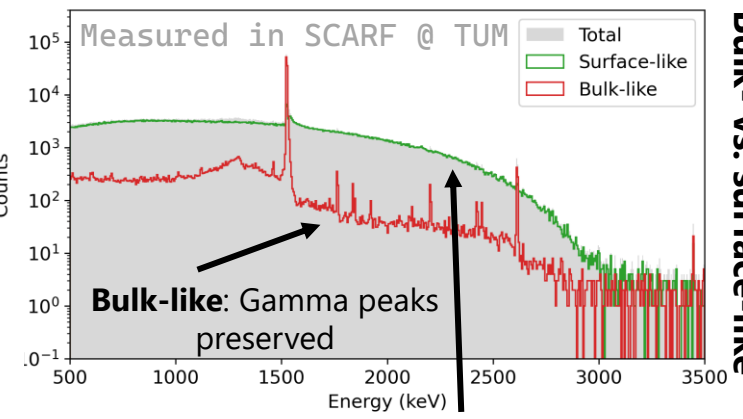
Figure: Krzysztof Panas, doctoral dissertation, Jagiellonian University, Cracow

## $n^+$ surface events suppression and identification:

Stable signal-like spectra before and after  $^{42}\text{Ar}$ -injection



## Signal- vs. background-like



## Bulk- vs. surface-like

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