# Probing Neutrino Nature with the LEGEND Experiment

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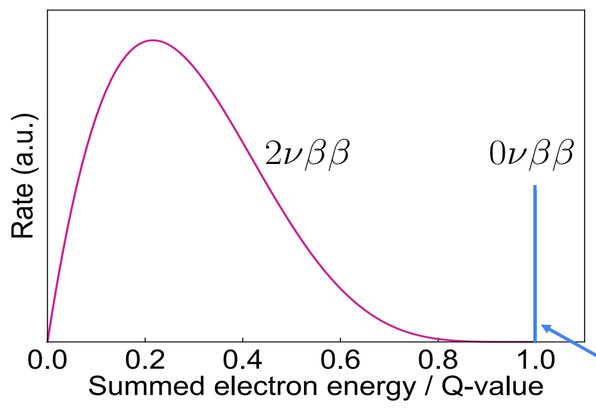
**Why is the Universe made of matter and not antimatter?** The Universe's matter dominance over antimatter, despite their equal creation at the Big Bang and annihilation upon contact, might be due to neutrinos. These elusive particles could be their own antiparticles, violating lepton-number conservation. The LEGEND experiment at Laboratori Nazionali del Gran Sasso, Italy, explores the nature of neutrinos by searching for a rare event called **neutrinoless double beta decay**.

**Physics Goal:** Find neutrinoless double beta decay (**0νββ**) in high purity germanium (HPGe) crystals enriched in $^{76}$Ge.




Two neutrinos emitted (2νββ):
$^{76}Ge \rightarrow {}^{76}Se + 2e^- + 2\bar{\nu}_e$ (ΔL=0)

No neutrino emitted (0νββ):
$^{76}Ge \rightarrow {}^{76}Se + 2e^-$ (ΔL=+2)

Lepton-number violating process!

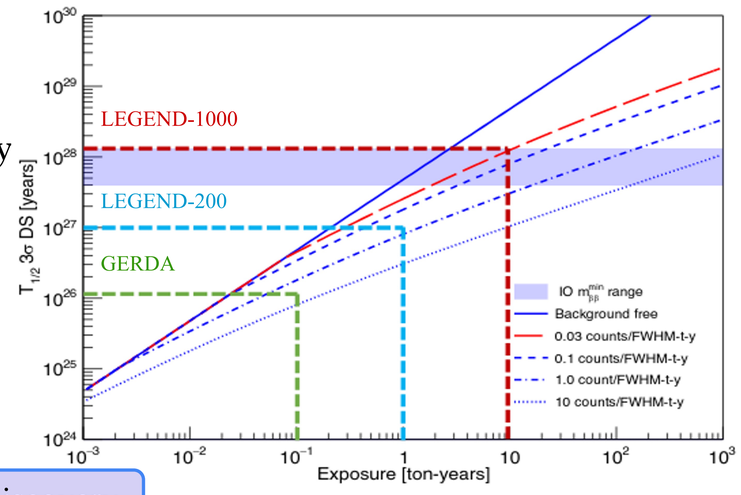
Excellent energy resolution ✚ Lower Background ➡ Higher chance of discovery

**Sensitivity Aim:**

LEGEND-200 (5 yr exposure): decay half-life of $T_{1/2} > 10^{27}$ yr

LEGEND-1000 (10 yr exposure): increase sensitivity to $T_{1/2} > 10^{28}$ yr

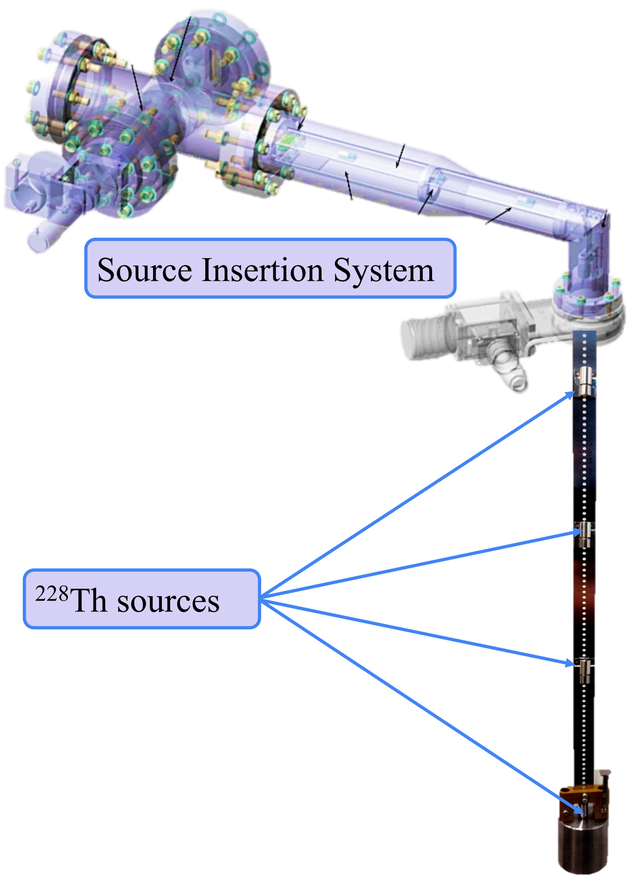
Very rare event!




## Our group's focus areas :

Gran Sasso Mountain: overburden (1.4 km)

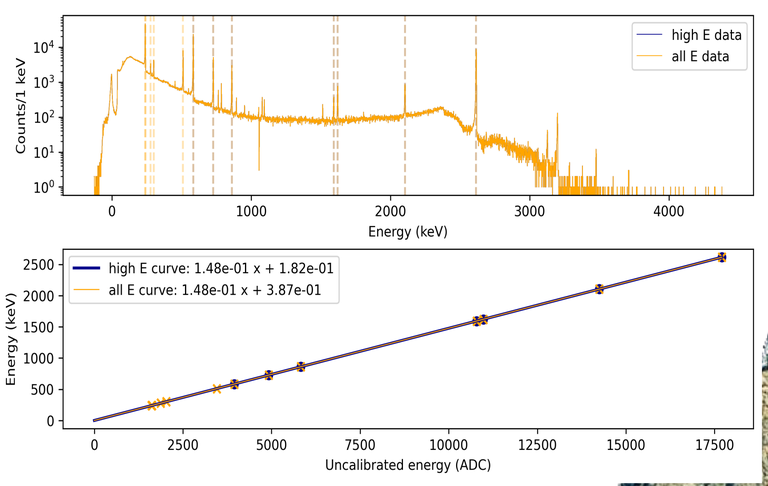
### 1. Source Insertion System Development




### 2. Wavelength-Shifting Materials Characterisation

Wavelength-shifting **reflectors** surround the **fibres** to enhance light collection

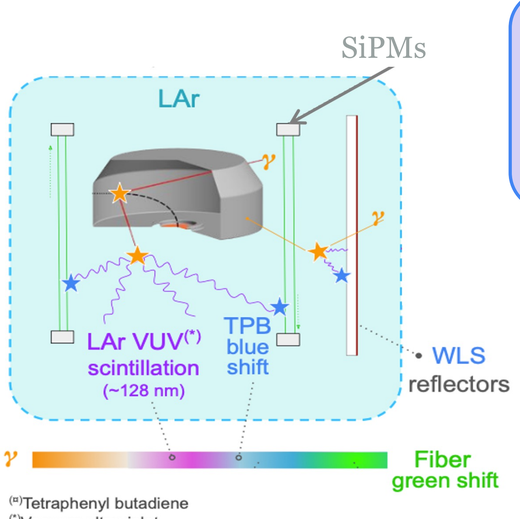
### 3. Energy Calibration



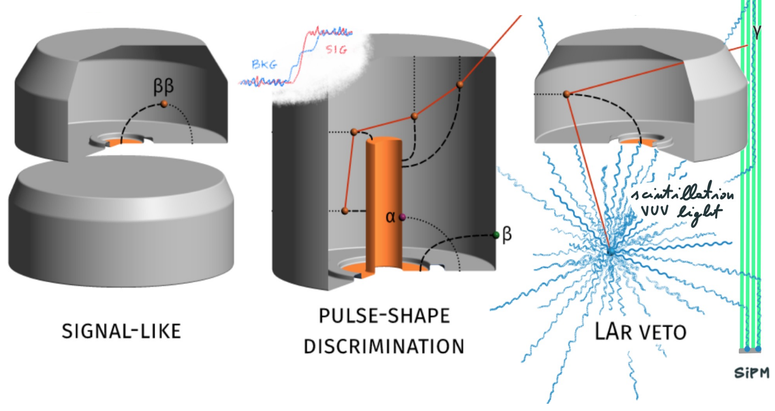


### 4. Background Rejection

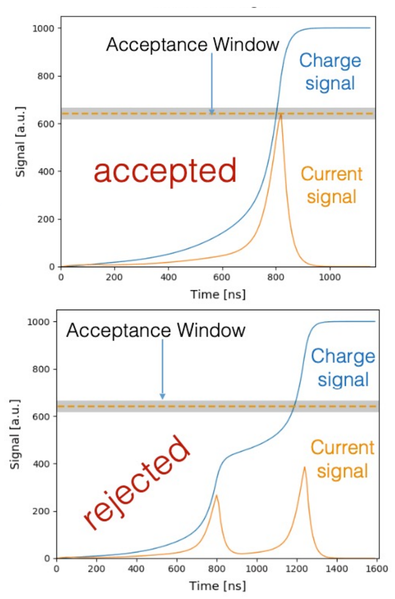
Detector holders, made of polyethylene naphthalate, shift VUV light:

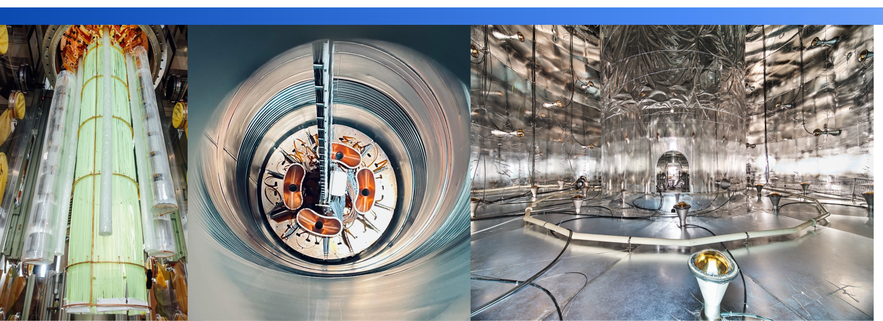



Point-like energy deposition | Multisite/surface interaction | Coincident light




✚ Deep Learning



LEGEND


11 countries,
~ 50 institutions,
> 250 members