LEGEND

Large Enriched
Germanium Experiment
for Neutrinoless ββ Decay

Michele Morella on behalf
of the LEGEND local groups

LEGEND collaboration

"LEGEND-1000 emerged as the winner of the portfolio review! We will be funded by the DOE!"

SNOLAB	Univ. Liverpool	Univ. of North Carolina	Leibniz Inst. Crystal Growth
Roma Tre	Tennessee Tech.	Univ. of South Carolina	Max Planck Inst., Munich
Duke Univ.	Univ. of Warwick	L'Aquila Univ. and INFN	Czech Tech. Univ. Prague
Univ. Zurich	Jagiellonian Univ.	Gran Sasso Science Inst.	North Carolina State Univ.
Queen's Univ.	Simon Fraser Univ.	Lab. Naz. Gran Sasso	Joint Inst. Nucl. Res. Inst.
Padova Univ.	Univ. New Mexico	Univ. College London	Lab. Exper. Nucl. Phy. MEPhI
INFN Padova	Univ. Texas, Austin	Los Alamos Natl. Lab.	INFN Milano Bicocca
Laurentian Univ.	Univ. Washington	Tech. Univ. Dresden	Milano Univ. and INFN
Univ. Tennessee	Univ. Tuebingen	Joint Res. Centre, Geel	Triangle Univ. Nuclear. Lab.
Univ. of Indiana	Tech. Univ. Munich	Lawrence Berkeley Natl. Lab.	Max Planck Inst., Heidelberg
Comenius Univ.	Oak Ridge Natl. Lab.	Univ. California, Berkeley	Inst. Nucl. Res. Russ. Acad. Sci.
Lancaster Univ.	Univ. South Dakota	Polymer Research Dresden	Natl. Res. Center Kurchatov Inst.
Univ. of Regina	South Dakota Mines		

11 countries
260 scientists
2 Collaboration Meeting per year
between Europe and USA

LEGEND local groups

GSSI

Natalia **Di Marco**
Physics professor

+1 new Post Doc

Michele **Morella**
3rd year Ph.D.

+ anyone of you!!

INFN LNGS

Marco **Balata**
INFN Researcher

Chiara **Vignoli**
INFN Researcher

Nicola **Rossi**
INFN Researcher

Matthias **Laubenstein**
INFN Researcher

Aldo **Ianni**
INFN Researcher

Francesco **Ferella**
INFN Researcher

Iza **Kochanek**
INFN Researcher

Alessandro **Razeto**
INFN Researcher

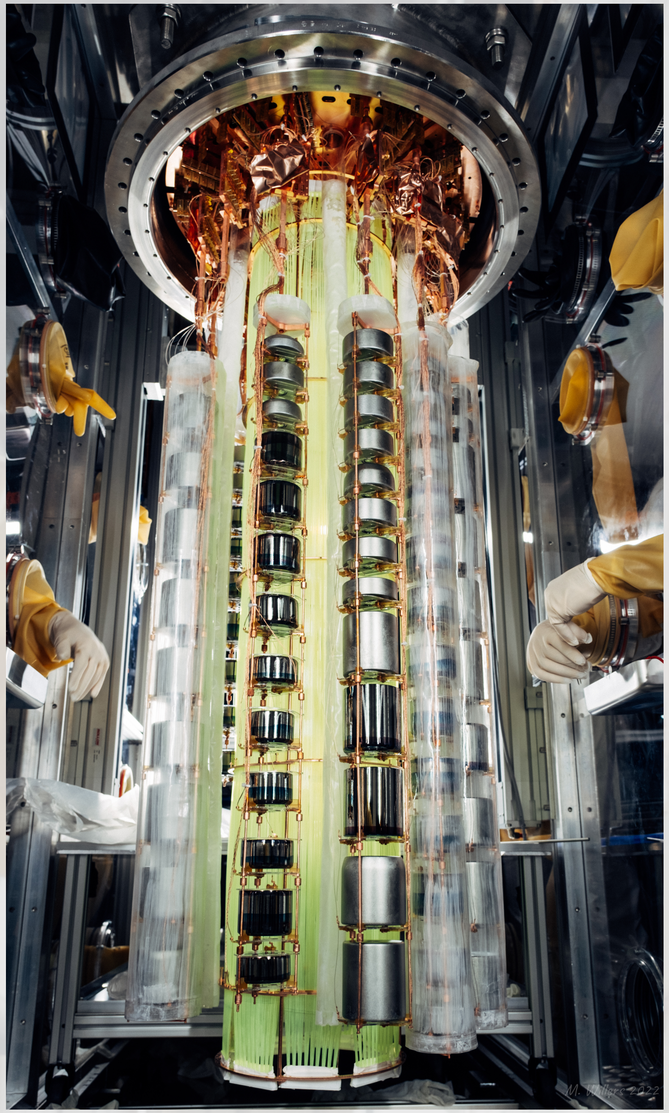
UNIVERSITÀ DEGLI STUDI DE L'AQUILA

Francesco **Salamida**
Physics Professor

Carla **Macolino**
Researcher

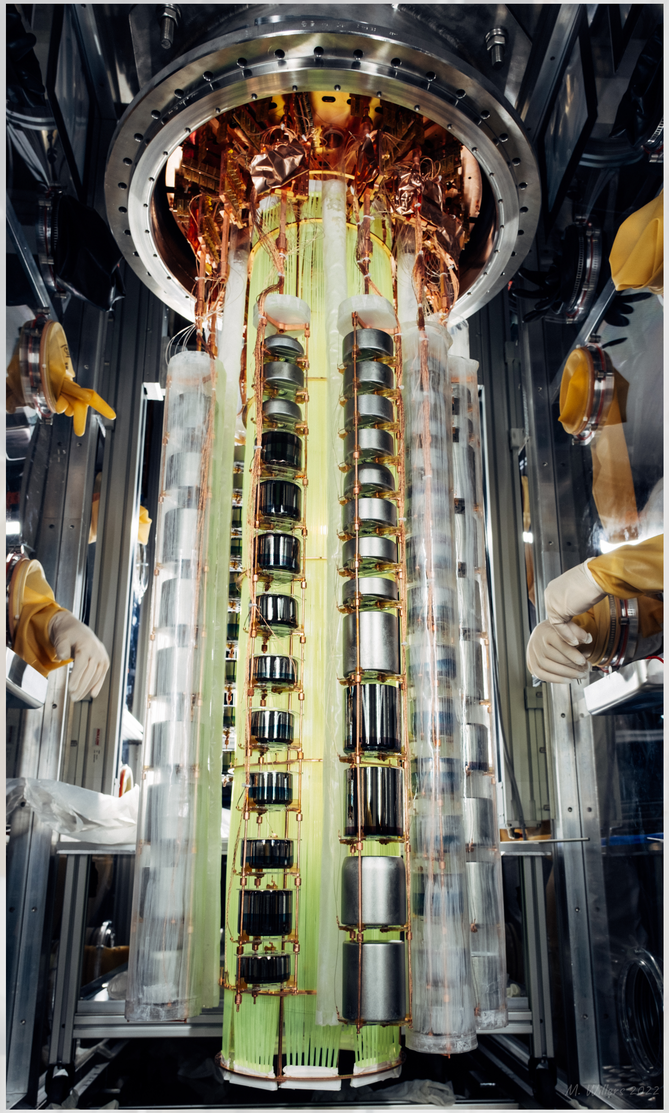
Sincler **Meireles**
Post Doc

LEGEND-200 Activities



- 140 kg of HPGe already installed
- Switching to **Physics data** taking during next weeks
- **First results (exposure = O(100kg yr))** expected at the beginning of 2024
- The remaining 60kg of HPGe will then be mounted and data taking resumed
- Official L200 analysis code written in python
- Many publications to be released over coming years

LEGEND-200 Activities



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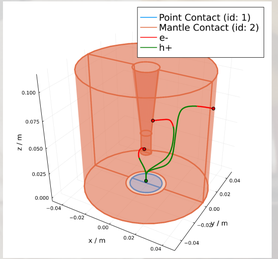
Analysis



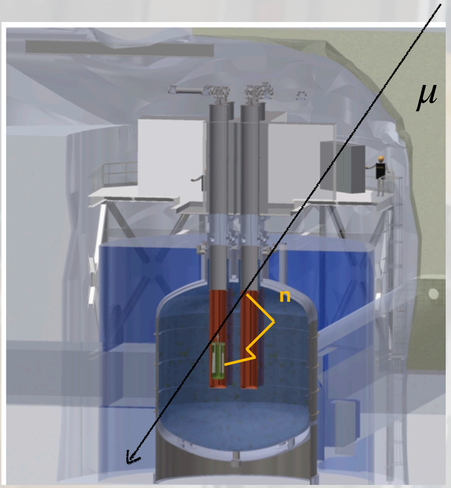
- Analysis of detector stability and energy resolution
- Pulser Shape Discrimination (PSD) for new Inverted Coaxial detectors
- Beyond Standard Model Physics Searches (dark matter, majoron emission, BSM using Liquid Argon)
- Analyse μ-induced background in **L200** data in view of **L1000 @LNGS**

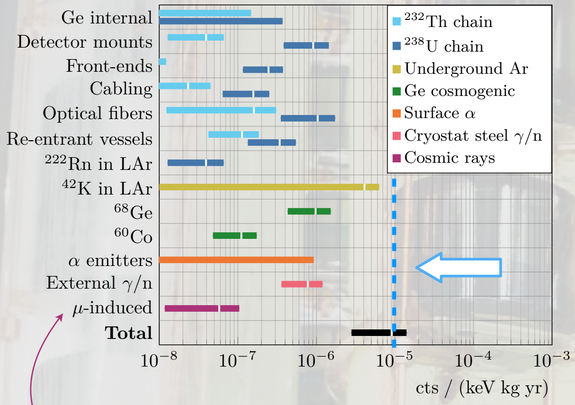
L200 will be taking data during the entire period of your Ph.D.

You can publish the results of your analysis in a collaboration paper

LEGEND-1000 @LNGS

LEGEND-1000: SNOLAB vs LNGS





LEGEND-1000 Background Goal: $< 10^{-5}$ counts/(keV·kg·yr)

μ-induced background @SNOLAB: (~ 6000 m.w.e.) $\sim 10^{-7}$ counts/(keV·kg·yr)

μ-induced background @LNGS: (~ 3400 m.w.e.) $> 10^{-5}$ counts/(keV·kg·yr)

Different depths imply different μ-induced background!

LEGEND-1000 @LNGS

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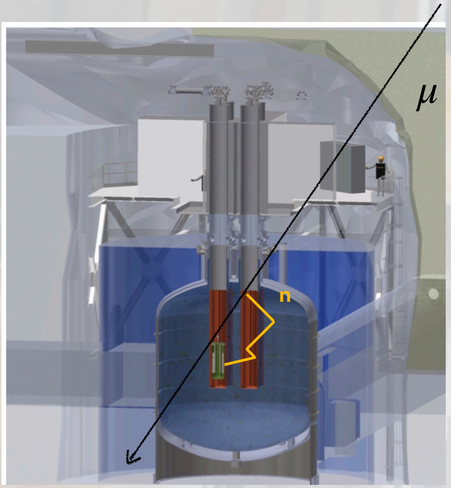

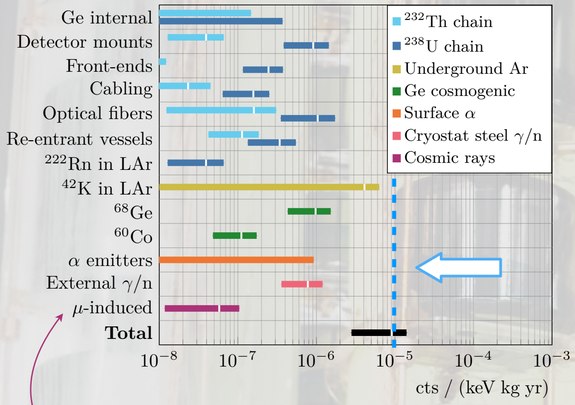

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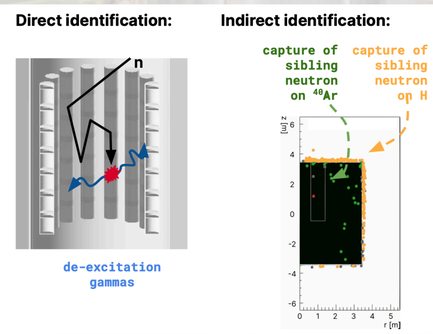
How to virtually increase LNGS depth and reduce cosmogenic background?

New dedicated tagging analysis



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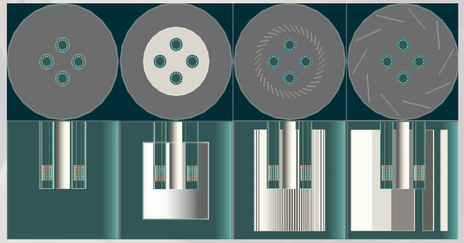
Neutron Moderator (passive shield)



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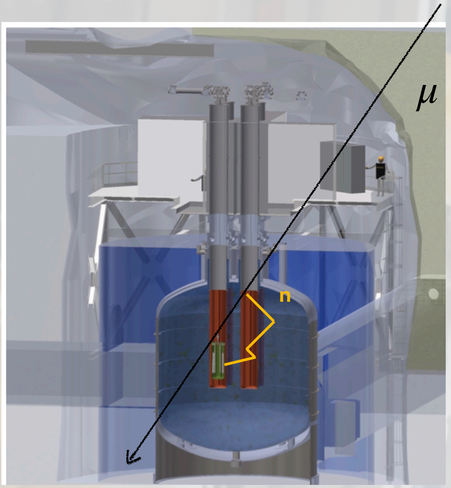

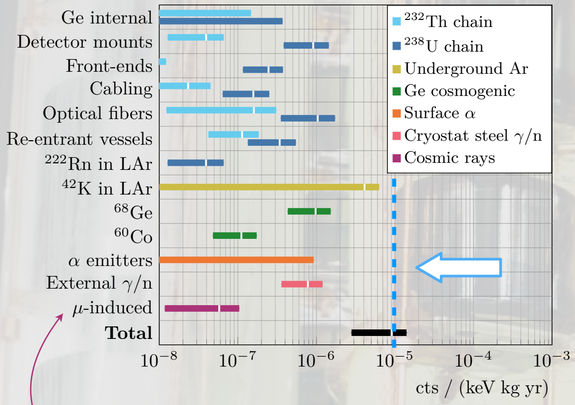

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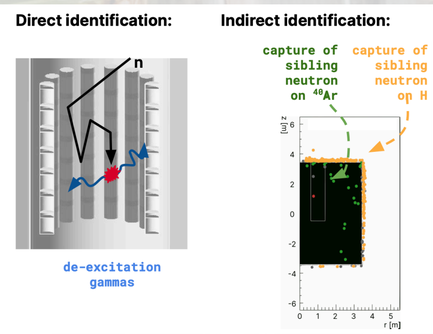

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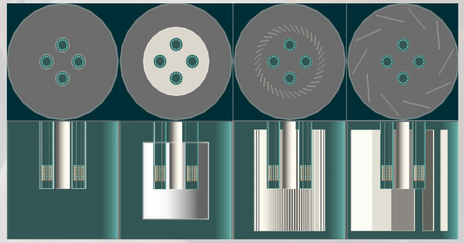

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Same sensitivity between LNGS & SNOLAB!!!!

LEGEND-1000 @LNGS

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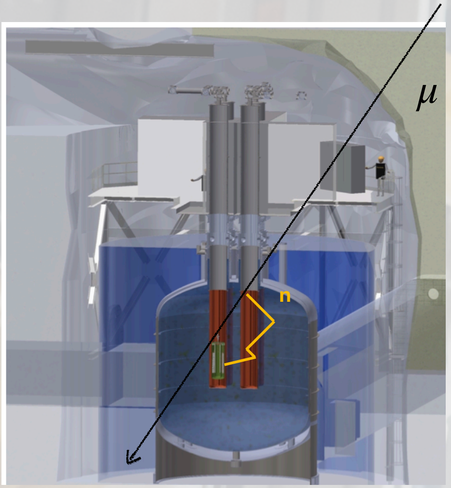

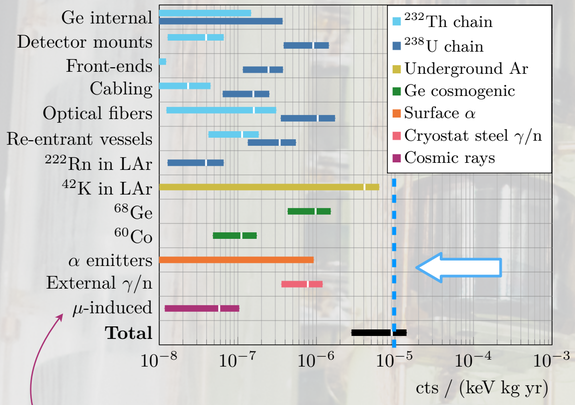

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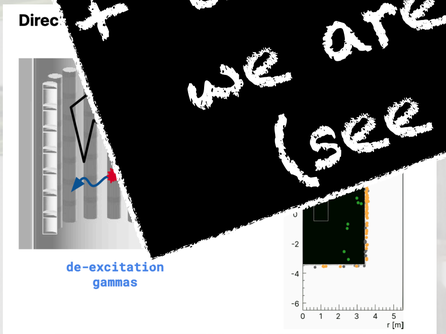
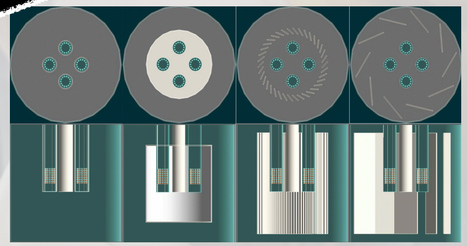
+ the neutron veto we are designing!! (see my poster)





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LEGEND-1000 Activities

Analysis

- can we reject μ-induced background using topology of the event?
  - standard cuts?
  - Machine Learning?
- study $^{77(m)}$Ge production and search for new channels to tag it
  - e.g. tagging production of other isotopes like ^{41}Ar
- benchmark **L1000** simulations @LNGS using **L200** data

Simulations

- optical simulations of energy depositions in LAr
- readout optimization

Hardware R&D

- active lab @LNGS with LAr setups
  - test readout options in LAr
  - test and characterization of WLS
  - direct 3D printing of scintillating supports
- innovative polymer for moderator material (in collaboration with UniPG)
  - radiopurity
  - Gd/B loading
  - evaluate moderation efficiency of different solutions