



LABORATÓRIO DE INSTRUMENTAÇÃO  
E FÍSICA EXPERIMENTAL DE PARTÍCULAS  
*partículas e tecnologia*

# Competence Center on Simulation and Big Data: Simulation

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on behalf of the Competence Center

Jornadas do LIP  
Braga, February 15<sup>th</sup>, 2020

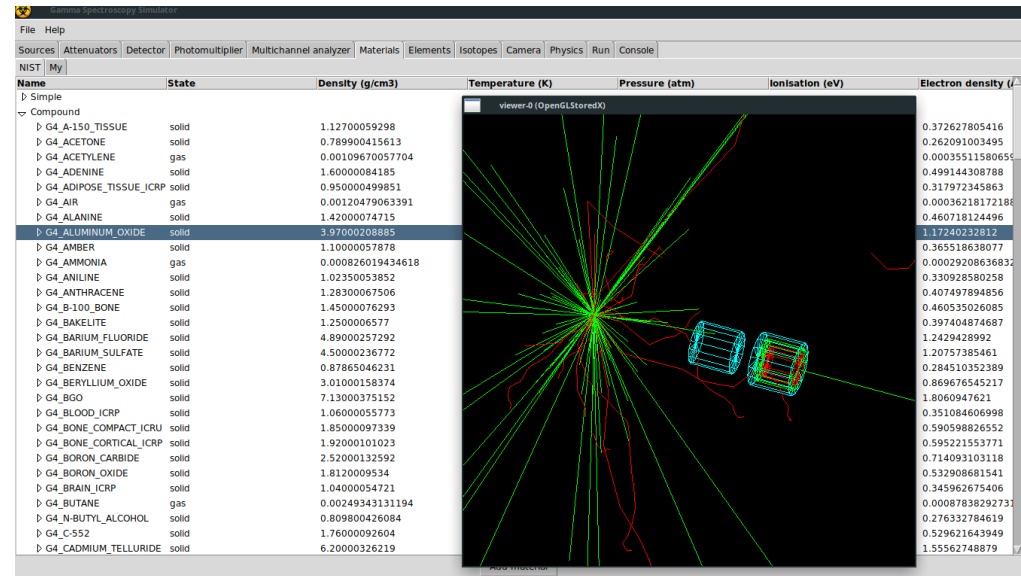
# Overview

- Coordinators: Bernardo Tomé and Patrícia Gonçalves
- Gathers and expands LIP's competences on computational simulations and provides consulting and training
- Report of the main activities in the last two years

# Virtual Lab for teaching

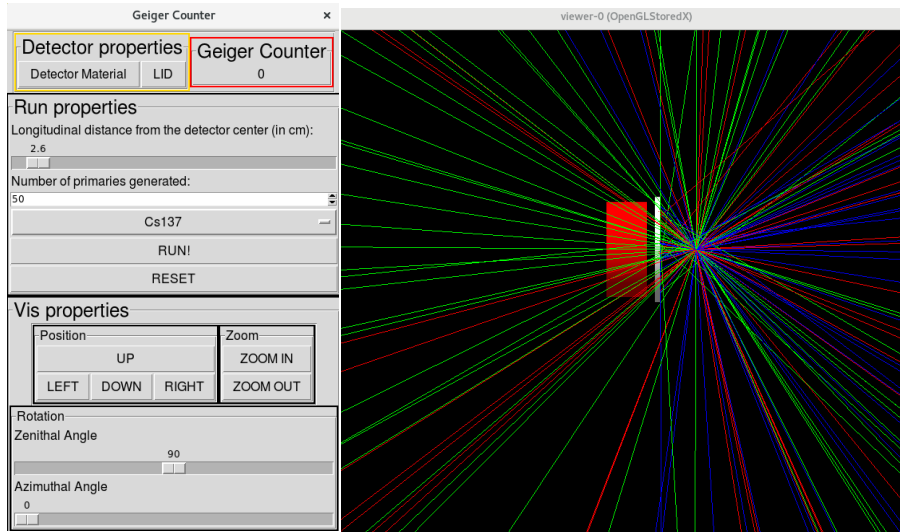
## Gamma spectroscopy

- Developed at IST by internship students
- Virtual laboratory of common experiments used in courses of nuclear and particle physics
- Geant4 based simulations plus python based user interface
- Presented at the Portuguese Physics Conference 2018

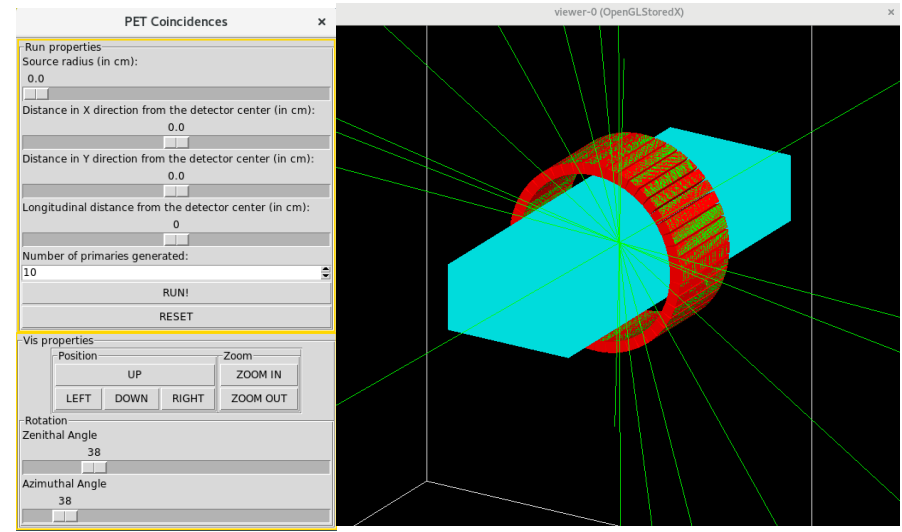


# Virtual Lab for teaching

## Geiger counter

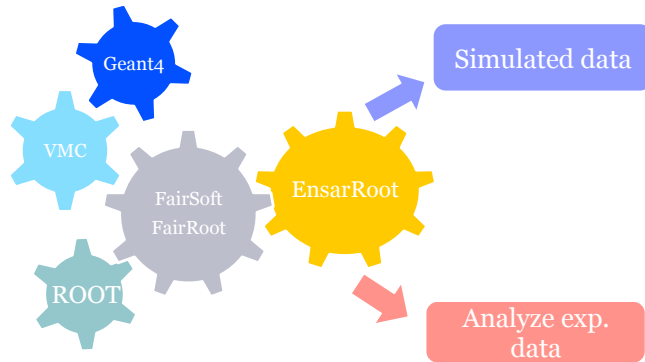


## PET



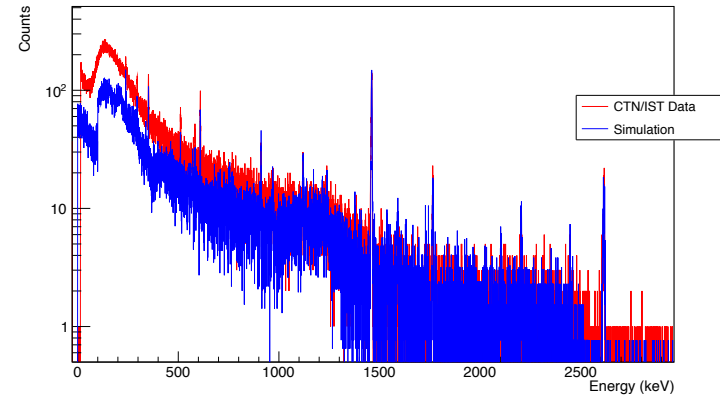


# Simulation of environmental radioactivity



- EnsarRoot: framework for the analysis and simulation of various experimental setups, analytical tools and examples

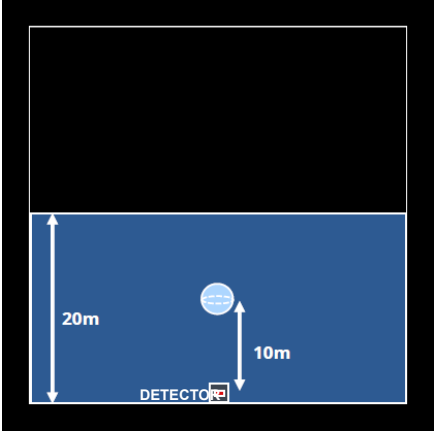
Simulation vs Natural Background



- Reconstruction of the three radioactive series and the potassium source yield
- Benchmarking with data from CTN and UBI

# Simulations for muography

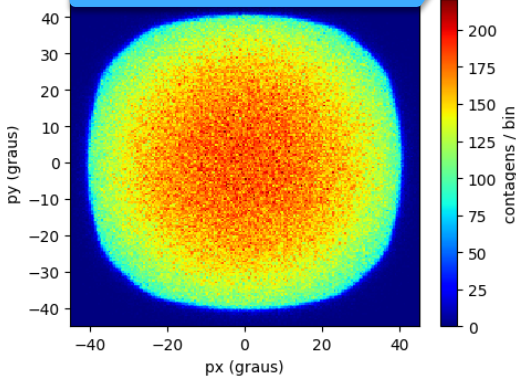
## BUILDING A SIMPLE GEOMETRY



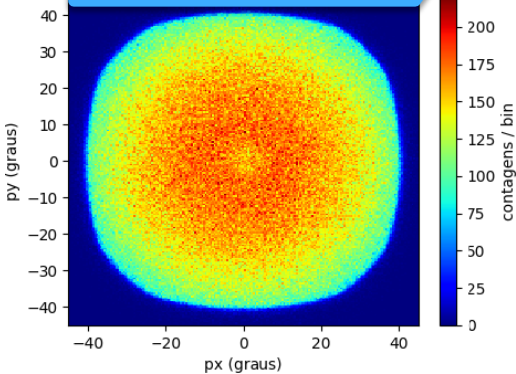
## ANALYSING THE RESULTS

Materials	Density (g/cm3)	1 day	2 days	4 days	8days
Air	0,0012	-2.6	○	○	○
Water	1	-1.6	○	○	○
Bone	1.85	-0.75	✗	✗	✓
Lithium Oxide (Li2O)	2,013	-0.59	✗	✗	?
Concrete	2.3	-0.3	✗	✗	✗
Glass Plate	2.4	-0.2	x	x	x
Sodium Carbonate (Na2CO3)	2.54	-0.06	x	x	x
Shale (medium)	2.6	0	x	x	x
Silica (SiO2)	2,648	0.05	x	x	x
Aluminium (Al)	2.7	0.1	x	x	x
Magnesium Carbonate (MgCO3)	2,958	0.36	✗	✗	✗
Calcium Oxide (CaO)	3.34	0.74	✗	✗	✓
Aluminium Oxide (Al2O3)	3,987	1.39	✗	✓	○
Titanium Dioxide (TiO2)	4.23	1.63	○	○	○
Ferric Oxide (Fe2O3)	5.25	2.65	○	○	○
Silver Bromide (AgBr)	6,473	3.87	○	○	○
Lead Oxide (PbO)	9.53	6.93	○	○	○
Plutonium Dioxide (PuO2)	11.5	8.9	○	○	○
Gold (Au)	19.3	16.7	○	○	○

## WITHOUT SPHERE – 2 DAYS



## WITH SPHERE OF TiO2 – 2 DAYS



- Geant4 simulations of muographs for varying exposures and test material spheres at the ground

# ANTS2 development

New features added in 2018:

- NCrystal library to handle coherent scattering of neutrons
- CERN's JSROOT library for 3D geometry viewer
- Support for simulation/reconstruction distributed over a computer grid
- Support for semi-automatic detector optimization
- Python scripting
- Docker container

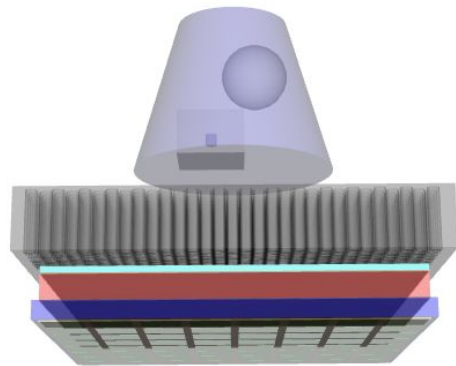
Reported at:

- IEEE NSS MIC 2018, Sydney, Australia
- International Workshop on Position Sensitive Neutron Detectors 2018, Julich, Germany

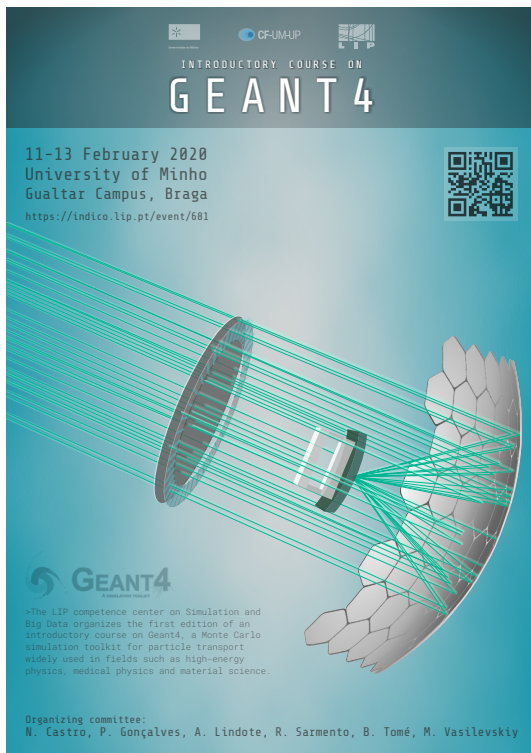
New features added in 2019:

- A possibility to delegate particle tracking to Geant4
- Flexible event viewer + simulation data extractor/analyzer

Reported at SINE2020 General Assembly 2019, Bilbao, Spain



# LIP introductory course on Geant4



- All LIP poles involved in the effort
- 17 participants: from HEP but also from material science and medical physics
- Editions envisaged for Coimbra and Lisbon, incorporating the feedback to be received

# Thanks for the attention!



**FCT**

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