Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO

Laboratori Nazionali di Legnaro – INFN

Characterization and simulation of a γ-ray detector for the ISOLPHARM project

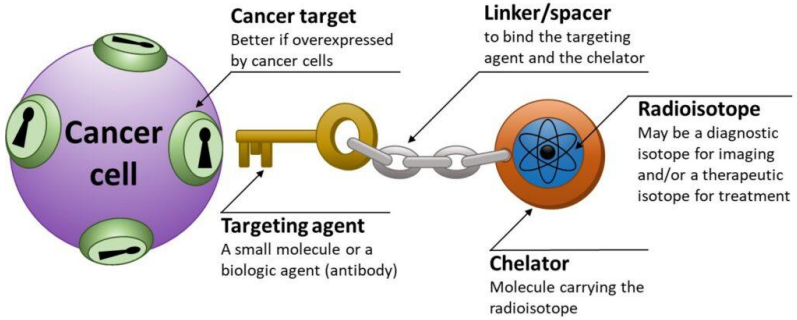
Anna Roccaforte

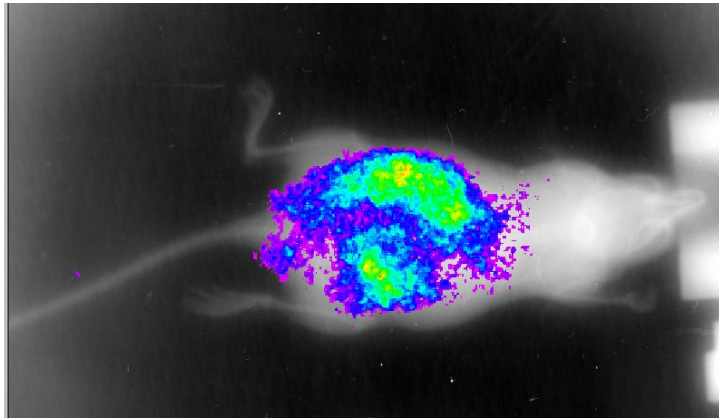
October 4th, 2024

Outline

I. Biodistribution measures
II. Simulations using Geant4
III. Activity measures with LBC scintillator
IV. Conclusions

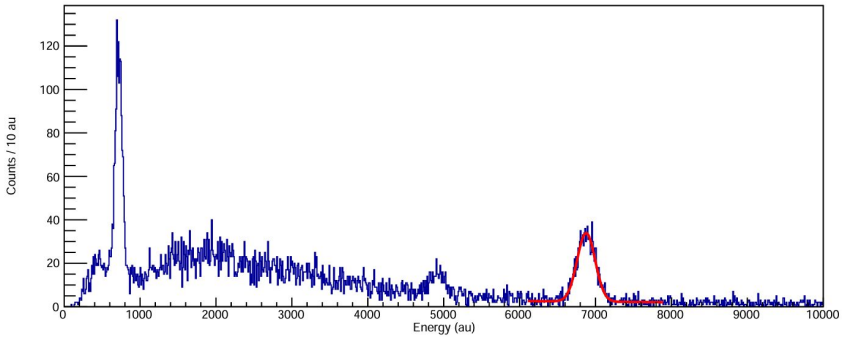
Biodistribution measures

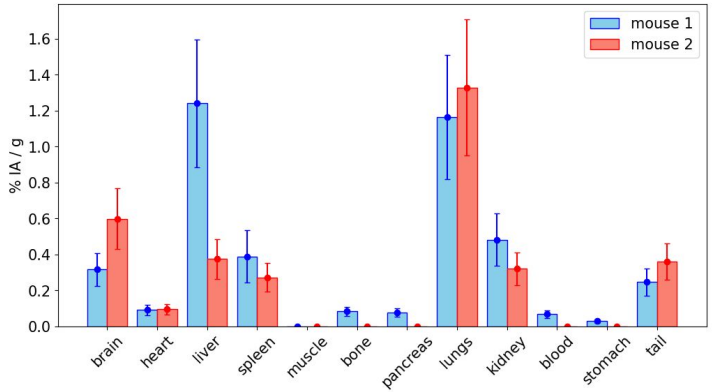




- Radiopharmaceutical solution injected in the tail
- ^{111}**Ag** accumulates in presence of the tumor in specific organs
- Emission of **2 γ-rays** at 245 keV and 342 keV
- γ-ray detector to measure **injected activity per gram**
- Highest activity for **lungs and liver**

Biodistribution measures





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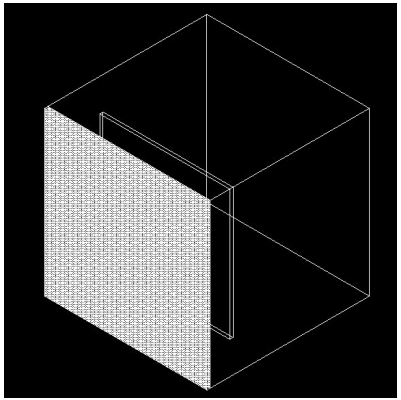
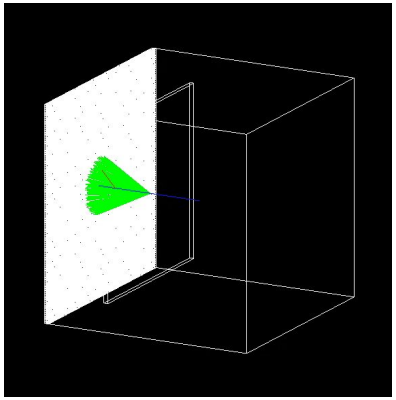
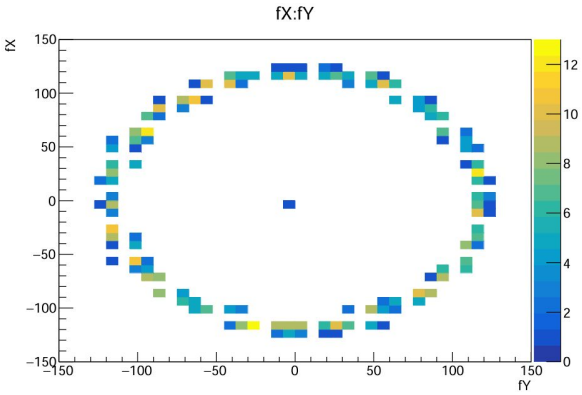
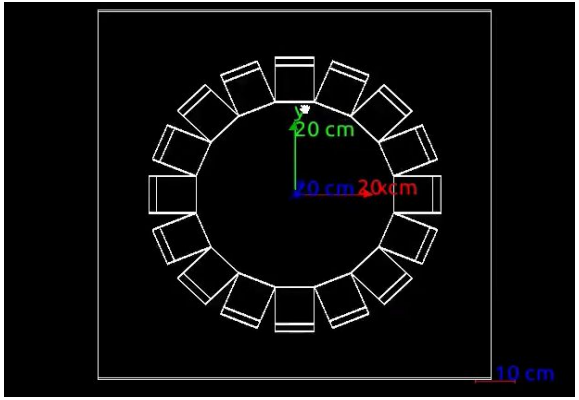
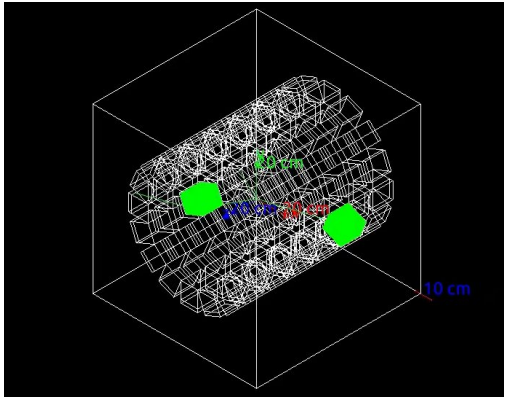
Simulations using Geant4

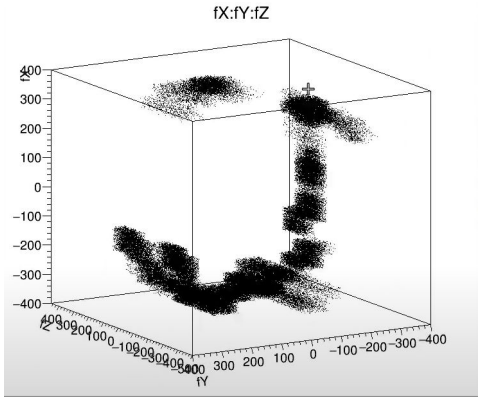




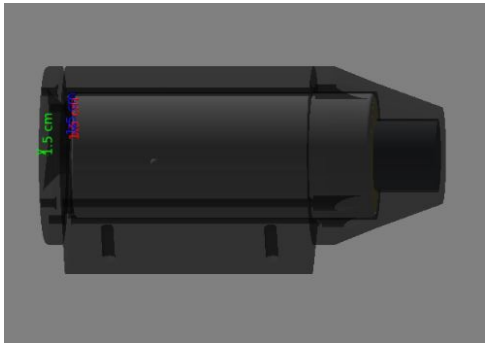




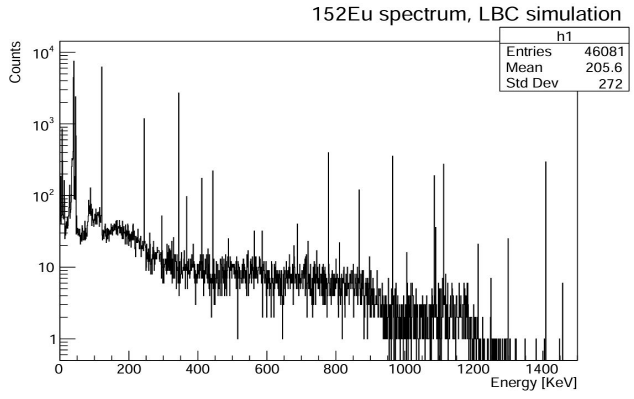




Geant4 simulation of the LBC detector



- Used to calculate **efficiency**
- **^{152}Eu** source at distance of 11 cm, 10^7 events
- The **geometric** efficiency is ε_{geom}=0.019±0.002
- The **absolute** efficiency for the main peaks is:



Energy[KeV]	ϵ_{abs}	$\sigma_{\epsilon_{abs}}$
121	0.0070	0.0004
245	0.0127	0.0003
344	0.0157	0.0002
964	0.03424	0.00005

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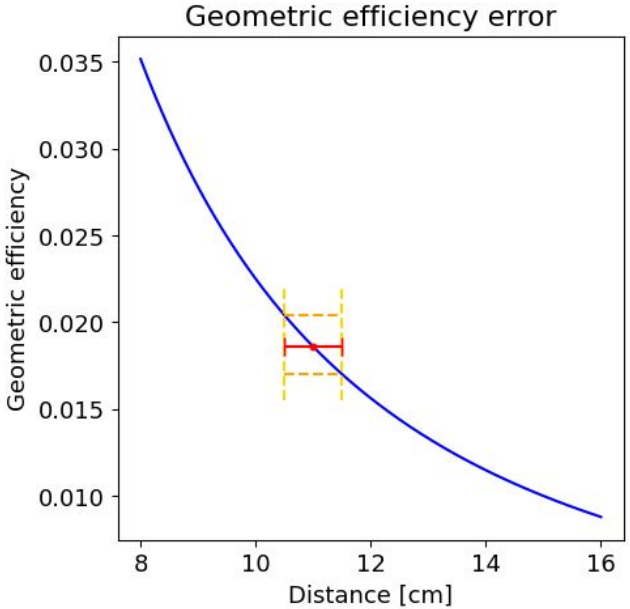

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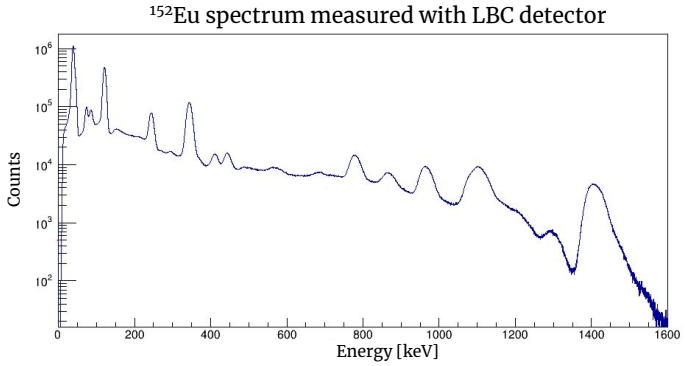
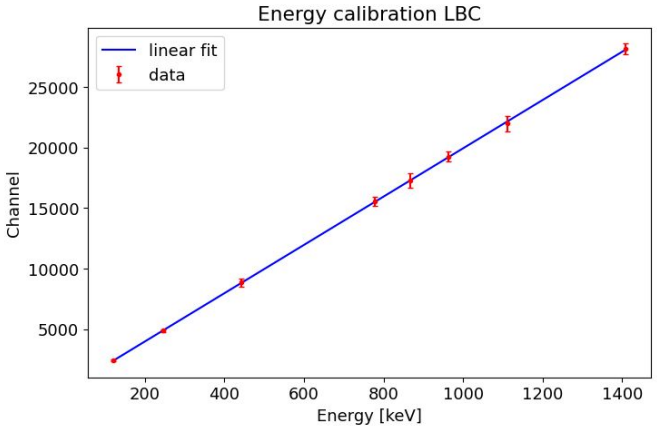
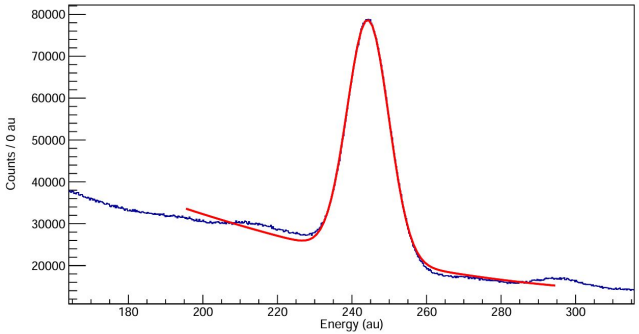
Activity measures with LBC scintillator





- Calibration of the acquired spectrum: y=19.96±0.04 ch/keV · x - 20±10 ch
- Gaussian fit with parabolic background to measure the integral
- The expected activity is $\mathbf{A_{ex}}$=140.1±0.2 kBq
- The measured activity is $\mathbf{A_{meas}}$=160±20 kBq

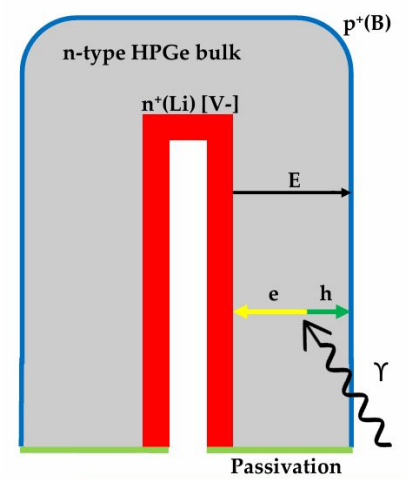
$$A = \frac{I}{\epsilon \cdot P_\gamma \cdot \Delta t}$$

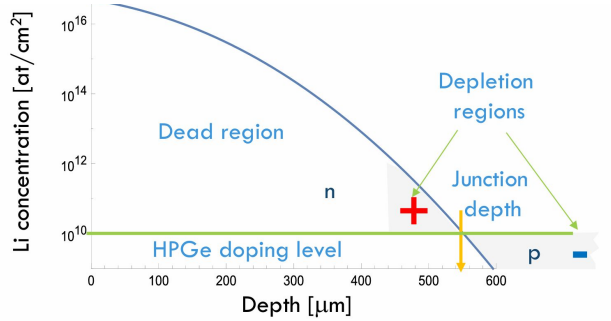


Conclusions

- γ-ray detectors used to measure activity per gram in organs
- Geant4 simulation of LBC detector to estimate efficiency
- Spectrum analysis to measure activity of ^{152}Eu source compatible with the nominal value

Workshop on HPGe Detectors





- γ-rays **ionize** the semiconductor
- **HV** induces charge separation
- **pn junction** created with **B** ion implantation and **Li** deposition
- **annealing** treatments because of neutron damage
- troubleshooting activity on Agata: spectrum errors due to **electronics** or **detector** problems

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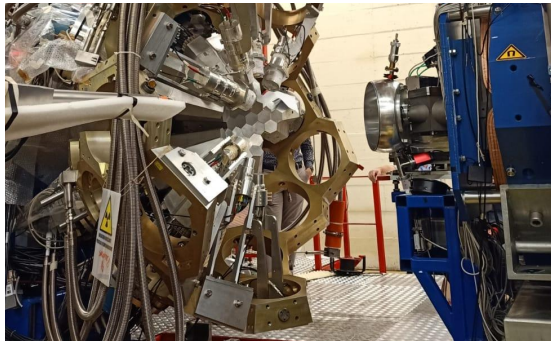

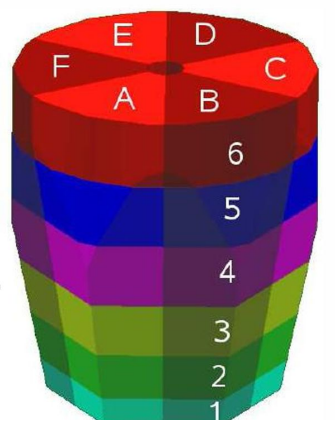

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