



## Cours de formation doctorale 2021 – PHENIICS doctoral training

### Titre :

Maintenance et opération des détecteurs Ge pour la spectroscopie nucléaire gamma à haute résolution.

Maintenance and operation of Ge detectors for high-resolution nuclear gamma spectroscopy.

**Intervenant(s) :** Gabriel CHARLES et Clément DELAFOSSE (IJCLab)

### Durée (en heure + répartition dans la semaine):

15 h de formation théorique (plus jusqu'à 25 h d'auto-formation pratique autonome).

15 hours of theoretical training (plus up to 25 hours of autonomous practical self-training).

**Langue du cours:** [English](#)/French

### Summary and outline:

The advent of liquid nitrogen-cooled germanium (Ge) semiconductor detectors and their implementation in in-beam experiments were a revolution in nuclear spectroscopy in the 1960s. Much progress has since been made with the successive appearance of high-volume detectors, multi-crystal detectors, encapsulation technology and gamma tracking. These detectors, regardless of their generation, continue to be successfully used in a very large number of contemporary nuclear spectroscopy experiments and in multiple configurations. The Institute of Nuclear Physics in Orsay has set up an infrastructure to characterize the performance and maintain part of this detector fleet. That last is made available to the "low-energy" nuclear physics community for advanced gamma-spectroscopy experiments, whether at the ALTO accelerator in Orsay or at other facilities in France or Europe.

This module will focus on germanium detector operation. It is hardware oriented. Step by step the participants will be able to autonomously operate a germanium detector. Moreover, the participants will know how to troubleshoot such kind of detector and repair one. Then, depending on their motivation a small project will be proposed. In order to prepare the students, classes mixed with hands-on work in the germanium workshop of IJCLab will be carried out.

During the courses, a short introduction to the physics of particle detectors will be given followed by a general presentation of their acquisition chain (3h). This will allow us to quickly focus on germanium detectors: physics involved, fabrication process, use... After this first lesson, participants will be ready to handle a germanium detector and invited to do so at the workshop. This will allow the students to work by themselves with a germanium detector and collect spectrum (2h).



The second session will start with classes about the calibration, resolution and efficiency of Ge. It will continue with a presentation of the signal analysis and Gamma-Ray Spectra analysis (2h). Practical examples will be performed at the workshop (3h).

The last session will start by a short lesson about the failures of Ge as well as the methods to troubleshoot them and repair (1h30). It will be followed by demonstrations and concret examples (4h).

For the project, the students will be invited to pair to take the lead among the three following projects:

- develop test bench to measure noise over background ratio
- develop test bench to measure the detector efficiency

Finally, depending on their personal motivations, all trained students will be allowed to contribute to the maintenance of the Orsay-based fleet of Ge detectors.

### **Start of the modul :**

9 am, April 5th, 2021 (first day only in the morning, other days expect to stay all time on site).

### **Pré-requis/pre-requisite:**

The students must be ready to work in regulated ionizing radiation environment (use of radioactive calibration sources). Support for regulatory aspects will be provided.

### **Planning :**

<https://gitlab.in2p3.fr/gcharles/maintain-and-operate-hpge/-/wikis/home>

### **Lieu du cours :**

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