Three-years PhD position at LPSC (Grenoble, France)

Experimental physicist: on-line monitoring in particle therapy

Project description

In order to improve efficacy and safety of particle therapy treatments, we have developed a novel detector for real-time monitoring, based on TOF-resolved (Time-Of-Flight) Prompt Gamma (PG) imaging with 100 ps time resolution, namely TIARA (Tof Imaging ARrAy). The existing prototype consists in 8 detection modules [1] based on Cherenkov radiators coupled to SiPMs, read in time coincidence with a fast beam monitor [2]. A clinical-scale demonstrator composed of 30 modules will be realized by the end of 2026. The TOF between the beam monitor and the TIARA modules, together with TIARA modules' positions constrain the PG vertex coordinates allowing a 3D reconstruction of the ion range in real-time and with a millimetric precision at pencil beam level [3]. The dedicated reconstruction algorithm developed paves the way to a new medical imaging technique, Prompt Gamma Time Imaging (PGTI) that can be used for both proton range monitoring and proton radiography. Supported by encouraging preliminary results, our aim is now to establish the potential and the limits of the PGTI technique with the full-scale TIARA detector through MC simulation and dedicated experiments at proton therapy facilities.

This multidisciplinary project has been funded by the European Community (ERC grant PGTI) for a duration of five years. Physicists, engineers, mathematicians and clinical medical physicists from three French institutes (two CNRS labs, LPSC[1] and CPPM[2] and the CAL[3] proton therapy centre) are jointly working on the development and test of the TIARA detector and the PGTI reconstruction algorithm in order to reach their clinical applicability.

Job description

The current position is based in Grenoble, at the CNRS Laboratory of Subatomic Physics and Cosmology (LPSC). The successful candidate will be responsible of two key tasks: detector integration and MC simulation.

Detector integration. In collaboration with the electronics and detector departments at LPSC, she/he will supervise the integration and test of the full-scale detector, ensuring the different modules are fully compatible. Through MC simulation, the PhD researcher will propose practical experiments that can be reproduced at proton and carbon therapy facilities to validate the feasibility of the technique. She/he will then contribute to their realization during dedicated experimental campaigns and will be in charge of the data analysis.

MC simulation. The candidate will also conceive and implement dedicated Monte Carlo simulations to study the image quality (spatial resolution, SNR…) achievable with this technique and the dose delivered to the patient in different irradiation scenarios. Starting from simplified geometries the study will progressively include all parameters that will have an impact on the experimental

[1] Laboratoire de Physique Subatomique et Cosmologie, Grenoble, France (https://lpsc.in2p3.fr/).
[2] Centre de Physique des Particules de Marseille, Marseille, France (https://cppm.in2p3.fr/).
[3] Centre Antoine Lacassagne, Nice, France (https://www.centreantoinelacassagne.org/).

application, including the simulation of realistic patient anatomies based on digital phantoms and patient's CT images.

Activities

- Test and characterization of particle detectors;
- Participate to the conception and realization of experiments at proton beam facilities and take charge of the related data analysis;
- Design and implement MC simulations to study the clinical feasibility of PGTI;
- Upload, document and maintain the software developed on GitLab;
- Format research data output according to the project Data Management Plan;
- Engage and collaborate effectively with other members of the collaboration;
- Give presentations at collaboration meetings and conferences;
- Write scientific papers, technical notes and reports.

Candidate profile

- Master in fundamental physics, medical physics or equivalent;
- Advanced knowledge of radiation detection physics and nuclear physics;
- Strong interest in detector instrumentation;
- Experience with python and its most common scientific libraries;
- Experience in Monte-Carlo simulation (Geant4, GATE…) will be considered a plus;
- Ability to present and synthesize research results;
- Good written and oral English skills;
- Ability to work in a collaborative environment.

Start date: October 2025.
Term of contract: 3 years.
Contract: full-time.

To apply, please send a CV, an application letter and at least one reference to Sara Marcatili: sara.marcatili@lpsc.in2p3.fr

References:

1) M. Jacquet et al., A high sensitivity Cherenkov detector for prompt gamma timing and time imaging, Scientific Report (2023) 13:3609. http://arxiv.org/abs/2309.03612
2) A. André et al., A Fast Plastic Scintillator for Low In- tensity Proton Beam Monitoring, IEEE Transactions on Radiation and Plasma Medical Sciences, 9 no. 3 (2025) 382-387. https://arxiv.org/abs/2411.07877
3) M. Jacquet et al., A Time-Of-Flight-Based Reconstruction for Real-Time Prompt-Gamma Imaging in Protontherapy, Phys Med Biol, 66 (2021) 135003. https://arxiv.org/abs/2012.09275