IRFU : Institut de recherche sur les lois fondamentales de l'univers

Saclay

DPhP

Détecteurs Imagerie TEP, temps de vol et haute résolution spatiale

Spécialité Instrumentation

Niveau d'étude Bac+5

Formation Master 2

Unité d'accueil DPhP

Candidature avant le 01/01/2020

Durée 5 mois

Poursuite possible en thèse oui

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Résumé

Dans ce stage, nous proposons de contribuer à un détecteur ambitieux basé sur les cristaux de Cherenkov / Scintillation pour la tomographie par émission de positrons. Le stage consistera à mesurer les propriétés de cristaux scintillantes, en utilisant des technologies de détection de particules avancées: photomultiplicateur à micro-canaux , des amplificateurs gigahertz et des modules d'acquisition de données rapide. Le traitement des données impliquera des simulations de Monté-Carlo et l'analyse des données.

Sujet détaillé

Positron emission tomography (PET) is a nuclear imaging technique widely used in oncology and neurobiological research. Decay of the radioactive tracer emits positrons, which annihilate in the nearby tissue. Two gamma quanta of 511 keV energy are produced by positron annihilation and allow one to reconstruct the annihilation vertex and distribution of the tracer activity in the body of the patient.
The precise determination of the position of the positron annihilation vertex is important for an accurate image reconstruction with a good contrast. In particular, it is useful for neuroimaging studies of brain and for pre-clinical studies with animal models (rodents). In this thesis we propose to contribute to an ambitious detector based on Cherenkov/Scintillating crystals. We have selected technologies that are particularly effective for PET imaging. The principles of the detector are patented. They will allow one to produce neurological PET with highly improved performances. The internship will consist in measuring the properties of scintillating crystals, using advanced particles detector technologies: micro-channel plate photomultipliers, gigahertz bandwidth amplifiers and fast data acquisition modules (WaveCatcher, SAMPIC). Data processing will involve Monté-Carlo simulations and data analysis based on GATE/Geant4 and Root C++ software libraries.

The successful candidate will work in the Department of Particle Physics of IRFU in close collaboration with the Department of Electronics Detectors and Computer Science for Physics. The CaLIPSO group includes two physicists and two students, with the support of IRFU/DEDIP. We collaborate closely with CNRS-LAL on fast readout electronic, with CPPM of Marseille and CEA-SHFJ, for simulations of medical imaging devices and image reconstruction algorithms, and with the University of Munster (Germany).

Requirements:
Knowledge in physics of particle interaction with matter, radioactivity and particle detector principles are mandatory. A vocation for instrumental (hardware) work, data analysis and the will to go on with a PhD will be considered as an asset. Being comfortable in programming, having a background in Gate/Geant4 simulation and C++ will be welcomed.

Acquired Skills:
You will acquire skills in particle detector instrumentation, simulation of ionizing radiation detectors, photo-detection, implementation, operation of fast digitizing electronics, and data analysis.

Mots clés

TEP, detecteur gamma

Compétences

You will calibrate and use the instrument for the measurement of the scintillating crystal properties and analyze the measured data. This will involve many aspects of the work of an instrument scientist : fast photo-detection, fast electronics read-out (analog and digital) with picosecond precision, hardware and detector simulations with GEANT4 and GATE software.

Logiciels

C++, ROOT, GEANT4, GATE

Detectors for time-of-flight PET imaging with high spatial resolution

Summary

In this internship we propose to contribute to an ambitious detector based on Cherenkov/Scintillating crystals for Positron emission tomography. The internship will consist in measuring the properties of scintillating crystals, using advanced particles detector technologies: micro-channel plate photomultipliers, gigahertz bandwidth amplifiers and fast data acquisition modules. Data processing will involve Monté-Carlo simulations and data analysis.

Full description

Positron emission tomography (PET) is a nuclear imaging technique widely used in oncology and neurobiological research. Decay of the radioactive tracer emits positrons, which annihilate in the nearby tissue. Two gamma quanta of 511 keV energy are produced by positron annihilation and allow one to reconstruct the annihilation vertex and distribution of the tracer activity in the body of the patient.
The precise determination of the position of the positron annihilation vertex is important for an accurate image reconstruction with a good contrast. In particular, it is useful for neuroimaging studies of brain and for pre-clinical studies with animal models (rodents). In this thesis we propose to contribute to an ambitious detector based on Cherenkov/Scintillating crystals. We have selected technologies that are particularly effective for PET imaging. The principles of the detector are patented. They will allow one to produce neurological PET with highly improved performances. The internship will consist in measuring the properties of scintillating crystals, using advanced particles detector technologies: micro-channel plate photomultipliers, gigahertz bandwidth amplifiers and fast data acquisition modules (WaveCatcher, SAMPIC). Data processing will involve Monté-Carlo simulations and data analysis based on GATE/Geant4 and Root C++ software libraries.

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Keywords

PET, gamma detectors

Skills

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Softwares

C++, ROOT, GEANT4, GATE