
Scintillator detectors for ionising radiation

Project Notebook

Definitions

Scintillator crystals - emit light when excited by ionising radiation.

Scilicon Photomultiplier (SiPM) - alternative to traditional vacuum photomultiplier tubes.

Scintillator detectors - scintillator crystal coupled with SiPM. Light emitted by the scintillator results in a electrical pulse. Pulse shape discrimination is used to identify the type of ionising particle.

In-beam gamma-ray spectroscopy at the RIBF

Overview of gamma-ray spectroscopy

- In beam γ -ray spectroscopy is used to study exotic nuclei by measuring γ -rays emitted during nuclear reactions.
- The Radioactive Isotope Beam Factory (RIBF) uses a high efficeincy γ -ray spectrometer to analyse secondary reaction products.

Physics case

- The method is used to explore shell evolution, the shell structure of known and predicted magic numbers in unstable states.
- A large area of nuclear structure research involves the driving mechanisms for shell evolution.
- In-beam γ -ray spectroscopy is useful for studying basic properties of exotic nuclei for this case.

Challenges

- Doppler correction in gamma-rau energy is necessary due to high secondary beam velocity.
- Unwanted gamma-ray signals from background atomic processes need to be accounted for.
- Scattering/angular and energy straggling due to thick targets.

Experimental setup

- The setup consists of the BigRIPS fragment seperator to produce and seperate RI beams, a secondary target surrounded by a γ -ray spectrometer, and the ZeroDegree recoil seperator.
- The two available gamma-ray detectors used in this setup are DALI2 and GRAPE.
- **DALI2** consists of large NAI(TI) scintillators. The crystals are long to allow for high full energy peak (FEP) efficiency for high energy γ rays. Optimum detector arrangement was found using GEANT4 Monte Carlo simuulations. The configuration consists of 186 crystals arranged in 12 layers.
- **GRAPE** is a postion sensitive Ge detector array. Pulse shape analysis is used to extract position data.
- DALI2 provides high efficiency but moderate energy resolution while GRAPE has higher energy resolution and position sensitivitiy.

Application and results

- The first experiments using the BigRIPS/ZeroDegree setup in was able to produce doppler shift corrected gamma-ray spectra to provide insight into shell structure and nuclear deformation.

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