Gamma Ray Detectors

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Gamma-ray detectors are used in fundamental research and for applications according to their energy resolution, time resolution and detection efficiency.

The relevant feature for low-energy Nuclear Physics experiments is, arguably, energy resolution. Consequently, the detector of choice is often a combination of a large-volume high-purity germanium crystal and a high-efficiency scintillator acting as a Compton suppression shield. Using a large number of such modules we have built detection systems like EUROBALL and GAMMASPHERE, having a total peak efficiency of up to 10%. These devices have been optimized, and work best, for experiments with heavy ion stable beams, where the nuclei of interest are produced at moderate recoil velocities.

The future of this research field depends on the availability of exotic nuclei produced by the upcoming radioactive beam facilities. However, the beam intensities will be extremely low and the nuclei of interest will often be produced with very high recoil velocities and in the presence of large backgrounds; consequently, their study will be beyond the capabilities of the existing detectors.

To achieve the required levels of efficiency and selectivity the gamma-ray spectroscopy community has developed a new detection paradigm, known as gamma-ray tracking. Tracking of gamma rays depends on the capability to determine the energy and the position of the individual interactions by which the gammas are absorbed inside the germanium crystals. If these quantities are known with sufficient precision, the individual gamma rays of the detected event can be reconstructed (tracked) and characterized. Position sensitivity inside the detector is achieved by the combination of: a) electrical segmentation of the germanium crystal; b) fully-digital data acquisition techniques and c) pulse-shape analysis of the signals induced on the segments by the charge collection process. The development of this technology has been performed by the AGATA and GRETA collaborations. The first gamma-ray tracking detectors are already operational.

The lectures will start with a general introduction on gamma-ray detection and a review of the different types of detectors. I will then concentrate on germanium detectors and on the gamma-ray tracking technique.