DNP11-2011-020075

Abstract for an Invited Paper
for the DNP11 Meeting of
the American Physical Society

Gamma ray energy tracking in GRETINA

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The next generation of stable and exotic beam accelerators will provide physics opportunities to study nuclei farther away from the line of stability. However, these experiments will be more demanding on instrumentation performance. These come from the lower production rate for more exotic beams, worse beam impurities, and large beam velocity from the fragmentation and inverse reactions. Gamma-ray spectroscopy will be one of the most effective tools to study exotic nuclei. However, to fully exploit the physics reach provided by these new facilities, better gamma-ray detector will be needed. In the last 10 years, a new concept, gamma-ray energy tracking array, was developed. Tracking arrays will increase the detection sensitivity by factors of several hundred compared to current arrays used in nuclear physics research. Particularly, the capability of reconstructing the position of the interaction with millimeters resolution is needed to correct the Doppler broadening of gamma rays emitted from high velocity nuclei. GRETINA is a gamma-ray tracking array which uses 28 Ge crystals, each with 36 segments, to cover $^1/_4$ of the 4π solid angle. The gamma ray tracking technique requires detailed pulse shape information from each of the segments. These pulses are digitized using 14-bit 100 MHz flash ADCs, and digital signal analysis algorithms implemented in the on-board FPGAs provides energy, time and selection of pulse traces. A digital trigger system, provided flexible trigger functions including a fast trigger output, and also allows complicated trigger decisions to be made up to 20 microseconds. Further analyzed, carried out in a computer cluster, determine the energy, time, and three-dimensional positions of all gamma-ray interactions in the array. This information is then utilized, together with the characteristics of Compton scattering and pair-production processes, to track the scattering sequences of the gamma rays. GRETINA construction is completed in March 2011, and extensive engineering runs were carried out using radioactive sources, and beams from the 88-Inch Cyclotron at LBNL. The data obtained will be used to optimize its performance. Then the first scientific campaign will start in March 2012 at NSCL MSU.