Phoswich Wall

The Washington University Phoswich Wall is a high-granularity fast-plastic, CsI(Tl) phoswich device, which is operated in conjunction with Gammasphere or Gretina. The Phoswich Wall distinguishes light charged particles, such as protons, α particles, ^{6}Li or ^{12}C ions, by pulse-shape discrimination. In addition, it has Z-identification capability for ^{7}Li, ^{8}Be*, ^{9}Be, ^{11}B, ^{12}C, and ^{14}N down to low energies. The device was designed for optimal performance in nucleon transfer, cluster transfer, and inelastic excitation (Coulex) in strongly inverse kinematics at near Coulomb barrier energies. A typical experiment will be ^{142}Ce(^{7}Li,α)^{145}Pr, where coincidences between the target-like fragment (α particle) and the γ rays of the projectile-like one (^{145}Pr) are recorded.

The fast-plastic scintillators are ~12 μm thick (ΔE detectors) and intimately attached to 2.2-mm thick CsI(Tl) crystals (E detectors), which are coupled to 64-element 2” × 2” multi-anode phototubes (Hamamatsu H8500). Four H8500 units are arranged in a certain tilted geometry that allows covering lab angles $9^\circ \leq \theta_{TLF} \leq 72^\circ$ for the target-like fragments (average target-detector distance: 55 mm). An element (pixel) of a H8500 phototube is 6.04 x 6.04 mm^{2} in size. A so-called position algorithm was established in source measurements; it is based on the optical cross-talk between the “central-hit” largest pulse-height pixel and its nearest face neighbors. The algorithm allows to achieve sub-pixel position resolution to better than 1 mm. This leads to an angular resolution $\Delta\theta_{TLF} \approx 1^\circ$, which, for a typical binary reaction, translates into a center-of-mass value $\Delta\theta'_{PLF} \approx 2^\circ$ for the projectile-like fragment. This ensures then a good PLF angular distribution provided that the statistics are sufficient. Interestingly, the somewhat comparable Microball has an angular resolution $\Delta\theta_{TLF} \approx 18^\circ$, which is too poor for particle angular distribution measurements required in the inverse-kinematic reactions.

The Phoswich Wall puts out 4 × 64 (256) signals. For each signal, the electronics create 4 parameters that are read out (1024 electronics channels). Three of these provide pulse heights (“fast”, “early”, and “late” gated) and one time. An ASIC chip is the centerpiece of the readout. The readout is VME based and can be easily coupled to the Myriad system of Digital Gammasphere and to Gretina. This ensures having a common trigger and event time stamp. Software in C++ has been developed and is ready for use that allows detector calibration and processing of all parameters for various tasks including 1D and 2D histogramming in ROOT. The whole system has been tested in an in-beam experiment at the Notre Dame FN Tandem, using protons of several energies on ^{12}C and α particles, ^{7}Li, ^{11}B, ^{12}C, and ^{14}N of several energies on ^{197}Au. These measurements helped to calibrate the fast-plastic and CsI(Tl) components and demonstrated that the ``particle identification (PID)’’ among the particles of interest is as good as expected.