DEVELOPMENT OF LASSA

A. Wagner, K. Chalut, C.K. Gelbke, T. Liu, M. Lennek, X. Liu, W. Lynch, M. Ramos, R. Shomin, W. Tan, M.B. Tsang, G. Verde, H. Xu, B. Davin[a], Y. Larochelle[a], R. de Souza[a], L. Sobotka[b],R. Charity[b]

A Large Solid angle Silicon strip detector Array (LASSA) was designed and constructed, in collaboration with scientists from Washington University and Indiana University, in order to measure isotopically resolved fragmentation products and two particle correlation functions with high efficiency. A photograph of the array is shown in Figure 1. It consists of nine telescopes, each composed of a 65 μm thick single-sided silicon strip detector and a 500 μm thick double-sided silicon strip detector, backed by four 6 cm thick CsI(Tl) crystals, which are read out by PIN diodes. At its standard operating distance of 20 cm, the LASSA subtends a solid angle of about 550 msr. The 65 μm thick single-sided silicon strip detector provides position information in one Cartesian coordinate direction (x) and the 500 μm thick double-sided silicon strip detector provides position information in two Cartesian coordinate directions (x, y). The 3 mm pitch of each silicon strip detector corresponds to an angular resolution (full width) of about 0.85°.

Figure 1: Nine LASSA telescopes.

To provide an efficient angular coverage suitable for two particle correlation function measurements, it is necessary to minimize the gaps in angular coverage between silicon detectors. A novel strip detector mount and readout assembly, shown in Figure 2, was developed to permit the necessary close packing of the silicon strip detectors. The assembly consisted of a thin 1-mm wide G-10 support frame coupled to a flexible circuit board cable. This cable runs inside the metal telescope can from the silicon wafer to the preamplifier cable at the rear of the telescope assembly. When the telescope is assembled, the silicon detectors are shielded from ambient noise as within a Faraday cage.

Particle identification is achieved by using the dependence of the energy loss within a silicon detector upon the mass and charge of the incident ion. The mass identification of particles that stopped in the 500 μm silicon detectors was degraded by the (≈10%) non-uniformity of the 65 μm silicon detectors. Without correction for this thickness non-uniformity, a typical PID spectrum, shown in the left panel of Figure 3, does not provide unit mass resolution. After correcting for the 65 μm silicon detector thickness variations, however, the corrected resolution, shown in the right panel of Figure 3, improves and unit mass resolution is easily obtained. Unit mass and charge identification of particles

that traverse the 500 μm silicon detectors and stop in the CsI(Tl) crystals is obtained without correction for the (≈1%) non-uniformity in the 500 μm silicon detectors.

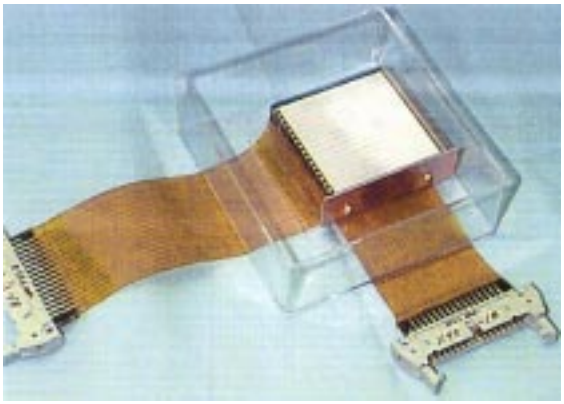

Figure 2: LASSA double sided Silicon detector.

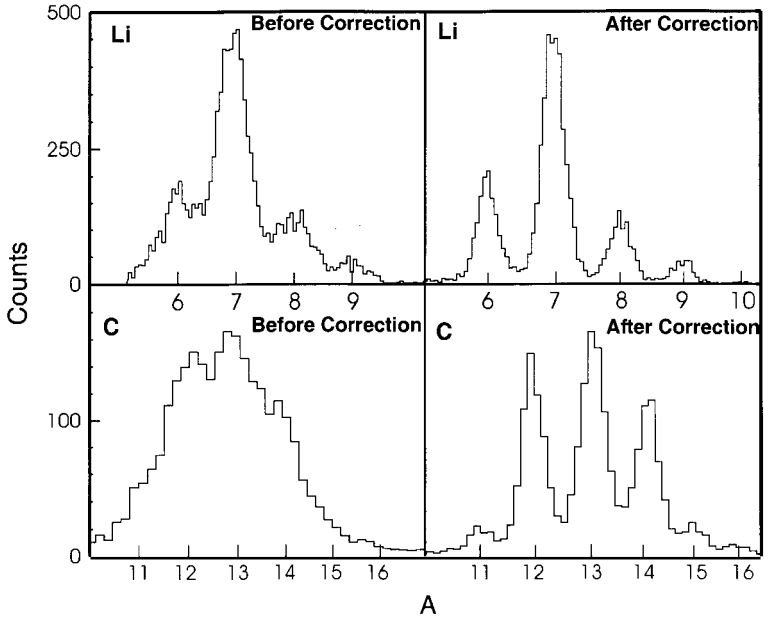

Figure 3: (Left panels) Lithium (upper panels) and Carbon PID spectrum without correction for the thickness non-uniformity of the first silicon. (Right panels) Corresponding spectra after the data have been corrected for the thickness non-uniformity.

The energies of particles, which stop in the CsI (Tl) crystals are partly derived from the light, collected by the PIN diode readout system. A side view of the interior of a LASSA telescope, which displays the CsI(Tl) crystals, is shown in Figure 4. The uniformity of the light output of such crystals is known to depend upon the Thallium doping gradient within the crystal [1]. Each LASSA CsI(Tl) crystal was tested for the uniformity of its light output with a ^{241}Am source that illuminated the front face of the crystal. Crystals were rejected if the non-uniformity exceeded 1%. The resolution of the CsI(Tl) crystals was examined with a 240 MeV ^{4}He beam that illuminated most of the detector surface area. An energy resolution of approximately 0.6% (1.6 MeV) was obtained for this crystal. Preliminary analyses

suggest that the resolution is increased over the noise resolution of 0.4 MeV by local variations in the light output, possibly due to local variations in the Thallium doping [2].

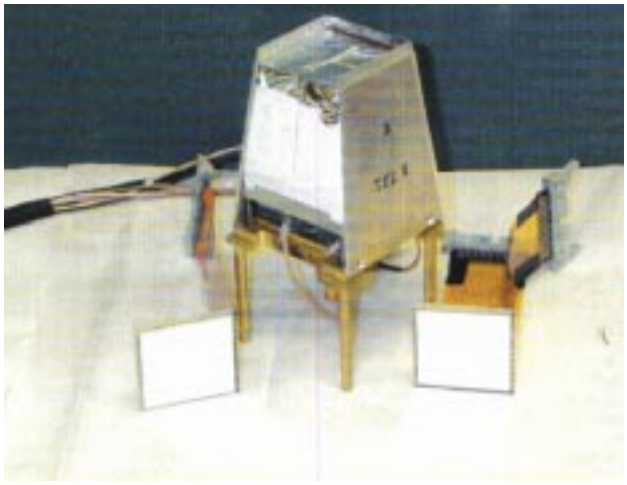

Figure 4: Side view of partly disassembled LASSA telescope. Shown are one of the sides of two CsI(Tl) crystals (in white), the associated preamplifiers (below), the telescope can and the two silicon strip detectors (lying on the table.

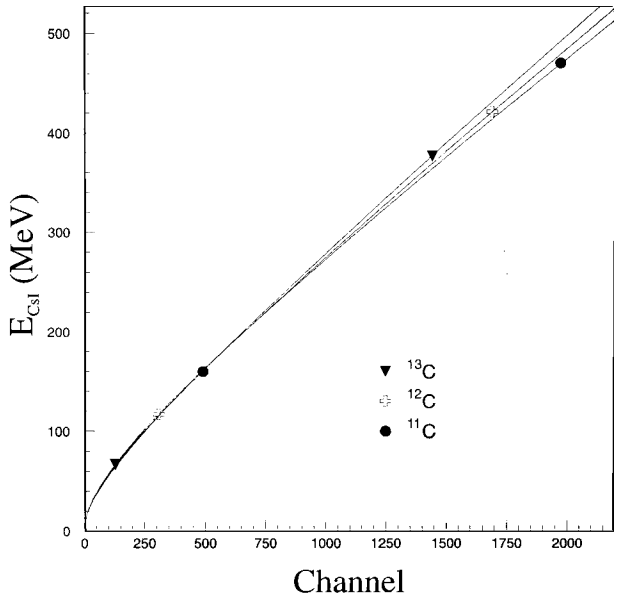

Figure 5: Calibration curves for ^{11}C, ^{12}C and ^{13}C for the CsI(Tl) crystals obtained using direct fragmentation beams.

CsI(Tl) crystals have a non-linear relation between energy deposition and light output, which is dependent upon the mass and charge of the detected particle. To energy calibrate the LASSA crystals, many different impurity beams and different fragmentation beams were directed into each LASSA CsI(Tl) crystal. These calibrations allowed corrections for the mass dependencies of the CsI(Tl) energy calibrations. Figure 5 illustrates the mass dependencies of the energy calibrations for the Carbon isotopes.

The electronic signals from LASSA were amplified by small surface mount preamplifiers in the scattering chamber and sent to CAMAC discriminator/shaper modules stationed outside the chamber. These modules, developed at Washington University, incorporated 16 channels of computer-controlled

discriminator, shaper, and time to FERA convertor in a doublewide CAMAC module. The energy signals were digitized in CAMAC peak sensing ADC's.

a. Department of Chemistry and IUCF, Indiana University, Bloomington, IN 47405, USA,
b. Department of Chemistry, Washington University, St. Louis, MO 63130, USA,

References

1. W.G. Gong, Y.D. Kim, G. Poggi, Z. Chen, C.K. Gelbke, W.G. Lynch, M.R. Maier, T. Murakami, M.B. Tsang, H.M. Xu and K. Kwiatkowski, Nucl. Instr. and Meth. A268 (1988) 190.
2. A. Wagner et al., in preparation.