PIBETA CALORIMETER RESPONSE CALIBRATION

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The PIBETA experiment will pursue a precise measurement of the rare pion beta decay ($\pi^+ \to \pi^0 e^+ \nu$) rate. Thanks to low theoretical uncertainties the latter can be used to constrain CKM unitarity and certain aspects of physics beyond the SM. At the heart of the PIBETA detector system is a spherical 240-element electromagnetic shower calorimeter made of pure CsI.

Over the past several years we have invested a large effort into development work aimed at maximizing (and measuring reliably) the CsI detector energy resolution. To this end we have set up two precise tomography facilities at PSI: one using cosmic muons (for volume response studies) and another using a ^{137}Cs source (for fast high statistics cross calibration). An important breakthrough resulted from a wavelength-shifting (WLS) lacquer treatment that has improved the CsI detector light collection uniformity, at the same time helping to insulate the detectors from ambient humidity. Figure 1 shows the results of an August 1997 measurement of the PIBETA calorimeter resolution using a 44-detector subset directly illuminated by 70 MeV positrons, and compares them with 1996 data; energy resolution is clearly improved.

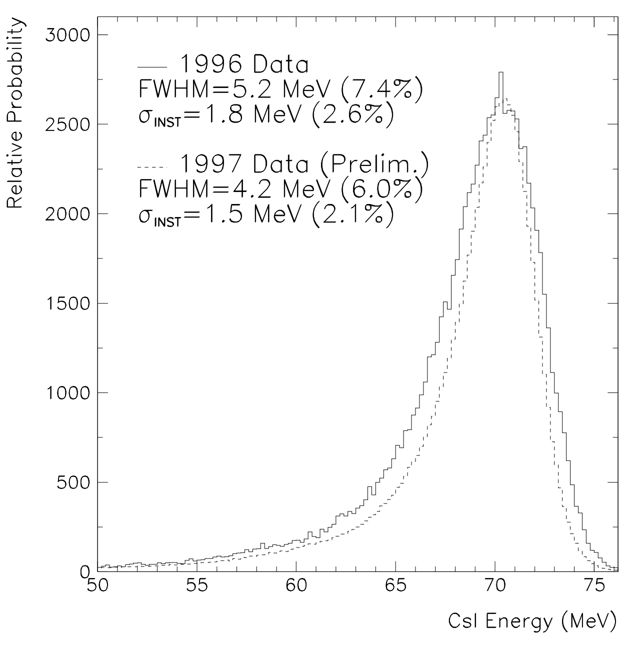

Figure 1: Energy response of a 44-detector pure CsI array to 70 MeV/c e^+'s measured in 1996, before the WLS lacquer surface treatment (full line), and after the treatment (1997, dashed line).

Another critical test of the calorimeter performance is our ability to resolve $\pi \to e\nu$ decay events (our normalization reaction) from the Michel background. Figure 2 shows $\pi \to e\nu$ data taken in 1997 without the benefit of any tracking detectors; even under these conditions excellent separation is achieved, superior to that observed in runs prior to the WLS treatment.

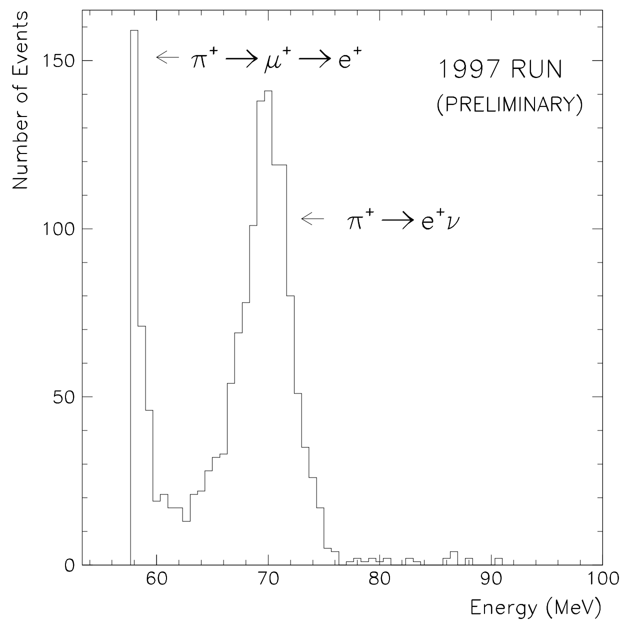

Figure 2: $\pi \to e\nu$ and background events detected in the same 44-detector CsI array viewing a stopped pion target. The Michel positron spectrum is cut off below about 57 MeV.

We have also measured the calorimeter response to photons using the $\pi^- p \to \pi^0 n$ and γn reactions. This work will result in a new precise measurement of the Panofsky ratio. All of the discussed calibration measurements had to be completed before the final assembly of the full calorimeter, which started in late 1997.