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A MEASUREMENT OF E/π FOR A FAST LEAD LIQUID ARGON CALORIMETER

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Abstract

The NA34 (HELIOS) calorimeter has measured $e/\pi \cong 1.1$ in a uranium / liquid argon calorimeter with a shaping time of 135 nsec. Lead may be a viable alternative, but e/π must first be measured at fast shaping times in lead. We are preparing to measure e/π at momenta ranging from 0.5 to 20 GeV/c and with shaping times of 50, 100 and 150 nsec.

Introduction

The use of uranium as an absorber in an SSC detector may prove to costly. It would be useful to make an accurate measurement of the performance of a liquid argon calorimeter with lead as an absorber. Some EGS studies have suggested that e/π is more nearly equal to one if thick lead plates are used. Described is a lead liquid argon calorimeter that closely follows the HELIOS design.[1] Our motivation for building this calorimeter has been to study the issue of compensation in lead. Where we could improve on the HELIOS design we have, when we could stu y other issues that might be applicable to a general SSC detector we have, but the major emphasis has been to study the e/π ratio. That has driven the cost and the time line.

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Lead Stack

Some EGS studies by our collaborators from the University of Washington [2] have suggested that e/π will more nearly equal one if 12 mm lead plate is used instead of 6mm plate. We have designed a stack approximately 100 cm X 100cm with a depth of 169 cm (7.5 λ). It is segmented into three longitudinal sections, each weighing five tons. Lead that is 12 mm thick, with 0.06% calcium and 1.3% tin added for hardness, will be used as an absorber. The signal boards are three layer printed circuit boards with the signal strip on the inner layer and high voltage strips on the outside. Figure 1. The strips are produced by machining copper clad G-10 printed circuit material and laminating them together. An offset is

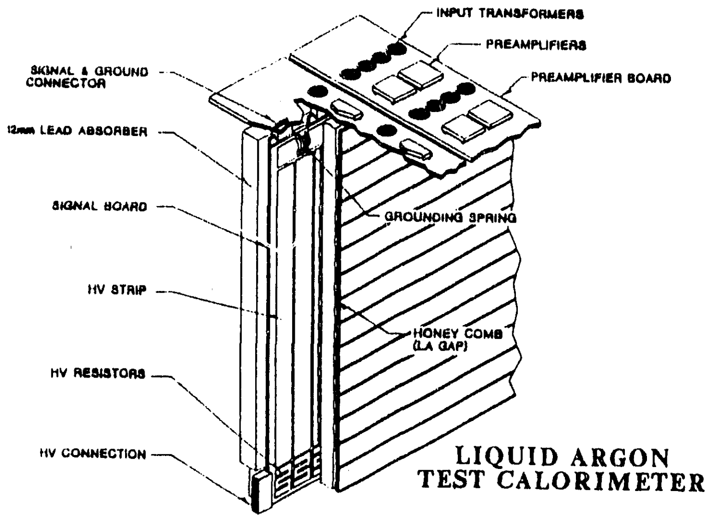

Fig. 1: A conceptual drawing of a liquid argon calorimeter (not to scale)

provided at the edge of each board to make electrical connections to the inner signal electrodes. The outer or high voltage electrodes are connected to a high voltage bus using epoxy carbon silk screen resistors. Charge deposited on the outer electrodes is capacitively coupled to the signal strips. A low inductance ground connection to the lead absorber is made with a specially designed copper-berylium spring. The input transformers and preamplifiers are located in the liquid argon in close proximity to the signal boards. The connection scheme follows closely the HELIOS method of achieving low induction charge transfer to the preamplifiers [3]. Each longitudinal section contains 32 cells, each cell consists of a lead absorber, a 2 mm argon gap, a 1.6 mm G-10 printed circuit signal board and another 2mm argon gap. The signal boards each have forty 2.5 cm strips. These strips alternate in X and Y in depth. The interleaving of the X and Y strips provide information about the transverse profile of the shower and a measurement of the sampling fluctuations. Figure 2. shows breakdown

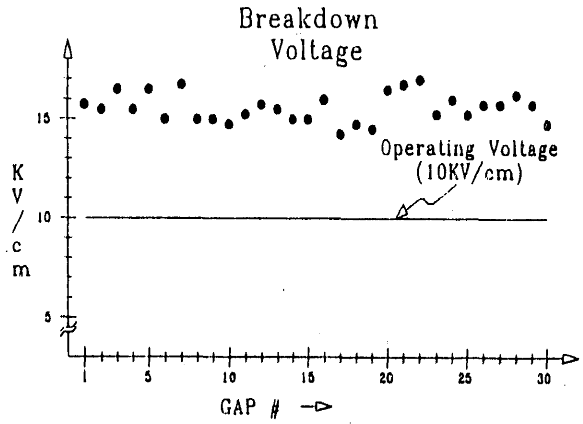

Fig. 2: Breakdown voltage for individual gaps in kV/cm)

voltage for the first 30 gaps in kV/cm. A large safety margin exists between operating voltage and breakdown voltage.

External Electronics

The external electronics consists of an intermediate amplifier stage a shaping and a summing amplifier. The intermediate amplifier stage is attached to the outside wall of the calorimeters cryogenics containment vessel, very close to the signal feedthroughs. A good electrical and mechanical connection between the vessel and the intermediate amplifier housing defines a faraday cage containing the stack, preamplifiers and intermediate amplifiers. See Figure 3. Besides driving the signal cables, the intermediate amplifier provides two fixed gains. This minimizes the dynamic range required for succeeding electronics and allows the same electronics chain to be used for tests at both the AGS and Fermilab energies. Signal cables are transformer-coupled at the output of the intermediate amplifier to provide electrical isolation and to break ground loops.

Following the intermediate amplifier is a Fastbus - sized printed circuit board which contains 48 channels of variable gain amplifiers, summing electronics and shaping amplifiers. The variable gain amplifier stages are controlled by an onboard microprocessor. This microprocessor accepts gain information for the individual channels via a RS 232 port. Gain is adjustable over a $\pm 25\%$ range. Individual channels are normalized to a fraction of a percent by injecting a known charge via precision resistors on the preamplifier boards located on the stack. One can also turn off individual channels in the variable gain amplifier. This aids in normalizing the gain per channel or in suppressing noisy channels. The signal from the variable gain amplifier is routed to two circuits. One circuit is a shaping amplifier with a fixed shaping time of 100 nsec. The output from these circuits is read

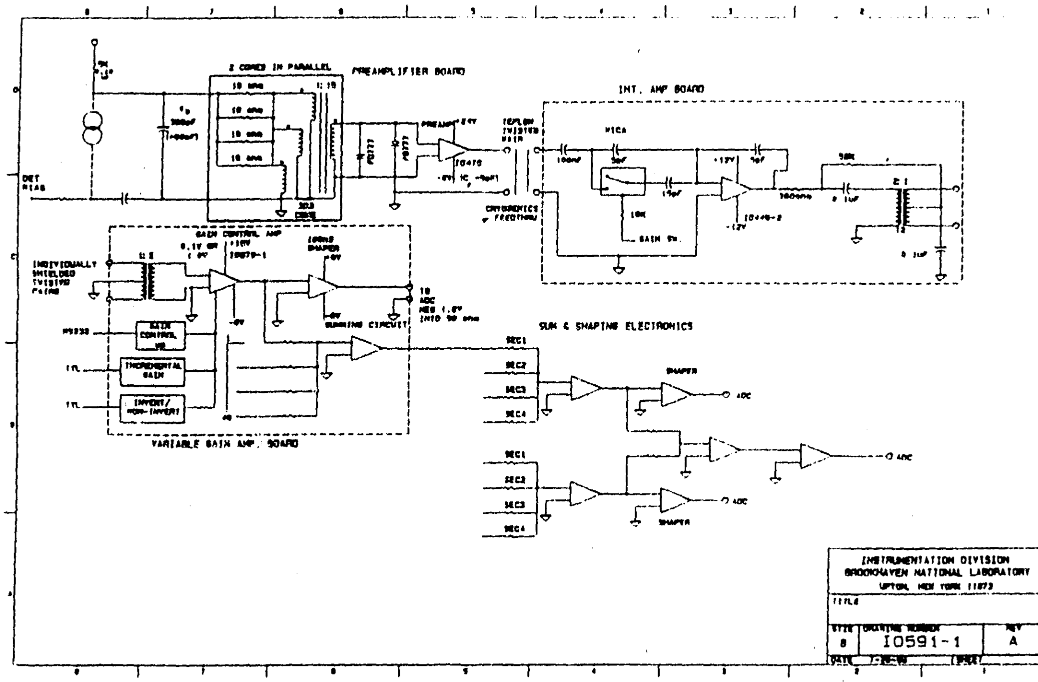

Fig. 3: Electronics Chain

out via a CAMAC based ADC system. The second circuit is an onboard summing amplifier. The 48 signal channels are summed at this point. It is important to note that the fast shape of the output signal from the stack preamplifiers is preserved throughout this chain. The output sums of the 48 channels are then summed again in X and Y. The X,Y and total sums go to individual shaping amplifiers with changeable shaping times between 50 and 200 nsec. Figure 4. is a photograph of the various moduled which constitute the external electronics chain. We plan to test this calorimeter in the spring of 1991 in the AGS beam at Brookhaven. The beam will have two Cerenkov counters to identify electrons. We will vary the momentum between 0.5 GeV and 20 GeV. The intensity of the beam can be as high as 10^7particles / sec. This will allow the study of pileup effects directly.

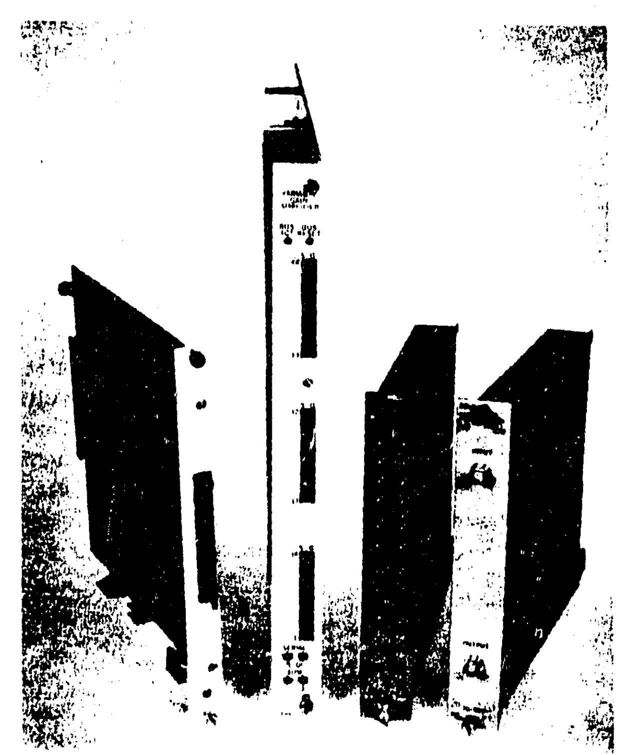

Fig. 4: Various modules which constitute the external electronic chain

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