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Calorimetry in a Multiplate Ion Chamber Operated With Gas Gain

The calorimeter modules for the e-p detector will have a very large number of cells. For example, a device covering 2π solid angle with layers of gas proportional tubes sufficient for hadron calorimetry might well have 10^5 wires. Broken wires are inevitable, and not easily replaceable. A group at Brookhaven Lab and Princeton University is exploring an alternative design which contains no proportional wires. The calorimeter would be a multi-plate sampling device with iron or lead plates and a gas as the sampling medium. High voltage is applied across adjacent plates to yield gas amplification of the ionization caused by a hadronic or electromagnetic shower. The electric field is, of course, uniform, so each ionized electron starts an avalanche which grows exponential with distance. The device is sometimes called a "parallel plate avalanche chamber".

Tests have been conducted with a chamber consisting of a single gap. This one gap was exposed to a pulse of 2 MeV electrons from a Van de Graaff accelerator. The number of electrons per burst was variable so as to simulate the effect of the large number of minimum ionizing particles observed in a hadronic shower. Figure 1 shows the gas amplication achieved in the chamber with a 3mm gap filled with a mixture of argon + 5% acetone. Gains of greater than 1000 are readily obtained, which is similar to that in proportional tube calorimeters. With carefully designed, low-noise, charge sensitive amplifiers, such as used in liquid argon calorimetry or the time projection chamber, it would be possible to detect a single minimum ionizing particle in a single gap (although this is not essential for calorimetry). Although charge is collected during the entire drift time of electrons and ions across the gap, a signal rise time of some 10 ns can be obtained. This is because the largest part of the prompt signal is due to the amplification very close to the anode of the avalanche initiated by electrons which were liberated near the cathode, and hence have a long path for the avalanche.