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A MICROCHANNEL PLATE BASED DETECTOR FOR A HEAVY
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Summary

The design parameters and operating characteristics of the detector used in the Brutus and Fannie heavy ion beam spectrometers at the SuperHILAC facility are described. The detector utilizes a 25 mm diameter microchannel plate array to obtain gains of $10^4$ to $10^8$ with a linear dynamic range of $10^6$. It has had over three years of almost maintenance-free service, detecting beam beams from carbon to xenon with energies between 1.2 and 8.5 MeV per nucleon.

Introduction

It was felt that design and build a heavy ion beam detector utilizing Bratto, an old F-type beam channel slitting magnet, and existing beam lines for use in investigating operating parameters of the SuperHILAC accelerator and for making precision beam energy measurements ($0.5\%$). The design incorporated a pair of 0.25 mm slits, separated by 2.75 m, which defined the trajectories of ions entering the magnet gap. A 0.5 mm slitted detector, 1.75 m down beam from the magnet, accepted particles that had been deflected by approximately $1\theta$. The spectrometer was calibrated by the floating wire analog technique. This paper describes the design and operational characteristics of the slitted detector.

The Look

The SuperHILAC beam macrostructure consists of pulses from approximately 0.5 to 1.0 s duration with separation resulting from a 36 Hz time share schedule. Beam pulses with peak particle currents of 0.1 milliampere to below one microampere needed to be analyzed. A resolution of 1 to 10^6 of each pulse was expected due to the 0.25 mm entrance slits and the 0.5 mm detector slit. A system which could faithfully reproduce beam macrostructure was needed for currents which ranged from $10^{-5}$ to $10^{-8}$ amperes.

A further complication of the beam emitted by the SuperHILAC accelerator is that it very often consists of a multiplicity of charge states, energies and occasionally ion species. A system was needed which would quantitatively determine the relative amounts of the various species. An electron multiplier based detector followed by electronic amplification could meet these system requirements.

The design objectives of the detector included: variable gain from $10^2$ to $10^8$; a linear dynamic range of at least $10^6$; low noise and long life; freedom from maintenance; operation in vacuums of $10^{-5}$ to $10^{-7}$ Torr; the ability to withstand continued exposure to the atmosphere and pneumatic insertion and withdrawal; simple vacuum feed-throughs; 55 cm length and under 90 mm diameter; an entrance slit of 0.5 mm; and low cost.

We were unsuccessful in meeting the latter design objective.
The enclosure for the detector has within it a voltage distribution network, resulting in only two electrical connections. The means by which the potential differences were generated is presented in Fig. 2. Resistors and capacitors in series/parallel combinations were used to accommodate the voltage, filtering, and power requirements of the distribution network. To eliminate arcing and sparking within the enclosure, sharp points on components and wiring were minimized.

The high voltage connection is an unshielded spring between the detector and an SHV connector. The signal is passed through the 1/4-inch diameter actuating shaft to a thermally sealed connector at the end of the shaft.

Results

Figure 1 is a photograph of the main components of the detector and Fig. 4 is a photograph of the assembled detector.

This detector has had over three years of almost maintenance-free service, detecting heavy ion beams from carbon to xenon with energies from 1.2 to 8.5 MeV/nucleon. The equivalent input noise with a gain of $10^5$ is under one event per second. The detector has been operated over six orders of magnitude of gain, and a linear dynamic range of better than three orders of magnitude has been verified.

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References