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DEVELOPMENT OF MICROSTRIP GAS CHAMBERS

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We report here the first results of a project to develop microstrip gas chambers (MSGCs) for use in nuclear physics experiments. The project is a collaborative effort between researchers in the Physics Department and the Electrical Engineering Department at the University of Louisville and the Wire Chamber Laboratory at the IUCF. The MSGC is a multiwire proportional chamber (MWPC) fabricated using the photolithographic and microfabrication techniques developed for the semiconductor industry.[1] The anode wires of the MWPC are replaced by metal traces on a glass substrate in the MSGC. The precise control of the size ($\approx$ 10-μm wide anodes) and spacing (as small as 50-μm anode-cathode separation) can result in a detector with position resolution of $\approx$ 50-μm, nanosecond timing, radiation hardness, and measured count rate capability[2] of $\approx 1 \times 10^6$ counts/mm^2/sec.

One ultimate goal of this project is the production of a MSGC detector suitable for use in the demanding environments of storage rings such as the Cooler and LISS. In particular, the MSGC offers a radiation-hardened alternative to the large area silicon detectors that are commonly used in Cooler experiments.[3] One particularly intriguing application, for example, would be "tagging" the atomic state of the pionium ($\pi^+\pi^-$) atom through detection of the X-ray emitted as the atom is formed. Another possible application might be using an MSGC array as the first detector element in the small angle spectrometer required for measurements of the charge-symmetry-violating ^{2}H(d, π^0)^{4}He reaction.

The significant accomplishment to date has been the successful operation of a detector fabricated in-house at the University of Louisville. A detector was reproduced from a commercially produced master photomask, and designed using an electrode configuration known to give good performance.[4] This electrode structure has a pitch of 1 mm, with an active area of 40 mm $\times$ 40 mm (Fig. 1). The metal layer is 0.1 μm chromium, deposited on soda-lime glass. All anodes were coupled in common to an Ortec 124 preamp and 472

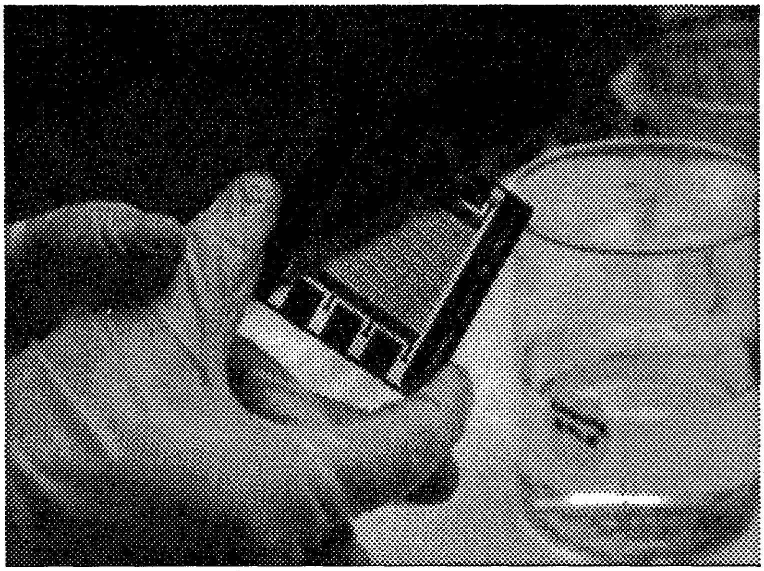

Figure 1. A MSGC duplicate plate fabricated at the University of Louisville.

spectroscopy amplifier. Argon (90%) and dimethyl-ether (10%) made up the counter gas. A pulse-height resolution of 15% (FWHM) was measured for the photopeak of the 6 keV X-ray from an ^{55}Fe source (Fig. 2). The small peak to the left is the escape peak at 3 keV. Note the good separation between the peaks; the ratio of counts per channel is about 40:1 between the main peak and the area between the two peaks. This resolution is comparable to those reported in the literature.[2]

In addition to the relatively simple MSGC electrode structure described above, the development of more advanced gas chambers such as the microgap chamber (MGC) is also underway.[5,6] The MGC differs from the MSGC in that the anode-cathode spacing is controlled by the deposition of a thin, insulating layer of 2-10 μm thick SiO_2. The electric field gradient is as high as 3 MV/cm, compared to the more typical 100 kV/cm of a MWPC.[5] The charge collection time is very fast, leading to good timing resolution and a high rate capability. The fabrication of the MGC requires more advanced processing techniques than the relatively simple MSGC, however, and few groups are actively pursuing this type of detector. Prototype MGC detectors have been fabricated and will be tested during the summer of 1995 (IUCF Experiment E393). An important goal of this activity is the operation of MGC (and MSGC) detectors at low pressures in pure isobutane. Low pressure operation in the two-stage mode, characterized by charge multiplication in the drift space as well as near the anode, offers increased gas gain and improved timing resolution compared to operation at atmospheric pressure.[7,8] A non-negligible consideration is that low pressure operation allows the use of thin windows for detectors mounted inside the Cooler vacuum chamber.

In addition to the bench tests with radioactive sources, a proposal was submitted to the June 1995 PAC for beam tests with split beam. These tests will be used to determine the operating characteristics of these detectors in the typical IUCF environment.

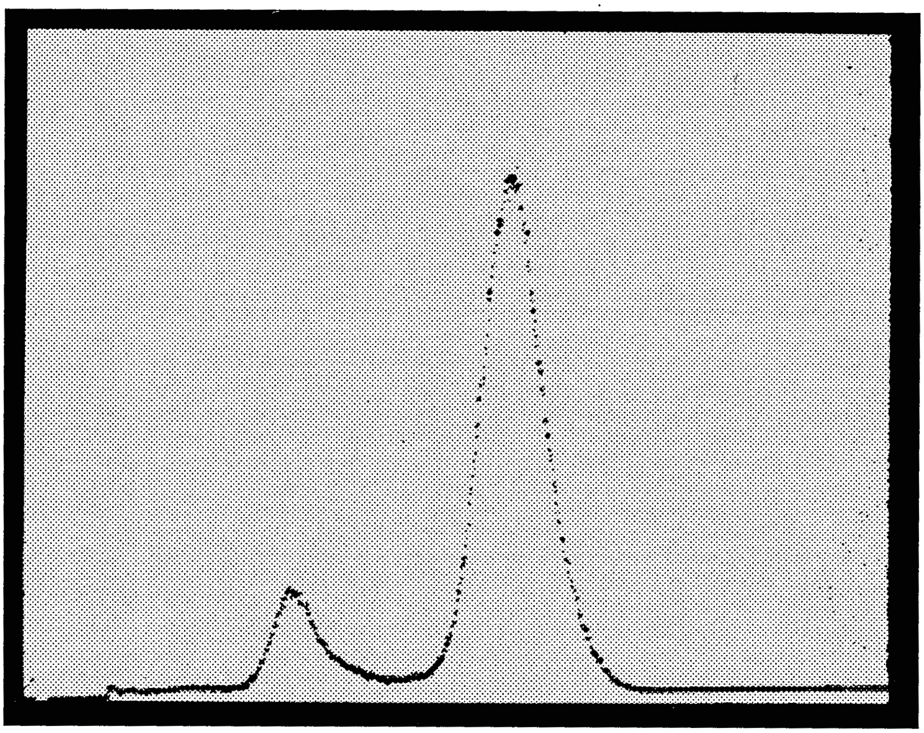

Figure 2. Pulse-height spectrum with an ^{55}Fe source.

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