Micro Patterned Gas Detectors for neutron detection

P. S. Barbeau[1], J. I. Collar[1], J. Miyamoto[2], I. P. Shipsey[2]
[1]Enrico Fermi Institute & Center for Cosmological Physics, University of Chicago, Chicago, IL
[2]Department of Physics, Purdue University, West Lafayette, IN

Poster session given for the Neutron Detector Workshop at Indiana University Cyclotron Facility, May 29 - 30, 2003

Micropatterned Gas Detectors (MPGD) good for SNS uses

1. Intensely studied and tested in severe radiation environment foreseen in high energy physics experiments

   a. High rate capability (>10E+6 Hz/mm2)

   b. Sub *mm* position resolution for charged particles (sufficient for more neutron applications)

   c. Large area possible (e.g. 30 cm x 30 cm for COMPASS experiment at CERN)

2. There are several types

   a. Glass substrate based (ILL, U of Tokyo)

   MSGC (microstrip gas chamber), MGP(Microgap) etc

   b. Kapton based

   GEM (gas electron multiplier)

   c. Metallic mesh based

   MICROMEGAS

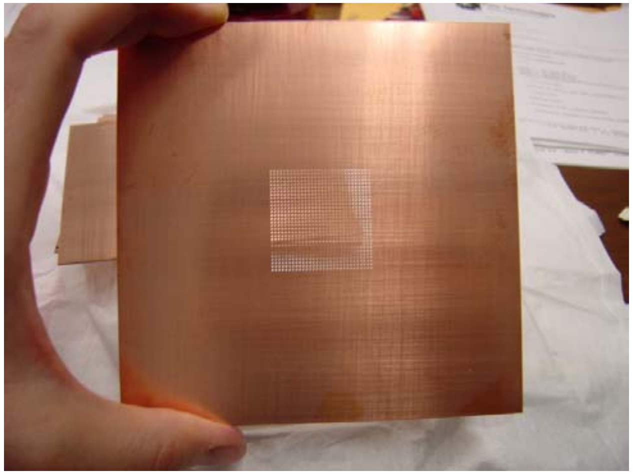
   d. Teflon based

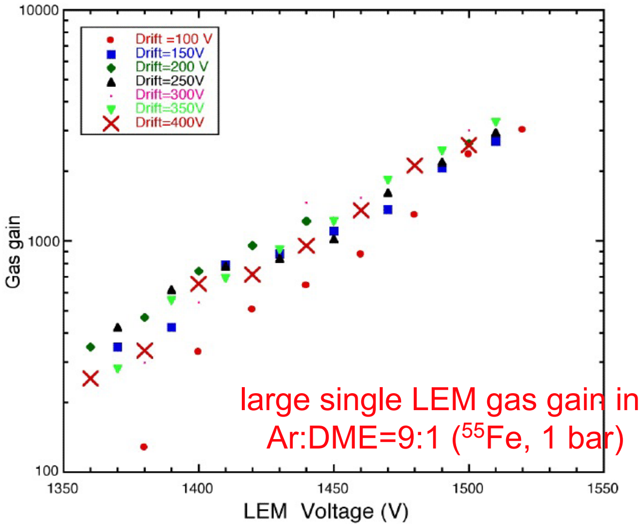
   LEM (Large electron multiplier) similar to the GEM

MPGD related activities at Purdue and Chicago

1. LEM, GEM/Micromegas aimed at
   a. TPC (time projection chamber) for Linear Collider experiments (good ion suppression and position sensitivity) at Purdue
   b. Low-background and high sensitivity (1 keV threshold) detection (e.g. coherent neutrino reaction) at U of Chicago
2. Industrial (mass) production for GEM/MICROMEGAS to produce reliable devices at U of Chicago/Purdue

3. Radiation hardness study for MPGDs to meet future high energy physics requirements at Purdue



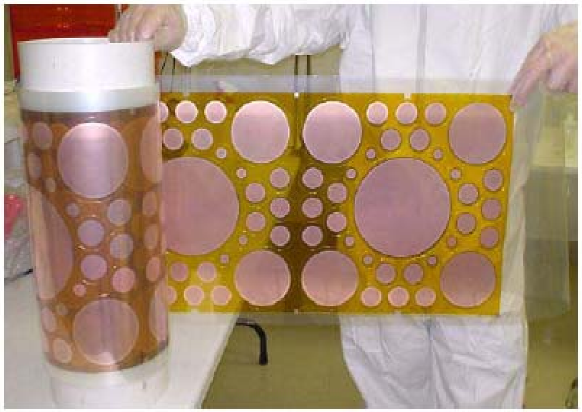


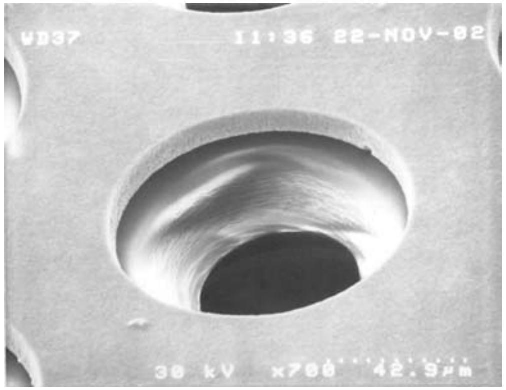
LEM made at U Chicago and tested at Purdue

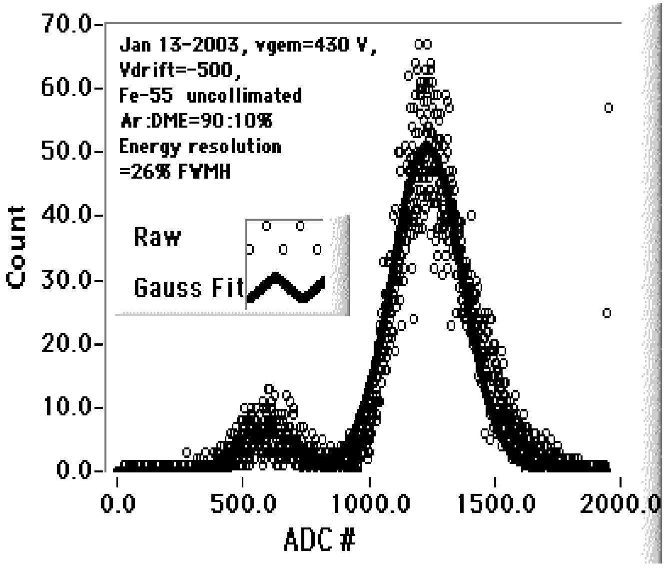
Made with ultra-low background materials (OFHC copper plated on virgin Teflon)

- In-house fabrication using automatic micromachining (no Lithography)
- Modest increase in V yields gain similar to GEM
- Self-supporting, easy to mount in multilayers
  Extremely resistant to discharges (lower Capacitance)
- Adequate solution when no spatial info needed
- Cu on PEEK under construction (zero outgassing)

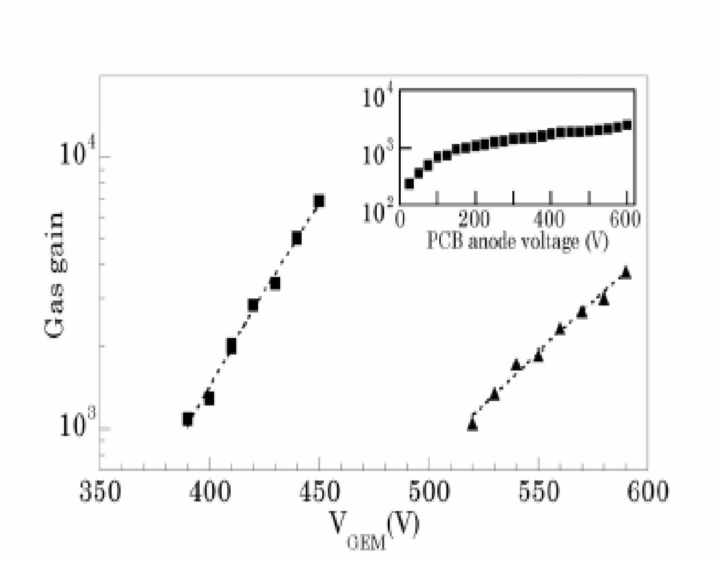
GEM mass production done at U of Chicago







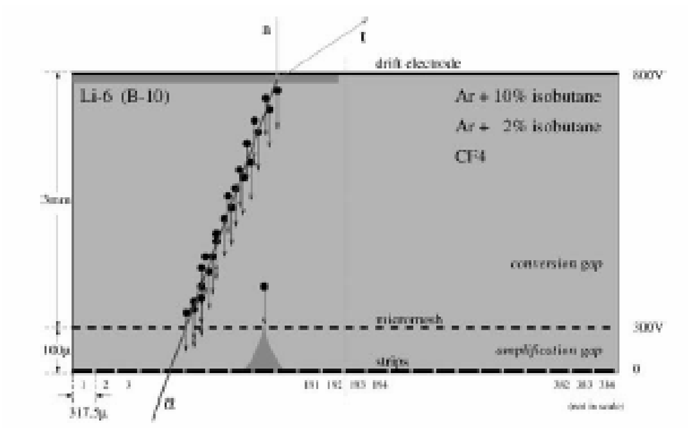
Fe-55 spectrum from a single GEM



High gas gain achieved before onset of discharge

MPGD for neutron detection

MICROMEGAS neutron detector demonstrated at the n-TOF facility at CERN (NIM 481(2002), 120)



1. Converter using $^{10}B(n,\alpha)^{7}Li$, $^{6}Li(n,\alpha)t$ reactions

2. Recoil proton from the gas (e.g. H(n,n)p)

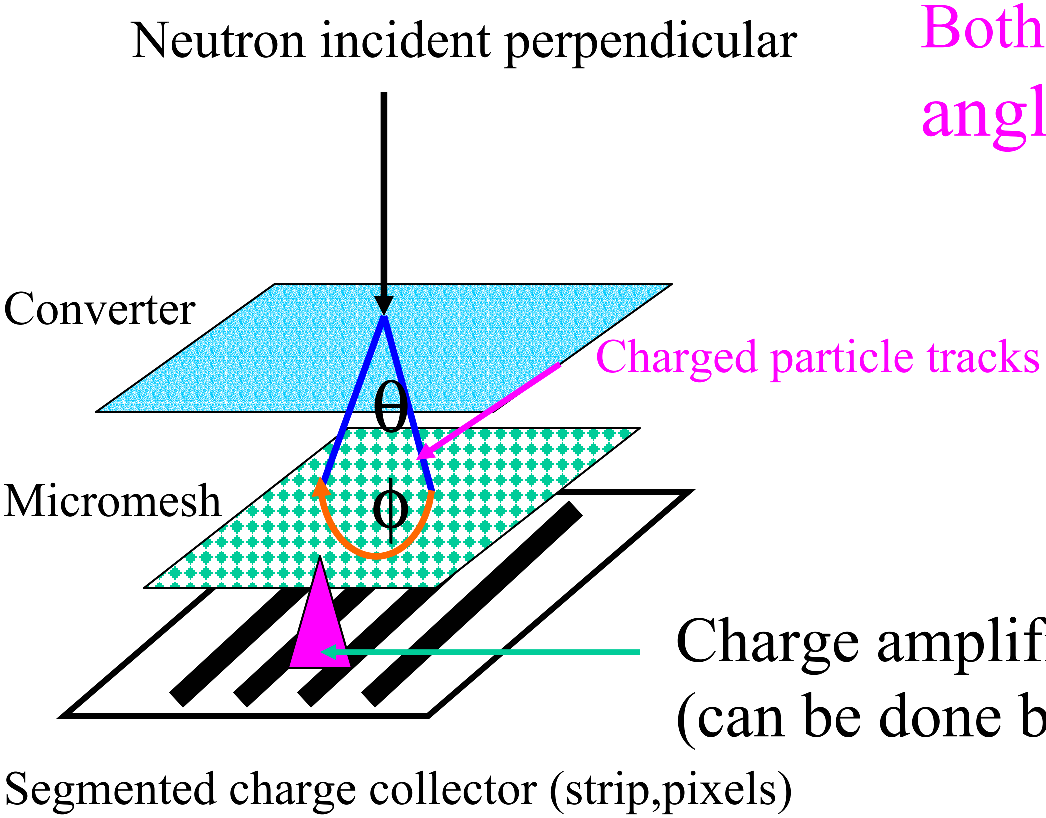
The resulting heavily ionizing charged particles are detected

Thermal neutron detection by pressurized GEM chambers was also demonstrated by van Vuure *et al.*

IEEE NS 48, 4 (2001), 1092

MPGD as a neutron imager and beam profiler

e.g. MICROMEGAS



Both ϕ(polar) and θ(azimuthal) angles influence

a. Charge multiplicity

b. Charge distribution on each segment

c. The total summed charge

Charge amplification in the μm-size gap (can be done by the GEM as well)

Examples of neat observations by MICROMEGAS neutron detection at n-TOF (ref: NIM 481(2002)120)

Recoiled proton Triton with high initial energy

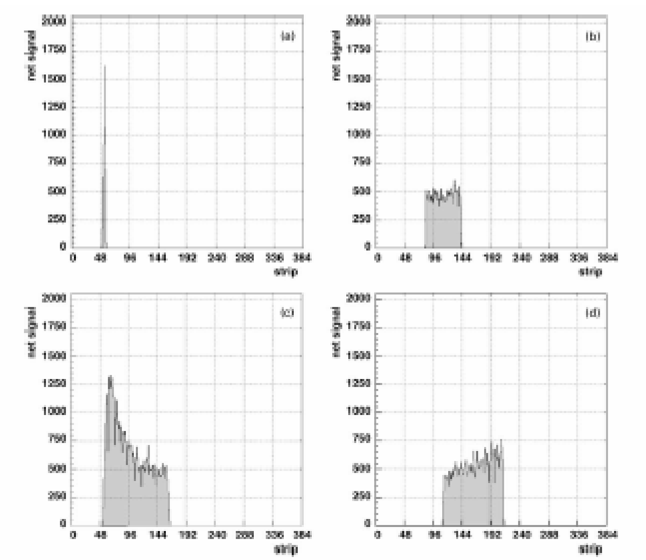


Fig. 3. Typical event types.

Triton Bragg curve Triton with low initial energy

Different tracks of charged particles with different dE/dx create different energy deposition profiles

Correlation between the cluster size and charge to do particle identification

Triton, protons, and alphas are distinguished