Prototypes For Particle Detectors Employing Gas Electron Multiplier

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GEM Foils

GEM (Gas Electron Multiplier)

- 3M Worldwide
- copper coated Kapton foil
- 60 µm holes - 140 µm apart
- 1 in. active area

Typical dimensions:

\[ D = 70 \mu \text{m} \]
\[ d = 60 \mu \text{m} \]
\[ p = 140 \mu \text{m} \]

Gas Electron Multiplier [F. Sauli, NIM A386, 531 (1997)]
GEM Foils

- Potential Difference across each GEM foil (300 V – 500 V)

- High energy particles ionize the gas inside the detector which drift to the GEM foil

- Electric field through the holes causes the electrons to cascade
Single GEM Detector

- All materials must have Negligible Out-Gassing

Drift Plane – Copper Coated G10 PC Board
Spacers – PeeK (Poly Ether Ether Ketone)

Florida Tech Single GEM Version 1.0
**Single GEM Detector**

**Setup**
- 9mm thick Plexiglas box  
  50x50x10 cm  
- Stainless Steel Tubing  
- Swagelok stainless steel fittings  
- 70:30 Ar/CO$_2$ Gas environment

**Initial GEM conditions**
- 2.5 kV total bias  
- 400 V potential difference across the GEM foil

**Observations**
- Large, irregular pulses found (Cosmic Rays or Discharge)  
- Frequency increased over time  
- No pulse change with source  
- Disassembled detector found damage near solder points
Single GEM Detector

Modifications

- BNC for signal output
- 500 V Potential Difference across GEM
- Hole drilled through Drift Plane covered with Mylar foil

Single GEM Electric Fields

- Electric Fields within Drift Gaps changed to match recommendations of F. Sauli, CERN
Single GEM Detector

Signal from Florida Tech Single Gem

- Acquired using National Instruments fast oscilloscope card
- Count rate consistent with Cosmic Ray muon flux
- However, no noticeable count rate change when using Fe55 source
- Most likely still sparking within in the GEM detector
Triple GEM Detector

- Design and Fabrication began as soon as the single GEM was complete.
- Learning from old mistakes and using new ideas.
- Pressed brass rings on either side of the GEM foil to apply High Voltage.
- Makes the detector more gas tight.
- Prevents damage from soldering iron and sparking due to solder points.
Triple GEM Detector

Top Assembly
Future Plans

- assemble
- use Fe55 source to find pulse height spectra
- compare our detector performance to others
- study aging in GEM detectors
- use for high energy physics/astrophysics research
Acknowledgements

Out-gassing Information

http://outgassing.nasa.gov/

GEM Graphics (order of appearance)

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