Introduction: Gas Electron Multiplier

Requirements on Electronics:
- triggered high voltage supply - HV
- sensitive readout = 10^14 e^-
- signal from the detector

Typical Detector
- sensitive volume; mm thick
- triple stack of GEM foils
- segmented readout

Principle of Operation
- signal creates low electrons
- GEM field accelerates electrons
- HV high field makes sensitive detector
- dead time typically > 100 µs
- readout: fast timing signal + residual gain

Fuel Hole

II) High Voltage Protection Circuit

Deal with Sparks in the Detector
- Signal: 10^14 e-
- Spark: x10^7

Sparks in the detector can cause damage to the electronics.

Classical Approach: Diode

Commercial Solution: USB3 protection diodes.
- designed to protect commercial electronics against static discharge events
- C_diss = 0.5 pF, FTR reference: C_diss = 30 pF

Testing the Protection Circuit

Useful for testing: Setup that mimics discharges
- Amplitude - 400 V
- Rise time - 100 ns

Testing the Durability
- Apply long simulated discharges
- No deterioration found

Technical Details

1) Generate Voltage Levels:
- External HV + Multi-Tiered Voltage Divider

Resistors:
- Rated for high voltage
- Low temp. coefficient!
- Stability voltages vs ambient temp

2) Stabilization vs Load Current
- Impedance converting amplifier:
  - high input impedance
  - low output impedance

3) Protection: Active Impedance

Using Depletion Mode MOSFET:
- Span
- Stability
- Current Through R
- Gate voltage
- Transistor turned off by gate voltage
- Limitation of current

Outlook - Next Steps

1) Implement Voltage Monitoring
   So far, voltages were measured in a dedicated test setup.
   In the final setup, multiple voltages should be measurable remotely.
   Supervise voltage supply, understand the detector performance in Beamtimes!

2) Test on live GEM detector
   All measurements so far were done in dedicated test setups.
   Next: Operate on GEM detector to prove performance under realistic conditions.

3) Determine radiation hardness
   Electronics are in many experiments exposed to high levels of ionizing radiation.
   Radiation hardness of commercial components varies.
   The hardness of the components used here has to be determined.