

The PRad GEM Operation Manual

1 GEM Tracker Overview

The Gas Electron Multiplier (GEM) tracker consists of a pair of large area $1.2 \text{ m} \times 0.6 \text{ m}$ three layer ionization chambers. The chambers are mounted to the front face of the HyCal calorimeter using a custom mounting frame. Each chamber has a 2-inch hole to allow the beam pipe to pass through the chambers. Both chambers will be powered by a single HV power supply. The signals will be read out via HDMI cables between the on-board pre-amplifier and digitizer boards and the SRS crate located next to the detector attached to the underside of the HyCal calorimeter. A pre-mixed gas of 70% Argon and 30% CO_2 will be supplied continuously to the chamber.

2 GEM Gas Flow System

The pre-mixed 70% Argon and 30% CO_2 will be supplied from the Hall-B gas shed. Gas bottles for the entire run have been stored in the shed and will be regularly replaced as needed. Gas flow should be maintained throughout the experiment.

2.1 Hazards

There are no hazards associated with the gas flow system.

3 The GEM High Voltage Supply

The GEM high voltage (HV) supply consists of a single ISEG SHQ 126L stand-alone supply that can deliver up to 6kV at 1 mA. Before turning on the HV supply ensure that the gas flow has been operational for at least few hours. When starting from off condition the HV should be increased slowly at the rate of $\sim 1 \text{ V/sec}$. The voltage should never exceed 4100 V.

3.1 Hazards and Mitigation

Hazards to personnel include the exposed high voltage connector which is used to bias the chamber. The region under high voltage is sandwiched between sealed G10 plates which prevents personnel from accidentally coming in contact with the electrodes. Hazards

to personnel are further mitigated by turning off HV and LV power before disconnecting cables or working on the chambers and internal electronics.

4 The GEM DAQ

The PRad GEM detectors are read out using the APV25 chip based Scalable Readout System (SRS) developed at CERN by the RD51 collaboration. The APV25 chip samples 128 channels in parallel at 20 MHz or 40 MHz and stores 192 analog samples, each covering 50 ns or 25 ns, per channel. Following a trigger, up to 30 consecutive samples from the buffer are read-out and transmitted to an ADC unit that de-multiplexes the data from the 128 channels and digitizes the analog information. Operating in the 20 MHz mode with the 30 sample readout will give a dynamic time.

The SRS system consists of the following components:

- SRS-APV25 hybrid cards mounted on the detector. These cards contain the 128 channel APV25 chip which reads data from the detector, multiplexes the data, and transmits analog to the ADC card via standard commercial HDMI cables.
- SRS-ADC unit that houses the ADC chips that de-multiplex data and convert into digital format.
- SRS-FEC card which handles the clock and trigger synchronization. A single Front End Card (FEC) and ADC card combination has the capability to read data from up to 16 APV hybrid cards. The data from the FEC are send either directly to the data acquisition computer (DAQ PC) or to the SRS-SRU via a 1 Gb Ethernet copper link.
- SRS-SRU, Scalable Readout Unit, handles communication between multiple (up to 40) FEC cards and the data acquisition computer. It also distributes the clock and trigger synchronization to the FEC cards.
- The data acquisition computer, which could be part of a larger DAQ system as one of the readout controllers.

A total of 9216 electronics channels are needed to readout the PRad GEM chambers. This amounts to 72 SRS-APV25 cards (128 channels per card). The SRS-ADC / SRS-FEC card can handle up to 16 SRS-APV25 cards and send data to the SRS-SRU through a newly implemented 10Gb Fiber link. We use 6 SRS-ADC/SRS-FEC cards to read out all 72 SRS-APV25 cards limiting the number of SRS-APV25 card per SRS-FEC to 12. The SRS-FECs cards are connected to 2 SRS-SRU boards (3 SRS-FECs per SRS-SRU).

For proper operation all the APV cards should be securely mounted on the GEM chamber and connected through the HDMI cables to the FEC cards in the SRS crates. The SRS crates should be powered and they should be connected via network cables to the SRU. The SRU should have a proper fiber connection to the DAQ PC. During DAQ crashes, the SRS crates and PC may have to be rebooted.

4.1 Hazards and Mitigation

Hazards to personnel include the low current which powers the readout electronics. Hazards to personnel are mitigated by turning off the LV power before disconnecting cables or working on the chambers and internal electronics.

4.2 Responsible personnel

Individuals responsible for the system are:

Name	Dept.	Phone	email	Comments
Kondo Gnanvo	UVa		nilanga@jlab.org	First contact
Xinzhan Bai	UVa		xb4zp@virginia.edu	2nd Contact
Krishna Adhikari	MSU		adhikari@jlab.org	3rd Contact

Table 1: Personnel responsible for the GEM tracker.