Questions on GEM chambers, R. Majka

The KPPs are all stated in terms of averages over a module. It would be good to have a sense of how much is in the tails and some idea of how values in the tails affect the performance. Are channels that are above the KPP value useless, or simply reduce the performance? Can the group provide something like a table of how many channels or what fraction are above the KPP value and what this means for final performance – suggestions below.

1. all foils have an average dark current of less than 5 nA per 20 x 5 cm2 section at 4100 V on the full module Do any of the foils in the final chamber have segments with greater than 5 nA? How many and how does this affect the performance?

   No, there are no operational sectors in any of the SBS modules with dark currents higher than 5 nA. 41 SBS GEM modules we have constructed are 100% operational with all sectors working; all these sectors have leakage currents less than 5 nA under the required conditions. There are 2 spare modules with one sector in each disabled due to a short. All other sectors in these two modules also have leakage currents less than 5 nA.

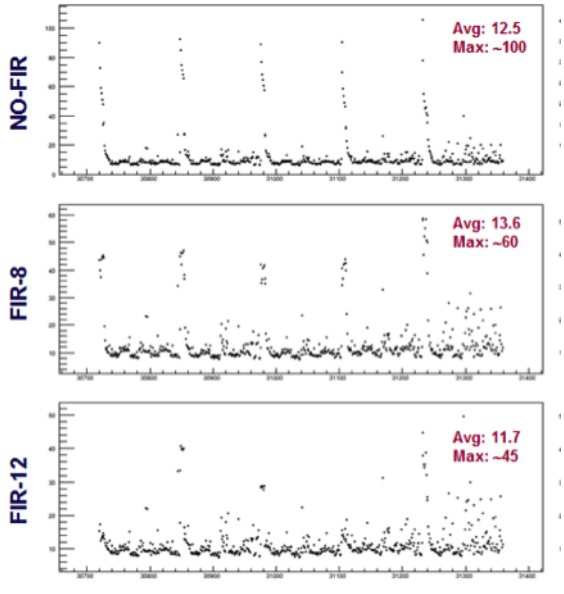
2. they have a gain of at least 5000 at the operational voltage of 4000 V in a gas mixture of 70% Argon and 30% CO2
3. they have a track efficiency of at least 95%, averaged over the module, in cosmic tests Are there any chambers with sections with < 95% efficiency (other than expected regions around support lattice).

   No, all chambers for which the efficiency has been measured so for have shown to reach efficiency plateaus exceeding 95%. Due to small variations of GEM foils from different batches the there are small differences in efficiency for different modules these modules reach the plateau at different voltages (roughly within +/- 100 V of 4200 V for the measured modules). So far the efficiency curves have been measured for 20 modules, while all 43 completed modules have been tested for high voltage stability and hit patterns to show that the sectors are operational. While we have currently have an ongoing testing program at UVa to measure efficiency curves for all remaining chambers, we may have to stop this activity due to lack of funds to purchase gas for the modules. In this case, the efficiency curves for the remaining modules will be measured at Jefferson lab over the next two years.

4. All GEM modules with their attendant electronics must be assembled in their frames and tested with cosmics. GEM electronics and DAQ must be attached to the above GEMs and functional in an integrated data-acquisition system.

5. The APV25 front-end read-out boards must be tested for low noise level performance and the equivalent noise charge must be less than 3500 e (RMS), averaged over the module. Again, what fraction of channels have noise above 3500 e and how does this affect performance?

   Over 95% of the channels have less than 3500 e (RMS) noise. As indicated in the attached plots a few (about 5 out of 128) channels at the edge of each APV card have higher noise levels than this. The origin of this noise is understood; application of a finite impulse response (FIR) filter allows the reduction of the pedestal noise level of these channels. After the application of this filter only a couple of percent of all channels have pedestal noise levels higher than 3500 e-. The relatively high noise level of these small number of channels has no significant impact on tracking.



   Measured RMS pedestal noise levels for MPD APV electronics. This test was done for a set of 5 APV cards. Horizontal axis shows the strip number where the vertical axis is pedestal noise level in units of ADC channels. One ADC channel is equivalent to approximately 160 e-.