DC HV Studies for RG-K

For the DC, we would like to take data under different conditions to study the effects of different HV settings on resolutions, as well as opportunistically gather data for high-lumi operation studies. The required measurements for the resolutions can be separated from those for the high-lumi data studies and can be taken at different times. We estimate that all of the tests can be completed in 1 PAC day (2 beam days).

Resolution study: ~4 shifts

Requirements:

- Hydrogen target
- 3rd or 4th pass beam (3rd pass preferred)
- Established production settings, *i.e.* beam setup, trigger checkout, mini lumi scan done
- Electron trigger without DC roads (with roads statistics goal can be reduced)

The goal is to determine the effect of changes in the DC HV settings on the resolutions (tracking and physics quantities). We plan to study the improvement of the track and missing mass resolutions as the HV is increased in steps in the different DC regions. The largest effect is expected for the R2 drift chambers. The study requires collecting data with sufficient statistics (~75M electron triggers) for calibration and analysis of the physics channels. The HV setting from RG-M/-C is R1=10, R2=10, and R3=10 (10, 10, 10).

HV settings for study:

Region 1 HV	Region 2 HV	Region 3 HV	Statistics Goal	Comment
10	10	10	75M	RG-M/-C setting
9	10	10	75M	RG-K F18 setting
10	11	11	75M	RG-D Setting
11	12	12	75M	Highest setting
10	10	11	75M	Study effect of R3
10	11	10	75M	Study effect of R2
10	12	10	75M	Study effect of R2
11	10	10	75M	Study effect of R1

We estimated that 75M triggers is about 2.5h-3h at 40 nA on the 50-cm-long LH2 target. Therefore, the plan will take about 3 to 4 shifts to measure all of the settings.

Calibration and Analysis Plan:

Each run requires a good calibration for the DC, FTOF, and ECAL to ensure that the obtained resolutions of physics quantities are comparable and only affected by the DC HV setting. We assume that the DC alignment and ECAL calibrations from RG-D will carry over for the RG-K

runs. We also assume that calibrations of each DC region are independent and a calibration at a specific HV setting does not depend on the HV setting of another region. This assumption is seen in previous calibrations for RG-D at different HV settings. Therefore, a T0/T2D calibrations for R1 at setting 10 should be good for HV settings (10,12,10) or (10,11,11), etc.
The initial calibrations will start with the T0s and T2D pressure-dependent calibration from RG-D at (10,11,11). The calibration needs fast turn-around and we envision the following plan and steps:

1) Cook first run ASAP to calibrate FTOF/RF (expected to be completed before Christmas) and upload new constants.
2) Cook 10M events from runs (10,10,10), (9,10,10), (10,11,11), (11,12,12) to obtain T00 calibrations for each HV setting in each region. The initial T0s will be from RG-D at (10,11,11).
3) Upload new T0s for each run along with the pressure values. This step should be completed before the end of the year.
4) Cook 10M events from runs (10,10,10), (9,10,10), (10,11,11), (11,12,12) to obtain T2D calibrations for each HV setting in each region. Note: it could be that some settings do not need a new calibration and are already good enough.
    a. In parallel, produce mini-timelines for all runs to check the calibrations from the previous step (means and T00s).
5) Upload new T2D calibrations for each run based on the individual T2D calibration for each region. To be completed within the first week of January.
6) Cook all runs completely with focus on runs (9,10,10), (10,11,11), and (11,12,12) first.
    a. In parallel, produce timelines to check the calibrations.

The analysis of runs after step 6 will focus on inclusive electrons, K^+Y, and $p\pi^+\pi^-$. We expect to have scripts ready to look at these runs and check resolutions of W, missing masses, and invariant masses to guide a decision on the HV setting for RG-K.

<u>Opportunistic high-lumi study: ~ 1h</u>

Requirements:

- Beam operation possible up to 150 nA on LH2 target

The goal is to collect data to determine the DC HVPS supply currents as a function of beam current and fill in the gaps from previous measurements when the HV supply was limited to 40 μA currents. We just need EPICs for this and no DAQ. The plan is to increase the beam currents in steps of 20 nA from 30-150 nA (6 steps) and wait until we have stable 30s-60s of beam. The HV current information is automatically stored and will be analyzed later, together with the beam currents. In parallel, screenshots of the DC HV will be logged. For each HV setting the current scan should take about 15 min. If the HVPS channels trip at higher beam currents, they will be kept off until the next HV setting and a logbook entry will be made.
The HV settings for this test are:

Region 1 HV	Region 2 HV	Region 3 HV
10	10	10
11	11	11

12	12	12
12	13	13

*this setting needs a careful increase of beam current to avoid any DC issues.