KAON-LT Run Plan - Part 4

September 21, 2018

9.404 GeV Beam Plan

Initial beam activities

- Hall entry for SHMS aerogel change.
  During the linac pass change, and in co-ordination with the RC, the SHMS aerogel experts (Bernikov, Trotta, Horn) need to enter the hall to remove the n=1.03 aerogel and replace it with n=1.011 aerogel. Estimated time required – 8 hours.

- SHMS fringe field beam steering study.
  MCC will want to do this "first thing" after beam is delivered to the hall, to establish operating parameters. Set the SHMS to the smallest angle, highest momentum setting needed at this beam energy [6.00^o, –6.842 GeV/c (polarity apparently does not matter)], and follow MCC instructions to either rotate the spectrometer or change the momentum setting. It could take 1–4 hours to complete the studies, depending on how much deflection they find.

- After the studies are done, configure the spectrometers for the carbon sieve run:

  1. SHMS angle = 9.50 deg (from TV). **This requires a hall access. The Run Coordinator will need to arrange in advance which expert personnel (e.g. Fowler, Lassiter) need to be present.**
  2. SHMS momentum = –6.000 GeV/c (negative polarity).
  3. HMS angle = 13.00 deg (from TV).
  4. HMS momentum = –5.000 GeV/c (negative polarity and all magnets cycled).

- Beam checkout.
  Follow the notes at:
  `https://hallcweb.jlab.org/wiki/index.php/Beam_Checkout_Procedures`
  including the "Carbon-hole" check to verify beam+target alignment and MCC raster size calibration.

Items to be done as soon as possible at this energy (time determined by RC).

- Superharp scan.
  The Run Co-ordinator should let the MCC know in advance that we are planning a Superharp scan. The beam should be stable and less than 25 μA. We want this done with the raster off, so that the beam spot size can be measured. If the spot size at 00A is < 0.1mm (sigma), instruct MCC to increase the spot size and remeasure to verify. **This must be completed before any production cross section data are to be taken!**

- Energy determination with arc.
  The Run Co-ordinator will coordinate the timing of this with the Program Deputy. MCC will have to set up a clean dispersive tune. It is important for the Shift Leader to make a full hclog entry of the MCC data.

Calibration runs.

1. HMS and SHMS sieve runs with $z = 0$ 1.5% r.l. carbon target.

   - Spectrometer angles and momenta as on previous page.
   - Sieve slits on both spectrometers.
   - **Raster off.** Current limit=20 μA. Carefully center the beam to the previously determined central position.
   - Verify that MCC has position at target lock on, and energy lock on.
   - Prescale factors:
     HMS singles daq disabled (all PS=-1).
     SHMS singles daq disabled (all PS=-1).
     COIN daq PS1(SHMS-3/4)=–1, PS2=(SHMS-ELREAL)=0, PS3(HMS-ELREAL)=0, PS4(HMS-3/4)=–1, PS5(HMS-ELREAL×SHMS-3/4)=–1, PS6(HMS-3/4×SHMS-3/4)=–1.

   Singles runs. Take 100,000 HMS and 100,000 SHMS electron triggers. Adjust PS2(SHMS-ELREAL) and PS3(HMS-ELREAL) as necessary to keep the deadtime at reasonable levels (below 20%).

	E_e	θ'_e	P'_e
HMS:	9404.0	13.0	-5000.0
SHMS:	9404.0	9.5	-6000.0

   Look at HMS and SHMS $x - fp$ vs $y - fp$ scatterplots, and compare to the "reference plots" taken at the beginning of the 10.6 GeV beam time. They should look extremely similar. If not, contact Mark Jones or Holly Szumila-Vance for instructions on what to do next.

2. $p(e,e')p$ Hydrogen elastic singles, and associated Thick Dummy target runs.

Set up the following configuration:

(a) HMS and SHMS angles and momenta as specified in the tables below. Negative polarity. Cycle all magnets before the first setting. Record all TV angle values.

(b) HMS large and SHMS collimators.

LH2 target runs:

Take two runs for each of the following HMS, SHMS angle and momentum settings. Stable 70 μA beam with **raster on.** Set the PS2(SHMS-ELREAL) and PS3(HMS-ELREAL) target rates to 1000 Hz, all others disabled (i.e. -1). As a guide, projected rates and PS factors are given in the table below. We want at least 10,000 elastics, which typically requires at least 100,000 total electron events (times below are only a guide). The total event estimate includes inelastics.

Thick Dummy target runs:

One run for each angle and momentum setting, taken immediately after the corresponding LH2 run. Remember to reduce the current to 40 μA.

9.404 GeV Heep-check singles runs									
θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{HMS}$	$\frac{PS3}{HMS}$	$Rate_{SHMS}$	$\frac{PS2}{SHMS}$	$\frac{Time}{LH2run}$	$\frac{Time}{ALrun}$
20.00	-5.861	15.70	-6.842	0.25 kHz	0	1.9 kHz	0	15 min	10 min
22.00	-5.436	18.00	-6.309	0.10 kHz	0	0.6 kHz	0	15 min	10 min
24.00	-5.038	20.00	-5.861	0.05 kHz	0	0.2 kHz	0	20 min	10 min
24.00	-5.038	22.00	-5.436	0.05 kHz	0	0.1 kHz	0	20 min	10 min
Total Time (including overhead): 2.8 hrs									

3. $\boxed{p(e,e'p)}$ Heep-check coincidence run.

Set up the following configuration:

(a) Cycle HMS magnets and set to –5.861 GeV/c (negative polarity).

(b) HMS angle = 20.00 deg (from TV).

(c) Switch the SHMS to positive polarity (follow the cycling procedure) and set to +4.382 GeV/c.

(d) SHMS angle = 27.23 deg (from TV).

(e) Prescale factors PS1(SHMS-3/4)=0, PS3(HMS-ELREAL)=0, PS5(HMS-ELREAL×SHMS-3/4)=0. All others disabled (i.e. -1).

(f) HMS large and SHMS collimators.

(g) Stable 70 μA beam with raster on.

Take two runs with a combined total of 13,000 $e+p$ elastic scattering coincidences. The first run should be 30 minutes, and should be immediately analyzed, checking E_m and p_m, while taking the second run.

9.404 GeV Heep-check coincidence run

θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{HMS}$	$Rate_{DAQ}$	Time
20.00	-5.861	27.23	4.382	0.25 kHz	260 Hz	3.0 hr

4. $\boxed{\mathrm{Al}(e,e'p)X}$ Thick Dummy target run for Heep-check.

Insert the "thick" dummy target (±5 cm) and **run for 18 minutes** at 40 μA (assuming 100% efficiency).

$\mathbf{Q^2}$=5.5, W=3.02, x=0.40, low ϵ data taking

Nominal Q^2=5.5 GeV$^2/c^2$, W=3.02 GeV, x=0.40 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\|t\|$ (GeV/c)^2	p_K GeV/c	θ_q deg
9.404	2.082	30.73	0.3721	0.503	6.842	-7.96

1. $p(e, e'K^+)\Lambda$ LH2 SHMS center ($\theta = 7.96^o$) run.

   Set up the following configuration:

   (a) SHMS angle = 7.96 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras while approaching the beamline, and be prepared to hit the rotation kill switch, if necessary.**

   (b) SHMS momentum = 6.842 GeV/c (should already be there).

   (c) HMS momentum = –2.082 GeV/c. Negative polarity.

   (d) HMS angle = 30.73 deg (from TV).

   (e) 10 cm LH2 target.

   (f) Update *standard.kinematics* with the new settings.

   (g) Set the PS1(SHMS-3-4) and PS3(HMS-ELREAL) target rates to 100 Hz, PS5(HMS-ELREAL×SHMS-3/4)=0, all others disabled (i.e. -1). For the projected rates listed below, these should correspond to factors of about PS1(SHMS-3/4)=8, PS3(HMS-ELREAL)=4, giving 100 Hz HMS and SHMS singles event rates to disk, and a 275 Hz DAQ rate overall, for 70 μA beam.

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K$+p)	Real coinc. $e^- \cdot K$
0.6 kHz	2.4 kHz	10 kHz	5.4 kHz	4.2 kHz	2.1 Hz	0.018-0.020 Hz

   The real rate above is only for the $p(e, e'K^+)\Lambda$ reaction, exclusive π^+ and p coincidence reactions are likely to at least triple this rate.

   Take data for approximately 48.1 hours (at 100% efficiency) to give 3,100-3,500 $\mathbf{p(e, e'K^+)\Lambda}$ coincidences. Use the physics replay to keep track of the event total.

2. Al$(e, e'K^+)X$ Thick Dummy target SHMS center ($\theta = 7.96^o$) run.

   Now put in the "thick" dummy target (±5 cm) and initially set prescale factors to the same as the LH2 run. If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, then the PS1,3 factors can be decreased accordingly.

   Take data for 3.4 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'K^+)\Lambda}$ LH2 SHMS left ($\theta = 10.96^o$) run.

   (a) Move the SHMS to 10.96 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras while departing the beamline, and be prepared to hit the rotation kill switch, if necessary.**

   (b) Leave the magnet settings unchanged.

   (c) Put the 10 cm LH2 target back in.

   (d) Update *standard.kinematics* with the new settings.

   (e) Set the PS1(SHMS-3-4) and PS3(HMS-ELREAL) target rates to 100 Hz, PS5(HMS-ELREAL×SHMS-3/4)=0, all others disabled (i.e. -1). For the projected rates listed below, these should correspond to factors of about PS1(SHMS-3/4)=5, PS3(HMS-ELREAL)=4, giving 100 Hz HMS and SHMS singles event rates to disk, and a 210 Hz DAQ rate overall, for 70 μA beam.

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K$+p)	Real coinc. $e^- \cdot K$
0.6 kHz	2.4 kHz	0.60 kHz	0.35 kHz	0.45 kHz	0.16 Hz	0.011-0.017 Hz

The real rate above is only for the $p(e,e'K^+)\Lambda$ reaction, exclusive π^+ and p coincidence reactions are likely to at least triple this rate.

Take data for approximately 48.1 hours (at 100% efficiency) to give 2,000-3,000 $\mathbf{p(e,e'K^+)\Lambda}$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 10.96^o$) run.

Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run. If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, then the PS1,3 factors can be decreased accordingly.

Take data for 3.4 hours (100% efficiency) at 40 μA.

5. **To be determined in consultation with the RC:** If there is extra time left over before the next pass change, go back to the $p(e,e'K^+)\Lambda$ setting with the lowest statistics and take more data.