

KAON-LT Run Plan - Part 2

November 7, 2018

3.835 GeV Beam Plan

Initial beam activities

- Hall entry for SHMS aerogel change.
During the linac gradient change, and in co-ordination with the RC, the SHMS aerogel experts (Bernikov, Trotta, Horn) need to enter the hall to remove the $n=1.015$ aerogel and replace it with $n=1.03$ 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 [6.79° , -3.007 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). **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.**
 2. SHMS momentum = -3.007 GeV/c (negative polarity).
 3. HMS angle = 13.00 deg (from TV).
 4. HMS momentum = -3.007 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 (BPM calibration check).

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 $25 \mu\text{A}$. We want this done with the raster off, so that the beam spot size can be measured. If the spot size at 00A is $< 0.1\text{mm}$ (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 hlog entry of the MCC data. Follow the “Hall C Beam Energy Measurement Procedure” at MCC Ops Doc: MCC-PR-06-004.

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= $20 \mu\text{A}$. 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 \times SHMS-3/4)=-1, PS6(HMS-3/4 \times 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:	3835.0	13.0	-3007.0
SHMS:	3835.0	9.5	-3007.0

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.
- (b) Record all TV angle values on the runsheets.
- (c) 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 .

3.835 GeV Heep-check singles runs									
θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{HMS}$	$\frac{PS3}{HMS}$	$Rate_{SHMS}$	$\frac{PS2}{SHMS}$	$\frac{Time}{LH2run}$	$\frac{Time}{ALrun}$
21.14	-3.007	21.14	-3.007	26 kHz	5	33 kHz	6	15 min	10 min
24.00	-2.834	24.00	-2.834	9.7 kHz	4	13 kHz	4	15 min	10 min
26.00	-2.713	26.00	-2.713	5.2 kHz	3	7.9 kHz	4	15 min	10 min
28.20	-2.583	28.20	-2.583	2.8 kHz	2	4.6 kHz	3	15 min	10 min
30.00	-2.478	30.00	-2.478	1.8 kHz	0	3.1 kHz	2	15 min	10 min
Total Time (including overhead): 3.3 hrs									

3. $p(e, e'p)$ Heep-check coincidence run.

Set up the following configuration:

- (a) Set the HMS to -2.026 GeV/c (negative polarity).
- (b) HMS angle = 38.60 deg (from TV).
- (c) Switch the SHMS to positive polarity (follow the cycling procedure) and set to $+2.583$ GeV/c.
- (d) SHMS angle = 29.31 deg (from TV).
- (e) Prescale factors PS1(SHMS-3/4)=2, PS3(HMS-ELREAL)=0, PS5(HMS-ELREAL \times SHMS-3/4)=0. All others disabled (i.e. -1).
- (f) HMS large and SHMS collimators.
- (g) Stable $70 \mu\text{A}$ beam with raster on.

Take two runs with a combined total of 50,000 $e + p$ elastic scattering coincidences. The first run should be ~ 15 minutes, and should be immediately analyzed, checking E_m and p_m , while taking the second run.

3.835 GeV Heep-check coincidence run						
θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{SHMS}$	$Rate_{DAQ}$	Time
38.60	-2.026	29.31	2.583	3.8 kHz	1500 Hz	0.75 hr

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

Insert the “thick” dummy target (± 5 cm) and **run for 12 minutes** at $40 \mu\text{A}$ (assuming 100% efficiency).

Q²=0.5, W=2.40, x=0.09, low ϵ data taking

Nominal $Q^2=0.5$ GeV ² /c ² , $W=2.40$ GeV, $x=0.09$ Kinematics						
E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$ t $	p_K	θ_q
GeV	GeV	deg		(GeV/c) ²	GeV/c	deg
3.835	0.968	21.14	0.4515	0.081	2.583	-6.79

1. $p(e, e'K^+)\Lambda$ LH2 SHMS center ($\theta = 6.79^\circ$) run PART 1.

Set up the following configuration:

- (a) SHMS angle = 6.79 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 = 2.583 GeV/c. Positive polarity (should already be there).
- (c) HMS momentum = -0.968 GeV/c. Negative polarity.
- (d) HMS angle = 21.14 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 \times 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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2800 Hz DAQ rate overall, for 16 μ A beam.
Adjust the beam current accordingly, keeping SHMS singles rates <650 kHz and live time >85%.

HMS	HMS	SHMS	SHMS	SHMS	Random coinc.	Real coinc.
e^- rate	π^- rate	π^+ rate	K rate	p rate	$(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + p)$	$e^- \cdot K$
5.0 kHz	178 kHz	466 kHz	59 kHz	103 kHz	2590 Hz	0.018-0.034 Hz

Expected rates for 16 μ A beam current. 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.

In total, we want 4,700-8,880 $p(e, e'K^+)\Lambda$ events, which will take approximately 71.3 hours (at 100% efficiency). Given its length, we will break it into two pieces.

For part 1, take about 40 hours of data (at 100% efficiency) to give 2,600-4,600 $p(e, e'K^+)\Lambda$ coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\text{Al}(e, e'K^+)X}$ Thick Dummy target SHMS center ($\theta = 6.79^\circ$) 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 5.0 hours (100% efficiency) at 20 μA . Adjust the beam current accordingly, keeping SHMS singles rates < 650 kHz and live time $> 85\%$.

3. $\boxed{p(e, e'K^+)\Lambda}$ LH2 SHMS left ($\theta = 9.79^\circ$) run.

Set up the following configuration:

- (a) SHMS angle = 9.79 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 \times 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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 3150 Hz DAQ rate overall, for 24 μA beam.

Adjust the beam current accordingly, keeping SHMS singles rates < 650 kHz and live time $> 85\%$.

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. $e^- \cdot K$
7.5 kHz	270 kHz	315 kHz	49 kHz	106 kHz	2920 Hz	0.027-0.048 Hz

Expected rates for 24 μA beam current. 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 42.8 hours (at 100% efficiency) to give 4,225-7,500 $p(e, e'K^+)\Lambda$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\text{Al}(e, e'K^+)X}$ Thick Dummy target SHMS left ($\theta = 9.79^\circ$) 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 3.0 hours (100% efficiency) at 30 μA . Adjust the beam current accordingly, keeping SHMS singles rates < 650 kHz and live time $> 85\%$.

5. $\boxed{p(e, e'K^+)\Lambda}$ LH2 SHMS center ($\theta = 6.79^\circ$) run PART 2.

Return to the $\theta_{SHMS} = 6.79^\circ$ setting for the remainder of the 3.835 GeV beam time and complete the data taking for this setting. If things have progressed reasonably on schedule, there should be about 72 hours until the linac gradient change.

Set up the following configuration:

- (a) Set SHMS angle = 6.79 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) Look up from the run sheets the PS1,3,5 values and beam currents used for the first part of the 6.79 deg run, and return to those settings. In consultation with the RC, verify that all running conditions are comparable to those of part 1.
- (c) Update *standard.kinematics* with the new settings, and fill out a “new configuration” run sheet. Carry over the $p(e, e'K^+)\Lambda$ event tally from the part 1 run sheets.

Desired total $p(e, e'K^+)\Lambda$ statistics: 4,700-8,880. Use the physics replay to keep track of the event total.