KAON-LT Run Plan - Part 3

December 8, 2018

4.933 GeV Beam Plan

Initial beam activities

- While waiting for beam, configure the spectrometers for the carbon sieve run:

    1. SHMS angle = 9.50 deg (from TV).

    2. SHMS momentum = –3.500 GeV/c (negative polarity and all magnets cycled).

    3. HMS angle = 13.00 deg (from TV).

    4. HMS momentum = –3.000 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 (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 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. 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 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).
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     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:	4933.0	13.0	-3000.0
SHMS:	4933.0	9.5	-3500.0

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, located at:
`https://redmine.jlab.org/projects/kltexp/wiki/Golden_SIEVE_runs`.
They should look extremely similar. Ask Holly Szumila-Vance or Mark Jones to inspect the plots, and if required, for instructions on what to do next.

2. $\boxed{p(e, e')p}$ 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:
Stable 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. For the last setting, divide the data taking into two runs, analyzing the first run while acquiring the second.

Thick Dummy target runs:
One run for each angle and momentum setting, taken immediately after the corresponding LH2 run. Remember the current limit is 40 μA.

4.933 GeV Heep-check singles runs									
θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{HMS}$	$\frac{PS3}{HMS}$	$Rate_{SHMS}$	$\frac{PS2}{SHMS}$	$\frac{Time}{LH2run}$	$\frac{Time}{ALrun}$
12.71	-4.371	8.86	-4.642	51 kHz	7	580 kHz	10	15 min@10 μA	10 min
15.00	-4.184	11.86	-4.436	51 kHz	7	303 kHz	9	15 min@35 μA	10 min
18.00	-3.923	15.00	-4.184	12 kHz	4	64 kHz	7	15 min@35 μA	10 min
34.20	-2.583	34.20	-2.583	0.14 kHz	0	0.69 kHz	0	40 min@70 μA	10 min
Total Time (including overhead): 3.1 hrs									

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

   Set up the following configuration:

   (a) Cycle HMS magnets and set to –3.124 GeV/c (negative polarity).

   (b) HMS angle = 27.15 deg (from TV).

   (c) Switch the SHMS to positive polarity (follow the cycling procedure) and set to +2.583 GeV/c.

   (d) SHMS angle = 33.50 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 55,000 $e + p$ elastic scattering coincidences. The first run should be $\sim$ 15 minutes, and should be immediately analyzed, checking E_m and p_m, while taking the second run.

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4.933 GeV Heep-check coincidence run

θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{SHMS}$	$Rate_{DAQ}$	Time
27.15	-3.124	33.50	2.583	2.0 kHz	2840 Hz	0.5 hr

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

Insert the "thick" dummy target ($\pm$5 cm) and **run for 15 minutes** at 40 μA (assuming 100% efficiency).

Q²=0.5, W=2.40, x=0.09, high 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
4.933	2.066	12.71	0.6979	0.081	2.583	-8.86

1. $\boxed{p(e, e'K^+)\Lambda}$ LH2 SHMS center ($\theta = 8.86^o$) run.

   Set up the following configuration:

   (a) Move the SHMS to 8.86 deg (from TV).

   (b) SHMS momentum = 2.583 GeV/c. Positive polarity (should already be there).

   (c) HMS momentum = –2.066 GeV/c. Negative polarity.

   (d) HMS angle = 12.71 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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 3200 Hz DAQ rate overall, for 13 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. $e^- \cdot K$
28 kHz	118 kHz	395 kHz	58 kHz	102 kHz	2935 Hz	0.25-0.73 Hz

Expected rates for 13 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 25.1 hours (at 100% efficiency) to give 22,800-65,900 p(e, e′K⁺)Λ coincidences. Use the physics replay to keep track of the event total.

If the singles and random coincidence rates are lower than expected (likely, given our experience from the 3.8 GeV run), the RC should instruct how to divide the run time between several different currents (e.g. 13, 20, 26 μA) to better understand the rate-dependent corrections to the data.

2. $\boxed{Al(e, e'K^+)X}$ Thick Dummy target SHMS center ($\theta = 8.86^o$) 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 1.8 hours (100% efficiency) at up to 40 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 ($\theta = 11.86^o$) run.

Set up the following configuration:

(a) SHMS angle = 11.86 deg (from TV).

(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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 3000 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. $e^- \cdot K$
10 kHz	218 kHz	318 kHz	56 kHz	122 kHz	2750 Hz	0.51-1.27 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 11.3 hours (at 100% efficiency) to give 21,000-68,250 p(e, e'K$^+$)Λ coincidences. Use the physics replay to keep track of the event total.

If the singles and random coincidence rates are lower than expected, the RC should instruct how to divide the run time between several different currents (e.g. 24, 37, 50 μA) to better understand the rate-dependent corrections to the data.

4. $\boxed{\text{Al}(e, e'K^+)X}$ Thick Dummy target SHMS left ($\theta = 11.86^o$) 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 0.8 hours (100% efficiency) at up to 40 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 right ($\theta = 6.00^o$) run.

(a) SHMS angle = 6.00 deg (from TV). **This requires a hall access. The Run Co-ordinator will need to arrange in advance which expert personnel (e.g. Fowler, Lassiter) need to be present.** Our goal is for this to happen at the beginning of Monday Dec 17 day shift.

(b) Leave the magnet settings unchanged.

(c) **SHMS fringe field beam steering study.**
The RC needs to arrange this in advance with Jay Benesch, to occur immediately after the hall is restored to Beam Permit. Follow instructions from MCC. **SHMS remote angle changes are not possible this close to the beamline.** SHMS momentum should not be changed without permission of the RC.

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

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

(f) 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)=13, PS3(HMS-ELREAL)=9, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2400 Hz DAQ rate overall, for 8.5 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K+\text{p})$	Real coinc. $e^- \cdot K$
18 kHz	73 kHz	505 kHz	60 kHz	86 kHz	2120 Hz	0.15-0.43 Hz

Expected rates for 8.5 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 38.9 hours (at 100% efficiency) to give 20,900-60,800 p$(e, e'K^+)\Lambda$ coincidences. Use the physics replay to keep track of the event total.

If the singles and random coincidence rates are lower than expected, the RC should instruct how to divide the run time between several different currents (e.g. 10, 15, 20 μA) to better understand the rate-dependent corrections to the data.

6. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 6.00^o$) 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 2.7 hours (100% efficiency) at up to 40 μA. Adjust the beam current accordingly, keeping SHMS singles rates <650 kHz and live time >85%.

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