PION-LT Low Q^2 Run Plan

July 15, 2019

2.758 GeV Beam Plan

Initial beam activities

- This run plan assumes the small angle downstream beam pipe is installed, and the $n = 1.015$ aerogel is installed in the SHMS detector.
- While waiting for beam, configure the spectrometers for the carbon sieve run:
  1. SHMS angle = 9.50 deg (from TV).
  2. SHMS momentum = –1.500 GeV/c (negative polarity and all magnets cycled).
  3. HMS angle = 11.50 deg (from TV). This requires a hall access.
  4. HMS momentum = –1.500 GeV/c (negative polarity and all magnets cycled).
  5. Update *standard.kinematics* with the new settings.
- 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).

- 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.

- Injector Faraday Cup calibration.
  This is recommended by Dave Mack, to ensure a good calibration for low current runs.

- High and low current BCM calibrations.
  The Run Co-ordinator will coordinate the timing of this with the Program Deputy, as it reqires the other Hall lasers to be turned off. This requires MCC's ability to reliably deliver 65-70 μA beam, so this calibration might have to wait at least a few days. Acquire data at 0, 2.5, 5, 10, 14, 20, 28, 40, 60, 80 μA, following the instructions in the "BCM Calibration" How-to at `https://hallcweb.jlab.org/doc-public/ShowDocument?docid=957`. Dave Mack will analyze the data later.

- BPM calibration with multiple harp scans.
  The purpose of this study is to check the BPM response.

- 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.

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:	2758.0	11.50	–1500.0
SHMS:	2758.0	9.50	–1500.0

   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. Ask Mark Jones to verify the data, and if there is a problem, give instructions on what to do next.

2. Luminosity scan on $z = 0$ 1.5% r.l. C targets.

   This step can be skipped if things are behind schedule.

   The purpose of the study is to study efficiency and live-time corrections versus rate and current, particularly for the low current running needed in this run.
   The kinematics have been chosen to give sufficient rate at low current. If the rates prove too large at high current, take what data you can with the lower rate spectrometer and continue with the rest of the scan.

   Initially set the spectrometers to:
   HMS=–1.500 GeV/c, 11.50 deg. SHMS=–1.500 GeV/c, 9.50 deg.

   ELREAL trigger in both arms. Set the PS2, PS3 target DAQ rates to 1.5 kHz, to give a total rate to disk of about 3 kHz.

   The EDTM event trigger rate needs to be increased to about 250 Hz, to ensure that after prescaling there are 10k-100k EDTM events per run. **The number of accepted EDTM events needs to be monitored carefully during the luminosity scan!**

   Make sure the raster is on (2×2), and take HMS and SHMS runs at 40, 20, 15, 10, 7.5, 5, 3 μA. Start at the highest current and work down, one target at a time. **Try to get runs with a minimum of beam trips (if possible).**

   Stephen Kay should do a sanity-check of the EDTM (and any other hardware deadtime measurement system) by comparing runs over a range of detector rates but with low software deadtimes.

3. Luminosity scan on LH_2 cryotarget.

   This scan is crucial, and cannot be skipped!

   The purpose of the study is to study efficiency and live-time corrections versus rate and current, particularly for the low current running needed in this run.
   The kinematics have been chosen to give sufficient rate at low current. If the rates prove too large at high current, take what data you can with the lower rate spectrometer and continue with the rest of the scan.

   See notes on previous page about increasing the EDTM event trigger rate, and other configuration details. When the scan is complete, return the EDTM rate back to normal.

2.758 GeV LH_2 Luminosity Scan						
μA	Targets	$\frac{Rate_{SHMS}}{LHrun}$	$\frac{Rate_{HMS}}{LHrun}$	DAQ_{SHMS}	DAQ_{HMS}	$\frac{Time}{run}$
θ_{HMS} = 11.50, P_{HMS}=-1.500 GeV/c, θ_{SHMS} = 9.50, P_{SHMS}=-1.500 GeV/c						
40	LH2	1450 kHz	680 kHz	1.5 kHz	1.5 kHz	15 min
20	LH2	730 kHz	340 kHz	1.5 kHz	1.5 kHz	15 min
15	LH2, Dummy	550 kHz	250 kHz	1.5 kHz	1.5 kHz	15 min
10	LH2	360 kHz	170 kHz	1.5 kHz	1.5 kHz	15 min
7.5	LH2	270 kHz	130 kHz	1.5 kHz	1.5 kHz	15 min
5	LH2	180 kHz	90 kHz	1.5 kHz	1.5 kHz	15 min
3	LH2	110 kHz	50 kHz	1.5 kHz	1.5 kHz	15 min
Total Time (including overhead): 3.9 hrs						

4. $\boxed{p(e,e')p}$ 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.

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

   (c) HMS large and SHMS collimators.

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

   LH2 target runs:
   Take two runs for each of the following HMS, SHMS angle and momentum settings. 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. In most cases, a 15 minute run should give 800k to 1000k electron events in each spectrometer (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 the current limint of 40 μA.

2.758 GeV Heep-check singles runs										
I_{beam}	θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{HMS}$	$\frac{PS3}{HMS}$	$Rate_{SHMS}$	$\frac{PS2}{SHMS}$	$\frac{Time}{LH2run}$	$\frac{Time}{ALrun}$
7	11.50	-2.604	11.00	-2.617	750 kHz	10	590 kHz	10	18 min	12 min
Hall access to rotate HMS to larger angle										
15	12.68	-2.573	12.68	-2.573	680 kHz	10	570 kHz	10	18 min	12 min
35	15.22	-2.501	15.22	-2.501	515 kHz	10	470 kHz	10	18 min	12 min
70	21.20	-2.300	21.20	-2.300	105 kHz	8	110 kHz	8	18 min	12 min
70	30.40	-1.964	30.40	-1.964	9 kHz	4	10 kHz	4	18 min	12 min
70	33.64	-1.848	33.64	-1.848	4 kHz	3	5 kHz	3	24 min	12 min
Total Time (including overhead): 5.9 hrs										

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

Set up the following configuration:

(a) Switch the SHMS to positive polarity (follow the cycling procedure) and set to +1.729 GeV/c.

(b) Set the HMS to –1.729 GeV/c (negative polarity).

(c) HMS angle = 37.10 deg (from TV).

(d) SHMS angle = 37.10 deg (from TV).

(e) Suggested prescale factors: PS1(SHMS-3/4)=5, PS3(HMS-ELREAL)=5, 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.

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

Take two runs of roughly equal length, each $\sim$ 15 minutes. The first should be immediately analyzed, checking E_m and p_m, while taking the second run. You will get of the order of 1000k coincidences over both runs.

2.758 GeV Heep-check coincidence run

θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{SHMS}$	$Rate_{DAQ}$	Time
37.10	-1.729	37.10	1.729	1.5 kHz	2.1 kHz	0.5 hr

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

Insert the "thick" dummy target ($\pm$5 cm) and **run for 12 minutes** at 40 μA (assuming 100% efficiency).

7. HMS trigger check at 448 MeV/c.

Many of the physics settings have very high π^-/e^- ratios in the HMS, and the data taking will be limited by the very high random coincidence rates that result. The HMS ELREAL trigger will be needed, in order to run with acceptable livetimes. The trigger threshold for low momentum electrons needs to be double checked.

Set up the following configuration:

(a) HMS momentum = –0.448 GeV/c. Negative polarity.

(b) 10 cm LH2 or z=0 1.5% r.l. Carbon target. **This check can be moved earlier in the run plan if the opportunity arises.**

(c) An expert should double check the HMS ELREAL PID leg threshold setup.

- HMS $\check{\text{C}}$ threshold in ELREAL. $\rightarrow$ Don't want to lose electrons.
- HMS Calorimeter threshold in ELREAL. $\rightarrow$ Should be a loose cut (5:1 π^- rejection is desired).

(d) It is likely that the HMS angle will need to be moved to vary the $\pi^- : e^-$ ratio.

Projected rates for 70 μA beam on 10 cm LH2

E_e	P'_e	θ'_e	e^- rate	π^- rate	$\pi^- : e^-$
2758.0	0.448	15.00	42 kHz	646 kHz	15 : 1
2758.0	0.448	20.00	22 kHz	525 kHz	24 : 1
2758.0	0.448	25.00	12 kHz	414 kHz	35 : 1
2758.0	0.448	30.00	7.6 kHz	320 kHz	42 : 1
2758.0	0.448	35.00	4.8 kHz	244 kHz	51 : 1

8. HMS optics check at 448 MeV/c.

Set up the following configuration:

(a) HMS sieve slit.

(b) $z = 0$ 1.5% r.l. carbon target.

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

(d) Verify that MCC has position at target lock on, and energy lock on.

(e) 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:	2758.0	13.00	–1500.0
SHMS:	2758.0	9.50	–1500.0

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. Ask Mark Jones to verify the data, and if there is a problem, give instructions on what to do next.

Q^2=0.375, W=2.20, low ϵ data taking (E12-06-101)

Nominal Q^2=0.375 GeV$^2/c^2$, W=2.20 GeV, x=0.087 Kinematics

E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
2.758	0.448	31.97	0.286	0.008	2.300	-5.70

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-2 ($\theta = 9.70^o$) run.

   Set up the following configuration:

   (a) HMS momentum = –0.448 GeV/c. Negative polarity.

   (b) HMS angle = 31.97 deg (from TV).

   (c) SHMS momentum = 2.300 GeV/c. Positive polarity. Magnets cycled according to the cycling procedure.

   (d) SHMS angle = 9.70 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 2400 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
6 kHz	288 kHz	222 kHz	26 kHz	96 kHz	2200 Hz	2.2 Hz

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

   Take data for approximately 3.1 hours (at 100% efficiency) to give ∼23k p$(e,e'\pi^+)$n coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-2 ($\theta = 9.70^o$) 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 0.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-1 ($\theta = 7.70^o$) run.

   (a) Move the SHMS to 7.70 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 58 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. $e^- \cdot \pi$
5 kHz	240 kHz	300 kHz	31 kHz	100 kHz	2300 Hz	1.8 Hz

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

Take data for approximately 3.6 hours (at 100% efficiency) to give ∼23k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-1 ($\theta = 7.70^o$) 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 0.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 5.70^o$) run.

   (a) Move the SHMS to 5.70 deg (from TV). **This requires a hall access. The Run Co-ordinator will need to arrange in advance which expert personnel (e.g. Lassiter, Wood, Gaskell) need to be present.**

   (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 2500 Hz DAQ rate overall, **for 48 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. $e^- \cdot \pi$
4 kHz	200 kHz	380 kHz	34 kHz	100 kHz	2300 Hz	1.5 Hz

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

Take data for approximately 4.1 hours (at 100% efficiency) to give ∼23k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

6. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 5.70^o$) 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 0.3 hours (100% efficiency) at 40 μA.

Q^2=0.425, W=2.20, low ϵ data taking (E12-06-101)

Nominal Q^2=0.425 GeV$^2/c^2$, W=2.20 GeV, x=0.097 Kinematics

E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
2.758	0.421	35.19	0.264	0.010	2.326	-5.75

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 5.70^o$) run.

   Set up the following configuration:

   (a) HMS momentum = –0.421 GeV/c. Negative polarity.

   (b) HMS angle = 35.19 deg (from TV).

   (c) SHMS momentum = 2.326 GeV/c. Positive polarity. (Cycle magnets according to the cycling procedure.)

   (d) Keep the SHMS angle unchanged at 5.70 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 2400 Hz DAQ rate overall, **for 54 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
3 kHz	195 kHz	400 kHz	36 kHz	105 kHz	2300 Hz	1.7 Hz

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

   Take data for approximately 3.8 hours (at 100% efficiency) to give ∼23k p$(e,e'\pi^+)$n coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 5.70^o$) 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 0.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-1 ($\theta = 7.75^o$) run.

   (a) Move the SHMS to 7.75 deg (from TV). **This requires a hall access. The Run Co-ordinator will need to arrange in advance which expert personnel (e.g. Lassiter, Wood, Gaskell) need to be present.**

   (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)=12, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2400 Hz DAQ rate overall, **for 64 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
4 kHz	230 kHz	305 kHz	32 kHz	105 kHz	2200 Hz	2.0 Hz

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

Take data for approximately 3.3 hours (at 100% efficiency) to give ∼23k $\mathbf{p(e,e'\pi^+)n}$ 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-1 ($\theta = 7.75^o$) 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 0.2 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-2 ($\theta = 9.75^o$) run.

   (a) Move the SHMS to 9.75 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2000 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
5 kHz	250 kHz	205 kHz	24 kHz	90 kHz	1750 Hz	2.2 Hz

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

Take data for approximately 2.8 hours (at 100% efficiency) to give ∼23k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-2 ($\theta = 9.75^o$) 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 0.3 hours (100% efficiency) at 40 μA.

3.660 GeV Beam Plan

Initial beam activities

- While waiting for beam, configure the spectrometers for the Heep coincidence run:
  1. SHMS angle = 32.50 deg (from TV).
  2. SHMS momentum = 2.300 GeV/c (positive polarity).
  3. HMS angle = 35.65 deg (from TV).
  4. HMS momentum = –2.114 GeV/c (negative polarity and all magnets cycled).
  5. Update *standard.kinematics* with the new settings.
- 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).

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

   Set up the following configuration:

   (a) SHMS momentum +2.300 GeV/c.

   (b) HMS momentum –2.114 GeV/c (negative polarity, magnets cycled).

   (c) HMS angle = 35.65 deg (from TV).

   (d) SHMS angle = 32.40 deg (from TV).

   (e) Suggested prescale factors: PS1(SHMS-3/4)=5, PS3(HMS-ELREAL)=3, 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.

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

   Take two runs of roughly equal length, each $\sim$ 15 minutes. The first should be immediately analyzed, checking E_m and p_m, while taking the second run. You will get of the order of 250k coincidences over both runs.

   3.660 GeV Heep-check coincidence run

θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{SHMS}$	$Rate_{DAQ}$	Time
35.65	-2.114	32.40	2.300	2.0 kHz	0.4 kHz	0.5 hr

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

   Insert the "thick" dummy target ($\pm$5 cm) and **run for 12 minutes** at 40 μA (assuming 100% efficiency).

Q^2=0.375, W=2.20, middle ϵ data taking (E12-06-101)

Nominal Q^2=0.375 GeV$^2/c^2$, W=2.20 GeV, x=0.087 Kinematics

E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
3.660	1.350	15.83	0.629	0.008	2.300	-8.87

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right-2 ($\theta = 5.55^o$) run.
   Set up the following configuration:
   (a) HMS momentum = –1.350 GeV/c. Negative polarity.
   (b) HMS angle = 15.83 deg (from TV).
   (c) SHMS momentum = 2.300 GeV/c. Positive polarity. (Should already be there.)
   (d) Move the SHMS to 5.55 deg (from TV). **This requires a hall access. The Run Co-ordinator will need to arrange in advance which expert personnel (e.g. Lassiter, Wood, Gaskell) need to be present.**
   (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)=9, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 17 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
22 kHz	86 kHz	400 kHz	39 kHz	103 kHz	2200 Hz	11 Hz

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

Take data for approximately 4.8 hours (at 100% efficiency) to give ∼220k p$(e,e'\pi^+)$n coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right-2 ($\theta = 5.55^o$) 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 0.4 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right-1 ($\theta = 6.87^o$) run.

   (a) SHMS angle = 6.87 deg (from TV). **The RC will likely want to be present for this movement. Pay close attention to the hall cameras while approaching 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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2400 Hz DAQ rate overall, **for 20 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
26 kHz	100 kHz	357 kHz	39 kHz	76 kHz	2200 Hz	13 Hz

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

Take data for approximately 4.3 hours (at 100% efficiency) to give ∼220k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right-1 ($\theta = 6.87^o$) 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 0.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 8.87^o$) run.

   (a) Move the SHMS to 8.87 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 25 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
33 kHz	126 kHz	280 kHz	35 kHz	78 kHz	2300 Hz	16 Hz

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

Take data for approximately 3.8 hours (at 100% efficiency) to give ∼220k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 8.87^o$) 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 0.3 hours (100% efficiency) at 40 μA.

7. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-1 ($\theta = 10.87^o$) run.

   (a) Move the SHMS to 10.87 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 30 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
40 kHz	150 kHz	210 kHz	29 kHz	74 kHz	2200 Hz	19 Hz

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

Take data for approximately 3.3 hours (at 100% efficiency) to give ∼220k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

8. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-1 ($\theta = 10.87^o$) 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 0.3 hours (100% efficiency) at 40 μA.

9. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-2 ($\theta = 12.87^o$) run.

   (a) Move the SHMS to 12.87 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=11, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 38 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
50 kHz	190 kHz	160 kHz	24 kHz	71 kHz	2300 Hz	24 Hz

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

Take data for approximately 2.8 hours (at 100% efficiency) to give ∼220k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

10. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-2 ($\theta = 12.87^o$) 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 0.3 hours (100% efficiency) at 40 μA.

Q^2=1.45, W=2.02, x=0.31, low ϵ data taking (E12-07-105)

Nominal Q^2=1.45 GeV$^2/c^2$, W=2.02 GeV, x=0.31 Kinematics

E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
3.660	1.182	33.64	0.511	0.114	2.412	-13.76

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 11.76^o$) run.

   Set up the following configuration:

   (a) SHMS angle = 11.76 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, and be prepared to hit the rotation kill switch, if necessary.**

   (b) SHMS momentum = 2.412 GeV/c (positive polarity). Magnets cycled.

   (c) HMS momentum = –1.182 GeV/c (negative polarity)

   (d) HMS angle = 33.64 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)=8, giving 100 Hz HMS and SHMS singles event rates to disk, and a 750 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. $e^- \cdot \pi$
5 kHz	30 kHz	310 kHz	48 kHz	129 kHz	540 Hz	3.0 Hz

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

   Take data for approximately 3.4 hours (at 100% efficiency) to give ∼36k p$(e,e'\pi^+)$n coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 11.76^o$) 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 0.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 13.76^o$) run.

   (a) Move the SHMS to 13.76 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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) 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)=12, PS3(HMS-ELREAL)=8, giving 100 Hz HMS and SHMS singles event rates to disk, and a 580 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
5 kHz	30 kHz	180 kHz	30 kHz	95 kHz	340 Hz	3.1 Hz

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

   Take data for approximately 3.4 hours (at 100% efficiency) to give ∼36k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 13.76^o$) 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 0.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 15.76^o$) run.

   (a) Move the SHMS to 15.76 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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) 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)=12, PS3(HMS-ELREAL)=8, giving 100 Hz HMS and SHMS singles event rates to disk, and a 390 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
5 kHz	30 kHz	100 kHz	18 kHz	66 kHz	205 Hz	2.7 Hz

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

Take data for approximately 3.4 hours (at 100% efficiency) to give ∼36k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 15.76^o$) 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 0.3 hours (100% efficiency) at 40 μA.

Q^2=0.425, W=2.20, middle ϵ data taking (E12-06-101)

Nominal Q^2=0.425 GeV$^2/c^2$, W=2.20 GeV, x=0.097 Kinematics

E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
3.660	1.323	17.03	0.617	0.010	2.326	-9.20

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 7.20^o$) run.

   Set up the following configuration:

   (a) HMS momentum = –1.323 GeV/c. Negative polarity.

   (b) HMS angle = 17.03 deg (from TV).

   (c) SHMS momentum = 2.326 GeV/c. Positive polarity. (Cycle magnets according to the cycling procedure.)

   (d) SHMS angle = 7.20 deg (from TV). **This requires a hall access. The Run Coordinator will need to arrange in advance which expert personnel (e.g. Lassiter, Wood, Gaskell) need to be present.**

   (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 2400 Hz DAQ rate overall, **for 23 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
23 kHz	101 kHz	370 kHz	42 kHz	83 kHz	2200 Hz	15 Hz

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

Take data for approximately 4.1 hours (at 100% efficiency) to give ∼220k p$(e,e'\pi^+)$n coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 7.20^o$) 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 0.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 9.20^o$) run.

(a) Move the SHMS to 9.20 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 29 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. $e^- \cdot \pi$
30 kHz	130 kHz	290 kHz	38 kHz	85 kHz	2300 Hz	19 Hz

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

Take data for approximately 3.4 hours (at 100% efficiency) to give ∼220k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 9.20^o$) 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 0.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-1 ($\theta = 11.20^o$) run.

   (a) Move the SHMS to 11.20 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 35 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
36 kHz	155 kHz	212 kHz	31 kHz	80 kHz	2200 Hz	23 Hz

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

Take data for approximately 2.9 hours (at 100% efficiency) to give ∼220k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-1 ($\theta = 11.20^o$) 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 0.2 hours (100% efficiency) at 40 μA.

7. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-2 ($\theta = 13.20^o$) run.

   (a) Move the SHMS to 13.20 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=11, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 45 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
46 kHz	200 kHz	162 kHz	26 kHz	77 kHz	2300 Hz	29 Hz

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

Take data for approximately 2.1 hours (at 100% efficiency) to give ∼220k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

8. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-2 ($\theta = 13.20^o$) 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 0.2 hours (100% efficiency) at 40 μA.

4.562 GeV Beam Plan

Initial beam activities

- While waiting for beam, configure the spectrometers for the Heep coincidence run:
  1. SHMS angle = 29.90 deg (from TV).
  2. SHMS momentum = 2.792 GeV/c (positive polarity and all magnets cycled).
  3. HMS angle = 33.05 deg (from TV).
  4. HMS momentum = –2.553 GeV/c (negative polarity and all magnets cycled).
  5. Update *standard.kinematics* with the new settings.
- 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).

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

   Set up the following configuration:

   (a) SHMS momentum +2.792 GeV/c. Magnets cycled.

   (b) HMS momentum –2.553 GeV/c (negative polarity, magnets cycled).

   (c) HMS angle = 33.05 deg (from TV).

   (d) SHMS angle = 29.90 deg (from TV).

   (e) Suggested prescale factors: PS1(SHMS-3/4)=4, PS3(HMS-ELREAL)=2, 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.

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

   Take two runs of roughly equal length, each $\sim$ 30 minutes. The first should be immediately analyzed, checking E_m and p_m, while taking the second run. You will get of the order of 170k coincidences over both runs.

   4.562 GeV Heep-check coincidence run

θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{SHMS}$	$Rate_{DAQ}$	Time
33.05	-2.553	29.90	2.792	1.0 kHz	0.3 kHz	1.0 hr

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

   Insert the "thick" dummy target ($\pm$5 cm) and **run for 12 minutes** at 40 μA (assuming 100% efficiency).

Q^2=0.375, W=2.20, high ϵ data taking (E12-06-101)

Nominal Q^2=0.375 GeV$^2/c^2$, W=2.20 GeV, x=0.087 Kinematics

E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
4.562	2.252	10.96	0.781	0.008	2.300	-10.33

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 7.64^o$) run.

   Set up the following configuration:

   (a) HMS momentum = –2.252 GeV/c. Negative polarity. Magnets cycled.

   (b) HMS angle = 10.96 deg (from TV). **This requires a hall access. The Run Coordinator will need to arrange in advance which expert personnel (e.g. Lassiter, Wood, Gaskell) need to be present.**

   (c) SHMS momentum = 2.300 GeV/c. Positive polarity.

   (d) SHMS angle = 7.64 deg (from TV). **Note, this puts the HMS and SHMS at their minimum closest angle. The SHMS will have to be rotated first, before moving the HMS.**

   (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 2300 Hz DAQ rate overall, **for 10 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
52 kHz	45 kHz	250 kHz	29 kHz	54 kHz	2100 Hz	21 Hz

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

Take data for approximately 4.6 hours (at 100% efficiency) to give ∼390k p$(e,e'\pi^+)$n coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 7.64^o$) 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 0.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 10.33^o$) run.

   (a) Move the SHMS to 10.33 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=11, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2600 Hz DAQ rate overall, **for 14 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. $e^- \cdot \pi$
73 kHz	63 kHz	190 kHz	26 kHz	57 kHz	2300 Hz	30 Hz

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

   Take data for approximately 3.3 hours (at 100% efficiency) to give ∼390k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 10.33^o$) 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 0.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-1 ($\theta = 12.33^o$) run.

   (a) Move the SHMS to 12.33 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=11, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 17 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
88 kHz	76 kHz	137 kHz	21 kHz	53 kHz	2200 Hz	37 Hz

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

Take data for approximately 3.1 hours (at 100% efficiency) to give ∼390k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-1 ($\theta = 12.33^o$) 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 0.2 hours (100% efficiency) at 40 μA.

7. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-2 ($\theta = 14.33^o$) run.

   (a) Move the SHMS to 14.33 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=11, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2400 Hz DAQ rate overall, **for 21 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
110 kHz	95 kHz	101 kHz	17 kHz	49 kHz	2200 Hz	45 Hz

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

Take data for approximately 2.3 hours (at 100% efficiency) to give ∼390k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

8. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-2 ($\theta = 14.33^o$) 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 0.2 hours (100% efficiency) at 40 μA.

Q^2=0.425, W=2.20, high ϵ data taking (E12-06-101)

Nominal Q^2=0.425 GeV$^2/c^2$, W=2.20 GeV, x=0.097 Kinematics

E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
4.562	2.226	11.74	0.774	0.010	2.326	-10.08

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right-2 ($\theta = 6.86^o$) run.

   Set up the following configuration:

   (a) HMS momentum = –2.226 GeV/c. Negative polarity.

   (b) HMS angle = 11.74 deg (from TV). **This requires a hall access. The Run Coordinator will need to arrange in advance which expert personnel (e.g. Lassiter, Wood, Gaskell) need to be present.**

   (c) SHMS momentum = 2.326 GeV/c. Positive polarity.

   (d) 10 cm LH2 target.

   (e) Move the SHMS to 6.86 deg (from TV). **Note, this puts the HMS and SHMS at their minimum closest angle.**

   (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)=9, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 11 μA 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	$(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	$e^- \cdot \pi$
45 kHz	42 kHz	320 kHz	36 kHz	62 kHz	2300 Hz	24 Hz

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

Take data for approximately 4.6 hours (at 100% efficiency) to give ∼390k p$(e,e'\pi^+)$n coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right-2 ($\theta = 6.86^o$) 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 0.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right-1 ($\theta = 8.08^o$) run.

   (a) SHMS angle = 8.08 deg (from TV). **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)=13, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2400 Hz DAQ rate overall, **for 12 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. $e^- \cdot \pi$
49 kHz	46 kHz	265 kHz	32 kHz	61 kHz	2100 Hz	26 Hz

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

   Take data for approximately 4.2 hours (at 100% efficiency) to give ∼390k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right-1 ($\theta = 8.08^o$) 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 0.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 10.08^o$) run.

   (a) Move the SHMS to 10.08 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=10, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 15 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
62 kHz	58 kHz	205 kHz	28 kHz	61 kHz	2200 Hz	32 Hz

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

Take data for approximately 3.4 hours (at 100% efficiency) to give ∼390k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 10.08^o$) 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 0.3 hours (100% efficiency) at 40 μA.

7. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-1 ($\theta = 12.08^o$) run.

   (a) Move the SHMS to 12.08 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=11, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 Hz DAQ rate overall, **for 19 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
78 kHz	73 kHz	160 kHz	24 kHz	58 kHz	2200 Hz	41 Hz

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

Take data for approximately 2.7 hours (at 100% efficiency) to give ∼390k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

8. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-1 ($\theta = 12.08^o$) 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 0.2 hours (100% efficiency) at 40 μA.

9. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left-2 ($\theta = 14.08^o$) run.

   (a) Move the SHMS to 14.08 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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)=12, PS3(HMS-ELREAL)=11, giving 100 Hz HMS and SHMS singles event rates to disk, and a 2500 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
100 kHz	92 kHz	120 kHz	20 kHz	56 kHz	2300 Hz	52 Hz

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

Take data for approximately 2.3 hours (at 100% efficiency) to give ∼390k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

10. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left-2 ($\theta = 14.08^o$) 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 0.2 hours (100% efficiency) at 40 μA.

Q^2=2.12, W=2.05, x=0.39, low ϵ data taking (E12-07-105)

Nominal Q^2=2.12 GeV$^2/c^2$, W=2.05 GeV, x=0.39 Kinematics

E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
4.562	1.662	30.65	0.559	0.195	2.792	-15.14

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 13.14^o$) run.

   Set up the following configuration:

   (a) SHMS angle = 13.14 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, and be prepared to hit the rotation kill switch, if necessary.**

   (b) SHMS momentum = 2.792 GeV/c (positive polarity). Magnets cycled.

   (c) HMS momentum = –1.662 GeV/c (negative polarity)

   (d) HMS angle = 30.65 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)=12, PS3(HMS-ELREAL)=7, giving 100 Hz HMS and SHMS singles event rates to disk, and a 450 Hz DAQ rate overall, for 70 μA beam.

HMS	HMS	SHMS	SHMS	SHMS	Random coinc.	Real coinc.
e^- rate	π^- rate	π^+ rate	K rate	p rate	$(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	$e^- \cdot \pi$
4 kHz	11 kHz	182 kHz	37 kHz	90 kHz	200 Hz	3.0 Hz

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

   Take data for approximately 3.4 hours (at 100% efficiency) to give ∼35k p$(e,e'\pi^+)$n coincidences. Use the physics replay to keep track of the event total.

2. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 13.14^o$) 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 0.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 15.14^o$) run.

   (a) Move the SHMS to 15.14 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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) 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)=11, PS3(HMS-ELREAL)=7, giving 100 Hz HMS and SHMS singles event rates to disk, and a 370 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
4 kHz	11 kHz	83 kHz	21 kHz	59 kHz	106 Hz	2.9 Hz

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

Take data for approximately 3.4 hours (at 100% efficiency) to give ∼35k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

4. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 15.14^o$) 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 0.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 17.14^o$) run.

   (a) Move the SHMS to 17.14 deg (from TV). **Beam off during the SHMS movement. Pay close attention to the hall cameras, 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) 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)=11, PS3(HMS-ELREAL)=7, giving 100 Hz HMS and SHMS singles event rates to disk, and a 260 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. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
4 kHz	11 kHz	48 kHz	11 kHz	38 kHz	65 Hz	2.7 Hz

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

Take data for approximately 3.4 hours (at 100% efficiency) to give ∼35k $\mathbf{p(e,e'\pi^+)n}$ coincidences. Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 17.14^o$) 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 0.3 hours (100% efficiency) at 40 μA.