Pion-LT Run Plan - Part 1

June 8, 2022

10.56 GeV Beam Plan

Initial beam activities

- Configure the spectrometers for the detector checkout prior to beam delivery:

  1. SHMS angle = 12.00 deg (from TV).
  2. SHMS momentum = -5.530 GeV/c (negative polarity and all magnets cycled).
  3. HMS angle = 12.50 deg (from TV).
  4. HMS momentum = -4.400 GeV/c (negative polarity and all magnets cycled).
  5. $z = 0$ 0.5% r.l. carbon target. If rates are low, we might want to switch to one of the nuclear targets (if the current limits are known).

     Current Limit = 80 μA.
  6. Prescale GUI settings:

HMS singles DAQ disabled	all PS=–1
SHMS singles DAQ disabled	all PS=–1
COIN DAQ:	
PS1(SHMS-3/4)	0
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	0
PS4(HMS-ELREAL)	–1
PS5(HMS-ELREAL×SHMS-3/4)	–1
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

- 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. **Dave G. will need to be present to determine offsets from harp scans**

- Fix beam angle at target.
  Use the gui at: `/home/cdaq/users/gaskelld/target_bpm/target_bpm.py`
  Adjust 3H07Ax,y to remove slope while keeping 3H07Cx,y fixed
  Recheck carbon hole and iterate as necessary.

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

- BPM calibration (bulls-eye scan).
  This is not part of the typical beam checkout procedure. We want this done so that we have reliable absolute beam position information from the BPMs. Follow the procedure at: `https://hallcweb.jlab.org/wiki/index.php/Bull%27s_Eye_Scan`
  Dave G. will need to be present for this calibration.

- Energy determination with arc.
  This should be completed as soon as possible. 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.

- BCM calibrations.
  The Run Co-ordinator will coordinate the timing of this with the Program Deputy. This requires MCC's ability to reliably deliver 75-80 μA beam, so this calibration might have to wait at least a few days. The BCM calibration procedure is at `https://hallcweb.jlab.org/doc-public/ShowDocument?docid=957`. Dave Mack will analyze the data later.

- Subsequent BCM calibrations.
  Dave Mack states "the BCMs are mostly reliable, but the gains might really drift at the 1% level. E.g., during this run cycle, the outside temperature is going to drop by 40-50^{o}F, which can affect the temperature of the RF cables and even the machine frequency, which is important for the older analog receivers." **He recommends a second BCM calibration 2 weeks after the first one, then every 2 weeks after that.** If Stephen checks the agreement of the full replay charge every few days, that will help to make educated decisions about the priority of doing more BCM calibrations.

Detector checkout

Mostly already done with cosmics, probably just some checks needed.

For hodoscope calibration, we want defocused settings to better fill the focal plane, **so save two runs with increased Q2 by +20% current on both spectrometers compared to their nominal values. Use LD2 target for these runs. Leave spectrometer settings unchanged.**

Someone (Junaid) should look through the root tree of a short defocused run and ensure all variables are filling correctly. This should be done as soon as possible.

Carbon sieve check

While the spectrometers are still at negative polarity, we should quickly confirm that the optics are correct.

1. Restore the Q2 current on both spectrometers to their nominal values.

2. Insert the Carbon 0.5% r.l. target and sieve slit collimators on both SHMS and HMS. **Raster off. Current limit=40 μA.** ELREAL singles. Take 100,000 HMS and 100,000 SHMS good electron events with $-8\% < \delta < +8\%$ in HMS and $-10\% < \delta < +24\%$ in SHMS. Adjust PS2(SHMS-ELREAL) and PS4(HMS-ELREAL) as necessary to keep the deadtime at reasonable levels (below 20%).

	E_e	θ'_e	P'_e
HMS:	10560.0	12.50	-4400.0
SHMS:	10560.0	12.00	-5530.0

3. Look at HMS and SHMS $x - fp$ vs $y - fp$ scatterplots. The "hourglass" should be nicely aligned vertically, indicating alignment of the beam with the HMS and SHMS optical axes. Mark Jones or Holly Szumila-Vance should be consulted if anything looks amiss.

4. During this run, Brad should complete the trigger checkout for the single-arm triggers (1-4). This should be completed before the Carbon Optics begins.

Carbon-Sieve Optics

10.56 GeV carbon-sieve optics run

θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}
15.00	-6.803	13.00	-8.035

1. Single Carbon Foil Optics

   Set up the following configuration:

   (a) Set the SHMS magnets to –8.035 GeV/c. Magnets cycled.

   (b) SHMS angle = 13.00 deg (from TV).

   (c) Set HMS magnets to –6.803 GeV/c. Magnets cycled.

   (d) **Switch HMS Optical Matrix to 6.6 GeV/c optimized matrix.** Contact Jacob Murphy with any questions.

   (e) HMS angle = 15.00 deg (from TV).

   (f) Insert the Carbon 0.5% target.

   (g) Prescale GUI settings:

PS1(SHMS-3/4)	–1
PS2(SHMS-ELREAL)	0
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	0
PS5(HMS-ELREAL×SHMS-3/4)	–1
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

   (h) HMS sieve and SHMS sieve collimators.

   (i) Stable 80 μA beam with 2×2 raster on.
   Current Limit = 80 μA.

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

   (k) **Jacob Murphy should be present for this run.** Take a first run for 10 minutes (at 100% data taking efficiency) which should be immediately analyzed using Holly's carbon optics script, then continue data collection. The statistics goal is 200 electron events per sieve hole. The first run should be used to estimate how long to run.

Estimated Running Time: 1.0 hours at 100% efficiency.

2. Carbon Foil ±8 Optics

Set up the following configuration:

(a) Insert Optical ±8 Carbon target. Keep spectrometer settings unchanged.

(b) Prescale GUI settings:

PS1(SHMS-3/4)	–1
PS2(SHMS-ELREAL)	0
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	0
PS5(HMS-ELREAL×SHMS-3/4)	–1
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

(c) HMS sieve and SHMS sieve collimators.

(d) Stable 50 μA beam with 2×2 raster on.

Current Limit = 50 μA.

(e) Do not update *standard.kinematics* as the setting is unchanged.

(f) **Jacob Murphy should be present for this run.** Take a first run for 10 minutes (at 100% data taking efficiency) which should be immediately analyzed using Holly's carbon optics script, then continue data collection. The statistics goal is 200 electron events per sieve hole. The first run should be used to estimate how long to run.

Estimated Running Time: 1.0 hours at 100% efficiency.

Configure the spectrometers for the trigger checkout with Heep coincidences

1. **Switch the SHMS to positive polarity** (follow the cycling procedure) and set to +5.530 GeV/c.
2. HMS momentum = -5.890 GeV/c. Follow the cycling procedure.
3. **Switch HMS Optical Matrix to standard optimized matrix.** Contact Jacob Murphy with any questions.
4. SHMS angle = 23.12 deg (from TV).
5. HMS angle = 21.64 deg (from TV).
6. 10 cm LH2 target.
7. Prescale GUI settings:

HMS singles DAQ disabled	all PS=–1
SHMS singles DAQ disabled	all PS=–1
COIN DAQ:	
PS1(SHMS-3/4)	–1
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	–1
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

Coincidence trigger checkout - Sawatzky, Jones, Murphy

We want to set up the following configurations in the coincidence DAQ:
HMS (e^- trigger): A(ELREAL $e^- + \frac{\pi^- + K^-}{5-10}$))
SHMS (e^- trigger): A(ELREAL $e^- + \frac{\pi^- + K^-}{5-10}$)
SHMS ($\pi^\pm$ trigger): B (SCIN-3/4)
HMS A × SHMS B

- Check the single arm trigger legs.
- Check the coincidence trigger with existing HMS-ELREAL.
- Check SHMS, HMS detector fADC timing windows and thresholds.
- Check fADC pedestals. Check fADC reference times and ADC gates (widths should be 40 ns).

- PID leg checkout. Fine tune thresholds. Someone (Burcu Duran?) might want to change momentum and/or angle to get a good e/π ratio.
- Take a short run with SCIN-3/4 trigger. Then based on that decide on specific cuts or scale factors appropriate for $p(e,e'\pi^+)n$ while not excluding $p(e,e'K^+)\Lambda$ and $p(e,e'p)\omega$ events.
- Double-check HMS Č threshold in ELREAL. → Don't want to lose electrons.
- Double-check HMS Calorimeter threshold in ELREAL. → Should be a loose cut (5:1 π^- rejection is desired).
- Double-check SHMS HGC threshold in ELREAL. → Don't want to lose electrons.
- Double-check SHMS Calorimeter threshold in ELREAL. → Should be a loose cut.
- Double-check SHMS timing for pions, kaons, and protons. Burcu Duran??
- Double-check SHMS+HMS coincidence timing. HMS start, SHMS stop. To limit noise/backround, narrow the gate as needed. Need to recheck and adjust timing.
  Extremely important: Look at the coincidence time plot in online analysis, and count the number of random pulses on each side of the prompt peak. The prompt peak should be centered in the distribution, with about 6 random pulses on each side. Preferably, these random pulses are of nearly equal height.
  In Kaon-LT we had a 60 ns SHMS gate, and a narrower 30 ns HMS gate with its leading edge centered in the SHMS gate `https://logbooks.jlab.org/entry/3602842`. With the lined up SHMS-3/4 overlap timing, an even narrower gate might be possible.
- The EDTM (Electronic Dead Time Monitor) needs to be set to a rate to give on the order of 10^4 accepted EDTM triggers (i.e. triggers on disk after deadtime losses) over the course of a 1 hour run. This rate is now supposed to be set automatically, but Jacob should replay a run to confirm this is the case, and post the result on hclog.

Heep-check coincidence runs

1. $p(e,e'p)$ setting for both spectrometer momenta

10.56 GeV Heep-check coincidence run

θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{HMS}$	$Rate_{DAQ}$	Time
21.64	-5.889	23.12	5.530	2.27 Hz	193 Hz	1.3 hr

Set up the following configuration:

(a) Set the SHMS magnets to +5.53 GeV/c (follow the magnet cycling procedure).

(b) SHMS angle = 23.12 deg (from TV).

(c) Set HMS magnets to –5.889 GeV/c.

(d) HMS angle = 21.64 deg (from TV).

(e) Prescale GUI settings:

PS1(SHMS-3/4)	0
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	0
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

(f) HMS large and SHMS collimators.

(g) Stable 80 μA beam with 2×2 raster on.

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

Take two runs with a combined total of 10,000 $e + p$ elastic scattering coincidences. The first run should be 15 minutes (at 100% data taking efficiency), and should be immediately analyzed, checking E_m and p_m, while taking the second run.

Estimated Running Time: 1.3 hours at 100% efficiency.

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

Insert the "thick" dummy target (±5 cm) and **run for 10 minutes** at 40 μA (assuming 100% efficiency).
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 target).

Q^2=3.85, W=2.02, x=0.55, high ϵ data taking

Nominal Q^2=3.85 GeV$^2/c^2$, W=2.02 GeV, x=0.55 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
10.56	6.803	13.29	0.888	0.049	3.493	-21.66

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 19.66^o$) run.

   Set up the following configuration:

   (a) HMS angle = 13.29 (from TV).

   (b) HMS momentum = –6.803 GeV/c. Negative polarity. Magnets will need to be cycled.

   (c) **Switch HMS Optical Matrix to 6.6 GeV/c optimized matrix.** Contact Jacob Murphy with any questions.

   (d) SHMS angle = 19.66 deg (from TV).

   (e) SHMS momentum = 3.493 GeV/c. Positive polarity.

   (f) 10 cm LH2 target.

   (g) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 430 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
35 kHz	0.6 kHz	41 kHz	12 kHz	38 kHz	195 Hz	5.6 Hz

   (h) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (i) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

(j) **Take data for 1 hour (at 100% efficiency) at 80 μA to get about 81,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 19.66^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 21.66^o$) run.

   (a) Move the SHMS to 21.66 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 319 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
35 kHz	0.6 kHz	17 kHz	5 kHz	20 kHz	91 Hz	5.6 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 1 hour (at 100% efficiency) at 80 μA to get about 81,000** $d(e,e'\pi^+)nn_{sp}$ **coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

4. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 21.66^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 23.66^o$) run.

   (a) Move the SHMS 23.66 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 338 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
35 kHz	0.6 kHz	7 kHz	2 kHz	10 kHz	91 Hz	5.6 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for approximately 1 hour (at 100% efficiency) at 80 μA to get about 81,000 p$(e,e'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 23.66^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

Q^2=2.73, W=2.63, x=0.31, high ϵ data taking

Nominal Q^2=2.73 GeV$^2/c^2$, W=2.63 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
10.56	5.889	12.03	0.834	0.118	4.605	-14.34

1. $p(e,e'\pi^+)n$ LH2 SHMS left ($\theta = 16.34^o$) run.
   Set up the following configuration:

   (a) HMS angle = 12.03 (from TV). **Follow the specific small angle rotation instructions on the Wiki. Beam off during the HMS movement. The Run Coordinator will need to arrange in advance which expert personnel (e.g. Amy Comer, Steve Lassiter) need to monitor remotely.**

   (b) HMS momentum = –5.889 GeV/c. Negative polarity.

   (c) **Switch HMS Optical Matrix to standard matrix.** Contact Jacob Murphy with any questions.

   (d) SHMS angle = 16.34 deg (from TV).

   (e) SHMS momentum = 4.605 GeV/c. Positive polarity.

   (f) 10 cm LH2 target.

   (g) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 478 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
79 kHz	10..7 kHz	21 kHz	8 kHz	16 kHz	220 Hz	9.9 Hz

   (h) Update *standard.kinematics* with the new settings.Use proton as the target mass.

   (i) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

(j) **Take data for approximately 1 hour (at 100% efficiency) at 80 μA to get about 145,000 p(e, e$'\pi^+$)n coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 16.34^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.

   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 14.34^o$) run.

   (a) Move the SHMS to 14.34 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 881 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
79 kHz	10.7 kHz	63 kHz	21 kHz	37 kHz	592 Hz	9.9 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 1 hour (100% efficiency) at 80 μA to get about 145,000** $d(e,e'\pi^+)nn_{sp}$ **coincidences**. Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

4. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 14.34^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 12.34^o$) run.

   (a) Move the SHMS 12.34 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 1874 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	12
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
79 kHz	10.7 kHz	179 kHz	56 kHz	82 kHz	1549 Hz	9.9 Hz

   (c) Update *standard.kinematics* with the new settings.Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for approximately 1 hour (at 100% efficiency) at 80 μA to get about 145,000 p$(e,e'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

6. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 12.34^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

Q^2=3.85, W=2.62, x=0.39, high ϵ data taking

Nominal Q^2=3.85 GeV$^2/c^2$, W=2.62 GeV, x=0.39 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
10.56	5.320	15.04	0.779	0.208	5.127	-14.28

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 12.28^o$) run.
   Set up the following configuration:
   (a) HMS angle = 15.04 (from TV).
   (b) HMS momentum = –5.320 GeV/c. Negative polarity.
   (c) SHMS angle = 12.28 deg (from TV).
   (d) SHMS momentum = 5.127 GeV/c. Positive polarity.
   (e) 10 cm LH2 target.
   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 465 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
22 kHz	3.7 kHz	88 kHz	31 kHz	43 kHz	218 Hz	2.11 Hz

   (g) Update *standard.kinematics* with the new settings.Use proton as the target mass.
   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**
   (i) **Take data for approximately 1.5 hour (at 100% efficiency) at 80 μA to get about 61,000 p$(e,e'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 12.28^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

   Take data for 0.3 hours (100% efficiency) at 40 μA.

   During this period, the Target Operator should park the LH2 target and prepare for LD2 data taking.

3. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS right ($\theta = 12.28^o$) run.

   (a) Now put in the 10 cm LD2 and leave the spectrometer settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 1118 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	12
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
43 kHz	7.3 kHz	176 kHz	61 kHz	85 kHz	871 Hz	2.11 Hz

   (c) Update *standard.kinematics* with the new settings.Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for approximately 1.5 hour (at 100% efficiency) at 80 μA to get about 61,000 p$(\mathbf{e},\mathbf{e}'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

4. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS center ($\theta = 14.28^o$) run.

   (a) Move the SHMS to 14.28 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 490 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
43 kHz	7.3 kHz	55 kHz	20 kHz	34 kHz	294 Hz	2.11 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 1.5 hours (100% efficiency) at 80 μA to get about 61,000** $d(e,e'\pi^+)nn_{sp}$ **coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

5. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 14.28^o$) run.

Now put in the "thick" dummy target (± 5 cm) and initially set prescale factors to the same as the LD2 run.
If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
Current limit: 40 μA.
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

Take data for 0.3 hours (100% efficiency) at 40 μA.

During this period, the Target Operator should park the LD2 target and prepare for LH2 data taking.

6. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 14.28^o$) run.

   (a) Now put in the 10 cm LH2 and leave the spectrometer settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 270 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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	3.7 kHz	27 kHz	10 kHz	17 kHz	73 Hz	2.11 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 1.5 hours (100% efficiency) at 80 μA to get about 61,000** $d(e,e'\pi^+)nn_{sp}$ **coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

7. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 16.28^o$) run.

   (a) Move the SHMS 16.28 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 252 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	8
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
22 kHz	3.7 kHz	8 kHz	3 kHz	6 kHz	24 Hz	2.11 Hz

   (c) Update *standard.kinematics* with the new settings.Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for approximately 1.5 hours (at 100% efficiency) at 80 μA to get about 61,000 p$(e,e'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

8. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 16.28^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

   Take data for 0.3 hours (100% efficiency) at 40 μA.

   During this period, the Target Operator should park the LH2 target and prepare for LD2 data taking.

9. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS left ($\theta = 16.28^o$) run.

(a) Now put in the 10 cm LD2 and leave the spectrometer settings unchanged.

(b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 324 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	9
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
43 kHz	7.3 kHz	16 kHz	6 kHz	13 kHz	96 Hz	2.11 Hz

(c) Update *standard.kinematics* with the new settings.Use proton as the target mass.

(d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

(e) **Take data for approximately 1.5 hours (at 100% efficiency) at 80 μA to get about 61,000 p$(e,e'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

Q^2=6.00, W=2.40, x=0.55, high ϵ data taking

Nominal Q^2=6.00 GeV$^2/c^2$, W=2.40 GeV, x=0.55 Kinematics						
E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
10.56	4.763	19.89	0.711	0.531	5.512	-14.92

1. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS left ($\theta = 16.92^o$) run.

   Set up the following configuration:

   (a) HMS angle = 19.89 (from TV).

   (b) HMS momentum = –4.763 GeV/c. Negative polarity.

   (c) SHMS angle = 16.92 deg (from TV).

   (d) SHMS momentum = 5.512 GeV/c. Positive polarity.

   (e) 10 cm LD2 target.

   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 194 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	8
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
6.4 kHz	0.5 kHz	4.8 kHz	2.1 kHz	4.4 kHz	4 Hz	1.55 Hz

   (g) Update *standard.kinematics* with the new settings.Use proton as the target mass.

   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (i) **Take data for approximately 2 hours (at 100% efficiency) at 80 μA to get about 30,000 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 left ($\theta = 16.92^o$) run.

   Now put in the "thick" dummy target (± 5 cm) and initially set prescale factors to the same as the LD2 run.

   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

   Take data for 0.4 hours (100% efficiency) at 40 μA.

   During this period, the Target Operator should park the LD2 target and prepare for LH2 data taking.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 16.92^o$) run.

   (a) Now put in the 10 cm LH2 and leave the spectrometer settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 190 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	7
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	6
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
3.2 kHz	0.5 kHz	2.4 kHz	1.0 kHz	2.2 kHz	1 Hz	1.55 Hz

   (c) Update *standard.kinematics* with the new settings.Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for approximately 2 hours (at 100% efficiency) at 80 μA to get about 30,000 p$(e,e'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total.

4. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 14.92^o$) run.

   (a) Move the SHMS to 14.92 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 257 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	8
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	6
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
3.2 kHz	0.5 kHz	9.2 kHz	3.8 kHz	6.6 kHz	4 Hz	1.55 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 2 hours (100% efficiency) at 80 μA to get about 30,000** $d(e,e'\pi^+)nn_{sp}$ **coincidences.** Use the physics replay to keep track of the event total.

5. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 14.92^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

   Take data for 0.4 hours (100% efficiency) at 40 μA.

   During this period, the Target Operator should park the LH2 target and prepare for LD2 data taking.

6. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS center ($\theta = 14.92^o$) run.

   (a) Now put in the 10 cm LD2 and leave the spectrometer settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 269 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	9
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
6.4 kHz	0.5 kHz	18.5 kHz	7.5 kHz	13.1 kHz	15 Hz	1.55 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 2 hours (100% efficiency) at 80 μA to get about 30** $d(e,e'\pi^+)nn_{sp}$ **coincidences.** Use the physics replay to keep track of the event total.

7. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS right ($\theta = 12.92^o$) run.

   (a) Move the SHMS 12.92 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 278 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
6.4 kHz	0.5 kHz	67 kHz	26 kHz	37 kHz	50 Hz	1.55 Hz

   (c) Update *standard.kinematics* with the new settings.Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 2 hours (at 100% efficiency) at 80 μA to get about 30,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

8. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 12.92^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LD2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

   Take data for 0.4 hours (100% efficiency) at 40 μA.

   During this period, the Target Operator should park the LD2 target and prepare for LH2 data taking.

9. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 12.92^o$) run.

(a) Now put in the 10 cm LH2 and leave the spectrometer settings unchanged.

(b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 240 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	6
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
3.2 kHz	0.5 kHz	33 kHz	13 kHz	18 kHz	13 Hz	1.55 Hz

(c) Update *standard.kinematics* with the new settings.Use proton as the target mass.

(d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

(e) **Take data for 2 hours (at 100% efficiency) at 80 μA to get about 30,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

Q^2=2.45, W=3.20, x=0.21, high ϵ data taking

Nominal Q^2=2.45 GeV$^2/c^2$, W=3.20 GeV, x=0.21 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
10.56	4.267	13.39	0.679	0.048	6.265	-8.77

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 10.77^o$) run.
   Set up the following configuration:
   (a) HMS angle = 13.39 (from TV).
   (b) HMS momentum = –4.267 GeV/c. Negative polarity.
   (c) SHMS angle = 10.77 deg (from TV).
   (d) SHMS momentum = 6.265 GeV/c. Positive polarity.
   (e) 10 cm LH2 target.
   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 460 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
38 kHz	70 kHz	45 kHz	19 kHz	20 kHz	268 Hz	6.3 Hz

   (g) Update *standard.kinematics* with the new settings.Use proton as the target mass.
   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**
   (i) **Take data for 1 hour (at 100% efficiency) at 80 μA to get about 92,000 p(e, e'π^+)n coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 10.77^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 8.77^o$) run.

   (a) Move the SHMS to 8.77 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 1221 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	12
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
38 kHz	70 kHz	176 kHz	68 kHz	59 kHz	963 Hz	6.3 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 1 hour (100% efficiency) at 80 μA to get about 92,000** $d(e,e'\pi^+)nn_{sp}$ **coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

4. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 8.77^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

$p(e,e'\pi^+)X$ coincidences fADC deadtime study

Ensure the following configuration is unchanged:

(a) SHMS momentum = +6.265 GeV/c.

(b) SHMS angle = 8.77 deg (from TV).

(c) HMS momentum = -4.267 GeV/c.

(d) HMS angle = 13.39 deg (from TV).
item10 cm LH2 target.

(e) Projected prescale GUI settings:

HMS singles DAQ disabled	all PS=–1
SHMS singles DAQ disabled	all PS=–1
COIN DAQ:	
PS1(SHMS-3/4)	see table
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	see table
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

(f) Make sure the raster is on (2×2), and take coincidences at 65, 50, 30, 20, 12, 8 μA. Start at the highest current and take LH2 target data. Then go down in current and repeat. The goal is 50k prompt $p(e,e'\pi^+)X$ coincidences per setting.

(g) At 40 μA, take one Thick Dummy target run. 125,000 electrons per run, about 0.3 hour.

9.177 GeV $p(e,e'\pi^+)X$ fADC Deadtime Study								
μA	Targets	$\frac{Rate_{SHMS}}{LHrun}$	$\frac{PS1}{SHMS}$	$\frac{Rate_{HMS}}{LHrun}$	$\frac{PS4}{HMS}$	DAQ_{SHMS}	DAQ_{HMS}	$\frac{Time}{run}$
θ_{HMS} = 12.40, P_{HMS}=-3.738 GeV/c, θ_{SHMS} = 12.30, P_{SHMS}=+3.260 GeV/c								
65	LH2	303 kHz	13	114 kHz	10	1 kHz	1 kHz	0.25 hr
50	LH2	246 kHz	13	93 kHz	10	1 kHz	1 kHz	0.33 hr
40	Dummy	189 kHz	13	71 kHz	9	1 kHz	1 kHz	0.3 hr
30	LH2	114 kHz	12	43 kHz	8	1 kHz	1 kHz	0.58 hr
20	LH2	76 kHz	11	28 kHz	8	1 kHz	1 kHz	0.83 hr
12	LH2	45 kHz	11	17 kHz	7	1 kHz	1 kHz	1.0 hr
8	LH2	30 kHz	10	11 kHz	7	1 kHz	1 kHz	1.0 hr
Total Time (at 100% efficiency): 8.3 hrs								

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 6.77^o$) run.

   (a) Move the SHMS 6.77 deg (from TV). **Follow the specific small angle rotation instructions on the Wiki. The Run Co-ordinator will need to arrange in advance which expert personnel (e.g. Amy Comer, Steve Lassiter) need to monitor remotely.** Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) **Adjust the beam current to keep the SHMS-S1X rate comfortably below 1 MHz.** We project the current for this run to be about 40 μA.

   (c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 40 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 1050 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	13
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
19 kHz	35 kHz	326 kHz	113 kHz	76 kHz	818 Hz	3.2 Hz

   (d) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (e) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (f) **Take data for 1 hour (at 100% efficiency) at 40 μA to get about 46,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

6. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 6.77^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 0.2 hours (100% efficiency) at 40 μA.

Q^2=3.85, W=3.07, x=0.31, high ϵ data taking

Nominal Q^2=3.85 GeV$^2/c^2$, W=3.07 GeV, x=0.31 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
10.56	3.955	17.46	0.632	0.120	6.538	-9.92

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 7.92^o$) run.

   Set up the following configuration:

   (a) HMS angle = 17.46 (from TV).

   (b) HMS momentum = –3.955 GeV/c. Negative polarity.

   (c) SHMS angle = 7.92 deg (from TV).

   (d) SHMS momentum = 6.538 GeV/c. Positive polarity.

   (e) 10 cm LH2 target.

   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 520 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	13
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	8
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
10 kHz	16 kHz	229 kHz	90 kHz	69 kHz	318 Hz	1.4 Hz

   (g) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (i) **Take data for 2.1 hours (at 100% efficiency) at 80 μA to get about 48,000 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 ($\theta = 7.92^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

   Take data for 0.5 hours (100% efficiency) at 40 μA.

   During this period, the Target Operator should park the LH2 target and prepare for LD2 data taking.

3. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS right ($\theta = 7.92^o$) run.

Set up the following configuration:

(a) Now put in the 10 cm LD2 and leave the spectrometer settings unchanged.

(b) **Adjust the beam current to keep the SHMS-S1X rate comfortably below 1 MHz.** We project the current for this run to be about 60 μA.

(c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For 60 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 938 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	13
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
15 kHz	24 kHz	343 kHz	135 kHz	104 kHz	715 Hz	1.1 Hz

(d) Update *standard.kinematics* with the new settings. Use proton as the target mass.

(e) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

(f) **Take data for 2.7 hours (at 100% efficiency) at 60 μA to get about 46,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

4. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS center ($\theta = 9.92^o$) run.

   (a) Move the SHMS to 9.92 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 550 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	12
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
20 kHz	32 kHz	113 kHz	48 kHz	47 kHz	341 Hz	1.4 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 2.1 hours (100% efficiency) at 80 μA to get about 48,000** $d(e,e'\pi^+)nn_{sp}$ **coincidences.** Use the physics replay to keep track of the event total.

5. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 9.92^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LD2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

   Take data for 0.4 hours (100% efficiency) at 40 μA.

   During this period, the Target Operator should park the LD2 target and prepare for LH2 data taking.

6. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 9.92^o$) run.

   (a) Now put in the 10 cm LH2 and leave the spectrometer settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 294 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	8
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
10 kHz	16 kHz	57 kHz	24 kHz	24 kHz	85 Hz	1.4 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 2.1 hours (100% efficiency) at 80 μA to get about 48,000** $d(e,e'\pi^+)nn_{sp}$ **coincidences.** Use the physics replay to keep track of the event total.

7. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 11.92^o$) run.

   (a) Move the SHMS 11.92 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 231 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	9
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	8
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
10 kHz	16 kHz	13.1 kHz	5.9 kHz	7.2 kHz	22 Hz	1.4 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 2.1 hours (at 100% efficiency) at 80 μA to get about 48,000 $\mathbf{p(e,e'\pi^+)n}$ 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 ($\theta = 11.92^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2, LD2 targets).

   Take data for 0.4 hours (100% efficiency) at 40 μA.

   During this period, the Target Operator should park the LH2 target and prepare for LD2 data taking.

9. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS left ($\theta = 11.92^o$) run.

(a) Now put in the 10 cm LD2 and leave the spectrometer settings unchanged.

(b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 296 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
20 kHz	32 kHz	26.3 kHz	11.9 kHz	14.4 kHz	86 Hz	1.4 Hz

(c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

(d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

(e) **Take data for 2.1 hours (at 100% efficiency) at 80 μA to get about 48,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

Q^2=5.00, W=2.95, x=0.39, high ϵ data taking

Nominal Q^2=5.00 GeV$^2/c^2$, W=2.95 GeV, x=0.39 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
10.56	3.727	20.53	0.596	0.209	6.719	-10.48

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 12.48^o$) run.

   Set up the following configuration:

   (a) HMS angle = 20.53 (from TV).

   (b) HMS momentum = –3.727 GeV/c. Negative polarity.

   (c) SHMS angle = 12.48 deg (from TV).

   (d) SHMS momentum = 6.719 GeV/c. Positive polarity.

   (e) 10 cm LH2 target.

   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 188 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	8
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
4.1 kHz	5.5 kHz	6.3 kHz	3.0 kHz	3.9 kHz	4 Hz	0.45 Hz

   (g) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (i) **Take data for 6.7 hours (at 100% efficiency) at 80 μA to get about 59,000 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 left ($\theta = 12.48^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 1.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 10.48^o$) run.

   (a) Move the SHMS to 10.48 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 209 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
4.1 kHz	5.5 kHz	29 kHz	13 kHz	14 kHz	18 Hz	0.45 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 6.7 hours (100% efficiency) at 80 μA to get about 59,000** $d(e,e'\pi^+)nn_{sp}$ **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 ($\theta = 10.48^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 1.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 8.48^o$) run.

   (a) Move the SHMS 8.48 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 260 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	12
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
4.1 kHz	5.5 kHz	126 kHz	53 kHz	43 kHz	70 Hz	0.45 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 6.7 hours (at 100% efficiency) at 80 μA to get about 59,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 8.48^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LH2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 1.3 hours (100% efficiency) at 40 μA.

Q^2=6.00, W=3.19, x=0.39, high ϵ data taking

Nominal Q^2=6.00 GeV$^2/c^2$, W=3.19 GeV, x=0.39 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
10.59	2.409	28.10	0.398	0.214	8.035	-7.66

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 5.66^o$) run.

   Set up the following configuration:

   (a) HMS angle = 28.10 (from TV).

   (b) HMS momentum = –2.409 GeV/c. Negative polarity.

   (c) SHMS angle = 5.66 deg (from TV).**This requires a hall access. The Run Coordinator will need to arrange in advance which expert personnel (e.g. Amy Comer, Steve Lassiter) need to be present.**

   (d) SHMS momentum = 8.035 GeV/c. Positive polarity.

   (e) 10 cm LH2 target.

   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 282 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	13
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	6
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
0.9 kHz	10.6 kHz	253 kHz	117 kHz	63 kHz	81 Hz	0.15 Hz

   (g) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (i) **HMS-3/4 trigger run**: Since the HMS momentum is fairly low, take a 20 minute run with HMS-3/4 triggers enabled instead of hELREAL (i.e. PS6 instead of PS5, and PS3

instead of PS4). This is to monitor the ELREAL threshold and will count as part of the physics run total. If the PS3 trigger rate is excessive, adjust PS3 to a higher level to compensate.

(j) **Take data for 19.3 hours (at 100% efficiency) at 80 μA to get about 53,000 $\mathbf{p(e,e'\pi^+)n}$ 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 ($\theta = 5.66^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 3.9 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 7.66^o$) run.

   (a) Move the SHMS to 7.66 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 200 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	6
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
0.9 kHz	10.6 kHz	48 kHz	25 kHz	18 kHz	17 Hz	0.15 Hz

   (c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **HMS-3/4 trigger run**: Since the HMS momentum is fairly low, take a 20 minute run with HMS-3/4 triggers enabled instead of hELREAL (i.e. PS6 instead of PS5, and PS3 instead of PS4). This is to monitor the ELREAL threshold and will count as part of the physics run total. If the PS3 trigger rate is excessive, adjust PS3 to a higher level to compensate.

   (f) **Take data for 19.3 hours (100% efficiency) at 80 μA to get about 53,000** $d(e,e'\pi^+)nn_{sp}$ **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 ($\theta = 7.66^o$) 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, the PS1,4 factors can be decreased accordingly.
Current limit: 40 μA.
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

Take data for 3.9 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 9.66^o$) run.

(a) Move the SHMS 9.66 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

(b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 231 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	8
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	6
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
0.9 kHz	10.6 kHz	8.3 kHz	4.6 kHz	4.2 kHz	3 Hz	0.15 Hz

(c) Update *standard.kinematics* with the new settings. Use proton as the target mass.

(d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

(e) **HMS-3/4 trigger run**: Since the HMS momentum is fairly low, take a 20 minute run with HMS-3/4 triggers enabled instead of hELREAL (i.e. PS6 instead of PS5, and PS3 instead of PS4). This is to monitor the ELREAL threshold and will count as part of the physics run total. If the PS3 trigger rate is excessive, adjust PS3 to a higher level to compensate.

(f) **Take data for 19.3 hours (at 100% efficiency) at 80 μA to get about 53,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

6. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 9.66^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 3.9 hours (100% efficiency) at 40 μA.

Q^2=8.50, W=2.79, x=0.55, high ϵ data taking

Nominal Q^2=8.50 GeV$^2/c^2$, W=2.79 GeV, x=0.55 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
10.56	2.352	34.01	0.375	0.550	7.913	-8.69

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 8.69^o$) run.
   Set up the following configuration:
   (a) HMS angle = 34.01 (from TV).
   (b) HMS momentum = –2.352 GeV/c. Negative polarity.
   (c) SHMS angle = 8.69 deg (from TV).
   (d) SHMS momentum = 7.913 GeV/c. Positive polarity.
   (e) 10 cm LH2 target.
   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 198 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	3
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

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. $e^- \cdot \pi$
0.2 kHz	1.6 kHz	23 kHz	12 kHz	10 kHz	1 Hz	0.05 Hz

   (g) Update *standard.kinematics* with the new settings. Use proton as the target mass.
   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**
   (i) **HMS-3/4 trigger run**: Since the HMS momentum is fairly low, take a 20 minute run with HMS-3/4 triggers enabled instead of hELREAL (i.e. PS6 instead of PS5, and PS3 instead of PS4). This is to monitor the ELREAL threshold and will count as part of the physics run total. If the PS3 trigger rate is excessive, adjust PS3 to a higher level to compensate.

(j) **Take data for 61.3 hours (at 100% efficiency) at 80 μA to get about 68,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 8.69^o$) 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, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 targets).

   Take data for 12.3 hours (100% efficiency) at 40 μA.

Calibration runs with SHMS at negative polarity (Part 1)

$\boxed{p(e,e')p}$ Hydrogen elastic singles, and associated Dummy target runs.

SHMS polarity change. Set up the following configuration:

1. HMS and SHMS angles and momenta as specified in the tables below. Both spectrometers are negative polarity, and both will have to be cycled initially.
2. Record all TV angle values on run sheets and hclog. Update *standard.kinematics* with the new settings.
3. 10 cm LH2 and "thick" dummy target data should be taken with the HMS large and SHMS collimators.

LH2 target runs:
Stable 80 μA beam with 2×2 **raster on.** Set the PS2(SHMS-ELREAL) and PS4(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 500,000 total electron events (times below are only a guide). The total event estimate in right-most column includes inelastics.

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

Noble Gas Cerenkov Check:
During the HeeP singles runs, an expert should ensure the noble gas Cerenkov npe Sum looks reasonable. **It is important this is examined before physics data collection begins at negative polarity following the completion of the HeeP Singles.**

HeeP Singles Analysis:
For the rates listed below, **the HMS delta cuts were widened to $-10\% < \delta < +10\%$** from the original $\pm 8\%$. The analysis scripts for these runs should be adjusted for this to ensure accurate estimates of counts. If the delta cuts are unchanged, then the 1^{st} and $5^{th} - 6^{th}$ settings will have significantly reduced HMS events, as they extend to the outer momentum acceptance of the HMS. **Make sure to restore HMS delta cuts back to original values after completing the HeeP singles.**

Delta Scans:
The HeeP singles settings include SHMS and HMS delta scans at fixed momenta of -8.035 and -6.803 GeV/c, respectively. **It is crucial that the HMS dipole NMR be stable and locked for the delta scan at -6.803 GeV/c.** Shift workers should keep a live plot of the NMR reading open in the magnet GUI. **Shift leads should take screenshots of the strip chart.** Contact Jacob Murphy with any questions.

Single Arm Runs:

The last four HeeP singles settings are divided into 2 runs each. The second run is for a shorter time and without the SHMS trigger being saved. **Make sure the prescales are updated correctly for these runs. Only the HMS events should be saved**

10.560 GeV Heep-check singles runs										
θ_{HMS}	P_{HMS}	θ_{SHMS}	P_{SHMS}	$Rate_{HMS}$	$\frac{PS4}{HMS}$	$Rate_{SHMS}$	$\frac{PS2}{SHMS}$	$\frac{Time}{LH2run}$	$\frac{Time}{ALrun}$	$Events_{SHMS}$
* **Widen HMS delta cuts**										
16.025	-6.803	12.715	-8.035	4.4 kHz	3	29.3 kHz	6	12 min	6 min	1268k
* Check the Noble Gas Cherenkov npe Sum										
17.015	-6.803	12.715	-8.035	1.7 kHz	0	29.3 kHz	6	12 min	6 min	1268k
18.025	-6.803	13.57	-8.035	0.57 kHz	0	14.8 kHz	5	24 min	6 min	1247k
19.06	-6.803	14.425	-8.035	0.16 kHz	0	7.13 kHz	3	21 min	6 min	1787k
20.125	-6.803	15.285	-8.035	0.04 kHz	0	3.23 kHz	2	15 min	6 min	964k
* Watch prescale GUI for short single-arm runs										
20.125	-6.803	16.15	-8.035	0.04 kHz	0	1.36 kHz	0	12 min	6 min	649k
20.125	-6.803	16.15	-8.035	0.04 kHz	0	0 kHz	-1	3 min	0 min	0k
20.125	-6.803	14.06	-7.913	0.04 kHz	0	0.25 kHz	0	10 min	6 min	64k
20.125	-6.803	14.06	-7.913	0.04 kHz	0	0 kHz	-1	5 min	0 min	0k
21.68	-5.889	18.385	-6.719	0.12 kHz	0	1.38 kHz	0	18 min	6 min	976k
21.68	-5.889	18.385	-6.719	0.12 kHz	0	0 kHz	-1	3 min	0 min	0k
21.68	-5.889	19.075	-6.538	0.12 kHz	0	1.04 kHz	0	24 min	6 min	983k
21.68	-5.889	19.075	-6.538	0.12 kHz	0	0 kHz	-1	3 min	0 min	0k
* **Narrow HMS delta cuts**										
Total Time (including overhead): 9.6 hrs										

Q^2=3.85, W=2.62, x=0.39, high ϵ data taking

Nominal Q^2=3.85 GeV$^2/c^2$, W=2.62 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
10.56	5.320	15.04	0.779	0.208	5.127	-14.28

1. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS right ($\theta = 12.28^o$) run.
   Set up the following configuration:
   (a) HMS angle = 15.04 (from TV).
   (b) HMS momentum = –5.320 GeV/c. Negative polarity.
   (c) SHMS angle = 12.28 deg (from TV).
   (d) SHMS momentum = –5.127 GeV/c. **Negative polarity. Cycle magnets.**
   (e) Now put in the 10 cm LD2.
   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 1033 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	12
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS	HMS	SHMS	SHMS	SHMS	Random coinc.	Real coinc.
e^- rate	π^- rate	e^- rate	π^- rate	$K-$ rate	$(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	$e^- \cdot \pi$
43 kHz	7.3 kHz	157 kHz	126 kHz	12 kHz	798 Hz	2.11 Hz

   (g) Update *standard.kinematics* with the new settings. Use neutron as the target mass.
   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**
   (i) **Take data for 1.5 hours (at 100% efficiency) at 80 μA to get about 61,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 12.28^o$) run.

   Now put in the "thick" dummy target (± 5 cm) and initially set prescale factors to the same as the LD2 run.

   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 0.3 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS center ($\theta = 14.28^o$) run.

   (a) Move the SHMS to 14.28 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 518 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	11
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	SHMS $K-$ rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	Real coinc. $e^- \cdot \pi$
43 kHz	7.5 kHz	72 kHz	40 kHz	4 kHz	314 Hz	2.11 Hz

   (c) Update *standard.kinematics* with the new settings. Use neutron as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 1.5 hours (100% efficiency) at 80 μA to get about 61,000 $d(e,e'\pi^+)nn_{sp}$ coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

4. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 14.28^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LD2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 0.3 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS left ($\theta = 16.28^o$) run.

   (a) Move the SHMS 16.28 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 325 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	10
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	SHMS $K-$ rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	Real coinc. $e^- \cdot \pi$
43 kHz	7.5 kHz	32 kHz	12 kHz	6 kHz	136 Hz	2.11 Hz

   (c) Update *standard.kinematics* with the new settings. Use neutron as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 1.5 hours (at 100% efficiency) at 80 μA to get about 61,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total. The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

6. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 16.28^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LD2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 0.3 hours (100% efficiency) at 40 μA.

Q^2=6.00, W=2.40, x=0.55, high ϵ data taking

Nominal Q^2=6.00 GeV$^2/c^2$, W=2.40 GeV, x=0.55 Kinematics						
E_e	$E_{e'}$	$\theta_{e'}$	ϵ	$\lvert t\rvert$	p_π	θ_q
GeV	GeV	deg		(GeV/c)^2	GeV/c	deg
10.56	4.763	19.89	0.711	0.531	5.512	-14.92

1. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS left ($\theta = 16.92^o$) run.

   Set up the following configuration:

   (a) HMS angle = 15.04 (from TV).

   (b) HMS momentum = –4.763 GeV/c. Negative polarity.

   (c) SHMS angle = 16.92 deg (from TV).

   (d) SHMS momentum = –5.512 GeV/c. Negative polarity.

   (e) 10 cm LD2 target.

   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 208 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	9
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS	HMS	SHMS	SHMS	SHMS	Random coinc.	Real coinc.
e^- rate	π^- rate	e^- rate	π^- rate	$K-$ rate	$(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	$e^- \cdot \pi$
6.4 kHz	0.5 kHz	21 kHz	3.6 kHz	0.3 kHz	10 Hz	1.92 Hz

   (g) Update *standard.kinematics* with the new settings. Use neutron as the target mass.

   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (i) **Take data for 5 hours (at 100% efficiency) at 80 μA to get about 75,500 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 16.92^o$) run.

   Now put in the "thick" dummy target (± 5 cm) and initially set prescale factors to the same as the LD2 run.

   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 1.0 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS center ($\theta = 14.92^o$) run.

   (a) Move the SHMS to 14.92 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 260 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	10
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	SHMS $K-$ rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	Real coinc. $e^- \cdot \pi$
6.4 kHz	0.5 kHz	53 kHz	13.7 kHz	1.3 kHz	26 Hz	1.55 Hz

   (c) Update *standard.kinematics* with the new settings. Use neutron as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 5 hours (100% efficiency) at 80 μA to get about 75,500** $d(e,e'\pi^+)nn_{sp}$ **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 ($\theta = 14.92^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LD2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 1.0 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS right ($\theta = 12.92^o$) run.

   (a) Move the SHMS 12.92 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 80 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 259 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	12
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	SHMS $K-$ rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	Real coinc. $e^- \cdot \pi$
6.4 kHz	0.5 kHz	126 kHz	49 kHz	5 kHz	70 Hz	1.55 Hz

   (c) Update *standard.kinematics* with the new settings. Use neutron as the target mass.

   (d) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (e) **Take data for 5 hours (at 100% efficiency) at 80 μA to get about 75,500 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 12.92^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LD2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 1.0 hours (100% efficiency) at 40 μA.

Q^2=3.85, W=3.07, x=0.31, high ϵ data taking

Nominal Q^2=3.85 GeV$^2/c^2$, W=3.07 GeV, x=0.31 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
10.56	3.955	17.46	0.632	0.120	6.538	-9.92

1. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS left ($\theta = 11.92^o$) run.

   Set up the following configuration:

   (a) HMS angle = 17.46 (from TV).

   (b) HMS momentum = –3.955 GeV/c. Negative polarity.

   (c) SHMS angle = 11.92 deg (from TV).

   (d) SHMS momentum = –6.538 GeV/c. Negative polarity.

   (e) 10 cm LD2 target.

   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **80 μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 565 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	12
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	SHMS $K-$ rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	Real coinc. $e^- \cdot \pi$
20 kHz	32 kHz	194 kHz	19.1 kHz	11.8 kHz	352 Hz	1.41 Hz

   (g) Update *standard.kinematics* with the new settings. Use neutron as the target mass.

   (h) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (i) **Take data for 2.1 hours (at 100% efficiency) at 80 μA to get about 48,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 11.92^o$) run.

   Now put in the "thick" dummy target (± 5 cm) and initially set prescale factors to the same as the LD2 run.

   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 0.4 hours (100% efficiency) at 40 μA.

3. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS center ($\theta = 9.92^o$) run.

   (a) Move the SHMS to 9.92 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) **Adjust the beam current to keep the SHMS-S1X rate comfortably below 1 MHz.** We project the current for this run to be about 70 μA.

   (c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **70μA beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 1027 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	13
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	9
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	SHMS $K-$ rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	Real coinc. $e^- \cdot \pi$
18 kHz	28 kHz	480 kHz	70 kHz	6 kHz	797 Hz	1.23 Hz

   (d) Update *standard.kinematics* with the new settings. Use neutron as the target mass.

   (e) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (f) **Take data for 2.4 hours (100% efficiency) at 80 μA to get about 48,000** $d(e,e'\pi^+)nn_{sp}$ **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 ($\theta = 9.92^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LD2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 0.5 hours (100% efficiency) at 40 μA.

5. $\boxed{p(e,e'\pi^+)n}$ LD2 SHMS right ($\theta = 7.92^o$) run.

   (a) Move the SHMS 7.92 deg (from TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged.

   (b) **Adjust the beam current to keep the SHMS-S1X rate comfortably below 1 MHz.** We project the current for this run to be about 25 μA.

   (c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For 25 μA beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 584 Hz DAQ rate overall.

Projected prescale GUI settings:	
PS1(SHMS-3/4)	13
PS2(SHMS-ELREAL)	–1
PS3(HMS-3/4)	–1
PS4(HMS-ELREAL)	7
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	SHMS $K-$ rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$	Real coinc. $e^- \cdot \pi$
6 kHz	10 kHz	493 kHz	98 kHz	8 kHz	306 Hz	0.44 Hz

   (d) Update *standard.kinematics* with the new settings. Use neutron as the target mass.

   (e) **fadcmode10 Run:** Start by taking a 2 minute fadcmode10 run. Be sure to mark this clearly on the Run Sheet. After the run, it is extremely important to **unclick the fadcmode10 setting button.**

   (f) **Take data for 6.5 hours (at 100% efficiency) at 25 μA to get about 46,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.

6. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 7.92^o$) run.

   Now put in the "thick" dummy target ($\pm$5 cm) and initially set prescale factors to the same as the LD2 run.
   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, the PS1,4 factors can be decreased accordingly.
   Current limit: 40 μA.
   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 targets).

   Take data for 1.3 hours (100% efficiency) at 40 μA.

Calibration runs with SHMS at negative polarity (Part 2)

1. Luminosity scan 1 on $z = 0$ Carbon target.

   (a) **SHMS polarity change.** Set the HMS momentum to -5.270 GeV/c, and the SHMS momentum to -5.470 GeV/c, both negative polarity.

   (b) Rotate the HMS to 12.50 degrees, and the SHMS to 9.00 degrees. Record the TV camera angles on the runsheet to 0.005 degree accuracy.

   (c) **IMPORTANT:** For these runs we would like to take single arm scans with only on ELREAL trigger saved at a time. This means taking a one run with the prescale of -1 in one arm with 1kHz daq rate in the other.

   (d) ELREAL trigger in both arms. Set the PS2, PS4 target DAQ rates to 1 kHz, to give a total rate to disk of about 2 kHz.

   (e) Make sure the raster is on (2×2), and take HMS and SHMS runs at 80, 60, 40, 20, 15, 8 μA on Carbon target. Start at the highest current, then go down in current.

   (f) **Try to get runs with a minimum of beam trips (if possible).**

   (g) An expert (Jacob) 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.

10.560 GeV Luminosity Scans #1 Carbon								
μA	Targets	$\frac{Rate_{SHMS}}{LHrun}$	$\frac{PS2}{SHMS}$	$\frac{Rate_{HMS}}{LHrun}$	$\frac{PS4}{HMS}$	DAQ_{SHMS}	DAQ_{HMS}	$\frac{Time}{run}$
θ_{HMS} = 13.00, P_{HMS}=-5.270 GeV/c, θ_{SHMS} = 10.00, P_{SHMS}=-5.470 GeV/c								
80	C	613 kHz	13	85 kHz	7	1 kHz	1 kHz	10 min
80	C	0 kHz	-1	85 kHz	6	0 kHz	2 kHz	10 min
80	C	613 kHz	12	0 kHz	-1	2 kHz	0 kHz	10 min
60	C	460 kHz	12	64 kHz	6	1 kHz	1 kHz	10 min
60	C	0 kHz	-1	64 kHz	5	0 kHz	2 kHz	10 min
60	C	460 kHz	11	0 kHz	-1	2 kHz	0 kHz	10 min
40	C	306 kHz	12	42 kHz	6	1 kHz	1 kHz	10 min
40	C	0 kHz	-1	42 kHz	5	0 kHz	2 kHz	10 min
40	C	306 kHz	11	0 kHz	-1	2 kHz	0 kHz	10 min
25	C	192 kHz	11	27 kHz	5	1 kHz	1 kHz	10 min
25	C	0 kHz	-1	27 kHz	4	0 kHz	2 kHz	10 min
25	C	192 kHz	10	0 kHz	-1	2 kHz	0 kHz	10 min
15	C	115 kHz	9	16 kHz	4	1 kHz	1 kHz	10 min
15	C	0 kHz	-1	16 kHz	3	0 kHz	2 kHz	10 min
15	C	115 kHz	8	0 kHz	-1	2 kHz	0 kHz	10 min
8	C	61 kHz	9	8 kHz	3	1 kHz	1 kHz	10 min
8	C	0 kHz	-1	8 kHz	2	0 kHz	2 kHz	10 min
8	C	61 kHz	8	0 kHz	-1	2 kHz	0 kHz	10 min
Total Time (including overhead): 6.6 hrs								

2. Luminosity scan #1 on $z = 0$ LH2 target.

   (a) Leave the spectrometer settings unchanged.

   (b) Put in LH2 Target.

   (c) **IMPORTANT:** For these runs we would like to take single arm scans with only on ELREAL trigger saved at a time. This means taking a one run with the prescale of -1 in one arm with 1kHz daq rate in the other.

   (d) Make sure the raster is on (2×2), and take HMS and SHMS runs at 80, 60, 40, 20, 15, 8 μA on LH2 target. Start at the highest current, then go down in current.

   (e) **Try to get runs with a minimum of beam trips (if possible).**

   (f) Take one Thick Dummy target run at 40 μA. 125,000 electrons per run, about 0.3 hour. During this run, the Target Operator should park the LH2 target and prepare for LD2 data taking.

   (g) An expert (Jacob) 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.

10.560 GeV Luminosity Scans #1 LH2								
μA	Targets	$\frac{Rate_{SHMS}}{LHrun}$	$\frac{PS2}{SHMS}$	$\frac{Rate_{HMS}}{LHrun}$	$\frac{PS4}{HMS}$	DAQ$_{SHMS}$	DAQ$_{HMS}$	$\frac{Time}{run}$
$\theta_{HMS} = 13.00$, P_{HMS}=-5.270 GeV/c, $\theta_{SHMS} = 10.00$, P_{SHMS}=-5.470 GeV/c								
80	LH2	0 kHz	-1	85 kHz	6	0 kHz	2 kHz	10 min
80	LH2	613 kHz	12	0 kHz	-1	2 kHz	0 kHz	10 min
60	LH2	0 kHz	-1	64 kHz	5	0 kHz	2 kHz	10 min
60	LH2	460 kHz	11	0 kHz	-1	2 kHz	0 kHz	10 min
40	LH2	0 kHz	-1	42 kHz	5	0 kHz	2 kHz	10 min
40	LH2	306 kHz	11	0 kHz	-1	2 kHz	0 kHz	10 min
25	LH2	0 kHz	-1	27 kHz	4	0 kHz	2 kHz	10 min
25	LH2	192 kHz	10	0 kHz	-1	2 kHz	0 kHz	10 min
15	LH2	0 kHz	-1	16 kHz	3	0 kHz	2 kHz	10 min
15	LH2	115 kHz	8	0 kHz	-1	2 kHz	0 kHz	10 min
8	LH2	0 kHz	-1	8 kHz	2	0 kHz	2 kHz	10 min
8	LH2	61 kHz	8	0 kHz	-1	2 kHz	0 kHz	10 min
40	Dummy	306 kHz	12	42 kHz	6	1 kHz	1 kHz	18 min
Total Time (including overhead): 5.1 hrs								

3. Luminosity scan #1 on LD2.

   (a) Leave magnet settings unchanged.

   (b) Rotate the HMS to 13.00 degrees, and the SHMS to 10.00 degrees. Record the TV camera angles on the runsheet to 0.005 degree accuracy.

   (c) Put in LD2 Target.

   (d) ELREAL trigger in both arms. Set the PS2, PS4 target DAQ rates to 1 kHz, to give a total rate to disk of about 2 kHz.

   (e) Make sure the raster is on (2×2), and take HMS and SHMS runs at 80, 60, 40, 20, 15, 8 μA on LD2 target. Start at the highest current, then go down in current and repeat.

   (f) **Try to get runs with a minimum of beam trips (if possible).**

   (g) An expert (Jacob) 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.

10.560 GeV Luminosity Scans #1 LD2								
μA	Targets	$\frac{Rate_{SHMS}}{LDrun}$	$\frac{PS2}{SHMS}$	$\frac{Rate_{HMS}}{LDrun}$	$\frac{PS4}{HMS}$	DAQ_{SHMS}	DAQ_{HMS}	$\frac{Time}{run}$
$\theta_{HMS} = 13.00$, P_{HMS}=-5.270 GeV/c, $\theta_{SHMS} = 10.00$, P_{SHMS}=-5.470 GeV/c								
80	LD2	747 kHz	15	134 kHz	8	1 kHz	1 kHz	10 min
60	LD2	560 kHz	14	100 kHz	7	1 kHz	1 kHz	10 min
40	LD2	374 kHz	14	67 kHz	7	1 kHz	1 kHz	10 min
25	LD2	233 kHz	13	41 kHz	6	1 kHz	1 kHz	10 min
15	LD2	140 kHz	12	25 kHz	5	1 kHz	1 kHz	10 min
8	LD2	74 kHz	11	13 kHz	4	1 kHz	1 kHz	10 min
Total Time (including overhead): 2.3 hrs								

4. Luminosity scan #2 on LD2, LH2, and $z = 0$ Carbon targets.

   (a) If things go well, we could to do a second set of luminosity scans. In Fpi-2, this proved helpful in disentangling rate and current effects in the π^- analysis. In this scan, the rates are roughly half of the first scan, at the same current.

   (b) Move the HMS to 13.00 deg, and the SHMS to 12.00 deg (on TV). Be sure to record and photograph the actual achieved vernier value to 0.005 degree precision. Leave the spectrometer magnet settings unchanged. Leave the spectrometer magnet settings unchanged.

   (c) ELREAL trigger in both arms. Set the PS2, PS4 target DAQ rates to 1 kHz, to give a total rate to disk of about 2 kHz.

   (d) Make sure the raster is on (2×2), and take HMS and SHMS runs at 80, 60, 40, 25, 15, 8 μA on LD2 target. Start at the highest current, then go down in current and repeat.

   (e) **Try to get runs with a minimum of beam trips (if possible).**

   (f) Take one Thick Dummy target run at 40 μA. 125,000 electrons per run, about 0.3 hour. During this run, the Target Operator should park the LD2 target and prepare for LH2 data taking.

   (g) Repeat the scans with Carbon 0.5% r.l. and LH2 targets at 80, 60, 40, 25, 15, 8 μA.
   Carbon 0.5% Current Limit = 80 μA.
   If the C rates are too low, we may be able to substitute the Gold target (consult the RC before doing this).

10.560 GeV Luminosity Scans #2								
μA	Targets	$\frac{Rate_{SHMS}}{LHrun}$	$\frac{PS2}{SHMS}$	$\frac{Rate_{HMS}}{LHrun}$	$\frac{PS4}{HMS}$	DAQ_{SHMS}	DAQ_{HMS}	$\frac{Time}{run}$
$\theta_{HMS} = 13.00$, P_{HMS}=-5.270 GeV/c, $\theta_{SHMS} = 10.00$, P_{SHMS}=-5.470 GeV/c								
80	LH2, C, LD2	142 kHz	11	23 kHz	5	1 kHz	1 kHz	10 min
60	LH2, C, LD2	113 kHz	10	17 kHz	5	1 kHz	1 kHz	10 min
40	LH2, Dummy, C, LD2	75 kHz	10	11 kHz	4	1 kHz	1 kHz	10 min
25	LH2, C, LD2	47 kHz	9	7 kHz	3	1 kHz	1 kHz	10 min
15	LH2, C, LD2	28 kHz	8	4 kHz	2	1 kHz	1 kHz	10 min
8	LH2, C, LD2	15 kHz	8	2 kHz	1	1 kHz	1 kHz	10 min
Total Time (including overhead): 7.4 hrs								

To be determined in consultation with the RC: If we are waiting for the linac gradient change, go back to the $(e, e'\pi^{\pm})$ setting with the lowest statistics and take more data, or do one of the deferred calibration studies.