# Pion-LT Run Plan - Part 1

September 6, 2021

## 9.177 GeV Beam Plan

### Initial beam activities

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

  1. SHMS angle = 7.50 deg (from TV).
  2. SHMS momentum = -5.27 GeV/c (negative polarity).
  3. HMS angle = 12.50 deg (from TV).
  4. HMS momentum = -5.890 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).
  6. Prescale GUI settings:

| | |
|---|---|
| HMS singles DAQ disabled<br>SHMS singles DAQ disabled | all PS=–1<br>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.

→ Fix Beam Angle at Target
- use GUI at /home/cdaq/users/gaskelld/target_bpm/target_bpm.py
- adjust 3H07A x,y to remove slope while keeping 3H07C x,y fixed
- recheck Carbon-Hole + 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`

- Energy determination with arc.
  The Run Co-ordinator will coordinate the timing of this with the Program Deputy. MCC will have to set up a clean dispersive tune. It is important for the Shift Leader to make a full hclog entry of the MCC data. Follow the "Hall C Beam Energy Measurement Procedure" at MCC Ops Doc: MCC-PR-06-004.

- BCM calibrations.
  The Run Co-ordinator will coordinate the timing of this with the Program Deputy. This requires MCC's ability to reliably deliver 65-70 $\mu$A 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°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 monthly 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.**

- SHMS hodoscope timing checkout and adjustment. Malace and Usman
- SHMS Preshower checkout and adjustment (mostly verification, timing windows). TBA
- SHMS Heavy Gas and Noble Gas Čerenkov detector checkout and adjustment (gain matching verification). Kay and Heinrich
- HMS Čerenkov detector checkout and adjustment (gain matching verification). Kay and Heinrich
- SHMS Aerogel Čerenkov detector checkout and adjustment (mostly verification). Berdnikov and Trotta

### Carbon sieve check (DO AFTER TRIGGER CHECKOUT).

Various work was done on the spectrometer magnet power supplies during the SAD. 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=~~20~~ 40 $\mu$A.** 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%).

| | $E_e$ | $\theta'_e$ | $P'_e$ |
|---|---|---|---|
| HMS: | 9200.0 | 15.00 | -3738.0 |
| ~~SHMS:~~ | ~~9200.0~~ | ~~15.00~~ | ~~-5270.0~~ |

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. Do a **second run with the $z = \pm 3$ cm carbon optics target.**
5. Do a **third run with the $z = \pm 8$ cm carbon optics target.**

## Configure the spectrometers for the trigger checkout with Heep coincidences

1. Switch the SHMS to positive polarity (follow the cycling procedure) and set to +4.120 GeV/c.
2. HMS momentum = -5.890 GeV/c. Follow the cycling procedure.
3. SHMS angle = 28.42 deg (from TV).
4. HMS angle = 19.45 deg (from TV).
5. 10 cm LH2 target.
6. 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, Malace, Jones, Murphy, Huber

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 $B$

- 3/4-trigger timing changes to reduce fADC reference time ambiguity have been implemented `https://logbooks.jlab.org/entry/3890337`. Need to verify that all timing adjustments and detector reference time windows are correctly set. Start with open Reference Time and Detector Time windows. Look at data and then tighten the windows up.
- fADC firmware has been updated to reduce the chance of missing pedestal information `https://logbooks.jlab.org/entry/3889989`. Checks with beam are likely needed to confirm everything is working as expected.
- 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. Simona might want to change momentum and/or angle to get a good $e/\pi$ 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 $\check{\text{C}}$ threshold in ELREAL. $\rightarrow$ Don't want to lose electrons.
- Double-check HMS Calorimeter threshold in ELREAL. $\rightarrow$ Should be a loose cut (5:1 $\pi^-$ rejection is desired).
- Double-check SHMS HGC threshold in ELREAL. $\rightarrow$ Don't want to lose electrons.
- Double-check SHMS Calorimeter threshold in ELREAL. $\rightarrow$ Should be a loose cut.
- Double-check SHMS timing for pions, kaons, and protons.
- 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. $p(e,e'p)$ equal angles and momenta setting

9.177 GeV Heep-check coincidence run

| $\theta_{HMS}$ | $P_{HMS}$ | $\theta_{SHMS}$ | $P_{SHMS}$ | $Rate_{HMS}$ | $Rate_{DAQ}$ | Time |
|---|---|---|---|---|---|---|
| 23.75 | -5.015 | 23.80 | 5.015 | 0.125 kHz | 125 Hz | 1.0 hr |

Set up the following configuration:

(a) Set the SHMS magnets to +5.015 GeV/c (follow the magnet cycling procedure).

(b) SHMS angle = 23.80 deg (from TV).

(c) Set HMS magnets to –5.015 GeV/c.

(d) HMS angle = 23.75 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 70 $\mu$A 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 30 minutes (at 100% data taking efficiency), and should be immediately analyzed, checking $E_m$ and $p_m$, while taking the second run.

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

Insert the "thick" dummy target (±5 cm) and **run for 6 minutes** at 40 $\mu$A (assuming 100% efficiency).

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

3. $p(e,e'p)$ setting for HMS angle and both spectrometer momenta

9.177 GeV Heep-check coincidence run

| $\theta_{HMS}$ | $P_{HMS}$ | $\theta_{SHMS}$ | $P_{SHMS}$ | $Rate_{HMS}$ | $Rate_{DAQ}$ | Time |
|---|---|---|---|---|---|---|
| 31.65 | -3.738 | 18.12 | 6.265 | 0.02 kHz | 150 Hz | 4.5 hr |

Set up the following configuration:

(a) Set the SHMS magnets to +6.265 GeV/c (follow the magnet cycling procedure).

(b) SHMS angle = 18.12 deg (from TV).

(c) Set HMS magnets to −3.738 GeV/c.

(d) HMS angle = 31.65 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 70 $\mu$A 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 30 minutes (at 100% data taking efficiency), and should be immediately analyzed, checking $E_m$ and $p_m$, while taking the second run.

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

Insert the "thick" dummy target (±5 cm) and **run for 30 minutes** at 40 $\mu$A (assuming 100% efficiency).
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 target).

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## $Q^2$=1.60, $W$=3.08, $x$=0.16, high $\epsilon$ data taking

| Nominal $Q^2$=1.60 GeV$^2/c^2$, $W$=3.08 GeV, $x$=0.16 Kinematics | | | | | | |
|---|---|---|---|---|---|---|
| $E_e$ | $E_{e'}$ | $\theta_{e'}$ | $\epsilon$ | $\lvert t\rvert$ | $p_\pi$ | $\theta_q$ |
| GeV | GeV | deg | | (GeV/c)$^2$ | GeV/c | deg |
| 9.177 | 3.738 | 12.40 | 0.685 | 0.026 | 5.422 | -8.26 |

1. $p(e,e'\pi^+)n$ LH2 SHMS left ($\theta = 10.26^o$) run.

   Set up the following configuration:

   (a) HMS angle = 12.40 (from TV). **Follow the specifc small angle rotation instructions on the Wiki. Beam off during the HMS movement.**

   (b) HMS momentum = –3.738 GeV/c. Negative polarity.

   (c) SHMS angle = 10.26 deg (from TV).

   (d) SHMS momentum = 5.422 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 70 $\mu$A beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 1800 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) | 11 |
| 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 $\pi^-$ rate | SHMS $\pi^+$ rate | SHMS $K$ rate | SHMS $p$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K$+p) | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 61 kHz | 166 kHz | 115 kHz | 42 kHz | 47 kHz | 1600 Hz | 13 Hz |

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

   (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 3.5 hours (at 100% efficiency) to give 150,000 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 ($\theta = 10.26^o$) 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 $\mu$A.
   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 $\mu$A.**

   During this period, the Target Operator should park the LH2 target and get ready for LD2 running.

3. $\boxed{d(e,e'\pi^+)nn_{sp}}$ LD2 SHMS left ($\theta = 10.26^o$) run.

   (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 35 $\mu$A.

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

   (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 4.5 hours (100% efficiency) at 35 $\mu$A to get about 100,000 $d(e,e'\pi^+)nn_{sp}$ coincidences. Use the physics replay to keep track of the event total.**

4. $\boxed{d(e,e'\pi^+)nn_{sp}}$ LD2 SHMS center ($\theta = 8.26^o$) run.

(a) Move the SHMS to 8.26 deg (from TV). 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 23 $\mu$A.

(c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For **23 $\mu$A beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 2200 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) | 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 $\pi^-$ rate | SHMS $\pi^+$ rate | SHMS $K$ rate | SHMS $p$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$ | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 40 kHz | 109 kHz | 243 kHz | 81 kHz | 72 kHz | 2010 Hz | 4.2 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 7.0 hours (100% efficiency) at 23 $\mu$A to get about 100,000 $d(e,e'\pi^+)nn_{sp}$ coincidences. Use the physics replay to keep track of the event total.**

Swing Saturday 11/9/21
→ 1 hour to go
Then more on

When beam comes back request 23 uA, and run for 4hr, 36 min.

5. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 8.26^o$) 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. → to 11, 9
Current limit: 40 $\mu$A.
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 $\mu$A.**

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 ($\theta = 8.26^o$) run.

(a) Now put in the 10 cm LH2 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 50 $\mu$A. → 52 $\mu$A

(c) 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.

(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 3.0 hours (at 100% efficiency) at 50 $\mu$A to get about 100,000 p(e, e'$\pi^+$)n coincidences.** Use the physics replay to keep track of the event total. → 4.0 hr

2.7 hours done
4.3 hours to go!
4:18
- 2:00
2:18 left (100%
4 hr, 36 min 50% eff

7. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 6.26^o$) run.

(a) Move the SHMS 6.26 deg (from TV). **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. ✓

(b) Put in the LH2 target. Leave the spectrometer magnet settings unchanged. ✓

(c) **Adjust the beam current to keep the SHMS-S1X rate comfortably below 1 MHz.** We project the current for this run to be about 28 $\mu$A. → 15 $\mu$A

(d) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz. ✓

15 For ~~28~~ **$\mu$A beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 2300 Hz DAQ rate overall.

| Projected prescale GUI settings: | |
|---|---|
| PS1(SHMS-3/4) | ~~14~~ 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 |

SIX SHMS at 970K at 15 μA → 1.3 MHz @ 20 μA

| HMS $e^-$ rate | HMS $\pi^-$ rate | SHMS $\pi^+$ rate | SHMS $K$ rate | SHMS $p$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + p)$ | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 24 kHz | 66 kHz | 452 kHz | 132 kHz | 91 kHz | 2100 Hz | 5.1 Hz |

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

(f) **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.** 6.0 @ 15 μA

(g) **Take data for approximately 5.5 hours (at 100% efficiency) at 28 $\mu$A to get about 100,000 p(e, e'$\pi^+$)n coincidences.** Use the physics replay to keep track of the event total.

2 hours done @ start of owl
+ 0.3 hours during owl

8. $\boxed{\mathrm{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 6.26^o$) 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 $\mu$A.

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

**Take data for 0.7 hours (100% efficiency) at 40 $\mu$A.**

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

9. $\boxed{d(e,e'\pi^+)nn_{sp}}$ LD2 SHMS right ($\theta = 6.26^o$) run.

(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 14 $\mu$A.

(c) Initially set prescale factors to the same as the LH2 run. If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, then the PS1,4 factors can be decreased accordingly.

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

(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 11 hours (100% efficiency) at ~~14~~ 10 $\mu$A to get about 100,000 $d(e,e'\pi^+)nn_{sp}$ coincidences. Use the physics replay to keep track of the event total.**

78751

Have ~~62K~~ from 7 hours at 10 uA

need 4 more hours of beam on target data

10. $\boxed{d(e,e'\pi^-)pp_{sp}}$ LD2 SHMS right ($\theta = 6.26^o$) run.

(a) **Change SHMS polarity to negative.** Turn the beam off while ramping the SHMS, and carefully follow the magnet cycling procedure.

(b) SHMS momentum = 5.422 GeV/c. Negative polarity.

(c) Leave in the 10 cm LD2 target and leave all other spectrometer settings unchanged.

(d) **Adjust the beam current to keep the SHMS-S1X rate comfortably below 1 MHz.** We project the current for this run to be about 12 $\mu$A.

(e) Update *standard.kinematics* with the new settings, using neutron mass for the target.

(f) **PID leg checkout Run:** Take a 1 hour run with PS1(SHMS-3/4) and PS3(HMS-3/4) with target rates of 1000 Hz, and PS5=–1. Start the replay shortly after starting the run and let Simona know the run number as soon as it is done, so she can verify the PID thresholds on the SHMS electron arm.

(g) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz. For **12 $\mu$A beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 1400 Hz DAQ rate overall.

| Projected prescale GUI settings: | |
|---|---|
| PS1(SHMS-3/4) | 14 |
| 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 $\pi^-$ rate | SHMS $e^-$ rate | SHMS $\pi^-$ rate | SHMS $K^-$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$ | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 21 kHz | 57 kHz | 535 kHz | 247 kHz | 14 kHz | 2100 Hz | 2.3 Hz |

(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 9 hours (100% efficiency) at 12 $\mu$A to get about 70,000 $d(e,e'\pi^-)pp_{sp}$ coincidences. Use the physics replay to keep track of the event total.**

Run a FULL (All branches) replay for this run → ALL event tot

Keep under 1 MHz for PID leg, we care less about going too low current here (SK)

Run as [ 4.5 hrs @ 10 nA → 2.5 hrs done as of 14/9/21 @ 18:00 DONE
4.5 hrs @ 8 nA
↳ Started run 12038 21:51, 14/09/21

Run for 3 more

11. $\boxed{\text{Al}(e, e'\pi^-)X}$ Thick Dummy target SHMS right ($\theta = 6.26^o$) 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, then the PS1,4 factors can be decreased accordingly.

Current limit: 40 $\mu$A.

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

**Take data for 0.8 hours (100% efficiency) at 40 $\mu$A.**

Keep SIX < 1 MHz! (in SHMS)

Ident w\ 30 uA

Means Run time will be ~1.1 hours
or 64 minutes

OWL 15/9/21 (Hopefully)

Rotate OUT, Watch Camera, Stand by on crash button.

12. $d(e,e'\pi^-)pp_{sp}$ LD2 SHMS center ($\theta = 8.26^o$) run.

(a) Move the SHMS to 8.26 deg (from TV), and put the 10 cm LD2 target back in. 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 20 $\mu$A. ~ 15 $\mu$A

(c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For ~~20~~ **$\mu$A beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 1800 Hz DAQ rate overall.

15 $\mu$A

| Projected prescale GUI settings: | |
|---|---|
| PS1(SHMS-3/4) | 13 |
| 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 |

← DO NOT SET ABOVE 0

| HMS $e^-$ rate | HMS $\pi^-$ rate | SHMS $e^-$ rate | SHMS $\pi^-$ rate | SHMS $K^-$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$ | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 35 kHz | 95 kHz | 326 kHz | 138 kHz | 9 kHz | 2100 Hz | 3.7 Hz |

(d) Update *standard.kinematics* with the new settings, using neutron mass for the target.

(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.** SJDK 15/9/21 13:00 → ~2.5 hrs left to run

(f) **Take data for 5.5 hours (100% efficiency) at 20 $\mu$A to get about 70,000 $d(e,e'\pi^-)pp_{sp}$ coincidences. Use the physics replay to keep track of the event total.**

Full analysis replay takes ~2hrs

↳ Run 100k and extrapolate from rate (100k = Xs of data get Y pions, $\pi$ rate = Y/X)

3 more hours @15 $\mu$A

13. $Al(e,e'\pi^-)X$ Thick Dummy target SHMS center ($\theta = 8.26^o$) 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 $\mu$A.
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 target).

**Take data for 0.6 hours (100% efficiency) at 40 $\mu$A.**

14. $d(e,e'\pi^-)pp_{sp}$ LD2 SHMS ~~center~~ ($\theta = 10.26^o$) run.

(a) Move the SHMS to 10.26 deg (from TV), and put the 10 cm LD2 target back in. 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 34 $\mu$A.

(c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For **34 $\mu$A beam** and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 1300 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) | 11 |
| 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 $\pi^-$ rate | SHMS $e^-$ rate | SHMS $\pi^-$ rate | SHMS $K^-$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (e^- + \pi^- + K^-)$ | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 59 kHz | 162 kHz | 223 kHz | 46 kHz | 3 kHz | 2100 Hz | 6.2 Hz |

(d) Update *standard.kinematics* with the new settings, using neutron mass for the target.

(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 3.5 hours (100% efficiency) at 34 $\mu$A to get about 70,000 $d(e,e'\pi^-)pp_{sp}$ coincidences. Use the physics replay to keep track of the event total.**

→ Please post a screen shot of the scaler GUIs + beam current.

15. $\boxed{\text{Al}(e,e'\pi^-)X}$ Thick Dummy target SHMS left ~~center~~ ($\theta = 10.26^o$) 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 $\mu$A.
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 target).

**Take data for 0.4 hours (100% efficiency) at 40 $\mu$A.**

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

## Calibration runs with SHMS at negative polarity

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

   Set up the following configuration:

   (a) 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. **For the 7.06 degree movement, the Run Co-ordinator will need to arrange in advance which expert personnel need to monitor remotely.**

   (b) Record all TV angle values on run sheets and hclog. Update *standard.kinematics* with the new settings.

   (c) 10 cm LH2 and "thick" dummy target data should be taken with the HMS large and SHMS collimators.

***LH2 target runs:***

Stable 70 $\mu$A beam with $2 \times 2$ **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 $\mu$A.

9.177 GeV Heep-check singles runs

| $\theta_{HMS}$ | $P_{HMS}$ | $\theta_{SHMS}$ | $P_{SHMS}$ | $Rate_{HMS}$ | $\frac{PS4}{HMS}$ | $Rate_{SHMS}$ | $\frac{PS2}{SHMS}$ | $\frac{Time}{LH2run}$ | $\frac{Time}{ALrun}$ | $Events_{SHMS}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 19.88 | -5.900 | 10.26 | -8.444 | 0.37 kHz | 0 | 113 kHz | 8 | 10 min | 6 min | 520k |
| 19.88 | -5.900 | 7.06 | -8.035 | 0.37 kHz | 0 | **2300 kHz*** | 12 | 10 min | 6 min | 670k |
| * Current likely must be reduced to 35 $\mu$A to keep SHMS rate $< 1$ MHz. Adjust run time accordingly. | | | | | | | | | | |
| 19.88 | -5.900 | 10.26 | -7.931 | 0.37 kHz | 0 | 168 kHz | 8 | 10 min | 6 min | 770k |
| 23.53 | -5.202 | 10.26 | -7.296 | 0.08 kHz | 0 | 237 kHz | 9 | 15 min | 6 min | 820k |
| 23.53 | -5.202 | 10.26 | -6.719 | 0.08 kHz | 0 | 304 kHz | 9 | 30 min | 6 min | 2060k |
| 23.53 | -5.202 | 11.73 | -6.719 | 0.08 kHz | 0 | 116 kHz | 8 | 30 min | 6 min | 1570k |
| 23.53 | -5.202 | 13.12 | -6.719 | 0.08 kHz | 0 | 43 kHz | 6 | 15 min | 6 min | 1140k |
| 23.53 | -5.202 | 15.72 | -6.719 | 0.08 kHz | 0 | 7.4 kHz | 3 | 15 min | 6 min | 1310k |
| 23.53 | -5.202 | 16.55 | -6.719 | 0.08 kHz | 0 | 4.0 kHz | 2 | 15 min | 6 min | 1180k |
| 25.02 | -4.707 | 17.79 | -6.719 | 0.16 kHz | 0 | 1.7 kHz | 0 | 10 min | 6 min | 670k |
| 25.02 | -4.707 | 12.85 | -6.265 | 0.16 kHz | 0 | 74 kHz | 7 | 42 min | 6 min | 2730k |
| 25.02 | -4.707 | 15.30 | -6.265 | 0.16 kHz | 0 | 16 kHz | 5 | 30 min | 6 min | 1640k |
| 25.02 | -4.707 | 17.80 | -6.265 | 0.16 kHz | 0 | 2.9 kHz | 2 | 20 min | 6 min | 1180k |
| 25.02 | -4.707 | 18.65 | -6.265 | 0.16 kHz | 0 | 1.5 kHz | 0 | 15 min | 6 min | 880k |
| 25.02 | -4.707 | 19.80 | -6.265 | 0.16 kHz | 0 | 0.57 kHz | 0 | 30 min | 6 min | 670k |
| Total Time (including overhead): 5.0 hrs | | | | | | | | | | |

2. Luminosity scans on LH2, LD2 and $z = 0$ Carbon targets.

   (a) Reduce the HMS momentum to -4.100 GeV/c, and the SHMS momentum to -5.270 GeV/c, both negative polarity.

   (b) Rotate the HMS to 12.50 degrees, and the SHMS to 7.50 degrees. Record the TV camera angles on the runsheet to 0.005 degree accuracy.

   (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 ($2 \times 2$), and take HMS and SHMS runs at 70, 55, 40, 25, 18, 12, 8, 5, 3 $\mu$A on LH2 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 $\mu$A. 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) Repeat the scans with Carbon 0.5% r.l. target. If the C rates are too low, we may be ~~able to substitute the Gold target (consult the RC before doing this).~~ Run limit = 70μA

   (h) Repeat the scans with LD2 target at 40, 25, 18, 12, 8, 5, 3 $\mu$A. (70, 55 $\mu$A rates on LD2 are too high and can be excluded.)

   (i) 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.

| | 9.177 GeV Luminosity Scans | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $\mu$A | Targets | $\frac{Rate_{SHMS}}{LHrun}$ | $\frac{PS2}{SHMS}$ | $\frac{Rate_{HMS}}{LHrun}$ | $\frac{PS4}{HMS}$ | $DAQ_{SHMS}$ | $DAQ_{HMS}$ | $\frac{Time}{run}$ |
| | $\theta_{HMS} = 12.50$, $P_{HMS}$=-4.100 GeV/c, $\theta_{SHMS} = 7.50$, $P_{SHMS}$=-5.270 GeV/c | | | | | | | | |
| 1 | 70 | ~~LH2~~, ~~C~~ | 1360 kHz | 11 | 163 kHz | 7 | 1 kHz | 1 kHz | 10 min |
| 2 | 55 | ~~LH2~~, ~~C~~ | 1070 kHz | 10 | 128 kHz | 7 | 1 kHz | 1 kHz | 10 min |
| 3 | 40 | ~~LH2~~, Dummy, ~~C~~, ~~LD2~~ | 780 kHz | 10 | 93 kHz | 6 | 1 kHz | 1 kHz | 10 min |
| 4 | 25 | ~~LH2~~, ~~C~~, ~~LD2~~ | 490 kHz | 9 | 58 kHz | 6 | 1 kHz | 1 kHz | 10 min |
| 5 | 18 | ~~LH2~~, ~~C~~, ~~LD2~~ | 350 kHz | 9 | 42 kHz | 5 | 1 kHz | 1 kHz | 10 min |
| 6 | 12 | ~~LH2~~, ~~C~~, ~~LD2~~ | 234 kHz | 8 | 28 kHz | 4 | 1 kHz | 1 kHz | 10 min |
| 7 | 8 | ~~LH2~~, ~~C~~, ~~LD2~~ | 156 kHz | 8 | 19 kHz | 4 | 1 kHz | 1 kHz | 10 min |
| 8 | 5 | ~~LH2~~, ~~C~~, ~~LD2~~ | 97 kHz | 7 | 12 kHz | 3 | 1 kHz | 1 kHz | 10 min |
| 9 | 3 | ~~LH2~~, ~~C~~, ~~LD2~~ | 59 kHz | 6 | 7 kHz | 3 | 1 kHz | 1 kHz | 10 min |
| | Total Time (including overhead): 11.2 hrs | | | | | | | | |

Repeat →

↓

10 70μA

↑ Do one extra at 70 AFTER the 3μA

← It takes time to get orbit config etc

↑ 20min on C 0.5%

3. Second set of Luminosity scans on LH2, LD2 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 $\pi^-$ analysis. In this scan, the rates are roughly half of the first scan, at the same current.

   (b) Move the HMS to 14.00 deg, and the SHMS to 9.00 deg (on TV). Leave the momentum 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 $(2 \times 2)$, and take HMS and SHMS runs at 55, 40, 25, 18, 10, 5 $\mu$A 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 $\mu$A. 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 70, 55, 40, 25, 18, 10, 5 $\mu$A. If the C rates are too low, we may be able to substitute the Gold target (consult the RC before doing this): We live with it.

9.177 GeV Luminosity Scans #2

| $\mu$A | Targets | $\frac{Rate_{SHMS}}{LHrun}$ | $\frac{PS2}{SHMS}$ | $\frac{Rate_{HMS}}{LHrun}$ | $\frac{PS4}{HMS}$ | $DAQ_{SHMS}$ | $DAQ_{HMS}$ | $\frac{Time}{run}$ |
|---|---|---|---|---|---|---|---|---|
| | $\theta_{HMS} = 13.00$, $P_{HMS}$=-4.100 GeV/c, $\theta_{SHMS} = 9.00$, $P_{SHMS}$=-5.270 GeV/c | | | | | | | |
| 70 | C, LH2 | 656 kHz | 10 | 86 kHz | 6 | 1 kHz | 1 kHz | 10 min |
| 55 | LD2, C, LH2 | 516 kHz | 9 | 68 kHz | 6 | 1 kHz | 1 kHz | 10 min |
| 40 | LD2, Dummy, C, LH2 | 375 kHz | 9 | 49 kHz | 6 | 1 kHz | 1 kHz | 10 min |
| 25 | LD2, C, LH2 | 234 kHz | 8 | 31 kHz | 5 | 1 kHz | 1 kHz | 10 min |
| 18 | LD2, C, LH2 | 169 kHz | 8 | 22 kHz | 4 | 1 kHz | 1 kHz | 10 min |
| 10 | LD2, C, LH2 | 94 kHz | 7 | 12 kHz | 3 | 1 kHz | 1 kHz | 10 min |
| 5 | LD2, C, LH2 | 47 kHz | 6 | 6 kHz | 2 | 1 kHz | 1 kHz | 10 min |
| 70 $\mu$A | LD2 C LH2 | Total Time (including overhead): 6.0 hrs | | | | | | 20 min for Carbon |

go back to 70 $\mu$A before changing to target

Beam had an LH2 run (back to 70 $\mu$A) Shipped, went to LH2 @ 70 $\mu$A

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

(a) **Change SHMS polarity to positive.** Turn the beam off while ramping the SHMS, and carefully follow the magnet cycling procedure.

(b) SHMS momentum = +3.260 GeV/c.

(c) SHMS angle = 12.30 deg (from TV).

(d) HMS momentum = -3.738 GeV/c.

(e) HMS angle = 12.40 deg (from TV).
item10 cm LH2 target.

(f) 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 |

rates too high

(g) Make sure the raster is on (2 × 2), and take coincidences at ~~70, 55, 40, 25, 18, 10,~~ $\mu$A. 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.

(h) At 40 $\mu$A, 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

| $\mu$A | Targets | $\frac{Rate_{SHMS}}{LHrun}$ | $\frac{PS1}{SHMS}$ | $\frac{Rate_{HMS}}{LHrun}$ | $\frac{PS4}{HMS}$ | $DAQ_{SHMS}$ | $DAQ_{HMS}$ | $\frac{Time}{run}$ |
|---|---|---|---|---|---|---|---|---|
| $\theta_{HMS}$ = 12.40, $P_{HMS}$=-3.738 GeV/c, $\theta_{SHMS}$ = 12.30, $P_{SHMS}$=+3.260 GeV/c | | | | | | | | |
| 40 | ~~LH2~~, Dummy | 746 kHz | 14 | 137 kHz | 10 | 1 kHz | 1 kHz | 0.4 hr |
| 30 | ~~LH2~~ | 560 kHz | 13 | 103 kHz | 10 | 1 kHz | 1 kHz | 0.55 hr |
| 20 | ~~LH2~~ | 373 kHz | 13 | 69 kHz | 9 | 1 kHz | 1 kHz | 0.8 hr |
| 16 | ~~LH2~~ | 299 kHz | 12 | 55 kHz | 9 | 1 kHz | 1 kHz | 1.0 hr |
| 12 | ~~LH2~~ | 224 kHz | 12 | 41 kHz | 8 | 1 kHz | 1 kHz | 1.4 hr |
| 8 | ~~LH2~~ | 149 kHz | 11 | 27 kHz | 8 | 1 kHz | 1 kHz | 2.0 hr |
| Total Time (at 100% efficiency): 6.5 hrs | | | | | | | | |

"if you can get a higher current great" garth

5. $p(e,e'\pi^+)X$ coincidences fADC deadtime study #2

(a) The Run Coordinator will advise whether to do this study, or defer it until later.

(b) SHMS momentum = +2.800 GeV/c.

(c) SHMS angle = 15.44 deg (from TV).

(d) HMS momentum = -3.870 GeV/c.

(e) HMS angle = 16.69 deg (from TV).

(f) 10 cm LH2 target.

(g) Prescale GUI settings:

| | |
|---|---|
| HMS singles DAQ disabled<br>SHMS singles DAQ disabled | all PS=–1<br>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 |

Bonus Run Plan

Take 1GeV Hms sieve run @ ~15°

~16.69°

(h) Make sure the raster is on (2 × 2), and take coincidences at 70, 55, 40, 25, 18 $\mu$A. Start at the highest current and take LH2 target data. Then go down in current ~~and repeat.~~ The goal is ~~30k~~ Solid prompt $p(e,e'\pi^+)X$ coincidences per setting.

(i) At 40 $\mu$A, 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 #2

| $\mu$A | Targets | $\frac{Rate_{SHMS}}{LHrun}$ | $\frac{PS2}{SHMS}$ | $\frac{Rate_{HMS}}{LHrun}$ | $\frac{PS4}{HMS}$ | $DAQ_{SHMS}$ | $DAQ_{HMS}$ | $\frac{Time}{run}$ |
|---|---|---|---|---|---|---|---|---|
| $\theta_{HMS}$ = 16.69, $P_{HMS}$=-3.870 GeV/c, $\theta_{SHMS}$ = 15.44, $P_{SHMS}$=+2.800 GeV/c | | | | | | | | |
| 70 | LH2 | 943 kHz | 14 | 35 kHz | 8 | 1 kHz | 1 kHz | 0.8 hr |
| 55 | LH2 | 741 kHz | 14 | 28 kHz | 8 | 1 kHz | 1 kHz | 1.0 hr |
| 40 | LH2, Dummy | 539 kHz | 13 | 20 kHz | 8 | 1 kHz | 1 kHz | 1.4 hr |
| 25 | LH2 | 337 kHz | 13 | 13 kHz | 7 | 1 kHz | 1 kHz | 2.2 hr |
| 18 | LH2 | 243 kHz | 12 | 9 kHz | 6 | 1 kHz | 1 kHz | 3.0 hr |
| Total Time (at 100% efficiency): 8.7 hrs | | | | | | | | |

NOTIFY SIMONA that we are switching HMS to 1 GeV/c. -she will want to recheck (and lower) the HMS Calorimeter thresholds before we start taking data.

## $Q^2$=6.0, $W$=3.19, $x$=0.39, low $\epsilon$ data taking

Nominal $Q^2$=6.0 GeV$^2/c^2$, $W$=3.19 GeV, $x$=0.39 Kinematics

| $E_e$ GeV | $E_{e'}$ GeV | $\theta_{e'}$ deg | $\epsilon$ | $\lvert t\rvert$ (GeV/c)$^2$ | $p_\pi$ GeV/c | $\theta_q$ deg |
|---|---|---|---|---|---|---|
| 9.177 | 1.026 | 47.04 | 0.179 | 0.214 | | |

1. $p(e,e'\pi^+)n$ LH2 SHMS left ($\theta = 7.06^o$) run.

   Set up the following configuration:

   (a) HMS angle = 47.04 deg (from TV).

   (b) HMS momentum = –1.026 GeV/c. Negative pola

   (c) Move the SHMS 7.06 deg (from TV). **The Run ( in advance which expert personnel (e.g. A to monitor remotely.** Be sure to record and p value to 0.005 degree precision.

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

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

   (f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) For 70 $\mu$A beam and the projected rates listed belo 100 Hz HMS and SHMS singles event rates to dis

| 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 $\pi^-$ rate | SHMS $\pi^+$ rate | SHMS $K$ rate | SHMS $p$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + p)$ | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 0.12 kHz | 34 kHz | 29 kHz | 16 kHz | 12 kHz | 32 Hz | 0.03 Hz |

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

   (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 82 hours (at 100% efficiency) to give 10,000 p(e, e'$\pi^+$)n coincidences.** Use the physics replay to keep track of the event total. See note regarding running on next page.

3/4 Run

Dummy

⇒ Once a week 3/4 + 3/4 coin run if rates OK.

→ If rates too high, then just a dedicated 3/4 singles run.

→ 70 + 40 ?

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 7.06^o$) 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.
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 target).

**Take data for 8 hours (100% efficiency) at 40 $\mu$A.**

**NOTE:** We prefer to alternate LH2 and Dummy target data acquisition. Each ~~shift~~ day, try to take one Dummy target run of approximately 0.8 hours long, and the rest of the shift as LH2 data taking, as conditions permit.

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 5.50^o$) run.

(a) Move the SHMS to 5.50 deg (from TV). **This requires a hall access. The Run Co-ordinator will need to arrange in advance which expert personnel (e.g. Amy Comer, Steve Lassiter) need to be present.** Record and photograph the actual achieved vernier angle to 0.005 degree precision.

(b) Put the 10 cm LH2 target back in. Leave the spectrometer magnet settings unchanged.

(c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For 70 $\mu$A beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 220 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 $\pi^-$ rate | SHMS $\pi^+$ rate | SHMS $K$ rate | SHMS $p$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$ | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 0.12 kHz | 34 kHz | 112 kHz | 56 kHz | 33 kHz | 114 Hz | 0.03 Hz |

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

(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 approximately 82 hours (at 100% efficiency) to give 10,000 p(e, e'$\pi^+$)n coincidences.** Use the physics replay to keep track of the event total.

See note regarding running on next page.

↑ 45 μA instead ↓ 70 μA

4. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 5.50^o$) 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.
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 target).

**Take data for ~~8~~ hours (100% efficiency) at 40 $\mu$A.**

↳ Scale down to 5.5hrs since we're taking LH2 data @ 45uA

**NOTE:** We prefer to alternate LH2 and Dummy target data acquisition. Each ~~shift~~ day, try to take one Dummy target run of approximately 0.8 hours long, and the rest of the shift as LH2 data taking, as conditions permit.

## $Q^2$=8.5, $W$=2.79, $x$=0.55, low $\epsilon$ data taking

Nominal $Q^2$=8.5 GeV$^2/c^2$, $W$=2.79 GeV, $x$=0.55 Kinematics

| $E_e$ GeV | $E_{e'}$ GeV | $\theta_{e'}$ deg | $\epsilon$ | $\lvert t\rvert$ (GeV/c)$^2$ | $p_\pi$ GeV/c | $\theta_q$ deg |
|---|---|---|---|---|---|---|
| 9.177 | 0.968 | 58.53 | 0.151 | 0.550 | 7.913 | -5.44 |

1. $p(e,e'\pi^+)n$ LH2 SHMS center ($\theta = 5.50^o$) run.
   Set up the following configuration:
   (a) HMS angle = 58.53 deg (from TV).
   (b) HMS momentum = –0.968 GeV/c. Negative polarity
   (c) SHMS angle = 5.50 deg (should already be there). Carefully record and photograph the achieved TV angle.
   (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 ~~50~~ 42 $\mu$A beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 220 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) | 5 |
| 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 $\pi^-$ rate | SHMS $\pi^+$ rate | SHMS $K$ rate | SHMS $p$ rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$ | Real coinc. $e^- \cdot \pi$ |
|---|---|---|---|---|---|---|
| 0.03 kHz | 9 kHz | 131 kHz | 63 kHz | 37 kHz | 33 Hz | 0.01 Hz |

   (g) Update *standard.kinematics* with the new settings.
   (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 307 hours (at 100% efficiency) to give 13,000 p(e, e'$\pi^+$)n coincidences.** Use the physics replay to keep track of the event total.

See note regarding running on next page.

42 μA instead of 70 μA

2. $\boxed{\text{Al}(e,e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 5.50^o$) 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.
DO NOT modify *standard.kinematics* for this run (i.e. keep as for LH2 target).

**Take data for ~~3~~ hours (100% efficiency) at 40 $\mu$A.**

↳ can be scaled down to ~20hrs since 40uA on Dummy is a higher fraction of Physics 4zuA beam current than if we had 7uA

**NOTE:** We prefer to alternate LH2 and Dummy target data acquisition. Each ~~shift~~ day, try to take one Dummy target run of approximately 0.8 hours long, and the rest of the shift as LH2 data taking, as conditions permit.

3. **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.

Take an HMS -3/4 Trigger run every 3-4 days.