

Pion-LT Run Plan - Part 3

September 1, 2022

6.399 GeV Beam Plan

Initial beam activities

- While waiting for beam, configure the spectrometers for beam checkout:
 1. **Change SHMS polarity to positive.** Turn the beam off while ramping the SHMS, and carefully follow the magnet cycling procedure.
 2. HMS angle = 13.81 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
 3. HMS momentum = -3.921 GeV/c. Negative polarity. (follow the magnet cycling procedure).
 4. SHMS angle = 17.86 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
 5. SHMS momentum = 2.412 GeV/c.
 6. Update *standard.kinematics* with the new settings.
 7. Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For 50 μ A beam and the projected rates listed above, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 215 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 \times SHMS-3/4) | -1 |
| PS6(HMS-3/4 \times SHMS-3/4) | -1 |
| EDTM Target Prescale Rate | 10 Hz |
| cermode10 | ON |

8. HMS large and SHMS collimators.
 9. **Warning!!! Rates are high here!!!** 50 μ A beam is the highest that is recommended. 2×2 raster should be 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.
Do this step only if MCC is unable to restore the beam positions used at the previous energy.
Use the gui at: `/home/cdaq/users/gaskellld/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).

- 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. Due to very high rate settings at this beam, **we will need a special BCM calibration to estimate as accurately as possible to a current as low as 1 μA** , in addition to the regular BCM Calibration reliable at 80 μA beam. This requires MCC’s ability to reliably deliver 65-80 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.

$Q^2=1.45$, $W=2.02$, $x=0.3118$, high ϵ data taking

| Nominal $Q^2=1.45$ GeV $^2/c^2$, $W=2.02$ GeV, $x=0.3118$ Kinematics | | | | | | |
|---|----------|---------------|------------|--------------|---------|------------|
| E_e | $E_{e'}$ | $\theta_{e'}$ | ϵ | $ t $ | p_π | θ_q |
| GeV | GeV | deg | | (GeV/c) 2 | GeV/c | deg |
| 6.399 | 3.921 | 13.81 | 0.867 | 0.114 | 2.412 | -19.86 |

1. $p(e, e'\pi^+)n$ LH2 SHMS right ($\theta = 17.86^\circ$) run.

Set up the following configuration:

- (a) Do not change the spectrometer angles or momenta. They should be the same as the previous setting.
- (b) Insert 10 cm LH2 target.
- (c) Update *standard.kinematics* with the new settings.
- (d) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For **50 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 2800 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) | 11 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 92 kHz | 16 kHz | 241 kHz | 48 kHz | 161 kHz | 2600 Hz | 58 Hz |

- (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 0.5 hour (at 100% efficiency) at 50 μA to give 104,000 $p(e, e'\pi^+)$ n coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 10 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 ($\theta = 17.86^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

Take data for 0.1 hour (100% efficiency) at 40 μA .

3. $p(e, e'\pi^+)n$ LH2 SHMS center ($\theta = 19.86^\circ$) run.

- (a) Move the SHMS to 19.86 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) Insert the LH2 target. Leave the spectrometer magnet settings unchanged.
- (c) Update *standard.kinematics* with the new settings.
- (d) 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 a 2500 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 \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 111 kHz | 20 kHz | 162 kHz | 34 kHz | 129 kHz | 2200 Hz | 18-20 Hz |

- (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 **unlick the fadcmode10 setting button**.
- (f) **Take data for 0.5 hour (100% efficiency) at 60 μA to get about 120,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total. The first run should be ~ 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. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 19.86^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

Take data for 0.1 hours (100% efficiency) at 40 μA .

5. $p(e, e'\pi^+)n$ LH2 SHMS left ($\theta = 21.86^\circ$) run.

- (a) Move the SHMS 21.86 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) Put in the LH2 target. Leave the spectrometer magnet settings unchanged.
- (c) Update *standard.kinematics* with the new settings.
- (d) 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 2600 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 \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 147 kHz | 26 kHz | 114 kHz | 26 kHz | 114 kHz | 2300 Hz | 25-27 Hz |

- (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 0.5 hour (at 100% efficiency) at 80 μA to get about 160,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 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 ($\theta = 21.86^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

Take data for 0.1 hours (100% efficiency) at 40 μA .

6.399 GeV fADC Deadtime Study

This is an optional setting to fill time before changing SHMS aerogel from the $n = 1.015$ tray, to the $n = 1.011$ tray. If there is significant delays the RC may decide to cut any amount of this setting in order to schedule the change with Vladimir Berdnikov and the other Hall C techs. The tray must be replaced before the starting the $Q^2 = 2.73$, $W = 2.63$, setting, but the Heep coins may be done before or after the change.

1. Insert the 10 cm LH2 target, and leave the spectrometer settings unchanged from the previous setting.
2. Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz. The predicted prescale values are listed in the table below. Keep PS5 = 0 at all times. Beam current is assumed to be 80 μA .

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

3. DO NOT check fADCmode10 in the coda GUI!
4. Take 50000 pion events at each setting current. Estimated run time is in at 100% efficiency.

| 6.399 GeV $p(e, e'\pi^+)n$ fADC Deadtime Study | | | | | | | | |
|--|---------|-----------------------------|--------------------|----------------------------|-------------------|---------------------|--------------------|--------------------|
| μA | Targets | $\frac{Rate_{SHMS}}{LHrun}$ | $\frac{PS1}{SHMS}$ | $\frac{Rate_{HMS}}{LHrun}$ | $\frac{PS4}{HMS}$ | DAQ _{SHMS} | DAQ _{HMS} | $\frac{Time}{run}$ |
| $\theta_{HMS} = 13.81$, $P_{HMS} = -3.921$ GeV/c, $\theta_{SHMS} = 21.86$, $P_{SHMS} = +2.412$ GeV/c | | | | | | | | |
| 60 | LH2 | 191 kHz | 12 | 131 kHz | 11 | 100 Hz | 100 Hz | 0.20 hr |
| 40 | LH2 | 127 kHz | 11 | 87 kHz | 10 | 100 Hz | 100 Hz | 0.30 hr |
| 30 | LH2 | 96 kHz | 11 | 65 kHz | 10 | 100 Hz | 100 Hz | 0.40 hr |
| 20 | LH2 | 64 kHz | 10 | 43 kHz | 9 | 100 Hz | 100 Hz | 0.60 hr |
| 12 | LH2 | 38 kHz | 9 | 26 kHz | 9 | 100 Hz | 100 Hz | 1.0 hr |
| Total Time (at 100% efficiency): 2.5 hrs | | | | | | | | |

Heep-check coincidence runs

1. $p(e, e'p)$ equal angles and momenta setting

6.399 GeV Heep-check coincidence run

| θ_{HMS} | P_{HMS} | θ_{SHMS} | P_{SHMS} | $Rate_{HMS}$ | $Rate_{DAQ}$ | Time |
|----------------|-----------|-----------------|------------|--------------|--------------|--------|
| 18.60 | -4.752 | 37.98 | 2.412 | 156 Hz | 215 Hz | 10 min |

Set up the following configuration:

- (a) **Change SHMS polarity to positive.** Turn the beam off while ramping the SHMS, and carefully follow the magnet cycling procedure.
- (b) Set the SHMS magnets to +2.412 GeV/c.
- (c) SHMS angle = 37.98 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (d) Set HMS magnets to -4.752 GeV/c (follow the magnet cycling procedure).
- (e) HMS angle = 18.60 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (f) Update *standard.kinematics* with the new settings.
- (g) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For 80 μ A beam and the projected rates listed above, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 215 Hz DAQ rate overall.

| Projected prescale GUI settings: | |
|-----------------------------------|-------|
| PS1(SHMS-3/4) | 5 |
| PS2(SHMS-ELREAL) | -1 |
| PS3(HMS-3/4) | -1 |
| PS4(HMS-ELREAL) | 3 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times SHMS-3/4) | -1 |
| EDTM Target Prescale Rate | 10 Hz |
| cermode10 | ON |

- (h) HMS large and SHMS collimators.
- (i) Stable 80 μ A beam with 2×2 raster on.

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.**

Data: Take one run with a total of 90,000 $e + p$ elastic scattering coincidences. This run should be taken for 10 minutes at 100% efficiency, and should be immediately analyzed, checking E_{miss} and p_{miss} , while taking the Dummy.

Estimated Running Time: 10 minutes at 100% efficiency.

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

Insert the “thick” dummy target (± 5 cm) and **run for 6 minutes** at $40 \mu\text{A}$ (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

6.399 GeV Heep-check coincidence run

| θ_{HMS} | P_{HMS} | θ_{SHMS} | P_{SHMS} | $Rate_{HMS}$ | $Rate_{DAQ}$ | Time |
|----------------|-----------|-----------------|------------|--------------|--------------|--------|
| 21.10 | -4.391 | 34.47 | 2.792 | 76 Hz | 238 Hz | 10 min |

Set up the following configuration:

- Set the SHMS magnets to +2.792 GeV/c (follow the magnet cycling procedure).
- SHMS angle = 34.474 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- Set HMS magnets to -4.391 GeV/c.
- HMS angle = 21.10 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- Update *standard.kinematics* with the new settings.
- Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For 70 μ A beam and the projected rates listed above, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 238 Hz DAQ rate overall.

| Projected prescale GUI settings: | |
|-----------------------------------|-------|
| PS1(SHMS-3/4) | 4 |
| PS2(SHMS-ELREAL) | -1 |
| PS3(HMS-3/4) | -1 |
| PS4(HMS-ELREAL) | 5 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times SHMS-3/4) | -1 |
| EDTM Target Prescale Rate | 10 Hz |
| cermode10 | ON |

- HMS large and SHMS collimators.
- Stable 80 μ A beam with 2×2 raster on.

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**.

Data: Take one run with a total of 45,000 $e + p$ elastic scattering coincidences. This run should be taken for 10 minutes at 100% efficiency, and should be immediately analyzed, checking E_{miss} and p_{miss} , while taking the Dummy.

Estimated Running Time: 10 min at 100% efficiency.

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

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

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

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

6.399 GeV Heep-check coincidence run

| θ_{HMS} | P_{HMS} | θ_{SHMS} | P_{SHMS} | $Rate_{HMS}$ | $Rate_{DAQ}$ | Time |
|----------------|-----------|-----------------|------------|--------------|--------------|--------|
| 26.55 | -3.716 | 28.46 | 3.493 | 21 Hz | 244 Hz | 20 min |

Set up the following configuration:

- Set the SHMS magnets to +3.493 GeV/c (follow the magnet cycling procedure).
- SHMS angle = 28.46 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- Set HMS magnets to -3.727 GeV/c.
- HMS angle = 26.55 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- Update *standard.kinematics* with the new settings.
- Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For 70 μ A beam and the projected rates listed above, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 244 Hz DAQ rate overall.

| Projected prescale GUI settings: | |
|-----------------------------------|-------|
| PS1(SHMS-3/4) | 3 |
| PS2(SHMS-ELREAL) | -1 |
| PS3(HMS-3/4) | -1 |
| PS4(HMS-ELREAL) | 2 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times SHMS-3/4) | -1 |
| EDTM Target Prescale Rate | 10 Hz |
| cermode10 | ON |

- HMS large and SHMS collimators.
- Stable 80 μ A beam with 2×2 raster on.

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**.

Data: Take two runs with a combined total of 25,000 $e + p$ elastic scattering coincidences. The first run should be taken for 10 minutes at 100% efficiency, and should be immediately analyzed, checking E_{miss} and p_{miss} , while taking the second run.

Estimated Running Time: 20 min at 100% efficiency.

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

Insert the “thick” dummy target (± 5 cm) and **run for 10 minutes** at $40 \mu\text{A}$ (assuming 100% efficiency).

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

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

6.399 GeV Heep-check coincidence run

| θ_{HMS} | P_{HMS} | θ_{SHMS} | P_{SHMS} | $Rate_{HMS}$ | $Rate_{DAQ}$ | Time |
|----------------|-----------|-----------------|------------|--------------|--------------|--------|
| 28.40 | -3.514 | 26.81 | 3.706 | 14 Hz | 315 Hz | 25 min |

Set up the following configuration:

- Set the SHMS magnets to +3.706 GeV/c (follow the magnet cycling procedure).
- SHMS angle = 26.81 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- Set HMS magnets to -3.514 GeV/c.
- HMS angle = 28.40 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- Update *standard.kinematics* with the new settings.
- Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For 70 μ A beam and the projected rates listed above, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 315 Hz DAQ rate overall.

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

- HMS large and SHMS collimators.
- Stable 80 μ A beam with 2×2 raster on.

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**.

Data: Take two runs with a combined total of 21,000 $e + p$ elastic scattering coincidences. The first run should be taken for 10 minutes at 100% efficiency, and should be immediately analyzed, checking E_{miss} and p_{miss} , while taking the second run.

Estimated Running Time: 25 min at 100% efficiency.

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

Insert the “thick” dummy target (± 5 cm) and **run for 10 minutes** at $40 \mu\text{A}$ (assuming 100% efficiency).

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

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

6.399 GeV Heep-check coincidence run

| θ_{HMS} | P_{HMS} | θ_{SHMS} | P_{SHMS} | $Rate_{HMS}$ | $Rate_{DAQ}$ | Time |
|----------------|-----------|-----------------|------------|--------------|--------------|--------|
| 33.35 | -3.014 | 23.12 | 4.220 | 6 Hz | 802 Hz | 1 hour |

Set up the following configuration:

- Set the SHMS magnets to +4.220 GeV/c (follow the magnet cycling procedure).
- SHMS angle = 23.12 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- Set HMS magnets to -3.014 GeV/c.
- HMS angle = 33.35 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- Update *standard.kinematics* with the new settings.
- Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For 70 μ A beam and the projected rates listed above, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and a 802 Hz DAQ rate overall.

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

- HMS large and SHMS collimators.
- Stable 80 μ A beam with 2×2 raster on.

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**.

Data: Take two runs with a combined total of 21,000 $e + p$ elastic scattering coincidences. The first run should be taken for 30 minutes at 100% efficiency, and should be immediately analyzed, checking E_{miss} and p_{miss} , while taking the second run.

Estimated Running Time: 1 hour at 100% efficiency.

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

Insert the “thick” dummy target (± 5 cm) and **run for 10 minutes** at $40 \mu\text{A}$ (assuming 100% efficiency).

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

Q²=2.73, W=2.63, x=0.3114, low ϵ data taking

| Nominal $Q^2=2.73 \text{ GeV}^2/c^2$, $W=2.63 \text{ GeV}$, $x=0.3114$ Kinematics | | | | | | |
|---|----------|---------------|------------|----------------------|---------|------------|
| E_e | $E_{e'}$ | $\theta_{e'}$ | ϵ | $ t $ | p_π | θ_q |
| GeV | GeV | deg | | (GeV/c) ² | GeV/c | deg |
| 6.399 | 1.727 | 28.77 | 0.458 | 0.118 | 4.605 | -9.66 |

1. $p(e, e'\pi^+)n$ LH2 SHMS right ($\theta = 7.66^\circ$) run.

Set up the following configuration:

- (a) HMS angle = 28.77 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) HMS momentum = -1.727 GeV/c. Negative polarity. (follow the magnet cycling procedure).
- (c) SHMS angle = 7.66 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (d) SHMS momentum = 4.605 GeV/c.
- (e) 10 cm LH2 target.
- (f) Update *standard.kinematics* with the new settings.
- (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 830 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) | 8 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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 kHz | 49 kHz | 491 kHz | 149 kHz | 149 kHz | 630 Hz | 2.5-2.7 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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 30 min 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 approximately 1.3 hour (at 100% efficiency) at 80 μA to give 11,000 $p(e, e'\pi^+)$ n coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 30 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 ($\theta = 7.66^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

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

3. $p(e, e'\pi^+)n$ LH2 SHMS center ($\theta = 9.66^\circ$) run.

- (a) Move the SHMS to 9.66 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) Insert the LH2 target. Leave the spectrometer magnet settings unchanged.
- (c) Update *standard.kinematics* with the new settings.
- (d) 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 510 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) | 8 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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 kHz | 49 kHz | 183 kHz | 59 kHz | 75 kHz | 250 Hz | 2.5-2.7 Hz |

- (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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 30 min 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.
- (g) **Take data for 1.3 hours (100% efficiency) at 80 μA to get about 11,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total. The first run should be ~ 30 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. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 9.66^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

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

5. $p(e, e'\pi^+)n$ LH2 SHMS left ($\theta = 11.66^\circ$) run.

- (a) Move the SHMS 11.66 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) Put in the LH2 target. Leave the spectrometer magnet settings unchanged.
- (c) Update *standard.kinematics* with the new settings.
- (d) 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) | 11 |
| PS2(SHMS-ELREAL) | -1 |
| PS3(HMS-3/4) | -1 |
| PS4(HMS-ELREAL) | 8 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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 kHz | 49 kHz | 65 kHz | 23 kHz | 35 kHz | 100 Hz | 2.5-2.7 Hz |

- (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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 30 min 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.
- (g) **Take data for approximately 1.3 hour (at 100% efficiency) at 80 μA to get about 11,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 30 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 ($\theta = 11.66^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

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

$Q^2=3.85$, $W=2.62$, $x=0.3915$, low ϵ data taking

| Nominal $Q^2=3.85$ GeV $^2/c^2$, $W=2.62$ GeV, $x=0.3915$ Kinematics | | | | | | |
|---|----------|---------------|------------|--------------|---------|------------|
| E_e | $E_{e'}$ | $\theta_{e'}$ | ϵ | $ t $ | p_π | θ_q |
| GeV | GeV | deg | | (GeV/c) 2 | GeV/c | deg |
| 6.399 | 1.158 | 42.23 | 0.292 | 0.208 | 5.127 | -8.00 |

1. $p(e, e'\pi^+)n$ LH2 SHMS left ($\theta = 10.00^\circ$) run.

Set up the following configuration:

- (a) HMS angle = 42.23 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) HMS momentum = -1.158 GeV/c. Negative polarity. (follow the magnet cycling procedure).
- (c) SHMS angle = 10.00 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (d) SHMS momentum = 5.127 GeV/c.
- (e) 10 cm LH2 target.
- (f) Update *standard.kinematics* with the new settings.
- (g) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For **80 μ 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 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 \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 0.5 kHz | 34 kHz | 61 kHz | 23 kHz | 31 kHz | 51 Hz | 0.40-0.47 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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 1 hour 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 approximately 7 hour (at 100% efficiency) at 80 μA to give 10,000 $\text{p}(e, e'\pi^+)\text{n}$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 1 hour (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 ($\theta = 10.00^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

Take data for 1.4 hour (100% efficiency) at 40 μA .

3. $n(e, e'\pi^+)p$ LD2 SHMS left ($\theta = 10.00^\circ$) run.

Set up the following configuration:

- (a) Insert 10 cm LD2 target. Leave the spectrometer settings unchanged.
- (b) Update *standard.kinematics* with the new settings.
- (c) 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 432 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) | 8 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 0.9 kHz | 69 kHz | 121 kHz | 46 kHz | 62 kHz | 205 Hz | 0.40-0.47 Hz |

- (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 1 hour 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 approximately 7 hour (at 100% efficiency) at 80 μA to give 10,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 1 hour (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. $n(e, e'\pi^+)p$ LD2 SHMS center ($\theta = 8.00^\circ$) run.

- (a) Move the SHMS 8.00 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) Put in the LD2 target. (Should already be there.) Leave the spectrometer magnet settings unchanged.
- (c) Update *standard.kinematics* with the new settings.
- (d) 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 830 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 \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 0.9 kHz | 69 kHz | 366 kHz | 128 kHz | 135 kHz | 563 Hz | 0.40-0.47 Hz |

- (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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 1 hour 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.
- (g) **Take data for approximately 7 hour (at 100% efficiency) at 80 μA to get about 10,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 1 hour (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 ($\theta = 8.00^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

Take data for 1.4 hours (100% efficiency) at 40 μA .

6. $p(e, e'\pi^+)n$ LH2 SHMS center ($\theta = 8.00^\circ$) run.

- (a) Put in the LH2 target. Leave the spectrometer settings unchanged.
- (b) Update *standard.kinematics* with the new target.
- (c) 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 409 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 \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 0.5 kHz | 34 kHz | 183 kHz | 64 kHz | 67 kHz | 141 Hz | 0.40-0.47 Hz |

- (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 1 hour 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 approximately 7 hour (at 100% efficiency) at 80 μA to get about 10,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 30 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.

$Q^2=1.60$, $W=3.06$, $x=0.1568$, low ϵ data taking

| Nominal $Q^2=1.60$ GeV ² /c ² , $W=3.06$ GeV, $x=0.1568$ Kinematics | | | | | | |
|---|----------|---------------|------------|----------------------|---------|------------|
| E_e | $E_{e'}$ | $\theta_{e'}$ | ϵ | $ t $ | p_π | θ_q |
| GeV | GeV | deg | | (GeV/c) ² | GeV/c | deg |
| 6.399 | 0.960 | 29.55 | 0.269 | 0.026 | 5.422 | -4.87 |

1. $p(e, e'\pi^+)n$ LH2 SHMS left ($\theta = 7.50^\circ$) run.

Set up the following configuration:

- (a) HMS angle = 29.55 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) HMS momentum = -0.960 GeV/c. Negative polarity. (follow the magnet cycling procedure).
- (c) SHMS angle = 7.50 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (d) SHMS momentum = 5.422 GeV/c.
- (e) 10 cm LH2 target.
- (f) Update *standard.kinematics* with the new settings.
- (g) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For **80 μ 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 455 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) | 8 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 2 kHz | 46 kHz | 149 kHz | 54 kHz | 55 kHz | 219 Hz | 0.9 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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 30 min 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 approximately 3.1 hour (at 100% efficiency) at 80 μA to give 10,000 $p(e, e'\pi^+)$ n coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 30 min (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 ($\theta = 7.50^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

Take data for 0.6 hour (100% efficiency) at 40 μA .

3. $n(e, e'\pi^+)p$ LD2 SHMS left ($\theta = 7.50^\circ$) run.

Set up the following configuration:

- (a) Insert 10 cm LD2 target. Leave the spectrometer settings unchanged.
- (b) Update *standard.kinematics* with the new settings.
- (c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For $80 \mu\text{A}$ beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 1111 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 \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 5 kHz | 93 kHz | 297 kHz | 107 kHz | 110 kHz | 875 Hz | 0.9 Hz |

- (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 30 min 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 approximately 3.1 hour (at 100% efficiency) at $80 \mu\text{A}$ to give 10,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 30 min (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. $n(e, e'\pi^+)p$ LD2 SHMS center ($\theta = 5.50^\circ$) run.

(a) Move the SHMS 5.50 deg (from TV). **This will require a hall access, The Run Coordinator will need to arrange in advance which expert personnel (e.g. Amy Comer, Steve Lassiter) and spotters need to be present.** Be sure to record and photograph the actual vernier value to 0.005 degree precision.

(b) Put in the LD2 target. (Should already be there.) Leave the spectrometer magnet settings unchanged.

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

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

For **35 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 705 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 \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 2 kHz | 41 kHz | 400 kHz | 120 kHz | 96 kHz | 458 Hz | 0.4 Hz |

(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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 1 hour 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.

(g) **Take data for approximately 7 hour (at 100% efficiency) at 35 μA to get about 10,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 1 hour (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 ($\theta = 5.50^\circ$) run.

Now put in the “thick” dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.

If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 target).

Take data for 1.4 hours (100% efficiency) at 40 μA .

6. $p(e, e'\pi^+)n$ LH2 SHMS center ($\theta = 5.50^\circ$) run.

- (a) Put in the LH2 target. Leave the spectrometer settings unchanged.
- (b) Update *standard.kinematics* with the new target.
- (c) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For **65 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 625 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 \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times 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. $e^- \cdot \pi$ |
|-------------------|---------------------|----------------------|------------------|------------------|--|--------------------------------|
| 2 kHz | 38 kHz | 371 kHz | 111 kHz | 89 kHz | 395 Hz | 0.7 Hz |

- (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 30 min 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 approximately 4 hour (at 100% efficiency) at 65 μA to get about 10,000 $p(e, e'\pi^+)n$ coincidences.** Use the physics replay to keep track of the event total.

The first run should be ~ 30 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.

$Q^2=3.85$, $W=2.62$, $x=0.3915$, low ϵ data taking

| Nominal $Q^2=3.85$ GeV $^2/c^2$, $W=2.62$ GeV, $x=0.3915$ Kinematics | | | | | | |
|---|----------|---------------|------------|--------------|---------|------------|
| E_e | $E_{e'}$ | $\theta_{e'}$ | ϵ | $ t $ | p_π | θ_q |
| GeV | GeV | deg | | (GeV/c) 2 | GeV/c | deg |
| 6.399 | 1.158 | 42.23 | 0.292 | 0.208 | 5.127 | -8.00 |

1. $n(e, e'\pi^-)p$ LD2 SHMS center ($\theta = 8.00^\circ$) run.

Set up the following configuration:

- (a) HMS angle = 42.23 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) HMS momentum = -1.158 GeV/c. Negative polarity.
- (c) SHMS angle = 8.00 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (d) SHMS momentum = -5.127 GeV/c. Negative polarity. (follow the magnet cycling procedure).
- (e) 10 cm LD2 target.
- (f) Update *standard.kinematics* with the new settings.
- (g) Rate will be very high at this setting. Make sure the rates do not exceed the following: SHMS-S1X around 2.5MHz and SHMS-3/4 up to 700kHz
- (h) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For **7 μ 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 260 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) | 4 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times SHMS-3/4) | -1 |
| EDTM Target Prescale Rate | 10 Hz |
| cermode10 | ON |

| HMS | HMS | SHMS | SHMS | Random coinc. | Real coinc. |
|------------|--------------|------------|--------------|---|-------------------|
| e^- rate | π^- rate | e^- rate | π^- rate | $(e^- + \frac{\pi^-}{5}) \cdot (\pi^- + e^-)$ | $e^- \cdot \pi^-$ |
| 0.08 kHz | 6.0 kHz | 772 kHz | 18 kHz | 62 Hz | 0.02-0.06 Hz |

- (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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 1 hour 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.
- (k) **Take data for approximately 40.0 hours (at 100% efficiency) to give 5200 $n(e, e'\pi^-)p$ coincidences.** Use the physics replay to keep track of the event total. The first 1 hour run 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 center ($\theta = 8.00^\circ$) 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 target).
- Take data for 8.0 hours (100% efficiency) at 40 μA .**

3. $n(e, e'\pi^-)p$ LD2 SHMS left ($\theta = 10.00^\circ$) run.

Set up the following configuration:

- (a) SHMS angle = 10.00 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) Insert the 10 cm LD2 target. Leave all other spectrometer settings unchanged.
- (c) Update *standard.kinematics* with the new settings.
- (d) Rate will be very high at this setting. Make sure the rates do not exceed the following: SHMS-S1X around 2.5MHz and SHMS-3/4 up to 700kHz
- (e) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For **27 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) | 14 |
| PS2(SHMS-ELREAL) | -1 |
| PS3(HMS-3/4) | -1 |
| PS4(HMS-ELREAL) | 6 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times SHMS-3/4) | -1 |
| EDTM Target Prescale Rate | 10 Hz |
| cermode10 | ON |

| HMS e^- rate | HMS π^- rate | SHMS e^- rate | SHMS π^- rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi^- + e^-)$ | Real coinc. $e^- \cdot \pi^-$ |
|-------------------|---------------------|--------------------|----------------------|--|----------------------------------|
| 0.3 kHz | 23.1 kHz | 769 kHz | 23 kHz | 239 Hz | 0.12-0.16 Hz |

- (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**.
- (g) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 1 hour 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.
- (h) **Take data for approximately 10.5 hours (at 100% efficiency) to give 5200 $n(e, e'\pi^-)p$ coincidences.** Use the physics replay to keep track of the event total. The first 1 hour run 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. $\boxed{\text{Al}(e, e'\pi^-)X}$ Thick Dummy target SHMS center ($\theta = 10.00^\circ$) 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 target).

Take data for 2.1 hours (100% efficiency) at 40 μA .

$Q^2=1.60$, $W=3.08$, $x=0.1568$, low ϵ data taking

| Nominal $Q^2=1.60$ GeV ² /c ² , $W=3.08$ GeV, $x=0.1568$ Kinematics | | | | | | |
|---|----------|---------------|------------|----------------------|---------|------------|
| E_e | $E_{e'}$ | $\theta_{e'}$ | ϵ | $ t $ | p_π | θ_q |
| GeV | GeV | deg | | (GeV/c) ² | GeV/c | deg |
| 6.399 | 0.960 | 29.55 | 0.269 | 0.026 | 5.422 | -4.87 |

1. $n(e, e'\pi^-)p$ LD2 SHMS left ($\theta = 6.00^\circ$) run.

Set up the following configuration:

- (a) HMS angle = 29.55 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) HMS momentum = -0.960 GeV/c. Negative polarity.
- (c) SHMS angle = 6.00 deg (from TV). **This will require a hall access, The Run Coordinator will need to arrange in advance which expert personnel (e.g. Amy Comer, Steve Lassiter) and spotters need to be present.** Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (d) SHMS momentum = -5.422 GeV/c. Negative polarity. (follow the magnet cycling procedure).
- (e) 10 cm LD2 target.
- (f) Update *standard.kinematics* with the new settings.
- (g) Rate will be very high at this setting. Make sure the rates do not exceed the following: SHMS-S1X around 2.5MHz and SHMS-3/4 up to 700kHz
- (h) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For **1.5 μ 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 230 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) | 3 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times SHMS-3/4) | -1 |
| EDTM Target Prescale Rate | 10 Hz |
| cermode10 | ON |

| HMS | HMS | SHMS | SHMS | Random coinc. | Real coinc. |
|------------|--------------|------------|--------------|---|-------------------|
| e^- rate | π^- rate | e^- rate | π^- rate | $(e^- + \frac{\pi^-}{5}) \cdot (\pi^- + e^-)$ | $e^- \cdot \pi^-$ |
| 0.1 kHz | 1.7 kHz | 793 kHz | 7 kHz | 26 Hz | 0.05-0.09 Hz |

- (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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 1 hour 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.
- (k) **Take data for approximately 81.0 hours (at 100% efficiency) to give 5000 $n(e, e'\pi^-)p$ coincidences.** Use the physics replay to keep track of the event total. The first 1 hour run 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 ($\theta = 6.00^\circ$) 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: $40 \mu\text{A}$.

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

Take data for 16.2 hours (100% efficiency) at $40 \mu\text{A}$.

3. $n(e, e'\pi^-)p$ LD2 SHMS further left ($\theta = 7.50^\circ$) run.

Set up the following configuration:

- (a) SHMS angle = 7.50 deg (from TV). **The Run Co-ordinator will need to arrange in advance which expert personnel (e.g. Amy Comer, Steve Lassiter), to watch the rotation remotely.** Be sure to record and photograph the actual vernier value to 0.005 degree precision.
- (b) Insert the 10 cm LD2 target. Leave all other spectrometer settings unchanged.
- (c) Update *standard.kinematics* with the new settings.
- (d) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.

For **5.2 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) | 14 |
| PS2(SHMS-ELREAL) | -1 |
| PS3(HMS-3/4) | -1 |
| PS4(HMS-ELREAL) | 5 |
| PS5(HMS-ELREAL \times SHMS-3/4) | 0 |
| PS6(HMS-3/4 \times SHMS-3/4) | -1 |
| EDTM Target Prescale Rate | 10 Hz |
| cermode10 | ON |

| HMS e^- rate | HMS π^- rate | SHMS e^- rate | SHMS π^- rate | Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi^- + e^-)$ | Real coinc. $e^- \cdot \pi^-$ |
|-------------------|---------------------|--------------------|----------------------|--|----------------------------------|
| 0.3 kHz | 6.0 kHz | 787 kHz | 10 kHz | 88 Hz | 0.22-0.26 Hz |

- (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) **HMS-3/4 trigger run:** Since the HMS momentum is fairly low, take a 1 hour 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.
- (g) **Take data for approximately 23 hours (at 100% efficiency) to give 5000 $n(e, e'\pi^-)p$ coincidences.** Use the physics replay to keep track of the event total. The first 1 hour run 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. $\boxed{\text{Al}(e, e'\pi^-)X}$ Thick Dummy target SHMS center ($\theta = 10.00^\circ$) 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 target).

Take data for 4.7 hours (100% efficiency) at 40 μA .

6.399 GeV Luminosity Scans

Set the following configuration:

1. HMS angle = 14.00 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.
2. HMS momentum = -3.970 GeV/c. Negative polarity. (follow the magnet cycling procedure).
3. Update *standard.kinematics* with the new settings.
4. ELREAL trigger in HMS turn **SHMS OFF**. Set the PS2 = -1 , PS4 target DAQ rates to 2.5 kHz, to give a total rate to disk of about 2.5 kHz.
5. Make sure the raster is on (2×2), and take HMS and then SHMS runs at 80, 60, 40, 25, 18, 12, 8, 5, 2.5, 1 μA on LH2 target. Start at the highest current, then go down in current. Times are listed at 100% efficiency.
6. **Try to get runs with minimum beam trips (if possible).**
7. Take one Thick Dummy target run at 40 μA . 125,000 electrons per run, about 20 min. During this run, the Target Operator should park the LH2 target and prepare for LD2 data taking.
8. Repeat scans with Carbon 0.5% r.l. target.
9. Repeat scans with LD2 target.

| 6.399 GeV Luminosity Scans | | | | | |
|---|--------------------|-------------------------------|-------------------|--------------------|--------------------|
| μA | Targets | $\frac{Rate_{HMS}}{LH_{run}}$ | $\frac{PS4}{HMS}$ | DAQ _{HMS} | $\frac{Time}{run}$ |
| $\theta_{HMS} = 14.00, P_{HMS} = - - 3.970$ GeV/c | | | | | |
| 80 | LH2, LD2, C | 160 kHz | 8 | 1000 Hz | 10 min |
| 60 | LH2, LD2, C | 120 kHz | 8 | 1000 Hz | 10 min |
| 40 | LH2, LD2, Dummy, C | 80 kHz | 7 | 1000 Hz | 10 min |
| 25 | LH2, LD2, C | 50 kHz | 6 | 1000 Hz | 10 min |
| 15 | LH2, LD2, C | 30 kHz | 6 | 1000 Hz | 10 min |
| 8 | LH2, LD2, C | 16 kHz | 5 | 1000 Hz | 10 min |
| 5 | LD2, C | 10 kHz | 4 | 1000 Hz | 10 min |
| 2.5 | LD2, C | 5 kHz | 3 | 1000 Hz | 10 min |
| 1 | LD2, C | 2 kHz | 1 | 1000 Hz | 10 min |
| Total Time (Including Overhead): 11.6 Hours | | | | | |

Calibration runs with SHMS at negative polarity

1. $p(e, e')p$ 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.

- (b) Record all TV angle values on run sheets and hlog. 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:

- Set the PS2(SHMS-ELREAL) and PS4(HMS-ELREAL) target rates to 1000 Hz, all others disabled (i.e. -1). The sum of the two rates should not exceed 2500 Hz. It is also desirable that one of the prescale factors are set to 0, although this is not necessary. As a guide, projected rates and PS factors are given in the table below.
- Projected beam currents are listed below, we desire to keep the SHMS-3/4 rate below 600 kHz so adjust accordingly. Stable beam with 2×2 **raster on**.
- We want about 20,000 elastics in the SHMS, and about 10,000 elastics in the HMS for each setting, which typically requires at least 400,000 total electron events (times 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, current limit: 40 μ A.

To be efficient, please minimize target changes and do LH2, Dummy for first setting, followed by Dummy, LH2 for second setting, etc.

6.399 GeV Heep-check singles runs

| θ_{HMS} | P_{HMS} | θ_{SHMS} | P_{SHMS} | Current | $Rate_{HMS}$ | $\frac{PS4}{HMS}$ | $Rate_{SHMS}$ | $\frac{PS2}{SHMS}$ | $\frac{Time}{LH2run}$ | $\frac{Time}{ALrun}$ | Evt_{SHMS} |
|----------------|-----------|-----------------|------------|------------|--------------|-------------------|---------------|--------------------|-----------------------|----------------------|--------------|
| 13.30 | -5.587 | 8.00 | -6.265 | 10 μ A | 7.7 kHz | 4 | 60 kHz | 10 | 10 min | 6 min | 450k |
| 15.05 | -5.320 | 10.50 | -5.512 | 10 μ A | 2.9 kHz | 2 | 8.5 kHz | 8 | 10 min | 6 min | 400k |
| 17.45 | -4.752 | 12.45 | -5.4218 | 10 μ A | 1.5 kHz | 0 | 2.2 kHz | 7 | 10 min | 6 min | 240k |
| 19.90 | -4.256 | 14.35 | -5.4218 | 20 μ A | 1.7 kHz | 0 | 1.3 kHz | 6 | 10 min | 6 min | 270k |
| 28.40 | -3.716 | 16.30 | -5.127 | 80 μ A | 0.07 kHz | 0 | 25 kHz | 6 | 15 min | 6 min | 670k |
| 29.55 | -3.300 | 19.65 | -4.605 | 80 μ A | 0.2 kHz | 0 | 7.1 kHz | 5 | 15 min | 6 min | 360k |
| 34.00 | -3.000 | 21.65 | -4.200 | 80 μ A | 0.03 kHz | 0 | 4.7 kHz | 4 | 20 min | 6 min | 580k |
| 34.00 | -3.000 | 23.65 | -4.200 | 80 μ A | 0.03 kHz | 0 | 0.5 kHz | 0 | 20 min | 6 min | 340k |

Total Time (including overhead): 9 hrs

Estimated Total Time for this Run Plan: 539.1 hours