Pion-LT Run Plan - Part 3

May 30, 2022

6.399 GeV Beam Plan

Initial beam activities

- While waiting for beam, configure the spectrometers for beam checkout:

  1. **Change SHMS polarity to negative.** Carefully follow the magnet cycling procedure.
  2. SHMS angle = 8.00 deg (from TV).
  3. SHMS momentum = -2.000 GeV/c (negative polarity and magnets cycled).
  4. HMS angle = 13.00 deg (from TV).
  5. HMS momentum = -2.000 GeV/c (negative polarity and magnets cycled).
  6. Update *standard.kinematics* with the new settings (Reminder: all momenta should be entered as positive quantities).
  7. Prescale GUI settings:

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

- Beam checkout.
  Follow the notes at:
  `https://hallcweb.jlab.org/wiki/index.php/Beam_Checkout_Procedures`
  including the "Carbon-hole" check to verify beam+target alignment and MCC raster size calibration.

- 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/gaskelld/target_bpm/target_bpm.py`
  Adjust 3H07Ax,y to remove slope while keeping 3H07Cx,y fixed
  Recheck carbon hole and iterate as necessary.

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

- 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 the 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.

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.

   (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:

   - Set the PS1(SHMS-3/4) 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 μA.

   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 μA	7.7 kHz	4	60 kHz	10	10 min	6 min	450k
15.05	-5.320	10.50	-5.512	10 μA	2.9 kHz	2	8.5 kHz	8	10 min	6 min	400k
17.45	-4.763	12.45	-5.4218	10 μA	1.5 kHz	0	2.2 kHz	7	10 min	6 min	240k
19.90	-4.267	14.35	-5.4218	20 μA	1.7 kHz	0	1.3 kHz	6	10 min	6 min	270k
28.40	-3.727	16.30	-5.127	80 μA	0.07 kHz	0	25 kHz	6	15 min	6 min	670k
29.55	-3.300	19.65	-4.605	80 μA	0.2 kHz	0	7.1 kHz	5	15 min	6 min	360k
34.00	-3.000	21.65	-4.200	80 μA	0.03 kHz	0	4.7 kHz	4	20 min	6 min	580k
34.00	-3.000	23.65	-4.200	80 μA	0.03 kHz	0	0.5 kHz	0	20 min	6 min	340k

Total Time (including overhead): 9 hrs

2. 6.399 GeV Luminosity Scans 1.

   Set the following configuration:

   (a) HMS angle = 14.00 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

   (b) HMS momentum = –3.970 GeV/c. Negative polarity. (follow the magnet cycling procedure).

   (c) SHMS angle = 11.00 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

   (d) SHMS momentum = –4.770 GeV/c. Negative polarity. (follow the magnet cycling procedure).

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

   (f) 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.

   (g) Make sure the raster is on (22), and take HMS and SHMS runs at 80, 60, 40, 25, 18, 12, 8, 5, 2.5, 1 A on LH2 target. Start at the highest current, then go down in current.

   (h) **Try to get runs with minimum beam trips (if possible).**

   (i) 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.

   (j) Repeat scans with Carbon 0.5% r.l. target.

   (k) Repeat scans with LD2 target. Skip 80 and 60 μA settings as the rates will be to high.

   (l) 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.

6.399 GeV Luminosity Scans 1								
μA	Targets	$\frac{Rate_{SHMS}}{LH_{run}}$	$\frac{PS2}{SHMS}$	$\frac{Rate_{HMS}}{LH_{run}}$	$\frac{PS4}{HMS}$	DAQ_{SHMS}	DAQ_{HMS}	$\frac{Time}{run}$
$\theta_{HMS} = 14.00$, $P_{HMS} = --3.970$ GeV/c, $\theta_{SHMS} = 11.00$, $P_{SHMS} = --4.770$ GeV/c								
80	LH2, C	744 kHz	14	160 kHz	8	1000 Hz	1000 Hz	18 min
60	LH2, C	558 kHz	13	120 kHz	8	1000 Hz	1000 Hz	18 min
40	LH2, LD2, Dummy, C	372 kHz	13	80 kHz	7	1000 Hz	1000 Hz	18 min
25	LH2, LD2, C	232 kHz	12	50 kHz	6	1000 Hz	1000 Hz	18 min
18	LH2, LD2, C	167 kHz	11	36 kHz	6	1000 Hz	1000 Hz	18 min
12	LH2, LD2, C	112 kHz	11	24 kHz	5	1000 Hz	1000 Hz	18 min
8	LH2, LD2, C	74 kHz	10	16 kHz	5	1000 Hz	1000 Hz	18 min
5	LH2, LD2, C	46 kHz	10	10 kHz	4	1000 Hz	1000 Hz	18 min
2.5	LH2, LD2, C	23 kHz	9	5 kHz	3	1000 Hz	1000 Hz	18 min
1	LH2, LD2, C	9 kHz	7	2 kHz	0	1000 Hz	1000 Hz	18 min
Total Time (Including Overhead): 11.2 Hours								

3. 6.399 GeV Luminosity Scans 2.

   Set the following configuration:

   (a) HMS angle = 14.50 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

   (b) HMS momentum = –3.970 GeV/c. Negative polarity (Should already be there).

   (c) SHMS angle = 11.50 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

   (d) SHMS momentum = –4.770 GeV/c. Negative polarity (Should already be there).

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

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

   (g) Make sure the raster is on (22), and take HMS and SHMS runs at 80, 60, 40, 25, 18, 12, 8, 5, 2.5, 1 A on LH2 target. Start at the highest current, then go down in current.

   (h) **Try to get runs with minimum beam trips (if possible).**

   (i) 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 LD2data taking.

   (j) Repeat scans with Carbon 0.5% r.l. target.

   (k) Repeat scans with LD2 target. Skip 80 μA settings as the rates will be to high.

   (l) 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.

6.399 GeV Luminosity Scans 2								
μA	Targets	$\frac{Rate_{SHMS}}{LH_{run}}$	$\frac{PS2}{SHMS}$	$\frac{Rate_{HMS}}{LH_{run}}$	$\frac{PS4}{HMS}$	DAQ_{SHMS}	DAQ_{HMS}	$\frac{Time}{run}$
$\theta_{HMS} = 14.50$, $P_{HMS} = --3.970$ GeV/c, $\theta_{SHMS} = 11.50$, $P_{SHMS} = --4.770$ GeV/c								
80	LH2, C	558 kHz	13	132 kHz	8	1000 Hz	1000 Hz	18 min
60	LH2, LD2, C	418 kHz	13	99 kHz	7	1000 Hz	1000 Hz	18 min
40	LH2, LD2, Dummy, C	279 kHz	12	66 kHz	7	1000 Hz	1000 Hz	18 min
25	LH2, LD2, C	174 kHz	12	41 kHz	6	1000 Hz	1000 Hz	18 min
18	LH2, LD2, C	126 kHz	11	29 kHz	6	1000 Hz	1000 Hz	18 min
12	LH2, LD2, C	84 kHz	10	20 kHz	5	1000 Hz	1000 Hz	18 min
8	LH2, LD2, C	56 kHz	10	13 kHz	4	1000 Hz	1000 Hz	18 min
5	LH2, LD2, C	35 kHz	9	8 kHz	4	1000 Hz	1000 Hz	18 min
2.5	LH2, LD2, C	17 kHz	8	4 kHz	2	1000 Hz	1000 Hz	18 min
1	LH2, LD2, C	7 kHz	7	2 kHz	0	1000 Hz	1000 Hz	18 min
Total Time (Including Overhead): 11.4 Hours								

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	$\lvert t\rvert$	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. $\boxed{n(e,e'\pi^-)p}$ LD2 SHMS center ($\theta = 8.00^o$) 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) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **7 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi^- + e^-)$	Real coinc. $e^- \cdot \pi^-$
0.08 kHz	6.0 kHz	772 kHz	18 kHz	62 Hz	0.02-0.06 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 40.0 hours (at 100% efficiency) to give 5200 $\mathbf{n(e,e'\pi^-)p}$ 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. $\boxed{\mathrm{Al}(e,e'\pi^-)X}$ Thick Dummy target SHMS center ($\theta = 8.00^o$) run.

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

Take data for 8.0 hours (100% efficiency) at 40 μA.

3. $\boxed{n(e,e'\pi^-)p}$ LD2 SHMS left ($\theta = 10.00^o$) 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) 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)	4
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	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

   (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 10.5 hours (at 100% efficiency) to give 5200 $\mathbf{n(e,e'\pi^-)p}$ 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 ($\theta = 10.00^o$) run.

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

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

   Current limit: 40 μA.

   DO NOT modify *standard.kinematics* for this run (i.e. keep as for LD2 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	$\lvert t\rvert$	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 ($\theta = 6.00^o$) 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) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
   For **1.5 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 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS e^- rate	SHMS π^- rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi^- + e^-)$	Real coinc. $e^- \cdot \pi^-$
0.1 kHz	1.7 kHz	793 kHz	7 kHz	26 Hz	0.05-0.09 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 81.0 hours (at 100% efficiency) to give 5000 $\mathbf{n(e,e'\pi^-)p}$ 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. $\boxed{\mathrm{Al}(e,e'\pi^-)X}$ Thick Dummy target SHMS left ($\theta = 6.00^o$) run.

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

Take data for 16.2 hours (100% efficiency) at 40 μA.

3. $\boxed{n(e,e'\pi^-)p}$ LD2 SHMS further left ($\theta = 7.50^o$) 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)	6
PS5(HMS-ELREAL×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS 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 $\mathbf{n(e,e'\pi^-)p}$ 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 ($\theta = 10.00^o$) run.

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

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

   Current limit: 40 μA.

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

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

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	-4.763	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 –4.763 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 μA 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

(h) HMS large and SHMS collimators.

(i) Stable 80 μA 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. $\boxed{\mathrm{Al}(e,e'p)X}$ Thick Dummy target run for Heep-check.

   Insert the "thick" dummy target ($\pm$5 cm) and **run for 6 minutes** at 40 μA (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:

(a) Set the SHMS magnets to +2.792 GeV/c (follow the magnet cycling procedure).

(b) SHMS angle = 34.474 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

(c) Set HMS magnets to –4.391 GeV/c.

(d) HMS angle = 21.10 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

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

(f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For 70 μA 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

(g) HMS large and SHMS collimators.

(h) Stable 80 μA 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. $\boxed{\mathrm{Al}(e,e'p)X}$ Thick Dummy target run for Heep-check.

   Insert the "thick" dummy target ($\pm$5 cm) and **run for 6 minutes** at 40 μA (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	-3.727	28.46	3.493	21 Hz	244 Hz	20 min

Set up the following configuration:

(a) Set the SHMS magnets to +3.493 GeV/c (follow the magnet cycling procedure).

(b) SHMS angle = 28.46 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

(c) Set HMS magnets to –3.727 GeV/c.

(d) HMS angle = 26.55 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

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

(f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For 70 μA 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

(g) HMS large and SHMS collimators.

(h) Stable 80 μA 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. $\boxed{\mathrm{Al}(e,e'p)X}$ Thick Dummy target run for Heep-check.

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

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:

(a) Set the SHMS magnets to +3.706 GeV/c (follow the magnet cycling procedure).

(b) SHMS angle = 26.81 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

(c) Set HMS magnets to –3.514 GeV/c.

(d) HMS angle = 28.40 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

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

(f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For 70 μA 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

(g) HMS large and SHMS collimators.

(h) Stable 80 μA 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. $\boxed{\mathrm{Al}(e,e'p)X}$ Thick Dummy target run for Heep-check.

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

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:

(a) Set the SHMS magnets to +4.220 GeV/c (follow the magnet cycling procedure).

(b) SHMS angle = 23.12 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

(c) Set HMS magnets to –3.014 GeV/c.

(d) HMS angle = 33.35 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

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

(f) Set the PS1(SHMS-3/4) and PS4(HMS-ELREAL) target rates to 100 Hz.
For 70 μA 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

(g) HMS large and SHMS collimators.

(h) Stable 80 μA 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. $\boxed{\mathrm{Al}(e,e'p)X}$ Thick Dummy target run for Heep-check.

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

Q^2=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	$\lvert t\rvert$	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. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 17.86^o$) run.

   Set up the following configuration:

   (a) HMS angle = 13.81 (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

   (b) HMS momentum = –3.921 GeV/c. Negative polarity. (follow the magnet cycling procedure).

   (c) SHMS angle = 17.86 deg (from TV). Be sure to record and photograph the actual vernier value to 0.005 degree precision.

   (d) SHMS momentum = 2.412 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 **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)	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 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	15-17 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 approximately 1 hour (at 100% efficiency) at 50 μA to give 209,000 p(e, e$'\pi^+$)n coincidences.** Use the physics replay to keep track of the event total.

The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

2. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 17.86^o$) run.

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

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

Current limit: 40 μA.

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

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

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 19.86^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K$+p)	Real coinc. $e^- \cdot \pi$
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 **unclick the fadcmode10 setting button.**

(f) **Take data for 1 hour (100% efficiency) at 60 μA to get about 251,000 p$(e,e'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total.
The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

4. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS center ($\theta = 19.86^o$) run.

Now put in the "thick" dummy target (± 5 cm) and initially set prescale factors to the same as the LH2 run.
If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 21.86^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
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 1 hour (at 100% efficiency) at 80 μA to get about 293,000 p$(\mathbf{e},\mathbf{e}'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total.
   The first run should be $\sim$ 20 minutes (at 100% data taking efficiency), and should be immediately analyzed to get an indication of the pion rate. Use this to calculate how long to run to get the desired statistics.

6. $\boxed{\text{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS left ($\theta = 21.86^o$) run.

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

   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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=2.73, W=2.63, x=0.3114, low ϵ data taking

Nominal Q^2=2.73 GeV$^2/c^2$, W=2.63 GeV, x=0.3114 Kinematics

E_e GeV	$E_{e'}$ GeV	$\theta_{e'}$ deg	ϵ	$\lvert t\rvert$ (GeV/c)^2	p_π GeV/c	θ_q deg
6.399	1.727	28.77	0.458	0.118	4.605	-9.66

1. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS right ($\theta = 7.66^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
3 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 12,000 p(e, e$'\pi^+$)n coincidences.** Use the physics replay to keep track of the event total.

The first run should be $\sim$ 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. $\boxed{\mathrm{Al}(e, e'\pi^+)X}$ Thick Dummy target SHMS right ($\theta = 7.66^o$) run.

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

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

Current limit: 40 μA.

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

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

3. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 9.66^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K$+p)	Real coinc. $e^- \cdot \pi$
3 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 12,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.
   The first run should be $\sim$ 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 ($\theta = 9.66^o$) run.

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

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

5. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 11.66^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K$+p)	Real coinc. $e^- \cdot \pi$
3 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 12,000 p$(e,e'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total.
The first run should be $\sim$ 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 ($\theta = 21.86^o$) run.

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

   If the HMS and SHMS singles event rates to disk are significantly less than 100 Hz each, 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 0.3 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	$\lvert t\rvert$	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. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 10.00^o$) 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 μA** beam and the projected rates listed below, these prescale factors should give 100 Hz HMS and SHMS singles event rates to disk, and an 278 Hz DAQ rate overall.

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

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K$+p)	Real coinc. $e^- \cdot \pi$
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 p$(\mathbf{e}, \mathbf{e}'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total.

The first run should be $\sim$ 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 ($\theta = 10.00^o$) run.

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

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

   Current limit: 40 μA.

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

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

3. $\boxed{n(e,e'\pi^+)p}$ LD2 SHMS left ($\theta = 10.00^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
0.9 kHz	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$(\mathbf{e},\mathbf{e}'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total.
The first run should be $\sim$ 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. $\boxed{n(e,e'\pi^+)p}$ LD2 SHMS center ($\theta = 8.00^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
0.9 kHz	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 $\sim$ 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 ($\theta = 8.00^o$) run.

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

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

6. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 8.00^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
0.5 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 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.
   The first run should be $\sim$ 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	$\lvert t\rvert$	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. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS left ($\theta = 7.50^o$) 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 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 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
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$(\mathbf{e}, \mathbf{e}'\pi^+)$n coincidences.** Use the physics replay to keep track of the event total.

The first run should be $\sim$ 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 ($\theta = 7.50^o$) run.

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

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

   Current limit: 40 μA.

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

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

3. $\boxed{n(e,e'\pi^+)p}$ LD2 SHMS left ($\theta = 7.50^o$) 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 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
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 μA to give 10,000 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.
   The first run should be $\sim$ 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. $\boxed{n(e,e'\pi^+)p}$ LD2 SHMS center ($\theta = 5.50^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K$+p)	Real coinc. $e^- \cdot \pi$
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 $\sim$ 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 ($\theta = 5.50^o$) run.

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

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

6. $\boxed{p(e,e'\pi^+)n}$ LH2 SHMS center ($\theta = 5.50^o$) 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×SHMS-3/4)	0
PS6(HMS-3/4×SHMS-3/4)	–1
EDTM Target Prescale Rate	10 Hz
cermode10	ON

HMS e^- rate	HMS π^- rate	SHMS π^+ rate	SHMS K rate	SHMS p rate	Random coinc. $(e^- + \frac{\pi^-}{5}) \cdot (\pi + K + \mathrm{p})$	Real coinc. $e^- \cdot \pi$
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 $\mathbf{p(e,e'\pi^+)n}$ coincidences.** Use the physics replay to keep track of the event total.
   The first run should be $\sim$ 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.

Estimated Total Time for this Run Plan: 556.5 hours