

Downstream Beamline Requirements for:
E12-06-101: Measurement of the Charged Pion Form Factor to High Q^2
and
E12-07-105: Scaling Study of the L–T Separated Pion Electroproduction
Cross Section at 11 GeV

Garth Huber
University of Regina

July 11, 2019

I have looked carefully at the kinematics for the two high Q^2 pion experiments expected to run in Hall C in the next few years, and find that the planned settings can be accommodated by three different downstream beam pipes optimized for different ranges of small angle rotation for the HMS and SHMS. These settings are listed on the following pages, to help with the planning of the spectrometer rotation requirements for our experiments.

The settings in each section are grouped according to required linac gradient per pass, and subgrouped according to pass number at each gradient. The standard gradient is assumed to be 2180 MeV/pass, which corresponds to 12.0 GeV beam to Hall D. My preference would be to run the 11.0 GeV beam energy settings last, when it is more probable that the linac will be capable of delivering this beam energy. The other settings can be run in any order, as long as the data taking is efficient and reliable.

In all three cases, some settings require the use of both liquid hydrogen and liquid deuterium targets.

1 Beampipe optimized for small SHMS angle

The overall requirements for these settings are reproducible SHMS angle to 5.50° , HMS to 12.49° , $\theta_{open} = 19.52^\circ$. For each HMS angle, the SHMS would be scanned across several different angles, as listed in the table. Reproducible movement of the SHMS to the smallest angle would be highly desirable. Currently, the “small” beampipe allows rotation to 5.75° , and the exact limit seems to vary with each rotation.

Three different linac gradients and six different beam energies are required to complete all of these settings. Total time: 1158 PAC-hours.

E_{beam}	Gradient	Q^2	W	x	ϵ	θ_{HMS}	θ_{SHMS}	θ_{open}
9.20	1820	6.00	3.19	0.39	0.18	46.43	5.50, 7.13	51.93
9.20	1820	8.50	2.79	0.55	0.16	57.70	5.52	63.22
8.00	1962	2.45	3.20	0.21	0.38	24.45	6.26 , 8.26	30.71
8.00	1962	3.85	3.07	0.31	0.30	34.15	5.50, 6.53 , 8.53	39.65
8.00	1962	5.00	2.95	0.39	0.24	42.91	6.35 , 8.35	49.26
9.90	1962	6.00	3.19	0.39	0.30	34.23	6.64 , 8.64	40.87
6.70	2180	1.60	3.00	0.17	0.41	22.85	6.36 , 8.36	31.21
6.70	2180	3.85	2.62	0.39	0.36	36.56	6.94 , 8.94, 10.94	43.50
8.80	2180	1.60	3.00	0.17	0.69	12.87	6.70 , 8.70, 10.70	19.57
8.80	2180	2.45	3.20	0.21	0.51	19.18	5.50, 7.30 , 9.30	24.68
8.80	2180	3.85	3.07	0.31	0.44	25.79	5.97 , 7.97, 9.97	31.76
11.00	2180	2.45	3.20	0.21	0.71	12.49	7.03 , 9.03, 11.03	19.52
11.00	2180	6.00	3.19	0.39	0.45	25.27	6.22 , 8.22	31.49

2 Beampipe optimized for small HMS angle

The overall requirements for these settings are reproducible HMS angle to 10.62° , SHMS to 7.39° , $\theta_{open} = 18.01^\circ$. My notes from last fall’s run are that the “medium” beampipe allows rotation only to 10.90° , while being compatible with this SHMS limit.

Achieving an 18.0° opening angle will require some careful inspection to identify the problem areas and see if they can be safely remedied.

Only three settings require this beam pipe, but it still takes two linac gradients to run them all.

E_{beam}	Gradient	Q^2	W	x	ϵ	θ_{HMS}	θ_{SHMS}	θ_{open}
9.90	1962	1.60	3.00	0.17	0.82	10.62	7.39, 9.39, 11.39	18.01
8.80	2180	2.12	2.05	0.39	0.91	11.60	19.44, 21.44, 23.44	31.04
11.00	2180	2.73	2.63	0.31	0.85	11.36	12.58, 14.58, 16.58	23.94

3 Larger beampipe

The overall requirements for these settings are reproducible SHMS angle to 7.31° , HMS to 12.62° , $\theta_{open} = 24.49^\circ$.

Two linac gradients and five beam energies are required to run all of these settings.

E_{beam}	Gradient	Q^2	W	x	ϵ	θ_{HMS}	θ_{SHMS}	θ_{open}
6.00	1962	3.85	2.02	0.55	0.58	31.02	13.58, 15.58, 17.58	44.60
8.00	1962	6.00	2.40	0.55	0.45	33.92	9.26, 11.26, 13.26	43.18
9.90	1962	3.85	3.07	0.31	0.57	19.78	7.31, 9.31, 11.31	27.09
9.90	1962	5.00	2.95	0.39	0.53	23.41	7.76, 9.76, 11.76	31.17
6.70	2180	1.45	2.02	0.31	0.88	13.00	18.17, 20.17, 22.17	31.17
6.70	2180	2.73	2.63	0.31	0.51	25.90	8.30, 10.30, 12.30	34.20
11.00	2180	3.85	3.07	0.31	0.67	16.22	8.27, 10.27, 12.27	24.49
11.00	2180	5.00	2.95	0.39	0.63	19.01	8.88, 10.88, 12.88	27.89
11.00	2180	3.85	2.62	0.39	0.80	14.16	12.58, 14.58, 16.58	26.74
11.00	2180	3.85	2.02	0.55	0.90	12.62	19.92, 21.92, 23.92	32.54
11.00	2180	6.00	2.40	0.55	0.74	18.63	13.31, 15.31, 17.31	31.94
11.00	2180	8.50	2.79	0.55	0.43	30.50	9.36	39.86