SHMS Scattering Chamber and Extended Target Acceptance

T. Horn,[1]

[1] *Jefferson Lab, Newport News, VA*

(Dated: February 6, 2009)

The geometry of the magnet apertures and the scattering chamber are most important for the acceptance of extended targets. This report discusses the impact of the horizontal bender acceptance and the scattering chamber geometry.

I. INTRODUCTION

Some experiments in Hall C at 12 GeV, such as the asymmetry measurements, depend on counting statistics. For such experiments targets with a length >15 cm are advantageous. On the other hand, the acceptance for such extended targets may be limited due to the geometry of the magnet apertures or the scattering chamber. This report discusses the impact of the horizontal bender acceptance and the scattering chamber geometry. The nominal target length and angle in this study are set by the currently approved experiments, i.e., 40 cm target at 40°, which corresponds to an effective target length of $\sim$ 25cm [1]. Table I lists a representative sample of Hall C experiments and their requirements.

Experiment	Target (cm)	SHMS angles (deg)
Fpi12	8	5.5-13
Pion Factorization	8	5.5-23
Kaon Factorization	8	5.5-21
$R=\sigma_L/\sigma_T$	10	5.5-30.5
SIDIS p_T	15	5.5
$x > 1$	15	8-16
$g2$	40	11-15.5
A_N^1	40	5.5-30.0
G_Ep	30	15.7-25.0
Neutron form factor	15, 40	16.8-40
CSV SIDIS	10	10.7-19.9
PV LD2	40	13.5

TABLE I: *Requirements for selected experiments approved by PAC30, PAC32, and PAC34 for Hall C at 12 GeV. The experiments with the largest effective target lengths are shown in red. The small angle requirement for L/T separations is shown in blue.*

II. HORIZONTAL BENDER ACCEPTANCE

The horizontal bender (HB) is essential for experiments at 12 GeV that need to detect scattered particles at very forward angles. The HB allows for reaching angles as low as 5.5° in the laboratory frame. The HB will be installed closest to the target, and will thus have very little space to the beam pipe. In the original design there were only 3.7 cm of material that separated the magnet from the beam pipe (see Figure 1). This issue was addressed by adding more material at the front of the HB magnet. As illustrated in Figure 2(a), the additional material between magnet and beam pipe did not affect the acceptance for 30-cm targets at 5.5°. The additional material did, however, have an impact on the extended target acceptance at 40° (see figure 2(b)).

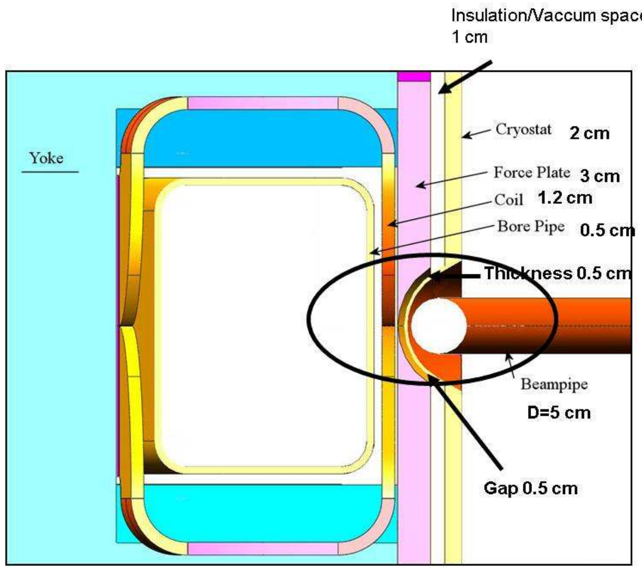
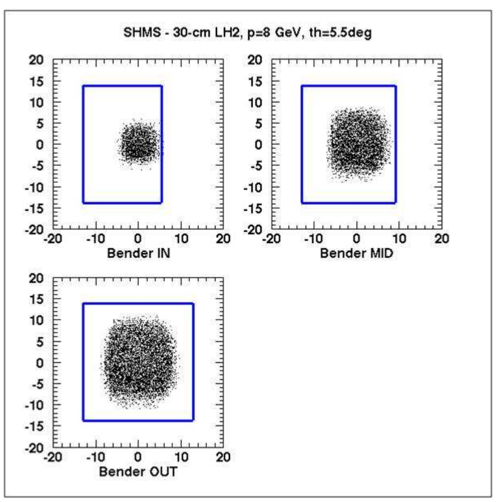
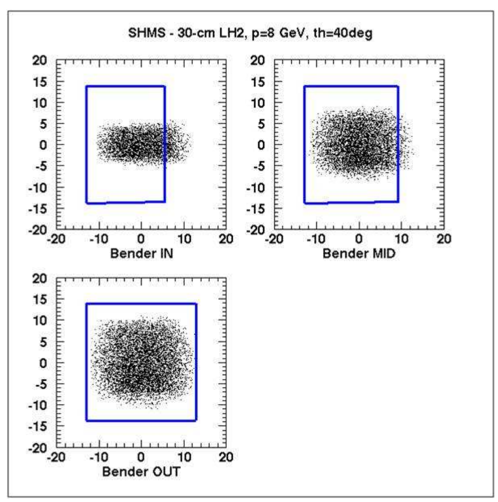


FIG. 1: *Cross section of the horizontal bender magnet (HB). Shown are the HB materials between the magnet and the beam pipe.*



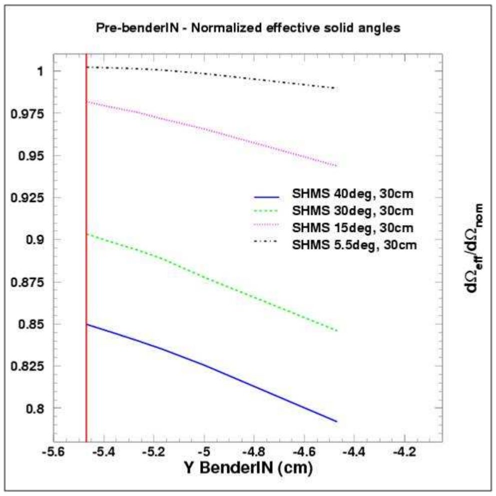
(a) *HB acceptance at 5.5°*



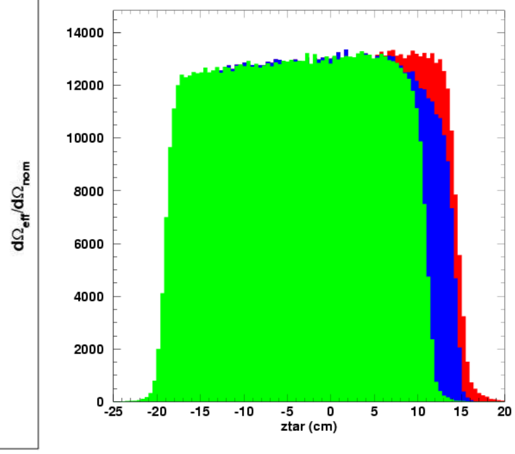
(b) *HB acceptance at 40°*

FIG. 2: *HB acceptance for a 30-cm long target at small and large angles. At 40° about 15% of the events are lost at the HB apertures.*

Figure 3(a) shows the influence of adding more material between HB magnet and beam pipe for a 30-cm long target at angles ranging from 5.5° to 40 °. The space at the front of the HB



(a)



(b)

FIG. 3: *The solid angle acceptance for a 30-cm long target at angles ranging from 5.5 to 40°. In the original design, the constraint at the front of the bender is 5.47 cm. The acceptance for extended targets can be opimized by moving the target along the beamline.*

magnet is constrained to 5.47 cm by the magnet itself, the force plate materials, and the beam pipe [2]. The reduction in acceptance is relatively small after inital losses due to the magnet front space constraint. Increasing the material by 0.5cm results in $\sim 3\%$ additional loss at 40°. There is no significant effect on the acceptance at 5.5°. Some of the loss in this acceptance can be recovered by shifting the target upstream. For a 30-cm target at 20°, this would, for instance, require a 2-3 cm shift as illustrated in Figure 3(b).

III. SCATTERING CHAMBER

The forward limit of the scattering chamber window aperture was implemented in the SHMS simulation to test acceptance effects of long targets. The window geometry was taken from the scattering chamber design drawings (67153-E-56003RevC). The limiting angle for a given event vertex was calculated and compared with the scattering angle. The result is shown in Figure 4.

The conclusion is that the scattering chamber can accomodate a 50-cm target, but if the target length exceeds 30 cm, it should be shifted upstream so that the downstream end coincides with that of a centered 30-cm target.

IV. CONCLUSION

The acceptance for extended targets is influenced by the acceptance of the HB magnet and the geometry of the scattering chamber. The addition of material between the HB magnet and the beam pipe has a small effect on the acceptance, which can be optimized by moving the target

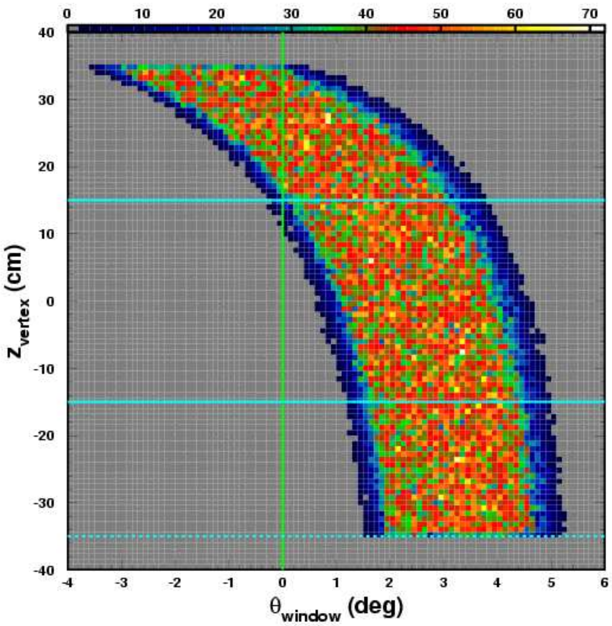


FIG. 4: *The event z vertex position as a function of the difference between the scattering and the limiting angle of the window for a central spectrometer angle of 5.5°. Events to the left of the green vertical line would have reached the detectors if they had not been lost in the scattering chamber walls. The light blue horizontal lines indicate a centered 30-cm target (solid line), and a 50-cm target shifted upstream by 10 cm (dashed line).*

upstream. The scattering chamber can accomodate target lengths up to 50 cm.

---

[1] Not all experiments using extended targets will also use the SHMS.

[2] In the meantime, the HB dimensions were updated to include the maximum possible amount of material between the magnet and the beam pipe.