Proposal Number: **PR12-25-003** **Hall: C**

Title: Final-State Interactions Studies in Deuterium at Very High Missing Momenta

Contact person: Carlos Yero (yero@cua.edu)

Beam time request:

Days requested for approval:	23 days
Tune up included in beam time request:	

Beam characteristics:

Energy:	10.55 GeV
Current:	80 μA
Polarization:	n/a

Targets:

Nuclei:	LD2/LH2/C12
Rastering:	3 x 3 mm
Polarized:	No

Spectrometers:

HMS	Yes (proton arm)
SHMS	Yes (electron arm)
Other (NPS, CPS, new):	None

Special requirements/requests:

Technical Comments:

Question/Comment 1:
80 uA could be challenging for accelerator, not possible if Hall A is running high current.

Answer 1:
The beam current limitation would be mainly a scheduling issue between the experimental halls. The actual limit is determined by a combined beam dump power limit from both Hall A/C and a limit on the total power that the machine can handle.

The combined beam dump limit is around 1100kW and the machine limit for this run period is 900 kW.

The combined power output for Halls A and C is given by:
(Beam Energy_A x current_A + Beam Energy_C x current_C) = power [kW].
where the beam energy is in units of [GeV] and current in [micro-Amps]

So, for example, if we ran Hall C at (5-pass) with beam energy ~10.7 GeV and 70 uA, and Hall A was running say at (1-pass) 2.200 GeV and 70 uA, the combined power output of both halls would be: total_power = 10.7 * 70 + 2.2 * 70 = 903 kW

Question/Comment 2:
Spectrometer Angles and momentum settings are within the design ranges. However extra SHMS optics may be required for these relatively high momentum settings.

Answer 2:
The highest SHMS momentum to-date has been ran by the x>1 / EMC experiment (XEM) group during their run-period on Fall 2022 - Spring 2023 with a maximum SHMS central momentum of 9.5 GeV. They have taken the corresponding optics runs.

Question/Comment 3:
While the coincidence trigger rates may be low, the hodoscope rate (e.g. S1X) could be high for the SHMS at these smaller angles.

Answer 3:
The SHMS hodoscope rates on the first plane are indeed expected to be on the order of ~1-2 MHz. This is based on the trigger rates observed from our 2018 deuteron experiment, as seen in the attached plots below.

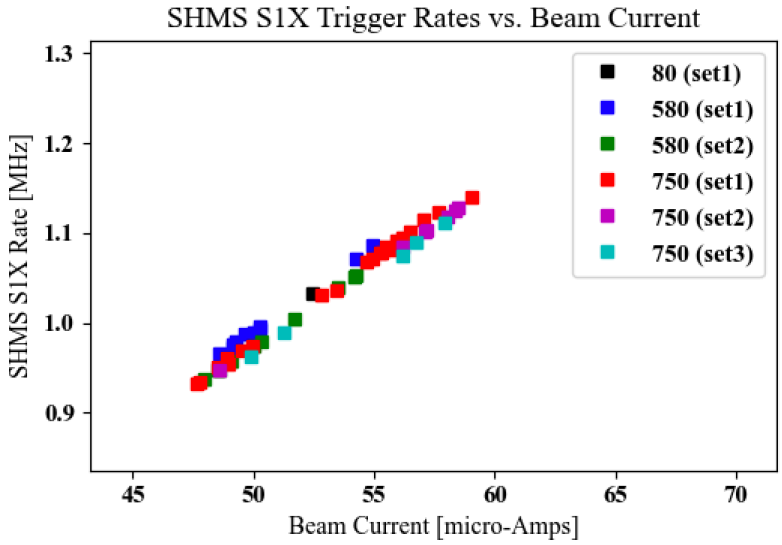

FIG 1. Shows the SHMS S1X plane rates go up to ~1.1 MHz for beam currents ~60 uA, We can make an extrapolation, based on the slope:

$\Delta y/\Delta x$ = (1.15 - 0.91) / (60-47) = 0.01846 MHz / uA

from which we can expect that for a maximum current of 80 uA, one expects a maximum S1X rate of ~ 0.01846 MHz / uA x 80 uA = 1.48 MHz. This increase in rates is **NOT** expected to be an issue during the experiment, given the upgrades of Hall C trigger interface to make it capable of handling higher rates via the TI "buffered mode", which we did not have during the 2018 deuteron commissioning experiment

Question/Comment 4:
Will a slightly higher beam energy, 10.68 or 10.78 GeV, impact the results?

(for reference)

SHMS: angles: 12.82, 13.14, 13.65 deg, momentum: 7.552, 8.151, 8.551 GeV/c

HMS: angles: 41.57, 44.17, 49.27, 54.85 deg, momentum 2.468, 2.891, 3.069, 3.516 GeV/c

Answer 4:
After running our code to calculate the central kinematics for a beam energy of 10.78 GeV, and central missing momenta Pm = 800 MeV/c, we have the following updated kinematics

SHMS: angles: 12.51, 12.81, 13.29 deg, momentum: 7.78, 8.38, 8.78 GeV/c

HMS: angles: 41.71, 49.41, 54.98 deg, momentum 2.468, 2.891, 3.516 GeV/c

The kinematics change is very small, and well within the acceptance of the Hall C spectrometers. For example, the largest change in the SHMS momentum corresponds to a momentum fraction (8.780 - 8.551)/ 8.551 = 0.0267 (2.67 %) which is well within the SHMS momentum acceptance (-10, 22) % . For the HMS side, the momentum itself did not change at all. The change in spectrometer angles was found to be less than 1 deg In all cases. **No change is expected with a slightly higher beam energy.**