D(e,e'p)n Simulation and Projected Errors for the completion of the remaining 18 PAC days of E12-10-003 (for year 2022)

The analysis cuts applied were:

- 4 < Q2 < 5 [GeV^2]
- -0.02 < Emiss < 0.04 [GeV]
- | ztar_diff_cut | < 2 [cm,]
- HMS collimator cut (octagonal shape cut),
- | HMS Delta | < 8 %
- SHMS Delta: (-10, 22) %

I also applied the following efficiencies to the yield (i.e., yield becomes smaller), for a more realistic estimate, based on the efficiencies from the commissioning part as follows:

- e-trk efficiency ~ 96.4
- h-trk efficiency ~ 98.8
- daq total live time ~ 98.8 (this was actually smaller during commissioning due to 100 ns windows on the HMS discriminators)
- tgt_boiling ~ 96.8 %
- proton loss due to interactions with HMS windows/detector/etc. ~ 95.34 (5 % of protons lost)

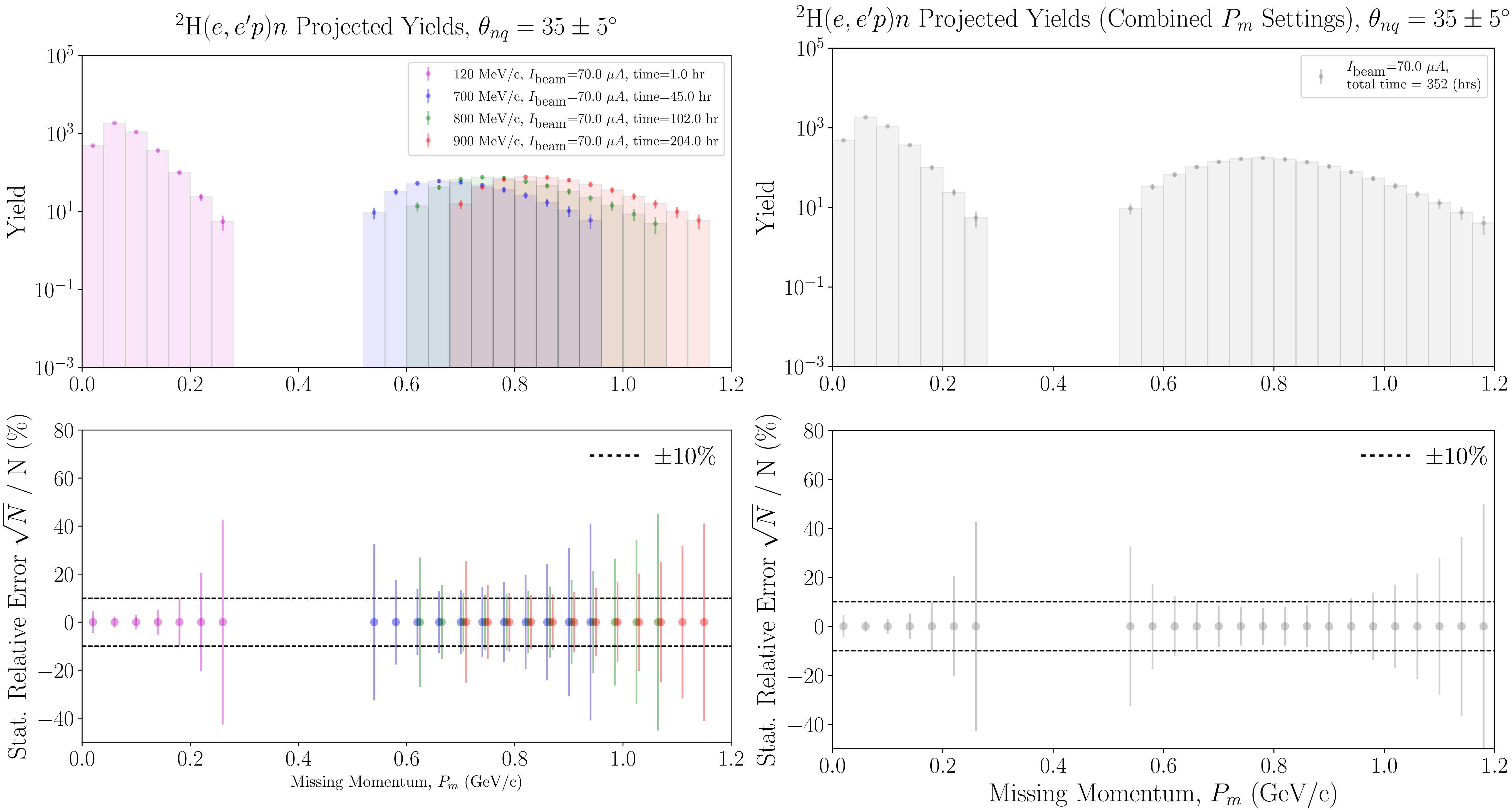
Total PAC Days: 21 (504 hrs @ 50 % beam efficiency)

Commissioning PAC Days: 3 (72 hrs @ 50 % beam efficiency)

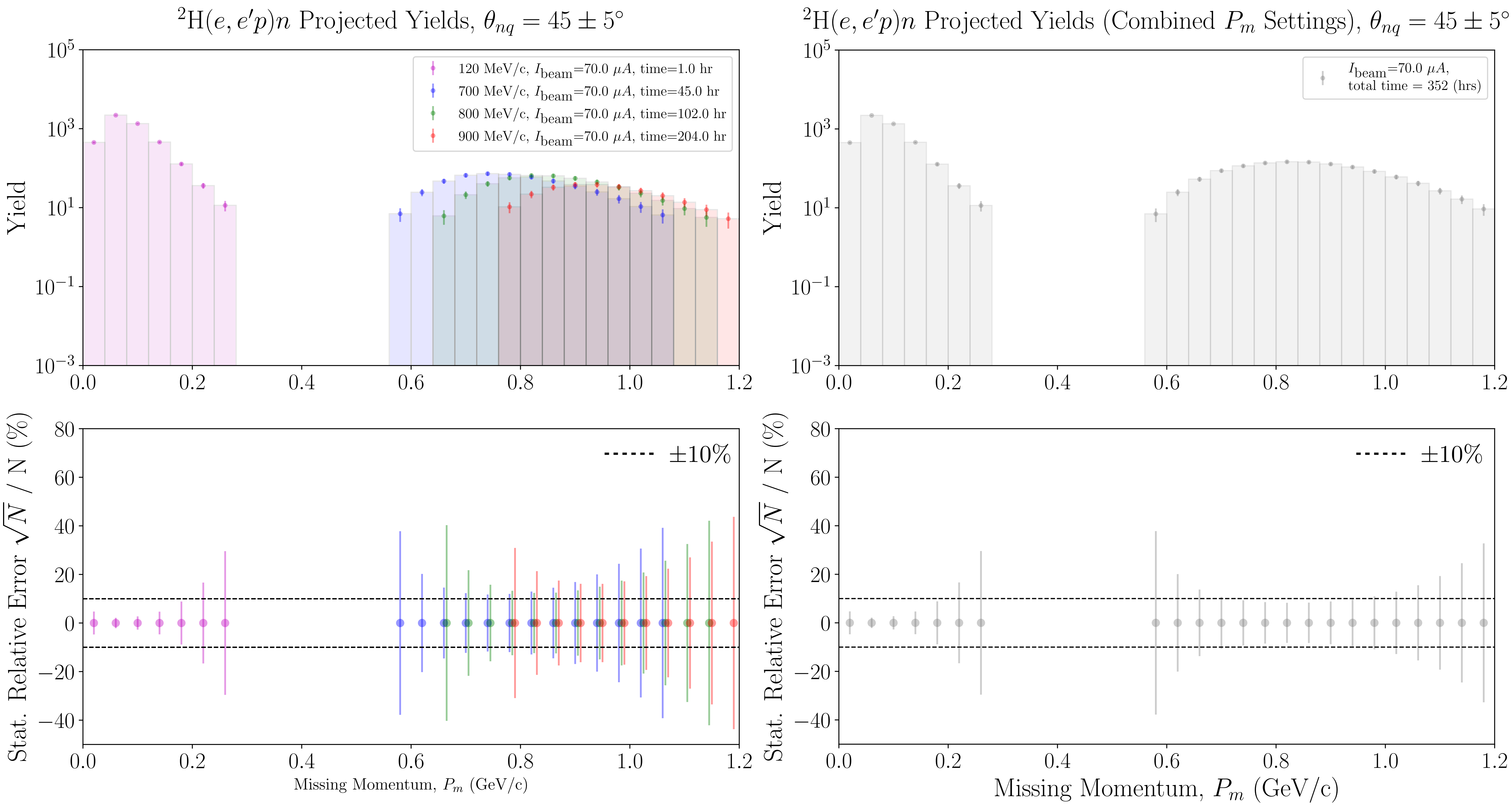
Remaining PAC Days: 18 (432 hrs @ 50 % beam efficiency)

Remaining PAC Days Tentative Time Allocation

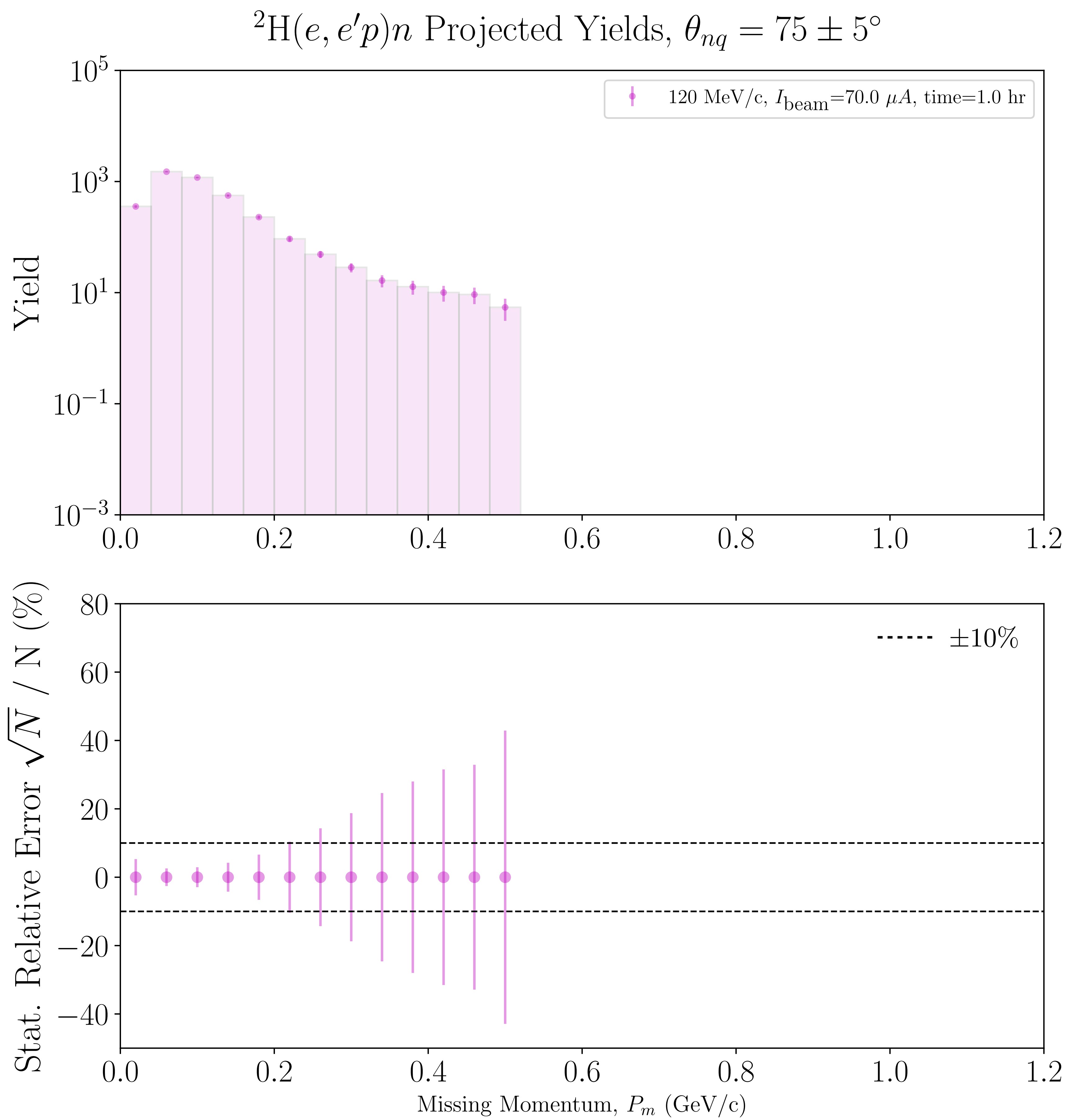
352 hrs :	low/high p-miss settings
80 hrs :	H(e,e'p) elastics, target boiling studies, proton absorption studies, Al. dummy runs
432 hrs	

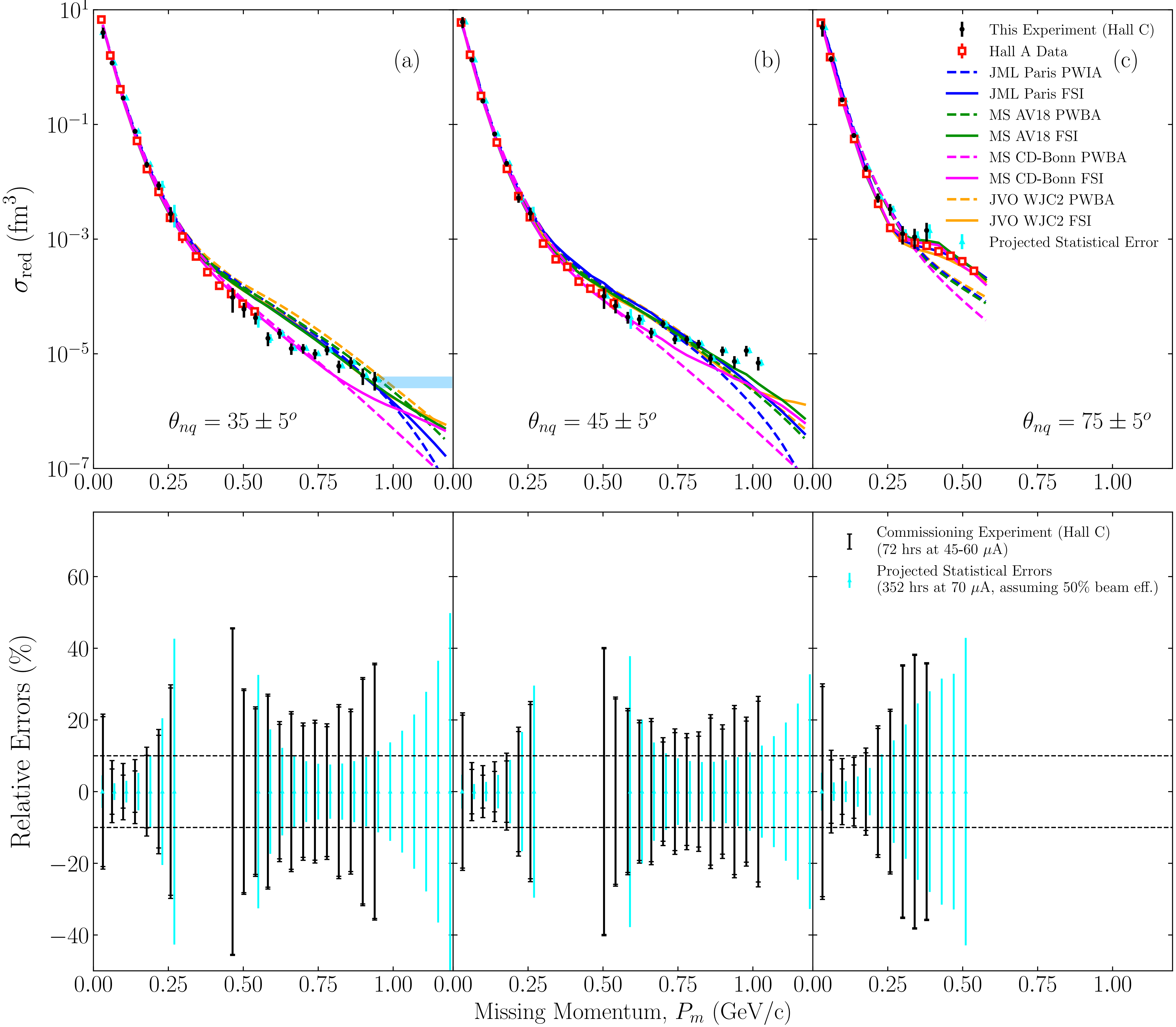


Data points are slightly offset for ease of comparison

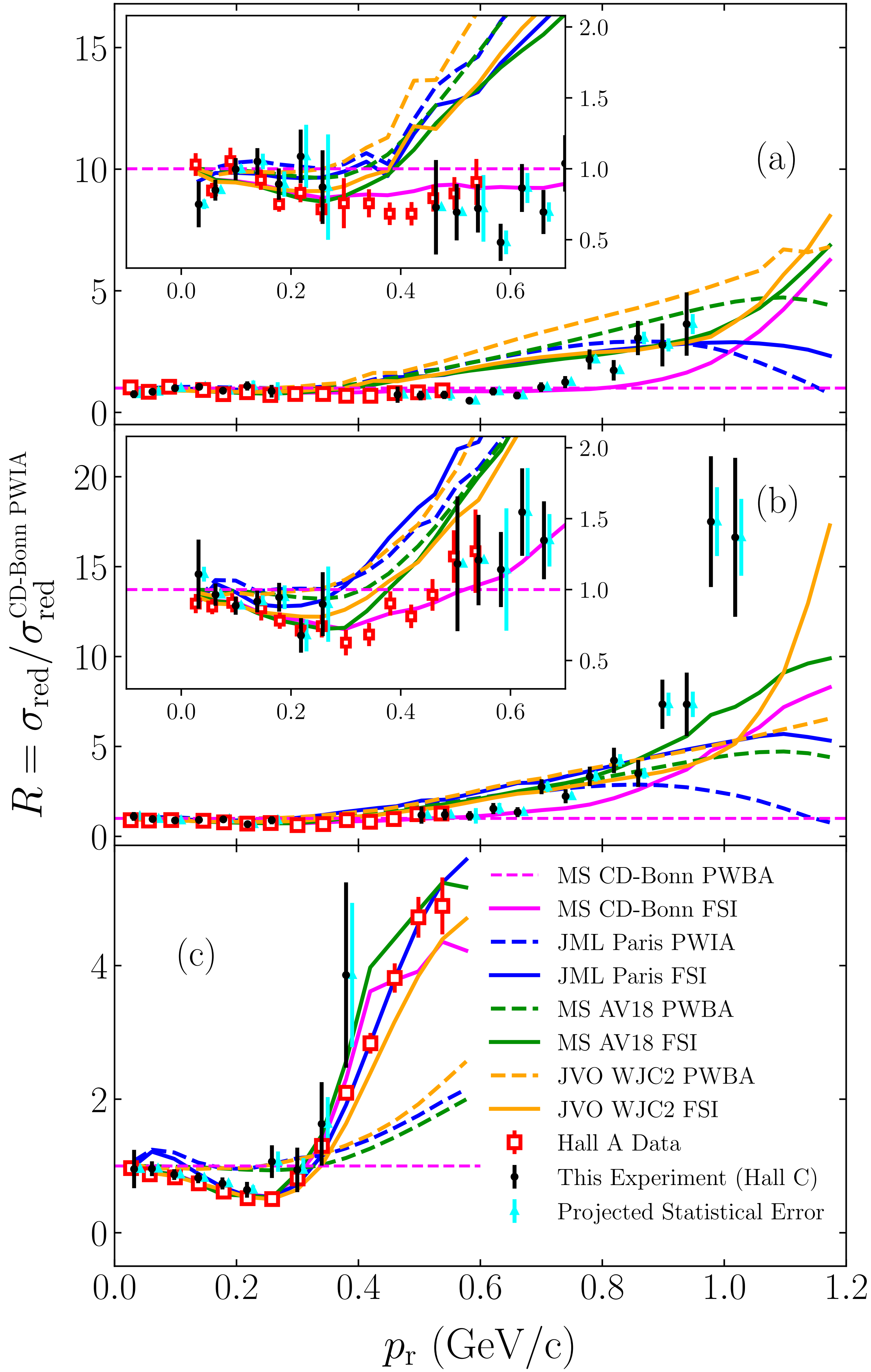


Data points are slightly offset for ease of comparison


^{2}H$(e, e'p)n$ Projected Yields, $\theta_{nq} = 75 \pm 5°$
120 MeV/c, I_{beam}=70.0 μA, time=1.0 hr
Yield
10^5
10^3
10^1
10^{-1}
10^{-3}
0.0
0.2
0.4
0.6
0.8
1.0
1.2
±10%
Stat. Relative Error $\sqrt{N}$ / N (%)
80
60
40
20
0
−20
−40
Missing Momentum, P_m (GeV/c)



(a)
(b)
(c)
This Experiment (Hall C)
Hall A Data
JML Paris PWIA
JML Paris FSI
MS AV18 PWBA
MS AV18 FSI
MS CD-Bonn PWBA
MS CD-Bonn FSI
JVO WJC2 PWBA
JVO WJC2 FSI
Projected Statistical Error
σ_{red} (fm^3)
$\theta_{nq} = 35 \pm 5^o$
$\theta_{nq} = 45 \pm 5^o$
$\theta_{nq} = 75 \pm 5^o$
Commissioning Experiment (Hall C)
(72 hrs at 45-60 μA)
Projected Statistical Errors
(352 hrs at 70 μA, assuming 50% beam eff.)
Relative Errors (%)
Missing Momentum, P_m (GeV/c)



(a)
(b)
(c)
MS CD-Bonn PWBA
MS CD-Bonn FSI
JML Paris PWIA
JML Paris FSI
MS AV18 PWBA
MS AV18 FSI
JVO WJC2 PWBA
JVO WJC2 FSI
Hall A Data
This Experiment (Hall C)
Projected Statistical Error
$R = \sigma_{\mathrm{red}}/\sigma_{\mathrm{red}}^{\mathrm{CD\text{-}Bonn\ PWIA}}$
p_{r} (GeV/c)

Cross Section Correction Factor

- Observation: JML FSI (SIMC model) differs from measured cross sections

- Possible approaches to correct in simulation:

1. Take ratio R = (data Xsec / JML FSI Xsec)_commissioning per "missing momentum" bin and apply to current JML FSI yield estimates to get a more realistic yield. This is done for each th_nq bin (i.e, 35+/-5 deg, 45+/-5 deg, . . .) The only possible issue is that this correction factor is dependent on (thnq, Q2) bins, so during on-line analysis, the missing momentum is reconstructed over all th_nq bins, so one would have to require "th_nq" binning in on-line analysis as well as "4<Q2<5 GeV^2" histograms and account for the number of neutrons in each thnq, since these are the conditions in the PRL plots we are taking a ratio of.
   ** This approach can be used, however, when estimating the relative statistical errors we expect to have on our measured cross sections since We bin the cross sections as a function of missing momentum in (Q2 and th_nq)

2. Since we have the actual data missing momentum yields per mC for the 580 and 750 MeV settings (commissioning), we can Use those yields to estimate the number of missing neutrons we expect per mC during the online analysis of the full experiment. To do this, we can take the yield /mC ratio, R= (data / JML FSI), and apply it as a correction to our current simulation yields.

   The number of "missing neutrons" that we estimate per missing momentum central setting (pm=120, 700, 800, 900) can then be set as a statistical goal during the on-line analysis data-taking.

   For example, if we estimate N "missing neutrons" at X central setting for the simulation, then we would instruct the shift crew to take data until we reach N "missing neutrons" at X central setting.

   To count number of "missing neutrons", we need to write a script that would be called for every run that is taken at X setting and return the integrated histogram of missing momentum counts (and other useful histos) given the following conditions:

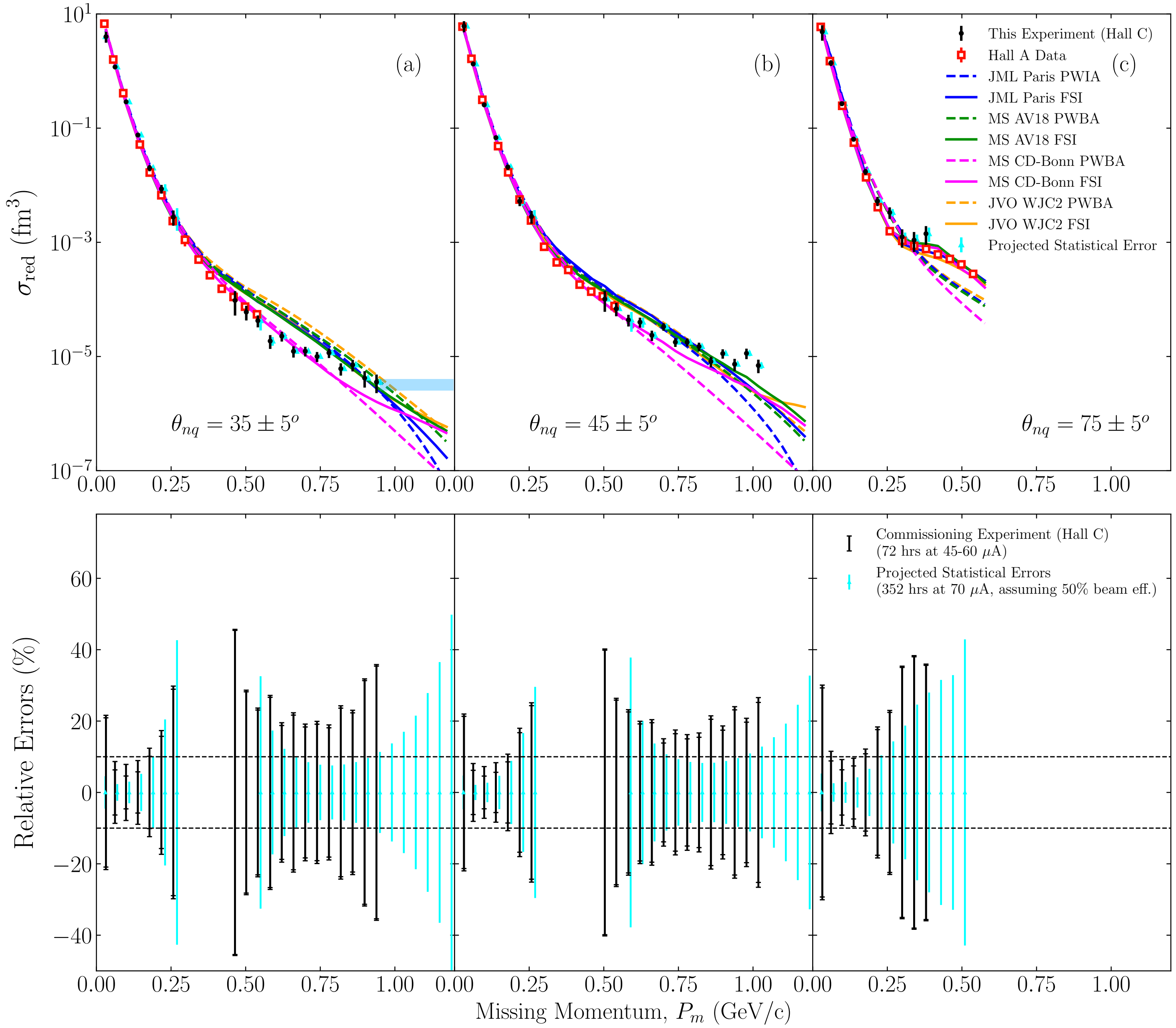
   - Applying "coin. time and SHMS e- track norm cuts" (specific to data only) in additon to the exact same cuts applied in the simulation {Emiss, shms/shms delta, and hms collimator cuts}

TO-DO:

Find strong arguments to the following questions:

1. What is the benefit of reducing the relative statistical error from ~20% to ~10% between ~640 MeV - 1 GeV/c ?
   (e.g., see the relative error comparison in the plot below)

2. The new simulations show that we can get statistical errors ~20 % beyond missing momentum ~1 GeV/c. These are roughly the same uncertainties for the high-Pmiss settings in the commissioning experiment. What new physics can we potentially explore in this very high missing momentum ? We need to justify our reason for spending 204 beam-time hours @ 70 uA on the 900 MeV/c setting.



Commissioning D(e,e'p)n Experiment Total Charge Accumulated

Pm	HMS Tracking Efficiency	sHMS Tracking Efficiency	Target Boiling Correction	Proton Absorption Correction	Total Live Time	Total Charge (mC)
80	0.989	0.965	0.958	0.953	0.908	142.140
580 (set 1)	0.990	0.965	0.960	0.953	0.929	1686.830
580 (set 2)	0.987	0.964	0.959	0.953	0.929	1931.770
750 (set 1)	0.988	0.964	0.957	0.953	0.924	5329.490
750 (set 2)	0.989	0.962	0.956	0.953	0.923	1894.010
750 (set 3)	0.989	0.962	0.956	0.953	0.924	1083.700

** Comparison of total charge measured in commissioning to total charge expected in remaining PAC days

COMMISSIONING (3 PAC DAYS)

Beam current: 45-60 uA

80 MeV/c: 142.14 mC

580 MeV/c: 1686.830 + 1931.770 mC = 3618.6 mC

750 MeV/c: 5329.490 + 1894.010 + 1083.7 mC = 8307.2 mC

REMAINING 18 PAC DAYS

Beam current: 70 uA

120 MeV/c (1 hr): 252 mC

700 MeV/c (45 hr): 11340 mC

800 MeV/c (102 hr): 25704 mC

900 MeV/c (204 hr): 51408 mC