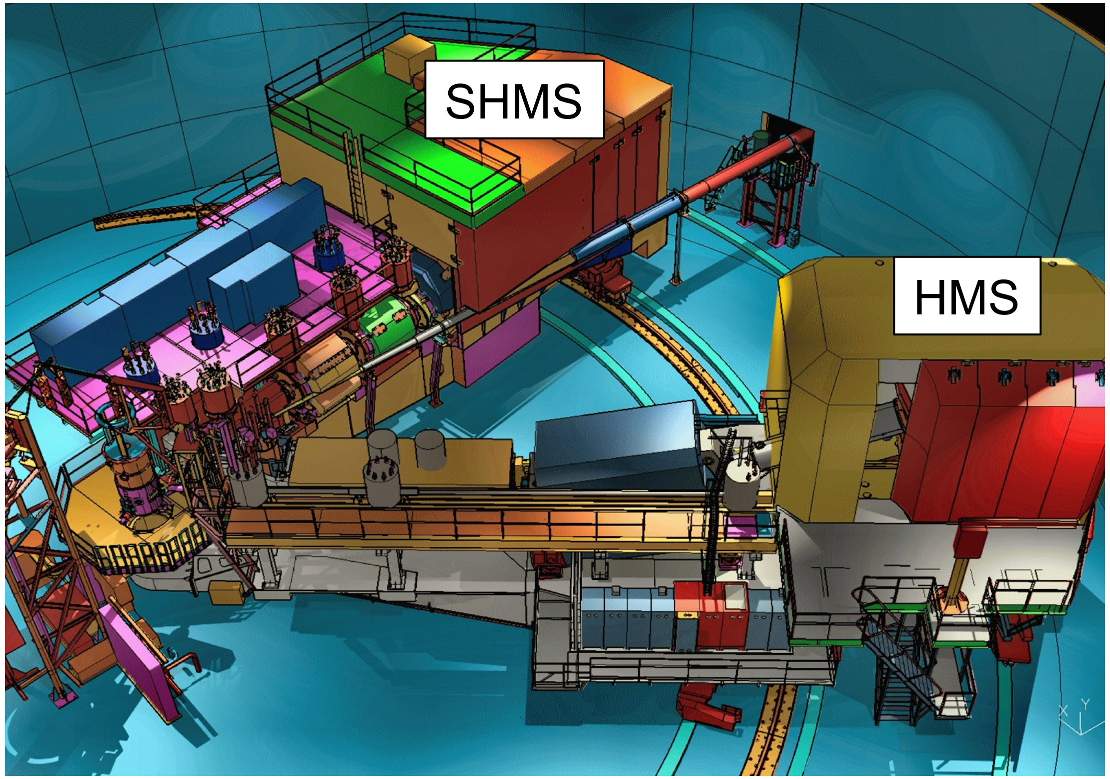
SIDIS in Hall C at 20+ GeV

The Next Generation of 3D Imaging

July 7-8

SHMS and HMS in Experimental Hall C



Spectrometer properties

HMS: Electron arm
Nominal capabilities:
$d\Omega \sim 6$ msr, $P_0 = 0.5 – 7$ *GeV/c*
$\theta_0 = 10.5$ *to 80 degrees*
e ID via calorimeter and gas Cerenkov

SHMS: Pion arm
Nominal capabilities:
$d\Omega \sim 4$ msr, $P_0 = 1 – 11$ *GeV/c*
$\theta_0 = 5.5$ *to 40 degrees*
π:*K*:*p* separation via heavy gas Cerenkov and aerogel detectors

Excellent control of point-to-point systematic uncertainties required for precise L-T separations
→ Ideally suited for focusing spectrometers
→ One of the drivers for SHMS design

Identical acceptance for positive and negative polarity
→ Precision measurement of charged meson ratios

Hall C 12 GeV SIDIS Program – Cross Sections and Ratios

Precise cross section measurements with magnetic focusing spectrometers (HMS/SHMS)

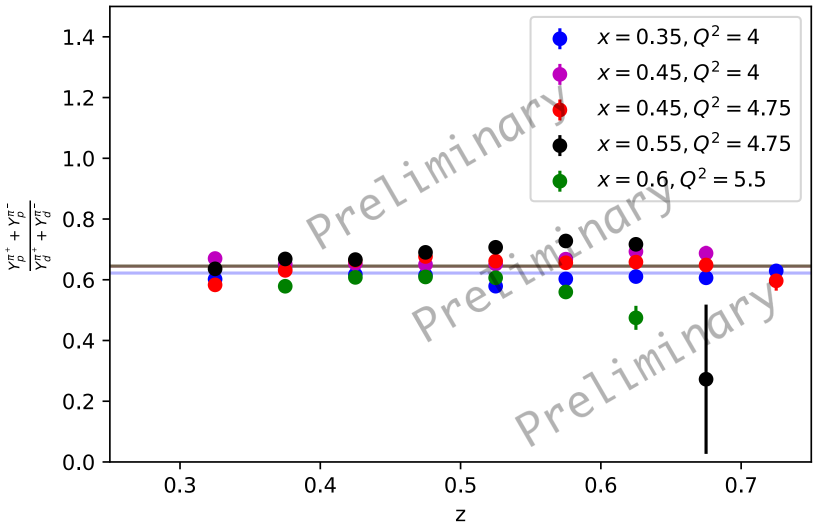
→ Demonstrate understanding of reaction mechanism, test factorization

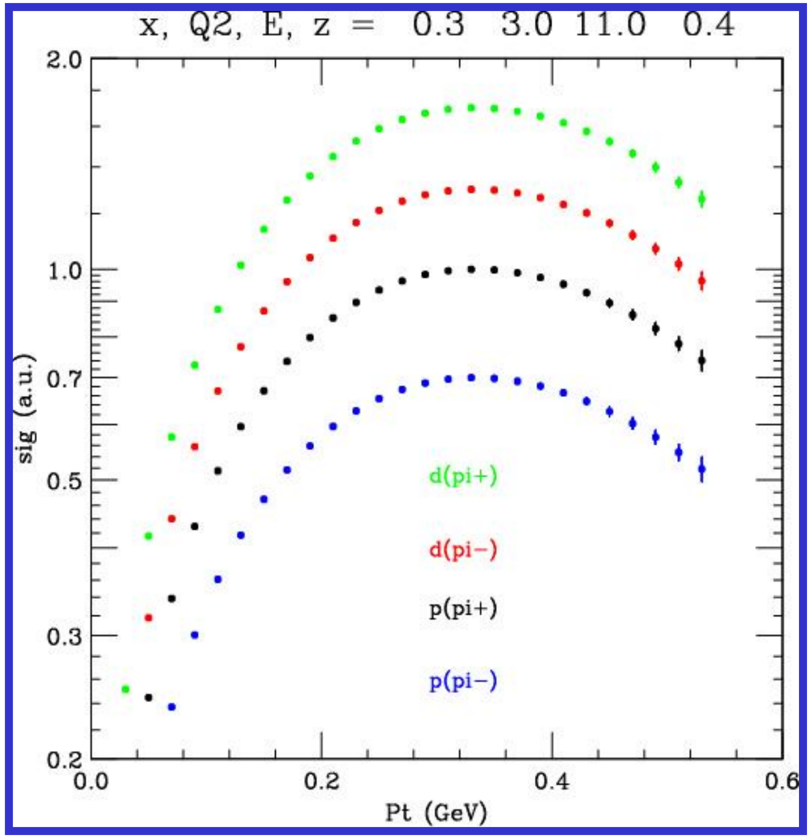
→ Able to carry out precise comparisons of charge states, $\pi+/\pi-$

→ Complete ϕ dependence at small P_T, access to large P_T at fixed ϕ

$$\sigma = \sum_q e_q^2 f(x) \otimes D(z)$$

$$\frac{H(\pi^+ + \pi^-)}{D(\pi^+ + \pi^-)}$$





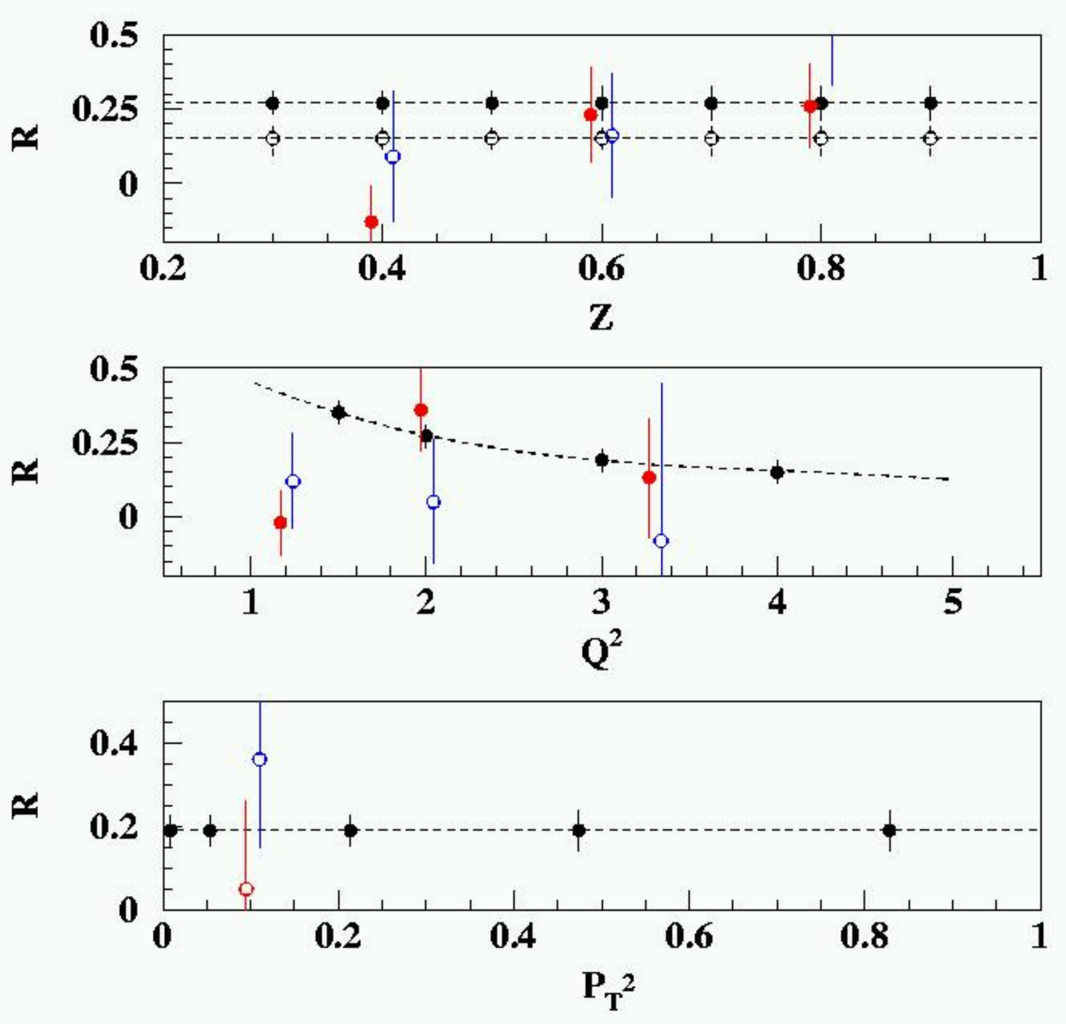
Shuo Jia: E12-09-002

E12-09-017 proposal

Hall C 12 GeV SIDIS Program – L-T Separations

R = σ_L/σ_T in SIDIS (ep → e'$\pi^{+/-}$X)

$$\sigma = \sum_q e_q^2 f(x) \otimes D(z)$$



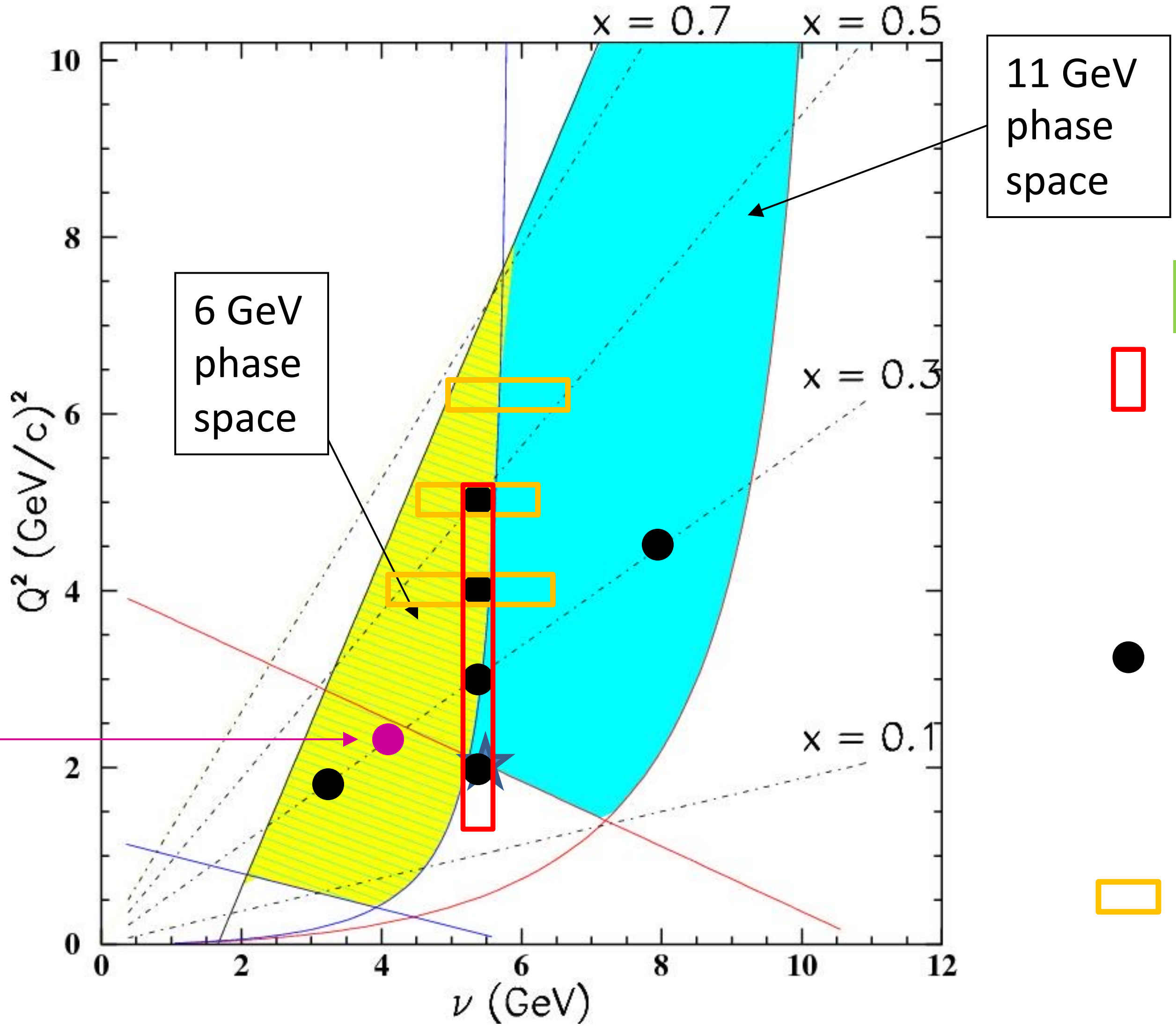
SHMS/HMS will allow precise L-T separations
→ Does $R_{DIS} = R_{SIDIS}$?

E12-06-104:
Measurement of the Ratio R=σ_L/σ_T in Semi-Inclusive Deep-Inelastic Scattering

12 GeV Hall C SIDIS Program – HMS+SHMS

Accurate cross sections for validation of SIDIS factorization framework and for L/T separations

E00-108 (6 GeV)



Charged pions:

- E12-06-104 L/T scan in (z,P_T) No scan in Q^2 at fixed x: $R_{DIS}(Q^2)$ known
- E12-09-017 Scan in (x,z,P_T) + scan in Q^2 at fixed x
- E12-09-002 + scans in z

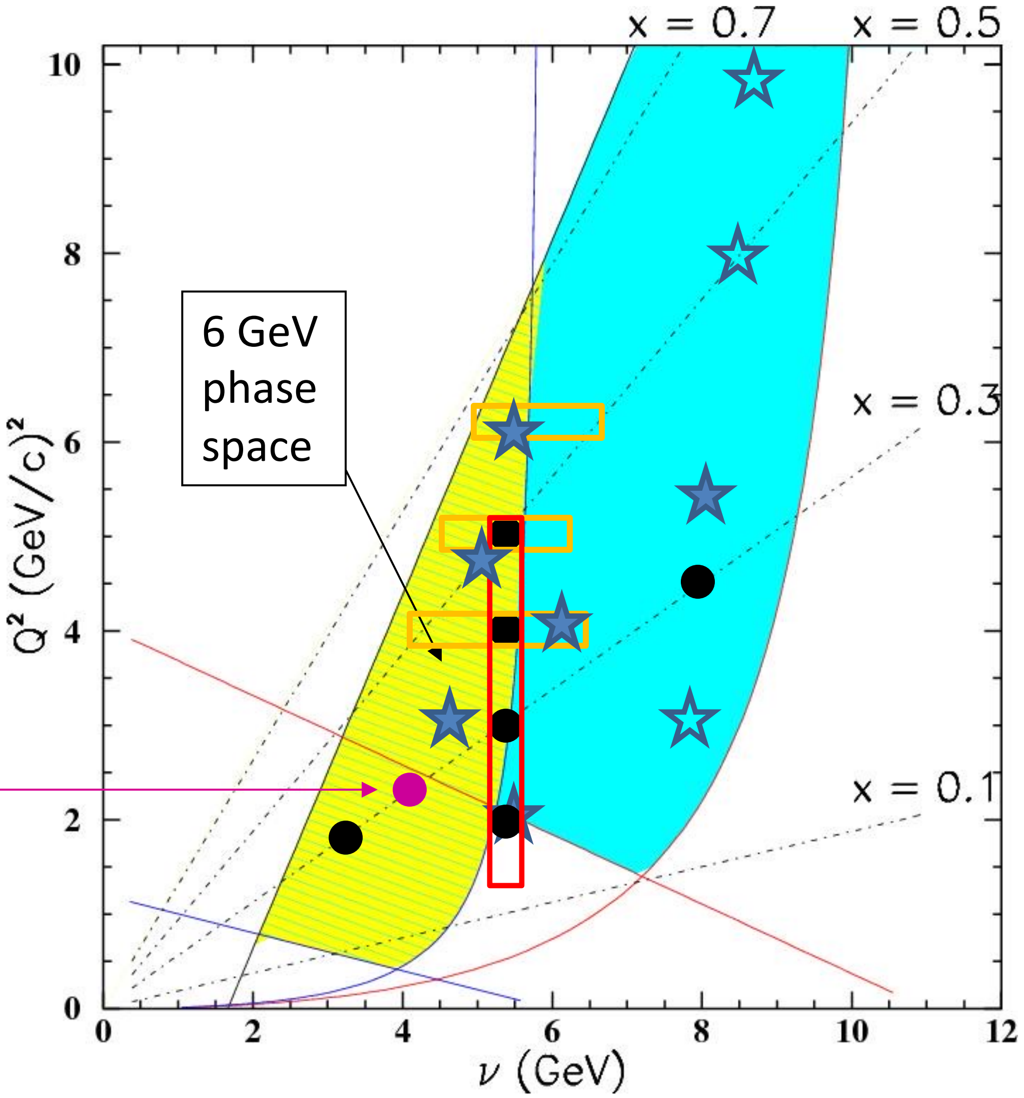
12 GeV Hall C SIDIS Program – HMS+SHMS+NPS

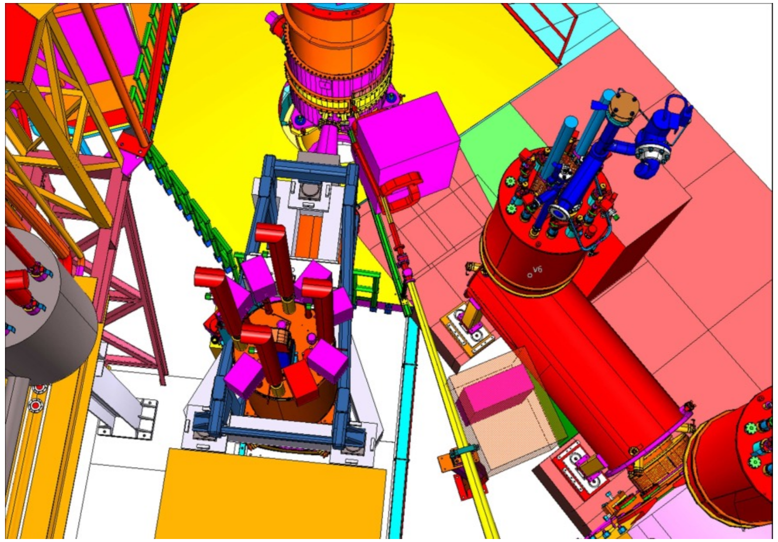
Accurate cross sections for validation of SIDIS factorization framework and for L/T separations

★ E12-13-007
Neutral pions:
Scan in (x,z,P_T)
Overlap with E12-09-017 & E12-09-002

☆ Parasitic with E12-13-010

E00-108 (6 GeV)



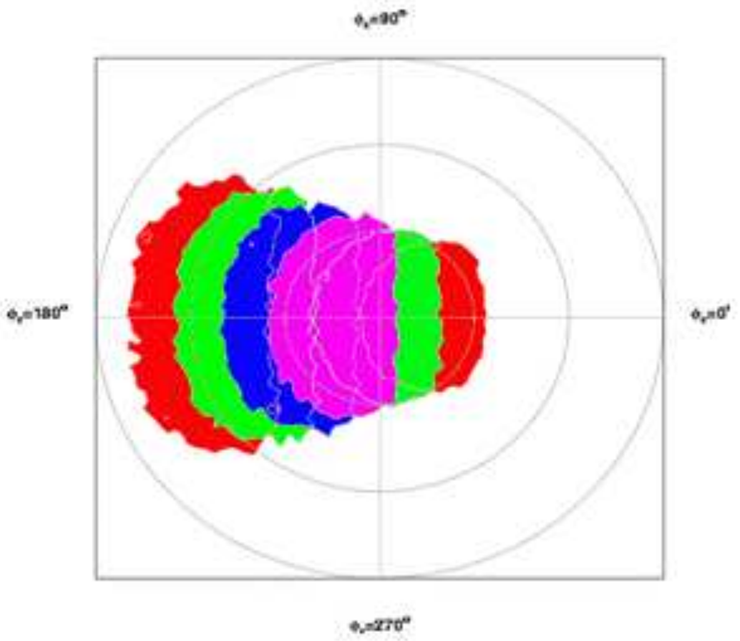


Calorimeter + sweeper magnet adds capability to detect neutral particles (γ and π^0)
→ In addition to broadening SIDIS program, enables DVCS, DVMP (π^0), WACS measurements

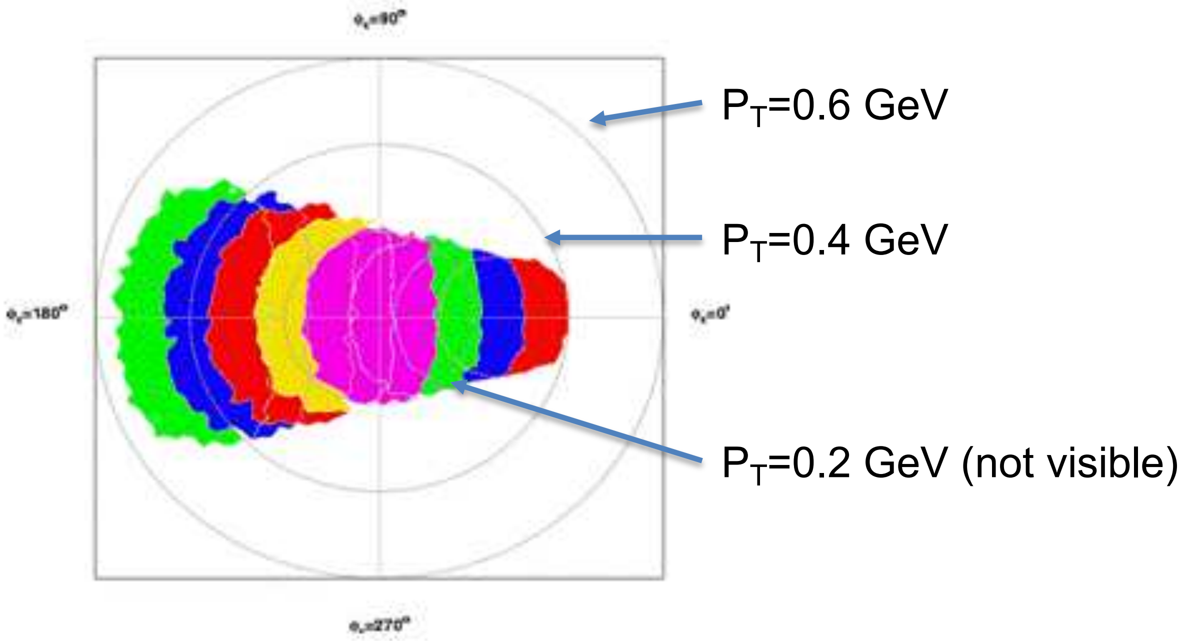
Courtesy R. Ent

HMS-SHMS P_T/ϕ acceptance

Simulated, from P_T-SIDIS experiment (11 GeV)



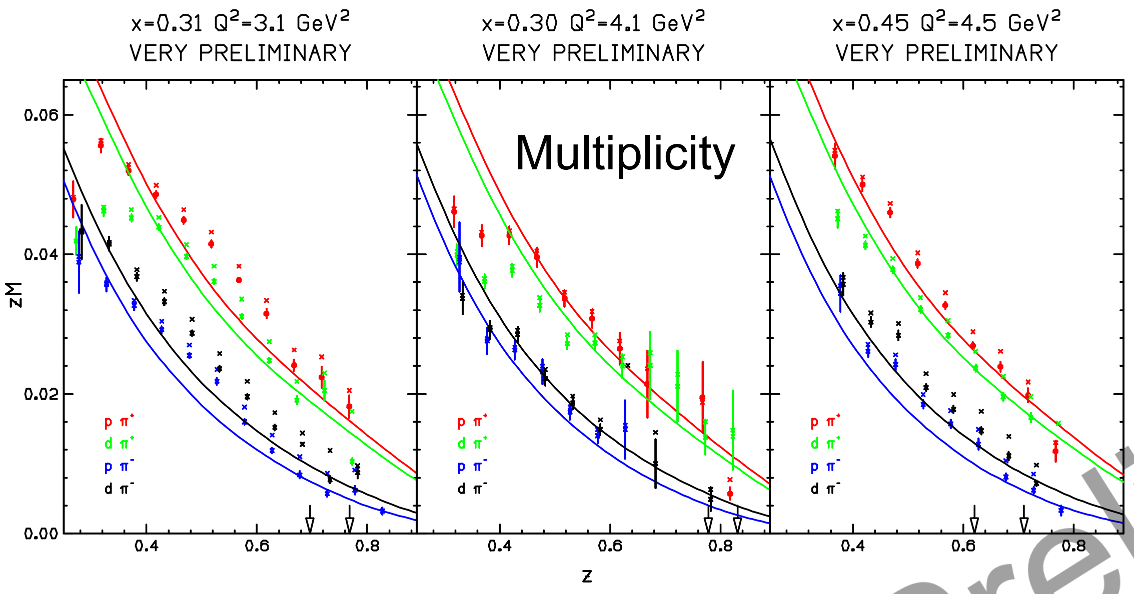
x=0.2 Q^2=2 GeV^2

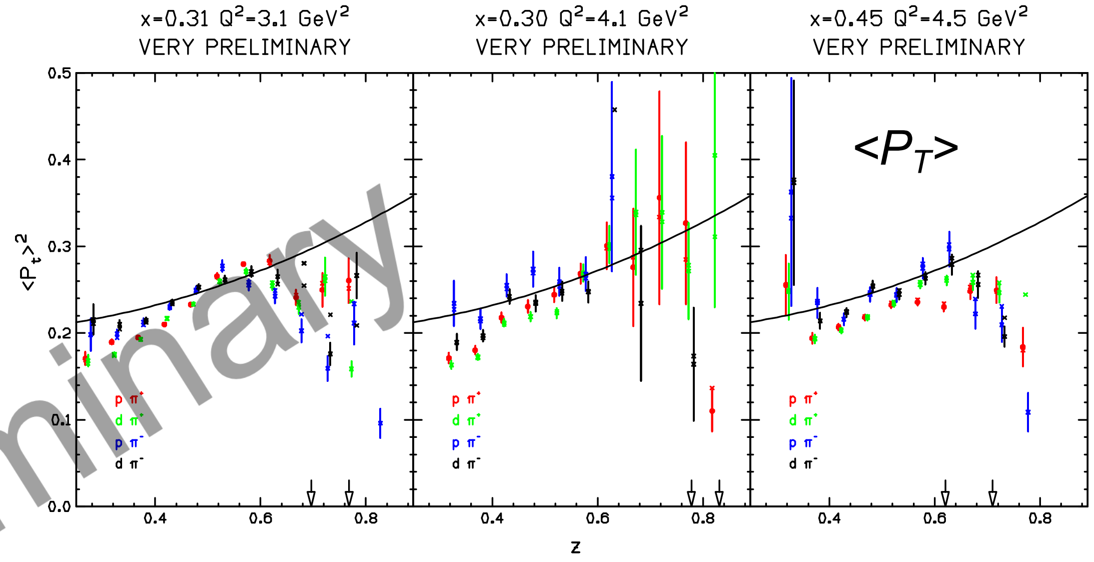


x=0.3 Q^2=3 GeV^2

Full ϕ coverage over limited P_T range → larger P_T covers narrow range in ϕ

11 GeV SIDIS Preliminary Analysis

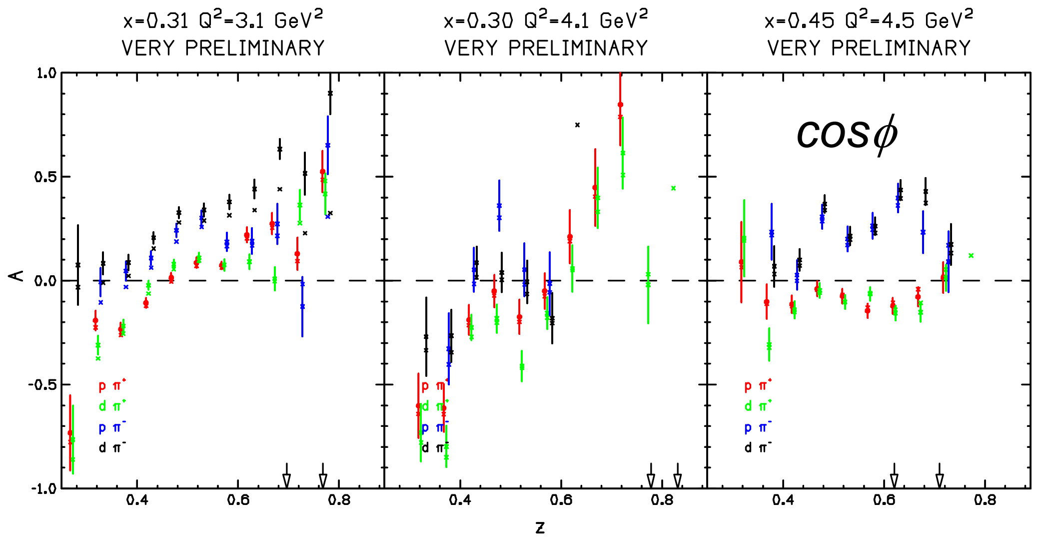




Preliminary

Cross sections fit to the form:

$$y = M_0 b e^{-b p_T^2} (1 + A p_T \cos\phi)$$

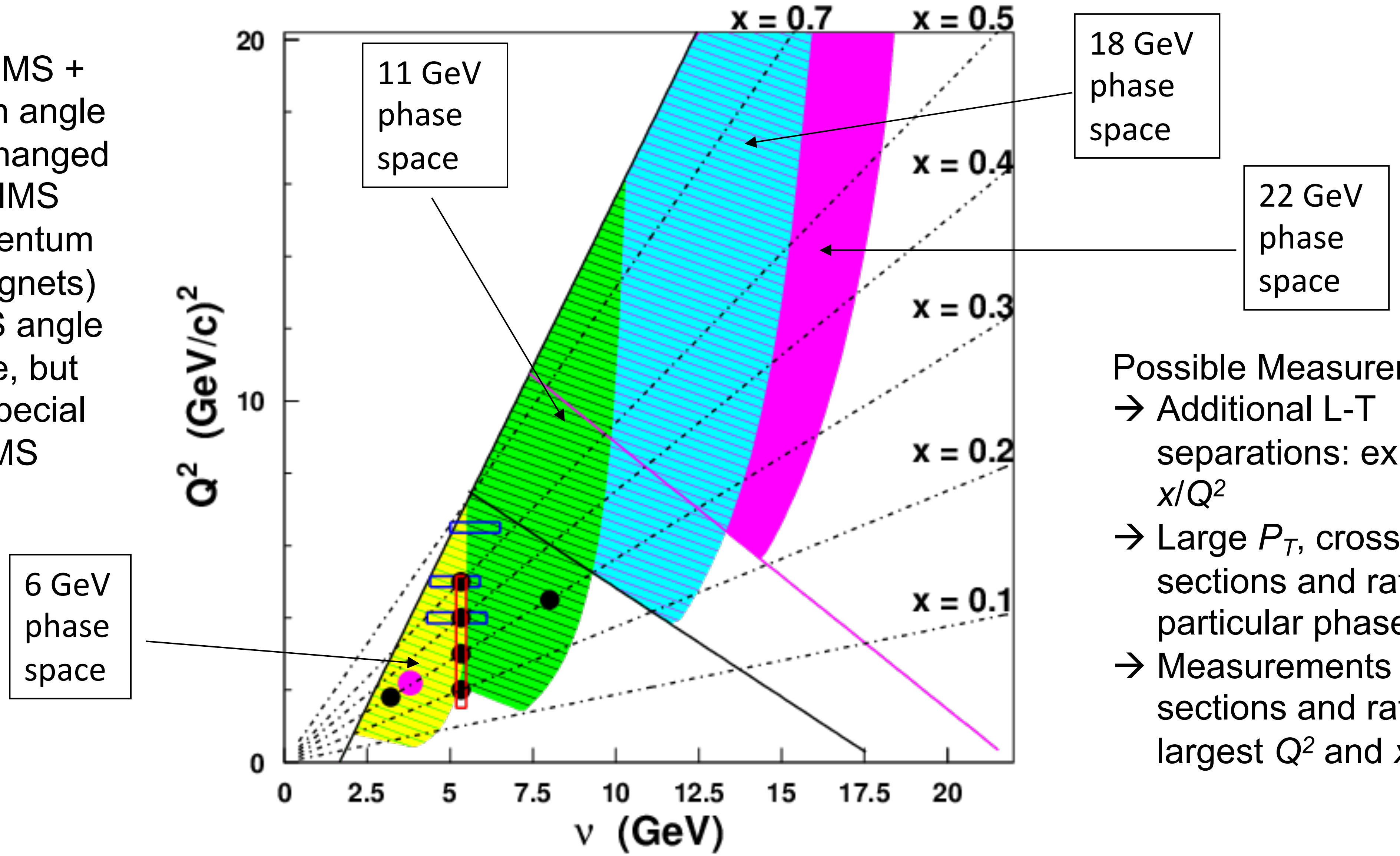


Jefferson Lab

Analysis by Peter Bosted

22 GeV Hall C SIDIS Phase Space – HMS+SHMS

Assumptions: HMS + SHMS minimum angle constraints unchanged
→ Increase in HMS maximum momentum (higher field magnets)
→ Smaller HMS angle may be possible, but would require special bender like SHMS



Possible Measurements
- → Additional L-T separations: expanded x/Q^2
- → Large P_T, cross sections and ratios in particular phase space
- → Measurements of cross sections and ratios at largest Q^2 and x

Measurements at 22 GeV: Parallel Kinematics

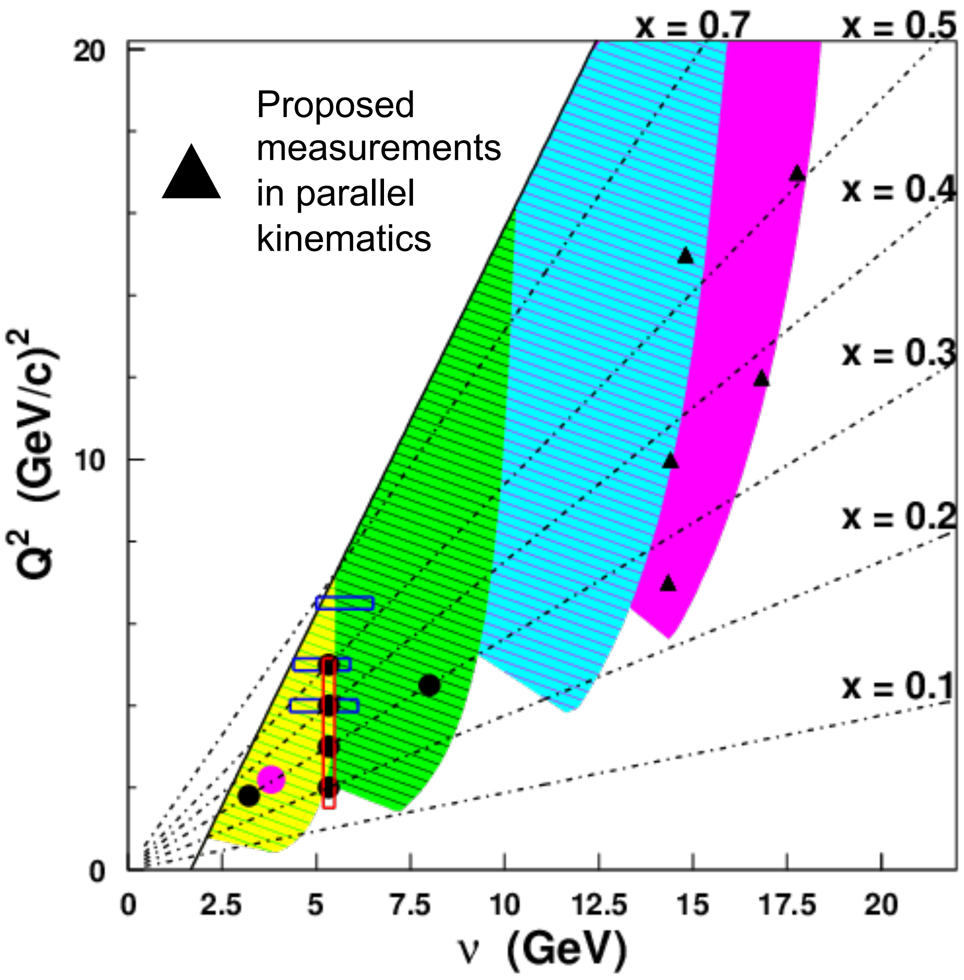
HMS+SHMS has excellent momentum/angle resolution
→ Complete ϕ coverage at low P_T

x	Q2	z
0.26	7	0.4-0.7
0.37	10	0.4-0.7
0.38	12	0.36-0.64
0.51	17	0.33-0.58
0.54	15	0.4-0.7

P_T=0-0.5
W' > 2 GeV for all settings

~45 days assuming 70 μA

No modifications to either HMS or SHMS needed for these measurements



Peter Bosted

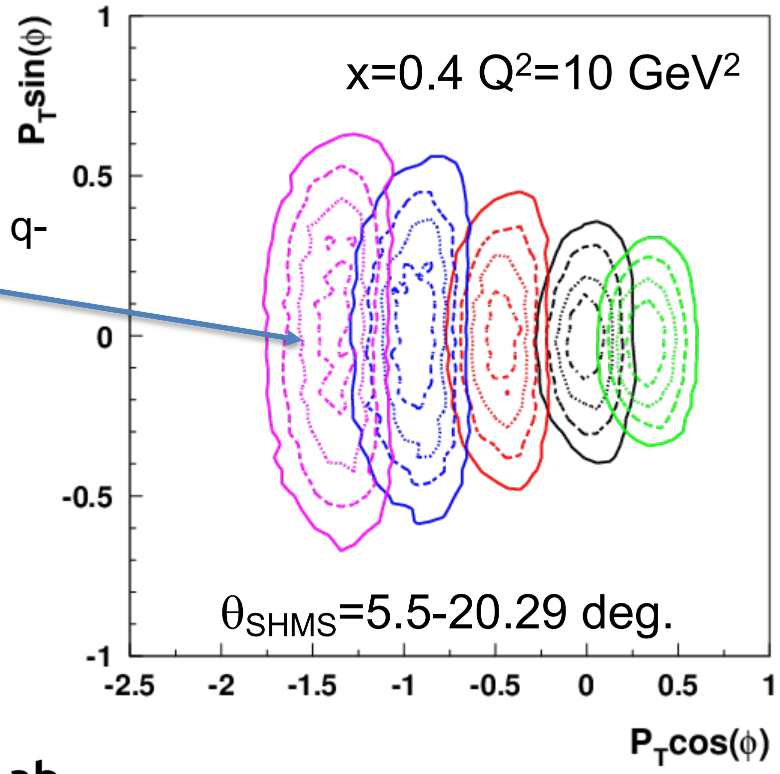
Measurements at 22 GeV: Large P_T

Access to large P_T by rotating SHMS away from q-vector
→ Interference term contribution difficult to constrain
→ Complicates possible L-T separations

This x/Q^2 assumes upgraded HMS

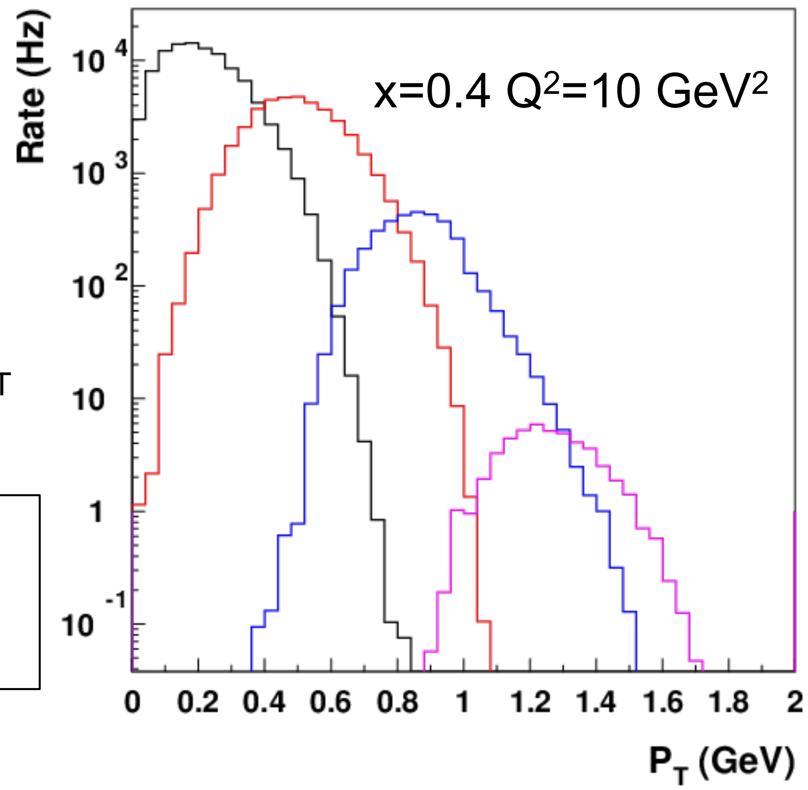
$$\frac{d\sigma}{dxdydzdp_T^2d\phi} = \frac{\alpha^2}{xyQ^2}\frac{y^2}{2(1-\epsilon)}\left[F_T + \epsilon F_L + \sqrt{2\epsilon(1+\epsilon)}\cos\phi F_{LT} + \epsilon\cos 2\phi F_{TT}\right]$$

SHMS +12 degrees from q-vector



Projected rates
→ 10 cm LH2 target
→ 80 μA
→ 40 MeV bins in P_T

$\Delta\varepsilon$ = 0.36 possible if L-T separation desired



Hall C Program at Higher Energy

- Higher energy capabilities similar to 12 GeV program
  - Precision cross sections
  - L/T separations
  - Low rate processes → large P_T
  - Precision ratios (π+/π-, and more)
  - Excellent π/K/p separation
  - Neutral particle capabilities w/calorimeter (NPS)
- Upgraded equipment
  - Higher momentum capability for electron arm (HMS) would be beneficial
  - Smaller angle capability?