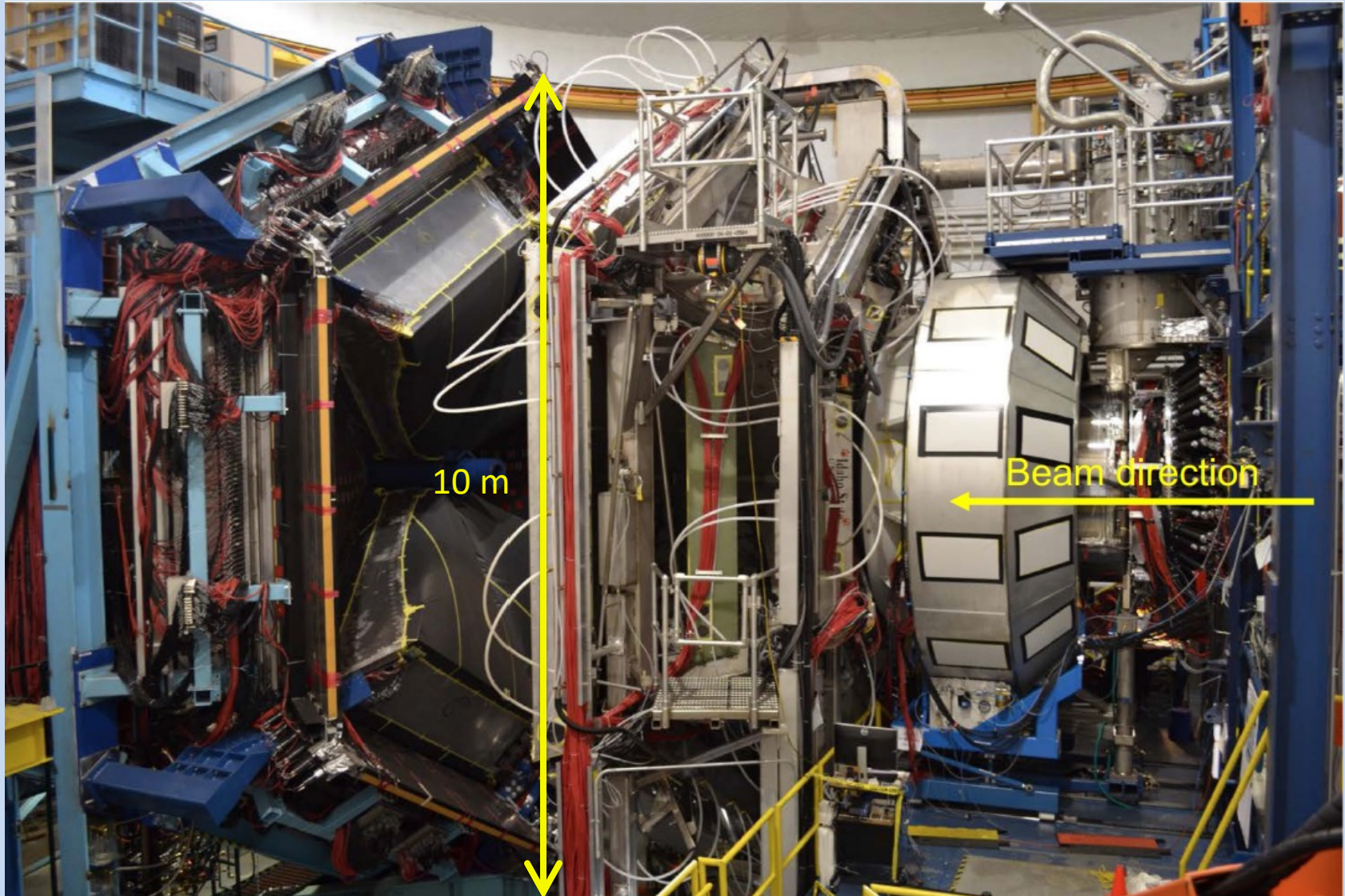
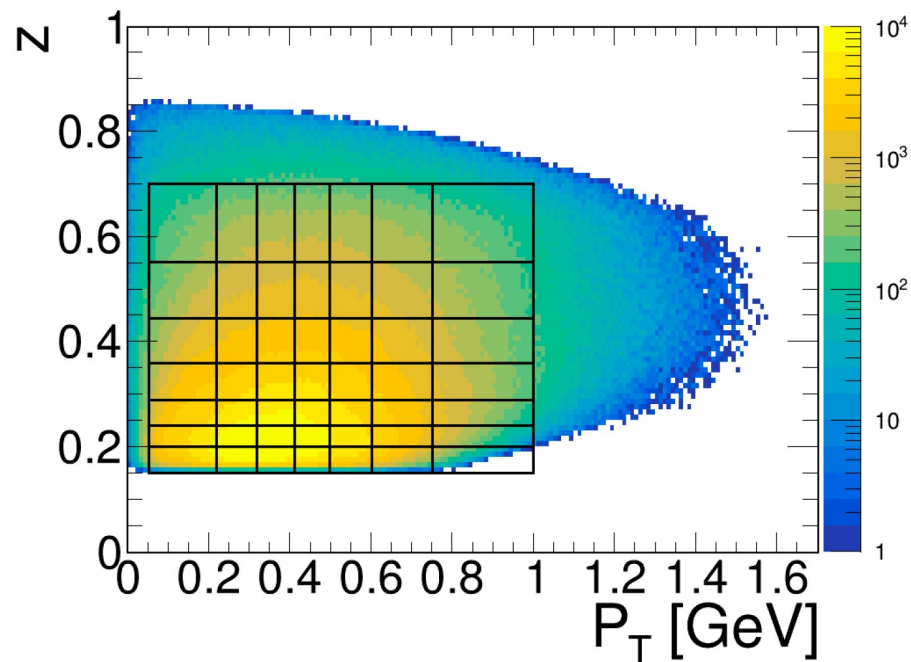
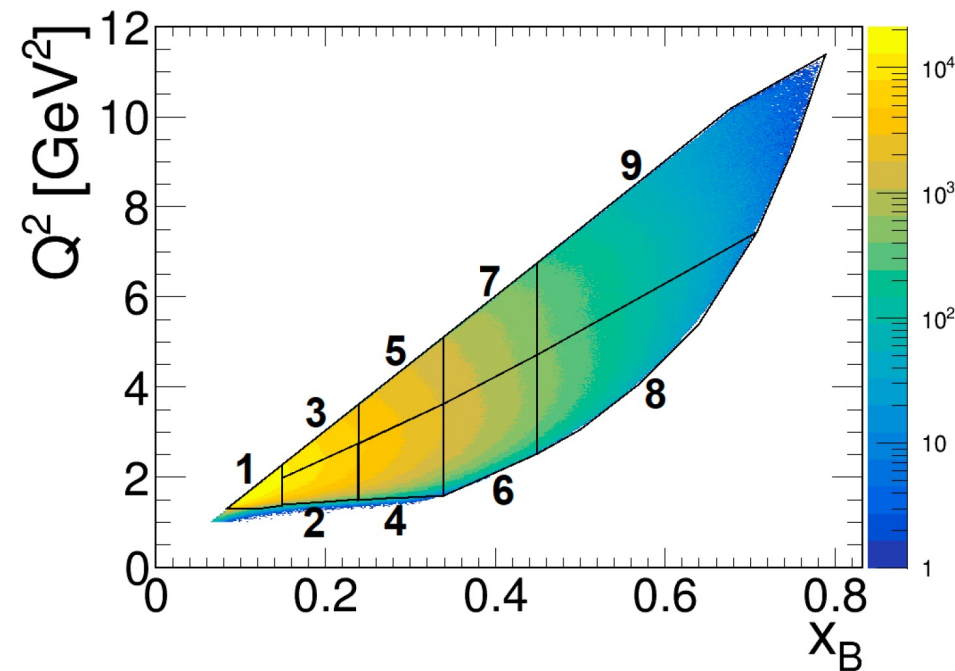


Large acceptance spectrometer. Operative since 02/18  
Luminosity up to  $10^{35} \text{ cm}^{-2} \text{ s}^{-1}$ ; Wide rapidity coverage



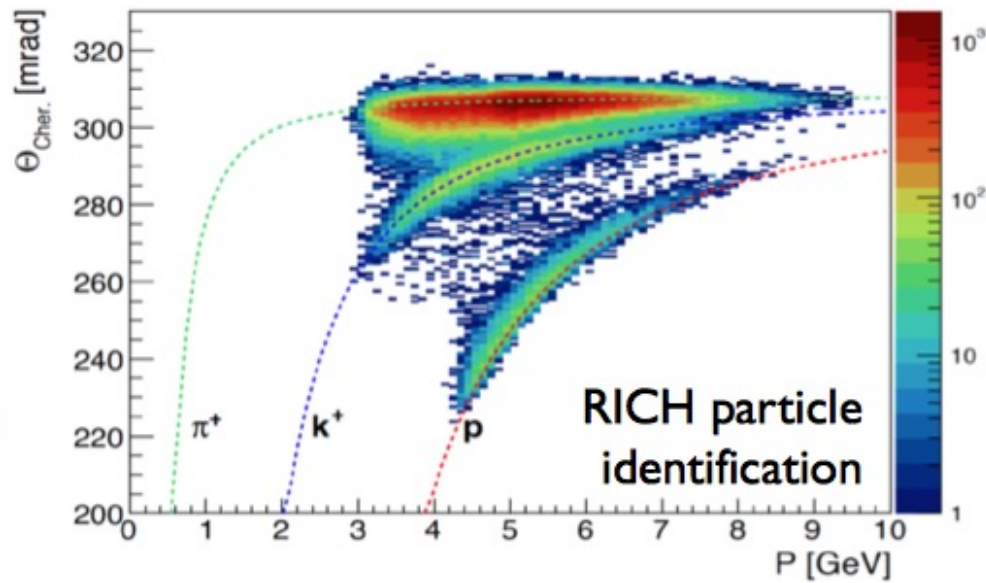
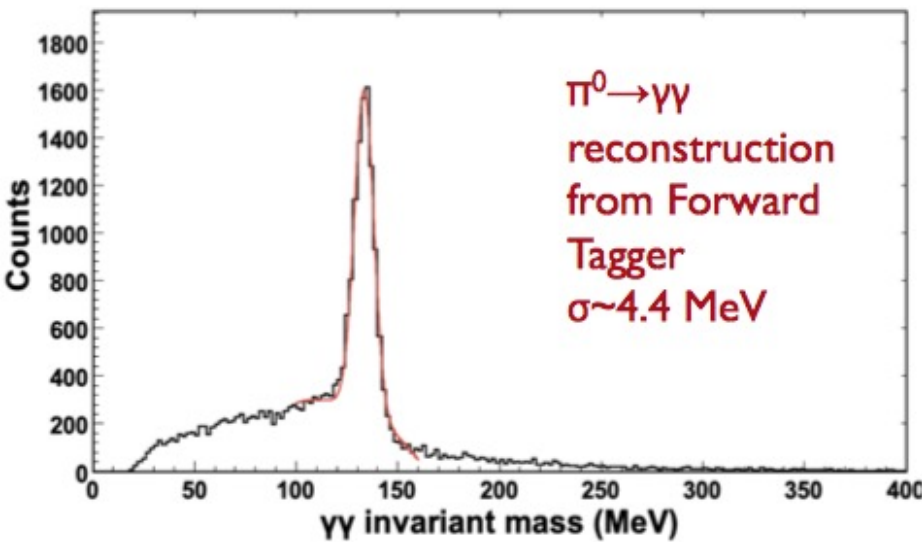
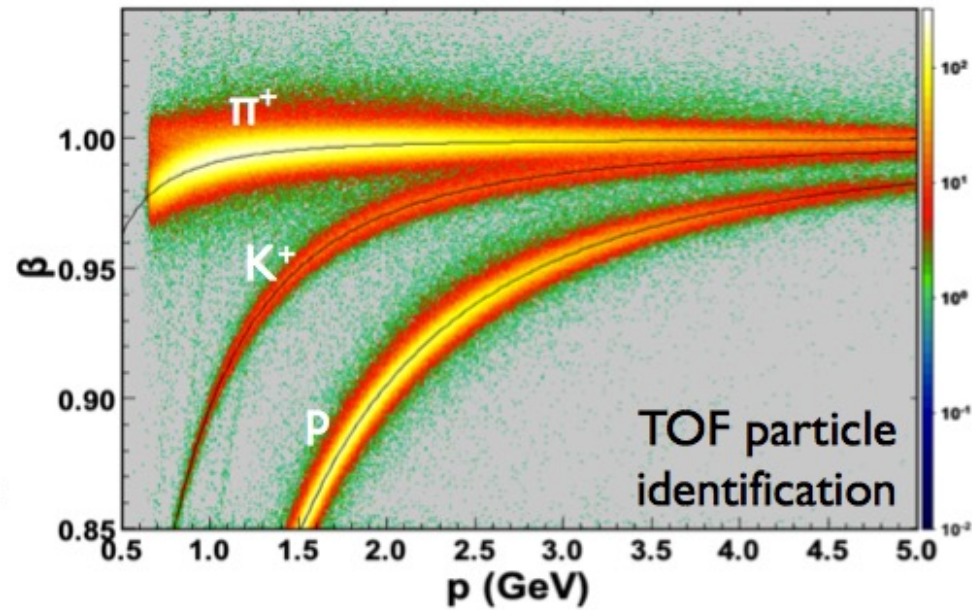
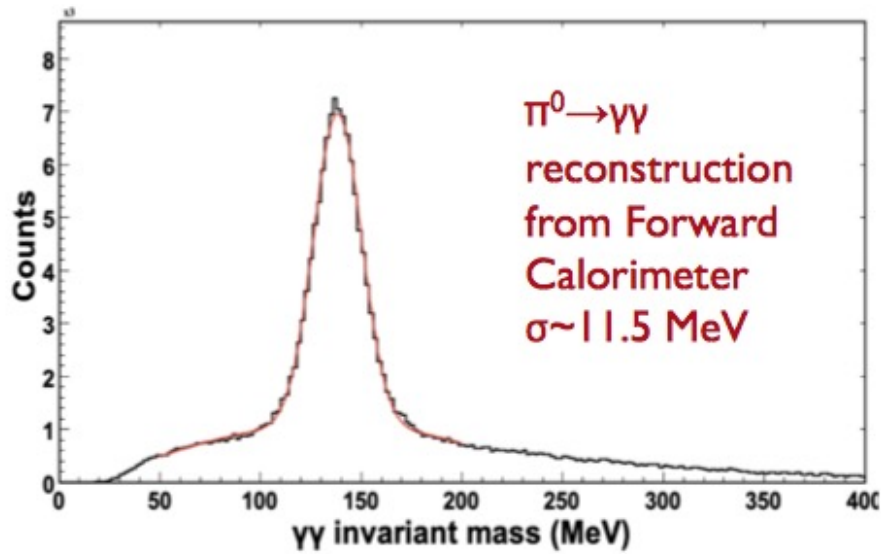
Valence region  
Several  $Q^2$

Extended  $p_T$  range  
Weak correlation with  $z$



Goal: explore quark dynamic effects in a extended phase-space  
matching various compelling regimes

Leverage in	$Q^2$ leverage: higher-twsts	} TMD study prescription
	$P_T$ leverage: perturbative vs non-perturbative	
	$\eta$ leverage: target fragmentation	



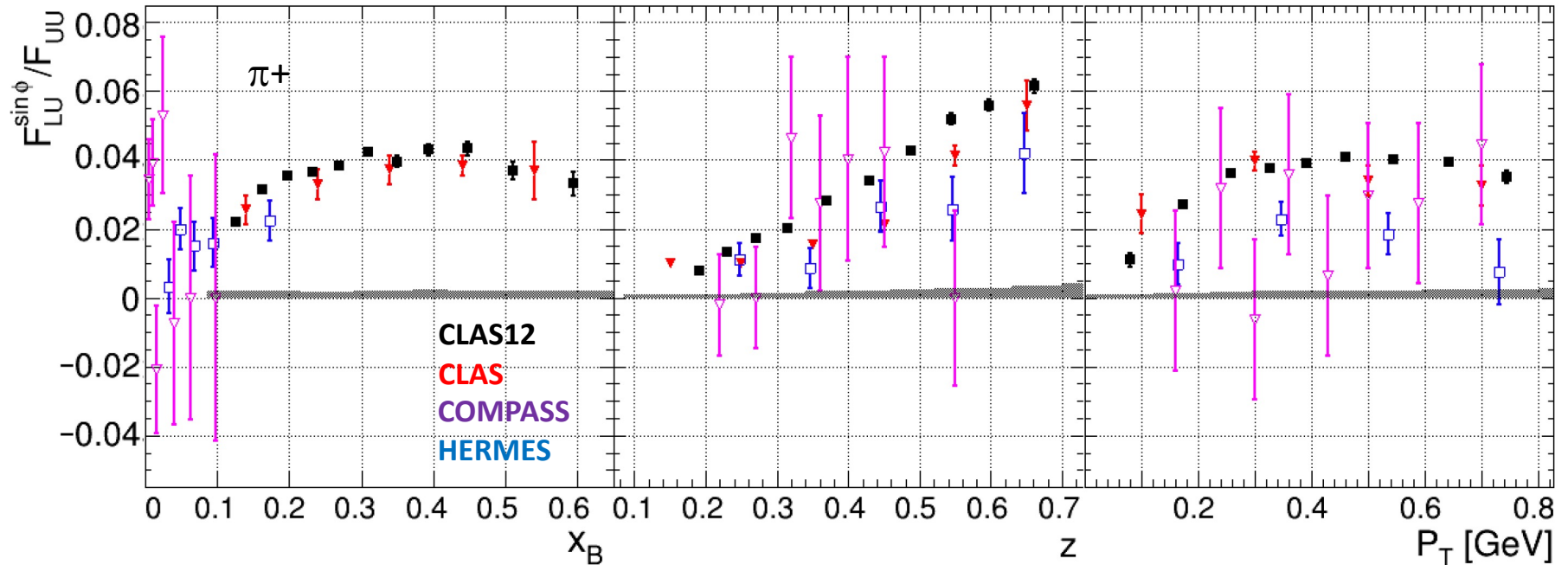
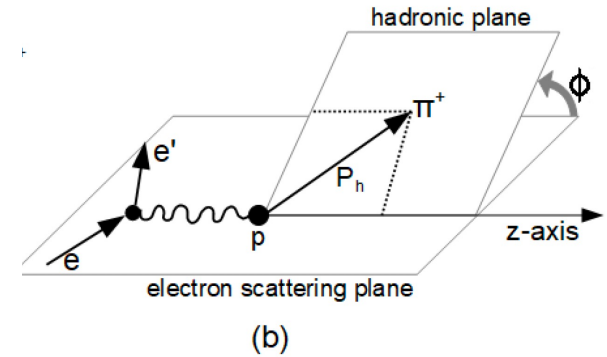
Year	Period	Run	Target	Polarization	Beam
2018	Spring-Fall	RGA	Proton	-	10.6 GeV
	Fall	RGK	Proton	-	6.5-7.5 GeV
<b>2019</b>	<b>Spring</b>	<b>RGA</b>	<b>Proton</b>	<b>-</b>	<b>10.6 GeV</b>
2019	Spring-Fall	RGB	Deuteron	-	10.6 GeV
2020	Spring-Fall	RGF	Deuteron	-	10.6 GeV
2021	Fall	RGM	Nuclear	-	Several GeV
2022	Spring-Fall	RGC	NH <sub>3</sub> -ND <sub>3</sub>	Longitudinal	10.6 GeV
> 2022		RGH	HDice, NH <sub>3</sub> -ND <sub>3</sub>	Transverse	10.6 GeV
			<sup>3</sup> He	Longitudinal	

++ Increased luminosity, extended energy range, additional targets

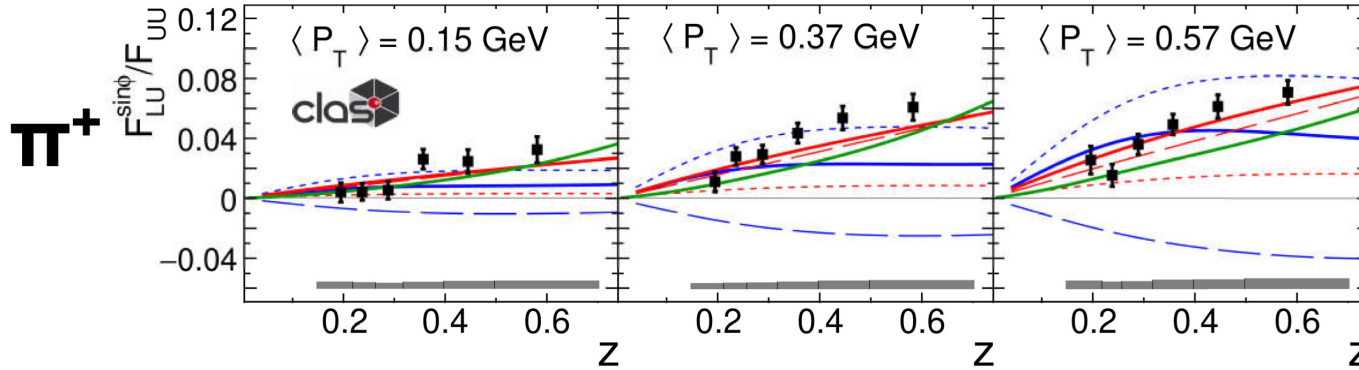
CLAS12 proton data (RGA)

S. Diehl et al., e-Print: 2101.03544

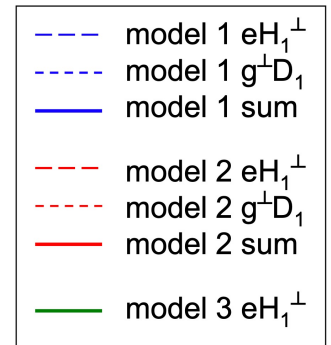
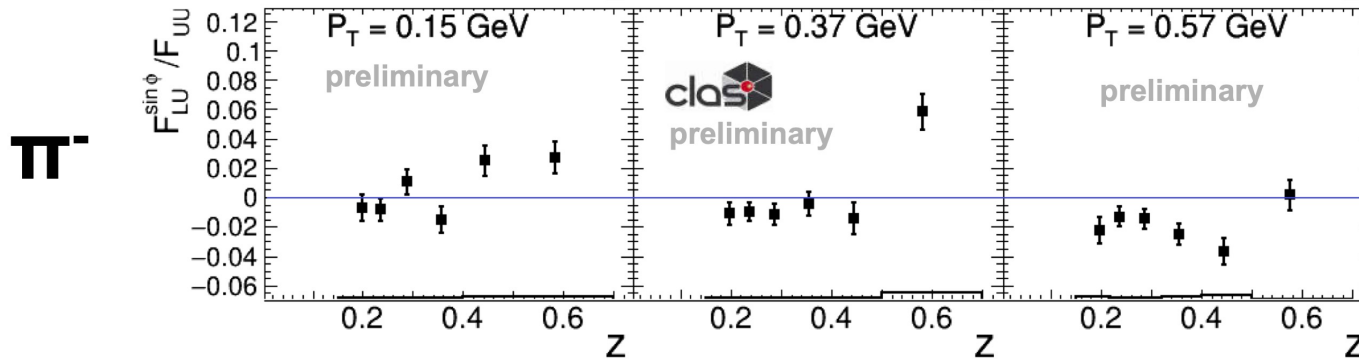
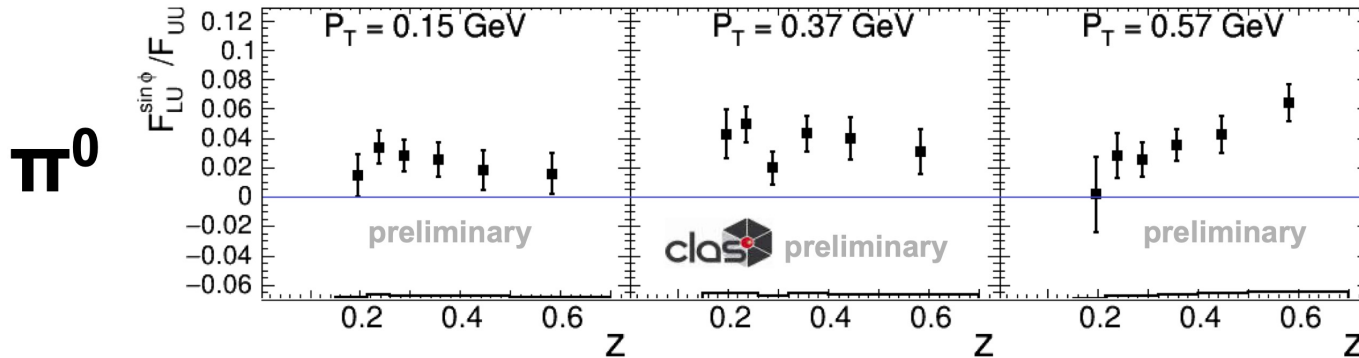
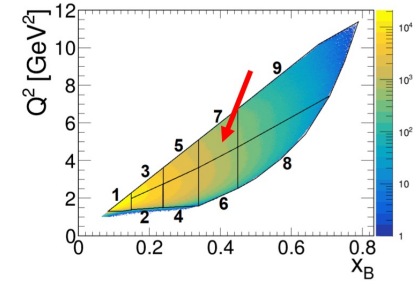
$$F_{LU}^{\sin\phi} = \frac{2M}{Q} C \left[ -\frac{\hat{h} \cdot k_T}{M_h} \left( x_B e H_1^\perp + \frac{M_h}{M} f_1 \frac{\tilde{G}^\perp}{z} \right) + \frac{\hat{h} \cdot P_T}{M} \left( x_B g^\perp D_1 + \frac{M_h}{M} h_1^\perp \frac{\tilde{E}}{z} \right) \right]$$



## Opening the multi-state & multi-dimensional study

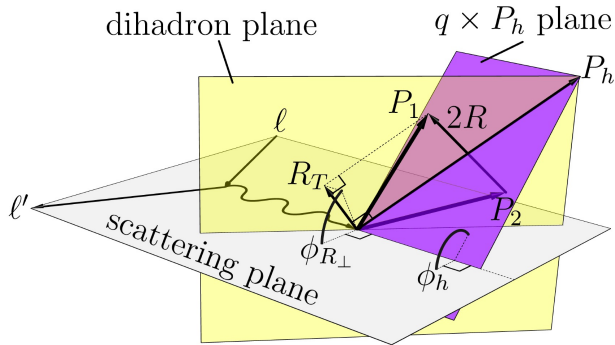


**bin 7:**  
 $Q^2 = 4.8 \text{ GeV}^2$   
 $x_B = 0.39$



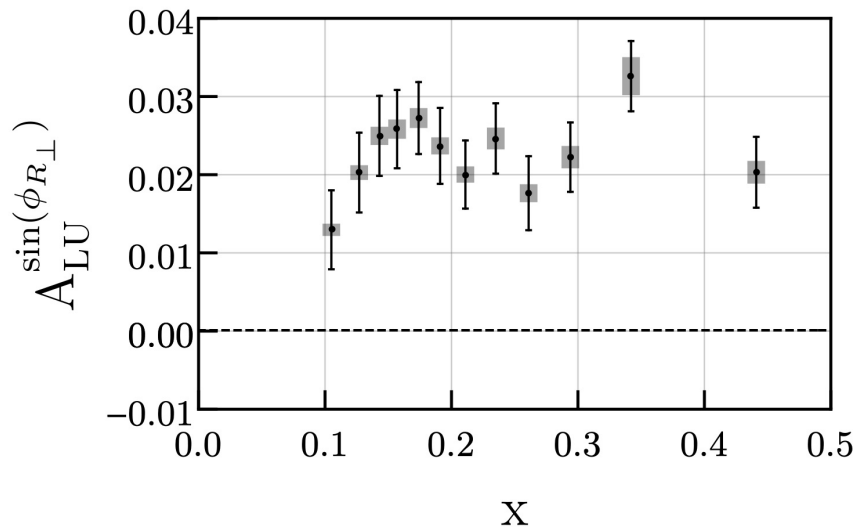
CLAS12 proton data (RGA)

T.B. Hayward et al., PRL 126 (2021) 152501

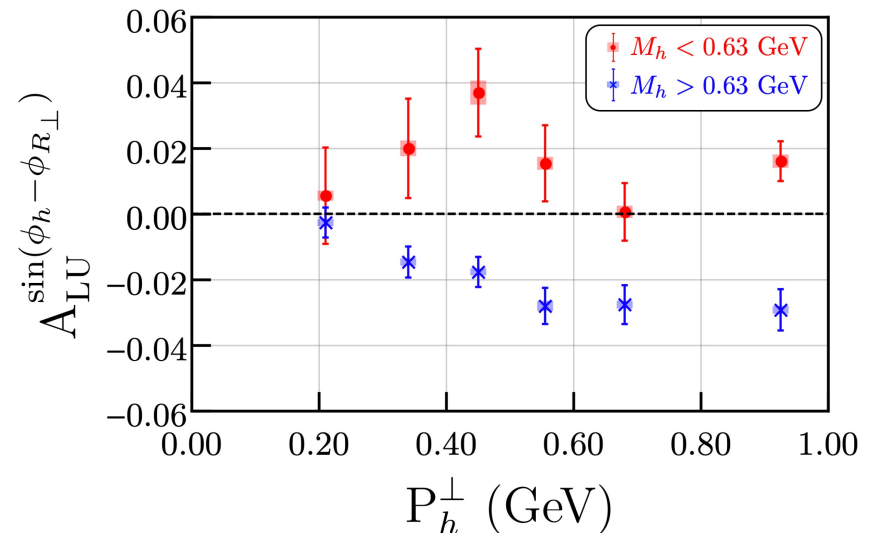
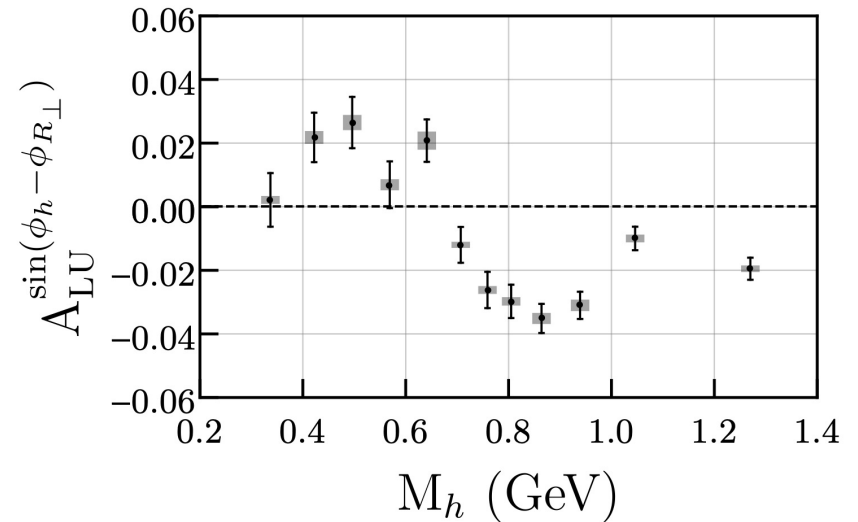


$d\sigma_{LU} \propto$

$$W \lambda_e \sin(\phi_{R_\perp}) \left( x e(x) H_1^\zeta(z, M_h) + \frac{1}{z} f_1(x) \tilde{G}^\zeta(z, M_h) \right)$$

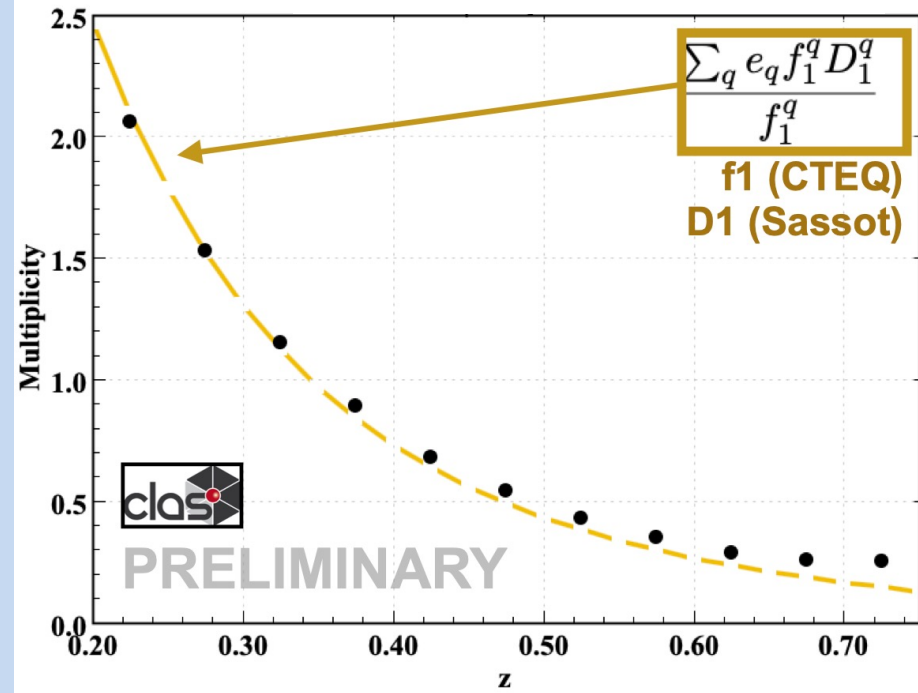


$$d\sigma_{LU} \propto C \lambda_e \sin(\phi_h - \phi_{R_\perp}) \mathcal{I} [f_1 G_1^\perp]$$

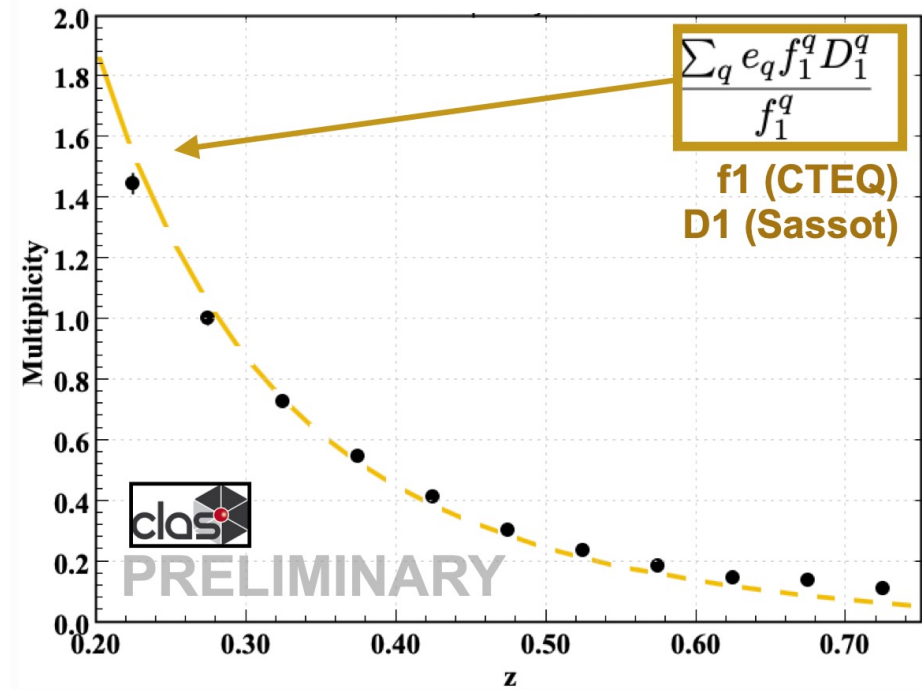


## Collinear study

$e p \rightarrow e \pi^+ X$



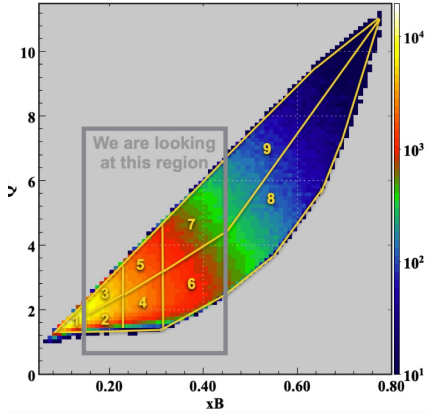
$e p \rightarrow e \pi^- X$





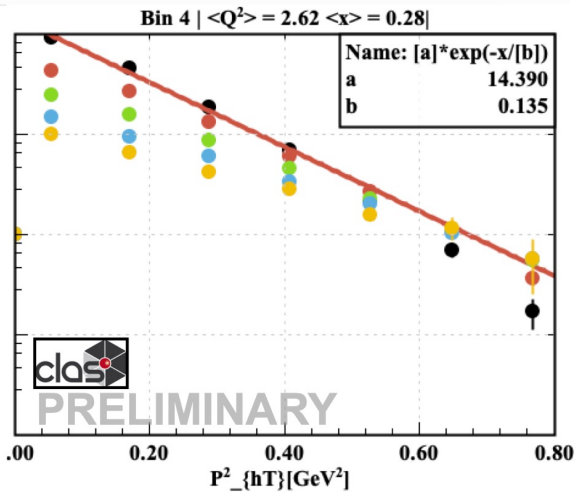
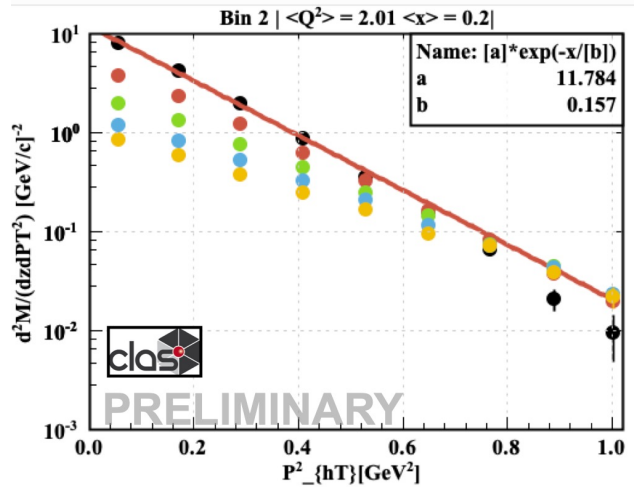
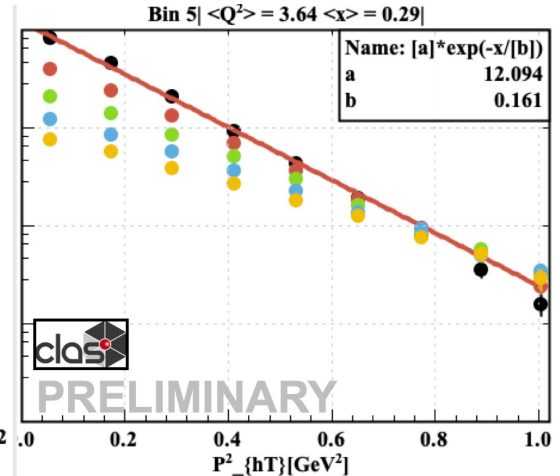
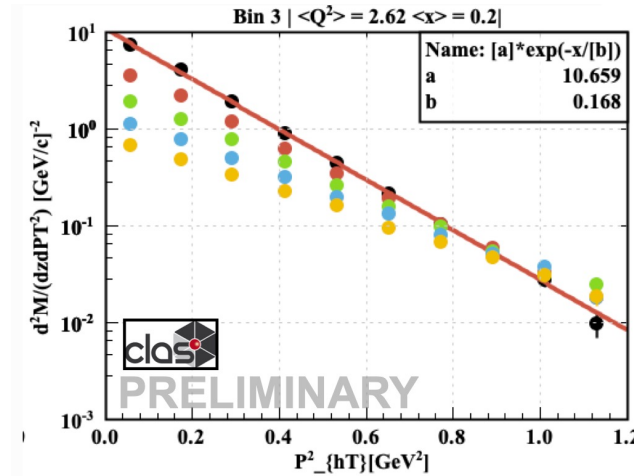
## Transverse momentum dependence and phase space

$ep \rightarrow e\pi^+X$



Color legend

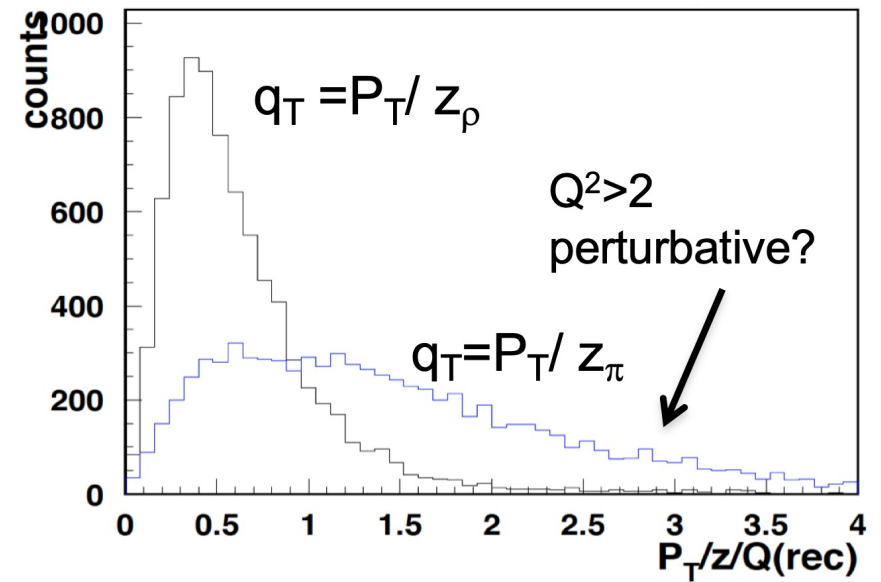
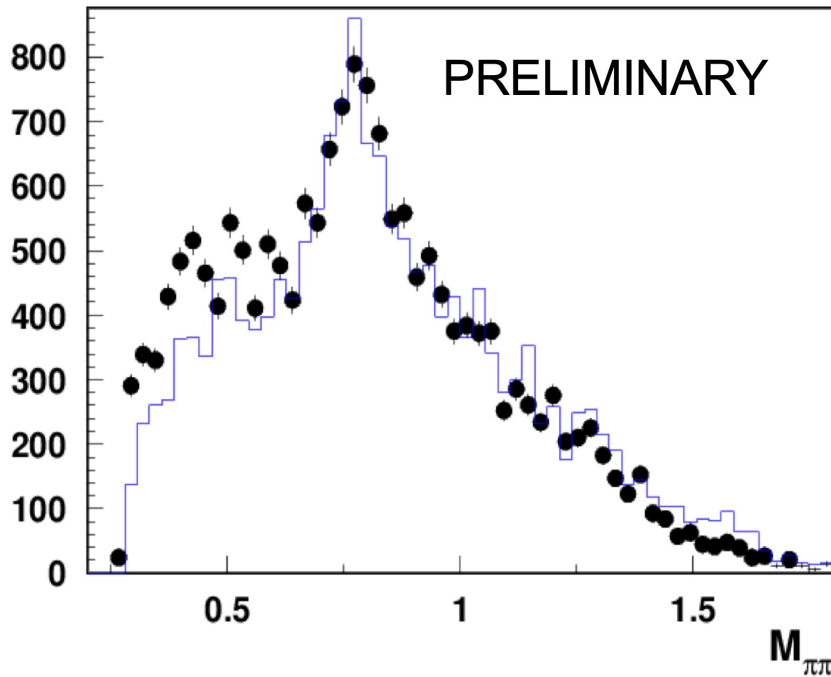
- $0.2 < z < 0.3$
- $0.3 < z < 0.4$
- $0.4 < z < 0.5$
- $0.5 < z < 0.6$
- $0.6 < z < 0.7$



$\langle x \rangle = 0.2$

$\langle x \rangle = 0.29$

Transverse momentum dependence and role of vector meson decays



Example of precision/validation study



CLAS12 is Entering the 12 GeV production era

Large luminosity, wide acceptance, excellent PID

First beam-spin asymmetry published

Comprehensive program with

- polarized targets
- nuclear targets

Important synergy with EIC activity

Working for precision and new approaches

to exploit existing infrastructure

and boost the physics program