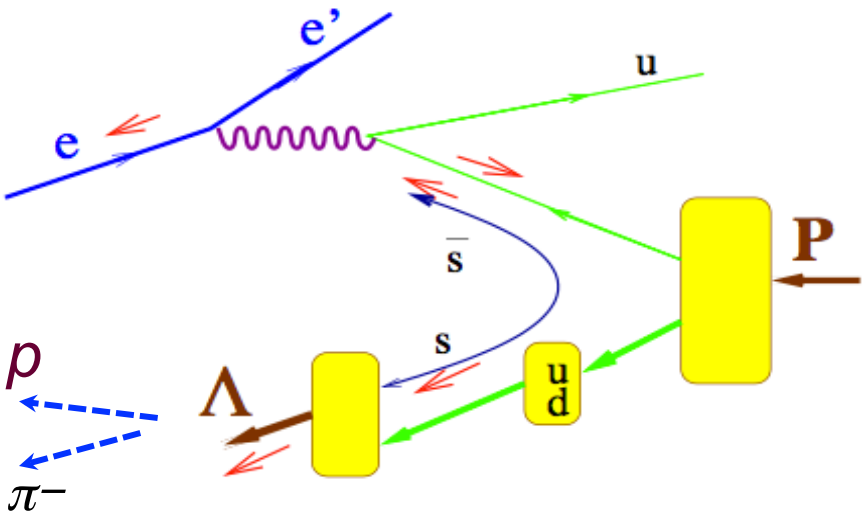
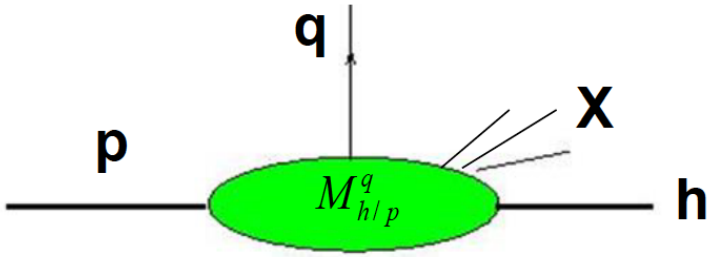
Target fragmentation region and fracture functions



Large acceptance of CLAS12 and EIC provide a unique possibility to study the nucleon structure simultaneously in current and target fragmentation regions in SIDIS



probability to produce the hadron h when a quark q is struck in a proton target

$$\frac{d\sigma^{TFR}}{dx_B dy d\zeta d\phi_S d\phi} =$$

$$= \frac{\alpha_{em}^2}{\pi Q^2 y} \sum_a e_a^2 \times$$

M. Anselmino, V. Barone and A. Kotzinian, Phys. Lett. B 699 (2011) 108

$$\left\{ \left(1 - y + \frac{y^2}{2}\right) \left[M(x_B,\zeta) + S_{N\parallel} S_\parallel M_L^L(x_B,\zeta) + |\mathbf{S}_{N\perp}|\,|\mathbf{S}_\perp|\, M_T^T(x_B,\zeta) \cos(\phi - \phi_S) \right] \right.$$

$$+ hy \left(1 - \frac{y}{2}\right) \left[S_{N\parallel} \Delta M_L(x_B,\zeta) + S_\parallel \Delta M^L(x_B,\zeta) + \right.$$

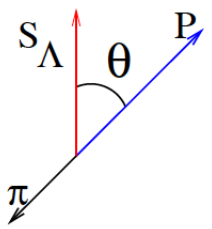
$$\left. \left. + |\mathbf{S}_{N\perp}|\,|\mathbf{S}_\perp|\, \Delta M_T^T(x_B,\zeta) \sin(\phi - \phi_S) \right] \right\}$$

Measurements of hadrons produced in the target fragmentation region (fracture functions) opens a new avenue in studies of the structure of the nucleon in general and correlations between current and target fragmentation in particular

Λ production in the target fragmentation region

Λ – unique tool for polarization study due to self-analyzing parity violating decay

$$\frac{dN}{d\cos\theta_p^*} \propto 1 + \alpha P_\Lambda \cos\theta_p^*$$

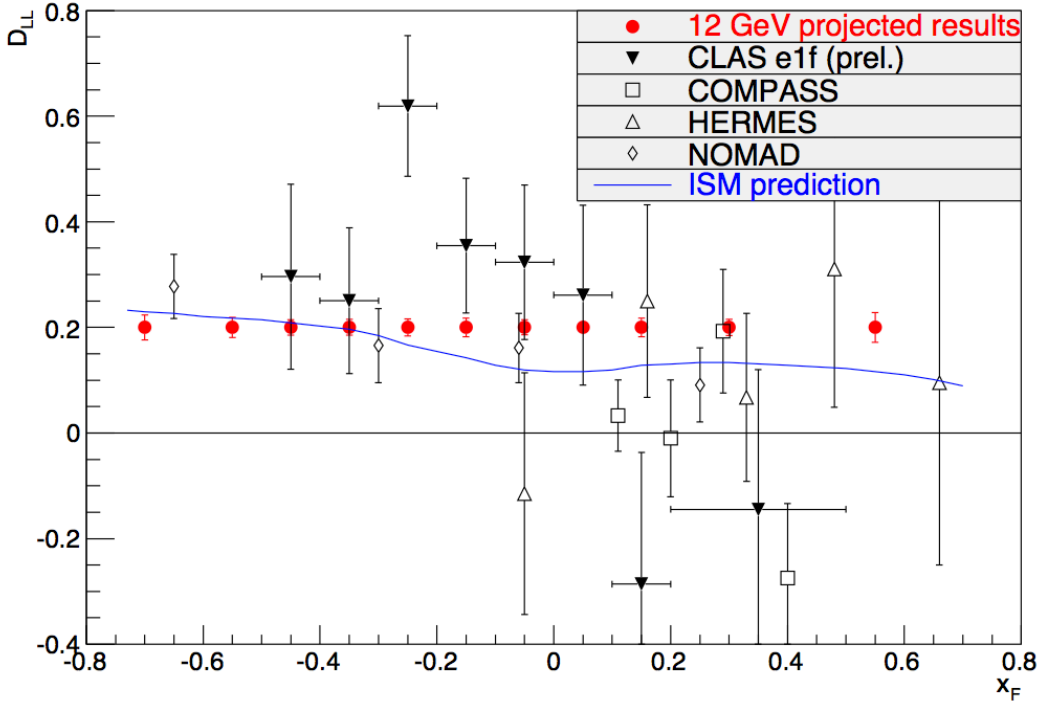


$$A_{LUL}^{TFR} = hS_\parallel \frac{y\left(1-\frac{y}{2}\right)\sum_a e_a^2 \Delta M^L}{\left(1-y+\frac{y^2}{2}\right)\sum_a e_a^2 M}$$

polarization tranfer coefficient

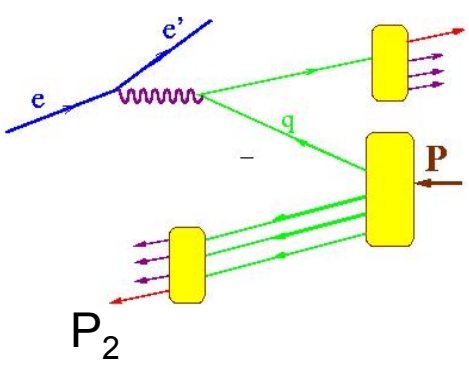
$$D^{LL} = \frac{\sum_a e_a^2 \Delta M^L}{\sum_a e_a^2 M}$$

30 days of CLAS12 data taking



Projected results of the longitudinal spin transfer as a function of $\mathbf{x}_F$ (red full circles) compared with the CLAS preliminary data and the ISM prediction

Back-to-back hadron (b2b) production in SIDIS

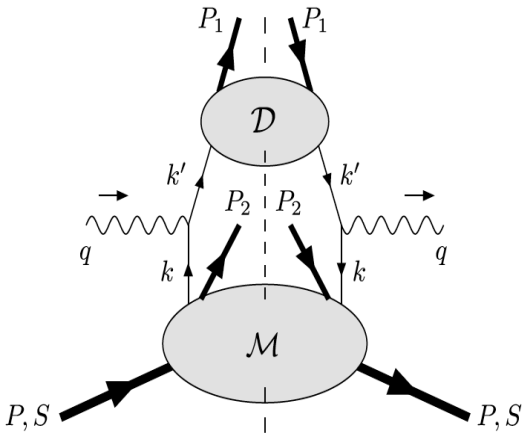


M. Anselmino, V. Barone and A. Kotzinian, Physics Letters B 713 (2012)

$$\mathcal{F}_{LU}^{\sin(\phi_1-\phi_2)} = \frac{|\vec{P}_{1\perp}\vec{P}_{2\perp}|}{m_N m_2}\mathcal{C}[w_5 M_L^{\perp,h} D_1]$$

	U	L	T
U	M	$M_L^{\perp,h}$	$M_T^h, M_T^\perp$
L	$\Delta M^{\perp,h}$	ΔM_L	$\Delta M_T^h, \Delta M_T^\perp$
T	$\Delta_T M_T^h, \Delta_T M_T^\perp$	$\Delta_T M_L^h$ $\Delta_T M_L^\perp$	$\Delta_T M_T, \Delta_T M_T^{hh}$ $\Delta_T M_T^{\perp\perp}, \Delta_T M_T^{\perp h}$

The beam–spin asymmetry appears, at leading twist and low transverse momenta, in the deep inelastic inclusive lepto-production of two hadrons, one in the target fragmentation region and one in the current fragmentation region.



$$\mathcal{A}_{LU} = -\frac{y(1-\frac{y}{2})}{(1-y+\frac{y^2}{2})}\frac{\mathcal{F}_{LU}^{\sin\Delta\phi}}{\mathcal{F}_{UU}}\sin\Delta\phi$$

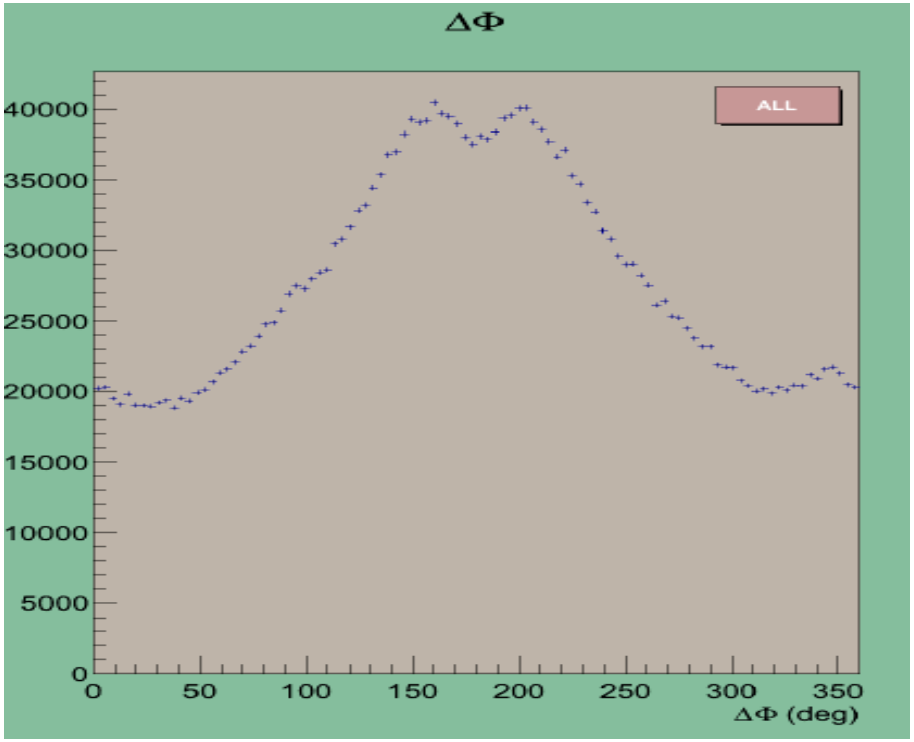
$$= -\frac{|\boldsymbol{P}_{1\perp}||\boldsymbol{P}_{2\perp}|}{m_N m_2}\frac{y(1-\frac{y}{2})}{(1-y+\frac{y^2}{2})}\frac{\mathcal{C}[w_5 M_L^{\perp,h} D_1]}{\mathcal{C}[M D_1]}\sin\Delta\phi$$

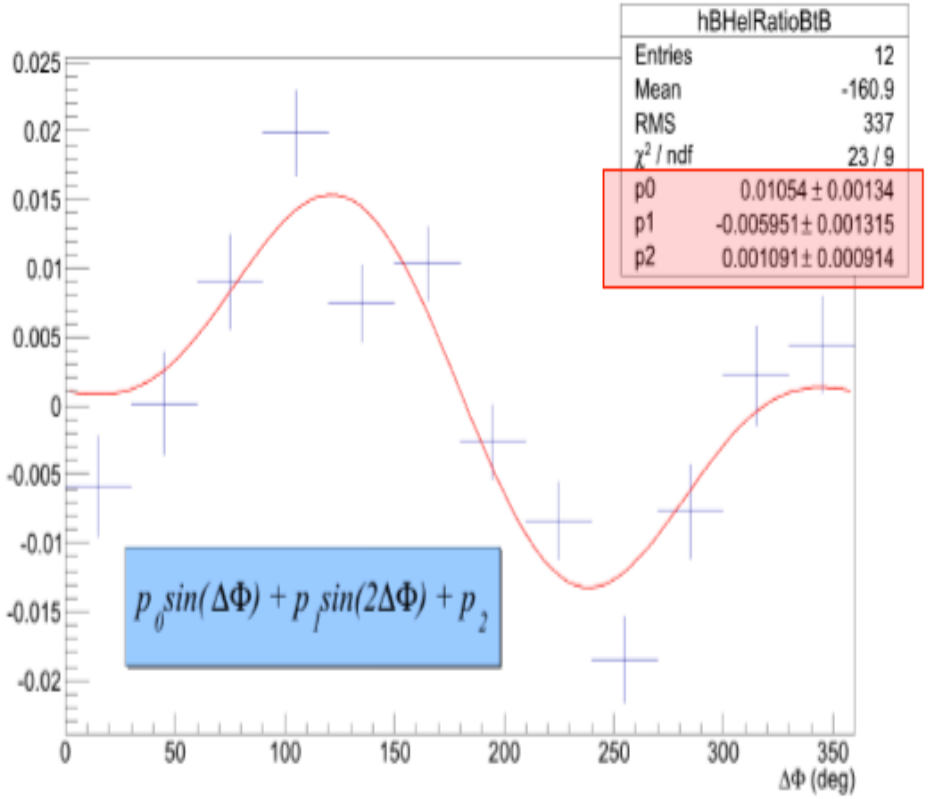
Back-to-back hadron production in SIDIS would allow:

- study SSAs not accessible in SIDIS at leading twist
- measure fracture functions
- control the flavor content of the final state hadron in current fragmentation (detecting the target hadron)
- study correlations in target vs current and access factorization breaking effects (similar to pp case)
- access quark short-range correlations and χSB (Schweitzer et al)
- ...

Support slides….

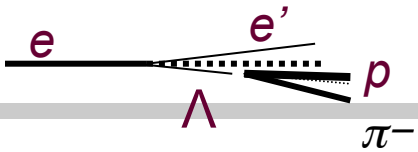
ALU in b2b SIDIS with CLAS @ 5.5 GeV

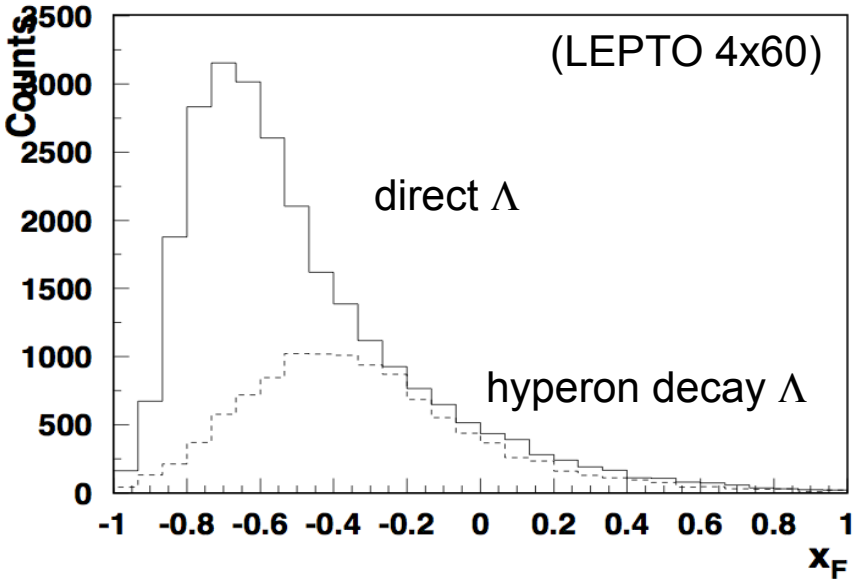


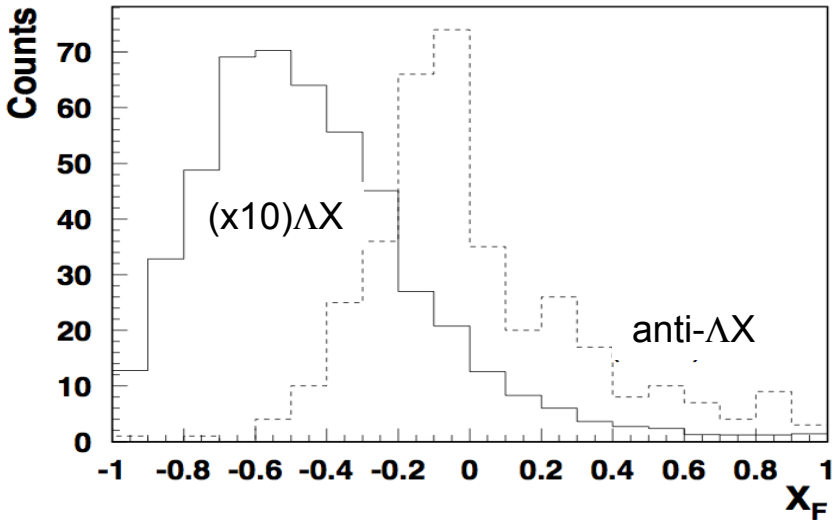


Preliminary results for a significant ALU asymmetry from CLAS with π+ produced in CFR and π− – in TFR.

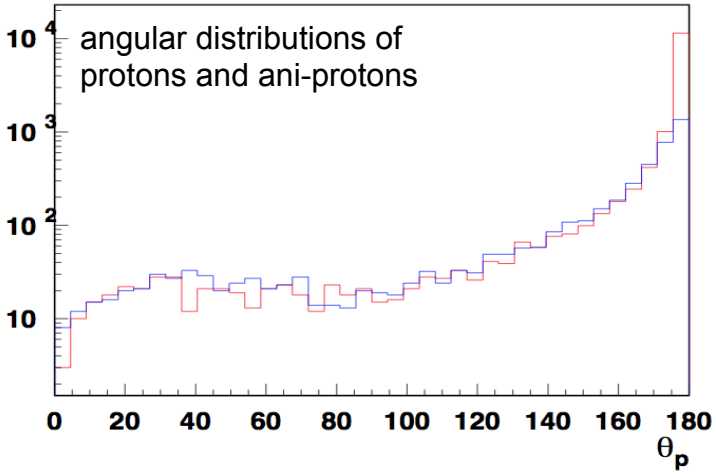
Λ production in the target fragmentation region

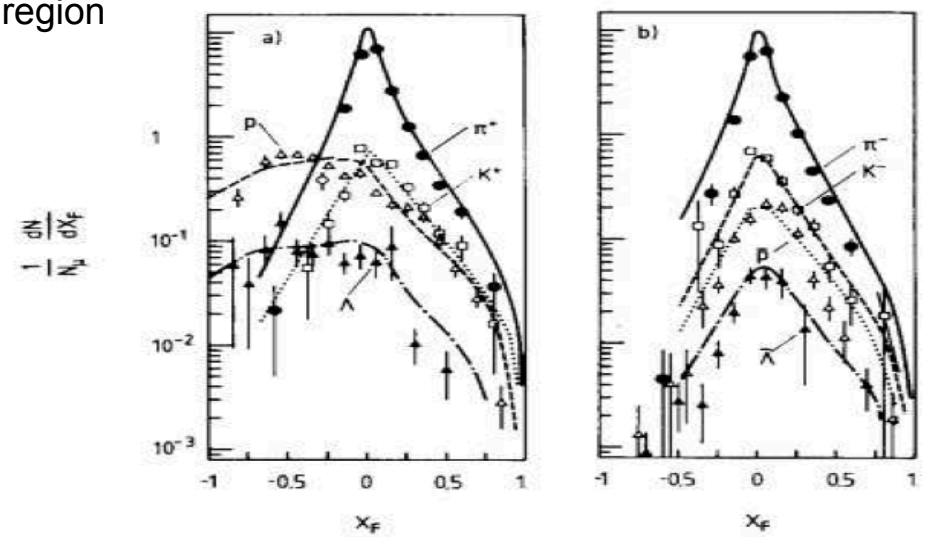




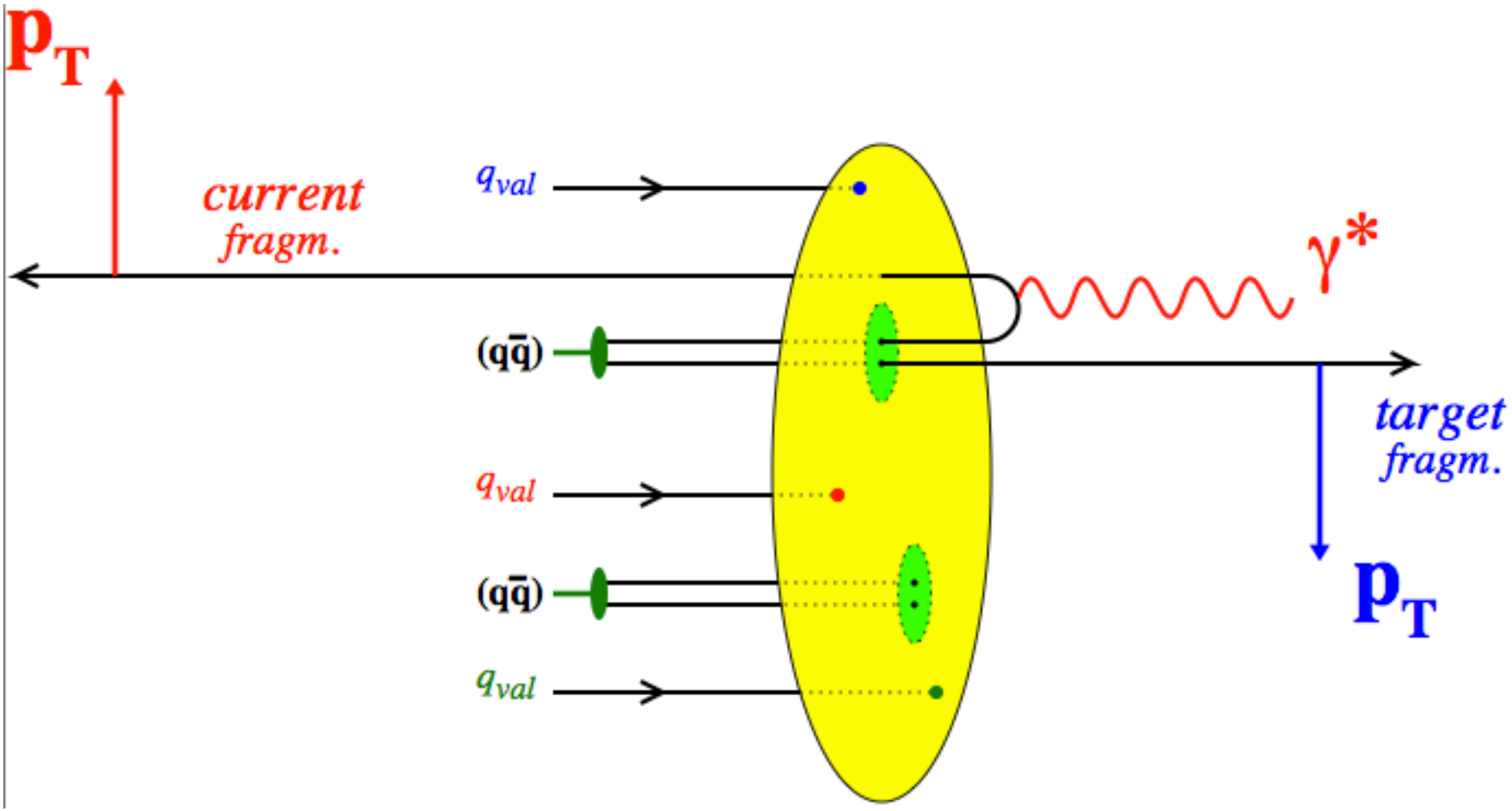


Most of the direct Lambdas in the target fragmenatation region



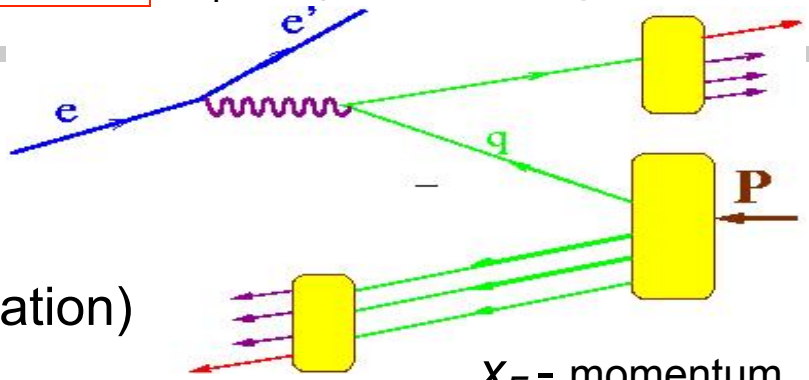


correlations between target and current



Single hadron production in hard scattering

x_F>0 (current fragmentation)



x_F<0 (target fragmentation)

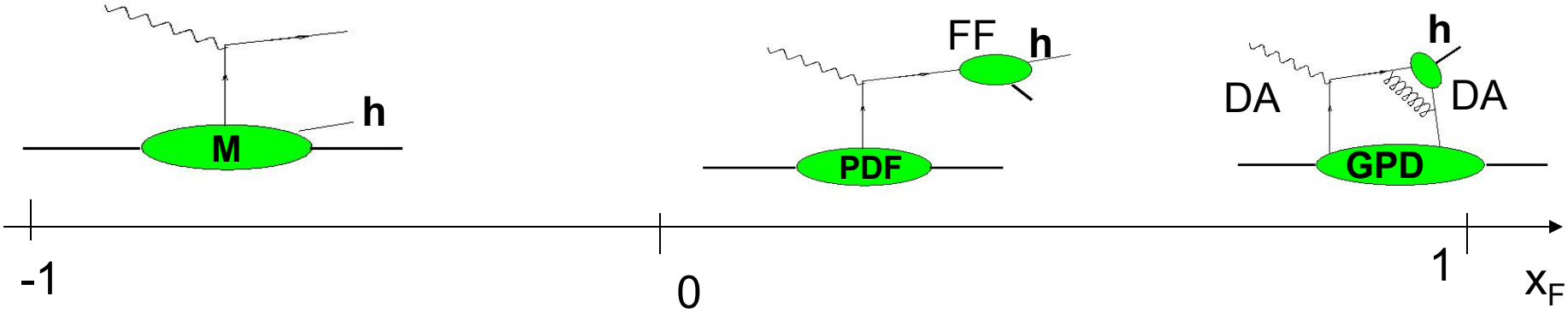
x_F - momentum in the CM frame

Target fragmentation

Current fragmentation

semi-inclusive

exclusive



Fracture Functions

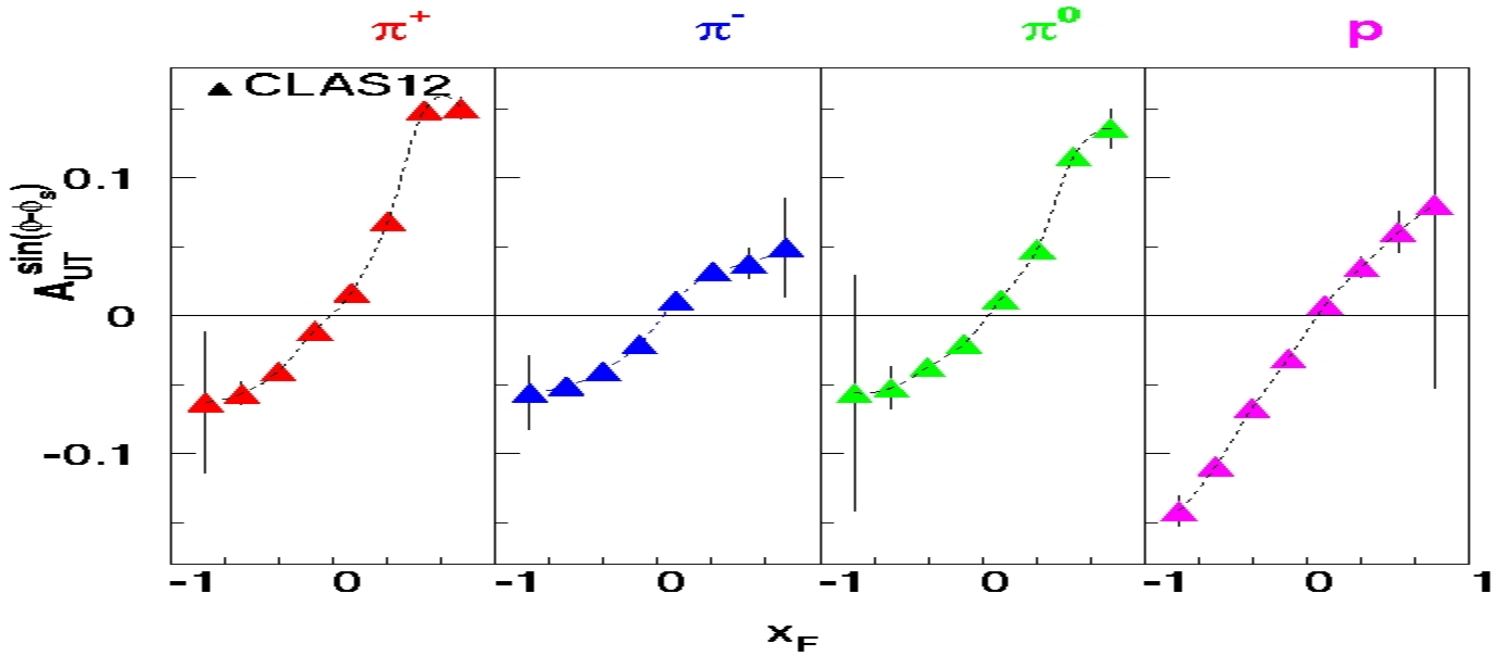
k_T-dependent PDFs

Generalized PDFs

Wide kinematic coverage of large acceptance detectors allows studies of hadronization both in the target and current fragmentation regions

Sivers effect in the target fragmentation

A.Kotzinian



High statistics of CLAS12 will allow studies of kinematic dependences of the Sivers effect in target fragmentation region