Semi-inclusive DIS measurement on A = 3

Dien Nguyen

1st EIC Yellow Report Workshop

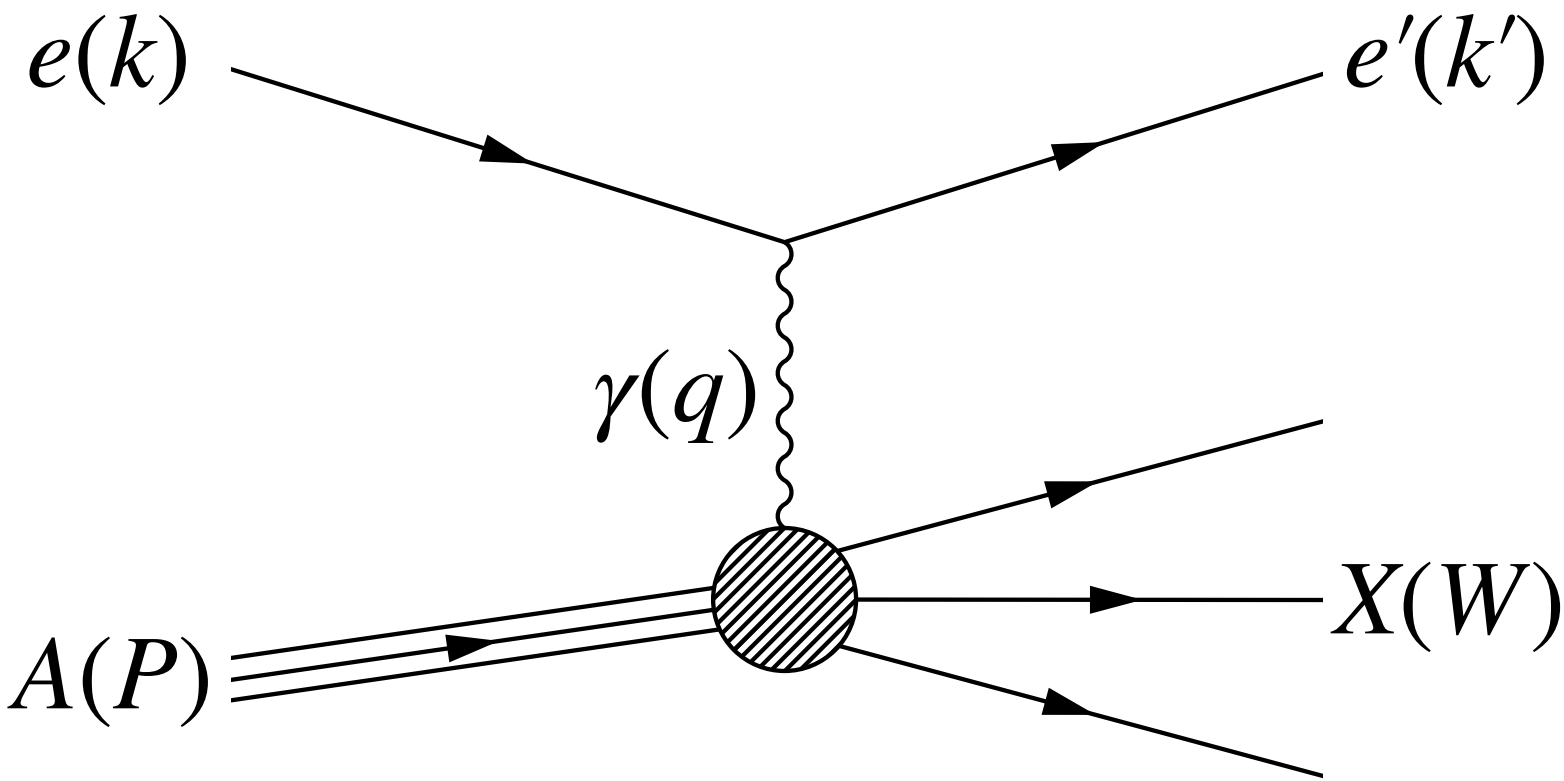
Hen Lab

Laboratory for Nuclear Science @ MIT

Outline:

- ❑ Semi-inclusive DIS on A = 3
- ❑ Semi-inclusive DIS on Polarized ^{3}He
- ❑ Current work on rate estimation
- ❑ Plan for EIC kinematic

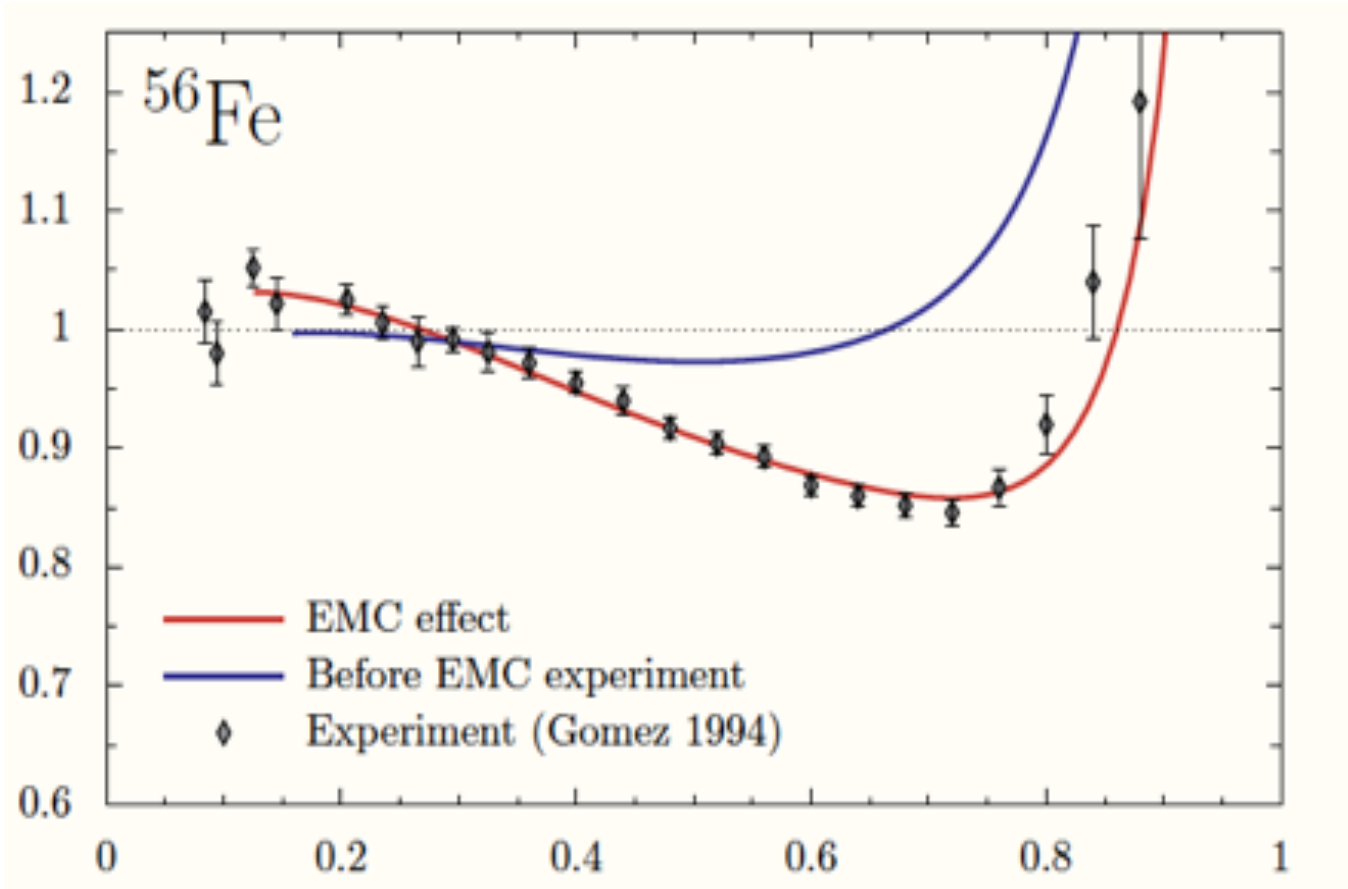
Deep inelastic scattering



- Sensitive to the nucleon structure and modification

EMC effect in Deep inelastic scattering

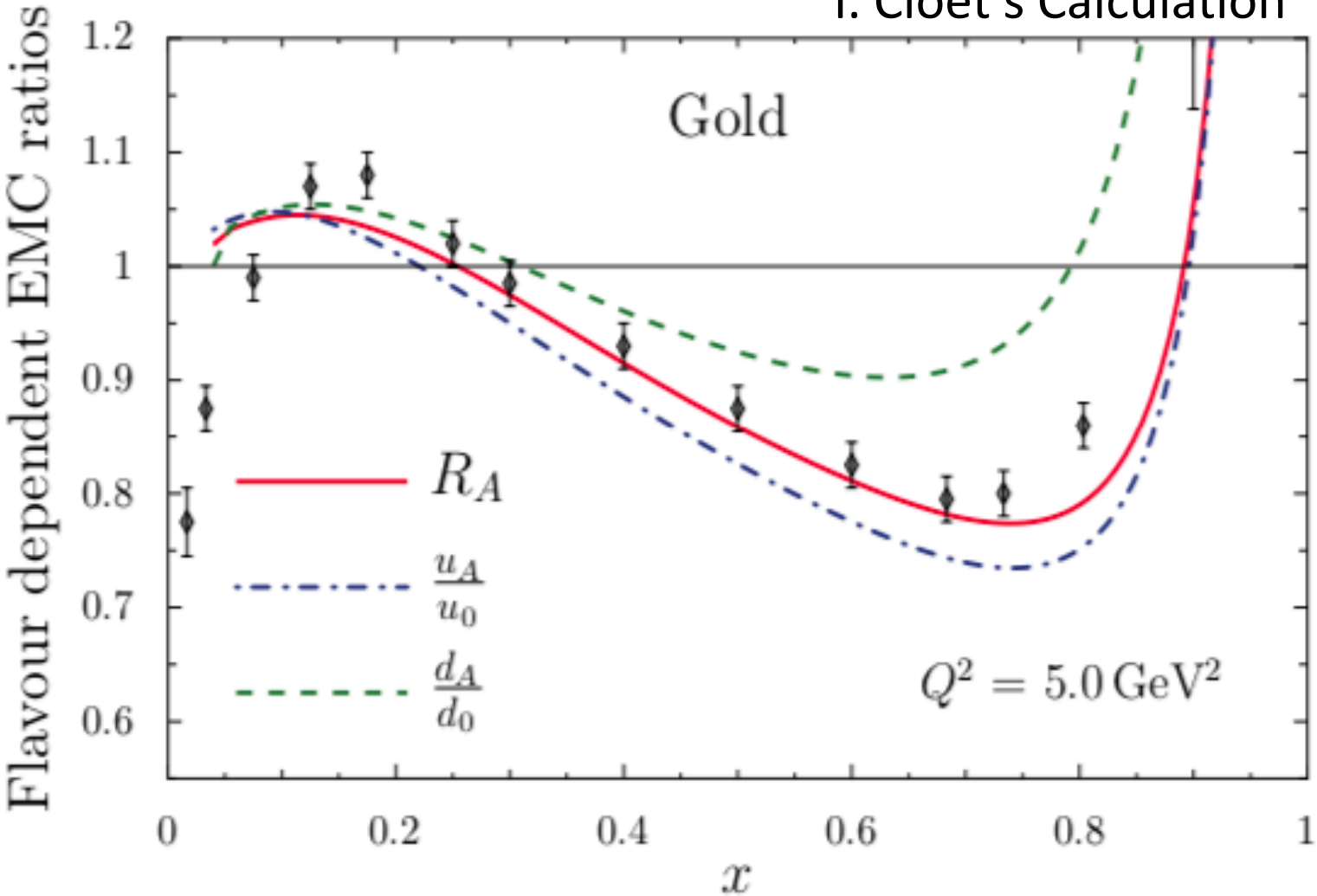
F_2^{Fe}/F_2^D



- Bound nucleons behave different from free nucleons

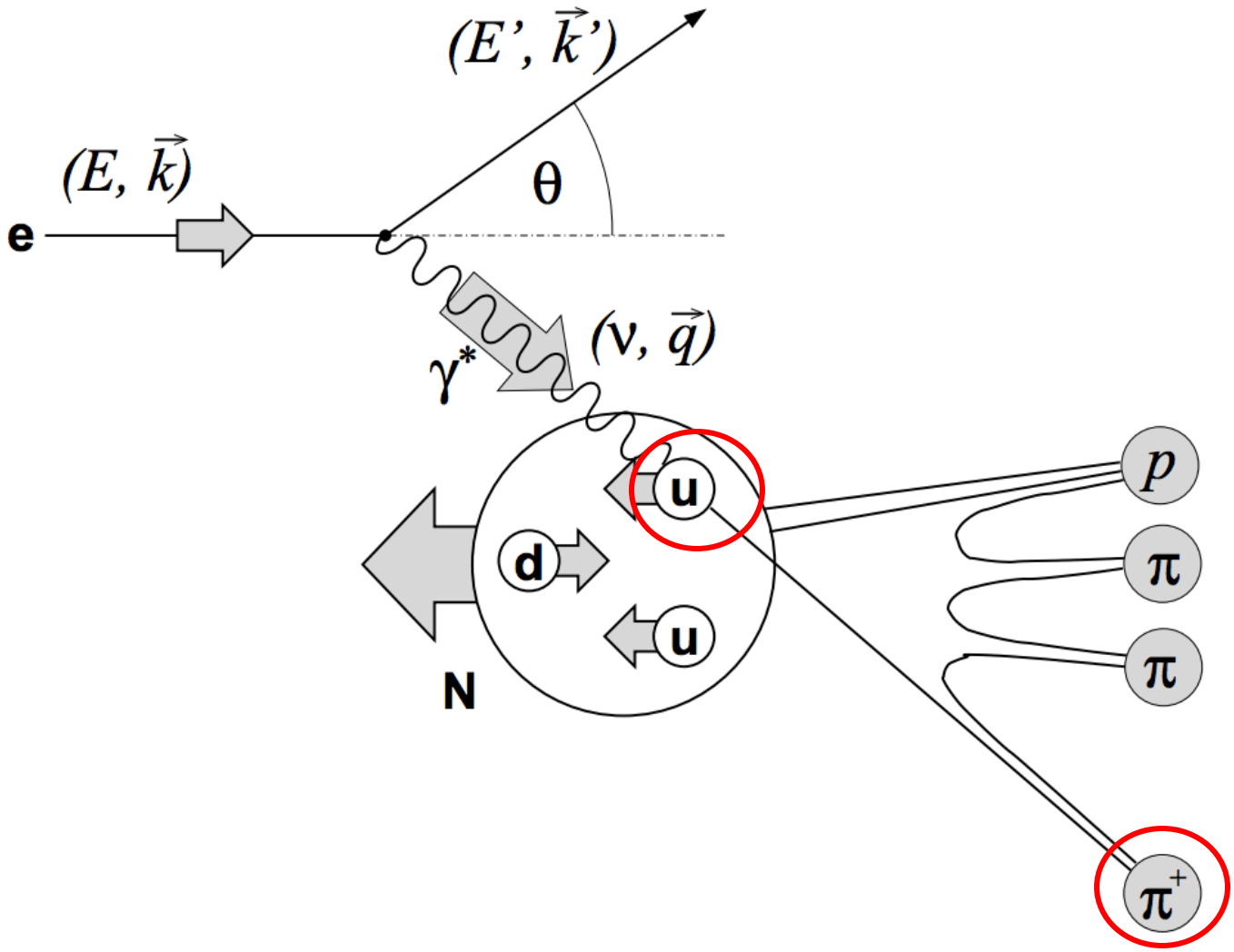
Flavor Dependence of the EMC

I. Cloet's Calculation



- Different flavors cause different modifications

Semi-Inclusive DIS: Flavor Tagging



Experimental observations

Yield sum

$$\frac{Y(\pi^+ + \pi^-)_A}{Y(\pi^+ + \pi^-)_D}$$

Yield difference

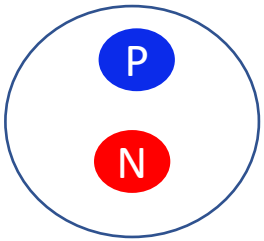
$$\frac{Y(\pi^+ - \pi^-)_A}{Y(\pi^+ - \pi^-)_D}$$

Double ratio

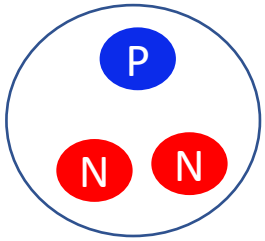
$$\frac{Y\left(\frac{\pi^+}{\pi^-}\right)_A}{Y\left(\frac{\pi^+}{\pi^-}\right)_D}$$

Target selection:

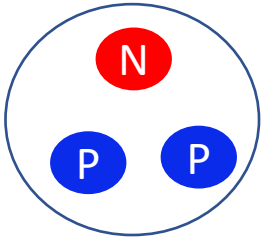
D



^{3}H



^{3}He



- ❑ Minimize hadron attenuation effects
- ❑ Maximizing nuclear asymmetry

SIDIS: moving to ^{3}He Polarization in CLAS12

Process	Reaction	Physics Focus	Issues
Inclusive DIS	$e+^3He \to e'$	$g_1^n(x,Q^2)$	
Tagged Structure Functions	$e+^3He \to e' + p$ $\to e' + d$	$g_1^p(x,Q^2)$ $g_1^d(x,Q^2)$ for p,d in ^{3}He Spin-dependent EMC effect	Detecting spectator p/d Coexistence of tagger and polarized target in central detector
Semi-Inclusive DIS	$e+^3He \to e' + \pi^{+/0/-}$ $e+^3He \to e' + K^{+/0/-}$	Flavor dependence of quark polarizations in neutron	Good particle ID
Deeply Virtual Processes	$e+^3He \to$ $e' + {}^3He +$ $\pi^0/\gamma/\phi$.....	Neutron GPDs	Detection of recoil ^{3}He

Available Semi-inclusive DIS generators

1. CLASDIS (What I am using now)

   - Using the CLAS12 acceptance for rate estimation. Working now.

2. e-^{3}He SIDIS collide code from Elke Aschenauer

3. LightIonEIC code from Christian Weiss

Rate estimation for CLAS12 detector

Unpolarized ^{3}He

Measurement	Rate (event/second)
Inclusive (e,e')	257
SIDIS (e,e'π^-)	8
SIDIS (e,e'π^+)	17
SIDIS (e,e'K^-)	0.5
SIDIS (e,e'K^+)	6

Unpolarized ^{3}H

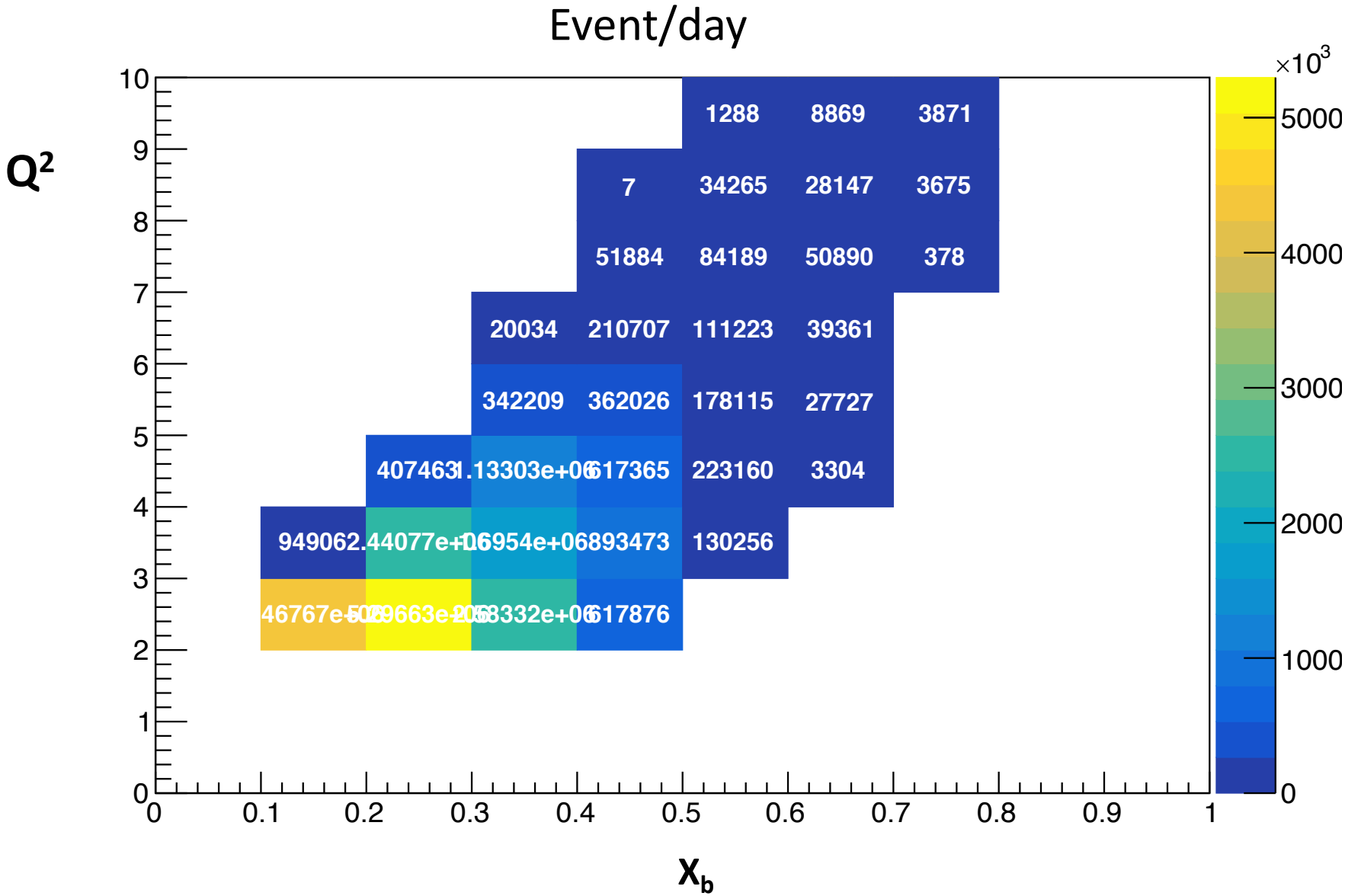
Measurement	Rate (event/second)
Inclusive (e,e')	226
SIDIS (e,e'π^-)	8
SIDIS (e,e'π^+)	13
SIDIS (e,e'K^-)	0.4
SIDIS (e,e'K^+)	4

Inclusive [e, e']: $x_b > 0.1$ && $Q^2 > 2$ && $W^2 > 4$

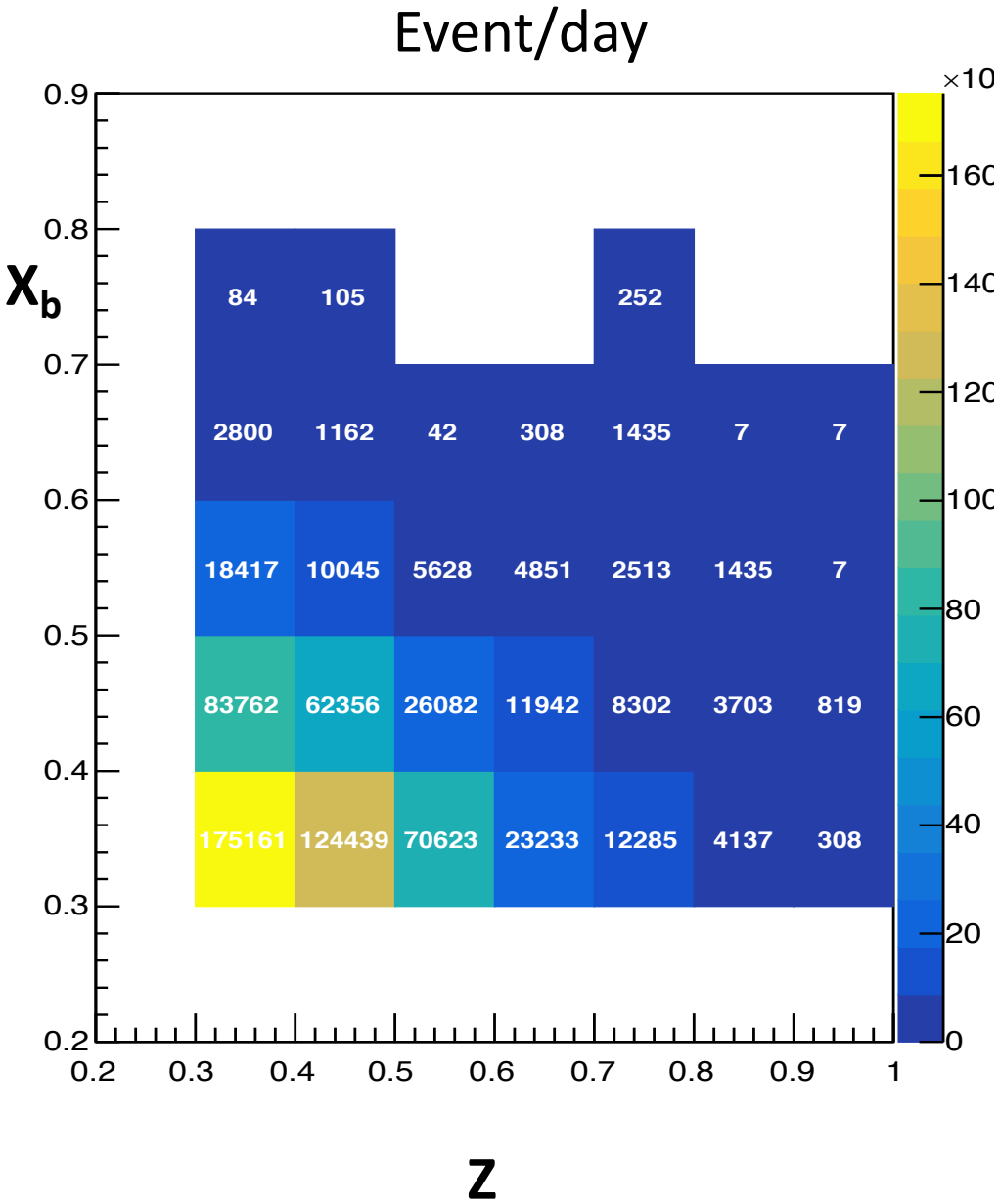
Luminosity: 3.5 e 34 /s

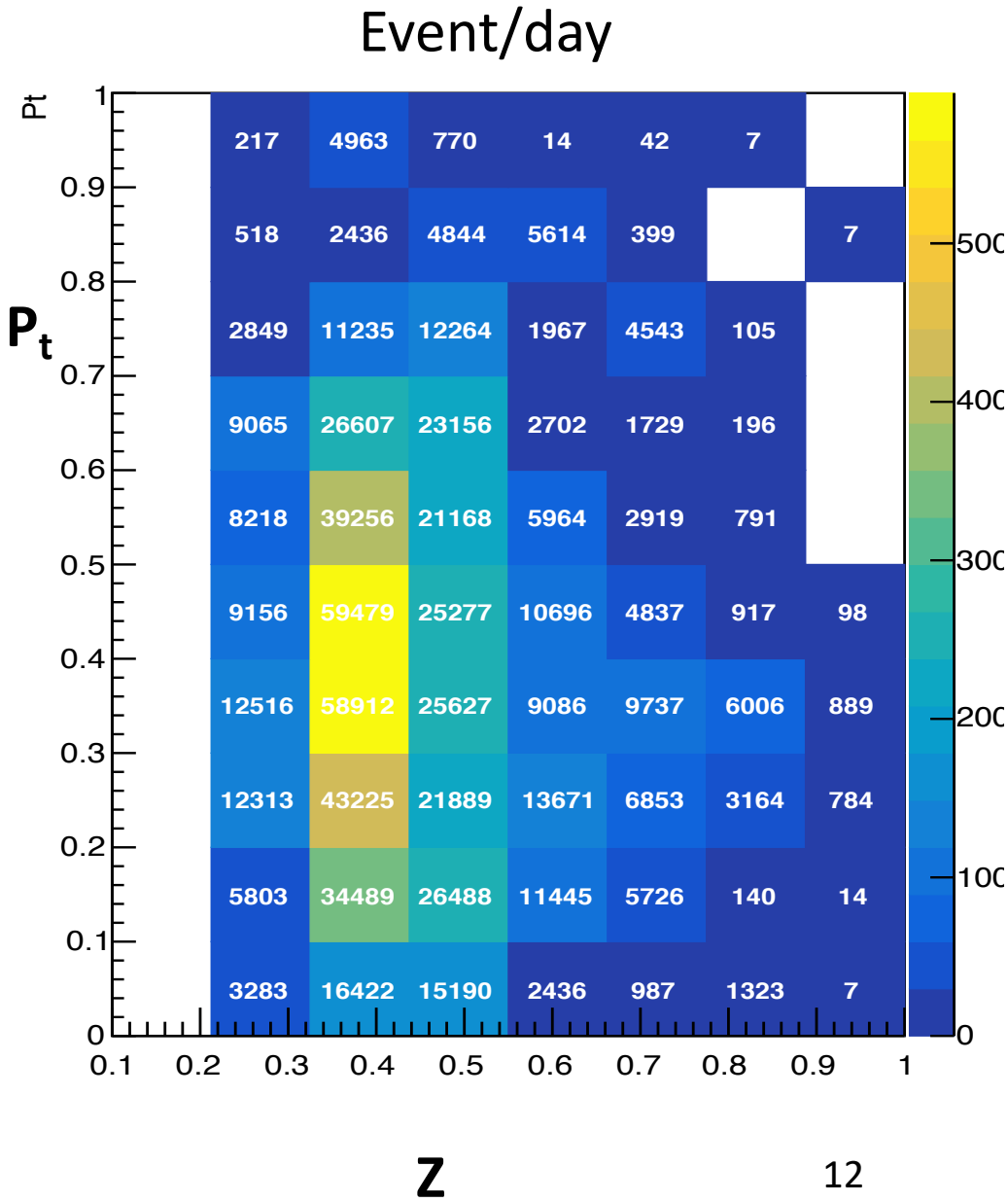
SIDIS [e, e'Pi] : $x_b > 0.3$ && $Q^2 > 2$ && $W^2 > 4$ && $Z > 0.3$

Inclusive (e,e’) DIS rate for ^{3}He



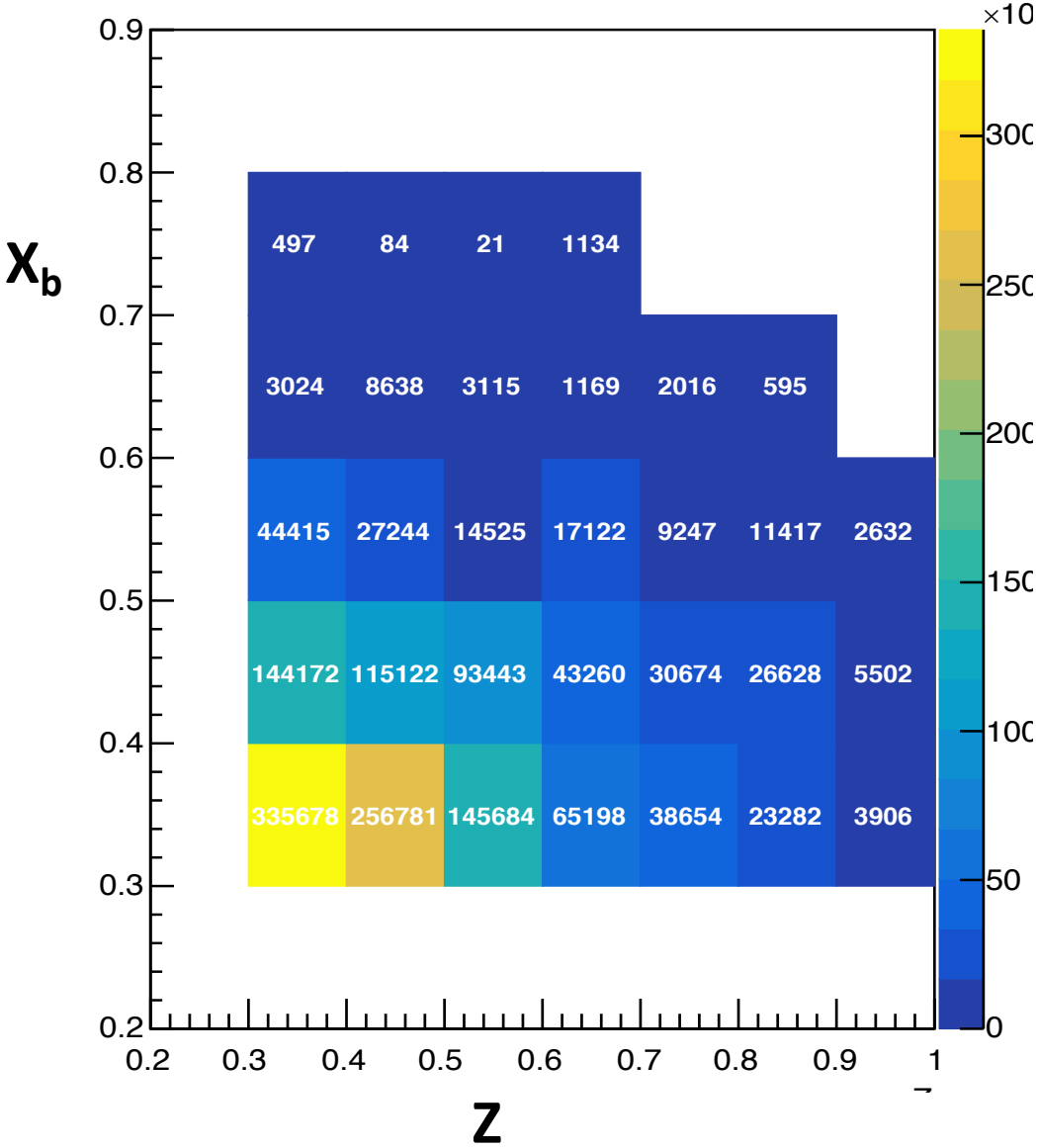
SIDIS (e,e'π^-) rate for ^{3}He



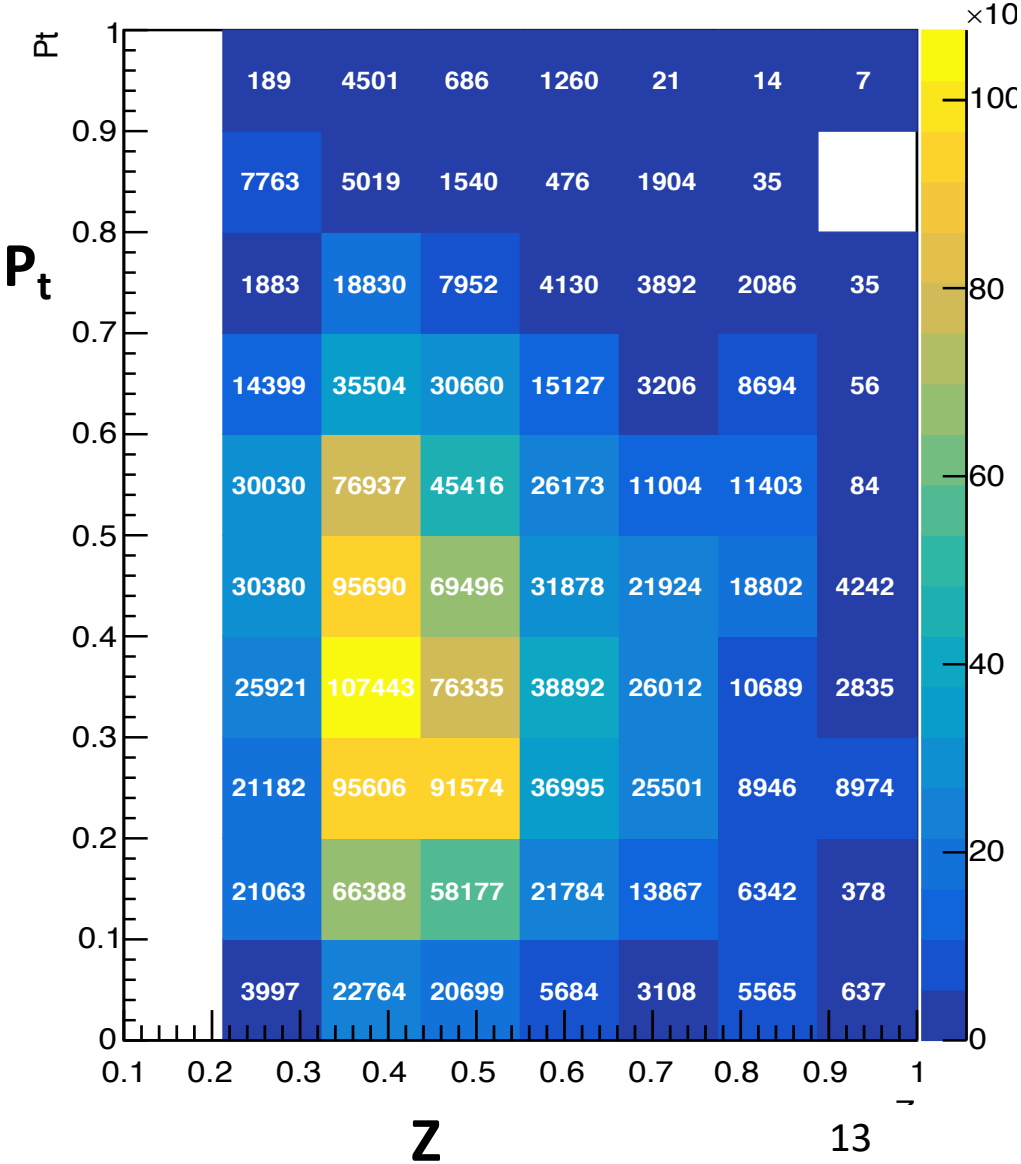


SIDIS (e,e'π^+) Rate estimation for ^{3}He

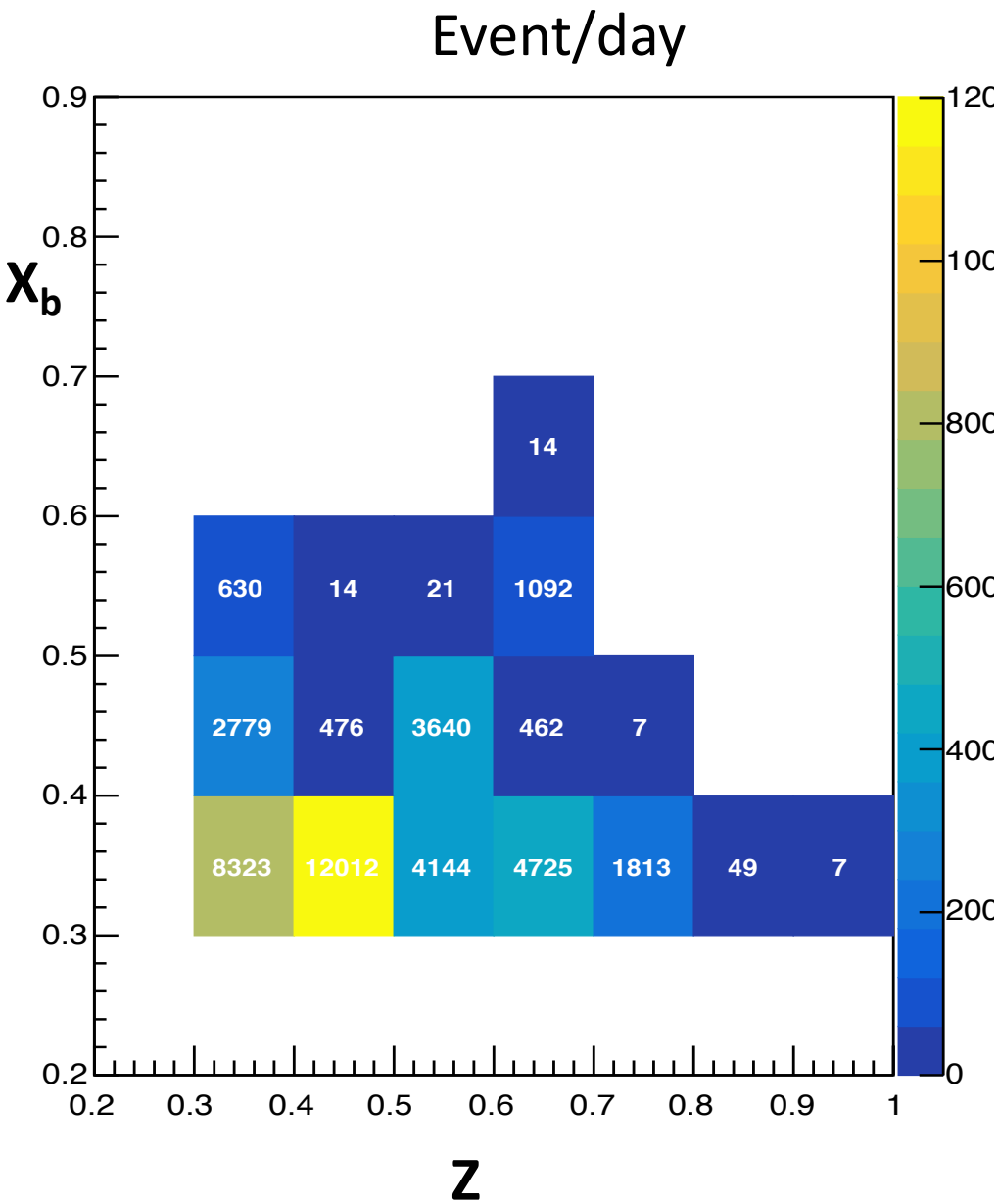
Event/day

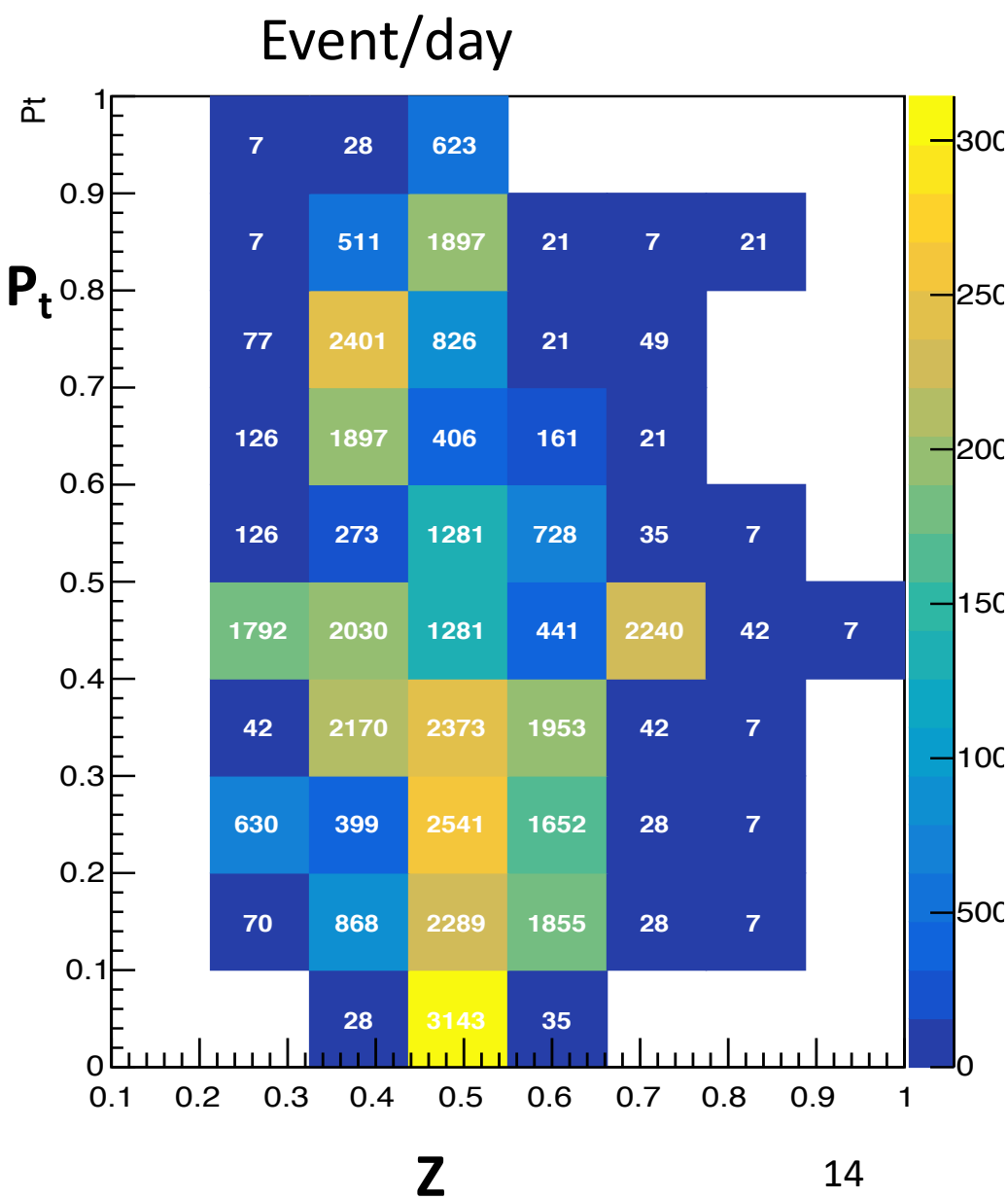


Event/day



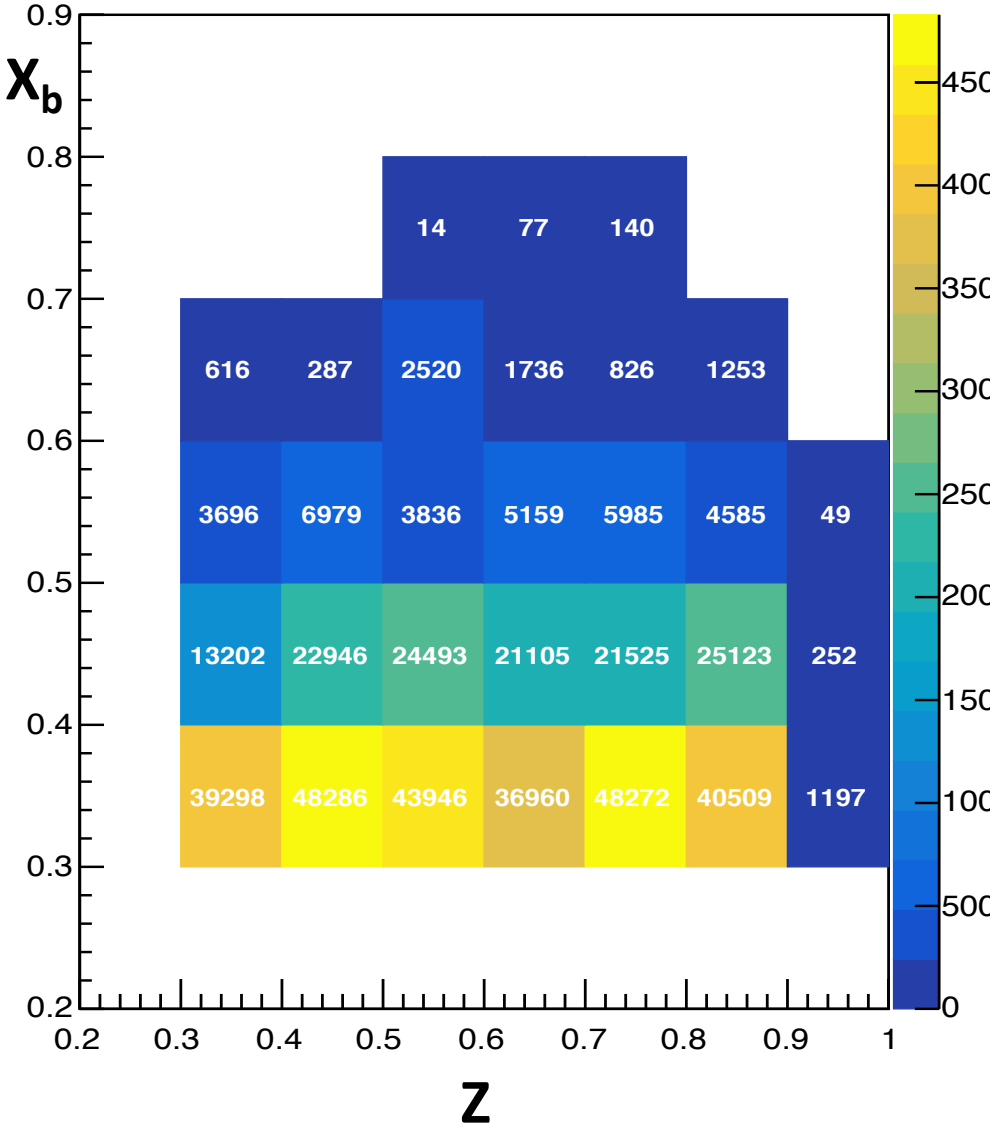
SIDIS (e,e'K^-) rate for ^{3}He



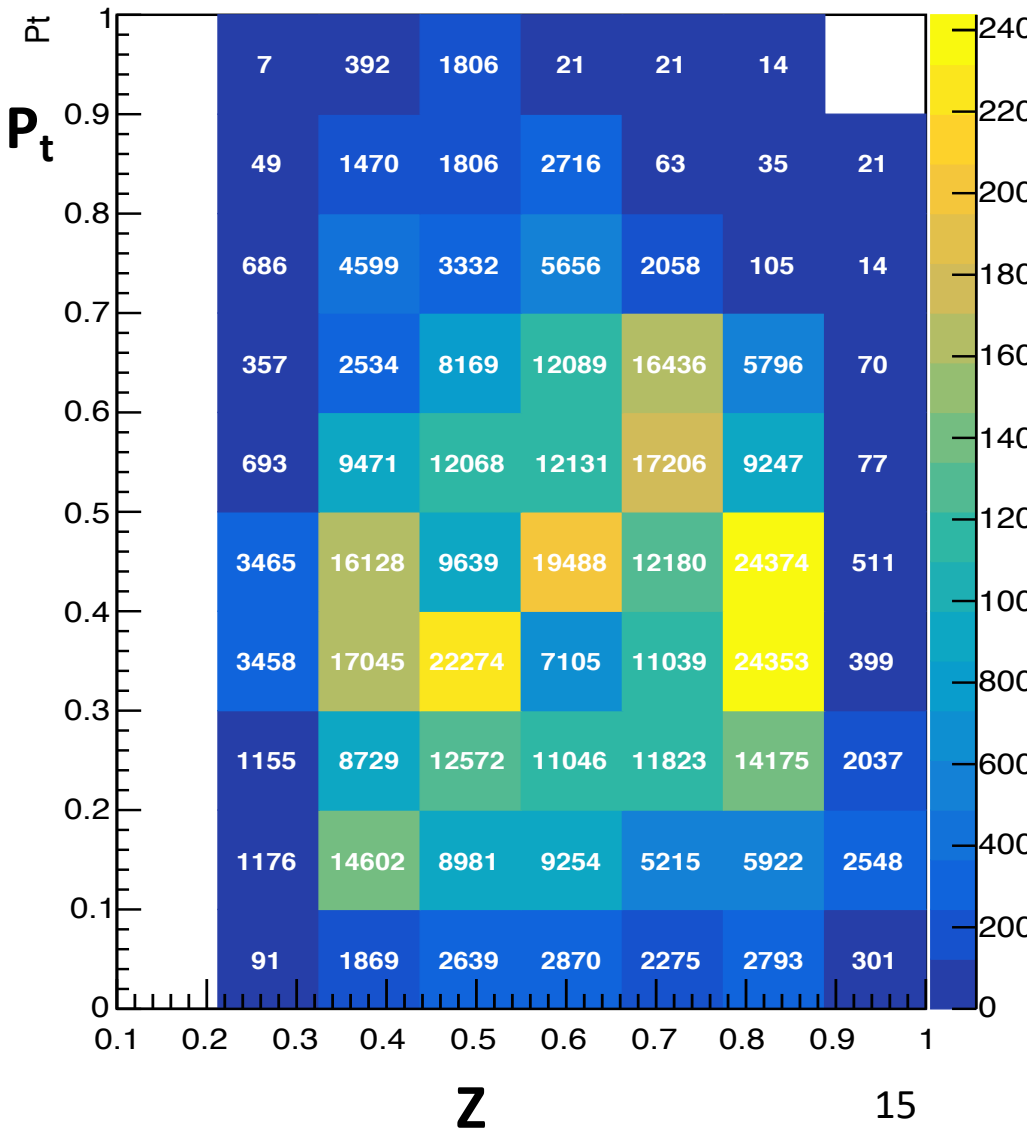


SIDIS (e,e'K^+) Rate estimation for ^{3}He

Event/day



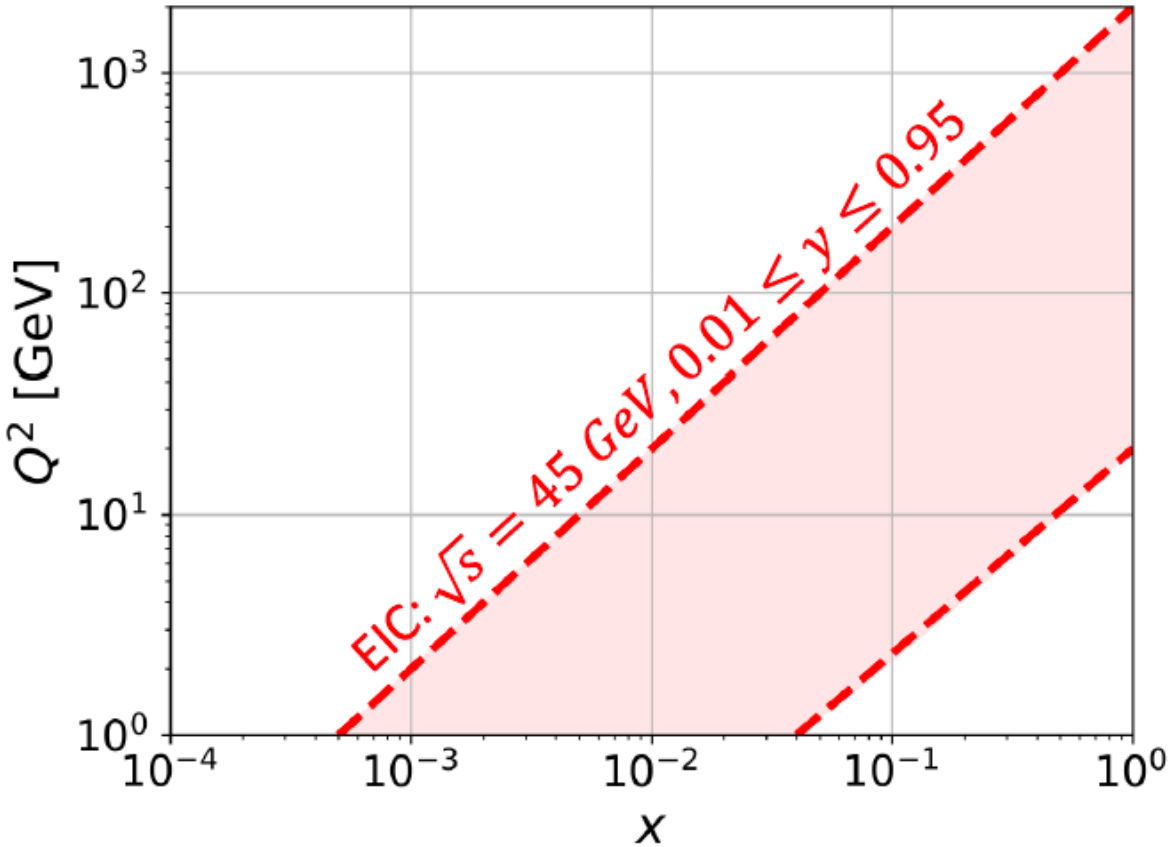
Event/day



EIC kinematic Coverage

Potential Physics:

- ❑ g_1^n Measurments
- ❑ Nucleon spin decomposition
- ❑ Neutron spin structure
- ❑ Spin-dependent EMC
- ❑ Sea quark and gluon PDFs

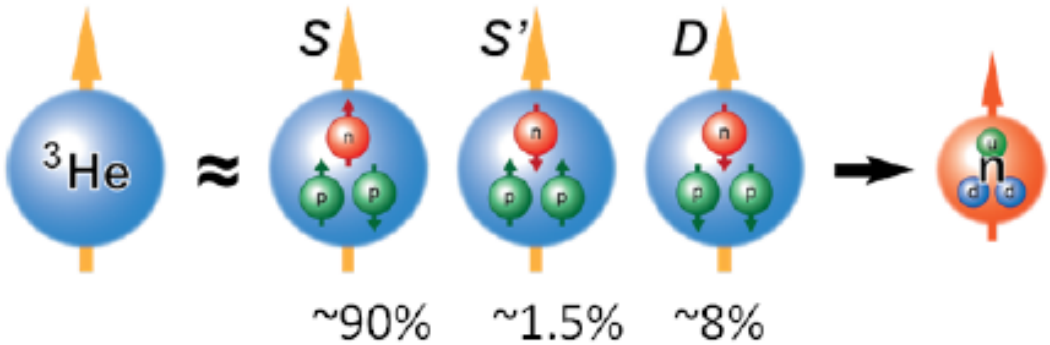


Plan for next steps: moving forward to EIC

- Taking the SIDIS generator for fixed target
- Boosted to the collide frame
- Apply the “EIC acceptance function”
- Check the kinematic coverage and rate estimation

Thank you !

SIDIS: moving to 3He Polarization in CLAS12



Neutron polarization: 87%
Proton polarization: 2.7%

- Measurement $g_1^n(x, Q^2)$?
- Spin structure functions of deuteron and proton in 3He?
- Spin- dependent EMC effect ?