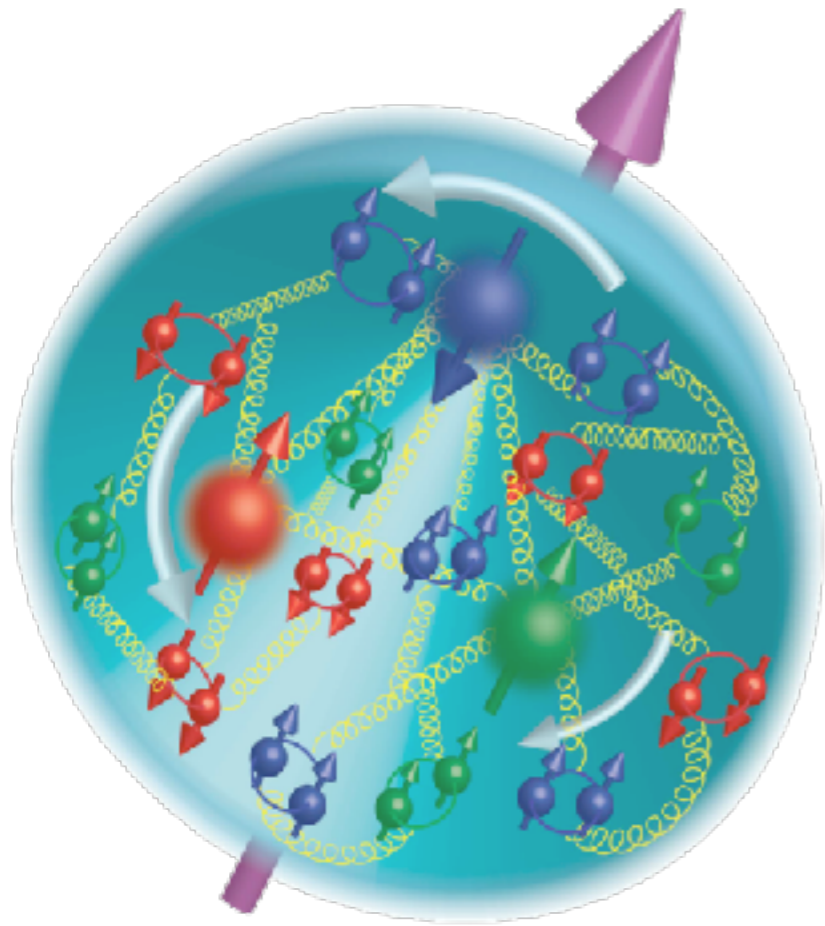


REGIONS IN SIDIS

Alexei Prokudin



JAM Collaboration Jefferson Lab

In collaboration with: M. Boglione, M. Diefenthaler, S. Dolan, L. Gamberg, S. Gordon, W. Melnitchouk, D. Pitonyak, T. Rogers, N. Sato

SEMI INCLUSIVE DEEP INELASTIC SCATTERING

Consider electron - hadron collisions in DIS regime

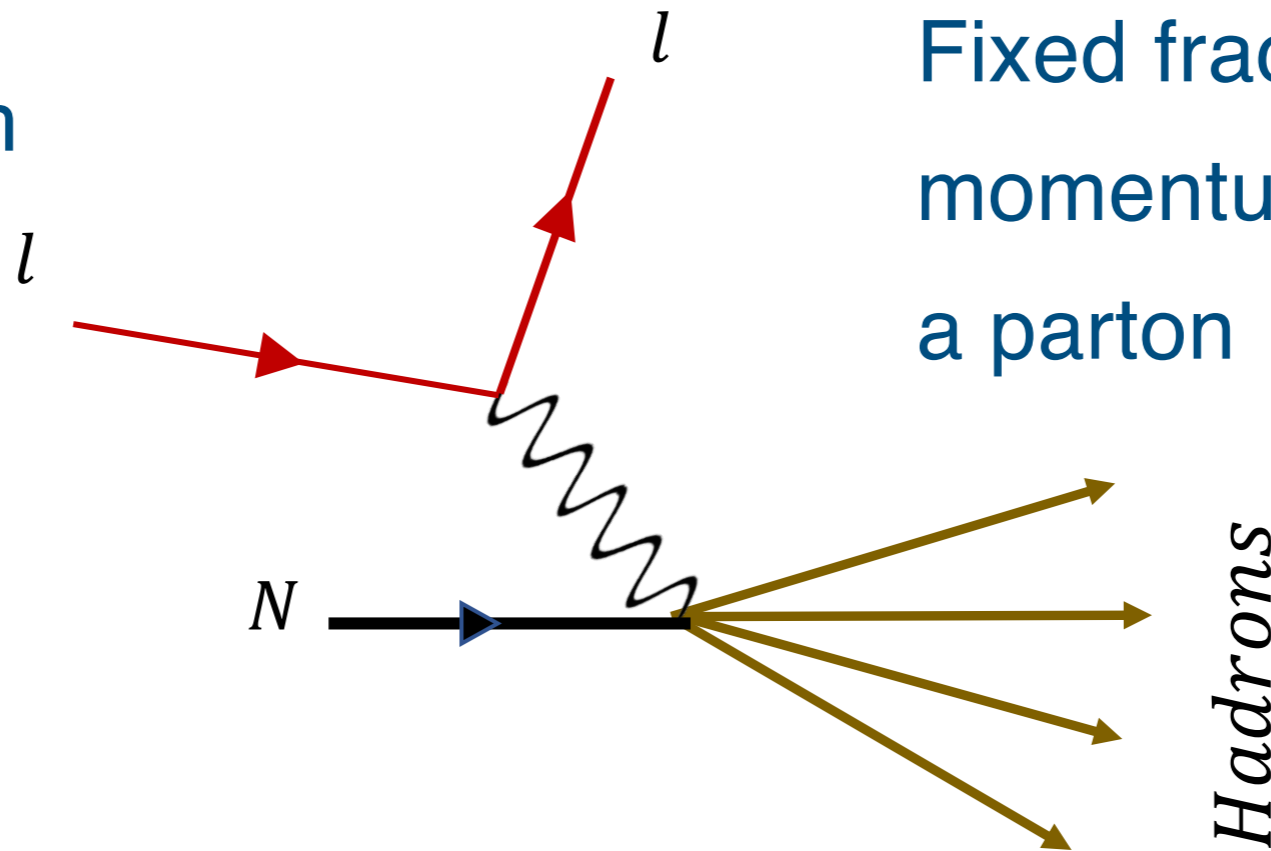
$$Q^2 \rightarrow \infty$$

Transverse

resolution < 1 fm

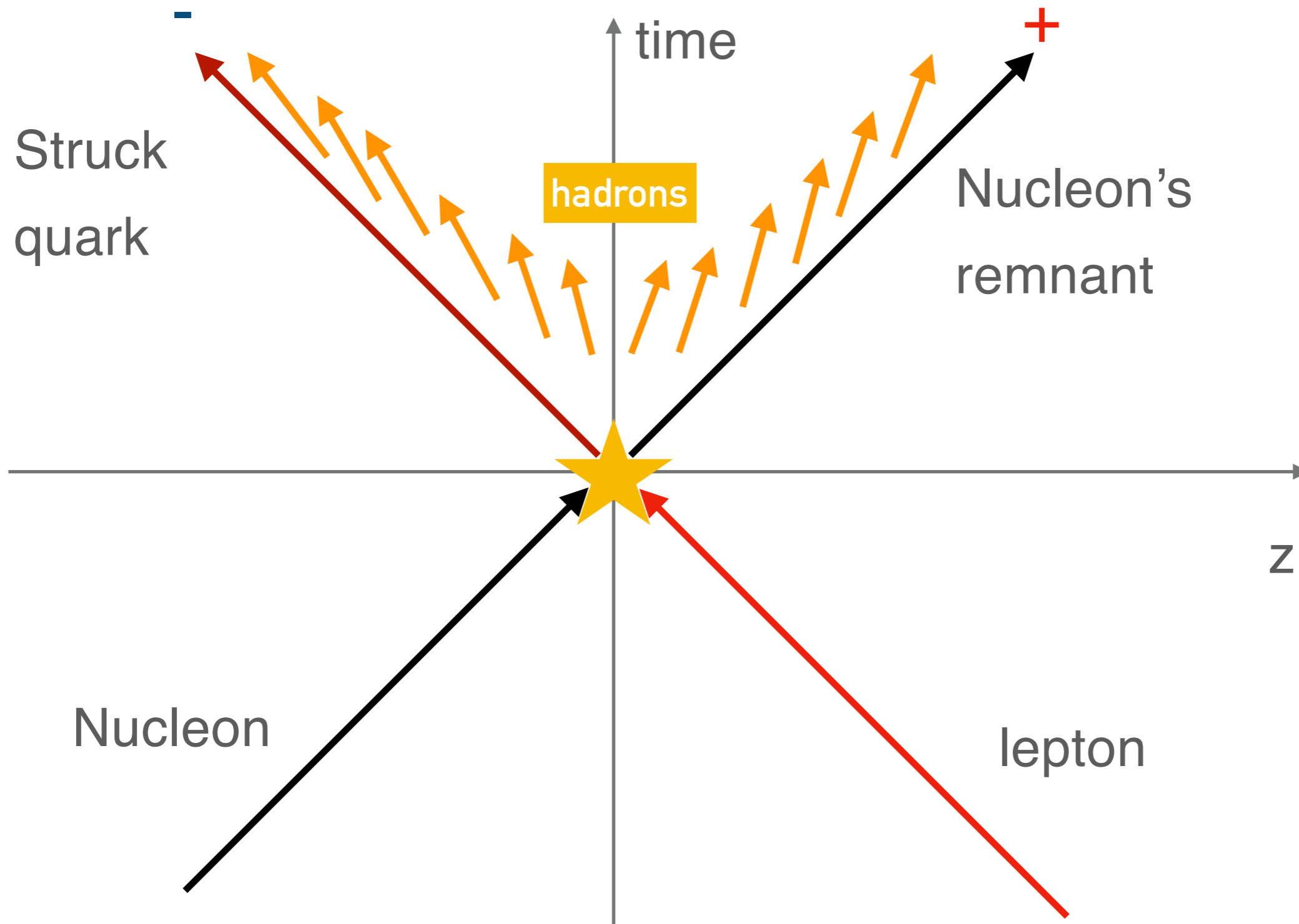
$$x_{Bj} = \frac{Q^2}{2P \cdot q} = \text{const}$$

Fixed fraction of
momentum carried by
a parton



Detect a pion in the final state

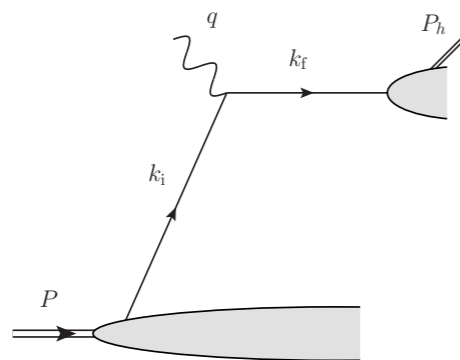
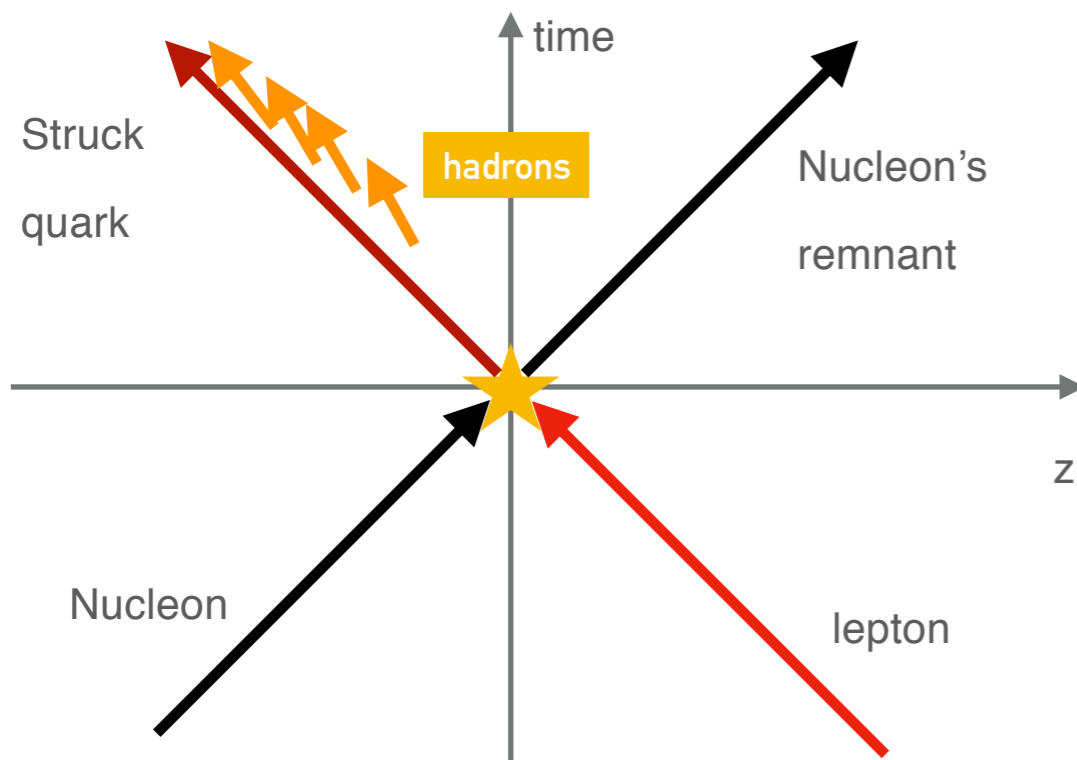
SPACE-TIME PICTURE OF THE COLLISION



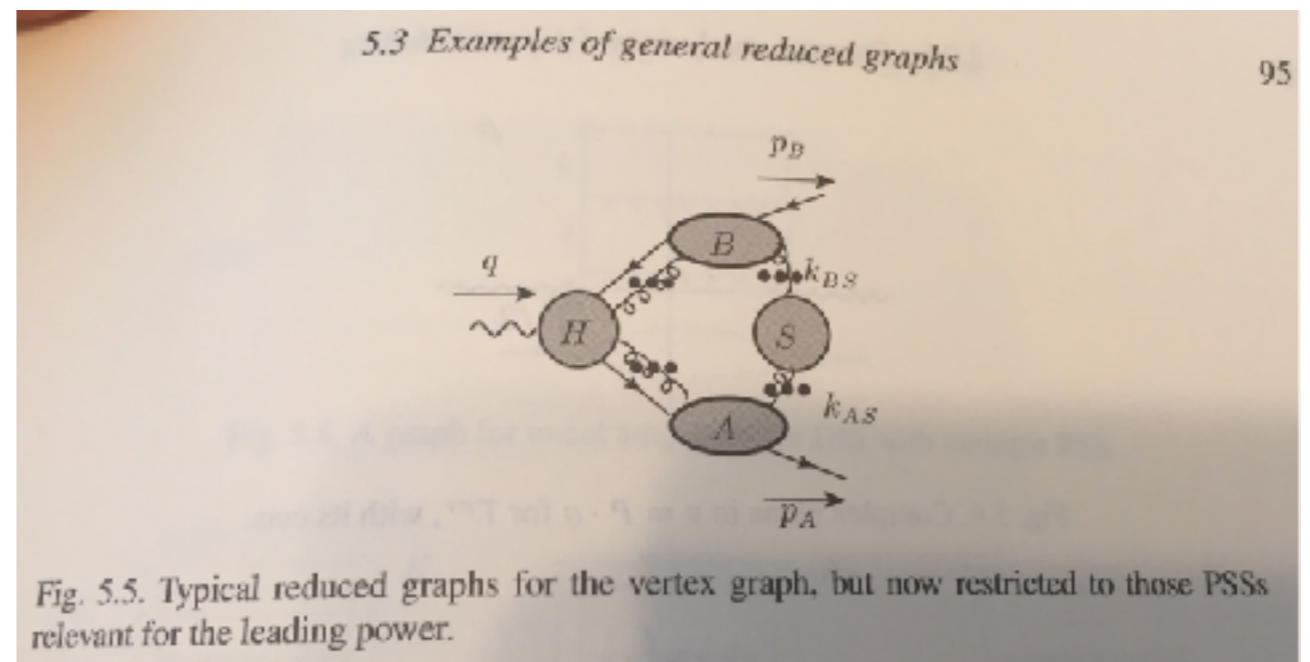
CURRENT REGION FACTORIZATION

$$\sigma \sim \sigma_0 f_{q/N}(x_{Bj}) \otimes D_{q/h}(z_h)$$

- Libby-Sterman analysis (Collins 2011 Ch.5) suggests that classical trajectories dominate
- Produced hadrons are close in rapidity to the fragmenting quark



Boglione et al, 1611.10329

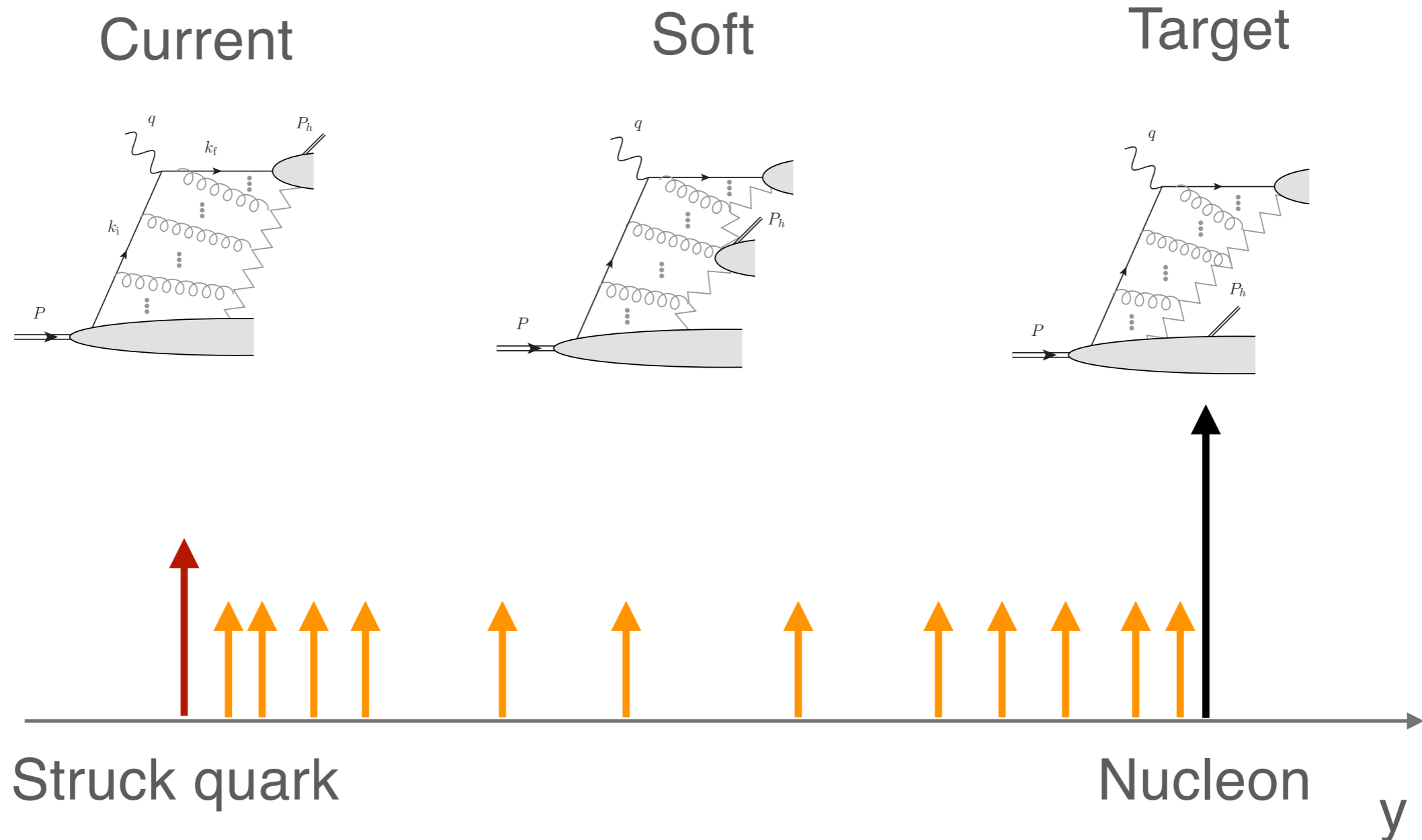


Example of pinch-singular surfaces for e+e-

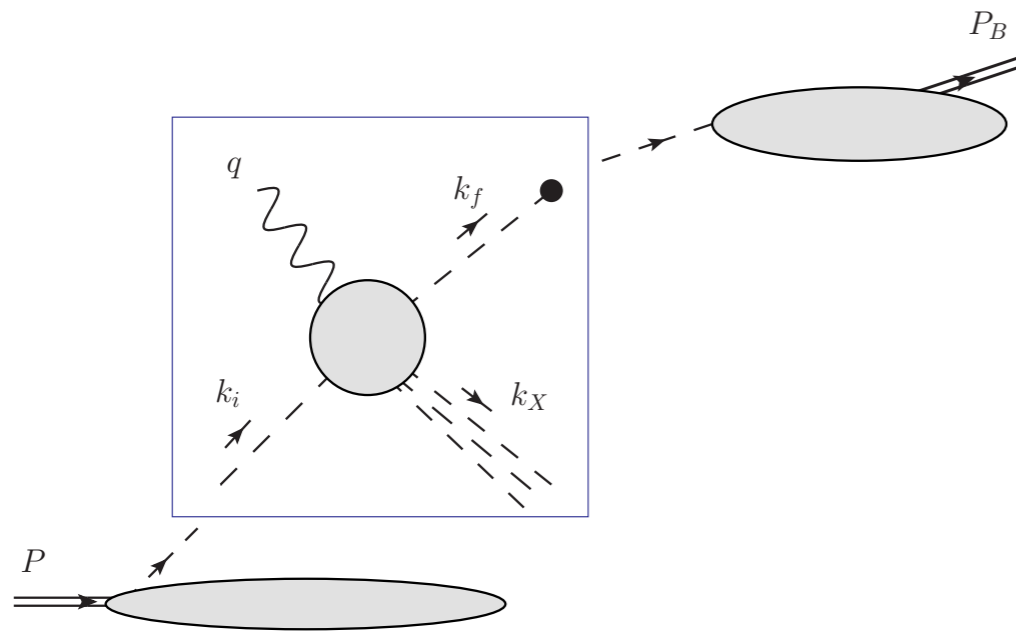
CURRENT REGION FACTORIZATION

Fresh look:

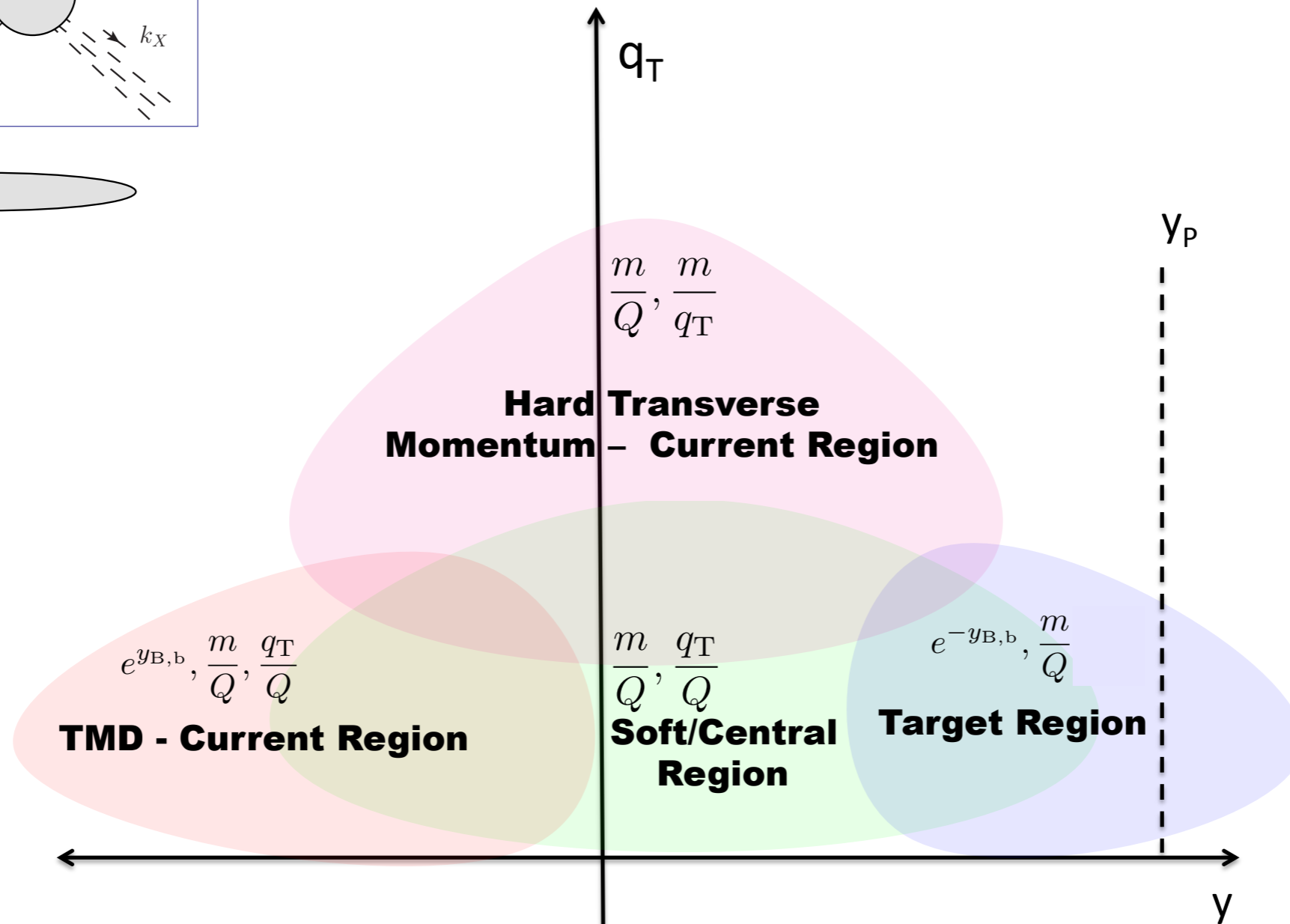
Define ratios of kinematical variables and identify regions



REGIONS IN SIDIS AND RATIOS

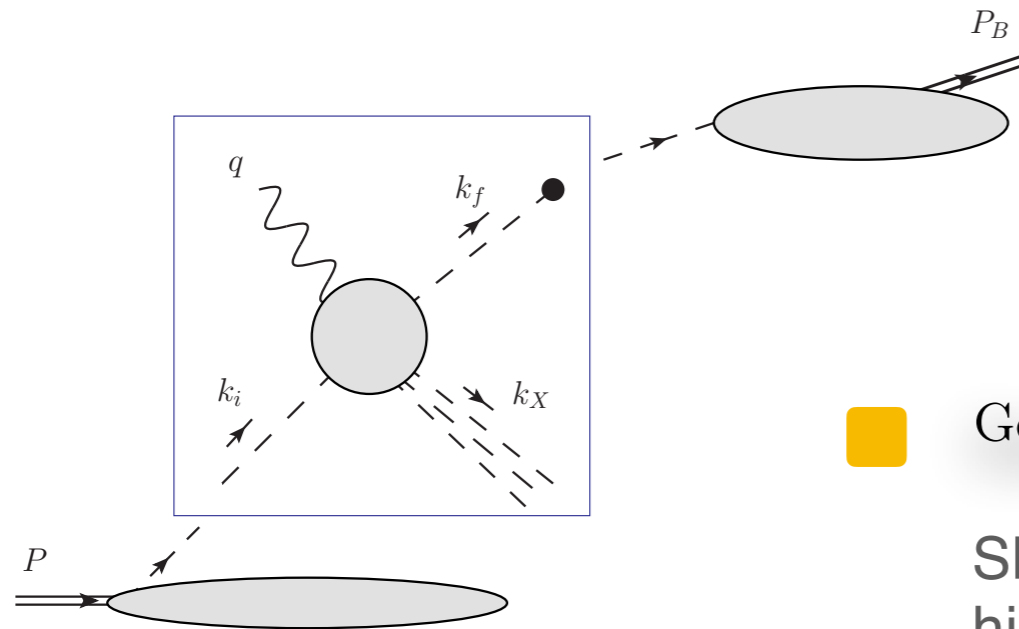


- Define ratios
- Identify regions



REGIONS IN SIDIS AND RATIOS

- Define ratios
- Identify regions



$$R_2 \propto \frac{q_T^2}{Q^2}$$

Used already in phenomenology

Bacchetta et al, 1912.07550

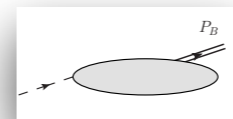
Vladimirov et al, 1912.06532

- General Hardness Ratio = $R_0 \equiv \max \left(\left| \frac{k_i^2}{Q^2} \right|, \left| \frac{k_f^2}{Q^2} \right|, \left| \frac{\delta k_T^2}{Q^2} \right| \right)$.

Should be small for partonic description to hold, high off-shellness = short distance

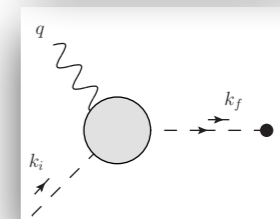
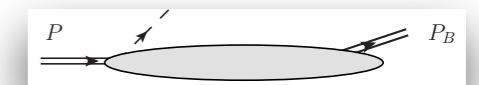
- Collinearity = $R_1 \equiv \frac{P_B \cdot k_f}{P_B \cdot k_i}$,

Should be small for current region, large for target region



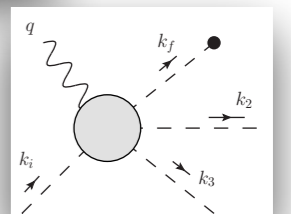
- Transverse Hardness Ratio = $R_2 \equiv \frac{|k^2|}{Q^2}$.
 $k \equiv k_f - q$.

Should be small for 2 → 1 process



- Spectator Virtuality Ratio = $R_3 \equiv \frac{|k_X^2|}{Q^2}$.

Small for lowest order QCD to be applicable



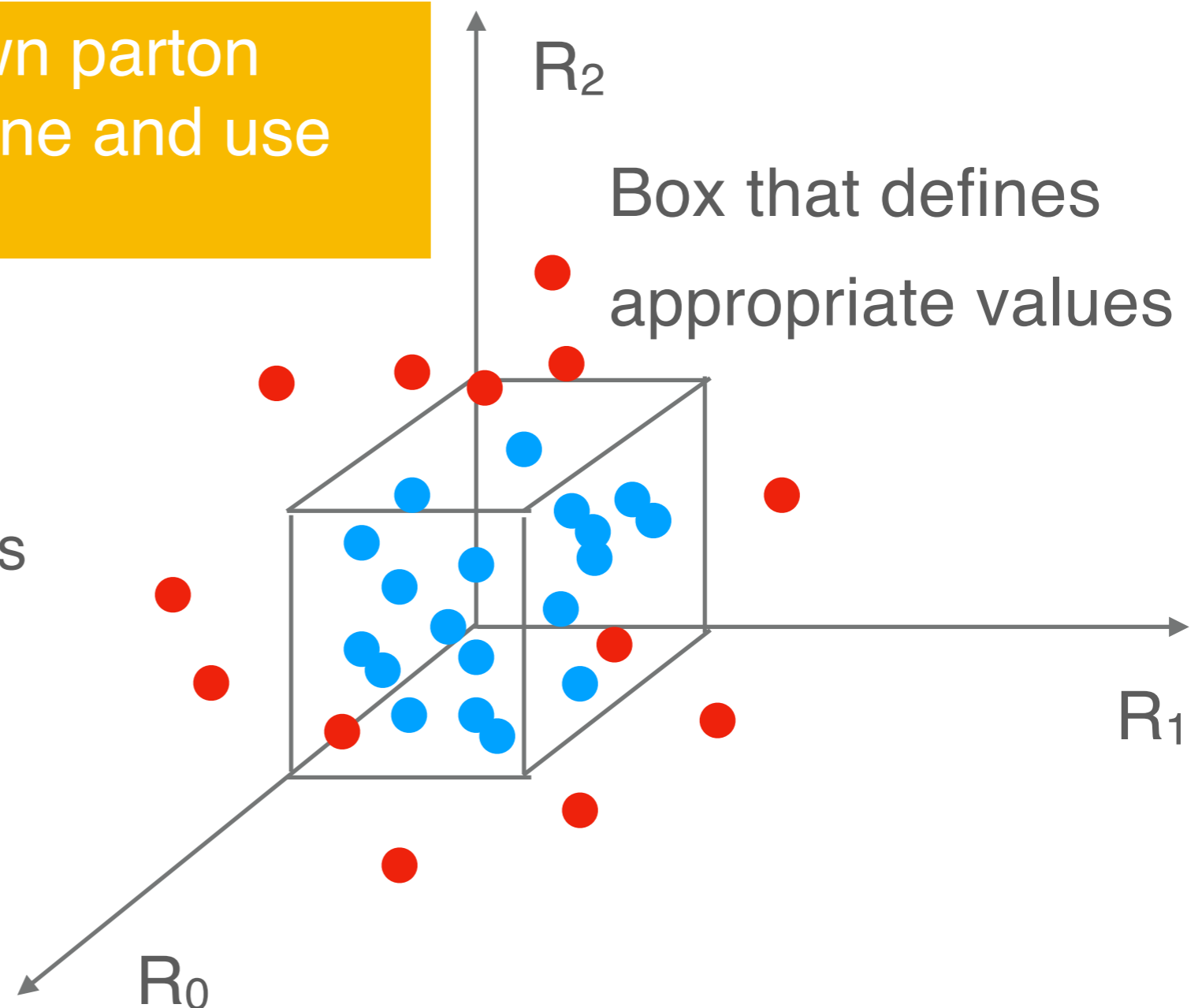
REGIONS IN SIDIS AND RATIOS

Boglione et al, 1611.10329
Boglione et al, 1904.12882
Current study

➤ Define ratios

Ratios depend on unknown parton momenta. How can we define and use them?

- Use a Monte Carlo* with parton momenta
- Sample experimental bins for ratios



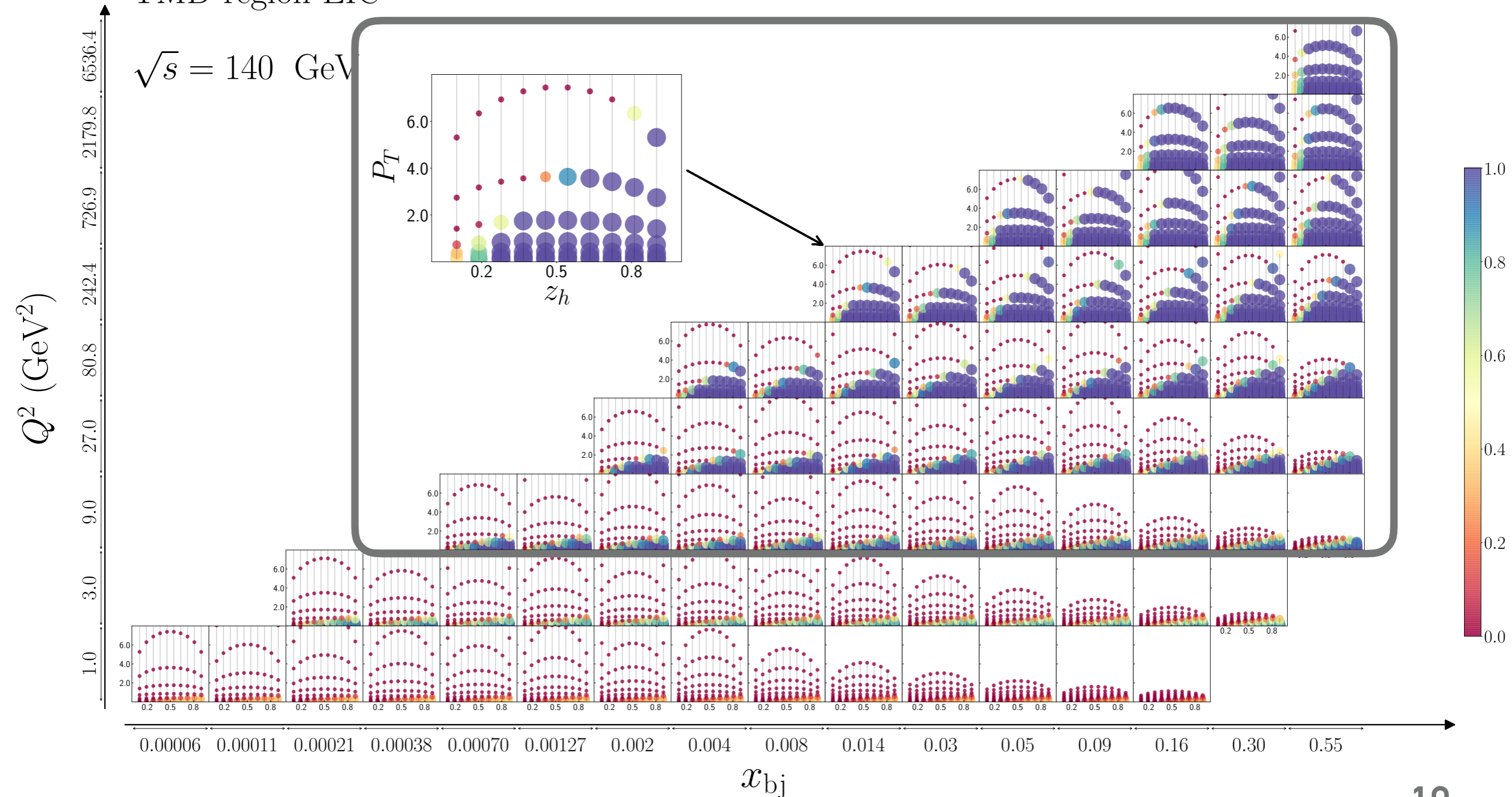
* by saying Monte Carlo we do not intend Pythia!

EIC: CURRENT REGION

Current study

Relatively large x_{Bj} , z_h , Q
TMD region EIC

$\sqrt{s} = 140$ GeV



THEORETICAL AND PHENOMENOLOGICAL DEVELOPMENT

- We have studies regions in SIDIS and identified TMD, Target, Soft and Hard regions
- New tool to guide our intuition is provided
- Further phenomenological and theoretical studies to follow