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Target jet substructure and correlation

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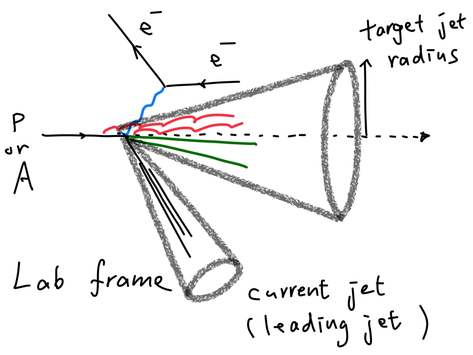
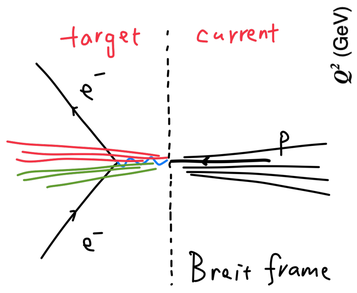
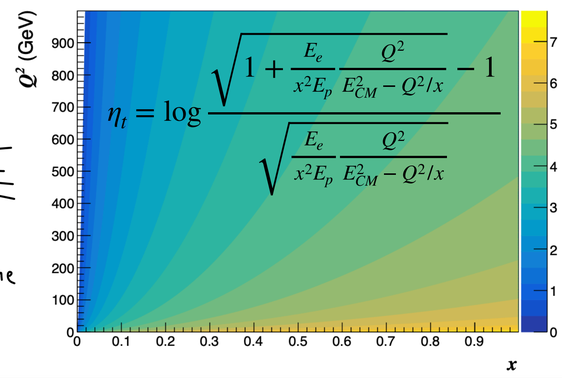
Abstract

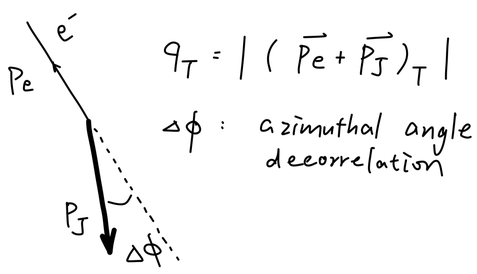
We discuss the reconstruction of **target jet** and the framework of quantifying its internal **substructure**. Due to momentum and charge conservation, **target and current correlation** can be exploited which significantly constrains the event-wide particle distributions. We demonstrate this method using Pythia simulations of **electron-proton** collisions in the context of determining the **flavor and substructure of the struck quark jet**. Extensions to **electron-ion** collisions and **target tagging** using BeAGLE simulations will be discussed. This study will provide novel physics cases for **forward detector designs** and promote the **synergy with nuclear physics**.

Target Jet in the Forward Region





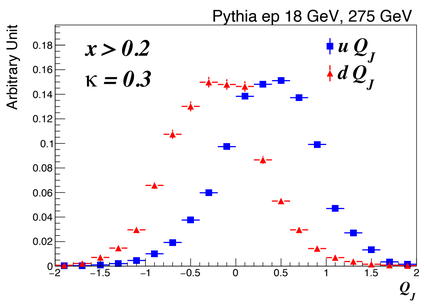


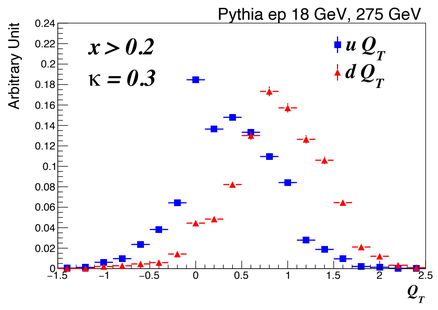


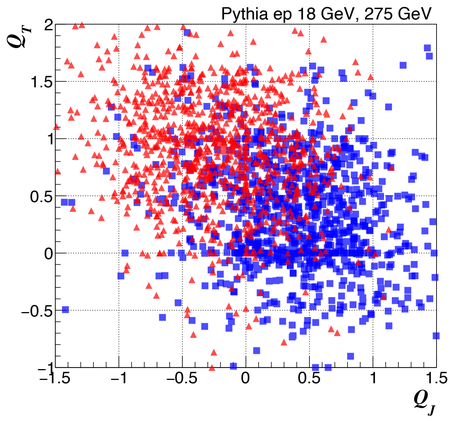
- Target region contains rich information about nuclear structure
- Target jet is concretely defined, with a radius as a function of the boost between Breit and lab frames: a function in x and Q^2
- Explore target jet substructure and its correlation with current to maximally enhance the sensitivity to nuclear structure

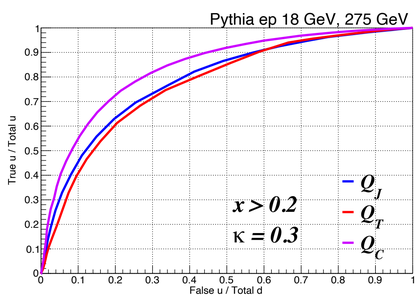
Leading Jet Charge & Target Jet Charge

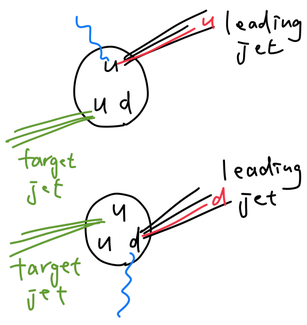
$$Q_J = \sum_{i \in L_J} z_i^\kappa Q_i\,, \quad z_i = \frac{p_{T,i}}{p_{T,L_J}} \qquad Q_T = \sum_{i \in T_J} z_i'^\kappa Q_i\,, \quad z_i' = \frac{e_i}{e_{T_J}}$$





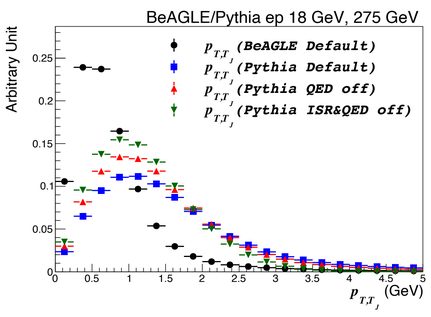


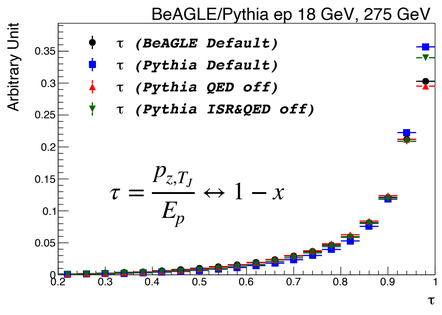


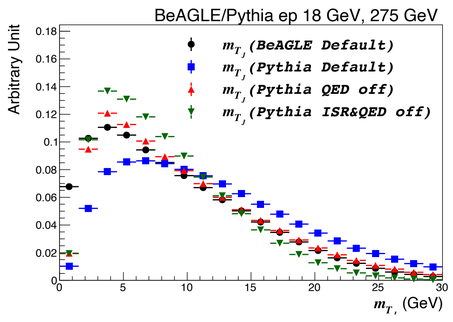


- Target jet charge provides significantly new information about the partonic structure
- Target jet pT, thrust and mass are sensitive to partonic structure and beam dynamics

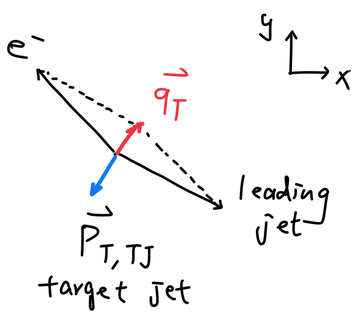
Target Jet Kinematics and Substructure

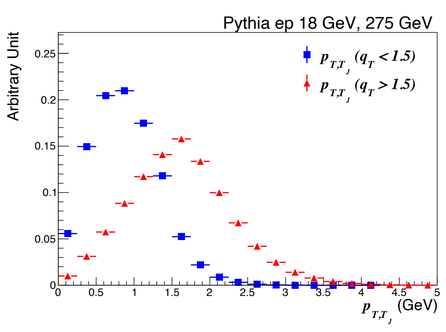


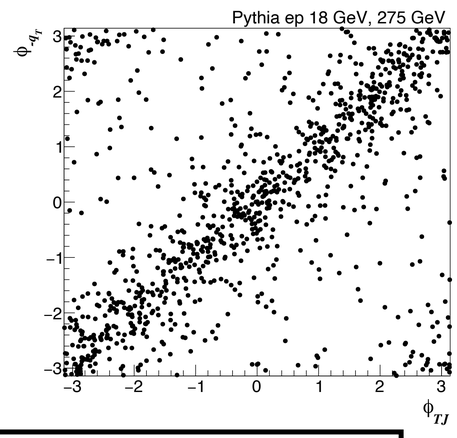




Current-Target Correlation



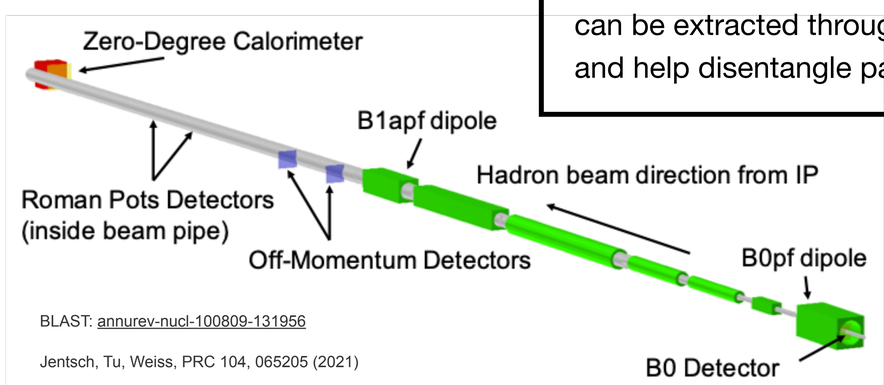




- Target jet and current jet are strongly correlated and can be used to constrain each sector.

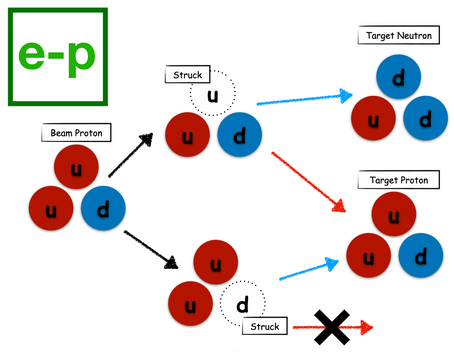
Target Tagging

- Flavor and hadron species information can be extracted through target tagging and help disentangle partonic structure

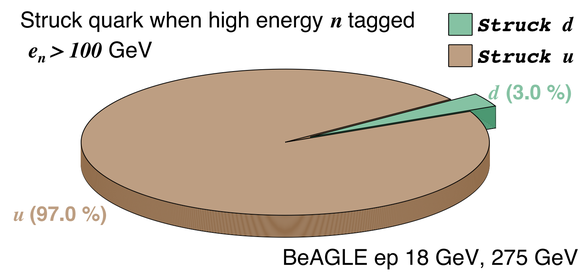


BLAST: annurev-nucl-100809-131956

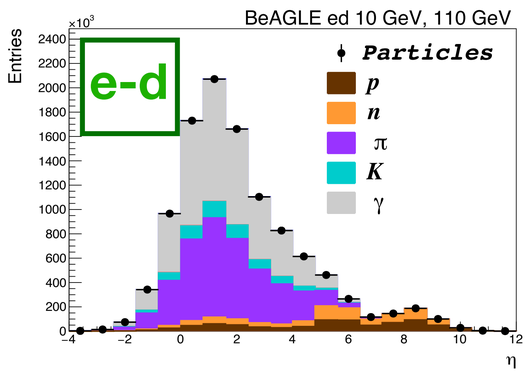
Jentsch, Tu, Weiss, PRC 104, 065205 (2021)

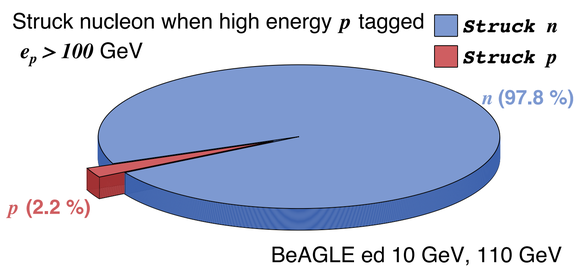


BeAGLE, PRD 106 (2022) 1, 012007

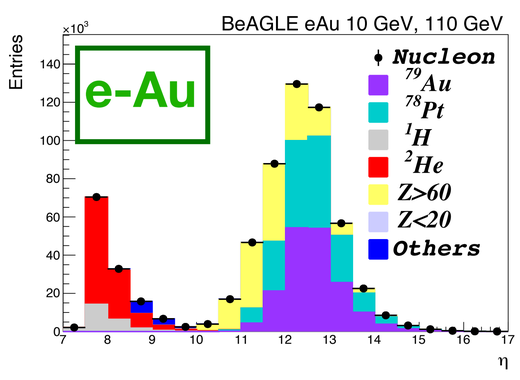


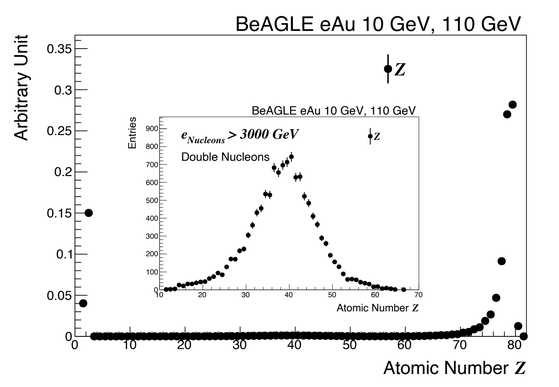
BeAGLE ep 18 GeV, 275 GeV

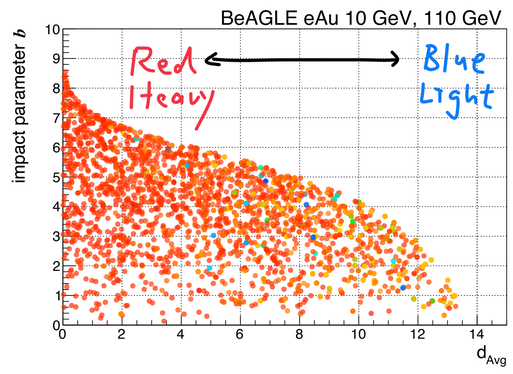


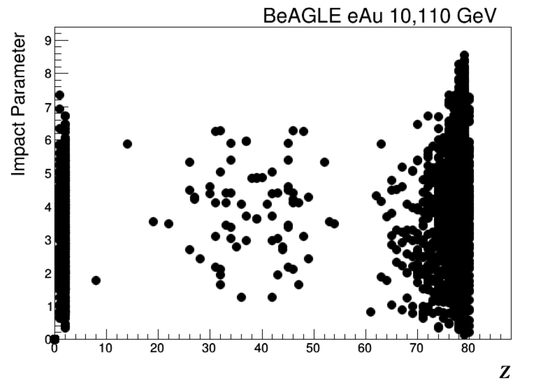


BeAGLE ed 10 GeV, 110 GeV









Conclusions & Outlooks

- Knowledge of target jet not only broadens the scope of EIC physics into nuclear dynamics, through current-target correlation it can also help constrain proton and ion 3D structure. Detector design is crucial to fulfill such studies!

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