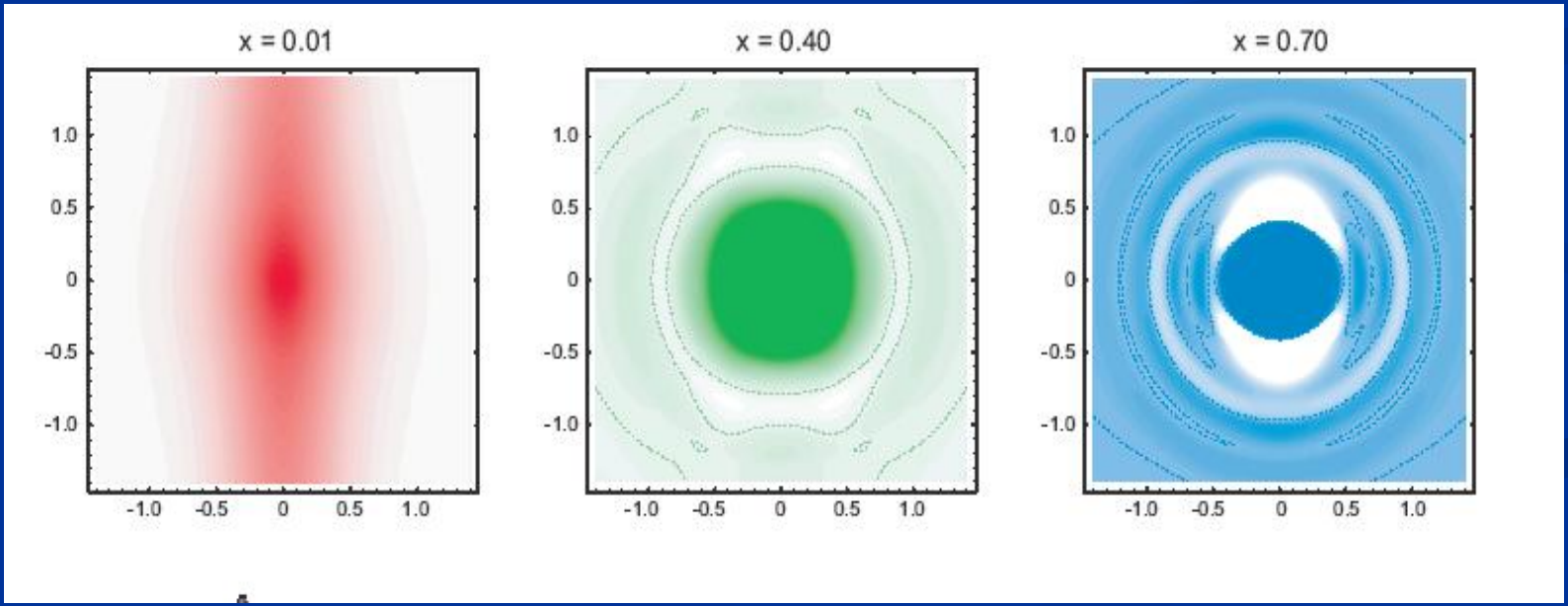
Cherenkov Detection at Future Facilities

Outline

- Brief Physics Motivation
- Component Characterization of Aerogel Cherenkov
- Aerogel Detector Construction
- Geant4-Monte Carlo (GEMC) Simulations for EIC DIRC

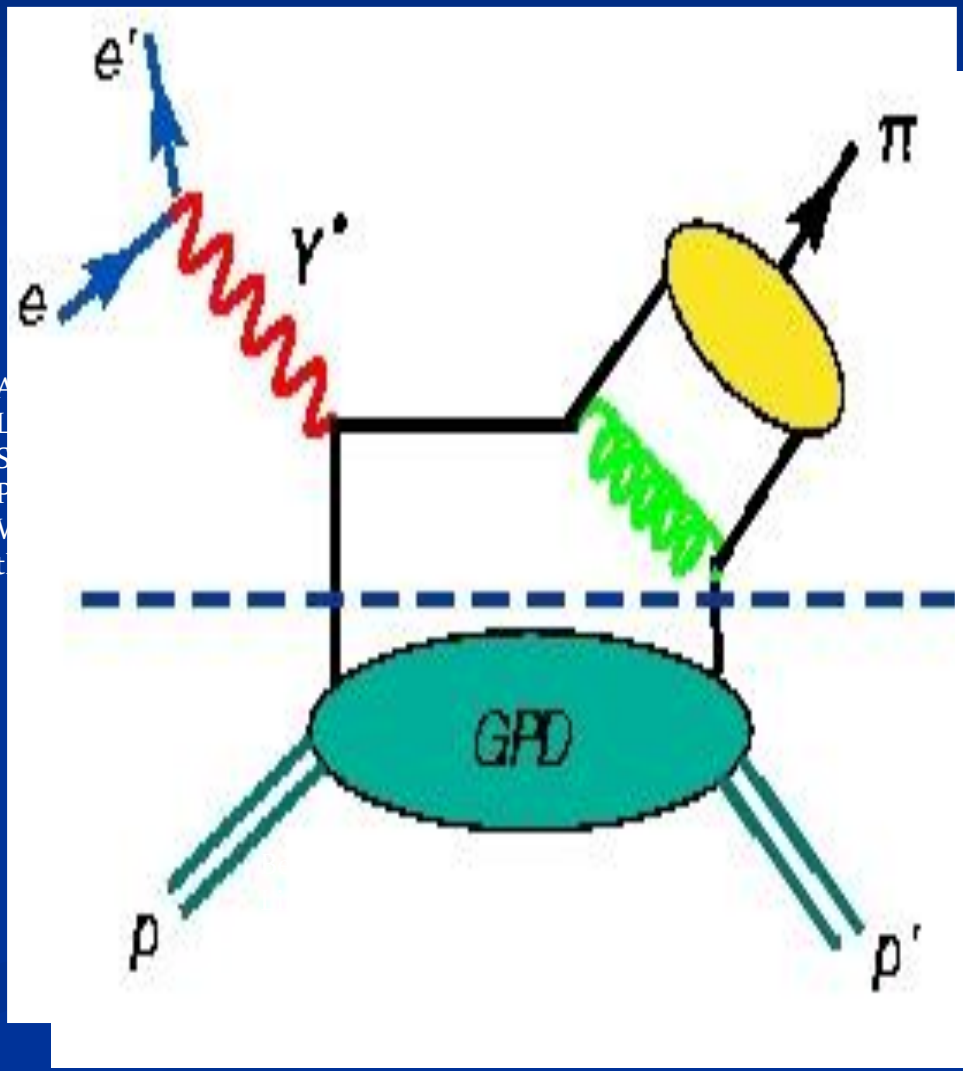
Physical Motivation: Proton Substructure

- To understand further what makes up a proton, we use Generalized Parton Distributions (GPD).
- They combine the spatial and momentum distribution of the quarks into one concise chart. Below are some examples based on models. We seek experimental confirmation. "x" is the fraction of the momentum of the quark over the momentum of the proton



Meson Electroproduction

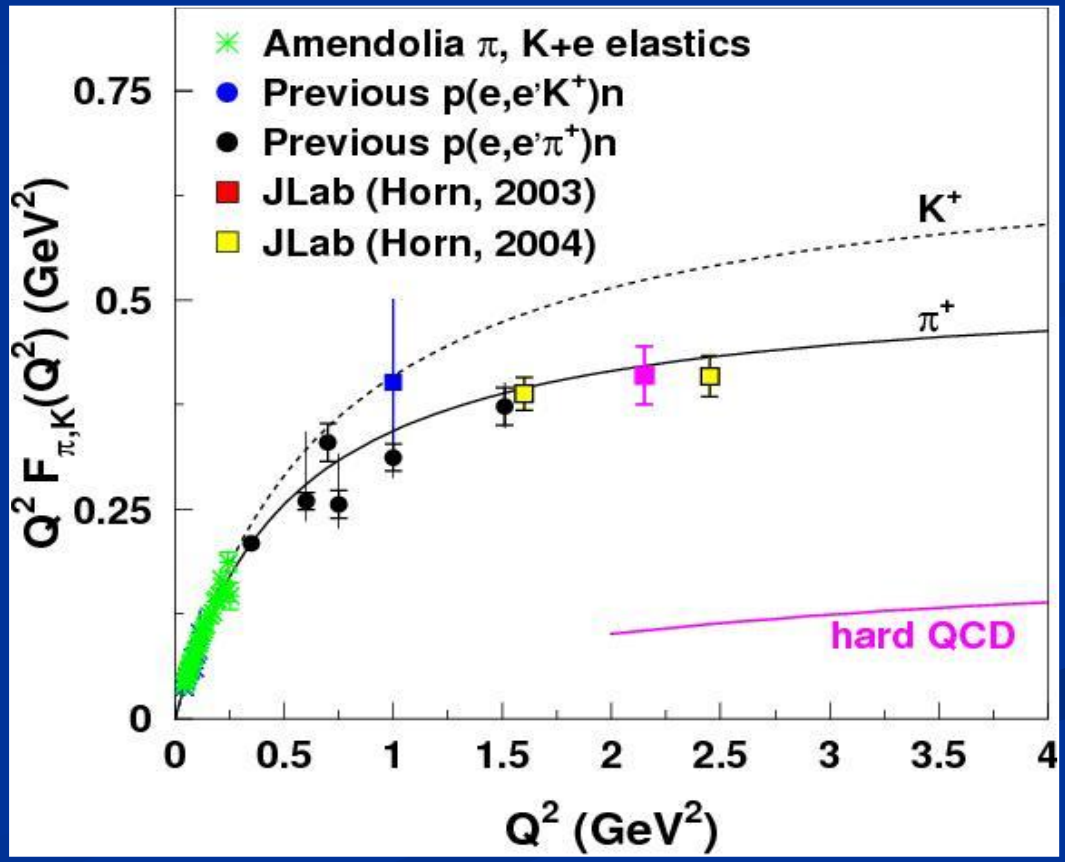
- A high-energy electron beam releases a photon of a very high frequency. The high-frequency allows us to observe objects with greater detail.
- The interaction of the photon and proton (pictured "GPD" here) results in a neutron (pictured here with momentum p') and a meson (for example a pion or a kaon). For our proposed experiment, the meson would be a kaon.
- We are able to detect/calculate the portions of the diagram above to dotted line, and from them we can contsruct the GPD. However, the meson released must conform with the Quantum Chromo Dynamic (QCD) theory of quarks.



Problematic Pions

- We know how to calculate the hard or perturbative QCD model, but our data for the pion spatial quark distribution does not match the QCD prediction.
- Further experimentation with the kaon could provide data that matches the QCD prediction. The dotted prediction seems to doubt it.
- Matching data would enable GPD construction to reveal the proton substructure.
- The 12 GeV upgrade allows for kaon production above a Q^2 value of 1, and even higher into the hard QCD range.

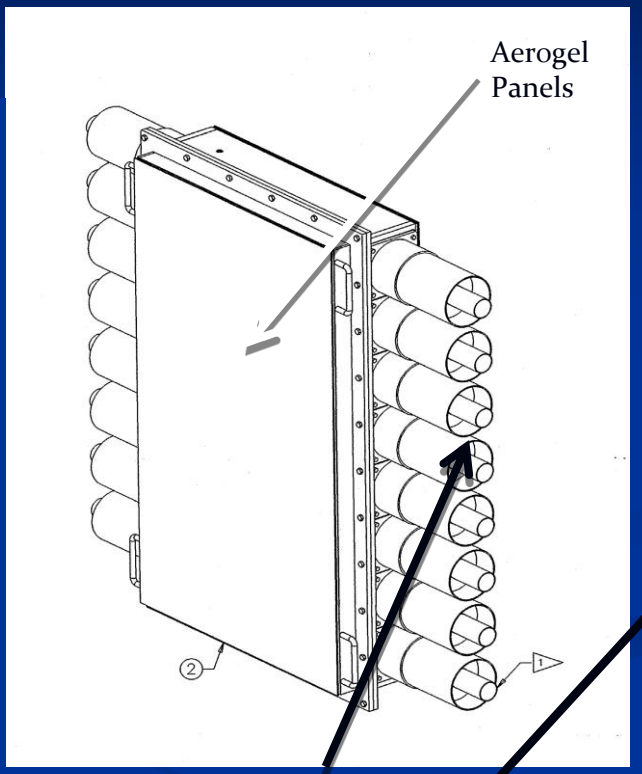
T. Horn et al., Phys. Rev. Lett. 97 (2006) 192001.
T. Horn et al., arXiv:0707.1794 (2007).



A.P. Bakulev et al, Phys. Rev. **D70** (2004)]

Kaon Aerogel Detector

- As a charged particle (kaon) passes through a substance (aerogel) faster than light passes through that substance, light is emitted.
- This light is called Cherenkov light and can be thought of as a shock wave in the electromagnetic field. It is analogous to a sonic boom.
- The light is collected by Photomultiplier Tubes (PMT) and converted into an electron signal by the photoelectric effect.
- This signal is then amplified into a signal that can be analyzed.
- An example image of a detector is pictured at right.



Side View