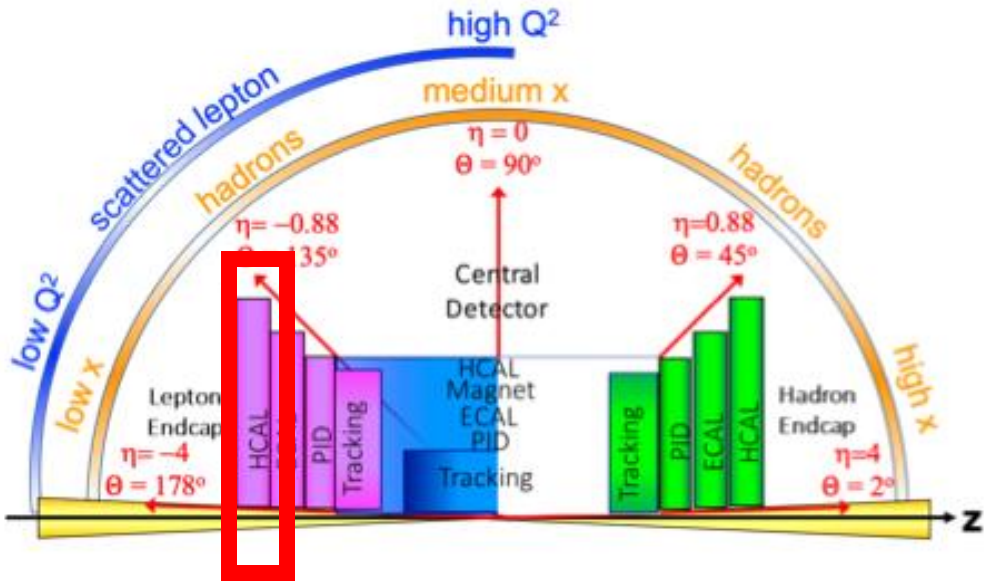
Physics Motivation for the Backward Hadronic Calorimetry in ePIC

Physics central to EIC Mission

- Key question: Why Hadronic Calorimetry in the BACKWARD (electron going direction)?
  - Hermiticity + Electron tagging in low-x
  - Diffractive Processes (Vector Mesons + Dijets)
  - Neutron detection and neutral veto



- Backward region = high gluon densities

"the EIC will be the first experimental facility capable of exploring the internal 3-dimensional sea quark and gluon structure of a nucleus at low x" – EIC White paper

Hadronic response and e/π separation with the H1 lead/fibre calorimeter

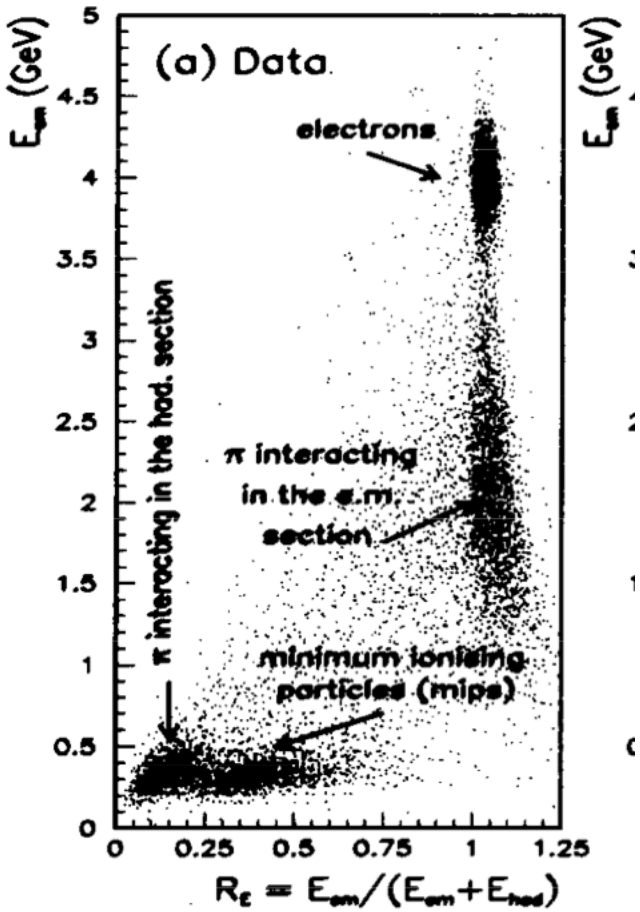
H1 SPACAL group

Lessons from HERA

- H1 upgrade to include SPACAL (1995) in the backward region
  - Purpose: Enhanced capability to study low Q^2 physics, improved trigger efficiency for low-energy electrons, and better background rejection, enabling precise measurements of structure functions and diffractive processes at low x.
  - Current understanding of low-x proton structure functions (GPDs) are based on HERA measurements
  - He
  - e/pi separation and background rejection are

key challenges at low-x. nHCAL allows hadronic veto

Determination of event kinematics – especially for photoproduction and CC where we rely on hadronic reconstruction



Diffractive Events

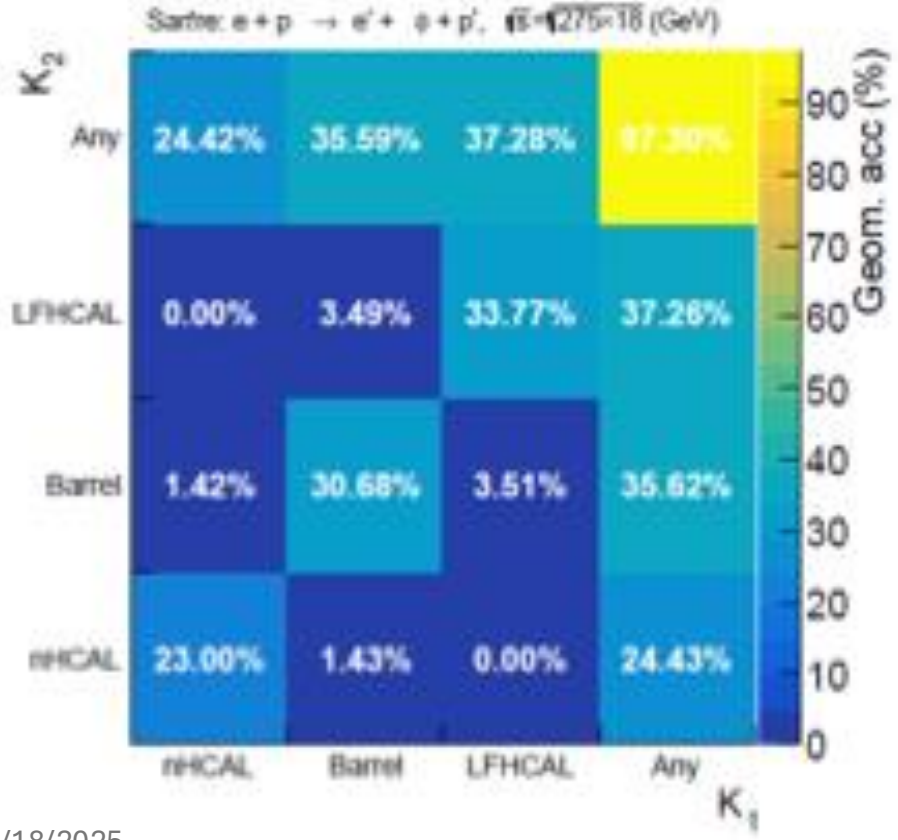
At HERA, diffractive events made up a large fraction of the total e+p cross-section (10–15%). Saturation models predict that at **the EIC, more than 20% of the cross section will be diffractive**

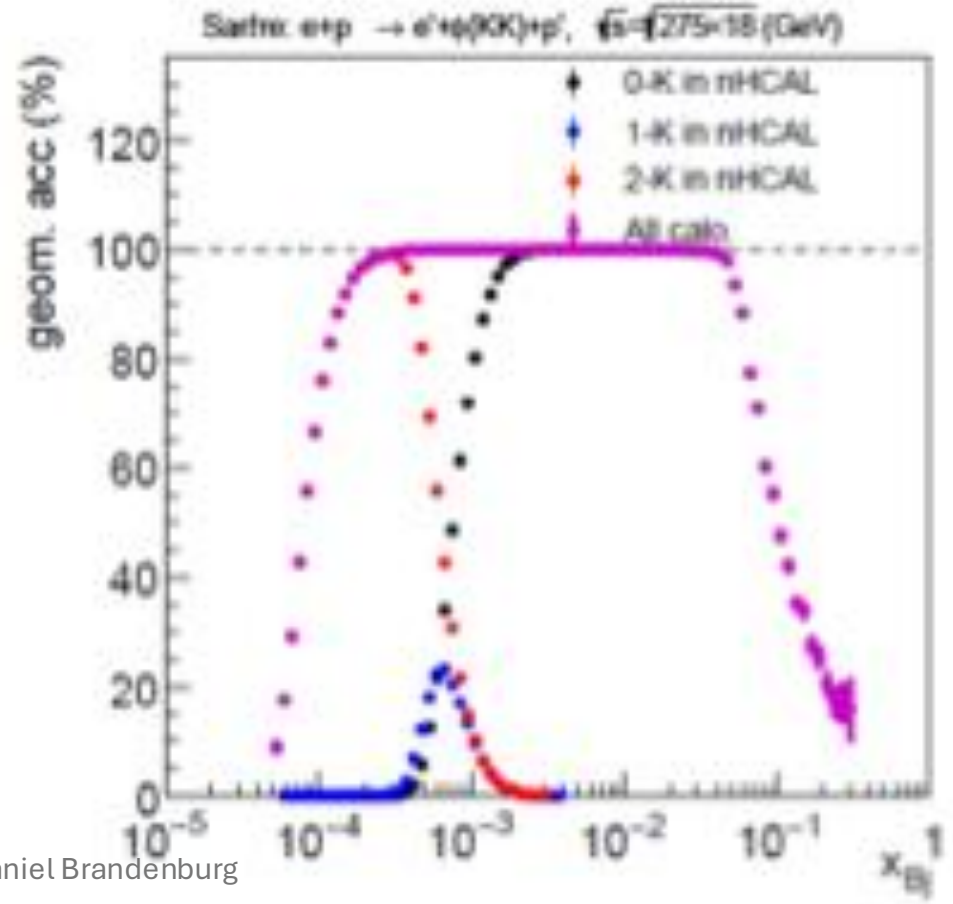
- Diffractive processes are directly proportional to square of gluon distribution – **“very sensitive to the onset of non-linear dynamics in QCD”**
- Exclusive production of the φ was one of the featured reactions in the EIC White Paper
- **Consider as motivation only the impact of an nHCAL on j/psi->mumu and phi->KK**

https://arxiv.org/pdf/2103.05419

Phi->KK

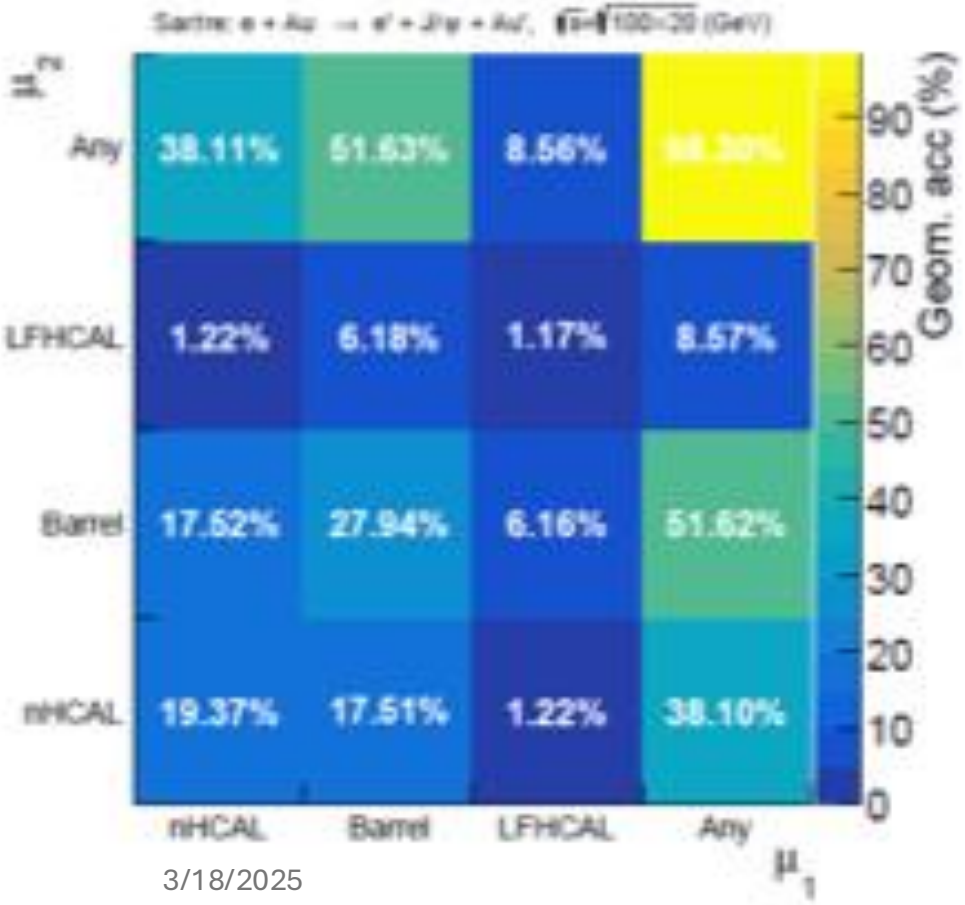
- nHCAL necessary for accessing low-x production

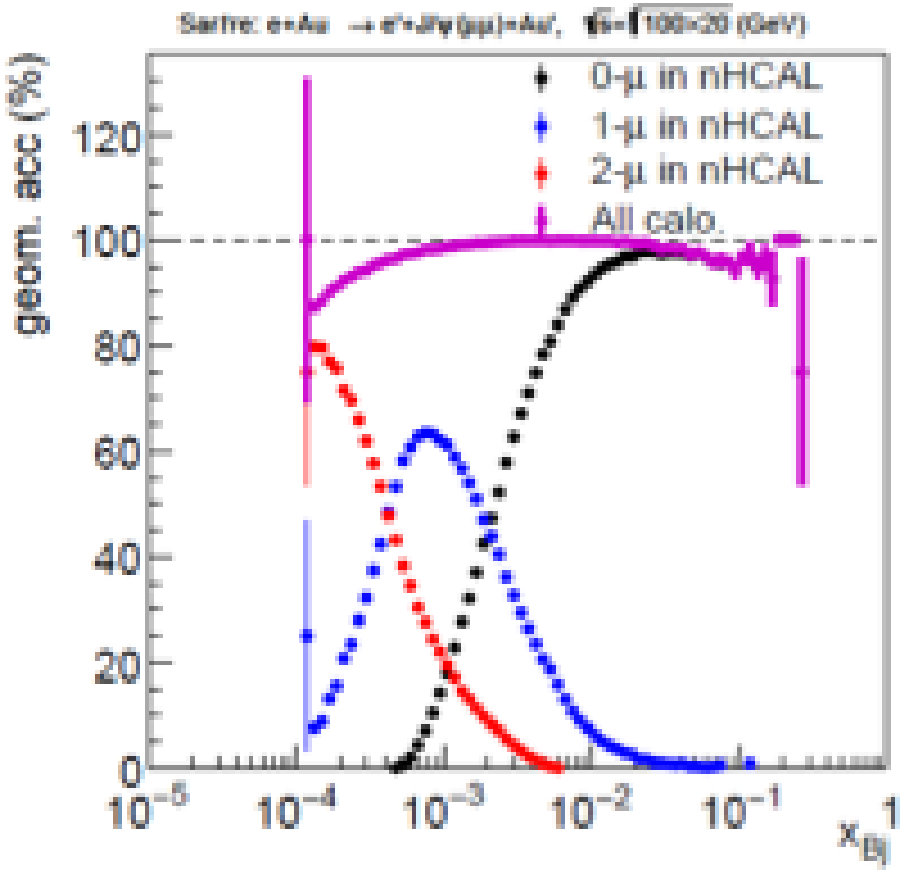




J/psi->mumu

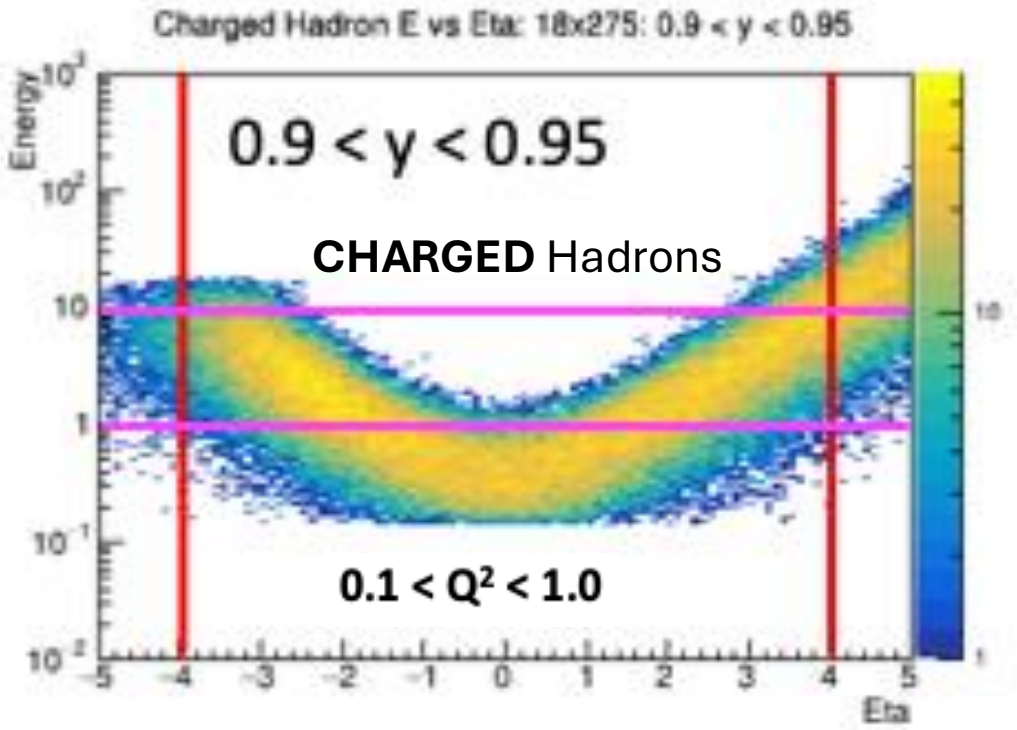
- Majority fraction of low-x diffractive J/psi send one or both muons into backward HCAL acceptance – **40% = nHCAL + any**

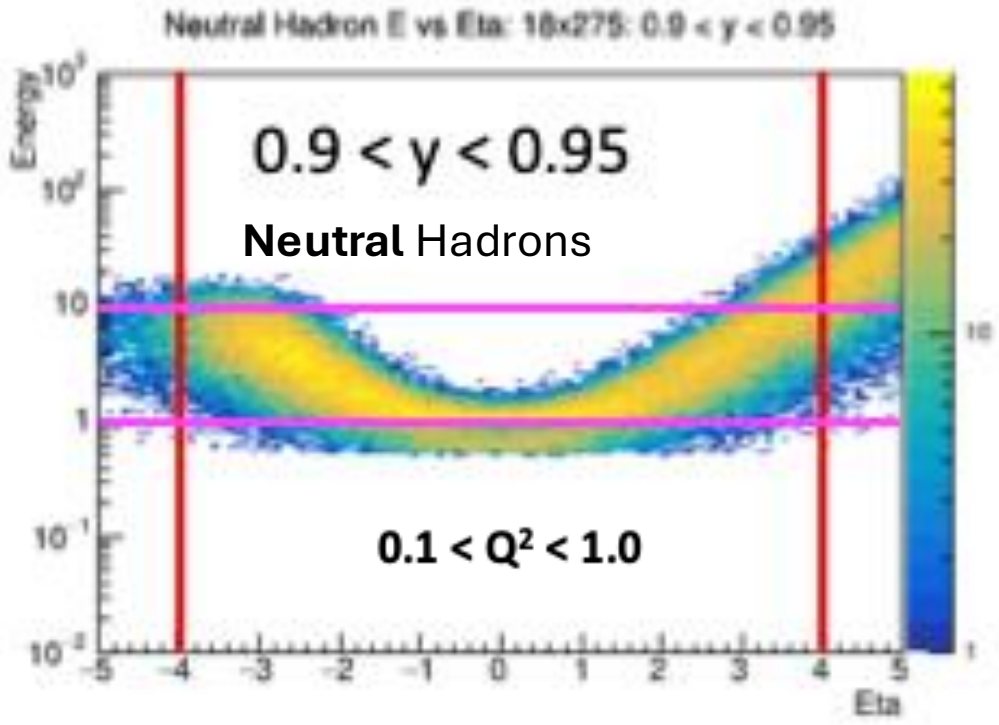




Jets and Neutron detection

- “Studies of (dijet) diffraction in high-energy electron-proton scattering is one of the high-lights of the HERA heritage”
- Low-x, high-y processes -> Jets in negative eta





https://arxiv.org/pdf/1911.00657

nHCAL – improve Jet Energy Resolution + Jet energy scale for large range of low-x measurements

Summary nHCAL