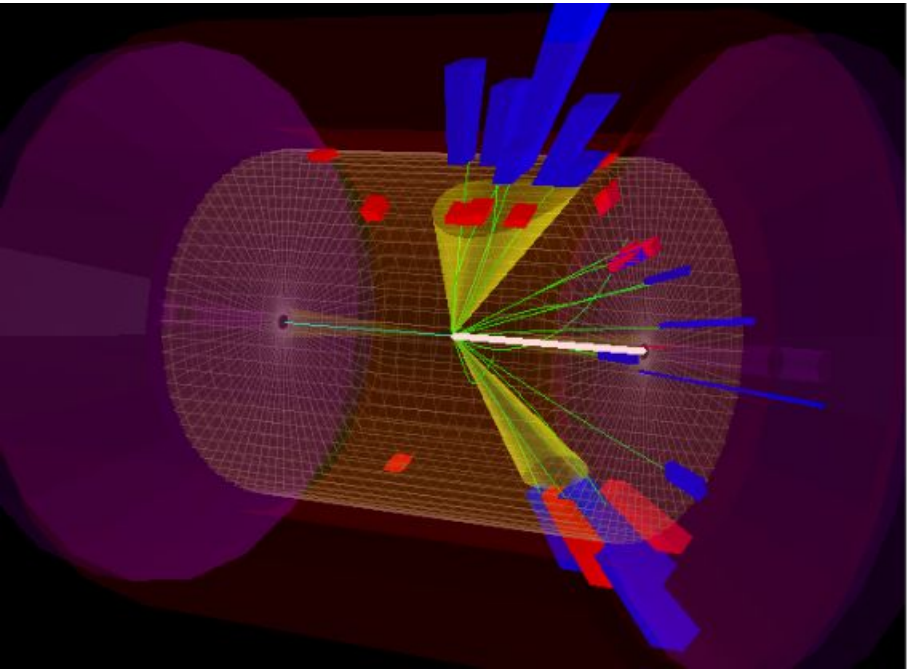
update

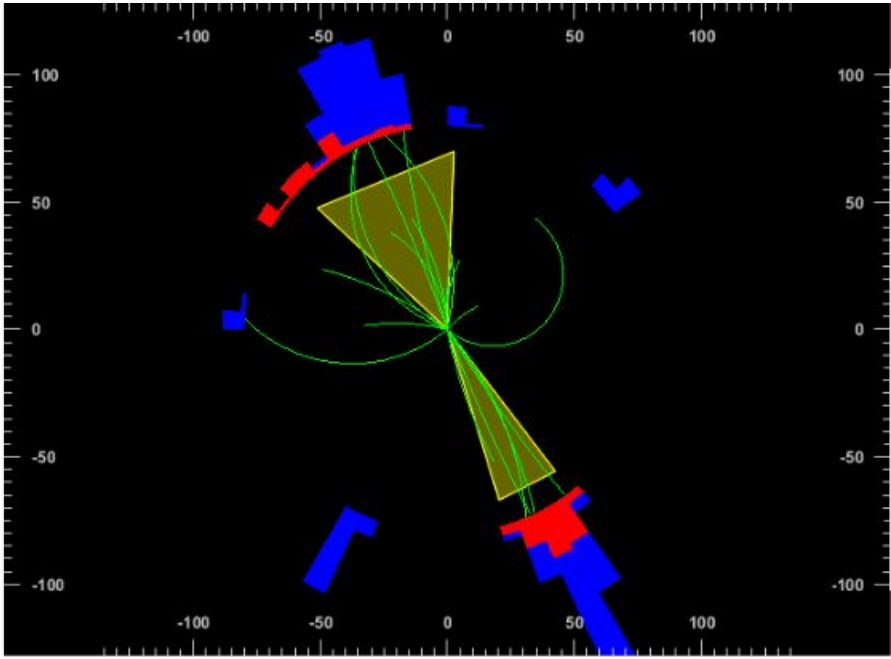
Miguel

Summary of tasks to be undertaken by the Consortium

Task 1: Develop a conceptual design of silicon pixel tracking detector and calorimeter systems to measure jets, heavy flavor, and quarkonium produced in e+p and e+nucleus collisions. (UCB, UCLA, UCR, UCD, LBNL, LANL)
Task 2: Simulations to quantify technical and physics performance of tracker and calorimeter conceptual designs. (UCB, UCLA, UCR, UCD, LBNL, LANL, LLNL)
Task 3: Experiment and theory collaboration to identify new observables for jet physics, and develop new approaches for heavy flavor and quarkonium physics. (UCLA, UCR, LANL, LLNL)
Task 4: R&D and prototype construction of silicon pixel and calorimeter technologies. (UCB, LBNL, LANL, UCLA, UCR)
Task 5: Beam tests of detector prototype response to electrons at Jefferson Lab, and radiation hardness tests at the LBNL 88-inch cyclotron. (UCB, UCD, UCLA, LANL, LBNL)
Task 6: Analysis of data from HERA (the previous electron-proton collider) to study tomography with jets and develop analysis approaches for EIC. (UCR)

Diffractive jet studies (relate to Task 2&3)

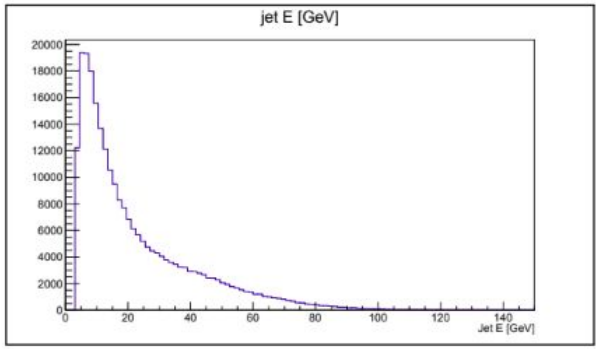


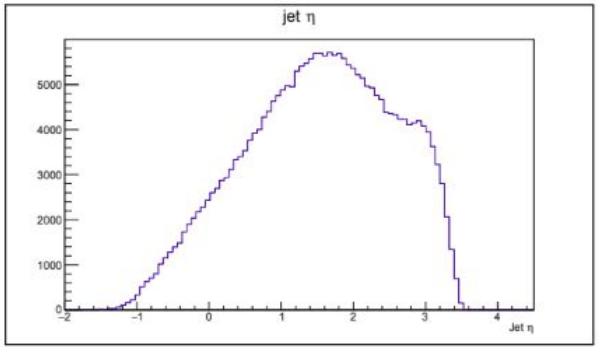


Key channel for **gluon orbital momentum** and **Wigner function** measurements.

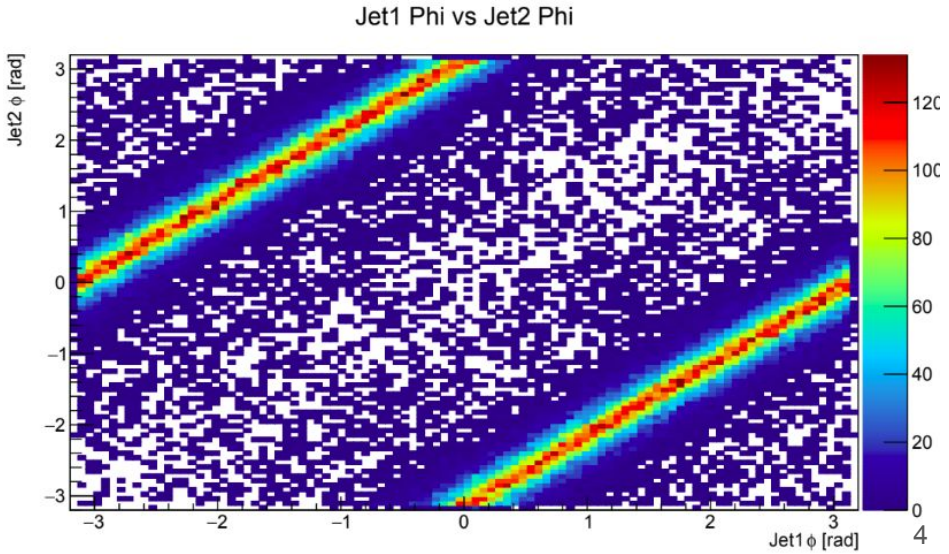
Delphes simulations

Latif

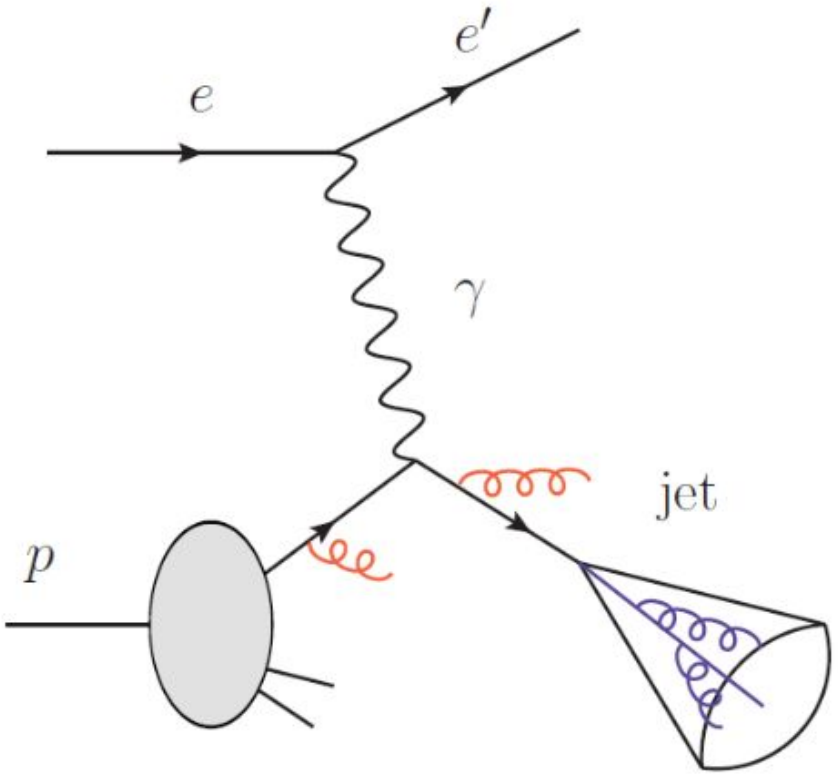


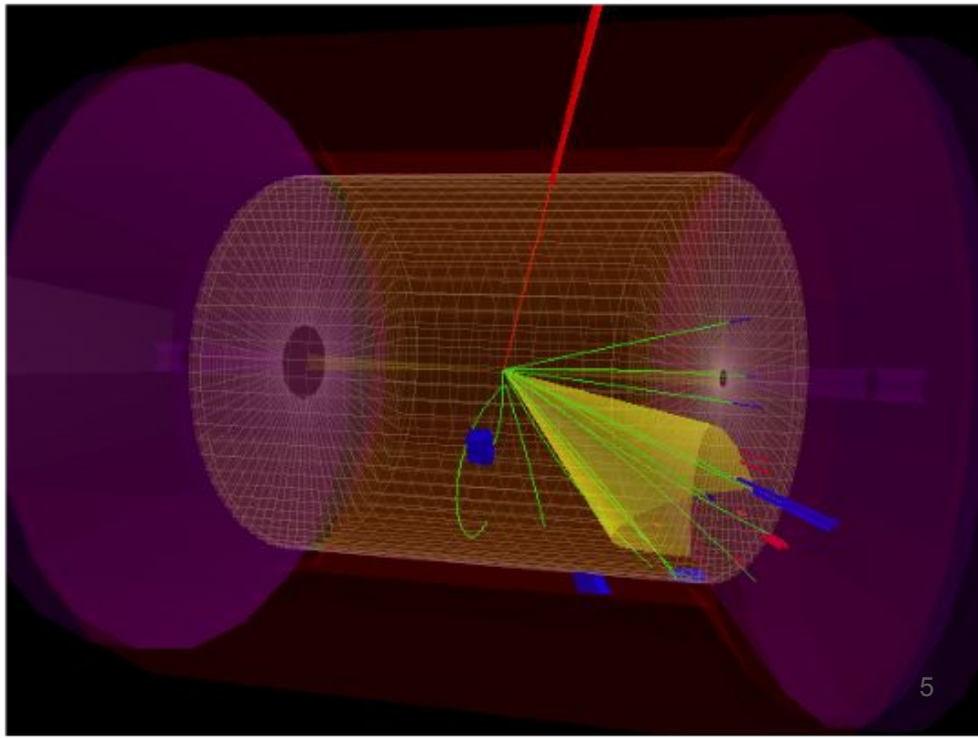


- Since last update, studies have incorporated full description of final EIC YR parametrizations (file available at arXiv:2103.06886)
- More recently, also added all-silicon performance taken from https://arxiv.org/abs/2102.08337
- Focusing on expected performance at large rapidities

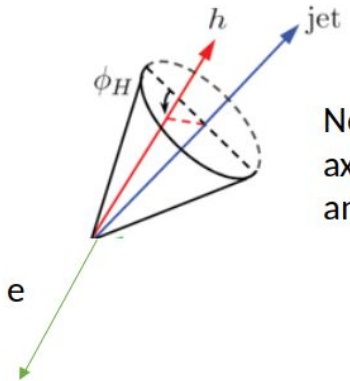


Single-jet fragmentation studies





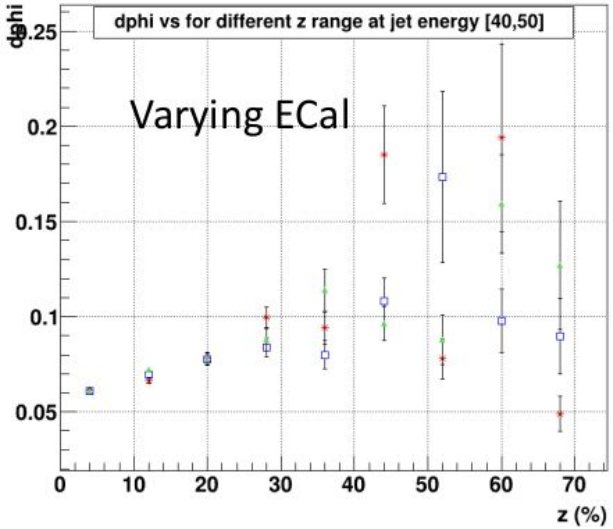
Xilin

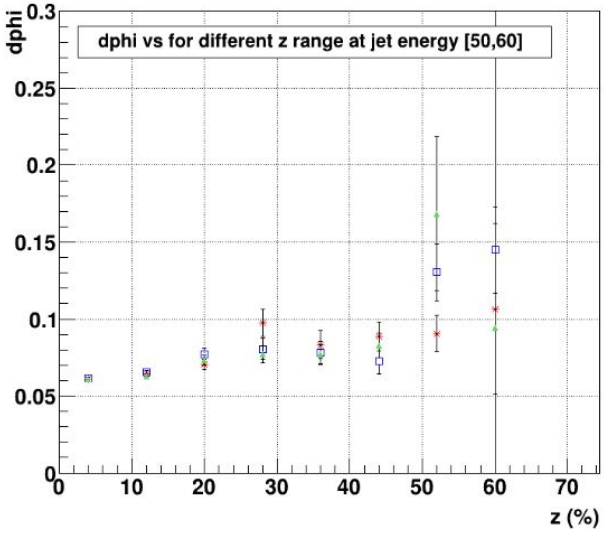


Note in DIS we have 2 axes (virtual photon and jet).

$$z_{jet} = \frac{|\vec{p}_{jet}| * |\vec{p}_{track}|}{|\vec{p}_{jet}|^2}$$

$$\phi_{jet} = \arctan\left(\frac{\overrightarrow{p_{track}} \cdot \widehat{N_{jet}}}{\overrightarrow{p_{track}} \cdot \widehat{S_{jet}}}\right),$$

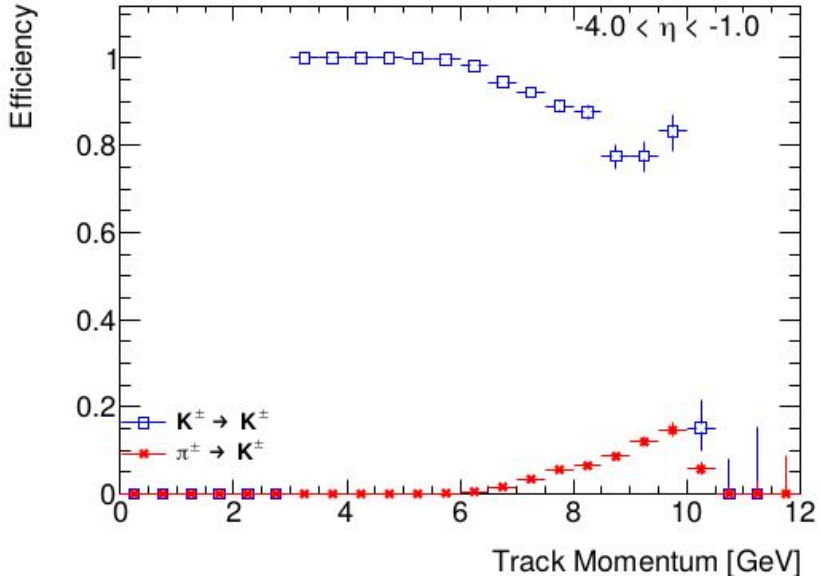


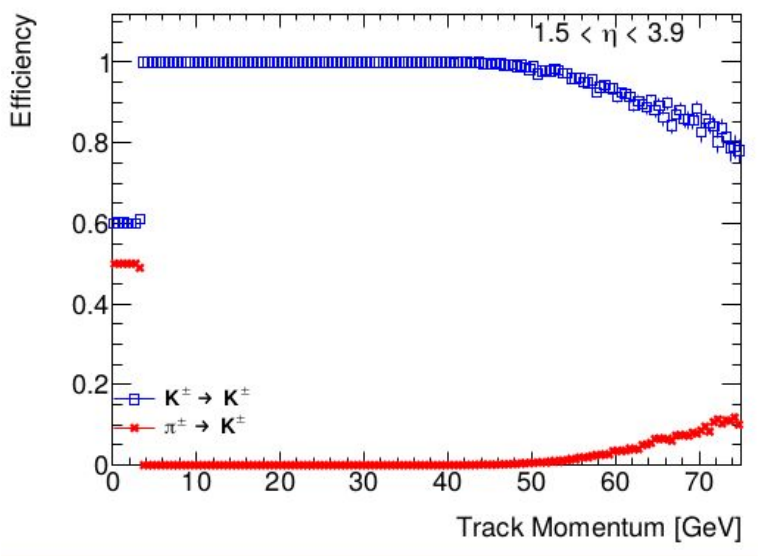


Realistic parametrizations of PID (DIRC, mRICH, dRICH, etc)

Geant-4 sims from PID groups were implemented in Delphes fast sim (S. Sekula)
These are available here: https://arxiv.org/abs/2103.06886

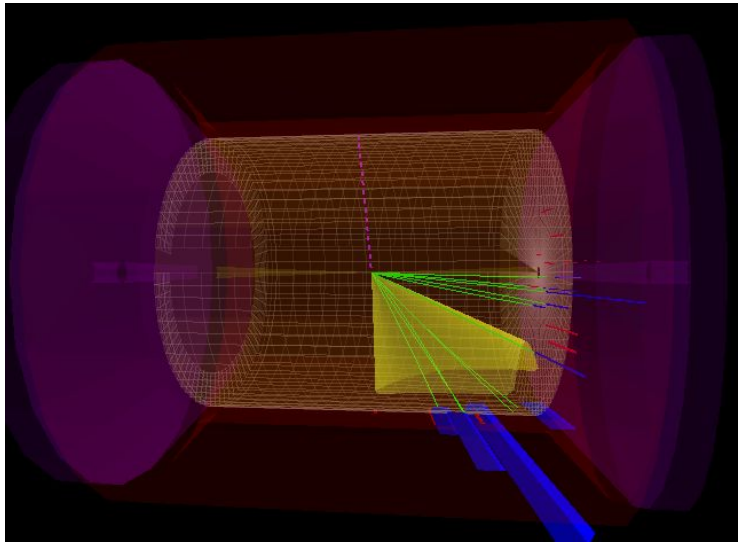
Xilin is working in using these to estimate performance for jet Collins asymmetry measurements in a more realistic way than what was done in YR





We plan to publish these feasibility studies in a paper similar to "*Jet-based measurements of Sivers and Collins asymmetries at the future Electron-Ion Collider*
Phys. Rev. D 102, 074015 (2020)

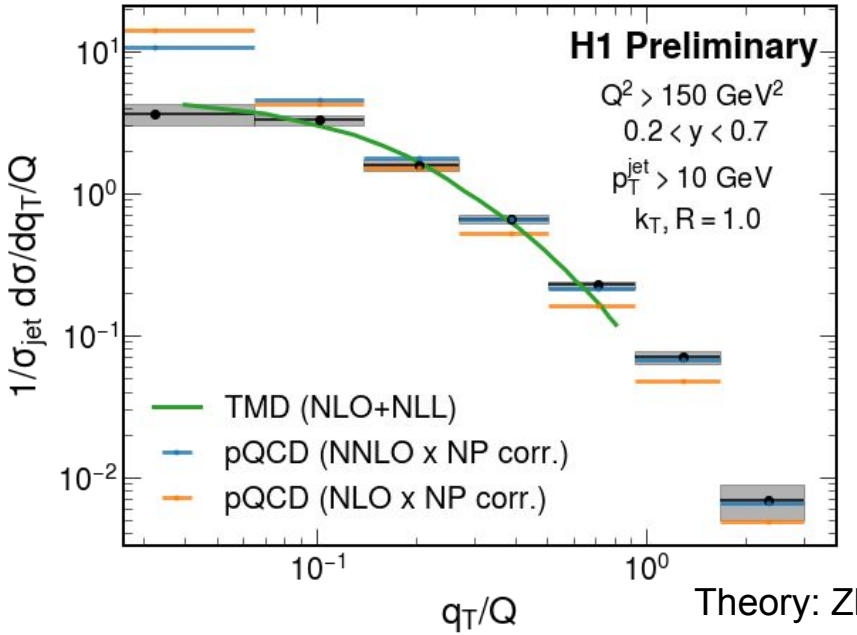
A follow up studies will focus on CC DIS, we will study the feasibility of
Neutrino-jet correlations and
Neutrino-tagged fragmentation
Will include new theory (Zhongbo et al.) and new performance (realistic PID performance, realistic tracker performance).

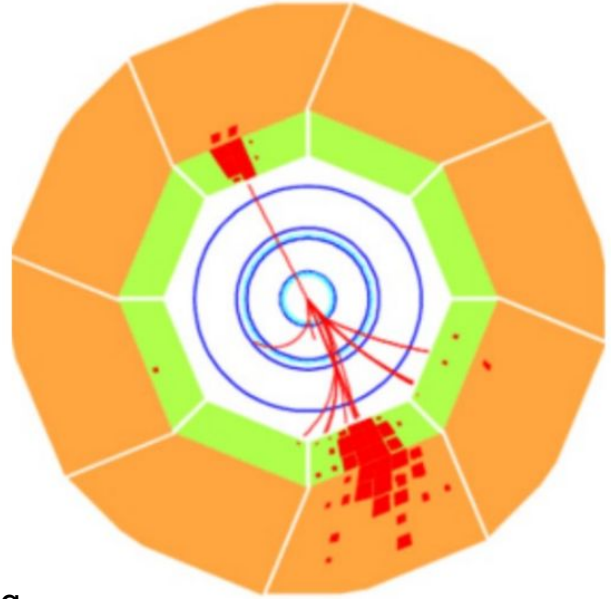


Status of our EIC pathfinder program with H1@HERA

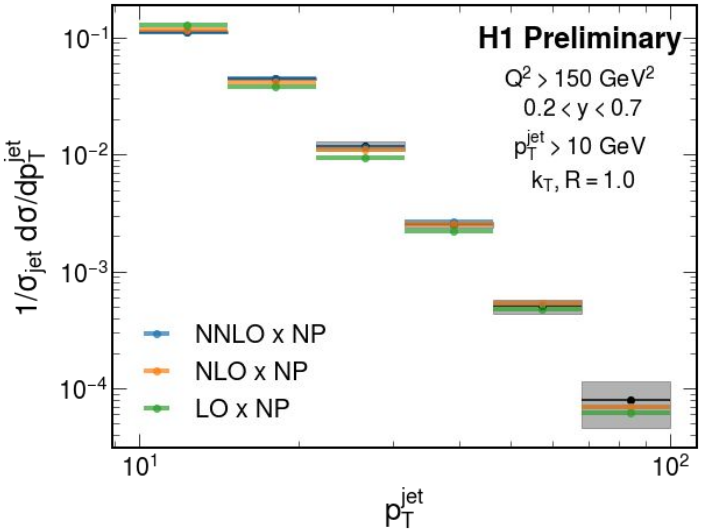
Our lepton-jet analysis was approved (yesterday) as preliminary for DIS2021

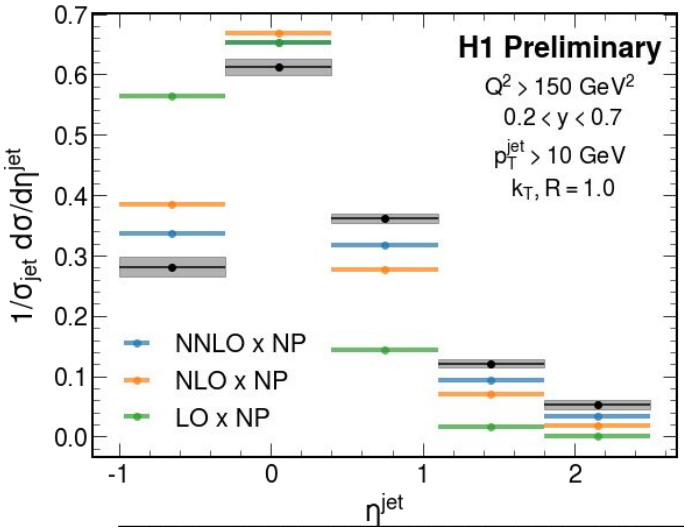
- Fist measurement of qT spectrum, which shows matching between TMD and pQCD frameworks (before seen only at Q2~10000 GeV2 with Z/W bosons)
- First actual use of AI-assisted unfolding (i.e. DNN-based, unbinned, high-dimensional data) [method in arXiv:1911.09107]

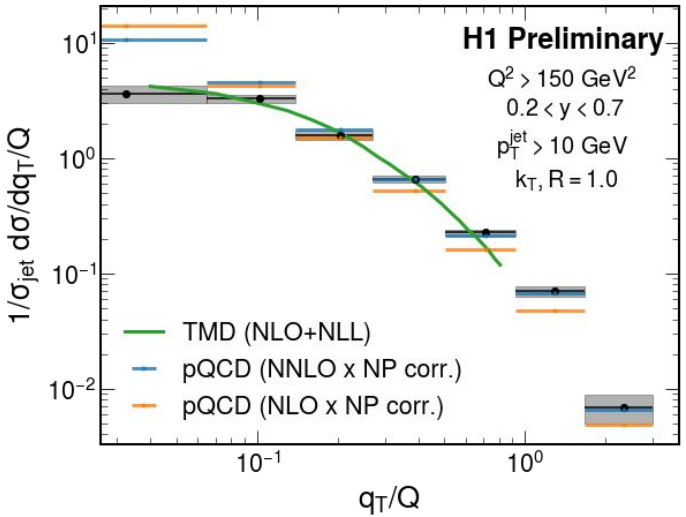


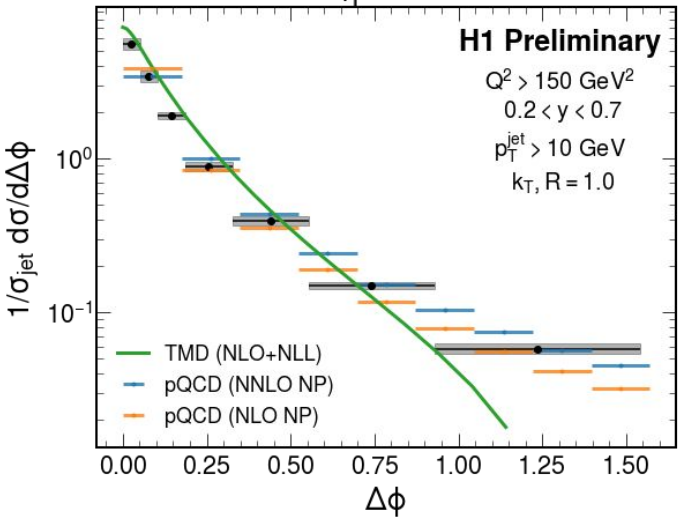


Theory: Zhongbo, Feng

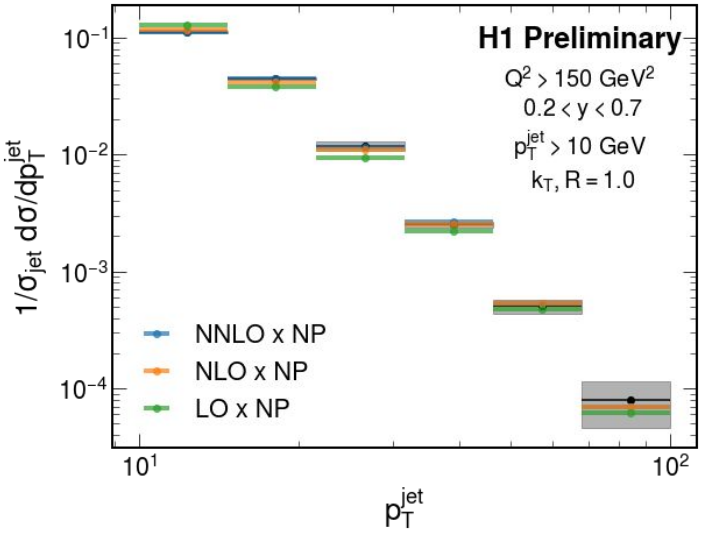


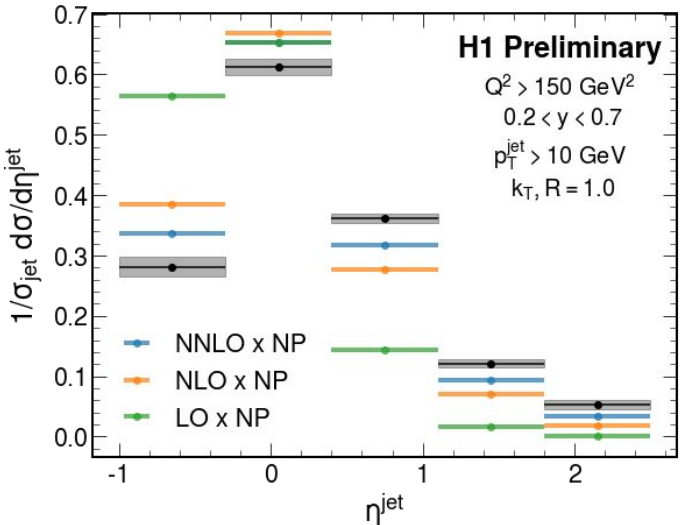






AI unfolded and applied efficiency correction in an unbinned way, for all 4 observables simultaneously!


H1 Preliminary
$Q^2 > 150$ GeV^2
$0.2 < y < 0.7$
$p_T^{jet} > 10$ GeV
k_T, R = 1.0
NNLO x NP
NLO x NP
LO x NP
$1/\sigma_{jet}\, d\sigma/dp_T^{jet}$
p_T^{jet}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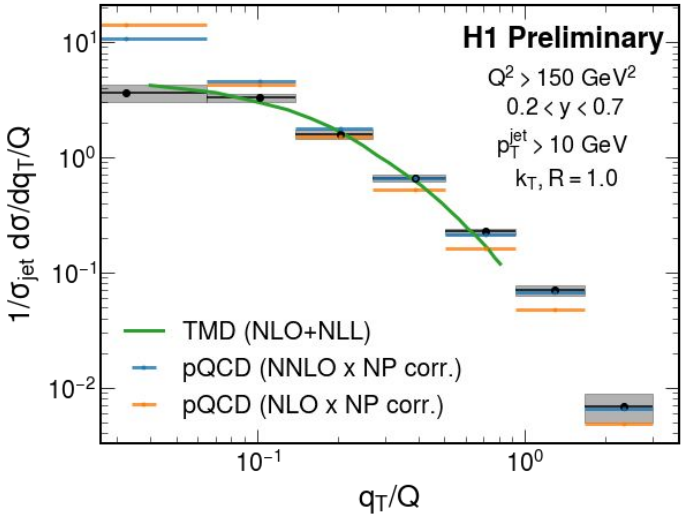
NNLO x NP
NLO x NP
LO x NP
$1/\sigma_{jet}\, d\sigma/d\eta^{jet}$
η^{jet}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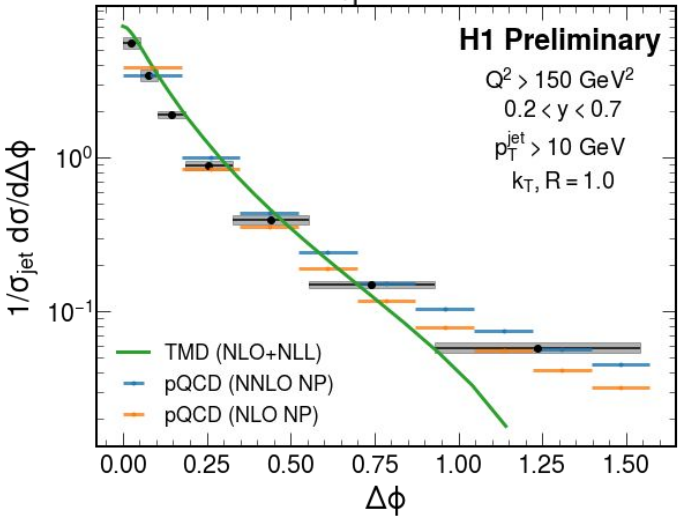
$p_T^{jet} > 10$ GeV
k_T, R = 1.0
TMD (NLO+NLL)
pQCD (NNLO x NP corr.)
pQCD (NLO x NP corr.)
$1/\sigma_{jet}\, d\sigma/dq_T/Q$
q_T/Q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$Q^2 > 150$ GeV^2
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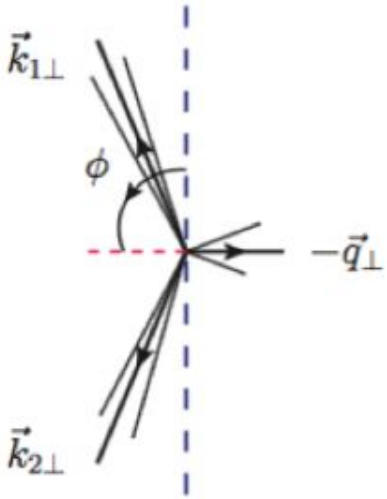
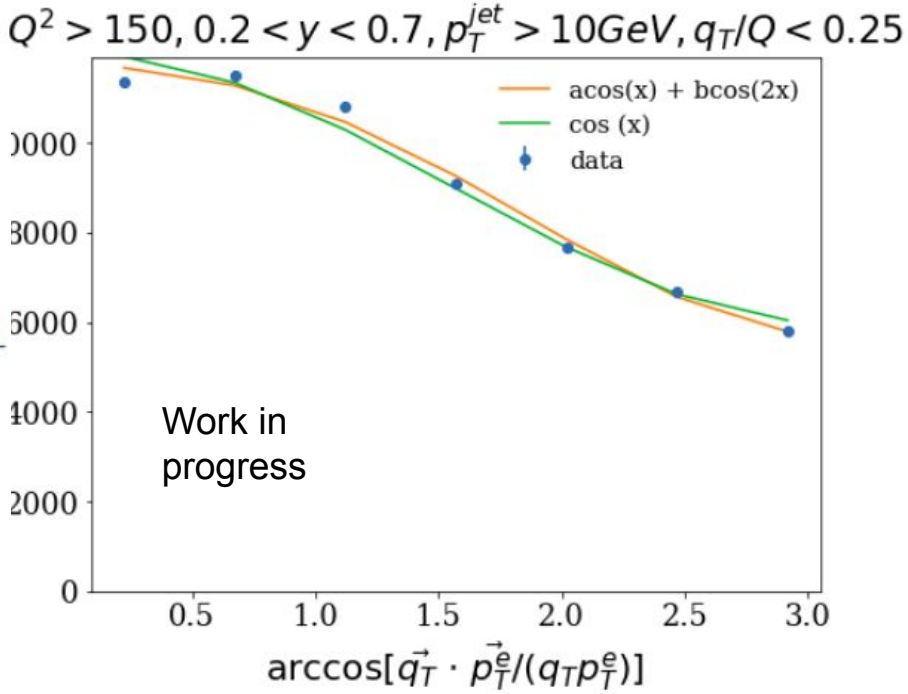
$p_T^{jet} > 10$ GeV
k_T, R = 1.0
TMD (NLO+NLL)
pQCD (NNLO NP)
pQCD (NLO NP)
$1/\sigma_{jet}\, d\sigma/d\Delta\phi$
$\Delta\phi$

Feng suggested me to look at azimuthal modulation between imbalance and electron
Relevant for future precision measurements of **gluon OAM** and **Wigner function** at EIC



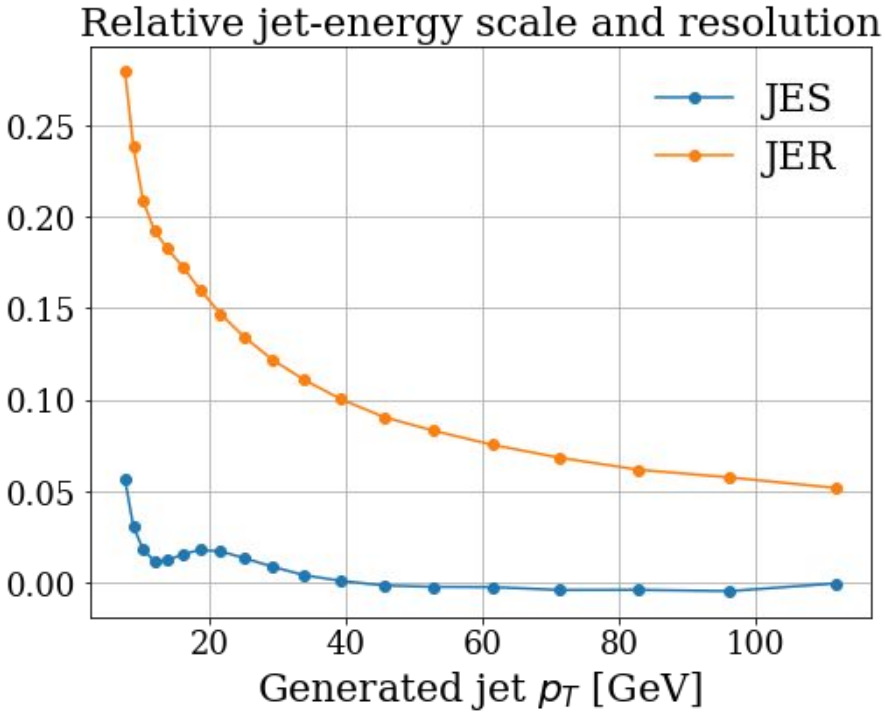


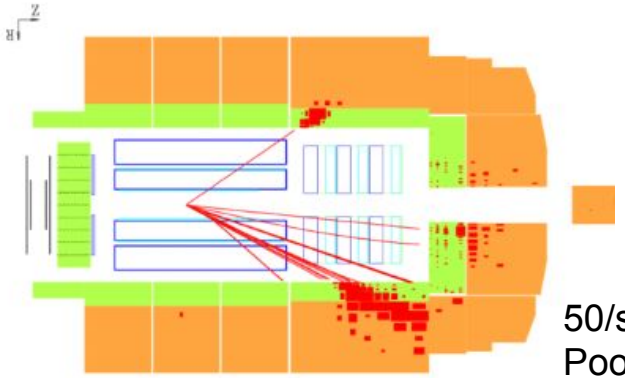
arXiv:1601.01585

This comes from free from our previous measurement! AI unfolded it already, without additional training

Our H1 analysis informs our EIC detector requirements discussions

H1 energy-flow performance (full-sim)



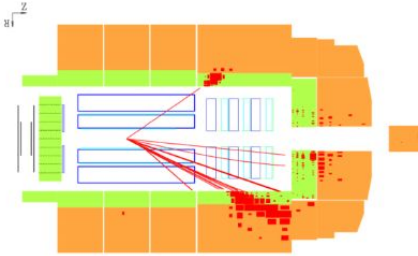


50/sqrt(E) HCAL
Poor tracking

"Jet performance" not only relevant for jets but also to reconstruct x, Q2 (lepton alone is not enough)

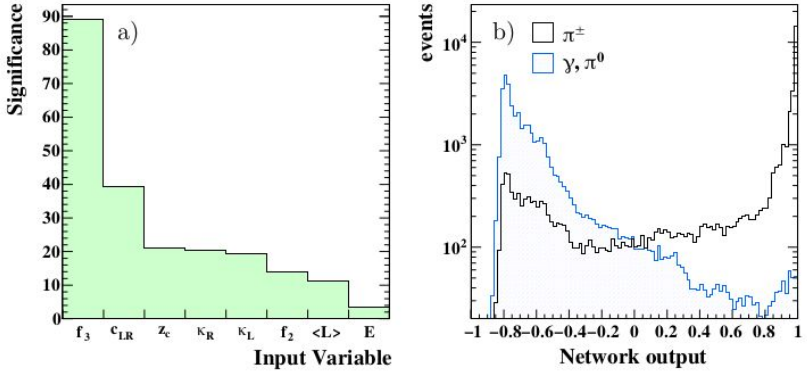
Slide I presented in EIC Calorimetry workshop this week:
https://indico.phy.ornl.gov/event/38/overview

Design HCAL with the calibration in mind. Go for 1% JES (down to 10 GeV)



- “Software compensation” a key aspect of H1 measurements from the beginning. Neural networks were a late addition (~20 years later).

- Fact: H1 (non-compensating calorimeter) achieved same JES uncertainty than ZEUS (compensating calorimeter). Both cases 1%



R. Kloger thesis
(Hamburg University)

Impact of AI-assisted software compensation: Smaller correction, smaller uncertainty

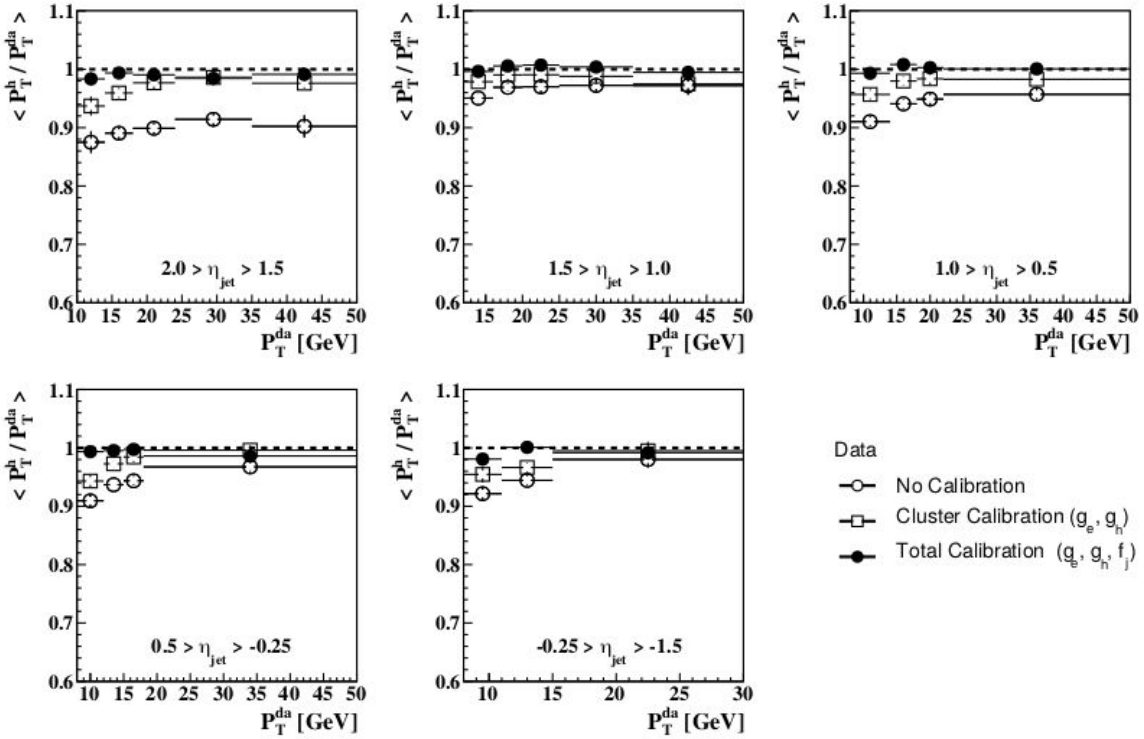
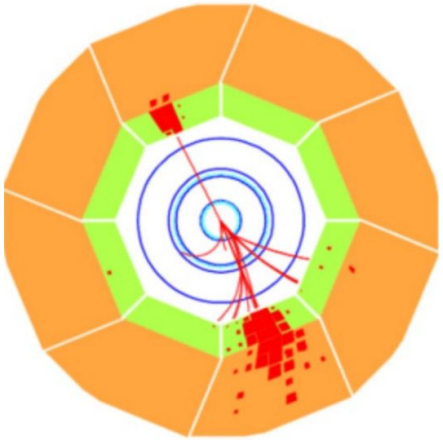
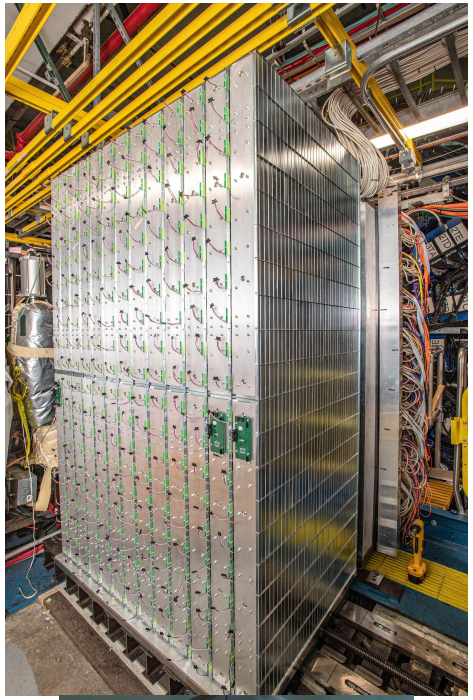


Figure 8.10: Mean values of the P_T-balance distributions as function of P_T^{da} in bins of



UCR Plans (related to Task 1 & 2)

One questions we plan to answer with full simulations:
What is the longitudinal segmentation that AI needs to give us enough info on the EM fraction to make a 1% calibration likely?
Note H1 HCAL (LAr HCAL portion) had between 4 to 6 longitudinal segments.



Or maybe: **What is the best performance AI can yield given the $$$ available to spend in the longitudinal readout.**
For which eta-range would this have the largest impact?
(likely high-x)
Where should the longitudinal layers placed?
(AI could tell us)

We plan to collaborate UCLA , anybody interested is welcomed of course
We plan to publish these studies, e.g. :
“AI-assisted design of the forward calorimetry system for the EIC” @ NIM
“Test beam results for forward calorimetry system and test of AI prediction”
…

From T. Ulrich's presentation in EIC Calorimetry workshop this week (https://indico.phy.ornl.gov/event/38/overview):

Projected R&D Needs (I)

Project (Targeted) R&D:

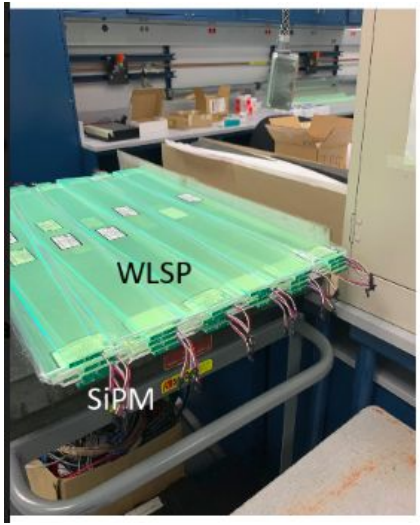
- ECAL Sc. Glass & Crystals (Backward EMCAL)
  - demonstrate scale up of SciGlass to block sizes ≥15 X_0 and establish SciGlass characteristics with beam tests
  - realistic full chain prototype (Sc Glass & PbWO4)
- W/ScFi EMCal and Fe/Sc HCal (Forward)
  - MC optimization hadron endcap calorimeter system optimization
  - Construction and test of a full chain prototype of W/ScFi + Fe/Sc calorimeter system

We should seize this

UCR involvement with STAR forward calorimetry

David Kapukchyan , Xilin Liang , Erik Loyd , Ananya Paul , Cameron Racz

Main supervisor: Oleg Tsai (UCLA)



Forward HCAL tasks being performed by UCR students:

Ongoing tasks on calorimeter commission

- Calibrated voltage and patterns for mapping check for Hcal (Ananya*)
- Temperature gain compensation study for calorimeter (Cameron*)
- FEE board attenuator study (Erik)
- Gain study between LED test event and physics simulation event (Xilin)
- π^0 reconstruction study as sanity check for Hcal (Xilin)
- Develop better way to fit for time bin pulse shape (David)

UCR plans

“UCR group enthusiastically expresses interest in making significant contributions to the IP6@EIC proposal”

Our suggested name for IP6@EIC proposal:
A Totally Hermetic Electron-Nucleus Apparatus

Suggested collaboration name for a new experiment at IP6: *

ATHENA

Brief explanation what your suggested name stands for: *

A Totally Hermetic Electron-Nucleus Apparatus (cool fact: ATHENA was ZEUS's favorite child. also "ancient Greek goddess of wisdom, craft, and strategic war.", which seems appropriate for an exp. collaboration)

Summary

- Our jet simulations are advancing by incorporating more realistic performance (all-silicon tracker, PID from various detectors + EIC YR final parameters) **Tasks 2&3**
  We plan to publish these as feasibility studies + new theory. (PRD)

- Our EIC Pathfinder program at HERA has produced first, sweet results for DIS2021
  First jet-TMD measurement in DIS and first use of AI-assisted unfolding. **Tasks 6&3**
- Plan to publish in PRL.

- We have identified projects for calorimeter optimization using AI. **Tasks 1&2&4**
  This project consistent with project R&D needs.
  We plan to publish these studies in NIM and/or computational journal.

- We have expressed strong interest in contributing to the detector#1 @ IP6 proposal.
  Given that we are at 36 weeks and 6 days away from the deadline,
  we are eager to start working asap.