A possible EIC Detector

The EIC Collider dEtector (ECCE) consortium comprises 36 institutions assembled around the idea of building on the foundation of existing infrastructure available at RHIC IP8 and experimental equipment available there and elsewhere at JLab and RHIC.

Central Barrel Detector:

- ❑ Hadronic Calorimetry - possibly based on the existing sPHENIX magnet flux return.
- ❑ Electromagnetic Calorimetry
- ❑ Central Tracker
- ❑ Pre-shower

Hadron Endcap

- ❑ Forward Calorimetry
- ❑ Particle ID
- ❑ Forward Tracking

Lepton Endcap:

- ❑ Electromagnetic Calorimetry
- ❑ Hadronic Calorimeter
- ❑ Particle ID

Far Forward Detectors
Far Backward Detectors
Polarized Beam and polarimetry
Electronics
Computing

Much of the EIC physics can be done with this field

Parameter	New Magnet	BABAR/sPHENIX Magnet
Maximum Central Field (T)	3	1.5
Coil length (mm)	3600	3512
Warm bore diameter (m)	3.2	2.8
Uniformity in tracking region ($z = 0$, $r < 80$ cm) (%)	3	3
Conductor	NbTi in Cu Matrix	Al stabilized NbTi
Operating Temperature (K)	4.5	4.5

Table 11.1: Summary of some of the main requirements of the EIC detector solenoid magnet.

Example of Physics possible with ECCE: Spin

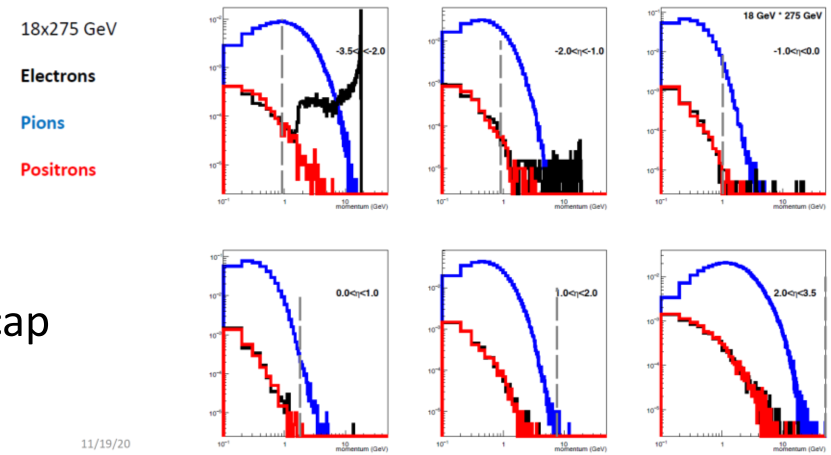
Major requirements:

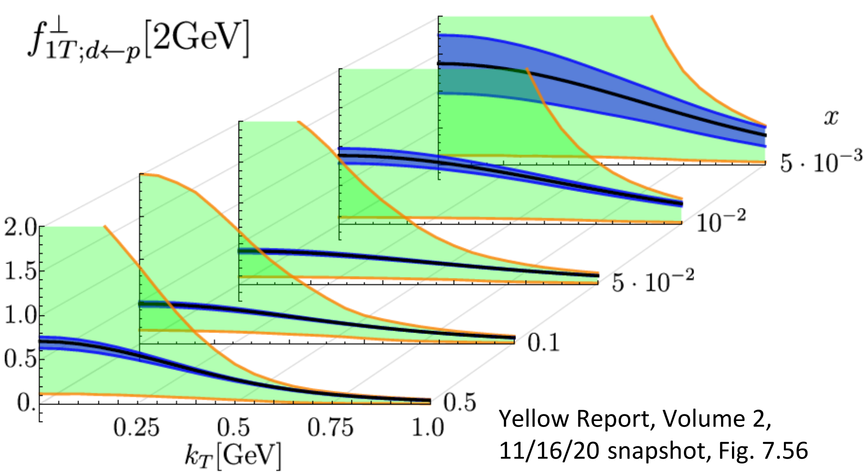
- ❑ Precision calorimetry in lepton endcap
- ❑ PID in barrel

ECCE:

- ❑ High resolution calorimetry in lepton endcap
- ❑ PID in barrel
- ❑ PID in forward endcap enables also TMDs

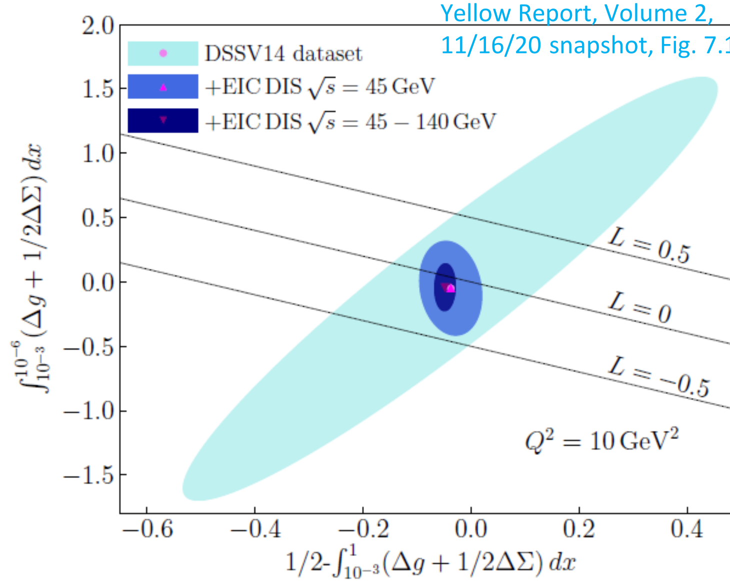
Scattered Electron Background





Yellow Report, Volume 2, 11/16/20 snapshot, Fig. 7.56

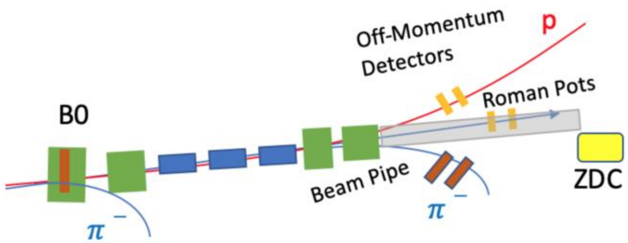
Yellow Report, Volume 2, 11/16/20 snapshot, Fig. 7.18



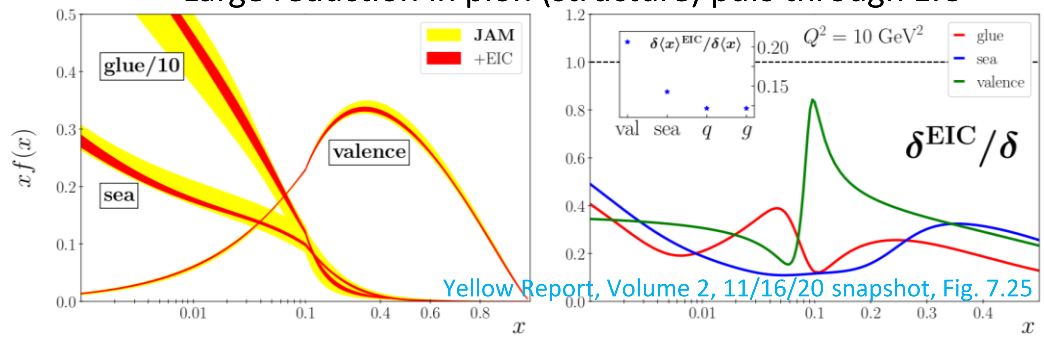
Physics WG (https://wiki.bnl.gov/eicug/index.php/Yellow_Report_Physics_Common)

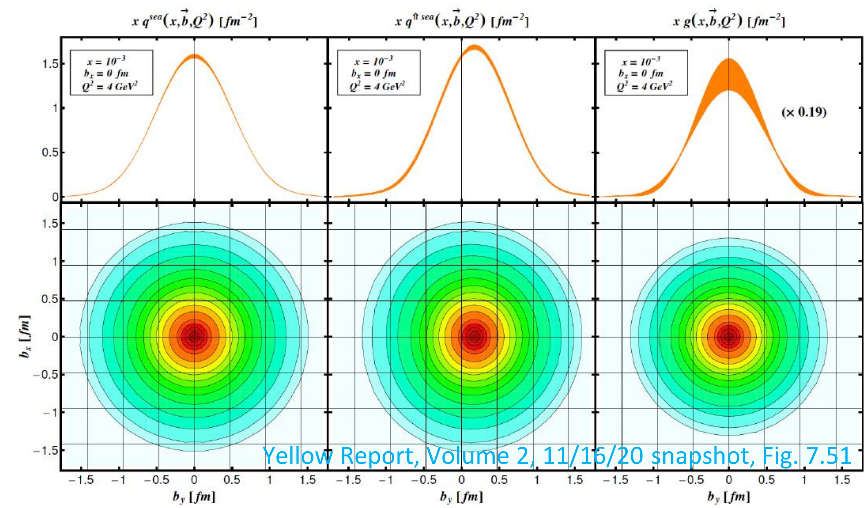
Yellow Report, Volume 2, Chapter 7

Example of Physics possible with ECCE: Origin of Hadron Mass



Large reduction in pion (structure) pdfs through EIC





Major requirements

- Far Forward detection to tag n and Λ (or Σ°) (meson structure) and to tag p (for DVCS/3D).
- Scattered electron detection in electron endcap
- Good hadron endcap and far-forward calorimetry (goal: 35%/E, <50%/E acceptable)
- For pion form factor: pion in hadron endcap

ECCE – physics reach enhanced in x_L and x_B with beam focus with dispersion – relevant for diffraction (e-p, e-A) and tagging (e-d, e-3He, etc), and exclusive measurements

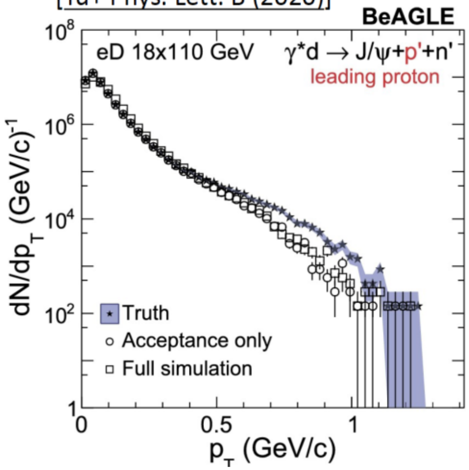
#	Parameter	EIC IR #1	EIC IR #2	Impact
8	Minimum $\Delta(B\rho)/(B\rho)$ allowing for detection of $p_T = 0$ fragments	0.1	0.003 – 0.01	Beam focus with dispersion, reach in x_L and p_T resolution, reach in x_B for exclusive processes

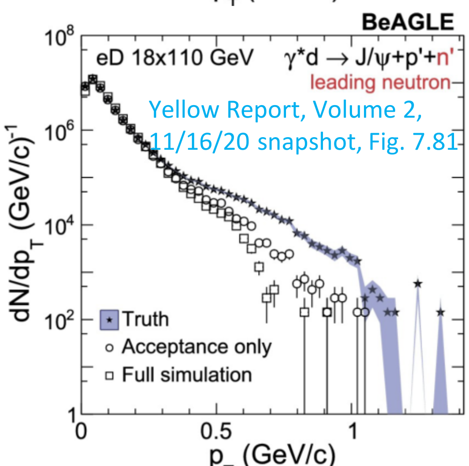
From 4th YR Workshop – talks on complementarity (Y. Zhang, V. Morozov)

Example of Physics possible with ECCE: Nuclei

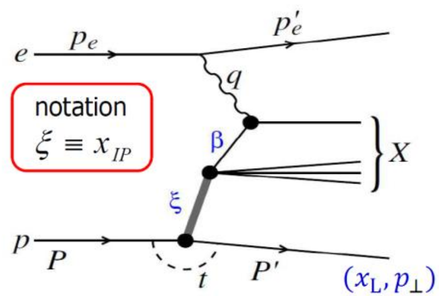
Incoherent diffractive J/Ψ production in e-d tagging

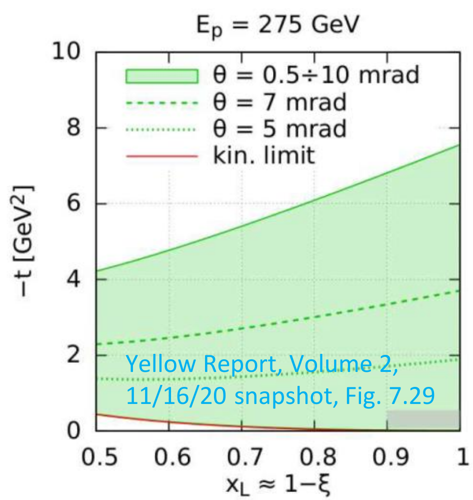
[Tu+ Phys. Lett. B (2020)]



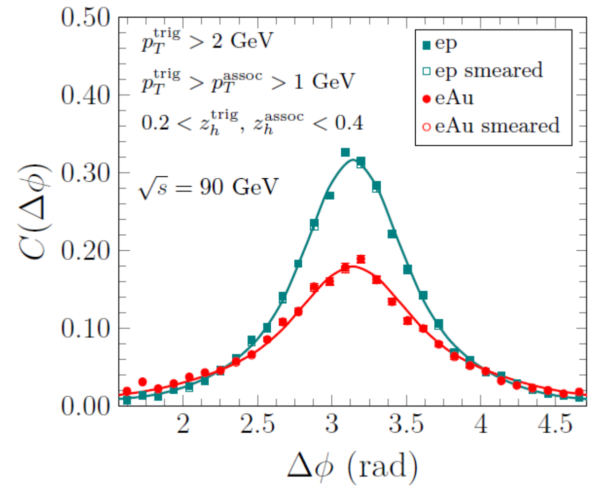


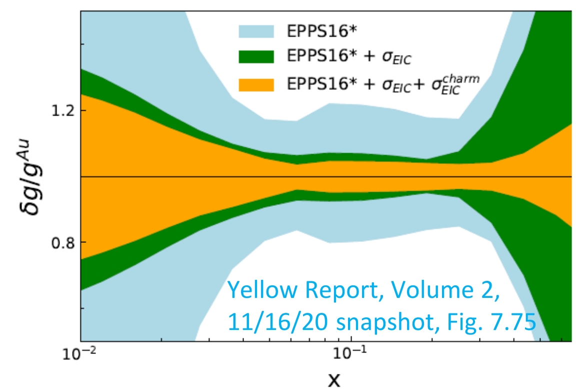
Inclusive diffraction in e-A





di-hadron azimuthal angle correlation, nuclear glue ratio through inclusive and open charm





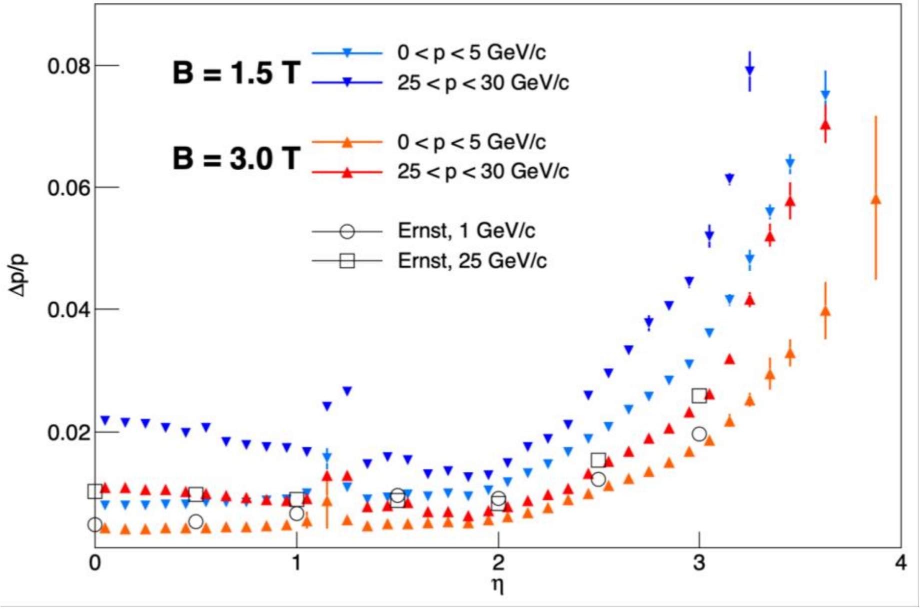
ECCE – physics reach enhanced in x_L and x_B with beam focus with dispersion – relevant for diffraction (e-p, e-A) and tagging (e-d, e-3He, etc), and exclusive measurements

Challenges with B=1.5T

Resolution in forward region η > 2.5

- ❑ Jets and heavy flavor group requires higher resolution in forward hadron region.

Jets/HF WG (https://wiki.bnl.gov/eicug/index.php/Yellow_Report_Physics_Jets-HF)



Track Momentum Resolution

Eta Range	Default Resolution (σP/P)%	Requested (σP/P)%
-3.5 < η < -2.5	0.1%*P + 0.5%	Same
-2.5 < η < -2.0	0.1%*P + 0.5%	Same
-2.0 < η < -1.0	0.05%*P + 0.5%	Same
-1.0 < η < 1.0	0.05%*P + 0.5%	Same
1.0 < η < 2.5	0.05%*P + 1.0%	Same
2.5 < η < 3.5	0.1%*P + 2.0%	Same

- ❑ However, lower field can also be useful in tagging and reconstruction of certain heavy mesons (D*) – resolution vs. acceptance/efficiency balance

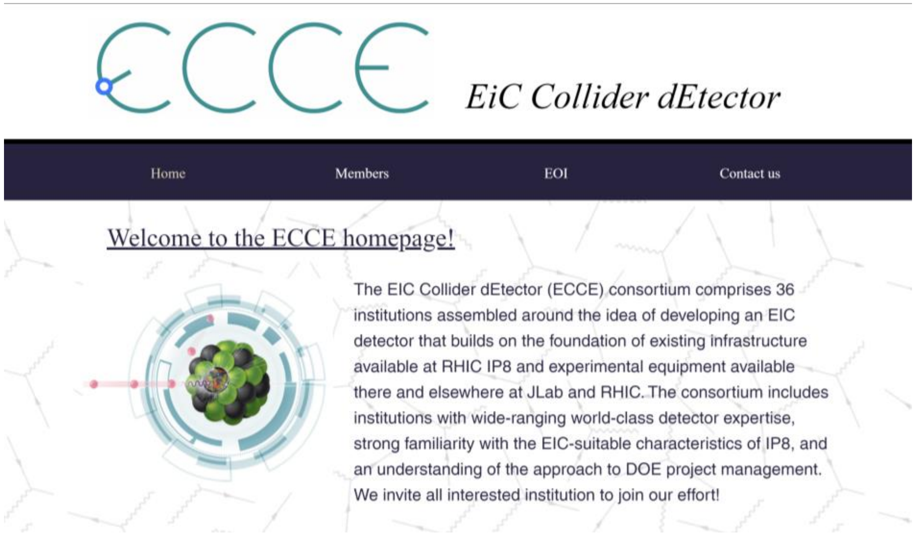
Pseudorapidity Range	Min p_T (3T) [MeV/c]	Min p_T (1.5T) [MeV/c]
$0.0 < \eta < 1.0$	400	200
$1.0 < \eta < 1.5$	300	150
$1.5 < \eta < 2.0$	160	70
$2.0 < \eta < 2.5$	220	130
$2.5 < \eta < 3.5$	150	100

Additional Information

- Web site including contact information: https://www.ecce-eic.org/

- First ECCE Workshop planned for February 2021
  - Discussion topics: physics focus
  - Open to everyone interested
  - Doodle poll for identifying workshop dates

- Please contact us if interested in exploring this avenue



We are open for all members of the EIC science community to join our effort. Please contact Or Hen (hen@mit.edu), Tanja Horn (hornt@cua.edu), and/or John Lajoie (lajoie@iastate.edu) for details on how you can get involved!

ECCE Consortium – present list of institutions

Institutions collectively involved at present:

AANL/Armenia, Academia Sinica/Taiwan, BGU/Israel, BNL, CU Boulder, CUA, Charles U./Prague, Columbia, FIU, GWU, GSU, IJCLab-Orsay/France, ISU, JLab, Kentucky, LANL, LLNL, Lehigh, MIT, National Cheng Kung University/Taiwan, National Central University/Taiwan, National Taiwan University/Taiwan, National Tsing Hua University/Taiwan, ODU, Ohio University, ORNL, Rice, Rutgers, SBU, TAU/Israel, UConn, UIUC, UNH, UVA, Vanderbilt, Wayne State, and WI/Israel.

Open to all – please contact us to join:

Or Hen (hen@mit.edu)
Tanja Horn (hornt@cua.edu)
John Lajoie (lajoie@iastate.edu