



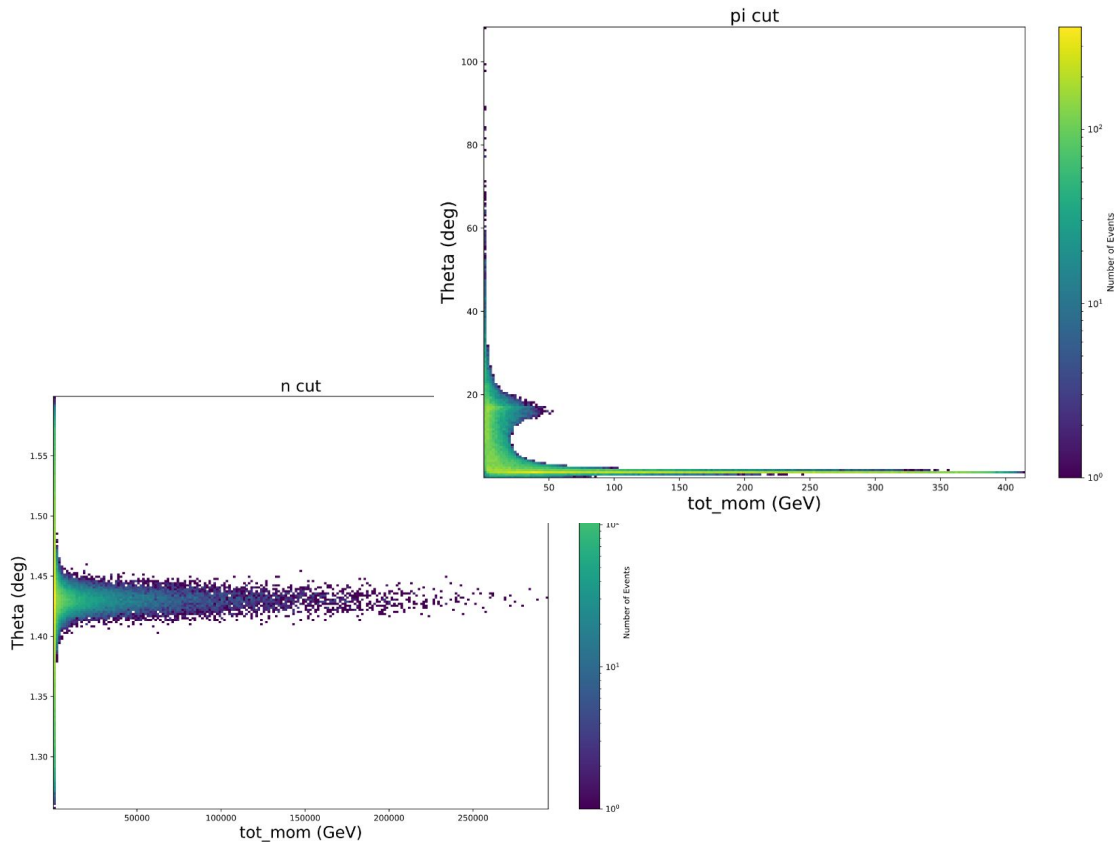
# EIC meson structure

April 27th, 2020

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# Problem: Unphysical kinematics in MC output for many events

- An example from lund
  - #1 - electron, 18 GeV
  - #2 - proton, 275 GeV
  - #3 - electron, 16.9 GeV
  - #4 - kaon+, 423 GeV
  - #5 - lambda, 492 GeV
- Not all events, but many are like this



## Redefining the scattered proton

$$P_{p2} = \sqrt{(P_{z_{p2}})^2 + (p_{2_{pt}})^2} \quad \phi_{p2} = \text{ran}(360 * D2R) \quad \theta_{p2} = \arccos\left(\frac{P_{z_{p2}}}{P_{p2}}\right) \quad p_{2_{pt}} = 0.005 * P_{Beam}$$

$$P_{z_{p2}} = \frac{-TDIS_{znq}(q_{virt,rest}\hat{z}) + \sqrt{(TDIS_{znq}q_{virt,rest}\hat{z})^2 + Q^2(E_{virt,rest})^2(M_p^2 + p_{2_{pz}}) - Q^2(TDIS_{znq})^2}}{Q^2}$$

$$P_{scat,rest} = [(P_{p2}\sin(\theta_{p2})\cos(\phi_{p2}))\hat{x}, (P_{p2}\sin(\theta_{p2})\sin(\phi_{p2}))\hat{y}, (P_{p2}\cos(\theta_{p2}))\hat{z}]$$

$$P_{scat,rest} = [(P_{x_{p2}}\sin(\theta_{p2}))\hat{x}, (P_{y_{p2}}\sin(\theta_{p2}))\hat{y}, (P_{z_{p2}}\cos(\theta_{p2}))\hat{z}]$$

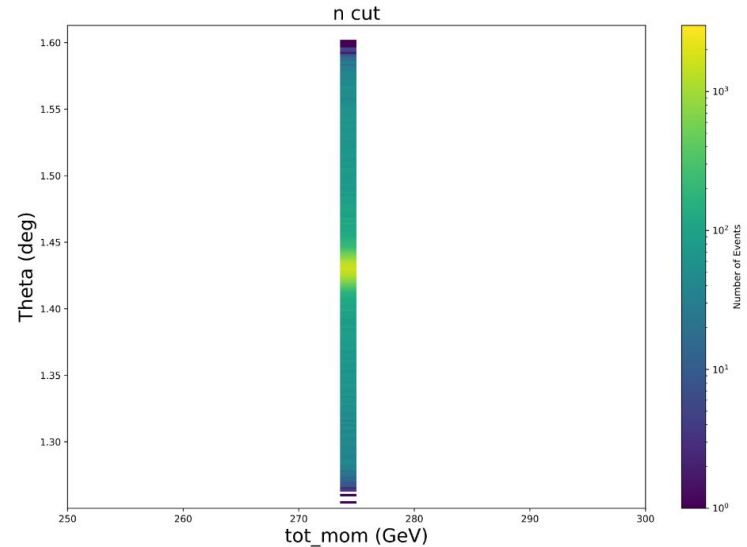
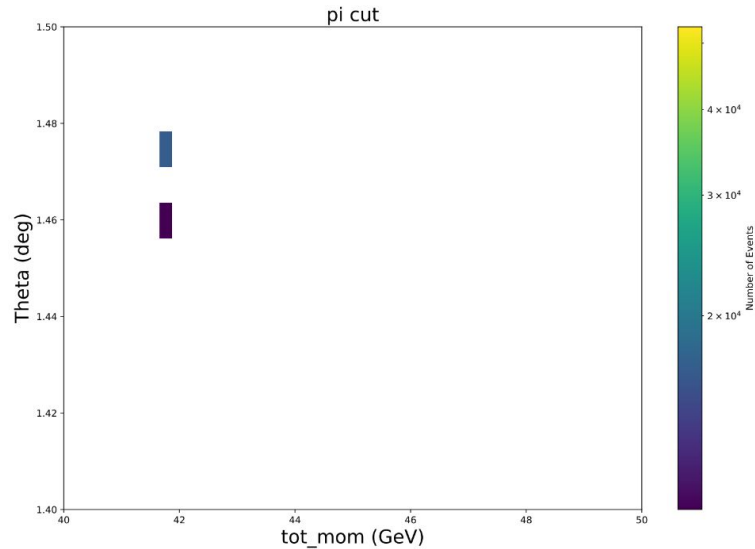
$$P_{x_{p2}} = p_{2_{pt}}\cos(\phi_{p2})$$

$$P_{y_{p2}} = p_{2_{pt}}\sin(\phi_{p2})$$

# Redefining the scattered proton



- Last time we saw these plots with the **energy conservation cut**
- These just resulted in delta functions when simulated in GEANT4



## Recalculating the scattered proton

- With the help of some 2015 documents of Charles Hyde and Kijun Park I found I recalculated everything
- For the scattered  $n/\Lambda$ , there are now new definitions for angles, amplitudes, and unit vectors
  - Angles selected from MC distribution
  - Amplitude selected from MC in a maximum spectator momentum range
  - Unit vectors redefined in terms of virtual photon direction
- The scattered  $\pi/K$ , redefined to include the missing mass contribution

$$P_{scat,proton,rest} = [(P_{s,rest} \sin(\theta_{recoil}) \cos(\phi_{recoil}))\hat{x}, (P_{s,rest} \sin(\theta_{recoil}) \sin(\phi_{recoil}))\hat{y}, (\sin(\phi_{recoil}))\hat{z}]$$

$$P_{scat,proton,vert} = P_{scat,proton,rest} \cdot Boost(BoostRest)$$

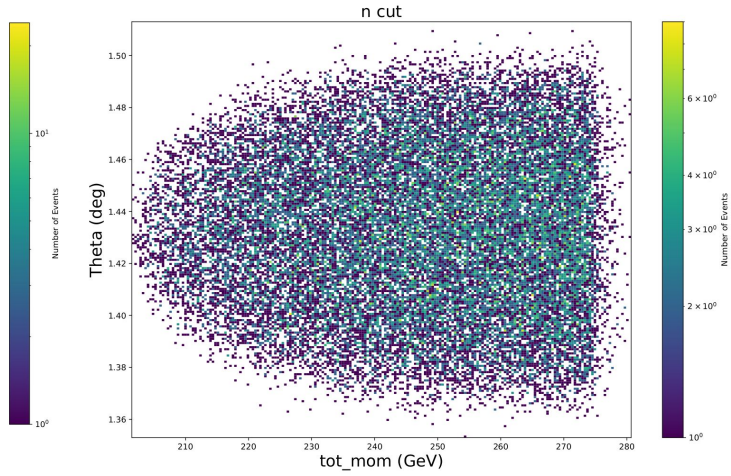
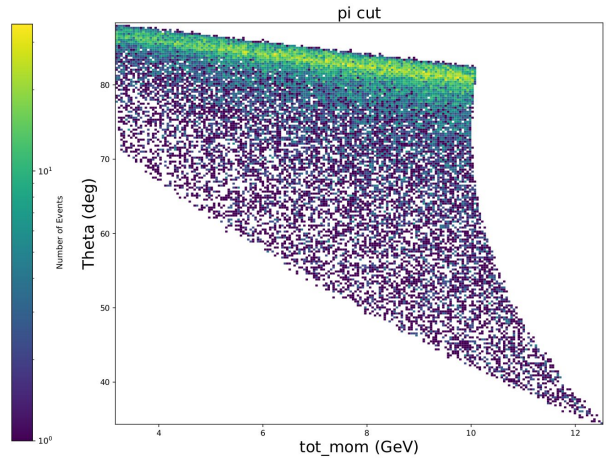
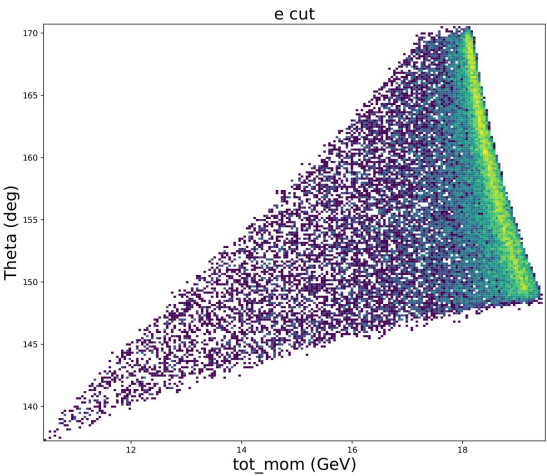
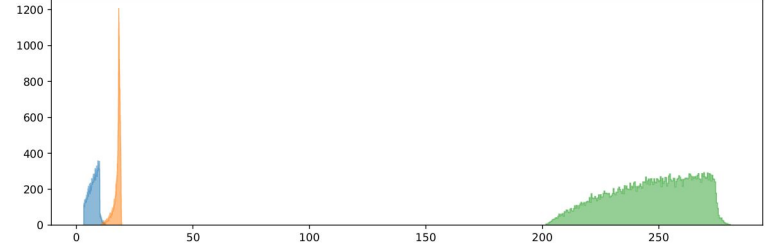
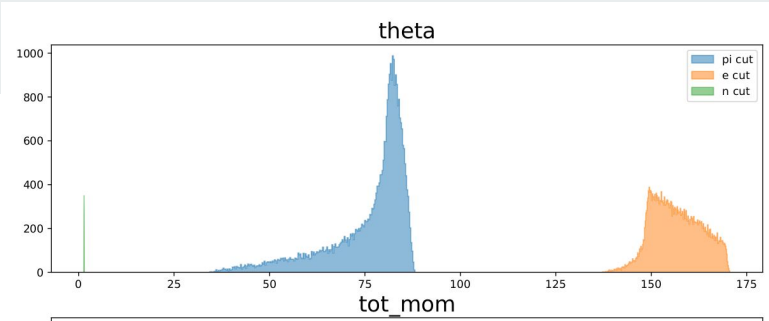
$$P_{scat,\pi,rest} = P_{inc,rest} - (P_{scat,proton,rest} + P_{X,rest})$$

$$P_{scat,\pi,vert} = P_{scat,\pi,rest} \cdot Boost(BoostRest)$$

# New pi/n samples

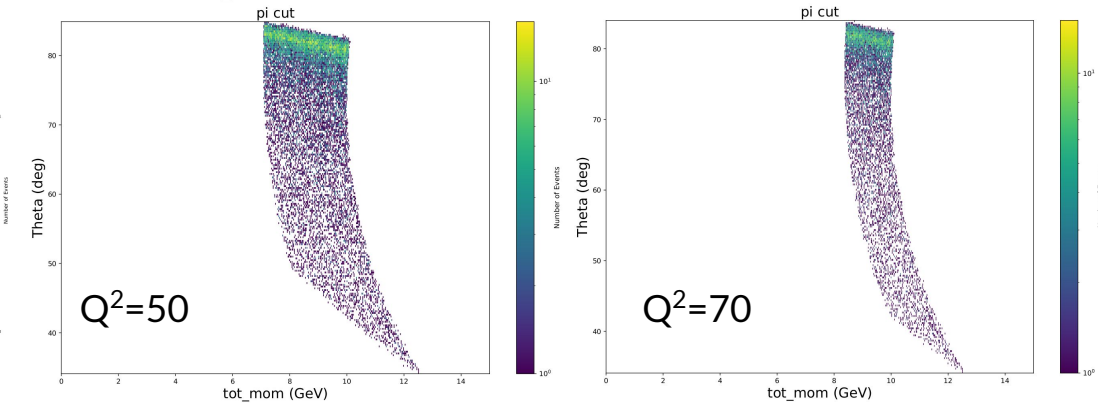
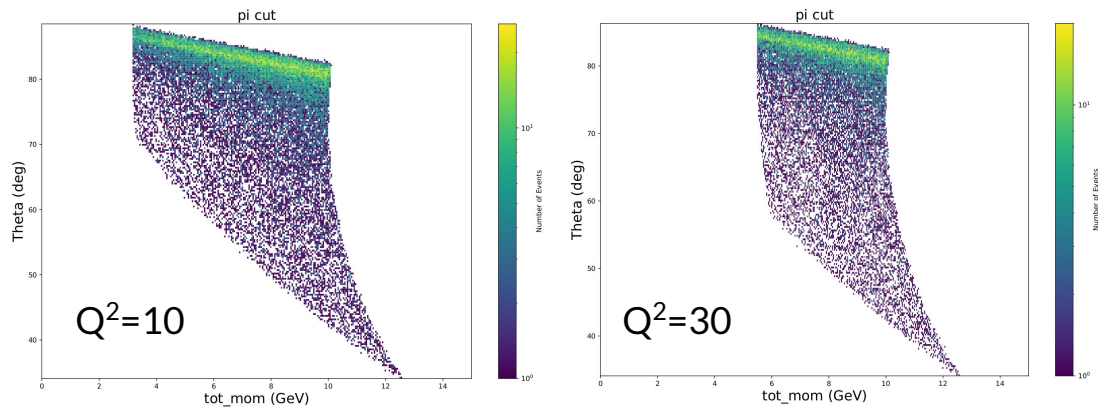
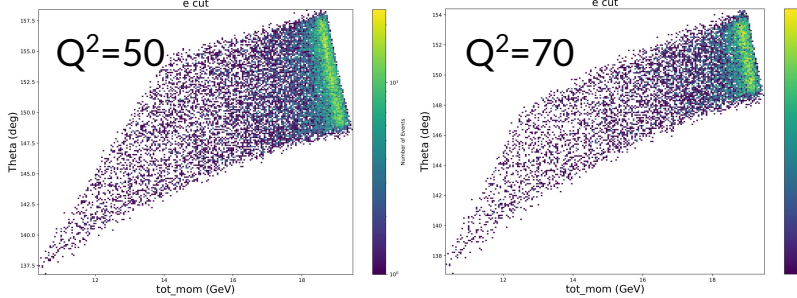
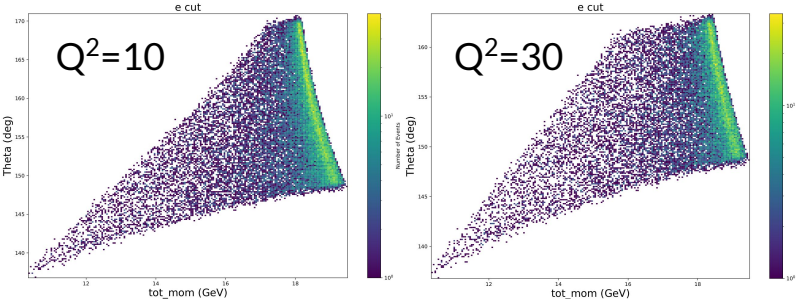


- Results look much more reasonable
- The results still require an **energy conservation cut**
- k/ $\Lambda$  samples look similar, just with fewer events



# $Q^2$ cuts

e cut



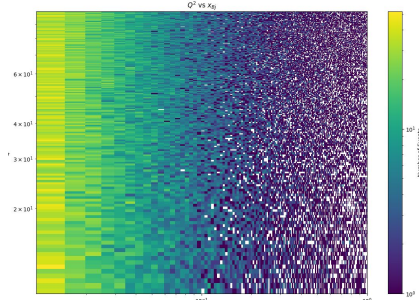
Electron

Pion

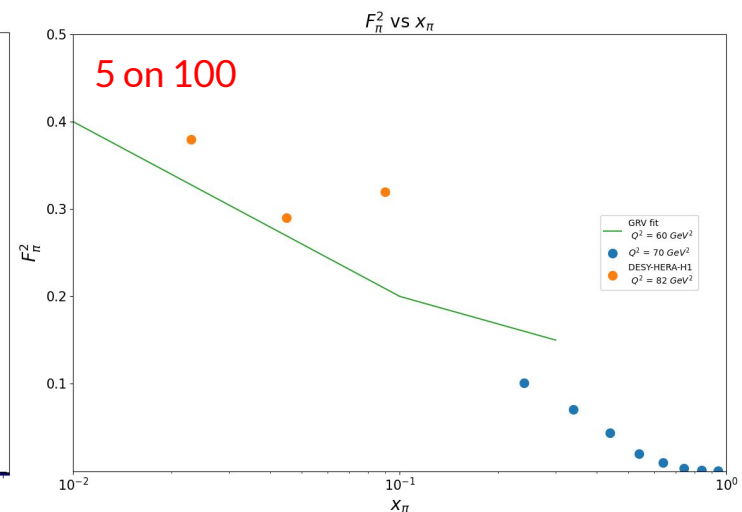
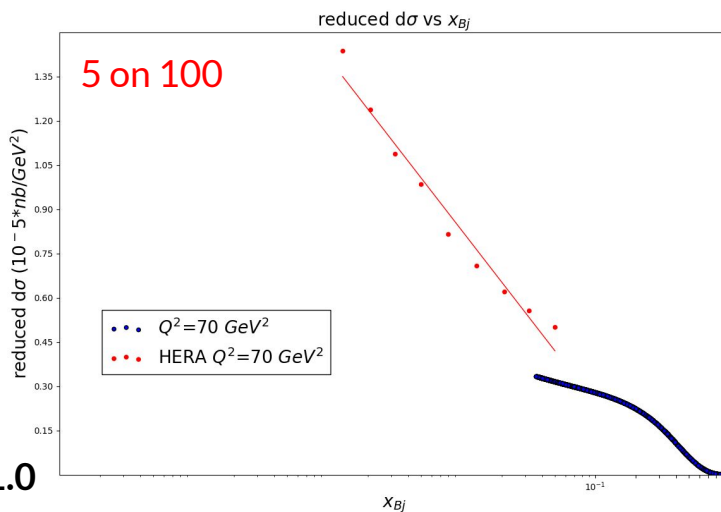
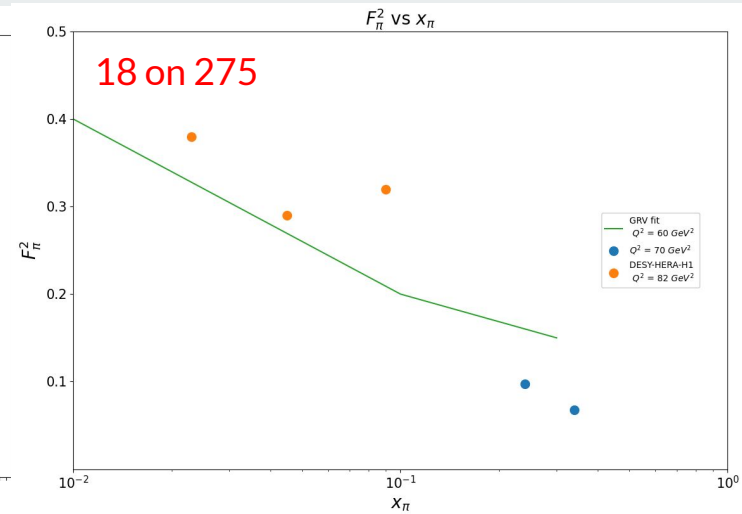
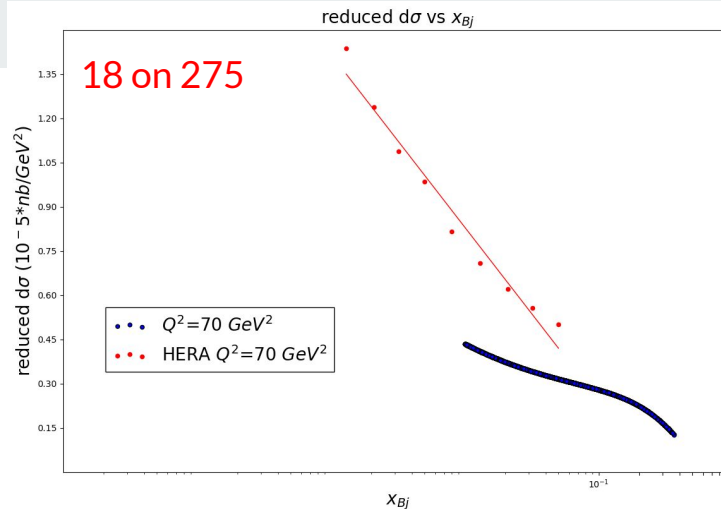
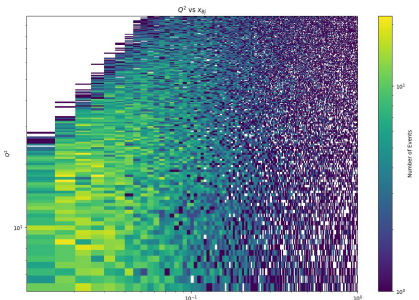
18 on 275  
VS  
5 on 100



18 on 275



5 on 100



\*Note:  $x_{Bj}$  range is 0.01 to 1.0



<b>Action Items</b>			
Method for distinguishing decay products	ON-GOING		
Analyzer plugin for physics variables (e.g. smearing)	TODO		
mesonMC for sigma final states	TODO		
Include additional pion SF models	TODO		
Impliment virtual detectors	ON-GOING		
Determine detection fractions	ON-GOING	->	Proton, <b>DONE</b> Neutron, <b>DONE</b> Lambda, <b>TODO</b>
Temple Meeting	<b>DONE</b>		

# Timeline to come



EPJA Publication	First Meson structure WG meeting	Current Meson Structure WG meeting	Second workshop at U of Pavia	Workshop on meson structure at EIC at CFNS/ SBU	<b>Status reports at EICUGM</b>	Third workshop at CUA	Week with pion and kaon structure focus	Fourth workshop at UCB/ LBL
July 19th, 2019	Jan. 27th, 2020	April 27th, 2020	May 22-24, 2020	June 1-5, 2020	<b>August 3-7, 2020</b>	Sep. 17-19, 2020	Oct. 5-9, 2020	Nov. 19-21, 2020