# EIC meson structure

## April 13th, 2020

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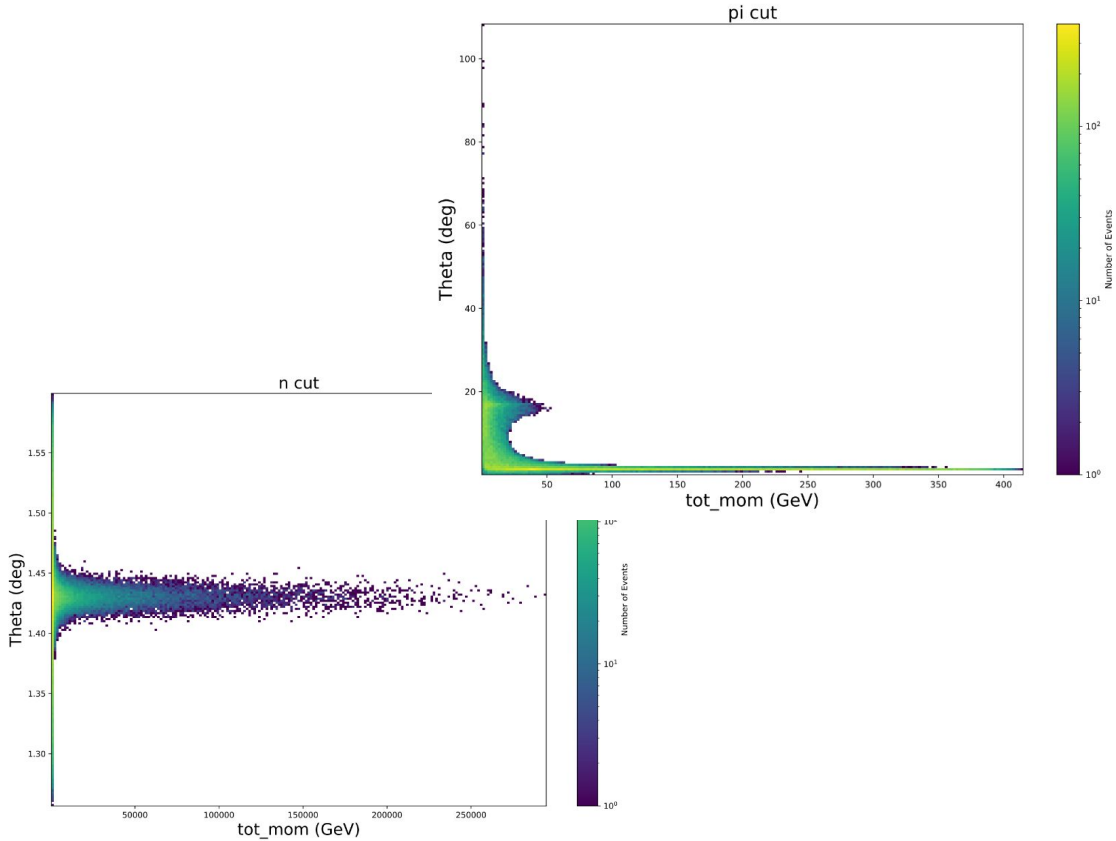
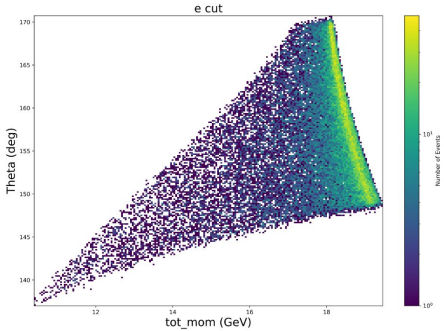
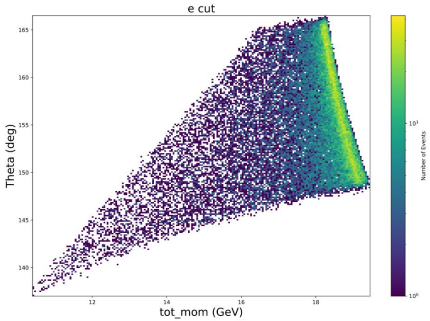
# Unphysical kinematics in MC output for many events

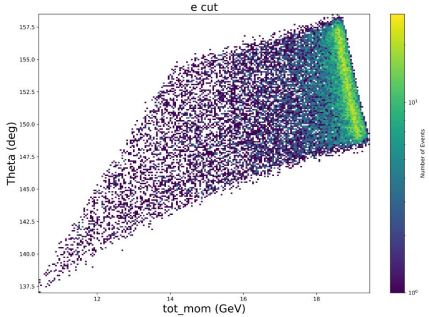
- An example from lund
  - #1 - electron, 18 GeV
  - #2 - proton, 275 GeV
  - #3 - electron, 16.9 GeV
  - #4 - kaon+, 423 GeV
  - #5 - lamba, 492 GeV
- Not all events, but many are like this

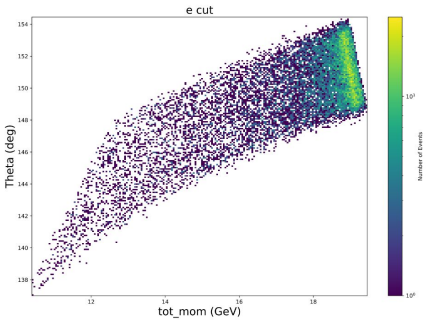


# $Q^2$ cuts

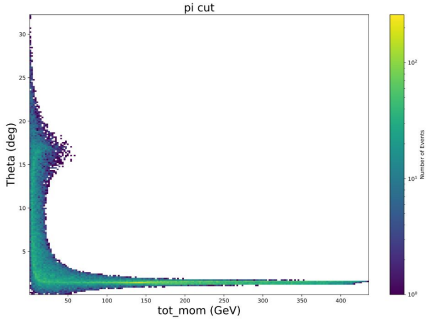


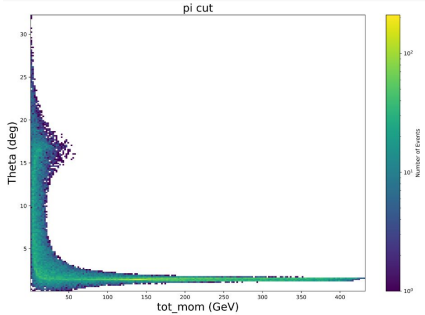



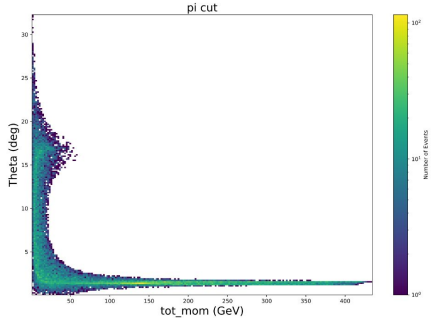

$Q^2$=10 GeV$^2$



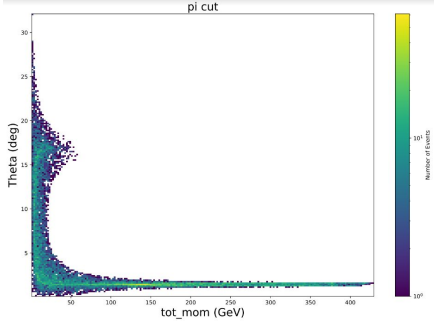

$Q^2$=20 GeV$^2$




$Q^2$=50 GeV$^2$

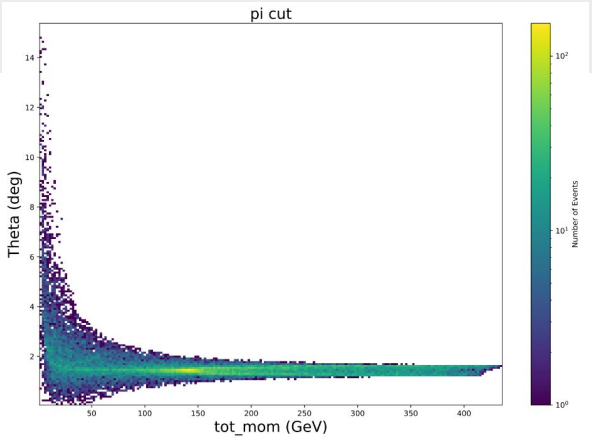


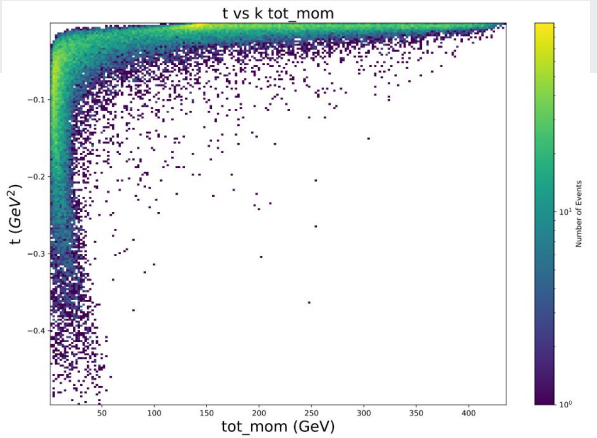

$Q^2$=70 GeV$^2$

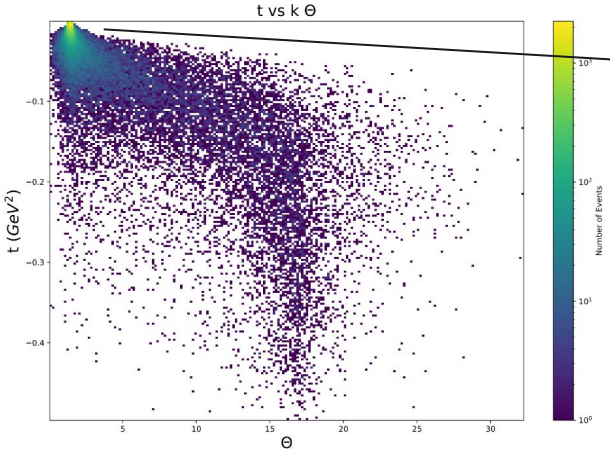


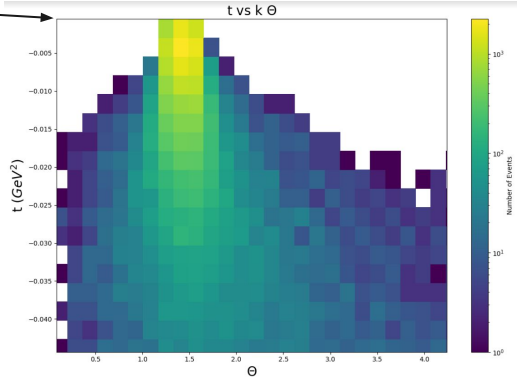
# t cuts

- These high momentum events are all at low angles (i.e. very forward)
- So I did a tcut (0,0.05) to see if I could isolate the events



# t definition

- I decided to check how t was defined to try and track down the source
- I investigated P_{spec,vertex} further as P_{inc,ver} and the masses were fine

$$tPrime = 2(P_{spec,vert} \cdot P_{inc,vert}) - M_{ion}^2$$

$$tSpec = M_{ion}^2 + M_{spec}^2 - 2(P_{spec,vert} \cdot P_{inc,vert})$$

# Defining the scattered proton

- From investigating P_{spec,vertex} I found the source of the issue and it was with how the scattered proton is defined

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

$$P_{p2} = \sqrt{(Pz_p2)^2 + (p2_pt)} \quad \phi_{p2} = ran(360 * D2R) \quad \theta_{p2} = arccos(\frac{Pz_{p2}}{P_{p2}}) \quad p2_{pt} = 0.005 * PBeam$$

$$Pz_{p2} = \frac{-TDIS_{znq}(q_{virt,rest}\hat{z}) + \sqrt{(TDIS_{znq}q_{virt,rest}\hat{z})^2 + Q^2(E_{virt,rest})^2(M_p^2 + p2_{pz}) - Q^2(TDIS_{znq})^2}}{Q^2}$$

$$TDIS_{nzq} = p2_{pt}(P_{spec,rest,new} \cdot q_{virt,rest})$$

# Redefining the scattered proton

- I couldn't find a reference to any of these variables so I played around with them
- I set this as a constant and placed an energy conservation cut (Ecut < PBeam)
- After playing around I redefined the P_{scat,rest} in terms of its transverse and longitudinal components

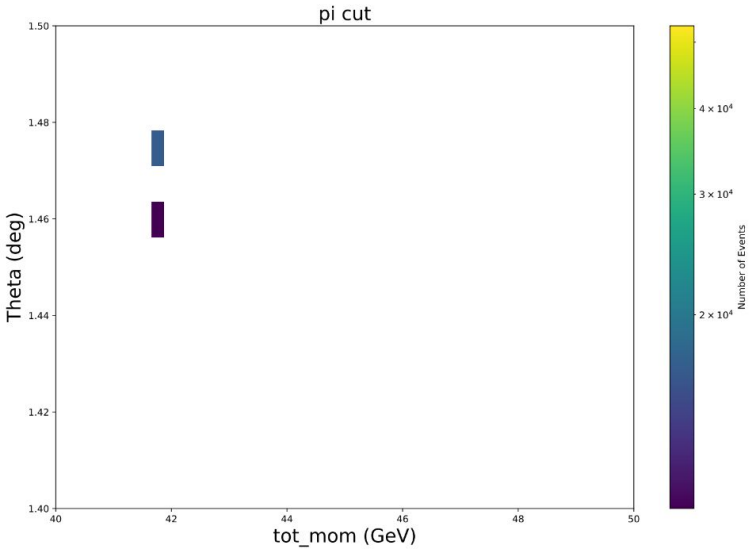
$$P_{scat,rest} = [(P_{p2}sin(\theta_{p2})cos(\phi_{p2}))\hat{x}, (P_{p2}sin(\theta_{p2})sin(\phi_{p2}))\hat{y}, (P_{p2}cos(\theta_{p2}))\hat{z}]$$

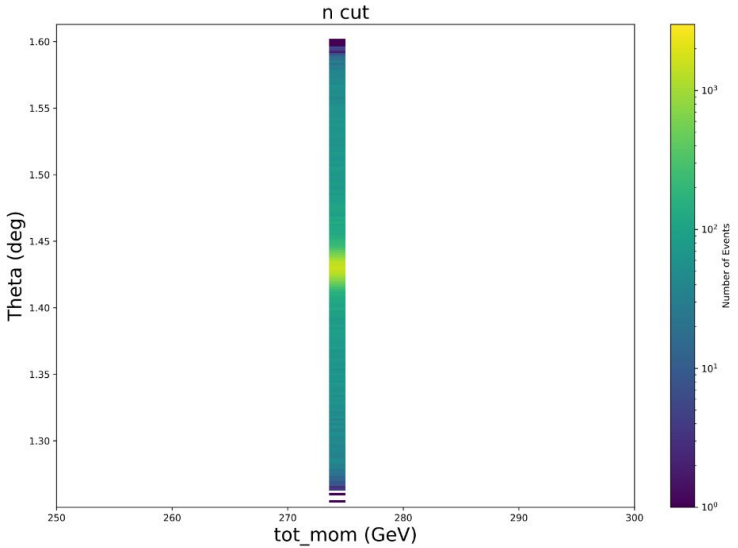
$$P_{scat,rest} = [(Px_{p2}sin(\theta_{p2}))\hat{x}, (Py_{p2}sin(\theta_{p2}))\hat{y}, (Pz_{p2}cos(\theta_{p2}))\hat{z}]$$

$$Px_{p2} = p2_{pt}cos(\phi_{p2}) \qquad Py_{p2} = p2_{pt}sin(\phi_{p2})$$

# Redefining the scattered proton

- This new definition (with the Ecut) has given us final state momenta that make sense for the neutron and pion!
- Although the distributions are incorrect, which is just a result of this band aid fix



| ***Action Items*** | |
|---|---|
| Method for distiguishing 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 |
| Temple Meeting | DONE |

-> Proton, DONE
Neutron, DONE
Lambda, TODO

# Timeline to come

| EPJA Publication | First Meson structure WG meeting | Meson structure WG meeting | Meson structure WG meeting | Next Meson structure WG meeting | Meson Structure WG meeting | Second workshop at U of Pavia | Workshop on meson structure at EIC at CFNS/ SBU | **Status reports at EICUGM** | Third workshop at CUA | Week with pion and kaon structure focus | Fourth workshop at UCB/ LBL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| July 19th, 2019 | Jan. 27th, 2020 | Feb. 25th, 2020 | March 16th, 2020 | March 30th, 2020 | April 13th, 2020 | May 22-24, 2020 | June 1-5, 2020 | **August 3-7, 2020** | Sep. 17-19, 2020 | Oct. 5-9, 2020 | Nov. 19-21, 2020 |