DVCS ^{4}He Quick Intro/Recap

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DVCS of ^{4}He

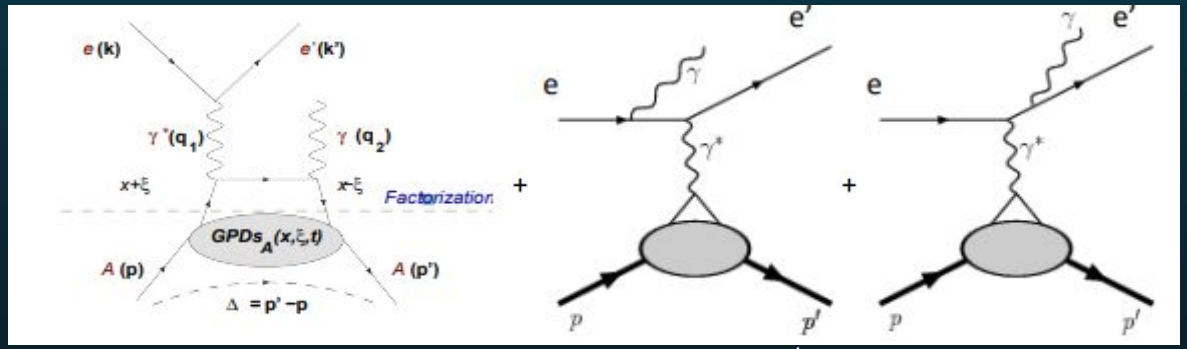
- Process which can give understanding of EMC effect, and tomographic view of nucleons.
- Pure DVCS reaction illustrated by ‘Handbag Mechanism’.
- At leading twist order full picture DVCS + Bethe-Heitler:

$Q^2 = -q^2 = -(k'- k)^2$, the virtuality of γ^*

$x_B = Q^2/2M\nu$

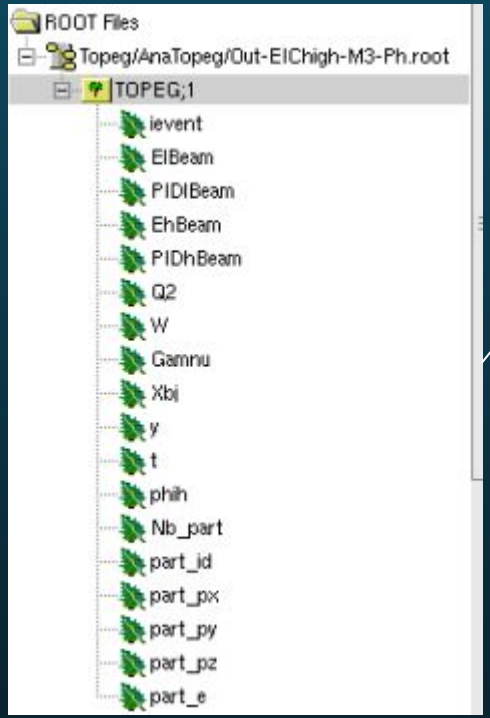
$t = -\Delta = -(p-p')^2$

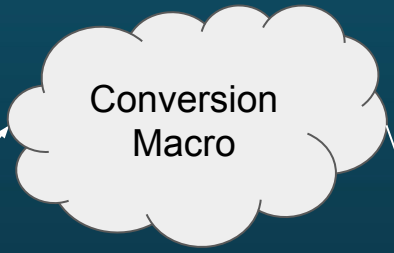
ϕ_h = angle between leptonic and hadronic scattering planes.

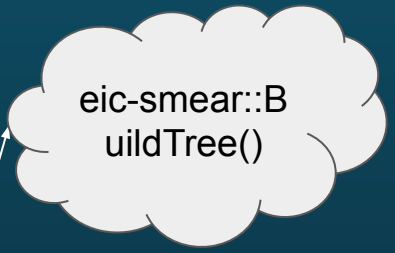


Handbag approximation of coherent DVCS of ^{4}He
https://arxiv.org/pdf/1910.07458.pdf

The Orsay Perugia Event Generator (TOPEG)



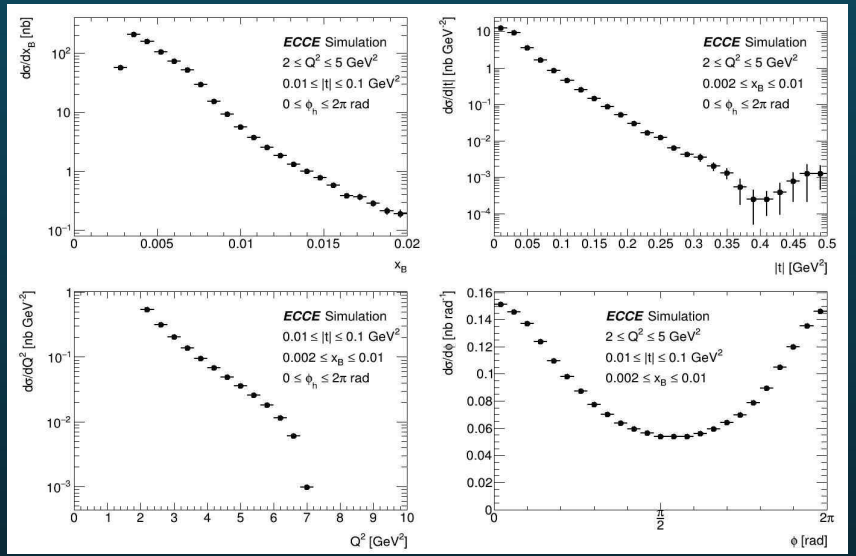




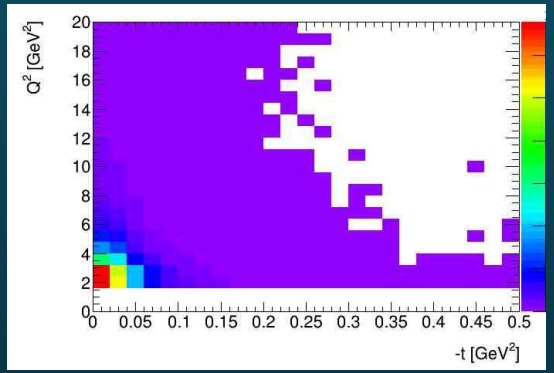

```
SIMPLE Event FILE
=========================================
I, ievent, nParticles
=========================================
I  K(I,1)  K(I,2)  K(I,3)  K(I,4)  K(I,5)  P(I,1)  P(I,2)  P(I,3)  P(I,4)  P(I,5)  V(I,1)  V(I,2)  V(I,3)
=========================================
0       0       3
=========================================
1    21           11     0     3     4           0           0         -18          18      0.000511     0     0     0
2    21   1000020040     0     6     6           0           0     109.937         110      3.72743     0     0     0
3    21           22     1     0     0   -0.800566   -0.802341   -15.3117     15.0826      -2.8723     0     0     0
4     1           11     1     0     0    0.800566    0.802341   -2.68827     2.91744     0.000511     0     0     0
5     1           22     1     0     0   -0.815832    -1.07251   -15.1671     15.2268            0     0     0     0
6     1   1000020040     2     0     0   0.0152656    0.270171    109.792     109.856      3.72752     0     0     0
============== Event finished ==============
```

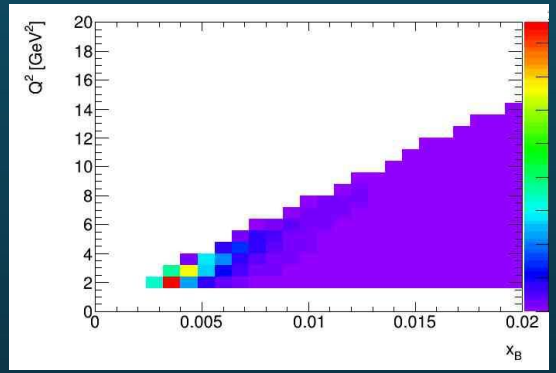
Where are we?

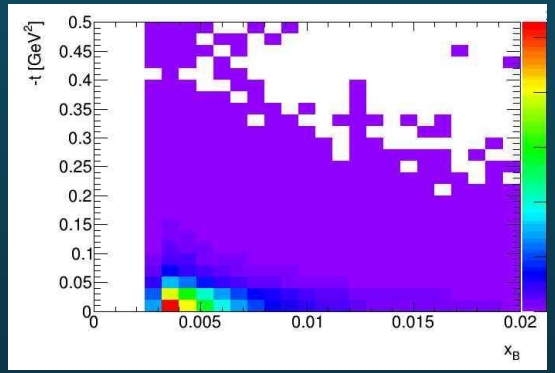
- 5x41/u setting studied for ECCE proposal (prop 4 high divergence)
- Dummy “high acceptance” files studied before exclusive paper
- No background study yet, uncertainties are statistical + 1% smearing
- Apparent improvement in acceptance ~7% -> ~59%

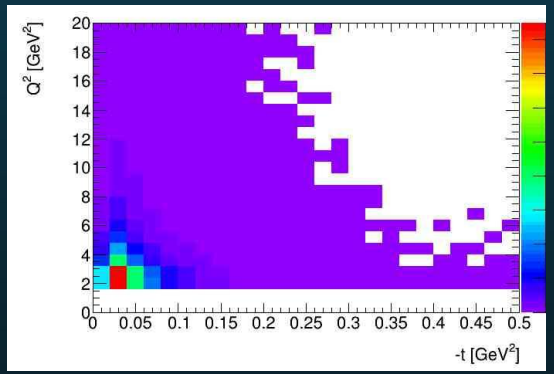


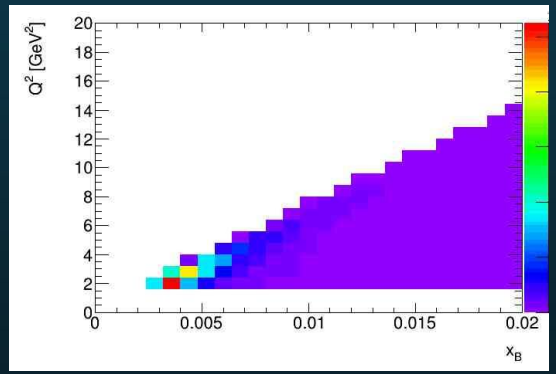
2D Phase Space Coverage (Gen / Reconstructed)

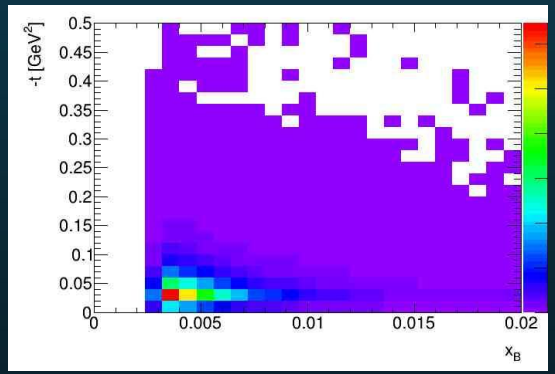












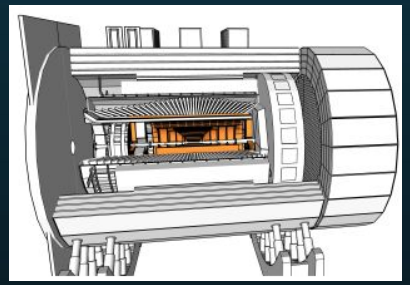
Electron Selection: Internal Tracker

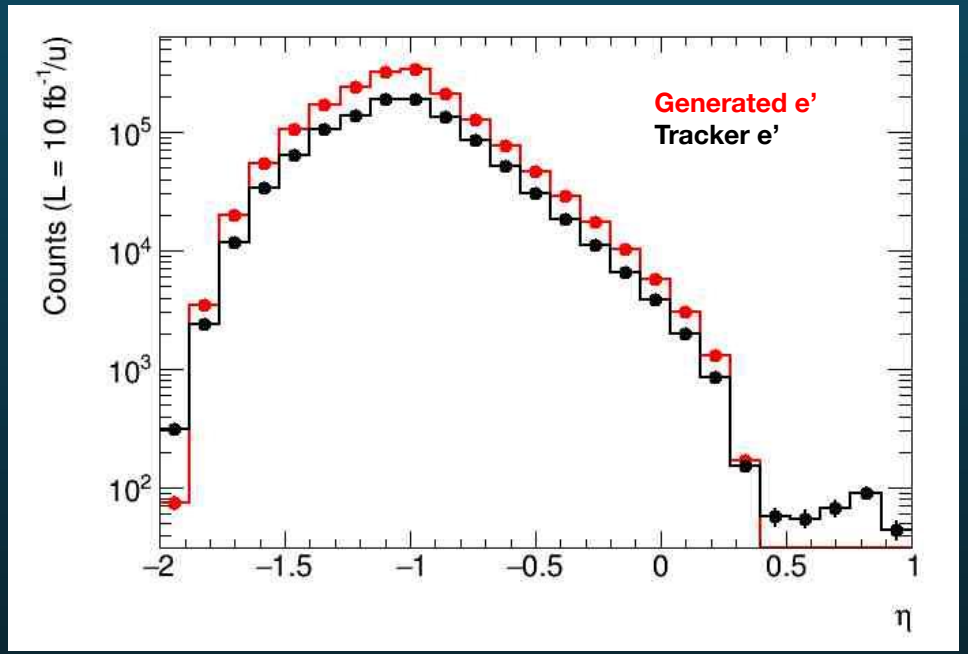
F4A outputs ‘containers’ (c++ classes containing objects that represent hits in each detector, and variables, momentum energy etc).

Truth Container includes all info input to simulation before detector effects.

To select electron we choose number of tracks in internal Si tracker == 1.

Resulting acceptance 883608 / 1M = 88.3%



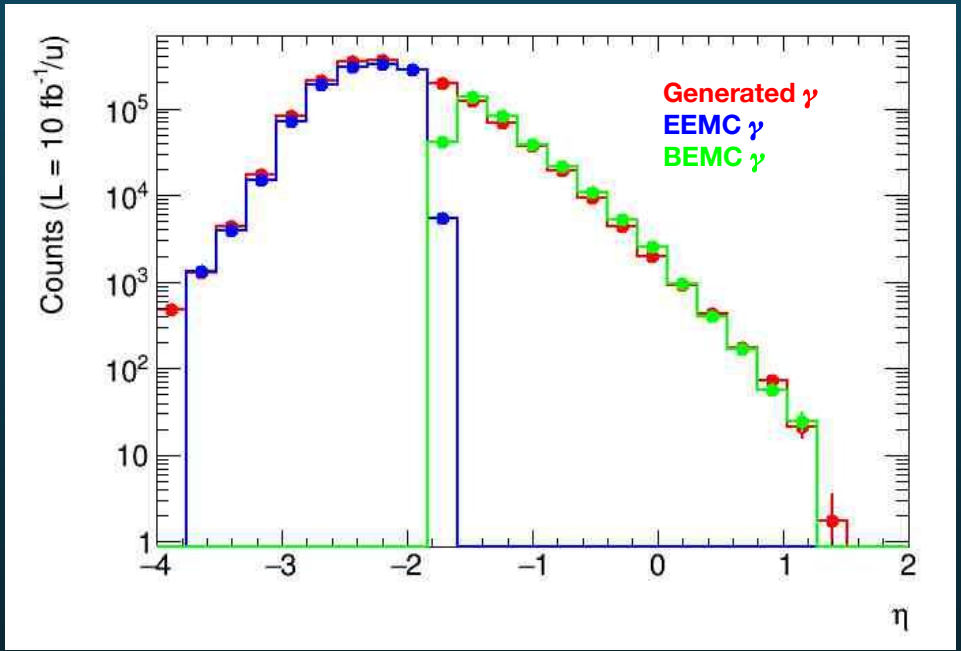


Photon Selection: Calorimeters

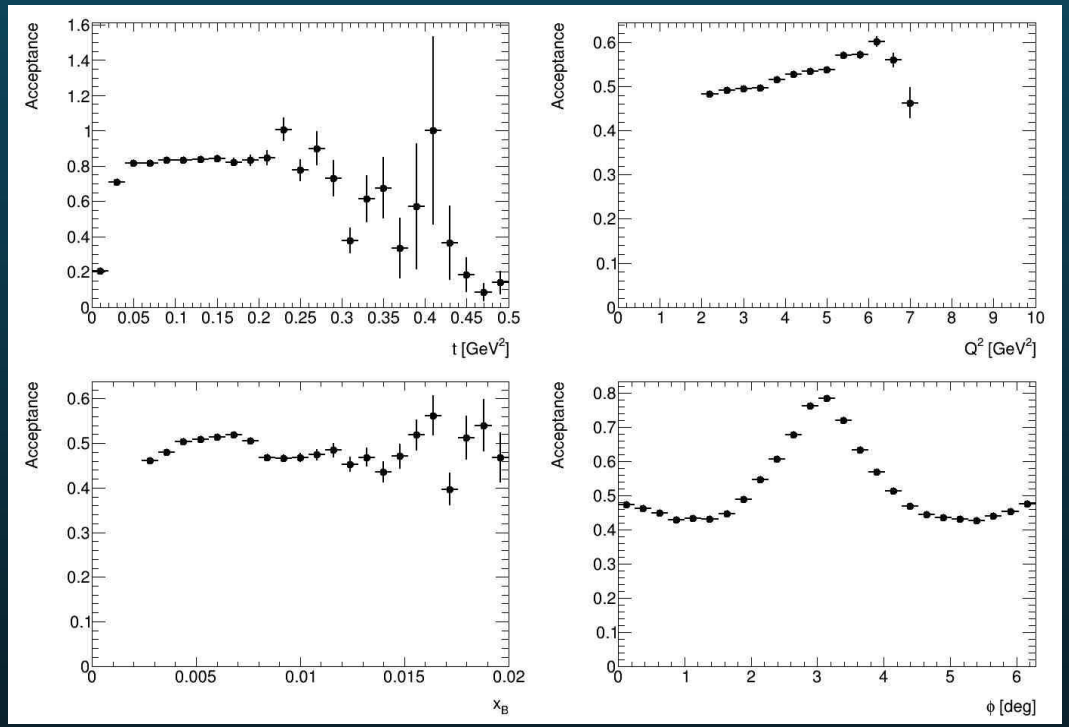
nElectronTracks == 1
&&
nCalorimeterHits > 0
&&
Calorimeter photon with max energy per event per cluster: Pmax
&&
Pmax > 250 MeV

EEMC (blue): 668757
BEMC (green): 192606
-> 861363/ 10^6 = 86.1%

Currently all photon hits detected in EEMC or BEMC.



Detector Acceptance for Physics Quantities (5x41/u)



ECCE

$2.0 \leq Q^2 \leq 5.0$ GeV^2

$0.002 \leq x_B \leq 0.01$

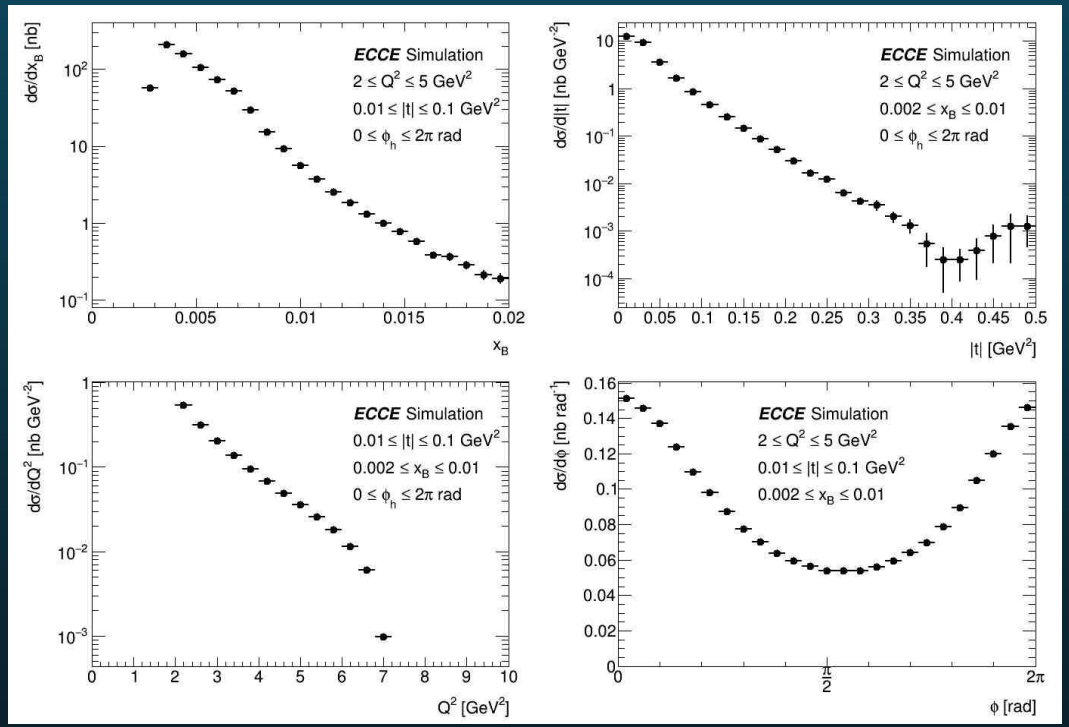
$0.01 \leq -t \leq 0.1$ GeV^2

$0 \leq \phi \leq 2\pi$

σ = 0.71 nb

(MC Integral)

Differential Cross Section Measurements (5x41/u)



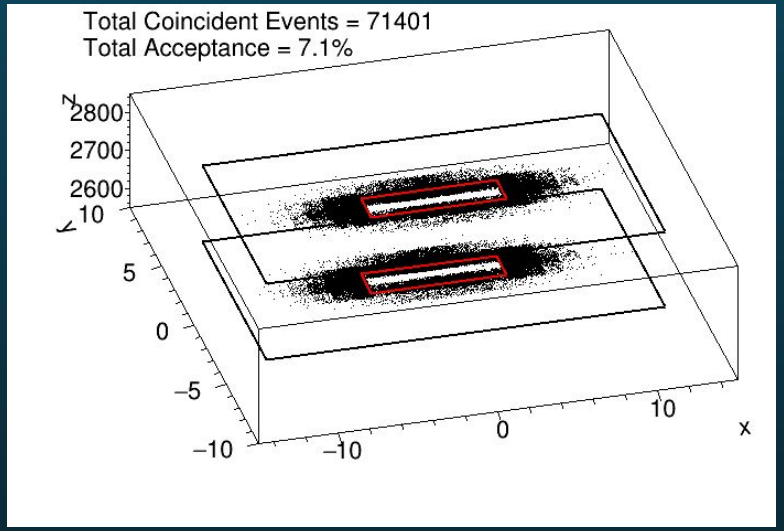
$$\frac{d^4\sigma}{dQ^2 dx_B dt d\phi} = \frac{1}{L\Delta\Omega}(N \pm \sqrt{N})$$

- N is the number of counts in the bin
- L is the integrated luminosity
- $\Delta\Omega$ is the multi-dimensional bin size:

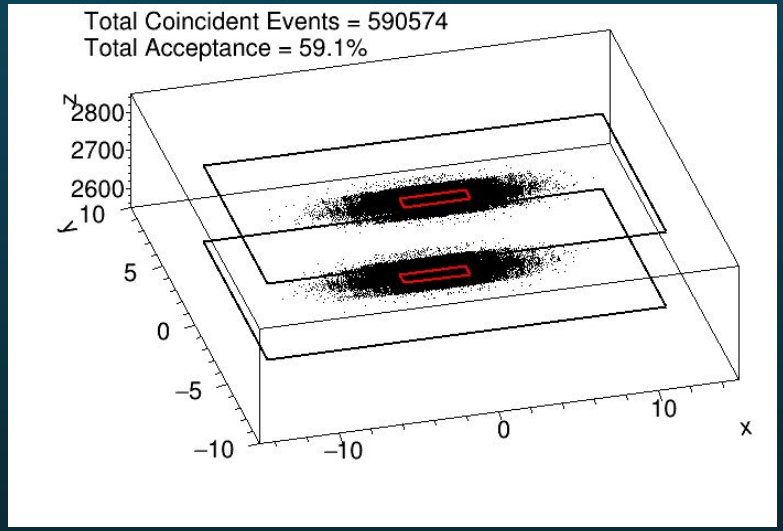
$$\Delta\Omega - \Delta Q^2 \Delta x_B \Delta t \Delta\phi$$

Beam Parameterisations - RP Occupancy

High Divergence



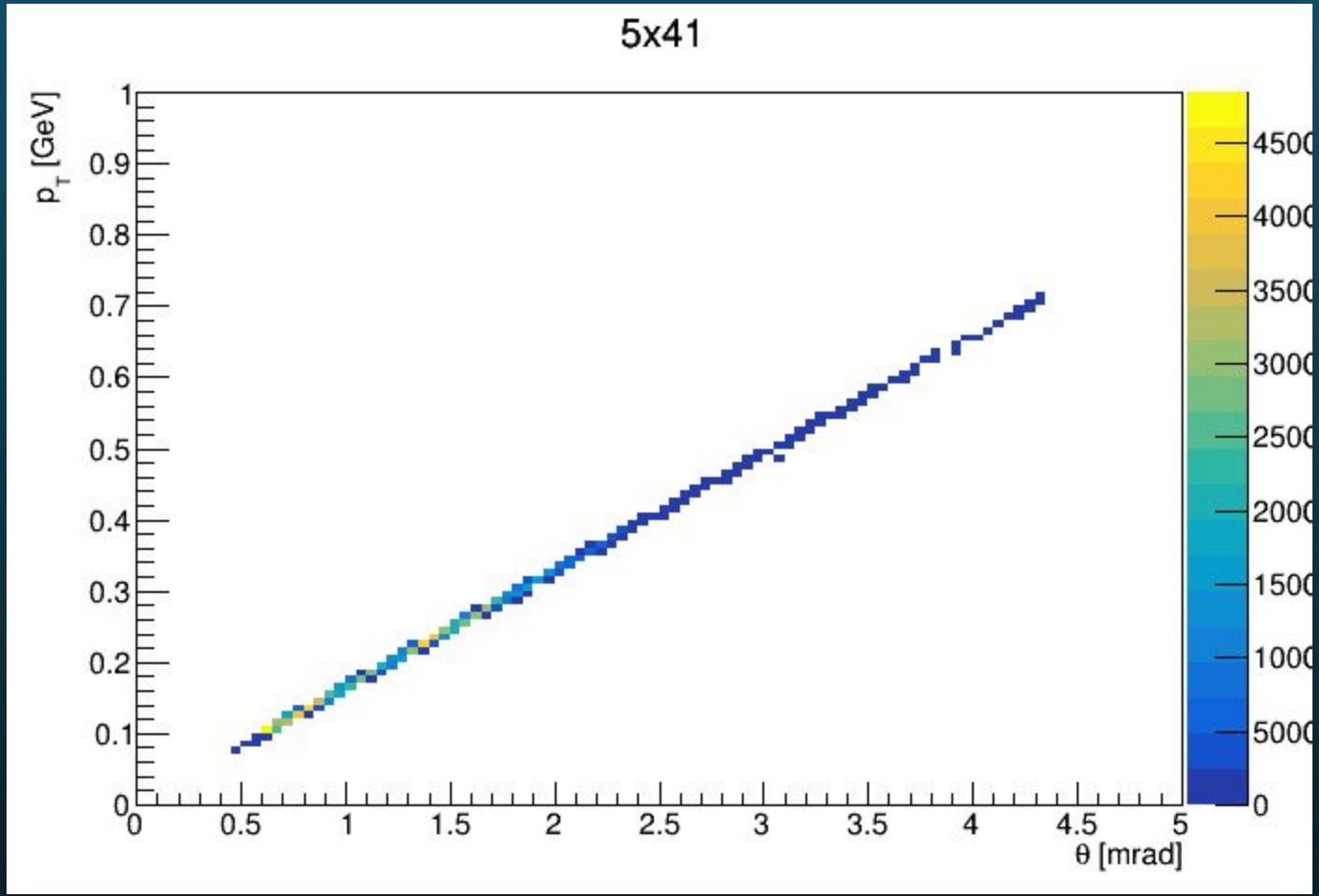
High Acceptance

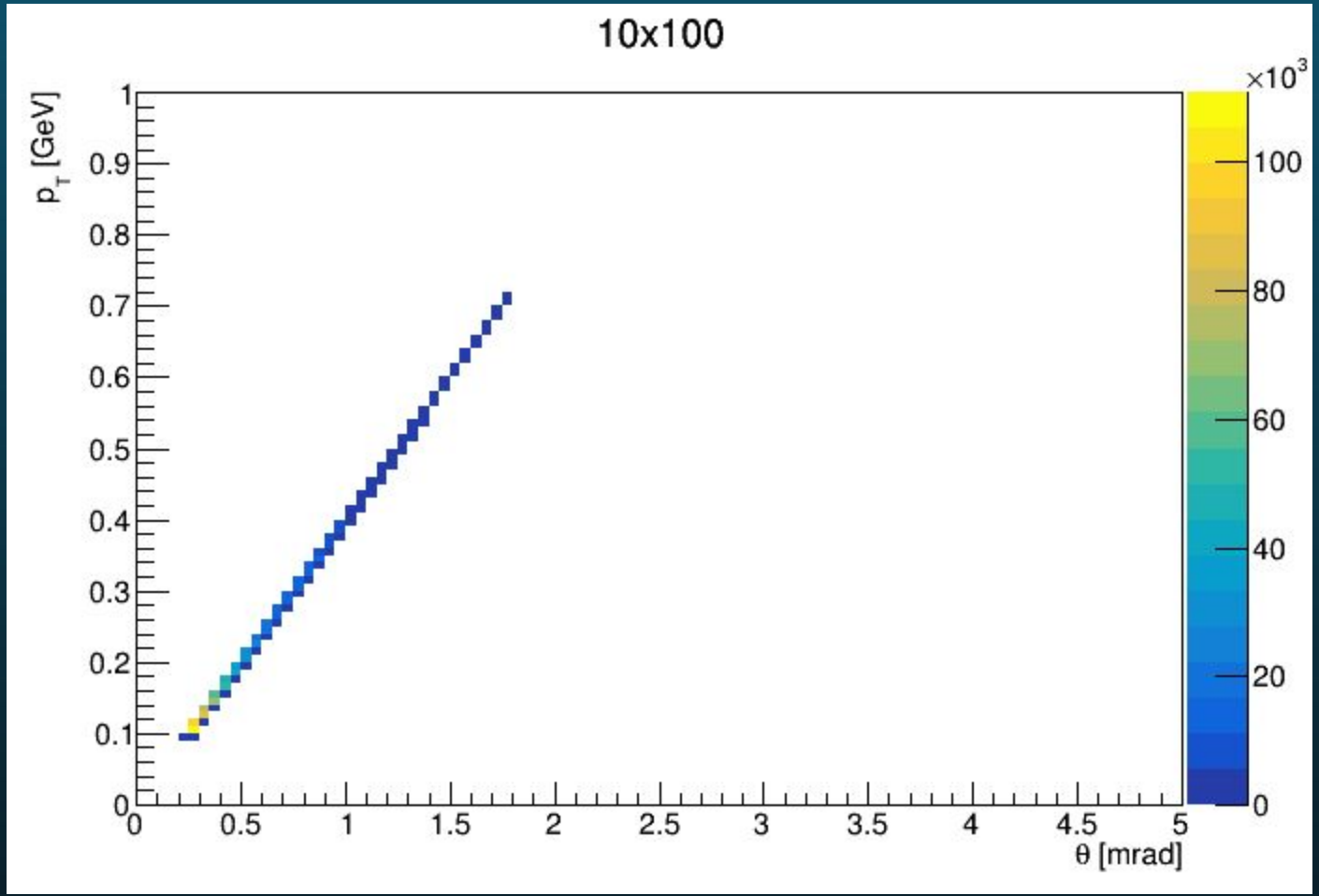


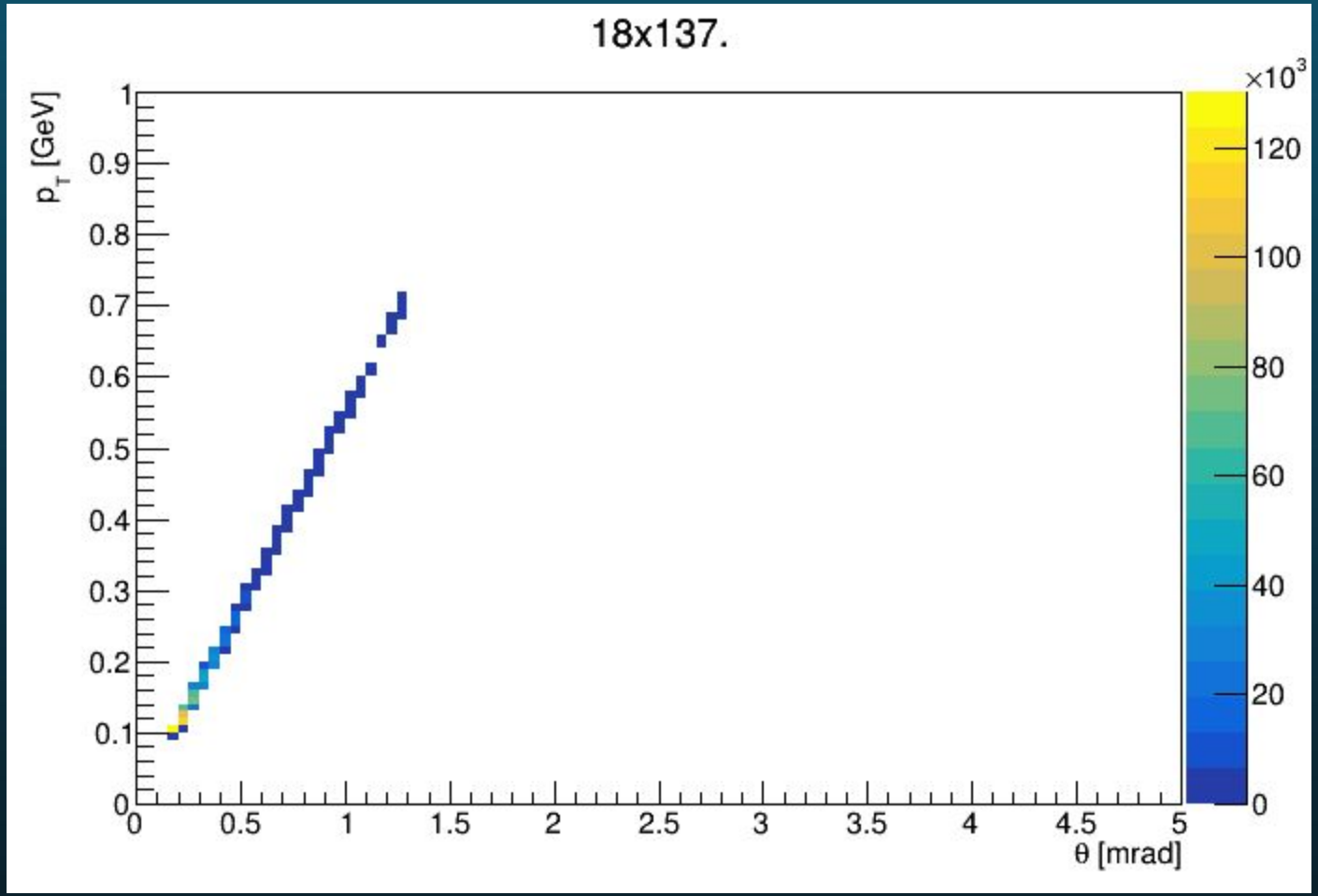
Understand That This is Wrong!

So what do we need?

- Proper parameterisation of ^{4}He at 41GeV/u as well as at medium and high machine settings. (Currently I think 100 and 137 GeV/u are appropriate)
- Need beta functions
- First step to look at $\boldsymbol{p}_{T}$ vs θ


5x41
p_T [GeV]
θ [mrad]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
4500
4000
3500
3000
2500
2000
1500
1000
5000
0


10x100
p_T [GeV]
θ [mrad]
×10^3
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
20
40
60
80
100


18x137.
p_T [GeV]
θ [mrad]
×10^3
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
20
40
60
80
100
120

October Simulation Campaign (Next Steps)

MC Files ready for FF / Machine WGs + any other studies

Attend software trainings

Process for new Software structure similar (Lund -> HepMC3)

Continue to check relevant physics plots at each simulation stage

Background studies