SIDIS Simulations – Phase space and MC generation limits

Florian Hauenstein

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Simulation parameter

- ^{12}C with E_e = 10 GeV and E_A = 600 GeV
- 1 Million events for each region ($Q^2 \leqslant 10$ and $p_t \leqslant 1$ GeV/c) -> total 4M events
- LO PDF sets and s-, sbar-, gluon-pdf = 0
- Event generation within:
  - 0.5 GeV/c < $p_e' < E_e$*3 GeV/c
  - 0 GeV/c < p_h < 10 GeV/c
  - $0^\circ < \theta_e < 140^\circ$ but generation itself in cos(θ)
  - $0^\circ < \theta_h < 180^\circ$ but generation itself in cos(θ)
  - $0^\circ < \phi_{e/h} < 360^\circ$
- Cuts in event generation:
  - 0 < x < 1
  - $Q^2 > 1$
  - W > 2

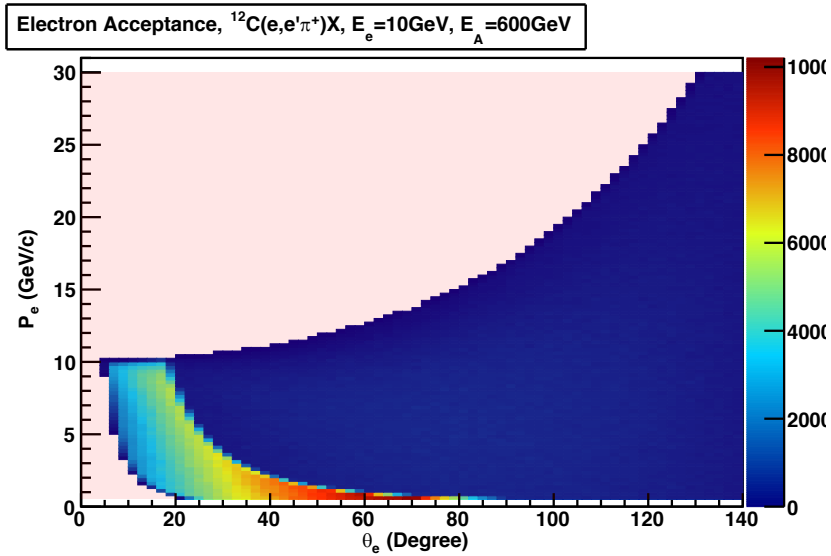
MC: Generated to Accepted Ratio

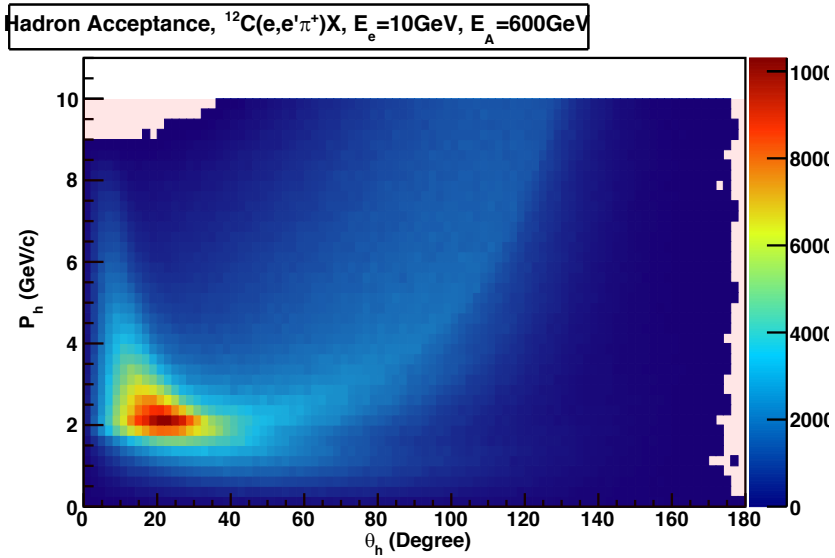
- Slow generation of the events in interesting region $Q^2 < 10$ and $p_t < 1$ GeV/c
- A lot of misses, for 10,000 events accepted around 25M generated (factor 2500!!!)

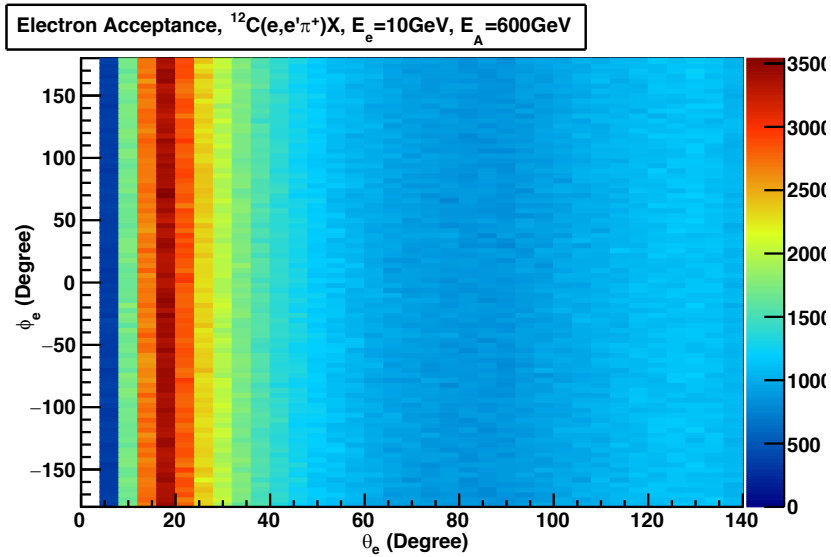
- For $Q^2 < 10$ and $p_t > 1$ GeV/c, around 860k generated (quite efficient)
- For $Q^2 > 10$ and $p_t < 1$ GeV/c, around 2M generated
- For $Q^2 > 10$ and $p_t > 1$ GeV/c, around 40k generated (efficient)

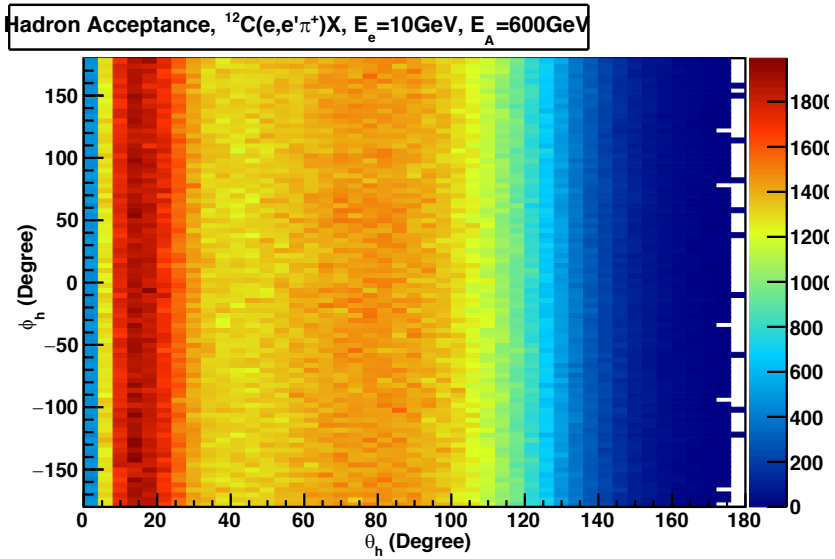
-> Check of Phase Space coverage of interesting region

Full phase space (lab values, no weight)



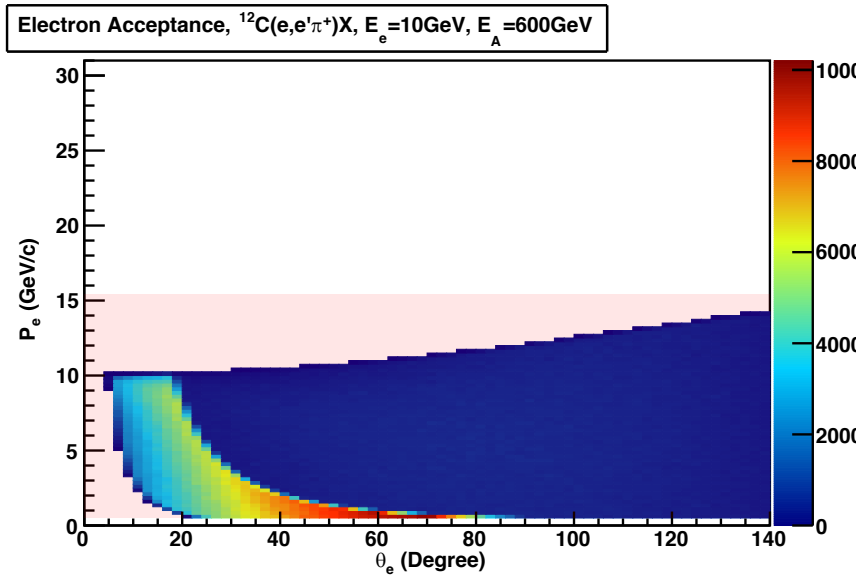


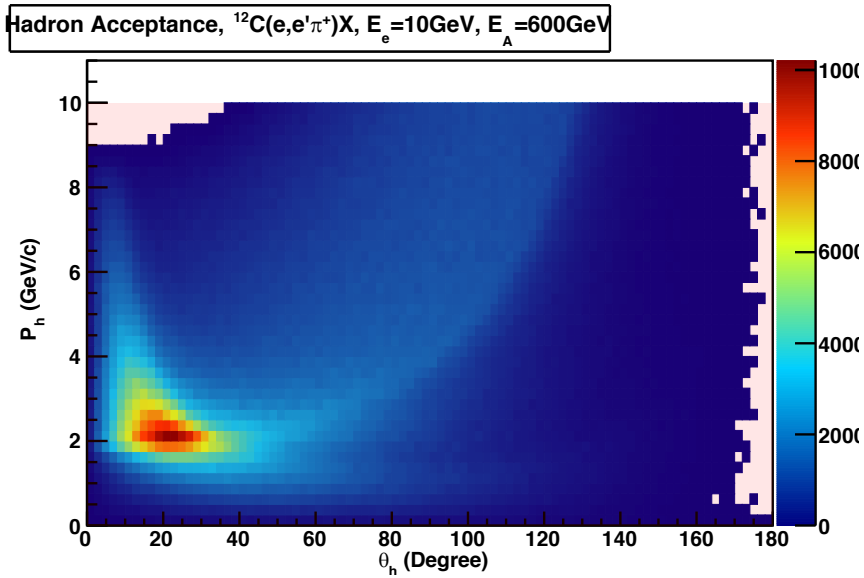




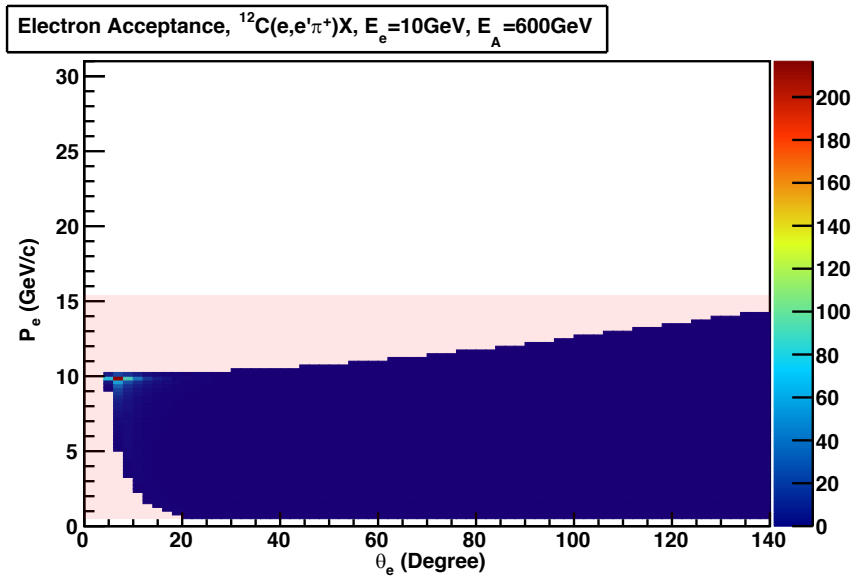
no x_B cut
no weighting
only positive hadrons

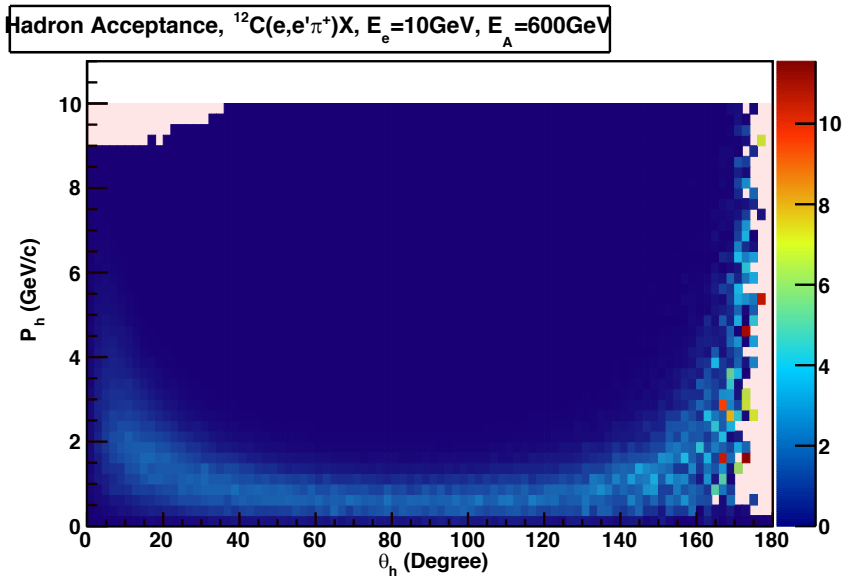
Full phase space (lab values, wide x_B-cut)





$0 < x_B < 0.3$
no weighting
only positive hadrons

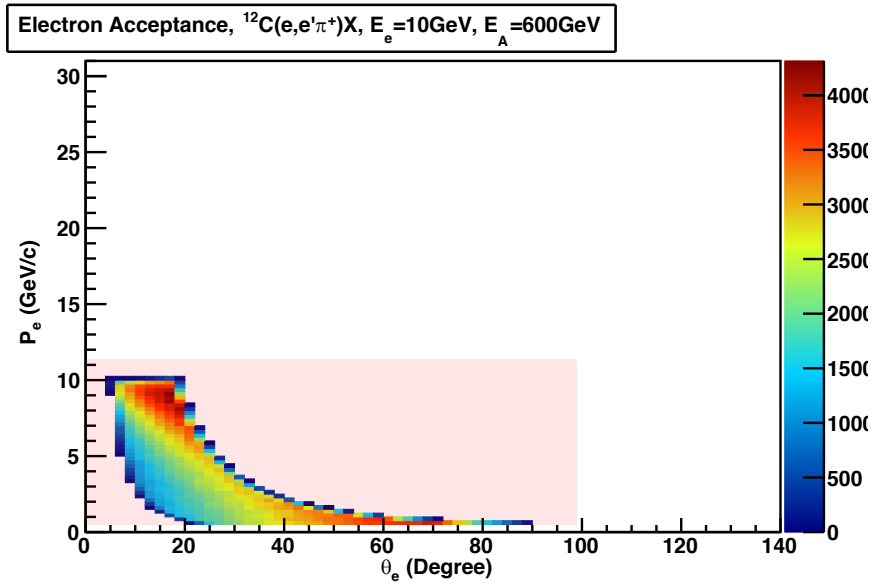


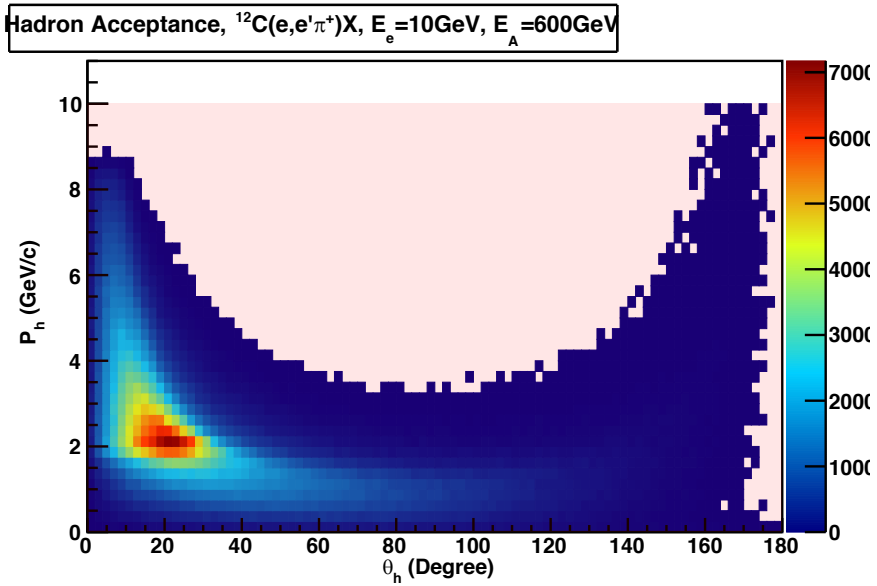


$0 < x_B < 0.3$
weighting
only positive hadrons

negative hadrons look the same

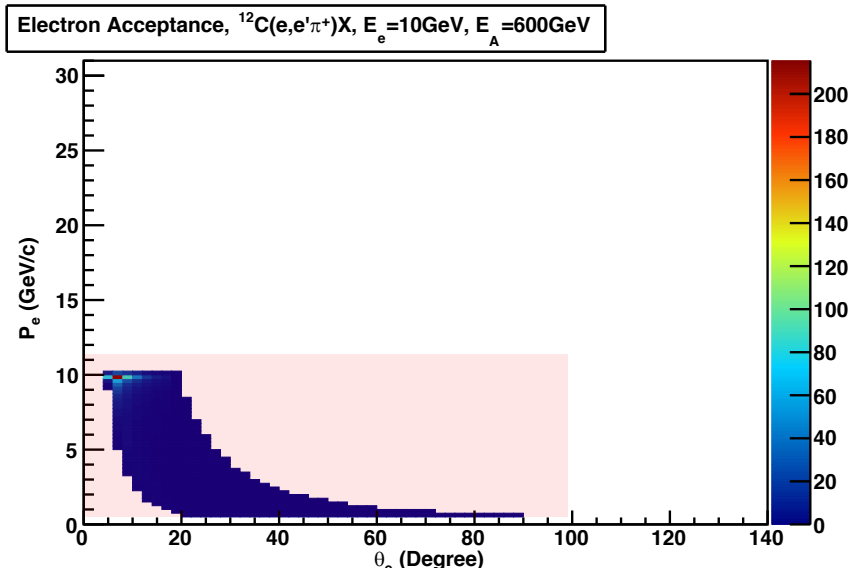
$Q^2 < 10$ and $p_t < 1$ GeV/c (lab values, wide x_B cut)

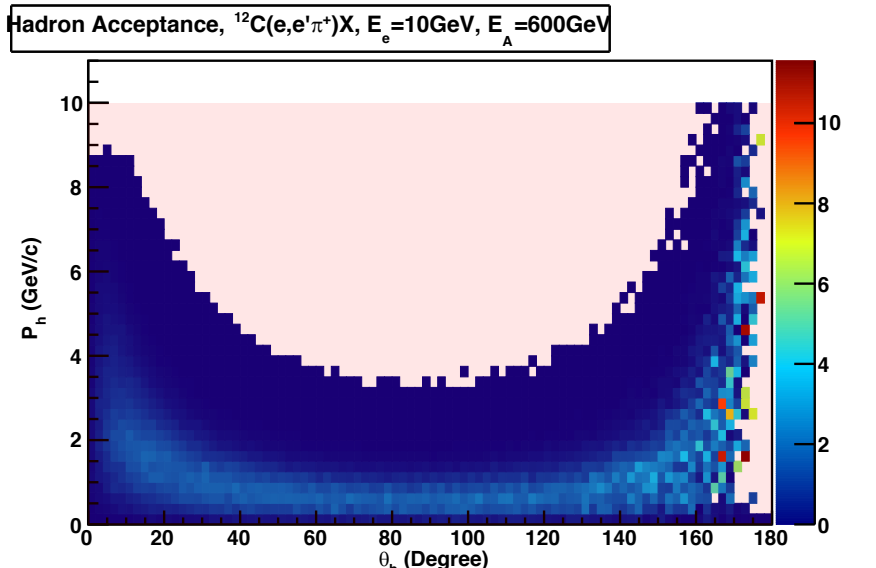




$0 < x_B < 0.3$
no weighting
only positive hadrons

Red Box: First or
Last Bin with content > 0
+/- 5*binwidth per axis
(if within generation limits)





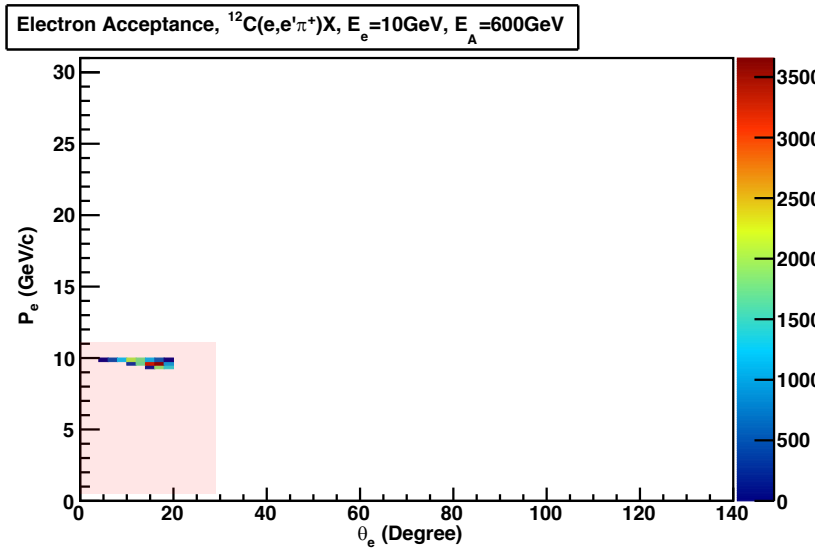
$0 < x_B < 0.3$
weighting
only positive hadrons

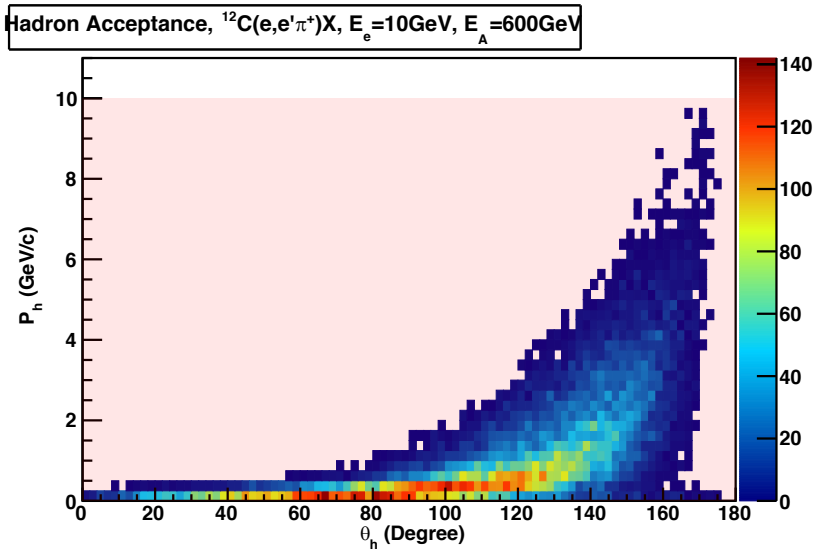
negative hadrons look the same as well as deuteron and hydrogen

Updated MC Generation Limits

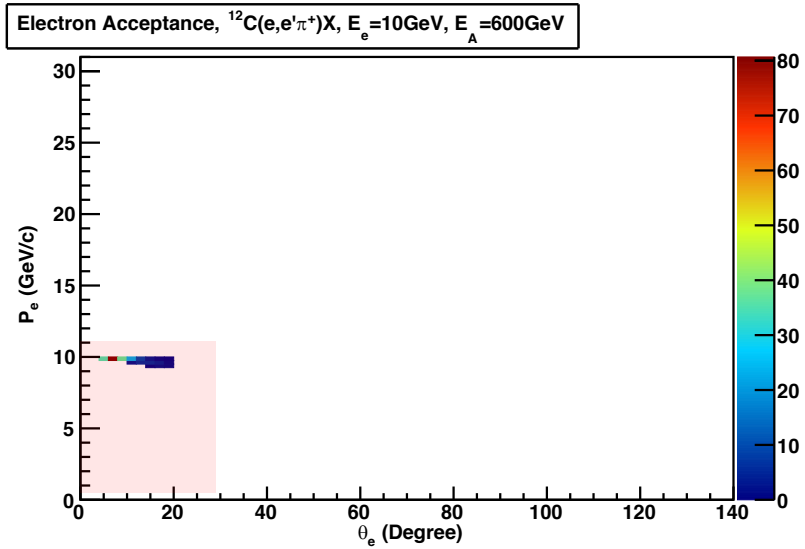
- Simulation with electrons limits
  - 0.5 GeV/c < p_e' < 11 GeV/c
  - $0^\circ < \theta_e < 95^\circ$ but generation itself in cos(θ)
  - Rest not changed
- Phase space area about factor 4.5 smaller to previous one
- Now 5.5M events generated for 10,000 events accepted -> expected decrease by 4.5 (previous value was 25M)
- Note: For all the considerations I assumed fix beam energies (electron and per nucleon)
- Can we optimize more?
  - More realistic x cut
  - Q^2 and z dependence

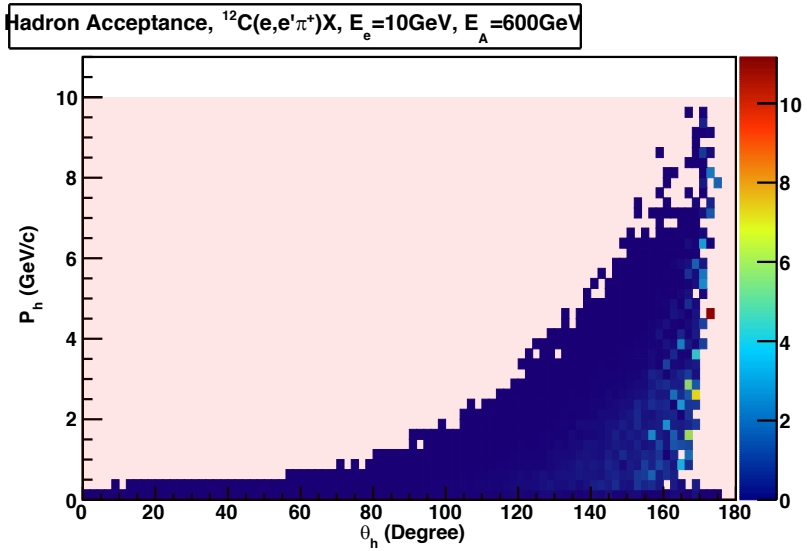
$Q^2 < 10$ and $p_t < 1$ GeV/c (lab values, small $x_B$cut)





$0.05 < x_B < 0.1$
no weighting
only positive hadrons





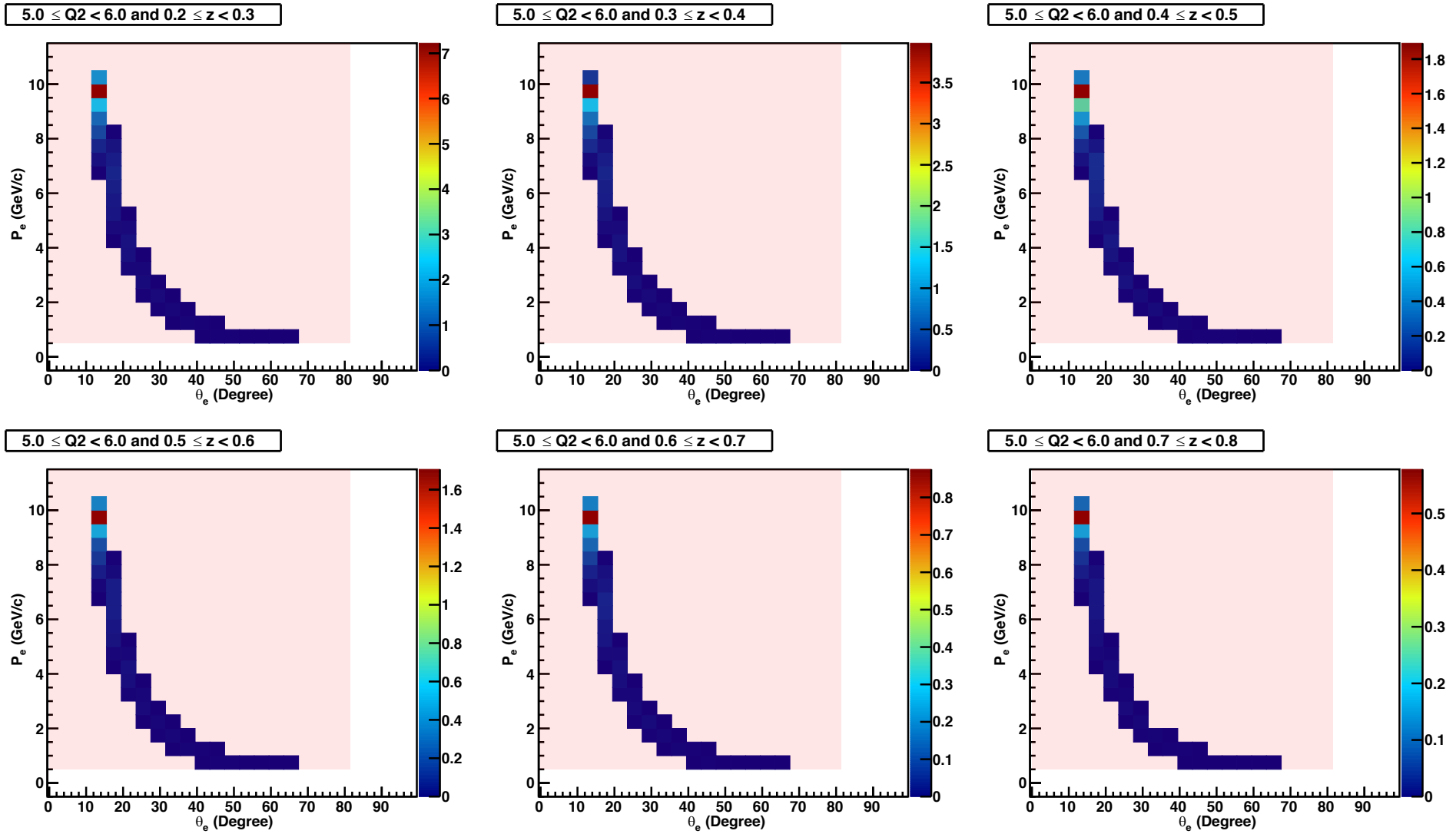
$0.05 < x_B < 0.1$
weighting
only positive hadrons

-> generation limits could be well optimized further
-> shall we do this???

Q^2 and z Dependence of Limits (for both x_B-cuts)

- Q^2 cut limits:
  - Q2_cut [9] = {2.0 , 3.0, 4.0 , 5.0, 6.0, 7.0, 8.0, 9.0, 10.}
- z cut limits:
  - z_cut[7] = {0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8}
- x cut:
  - $0 < x_B < 0.3$ (wide)
  - $0.05 < x_B < 0.1$ (small)
- $p_t < 1$ GeV/c

Generated Values for fix Q^2 and variable z (for $0 < x_B < 0.3$)

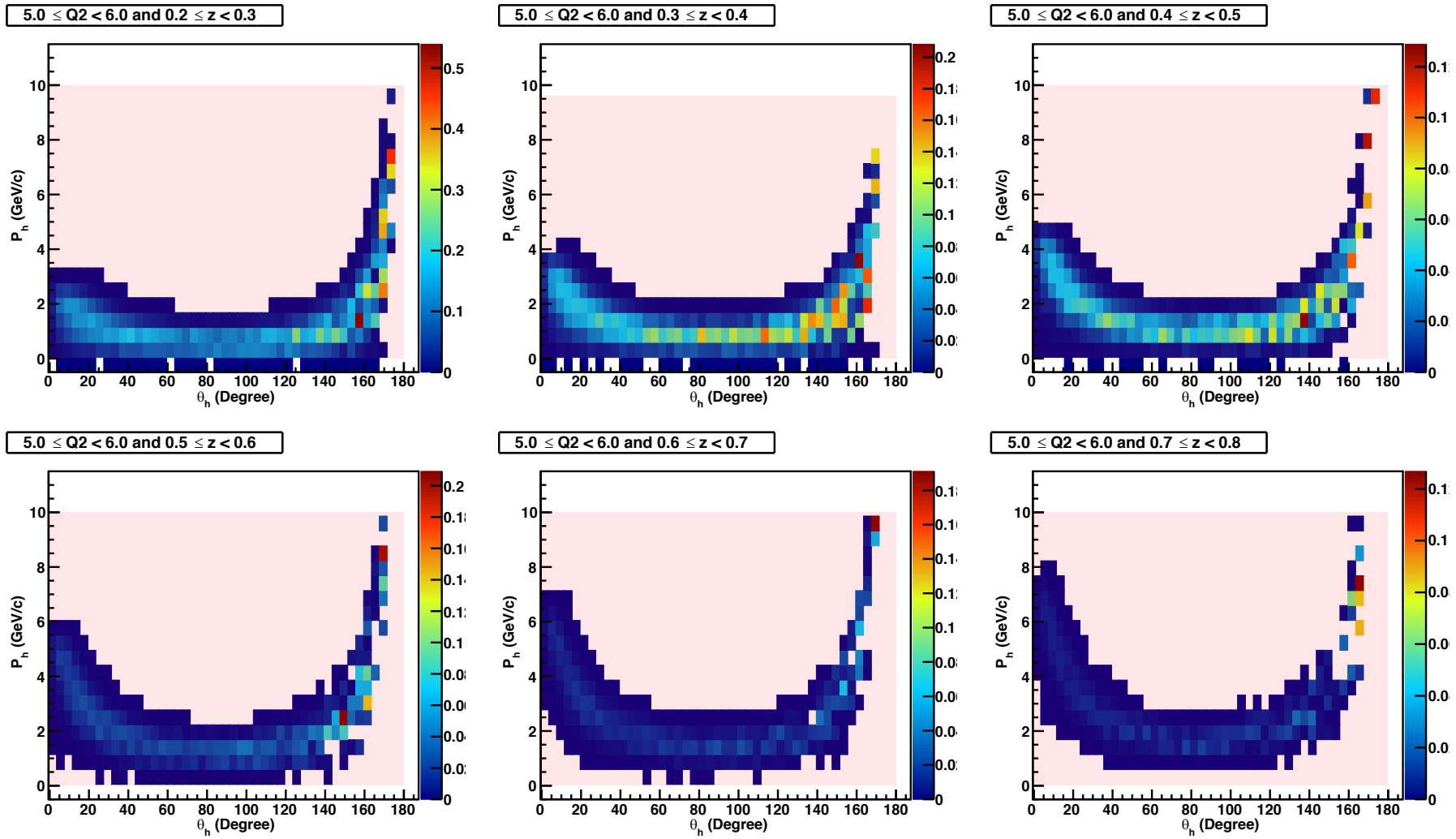


Electrons
weighting
only positive hadrons

$5.0 <= Q^2 < 6.0$

No z-dependence

Generated Values for fix Q^2 and variable z (for $0 < x_B < 0.3$)

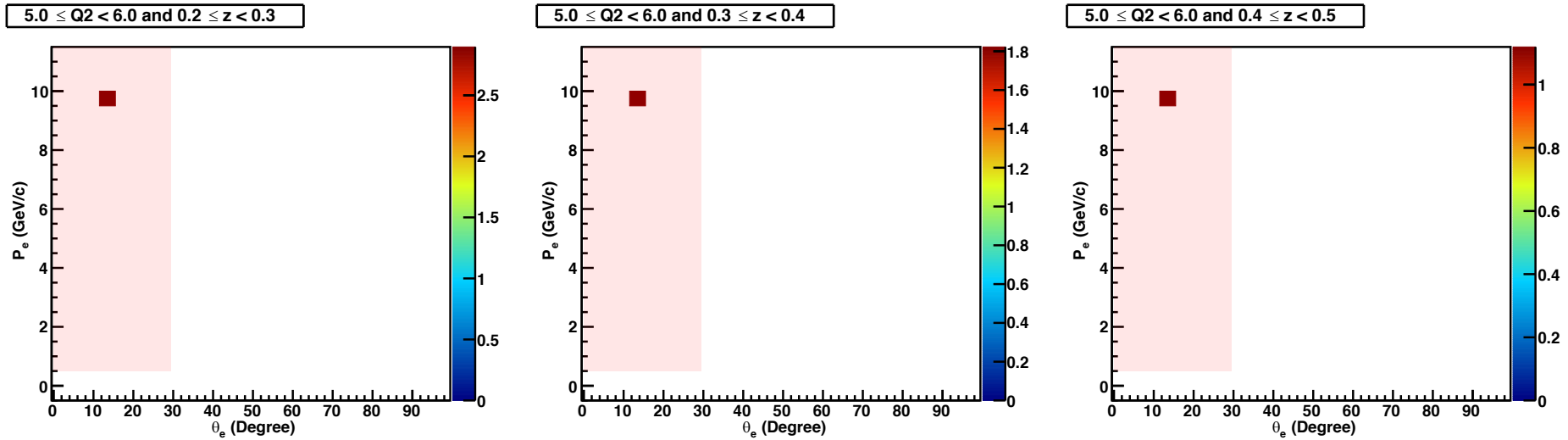


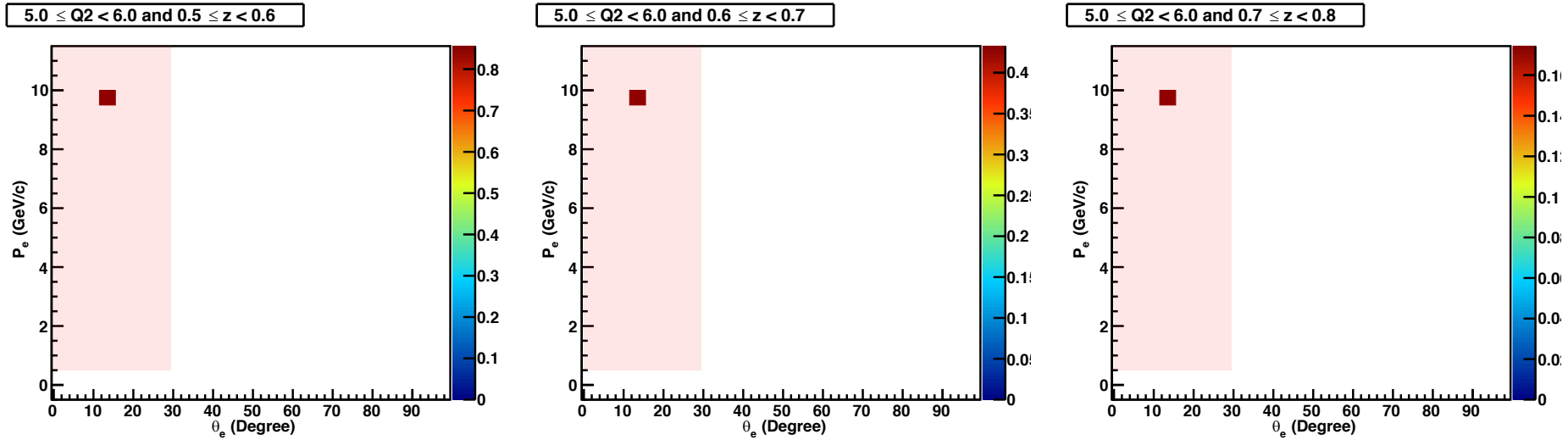
Hadrons
weighting
only positive hadrons

$5.0 <= Q^2 < 6.0$

No z-dependence

Generated Values for fix Q^2 and variable z ($0.05 < x_B < 0.1$)



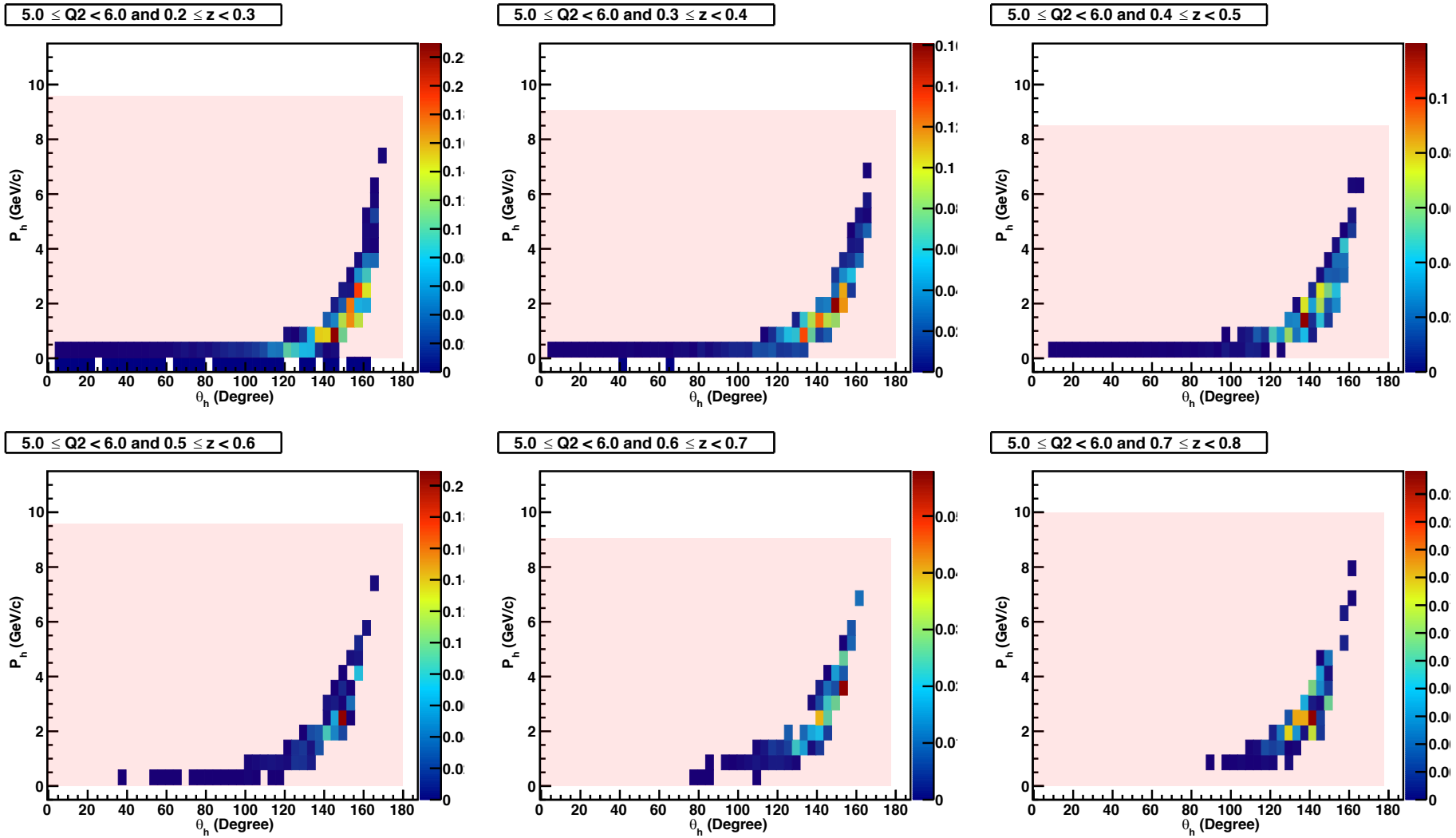


Electrons
weighting
only positive hadrons

$5.0 <= Q^2 < 6.0$

Very small
phase space
In generated
values

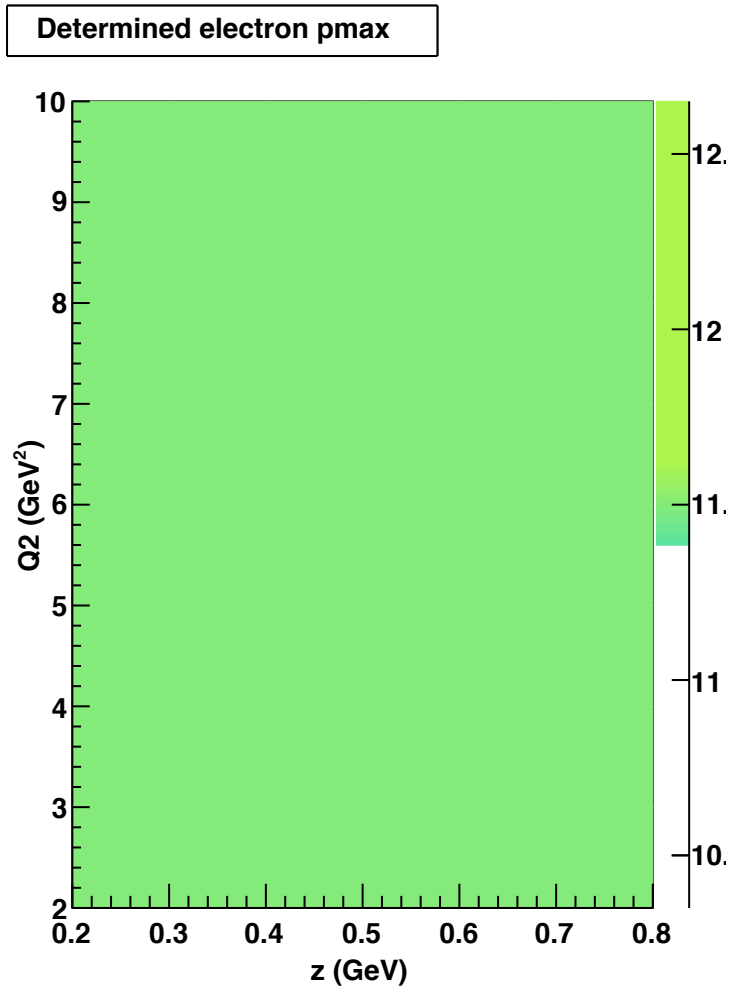
Generated Values for fix Q^2 and variable z ($0.05 < x_B < 0.1$)

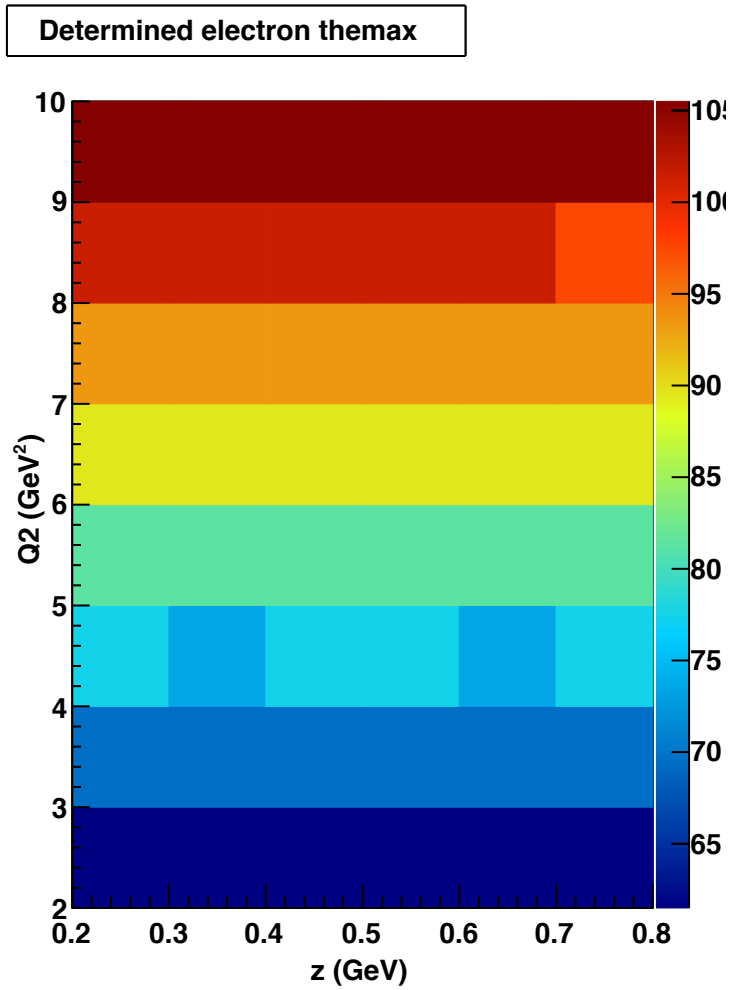


Hadrons
weighting
only positive hadrons

$5.0 <= Q^2 < 6.0$

Determined Limits for Q^2 and z ($0 < x_B < 0.3$)

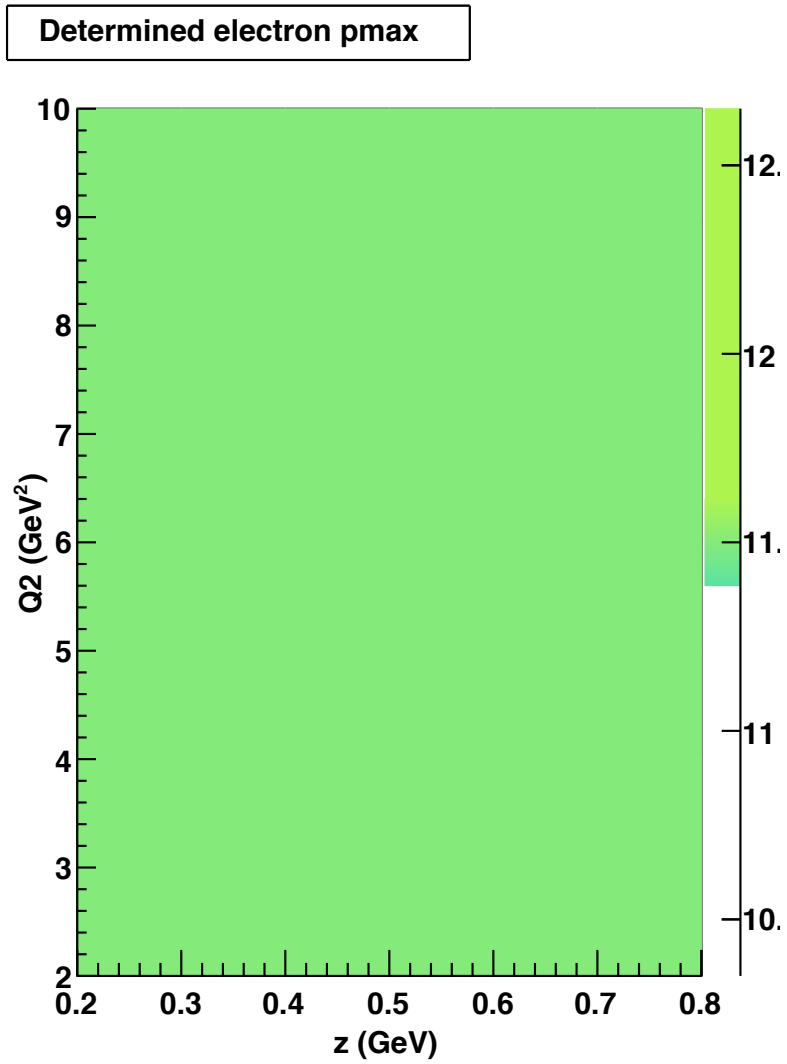


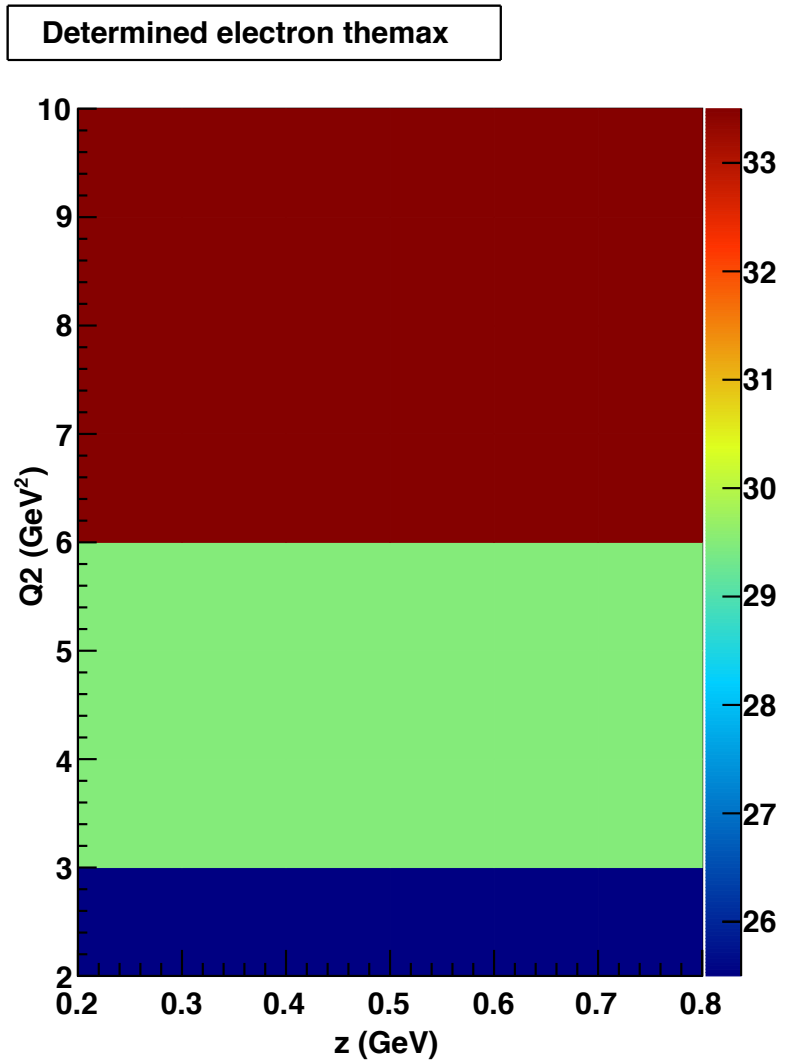


No dependence on maximum electron momentum

Expected dependence of theta max on Q2

Determined Limits for Q^2 and z ($0.05 < x_B < 0.1$)

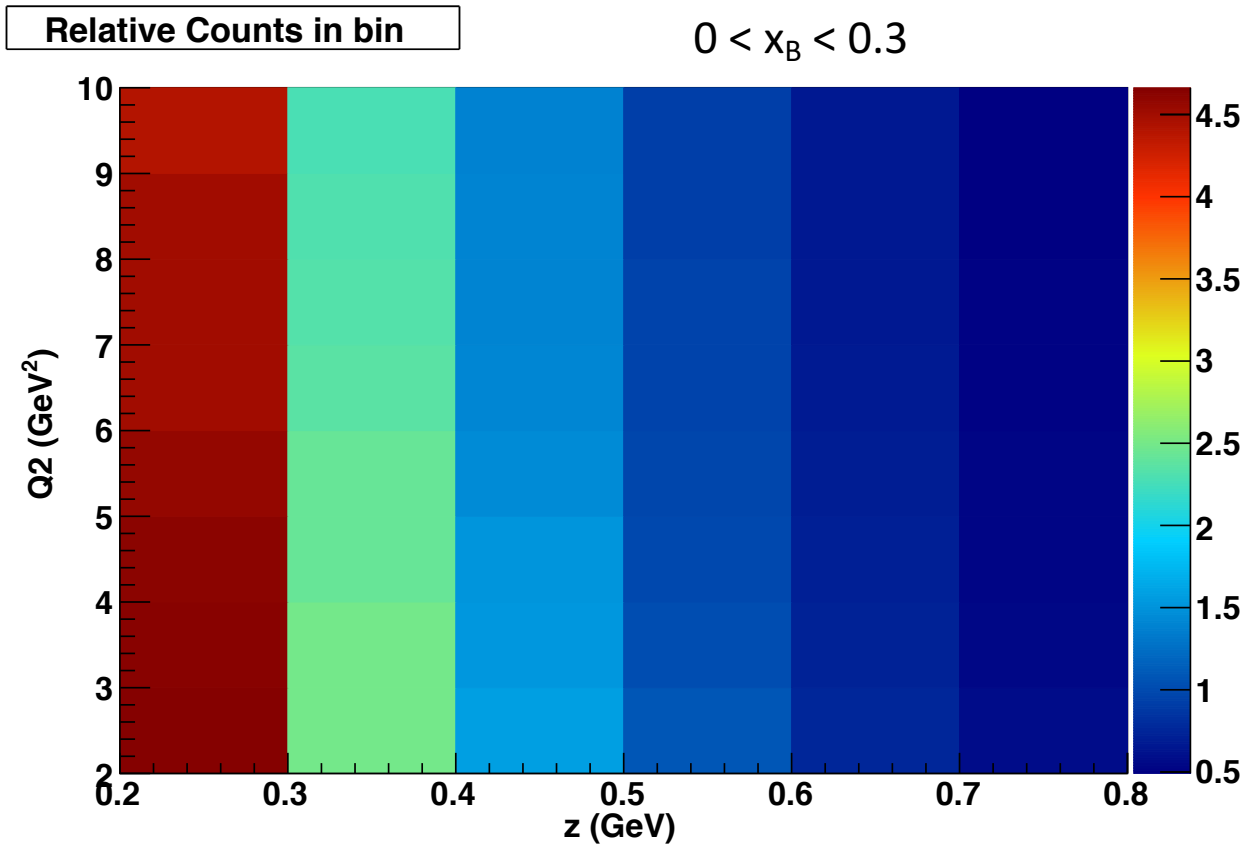


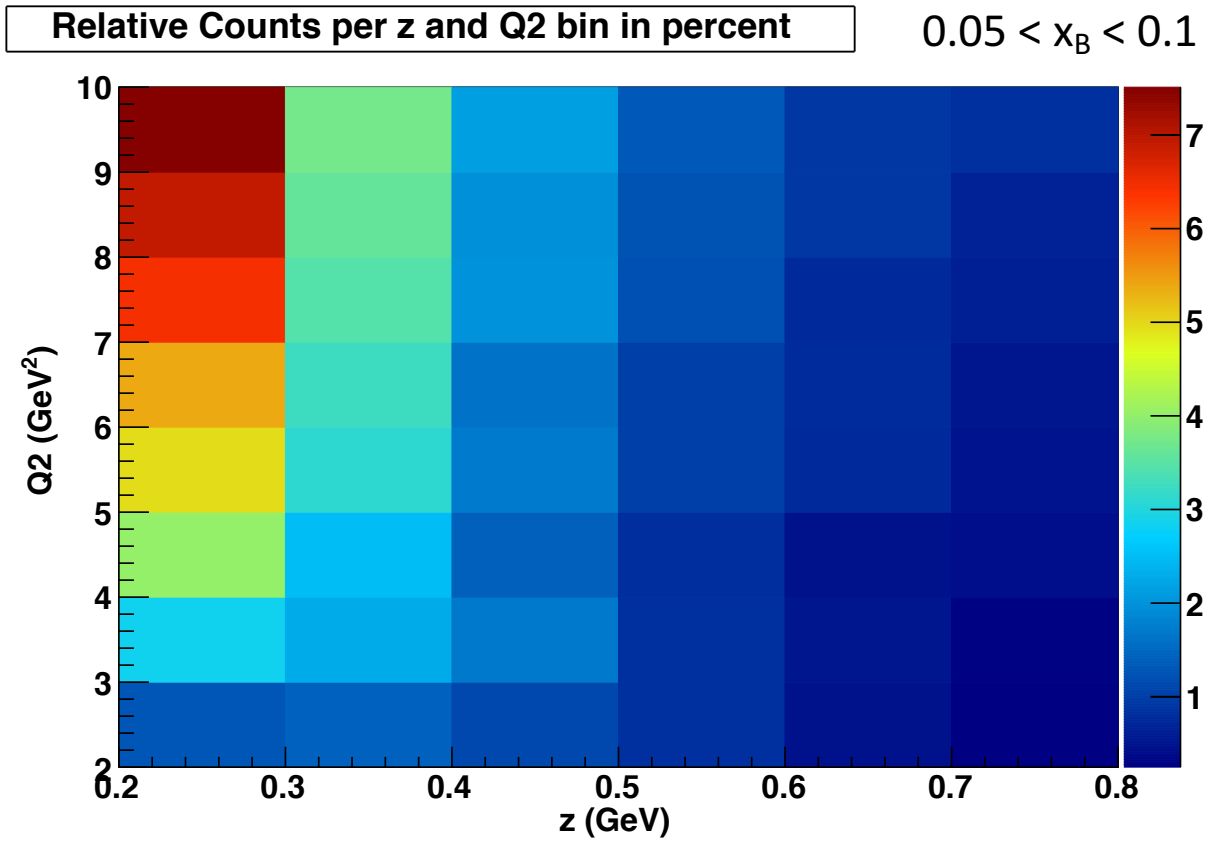


No dependence on maximum electron momentum

Almost no dependence of theta max on Q2 since binning too wide

Phase Space Fraction for Q^2 and z Bins





Fraction = $N_{bin}(z, Q^2) * 100 / N_{tot}(Q^2 < 10, p_t < 1, x_B\text{-cut})$

Summary and Outlook

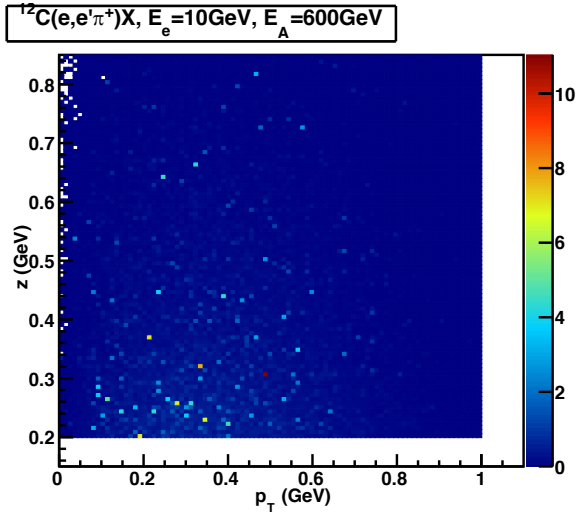
- MC can be optimized by changing limits of event generation
- For electron momentum and angle:
  - No dependence of limits on z
  - Expected dependence of limits on Q^2 and x_B

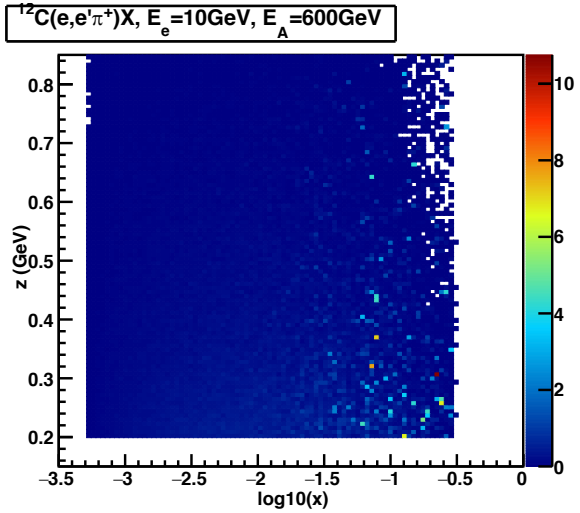
<u>To do:</u>

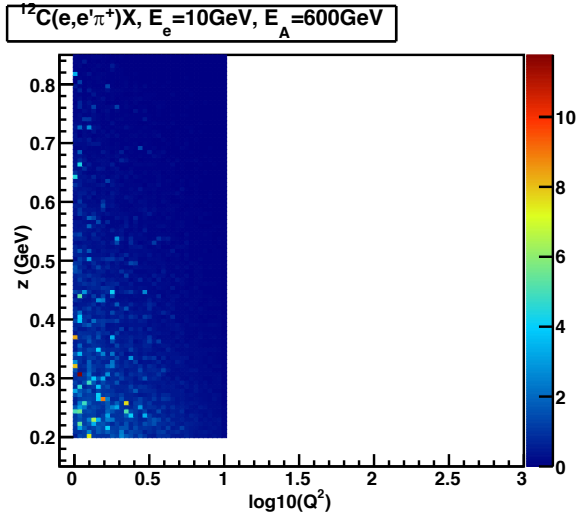
- Which generation limits shall we choose?
- Comparison of number of entry in one weighted histogram with MC integration of the same regions using GSL Library (or other one??)
- Determination of error from MC sampling (according to Charles‘ Note)

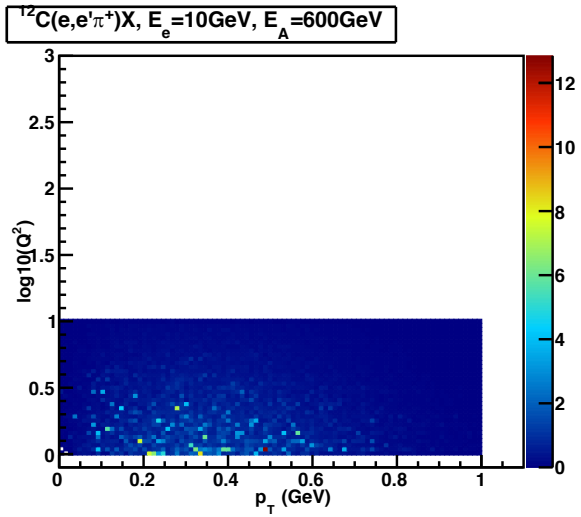
Extra Slides

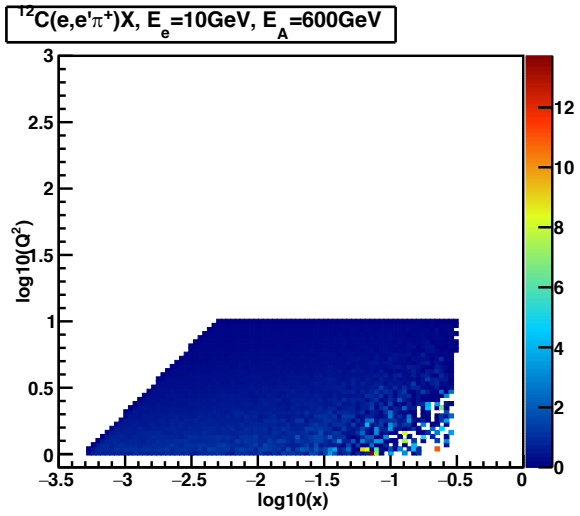
$Q^2 < 10$ and $p_t < 1$ GeV/c (kinematic values, xbcut)

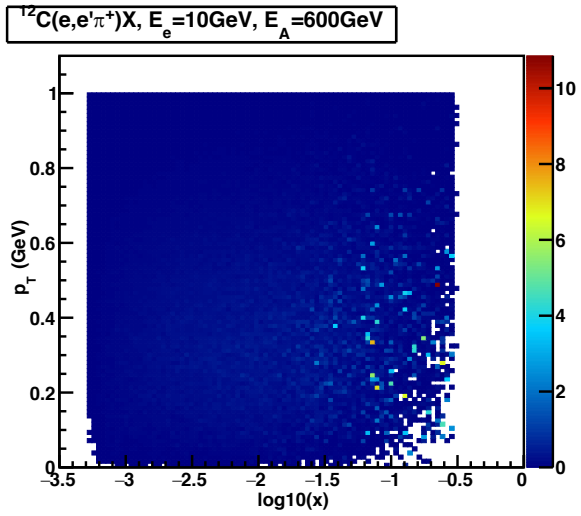








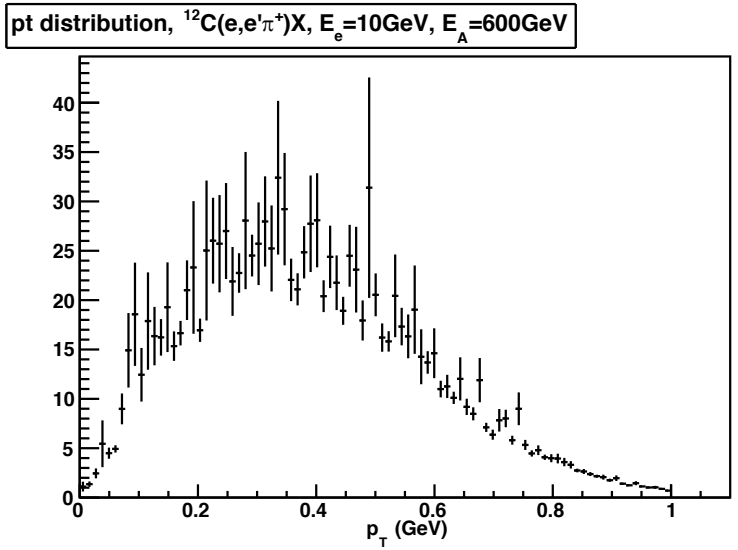


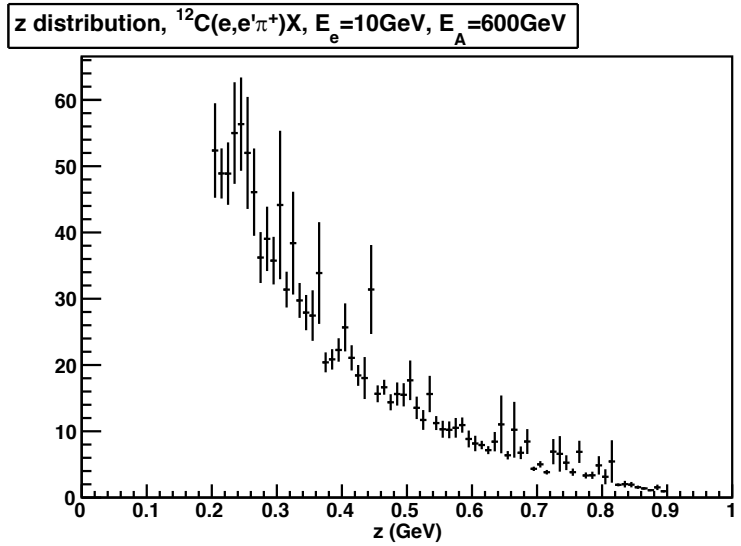


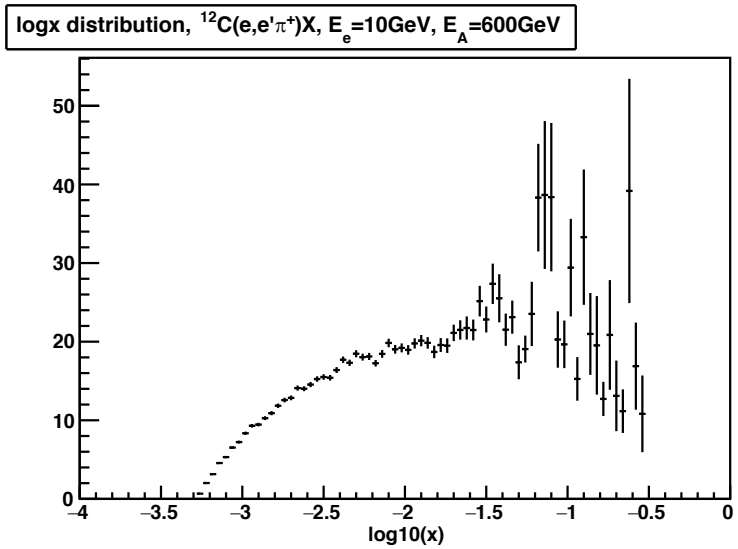
$0 < x_B < 0.3$
weighting
only positive hadrons

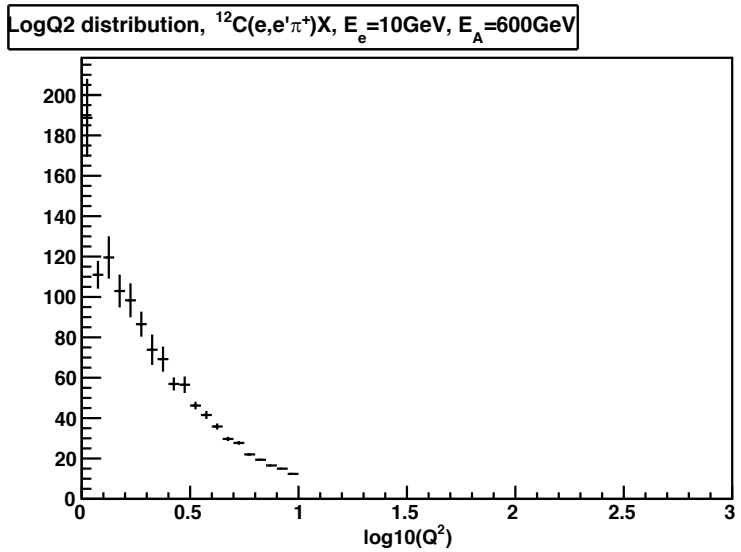
negative hadrons look the same

$Q^2 < 10$ and $p_t < 1$ GeV/c (kinematic values, xbcut)









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