JHF WG PID Requirements Summary

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PID Group Meeting

October 2nd, 2020

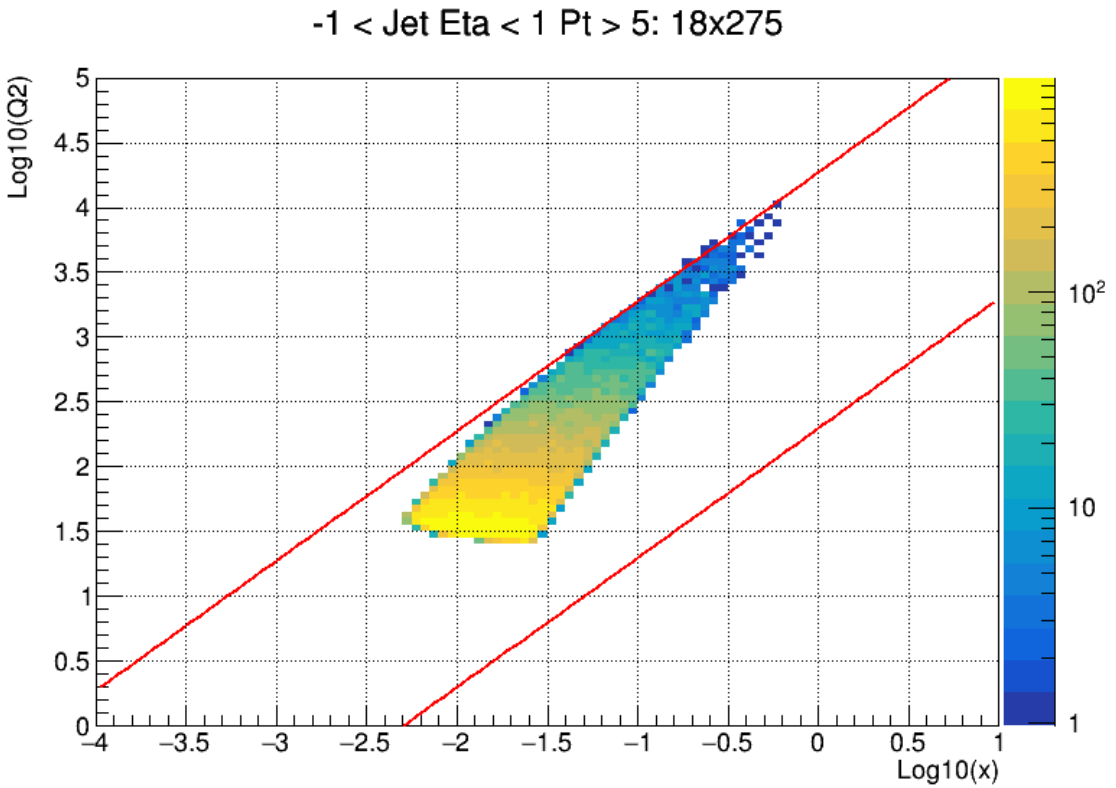
Questions for Today

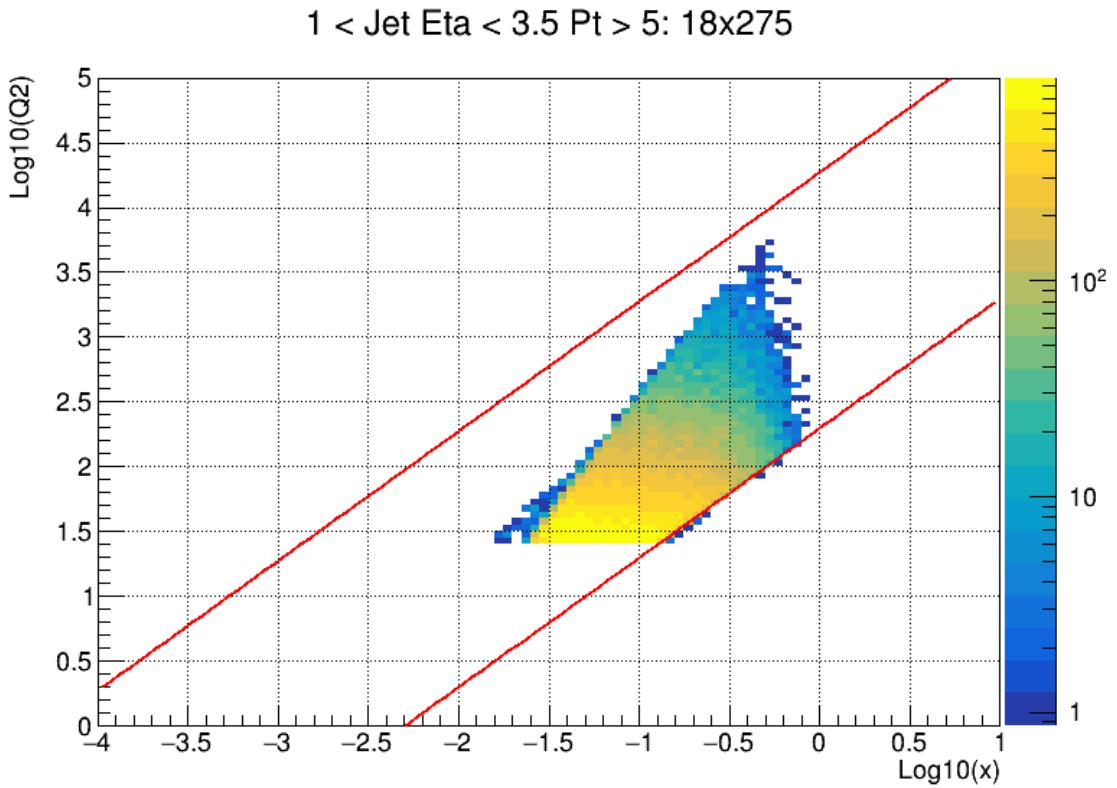
- Where do our jets live?
  - Look as a function of x-Q2, eta, COM energy
  - Does changing COM energy buy us anything?

- What PID coverage do we want?
  - How does less coverage affect our measurements?
  - Aren't we just looking at tails?

Jet Phase Space: 18x275

- Here “jet” is actually just the struck quark in the LO DIS process – no jet finding is performed



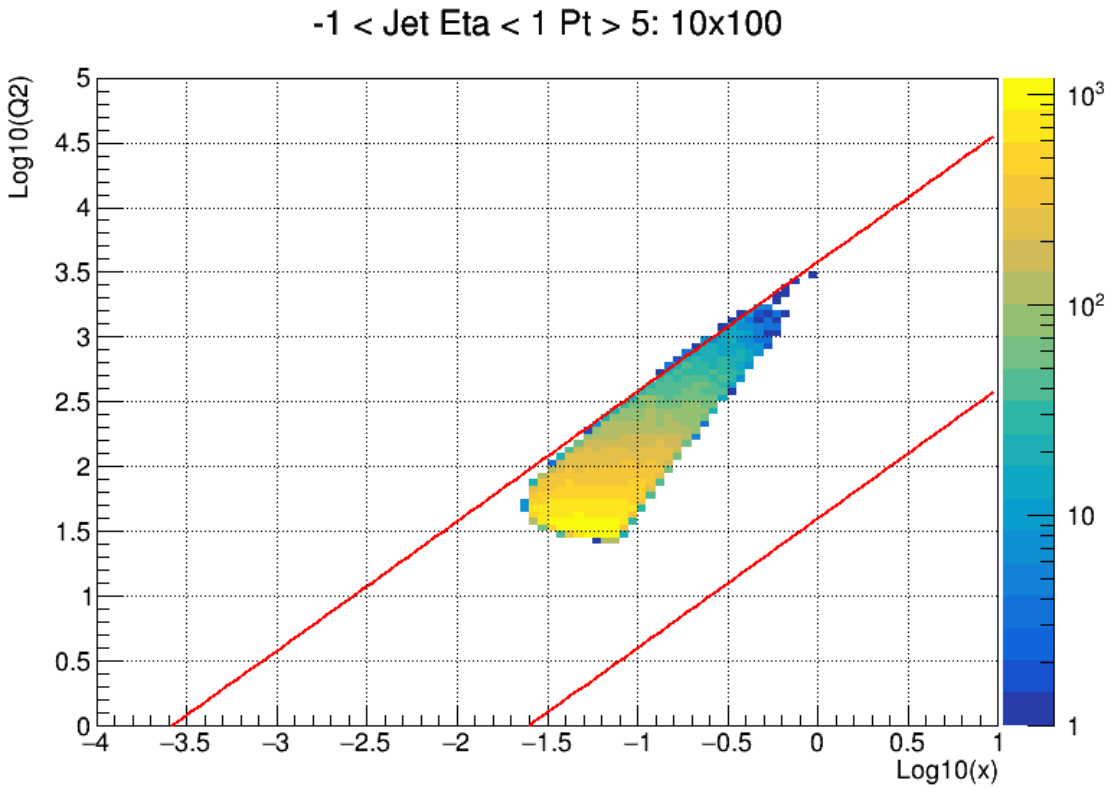


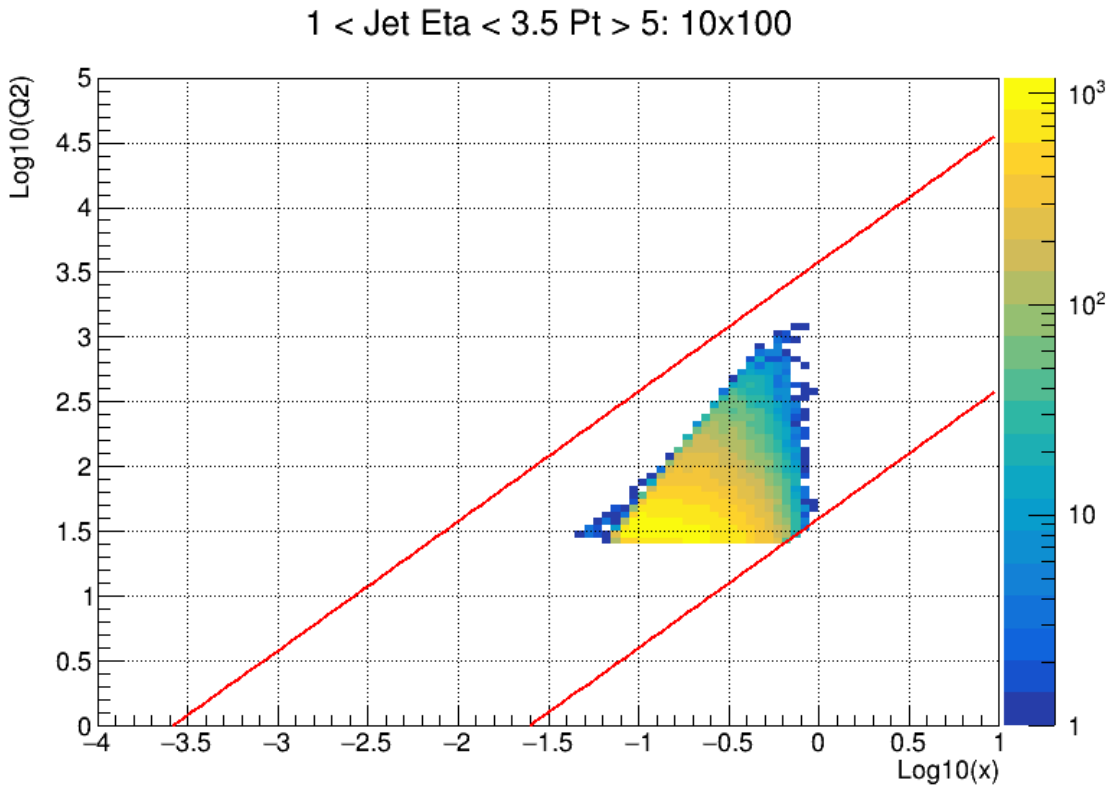
- Look at x-Q2 of “jets” with pseudorapidity in the barrel and endcap for different energies
- Require “jet” to have pT > 5 GeV
- Cut on y: 0.01 < y < 0.95 (red lines)

❑ Minimum Q2 = 10 GeV2

Jet Phase Space: 10x100

- As COM energy is lowered, jet distributions move to lower Q2 and higher x – as expected (gain some x-Q2 coverage in endcap)

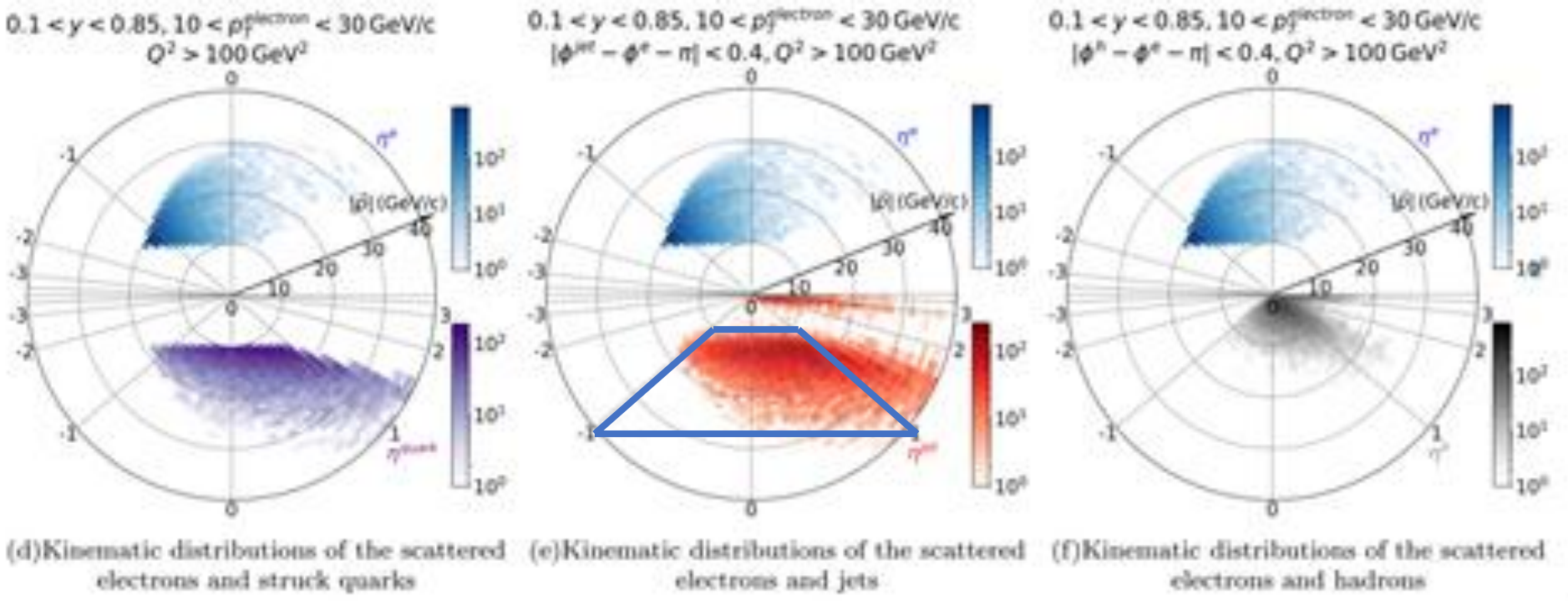




- In the barrel, phase space probed by jets is almost orthogonal between energies
- x-Q2 probed by jets in barrel at 10x100 is completely covered by jets in the endcap at 18x275

- Lowering COM energy will bring jets at a given x-Q2 from the endcap toward the barrel (where presumably PID coverage is worse) – hard to see the advantage

10x100: Max eA Energy



(d)Kinematic distributions of the scattered electrons and struck quarks

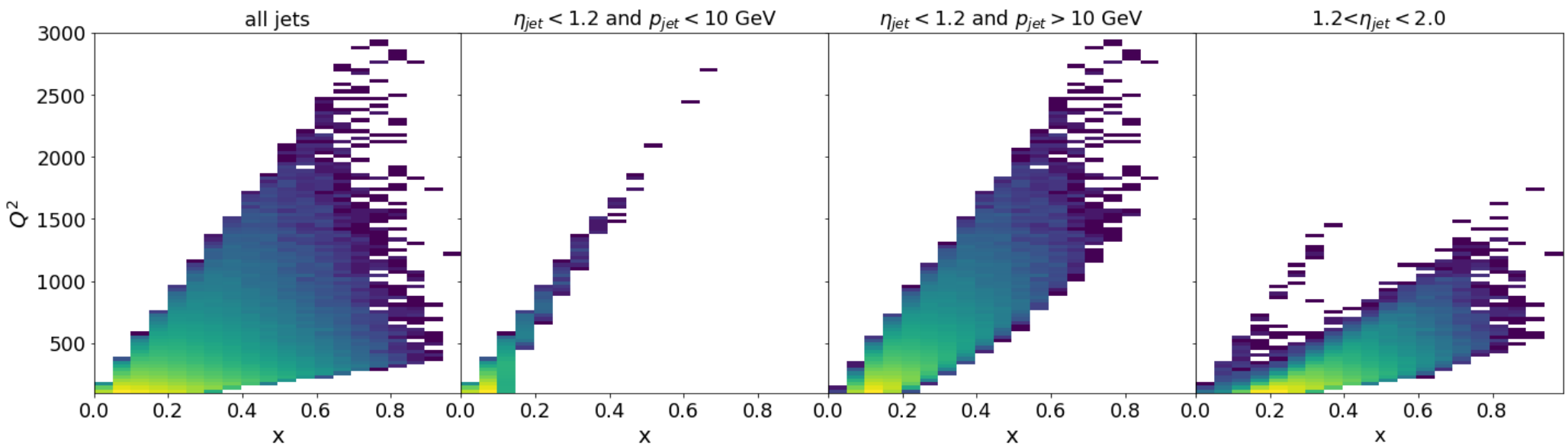
(e)Kinematic distributions of the scattered electrons and jets

(f)Kinematic distributions of the scattered electrons and hadrons

- While moving from 18x275 to 10x100 may not provide much benefit in ep, 10x100 is the max eA energy (well actually 10x110)

- Significant fraction of relevant jets will go into the barrel – important for TMD measurements in eA
- Will still need good PID coverage here

Another look at Phasespace

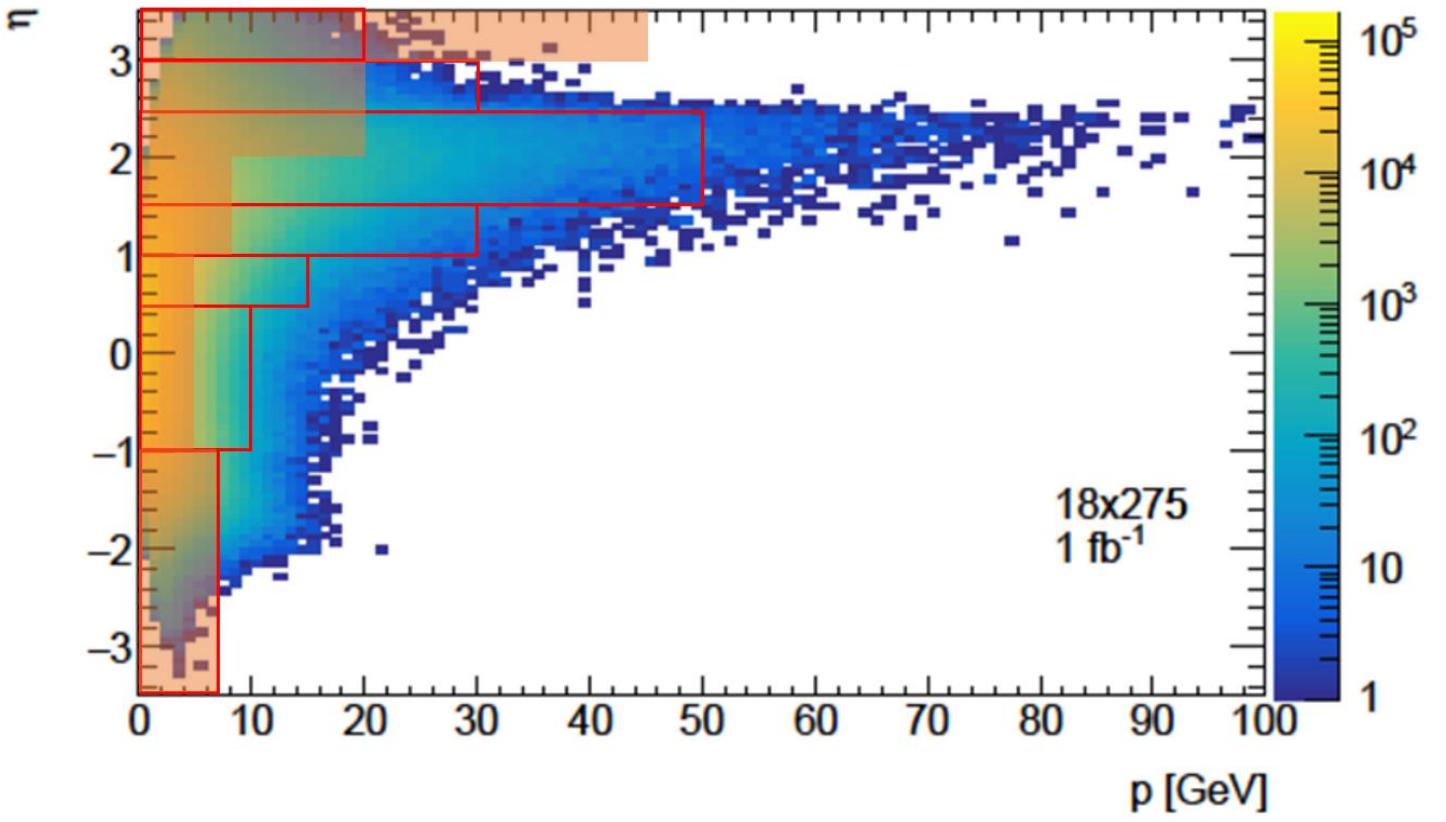


Our PID Requests: A Reminder

PID Momentum Coverage

Eta Range	Default Momentum Coverage	Requested Momentum Coverage
-3.5 < η < -1.0	≤ 7 GeV	Same
-1.0 < η < 0.0	≤ 5 GeV	≤ 10 GeV
0.0 < η < 0.5		
0.5 < η < 1.0		≤ 15 GeV
1.0 < η < 1.5	≤ 8 GeV	≤ 30 GeV
1.5 < η < 2.0		≤ 50 GeV
2.0 < η < 2.5	≤ 20 GeV	
2.5 < η < 3.0		≤ 30 GeV
3.0 < η < 3.5	≤ 45 GeV	Can tolerate ≤ ~20 GeV

18x275



- Plot of pseudorapidity vs momentum of pions found within jets
- Default PID ranges leave significant gaps in coverage
- Reduction of particle momenta at highest (and lowest) eta are due to jet radius

- Shaded boxes = default momentum coverage
- Red outlined boxes = requested momentum coverage

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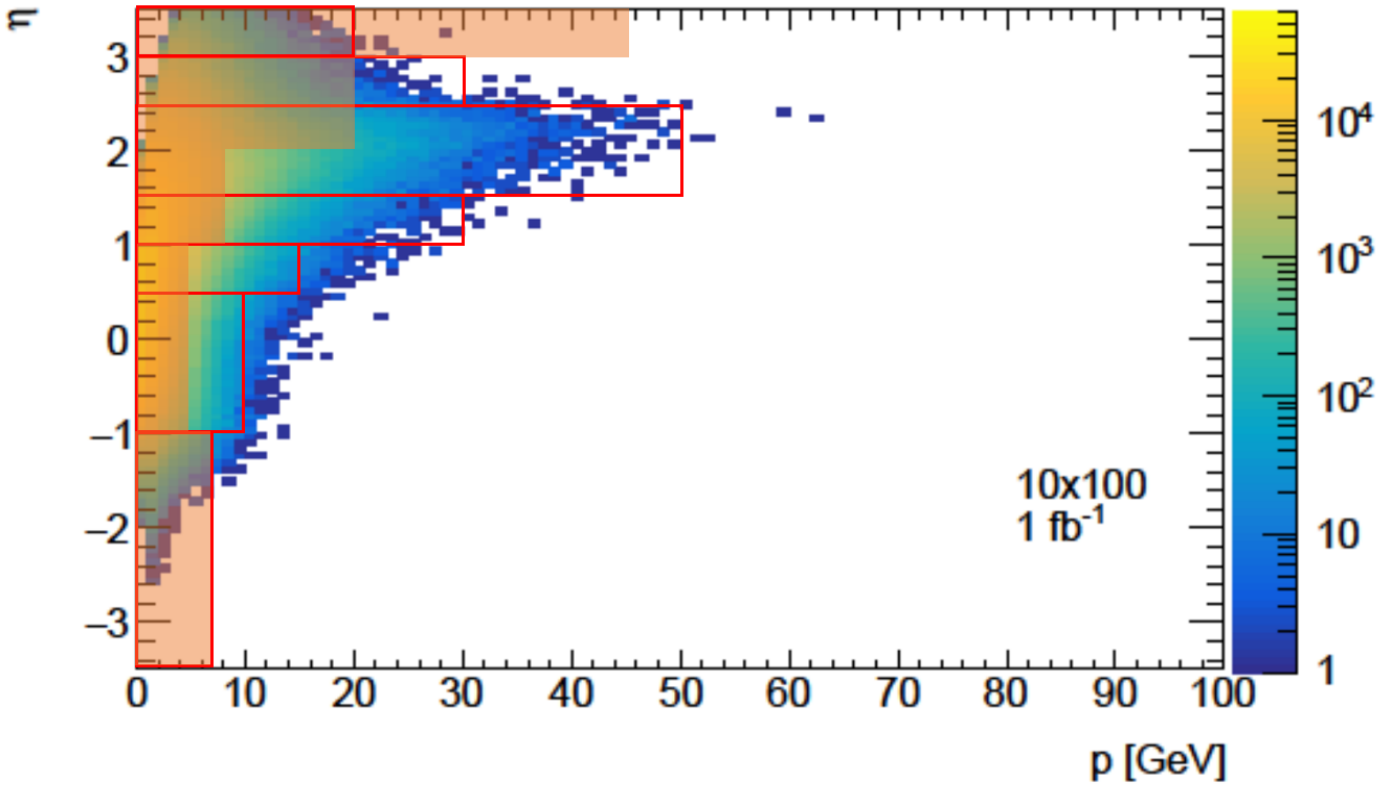
1.5 < η < 2.0		≤ 50 GeV
2.0 < η < 2.5	≤ 20 GeV	
2.5 < η < 3.0		≤ 30 GeV
3.0 < η < 3.5	≤ 45 GeV	Can tolerate ≤ ~20 GeV

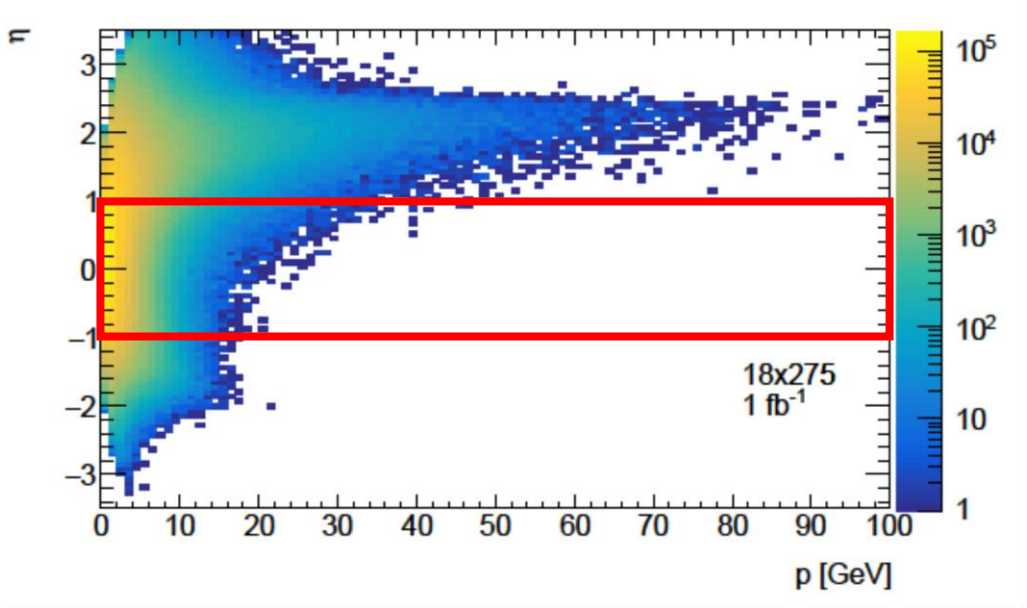
- Even at low Q2, where particle momenta are lower, default values leave a lot of particle momentum range uncovered

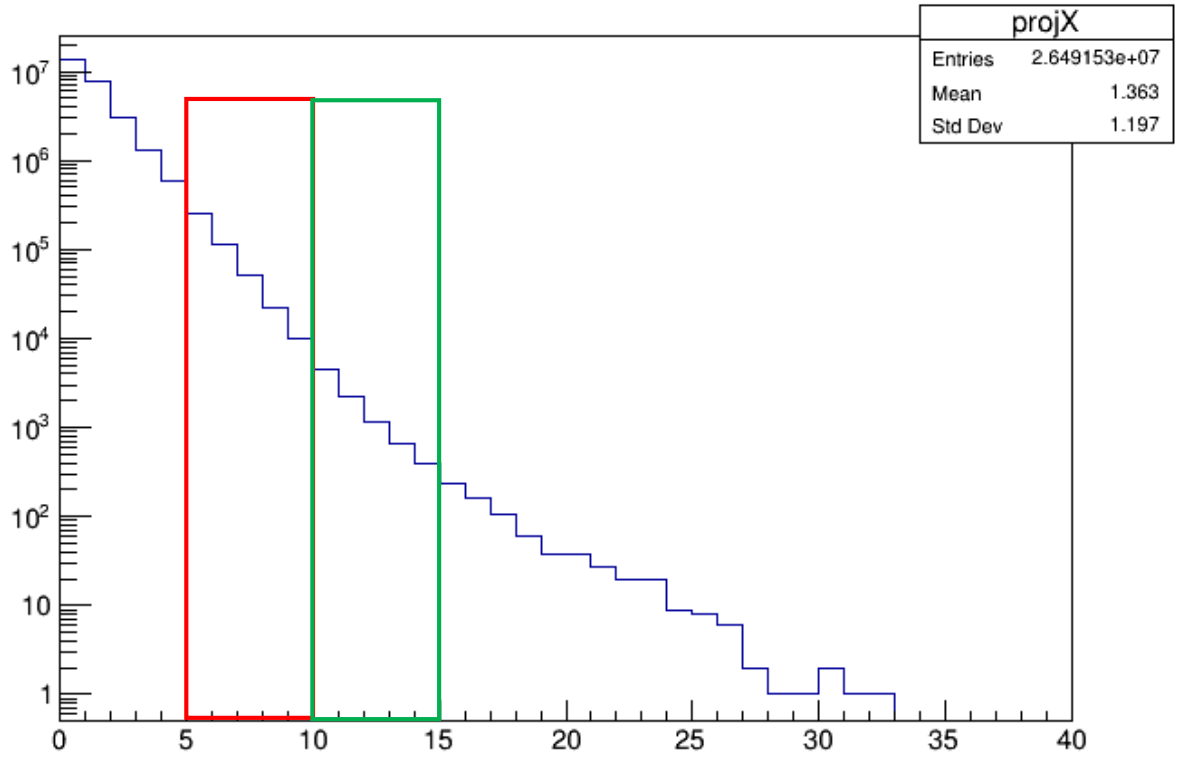
10x100



- Shaded boxes = default momentum coverage
- Red outlined boxes = requested momentum coverage

Do We Care About the Tails?

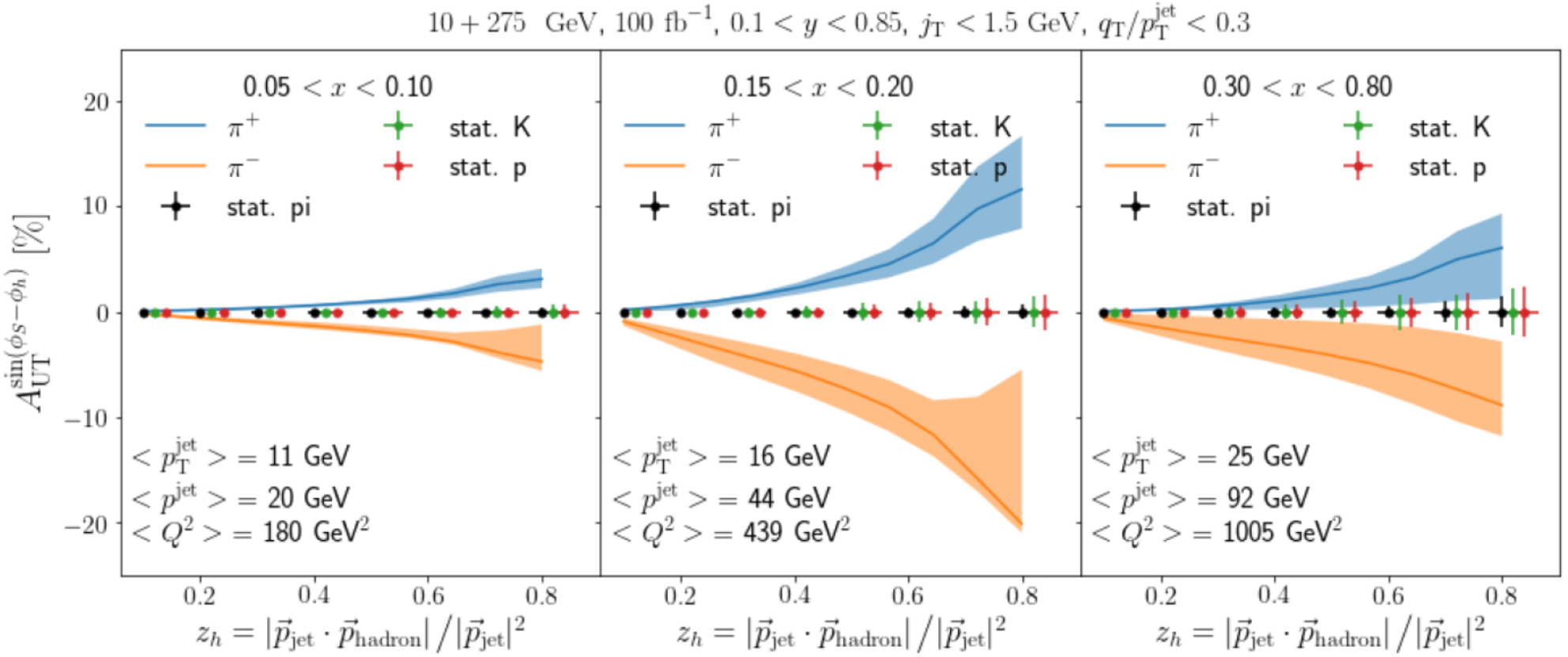




- For the barrel region, we see roughly 345K particles with momenta between 5 and 10 GeV for 1 fb-1 of integrated luminosity
- See roughly 9000 particles with momenta between 10 and 15 GeV
- Should provide ample statistics for measurements out to these high momenta

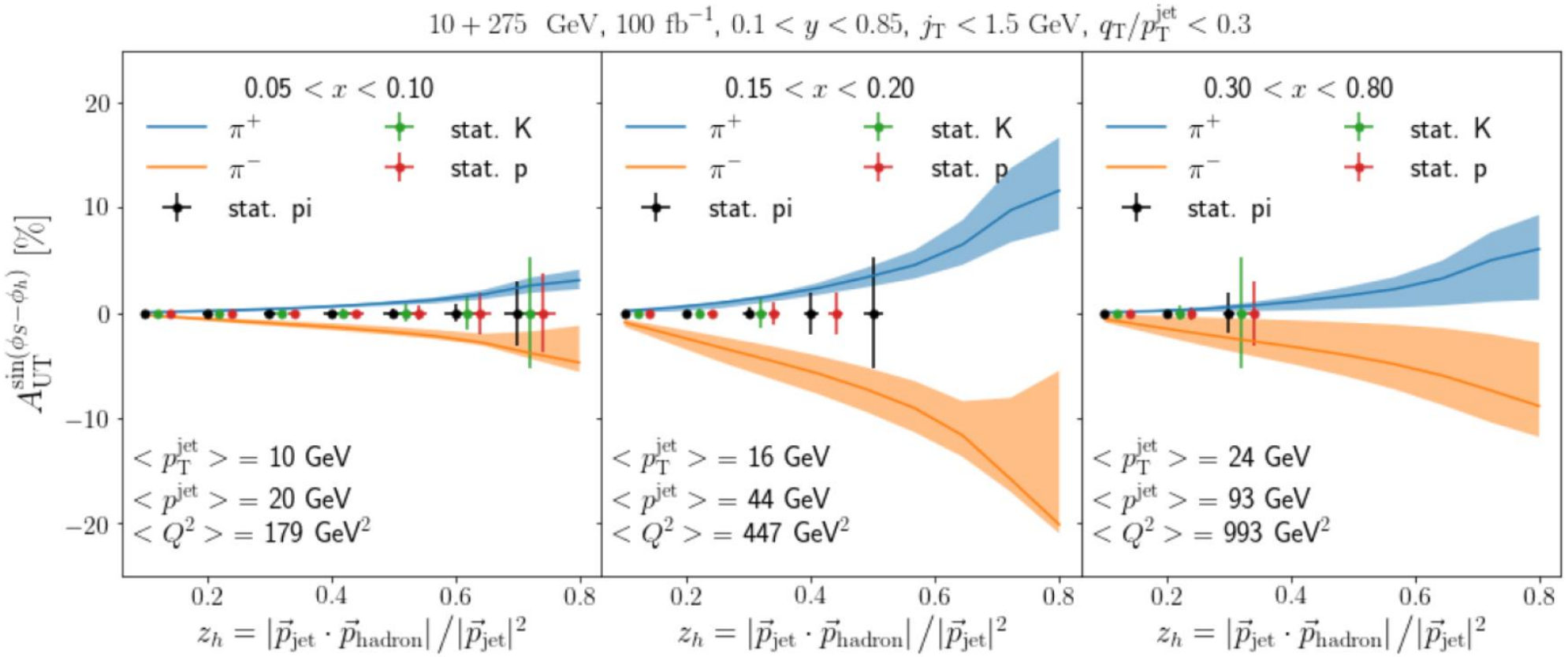
Impact on Collins Analysis

Perfect PID



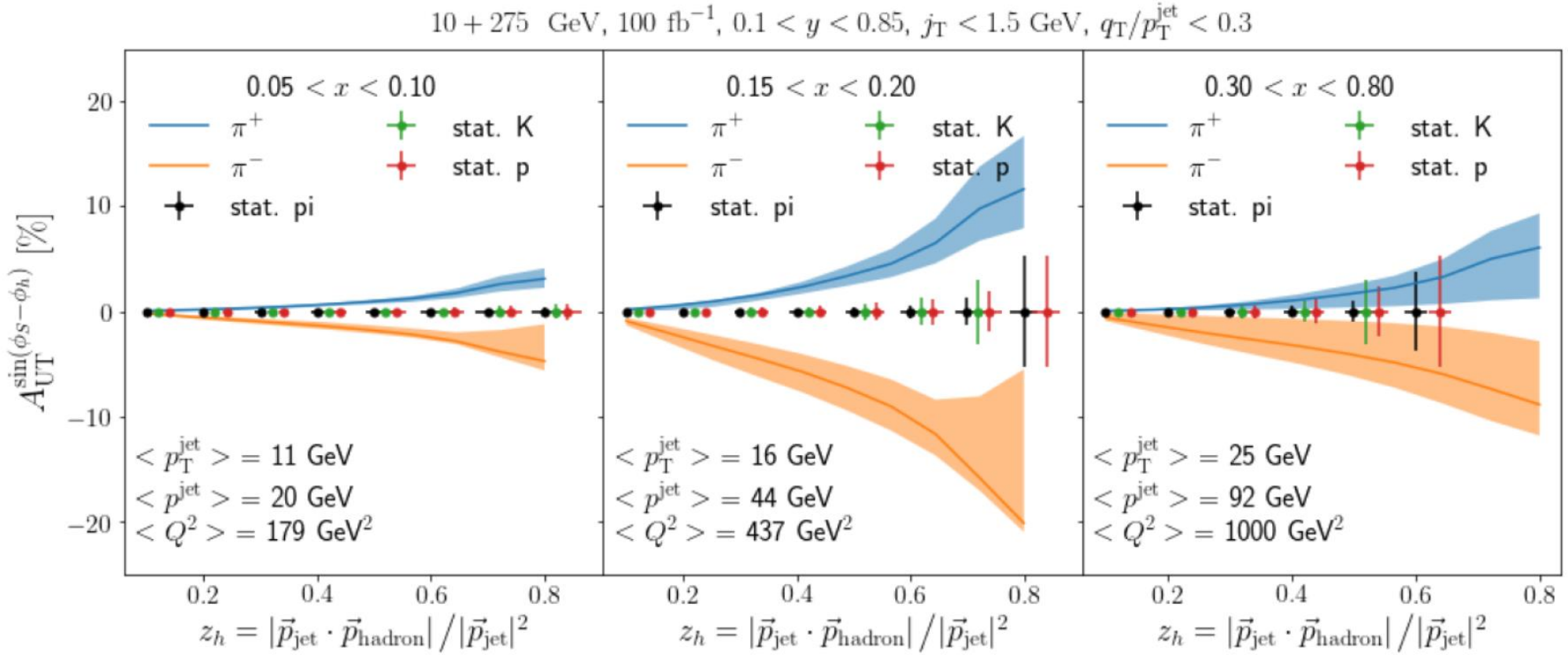
Impact on Collins Analysis

Detector Matrix PID

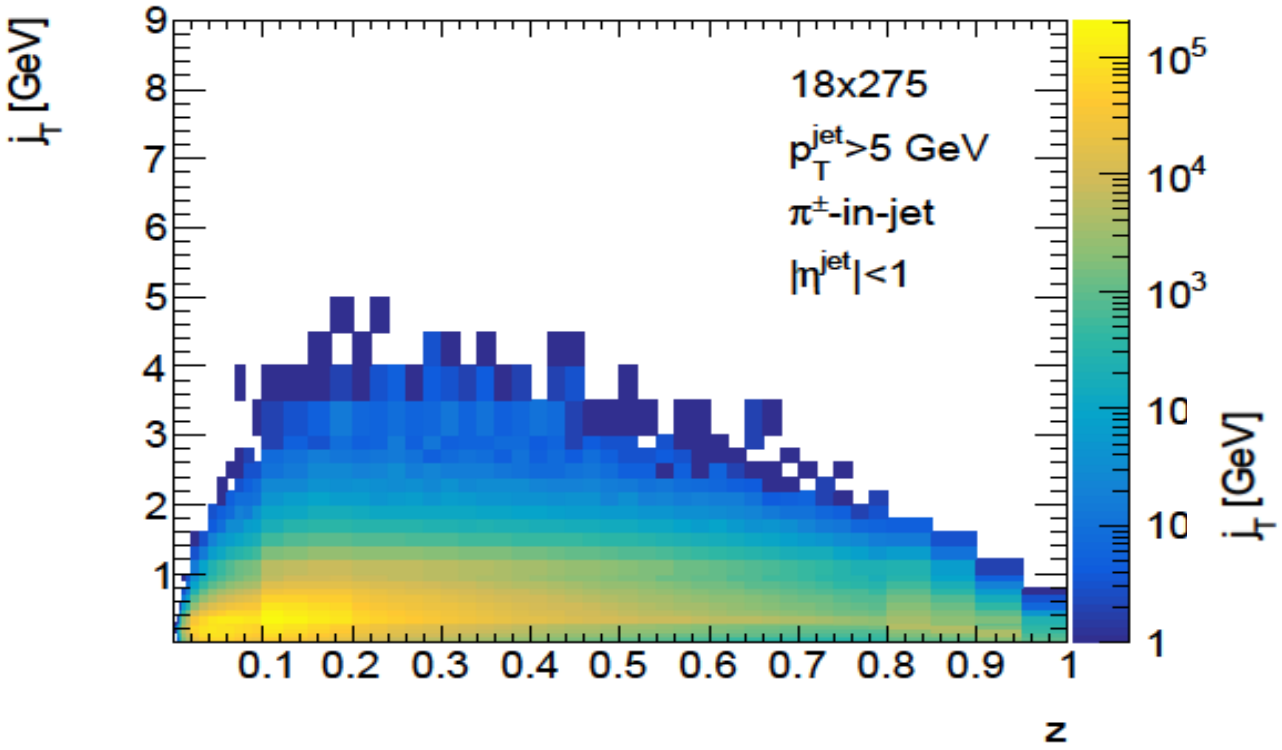


Impact on Collins Analysis

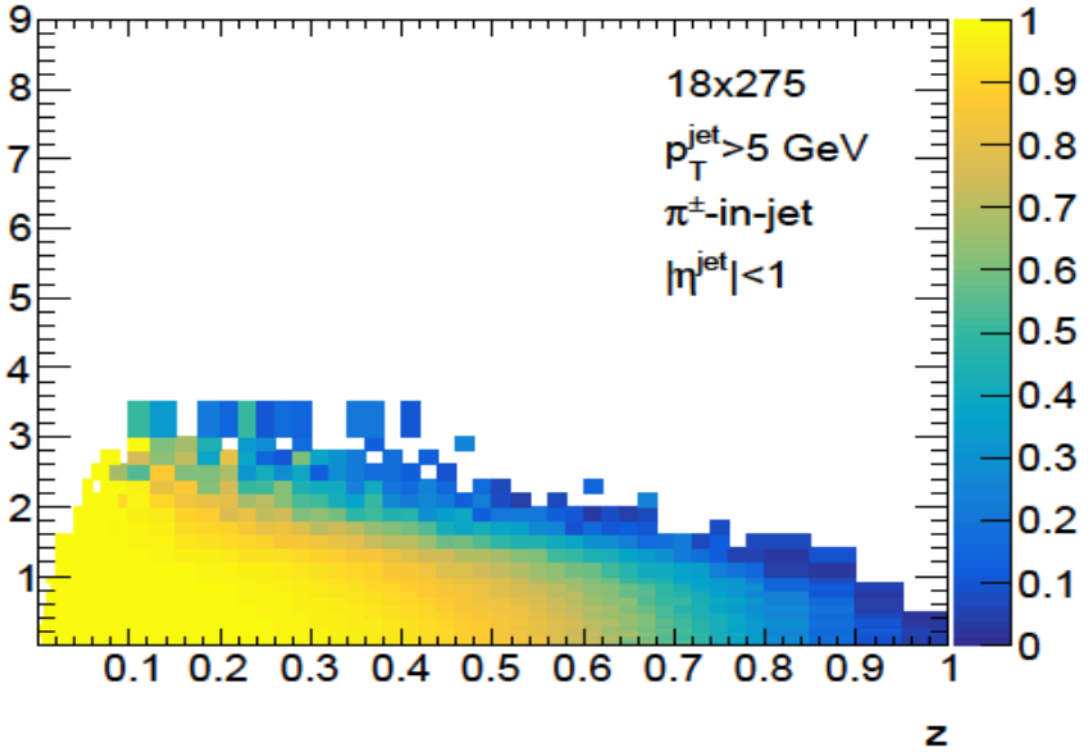
Requested PID



Impact on z-jT Coverage



- Left plot shows possible identified particle z-jT acceptance given our requested PID ranges
- Right plot shows ratio of acceptance assuming default PID to acceptance assuming requested PID
- Jet pT > 5 GeV and restricted to barrel



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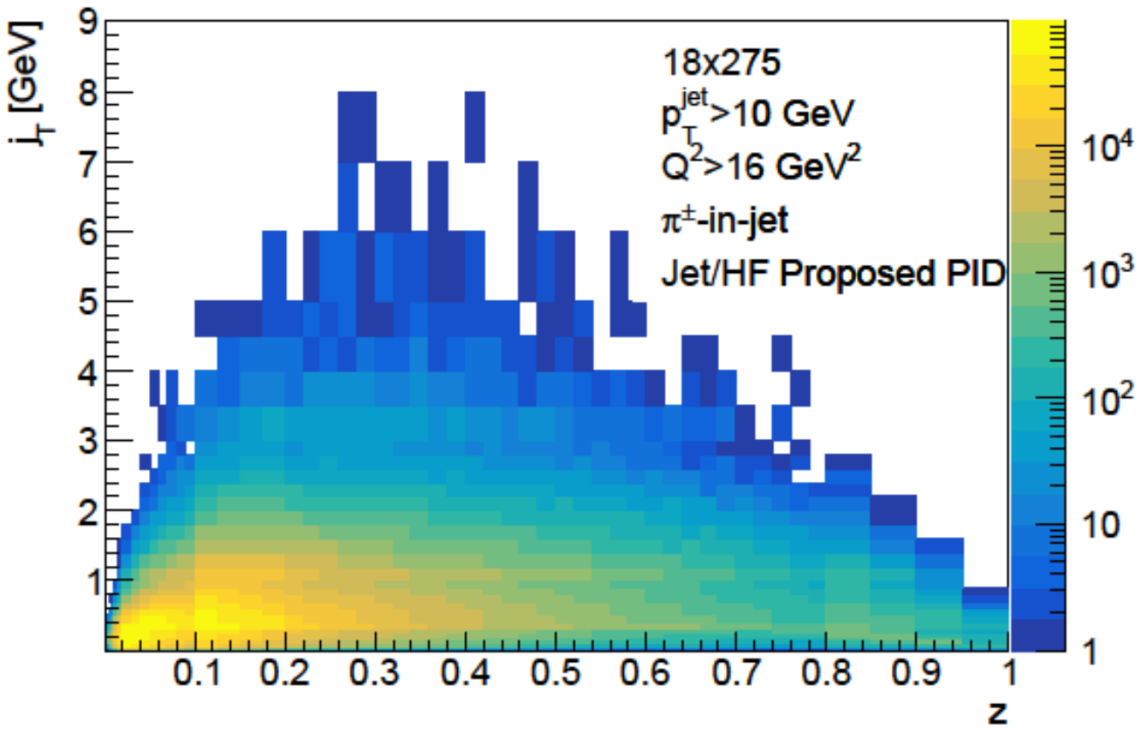
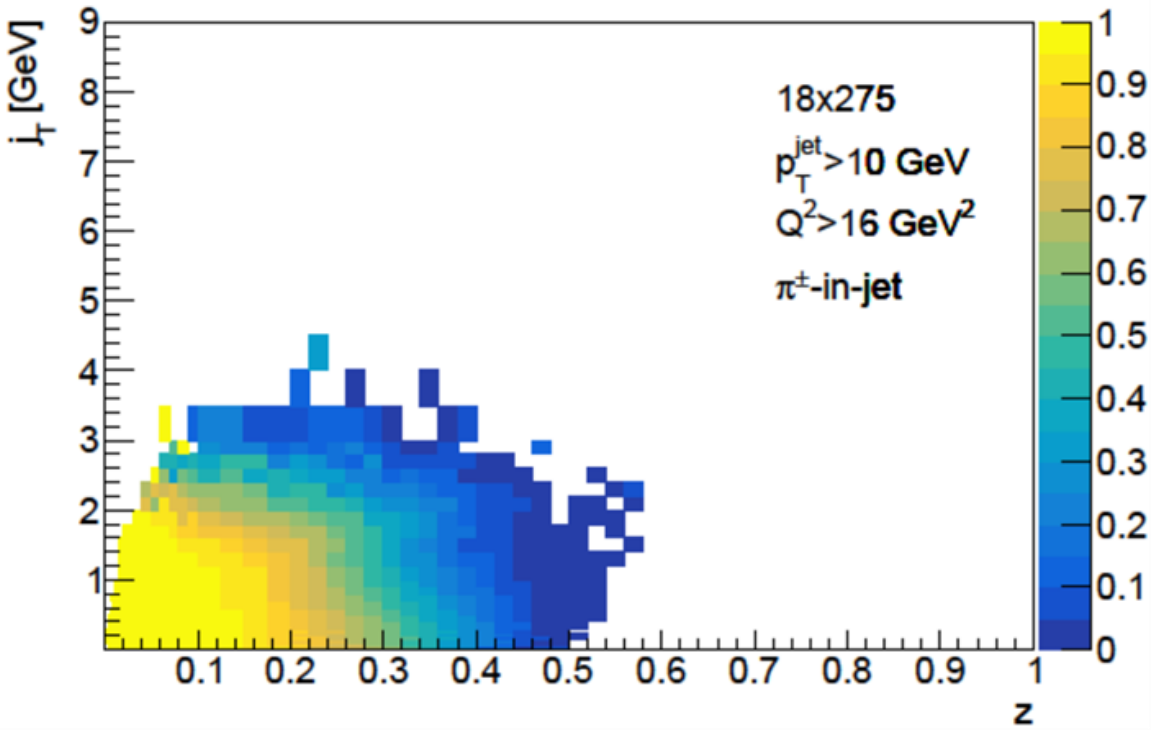


- If minimum jet pT is increased to 10, we see a dramatic difference in acceptance between the two PID ranges
- To measure as a function of jet pT, need extended PID coverage

- Note that these plots integrate over full jet eta range
- Also slightly higher min Q2 from plots above

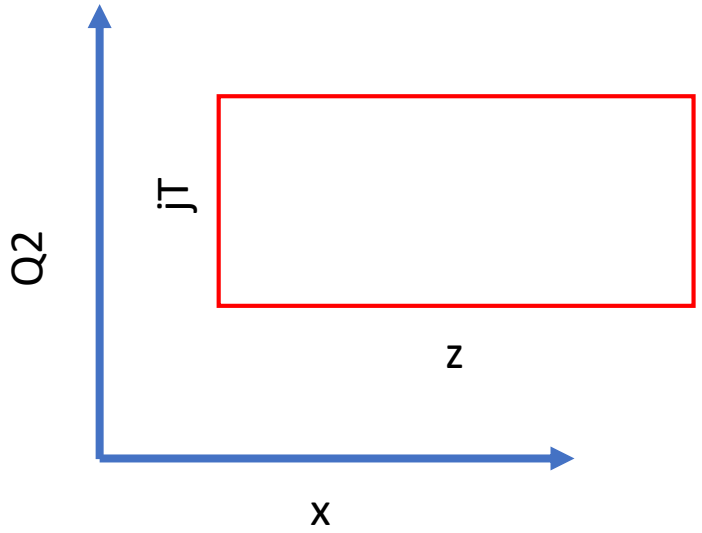


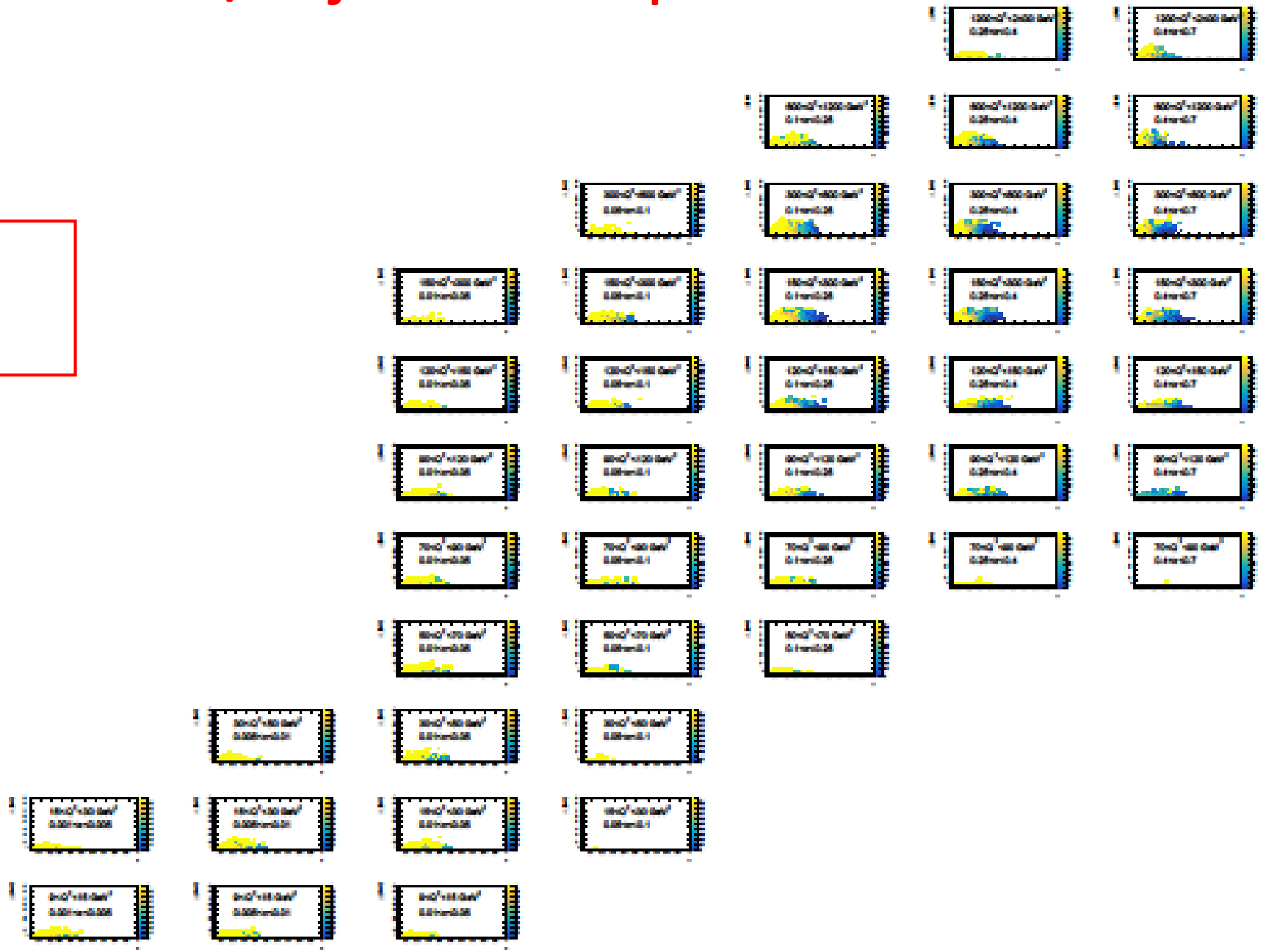
x-Q2 / z-jT Phase Space

10x100

p_T^{jet}>10 GeV

$\pi^{\pm}$-in-jet





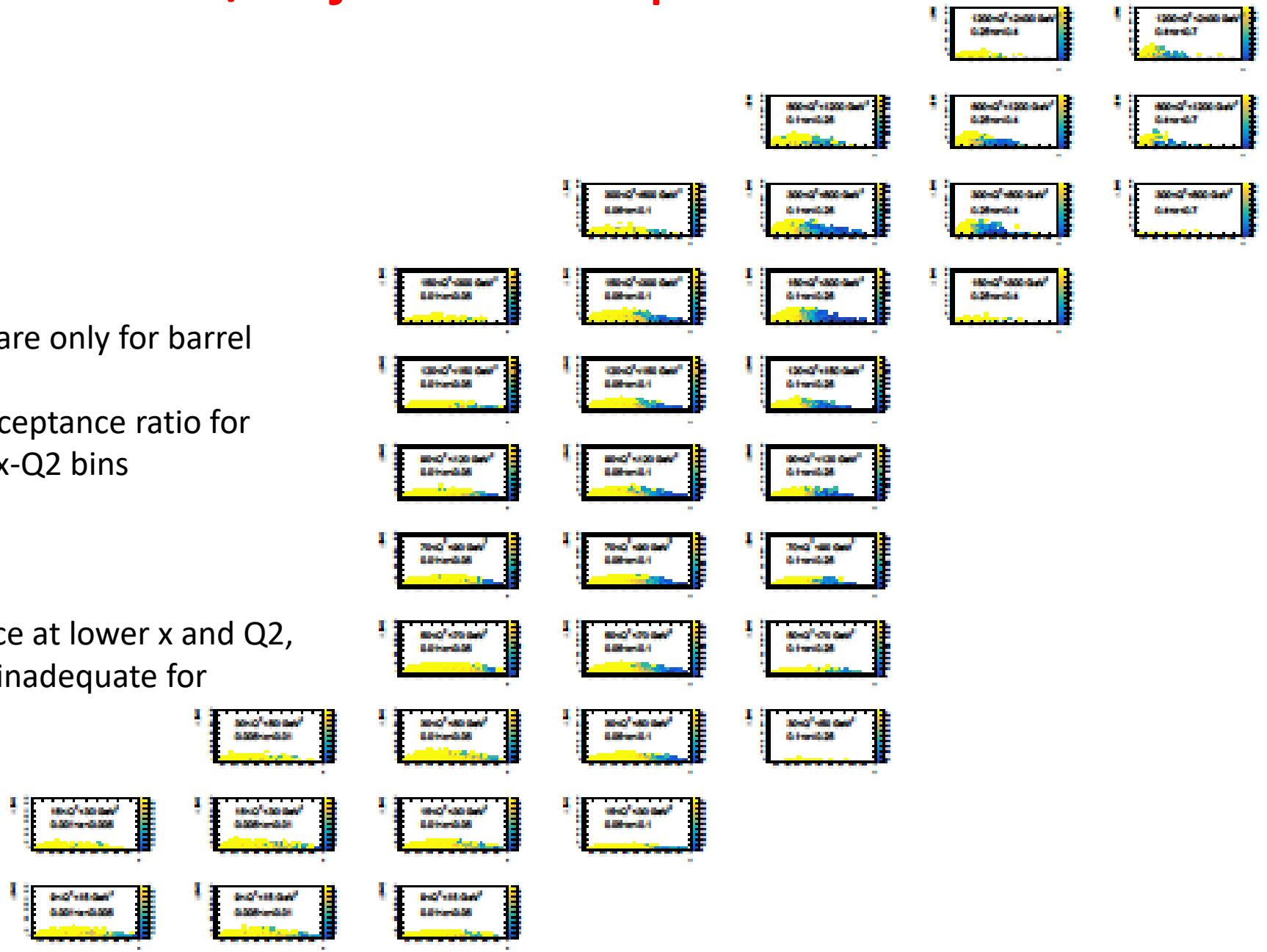
x-Q2 / z-jT Phase Space

10x100

p_T^{jet}>5 GeV

$\pi^{\pm}$-in-jet

$|\eta^{jet}|$<1



- NB: Plots for jet pT > 5 GeV also are only for barrel
- Hard to see, but compare z-jT acceptance ratio for min pT = 5 and 10 for 10x100 in x-Q2 bins
- See little change at high Q2
- Lower pT jets recover phase space at lower x and Q2, but default PID coverage will be inadequate for higher momentum jets

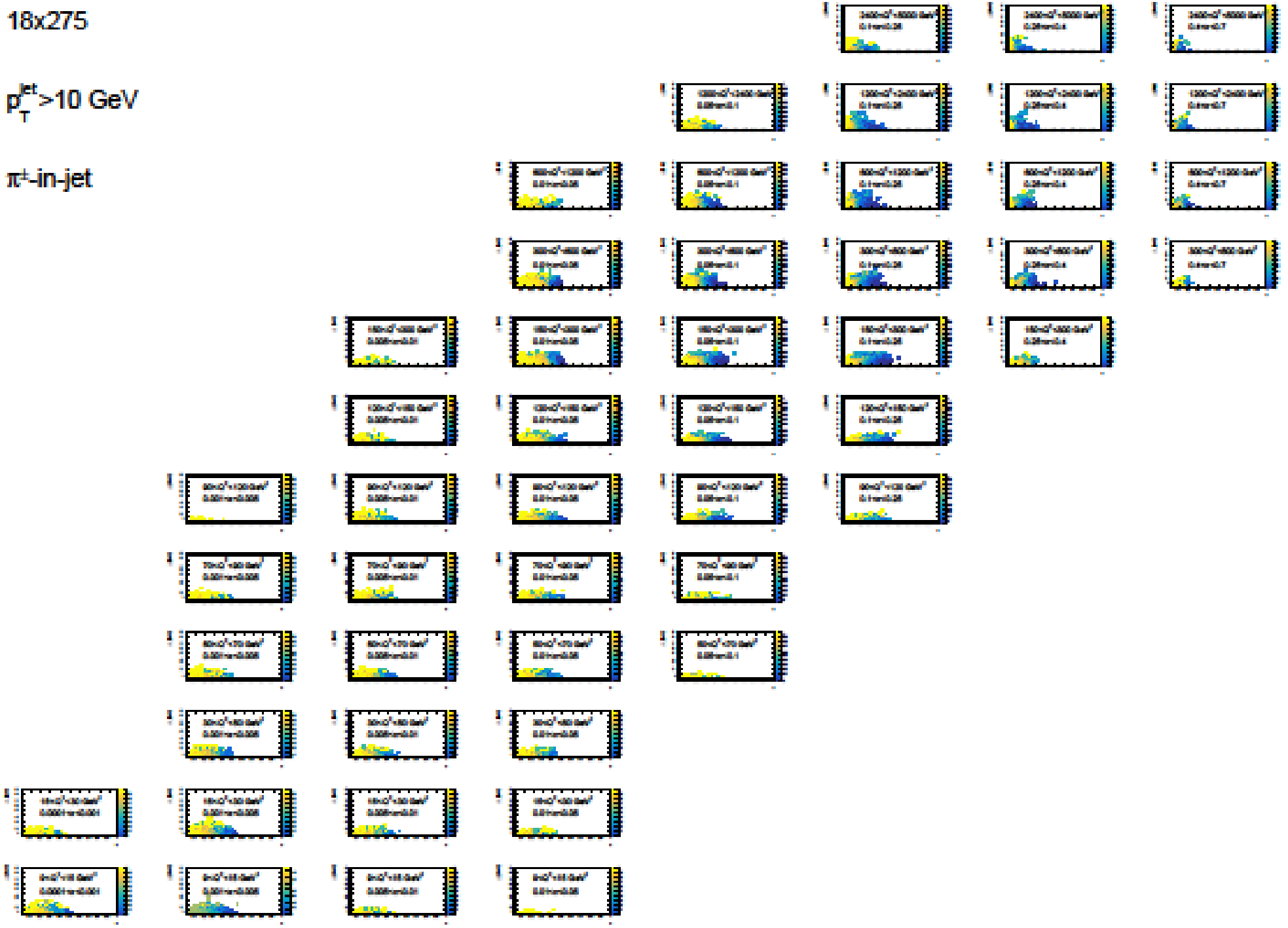
Summary

- ❑ Looked in detail at what x-Q2 jets cover in barrel and endcap for different COM energies
- ❑ Varying COM energy to move jets to more favorable PID regions unlikely to offer benefits
- ❑ PID in barrel critical for eA program where 100 GeV is top hadron beam energy
- ❑ Statistics should be sufficient for precision measurements in high momentum tails
- ❑ Default PID coverage leads to significant degradation of Collins asymmetry measurement and loss of z-jT phase space in general
- ❑ Lowering jet pT will recover some z reach, but this is a somewhat trivial solution – also want coverage for higher momentum jets

18x275

p_T^{jet}>10 GeV

$\pi^{\pm}$-in-jet



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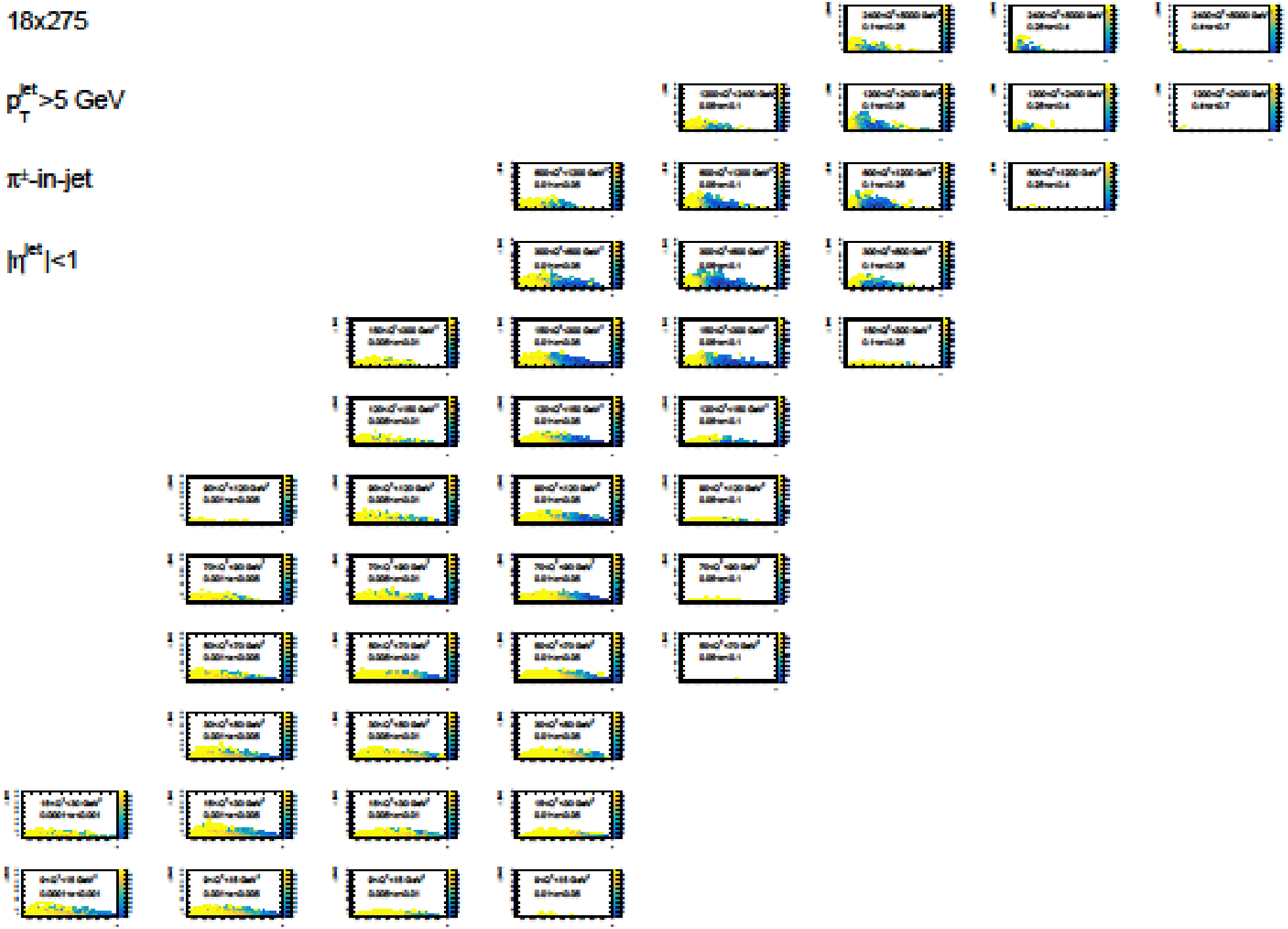
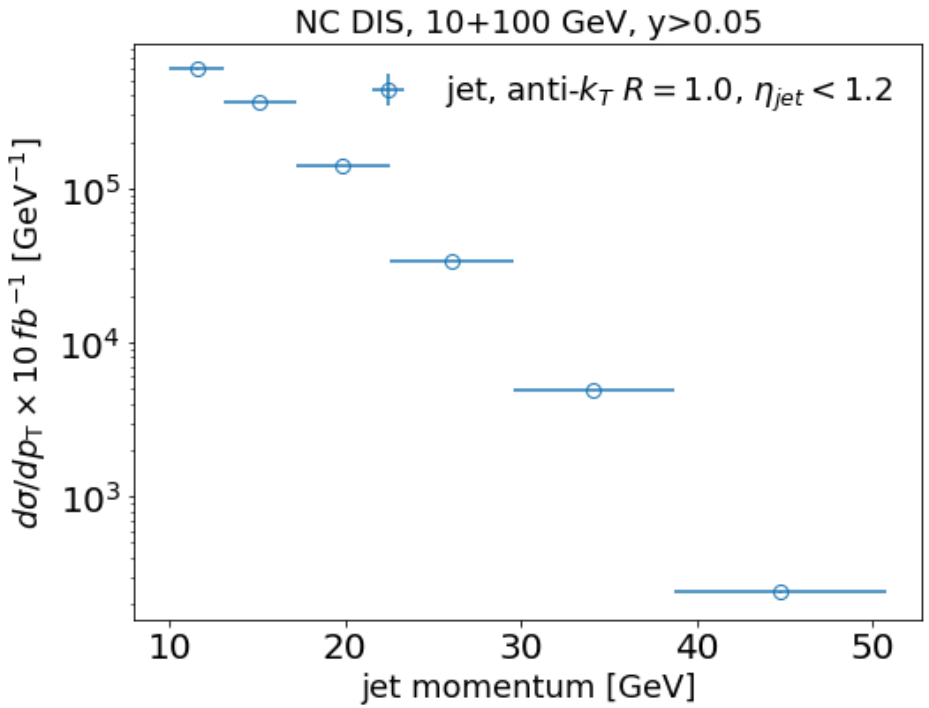
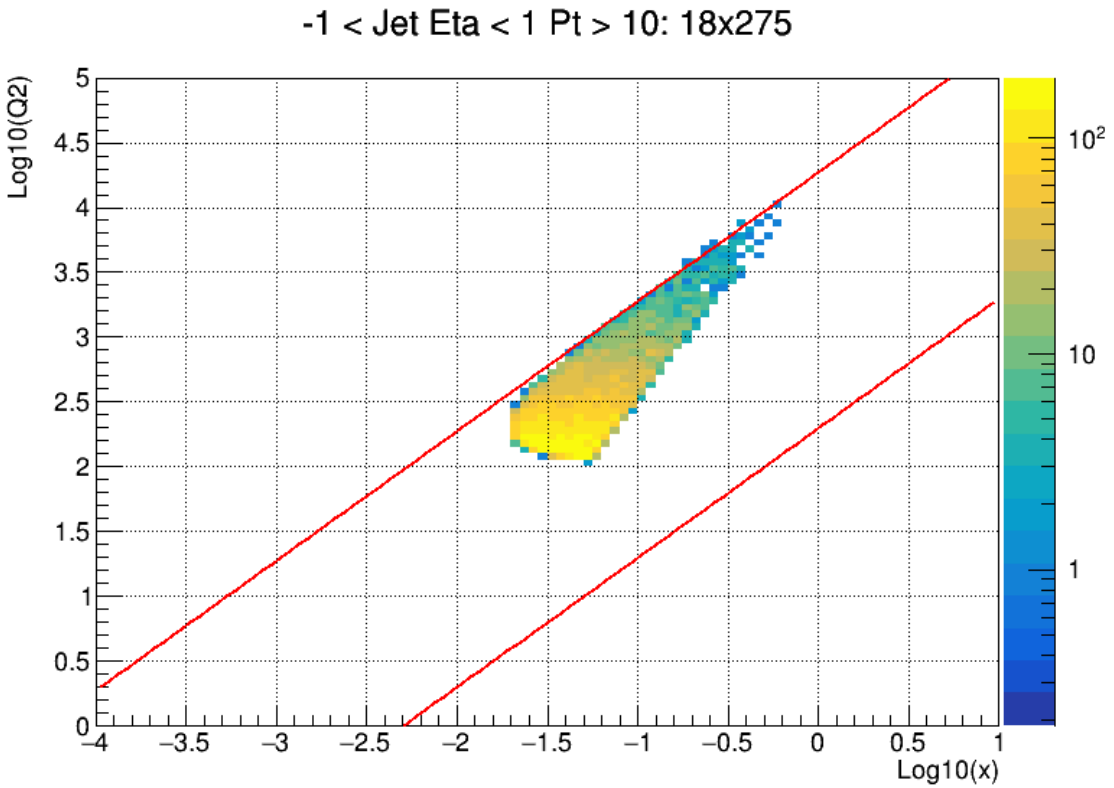
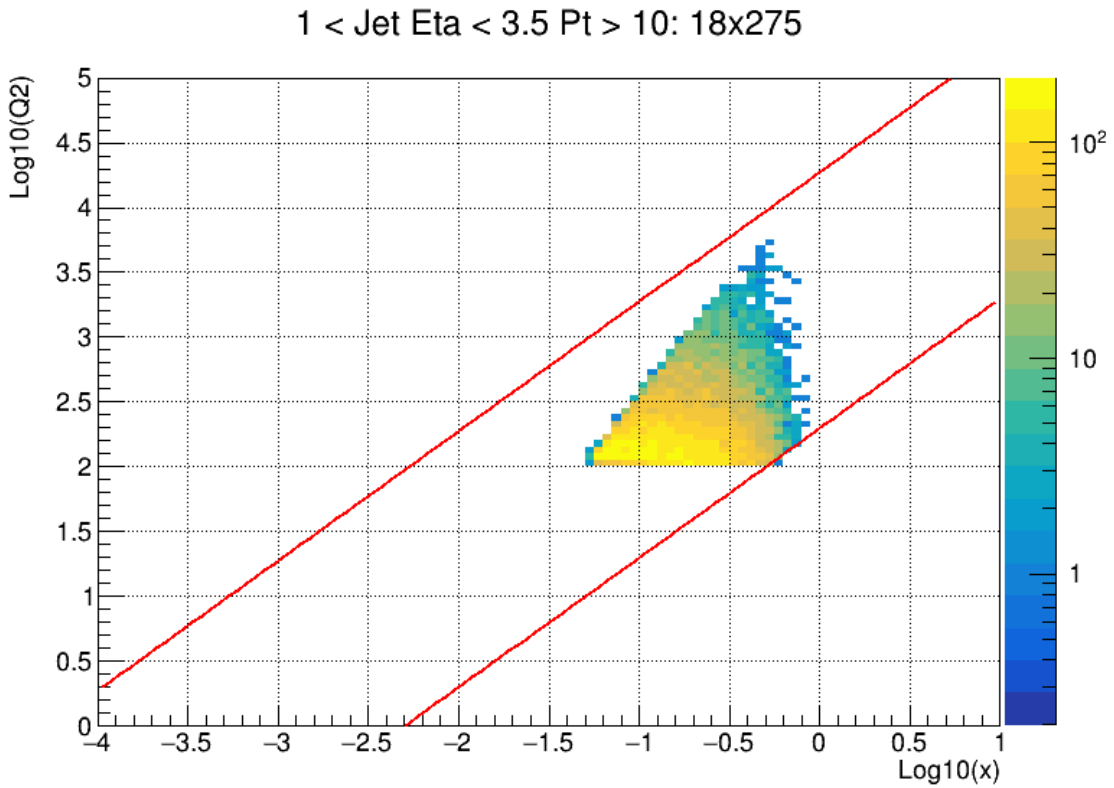



NC DIS, 10+100 GeV, y>0.05
jet, anti-k_T $R = 1.0$, $\eta_{jet} < 1.2$
$d\sigma/dp_T \times 10\,fb^{-1}$ [GeV^{-1}]
10^5
10^4
10^3
10
20
30
40
50
jet momentum [GeV]

Jet Phase Space: 18x275

- Here “jet” is actually just the struck quark in the LO DIS process – no jet finding is performed





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Jet Phase Space: 10x100