Jets and Heavy Flavor Detector Requirements Summary

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PWG Conveners Meeting

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- All requirements and supporting material can be found on our wiki page: https://wiki.bnl.gov/eicug/index.php/Yellow_Report_Physics_Jets-HF

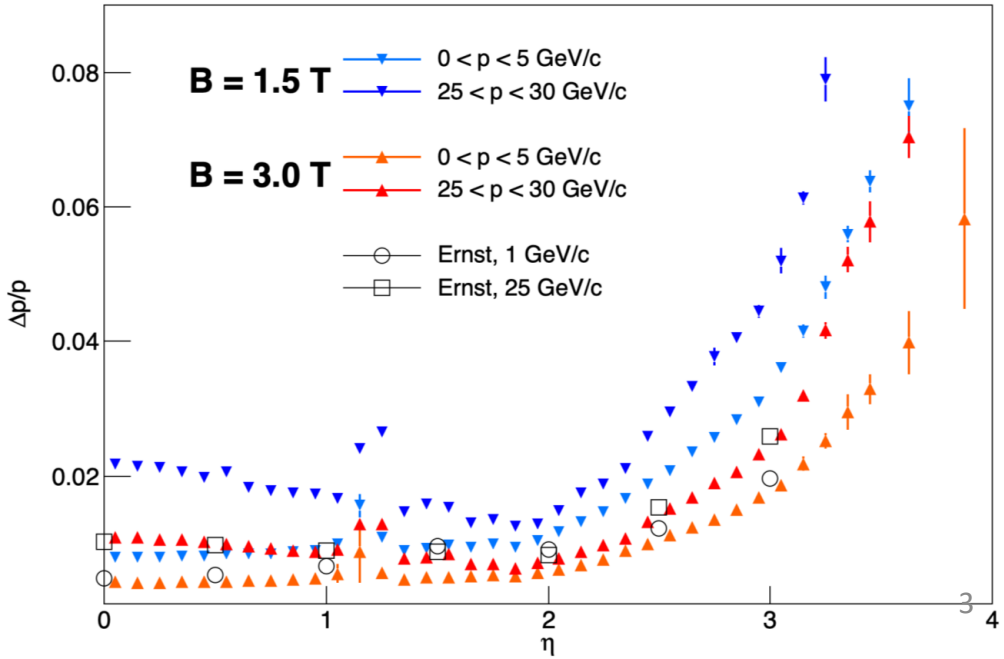
Tracking: Momentum Resolution

Track Momentum Resolution

Eta Range	Default Resolution (σP/P)%	Requested (σP/P)%
-3.5 < η < -2.5	0.1%*P + 0.5%	Same
-2.5 < η < -2.0	0.1%*P + 0.5%	Same
-2.0 < η < -1.0	0.05%*P + 0.5%	Same
-1.0 < η < 1.0	0.05%*P + 0.5%	Same
1.0 < η < 2.5	0.05%*P + 1.0%	Same
2.5 < η < 3.5	0.1%*P + 2.0%	Same

- In addition to momentum resolution and minimum p_T, it would be good to have some input on potential track efficiencies
- We also worry that in the highest eta bin, the resolution formula overestimates the achievable resolution for high momentum (~20-25+ GeV) tracks

- We also request a field for minimum track transverse momentum be included (several analyses assumed values between 100 and 250 MeV)
- This will be relevant for substructure / global event shape measurements as well as decays from HF mesons
- The soft pion from D* decays is a driver here

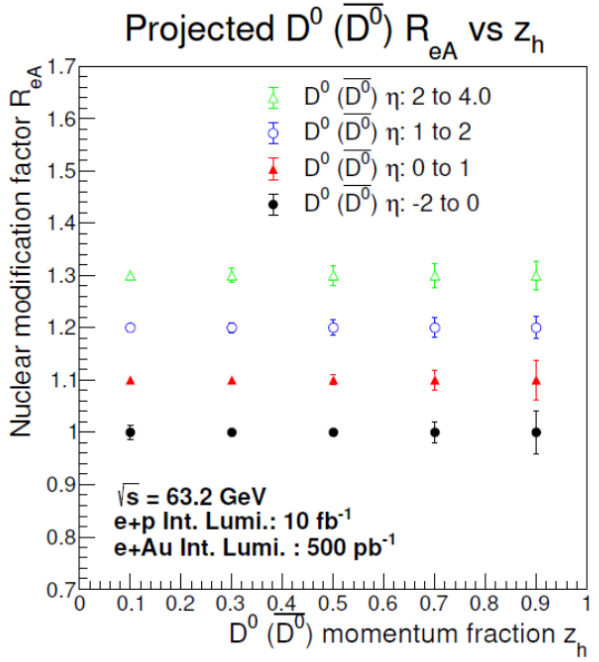


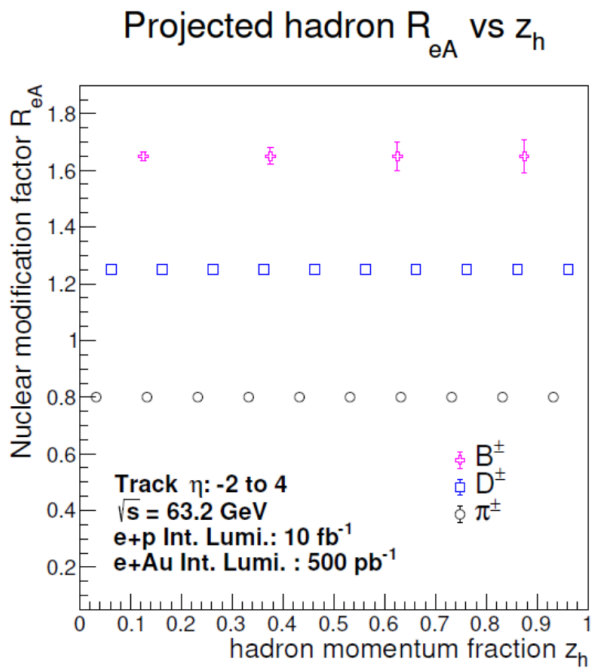
Tracking: Vertex Resolution

Vertex Resolution

Eta Range	Default Resolution	Requested Resolution
$-3.5 < \eta < -3.0$	TBD	N/A
$-3.0 < \eta < -2.5$		$\sigma_{xy} = 30/p_T + 40\ \mu m$
$-2.5 < \eta < -1.0$		$\sigma_{xy} = 30/p_T + 20\ \mu m$
$-1.0 < \eta < 1.0$	σ_{xyz}~20μm, $\sigma_{xy} \sim \sigma_z \sim 20\mu m/p_T + 5\mu m$	Same
$1.0 < \eta < 2.5$	TBD	$\sigma_{xy} = 30/p_T + 20\ \mu m$
$2.5 < \eta < 3.0$		$\sigma_{xy} = 30/p_T + 40\ \mu m$
$3.0 < \eta < 3.5$		$\sigma_{xy} = 30/p_T + 60\ \mu m$

- Vertex resolution driven by need to reconstruct charmonium and bottomonium states
- Resolutions listed above enable the high statistics measurements of ReA shown to the right for D and B mesons over a wide pseudorapidity range
- Enhancing (degrading) resolutions will improve (decrease) signal significance and decrease (increase) integrated luminosity needed to reach a given precision

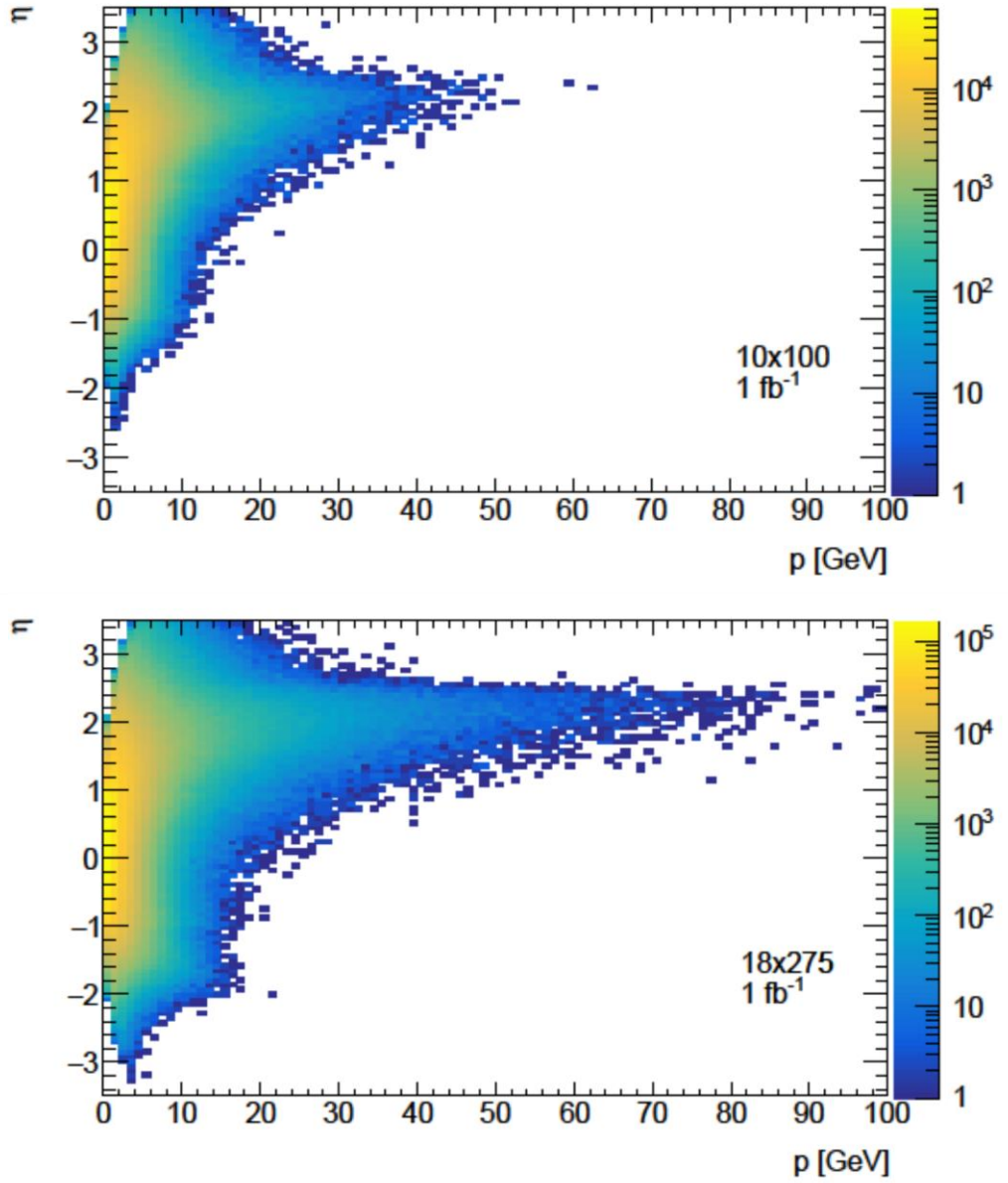




PID

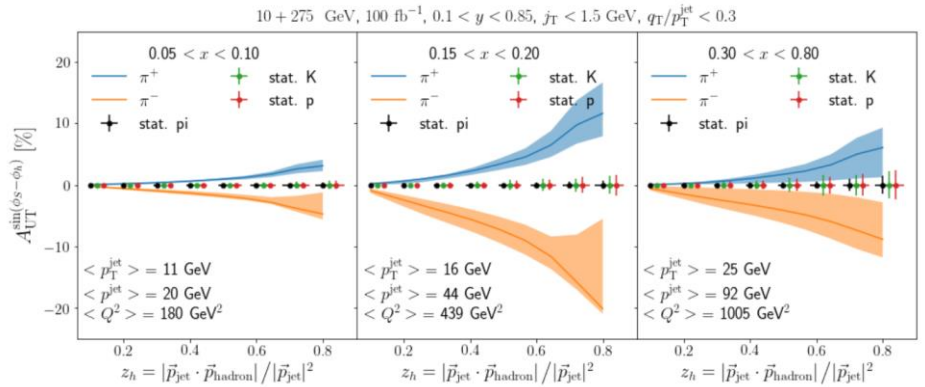
PID Momentum Coverage

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

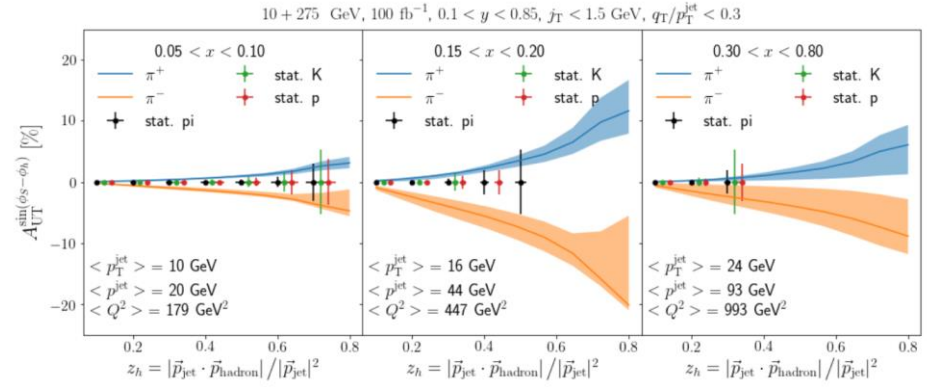


- PID requirements driven by unpolarized and polarized (Collins asymmetry) hadron-in-jet fragmentation measurements at mid to high z
- Figures to the right show charged particle momentum for different pseudorapidity – inform the eta ranges and momentum requirements above
- Very demanding expansion of PID capabilities – important for complementarity discussions

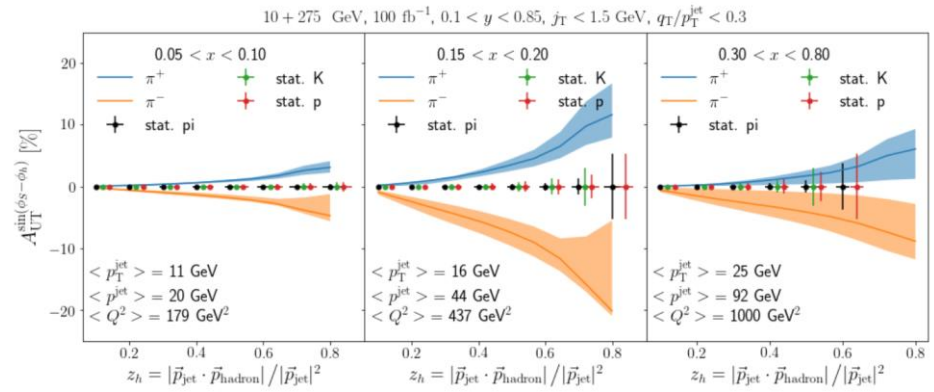
PID



Perfect

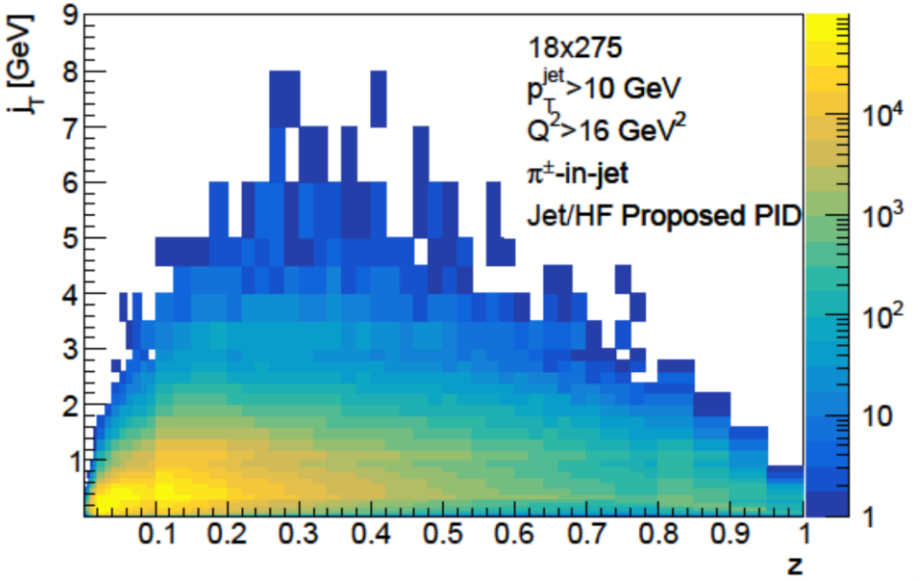


Default

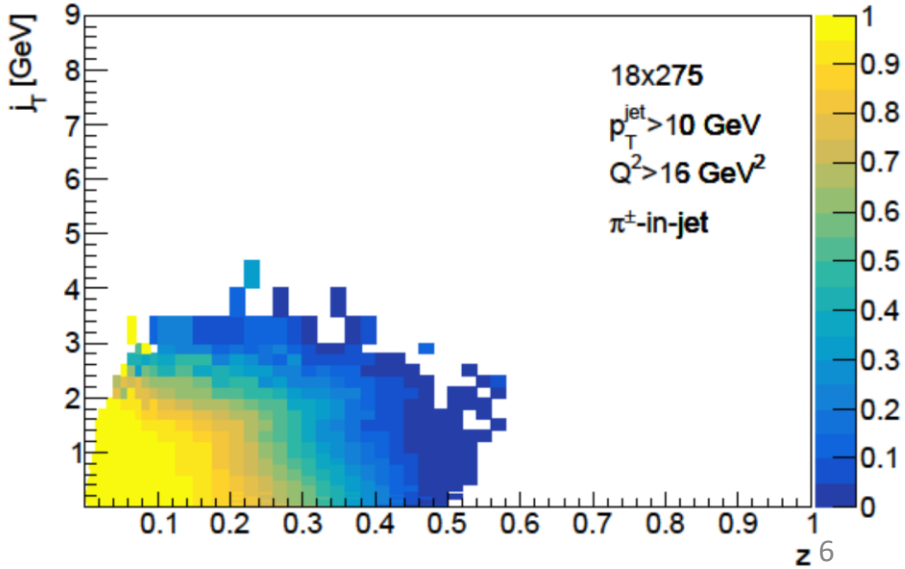


Requested

Requested Coverage: j_T Vs z



Default / Requested Ratio



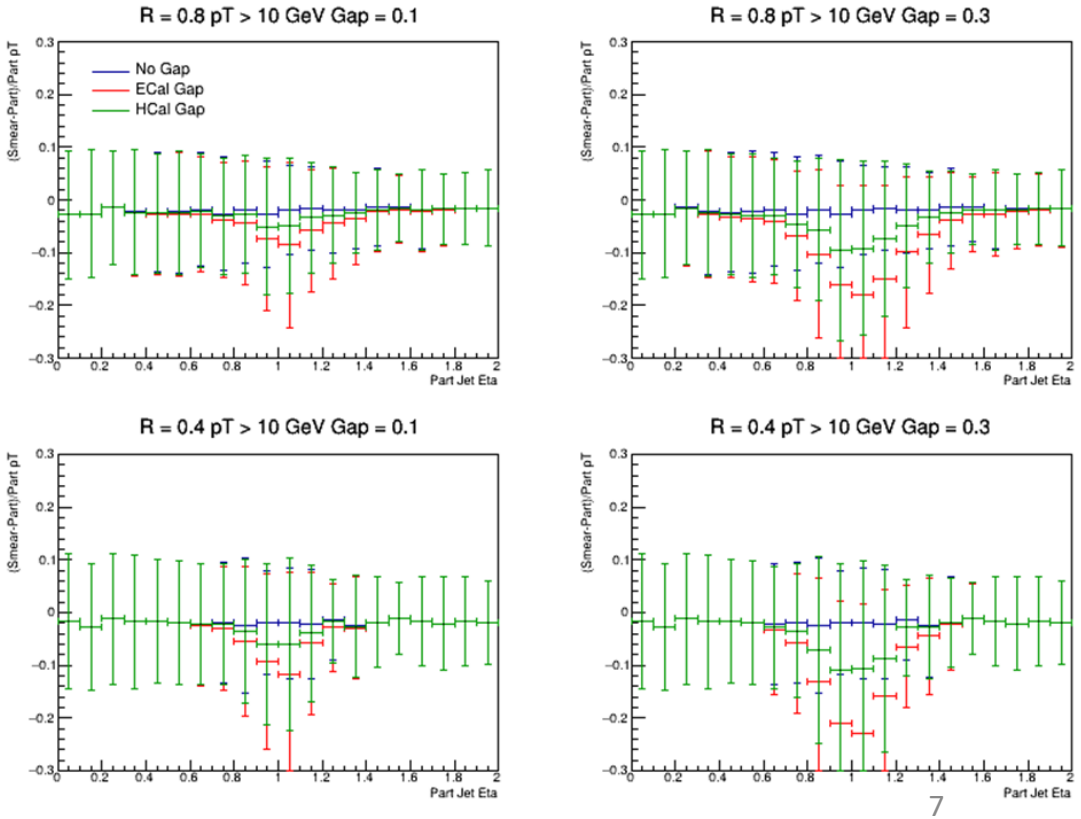
Calorimetry: Electromagnetic

EMCal Energy Resolution

Eta Range	Default Resolution (σE/E)	Requested (σE/E)
-4.5 < η < -2.5	2%/√E	Same (1-3% constant term acceptable)
-2.5 < η < -2.0	2%/√E	Same (1-3% constant term acceptable)
-2.0 < η < -1.5	7%/√E	Same (1-3% constant term acceptable)
-1.5 < η < -1.0	7%/√E	Same (1-3% constant term acceptable)
-1.0 < η < 4.5	10-12%/√E	Same (1-3% constant term acceptable)

- Default ECal energy resolutions were found to be sufficient for our needs – even with the addition of realistic constant terms of 1 to 3%
- As with tracker, would like guidance on minimum cluster energy
- Would also like estimate on achievable cluster position resolution and separation
- Can the ECal actually extend to eta of 4.5?

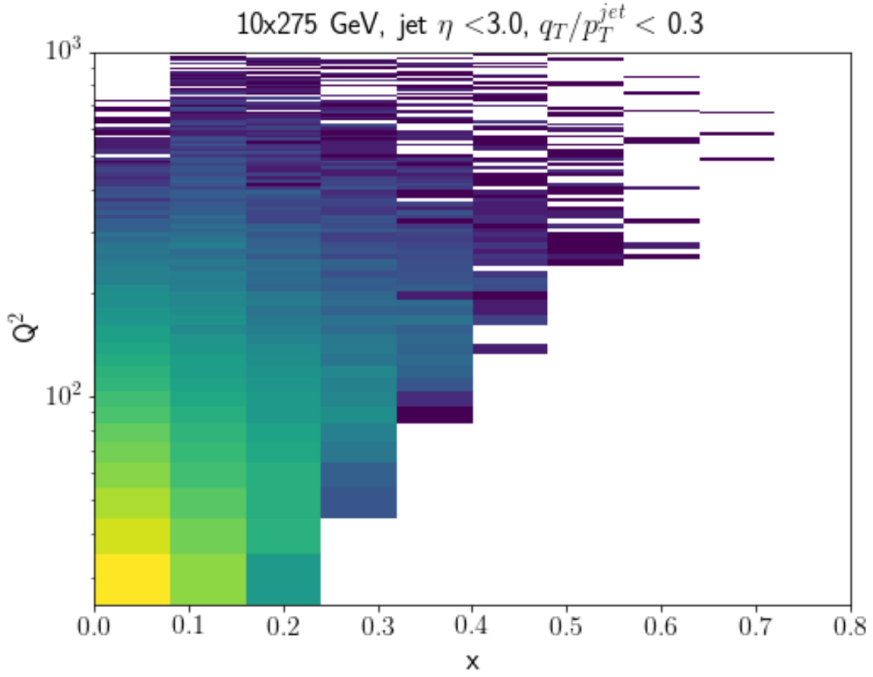
- Also looked at the effect of a service gap (eta = 0.1 or 0.3) on jet reconstruction
- Advocate for the most complete coverage possible

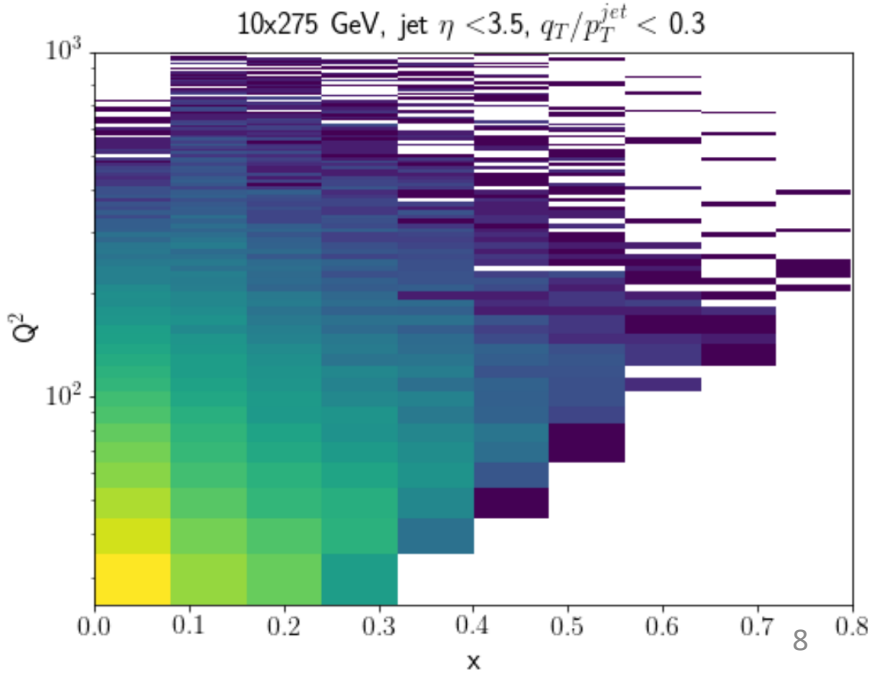


Calorimetry: Hadronic

HCal Energy Resolution

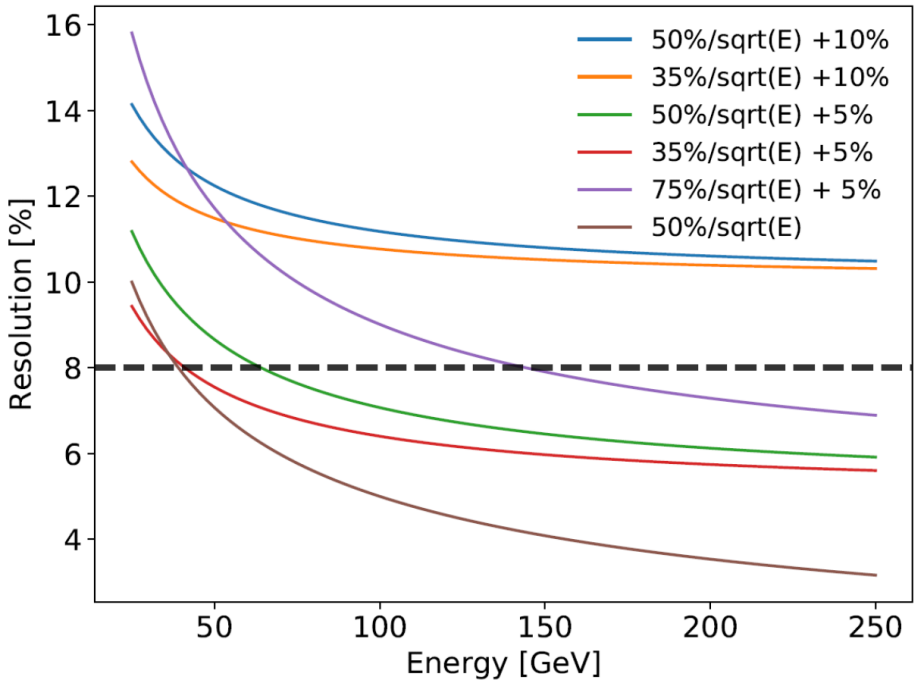
Eta Range	Default Resolution (σE/E)	Requested (σE/E)
-3.5 < η < -1.0	50%/√E	Same (~10% constant term is acceptable)
-1.0 < η < 1.0	N/A	85%/√E + 10%
1.0 < η < 3.0	50%/√E	50%/√E + 10%
3.0 < η < 3.5		50%/√E + 5%
3.5 < η < 4.0	N/A	





- Barrel HCal requested for missing transverse energy measurements in CC events (also for Jaquet-Blondel), measurement of neutral hadrons
- 100%/√E sufficient for missing energy, but seen that better resolution needed for accurate jet reconstruction toward smaller eta values
- Request coverage extension up to eta = 4 to gain access to higher x values – constant term of 5% for eta > 3 (constant term dominates at these energies) keeps jet energy resolutions at required levels for measurements such as lepton-jet Sivers
- More study of position resolution / potential cluster separation needed as being able to select jets with no neutral hadron shows possibility of greatly improving jet energy resolution, especially at low eta / p_T / x

Calorimetry: Hadronic



- Plot of different HCal stochastic and constant term combinations shows that constant term dominates at large energy (high eta)

- Improving resolution of barrel HCal can reduce bias in jet energy scale at low eta caused by poorly reconstructed neutral hadrons as seen in left plot below
- Using HCal as a 'neutral hadron veto' can substantially improve jet energy resolution and reduce scale bias as seen in the right plot below