Kinematic reconstruction for SIDIS processes

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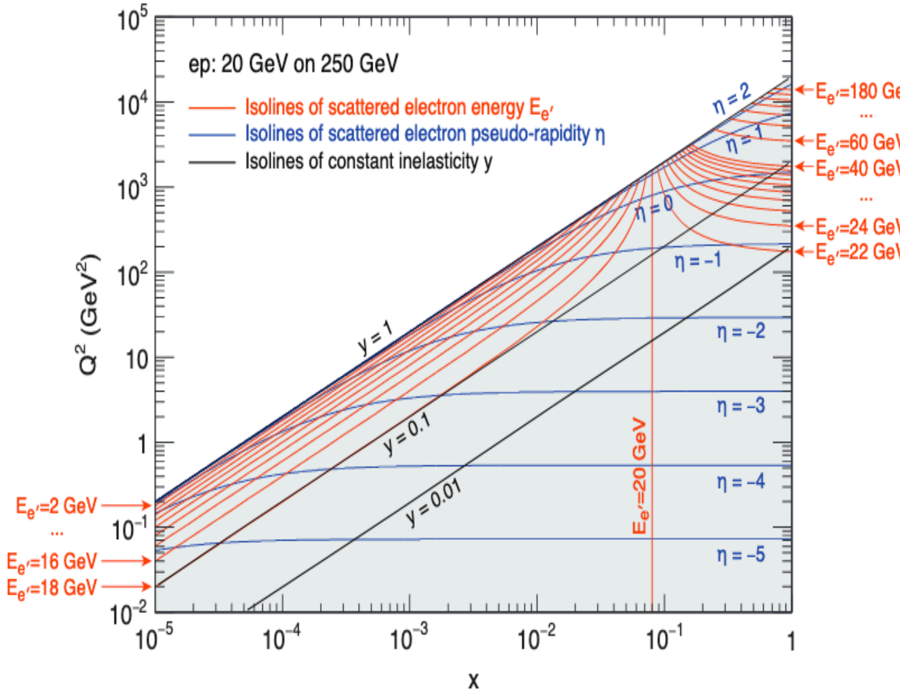
What is the issue

- At low y resolution of kinematic variables x_{Bj}, Q^2 suffers due to relatively large uncertainty on y
- →potentially also a problem for ϕ measurements in Breit frame, due to q dependent boost (haven't looked at this yet, but Q^2 resolution is in general less problematic then x_{Bj}, so there is hope)
- The low y region is the overlap region with the Jlab kinematic regime
- At low y, we also loose sensitivity to pretzelosity g_{1L} and worm-gear g_{1T}



What can be done?

- Reconstruct kinematic variables from final state
- Multiple methods available
  - Jaquet-Blondel
  - Double-Angle
  - Mixed Method
- See plots in

eRHIC Design Study
An Electron-Ion Collider at BNL

for studies with
BEAST detector

(in backup slides)

i)	*Leptonic variables*	$q \equiv q_l = k_2 - k_1, \quad y_l = p_1.(k_1 - k_2)/p_1.k_1$
ii)	*Hadronic variables* [81]	$q \equiv q_h = p_2 - p_1, \quad y_l = p_1.(p_2 - p_1)/p_1.k_1$
iii)	*Jacquet-Blondel variables* [82]	$Q^2_{JB} = (\vec{p}_{2,\perp})^2/(1 - y_{JB}), \quad y_{JB} = \Sigma/(2E(k_1))$ $\Sigma = \sum_h (E_h - p_{h,z})$
iv)	*Mixed variables* [81]	$q = q_l, y_m = y_{JB}$
v)	*Double angle method* [83]	$Q^2_{DA} = \frac{4E(k_2)^2 \cos^2(\theta(k_2)/2)}{\sin^2(\theta(k_2)/2 + \sin(\theta(k_2)/2)\cos(\theta(k_2)/2)\tan(\theta(p_2)/2)},$ $y_{DA} = 1 - \frac{\sin(\theta(k_2)/2)}{\sin(\theta(k_2)/2) + \cos(\theta(k_2)/2)\tan(\theta(p_2)/2)},$
vi)	θy *method* [84]	$Q^2_{\theta y} = 4E(k_2)^2(1 - y_{JB})\frac{1 + \cos(\theta(k_2))}{1 - \cos(\theta(k_2))}, \quad y_{\theta y} = y_{JB}$
vii)	Σ *method* [85]	$Q^2_\Sigma = \frac{(\vec{k}_{2,\perp})^2}{1 - y_\Sigma}, \quad y_\Sigma = \frac{\Sigma}{\Sigma + E(k_2)[1 - \cos(\theta(k_2))]}$
viii)	$e\Sigma$ *method* [85]	$Q^2_{e\Sigma} = Q^2_l, \quad y_{e\Sigma} = \frac{Q^2_l}{s x_\Sigma}$

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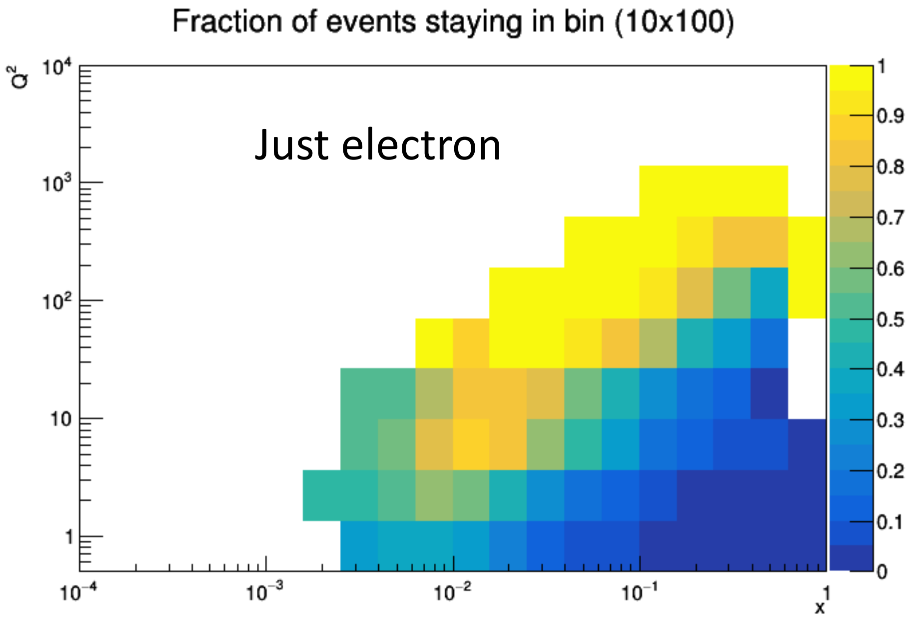
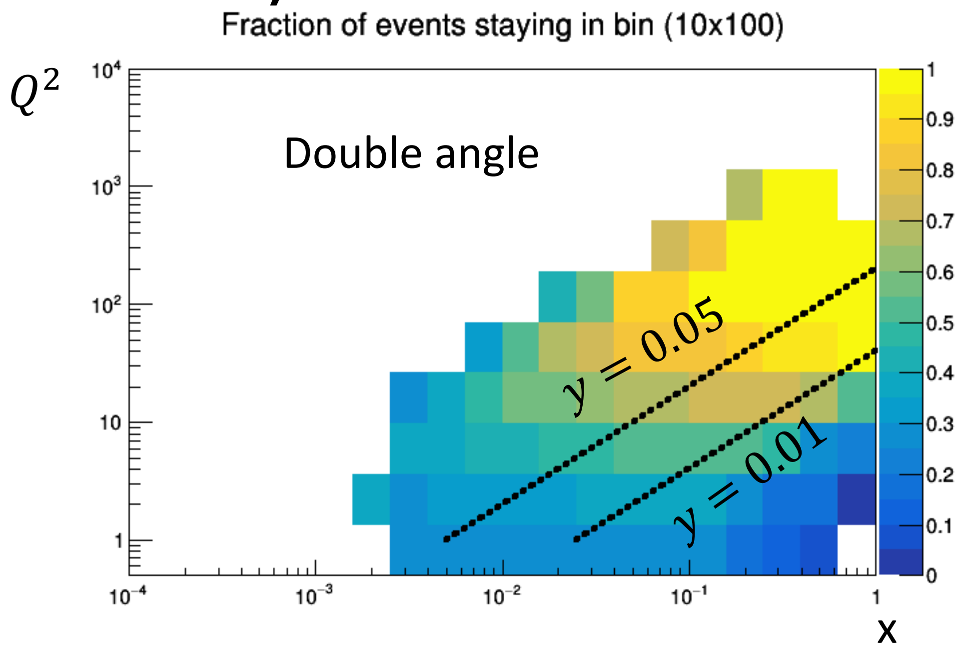
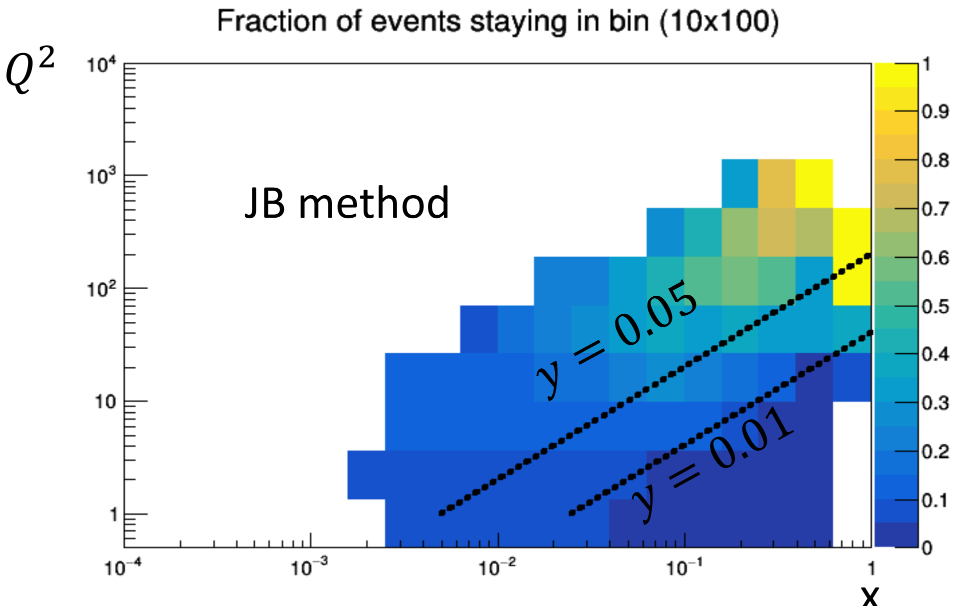
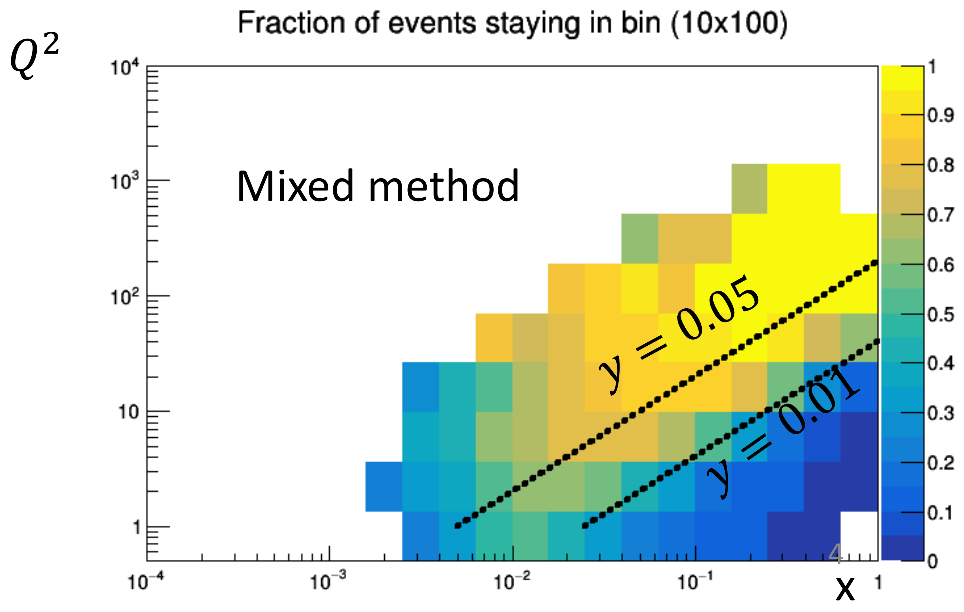
Bluemlein, arXiv:1208.6087

Results with EIC smear (100k events)

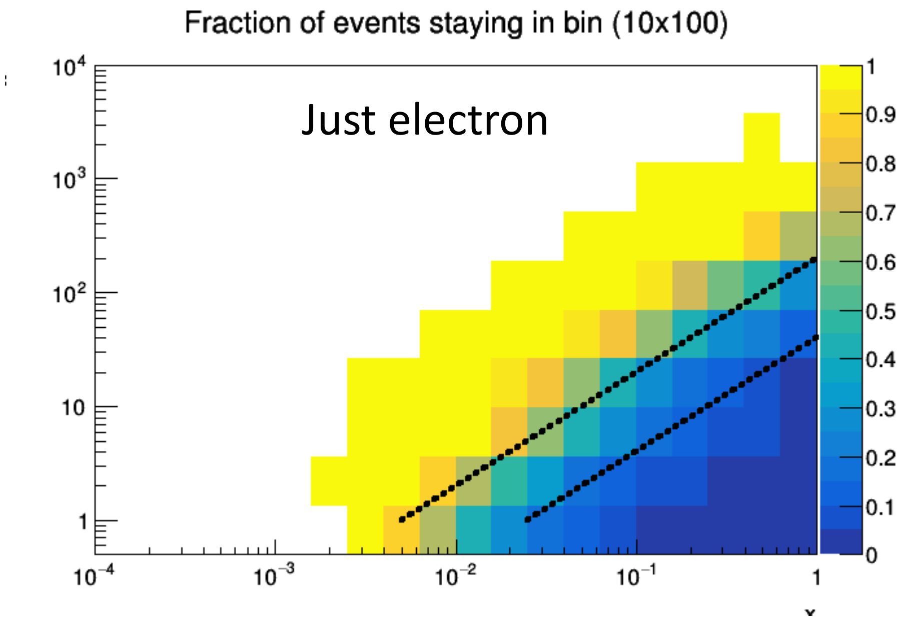


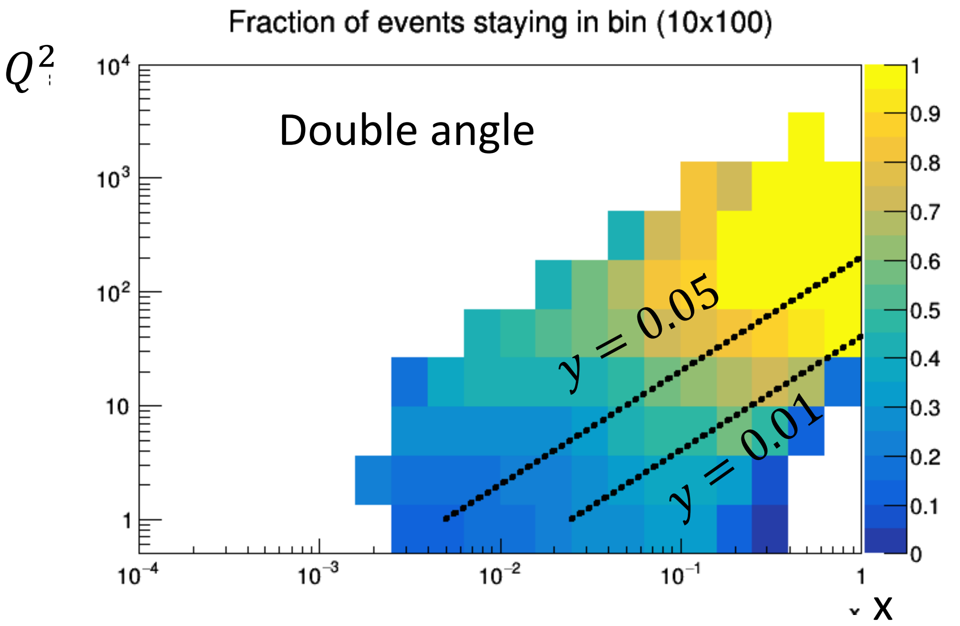


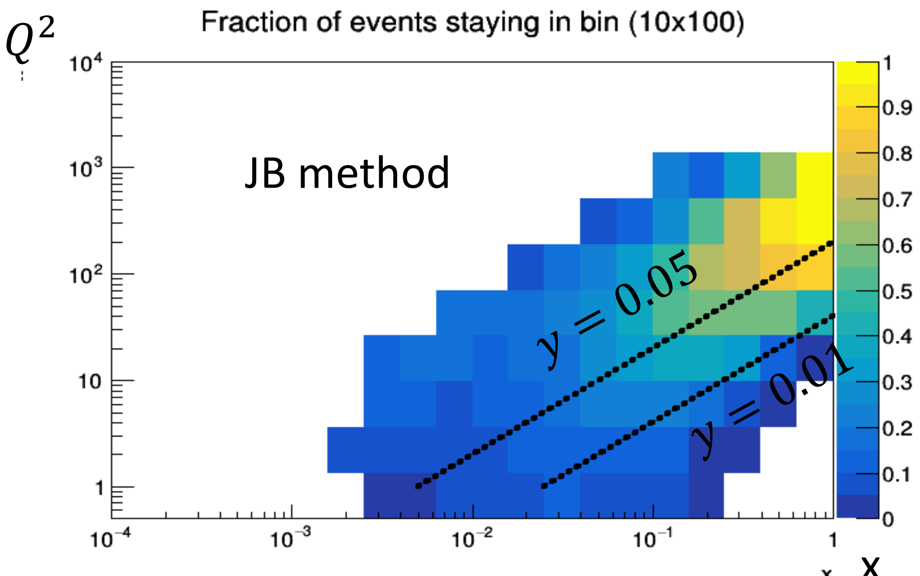


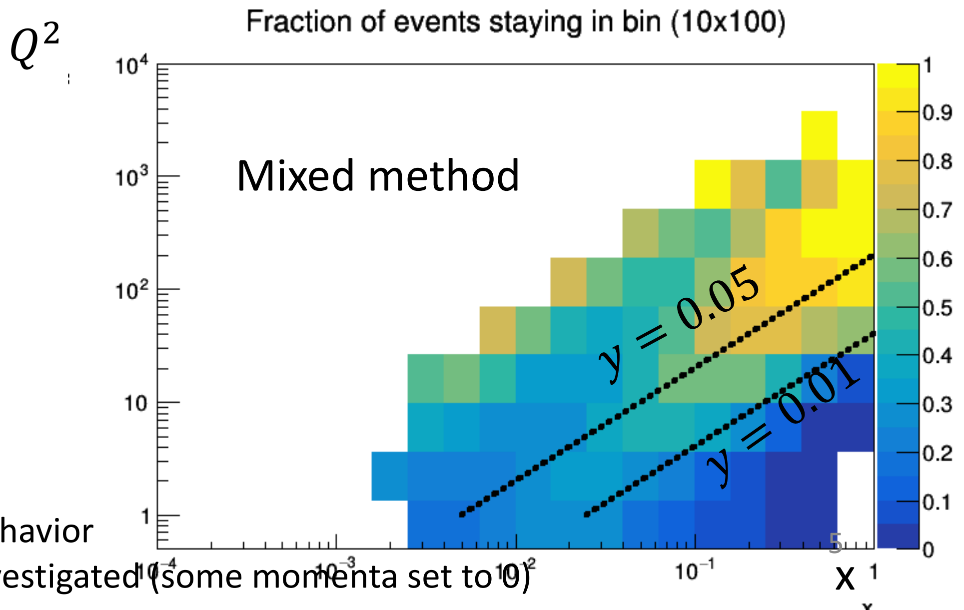


Using Delphes+EFlow: consistent results



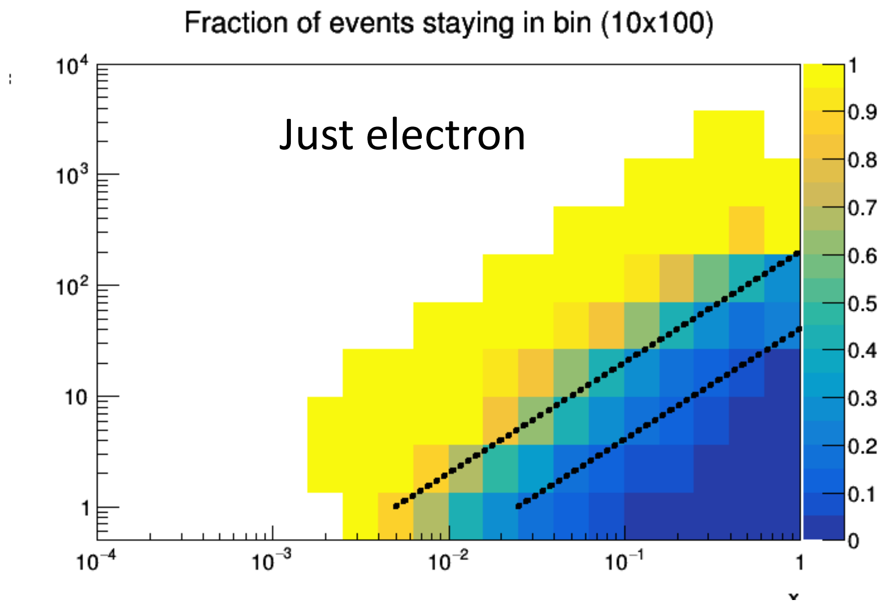


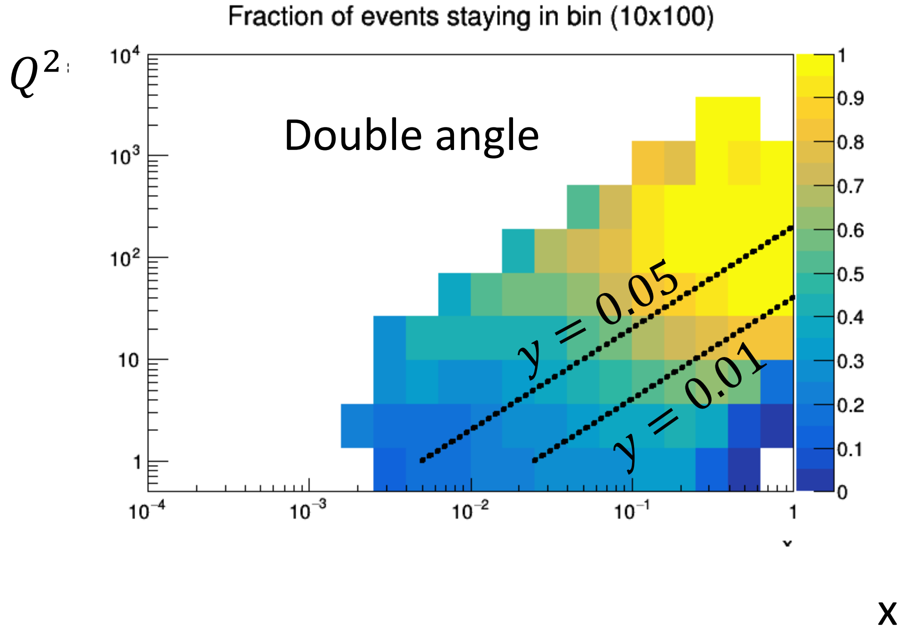


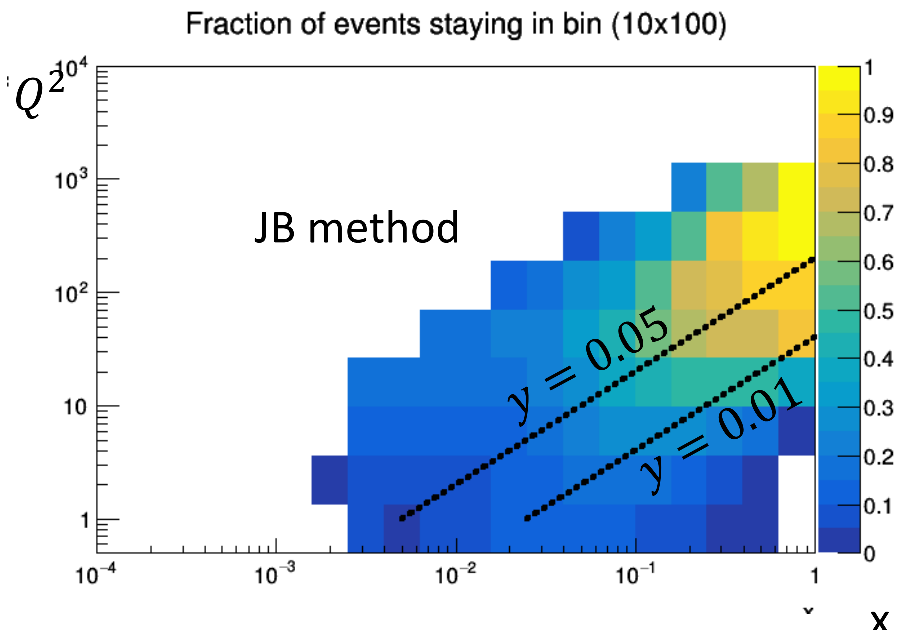


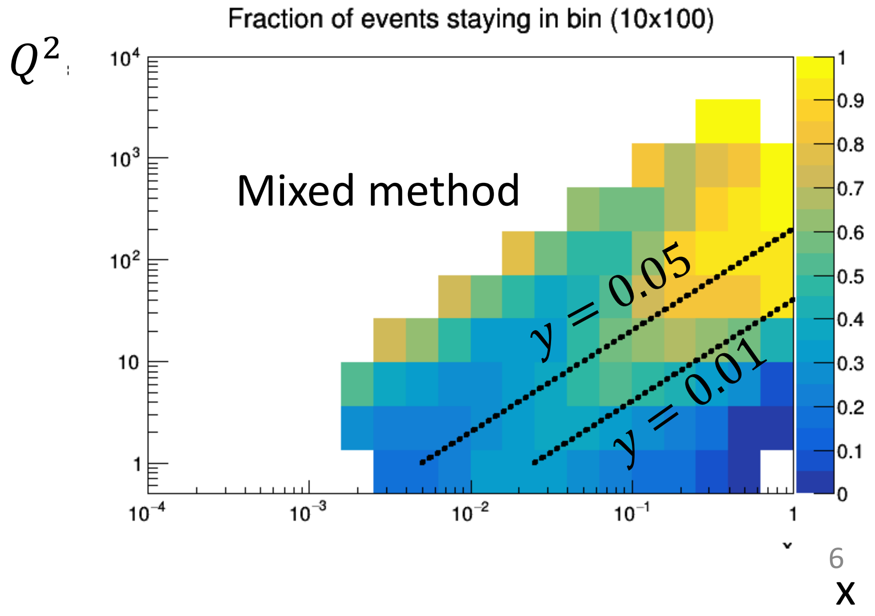
NB: we observed some strange behavior using eflow which is still being investigated (some momenta set to 0)

Expanding coverage to $|\eta| < 4$

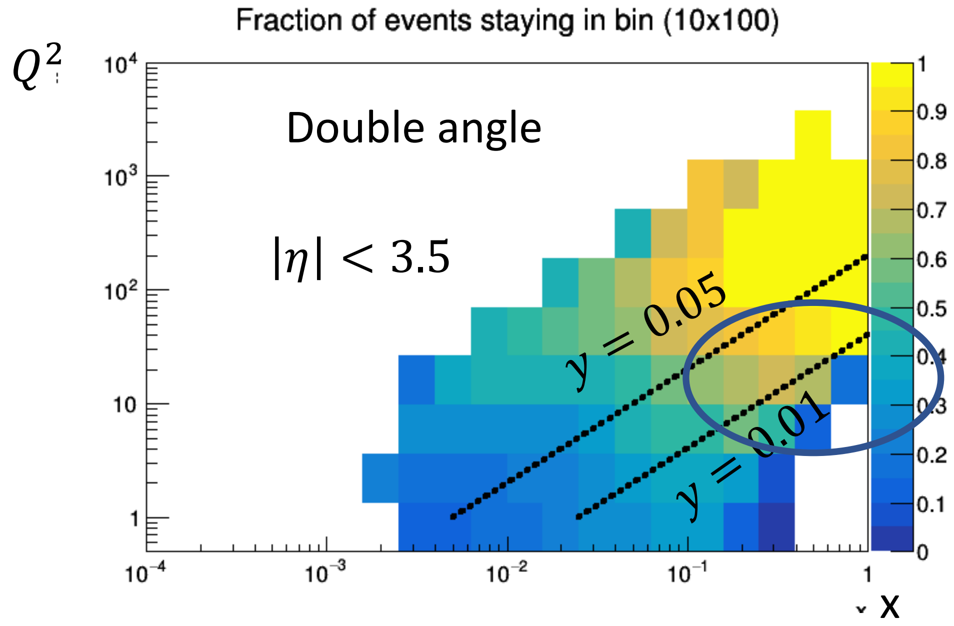


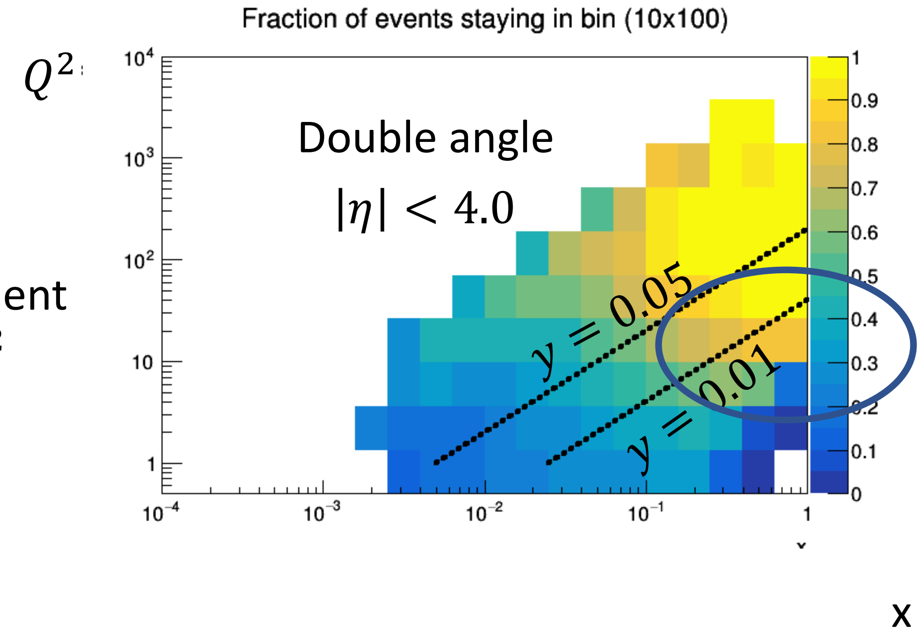




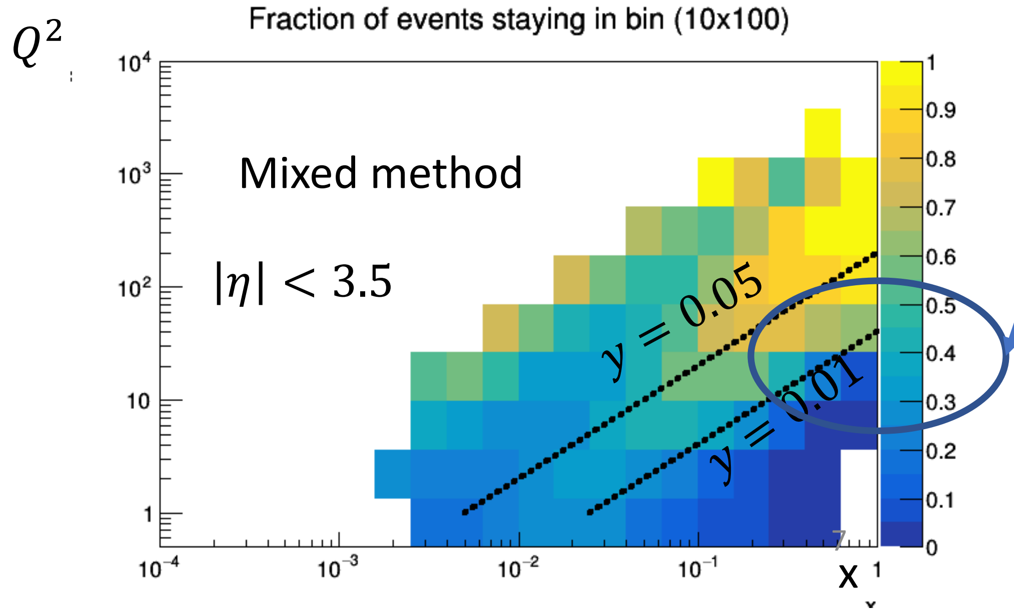


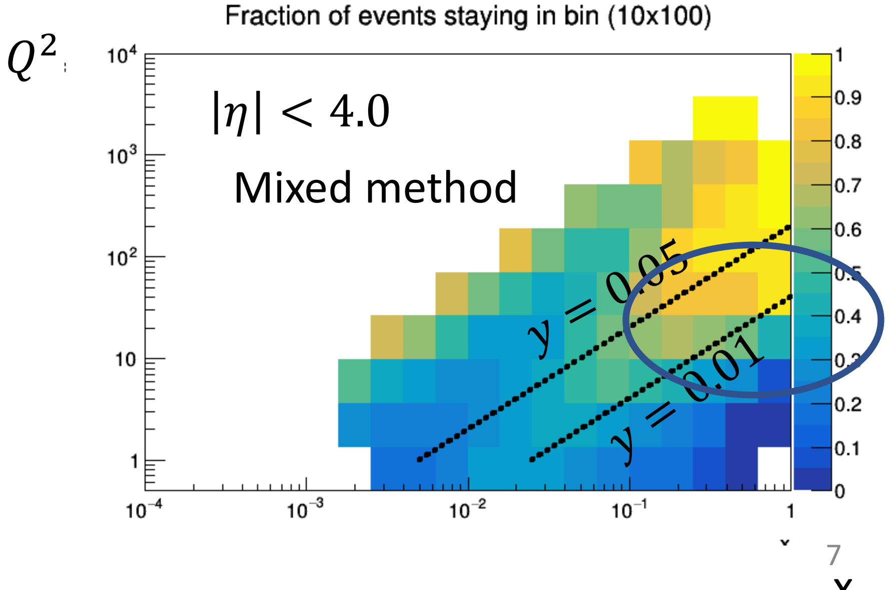
Comparison



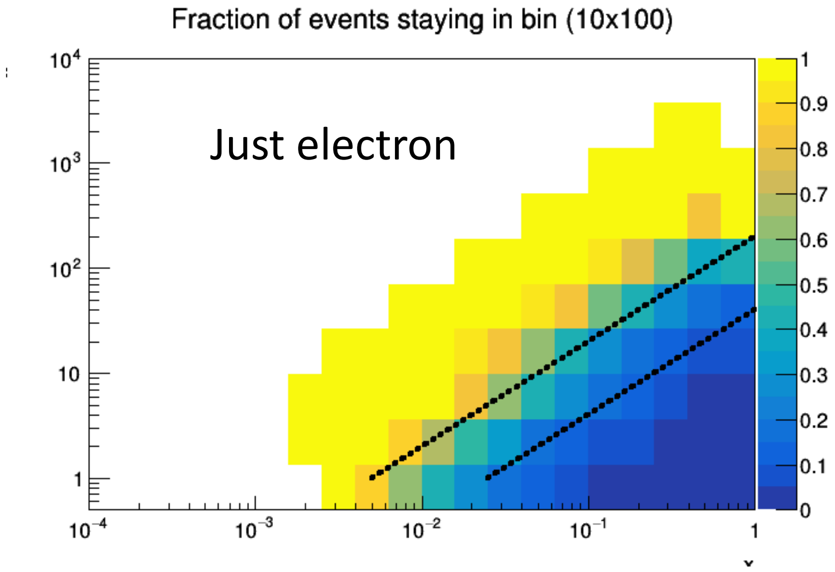


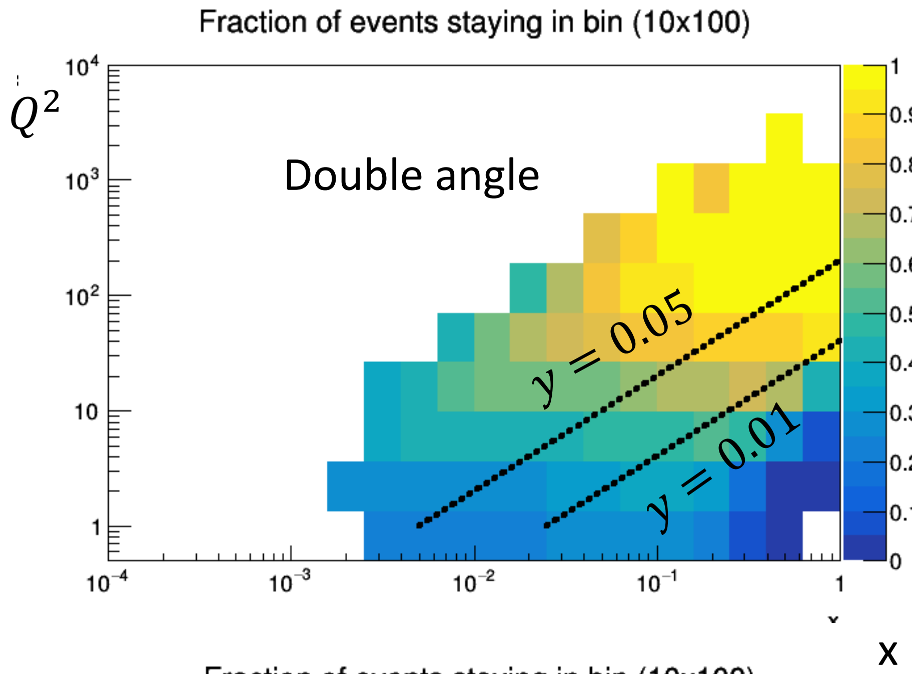
Some improvement
At low x high Q^2

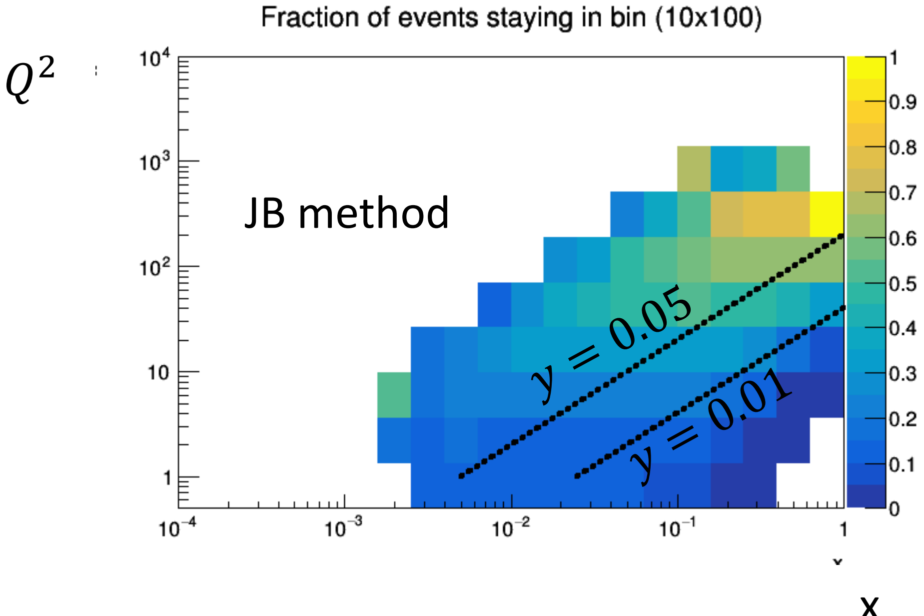




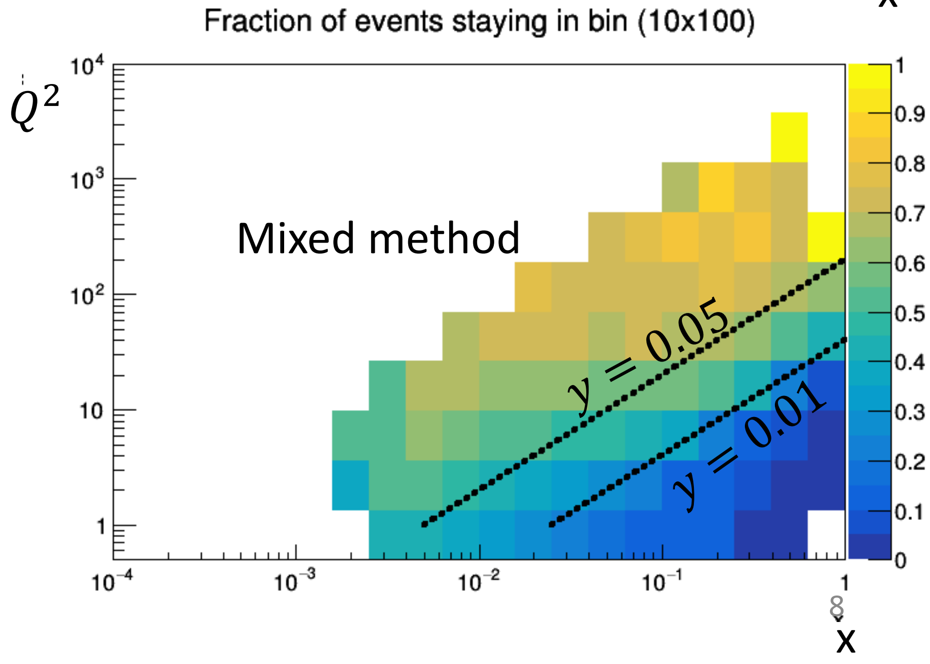
No HCAL, $|\eta| < 3.5$



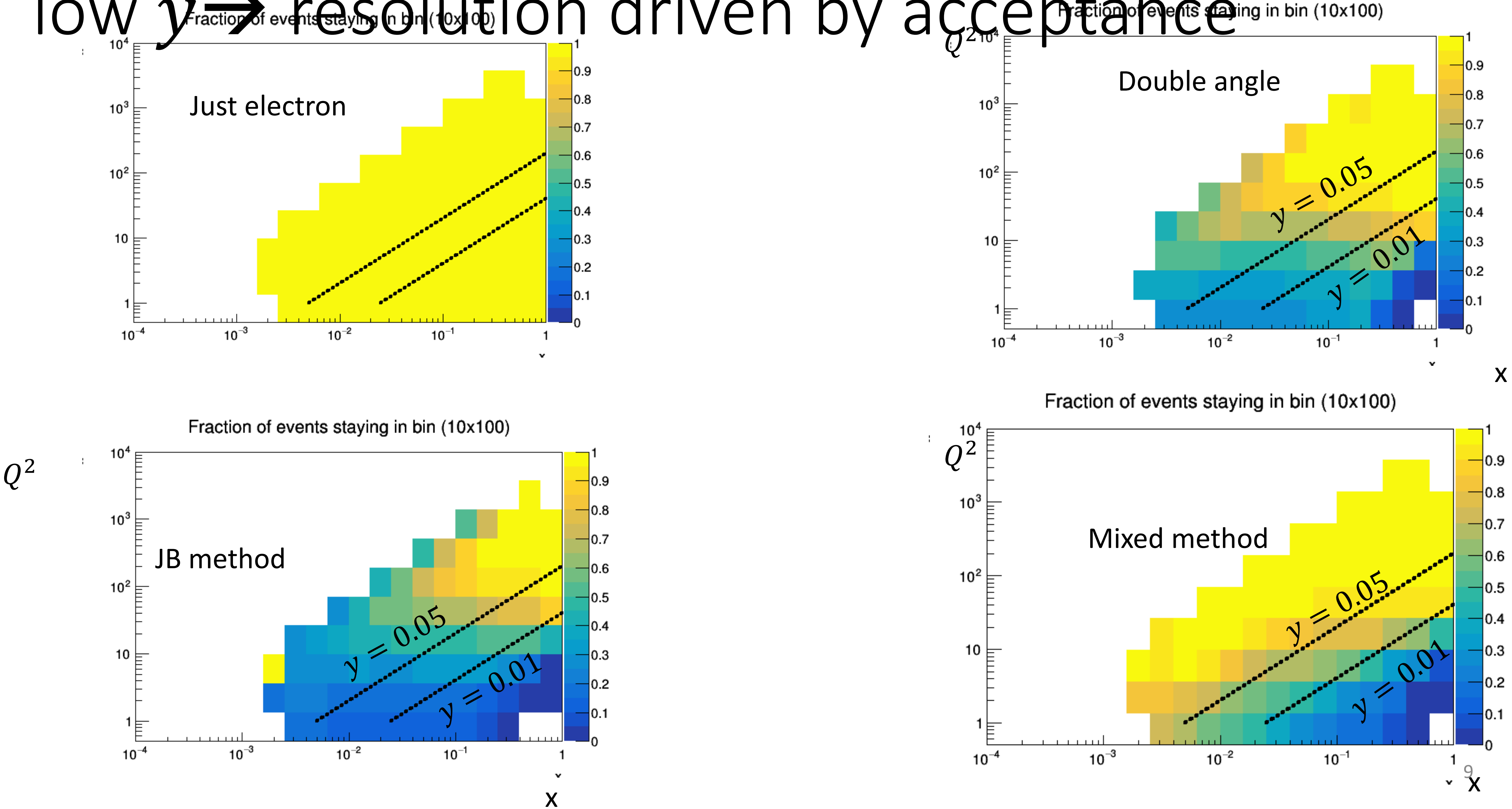




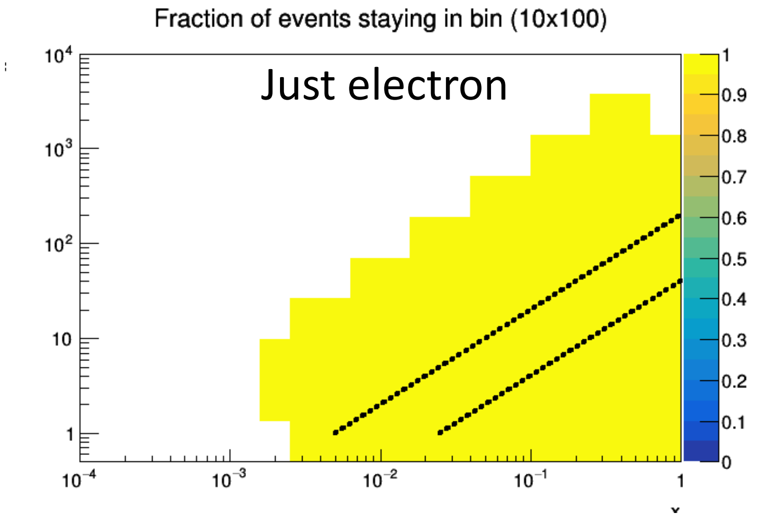
JB method worse, others
Same if not better?

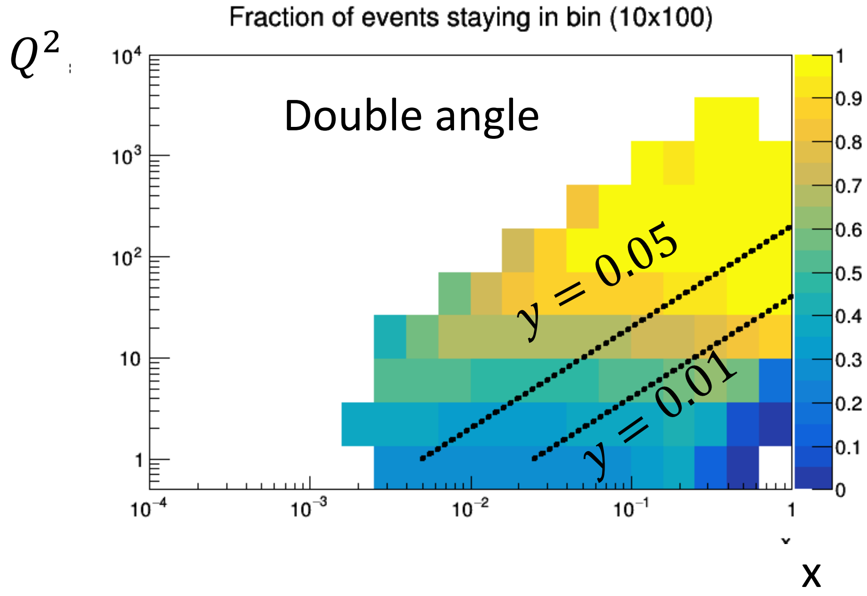


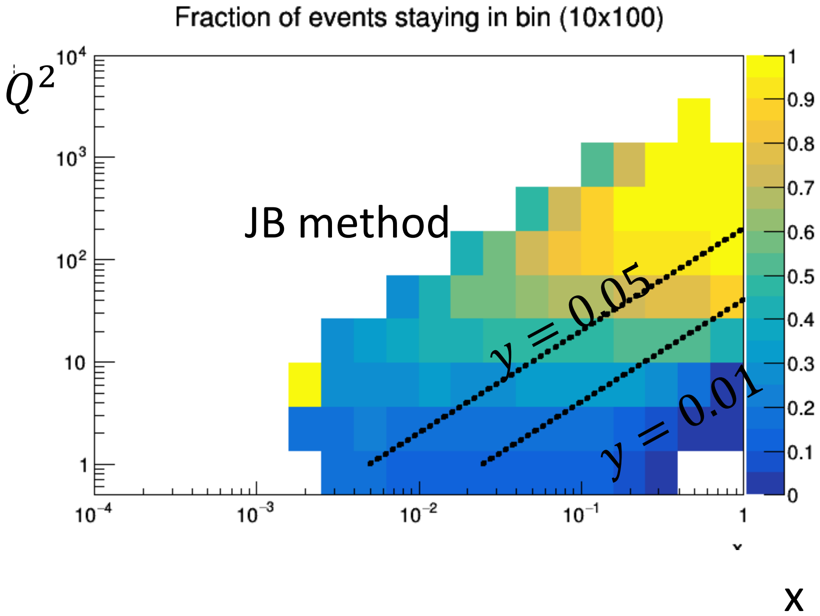
Perfect detector $|\eta| < 4.0$: minimal gain at low $y \rightarrow$ resolution driven by acceptance

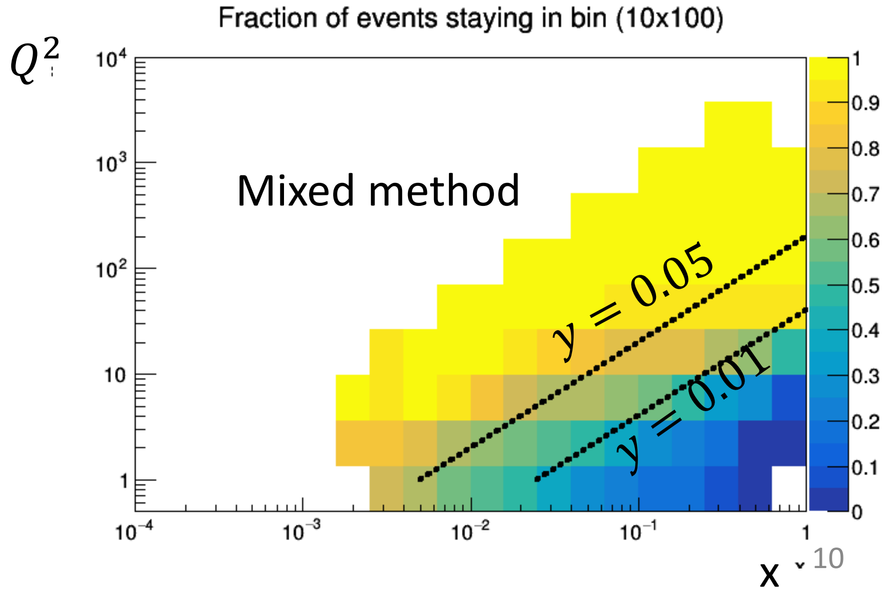


Perfect detector with min p_T cut: little change

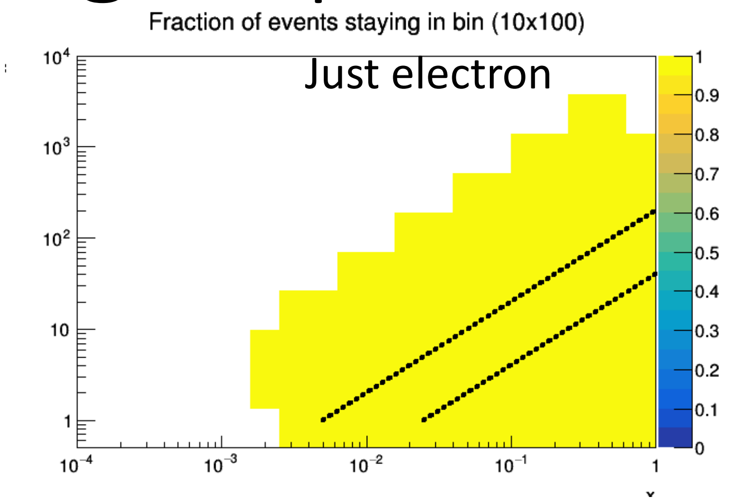


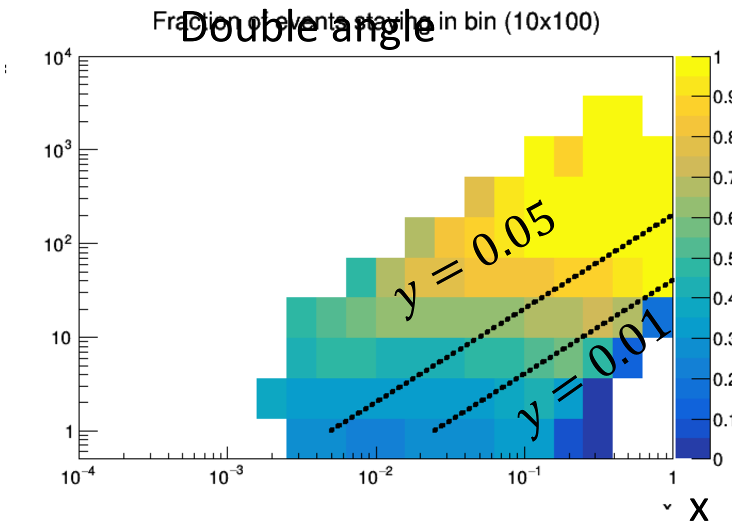


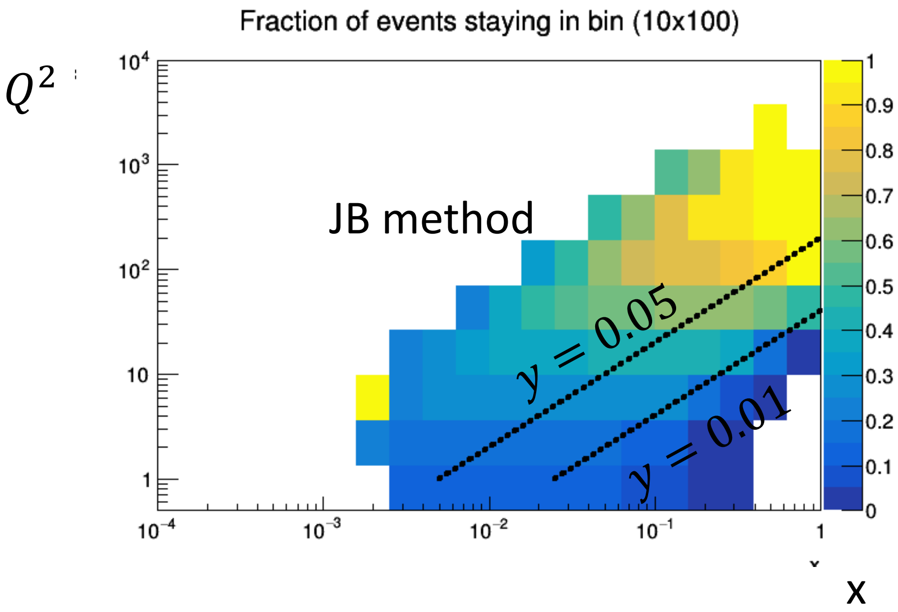


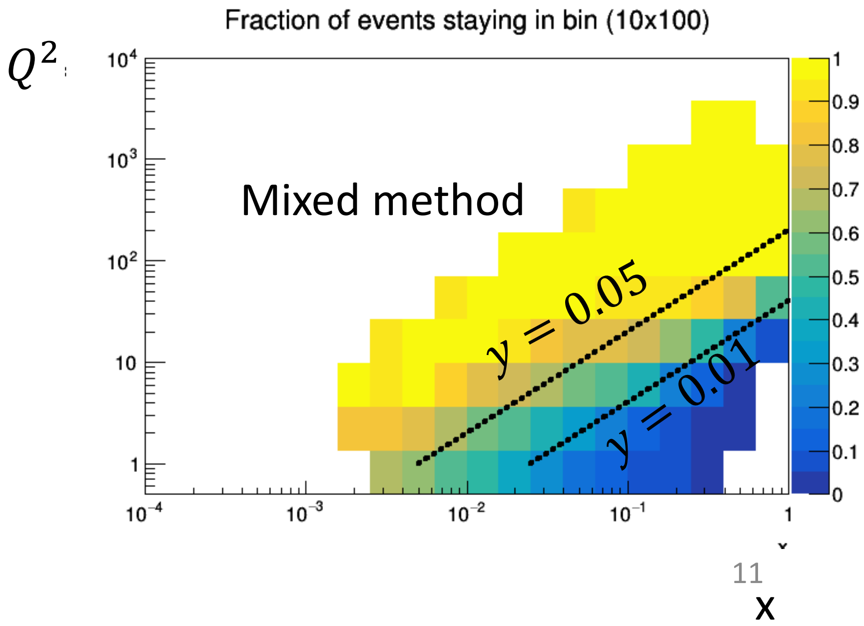


Perfect detector with $|\eta| < 3.5, \min p_T$ cut: sig. impact on resolution at low Q^2 y





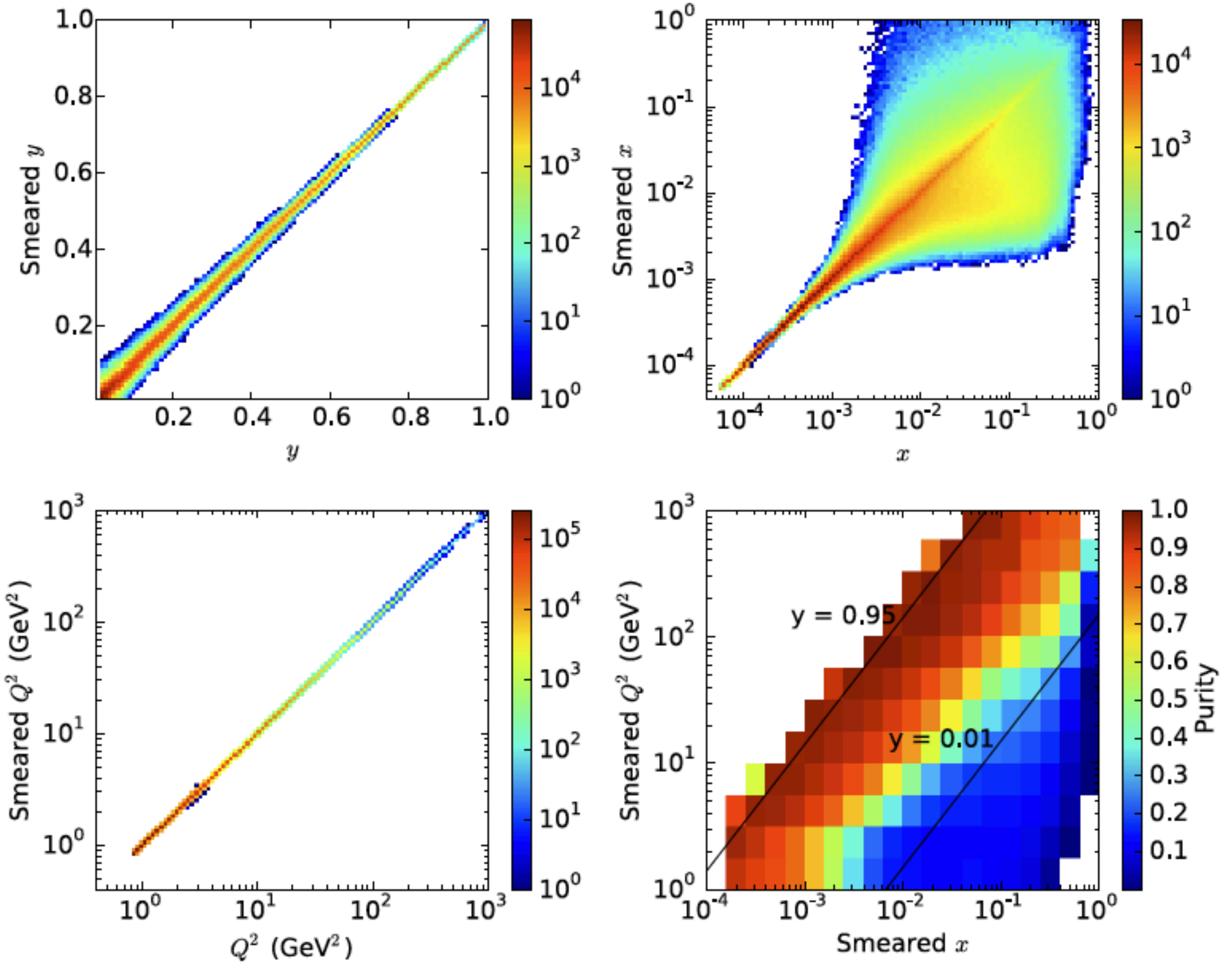




Summary

- Important to extend coverage to $|\eta| < 4$
- HCAL seems to be important for JB method, for mixed and DA not so much

Electror

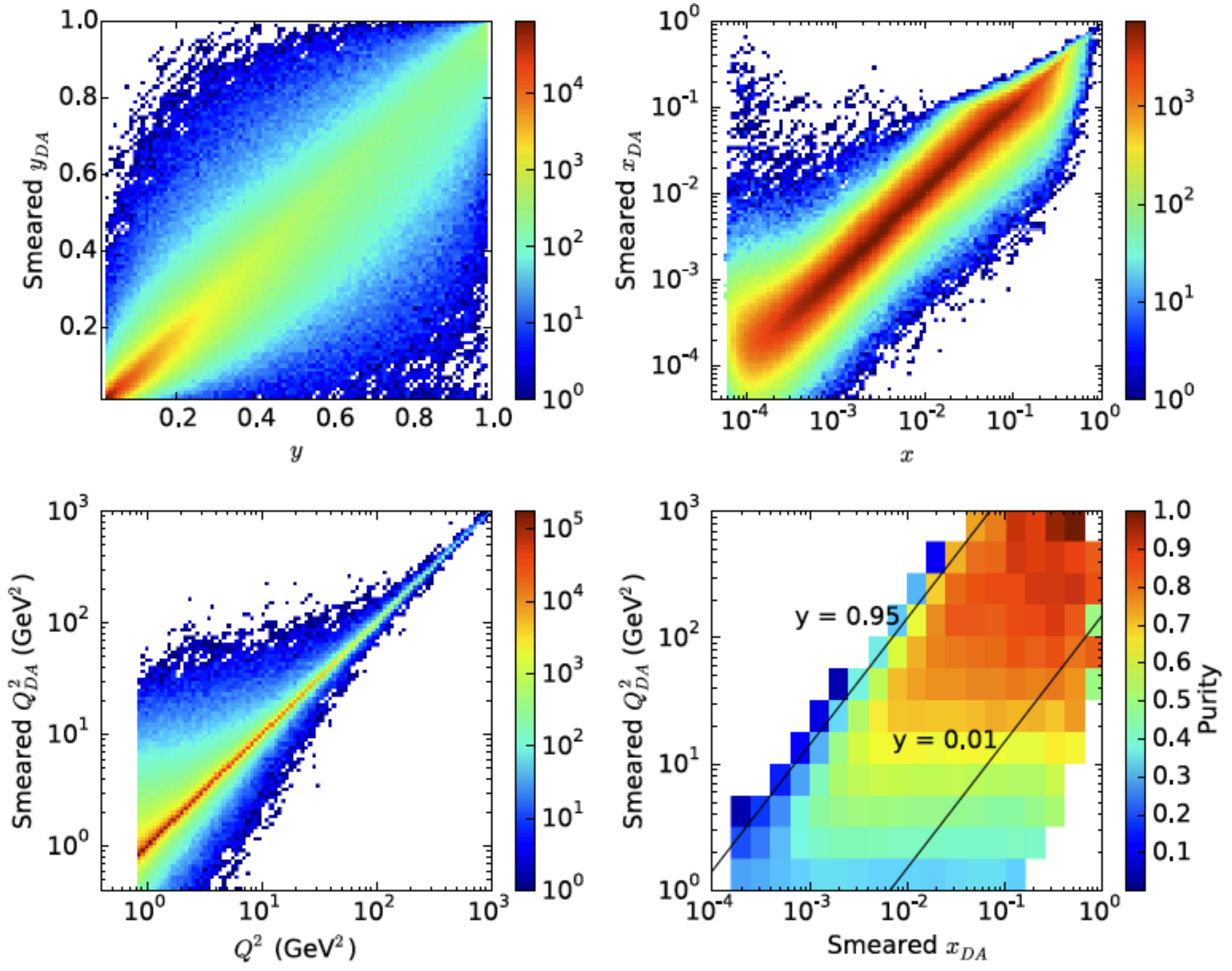


These and following plots from

Simulations are for 15x250 and $38\%/\sqrt{E}$ HCAL

('handbook' detector has $\frac{45\%}{\sqrt{E}} + 6\%$)

Double Angle Method – BEAST detector



JB Method –BEAST detecto