Hadronic Reconstruction of DIS Q^2, x, y

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Motivation and Overview

- In some regions of DIS phase space, using the Hadronic Final State (HFS) to reconstruct the DIS variables (Q2, x, y) is superior to using the scattered electron only.

- Hadronic reconstruction resolution is sensitive to detector acceptance and resolution.

- We may have to rely on fast simulation (Delphes) for physics studies for the Athena proposal, due at the end of the year.

- We can use Fullsim – Fastsim comparisons of the H1 detector to learn how to tune the fast simulation of Athena to make it more realistic.

Definitions

- Fastsim reconstruction of Hadronic Final State (HFS)
  - HFS is everything except the scattered electron (NC DIS).
  - Sum of px, py, pz, E of all Energy Flow candidates (tracks, photons, neutral hadrons).
- With HFS and scattered electron, you can compute everything.

$$\Sigma = \sum_h (E_h - p_{z,h})$$

$$T = \sqrt{(\sum_h p_{x,h})^2 + (\sum_h p_{y,h})^2}$$

$$\tan\frac{\gamma}{2} = \frac{\Sigma}{T}$$

Appendix: y, Q^2 and x formulae

method	y	Q^2	x	
e	$1-\frac{E}{E^e}\sin^2\frac{\theta}{2}$	$4E^eE\cos^2\frac{\theta}{2}$	Q^2/ys	*Electron*
h	$\frac{\Sigma}{2E^e}$	$\frac{T^2}{1-y_h}$	Q^2/ys	*Hadron*
m	y_h	Q_e^2	Q^2/ys	
DA	$\frac{\tan\gamma/2}{\tan\gamma/2+\tan\theta/2}$	$4E^{e2}\frac{\cot\theta/2}{\tan\gamma/2+\tan\theta/2}$	Q^2/ys	*Double Angle*
Σ	$\frac{\Sigma}{\Sigma+E(1-\cos\theta)}$	$\frac{E^2\sin^2\theta}{1-y_\Sigma}$	Q^2/ys	*Sigma*
IDA	y_{DA}	$E^2\ \tan\frac{\theta}{2}\frac{\tan\gamma/2+\tan\theta/2}{\cot\theta/2+\tan\theta/2}$	$\frac{E}{E^p}\frac{\cot\gamma/2+\cot\theta/2}{\cot\theta/2+\tan\theta/2}$	
IΣ	y_Σ	Q_Σ^2	$\frac{E}{E^p}\ \frac{\cos^2\theta/2}{y_\Sigma}$	

From the paper that introduced the Sigma method.
U. Bassler and G. Bernardi, NIM A361 (1995) 197-208.

H1 Fastsim

- Recently implemented in Delphes (Miguel).
- Resolutions are set to quoted results for HCAL, but that is single particle response. Might be different for HFS.

H1 Hadronic DIS Reconstruction

This figure is from the paper that introduced the Sigma method.

U. Bassler and G. Bernardi, NIM A361 (1995) 197-208.

Event selection: $Q^2 > 200$

Shows how the HFS and the electron are complementary.

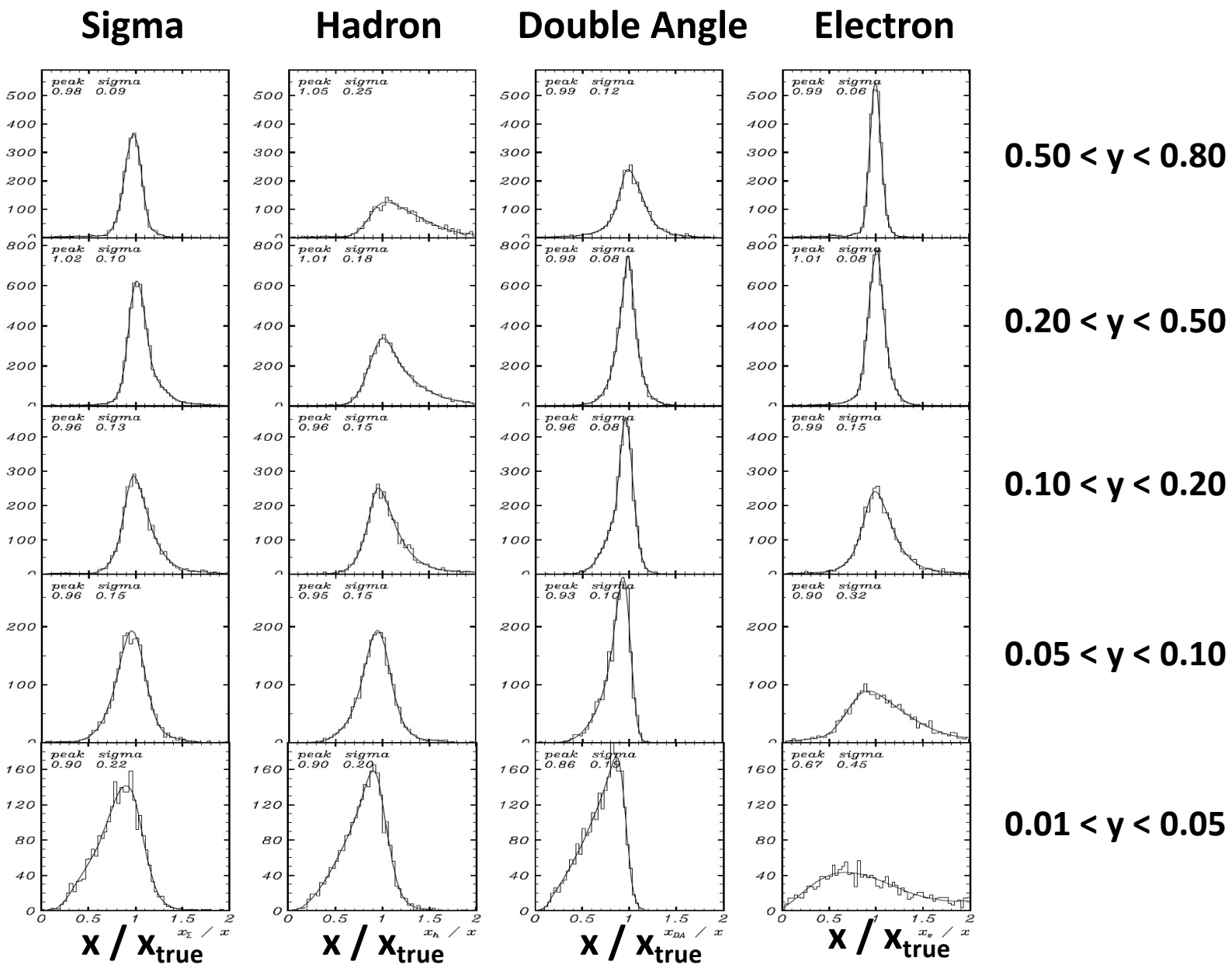
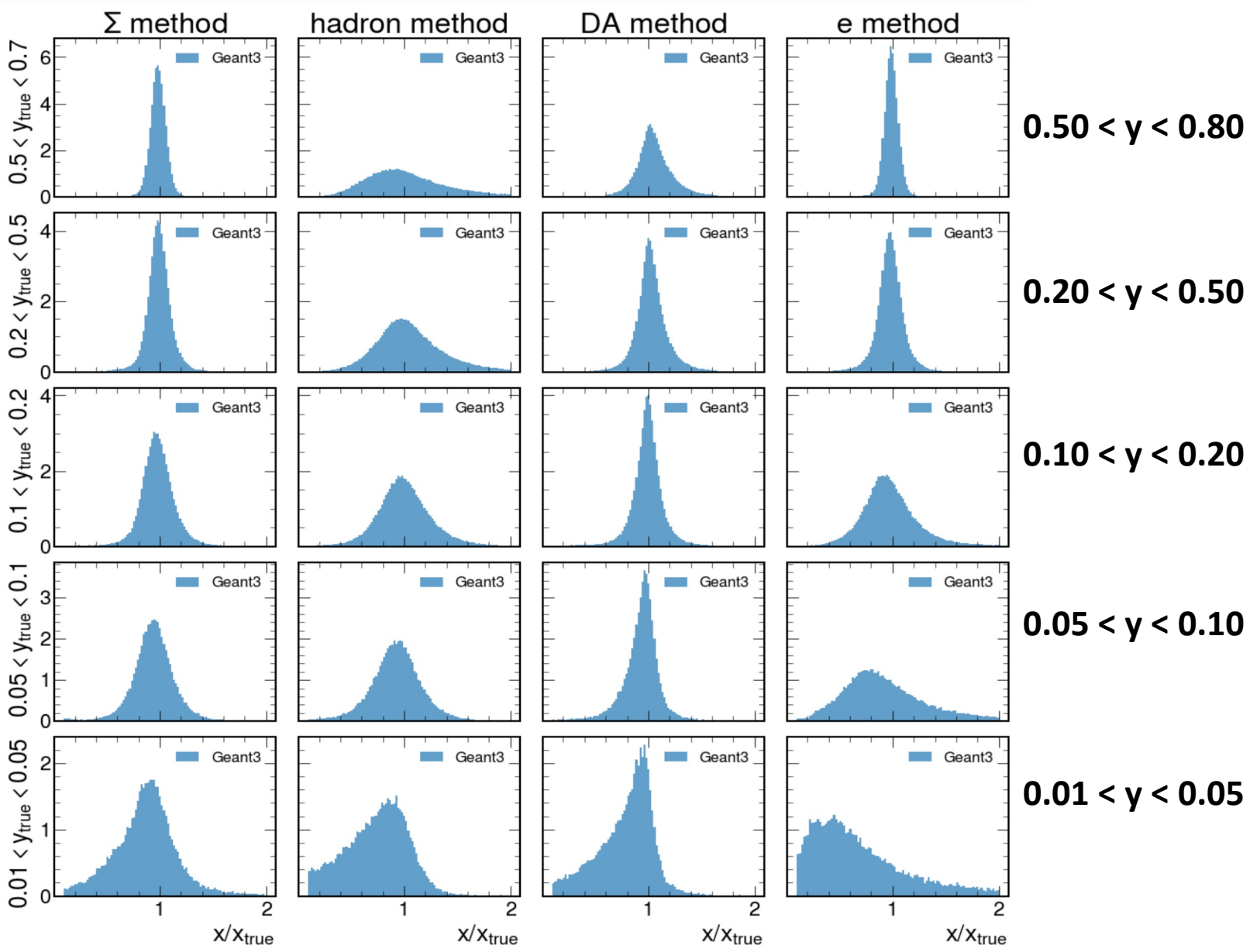


Figure 4: *Comparison x_{method}/x at high Q^2 ($Q^2 > 200\ GeV^2$) for the Σ, mixed , DA and e methods. From top to bottom, each row represent a bin in y: very high (0.5-0.8), high (0.2-0.5), medium (0.1-0.2), low (0.05-0.1), very low (0.01-0.05).*

H1 Fullsim MC

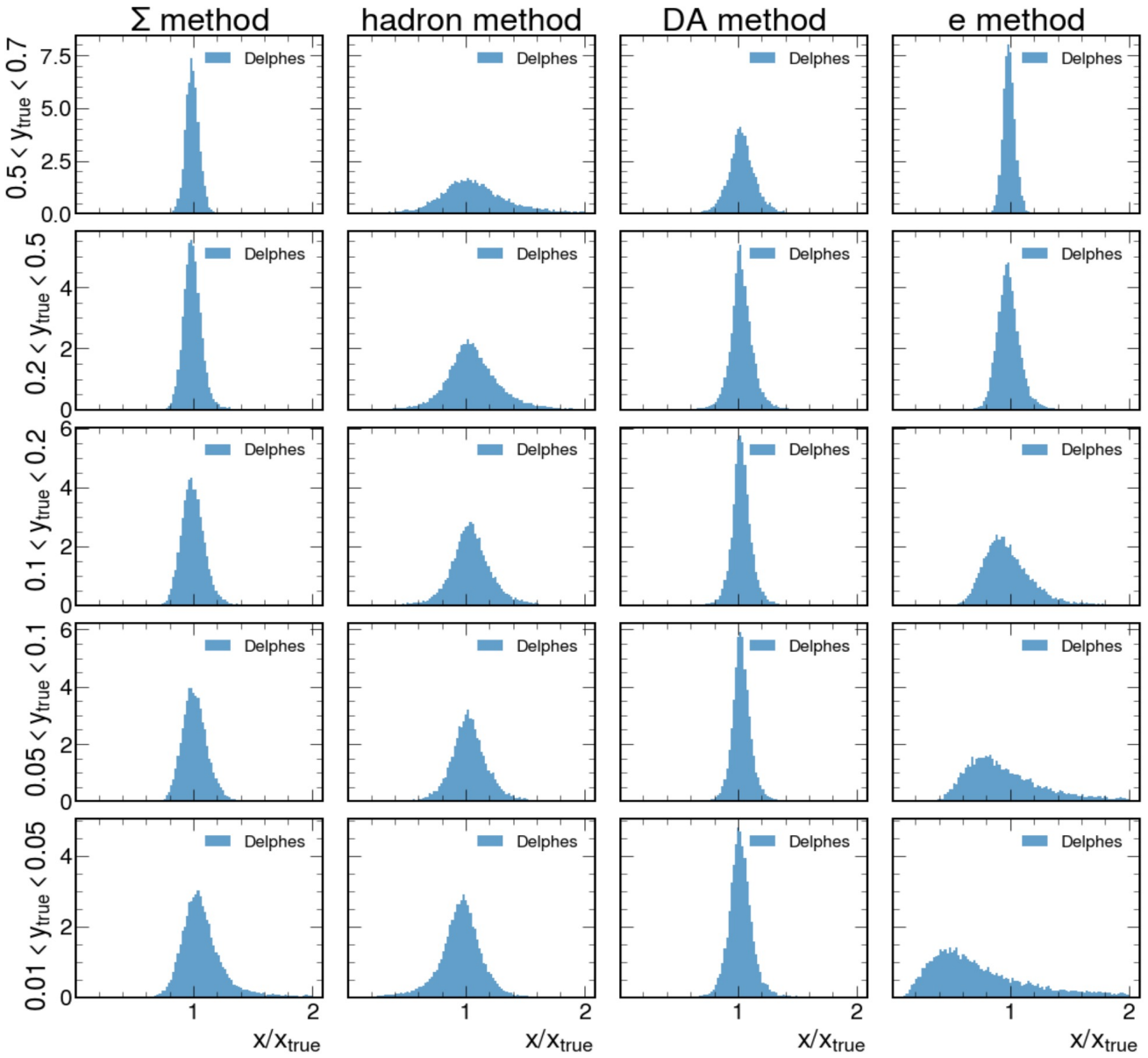
We can reproduce the figure from the paper with Fullsim (Django+G3).



H1 Fastsim MC

The resolution for the hadronic reconstruction in the fastsim (Delphes) is too good.

The electron reconstruction is pretty close though.



H1 Fullsim vs Fastsim MC

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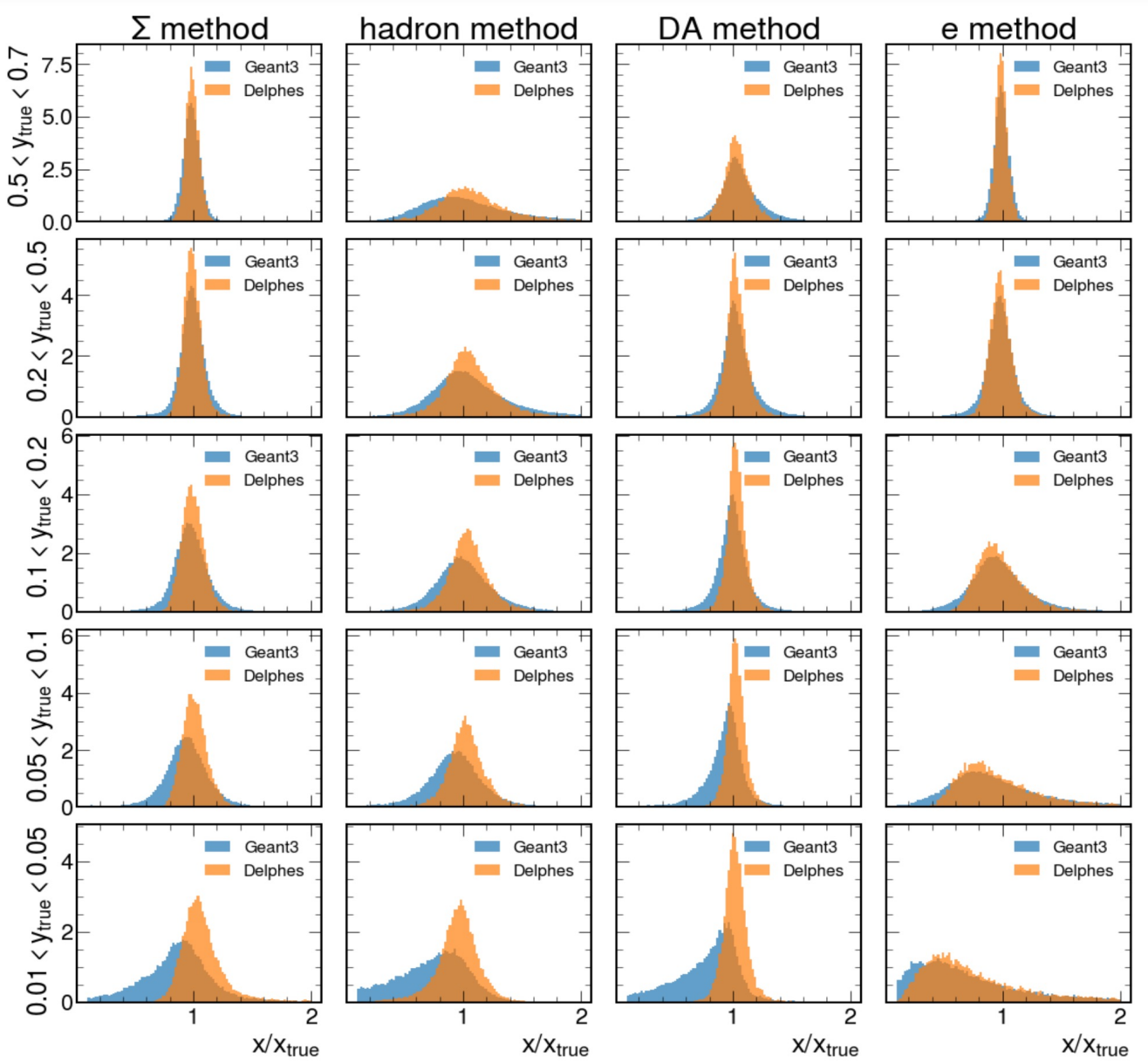


0.50 < y < 0.80

0.20 < y < 0.50

0.10 < y < 0.20

0.05 < y < 0.10

0.01 < y < 0.05

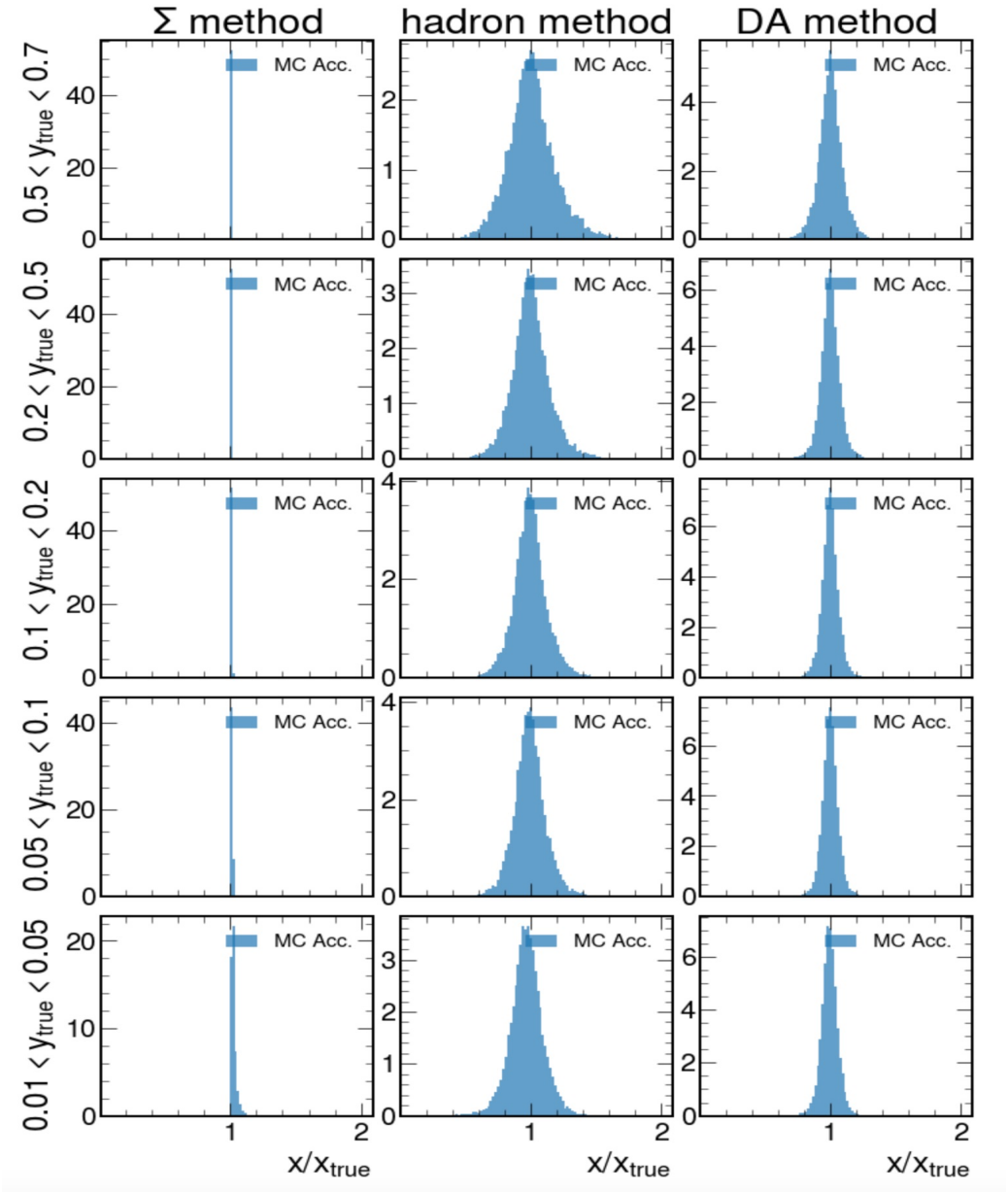
H1 Geometric Acceptance

This shows the resolution effect of the geometric acceptance *only*.

All generated status=1 MC particles from Pythia that are within |eta|<4 are summed up to make this cheat reconstruction.

Sigma method is robust against acceptance losses, but hadron method is not!

We initially thought this might be a bug, but it's real. See the Extra Slides.



0.50 < y < 0.80

0.20 < y < 0.50

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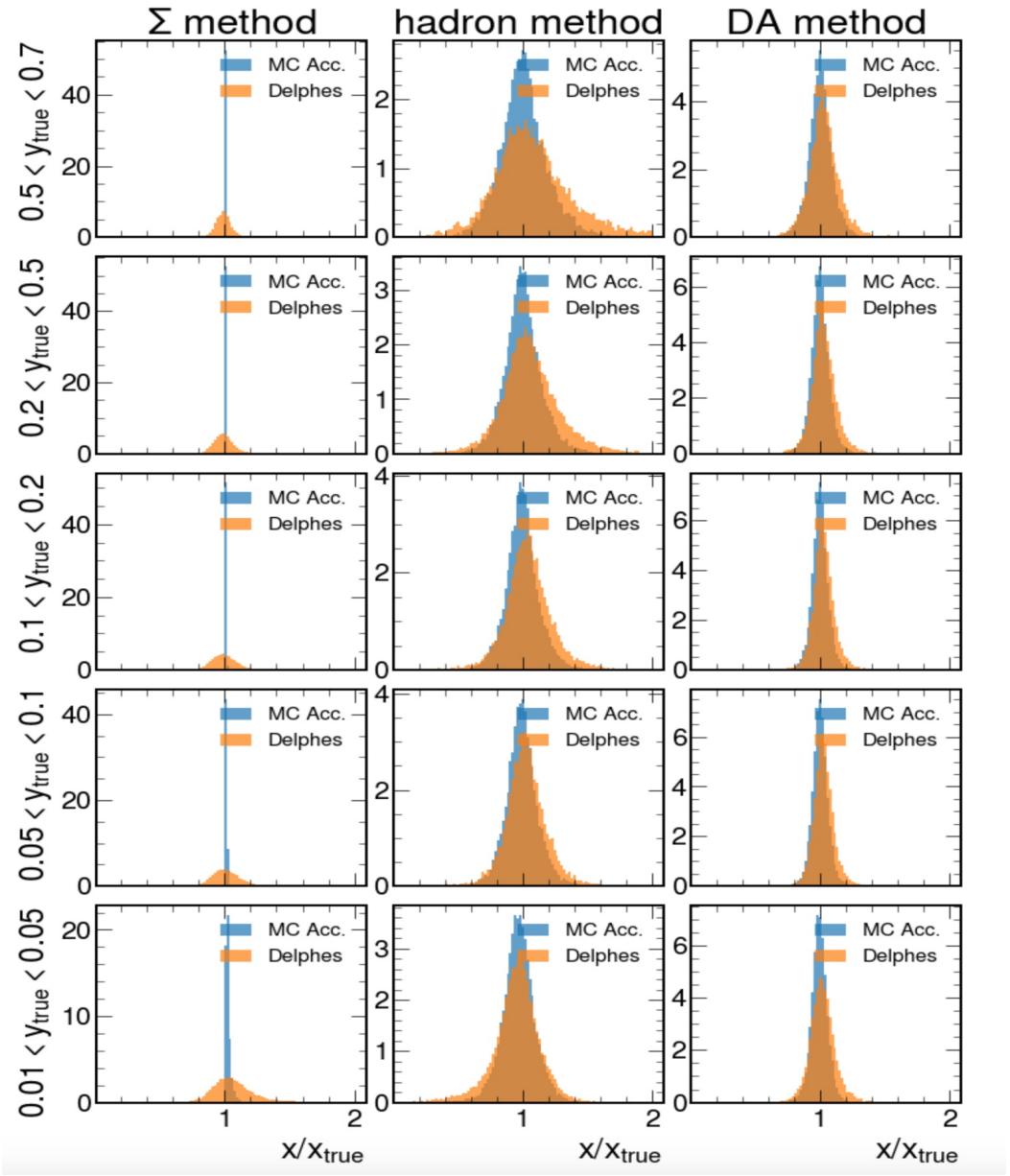
H1 Geometric Acceptance vs Fastsim

This shows the resolution effect of the geometric acceptance *only*.

All generated status=1 MC particles from Pythia that are within |eta|<4 are summed up to make this cheat reconstruction.

Sigma method is robust against acceptance losses, but hadron method is not!

With (too good) fastsim, acceptance alone accounts for a significant fraction of the resolution.



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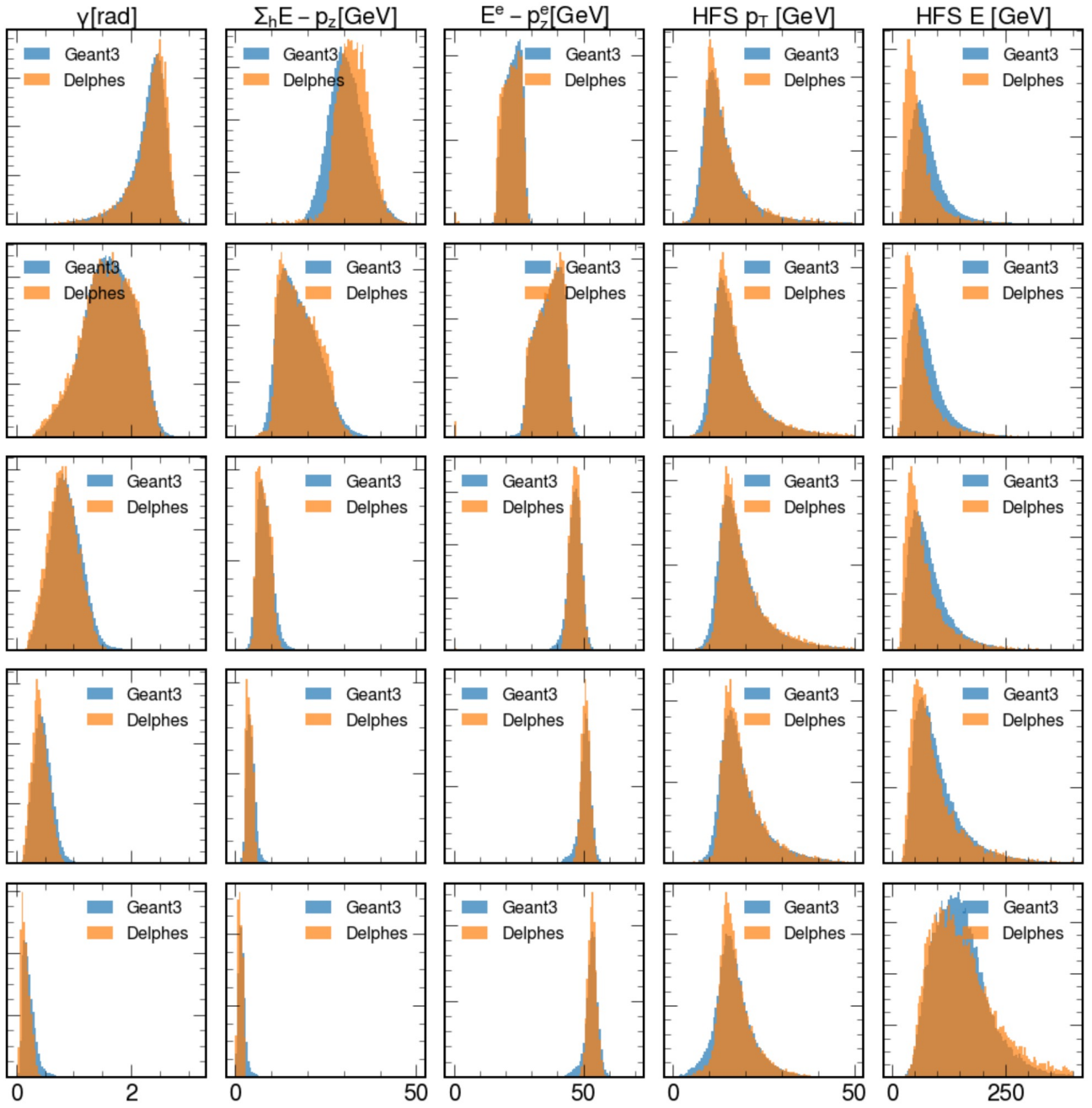
HFS reconstruction distributions, Fullsim vs Fastsim



0.50 < y < 0.80

0.20 < y < 0.50

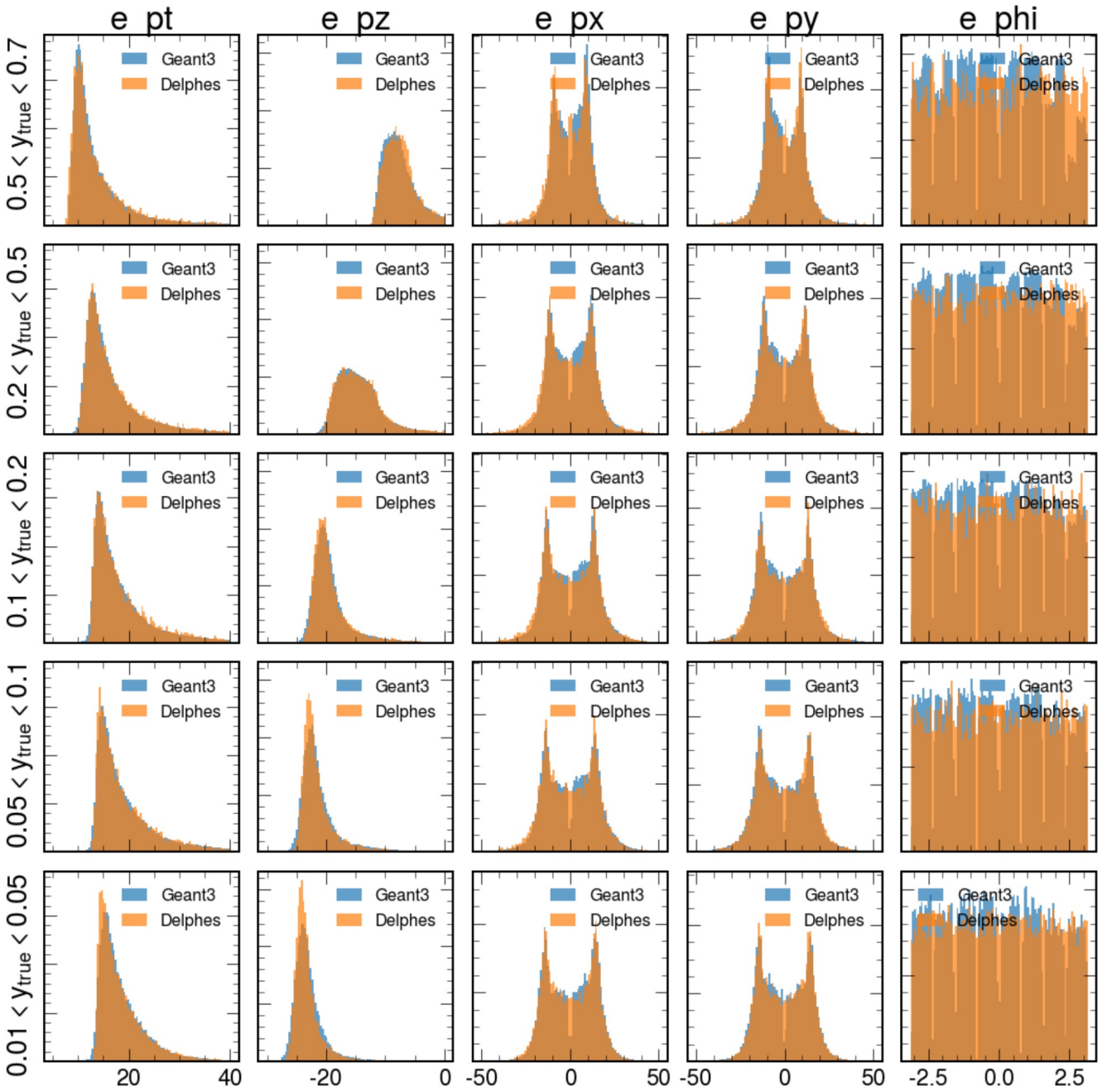
0.10 < y < 0.20

0.05 < y < 0.10

0.01 < y < 0.05

Electron reconstruction distributions, Fullsim vs Fastsim

Looks pretty good.



0.50 < y < 0.80

0.20 < y < 0.50

0.10 < y < 0.20

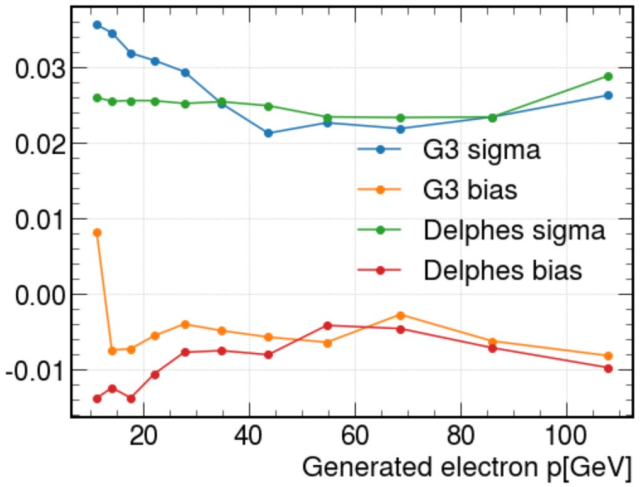
0.05 < y < 0.10

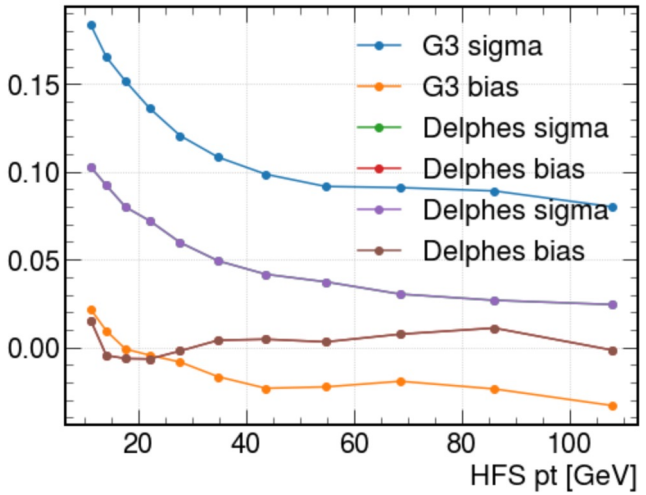
0.01 < y < 0.05

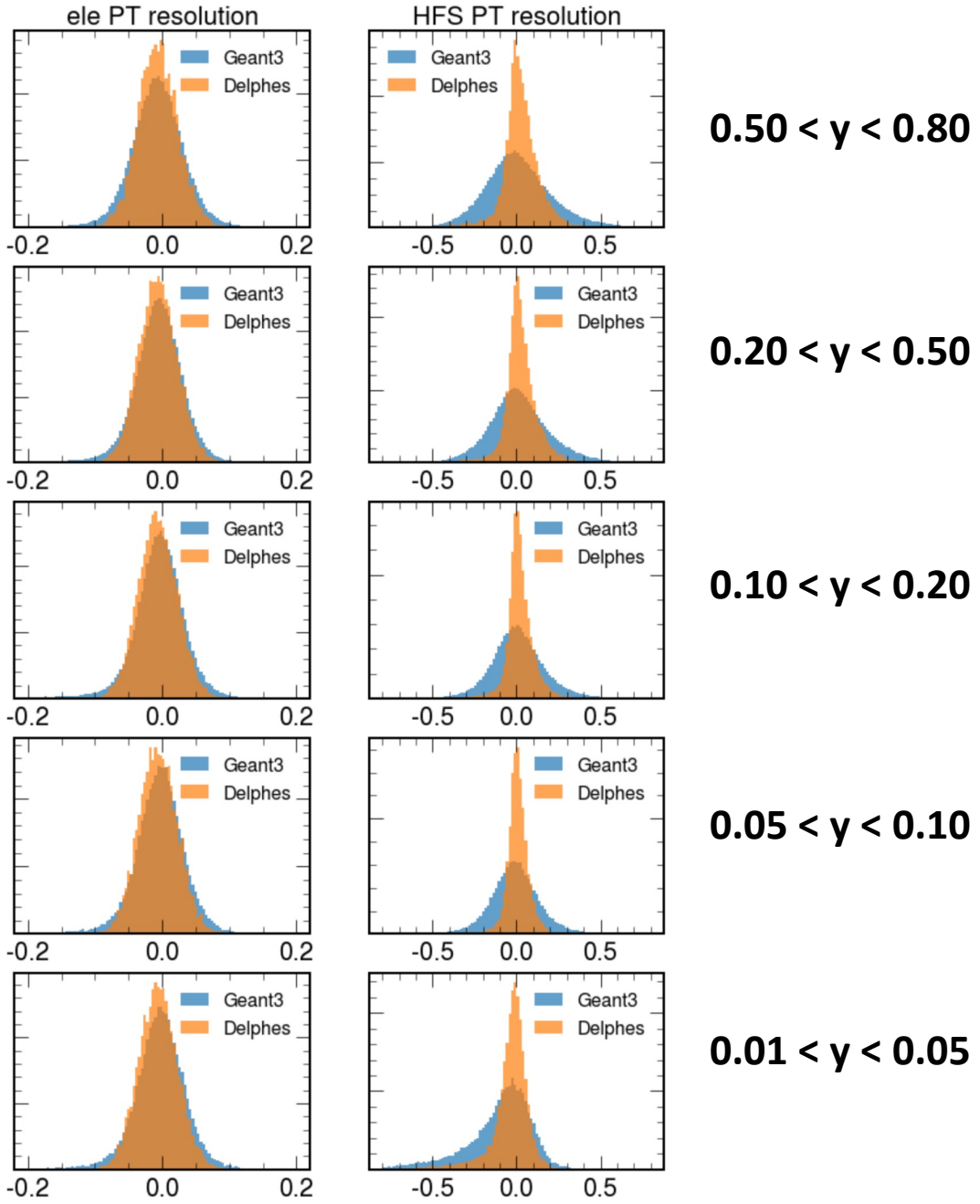
H1 Electron and HFS PT resolution, Fastsim vs Fullsim

Electrons look pretty reasonable.

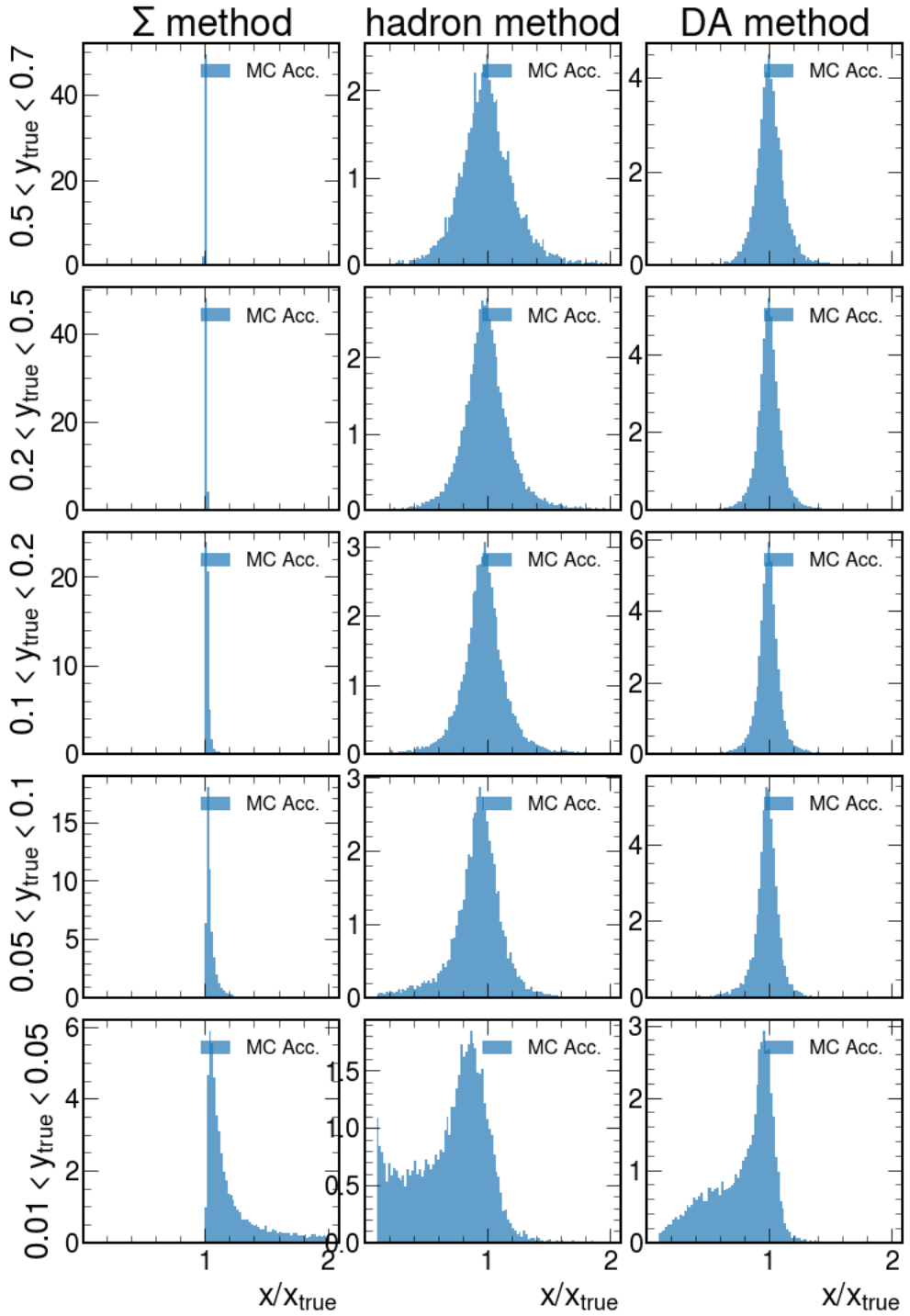
HFS resolution needs some tuning work.







Extra Slides

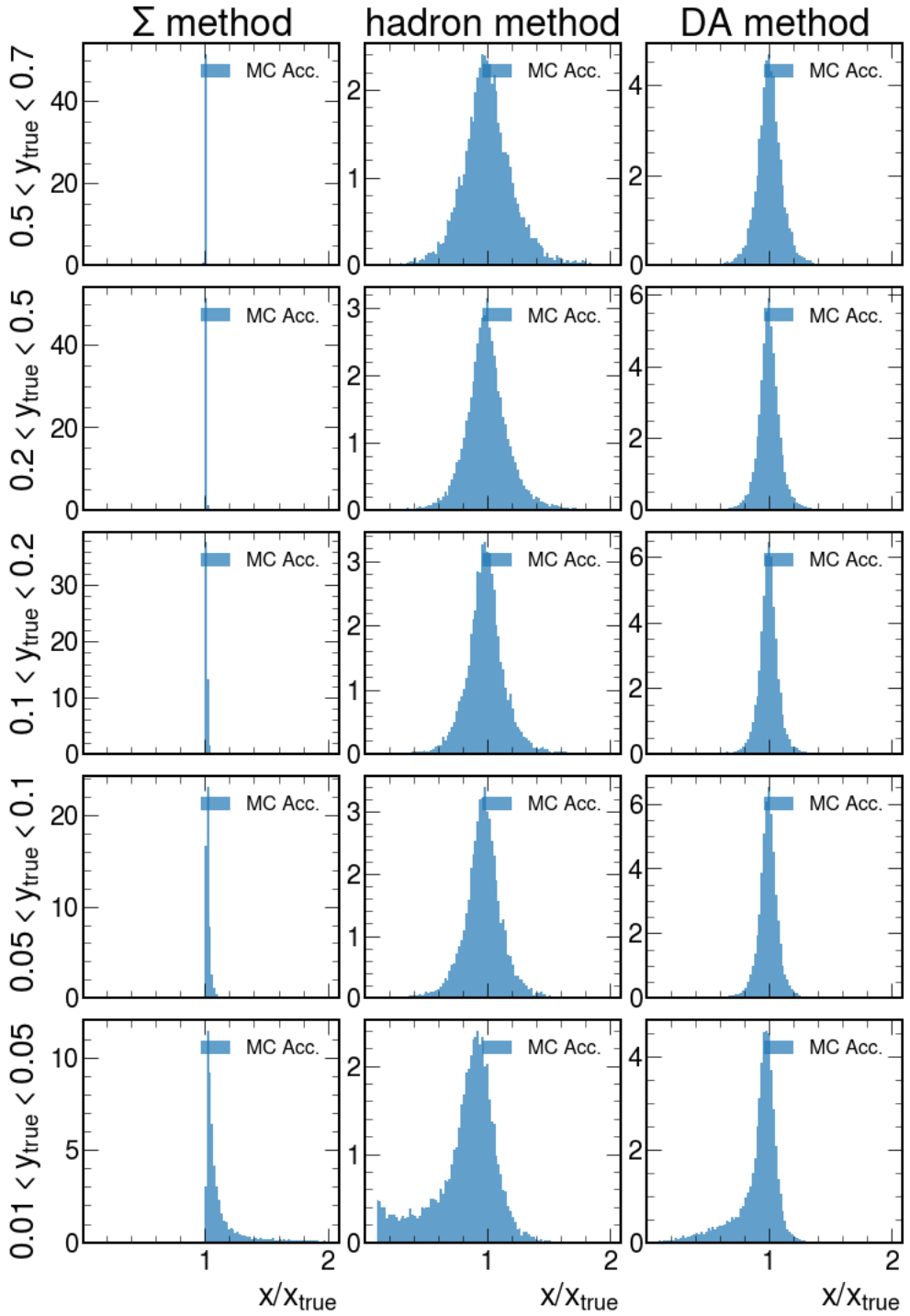


Generator-level MC HFS, |eta|<2.5

This is a cheat using all HFS status=1 MC particles.

The only requirement is on the |eta| of the particles.

This models acceptance effects only with a perfect-response detector.

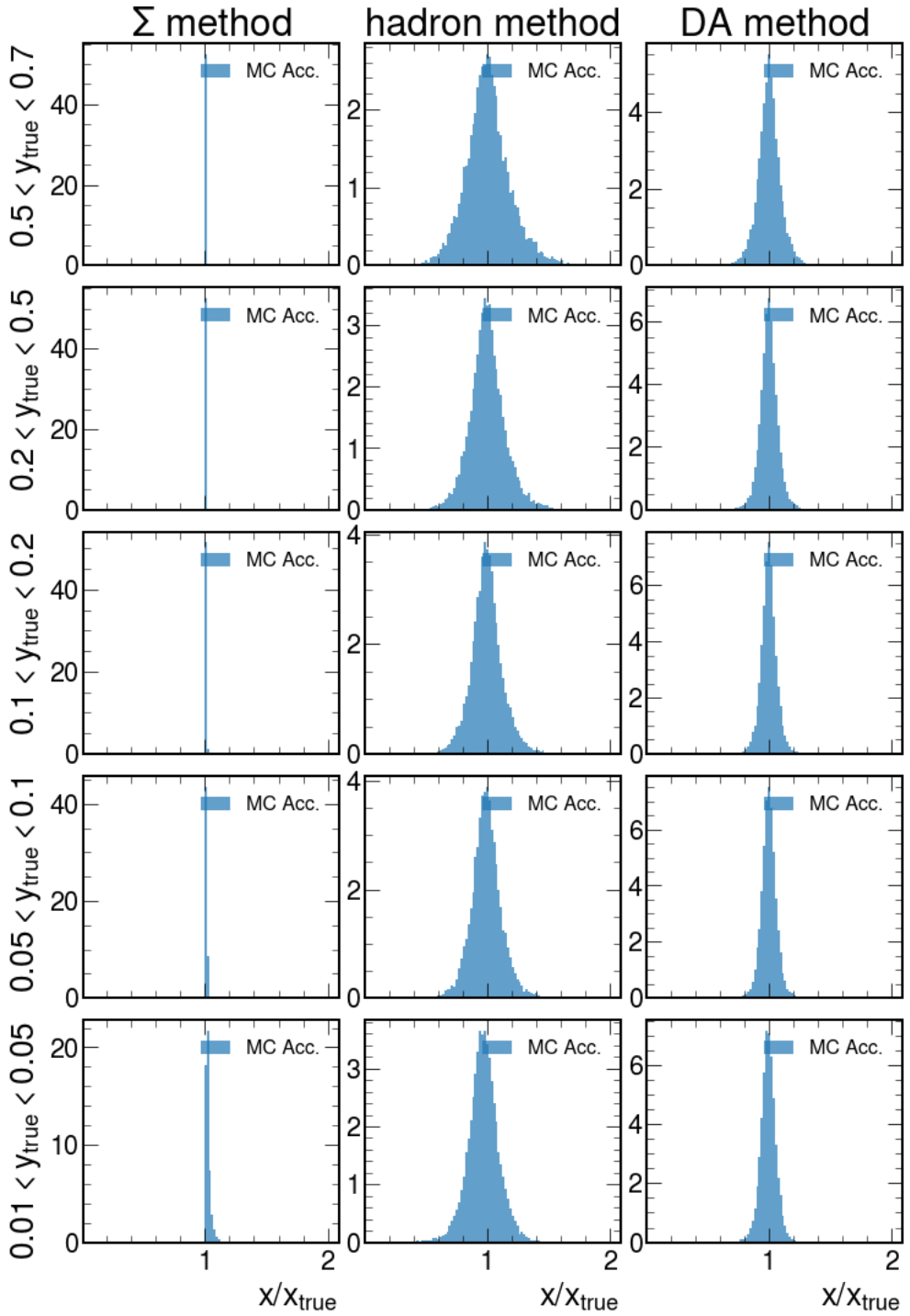


Generator-level MC HFS, |eta|<3.0

This is a cheat using all HFS status=1 MC particles.

The only requirement is on the |eta| of the particles.

This models acceptance effects only with a perfect-response detector.

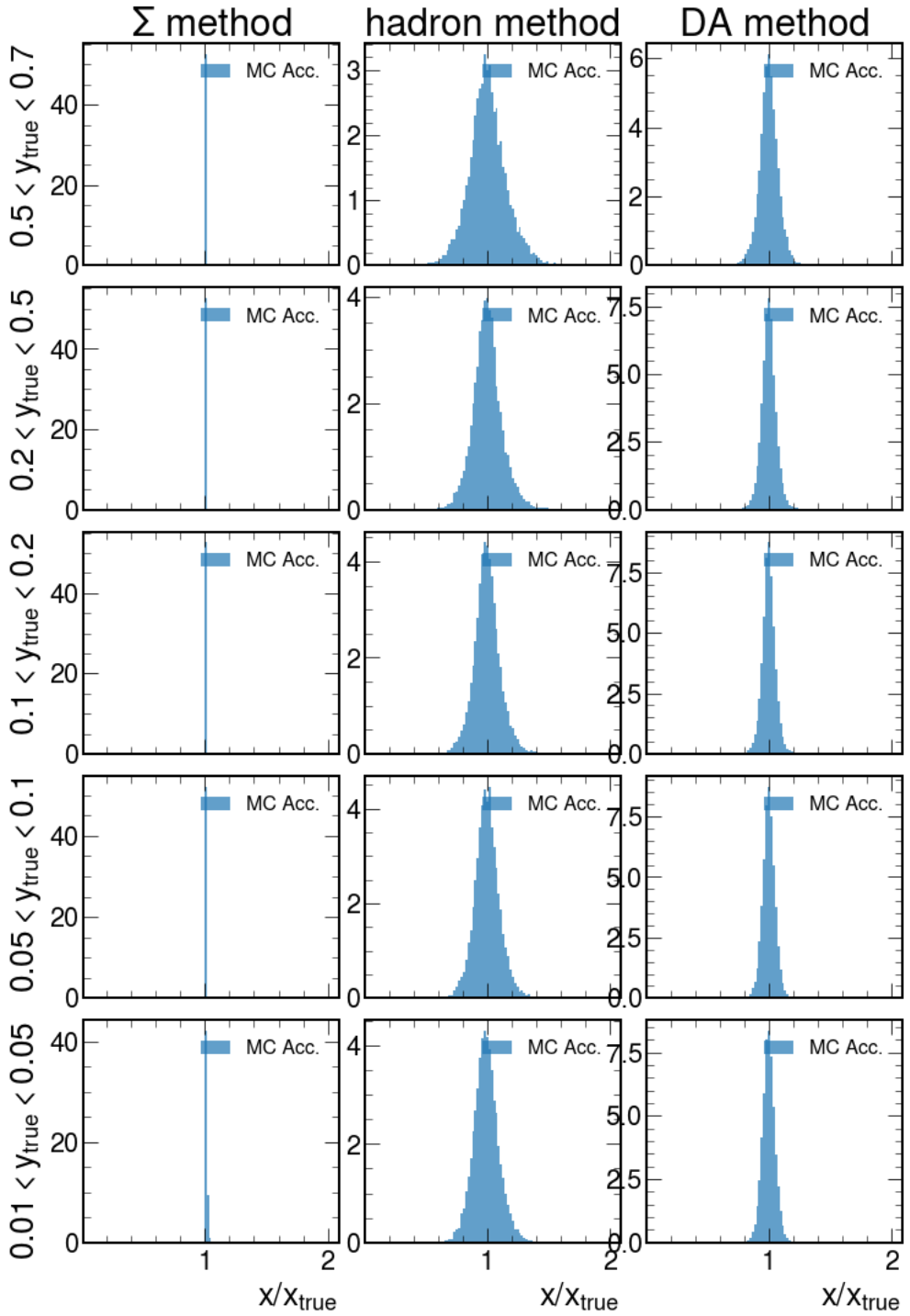


Generator-level MC HFS, |eta|<4.0

This is a cheat using all HFS status=1 MC particles.

The only requirement is on the |eta| of the particles.

This models acceptance effects only with a perfect-response detector.

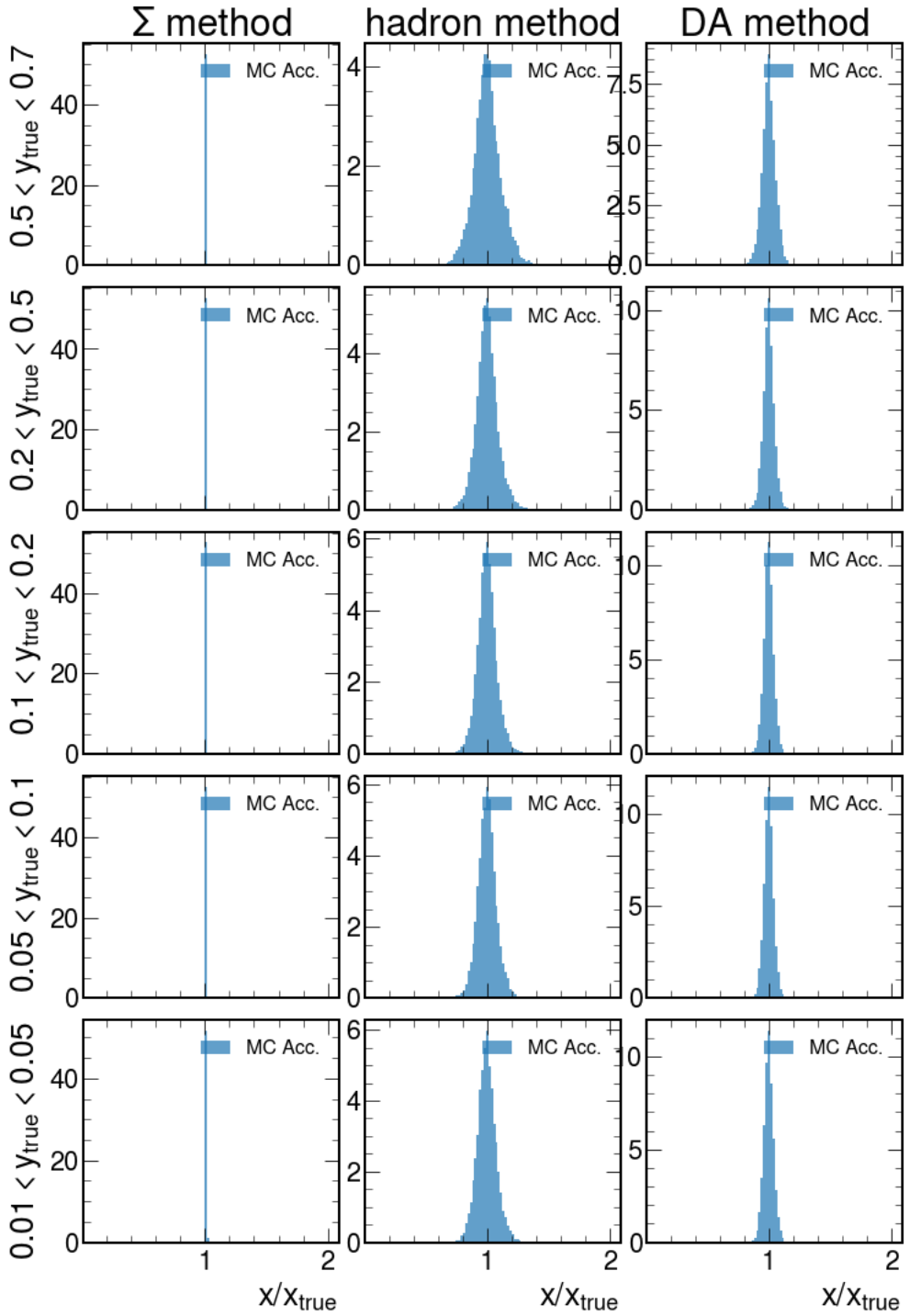


Generator-level MC HFS, |eta|<5.0

This is a cheat using all HFS status=1 MC particles.

The only requirement is on the |eta| of the particles.

This models acceptance effects only with a perfect-response detector.

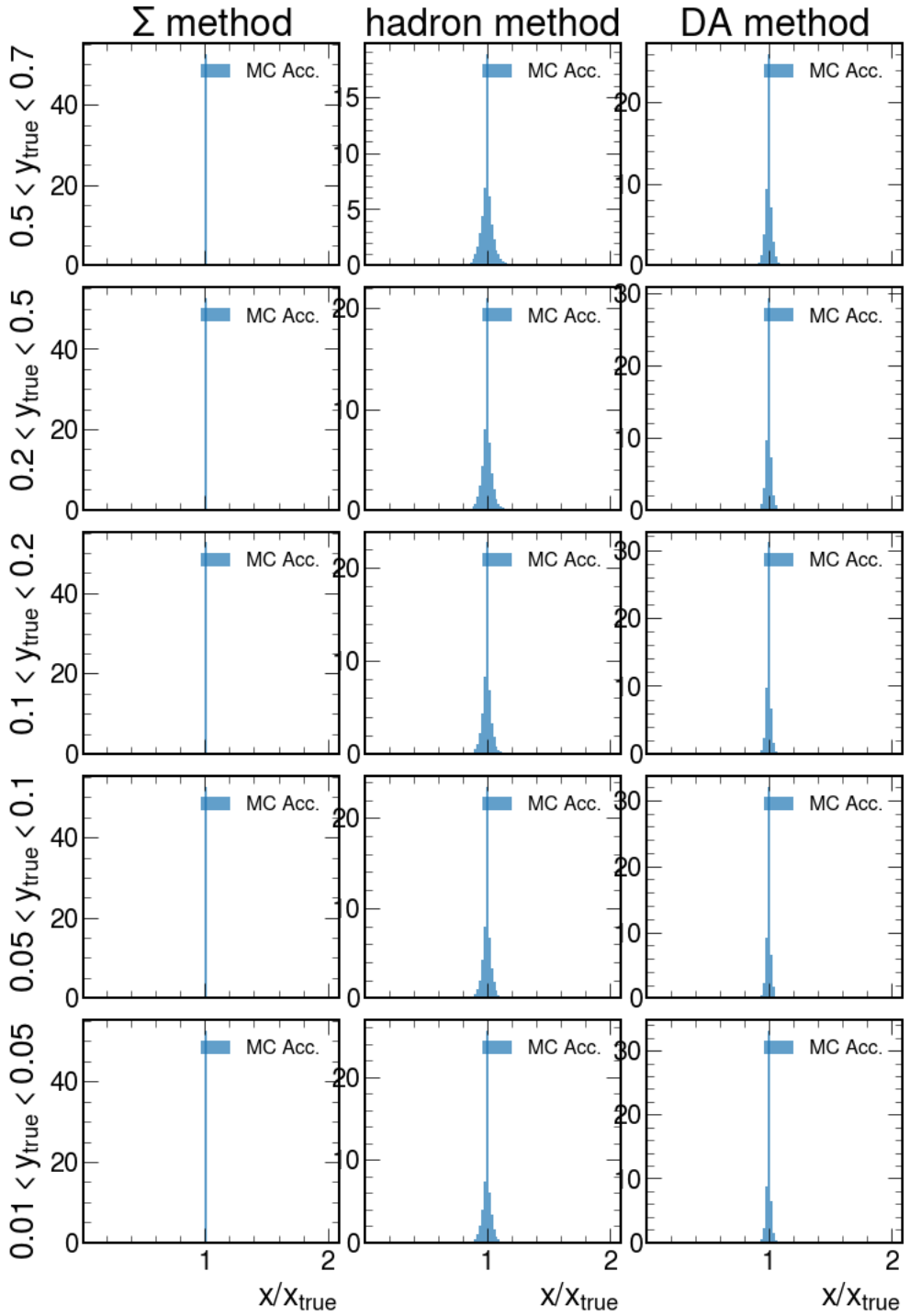


Generator-level MC HFS, |eta|<6.0

This is a cheat using all HFS status=1 MC particles.

The only requirement is on the |eta| of the particles.

This models acceptance effects only with a perfect-response detector.

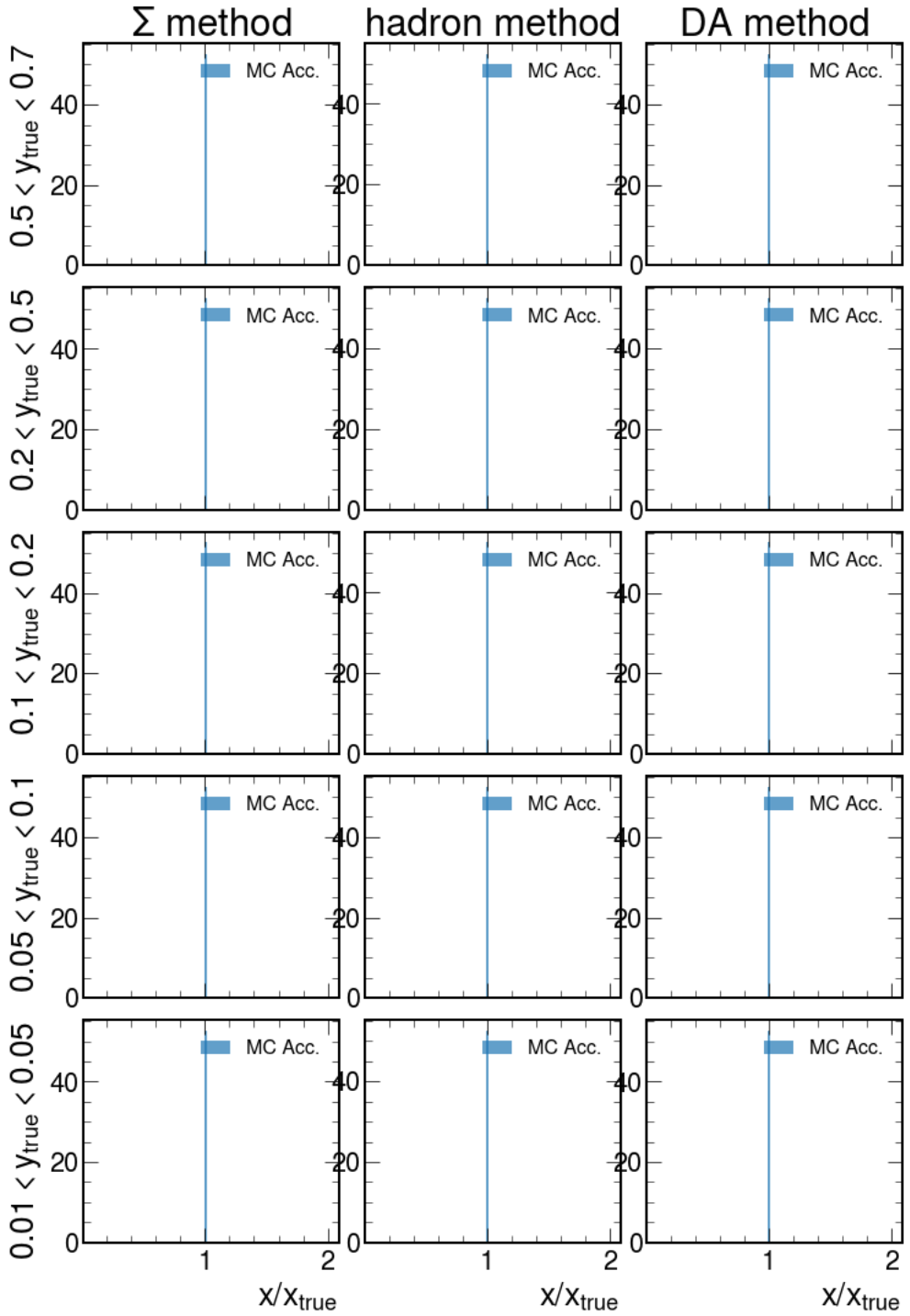


Generator-level MC HFS, |eta|<7.0

This is a cheat using all HFS status=1 MC particles.

The only requirement is on the |eta| of the particles.

This models acceptance effects only with a perfect-response detector.



Generator-level MC HFS, |eta|<9.0

This is a cheat using all HFS status=1 MC particles.

The only requirement is on the |eta| of the particles.

This models acceptance effects only with a perfect-response detector.