

Detector smearing effect on gluon Sivers related measurements

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SIDIS YR group meeting
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Baseline: perfect detector

<https://gitlab.com/eic/eic-smear/-/blob/master/scripts/PerfectDetector.cxx>

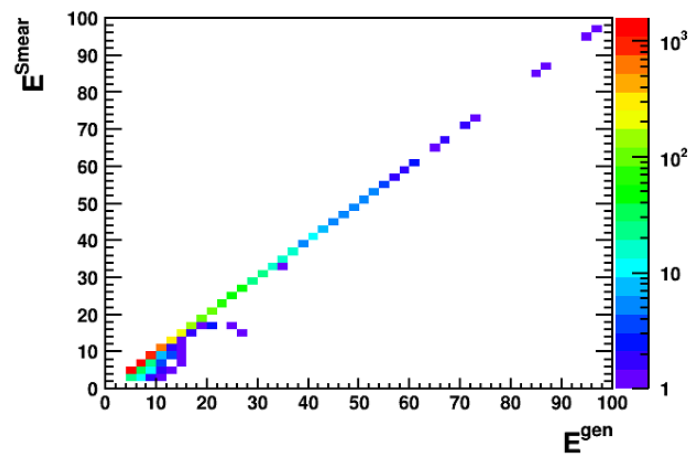
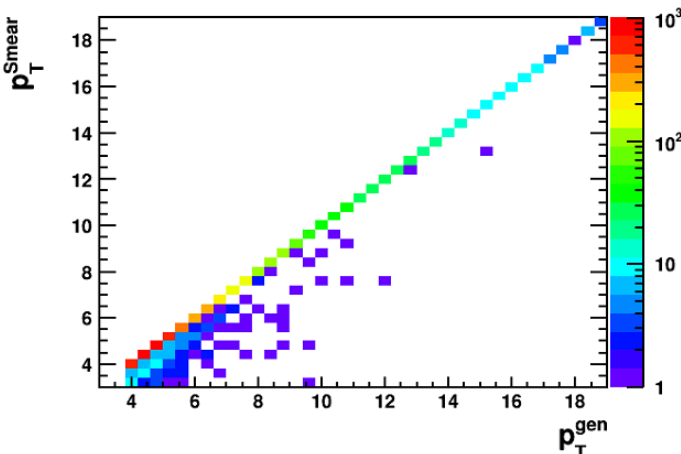
Perfect detector: $-15 < \eta < 15$, perfect resolution

Leading jet comparison, smeared jet match with R

ep 18x275, $Q^2 > 1 \text{ GeV}^2$, $0.1 < y < 0.85$
Generator level jet selection
Jet constituent: all final, $p_T^{\text{Lab}} > 0.25 \text{ GeV}$, $|\eta^{\text{Lab}}| < 3.5$
Jet find in Lab R=1.0, Jet cut: $|\eta_{\text{jet}}^{\text{Lab}}| < 2.5$, $p_T^{\text{jet}} > 4 \text{ GeV}$

Smear Jet p_T

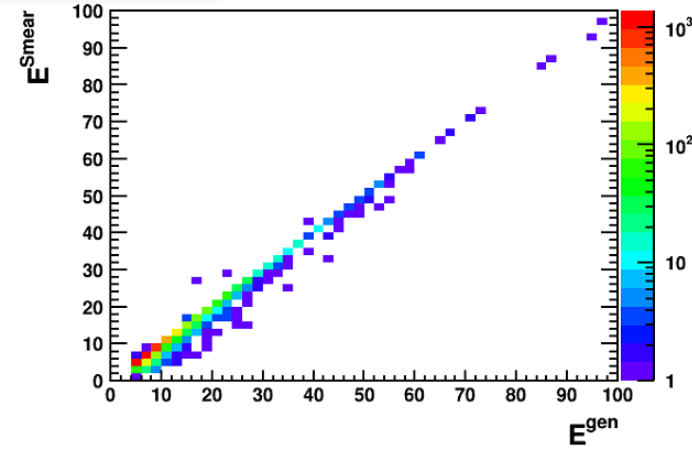
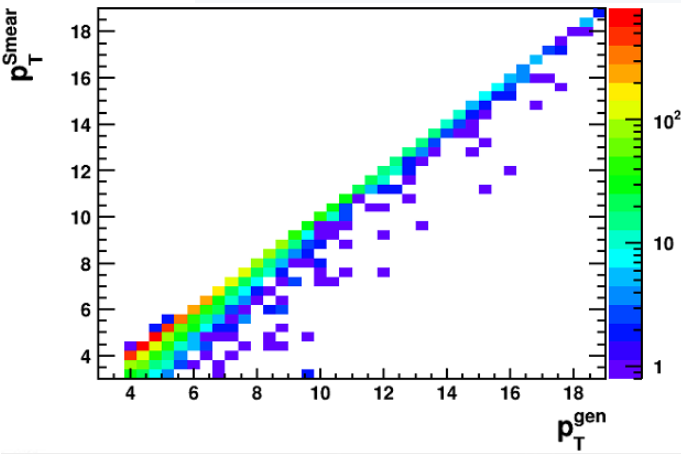
Smear Jet Energy



Smear due to miss neutrino from HF decay

```
eff = new TF1("eff", "(x>[2]) * [0]*TMath::Erf(x-[1]),0, 100);  
// mostly 99%, dropping toward small pT, sharp cutoff at 0.2  
eff->SetParameters (0.99,-0.8, 0.2);
```

<https://github.com/eic/eicsmear-jetexample>



Toy track efficiency applied, no significant impact

Handbook detector resolution map

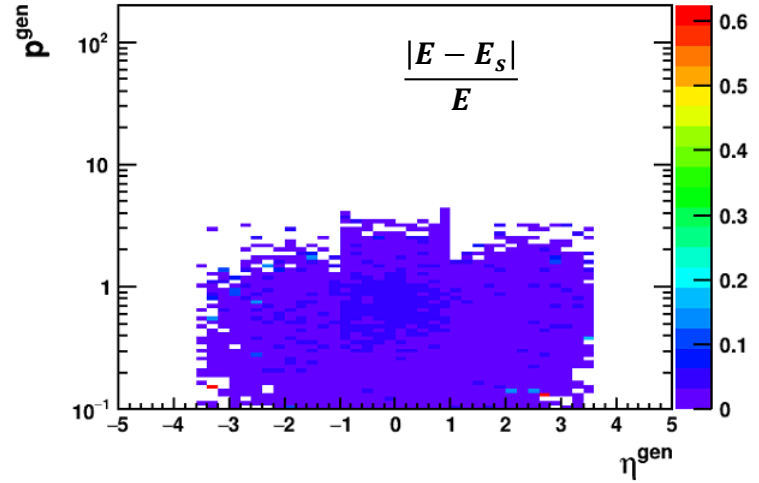
<https://gitlab.com/eic/eic-smear/-/blob/master/scripts/smearHandBook.cxx>

EIC Jet Analysis Skeleton <https://github.com/eic/eicsmear-jetexample>

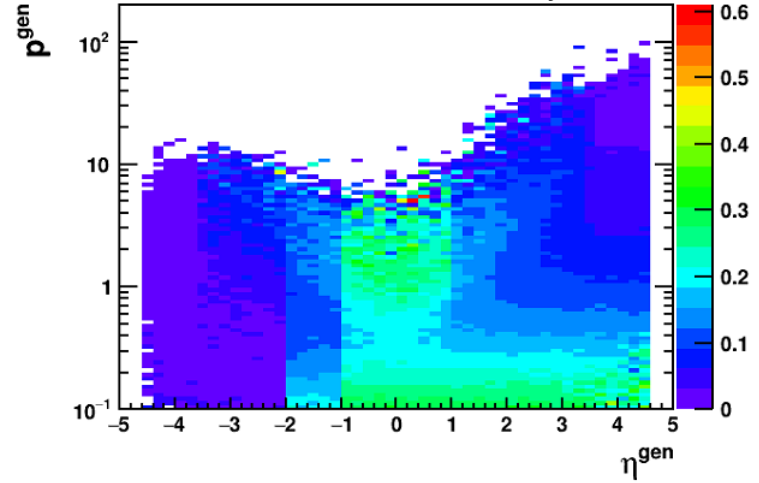
Pragmatic treatment to jet constituent:
Tracker: $p > 0, E = 0$ assume pi mass
Calo: $E > 0, p = 0$ assume 0 mass
Tracker&Calo: $p > 0, E > 0$ assume pi mass with p

ep 18x275, $Q^2 > 1 \text{ GeV}^2, 0.1 < y < 0.85$
Generator level jet selection
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Smear Jet: $p_T^{\text{Lab}} > 0.25 \text{ GeV}, |\eta^{\text{Lab}}| < 3.5, R = 1$
Weak angular smear: 0.001 in theta/phi

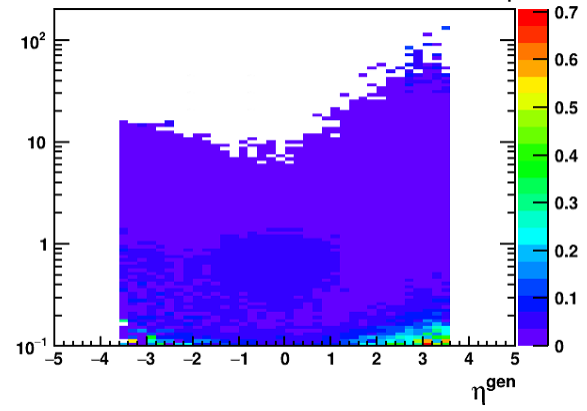
E resol Tracker only



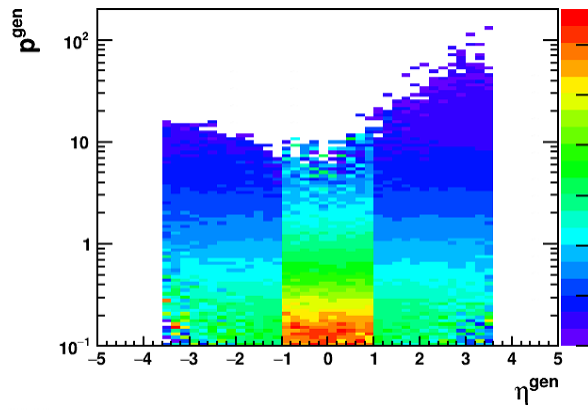
E resol Calo only



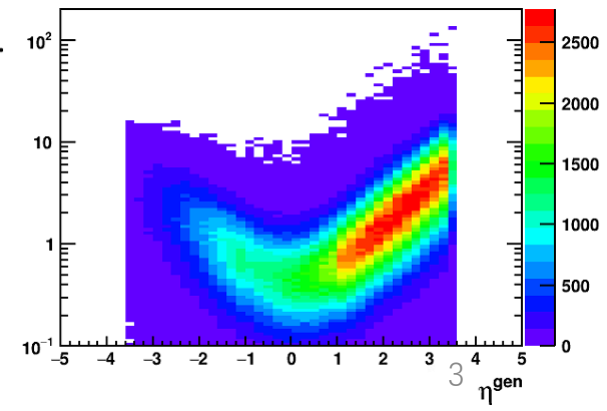
E resol Tracker&Calo with p



E resol Tracker&Calo with E



Tracker&Calo hits



Detector response on jet reconstruction with eic-smear

ep 18x275, $Q^2 > 1 \text{ GeV}^2$, $0.1 < y < 0.85$

Generator level jet selection

Jet constituent: all final, $p_{\text{T}}^{\text{Lab}} > 0.25 \text{ GeV}$, $|\eta^{\text{Lab}}| < 3.5$

Jet find in Lab $R=1.0$, Jet cut: $|\eta_{\text{jet}}^{\text{Lab}}| < 2.5$, $p_{\text{T}}^{\text{jet}} > 4 \text{ GeV}$

Smear Jet: $p_{\text{T}}^{\text{Lab}} > 0.25 \text{ GeV}$, $|\eta^{\text{Lab}}| < 3.5$, $R=1$

Pragmatic treatment to jet constituent:

Tracker: $p > 0$, $E=0$ assume pi mass

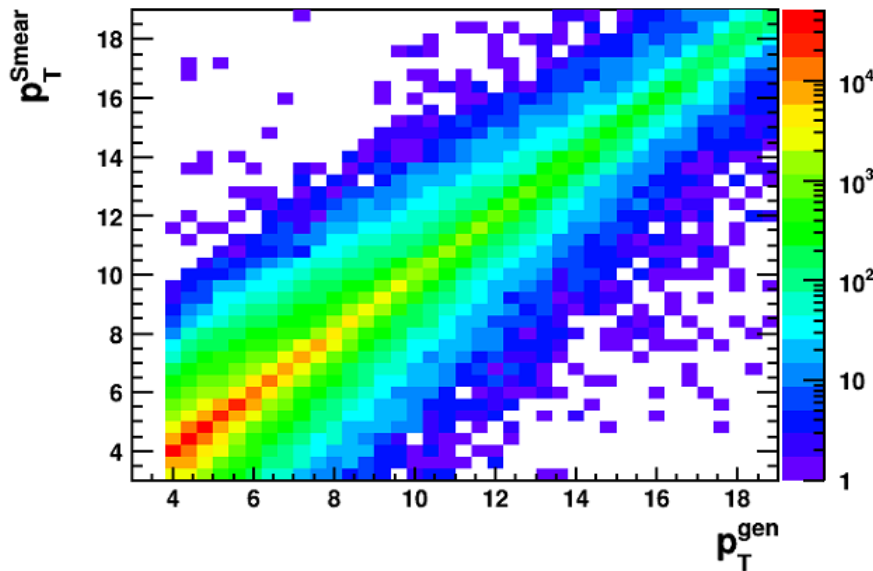
Calo: $E > 0$, $p=0$ assume 0 mass

Tracker&Calo: $p > 0$, $E > 0$ assume pi mass with p

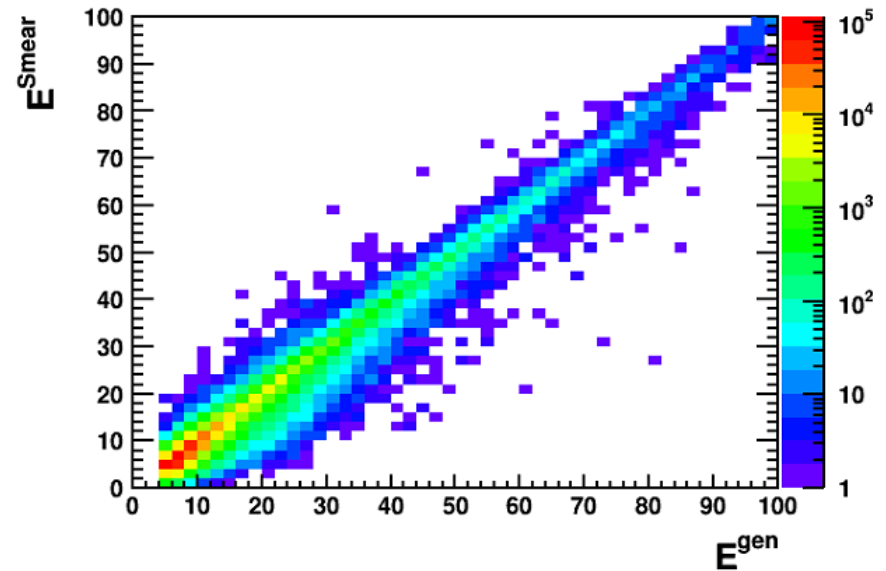
Track efficiency applied to all the tracked objects

Leading jet comparison, smeared jet match with R

Smear vs true p_{T}



Smear vs true E



Smeard jet resolutions

ep 18x275, $Q^2 > 1 \text{ GeV}^2$, $0.1 < y < 0.85$

Generator level jet selection

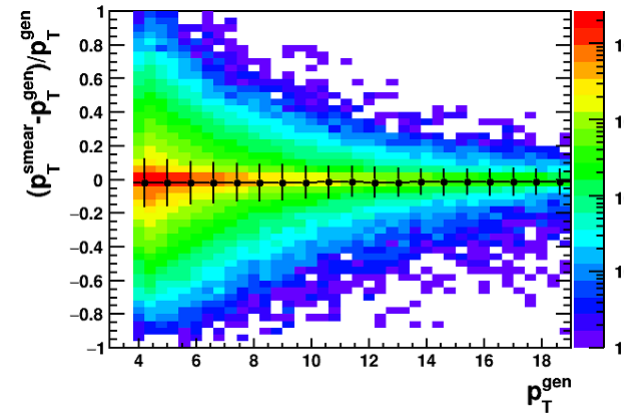
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Jet find in Lab $R=1.0$, Jet cut: $|\eta_{\text{jet}}^{\text{Lab}}| < 2.5$, $p_{T}^{\text{jet}} > 4 \text{ GeV}$

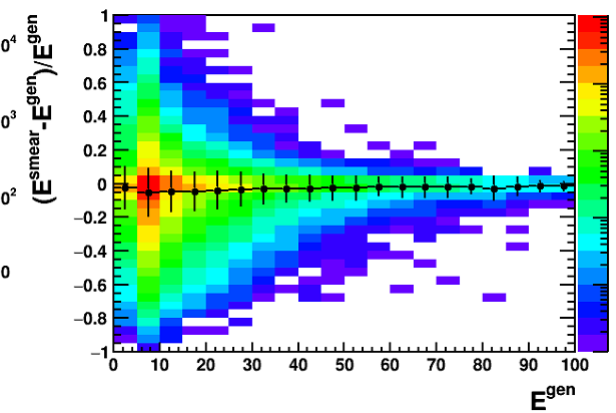
Smear Jet : $p_{T}^{\text{Lab}} > 0.25 \text{ GeV}$, $|\eta^{\text{Lab}}| < 3.5$, $R=1$

Resolution defined with the RMS in each bin

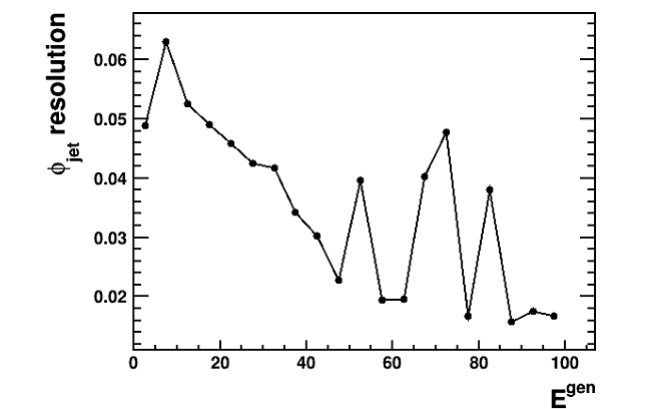
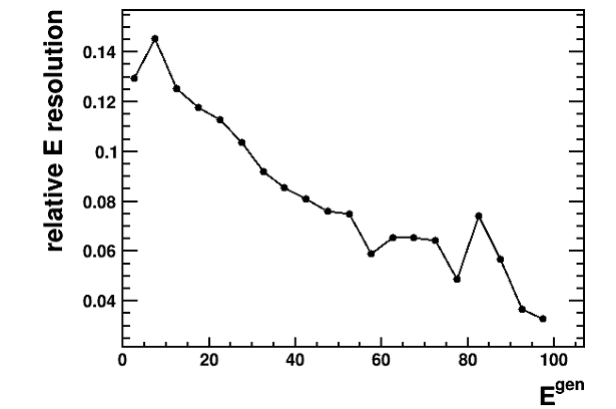
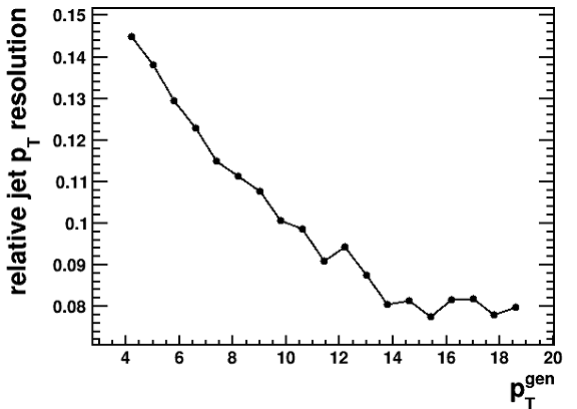
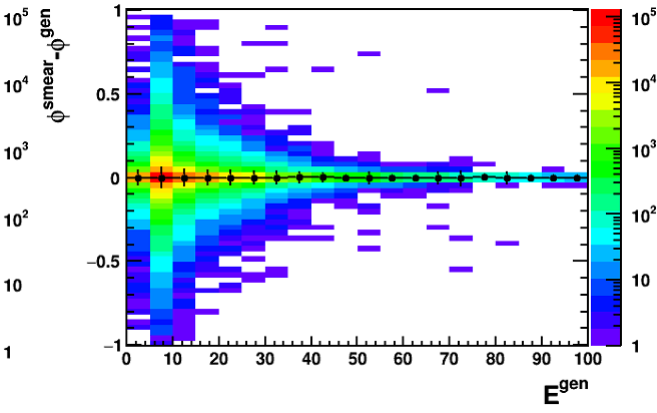
Jet p_T resolutions



Jet E resolutions



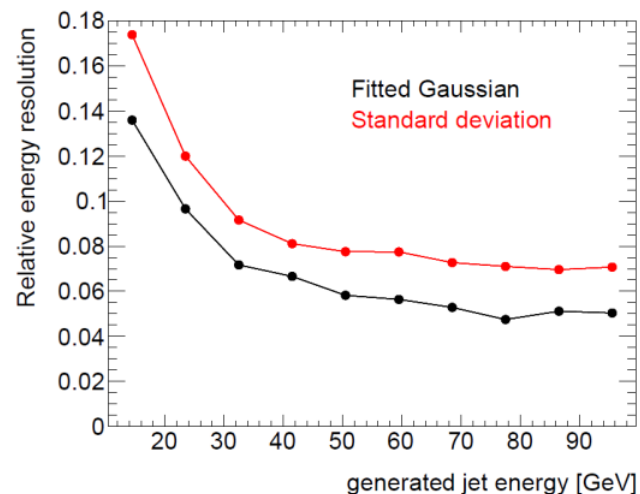
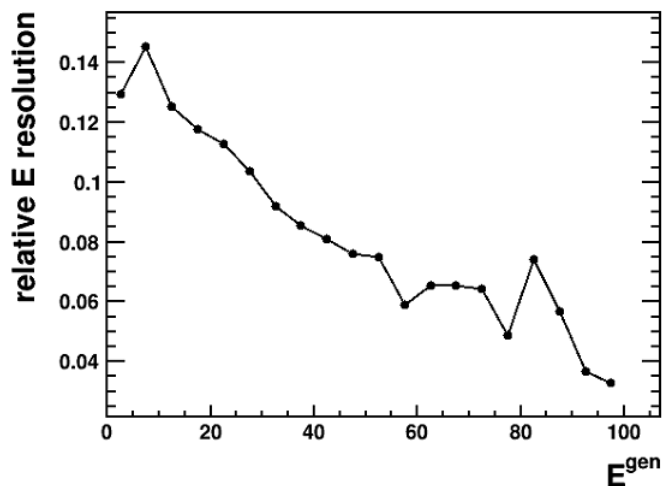
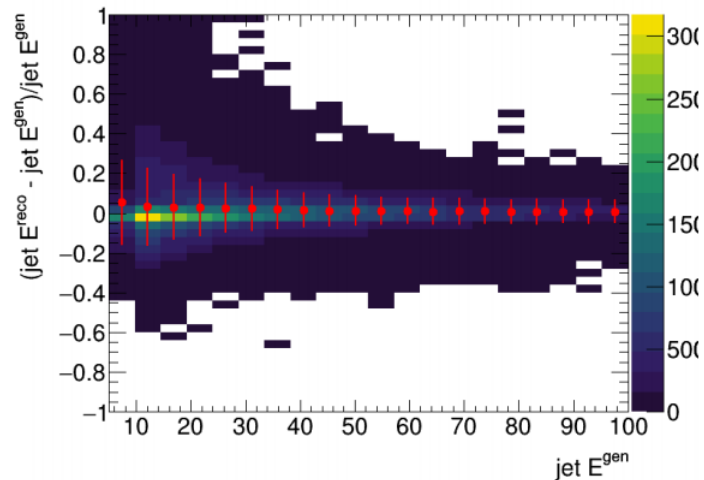
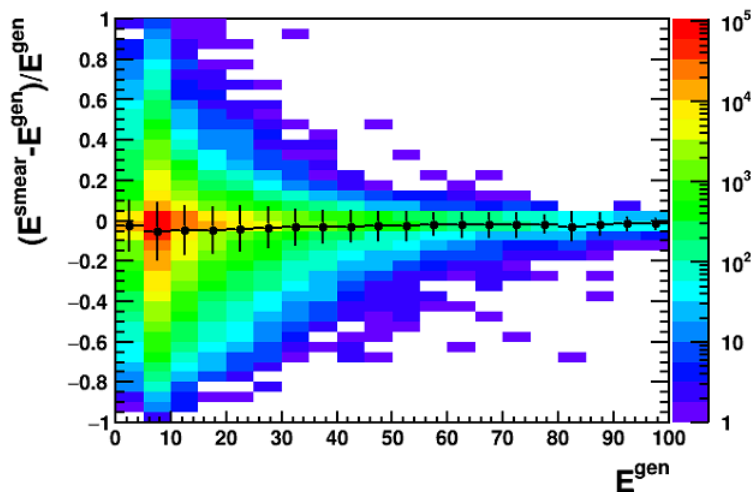
Jet azimuthal angle resolutions



Cross check with DELPHES results

Behavior seems to be similar, the current framework predicts slightly smaller resolution

From Miguel Arratia Pavia YR talk

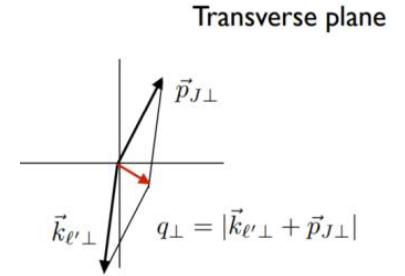
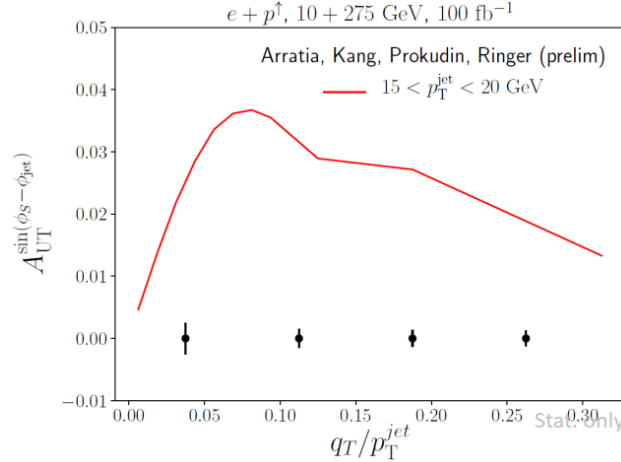


Dilution on jet single spin asymmetry

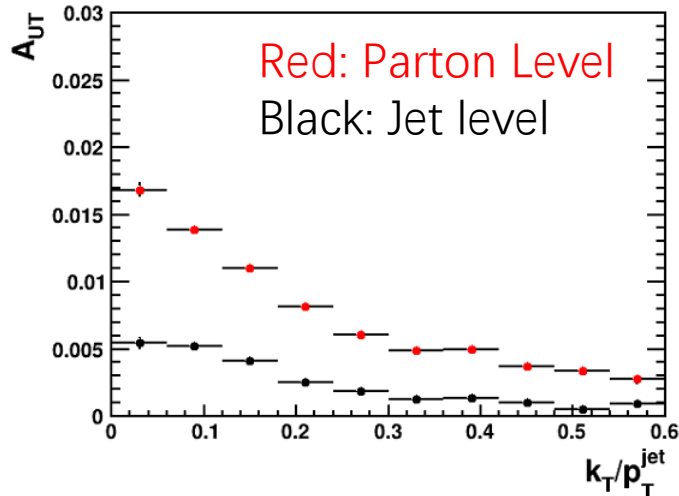
From Miguel Arratia Pavia YR talk

$$A_{UT} = \langle 2 \sin(\phi_{jet} - \phi_S) \rangle$$

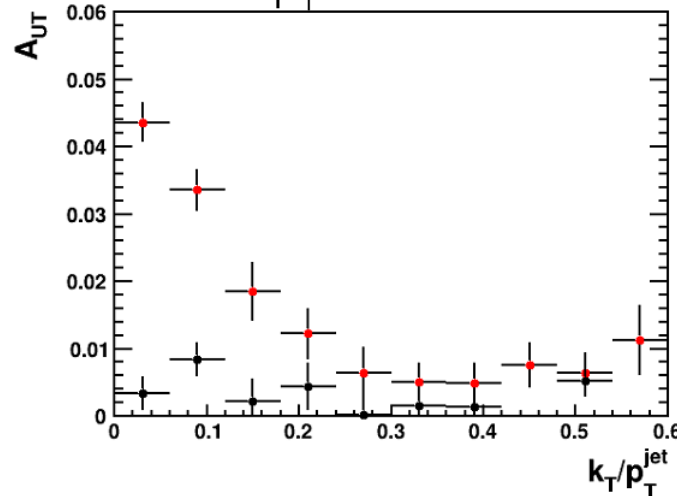
ep 18x275, $Q^2 > 1 \text{ GeV}^2$, $0.1 < y < 0.85$
Generator level jet



$p_T^e < 15 \text{ GeV}$



$p_T^e > 15 \text{ GeV}$



Dilution factor from parton level to jet level can be estimated with the weighting, about a factor of 3

Smearred jet with high Q^2

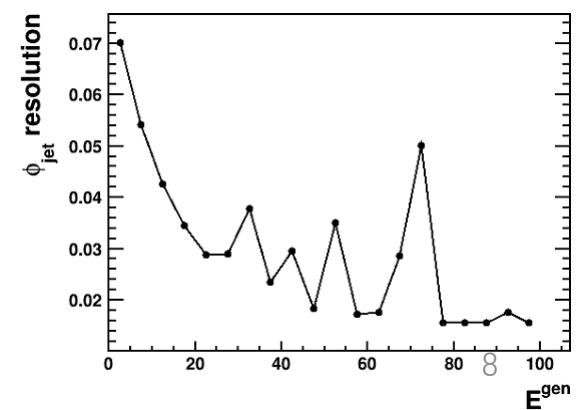
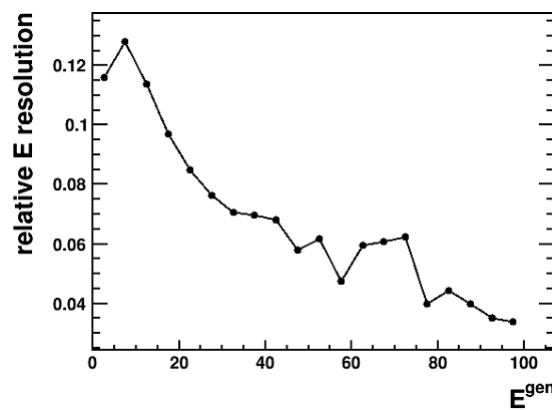
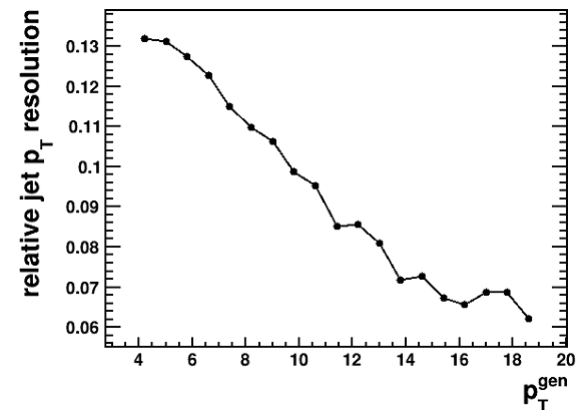
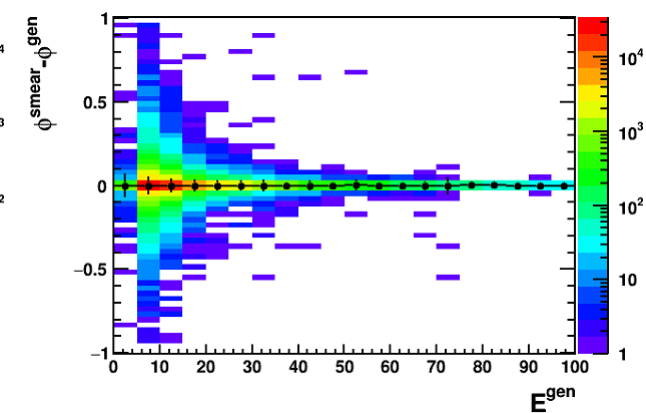
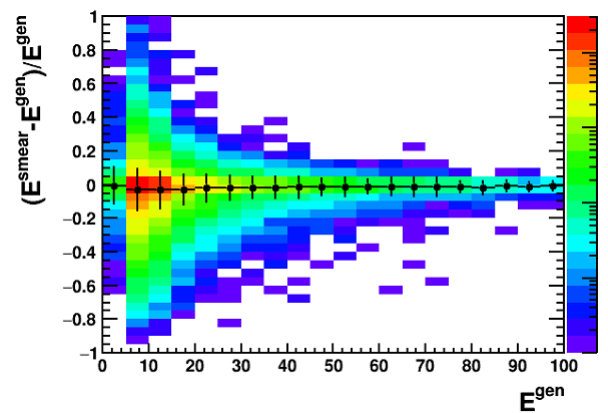
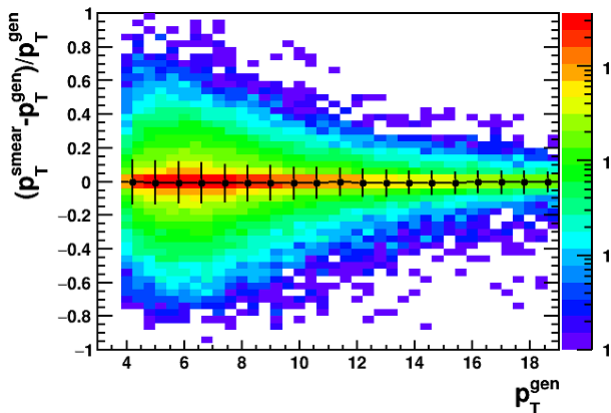
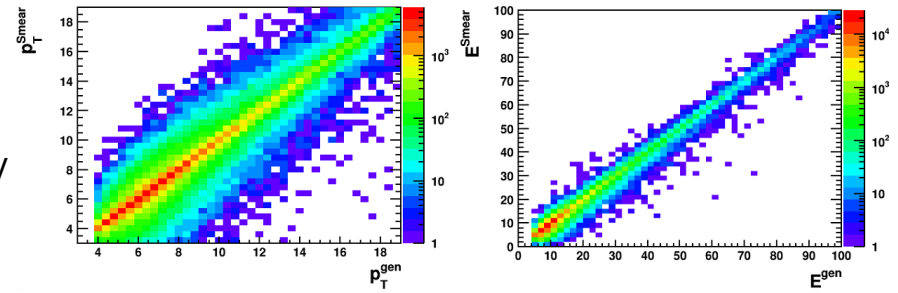
ep 18x275, $Q^2 > 50 \text{ GeV}^2$, $0.1 < y < 0.85$

Generator level jet selection

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Smear Jet : $p_{T}^{\text{Lab}} > 0.25 \text{ GeV}$, $|\eta^{\text{Lab}}| < 3.5$, $R=1$

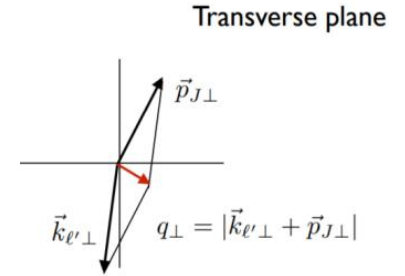
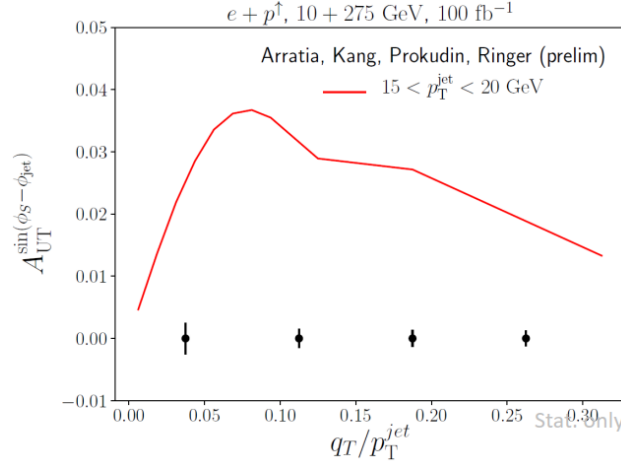


Dilution on jet single spin asymmetry with high Q^2

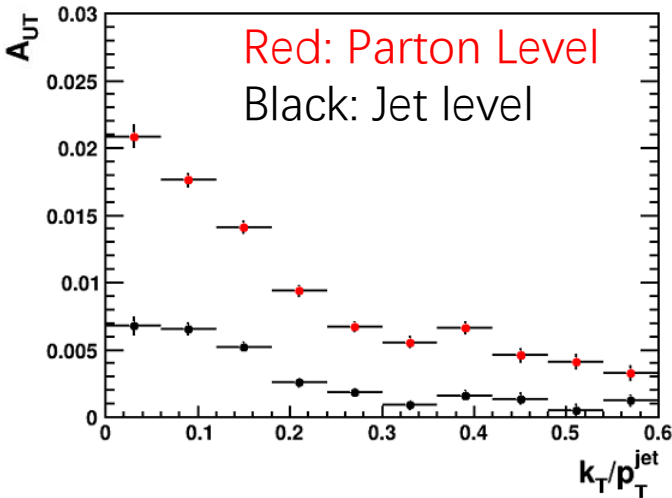
Miguel Pavia YR talk

$$A_{UT} = \langle 2 \sin(\phi_{jet} - \phi_S) \rangle$$

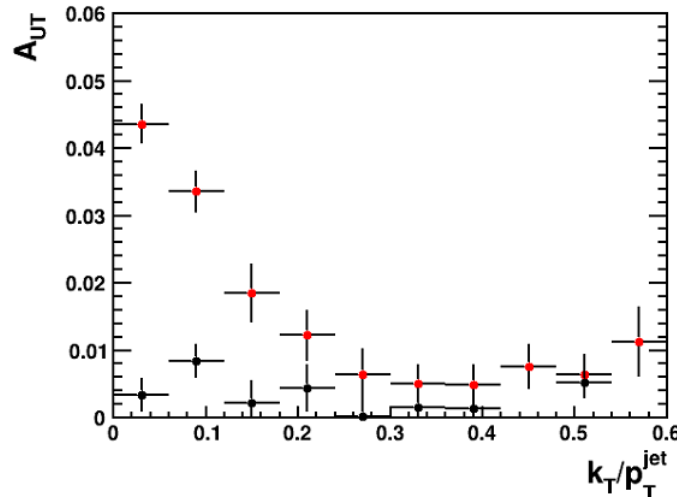
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Generator level jet



$p_T^e < 15 \text{ GeV}$

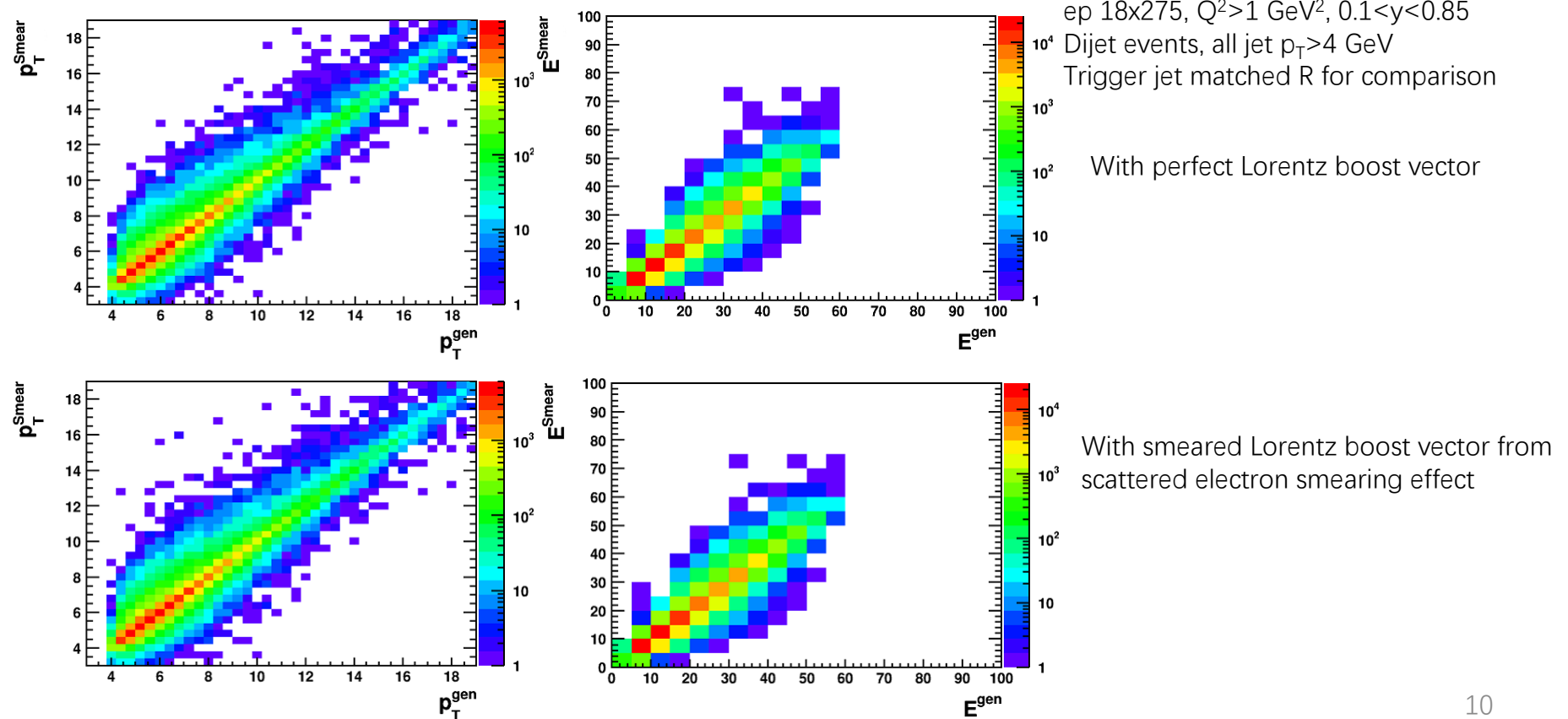
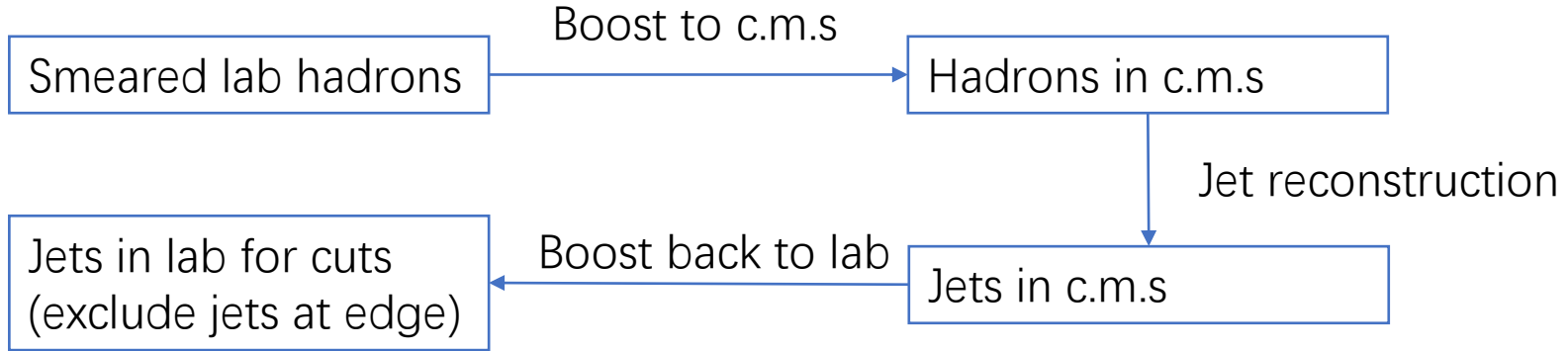


$p_T^e > 15 \text{ GeV}$



Asymmetry enlarged in the low p_T bin, while high p_T bin unchanged.

Jet reconstruction in γ^*p center-of-mass



Smearred jet resolutions in γ^*p center-of-mass

ep 18x275, $Q^2 > 1 \text{ GeV}^2$, $0.1 < y < 0.85$

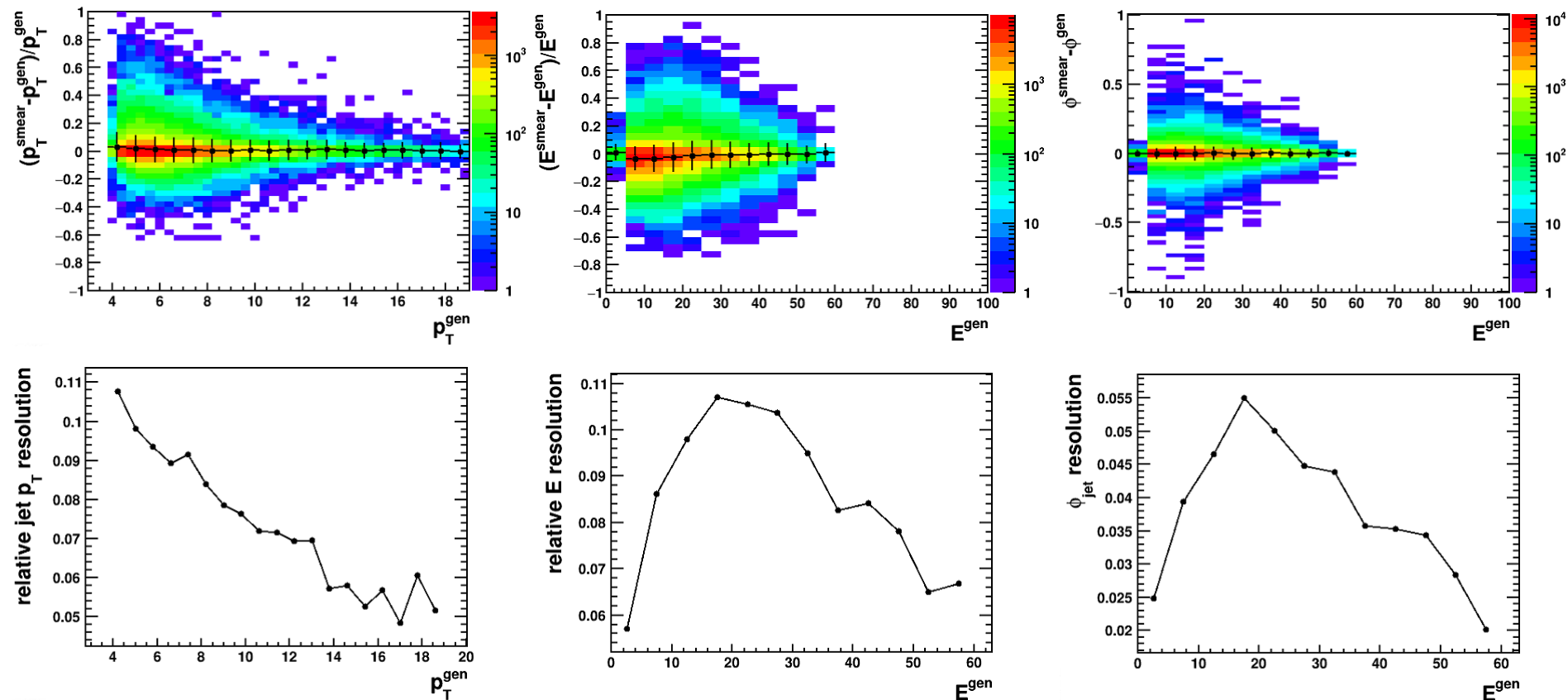
Dijet events, all jet $p_{T^{\text{gen}}} > 4 \text{ GeV}$

Trigger jet matched R for comparison

Jet constituent $p_{T^{\text{Lab}}} > 0.25 \text{ GeV}$, $|\eta^{\text{Lab}}| < 3.5$

Jet find R=1, all smear in

Matched trigger jet resolution in c.m.s
close to the matched leading jet
resolution in lab.



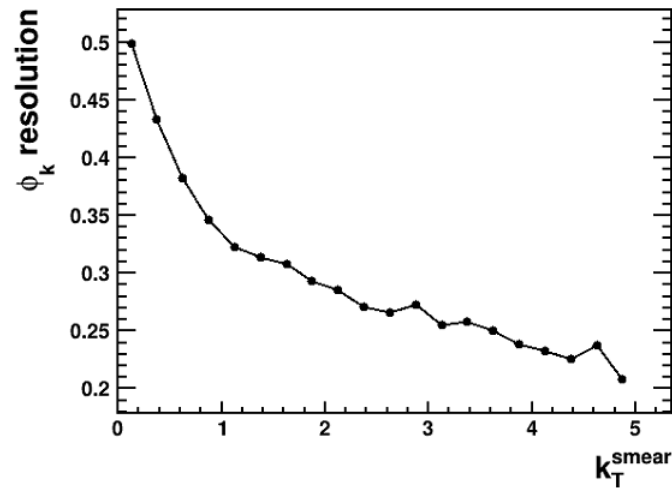
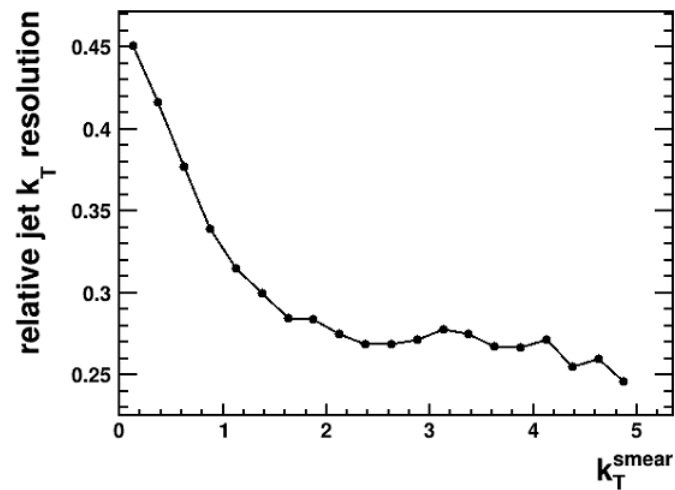
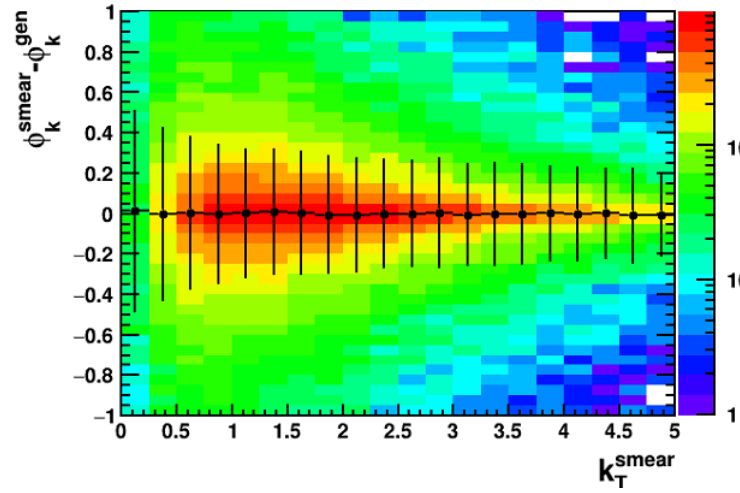
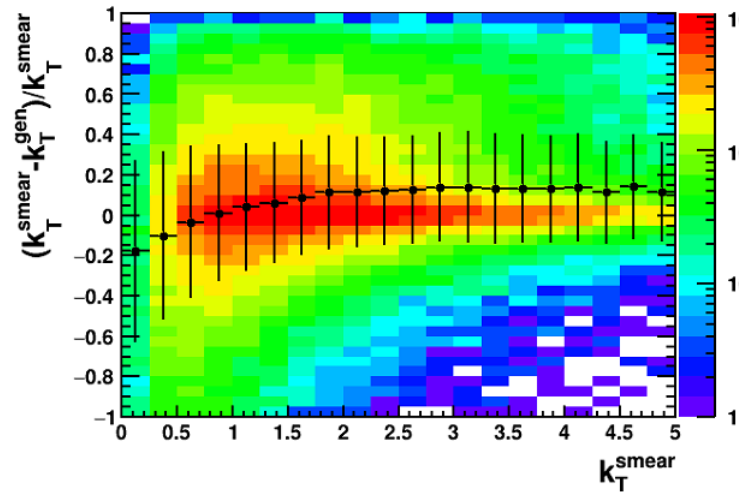
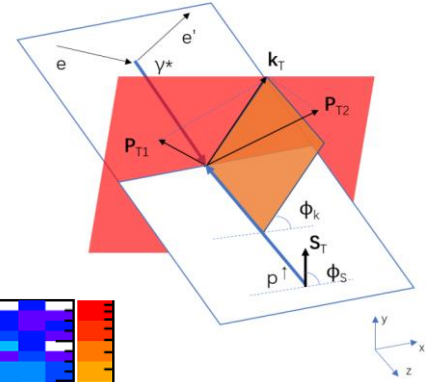
Smearred jet sum resolutions in γ^*p center-of-mass

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Smearred jet constituent: $p_T^{\text{Lab}} > 0.25 \text{ GeV}$, $|\eta^{\text{Lab}}| < 3.5$

Reconstruction $R=1$, all smear in

Smearred Jet trigger $p_T > 4.5$, associate $p_T > 4$



Summary

- Jet resolution estimated in the eic-smear framework, results similar to the DELPHES estimations
- Quick look at the detector smearing effects on dijet kinematics
- Projections with detector response on the gluon Sivers measurements to be made

EIC Detector Requirements

η	Nomenclature		Tracking			Electrons		n/K/p PID		HCAL	Muons
			Resolution	Allowed X/X ₀	Si-Vertex	Resolution σ_E/E	PID	p-Range (GeV/c)	Separation	Resolution σ_E/E	
-6.9 – -5.8	↓ p/A	Auxiliary Detectors	low-Q ² tagger	$\delta E/E < 1.5\%$; $10^{-6} < Q^2 < 10^{-2} \text{ GeV}^2$							
...											
-4.5 – -4.0		Instrumentation to separate charged particles from photons									
-4.0 – -3.5	Central Detector	Backwards Detectors	$\sigma_{p/p} \sim 0.1\%xp+2.0\%$	~5% or less	TBD	2%√E	n suppression up to 1:10 ⁴	≤ 7 GeV/c	≥ 3σ	TBD	TBD
-3.5 – -3.0											
-3.0 – -2.5			$\sigma_{p/p} \sim 0.05\%xp+0.5\%$			TBD					
-2.5 – -2.0											
-2.0 – -1.5		$\sigma_{p/p} \sim 0.1\%xp+2.0\%$	≤ 8 GeV/c								
-1.5 – -1.0					Forward Detectors	≤ 20 GeV/c					
-1.0 – -0.5		$\sigma_{p/p} \sim 0.05\%xp+0.5\%$	≤ 45 GeV/c								
-0.5 – 0.0					$\sigma_{p/p} \sim 0.05\%xp+1.0\%$	≤ 8 GeV/c					
0.0 – 0.5		Barrel	≤ 20 GeV/c								
0.5 – 1.0					$\sigma_{p/p} \sim 0.05\%xp+0.5\%$	≤ 45 GeV/c					
1.0 – 1.5	Forward Detectors	≤ 8 GeV/c									
1.5 – 2.0			$\sigma_{p/p} \sim 0.05\%xp+1.0\%$	≤ 20 GeV/c							
2.0 – 2.5	$\sigma_{p/p} \sim 0.05\%xp+1.0\%$	≤ 45 GeV/c									
2.5 – 3.0			Forward Detectors	≤ 8 GeV/c							
3.0 – 3.5	$\sigma_{p/p} \sim 0.1\%xp+2.0\%$	≤ 20 GeV/c									
3.5 – 4.0			Instrumentation to separate charged particles from photons								
4.0 – 4.5	Auxiliary Detectors										
...			Proton Spectrometer								
> 6.2	$\sigma_{\text{intrinsic}}(\text{ }) \ll 1\%$; Acceptance: $0.2 < p_T < 1.2 \text{ GeV}/c$										