Heavy-flavor studies for Early Science (ES)

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e+p 10x250: 2.5 fb^{-1} for Λ_c/D^0 ratio

e+p 10x130, e+Au 10x100: 1 fb^{-1} for R_{eAu} vs z_{proj}

Statistical Projection for Λ_c/D^0 ratio (Updated)

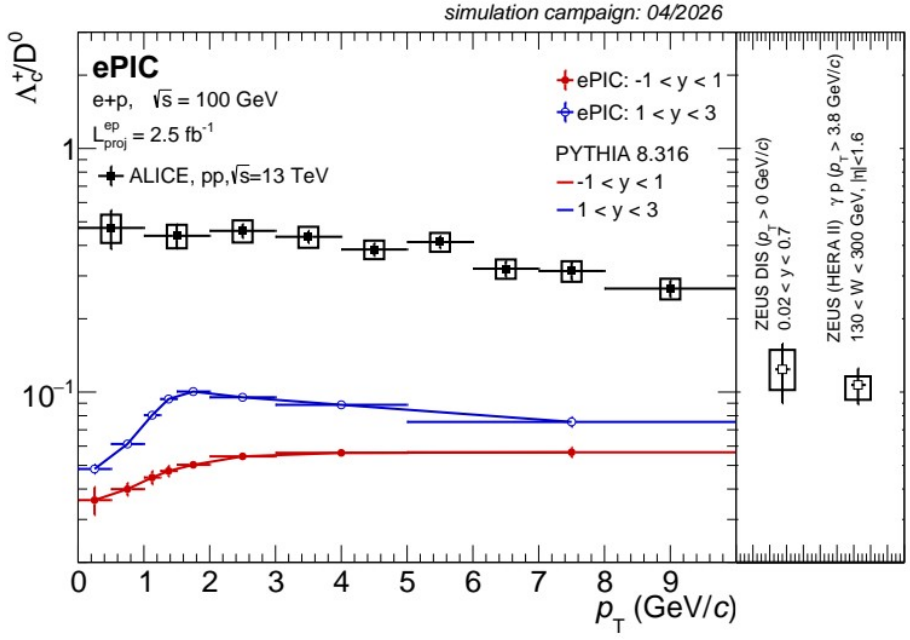
JHEP12(2023)086 https://arxiv.org/pdf/2011.06079

REACTION	PP --> LAMBDAC + X
REACTION	PP --> D0 + X
SQRT(S)	13000 GEV
YRAP	-0.5 TO 0.5

p_T [GeV/c]	Λ_c^+/D^0
0.0 - 1.0	0.472 ±0.086 stat ±0.059 syst ±0.021 systBR
1.0 - 2.0	0.438 ±0.049 stat +0.043 -0.044 syst ±0.021 systBR
2.0 - 3.0	0.459 ±0.03 stat ±0.043 syst ±0.021 systBR
3.0 - 4.0	0.434 ±0.025 stat ±0.038 syst ±0.02 systBR
4.0 - 5.0	0.385 ±0.023 stat ±0.029 syst ±0.017 systBR
5.0 - 6.0	0.413 ±0.024 stat +0.032 -0.031 syst ±0.019 systBR
6.0 - 7.0	0.321 ±0.024 stat ±0.025 syst ±0.015 systBR
7.0 - 8.0	0.314 ±0.026 stat ±0.027 syst ±0.014 systBR
8.0 - 10.0	0.266 ±0.021 stat ±0.023 syst ±0.012 systBR
10.0 - 12.0	0.249 ±0.033 stat ±0.023 syst ±0.011 systBR
12.0 - 24.0	0.141 ±0.023 stat +0.015 -0.016 syst ±0.006 systBR

$$\text{Total Systematic} = \sqrt{\text{sys}^2 + \text{sysBR}^2}$$

	$\Lambda_c^+/D^0 \pm$ stat. $\pm$ syst.	System	$\sqrt{s}$ (GeV)	Notes
ALICE	$0.51 \pm 0.04 \pm 0.04\,^{+0.01}_{-0.02}$	pp	5020	$p_T > 0, \lvert y \rvert < 0.5$
ALICE	$0.42 \pm 0.03 \pm 0.06^{+0.05}_{-0.03}$	p–Pb	5020	$p_T > 0, -0.96 < y < 0.04$
CLEO [16]	$0.119 \pm 0.021 \pm 0.019$	e^+e^-	10.55	
ARGUS [15, 17]	0.127 ± 0.031	e^+e^-	10.55	
LEP average [18]	$0.113 \pm 0.013 \pm 0.006$	e^+e^-	91.2	
ZEUS DIS [21]	$0.124 \pm 0.034^{+0.025}_{-0.022}$	e^-p	320	$1 < Q^2 < 1000$ GeV^2, $0 < p_T < 10$ GeV/c, $0.02 < y < 0.7$
ZEUS γp, HERA I [19]	$0.220 \pm 0.035^{+0.027}_{-0.037}$	e^-p	320	$130 < W < 300$ GeV, $Q^2 < 1$ GeV^2, $p_T > 3.8$ GeV/c, $\lvert\eta\rvert < 1.6$
ZEUS γp, HERA II [20]	$0.107 \pm 0.018^{+0.009}_{-0.014}$	e^-p	320	$130 < W < 300$ GeV, $Q^2 < 1$ GeV^2, $p_T > 3.8$ GeV/c, $\lvert\eta\rvert < 1.6$



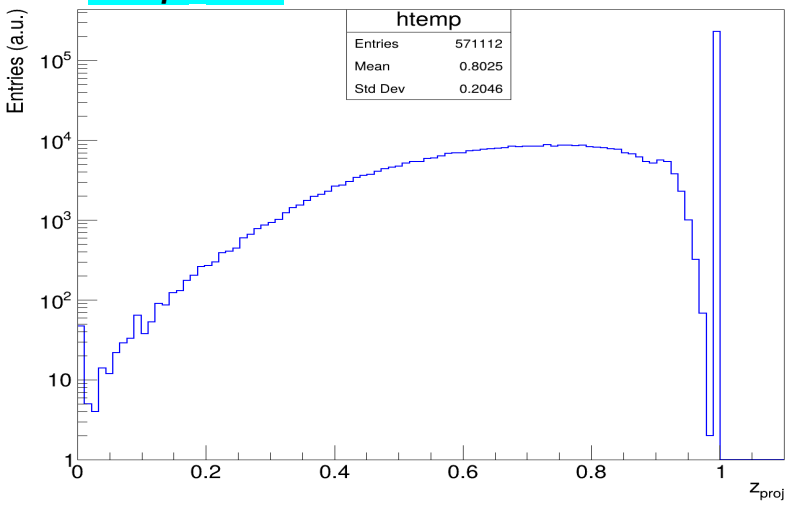
Fragmentation Variable (e+p)

Signal pairs from D^0 Sample

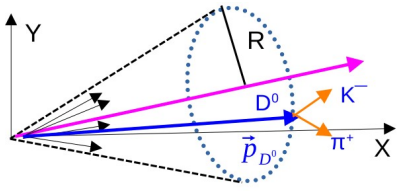
e+p, 10x130, **D^0 sample**

No p_T cut

p_T > 3 GeV/c

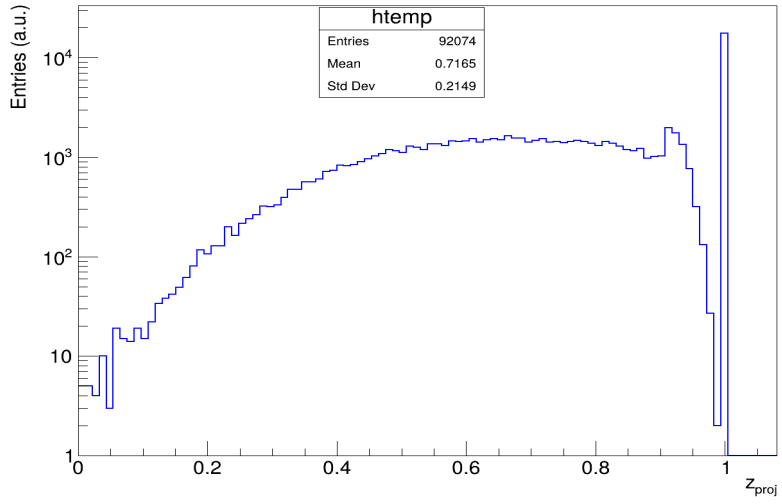


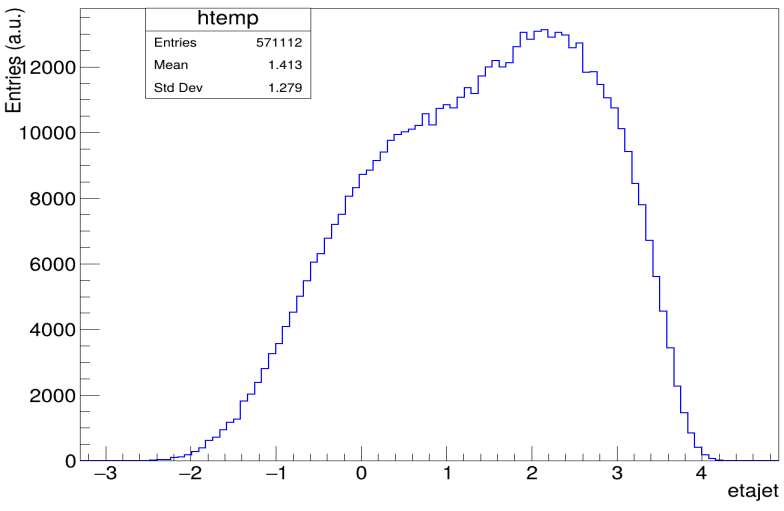
Anti-k_T, R = 1,



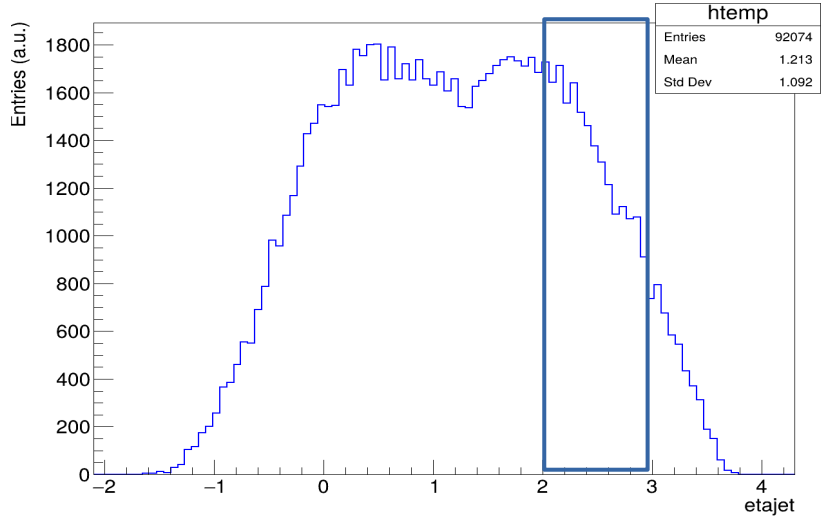
$$z = z_{proj} = \frac{\vec{p}_{D0.}\vec{p}_{jet}}{p_{jet}^2}$$

z {pTjet>3}





etajet {pTjet>3}



Fragmentation Variable (e+p)

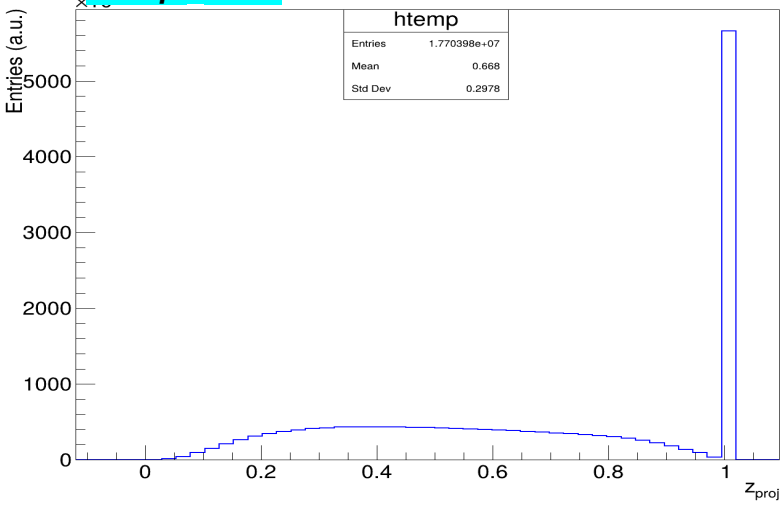
Bkg pairs from DIS Sample

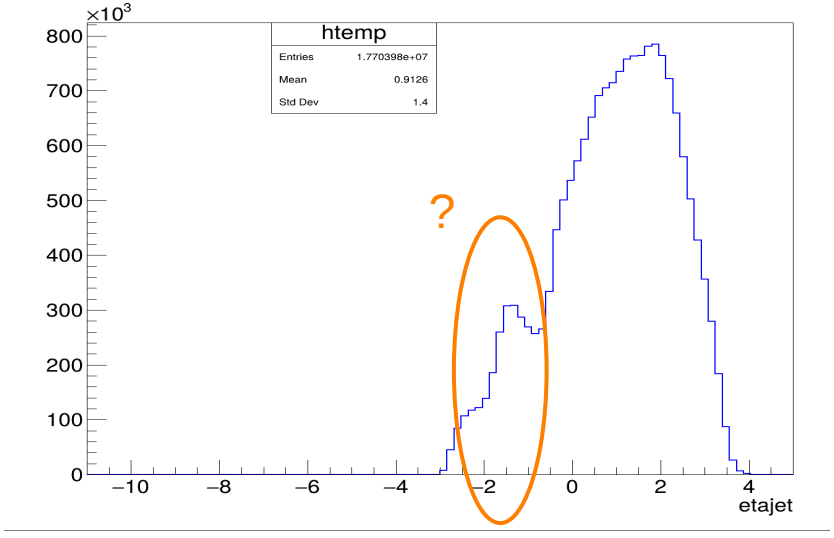
e+p, 10x130, **Biased DIS sample**

No p_T cut

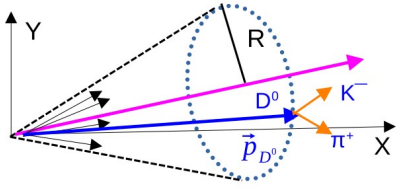
$p_T > 3$ GeV/c

z





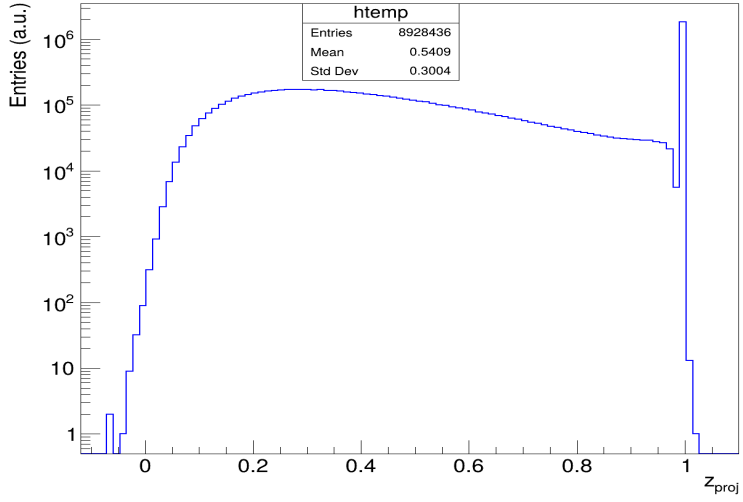
Anti-k_T, R = 1,



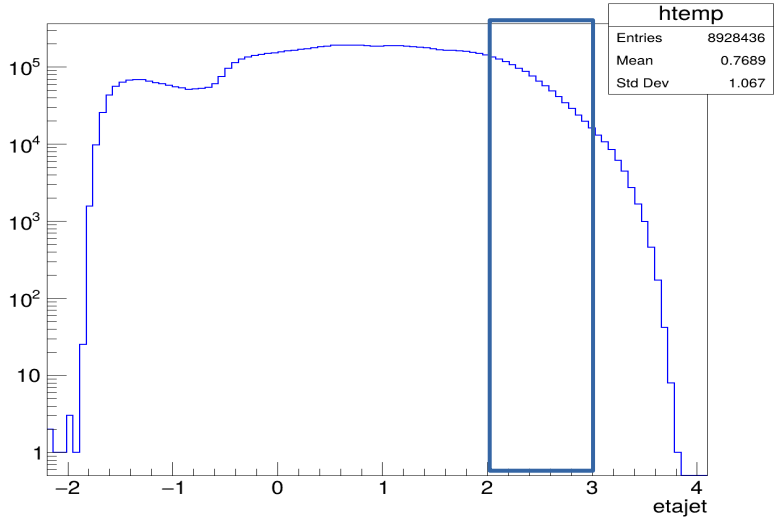
$$z = z_{proj} = \frac{\vec{p}_{D0.}\vec{p}_{jet}}{p^2_{jet}}$$

Removed scattered electron already

z {pTjet>3}

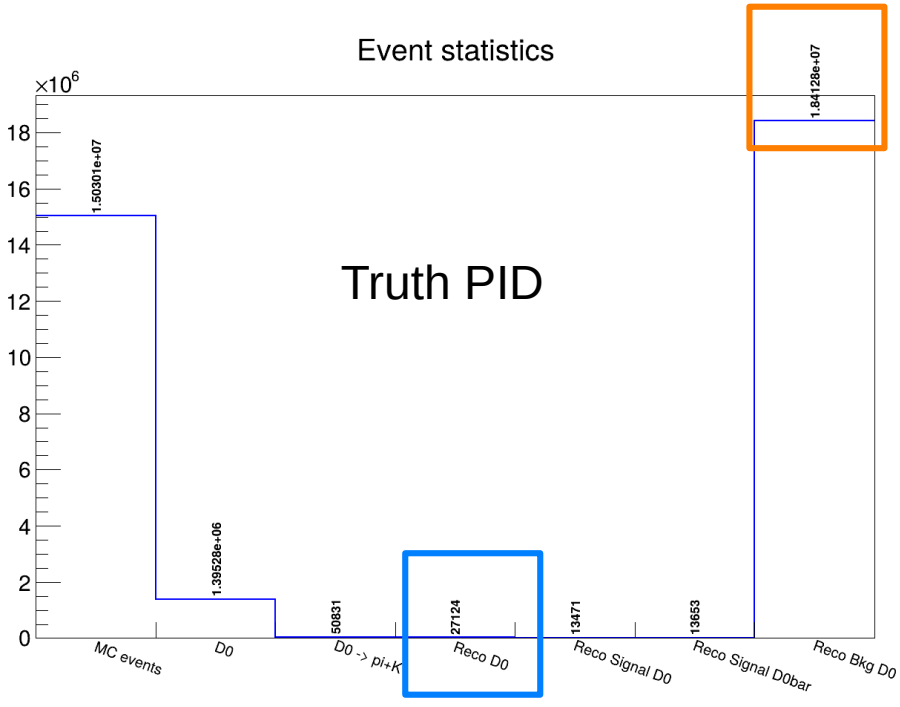


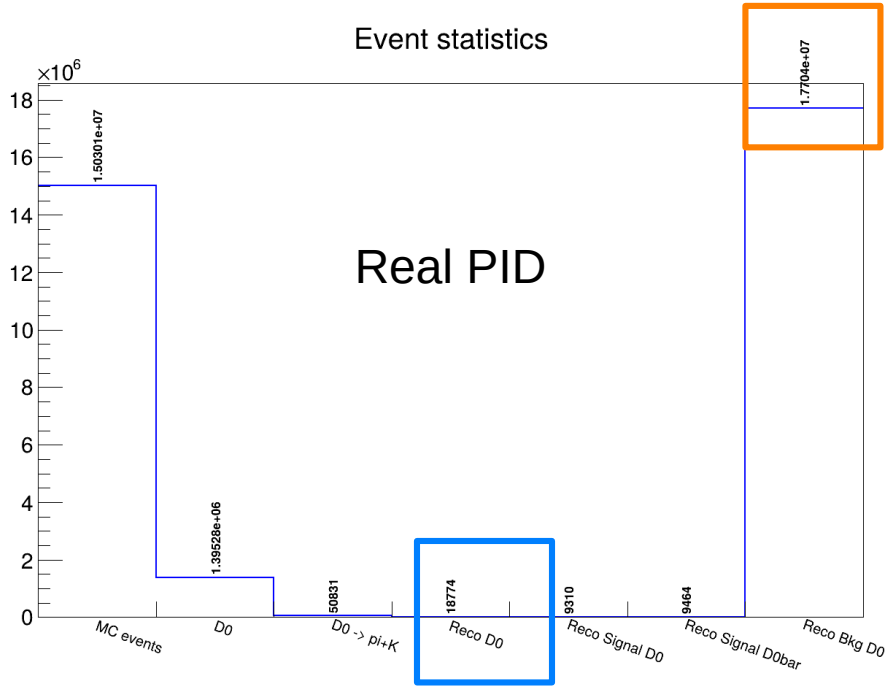
etajet {pTjet>3}



Event Stats (e+p, DIS Sample)

Reco Signal Pairs
Reco Bkg Pairs



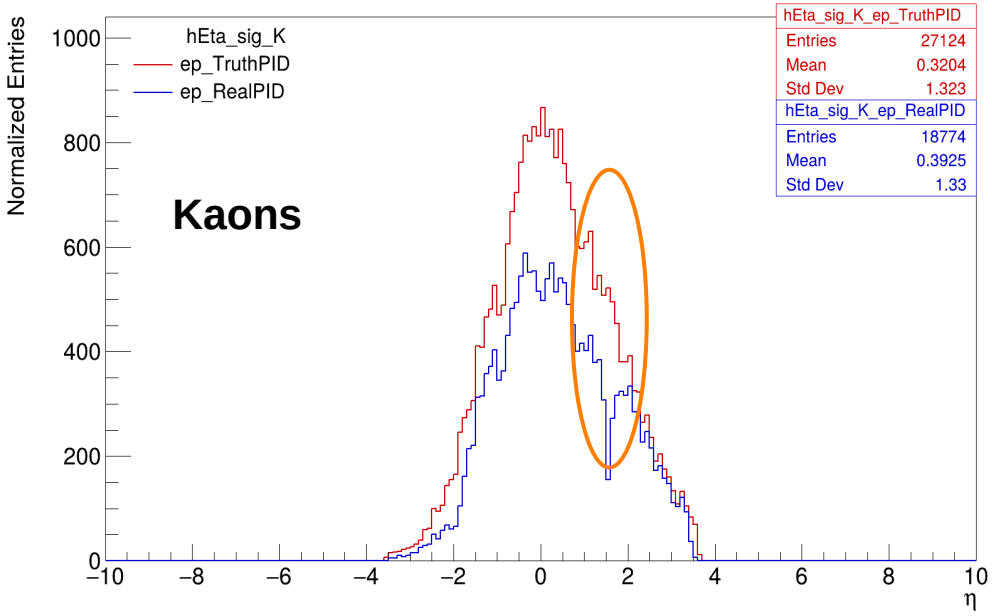


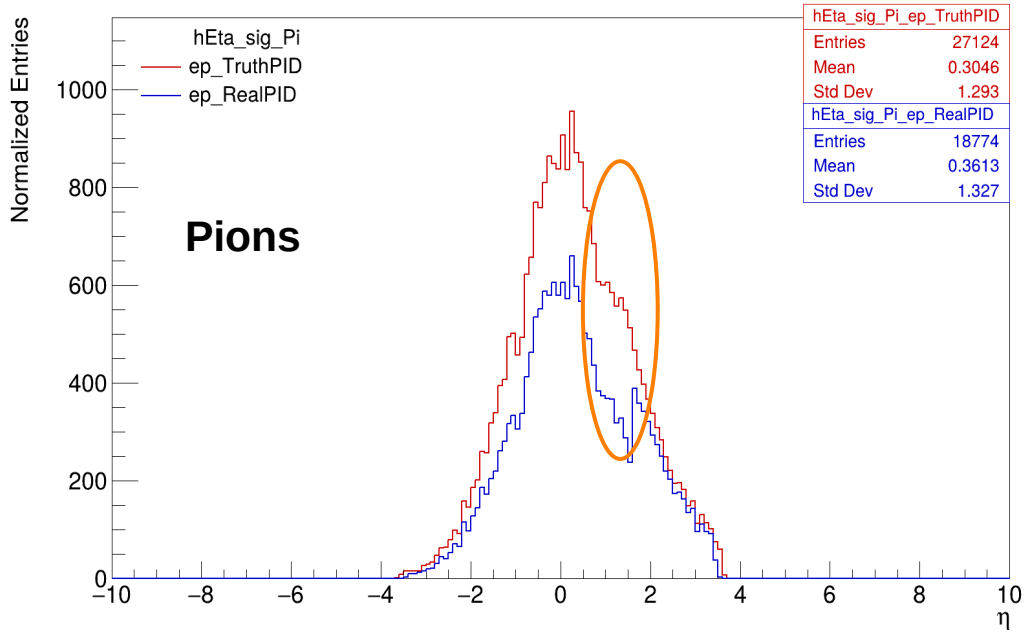
Signal D^0 daughter distributions (e+p)

e+p, 10x130, **Biased DIS sample**

Absolute entries

Signal pairs (Kaons/Pions η distribution)





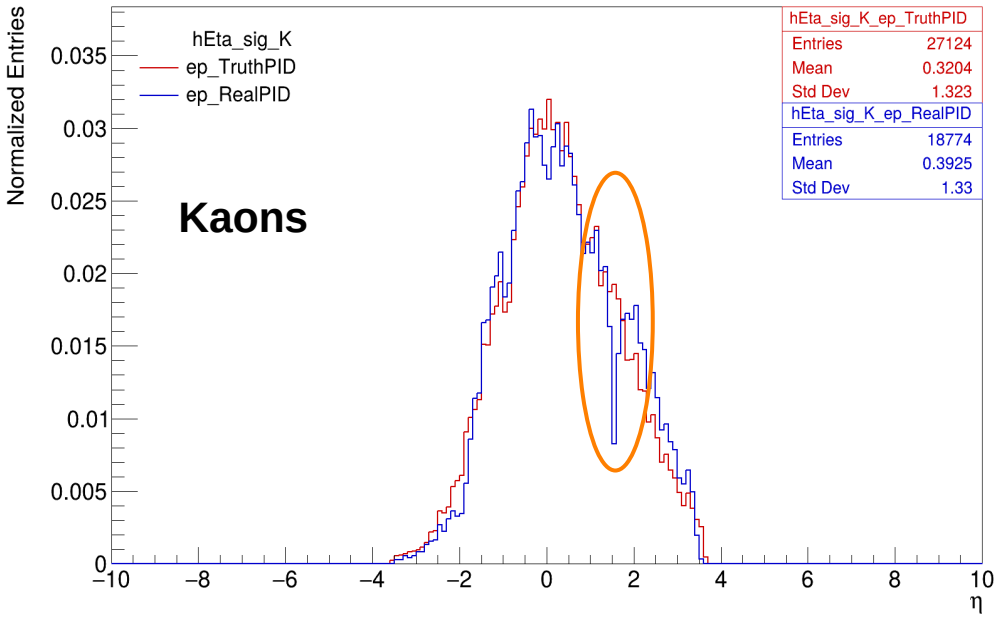
Drop at η~1.5 is created by the real PID

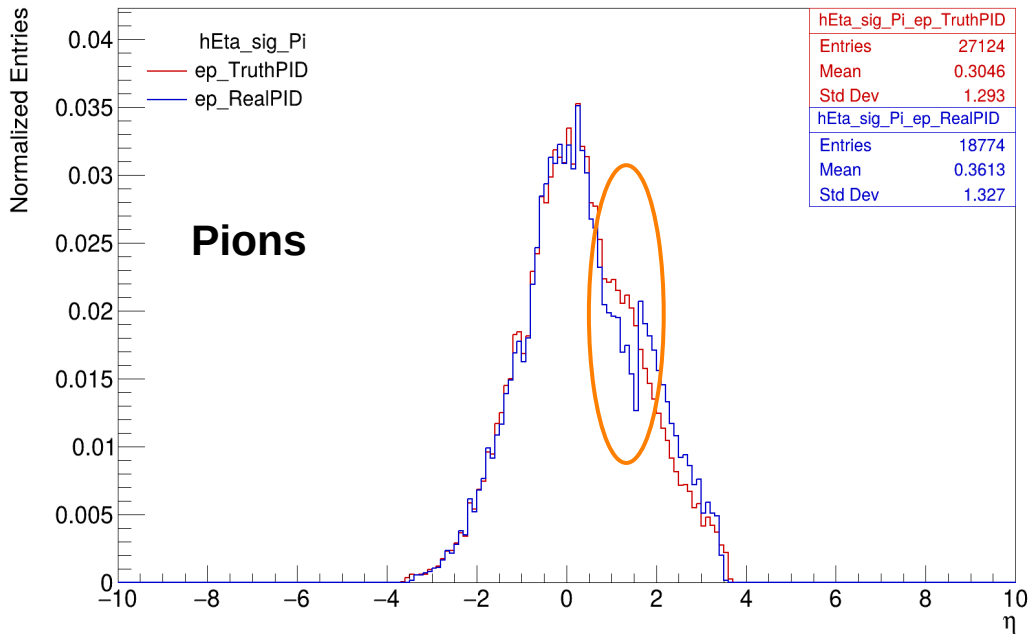
Signal D^0 daughter distributions (e+p)

e+p, 10x130, **Biased DIS sample**

Normalized entries

Signal pairs (Kaons/Pions η distribution)





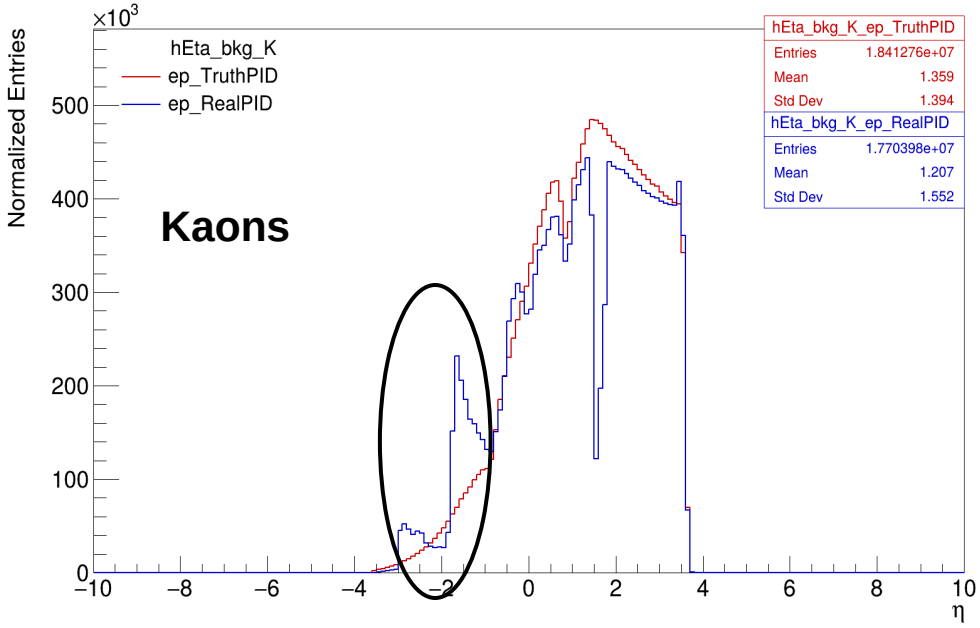
Drop at η~1.5 is created by the real PID

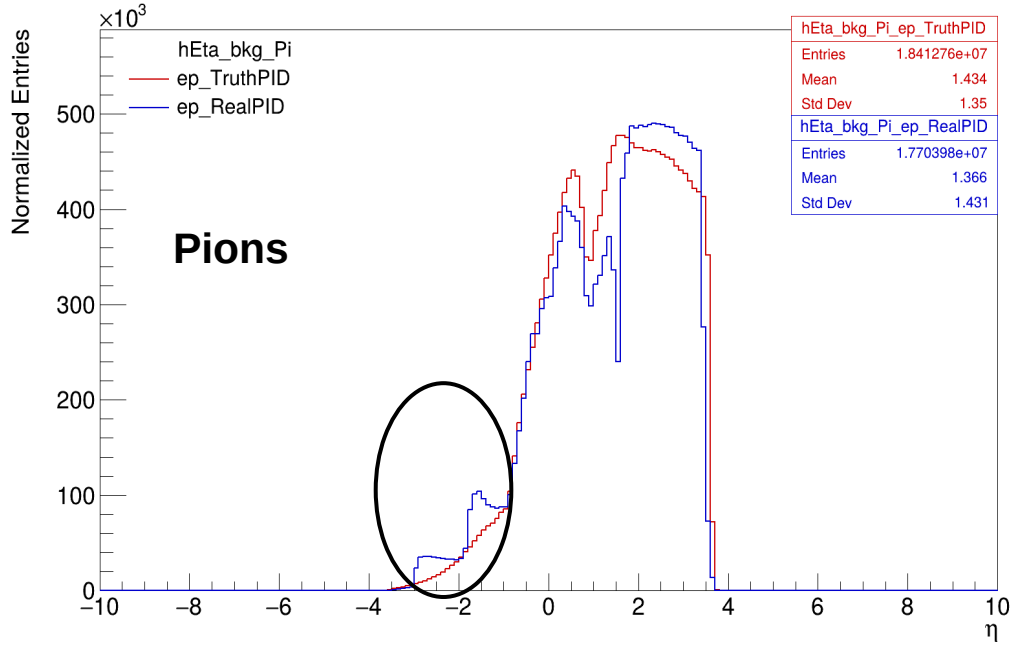
Background D^0 daughter distributions (e+p)

e+p, 10x130, **Biased DIS sample**

Absolute entries

Bkg pairs (Kaons/Pions η distribution)





Drop at η~1.5 is created by the real PID and additional bumps at -ve η

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e+p, 10x130, **Biased DIS sample**

Normalized entries

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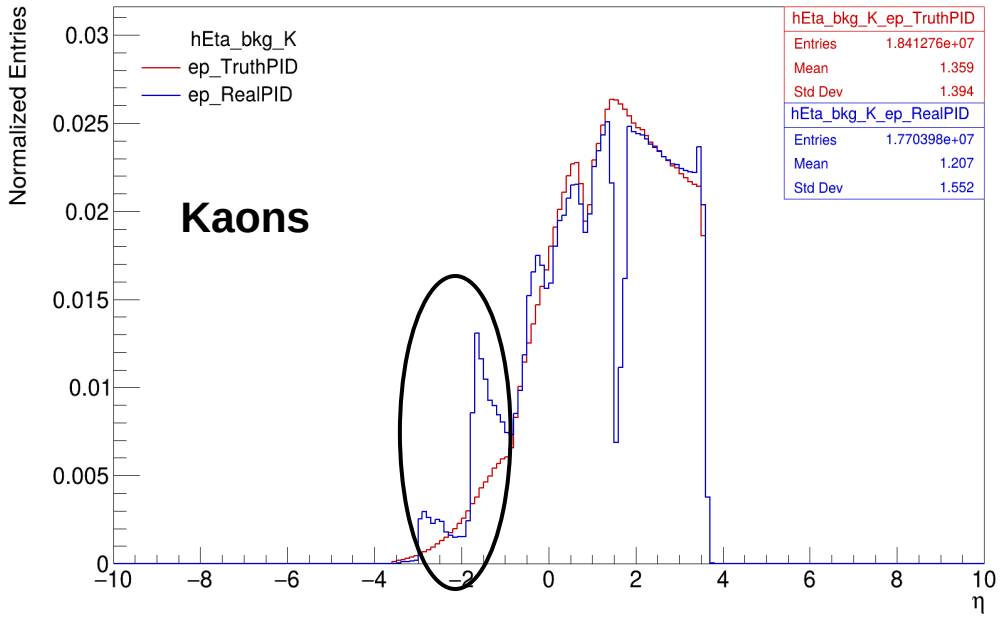
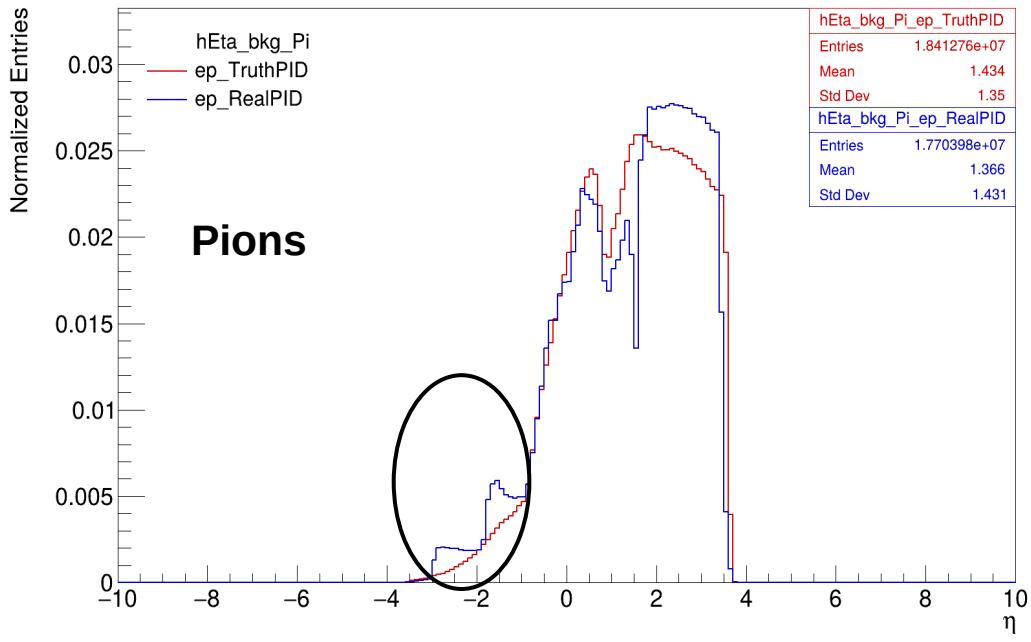




Drop at η~1.5 is created by the real PID and additional bumps at -ve η

Fragmentation Variable (e+Au)

Signal pairs from D^0 Sample

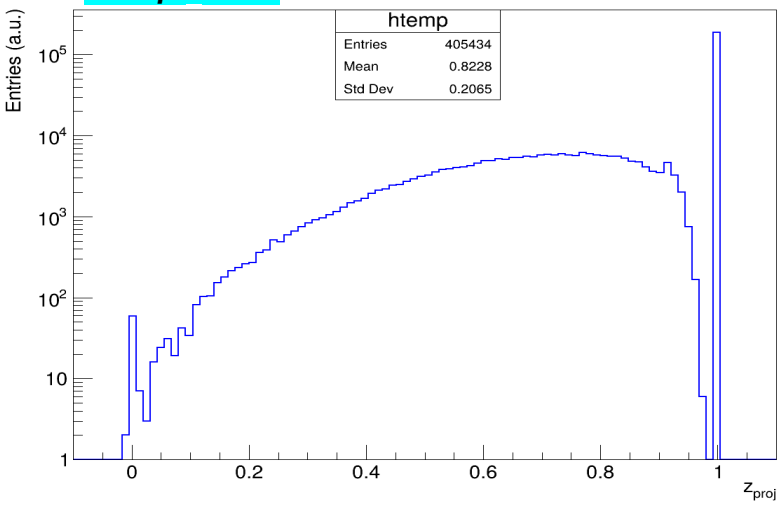
No p_T cut

z

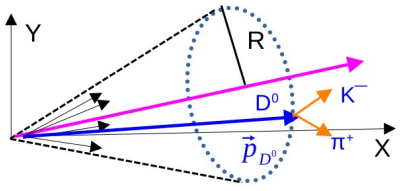
e+Au, 10x100, **D^0 sample**

p_T > 3 GeV/c

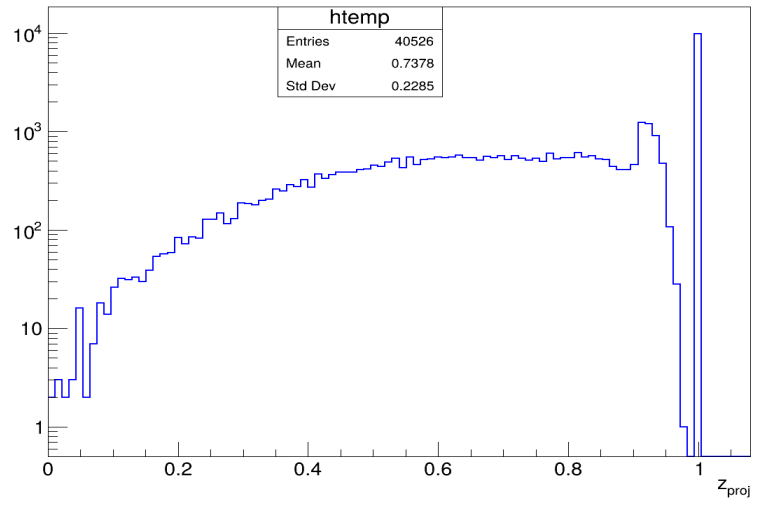
z {pTjet>3}

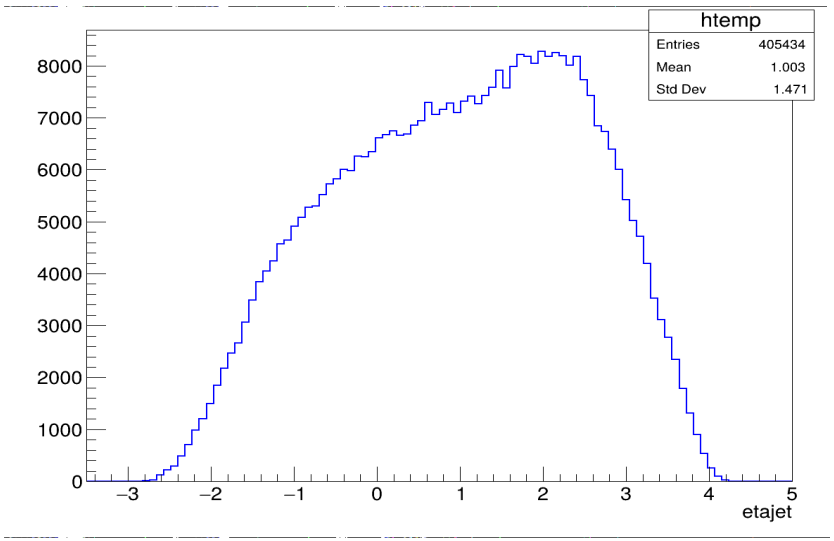


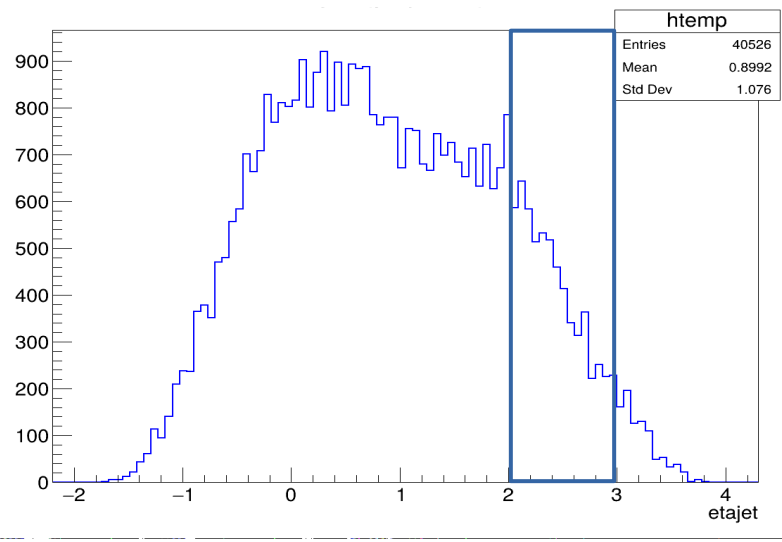
Anti-k_T, R = 1,
p_{Tjet} > 3 GeV/c



$$z = z_{proj} = \frac{\vec{p}_{D0}.\vec{p}_{jet}}{p_{jet}^2}$$







Fragmentation Variable (e+Au)

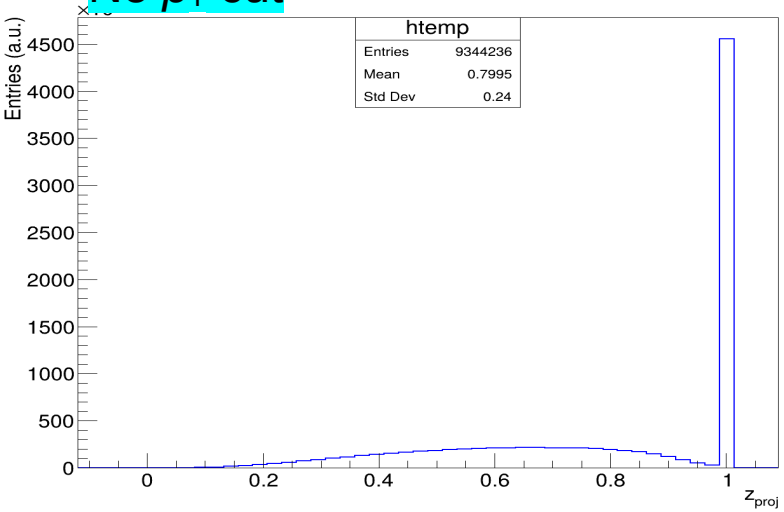
Bkg pairs from DIS Sample

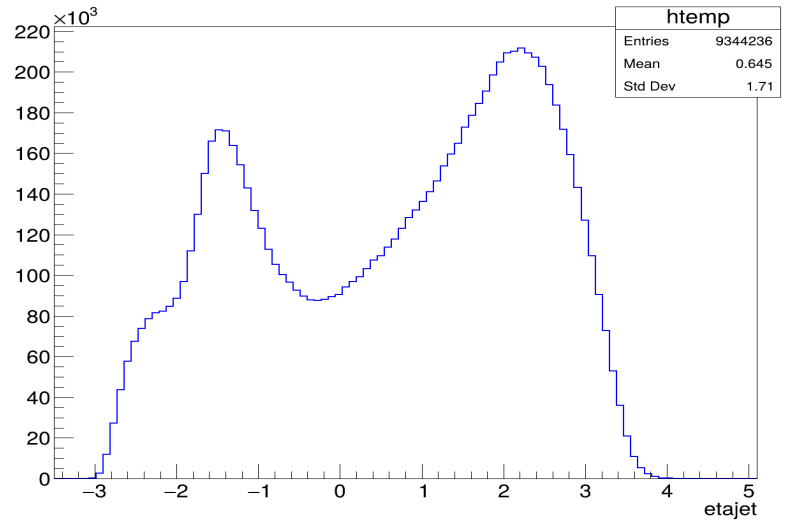
e+Au, 10x100, **Biased DIS sample**

No p_T cut

$p_T > 3$ GeV/c

z





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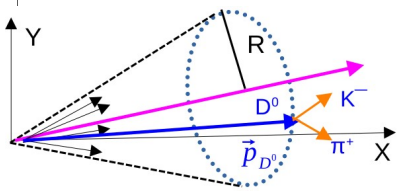
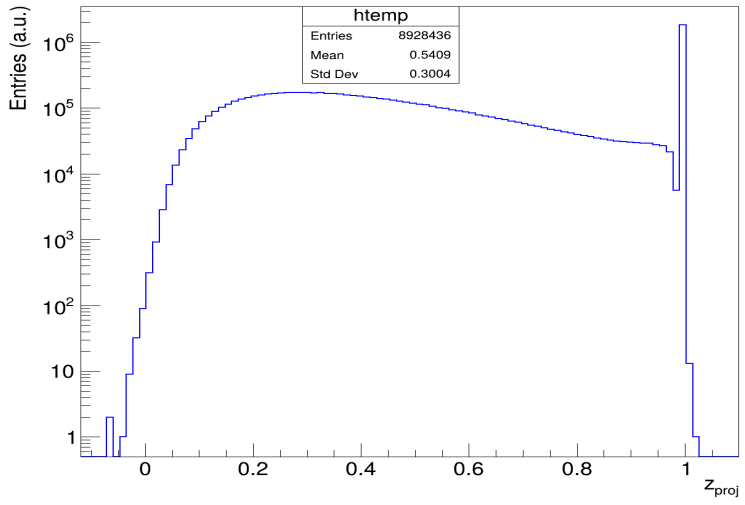
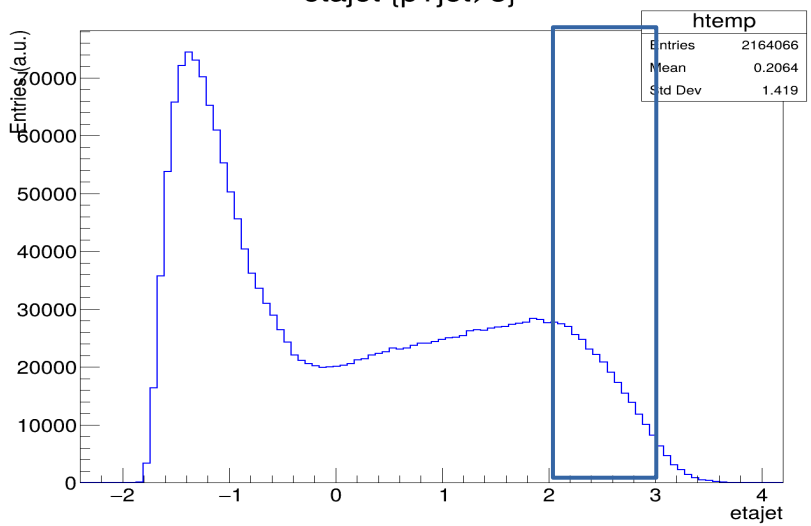


$$z = z_{proj} = \frac{\vec{p}_{D0.}\vec{p}_{jet}}{p^2_{jet}}$$

z {pTjet>3}

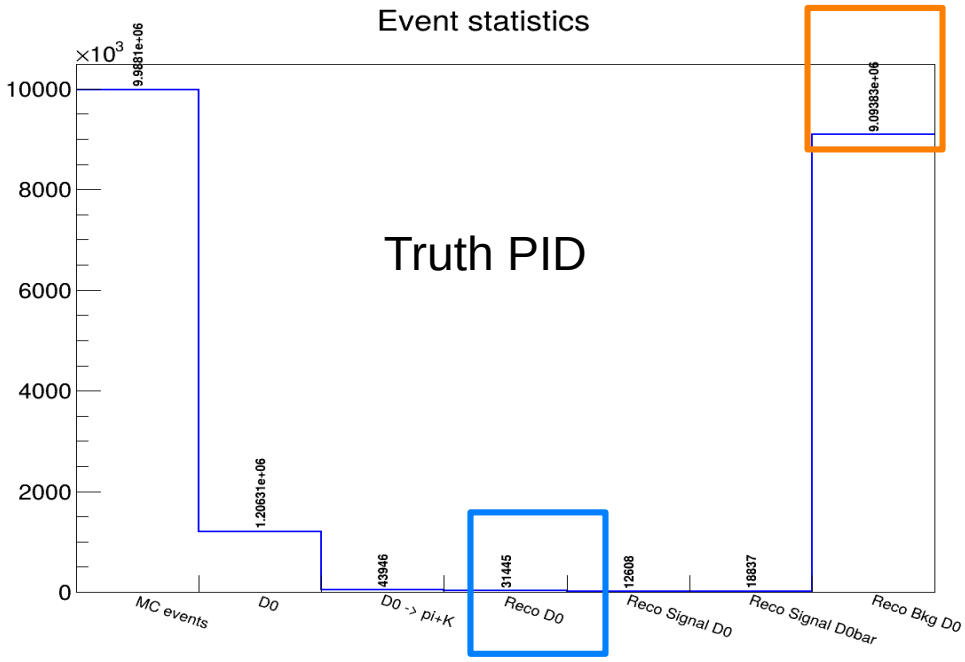


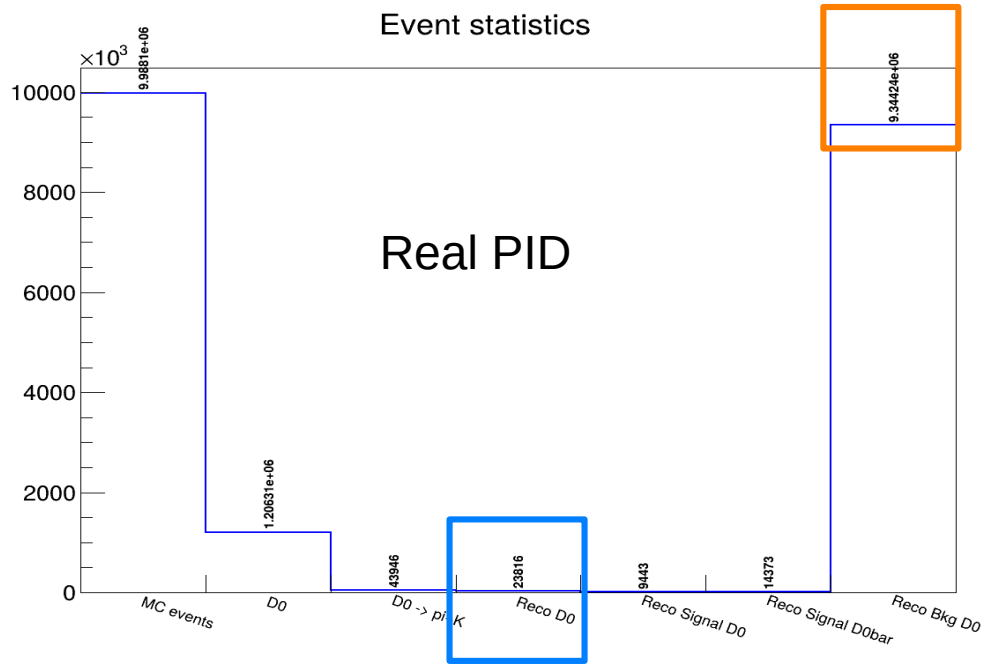
etajet {pTjet>3}



Event Stats (e+Au, DIS Sample)

Reco Signal Pairs
Reco Bkg Pairs



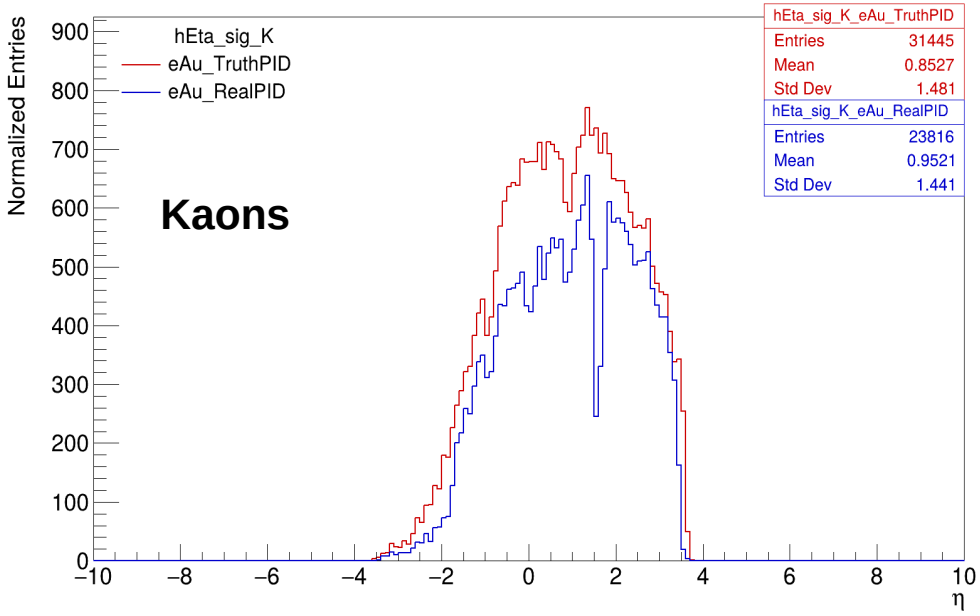


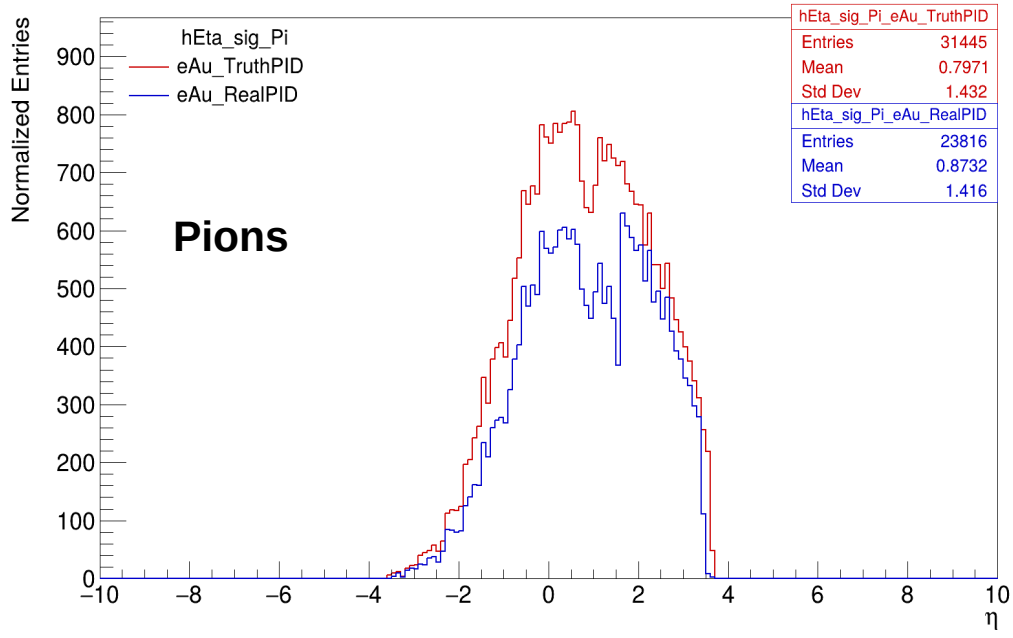
Signal D^0 daughter distributions (e+Au)

e+Au, 10x100, **Biased DIS sample**

Absolute entries

Signal pairs (Kaons/Pions η distribution)





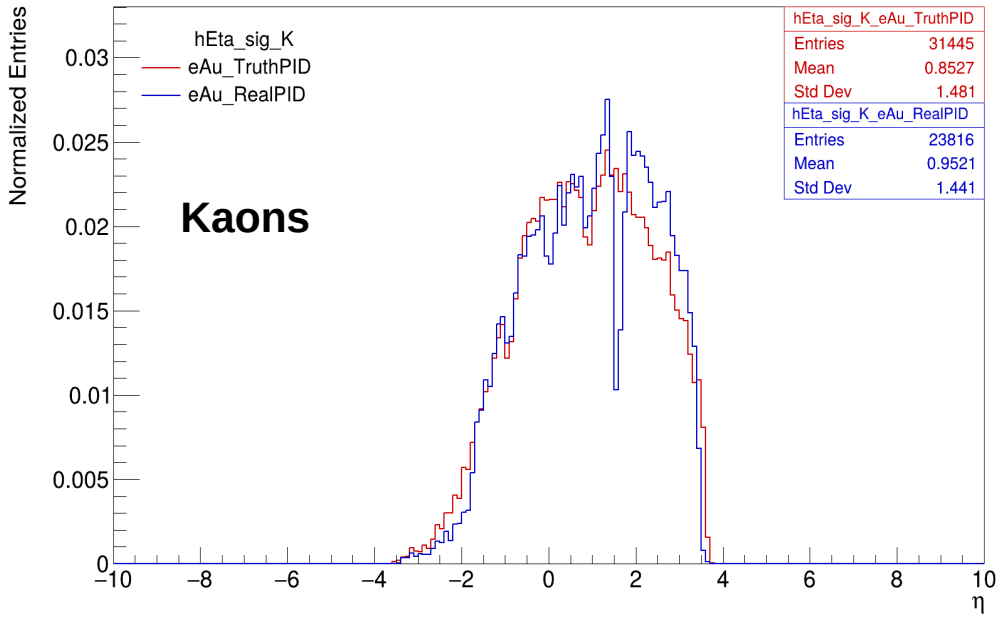
Drop at η~1.5 is created by the real PID

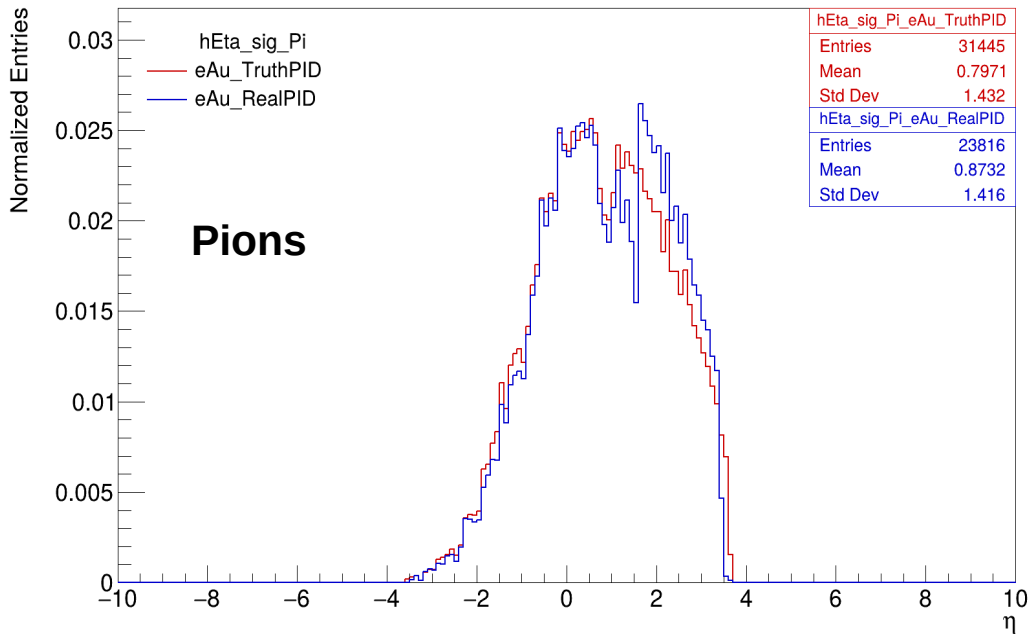
Signal D^0 daughter distributions (e+Au)

e+Au, 10x100, **Biased DIS sample**

Normalized entries

Signal pairs (Kaons/Pions η distribution)





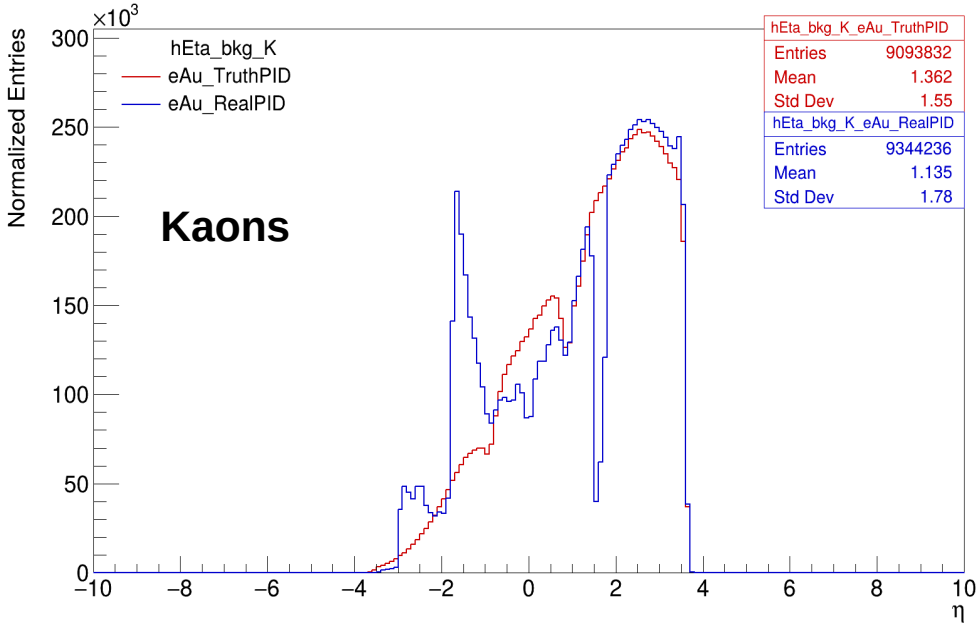
Drop at η~1.5 is created by the real PID

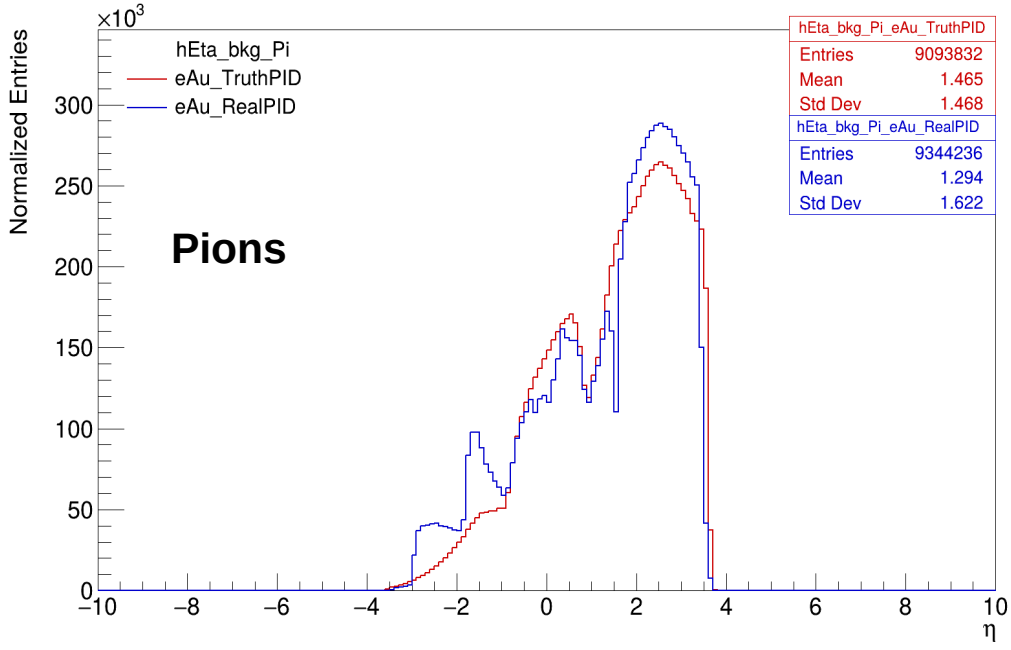
Background D^0 daughter distributions (e+Au)

e+Au, 10x100, **Biased DIS sample**

Absolute entries

Bkg pairs (Kaons/Pions η distribution)





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Background D^0 daughter distributions (e+Au)

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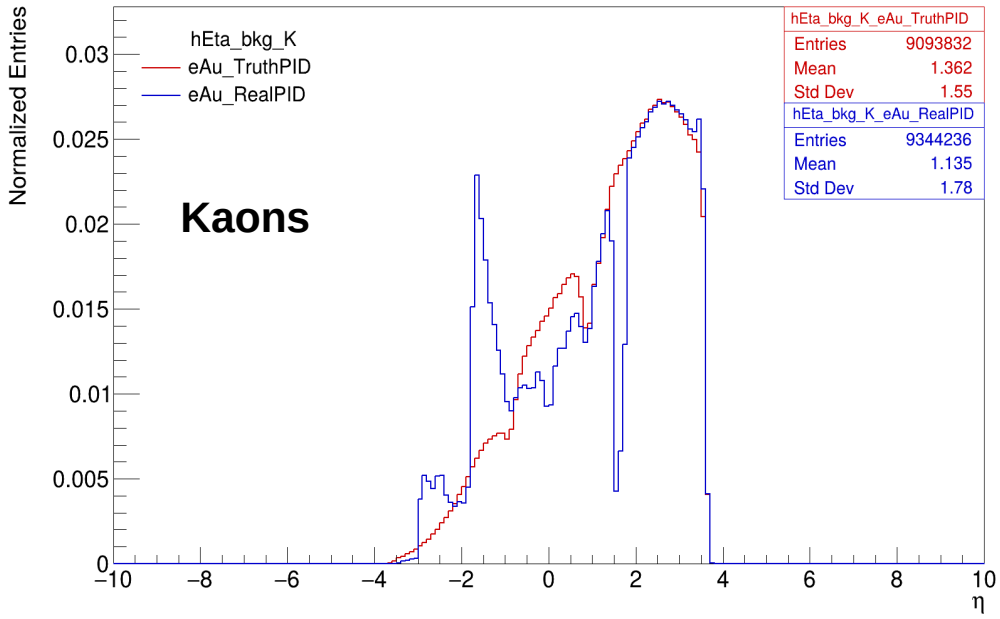
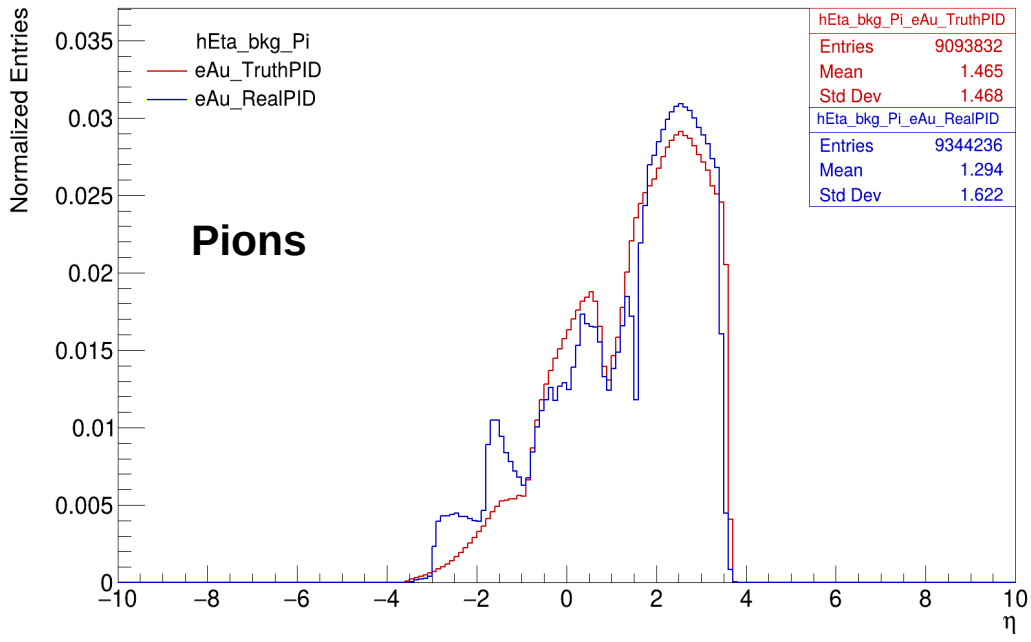
Normalized entries

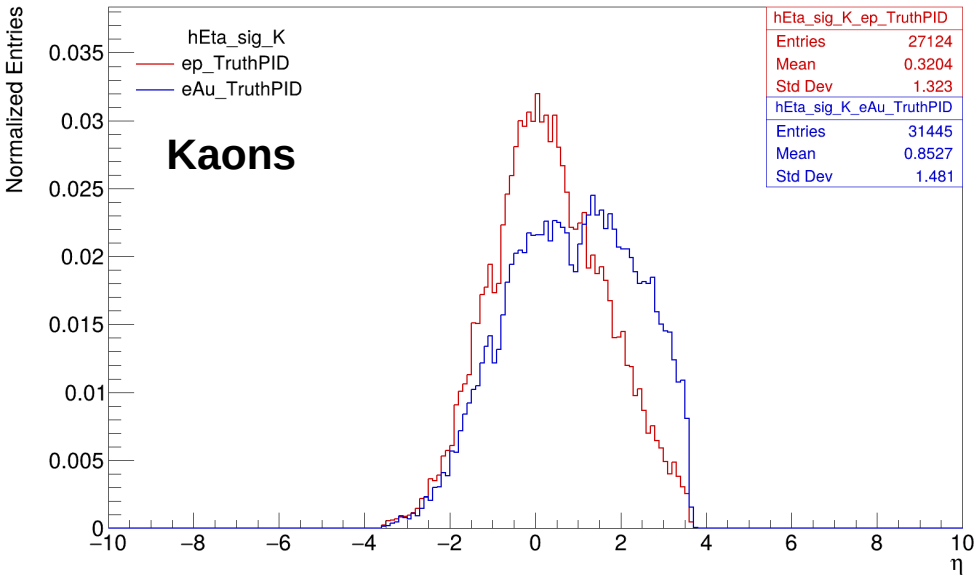
Bkg pairs (Kaons/Pions η distribution)

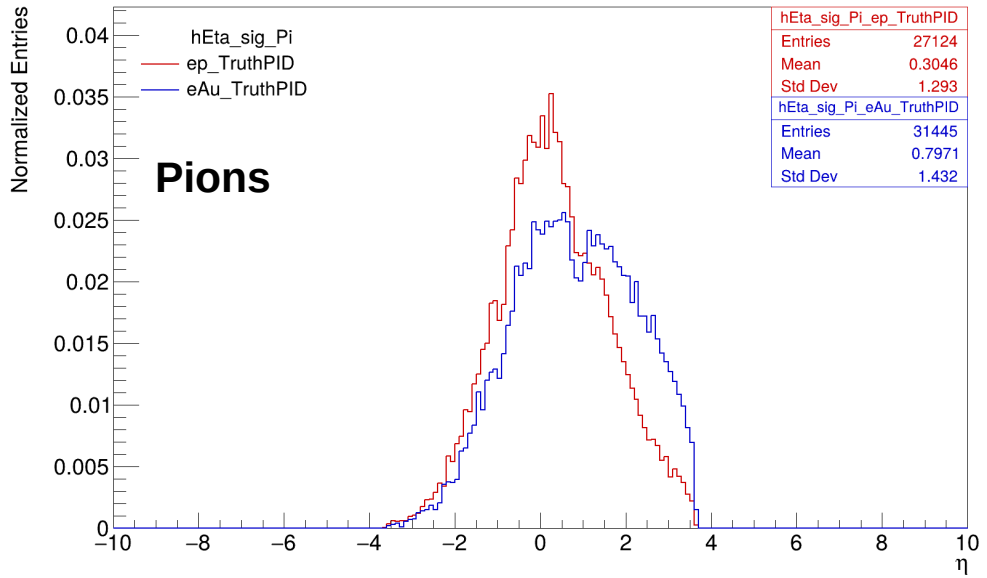




Drop at η~1.5 is created by the real PID and additional bumps at -ve η

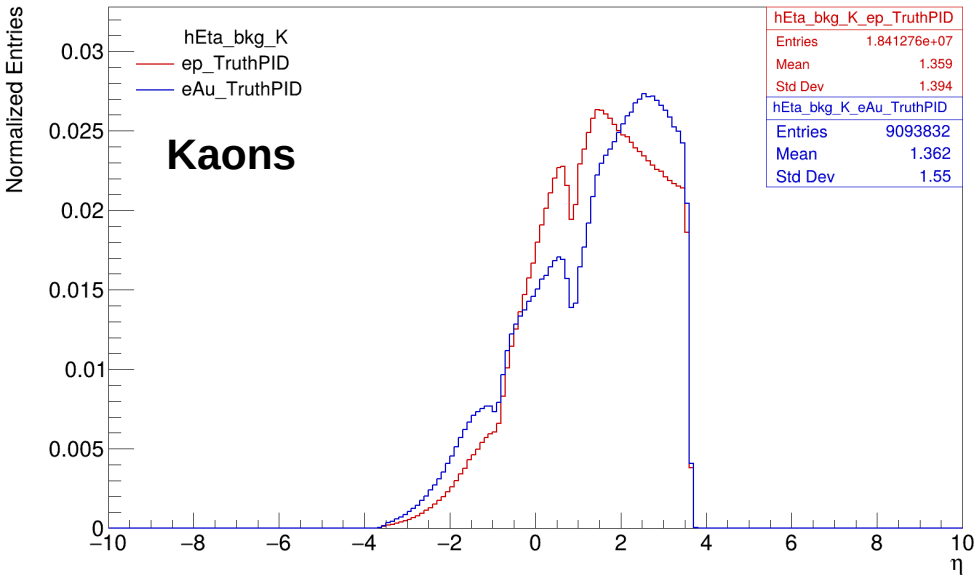
Signal pairs (Kaons/Pions η distribution)

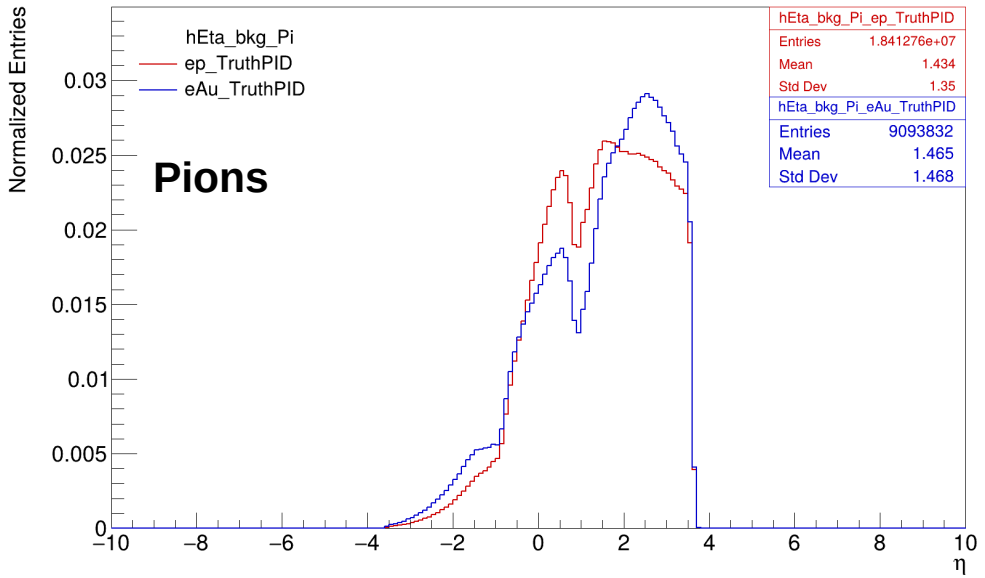




Dip at η~1.0

Bkg pairs (Kaons/Pions η distribution)

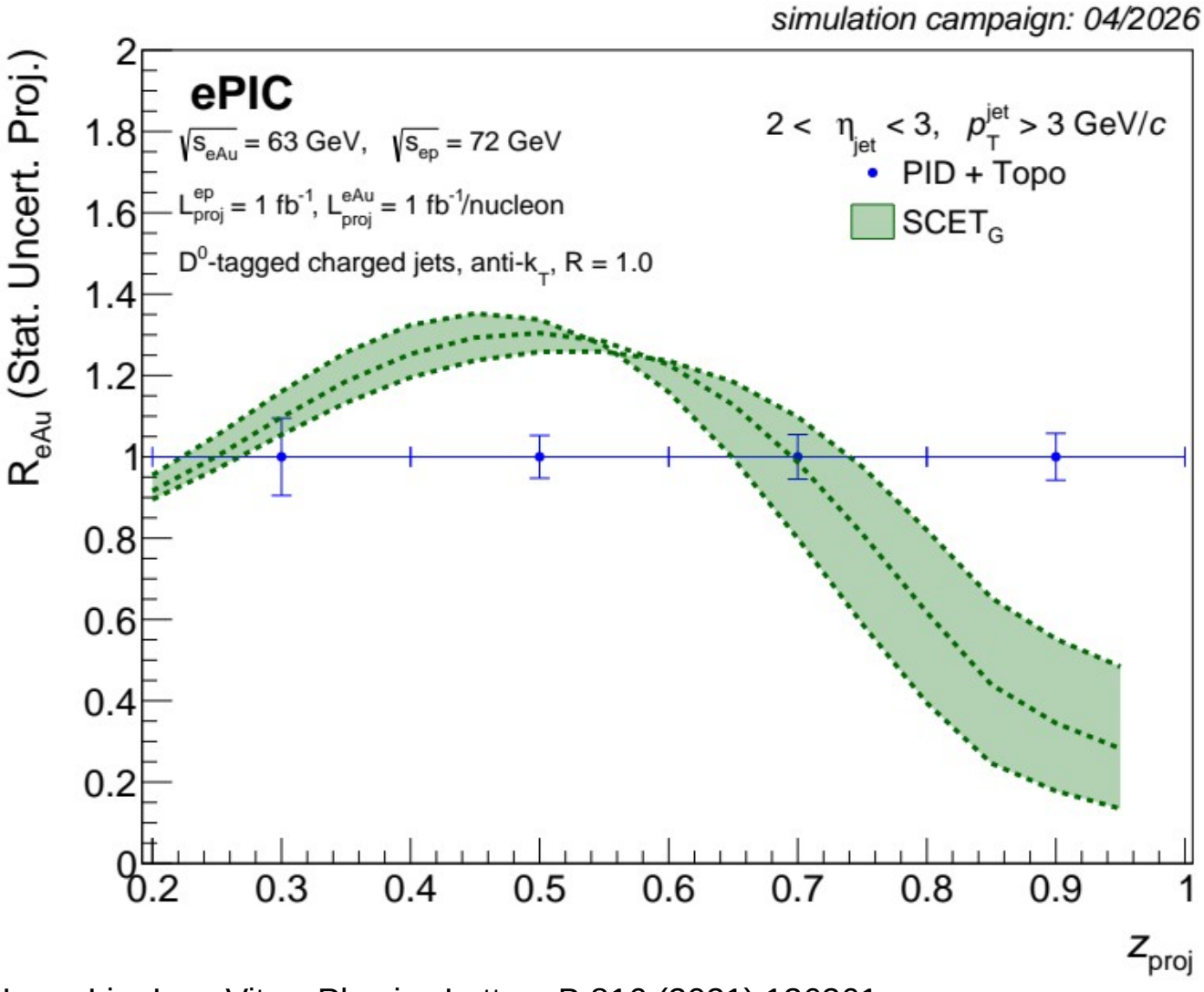




Dip at η~1.0

Nuclear Modification Factor (R_{eAu})

After PID+ Preselection + ML



Hai Tao Li, Ze Long Liu, Ivan Vitev, Physics Letters B 816 (2021) 136261

Summary and Future Plan

- Λ_c^+/D^0 ratio is included in ES report
- Result of R_{eAu} vs z_{proj} is also included on ES report
- Still investigating realistic PID issue!

Thank you for your attention!