

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}

Data Sample

- D^0 Sample, e+p, 10x250, $Q^2 > 1 \text{ GeV}^2$
 - epic:/RECO/26.04.1/epic_craterlake/SIDIS/D0_ABCONV/HFsim-PYTHIA/pythia8.312-2.0/ep/10x250/q2_1
- Λ_c Sample, e+p, 10x250, $Q^2 > 1 \text{ GeV}^2$
 - epic:/RECO/26.04.1/epic_craterlake/SIDIS/Lc_ABCONV/HFsim-PYTHIA/pythia8.312-2.0/ep/10x250/q2_1
- **Biased** NC, DIS Sample e+p, 10x250, $Q^2 > 1 \text{ GeV}^2$ (Biased in different Q^2 bins)
 - Command: rucio did list --short "epic:/RECO/26.04.1/epic_craterlake/DIS/pythia6.428-1.0/NC/noRad/ep/10x250/*"
 - epic:/RECO/26.04.1/epic_craterlake/DIS/pythia6.428-1.0/NC/noRad/ep/10x250/q2_1to10
 - epic:/RECO/26.04.1/epic_craterlake/DIS/pythia6.428-1.0/NC/noRad/ep/10x250/q2_10to100
 - epic:/RECO/26.04.1/epic_craterlake/DIS/pythia6.428-1.0/NC/noRad/ep/10x250/q2_100to1000
 - epic:/RECO/26.04.1/epic_craterlake/DIS/pythia6.428-1.0/NC/noRad/ep/10x250/q2_1000to10000

Event generator and energy	$Q^2 > 1$	$1 < Q^2 < 10$	$10 < Q^2 < 100$	$1e2 < Q^2 < 1e3$	$1e3 < Q^2 < 1e4$
PYTHIA 8.316, 10x130	5.847e5 pb	5.391e5 pb	4.223e4 pb	1.590e3 pb	1.260e1 pb
PYTHIA 8.316, 10x250	6.556e5 pb	6.054e5 pb	5.291e4 pb	2.322e3 pb	3.686e1 pb
PYTHIA 8.316, 9x130	5.719e5 pb	5.307e5 pb	4.048e4 pb	1.475e3 pb	1.001e1 pb
PYTHIA 8.316, 9x275	6.546e5 pb	6.025e5 pb	5.178e4 pb	2.292e3 pb	3.697e1 pb

Cross section in different Q^2 bins: [Slides](#)

Current scaling factor

$$f_i = \frac{\sigma_i}{\sigma(1 < Q^2 < 10)}$$

Λ_c Reconstruction

Signal from Λ_c sample while combinatorial bkg from DIS Sample

Corrections on signal:

1. Weight factor of 3 for signal for $Q^2 < 5 \text{ GeV}^2$
2. Branching Ratio Scaling
3. Scaling to target luminosity 2.5 fb^{-1}

Bkg:

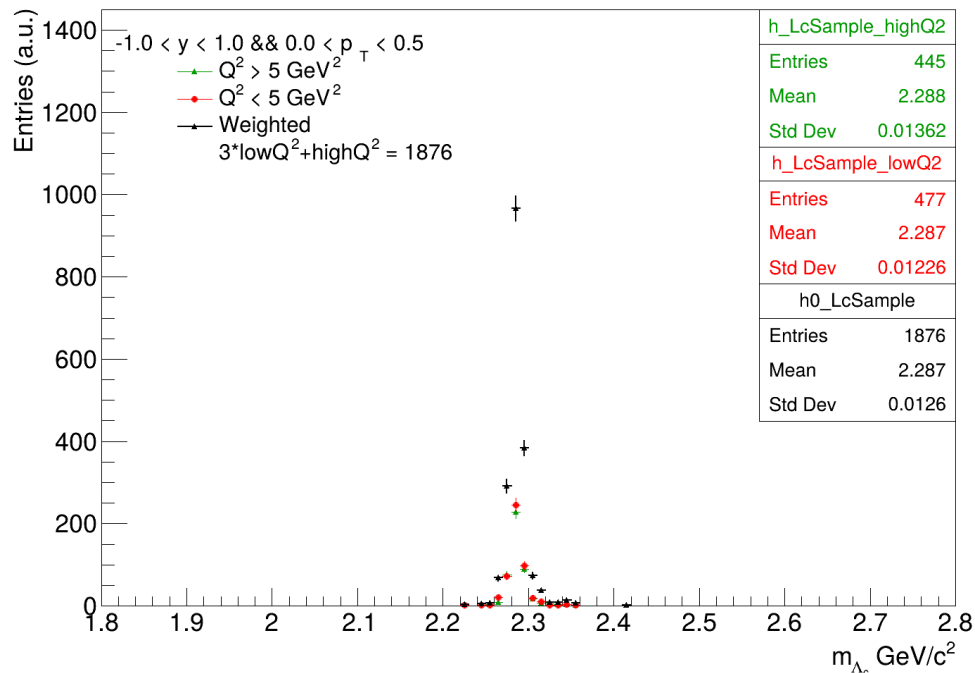
1. Scaling of cross section in each Q^2 bin
2. Scaling to targeted luminosity

preselection_cuts='(mass_Lcp > 1.8 && mass_Lcp < 2.8) && d0xy_p<10. && d0xy_pi<10. && d0xy_k<10. && chi2 <10.'

Applying weight factor on Signal (Checks)

Weight factor of 3 on signal for $Q^2 < 5 \text{ GeV}^2$

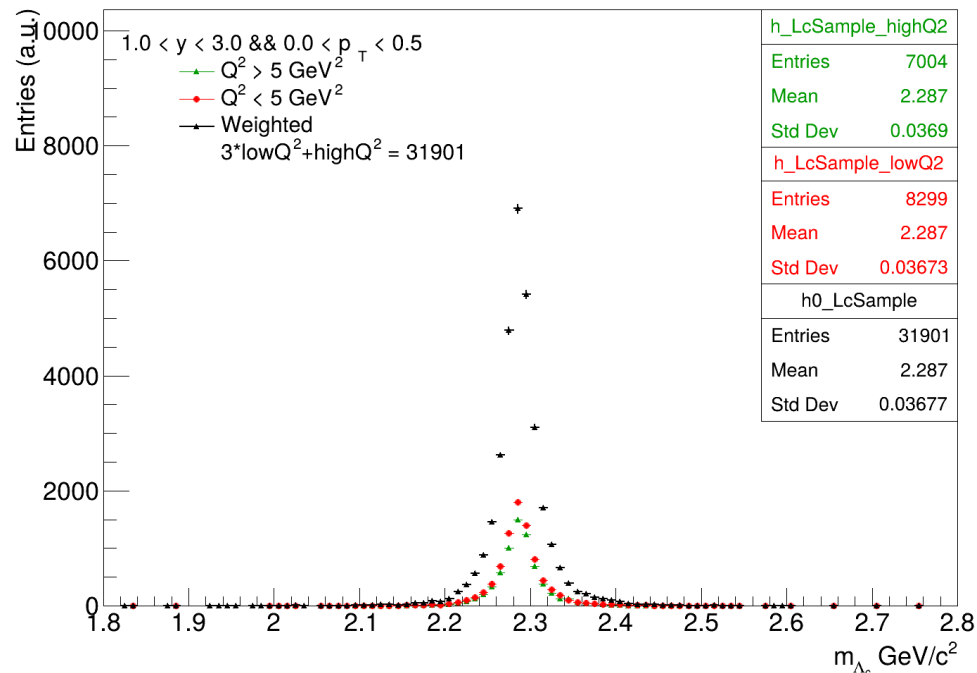
Mid rapidity



bin 47 $x=2.265$ low= 20 ± 4.47214 high= 8 ± 2.82843
weighted= 68 ± 8.24621

bin 48 $x=2.275$ low= 72 ± 8.48528 high= 76 ± 8.7178
weighted= 292 ± 17.088

Forward rapidity



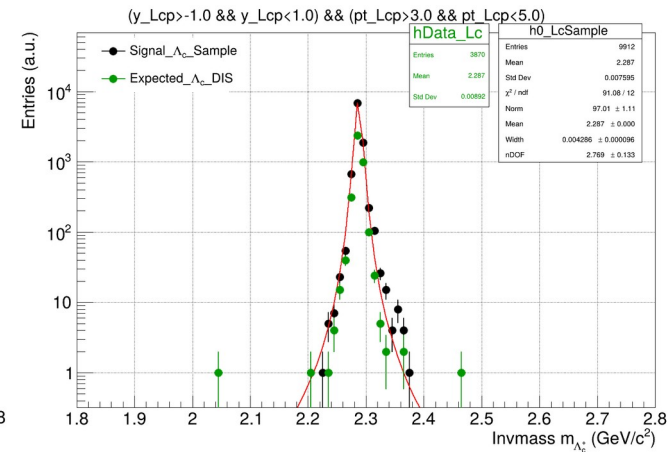
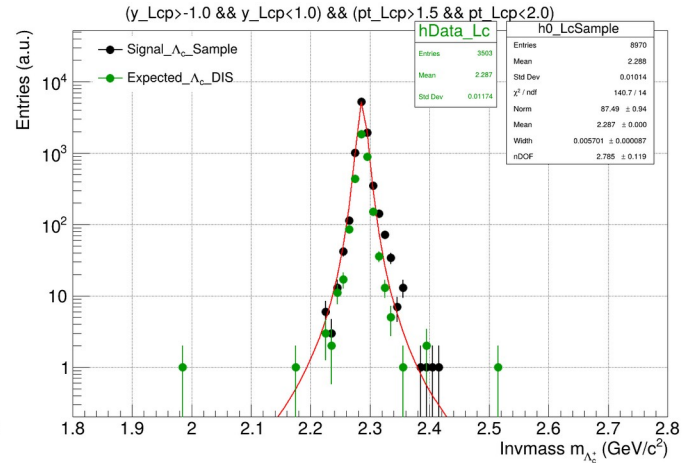
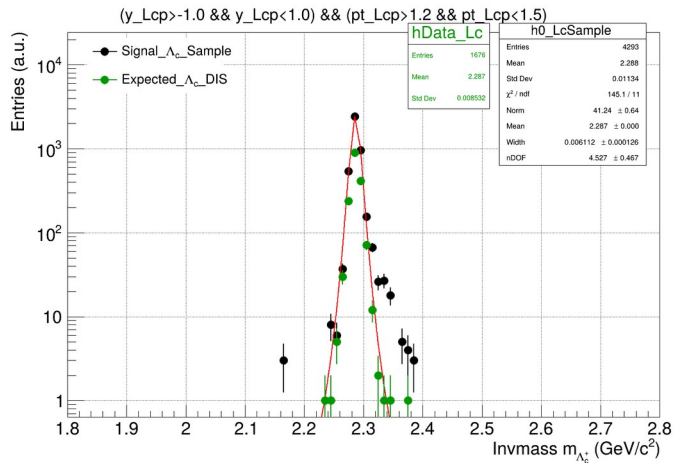
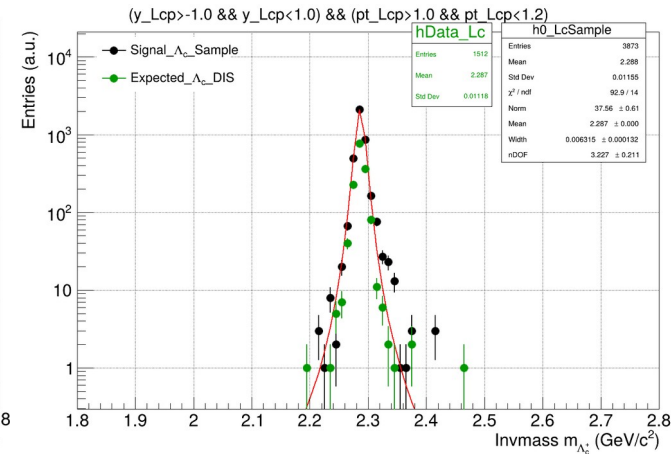
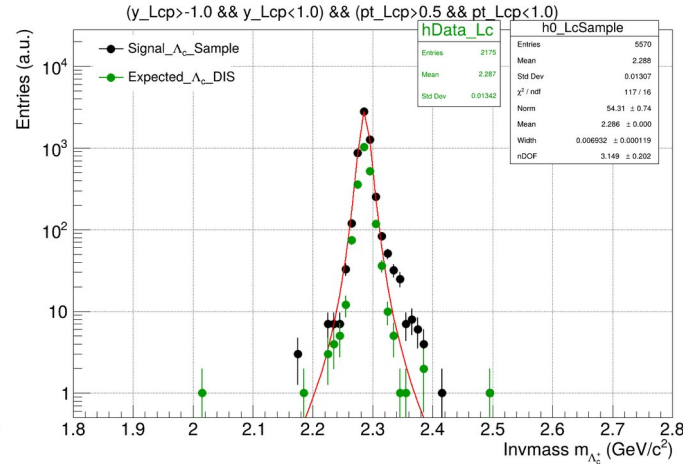
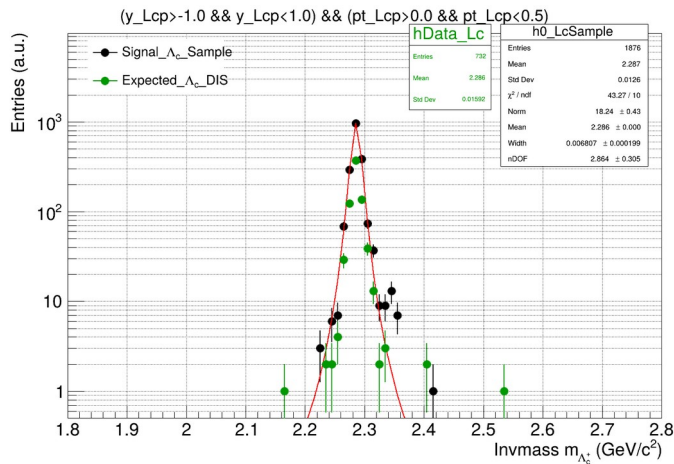
bin 47 $x=2.265$ low= 683 ± 26.1343 high= 574 ± 23.9583
weighted= 2623 ± 51.2152

bin 48 $x=2.275$ low= 1261 ± 35.5106 high= 1006 ± 31.7175
weighted= 4789 ± 69.2026

Sampling Signal ($-1 < y < 1$)

B.R. Scaling = $0.0635/0.0075 \sim 8.47$

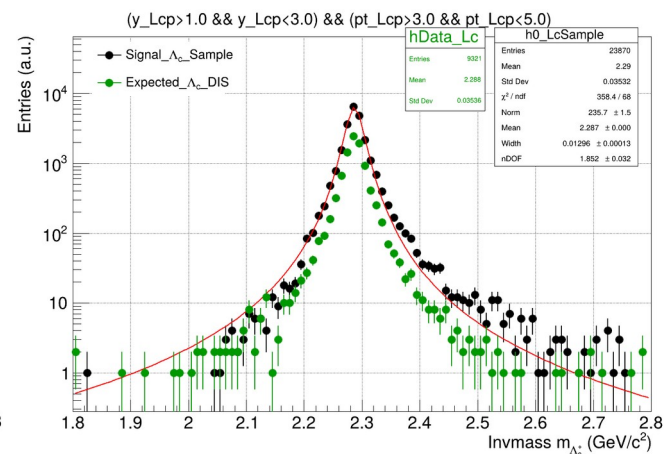
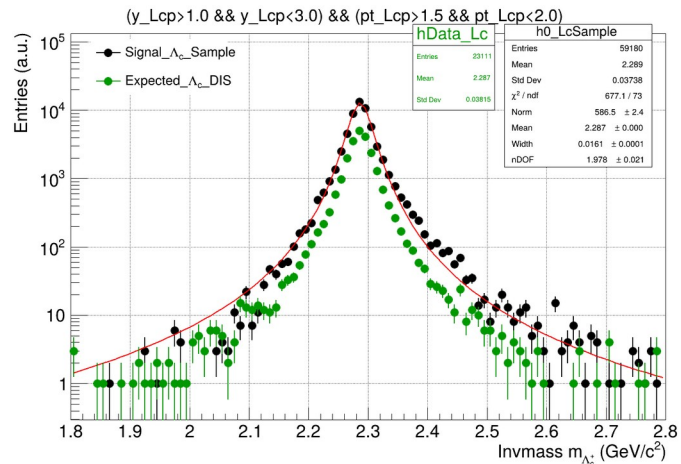
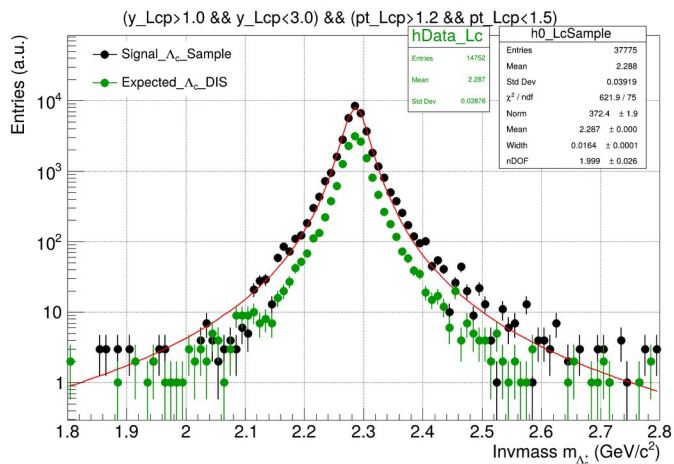
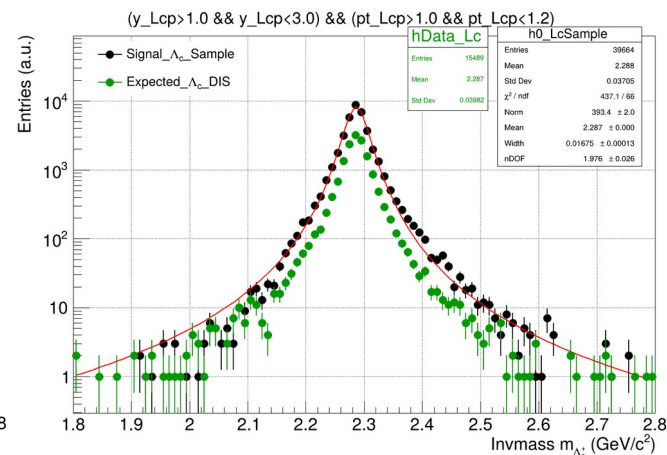
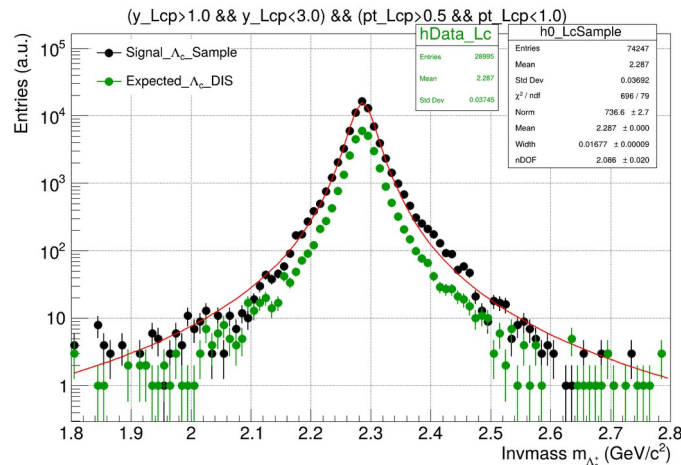
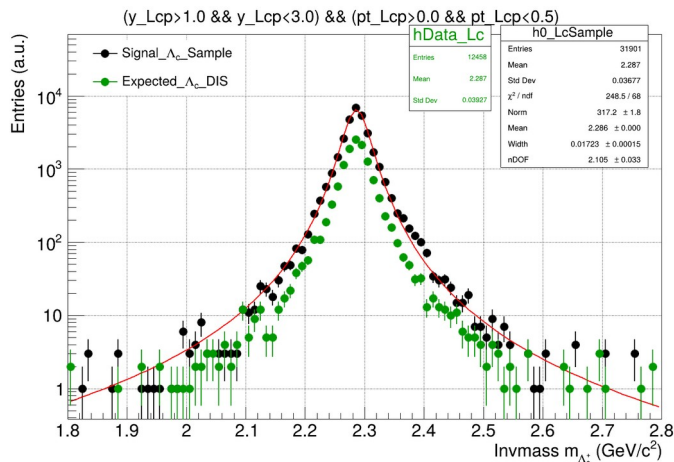
$$L_{\text{int}} = 54.2 \text{ fb}^{-1} (\text{Q2 Weighted}) \quad L_{\text{int}} = 2.5 \text{ fb}^{-1}$$



Sampling Signal ($1 < y < 3$)

B.R. Scaling = $0.0635/0.0075 \sim 8.47$

$$L_{\text{int}} = 54.2 \text{ fb}^{-1} (\text{Q2 Weighted}) \quad L_{\text{int}} = 2.5 \text{ fb}^{-1}$$

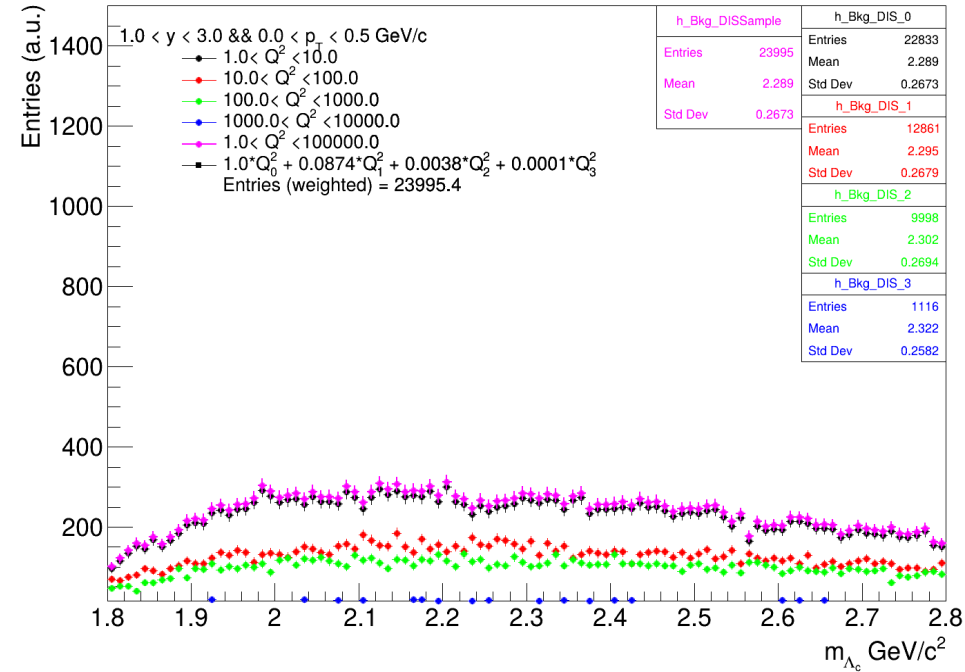
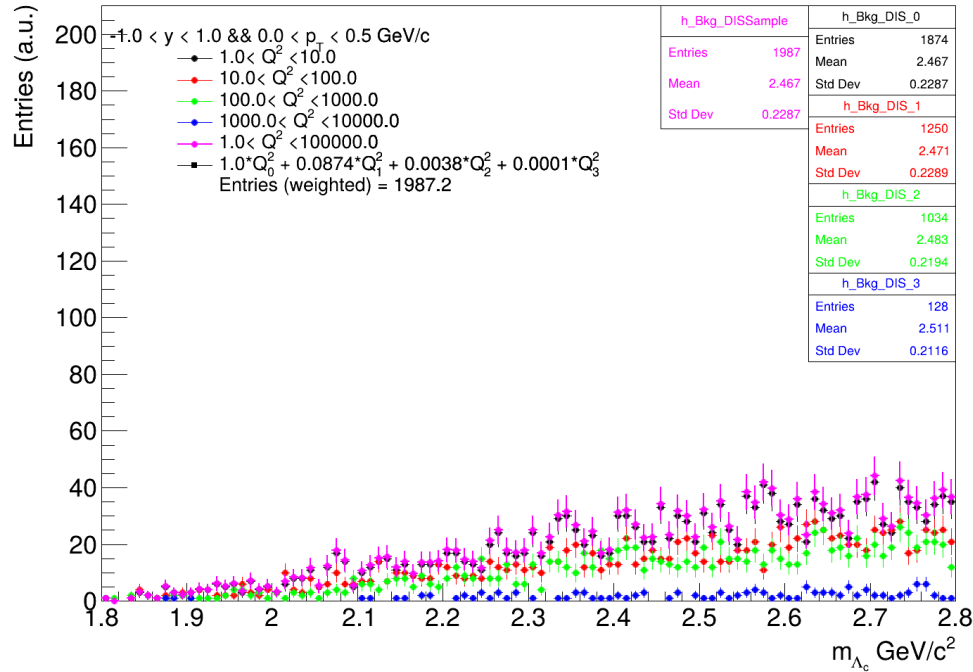


Applying scaling factor on Bkg (Checks)

Mid rapidity

Weight factor according to cross section

Forward rapidity



Event generator and energy	$Q^2 > 1$	$1 < Q^2 < 10$	$10 < Q^2 < 100$	$1e2 < Q^2 < 1e3$	$1e3 < Q^2 < 1e4$
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PYTHIA 8.316, 10x250	6.556e5 pb	6.054e5 pb	5.291e4 pb	2.322e3 pb	3.686e1 pb
PYTHIA 8.316, 9x130	5.719e5 pb	5.307e5 pb	4.048e4 pb	1.475e3 pb	1.001e1 pb
PYTHIA 8.316, 9x275	6.546e5 pb	6.025e5 pb	5.178e4 pb	2.292e3 pb	3.697e1 pb

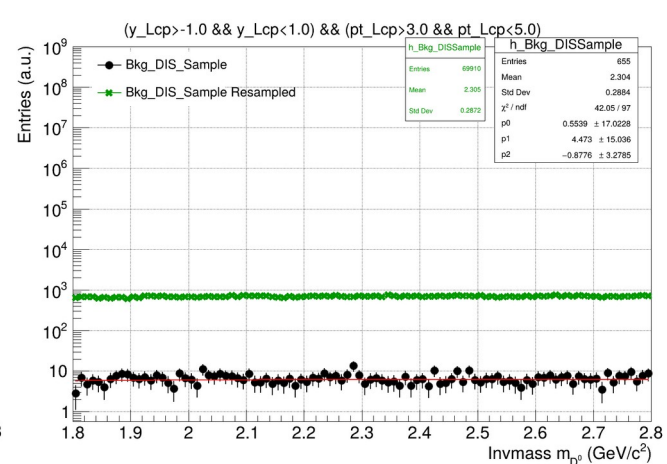
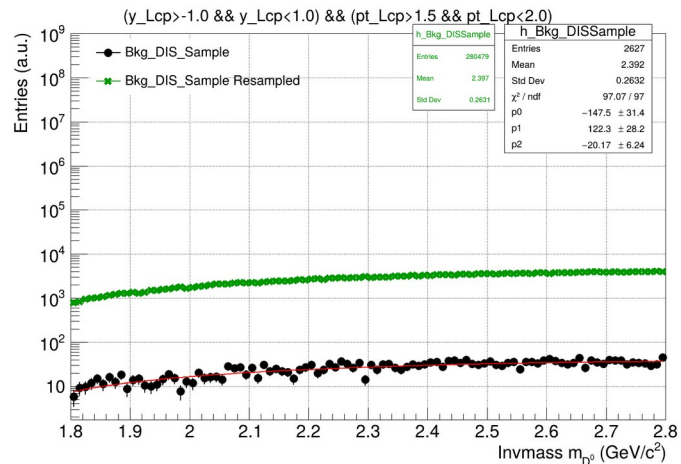
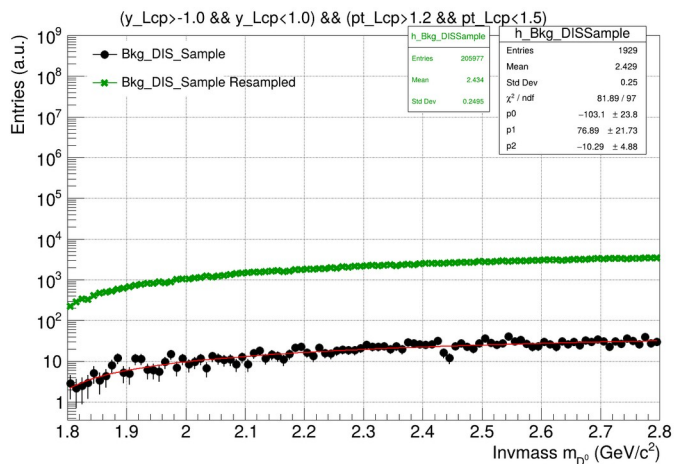
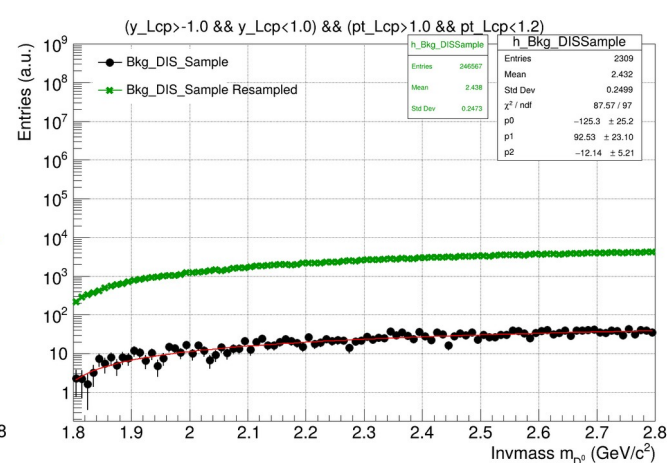
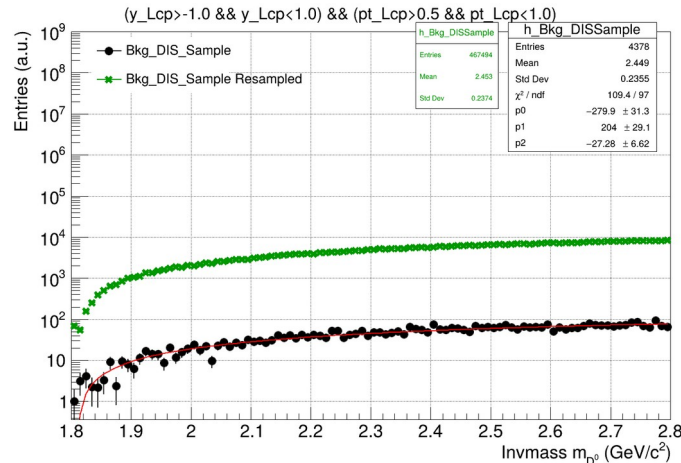
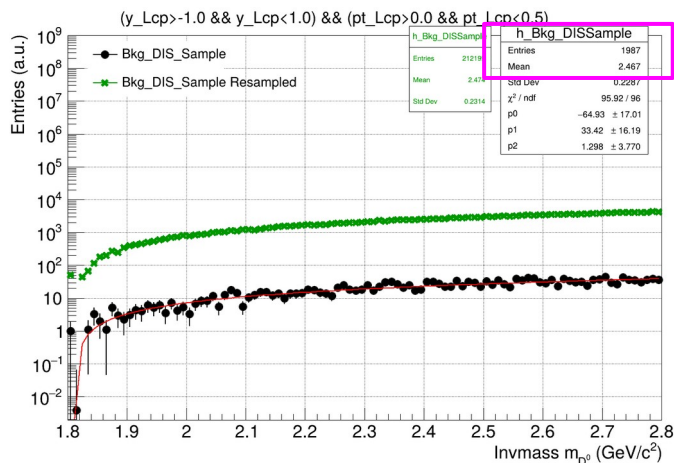
$$f_i = \frac{\sigma_i}{\sigma(1 < Q^2 < 10)}$$

Sampling Background ($-1 < y < 1$)

$$\sigma_{\text{MB}} = 655.6 \text{ nb}$$

$$L_{\text{int}} = 0.023412178 \text{ fb}^{-1}$$

$$L_{\text{int}} = 2.5 \text{ fb}^{-1}$$

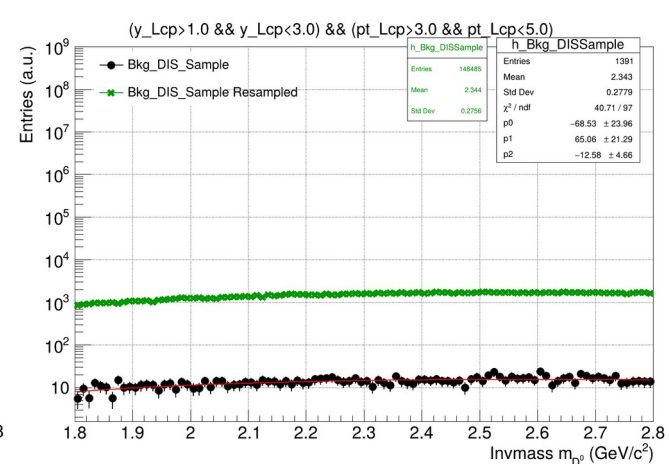
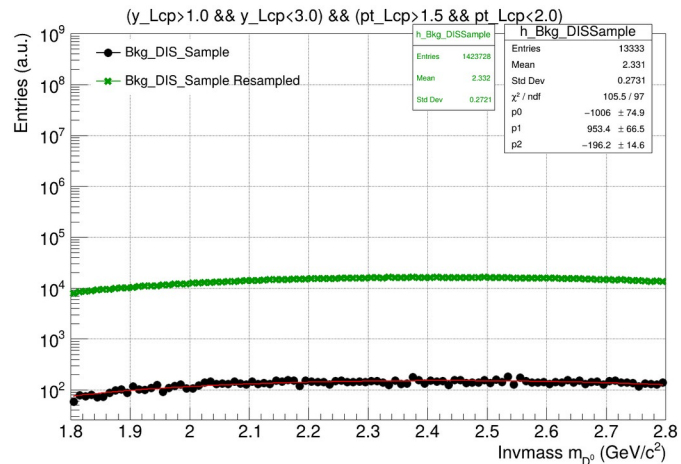
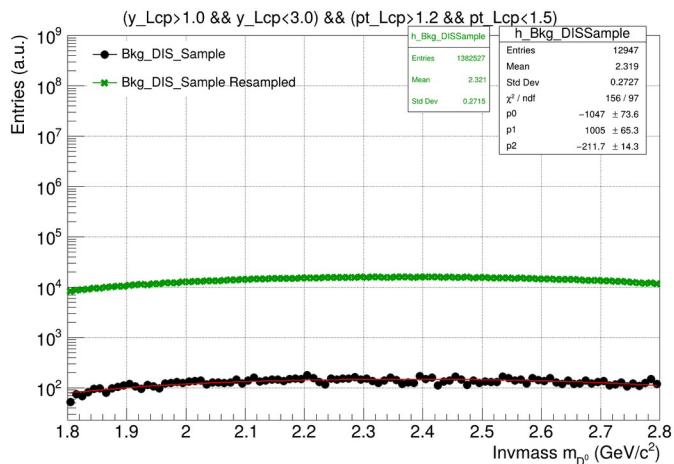
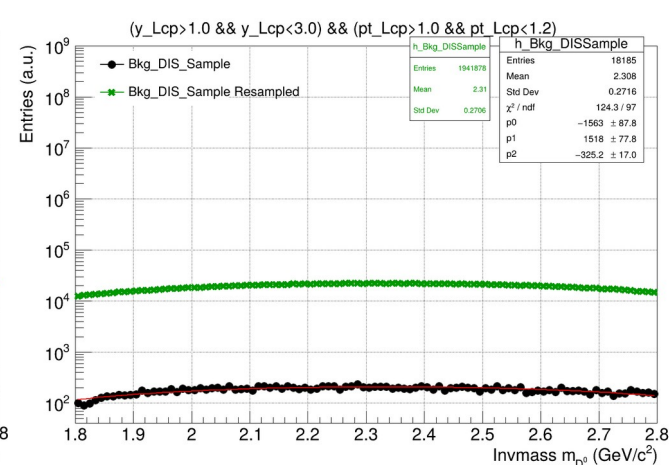
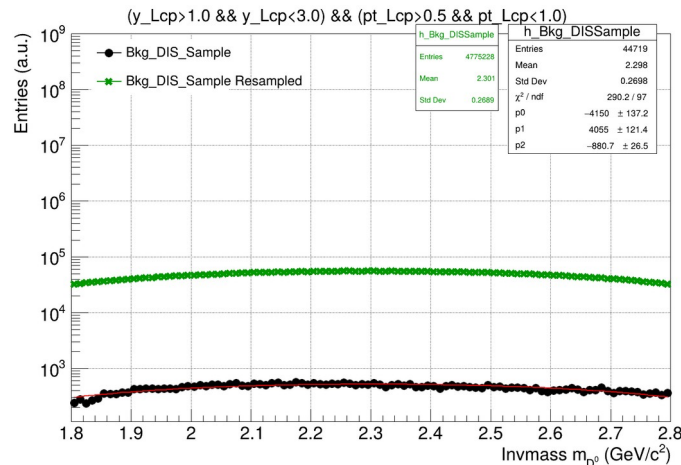
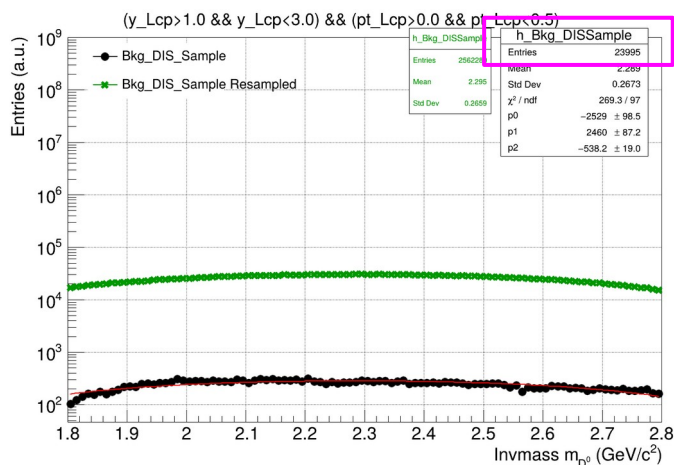


Sampling Background (1 < y < 3)

$\sigma_{MB} = 655.6 \text{ nb}$

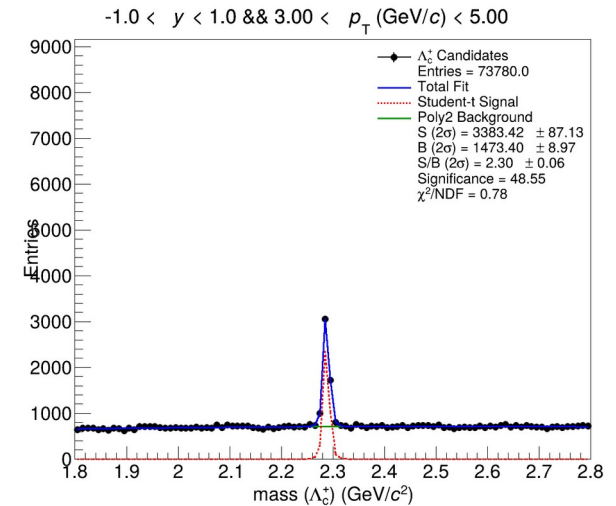
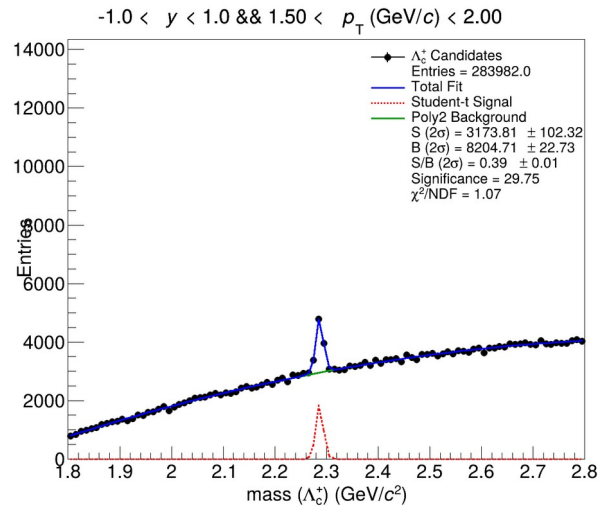
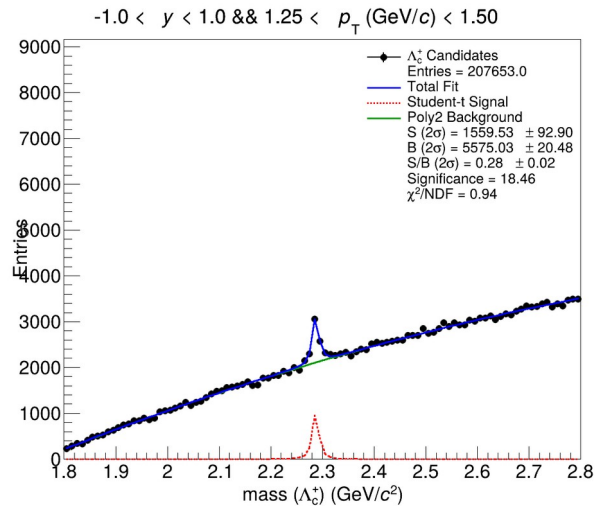
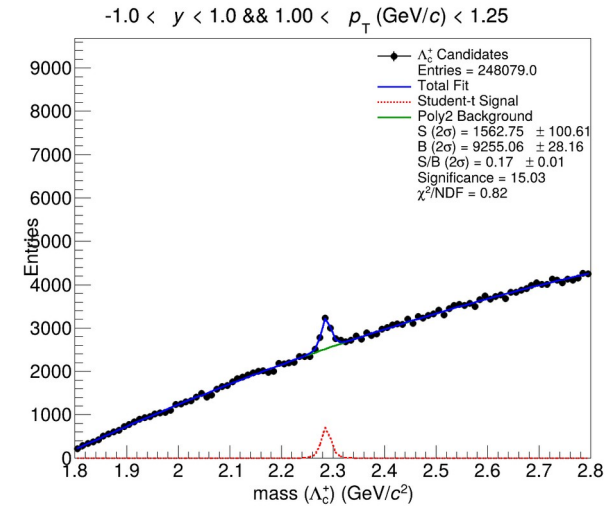
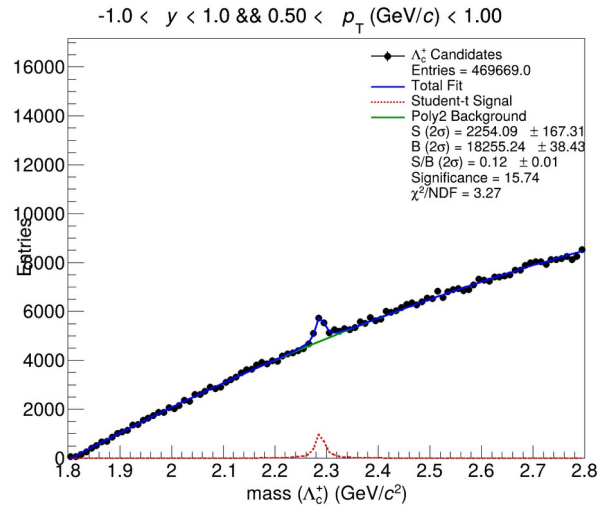
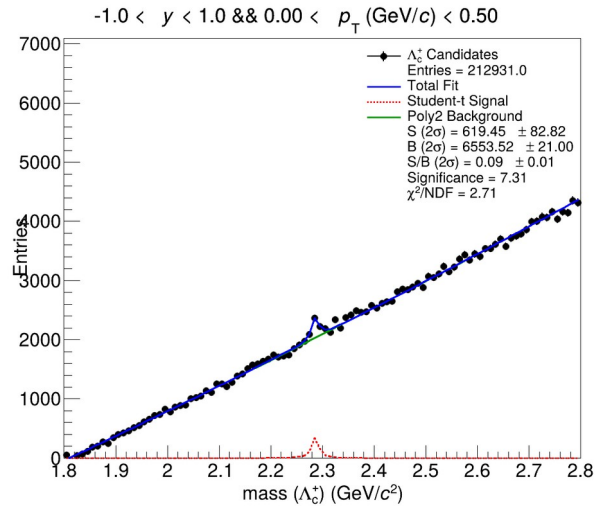
$L_{int} = 0.023412178 \text{ fb}^{-1}$

$L_{int} = 2.5 \text{ fb}^{-1}$



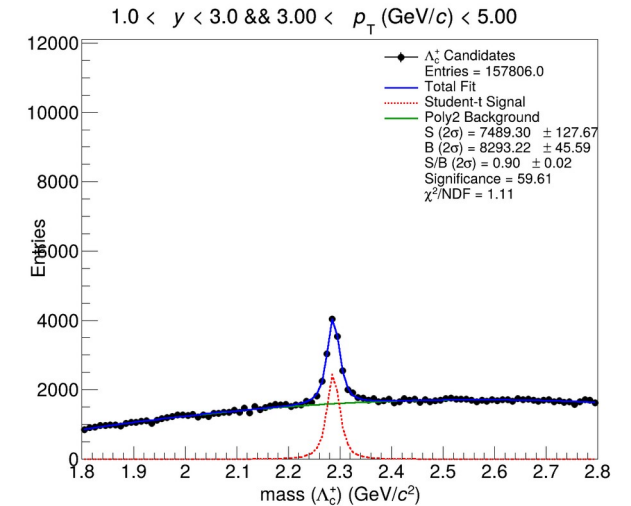
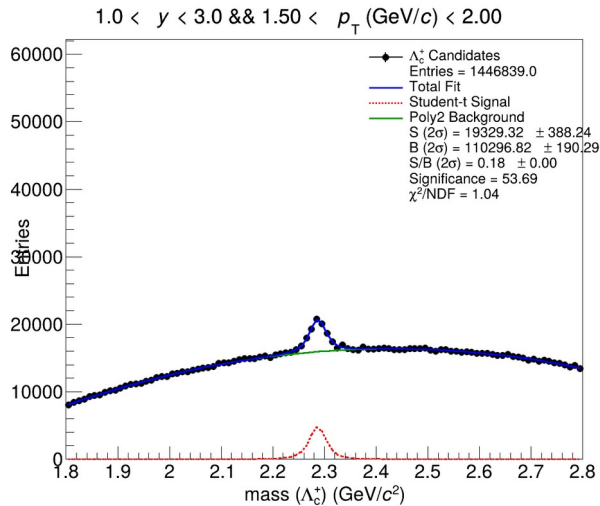
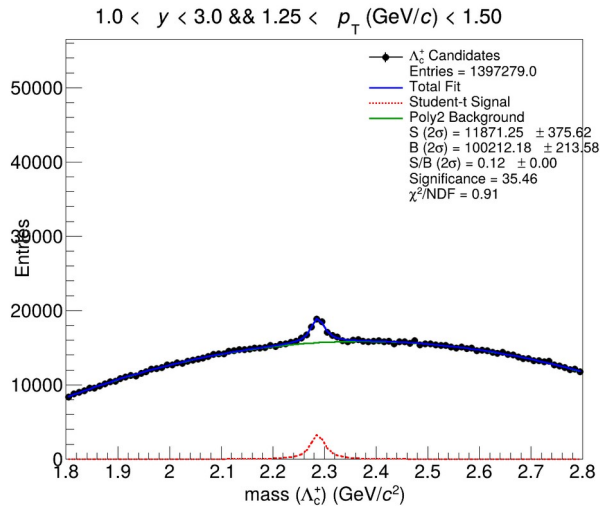
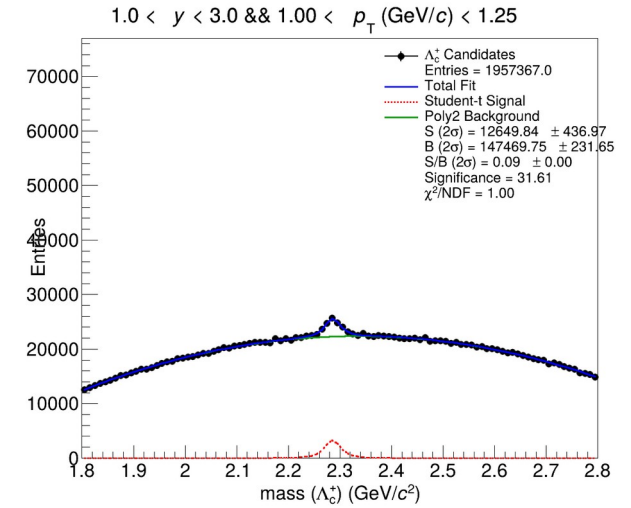
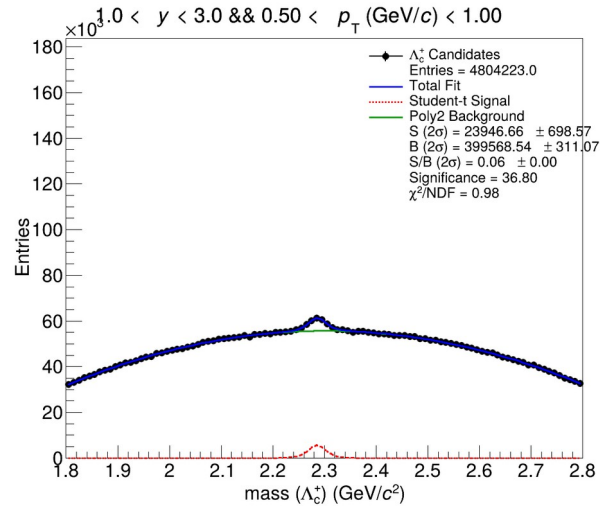
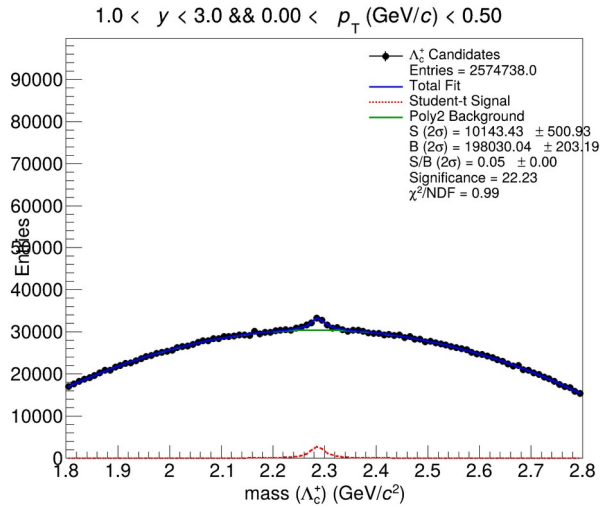
Invariant Mass (Λ_c)

After PID+ Preselection on slide 9



Invariant Mass (Λ_c)

After PID+ Preselection on slide 9



D⁰ Reconstruction

Signal from D⁰ sample while combinatorial bkg from DIS Sample

Corrections on signal:

1. Weight factor of 3 on signal (Pythia8) for $Q^2 < 5 \text{ GeV}^2$
2. Scaling to target luminosity 2.5 fb^{-1}

Bkg:

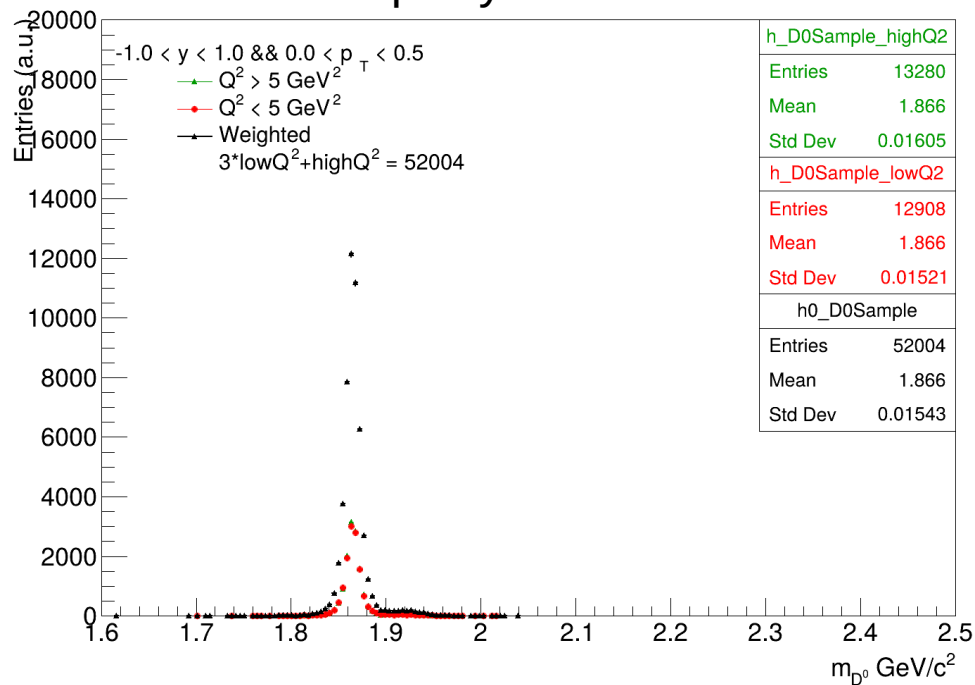
1. Scaling of cross section in each Q^2 bin
2. Scaling to targeted luminosity

```
preselection_cuts='(mass_D0 > 1.6 && mass_D0 < 2.5) && d0xy_pi<100. && d0xy_k<100. && decay_length <100.'
```

Applying weight factor on Signal (Checks)

Weight factor of 3 on signal for $Q^2 < 5 \text{ GeV}^2$

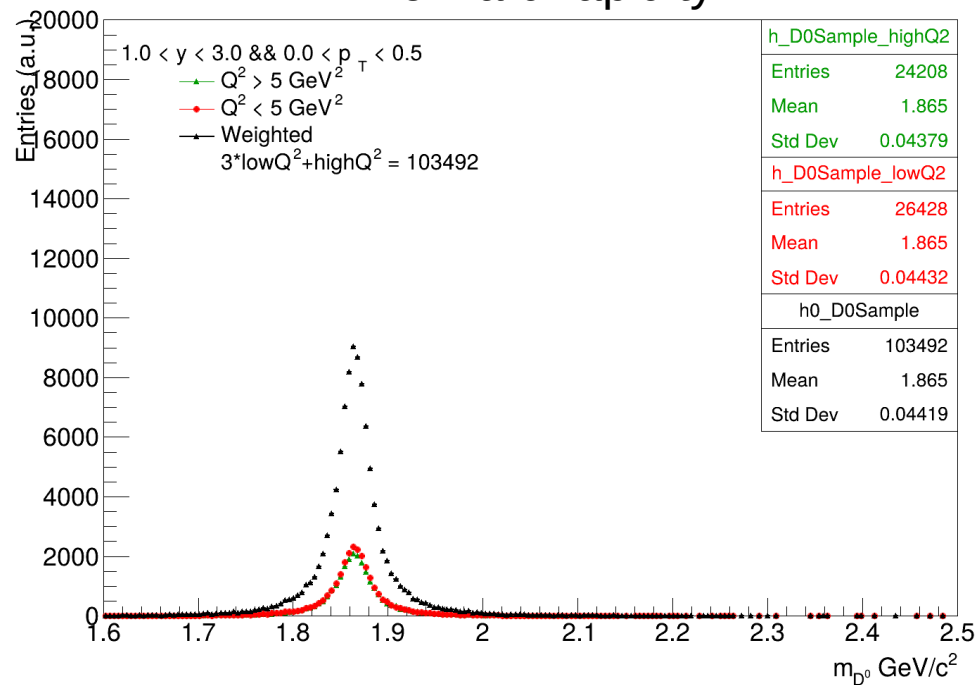
Mid rapidity



bin 48 $x=1.81375$ low= 15 ± 3.87298 high= 11 ± 3.31662
weighted= 56 ± 7.48331

bin 49 $x=1.81825$ low= 8 ± 2.82843 high= 8 ± 2.82843
weighted= 32 ± 5.65685

Forward rapidity



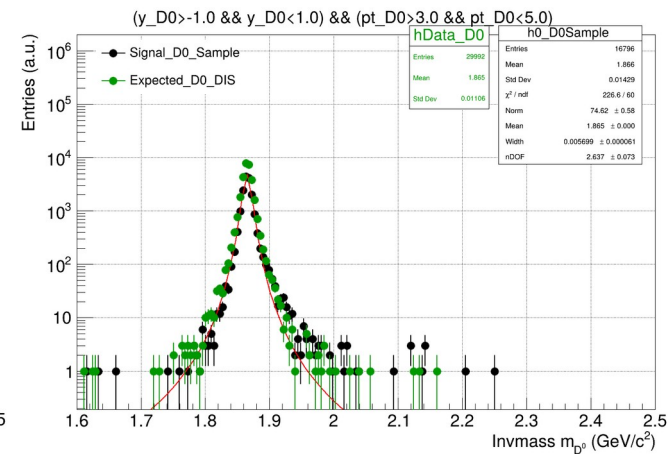
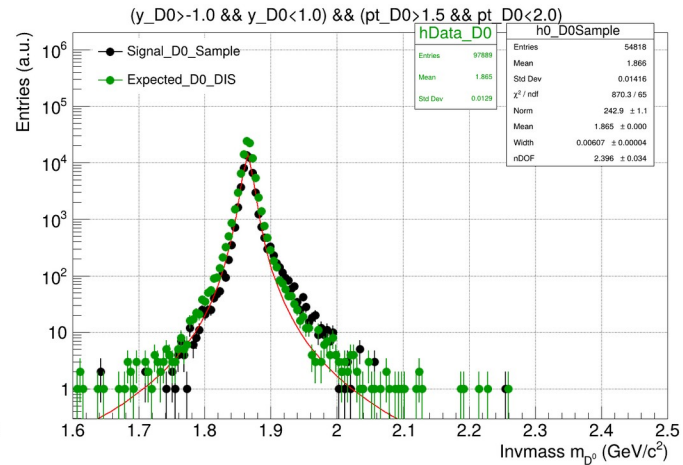
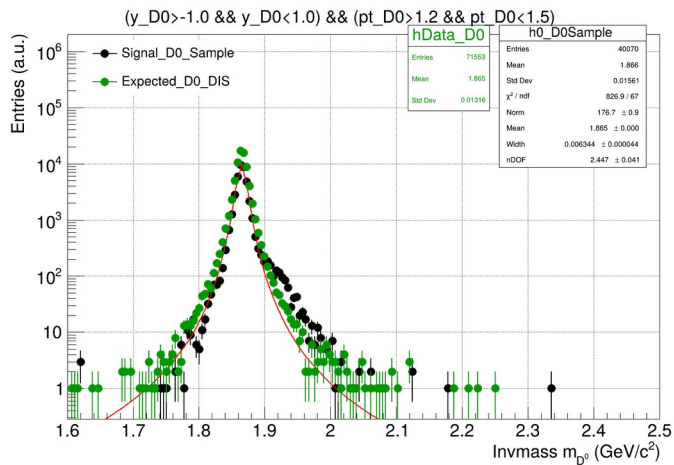
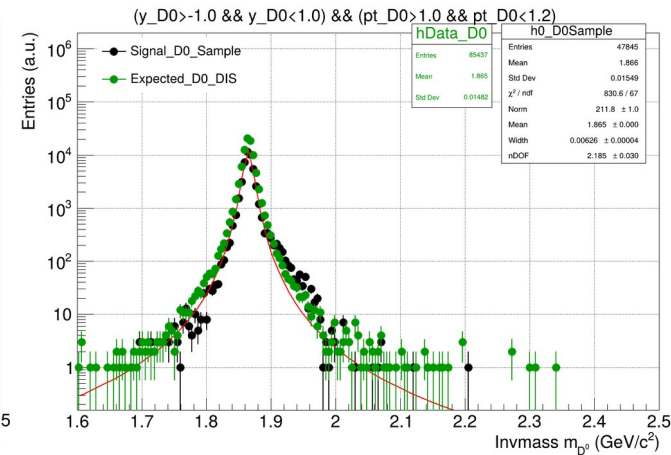
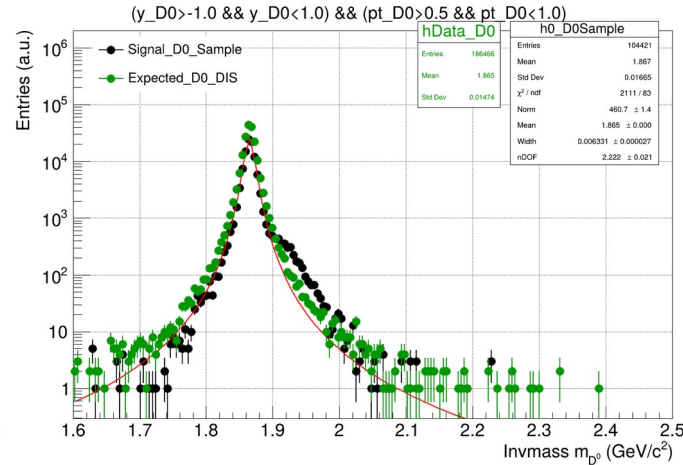
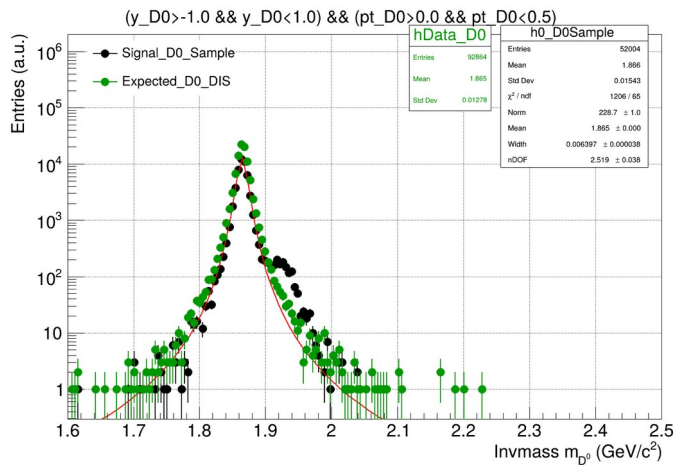
bin 48 $x=1.81375$ low= 266 ± 16.3095 high= 246 ± 15.6844
weighted= 1044 ± 32.311

bin 49 $x=1.81825$ low= 281 ± 16.7631 high= 261 ± 16.1555
weighted= 1104 ± 33.2265

Sampling Signal ($-1 < y < 1$)

$L_{\text{int}} = 1.4 \text{ fb}^{-1}$ (Q2 Weighted)

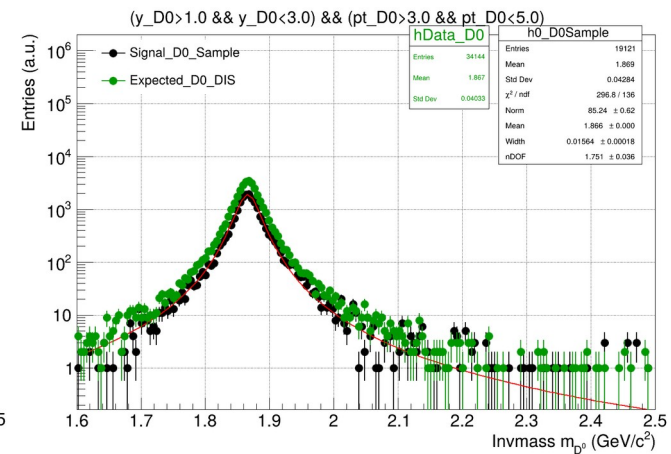
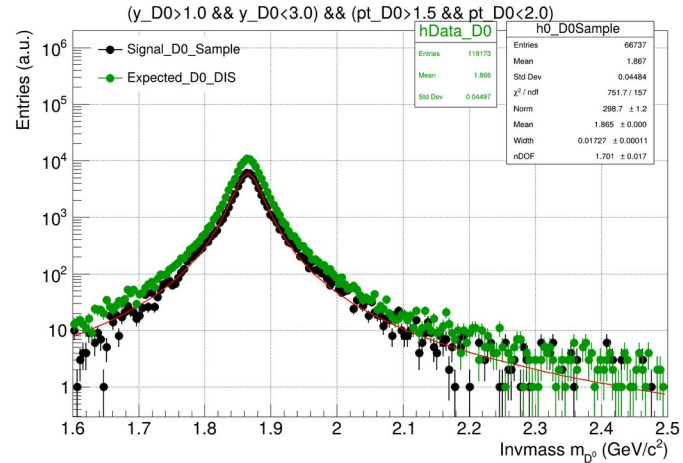
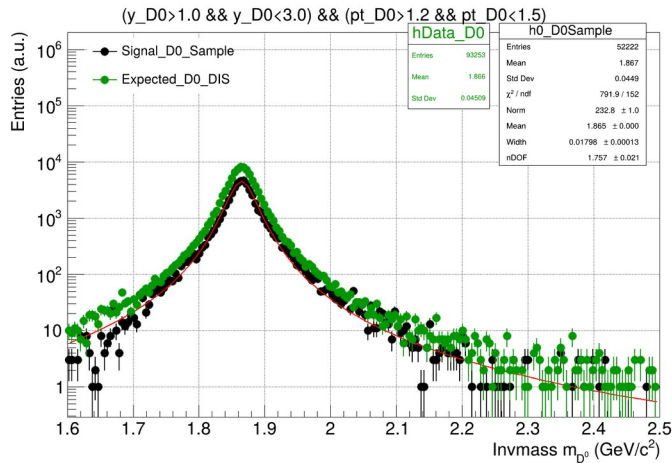
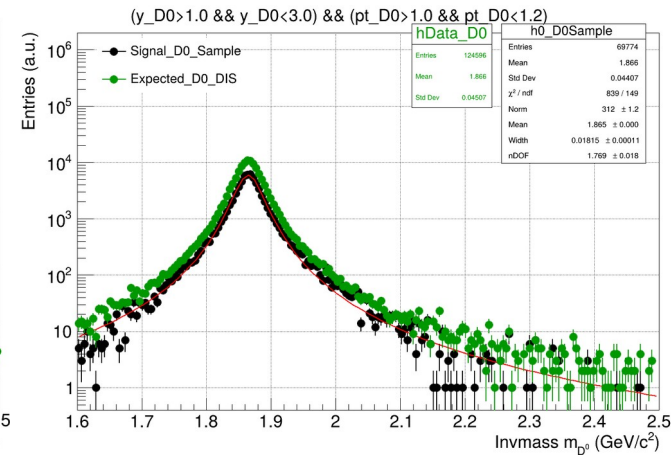
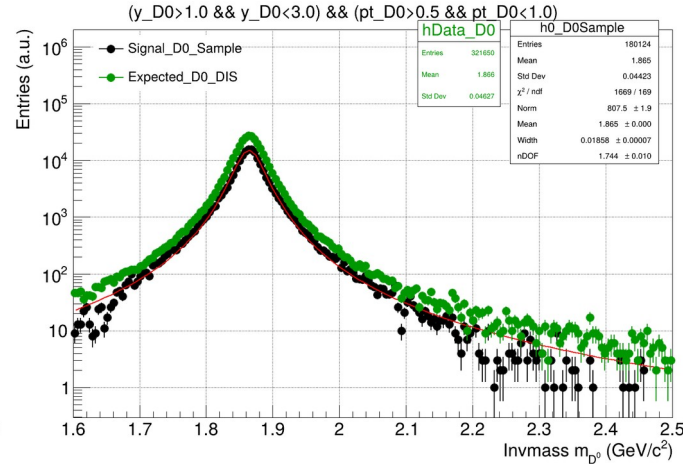
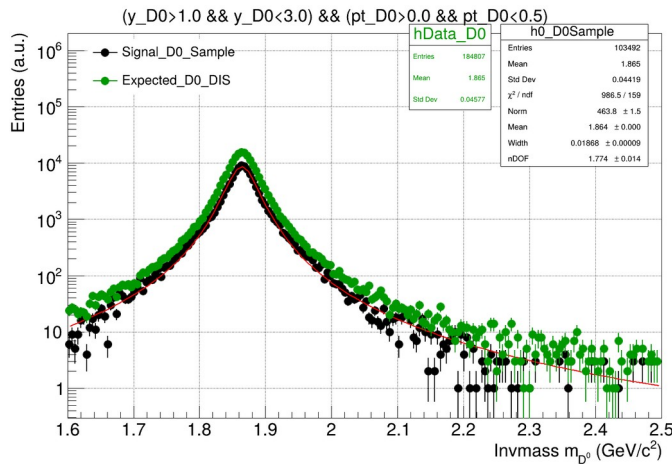
$L_{\text{int}} = 2.5 \text{ fb}^{-1}$



Sampling Signal ($1 < y < 3$)

$L_{\text{int}} = 1.4 \text{ fb}^{-1}$ (Q2 Weighted)

$L_{\text{int}} = 2.5 \text{ fb}^{-1}$

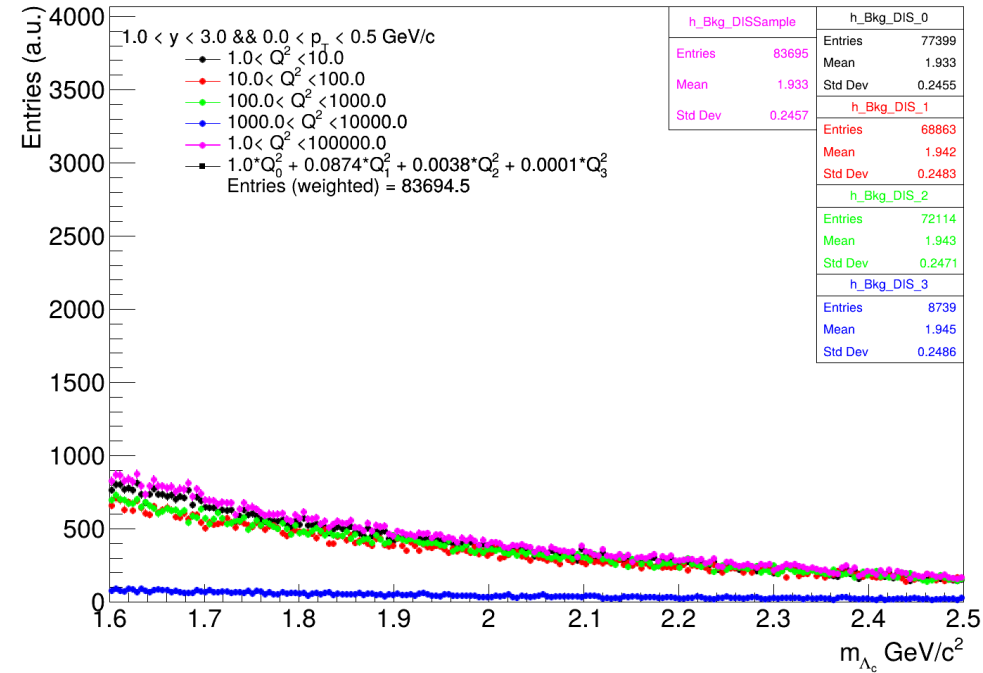
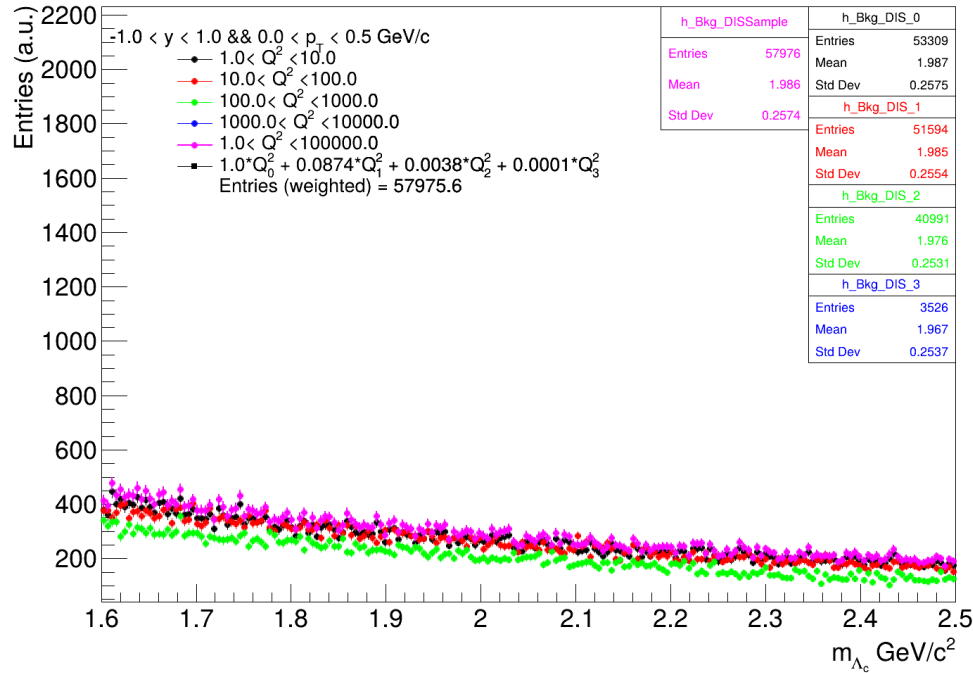


Applying scaling factor on Bkg (Checks)

Weight factor according to cross section

Mid rapidity

Forward rapidity



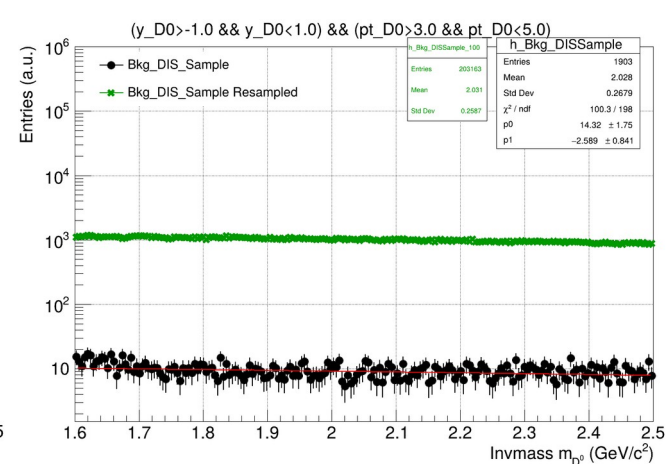
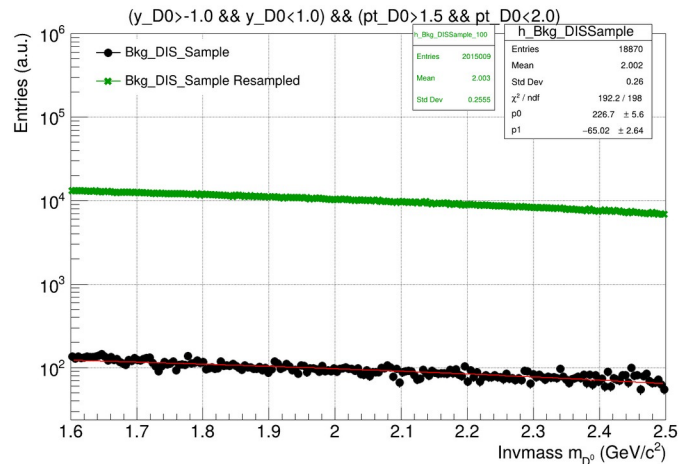
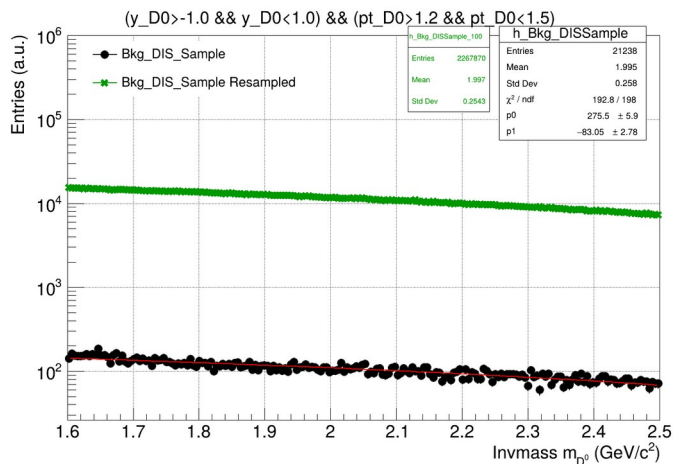
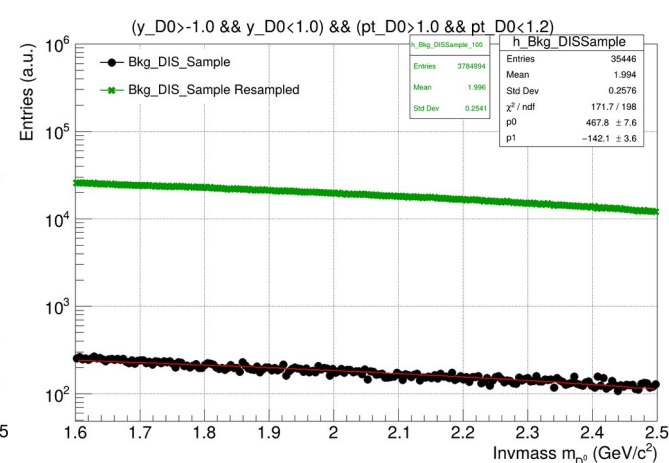
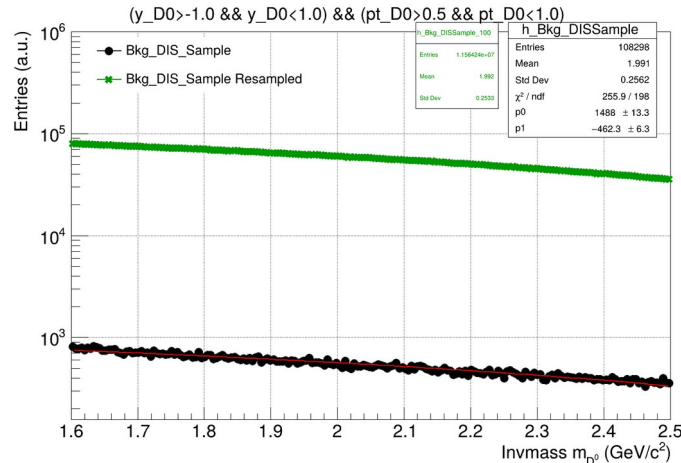
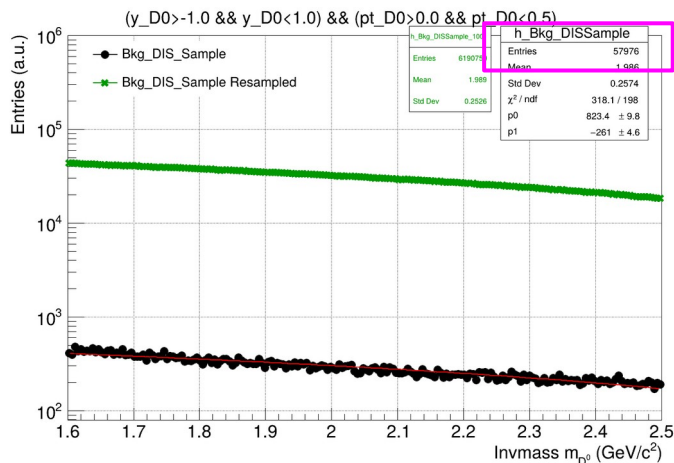
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PYTHIA 8.316, 9x275	6.546e5 pb	6.025e5 pb	5.178e4 pb	2.292e3 pb	3.697e1 pb

Sampling Background (-1 < y < 1)

$\sigma_{MB} = 655.6 \text{ nb}$

$L_{int} = 0.023412178 \text{ fb}^{-1}$

$L_{int} = 2.5 \text{ fb}^{-1}$

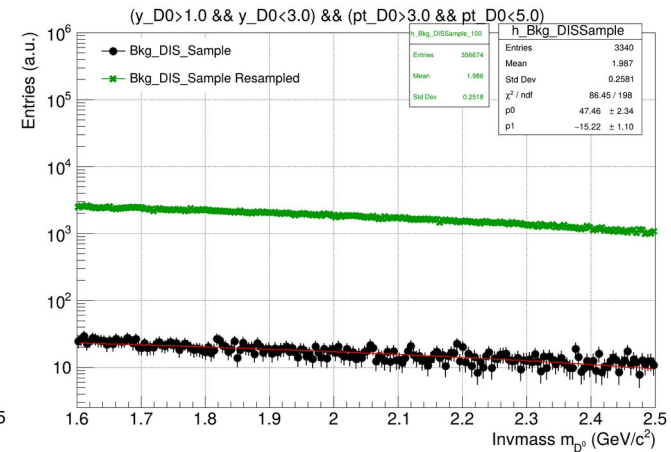
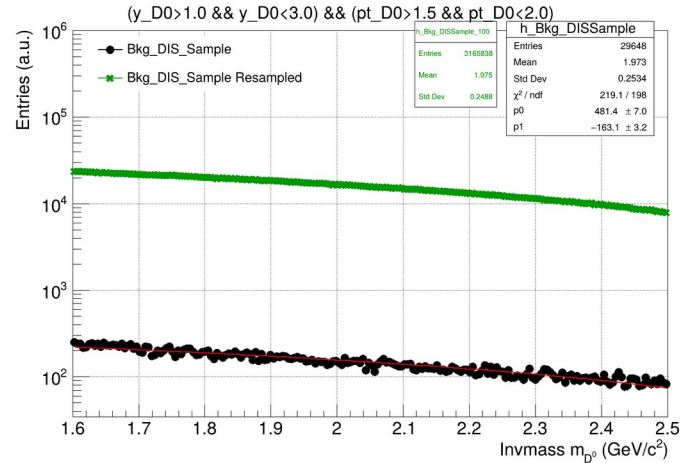
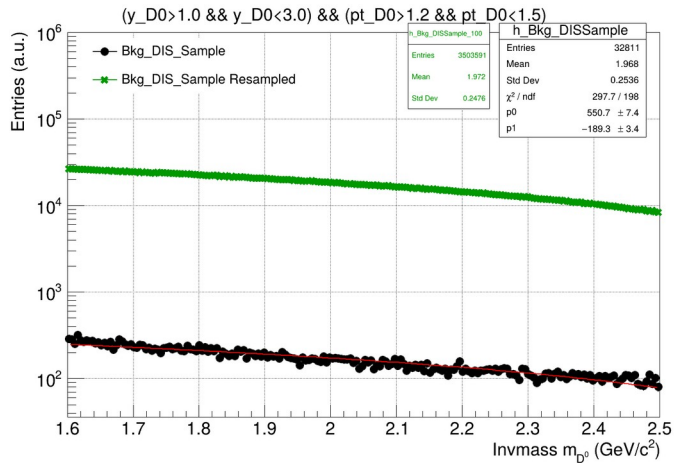
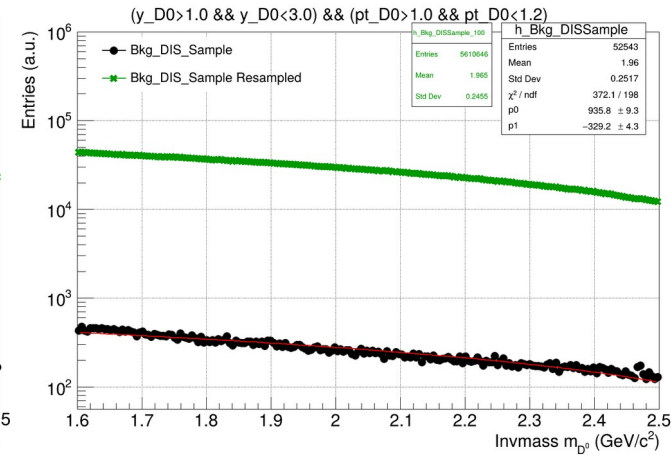
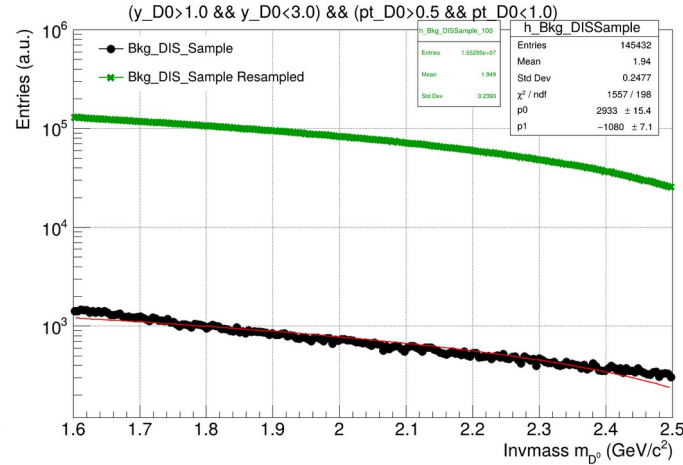
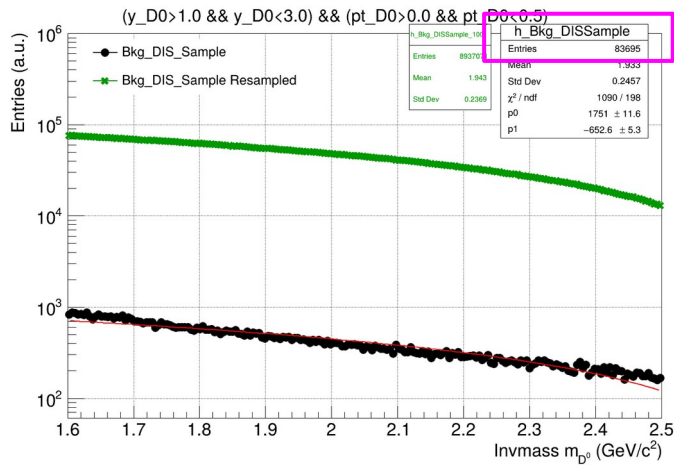


Sampling Background (1 < y < 3)

$\sigma_{MB} = 655.6 \text{ nb}$

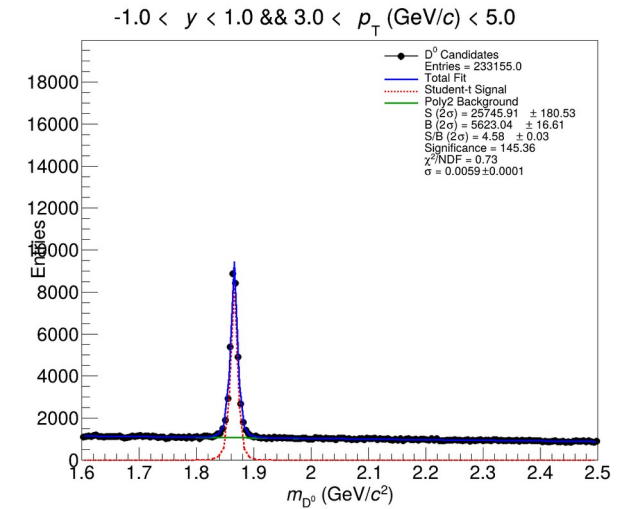
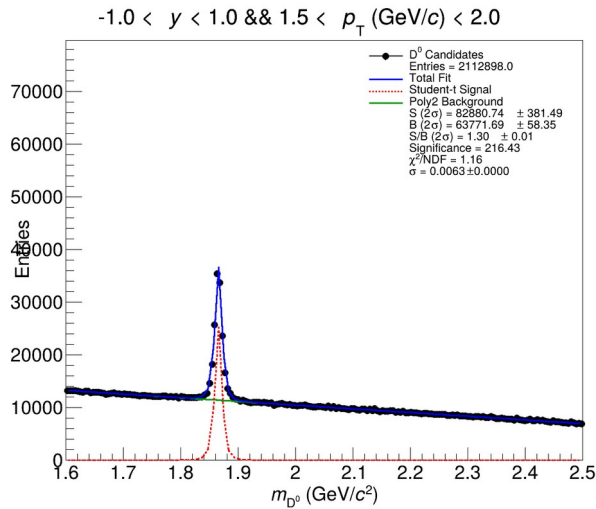
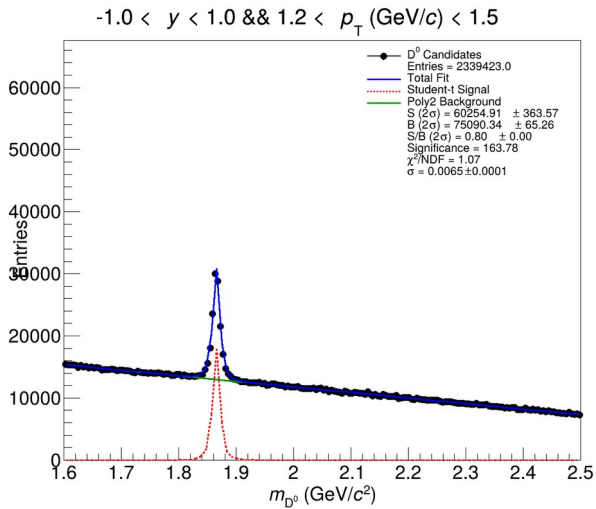
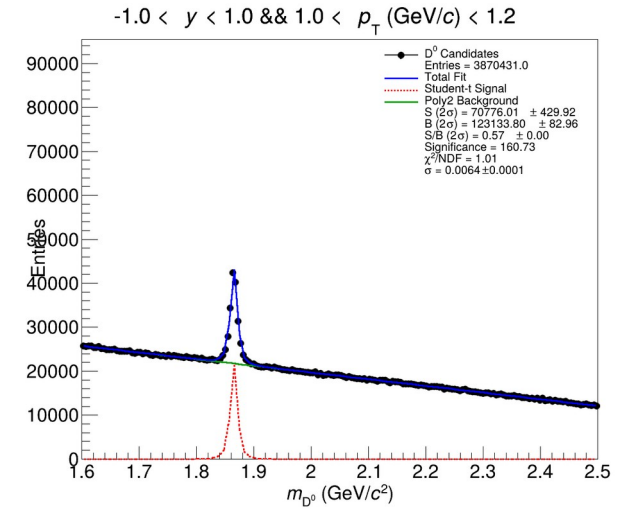
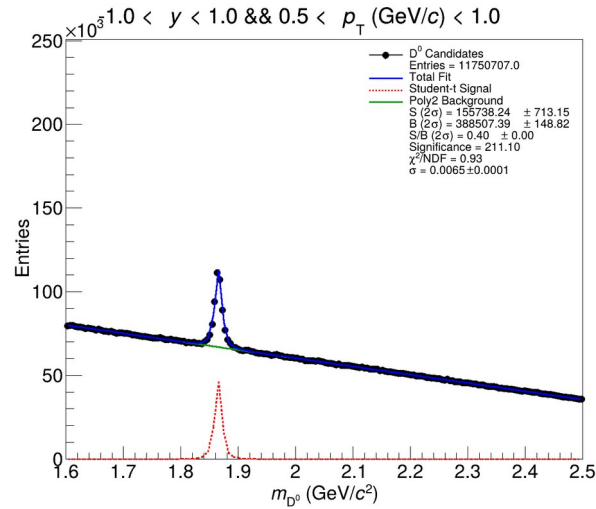
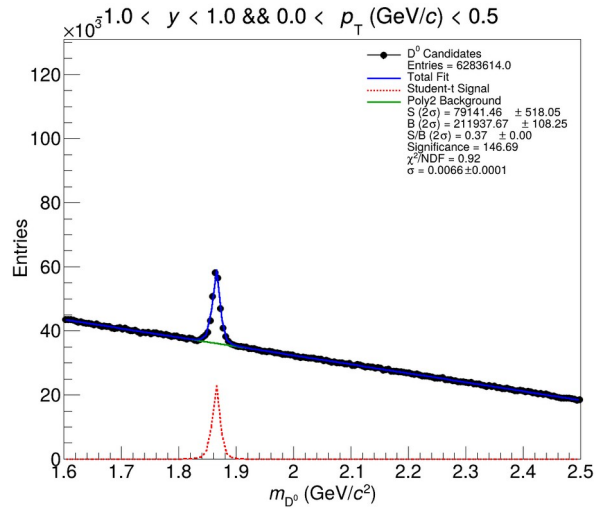
$L_{int} = 0.023412178 \text{ fb}^{-1}$

$L_{int} = 2.5 \text{ fb}^{-1}$



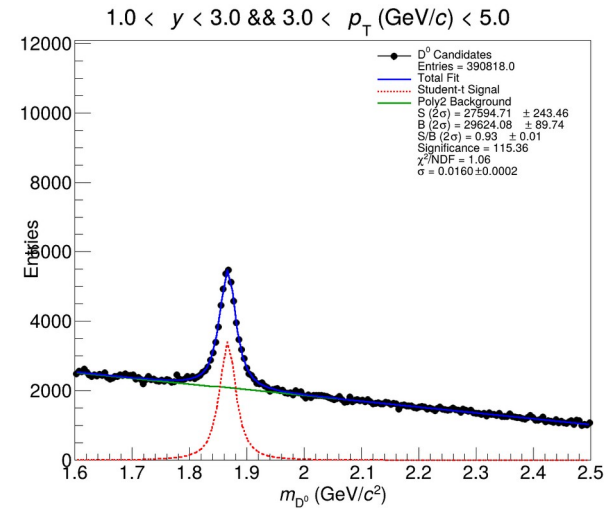
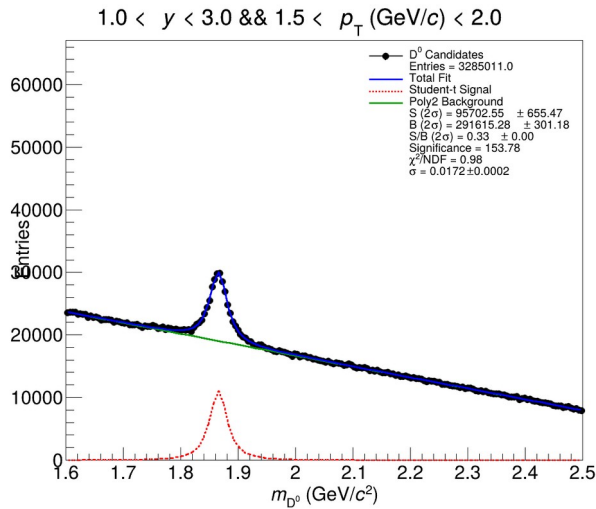
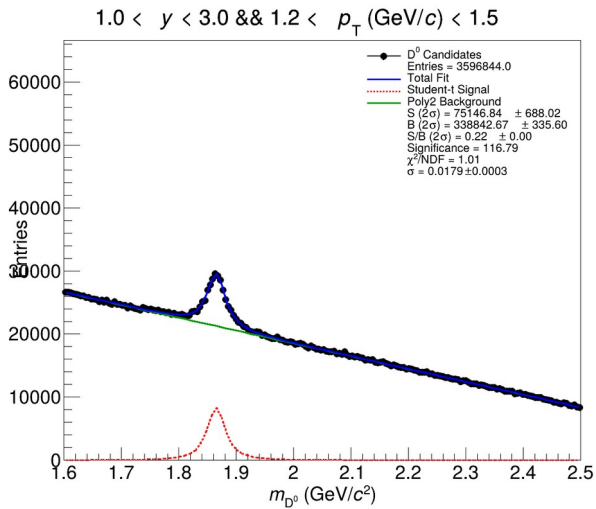
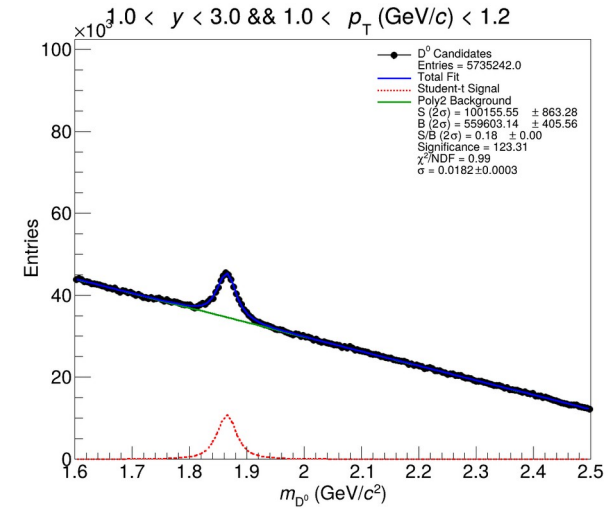
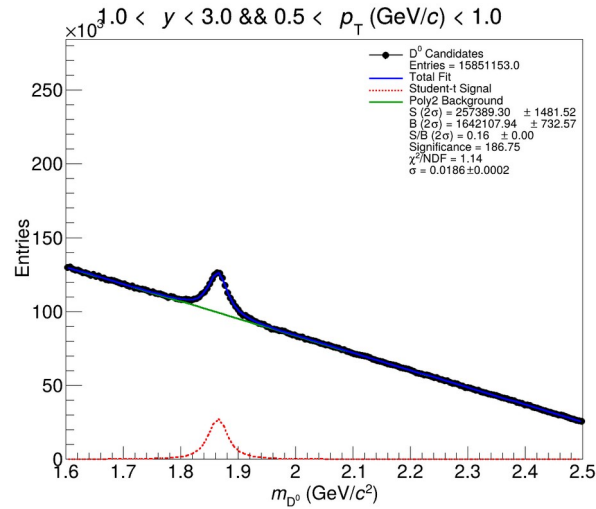
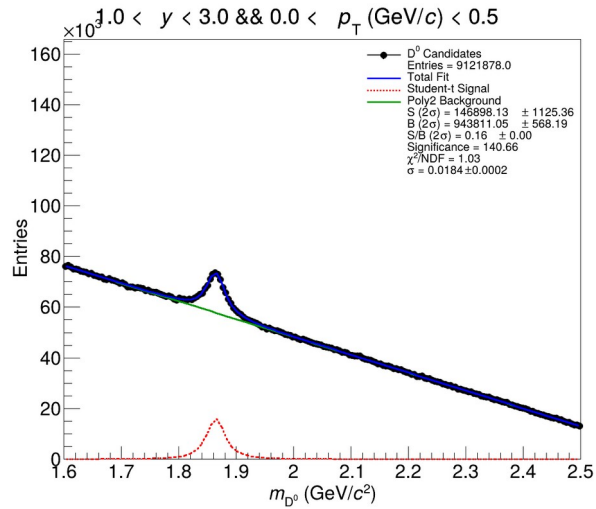
Invariant Mass (D^0)

After PID+ Preselection on slide 9



Invariant Mass (D^0)

After PID+ Preselection on slide 9

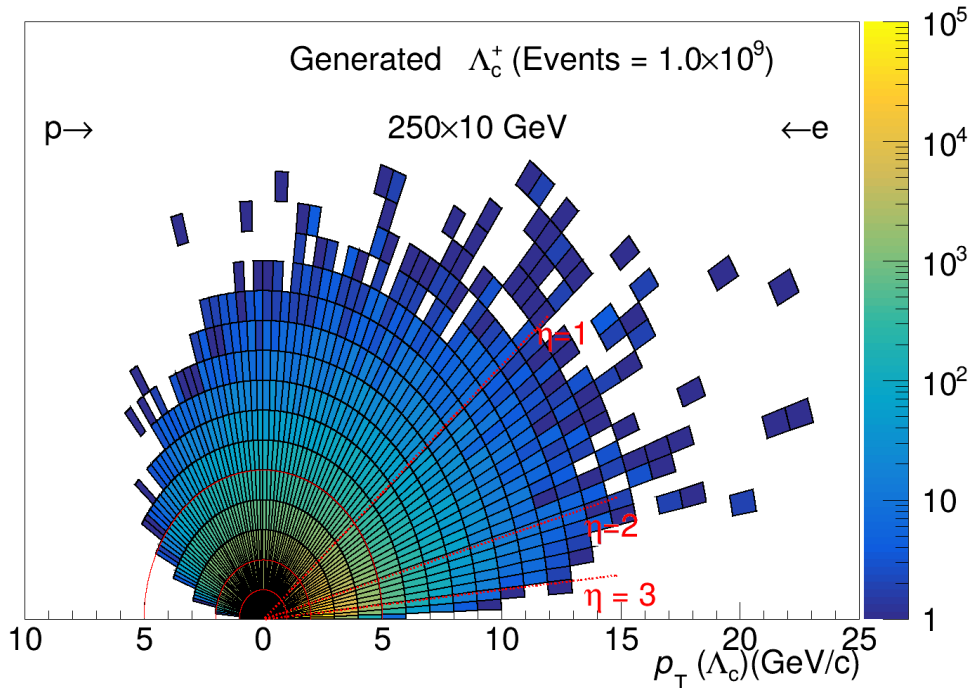


Machine Learning

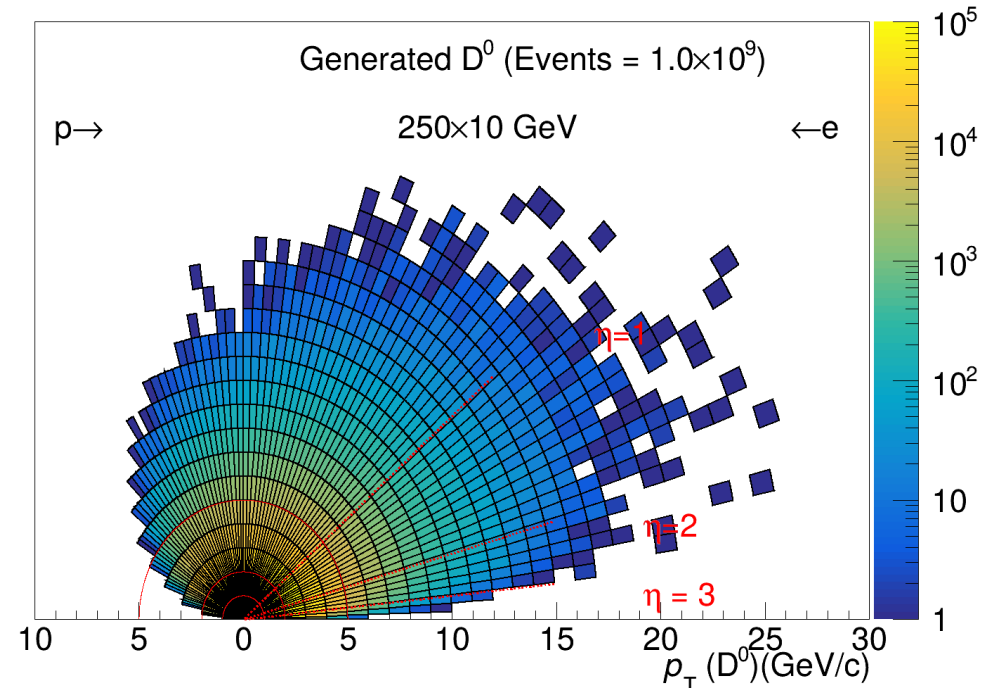
Train the model in two bins ($p_T < 1$ and $p_T > 1$ GeV/c) at mid and forward rapidities
Maximization of Significance

Phase Space (PYTHIA8307 Simulation)

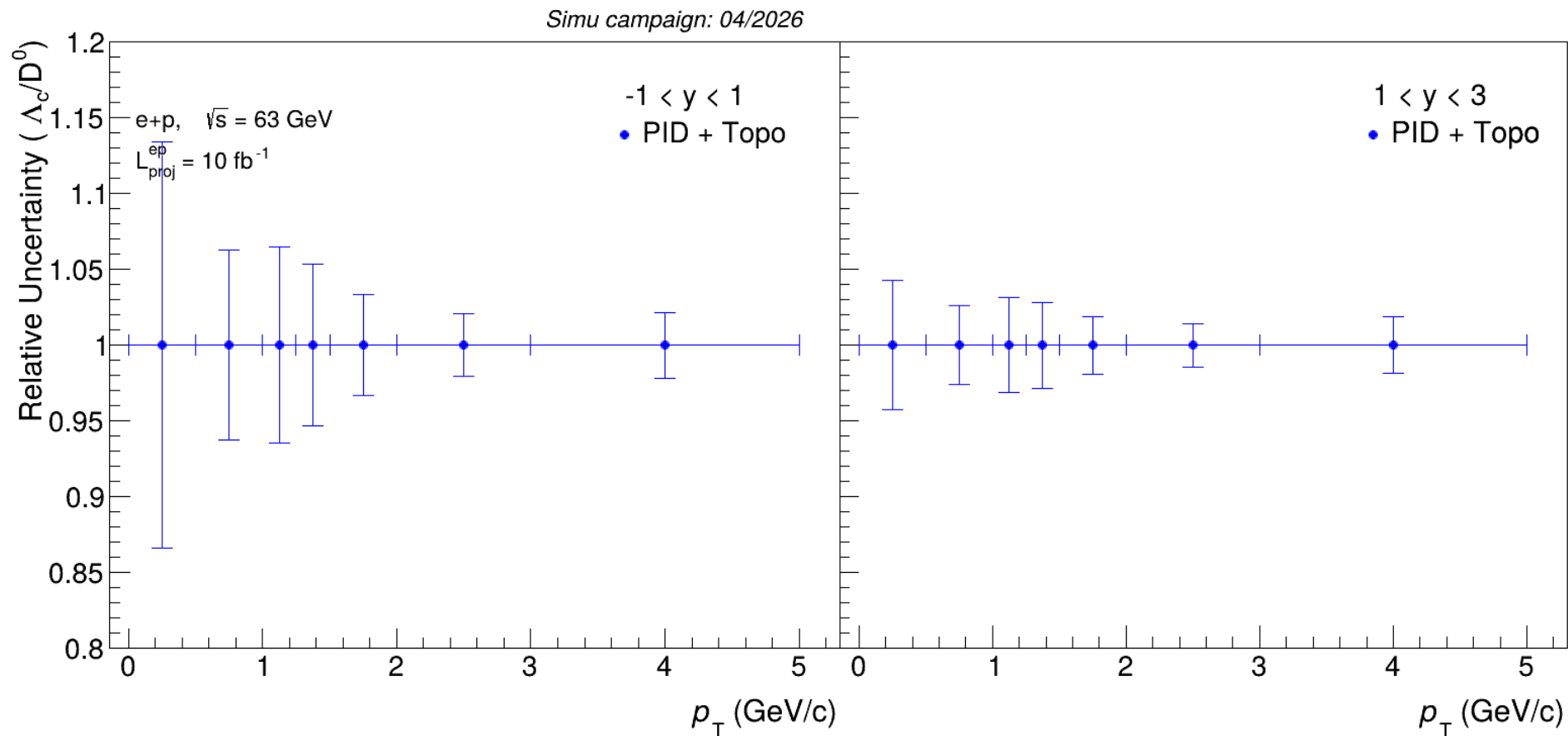
main41_D0_from_piK_NoEtaCut.cc



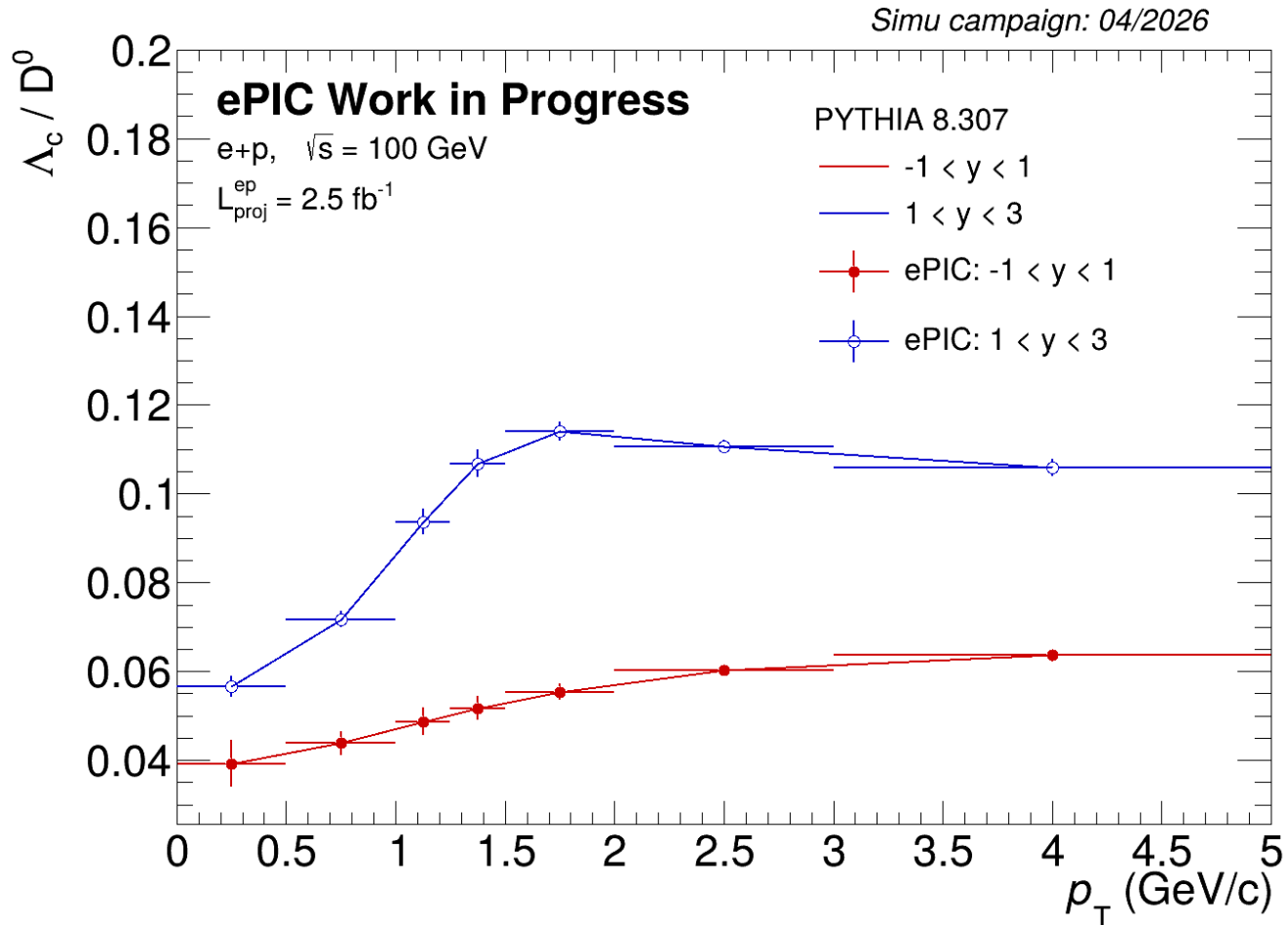
main41_LcToPiKp.cc



Statistical Projection for Λ_c/D^0 ratio



Statistical Projection for Λ_c/D^0 ratio



Further to superimpose the data points from ALICE and HERA

R_{eAu} vs fragmentation (z_{proj}) for D^0 -tagged jets

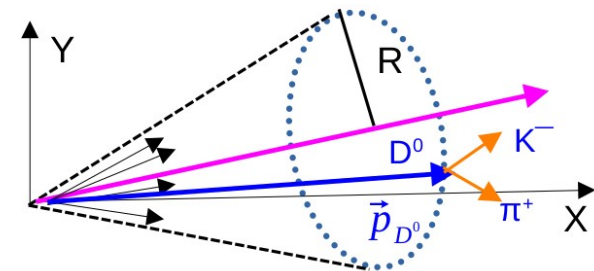
Signal for D^0 sample while combinatorial bkg from DIS Sample

Corrections on signal:

1. Weight factor of 3 on signal (Pythia8) for $Q^2 < 5 \text{ GeV}^2$
2. Projection in different rapidity bins
3. Scaling to target luminosity 1.0 fb^{-1}

Bkg:

1. Scaling to targeted luminosity (1.0 fb^{-1})
2. Cross section scaling for **biased** DIS sample
3. Projection in different eta and z bins
4. Training in ML: $0 < z < 0.6$ and $0.6 < z < 1$



preselection_cuts='(mass_D0 > 1.6 && mass_D0 < 2.5) && d0xy_pi<100. && d0xy_k<100. && decay_length <100.'

Data Sample

- D⁰ Sample, e+p, 10x130, Q² > 1 GeV²
 - epic:/RECO/26.04.1/epic_craterlake/SIDIS/D0_ABCONV/HFsim-PYTHIA/pythia8.312-2.0/ep/10x130/q2_1
- D⁰ Sample, e+Au, 10x100, Q² > 1 GeV² (Pythia6)
 - epic:/RECO/26.04.1/epic_craterlake_without_zdc/SIDIS/D0_ABCONV/HFsim-BeAGLE/BeAGLE1.03.01-2.0/eAu/10x100/q2_1to10000
- **Biased** NC, DIS Sample e+p, 10x130, Q² > 1 GeV² (Biased in different Q² bins)
- NC, DIS Sample e+Au, 10x100, **Q²: 1-100 GeV²**

Current scaling factor

$$f_i = \frac{\sigma_i}{\sigma(1 < Q^2 < 10)}$$

Cross section in different Q² bins: [Slides](#)

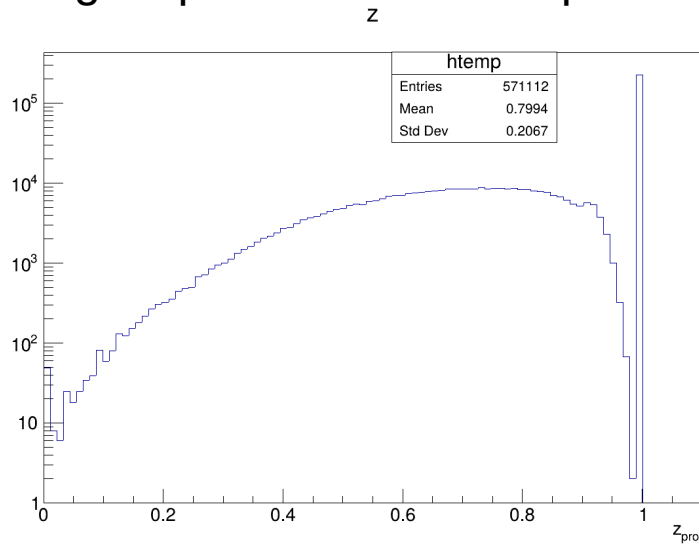
Event generator and energy	Q ² > 1	1 < Q ² < 10	10 < Q ² < 100	1e2 < Q ² < 1e3	1e3 < Q ² < 1e4
PYTHIA 8.316, 10x130	5.847e5 pb	5.391e5 pb	4.223e4 pb	1.590e3 pb	1.260e1 pb
PYTHIA 8.316, 10x250	6.556e5 pb	6.054e5 pb	5.291e4 pb	2.322e3 pb	3.686e1 pb
PYTHIA 8.316, 9x130	5.719e5 pb	5.307e5 pb	4.048e4 pb	1.475e3 pb	1.001e1 pb
PYTHIA 8.316, 9x275	6.546e5 pb	6.025e5 pb	5.178e4 pb	2.292e3 pb	3.697e1 pb

Fragmentation Variable (z)

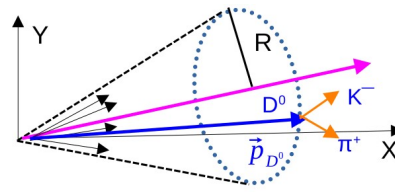
Signal pairs from D⁰ Sample

e+p, 10x130, D⁰ sample, **Biased** DIS sample

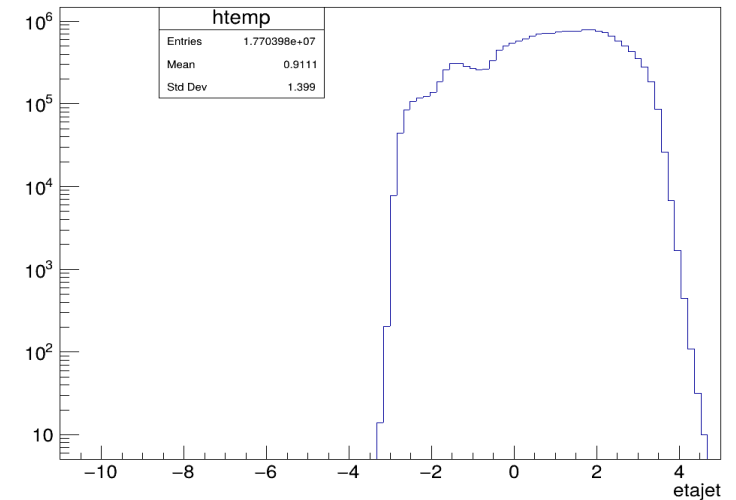
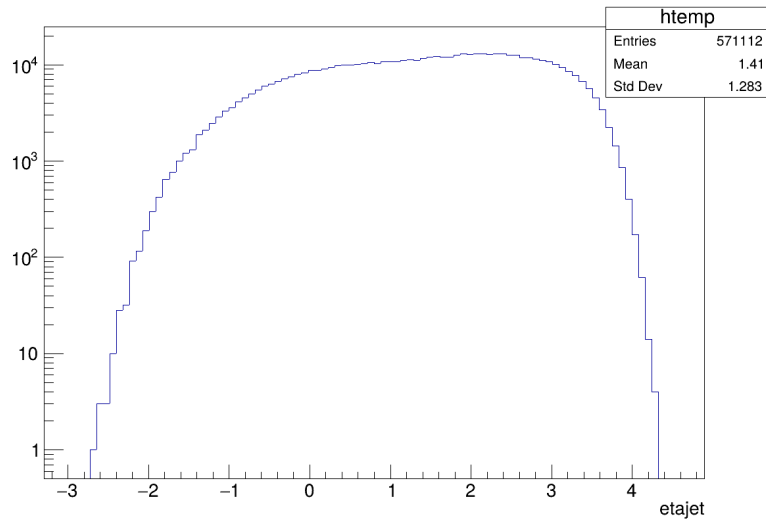
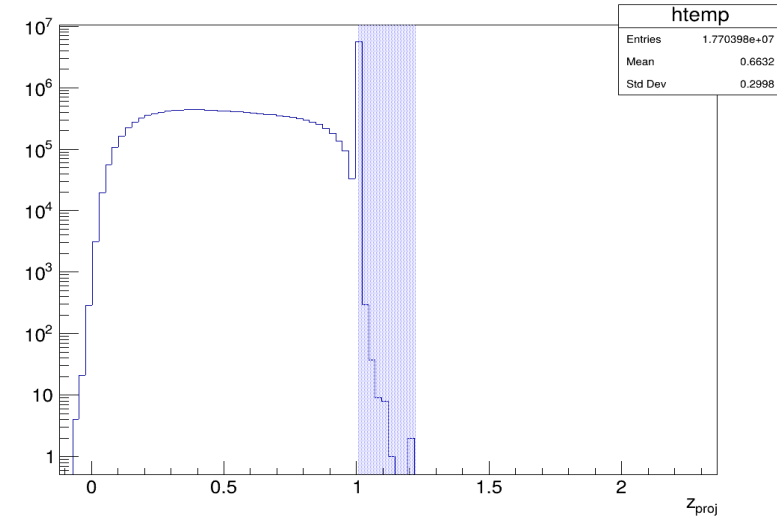
Bkg pairs from DIS



Anti-k_T, R = 1



$$z = z_{proj} = \frac{\vec{p}_{D^0} \cdot \vec{p}_{jet}}{p_{jet}^2}$$



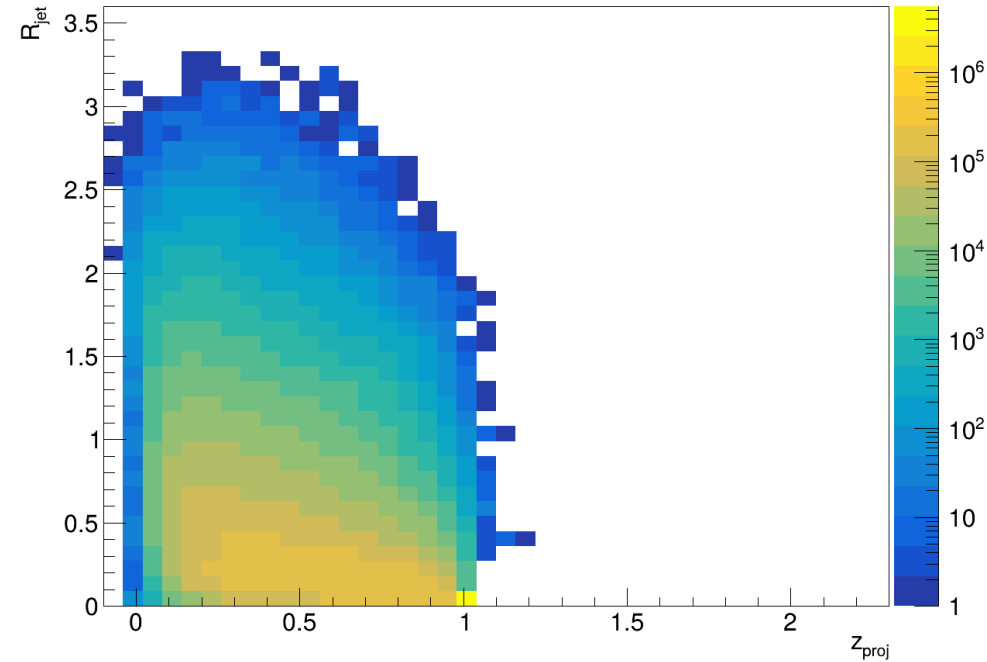
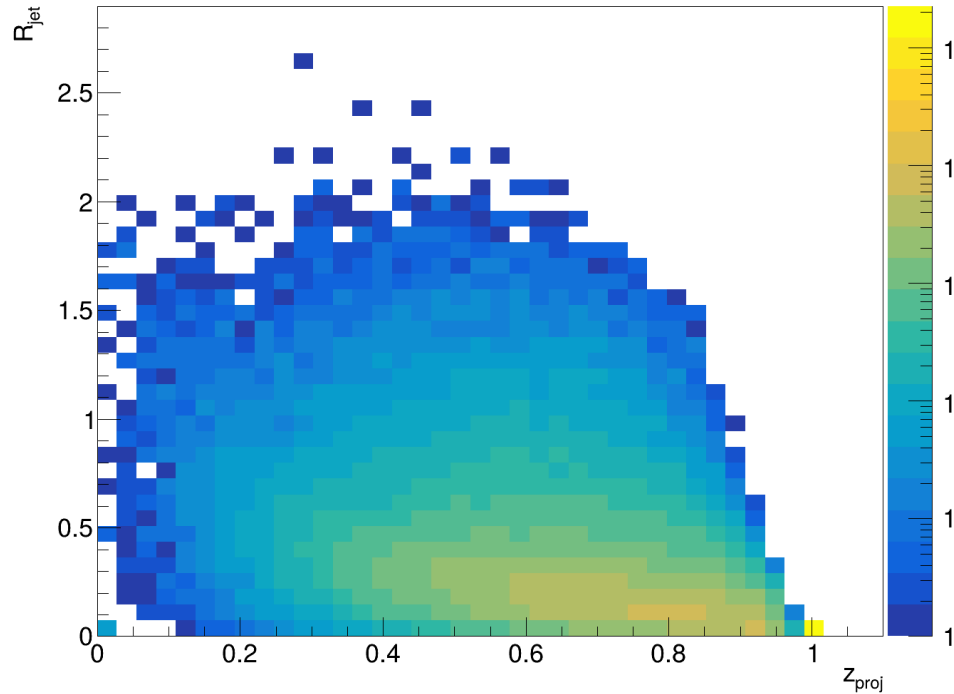
Fragmentation Variable (z)

e+p, 10x130, D⁰ sample, **Biased** DIS sample

Signal pairs from D⁰ Sample

Anti-k_T, R_{jet} = 1

Bkg pairs from DIS

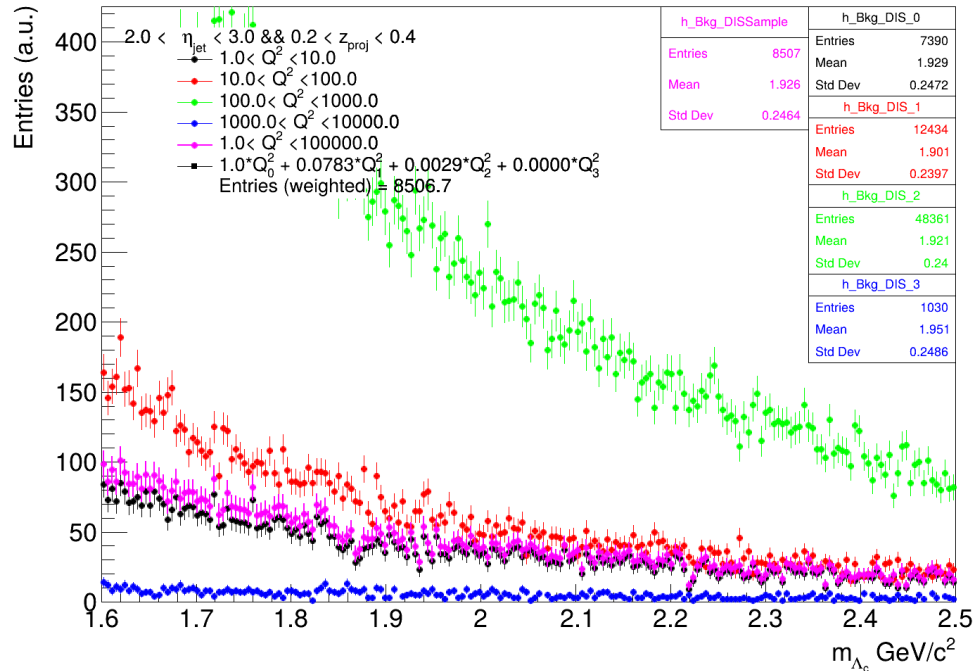


R_{jet} > 1, while doing clustering R_{jet} is defined using (η, φ), while anti-k_T calculates using (y, φ)

$$R_{jet} = \sqrt{(\eta_{D0} - \eta_{jet})^2 + (\phi_{D0} - \phi_{jet})^2}$$

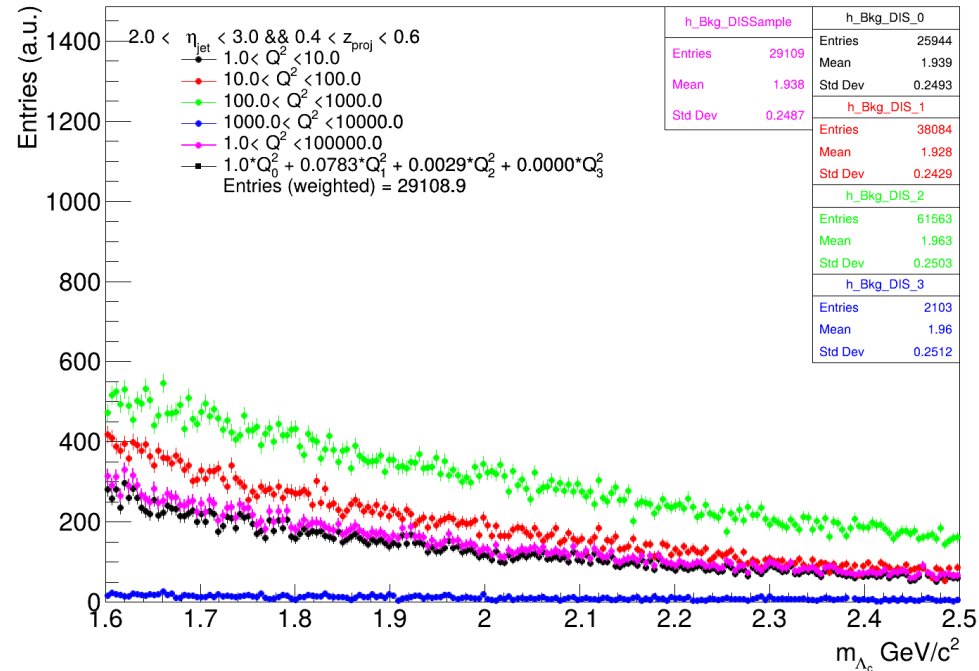
Applying scaling factor on Bkg pairs (e+p, 10x130)

Mid rapidity



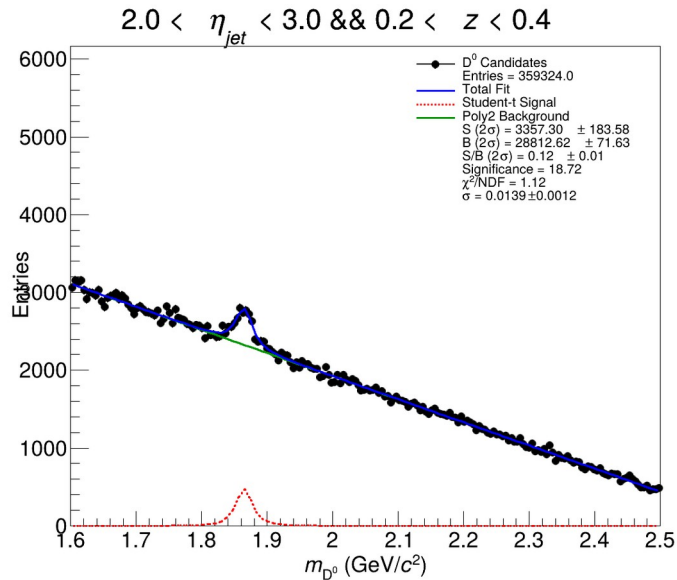
Weight factor according to cross section

Forward rapidity



Event generator and energy	$Q^2 > 1$	$1 < Q^2 < 10$	$10 < Q^2 < 100$	$1e2 < Q^2 < 1e3$	$1e3 < Q^2 < 1e4$
PYTHIA 8.316, 10x130	5.847e5 pb	5.391e5 pb	4.223e4 pb	1.590e3 pb	1.260e1 pb
PYTHIA 8.316, 10x250	6.556e5 pb	6.054e5 pb	5.291e4 pb	2.322e3 pb	3.686e1 pb
PYTHIA 8.316, 9x130	5.719e5 pb	5.307e5 pb	4.048e4 pb	1.475e3 pb	1.001e1 pb
PYTHIA 8.316, 9x275	6.546e5 pb	6.025e5 pb	5.178e4 pb	2.292e3 pb	3.697e1 pb

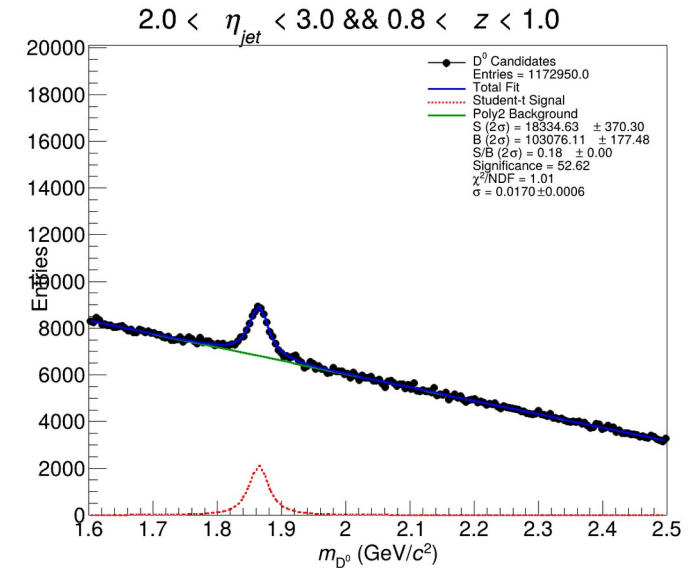
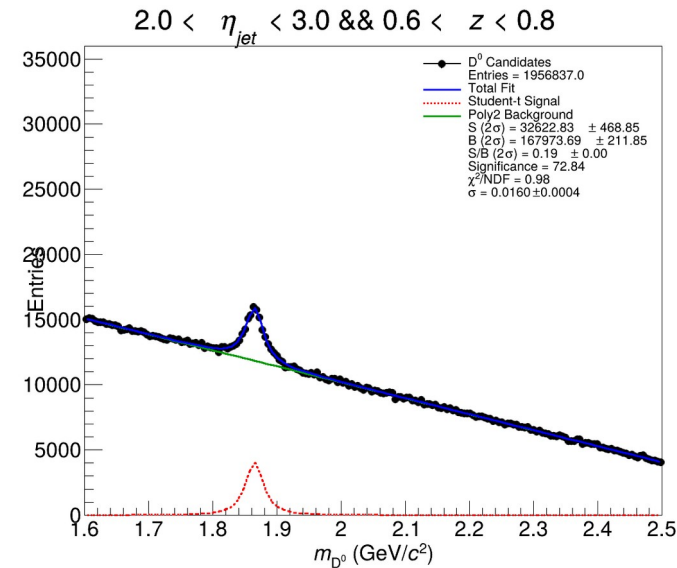
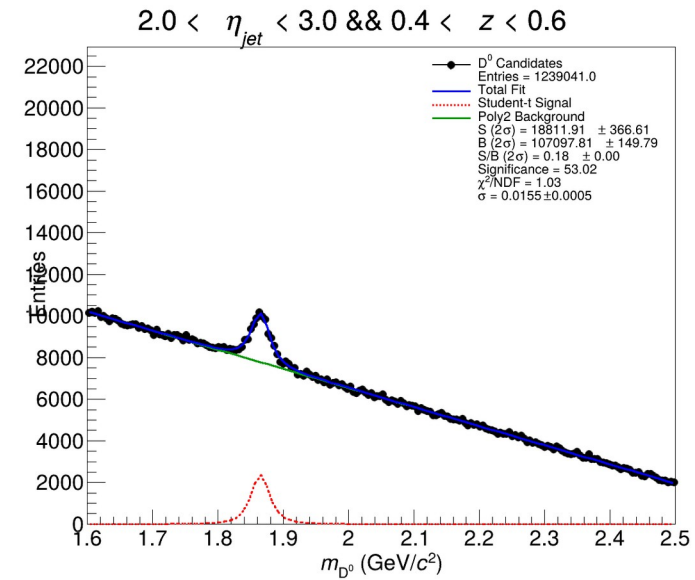
Invariant Mass Spectra (e+p)



After PID+ Preselection

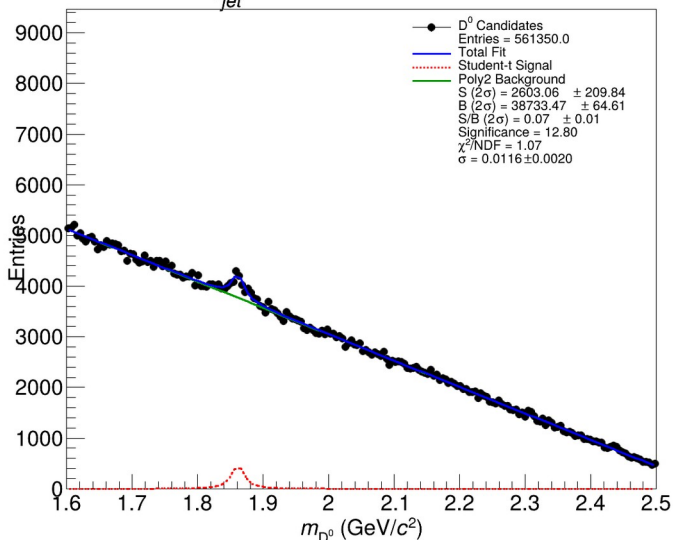
$$z = z_{proj} = \frac{\vec{p}_{D^0} \cdot \vec{p}_{jet}}{p_{jet}^2}$$

D⁰-jet reconstruction
Gurtaj, Lokesh, Rongrong, Shyam



Invariant Mass Spectra (e+Au)

$2.0 < \eta_{jet} < 3.0$ && $0.2 < z < 0.4$

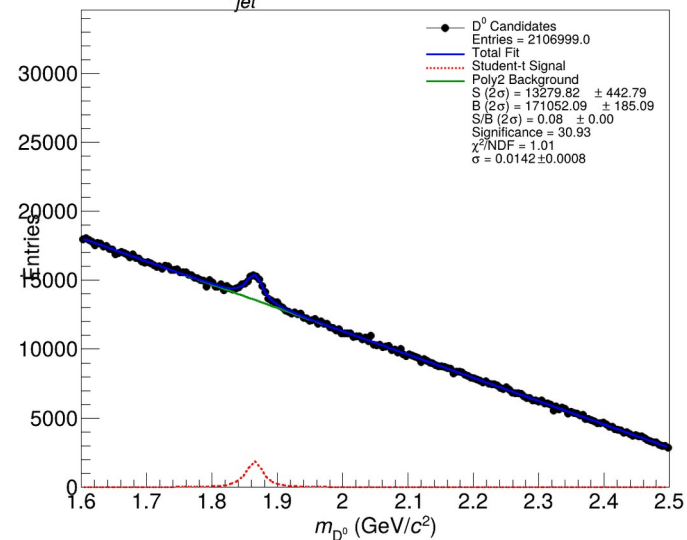


After PID+ Preselection

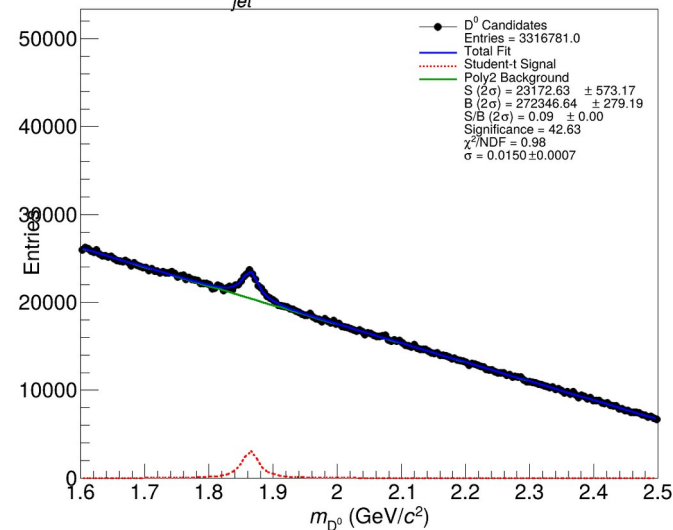
$$z = z_{proj} = \frac{\vec{p}_{D^0} \cdot \vec{p}_{jet}}{p_{jet}^2}$$

D⁰-jet reconstruction
 Gurtaj, Lokesh, Rongrong, Shyam

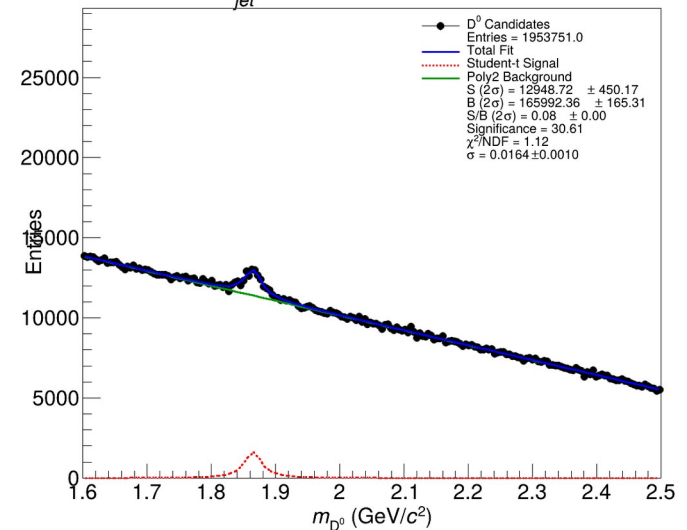
$2.0 < \eta_{jet} < 3.0$ && $0.4 < z < 0.6$



$2.0 < \eta_{jet} < 3.0$ && $0.6 < z < 0.8$

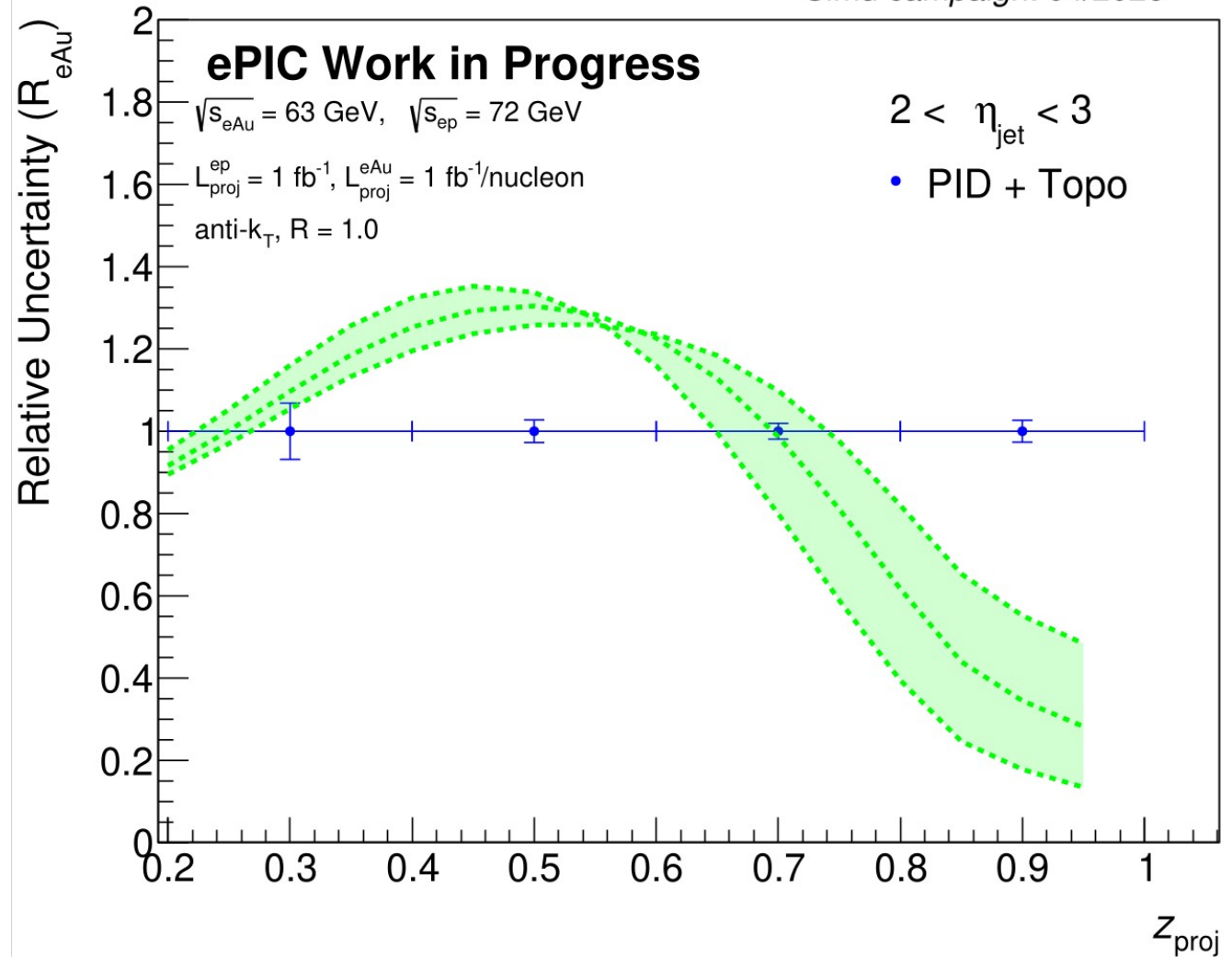


$2.0 < \eta_{jet} < 3.0$ && $0.8 < z < 1.0$



Nuclear Modification Factor (R_{eAu})

Simu campaign: 04/2026



After PID+ Preselection + ML

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

Summary and Future Plan

- First result of Λ_c/D^0 ratio is included in ES report
- First result of R_{eAu} vs z_{proj} is also included on ES report
- Analysis cross-checks in progress
- Optimization of selection is ongoing

Thank you for your attention!

Results (w PID+ Preselection)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (0,0.5)-----
Lc_ep: S/sqrt(S+B)=20.9105 Inverse Significance = 0.0478 rel sqrt(S+B)/S =0.0478
D0_ep: S/sqrt(S+B)=133.1308 Inverse Significance = 0.0075 rel sqrt(S+B)/S=0.0075
(relative uncertainty after adding in quadrature = 0.0484 = 4.8409%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (0.5,1)-----
Lc_ep: S/sqrt(S+B)=34.2538 Inverse Significance = 0.0292 rel sqrt(S+B)/S =0.0292
D0_ep: S/sqrt(S+B)=176.6132 Inverse Significance = 0.0057 rel sqrt(S+B)/S=0.0057
(relative uncertainty after adding in quadrature = 0.0297 = 2.9738%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (1,1.25)-----
Lc_ep: S/sqrt(S+B)=30.4505 Inverse Significance = 0.0328 rel sqrt(S+B)/S =0.0328
D0_ep: S/sqrt(S+B)=116.5132 Inverse Significance = 0.0086 rel sqrt(S+B)/S=0.0086
(relative uncertainty after adding in quadrature = 0.0339 = 3.3943%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (1.25,1.5)-----
Lc_ep: S/sqrt(S+B)=33.9772 Inverse Significance = 0.0294 rel sqrt(S+B)/S =0.0294
D0_ep: S/sqrt(S+B)=110.7324 Inverse Significance = 0.0090 rel sqrt(S+B)/S=0.0090
(relative uncertainty after adding in quadrature = 0.0308 = 3.0786%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (1.5,2)-----
Lc_ep: S/sqrt(S+B)=51.4688 Inverse Significance = 0.0194 rel sqrt(S+B)/S =0.0194
D0_ep: S/sqrt(S+B)=145.7956 Inverse Significance = 0.0069 rel sqrt(S+B)/S=0.0069
(relative uncertainty after adding in quadrature = 0.0206 = 2.0604%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (2,3)-----
Lc_ep: S/sqrt(S+B)=70.4593 Inverse Significance = 0.0142 rel sqrt(S+B)/S =0.0142
D0_ep: S/sqrt(S+B)=162.7058 Inverse Significance = 0.0061 rel sqrt(S+B)/S=0.0061
(relative uncertainty after adding in quadrature = 0.0155 = 1.5466%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (3,5)-----
Lc_ep: S/sqrt(S+B)=57.6186 Inverse Significance = 0.0174 rel sqrt(S+B)/S =0.0174
D0_ep: S/sqrt(S+B)=111.5921 Inverse Significance = 0.0090 rel sqrt(S+B)/S=0.0090
(relative uncertainty after adding in quadrature = 0.0195 = 1.9532%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (0,0.5)-----
Lc_ep: S/sqrt(S+B)=6.5956 Inverse Significance = 0.1516 rel sqrt(S+B)/S =0.1516
D0_ep: S/sqrt(S+B)=139.7050 Inverse Significance = 0.0072 rel sqrt(S+B)/S=0.0072
(relative uncertainty after adding in quadrature = 0.1518 = 15.1785%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (0.5,1)-----
Lc_ep: S/sqrt(S+B)=15.7793 Inverse Significance = 0.0634 rel sqrt(S+B)/S =0.0634
D0_ep: S/sqrt(S+B)=201.8392 Inverse Significance = 0.0050 rel sqrt(S+B)/S=0.0050
(relative uncertainty after adding in quadrature = 0.0636 = 6.3568%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (1,1.25)-----
Lc_ep: S/sqrt(S+B)=14.0111 Inverse Significance = 0.0714 rel sqrt(S+B)/S =0.0714
D0_ep: S/sqrt(S+B)=154.1781 Inverse Significance = 0.0065 rel sqrt(S+B)/S=0.0065
(relative uncertainty after adding in quadrature = 0.0717 = 7.1666%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (1.25,1.5)-----
Lc_ep: S/sqrt(S+B)=17.6088 Inverse Significance = 0.0568 rel sqrt(S+B)/S =0.0568
D0_ep: S/sqrt(S+B)=157.7569 Inverse Significance = 0.0063 rel sqrt(S+B)/S=0.0063
(relative uncertainty after adding in quadrature = 0.0571 = 5.7142%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (1.5,2)-----
Lc_ep: S/sqrt(S+B)=28.2320 Inverse Significance = 0.0354 rel sqrt(S+B)/S =0.0354
D0_ep: S/sqrt(S+B)=210.3489 Inverse Significance = 0.0048 rel sqrt(S+B)/S=0.0048
(relative uncertainty after adding in quadrature = 0.0357 = 3.5738%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (2,3)-----
Lc_ep: S/sqrt(S+B)=47.3236 Inverse Significance = 0.0211 rel sqrt(S+B)/S =0.0211
D0_ep: S/sqrt(S+B)=220.9039 Inverse Significance = 0.0045 rel sqrt(S+B)/S=0.0045
(relative uncertainty after adding in quadrature = 0.0216 = 2.1611%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (3,5)-----
Lc_ep: S/sqrt(S+B)=47.4838 Inverse Significance = 0.0211 rel sqrt(S+B)/S =0.0211
D0_ep: S/sqrt(S+B)=143.5299 Inverse Significance = 0.0070 rel sqrt(S+B)/S=0.0070
(relative uncertainty after adding in quadrature = 0.0222 = 2.2182%)

Results (w PID+ Preselection+ML)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (0,0.5)-----
Lc_ep (ML): S/sqrt(S+B) =22.1329 Inverse Significance = 0.0452 rel sqrt(S+B)/S =0.0452
D0_ep (ML): S/sqrt(S+B) =187.9427 Inverse Significance = 0.0053 rel sqrt(S+B)/S=0.0053
(relative uncertainty after adding in quadrature = 0.0455 = 4.5494%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (0.5,1)-----
Lc_ep (ML): S/sqrt(S+B) =36.2241 Inverse Significance = 0.0276 rel sqrt(S+B)/S =0.0276
D0_ep (ML): S/sqrt(S+B) =249.0819 Inverse Significance = 0.0040 rel sqrt(S+B)/S=0.0040
(relative uncertainty after adding in quadrature = 0.0279 = 2.7896%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (1,1.25)-----
Lc_ep (ML): S/sqrt(S+B) =31.3446 Inverse Significance = 0.0319 rel sqrt(S+B)/S =0.0319
D0_ep (ML): S/sqrt(S+B) =144.3395 Inverse Significance = 0.0069 rel sqrt(S+B)/S=0.0069
(relative uncertainty after adding in quadrature = 0.0326 = 3.2647%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (1.25,1.5)-----
Lc_ep (ML): S/sqrt(S+B) =34.9054 Inverse Significance = 0.0286 rel sqrt(S+B)/S =0.0286
D0_ep (ML): S/sqrt(S+B) =133.4553 Inverse Significance = 0.0075 rel sqrt(S+B)/S=0.0075
(relative uncertainty after adding in quadrature = 0.0296 = 2.9613%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (1.5,2)-----
Lc_ep (ML): S/sqrt(S+B) =52.7153 Inverse Significance = 0.0190 rel sqrt(S+B)/S =0.0190
D0_ep (ML): S/sqrt(S+B) =169.3684 Inverse Significance = 0.0059 rel sqrt(S+B)/S=0.0059
(relative uncertainty after adding in quadrature = 0.0199 = 1.9867%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (2,3)-----
Lc_ep (ML): S/sqrt(S+B) =71.6072 Inverse Significance = 0.0140 rel sqrt(S+B)/S =0.0140
D0_ep (ML): S/sqrt(S+B) =179.0965 Inverse Significance = 0.0056 rel sqrt(S+B)/S=0.0056
(relative uncertainty after adding in quadrature = 0.0150 = 1.5040%)

-->(ymin, ymax) = (1,3)-->(ptmin, ptmax) = (3,5)-----
Lc_ep (ML): S/sqrt(S+B) =58.1079 Inverse Significance = 0.0172 rel sqrt(S+B)/S =0.0172
D0_ep (ML): S/sqrt(S+B) =118.9311 Inverse Significance = 0.0084 rel sqrt(S+B)/S=0.0084
(relative uncertainty after adding in quadrature = 0.0192 = 1.9154%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (0,0.5)-----
Lc_ep (ML): S/sqrt(S+B) =6.7196 Inverse Significance = 0.1488 rel sqrt(S+B)/S =0.1488
D0_ep (ML): S/sqrt(S+B) =175.3675 Inverse Significance = 0.0057 rel sqrt(S+B)/S=0.0057
(relative uncertainty after adding in quadrature = 0.1489 = 14.8927%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (0.5,1)-----
Lc_ep (ML): S/sqrt(S+B) =16.0601 Inverse Significance = 0.0623 rel sqrt(S+B)/S =0.0623
D0_ep (ML): S/sqrt(S+B) =251.0902 Inverse Significance = 0.0040 rel sqrt(S+B)/S=0.0040
(relative uncertainty after adding in quadrature = 0.0624 = 6.2393%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (1,1.25)-----
Lc_ep (ML): S/sqrt(S+B) =14.4969 Inverse Significance = 0.0690 rel sqrt(S+B)/S =0.0690
D0_ep (ML): S/sqrt(S+B) =178.3316 Inverse Significance = 0.0056 rel sqrt(S+B)/S=0.0056
(relative uncertainty after adding in quadrature = 0.0692 = 6.9208%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (1.25,1.5)-----
Lc_ep (ML): S/sqrt(S+B) =18.0537 Inverse Significance = 0.0554 rel sqrt(S+B)/S =0.0554
D0_ep (ML): S/sqrt(S+B) =175.3351 Inverse Significance = 0.0057 rel sqrt(S+B)/S=0.0057
(relative uncertainty after adding in quadrature = 0.0557 = 5.5683%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (1.5,2)-----
Lc_ep (ML): S/sqrt(S+B) =28.8112 Inverse Significance = 0.0347 rel sqrt(S+B)/S =0.0347
D0_ep (ML): S/sqrt(S+B) =224.0774 Inverse Significance = 0.0045 rel sqrt(S+B)/S=0.0045
(relative uncertainty after adding in quadrature = 0.0350 = 3.4994%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (2,3)-----
Lc_ep (ML): S/sqrt(S+B) =47.7718 Inverse Significance = 0.0209 rel sqrt(S+B)/S =0.0209
D0_ep (ML): S/sqrt(S+B) =226.5060 Inverse Significance = 0.0044 rel sqrt(S+B)/S=0.0044
(relative uncertainty after adding in quadrature = 0.0214 = 2.1393%)

-->(ymin, ymax) = (-1,1)-->(ptmin, ptmax) = (3,5)-----
Lc_ep (ML): S/sqrt(S+B) =47.6110 Inverse Significance = 0.0210 rel sqrt(S+B)/S =0.0210
D0_ep (ML): S/sqrt(S+B) =144.9118 Inverse Significance = 0.0069 rel sqrt(S+B)/S=0.0069
(relative uncertainty after adding in quadrature = 0.0221 = 2.2108%)