Effects of machine background on D0 invariant mass

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Samples and methods

October ep simulations, D0 and DIS samples, with and without machine background
10x100 ep, Q2 > 1 D0 samples —> signal candidates
10x100 ep, Q2 > 1 DIS samples —> background candidates
1 bin with -2 < y_D0 < 3 and pt_D0 > 1

With machine background
D0: /volatile/eic/EPIC/RECO/25.10.4/epic_craterlake/Bkg_Exactly1SignalPer2usFrame/SIDIS/D0_ABCONV/pythia8.306-1.1/10x100/q2_1/hiDiv/
DIS: /volatile/eic/EPIC/RECO/25.10.4/epic_craterlake/Bkg_1SignalPer2usFrame/DIS/NC/10x100/minQ2=1

Without machine background
D0: /volatile/eic/EPIC/RECO/25.10.3/epic_craterlake/SIDIS/D0_ABCONV/pythia8.306-1.1/10x100/q2_1/hiDiv/
DIS: /volatile/eic/EPIC/RECO/25.10.0/epic_craterlake/DIS/NC/10x100/minQ2=1

Steps

1. Run analysis to get sig and bkg candidates from samples.
2. Train BDT using sig and bkg candidates from samples **without** machine background.
3. Apply topological cuts to sig+bkg candidates using BDT.
4. Compare D0 invariant mass distributions for samples with and without machine bkg.

Sample statistics

Preselections applied to sig and bkg candidates:

1.6 < mass_D0 < 2.5
0.02 < d0xy_pi < 10
0.02 < d0xy_k < 10
decay_length < 100

Samples **without** machine background

D0 events in sample: 985468

Signal candidates: 405511

DIS events in sample: 4968067

Background candidates: 188813

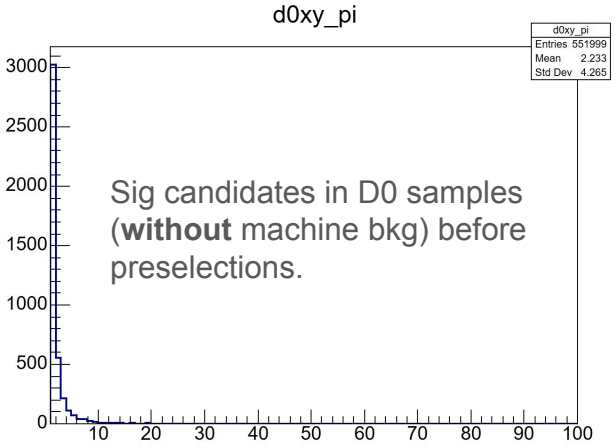
Samples **with** machine background

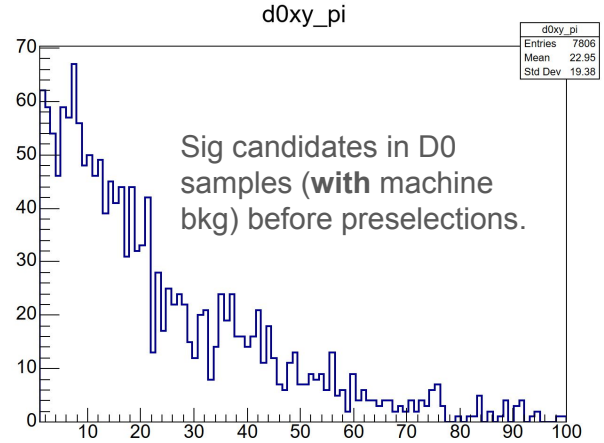
D0 events in sample: 22908

Signal candidates: 412

DIS events in sample: 238944

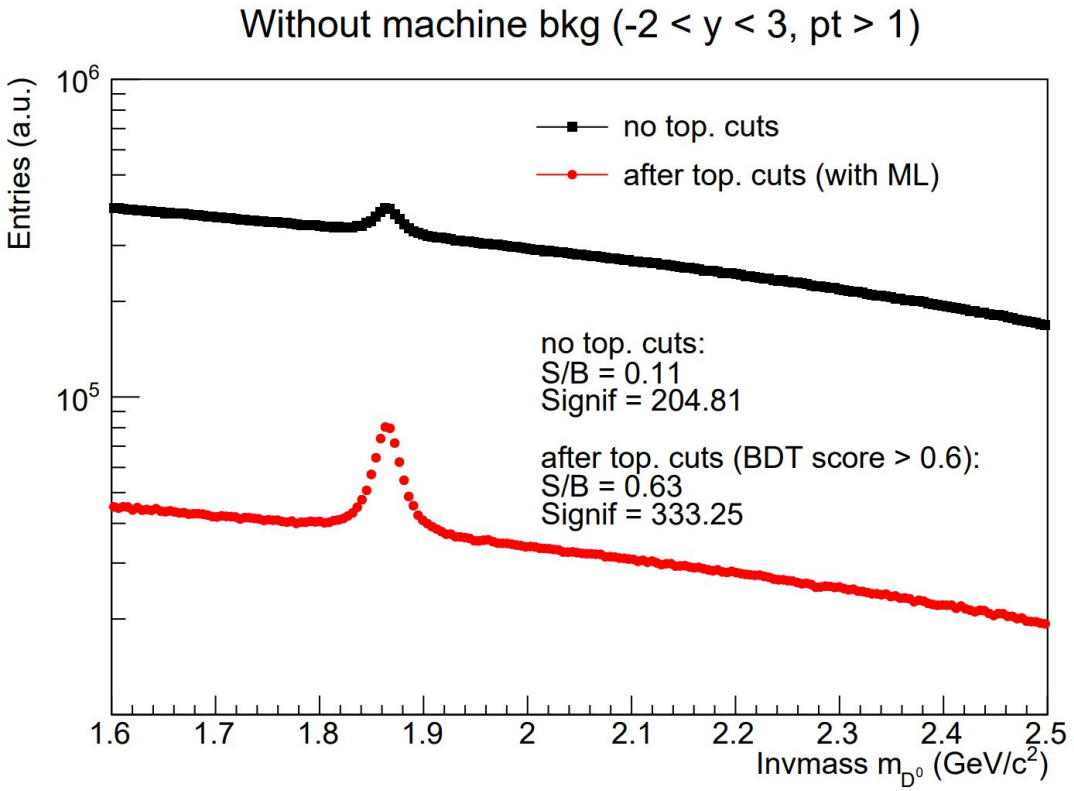
Background candidates: 770





Greater spread in top. distributions with machine bkg. Many candidates are cut out by preselections.

Without machine bkg, before and after top. cuts



D0 events in sample: 985468

DIS events in sample: 4968067

Nevents D0: Estimated scale factor from Shyam's example

985468 * 1821.83 ~ 1.80×10^9

Nevents DIS: 4968067

$$N_{\text{resampled}} = \frac{N_{\text{candidates}}}{N_{\text{events}}} \times 4.72162e9$$

Expected Nevents for 10 fb^{-1}

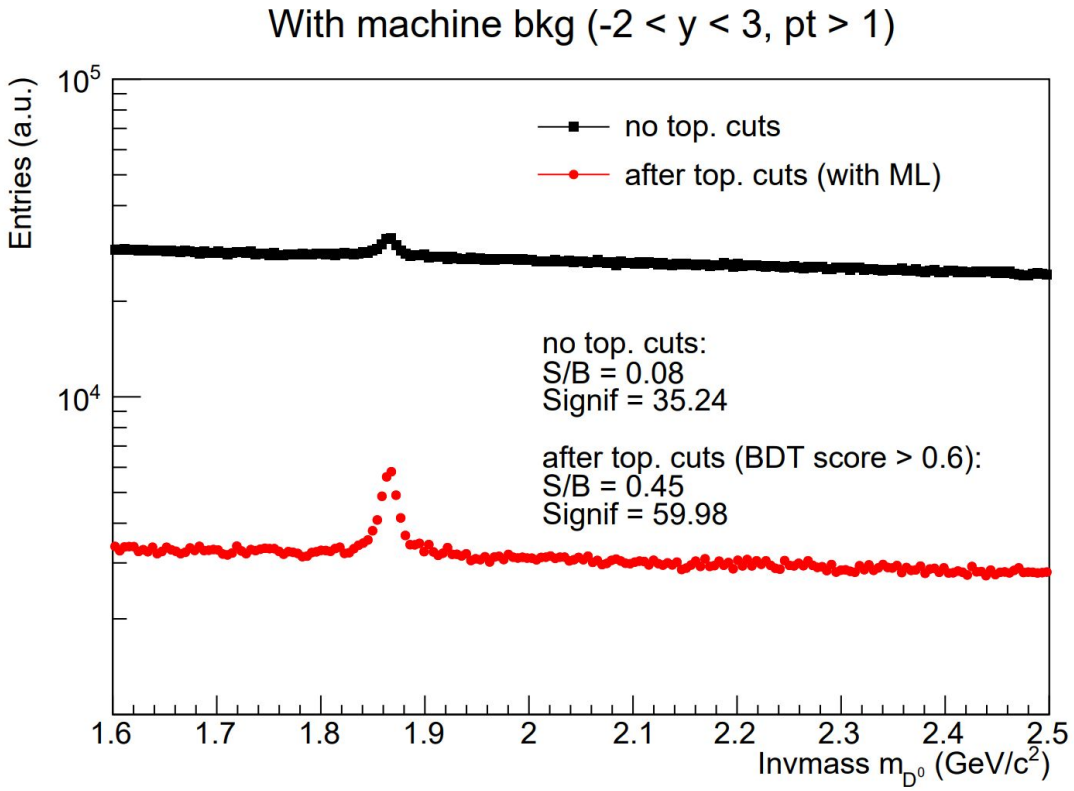
$$N^{\text{ML}}_{\text{resampled}} = N_{\text{resampled}} \times eff(\text{BDT} = 0.6)$$

Signal peak: 1.84 < Invmass < 1.89

$$\text{S/B} = N^{\text{sig}}_{\text{resampled}} / N^{\text{bkg}}_{\text{resampled}}$$

$$\text{Signif} = N^{\text{sig}}_{\text{resampled}} / \sqrt{N^{\text{sig}}_{\text{resampled}} + N^{\text{bkg}}_{\text{resampled}}}$$

With machine bkg, before and after top. cuts



D0 events in sample: 22908

DIS events in sample: 238944

Nevents D0: Estimated scale factor from Shyam's example

22908 * 1821.83 ~ 4.17×10^7

Nevents DIS: 238944

$$N_{\text{resampled}} = \frac{N_{\text{candidates}}}{N_{\text{events}}} \times 4.72162e9$$

Expected Nevents for 10 fb^{-1}

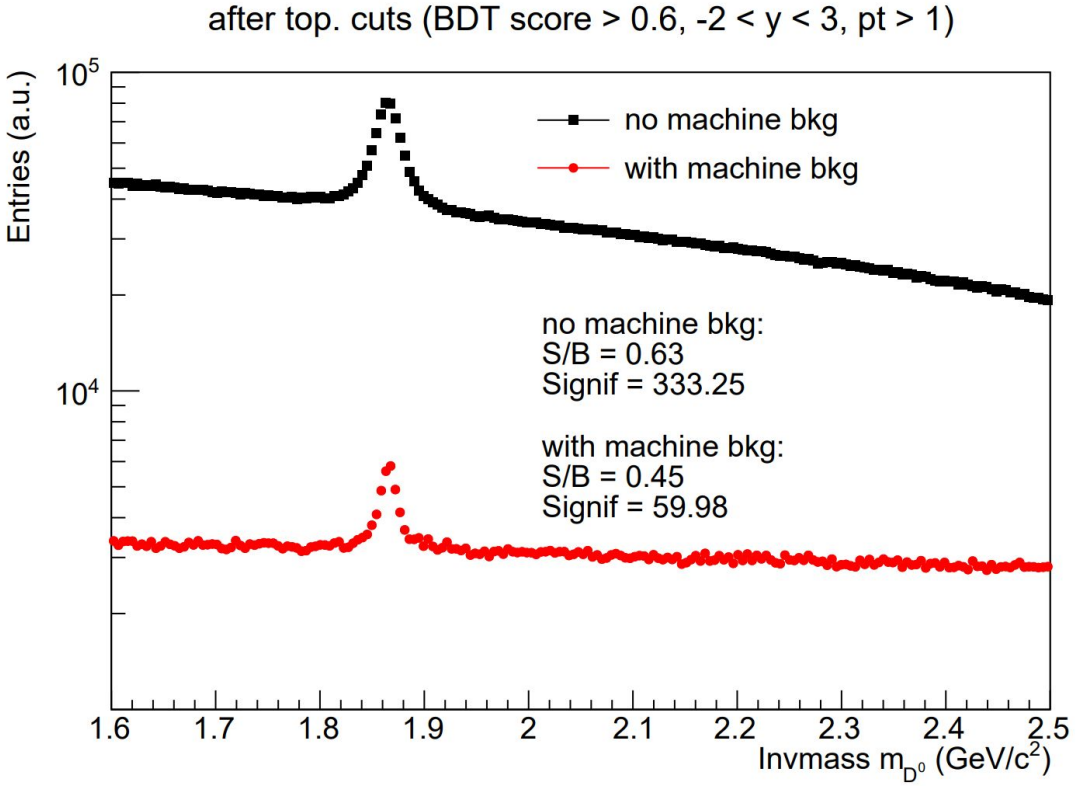
$$N^{\text{ML}}_{\text{resampled}} = N_{\text{resampled}} \times eff(\text{BDT} = 0.6)$$

Signal peak: 1.84 < Invmass < 1.89

$$\text{S/B} = N^{\text{sig}}_{\text{resampled}} / N^{\text{bkg}}_{\text{resampled}}$$

$$\text{Signif} = N^{\text{sig}}_{\text{resampled}} / \sqrt{N^{\text{sig}}_{\text{resampled}} + N^{\text{bkg}}_{\text{resampled}}}$$

With vs. without machine background, after top. cuts



Reduction in S/B and Signif with machine bkg.