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ML FOR NUCLEON ID IN THE CENTRAL DETECTOR

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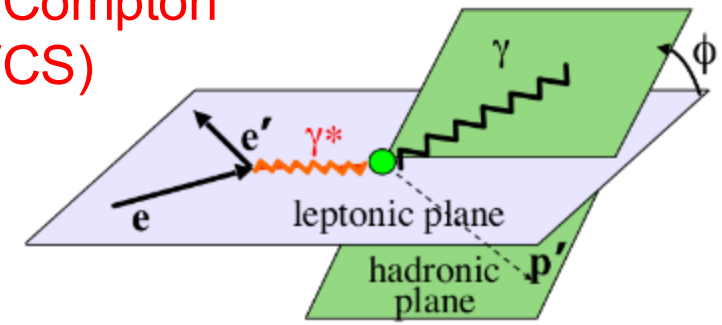
CONTEXT

Deeply Virtual Compton Scattering (DVCS)

$ep \rightarrow e'p'\gamma$



Protons: Identified as hits in the CTOF with associated CVT tracks

Neutrons: Identified as hits in the CTOF and CND with no associated CVT tracks

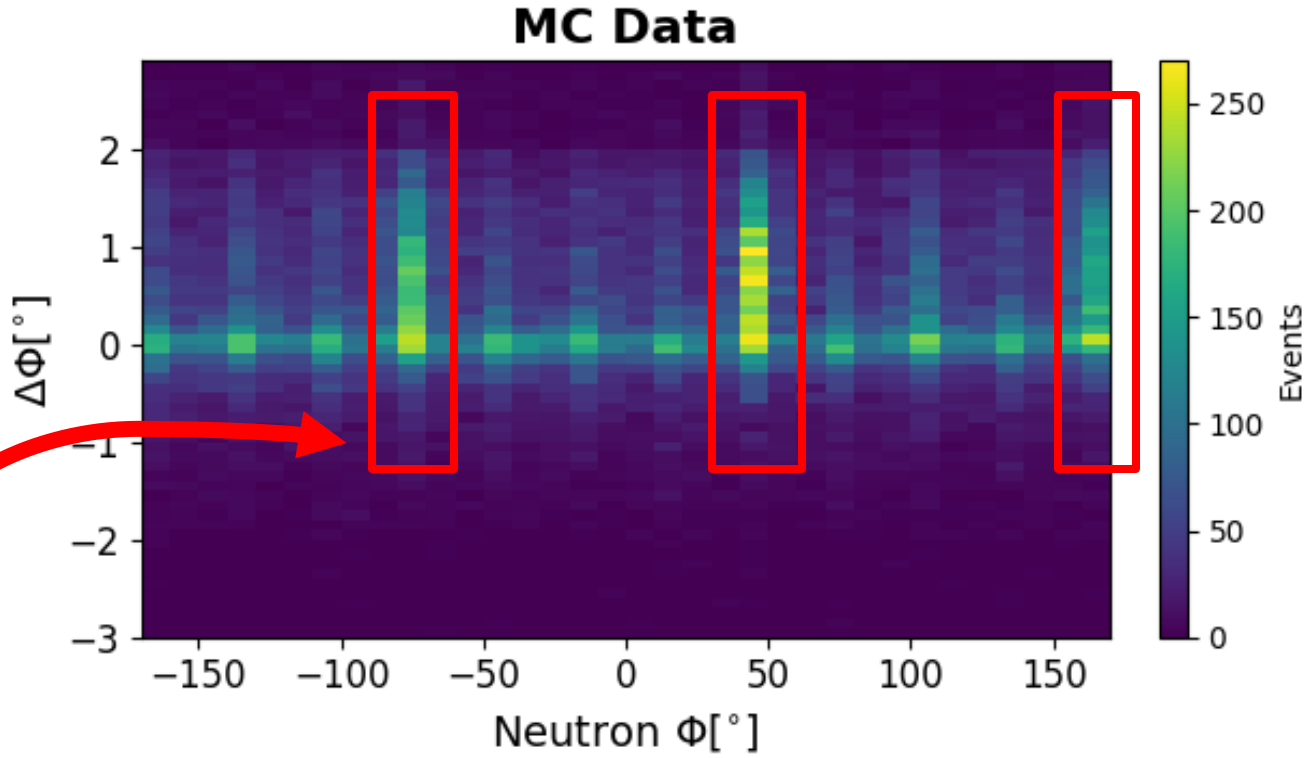
In low efficiency zones in CVT:

- proton tracks are missed

- protons are misidentified as neutrons and assigned a straight tracks

OBJECTIVE: use **detector-level information** to better classify neutrons (signal) and protons (background)!

Regions where momentum is not conserved in $en \rightarrow en\gamma$ **(low eff zones)**



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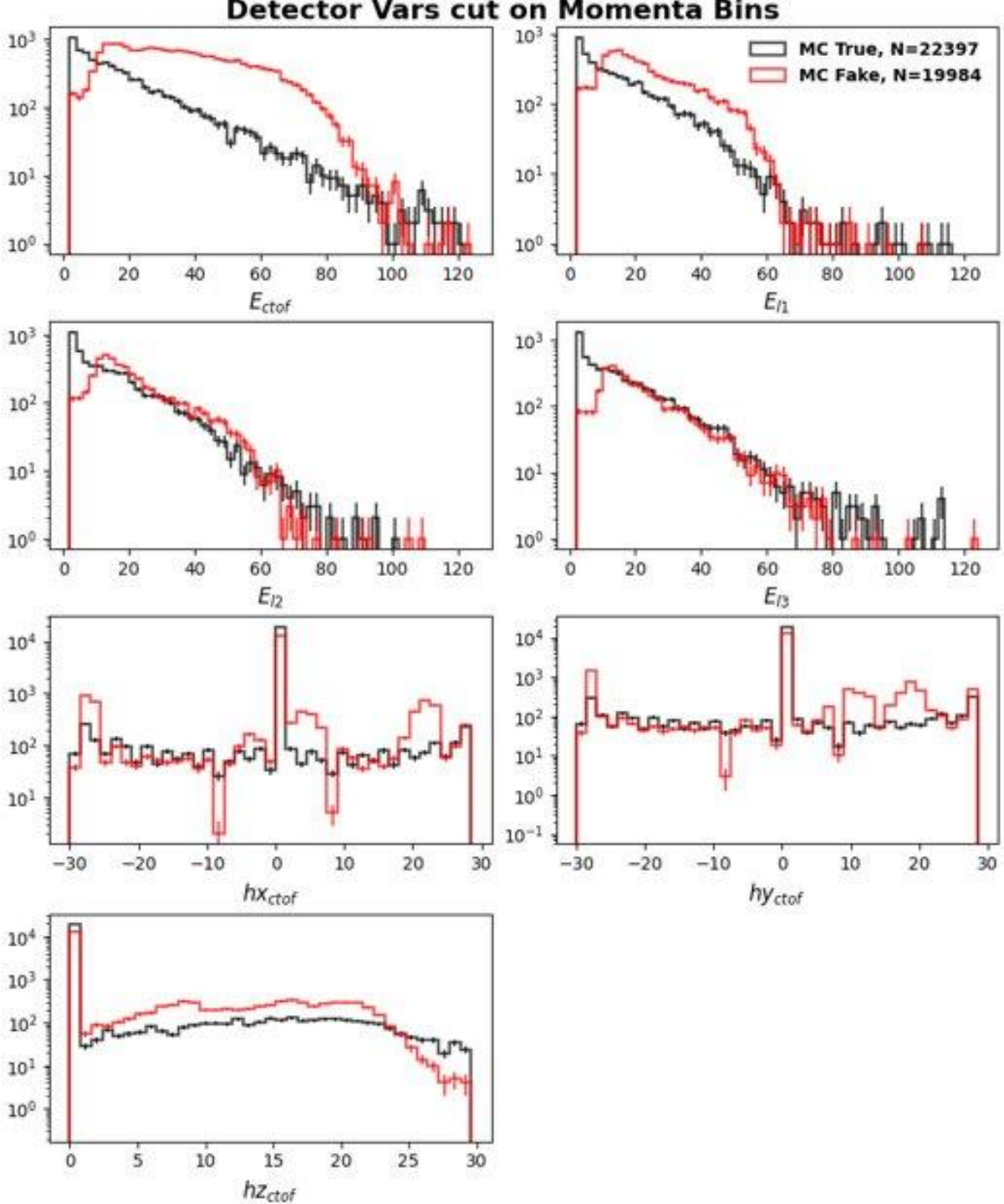
DATASET & TRAINING VARIABLES

- **MC – ND3 target** (any neutrons simulated from both pdvcs and ndvcs events)
  - Used for training
  - **True**: neutrons from generated neutron (**en -> eny**)
  - **Fake**: neutrons from generated proton (**ep -> eny**)
- **Training Vars**:
  - Energy deposition variables
  - Cluster distance from straight track



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MODELS

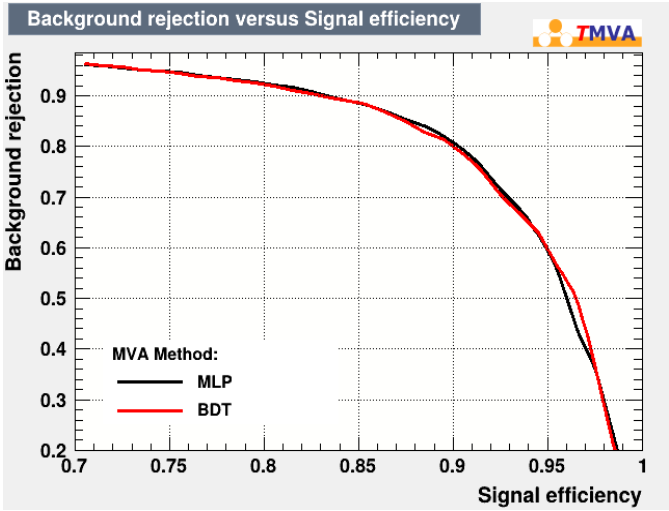
Software: ROOT TMVA

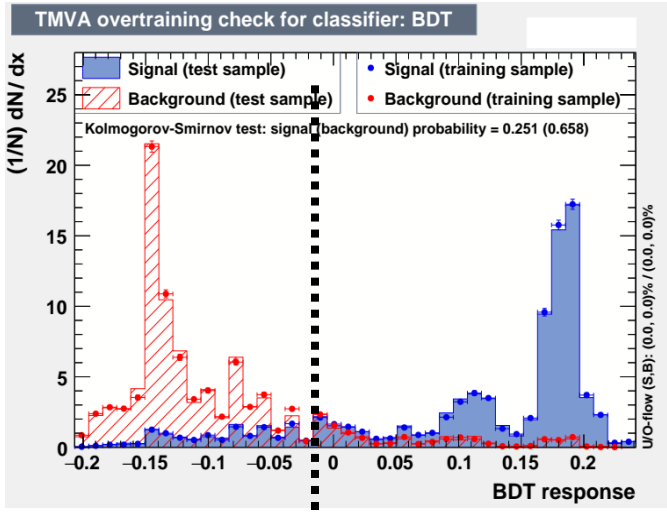
- Multilayer perceptron (MLP) and adaptive BDT were trained
- **MLP** →AUC = **0.927**
- **BDT** →AUC = **0.926**
- The models perform similarly! **BDT was chosen because it was 20x faster than MLP on my desktop and has a simpler structure to visualize.**

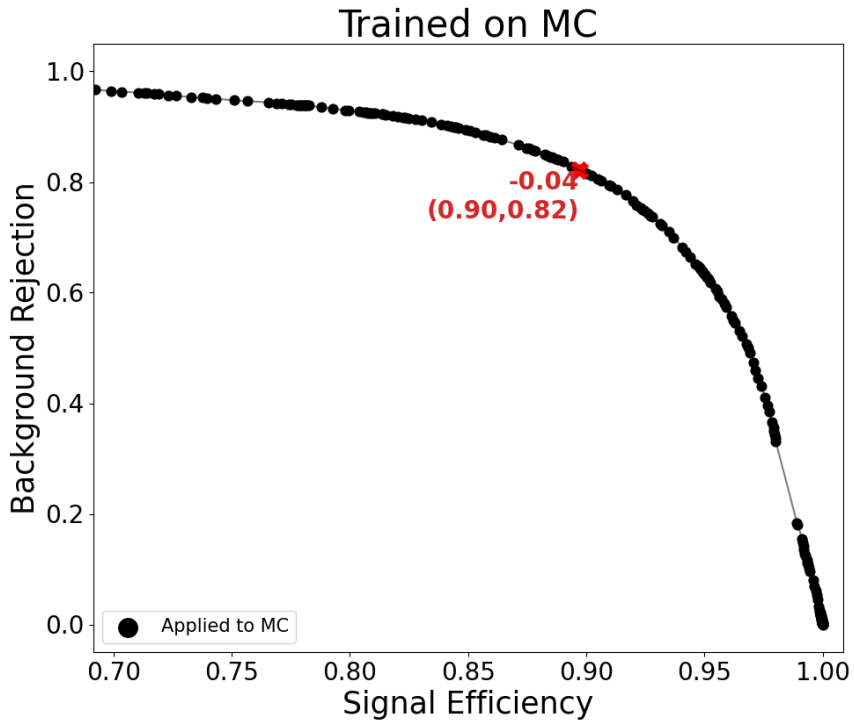
NEXT: a cut was chosen on BDT response

What is the cut criteria? In the context of **DVCS** studies which have low statistics and methods of removing remaining background, **high signal efficiency is preferred.**

Selected Cut: BDT Response = -0.04
signal efficiency = 90%
background rejection = 82%







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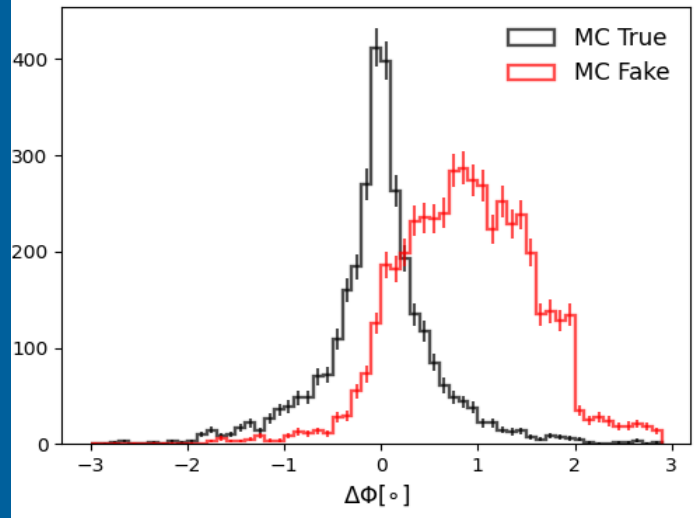
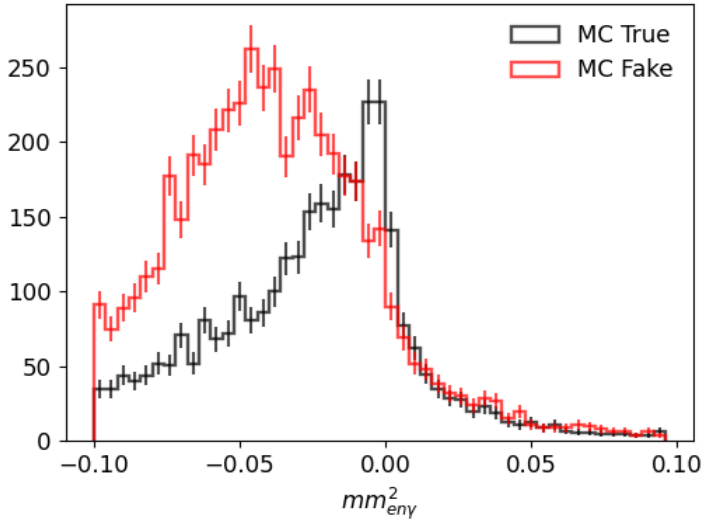
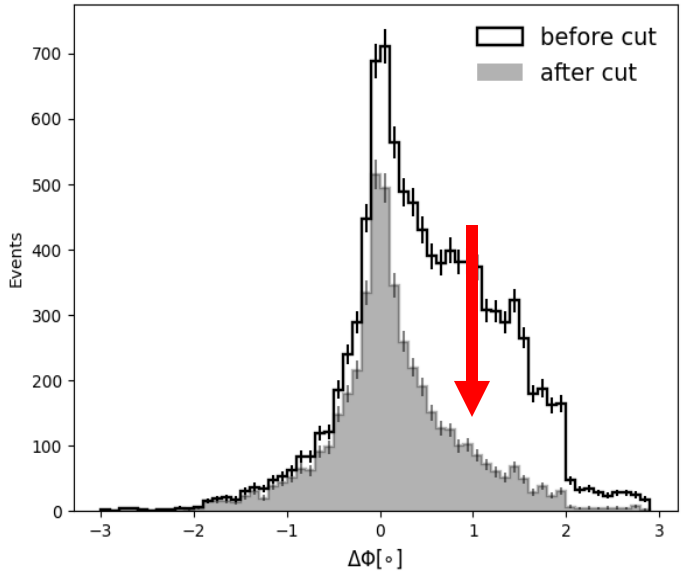
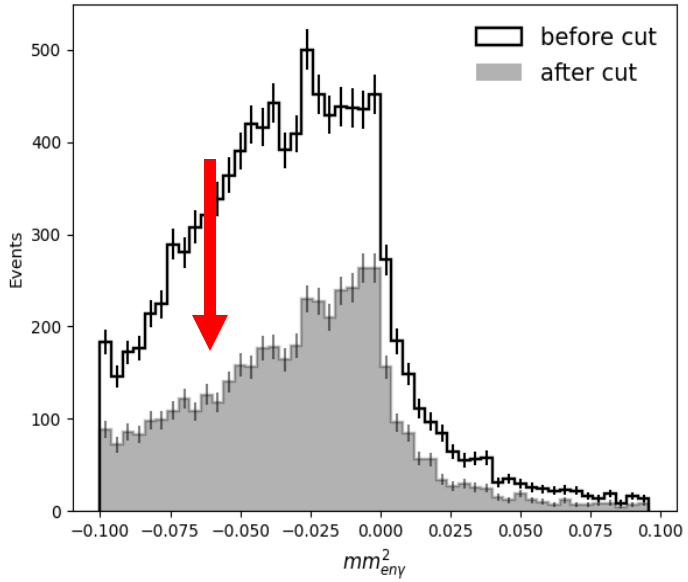
CUT APPLICATION

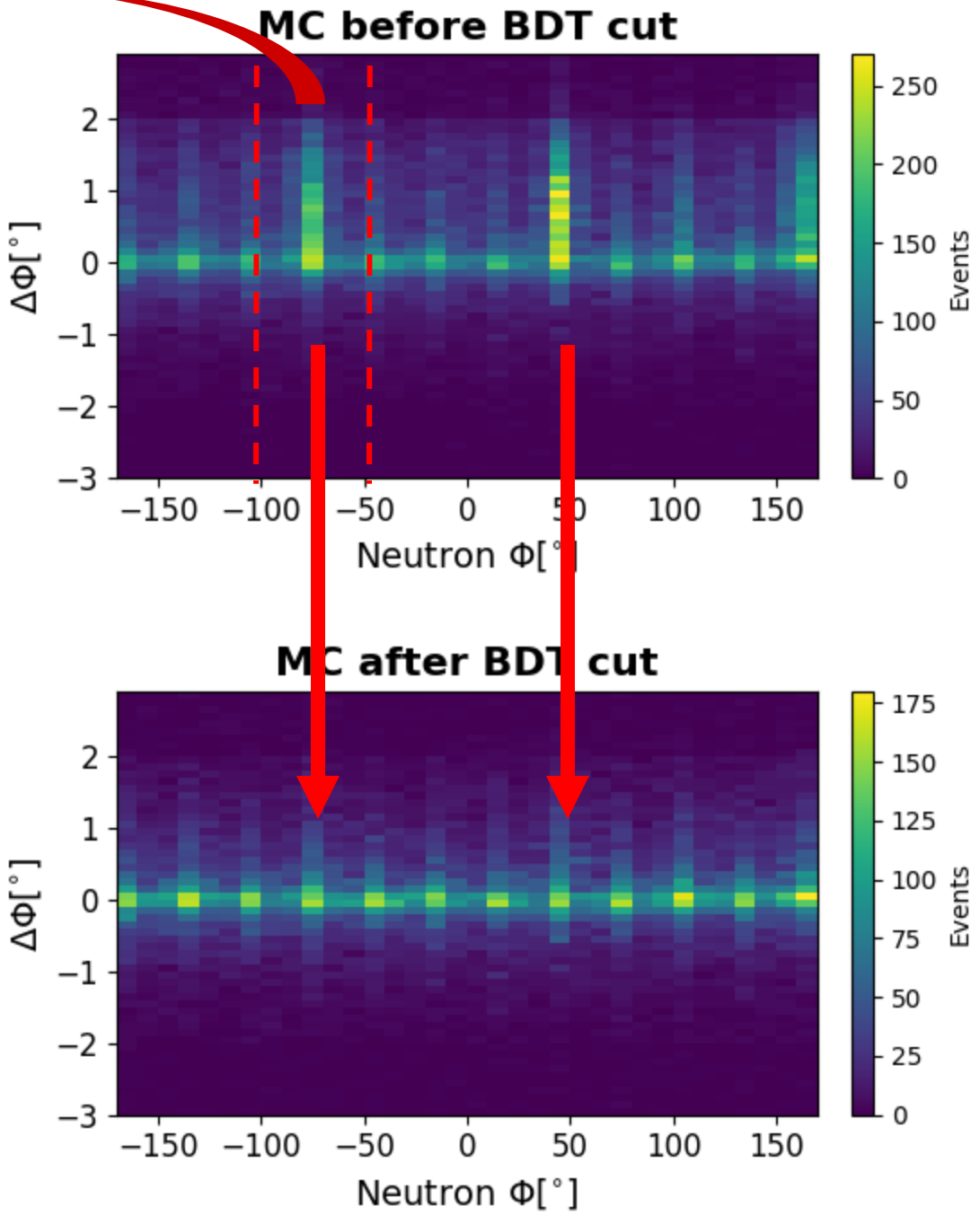
Low Efficiency Zones











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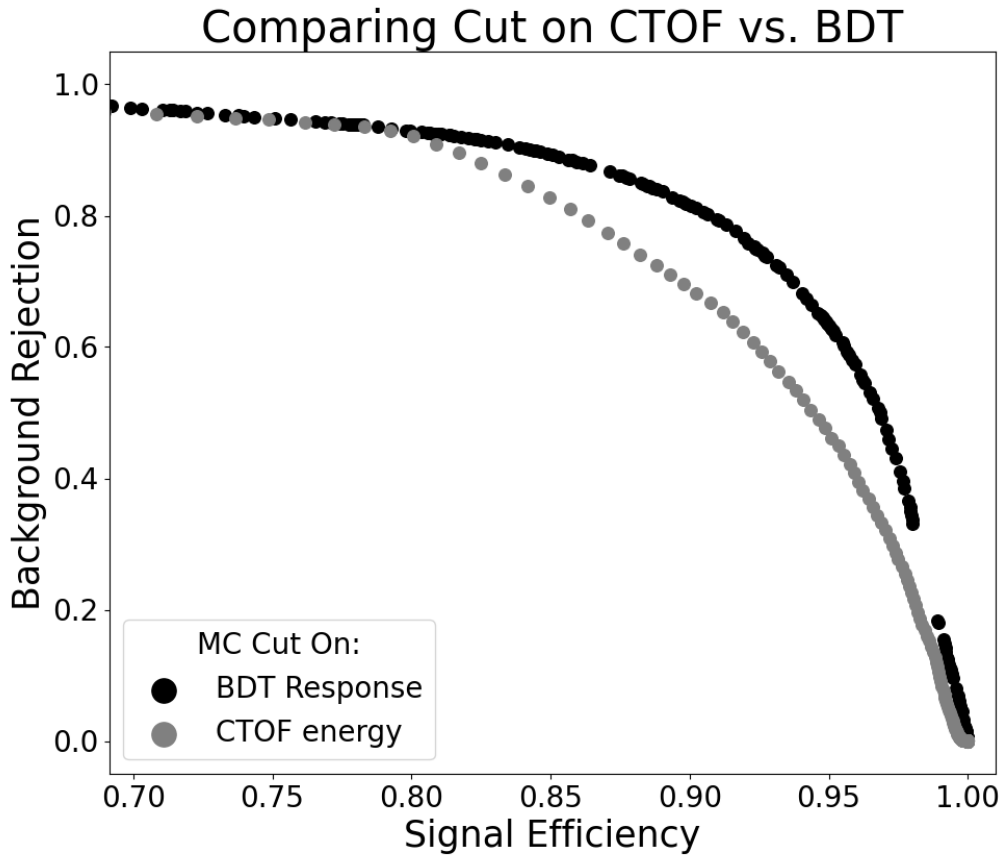
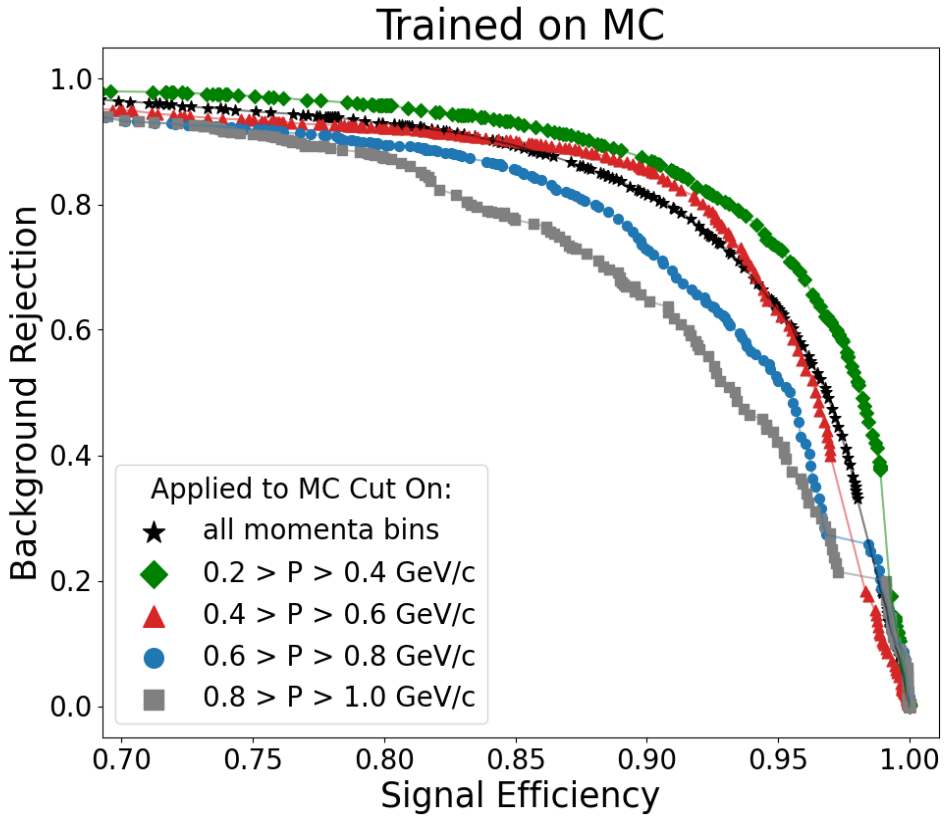
PERFORMANCE & APPLICATION TO MOMENTA BINS





- **Momenta Binning -** At high momentum, protons move quickly through the CVT and have straight tracks which make them hard to distinguish from neutrons in the detectors
  - Applying training to high and low momenta bins can show us how we can adjust training in future tests

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SUMMARY

- **Generic Problem:** Protons get misidentified as neutrons in the CD
  - Low efficiency zones in CVT
- **Specific Example:** Deeply Virtual Compton Scattering (ndvcs and pdvcs)
  - Trained BDT on MC with ND3 target for the purpose of cleaning up neutron data contaminated by misidentified protons
  - BDT response cut was made preserving high signal efficiency (~90%)

- Applied BDT trained on MC to MC cut on low and high momenta bins
  - Shows an area of interest for adjustments to BDT training (can train on momenta bins & see performance)

THANK YOU!

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