$\Lambda_b \to J/\Psi\, p\, K$

Production Correction

Run2 {'16, '17, '18}

M. Ferrillo
UZH

Novelty

```
# Lb -> J/Psi p K
# L0 trigger requirement + enforced mu_P, mu_PT cut to get rid of L0 mis-modelling
sel = (( (rootdf['J_psi_1S_L0MuonDecision_TOS']==1) & (rootdf['muplus_P']>2000) & (rootdf['muplus_PT']>2000)    )
      |( (rootdf['J_psi_1S_L0MuonDecision_TOS']==1) & (rootdf['muminus_P']>2000) & (rootdf['muminus_PT']>2000) ))
```

- Enforced a cut on mu_P, mu_PT $>$ 2 GeV
- Repeat the analysis chain for 2016, 2017, 2018
  - Run PIDCorr to retrieve PID vars correlations ({p, K}ProbNN, DLL)
  - Apply preselection
  - Build MC/Data samples for MVA to tackle MisID/comb bkg
  - Optimise hyperparams MVA
  - Train MVA. Post training checks on Lb_M correlation with MVA score
  - Apply MVA cut and design a MisID selection (cut on reflection backgrounds)
  - Pre-fit MC Lb_M to extract the shape parameters of signal (extended unbinned ML fit with Double Crystal Ball)
  - Extended unbinned ML fit data Lb_M with DCB (sig) + exp (bkg)
  - Extract sWeights for signal Data
  - Calculate the Data/MC correction in bins of Lb_P, Lb_PT. Check pre-post correction distributions

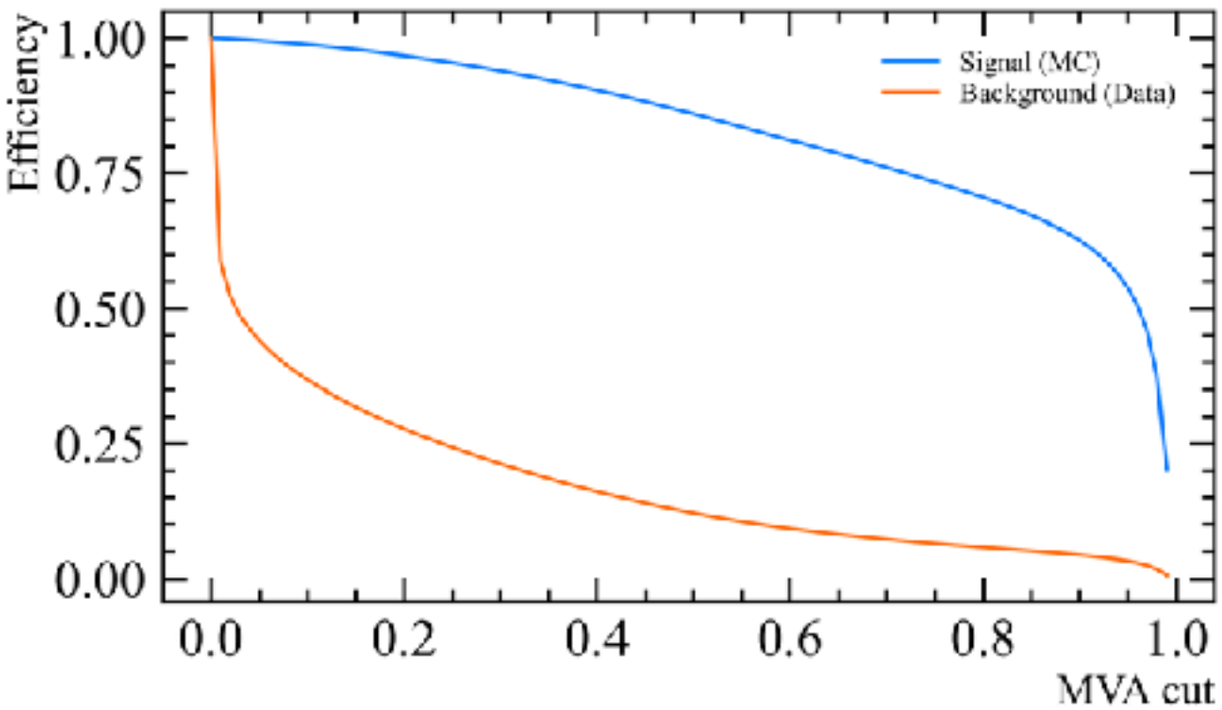
MVA Training Set Variables

Taken from the Pentaquark analysis [PRL122(2019)222001]

- $K_{\mathrm{PT}} + p_{\mathrm{PT}}$
- $\ln p_{\mathrm{P}}$
- $\ln \mathrm{IPCHI2}_{\Lambda_b}$
- $\Lambda_b \,\mathrm{PT}$
- $\ln \mathrm{FD}_{\Lambda_b}$
- $\ln \mathrm{CHI2OWNPV}_{\Lambda_b}$
- $\ln(1 - \mathrm{DIRA}_{\Lambda_b})$
- $\ln \mathrm{MINIPCHI2}_{h}$
- $\min \mathrm{DLL}(\mu - \pi)$ - PIDCorr sampled
- $p_{\mathrm{probNN}p}$ - PIDCorr sampled
- $K_{\mathrm{probNN}K}$ - PIDCorr sampled

MVA CUT "OPTIMISATION"

2016

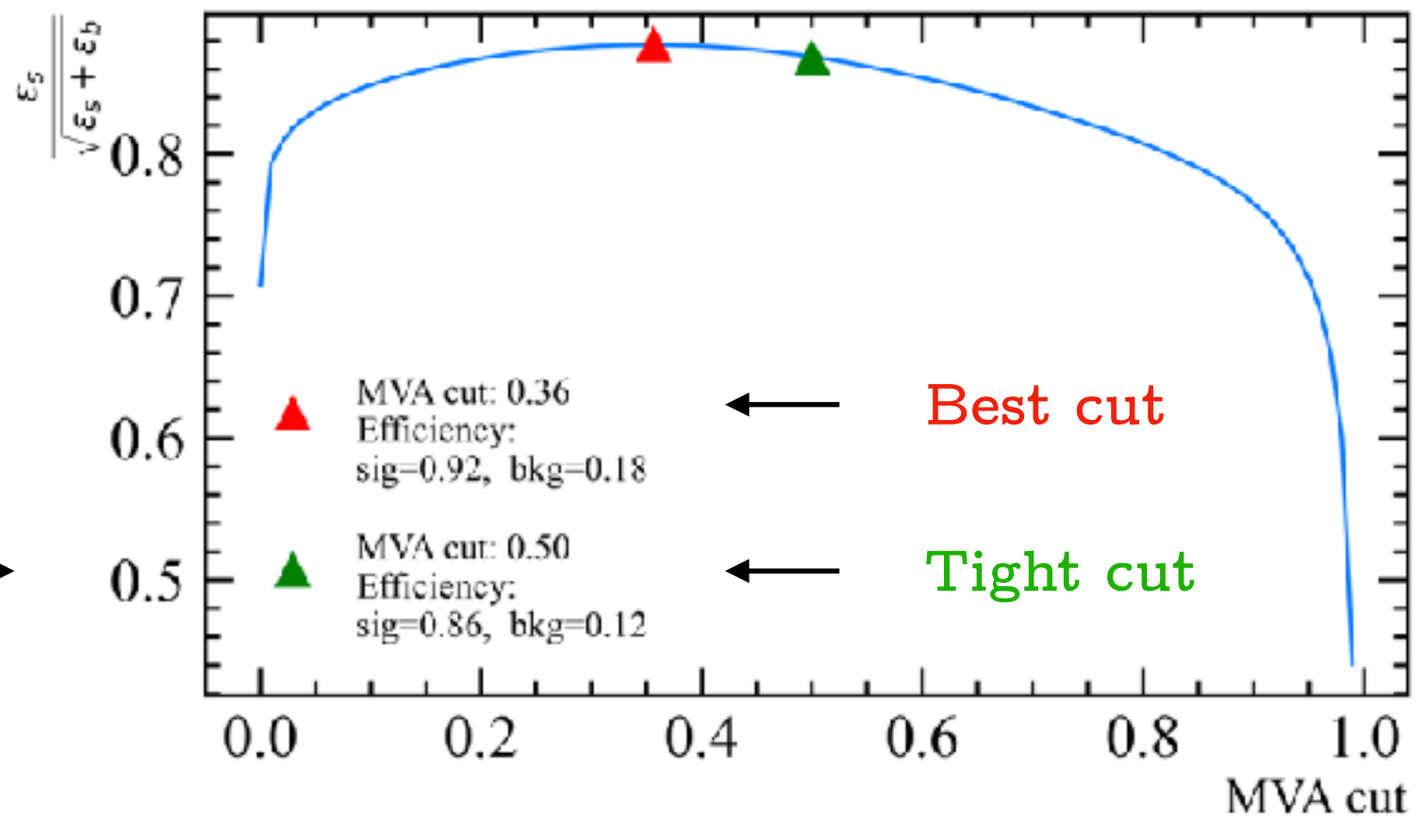


I have had a quick look at the efficiency curves. No fitting to extract the yields.

← **Signal**: peak region

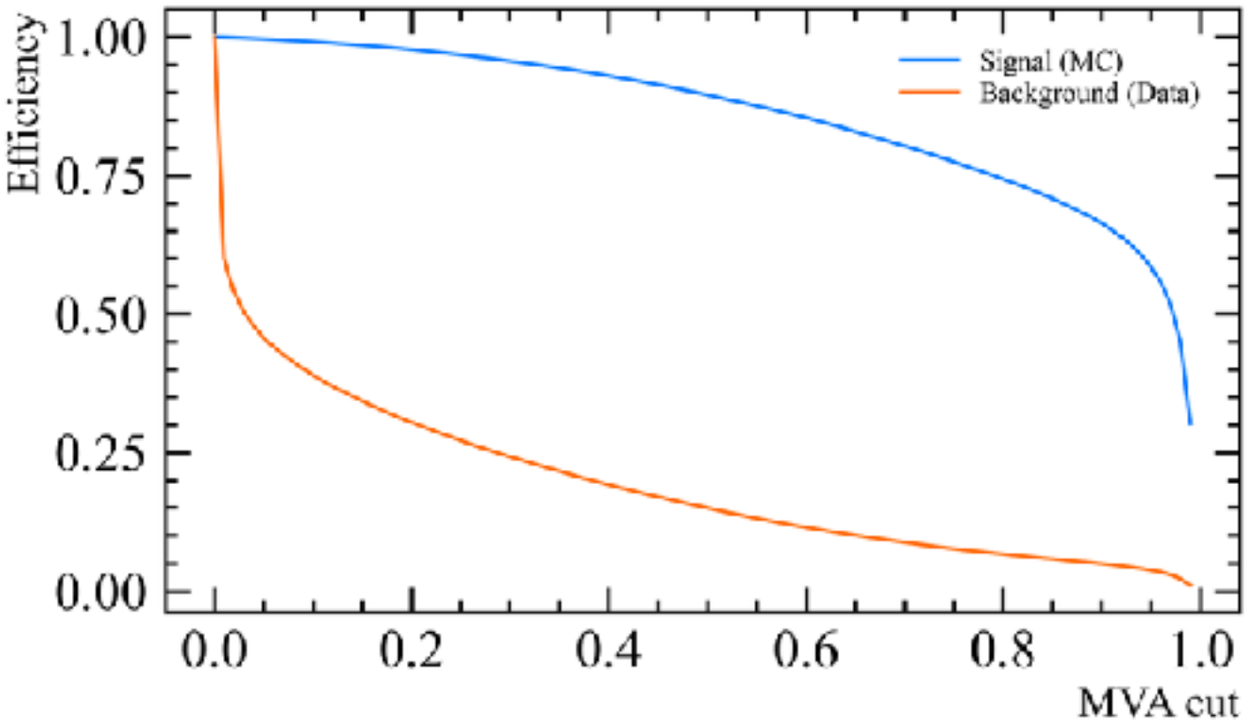
Background: lower and upper sidebands

Significance of the cut as efficiency ratios →



MVA CUT "OPTIMISATION"

2017



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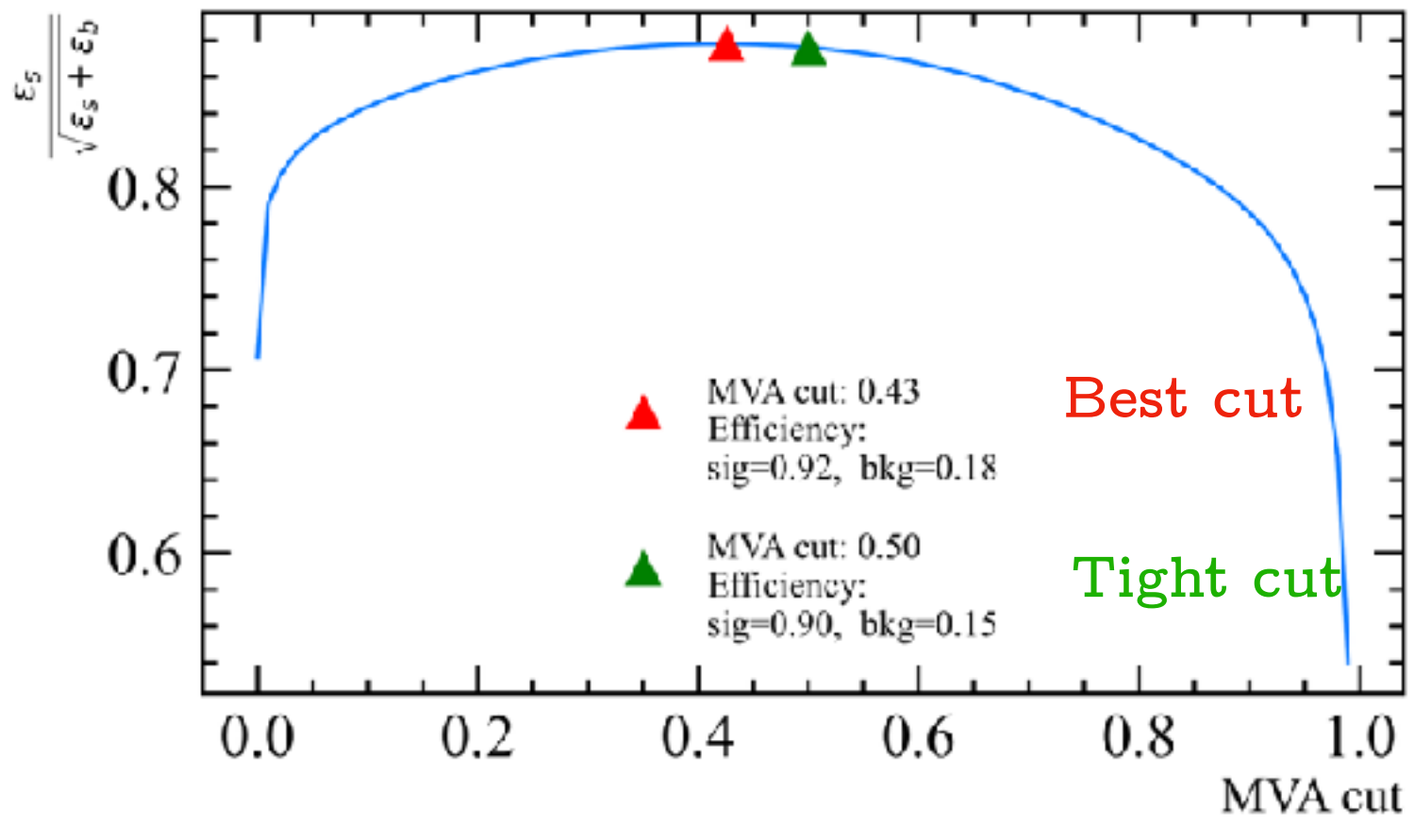
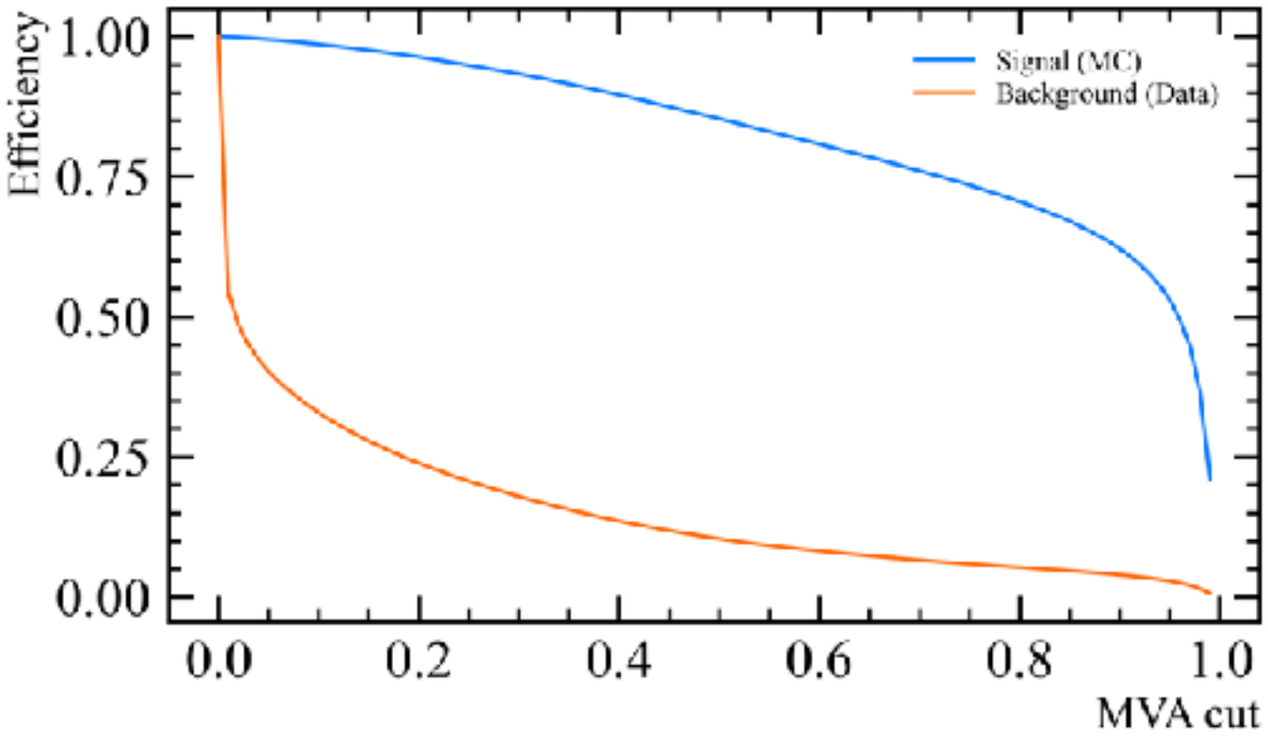
Significance of the cut as efficiency ratios →



MVA CUT "OPTIMISATION"

2018



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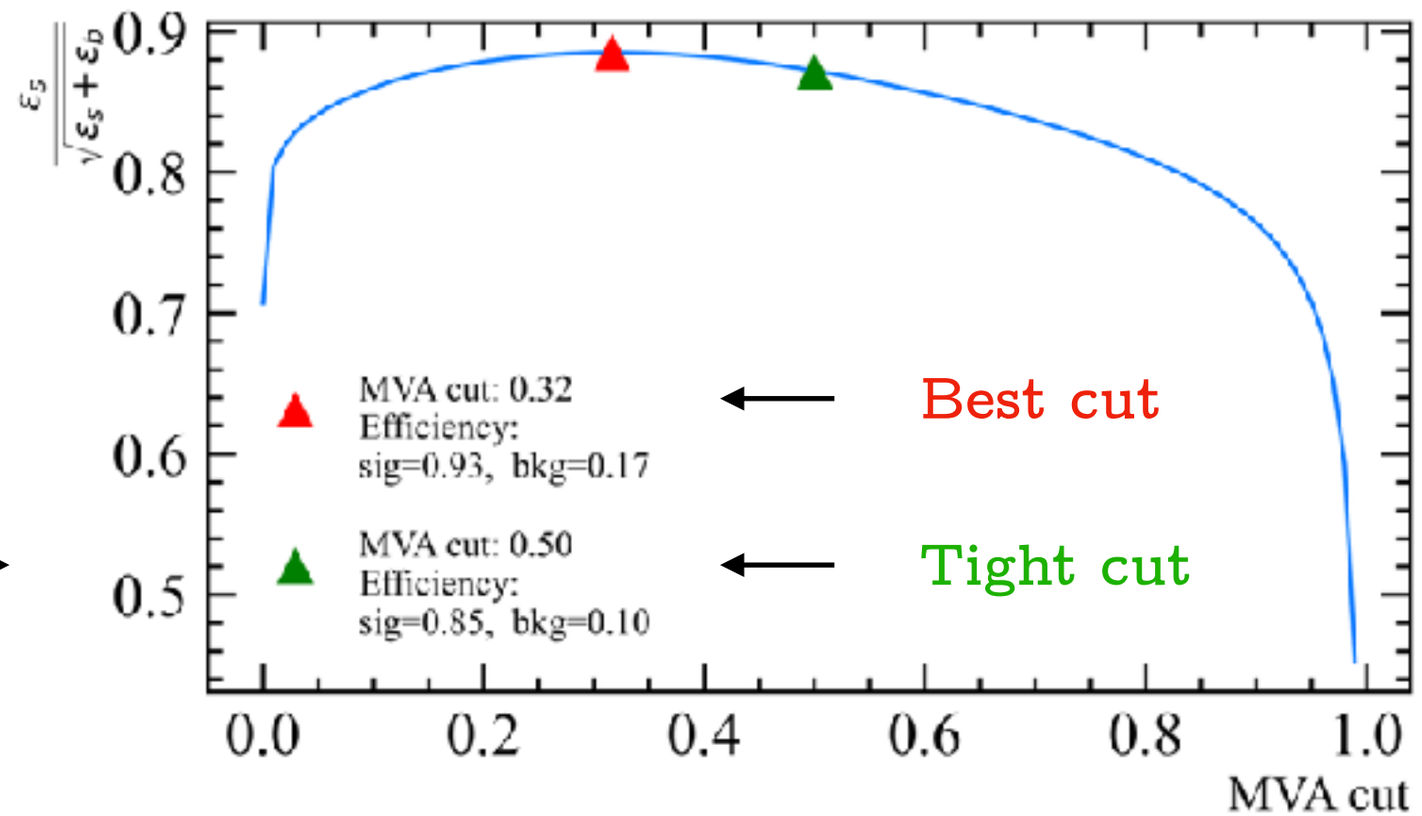
Background: lower and upper sidebands

Significance of the cut as efficiency ratios →



MisID Components

- The three main contributions to MisID of $\Lambda_b^0 \to J/\Psi\, p\, K^-$

  a) $\bar{B}_s^0 \to J/\Psi(\Phi \to K^+K^-)$

  b) $B^0 \to J/\Psi \pi^+ K^-$

  c) $\bar{\Lambda}_b^0 \to J/\Psi\, \bar{p}\, K^+$

I have checked the following:

- The **reconstructed mass** distribution in the replaced mass hypothesis for each MisID channel, **after** the MVA selection
  - Case I: MVA score $>$ best cut
  - Case II: MVA score > 0.50 (tighter cut)

- The **reconstructed Λ_b mass** after a $1\,\sigma, 2\,\sigma, 3\,\sigma$ Veto cut on the MisID reconstructed mass for each contribution ($\sigma = 20$ MeV):
  - Singularly (cut on a, b or c separately)
  - Combined cut

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why: probNN distributions show less contamination

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  - Singularly (cut on a, b or c separately)
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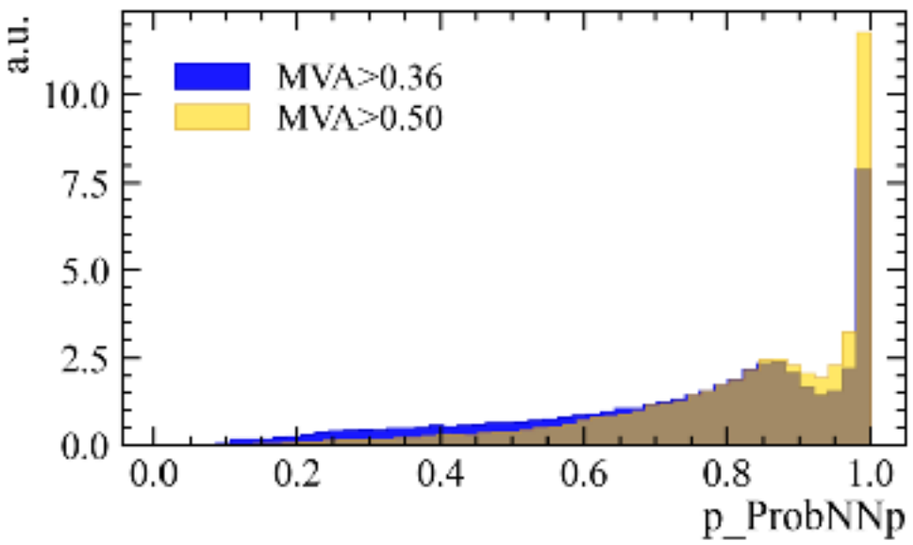
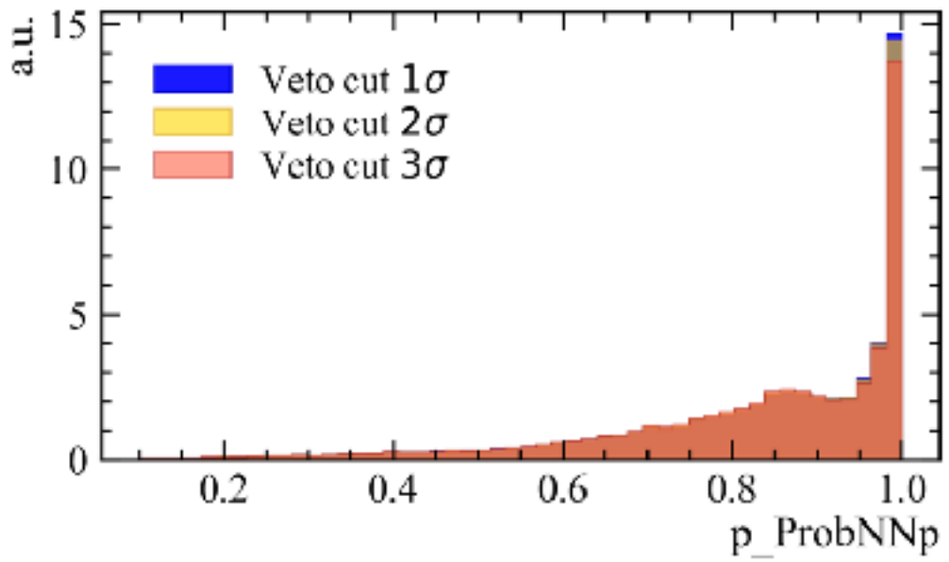
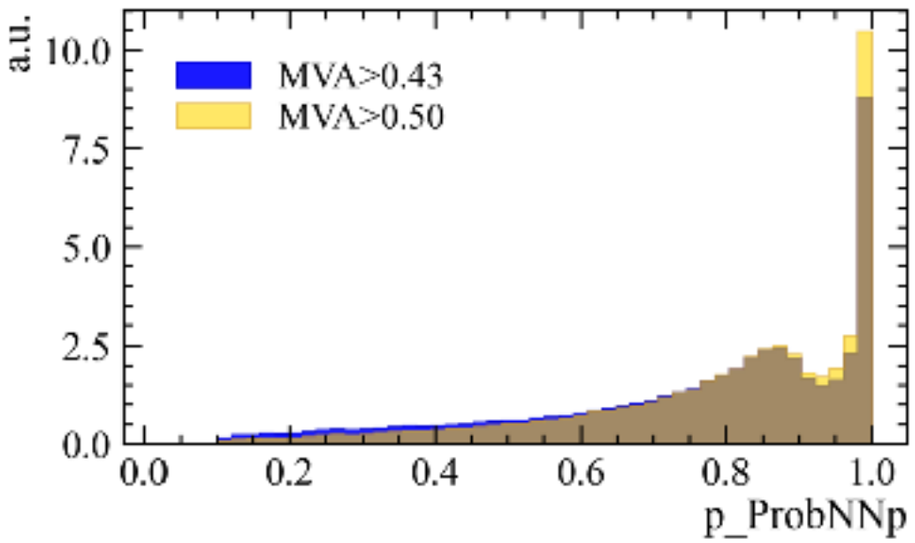
MisID Components: probNN

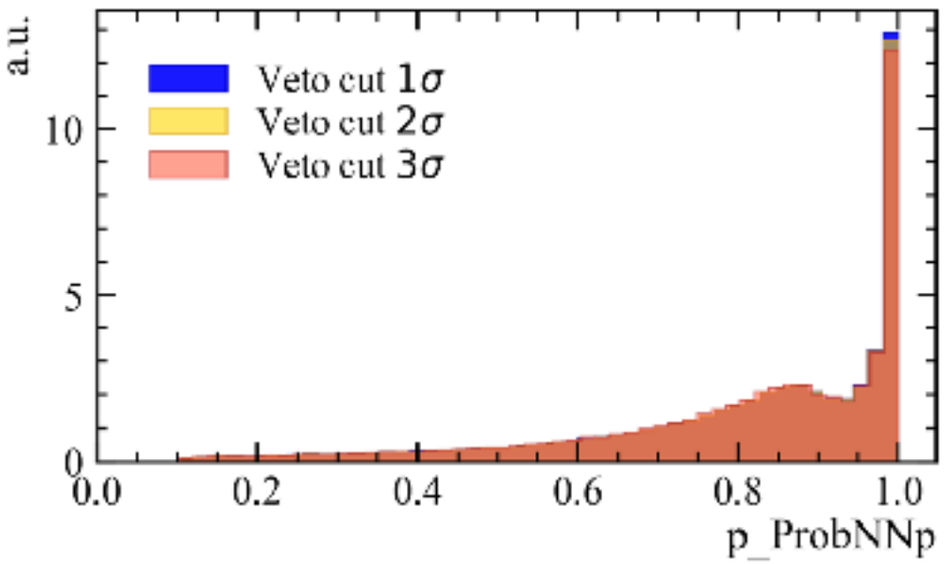


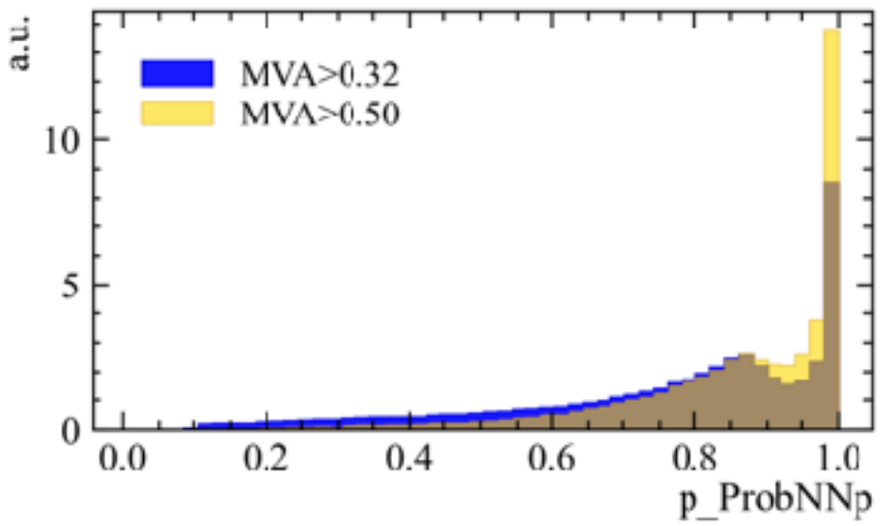
2016



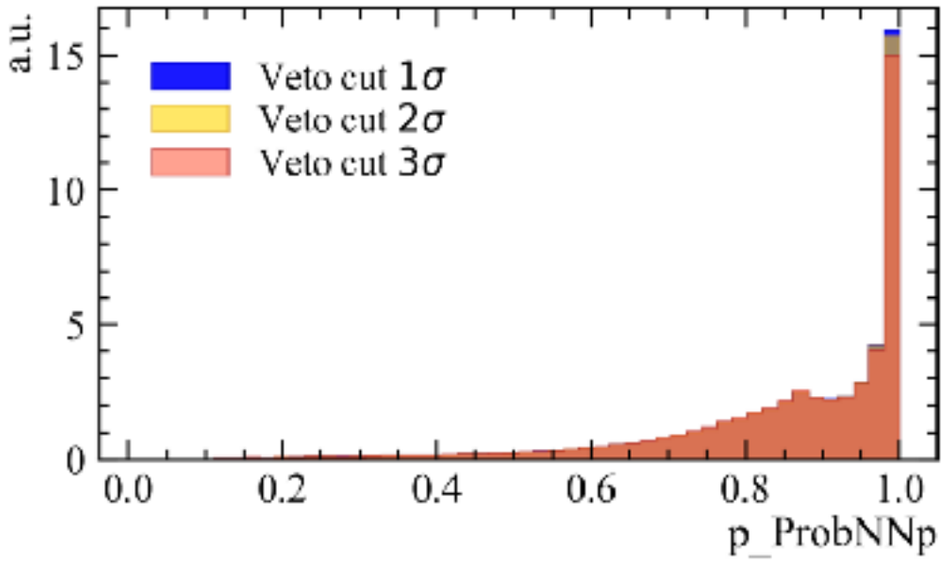


2017





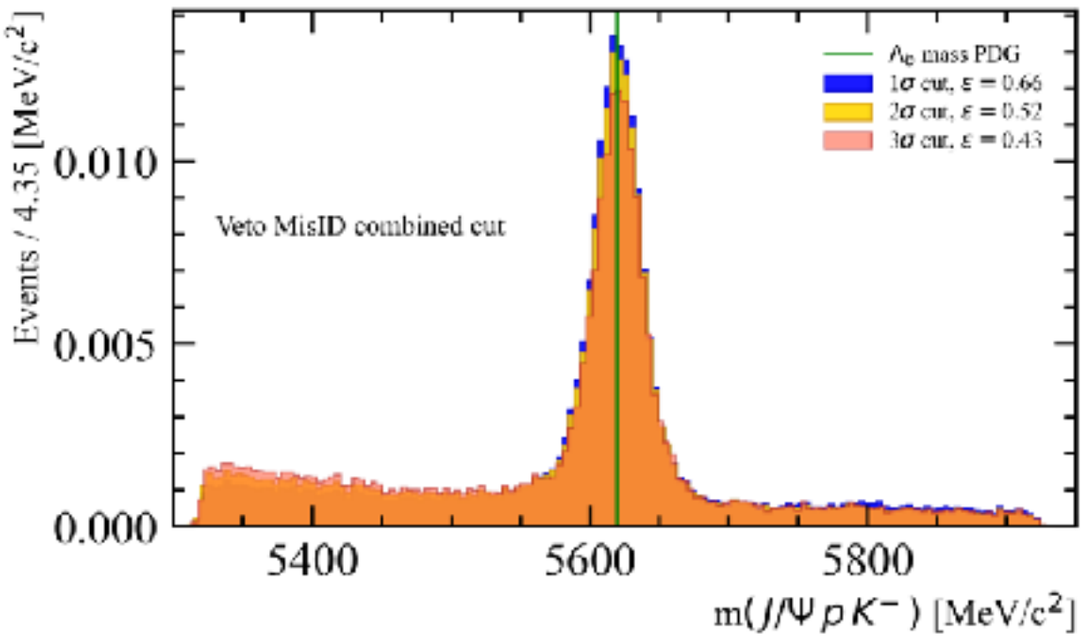
2018



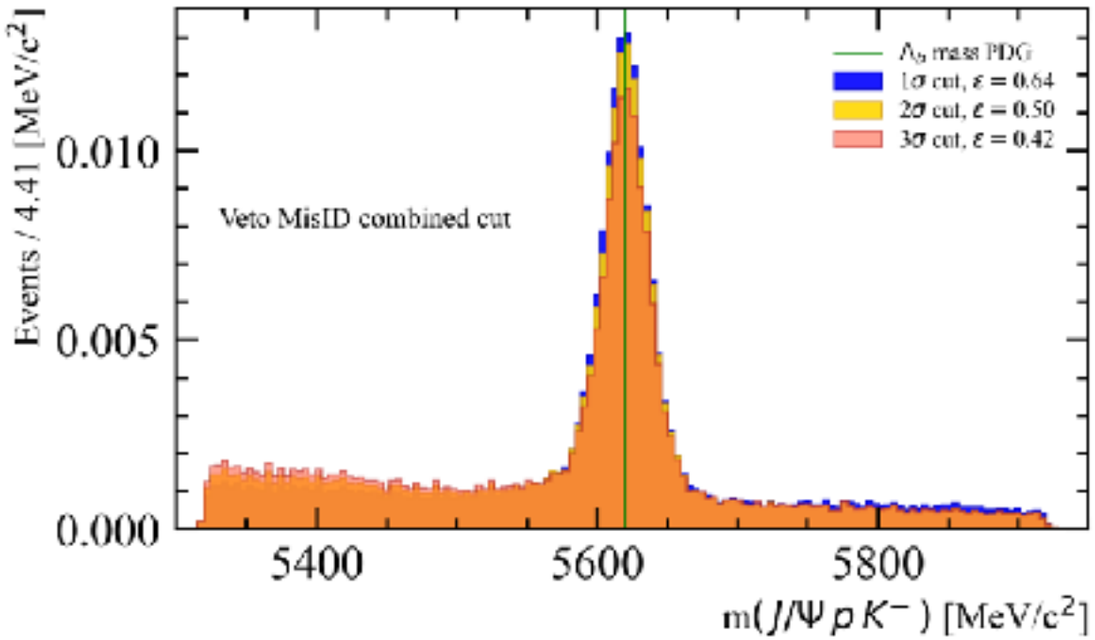
MisID Components

MVA>0.5

2016



2017



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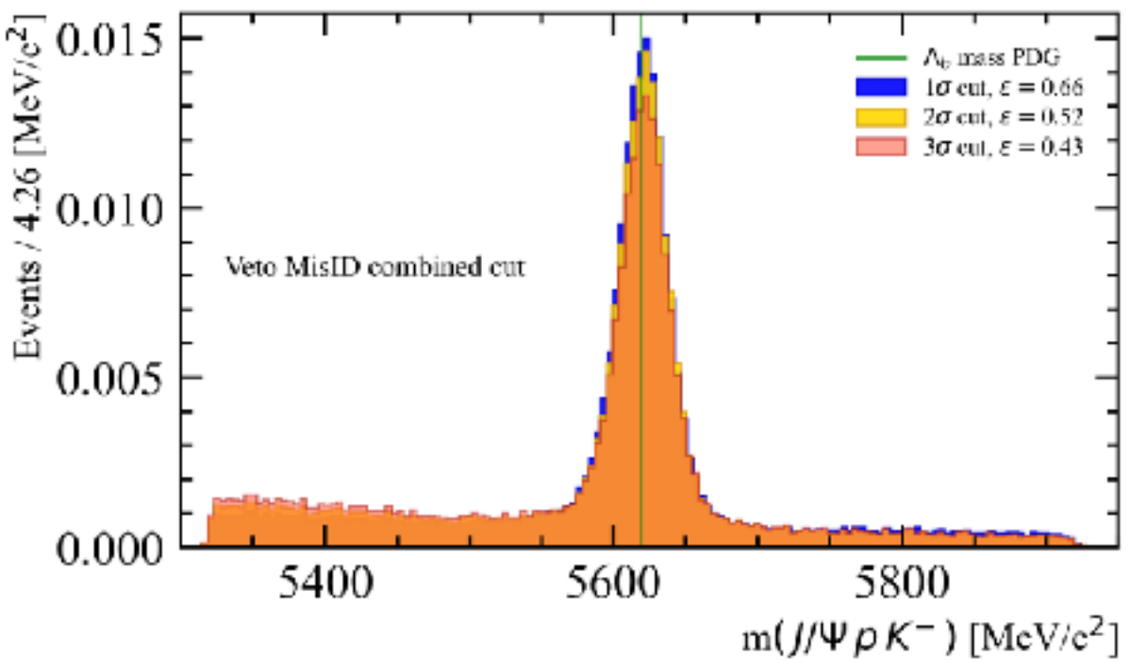
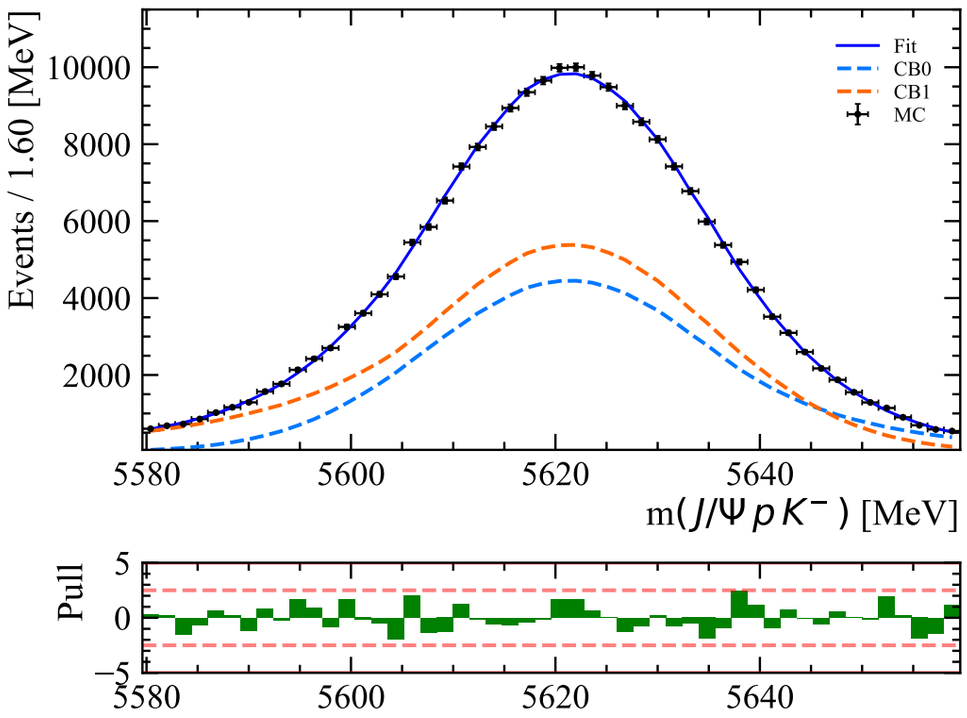
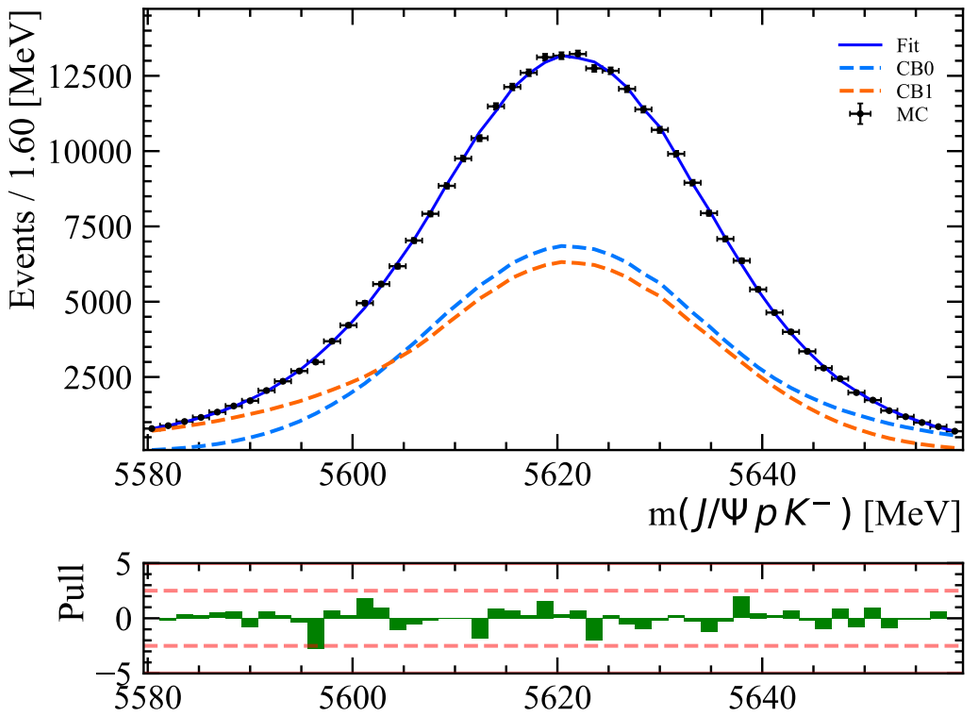


LbM fit (MC)

2016



2017



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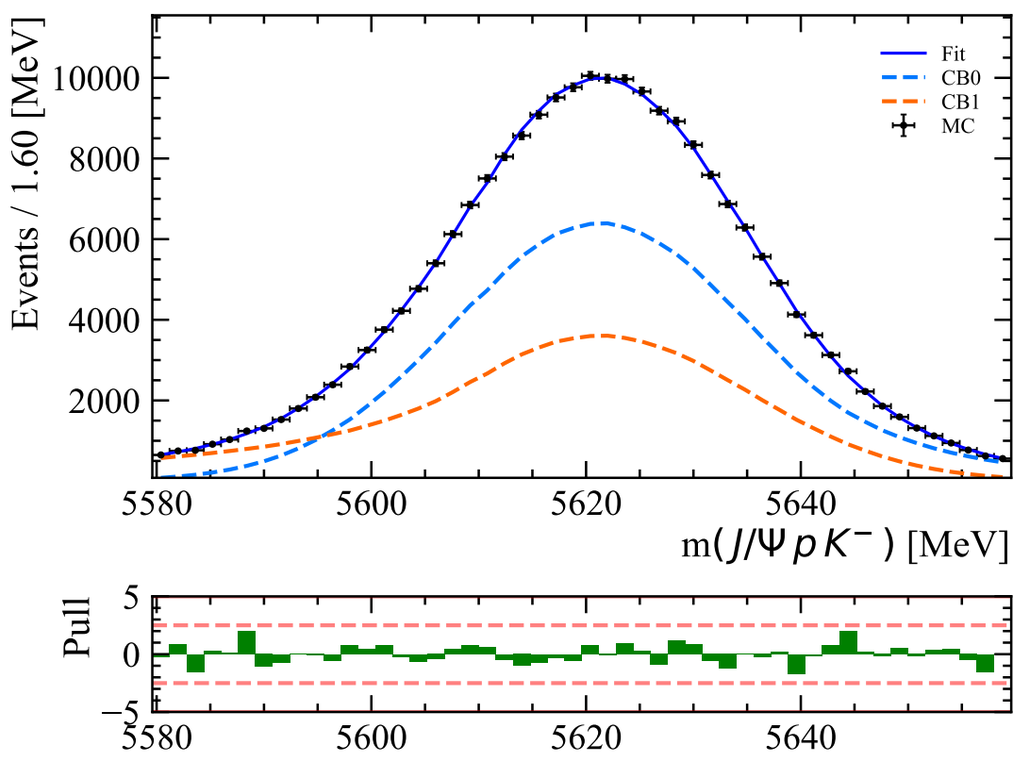
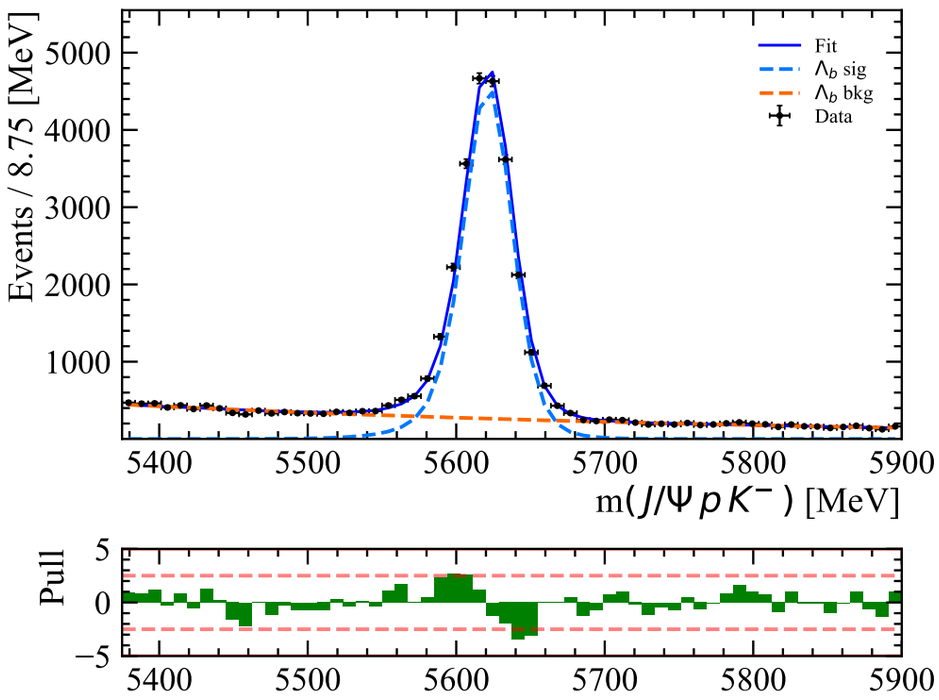
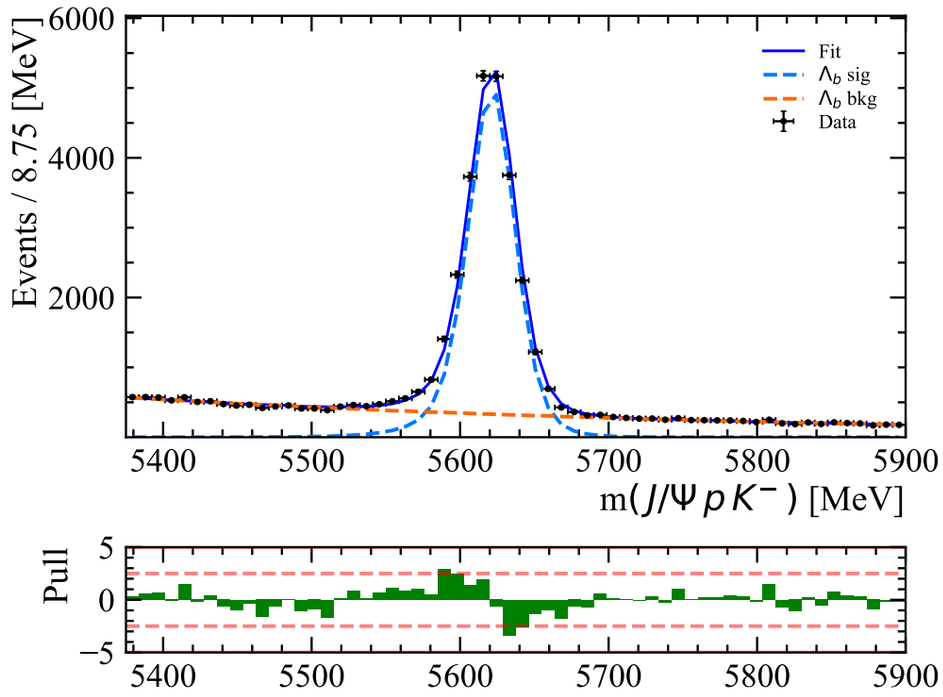


LbM fit (Data)

2016



2017



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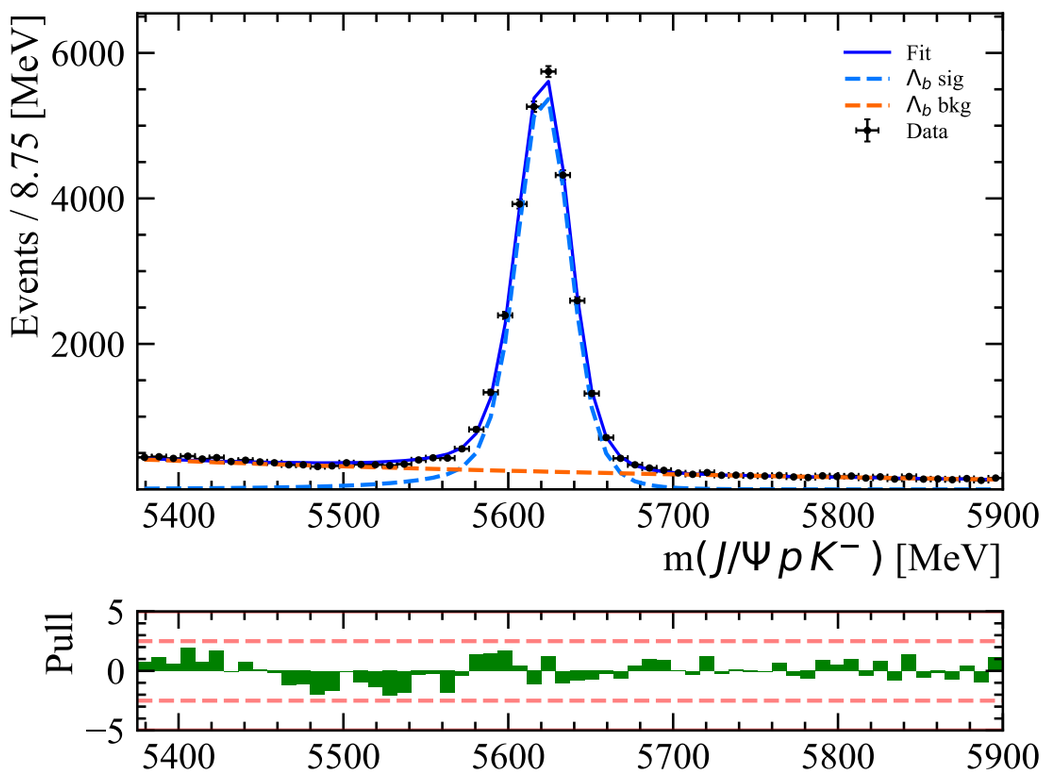


Evaluate the Correction: Strategy

- Option 1:
  - Define a **regular-sized binning** scheme (Nbins = 15*15 = 225);
  - Retrieve the corrections as the ratio of the normalised Data/MC 2D (Lb_P, Lb_PT) distributions;
  - Save to ROOT file;
  - Get the MC reweighed P and PT distributions and compare them to data.

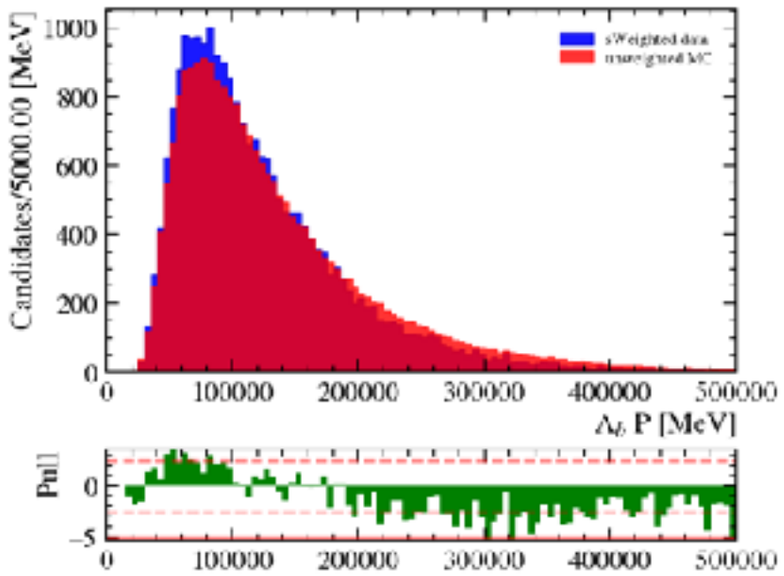
- Option 2:
  - Define a **rectangular binning** scheme (Nbins = 15*30 = 450);
  - Retrieve the corrections as the ratio of the normalised Data/MC 2D (Lb_P, Lb_PT) distributions;
  - Save to ROOT file;
  - Get the MC reweighed P and PT distributions and compare them to data.

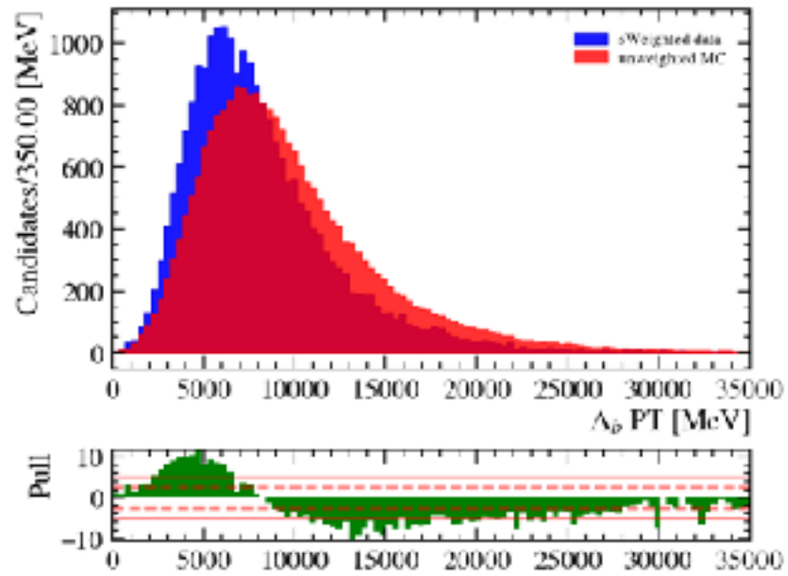
Strategy

- Option 3:
  - Define a **polygonal binning scheme** by optimising for the number of MC entries per bin (Nentries $= 10^3 \Rightarrow$ Nbins ~ 250);
  - Optimisation performed with a **KDTreeBinning** algorithm (ROOT);
  - The binning structure of MC is adopted also for Data. **TH2Poly** histograms are used;
  - Retrieve the corrections as the ratio of the normalised Data/MC 2D (`Lb_P`, `Lb_PT`) distributions;
  - Save to ROOT file;
  - Get the MC reweighed P and PT distributions and compare them to data.

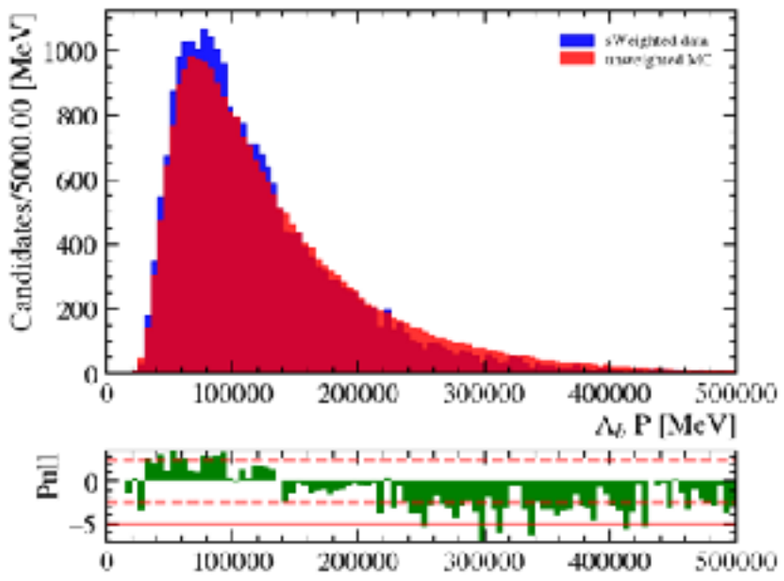
Pre-Correction Distributions

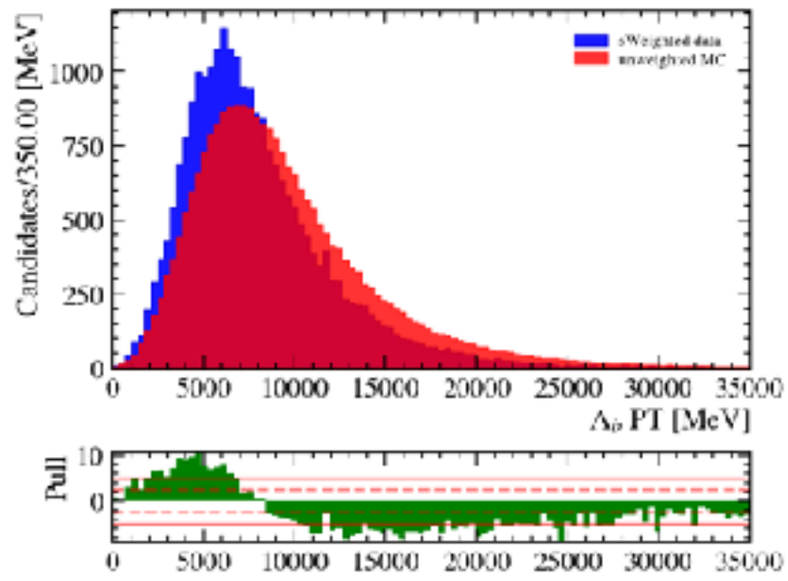
2016



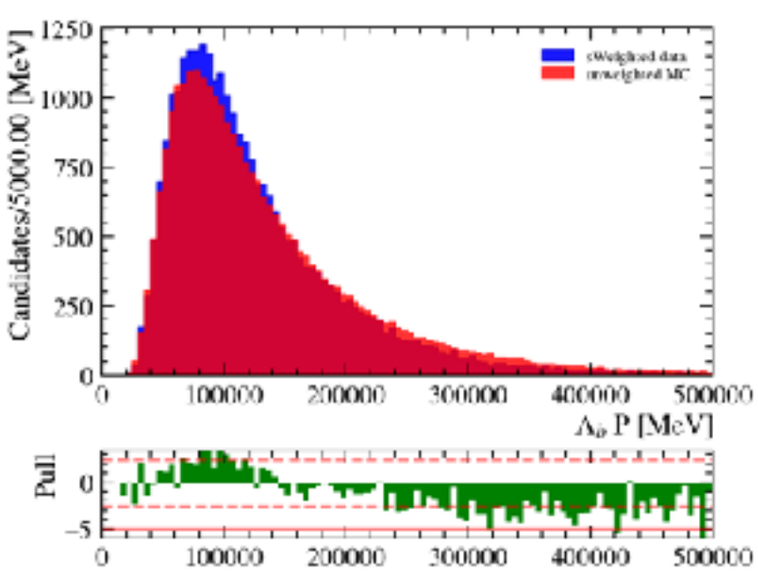


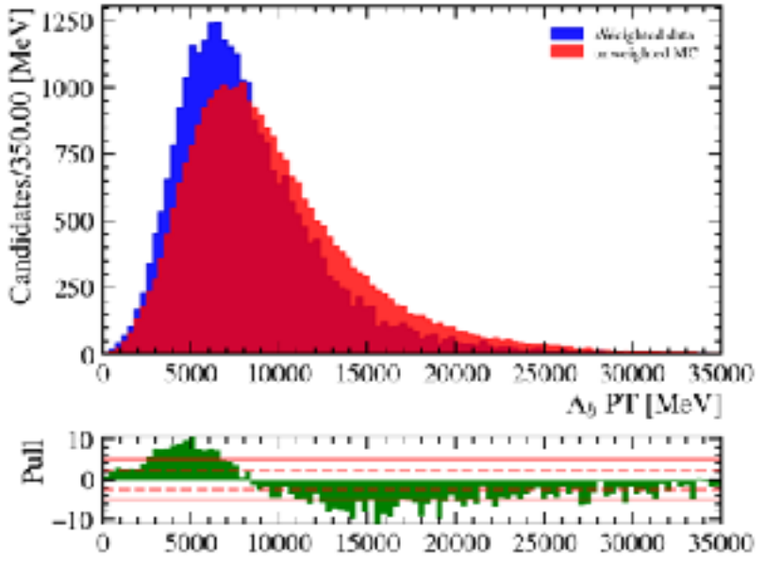
2017





2018

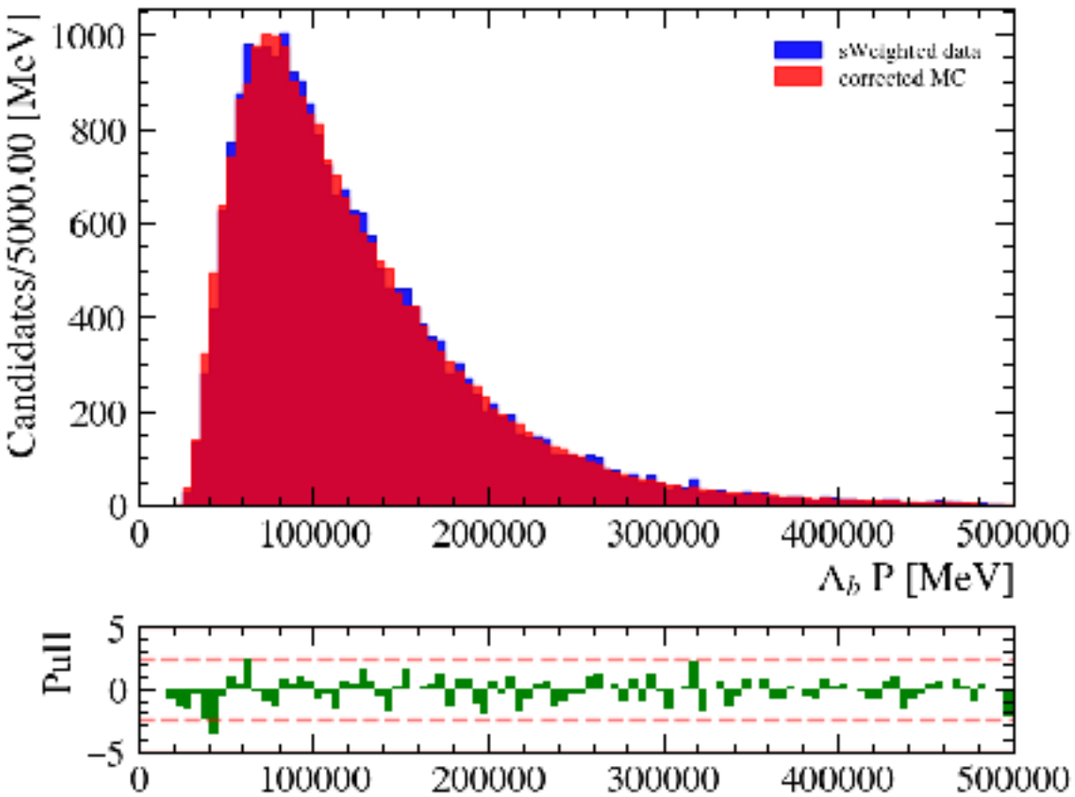


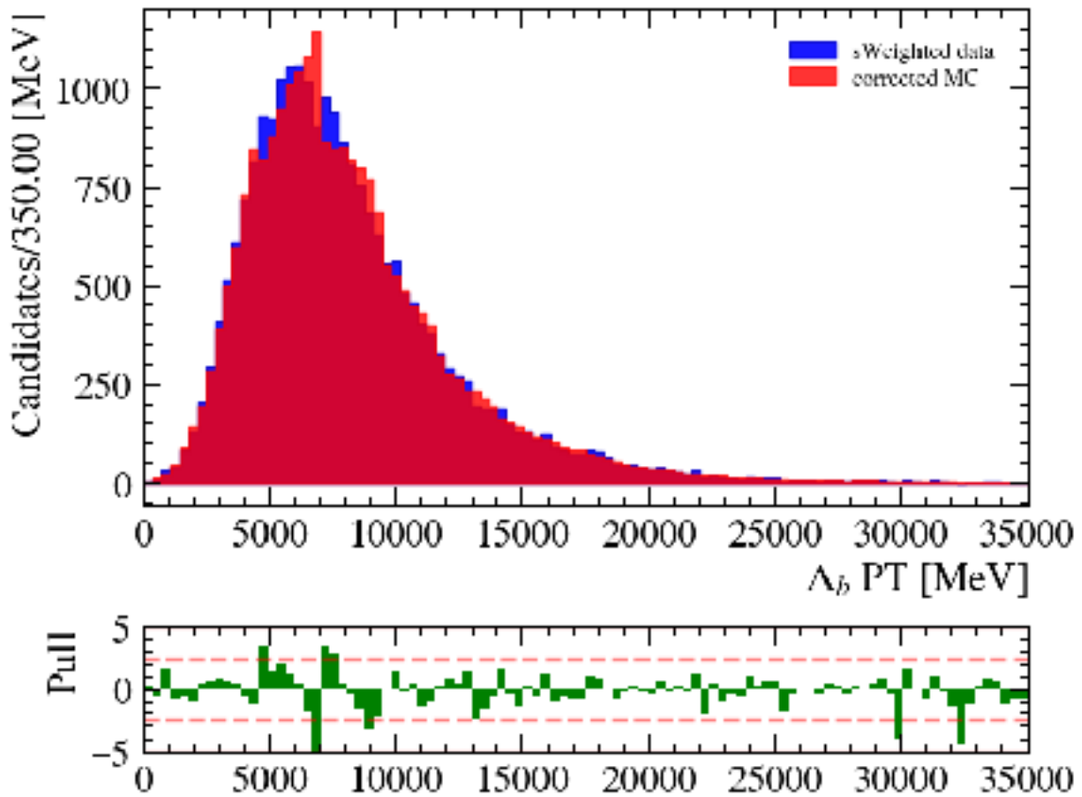


Option 1: Data/MC Comparison 2016

Regular Binning

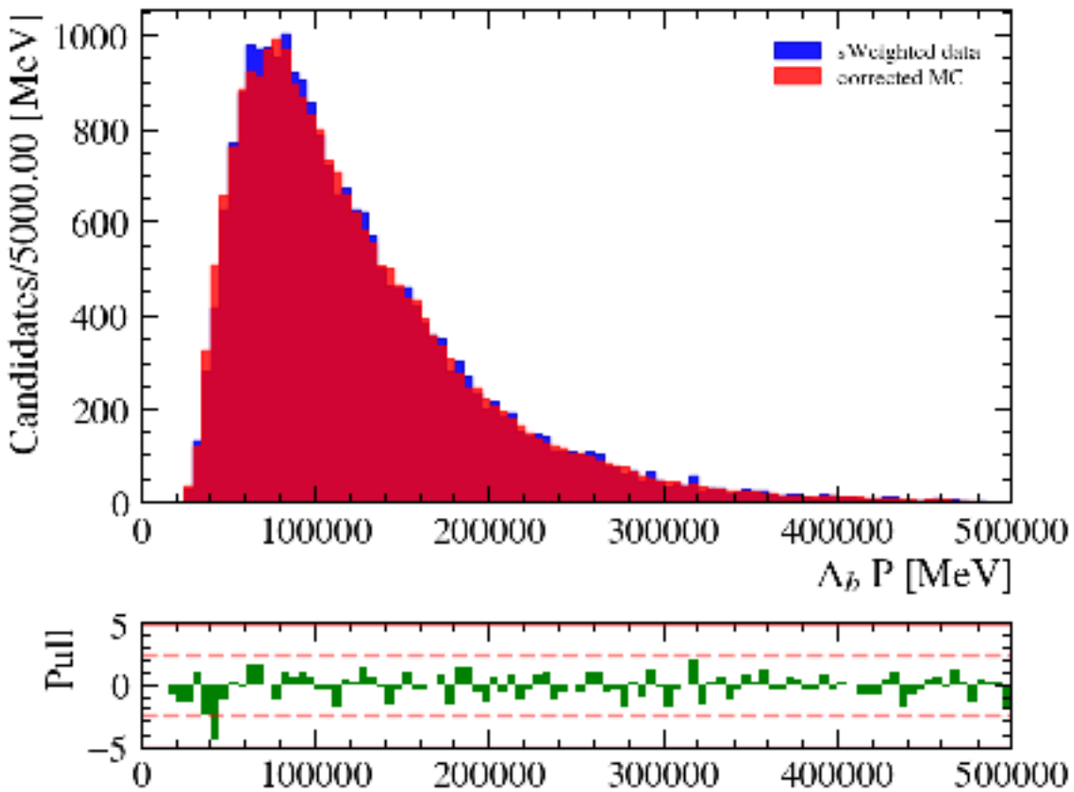
Post-Correction Distributions



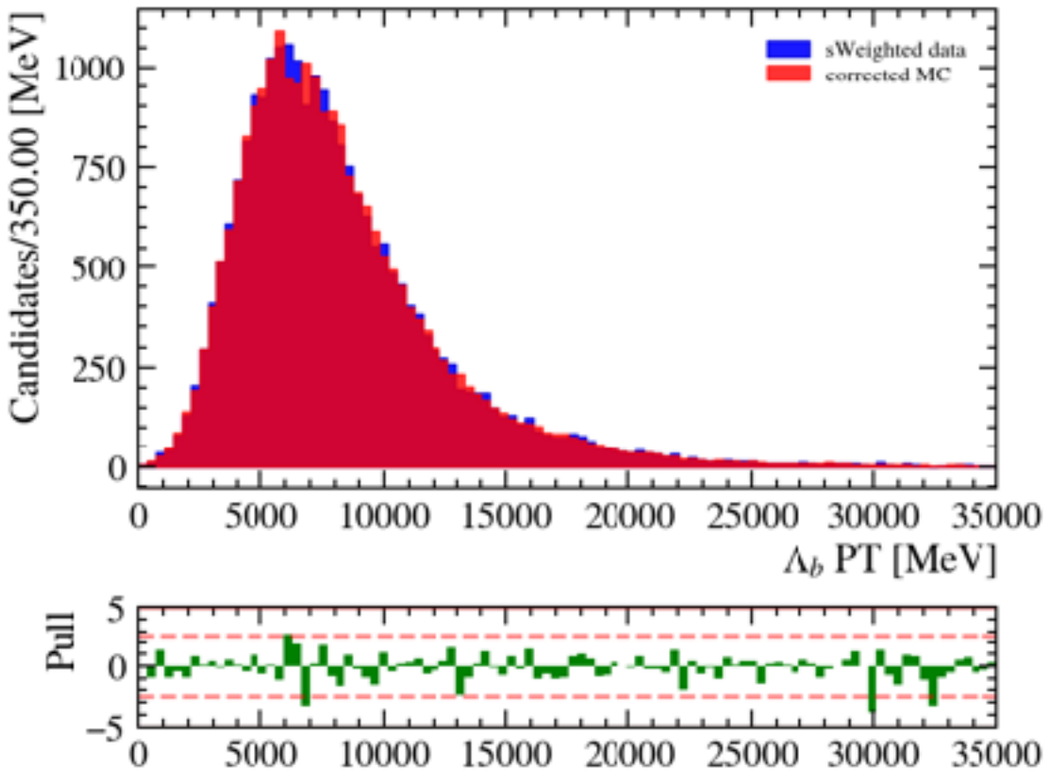


Option 2: Data/MC Comparison 2016

Rectangular Binning

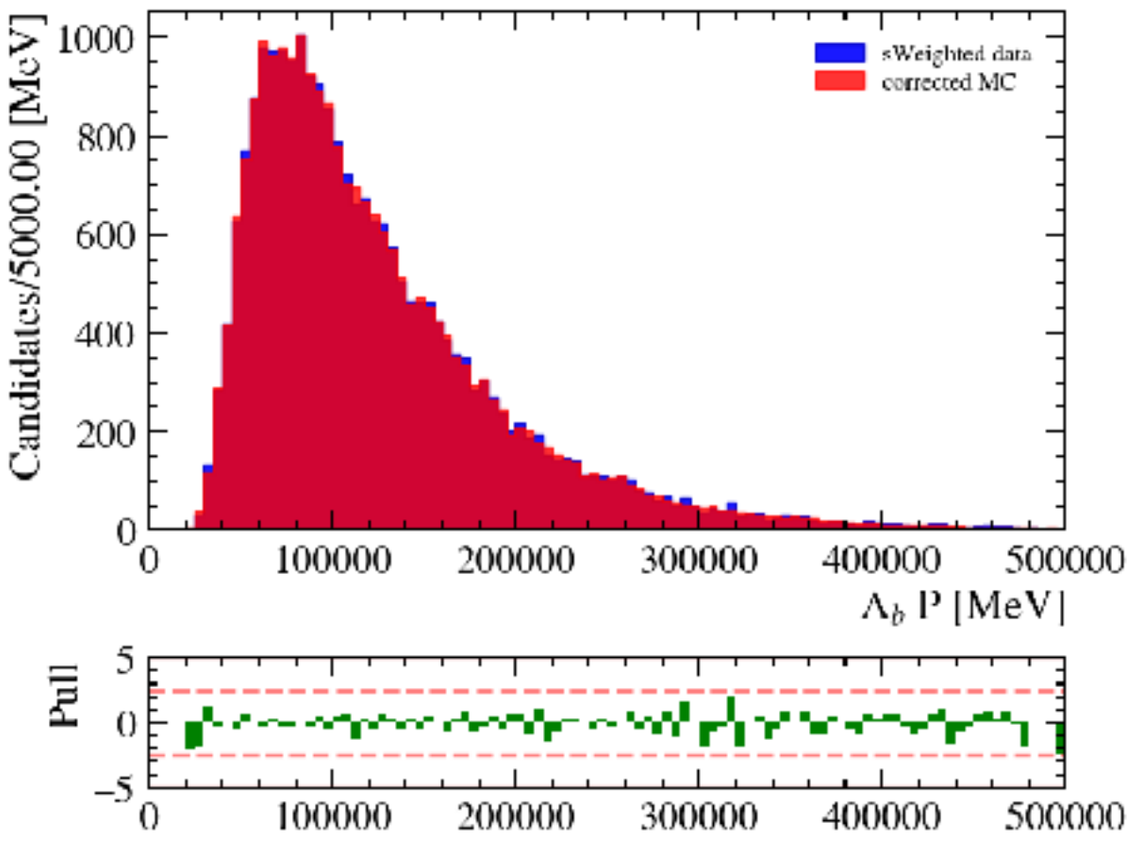


Post-Correction Distributions

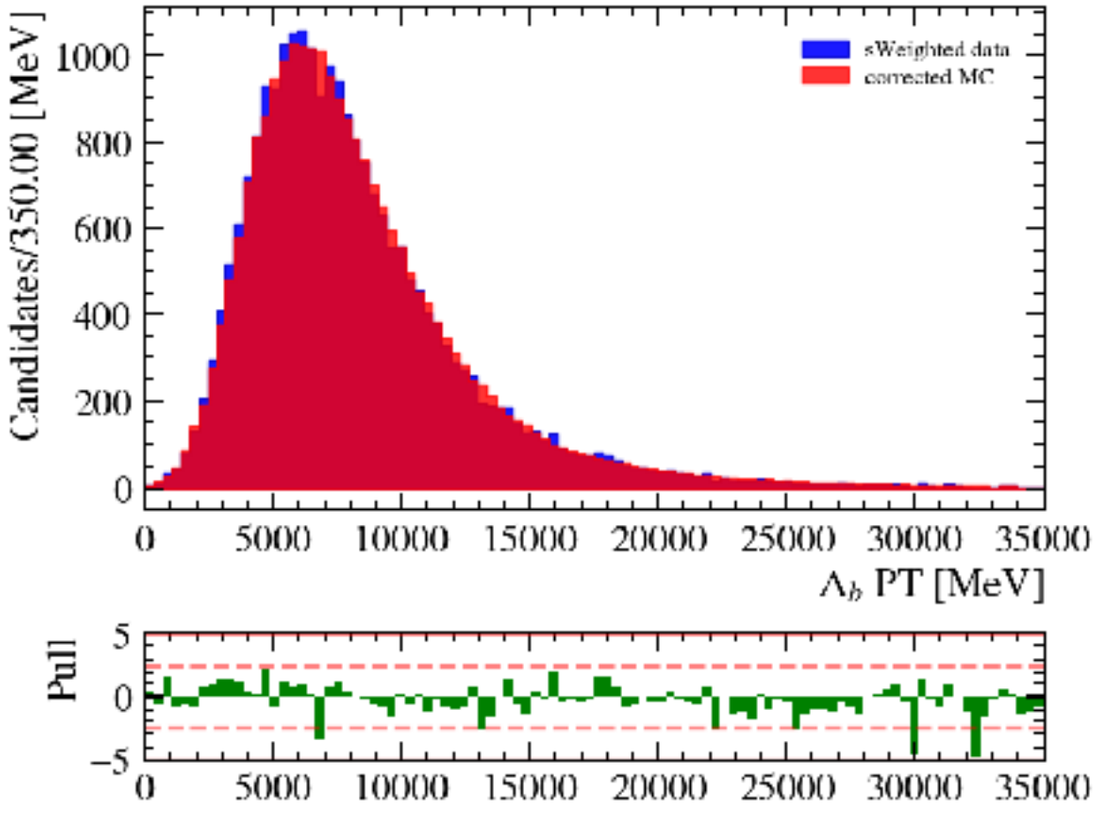


Option 3: Data/MC Comparison 2016

Adaptive Binning



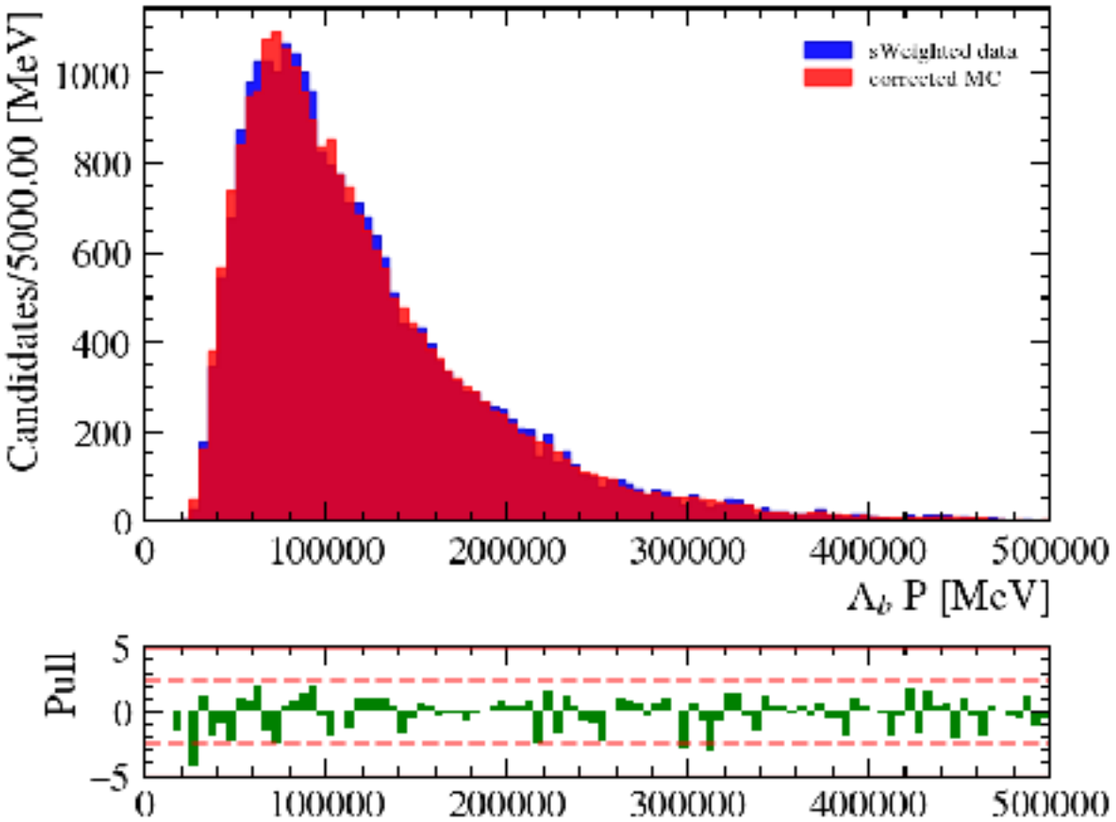
Post-Correction Distributions

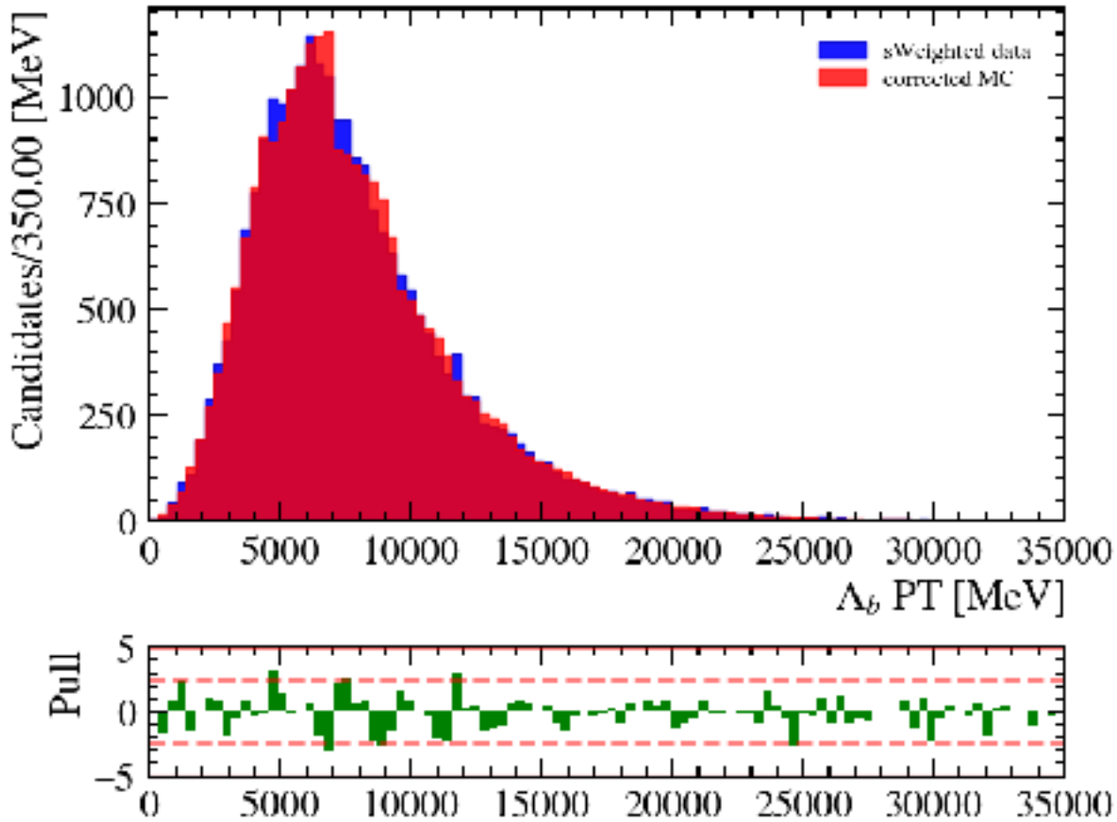


Option 1: Data/MC Comparison 2017

Regular Binning

Post-Correction Distributions

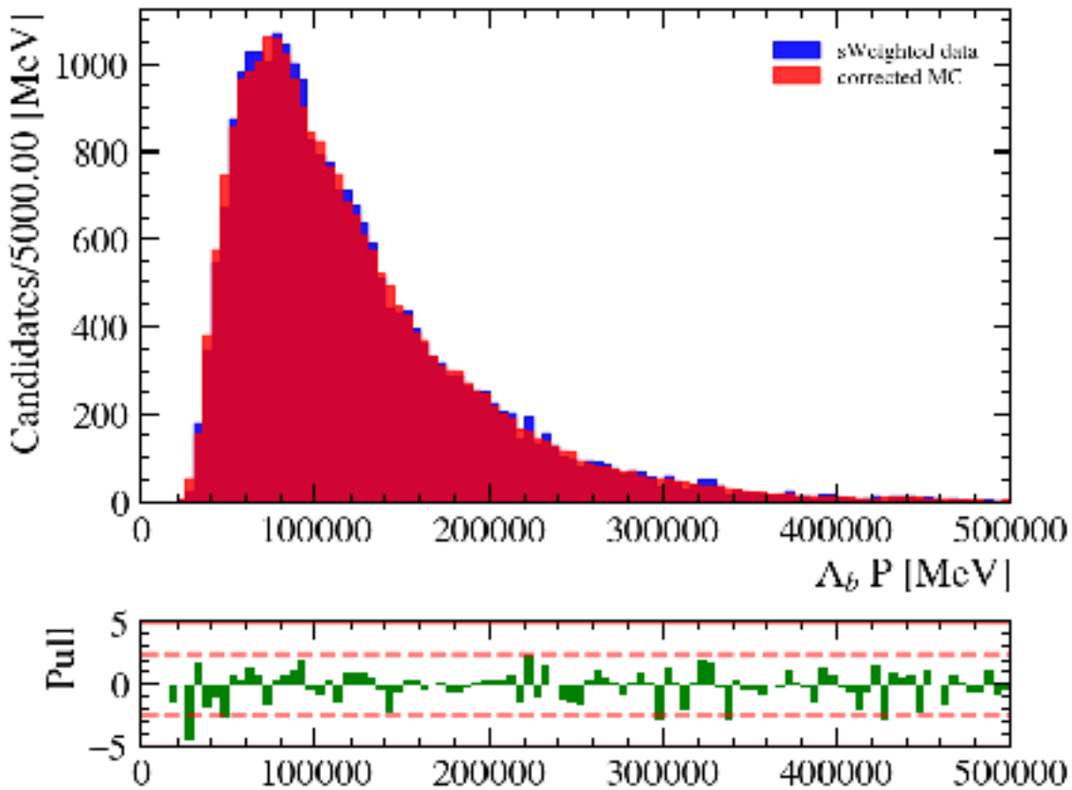


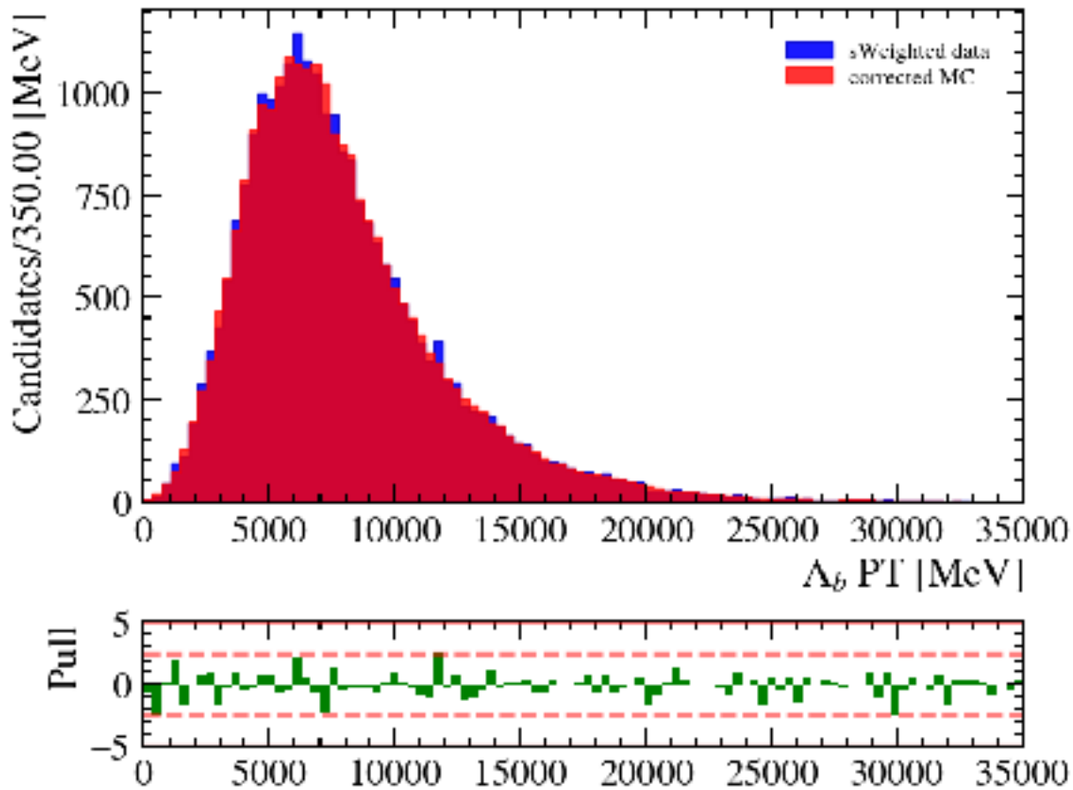


Option 2: Data/MC Comparison 2017

Rectangular Binning

Post-Correction Distributions

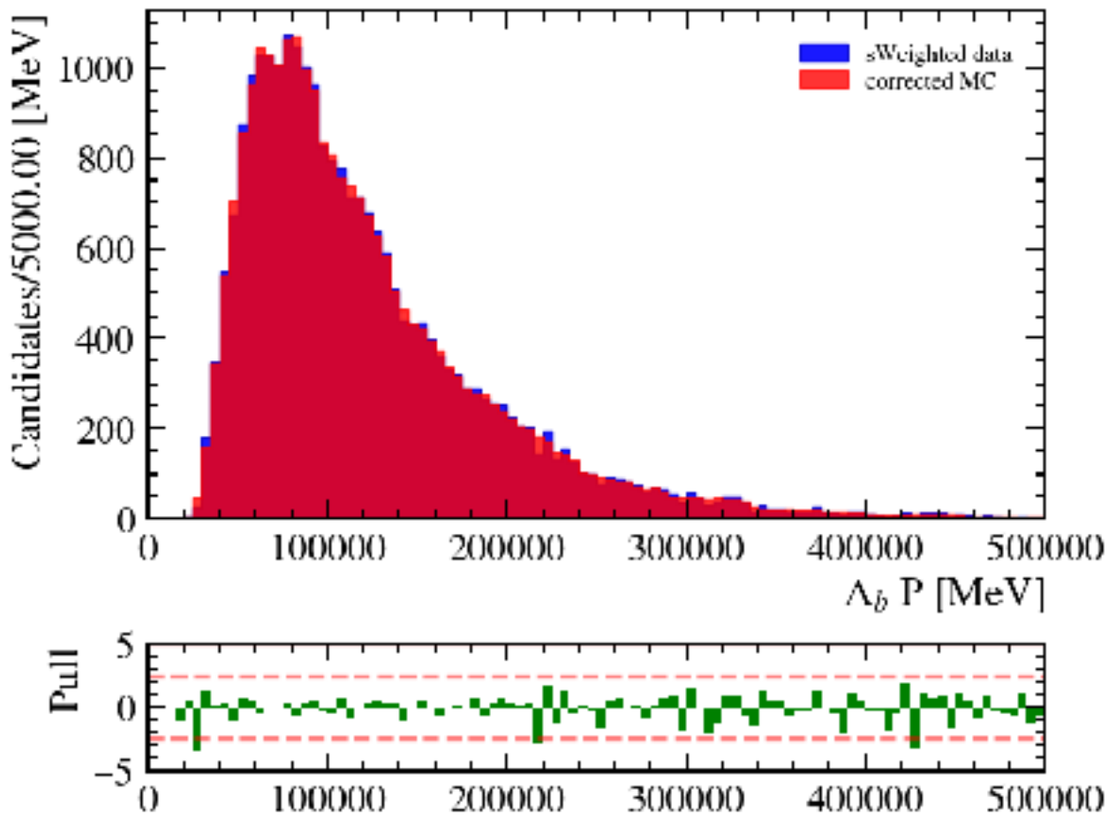


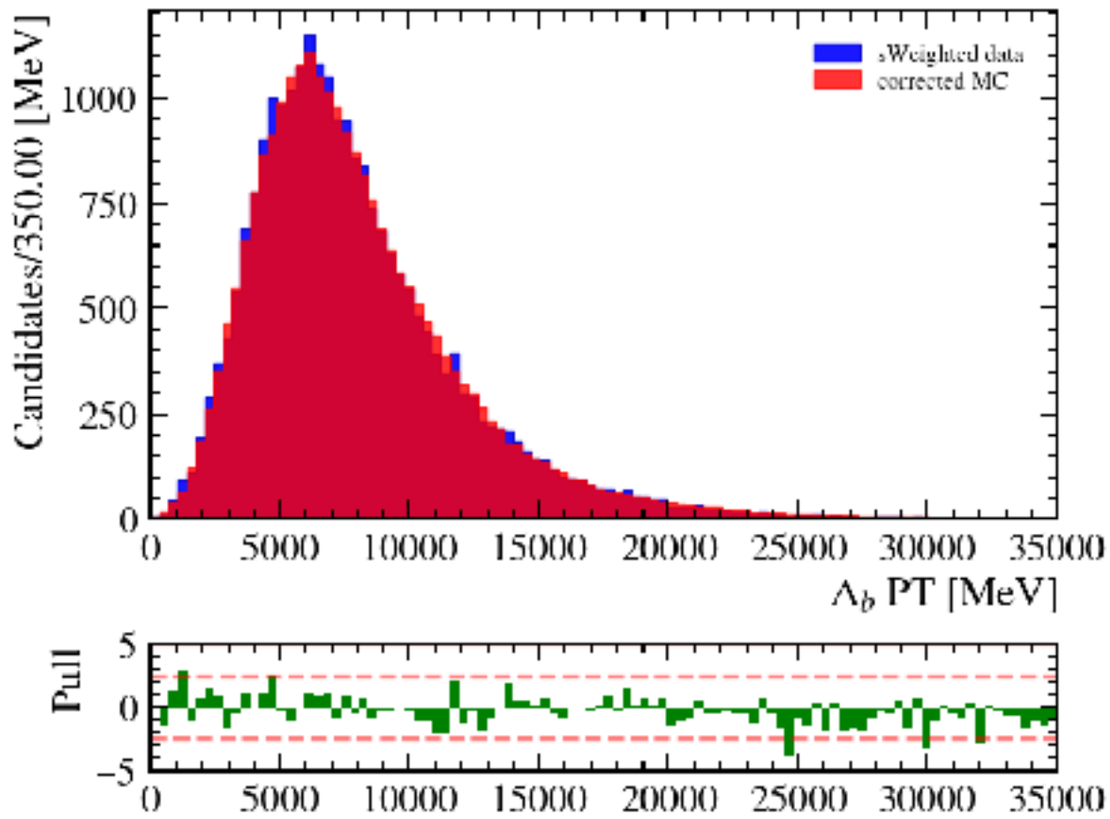


Option 3: Data/MC Comparison 2017

Adaptive Binning

Post-Correction Distributions

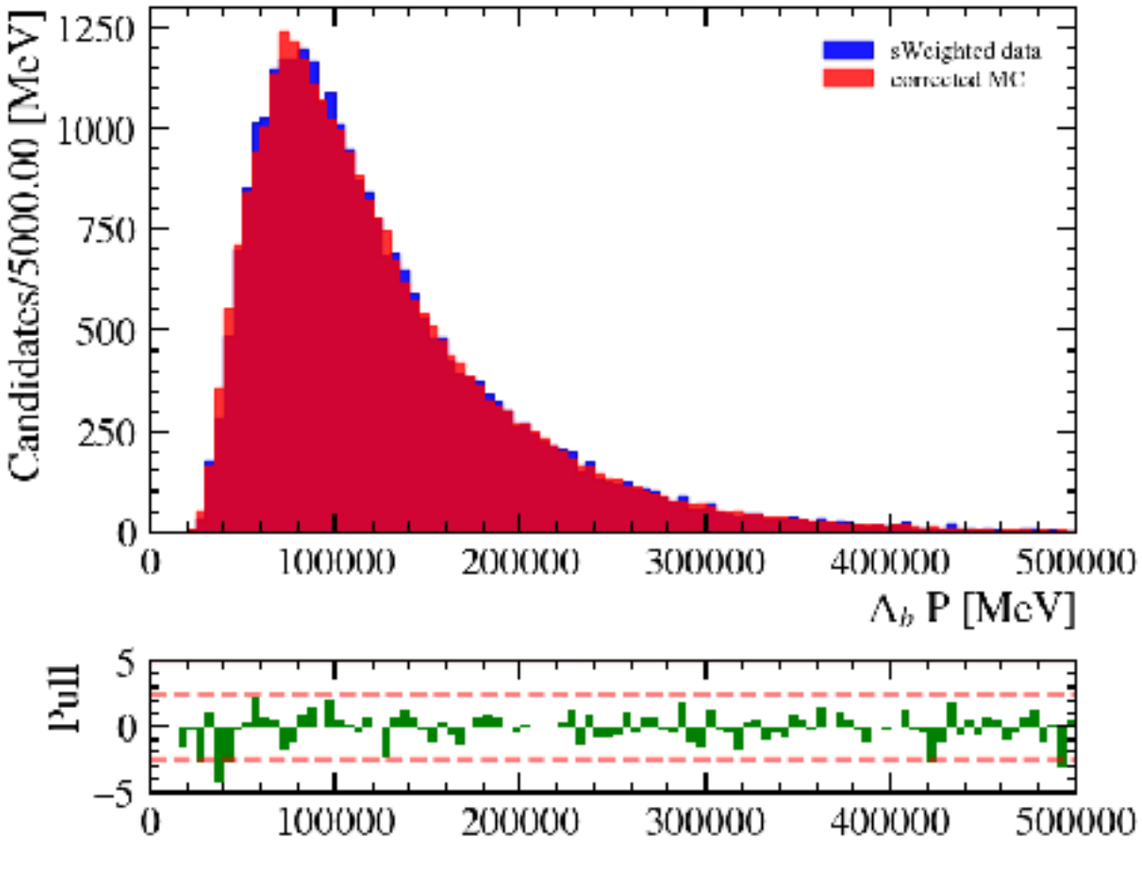


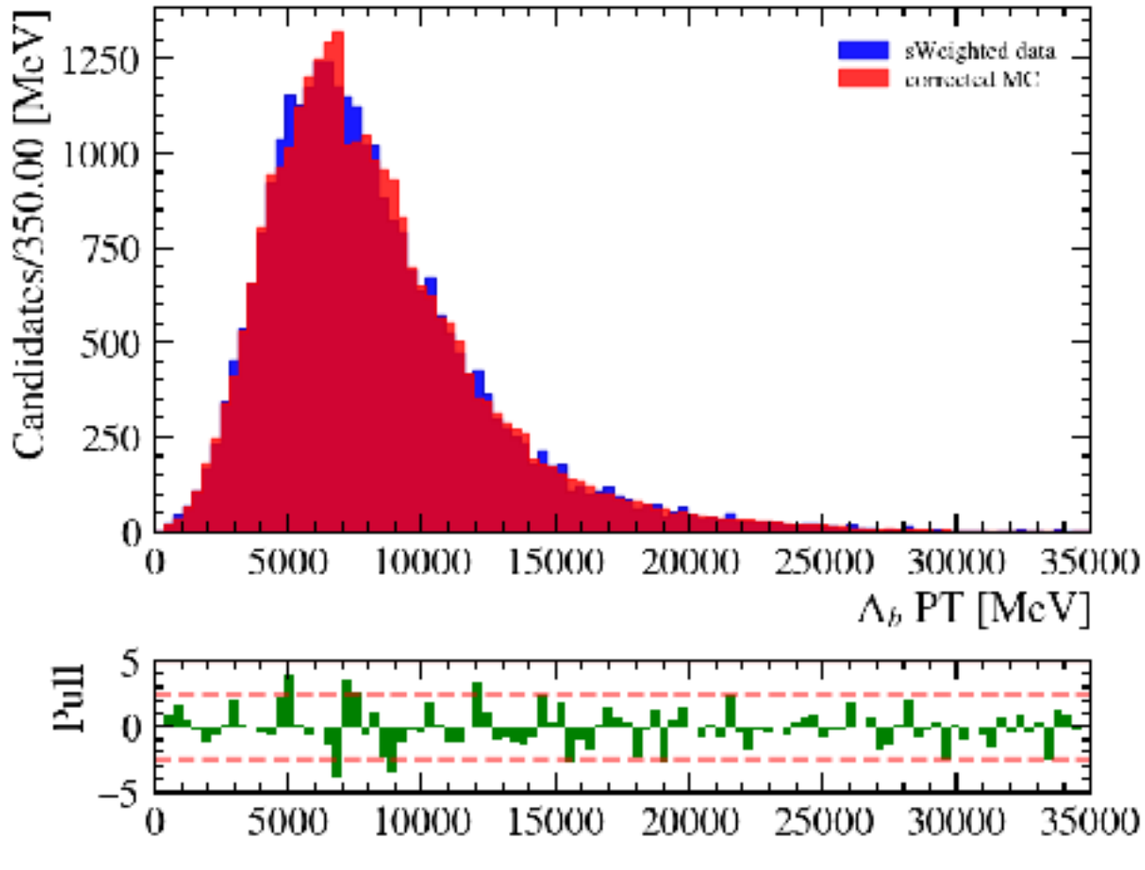


Option 1: Data/MC Comparison 2018

Regular Binning

Post-Correction Distributions

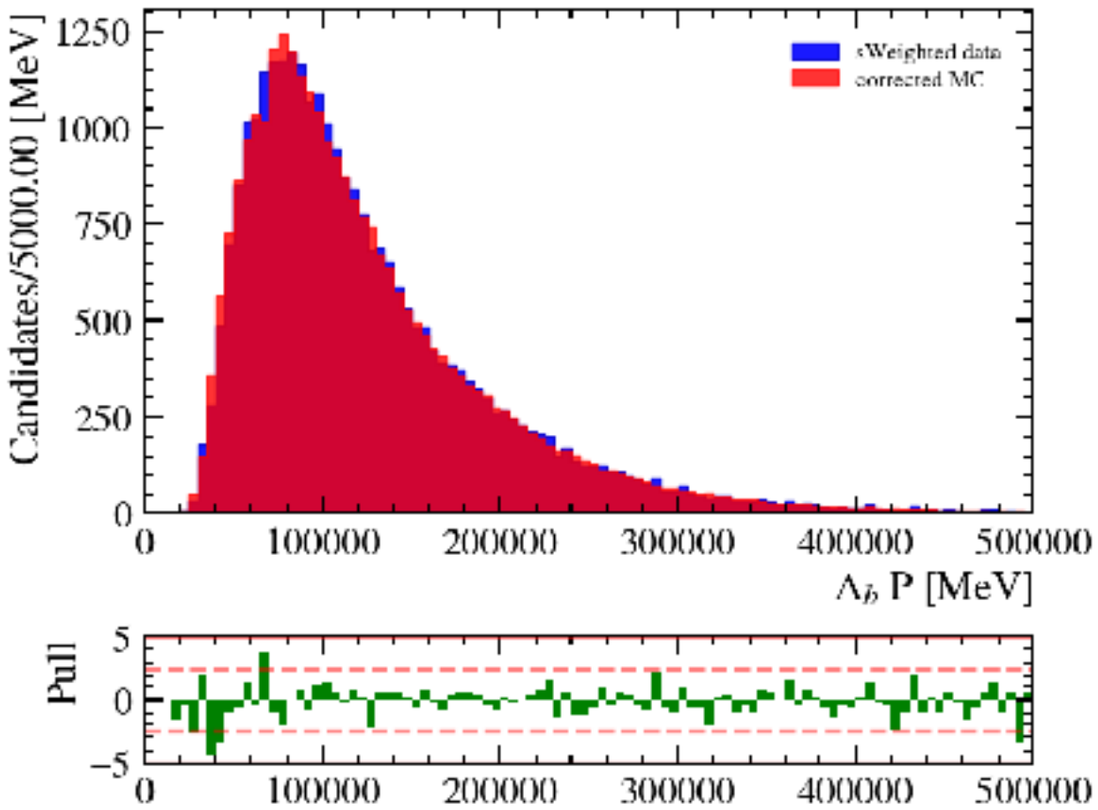


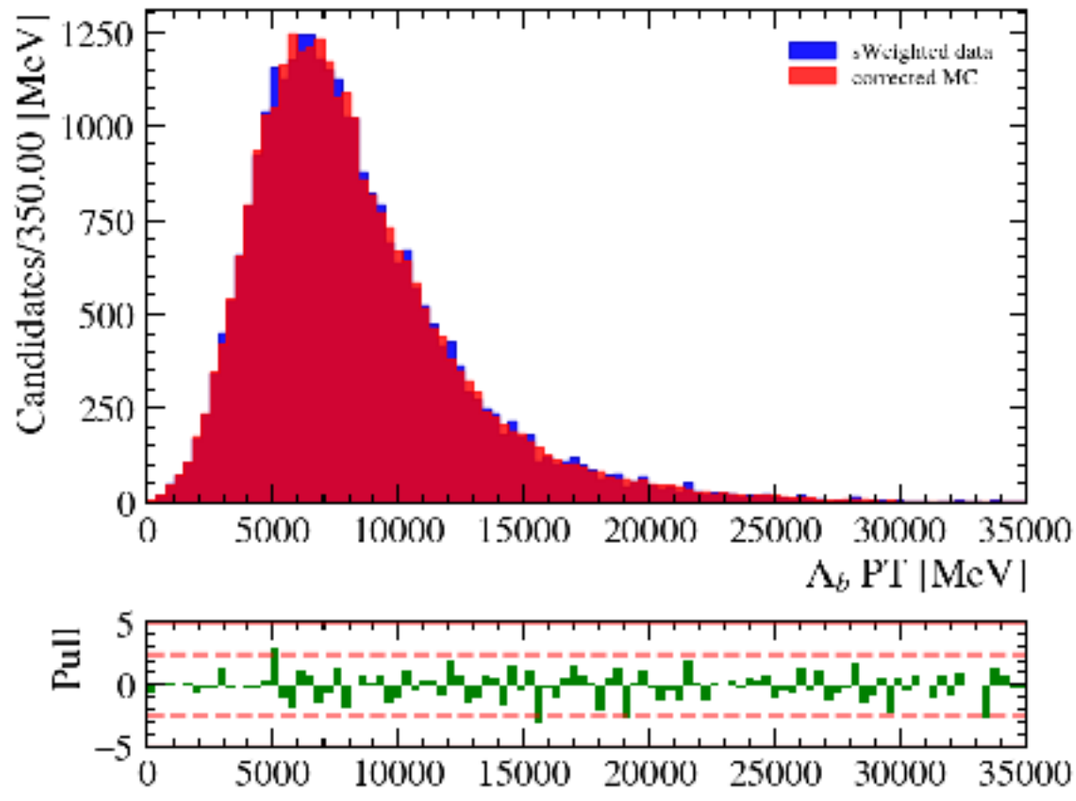


Option 2: Data/MC Comparison 2018

Rectangular Binning

Post-Correction Distributions





Option 3: Data/MC Comparison 2018

Adaptive Binning

Post-Correction Distributions