



## Weekly Update 3 & 4 - Semester 2

Edward Wardell

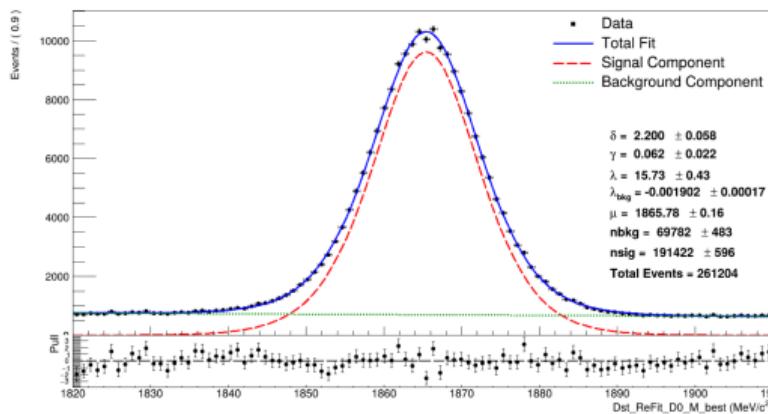
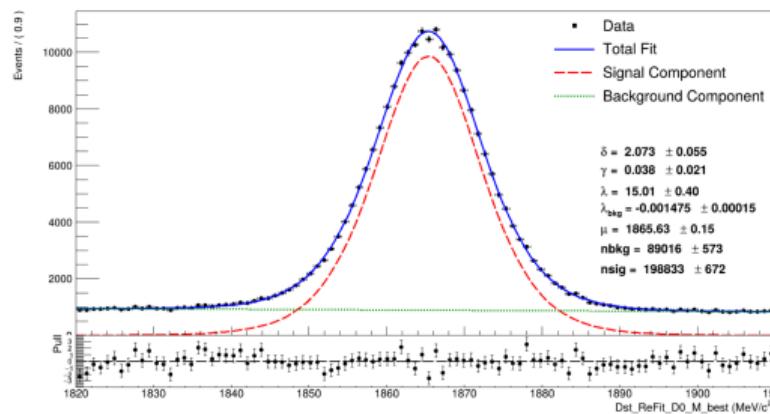
29<sup>th</sup> January - 5<sup>th</sup> February 2025

## Tasks Undertaken

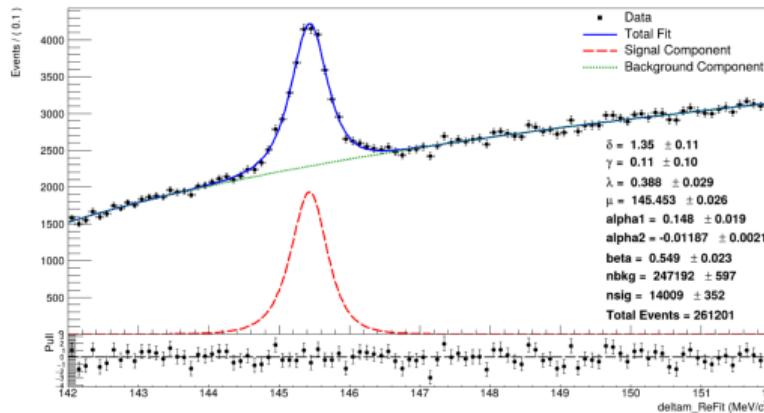
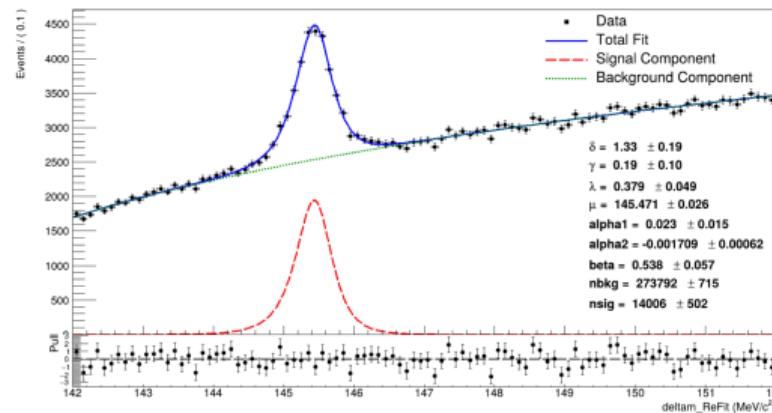
- ▶ Mass fitting for 1D Classifier and Yields obtained
- ▶ Mass fitting for 2D Classifier and Yields obtained
- ▶ Comparison of 1D & 2D Classifiers
- ▶ **NOTE:** For the WS fitting, the left plot is the Mass fitting for the ntuples from 2015 MagDown. The right is after the BDT cut, with the 1D or 2D cut applied.



## WS Mass Fit of Dst\_ReFit\_D0\_M\_best with 1D Classifier BDT cut: (Signal = Johnson), (Background = Negative Exponential)



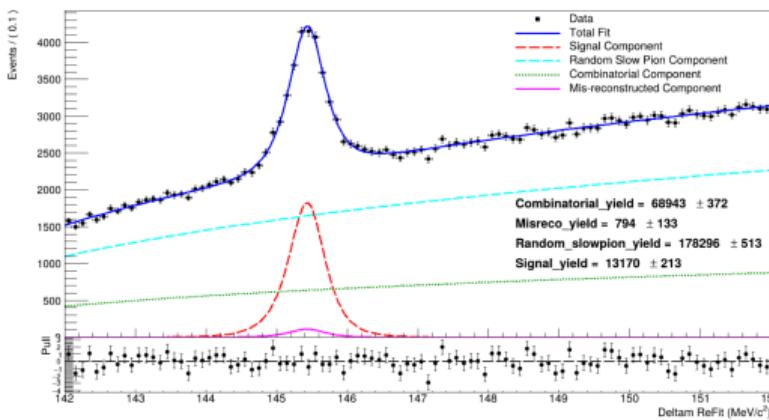
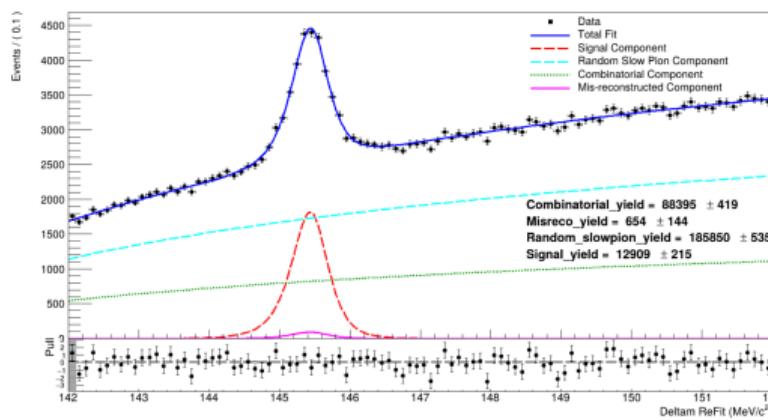
## WS Mass Fit of `deltam_ReFit` with 1D Classifier BDT cut: (Signal = Johnson), (Background = 2nd Order Polynomial)



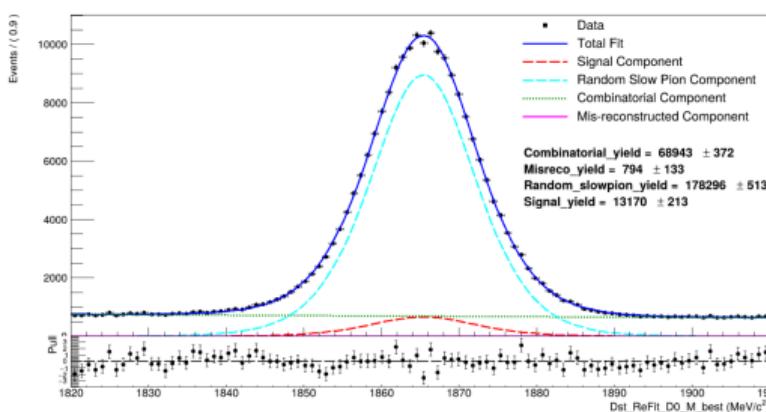
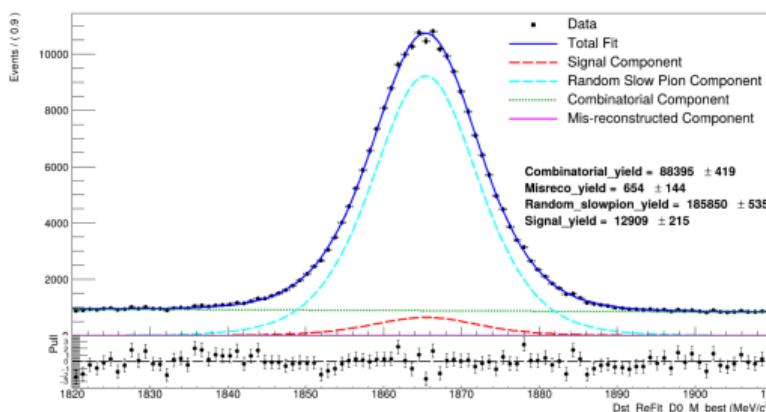
- Purity in range [144.5, 146]: Standard = 0.3492, 1D Classifier = 0.3867.



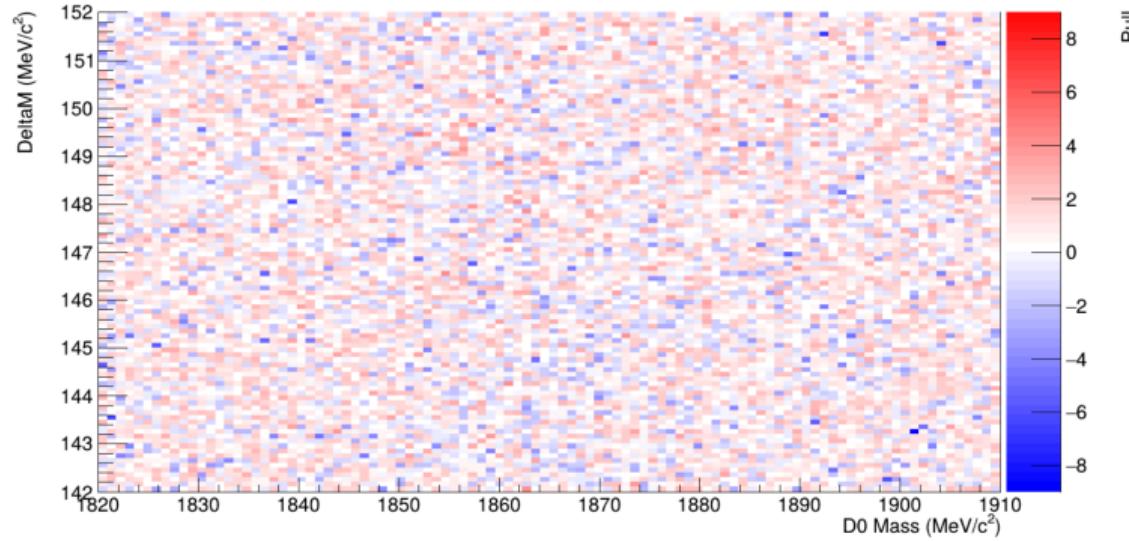
## WS Mass Fit of $\text{deltam\_ReFit}$ : (left = standard variable), (right = BDT 1D Classifier)



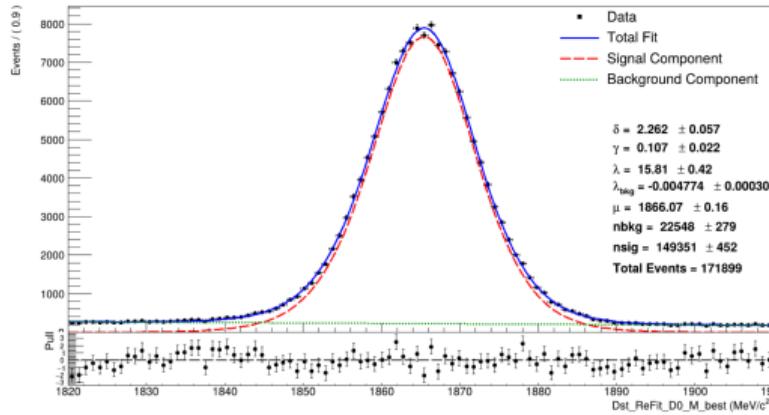
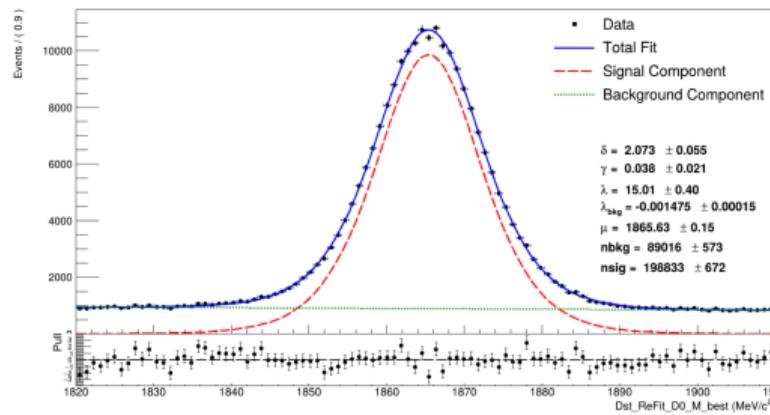
## WS Mass Fit of Dst\_ReFit\_D0\_M\_best: (left = standard variable), (right = BDT 1D Classifier)



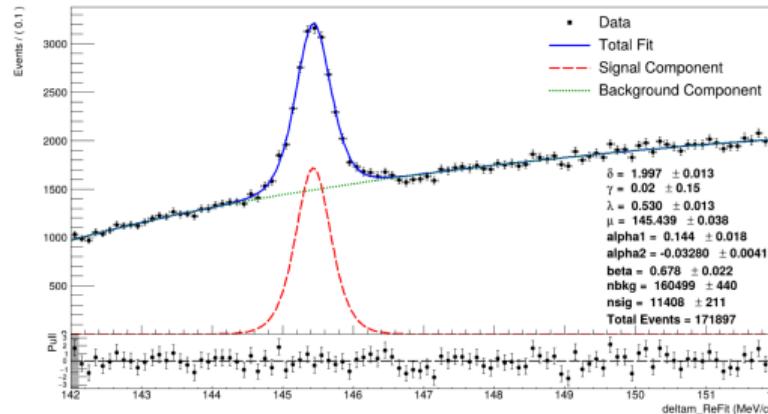
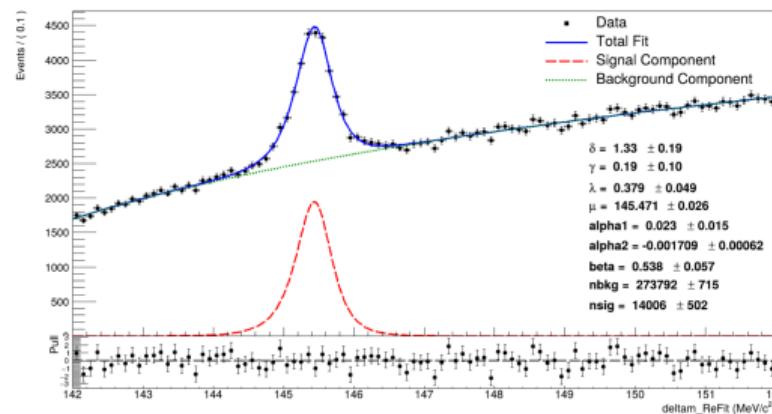
## 2D Pullplot for 1D Classifier



## WS Mass Fit of Dst\_ReFit\_D0\_M\_best with 2D Classifier BDT cut: (Signal = Johnson), (Background = Negative Exponential)



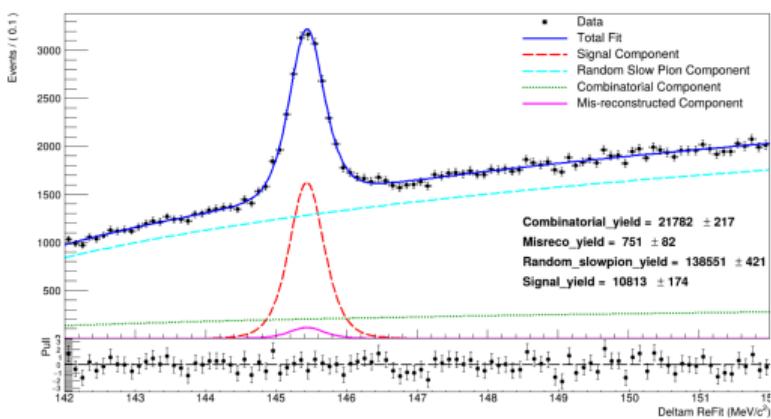
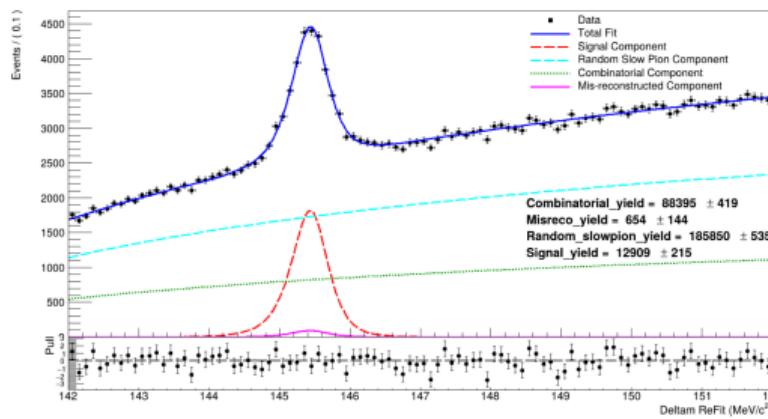
## WS Mass Fit of `deltam_ReFit` with 2D Classifier BDT cut: (Signal = Johnson), (Background = 2nd Order Polynomial)



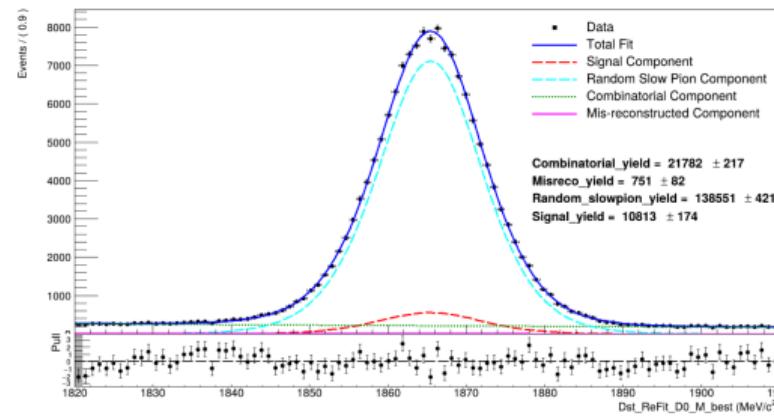
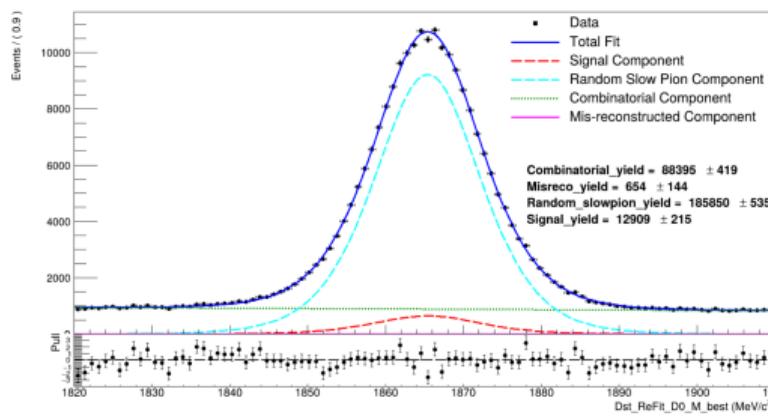
- Purity in range [144.5, 146]: Standard = 0.3492, 2D Classifier = 0.499.



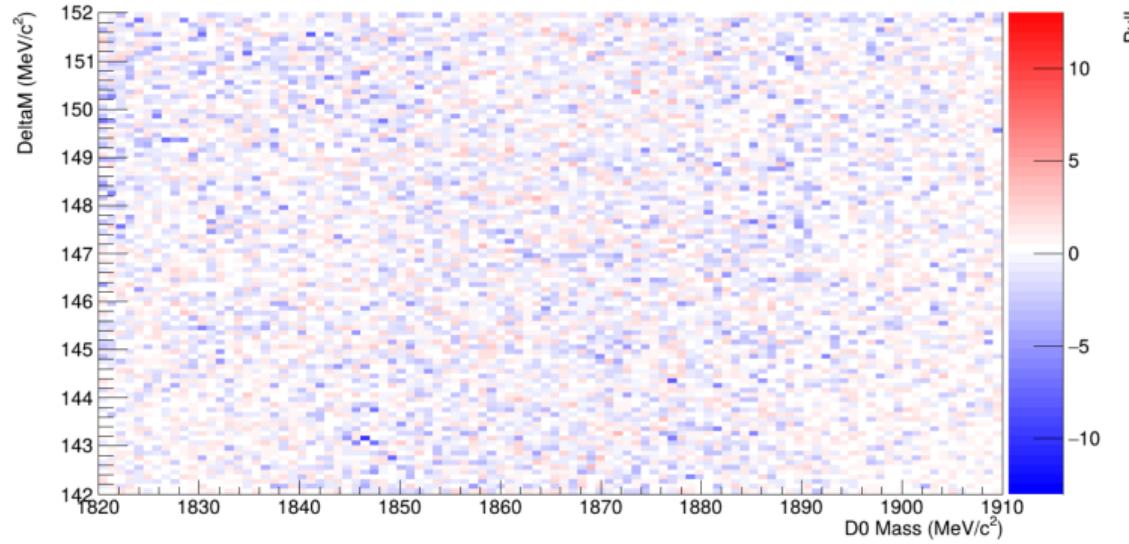
## WS Mass Fit of $\text{deltam\_ReFit}$ : (left = standard variable), (right = BDT 2D Classifier)



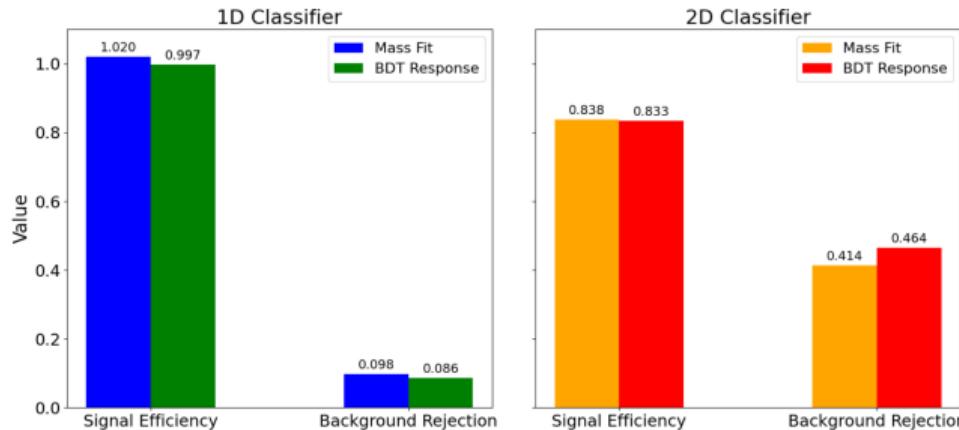
## WS Mass Fit of Dst\_ReFit\_D0\_M\_best: (left = standard analysis cuts), (right = BDT 2D Classifier)



## 2D Pullplot for 2D Classifier



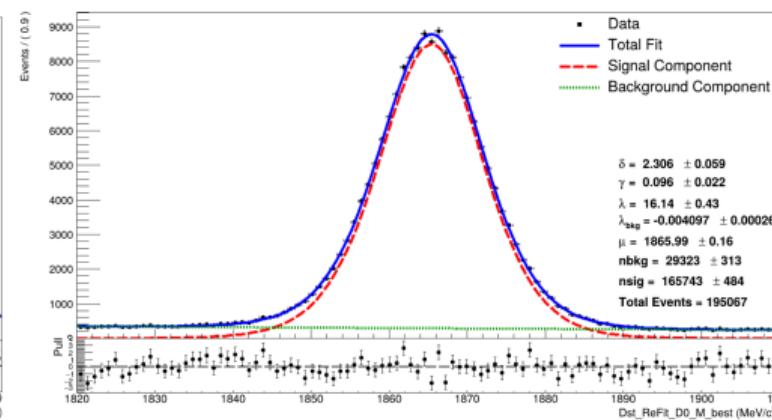
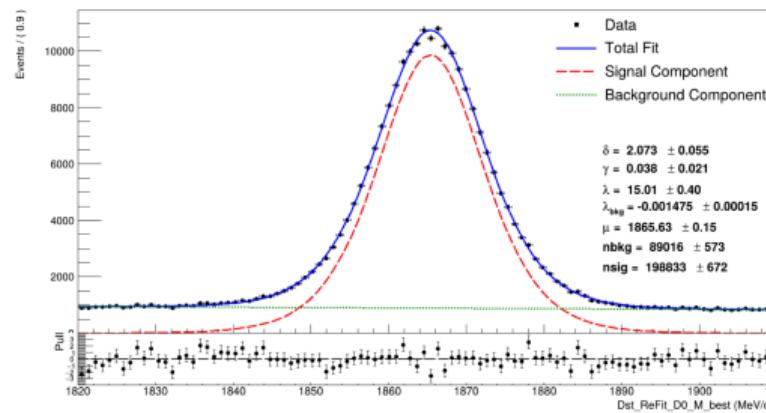
## Signal Efficiency and Background Rejection comparison for 1D & 2D Classifier



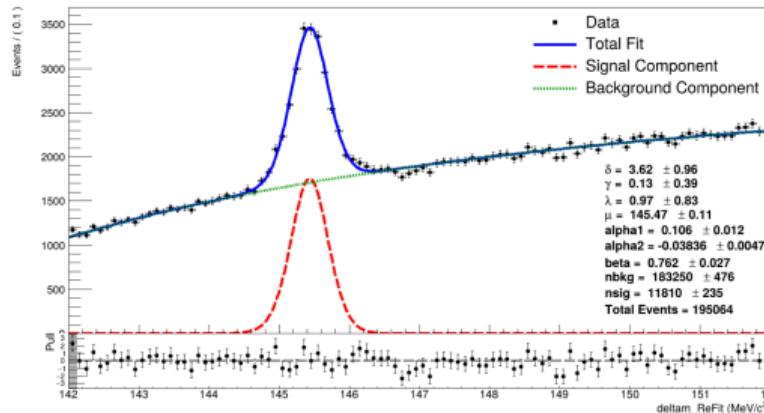
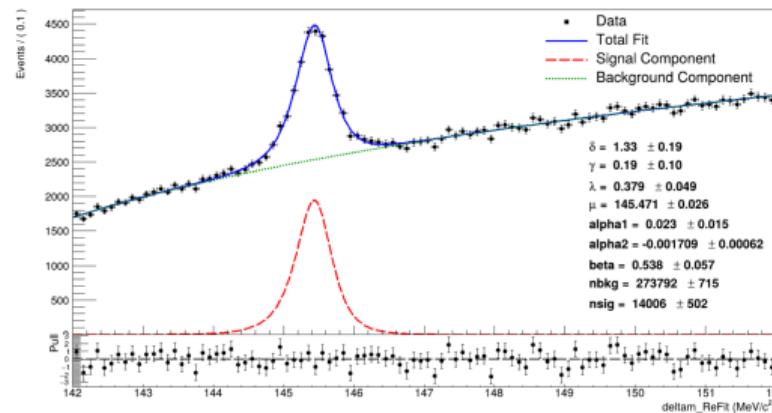
- ▶ **Note:** For the 1D Classifier, I accidentally took a looser cut, which was actually the cut determined from the BDT for the RS sample, not WS. So I re-did the fitting with the correct (tighter) BDT response cut.

## “Tighter” 1D Classifier

WS Mass Fit of `Dst_ReFit_D0_M_best`: (Signal = Johnson),  
(Background = Negative Exponential)

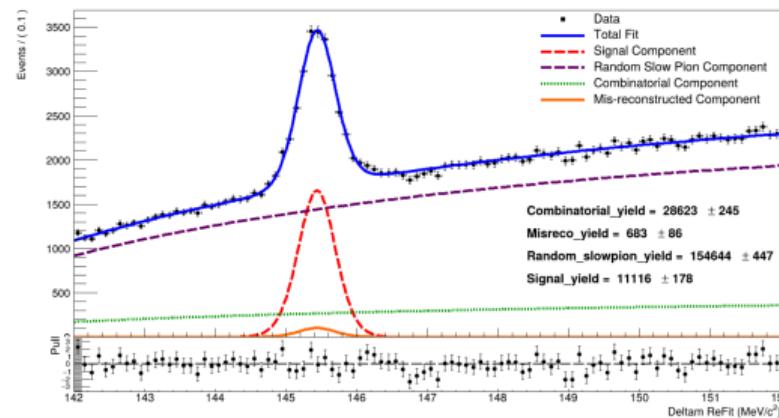
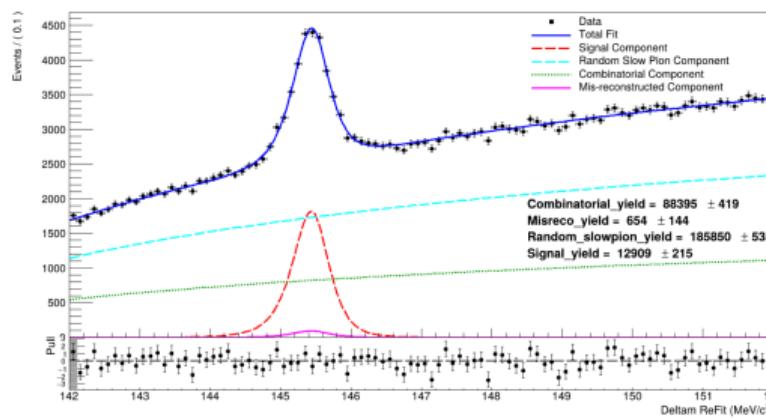


## WS Mass Fit of `deltam_ReFit` with 1D Classifier BDT cut: (Signal = Johnson), (Background = 2nd Order Polynomial)



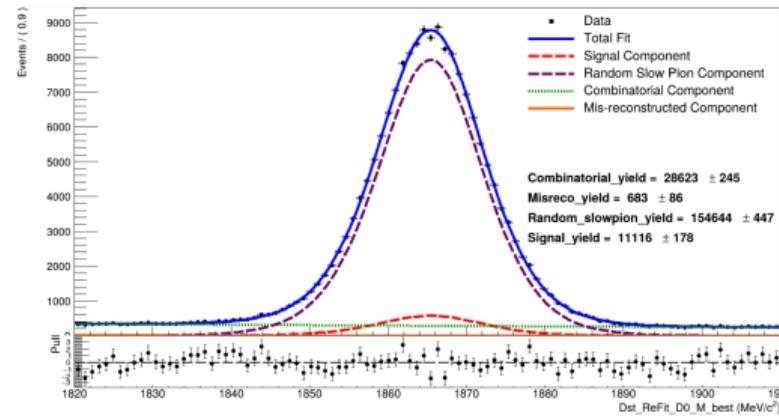
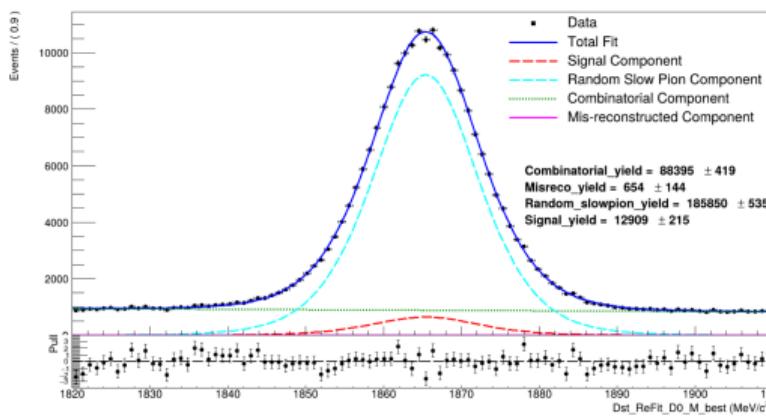
- Purity in range [144.5, 146]: Standard = 0.3492, 1D Classifier = 0.3867.

## WS Mass Fit of `deltam_ReFit`: (left = standard variable), (right = BDT 1D Classifier)



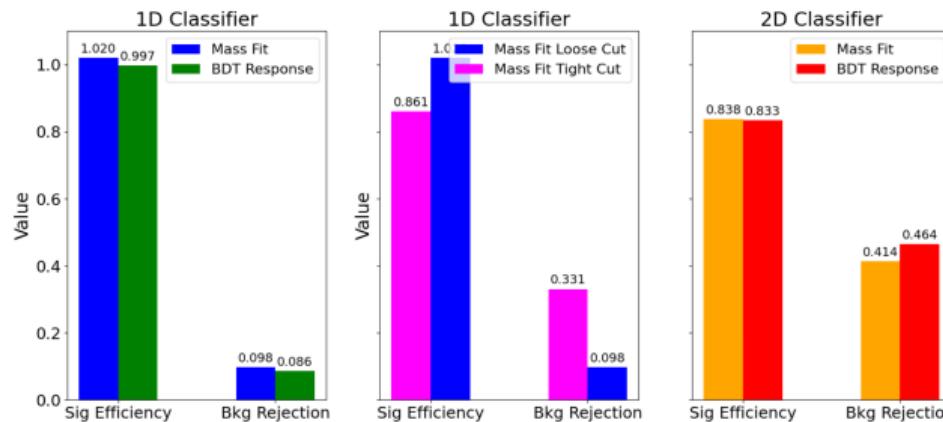


## WS Mass Fit of Dst\_ReFit\_D0\_M\_best: (left = standard variable), (right = BDT 1D Classifier)

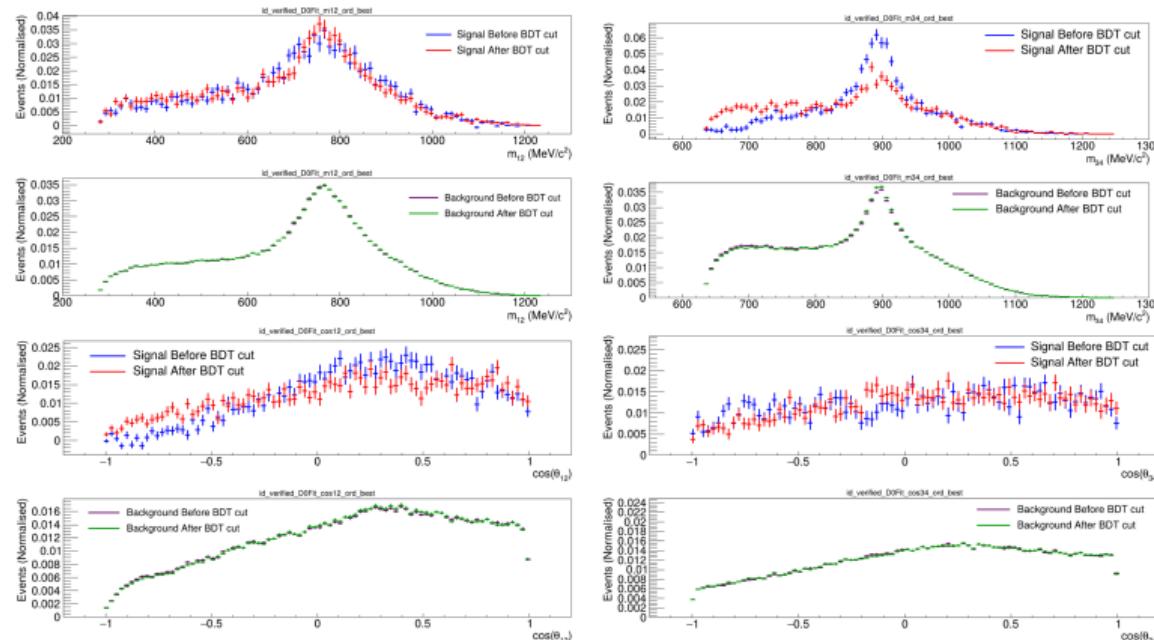


## Signal Efficiency and Background Rejection comparison for 1D & 2D Classifier

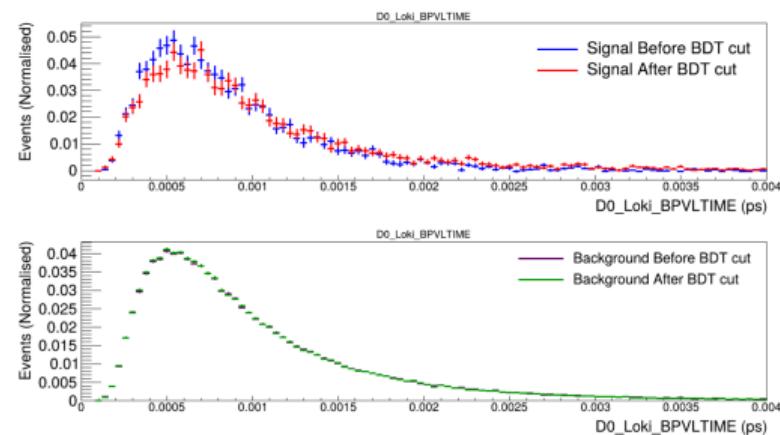
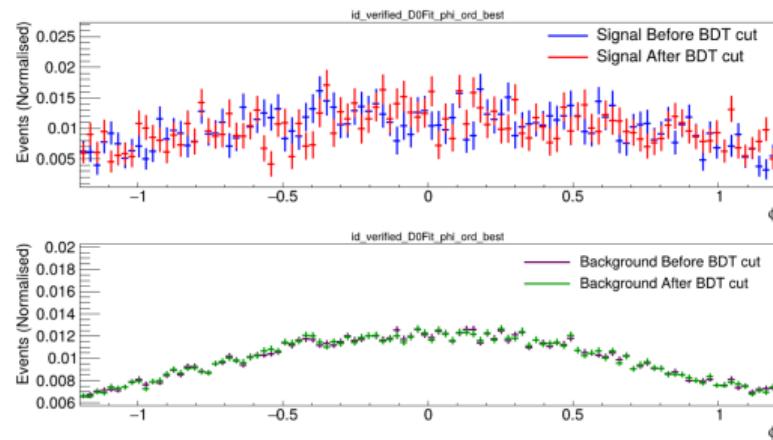
Comparison of Mass Fit vs. BDT Response



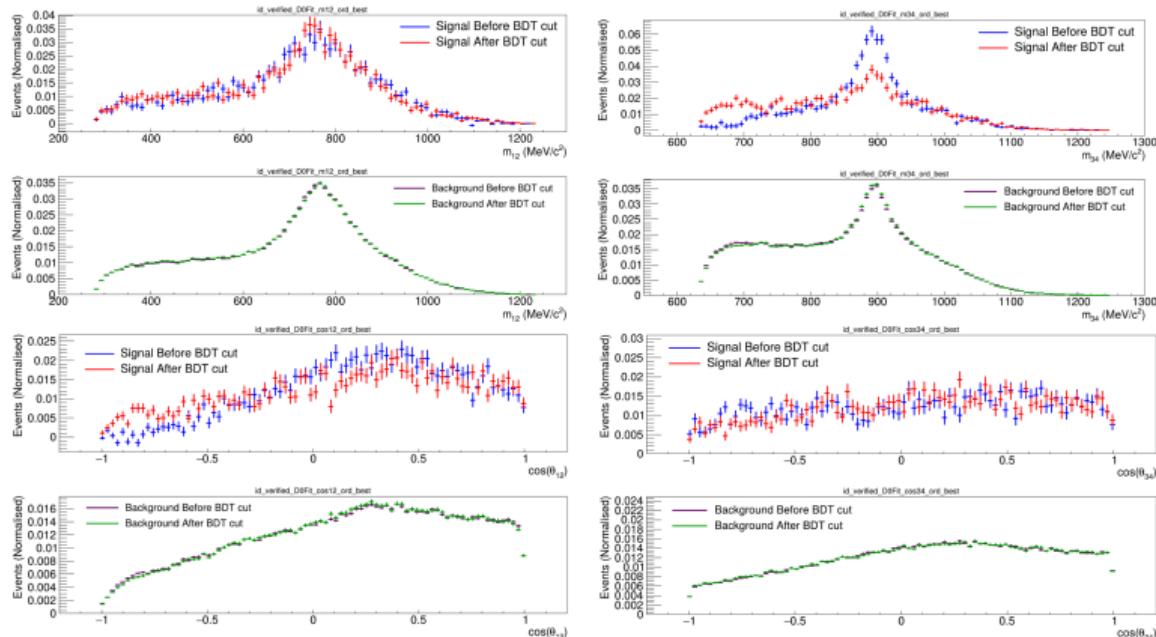
# 1D-Classifier (Loose BDT Cut) Phase-Space Variables sWeighted Before and After BDT Cut



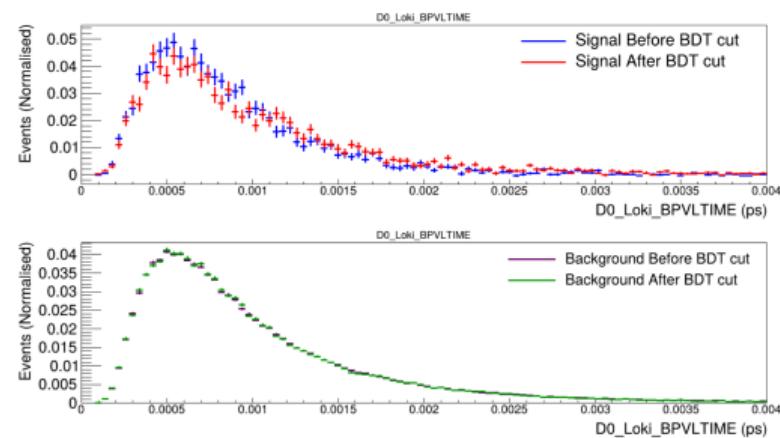
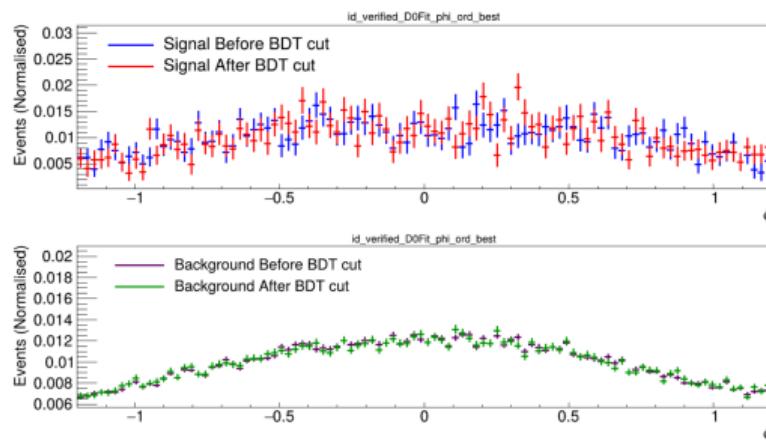
## 1D-Classifier - (Loose BDT Cut) Phase-Space Variables and D0 decay time sWeighted Before and After BDT Cut



## 2D-Classifier Phase-Space Variables sWeighted Before and After BDT Cut



## 2D-Classifier Phase-Space Variables and D0 decay time sWeighted Before and After BDT Cut

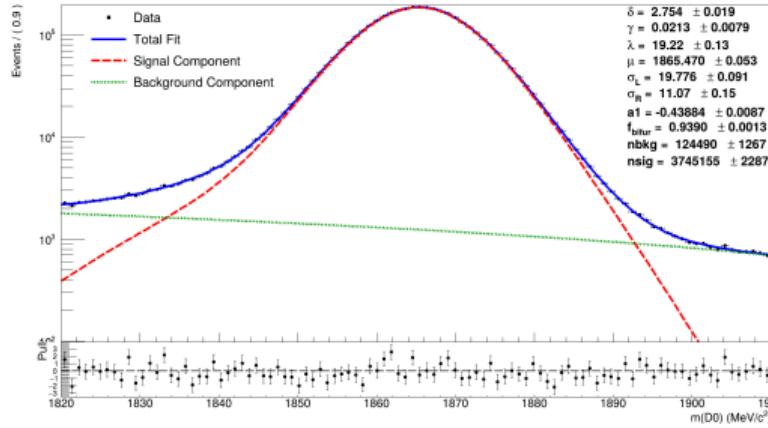
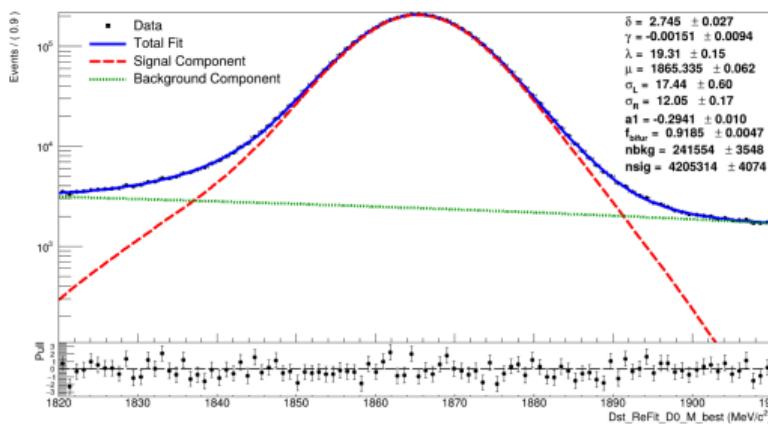


Fitting the **RS** sample to obtain sWeights for before and after the BDT, for 1D and 2D classifiers, and see if the BDT sculpts the "signal phase space regions".

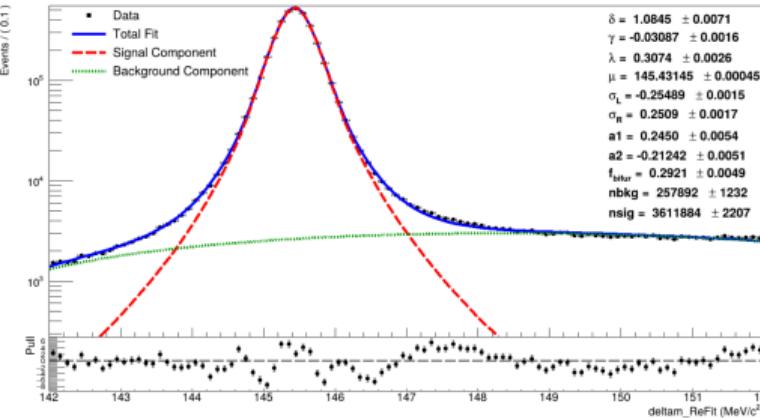
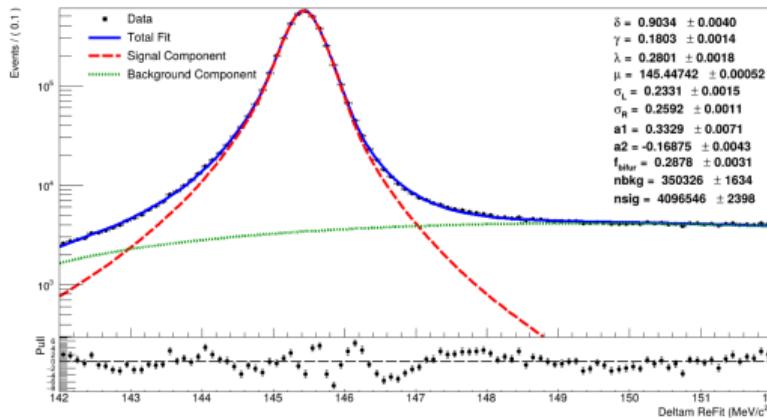
**NOTE:** For the RS fitting, the left plot is the Mass fitting for the ntuples from 2015 MagDown. The right is after the BDT cut, with the 1D or 2D cut applied.

- ▶ First, we consider the **1D Classifier**
- ▶ Then the **2D Classifier**

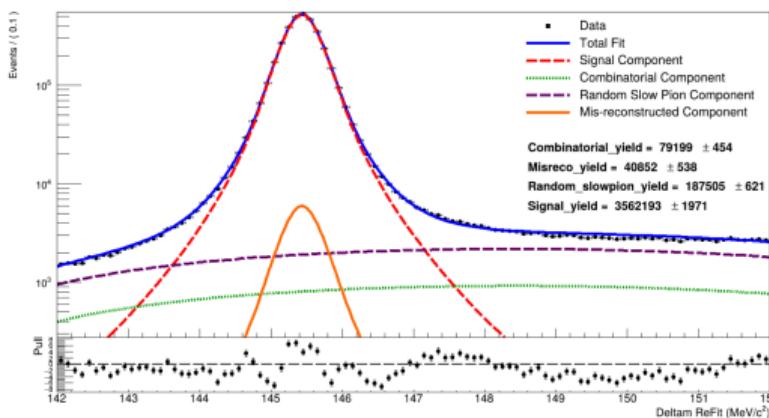
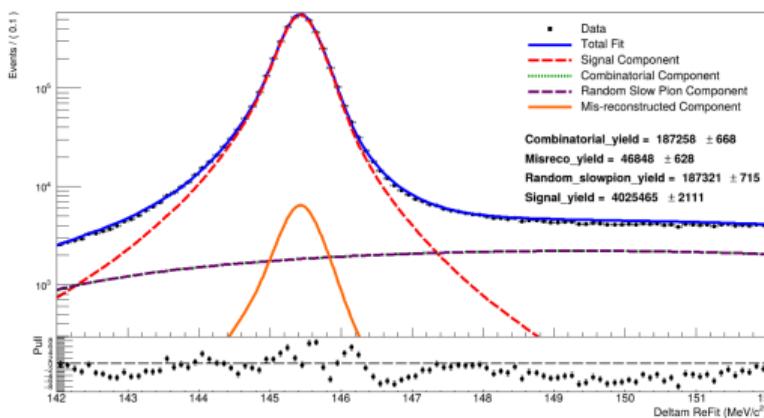
## RS Mass Fit of Dst\_ReFit\_D0\_M\_best with 1D Classifier BDT cut: (Signal = Johnson), (Background = Negative Exponential).



## RS Mass Fit of `deltam_ReFit` with 1D Classifier BDT cut: (Signal = Johnson), (Background = 2nd Order Polynomail)

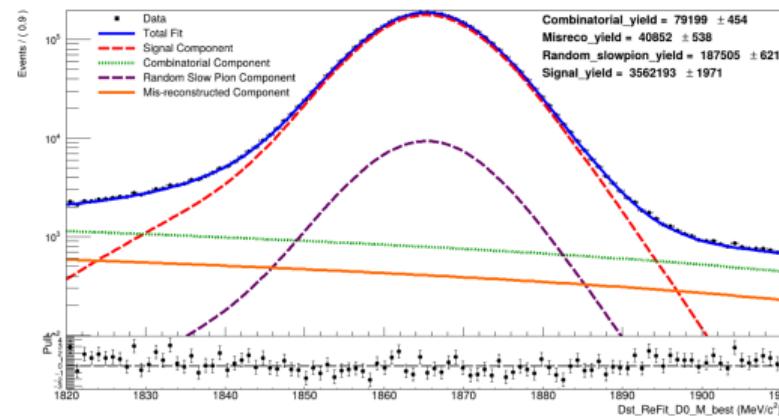
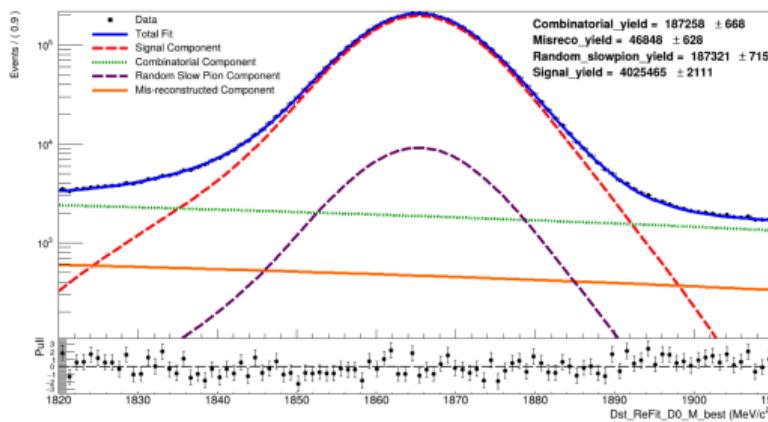


## RS 2D Mass Fit, **deltam\_ReFit**: (left = standard variable), (right = BDT 1D Classifier)

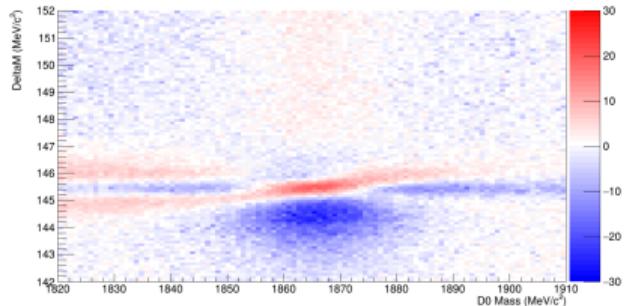


I still have fitting issues with the right tail of the `deltam_ReFit`. I have tried to perform the 2D mass fit with additional loosened background and signal parameters and then varying these; to no avail (yet).

**RS 2D Mass Fit, Dst\_ReFit\_D0\_M\_best: (left = standard variable),  
(right = BDT 1D Classifier)**

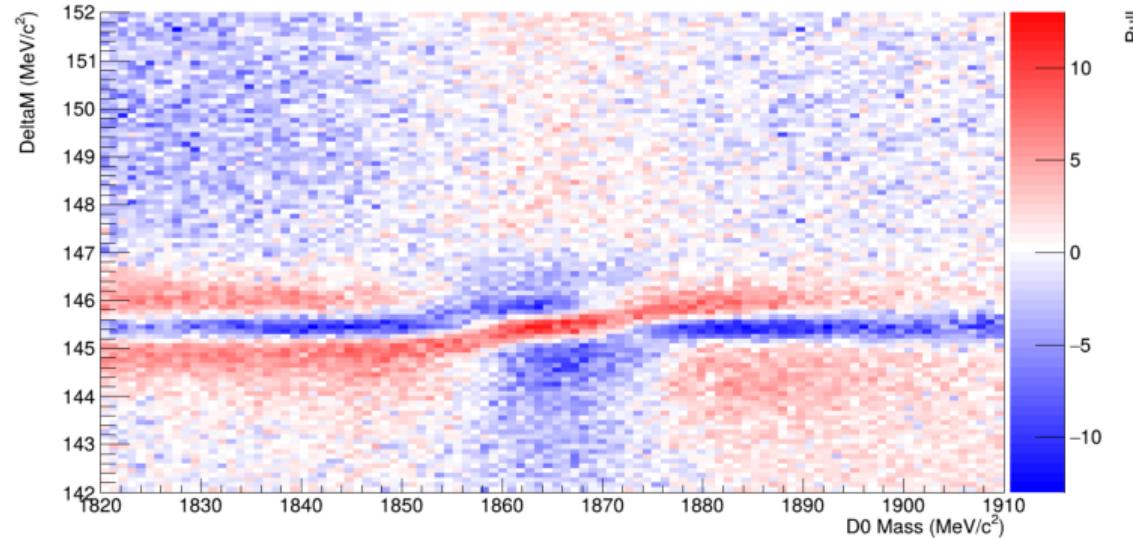


## 2D Pull from the 2D Mass fit on the RS Invariant Masses with 1D Classifier BDT cut applied

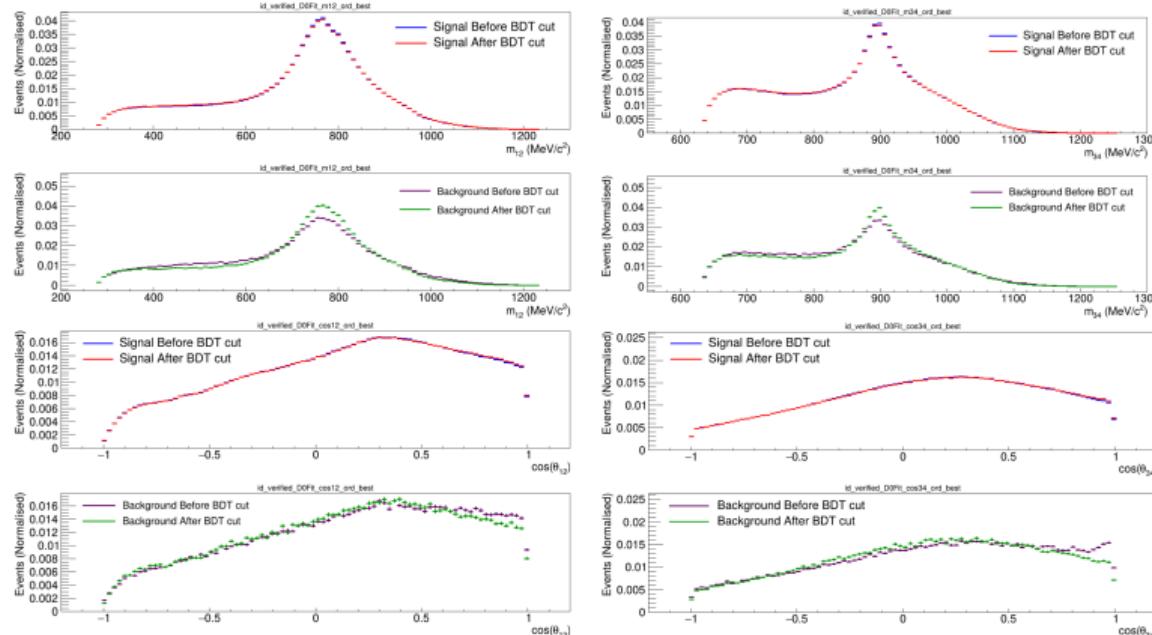


- ▶ The fit seems to have worse performance than the fit performed before the BDT (on the next slide), the blue blob that comes from the left tail of the `deltam_ReFit` but from events in the  $m(D^0)$  peak is odd... I am unsure what to make of this, the pull values are very bad (minimum of -27, maximum of 17), but there is nothing that is screaming at me in the mass fits. (I will keep fitting)

## 2D Pull for 2D Mass Fit on the RS Invariant Masses (Before BDT cut)

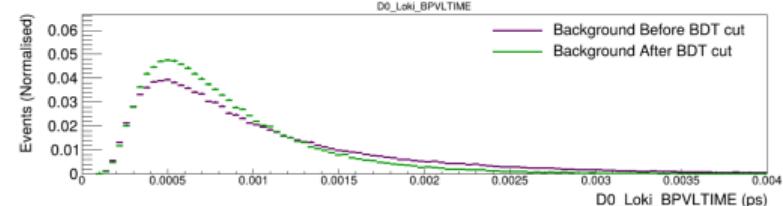
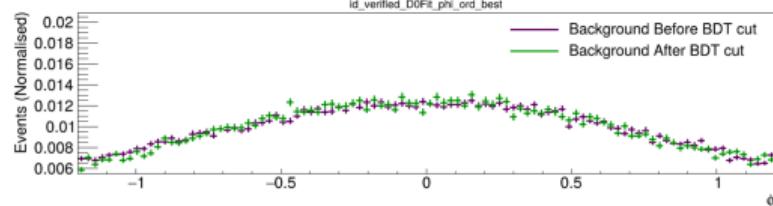
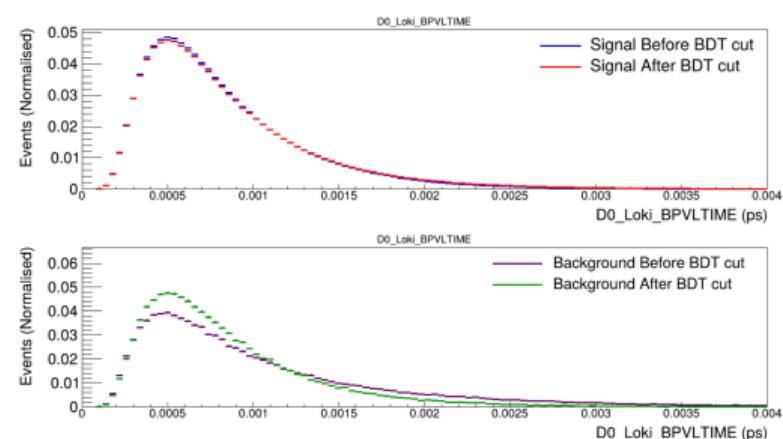
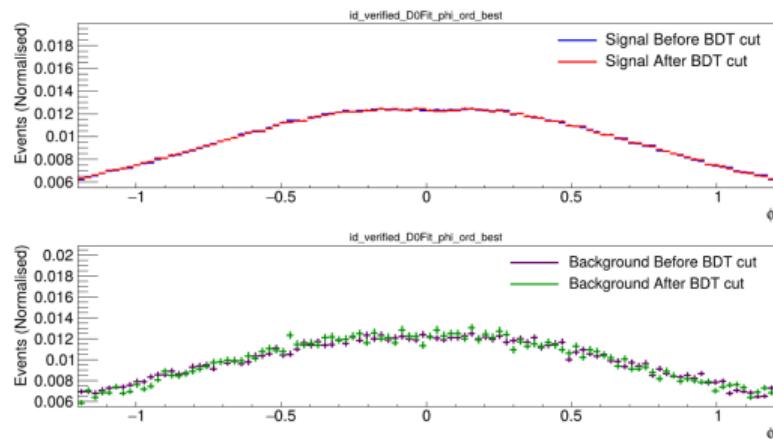


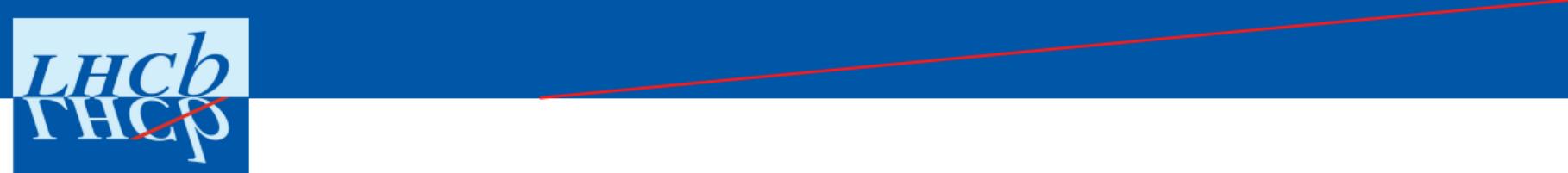
# 1D-Classifier Phase-Space Variables sWeighted Before and After BDT Cut



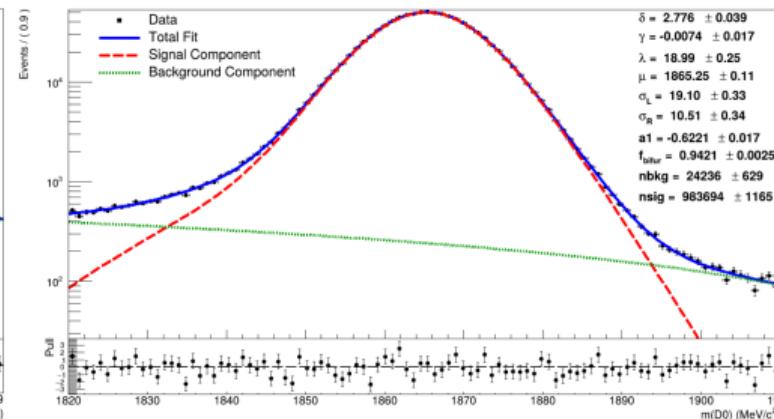
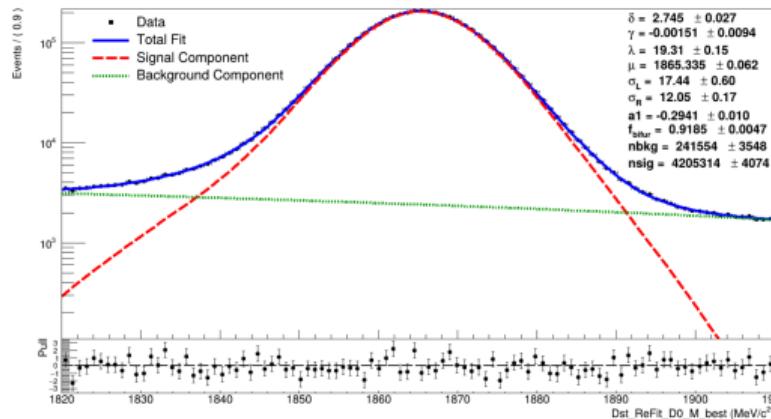


## 1D-Classifier Phase-Space Variables and D0 decay time sWeighted Before and After BDT Cut



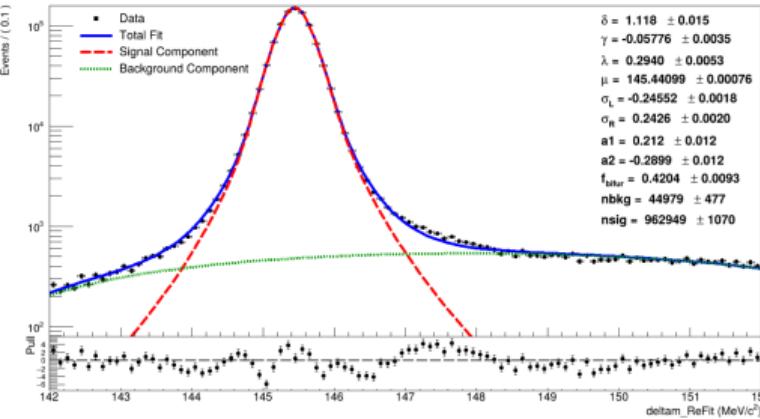
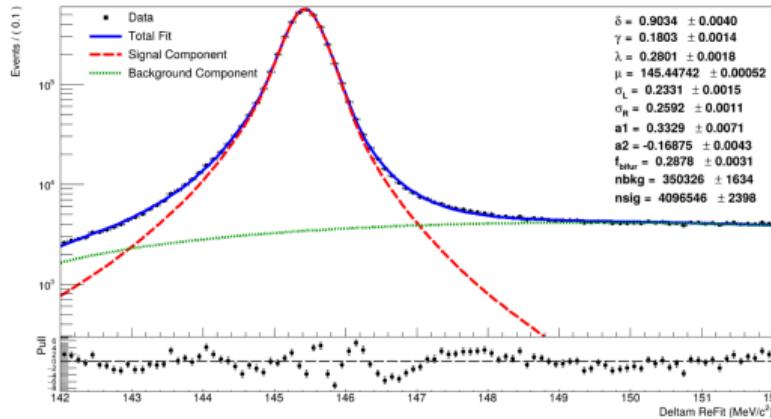


## RS Mass Fit of Dst\_ReFit\_D0\_M\_best with 2D Classifier BDT cut: (Signal = Johnson), (Background = Negative Exponential)

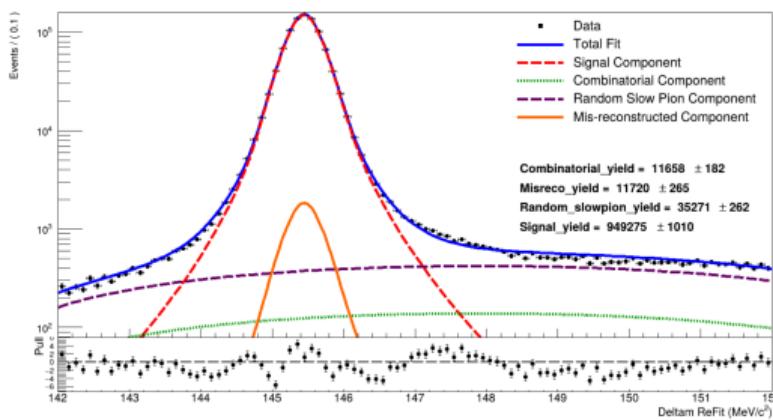
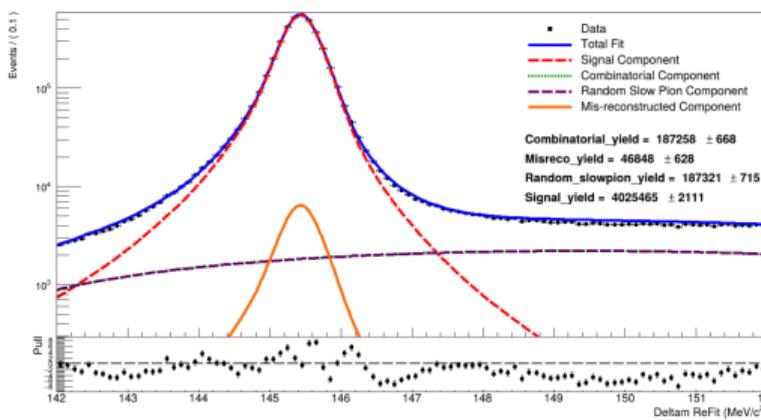




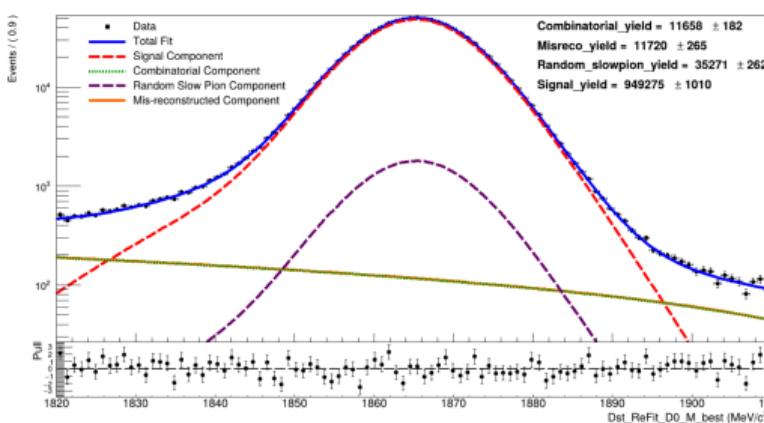
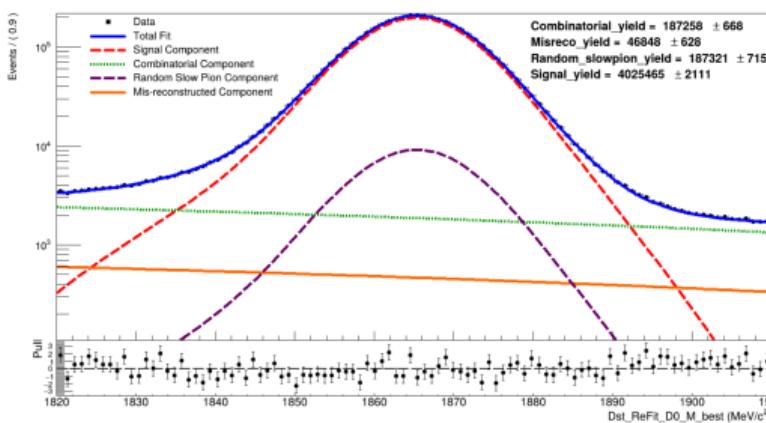
## RS Mass Fit of `deltam_ReFit` with 2D Classifier BDT cut: (Signal = Johnson), (Background = 2nd Order Polynomail)



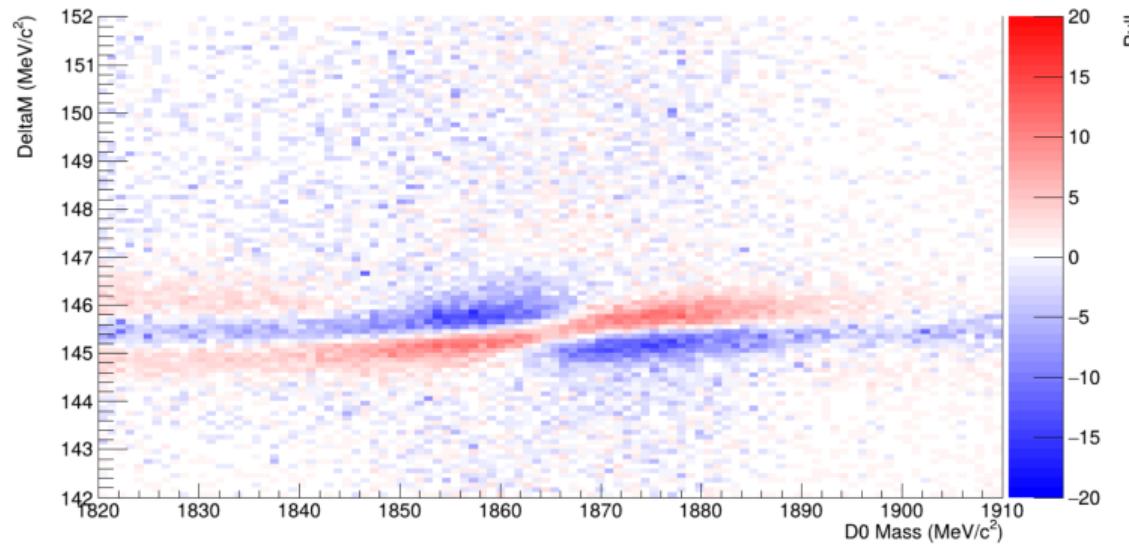
## RS 2D Mass Fit, **deltam\_ReFit**: (left = standard variable), (right = BDT 2D Classifier)



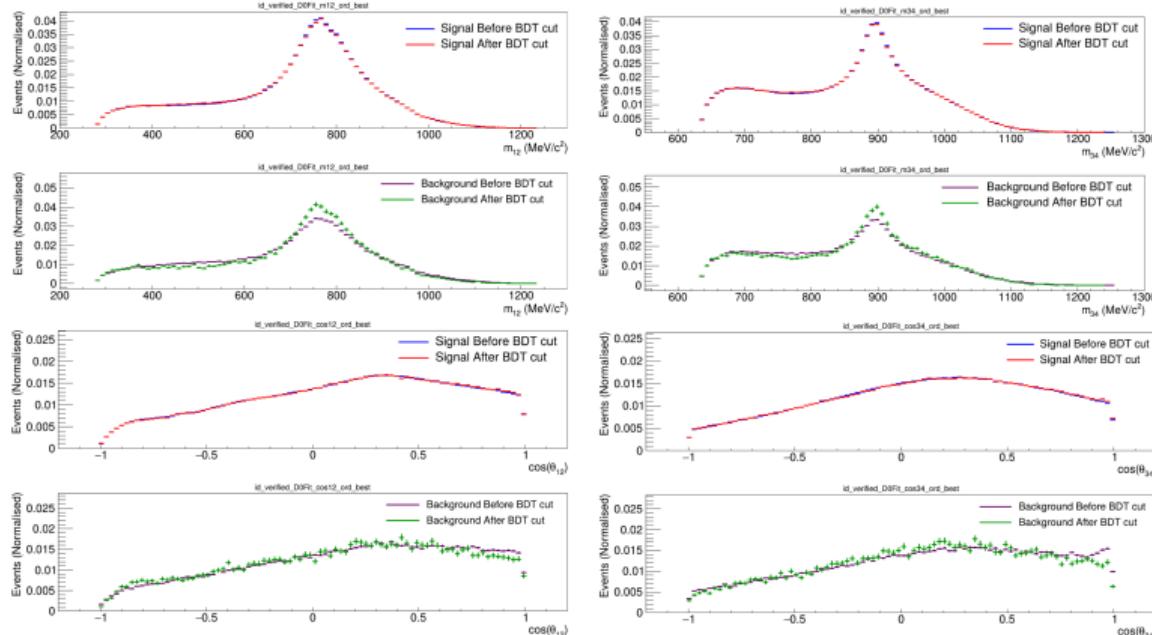
## RS 2D Mass Fit, Dst\_ReFit\_D0\_M\_best: (left = standard variable), (right = BDT 2D Classifier)

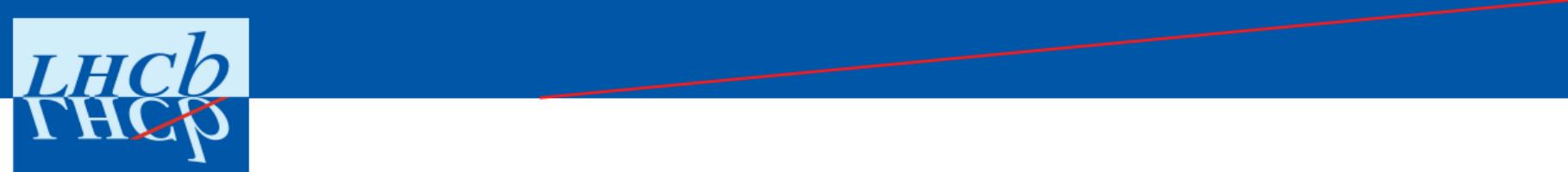


## 2D Pullplot for 2D Classifier

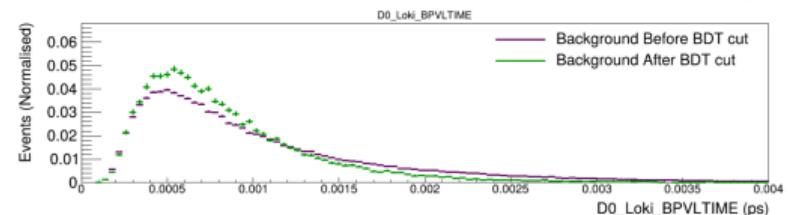
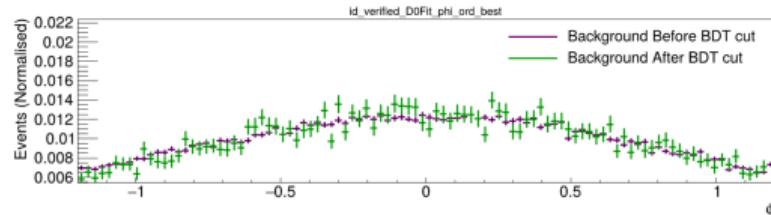
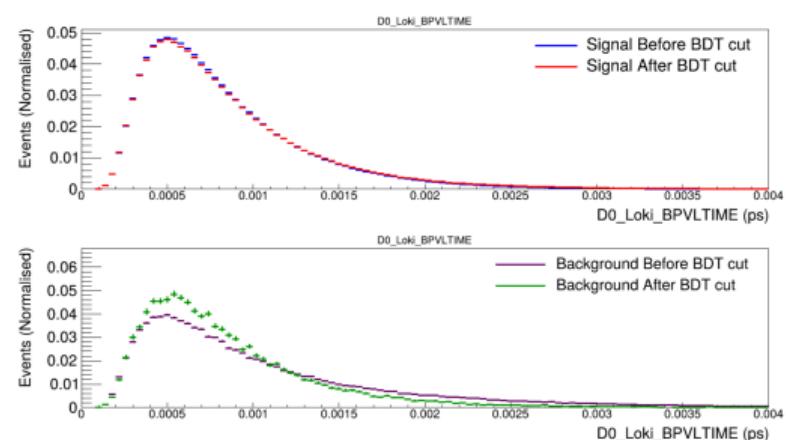
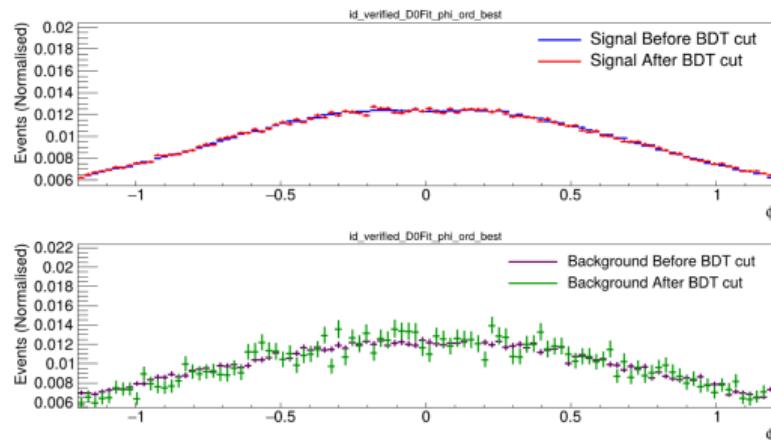


## 2D-Classifier Phase-Space Variables sWeighted Before and After BDT Cut





## 2D-Classifier Phase-Space Variables and D0 decay time sWeighted Before and After BDT Cut



**Conclusion:** There is no obvious sculpting of the phase space regions when cutting the BDT response(s).

Signal disagreement in phase space variables for the WS fit is due to sWeights not being a perfect discriminator. Leakage of background events into the signal region is easier to see, given fewer signal events in the WS sample.

When we take the BDT cut, we expect this background leakage to result in variables to be less signal dominated than before the BDT cut. The opposite can be seen for the RS fit, signal leakage into the background is observed.