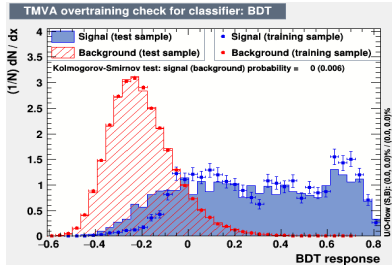# Search for dark matter production in association with a single top quark or a top quark pair in the dilepton final state at $\sqrt{s} = 13$ TeV

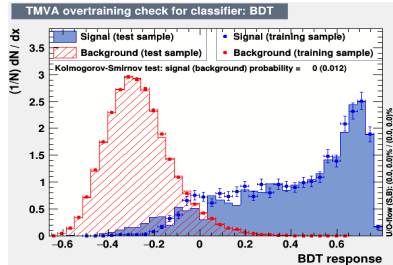Pablo Martínez Ruíz del Árbol, Jónatan Piedra Gomez, **Cédric Prieëls**
February 9th 2022

Thesis Endorsement - Answer to questions
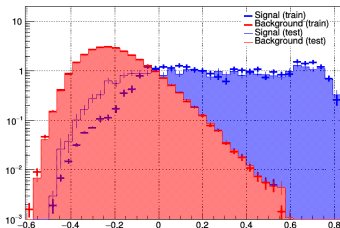Instituto de Física de Cantabria

"You showed that signal in the low BDT region has large data/simulation disagreement. This should be investigated. In addition, it would be good to see the overtraining plots in log-scale so that we ensure there is no large further disagreement in the tails of the background in the high BDT region."

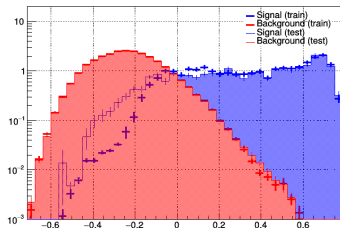We first of all produced the exact same plots in log scale, as required.

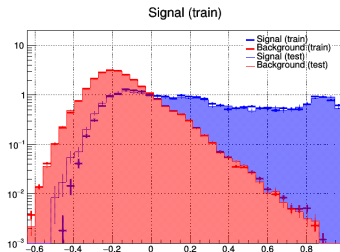| Scalar 100 GeV	Pseudo 100 GeV
Signal (train)	Signal (train)

These plots comfort us in the fact that no sign of test/train discrepancy is observed for the background samples, even in the tail.
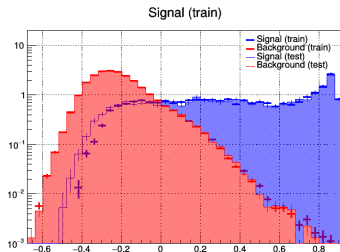
Low BDT region large discrepancies

For the training process, both the $t/\bar{t}$ and $t\bar{t}$+DM are mixed together, with a weight corresponding to their respective cross-sections, however in the test we were using the same number of events for both signals. If we set the same conditions in train and test then the agreement is much better.

This small discrepancy on the left side of the signal distribution was probably somehow an artifact of the composition of the test sample.

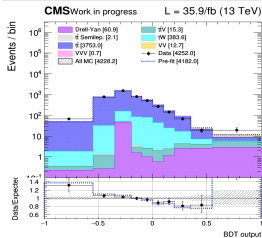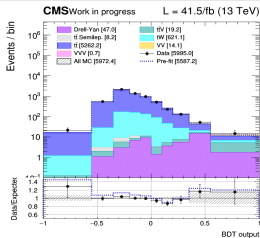These discrepancies should not have any impact on the final results as they impact a region with very low amounts of signal.

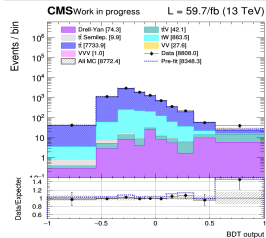$t/\bar{t}$+DM region (scalar 100 GeV)

$t\bar{t}$+DM region
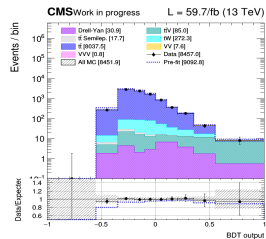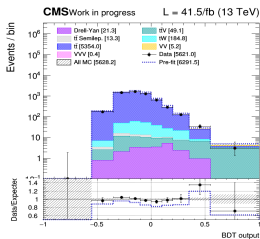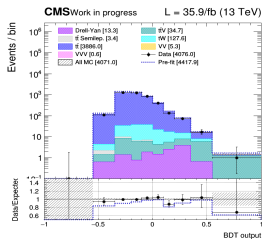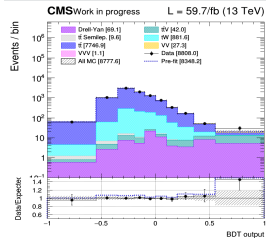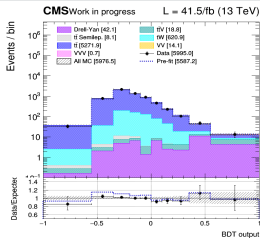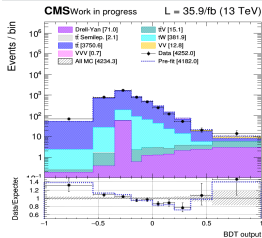
Post-fit plots (pseudoscalar 100 GeV)
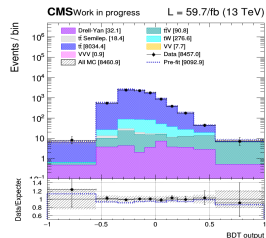
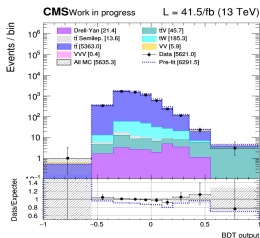

$t/\bar{t}$+DM region (pseudoscalar 100 GeV)
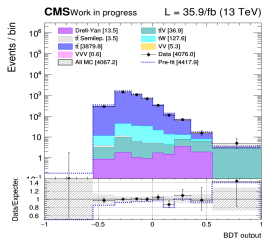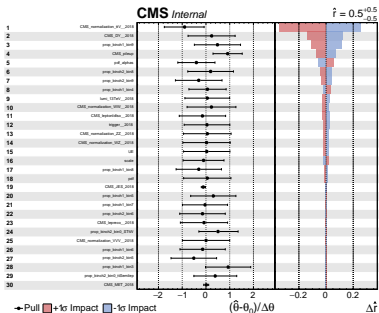
2016   2017   2018

$t\bar{t}$+DM region

All the post-fit plots can be found in the v4 of the AN-22-014.
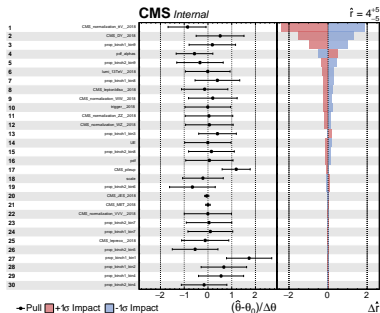
Pulls and impact plots

" In addition, please provide information on the fit itself: such as pulls with the data."

2018, scalar

100 GeV | **500 GeV**

All the impact plots with real data can also be found in the newest version of the AN.
In general no large pulls, the most significant effect is the constraint of the JES/MET.

Pulls and impact plots

These strong constraints seem to come from the low BDT output region of the plots fed into the algorithm, where a lot of $t\bar{t}$ can be found. This region is playing the role of a control region constraining a lot these two systematic.

We therefore tried removing the BDT output < 0 region and observed that the constraints were gone.

2018, scalar