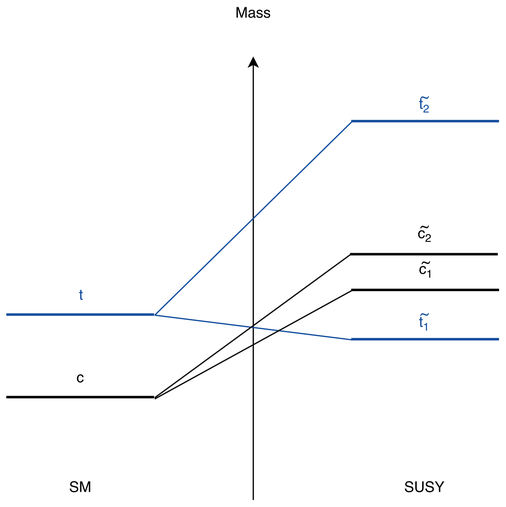
Search for the Supersymmetric partner of the top quark at the LHC: Multivariate approach

Diogo de Bastos, Pedrame Bargassa, Cristóvão da Cruz e Silva and João Varela
LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS

Motivation for stop decaying four-body

The supersymmetric partner of the top quark (stop) might be the lightest squark. Therefore, a great particle to search for at the LHC.

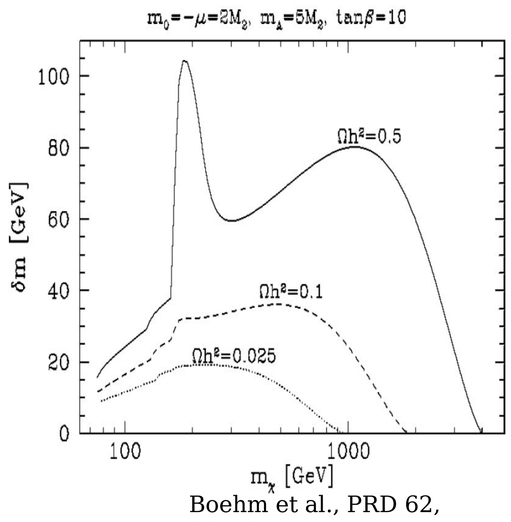


Knowing that the Neutralino is a candidate for Cold Dark Matter (CDM) in many supersymmetry (SUSY) models and with the cosmology argument in mind:

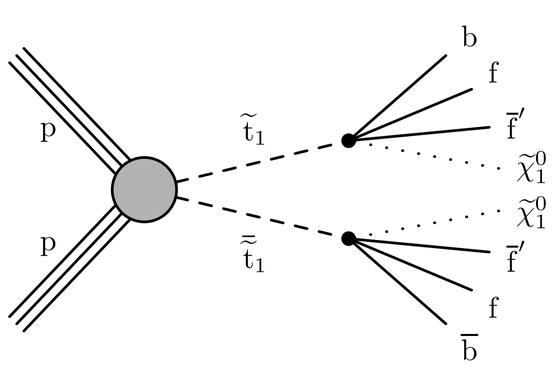
$$\Omega_{CDM}h^2 = 0.11 \pm 0.02$$

We define δm as:

$$\delta m = M(\widetilde{P}) - M(\widetilde{\chi}_1^0)$$



Boehm et al., PRD 62, 35012



Taking into account the figure on the left we conclude that δm < 50 GeV:

$$M(\widetilde{t}_1) - M(\widetilde{\chi}_1^0) \leq 50GeV$$

The four-body decay of stop meets this requirements:

$$\widetilde{t}_1 \rightarrow bff'\chi_1^0$$

In this analysis will be looking at a signature of:

$$1l + jets + E_T^{miss}$$

Standard Model Background

There are standard model processes that imitate the signal signature. These are considered as background. The main background processes are:

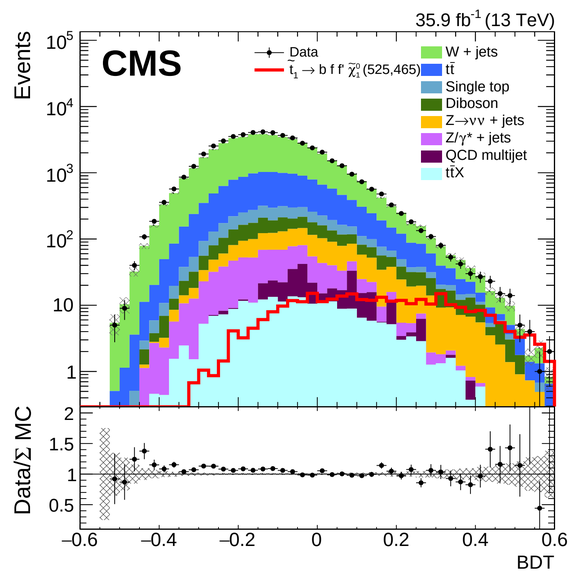
$$W + jets$$

$$t\bar{t}$$

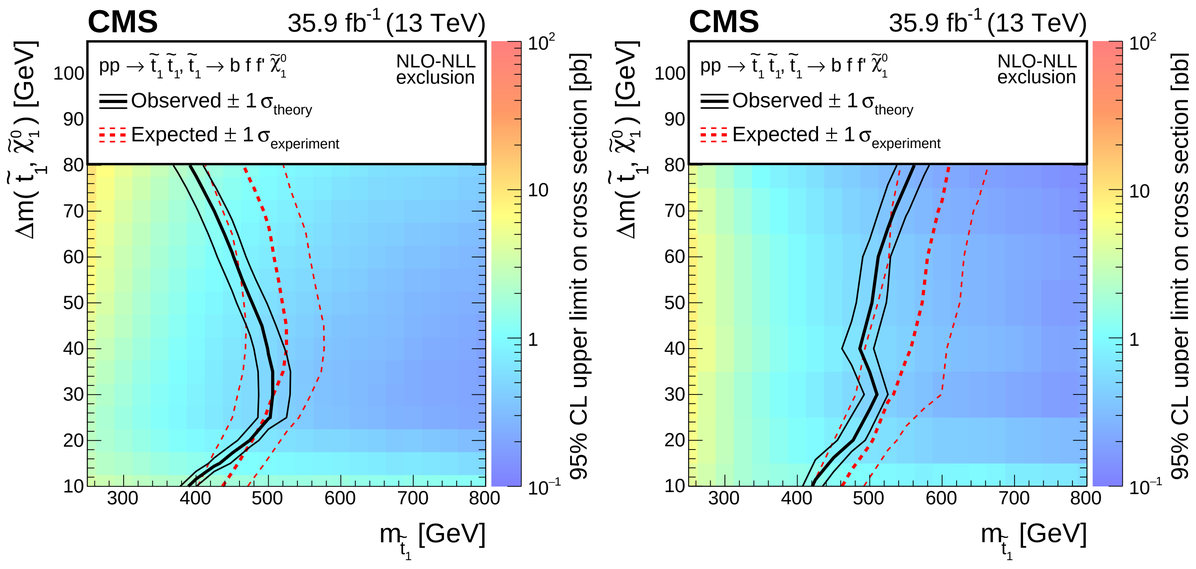
$$Z \rightarrow \nu\nu + jets$$

Previous Analysis: Boosted Decision Trees

For the signal selection, we use a boosted decision tree (BDT) to take advantage of the differences of correlations among discriminating variables between signal and background. The following figure shows the output distribution of the BDT in data and for the total SM background as taken from MC simulation:



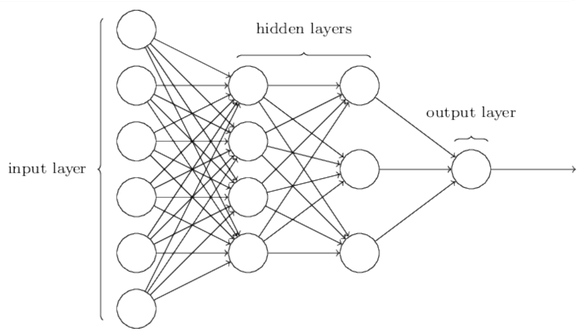
No evidence for direct stop production is observed, as can be seen in the next figure for "cut-and-count" approach (left) and for BDT approach (right):



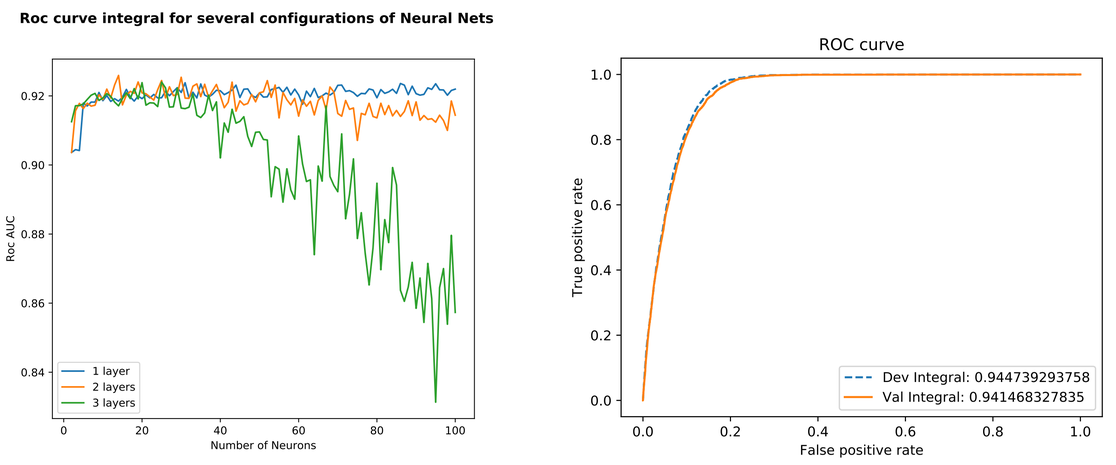
The Multivareate approach improves the "cut-and-count".

Very Preliminary Results: using Deep Learning

We want to use Artificial Neural Networks (ANNs) to better classify signal and background. The first step is to use the same data used for the BDTs to train an ANN. Then, evaluate it's performance and tune it to achieve a good classifier.



One way to find the best performing ANN is to train various configurations and choose the one with the best performance according to the Receiver operating characteristic (ROC) curve.



Work in progress: Next steps

- The best performing ANN so far is a feed forward neural network with 2 hidden layers each with 14 neurons. Reaching a ROC curve integral of ≈ 0.94
- Other ANN architectures will be exploited to improve area under ROC curve
- Test on data from 2016 and compare to BDT output
- Train and test on data from 2016+2017
- Analysis Note

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