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Optimisation of the multivariate discriminant in the search for the New Physics

21.04.23

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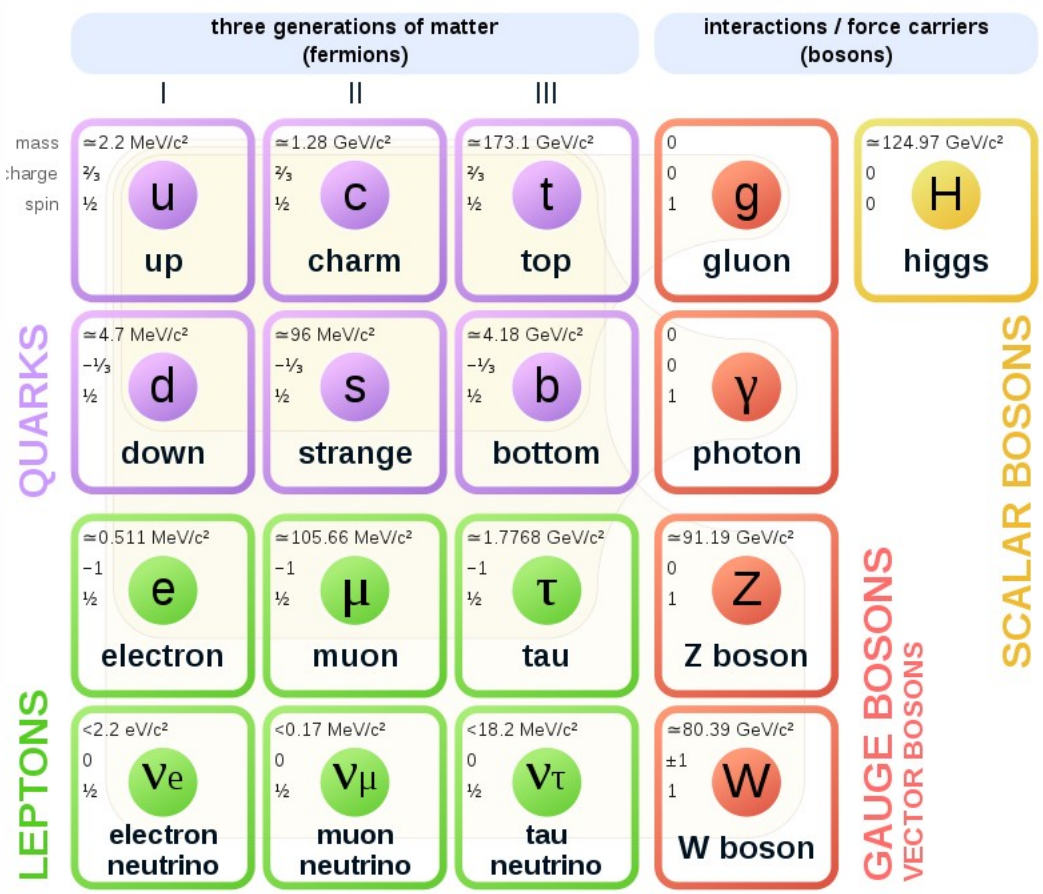
Plan of the presentation

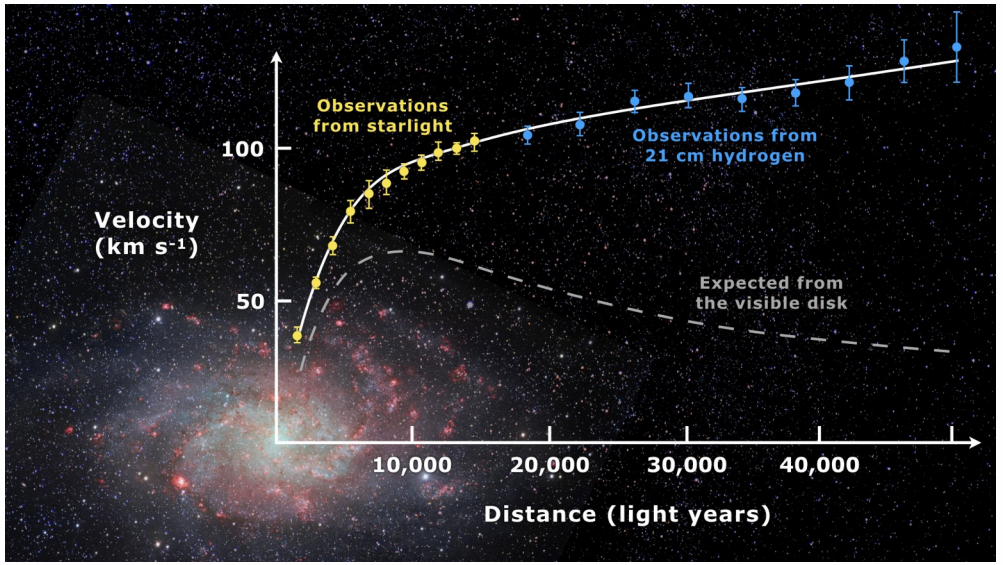
- What is the New Physics
- Charged Higgs boson
- Data analysis in the ATLAS experiment

The Standard Model



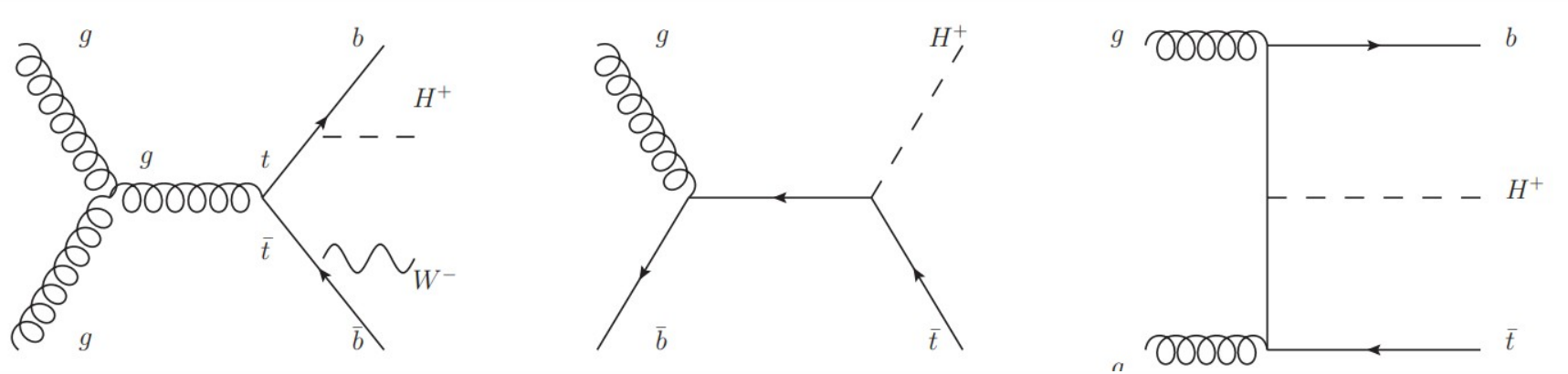
What the Standard Model can't explain

- Gravity
- Dark matter, dark energy
- Matter-antimatter asymmetry
- Neutrino's mass
- … and more



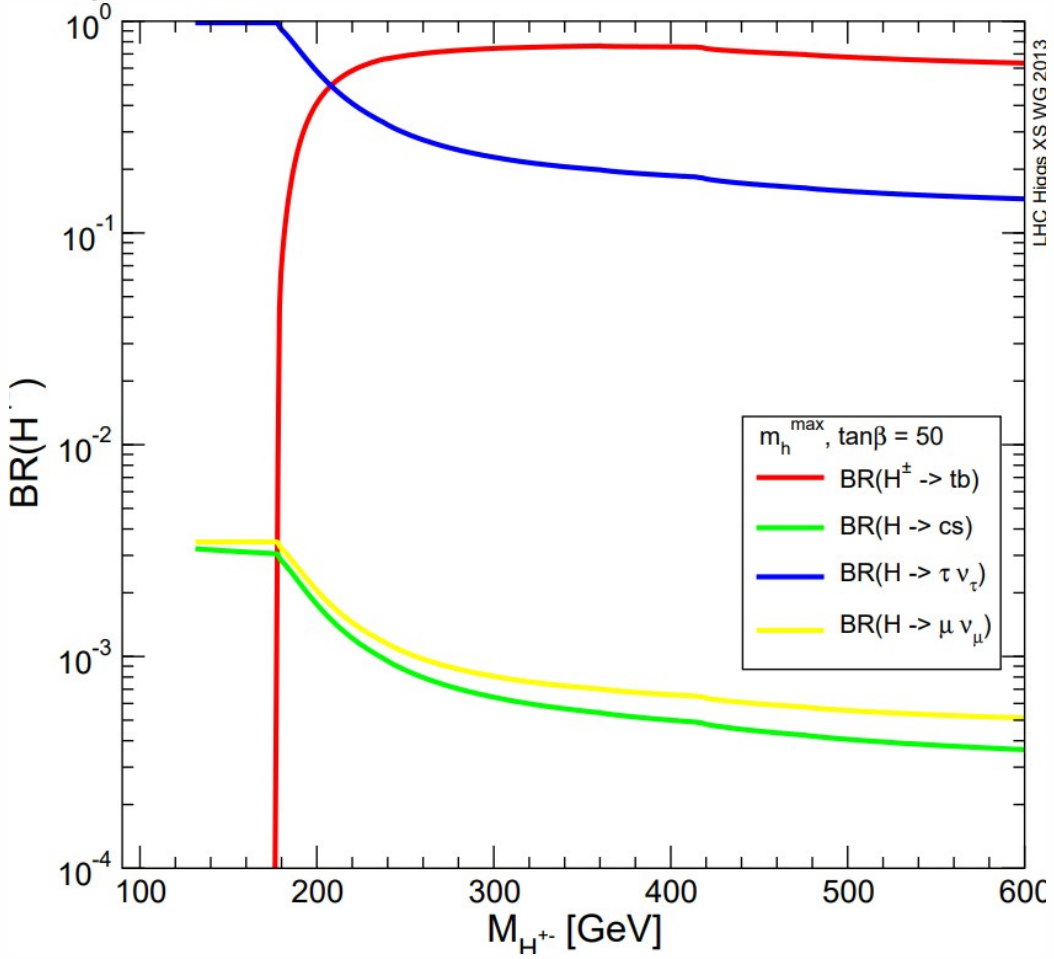
Rotation curve of the galaxy Messier 33

Beyond the Standard Model?



H^+ production modes in the Minimal Supersymmetric Extension of the Standard Model

Beyond the Standard Model?

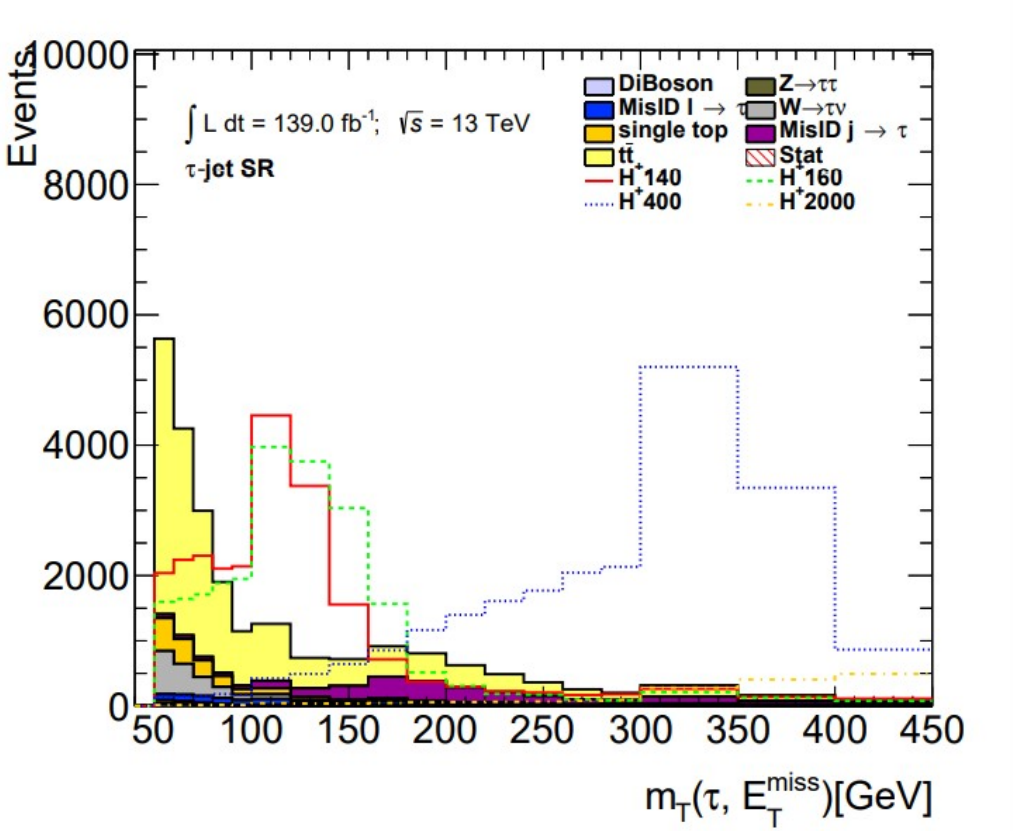


The analysis searches for the decay:

$$H^+ \rightarrow \tau\nu$$

Branching ratios of the different charged Higgs decays.

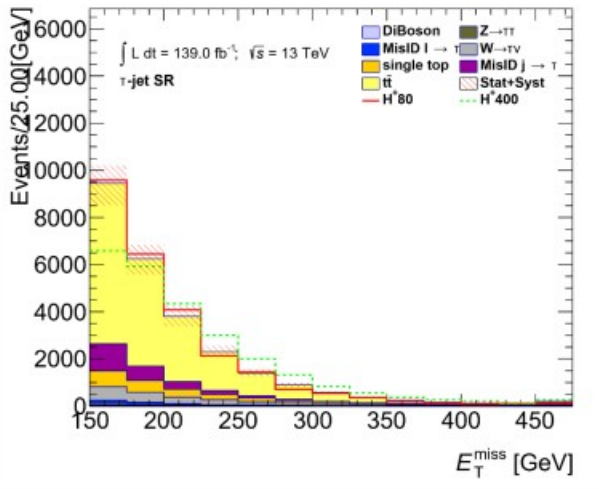
Cuts on the variables

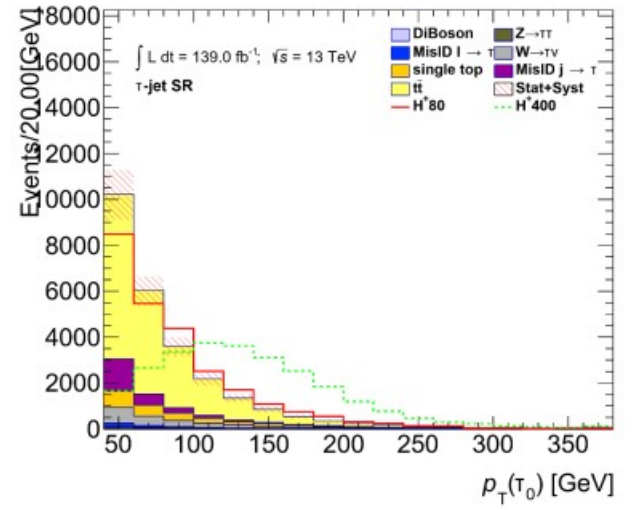


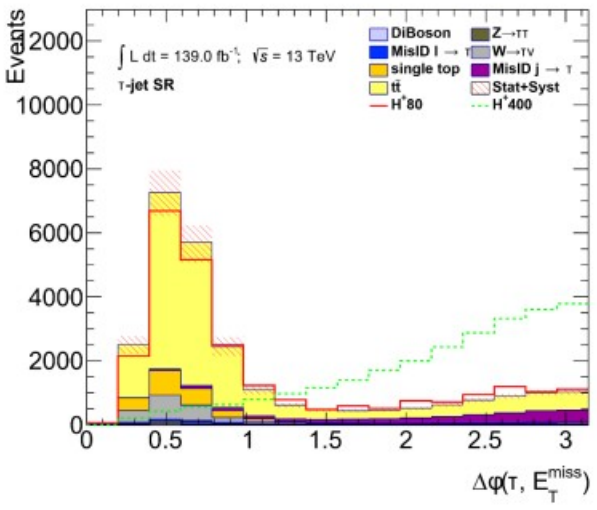
Multivariate Discriminant

Many variables are used to train a machine learning algorithm so they can be combined into a multivariate discriminant, which allows for the optimised separation of the signal and background.

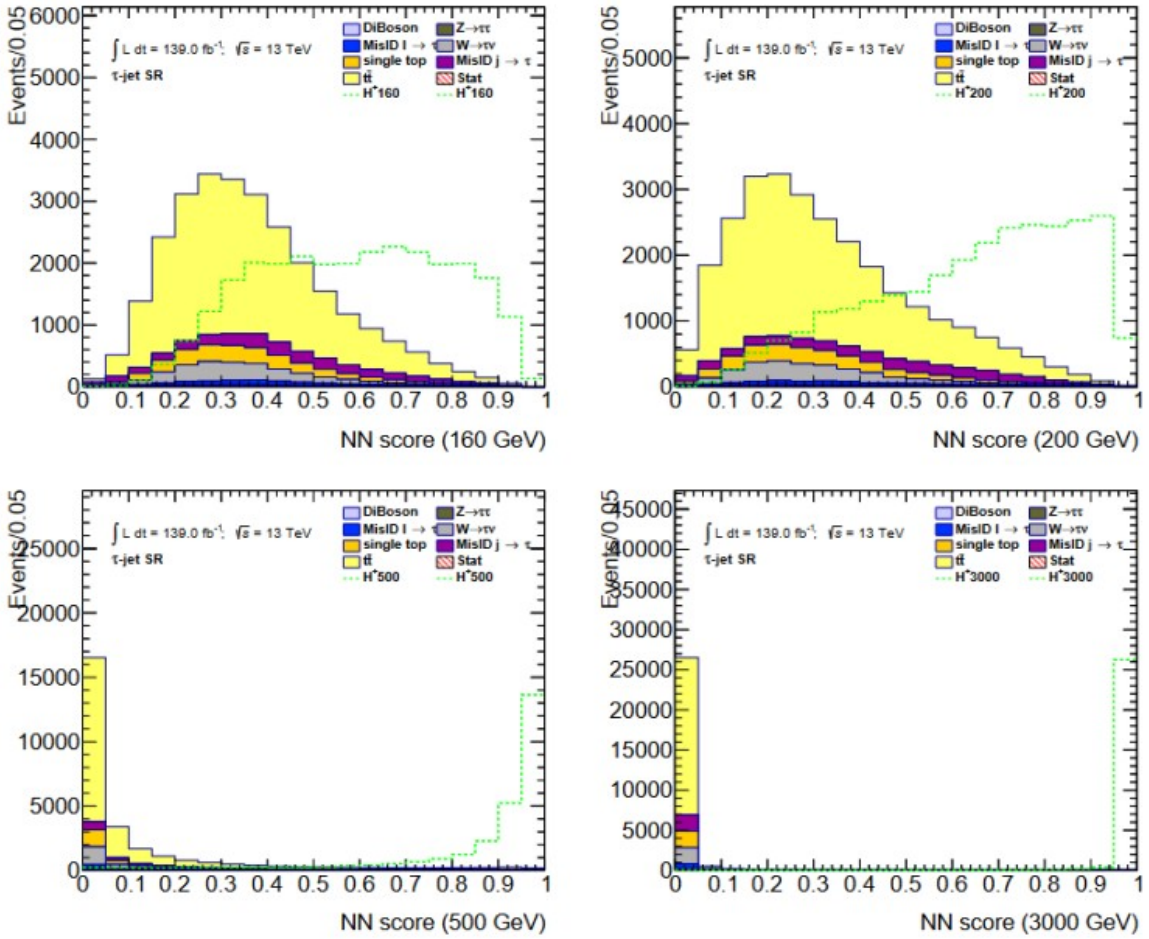
Signal vs background separation for the 3 strongest variables used for PNN training



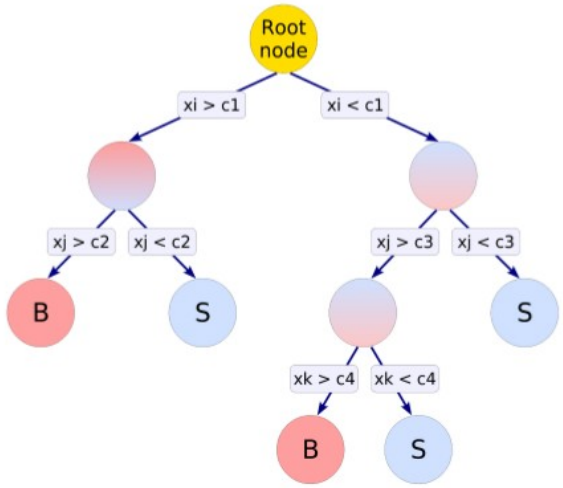




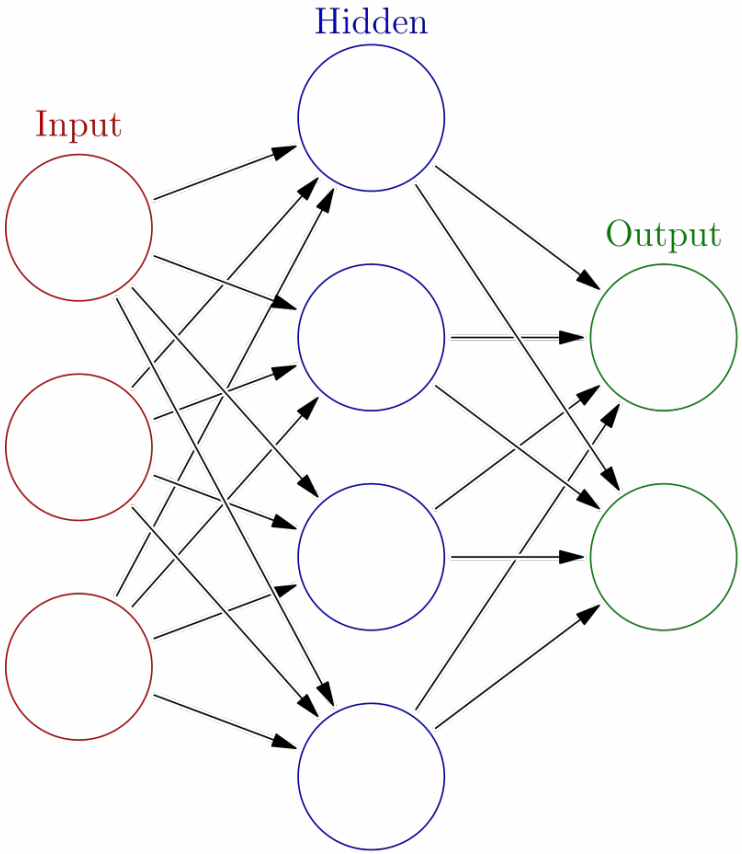
pNN score distribution in the signal region for 4 different values of H^+ mass



Multivariate discriminant - machine learning methods used

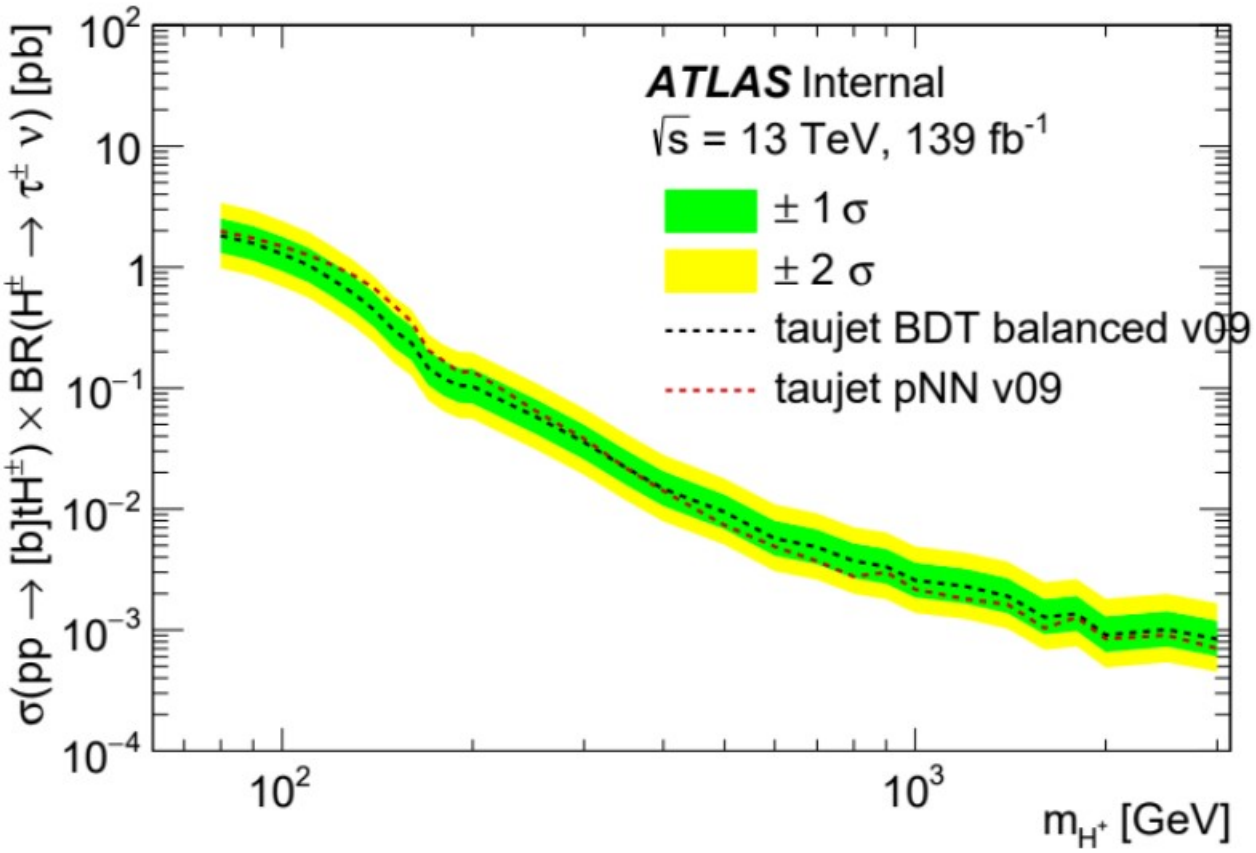


Boosted Decision Trees



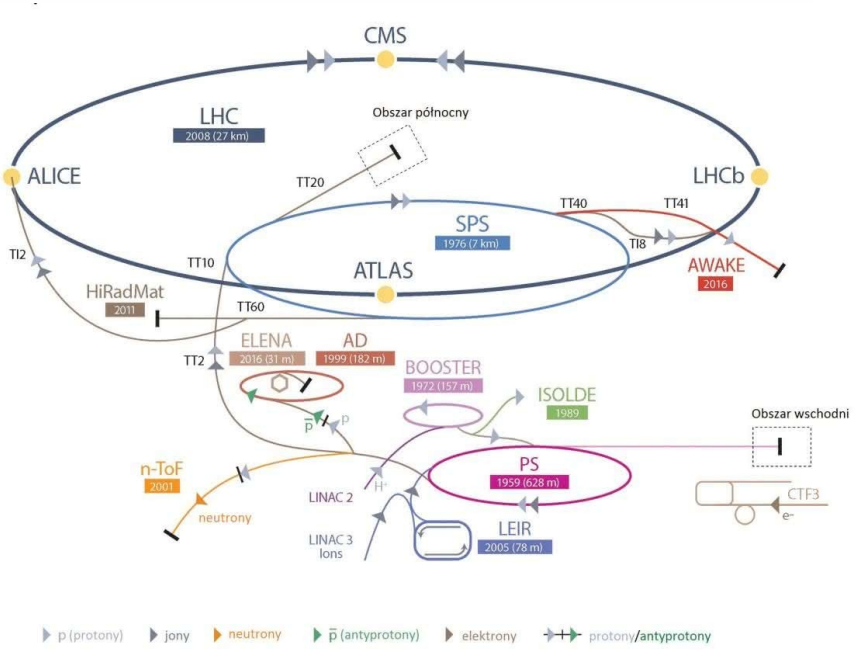
Neural Networks

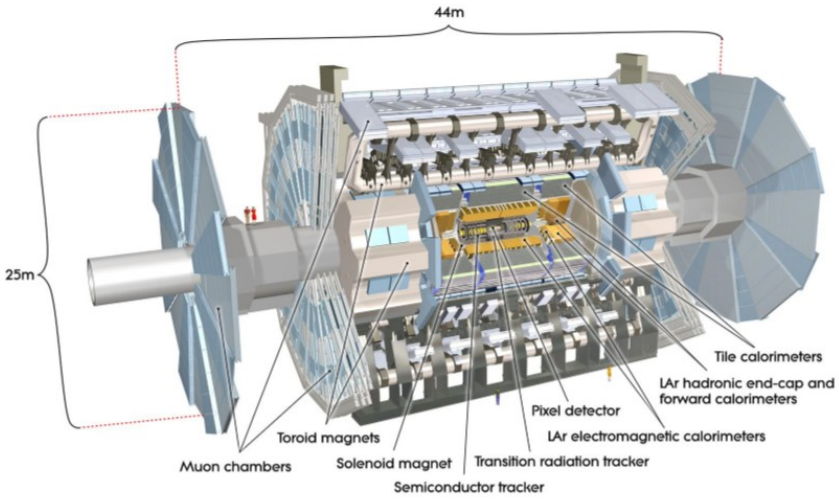
Comparison of expected limits on σ(pp → [b]tH+) × BR(H+ → τν) as a function of H+ mass for the results obtained with BDTs and pNNs.



THANK YOU FOR YOUR ATTENTION

Data collection





Trigger system

Up to 1.7 billion proton-proton collisions per second

Hardware trigger: 100,000 events per second

Software trigger: 1000 events per second

Kinematic variables used as an input to pNNs

PNN input variable	$\tau_{\text{had-vis}}$+jets	$\tau_{\text{had-vis}}$+lepton
$E_{\text{T}}^{\text{miss}}$	✓	✓
p_{T}^{τ}	✓	✓
$p_{\text{T}}^{b\text{-jet}}$	✓	✓
p_{T}^{ℓ}		✓
$\Delta\phi_{\tau_{\text{had-vis}},\,\text{miss}}$	✓	✓
$\Delta\phi_{b\text{-jet},\,\text{miss}}$	✓	✓
$\Delta\phi_{\ell,\,\text{miss}}$		✓
$\Delta R_{\tau_{\text{had-vis}},\,\ell}$		✓
$\Delta R_{b\text{-jet},\,\ell}$		✓
$\Delta R_{b\text{-jet},\,\tau_{\text{had-vis}}}$	✓	
$\Delta\phi_{\tau_{\text{had-vis}},\text{miss}}/\Delta\phi_{\text{jet,miss}}$	✓	✓
Υ	✓	✓