ATLAS EXPERIMENT

Search for direct top squark pair production in the 3-body decay mode with one lepton final states in √s=13 TeV pp collisions with the ATLAS detector
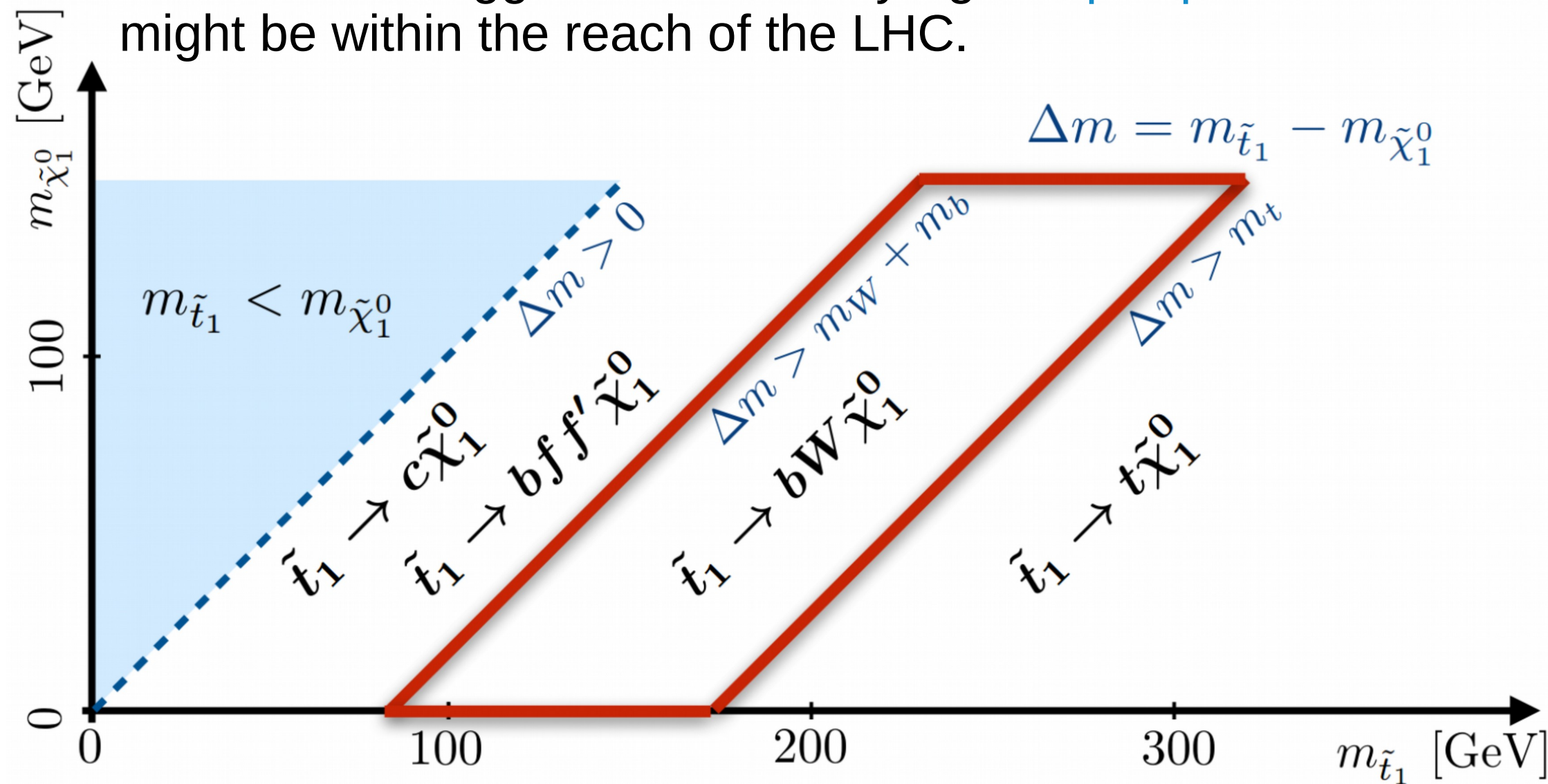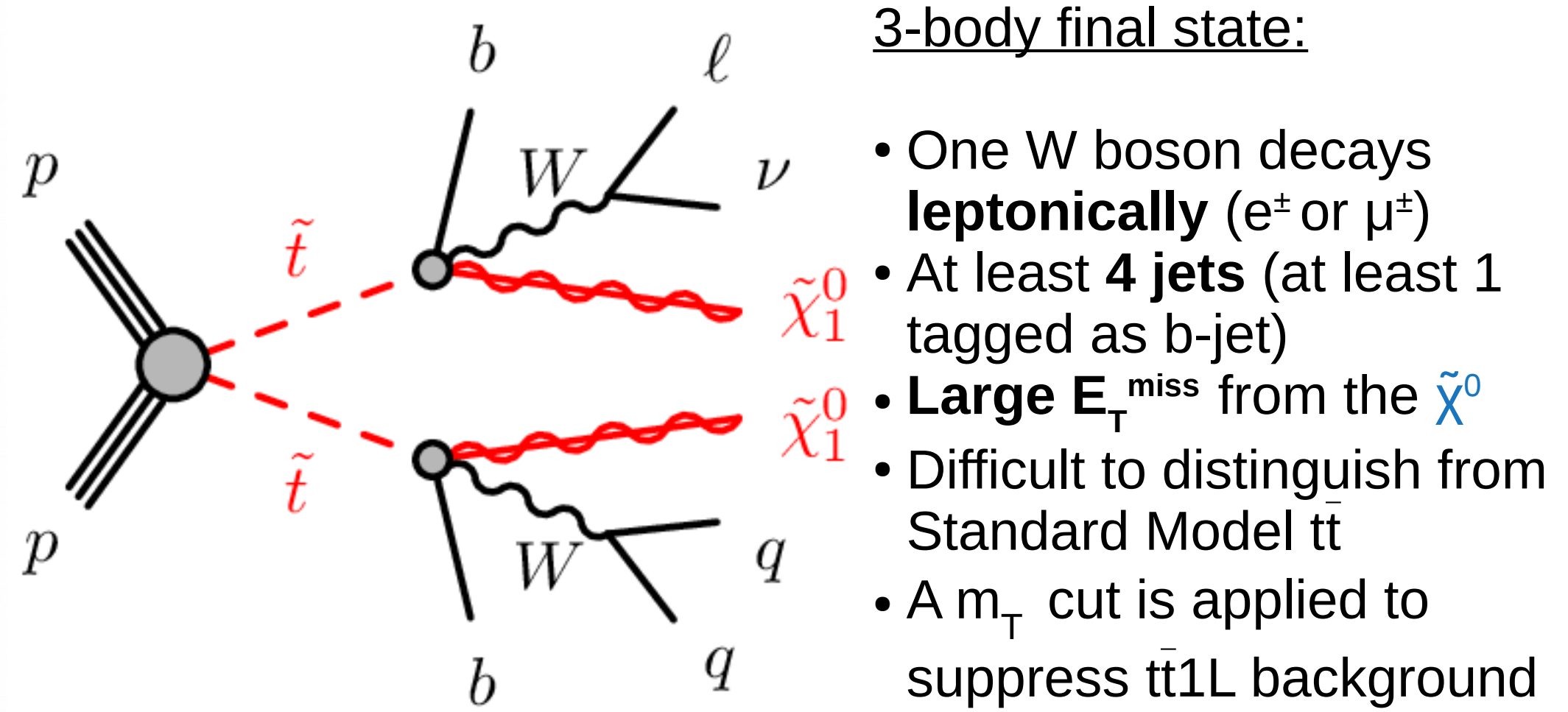
Overview

Naturalness suggests a relatively light top squark $\tilde{t}$ which might be within the reach of the LHC.

Simplified model for pair-produced $\tilde{t}$ decaying with 100% BR to neutralinos $\tilde{\chi}_1^0$ (dark matter candidates!).
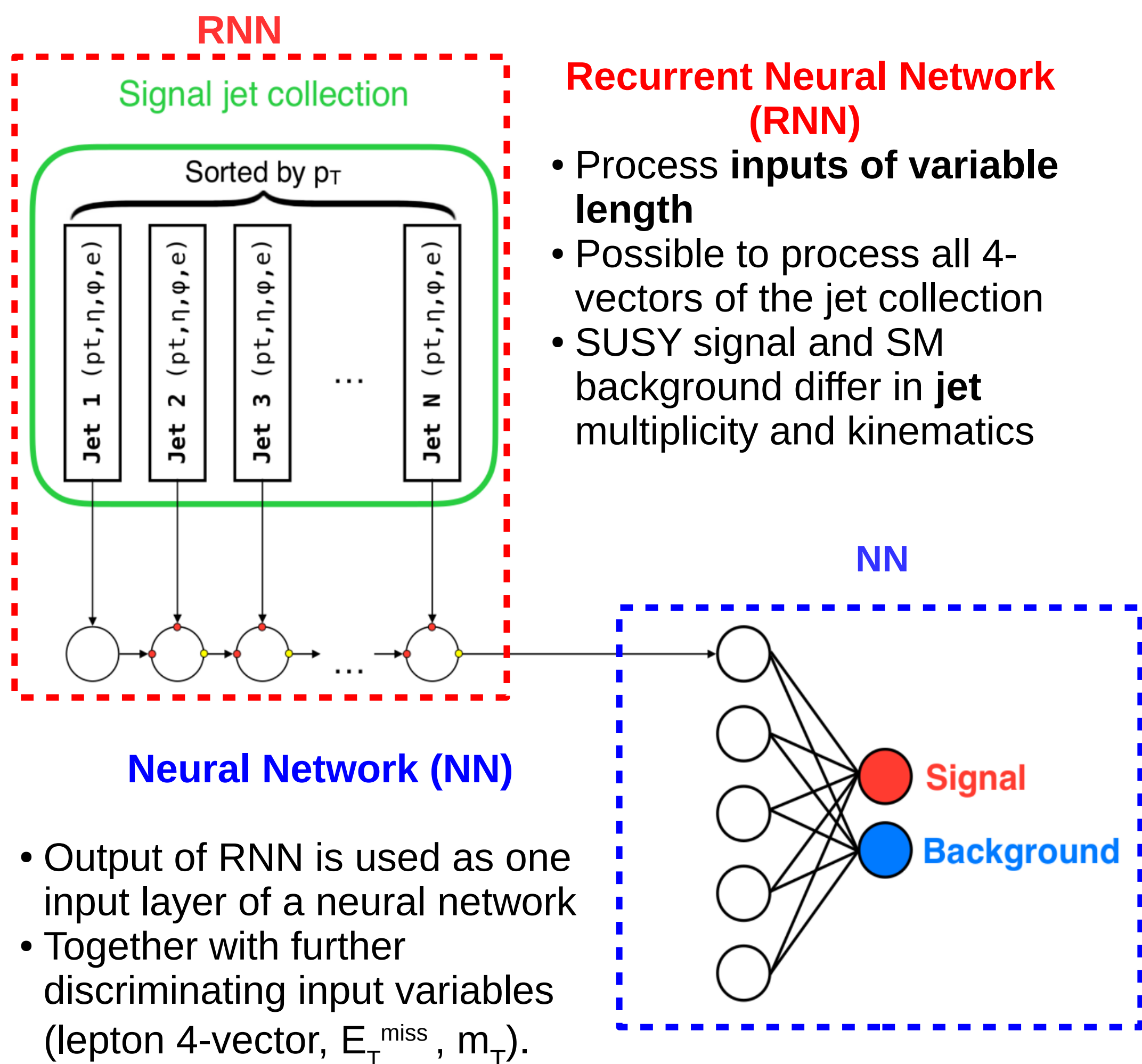

$\Delta m = m_{\tilde{t}_1} - m_{\tilde{\chi}_1^0}$

$m_{\tilde{t}_1} < m_{\tilde{\chi}_1^0}$ $\Delta m > 0$

$\tilde{t}_1 \to c\tilde{\chi}_1^0$ $\tilde{t}_1 \to bff'\tilde{\chi}_1^0$ $\Delta m > m_W + m_b$ $\tilde{t}_1 \to bW\tilde{\chi}_1^0$ $\Delta m > m_t$ $\tilde{t}_1 \to t\tilde{\chi}_1^0$

3-body final state:

- One W boson decays **leptonically** (e± or μ±)
- At least **4 jets** (at least 1 tagged as b-jet)
- **Large E_T^{miss}** from the $\tilde{\chi}_1^0$
- Difficult to distinguish from Standard Model $t\bar{t}$
- A m_T cut is applied to suppress $t\bar{t}$1L background

Analysis Strategy

A machine learning (ML) algorithm based on two related learning techniques:

RNN

Signal jet collection

Sorted by p_T

Jet 1 (p_T, η, φ, e) Jet 2 (p_T, η, φ, e) Jet 3 (p_T, η, φ, e) ... Jet N (p_T, η, φ, e)

Recurrent Neural Network (RNN)

- Process **inputs of variable length**
- Possible to process all 4-vectors of the jet collection
- SUSY signal and SM background differ in **jet multiplicity and kinematics**

Neural Network (NN)

- Output of RNN is used as one input layer of a neural network
- Together with further discriminating input variables (lepton 4-vector, E_T^{miss}, m_T).
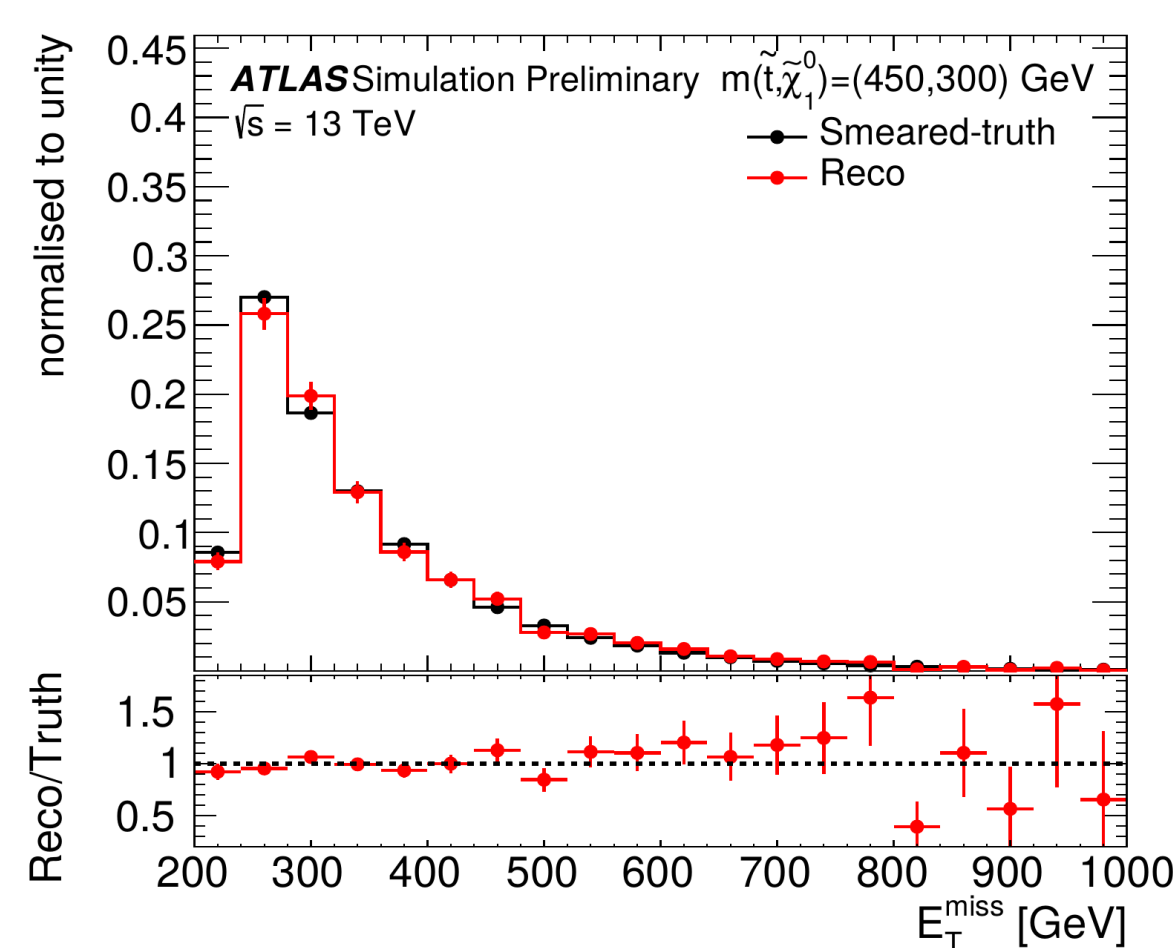
NN

Signal
Background

Single discriminating variable based on a machine learning classifier trained at preselection.

- **Normalize** simulated $t\bar{t}$ events to data (CR)
- **Extrapolation** from CR to SR
- **Verify** extrapolation in VR
- **Signal enriched** region (SR)
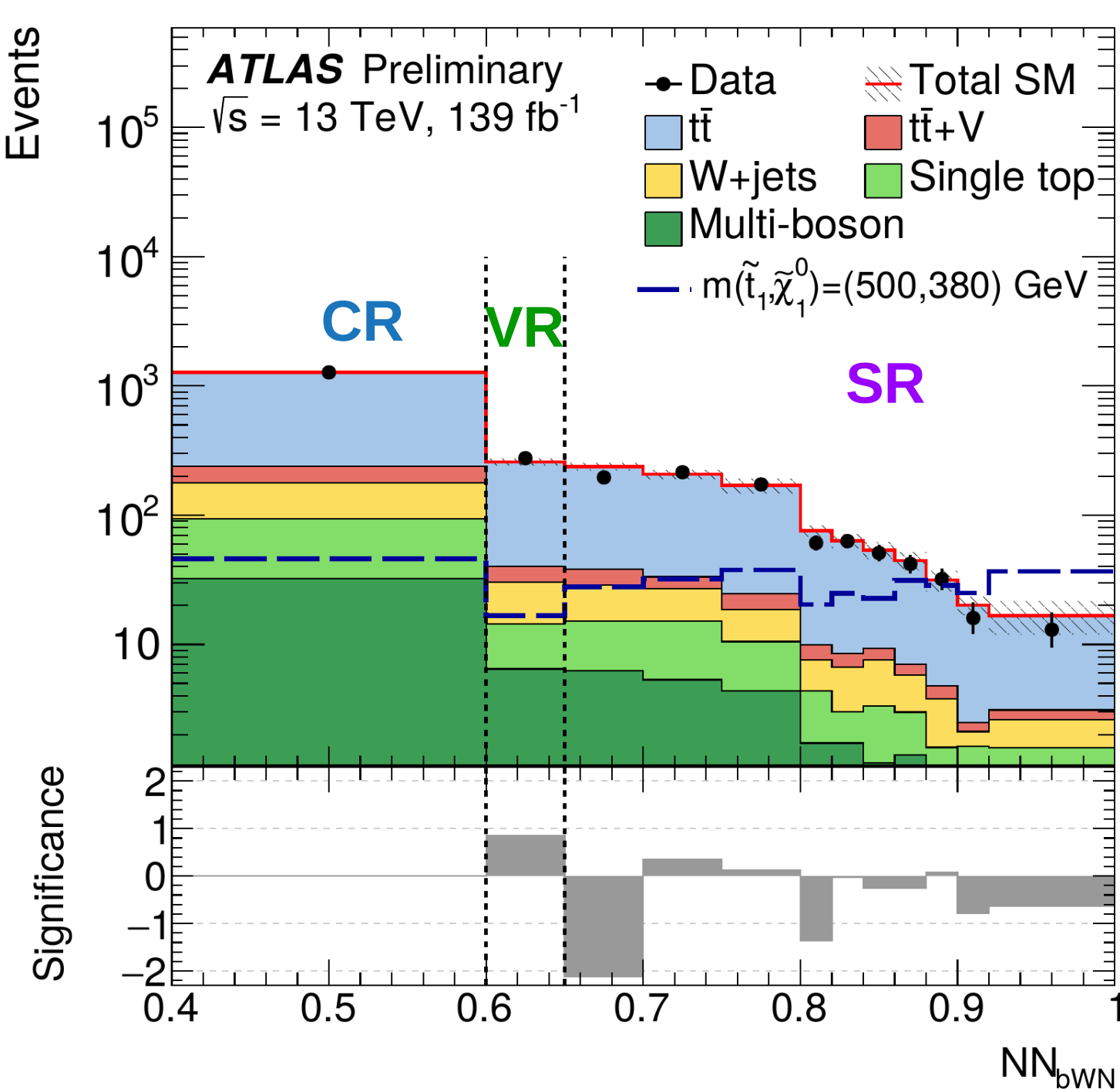- **Exclusion shape fit** (10 bins)
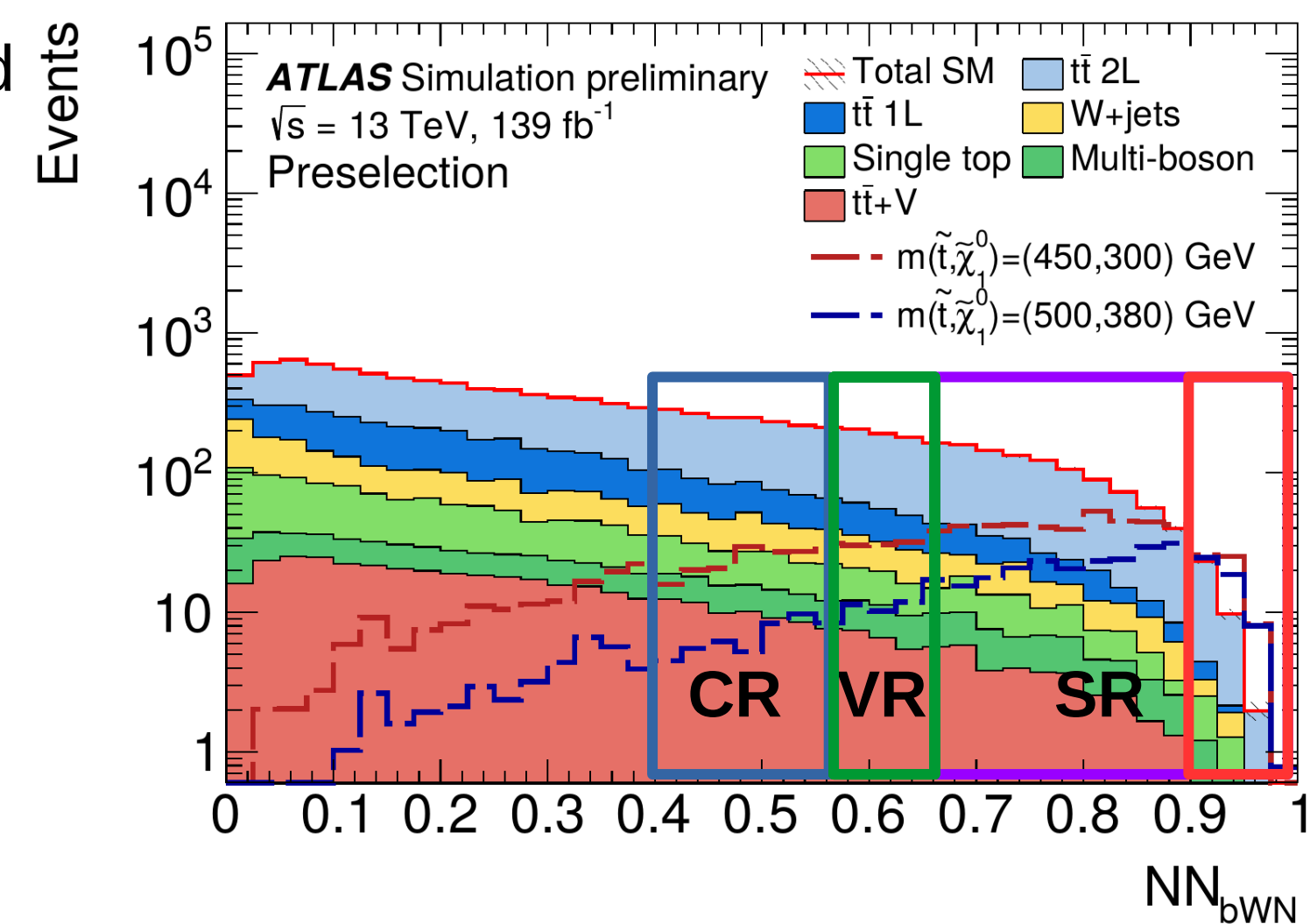
Performance of ML classifier depends on the training **statistics**

- Training performed with particle-level signal events (Truth) and detector-level events (Reco)
- Applied a dedicated smearing procedure to the signal at truth level
- Signal statistics enhanced by a **factor of 75**

Results and Interpretation

- Reasonable agreement between Data and SM prediction along the ML classifier output score
- Since there is no significant excess, derive exclusion limits at 95% confidence level
- Improved exclusion limits

More information : **ATLAS-CONF-2019-017**

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