

Beyond Standard Model with the ATLAS Experiment

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FOR FUNDAMENTAL PHYSICS

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Introduction

Up to 3 new BSM results to be presented at ECFA.

SUSY:

- Compressed Stop pair production
- Direct stau production
- Direct pair production of a chargino and a neutralino (1L+2bjet)*

Exotics:

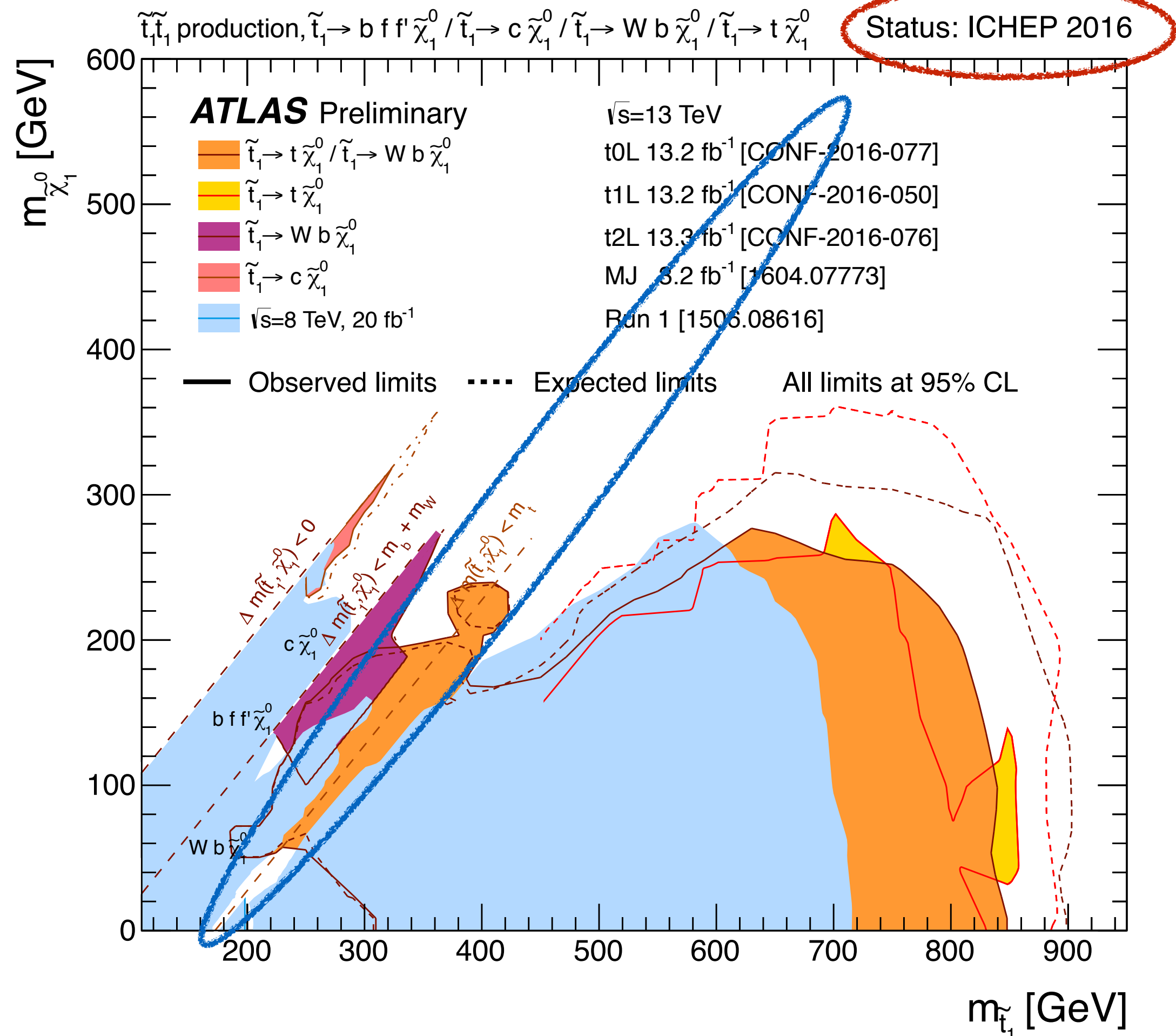
- $t\bar{t}$ resonance
- Dijet resonance searches*
- Search for resonant HH to bbbb production*

*results already Public

Results were done with standard approach of using smearing functions.

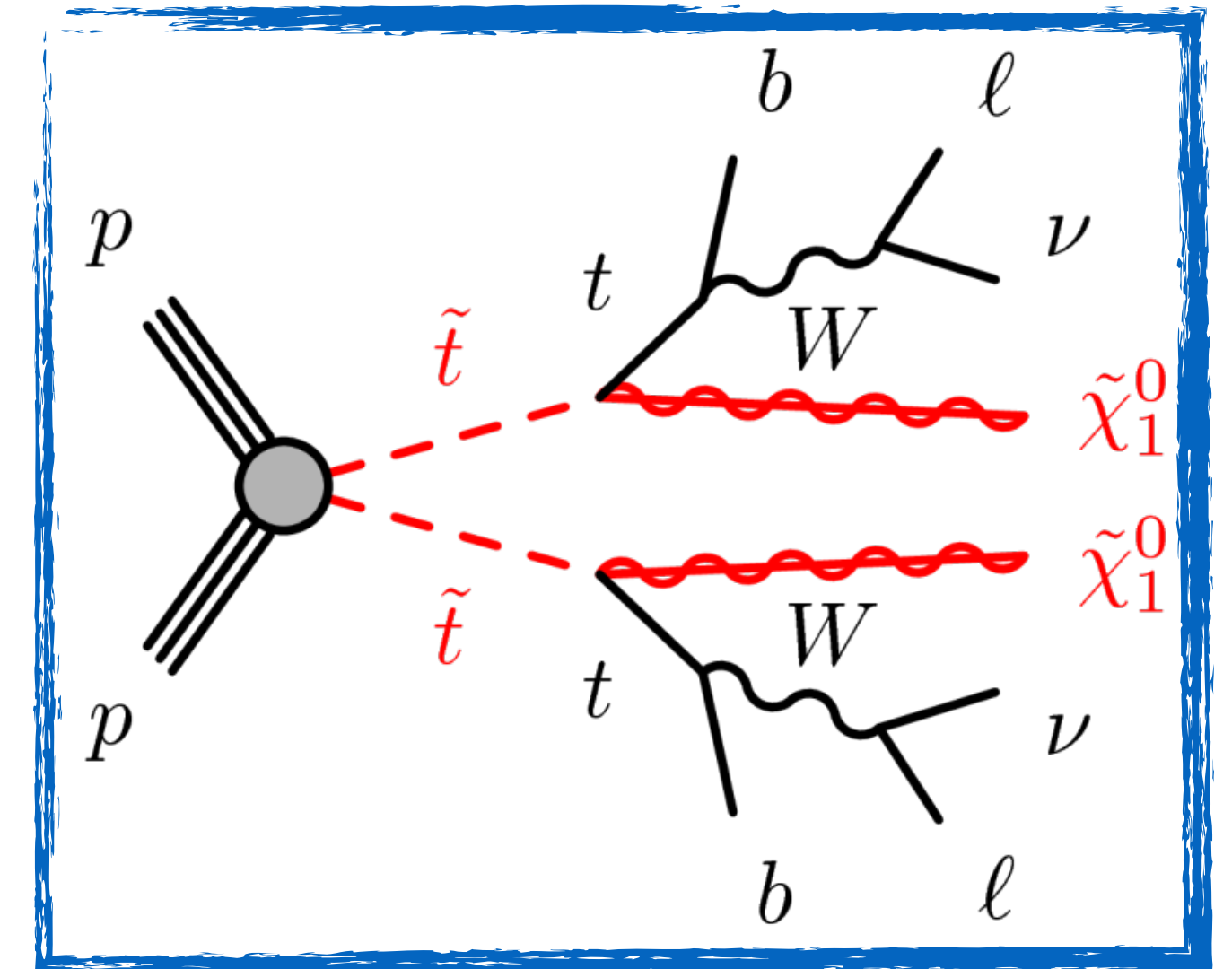
Prospect for a search for direct pair production of top squarks with compressed mass spectra at the high luminosity LHC with the ATLAS Detector

IN PREPARATION



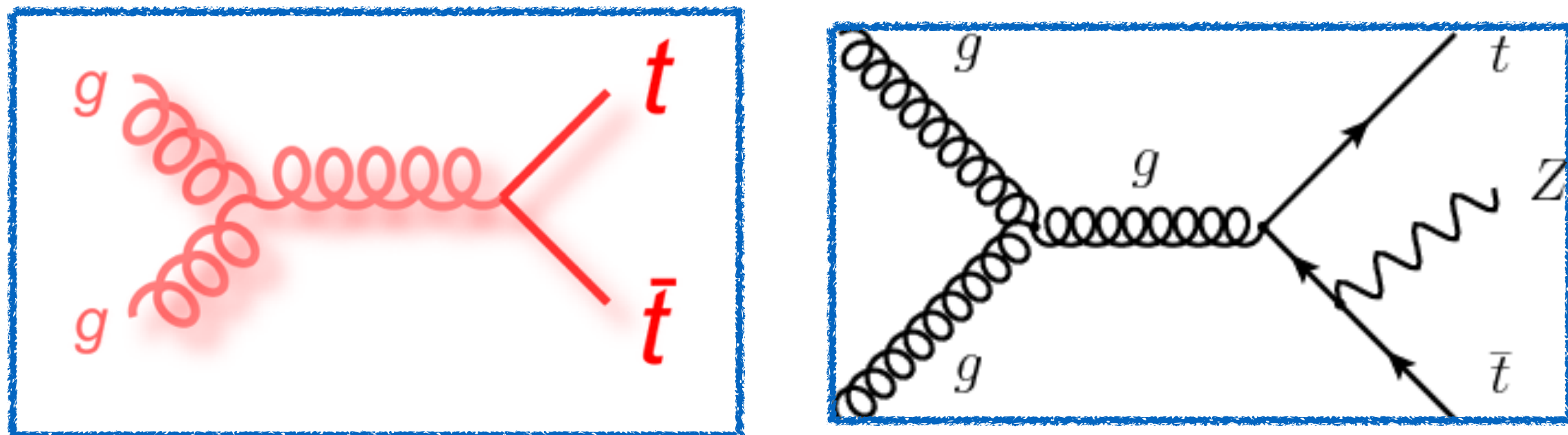
- Compressed Scenario $\Delta(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0}) \simeq m_t$
- Stop Decay in 2 leptons OS.

$$\tilde{t}\tilde{t} \rightarrow \tilde{\chi}_1^0 t \tilde{\chi}_1^0 t \rightarrow \tilde{\chi}_1^0 b l^+ \nu \tilde{\chi}_1^0 b l^- \nu$$



Background

mainly $t\bar{t}$ + ttZ (Z to neutrino)

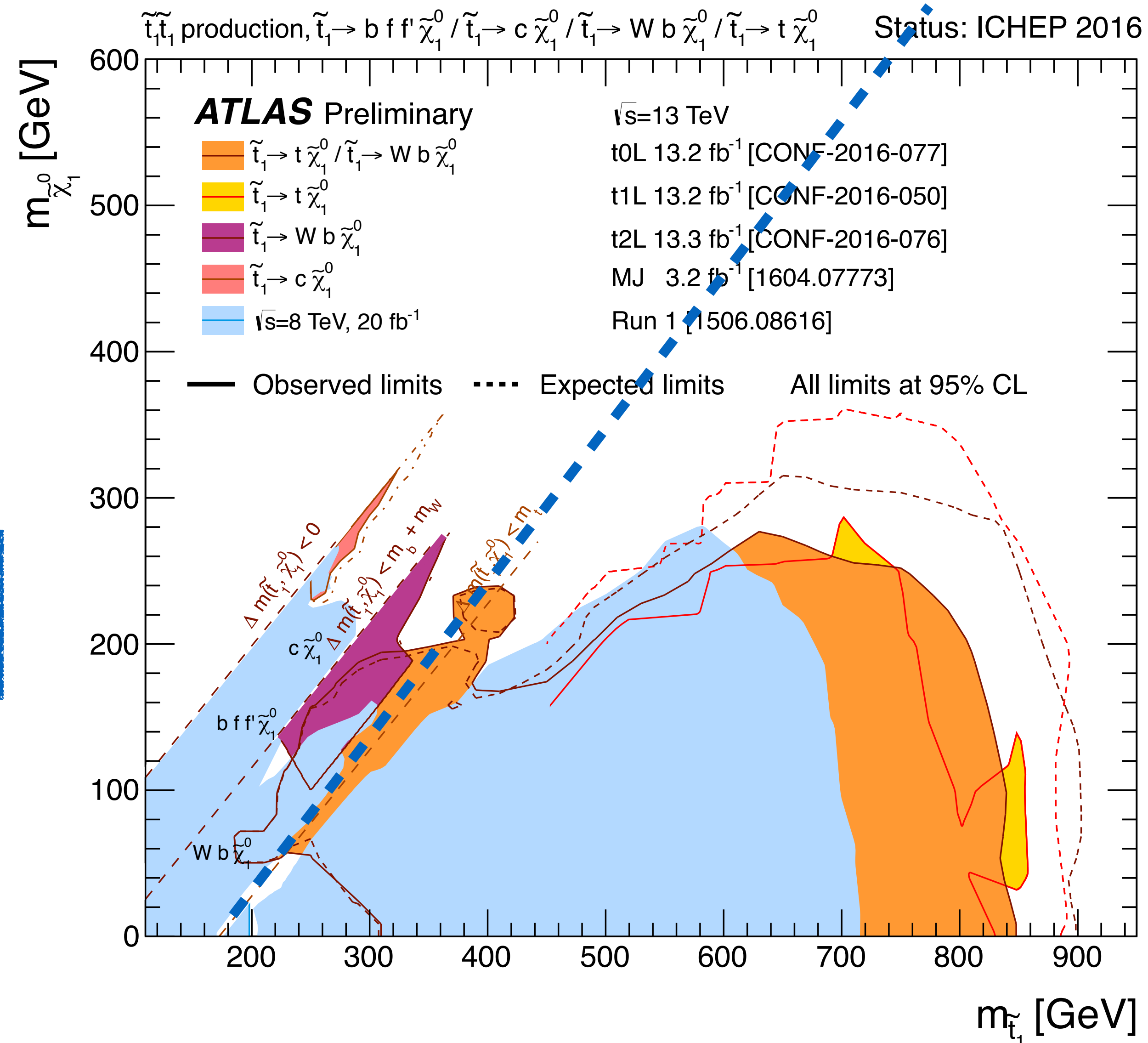


Signal

Top quarks are on-shell in the decay chain.

$$300 \text{ GeV} < m_{\tilde{t}_1} < 1 \text{ TeV}$$

$$\text{with } \Delta(m_{\tilde{t}_1}, m_{\tilde{\chi}_1^0}) \simeq m_t$$



Selection Cuts

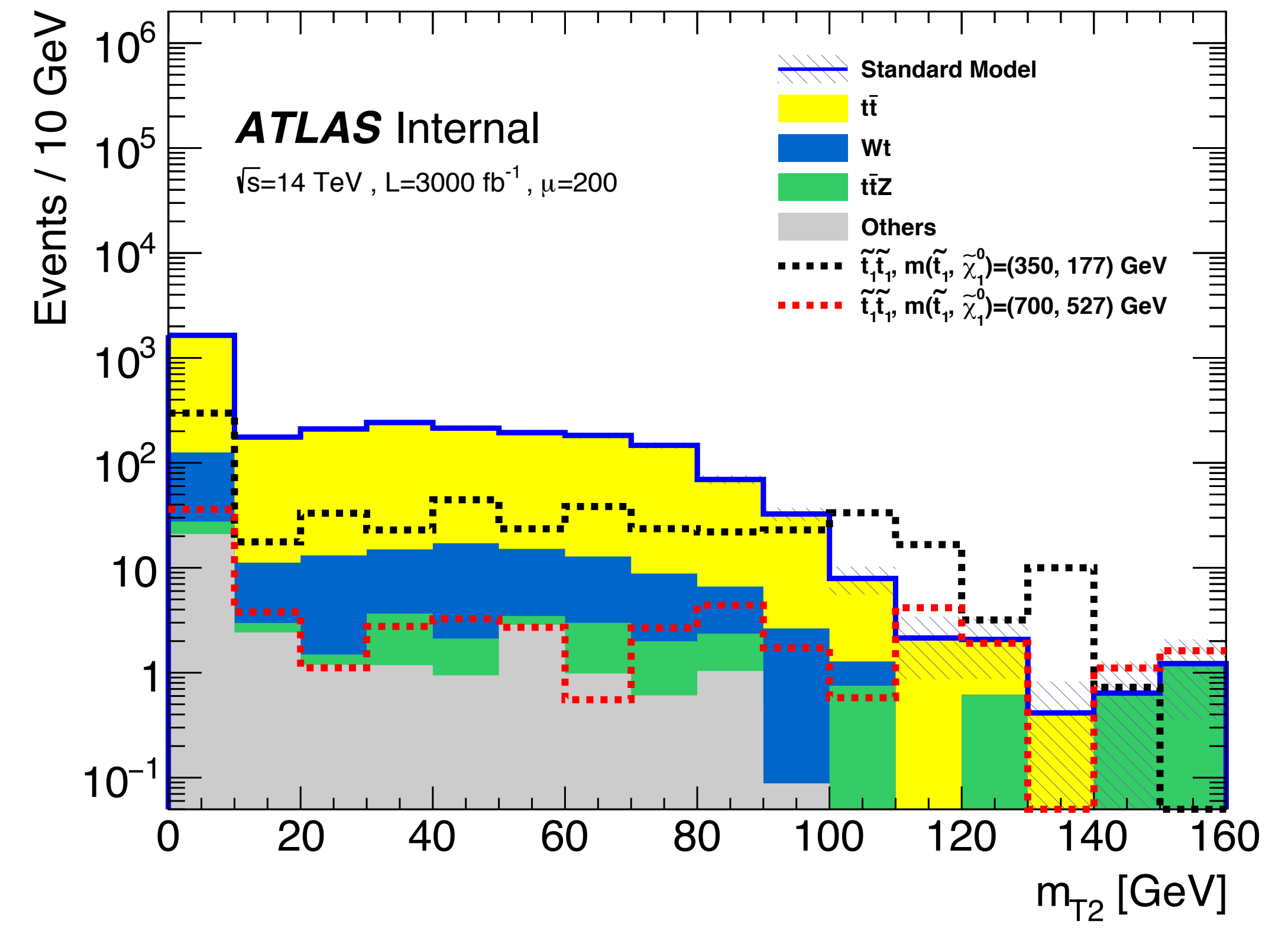
- 2 Opposite sign leptons

Exploiting **ISR based** selection to enhance the signal kinematical features:

- **Stop System:**
2 most energetic b-tag jets.
- **ISR-System:**
All the other jets.
 P_t cut of the leading jet at 300 GeV

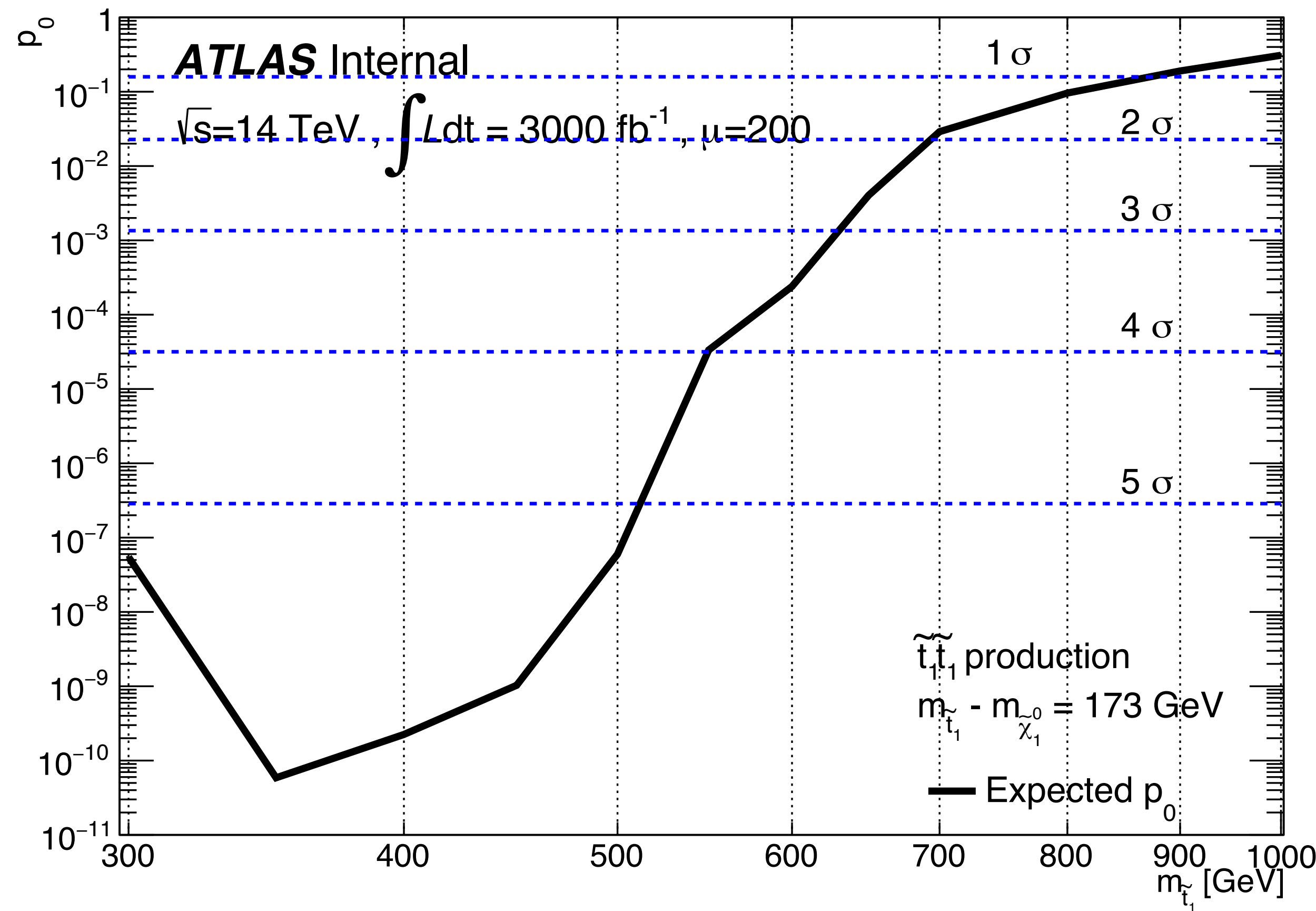
$$R_{ll} = \frac{E_T^{miss}}{p_T^{lep1} + p_T^{lep2}}$$

$$m_{T2}(\mathbf{p}_{T,1}, \mathbf{p}_{T,2}, \mathbf{q}_T) = \min_{\mathbf{q}_{T,1} + \mathbf{q}_{T,2} = \mathbf{q}_T} \{ \max[m_T(\mathbf{p}_{T,1}, \mathbf{q}_{T,1}), m_T(\mathbf{p}_{T,2}, \mathbf{q}_{T,2})] \},$$

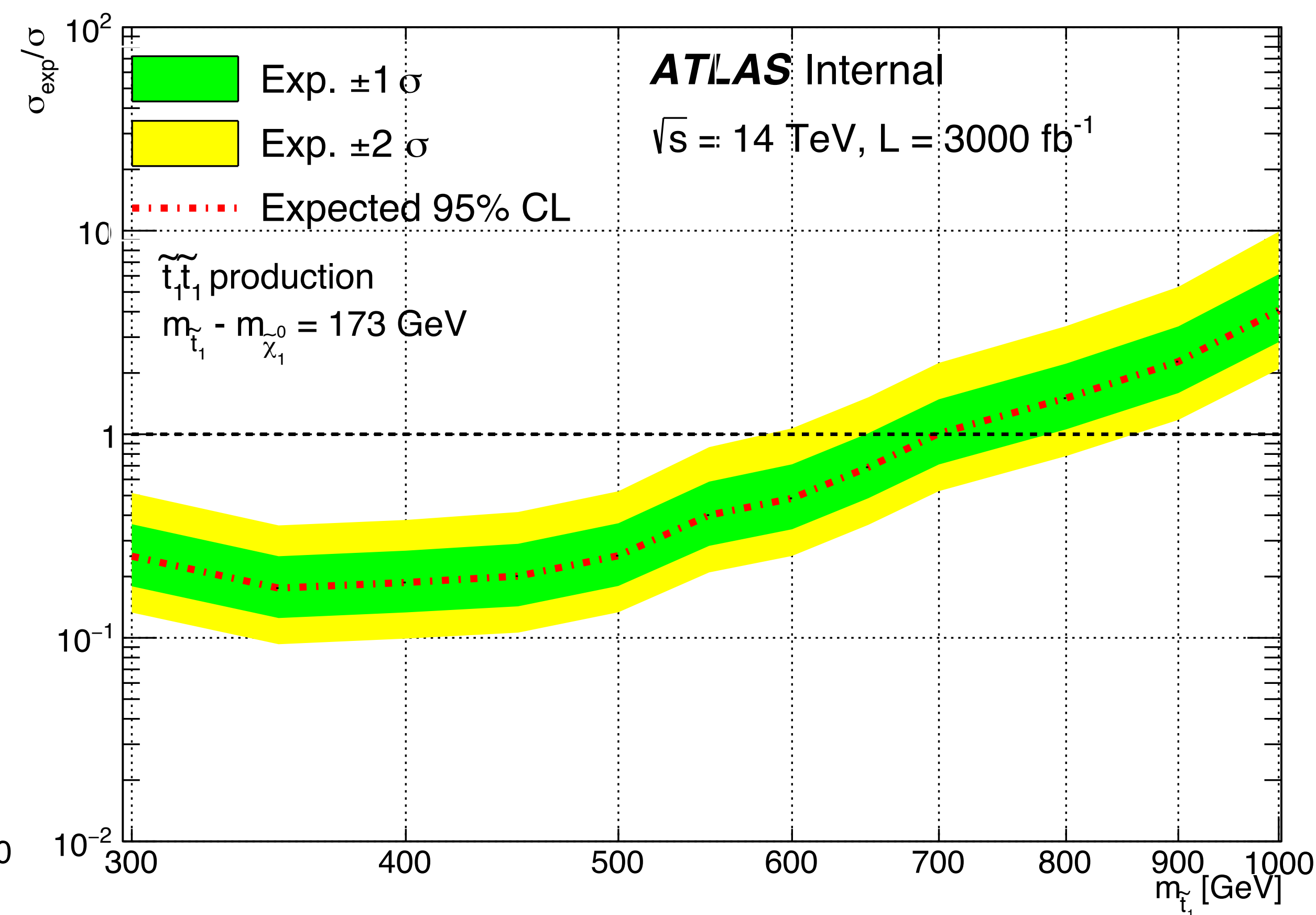


	SR
Expected Standard Model	13.79 ± 6.00
$t\bar{t}$	11.35 ± 5.10
$t\bar{t} + Z$	2.44 ± 1.52
Others	$0.0^{+0.X}_{-0.X}$
$\tilde{t}_1 \tilde{t}_1 m(\tilde{t}_1, \tilde{\chi}_1^0) = (350, 177) \text{ GeV}$	62.68 ± 7.48
$\tilde{t}_1 \tilde{t}_1 m(\tilde{t}_1, \tilde{\chi}_1^0) = (700, 527) \text{ GeV}$	11.04 ± 2.00

Discovery



Exclusion



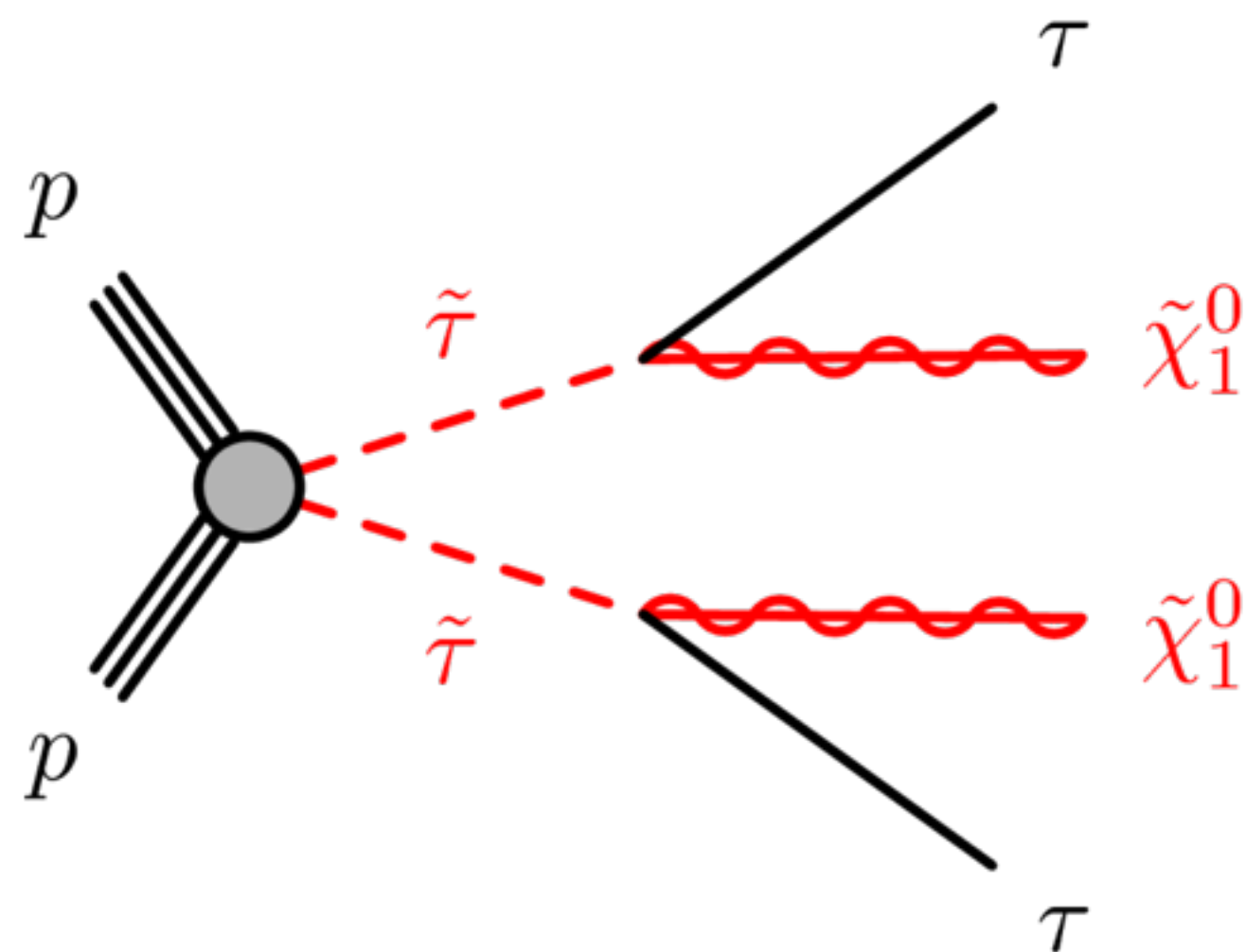
Discovery significance and exclusion upper limits are quoted assuming 30% background uncertainty

Prospects for a search for direct stau production in events with at least two hadronic taus and missing transverse momentum at the high luminosity LHC with the ATLAS Detector

IN PREPARATION

Considering **2** models:

1. stau partners of the **left-handed tau lepton**
2. stau partners of the **right-handed tau lepton**



Both cases assume stau decays with 100% BR to the SM tau leptons and the LSP.

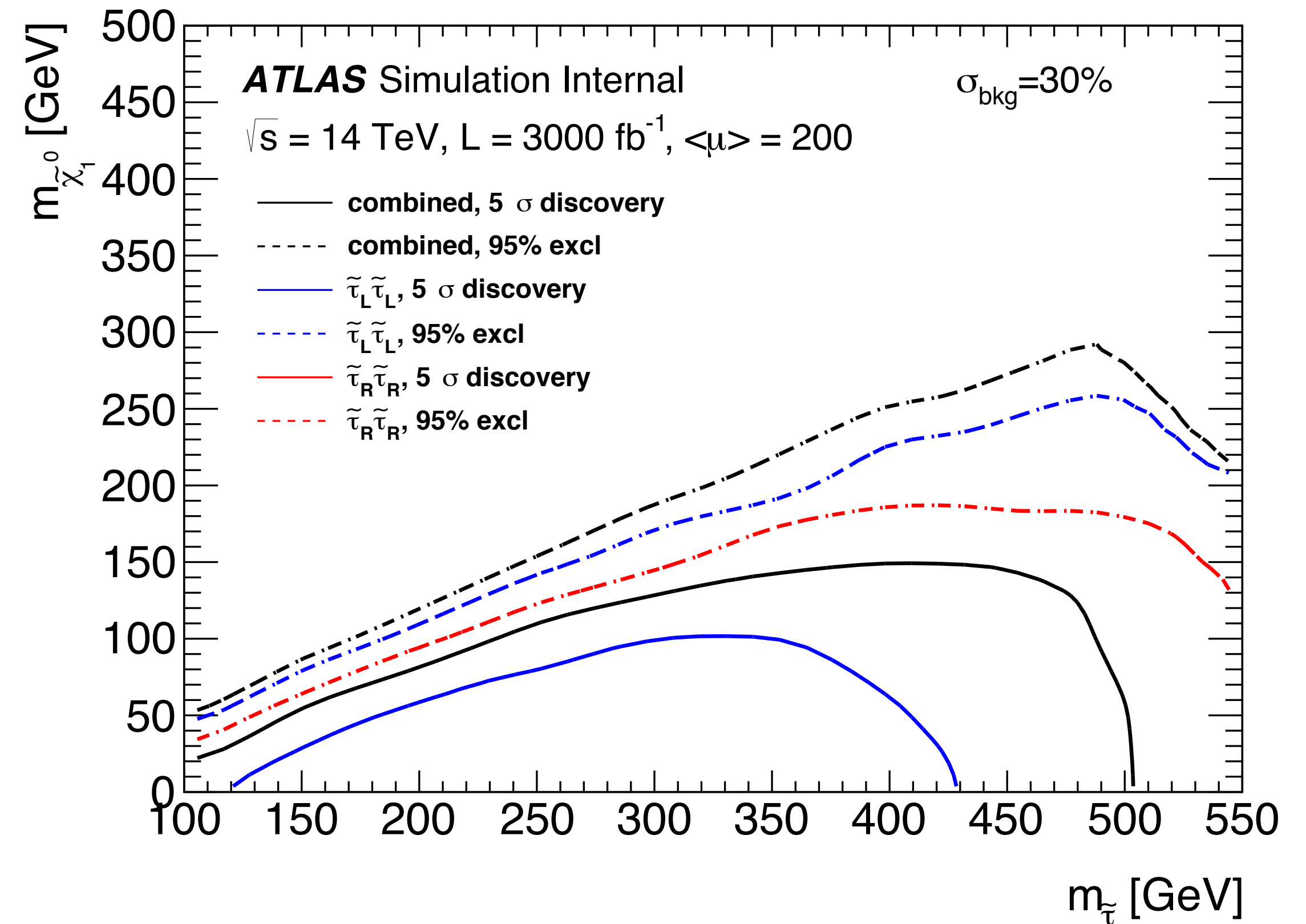
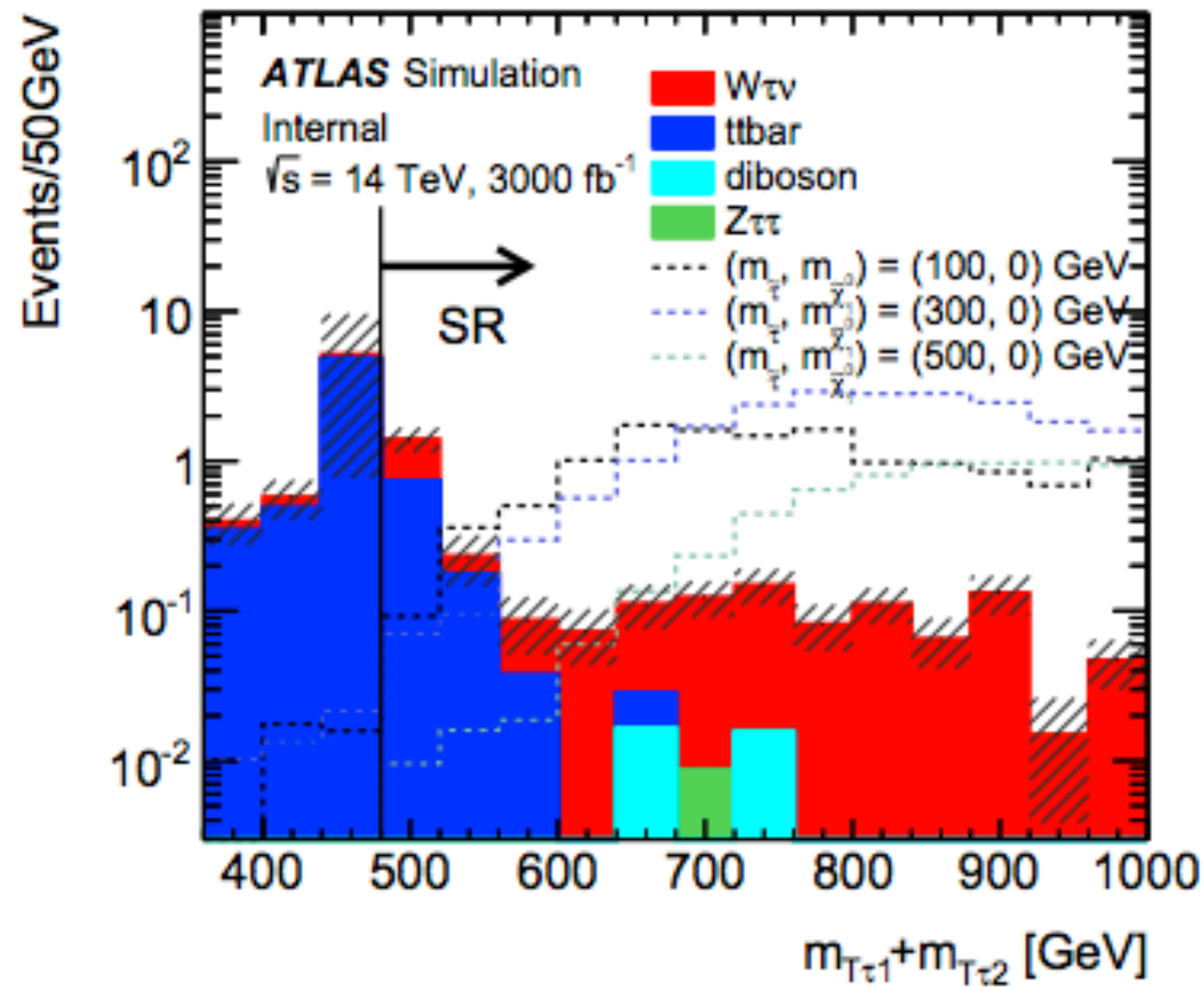
Signature:

- 2 Hadronically decaying taus
- Small additional jet activity
- Large Missing Transverse Energy

Background:

W+jets and $t\bar{t}$

SM process	Event yields
W+jets	1.91 ± 0.19
$t\bar{t}$	0.97 ± 0.23
Z+jets	0.009 ± 0.009
diboson	0.03 ± 0.02
SM total	2.9 ± 0.3
$m(\tilde{\tau}) = 100 \text{ GeV}, m(\tilde{\chi}_1^0) = 0 \text{ GeV}$	19.1 ± 0.9
$m(\tilde{\tau}) = 300 \text{ GeV}, m(\tilde{\chi}_1^0) = 0 \text{ GeV}$	31.6 ± 0.4
$m(\tilde{\tau}) = 500 \text{ GeV}, m(\tilde{\chi}_1^0) = 0 \text{ GeV}$	14.21 ± 0.11



Selection based and $m_{T\tau 1}, m_{T\tau 2}$ and m_{T2}

Limits are quoted assuming 30% background uncertainty

Search for direct pair production of a chargino and a neutralino decaying via a W boson and the lightest Higgs boson

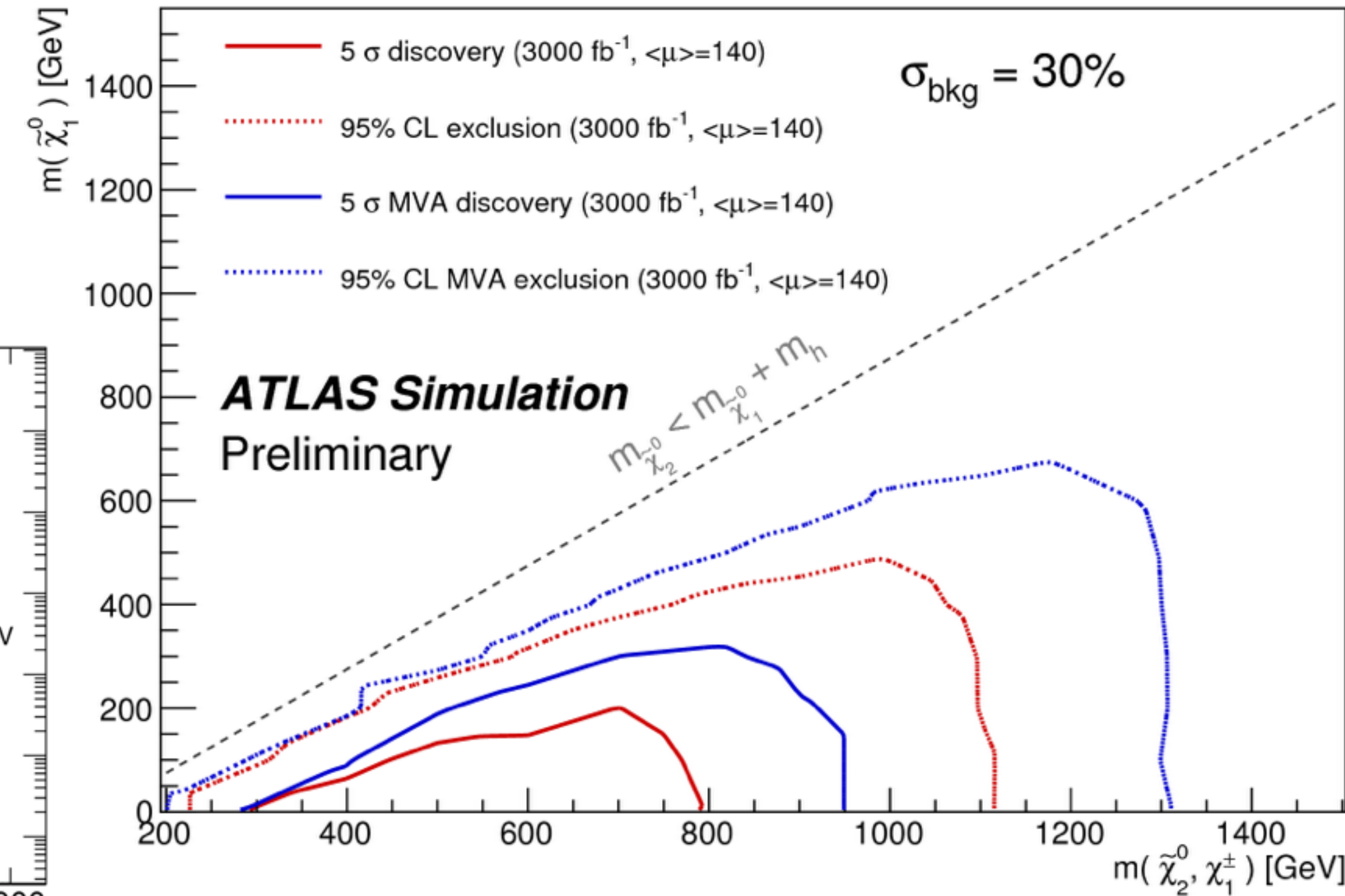
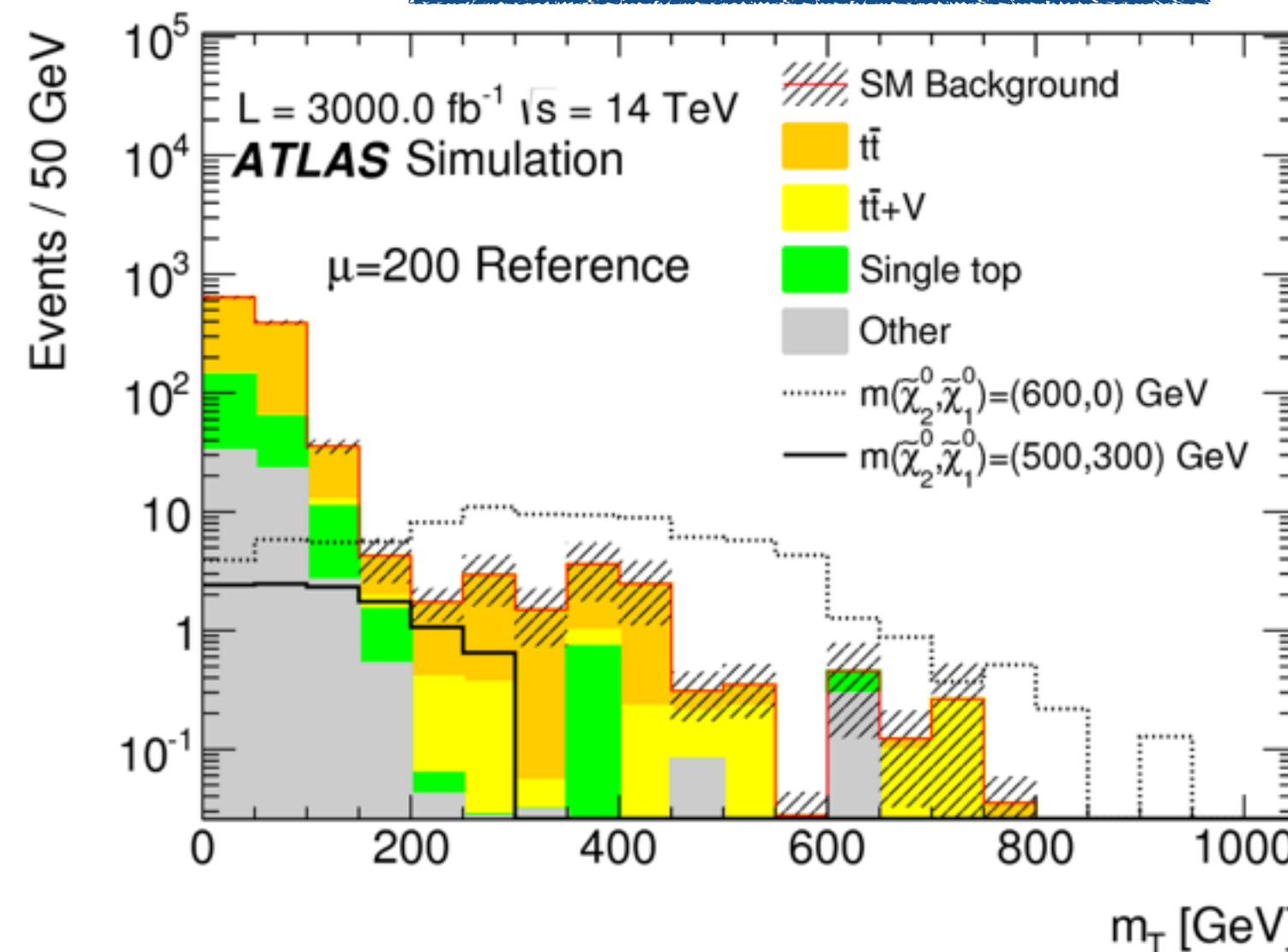
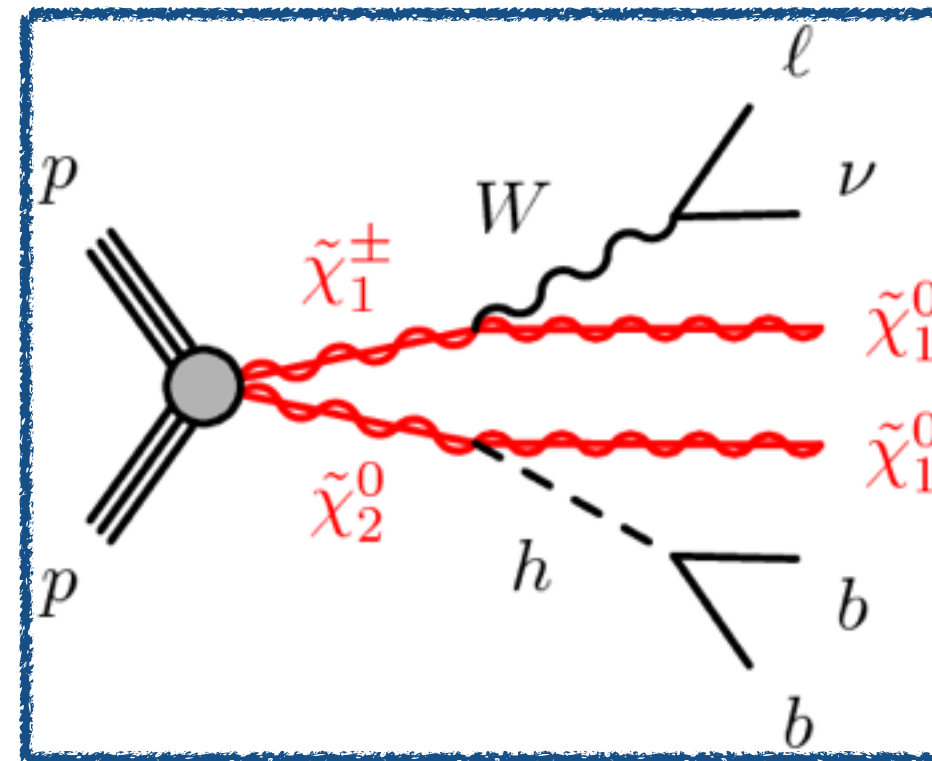
Final state with 1l and 2b-jet

Dominant background:

ttbar, single top, W+jets and itv

Discriminant variable:

- Transverse mass of the leptons and the missing transverse energy
- Boost-corrected contransverse mass m_{CT}

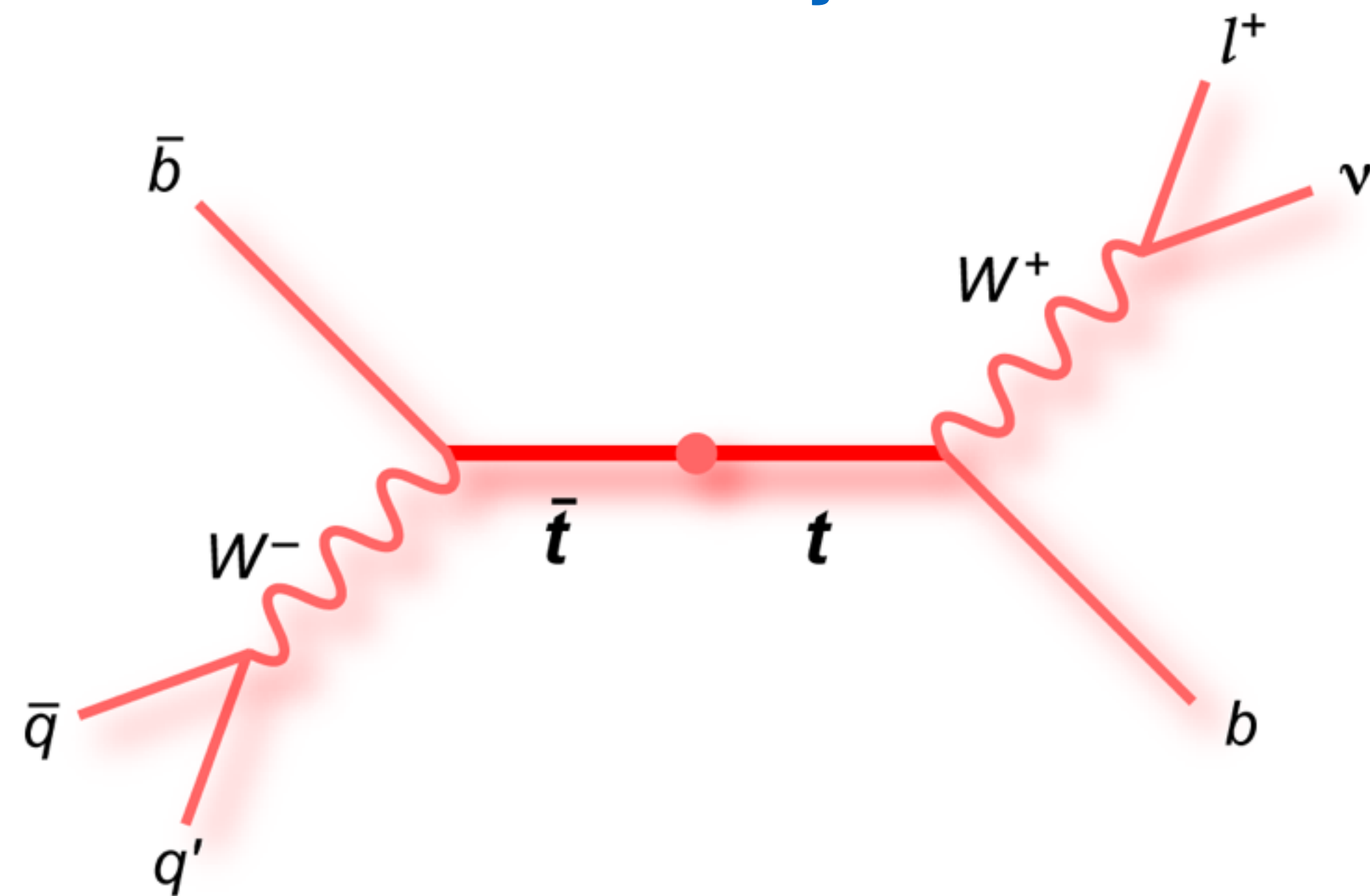


<https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/UPGRADE/CERN-LHCC-2015-020>

Prospects for a $tt\bar{b}$ resonances search at HL-LHC

IN PREPARATION

Benchmark signal model:
BSM model that predicts a heavy Z' boson that decays to $tt\bar{b}$



Analysis performed in the semi-leptonic decay channel

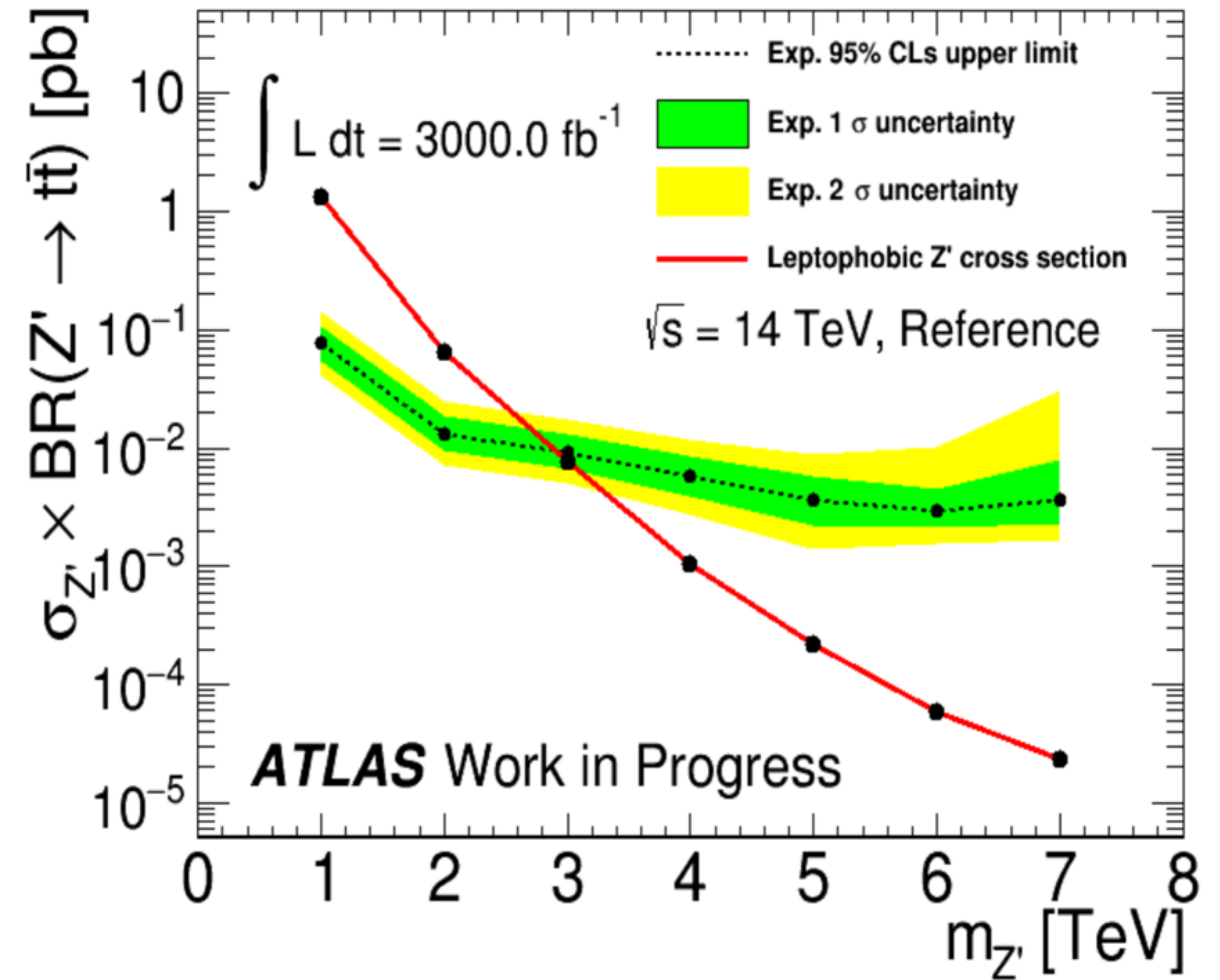
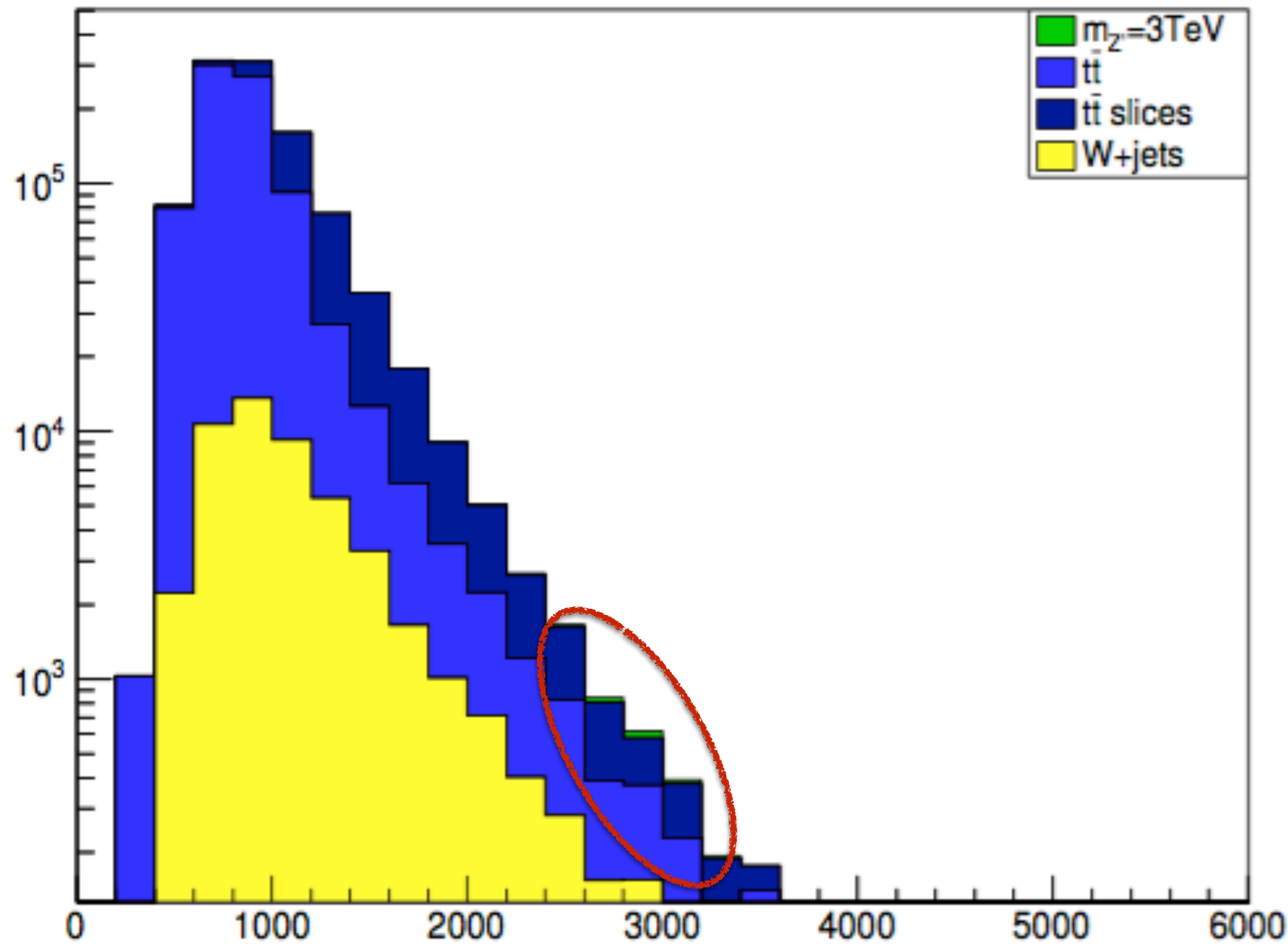
Exactly **one lepton** in the final state.
At least **one b-jet** (anti- k_T $R=0.4$).

Two selection based on the top decay properties:

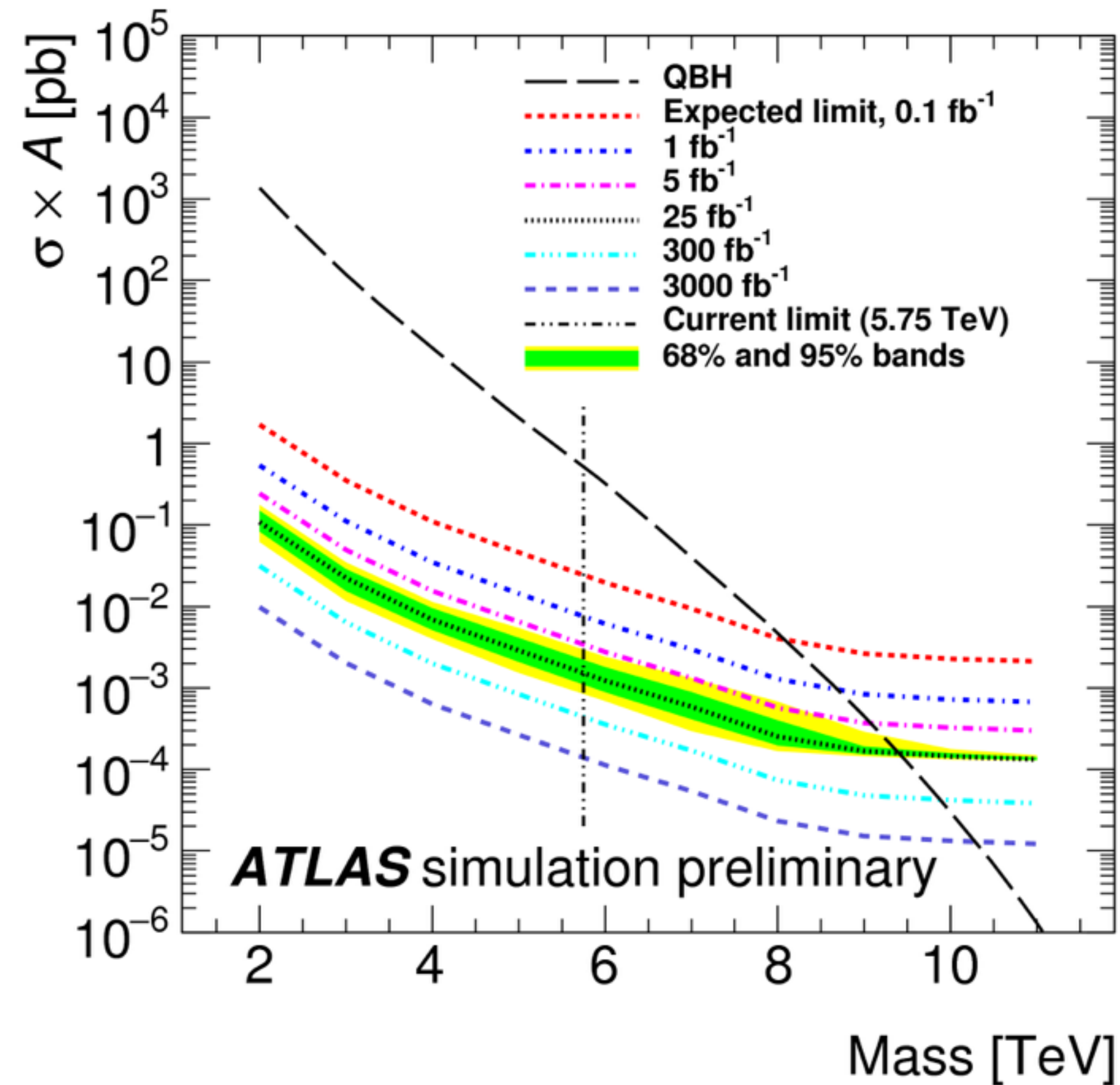
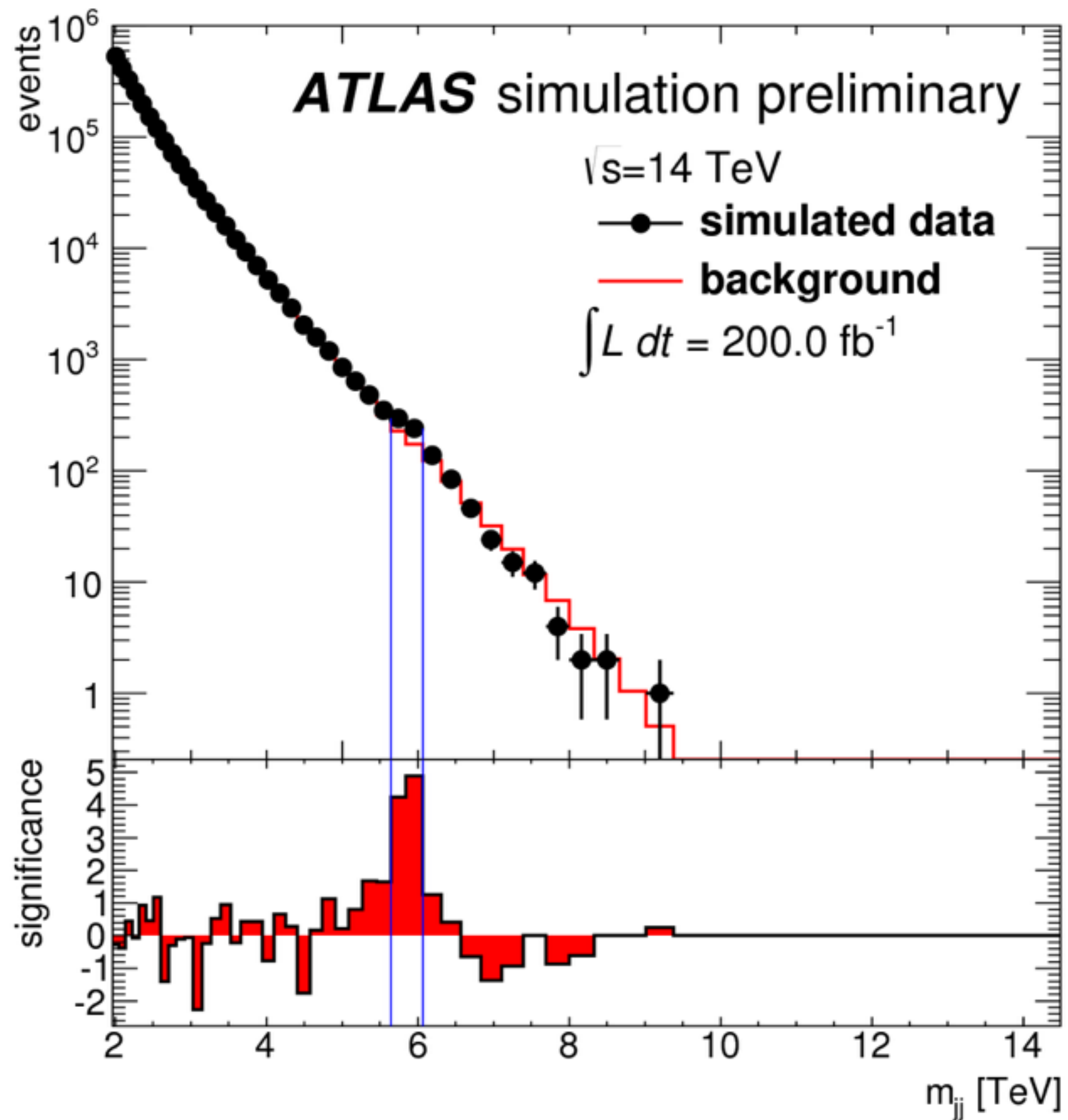
- **Boosted selection:**
Using large-jet $\mathbf{top}_{\text{had}}$ mass is reconstructed from the large jet, $\mathbf{top}_{\text{lep}}$ from W_{lep} + highest p_t jet.
- **Resolved selection:**
Did not pass the boosted selection and have > 4 jet (anti- k_T $R=0.4$)
chi2 algorithm to identify $\mathbf{top}_{\text{had}}$ mass and $\mathbf{top}_{\text{lep}}$ mass

Z' Sensitivity

$m_{t\bar{t}}$ Boosted Electron Channel



Dijet resonance searches with the ATLAS detector at 14 TeV LHC



BumpHunter algorithm

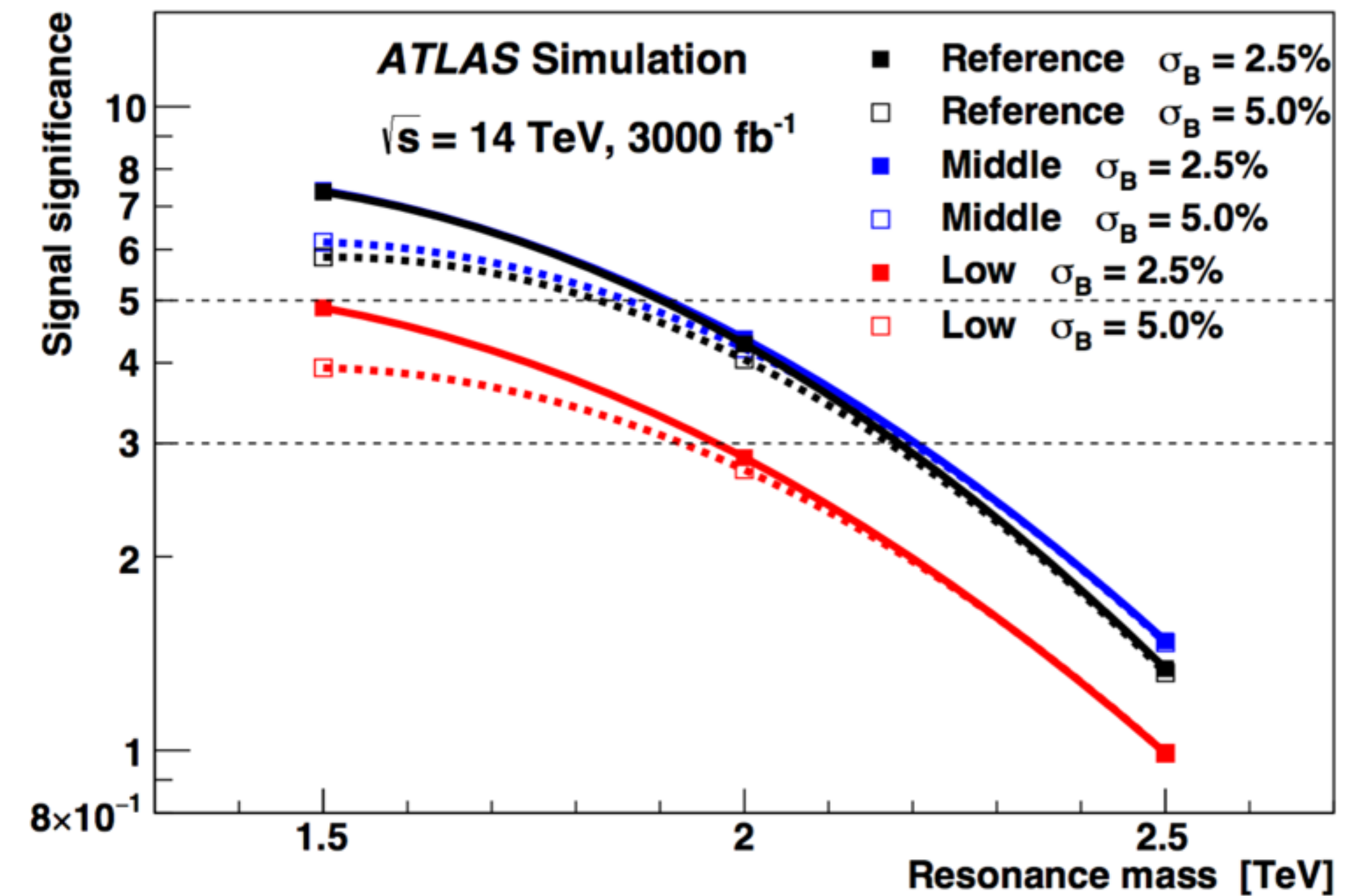
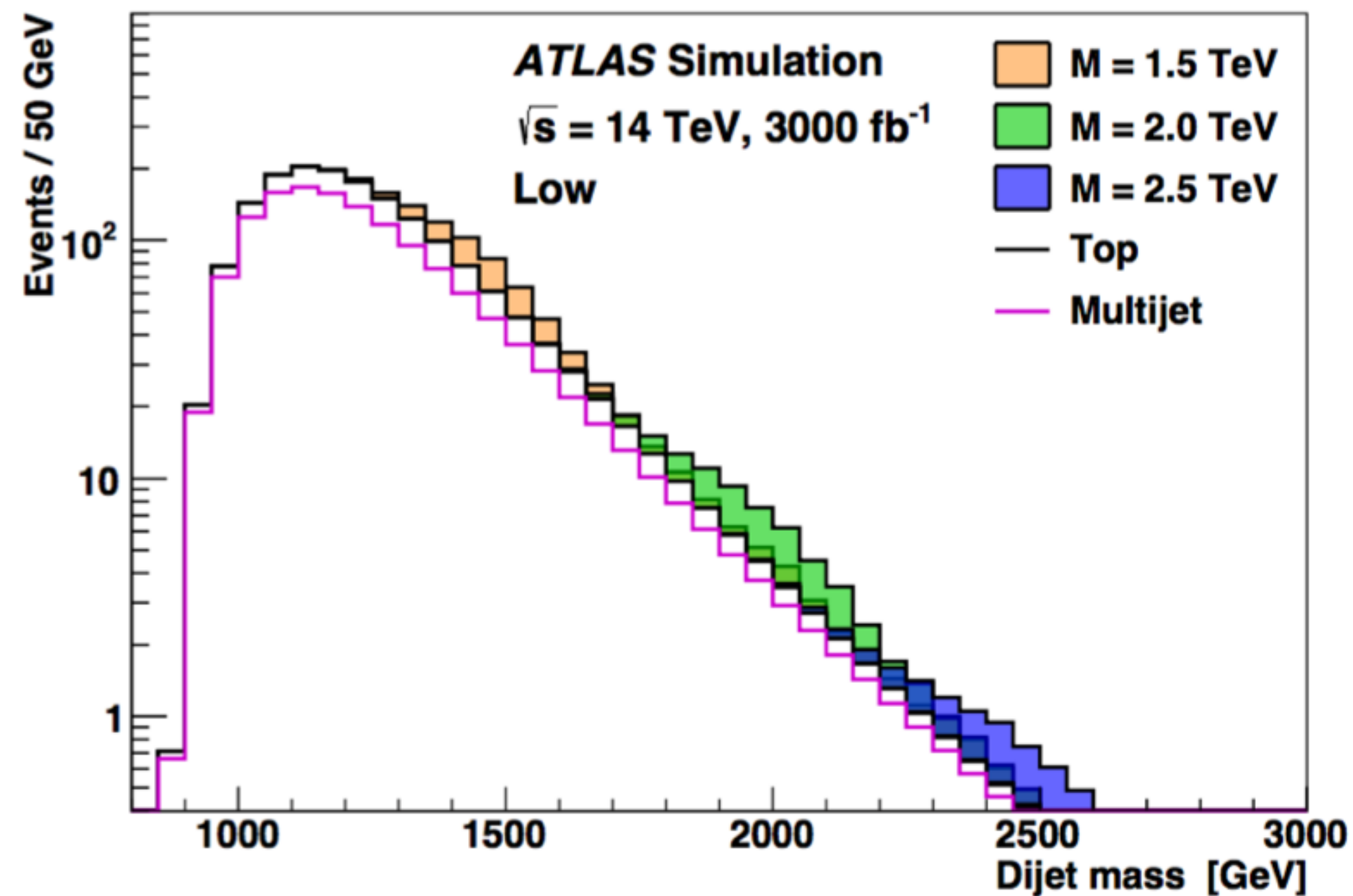
Search for resonant HH to bbbb production

High-Mass Kaluza-Klein gravitons with each of the Higgs bosons decaying to bb^- .

- Large Jet: anti-Kt R=1.0
- Track Jet: anti-Kt R=0.2. Used as proxy for “track jet” that are b-tagged.
- Trigger Jet anti-Kt R=0.4

The dominant background process originates from **multi-jet production**.

Sliding mass window region is defined around the resonance mass for each of the signal mass point



Conclusion

- 3 new Upgrade Prospects aiming for ECFA 2016:
- Finalisation of the Public Documents.

Thank you!