LHCP Poster Session - Shanghai, 16 May 2017

Search for Supersymmetry in final states with two hadronically decaying tau leptons at ATLAS

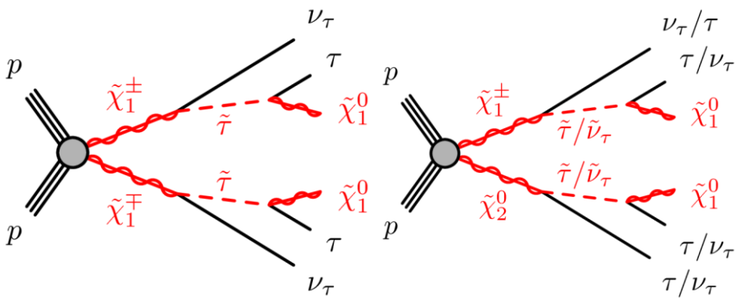
Abstract

A search for the electroweak production of charginos and neutralinos in final states with at least two hadronically decaying tau leptons and MET is presented. The analysis uses a dataset of proton–proton collisions corresponding to an integrated luminosity of 36.1 fb^{-1}, recorded with the ATLAS detector at the Large Hadron Collider at a centre-of-mass energy of 13 TeV. In additional, the prospect of the search for direct stau production at the High Luminosity LHC with ATLAS detector with 30000 fb^{-1} is performed.

Chargino and neutralino production

Analysis Overview

- If the coloured sparticles are too heavy for LHC, EWK processes will be dominant.
- Light stau models are consistent with current dark matter searches
- BR of C1 and N2 decay through staus or stau neutrinos assumed to be 100%.
- Free parameter: masses of the charginos and neutralinos.



Signal Region

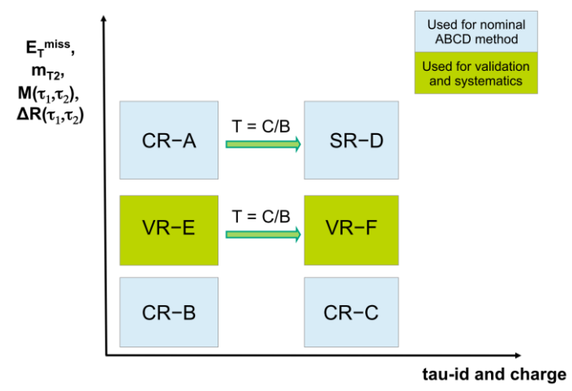
SR-highMass		SR-lowMass
di-tau+E_T^{miss} trigger E_T^{miss} > 150 GeV p_{T,τ_1} > 80 GeV p_{T,τ_2} > 40 GeV	asymmetric di-tau trigger E_T^{miss} > 110 GeV p_{T,τ_1} > 95 GeV p_{T,τ_2} > 65 GeV	di-tau+E_T^{miss} trigger E_T^{miss} > 150 GeV p_{T,τ_1} > 50 GeV p_{T,τ_2} > 40 GeV
at least one medium and one tight tau $M(\tau_1,\tau_2)$ > 110 GeV m_{T2} > 90 GeV		at least two medium taus m_{T2} > 70 GeV
at least one opposite sign tau pair *b*-jet veto *Z*-veto		

Background Strategy

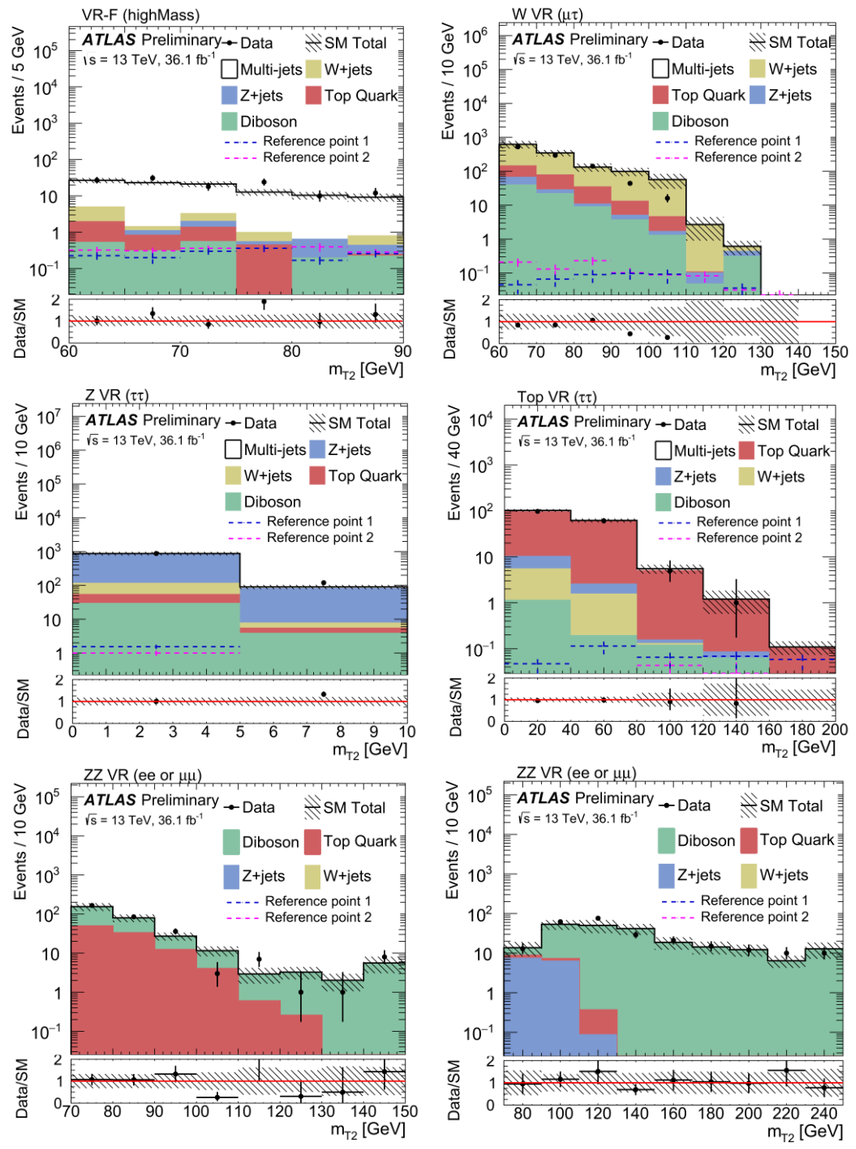
- Reducible backgrounds: (fake taus)
  - Multi-jets: Data-driven ABCD method
  - W+jets: Semi-data-driven
- Irreducible backgrounds: (real taus)
  - Z+jets, Diboson, Top quacks
  - MC simulation based estimation
- Combined fit of W CR, multi-jet CR
- Dedicate VR for each process

ABCD Method

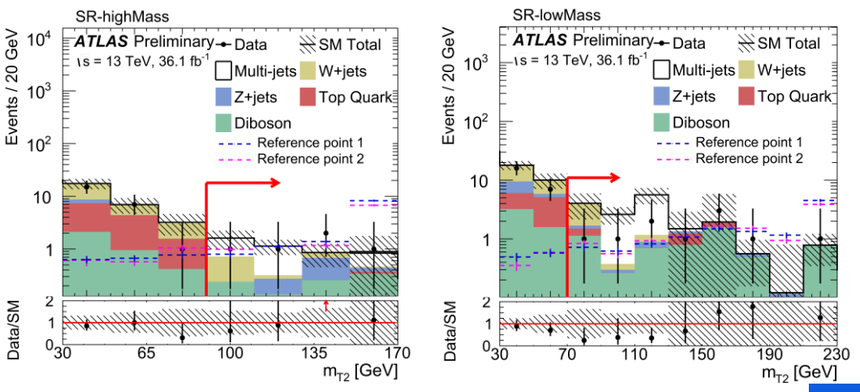
- Four exclusive regions by two sets of uncorrelated variables
- $N_D/N_A = N_C/N_B$
- VR for validation and systematics



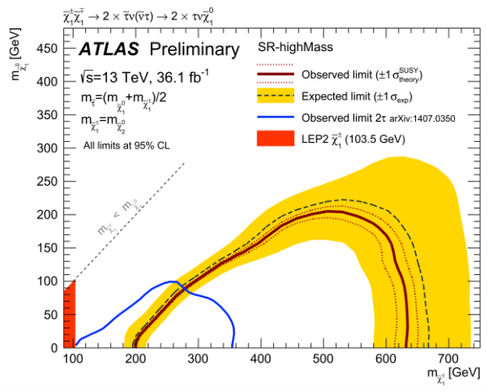
Validation Regions



Signal Region Results



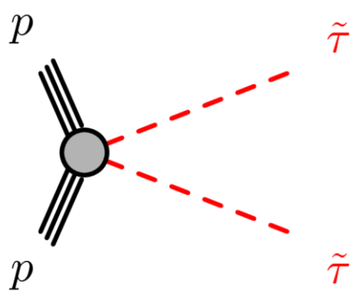
SM process	SR-highMass	SR-lowMass
diboson	1.0 ± 0.8	5.9 ± 2.2
W+jets	0.7± 0.5	1.8± 1.1
top	$0.03^{+0.26}_{-0.03}$	1.2 ± 1.0
Z+jets	0.6 ± 0.5	$0.6^{+0.7}_{-0.6}$
multi-jet	1.3 ± 1.1	4.3 ± 4.0
SM total	3.7 ± 1.4	14 ± 6
Observed	5	10
Reference point 1	11.8 ± 2.8	11.6 ± 2.6
Reference point 2	11.4 ± 2.6	10.0 ± 2.1
p_0	0.3	0.5
Expected σ_{vis}^{95} [fb]	$0.17^{+0.08}_{-0.05}$	$0.31^{+0.12}_{-0.08}$
Observed σ_{vis}^{95} [fb]	0.20	0.26



Direct stau production

Motivation

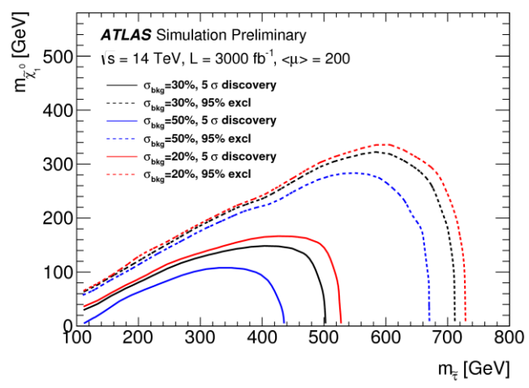
- Direct stau search very challenging in Run 2 due to low cross section.
- Only one scenario(100, 0) excluded in Run 1 using MVA technique[2].



Strategy and Results

- Cut and count method based on MC estimations.
- Expected limits based on Zn with different systematic uncertainty are given[3].

SR Definition
≥ 2 OS taus
loose jet-veto
Z-veto
$\Delta R(\tau 1, \tau 2) < 3.5$
$E_T^{miss} > 280$ GeV
$m_{T2} > 40$ GeV
$m_{T\tau 1} + m_{T\tau 2} > 480$ GeV



Variable Definitions

- The stransverse mass mT2 defined as:

$$m_{T2} = \min_{\mathbf{q}_T}\left[\max\left(m_{T,\tau_1}(\mathbf{p}_{T,\tau_1}, \mathbf{q}_T), m_{T,\tau_2}(\mathbf{p}_{T,\tau_2}, \mathbf{p}_T^{miss} - \mathbf{q}_T)\right)\right]$$

where mT is :

$$m_T(\mathbf{p}_T, \mathbf{q}_T) = \sqrt{2(p_T q_T - \mathbf{p}_T \cdot \mathbf{q}_T)}.$$

the mT2 distribution from ttbar or WW with 2 leptonically decay W boson has a kinematic end-point at the W mass, while for SUSY particles the distribution extends significantly beyond this end-point.

Reference

[1] Search for the direct production of charginos and neutralinos in final states with tau leptons in √s = 13 TeV pp collisions with the ATLAS detector. ATLAS-CONF-2017-035, 2017, https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2017-035/

[2] Aad G, Abbott B, Abdallah J, et al. Search for the electroweak production of supersymmetric particles in s= 8 TeV p p collisions with the ATLAS detector[J]. Physical review D, 2016, 93(5): 052002.

[3] Prospect for a search for direct stau production in events with at least two hadronic taus and missing transverse momentum at theHigh Luminosity LHC with the ATLAS Detector Tech. Rep. ATL-PHYSPUB-2016-021, 2016, http://cds.cern.ch/record/2220805

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ATLAS EXPERIMENT