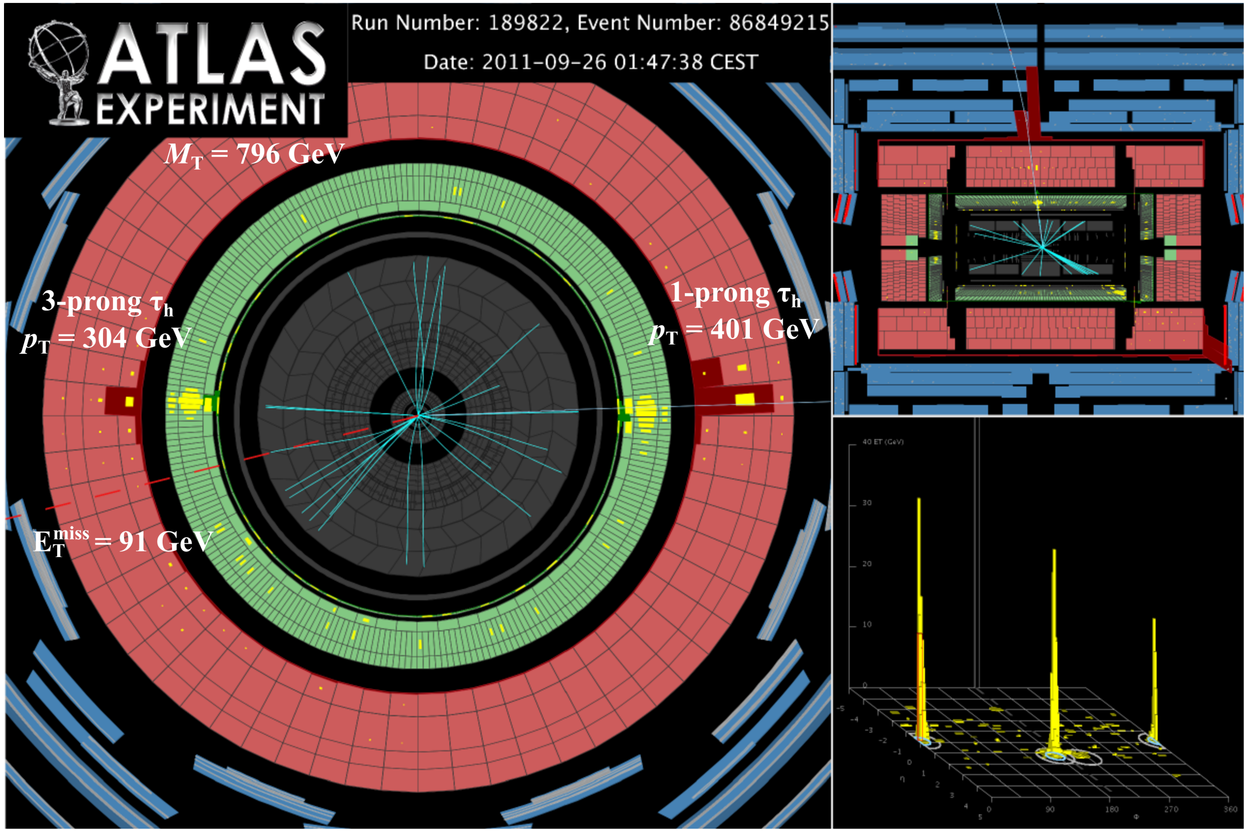
EWK SUSY searches with taus.

DESY LHC Physics Discussions.



ATLAS Event display of di-tau event

HELMHOLTZ ASSOCIATION

DESY

Kerry Parker - DESY - 10th July, 2017

Outline.

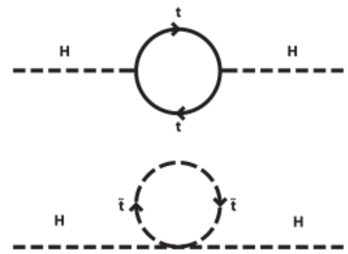
ATLAS-CONF-2017-035

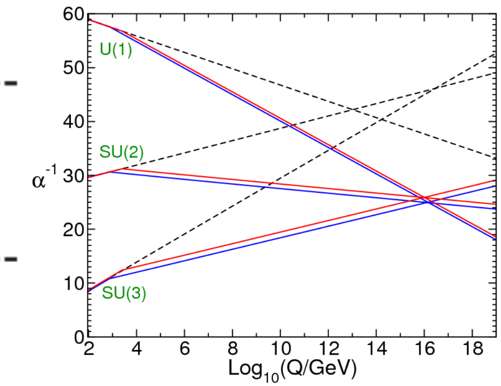
Search for the direct production of charginos and neutralinos in final states with tau leptons in $\sqrt{s}$=13TeV pp collisions with the ATLAS detector

- Motivation and background.
- Analysis overview.
- Signal regions.
- Background estimation.
- Results and interpretation.

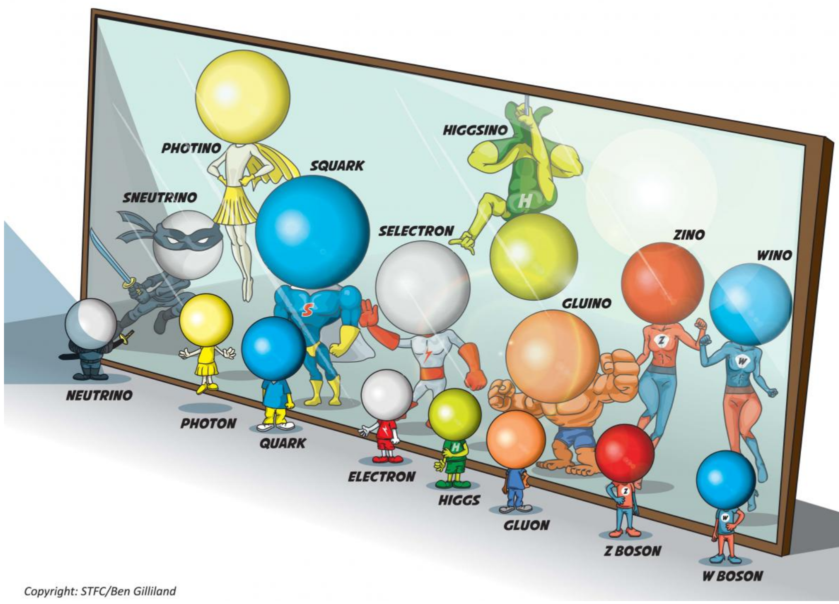
Motivation.

- **Why SUSY?**
  - Standard Model is a beautiful incomplete model: hierarchy problem, no unification of couplings at the Planck scale, no explanation of Dark Matter or Dark Energy
  - SUSY - extension to SM, linking fermions and bosons; fixing Higgs mass, and offering potential DM candidates



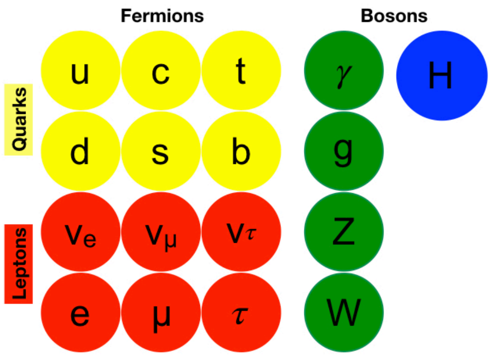


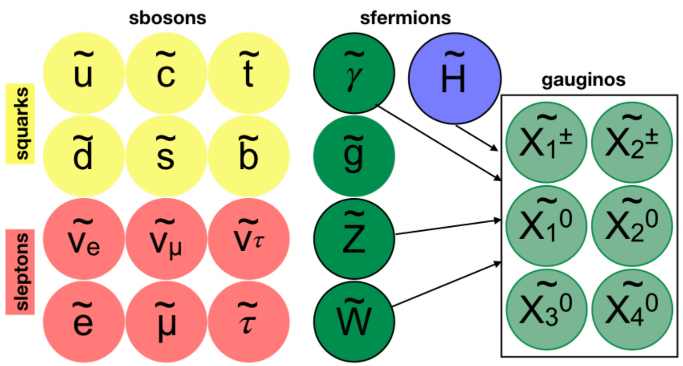
- Sector of sparticles with only electroweak interactions contains charginos, neutralinos, sleptons and sneutrinos
  - If sufficiently light electroweak sector may dominate SUSY production at the LHC
- Limits on squark/gluinos are being pushed to high masses favouring EWKino masses around 100 GeV



Electroweak SUSY.

- **Electroweak (EWK) production can be dominant at the LHC**
  - Low cross-sections
  - Suppressed SM backgrounds
  - Multi-leptonic signatures (in particular taus!) with large missing transverse energy
- Mass parameters: M_1 (bino), M_2 (wino), μ (higgsino)
- Charginos ($\tilde{\chi}_i^{\pm}$ i=1,2) and neutralinos ($\tilde{\chi}_i^{0}$ i=1,2,3,4) are mass eigenstates composed of bino, wino, higgsino fields



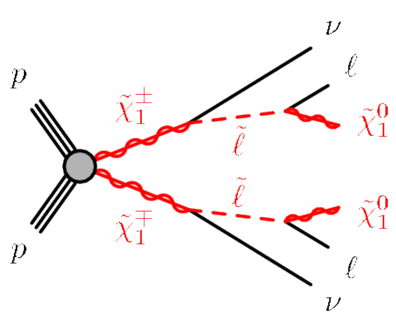


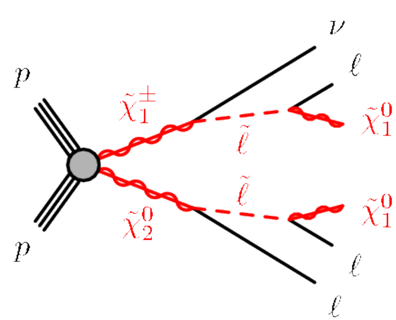
ATLAS EWK SUSY Searches.

- EWK SUSY searches in ATLAS involving multi-lepton final states, MET and corresponding references

	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\, dt[\text{fb}^{-1}]$		Reference
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e, μ	0	Yes	36.1	$m(\tilde{\chi}_1^0)$=0	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e, μ	0	Yes	36.1	$m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell}, \tilde{\nu})$=0.5($m(\tilde{\chi}_1^\pm)$+$m(\tilde{\chi}_1^0)$)	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp/\tilde{\chi}_2^0, \tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu}), \tilde{\chi}_2^0\to\tilde{\tau}\tau(\nu\tilde{\nu})$	2 τ	-	Yes	36.1	$m(\tilde{\chi}_1^0)$=0, $m(\tilde{\tau}, \tilde{\nu})$=0.5($m(\tilde{\chi}_1^\pm)$+$m(\tilde{\chi}_1^0)$)	ATLAS-CONF-2017-035
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e, μ	0	Yes	36.1	$m(\tilde{\chi}_1^\pm)$=$m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell}, \tilde{\nu})$=0.5($m(\tilde{\chi}_1^\pm)$+$m(\tilde{\chi}_1^0)$)	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0 Z\tilde{\chi}_1^0$	2-3 e, μ	0-2 jets	Yes	36.1	$m(\tilde{\chi}_1^\pm)$=$m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $\tilde{\ell}$ decoupled	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0 h\tilde{\chi}_1^0, h\to b\bar{b}/WW/\tau\tau/\gamma\gamma$	e, μ, γ	0-2 b	Yes	20.3	$m(\tilde{\chi}_1^\pm)$=$m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $\tilde{\ell}$ decoupled	1501.07110
	$\tilde{\chi}_2^0\tilde{\chi}_3^0, \tilde{\chi}_{2,3}^0 \to\tilde{\ell}_R\ell$	4 e, μ	0	Yes	20.3	$m(\tilde{\chi}_2^0)$=$m(\tilde{\chi}_3^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell}, \tilde{\nu})$=0.5($m(\tilde{\chi}_2^0)$+$m(\tilde{\chi}_1^0)$)	1405.5086
	GGM (wino NLSP) weak prod., $\tilde{\chi}_1^0\to\gamma\tilde{G}$	1 $e, \mu + \gamma$	-	Yes	20.3	$c\tau$<1 mm	1507.05493
	GGM (bino NLSP) weak prod., $\tilde{\chi}_1^0\to\gamma\tilde{G}$	2 γ	-	Yes	20.3	$c\tau$<1 mm	1507.05493

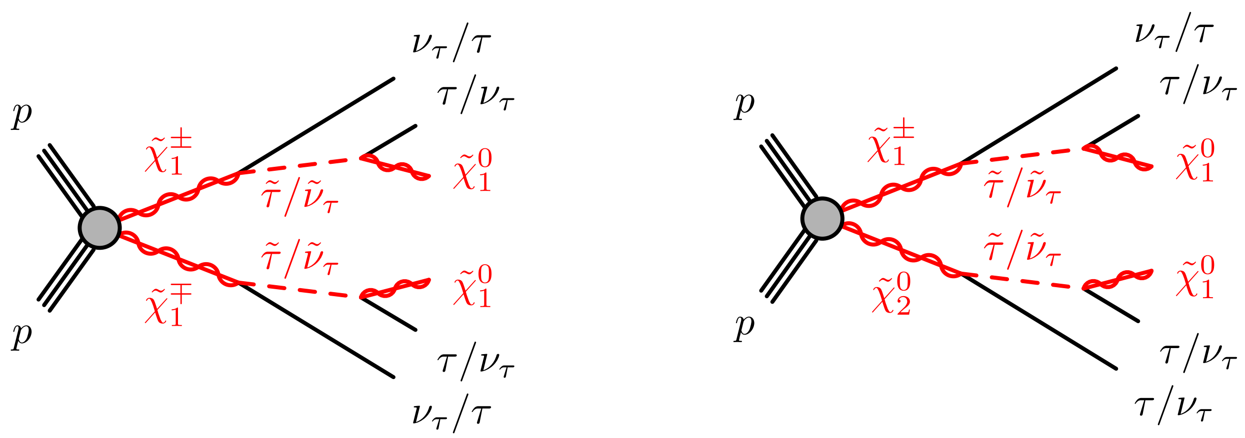
- Focus on **ditau** channel here, also relevant for comparison is 2/3L channel





Overview.

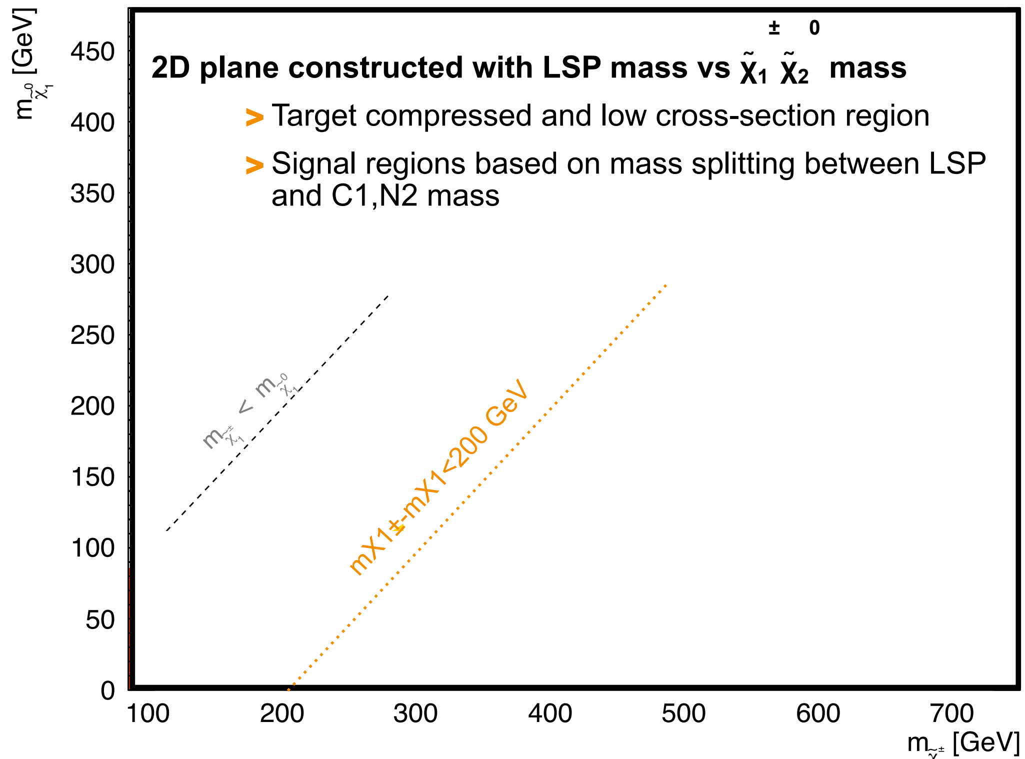
- The processes of interest are $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ and $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ decaying via staus or stau neutrinos
- Final state: two or more hadronic taus, low jet activity and large MET



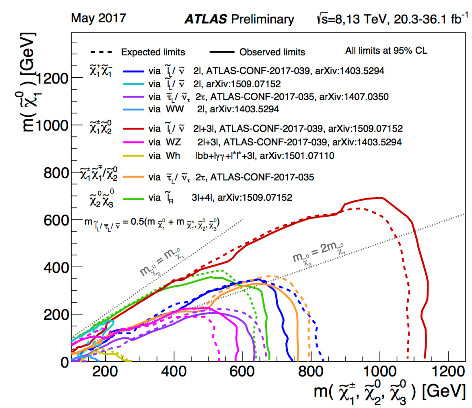
- Light stau models are consistent with current DM searches
- Lightest neutralino is the LSP (lightest supersymmetric particle)

Interpretation.

- **Two Simplified Models ($\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0}$ production):**
  - Minimal particle content necessary to produce SUSY-like events
  - Free parameters are the mass and decay modes of $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_2^{0}$, $\tilde{\chi}_1^{0}$ and stau
  - Large cross-section and short decay chains for $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_2^{0}$

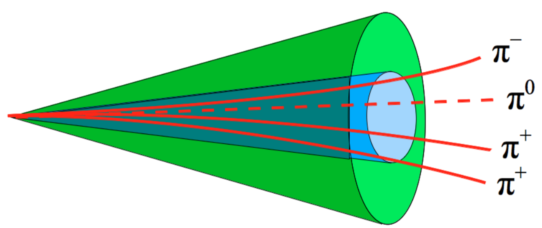


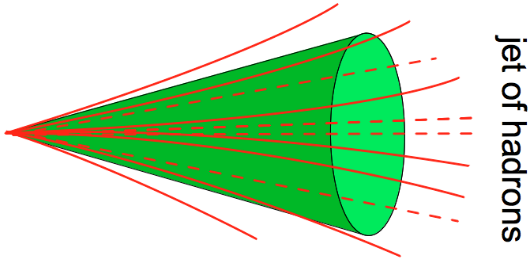
$m(\tilde{\chi}_1^{\pm}) = m(\tilde{\chi}_2^{0})$
mstau = $(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^{0}))/2$
BR($\tilde{\chi}_1^{\pm}$,$\tilde{\chi}_2^{0}$) —> 100% tau final states



Tau Reconstruction.

arXiv:1409.2699





- Taus: 3rd generation leptons m(τ) 1.78 GeV
- Short lifetime and short decay length, decays inside the beam pipe and identification is through it's decay products
- Tau decays can be classified as hadronic (65%) or leptonic (35%)
- Main background of τ_{had} are jets:
  - Jets - large number of tracks
  - τ_{had} - one (1-prong) or three (3-prong) tracks from decays into 1 or 3 $\pi^{\pm}$, up to 2 π^0 and a neutrino
  - Identification by 1 or 3 tracks in the core cone, no tracks and energy deposition in isolated ΔR cone around highest p_T track

Analysis Details.

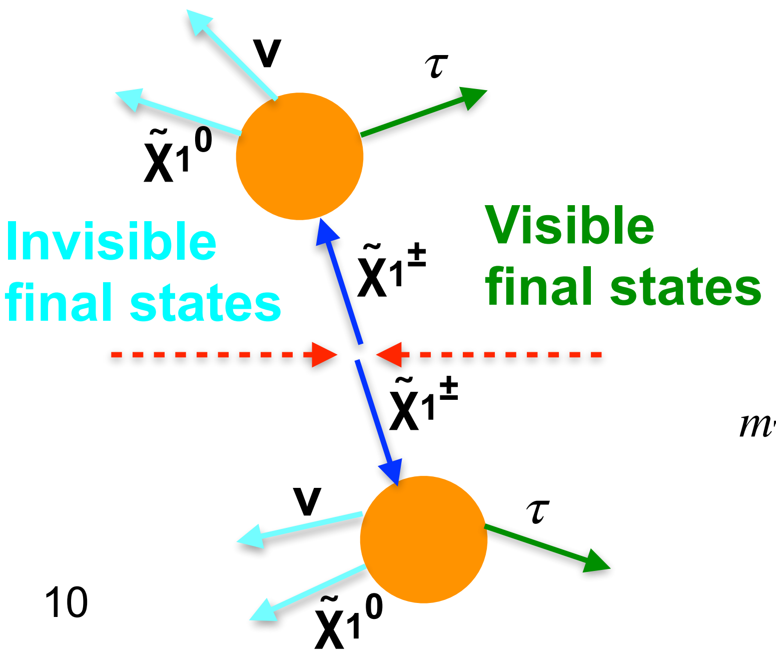
Objects:
- Electrons: p_T > 10 GeV, $|\eta|$ < 2.47
- Muons: p_T > 10 GeV, $|\eta|$ < 2.7
- Taus: p_T > 20 GeV, $|\eta|$ < 2.5
- Jets (AntiKt4EMTopo): p_T > 20 GeV, $|\eta|$ < 2.8

Event Selection:
- **Event cleaning**
- **Di-tau channel:** at least 2 hadronic taus with opposite sign (OS)
- **Muon-tau channel:** exactly 1 signal muon and 1 medium tau with OS, electron veto
- **Lep-lep channel:** exactly 2 signal leptons with same/different flavour with OS

Triggers:
- **Di-tau**
  - ditau trigger: p_T > 50,40 GeV
  - ditau + MET trigger: p_T > 50,40 GeV, MET > 150 GeV
  - asymmetric ditau trigger: p_T > 95,65 GeV
- **Muon+tau**
  - Single muon trigger: p_T > 40 GeV
- **Lep-lep**
  - di-lepton trigger: $p_{T,\mu}$ > 30 GeV, $p_{T,e}$ > 40 GeV

Transverse mass variables.

- **Transverse mass m_T:**
  Useful variable when one particle cannot be detected directly, only through missing energy
- **Stransverse mass m_{T2}:**
  Based on transverse mass, if a pair of identical produced particles cannot be directly detected and then decay into particles which can be detected
  - m_{T2} is a function of the momenta of two visible particles and MET in an event
  - If there are more than two tau candidates, m_{T2} computed among all possible pairs and the pair which gives the largest m_{T2} is selected



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

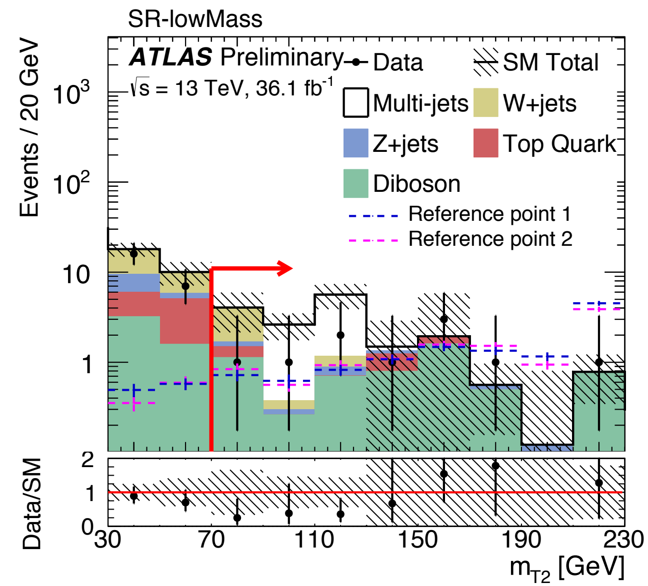
$$m_{T2} = \min_{\mathbf{q}_T} \left[\max \left(m_{T,\tau_1}(\mathbf{p}_{T,\tau_1}, \mathbf{q}_T), m_{T,\tau_2}(\mathbf{p}_{T,\tau_2}, \mathbf{p}_T^{miss} - \mathbf{q}_T) \right) \right]$$

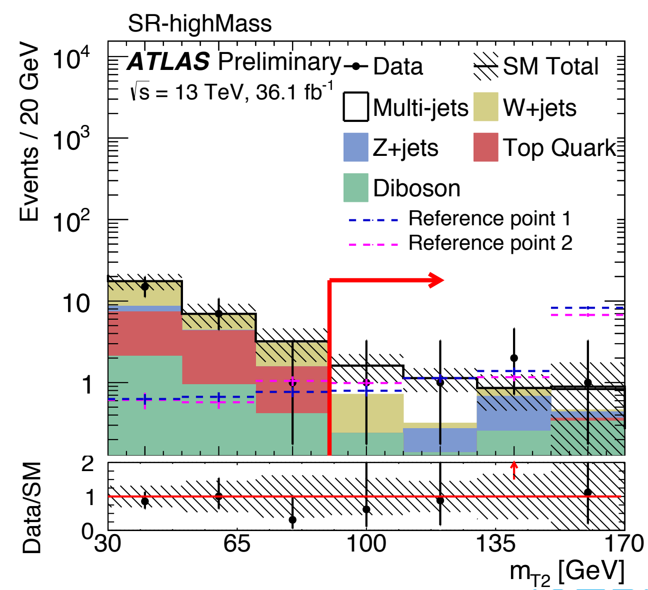
Signal Regions.

- Two signal regions designed to cover signal models where the mass difference between the chargino and lightest neutralino is larger or smaller than 200 GeV
- Named SR-highMass and SR-lowMass, based on m_{T2} and E_T^{miss}
- SR-lowMass: ditau+MET trigger high efficiency in selection events from C1N2 decays where small mass difference
- SR-highMass: different pT and MET requirements depending on trigger fired

SR-lowMass	SR-highMass	
at least one opposite sign tau pair		
b-jet veto Suppress top		
Z-veto Suppress Z->tautau		
at least two medium tau candidates	at least one medium and one tight tau candidates	
	$m(\tau_1, \tau_2) > 110$ GeV	
$m_{\mathrm{T2}} > 70$ GeV	$m_{\mathrm{T2}} > 90$ GeV	
di-tau+$E_{\mathrm{T}}^{\mathrm{miss}}$ trigger	di-tau+$E_{\mathrm{T}}^{\mathrm{miss}}$ trigger	asymmetric di-tau trigger
$E_{\mathrm{T}}^{\mathrm{miss}} > 150$ GeV	$E_{\mathrm{T}}^{\mathrm{miss}} > 150$ GeV	$E_{\mathrm{T}}^{\mathrm{miss}} > 110$ GeV
$p_{\mathrm{T},\tau_1} > 50$ GeV	$p_{\mathrm{T},\tau_1} > 80$ GeV	$p_{\mathrm{T},\tau_1} > 95$ GeV
$p_{\mathrm{T},\tau_2} > 40$ GeV	$p_{\mathrm{T},\tau_2} > 40$ GeV	$p_{\mathrm{T},\tau_2} > 65$ GeV

Larger mass splitting => Higher pT taus
=> Larger mT2 and pT thresholds





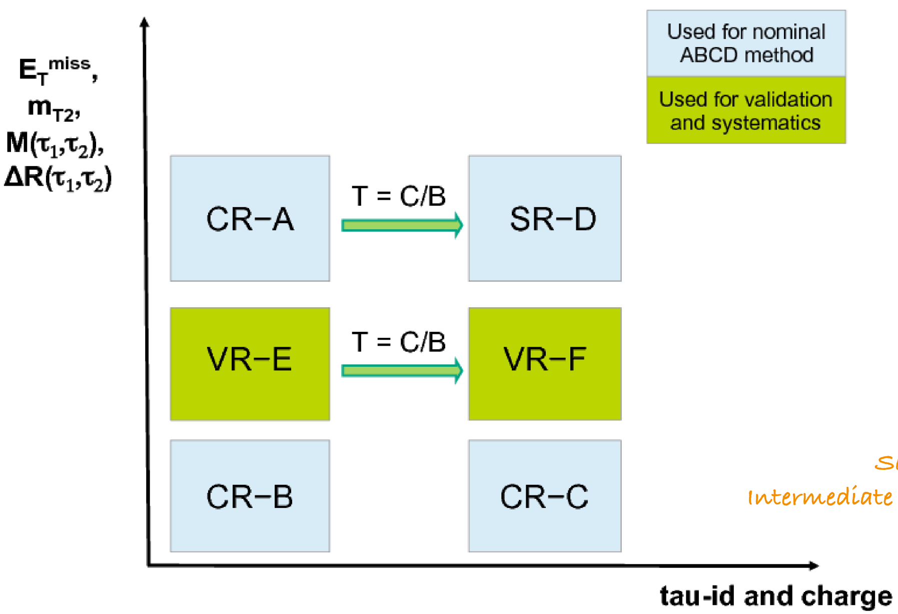
Background Estimation

- **Reducible backgrounds (>= 1 fake tau)**
  - Multi-jets and W+jets
  - Data-driven/ Semi-data-driven estimation
  - Dedicated CRs and VRs

- **Irreducible backgrounds (mostly 2 real taus)**
  - Diboson, Z+jets, top (ttbar, ttbar+V and single top)
  - Estimated with MC simulation
  - Validated in data

ABCD method for multi-jet estimation

- Use the ABCD method to estimate the multi-jet backgrounds from jets misidentified as taus
- Four exclusive regions (CR-A,B,C and SR-D) defined by uncorrelated discriminating variables
- Number of events in SR-D can be estimated by extrapolation performed from A to D:
  - transfer factor $T = N_C/N_B$
  - VR-E and VR-F are used for validation and systematics: N_F vs. $T \cdot N_E$
  - SR estimate $N_D = T\,N_A$



Orthogonal
Suppress SUSY events

CR-A	SR-D (SR-lowMass)
di-tau+E_T^{miss} trigger	
$\geq$ 2 loose tau leptons (SS)	$\geq$ 2 medium tau leptons (OS)
$m(\tau_1,\tau_2) < 250$ GeV	
$\Delta R(\tau_1,\tau_2) > 1.5$	
$E_T^{miss} > 150$ GeV	$E_T^{miss} > 150$ GeV
$m_{T2} > 70$ GeV	$m_{T2} > 70$ GeV
VR-E	**VR-F**
di-tau trigger	
$\geq$ 2 loose tau leptons (SS)	$\geq$ 2 medium tau leptons (OS)
$m(\tau_1,\tau_2) < 250$ GeV	
$\Delta R(\tau_1,\tau_2) > 1.5$	
$E_T^{miss} > 40$ GeV	$E_T^{miss} > 40$ GeV
$50 < m_{T2} < 70$ GeV	$50 < m_{T2} < 70$ GeV
CR-B	**CR-C**
di-tau trigger	
$\geq$ 2 loose tau leptons (SS)	$\geq$ 2 medium tau leptons (OS)
$m(\tau_1,\tau_2) < 250$ GeV	
$\Delta R(\tau_1,\tau_2) > 1.5$	
$E_T^{miss} > 40$ GeV	$E_T^{miss} > 40$ GeV
$20 < m_{T2} < 50$ GeV	$20 < m_{T2} < 50$ GeV

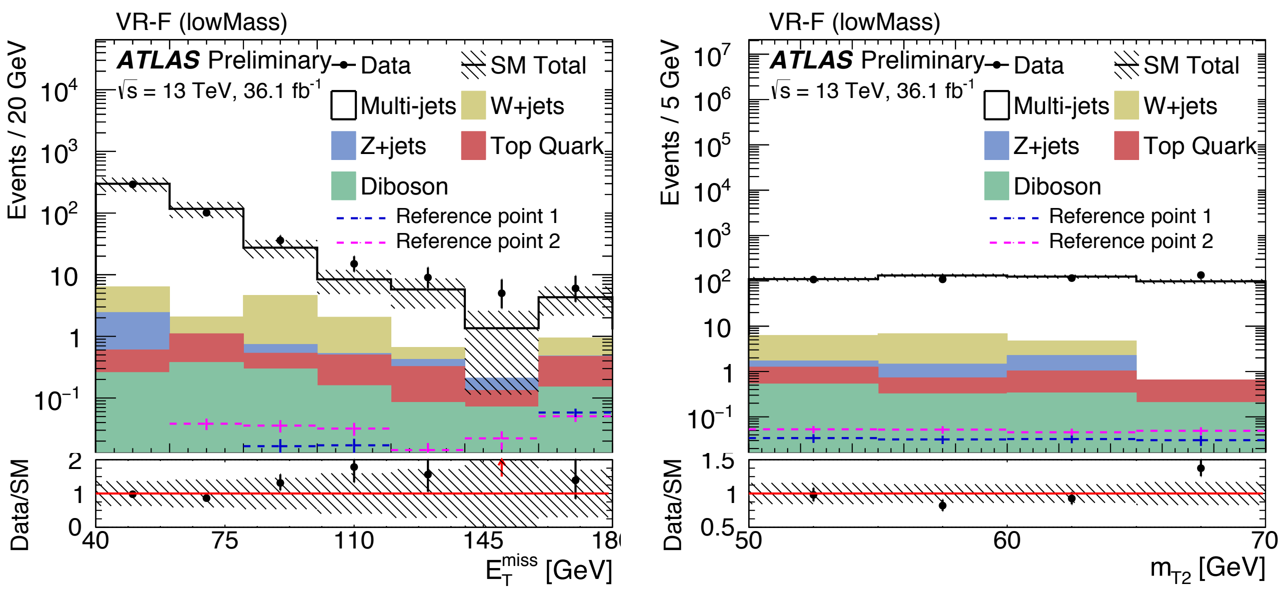
Same as A,D
Intermediate kinematics

Same as A,D
Loose kinematics

ABCD: Validation

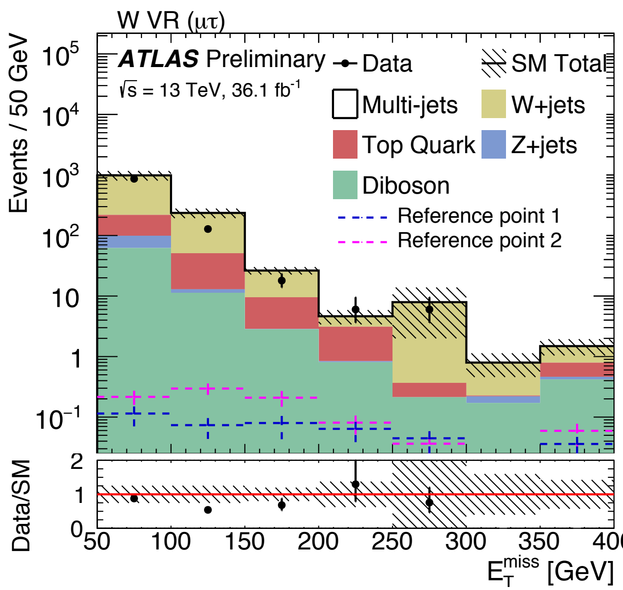
- SM predictions in agreement with the observed data in multi-jet validation regions
- Only statistical uncertainty except for multi-jet contributions
- Distributions of MET and m_{T2} in VR-F are shown

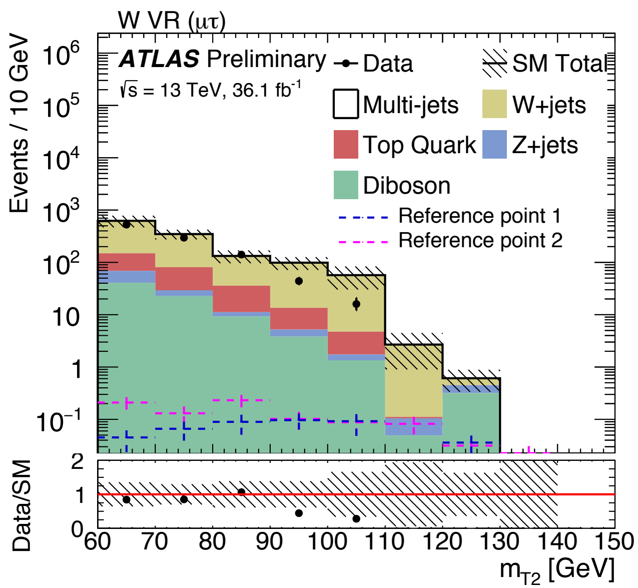
lowMass



W+jets estimation in muon-tau channel

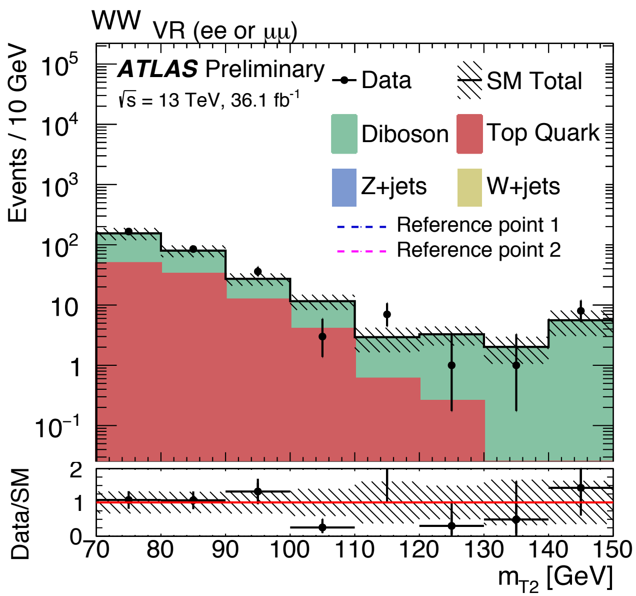
- W+jets (one fake tau) normalised to data in the control region and tested in the validation region
- W-CR/W-VR defined based on “muon-tau” channel with 1 fake tau
- W-CR used to normalise W+jets MC estimation to data
- Multi-jet background is estimated from data with the “OS-SS” method
- The purity of W+jets events in CR > 70%
- Good agreement between data and SM predictions in the VR

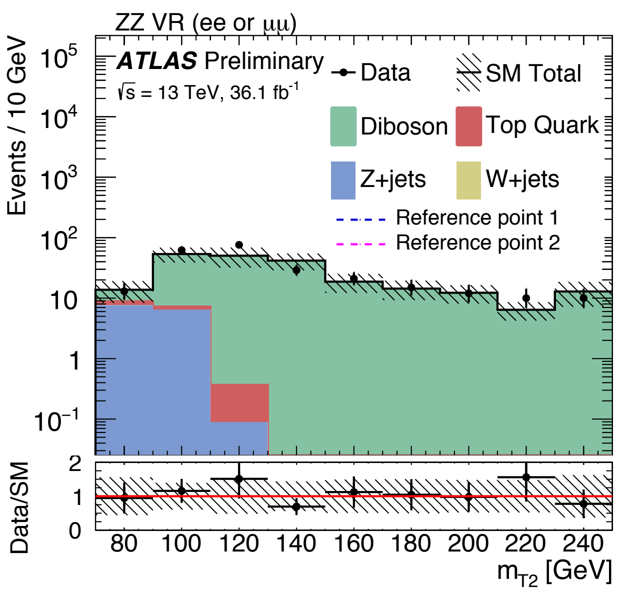




Irreducible background: diboson

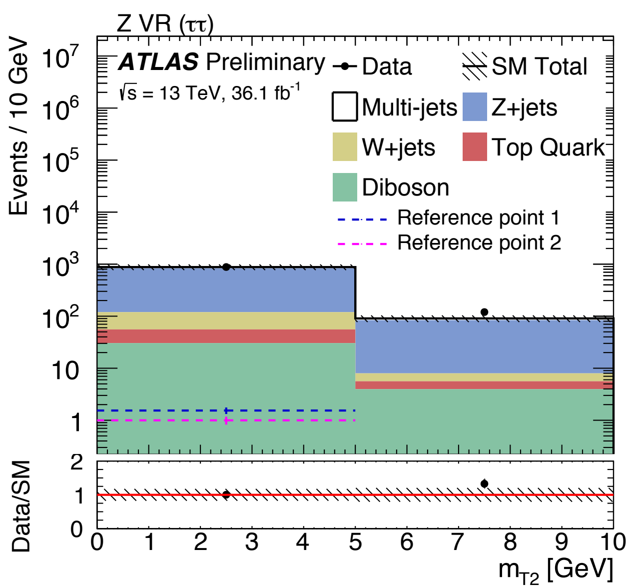
- Dominant contribution from fully leptonic decay (VV—>llvv)
- VRs defined to be close to SR except with light lepton pair
- Diboson VRs are defined in lep-lep (e-mu) channel using DF(WW-VR) or SF(ZZ-VR)
- High purity of WW (65%) and ZZ (92%) in VRs, negligible signal contamination
- Good agreement between data and SM

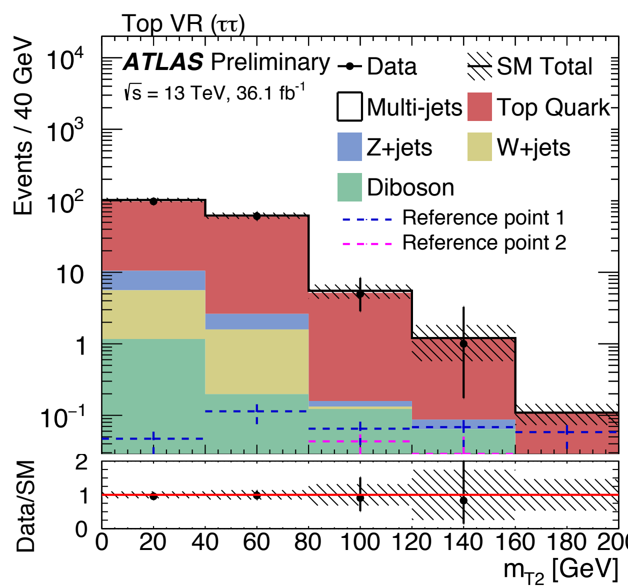




Irreducible background: top and Z+jets

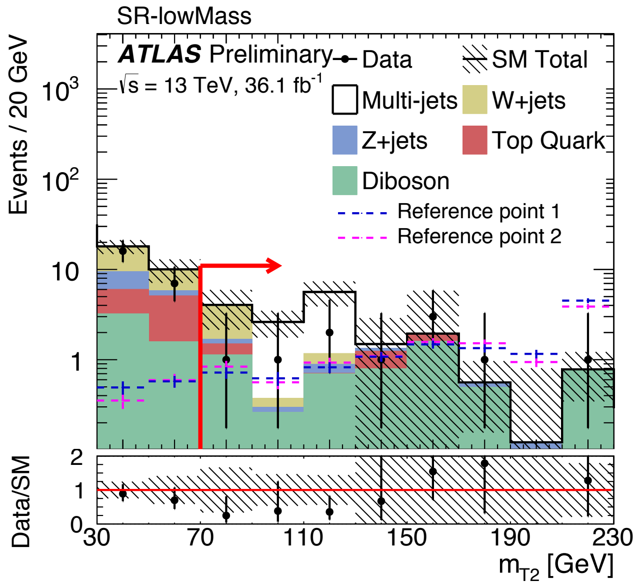
- Top VR (T-VR) and Z+jets VR (Z-VR) defined in ditau channel using ditau+MET or asymmetric ditau trigger
- MC estimates validated in regions enriched with top/Z+jets events
- Multi-jet contribution estimated using ABCD method
- High purity of Z+jets and top (>80%) in VRs, negligible signal contamination
- Good agreement between data and SM

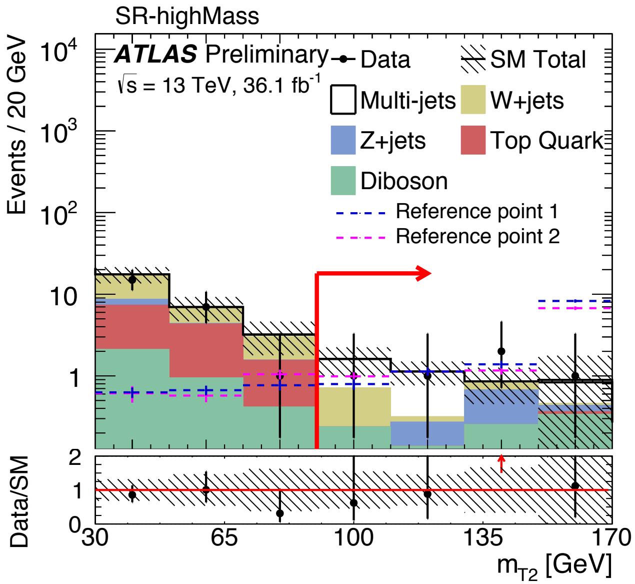




Results.

- Combined fit of W-CR, multi-jet CR
- Dominant backgrounds are multi-jet, diboson and W+jets
- Dominant systematic uncertainties on total background predictions in SRs: normalisation uncertainties in multi-jet background, statistical uncertainties on MC predictions; experimental uncertainties: tau lepton id and energy scale
- No SUSY signal observed

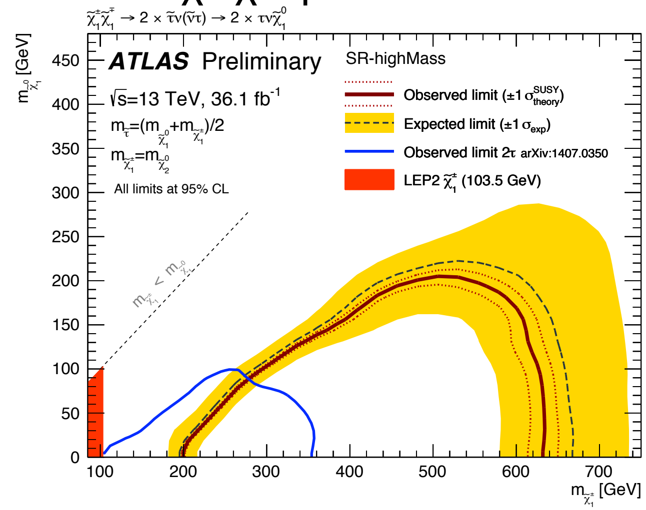




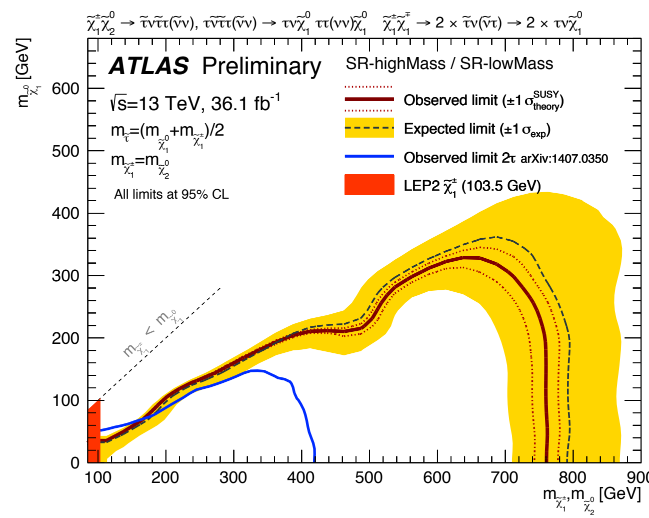
Interpretation.

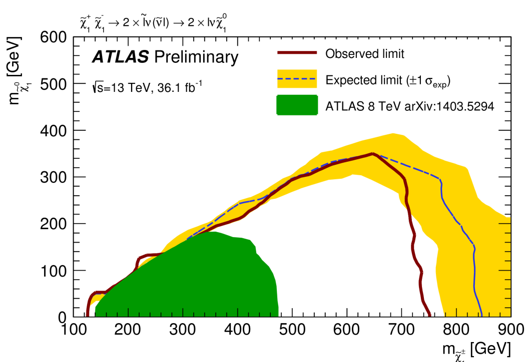
- No significant excess over SM background prediction, set exclusion limits at 95% CL (CLs prescription)
- For a massless LSP:
  - $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ production: $m(\tilde{\chi}_1^{\pm}) > 630$ GeV
  - $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0}$ and $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ associated production: $m(\tilde{\chi}_1^{\pm},\tilde{\chi}_2^{0}) > 760$ GeV
- Good agreement with lepton channel:
  - $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0}$ and $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ associated production: $m(\tilde{\chi}_1^{\pm},\tilde{\chi}_2^{0}) > 1150$ GeV for 200 GeV LSP
  - $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ production: $m(\tilde{\chi}_1^{\pm}) > 750$ GeV for massless LSP

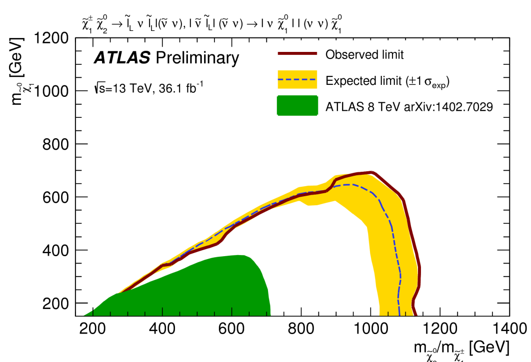
$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ production



$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0}$ and $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm}$ associated production







Summary.

- ATLAS search for the production of charginos and neutralinos in 13 TeV pp collisions with 36.1 fb^{-1} data in final states with at least two taus + MET has been presented
- No significant excesses observed in signal regions
- Exclusion limits are set on $m(\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0})$
- $m(\tilde{\chi}_1^{\pm})$ excluded up to 630 GeV for massless LSP
- $m(\tilde{\chi}_1^{\pm},\tilde{\chi}_2^{0})$ excluded up to 760 GeV for massless LSP
- Further analyses with tau leptons are on-going for Run-2

BACK UP

Object Definition.

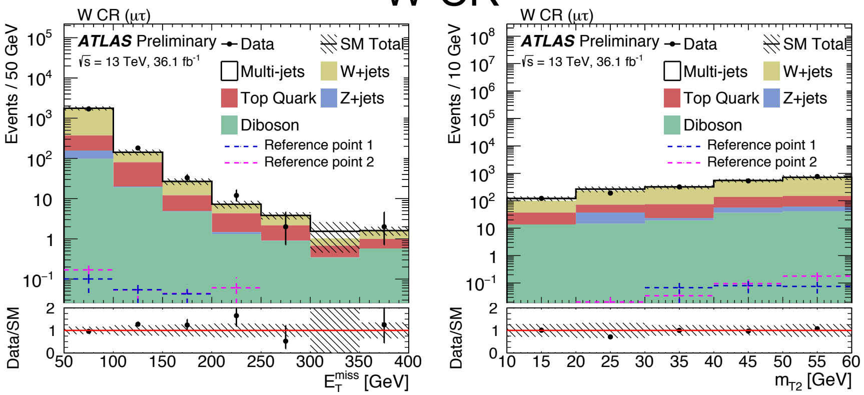
Electrons	Baseline	Signal
p_T	$p_T > 10\,\text{GeV}$	$p_T > 25\,\text{GeV}$
η-acceptance	$\lvert\eta_{\text{cluster}}\rvert < 2.47$	$\lvert\eta_{\text{cluster}}\rvert < 2.47$
quality	LooseLH	TightLH
isolation	—	GradientLoose
tracking cuts		$\lvert d_0/\sigma(d_0)\rvert < 5$
		$\lvert z_0 \sin(\theta)\rvert < 0.5$ mm
Muons	Baseline	Signal
p_T	$p_T > 10\,\text{GeV}$	$p_T > 25\,\text{GeV}$
η-acceptance	$\lvert\eta\rvert < 2.7$	$\lvert\eta\rvert < 2.7$
quality	xAOD::Muon::Medium	xAOD::Muon::Medium
isolation	—	GradientLoose
tracking cuts		$\lvert d_0/\sigma(d_0)\rvert < 3$
		$\lvert z_0 \sin(\theta)\rvert < 0.5$ mm
Taus	Baseline	
p_T	$p_T > 20\,\text{GeV}$	
η-acceptance	$\lvert\eta\rvert < 2.5$	
n-prongs	1 or 3	
quality/jet BDT WP	medium	
electron OR	yes	
Jets	Baseline	*b*-jets
Collection	AntiKt4EMTopo	AntiKt4EMTopo
p_T	$p_T > 20\,\text{GeV}$	$p_T > 20\,\text{GeV}$
η-acceptance	$\lvert\eta\rvert < 2.8$	$\lvert\eta\rvert < 2.5$
JVT cut	> 0.59 (or $p_T > 60\,\text{GeV}$)	> 0.59 (or $p_T > 60\,\text{GeV}$)
b-tag	–	MV2c10 @ 77 % OP

Background Estimation: W+jets.

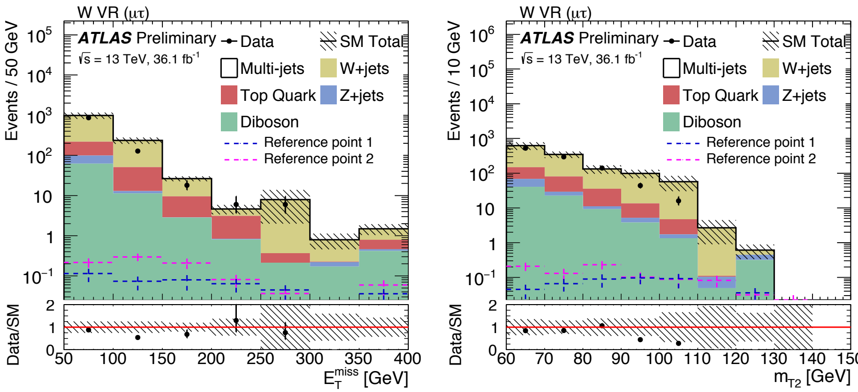
W-CR	W-VR
one isolated muon and one medium tau lepton with opposite sign	
b-jet veto	
$m(\mu,\tau) > 70$ GeV	
$E_{\mathrm{T}}^{\mathrm{miss}} > 60$ GeV	
50 GeV $< m_{T,\mu} <$ 150 GeV	
$m_{T,\mu} + m_{T,\tau} > 80$ GeV	
$0.5 < \Delta R(\mu,\tau) < 3.5$	$0.5 < \Delta R(\mu,\tau) < 4.5$
10 GeV $< m_{\mathrm{T2}} <$ 60 GeV	$m_{\mathrm{T2}} > 60$ GeV

Sample	W-CR	W-VR
Data	1928	1023
SM total	1930 ± 50	1260 ± 440
W+jets	1395 ± 130	980 ± 410
Z+jets	60 ± 28	39 ± 15
Diboson	125 ± 24	78 ± 20
Top quark	290 ± 80	170 ± 60
Multi-jet	60 ± 60	0 ± 100
Reference point 1	0.22 ± 0.07	0.44 ± 0.08
Reference point 2	0.33 ± 0.08	0.87 ± 0.11

W-CR



W-VR



Background Estimation: Diboson, Z+jets, top.

<table>
<tr><th>WW-VR</th><th>ZZ-VR</th></tr>
<tr><td colspan="2">one opposite sign lepton pair
μ p_{T} >30 GeV, e $p_{\mathrm{T}} > 40$ GeV
jet veto
$m_{\ell\ell} > 50$ GeV
$E_{\mathrm{T}}^{\mathrm{miss}}$ >50 GeV
$m_{T\mu} > 100$ GeV
$m_{\mathrm{T2}} > 70$ GeV</td></tr>
<tr><td>two isolated leptons (e or μ) with different flavor
m_{CT} top tag veto</td><td>two isolated leptons (e or μ) with same flavor
$\Delta R(\ell, \ell) < 1.5$
$|m_{\ell\ell} - m_Z| < 15$ GeV</td></tr>
</table>

<table>
<tr><th>Z-VR</th><th>Top-VR</th></tr>
<tr><td colspan="2">at least one opposite sign tau lepton pair
tau $p_{\mathrm{T}} > 50, 40$ GeV
$E_{\mathrm{T}}^{\mathrm{miss}} > 60$ GeV</td></tr>
<tr><td>at least two medium tau leptons
b-jet veto
$m_{\mathrm{T2}} < 10$ GeV</td><td>at least one medium and one loose tau lepton
at least 1 b-jet
$m_{\mathrm{T2}} > 10$ GeV
m_{CT} top-tagged</td></tr>
</table>

ATLAS EWK SUSY Searches.

> Summary of ATLAS EW SUSY searches

ATLAS SUSY Searches* - 95% CL Lower Limits

May 2017

ATLAS Preliminary

$\sqrt{s}$ = 7, 8, 13 TeV

	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\, dt[\mathrm{fb}^{-1}]$	Mass limit		Reference
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e, μ	0	Yes	36.1	$\tilde{\ell}$ 90-440 GeV	$m(\tilde{\chi}_1^0)$=0	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e, μ	0	Yes	36.1	$\tilde{\chi}_1^\pm$ 710 GeV	$m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})$=0.5($m(\tilde{\chi}_1^\pm)$+$m(\tilde{\chi}_1^0)$)	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp/\tilde{\chi}_2^0, \tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu}), \tilde{\chi}_2^0\to\tilde{\tau}\tau(\nu\tilde{\nu})$	2 τ	-	Yes	36.1	$\tilde{\chi}_1^\pm$ 760 GeV	$m(\tilde{\chi}_1^0)$=0, $m(\tilde{\tau},\tilde{\nu})$=0.5($m(\tilde{\chi}_1^\pm)$+$m(\tilde{\chi}_1^0)$)	ATLAS-CONF-2017-035
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e, μ	0	Yes	36.1	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ 1.16 TeV	$m(\tilde{\chi}_1^\pm)$=$m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})$=0.5($m(\tilde{\chi}_1^\pm)$+$m(\tilde{\chi}_1^0)$)	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0 Z\tilde{\chi}_1^0$	2-3 e, μ	0-2 jets	Yes	36.1	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ 580 GeV	$m(\tilde{\chi}_1^\pm)$=$m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $\tilde{\ell}$ decoupled	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0 h\tilde{\chi}_1^0, h\to b\bar{b}/WW/\tau\tau/\gamma\gamma$	e, μ, γ	0-2 b	Yes	20.3	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$ 270 GeV	$m(\tilde{\chi}_1^\pm)$=$m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $\tilde{\ell}$ decoupled	1501.07110
	$\tilde{\chi}_2^0\tilde{\chi}_3^0, \tilde{\chi}_{2,3}^0\to\tilde{\ell}_R\ell$	4 e, μ	0	Yes	20.3	$\tilde{\chi}_{2,3}^0$ 635 GeV	$m(\tilde{\chi}_2^0)$=$m(\tilde{\chi}_3^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell},\tilde{\nu})$=0.5($m(\tilde{\chi}_2^0)$+$m(\tilde{\chi}_1^0)$)	1405.5086
	GGM (wino NLSP) weak prod., $\tilde{\chi}_1^0\to\gamma\tilde{G}$	1 $e, \mu + \gamma$	-	Yes	20.3	$\tilde{W}$ 115-370 GeV	$c\tau$<1 mm	1507.05493
	GGM (bino NLSP) weak prod., $\tilde{\chi}_1^0\to\gamma\tilde{G}$	2 γ	-	Yes	20.3	$\tilde{W}$ 590 GeV	$c\tau$<1 mm	1507.05493

$\sqrt{s}$ = 7, 8 TeV; $\sqrt{s}$ = 13 TeV

10^{-1} … 1 — Mass scale [TeV]

*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.