Search for $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \to 1l^\pm + 2b + E_T^{miss}$

ATLAS-CONF-2013-093
(preliminary results)
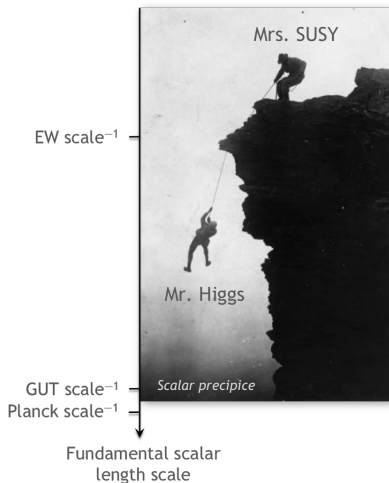
Steve Muanza, <u>Michaël Ughetto</u>

CPPM, CNRS-IN2P3 and Aix-Marseille University
L2C, CNRS-INP and Montpellier 2 University
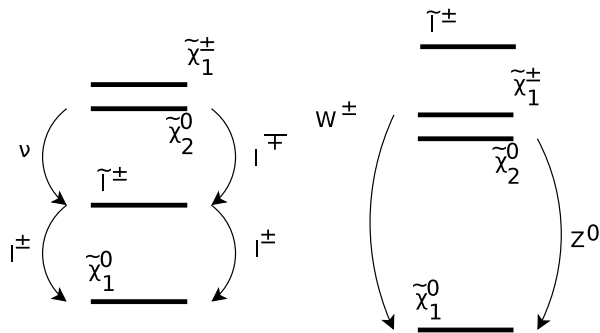
October 29, 2013

SuSy status at 8 TeV (simplified)

- We caught the lightest higgs of the MSSM (see Jeremie Quevillon's talk)
- No superpartners yet
- gluinos, 1st and 2nd generation squarks *most likely* above the TeV
- charginos and neutralinos pair production may be dominant at LHC8

Mrs. SUSY

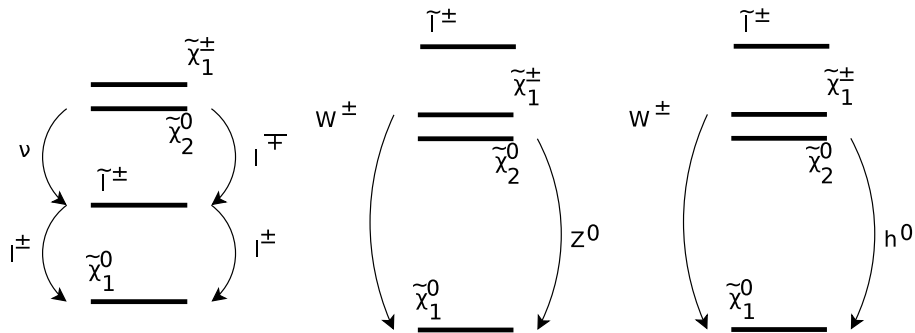EW scale^{-1}

Mr. Higgs

Scalar precipice

GUT scale^{-1}
Planck scale^{-1}

Fundamental scalar length scale

Simplified spectra

$$\tilde{\chi}_1^{\pm} \tilde{\chi}_2^0 \rightarrow 3l^{\pm} + E_T^{\text{miss}}$$

$$\tilde{\chi}_1^{\pm} \tilde{\chi}_2^0 \rightarrow 3l^{\pm} + E_T^{\text{miss}}$$
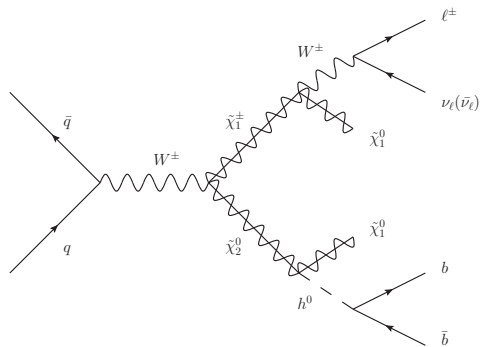$$\tilde{\chi}_1^{\pm} \tilde{\chi}_1^{\pm} \rightarrow 2l^{\pm} + E_T^{\text{miss}}$$

Simplified spectra

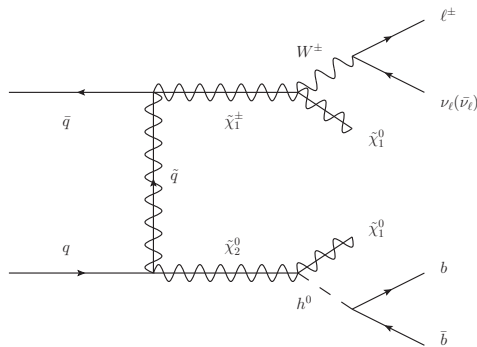$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to 3l^{\pm} + E_T^{\text{miss}}$

$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to 3l^{\pm} + E_T^{\text{miss}}$
$\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\pm} \to 2l^{\pm} + E_T^{\text{miss}}$

$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to 1l^{\pm} + 2b + E_T^{\text{miss}}$

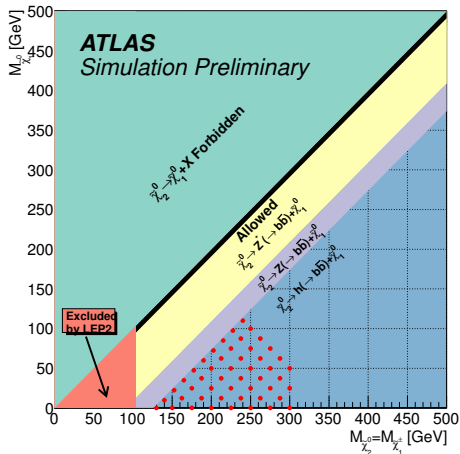# $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ production diagrams

s-channel

t-channel

Production by s-channel dominant but can interfer with t-channel
if squarks are light enough

Analysis signal grid

Some assumptions

- $m_{\tilde{\chi}_2^0} = m_{\tilde{\chi}_1^\pm}$
- squarks and sleptons decoupled
- $\mathrm{BR}(\tilde{\chi}_1^\pm \to W^\pm \tilde{\chi}_1^0) = 1$
- $\mathrm{BR}(\tilde{\chi}_2^0 \to h^0 \tilde{\chi}_2^0) = 1$
- Conservative choice of h^0 properties:
  $\mathrm{BR}(h^0 \to bb) = 0.58$
  $m_h = 125$ GeV
- Cross-section:
  $\mathcal{O}(100 - 1000$ fb$)$

Event preselection

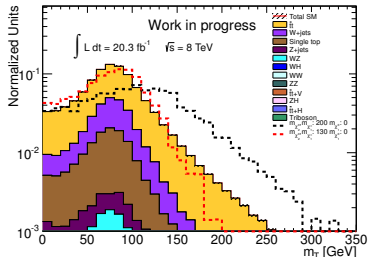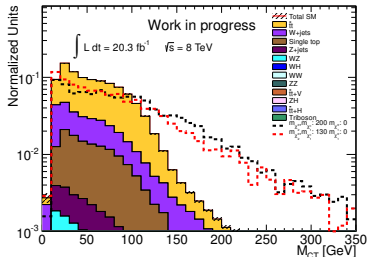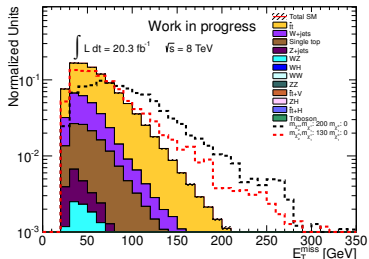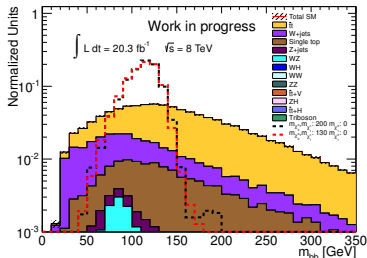| Triggers	Isolated	Non-Isolated
Electron p_T threshold	24 GeV	60 GeV
Muon p_T threshold	24 GeV	36 GeV

Signal objects:

- ▶ 1 tight lepton, trigger matched, $p_T > 25$ GeV, $|\eta| < 2.47(e)/2.4(\mu)$
- ▶ $E_T^{\mathrm{miss}} > 25$ GeV
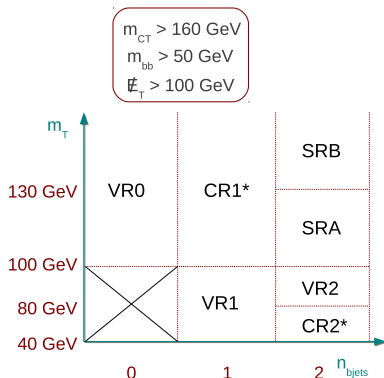- ▶ Two p_T-leading jets are b-tagged with a b-tagging efficiency of 70%, $p_T > 25$ GeV and $|\eta| < 2.4$

Vetos:

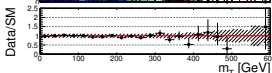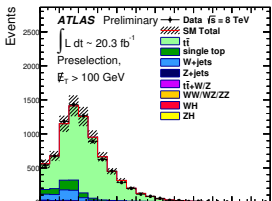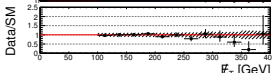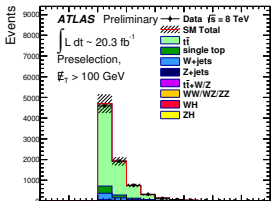- ▶ No additional isolated lepton
- ▶ No 4th jet

Discriminant variables

Use of h^0 resonance

$E_T^{miss} > 100$: supresses QCD and reduces physics backgrounds

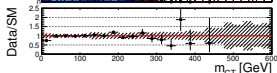$m_{ct} > 160$: kills top backgrounds

Larger tails for high Δm

Region definitions

- SRA: targets to low Δm
- SRB: targets to high Δm
- CR1*,CR2*: regions used to constrain μ_{tt} and μ_{wjets}
- VR0,VR1,VR2: different heavy-flavor content

Kinematic checks

- Normalized in CRs
- All variables used are well-modeled by simulation

- Dashed band contains both stat. and syst. errors

Fitting procedure

Inputs:

- Binned m_{bb} distribution: $m_{bb} \in [50, 75, \mathbf{105,135}, 165, \infty]$, with the signal bin in red

  - for all regions
  - for nominal detector simulation and detector/reconstruction systematics variations
  - for some processes, theoretical systematics are also added

A p.d.f. is build out of this inputs and fitted in different regions.

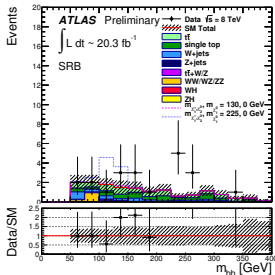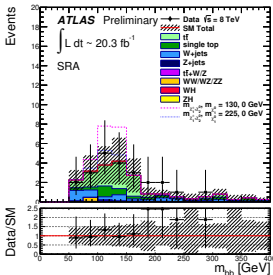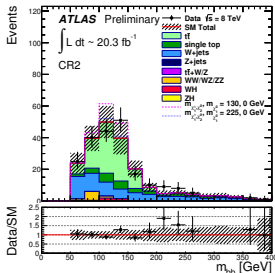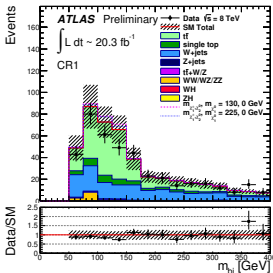# Model Independent Limits

- Fitting m_{bb} only in CRs

- Do not use the signal bin for this fit

- Float μ_{tt}, μ_{wjets}

Observed σ_{vis}^{95}:

- SRAh: 0.34 fb

- SRBh: 0.21 fb

Dominant systematics:

- JES: ~10%

- b-tagging: ~4.0%

Model Dependent Limits

Fitting the full m_{bb} distribution in CRs and SRs, floating μ_{tt}, μ_{wjets}, μ_{signal}

Upper limits on signal strength

For a massless $\tilde{\chi}_1^0$, mass ranges:
$125 < m(\tilde{\chi}_1^\pm, \tilde{\chi}_2^0) < 141$ GeV and
$166 < m(\tilde{\chi}_1^\pm, \tilde{\chi}_2^0) < 287$ GeV are
excluded at 95% confidence level

Overall view

Grey numbers shows 95%CL upper limit on $pp \to \tilde{\chi}_1^{\pm} \tilde{\chi}_2^0$ production cross-section

Conclusion and prospects

- First ATLAS results for SUSY with a 125 GeV higgs in the final state
- Analysis able to exclude the following masse ranges for massless $\tilde{\chi}_1^0$:
  $125 < \mathrm{m}(\tilde{\chi}_1^\pm, \tilde{\chi}_2^0) < 141$ GeV and $166 < \mathrm{m}(\tilde{\chi}_1^\pm, \tilde{\chi}_2^0) < 287$ GeV
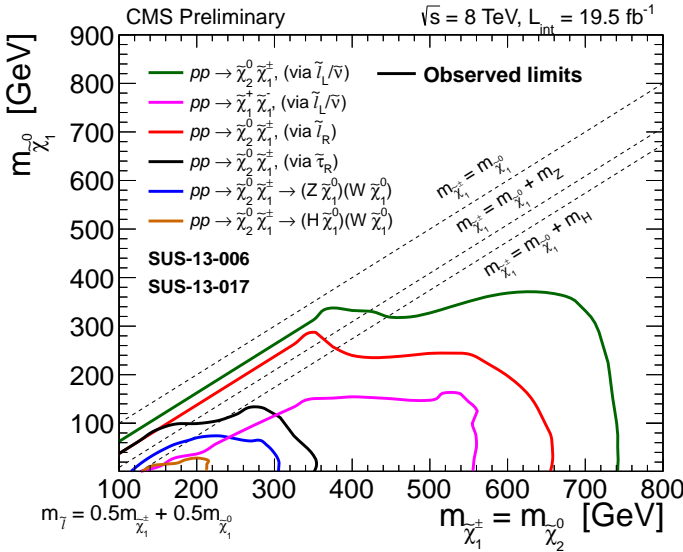
We're improving analysis and aim at a combined publication with other SUSY/higgs analysis:

- $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow W(\rightarrow l\nu) h^0(\rightarrow bb) + 2\tilde{\chi}_1^0$
- $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow W(\rightarrow l\nu) h^0(\rightarrow WW) + 2\tilde{\chi}_1^0$
- $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow W(\rightarrow l\nu) h^0(\rightarrow \tau\tau) + 2\tilde{\chi}_1^0$
- $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow W(\rightarrow l\nu) h^0(\rightarrow \gamma\gamma) + 2\tilde{\chi}_1^0$

Background-only fit table

	SRAh	SRBh
Observed events	4	2
Background estimate		
ttbar	2.9 ± 2.8	1.0 ± 0.6
$W + \text{jets}$	0.7 ± 0.4	0.3 ± 0.2
Single top	1.6 ± 1.3	0.6 ± 0.4
$Z + \text{jets}$	$0.01^{+0.02}_{-0.01}$	$0.00^{+0.01}_{-0.00}$
Diboson (VV)	$0.01^{+0.05}_{-0.01}$	$0.05^{+0.07}_{-0.05}$
WH	0.18 ± 0.10	0.12 ± 0.07
ttbar$+V$	0.01 ± 0.01	0.11 ± 0.06
Total	5.4 ± 3.1	2.1 ± 0.7
Signal prediction		
$(130, 0)$GeV	6.5	0.2
$(225, 0)$GeV	1.9	4.1

CMS results

ATLAS detector