SUSY Higgs results from 2010 ATLAS data

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Discovering the mechanism responsible for the electroweak symmetry breaking, which requires the existence of at least one scalar Higgs boson in the Standard Model (SM), is one of the major goals of the physics program at the LHC. In SUSY, additional scalar bosons are predicted with altered couplings. First results of SUSY Higgs searches with 39 pb^{-1} of data recorded with ATLAS in 2010 are presented here.

1 Search for a neutral MSSM $H \to \tau^+\tau^-$

The Minimal Supersymmetric Standard Model (MSSM) predicts an enhanced coupling of Higgs bosons to third generation fermions for large regions of the parameter space. Their decay to $\tau^+\tau^-$ pairs is the most promising search channel [1]. It is subdivided into the $e\mu$ and $\ell\tau_h$ final states, depending on the decay of the τ-leptons either to lighter charged leptons or hadronic jets (τ_h-jets). After a basic selection of oppositely charged τ-decay products, top and di-boson backgrounds are suppressed requiring $|p_T^e| + |p_T^\mu| + |\not{E}_T| < 120$ GeV and $\Delta\phi(e,\mu) > 2$ in the $e\mu$ channel. The $\ell\tau_h$ channel selects events fulfilling $\not{E}_T > 20$ GeV and $m_T = \sqrt{2p_T^\ell \not{E}_T \left(1 - \cos\Delta\phi(\ell, \not{E}_T)\right)} < 30$ GeV in order to reduce QCD and W+jets backgrounds with misidentified τ_h-jets. In both channels, the QCD background is estimated from the observed number of like-signed events in data (see Fig. 1 (left)). The simulation of the $Z \to \tau\tau$ background is validated using $Z \to \mu\mu$ data, where simulated τ-decays are embedded in place of the muons (see Fig. 1 (middle)). Limits on $\tan\beta$ and m_A are presented in Fig. 1 (right), which exceed the region excluded by Tevatron.

2 Studies for $H^\pm$ searches in τ final states

Assuming the mass relation $m_{H^\pm} < m_t$, charged Higgs bosons are produced via $t \to bH^\pm \to b\tau^\pm\nu$. Although the 2010 dataset does not provide sufficient statistics to set limits in this channel, studies are presented showing a promising discovery potential with an increased dataset. For subsequent τ-decays to leptons, variables with discrimination against W+jets are validated with 2010 data [2]. In final states with hadronic τ_h-jets, methods for data-driven background estimates are commissioned. Backgrounds with misidentified τ_h-jets are estimated via dedicated fake-rate measurements, while $\mu \to \tau$ embedding is used for backgrounds with real τ_h-decays [3].

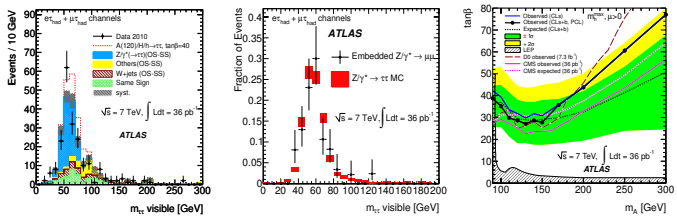

Figure 1: $H \to \tau^+\tau^-$: Visible mass compared between data and backgrounds (left) and validated with embedded data (middle). Limits on $\tan\beta$ and m_A (right).

3 Search for a light CP-odd $a_1 \to \mu^+\mu^-$

The next-to minimal supersymmetric SM (NMSSM) predicts two CP-odd scalars (a_1, a_2), of which the lightest can have a mass as low as 10 GeV. The dedicated search [4] selects muon pairs with $p_T^\mu > 4$ GeV and $4.5 < m(\mu,\mu) < 12$ GeV. Backgrounds are estimated from sidebands and fits to the Y resonances (see Fig. 2 (left)), allowing first limits on $\sigma(gg \to a_1) \times BR(a_1 \to \mu^+\mu^-)$, which are presented in Fig. 2 (right).

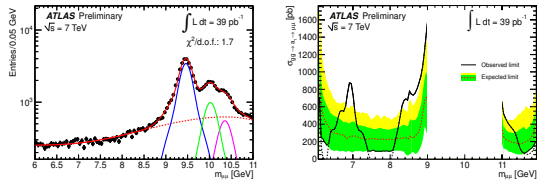

Figure 2: $a_1 \to \mu^+\mu^-$: Fit to the mass spectrum (left), and limits on $\sigma \times BR$ (right).

References

[1] The ATLAS Collaboration, arXiv:1107.5003v1 [hep-ex]

[2] The ATLAS Collaboration, ATLAS-CONF-2011-018.

[3] The ATLAS Collaboration, ATLAS-CONF-2011-051.

[4] The ATLAS Collaboration, ATLAS-CONF-2011-020.