Search for direct chargino production in AMSB scenarinos based on a disappearing-track signature with the ATLAS detector

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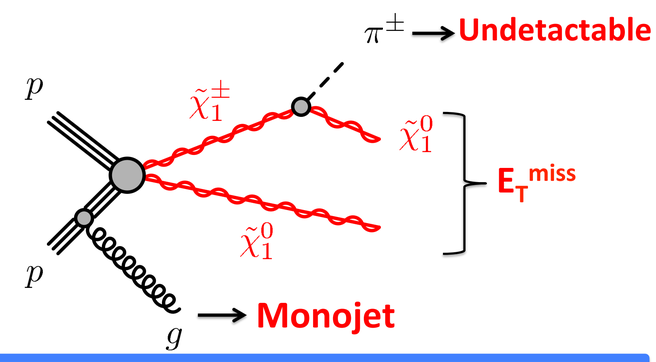
Anomaly Mediated SUSY Breaking (AMSB) scenario

- No SUSY-FCNC/CP problem
- No gravitino overproduction problem
- Wino can be a good candidate for dark matter
- M_h ~ 126 GeV can be realized due to large squark mass ~ O(10-100) TeV
- $m_{\tilde{B}} : m_{\tilde{W}} : m_{\tilde{g}} \approx 3:1:8$, LSP = Pure neutral wino
- Δm_χ (chargino/neutralino) ≈ 160 MeV
  - Measurable lifetime ($\tau_{\chi^\pm} \approx 0.2$ns → $c\tau_{\chi^\pm}$ ≈ O(1-10)cm).
  - Decay inside the tracking detectors.
- Chargino decays into a neutralino + soft pion.
  (E_T^{miss}) (undetactable)

→Chargino is observed as a "**disappearing track**"

Direct chargino production



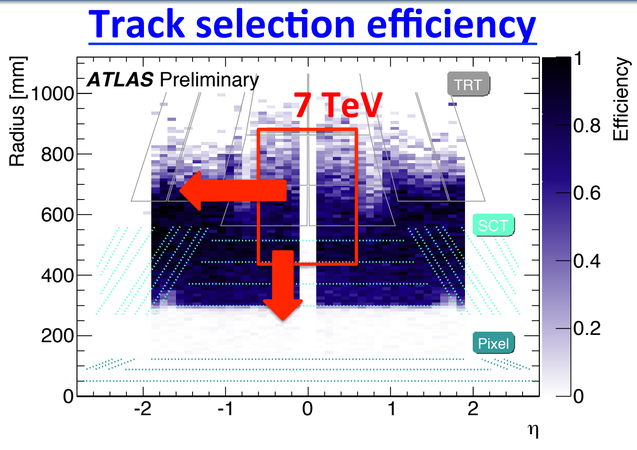
Monojet selection

- Topological Trigger
  - Jet + E_T^{miss} + ΔΦ(jets, E_T^{miss})
  - Dedicated trigger for the analysis
- No lepton (p_T > 10 GeV)
- ≥ 1 jets
- Leading jet p_T > 90 GeV
- E_T^{miss} > 90 GeV
- ΔΦ(jets, E_T^{miss}) > 1.5

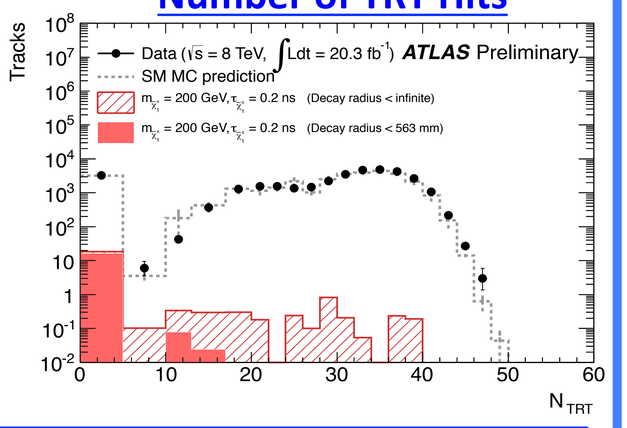
Disappearing track selection

- **Isolation from hadronic activity**
  - $p_T$cone40 / p_T < 0.04
  - ΔR(jets, track) > 0.4
- **Quality requirements**
  - Probability(χ^2, ndf) > 0.1
  - $|d_0|$ < 0.1mm, $|z_0 \sin\theta|$ < 0.5mm
  - No holes in Pixel and SCT detector.
- **Disappearing track selection**
  - **Number of TRT Hits: N(TRT) < 5**
- **Short-length track reconstruction**
  - **Number of SCT Hits: N(SCT) ≥ 2**

Track selection efficiency

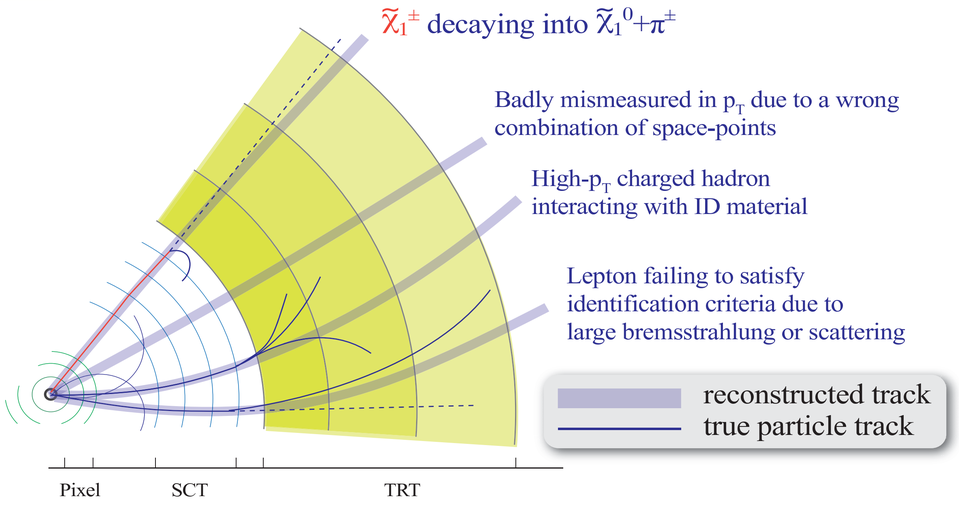


Number of TRT Hits



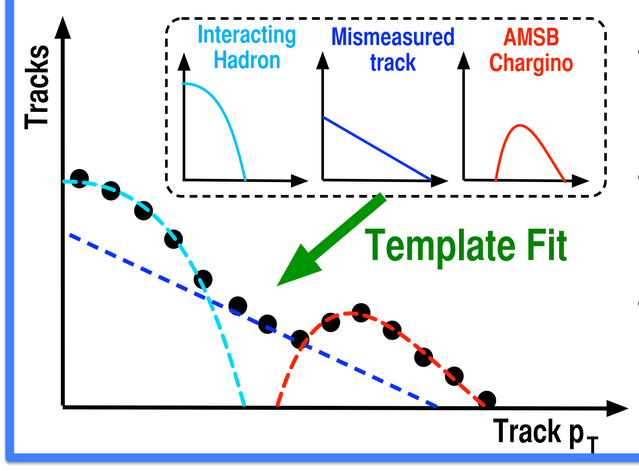
- **Dedicated track reconstruction** for the analysis.
- Achieved **O(10 - 100) times higher reconstruction efficiency** for charginos with small lifetime than that for 7 TeV result.

Background estimation



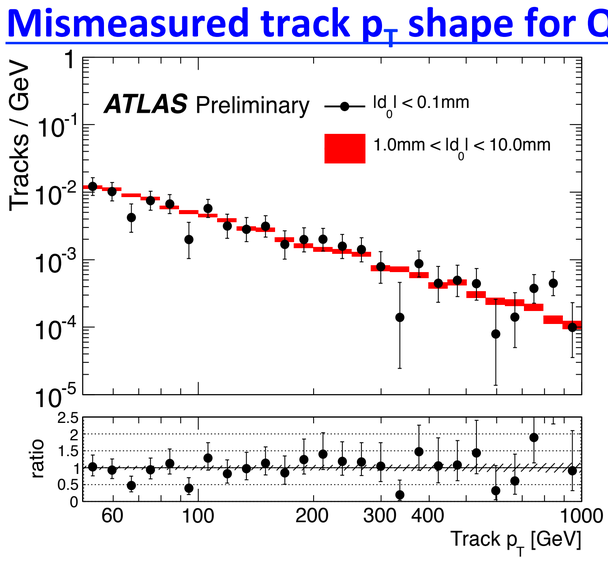
Background tracks	Signal Region	Control Sample
p_T-mismeasured track (Main Background)	$\|d_0\|$ <0.1 mm	p_T spectrum does not depend on the impact parameter **→ 1 mm <$\|d_0\|$ <10 mm**
Interacting hadron track	N(TRT) < 5	p_T spectrum for interacting hadrons is the same as that for non-interacting hadrons (J.Phys.G37 (2010) 075021) **→ N(TRT) ≥ 25**
Unidentified lepton	N(lepton) = 0	**N(lepton) = 1 ⊗ Probability (disappearing)** → Estimated by Z→ee, μμ tag & probe method

How to estimate: data-driven method



- Derive background track p_T shapes from their data control samples.
- Perform a "Signal + Background template fit" to candidate track p_T.
- Track p_T shapes in control samples must be the same as those in SR.

Mismeasured track p_T shape for QCD control samples



- Main background in p_T > 100 GeV is p_T-mismeasured tracks.
- p_T spectrum does not depend on the impact parameter (d_0).
- This feature is confirmed in QCD enriched data samples. (E_T^{miss} < 90 GeV)

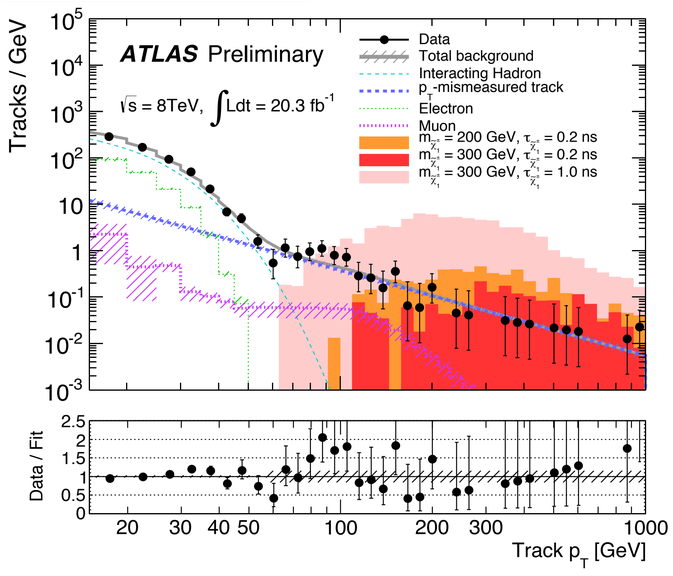
Results

1. Counting experiment

Signal Region	p_T > 200 GeV
Expected events	18.0 ± 4.6
Observed events	13

- Chargino tracks have high p_T and the best sensitivity derives from the region with p_T > 200GeV.
- Expectation from the Standard Model BG is derived by BG-only fit in the region with p_T < 75 GeV.
- Counting experiment shows that there is no significant excess in the high p_T region.

2. Shape analysis

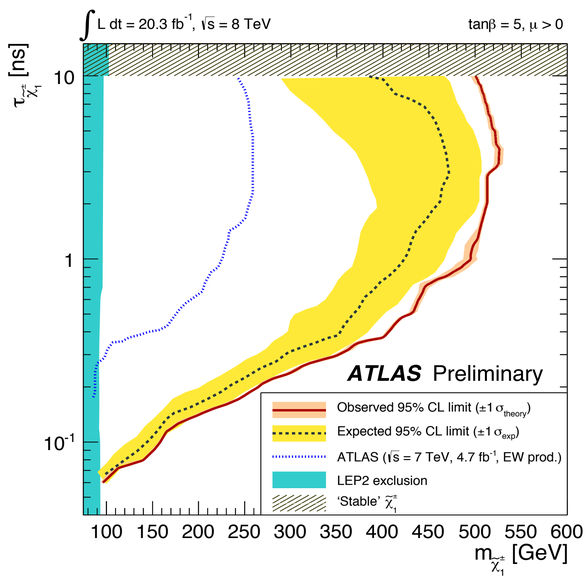


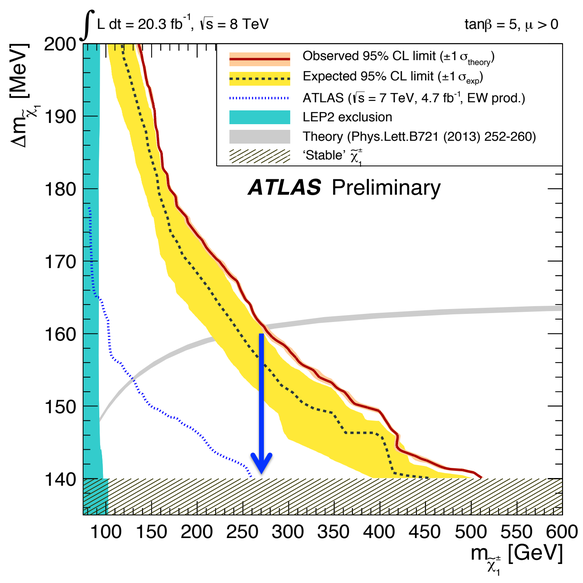
→ Perform a "Signal + Background" template fit in 15 GeV < p_T < 1000 GeV to extract a contribution from signal.

Interpretation

- No significant excess beyond the Standard Model.
- In AMSB scenarios ($\tau_{\chi^\pm} \approx 0.2$ns, $\Delta m_\chi \approx 160$MeV), **chargino mass < 270 GeV is excluded** at 95% C.L.

→ These constraints are generally valid in Wino LSP scenarios.





Reference: *ATLAS-CONF-2013-069, July, 2013*

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