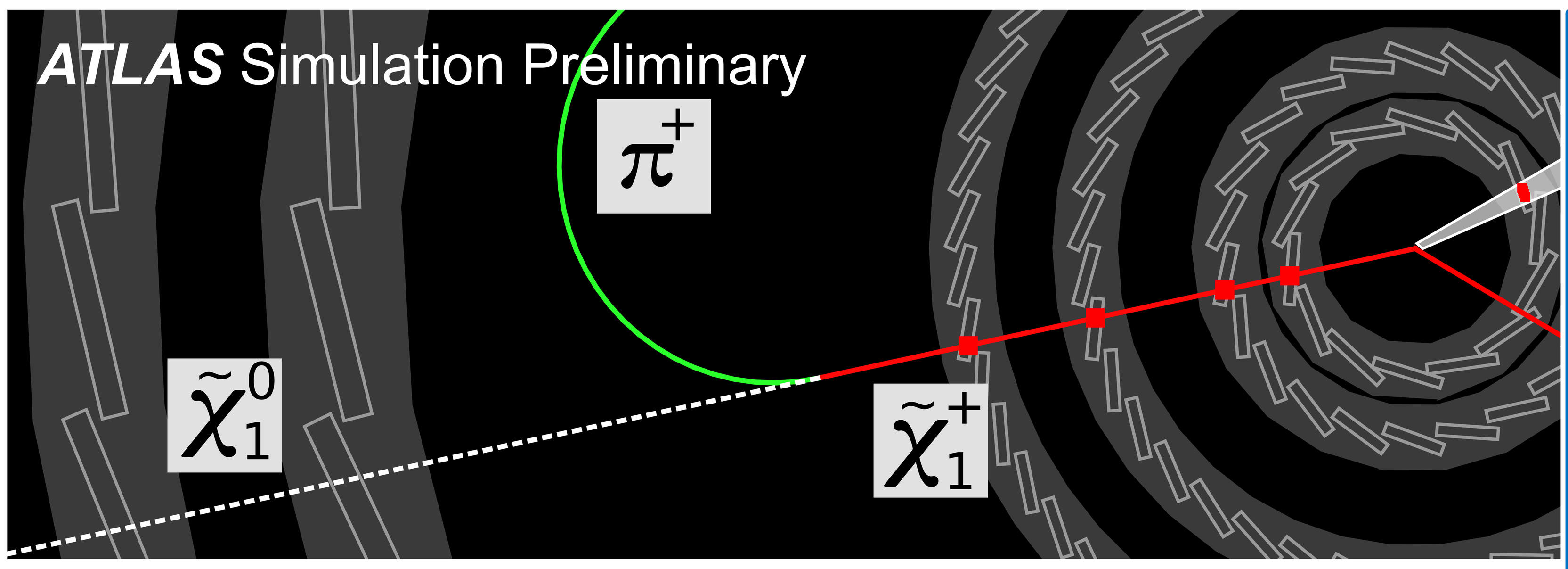
Search for Long-lived particles with the ATLAS detector

EPS poster session - Venice, 5th-12th July 2017

Motivation

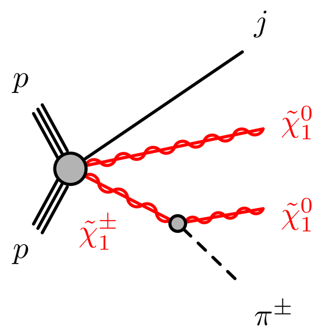
The **wino** is one of the most attractive dark matter candidates. In many models, the charged wino (chargino) mass is naturally highly degenerate with neutral wino mass (Δm ~ 160 MeV), so that charged wino becomes long-lived (τ ~ 0.2 nano sec). Metastable charginos leave a **disappearing-track signature**. Thanks to a new inner pixel layer, new short tracking becomes possible.



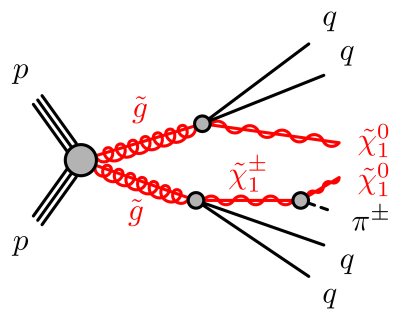
Overview

- Searched for long-lived charginos based on a disappearing-track signature in p-p collision at $\sqrt{s}$ = 13 TeV with ATLAS detector.
- Two signal productions are considered, both requiring a disappearing track as well as:

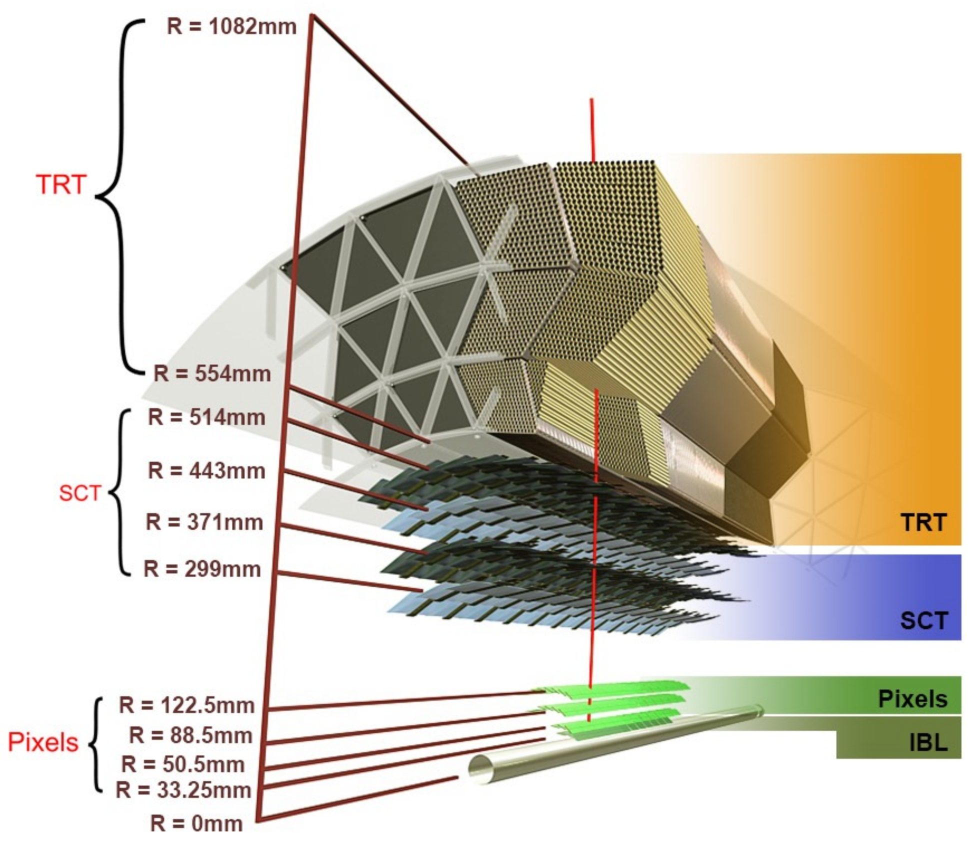
EW production
- ISR jet is tagged
- Require at least 1 jets + Missing E_T



Strong production
- Gluino cascade decay
- Require at least 3 jets + Missing E_T

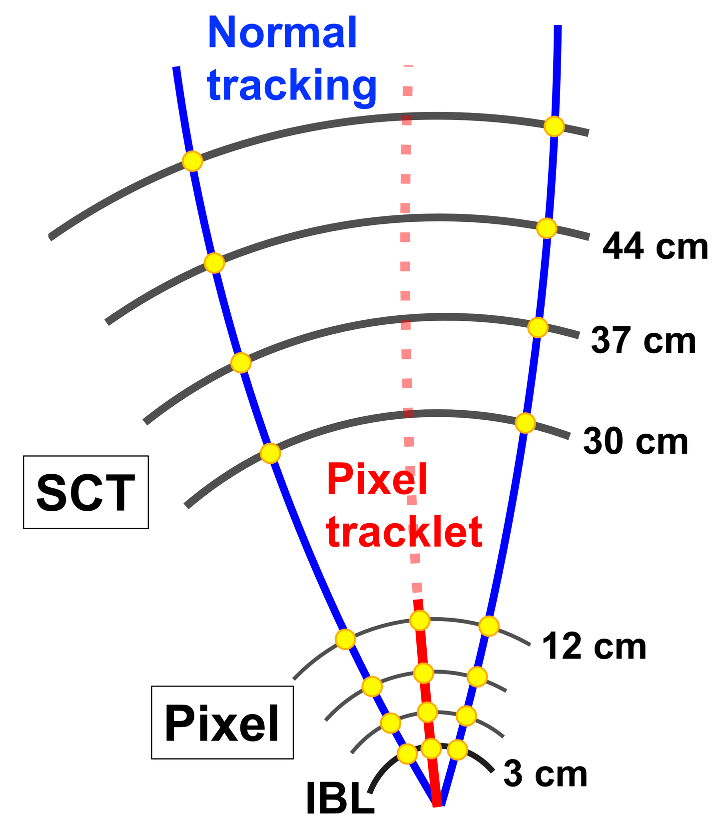


Special tracking



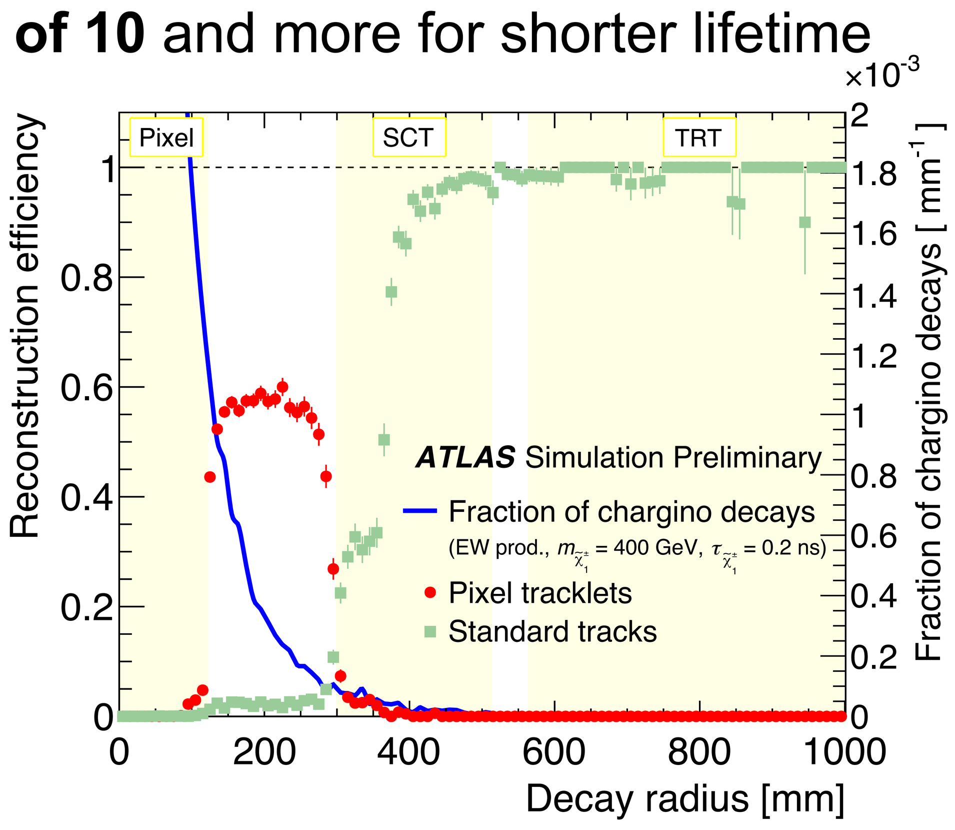
Tracking strategy

- ATLAS inner detector consists of 3 detectors (Pixel, SCT, TRT).
- Pixel detector, which is the innermost detector, has 4 barrel layers and spans the radius range from 3 to 12 cm. The new innermost layer (**IBL**) was installed at the beginning of Run-2.
- Usually ATLAS tracking requires at least 7 hits per track. However this cannot reconstruct target signals ($\langle c\tau \rangle_{mean}$ ~ 6 cm for 0.2 nano sec chargino).
- To recover short length tracks, developed **Pixel tracklet** which is reconstructed by using **only 4 hits** in pixel detector and required no SCT hits on tracks.
- To reduce fake tracks, require no missing hits on tracks and no shared hits with normal tracks.



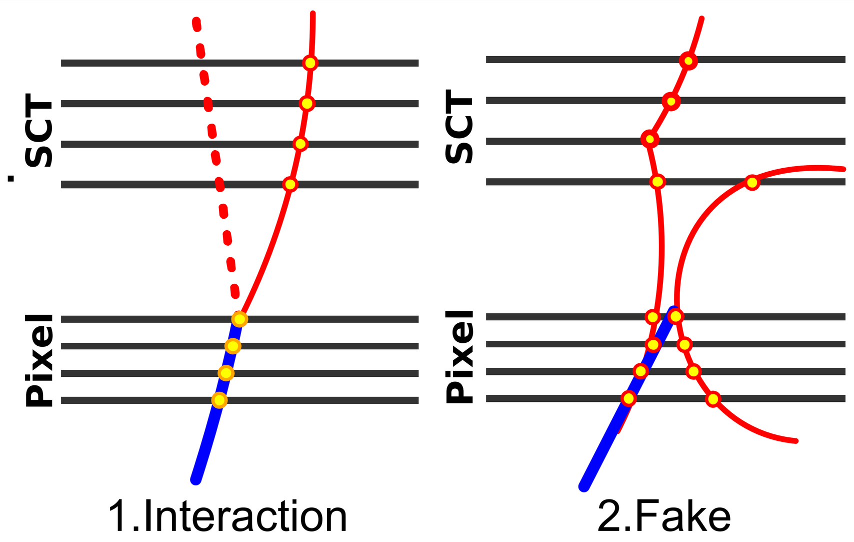
Pixel tracklets

- Signal exponentially decays before SCT detector.
- Pixel tracklet recovers signals decaying between 12 cm ~ 30 cm.
- Pixel tracklet can increase signal acceptance for 0.2 nano sec chargino (pure wino) **a factor of 10** and more for shorter lifetime signals (e.g. pure higgsino).
- The track length of pixel tracklet is 3 times shorter than normal tracks, so that p_T resolution is 9 times worse.
- Pixel tracklet p_T resolution is measured in data and applied to background estimation and the signal modelling.



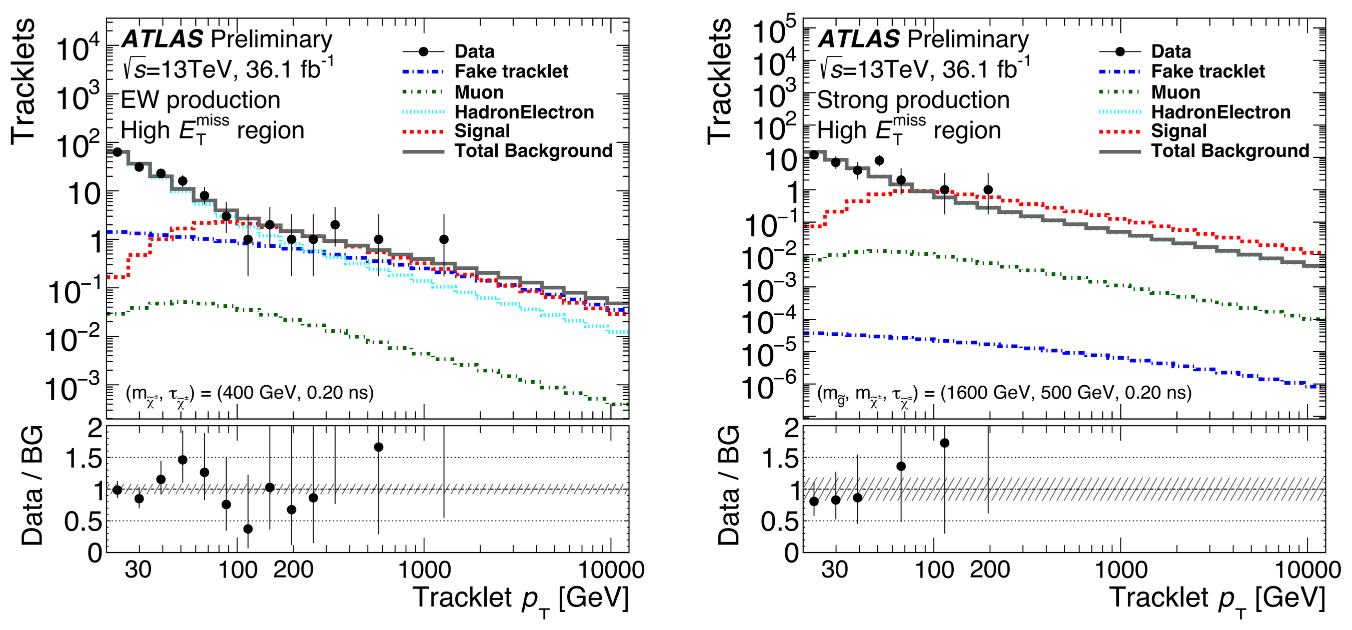
Background estimation & Signal extraction

- Two categories of backgrounds:
  1. interaction with the detector material.
  2. wrong combination of detector hits (fakes).



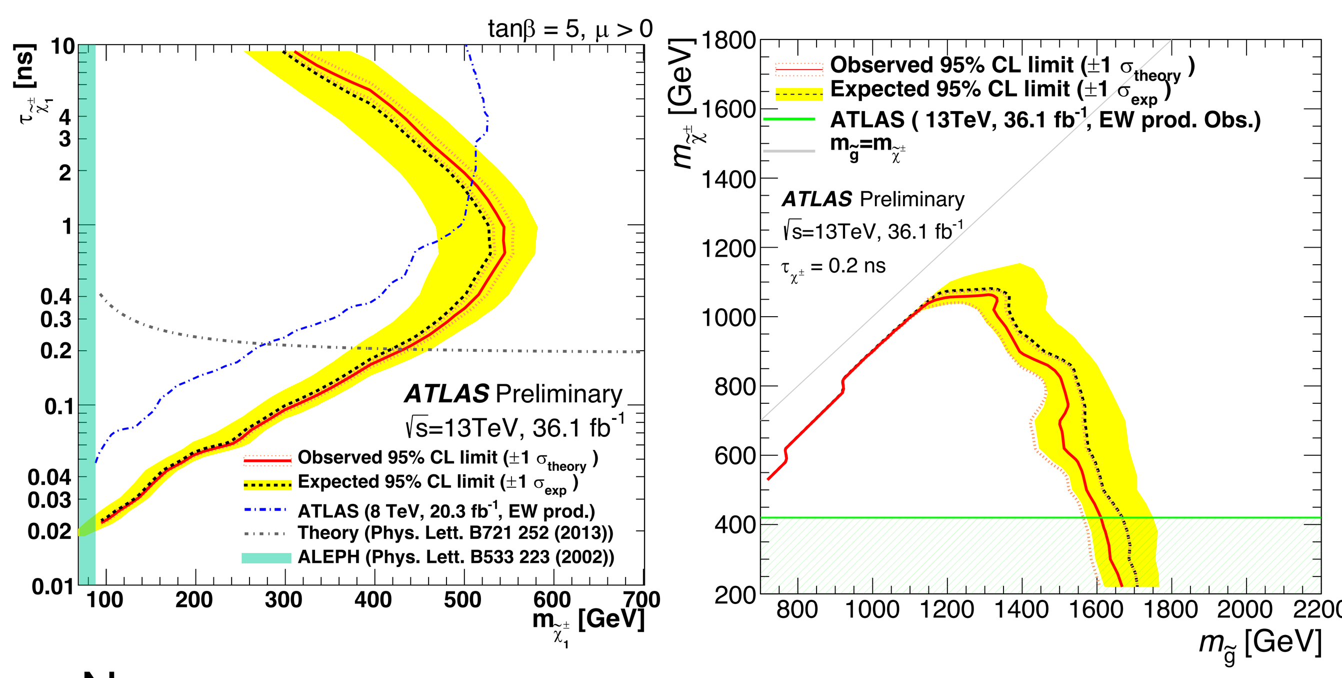
- Signal is extracted by **fitting track p_T shapes**.
- Background pT template are estimated from real data.
- For interacting background, hadron/electron template and muon template are prepared separately because they have different p_T shapes.
- For fake background, template are estimated from large impact parameter tracks.

Result



	Observed	Expected BG	Observed $\sigma_{vis}^{95\%}$ [fb]
EW	9	11.8 ± 3.1	0.22
Strong	2	2.1 ± 0.9	0.14

Interpretation



- No excess.
- 95 % CLs exclusion limit.
  - $m_{\tilde{\chi}_1^\pm}$ < 430 GeV (for 0.2 nano sec chargino)
  - $m_{\tilde{g}}$ < 1.6 TeV (for above chargino limits)
  - $m_{\tilde{\chi}_1^\pm}$ < 1.05 TeV (for gluino/chargino compressed scenario)

Conclusion

- Searched for long-lived charginos using **disappearing-tracks signature** at 36.1 fb^{-1}.
- New special tracking is developed to recover short tracks. This increases signal acceptance for pure wino a factor of 10.
- No excess is found.
- Excluded many signal parameter regions compared to previous collider search.

Masahiko Saito (The University of Tokyo), for the ATLAS Collaboration

Reference : ATLAS-CONF-2017-017

ATLAS EXPERIMENT