

Search for Disappearing Tracks as Signature for SUSY and Dark Matter

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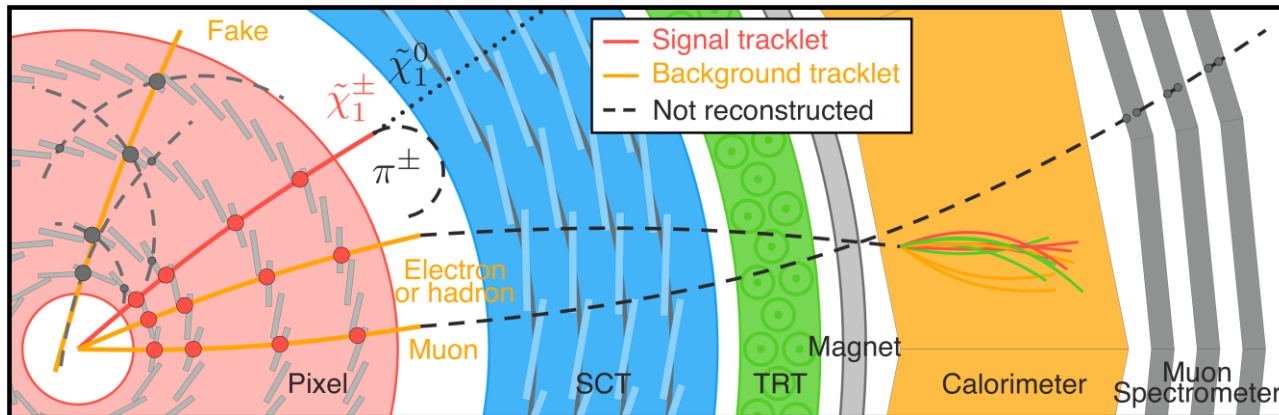
James Smith, ATLAS, 2nd Year

Liverpool Christmas Meeting 2020, 28th April 2021

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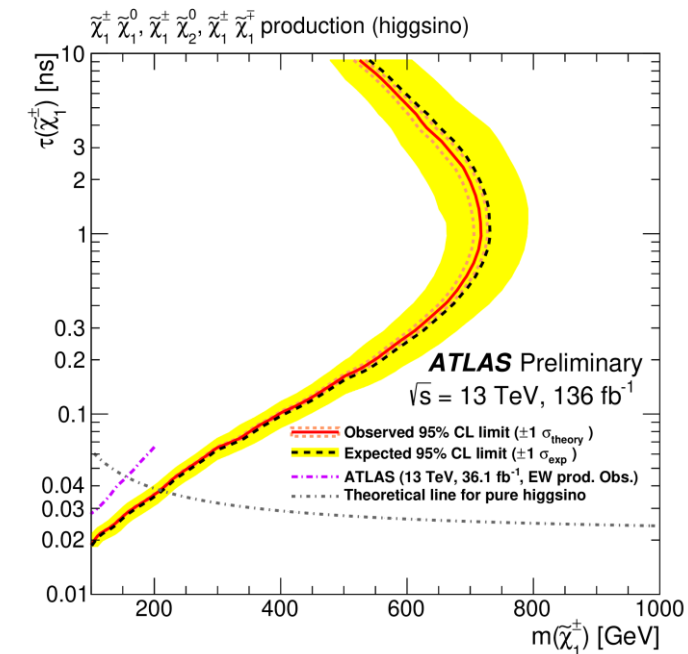
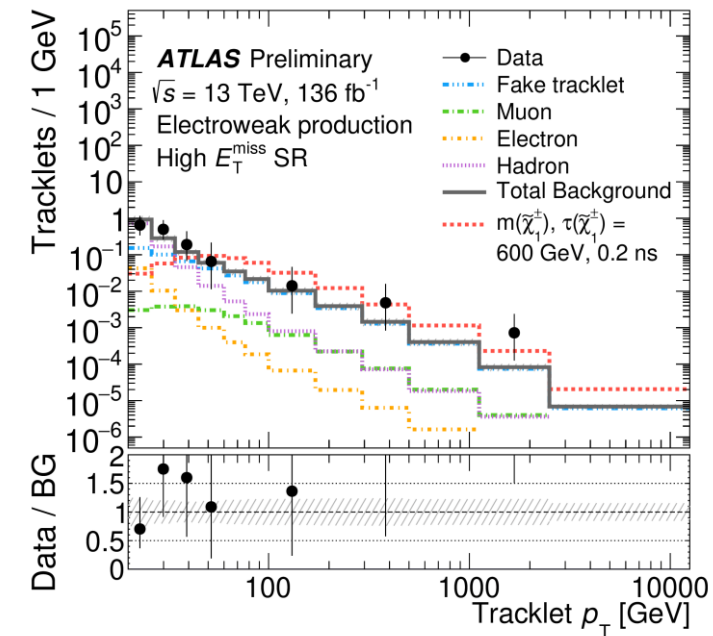
Disappearing Tracks

- ▶ Many SUSY and Exotics models predict weak couplings or compressed mass spectra leading to long-lived particles, often with unique or uncovered signatures
- ▶ Compressed mass spectra leads to $O(100)$ MeV mass difference between lightest chargino and neutralino
- ▶ Chargino decays in approximately $O(0.1 \rightarrow 1)$ ns ($c\tau = \text{cm}$) to stable neutralino and very soft pion
- ▶ Detector signature is a short track in the pixel detector, leading to soft or undetectable particles - a “Disappearing Track” or “Tracklet”
- ▶ Backgrounds are dominantly “fake” tracklets or scattered SM particles
- ▶ Anomaly-Mediated (AMSB) SUSY used as benchmark to compare against other analyses, predicts 0.2ns chargino in the pure-wino case, and 0.03ns in the pure-higgsinos case



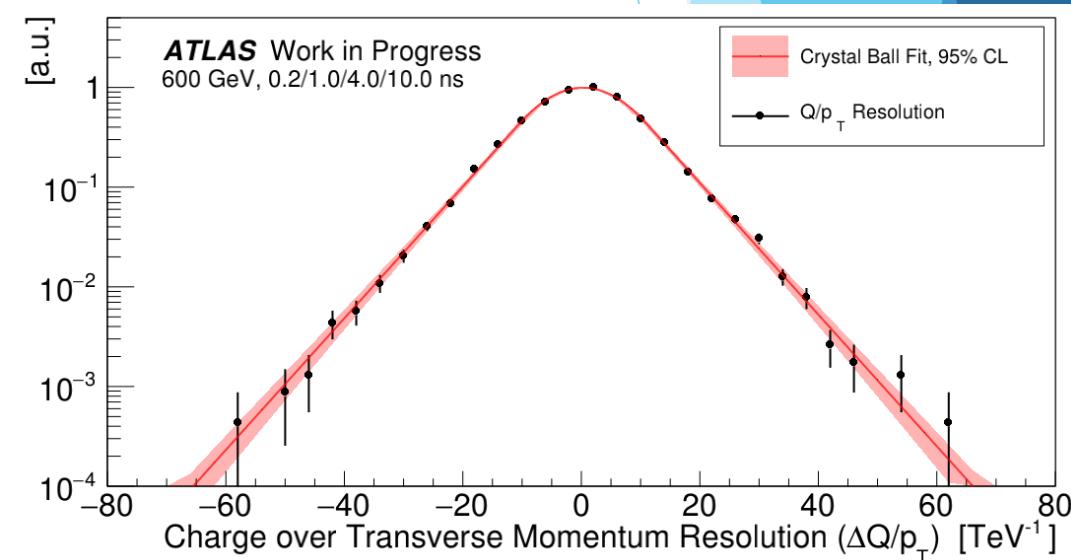
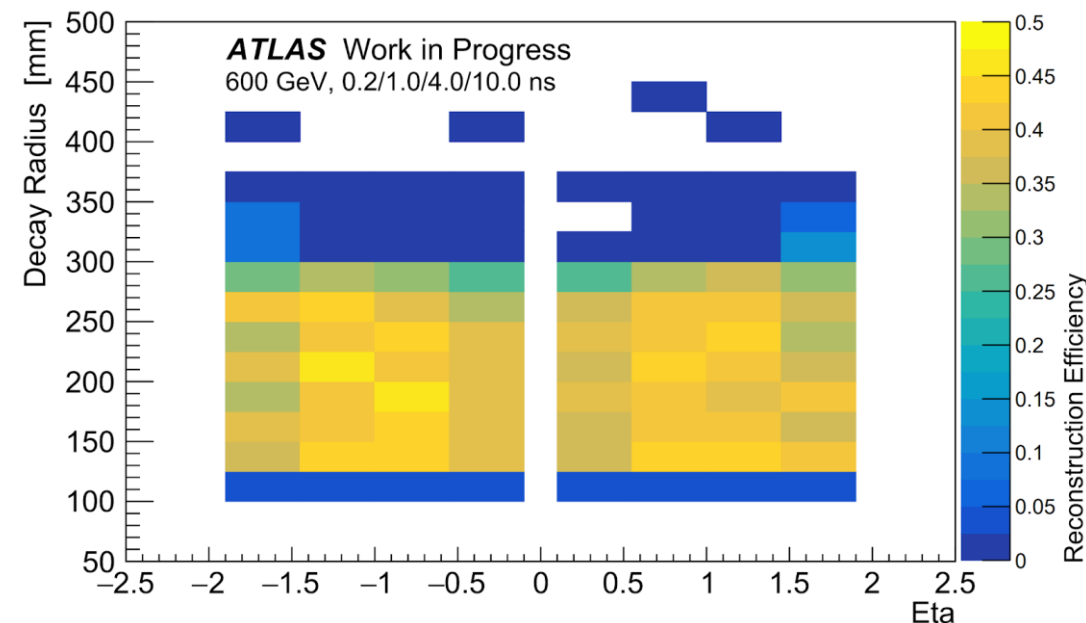
Analysis Status and Future Plans

- ▶ Powerful limits but no SUSY yet
 - ▶ Pure-wino limit: 660 GeV (previous paper: 460 GeV)
 - ▶ Pure-higgsino limit: 210 GeV (previous paper: 152 GeV)
- ▶ Conference note published for Moriond, paper to follow shortly
 - ▶ ATLAS-CONF-2021-15
- ▶ Second round of analysis planned targeting uncovered regions, particularly short-lifetime
 - ▶ Using same dataset but new techniques
 - ▶ Main focus for the next year
 - ▶ Soft pion reconstruction
 - ▶ Shorter tracklets with less hits
 - ▶ Improved background constraints
 - ▶ Alternatively, longer tracklets with more hits (SCT extension)



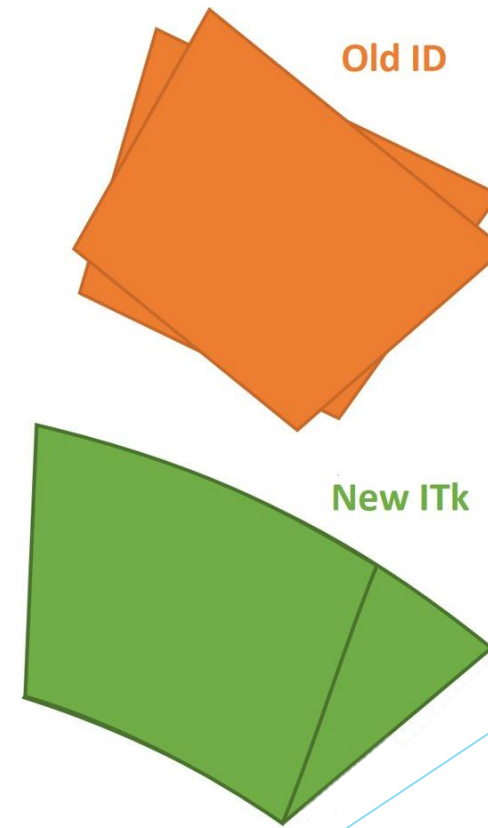
Reinterpretation Tools

- ▶ Due to its generality and sensitivity to many models, this analysis is regarded by theorists as an extremely powerful and useful, particularly in DM models
 - ▶ Papers already published from theorists using past analysis [[arxiv:2008.08581](https://arxiv.org/abs/2008.08581)]
 - ▶ Reinterpretation of past analysis discussed in depth with theorists at 8th LHC LLP Workshop [[Indico](https://indico.cern.ch/event/1111111)]
- ▶ Robust and accurate reinterpretation tools are essential
 - ▶ My main task for the past few months
 - ▶ Event- and tracklet-level acceptance and efficiency
 - ▶ Truth-level pseudocode implementation of analysis
 - ▶ Parameterisation of tracklet reconstruction efficiency
 - ▶ Tracklet momentum resolution
 - ▶ Other group members working on overall acceptance-times-efficiency plots, RECAST, HEPData



Qualification/Support Task: Software for the ATLAS ITk Upgrade

- ▶ ATLAS tracking system to be replaced in 2024 with new, all-silicon Inner Tracker - the ITk
- ▶ Ongoing efforts by team to adapt or replace existing software
 - ▶ Up until now, ATLAS used modified software from the existing detector for the ITk developments
- ▶ My current sub-tasks include:
 - ▶ Separating inner detector event model classes into ITk-specific classes
 - ▶ Integration of polar co-ordinate representation into main software
 - ▶ Endcaps currently use cartesian co-ordinates, polar is more natural
 - ▶ Improving data convertors between transient and persistent memory



Questions?

Merry Christmas!

