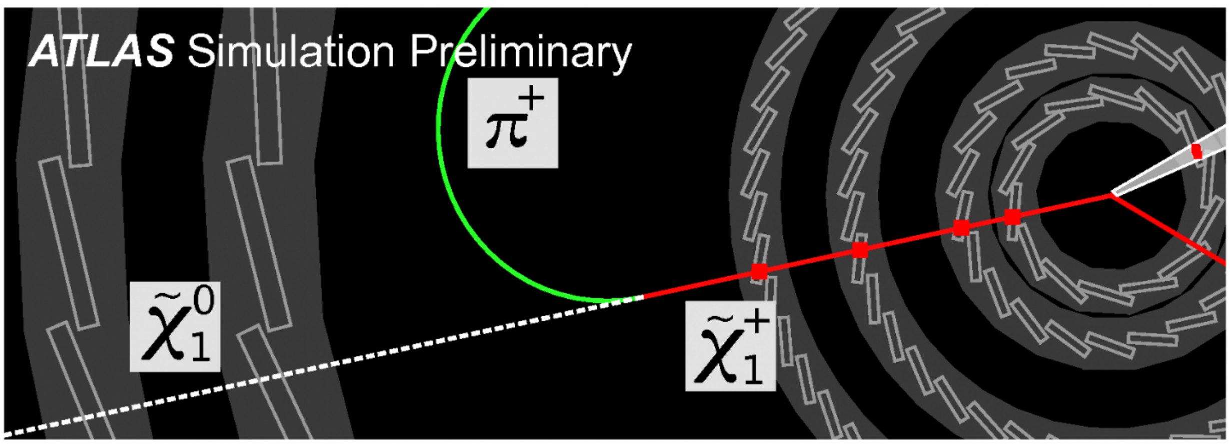
The ATLAS Experiment's quest for the lost arc

March 28 2017

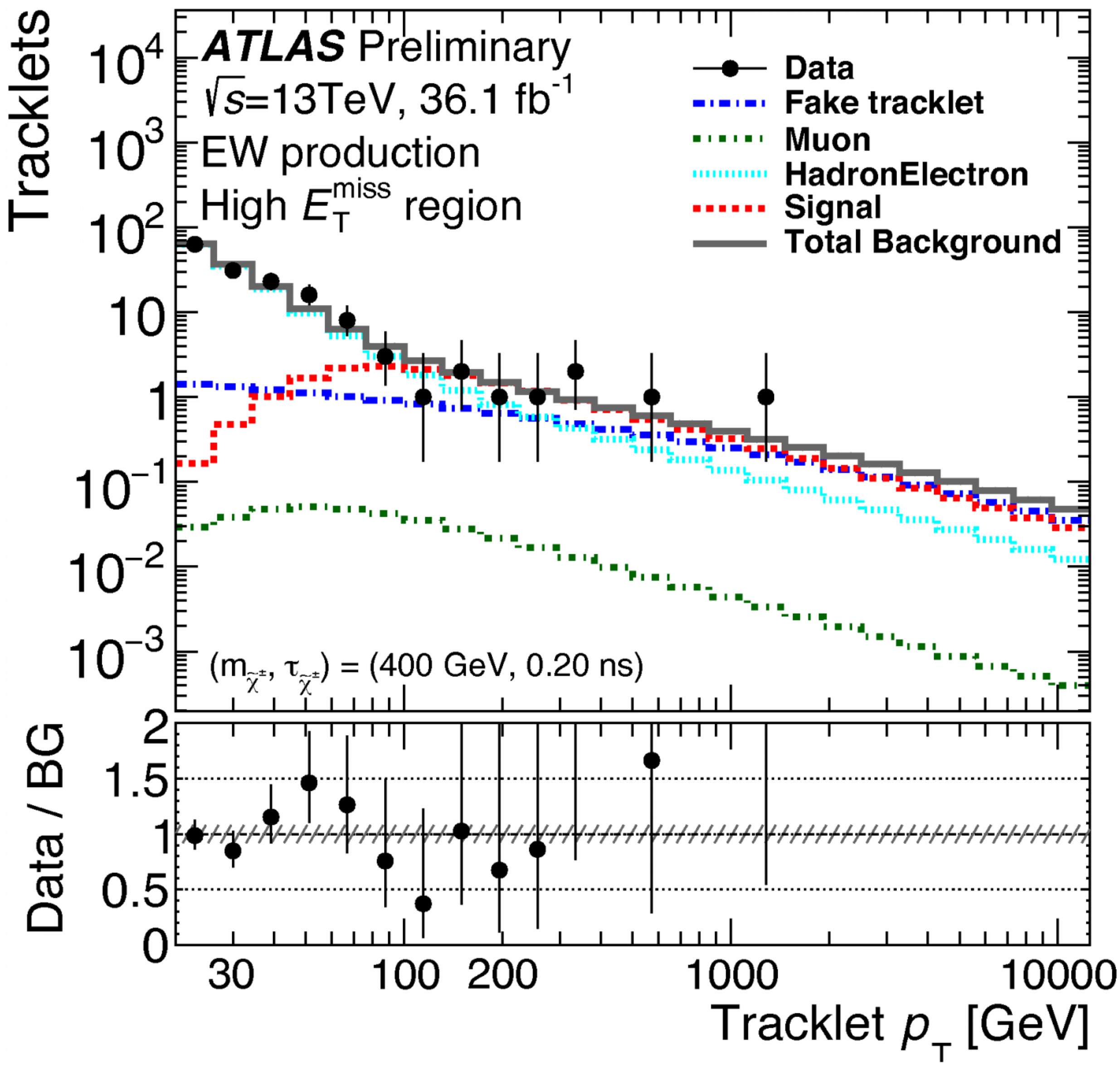


ATLAS simulation showing a hypothetical new charged particle (χ1+) traversing the four layers of the pixel system and decaying to an invisible neutral particle (χ10) and an un-detected pion (π+). The red squares represent the particle interactions with the detector. Credit: ATLAS Collaboration/CERN

Nature has surprised physicists many times in history and certainly will do so again. Therefore, physicists have to keep an open mind when searching for phenomena beyond the Standard Model.

Some theories predict the existence of new particles that live for a very short time. These particles would decay to known particles that interact with the sophisticated "eyes" of the ATLAS Experiment at CERN. However, this may not be the case. An increasingly popular alternative is that some of these new particles may have masses very close to each other, and would thus travel some distance before decaying. This allows for the intriguing possibility of directly *observing* a new type of particle with the ATLAS experiment, rather than reconstructing it via its decay products as physicists do for example for the Higgs boson.

An attractive scenario predicts the existence of a new electrically charged particle, a chargino ($\chi_1^{\pm}$), that may live long enough to travel a few tens of centimetres before decaying to an invisible neutral weakly interacting particle, a neutralino (χ_1^0). A charged pion would also be produced in the decay but, due to the very similar mass of the chargino and the neutralino, its energy would not be enough for it to be detected. As shown in Figure 1, simulations predict a quite spectacular signature of a charged particle "disappearing" due to the undetected decay products.



The number of reconstructed short tracks (tracklets) as a function of their transverse momentum (pT). ATLAS data (black points) are compared with the expected contribution from background sources (gray solid line shows the total) . A new particle would appear as an additional contribution at large pT, as shown for example by the dashed red line. The bottom panel shows the ratio of the data and the background predictions. The error band shows the uncertainty of the background expectation including both statistical and systematic uncertainties. Credit: ATLAS Collaboration/CERN

ATLAS physicists have developed dedicated algorithms to directly observe charged particles travelling as little as 12 centimetres from their origin. Thanks to the new Insertable B-Layer in the ATLAS experiment, these algorithms show improved performance reconstructing such charged particles that do not live long enough to interact with other detector systems. So far, the abundance and properties of the observed particles are in agreement with what is expected from known background processes.

New results presented at the 2017 Moriond Electroweak conference set very stringent limits on what mass such particles may have, if they exist. These limits severely constrain one important type of Supersymmetry dark matter. Although no new particle has been observed, ATLAS physicists continue the search for this "lost arc". Stay tuned!

More information: Search for long-lived charginos based on a disappearing-track signature in pp collisions at √s=13 TeV with the ATLAS detector: atlas.web.cern.ch/Atlas/GROUPS … /ATLAS-CONF-2017-017
Presentation at Moriond Electroweak Conference by Toshiaki Kaji: "Search for winos using a disappearing track signature in ATLAS": indico.in2p3.fr/event/13763/se … /75/material/slides/

Provided by ATLAS Experiment

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