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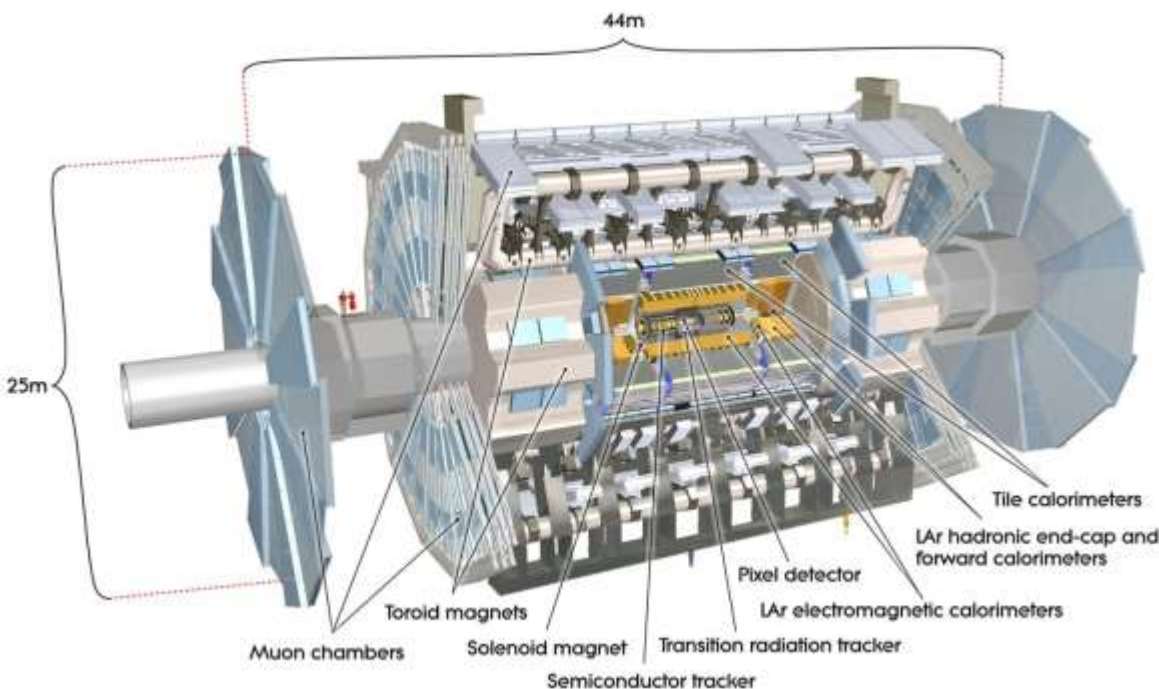
# The Characterisation Of Non-Collision Background Events In The ATLAS Detector During LHC Run 2 Data-Taking

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# Introduction



Unconventional new-physics signals may have signatures similar to events originating from cosmic rays, beam gas interactions and interactions of beam halo with LHC collimators. Especially when overlapping with a physics event, these collisions can be a non-negligible source of background. The performances of the beam halo tagging methods, developed during Run 1 and Run 2 data-taking to identify events coming from beam-induced background are evaluated.

Three main sources of NCB:

- **Beam halo:** protons with high transverse amplitude hitting tertiary collimators (TCT)
- **Beam gas:** small-angle deflections of the protons originated by elastic beam-gas scattering (adds to TCT loss) or inelastic hits of protons with residual gas molecules
- **Cosmic rays:** predominantly muons travelling downward due to atmospheric cosmic-rays showers

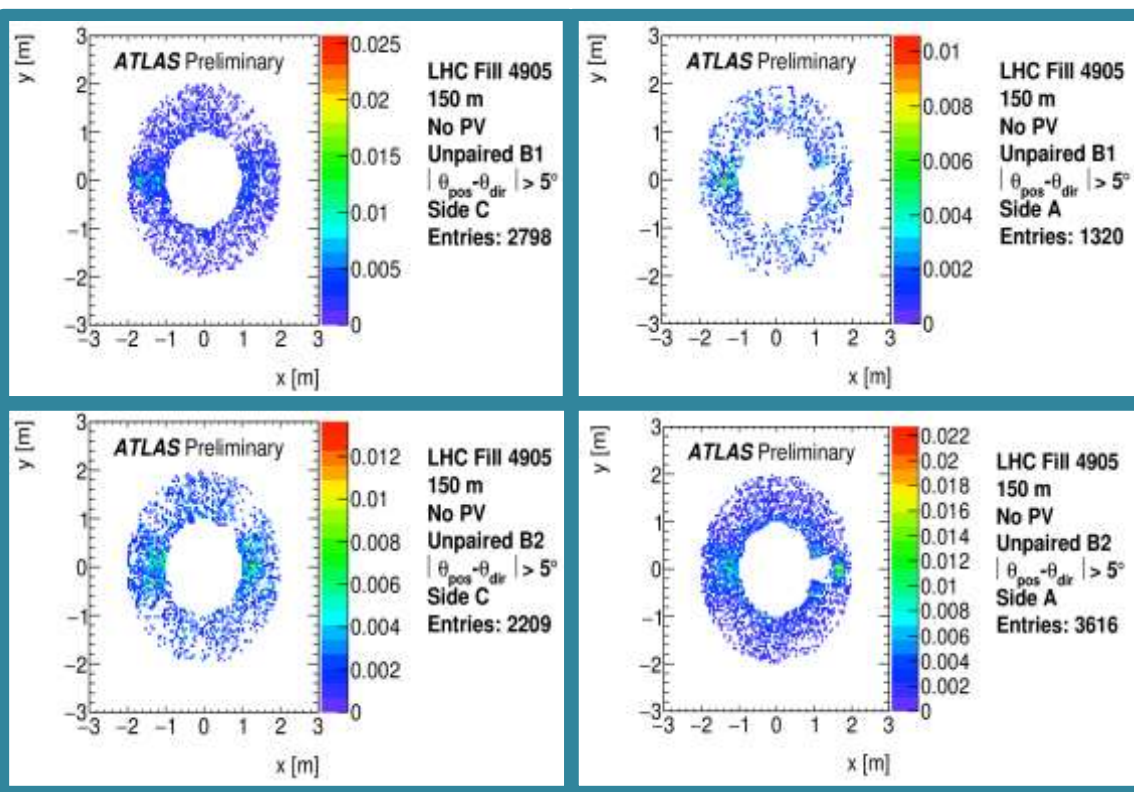


# BLB in the tracking system

## Spatial distributions of CSC muon segments

✓ The plots show the distributions of muon segments from CSC End Cap C, while the bottom row shows the distributions for CSC End Cap A.

✓ The Events without any primary vertex are selected and a cut on the difference between the polar position and the polar direction of the muon segment is applied in order to select muon candidates going in a direction parallel to the beam-pipe.



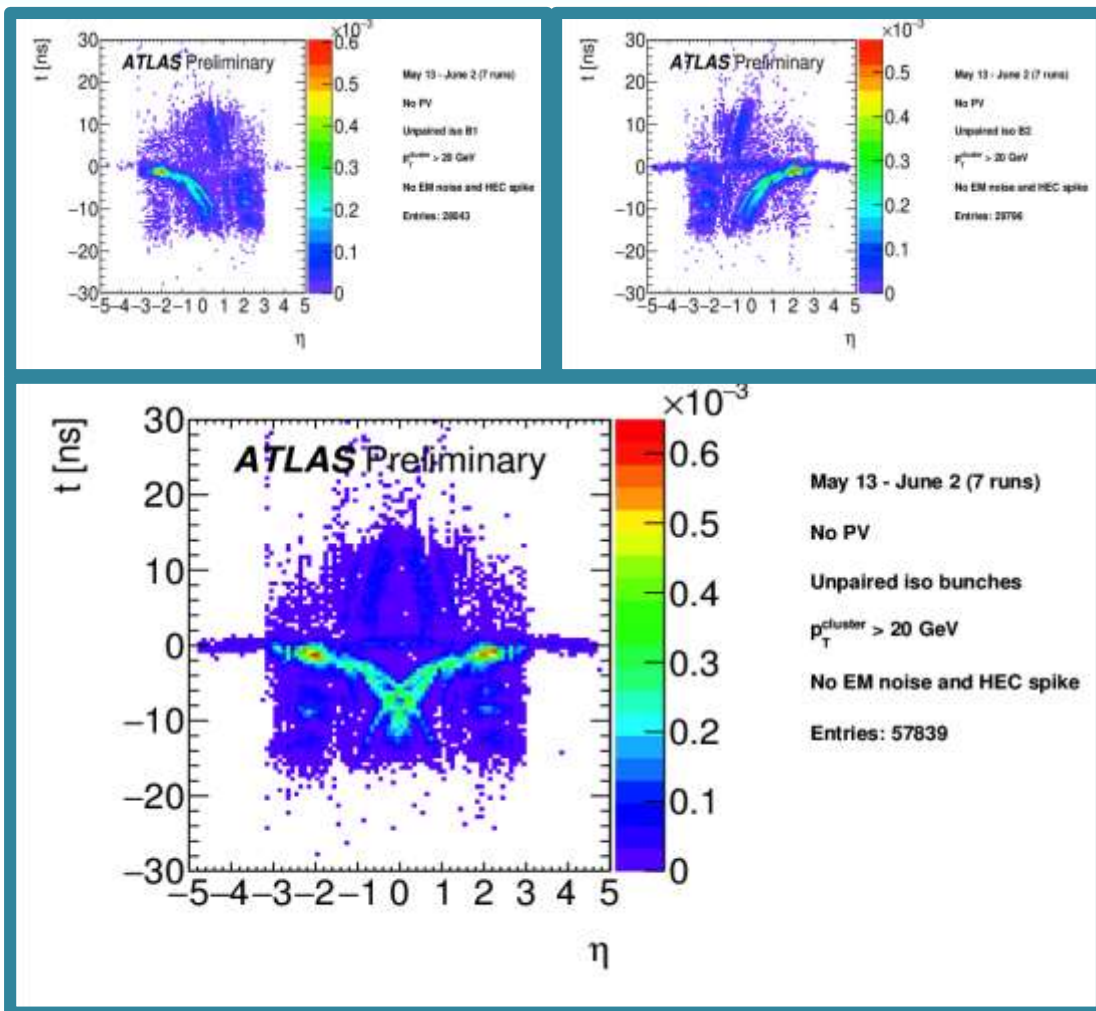




# “Banana Plots” Distribution

✓ The “banana plots” show the distribution of the time of the leading calorimeter clusters vs. pseudorapidity, in events from unpaired isolated bunches, without any primary vertex and passing a trigger requiring a jet with  $p_T > 12$  GeV in unpaired isolated bunches.

✓ The cut on the leading cluster  $p_T$  is 20 GeV.

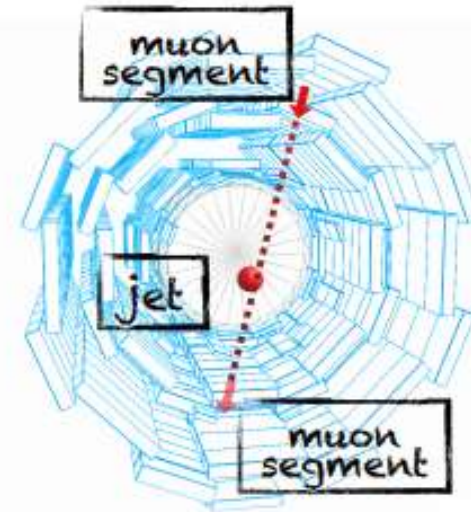
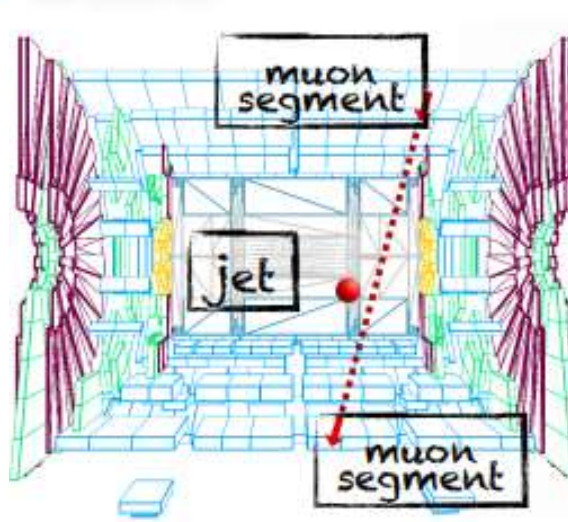




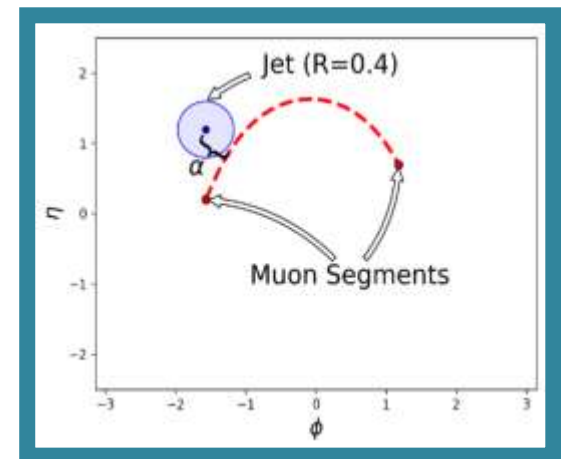
# Cosmic-ray muons in the Calorimeter and Muon System

✓ A cosmic muon traverses the detector from top to bottom passing through the calorimeter and inducing a jet.

✓ The two clusters of muon segments and the jet can be connected by a line which curved due to the influence of the magnetic field on the muon trajectory.



$\alpha$  is indicated as the smallest spatial distance between the jet and the muon segment connection





# *Conclusion*

The term non-collision backgrounds (NCB) refers to signals seen in the ATLAS detector which have not been produced by standard collisions of the LHC beams. The studies are based on :

- ✓ Offline studies of NCB events and monitoring tool to ensure good data quality.
- ✓ The events are an important background source for searches with displaced objects.



# References

- **arXiv:2104.03050** : *A search for the decays of stopped long-lived particles at  $\sqrt{s}=13$  TeV with the ATLAS detector*
- **arXiv:1603.09202** : *Beam-induced and cosmic-ray backgrounds observed in the ATLAS detector during the LHC 2012 proton-proton running period*