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Unveiling Initial State Fluctuations Using $[p_{\mathrm{T}}]$ Cumulants With ATLAS

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The event-by-event variations in the initial conditions and subsequent expansion of the Quark-Gluon Plasma (QGP) directly affects the distribution of the event-averaged transverse momentum ($[p_{\mathrm{T}}]$) of particles. Typically, the contributions to the transverse momentum from radial flow velocity and thermal components are extracted using simultaneous Blast-Wave fits to p_{T} spectra of identified hadrons. However, disentangling these contributions on an event-by-event basis arising from fluctuations in the overlap area ("Geometrical component") from all other sources at fixed geometry ("Intrinsic component") remains a challenge.
In this talk, I will present new, precise ATLAS measurements of $[p_{\mathrm{T}}]$ cumulants up to third order in heavy-ion collisions as a new tool to disentangle Geometric and Intrinsic fluctuations. The observables exhibit distinct behavior, particularly in ultra-central collisions where geometrical variations are suppressed as the overlap area reaches its maximum. These measurements provide the first experimental means to disentangle different sources of fluctuations arising from the initial state and medium evolution, offering new constraints on key properties of the QGP, such as the speed of sound.

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