The ATLAS Collaboration recently released a comprehensive measurement of the distributions of muon pairs from two-photon annihilation processes, in UPC and non-UPC collision events. The measurement utilizes the large dataset recorded during the 2015 and 2018 heavy-ion runs of the LHC.

ATLAS physicists found that the distributions of muon pairs varied systematically depending on the "centrality" of the collision (a measure of how head-on two nuclei collide). This behavior is quantified by the observable \( k_T \), which represents the transverse momentum of the dimuon pair perpendicular to the muon directions. The figure shows the distribution of several different centrality classes, ranging from UPC events to central collision events.

A significant change in the distributions is observed from UPC to peripheral to central collision events. In particular, for the UPC events, the two muons are most likely to be produced back-to-back,
leading to the $k_T$ distributions peaking at $k_T = 0$ MeV. However, in more central collisions with hadronic interactions, the two muons are more likely to have a slight shift from being purely back-to-back, resulting the $k_T$ distributions to have a most probable value larger than zero. The most probable value of $k_T$ shifts, depending on the centrality of the collision event, from $k_T = 0$ MeV in UPC events to $k_T = 36 \pm 1$ MeV in the 0-5% most central collisions.

These measurements provide new insight into the possible interaction of the outgoing muons with electromagnetic charges or fields present in the quark-gluon plasma. However, recent calculations suggest that effects similar to those seen in the data may result from a combination of the initial state broadening of the photon transverse momenta and from the production process itself. Future analyses and additional measurements are needed to establish the mechanism(s) responsible for the features observed in the data.

**More information:** Measurement of non-exclusive dimuon pairs produced via $\gamma \gamma$ scattering in lead-lead collisions at 5.02 TeV with the ATLAS detector (ATLAS-CONF-2019-051):


Provided by ATLAS Experiment


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