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Unveiling the yoctosecond structure of the QGP with top quarks

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Top quarks have been recently measured for the first time in nuclear collisions. With most of the integrated luminosity of the LHC PbPb program to be recorded in the coming years and the impressive projections for the future HL-LHC, HE-LHC or FCC, top quark observables will be measured with good precision and become an excellent probe of the QGP. We argue here that the unique properties of the top quark provide a completely new way to study differentially the space-time evolution of the medium created in heavy ion collisions. Top quarks decay almost exclusively into a W boson and a b quark. The finite lifetimes of the top and W particles and the time-delay in the interaction of the (colour-singlet) W-boson's decay products with the medium add up to a total time during which the top-decay system is unaffected by the QGP. The three times are correlated with the kinematics of the top quark allowing the approximate determination of the time at which the interaction with the QGP begins. We carry out a simple Monte Carlo feasibility study and find that the LHC has the potential to bring first, limited information on the time structure of the QGP. Substantially increased LHC heavy-ion luminosities or future higher-energy colliders would open opportunities for more extensive studies.

Content type

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