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Jet shapes and jet cross sections in relativistic heavy-ion collisions

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Energetic partons traversing a hot/dense nuclear medium are expected to lose a large fraction of their energy. In fact, the stopping power of strongly-interacting matter for color-charged particles has, by far, the largest experimentally established effect: the attenuation of the cross section for final-state observables of large mass/momentum/energy. This jet quenching mechanism has been used to successfully explain the strong suppression of the hadron spectra at large transverse momentum observed in nucleus-nucleus collisions at the Relativistic Heavy Ion Collider (RHIC). However, at present, most measurements of hard processes are limited to single particles and particle correlations, which are only the leading fragments of a jet. Experimental advances at RHIC and new opportunities provided by LHC will allow for innovative and much more definitive tests of the mechanisms of parton attenuation in matter. In this study we demonstrate that jet shape and jet cross section measurements are precisely the tools to probe the underlying QCD theory. We present a first step in understanding these shapes and cross sections in heavy ion reactions. Our approach allows for detailed simulations of the experimental acceptance/cuts that help isolate jets in such high-multiplicity environment. It is demonstrated for the first time that the pattern of stimulated gluon emission can be correlated with a variable quenching of the jet rates and provide an approximately model-independent approach to determining the characteristics of the medium-induced bremsstrahlung spectrum. Surprisingly, in realistic simulations of parton propagation through the QGP we find a minimal increase in the mean jet radius even for large jet attenuation. Jet broadening is manifest in the tails of the energy distribution away from the jet axis and its qualification may need high statistics measurements.