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## Multi-particle Bose-Einstein correlations in Au+Au collisions at PHENIX

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Exploration of the rich structure of the QCD phase diagram is an important topic in the RHIC heavy ion program whose ultimate goal is to discover the critical endpoint. Investigation of the space-time structure of hadron emissions at various phase transition points using Bose-Einstein correlation of identical bosons will provide insight on the location of the critical endpoint. PHENIX has performed comprehensive measurements of the Bose-Einstein correlation in Au+Au collisions at  $\sqrt{s_{NN}} = 15, 19, 27, 39, 62.4,$  and 200 GeV, where we incorporated Levy-type source function to describe the measured correlation functions. We also extended our analysis from two particles to three particle correlations to characterize the nature of the hadron emission source. We put particular focus on one of the parameters in the Levy-type source function, the index of stability  $\alpha$ , which is related to one of the critical exponents (the so-called correlation exponent  $\eta$ ). We have measured its collision energy and centrality dependence. The three particle correlations confirmed the findings of the two-particle correlations, and also provided insight on pion production mechanism beyond Core-Halo models. We will present the latest PHENIX results on the multi-particle Bose-Einstein correlation, and discuss its physics interpretation.

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