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Insights from the STAR Collider Program[1]

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Quantum Chromodynamics (QCD) predicts that the phase diagram of nuclear matter has a rich structure, including that of a deconfined state of quarks and gluons at extreme temperatures and/or pressure. We have shown that we create such a state, termed the Quark-Gluon Plasma or QGP, in the medium generated by colliding heavy nuclei at ultra-relativistic velocities. Understanding the properties of the QGP and locating key features, such as the predicted first order phase transition boundary and the corresponding critical point in the QCD phase diagram, will enhance our knowledge of the universe's evolution and the structure of all visible matters. Experimentally we can probe different regions of the phase diagram by varying the energy of the colliding beams thus altering the initial temperature and net-baryon density of the medium produced. The first Beam Energy Scan (BES-I) took place at RHIC from 2010-2017. While intriguing hints for a first order phase transition were revealed, more precise data were needed before firm conclusions could be drawn. The STAR collaboration therefore proposed, and is now conducting, a second phase of the beam energy scan program (BES-II) focusing on energies below 27 GeV. The expected order of magnitude higher statistics datasets will allow STAR to perform one of the most precise explorations of the phase diagram to date. In this talk, I will briefly review the experimental progress for exploring the QCD phase structure at STAR, with a focus on the status and plans for analysis of the data taken in collider mode. Details of the fixed target program, which allows us to record data at beam energies below that that can be collided at RHIC, will be discussed in another talk in this session.

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