PARTICLE PRODUCTION IN RELATIVISTIC NUCLEAR COLLISIONS AND THE PHASE STRUCTURE OF QCD

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Quark Matter is a state of matter which existed in the early universe until about 10 microseconds after the big bang. In this state the hadrons are all dissolved and the quarks and gluons are deconfined. We review how this state of matter is formed over a large space-time volume in a fireball in Pb-Pb collisions at the Large Hadron Collider LHC. The initially very hot and dense fireball expands collectively and its properties can be diagnosed with tomographic and hydrodynamic concepts. Hadron production at the phase boundary between confined and deconfined matter leads to a thermodynamic state whose properties can be directly compared with predictions from Quantum Chromodynamics. Analysis of hadron spectra and multiplicities (including quarkonia and hadrons containing heavy quarks) provides information on the QCD phase structure and on the degree of deconfinement reached. We will demonstrate this by providing a quantitative comparison of hadron production data with predictions using the QCD statistical operator. Future opportunities with the currently underway full energy and high luminosity collisions at the LHC will be discussed.