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# Probing the nuclear matter with NA61/Shine

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The study of the phase diagram of strongly interacting matter is probably the most challenging problem in the filed of heavy-ion collisions. The most prominent feature of the phase diagram is the existence of the deconfinement/chiral transition lines between hadronic and partonic phases. Modern Lattice QCD calculations advocate rapid crossover transition towards low net-baryon densities with the coincidence of deconfinement and chiral phase transition regions [1]. At higher densities, however, the deconfinement phase transition is expected to be of first order [2]. The logical consequence is the existence of a second order critical point at some intermediate values of net-baryon densities [3]. Experimentally, by changing the energy and the size of colliding nuclei one can control the net-baryon density and the temperature of the created matter. The excellent particle identification capabilities (high precision momentum and energy loss measurements) as well as its large phase-space coverage makes the NA61/SHINE experiment [4] at the CERN SPS particularly suited for these studies: (i) it probes the interesting region of the phase diagram, such that the deconfinement transition happens within the energy range of these collisions, (ii) the critical point at the location predicted by several theory groups can be probed at these energies. In this context, a survey is given of signals probing the phase structure of nuclear matter created in the interactions of heavy atomic nuclei. Seen in this light, the necessity for the differential study of event-by-event fluctuations in two dimensions is introduced and the dedicated program of the NA61/SHINE experiment is discussed. The Collaboration has already recorded p+p and 7Be+9Be runs at projectile momenta of 13A, 20A, 30A, 40A, 80A and 158A GeV/c. The results from elementary p+p reactions will serve as an important baseline for heavier systems. The energy scan of 40Ar+40Ca and p+208Pb systems will be completed in 2015. Starting from 2017 the heavier systems like 129Xe+139La and 208Pb+208Pb will be exploited. Some fluctuation measures in collected p+p reactions have already been measured and reported at several conferences [5,6]. Looking to yet another signals of fluctuations, in particular to those involving higher cumulants of the multiplicity distributions will complement these studies. For the latter a rigorous probabilistic approach has been proposed recently [7] .

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