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Intermittency analysis in NA61/SHINE: hunting for critical point signatures in proton fluctuations

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The search for experimental signatures of the critical point (CP) of strongly interacting matter is one of the main objectives of the NA61/SHINE experiment at CERN SPS. In the course of the experiment, a beam momentum (13A –150A GeV/c) and system size (p+p, p+Pb, Be+Be, Ar+Sc, Xe+La, Pb+Pb) scan is performed. Local proton density fluctuations in transverse space represent an order parameter of the chiral phase transition and are expected to scale according to a universal power-law in the vicinity of the CP. They can be probed through an intermittency analysis of the proton second scaled factorial moments (SSFMs) in transverse momentum space. The first such analysis [1] revealed power-law behavior in NA49 Si+Si collisions at 158A GeV/c, the fitted power-law exponent being consistent with the theoretically expected critical value, within errors.

Proton intermittency analysis of experimental data poses unique challenges, in that it requires good proton identification and careful handling of statistical and systematic uncertainties, especially in the face of moderate event statistics and low per event proton multiplicity. In the present talk, we review the current status of NA61/SHINE intermittency analysis, focusing on the results of the analyzed collision systems (Be+Be, Ar+Sc, Pb+Pb), and explore the novel techniques developed and employed to account for non-critical background and estimate statistical and systematic uncertainties. In particular, we address the issue of obtaining reliable estimates and confidence intervals for the intermittency index (power-law exponent) ϕ_2 from correlated data points, and discuss the possible treatments available. Finally, we present Monte Carlo simulation techniques used in assessing the statistical significance of intermittency results and weighing the alternative models.

References:
[1] T. Anticic et al, Eur. Phys. J. C **75**: 587 (2015).

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