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Importance of separated efficiencies for positively and negatively charged particles for cumulant calculations

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At star experiment, average sfficiency of positively and negatively charged particles had been used for cumulants calculation because of thge small efficiency difference between positively and negatively charged particles. However, there is finite difference in the detecting efficiency for positively and negatively charged hadrons. The difference is also dependent on collision energy. In addition, we don't know quantitatively the effect on cumulants and cumulant ratios compared to the case of separated efficiencies.

In this talk, we will show the Monte Carlo toy model assuming Poisson distribution where input parameters are taken from proton(anti-proton) multiplicity distributions at STAR experiment. Results of MC toy model were also checked by analytical calculations. Deviations are proportional to the sum of multiplicity for odd order cumulants, while they are proportional to the difference of multiplicity for even order cumulants. This is also studied as a function of beam energy. The deviation becomes $\sim 20\%$ for odd order cumulants at $\sqrt{s_{NN}}$ = 200 GeV in the most peripheral collisions and $\sim 10\%$ in the most central collisions, while less than 5% at the beam energy of 7.7GeV to 27GeV. The deviations of $S\sigma$ is also as large as the odd order cumulants at high beam energies. But $S\sigma/Skellam$ and $\kappa\sigma^2$ have little deviation($\sim 1\%$) at all over the BES energies. These results would suggest that it is important for us to use separated efficiencies instead of average efficiency.

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