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Missing Mass Method for reconstruction of short-lived particles in the CBM and STAR experiments

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The search for short-lived particles is an important part of the physics research in experiments with relativistic heavy ions.
Such investigations mainly study decays of neutral particles into charged daughter particles, which can be already registered in the detector system. In order to find, select and study the properties of such short-lived particles in real time in the CBM experiment (FAIR/GSI, Germany), we have developed a package of algorithms KF Particle Finder, which contains a search for more than 150 decay channels.
Of great physics interest are also the decays of short-lived charged particles, when one of the daughter particles is neutral and cannot be registered in the detector system. To find and study such decays, we have extended the KF Particle Finder package by implementing the missing mass method, which is based on the conservation of energy and momentum laws.
The method was studied in detail on simulated data of the CBM experiment, showing high efficiency with a large signal-to-background ratio, as well as high significance.
As part of the FAIR Phase-0 program, the KF Particle Finder package of algorithms has been adapted for online and offline processing in the STAR experiment (BNL, USA).
Based on the STAR HLT computer farm, we have created an express data production chain that extends the high-level trigger (HLT) functionality in real time all the way to physics analysis.
An important advantage of express analysis is that it allows us to start calibrating, producing, and analyzing data as soon as it is collected. Therefore, the use of express analysis is extremely useful for data production in the BES-II physics program and will help accelerate scientific discovery by helping to produce results within a year of data collection completion.
Here we describe and discuss in detail the missing mass method for finding and analyzing short-lived particles. Features of the application of the method to both simulated data in the CBM experiment and in the STAR experiment as part of real-time express data processing are given, as well as the results of real-time reconstruction of short-lived particle decays in the BES-II environment of the STAR experiment.

Summary

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