The KF Particle Finder package for short-lived particles reconstruction for CBM*

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Today the most interesting physics is contained in the properties of short-lived particles which can not be registered by a detector system directly but only reconstructed through their decay products. Also, short-lived particles which have a very small production probability are of the particular interest. Thus, a statistically significant result can be obtained only in case of the operation with a high rate of collisions up to 10^7 Hz. This raises the problem of data processing and storage. Therefore only those events are selected for the further analysis that can potentially contain interesting particles. The CBM experiment requires the full reconstruction of events, including reconstruction of short-lived particles, already at the selection stage.

A fast and efficient algorithm based on the Kalman filter (KF) method for finding, reconstruction and selection of short-lived particles is developed. A search for about 50 particles (decay channels) has been implemented. At first all tracks are divided into two groups for a further analysis: secondary and primary. Secondary tracks are produced in a decay of short-lived particles that have sufficient lifetime to move away from the primary vertex. These particles are strange particles (K^0_s-mesons and Λ-hyperons), multi-strange hyperons (Ξ and Ω) and charmed particles (D^0, $D^{\pm}$, $D^{\pm}_s$ and Λ_c). Primary tracks are those, which are produced directly in the collision of a beam with a target. Tracks from the resonances decays (strange, multi-strange and charmed resonances, light vector mesons, charmonium) are also considered as primary since they are produced directly at the point of the primary vertex due to the extremely small lifetime.

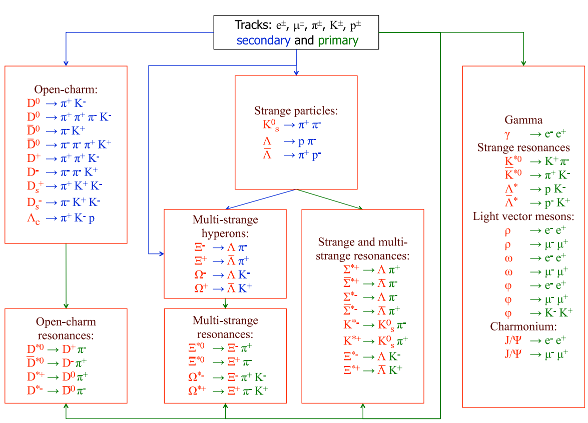

Figure 1: Block diagram of the KF Particle Finder algorithm.

*This work was supported by the Hessian LOEWE initiative through the Helmholtz International Center for FAIR (HIC for FAIR) and EU-FP7 HadronPhysics2. Das Projekt wird vom Hessischen Ministerium fuer Wissenschaft und Kunst gefoerdert.

Selected tracks are combined into particle-candidates according to the block diagram in Figure 1. The particles are reconstructed with the KFParticle package [1]. All particles are reconstructed in one go that makes the algorithm local with respect to the data and therefore very fast.

KF Particle Finder achieves a high efficiency of the particle reconstruction. For example, the efficiency of the strange particles reconstruction for 240 000 of minimum bias Au+Au collisions at 25 AGeV as well as a signal to background ratio is given in Table 1.

Particle	K^0_s	Λ	Ξ^-	Ω^-
Efficiency, %	15.3	17.8	5.0	2.5
S/B	3.5	5.1	42.2	4.3

Table 1: The efficiency and a signal to background ratio (S/B) for strange particles.

In order to utilize all possible resources of modern CPUs and to achieve the highest possible speed KF Particle Finder is based on the SIMD instructions. Also, the algorithm has been parallelized between cores of the modern CPUs and demonstrates a strong linear scalability on many-core servers with respect to the number of cores (see Figure 2).

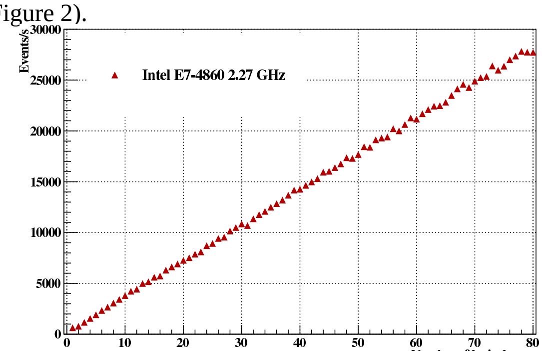

Figure 2: Scalability of the KF Particle Finder package with minimum bias Au+Au events at 25 AGeV on a many-core server lxir075 equipped with four Intel E7-4860 (2.27 GHz) CPUs.

Summarizing, the KF Particle Finder package reconstructs about 50 of the most important decay channels for the CBM experiment with a high efficiency and a high signal to background ratio achieving speed of 1.5 ms per Au+Au minimum bias collisions at 25 AGeV on a single core.

References

[1] S. Gorbunov and I. Kisel, Reconstruction of decayed particles based on the Kalman filter. CBM-SOFT-note-2007-003, 7 May 2007.