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Parallel framework for partial wave analysis for the BES-III experiment

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The partial wave analysis at the BES-III experiment is being done event-by-event using the maximum likelihood estimation, with the typical statistics of the order of 10 billion J/ψ events per year, resulting in huge computation times. On the other hand, the event-by-event analysis can be naturally parallelized.

We developed the parallel cross-platform software architecture that can run calculations at various high-performance computing platforms, such as multi-core CPUs, Intel Xeon Phi co-processors, and GPUs. The software supports switching between different minimization algorithms like MINUIT or FUMILI.

The wave functions are constructed using covariant tensor formalism. Currently analysis is developed for the $J/\psi \rightarrow K+K-\pi^0$ decay channel.

The algorithm for caching the intermediate results has been developed, minimizing the amount of calculations performed in each iteration. Besides, a number of software optimizations has been used, including vectorization, memory access linearization, and data alignment.

In future we plan adding the analysis for new reaction channels, and possibly adapting our software for use in other experiments.

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