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Performance studies of GooFit on GPUs versus RooFit on CPUs while estimating the global statistical significance of a new physical signal

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Graphical Processing Units (GPUs) represent one of the most sophisticated and versatile parallel computing architectures available that are nowadays entering the High Energy Physics field. GooFit is an open source tool interfacing ROOT/RooFit to the CUDA platform on nVidia GPUs (it also supports OpenMP). Specifically it acts as an interface between the MINUIT minimization algorithm and a parallel processor which allows a Probability Density Function (PDF) to be evaluated in parallel.

In order to test the computing capabilities of GPUs with respect to traditional CPU cores, a high-statistics pseudo-experiment technique has been implemented both in ROOT/RooFit and GooFit frameworks with the purpose of estimating the local statistical significance of the structure observed by CMS close to the kinematical threshold of the J/psi phi invariant mass in the B+ to J/psi phi K+ decay. As already shown in ACAT2016, the optimized GooFit application running on GPUs provides striking speed-up performances with respect to the RooFit application parallelised on multiple CPU workers through the PROOF-Lite tool.

Now the described technique has been extended to situations when, dealing with an unexpected signal, a global significance must be estimated. The LEE is taken into account by means of a scanning technique in order to consider - within the same background-only fluctuation and everywhere in the relevant mass spectrum - any fluctuating peaking behavior with respect to the background model. The execution time of the fitting procedure for each MC toy considerably increases, thus the RooFit-based approach is not only time-expensive but gets unreliable and the use of GooFit as a reliable tool is mandatory to carry out this p-value estimation method.

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