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Matrix Element Method for High Performance Computing platforms

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The Matrix Element Method (MEM) is a well known powerful approach in particle physics to extract maximal information of the events arising from the LHC pp collisions. Compared to other methods requiring trainings, the MEM allows direct comparisons between a theory and the observation. Since the phase space has a higher dimensionality to explore, MEM is much more CPU time consuming at the analysis level than classic methods. As a consequence, this method is hardly exploitable with sequential implementation, in particular, when one has to deal with channels with large backgrounds. For the upcoming LHC data-taking, this issue will become even more crucial.

The major challenge of this project is to provide a MEM implementation based on widely used standards such as MPI and OpenCL, which, taking advantage of multi-accelerators and multi-node architectures, offers a drastic speed-up with low cost technologies.

In this talk, we will present how, in the context of the CMS experiment, we parallelized the MEM with the OpenCL abstract model and the memory distributed model (MPI layer). We will describe the necessary work on the different ingredients: the Parton Distribution Functions library (LHAPDF), the computation of the matrix element (MadGraph) and a small subset of ROOT tools. In addition, we will focus on the main tricky points to have access to an implementation of quality, e.g. uncorrelated random number sequences, minimizing synchronizations, minimizing the number of kernel calls. Finally, we will present the performance obtained on various platforms : CPUs, GPGPU, MIC, multi-GPGPUs or MICs, and cluster of GPU-nodes.

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