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Speeding up experiments software with VecCore, a portable SIMD library

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Portable and efficient vectorization is a significant challenge in large software projects such as Geant, ROOT, and experiment frameworks. Nevertheless, taking advantage of the expression of parallelism through vectorization is required by the future evolution of the landscape of particle physics, which will be characterized by a drastic increase in the amount of data produced.

In order to bridge the widening gap between data processing and analysis needs, and available computing resources, the particle physics scientific software stack needs to be upgraded to fully exploit SIMD. While libraries exist that wrap SIMD intrinsics in a convenient way, they don't always support every available architecture, or perform well only in a subset of them. This situation needs an improvement.

VecCore provides a solution. It features a simple API to express SIMD-enabled algorithms that can be dispatched to one or more backends, such as CUDA, or other widely adopted SIMD libraries such as Vc or UME::SIMD. In this talk we discuss the programming model associated to VecCore, the most relevant details of its implementation, and some use cases in HEP software packages such as ROOT and GeantV. Outlooks on possible usage in experiments' software are also highlighted.

Performance figures from benchmarks on NVidia GPUs, and on Intel Xeon and Xeon Phi processors are discussed that demonstrate nearly optimal gains from SIMD parallelism.

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