

High performance physics simulation algorithms suitable for modern CPU and coprocessor architectures

The recent prevalence of hardware architectures of many-core or accelerated processors opens opportunities for concurrent programming models taking advantages of both SIMD and SIMT architectures. One of the most compute intensive tasks in high energy physics (HEP) experiments is simulation of passage of particles through a complicated geometry of detector materials. However, most of conventional HEP Monte Carlo simulation toolkit using event level parallelism do not fully utilize vector pipelines or highly threaded streaming multiprocessors as they have been designed for a sequential paradigm and optimized for the single-core CPU architecture. We will present strategies for high performance detector simulation algorithms suitable for modern vector or GPGPU architectures using track level parallelism. The impacts of task decomposition, vectorization, efficient sampling techniques and data lookup on the performance of HEP detector simulation will be evaluated on vector and massively parallel architectures.