Abstract

Overview :

In the past, particle physics has relied upon improvements in processing speed of single computing cores in order to improve data acquisition rates. This feature will be critical to the proposed "High Luminosity Large Hadron Collider" (HLLHC). Unfortunately, since the mid-2000's, this improvement in single-core processing speed has hit a limit, and improvements in processing time must now come from concurrent processing. However, the current reconstruction techniques are not enabled for concurrent processing. In order to continue improving the processing capabilities of particle physics experiments in the HLLHC era, it will be necessary to explore cutting-edge techniques in parallel processing.

There are several general classes of problems in particle physics event reconstruction that could be modified in order to achieve concurrent processing. One such opportunity that has not yet been explored is in "jet clustering," a nearest-neighbor type of algorithm used to cluster hadronically-fragmented jets into a single object.

Intellectual Merit :

This proposal focuses on parallelizing the existing jet clustering algorithms in use at the LHC experiments. The proposed improvements will be to use this as a test case for deployment of cutting-edge parallelization techniques such as lightweight concurrency extraction, speculative computing, and smarter distribution. Some recent experience shows that this nearest-neighbor type of algorithm used by the jet clustering is amenable to such improvements.

Broader Impacts :

The benefits of this proposal are twofold : firstly, there will be an immediate improvement of the jet clustering algorithms themselves that will lead to higher data acquisition rates at the LHC. Secondly, the computing techniques developed could be used in other applications, inside of particle physics and elsewhere. Since nearest-neighbor algorithms are ubiquitious in scientific computing, it is expected that techniques developed to parallelize this particular problem will be applicable to a wide variety of others in academia and industry.

In addition, these core developments can train students in the newest computing techniques, giving them cutting-edge experience that is highly relevant in academia and private industry.