**A high-overlap algorithm for massive pseudo-spectral simulations of turbulence on SUMMIT**  
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**Abstract**

A new massively parallel, GPU-accelerated algorithm is being developed on Summit to allow direct numerical simulations of three-dimensional turbulent fluid flow at resolution exceeding 4 trillion grid points --- which will be beyond the current state of the art and very valuable for advancing scientific understanding. The algorithm is designed to take maximum advantage of several specific features of Summit (compared to Titan), including a high NVLINK bandwidth for data movement, a large number of GPUs per CPU, large memory on both CPU and GPU, and a high projected Spectrum-MPI network bandwidth for communication. We use a one-dimensional domain decomposition, and CUDA FFT for Fourier transforms in successive directions. Aggressive efforts are made to enable fine-grained overlapping, between operations on CPU vs. GPU, data movement with GPU, and GPU operations with communication between CPUs using non-blocking one-sided protocols. While initial efforts focused on OpenMP 4.5, recent progress after the CAAR Workshop in March 2018 has been achieved primarily using CUDA Fortran. Intensive testing including measurements of both performance and scalability is under way.