MG Proto: Multigrid LQCD Propagators for Multicore x86 systems

Objectives

- Discovery of the properties of hadronic and nuclear matter through world leading Lattice Quantum Chromodynamics (LQCD) calculations
- Extension of the state of the art in LQCD computational capability by the development and integration of advanced algorithms
- Maximally exploiting advanced hardware capabilities of DOE systems such as Cori at NERSC and Theta at ALCF

Impact

- Improvements increase the value of allocations on DOE systems such as Cori-KNL and ALCF Theta by ***a near order of magnitude***, and (re)open other systems for our calculations (e.g. Stampede-2 & Frontera at TACC).
- The solver development will enable more efficient gauge generation in the future, building on experience gained with similar work on GPU systems.
- The MG Proto library serves as a spring-board for exploration of new programming models for LQCD such as Kokkos & SyCL for performance portability, e.g. targeting ALCF Aurora in the future.

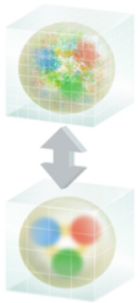
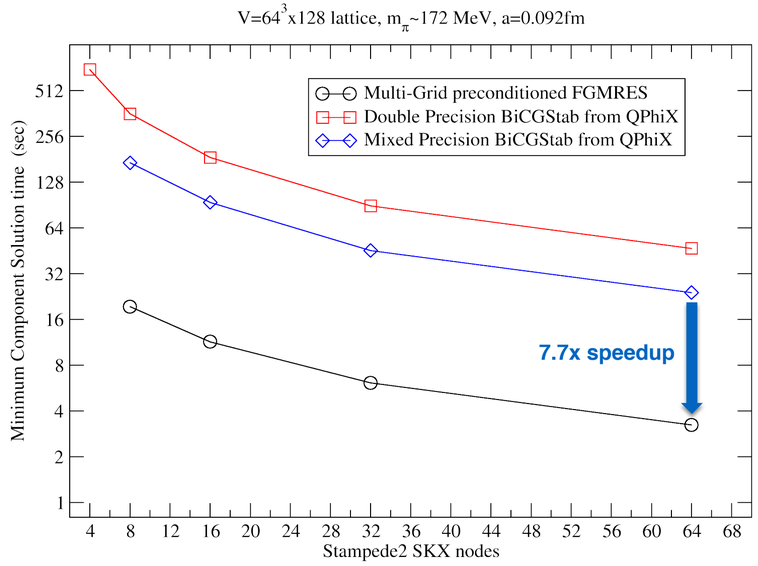


Image Credit: Joanna Griffin, Jefferson Lab Public Affairs



Accomplishments

- Implemented an Adaptive-Multigrid solver for Lattice QCD on x86 multi-core systems (Intel Knights Landing, Skylake) with OpenMP and AVX512 vectorization
- The fine level of the Multigrid uses the optimized solvers from the QPhiX library
- Investigated the potential for fine grained nested parallelism within OpenMP in collaboration with T. Kurth at NERSC (IXPUG-ISC 17 paper contribution)
- Investigated Kokkos for Performance Portability in Wilson-Dslash kernel during a summer associate visit to NERSC as part of NESAP.
- ***7-8x speedup*** achieved over previous Mixed Precision Iterative Refinement BiCGStab solvers from the QPhiX library for light quark masses

Computing Properties of Matter with Leadership Computing Resources

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