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CUDA implementation of CG inverters for the Faddeev-Popov matrix

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The study of Green's functions in Yang-Mills theory in minimal Landau gauge (MLG) may offer crucial insights for the understanding of quark confinement in quantum chromodynamics. In MLG, the functional integral over gauge-field configurations is restricted to the set of transverse configurations for which the so-called Faddeev-Popov (FP) matrix is positive definite. Thus, this matrix should encode all the relevant (non-perturbative) aspects of the theory, related to the color-confinement mechanism. In particular, the inverse of the FP matrix enters into the evaluation of several fundamental Green's functions of the theory, such as the ghost propagator, the ghost-gluon vertex, the Bose-ghost propagator, etc. These Green's functions can be computed through Monte Carlo simulations using the lattice formulation of gauge theories. However, the numerical inversion of the FP matrix is rather time consuming, since it is a huge (sparse) matrix with an extremely small eigenvalue, thus requiring the use of a parallel preconditioned conjugate-gradient (CG) algorithm. Moreover, for each lattice configuration, this inversion has to be done for hundreds of different kinematic combinations. In fact, this matrix inversion is the performance bottleneck for these numerical studies. In this poster we present several preconditioned CG algorithms and their implementation (through CUDA) in double and mixed precisions using multiple GPUs. In particular, we report on the performance of the code for Tesla and Kepler GPUs, as well as on its weak and strong scaling for up to 32 GPUs interconnected by InfiniBand.

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