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ADRESSING TOP SUPERCOMPUTERS WITH ANISOTROPIC MESH ADAPTATION AND MULTIGRID SOLVERS

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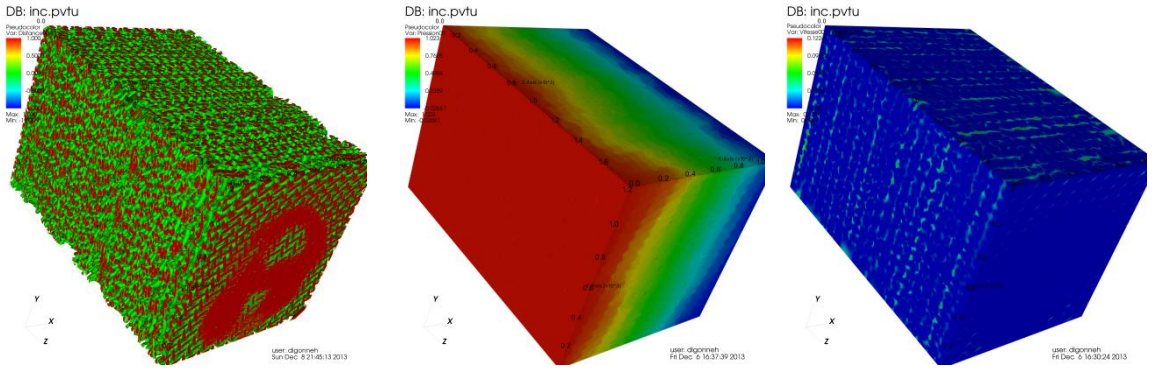
Nowadays, the power of computers and supercomputers is no longer driven by frequency improvement but by cores' multiplication. Traditional computers contain nowadays up to 16 cores and top supercomputers more than one million of cores. Thanks to PRACE call for projects, we have had access to two top European supercomputers: the French Curie supercomputer, with 80640 Intel Xeon cores and InfiniBand QDR network; the German IBM BlueGene/Q JuQUEEN supercomputer, with 458752 PowerPC cores and 5D torus network. This access provided us the opportunity to evaluate the scalability of our numerical methods in the range of the hundred-thousand cores. This paper describes the improvements done on or software, initially run on 8192 cores [1], to enable simulations on one hundred thousand cores, focusing on anisotropic mesh adaptation and linear systems resolution using a multigrid solver (thanks to PETSc framework [2]). Parallel performance, including strong and soft Speed-Up, is presented. The biggest linear system solved consists of 100 billion of unknowns arising from the discretisation of the Stokes equation using a P1+/P1 mixed finite element formulation in velocity-pressure. Runs on both supercomputers are also discussed, clearly showing the scalability of our approach on today's top supercomputers. Some comments on the execution of very large runs will also be detailed. Finally, applications on flow calculations across complex composite microstructures given by high resolution (several billion of voxels) 3d X-Ray microtomography images composite are shown.



REFERENCES

[1] H. Digonnet, "Multigrid using Adaptive Unstructured Meshes for Massively Parallel Computation", 3rd PARENG Conference Proceedings, Civil-Comp, 2013.
[2] S. Balay and all. "PETSc User Manual 3.1", Argonne National Laboratory, 2013.