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PARALLEL MESH ADAPTATION ON COMPLEX MICROSTRUCTURES

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In this paper, we will present work performed to combine benefits of four main optimizations used in FEM simulations: parallel computing to increase the computational power using a large number of cores; mesh adaptation [1] to reduce the problem size for a given accuracy; multigrid solvers to reduce algorithmic complexity for solving large systems and high order elements to increase the convergence rate. Combining all these algorithmic and numerical optimizations enable us to run extremely large-scale simulations to obtain the most accurate results on complex structures.

We will present some benchmarks done on the French supercomputer Irène Joliot-Curie. These benchmarks will end with some impressive computations while using almost all resources: 131 072 cores and 400 TB of RAM. At this scale, we have been able to generate 2d and 3d meshes with more than 2000 billion elements and solve 2d and 3d linear systems with, respectively, 400 and 200 billion unknowns. Finally, application to complex microstructures will be presented using several thousands of cores. Given a microstructure [2], we firstly generate a suitable anisotropic adapted mesh to then perform FEM simulations of flows and determine permeability coefficients.

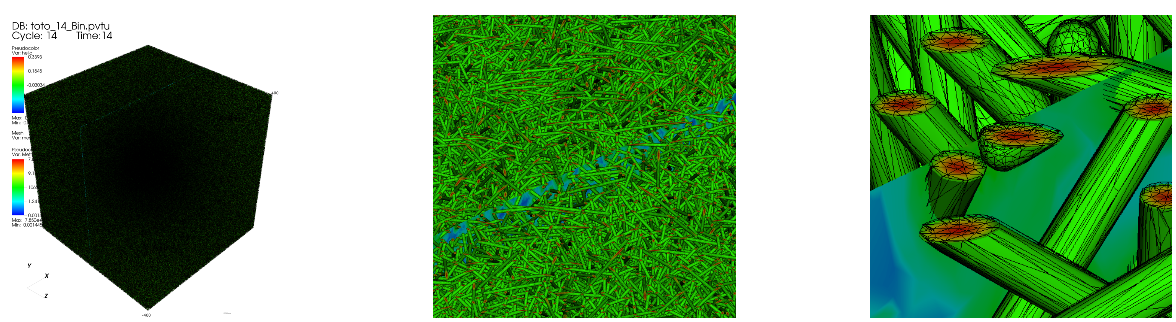

Figure 1: Three zoom levels: $\times 1$, $\times 256$, $\times 256^2$ of an anisotropic adapted mesh around millions of fibers.

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