Massively parallel anisotropic mesh adaptation applied to complex microstructures

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ABSTRACT

In this paper, we will present work and results obtained during a "Grand Challenges" session on the new french supercomputer Irène Jolio-Curie with both partitions: one with 79 488 Intel Xeon SkyLake Cores and 320 TB, the other with 56 304 Intel Xeon Phi KNL cores and 80 TB. The goal of such a project was to evaluate the scalability of our mesher [1], at such a large scale, on different hardwares. Running over tens of thousand of cores, validates the good scalability of the application, but also allows loooking deep into some more practical aspects, such as the IO strategies and the possibility of graphically exploit such huge results.

Both isotropic and anisotropic benchemarks have been done. For the isotropic part, the goal was to be able to build a 1000 billions elements mesh. Building such a mesh needed the use of at least 65 536 cores and up to 200 TB of memory (almost the full supercomputer). The anisotropic one consisted in the adaptation of the mesh to capture interface in a microstructure [2] with several million of fibers and using 9126 cores. During this bench, two ouput strategies have been tested: the standard one consists in writing one file per core, the distributed MPI-IO one consists in writing one large MPI-IO file per group of 256 cores. If the first one is still the most efficient with a 130 GB/s it uses a large amount of Inodes (here 65 536). The second one is a little less efficient, but reduces the number of Inodes used (256) and produces a "well sized" file of 120GB.

Finally, to exploit this results graphically, we have generated a very high quality images (16Gpixels) to keep details visible into a general overview to be exploited offline, as shown in figure 1.

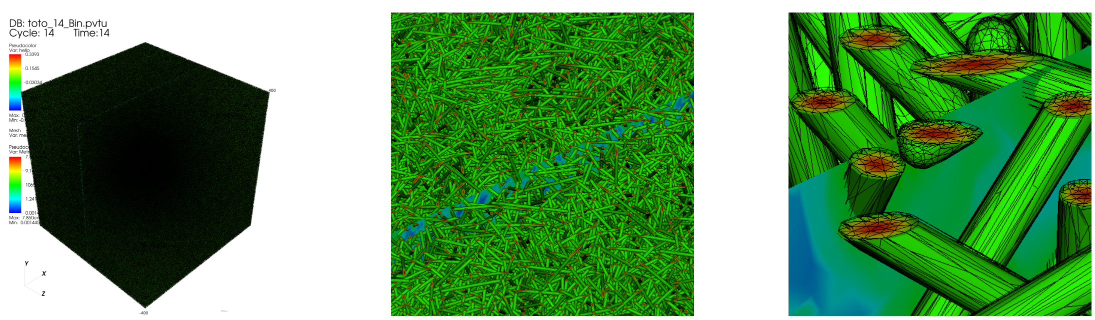

Figure 1: Anisotropic adapted mesh over a 3 millions fibers microstructures. Final mesh with 3 billion nodes and 18 billions thetrahedra. Pictures for three zoom levels: x1, x256, x65536 (a 512x512 pixel image).

REFERENCES

[1] Digonnet, H. *et al.* Massively parallel anisotropic mesh adaptation. *Int. J. High Perf. Comp. App.*, Vol. **33**(1), pp. 3–24, (2017).

[2] Laurencin, T. *et al.* 3D real-time and in situ characterisation of fibre kinematics in dilute non-Newtonian fibre suspensions during confined and lubricated compression flow. *J. Compos. Sci. Technol.*, Vol. **134**, pp. 258–266, (2016).