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RECENT TRENDS IN SCIENTIFIC COMPUTING FOR COMPUTATIONAL FLUID DYNAMICS AND SOLID MECHANICS IN THE EXASCALE RANGE

TRACK NUMBER 1800, 1700, 800, 600, 500

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ABSTRACT

The aim of this mini-symposium is to discuss and to share recent ideas from numerics (w.r.t. discretization and solver techniques), scientific computing (w.r.t. computational, algorithmic, and implementational aspects) and data science (w.r.t. machine learning and neural network approaches) for the highly efficient treatment of partial differential equations (PDEs) that arise in the simulation of problems from computational fluid dynamics (CFD) and computational solid mechanics (CSM). The presented approaches shall particularly address new ideas regarding future high-performance computing (HPC) environments which will be in the exascale range and which will include massively parallel, heterogeneous architectures together with specific accelerator hardware (GPUs, TPUs, FPGAs) including reduced arithmetic precision. The mini-symposium will concentrate on methods and their foundations and will highlight the interplay of these aspects with computational and algorithmic tools and particularly their realization in simulation software. We shall discuss, for instance, aspects regarding hardware-oriented numerics [1], energy-efficient and extremely scalable numerical approaches, scientific machine learning techniques together with artificial neural networks, numerical cloud computing, and massively parallel solvers exploiting parallelism in time [2]. Other aspects to be included are nonlinear domain decomposition methods [3] and extremely scalable numerical homogenization methods [4].

REFERENCES

[1] Turek, S., Becker, Chr., and Kilian, S. (2006). *Hardware-oriented numerics and concepts*

for PDE software, *Future Generat. Comput. Syst.*, 22, 1-2, 217-238.

[2] Dünnebacke, J., Turek, S., Lohmann, C. et al. (2021) Increased space-parallelism via time-simultaneous Newton-multigrid methods for nonstationary nonlinear PDE problems. *The International Journal of High Performance Computing Applications*, 35(3), 211–225.

[3] Klawonn, A., Lanser, M., Rheinbach, O. (2015). Towards extremely scalable nonlinear domain decomposition methods for partial differential equations. *SIAM Journal on Scientific Computing*, 37(2), C667–C696.

[4] Klawonn, A., Köhler, St., Lanser, M., Rheinbach, O. (2020). Computational homogenization with million-way parallelism using domain decomposition methods. *Computational Mechanics*, 65(1), 1--22