

ESPRESSO

Massively parallel sparse linear solver for numerical PDEs, designed to take full advantage of today's most powerful petascale supercomputers



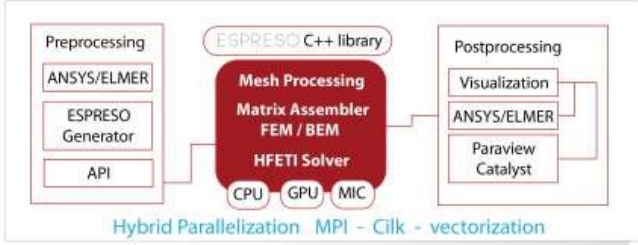
IT4Innovations
national
supercomputing
center

Lubomir Riha | lubomir.riha@vsb.cz | Tomas Brzobohaty | Alexandros Markopoulos | Ondrej Meca | Michal Merta

espresso.it4i.cz

Based on Finite Element Tearing and Interconnecting (FETI) methods

Hybrid FETI with multi-level decomposition

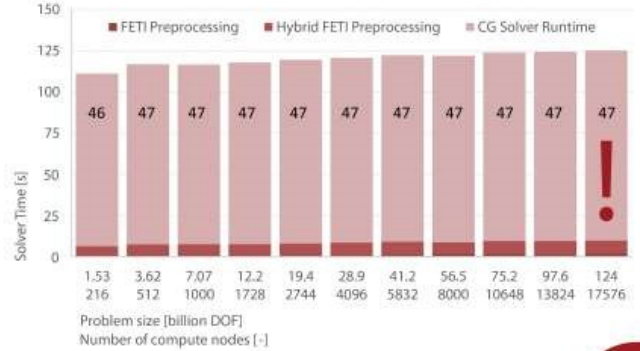


ESPRESSO is a highly parallel implementation of Hybrid FETI solver. This method is designed to provide parallelism required for future Exascale machines. It has been successfully tested on the largest US supercomputer TITAN. Tests were performed on 17 576 compute nodes.

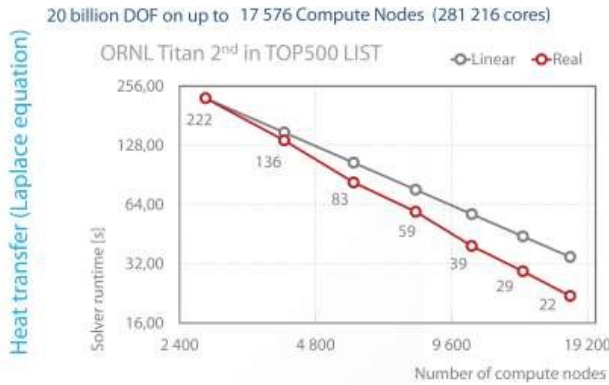
124 billion DOF

Espresso HFETI Weak Scalability

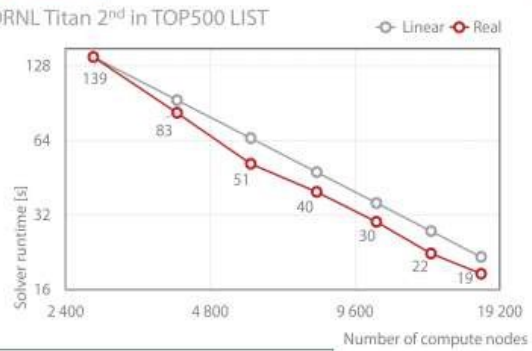
Up to 124 billion DOF on 17576 Compute Nodes (281 216 cores)
Heat transfer (Laplace equation) ORNL Titan 2nd in TOP500 LIST



Espresso HFETI Strong Scalability



11 billion DOF on up to 17 576 Compute Nodes (281 216 cores)
Linear elasticity ORNL Titan 2nd in TOP500 LIST



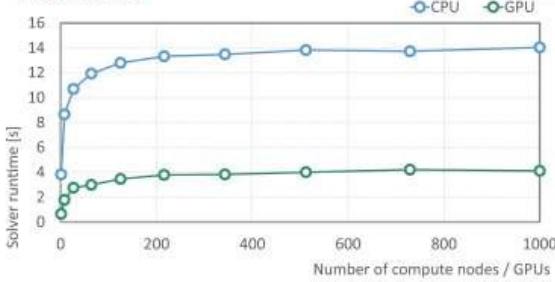
1

Espresso with GPU Acceleration



TITAN 2nd in TOP500 LIST

0.3 - 300 million DOF Hybrid FETI CG Solver Runtime
Linear elasticity

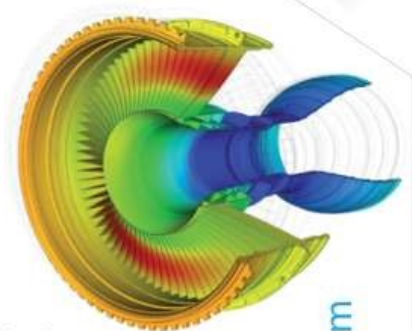


SpeedUp

3.4

CPU vs GPU

AMD Opteron 6274
Nvidia Tesla K20x



2

Intel® Parallel Computing Center

ESPRESSO with Intel® Xeon Phi™ - same idea as for GPU accelerators. Sparse iterative linear solvers combined with appropriate preconditioners and domain decomposition methods, suitable for solution of very large problems distributed over tens of thousands of Intel® Xeon Phi™ coprocessor accelerated nodes.

SpeedUp
2.6
CPU vs PHI



Acceleration of Iterative Solver using SC CPU and Xeon Phi
Interfacing FEM community codes ELMER and OpenFOAM

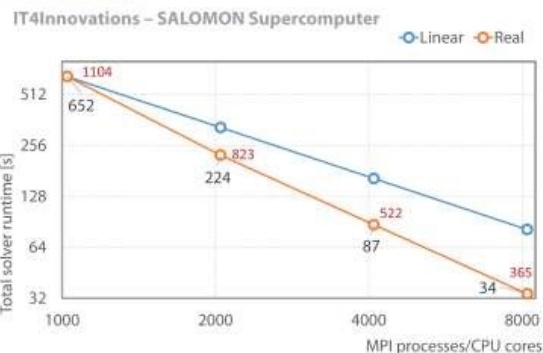
Acknowledgement

We thank to
- Oak Ridge
- SURFdata (www.surfdata.nl)
- CSCS (www.cscs.ch)
- IT4Innovations (www.it4i.cz)
- Olaf Schenk for his support with Pardiso SC

- TITAN supercomputer
- Cortesius supercomputer
- Piz Daint supercomputer
- Anselm supercomputer



300 million unknown - ANSYS Workbench
Linear elasticity



Real World Problem

The work was also supported by the European Regional Development Fund in the IT4Innovations Centre of Excellence project IZ13/02/1:1.0/03/0:0/0 and the Project of major infrastructures for research, development and innovation of Ministry of Education, Youth and Sports with reg. num. LM011033, and by the project ENIGMA funded from the EU's Seventh Framework Programme FP7/2007-2013 under grant agreement no. 610241

www.it4i.cz