Digital Core Analysis with GPU application

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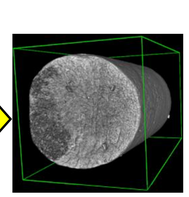
Core Sample Analysis

Core is a cylindrical rock sample, which is obtained by drilling.
Core analysis required:
•To determine the amount of hydrocarbon reserves;
•To choice the technologies for oil and gas production
The **Digital Core Analysis** make it possible to simulate the parameters of the core samples on your computer.
GPU helps to accelerate the calculations significantly.

Workflow

Core sample

CT scanner



Tomography Results – 3D core image

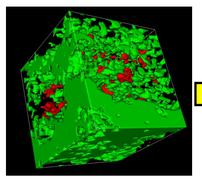
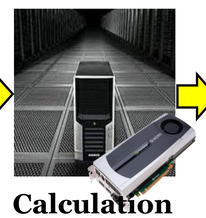
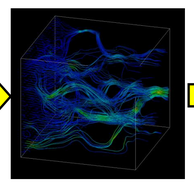


Image processing



Calculation on GPU



Multiphysics Modeling

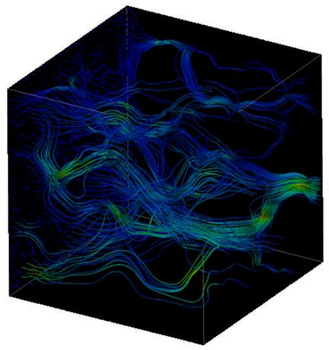
Full Report

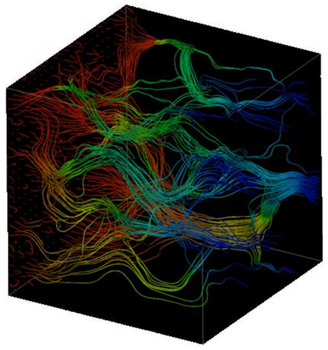
References

1. Jonas Tölke. Implementation of a lattice Boltzmann kernel using the compute unified device architecture developed by NVIDIA. *Computing and Visualization in Science, 2008.*
2. Wang Xian and Aoki Takayuki. Multi-gpu performance of incompressible flow computation by lattice Boltzmann method on GPU cluster. *Parallel Computing, pages 521--535,* 2011.
3. C. Obrecht, F. Kuznik, B. Tourancheau, and J.-J.Roux. Multi-gpu implementation of the lattice boltzmann method. *Computers and Mathematics with Applications, 2011.*

Method

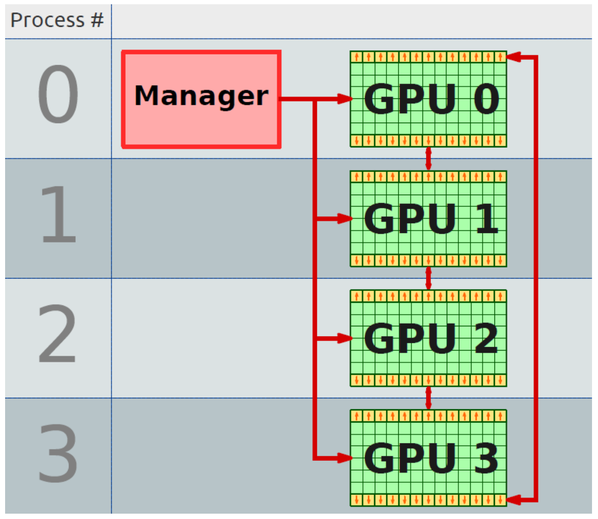
Lattice Boltzmann Method (LBM) was used to simulate physical processes in a 3D model of a porous medium. This algorithm is ideally suited for implementation on massively parallel architecture, like GPU.





MultiGPU

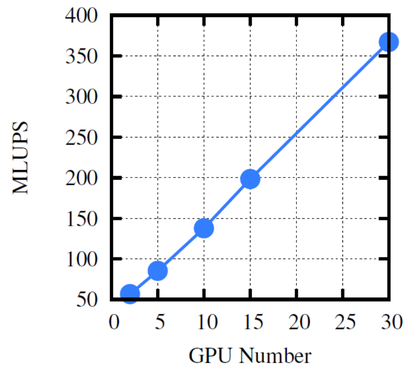
The following **achievements** have been obtained by improving the implementation of the LBM algorithm for multiGPU + MPI architecture:
1. Reduced the amount of shared memory used by a factor of 2;
2. Reduced the amount of DRAM in 2 times required for the algorithm;
3. A strong simplification of the code
(no additional copying blocks of memory);
4. The time required for the calculation remains the same.



Performance Results

Tests were performed on a supercomputer “Lomonosov” of Lomonosov MSU (Tesla C2070).

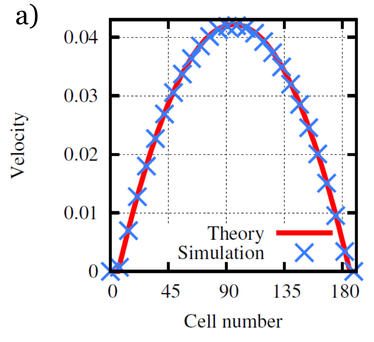
GPU Number	MLUPS
2	56.75
5	85.26
10	137.83
15	198.36
30	367.29



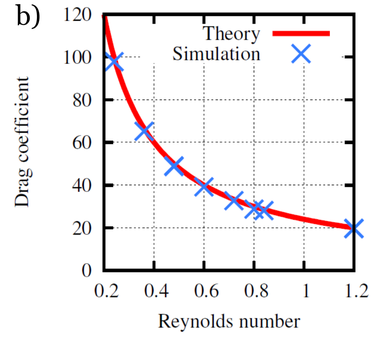
Verification

Verification of the resulting algorithms was done using a test with stationary Poiseuille flow (a), calculation the drag coefficient of the sphere (b) and verification of Darcy's law for the filtration through porous media (c)

a)



b)



c)