Multi-GPU implementation of finite-size particles in a pipe flow

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4. NVIDIA

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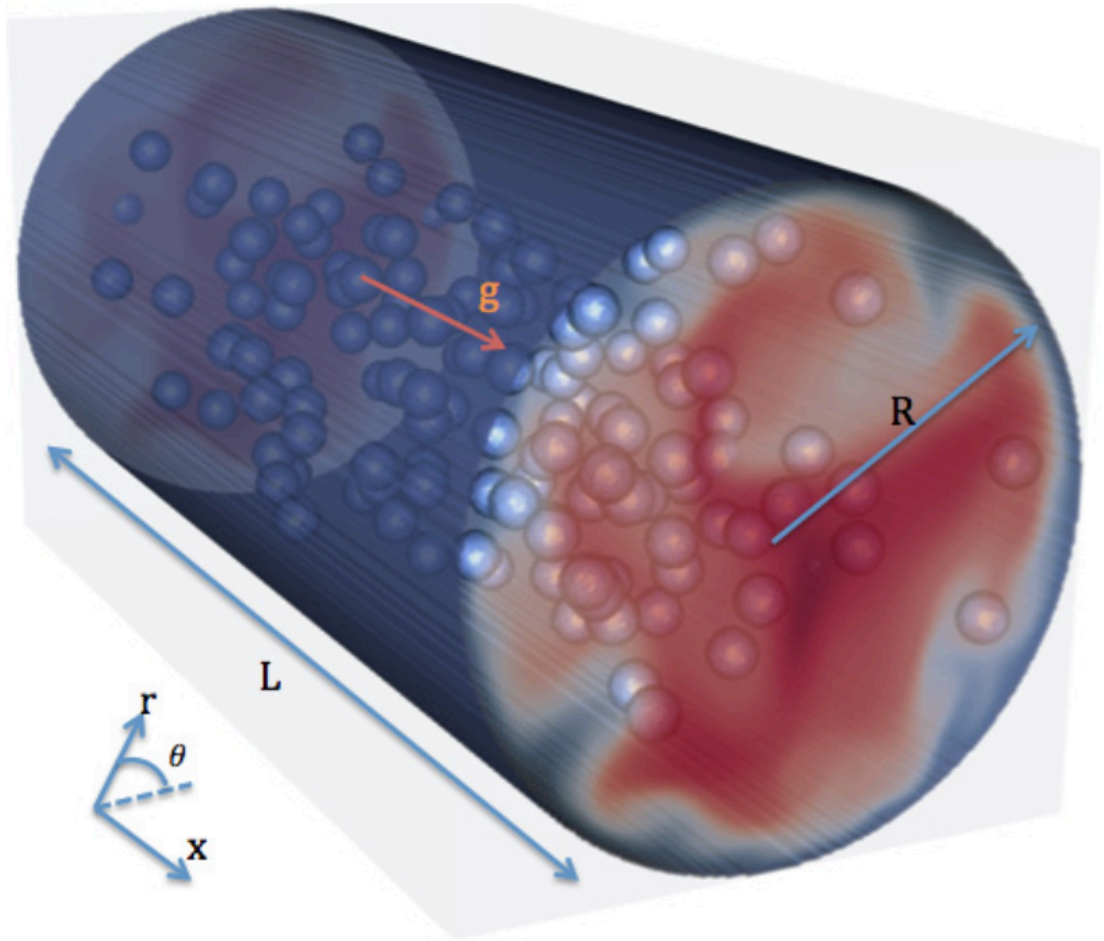
Finite-size particle in fluid

Study transportation behavior particles in the sand storm

Algae population dynamics

Goal: Particles in complex flows



- Multi-GPU implementation for lattice Boltzmann
- Multi-GPU implementation for particle-fluid interaction and particle-particle interaction

A Gupta, HJH Clercx, F Toschi
Communications in Computational Physics 23 (3), 665-684 2018

A Gupta, HJH Clercx, F Toschi
The European Physical Journal E: Soft Matter 2018

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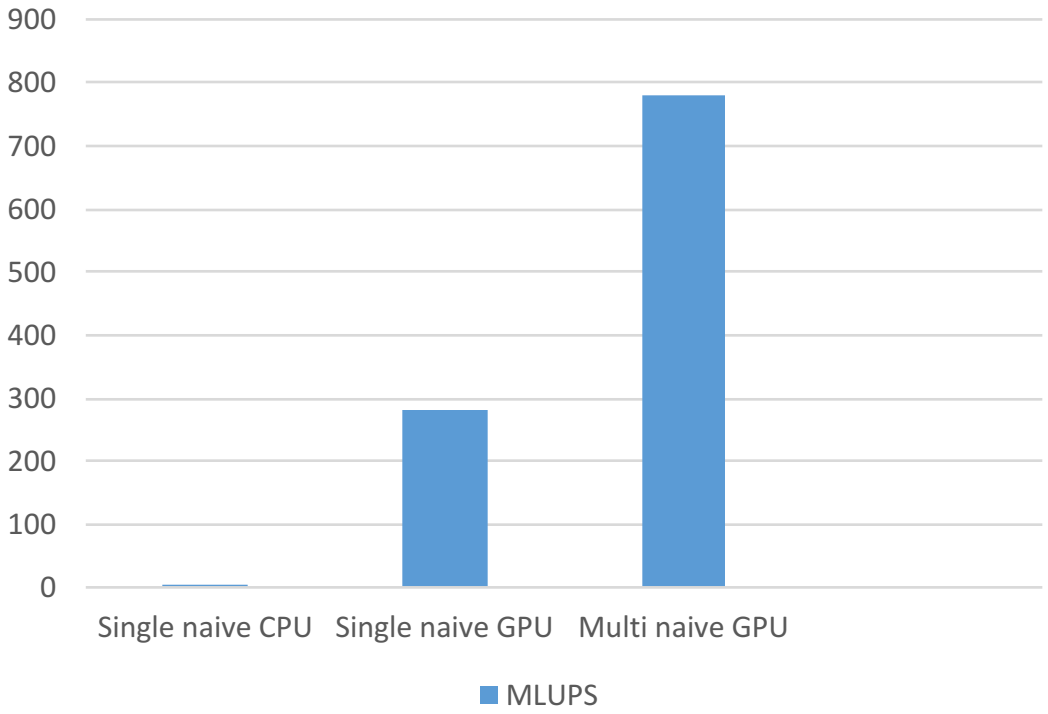
The European Physical Journal E 41 (3), 34 2018

Difficulties

- numerical: particle-fluid interaction
- MPI parallelistaion: efficient halo communication
- GPU parallelisation: efficient data layout without breaking variable dependencies
- Thrust library: efficient usage with CUDA (exotic conflict)

Mini-app speed up

single naive CPU mini app	single naive GPU	4 naive GPUs
2 MLUPS	280 MLUPS	780 MLUPS



Particle algorithm

single CPU particle	single GPU	many GPUs…
1.5 MLUPS	?	?

Next step: possible optimization

- Better memory access pattern
- Mapping 3D blocks in 4D nested algorithms
- Shared memory…
- Smart way to handle boundary condition for particle-fluid interaction

Feedback and Conclusion

- Challenging team experience
  - Xiao: C programmer, limited experience in GPU programming (forgot about much stuff)
  - Felix: C programmer, about 0 knowledge about GPU programming before the event (theoretical phycists)
  - Teo: C++ programmer, advanced CUDA programmer
  - Great learning experience between team members!
- Good boost in the progress
  - speed up for mini app achieved relatively soon
  - embedded particle algorithm in mini app, porting to GPU started
- Very helpful mentors
- Good starting point for CUDA journey

HPC-LEAP
EUROPEAN JOINT DOCTORATES

Thank you for the organization!