# GPU-SPHEROS: A GPU-Accelerated Versatile Solver Based on the Finite Volume Particle Method

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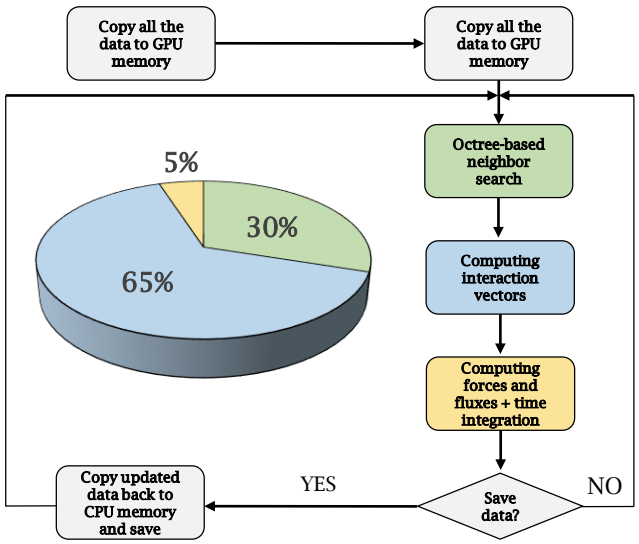
## Introduction

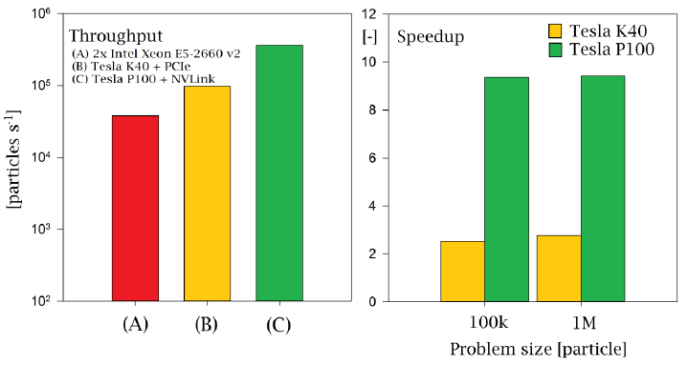
**GPU-SPHEROS** is a **GPU-accelerated particle-based solver** based on Finite Volume Particle Method (**FVPM**) which inherits desirable features of both Smoothed Particle Hydrodynamics (**SPH**) and mesh-based Finite Volume Method (**FVM**) and is able to simulate the interaction between fluid, solid and silt. With GPU-SPHEROS, the goal is to perform a industrial size setup simulations of hydraulic machines.

## Software flowchart



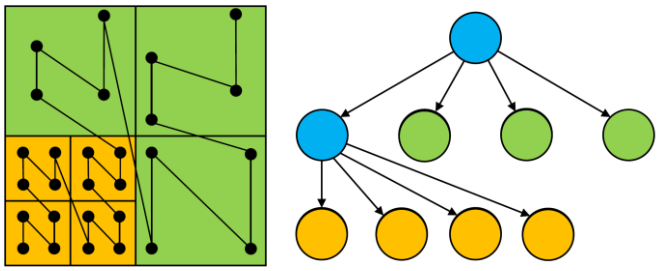

## Speedup

- On NVIDIA Tesla P100, GPU-SPHEROS is almost 10x faster than the CPU version running on a node with 2 x Intel® Xeon® E5-2660 v2.



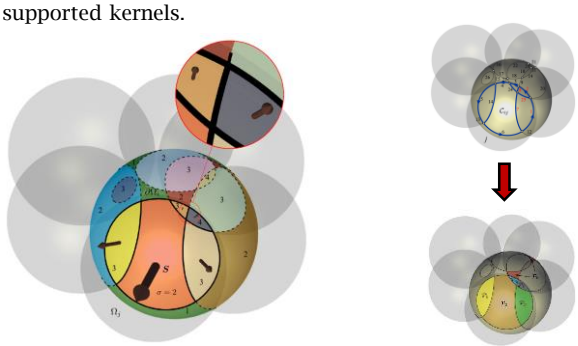

## Octree-based neighbor search

- Memory access efficiency is a key point for GPU applications to be able to get a good performance
- The data has been reordered using space filling curves (here, Morton curve) to improve memory access
- An octree-based neighbor search algorithm has been implemented to find the neighbor particles
- A highly optimized kernel has been implemented for parallel distance check between the particles



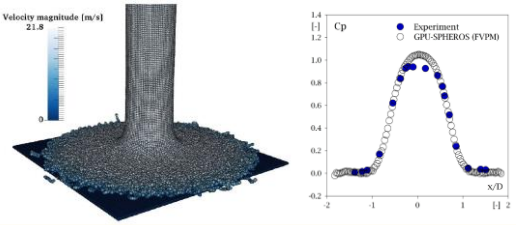
## Computing interaction vectors

- FVPM can be interpreted as a generalization of conventional mesh-based FVM. In FVM.
- In FVPM, control volumes are replaced by overlapping particles and the exchange occurs through the interfaces defined by overlapping regions. [1]
- GPU-SPHEROS has been developed based on spherical-supported kernels.



## Case study

- Fluid jet impinging on a flat plate
- The pressure coefficient has been compared to experimental data.

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## References

[1] E. Jahanbakhsh, A. Maertens, N. J. Quinlan, C. Vessaz, F. Avellan, Exact finite volume particle method with spherical-support kernels, Comput. Methods Appl. Mech. Engrg. 317 (2017) 102–127