Introduction to PhasicFlow

Toward DEM at industrial scale

- Obstacles
  - Large data sets ➔ limitations on memory and disk
  - Very long computation time ➔ limitation on available flops

- What is the opportunity here?
  - The hardware is growing at a fast pace due to Gaming industry and AI investments:
    - GPU
    - Multi-core CPU
    - Faster memory with higher bandwidth
- What is missing?
  - Software to exploit the maximum available computational power

The philosophy behind PhasicFlow

- To have a parallel, efficient code for DEM and CFD-DEM simulations
- To be executed on different hardware
  - CPUs, GPUs
- The design should be flexible for future extensions
  - It is completely open for addition of new models
- Everyone can have access to it with no charge
  - open-source
- Provide support for users
  - Documentation and tutorials
  - Workshops
  - Github issues

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Computer Programs in Physics

PhasicFlow: A parallel, multi-architecture open-source code for DEM simulations ☆,☆☆

The features

- Spherical particles with various contact force models
  - Linear models
  - Non-linear models
- Geometry
  - Built-in: for simple geometries
  - CAD drawing: for complex geometries
  - Motion models: stationary, rotating axis, conveyor, vibration, multi-rotating axis
- Coarse-graining
  - With models to perform coarse-graining simulations

The features

- Post-processing tools
  - pFlowToVTK
  - postprocessData
    - In-simulation
    - Post-simulation

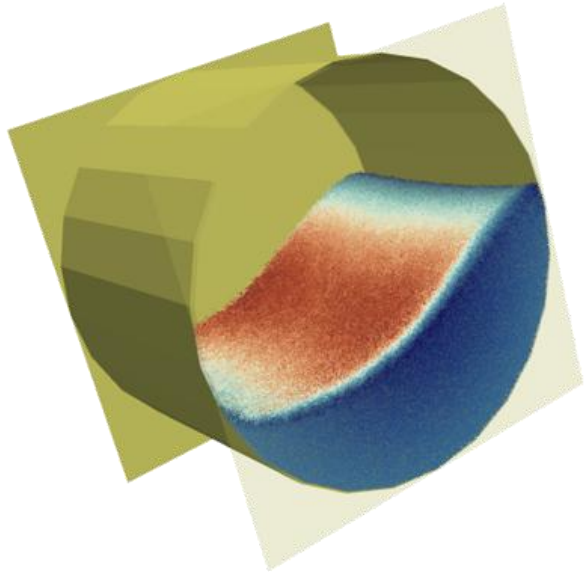
- Parallelization
  - OpenMP parallelization for shared-memory execution on **CPUs**
  - CUDA parallelization for execution on **GPUs**
  - MPI parallelization for **cluster** and **multi-GPU execution** (this feature has not officially finalized)

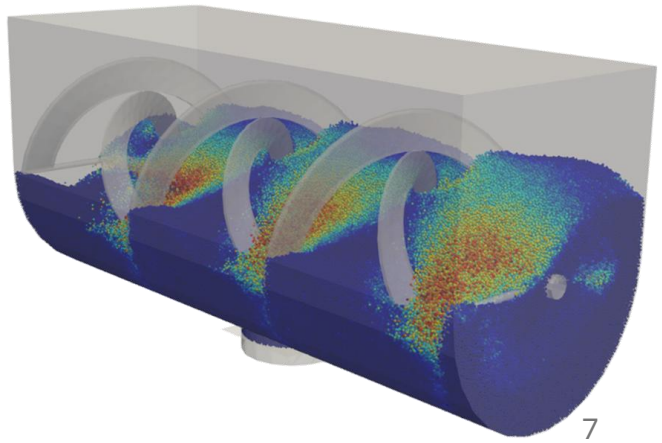
What we have planned?

- Chemical Reaction and heat transfer
- Non-spherical particles
- Additional geometry motion models

How Is the Performance?

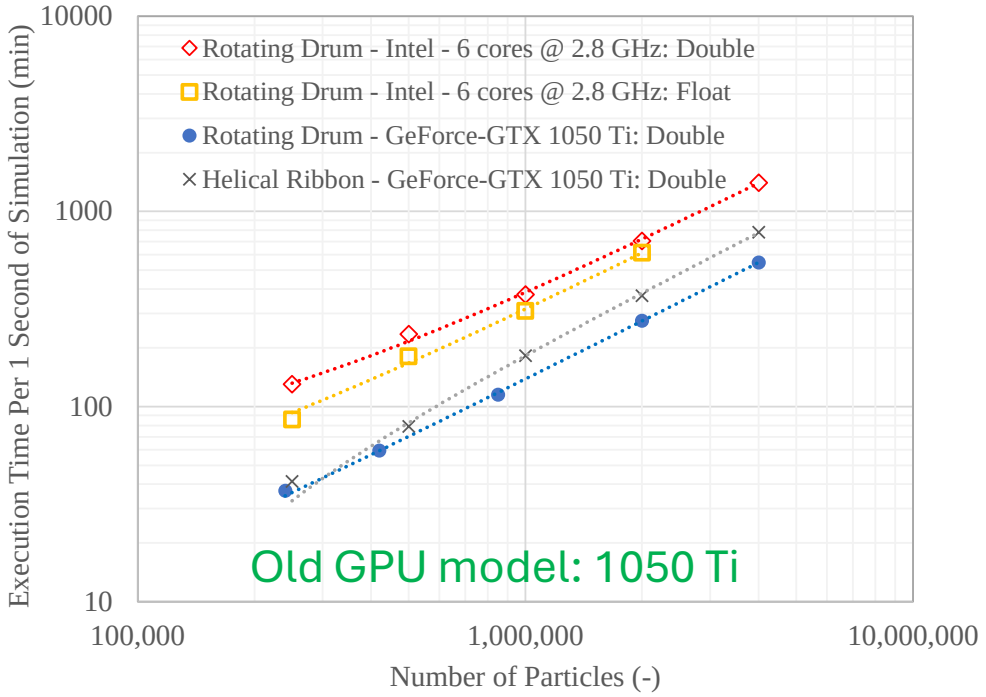
- Number of particles
  - 250 Kilo to 80 Million particles
- Geometry of system
  - Simple: rotating drum with 52 triangles on the surface
  - Complex: helical ribbon mixer with 5916 triangles on the surface



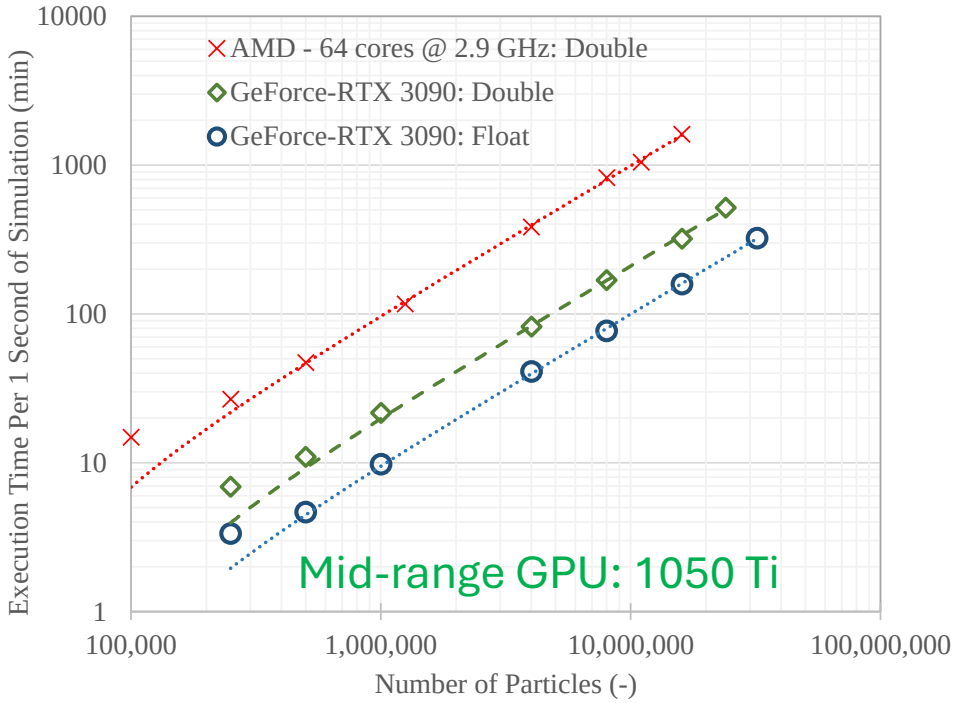


How Is the Performance?

120 min: rotating drum (double)
180 min: helical mixer (double)



22 min: rotating drum (double)
10 min: rotating drum (float)



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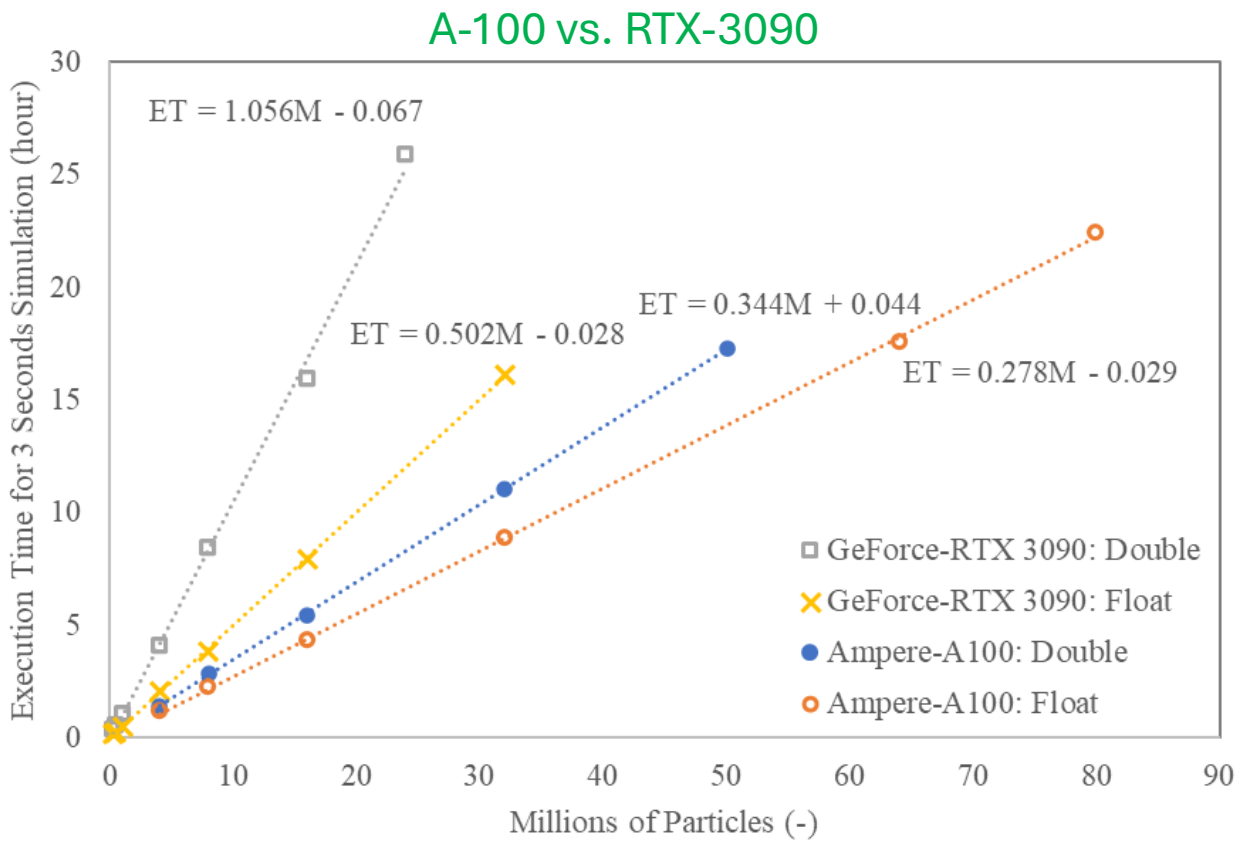
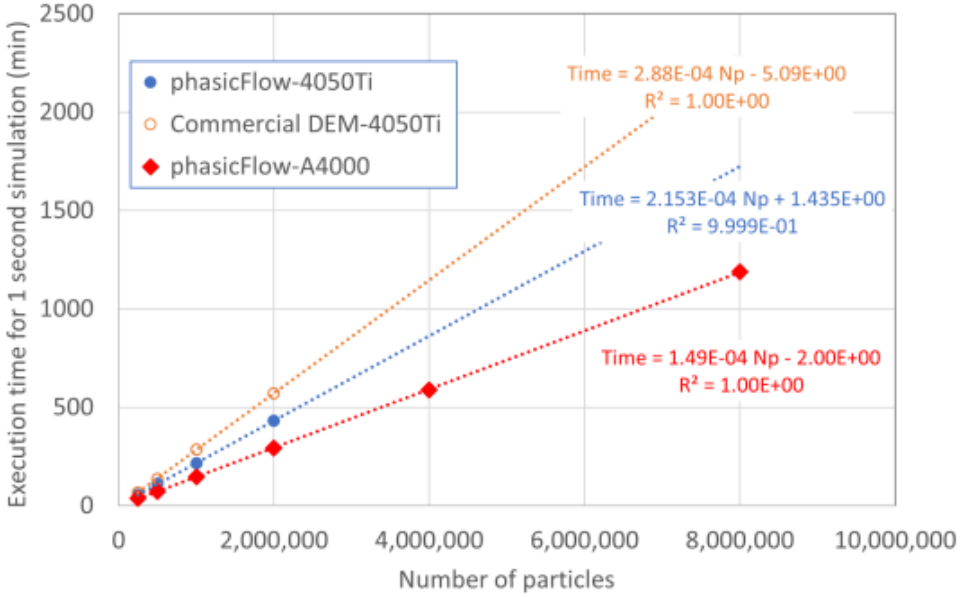


How Is the Performance?

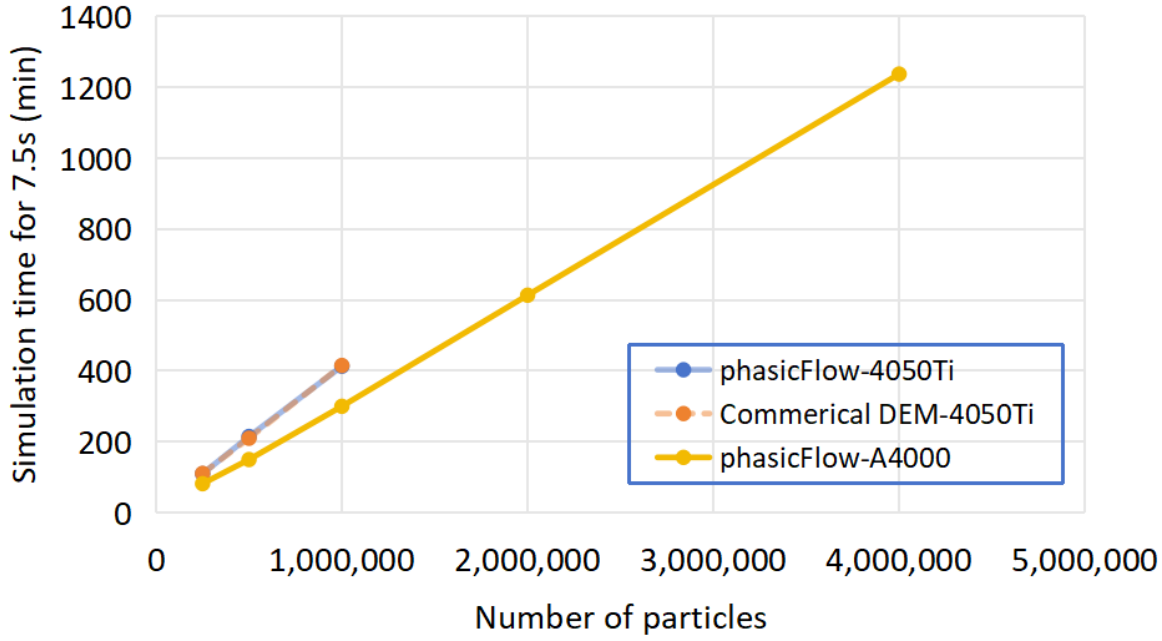
PhasicFlow vs. well-established commercial DEM software

Rotating drum case



PhasicFlow is **20%** faster
PhasicFlow uses **42%** lower RAM

Helical mixer case



PhasicFlow has **similar** performance
PhasicFlow uses **50%** lower RAM

https://github.com/PhasicFlow/phasicFlow/wiki/Rotating-Drum-Benchmark
https://github.com/PhasicFlow/phasicFlow/wiki/Helical-Mixer-Benchmark

How to get and install?

- Download the source code from its official repository

- Install
  - On YouTube: search for “install phasicFlow”

  - On repository: got to wiki pages, on the build section
    - https://github.com/PhasicFlow/phasicFlow/wiki/How-to-build-PhasicFlow%E2%80%90v%E2%80%901.0