Highly-Parallel Fluid-Solid Interactions for Compressible Flows

Overview We implemented a performant fluid-solid interaction solver. We decided to follow the implementation of the open-source jCODE and add GPU support. We then compare to a standard case of the 2D shock-driven cylinder by Henshaw et al.

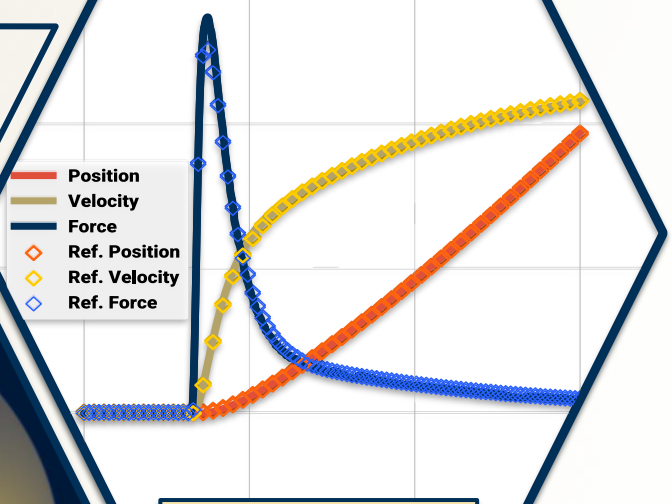
Methods Beyond jCODE, we implemented two features. First a macro library compatible with many GPUs & compilers. Second a memory reduction scheme, cutting memory usage by a factor of 4.

Results The figures show results from the shock cylinder:

1. The kinematic terms of the cylinder's motion
2. The fluid density distribution
3. Our computational speed up.

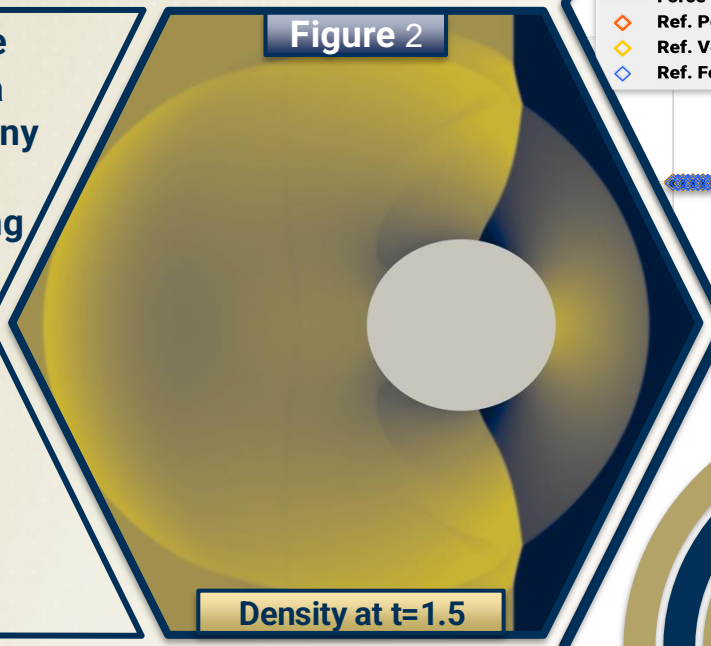
Discussion We measure a slightly-higher peak force attributed to the ghost-point method, our measurements of the position, velocity, and density show good agreement with previous work. The computational optimizations resulted in x1.3 performance per MPI rank on CPUs and x22-x54 performance on the GPUs. We also have a reduced memory footprint to support more immersed boundaries.

Figure 1



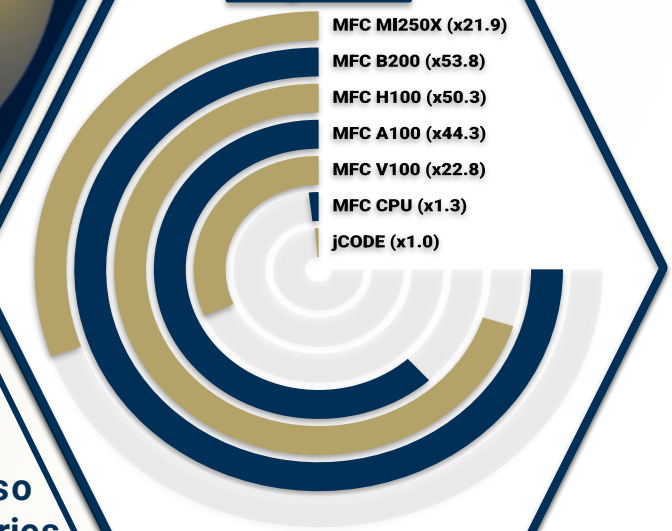
Force Comparison

Figure 2



Density at t=1.5

Figure 3



Speedup

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Watch the simulation

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