Load-balancing Reacting Multiphase Flows

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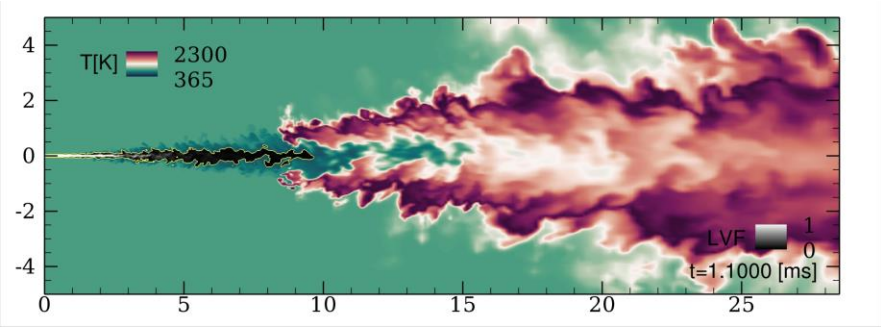
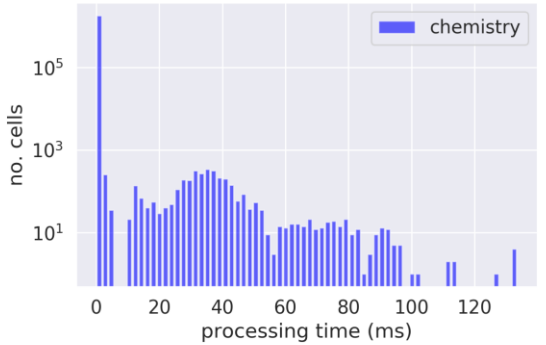
Reacting, multi-phase turbulent flows are amongst the most compute-intensive CFD simulations. They are key to designing and optimizing industrial applications and combustion engines.

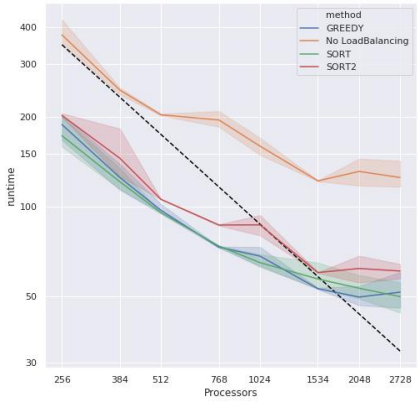


In the Spray-A benchmark, a combusting jet is localized within a limited region of the 3D grid at trans-critical pressure, leading to a heavy computational load imbalance for traditional mesh partitioning.

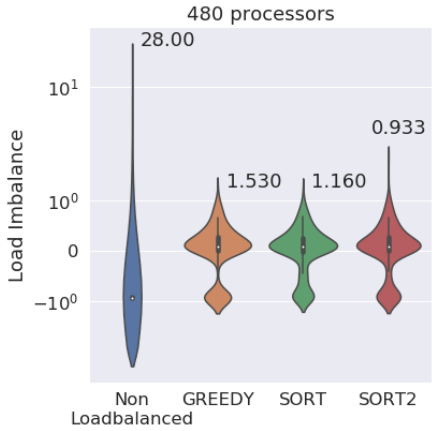
Solving the stiff system of reaction rates results in a large spread of compute time over the grid cells



Our methods improve the strong scaling of the reacting Spray-A setup to thousands of cores



Dynamical re-partitioning shows a clear improvement in the distribution of computational load among processes



We have designed and implemented a mechanism to offload work to idle processors using dynamical load-balancing. We have applied this method to the INCA CFD solver and achieved more than 2x speedup for the reacting Spray-A benchmark.