PREDICTION OF EXHAUST FLOW SOUND PRESSURE LEVEL (SPL) BY COMPUTATIONAL SIMULATION

Highly accurate numerical solution of the Navier-Stokes equations in pipes

PROBLEM DESCRIPTION

Prediction of exhaust flow sound pressure level (SPL) by computational simulation is an important step of the development of vehicles. The main research problem is to construct a fast and accurate numerical algorithm for the exhaust air flow, implement it efficiently, and test the resulting code on prescribed very large scale computational problem.

CHALLENGES AND GOALS

- Development of a solver from the scratch, the Fluid-Solver on GPU for air flow simulation
- Performing two series of simulations for a selected set of the industrial use cases: one with the industrial state-of-the-art solver and one with developed solver
- Measurements, validation, result evaluation

CHALLENGES: Smart, green and integrated transport

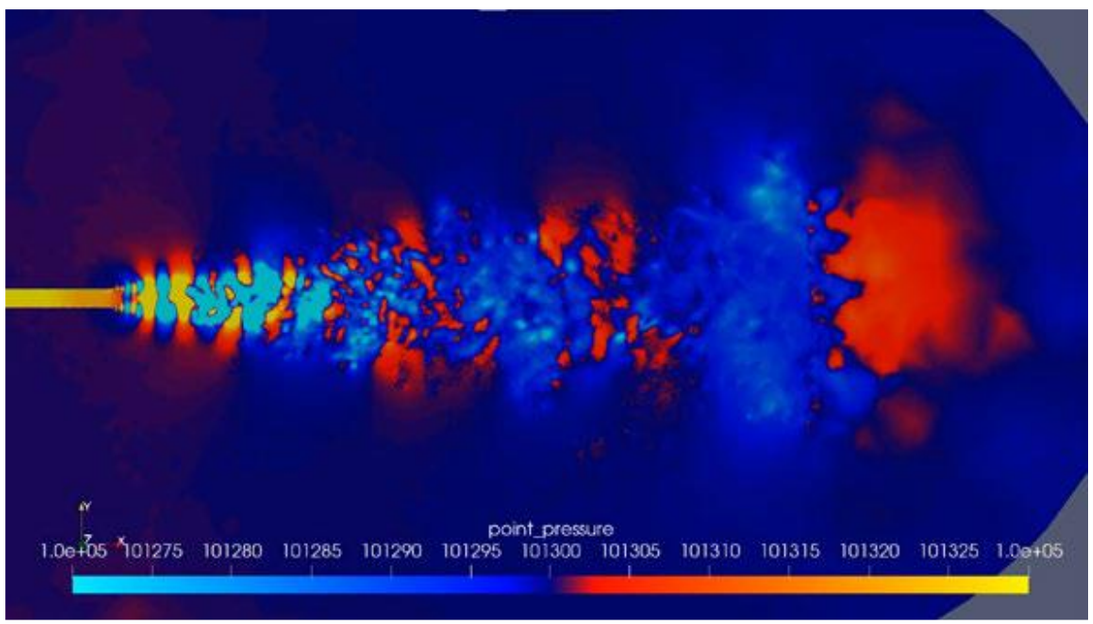
PRODUCTIVE SECTOR: Vehicle industry

MATHEMATICAL AND COMPUTATIONAL METHODS

The industrial benchmark problem of turbulent flow simulation in the exhaust pipe system has been modelled with the commercial software STAR-CCM+ (version: 13.06) using large Eddy Simulation.

Direct Numerical Simulation with our inhouse developed Fluid-Solver research software:

- 2nd order finite-volume, cell-based tetrahedral solver was created to solve the unsteady, compressible Navier-Stokes equations on 3D domain
- The algorithm was implemented on GPGPU and multicore CPU systems



Cross section of the pressure field from the simulation

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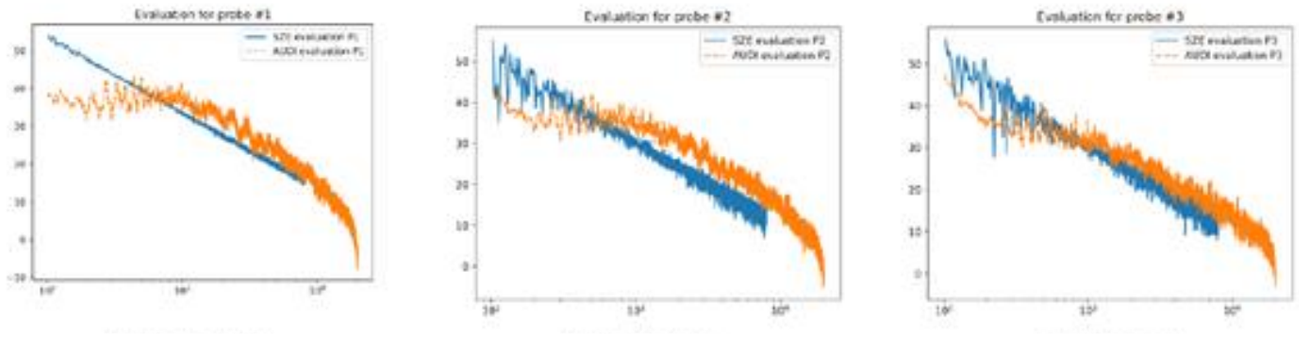
Results and Benefits

- The computational time for the pipe acoustics is 1 day on an NVIDIA A100 GPU with our Fluid-Solver and 5-12 days on a cluster with the LES-simulation.
- Both methods provide suitable accuracy for the pipe SPL values.

Comparison: AUDI measurements / SZE results.

Evaluated Time: [0.1s, 0.4s]



The Fluid-Solver saves several working days for each pipe scenario at the same accuracy as the present industrial state-of-the-art.

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