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# Time stepping review of open-source solvers

Guided research

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## 1 Introduction

- Introduction to coupling simulations (FSI) and to the preCICE library.
- Some brief motivation of performing a convergence study on the known solvers.
- Talk somehow about higer timestepping schemes, and why/when is good to use them. Should you use a higher order timestepping scheme if it doesn't give good results? (No bc it is slower)
- Say why we chose this two open source solvers.
- Explain difference between preCICEv2 and preCICEv3.

## 2 OpenFOAM

- Small introduction to OpenFOAM.
- Explain time stepping schemes available in the solver, and their orders. Mainly talk about Euler method, and Crank Nikolson, as they are the two cases we used.
- Talk about the script created to automatize the procedure of running these simulations.

### 2.1 Solver parameters

- Talk about the important parameters in the configuration, to obtain accurately enough results, as those where quite time consuming to find. For example, foamToVTK is not accurate enough, and was misleading at the beginning. Also mention the solver used.

### 2.2 Case study: Taylor Green Vortex

- Short introduction to the scenario, present generation formulas of initial conditions and boundary conditions.
- Explain how the error is computed, while commenting Figure 1.
- Talk about the second way of computing the error, while commenting Figure 2. Talk about the appearence of the spatial discretization error, and at which scales happens.

## 3 Calculix

- Small introduction to Calculix.

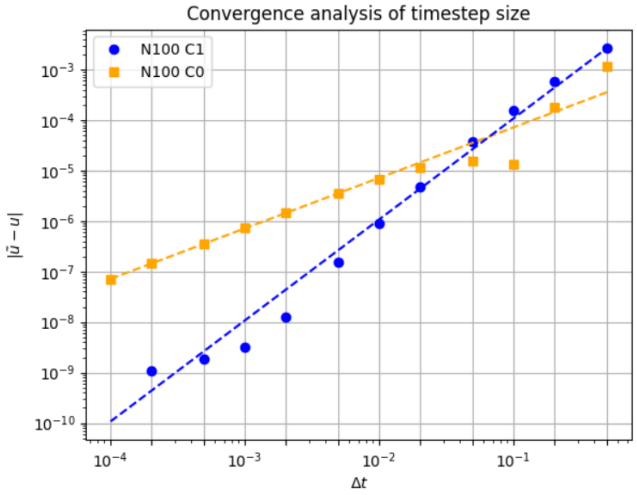


**Figure 1** Figure comparing data to the analytical solution of Taylor green vortex.

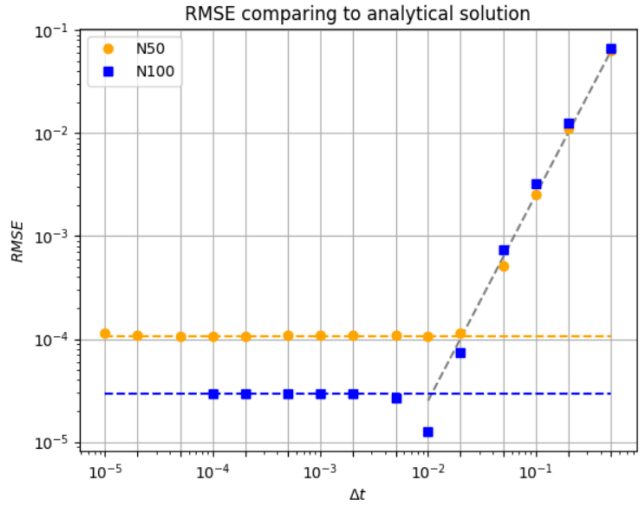


**Figure 2** Figure showing spatial error decrease with higher grid definition. TODO: improve this figure, as you computed also with N150.

### 3.1 Solver parameters

- Talk about the supported time stepping scheme (only one, but higher order). In this case the parametrization is quite simpler, so I would also summarize it here.

### 3.2 Case study: perpendicular flap

- Talk about the simulation that we performed, a perpendicular flap versus a constant force.
- Mention the scripts created to automatize this task, and to obtain the tip point value from the results.
- Comment on Figure 3, that shows a higher order (between 1 and 2) of convergence. Mention how we compute the error, and how for values <1e-4 the outputed value is the same, meaning either that for lower timesteps the spatial discretization error governs, or that the solver can't achieve better accuracy bc of how values are stored (max of 6 decimal values, more likely given that the results are the exact same).

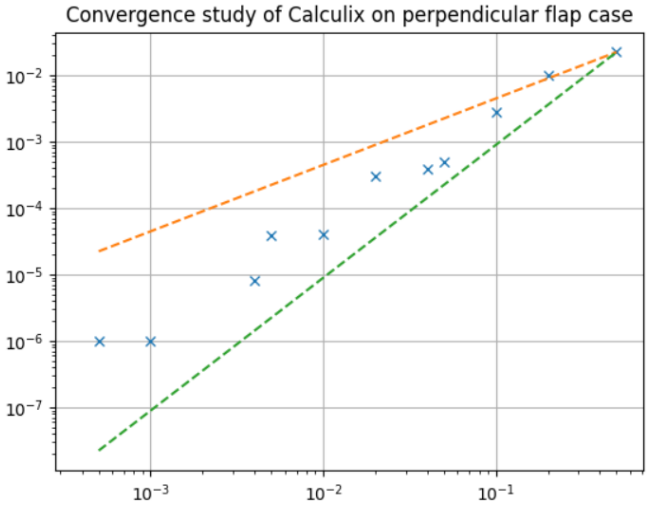


**Figure 3** TODO: improve this figure, by adding legend and nicer colors.

## 4 Coupling the two solvers

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