

Masters Internship

Reusability of preconditioners

Context

At Ignition Computing, we are developing the **PreconNet Toolbox** in order to speed up the solving of systems of linear equations of the form $Ax=b$. Solving such systems is at the core of many multi-physics simulations (like in figure 1), and often is the **computational bottleneck** of the simulation. Speeding up this step would significantly reduce compute power needs.

One approach is to use preconditioned iterative solvers, and **optimizing the reuse of previous preconditioners**. In practice, if reuse happens at all, it is with simple heuristics. In this project you will look into the '**reusability**' of a **preconditioner**. What would be a good definition and which measures describe this relationship? Can we gain any performance?

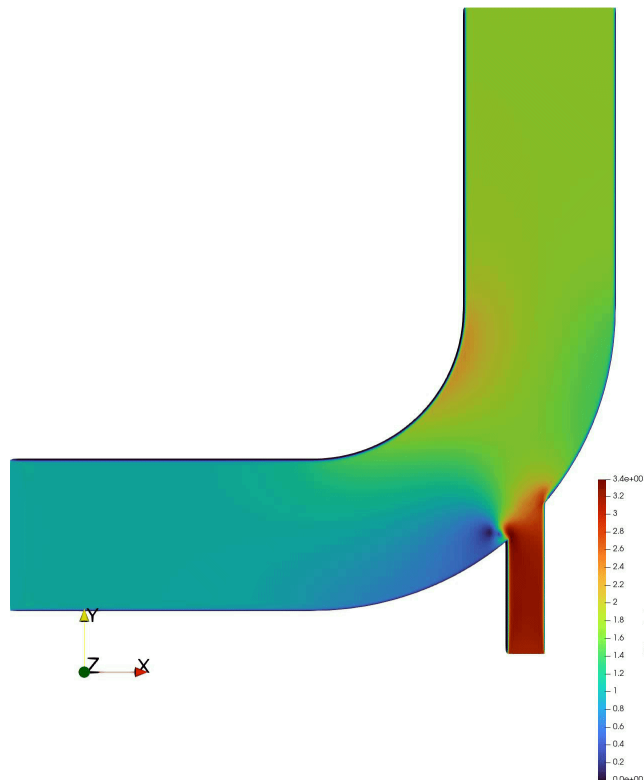


Figure 1: OpenFoam simulation of flow through a bent pipe

Project overview

In this project you will:

- Conduct a literature study on preconditioning reuse tactics.
- Define **reusability of preconditioners**, and **identify potential measures** to quantify it.
- Perform **analytical and numerical analysis** on test cases to investigate the relation between the chosen measures and the preconditioner reusability.

What we are looking for

The best fit for this internship is a **MSc student** with:

- A background in **numerical linear algebra** or **scientific computing**.
- An interest in iterative solvers and **preconditioning techniques**.
- Programming skills and knowledge/interest in programming languages such as Python, C++, Mathematica or MATLAB.

What we are offering

Besides a challenging internship project we offer:

- Good support from enthusiastic team members.
- Free lunch, drinks and snacks.
- Nice office, located in Strijp-S.
- An internship allowance of €500,- per month.

● About Ignition Computing

We are an Eindhoven-based consultancy firm for research software, focussing on nuclear fusion and physics- and mathematics-heavy problems. We assist our clients by **writing and optimizing simulation codes**, combining them into streamlined modelling workflows, and **building advanced visualizations and infrastructure tools**. We work almost completely on green projects like **clean energy production** and greenhouse improvement.

● Reading material

- Example of preconditioning being reused until GMRES-iterations exceeds 50
<https://github.com/idaholab/moose/discussions/20627>
- Y. Saad - [*Iterative methods for sparse linear systems \(2nd edition\)*](#)

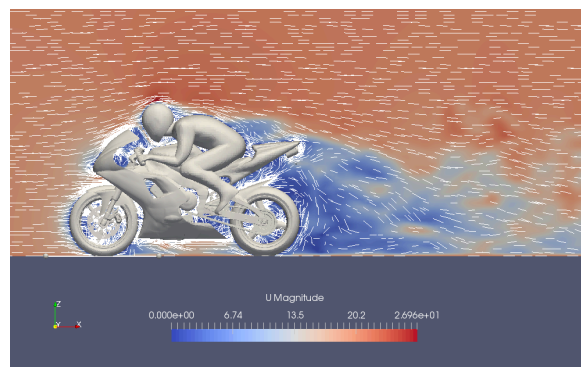


Figure 2: 3D simulation of 0.7s of wind flow around a motorcycle. Calculation time ~ 29 hours. OpenFoam tutorial [incompressible/pisoFoam/les/motorBike](#)