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Hydropower meets supercomputing: EuroCC Austria provided access to a supercomputer for a CFD training event

In this successful cooperation between academia and industry, engineers from Austrian small and middle-sized enterprises (SMEs) practiced numerical flow simulations with the help of high-performance computing and got to try out the Vienna Scientific Cluster — Austria's most powerful supercomputer. The knowledge gained will help the companies improve the efficiency of hydropower plants.

On 21-25 March 2022, five Austrian SMEs from the field of hydropower plant construction and operation participated in a training in computational fluid dynamics (CFD) at TU Wien. The aim was to use numerical flow simulations to simulate the parts of a hydroelectric power plant under the greatest stress, such as a turbine or impeller, with open-source software (OpenFOAM and Paraview).

The training took place in the context of the innovation camp WakaSi funded by FFG Austrian Research Promotion Agency and was organised and conducted by Bernhard Semlitsch from the Research Unit of Fluid Flow Machinery of the Institute of Energy Systems and Thermodynamics at TU Wien.

The challenge

A successful simulation is made up of several demanding steps that require much computing power. This is why CFD applications are most efficiently run on high-performance computing (HPC) systems with large throughput local storage, low latency networks and optimised CPUs.

Even with experience in CFD, running simulations on an HPC cluster requires additional know-how. One has to be familiar with parallel programming, software, hardware and network infrastructure of a cluster. The participants of the innovation camp all had varying degrees of experience with flow simulations and none of them had used HPC before.

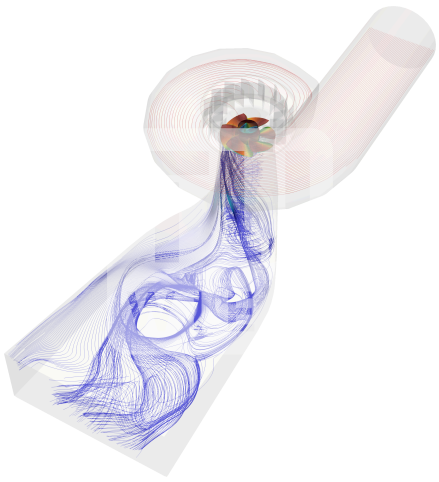
Tailor-made solution

Being affiliated with TU Wien, EuroCC Austria offered Bernhard Semlitsch and his team the provision of necessary compute power on the supercomputer VSC-4 and technical support from the staff of the Vienna Scientific Cluster (VSC). It soon became clear however, that the conventional workflow would pose an entry hurdle for the participants for using HPC.

Conventionally, one would have to create a model on a local machine, check the mesh for inconsistencies, set the appropriate boundary conditions and parameters and only then send the resulting file to the supercomputer, write a job script, submit the job, transfer the outcome back to the local machine in order to visualise and interpret the results.

To facilitate access to HPC, EuroCC Austria offered the use of the recently set up GPU accelerated rack workstations on VSC-4. This enabled the participants to run their simulations entirely on the supercomputer.

Thanks to the GPUs in the rack workstations, the graphical output was fluid. Having never used the brand-new rack workstations in a larger training event before, EuroCC Austria had to check and test the functionality thoroughly before the event and also set aside staff to ensure a smooth operation.



One of the successful outcomes of the CFD training is demonstrated, for example, by the simulation of partial load behaviour of a Kaplan turbine.

The streamlines in the image show the flow behaviour in the turbine, with the colour gradient indicating the total pressure drop. The colour contours on the impeller represent the static pressure.

In addition, EuroCC Austria offered training sessions on general HPC utilisation and, towards the end of the five-day training, introduced participants to the more conventional workflow of submitting jobs to speed up the simulations and harness the full power of the HPC system with parallelisation across multiple nodes.

Know-how to go

As a result, the participants mastered flow simulations and workflows on HPC systems, and learned to find solution-oriented and cost-effective answers to flow engineering problems that should help them improve the efficiency of hydroelectric power plants. On top of that, the engineers learned of the possibility to utilise the VSC and make use of its compute power.

It was a pleasure for us to have played a significant role in this training event and we are looking forward to the innovative and optimised solutions for renewable energy by gbd Hydro ZT GmbH, Voith Hydro, GUGLER Water Turbines GmbH, Global Hydro Energy and Geppert Hydropower.