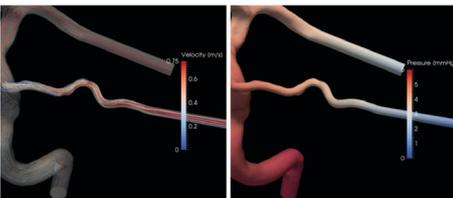
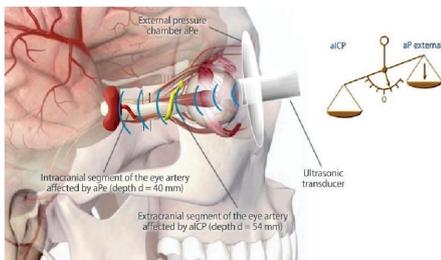


## Cerebral blood flow simulations

### Fortissimo Experiment Facts:

- Segment: Health
- Application Domain: Medical simulation
- Application: In house code



### The Company

The non-invasive accurate and quick measurement of the intracranial pressure (ICP) is of paramount importance for the diagnosis and treatment of neurological diseases, brain injuries and other neuro-pathologies. The world's first accurate, non-invasive ICP absolute value measurement device, based on two-depth ultrasound Doppler technology, has been developed by a Lithuanian SME, Vittamed. Despite the technological achievements and success of measuring ICP non-invasively, Vittamed faces technological challenges in seeking to increase accuracy and precision of its measurement device, its user-friendliness and its cost effectiveness both to reinforce the company's leadership and to open access to new markets. Mathematical modelling and simulation are key to improvements in Vittamed's technology because of the impossibility of obtaining this information in other ways, such as experiments with humans.

The Simula Research Laboratory was founded in Norway in 2001. Its main objective is to create knowledge about fundamental scientific challenges of genuine value for society. Simula has developed leading-edge blood flow models. The use of these models in the simulation of ICP requires the use of HPC. The implementation of these models on a Cloud-based-HPC system is the objective of this experiment.

### The Challenge

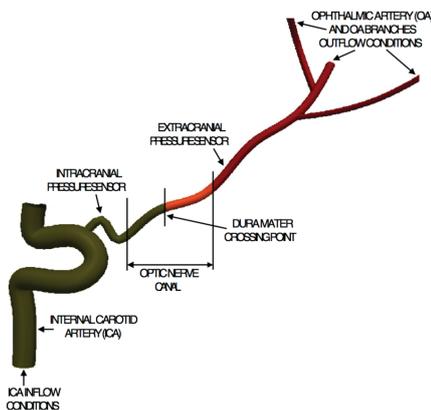
The challenge facing the partners in this experiment was to create mathematical models and develop the necessary software tools to enable simulations of cerebral blood flow in the ophthalmic artery to be performed. The computational requirements of such simulations made it necessary to adapt the software tools to run on an HPC system. The goal was to demonstrate the feasibility and benefits of such simulations to Vittamed and how the necessary computations could be performed via a pay-per-use Cloud-based-HPC solution.

### The Solution

An internal Carotid/Ophthalmic Artery model has been developed, based on MRI imaging, and used to simulate blood flow. This model has been tested and optimised to run on a multi-processor HPC system. It will be used by Vittamed in the future development of its non-invasive ICP measurement technology by simulating blood flow in arteries with specified parameters under different external conditions in order to gain understanding of blood-flow pulsations. Simula has written and tested the necessary software tools needed to implement the required simulations. These tools enable the efficient implementation of the model on an HPC-system. Simulations of the blood-flow model can be performed easily by non-experts by specifying the model parameters through a simple text file.

### The Benefits

Through cloud based-HPC simulations Vittamed can realise a reduction in time to market, due to shorter simulation times. It can also design more accurate products. In particular, Vittamed is targeting a new ophthalmological market niche for glaucoma diagnostics, where more precise and accurate ICP measurements are needed. Glaucoma blindness is irreversible, but it may become preventable, if aided by advancements in screening and



### Fortissimo Experiment Partners:

- Vittamed (End-user)
- Simula (HPC and Application Expert)
- CINECA (Provider and Host Centre)

### More Information:

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E-Mail: [info@fortissimo-project.eu](mailto:info@fortissimo-project.eu)



simula



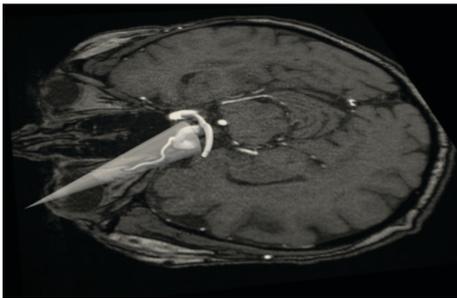
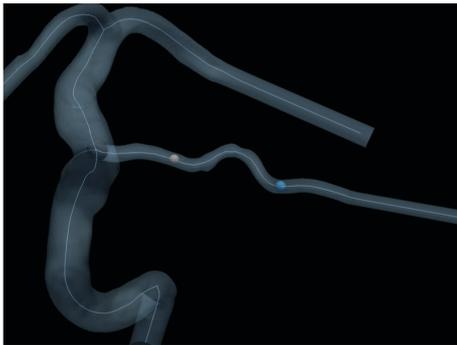
early detection. Improved measurements of intraocular and intracranial pressure would enable the development of innovative diagnostic and screening technologies and treatment methods. Vittamed can gain a significant commercial benefit resulting from the global expansion of the market for ICP diagnostic devices in ophthalmology. The global market for ophthalmic diagnostic equipment is estimated to reach \$947M in 2017. The new market niche for SME in ophthalmology will create a commercial opportunity with an estimated potential of more than €100M per year.

Simula Research Laboratory will exploit the results of this experiment by developing research projects with industrial, clinical, and scientific communities across Europe and beyond. The open-source solver developed is an attractive alternative to commercial solvers because there are no associated licence fees.

The results of the experiment will support the HPC cloud provider, CINECA, in offering its services to the biomedical market, enabling SMEs to benefit from HPC-based simulation.

### The Fortissimo Project

Fortissimo is a collaborative project that enables European SMEs to be more competitive globally through the use of simulation services running on a High Performance Computing cloud infrastructure. The project is coordinated by the University of Edinburgh and involves 123 partners including Manufacturing Companies, Application Developers, Domain Experts, IT Solution Providers and HPC Cloud Service Providers from 14 countries. These partners are engaged in 53 experiments (case studies) where business relevant simulations of industrial processes are implemented and evaluated. The project is funded by the European Commission within the 7th Framework Programme and is part of the I4MS Initiative.



**I4MS** Fortissimo is part of I4MS ICT Innovation for Manufacturing SMEs: [www.i4ms.eu](http://www.i4ms.eu)



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