EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

Simulation services for complex multi-physics problems

A Spanish R&D centre has developed an advanced simulation software for multi-physics problems including fluid dynamics, solid mechanics, heat transfer, electromagnetism, chemical reactions, neutronics and excitable media. The software has been specifically designed to run efficiently in supercomputers and it has in part been developed under the Education and Training Workpackage of EUROfusion. The R&D centre provides its simulation services under research project, publicly (H2020 or similar) or privately funded.

Description of the technology

The software is a high performance computational mechanics code to solve complex engineering problems. It is capable of solving different physics problems in a coupled way. The different physics available are: incompressible and compressible flow, solid mechanics (linear and non-linear), turbulence modelling, chemical reactions, thermal flows, deterministic neutron transport, and electrical propagation. The software has been specially designed to run efficiently in parallel supercomputers. The software is based on the Finite Element Method (FEM), which permits dealing with complex geometries and unstructured meshes. It is capable of solving different physics in a coupled way in large scale supercomputers. High parallelism standards and scaling up beyond 100.000 CPU cores for multi-physics applications have been demonstrated.

Innovation and advantages of the offer

The code is capable of running in thousands of processing cores with excellent scalability. This allows to model very complex problems (in terms of size, space and time scales and/or physics), not achievable by current commercial CAE software. The team is experienced in developing and quickly adapting it to high quality custom engineering software for specific applications.

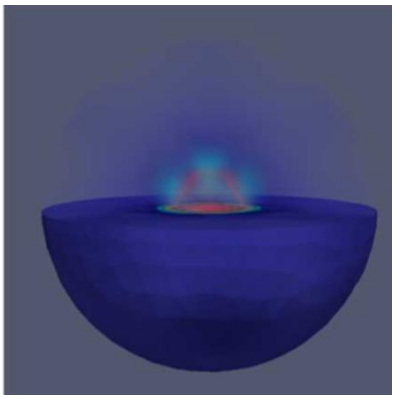
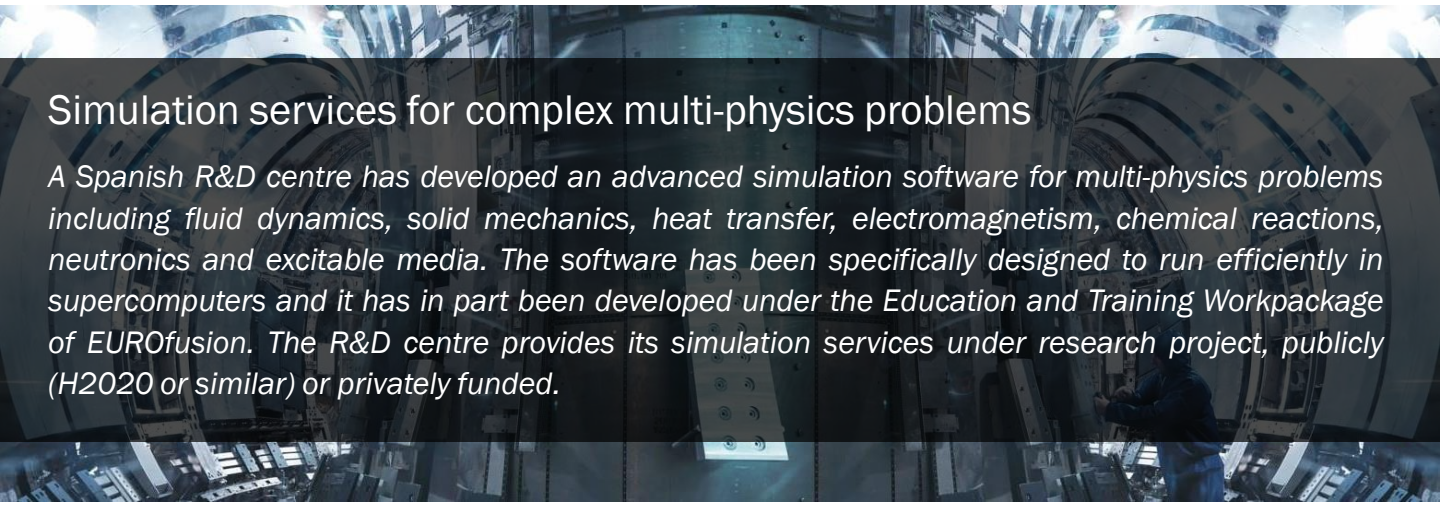


Fig. 1: Simulated neutron flux for simple benchmark case



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Non-fusion Applications

These solutions and services could be promising for neutronics and electromagnetic simulation and could find applications in external aerodynamics in automotive, aeronautics, and wind energy; combustion in gas turbines; biomechanics (cardiovascular and respiratory systems); fusion reactors; thermal cooling

EUROfusion Heritage

Fusion multi-physics capabilities have been developed within the EUROfusion Education and Training programme, motivated by significantly improved multiphysics modelling capabilities that could be thus attained in fusion technology The efforts include a MSc thesis by Carles Riera (2016) entitled “Development of a Deterministic Neutron Transport Code Based on the Alya System at Barcelona Supercomputing Center” https://recercat.cat//handle/2072/281265 within the MSc Programme “Modelling for Science and Engineering” at Universidad Autonoma de Barcelona, Spain, under the supervision of Prof. Mervi Mantsinen (BSC/ICREA, Spain) and Prof. Lluís Batet (UPC, Spain). The capabilities are further developed and discussed in the paper by A. Gutierrez-Milla et al. 2018, 'New High Performance Computing Software for Multiphysics Simulations of Fusion Reactors', Nucl. Eng. Design, 136A, 639,

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This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission