MC3D is a 3D thermohydraulic multiphase CFD software program developed by IRSN. It simulates the fuel-coolant interactions (FCI) in the event of a severe accident in a nuclear reactor (principally water reactors). It is also used to characterise the dispersion of liquid corium in the event of vessel failure when the vessel is still pressurised (known as direct containment heating, or DCH). The software is currently undergoing development to incorporate modelling of the cooling of a corium pool interacting with concrete under water.

**Corium-water interactions and steam explosion**

Fuel-coolant interactions are likely to occur during a severe accident when the molten fuel (corium) interacts with a volatile liquid used as a coolant or moderator. The initial phase of the phenomenon, known as premixing, consists of the two liquids roughly mixing together, accompanied by more or less extensive vaporisation and possibly oxidation*. In certain conditions, the premix may become unstable and cause a violent, detonation-like explosion (steam explosion**). MC3D is one of the most sophisticated and reliable tools for modelling this phenomenon.

**Description of the software**

The software is similar to a development platform, with a modular structure organised around the notion of an "application" for modelling a given physical problem. The current version contains two main applications - PREMEL, which is designed to study the liquid fuel-coolant premixing phase, and EXPLO, which is used to calculate the explosion propagation phase. The software is based on an Eulerian model using a finite-volume method together with a structured mesh.

**Future prospects**

Greater understanding of corium-water interactions and their modelling is the subject of the RSNR-ICE project, an ANR-sponsored programme launched in 2014 in the post-Fukushima context. The CEA, University of Nancy, EDF and AREVA are working together to develop models in MC3D which allow refined simulations of phenomena that are inaccessible to experimental investigation, such as boiling around hot fragments. The software is currently undergoing development to incorporate modelling of the cooling of corium interacting with concrete under water and to provide additional information to aid understanding and interpretation of the experiments.

It is distributed, through collaborative agreements, to the RSNR-ICE project partners, as well as the Slovenian Jožef Stefan Institute. It is also distributed to CRL (Canada), VTT (Finland), CNPDC and CNPE (China), KAERI and KINS (South Korea).