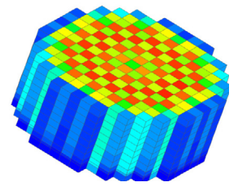
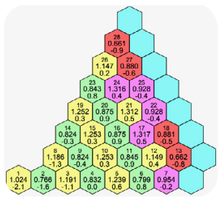
NURESIM

A world-class multiphysics-multiscale software set for light water nuclear reactor simulation



The NURESIM platform is a set of state of the art software devoted to the simulation of normal operation and design basis accidents of light water reactors: BWR, PWR, VVER. This platform currently includes 14 codes covering different physics: neutronics, thermal-hydraulics, fuel thermo-mechanics (see page 2) and relevant scales: local (sub-channel or pin), fuel assembly, core and reactor system. Given their complementary features, the selected codes offer solutions suitable for various situations.



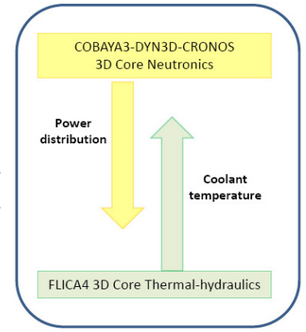
The codes have been extensively benchmarked and validated against experiments during the course of the European NURISP and NURESAFE collaborative projects (2009-2015). The fuel thermo-mechanics capacity of the platform, limited to LOCA in the FP7 NURISP project, is now extended to a large range of accidental transients.

Coupling applications can run simultaneously two or three codes while exchanging data between them for a more accurate simulation of transients.

Up to now, 12 coupling applications have been developed, in particular those involving a sub-channel thermal-hydraulics code and a core simulators in order to run higher-fidelity simulation of accidental transients involving several physics.

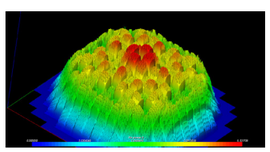
A SALOME platform:

The codes use generic features provided by the SALOME open-source software for pre-processing, post-processing of codes and use of the coupling applications.



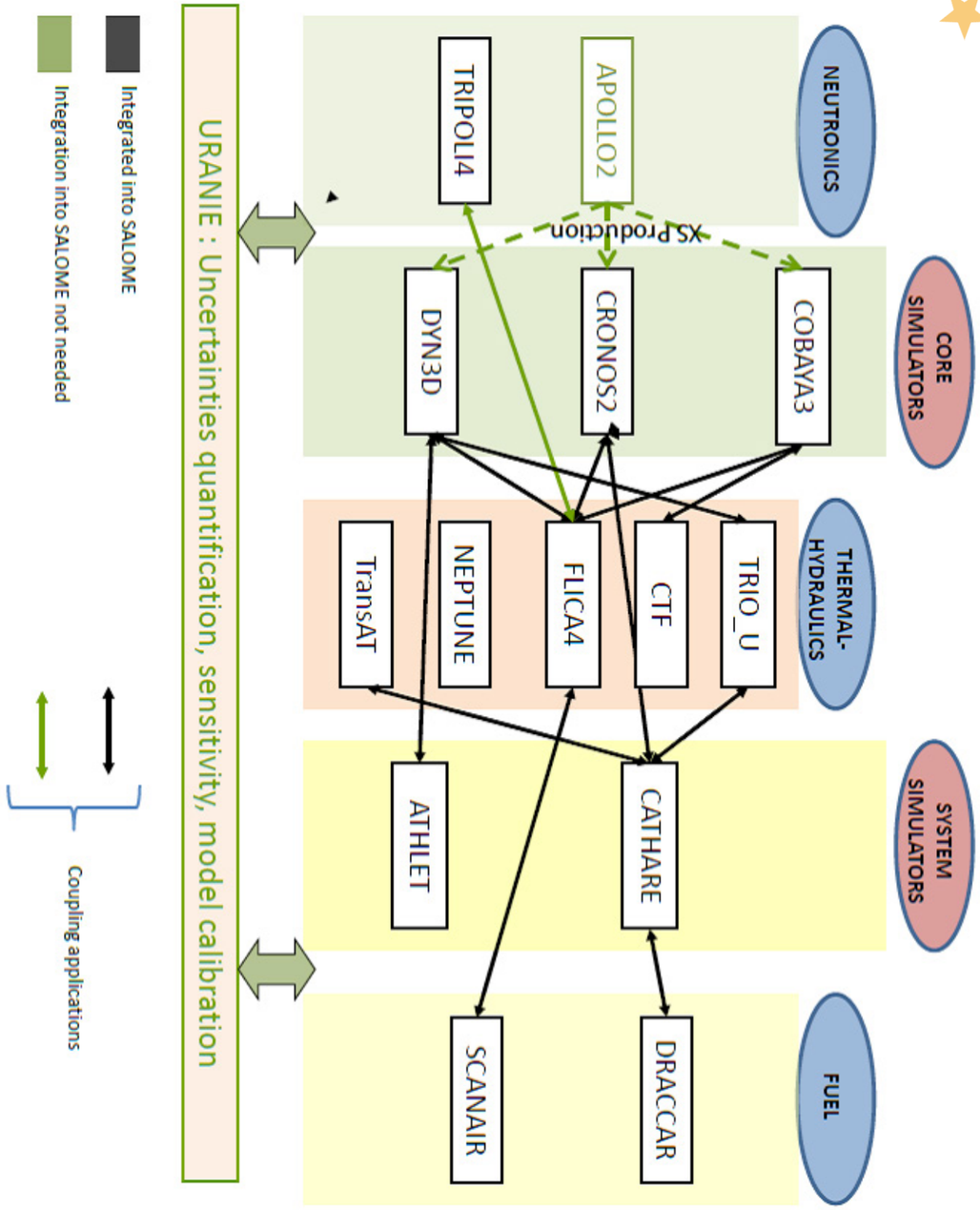
The use of the SALOME standard facilitates the interoperability of software and contributes to reduce the costs.

NURESIM includes a comprehensive capability for uncertainty quantification, sensitivity analysis and model calibration provided by the URANIE open-source software.



URANIE is designed in such a way that it can analyse data provided by all NURESIM codes.

The NURESIM Platform



NURESIM is developed by the NURESAFE European consortium comprising: CEA, EDF, HZDR, GRS, AREVA, KIT, PSI, ASCOMP, KTH, UPISA, ENEA, UPM, UCL, JSI, VTT, LUT, INRNE, UJV, KFKI, ICL, IRSN, LGI, NCJB.

Website: http://www.nuresafe.eu

The NURESIM Software (Status on 30 September 2014)

Website: http://www.nuresafe.eu

To use most of the codes, it is necessary to ask a user license agreement to the owner of the code (or to one of the owners). In principle, licenses are free for use limited to research and development purposes.

Code	Scope	Highlights	How to get the code
Common generic tools			
SALOME	Software that provides a generic platform for pre and post-processing and coupling for numerical simulation	• Open source • Includes CAD (Computer Aided Design) interface *Website:* http://www.salome-platform.org/	Open-source software, can be downloaded from the website
URANIE	Software that provides a generic platform for uncertainties analysis for numerical simulation	Based on ROOT software developed by CERN for large database numerical processing *Website*: http://sourceforge.net/projects/uranie/	Open-source software, can be downloaded from the website
Reactor system simulators			
CATHARE	Analysis of the whole spectrum of leaks and transients in PWRs and BWRs	• CATHARE2 with 2-fluid model: Extensive validation for PWR • CATHARE-3: R&D version with • multi-field, Transport of Interfacial area and turbulence modeling capabilities in 0D, 1D and 3D *Website:* http://www-cathare.cea.fr/scripts/home/publigen/content/templates/show.asp?L=EN&P=134	Ask CEA for a User License agreement
ATHLET	Analysis of the whole spectrum of leaks and transients in PWRs and BWRs	Validation for PWR & BWR *Website:* http://www.grs.de/en/computer-code-athlet	Ask GRS for a User License agreement http://www.grs.de
Core simulators			
COBAYA3	PWR and BWR Core simulation inc. neutronics and a simplified thermal-hydraulics model, for normal operation and transients	• 2D, 3D, cartesian, hexagonal geometries • Multigroup diffusion with IDF (Interface Discontinuity Factors) • Pin-by-pin & nodal solvers • Domain decomposition, Parallelization • Steady state and transient problems • Specific simplified thermal-hydraulics capacity	Ask UPM for a User License agreement
DYN3D	PWR and BWR Core simulation inc. neutronics and a simplified thermal-hydraulics model, for normal operation and transients	• 3D cartesian, hexagonal, triagonal geometries • Multigroup solvers: Diffusion and SP3 • Pin power reconstruction • Steady state and transient problems • Specific simplified thermal-hydraulics capacity	Ask HZDR for a User License agreement
CRONOS	PWR and BWR Core simulation inc. neutronics and a simplified thermal-hydraulics model, for normal operation and transients	• 1D, 2D, 3D, cartesian, cylindrical, hexagonal geometries • Multigroup Solvers: Finite differences, Pn and Sn Transport • Static and kinetic calculations • Burnup simulation nuclide by nuclide • Specific simplified thermal-hydraulics capacity	Ask CEA for a User License agreement

Code	Scope	Highlights	How to get the code
Neutronics			
APOLLO2	• Lattice code for PWR and BWR: cross-section generation for core-simulators • Reference deterministic simulations	• 2D spectral and core code • Multigroup and Multiparameter XS's generation • MOC solvers, collision probability solvers	Ask CEA for a User License agreement
TRIPOLI4	Monte-Carlo code applicable for core physics, criticality and shielding studies	• Monte Carlo method to simulate neutron and photon behaviour in three-dimensional geometries • Static and kinetic calculations	Code can be downloaded from the OECD NEA website, under a standard license agreement
Thermal-hydraulics			
NEPTUNE_CFD	CFD 2-phase thermal-hydraulics code	• 2-fluid & multi-fluid 2-phase CFD (Computational Fluid Dynamics) • Models for boiling bubbly flow and for free surface flow • Developments on-going for all flow regimes	Ask EDF for a User License agreement
TRIO_U	• Single-phase CFD • Two-phase pseudo-DNS	• Single phase CFD (RANS & LES) • 2-phase pseudo DNS with Interface Tracking Method	Ask CEA for a User License agreement
TransAT	• Single-phase CFD • Multiphase CFD & CMFD	• Phase average N-phase model • Interface Tracking • Phase change heat transfer • Lagrangian droplet tracking (2 way) • Compressible multiphase flow	Ask ASCOMP for a User License agreement
FLICA	Sub-channel core thermal-hydraulics	Two phase TH simulation for BWR and PWR	Ask CEA for a User License agreement
COBRA-TF (CTF)	Multipurpose subchannel thermal-hydraulics	Two-phase, three field equations models, flexible geometry definition for PWR and BWR applications, improved numerical solvers, parallelisation, vertical and horizontal flow regimes, RPV and core thermal hydraulics, up-flow and reverse flow, boron tracking models, etc.	Ask Penn State University for a User License agreement
Fuel-Thermomechanics			
DRACCAR	• Fuel behaviour during LOCA • Spent fuel pool LOCA	• 3D thermomecanics modeling from a single rod to a full core. • Modeling of fuel rods ballooning, contact between rods, fuel relocations, cladding oxidation under steam and air conditions,hydriring, impact on flow and fuel cooling and integrity	Ask IRSN for a User License agreement
SCANAIR	Single Fuel Rod behaviour during RIA	• 2D thermomechanical modelling of a single rod • Specific model for clad behaviour during RIA (including rupture modelling) • Specific thermal-hydraulics and fission gas behavior models	Ask IRSN for a User License agreement