THE NURESIM PROJECT

NURESIM = NUclear REactor SIMulation

OUTLINE

1. **The NURESIM roadmap**
   - ✓ **A single platform**
   - ✓ **Successive European projects**
2. **The NURESIM project**
   - ✓ **Partners**
   - ✓ **Organization**
   - ✓ **Subprojects**

www.nuresim.com
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The NURESIM roadmap

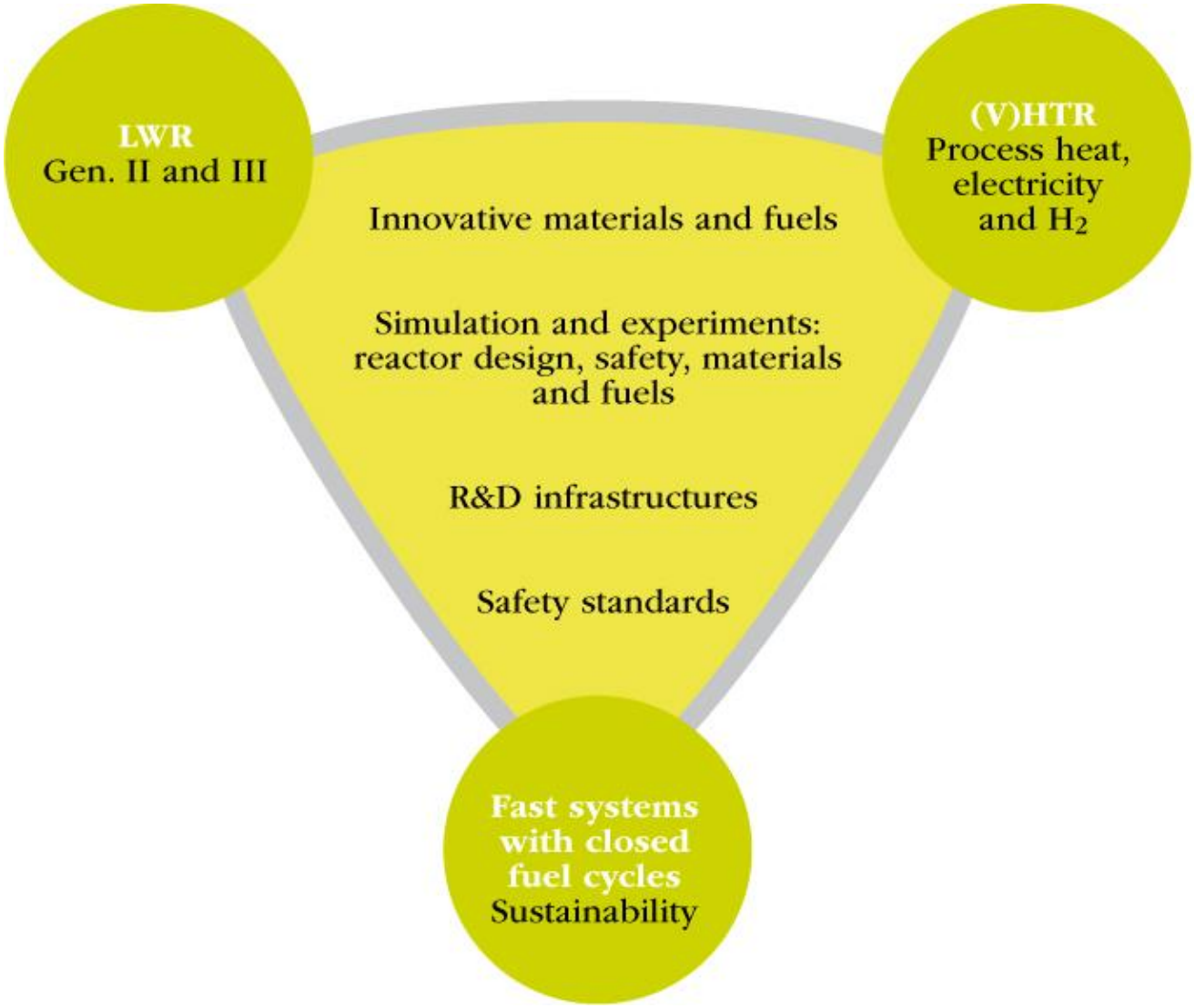
CONTEXT

- **SNETP:** Sustainable Nuclear Energy Technology Platform

TARGET

- **Integrated Platform**
  - ✓ Common functions, multiscale, multiphysics, user friendly
- **Reference**
  - ✓ An optimized set of codes, beyond SOA, well validated, with standardization, with capacity to connect external codes
- **European**
  - ✓ A joint European effort, a European product
- **For Simulation of Nuclear Reactors**
  - ✓ Gen-II to Gen-IV, Users' Group with the Industry

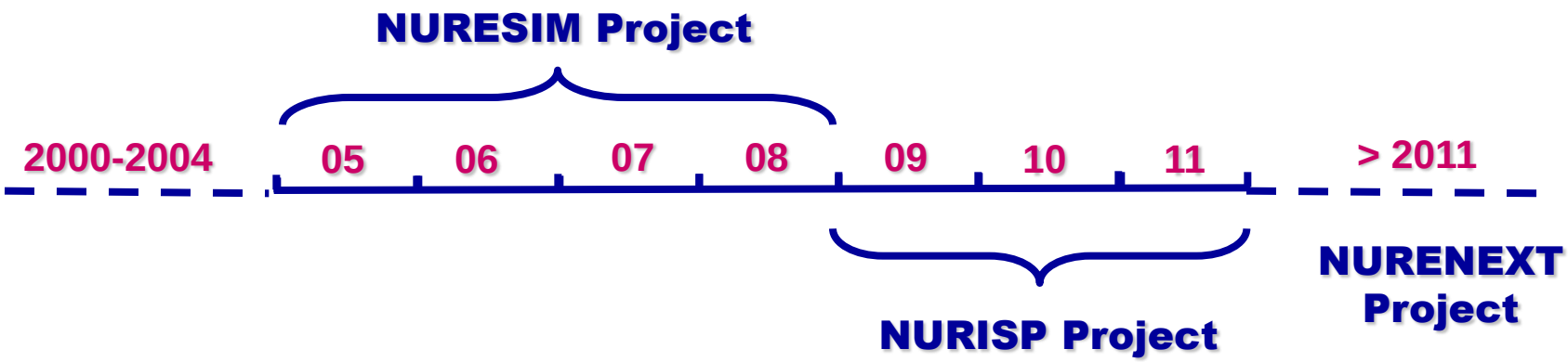
Sustainable Nuclear Energy Technology Platform



The NURESIM roadmap

- **2000 – 2004: Genesis**
  - ✓ 2000 – 2002: EUROFASTNET
    → 44 industrial needs for T/H R&D
  - ✓ 2001 – 2004: genesis of NURESIM
    (an integrated approach)

NURESIM: a single platform



- **NURESIM Project: basis towards the target with first significant possibilities**
- **NURISP: consolidation + extension**
- **NURENEXT: confirmation + rationalization + further extension**

The objectives for the NURESIM project are:

- To build a united team of top international level experts gathered within a single project where barriers are broken down
- To integrate a first set of codes into the NURESIM platform and get experience feedback for the definition of integration standards
- To improve methods and develop advanced models in Core Physics and Thermal-Hydraulics
- To develop generic functions for multiphysics coupling, to make some first demonstrations of their application and to show the potential of the method
- To implement a first set of S&U methods
- To validate the platform through comparison to experiments and benchmarking
- To make significant advances meeting industrial needs

A first step within the NURESIM roadmap

Objectives for NURISP

NUclear Reactor Integrated Simulation Project

- Continuity: a project based on the NURESIM platform and the results of the NURESIM project
- More: accurate physics, multiscale and multiphysics, S&U, integration
- New field: fuel
- Application to LWR (Gen-II and Gen-III): PWR, VVER, BWR
- Links with other European Projects : PRACE

- *Partners : the NURESIM team + 4 new partners*

Detailed objectives of NURISP

- To further integrate the first set of codes into the NURESIM platform, to add new codes (T-H and fuel codes) and to complement the integration standards
- To improve the usability and the consistency of the core physics codes, to define and test well established calculation routes,
- To enlarge the T-H developments to system codes, LOCA and multiscale coupling through the platform
- To put more emphasis on multiphysics and S&U
  - ✓ To add new generic functions for multiphysics coupling, to further test nodal and pin level coupling with different levels of refinement of neutronics and T-H
  - ✓ To test the first set of S&U methods and add new ones
- To further validate the platform through comparison to experimental results and benchmarks
- To make new significant advances for industrial issues

A second step (after NURESIM) within the roadmap

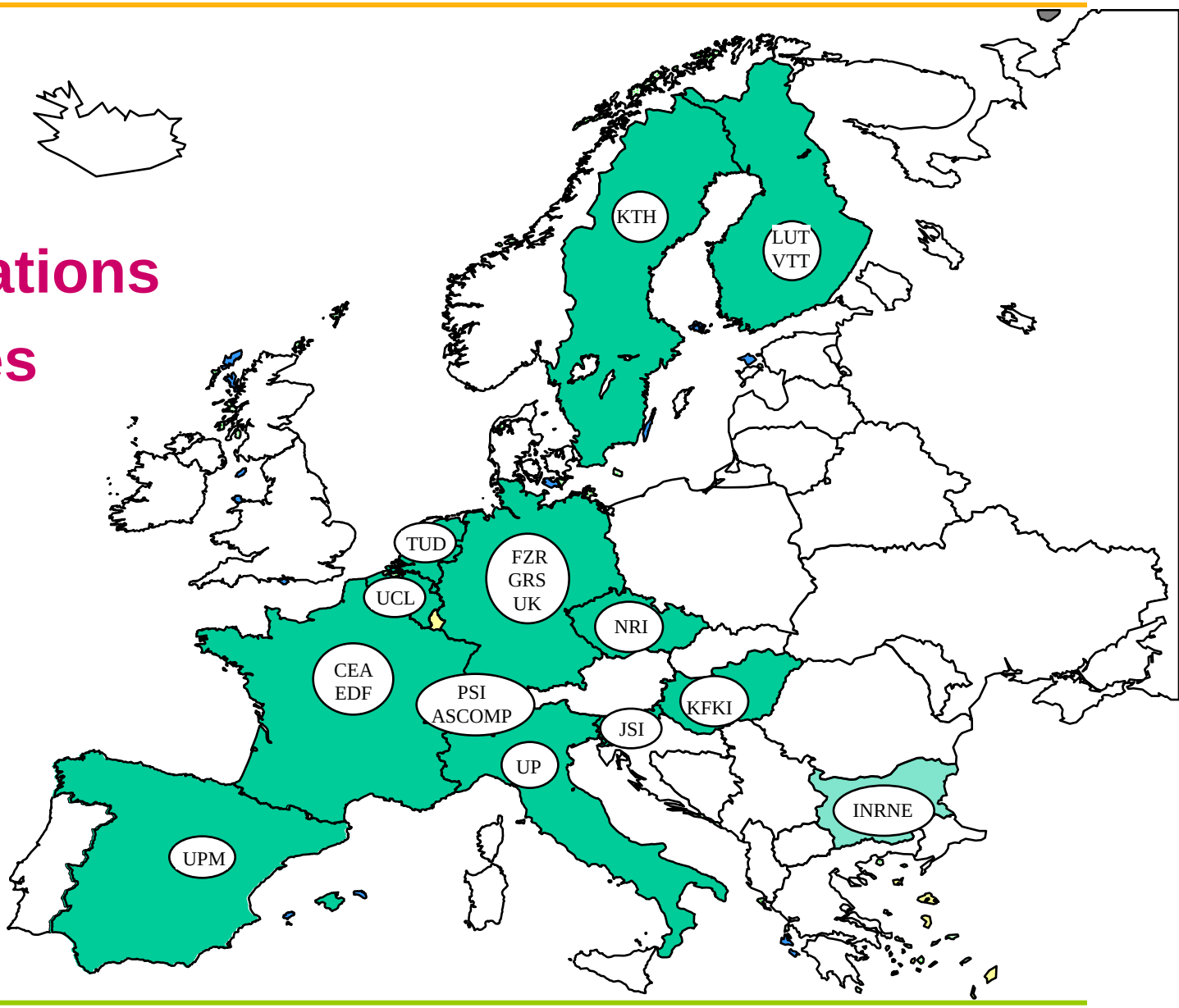
NURENEXT

- NURESIM and NURESP are mainly focussed on Gen-II and Gen-III, but some of their codes have generic capacities for Gen-IV
- NURENEXT will enlarge the scope specifically to Gen-IV, consistently with the beginning of the detailed design of Gen-IV reactors after 2012
- Through interaction with the Users' Group, previous developments will be made more robust and the validation will be further improved
- New disciplines such as structural mechanics will be added to the platform
- The platform will converge towards an optimum set of codes, but connection of external codes to the platform will be easy

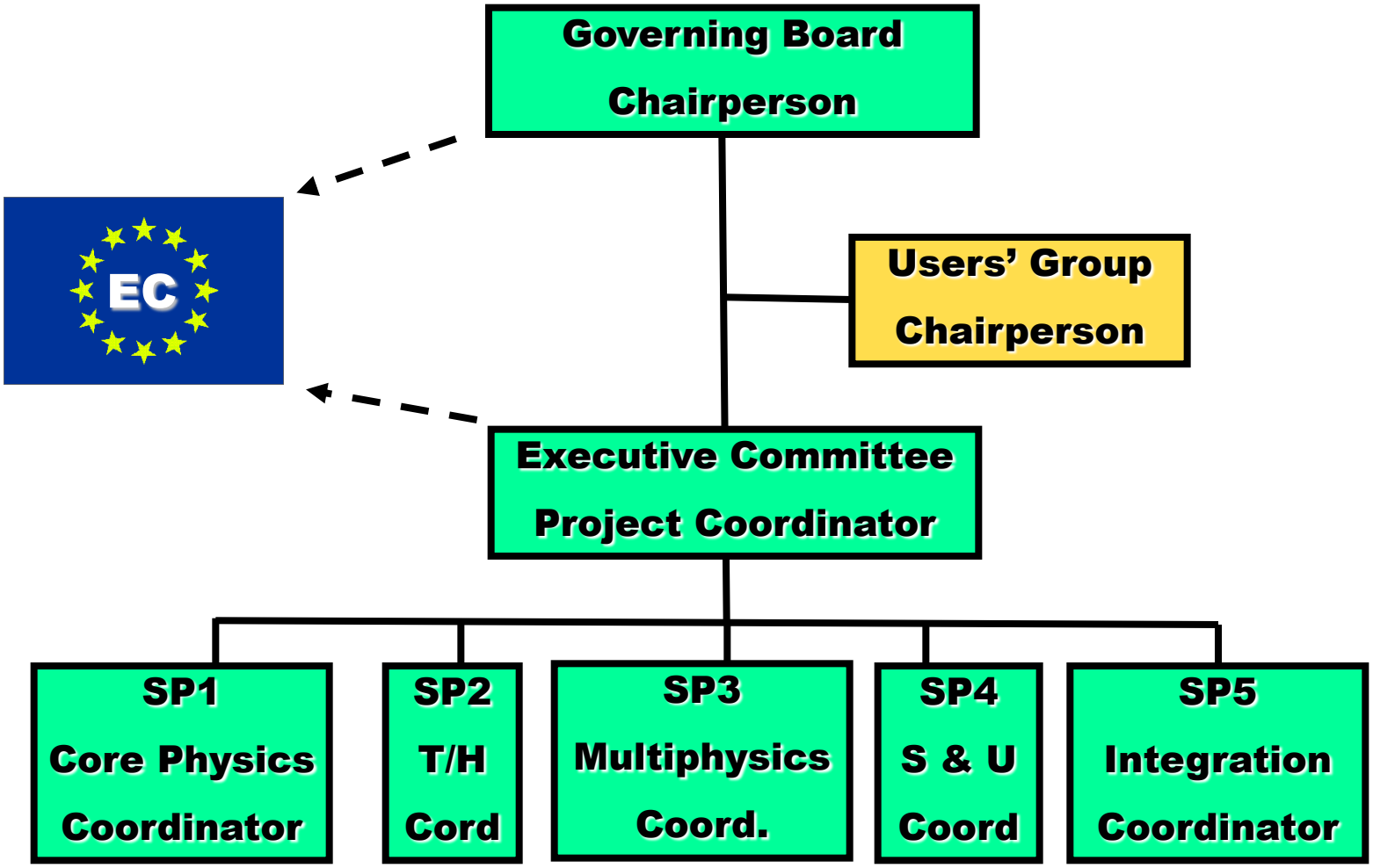
PARTNERS OF THE NURESIM IP

18 Organizations

13 Countries



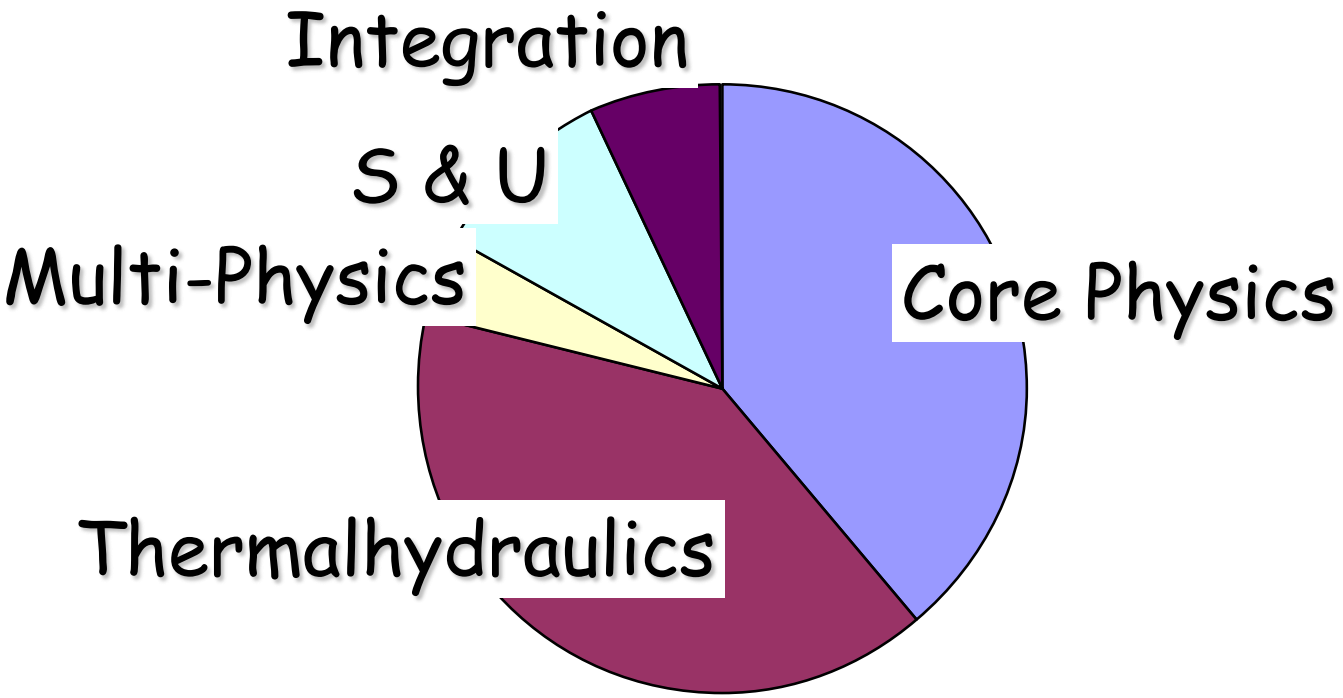
NURESIM ORGANIZATION CHART



NURESIM USERS GROUP (NUG)

- AREVA-NP
- TRACTEBEL Engineering
- FORTUM
- IRSN
- TÜV SÜD
- FZK

NURESIM MANPOWER



Total EC Funding: 4.5 M€
Total Manpower: 73 p*y

Global infrastructure

User environment, management of studies, coupling

SHARED (Open-Source or Partnership)

Correlations, data, closure laws, calculation routes,…

PROPRIETARY

Toolbox of solvers (Neutronics, T/H,…), data

SHARED (Open-Source or Partnership)

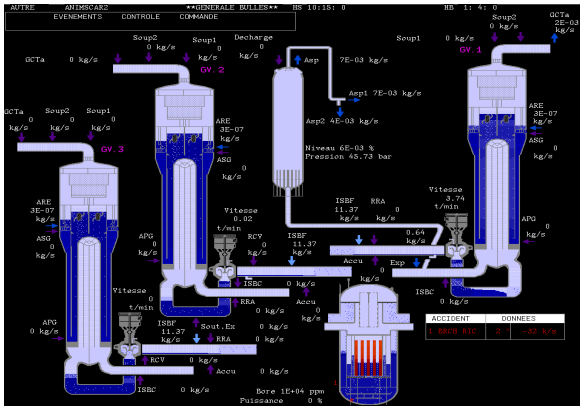
SP1: CORE PHYSICS

- **Two main areas**
  - ✓ Advanced Monte-Carlo Methods
  - ✓ Advanced Deterministic Methods
- **Three main topics**
  - ✓ Integration of the existing codes and modules into the platform
  - ✓ Benchmarks
  - ✓ Improvement of the codes and modules

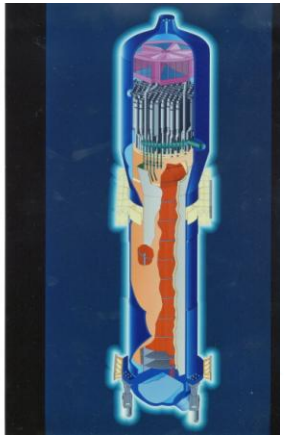
SP2: TWO-PHASE THERMALHYDRAULICS

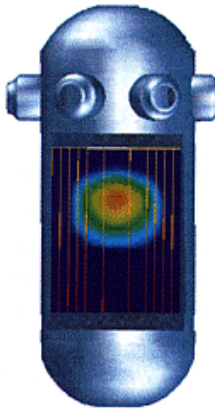
Two main topics:

- **PTS**
- **CHF**

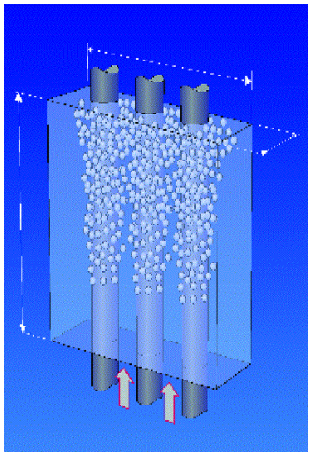


SYSTEM SCALE

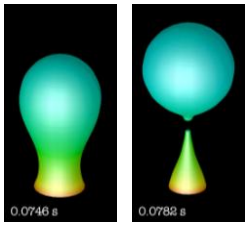




CFD IN POROUS MEDIA



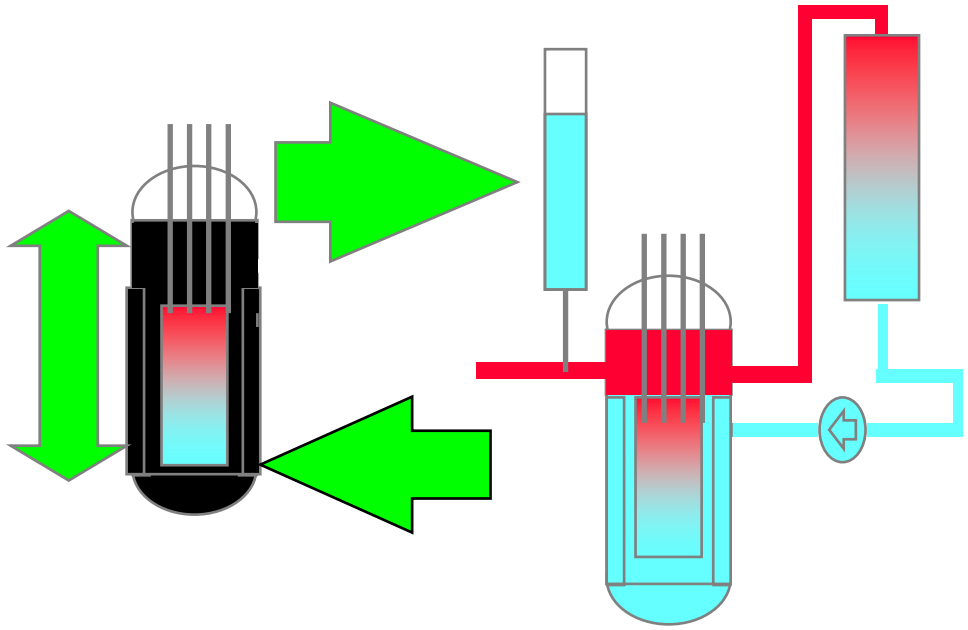
CMFD IN OPEN MEDIA



DNS SCALE

Critical review of experimental data, improvement of models and modules, assessment and benchmarking

SP3: MULTIPHYSICS



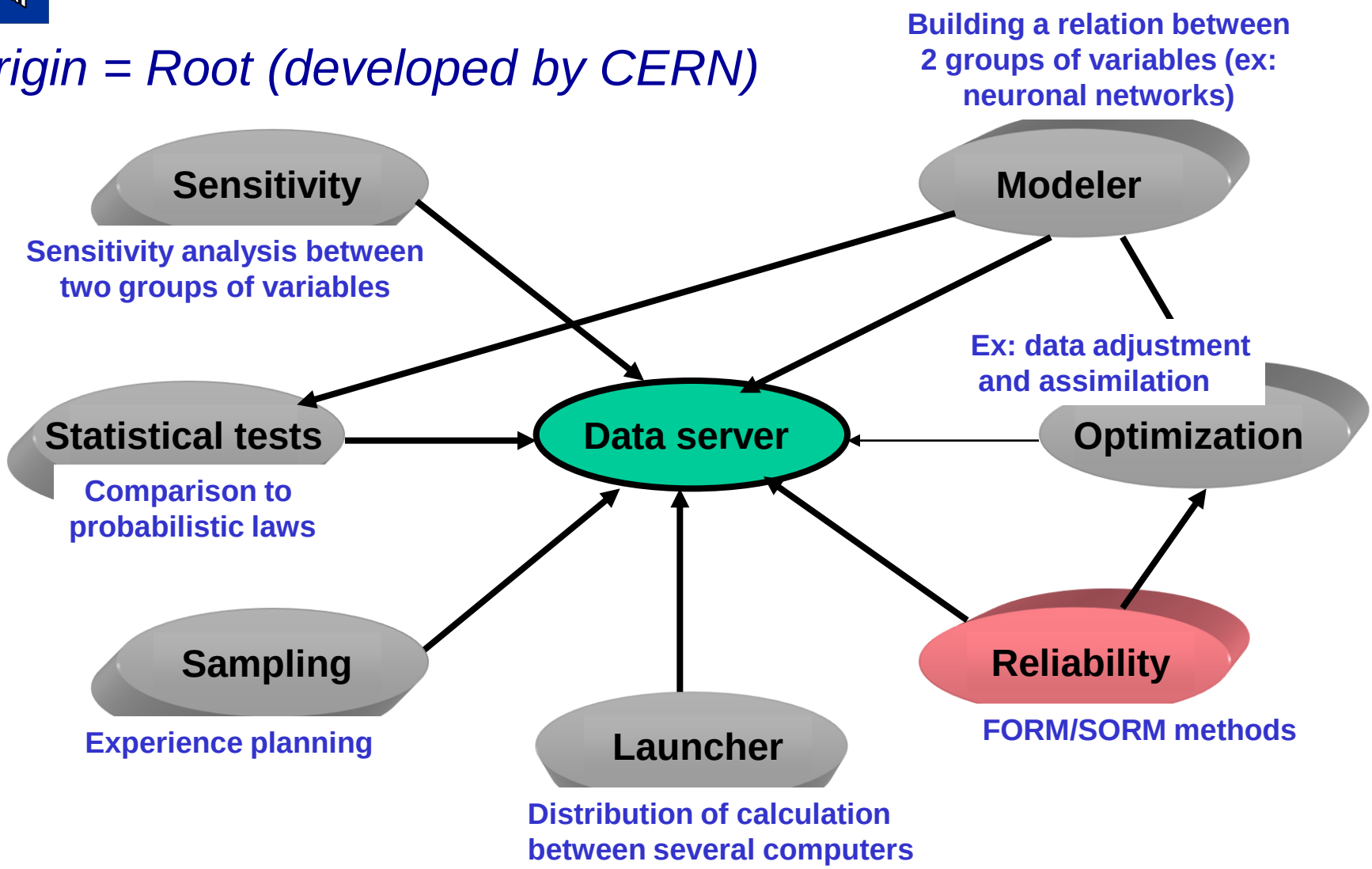
- **Interpolation and averaging schemes and data transfer**
- **Coupling schemes**
  - ✓ At the nodal level (fuel assembly)
  - ✓ At the sub-node level (pin)
- **Application to benchmarks**

SP4: SENSITIVITY AND UNCERTAINTY

- **Deterministic and statistical methods for multiphysics modules**
- **Implementation within the NURESIM platform of procedures for propagation of uncertainties**

The URANIE Platform

Origin = Root (developed by CERN)

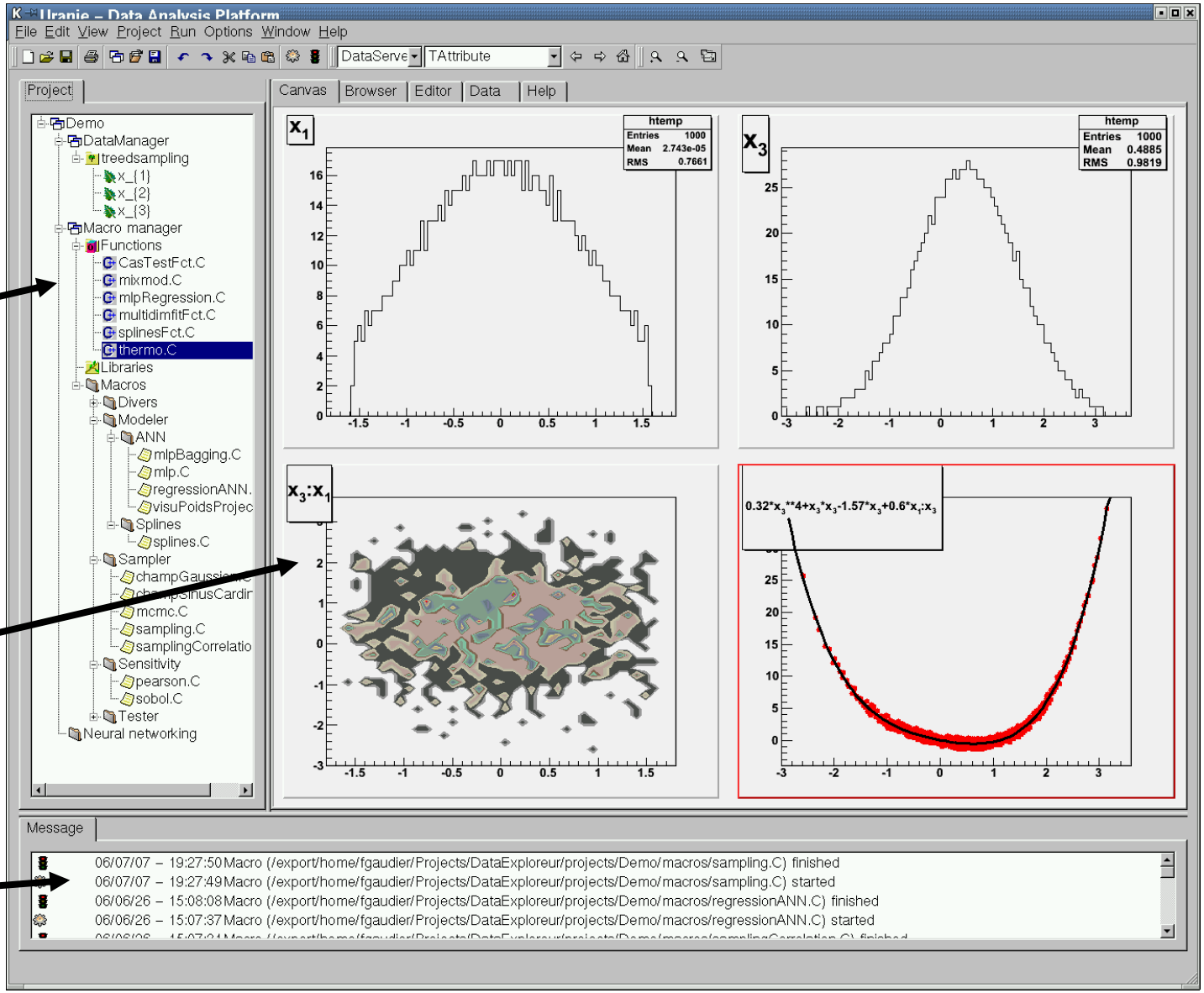


URANIE

Data, functions, models, …

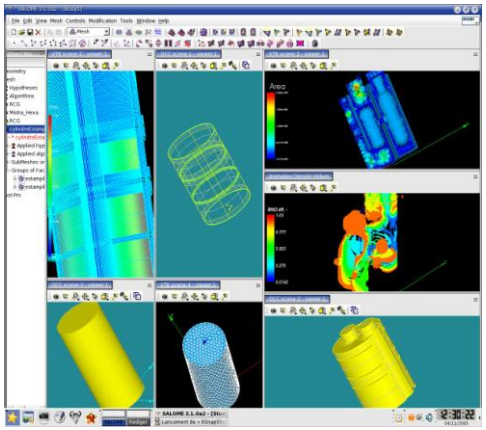
Edition and visualization

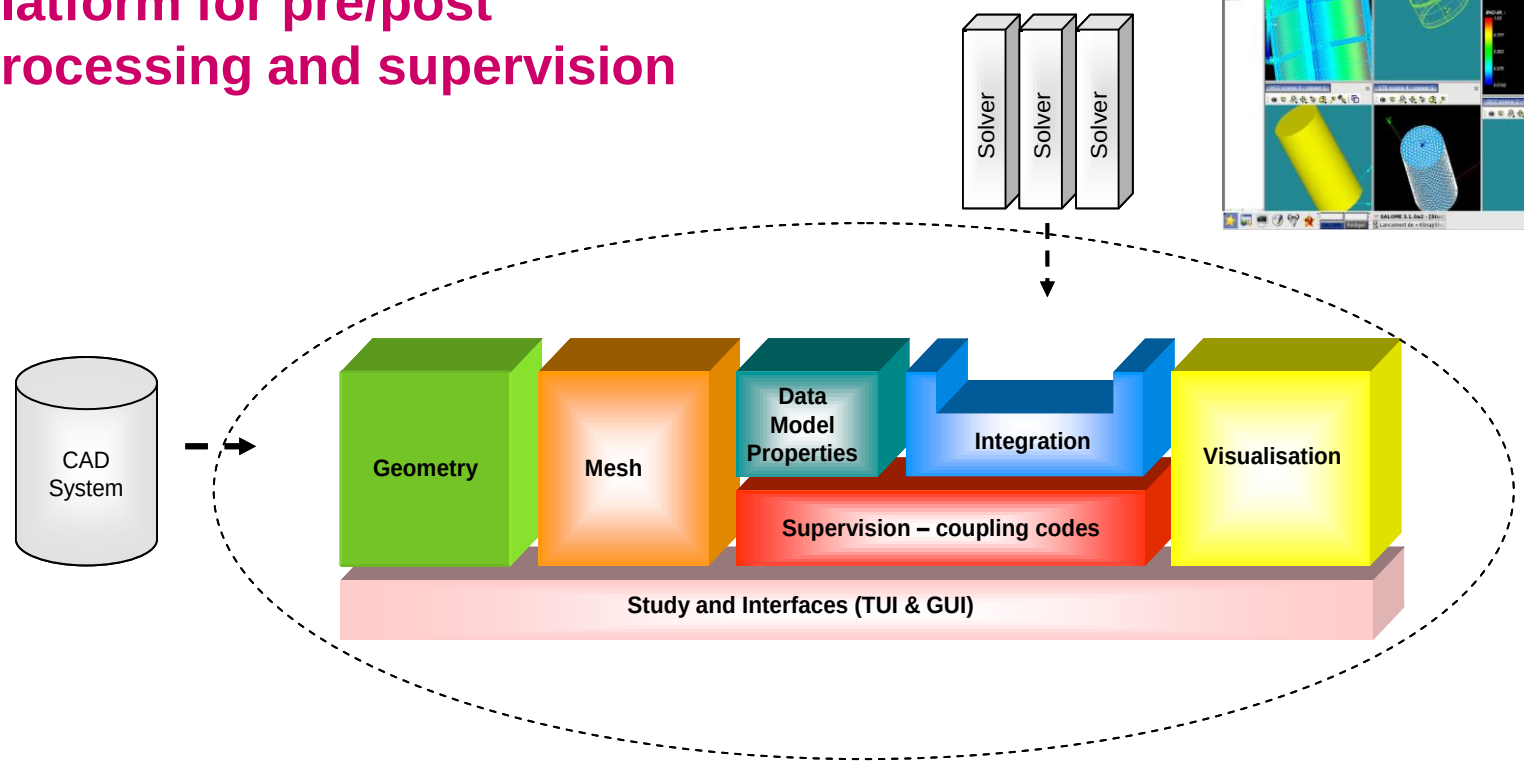
Display of messages



SP5: INTEGRATION

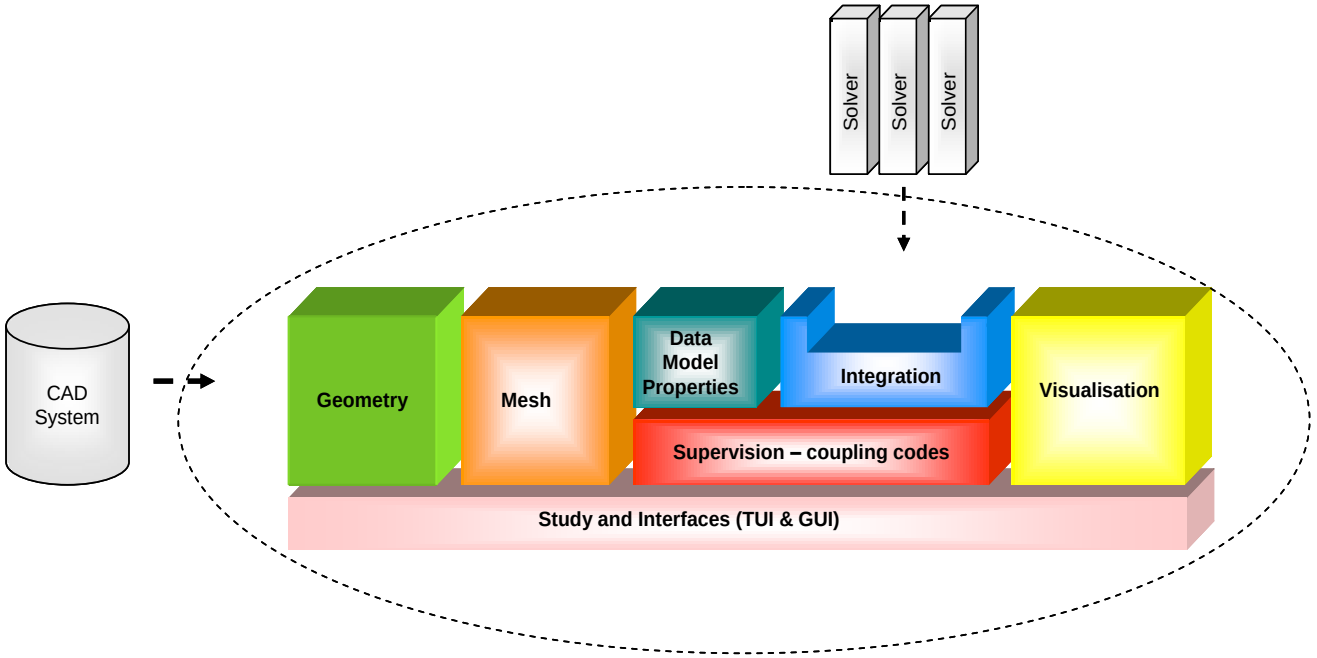
A generic open-source platform for pre/post processing and supervision





http://www.salome-platform.org

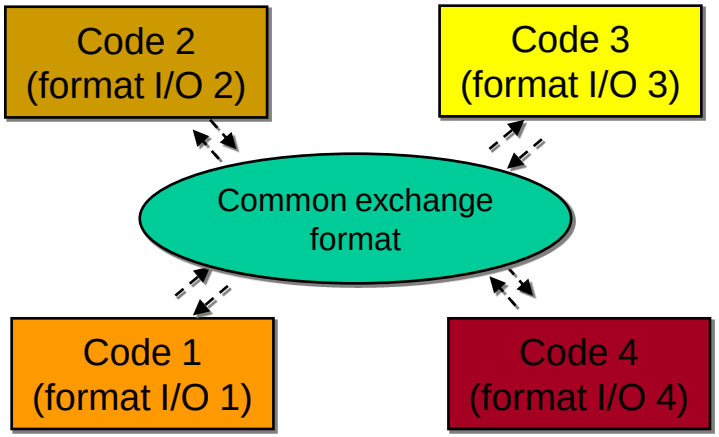
Main Features



- *Import/export of geometries, repairing/cleaning of geometries, creating/modifying*
- *Meshing of the geometric elements, controlling quality, importing/exporting*
- *Handling physical or numerical properties of geometrical elements*
- *Performing a computing step using a solver: input of data, configuration of the solver, output of the result field*
- *Implementing chaining/coupling between solvers*
- *Visualizing/post-processing the results fields*

Main functionalities – Data Exchange Model

Data Exchange Model for mesh & field (MED/DEM)



- A common format to facilitate exchanges between solvers
- all integrated solvers are able to import/export data in a common format
- possibility of sharing high-level services on meshes and fields

- A memory layer with a set of services :
  - Localisation, interpolation, norms of fields, logical operations on field supports, arithmetic operations on fields, geometric measurements, import/export different solver formats … (MEDMemory)
  - classes to make easier distributed computations – optimization of interaction of distant objects within the local solver (MEDClient)
- A file layer for persistency of meshes and fields (use of the portable HDF Library)

THANK YOU FOR YOUR ATTENTION!