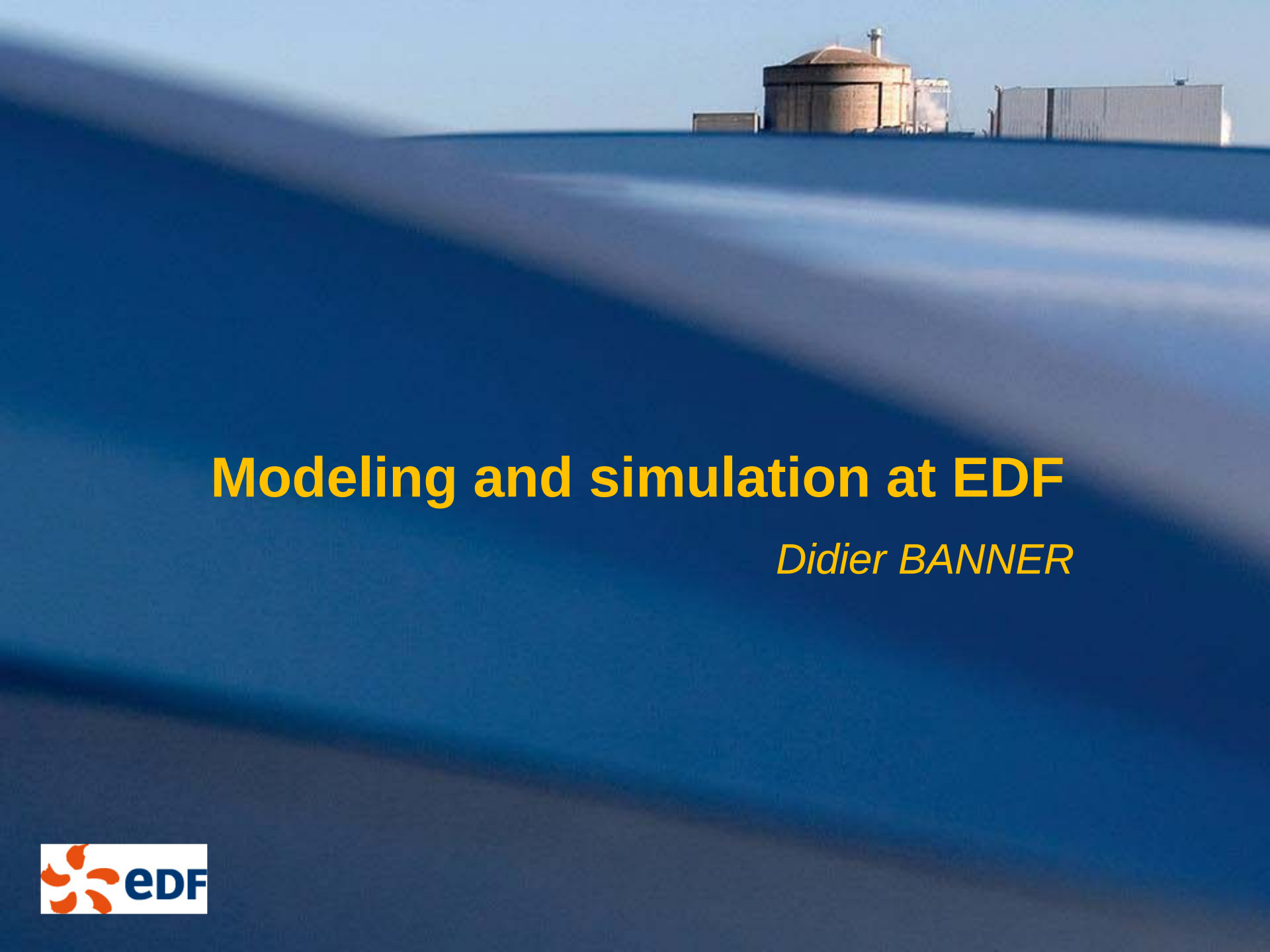


Modeling and simulation at EDF

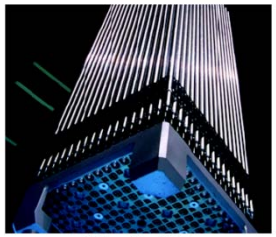
Didier BANNER

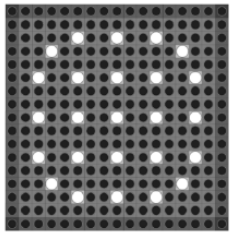
Modelling and simulation - what for ?

- **Justifying installations**
  - Identification of **new safety margin** ie. thermal shock on vessel
  - Evolution of regulations and rules
  - Analysis of accidental situations non reproducible by experiments
    - i.e, severe accidents, fire propagation, geological disposal
- **Understanding physics or system response**
  - **Ageing** of materials and installations i.e loads,
  - Addressing the issue of uncertainties and identifying the prominent parameters
- **Qualifying and optimizing processes**
  - NDT methods
  - **Optimizing** equipment i.e combustion, cooling systems

The need for a complete chain of skills and tools

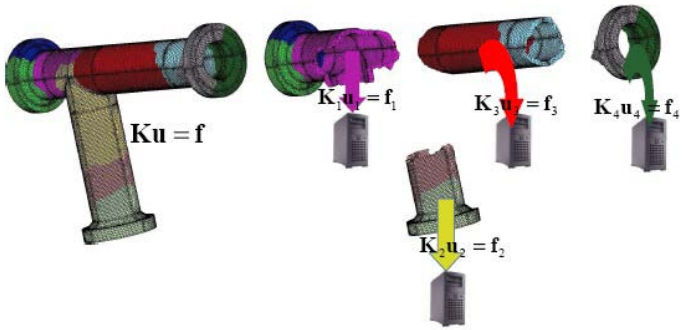
1- Modelling :
from physics to equations
Navier-Stokes


(b) Assemblage MOX

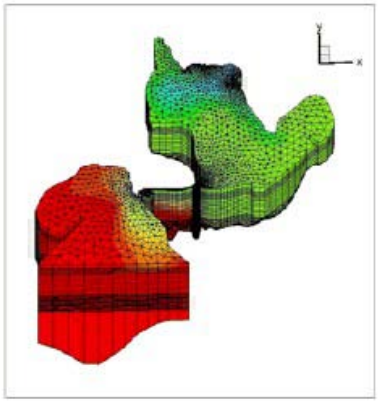


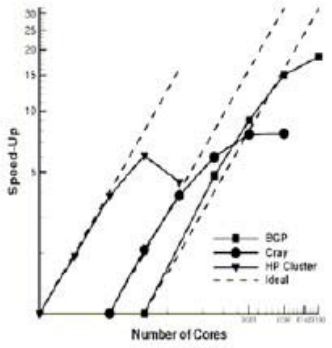
$$\frac{1}{v}\frac{\partial\phi(\vec{r},\vec{\Omega},E,t)}{\partial t} = -\left[\vec{\Omega}\cdot\vec{\nabla}+\Sigma(\vec{r},E)\right]\phi(\vec{r},\vec{\Omega},E,t)+$$
$$\frac{\chi(\vec{r},E)}{4\pi}\int dE'\,\nu\Sigma_f(\vec{r},E')\int d^2\Omega'\,\phi(\vec{r},\vec{\Omega}',E',t)+$$
$$\int dE'\int d^2\Omega'\,\Sigma_s(\vec{r},\vec{\Omega}'\leftarrow\vec{\Omega},E\leftarrow E')\phi(\vec{r},\vec{\Omega}',E')+Q_e(\vec{r},\vec{\Omega},E,t)$$

2- Analysing and coding :
from equations to algorithms and codes
Solvers



3- Adaptation to computers architectures for HPC
Code_Saturn, massively parallel

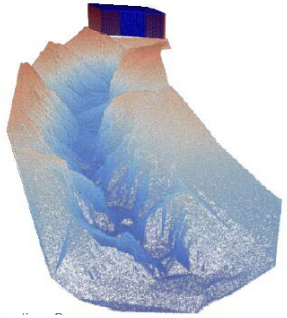


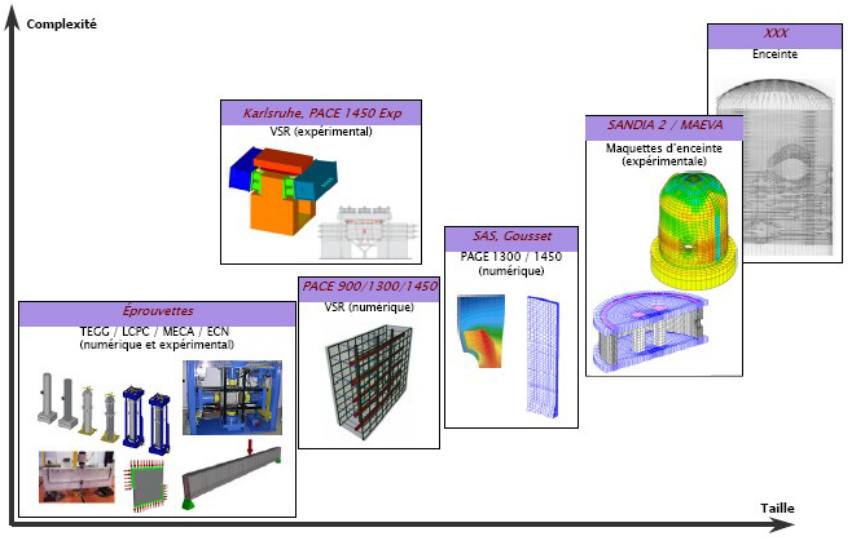


Chemistry-hydraulics of Berre Lagoon

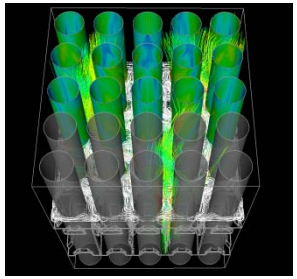
The need for a complete chain of skills and tools

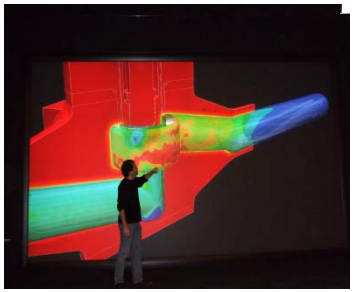
4- Validating and identifying :
on benchmarks and experimental campaigns, determination of physical parameters V& V requirements





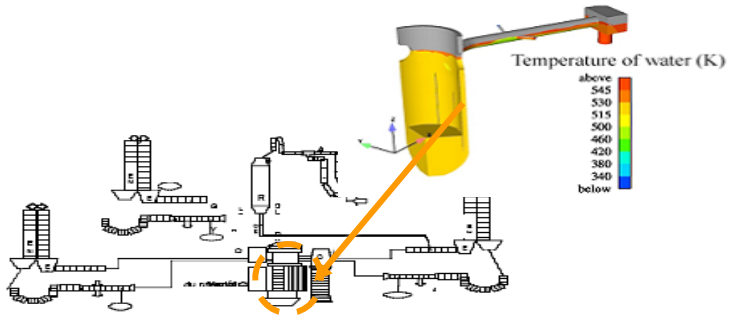
5-Pre and post processing :
Meshing, visualisation, error computation and mesh adaptation

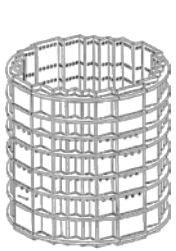


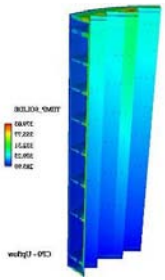


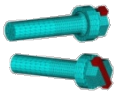
The need for a complete chain of skills and tools

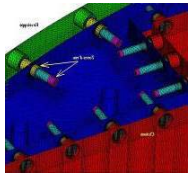
6- Building of methodologies :
probabilistic approach, coupled physics, multiscale analysis, best estimate analysis, data assimilation (SALOME)

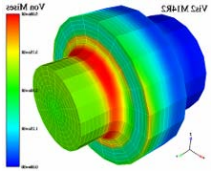


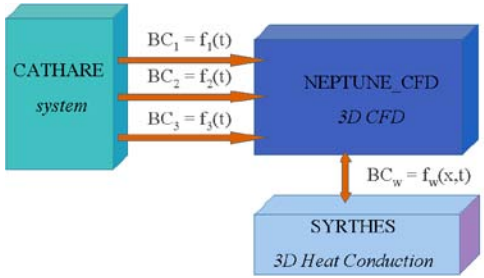




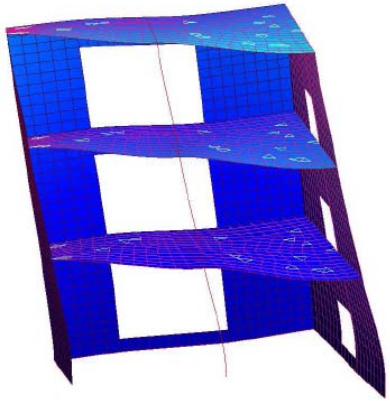








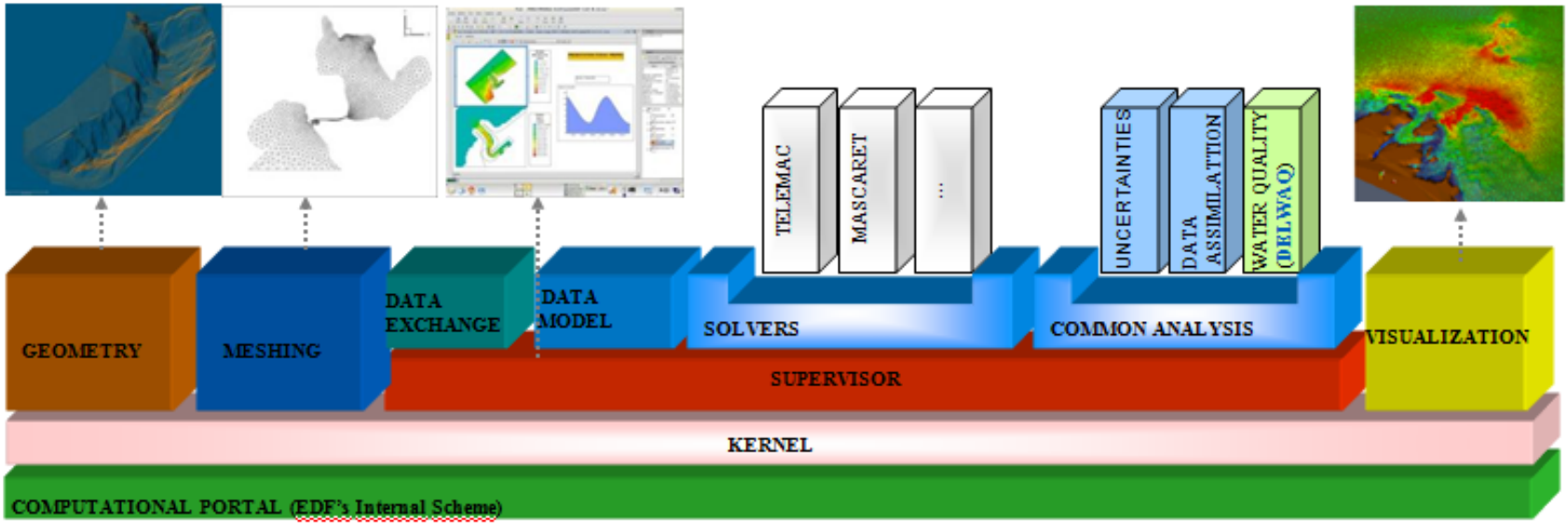
7- Qualifying :
determination of validity domains of methodology in real life applications



CFD – Code_Saturne – Main Priorities

- **Verification and Validation, Uncertainty Quantification**
  - According to Int'l and EDF rules
- **Interoperability – towards a fully packaged product**
  - Salome Platform
- **Improved physics**
  - Heat transfer
- **Anticipation**
  - Assessment of advanced CFD methods
  - Next Generation of Nuclear T/H (reactor cores, SGs, ...)

THE SALOME MODELLING ENVIRONNEMENT



SALOME

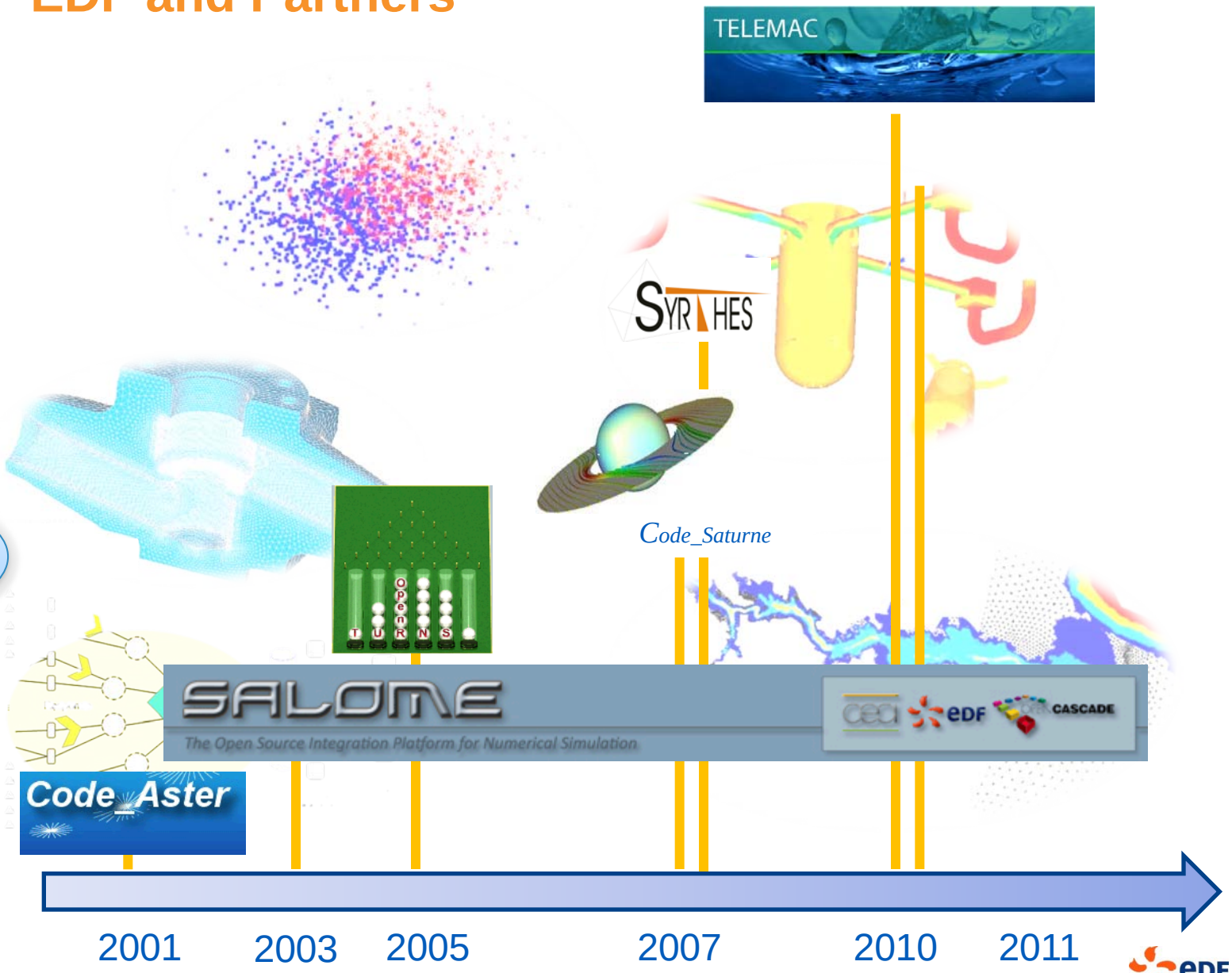
The open source way for in-house developed codes and systems

Code_Saturne, Code_Aster , Telemac, Open-Turns, Salomé

- **Improving the codes :**
  - By validation, bug detection,
  - Extension of validity domain or to new simulation domains
- **Sharing development effort**
  - Development induced in the community
  - Open codes can be coupled with other ones in multiphysics or multi purposes platforms
  - Sharing validation effort
- **Facilitating collaboration**
  - With academia (no licence, capitalisation tool, .)
  - With industrial partners (interaction with others codes,
- **Facilitating dissemination acceptance of methods**
- **Support to education**
  - For students and initial formation
  - Building a community of end-users

Open Source dissemination of softwares of EDF and Partners

- Free surface Hydraulics
- Simulation
- Heat Transfer
- CFD
- Uncertainties & probabilistic methods
- Simulation Plate-form
- Thermo-Mechanics for structures



Thanks for your attention