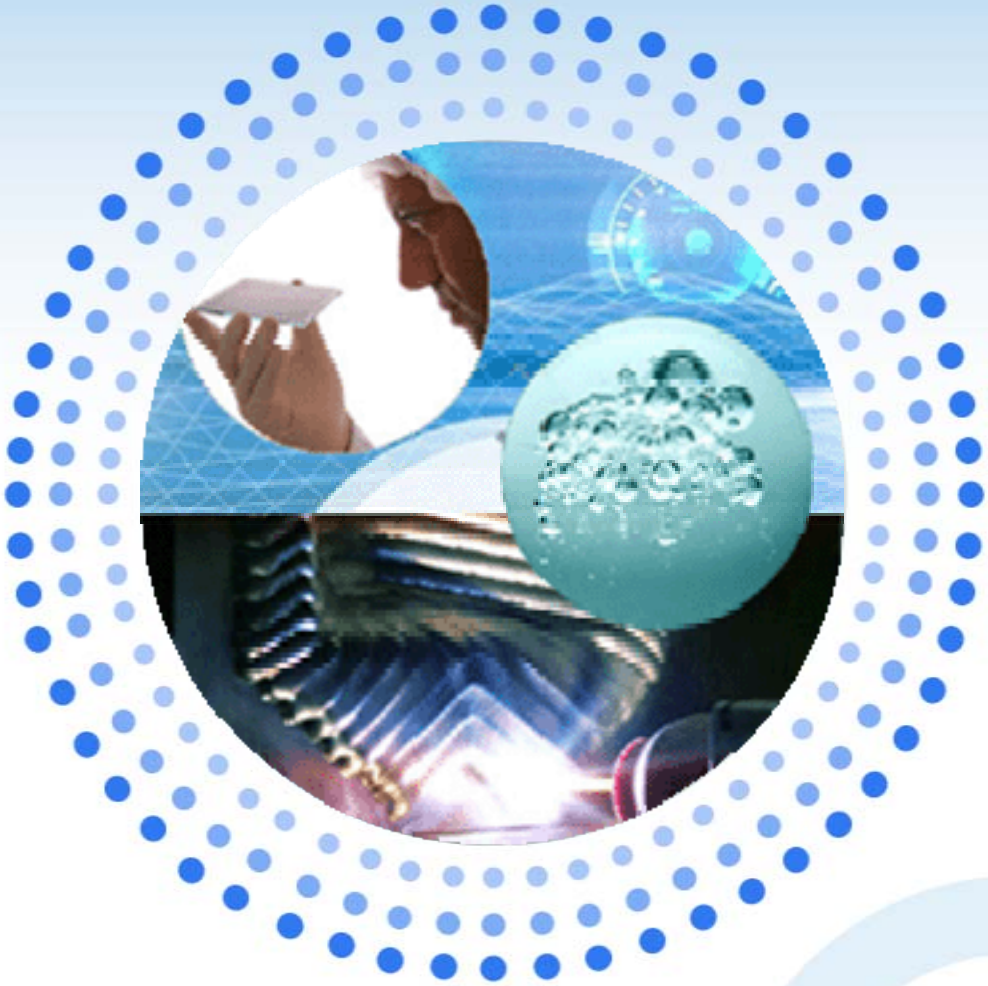


Code_Saturne: latest news and prospects

Code_Saturne development team

EDF R&D

Code_Saturne practical information

- Distribution of *Code_Saturne*
  - Under GPL license (LGPL for BFT and FVM libraries)
  - New website url: http://www.code-saturne.org/
  - Downloadable versions (released end of November):
    - Production version 1.3.3 – validated under EDF quality assurance
    - Development version 1.4.0 – beta version, partially tested
  - **Open-source release of SYRTHES** for transient thermal simulation in solid
    - Downloadable at http://rd.edf.com/syrthes/
  - **Source CD available at the *Code_Saturne* user meeting**

- Contact and support around *Code_Saturne*
  - Contact and support address: saturne-support@edf.fr
  - For specific information on SYRTHES, please contact syrthes-support@edf.fr
  - Forum and bug-tracker still under construction, but available soon!
  - Annual user club meeting in Chatou
  - Initial training sessions in March and November in Chatou

Code_Saturne general information

- *Code_Saturne* « gold award » in Computational Fluid Dynamics
  - UK HPCx supercomputer, located at Daresbury Laboratory
  - *Code_Saturne* was 1.82x faster on 1024 processors than on 512 processors (a factor 1.7 was required to obtain a gold award)

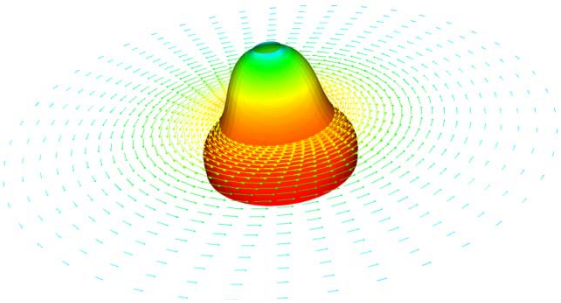
  - For more information:
    - http://www.hpcx.ac.uk/support/documentation/capability.html/
  - See also talk of C. Moulinec, from Daresbury Labs

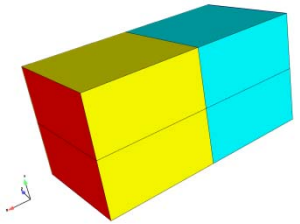
Latest production version

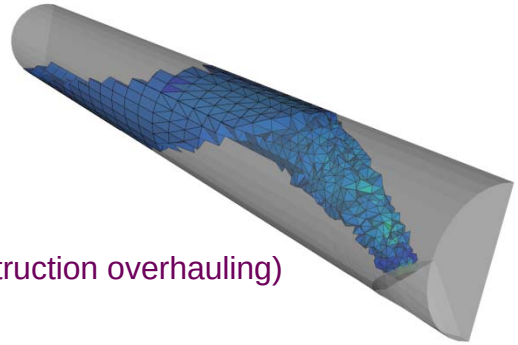
Code_Saturne version 1.3

Code_Saturne version 1.3

- Fully validated under EDF's Quality Assurance!
  - July – October 2007: 1st phase – validation of version 1.3.0
    - 29 test cases
    - more than 200 calculations for first phase (1.3.0)
    - wide range of mesh sizes (4 to 2 000 000 cells) and mesh types
    - wide range of calculation size
    - validation of new features and non-regression tests
    - tests on every available computer architecture
    - tests on every available specific physics
  - November 2007 – March 2008: 2nd phase – validation of corrected version 1.3.1
    - all configurations tested again
    - all cases showing problems with 1.3.0 retested
    - several non-regression cases retested
  - April 2008: release of validated version 1.3.2
    - latest corrections accounted for (mainly due to the halos construction overhauling)





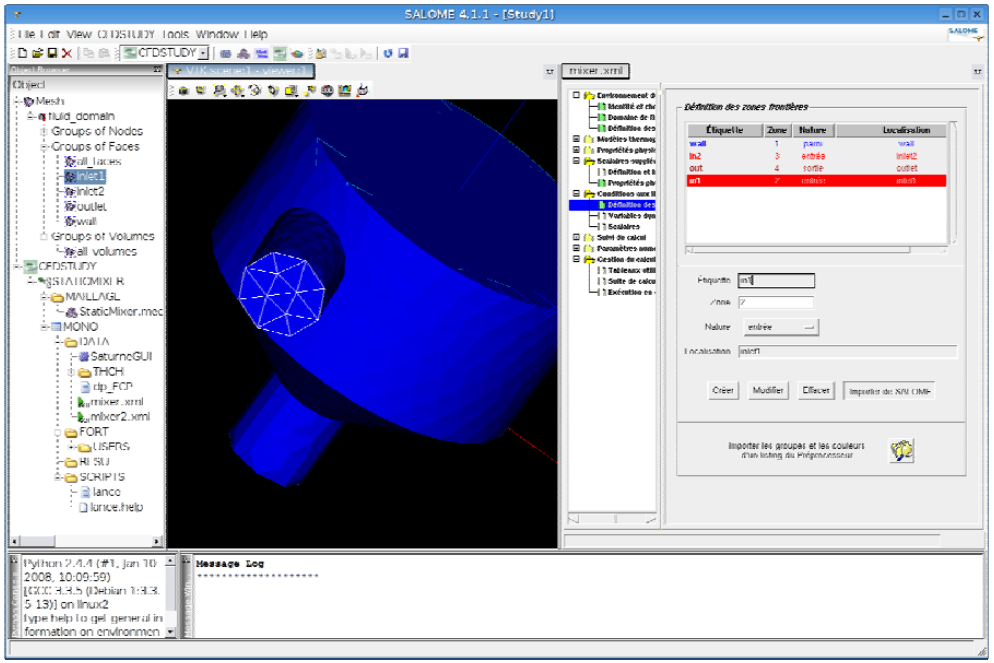


Corrective version 1.3.3

- Corrections:
  - Inconsistent arguments in the heavy fuel combustion module
  - GUI related corrections:
    - Wall roughness
    - Scalar boundary conditions (when exchange coefficient is specified)
    - Specific numerical model parameters for pressure
  - Periodicity related corrections:
    - Rotation handling in the Lagrangian module
    - Improvement in mesh coherency tests
    - Ghost cell treatment for rotation periodicity
  - For details, see the ChangeLog files
- Improvements:
  - Integrated within the SALOME Platform (as of version 4.3.1)
  - Linked with newest BFT and FVM version (resp. 1.0.8 and 0.1.20)
  - Porting to BlueGene/P super-computers
  - Coupling with SYRTHES 3.4.2 (compliant with larger mesh size)
  - Partial English translation of Kernel messages
  - Partial English translation of the theory documentation
  - No more CPU time per iteration sensitivity when post-processing is activated (on HPC systems like the CCRT)

Integrated in the SALOME platform

- In SALOME version 4.1.3
  - Not yet publicly released
  - Available in the MFEE department
    - Type: `/home/salome/runSalome`
- Extends the GUI features
  - Integrated access to *Code_Saturne* GUI
  - Boundary zones selection
  - *Code_Saturne* simulations can be launched and stopped directly from SALOME
  - Virtual results and drafts directory for an easier user files management
- See next talk of A. Douce for a demonstration



Latest development version

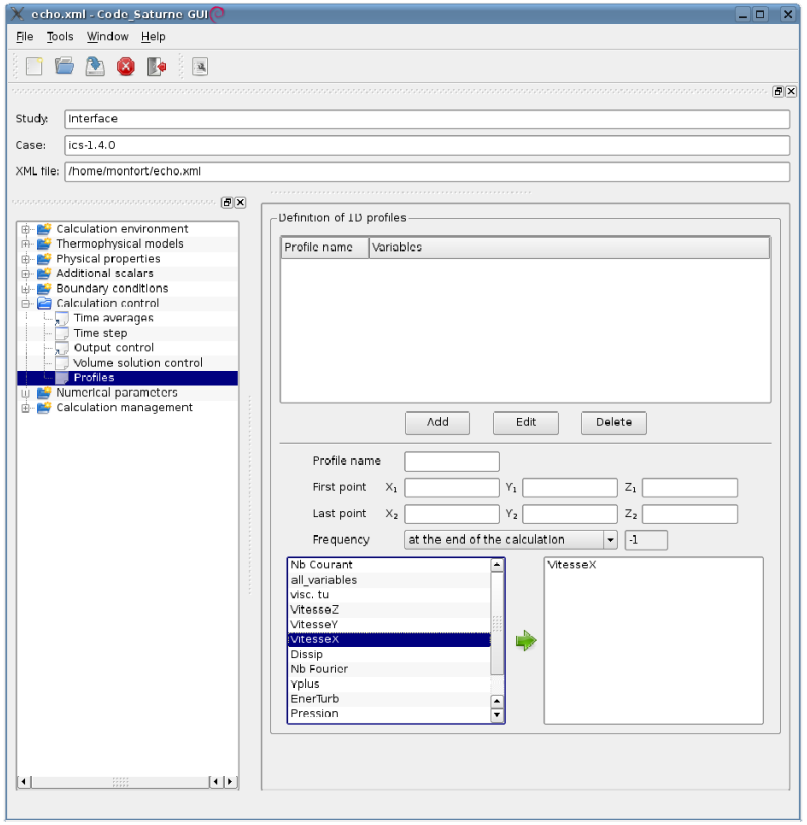
Code_Saturne version 1.4

Code_Saturne version 1.4

- Intermediate release of stable *Code_Saturne* development version 1.4.0
  - Partially tested, but not validated under EDF quality assurance!
  - Will remained accessible until release of next fully validated version
    - To enable new features to be tested
    - To have a better feedback from users
    - To provide test users with the more stable environment
  - Corrective patched versions will be released if needed
- Release of version 1.4.0, end of November 2008, for the User Meeting
  - Make sure to re-generate your studies, some user files being incompatible between versions 1.3 and 1.4, likewise for the XML files!

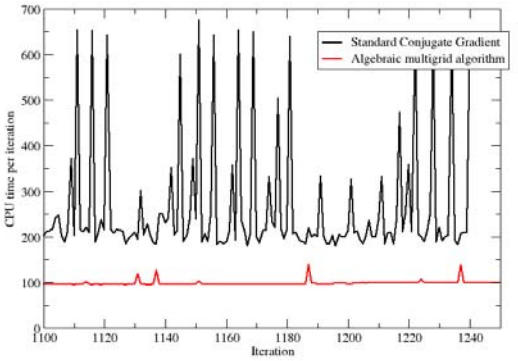
New Graphical User Interface

- Fully re-written in PyQt 4
  - For a better integration in SALOME
  - Natively supported on GNU/Linux, MacOS X and Windows systems
  - Drag'n drop feature for time average and profile definitions
- Unsupported features (yet) within the new Graphical User Interface:
  - Coal combustion
  - Conjugate heat transfer
  - Verification mode a.k.a. « stand-alone preprocessor »
  - Matisse engineering module for nuclear waste storage

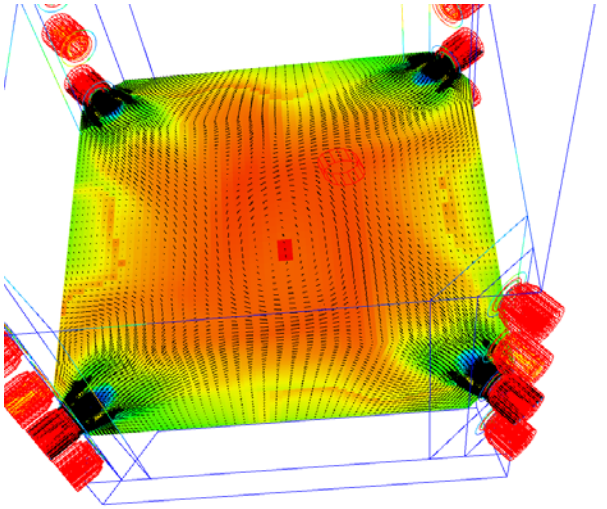


Numerical aspects

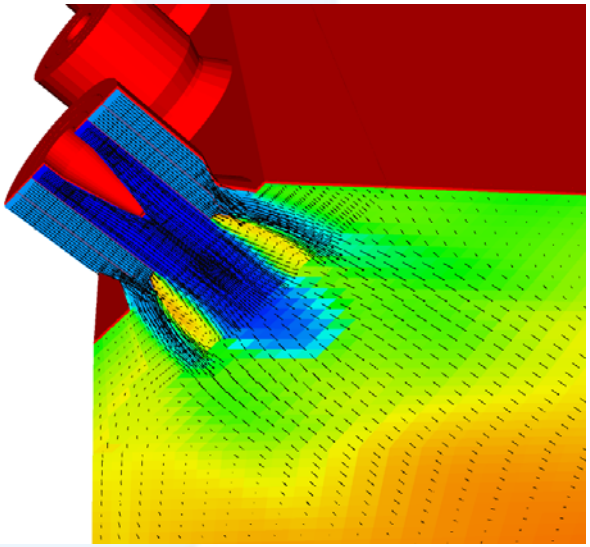
- New algebraic multigrid algorithm for Pressure
  - Compatible with parallelism and periodicity
    - Periodicity of translation and/or rotation are compatible
    - Scalable up to a large number of cells and/or processors
  - May leverage convergence issues on mesh of poor quality
  - Smoother evolution of CPU time per iteration than with standard Conjugate Gradient algorithm
  - Major improvement on the elapsed CPU
    - Up to 10x faster on the pressure resolution
    - Up to 3 or 4x faster on the global elapsed time!



Combustion modeling



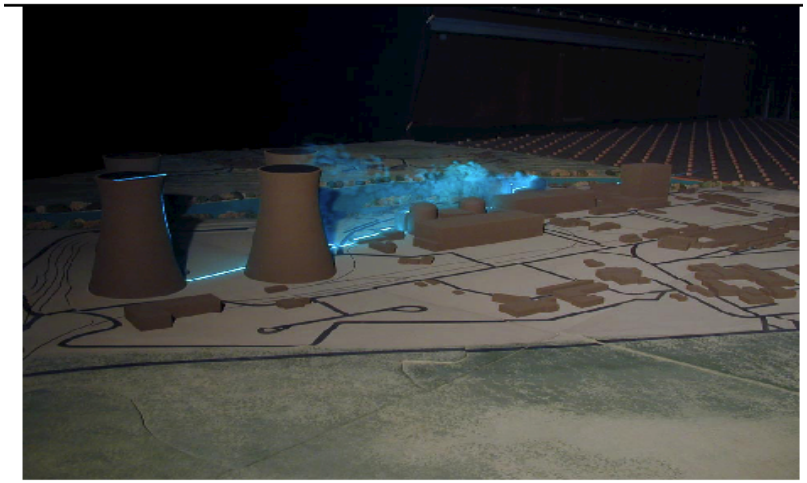
- Accounting for possible oxycombustion in coal combustion
  - See dedicated talk of J. Santamaria
- Extension of the heavy fuel combustion
  - Possibly several initial droplets size
  - Not yet validated



- Coal combustion in Lagrangian formulation is now deprecated
  - Not working since several releases
  - No decision yet on whether it will be reactivated
  - Lagrangian coal particles post-processing still available

Atmospheric flows modeling

- Based on the code *Mercure_Saturne*
  - Step-by-step integration
  - At the moment, only neutral atmosphere modeling is available

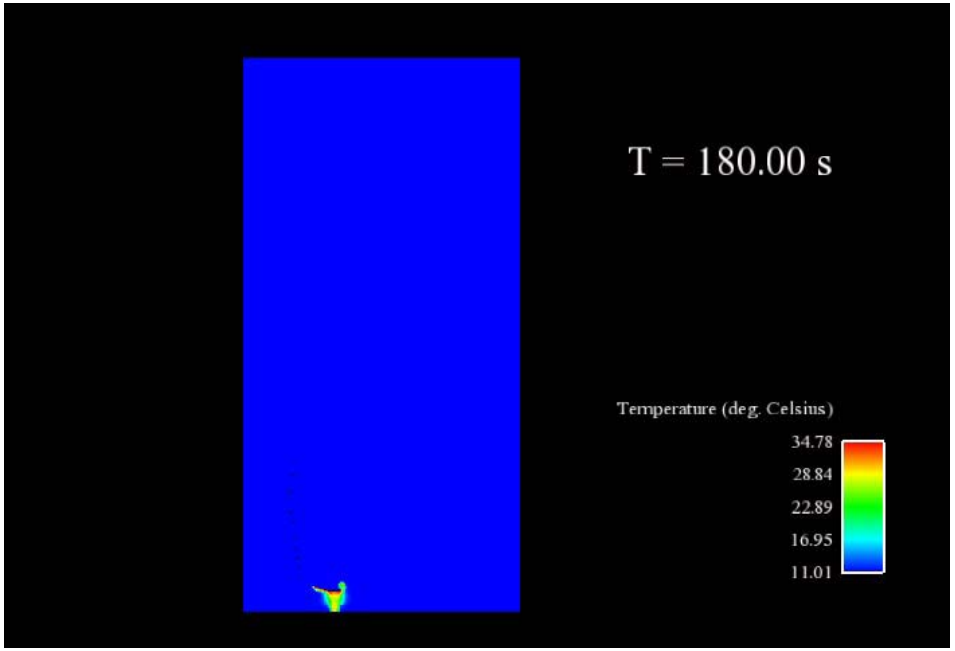


- End-user setup:
  - `METEO_DATA`: meteo files to be given in the `runcase` script
  - `usppmo.F`: choice of the atmospheric modelling feature
  - `usatin.F`: parameters initialization
  - `usatcl.F`: boundary conditions setup
  - `usativ.F`: variables initialization

Cooling tower simulation

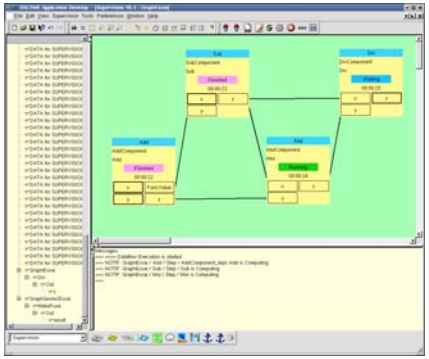
- Based on former *N3S_Aeros*
  - Not fully integrated yet
  - Missing features and some user files
  - Poppe and Merkel models available
  - Post-processing of exchange zones
  - Contact the development team for more information
  - See dedicated talk of F. David and H. Cordier

Saint-Laurent 2D simulation

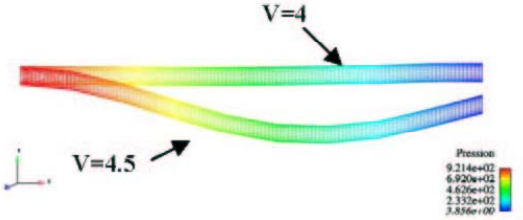


Code coupling features

- *Code_Saturne* / SYRTHES coupling
  - Coupling with version 3.4.2 for larger mesh sizes.
  - Incompatible with former file format: no restarting with a calculation from SYRTHES 3.3 version
  - All codes are open-source (see *Code_Saturne* website)



- *Code_Saturne* / *Code_Aster* coupling
  - External fluid/structure interaction studies
  - Coupling in SALOME platform with YACS module
  - Still under development and validation
  - Final stage of integration in **standard version** of *Code_Saturne*, *Code_Aster* and SALOME
  - Contact the development team for more information



- *Code_Saturne* / *Code_Saturne* coupling
  - Still under development and validation
  - Contact the development team for more information

Architectural changes

- Complete translation of user scripts and study directories structure
  - English translation of comments and variables
  - English translation of script names
    - `cree_sat` becomes `cs_create`
    - `info_cs` becomes `cs_info`
    - `lance` becomes `runcase`
  - English translation of study structure
    - `FORT` becomes `SRC`
    - `USERS` becomes `REFERENCE`
- Change in the MPI initialization
  - SYRTHES coupling is no more handle by the script but by a user file `ussyrc.F` (via criteria selection with the `GETFBR` function)

Architectural changes

- Change in the pre-processing phase
  - A single file `preprocessor_output` is now generated by the Preprocessor
  - A Partitionner reads the `preprocessor_output` file and generates a `domain_nXXXXX` file for domain splitting
- New keywords
  - `IMGR(IPR(IPHAS)) = 1` to activate the multigrid algorithm for the pressure
  - `EPSRSM = 1.D-8` to control the precision of the right-hand side reconstruction (splitting of `EPSILO` in two variables)
  - `NCKPDC` (size of the head-loss tensor) doest not exist anymore, it is now supposed to be always equal to 6
    - `uskpdc.F` files have to be re-written
    - Pay attention to all user files that passed NCPDC as an argument of the subroutine!

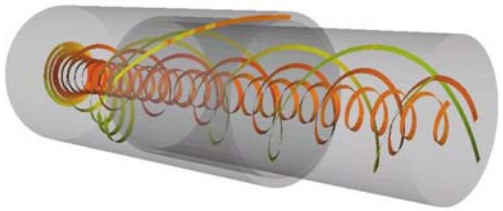
Prospects

Towards *Code_Saturne* version 2.0
and beyond…

EDF R&D

Stabilization of 1.4 features

- Add missing features to the new GUI (coal combustion, radiative transfer, ...)
- Finalization of the *Code_Aster* coupling
- Finalization of the cooling tower module
  - Enabling the restarting capabilities
  - Test the parallelism computation
- Further integration of atmospheric module
  - Potential temperature for non-neutral atmosphere
- Continue the improvement on the linear solver
  - Scalability of the multigrid algorithm for the pressure
- Make *Code_Saturne* still more efficient on HPC systems
  - Parallelize the non-conforming joining algorithm
  - Parallelize the Lagrangian modelling



Architecture improvements

- Smooth transition to Fortran 95
  - Fortran 77 shows some limits in terms of code complexity and maintenance
  - Use of limited new features in first step: dynamic allocations, data structure, function prototypes, ...
- Switch to autotools for Kernel building
  - Keep the coherency with other module (Enveloppe, BFT, FVM)
  - Installation should be easier for the end-user
- Provide some binary packages for Linux distributions
  - Already available for FreeBSD systems
  - Work on progress for Debian systems
- Provide some binary packages for Windows
  - Not planned at EDF, all external contributions would be welcome!

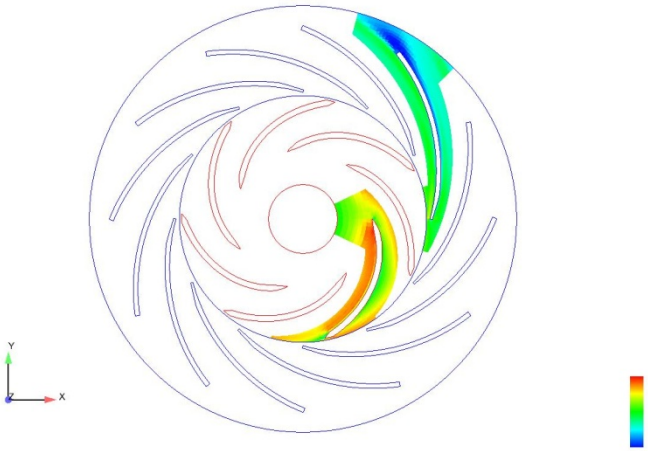
Perspective in further developments

- Progress in algorithms
  - Opportunity of velocity-pressure coupled solver
  - Pseudo-compressible solver scheme for dilatable flows
  - Optimized relative precision of solvers for faster calculations
- Physical modeling
  - Ionic mobility
  - Opportunity of specific module for fire-driven flows
  - Adaptation to simulation of flows in pumps
- *Code_Saturne* / *Code_Saturne* coupling
  - Work in progress
- Treatment of uncertainties
  - Test of plugging of OpenTurns platform (open source) to *Code_Saturne*
  - If convenient, triggering from *Code_Saturne* GUI

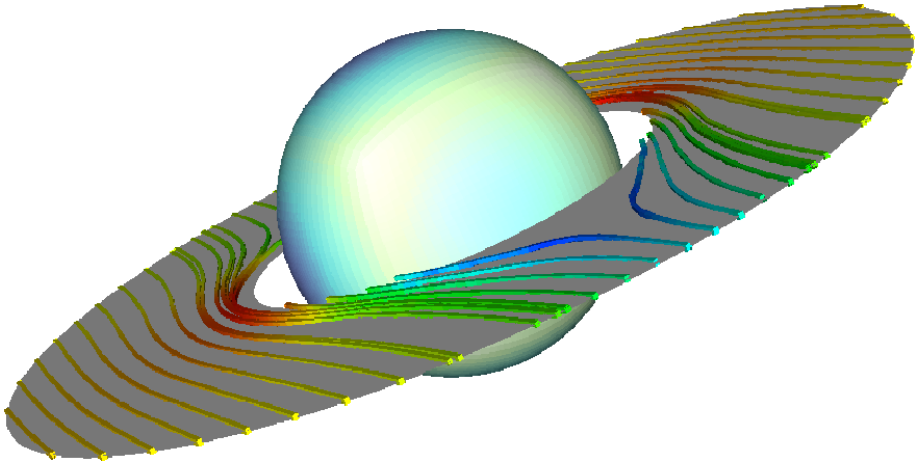
Focus: pumps modelling

- Only for incompressible flows
- First step: development of a steady method
  - So-called « mixing plane » method
  - Based on code/code coupling feature
  - A non-conservative method by design
  - Mass-flux loss < 1% in most tests

Still under development!



Thank you for your attention!



And a special thank for every *Code_Saturne* user and developer for their contribution!