

Overview

The Code_Aster Professional Network aims to spread and to acknowledge the benefits of Code_Aster and Salome-Meca as open-source software.

<http://www.code-aster.org/spip.php?rubrique63>

This report is the fourth issue, after the first three published since July 2015



Read the previous issues <http://www.code-aster.org/spip.php?article890>

Summary of ProNet UPDATE 4

Meetings in the world : UK – QUEBEC – FRANCE

Publications of developments with Code_Aster Open source

Regional conference NAFEMS France

Teacher corner in the world

Applications submitted by members

- Seismic analysis by NECS
- Benchmarking between Code_Aster and Nastran NX* by ACKVA & IMG
- Round Robin for residual stresses after welding by EC2 Modelisation
- Checking the integrity of gas pipelines with Salome-Meca by DeltaCAD

Development corner : implementation of MFront

New releases available for download

July 6th 2016

Code_Aster Open Source versions **stable (12.6)** and **testing (13.2)** under GPL License

July 25th 2016

Salome-Meca 2016 under LGPL license integrates the following products:

- **SALOME 7.8.0;**
- Code_Aster *stable* (12.6);
- Code_Aster *testing* (13.2);

Dedicated forum for the members

The discussions conducted in the ProNet forum are dedicated to all cooperative exchanges between members of the network, expression of needs, follow-up of developments and all feedbacks.

Contact

Jean-Raymond Lévesque – Representative of Code_Aster ProNet
contact@code-aster-pronet.org

New members

2016

SWITZERLAND



FRANCE



UK



Imperial College London

MEXICO



CHILE



UNIVERSIDAD DEL BÍO-BÍO

GERMANY





ITALY



August 2016
72 members
(see last page)

Meetings in the world

Next regular 2016 meetings in France

- **11th ProNet meeting** 
Thursday December 8th at **IFPEN Center** – RUEIL MALMAISON
- **SALOME Users Day 2016** 
Friday December 9th at **EDF LAB** PARIS-SACLAY

Recent special meetings

- **Québec users meeting** **Second event**
At **IREQ** (R&D Hydro Quebec Centre- VARENNES), Wednesday **June 8th 2016**

Sebastien LANGLOIS gathered together 30 users of Salome-Meca and Code_Aster from **Université Sherbrooke (UdS)**, **Hydro Quebec**, **RTE** and **Université Québec Trois Rivières (UQTR)**.

After a workshop with four tutorials on beam and cable structures, the two universities and Hydro Quebec Equipment presented several examples of R&D projects and applications.

In conclusion an open exchange forum made it possible to discuss installation problems, High Performance Computing, contact and nonlinear convergence, 3D meshing.

- **UK users meeting** **A first and a success!**

At EDF Energy R&D UK Centre, Thursday, **June 23th, 2016** will be remember not as the day of Brexit but as the first Code_Aster Users Day in the UK.



More than 70 participants attended the event in Manchester. These were from different backgrounds, from industry to academics and included attendants from the British nuclear safety authority (Office for Nuclear Regulation).

The day was punctuated by six technical presentations which highlighted the high penetration of Salome-Meca in the UK since its introduction in 2011, particularly in the engineering offices working for EDF Energy.

The presentations, such as the one regarding the behaviour of concrete subjected to high transient temperatures, also showed that Code_Aster and MFront are accompanying the research activity in the UK.

The highlight of the day was a panel discussion to answer the many questions from the audience and gather improvements and ideas for Code_Aster and Salome-Meca.

The discussion showed that these were aligned with the objectives of the "Platform for Simulation in Mechanics" project, particularly regarding Anglicization.

TRAINING

For **2016** several organizations propose **training sessions** for **Code_Aster** and **Salome-Meca** in France and Germany



phimeca.com/Formations



www.code-aster-services.org



www.tgdelta.com/formation-code-aster



www.code-aster.de/services

see also teaching corner

TUTORIALS

The course materials used by EDF for internal teaching are online and written directly in English.

<http://code-aster.org/spip.php?article282>

Developments with Code_Aster Open source

Hyper elastic characterization of an expanded polyurethane using the Virtual Field Method

Jamel BENKAHLAB (University Lyon 1), Thouraya Nouri BARANGER (LaMCOS), Jérôme ISSARTEL (Centre Technique du cuir)

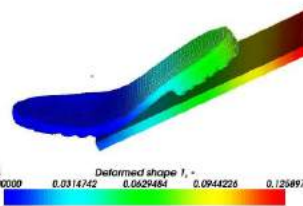
We focus on the mechanical behaviour of a compressible elastomeric material in a high strain case. An identification procedure called the Virtual Field Method (VFM) associated with full-field measurement is presented in the framework of an Ogden-Hill hyper elastic model. Firstly, a numerical study is proposed to verify the reliability of this method for a compressible material.

Then, expanded polyurethane is characterized using the strain field measurements obtained by a Digital Image Correlation (DIC) system. Parameters are identified through tensile tests performed for three different thin samples to obtain heterogeneous strain fields (from uniaxial to plane tensile tests).

Finally, an industrial application is presented to simulate a quasi-static shoe outsole bending with Code_Aster.



(a) Bending test bench



(b) FE model: deformed shape

2D coupled HM-XFEM modeling with cohesive zone model and applications to fluid-driven fracture network

Maxime FAIVRE, Fabrice GOLFIER, Richard GIOT (GéoRessources) Patrick MASSIN (IMSIA) - Bertrand PAUL, Daniele COLOMBO (IFPEN) Engineering Fracture Mechanics – ELSEVIER – July 2016

An XFEM coupled hydro-mechanical model with a non-regularized cohesive zone constitutive law is developed. A Lagrange multiplier formulation is considered to stabilize the fracture propagation and the fluid exchanges.

The competition mechanisms between fluid-driven fractures are investigated.

Comparisons between numerical results with Code_Aster and theoretical solution assess the validity of the model presented in this paper.

A damage model for transversely isotropic materials

Mohamed MAHJOUB, Ahmed ROUABHI, Michel TIJANI (Mines Paris Tech) Sylvie GRANET (EDF R&D)

Petrus PHD Conference June 2015 – NANCY - France

In a nuclear disposal project, the damage of the hosting rock is a capital issue that should be studied and understood. This problem is even more complex when the studied rock is anisotropic.

A damage model that takes into account both initial and induced anisotropy is introduced using equivalence relations between the real material and a fictitious isotropic one on which we can take all the advantages of the well-established isotropic theory.

Numerical simulations using Code_Aster shows an agreement between the theoretical predictions and the experimental data of Brazilian tests with different orientation angles.

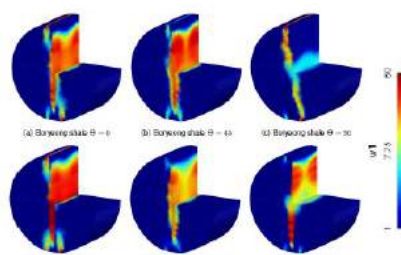


Figure 2: Horizontal damage state at the end of the Brazilian test

SALOME MECA DOCUMENTATION

Since the release of **Salome Meca 2015.2**

Some documents for Utilization, Validation and Construction of assistant are now freely available

<http://code-aster.org/docsmeca>

QUALITY ASSURANCE

After the installation of binary package

Salome-Meca

a procedure may be used to **verify the quality** of the versions of Code_Aster packaged with it.

More information may be found in the manual **SV4.02.01 Note for receipt of Salome-Meca**

Regional Conference NAFEMS France



Two contributions from ProNet Members 2016 June 8th and 9th

➔ Project SDM4DOE

Gilles BESOMBES - VALEO: Conclusion of research project SDM4DOE: Simulation Data Management for DOE with collaboration of ALNEOS, NECS, ECN, CEA and UTC.

➔ Project ICARE

Stéphane GUINARD - AIRBUS Group Innovations hosted a workshop with all partners of ICARE project: Generalized and non-intrusive interfaces of research codes with industrial codes for highly nonlinear structural analysis.

Teaching corner

➔ Code_Aster and Salome Meca as teaching platform for mechanical engineering

- Prof. Dr.-Ing. Michael MAGIN

Hochschule Kaiserslautern - University of Applied Sciences - GERMANY

Analysis of industrial methods of FEM programming and FEM usage



- Prof. Dr. Norberto DOMÍNGUEZ RAMÍREZ

National Polytechnic Institute of Mexico - MEXICO

Master degree courses :Finite Element Method – Nonlinear Behavior and Response of Structures and Materials – Special Topics of Structures



- Dr. Ing. Krzysztof HERMAN

Escuela Ing. Civil en Automatización – Universidad Bío – Bío - CHILE

Course for numerical computation, concerning sensors and actuators applied in the area of automation (acoustic field in ultrasonic frequencies and ultrasonic transducers).



- Prof. Eric CHARPALUK and Dr. Ing. Eric LORENTZ

Ecole Polytechnique – University PARIS SACLAY – FRANCE

FEM numerical simulation and industrial mechanical applications : elasticity – plasticity – large deformations -contact, thermo-mechanics



- MCF – HDR Thouraya BARANGER

University Claude Bernard – LYON 1 – FRANCE

Department of Mechanics Polytech Lyon - Master Pro Mechanics and Energetics
Structural nonlinear mechanics. Practical works and mini projects.



➔ Other projects 2016

- UK – Training Code_Aster

contact EDF ENERGY R&D UK Centre Philippe.Martinuzzi@edfenergy.com

- CHINA – Training session Code_Aster and Salome-Meca

contact R&D Center EDF China gongchen.zhang@edf.fr

- CRIANN FRANCE – Training session meshing with SALOME – 2016 October 11th – 12th

contact Tangent Delta – CEVAA nicolas.merlette@tgdelta.com or admin@criann.fr

- INDIA – Training for dynamic soil-structure interaction at NERIST – 2016 October 16th – 17th

contact shahrokh.ghavamian@necs.fr and sukumar.baishya@gmail.com

- ITALY – Seminar “numerical modelling with open source software” in Civil Engineering

contact University of Florence mbetti@dicea.unifi.it

Applications submitted by members

➔ MAGNA Steyr Fuel Systems benchmarks Code_Aster versus NX - Nastran



April 2016 Johannes ACKVA Ingenieurbüro für Mechanik and IMG Ingenieurbüro Michael GRABIETZ (Germany).

The codes employed for this project of MAGNA Steyr Fuel Systems (AUSTRIA) are:

- NX.Nastran version 10.1 as included in the package "FEMAP" version 11.2. It runs on Windows 7.
- Code-Aster version 12.3 compiled with MPI and PETSC for parallel computations, using GNU compilers. Running on Open SUSE 13.1

Identical model and identical hardware for both codes

The FE model being investigated comprises 477859 TETRA10 elements and 746896 nodes, round about 2M degrees of freedom. One linear static load case has been analyzed.

All computations have been done on the same hardware: a workstation with a dual boot system with Windows 7 and Open SUSE 13.1 installed - CPU: 6 x 3.4 GHz, Intel i7-4930 -RAM: 32 GB

The elapsed time comprises always a complete run, from reading the input file(s) to writing the output file containing the displacement field. The model size was chosen such that there should always be enough RAM to avoid memory swapping.

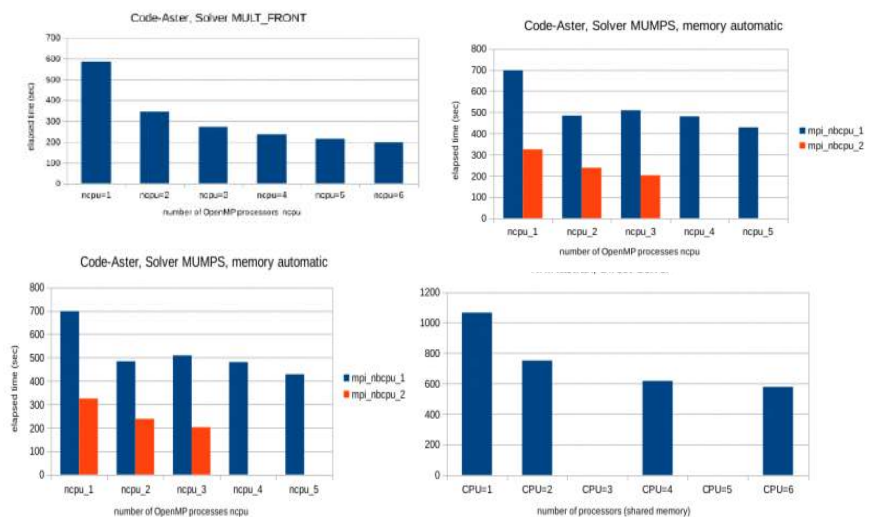
Comparison of direct solvers

The following 4 diagrams show the elapsed times for the direct solver(s) of Code_Aster (MULT_FRONT and MUMPS) and NX - Nastran. The MUMPS solver is employed with an "in-core" and with an "automatic" memory management. It was detected only afterwards that in case of "MUMPS in-core" and when running several MPI-processes (mpi_ncpu>1) the available RAM was too small, so that swapping of data occurred which extended the elapsed time.

MULT_FRONT knows only the shared-memory parallelization (OpenMP). The elapsed time is divided by two when using about 3 or 4 processor cores.

MUMPS knows both, shared-memory (OpenMP) and distributed-memory (MPI) parallelization. The results show that it is most effective to mix them: setting ncpu=2 and mpi_nbcpu=2 will always reduce the elapsed time compared to the same number of processors using only one of the both parallelization methods (ncpu=4 and mpi_nbcpu=1 or ncpu=1 and mpi_nbcpu=4).

The direct solver of NX.Nastran uses shared memory.



Conclusion

For the investigated model size the direct solver MUMPS (Code_Aster) has the best performance, in particular when used with both types of parallelism. This holds although MUMPS was the only solver which "lost" time due to swapping to the hard disk because 32 GB RAM did not suffice. NX.Nastran shows the longest elapsed times. MUMPS has the disadvantage of the largest need of RAM.

When doing the same kind of comparison for extremely large models MUMPS (Code_Aster) is even more advantageous in terms of elapsed time due to its scalability with MPI. The problem of the increasing demand of RAM can be attenuated by distributing the calculation over different computing nodes of a cluster.

Applications submitted by members

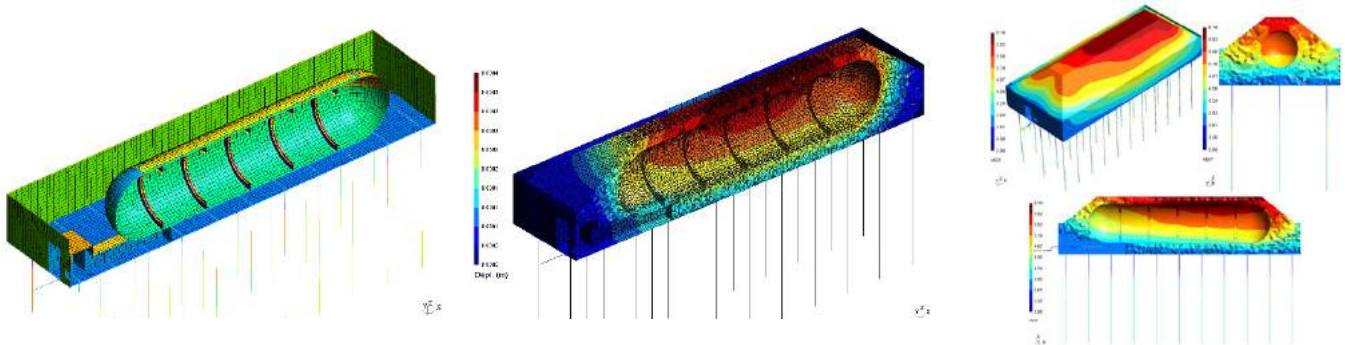


➔ Gas filling plant (MACÔN - France)

Seismic study in the context of the 04/10/2010 Ministerial Order regarding classified industrial plants. Assessment of the buried steel tank, the reinforced concrete structure, foundation piles and soil. Elaboration of mitigation measures through retrofitting.

Following a walk down of site and a document examination, a 3D finite element modeling and a linear analysis were carried out to assess the seismic behaviour of the buried gas tank, its filling line, the peripheral reinforced concrete structure, the foundation piles and the soil.

The 3D modeling uses linear finite elements (beams, piles, and filling line), surface finite elements (steel tank, reinforced concrete walls and slab) and volume finite elements (backfilling material). The dynamic calculation is based on a seismic modal spectral analysis. The results allow to assess the resistance of each element of the structure and the overall stability. Two soil configurations were studied in order to take into account the possibility of liquefaction.



➔ Hotel (CANNES - France)

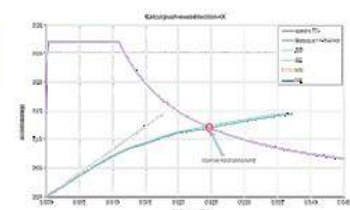
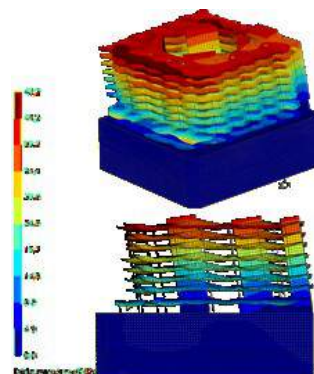
The expertise of NECS was required to study the possibility of expanding the capacity of an hotel, through the construction of several additional floors, taking into account the regulators requirements concerning seismicity of the site. And therefore evaluate the cost of retrofitting work and type of construction to be considered.

Seismic study of the expansion project of building: addition of several levels on top of the existing structure - Modal-spectral analysis and nonlinear push over calculations, feasibility studies of the project and validation that seismic reinforcement of the existing structure is not required.

The aim of the study was principally to verify that the project was satisfactory with regards to the 22/10/2010 Ministerial Order for existing structures, and to check the seismic behaviour of the future building.

The study was divided into several steps. The first step, involving a first analytical analysis and giving an expert point of view, allowed confirming the opportunity to follow the feasibility study with a more detailed analysis based on numerical modelling and calculations. The goal of that second step was to give the complete demonstration of the structural consequences of the expansion on the existing building, and provide retrofitting solutions if necessary.

The numerical study of the second step was based on a nonlinear push-over analysis which allowed to prove that the seismic behaviour of the whole structure (project + existing) was satisfactory without any retrofitting work.

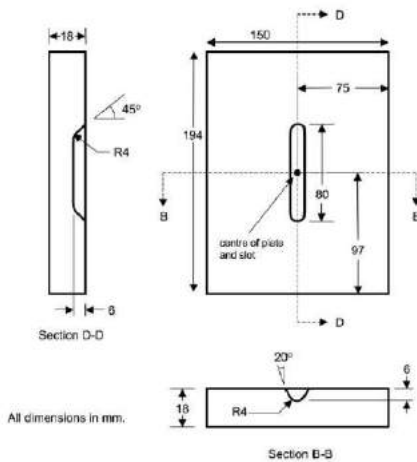


Applications submitted by members



➔ Round Robin for residual stresses after welding

The **NeT international network** has undertaken a number of round robin studies examining the prediction and measurement of weld residual stresses. NeT TG4 examined the case of a three-pass slot weld made from AISI 316L steel.



EC2 Modelisation presents comparisons of several constitutive laws with Code_Aster :

- VMIS_ECMI_LINE model (EP Prager)
- META_V_IL model (EVP IL)
- VISC_CIN2_CHAB model (EVP Chab)

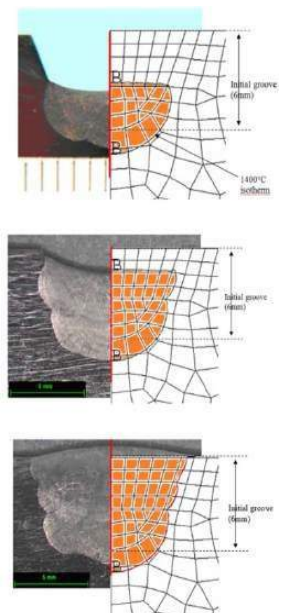
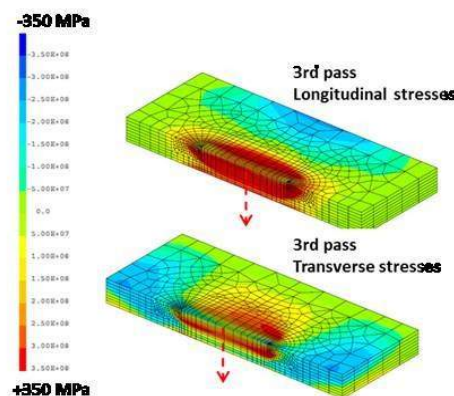
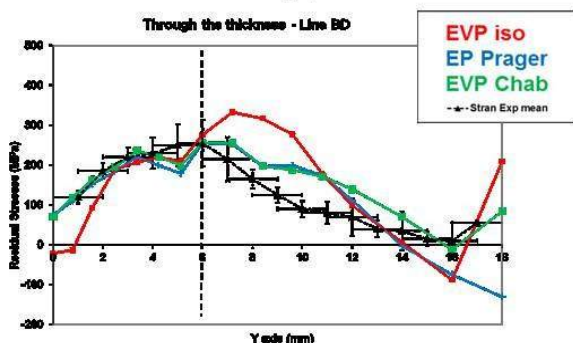
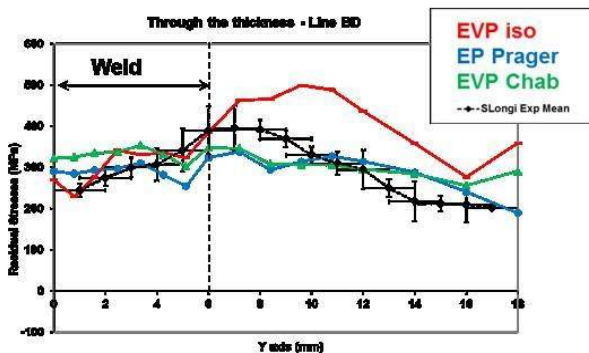
L. DEPRADEUX, R. COQUARD, "Influence of visco-plasticity, hardening, and annealing effects during the welding of a three-pass slot weld (NET-TG4 Round Robin)" (submitted for publication in **Int. Journal of Pressure Vessel and Piping**)

See also on the same experiment

Sensitivity analysis of a numerical welding simulation model
A-L. POPELIN - A. BALMONT - J-C. CLEMENT - J. ANGLES
 EDF R&D – ENSTA- LAMSID
 Ecole Nationale Supérieure des Techniques Avancées
31^{ème} Congrès Français de Mécanique - 2013

NET TG 4 experiment :

- Plate 194 ´ 150 ´ 18
- Slot 80 mm long ; 6 mm deep
- 316L austenitic steel
- E ~ 10 to 15 kJ/cm ;
- V = 1.27mm/s GTAW
- – 3 weld passes



Applications submitted by members

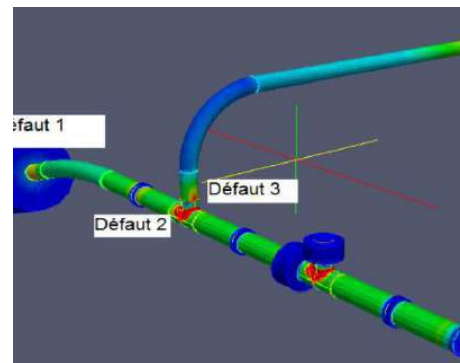
➔ Checking the integrity of gas pipelines with Salome-Meca



To check the integrity of the gas pipelines in the presence of defects (corrosion, thickness reduction, depression,...) ENGIE developed a skill module (Brutus) in Salome-Meca allowing to model piping system by assembling building blocks (elbows, pipes, supports,...) with or without defects.

The objectives of the development as a skill module (**DeltaCAD for ENGIE and GRTgaz**) were:

- To generalize and industrialize Brutus (in close relationship with ENGIE);
- To allow its use by people not familiar with finite elements and Salome-Meca;
- To manage and centralize knowledge (data, results...);
- To allow the diffusion and a widened use within ENGIE or GRTgaz.



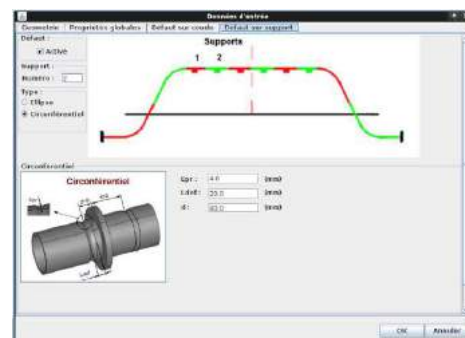
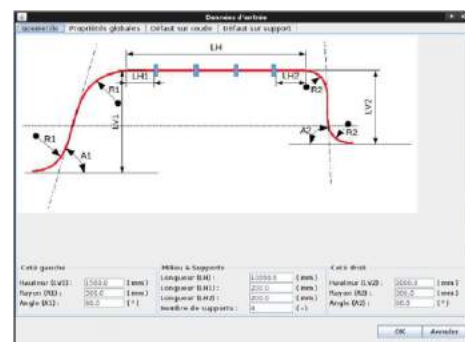
Brutus tool - two modes of use

◆ **Simple mode:** to carry out a quick analysis. The advantages of this operating process are the following:

- Easy use within a maintenance office,
- No knowledge of Salome-Meca and Code_Aster is required,
- Automatic creation of a PDF summary report (data, results).

◆ **Advanced mode:** starting from the files produced by the skill module in simple mode, one may use Salome-Meca in a traditional way to:

- carry out a finer analysis of the results by exploiting other criteria,
- carry out specific visualizations (zoom, iso-colors...),
- start again calculations by modifying non accessible parameters in simple mode (new types of defects, loadings ...).



Developer's corner



➔ MFront: constitutive laws for everyone

J.-M. PROIX, EDF R&D / AMA

You want to easily develop a new mechanical behaviour?

MFront is for you. It allows you to define any constitutive law using simple instructions, close to physical equations, without having to worry about solving methods: several algorithms are indeed offered.

What is it about?

MFront is a constitutive law generator developed by the CEA in the framework of the fuel simulation software platform PLEIADES. It comes in the form of a software library that provides interfaces to several mechanical solvers among which Code_Aster, it also features a resolution tool for single material point (MTest).

Since October 2014, MFront is Open Source under the dual GPL and CECILL-A license. The website <http://tfel.sourceforge.net> was open for the occasion, it gives access to the source code, complete documentation including training materials and a tutorial, a bug tracker to allow feedback, bug reporting and feature request as well as a forum.

Coupling with Code_Aster

The coupling between Code_Aster and MFront is already operational and many tests have demonstrated its effectiveness. More than twenty laws are tested in Code_Aster including :

- the elastic-visco-plastic laws ; (MFRON01, [\[V1.03.126\]](#)) ;
- the laws for concrete and soil behaviour (MFRON02, [\[V1.03.127\]](#)) ;
- crystal plasticity laws (MFRON03, [\[V1.03.128\]](#)) ;
- laws with metallurgy (MFRON04, [\[V1.03.129\]](#)) ;
- laws with damage (MFRON05, [\[V1.03.130\]](#)).

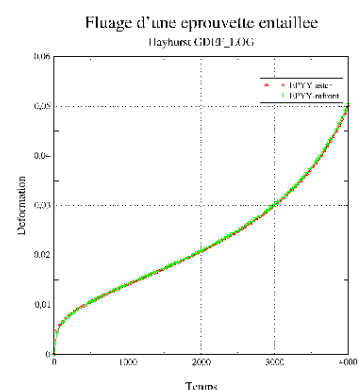
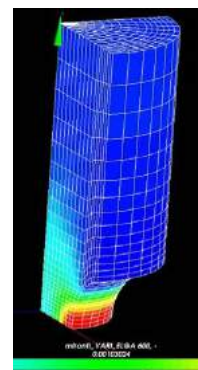
These behaviours are used in Code_Aster via [the Aster-MFront interface](#) and compatible with 3D and 2D modeling, shells, THM and for the joint elements. Large strains may be used with GDEF_LOG Code_Aster kinematic hypothesis.

In addition, MFront produces efficient code because the tensor operations are optimized as shown in benchmarks made against equivalent behaviours in Code_Aster.

Once your constitutive law is developed, it can be tested using MTest which can also be used for parameters fitting using the ADAO module in SALOME.

The 2016 MFront Users Day - Friday May 20th 2016 at EDF Lab PARIS-SACLAY – present the MFront 3.0 and several applications (EDF R&D, CEA, AIRBUS Group, Manchester University).

Creep of a notched specimen in large strains



Industrial and research centers, services providers and teachers are welcome

72 members - 15 countries

Italy	France	France	Switzerland	France	Spain	France
Switzerland	France	Switzerland	France	Spain	France	France
France	UK	France	France	France	Czech Republic	France
Canada	Spain	France	France	Germany	France	Germany
UK	France	Korea	Italy	France	France	France
France	UK	France	France	Poland	Switzerland	France
France	Switzerland	Germany	France	France	Spain	France
France	Japan	France	Poland	France	Germany	France
Poland	France	France	Germany	Switzerland	Italy	Germany
Canada	Germany	Mexico	China	France	Canada	Latvia
		Germany	Chile			