

# TASK 5.4: *INTEGRATION* *& APPLICATION* PROGRESS & ACHIEVEMENTS

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Task leader: Phimeca

Contributing partners: All



## □ Integration of new modules

### • Analytical Tensile Curve

- Evaluate the stress-strain curve using
  - A temperature-depending elastic law
  - A hardening model

### • Experimental Tensile Curve

- Load experimental stress-strain data and make it compatible with Charpy or CT calculation

### • Charpy

- Predict a Charpy energy based on a finite element plastic calculation and a local approach to fracture models

### • Fit Analytical Tensile Curve

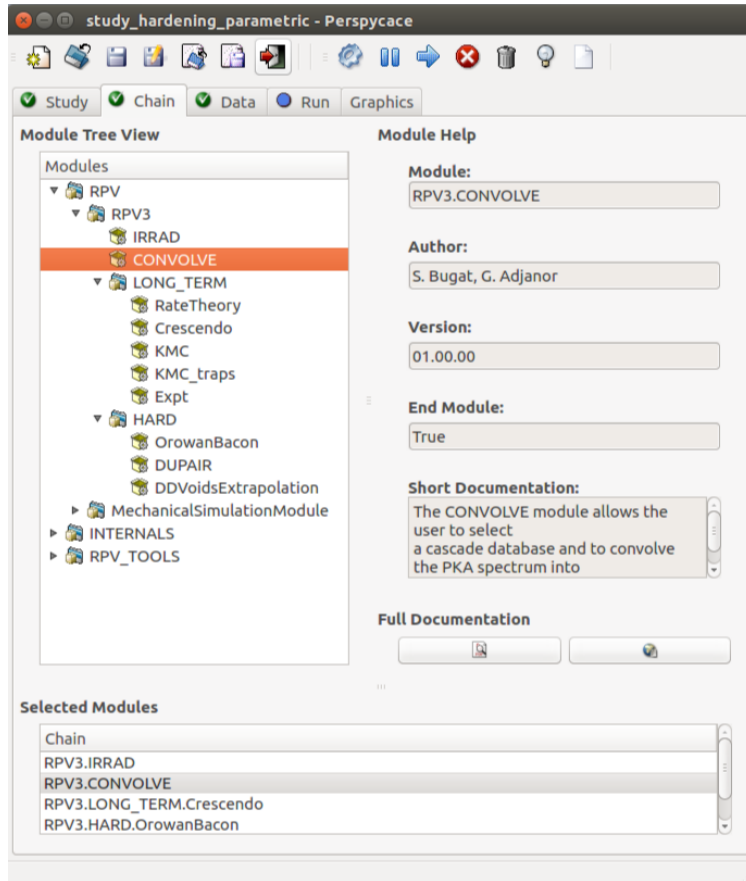
- Provide the coefficient of the Analytical Tensile Curve identified from experimental data

- Integration of Initeac module (Statistical modeling of IASCC)
  - Presentation of Initeac module with 12 test cases.
  - Integration the UserGuide into the presentation.
- Integration of Mibf
  - The Microstructurally Informed Brittle Fracture (MIBF) model takes into account the microstructure of the RPV steel.

- UserGroup meeting
  - Collective exercise
    - The new presentation was presented
    - Several case studies from the presentation were presented and tested
  - on June 19th 2017 in EDF
  - on June 22th 2018 in EDF
  - on June 28<sup>th</sup> 2019 in Madrid
  
- Soteria Training school on 3-7 September in Valencia
  - Collective exercise
    - The new presentation was presented
    - Several case studies from the presentation were presented and tested

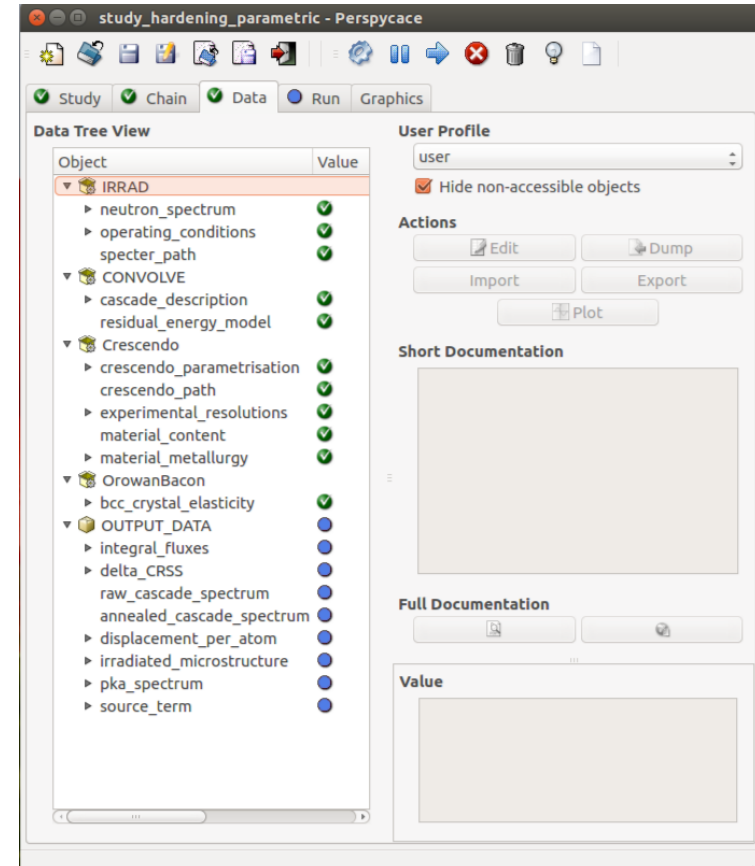
- ❑ **Construction of the Graphical User interface to realize parametric Soteria studies :**
  - Design of experiment → Operational
  - 3 post-treatments → Operational
    - A table of input and output variable
    - A table with the minimum and maximum values of each input and output
    - A scatter plot showing the relationship between inputs and outputs
  - We were inspired by graphical user interface of **OpenTurns**
    - Phimeca and EDF developed a graphical user interface (GUI) of **OpenTURNs**. This interface is integrated into SALOME-MECA
    - **OpenTURNs** is a C++ library open source to treat uncertainties. It is co-developed by EADS IW, EDF R&D and PHIMECA Engineering.

## CHAIN



The screenshot shows the 'CHAIN' view of the software interface. The 'Module Tree View' on the left lists a hierarchy of modules: RPV, RPV3, IRRAD, CONOLVE (highlighted), LONG\_TERM, RateTheory, Crescendo, KMC, KMC\_traps, Expt, HARD, OrowanBacon, DUPAIR, DDvoidsExtrapolation, MechanicalSimulationModule, INTERNALS, and RPV\_TOOLS. The 'Module Help' panel on the right displays details for the 'CONOLVE' module, including its name (RPV3.CONVOLVE), author (S. Bugat, G. Adjanor), version (01.00.00), end module (True), and a short documentation snippet. A 'Selected Modules' list at the bottom shows the active chain: Chain, RPV3.IRRAD, RPV3.CONVOLVE, RPV3.LONG\_TERM.Crescendo, and RPV3.HARD.OrowanBacon.

## DATA



The screenshot shows the 'DATA' view of the software interface. The 'Data Tree View' on the left is a table with columns for 'Object' and 'Value'. The 'IRRAD' object is expanded, showing a tree of sub-objects with their corresponding values (green checkmarks for active, blue circles for inactive). The 'User Profile' panel on the right shows the user 'user' and options like 'Hide non-accessible objects'. The 'Actions' panel includes buttons for Edit, Dump, Import, Export, and Plot. The 'Short Documentation' and 'Full Documentation' panels are currently empty.

Object	Value
IRRAD	
neutron_spectrum	✓
operating_conditions	✓
specter_path	✓
CONVOLVE	
cascade_description	✓
residual_energy_model	✓
Crescendo	
crescendo_parametrisation	✓
crescendo_path	✓
experimental_resolutions	✓
material_content	✓
material_metallurgy	✓
OrowanBacon	
bcc_crystal_elasticity	✓
OUTPUT_DATA	
integral_fluxes	●
delta_CRSS	●
raw_cascade_spectrum	●
annealed_cascade_spectrum	●
displacement_per_atom	●
irradiated_microstructure	●
pka_spectrum	●
source_term	●

# Parametric hardening study



Parametric studies

Physical Model | Designs of experiment

Study: /home/gosset/PerfectStudy/studies/study\_hardening\_parametric.prf Open...

**Inputs**

	Name	Selected	Range	Units	Levels %
1	dual_energy_model.beta	Off	0.779		
2	dual_energy_model.alpha	Off	5.67		
3	fusion_model.monovacancy_migration_energy	On	1.2	eV	1.03, 1.04, 1.05, 1.06, 1.07, 1.08, 1.09, 1.1, 1.11, 1.12
4	fusion_model.Zv	Off	1.0		
5	fusion_model.Zi	Off	1.1		
6	scendo_parametrisation.solver_absolute_error	Off	1e-14		
7	scendo_parametrisation.solver_relative_error	Off	0.001		
8	material_metallurgy.alloy_friction	Off	10.0	Mpa	
9	material_metallurgy.grain_size	Off	0.01	mm	
10	material_metallurgy.dislocation_density	Off	100000000.0	cm/cm <sup>3</sup>	
11	_crystal.atomic_volume	Off	1894238688e-	m <sup>3</sup>	
12	_crystal.lattice_parameter	Off	3.575	angstrom	

**Outputs**

	Name	Value	Unit
1	delta_CRSS.Delta_CRSS_final_value	25.75...	MPa

Add Remove

Ready



# A table of input and output variables



Parametric studies

Physical Model | Designs of experiment

Evaluate Abort

100% Results

Designs of experiment

Table | Min/Max | Scatter plots

	sion_model.monovacancy_migration_er	delta_CRSS.Delta_CRSS_final_value
28	1.12	15.93012084
29	1.13	17.0080466737
30	1.14	18.1271433572
31	1.15	19.2855866949
32	1.16	20.4867050096
33	1.17	21.731356635
34	1.18	23.0206170629
35	1.19	24.3612639126
36	1.2	25.7545465866
37	1.21	27.2094852036
38	1.22	28.7182804925
39	1.23	30.2986493037
40	1.24	31.9431640964
41	1.25	33.6608423692
42	1.26	35.4447471458
43	1.27	37.3025308185
44	1.28	39.2336604079
45	1.29	41.2408613047
46	1.3	43.3141764959

Ready





# A table with min and max value of each input and output



Parametric studies

Physical Model Designs of experiment

Evaluate Abort

100% Results

Designs of experiment

Table Min/Max Scatter plots

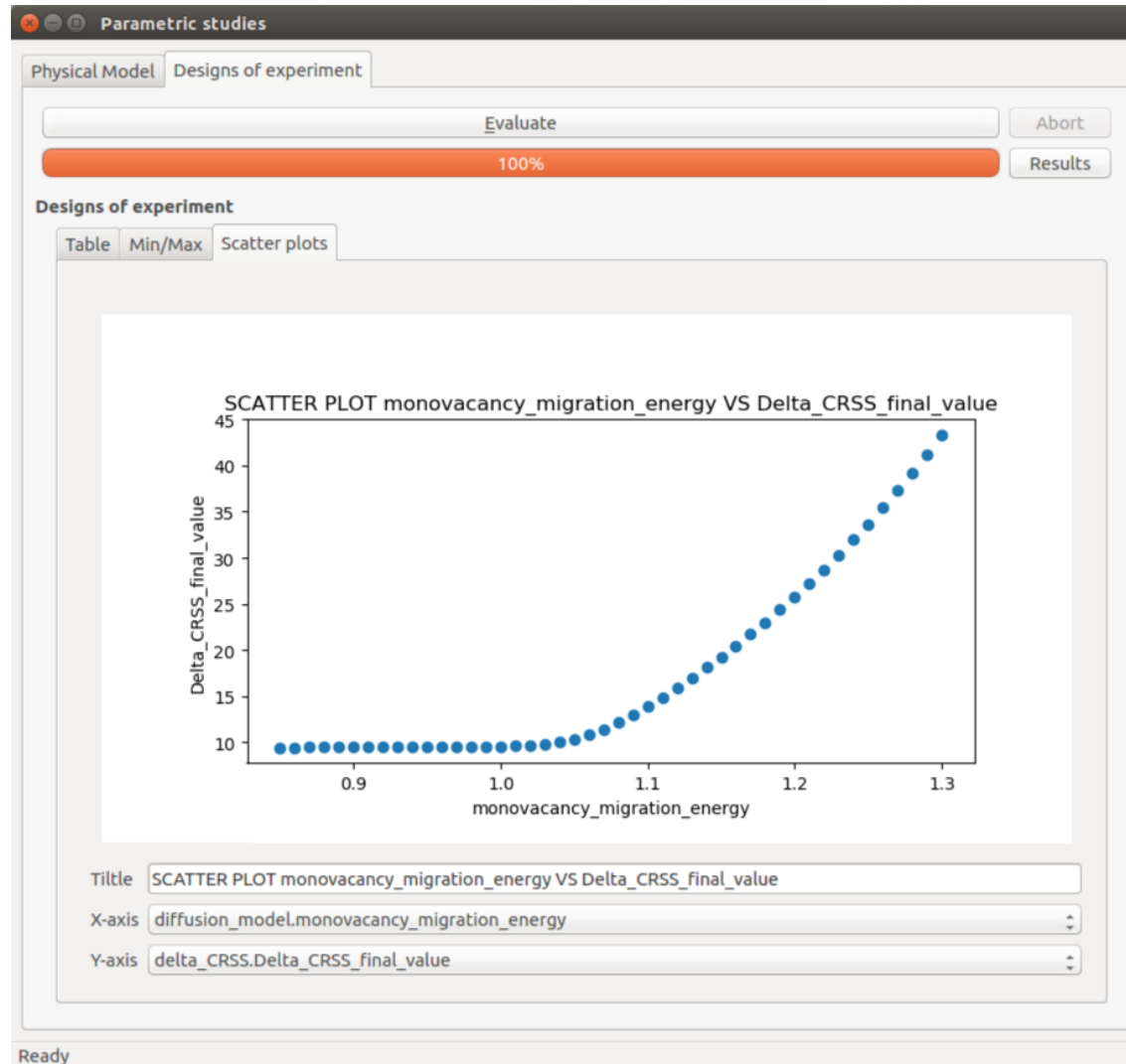
Output delta\_CF

	Variable	Minimum	Maximum
outputs	delta_CRSS.Delta_CRSS_final_value	9.45178909549	43.3141764959
inputs at extremum	diffusion_model.monovacancy_migration_energy	0.85	1.3

Ready



# A scatter plot between input and output



## □ Dissemination of the platform

- **New version of the platform with Salome-Meca 2018**

- **For linux**

- The document “Installation instructions for the Soteria Platform” on the web-site of SOTERIA

- **For windows**

- By using a virtualBox

- **SciMotors platform (EDF)**

- Remote connection to a machine containing the Soteria Platforms

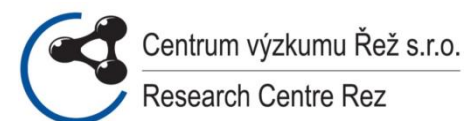
## ❑ **ENTENTE : EUROPEAN DATABASE FOR MULTISCALE MODELLING OF RADIATION DAMAGE**

- Implementing MFront into the platform
- Performing quantitative sensitivity studies of the model based on variance analysis
- Maintenance of the platform

## ❑ **BOLTS : Lifetime prediction of baffle-former bolt cracking**

- Implementing MFront into the platform
- Performing quantitative sensitivity studies of the model based on variance analysis
- Integration of Amitex (CEA)
- Integration of new modules

# The SOTERIA Consortium



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