PAUL SCHERRER INSTITUT

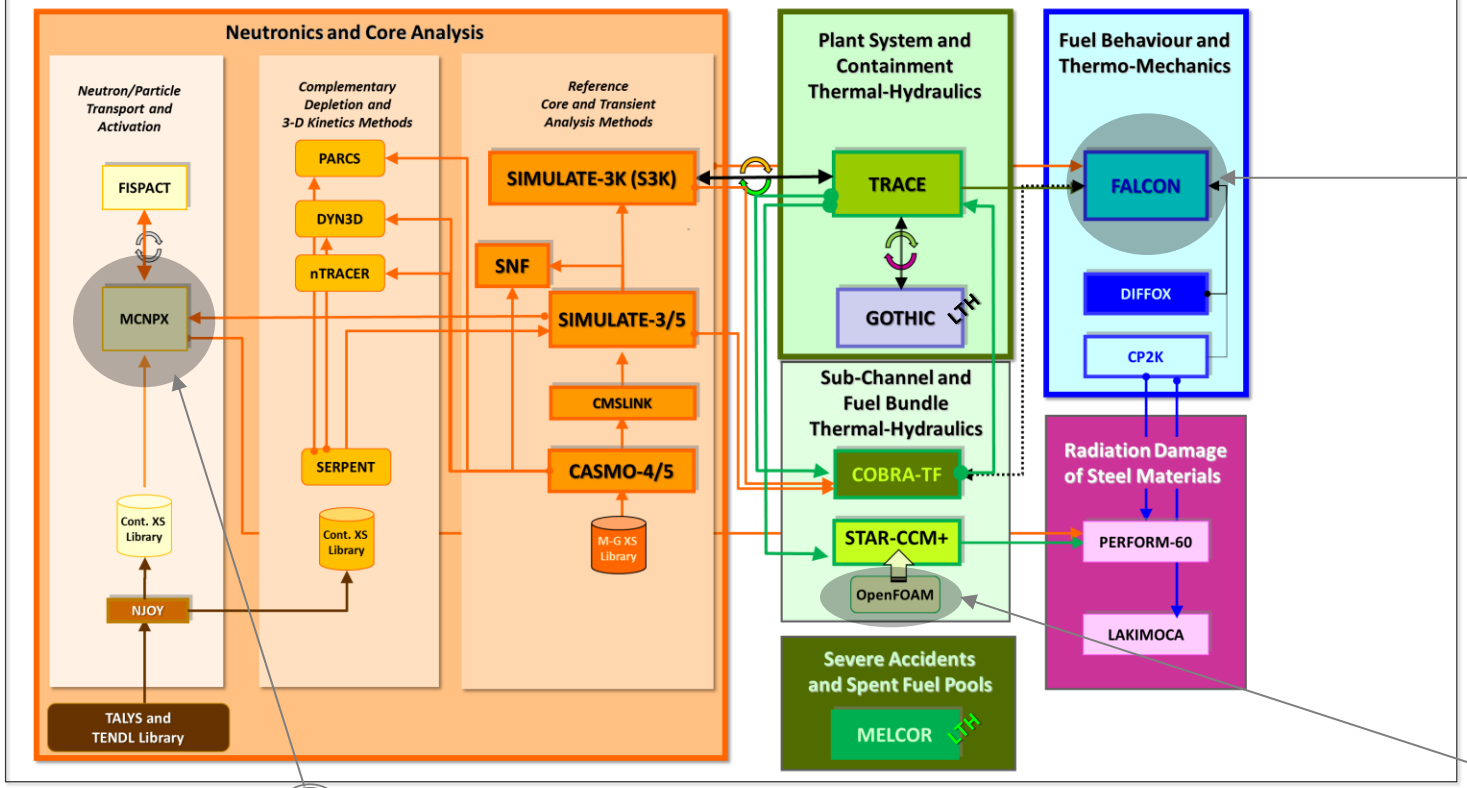
PSI

Semester/Master Projects 2017-2018

Method Development and Verification for LWR Safety Analyses

1. Fuel Safety
2. Uncertainty Analysis
3. Criticality Safety

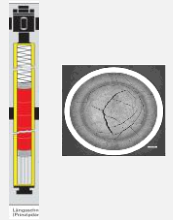
SWISS SIMULATION PLATFORM *for Deterministic Safety Analyses*



High Performance Computing (PSI Merlin Cluster, CSCS Swiss National Supercomputing Centre)

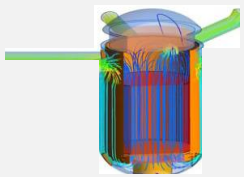
1

Burnup Model
for Nuclear Fuel Irradiation



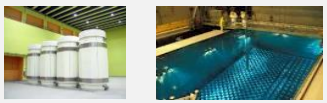
2

Uncertainty Analysis
for CFD Simulations



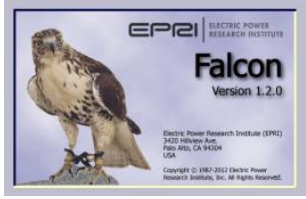
3

Criticality Safety
of Spent Fuel Management Systems



PAUL SCHERRER INSTITUT

Burnup Model Update & Validation For the Fuel Performance Code Falcon



STARS.1

Scope

LRS/STARS is part of the EPRI Development Team for the re-designed new Falcon V1 state-of-the-art FEM Fuel Performance Code

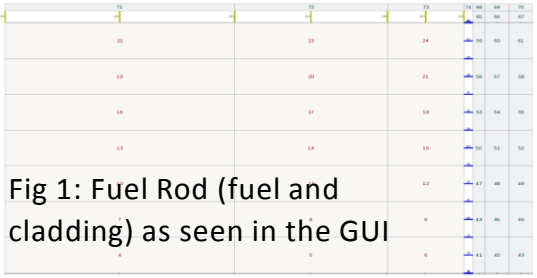


Fig 1: Fuel Rod (fuel and cladding) as seen in the GUI

Objectives

1. Literature review: open & PSI internal publications
2. Update of the burn-up model for Falcon V1
3. Development of a test matrix to validate the new versions of the code

Codes and Relevance

→ Falcon V1 (2D FEM Fuel Thermo-mechanics)
→ CASMO/Serpent (Neutronics)
→ Fuel Depletion
→ Fuel Safety and Reliability

Topics

→ Nuclear Fuels and Materials
→ Heat Transfer and Structural Mechanics

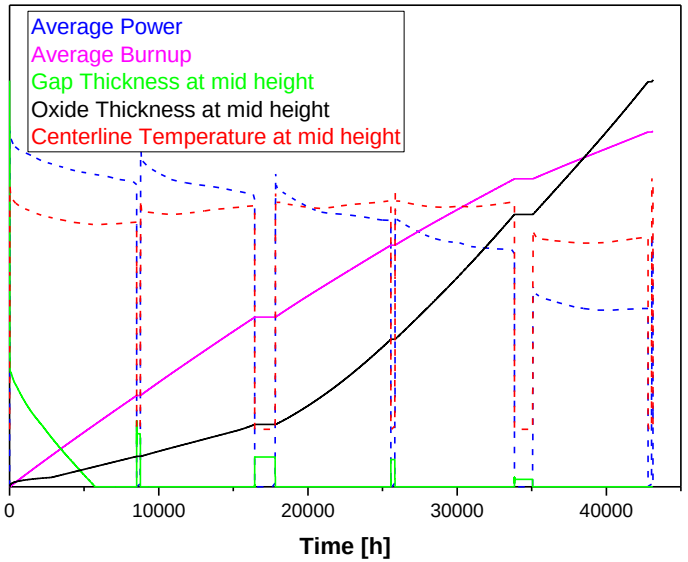


Fig 2: Typical output of a standard operation

Contact: Cedric.Cozzo@psi.ch

Uncertainty Quantification Applied to CFD

STARS.1

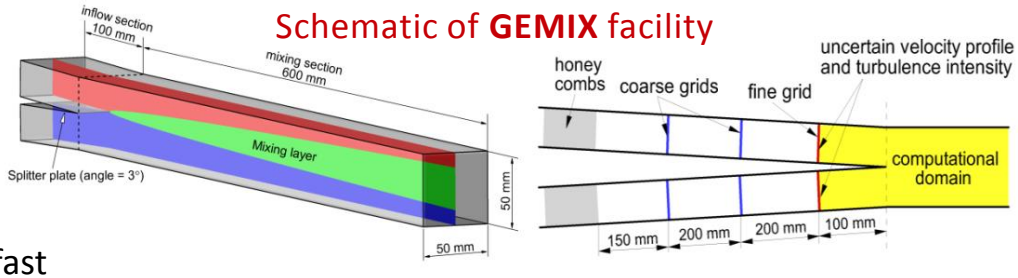
Project Overview

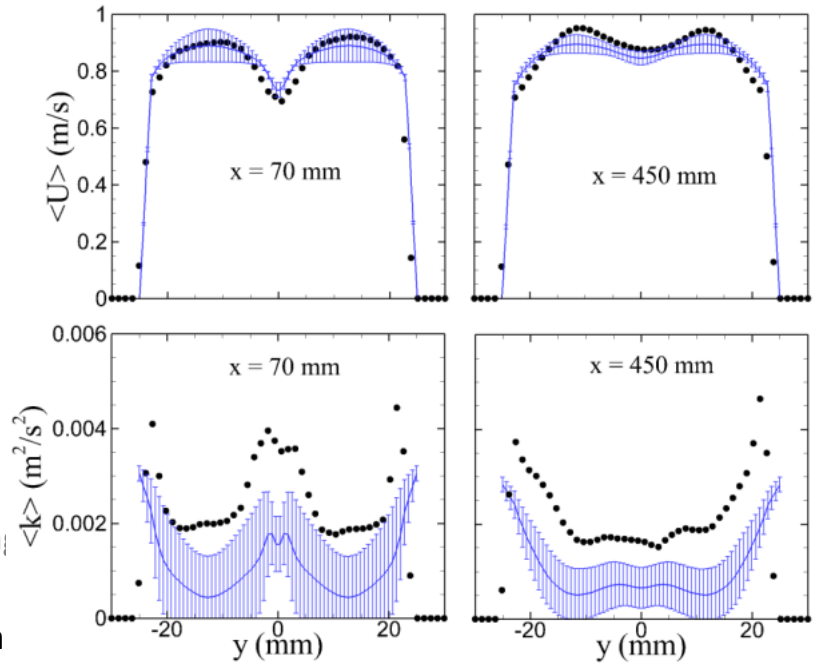
- **Python scripts** for generating inputs files based on **non-intrusive Polynomial Chaos Expansion** (PCE) theory
- Open-source **OpenFOAM CFD** solver for 2D fast solutions
- **Global Sensitivity Analysis** (GSA) for discarding input parameters with negligible influence on the output
- **GEMIX experiment** measurements available for validation

Semester/Master Project Plan

- **Familiarization** with **PCE** theory and **OpenFOAM** code
- **Identification of realistic probability density functions (PDF)** for turbulent model constants
- **Development of Python scripts** for pre- and post-processing according to PCE theory
- **Running 2D CFD simulations** on the multi-dimensional sam
- **Performing GSA**

Schematic of **GEMIX** facility





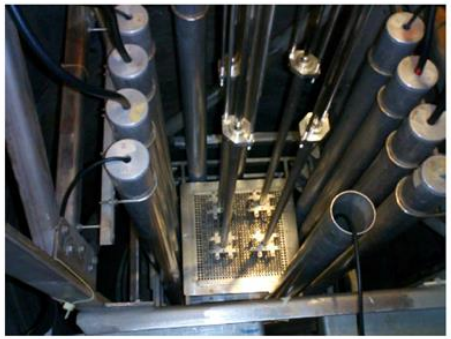
ANSYS-FLUENT solution (±1σ) vs. Experiments (dots) [*]. First row, mean velocity field <U>; Second row, turbulent kinetic Energy <k>.

[*] D. Bestion, R. Camy, A. Barthet et al. "Review of Uncertainty Methods for Computational Fluid Dynamics Application to Nuclear Reactor Thermal Hydraulics", NEA/CSNI/R(2016)4, Feb. 2016

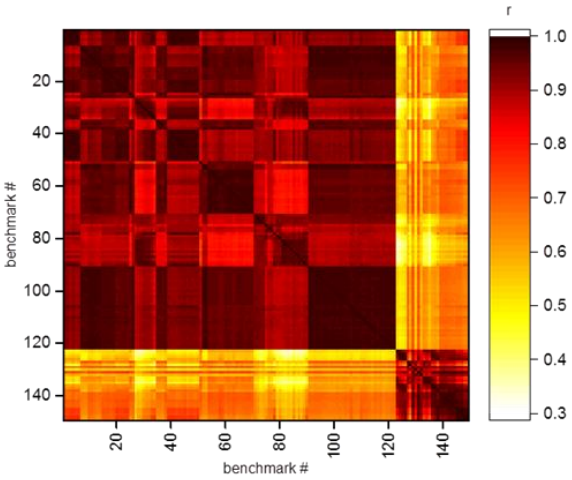
Contact: Riccardo.Puragliesi@psi.ch

PSI CSE/BUC and MCNP/NUSS -based Representativity Assessment for enhanced V&V

An application system



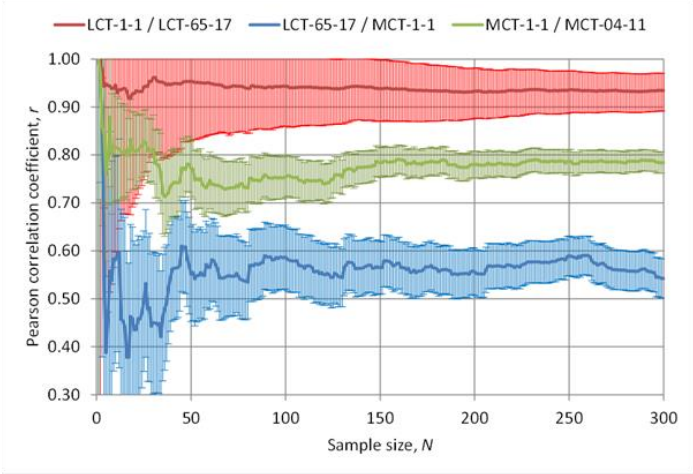
A benchmark experiment



NUSS can be used to produce a correlation matrix for the PSI validation benchmark suite + an application case

We need to assess systems "similarities" through correlation analysis

$$r = \frac{\sum_i^N (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_i^N (X_i - \bar{X})^2}\sqrt{\sum_i^N (Y_i - \bar{Y})^2}} \approx \frac{COV(X,Y)}{\sqrt{VAR(X)}\sqrt{VAR(Y)}} = \frac{\sigma_{XY}^2}{(\sigma_X \sigma_Y)}$$



The MS project goals:

- Identify additional criticality benchmarks, appropriate for BUC V&V (including Proteus configurations with SNF)
- Develop MCNP Models for the selected benchmarks
- Produce correlation matrix for the entire set of models
- Derive Upper Subcritical Limit for Keff of the application system using the performed V&V

Contact: Alexander.Vasiliev@psi.ch

PAUL SCHERRER INSTITUT

For more on STARS and associated research/education programs please consult

http://www.psi.ch/stars

PSI Home › Project STARS

- Project STARS
- About STARS
- Team
- Partners
- Code System
- Research & Highlights
- Scientific Support
- Education and Training
- Publications
- Progress Reports
- Events
- Quality Management

Welcome to the STARS Program