PAUL SCHERRER INSTITUT

PSI

Cedric Cozzo and Johannes Bertsch :: Paul Scherrer Institut

ATF activities at PSI: the swissnuclear project **ATF@LWR**

OECD/NEA 6th EGATFL Meeting, Boise, Idaho, USA, September 15-16, 2016

Context

- PSI ATF ongoing activites
  - PSI involved in CARAT
  - PSI involved in EU project MATISSE

- Swiss context
  - Long term phase out
  - Next votation november 2016: 45 years max
    https://www.admin.ch/ch/f/pore/vi/vis407t.html (in French)

Project at a glance

- What is swissnuclear?
  - nuclear energy section of swisselectric, the organisation of Swiss electricity grid operator (it comprises representants of the swiss nuclear electricity suppliers)

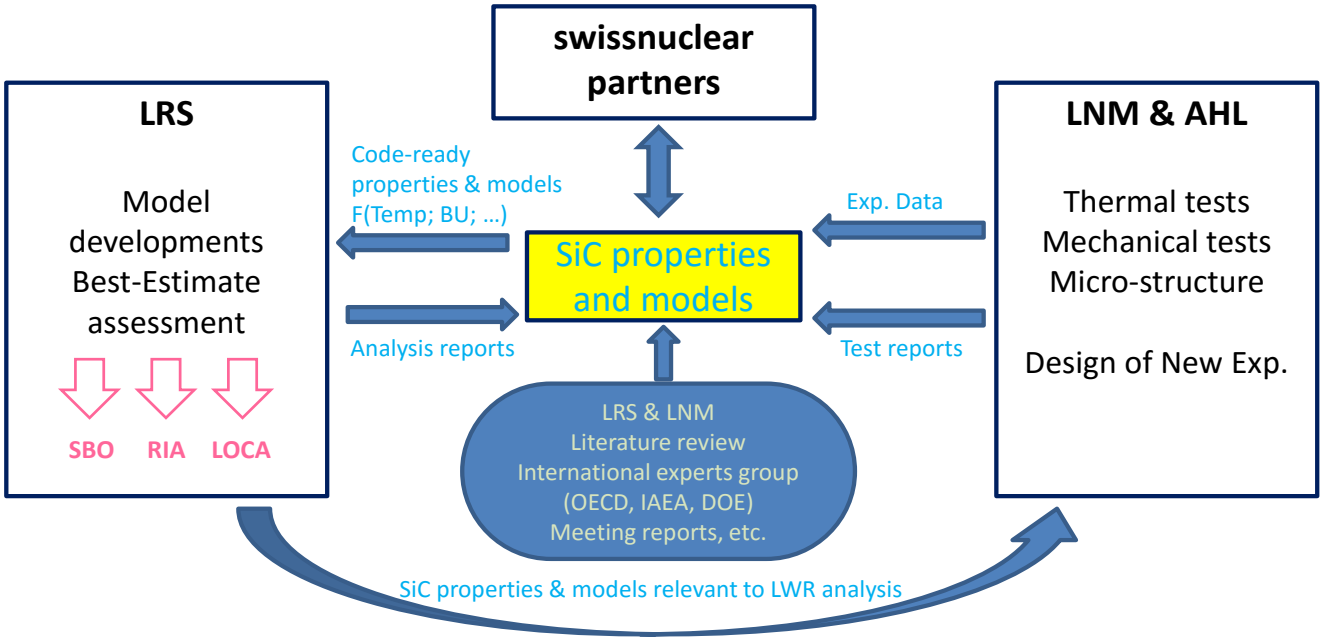
- Objectives of the study:
  - Implementation of selected SiC cladding thermomechanical properties
  - Pilot integral evaluation of SiC cladding using best-estimate sumulation schemes
  - Launch experimental programme to enrich state-of-knowledge on SiC properties for LWR application
  - Enrich PSI and swissnuclear partners state-of-knowledge

- Manpower
  - 15 pm (LRS)
  - and 15 pm (LNM)

- Contributors involved
  - PSI: LNM, LRS (a little AHL)

- Time frame
  - 2 years: Sept. 16 – Aug. 18

Overview of the project



Model	Inventory of properties required by the simulation codes (CASMO-SIMULATE, FALCON, TRACE)
Model	Implementation and verification of the SiC/SiC properties and models into codes
Model	Evaluation of SiC/SiC on basis of representative accident scenarios (LOCA/RIA/SBO)
Exp	Measurement of thermal conductivity of tubular SiC/SiC samples (vs irradiation)
Exp	3-point mechanical tests of SiC irradiated in SINQ (3.1 – 7.7 dpa)
Exp	Investigation of microstructure and failure mechanisms

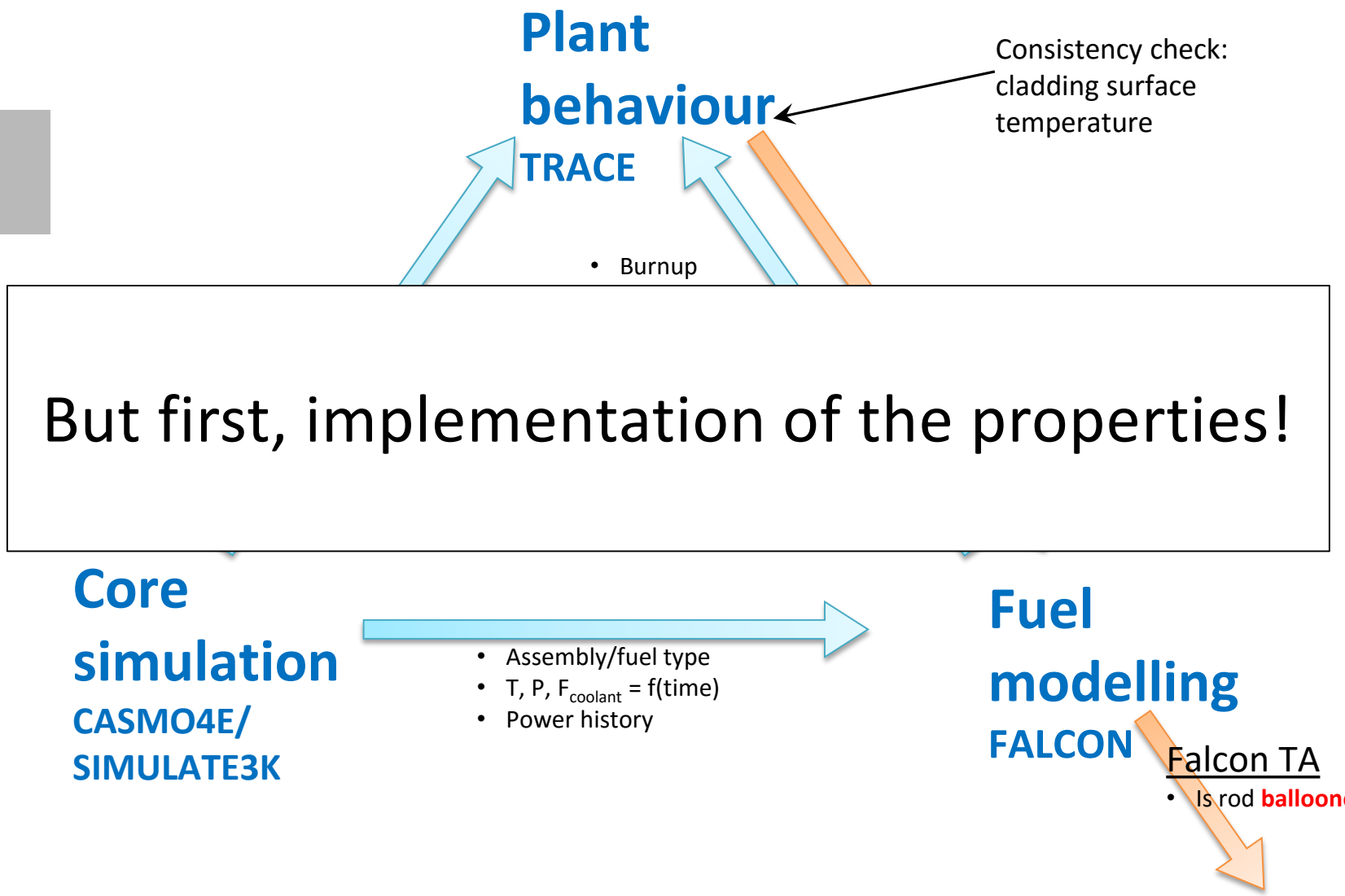
Program

- General:
  - Internal database focused on the properties/models that will be implemented
  - Internal interaction between experimental and modelling

- LRS: modelling
  - Starting point:
    - Loose coupling of codes for Accident simulation mentioned in Top Fuel 2016 (LOCA)
  - Codes that will be used
    - SIMULATE3K: neutronics
    - TRACE: thermo-hydraulics
    - FALCON: fuel thermo-mechanics
  - Limitations

- LNM: experimental
  - Starting point
    - Last sn proposal
  - Planned measurements (see previous slide)
    - Thermal conductivity
    - Mechanical tests
    - Microstructural investigation
  - Limitaitons

LRS: Cross modeling approach



SiC/SiC TC measurements - apparatus

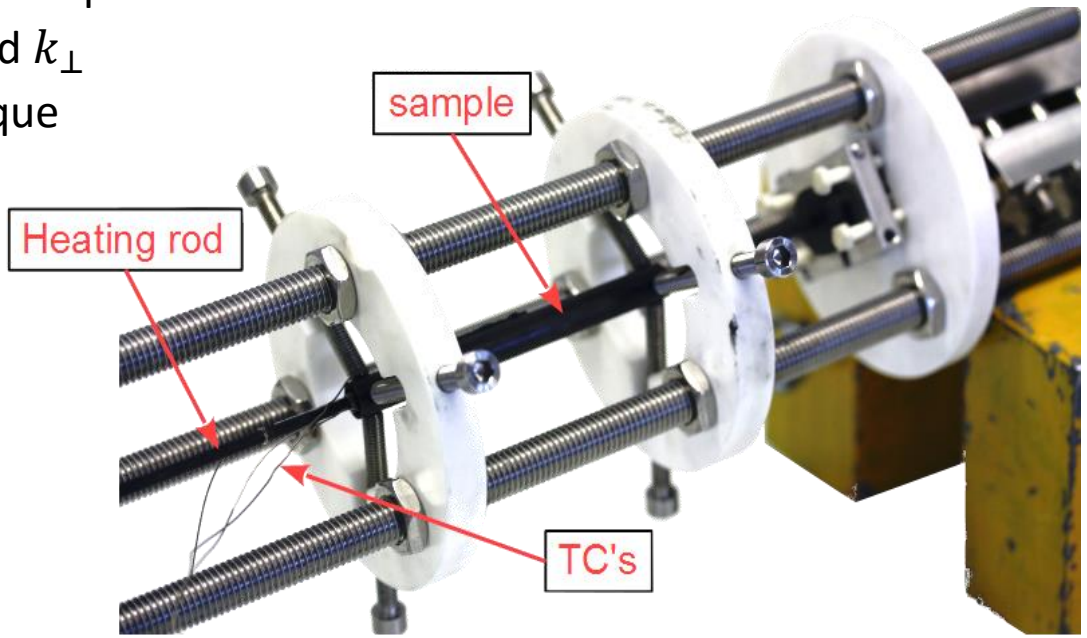
- Radial heat flow apparatus → axis-symmetric setup

Pros

- Flexible:
  - Length: 3 to 25 cm
  - $Ø_{in}$: min 6 mm
  - $Ø_{out}$: max 40 mm
  - T: RT to ~700°C
- Can measure active samples
- Decoupling of $k_{\parallel}$ and $k_{\perp}$
- Steady-state technique

Cons

- Heat exchange rates through radiosity analysis (Gebhart) → sensitive to uncertainties
- Lengthy (7-10 day per measurement)
- Thermocouples attachment (glue)



My thanks go to

- J.-C. Chen
- Y. Dai
- A. Dokhane
- L. Fave
- H. Ferroukhi
- M. A. Pouchon
- S. Rahman
- A. Vasiliev
- O. Zerkak

and

- **swissnuclear**