

Workshop on “Nuclear fuel modelling in support of safety and performance enhancement of water-cooled reactors”

Workshop Co-chairs: K. Pasamehmetoglu (INL), M.
Petit (IRSN), T. Besmann (USC)

NEA Secretariat: S. Massara (NSC), M. Kissane (CSNI)

7-9 March 2017, NEA HQ

NSC activities

Nuclear Science Committee (NSC)

Expert Group on Integral Experiments for Minor Actinide Management

Working Party on International Nuclear Data Evaluation Co-operation (WPEC)

- High Priority Request List for Nuclear Data
- Methods and Issues for the Combined Use of Integral Experiments and Covariance Data
- Co-ordinated Evaluation of ^{239}Pu in the Resonance Region
- Scattering Angular Distribution in the Fast Energy Range
- Evaluation of Experimental Data in the Resolved Resonance Region

Expert Group on Accident Tolerant Fuels for LWRs

Working Party on Scientific Issues of the Fuel Cycle (WPFC)

- Heavy Liquid Metal Technologies
- Fuel Recycling Chemistry
- Advanced Fuel Cycle Scenarios
- Innovative Structural Materials
- Innovative Fuels
- Task Force on Benchmarking of Thermal-hydraulic Loop Models for Lead-alloy-cooled Advanced Nuclear Energy Systems

Working Party on Multi-scale Modelling of Fuels and Structural Materials for Nuclear Systems (WPMU)

- Validation and Benchmarks of Methods
- Multi-scale Modelling Methods
- Structural Materials Modelling
- Multi-scale Modelling of Fuels
- Primary Radiation Damage

Working Party on Nuclear Criticality Safety (WPNCs)

- Advanced Monte Carlo Techniques
- Criticality Safety Benchmarks
- Burn-up Credit
- Criticality Excursions
- Assay Data of Spent Nuclear Fuel
- Uncertainty Analyses for Criticality Safety Assessment

Working Party on Scientific Issues of Reactor Systems (WPRS)

- Reactor Physics and Advanced Nuclear Systems
- Uncertainty Analysis in Modelling
- Reactor Fuel Performance
- Radiation Transport and Shielding

IAEA/FUMEX

Expert Group on MP Experimental Data, Benchmarking and Validation

Executive Group of the NSC (Data Bank Management Committee)

Databases and Scientific Services

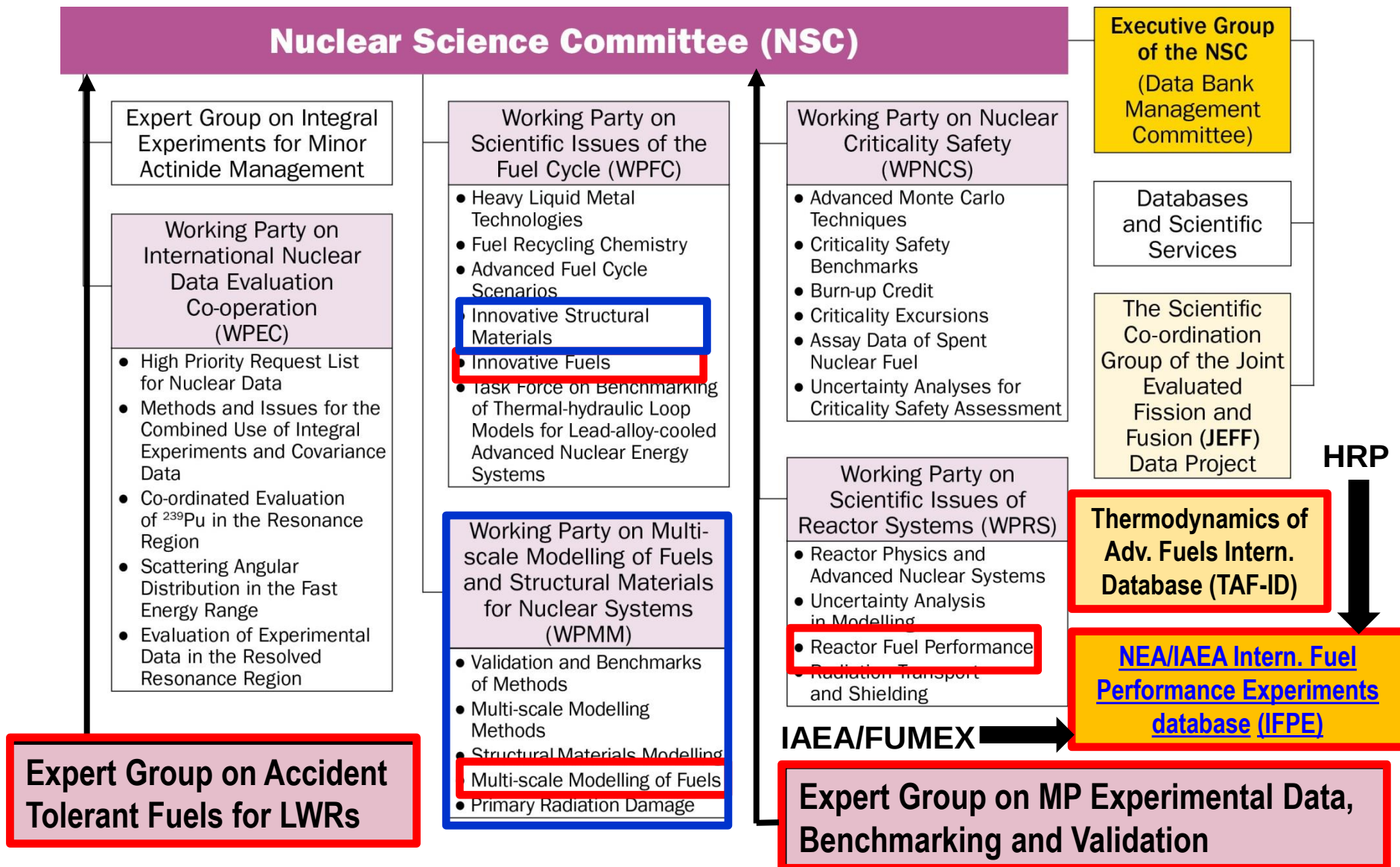
The Scientific Co-ordination Group of the Joint Evaluated Fission and Fusion (JEFF) Data Project

Thermodynamics of Adv. Fuels Intern. Database (TAF-ID)

[NEA/IAEA Intern. Fuel Performance Experiments database \(IFPE\)](#)

HRP

NSC activities **related to fuels** and **structural materials**



Materials Database

EG on Reactor
Fuel Performance
(EGRFP)

International Fuel
Performance Experiments
Database (IFPE)

Project on
Thermodynamics of Advanced
Fuels International Database
(TAF-ID)

Task Force on 'Unit
mechanisms of gaseous FPs
release'

EG on Multiscale Modelling
of Fuels (EGM2F)

Working Party on Multiscale
Modelling (WPMM)

Advanced Modelling

*EG on Multiphysics,
Experimental Data,
Benchmarking and
Validation (EGMPEBV)**

Advanced Materials Research

EG on Accident Tolerant
Fuels for LWRs (EGATFL)

*EG on Innovative
Fuels (EGIF)**

*EG on Innovative
Structural Materials
(EGISM)**



Materials Database

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Advanced Modelling

CSNI

Working Group on
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Advanced Modelling

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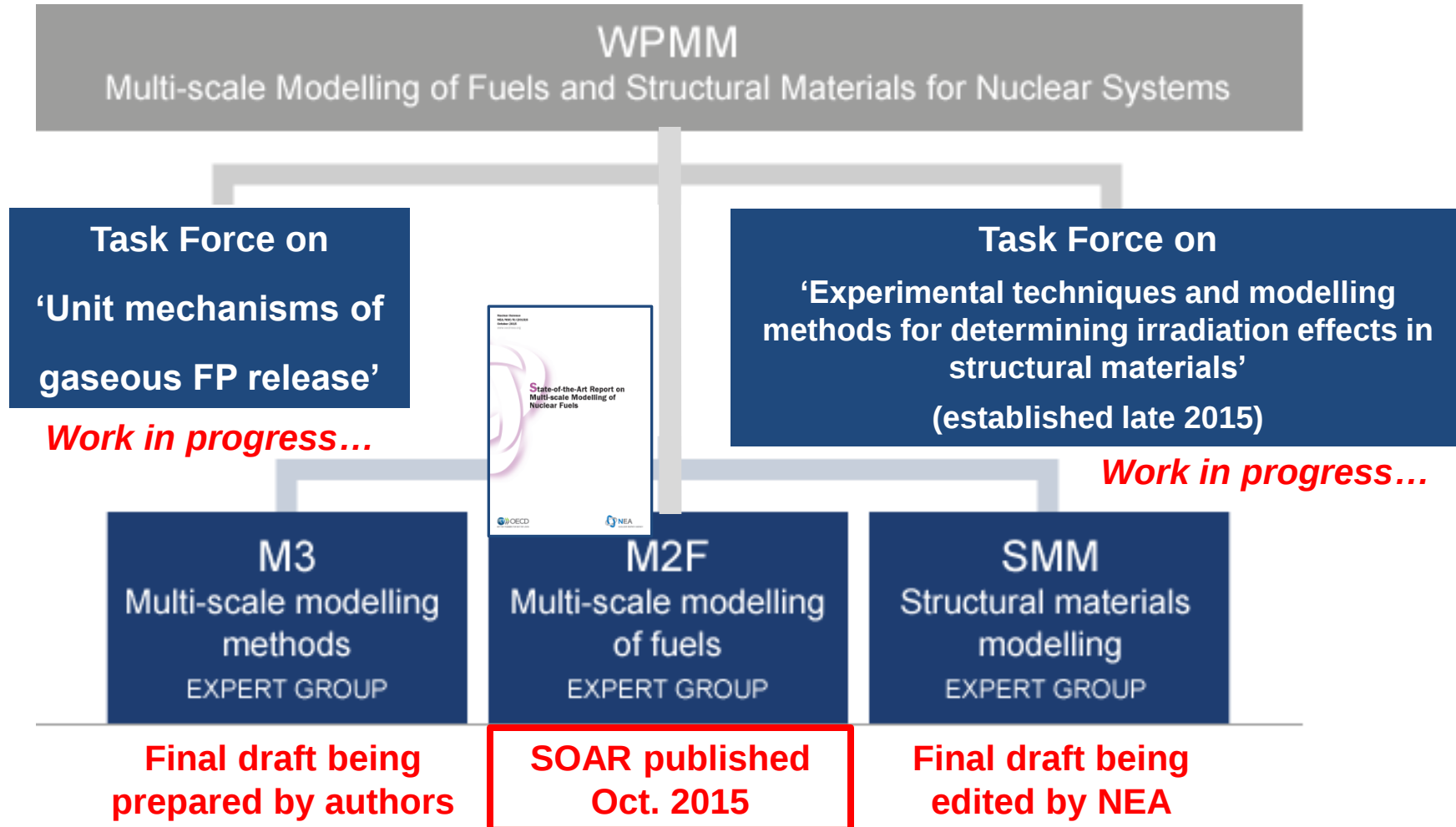
Advanced Materials Research

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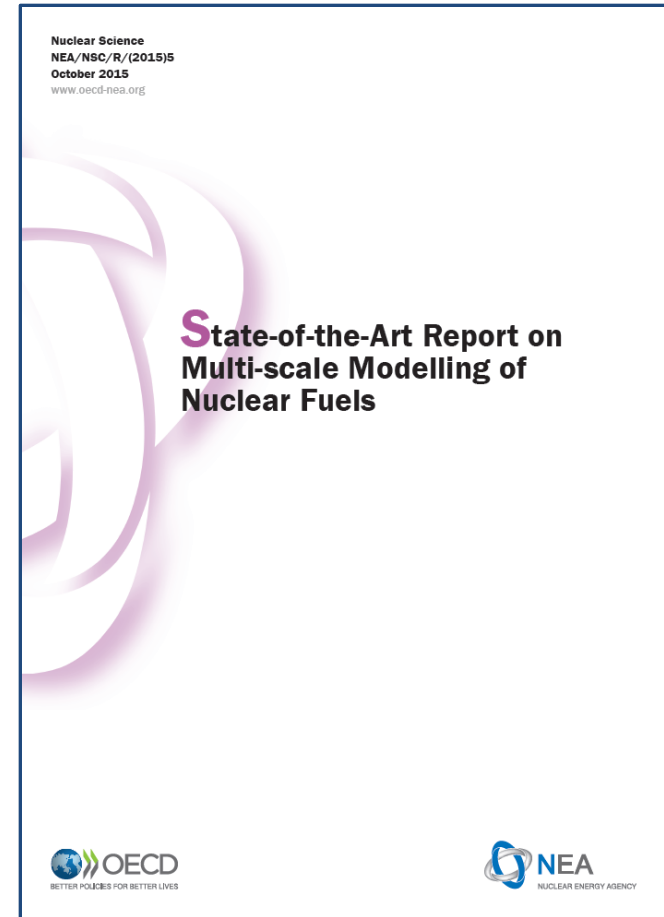
*EG on Innovative
Structural Materials
(EGISM)**

Structure of the WPMM Expert Groups (2015 – 2017) and status Jan. 2016



EG on Multiscale Modelling of Fuels (M2F)

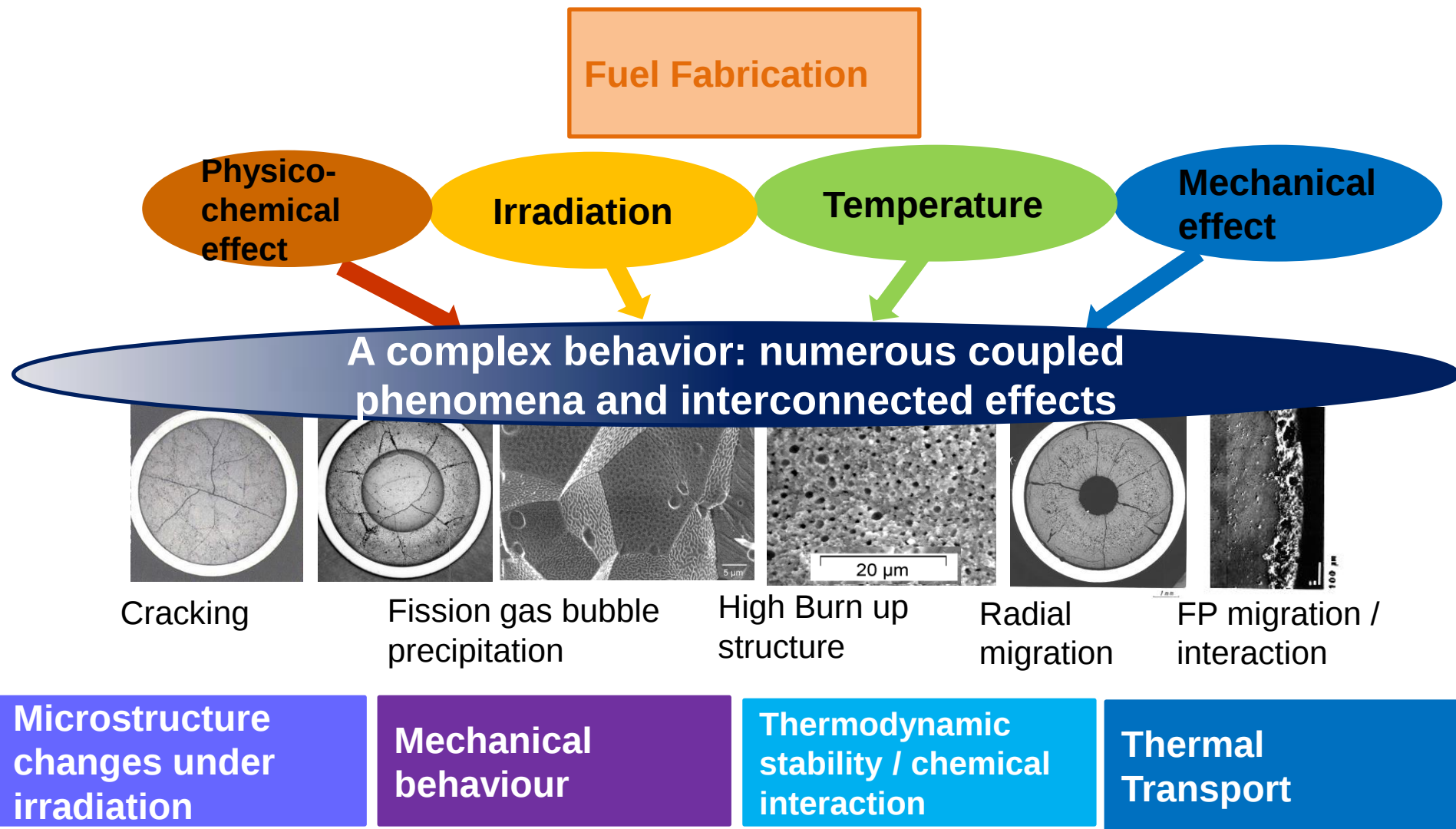
- Assess multi-scale modeling approaches devoted to nuclear fuels from the atomic to the macroscopic scale
 - Address all types of fuels: both current (mainly oxide fuels) and advanced fuels
 - Address key engineering issues associated with each type of fuels
 - Assess the quality of existing links between the various scales
- ❑ Report published Oct. 2015
 - ❑ Chair & SOAR editor: T. Besmann (Univ. of South Carolina)
 - ❑ 54 authors and co-authors
 - ❑ 380 pages



Download at:

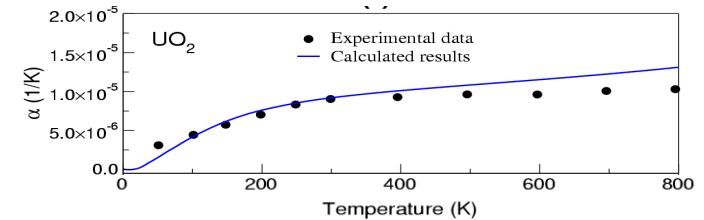
<https://www.oecd-nea.org/science/docs/2015/nsc-r2015-5.pdf>

Part I : Phenomena relevant for nuclear fuels: state of the art and challenges of their modeling

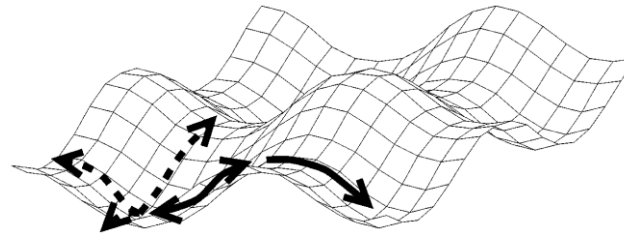


Part II: Methodologies for Developing and Assessing Material Properties

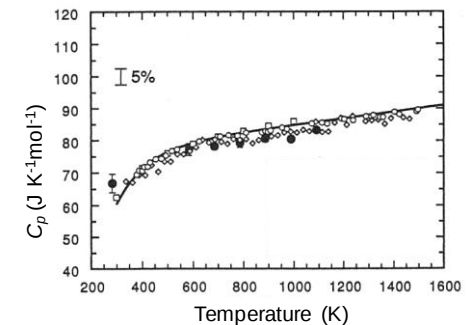
Thermal expansion



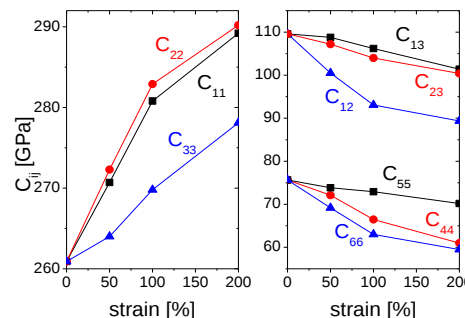
Atomic transport properties



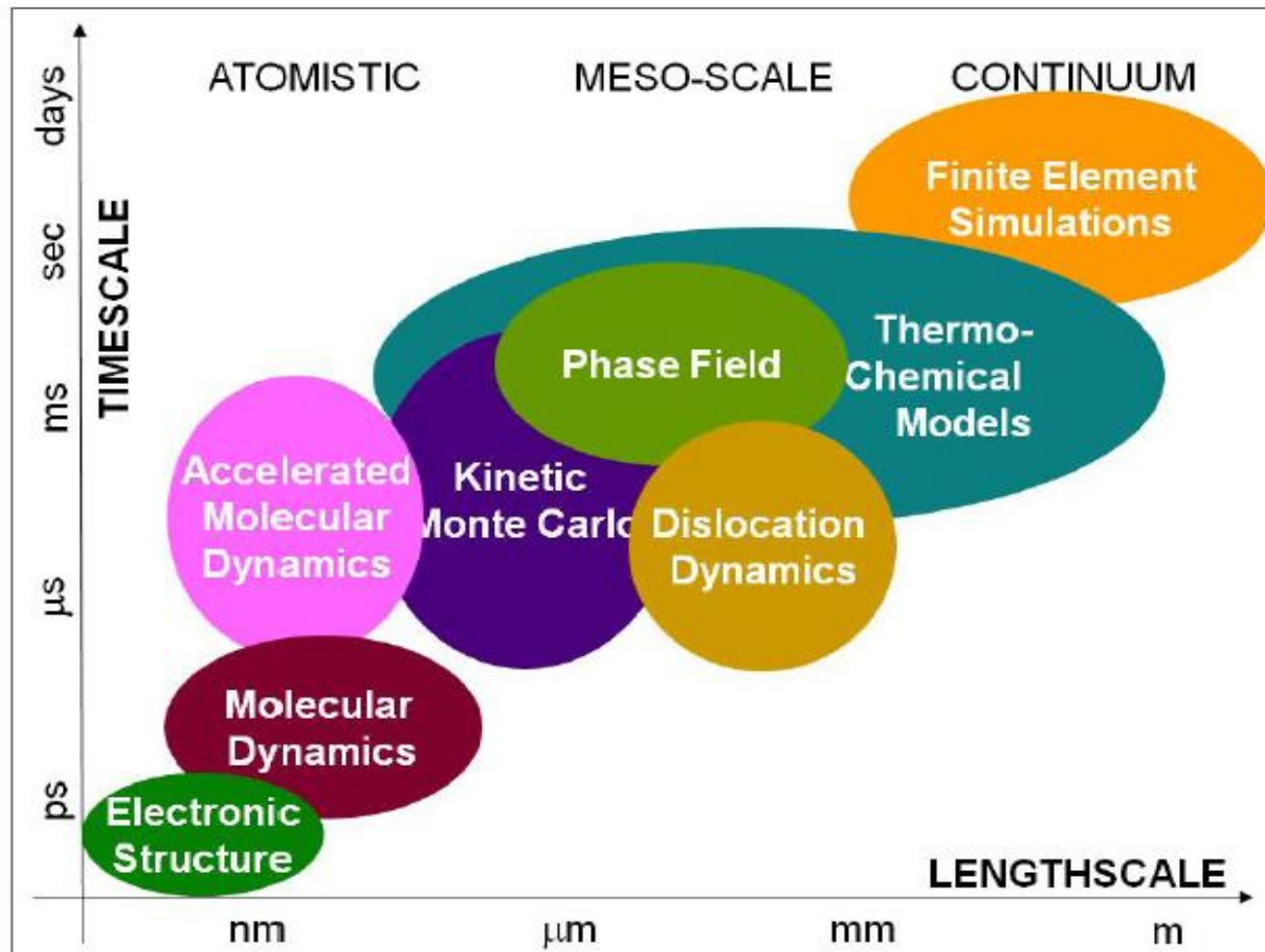
Free energy/heat capacity



Elastic and mechanical properties



Part III: Modeling and computational principles, specificities regarding fuel



Materials Database

NSC

**EG on Reactor
Fuel Performance
(EGRFP)**

International Fuel
Performance Experiments
Database (IFPE)

Advanced
Materials
Research

*Needs in order to improve
the economic performance
of nuclear fuel*

*Needs in order to improve
the design of ATF*
**EG on Accident Tolerant
Fuels for LWRs (EGATFL)**

NEA Workshop (7-9 March 2017)

*How fuel modelling could
contribute (at least partially)
addressing some of these needs*

EG on Innovative
Fuels (EGIF)

**EG on Multiscale Modelling
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EG on Multiphysics
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EG on Innovative
Structural Materials
(EGISM)

Working Party on Multiscale
Modelling (WPMM)

*Needs to allow safety
enhancement of LWRs*

CSNI

**Working Group on
Fuel Safety (WGFS)**

Advanced Modelling

Proposal of OECD/NEA workshop

- ❑ **Nuclear fuel modelling in support of safety and performance enhancement of water-cooled reactors**
- ❑ Targeted period: 7-9 March 2017, NEA HQ
- ❑ Objectives and scope
 - To identify areas where **advanced rod-scale, mesoscale or microscale (or any multiscale integration of these) modelling of nuclear fuels is contributing or may contribute to significant progress on or insights into fuel safety and/or fuel performance** for water-cooled reactors. The focus will be on the design and operation of nuclear fuel, with consideration of nominal and off-nominal operating conditions including design-basis accidents.
 - To identify gaps and possible experimental needs.
 - To identify areas for enhanced international collaboration, and the NEA contribution.

Proposal of OECD/NEA workshop

For each of these areas (safety, economic performance) the workshop will aim at

- **promoting discussions between the communities of experts in different fuel areas** (fuel modelling, fuel safety, fuel economic performance)
- with the **aim of identifying key items which would strongly benefit from the application of advanced modelling techniques** in a “reasonable” timeframe (5-10 years).

Proposal of OECD/NEA workshop

Support for the organisation of this workshop will be provided by Expert Group members involved in these activities:

- WPMM EG on Multiscale Modelling of Fuels (M2F), Chair: T. Besmann
 - WPRS EG on Reactor Fuel Performance (EGRFP), Chair: G. Rossiter
 - EG on Accident Tolerant Fuels for LWR (EGATFL), Chair: K. Pasamehmetoglu
 - CSNI Working Group on Fuel Safety (WGFS), Chair:, M. Petit
- + on-going contacts with IAEA Fuel Engineering Section

Further steps

Formal endorsement by NEA Nuclear Science Committee (NSC) bureau and CSNI Working Group on Fuel Safety.

Further steps prior to request formal approval by NSC and CSNI at next NSC and CSNI meetings:

- 1st preparation meeting (videoconference) with Scientific Advisory Committee on 27 April
- Presentation and discussion at next annual meeting of WPMM (17-19 May)
- Pre-announcement in June 2016

Participation by EGATFL members is highly encouraged!