INSPYRE

Investigations Supporting MOX Fuel Licensing in ESNII Prototype Reactors

Introduction on INSPYRE

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CEA, DEN, DEC, Centre de Cadarache

INSPYRE First school,
Delft, May 13-17, 2019

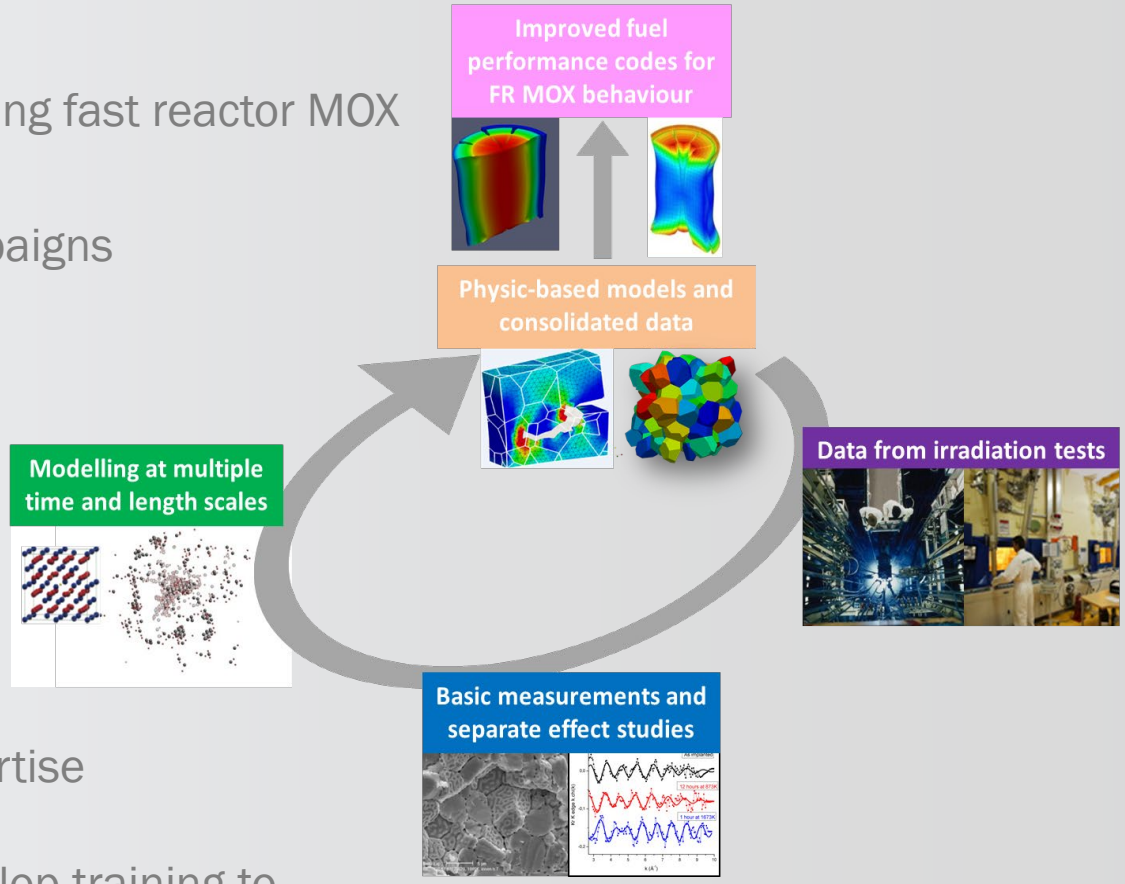
The Project

INSPYRE: Investigations Supporting MOX Fuel Licensing in ESNII Prototype Reactors

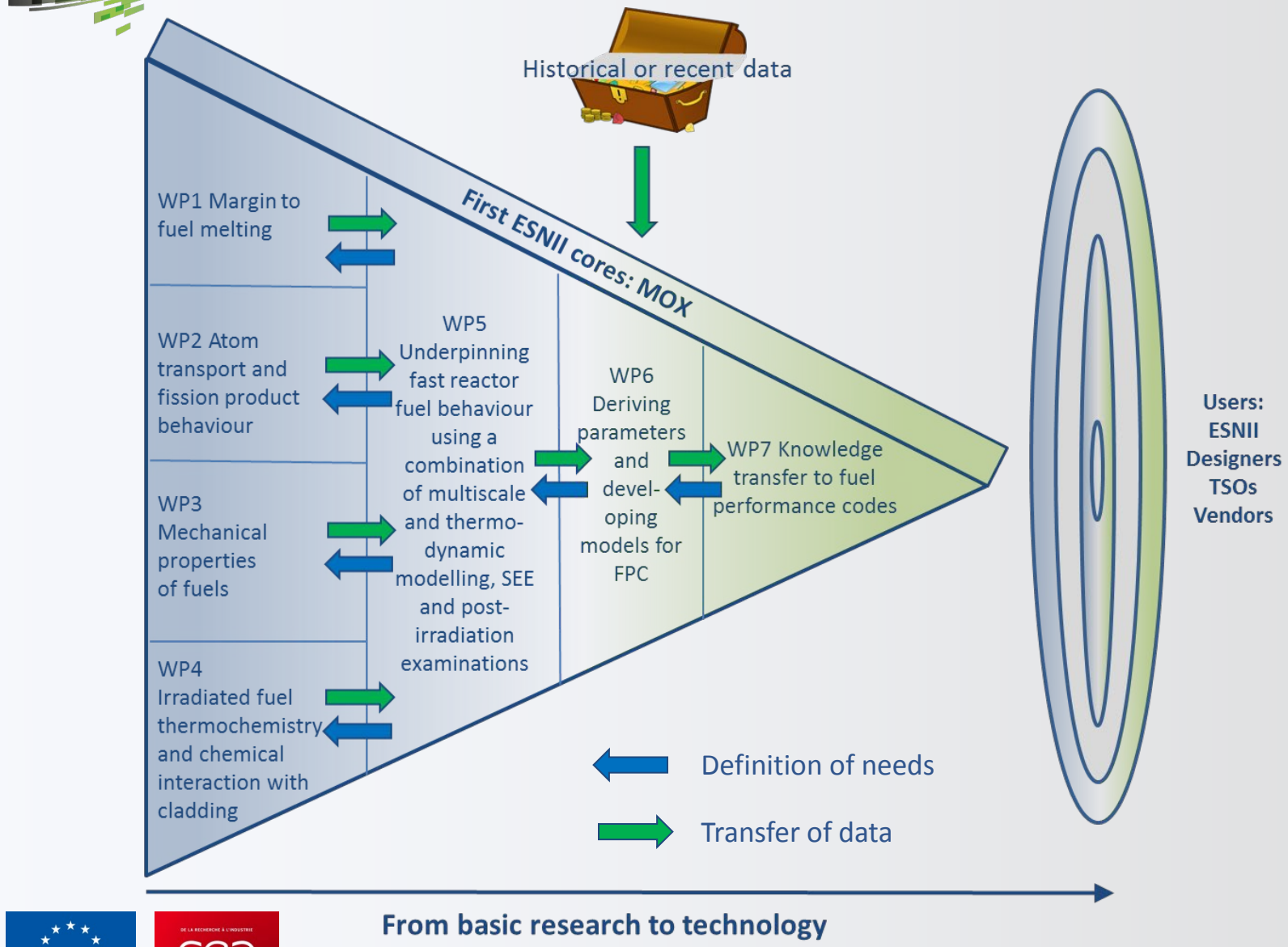
- Answer to section 5 of H2020 Euratom call for 2016-2017: Materials research for Generation-IV reactors
- Under the auspices of the Joint Programme of Nuclear Materials (JPNM) of the European Energy Research Alliance
- Aim of project: harness basic and applied science to
  - Make the motto “Better data in better codes for better predictive performance” a reality
  - Bring significant advances to the licensing of MOX fuel, first cores of ESNII reactors by solving operational and safety issues
- Total budget: 9.37 M€; European contribution: 4.00 M€
- Start: September 1st, 2017
- Duration: 4 years

INSPYRE Strategic Objectives and Approach

- Make major breakthrough in understanding and describing fast reactor MOX behaviour under irradiation by coupling
  - PIE results on neutron-irradiated fuel from past campaigns
  - Separate effect experiments
  - Multiscale and thermodynamic modelling
- Advance predictive capabilities of fast reactor fuel performance codes by
  - Transferring knowledge acquired from basic and technological research into operational tools
  - Bringing together experts from various areas of expertise
- Transfer results and approach of proposal to users, develop training to prepare next generation of researchers and initiate or participate in outreach activities to improve public acceptance of next reactor generation



INSPYRE Rationale and Organisation



+ 3 support WP

- WP8: Education and training and exchanges
- WP9: Communication, dissemination and exploitation of results
- WP10: Project management

User Group

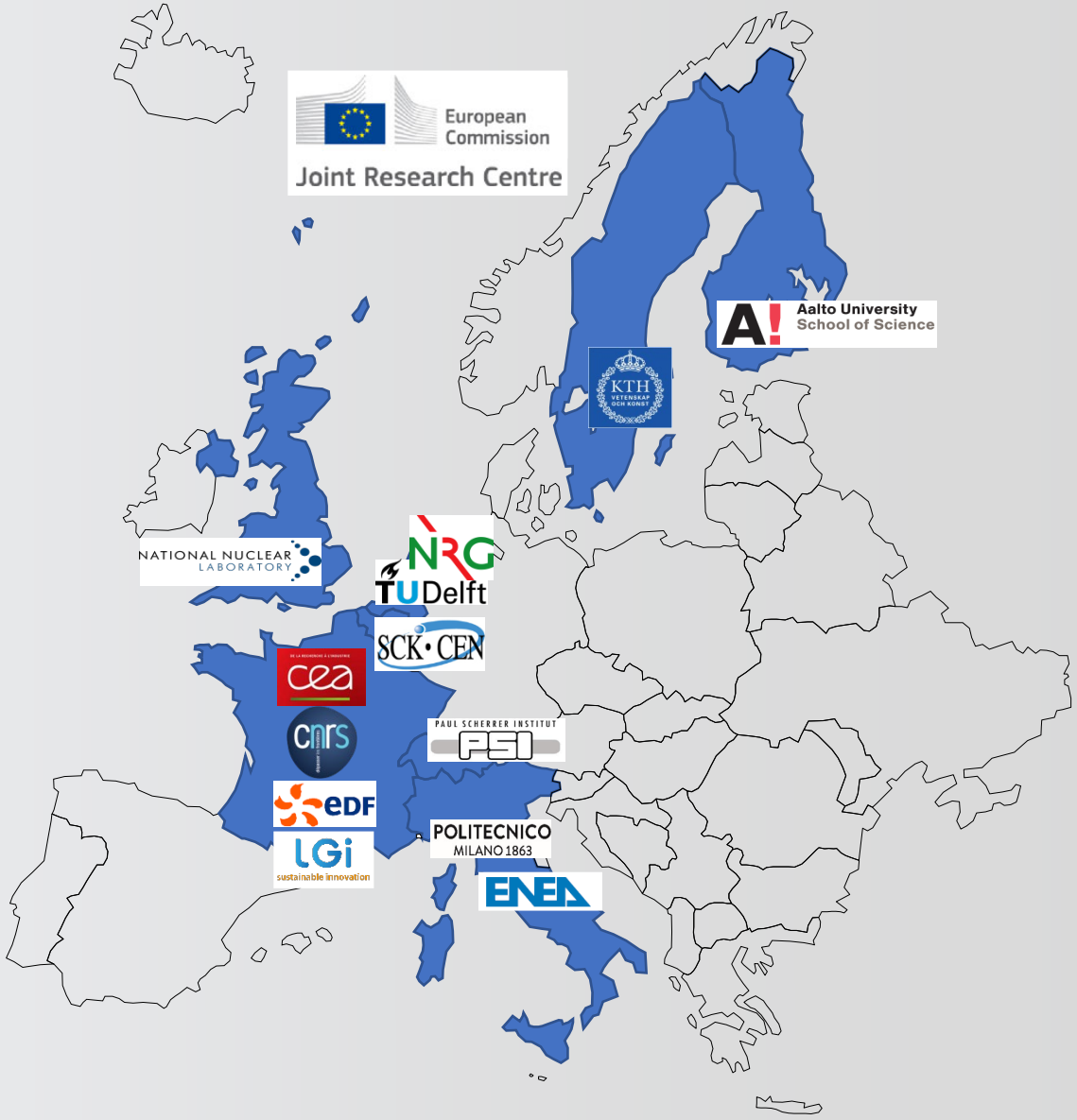
Customers of the project: designers of ESNII reactor concepts, future fuel manufacturers, operators and TSOs that will license them

Organisation	Who
ESNII	Peter Baeten, SCK.CEN
ASTRID	Nicolas Devictor, CEA
MYRRHA	Hamid Hamid Aït Abderrahim, SCK.CEN
ALFRED FALCON Consortium	Alessandro Alemberti, Ansaldo Nucleare
ALLEGRO	Akos Horvath, MTA center for Energy research
TSO	?, IRSN
EDF	Eric Molinié, EDF
AREVA	Dominique Favet, MELOX

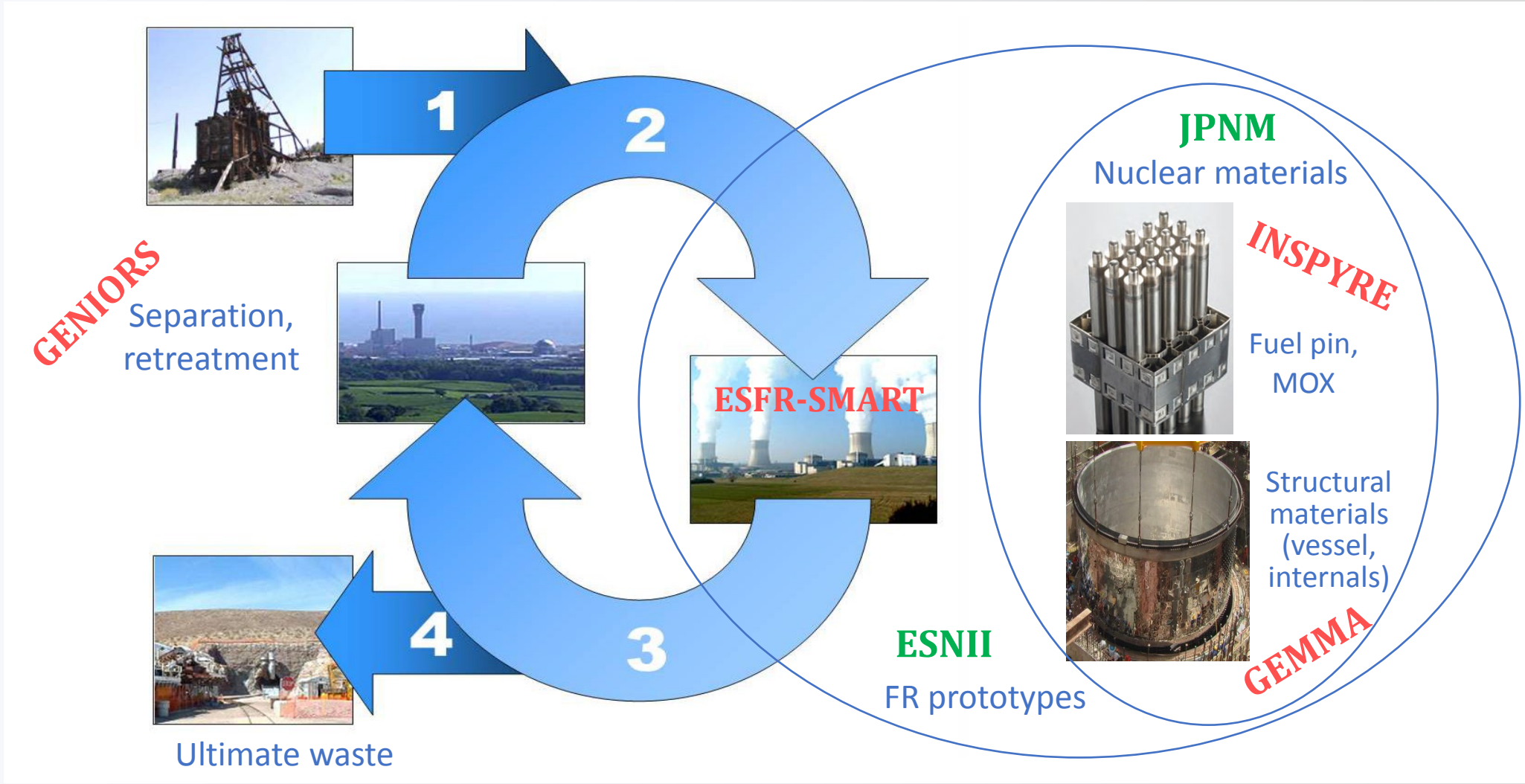
Partners

- Nuclear organizations: CEA/DEN (France), JRC (European Commission), ENEA (Italy), NNL (UK), NRG (The Netherlands), PSI (Switzerland), SCK.CEN (Belgium)
- Industrials: EDF (France)
- Academic organizations: CNRS (France), Aalto (Finland), KTH (Sweden), Polimi (Italy), TU Delft (The Netherlands)
- SME: LGI (France)

8 countries + JRC



Links to others H2020 projects and European initiatives



Achievements of the First 18 Months

Laying the foundations for the success of INSPYRE

Analysis of available data and models and identification of gaps, e.g. thermodynamic description of (U-Pu-Am-O) system and models for MOX fuel in fast reactor conditions

Development of new experimental set-ups in hot labs of several partners: electrical conductivity device, positron annihilation lifetime spectrometer, compression test with O content control, High temperature Raman spectrometer, laser heating devices

- First detailed characterizations of fresh uranium-plutonium oxide samples: microstructure, He behaviour
- Significant progress in the preparation of the experiments planned for the measurement of creep under irradiation in the CNRS cyclotron in Orléans and the High Flux Reactor in Petten. Experiments will start in 2019

- First-of-a-kind electronic structure calculations on defect behaviour and fission gas incorporation in MOX
- Assessment of capability of Adaptive Kinetic Monte Carlo for investigation of fuel under irradiation
- At the microscale, development of physics-based models describing inert gas behaviour, thermal and mechanical evolution

E&T activities 2018-2019

Generation IV reactors fuel cycle

First INSPYRE school
May 13-17, 2019, Delft (NL)

The school, designed for graduate students, young scientists and professionals, will give a comprehensive overview of the nuclear fuel cycle for next generation nuclear reactors.
It will cover key aspects of chemistry, physics and materials science involved in each stage of the fuel cycle, with a particular focus on the challenges of oxide fuels.

Courses and tutorials

- Generation IV systems and closed fuel cycle
- Fuel manufacturing and qualification
- Detailed fuel characterization
- In-reactor behaviour
- Multiscale modelling & fuel performance codes
- Fuel reprocessing and recycling

Visit of the research reactor at the Reactor Institute Delft.

INSPYRE

GENIORS

funded by the Euratom research and training program 2014-2018

Organizing committee
Anna L. Smith - TU Delft
Philippe Martin - CEA

Advisory committee
Marjorie Bertolus - CEA
Stephane Bourg - CEA
Pär Olsson - KTH

Registration deadline 15 January 2019

www.eera-jpnm.eu/inspyre

INSPYRE-school@tudelft.nl

INSPYRE

NuFuel

Research into Nuclear Fuel in Europe

MMSNF 2019

PAUL SCHERRER INSTITUT

PSI

4-7 NOVEMBER 2019

PAUL SCHERRER INSTITUT | SWITZERLAND

The NuFuel-MMSNF workshop is organised as part of the Horizon 2020 project INSPYRE, which received funding from the EURATOM research and training programme 2014-2018 under Grant Agreement No 754329.

Chairs: M. Krack, S. Nichenko (PSI), A. Del Nevo (ENEA), H. Chichester, L. Capriotti (INL)

Implementation of a mobility scheme

To foster the mobility of researchers between partner institutes of the project

Will allow access to hot laboratories and specific facilities for PhDs, Post Docs, master students, researchers, and increase collaborations between partners

Dissemination and Communication

Communication

- Website online since September 2017, refurbished in first trimester 2019
- First newsletter distributed in December 2018

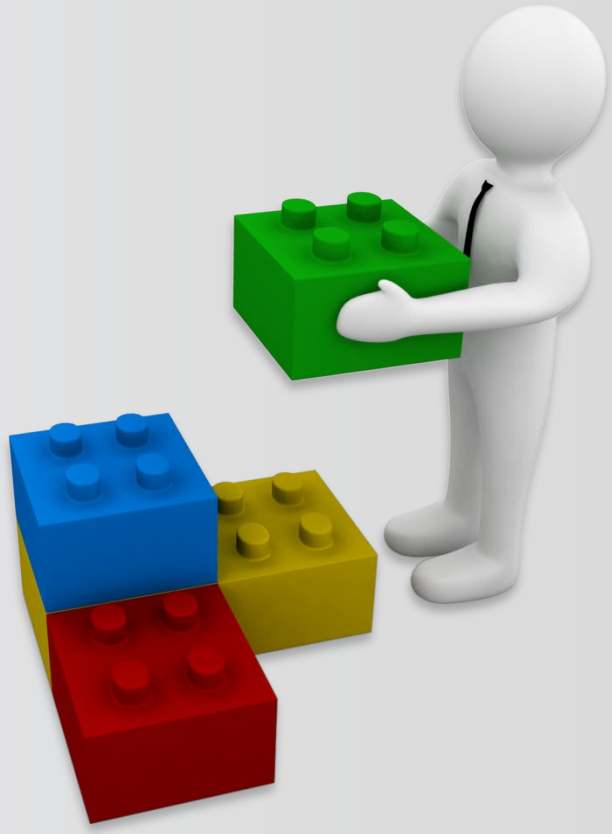
Dissemination of results

- 9 peer-reviewed articles submitted to journals
- 30 abstracts submitted for communications at conferences
- 4 PhD defended

Conclusion

INSPYRE importance

- Ambitious objectives
- Challenging studies on challenging materials
- Common work between a lot of researchers with different areas of expertise
- Very important for the European community on nuclear fuel research
- After 18 months, already significant progress made, some difficulty appearing



Agenda of the school

Agenda

		Topic	Courses and tutorials	Speaker
Monday 13/05	10.00-10.15	Introduction	Introduction INSPYRE	M. Bertolus, *CEA DEN*
	10.15-11.00		General introduction on Gen IV and ESNII concepts and associated fuels	A. Alemberti, *Ansaldo Nucleare*
	11.00-11.45		Closed fuel cycle and transition from LWRs to fast reactors	S. Bourg, *CEA.DEN*
	11.45-12.00		Coffee break	
	12.00-12.45		Structural materials challenges for ESNII reactors	L. Malerba, *CIEMAT*
	12.45-14.00		Lunch	
	14.00-14.45	Innovative (oxide) fuels containing minor actinides	Gen IV advanced fuel fabrication routes (Part I)	K. Popa, *JRC Karlsruhe*
	14.45-15.30		Gen IV advanced fuel fabrication routes (Part II)	R. Vauchy, *CEA DEN*
	15.30-16.00		Coffee break	
	16.00-16.45		Thermodynamic aspects of nuclear fuels (experiments)	R. Konings, *JRC Karlsruhe*
	16.45-17.45		Student presentations (3 min each)	
Tuesday 14/05	9.00-9.45		Thermodynamic aspects of nuclear fuels (modelling)	C. Guéneau, *CEA DEN*
	9.45-10.30	Fuel behaviour under irradiation (Part I)	Fuel chemistry and thermodynamic aspects under irradiation	R. Konings, *JRC Karlsruhe*
	10.30-10.45		Coffee break	
	10.45-11.30		Fuel microstructural evolution and thermal properties under irradiation	J. Noirot, *CEA DEN*
	11.30-12.15		Transmutation: irradiation and post-irradiation examination	E. D'Agata, *JRC Petten*
	12.15-13.30			
	13.30-14.30	Fuel behaviour under irradiation (Part II)	Student presentations (3 min each)	
	14.30-15.15		Simulation methods and multiscale modelling	P. Olsson, *KTH*
	15.15-15.45		Coffee break	
	15.45-16.30		Fuel performance codes	L. Luzzi, *Politecnico di Milano*
	16.30-17.15		Tutorial on multiscale modelling (1h30 - half of the group)	P. Olsson, *KTH* M. Bertolus, *CEA DEN*
	17.15-18.00		Tutorial on thermodynamic modelling (1h30 - half of the group)	C. Guéneau, *CEA DEN* E. Epifano, *ONERA*
	18.30-21.00		School banquet	

Agenda

Wednesday 15/05	9.00-9.45	Irradiation tests in research reactors and experimental facilities	Behavior of fast reactor fuel during transient and accident conditions	A. Rineiski, *KIT*
	9.45-10.30		Irradiation tests in research reactors	R. Hania, *NRG*
	10.30-10.45		Coffee break	
	10.45-11.30		Hot labs and post irradiation examination	J. Noirot, *CEA DEN*
	11.30-12.15		Separate effect studies	M.F. Barthe, *CNRS-CEMHTI*
	12.15-13.30		Lunch	
	13.30-14.15	Fuel reprocessing, recycling and radioactive waste (Part I)	Spent fuel reprocessing strategies & proliferation issues	A. Geist, *KIT*
	14.15-15.00		Safety/criticality issues during reprocessing	L. Flint, NNL
	15.00-15.30		Coffee break	
	15.30-16.15		Modelling and simulation of processes	B. Dinh, *CEA DEN*
	16.15-17.00		Tutorial on modelling of processes (1h30)	B. Dinh, *CEA DEN*
	17.00-17.45			
Thursday 16/05	9.00-9.45	Visit + Tutorials	RID research reactor tour	Visit RID (1h30)
	9.45-10.30			
	10.30-10.45		Coffee break	
	10.45-11.30		Tutorial on Fuel Performance Codes (1h30 - half of the group)	L. Luzzi, *Politecnico di Milano* D. Pizzocri, *Politecnico di Milano*
	11.30-12.15			
	12.15-13.30		Lunch	
	13.30-14.00		QUIZZ	30 min
	14.00-14.45	Fuel cycle in MSRs	MSR concept and fuel cycle	J.L. Kloosterman, *TU Delft*
	14.45-15.30		Fuel fabrication, fuel chemistry and in-reactor behaviour	E. Capelli, *ENEA*
	15.30-16.00		Coffee break	
	16.00-16.30	Case studies	Case study: MOX in fast reactors	R. Vauchy, *CEA DEN*
	16.30-17.00		Case study: $(U,Am)O_2$ and JOG chemistry in fast reactors	E. Epifano, *Onera*
	17.00-17.30		Case study: Fuel performance codes in fast reactors	D. Pizzocri, *Politecnico di Milano*
	17.30-20.00		School BBQ	
Friday 17/05	9.00-9.55	Fuel reprocessing, recycling and radioactive waste (Part II)	Reprocessing of metallic fuels and pyrochemistry	J. Serp, *CEA*
	9.55-10.50		Radiolytic effects/radiological issues on the performance of reprocessing	H. Galan, *CIEMAT*
	10.50-11.05		Coffee break	
	11.05-12.00		Dissolution issues	N. Dacheux, *ICSM*

Thank you for your attention

INSPYRE has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 754329.
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