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Application

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The target participants are junior as well as experienced scientists and engineers in the broad field of nuclear sciences, engineering and technologies.

The application form should be filled out online at: http://www.fjohss.eu

Should there be any problem with the online registration, please contact: fjoh@cea.fr

Application deadline: May 20th, 2023
Full Registration fees: €2200

Information for payment of the fees will be provided after review of the applications.

The fees cover: lectures, class notes, meals and accommodations at the GenoHotel Karlsruhe from August 23rd evening to September 1st, 2:00 pm.

The fees do not cover travel expenses.

A small number of **fellowships** wil be available for qualified candidates. A fellowship covers the amount of €1100, the same amount of €1100 having to be financed by the applicant or his/her employer. These fellowships are primarily intended for candidates from developing countries. Requests should be motivated.

All applicants are required to provide a short curriculum vitae, which will be used for selection purposes.

The FJOH School considers that the 2023 program corresponds approximately to **3-4 ECTS credits** of post graduate-level course work in Nuclear Engineering.

Selection by the FJOH School organizers is final.

Partial participations are not accepted.

Information

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Key dates

May 20th, 2023: Application deadline

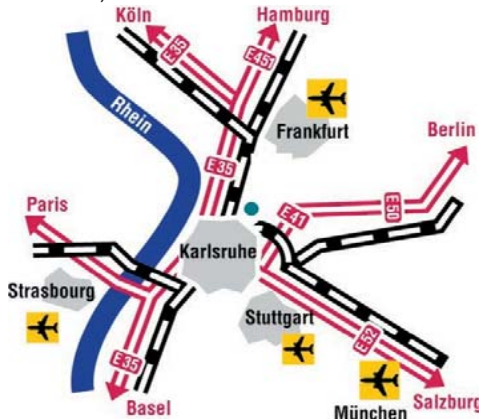**June 10th, 2023:** Notification to applicants

August 22nd, 2023, 7:00 pm: Welcome of the participants with a get-together dinner at the GenoHotel Karlsruhe

August 23rd, 2023, 9:00 am: Start of the school's lectures

September 1st, 2023: End of school

Location

Karlsruhe, GERMANY

For more information, please visit our web site:
www.fjohss.eu

Coordination

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Executive Bureau

Professor Dr. Robert Stieglitz
School Director
KIT, Germany
robert.stieglitz@kit.edu

Dr. Michael Rieth
School Co-Director
KIT, Germany
michael.rieth@kit.edu

Dr. Robert Jacqmin
School Director
CEA, France
robert.jacqmin@cea.fr

Dr. Carole Valot
School Co-Director
CEA, France
carole.valot@cea.fr

Scientific Secretariat

Dr. Victor H. Sánchez-Espinoza
Dr. Gabrielli Fabrizio
KIT, Germany
victor.sanchez@kit.edu
fabrizio.gabrielli@kit.edu

Dr. Vanessa Vallet
Dr. Isabelle Guénot-Delahaie
CEA, France
vanessa.vallet@cea.fr
isabelle.guenot-delahaie@cea.fr

Secretariat

Mrs Ingeborg Schwartz
KIT, Germany
Phone: +49 (0) 721 6082 2552
ingeborg.schwartz@kit.edu

Mrs Valérie Fontanay
Corinne Druesne
Manon Ori
CEA, France
Phone: +33 (0) 4 4225 3788
fjoh@cea.fr

FJOH Scientific Board members

- **Dr. Paul Bryce** (EdF Energy, UK)
- **Dr. Nathalie Chauvin** (CEA, France)
- **Pr. Leon Cizelj** (JSI, Slovenia)
- **Pr. Mariusz Dabrowski** (NCBJ, Poland)
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- **Dr. Harri Tuomisto** (Fortum Power, Finland)
- **Pr. Gert Van den Eynde** (SCK-CEN, Belgium)
- **Dr. Nicolas Waeckel** (EdF, France)

2023

FJOH
FREDERIC JOLIOT / OTTO HAHN
SUMMER SCHOOL ON NUCLEAR REACTORS

"Physics, Fuels and Systems"

Digital Twins:
New Horizons in Nuclear Reactor Design and Optimisation

Jointly organized by the Commissariat à l'Energie Atomique et aux Energies Alternatives (France) and the Karlsruhe Institute of Technology (Germany)

August 23rd > September 1st, 2023

cea

KIT
Karlsruhe Institute of Technology

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Programme Outline
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Lecturers

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Description

Digital Twins: New Horizons in Nuclear Reactor Design and Optimisation

Lectures

1. **Opportunities in Developing Digital Twins for Near-Term and Future Nuclear Reactors** — 4 h
   1.1 Digital Twins: from Basic Concepts to Application to Nuclear Reactors. A Power Utility Perspective — E. Décossin (EDF) 🇫🇷
   1.2 The Promise of Artificial Intelligence and the 4th Industrial Revolution for Generation-IV Reactor Design — N. Prinja (Jacobs) 🇬🇧

2. **Methods for Data Management and High-Performance Computing** — 7 h
   2.1 Data-driven Uncertainty Quantification and Sensitivity Analysis — R. McClarren (Univ. Notre Dame) 🇺🇸
   2.2 Data-driven Surrogate Modelling, Artificial Intelligence and Machine Learning — M. Frank (KIT HPC Center) 🇩🇪
   2.3 Data Assimilation and Data Mining — M. Asch (CNRS) 🇫🇷

3. **Computer-based Materials and Fuel Developments** — 6 h
   3.1 Using Machine Learning in Material Science: Application to the Simulation of Fuel and Structural Materials — L. Messina (CEA) 🇫🇷 / P. Grigorev (AMU) 🇫🇷
   3.2 From Nuclear Fuel Element Simulation towards the Use of Digital Twins — D. Pizzocri (Polimi) 🇮🇹 / K. Gamble (INL) 🇺🇸

4. **Advanced Methods in Nuclear Data and Reactor Physics** — 6 h
   4.1 Recent Trends in Applying Machine Learning Methods to Nuclear Data Life Cycle — O. Cabellos (UPM) 🇪🇸
   4.2 How Can Modern Artificial Intelligence Serve Reactor Physics? — L. Fiorito (SCK-CEN) 🇧🇪

5. **High-fidelity Nuclear Thermal-Hydraulics** — 6 h
   5.1 Machine Learning for Fluid Dynamics — M. A. Mendez (VKI) 🇧🇪
   5.2 CFD and Multi-scale Simulations: From Aiding the Designers to Helping the Safety Demonstration — A. Gerschenfeld (CEA) 🇫🇷

6. **Nuclear Design and Optimisation Using Multi-physics Modelling and Simulation** — 5 h
   6.1 Nuclear Reactor Safety by Design — F. Bertrand (CEA) 🇫🇷
   6.2 Safety and Regulatory Aspects of Digital Twin-based Approaches — V. Yadav (INL) 🇺🇸

Seminar — 2 h

From Aerospace to Nuclear: the Benefits of Digital Twins — V. Badalassi (ORNL) 🇺🇸

Group activities — 6 h

Technical visits

Objectives

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The main objective of the FJOH-2023 edition is to help the school participants broaden their knowledge of the scientific and technical aspects underpinning nuclear digital twins. The lectures will lay emphasis on the required modelling and simulation (M&S) techniques, including the information and data flows between the physical system and its digital representation.

The FJOH-2023 participants will learn about:
- The incentives for developing digital twins for nuclear applications;
- General data and information management methods and digital twin-enabling technologies for uncertainty estimation and propagation, data-informed surrogate modelling, machine learning and data assimilation, in connection with high-performance computing resources;
- High-fidelity M&S models integrated in digital twins, for the purpose of fuel developments, core physics simulations, system thermo-hydraulics studies;
- The regulatory implications of digital twin-based approaches for optimised nuclear design and licensing.

By the end of the course, the participants should be able to explain why and how digital twins are expected to take a growing importance in nuclear applications, also discuss some of the corresponding challenges and gaps.

FJOH-2023 includes plenary lectures, group discussions, seminars, and technical visits. The invited speakers are internationally recognized experts from leading universities, research and development laboratories and industry.

The FJOH-2023 participants will have the opportunity, as part of group activities, to practice their freshly-acquired knowledge and to reflect upon open-ended questions in group activities. Time for these group activities is set aside in the School schedule.

The 28th session of the Frédéric Joliot/Otto Hahn (FJOH) Summer School on "Nuclear Reactors Physics, Fuels, and Systems", will be dedicated to "Digital Twins: New Horizons in Nuclear Reactor Design and Optimisation". It will be held in Karlsruhe from **August 23rd to September 1st, 2023**.

FJOH summer school is an advanced post-graduate-level course aimed at junior as well as experienced scientists and engineers engaged in the broad field of nuclear sciences, engineering and technologies.

Lecturers are invited from internationally leading universities and industry. The School format encourages informal discussions and the exchange of knowledge between lecturers and participants.

The Frédéric Joliot / Otto Hahn Summer School course represents the continuation of the Frédéric Joliot Summer Schools on "Modern Reactor Physics and the Modelling of Complex Systems", which was created by CEA in 1995 to promote knowledge in the field of reactor physics, in a broad sense, and the international exchange of teachers, scientists, engineers and researchers. Beginning in 2004, the scope of the School was extended to include scientific issues related to nuclear fuels. The venues of the FJOH School sessions alternate between Karlsruhe and Aix-en-Provence.

The program of each School session is defined by the International FJOH Scientific Board.

FJOH is jointly organized by the CEA Energy Division (France) and the Karlsruhe Institute of Technology (KIT, Germany).

FJOH
FREDERIC JOLIOT / OTTO HAHN
SUMMER SCHOOL ON NUCLEAR REACTORS

2023