European Safety and Reliability Conference
14–19 June 2026
Braga, Portugal

SS-14: Artificial Intelligence, Meta-Modelling and Advanced Simulation for the Safety Analysis of Nuclear Systems

Ibrahim Ahmed[1], Francesco Di Maio[1], Nicola Pedroni[2], and Enrico Zio[1,3]
[1] Polytechnic of Milan, Italy
[2] Polytechnic of Turin, Italy
[3] MINES Paris-PSL, France
ibrahim.ahmed@polimi.it; francesco.dimaio@polimi.it; nicola.pedroni@polito.it; enrico.zio@polimi.it

Description

The use of the Best-Estimate Plus Uncertainty (BEPU) approach is currently of great interest for the international scientific nuclear technical community in evaluating the safety margins. In the BEPU framework, the response of nuclear systems under different uncertain conditions is studied in general by means of mathematical models implemented in corresponding BE computer codes for numerical simulations.

Repeated BE model simulations are typically used to identify undesired or abnormal states, which is of paramount importance for optimally designing and operating such systems and defining accident prevention and mitigation actions. However, this way of proceeding is in general challenging because the corresponding BE codes are: i) computationally demanding (i.e., they require a long time to run a simulation compared to the available computational resources); ii) high-dimensional (i.e., they involve large number of inputs and/or outputs); iii) black-box (the mathematical function underlying the input-output relation is not known explicitly and is usually nonlinear); iv) dynamic (i.e., they evolve in time); and v) affected by severe uncertainties (often due to the scarcity of quantitative data available).

Within this broad framework, this Special Session is aimed at gathering expert researchers, academics and practicing engineers to present their recent findings, methodological developments, as well as innovative applications, related to the use (and possibly to the combination) of artificial intelligence, meta-modelling and advanced simulation tools for the efficient analysis of the BE computer models of nuclear systems, in the presence of uncertainties.

Topics of Interest

- Sensitivity Analysis methods and applications
- Forwards Uncertainty Quantification methods and applications
- Inverse Uncertainty Quantification methods and applications
- Failure Domain Characterization methods and applications
- Safety Margins Quantification methods and applications