MACHINE LEARNING BASED MODELS FOR HPC THERMOMECHANICAL FUEL ASSESSMENT

ROSA LO FRANO[1, *], SALVATORE ANGELO CANCEMI[1], MANTAS POVILAITIS[2], ANDRIUS AMBRUTIS[2], FRANCISCO FERIA[3], LUIS E. HERRANZ[3], ISABELLE RAMIERE[4], RORDIGUE LARGENTON[5] Simone GIANFELICI[6], MARCO CHERUBINI[7]

[1]*DICI-University of Pisa, lg. L. Lazzarino, n.2, 56126 Pisa (IT)*
[2] *Lithuanian Energy Iinstiutute, Breslaujos g. 3, 44403, Kaunas (LT)*
[3]*CIEMAT, Avda. Complutense, 40, 28040 Madrid (ES)*
[4]*CEA Cadarache, Saint Paul lez Durance (FR)*
[5]*Electricité de France, 22-30, avenue de Wagram, Paris (FR)*
[6]*ENEA Centro Ricerche Bologna, Via Martiri di Monte Sole 4, Bologna (IT)*
[7]*Nuclear and Industrial Engineering (NINE), Lucca (IT)*

** Corresponding author email: rosa.lofrano@ing.unipi.it*

The nuclear sector is characterized by complex systems and processes that require detailed and accurate simulations to ensure safety, efficiency, and reliability.
Despite the rapid growth of computational resources in engineering, the definition and abstraction of new analysis models will be necessary in the near future to improve both their capacity and predictive efficiency.
In particular, the representation of the complexity and real multiplicity of multiphysics phenomena, such as the simulation of pellet-cladding mechanical interaction (PCMI), just to mention one of the phenomena that could significantly influence the behaviour of nuclear fuel, could greatly benefit from the replacement of sophisticated mathematical models and computational methods with a formula or experimental data.
Differently from the usual computational approach that is generally accompanied by the availability of higher computational capabilities consisting in increasing the number of design variables explored and the dimensionality of the numerical model, the high performance computing (HPC) approach investigated in the EU OPERA-HPC project is aimed at developing new (improved) machine learning based reduced-order fast-running models (ML-ROM), to be implemented/incorporated into an fuel performance codes or in standalone mode.
In nuclear power plants, real-time monitoring is in fact essential to prevent any anomaly or malfunction, and an emergency scenario that can jeopardize plant safety.
This study provides firstly a review of the modelling currently used in fuel performance codes, such as TRANSURANUS, and secondarily a description of the computation time reduction models developed. The provide study also underscored the importance of digital replicas (DR), using 3D advanced simulation tools, to build learning data bases which are needed for the identification or training of ML-ROM and surrogate models. Results highlights the need to automate analysis modelling by means of suitable algorithms or methods and specific tools to control a priori and a posteriori the reliability of the fuel performance analysis.

086_abstract