Contribution ID: **106** Type: **not specified**

Surrogate Model Comparison for Uncertainty Quantification of Heating for Nuclear Fusion Plasma through Neutral Beam Injection

Nuclear fusion holds the promise of clean, virtually limitless energy. For fusion reactions to occur in the plasma, extreme temperatures must be reached –up to 150 million degrees Celsius. This constitutes an immense engineering challenge, requiring a necessary degree of accuracy. The Neutral Beam Injection (NBI) is one key technology enabling the auxiliary heating of the plasma. Fast neutral particles bypass the strong magnetic field confining the plasma, ionizing and subsequently transferring their energy through plasma collisions. The NBI heating heavily depends on the plasma state, which is difficult to measure directly, and also on ionization data, which stems from quantum mechanics. Furthermore, the scenario where most of the beam does not ionize and deposits its energy on the wall of the device, thus damaging it, must be avoided.

We employ Uncertainty Quantification (UQ) and Sensitivity Analysis (SA) methods, in order to inform investment decisions in such high-stakes fusion energy projects, aiming at reducing risk. We consider parametric uncertainty for the modeling of the NBI heating through the TAPAS code. Through Latin Hypercube Sampling (LHS), the multi-dimensional input space of the uncertainty sources is efficiently explored. Through uncertainty propagation into the TAPAS code, multiple surrogate models are constructed, including Polynomial Chaos Expansion (PCE) and Gaussian Processes (GP), which allow for accurate uncertainty intervals. The surrogates enable rapid scenario analysis, leading to a Sensitivity Analysis (SA) through the computation of the Sobol'indices, which reveal the most influential factors driving the variability of the code output.

Special/ Invited session

Classification

Mainly application

Keywords

Uncertainty Quantification, Sensitivity Analysis, Nuclear Fusion

Primary author: MAVROGIANNIS, Ioannis (Aix Marseille Univ, CNRS, Centrale Med, M2P2, Marseille, France)

Co-authors: Dr ZARZOSO FERNANDEZ, David (Aix Marseille Univ, CNRS, Centrale Med, M2P2, Marseille, France); Prof. FOULADIRAD, Mitra (Aix Marseille Univ, CNRS, Centrale Med, M2P2, Marseille, France)

Presenter: MAVROGIANNIS, Ioannis (Aix Marseille Univ, CNRS, Centrale Med, M2P2, Marseille, France)

Track Classification: Measurement Uncertainty