# EFFECT OF PARAMETRIC TUNING ON THE SOLUTION OF THE INVERSE UNCERTAINTY QUANTIFICATION PROBLEM

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## ABSTRACT

Thermal-hydraulics system codes like TRACE and RELAP5 are extensively used for the safety analysis of nuclear reactors. The mathematical models solved by these codes incorporate several physical models (input parameters) that are derived either empirically or based on experience judgment. Due to several factors, such as lack of perfect knowledge and experimental errors, these physical models exhibit inherent uncertainties that may be propagated to uncertainties in code predictions for surrogate variables of interest. For this process to be done, the uncertainties in the physical models (input parameters) should be properly identified by solving the Inverse Uncertainty Quantification (IUQ) problem. The solution of the IUQ problem is affected by several parameters including mesh size of the model and uncertainties in initial and boundary conditions. In this study, the effect of both parameters on the solution of the IUQ problem is studied. Two mathematical formulations, the Maximum Likelihood Estimate (MLE) method and the Maximum A Posterior (MAP), are adopted to solve the IUQ problem. Global Sensitivity Analysis (GSA) and Local Sensitivity Analysis (LSA) are performed to provide the necessary data for MLE and MAP implementation. TRACE models with three different mesh sizes based on the Flooding Experiment with Blocked Array (FEBA) benchmark were developed to study the effect of mesh refinement on the solution of the IUQ problem. Results of this analysis show that solving the IUQ problem with larger mesh sizes leads to code predictions closer to experimental data. Moreover, statistical expectation of the physical models (statistical mean) tends to shift towards a certain value as the mesh is refined. This shifting behavior is attributed to the fact that mesh refinement tends to decrease the truncation error resulting from numerical schemes used by TRACE, consequently, compensating for discrepancies between experimental data and code prediction that may be falsely attributed to uncertainties in the physical models. Such compensation allows for more realistic values of the statistical parameters of the physical models used by TRACE. Moreover, the results show that the relative absolute error between experimental data and code prediction results based on MLE and MAP formulations were smallest for the most refined mesh.

Finally, a mathematical formulation is presented to account for uncertainties in initial and boundary conditions and study their effects on the solution of the IUQ problem. The formulation is based on adding new bias terms to MLE and MAP formulations. A detailed strategy for methodology implementation to the FEBA benchmark is presented and results of such implementation is yet to be obtained in future work.