Design of experiments for calibration

To gain more insight into physical processes, IFPEN develops or uses a large number of numerical simulators. These numerical models are useful to reproduce phenomena in specific conditions and thus to predict and explore the system response under various conditions. However, these models must be parameterized according to the intrinsic characteristics of the system under study while these parameters values are often little or poorly known. The relevance of these models will therefore depend on the validation of parameters calibration and predictions for the responses of interest relatively to the set of real experiments results. Obtaining reliable numerical models is ultimately based on the choice of a relevant experimental design and on the definition of suitable criteria to evaluate the model quality in terms of calibration and prediction. The objective of this PhD project is to propose a statistical methodology to design experiments dedicated to the calibration and prediction of a non-linear model, so that it is robust to uncertainties in data, capable of handling functional input and output variables and applicable to numerical codes that are computationally expensive. The first step will be to apply dimension reduction strategies to functional data and to build a metamodel for the numerical simulator under consideration. On the other hand, consideration will be given to estimate the contribution of the data through dependency measures at lower computational cost and that can be applied to vector responses. Other non-asymptotic selection criteria, constructed directly from distances between model responses for different parameter values, may also serve as reference approaches in academic cases to quantify the contribution of previous methods. Finally, the notion of cost associated with experiments can be introduced through approaches based on a constrained but optimal design of experiments in terms of information provision.