Summary

In this project, we deal with the simulation and the optimisation of flows when uncertainties exist in the models and/or the data. We only consider non intrusive methods so that existing CFD softwares can be re-used, in particular those of the partners. We concentrate ourselves on the management of uncertainties coming out of turbulence models for aerodynamic configurations and those associated with the thermodynamical models for dense organic gas flows used in some energy production devices. It is known that the equation of state for organic gas as well as the optimal turbulence models for any given configuration are not well known, we have, from experimental data, to reconstruct he probability density function (pdf) of the variables, then we need to couple them to existing codes in order to reproduce the results. This necessitates to master at least the following:

1. The number of uncertain variables can be large, thus we need to have in hand numerical schemes able to deal with these two constraints, and this needs to be true for very non linear systems of PDEs, where the solutions are often discontinuous and/or chaotic. To this aim, we pursue the study of a non intrusive, accurate method, which is also non sensitive to the choice of the pdfs. We are also interested in robust and accurate methods for the construction of surface responses. The aim is to generate reduced models to speed up the algorithm.
2. The second aspect is to consider Bayesian approaches. They are most;y used in solid mechanics, a critical analysis of existing methods will be done to design an (original) method adapted to fluid mechanics. This method will be tested for turbulence modeling. We will also study the difficult problem of epistemic uncertainties, i.e. the uncertainty on the mathematical form of the model itself. The solution to this difficult problem can have a large impact on applications. The new methodological framework will enable to test and validate the most appropriate Bayesian method for the evaluation of the pdfs of unknown from experimental data. Data basis from ONERA will be useful.
3. A platform, in python, will be developed in order to gather the different methods developed by the partners. The aim of this platform is to facilitated the coupling of the partners' method. Two problems will be considered: an external CFD configuration (transonic) and an internal one arising from the study of energy generators for renewable sources.

The three task will be done in parallel, so that one can guaranty that the methods of task 1 can truly be used for task 2, and this can only be done by the validation of task 3.

The partners of the project are INRIA (team project Bacchus), ENSAM-ParisTech, LEGI (University of Grenoble), ONERA and Phimeca.