Internship Projects at Tractebel Engineering

SERVICE DE METROLOGIE NUCLEAIRE
NUCLEAR ENGINEERING

MASTER THESES

Academic year **2020-2021**

The nuclear department of Tractebel Engie has proposed several master theses and internships, the latter being possibly transformed into master thesis topics, a.o. because of the uncertainty on the organization of internships during the Covid crisis. Interested students can contact Mrs. Florence Dandoy florence.dandoy@tractebel.engie.com or Mr. Christophe Schneidesch christophe.schneidesch@tractebel.engie.com for further information.

Application of artificial intelligence techniques to in-core fuel management for nuclear reactors

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Nuclear physics | Computer sciences | Algorithmics

Business line: Nuclear
Department of Core and Fuel Studies

Type: Master thesis or master thesis combined with an internship

Site: Brussels Engie Tower (flexible)

Who is Tractebel?

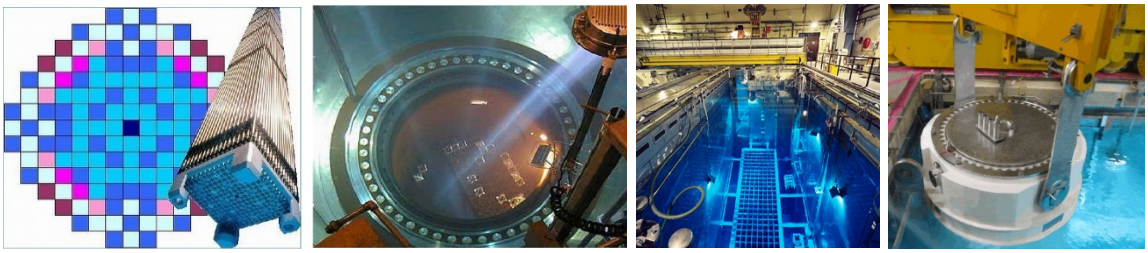
Tractebel, part of Engie group, has more than 150 years of experience and is one of the world's largest engineering consultancy companies. Tractebel offers his clients multidisciplinary solutions in the fields of energy, nuclear, water and urban. Our teams are present in all the possible phases of a project, from the feasibility studies to the implementation.

What will you be working on?

At each new cycle, the fresh and already-used uranium assemblies are positioned at specified slots in the reactor core. This loading pattern is designed by the engineer, using calculation tools, in order to:

- Maintain safety margins for controlling and shutting down the reactor (technical requirement)
- Meet the demands of the producer and the Belgian grid, in order to maximize the energy production (economical requirement)

The physical parameters that rule the technical and economical performance of a loading pattern are various. As examples, one can mention : core reactivity, power distribution, isotopic inventory, cycle length, burnup, etc. These physical parameters depend on the characteristics of each uranium assembly that will be loaded in the core, but also on the configuration of these assemblies in the core, making the problem a very challenging one: indeed, it is a multi-dimensional, time-dependent and non-linear combinatorial problem. The difficulty is further increased when designing successive cycles strategies.



Tractebel Engie is in charge of the engineering support for Belgian utility operator Electrabel and therefore developed a know-how on loading pattern design during the past 50 years. Nowadays, designing in-core management strategies becomes more and more demanding, requiring continuous improvement of calculation tools. The work proposed here is to explore the rather new and trending set of algorithms available in the domain of Artificial Intelligence, and apply it to two of the tools designed by Tractebel:

- Autunite (AUtomated Tool for UNplanned Incident Technical Evaluation), which is basically a loading pattern recycling tool: it relies on a database of loading patterns with proven qualities and a heuristic search engine to give a quick (and preliminary) solution to the problem.
- LPO (Loading Pattern Optimizer), which is an optimization tool, based on algorithms like Genetic Algorithms or Simulated Annealing. The algorithm will move around assemblies or change their types, in order to optimize a parameter (the “objective function”), chosen by the user.

A rough outline of the steps that the student needs to achieve is the following one:

- Understand the basics of reactor physics and loading pattern design
- Be able to design a simple loading pattern
- Understand the functioning and be able to use the tools used and developed by Tractebel, in particular Autunite and LPO
- Understand and perform a literature review of Artificial Intelligence basics and existing algorithms that may be applied to Autunite or LPO
- Translate the problem here into a simplified one, in order to build a first prototype
- Test the prototype with a simple example to demonstrate its viability
- Propose a plan of further improvement (for example, increase the number of parameters that can be taken into account, increase the computational capability or speed, investigate other algorithms, …)

In order to achieve the work, the student will need to have, or at least be ready to learn, the following skills: mathematics, nuclear physics, different programming languages (python, bash, etc), numerical analysis.

Some tasks will ask of the student that he comes at the Tractebel office, in order to use the software available here: four or five days for an introduction, and whenever is needed to use the tools available here. Everything more “theoretical” can be done outside of Tractebel’s office, but the student is always welcome to come and work at the office whenever he feels the need. This would facilitate the follow up of the student, but skype meetings can be organized when it is not convenient.

Who are we looking for?

- ✓ You are studying Electromechanical/Physical engineering
- ✓ Knowledge of Python programming is a must
- ✓ You are driven by the search of innovative solutions
- ✓ You are curious and have an initiative mindset
- ✓ You are client oriented and flexible
- ✓ You are dynamic and have good communication skills

What do we offer?

- ✓ An interesting and varied internship in an international environment with a good work-life balance
- ✓ The opportunity to work in a team of experienced professionals and to receive sufficient professional guidance
- ✓ An interesting topic, simply!

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How to apply?

Do you think that Tractebel is the perfect fit for your internship/master thesis?

Contact your professor ! He/she will be the point of contact with us.

We hope to see you soon !