ST5 – 55 – LIGHT AND MATTER : DEVELOPMENT OF HIGH TECHNOLOGY INSTRUMENTS

Dominante : PNT (Physics & NanoTechnology)
Langue d'enseignement : French
Campus où le cours est proposé : Paris-Saclay

Engineering problem

Modern physics has many outlets through the control of the properties of matter and its functional engineering. In this ST, students will be confronted with the problem of innovation and product development when it is a high-tech instrument using physics, developed in small series for research or R&D. In particular, the students will answer the following questions
- how to qualify and respond to a customer need in this context?
- which approach to design, realization and evolution to implement?
- how to design a solution for an intermediate customer who has customers with various needs?

The integration courses concern devices at the cutting edge of physics requiring a real engineering approach since the theoretical concepts are applied to real devices that must integrate elements of feasibility both technical and economic.

Adviced prerequisites

It is recommended to have taken the SPI course of Wave Physics or Transfer Science

Context and issue modules: This part is structured around half-day training sessions aimed at presenting the sequence, the integration lessons and introducing the theme. The following lectures/presentations will be organized:
- Presentation of the theme and its challenges
- Round-table discussion on professions: What is a physics engineer?
- Visit of a company
- Presentation of the EI

Specific course (60 HEE): *Physics of Matter*

Brief description: The course will provide students with a basic understanding of the physics of solid state matter. Crystallography and wave diffraction (especially X-rays), lattice vibrations (phonons, thermal effects), electronic states (Sommerfeld model, band theory), as well as specific topics: semiconductors, defects, superconductivity will be covered. The goal

is to show students that the understanding and control of material properties requires studies at the microscopic scale**.**

Challenge Week n°1 : *Synchrotron Beamline Design*

- Associated partners: European Synchrotron Radiation Facility (ESRF, Grenoble), SOLEIL synchrotron (Gif-sur-Yvette), NSLS synchrotron (Brookhaven, USA)

- Location: Paris-Saclay campus

- Brief description:
The objectives are the following:
- To dimension a device using basic (modern) physics notions and to do functional modeling.
- Identify the relevant heat transfers, model them, and size these systems.
- Know the key points of a pre-project study in a multidisciplinary context
- Have realistic orders of magnitude on the standard mechanical and physical properties of "common" materials.
- Carry out a preliminary design of the scientific instruments studied, justifying the choices made.
- Work in a team, know and be able to identify the different roles of the members of a team, lead and coordinate a work group, collect and share information, format and present the work done (express oneself in front of an audience / defense)

Challenge Week n°2 : *Quantum cascade lasers*

- Associated partners: Airbus Defence and Space, Thales

- Location: Paris-Saclay campus

- Brief description: Quantum cascade lasers are nano devices invented about 20 years ago. Engineering miracles, their operation has been made possible by the latest advances in quantum mechanics, optics and thermics. Due to their very small size, operating wavelength and precision, they are a technological solution of choice for the detection of minute traces of pollutants as well as high-speed communications in free space.

In a team work, the students will be brought to familiarize themselves with these notions and to acquire the mathematical elements necessary to numerically model the behavior of these systems. They will have to implement an engineering approach to transform their theoretical knowledge into an object constrained by the reality of the world.