Photonic & Electronic Sensors for Environment & Health



Explore this IDIL Master's track in detail, including its academic objectives, curriculum, research opportunities, admission requirements and career prospects.

TRACK OVERVIEW & LEARNING OBJECTIVES

Sensors are ubiquitous in our modern world. To cite just a few examples: on the environmental side, they aim to detect and quantify the presence of pollutants in water or the atmosphere; in medicine, they enable 2D or even 3D imaging of the eye, arteries, or early diagnosis of diseases. Most of the latest and highest-performing sensors are based on electronic or optical/photonic components without us even knowing it. In this context of ever-increasing and more demanding needs, the IDIL Master's track "Photonic & Electronic Sensors for Environment and Health" aims to train highly qualified personnel in the field of electronic and photonic sensors, with an orientation towards applications in environment and health, relying on long stays in research laboratories. Graduating students can then choose to complete their training to become researchers in the public or private sectors, responsible for developing new systems opening up new possibilities for the future.

The training is backed by the Institute of Electronics and Systems (IES), a research laboratory of the University of Montpellier / CNRS of international standing in the field of sensors and photonics. Supervised by renowned researchers, you will learn to master state-of-the-art experimental techniques allowing you to design and manufacture lasers, sensors, detectors, and other key components using cutting-edge technological equipment, leading up to the application of components particularly in the fields of environment and health.

In terms of objectives, the "Photonic & Electronic Sensors for Environment and Health" track's main objective is to train autonomous students with a great spirit of innovation to develop the systems of tomorrow for diagnosis or even treatment in health and environment, thanks to an immersion in a research laboratory of excellence. As a track of the IDIL program, this training aims to train students through and for research, with a view to pursuing a doctorate, notably via IDIL program funding. Through this program, we wish to train students with cutting-edge knowledge in photonics and sensors, able to easily address applications in environment and health thanks to the interdisciplinarity of the IDIL program.

KNOWLEDGE, SKILLS & COMPETENCIES

The IDIL Model: The IDIL graduate program (Interdisciplinary In-Lab) of the University of Montpellier opened its doors in September 2022, and aims to train students through and for research via pedagogical innovation. The available IDIL tracks are diversified and cover numerous disciplines, from bio-health to political science.

Taught entirely in English, IDIL tracks offer students the opportunity to follow their coursework through a unique structure thanks to four main aspects:

- **Learning by Doing:** IDIL tracks place a decisive emphasis on learning by doing by including in their curricula In-Lab units (courses taking place within a laboratory) as well as a subsidized research internship in M1 and M2. The IDIL program opens the doors to around a hundred laboratories at the University of Montpellier, in which students will work in immersion.
- **Curriculum Personalization:** IDIL students have the possibility to compose their track according to their professional project and interests by selecting their courses through three different teaching units: Non-Core, In-Lab, and Transversal. Support will be offered so that the student's curriculum matches their orientation choice.
- **Introduction to a New Discipline:** All IDIL students must choose a Non-Core teaching unit, which is an introductory course to a discipline from another IDIL track. For example, a student in Comparative Politics and Public Policy can take an introductory course to the Applied Ecological and Evolutionary Sciences track. This mechanism allows students to possess a unique profile, and represents an effective way to develop interdisciplinary thinking, a major challenge in modern research.
- **Mentorship:** Throughout their IDIL curriculum, students will be coached by a researcher from Montpellier laboratories. They assume a role of internship preparation, teaching theory through various workshops, as well as developing the student's professional network.

Technical Skills: Upon completion of the training, students will have developed technical skills in the field of electronic and photonic sensors, which they can particularly apply to health and environment. Students will be able to propose, develop, manufacture, and implement sensors based on existing or innovative technologies.

DETAILED CURRICULUM

MASTER 1

- **Teaching units (20 ECTS):**
  - Core Units: Fundamental teachings specific to a discipline.
  - Non-Core Unit: Introduction to another discipline of the IDIL graduate program.
  - In-Lab Units: Workshops and practical cases in the laboratory in order to acquire particular skills or techniques over a few days.
  - Transversal Units: Methodological and professionalizing teachings.
- **Personal Project (10 ECTS):** Development of a research-related personal project, preparation for the research internship.
- **Research Internship (30 ECTS):** Participation in a research project, and learning theory and skills through practice.

MASTER 2

- **Teaching units (20 ECTS):**
  - Core Units: Fundamental teachings specific to a discipline.
  - Non-Core Unit: Introduction to another discipline of the IDIL graduate program.
  - Transversal Units: Methodological and professionalizing teachings.
- **Multidisciplinary Team Project (10 ECTS):** Interdisciplinary project conducted by students from different IDIL tracks.
- **Research Internship (30 ECTS):** Participation in a research project, and learning theory and skills through practice.

Detailed Program

- **Semester 1 (S7)**
  - [HBE707E] Thermal & Optical sensors (5 ECTS)
  - [HBE708E] Ultrasonic sensors and associated systems (5 ECTS)
  - [HBE709E] Waves (4 ECTS)
  - [QAM1ILAB] In-lab course (2 ECTS)

- [HBM1E6C1] Non-Core (2 ECTS)
- [QAM1TTRA] Transversal Training Unit, by Doctoral School (2 ECTS)
- [QAMPPRJ] Personal project chosen during Summer School (10 ECTS)

- **Semester 2 (S8)**
  - [HBE817E] Internship (30 ECTS)
- **Semester 3 (S9)**
  - [HBE937E] Random signals (2 ECTS)
  - [HBE938E] Photodetection (3 ECTS)
  - [HBE939E] Lasers and optical amplifiers (6 ECTS)
  - [HBE940E] Photonic components and instrumentation (5 ECTS)
  - [QAM2MUTP] Multidisciplinary team project (10 ECTS)
  - [QAM2TTRA] Transversal Training Unit, by Doctoral School (2 ECTS)
  - [HBM2E6C] Non-Core (2 ECTS)
- **Semester 4 (S10)**
  - [HBM2E6S0] Internship (30 ECTS)

In-Labs Proposed Courses: In-lab courses are updated every year as new courses can be proposed in alignment with personal projects. Here is a list of recently proposed in-lab courses:

- Introduction to modeling and simulation of carrier transport in electronic devices
- Optical sensors for agro-environmental applications
- Gas sensors based on IR spectroscopy, applications to environment and health diagnosis
- Infrared detectors for environmental spectroscopy applications and medical thermal imaging
- Introduction to epitaxy
- Advanced optical characterisations (Beam, streak-camera, Wavefront, etc.)
- CW THz instrumentation

- Optical fibers and optical components (Principles, Manipulation, cleave, splicing, characterisation)
- Instrumentation & microwave metrology
- RFID and Sensor RFID: Design, fabrication, characterization

Non-Core (one course chosen among):

- UE Why democracy is hard?
- UE Mediterranean Terrestrial Ecosystems
- UE Defusing quantitative bullshit
- UE Scientific openness to earth and water issues under global change
- UE Plant health 2.0: a global war
- UE One health and eco-epidemiology
- UE Explore, understand and learn
- UE Biology by the numbers: Measure, Predict, and Design
- UE Who's afraid of AI?
- UE Sustainable management basics
- UE Innovations in clinical biomarkers, biotechnologies for personalized medicine
- UE How the way we move reveals who we are

ADMISSION REQUIREMENTS & STUDENT PROFILE

- Bachelor's degree (*Licence*) in the relevant disciplinary field (electronics, photonics, sensors, physics, applied physics, etc.).
- Minimum B2 English level.

This training is aimed at students interested in cutting-edge technologies in electronics and photonics allowing them to surpass the current limits of systems used for environment and health, and having the professional objective of working in the field of research or research and development around technologies and their applications.

CAREER OPPORTUNITIES

The IDIL Master's program is designed to train students through and for research. A continuation into a doctorate is thus a natural progression at the end of this master's degree, in the short term, in order to then work as engineers, researchers, and university lecturers focusing on electronic and photonic technologies, particularly for environment and health. However, given the monumental rise of these technologies across numerous fields in a hyper-connected world consisting of multiple sensors—and knowing that photonics in the 21st century is what electronics was in the 20th century—numerous engineer-level career opportunities will open up in other sectors such as industrial control, defense, communications, space, etc.

RESEARCH LABORATORIES & ACADEMIC PARTNERS

- Institute of Electronic & Systems (IES), CNRS UMR
- Photonics France Federation
- French Optical Society (*Société Française d'Optique* - SFO)
- IATE, INRAE, Institut Agro
- ITAP, INRAE, Institut Agro