

# Master Physique

## Radiation Physics, Detector, Instrumentation and Imaging

### Présentation

#### English presentation:

Recent advances in physics (high energy physics, quantum physics, condensed matter...) and related disciplines (astrophysics, life sciences, medical treatment and medical imaging...) are based on gathering, in laboratories or within national and international collaborations, a great diversity of skills and knowledge such as:

- Knowledge about fundamental theoretical and experimental physics;
- A broad view of the discipline: currently accepted theories, major open questions and plans to address them...
- Excellent knowledge of practical tools for modeling and analysis (mathematics, statistics, signal processing, database management, numerical simulations, instrumental developments);
- Ease with high-level experimental techniques;
- Teamwork and communication skills (project management, English, report writing, oral presentations).

The main objective of the Master of Physics is to train candidates to fit effectively into this framework, providing them with sound theoretical and practical bases, and giving them the opportunity to start specializing gradually through courses, personal projects and internships. The training aims to provide students with the necessary skills to carry out research and / or development work by focusing on:

- Autonomy in the analysis of a complex problem and the proposal of approaches (theoretical, numerical and / or experimental);
- Solid skills in computing (especially for the analysis of large datasets);
- Collaborative work;
- Ability to communicate scientific results.

The Master of Physics is a research-driven training, leading to fundamental or applied research, work in the *Science, Technology, Engineering and Mathematics* -STEM- industry (especially high-tech) and trades of education or dissemination of science. From a professional point of view, the training prepares either for a career as a researcher or a research engineer in the disciplinary fields concerned, or for a career in a sector where the knowledge and / or skills acquired as physicists prove to be useful. Thanks to a long-standing partnership with [Télécom Physique Strasbourg](#), the Master's degree also assumes the role of contributing to the formation of young engineers. In parallel with research-focused objectives, the Master of Physics also prepares students to pass the French recruitment competition for teachers Agrégation de Physique-Chimie, Option Physique through a specific track PA (Préparation à l'Agrégation). The mastery of the disciplinary foundations of Physics and Chemistry give rise to a solid theoretical and practical professional training in the trades of the education.

The Master of Physics consists of **7 tracks** with of a common first M1 year followed by a specialization at the M2 level. The content of each course is described in the specific pages. The courses are taught in English during the two years. For the main lectures, tutorial classes are duplicated with French and English teaching languages. M1 training consists of a common core of general physics taught through courses and tutorials in the first and second semester. Experimental training is an important part of the curriculum, with projects hosted by local laboratories. During these two semesters, optional courses allow students to discover the different possible tracks and specializations. The ties with ongoing academic research are ensured by weekly seminars given by researchers from Strasbourg laboratories during the first semester. In addition, students will train to actual research work via supervised projects and research internships in physics laboratories through (both in M1 and M2).

#### Résumé français:

Le master Physique de l'Université de Strasbourg est porté par la Faculté de Physique et Ingénierie, en partenariat avec [l'Observatoire d'Astrophysique de Strasbourg \(ObAS\)](#), [Télécom Physique Strasbourg \(TPS\)](#) et [l'École supérieure de biotechnologie de](#)

|                        |  |
|------------------------|--|
| Composante             | • <a href="#">Faculté de physique et ingénierie</a>  |
| Langues d'enseignement | • Anglais  |
| Niveau d'entrée        | BAC +3   |
| Durée                  | 2 ans  |
| ECTS                   | 120  |
| Volume global d'heures | 750  |
| Formation à distance   | Non, uniquement en présentiel  |
| Régime d'études        | • FI (Formation initiale)  |
| Niveau RNCP            | Niveau 7   |
| Disciplines            | <ul style="list-style-type: none"> <li>• Physique - Milieux dilués et optique</li> <li>• Physique - Constituants élémentaires</li> <li>• Biophysique et imagerie médicale</li> <li>• Sciences physico-chimiques et ingénierie appliquée à la santé</li> <li>• Génie informatique, automatique et traitement du signal</li> </ul>                       |
| Lieu                   | Strasbourg   |
| Campus                 | <ul style="list-style-type: none"> <li>• Campus Cronenbourg</li> <li>• Campus Illkirch-Graffenstaden</li> <li>• Campus Esplanade</li> </ul>  |
| Secteurs d'activité    | <ul style="list-style-type: none"> <li>• <a href="#">Recherche-développement scientifique</a></li> <li>• <a href="#">Enseignement</a></li> <li>• <a href="#">Télécommunications</a></li> <li>• <a href="#">Programmation, conseil et autres activités informatiques</a></li> </ul>   |
| Code ROME              | <ul style="list-style-type: none"> <li>• <a href="#">Enseignement supérieur</a></li> <li>• <a href="#">Recherche en sciences de l'Univers, de la matière et du vivant</a></li> <li>• <a href="#">Management et ingénierie études, recherche et développement industriel</a></li> <li>• <a href="#">Études et développement informatique</a></li> </ul> |
| Stage                  | Obligatoire  |
| Stage à l'étranger     | Non prévu  |
| Alternance             | Non  |

### Aménagements pour les publics ayant un profil

Strasbourg (ESBS) et avec les *Instituts Thématiques Interdisciplinaires* ITI/EUR HiFunMat, IRMIA++ et QMat. Après une première année de formation généraliste fortement mutualisée, il propose 6 parcours orientés vers la recherche -Astrophysics and data science (Astro); Physics of Quantum and Soft Condensed Matter (PhyQS); Cell physics; Radiation physics, detector, instrumentation and imaging (PRIDI); Subatomic and astroparticle physics (SAP) and Quantum Technologies-European Program -s'appuyant sur les laboratoires Strasbourgeois et un parcours permettant de préparer le concours de recrutement de l'Agrégation de Physique-Chimie-Option Physique.

## Objectifs

### English version:

At the end of this training, students should be able to interact with biologists/doctors in order to design/develop tools that allow them to respond to clinical or preclinical imaging issues. Students will be trained in the main in-vivo imaging techniques from the physicist's point of view, from the detector to the use of artificial intelligence. They will thus be able to understand all the processes leading to the formation of an image. A particular focus is placed on MRI and nuclear imaging. The skills acquired will be numerical, theoretical and experimental.

### Version française:

Le parcours « Physique des Rayonnements, Détecteur, Instrumentation et Imagerie » est destiné à former des étudiants par la recherche pour les laboratoires de recherche publique et privée.

L'objectif de cette formation est l'acquisition des connaissances nécessaires à la conception de nouveaux instruments de détection principalement dédiés à l'imagerie médicale répondant aux besoins des problématiques soulevées dans les disciplines telles que la biologie et la médecine. Ce parcours a donc également pour objectif de délivrer à l'étudiant les connaissances indispensables pour comprendre et analyser les problèmes se situant à l'interface entre la biologie, la médecine, la chimie et la physique.

## Insertion professionnelle

In addition to pursuing a doctorate, it is possible under certain conditions to take the competitive examination to become a medical physicist. Several Alsatian industrialists offer courses/interventions which allow students to be in contact with the social-economic world.

## Métiers visés

- Ingénieur à l'interface physique/biologie
- Physicien médical
- Ingénieur R&D, etc..

### Après un doctorat

- Enseignant-chercheur ou chercheur
- Ingénieur de recherche

Pour connaître en détail l'insertion professionnelle de nos diplômés, consultez [cette page](#).

## Les + de la formation

- Both practical and theoretical training
- A very good success and integration rate
- Courses given by industrialists
- Close links with laboratories

## Candidater

- Find out the information relative to [admission and registration on the site of the University of Strasbourg](#)
- Pour connaître les modalités de candidature, consultez [la page dédiée](#) sur le site de l'Université de Strasbourg.

## Prérequis obligatoires

## spécifique

See the page of / Voir la page du [régime spécial d'études \(RSE\)](#)

L'Université de Strasbourg adapte la scolarité des étudiants aux besoins spécifiques (liés à une situation particulière du fait de leur état ou de leur statut) et leur offre un accompagnement personnalisé pour les soutenir dans la réalisation de leur projet professionnel.

Pour les étudiants en médecine, un contrat pédagogique est possible sur 1 ou 2 années.

## Droits de scolarité

- To know about the registration fees, [check the dedicated page on the site of the University of Strasbourg](#)
- Pour connaître les droits de scolarité, consultez la page dédiée [sur le site de l'Université de Strasbourg](#).

## Contacts

### Responsable(s) de parcours

- [Patrice Laquerriere](#)
- [Dominique Aubert](#)

- All the courses of this master are taught in English. A B2 level (CEFR scale) is required.
- A knowledge of a programming language and algorithmic (Python) is strongly recommended to be able to adequately follow some optional trainings.
- Candidates must have a strong background in physics.

## Stage

### Stage en France

Durée du stage : 15 weeks / 15 semaines minimum

Période du stage : february to june, 2nd year

# Programme des enseignements

## Radiation Physics, Detector, Instrumentation and Imaging

### Master 1 - Physique - Radiation Physics, Detector, Instrumentation and Imaging

Master 1 - Physique - Physics research - Tronc commun

| Semester 1 - Physics research   |        |     |     |    |
|---|--------|-----|-----|----|
|   | CM     | TD  | TP  | CI |
| UE 1 - Semestre 1 - Quantum mechanics and statistical mechanics       | 9 ECTS | -   | -   | -  |
| Quantum mechanics   | 26h    | 26h | -   | -  |
| Statistical mechanics   | 26h    | 26h | -   | -  |
| UE 2 - Semestre 1 - Numerical physics and Current research in physics | 6 ECTS | -   | -   | -  |
| Numerical physics   | 16h    | -   | 16h | -  |
| Current research in physics   | 14h    | -   | -   | -  |
| UE 3 - Semestre 1 - Experimental physics I                            | 6 ECTS | -   | -   | -  |
| Experimental physics I  | -      | -   | 56h | -  |
| UE 4 - Semestre 1 - Elective course (2 to choose among)               | 6 ECTS | -   | -   | -  |
| Liste UE 4 - choisir 2 parmi 10                                       |        |     |     |    |
| Mécanique des milieux continus  | 26h    | -   | -   | -  |
| Astrophysical objects and their observations                          | 26h    | -   | -   | -  |
| Group theory  | 26h    | -   | -   | -  |
| Ionizing radiation and detection methods                              | 26h    | -   | -   | -  |
| General relativity  | 26h    | -   | -   | -  |
| Advanced quantum mechanics  | 26h    | -   | -   | -  |
| Project   | 26h    | -   | -   | -  |
| Photonics for quantum science and technology                          | 26h    | -   | -   | -  |
| Soft condensed matter   | 26h    | -   | -   | -  |
| Focus : sciences physiques ou mathématiques                           | 20h    | -   | -   | -  |
| UE 5 - Semestre 1 - Free course                                       | 3 ECTS | -   | -   | -  |

|  | CM  | TD | TP | CI |
|--|-----|----|----|----|
| <b>Liste UE 5 - choisir 1 parmi 9</b>  |     |    |    |    |
| Mécanique des milieux continus   | 26h | -  | -  | -  |
| Astrophysical objects and their observations   | 26h | -  | -  | -  |
| Group theory   | 26h | -  | -  | -  |
| Ionizing radiation and detection methods   | 26h | -  | -  | -  |
| General relativity   | 26h | -  | -  | -  |
| Advanced quantum mechanics   | 26h | -  | -  | -  |
| Project  | 26h | -  | -  | -  |
| Photonics for quantum science and technology   | 26h | -  | -  | -  |
| Soft condensed matter  | 26h | -  | -  | -  |
| <b>UE facultative (au-delà de 30 ECTS validés) - Bases de mécanique quantique et physique statistique TEST</b> |     |    |    |    |
| Bases de mécanique quantique   | 16h | -  | -  | -  |
| Bases de physique statistique  | 16h | -  | -  | -  |

| <b>Semester 2 - Physics research</b>   |     |     |     |    |
|--|-----|-----|-----|----|
|  | CM  | TD  | TP  | CI |
| <b>UE 1 - Semestre 2 - Nuclear physics and elementary particles 6 Solid state physics 9 ECTS</b> |     |     |     |    |
| Nuclear physics and elementary particles   | 26h | 26h | -   | -  |
| Solid State physics  | 26h | 26h | -   | -  |
| <b>UE 2 - Semestre 2 - Numerical simulations 3 ECTS</b>  |     |     |     |    |
| Numerical simulations  | 12h | -   | 16h | -  |
| <b>UE 3 - Semestre 2 - Experimental physics II and Laboratory internship 12 ECTS</b>             |     |     |     |    |
| Experimental physics II (in laboratory)  | 4h  | -   | 16h | -  |
| Laboratory internship  | -   | -   | -   | -  |
| <b>UE 4 - Semestre 2 - Elective course (1 to choose among) 3 ECTS</b>                            |     |     |     |    |
| <b>Liste UE 4 - choisir 1 parmi 9</b>  |     |     |     |    |
| Particles and astroparticles   | 26h | -   | -   | -  |
| Stellar physics  | 26h | -   | -   | -  |
| Atomic and molecular physics   | 26h | -   | -   | -  |
| Introduction to physics of living systems  | 26h | -   | -   | -  |
| Relativistic quantum mechanics   | 26h | -   | -   | -  |
| Numerical methods in physics   | 26h | -   | -   | -  |
| Project  | 26h | -   | -   | -  |
| Electronics for quantum science and technology   | 26h | -   | -   | -  |
| Phénomènes critiques et physique statistique hors-équilibre                                      | 26h | -   | -   | -  |
| <b>UE 5 - Semestre 2 - Free course 3 ECTS</b>  |     |     |     |    |

|   | CM  | TD | TP | CI |
|---|-----|----|----|----|
| <b>Liste UE 5 - choisir 1 parmi 9</b>                       |     |    |    |    |
| Particles and astroparticles                                | 26h | -  | -  | -  |
| Stellar physics   | 26h | -  | -  | -  |
| Atomic and molecular physics                                | 26h | -  | -  | -  |
| Introduction to physics of living systems                   | 26h | -  | -  | -  |
| Relativistic quantum mechanics                              | 26h | -  | -  | -  |
| Numerical methods in physics                                | 26h | -  | -  | -  |
| Project   | 26h | -  | -  | -  |
| Electronics for quantum science and technology              | 26h | -  | -  | -  |
| Phénomènes critiques et physique statistique hors-équilibre | 26h | -  | -  | -  |
| <b>Liste UE facultative Facultatif</b>                      |     |    |    |    |
| UE 7 - Semestre 2 - Optional                                | -   | -  | -  | -  |
| Voluntary internship  | -   | -  | -  | -  |

### Master 2 - Physique - Radiation Physics, Detector, Instrumentation and Imaging

| <b>Semester 3 - Radiation Physics, Detector, Instrumentation and Imaging</b>                                   |     |    |     |     |
|--|-----|----|-----|-----|
|  | CM  | TD | TP  | CI  |
| UE 1 - Semestre 3 - Interaction radiation/matter, biological effects <span style="float: right;">6 ECTS</span> | -   | -  | -   | -   |
| Biological basics for physicists   | 24h | -  | 4h  | -   |
| Interaction radiation/matter   | 18h | -  | -   | -   |
| Dosimetry  | 12h | -  | -   | -   |
| UE 2 - Semestre 3 - Signal treatment <span style="float: right;">3 ECTS</span>                                 | -   | -  | -   | -   |
| Signal treatment   | 20h | -  | 12h | -   |
| UE 3 - Semestre 3 - Detector/Instrumentation <span style="float: right;">3 ECTS</span>                         | -   | -  | -   | -   |
| Detector/Instrumentation   | 30h | -  | -   | -   |
| UE 4 - Semestre 3 - Medical imaging: physical basics <span style="float: right;">3 ECTS</span>                 | -   | -  | -   | -   |
| Medical imaging: physical basics   | 18h | -  | 8h  | -   |
| UE 5 - Semestre 3 - Numerical simulation for imaging <span style="float: right;">6 ECTS</span>                 | -   | -  | -   | -   |
| Python   | -   | -  | -   | 25h |
| Artificial intelligence  | -   | -  | -   | 25h |
| UE 6 - Semestre 3 - Elective lectures (3 au choix) <span style="float: right;">9 ECTS</span>                   | -   | -  | -   | -   |
| <b>Liste UE6 - choisir 3 parmi 4</b>   |     |    |     |     |
| Magnetic Resonance Imaging   | 20h | -  | -   | -   |
| Optical microscopies   | 20h | -  | -   | -   |
| Nuclear imaging  | 20h | -  | -   | -   |
| Image treatment  | -   | -  | -   | 20h |

## Semester 4 - Radiation Physics, Detector, Instrumentation and Imaging

|  | CM  | TD | TP | CI |
|--|-----|----|----|----|
| UE 1 - TIPP <span style="float: right;">3 ECTS</span>                                  | -   | -  | -  | -  |
| TIPP   | -   | -  | 8h | -  |
| UE 2 - Semestre 4 - Professional integration <span style="float: right;">3 ECTS</span> | -   | -  | -  | -  |
| Professional integration   | 18h | -  | -  | -  |
| UE 3 - Semestre 4 - Internship <span style="float: right;">24 ECTS</span>              | -   | -  | -  | -  |
| Internship   | -   | -  | -  | -  |
| Liste UE facultative <b>Facultatif</b>   |     |    |    |    |
| Optional   | -   | -  | -  | -  |
| Liste <b>Facultatif</b>  |     |    |    |    |
| Voluntary internship   | -   | -  | -  | -  |