ISFIN
Aix Marseille Université

THE ISFIN PhD PROGRAM

Any question about the doctoral program: isfin-direction@univ-amu.fr

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ISFIN'S PHD PROGRAM

I – LOOK AT NUCLEAR SCIENCE FROM A DIFFERENT PERSPECTIVE

Sociologistic, artistic, historic… approaches of nuclear science through visits, debates, movie screening…

II – SEMINARS AND CONFERENCES IN NUCLEAR SCIENCES

Broad audience talks on fission, fusion, instrumentation in nuclear science…

III – M2 courses

Fission or Fusion

IV – Any formation proposed by Doctoral Schools or Doctoral Colleges

Bonus:

INTERNATIONAL MOBILITY

A yearly call for project to spend up to three months in a foreign country research laboratory

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I- LOOK AT NUCLEAR SCIENCE FROM A DIFFERENT PERSPECTIVE

The aim is to look beyond the technical processes involved in nuclear power, and in particular to examine how nuclear sites fit into the landscape, how much land they occupy, the size of the facilities, the activities associated with them, the communities they support, and the links between nuclear, civil and military research and production activities upstream and downstream, drawing on sociology, history, geography, political science and law

Accounted in disciplinary formation by EDs

See after…

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I- LOOK AT NUCLEAR SCIENCE FROM A DIFFERENT PERSPECTIVE

- EVENT 1: NEW PUBLISHING SEASON ! (2h in October)
  - A debate and discussion on a recently published book on the sociology of nuclear energy, with the author and other specialists in attendance

  - Example 2023: "*The territories of energy transitions. Nuclear power and renewable energy in Italy and France*" (Ed. Khartala, Maison méditerranéenne des sciences de l'Homme)

    - Presentation of the book by two of the authors
    - Discussion with historians, thermal engineers, sociologists and physicists
    - Closing round table on interdisciplinarity

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I- LOOK AT NUCLEAR SCIENCE FROM A DIFFERENT PERSPECTIVE

- EVENT 2: SCREENING OF FILM ON NUCLEAR ENERGY WITH A DEBATE (2h in Jan - Feb)

  - Film screening followed by a debate and discussion

  - Example 2023 : « *Nomades du nucléaire (Nuclear Nomads)*», directed by Tizian Stromp Zargari and Kilian Armando Friedrich.

    This film ‘Nomades du nucléaire’ (Nuclear Nomads) documents the lives nuclear maintenance workers, their journeys, the constraints caused by the way work is organised in subcontracting and time-grouped operations, the unexpected effects of the distribution of nuclear power plants over the territory and their eccentricity in relation to towns, the resulting intermittence of family life...

    The screening has been followed by commentary and a debate with co-director Tizian Stromp Zargari, sociologists Pierre Fournier and Cesare Mattina and a ‘nuclear nomad’ Vincent Jouet

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I- LOOK AT NUCLEAR SCIENCE FROM A DIFFERENT PERSPECTIVE

- EVENT 3: ANNUAL VISIT TO A NUCLEAR SITE WITH SOCIOLOGISTS (6h in April-June)

  - The visit follows the two previous events and complement them
  - Visits are commented by sociologist from AMU : See nuclear sites, their impact on the territory, on workers and inhabitants, their history…
  - Day of cohesion and meeting of the AMU community in nuclear sciences
  - One different site each year on the basis of a three year cycle:
    - Tricastin power plant
    - Cadarache nuclear Center
    - Plateau d'Albion (former nuclear military site)
    - Marcoule nuclear site

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ISFIN'S PHD PROGRAM

II – SEMINARS AND CONFERENCES IN NUCLEAR SCIENCES

Broad audience talks on fission, fusion, instrumentation in nuclear science...

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II – SEMINARS AND CONFERENCES IN NUCLEAR SCIENCES

- Principle

  ISFIN organizes events around nuclear energy, fission and fusion. Some event are especially dedicated to PhD students and your presence is required. For the other, choose freely.

  The events consist in broad audience talks on fission, fusion, instrumentation in nuclear science. The events are varied and some examples are listed hereafter

Accounted in disciplinary formation by EDs

See after…

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II – SEMINARS AND CONFERENCES IN NUCLEAR SCIENCES

- ISFIN days (3h or 6h formation, Oct – Nov)
  - Every year, the institute organises ISFIN days, which can take different forms
    - A one-day presentation meeting with nuclear start-ups
    - A half-day presentation of the opportunities offered by ISFIN to doctoral students
    - A remote demonstration of how a fission reactor works...
    - Program 2023 as an example here

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II – SEMINARS AND CONFERENCES IN NUCLEAR SCIENCES

- "From the discovery of the origin of solar energy to the fusion reactor concepts : discover the scientific adventure of fusion", *by Yannick Marandet, ISFIN director (1st semester)*

Summary:
The question of the age of the sun, first approached scientifically in the 19th century, is strongly related to where its energy comes from. The first part of the talk will walk you through some of the key steps that led to discover that fusion reactions are powering stars. The features fusion reactions would have if used a power source on earth are then discussed, as well as the basic principles guiding the design of a suitable magnetic bottle to contain the 150 million degrees deuterium-tritium plasma necessary to sustain fusion reactions. The current status of the field is discussed, with a focus on the goals of the ITER project, currently being built in Cadarache. In the recent years more than 35 start-ups have been created promising faster success on the way to harness fusion, often through more compact machines. The superconducting magnet technology breakthrough behind some of these projects is briefly presented, and the promises are put into context.

- This seminar is a very good (and almost required) preparation for the ITER visit (see hereafter)

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II – SEMINARS AND CONFERENCES IN NUCLEAR SCIENCES

- ITER visit and introductive seminar (2h of doctoral formation, Jan-Feb)
  - Follow the introductive seminar given by Richard Pitts from the ITER Science Division and then visit the ITER worksite with commentary by Richard Pitts and other specialists from the ITER science division

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II – SEMINARS AND CONFERENCES IN NUCLEAR SCIENCES

- IMSci-Nu winter school (Jan – Feb, half a day of seminars, 3h formation)
  - This winter school deals with instrumentation and measurement science for different nuclear domains (fission, fusion, space, medicine)
  - It involves several scientists and experts from France and abroad, both from industrial and academic world
  - Program 2023 as an example here

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III – M2 courses

Fusion or Fission

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III – M2 COURSES

- All master courses can be accounted for the doctoral formation (disciplinary formation)

You can track in the list of courses of the following masters, they all include nuclear science courses:

- MASTER “Fundamental Physics and Applications”- *Faculty of Science, Department of Physics (French and English courses)*
- MASTER “Instrumentation Measurement and Metrology” - *Faculty of Science, Department of Physics (French and English courses)*
- MASTER “Process and bio-process engineering” - *Faculty of Science, Department of Chemistry (French)*
- MASTER “Health Engineering” - *Faculty of Pharmacy*
  - Track “Prévention des Risques et Nuisances Technologiques” *(French)*
  - Track newDEAL “Innovative diagnostic and therapeutic drugs and health products” *(English)*

ISFIN has selected a certain number of master courses around fusion science and nuclear instrumentation that could be potentially interesting to you and that fits well with doctoral training. These courses are all taught in English and are detailed hereafter.

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Key Facts	IRRADIATION AND MATERIAL DAMAGES (ED 352)
Keywords	Irradiation, Collisions, Material damage
Training Website	https://piim.univ-amu.fr/annuaire/regis-bisson/
Training Location	St-Jérôme Campus
Training Duration	6.5 – 12.5 HETD (Hours of teaching and practical work)
Dates or Training Period	1st semester
Objectives	The course has two main objectives : • To understand the elementary mechanisms causing damage in materials impacted by fast particles • To leverage this understanding to : Analyse the composition and structure of materials, Modify materials to create new properties and Predict how materials will behave under extreme conditions.
Program	The lecture is divided into 6 parts : A : Why is understanding materials irradiation important for technology ? B : Fundamental aspects of interactions between fast particles and materials C : The eV range - Potentials (binding) and energy losses D : The keV range - Stopping range and displacement damage E : The MeV range - Thermal spikes and nuclear transmutation F : Analytical and technological applications
Prerequisites	A bachelor's level knowledge of Physics is required (force, potential, elastic collision…)
Skills acquired after training	By the end of this course, students will be able to : 1. Estimate the time constant for energy dissipation ; 2. Identify where the dissipated energy goes and its effect on the irradiating particle's trajectory ; 3. Understand families of potentials and methods for calculating damage creation ; 4. Use the SRIM freeware to determine implantation profiles and quantify damage in materials ; 5. Predict how changes in mass and/or energy of irradiating particles affect damage creation in materials
Special Notes	The lecture content and duration may evolve based on student feedback. Currently, the focus is on the dynamics of microscopic events. The course could expand to include more macroscopic and kinetic considerations.
Teaching Methodology	The course is 75% lecture and 25% practical exercises using SRIM software. For an additional 3 hours or two sessions of 3 hours, laboratory experiments can be offered to students at the AMU-PSI facility in the PIIM laboratory. Two practical exercises are proposed : The threshold effect of kinetic energy on damage creation in materials and Characterization of surface sputtering.
Instructor	Régis BISSON, specialized in the effects of particle irradiation in materials. He conducts research at the PIIM laboratory and teaches in the Master of Physics and Master in Instrumentation, Measurement, and Metrology (IMM) programs.

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Key Facts	Plasma physics (MASTER IMM - IMSci-Nu)
Keywords	Plasma ; Debye shielding ; plasma oscillations ; magnetic field
Training Website	https://filiere-instrumentation.com/master-imm/imsci-nu-master
Training Location	St-Jérôme Campus
Training Duration	6.5 HETD
Dates or Training Period	
Objectives	Acquire foundational knowledge of plasma physics
Program	1) Definition of a plasma 2) The Saha equation 3) Temperature in plasma physics 4) Debye shielding 5) Plasma parameter 6) Plasma oscillations 7) Magnetized plasmas 8) Plasma classification
Prerequisites	Basic knowledge of electromagnetism and thermodynamics
Skills acquired after training	Students will Understand the physical mechanisms involved in plasma behavior and will Be able to apply basic models of plasma physics
Special notes	
Teaching Methodology	Traditional lectures with slides and board presentations
Instructor	Joël Rosato

Key Facts	Fundamentals in Nuclear Physics and Radiation Matter Interaction (MASTER IMM-IMSci-Nu)
Keywords	Fundamental forces, weak interaction, binding energy, Mass Defect, Valley of Stability, radioactive decay, Radioactivity, nuclear reactions, nuclear radiations, charged and neutral radiation interaction with matter, conservation laws
Training Website	https://filiere-instrumentation.com/master-imm/imsci-nu-master
Training Location	St-Jérôme Campus
Training Duration	21 HETD
Dates or Training Period	October - December
Objectives	By the end of this course, students will be able to : • Describe the forces acting within and around the atomic nucleus • Explain the process behind spontaneous nuclear reactions (radioactivity or radiation emission) and induced reactions • List the basic radioactive decay reactions and their processes • Calculate mass defects and their energy equivalence • Describe a typical induced nuclear reaction (incident particle + target nucleus = residual nucleus + ejected particle) • Identify the specific interactions of charged (light and heavy) and neutral particles with matter, based on their energy • Define the concepts of microscopic and macroscopic cross-sections, particle flux, and reactions rates
Program	Nuclear Physics and Radiation-Matter Interaction
Prerequisites	Basic knowledge of mathematics (integration, differentiation, differential equations) and fundamental concepts in physics/chemistry of atoms
Skills acquired after Training	Students will : • Understand the types of radiation involved in spontaneous or induced nuclear reactions • Grasp the processes of nuclear radiation interaction with matter and the associated influencing parameters.
Special Notes	None
Teaching Methodology	Lectures combined with practical exercises and reflection tasks (individual or groupe work)
Instructor	Abdallah Lyoussi

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Key Facts	Low temperature plasma physics (MASTER PHYSICS - Fusion Course)
Keywords	Cold plasma, low temperature plasma, modeling, experiment
Training Website	https://sciences.univ-amu.fr/fr/formation/masters/master-physique https://www.univ-amu.fr/fr/public/master-plasma-et-fusion
Training Location	St-Jérôme Campus
Training Duration	30 HETD
Dates or Training Period	From early September to mid-October at the latest
Objectives	Despite its name, this course serves as an introduction to low-temperature plasmas (plasma discharges) The goal is to provide a fundamental understanding of the physics of laboratory cold plasmas (gas discharges). During the course, a simple numerical model will be developed to calculate electron density and temperature variations based on external plasma control parameters (gas, pressure, power). These model results will be compared to measurements taken on a low-temperature plasma reactor at the PIIM laboratory.
Program	• Debye length • Sheath and pre-sheath • Bohm criterion • Child Langmuir law • Conservation equations • Ionization equilibrium • Power equilibrium • Estimation of electron density and temperature
Prerequisites	General physics knowledge at the Master 1 level
Skills acquired after Training	The course provides a solid foundation to understand and control the industrial applications of cold plasmas, such as : • Etching and deposition in microelectronics • Space propulsion • Surface treatments
Teaching Methodology	Lessons and exercises (21h-26h) + numerical modelling (6h) + experimental measurements (3h)
Instructor	Gilles Cartry

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Nuclear fusion and fission reactions

Y. Marandet

7h formation
October – November
https://filiere-instrumentation.com/master-imm/imsci-nu-master

1. Introduction : orders of magnitude
2. Nuclear physics basics
2.1 Semi-empirical model for the nucleus
2.2 Mass defect and binding energy
2.3 Binding energy as a function of nucleus number
3. Fusion reactions
3.1 Overcoming the Coulomb barrier
3.2 Cross section and rate coefficients
3.3 Fusion reactions in stars and on Earth
4. Fission reactions
4.1 Basic mechanism
4.2 Products (energy…)
4.3 Most important fission reactions

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ISFIN'S PHD PROGRAM

IV – Any formation proposed by ED or DC

Accounted in transverse or disciplinary formation

You can freely choose training proposed by the doctoral schools and the college doctoral. Here

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ISFIN'S PHD PROGRAM

INTERNATIONAL MOBILITY

A yearly call for project to spend up to three months in a foreign country research laboratory

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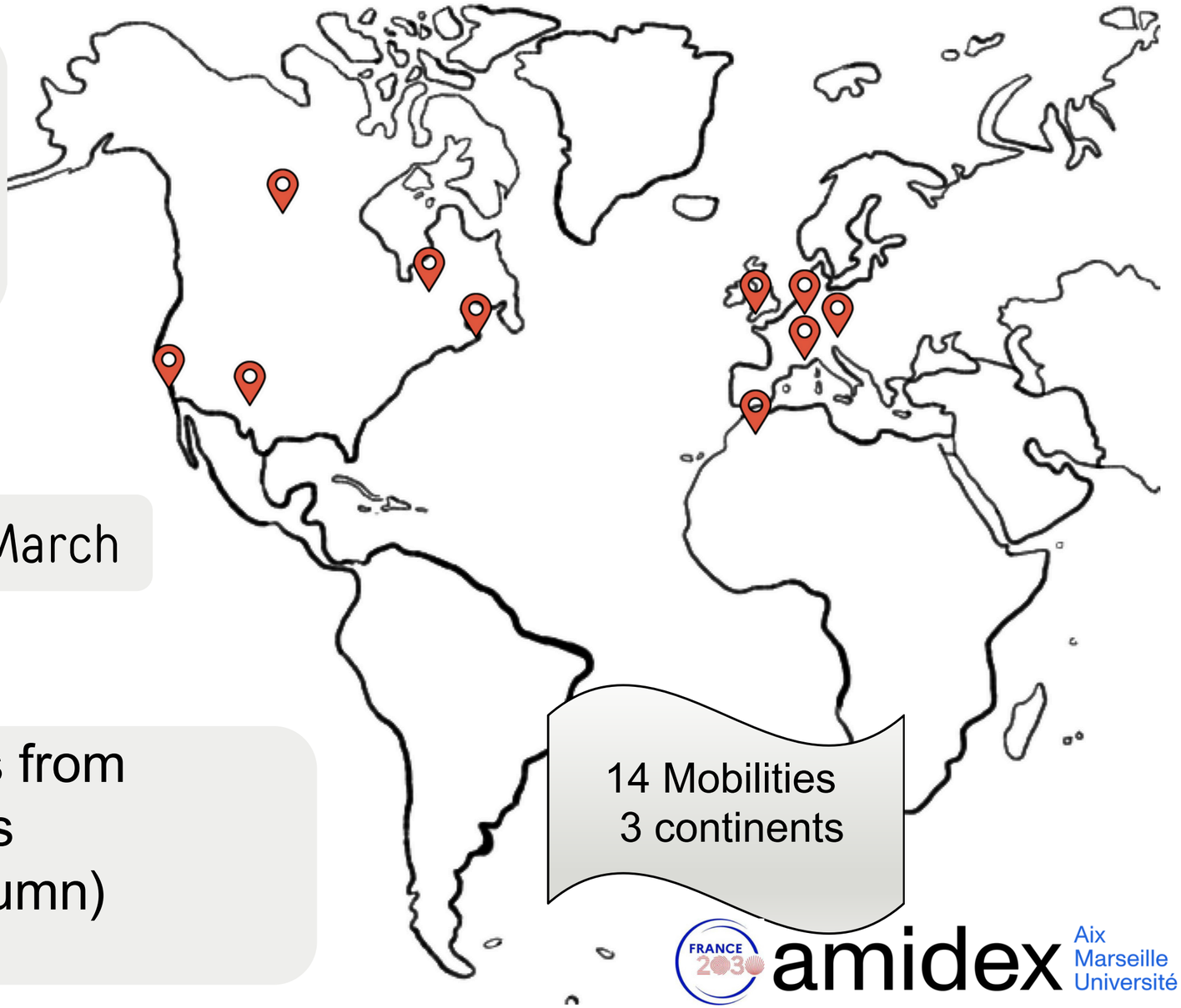
International mobility for PhD students

- In a laboratory abroad,
- From 6 to 12 weeks,
- On the doctoral student's proposal



14 Mobilities
3 continents

Yearly call open from October to March

See testimonies from
our students
(here, right column)

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Monday	February 19	9:00 - 9:15	Christelle REYNARD-CARETTE	Aix-Marseille University, France	Introduction
		9:15 - 10:45	Damien DROCOURT	NUWARD	Opening conference
		10:45 - 12:15	Antony WOAYE HUNE	NEWCLEO, France	Newcleo's Lead-cooled Fast Reactors Enhancing nuclear energy
		14:00 - 15:30	Ludo VERMEEREN and Jared WIGHT	SCK-CEN, Belgium	Major nuclear facilities at SCK CEN and associated instrumentation: BR2 and MYRRHA
		15:45 - 17:15	Claire VAGLIO-GAUDARD	CEA, France	The European TANDEM project to study the SMR integration into the future low-carbon energy mix
Tuesday	February 20	9:00 - 10:30	Jean-Pierre COULON	JPCo Consulting, France	Production of radioisotopes for medical use
		10:45 - 12:15	Benoit PETITPREZ	CEA, France	CABRI Nuclear Experimental Reactor Activities
		14:00 - 15:30	Paolo MUTTI	Institut Laue-Langevin, France	Institut Laue-Langevin: technology for science
		15:45 - 17:15	Adrien VOLTE	Aix-Marseille University, France	Numerical and experimental characterizations of a new reduced-height CALORRE differential calorimeter for CALOR-I irradiation in the MITR
Wednesday	February 21	9:00 - 17:15	Abdallah LYOUSSI	CEA, France	CEA visit (only for IMSci-Nu students)
Thursday	February 22	9:00 - 10:30	Stefan GOHL	IEAP, Czech Republic	Timepix detectors in Space: From radiation monitoring in LEO to astroparticle physics
		10:45 - 12:15	Bruno CORITON	ITER org	Diagnostics for ITER and Fusion Devices
		14:00 - 15:30	Bruno SOARES GONCALVES	IPFN, Portugal	High availability control and data acquisition systems in Fusion environments
		15:45 - 17:15	Gordon KOHSE	MIT, NRL, USA	Introduction to the MIT Research Reactor (MITR)
Friday	February 23	9:00 - 10:30	IMSci-Nu STUDENTS	Poster award committee	Poster session
		10:45 - 12:15	Malcolm JOYCE	University of Lancaster, UK	Discriminating bremsstrahlung and gamma-ray spectra with a single detector
		14:00 - 15:30	Massimo MORICHI	CAEN S.p.A., Italy	Radiological characterization of nuclear waste
		15:45 - 17:15	Jean-Michel RUGGIERI	CEA, France	Closing conference (Instrumentation and SMR/AMR)

Chairperson:
christelle.carette@univ-amu.fr

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JOURNEE DES
REACTEUR NUCLEAIRES INNOVANTS 13/10/23

BILAN

Le 13 octobre 2023, l'institut ISFIN a organisé une journée sur la thématique des Réacteurs innovants (SMR, AMR) au World Trade Center de Marseille. L'objectif de cet événement, était de sensibiliser les participants à la richesses des perspectives d'innovation dans le domaine des réacteurs nucléaires ainsi qu'à la grande variété des débouchés professionnels dans ce secteur en forte tension. Le programme de la journée à permis de répondre à ces objectifs grâce à une alternance de conférences, présentations et temps de pause permettant d'aller à la rencontre des start-up.

CONFÉRENCE D'OUVERTURE

«État de l'art et défis dans l'innovation pour les réacteurs nucléaires (SMR, AMR)» - Par J.M. Ruggieri (directeur de l'institut IRESNE du CEA).

8 PRESENTATIONS DE START-UP

BLUE CAPSULE, HEXANA, MARVEL FUSION, NAAREA, NEWCLEO, OTRERA, RENAISSANCE FUSION, STELLARIA ont présenté leurs technologies et échangé avec le public.

TABLE RONDE

«Innovation, métiers d'avenir dans le nucléaire» - Avec A. Bender (GIFEN), J.C. Bosq (APNI), S. Brémond (CAPENERGIES), Y. Martinetto (CISAM).

JOB DATING ETUDIANTS/START-UP

Lors des 4 temps de pause de la journée, le public à eu l'opportunité d'échanger directement avec les start-up qui disposaient de stands dans l'espace de réception.

340 PARTICIPANTS

224 ETUDIANTS
Filière Instrumentation,
IUT La Ciotat, Master & Licence Physique, Polytech,
Doctorants ED 252, ED 353

31 ENSEIGNANTS CHERCHEURS AMU
PIIM, IM2NP, LMA, IUSTI

85 PARTICIPANTS ISSUS DU MSE
Dont 55 sociétés différentes (CEA, IRSN, JACOBS, VEOLIA, ONET,(...))

On 13 October 2023, the ISFIN institute organised a day on the theme of Innovative Reactors (SMR, AMR) at the Marseille World Trade Centre. The aim of this event was to raise participants' awareness of the wealth of opportunities for innovation in the field of nuclear reactors, as well as the wide variety of career opportunities in this highly competitive sector. The day displays these objectives through a series of conferences and workshops led by industry experts, researchers, and policymakers. Attendees had the opportunity to engage in discussions about the latest advancements in Small Modular Reactors (SMR) and Advanced Modular Reactors (AMR), exploring their potential to revolutionize energy production with enhanced safety and efficiency.