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Strategy for NDTE education at universities in France

Philippe Duvauchelle ¹, Rachid El Guerjouma ², Serge Dos Santos ³

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Abstract: In many fields, Non-Destructive Testing is expanding to meet growing industrial and societal needs. This is particularly the case with regard to safety of structures, sustainable development and issues associated with energy transitions. Industrie of future will have to manufactured products with advanced materials in compliance with economic, ecological, safety and quality requirements.

France has historically been a leader in the field of NDTE thanks to its dynamism in high technology sectors such as nuclear, aeronautics and aerospace. The certification organization established by COFREND operates efficiently and allows to train competent and internationally recognized experts on many NDT methods.

Paradoxically, until recently, there was little training at the bachelor level and almost no training at the master's or engineer level to train NDTE specialists. Most people currently working in the industry, with the exception of a few PhDs, are required to learn by doing. Given the growing needs for NDTE and the age pyramid of current experts, French higher education must propose in the short term a national framework for NDTE training to cover all needs at the risk of losing its skills.

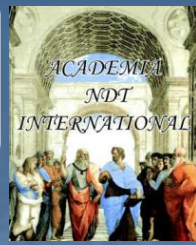
The University of Le Mans with its ECND Academy and the National Institute of Applied Sciences (INSA) have joined forces to create a training offer dedicated to the NDTE. This organization could be extended to other French universities and French School of Engineering to build in collaboration with COFREND, a high-performance national network dedicated to NDTE training.

Taking advantage of the specificities and skills of each institution, this network should build and consolidate bridges with the other lifelong learning, e-learning, certification, research and industry.

The ambition of French academic teachers and researchers in NDTE is to develop a strong and high level skills network facilitating technology transfer from experimental platforms with innovative pilot lines.

Keywords: NDT-wide, Electromagnetic Testing (ET), Magnetic Testing (MT), Ultrasonic Testing (UT)





Strategy for NDTE education at universities in France

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(* Vice-President of the Academia NDT International)



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13th EUROPEAN CONFERENCE ON NON-DESTRUCTIVE TESTING
LISBON – PORTUGAL, 3 – 7 JULY 2023

Motivations and Outline

■ Introduction

- Many areas of activity : Non-Destructive Testing and Evaluation (NDTE)
- Industry 4.0 is a major challenge in which NDTE have an important role
- Paradoxically, there is little training at the master's or engineer level to train NDTE specialists in France

■ Methodology

- Taking advantage of the specificities and skills of each institution
- The ambition of French academic teachers and researchers in NDTE to develop a strong and emerging network
- Examples of Curriculum with NDT parts at the master level

■ Conclusions, discussion and perspective

Some NDT news from French media

Industry: “la Nouvelle-Aquitaine “ mobilizes on non-destructive testing To succeed in factory 4.0, the factory of the future, it is essential to master the non-destructive testing of industrial parts.

[La tribune \(2019\)](#)



“Non-destructive testing: professions of the future and more than 1,000 recruitments at Safran”

[hellowork \(2019\)](#)



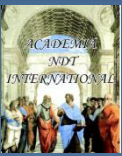
[Usine nouvelle \(2023\)](#)



[Les echos \(2023\)](#)

Nuclear: a non-destructive testing platform inaugurated in Chalon-sur-Saône : A “European nuclear school”

NDT Masters in France



The screenshot shows the MonMaster website interface. At the top, there are logos for the French Republic, MonMaster, and the National Diploma of Master Control by the State. The main header reads 'La plateforme nationale des masters' with links to 'Candidater' and 'Saisir le recteur'. Below this, there are search filters and a notification: 'La période de candidature est close. Les établissements examinent désormais les dossiers des candidats. Ces derniers doivent consulter régulièrement leur compte sur la plateforme, ainsi que leur messagerie : ils peuvent être convoqués à des entretiens ou à des examens et, pour ce qui concerne les formations en alternance, ils sont susceptibles de recevoir dès à présent des réponses à leurs candidatures.'

The search results section shows a search for 'control non destructif' with 1 result. The result is for 'Physique fondamentale et applications' at 'Université Paris Cité' in Paris (75). The result card includes the text 'RENTRÉE 2023', 'SCIENCES, TECHNOLOGIES, SANTÉ', and a button 'EN SAVOIR PLUS'.

The official French Master portal : no specialized NDT Master Training !

<https://www.monmaster.gouv.fr/>

Masters with NDT parts

- 1.École Nationale Supérieure de Techniques Avancées (ENSTA ParisTech) - Mastère Spécialisé (MS) en **Contrôle Non Destructif** et Mesures Industrielles. Site web : <https://www.ensta-paris.fr/>
- 2.Université de Technologie de Compiègne (UTC) - Master Recherche en Mécanique, spécialité **Contrôle Non Destructif**. Site web : <https://www.utc.fr/>
- 3.Université Paris-Est Créteil (UPEC) - Master Professionnel **Contrôle** Qualité et **Non Destructif** (CQND). Site web : <https://www.u-pec.fr/>
- 4.Institut National des Sciences Appliquées (INSA) Lyon - Master Recherche en Mécanique, spécialité **Contrôle Non Destructif**. Site web : <https://www.insa-lyon.fr/>
- 5.École Supérieure des Techniques Aéronautiques et de Construction Automobile (ESTACA) - Mastère Spécialisé en **Contrôle Non Destructif**. Site web : <https://www.estaca.fr/>
- 6.Université de Bourgogne - Master Professionnel Procédés, Contrôle et Matériaux Métalliques: Industrie du Nucléaire (PC2M). CND en alternance. Site web : <https://blog.u-bourgogne.fr/master-pc2m/>
- 7.Université de Nantes - Master Recherche en Sciences et Techniques, spécialité **Contrôle Non Destructif** et Mesures. Site web : <https://www.univ-nantes.fr/>
- 8.Université de Lorraine - Master Recherche en Mécanique, spécialité **Contrôle Non Destructif**. Site web : <https://www.univ-lorraine.fr/>

Masters with NDT parts

1. Université de Technologie de Troyes (UTT) - Master Recherche en Sciences et Technologies, spécialité Contrôle Non Destructif et Fiabilité des Matériaux. Site web : <https://www.utt.fr/>
2. Institut National Polytechnique de Toulouse (INPT) - Master Recherche en Mécanique, spécialité Contrôle Non Destructif et Mesures. Site web : <https://www.inp-toulouse.fr/>
3. Université de Technologie de Belfort-Montbéliard (UTBM) - Master Recherche en Mécanique et Energétique, spécialité Contrôle Non Destructif. Site web : <https://www.utbm.fr/>
4. Université Claude Bernard Lyon 1 - Master Recherche en Sciences et Technologies, spécialité Contrôle Non Destructif des Matériaux et Structures. Site web : <https://www.univ-lyon1.fr/>
5. Université de Lille - Master Recherche en Sciences de l'Ingénieur, spécialité Contrôle Non Destructif. Site web : <https://www.univ-lille.fr/>
6. Institut Supérieur de Mécanique de Paris (ISMEP) - Master Recherche en Sciences et Génie des Matériaux, spécialité Contrôle Non Destructif et Intégrité des Structures. Site web : <http://www.ismep.fr/>
7. Université de Strasbourg - Master Recherche en Physique, spécialité Contrôle Non Destructif. Site web : <https://www.unistra.fr/>
8. Université de Bordeaux - Le Coursus Master en Ingénierie IMSAT (Ingénierie et Maintenance des Systèmes pour l'Aéronautique et les Transports) ; <https://evering.u-bordeaux.fr/Nos-formations/Cursus-Master-en-Ingénierie-IMSAT>

NDT Engineering Schools

1. École d'ingénieur ESIREM (POLYTECH' Dijon en 2024) – Formation ingénieur en alternance sur 3 ans Matériaux et Contrôle Non Destructif (Ouverture septembre 2023) Site web : <https://esirem.u-bourgogne.fr/wp-content/uploads/2023/04/cnd.pdf>

Engineer level NDT training @ INSA Lyon

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

CND

**SPECIALIZED MASTER®
NON DESTRUCTIVE TESTING**
issued by INSA Lyon

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

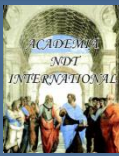
Mastère Spécialisé Contrôle Non Destructif

Philippe Duvauchelle
Responsable du Mastère Spécialisé CND - INSA Lyon

**CONTRÔLE
Non
DESTRUCTIF**
Mastère spécialisé

[Webinar on Youtube \(in French\)](#)

Engineer level NDT training @ INSA Lyon

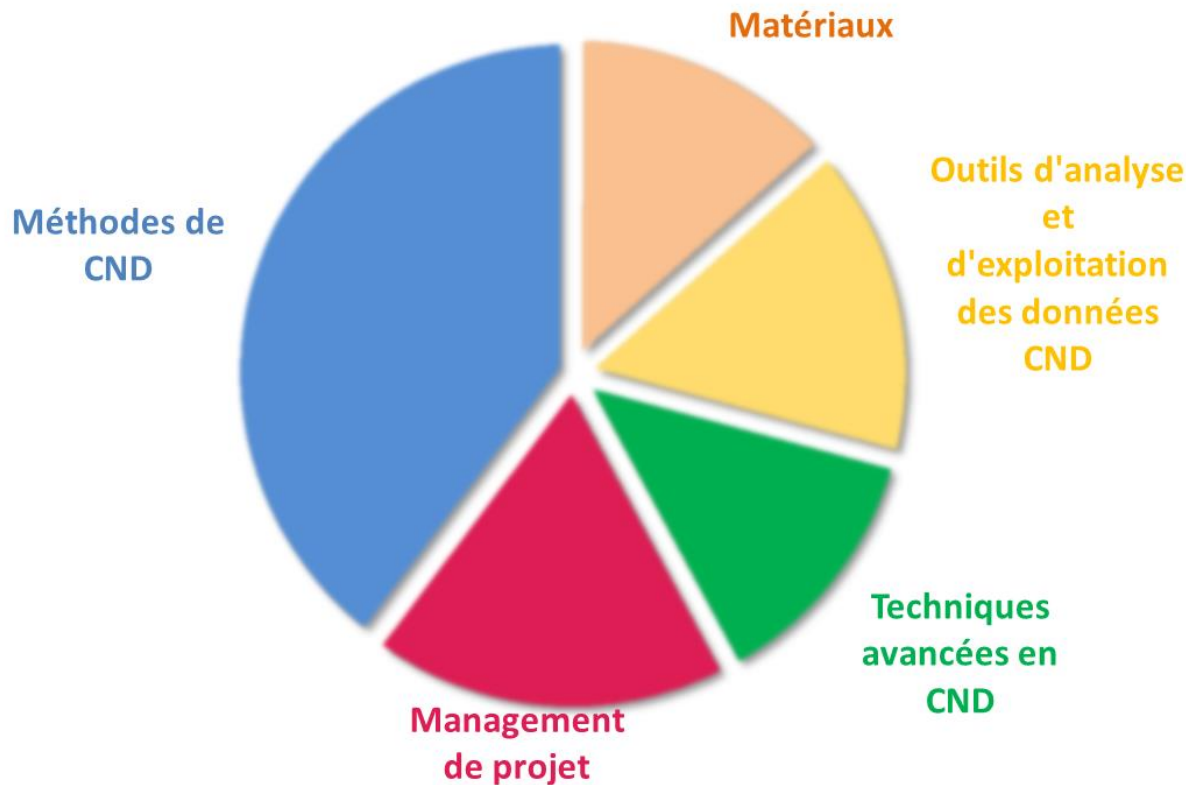


Goal : train students with a cross-disciplinary vision of NDT without being specialists in all NDT methods

- Program elaboration in concertation with industrials
- Well balanced program between industrial and academic
- Experimental activities ratio : 30 %
- Training specialized on NDT :
 - 8 methods/technics (ultrasons, courants de Foucault, thermographie, Radiographie, Ressuage, magnétoscopie, inspection visuelle, émission acoustique)
 - Materials (metal, ceramic, composites, ...) and manufacturing process (welding, casting, additive manufacturing)
 - Data analysis (simulation, IA, ...)

Engineer level NDT training @ INSA Lyon

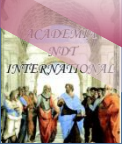
RÉPARTITION DES HEURES
(~460H)



4 to 6 months
internship in
NDT companies

1 year Training

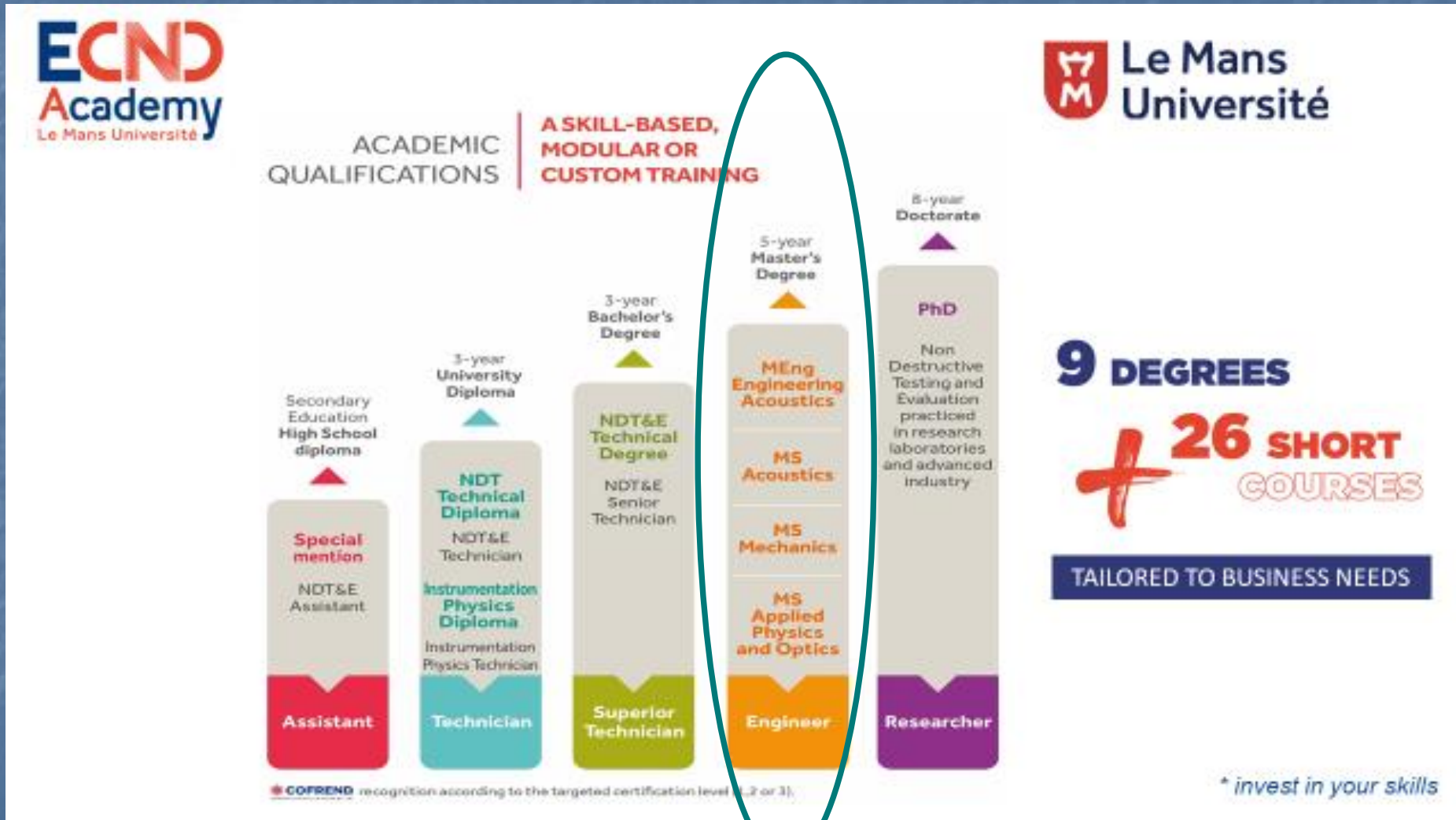
Companies involved



➤ Moodle dedicated platform for NDE courses

<https://moodle.opennde.org/>

NDT Master : Le Mans université



NDT topics : NDT Integrity Engineering INSA Centre Val de Loire, Blois

DUNAÚJVÁROSI EGYETEM
UNIVERSITY OF DUNAÚJVÁROS

NDT Integrity Engineering – A New Profession
Part 2: Non-destructive testing

Peter Trampus
professor emeritus
trampus@uniduna.hu

„Non-Destructive Testing” Course, INSA, France
November 16-17, 2020

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- ▶ COMPUTER SECURITY AND TECHNOLOGIES
- ▶ INDUSTRIAL SYSTEMS ENGINEERING
- ▶ ENERGY RISKS AND THE ENVIRONMENT

MASTER

MASTER'S DEGREE IN APPLIED PHYSICS AND PHYSICS ENGINEERING (SEPT. 2023)

Application Form **Presentation**

The Master's degree in fundamental physics "Applied Physics - Electronics, Electrical Energy and Automation", (M2P1 SEA), is evolving and becoming the **Master's degree in Applied Physics and Physics Engineering**. It will open in September 2023.

The Master addresses students interested in disciplines oriented toward applied physics and engineering sciences in the fields of electronic systems and components, instrumentation and ultrasounds, automatic, robotics and computer vision. It is also intended for students interested in the design of renewable energy systems. Students take scientific courses in applied mathematics and computer science, electronics, signal processing, automatic, instrumentation, ultrasound, etc., as well as in the behavior of organizations, scientific communication and professional English or French for foreign students. At the end of the Master 1, students can join one of the two Master 2 tracks of the master: Electronics, Instrumentation and Ultrasound for the first track, and Automatic Robotics and Computer Vision for the second one.

<https://www.insa-centrevaldeloire.fr/en/training/master>

Material Engineering and NDT ESIREM (2024 : Polytech Dijon)

- New: opening September 2023
- Engineering degree (Master level)
- 3-year apprenticeship with a company

Content :

- Extensive training in material science
- About 225h of training in NDT
- Engineering science & advanced tools

<https://esirem.u-bourgogne.fr/wp-content/uploads/2023/04/cnd.pdf>

Material Engineering and NDT ESIREM (2024 : Polytech Dijon)

Matériaux
Élaboration, structure et propriétés des matériaux (métaux, céramiques, SC, verres, polymères, ciments, composites)
Choix des matériaux - Génie des matériaux
Techniques d'assemblage (soudage, brasage, collage) Fabrication additive
Méthodes de caractérisation (MEB, DRX, Fluo X, ...)
Défectologie: mécanismes d'apparition des défauts en fabrication et en service (corrosion, fissuration, ...)
Vieillessement, suivi de vie des pièces

Sciences pour l'ingénieur
Mathématiques
Mécanique, thermique
Informatique, calculs
Ondes électromagnétiques
Acoustique et vibrations
Systèmes de vision
Électronique et signal
Optique et lasers

Techniques CND
Radiographie / Tomographie
Ultrasons
Méthodes électromagnétiques
Ressuage et magnétoscopie
Étanchéité
Émission acoustique
Méthodes visuelles
Thermographie infrarouge

Règlementation / Normes / Métrologie

Outils avancés
Stockage et intégrité des données
Simulation numérique – Interaction capteur-matériau
Traitement de l'image
Acquisition et traitement des données
Automatisation des contrôles (robotisation, IHM)
Représentation 2D et reconstruction 3D

NDT Master : Sorbonne University Abu Dhabi – in a nutshell



Master in Physics – NDCCH



- ✓ Physics and Non destructive characterization
- ✓ Cross-disciplinarity
- ✓ Study of cases in Cultural Heritage and Space Sciences
- ✓ Other fields: forensics, material science, environment, aerospace, oil & gas...

Key facts

- ✓ “Master in Physics” degree awarded by Sorbonne Université in Paris
- ✓ Taught in English
- ✓ Two-year program, including a six-month internship

Program designed and implemented with the LAMS – Sorbonne Université, leader in the field

Future NDT Master : Sorbonne University Abu Dhabi - structure of program

Term	Course Title	Contact hours	ECTS
Semester 1	Quantum Physics: basis and applications	40	4
	Fundamental of Statistical Physics	40	4
	Experimental Methods in Material Physics	60	6
	Scientific Computing (Python & MATLAB)	40	4
	Experimental or numerical group project in heritage sciences 1	30	3
	Heritage Science course 1 (Art history, Archeology, physical geography)	30	3
	Non-Destructive characterization in heritage sciences	30	3
	Language 1 (French or another Foreign language for French speakers)	20	3
Total		290	30
Semester 2	Introduction to Atomic and Molecular Physics	60	6
	Project management	30	3
	Vibrations, Acoustics and Control Sensor	30	3
	Spectroscopy techniques and applications	60	6
	Introduction to Artificial Intelligence for Big Data and Signal Processing	30	3
	Experimental or numerical group project in heritage sciences 2	30	3
	Heritage Science course 2 (Art history, Archeology, physical geography)	30	3
	Language 2 (French or another Foreign language for French speakers)	20	3
Total		290	30

Term	Course Title	Contact hours	ECTS
Semester 3	Ultrasonic Non-Destructive Testing	30	3
	Materials Characterization in Cultural Heritage	30	3
	Applications of Non-Destructive characterization	30	3
	Experimental study for the characterization of real materials related to archaeological and art interest.	60	6
	Introduction to Artificial Intelligence for Cultural Heritage science	30	3
	Long term practical on-site project (cross-group, course common to the Master students in Archeology).	90	9
	Language 3 (French or another Foreign language for French speakers)	20	3
Total		290	30
Semester 4	6-month Internship and Master Thesis	N/A	30

Contact: valerie.leguyon@sorbonne.ae

<https://www.sorbonne.ae/study/postgraduate-study/master-in-physics-specialisation-in-non-destructive-characterisation-with-applications-for-cultural-heritage/>

Acknowledgements and Collaborations

- Colleagues from the French Academic community
 - Prof. Patrick Marquié, Université de Bourgogne, Dijon
 - Dr. Valérie Le Guyon, Dr. Delphine Syvilay, Sorbonne Université, Abu Dhabi

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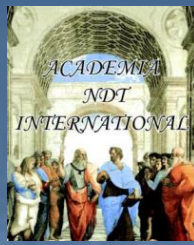
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Le Mans
Université

ECND
Academy
Le Mans Université



Announcement



EVIDENT

20th WCNDT

20th World Conference on Non-Destructive Testing

Songdo Convensia, Incheon, Korea

27-31 May 2024

The banner features a large, modern building with a glass facade and a prominent blue sculpture of a figure in the foreground. The text is overlaid on a dark blue background with a stylized white decorative element on the right.

<https://www.20thwcondt.com/>

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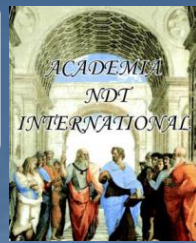
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Thank you ! Questions ?



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