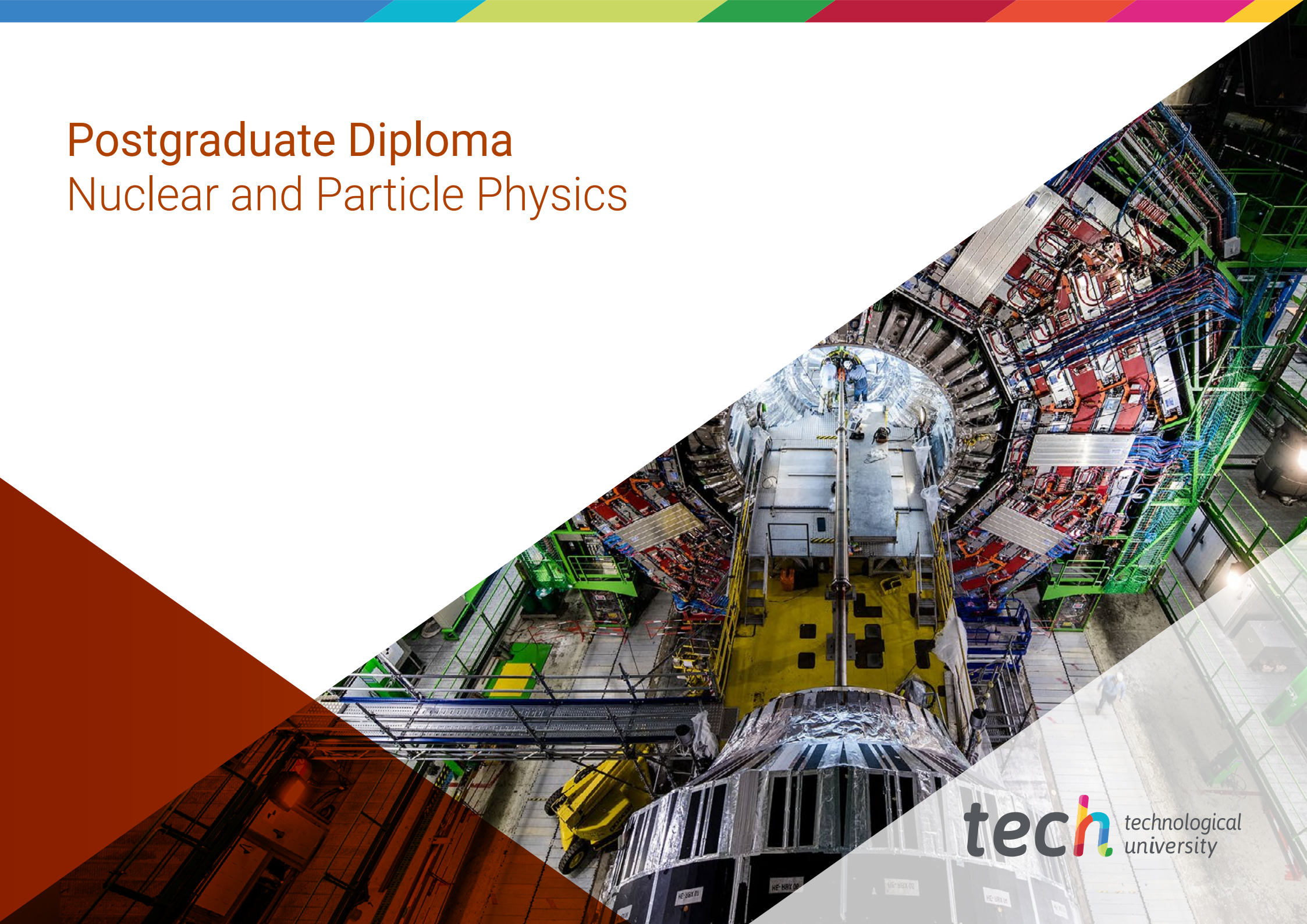
Postgraduate Diploma
Nuclear and Particle Physics



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Postgraduate Diploma
Nuclear and Particle Physics

Course Modality: **Online**
Duration: **6 months**
Certificate: **TECH Technological University**
Teaching Hours: **450 h.**
Website: **www.techtitute.com/us/engineering/postgraduate-diploma/postgraduate-diploma-nuclear-particle-physics**

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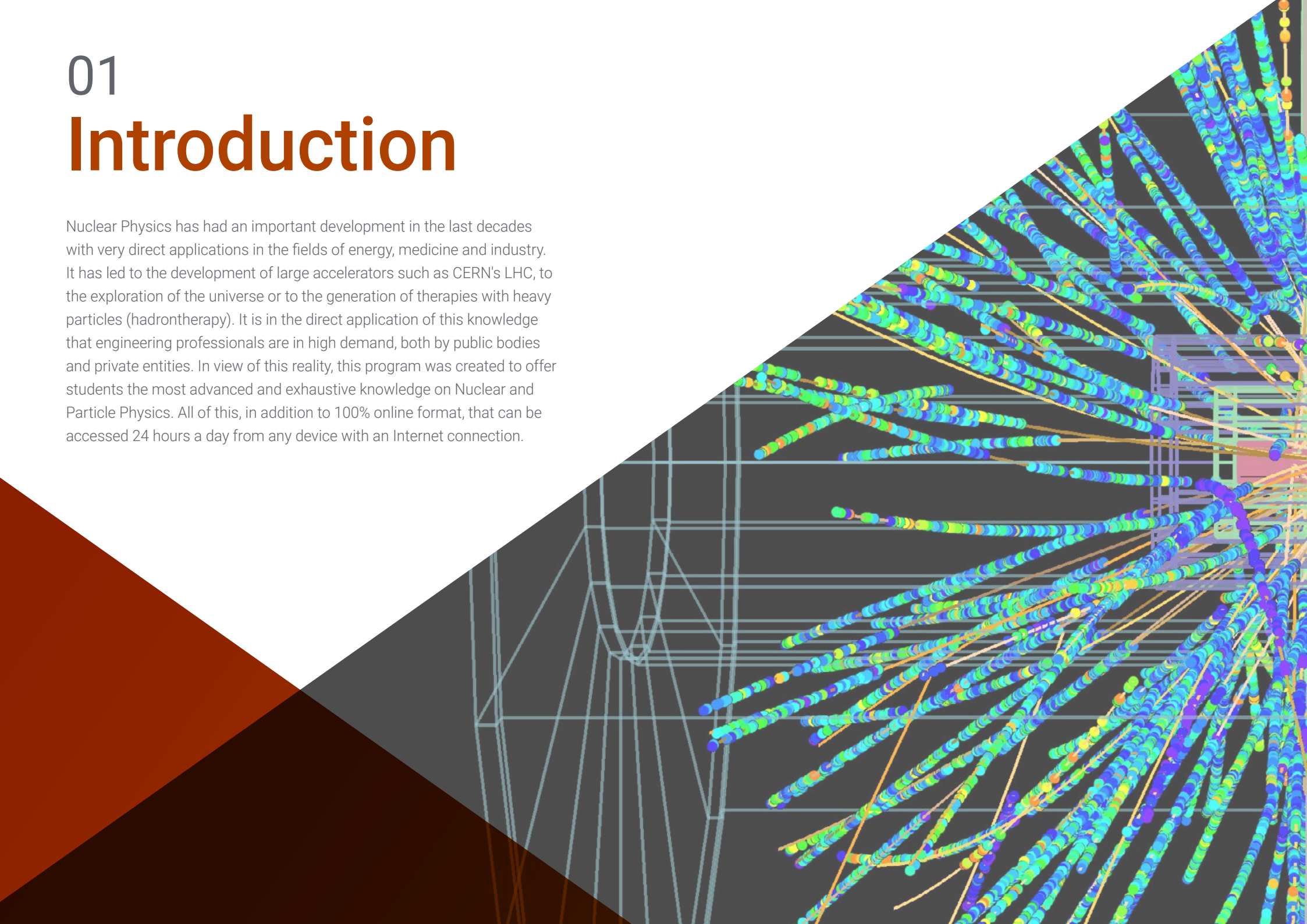
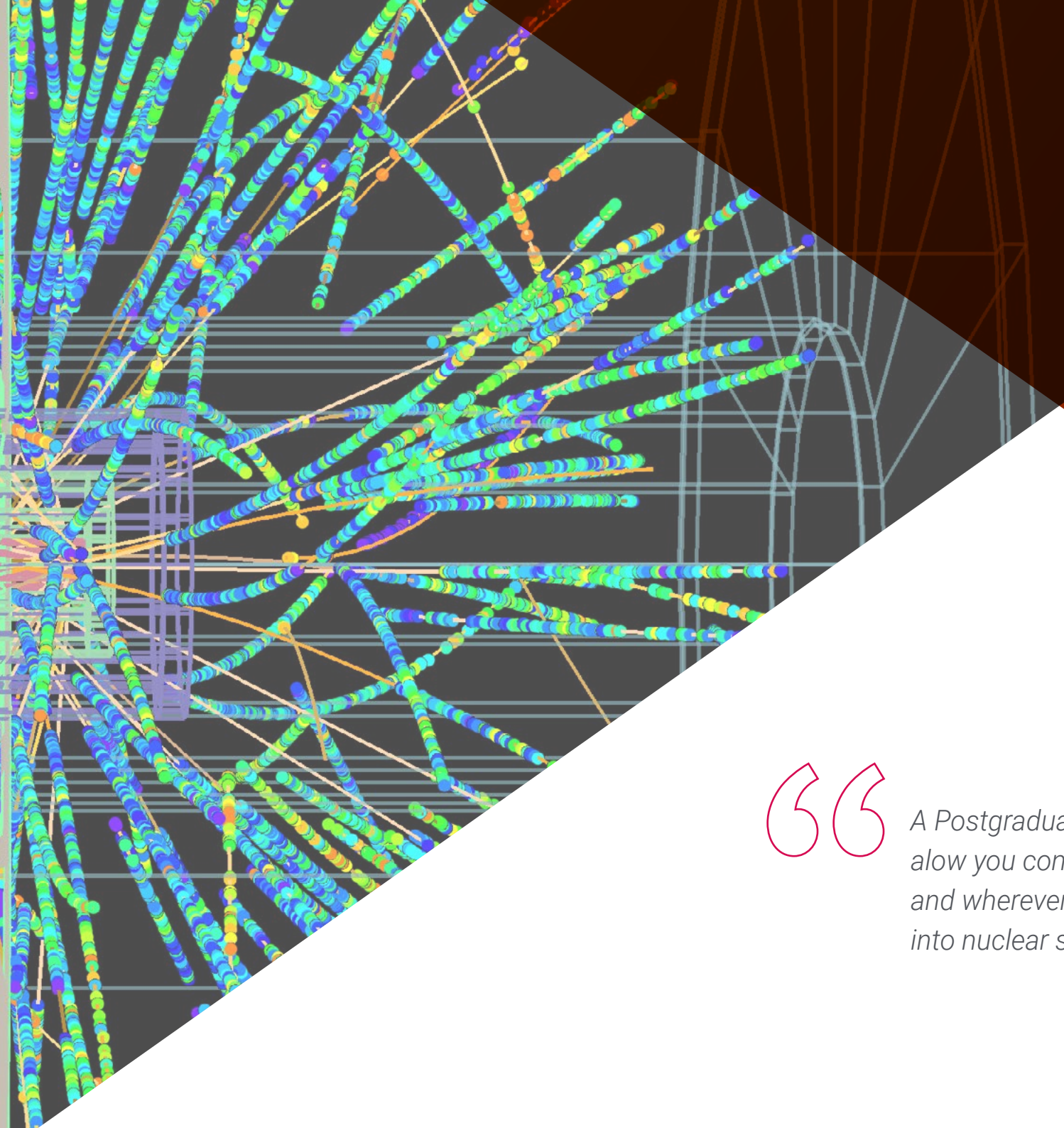
01

Introduction

Nuclear Physics has had an important development in the last decades with very direct applications in the fields of energy, medicine and industry. It has led to the development of large accelerators such as CERN's LHC, to the exploration of the universe or to the generation of therapies with heavy particles (hadrontherapy). It is in the direct application of this knowledge that engineering professionals are in high demand, both by public bodies and private entities. In view of this reality, this program was created to offer students the most advanced and exhaustive knowledge on Nuclear and Particle Physics. All of this, in addition to 100% online format, that can be accessed 24 hours a day from any device with an Internet connection.





A Postgraduate Diploma that will alow you conveniently, whenever and wherever you wish, to delve into nuclear structure and particles”

Nuclear Physics applications are currently presented as the solution to some of mankind's problems, such as the search for alternative energy to some of humanity's problems, such as the search for alternative energy sources to fossil fuels, the reduction of pollution, manned space travel or the treatment of diseases through more precise and effective treatments.

A multitude of possibilities, which in turn open the way to engineering professionals who wish to obtain a solid knowledge in this field, to contribute to the development of devices or equipment. A promising future, where TECH has decided to contribute with a Postgraduate Diploma in Nuclear and Particle Physics, which will lead graduates to advance in their careers.

An exclusively online program which in only 6 months will lead you to delve into key concepts such as the hydrogen atom, the Quarkonium, baryons or light mesons. In addition, the multimedia teaching materials provided in this program will lead you to delve in a much more dynamic way into the Yang-Millis theory, cosmology and the primitive universe.

Furthermore, the simulations of case studies provided by the specialists, will lead you to acquire a closer and practical learning experience, allowing you to incorporate it into your professional performance.

This postgraduate diploma will allow the Engineers to advance their careers through an education that they can access whenever and wherever they wish. All you need is a device with Internet connection to access the content hosted on the virtual campus. In addition, you have the freedom to distribute the teaching load according to your needs. An excellent opportunity to study a quality Postgraduate Diploma while combining work and/or personal responsibilities.

This **Postgraduate Diploma in Nuclear and Particle Physics** contains the most complete and up-to-date program on the market. The most important features include:

- Practical case studies are presented by experts in Physics
- The graphic, schematic, and practical contents with which they are created, provide scientific and practical information on the disciplines that are essential for professional practice
- Practical exercises where the self-assessment process can be carried out to improve learning
- Its special emphasis on innovative methodologies
- Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- The availability of access to the contents from any device fixed or portable with Internet connection

With this Postgraduate Diploma you will be an expert in the standard model of elementary particles: leptons and quarks"

You will have access 24 hours a day, from any device with Internet connection to the application of the knowledge of quantum field theory and the mathematics of group theory"

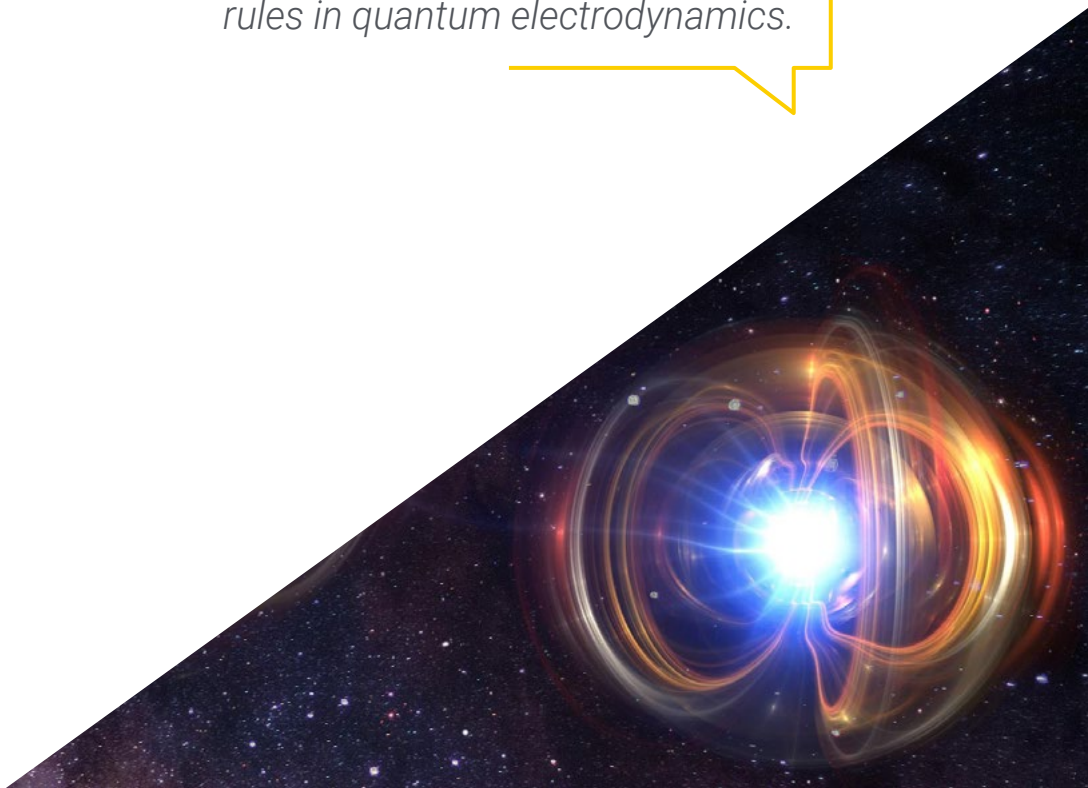
Enroll in a Postgraduate Diploma that will lead you to delve into the theory of relativity, cosmology and thermodynamics of the early universe.

With this academic program you will be able to master Feynman's rules in quantum electrodynamics.

The program's teaching staff includes professionals from the sector who contribute their work experience to this educational program, as well as renowned specialists from leading societies and prestigious universities.

Its multimedia content, developed with the latest educational technology, will allow professionals to learn in a contextual and situated learning environment, i.e., a simulated environment that will provide immersive education programmed to prepare in real situations.

The design of this program focuses on Problem-Based Learning, by means of which professionals must try to solve the different professional practice situations that are presented to them throughout the academic year. For this purpose, students will be assisted by an innovative interactive video system developed by renowned experts.



02

Objectives

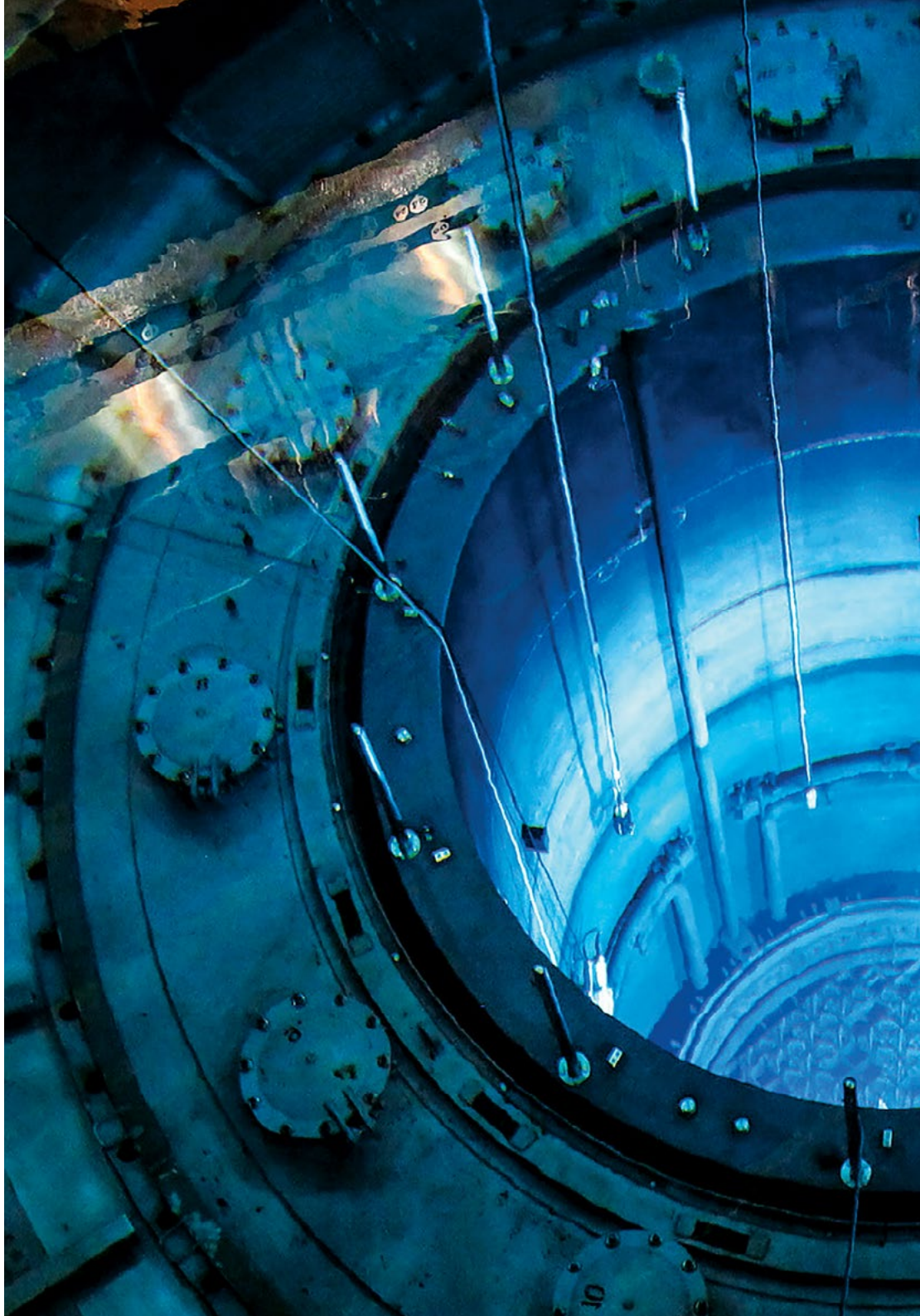
The syllabus of this postgraduate diploma has been designed with the main objective of boosting the professional careers of the engineering professionals. For this reason, they will obtain the most relevant and advanced information on Nuclear and Particle Physics, with which they will be able to master this subject and take it to practical and technical application from the engineering field. In addition, a specialist team is available to answer any questions students may have about the syllabus of this 100% online program.

Enroll now in a Postgraduate Diploma that will provide you with the necessary knowledge in Nuclear and Particle Physics to progress in the field of engineering"

General Objectives

- Acquire basic concepts of astrophysics
- Obtain basic notions about Feynman diagrams, how they are drawn and their utilities
- Learn and apply approximate methods to study quantum systems
- Master the Klein-Gordon, Dirac and electromagnetic fields

With this Postgraduate Diploma, you will delve into Einstein's equations and Schwarzschild's solutions in a much more dynamic way"



Specific Objectives

Module 1. Nuclear and Particle Physics

- Obtain basic knowledge of nuclear and particle physics
- Know how to distinguish the different nuclear decay processes
- Know the Feynman diagrams, their use and how to draw them
- Know how to calculate relativistic collisions

Module 2. General Relativity and Cosmology

- Acquire basic notions of general relativity
- Apply knowledge of calculus and algebra to the study of gravity using the theory of general relativity
- Know the Einstein's equations in tensor format
- Acquire basic knowledge of cosmology and the primitive universe

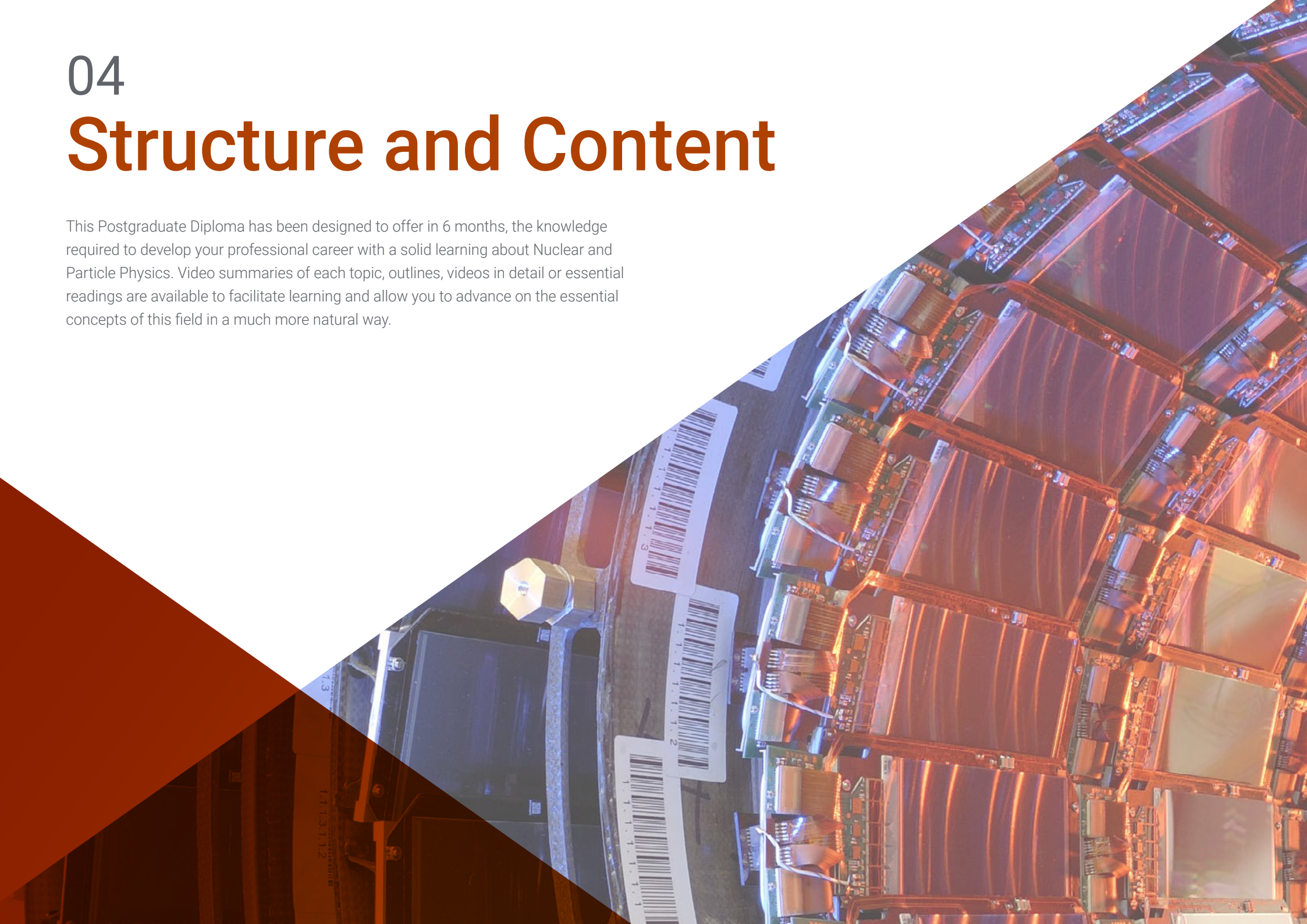
Module 3. High-Energy Physics

- Apply knowledge of quantum field theory and the mathematics of group and representations theory to elementary particle physics
- Know the spontaneous symmetry breaking mechanisms and the Higgs mechanism
- Have notions of neutrino physics, their masses and oscillations
- Know Feynman's rules for quantum electrodynamics, quantum chromodynamics and weak interaction
- Acquire Basic Notions of Yang-Millis Theory

04

Structure and Content

This Postgraduate Diploma has been designed to offer in 6 months, the knowledge required to develop your professional career with a solid learning about Nuclear and Particle Physics. Video summaries of each topic, outlines, videos in detail or essential readings are available to facilitate learning and allow you to advance on the essential concepts of this field in a much more natural way.



Thanks to the Relearning method you will be able to advance quickly through the content of this syllabus and reduce the long hours of study"

Module 1. Nuclear and Particle Physics

1.1. Introduction to Nuclear Physics
- 1.1.1. Periodic Table of the Elements
- 1.1.2. Important Discoveries
- 1.1.3. Atomic Models
- 1.1.4. Important Definitions Scales and Units in Nuclear Physics
- 1.1.5. Segré's Diagram

1.2. Nuclear Properties
- 1.2.1. Binding Energy
- 1.2.2. Semiempirical Mass Formula
- 1.2.3. Fermi Gas Model
- 1.2.4. Nuclear Stability
  - 1.2.4.1. Alpha Decay
  - 1.2.4.2. Beta Decay
  - 1.2.4.3. Nuclear Fusion
- 1.2.5. Nuclear Deexcitation
- 1.2.6. Double Beta Decay

1.3. Nuclear Scattering
- 1.3.1. Internal Structure: Dispersion Study
- 1.3.2. Effective Section
- 1.3.3. Rutherford's Experiment: Rutherford's Effective Section
- 1.3.4. Mott's Effective Section
- 1.3.5. Momentum Transfer and Shape Factors
- 1.3.6. Nuclear Charge Distribution
- 1.3.7. Neutron Scattering

1.4. Nuclear Structure and Strong Interaction
- 1.4.1. Nucleon Scattering
- 1.4.2. Bound States Deuterium
- 1.4.3. Strong Nuclear Interaction
- 1.4.4. Magic Numbers
- 1.4.5. The Layered Model of the Nucleus
- 1.4.6. Nuclear Spin and Parity
- 1.4.7. Electromagnetic Moments of the Nucleus
- 1.4.8. Collective Nuclear Excitations: Dipole Oscillations, Vibrational States and Rotational States

1.5. Nuclear Structure and Strong Interaction II
- 1.5.1. Classification of Nuclear Reactions
- 1.5.2. Reaction Kinematics
- 1.5.3. Conservation Laws
- 1.5.4. Nuclear Spectroscopy
- 1.5.5. The Compound Nucleus Model
- 1.5.6. Direct Reactions
- 1.5.7. Elastic Dispersion

1.6. Introduction to Particle Physics
- 1.6.1. Particles and Antiparticles
- 1.6.2. Fermions and Baryons
- 1.6.3. The Standard Model of Elementary Particles: Leptons and Quarks
- 1.6.4. The Quark Model
- 1.6.5. Intermediate Vector Bosons

1.7. Dynamics of Elementary Particles
- 1.7.1. The Four Fundamental Interactions
- 1.7.2. Quantum Electrodynamics
- 1.7.3. Quantum Chromodynamics
- 1.7.4. Weak Interaction
- 1.7.5. Disintegrations and Conservation Laws

1.8. Relativistic Kinematics
- 1.8.1. Lorentz Transformations
- 1.8.2. Quatrivectors
- 1.8.3. Energy and Linear Momentum
- 1.8.4. Collisions
- 1.8.5. Introduction to Feynman Diagrams

1.9. Symmetries
- 1.9.1. Groups, Symmetries and Conservation Laws
- 1.9.2. Spin and Angular Momentum
- 1.9.3. Addition of Angular Momentum
- 1.9.4. Flavor Symmetries
- 1.9.5. Parity
- 1.9.6. Load Conjugation
- 1.9.7. CP Violation
- 1.9.8. Time Reversal
- 1.9.9. CPT Conservation

1.10. Bound States
- 1.10.1. Schrödinger's Equation for Central Potentials
- 1.10.2. Hydrogen Atom
- 1.10.3. Fine Structure
- 1.10.4. Hyperfine Structure
- 1.10.5. Positronium
- 1.10.6. Quarkonium
- 1.10.7. Lightweight Mesons
- 1.10.8. Baryons

Module 2. General Relativity and Cosmology

2.1. Special Relativity
- 2.1.1. Postulates
- 2.1.2. Lorentz Transformations in Standard Configuration
- 2.1.3. Impulses (Boosts)
- 2.1.4. Tensors
- 2.1.5. Relativistic Kinematics
- 2.1.6. Relativistic Linear Momentum and Energy
- 2.1.7. Lorentz Covariance
- 2.1.8. Energy-Momentum Tensor

2.2. Principle of Equivalence
- 2.2.1. Principle of Weak Equivalence
- 2.2.2. Experiments on the Weak Equivalence Principle
- 2.2.3. Locally Inertial Reference Systems
- 2.2.4. Principle of Equivalence
- 2.2.5. Consequences on the Equivalence Principle

2.3. Particle Motion in the Gravitational Field
- 2.3.1. Path of Particles under Gravity
- 2.3.2. Newtonian Limit
- 2.3.3. Gravitational Redshift and Tests
- 2.3.4. Temporary Dilatation
- 2.3.5. Geodesic Equation

2.4. Geometry: Necessary Concepts
- 2.4.1. Two-Dimensional Spaces
- 2.4.2. Scalar, Vector and Tensor Fields
- 2.4.3. Metric Tensor: Concept and Theory
- 2.4.4. Partial Derivative
- 2.4.5. Covariant Derivative
- 2.4.6. Christoffel Symbols
- 2.4.7. Covariant Derivatives of Tensors
- 2.4.8. Directional Covariant Derivatives
- 2.4.9. Divergence and Lapacian

2.5. Curved Space-Time
- 2.5.1. Covariant Derivative and Parallel Transport: Definition
- 2.5.2. Geodesics from Parallel Transport
- 2.5.3. Riemann Curvature Tensor
- 2.5.4. Riemann Tensor: Definition and Properties
- 2.5.5. Ricci Tensor: Definition and Properties

2.6. Einstein Equations: Derivation
- 2.6.1. Reformulation of the Equivalence Principle
- 2.6.2. Applications of the Equivalence Principle
- 2.6.3. Conservation and Symmetries
- 2.6.4. Derivation of Einstein's Equations from the Equivalence Principle

2.7. Schwarzschild Solution
- 2.7.1. Schwartzschild Metrics
- 2.7.2. Length and Time Elements
- 2.7.3. Conserved Quantities
- 2.7.4. Equation of Motion
- 2.7.5. Light Deflection. Study of Schwartzschild Metrics
- 2.7.6. Schwartzschild Radius
- 2.7.7. Eddington-Finkelstein Coordinates
- 2.7.8. Black Holes

2.8. Linear Gravity Limits Consequences
- 2.8.1. Linear Gravity: Introduction
- 2.8.2. Coordinate Transformation
- 2.8.3. Linearized Einstein Equations
- 2.8.4. General Solution of Linearized Einstein Equations
- 2.8.5. Gravitational Waves
- 2.8.6. Effects of Gravitational Waves on Matter
- 2.8.7. Generation of Gravitational Waves

2.9. Cosmology: Introduction
- 2.9.1. Observation of the Universe: Introduction
- 2.9.2. Cosmological Principle
- 2.9.3. System of Coordinates
- 2.9.4. Cosmological Distances
- 2.9.5. The Hubble's Law
- 2.9.6. Inflation

2.10. Cosmology: Mathematical Study
- 2.10.1. Friedmann's First Equation
- 2.10.2. Friedmann's Second Equation
- 2.10.3. Densities and Scale Factor
- 2.10.4. Consequences of Friedmann Equations Curvature of the Universe
- 2.10.5. Primitive Universe Thermodynamics

Module 3. High-Energy Physics

3.1. Mathematical Methods: Groups and Representations
- 3.1.1. Theory of Groups
- 3.1.2. SO (3), SU(2) and SU(3) and SU(N) Groups
- 3.1.3. Lie Algebra
- 3.1.4. Representations
- 3.1.5. Multiplication of Representations

3.2. Symmetries
- 3.2.1. Symmetries and Conservation Laws
- 3.2.2. C, P, T Symmetries
- 3.2.3. CPT Symmetry Violation and Conservation
- 3.2.4. Angular Momentum
- 3.2.5. Addition of Angular Momentum

3.3. Feynman Calculus: Introduction
- 3.3.1. Average Lifetime
- 3.3.2. Cross Section
- 3.3.3. Fermi's Golden Rule for Decay
- 3.3.4. Fermi's Golden Rule for Dispersion
- 3.3.5. Dispersion of Two Bodies in the Center of Masses of Reference Systems

3.4. Application of Feynman Calculation: Toy Model
- 3.4.1. Toy Model: Introduction
- 3.4.2. Feynman Rules
- 3.4.3. Average Lifetime
- 3.4.4. Dispersion
- 3.4.5. Higher Order Diagrams

3.5. Quantum Electrodynamics
- 3.5.1. Dirac Equation
- 3.5.2. Solution for Dirac Equations
- 3.5.3. Bilinear Covariants
- 3.5.4. The Photon
- 3.5.5. Feynman Rules for Quantum Electrodynamics
- 3.5.6. Casimir Trick
- 3.5.7. Renormalization

3.6. Electrodynamics and Chromodynamics of Quarks
- 3.6.1. Feynman Rules
- 3.6.2. Production of Hadrons in Electron-Positron Collisions
- 3.6.3. Feynman Rules for Chromodynamics
- 3.6.4. Color Factors
- 3.6.5. Quark-Antiquark Interaction
- 3.6.6. Quark-Quark Interaction
- 3.6.7. Pair Annihilation in Quantum Chromodynamics

3.7. Weak Interaction
- 3.7.1. Weak Charged Interaction
- 3.7.2. Feynman Rules
- 3.7.3. Muon Decay
- 3.7.4. Neutron Decay
- 3.7.5. Pion Decay
- 3.7.6. Weak Interaction between Quarks
- 3.7.7. Weak Neutral Interaction
- 3.7.8. Electroweak Unification

3.8. Gauge Theories
- 3.8.1. Local Gauge Invariance
- 3.8.2. Yang-Millis Theory
- 3.8.3. Quantum Chromodynamics
- 3.8.4. Feynman Rules
- 3.8.5. Mass Term
- 3.8.6. Spontaneous Symmetry Breaking
- 3.8.7. Higgs Mechanism

3.9. Neutrino Oscillation
- 3.9.1. Solar Neutrino Problem
- 3.9.2. Neutrino Oscillation
- 3.9.3. Neutrino Masses
- 3.9.4. Mixing Matrix

3.10. Advanced Topics Brief Introduction
- 3.10.1. Higgs Boson
- 3.10.2. Grand Oscillation
- 3.10.3. Matter-Antimatter Asymmetry
- 3.10.4. Supersymmetry, Strings and Extra Dimensions
- 3.10.5. Dark Matter and Energy

An ideal academic option for those who wish to deepen their knowledge on the latest advances in the field of Nuclear and Particle Physics"

05

Methodology

This academic program offers students a different way of learning. Our methodology uses a cyclical learning approach: **Relearning.**

This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.

Discover Relearning, a system that abandons conventional linear learning, to take you through cyclical teaching systems: a way of learning that has proven to be extremely effective, especially in subjects that require memorization"

Case Study to contextualize all content

Our program offers a revolutionary approach to developing skills and knowledge. Our goal is to strengthen skills in a changing, competitive, and highly demanding environment.

At TECH, you will experience a learning methodology that is shaking the foundations of traditional universities around the world"

You will have access to a learning system based on repetition, with natural and progressive teaching throughout the entire syllabus.

The student will learn to solve complex situations in real business environments through collaborative activities and real cases.

A learning method that is different and innovative

This TECH program is an intensive educational program, created from scratch, which presents the most demanding challenges and decisions in this field, both nationally and internationally. This methodology promotes personal and professional growth, representing a significant step towards success. The case method, a technique that lays the foundation for this content, ensures that the most current economic, social and professional reality is taken into account.

> *Our program prepares you to face new challenges in uncertain environments and achieve success in your career"*

The case method is the most widely used learning system in the best faculties in the world. The case method was developed in 1912 so that law students would not only learn the law based on theoretical content. It consisted of presenting students with real-life, complex situations for them to make informed decisions and value judgments on how to resolve them. In 1924, Harvard adopted it as a standard teaching method.

What should a professional do in a given situation? This is the question that you are presented with in the case method, an action-oriented learning method. Throughout the program, the studies will be presented with multiple real cases. They will have to combine all their knowledge and research, and argue and defend their ideas and decisions.

Relearning Methodology

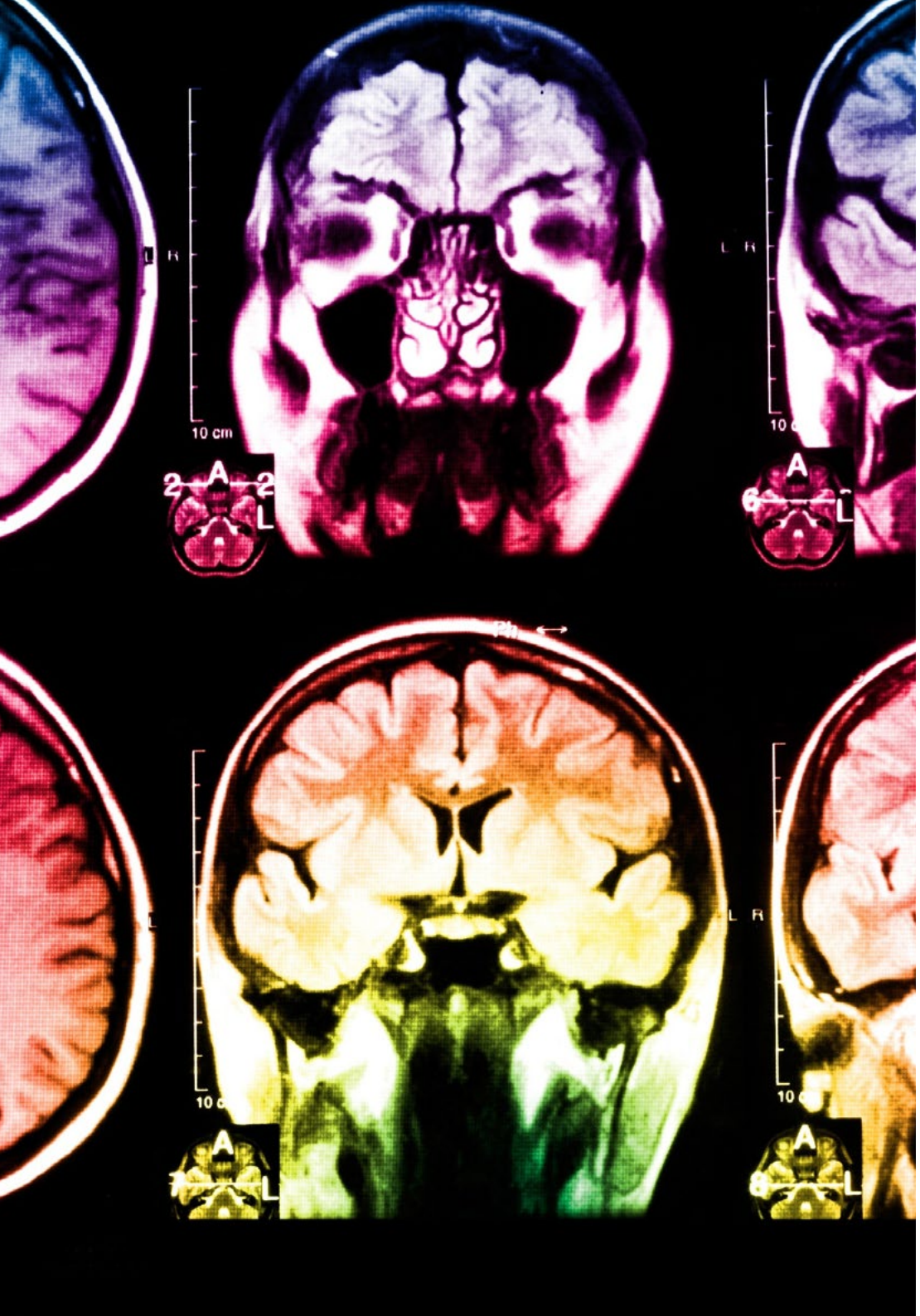
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

We enhance the Case Study with the best 100% online teaching method: Relearning.

In 2019, we obtained the best learning results of all online universities in the world.

At TECH, you will learn using a cutting-edge methodology designed to train the executives of the future. This method, at the forefront of international teaching, is called Relearning.

Our university is the only one in the world authorized to employ this successful method. In 2019, we managed to improve our students' overall satisfaction levels (teaching quality, quality of materials, course structure, objectives...) based on the best online university indicators.



In our program, learning is not a linear process, but rather a spiral (learn, unlearn, forget, and re-learn). Therefore, we combine each of these elements concentrically. This methodology has trained more than 650,000 university graduates with unprecedented success in fields as diverse as biochemistry, genetics, surgery, international law, management skills, sports science, philosophy, law, engineering, journalism, history, and financial markets and instruments. All this in a highly demanding environment, where the students have a strong socio-economic profile and an average age of 43.5 years.

Relearning will allow you to learn with less effort and better performance, involving you more in your training, developing a critical mindset, defending arguments, and contrasting opinions: a direct equation for success.

From the latest scientific evidence in the field of neuroscience, not only do we know how to organize information, ideas, images and memories, but we know that the place and context where we have learned something is fundamental for us to be able to remember it and store it in the hippocampus, to retain it in our long-term memory.

In this way, and in what is called neurocognitive context-dependent e-learning, the different elements in our program are connected to the context where the individual carries out their professional activity.

This program offers the best educational material, prepared with professionals in mind:

Study Material

All teaching material is produced by the specialists who teach the course, specifically for the course, so that the teaching content is highly specific and precise.

These contents are then applied to the audiovisual format, to create the TECH online working method. All this, with the latest techniques that offer high quality pieces in each and every one of the materials that are made available to the student.

Classes

There is scientific evidence suggesting that observing third-party experts can be useful.

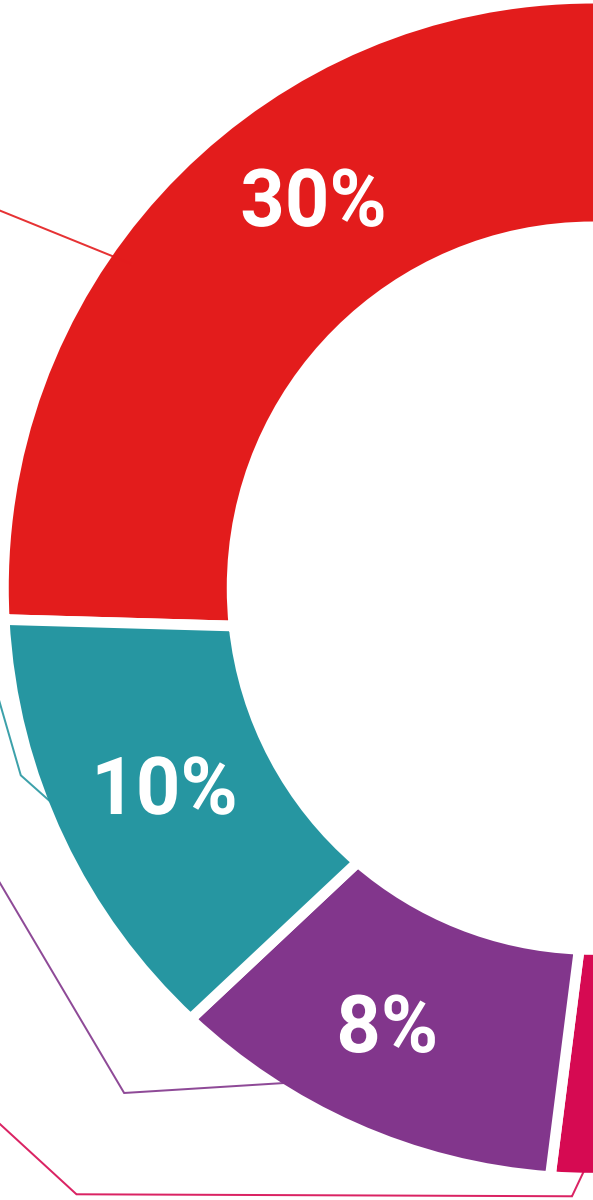
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

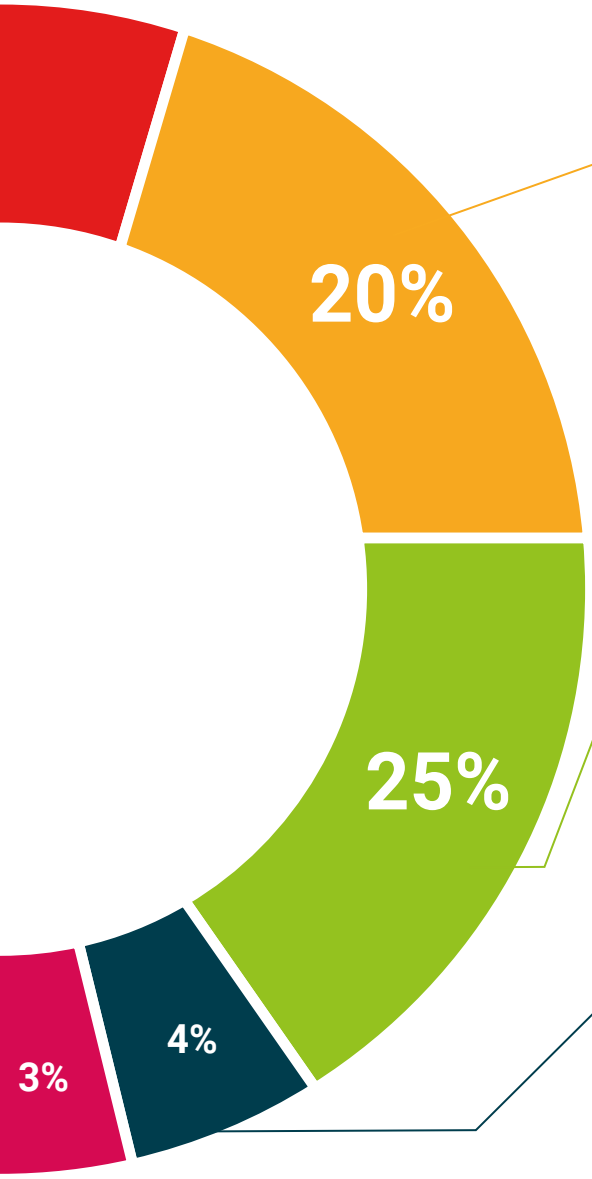
Practising Skills and Abilities

They will carry out activities to develop specific skills and abilities in each subject area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop in the context of the globalization that we are experiencing.

Additional Reading

Recent articles, consensus documents and international guidelines, among others. In TECH's virtual library, students will have access to everything they need to complete their course.





Case Studies

Students will complete a selection of the best case studies chosen specifically for this program. Cases that are presented, analyzed, and supervised by the best specialists in the world.

Interactive Summaries

The TECH team presents the contents attractively and dynamically in multimedia lessons that include audio, videos, images, diagrams, and concept maps in order to reinforce knowledge.

This exclusive educational system for presenting multimedia content was awarded by Microsoft as a "European Success Story".

Testing & Retesting

We periodically evaluate and re-evaluate students' knowledge throughout the program, through assessment and self-assessment activities and exercises, so that they can see how they are achieving their goals.

06

Certificate

The Postgraduate Certificate in Nuclear and Particle Physics guarantees students, in addition to the most rigorous and up-to-date education, access to a Postgraduate Certificate issued by TECH Technological University.

Successfully complete this program and receive your university qualification without having to travel or fill out laborious paperwork”

This **Postgraduate Diploma in Nuclear and Particle Physics** contains the most complete and up-to-date program on the market.

After the student has passed the assessments, they will receive their corresponding **Postgraduate Diploma** issued by **TECH Technological University** via tracked delivery*.

The diploma issued by **TECH Technological University** will reflect the qualification obtained in the Postgraduate Diploma, and meets the requirements commonly demanded by labor exchanges, competitive examinations, and professional career evaluation committees.

Title: **Postgraduate Diploma in Nuclear and Particle Physics**

Official Nº of Hours: **450 h.**


tech technological university

Awards the following

DIPLOMA

to

Mr./Ms. _____, with identification number _____.

For having passed and accredited the following program

POSTGRADUATE DIPLOMA

in

Nuclear and Particle Physics

This is a qualification awarded by this University, equivalent to 450 hours, with a start date of dd/mm/yyyy and an end date of dd/mm/yyyy.

TECH is a Private Institution of Higher Education recognized by the Ministry of Public Education as of June 28, 2018.

June 17, 2020

Tere Guevara Navarro

Dean

This qualification must always be accompanied by the university degree issued by the competent authority to practice professionally in each country. Unique TECH Code: AFWORD23S techtitute.com/certificates

*Apostille Convention. In the event that the student wishes to have their paper diploma issued with an apostille, TECH EDUCATION will make the necessary arrangements to obtain it, at an additional cost.

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Nuclear and Particle Physics

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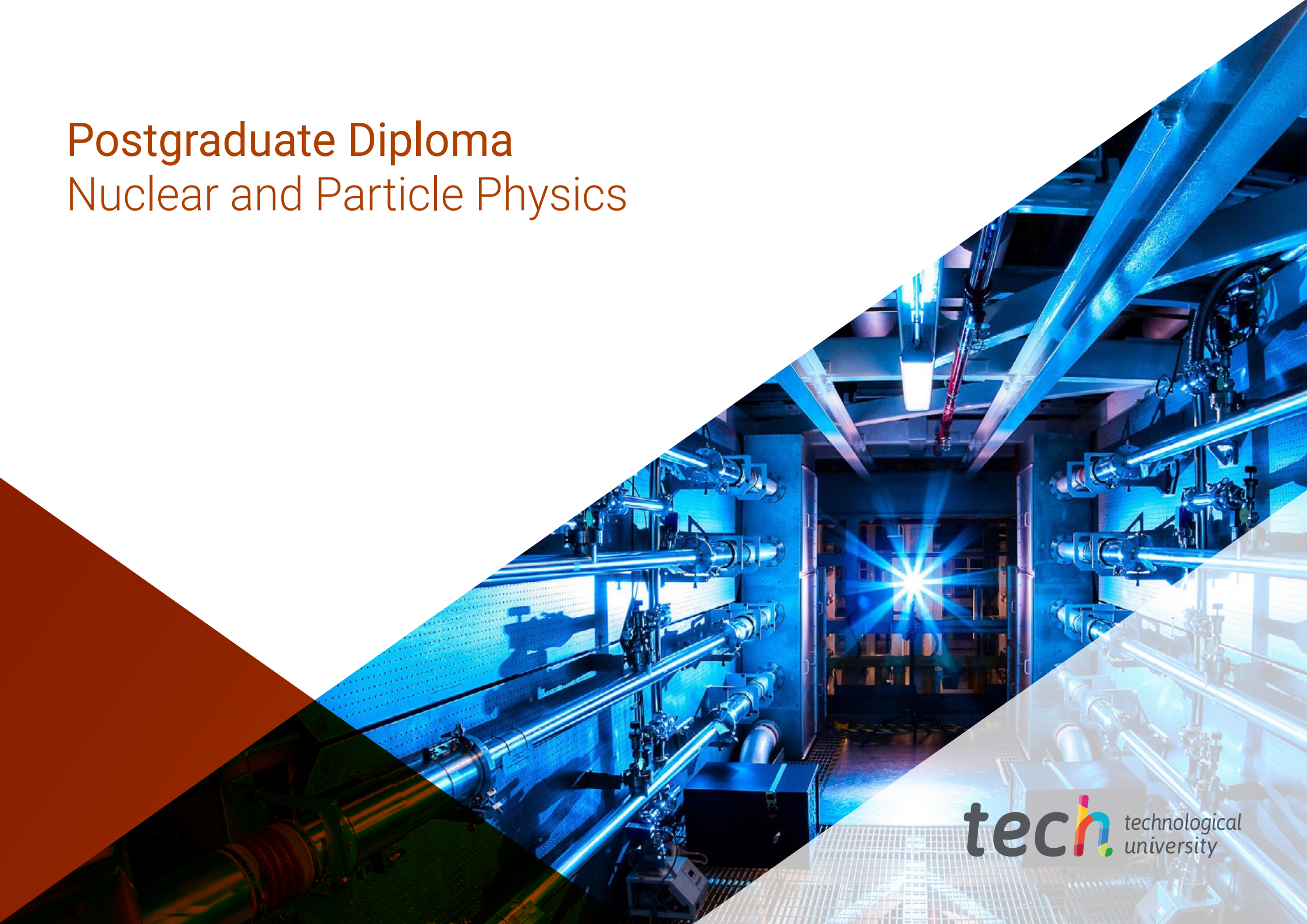

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