UNIVERSITÀ DI PISA

The Master of Science in Nuclear Engineering

Fully Taught in English Language
to work in the field of present and future energy

Walter Ambrosini

President of the MSc in Nuclear Engineering

Studiare Ingegneria Nucleare a Pisa
Nuclear Engineering Studies in Pisa

http://younuclear.ing.unipi.it/

FUSENET
The European Fusion Education Network

What Physicists and Nuclear Engineers have in common

Let's list a few points of contact by quoting famous scientists:

"It is our task, both in science and in society at large, to prove the conventional wisdom wrong and to make our unpredictable dreams come true"

— Freeman Dyson

"Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning"

— Albert Einstein

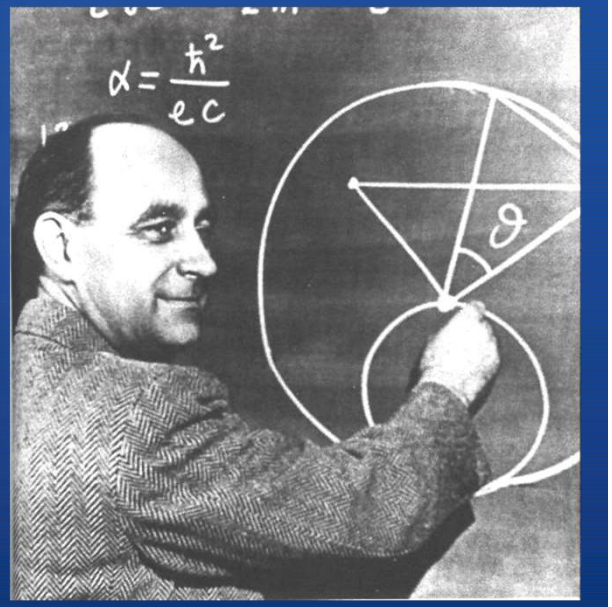
"It is no good to try to stop knowledge from going forward. Ignorance is never better than knowledge"

— Enrico Fermi

A first point of contact: we go often countercurrent with respect to common views to achieve something new and valuable

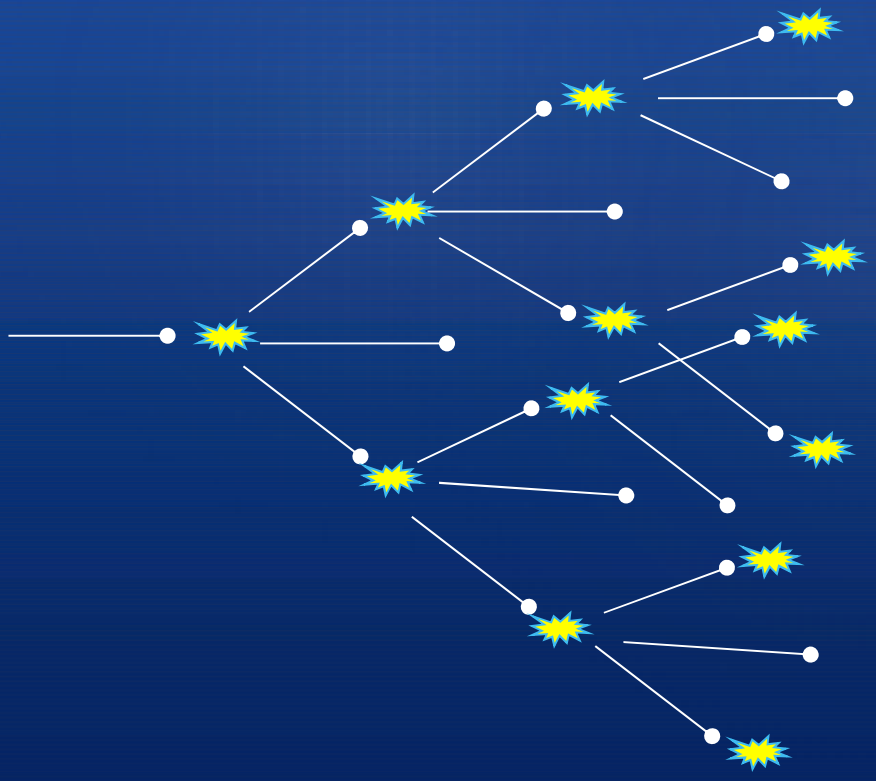
The first Nuclear Engineer was actually a Physicist... Enrico Fermi

- On December 2nd 1942, in a squash court in Chicago, the first nuclear reactor in the world reached "criticality"
- The Nobel Laureate Enrico Fermi, escaped to United States from fascist Italy, was the project leader
- His studies on "slow neutrons" were of fundamental importance
- In that memorable afternoon, the Fermi "pile", named CP-1, worked for about 4.5 minutes at the power of 1.5 W

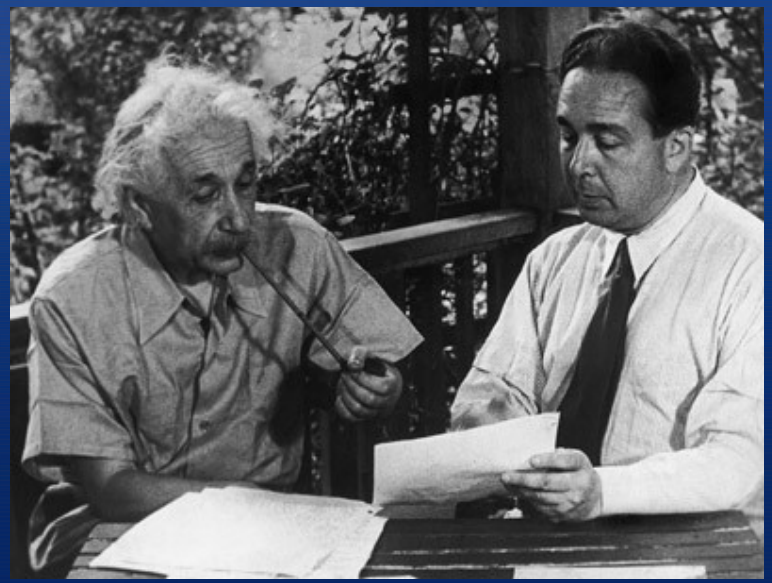


The result was enabled by smart ideas like the one of the reaction chain

no more “talking moonshine”
(as Rutherford had said about
the use of energy from radioactivity)



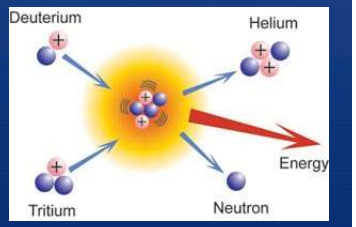
Leo Szilard
and Albert Einstein

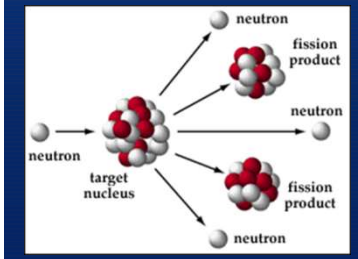


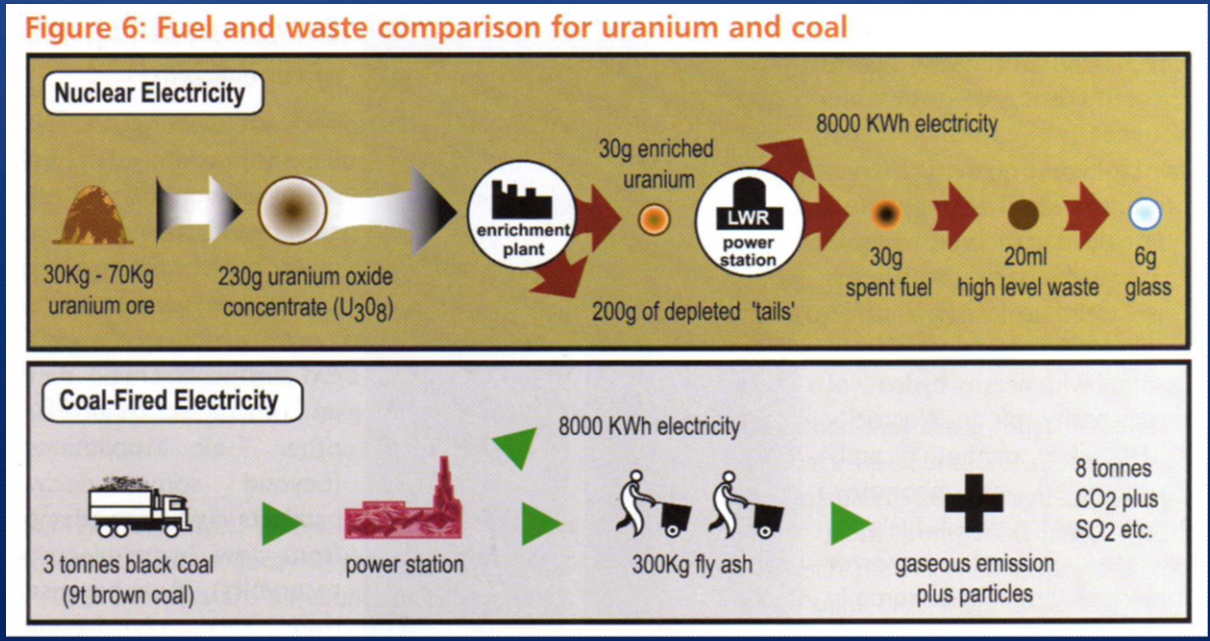
Why Nuclear Engineering…

- **The one springing from nuclei is the most intensive form of energy we possess nowadays: it is a precious gift to be developed in the benefit of mankind**

- **Nuclear fission (today) and nuclear fusion (tomorrow) allow for producing energy with a minimum involvement of materials and wastes**



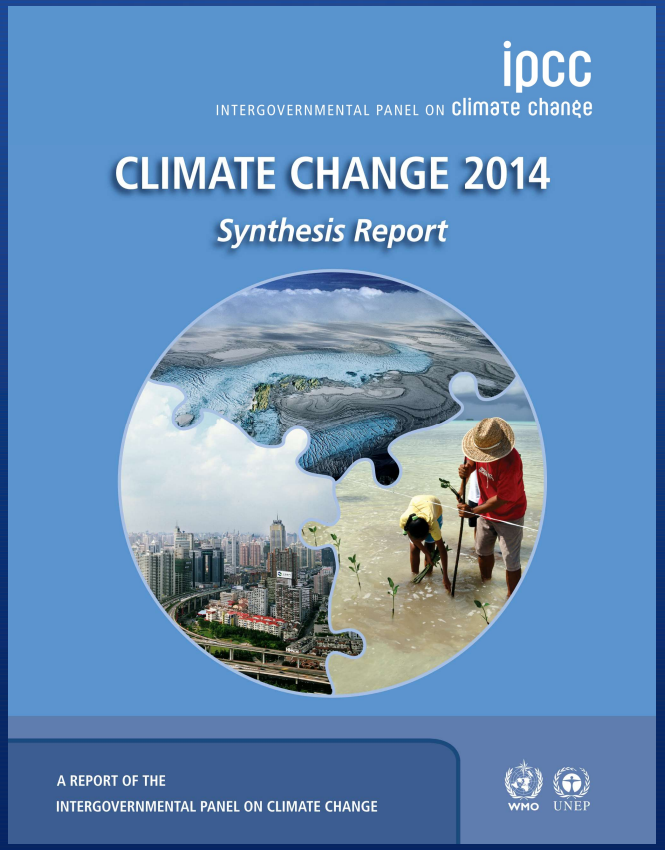


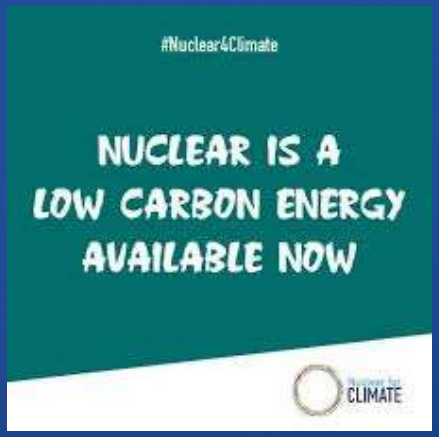


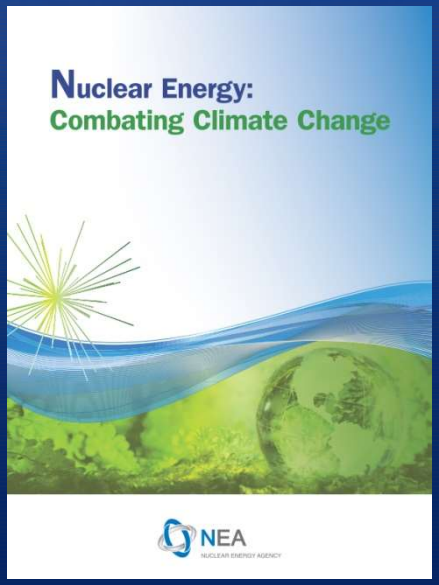
$$E = \Delta m\, c^2$$

From Nuclear Energy in the 21st Century: World Nuclear University Primer by Ian Hore-Lacy

Coping with Environmental Issues…





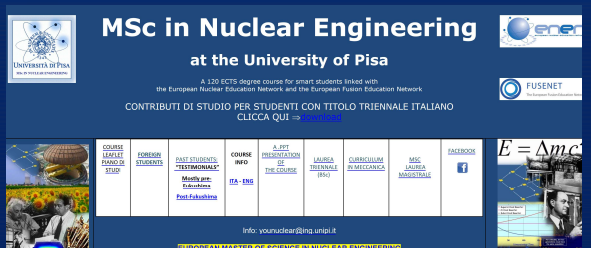


An exciting field of study that fascinated generations of students..

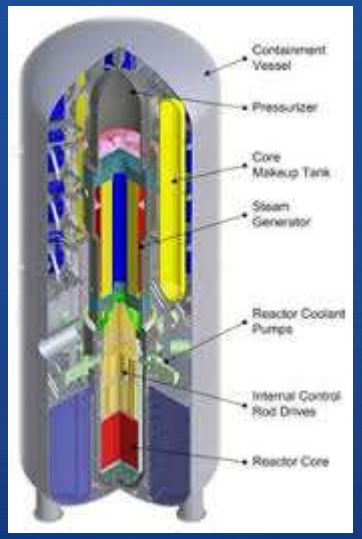
...and that keeps on fascinating young generations entering the job and research markets...

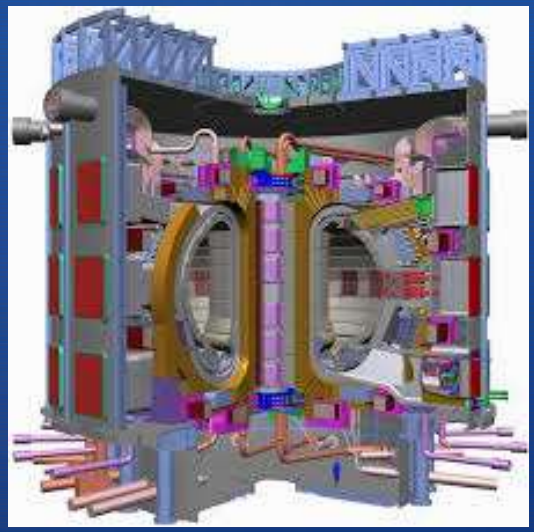
Job placement opportunities…

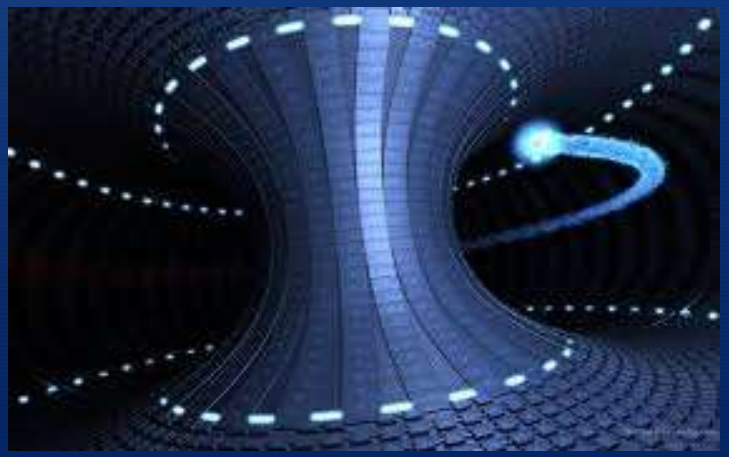
- The educational background of Nuclear Engineers from Pisa is electively oriented to **mechanics, safety and research**: even in times of nuclear phase-out policies, it is possible to work as engineers and researchers in Italy and abroad
- The professional profile of our Engineers is also **highly valued abroad**, where schools in Nuclear Engineering are often missing, even where nuclear power stations do operate
- Our engineers find placement in industry as well as in research
- A gallery of Alumni is available at the **YouNuclear** web site



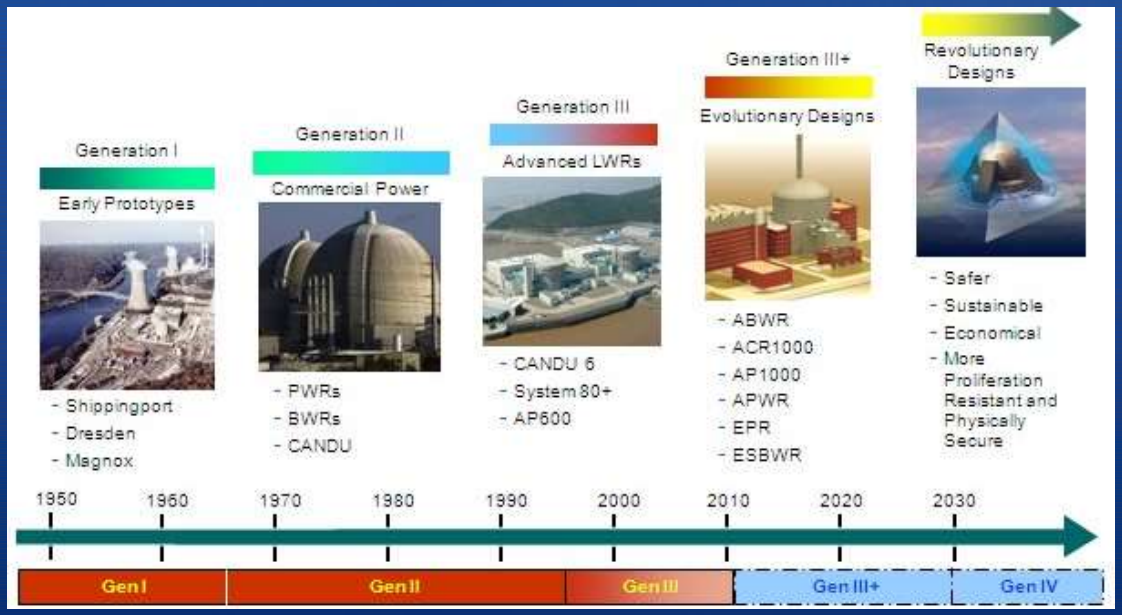
Fission and fusion represent fields of lively research



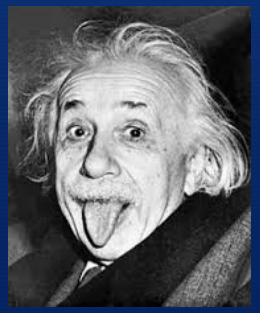




The existing prejudices in relation to nuclear energy represent an additional motivation for a renewed commitment in the field



«It's harder to crack a prejudice than an atom»
A. Einstein



Why a programme taught in English…

- **The language of advanced science and technology fields is nowadays English**

- **The teachers of our programme are involved in international activities: they have therefore a good «working knowledge» of English language that they can easily transfer to their students**

- **The students involved in the programme taught in English in the last years appreciated very much the novelty, which makes them better prepared to enter the global work market**

Access … different possibilities

- **Italian students may access through:**

1. **The Curriculum Nucleare nella Laurea di Ingegneria Meccanica (BSc)**

Al secondo anno:

- Principi Fisici di ingegneria Nucleare (6 CFU)
  invece di Economia e Organizzazione Aziendale

Al terzo anno:

- Fondamenti di Impianti Nucleari (6 CFU)
  invece di Impianti Meccanici
- Trasmissione del Calore con Applicazioni Numeriche (6 CFU)
  invece di Fondamenti di Energetica
- Sicurezza e Analisi di Rischio (9 CFU)
  invece di Macchine

Access … different possibilities

2. Through the BSc programmes in

- Ingegneria Aerospaziale
- Ingegneria Chimica
- Ingegneria Energetica
- Ingegneria Meccanica
- Fisica

The educational path in the MSc has been conceived to include the basic education in nuclear matters

The new possibilities for the Laureati in Fisica (BSc in Physics) are explained below

Access from “Fisica”

A new course (12 CFU) in Italian language entitled

“Fondamenti Termici e Meccanici per l'Ingegneria Nucleare”

was added to your curriculum of the “laurea in Fisica” as an elective course and will be delivered from the academic year 2017-2018 by Engineering Teachers

It can be used in a twofold way:

- **those who are in their third year in Physics may attend the course within their elective share and then enroll**
- **those who already graduated or will graduate this year may enrol in the MSc in Nuclear Engineering, replacing 12 CFU of courses (Physical Fundamentals of Nuclear Engineering plus an elective course)**

Access for foreign students…

Foreign students are pre-enrolled according to the procedure described at

http://younuclear.ing.unipi.it/faq/faq_display.html

In general terms, a good BSc in Mechanical Engineering is necessary to access, including the following matters:

- **Mathematics (MATH, at least 4 semesters)**
- **Physics (PHYS, at least 2 semesters)**
- **Chemistry (CHEM, at least 1 semester)**
- **Thermodynamics, Heat transfer, Energy systems (THE, at least 1 semester)**
- **Strength of materials, mechanical drawing, mechanical design and production (MECH, at least 2 semesters)**

The matters to be studied...

First Year	CFU
First Semester	
Physical Fundamentals of Nuclear Engineering	6
Thermal-Hydraulics and Core Engineering (1)	6
Physics and Numerical Models of Nuclear Reactors (1)	6
Structural Mechanics and Nuclear Constructions (1)	6
Nuclear Plants I	6
Second Semester	
Nuclear Measurements	6
Nuclear Materials	6
Structural Mechanics and Nuclear Constructions (2)	6
Thermal-Hydraulics and Core Engineering (2)	6
Physics and Numerical Models of Nuclear Reactors (2)	6
Second Year	**CFU**
First Semester	
Control of Nuclear Plants	6
Nuclear Safety	12
Elective	6
Second Semester	
Radiation Protection	6
Nuclear Plants II	6
Elective	6
Thesis Work	18
	120

The matters to be studied...

Elective courses are also available (6 + 6 ECTS)

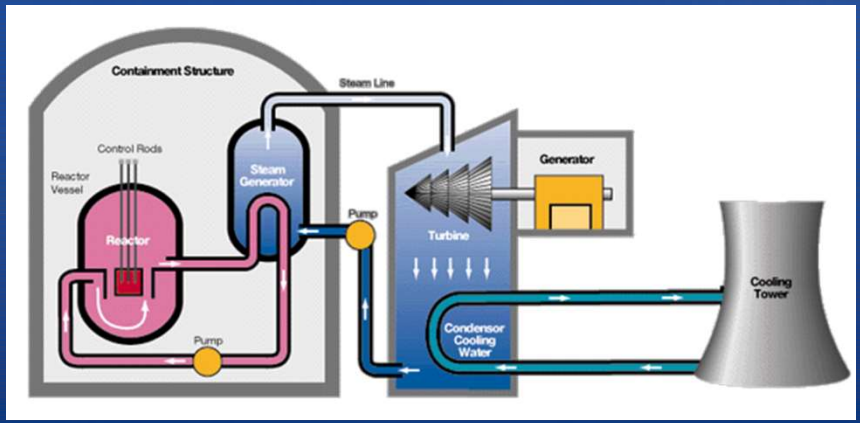
Elective Courses	CFU/ ECTS
Engineering of fusion reactors	6
Design of Complex Plants	6
Scienza e Tecnica della Prevenzione Incendi	12
Codes for Nuclear Reactors	6
Medical Applications of Nuclear Technologies	6
Single and Two-Phase thermal-Hydraulics	6
Decommissioning of nuclear plants and radioactive waste management	6

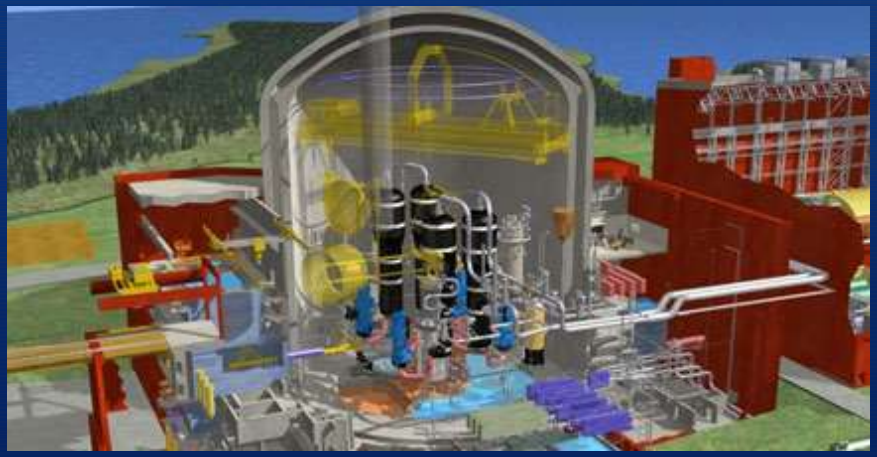
The degree thesis (18 or 24 ECTS), as an application of the previously achieved learning outcomes, concludes the study program

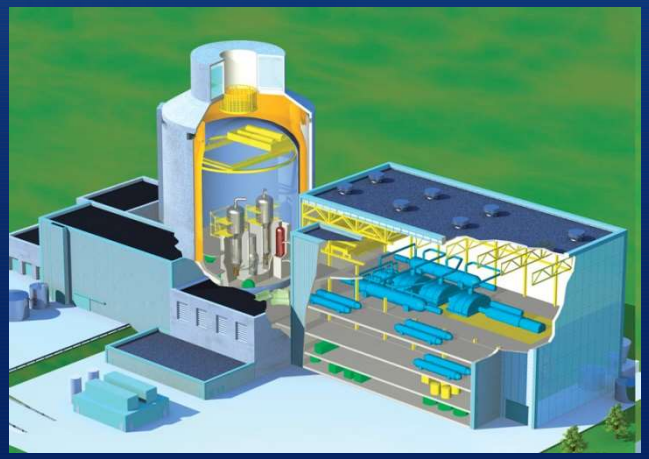
The matters to be studied...

Nuclear Plants

Existing and future plants are addressed in detail



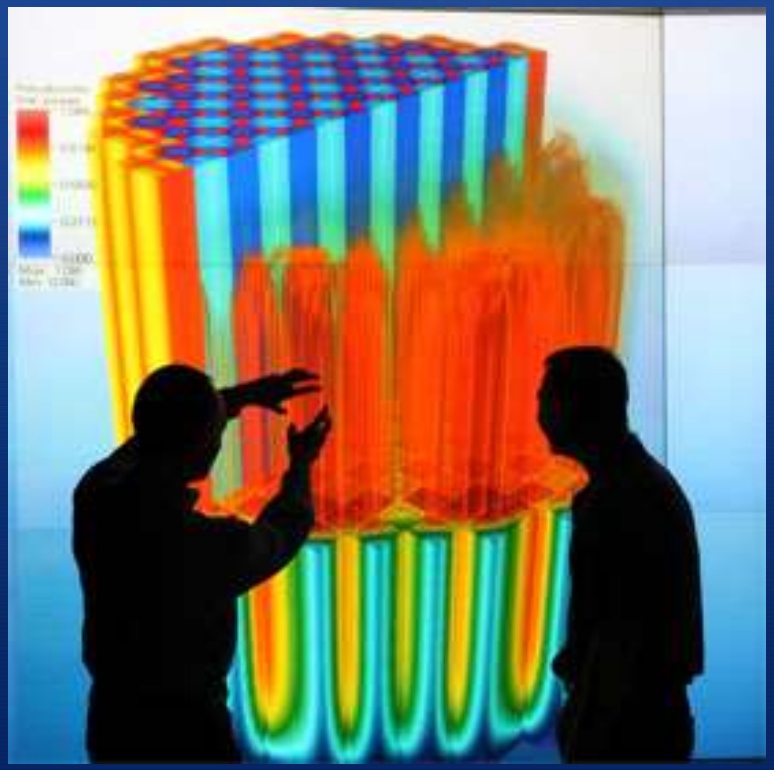




The matters to be studied...

Physics and Numerical Models for Nuclear Reactors

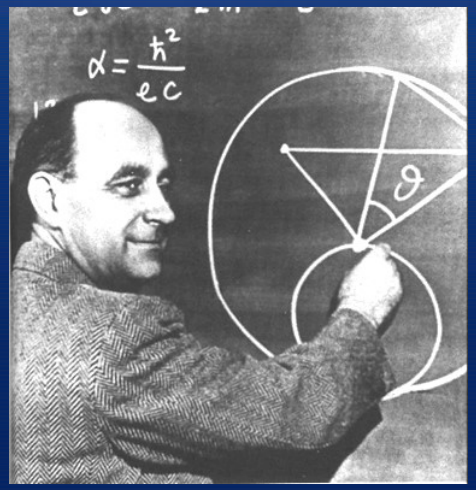
Mathematical models for the prediction of the behaviour of neutrons in the reactor «core» are studied



$$\frac{1}{v_g}\frac{\partial \phi_g}{\partial t} = div\, D_g(\vec{r})\, grad_{\vec{r}}\phi_g(\vec{r},t) - \Sigma_{r,g}(\vec{r})\phi_g(\vec{r},t) + \sum_{g'<g}\Sigma_{s,g'\to g}(\vec{r})\phi_{g'}(\vec{r},t)$$

$$+(1-\beta)\chi_g^p\sum_{g'=1}^{G}\nu\Sigma_{f,g'}(\vec{r})\phi_{g'}(\vec{r},t) + \sum_{d=1}^{N_d}\lambda_d\chi_g^d C_d(\vec{r},t) \quad (\vec{r}\in V,\ g=1,\ldots,G)$$

$$\frac{\partial C_d}{\partial t} = -\lambda_d C_d(\vec{r},t) + \beta_d\sum_{g'=1}^{G}\nu\Sigma_{f,g'}(\vec{r})\phi_{g'}(\vec{r},t) \quad (\vec{r}\in V,\ d=1,\ldots,N_d)$$

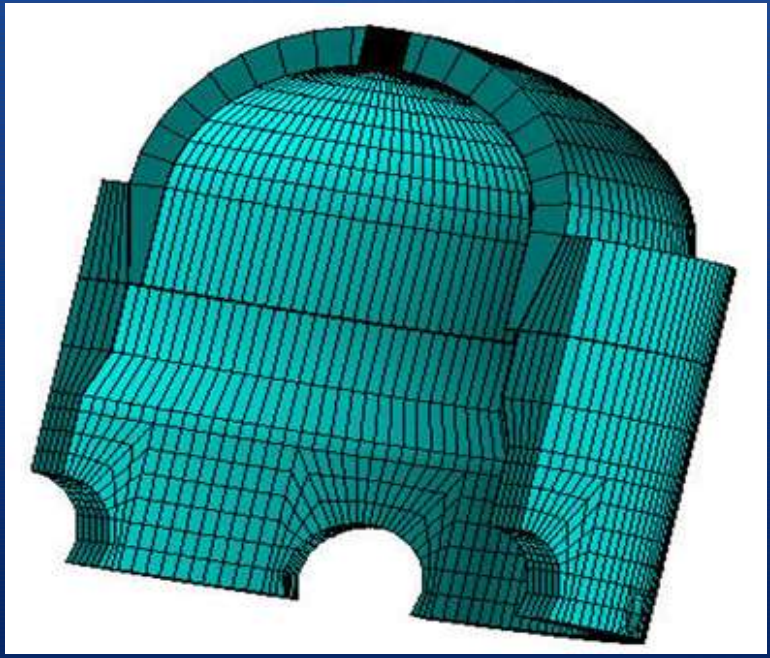


Enrico Fermi put the first basis of this fascinating matter

The matters to be studied...

Structural Mechanics and Nuclear Constructions

The techniques for the design of the large mechanical components in the nuclear plant are mastered



The matters to be studied...

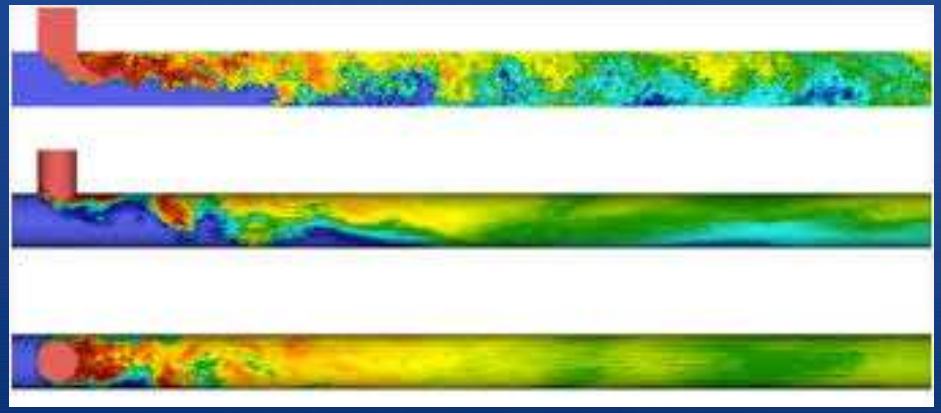
Nuclear Materials

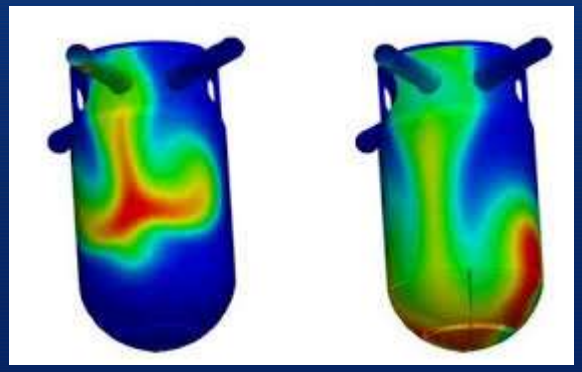
The materials necessary to construct nuclear reactors and their production processes are deeply addressed

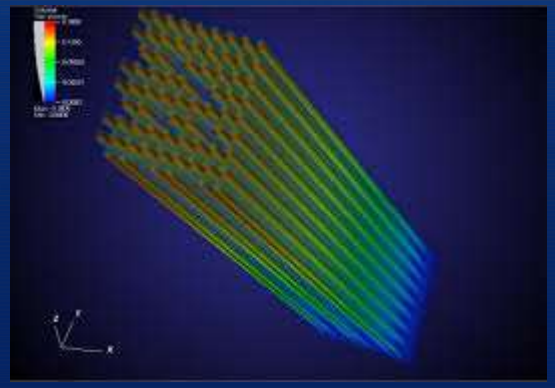
The matters to be studied...

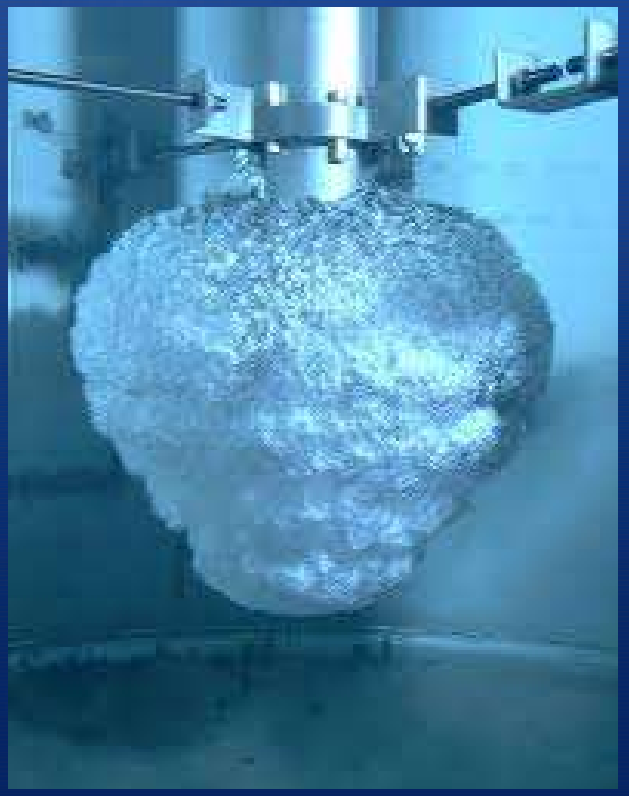
Thermal-hydraulics and Core Engineering

The basic laws and the balance equations necessary to represent the thermal and fluid-dynamic behaviour of nuclear plants are here addressed





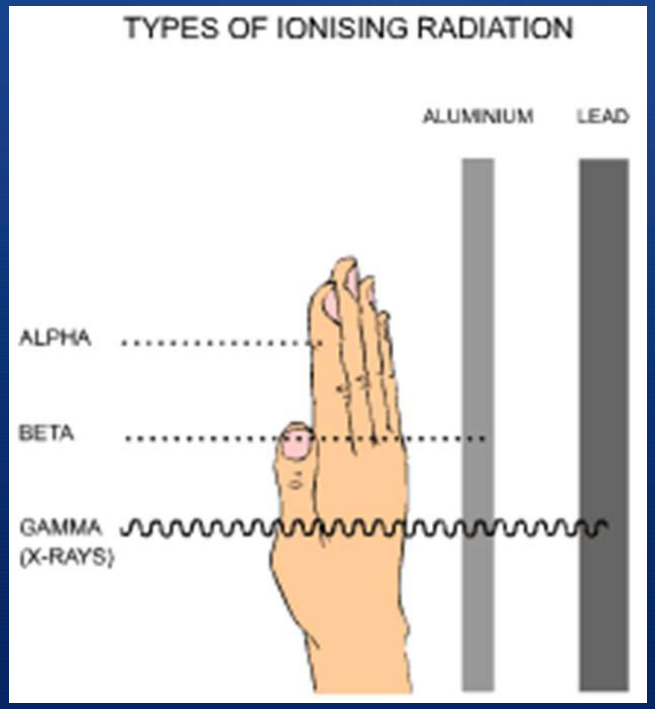


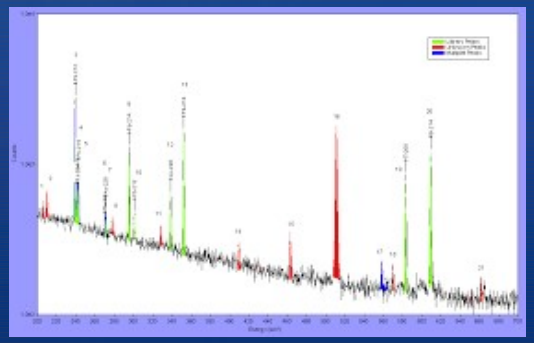


The matters to be studied...

Nuclear Measurements

The interaction of radiation with matter are considered, together with the measurement devices for detecting particles and electromagnetic radiations





The matters to be studied...

Control and Operation of Nuclear Plants

As a field of great interest nowadays, also in relation to the transition to digital I&C, the dynamic characteristics of plants and of their control systems are studied

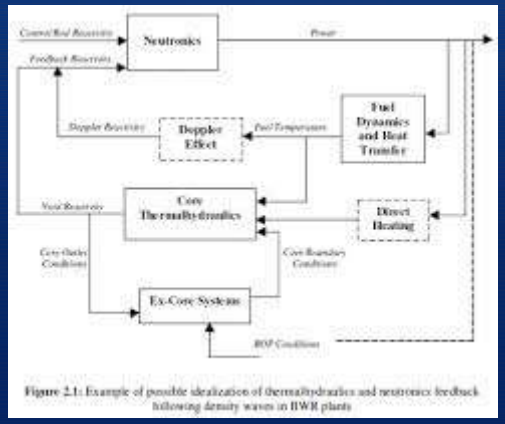
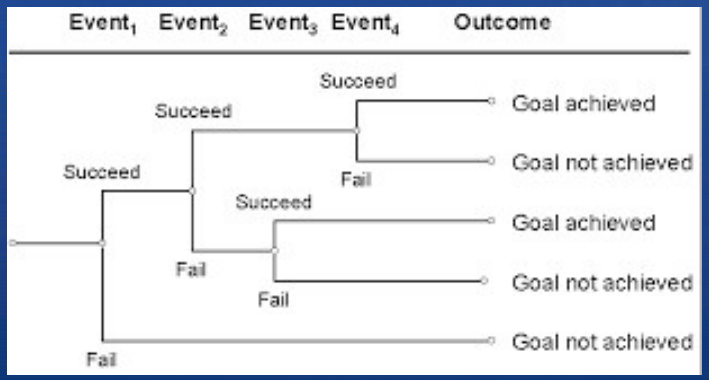


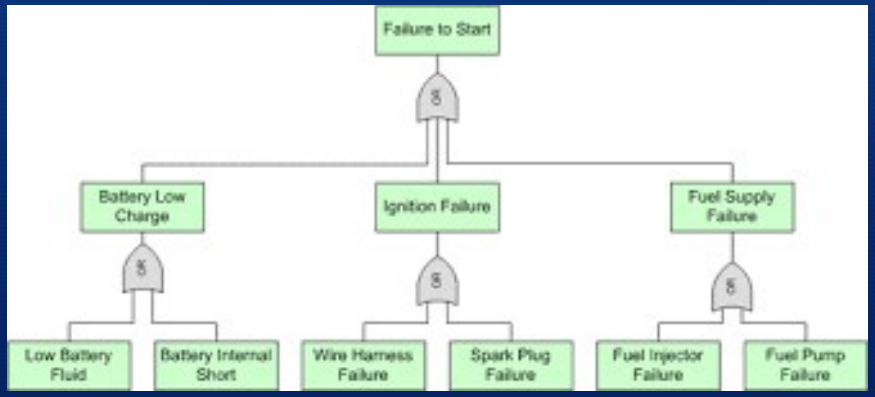
Figure 2.1: Example of possible idealization of thermalhydraulics and neutronics feedback following density waves in BWR plants

The matters to be studied...

Nuclear Safety

Safety is the main objective of most of the design and analysis activities: a deep concern for «nuclear safety culture» is embedded in all the activities in this field

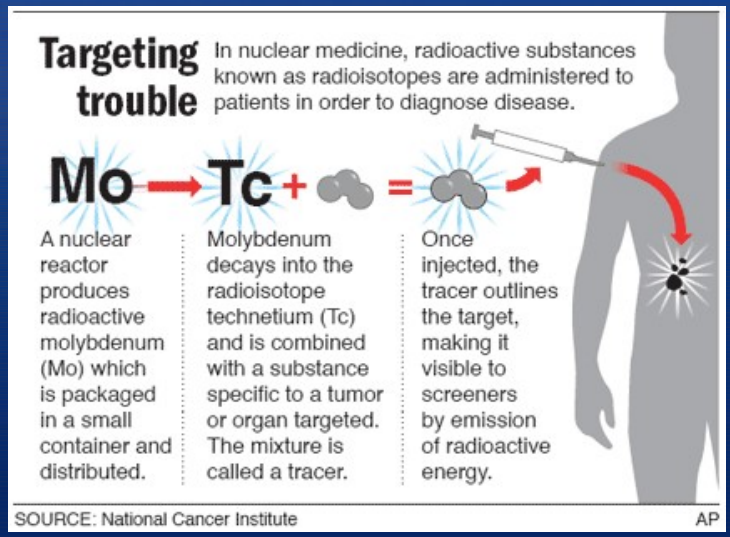




The matters to be studied...

Medical Application of Nuclear Technologies

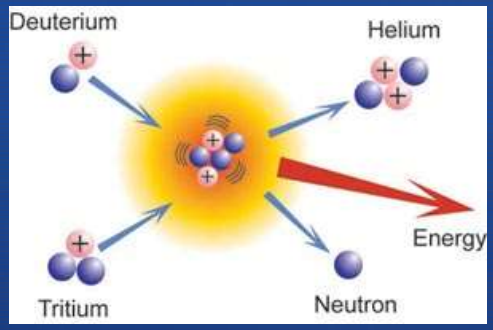
This is an important field, related to the production and the utilisation of radioactive isotopes for medical diagnosis and health care

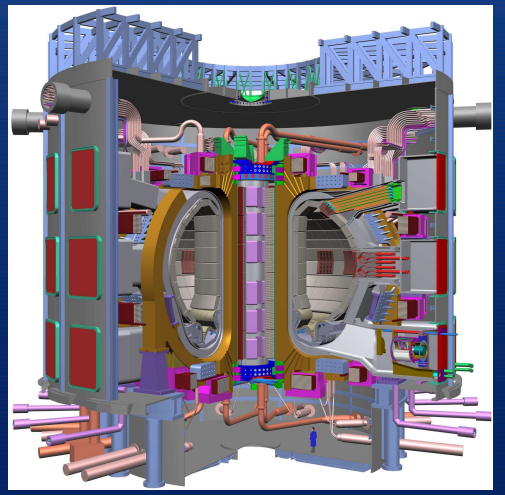


The matters to be studied...

Engineering of Fusion Reactors

The studies for the realization of controlled nuclear fusion are going on in several places (e.g., ITER in Cadarache, F)





The matters to be studied...

...and more ...

We are in fact open to personalised curricula aiming to produce variants of our classical profile, also in consideration of possible international study paths, as:

Engineering for physics experiments and machines (colliders, etc.)

This will be part of further elaboration among the teachers of Physics and Engineering

Opportunities for thesis stages

In addition to the opportunities offered by the teachers in the programme, there are several opportunities for developing thesis works abroad

The strong link with the European Nuclear Education Network and FuseNet further facilitates the exchanges

Most of our students qualified for the release of the certification of European Master of Science in Nuclear Engineering (EMSNE):

- **High level of qualification of the courses in Pisa**
- **«European dimension» granted by the thesis abroad**

Broad possibilities for research theses in Italy and abroad

(almost always with financial support !!!)

- il Centro ENEA del Brasimone (http://www.brasimone.enea.it/)
- la SOGIN (http://www.sogin.it/it/pagine/default.aspx)
- ITER che sta costrunedo la più grande macchina a fusione (https://www.iter.org/)
- AREVA France, Parigi (http://www.areva.com/)
- la Westinghouse di Pittsburgh, PA, USA (http://www.westinghousenuclear.com/)
- l'University of Illinois, Campus di Urbana Champaign, USA (http://illinois.edu/)
- il Centro Belga per la ricerca nel nucleare SCK-CEN (https://www.sckcen.be/)
- il JRC-IET di Petten (https://ec.europa.eu/jrc/en/about/jrc-site/petten)
- il Commissariàt à l'Energie Atomique di Saclay, DM2S, Parigi (http://www-centre-saclay.cea.fr/en/La-Direction-des-activites-nucleaires-de-Saclay/DM2S)
- l'NRG di Petten, Olanda, (https://www.nrg.eu/)
- l'UJV Rez, Centro di Ricerca Nucleare di Praga (http://www.ujv.cz/en/)
- il Karlsruhe Institute of Technology, Germania (https://www.kit.edu/english/)
- il Royal Institute of Technology, KTH, Stoccolma, Svezia (https://www.kth.se/en)
- la Texas A&M University (https://engineering.tamu.edu/nuclear)
- inoltre, tutti i membri delle reti ENEN (http://www.enen-assoc.org/) e FuseNet (http://www.fusenet.eu/) di cui fa parte il corso di studio possono accogliere gli studenti dei nostri corsi per stage e tesi di dottorato.

The EMSNE Certification…

It is a recognition of the value of the studies

It is released in a ceremony held at IAEA headquarters in Vienna

7 EMSNE Laureates in 2015

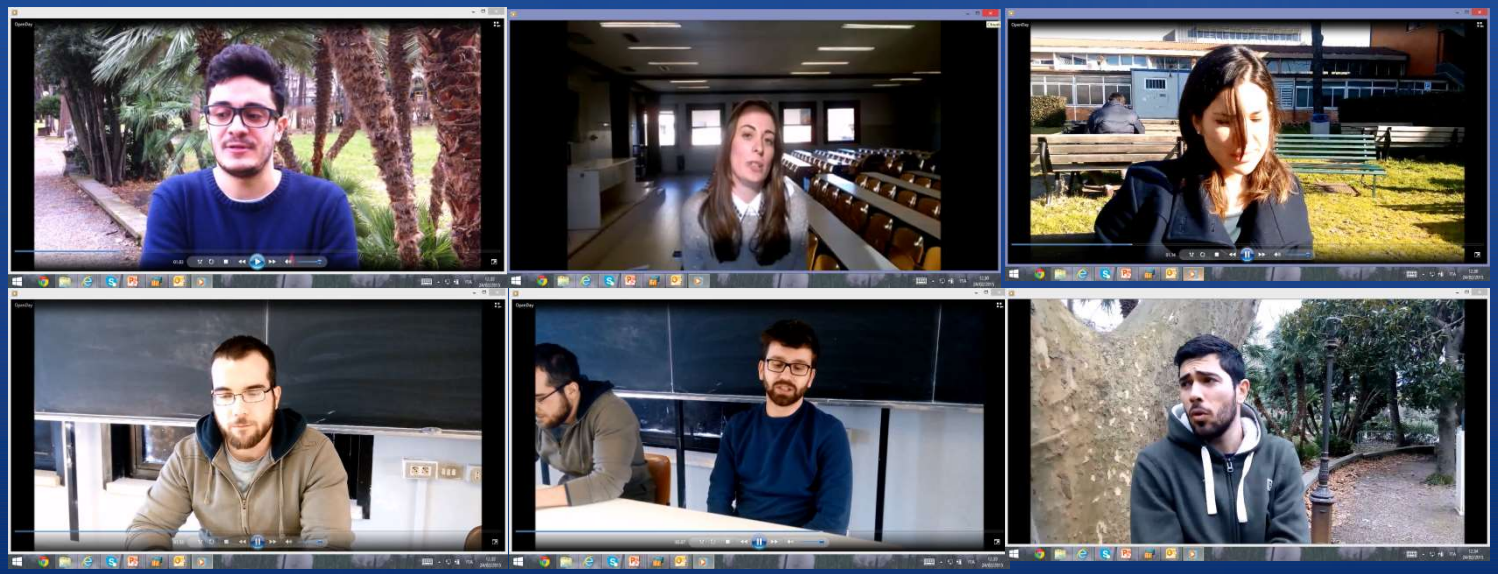
9 EMSNE Laureates in 2016

3 EMSNE Laureates in 2017

Have been already approved: ceremony planned in September

International Students

Our students speak about us...



https://www.facebook.com/alberto.facchini.9/videos/10206704119469819/

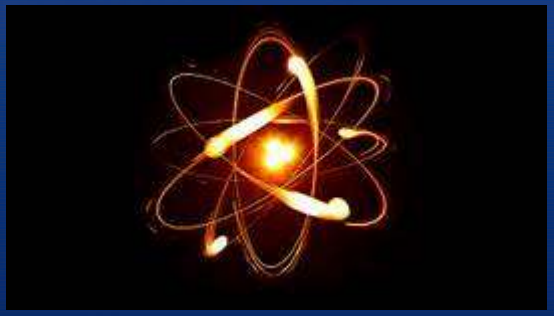
Conclusion

If you want to help a growing world to exploit in a sustainable way the most intensive and young source of energy…

… join us and become one of the several past-students we disseminated around the world…

UNIVERSITÀ DI PISA

MSc IN NUCLEAR ENGINEERING



For info...

UniPi Website
http://www.unipi.it/index.php/lauree/corso/10621

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YouNuclear Website
http://younuclear.ing.unipi.it/

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