POLITECNICO
MILANO 1863

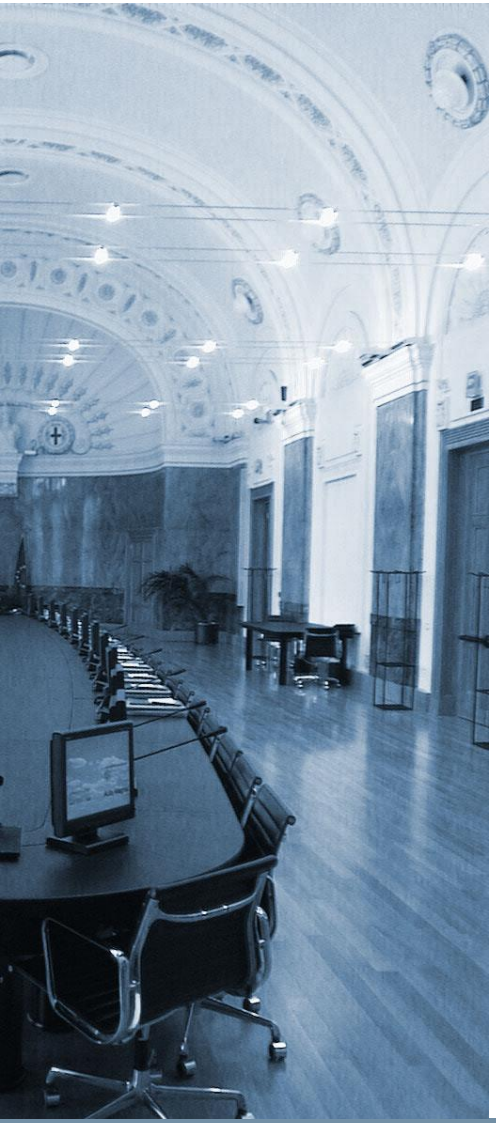
ARIES Project
Work Package 17

ARIES

Kick-off meeting,
Geneva, May 5, 2017

Marco G. Beghi

Faculty & Students - Academic Year 2015/2016



Architecture

Professors & Researchers	Students
297	8260

Design

Professors & Researchers	Students
94	4054

Engineering

Professors & Researchers	Students
925	30430

Human Resources, Academic year 2015/2016

Professors and Assistant Professors	1316
Technical and Administrative staff	1207
PhD students	1122
Students	41622

The Energy Department

The present Energy Department (www.energia.polimi.it) :

- founded in 2008, merging former Departments, including the Nuclear Engineering Dept..
- owns all the major expertise in nuclear engineering
- Organized in 5 Sections:
  - Machines, propulsion and energy systems
  - Thermal engineering and environmental technologies
  - Electrical engineering
  - Nuclear engineering
  - Chemical technologies and nanotechnologies

The Micro- and Nano-structured Materials Laboratory

- The former Materials Laboratory had a strong tradition in
  - Condensed Matter Physics
  - materials behaviour, including - deformation mechanisms
    - thermophysical properties
- It evolved into the Micro- and Nano-structured Materials Laboratory (www.nanolab.polimi.it) pushing its research towards
  - nanotechnology
  - thin films and functionalized surfaces
  - energy applications: - photovoltaics
    - photochemical water splitting

The Micro- and Nano-structured Materials Laboratory

- 2 full professors, 4 associate professors, 1 assistant professor
- 4 post-docs, 4 PhD students, several master's thesis students

- several courses offered, at B.S., M.S., PhD levels, mainly to Nuclear Eng.ng and Materials Eng.ng students:
  Introduction to Nanotechnology, Atomic Physics, Solid State Physics, Nuclear Physics, Plasma Physics, Physics of Disordered Materials, Nanomaterials for Energy Conversion, Physics of Nuclear Materials

❖ Thin film production by Physical Vapour Deposition (PVD) techniques (Pulsed Laser Ablation, PLD)

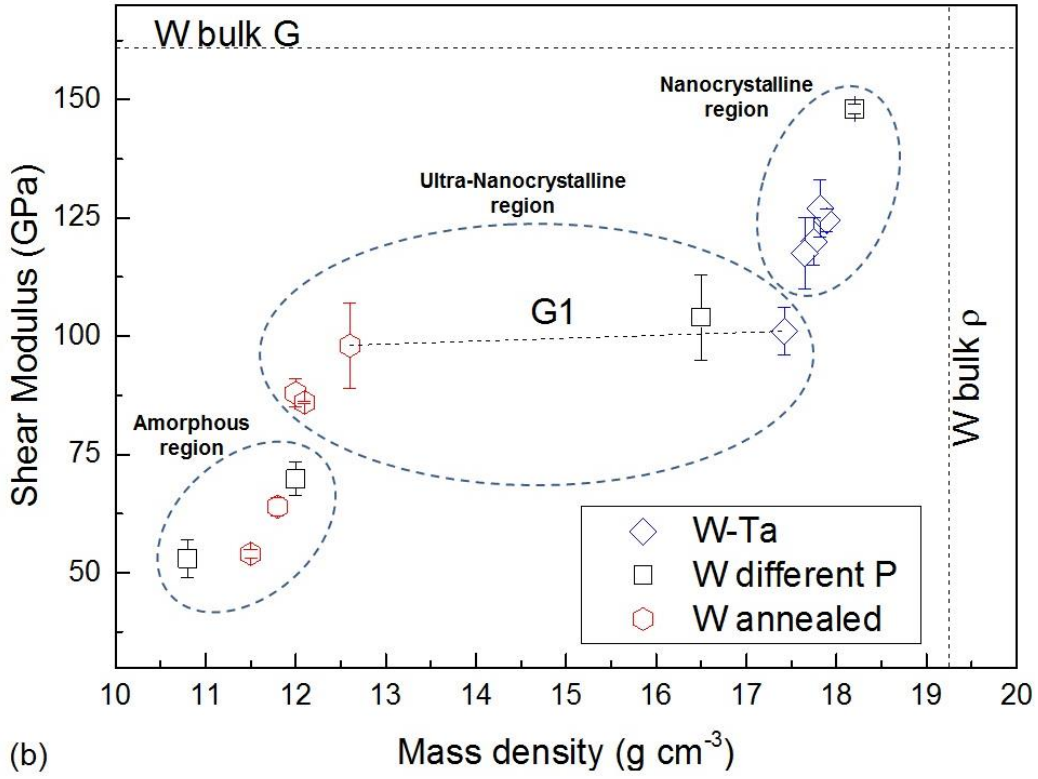
❖ Characterization by:
- Raman spectroscopy
- Brillouin spectroscopy
- SEM with EDX
- AFM
- Scanning Tunneling - Microscopy (STM)
  - Spectroscopy (STS)

Recent research by Marco G. Beghi

Full characterization of the elastic properties of thin films by non-contact acoustic methods (Brillouin spectroscopy).

E. Besozzi, D. Dellasega, A. Pezzoli, C. Conti, M. Passoni, M.G. Beghi, Amorphous, ultra-nano- and nano-crystalline tungsten-based coatings grown by Pulsed Laser Deposition: mechanical characterization by Surface Brillouin Spectroscopy Materials and Design **106**, 14-21 (2016)

W and W-Ta films (thickness: 200 nm ÷ 2 μm) deposited by laser ablation, with different microstructures (amorphous, ultra-nano crystalline, and nano-crystalline)



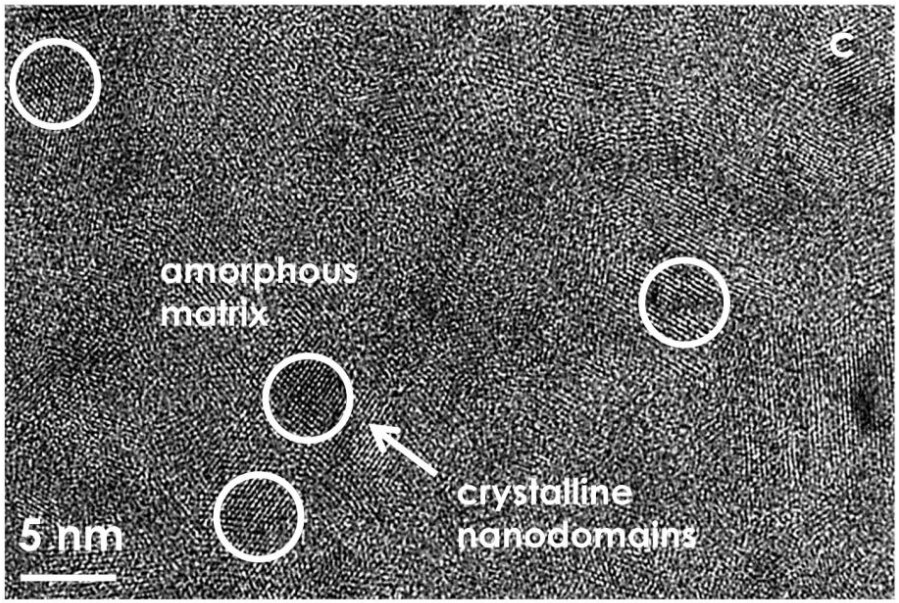
Recent research by Marco G. Beghi

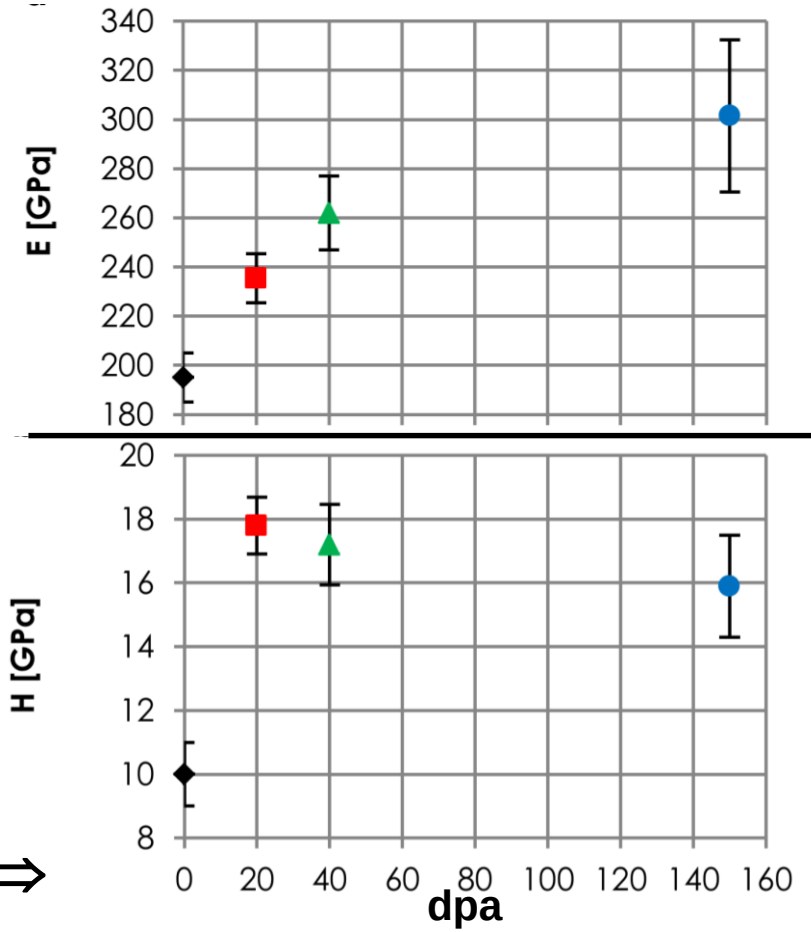
in collaboration with Italian Institute of Technology:

Development of corrosion and irradiation resistant films

F. García Ferré, A. Mairov, L. Ceseracciu, Y. Serruys, P. Trocellier, C. Baumier, O. Kaïtasov, R. Brescia, D. Gastaldi, P. Vena, M. G. Beghi, L. Beck, K. Sridharan, F. Di Fonzo, Radiation endurance in Al_2O_3 nanoceramics Scientific Reports, **6**:33478 (2016)

1.3 μm thick Al_2O_3 films deposited by laser ablation





12 MeV Au^{5+} + 18 MeV W^{8+} ⇒

Ongoing research

Optical profilometry for the measurement of the thermal expansion coefficient of thin films

new measurement system, built in-house, is beginning to operate

Modeling of the temperature and strain fields (waves) induced by laser pulses, also in multilayers

Numerical model implemented, exploitation to analyze laser pulses on tungsten has begun

Marco Beghi has been academic supervisor of the doctoral theses of Nicola Mariani and Elena Quaranta

Possible contributions to WP 17

Task 17.2: Materials development and characterization

- Research, investigation, development and characterization of novel CMC and MMC based on graphitic, carbide or diamond reinforcements and dopants (in collaboration with Task 14.4).
  - measurement of the elastic properties by Brillouin spectroscopy
  - analysis of the structure of carbonaceous materials by Raman spectroscopy
- Study and development of electrically conductive coatings, resisting the impact of high intensity particle beams.
- Characterization of thermophysical and outgassing properties, microstructural analyses, study of phases and of their change under various environments …
  - measurement of the thermal expansion coefficient of supported layers

Possible contributions to WP 17

Task 17.3: Dynamic testing and online monitoring

Testing of material samples in a broad range of environments:

- Mechanical testing in quasi-static and dynamic conditions, at various temperatures
- Tests under very high power laser beams
  - modeling of the temperature and strain fields and waves induced by laser pulses, also in multilayers
- Irradiation tests with online monitoring of properties evolution
  - contribution to the design of irradiation tests and to the estimation of primary damage
- Hydrodynamic simulations of experiments – Equations of State, Spall Strengths for new materials

Possible contributions to WP 17

Task 17.4: Simulation of irradiation effects and mitigation methods

- Investigation and simulations of material damage induced by irradiation with protons and ions at various energies and doses
- Quantify Displacement per atom (DPA), gas production, nuclear transmutations for equipment in complex accelerator environments and provide a relationship with radiation experiments at lower energies and/or different particle species
- Ideally, relate radiation damage quantities (e.g. DPA) with change of relevant macroscopic material properties
- Open to co-operation with other international collaborations such as RaDIATE – (Radiation Damage In Accelerator Target Environment)

guidance of a doctoral thesis aiming at monitoring and characterizing the evolution of properties of materials, and at modeling it, in relation to the primary damage

Apologies

My train is at 18.39, from Cornavin

- I must leave shortly after 17.30
- I will miss tonight's dinner

Possible contributions to WP 17

QS World University Rankings by Faculty - Engineering and Technology 2017

	World	EU	Italy
Engineering & Technology	24	7	1

Politecnico di Milano	Score	World Rank
Academic Reputation (40%)	86,4	32
Employer Reputation (30%)	88,4	12
Citations per Paper Measures productivity for the last five years (15%)	79.4	301
H-index Citations (15%) Measures both the number of papers produced and the impact of the published work	81,2	87
Overall	**83.7**	**24**

QS World University Rankings by Subject 2017

	World	EU	Italy
Architecture & Built Environment	14	6	1
Art & Design	7	3	1
Computer Science & Information Systems	49	10	1
Chemical Engineering	100	22	2
Civil & Structural Engineering	14	6	1
Electrical & Electronic Engineering	50	10	1
Mechanical, Aeronautical & Manufacturing Engineering	29	7	1
Materials Science	70	15	1
Mathematics	78	23	1
Business & Management Studies	88	29	2
Physics & Astronomy	123	54	5

Best European universities in Engineering/Technology according to Employer evaluation (QS 2017) - 1

	Architecture & Built Environment	Art & Design	Computer Science	Chemical Engineering	Civil & Structural Engineering
1	Cambridge	Oxford	Cambridge	Cambridge	Cambridge
2	MSA Manchester	Royal College of Art	Oxford	Oxford	Oxford
3	Politecnico di Milano	Politecnico di Milano	Lomonosov Moscow	Imperial College London	Imperial College London
4	TU Delft	Goldsmiths London	CentraleSupélec	ETH Zurich	Politecnico di Milano
5	RWTH Aachen	Kingston University London	LSE London	TU Delft	TU Delft
6	Lund University	Edinburgh	Imperial College London	Novosibirsk	ETH Zurich
7	UPC Barcelona	UCM Madrid	ETH Zurich	RWTH Aachen	CentraleSupélec
8	Edinburgh	Politecnico di Torino	Bauman Moscow	Manchester	RWTH Aachen
9	UCL London	ITU Copenhagen	Politecnico di Milano	TU Munich Politecnico di Milano	TU Munich
10	Salford	TU Berlin	Novosibirsk		Politecnico di Torino

Best European universities in Engineering/Technology according to Employer evaluation (QS 2017) - 2

	Electrical & Electronic Engineering	Material Sciences	Mechanical Engineering	Environmental Sciences	Mineral & Mining Engineering
1	Cambridge	Oxford	Cambridge	Cambridge	Cambridge
2	Oxford	Cambridge	Oxford	Oxford	Oxford
3	Imperial College London	EPFL Lausanne	Imperial College London	Imperial College London	LSE London
4	ETH Zurich	Imperial College London	Lomonosov Moscow	ETH Zurich	Politecnico di Milano
5	Bauman Moscow	Politecnico di Milano	Bauman Moscow	Lomonosov Moscow	Imperial College London
6	CentraleSupélec	Lomonosov Moscow	ETH Zurich	RWTH Aachen	ETH Zurich
7	Politecnico di Milano	CentraleSupélec	CentraleSupélec	Manchester	RWTH Aachen
8	TU Munich	UPM Madrid	RWTH Aachen	Politecnico di Milano	King's College London
9	MIPT / Phystech Moscow	University College Dublin	Politecnico di Milano	EPFL Lausanne	Lomonosov Moscow
10	RWTH Aachen	Ecole Polytechnique Palaiseau	TU Delft	UCL London	University College Dublin

ARWU Ranking in Engineering and Technology 2015

ARWU (Academic Ranking of World Universities) ranks the Politecnico di Milano 92nd on a World scale

Italy	Europe	World
1	17	92

Wharton-QS Stars Awards 2014 - Reimagine Education

A panel of international judges has voted Polimi as the best of the 43 universities worldwide participating in the Nurturing Employability category.

Nurturing Employability Award:

Winner	Enhancing Engineering Education for 21st Century Employability	Politecnico di Milano	Italy
Runner up	Accelerating Medical Innovation and Careers: MILI Global Valuation Laboratory	University of Minnesota	USA
3rd place	The HealthFusion Team Challenge; Building Stronger Healthcare	Queensland University of Technology	Australia

Politecnico di Milano: internationalisation
A.Y. 2015/2016

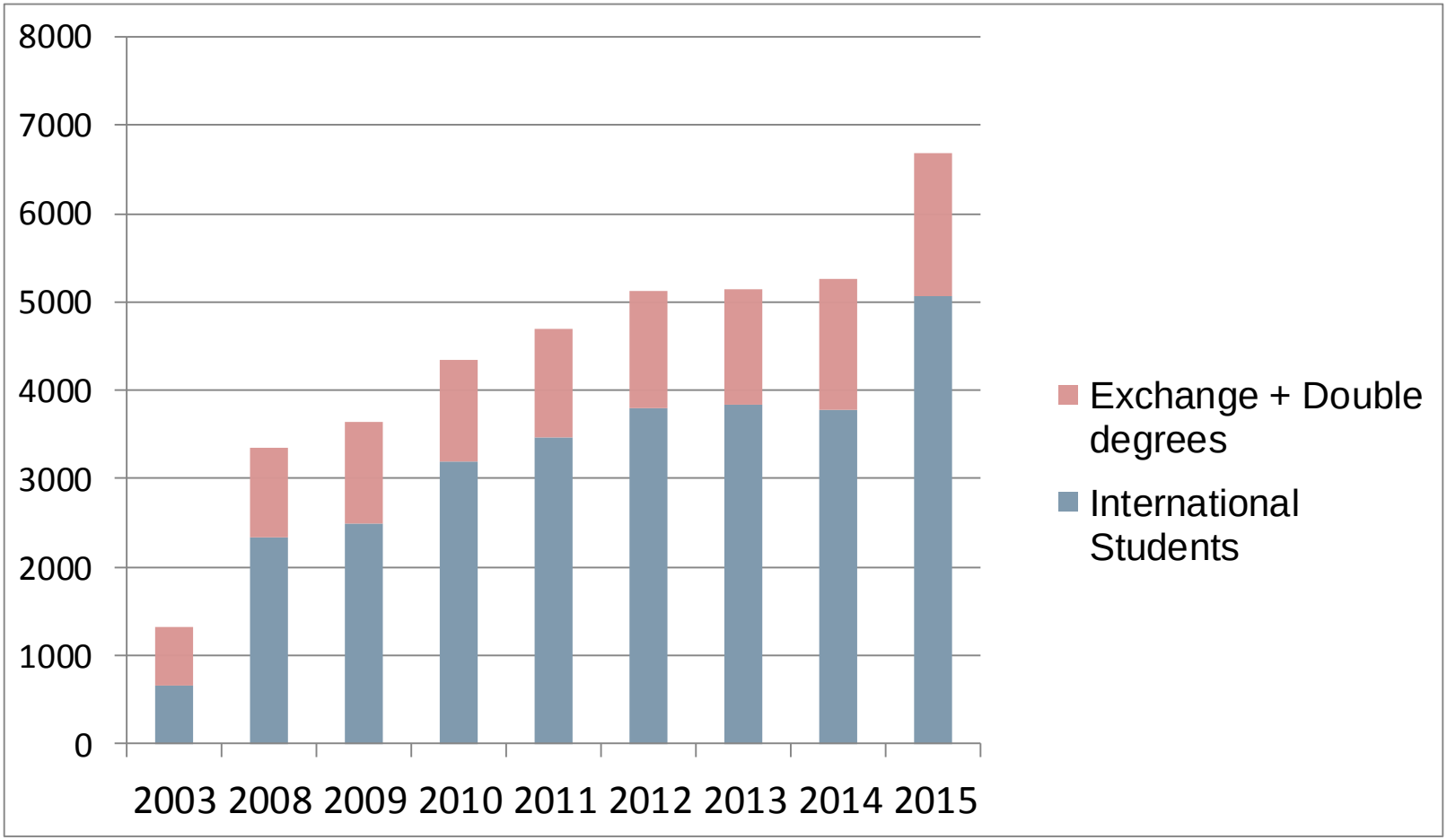
International students coming from more than 100 countries

- 1497 at BSc (6%)
- 3228 at MSc (21%)
- 343 PhD (31%)

Specializing Master and Short post-graduation courses

More than 2500 students (20% from foreign countries)

The growth of international students



International Co-operation Agreements
Effective in December 2015 – Total: 949

PhD Cooperation and mobility agreements	44
Double degree agreements	94
Student exchange agreements with EU partners	432
Students exchange agreements with non-EU partners	209
Framework agreements	170

Exchange Programmes AY 2015/16

- Erasmus +
- Unitech Programme
- MEDes Programme
- PEGASUS Network
- Erasmus Mundus
- T.I.M.E. Programme
- Extra EU Projects
- Sino-Italian Campus
- Ciência sem Fronteiras

Exchange Programmes AY 2015/16

	incoming	outgoing
Erasmus+	927	729
	Incoming	**outgoing**
Extra EU Bilateral Agreements	466	240
	incoming	**outgoing**
Double Degrees	178	153

Strategic partnerships: IDEA LEAGUE

Since March 2016

Strategic Network with 4 of the best TU in Europe

TU Delft Delft University of Technology

ETH Zürich

RWTH AACHEN UNIVERSITY

CHALMERS UNIVERSITY OF TECHNOLOGY

MEMBER OF

IDEA League

A focused network of leading European universities of science and technology

Initiatives:

Summer Schools, PhD Schools, Challenge Programme, Research Grants, etc.

Strategic partnerships: ALLIANCE4TECH

Strategic Network with
CentraleSupelec
TU-Berlin
University College London

ALLIANCE 4 TECH

European Campus without borders:
a real international experience!

Objective: creating a European Campus without borders, for students and professors.

Opportunity to study in at least 3 different campuses for:
Management Engineering
Mechanical Engineering

Agreement in Computer Science under negotiation