



**POLITECNICO**  
MILANO 1863

**PhD School - Politecnico di Milano**  
**Regulations of the PhD Programme in:**

**PHYSICS**

**Cycle XXXII**

Location: Milano Leonardo

# 1. General Information

PhD School - Politecnico di Milano

PhD Programme: PHYSICS

Location of the PhD Programme: Milano Leonardo

Subjects (SSD): FIS/01 Experimental physics; FIS/03 Physics of matter

PhD School Website: <http://www.polimi.it/phd>

PhD Programme Website: [http://www.fisi.polimi.it/en/teaching/teaching\\_offer/phd](http://www.fisi.polimi.it/en/teaching/teaching_offer/phd)

Areas: FIS/01 – Experimental Physics  
FIS/03 – Physics of Matter

## 2. General presentation

Translating scientific knowledge into new technology and transferring innovation to the production system represent a necessary step for many companies, also dictated by an increasingly global market. For that purpose, a professional profile with a broad cultural background is needed. In particular, many advanced sectors of industry and research require good knowledge in topics such as condensed matter physics, optics, laser technology and instrumentation, and nanostructured materials.

The aim of the PhD in Physics at Politecnico di Milano is the training of personnel with strong research capacity, able to operate in basic and applied research and development facilities, and to manage and design high-tech and innovative products and processes in various industrial sectors. This application-oriented character clearly distinguishes the PhD Programme in Physics at Politecnico from those at the Schools of Science.

The education contents are strictly related to the research activities carried out in the research laboratories at the Department of Physics. Although a clear distinction is not possible, they can be divided into two main research tracks:

### 1) Laser physics, photonic devices and applications

(optics and quantum electronics, including biomedical applications of lasers, laser applications in optical communications; diagnostics for works of art; time-resolved optical spectroscopy; ultrashort light pulse generation and applications; UV and X optical harmonic generation)

### 2) Solid state physics: Advanced spectroscopy, scanning probe microscopy, nanostructure fabrication

(photoemission; spin-resolved electronic spectroscopy; magneto-optics; X ray diffraction; magnetic nanostructures for spintronics; synchrotron radiation spectroscopy, positron spectroscopy, semiconductor nanostructures)

These research activities make use of advanced experimental laboratories located at Politecnico di Milano (Milano-Leonardo Campus and Como Campus), including:

Coherent vibrational spectroscopy

- Spectroscopy with femtosecond time resolution

- Attosecond generation
- Coherent Raman spectroscopy and microscopy
- Applications of lasers in telecommunications
- Photonic and optofluidic devices
- Ultrashort laser pulse micromachining
- Solid state lasers
- Biomedical applications of lasers
- Time-domain diffuse optical spectroscopy
- Imaging and spectroscopy for Cultural Heritage
- Optical projection tomography
- Electron spectroscopy with spin resolution
- Magneto-Optics
- Growth and characterization of magnetic nanostructures for spintronics
- Scanning Auger Microscopy (SAM)
- Scanning Near-field Optical Microscopy (SNOM)
- Scanning Tunnelling Microscopy (STM)
- Spectroscopy with synchrotron radiation
- Spectroscopy with positrons
- Epitaxial semiconductor nanostructures for electronics and optoelectronics
- Optical and electron beam lithography

Moreover, many collaborations are on-going with high-level international institutions, such as: European Synchrotron Radiation Facility (ESRF) in Grenoble, Polytechnic University of Zurich (ETH) and Lausanne (EPFL), Ecole Polytechnique - Palaiseau (Paris), Paul Scherrer Institut (PSI), Institut de Ciència de Materials de Barcelona, Institut d'Electronique Fondamentale Université Paris-Sud, Argonne National Laboratory, Technical University of Denmark, Royal Institute of Technology (KTH, Stockholm), Max Planck Institute - Stuttgart, University College London, Interuniversitair Micro-Elektronica Centrum (IMEC) Leuven Belgium.

Students in our PhD Programme will therefore have a real opportunity to gain experience also in prestigious laboratories abroad.

### 3. Objectives

The main purpose of the PhD Programme in Physics at Politecnico di Milano is the development of an experimental approach in problem-solving techniques and the attainment of a high level of professional qualification. Scientific education and training to develop general research abilities in all areas of applied physics is increasingly needed by advanced technological companies in Italy, especially northern Italy, and abroad. The PhD Programme aims at providing engineers and physicists, after a Bachelor of Science ("Laurea", 3 years) and a Master of Science ("Laurea Magistrale", 2 years), with a general education in the basic areas of applied physics and specific knowledge in condensed matter physics, optics, lasers and photonics.

### 4. Professional opportunities and job market

The PhD at Politecnico di Milano offers a wide range of opportunities in the fields of advanced technologies, such as photonics and optoelectronics (lasers, optofluidic devices), advanced physical instrumentation (electronic and

atomic microscopy, nuclear magnetic resonance), biomedical optics (optical tomography, non-invasive diagnostic devices), vacuum technologies (thin film depositions), and material technologies (microelectronics and nanotechnologies).

Concerning Italy and similar Countries, the following professional profiles are well established:

- Manager of devices, equipment and systems (see above), to solve methodological and technological problems within large industries and companies.
- Designer of advanced optoelectronic devices and systems, relying on a physical background and competencies in optics and laser technologies to promote, design and realize new components and devices in high-tech industries as well as small innovative enterprises.
- Researcher in industries, universities, research centres, operating in the technological areas outlined above.

Interesting opportunities are found also at international level, where technological innovation is even more relevant than in the national scenario. In this frame, the PhD Programme in Physics at Politecnico provides excellent preparation for a highly competitive international arena.

## 5. Enrolment

### 5.1 Admission requirements

Italian and International citizens can apply. They are requested to have graduated in accordance with the pre-existing laws D.M. 3.11.1999 n. 509, or to have a Master of Science degree in accordance with D.M. 3.11.1999 n. 509, or a Master of Science in accordance with D.M. 22.10.2004 n. 270, or similar academic title obtained abroad, equivalent for duration and content to the Italian title, with an overall duration of university studies of at least five years.

The certified knowledge of the English language is a requirement for admission. Please refer to the PhD. School website for details.

The admission to the programmes will be established according to the evaluation of the candidates' curricula, motivation letters, and an illustrative report about the development of a possible PhD research, which candidates will send contextually with their application to the admission announcement.

### 5.2 Admission deadlines and number of vacancies

The number of vacancies is indicated in the Call for admission to the 32<sup>nd</sup> PhD cycle

Programmes: <http://www.polimi.it/phd>

Scholarships both on general and on specific themes are available, in accordance with what is specified in the call for admission.

## 6. Contents

### 6.1 Requirements for the PhD title achievement

The achievement of the PhD title in Physics requires at least three years of full time study, research and development of PhD thesis.

The PhD in Physics requires **30 credits** from PhD level courses, to be earned as described in paragraph 6.3 below.

## 6.2 Research development

The main aim of all Politecnico di Milano PhD programmes is the development of a research-oriented mind-set, with expertise and skills in a specific research topic. The PhD Programme in Physics, in particular, aims at developing a problem-solving capability in complex contexts, including the capacity to perform deep problem analysis, identify original solutions, and evaluate their applicability in practical contexts.

These skills provide the PhD candidates with major opportunities of development in their research both in the academic field, and in public and private organisations.

PhD candidates are requested to develop an original research contribution. The PhD thesis must thus contribute to increase the knowledge in the candidate's research field. Besides, it has to be coherent with the research topics developed in the Department where the PhD Programme is carried out.

The original research results are collected in the PhD thesis, where the student's contribution is put in perspective with respect to the research state of the art in the specific research field.

The PhD research is developed under the guidance of a supervisor, who supports the candidate in the setting-out and in the everyday activities related to the thesis development. The supervisor is not necessarily a member of the Board of Professors, and may also belong to an institution different from Politecnico di Milano. The supervisor can be supported by one or more co-supervisors.

To develop the capability of carrying out research activities, candidates must earn a minimum of **30 credits** from courses coherent with their PhD programme. A tutor, belonging to the Board of Professors, is appointed to each PhD student admitted to the programme. The tutor supervises and supports the candidate over all his/her training path. The tutor assists the candidate in the choice of courses to be included in a study plan, which must finally be approved by the Coordinator of the PhD Programme.

The same person may assume both roles of supervisor and tutor.

Further activities intended to develop the candidate's personal skills and research expertise are encouraged during the PhD path.

Candidates must acquire the capability to present and discuss their work in their research community. Consequently, both the participation to international conferences and the publication of the research results in peer-reviewed journals are encouraged.

The PhD Programme favors the candidates' research interactions with other groups in their research field, preferably abroad. Research visits of three to six months are strongly encouraged, as through them the candidates may acquire further skills to develop their research work and thesis.

## 6.3 Objectives and general framework of the teaching activities

The PhD Programmes and the PhD School activate teaching forms of different kind and credit value, including courses, seminars, project workshops, laboratories. Teaching activities both cover basic research issues (open research questions, modelling, experimental methods, which represent the founding element of the PhD Programme and characterize it), and specialist research issues more strictly connected with the candidate's thesis work.

Lectures are usually held in English, except when indicated otherwise. The PhD Programme includes at least one complete path delivered in English language.

Structured teaching activities allow earning of ECTS credits. Other activities, like attendance to workshops, seminar series, and summer schools, contribute to the overall evaluation, but they do not allow earning of specific credits.

The tables below summarize the candidate's path (as regards coursework activities). At the same time, the Programme requires that the candidates are devoted to research activity in a continuous way over the entire duration of their course, following the lead of their supervisors and of the Board of Professors.

### **First/Second Year**

Within the first two years, the candidate is expected to acquire 30 ECTS following the rules summarized here below and described in the following:

<b>Course type</b>	<b>Number of ECTS (min-max)</b>	<b>Notes</b>
PhD School Courses	5 – 15	Chosen from the list available at: <a href="http://www.dottorato.polimi.it/en/during-your-phd/phd-school-courses">http://www.dottorato.polimi.it/en/during-your-phd/phd-school-courses</a>
Courses characterising the PhD Programme	15 – 25	Chosen among the 25 ECTS offered by the Department of Physics (see Table A, and: <a href="http://www.dottorato.polimi.it/en/phd-programmes/active-phd-programmes/physics/">http://www.dottorato.polimi.it/en/phd-programmes/active-phd-programmes/physics/</a> )
Other PhD Programmes	0 – 10	<a href="http://www.dottorato.polimi.it/en/phd-programmes/active-phd-programmes/">http://www.dottorato.polimi.it/en/phd-programmes/active-phd-programmes/</a>

### **Third year**

The third year should be devoted entirely to the research and to the development of the PhD thesis.

### **PhD Course List**

**A)** The PhD Programme in Physics organises the **Characterising Courses** listed in table A. For the admission to the final exam the acquisition of at least **15 credits** in this list is **mandatory**.

**Table A: PHD COURSES CHARACTERISING THE PHD PROGRAMME**

<b>Name of the Course</b>	<b>Professor</b>	<b>Academic Year</b>	<b>Language</b>	<b>Credits</b>
Plasmonics	P. Biagioni, G. Della Valle	2016-17	English	5
Spectroscopy of solids	G. Ghiringhelli	2016-17	English	5
Optical Properties of low-dimensional materials	F. Scotognella	2016-17	English	5
Advanced optical microscopy and applications	A. Bassi, G. Chirico	2017-18	English	5
Multiscale materials modeling	P. Folegati	2017-18	English	5
Special relativity and its implications	E. Puppini	2017-18	English	5
Photon migration and wave diffusion in random media	A. Torricelli	2017-18	English	5

**B)** The PhD School organises every year **General and Interdoctoral courses**. The acquisition of **at least 5 credits** is **mandatory** among the courses of B type. The list of PhD courses organized by the PhD School is available at the website <http://www.dottorato.polimi.it/en/during-your-phd/phd-school-courses>

### **Table B SUGGESTED CROSS –SECTORAL COURSES OR WITH A FOREIGN PROFESSOR**

The following table shows the courses offered (to be confirmed) by the Department of Physics in 2016-17 as general or methodological courses of the PhD School.

<b>Name of the Course</b>	<b>Professor</b>	<b>Academic Year</b>	<b>Language</b>	<b>Credits</b>
Symmetry Applications in Classic and Quantum Physics	M. Finazzi M. Passoni	2016-17	English	5
Physical methods for Cultural Heritage	G. Valentini	2016-17	English	5
Scientific Communication in English	T. Sluckin	2016-17	English	5

### **C) Other PhD courses**

Up to 10 off the 30 mandatory credits can be obtained choosing among PhD courses of type A or B, or among other courses provided by other PhD Programmes at Politecnico.

### **PREPARATORY COURSES**

If the supervisor and the tutor find it useful or necessary that the candidate attends preparatory courses (chosen among the activated courses at the Politecnico di Milano) the Board of Professors of the PhD Programme may assign some extra-credits to be acquired to complete the training path. The credits acquired in this way will be considered as additional, in relation to the mandatory credits to be acquired with the PhD courses.

### **SPECIALISTIC COURSES, LONG-TRAINING SEMINARS**

The attendance of specialist courses, workshops, schools, seminar cycles is strongly encouraged. Generally they do not allow to earn credits. In specific cases, if certified and evaluated, they may permit to acquire credits according the modalities established by the Board of Professors and previous approval of the study plan submitted by the candidate. These courses and workshops can be inserted in the study plan, even if they are not evaluated (and therefore not qualified as credits), as optional “additional teaching”.

## **6.4 Presentation of the study plan**

PhD candidates must submit a study plan, which may be revised periodically (approximately every three months), in order to adequate them to possible changes in the course list, or to needs motivated by the development of their PhD career. The study plans must be approved by the PhD Programme Coordinator, according to the modalities established by the Board of Professors of the PhD Programme itself.

## **6.5 Yearly evaluations**

Candidates present their work to the Board of Professors at least once a year. In particular, the candidates must pass an annual evaluation in order to be admitted to the following PhD year.

The third year evaluation establishes the candidate's admission to the final PhD defense. As a results of each successful annual evaluation, the candidates receive an evaluation (A/B/C/D). Candidates who do not pass the exam will be qualified as “Repeating candidate”(Er) or “not able to carry on with the PhD (Ei)”.

After the final year, candidates who have achieved sufficient results but need more time to draw up their theses, may obtain a prorogation of 6 or 12 months.

## 6.6 PhD thesis preparation

The main objective of the PhD career is the development of an original research contribute. The PhD thesis is expected to contribute to the advance of the knowledge in the candidate's research field.

The PhD study and research work is carried out, full time, during the three years of the PhD course. Stages or study periods in (Italian or International) companies or external Institutions may complete the candidate's preparation.

The resulting thesis needs to be coherent with the research issues developed at the Department of Physics, where the PhD Programme is developed.

The candidate must present an original thesis, discuss its contribution to the state of the art in the research field in the research community.

The PhD research is developed following the lead of a supervisor, who supports the candidate in the setting out and in the everyday activities regarding the thesis development.

At the conclusion of the PhD studies, the Board of Professors evaluates the candidates. Candidates who receive a positive evaluation submit their theses to two external reviewers for refereeing. If the reviewers provide positive evaluations (or after revisions required by the external reviewers), the candidates defend their theses in a final exam, in front of a Committee composed of three members (at least two of them must be external experts).

## 7. Laboratories, PhD Secretary Services

### 7.1 Laboratories

The PhD students will join advanced research laboratories of the Department of Physics, learn about experimental techniques, contribute to research activity, and attend meetings and internal seminars aimed at providing more in-depth knowledge on specific research topics. A non-comprehensive list of the experimental laboratories is provided here below:

1. Ultrashort light pulse generation and applications to the study of ultrafast phenomena in the matter
  - Attosecond Reaction Microscope
  - Femtosecond laser laboratory
  - High-energy attosecond pulse laboratory
  - Laboratory for coherent Raman spectroscopy and microscopy
  - Laboratory for IR-VIS ultrafast spectroscopy
  - Laboratory for XUV ultrafast spectroscopy
  - Positron laboratory
  - Terawatt laser laboratory
2. Solid state lasers and photonic devices for integrated systems
  - Characterization of photonic and optofluidic devices
  - Frequency comb laboratory - Campus Point (Lecco)
  - High-resolution and high-precision laser spectroscopy
  - Laboratorio virtuale di elettromagnetismo computazionale
  - Laboratory of coherent vibrational spectroscopy
  - Solid state lasers
  - Two-photon polymerization by femtosecond lasers



- Ultrashort laser pulse micromachining
  - Wet etching in hydrofluoric acid for microfluidic circuits
3. Photonics for health, food and cultural heritage
- Diffuse Optical Spectroscopy
  - Diffusive Optical Phantoms
  - Fast Fluorescence Molecular Tomography
  - Fluorescence Spectroscopy
  - Functional Near Infrared Spectroscopy
  - Gated Photon Counting
  - Imaging Spectroscopy for Cultural Heritage
  - Near Infrared Spectroscopy for Food
  - Optical Mammography
  - Optical Projection Tomography
4. Epitaxial growth and nanostructure fabrication
- Electron Beam Lithography
  - Materials and devices for Spin Electronics
  - Nanobio
  - Scanning Tunnelling Microscope
  - Semiconductor growth
  - Versatile Electron Spectroscopy Instrumentation
5. Electronic, optical and magnetic properties of low-dimensional systems
- Magneto-Optical Kerr
  - Scanning Auger Microscope
  - Scanning probe microscopy
  - Scanning near-field optical microscopy
  - Synchrotron radiation facilities
  - Ultrafast Photoemission and Optical Spectroscopy
  - Variable energy positron annihilation spectroscopy

## **7.2 PhD Secretary Services**

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## 8. Internationalisation and other activities

Carrying out study and research activities at external laboratories is strongly recommended. As mentioned in Section 2, the students can take advantage of scientific collaborations that are on-going between the Department of Physics and several high-level international institutions.

Politecnico di Milano supports joint PhD paths with International Institutions, as well as Joint and Double PhD programmes. Further information are available on the PhD School website and on the PhD Programme website.

## Attachment A1 – PhD Board of Professors – Collegio dei Docenti

The Board of Professors is composed of 11 full professors, 10 associate professors, and a retired full professor of Politecnico di Milano. The director of the CNR Institute of Photonics and Nanotechnology is also part of the Board, as strong long-lasting collaboration and integrated research are on-going between the CNR Institute and the Department of Physics. The director of the Centre for Nano Science and Technology of the Italian Institute of Technology – who is also affiliated to Politecnico di Milano – is also part of the Board.

<b>Name</b>	<b>Affiliation</b>	<b>SSD / Title of SSD</b>
Paola TARONI (coordinator)	Politecnico di Milano	FIS/01 Experimental Physics
Riccardo BERTACCO	Politecnico di Milano	FIS/01 Experimental Physics
Paolo BISCARI	Politecnico di Milano	FIS/03 Physics of Matter
Alberto BRAMBILLA	Politecnico di Milano	FIS/01 Experimental Physics
Franco CICCACCI	Politecnico di Milano	FIS/01 Experimental Physics
Rinaldo CUBEDDU	Politecnico di Milano*	FIS/01 Experimental Physics
Cosimo D'ANDREA	Politecnico di Milano	FIS/01 Experimental Physics
Claudia DALLERA	Politecnico di Milano	FIS/01 Experimental Physics
Giuseppe DELLA VALLE	Politecnico di Milano	FIS/01 Experimental Physics
Sandro DE SILVESTRI	Politecnico di Milano	FIS/01 Experimental Physics
Lamberto DUO'	Politecnico di Milano	FIS/01 Experimental Physics
Marco FINAZZI	Politecnico di Milano	FIS/01 Experimental Physics
Giacomo GHIRINGHELLI	Politecnico di Milano	FIS/01 Experimental Physics
Giovanni ISELLA	Politecnico di Milano	FIS/01 Experimental Physics
Guglielmo LANZANI	Politecnico di Milano IIT - Centre for Nano science and Technology	FIS/01 Experimental Physics
Paolo LAPORTA	Politecnico di Milano	FIS/01 Experimental Physics
Marco MARANGONI	Politecnico di Milano	FIS/01 Experimental Physics
Mauro NISOLI	Politecnico di Milano	FIS/03 Physics of Matter
Roberta RAMPONI	Consiglio Nazionale delle Ricerche	FIS/01 Experimental Physics
Salvatore STAGIRA	Politecnico di Milano	FIS/01 Experimental Physics
Alessandro TORRICELLI	Politecnico di Milano	FIS/01 Experimental Physics

\*Retired on November 1, 2014.

## Attachment A2 – PhD Advisory Board

The composition of the Advisory Board has been recently changed. It is now composed of five distinguished researchers/managers representative of different applied research environments: two of them belong to important international technical universities (ETH and EPFL), and the other three to leading hi-tech companies in the fields of lasers, microelectronics, and chemistry (for photovoltaic applications), as specified in the following table:

<b>Name</b>	<b>Affiliation</b>
Fabio DONATI	EPFL - Lausanne
Giovanni MASOTTI	El.En. S.p.A
Luciano MIOZZO	Solvay Specialty Polymers
Agostino PIROVANO	Micron Semiconductor Italia s.r.l.
Hans von KÄNEL	ETH - Zürich

Periodic meetings of the Advisory Board with the PhD Faculty, open to all PhD students and other researchers of the Department, are foreseen to discuss the PhD Programme organisation and possible professional opportunities. In particular, a meeting took place on May 16, 2015, connected to the Diploma Ceremony of the XXVI cycle. The minutes of the meeting are attached.



**VERBALE della riunione del Comitato di Riferimento del 16 giugno 2015**

Il Comitato di Riferimento del Dottorato in Fisica del Politecnico di Milano si è riunito il giorno 16 giugno 2015 al Politecnico di Milano presso l'aula Giulio Natta alla presenza del Collegio dei Docenti del Dottorato, appositamente convocato.

Le seguenti componenti del Comitato sono intervenute alla Riunione o in presenza o rappresentate da un delegato ufficiale:

<b>Componente del Comitato</b>	<b>Istituzione</b>
Agostino PIROVANO (rappresentato da Paolo Fantini)	Micron Semiconductor Italia s.r.l.
Fabio DONATI	EPFL - Lausanne
Luciano MIOZZO	Solvay Specialty Polymers
Hans von KÄENEL	ETH - Zürich

Sono inoltre presenti numerosi dottorandi del XXVIII ciclo e dei successivi due cicli, docenti e ricercatori del Dipartimento di Fisica.

La riunione ha inizio alle ore 15:30.

Il Coordinatore, Prof. Paola Taroni, presenta i membri del Comitato, descrive brevemente la struttura del Dottorato in Fisica ed illustra in particolare il piano di studi per la formazione dei dottorandi.

Si apre poi la discussione.

- Paolo Fantini descrive la propria esperienza in qualità di Dottore di Ricerca in Fisica dello Stato Solido che si è inserito in ST Microelectronics senza avere una preparazione specifica nell'ambito dei dispositivi a semiconduttore. Afferma che le capacità sviluppate durante il corso di Dottorato che vengono particolarmente apprezzate sono la disposizione ad approfondire e affrontare problemi in modo creativo e il

possesso di abilità tecniche maturate attraverso l'attività scientifica sperimentale condotta durante il corso di Dottorato.

Conclude il proprio intervento ricordando che Micron Semiconductor è fortemente interessata ad acquisire risorse umane con un solida formazione in ambito scientifico e che finanzia borse di Dottorato sia presso il Politecnico di Milano sia presso l'università di Milano Bicocca.

- Luciano Miozzo, che si occupa di polimeri fluorinati presso il centro di ricerca Solvay a Bollate, afferma che il possesso del titolo di Dottore di Ricerca è ritenuto un fattore di merito dall'azienda per cui lavora e che ciò viene effettivamente riconosciuto. Solvay si aspetta che un Dottore di Ricerca possieda una solida formazione tecnica. Il particolare ambito scientifico in cui il Dottore di Ricerca ha operato durante la sua formazione non è particolarmente importante, si richiede invece flessibilità e capacità di lavorare in gruppo e di gestire persone con diversa formazione e collocazione nell'azienda. A riguardo quest'ultimo punto, sottolinea l'importanza di sviluppare "abilità di comunicazione".
- Alessandro Torricelli (membro del Collegio di Dottorato) chiede di specificare meglio in cosa consistano le "abilità di comunicazione" necessarie.
- Luciano Miozzo risponde che è necessario gestire e comunicare persone dal background culturale molto eterogeneo (con competenze che possono variare fra la fisica, la chimica, il management e il marketing) e con diversi livelli di inquadramento nell'azienda. Conclude sottolineando l'importanza della condivisione delle informazioni in un'azienda.
- Paola Taroni (coordinatore del Collegio di Dottorato), rivolgendosi ai due membri del Comitato di Riferimento con incarichi accademici, chiede come si differenzino i corsi di Dottorato organizzati da diverse istituzioni accademiche.
- Hans von Känel risponde di non essere coinvolto esclusivamente in compiti accademici ma di partecipare anche ad alcuni spin-off. Afferma che gli studenti di Dottorato sono incoraggiati ed incentivati a creare nuovi spin-off. Aggiunge che, presso ETH, viene data particolare importanza allo sviluppo attraverso l'attività di ricerca fondamentale di capacità quali flessibilità e attitudine a risolvere problemi. Conclude riportando che circa il 50% degli studenti di Dottorato in Svizzera trova lavoro in istituti bancari.
- Fabio Donati, forte della propria esperienza personale, sostiene che gli studenti di Dottorato in Italia e all'estero hanno attitudini diverse: la sua impressione è che in Italia gli studenti siano più indipendenti e maggiormente predisposti a svolgere nuove attività. All'estero i dottorandi mantengono più a lungo l'atteggiamento tipico dello studente e hanno maggiormente bisogno di direttive. Chiude il proprio intervento affermando che anche EPFL fornisce supporto (soprattutto burocratico) per la creazione di start-up e che, comunque, le aziende svizzere apprezzano i Dottori di Ricerca per la loro propensione alla soluzione di problemi.
- Paola Taroni chiede quale sia il grado di coinvolgimento dei dottorandi nelle attività didattiche della propria istituzione.
- Hans von Känel e Fabio Donati rispondono che i dottorandi hanno obblighi di insegnamento, per il quale sono retribuiti per il 20% del loro salario. I dottorandi non si occupano dell'insegnamento frontale ma sono coinvolti nella didattica integrativa.
- Paola Taroni riporta alcune statistiche relative ai Dottori di Ricerca che hanno ottenuto il diploma presso la Scuola di Dottorato in Fisica del Politecnico di Milano: il 75% lavora in ambito scientifico in università o centri di ricerca (60% in Italia, 40% all'estero).  
Chiede poi se i dottorandi stranieri incontrino problemi di lingua.

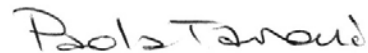
- Fabio Donati risponde dicendo che, ovviamente, una buona conoscenza della lingua costituisce un grosso aiuto, anche perché gli insegnamenti sono erogati nella lingua locale. Aggiunge che la Svizzera ammette un numero di lavoratori stranieri limitato e che i posti disponibili sono per la maggior parte riservati a europei.

Si apre poi un dibattito sulle prospettive di impiego e di carriera di personale in possesso del titolo di Dottorato in istituzioni universitarie, centri di ricerca e aziende pubbliche o private.

- Silvia Petralunga (ricercatore CNR affiliato al Dipartimento di Fisica del Politecnico di Milano) chiede se e come sia valorizzato in un'azienda il titolo di Dottore di Ricerca e se tale titolo garantisca una carriera più rapida e un accesso più agevole a lavori di alto.
- Luciano Miozzo risponde che il dottorato costituisce titolo di merito e che a volte è persino richiesto esplicitamente. Esso tuttavia non assicura, di per sé, una corsia preferenziale per accedere a posizioni di prestigio.
- Paolo Fantini afferma che nelle piccole aziende il dottorato non è apprezzato, ma che in grandi compagnie costituisce ormai un titolo di merito. Ciò che in realtà determina la carriera all'interno di un'azienda non è tanto il titolo di studio quanto le competenze e le conoscenze acquisite. Il possesso del titolo di dottorato è quindi assai rilevante non come titolo in sé ma poiché garantisce che il possessore possieda capacità rilevanti quali una maggiore maturità, competenze tecnico-scientifiche, capacità comunicative. Riporta l'esempio di un progetto svolto da Micron Semiconductor in collaborazione con Intel nel quale il personale coinvolto è costituito per il 50% da Dottori di Ricerca. Aggiunge che il possesso del titolo di dottorato è particolarmente importante per coloro i quali ambiscono a lavorare nel settore Ricerca e Sviluppo.
- Rossella Yvialin (studente di Dottorato del XXIX ciclo) chiede se vi siano svantaggi a dedicarsi alla ricerca fondamentale se poi si è interessati a ottenere un lavoro in un'azienda.
- Hans von Käenel risponde che una scuola di Dottorato dovrebbe educare gli studenti affinché questi possano poi trovare facilmente lavoro in un'azienda, ma ammette che questo non è il caso dell'Italia. Aggiunge che in Svizzera non è possibile rimanere nell'istituzione dove si è ottenuto il titolo di Dottore di Ricerca.
- Paolo Fantini ribatte che, pur costituendo il dottorato un titolo di merito, è preferibile abbandonare l'accademia rapidamente se si desidera trovare lavoro nell'industria.
- Paola Taroni chiede se il dottorato assicuri un migliore livello di ingresso o una carriera più veloce.
- Luciano Miozzo risponde, che nell'azienda per cui lavora, il salario di ingresso di un Dottore di Ricerca corrisponde a quello cdi un normale laureato dopo tre anni di lavoro. Tipicamente anche la progressione di carriera è diversa. Tuttavia quest'ultima è determinata dalla capacità personali più che dal titolo di studio.
- Paolo Fantini replica che, anche per Micron Semiconductor, il salario di ingresso di un Dottore di Ricerca è più alto di quello di un neolaureato.
- Alberto Brambilla (membro del Collegio di Dottorato), chiede se sia necessario cambiare spesso azienda per garantirsi una progressione di carriera più rapida.
- Luciano Miozzo risponde dicendo che la mobilità all'interno della stessa azienda e la flessibilità sono requisiti essenziali, esplicitamente richiesti nei colloqui di lavoro. L'esperienza all'estero è certamente importante per la progressione di carriera. Solvay partecipa al sostegno economico della famiglia del dipendente impegnato all'estero.
- Alberto Tagliaferri (Professore del Dipartimento di Fisica del Politecnico di Milano) chiede quali siano le qualità più apprezzate da un'azienda in un suo dipendente.

- Luciano Miozzo risponde affermando che, al primo impiego le abilità richieste sono ugualmente ripartite fra competenze tecniche e capacità di gestire progetti. Questo secondo aspetto diventa sempre più importante man mano che la carriera progredisce.
- Sandro de Silvestri (membro del Collegio di Dottorato) chiede agli studenti presenti quali fossero le loro motivazioni al momento di iscriversi alla Scuola di Dottorato in Fisica. Le risposte variano fra la volontà di prolungare e approfondire l'attività svolta durante la tesi di laurea magistrale, la passione per lo studio e l'apprendimento, il desiderio di sentirsi responsabili in prima persona di un'attività di ricerca. Sandro de Silvestri chiede inoltre quanti siano gli studenti convinti a cercare lavoro al di fuori dell'ambito accademico una volta conclusa l'esperienza del dottorato. Solo due fra gli studenti presenti si dicono convinti di cessare l'attività scientifica dopo la fine del corso di Dottorato.

Non essendoci ulteriori interventi, la riunione si conclude alle ore 17:15.



Il Coordinatore del Dottorato in Fisica

Prof. Paola Taroni