PHD SCHOOL IN INFORMATION ENGINEERING

UNIVERSITY OF PADOVA

SELF EVALUATION REPORT 2008-2010

INTRODUCTION

What follows is the second self-evaluation report (SER) of the Ph.D. School in Information Engineering. It is addressed to the Scientific Committee (SC) at the conclusion of its three-year term and constitutes the basis, possibly complemented by an on-site visit, for the preparation of the SC final evaluation report.

The kind of information to be included in the SER and its organization is defined by the Quality and Performance Assessment Council, a University board in charge of supervising the quality and the planning strategy of undergraduate, master and Ph.D. courses, the output of scientific research and the application of good practices in the administration of financial resources. The Council is the prime recipient of the SC evaluation report, a copy of which is also sent to the School Governing Bodies and to the University Rector. The Council uses the report for a periodic redefinition of resource allocation among the Ph.D. Schools of the University of Padova.

The reference period analyzed in this second SER is 2008-2010. Though the information reported in the document is essentially an update of that contained in the first SER (that concerned the year 2007), whenever possible the organization of the document has been changed and data have been aggregated to make the report hopefully more readable, as suggested by some of the SC members.

1   GENERAL DESCRIPTION

1.1   School organization

School structure

The School is organized in two *Indirizzi* (Curricula) in which students are carrying out research on specific topics:

- Bioengineering
- Information and Communication Science and Technologies (I.C.T.)

Students enrolled in the Bioengineering Curriculum are engaged in research related to the modelling of biological and physiological systems in order to identify normal and abnormal behaviour for the purpose of identification of illness, biomedical signal and image processing, application of computer engineering and robotics to medicine, identification of biological movement of legs and arms and their application to rehabilitation, biomedical instrumentation, biomaterials.

Students enrolled in the I.C.T. Curriculum are engaged in research activities in one of the fields of Information Engineering. They are related to the design of devices and systems in the fields of micro- and nanoelectronics, optoelectronics, telecommunications and quantum communications, automatic controls, computer engineering; to the study of the techniques for their optimization; to the measurement of their performance. Such areas are strongly connected, and research subjects frequently cover several of the cited subjects, or make use of techniques and methodologies of other scientific disciplines.

Admission to the School

To be admitted to the PhD School in Information Engineering each applicant has to pass an exam that includes the evaluation of the curriculum of the candidates and the evaluation of the GRE General Part Test.

Each curriculum is scored based on criteria that are publicly available on the School website and on the call for application and that include:

- the average exam score during the Bachelor and Master's Degrees;
- the final score achieved in the Master's Degree;
- a research plan for the Ph.D. program;
- a letter of recommendation;
- scientific publications co-authored by the candidate.

The lack of a written or oral examination at the School site is intended as a stimulus to increase the number of applications from foreign candidates.

The School has created and regularly updates a website (both in Italian and English) that contains detailed information on the School organization, the admission procedure, the School regulations, the course catalogue: http://www.dei.unipd.it/phd

Bodies of the School

The bodies of the School are:

- *Direttore* (Director)
- *Consiglio Direttivo* (Steering Board)
- *Collegio Docenti* (Teaching Faculty Council)
- *Comitato Scientifico* (Scientific Committee)

The Director is the representative of the School both towards the University and outside, and his tasks include the organization and coordination of the activities of the School.

The Teaching Faculty Council (TFC) includes the Director, the vice-Director, the Teaching Staff (described in section 1.3), two representatives of the Ph.D. Students. The TFC organizes and monitors the educational activities of the School.

The Steering Board (SB) includes the Director, the Coordinators of the two Curricula of the School, a Department representative, 8 Faculties designated by the Teaching Faculty Council, two representatives of the Ph.D. Students. The SB is the planning body of the School.

Depending on the matter, the decisional process may involve the Director alone (for well codified cases like students requests for a research period abroad, standard changes to the study plan), or, in cascade, the Steering Board and the Teaching Faculty Council.

Evaluation of student proficiency

The decision about the admission of students to the second and third year of the Ph.D. program and to the final examination is taken by the TFC.

The admission to the second year is based on the successful completion of the course requirements during the first year, as detailed in section 3.1.

For the admission to the third year, each student is examined by a committee formed by the supervisor and a faculty nominated by the School. The committee evaluates the second-year activity report submitted by the student; organizes an open seminar for the student to present the progress and partial results of his/her research activity; submits to the TFC a report used as a basis for the discussion on the admission of the student to the third year.

Similarly, for the admission to the final exam, each student is examined by a committee formed by the supervisor and two faculties nominated by the School. The committee evaluates the draft of the thesis submitted by the student by mid October of the third year; organizes an open seminar for the student to present the results of his/her research activity; submits to the TFC a report on the student research activity, used as a basis for the discussion on the admission of the student to the final exam.

The final exams are normally held in the months of March and April after the conclusion of the third year. The committees for the final exam are composed by three external members each, i.e. none of them can be an employee of the University of Padova neither be a member of the School TFC, and none may have cooperated with the Ph.D. candidates being evaluated.

1.2   National and international collaborations

This section analyzes the collaborations with academic and non-academic partners in which the School is involved through its student and teaching staff. A collaboration between (members of) the Department of Information Engineering (DEI) and an external institution has been considered in this analysis if it has generated at least one of the following actions:

Academic Institutions

- a member of the external institution has visited the School either to teach a course or supervise Ph.D. student activity;
- either an occasional or structured agreement between the external institution and the School has been set up to foster Ph.D. student exchange;

Non-Academic Institutions

- the external institution has funded a grant for a Ph.D. student of the School;

- the external institution has funded a project that directly involved one or more Ph.D. student of the School;
- the external institution has hosted for at least one month a Ph.D. student of the School for training or research activity.

Data for the period 2008-2010, together with the reference data concerning the year 2007, are reported graphically below.
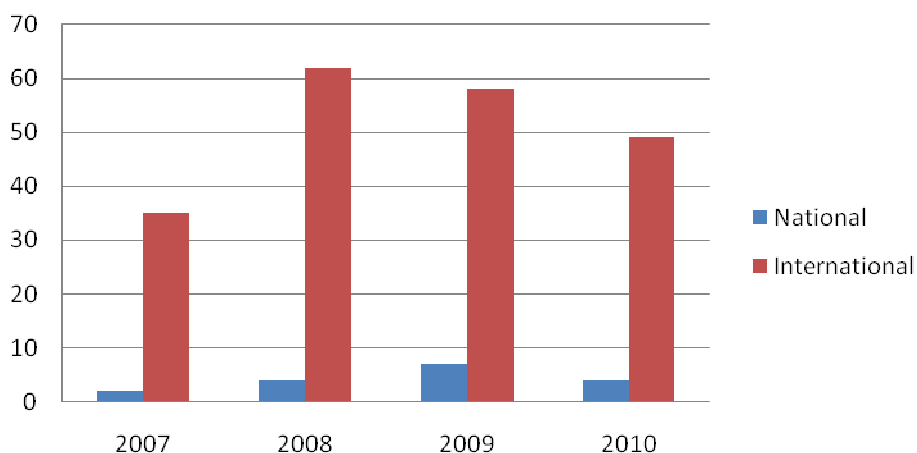
Academic collaborations - Total

Fig.1 Total number of collaborations with academic institutions.

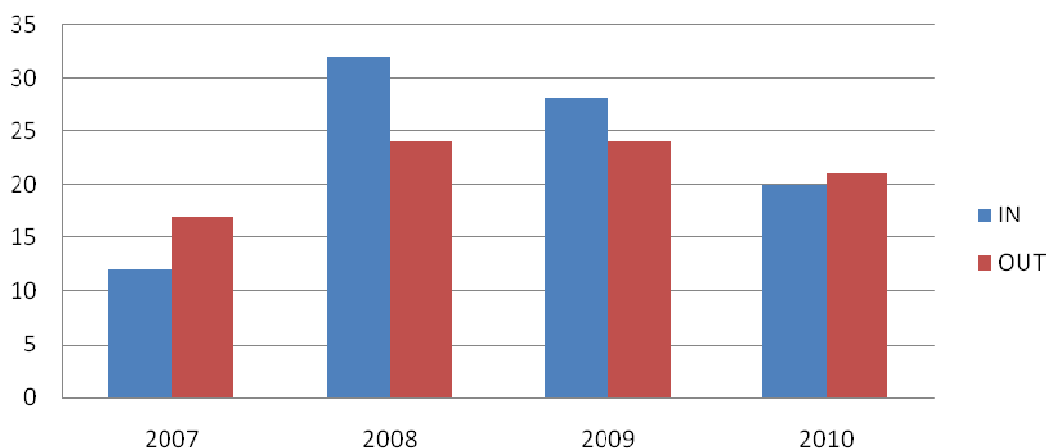## Collaborations based on student exchange

Fig.2 Number of collaborations consisting of Ph.D. student mobility (IN: School hosting external students; OUT: external institution hosting School students).

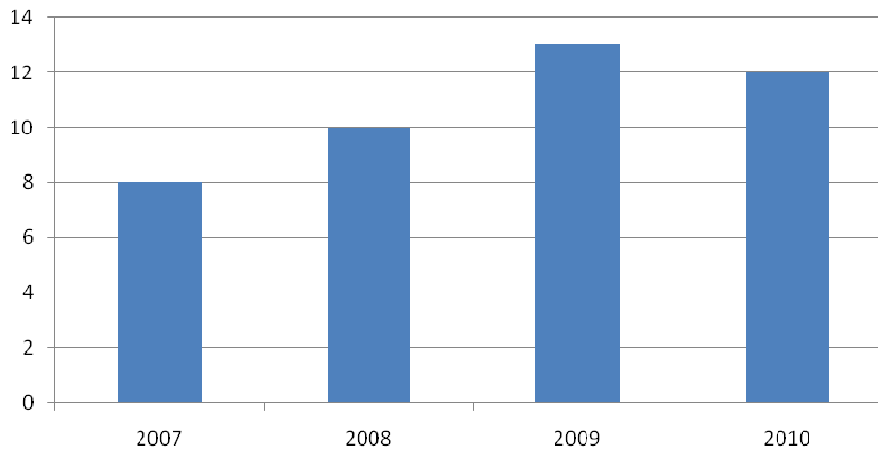## Visiting professors/researchers

Fig.3 Members of external academic institutions that visited the School

The panorama of non-academic partners of the School include large international companies (STMicroelectronics, Infineon Technologies, Alcatel Thales, Qualcomm, Huawei), medium national industries (Piaggio, Salvagnini, Selex), both national and international high-tech SME's (M31, Wisycom, Canesta, VI-grade), well-renowned research centers (IMEC, Fraunhofer Institute).

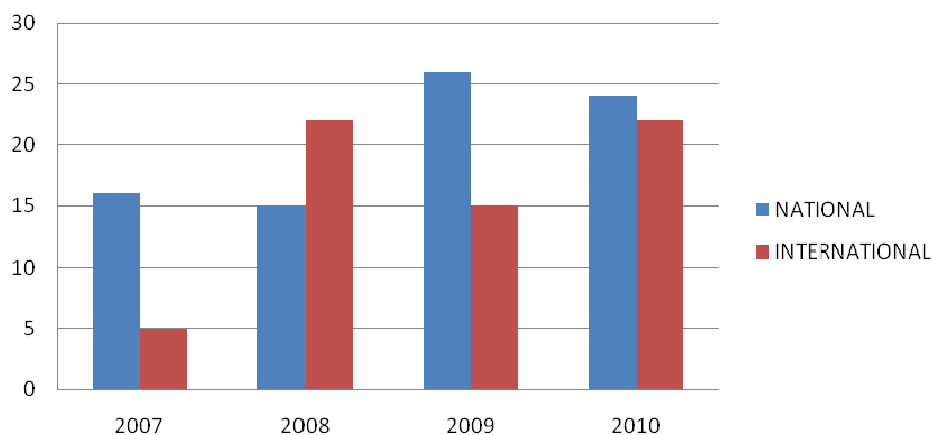## Collaborations with non academic partners

Fig.4 Number of collaborations with non-academic partners

1.3 Teaching Staff

The teaching staff of the Ph.D. School is composed by Academic and non-Academic members playing at least one of the following roles:

- supervisor of one or more Ph.D. students;
- instructor of one of the courses or seminars offered by the School;
- School Director, Vice-Director, members of the Steering Board (see section 1.1 – Bodies of the School) .

The number of School staff members is reported in Fig. 5. The number of students per staff member was 1.5 (2007), 1.4 (2008), 1.5 (2009), 1.5 (2010). The distribution of students among supervisors reported in Fig. 6 shows that the most common situation (about 80% of total cases) is that of a supervisor guiding one or two Ph.D. students.
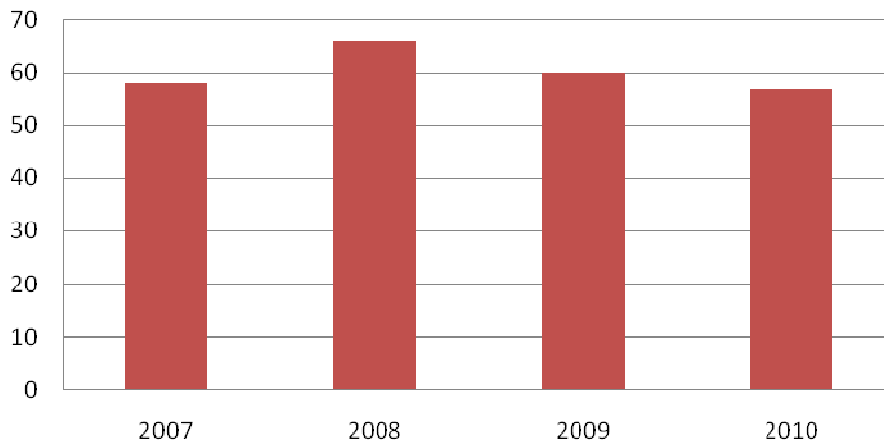
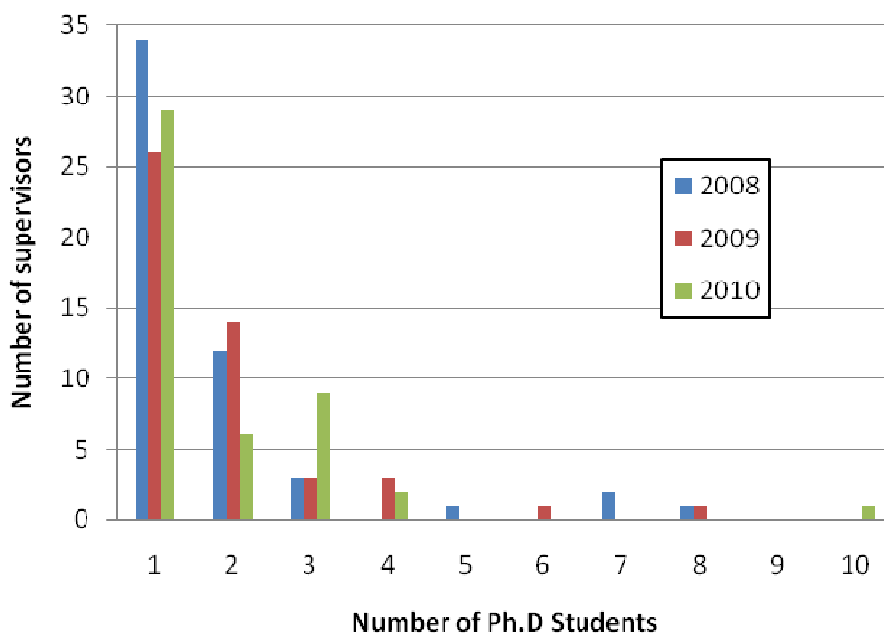## School Staff - total

Fig. 5 Number of School staff members.

Fig. 6 Distribution of students among supervisors.

As shown in Fig. 7, the majority of staff is affiliated to the University of Padova. Based on the rules outlined above, the number of potential staff members affiliated to other institutions could be larger. Nonetheless, since the staff members should participate to the periodical meetings of the Teaching Faculty Council (see section 1.1 – Bodies of the School), it would be impractical to

increase over a certain threshold the fraction of members located at an inconvenient traveling distance from Padova.
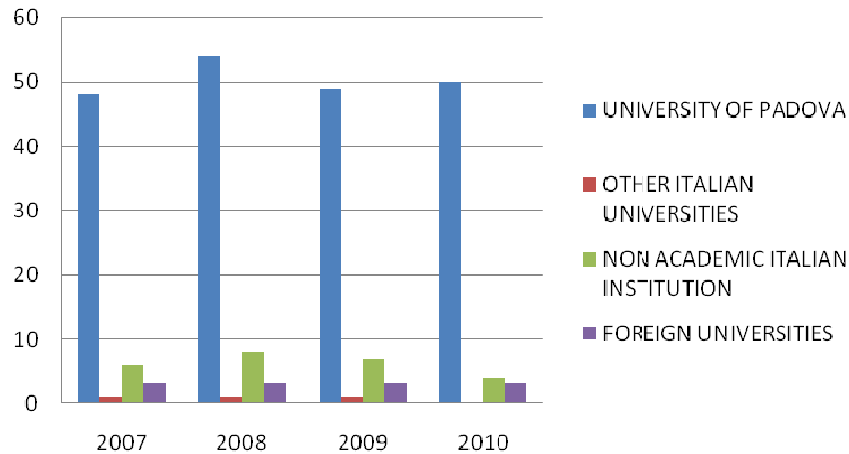
School Staff - by affiliation

Fig. 7 School staff classified based on the affiliation.

1.4 Research Funds

As pointed out by some SC members in the first review round, an informative analysis of the research funds actually allocated to the School should outline the global expenses directly related with Ph.D. students, such as compensations, missions, stage support, administrative costs and the like, rather than the global research funds available to the teaching staff.

Unfortunately, the accounting system actually in use does not allow such an analysis. An exception is the specific financial resources of the School (section 1.6) and the number of grants funded by external institutions (section 1.5). Thus, the only figure we are able to report to give at least an idea of the theoretical spending capability in support of the Ph.D. students research activity is the funding of projects whose Principal Investigator is a member of the teaching staff, as already done in the first SER. The projects considered are only those where part of the manpower has been provided by Ph.D. students. The new funding acquired in each year of the period 2008-2010 is reported in Fig. 8.
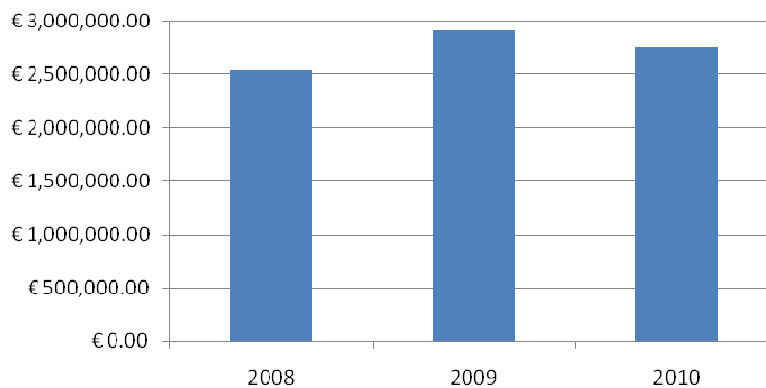
New research funds per year

Fig. 8 New funding acquired in each year of the period 2008-2010.

The sources of the funding is detailed in the pie charts below (UNIPD: University of Padova; MIUR: Ministry of Education, University and Research). European Union projects and research contracts with non academic institutions account for most of the total funding.
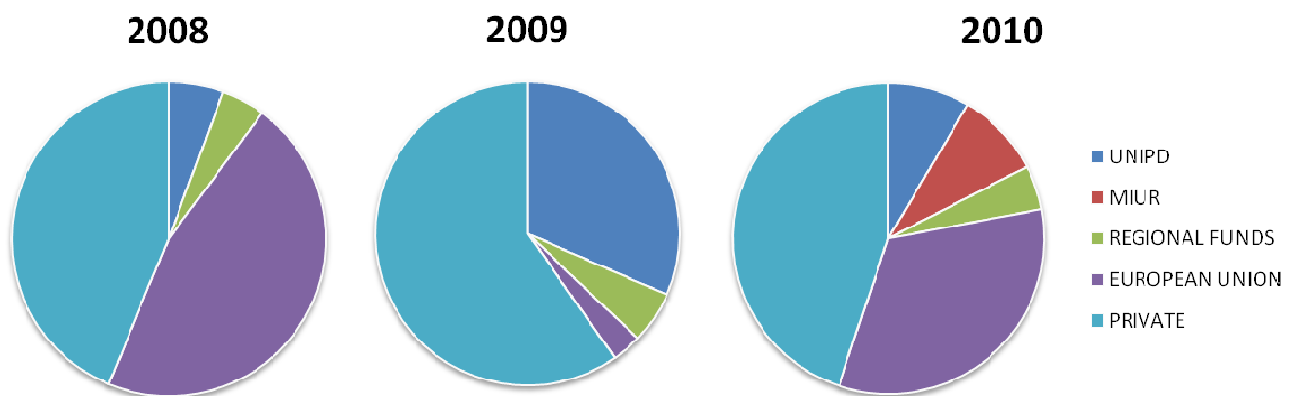

Fig. 9 Sources of the teaching staff research funds.

1.5 Students

The total number of Ph.D. students enrolled in the School is reported in Fig. 10. Despite the number of foreign students is slowly increasing, these data show a limited attractiveness of the School abroad. The improvement of the English version of the Ph.D. School website and the admission procedure based on the evaluation of the candidate curriculum and on the GRE test (general part) have contributed to increase substantially the number of applications by foreign students. Unfortunately, the fraction of these applications reaching the minimum score required to be considered for the admission to the School is still much less than that of local students.
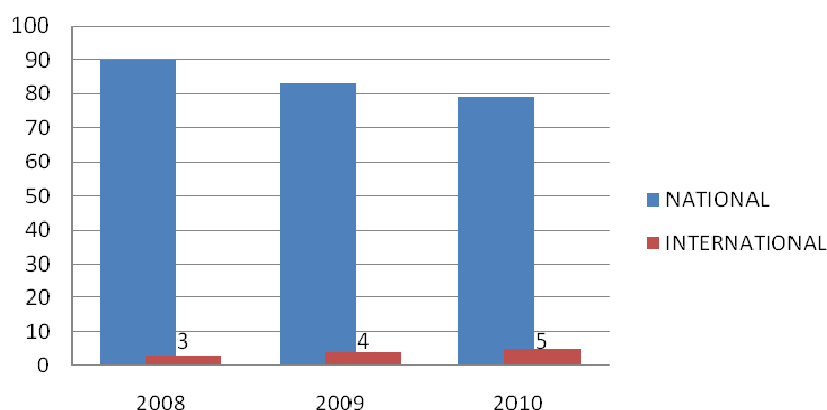
Total enrollment

Fig. 10 Number of students enrolled in the School (total headcount of first, second and third-year students)

Most of the Ph.D. positions available every year come with a fellowship whose sources are the University (UNIPD), the Ministry of Education, University and Research (MIUR), or a sponsoring institution (private companies, non-profit foundations or research institutes, and, lately, the Department of Information Engineering through dedicated project funding).

Students that get a Ph.D. position without a fellowship are normally paid directly through a contract using research funds of the student supervisor.

The distribution of the different sources of fellowships and contracts is reported in Fig. 11.

Sources of grants and contracts
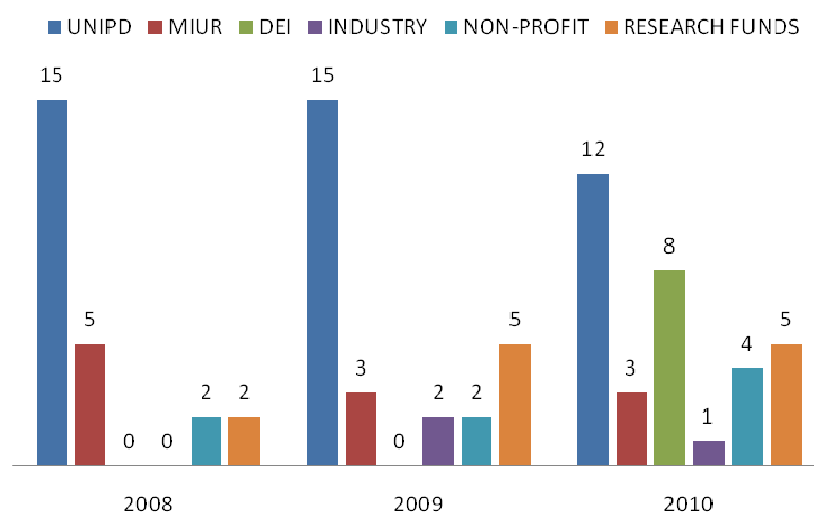

Fig. 11 Sources of grants and contracts for the Ph.D. positions opened at the School every year.

The possibility for the Department to sponsor Ph.D. positions has been exploited in 2010 to compensate for the reduction of grants coming from national public funding (i.e. University and MIUR). The number of industries sponsoring Ph.D. grants is limited, though not as limited as it

DIPARTIMENTO
DI INGEGNERIA
DELL'INFORMAZIONE

SCUOLA DI DOTTORATO
IN INGEGNERIA
DELL'INFORMAZIONE

might appear at first glance from Fig. 11. In fact, the source of most of the contracts based on supervisors funds (the orange bar labeled RESEARCH FUNDS) are research project financed by industries.

1.6 Specific Financial Resources of The School

Since 2007 the School has significantly improved its spending capacity for what concerns the specific financial resources transferred from the University Central Administration. These resources are constrained to student training, long and short term student mobility, expenses for the School evaluation process. This means that they cannot be used for Ph.D. grants, research prizes, instrumentation acquisition or consumables.

In 2007 the amount of resources spent was 46.600 € and the surplus brought forward to 2008 was roughly 139.800 €. In the year 2010, the total resources available were 130.685 € while the resources used were 82.000 €, 22.000 € of which to pay for courses held at the School by foreign academic personnel, 40.000 € to support student long term mobility (training or research activity abroad for at least one month), 20.000 € to support student short term mobility (participation to conferences and workshops).

1.7 Laboratories and Facilities

It is a well established practice of the School, recognized also in the Department regulations regarding space allocation, that every student is assigned a desk and a personal computer with full access to the Department software services (internet access, mail account, licensed application software, data storage on NAS system, computing resources on Blade cluster).

Ph.D. students have full access to the University Library System (SBA); they have the right to reserve the two meeting rooms and the videoconference room available at DEI; they are granted assistance from the Department Administrative, Computing, Laboratory and Technical Services on the same basis as Faculty members.

As of 2010, the Department hosts 18 instrumentation laboratories (a.k.a. heavy labs) and 12 computer laboratories (a.k.a. light labs) endowed with equipment and software tools that Ph.D. can access to carry on their research. Two tables listing the number of Ph.D. students that have been granted access to each lab are reported below.

Computer Laboratories (Light Labs)

Lab Name	2008	2009	2010	Lab Supervisor
Structural Bioinformatics	0	1	2	Concettina Guerra
Databases	3	4	3	Maristella Agosti
GIRTS (GIS and Real-Time Systems)	1	1	1	Sergio Congiu
Advanced Computing Paradigms	4	5	4	Gianfranco Bilardi
Artificial Intelligence	1	1	0	Silvana Badaloni
Communication Networks	3	2	1	Michele Zorzi
CAD for Photonics	2	1	1	Andrea Galtarossa
Radio Systems - Telecommunications	5	7	6	Silvano Pupolin
MIAN (Multimedia Information Advanced Networking)	7	8	8	Lorenzo Vangelista
DISP (Digital Signal and Image Processing)	0	1	1	Giancarlo Calvagno
ICE (Identification, Control and Estimation)	8	9	7	Sandro Zampieri
Biomedical Signal Processing	5	8	5	Gianna Maria Toffolo

Instrumentation Laboratories (Heavy Labs)

Lab Name	2008	2009	2010	Lab Supervisor
SIGNET (Special Interest research Group on NETworking)	9	10	10	Michele Zorzi
Electromagnetic Compatibility	3	3	2	Matteo Bertocco
MAGIC (Multi-AGent Intelligent Control)	4	6	7	Luca Schenato
Photonics and Electromagnetic Fields	1	0	1	Andrea Galtarossa
Control Systems	1	1	1	Luca Schenato
Clean Room	5	4	3	Alessandro Paccagnella
RREACT (Reliability and Radiation Effects on Advanced CMOS Technologies)	2	1	1	Alessandro Paccagnella
BioDevices	1	0	1	Alessandro Paccagnella
ICARUS (Integrated Circuits for Analog and Radiofrequency micro Systems)	2	2	2	Andrea Neviani
Optoelectronics	1	3	4	Enrico Zanoni
MOSLAB (Molecular and Organic Semiconductor Lab.)	1	1	0	Andrea Cester
PEL (Power Electronics)	1	1	2	Giorgio Spiazzi
NAVLAB (Autonomous Navigation and Computer Vision)	5	4	4	Luca Schenato
Microelectronics	9	9	7	Gaudenzio Meneghesso
LTTM (Multimedia Technology and Telecommunications)	0	0	2	Guido Maria Cortelazzo
Center for Computational Sonology	1	2	2	Giovanni De Poli
IAS (Intelligent Autonomous Systems)	4	3	3	Enrico Pagello
Bioengineering of Human Movement	1	2	1	Claudio Cobelli

2 RESEARCH ACTIVITY

2.1 Research Areas

The Department, through the School faculty members, offers the Ph.D. students a wide selection of active research fields among which to choose the one to join to carry on their thesis work. The selection is made right at the beginning of the first year, mainly based on the research proposal submitted by the student as part of the documentation for the admission to the School. The choice is subject to the approval by the Teaching Faculty Council.

A description of the active research topics in each area updated in 2010 is available at:

http://www.dei.unipd.it/wdyn/index.php?IDsezione=3299

An itemized summary of the research topics is reported below:

- Applied Optics
    - Laser Applications
    - Nanotechnologies for optical applications
    - Optical instrumentation for satellite and ground astronomical telescopes
    - Quantum Communications
    - Ultrashort Pulses Generation and Study
- Bioengineering
    - Bioengineering of the Movement
    - Biomedical Image Analysis
    - Biomedical Signal Processing
    - Computational Biology in Genomics & Proteomics
    - Identification of Physiological Systems
    - Modeling and Control of Physiological Systems
    - PET and MRI Functional Imaging
- Computer Science
    - Advanced Computing Paradigms
    - Artificial Intelligence
    - Cartographic generalization (CARGEN)
    - Computational Methods for the Functional Prediction of Proteins
    - Information Management Systems (IMS)
    - Intelligent Robotics
    - Naevi in Silico
    - Natural Language Processing
    - Operations Research: Methods and Applications
    - Sound and Music Computing
- Electronics
    - Characterization and reliability of wide bandgap semiconductors devices

- o Characterization, modeling and reliability of advanced optoelectronic devices: towards high efficiency LEDs, lasers and solar cells
- o Communication and control architectures for efficient use of renewable energy resources in smart grids
- o Design and control of switch mode power supplies (SMPS)
- o Design, characterization and development of Electrostatic Discharge (ESD) protection structures for advances CMOS and Smart Power
- o Development and reliability investigation of Radio Frequency Micro Electro Mechanical Systems (RF-MEMS)
- o Electromagnetic compatibility
- o Low-power integrated circuits for wireless communication
- o Microelectronics for human health care
- o Organics technologies: the keystone for electronic, light, and energy anywhere.
- o Radiofrequency integrated circuits design for biomedical radars and imaging
- o Renewable energy sources
- o Soft Errors in Advanced Electronic Components
- Systems and Control Theory
  - o Adaptive Optics
  - o Applications of Advanced Control Techniques
  - o Biomimetic Locomotion: Insect Flight and Fish Swimming
  - o Industrial Communication Systems
  - o Networked Control Systems
  - o New Techniques for Identification, Estimation and Applications
  - o Plasma Physics and Controlled Fusion Devices
  - o Quantum Control and Quantum Information
  - o Switched systems under positivity constraints
- Telecommunications
  - o Wireless Sensor Networks and Internet of Things
  - o 3D data acquisition, processing and transmission
  - o Antennas
  - o Cognitive Wireless Networks
  - o Digital TV
  - o Image, video and 3D data processing and coding
  - o Next Generation Wireless Networks - Towards the 4th Generation of Cellular systems
  - o Photonic devices for signal processing
  - o Transmission
  - o Ultra Wide Band Communications
  - o Underwater Acoustic Networks

2.2   School staff publications

In this section the publications on international, peer-reviewed journals co-authored by the teaching staff members in the last five years (2006-2010) has been considered. The data are first reported in Fig. 12 to show the number of publications of each member of the teaching staff.
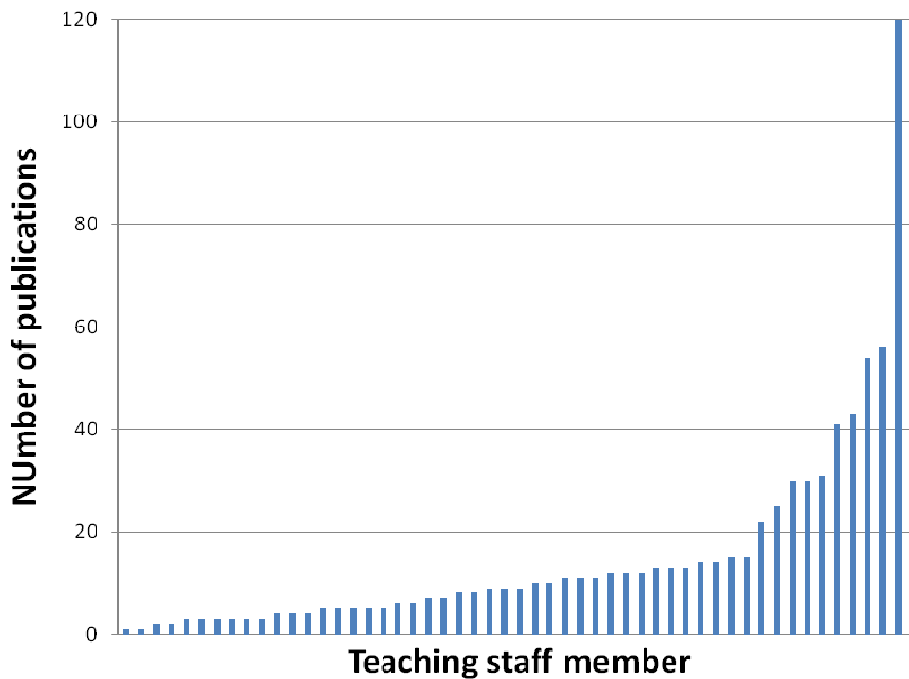

Fig. 12 Number of journals co-authored by each staff member in 2006-2010

The same data are rearranged in Fig. 13 to show the number of teaching staff members against the number of publications per member in a given range.
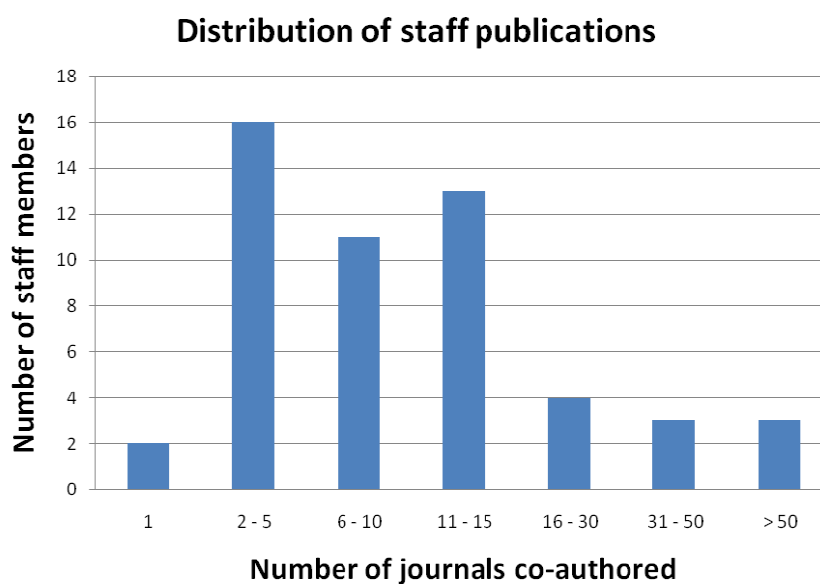

Fig. 13 Number of teaching staff members against the number of publications per member.

2.3 Ph.D. Students Publications

In this section the publications of Ph.D. Students that graduated in 2010, and thus attended the School in the period 2007-2009, are analyzed. The choice is motivated by the fact that, in order to get a realistic idea of the publications generated by the research activity carried on during the attendance of the School, it is reasonable to include also at least the year following the conclusion of the Doctorate, considering that the publication time of journal papers is normally several months (and often, well over one year).

The type of publications considered are international, peer-reviewed journals and international conferences with peer review and publications of proceedings. The time interval considered is 2007-2010. The data are reported in Fig. 14 that shows the number of students against the number of publications per student in a given range.
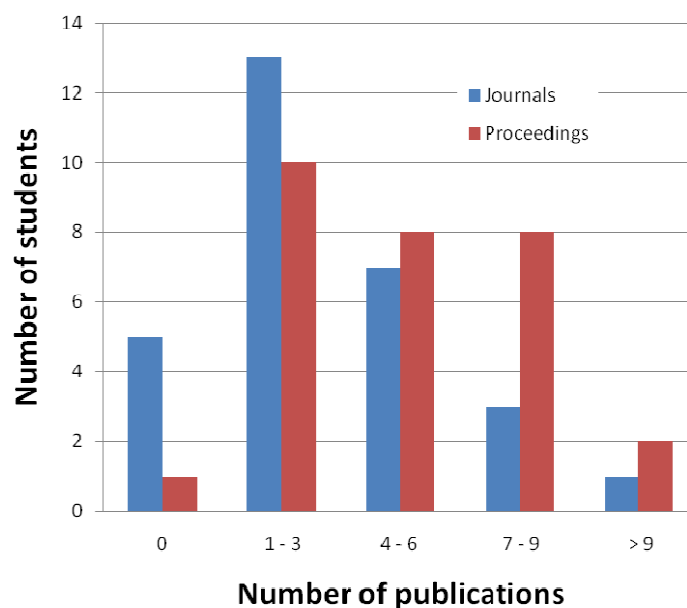

Fig. 14 Number of students against the number of publications per student.

3 TEACHING ACTIVITY

3.1 Courses and Seminars of the School

Every year, the School offers a catalog of specific courses for Ph.D. students, held at the School by instructors of the University of Padova and of external Academic Institutions. The official course catalogues can be found at:

http://www.dei.unipd.it/wdyn/?IDsezione=4854

Each course listed in the catalogue includes a final exam. The following rules apply:

1. Students are required to take courses from the catalogue for a minimum of 80 hours (20 credits) during the first year of the Ph.D. program. This on average corresponds to five courses.
2. Students are required to take for credit at least two out of the three basic courses, i.e. "Applied Functional Analysis", "Applied Linear Algebra", and "Statistical Methods" during the first year of the Ph.D. program. Moreover, the third course is strongly recommended to all students.
3. After the first year, students are strongly encouraged to take courses (even outside those offered in the official catalogue) for at least 10 credits (or equivalent) according to their research interests.

The table below summarizes the educational offer contained in the 2008-2010 catalogues. The three rightmost columns classify the course instructors based on their affiliation.

Year	Number of courses	Total number of hours	Instructor affiliation		
			University of Padova	Other Italian University	Foreign University
2008	21	344	15	1	5
2009	18	324	8	6	4
2010	19	332	14	2	3

Since 2010, in order to give the student the fundamentals of project and spin-off management, a specific 20-hour course entitled "Project management" has been added to the catalogue.

The Department periodically organizes meeting occasions and public debates in order to verify the coherence of its research activities with the most up-to-date international strategic lines and trends, and also with the demands of the local community and local industries. Such occasions are also intended as a stimulus for youngest researchers, such as Ph.D. and Post-Doc students.

In this respect, the major initiatives are:

- Distinguished Lectures offered by esteemed international scientists (http://www.dei.unipd.it/wdyn/index.php?IDsezione=1339)
- Colloquia weekly presentations, offered by researchers of the Department, and opened to industries and other research centers (http://www.dei.unipd.it/wdyn/index.php?IDsezione=65)
- Guest seminars, offered by guest researchers at the Department

All Ph.D. students are strongly encouraged to attend these seminars.

It is usual practice to organize national meetings, here called Seasonal Schools, where Ph.D. students from a specific research area can attend lectures, present their work, and build business relationships. The School actively contributes to the organization of the following initiatives:

- National School in Bioengineering, hosted by the national Bioengineering group (http://www.bioing.it/)
- Summer School on Information Enginnering of Bressanone, covering subjects in Electronics and Telecommunications (http://www.dei.unipd.it/ssie)
- Summer School in Electronic Measurements, hosted by national Electrical Measurements group *Seminario di eccellenza Italo Gorini* (http://www.gorini.diei.unipg.it/joomla)

All Ph.D. students are strongly encouraged to attend the Seasonal Schools relevant to their research interests.

3.2 Training Activities Outside the University of Padova

The table below summarizes the data regarding student training activity during period spent at international academic or public research institutions. The student activity plan always included research activity training, through the participation to a project at the host institution under the guidance of a local supervisor, and, in some cases, also education through graduate courses available at the host institutions. The total number of students that spent a period abroad in the years 2008-2010 is summarized in the table below.

Overall student mobility in the period 2008-2010

Year	2008	2009	2010
Number of students	22	28	37
Total number of months	133	168	196

Conclusive data concerning the mobility of students that completed their Ph.D. in the years 2008 (XXI Ph.D. program cycle) 2009 (XXII) and 2010 (XXIII) are reported in the following table:

Overall mobility of students that completed their Ph.D.

Ph.D. program cycle	Students gone abroad	Total number of students	Average months abroad	Min. months abrod	Max. months abroad
XXI	22	30	4.7	1	12
XXII	16	30	10.4	4	18
XXIII	23	33	8.7	4	18

4 CONCLUSIVE ANALYSIS

4.1 Vocational and Academic Recruiting

The data concerning the professional career of Doctors graduated at our Ph.D. School are obtained mainly through contacts maintained by supervisors, as the University of Padova lacks any kind of Alumni Service. As such, they are only partial and with a certain degree of uncertainty.

We could examine the position of 43 Doctors that graduated in 2008, 2009 and 2010 one year after the conclusion of their Ph.D. program. The results are summarized in Fig. 15: a large fraction of the Doctors (21 out of 43) found a post-doctoral position in the Academia, another 8 in public or private Research Institutes. About 25% of the Doctors have found a position in the ITC industry, but this figure might be underestimated considering the data collection method (contact between Doctors and their former Ph.D. supervisors is normally more easily maintained in case of academic post-doc positions). Finally, two Doctors have contributed to the creation of a spin-off stemming from a research project carried on during their Ph.D. program.
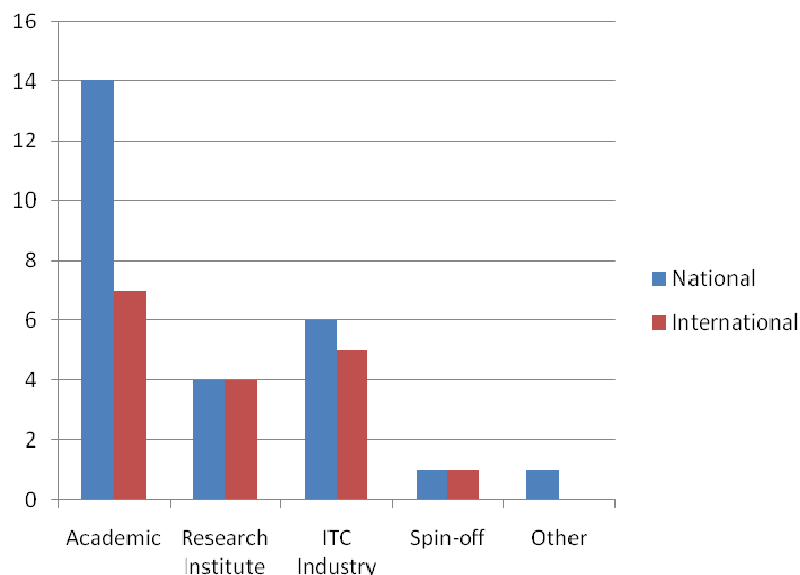

Fig. 15 Ph. Doctors working position one year after graduation.