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The Science Training Program for Young Italian Physicists and Engineers at Fermilab

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Since 1984 Fermilab has been hosting a two-month summer training program for selected undergraduate and graduate Italian students in physics and engineering. Building on the traditional close collaboration between the Italian National Institute of Nuclear Physics (INFN) and Fermilab, the program is supported by INFN, by the DOE and by the Scuola Superiore di Sant'Anna of Pisa (SSSA), and is run by the Cultural Association of Italians at Fermilab (CAIF). This year the University of Pisa has qualified it as a "University of Pisa Summer School", and will grant successful students with European Supplementary Credits. Physics students join the Fermilab HEP research groups, while engineers join the Particle Physics, Accelerator, Technical, and Computing Divisions. Some students have also been sent to other U.S. laboratories and universities for special trainings. The programs cover topics of great interest for science and for social applications in general, like advanced computing, distributed data analysis, nanoelectronics, particle detectors for earth and space experiments, high precision mechanics, applied superconductivity. In the years, over 350 students have been trained and are now employed in the most diverse fields in Italy, Europe, and the U.S.

In addition, the existing Laurea Program in Fermilab Technical Division was extended to the whole laboratory, with presently two students in Master's thesis programs on neutrino physics and detectors in the Neutrino Division.

And finally, a joint venture with the Italian Scientists and Scholars North-America Foundation (ISSNAF) provided this year 4 professional engineers free of charge for Fermilab. More details on all of the above can be found below.

THE SCIENCE TRAINING PROGRAM FOR YOUNG ITALIAN PHYSICISTS AND ENGINEERS AT FERMILAB

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Abstract

The summer training program for Italian undergraduate and graduate students at the Department of Energy (DOE) laboratory of Fermilab (Batavia, Illinois, USA), which was described two years ago at this Conference [1, 2, 3], grew recently very significantly in scope. Support was granted by the Scientists and Scholars in North America Foundation (ISSNAF) to the Cultural Association of Italians at Fermilab (CAIF) for a two-month training program for young associates of the Italian Engineering Professional Order (CNI). These young professionals will profit from training in the most advanced technical R&D taking place at Fermilab. This new program started in 2013, when CAIF hosted just 1 engineer. In 2014, the program has been expanded to include 4 engineers. In the future, it has the potential to become a major component of the CAIF educational effort.

This extended program is rooted in the remarkable success of the summer training program for, at the time, undergraduate students in science. This program was started in 1984 by the Italian physicists of the Istituto Nazionale di Fisica Nucleare (INFN) collaborating in the Collider Detector experiment (CDF) at the Fermilab Tevatron proton-antiproton collider. In 1984 the program involved 4 physics students from Pisa University. This is to be compared to the 2014 program described in this paper, which includes 4 CNI engineers and 21 graduate and undergraduate students in physics and engineering, 2 of which are supported by ISSNAF and trained in Maryland at NASA's Goddard Space Flight Centre and at Stanford University.

Besides describing the 2014 training programs, detailed information is given on the student recruiting process, on the programs themselves and how the trainees' performance is evaluated.

Keywords: Education, technology, Physics, Engineering, accelerators, superconductivity.

1 FOREWORD

In this paper we review the past and describe the present training programs of Italian science students and young graduates at the Fermi National Accelerator Laboratory of the United States. The program started in 1984 with four undergraduate physics students from the University of Pisa. Now, thirty years later, we are managing 25 trainees including some post docs in engineering, who are distributed all over Fermilab as well as at some U.S. Space Science laboratories.

The program is now part of the extensive Fermilab educational effort. It is run by CAIF under the sponsorship of INFN and of the Italian Embassy in Washington. The emerged picture will hopefully induce interested colleagues in science education to repeat this experience elsewhere. We shall also suggest that in the future the Italian Minister of University and new sponsors would do well in supporting our program.

2 HISTORICAL BACKGROUND

Since 1984 the Italian groups of the Istituto Nazionale di Fisica Nucleare (INFN) performing experiments at the national DOE laboratory of Fermilab (Batavia, Illinois) have been running a two months summer training program for Italian students. For many years the program was motivated by the interest of the Italian groups of the Collider Detector (CDF) in raising students who would join their experiment. The CDF Italians were able to save enough money from their research funds for offering to a few students living conditions comparable to those of the students of the CERN summer training program. Under the management of the Cultural Association of Italians at Fermilab (CAIF, www-org.fnal.gov/caif/Home.html), the program was progressively expanded thanks to support from the American CDF groups, to include physics and engineering students of the Italian universities where a CDF group was active, i.e. Pisa, Padua, Rome, Trieste, Udine, Bologna. In 2004, the Italian groups' research budget was reduced while the potential students were increasing in number, and the groups could no longer afford the cost. As a result, the program was entering a dead end; however, the Italian Nuclear Research Institute (INFN) and the American Department of Energy (DOE) intervened and signed an exchange agreement according to which about 4 students would be supported yearly by DOE at Fermilab, while INFN would provide the same support to American students visiting INFN laboratories in Italy. Since then this support has been granted every year and has become the solid root around which a much wider program could grow. In 2007 an agreement was reached between the Scuola Superiore of Sant' Anna of Pisa (<http://www.sssup.it/>) and Fermilab for sharing yearly the support for four or more engineering students of the School. In 2009 the Italian Scientists and Scholars in North America Foundation (ISSNAF, <http://www.issnaf.org/>) was able to raise funds from Italian sponsors, primarily astrophysics and space research institutions. ISSNAF transferred funds to CAIF as needed to support training programs in the fields of interest of the sponsors. Accordingly, since then some students are being sent by CAIF to other labs for training in areas not covered

by the Fermilab mission. In 2014, one physics and one engineering ISSNAF-supported students have been sent by CAIF to Stanford University and to the Goddard Space Research Centre at CalTech (see Appendix A).

At all times the Fermilab groups have contributed to supporting their students, thus allowing expansion of the program beyond the limited DOE+SSSA+ISSNAF funds. Since the CDF Collaboration ended data-taking in 2011 and the physics analysis is rapidly getting to an end, the program is now included among the Fermilab educational programs run by the lab Education Office and the students are assigned to a wide spectrum of research and technical groups. Because of the several new experiments presently under construction at Fermilab, there are now many more engineering than physics students. Indeed, the 2014 program detailed in Appendix A includes 16 engineers and 9 physicists.

3 RECRUITMENT

3.1 Students

In January each year we announce the available grants with a number of posters and flyers, slightly different from one another depending on the sponsor, whereby some basic information is given to the applicants. CAIF members and friends take care of appending posters in a number of Italian Universities. As of now we have not been able to get this information distributed c/o the Italian Minister of University and Scientific Research. We shall continue shooting for this goal, which would allow for a much more efficient transfer of information to all universities.

The youngest undergraduate physics students are excluded by requesting students of the last year course of the triennial Laurea or of the “Laurea Magistrale” courses (equivalent to an American Masters degree). Similarly, the engineering students must be following their own Laurea Magistrale courses. The list of passed exams should be provided, and an average grade higher than 26/30 is requested. Computer science skills and good knowledge of English must be stated. Pre-selected candidates are informed that they will have to discuss their case in person or by a Skype meeting with representatives of CAIF and of the sponsors. Thorough interviews are performed by S. Donati, an extremely keen and well-honed evaluator. The selected students are made available as potential trainees in the months of August and September. Those for whom a good fit and work program are found within a Fermilab team will enter the USA with a J1 visa supported by the laboratory. Free housing and rental cars are provided besides a weekly salary, and some sponsors also cover the round trip journey to the U.S. and the health insurance. Their salary, however, is sufficient to allow even students who pay for their travel to cover all costs encountered in two months of stay.

In early spring CAIF members explore the available training programs at the lab, to be matched to the skills and interests of the trainees. Agreement is also found with outside labs for training students sponsored by Space Science agencies. In late spring the winners are selected. As a rule, their training period is from the end of July to the end of September.

3.2 Young Engineers

CAIF is hosting in the fall since last year a number of young professional engineers, proposed by the Italian Engineering Order (CNI, “Consiglio Nazionale degli Ingegneri”, <https://www.tuttoingegnere.it/PortaleCNI/>), for internships on advanced technologies in USA. In 2014 CNI granted ISSNAF with 22 two-month fellowships in various U.S. labs, out of which 4 were assigned to CAIF. During the year, we have asked the Fermilab groups, all-over Particle Physics (PPD), Accelerator (AD), Computing (CD) and Technical Divisions (TD), to propose training programs. 23 programs were offered to CNI. Their impressive list is given in Appendix B. Many young engineers applied to these programs, but only 4 could be funded by CNI. The winners were selected by CAIF according to their profiles. The 23 proposed programs indicate to potential sponsors the outstanding role offered by Fermilab as a tutoring Institution in science and technology. The four positions that have been assigned are highlighted.

3.3 Laurea Students

Based on the strong interest that a number of former Italian summer students showed to come back to the lab and continue their research, E. Barzi started in 1998 what later became an official thesis program for a Laurea Magistrale. Some students were invited back to the lab and employed again for a period of about 6 months, as needed for performing an adequate research program for their “Specialized Laurea”. Since 2009, she has been officially in charge of a TD Laurea Committee that assigns these contracts in the Technical Division. Although the funds made available have been rather limited and the program was

confined to that Division, 23 Italian engineering students, out of which 9 (highlighted in Appendix C) had been previously summer students, have been supported by the lab for their Laurea program. A number of them are now permanent employees. This shows how the laboratory had a significant return from this program.

Besides the above young Italian engineers trained with lab support, many physics summer students have been supported by the INFN groups for furthering their studies at Fermilab. In the period 2003-2011, 22 students have obtained their three-annual "Short Laurea" with the work done during their two month summer internship. Out of about 200 Italian physics students who got their Specialized Laurea and Ph. D.s within the CDF Italian research groups, about 50% were initially summer students. In the interest of the Italian students as well as those of the Laboratory [4], CAIF is now supporting the proposal for a substantial increase in funding for the lab Laurea program.

4 LOGISTICS

A key action item is contacting research groups and finding out which ones are interested in offering a training program to Italian students. It is essential to find a match between the profiles of the candidates and the interest of the groups. Only students matching an available training program are ultimately selected. The Fermilab Personnel Office is informed and e-mails the students the job offers needed to get the appropriate J1 entry visa.

Once the offer is accepted the students are responsible for requesting a J1 entry visa to an U.S. consulate in Italy. In addition, substantial paperwork is requested from the students by the Fermilab Visa Office. This includes accessing from Italy the FermiWorks website to complete an Onboarding process and filling a New Hire document. The rules for accessing the FERMI computing domain can also be followed from a distance, in order to gain access to the domain immediately upon arrival at the lab.

Upon arrival the students are instructed to get a limo from the Chicago airport to the lab, where they can pick up rented car and room keys. CAIF Members are around watching and making sure that the process proceeds smoothly.

On the first and the second day at the lab the students convene for an International Orientation session, where they must provide proof of admission and of medical insurance, and are instructed on traffic rules and life in the U.S., for instance how to open a bank account and get a Social Security number, and specifically on Fermilab policies. They are also instructed on how to get their work certified by their supervisor in order to get their weekly salary.

A twin mandatory concluding session must be followed shortly before departure at the end of the training period. There students are instructed on how to handle their bank account at later times, how to fulfil U.S. tax regulations and how to adhere to the J1 visa conditions when coming back to the U.S.

Although this bureaucracy may scare the students at the beginning, experience shows that they are able to learn quickly to fulfil all the requests, and that in a few days they are able to work efficiently in their groups, who are responsible for assigning to them adequate office space and computing power.

Since at the end of July not enough laboratory dorms may be available to accommodate all students, some may be initially housed in nearby hotels. Within a couple of weeks, however, they return to the lab dorms. Accommodation on the lab site is very convenient for saving time, working more efficiently and living comfortably at the same time.

5 WORK PROGRAMS

The training programs span a very wide range of science and technology. The programs assigned in 2014 are listed in Appendix A. For physicists, they address analysis of experimental data in particle physics and astrophysics, setting-up of particle detectors, particle accelerator theory. For engineers, they include fast digital electronics, design of detectors and of accelerator components, superconducting materials and magnets, high precision mechanics, advanced computing. Students make extensive use of advanced computation means and programming languages, as C, C++, and Java, and apply advanced CAD and technical tools for mechanics and electronics design (MatLab, OrCAD, etc.). Physicists develop significant knowledge in statistical data analysis (Root). Work is performed within projects, programs and experiments like CDF, Nova, Mu2e, DESI, Muon g-2, General Accelerator R&D and CMS.

The student is integrated as much as possible in his or her research group and is encouraged to interact with as many colleagues as needed in addition to his or her supervisor. The supervisor meets his or her student on an individual basis, with meetings held at least once per week, mostly because of the

outstanding productivity of these students. The students also participate in standard meetings, where they often present their results to their group to discuss them in an ampler professional environment.

All students are requested to give a mid-term oral presentation and to write a technical report at the end of their stay. These documents are stored in the Education Office web archive. They illustrate the quality of the work, and can be easily accessed at <http://eddata.fnal.gov/lasso/summerstudents/view.lasso>.

6 ENDORSEMENTS AND SPONSORSHIPS

The high quality of the CAIF student training programs was acknowledged in 2012 by INFN with the assignment of the Institute logo and with an annual donation. In 2013 the Italian Washington Embassy also authorized CAIF to make use its logo and requested CAIF to be sponsored by the Italian Minister of University and Scientific Research.

7 SUMMARY

A voluntary, self-managed education program started long ago by a few Italian physicists engaged in a particle physics experiment in the U.S. has turned into a solid, multi-disciplinary program bringing dozens of bright young undergraduate and graduate physicists and engineers to learn and contribute in high-tech research in the U.S. every year. The following Table summarizes the student statistics for the last few years.

Year	Applicants	Accepted	INFN and FNAL groups	SSSA	ISSNAF	CNI	No. Physicists	No. Engineers
2008	60	20	14	6			12	8
2009	60	22	18	4			9	13
2010	230	24	18	2	4		16	8
2011	100	27	18	4	5		19	8
2012	110	21	12	5	4		10	11
2013	100	23	15	4	3	1	11	12
2014	100+	25	15	4	2	4	9	16

Over the thirty years of its life, about 400 students have taken part in the program. Stimulated by the enthusiastic reports of their students, Italian universities now convey a strong feeling of appreciation for this program.

APPENDIX A – SUMMER STUDENT TRAINING PROGRAMS IN 2014

7.1 Engineering Program

- 1) Martina Benvenuti – Electronic Eng., Pisa University, "FPGA based digitizer for Mu2e, Part-A", Supervisor Vadim Rusu, Particle Physics Division - Fermilab
- 2) Gabriele Meoni – Electronic Eng., Pisa University, "FPGA based digitizer for Mu2e, Part-B", Supervisor Vadim Rusu, Particle Physics Division - Fermilab
- 3) Enrico Beghini – Mechanical Eng., SSSA (Pisa), "Optimization of the T-Tracker Detector Mechanical Structure for Mu2e", Supervisor Giuseppe Gallo, Particle Physics Division - Fermilab
- 4) Luca Cesaretti – Mechanical Eng., SSSA (Pisa), "Development and optimization of conceptual design of ADCs Rotating Mechanism for DESI", Supervisor Gaston Gutierrez, Particle Physics Division - Fermilab
- 5) Paola Mazzotta – Industrial Eng., Lecce University, "Mu2e TS Magnet support rod analysis", Supervisor Mauricio Lopes, Technical Division - Fermilab
- 6) Mattia Duranti – Energy Eng., SSSA (Pisa), "Analysis of superconductors mechanical degradation due to quench heating", Supervisor T. Shen, Technical Division - Fermilab
- 7) Pietro Peronio – Electronic Eng., Milan Polytechnics, "Testing of the new VIPIC chip for X photon counting applications", Supervisor Grzegorz Deptuch, Particle Physics Division - Fermilab

8) Gianluca Nicosia – Electronic Eng., Milan Polytechnics, "Magnetic field measurement system based on rotating PCB coils", Supervisors Joe DiMarco, Technical Division - Fermilab

9) Lorenzo Andrea Parrotta – Mechanical Eng., SSSA (Pisa), "Conceptual design of a 20 Tesla High Field Dipole Magnet for GARD", Supervisor Emanuela Barzi, Technical Division - Fermilab

10) Alfredo Nardi – Electronic Eng., Pisa University, "VIPIC: a 3D Read Out Chip at the Fermilab Test Beam Facility", Supervisor Alan Prosser, Computing Division - Fermilab

11) Alessio Balsini – Electronic Eng., Pisa University, "Extending On-Demand Services to Public Clouds", Supervisor Gabriele Garzoglio, Computing Division - Fermilab

12) Federico Patota – Robotic Eng., University of Roma La Sapienza, ISSNAF-ASI, "Investigate the application of robotic motion planning algorithms to space craft control", Stanford University, supervisor Marco Pavone, Director, Autonomous Systems Laboratory, Department of Aeronautics and Astronautics, Stanford University.

7.2 Physics Program

1) Andrea Isgro' – Milan University, "W charge asymmetry at CDF", Supervisor Willis Sakumoto, Particle Physics Division - Fermilab

2) Ludovico Capparelli – University of Roma La Sapienza, "G-2 lost muon study", Supervisor Adam Lyon, Particle Physics Division - Fermilab

3) Marco Del Tutto – University of Roma La Sapienza, "Beam simulations & target studies for the NOvA experiment using G4NuMI", Supervisor Giulia Brunetti, Particle Physics Division - Fermilab

4) Raffaella Donghia – University of Roma III, "Mu2e calorimeter calibration using DIO electrons", Supervisors Pasha Murat, Particle Physics Division - Fermilab

5) Ciro Riccio – Napoli University, "Nu_e identification in the NOvA near detector events", Supervisor Xuebing Bu, Particle Physics Division - Fermilab

6) Andrea Sciandra – University of Roma III, "Evidence for low pt D+ production in the 900 GeV Run of CDF", Supervisor Luciano Ristori, Particle Physics Division - Fermilab

7) Marco Chiappini – Pisa University, "Calibrating the Mu2e Tracker Momentum Scale Using DIOs at 0.5 Tesla", Supervisor Pasha Murat, Particle Physics Division - Fermilab

8) Irene Nutini – University of Florence, "Scintillation light collection with SiPM and Artg4tk simulations for interactions in Liquid Argon (LArIAT)", Supervisors Flavio Cavanna, Jennifer Graf, Particle Physics Division - Fermilab

9) Michela Negro – Torino University, ISSNAF-ASI, "Research on the Fermi Gamma Ray Space Telescope", supervisor Julie McEnery, Co-Director of Joint Space Science Institute of Maryland, Caltech Goddard Space Flight Centre.

APPENDIX B – OFFERED FERMILAB INTERNSHIPS TO CNI ENGINEERS

1) **ASSIGNED** to Claudio Pontili, Computing Eng. – Development of advanced distributed GRID/CLOUD computing, Gabriele Garzoglio, Steven Timm supervisors, Computing Division.

2) Development of low-noise electronics for astrophysics experiments, Gustavo Canelo supervisor, Electronic Department of the Computing Division. One opening for an electronic engineer preferably in fall 2014.

3) Creating and integrating new methods for accessing and delivering large data sets for distributed physics analysis. Andrew Norman, Marc Mengel supervisors, Scientific Data Processing Department of the Computing Division. One opening for a computing engineer in summer and/or in fall 2014.

4) Work in the team of software professionals of the Fermilab Computing Center of the CMS experiment at the LHC of CERN, to develop distributed monitoring of on-going data analysis in the world-wide grid and to improve the processing infrastructures of the Center. Oliver Gutsche, Dave Mason supervisors, Scientific Data Processing Department of the Computing Division. One opening for a computing engineer in summer and/or in fall 2014.

- 5) Evaluation of the mechanical accuracy achievable in the muon transport system of the Mu2e experiment, Rodger Bossert supervisor, Magnet System Department of the Technical Division. One opening for a mechanical engineer in summer 2014.
- 6) Simulation and construction of a prototype Nb₃Sn superconducting helical solenoid for the Mu2e experiment, Mauricio Lopes supervisor, Magnet System Department of the Technical Division. One opening for a mechanical engineer in summer 2014.
- 7) Electrical modeling of toroid magnet coils and measurement and analysis of performances of dipole magnet prototypes for the Mu2e experiment at Fermilab, Luciano Elementi supervisor, Magnet Systems Department of the Technical Division. One opening for an electronic engineer in summer 2014.
- 8) Development of strain-resistant Nb₃Sn superconducting strand and cables for applications in high field magnets, and electro-mechanical modeling of composite and anisotropic materials in the plastic regime, Emanuela Barzi supervisor, Superconducting Strand and Cable Group of the Technical Division. One opening for a mechanical engineer in summer and/or in fall 2014.
- 9) Construction of a ultra-high frequency spectrometer based on Cesium Iodide (CsI) to measure the Tera-Hz spectrum of a pico-second-electron beam, Vic Scarpine, Randy Thurman-Keup, Jayakar Thangaraj supervisors, Beam Instrumentation Department of the Accelerator Division. One opening for a mechanical/optical engineer in summer 2014.
- 10) Ceramic beam tube resistive coating R&D, Linda Valerio supervisor, Mechanical Support Department of the Accelerator Division. One opening for a Mechanical Engineer and/ or a Material Scientist in summer (preferred) or in fall 2014.
- 11) Construction and commissioning of a Titanium-sapphire multi-pass amplifier of a laser source, for studies of laser-induced particle beams acceleration, Philippe Piot supervisor, Experimental Beam Physics Department of the Accelerator Physics Center. One opening for a photonics-engineering or/and electrical-engineering in fall (preferred) or in summer 2014.
- 12) Simulation of the electron beam transport through the linac of the Advanced Superconducting Test accelerator ASTA of the Accelerator Physics Center, Jayakar Thangaraj supervisor. One opening for a computing engineer in summer 2014.
- 13) **ASSIGNED** to Giorgio Fasce, Electrical Eng. – Design of a gas-filled RF cavity for large-acceptance muon beam ionization cooling, Katsuya Yonehara supervisor, Muon Accelerator Department of the Accelerator Physics Center.
- 14) Development and production of materials for applications in improved scintillation detection, Anna Pla-Dalmau supervisor, Detector Development and Fabrication Department of the Particle Physics Division. One opening for a chemical or materials engineer in fall 2014.
- 15) Development of an increased sensitivity photo-detector for an optimized veto of cosmic ray muons for the Mu2e experiment, Paul Rubinov supervisor, Electrical Engineering Department of the Particle Physics Division. One opening for an electronic engineer in summer or in fall 2014.
- 16) Development of warm electronics for the CDMS detectors, Sten Hansen supervisor, Electrical Engineering Department of the Particle Physics Division. One opening for an electronic engineer in fall 2014.
- 17) Tests of three-dimensional integrated circuits bonded to pixelated sensors, Grzegorz Deptuch, Ron Lipton supervisors, Electrical Engineering Department of the Particle Physics division. One opening for an electrical engineer in summer or in fall 2014.
- 18) Testing of Application Specific Integrated Circuits (ASIC) bonded to high sensitivity single photon detection sensors, Farah Fahim supervisor, Electrical Engineering Department of the Particle Physics division. One opening for an electronic engineer in fall 2014.
- 19) Design of the cooling system of the upgraded cryogenic distillation column to separate Argon from an Argon/Nitrogen mixture, David Montanari supervisor, Mechanical Engineering Department of the Particle Physics Division. One opening for a cryogenic/thermal engineer in summer 2014.
- 20) Design of new gas distribution system for the upgraded cryogenic distillation column at PAB to separate Argon from an Argon/Nitrogen mixture, David Montanari supervisor, Mechanical Engineering Department of the Particle Physics Division. One opening for a mechanical engineer in summer 2014.
- 21) **ASSIGNED** to Martina Pagnani, Mechanical Eng. – Development of the mechanical structure for the calorimeter of the Mu2e experiment, Matteo Martini supervisor, Mu2e Group, Particle Physics Division.

22) Development of the front-end electronics for the calorimeter of the Mu2e experiment, Fabio Happacher supervisor, Mu2e Group, Particle Physics Division. One opening for an electronic engineer in summer or in fall 2014.

23) **ASSIGNED** to Lisa Favilli, Civil Eng. – Design and construction of facilities and equipment to support the LBNE neutrino experiment at Fermilab and at the Sanford Underground Research Facility located in Lead, South Dakota (SURF), Tracy Lundin supervisor, LBNE Department of the Neutrino Division.

APPENDIX C – LAB-SUPPORTED ENGINEERING LAUREAS AS OF 1999

1) Cristian Boffo, **former summer student** – Mechanical Eng., University of Udine, 1999: Magnetization Measurements at 4.2K of Multifilamentary Superconducting Strand, Prof. G. Pauletta, E. Barzi Advisors - TD (**originally hired at Fermilab**, later at Babcock Noell GmbH, Germany)

2) Michela Fratini – Nuclear Eng., Pisa University, 2002: A Device to Test Critical Current Sensitivity of Nb₃Sn Cables to Transverse Pressure, Prof. C. Angelini, Prof. F. Fineschi, E. Barzi Advisors - TD (originally was offered a contract at CEA/Saclay, then hired at ENEL, Italy)

3) Sara Mattafirri – Nuclear Eng., Pisa University, 2002: Kinetics of Phase Growth during the Cu-Sn Diffusion Process and the Nb₃Sn Formation. Optimization of Superconducting Properties, Prof. C. Angelini, Prof. F. Fineschi, Prof. S. Lanza, E. Barzi, J.M. Rey Advisors - TD (originally hired at LBNL, later at Nuovo Pignone, Florence)

4) Licia Del Frate – Nuclear Eng., Pisa University, 2004: Design of a Low Resistance Sample Holder for Instability Studies of Superconducting Wire, Prof. C. Angelini, Prof. F. Fineschi, Prof. S. Lanza, E. Barzi Advisors - TD (was offered a contract at Fermilab, then hired as a Ph.D. student at Pisa University, now in industry, Italy)

5) Vito Lombardo – Computing/Automation Eng., Sant' Anna School (Pisa), 2007: Automation of Short Sample Facility for Critical Current and Low Field Instability Measurements of Superconducting Strands at Cryogenic Temperatures, Prof. M. Innocenti, Prof. L. Pollini, E. Barzi, D. Turrioni Advisors - TD (**hired at Fermilab**)

6) Marco Danuso, **former summer student** – Mechanical Eng., Sant' Anna School (Pisa), 2008: Parametric Analysis of Forces and Stresses in Superconducting Magnets Windings, Prof. M. Beghini, E. Barzi, A. Zlobin Advisors - TD (hired at Finmeccanica, Italy)

7) Gabriella Norcia, **former summer student** – Mechanical Eng., Pisa University, 2009: Design of Modular Test Facility for HTS Insert Coils, Prof. M. Beghini, E. Barzi Advisors - TD (hired at Ansaldo, Italy)

8) Giuseppe Gallo – Mechanical Eng., Pisa University, 2010: Mechanical Modeling of Superconducting Rutherford-type Cable Fabrication, Prof. M. Beghini, Prof. L. Bertini, E. Barzi Advisors - TD (**hired at Fermilab**)

9) Antonio Bartalesi – Mechanical Eng., Pisa University, 2010: Design of High Field Solenoids made of High Temperature Superconductors, Prof. M. Beghini, E. Barzi Advisors - TD (originally was offered a contract at Fermilab, then moved to CERN)

10) Alessandro Quadrelli, **former summer student** – Electrical Eng., Pisa University, 2010: Automated Control of the Tuning of Superconducting RF Cavities, Mirko Marracci, Franco Bedeschi Advisors (Warren Schappert supervisor) - TD

11) Matteo Scorrano, **former summer student** – Electronic Eng., Pisa University, 2010: Development of a Control System for Superconducting Cavities with Fast Tuners, Giovanni Pennelli, Franco Bedeschi Advisors (Youri Pischnikov supervisor) - TD

12) Simone Moio, **former summer student** – Physics Eng., Turin Polytechnics, 2011: Effect of Subelement Size, RRR and Strand Size on Stability of RRP Nb₃Sn Strands, Prof. R. Gonnelli, E. Barzi Advisors - TD (hired at Magneti Marelli, Italy)

13) Donato Passarelli – Mechanical Eng., Pisa University, 2011: Analysis of the mechanical behavior of the Superconducting Single Spoke Resonator type 1 in tests at cryogenic temperature, Prof. M. Beghini, L. Ristori Advisors - TD (**hired at Fermilab** and Ph.D. student at Pisa University)

- 14) Federico Puccinelli – Mechanical Eng., Pisa University, 2011: Detector support structure and installation system for the Mu2e experiment, Prof. Marco Beghini, Sandor Feher, Rodger Bossert Advisors - TD
- 15) Paolo Berrutti – Physics Eng., Turin Polytechnics, 2011: Radio frequency design and optimization of the low-medium-beta section for a 3 GeV linear particle accelerator, Prof. Gianni Coppa, Slava Yakovlev Advisors - TD (**hired at Fermilab**)
- 16) Andrea Pisoni – Physics Eng., Milan Polytechnics, 2012: Implementation of Nano Scale Formations in A15 Brittle Superconductors, Prof. R. Bertacco, E. Barzi, T. Rajh Advisors - TD (hired as a Ph.D. student at University of Lausanne)
- 17) Giulia Collura, **former summer student** - Electronic Eng., Turin Polytechnics, 2012: Beam Test of a High Pressure RF Cavity for the Muon Collider, Prof. Felice Iazzi Advisor (Alvin Tollestrup Supervisor) - AD
- 18) Pietro Giannelli – Electronic Eng., Turin Polytechnics, 2012: Design of a Signal Conditioner for the Fermilab Magnet Test Facility, Prof. Marco Parvis Advisor (Darryl Orris Supervisor) - TD
- 19) Vincenzo Li Vigni – Electronic Eng., Palermo University, 2012: Design and testing of a digital regulator for Fermilab magnet power systems, Prof. Giuseppe Capponi, Valeria Boscaino, Andrzej Makulski Advisors - TD
- 20) Silvia Zorzetti, **former summer student** - Electronic Eng., Pisa University, 2013: Development of the world's first digital direct-current current transformer (DCCT) to measure particle beam intensities, Prof. Luca Fanucci, Manfred Wendt Advisors - AD (hired as a Ph.D. student at Pisa University/CERN)
- 21) Matteo Grandini – Mechanical Eng., Pisa University, 2014: Design of a liquid helium transfer line support system, Prof. Bernardo Disma Monelli, Thomas Page Advisors - TD
- 22) Federico Reginato, **former summer student** – Physics Eng., Milan Polytechnics, 2014: Electrochemical Synthesis of Nb-Sn Coatings for High Field Accelerator Magnets, Prof. Silvia Franz, E. Barzi Advisors - TD
- 23) Andrea Palagi – Mechanical Eng., Pisa University, 2014: ASME Verification and Pressure Sensitivity optimization of the Cryostat of the 1.3 GHz Cavity, Prof. Marco Beghini, Prof. Leonardo Bertini, Allan Rowe Advisors - TD

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