



## Progress of the Italian Summer Students Program at Fermi National Accelerator Laboratory

E. Barzi<sup>1</sup>, G. Bellettini<sup>2</sup>, S. Donati<sup>3</sup>, C. Luongo<sup>4</sup>,

### Abstract

*In this paper we describe the 9-week training program of Italian physics and engineering students and young graduates at the Fermi National Accelerator Laboratory of the United States. The program started in 1984 with 4 undergraduate physics students from the University of Pisa. Now, more than thirty years later, each year we are managing on average 30 trainees, who are distributed all over Fermilab as well as at some US Space Science laboratories. The program is now part of the extensive Fermilab educational effort and is a summer course of the University of Pisa, which acknowledges 6 ECTS to the interns. It is run by the Cultural Association of Italians at Fermilab under the sponsorship of Italian National Institute of Nuclear Physics and of the Italian Embassy in Washington. Detailed information is given on the students' recruiting process, on the training programs and on how the trainee's performance is evaluated. The success of our endeavour may suggest to colleagues interested in science education to repeat this experience elsewhere.*

**Keywords:** education, technology, physics, engineering, accelerators

### 1. 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 2-month summer training program for Italian students [1]. 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 could save enough money from their research funds for offering for two months 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), support was provided also by the American CDF groups who hosted physics students of the Italian universities where a CDF group was active.

After completion of the upgraded CDF detector in 2004, the CDF budget was significantly reduced by INFN. The Italian groups could no longer afford covering the cost. As a result, the program was getting to a dead end. However, INFN and 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. In 2007 an agreement was reached between the School of Advanced Studies of Pisa (SSSA) and Fermilab for sharing yearly the support for 4 engineering students of the School. In 2009 the Italian Scientists and Scholars in North America Foundation (ISSNAF) was able to raise funds from Italian sponsors, for training students primarily in astrophysics and space research institutions (INAF and ASI). 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.

At all times the Fermilab groups have contributed to supporting their Italian 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, within the Fermilab educational program the students are now assigned by CAIF to a wide spectrum of research and technical groups.

### 2. Recruitment

In January each year we announce the available grants with a number of posters and flyers. The list of qualified applicants is limited to physics and engineering students following the last year course of the triennial Laurea or the "Laurea Magistrale" courses (equivalent to an American Master degree).

<sup>1</sup> Fermi National Accelerator Laboratory and Ohio State University, United States

<sup>2</sup> University of Pisa and Istituto Nazionale di Fisica Nucleare, Italy

<sup>3</sup> University of Pisa and Istituto Nazionale di Fisica Nucleare, Italy

<sup>4</sup> Istituto Nazionale di Fisica Nucleare, Italy



The program is international. Non-Italian students are accepted within rules that define equivalent qualifications as for Italians. Computer science skills and good knowledge of English must be stated in the application, to be later checked in the interview. Thorough interviews are performed with great care. The profiles of the qualified students are made available to the potential supervisors who indicate those best suited for their program. 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. Their salary 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. 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.

## **2.2 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. 23 students were invited back to the lab and employed again for a period of about 6 months for their Laurea Magistrale. A number of them are now permanent employees. 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 PhD within the CDF Italian research groups, about 50% have been initially summer students.

## **3. Logistics**

A key action item is contacting research groups and finding out which ones are interested in offering a training program to Italian students. Only students matching an available training program are selected. In order to reach a consistent picture, in springs CAIF sends the list of the qualified candidates to the supervisors and in turn informs the students of the available programs. By exchanging questions and information between students and supervisors, the list of accepted students can be created. The Fermilab Personnel Office is informed and e-mails are sent to the winners with 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 to the students by the Fermilab Visa Office.

Upon arrival to the Chicago airport, students are instructed to get a limo to the lab, where they can pick up rental car and are instructed on how to reach their accommodation. On their first workday at the lab the students are convened for an Orientation Session, where they are asked to provide proof of admission to USA and show a medical insurance. They are introduced to their supervisors who are responsible for assigning them adequate office space and access to computers. Finally, they are instructed on how to get their work certified weekly by their supervisor as a condition for being timely paid.

A final session must be attended shortly before departure at the end of the training period. There students are instructed on how to fulfil U.S. tax regulations and how to adhere to the J1 visa conditions when coming back to the U.S.

Experience shows that students are able to learn quickly and fulfil all requests, and that in few days they are able to work efficiently.

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 few weeks, however, all students return to lab dorms. Accommodation on the lab site is very convenient for saving time, working more efficiently and living comfortably at the same time.

## **4. Work programs**

The training programs span a very wide range of science and technology. For physicists, they include analysis of experimental data, set-up particle detectors, test of particle accelerator components. Programs for engineers include design of fast digital electronics, of detectors and of accelerator components, test of superconducting materials and magnets, high precision mechanics, advanced computing. Students make 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).



This work is performed within projects, by analysing data from experiments like CDF, Nova, Mu2e, DESI, Muon g-2, MicroBooNE, SBND, ICARUS, 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 possible, well beyond their supervisor. The supervisor should meet his or her student personally at least once per week in order to ensure the best productivity of the trainee. The students also participate in group meetings, where they present and discuss their results in a wide professional environment.

All students are requested to give a mid-term and a final 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 can be easily accessed at <http://eddata.fnal.gov/lasso/summerstudents/view.lasso> and can be consulted to illustrate the excellence of the program.

#### **4.2 Internships funded by the Italian Space Agency (ASI) and National Institute of Astrophysics (INAF)**

In 2010 ASI and INAF started providing financial support to CAIF for 2-month internships in US space science laboratories, similarly to the Fermilab program. Students' selection is made by CAIF members in collaboration with INAF or ASI personnel. As of now, host institutions in US have included the NASA Goddard Space Flight Center, the NaSA Jet Propulsion Laboratory in Pasadena, Stanford University, Columbia University in New York, the SLAC National Accelerator Laboratory.

### **5. Growing involvement at European level**

#### **5.1 The University of Pisa Summer School**

In 2015 an ad-hoc summer course was approved at the University of Pisa to provide an academic framework to the Fermilab program. Interns are enrolled for the 9-week duration of the internship. Upon successful completion of the internship with an accurate final report and an oral interview, they are acknowledged 6 ECTS in their Diploma Supplement.

#### **5.2 Outreach effort of EU projects**

In 2016 the Fermilab internship program has become part of the outreach activities of two European Projects, MUSE "Muon Campus in US and Europe contribution" (H2020-MSCA-RISE-2015, GA 690835), and NEWS "New WindowS on the Universe and technological advancements from trilateral EU-US-Japan collaboration" (H2020-MSCA-RISE-2016, GA 734303). INFN coordinates both European Projects.

<b>Year</b>	<b>Accepted</b>	<b>INFN &amp; FNAL groups</b>	<b>SSSA</b>	<b>ASI</b>	<b>INAF</b>	<b>CNI</b>	<b>No. Physicists</b>	<b>No. Engineers</b>
2008	20	14	6				12	8
2009	22	18	4				9	13
2010	24	18	2	2	2		16	8
2011	23	17	4		2		16	7
2012	21	14	5	2			10	11
2013	23	16	4	2		1	11	12
2014	25	15	4	2		4	9	16
2015	35	28	3	3		1	17	18
2016	40	33	4	3			21	19
2017	30	24	3	3			15	15

Table 1: STUDENTS STATISTICS IN THE YEARS 2008-2017. NUMBERS OF ACCEPTED STUDENTS ARE SEPARATED CORRESPONDINGLY TO THE SOURCES OF FINANCIAL SUPPORT.



## 6. 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 multi-disciplinary program bringing dozens of undergraduate physicists and engineers to contribute in high-tech research in the U.S. every year. Over the 35 years of its life, more than 500 students have taken part in the program. Table 1 reports the statistics relative to the programs of the last 10 years.

## Acknowledgements

This work was supported by the EU Horizon 2020 Research and Innovation Programme under the Marie Skłodowska-Curie Grant Agreement No. 690835.

## References

- [1] Donati, S., et al., "The Italian Summer Students Program at the Fermi National Accelerator Laboratory", European Physical Society Conference on High Energy Physics, Venice, Italy, 5-12 July 2017, 3 pages.