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Involving the new generations in Fermilab endeavors

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Abstract. Since 1984 the Italian groups of the Istituto Nazionale di Fisica Nucleare (INFN) and Italian Universities, collaborating with the DOE laboratory of Fermilab (US) have been running a two-month summer training program for Italian university students. While in the first year the program involved only four physics students of the University of Pisa, in the following years it was extended to engineering students. This extension was very successful and the engineering students have been since then extremely well accepted by the Fermilab Technical, Accelerator, and Scientific Computing Division groups. Over the many years of its existence, this program has proven to be the most effective way to engage new students in Fermilab endeavors. Many students have extended their collaboration with Fermilab with their Master's Thesis and PhD. Since 2004 the program has been supported in part by DOE in the frame of an exchange agreement with INFN. Over its almost 40 years of history, the program has grown in scope and size and has involved more than 550 Italian students from more than 20 Italian Universities, Several Institutes of Research, including ASI and INAF in Italy, and the ISSNAF Foundation in the US, have provided additional financial support. Since the program does not exclude appropriately selected non-Italian students, a handful of students from European and non-European Universities were also accepted over the years. Each intern is supervised by a Fermilab Mentor responsible for performing the training program. Training programs spanned from Tevatron, CMS, Muon (g-2), Mu2e, and Short Baseline Neutrino Experiments and DUNE design and experimental data analysis, development of particle detectors (silicon trackers, calorimeters, drift chambers, neutrino and dark matter detectors), design of electronic and accelerator components, development of infrastructures and software for exascale data handling, research on superconductive elements and on accelerating cavities, and theory of particle accelerators. Since 2010, within an extended program supported by the Italian Space Agency and the Italian National Institute of Astrophysics, a total of 30 students in physics, astrophysics, and engineering have been hosted for two months in the summer at US space science Research Institutes and laboratories. In 2015 the University of Pisa included these programs within its educational programs. Accordingly, Summer School students are enrolled at the University of Pisa for the duration of the internship and are identified and ensured as such. At the end of the internship, the students are required to write summary reports on their achievements. After positive evaluation by a University Examining Board, interns are acknowledged credits for their Diploma Supplement. The program was canceled in 2020 and 2021 due to

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the pandemic but restarted successfully in 2022. We believe this program can be taken as a model and easily adopted by interested institutions.

1 Introduction

Internship programs have become increasingly popular in recent years, as both employers and students recognize the benefits that they offer. For employers, internships can be a valuable way to identify and recruit top talent, while for students, internships can provide real-world experience and help them develop their skills.

The Italian Summer Students Program at Fermilab has been breaking ground since 1984 by selecting students and matching them with top research programs. The Cultural Association of Italians at Fermilab (CAIF) has always provided a strong grassroots support for the program with many volunteers. Key differentiating factors of this program are its long history, the international scope, and the attention put into the selection and the matching of the students based on the training programs. This paper will provide a detailed description of the program, which can be taken as a model that can be easily adopted by interested Laboratories. The next section will give information on the student recruiting methods, and then we will talk about the training programs of recent years, the students' onboarding, life on campus, and the final students' evaluation process at Fermilab and at the University of Pisa. We will provide also some statistics and talk about present and future expansions of the program.

2 Students' recruitment

In January the internship program is advertised with posters and flyers, on the web, and in most Italian Universities, whereby some basic information is given to the applicants. The youngest undergraduates are excluded by requesting students of the "Laurea Magistrale" courses from Italian universities and of the Master's degree from European universities. Basic computing skills and good knowledge of English are required. In early spring CAIF members inquire about the available training programs at the Fermilab, to be matched to the skills and interests of the trainees. One must find out which groups are interested in offering a training program for the students, get a clear description of the offered program, and secure the funding. Some programs are sponsored at the institutional level, some are sponsored directly by the research groups. It is essential to find a match between the profiles of the candidates and the interests of the groups. Only students matching an available training program are ultimately selected. Pre-screened candidates are informed that they will have to discuss their case in person or by Skype with representatives of CAIF and of the sponsors. Thorough interviews are performed. The selected students are introduced to the supervisors as potential trainees in April. We used to have more time to perfect matches and search for additional sponsorships, but the visa and access requirements became more complicated and require at least three months to complete. The supervisors make their best choice and conditional work offers are sent to the students. All these students are a good fit for at least one of the training programs proposed by a Fermilab team and have funding secured to cover the expenses. Some slots are covered at the institutional level, but research groups may sponsor additional students for an approximate cost of $9000. Finally, the students will enter the US with a J1 Visa for training in August and September. A timeline is visible in figure 1.

Free housing and shared rental cars are provided besides a weekly salary. Fermilab does not cover the round trip journey to the US and the health insurance. However, the salary is fully adequate to allow the students to cover the travel cost as well as all costs encountered

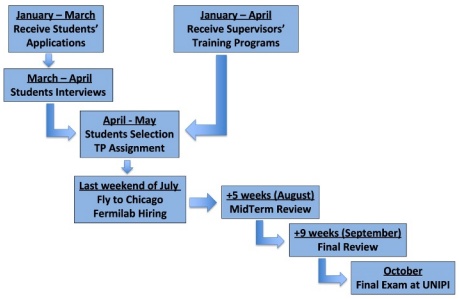

Figure 1. Important Actions/Dates

in the two months of their stay. CAIF negotiates agreements also with other laboratories and facilitates living arrangements for training the students sponsored by the Italian Space Science Agency (ASI). As for the Fermilab students, early in the year the available ASI fellowships (currently 3/year) and the support offered by CAIF are advertised, and in late spring the winners are selected. Their training period is from the end of July to the end of September. Figure 2 (Left) shows the number of students selected each year from 1984 to 2019 The programs of the years 2020 and 2021 were canceled and restarted with 21 students in 2022 and 27 expected for 2023. Figure 2 (Right) shows the students' universities. About 75% of the students come from the universities of Pisa, Rome, Milan, and Padova.

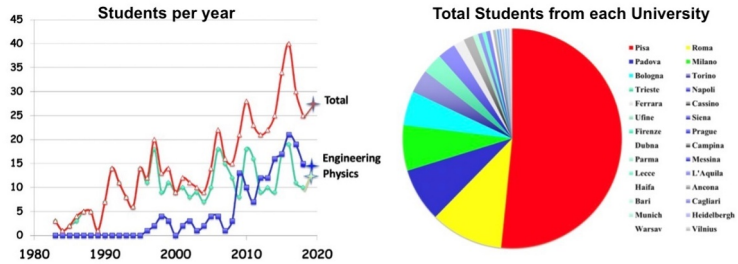

Figure 2. Program participation by sector and university. The blue curve represents the distribution of the engineering students, the green curve represents the distribution of the physics students and the red curve represents the total distribution. One notes an increased rate of engineering students in recent years, who are now as many as the physics students.

3 Logistics at Fermilab

Fermilab receives the list of the selected students, their supervisors, and all contact information. There are a number of offices involved: EDIA (Equity, Diversity, Inclusion, and Accessibility), which coordinates all internships, HR, and Global Services, which includes the Visa Office, Badging, and people vetting and approving visitors. All students are foreign nationals, so they require a J1 Visa to be employed as Fermilab interns. The Visa office helps the supervisors to prepare a training plan for the J1 petition. Then it sends the required job offer letter via email and supports the students with the Visa application. The students are responsible for getting their Visas, including providing all the required paperwork. From Italy

they have to access "FermiWorks", Fermilab's customization of the Workday Human Capital Management suite, to complete the onboarding process and fill a New Hire document. Finally, all students have to complete the access request, for Onsite Access and Computing Accounts, which may take four to six weeks. This includes steps like the Foreign National Access Program (FNAP). Once the students get computing access, they can start the mandatory training even before arriving physically at the Lab. All this should allow the students to gain site access and access to the desired computing resources right away when they arrive. CAIF has always coordinated informal and formal orientation sessions. Volunteers welcome the students and make sure that students' housing proceeds smoothly in the lab dorm or in nearby hotels. And on the first and the second day at the lab, the students convene for an International Orientation session with CAIF members and program organizers, where they are instructed on basic lab and US rules. This year Fermilab added an in-person onboarding session to provide information and perform the main safety training. Similarly, the students must attend a de-briefing session shortly before their departure at the end of the training period. Although this bureaucracy may worry the students at the beginning, experience shows that they can learn quickly to fulfill all the requests, and that in a few days, they are able to learn and work efficiently in their groups, which are responsible for assigning them adequate office space, computing resources, and lab equipment. CAIF continues to support the students throughout their stay, providing a support network when the unexpected happens and involving them in social activities like the celebration BBQ for students and supervisors.

4 Students' Training Programs

The training programs span a very wide range of science and technology. The students are integrated into their research groups and are encouraged to interact with as many colleagues as possible. The supervisors meet with their students on an individual basis, with meetings held at least once per week, to allow for mutual profit from the group and the students. The students also participate in collaboration meetings, where they present their results in a wide professional environment. For physicists, students address analysis of experimental data in particle physics and astrophysics, simulation and setting up of particle detectors, and particle accelerator theory. For engineers, the programs include fast digital electronics, design of detectors and accelerator components, superconducting materials and magnets, high precision mechanics, and advanced computing as well as civil engineering projects. Students make extensive use of advanced computing resources and programming languages, as Python, C, C++, and Java, and apply advanced CAD and other technical tools for mechanics and electronics design (MatLab, OrCAD, Ansys, etc.). Physicists develop knowledge in statistical data analysis (ROOT). At Fermilab work is performed within projects, programs, and experiments like Mu2e, Muon (g-2), NoVA, MicroBoone, LAriAT, Icarus, SBND, LBNF, DUNE, CDF, CMS, General Accelerator R&D, Quantum Systems, and Scientific Computing and Artificial Intelligence. Figure 3 shows the students' assignments to the Fermilab groups in 2018 and 2019. All students are requested to give midterm and final oral presentations and to write a technical report at the end of their stay. These documents are saved in Fermilab archives (e.g. Indico and DocDB). A few students contribute also to internal papers or scientific papers.

5 Internships at US Space Science Laboratories

Outside Fermilab, work is performed in astrophysics, space science, and technology. In 2010 ASI and INAF started providing financial support to CAIF for 2-month internships in US

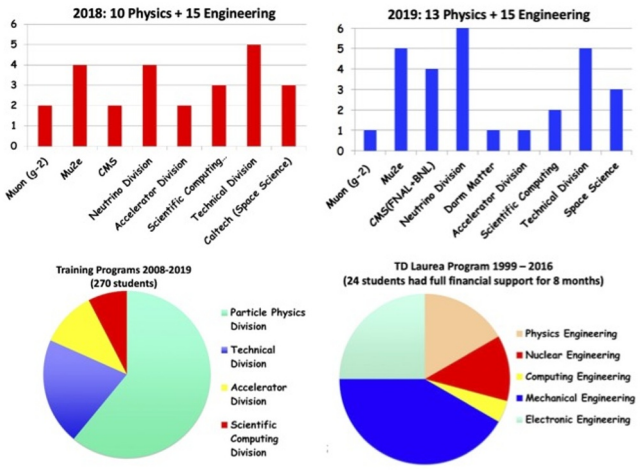

Figure 3. Students' assignments to the Fermilab groups in 2018 and 2019

space science laboratories, similarly to the Fermilab program. The students' selection is made by CAIF members in collaboration with INAF or ASI personnel. Figure 4 shows the distribution of the 30 students among US space science laboratories and universities.

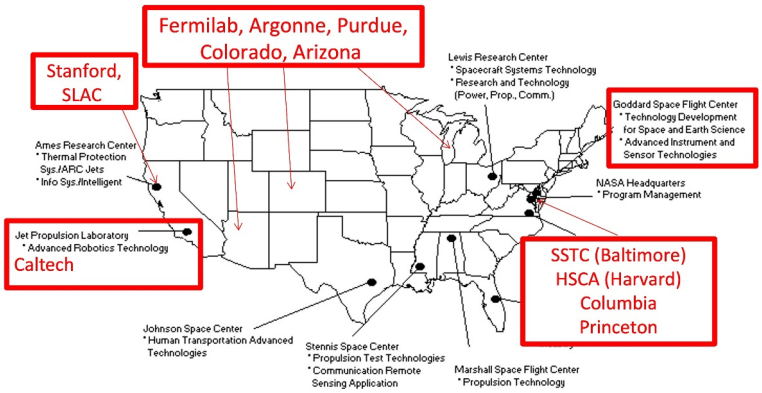

Figure 4. Space Science laboratories selected by the students for the INAF and ASI fellowships. ASI, INAF, INFN (ISSNAF, CAIF) supported 30 students outside Fermilab in 2010-2019

6 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 as University of Pisa students for the 9-week duration of the internship. They have a regular position as local students with

proper identification and insurance coverage. Upon successful completion of the internship with an accurate final report and an oral interview, they are acknowledged 6 European Credit Transfer and Accumulation System (ECTS) in their Diploma Supplement[2].

7 Growing involvement at European Level

The Fermilab internship program has become part of the outreach activities of European Projects coordinated by INFN and the University of Pisa. These are: MUSE "Muon Campus in US and Europe contribution"[3], NEWS "NEw WindowS on the Universe and technological advancements from trilateral EU-US-Japan collaboration"[4], INTENSE "INTENSE: particle physics experiments at the high intensity frontier, from new physics to spin-offs. A cooperative Europe – United States – Japan effort"[5], INTENSE "INTENSE: particle physics experiments at the intensity frontier. A cooperative Europe – United States effort"[6], and PROBES "Probes of new physics and technological advancements from particle and gravitational wave physics experiments. A cooperative Europe – United States – Asia effort[7].

8 Workshop at INFN National Laboratories of Frascati and Pisa

Due to the COVID-19 pandemic, we had to cancel the Summer Students Program for the years 2020 and 2021. To keep the connection between students and Fermilab alive, in August 2021 we organized a three-day workshop at the INFN National Laboratory of Frascati. A cohort of 20 students was hosted at the Laboratory and attended a series of seminars and lectures dedicated to Fermilab experiments. Given the good response, the three-day workshop in Italy has been kept even if the regular program restarted. In 2022 and 2023 all students went to Pisa at the end of July, shortly before departing for the USA, for three days filled with technical workshops with experts from INFN and Fermilab, and a visit to the Virgo detector at the European Gravitational Observatory.

9 Conclusions

A voluntary, self-managed education program started long ago by a few Italian physicists at INFN and the University of Pisa engaged in particle physics experiments at Fermilab in the US 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 US every year. Since 1984, almost 600 Italian students participated in the program. Many of them were inspired by it and extended their collaboration with Fermilab for their Master Theses, their PhDs, or employment. The program also had a huge impact also of the students who made different choices for their careers since it allowed them to have their first experiences "out of the library" in an international research laboratory.

10 Acknowledgements

Many colleagues at Fermilab and elsewhere have contributed to the success of this program by supervising the students and guiding them to take full advantage of the lab's capabilities. The program would not have been possible without the highly professional and friendly help of the Visa, EDIA, and the Education Offices. This work was supported by the EU Horizon 2020 Research and Innovation Programme under the Marie Sklodowska-Curie Grant Agreement No. 690835, 734303, 822185, 858199, 101003460 and by the Fermi National Accelerator Laboratory, managed and operated by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy.

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