



Survey of training needs in accelerator science

ARIES Final Annual Meeting May 2-3, 2022

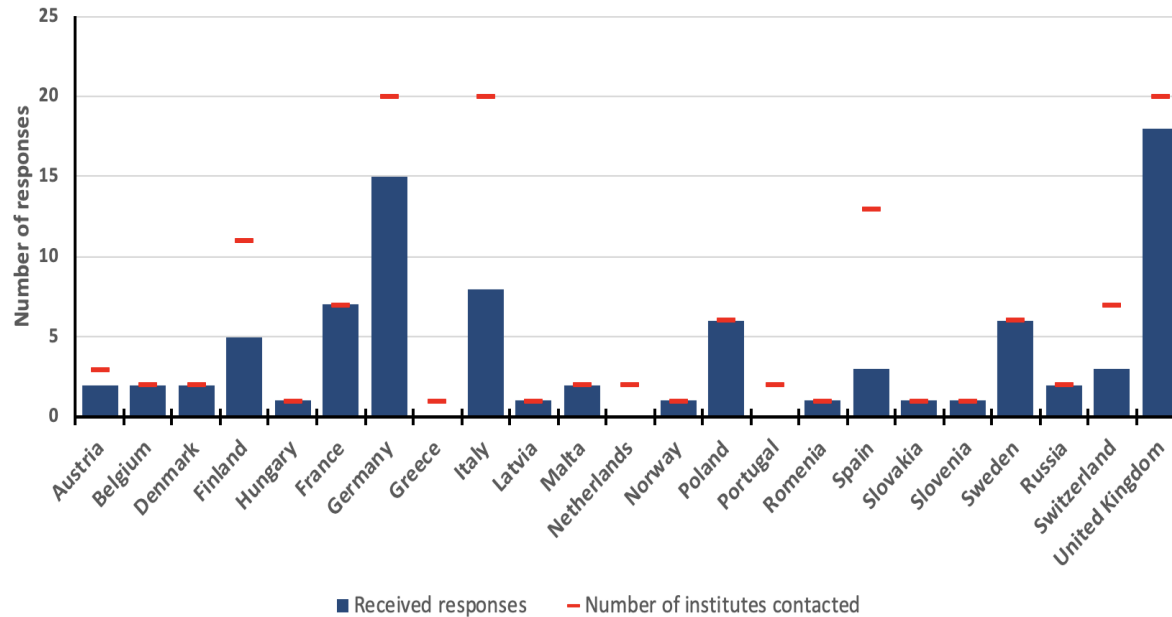
Rutambhara YOGI (ESS)

ARIES survey:

- The ARIES survey questions were designed to map out the TIARA survey
- TIARA survey: A “Education and Training Survey” was carried out in 2012 by the TIARA project, based on input from 88 institutes in 13 countries. This resulted in the “Needs for Accelerator Scientists Report” (<http://cds.cern.ch/record/1521336/files/>)
- ARIES survey also considers additional training provisions which were not prominent during TIARA survey such as MOOC. Survey was also sent to a group of representing companies to find out their training needs. The findings are reported in ‘Co-ordination of Training Activities’ (<https://edms.cern.ch/document/1816951/1.0>)
- It maps the accelerator training provision between the two survey periods 2005-2012 and 2013-2019.

Survey Response: universities and laboratories

The survey questionnaire was sent to 140 institutes in more than 23 countries. The responses were received from 90 institutes and companies from 20 countries. **(Response rate ~ 64%).**

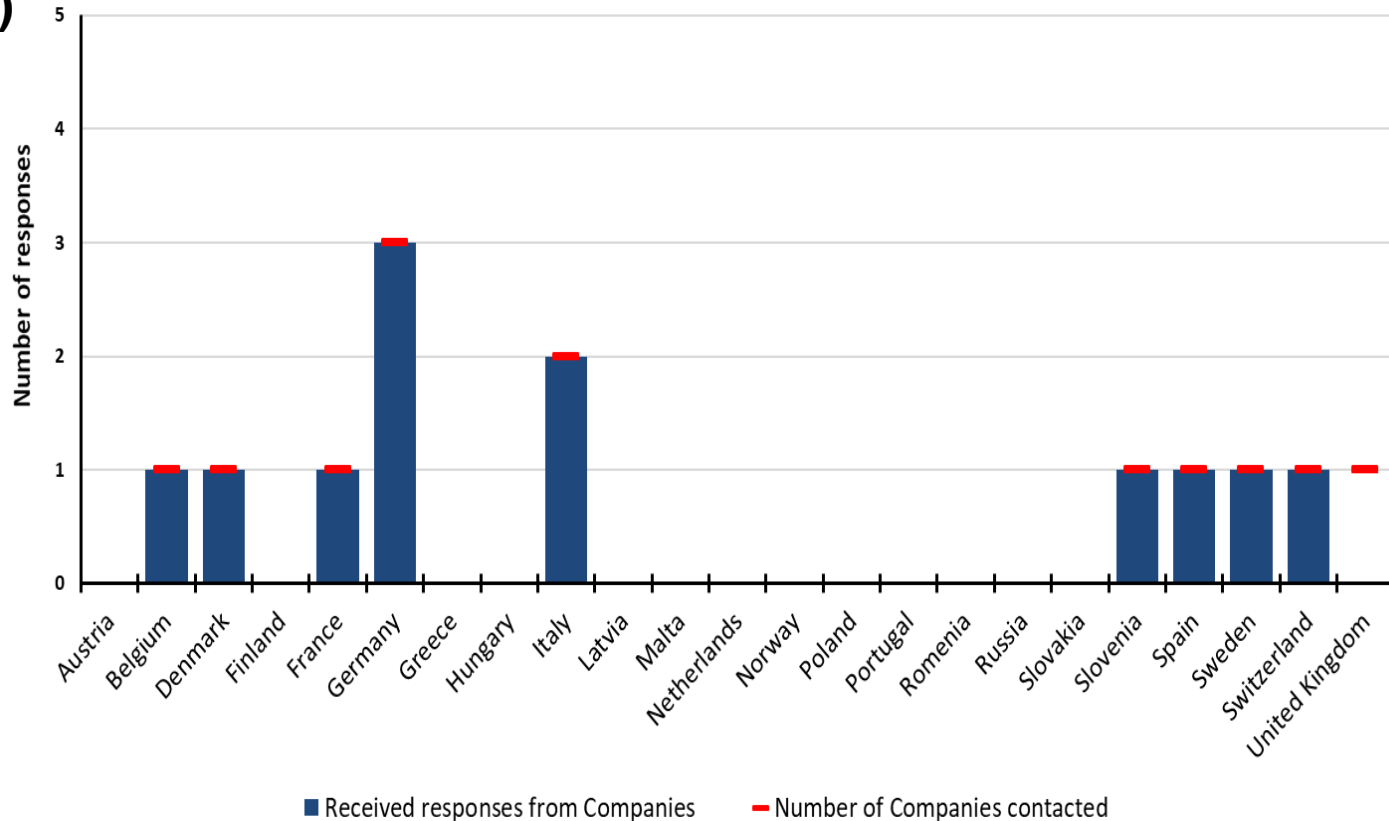


It gives quite a complete picture of status of Accelerator training in Europe

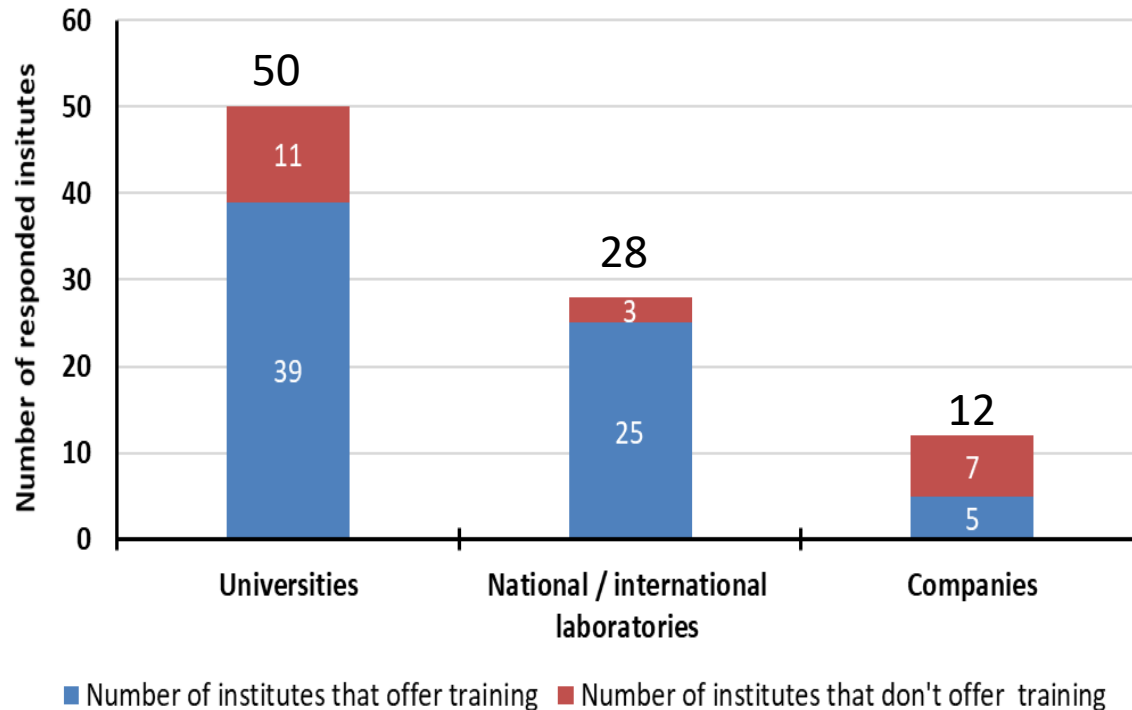
Survey Response: Companies

The survey questionnaire was sent to 13 representing companies in 10 countries, working in Accelerators.

12 companies from 9 countries have responded to the survey. **(Response rate ~92%)**



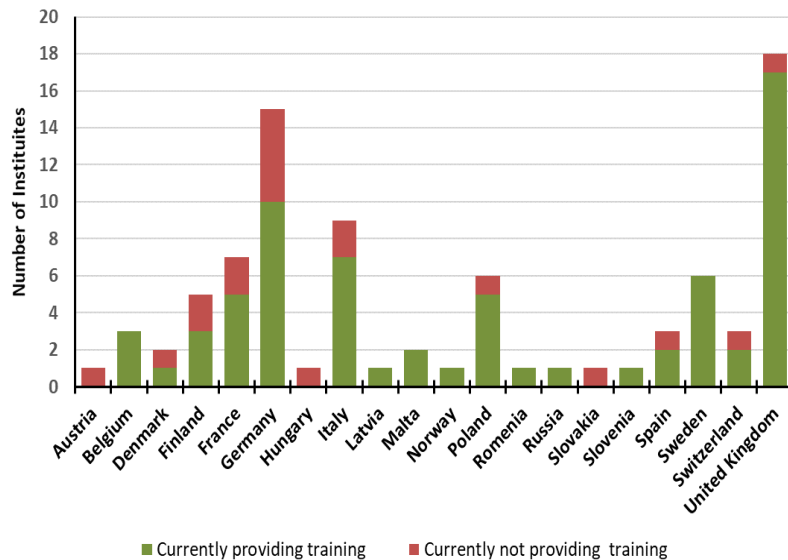
Training Provision



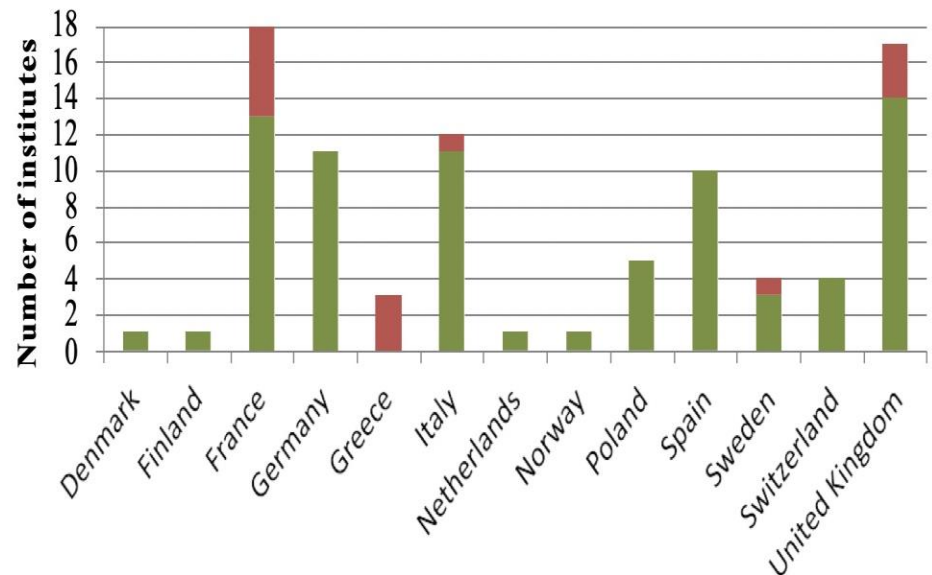
78% Universities, 89% of National / International laboratories and 41 % Companies offer training in Accelerators

The country-wise distribution of institutes providing training

ARIES SURVEY IN 2018

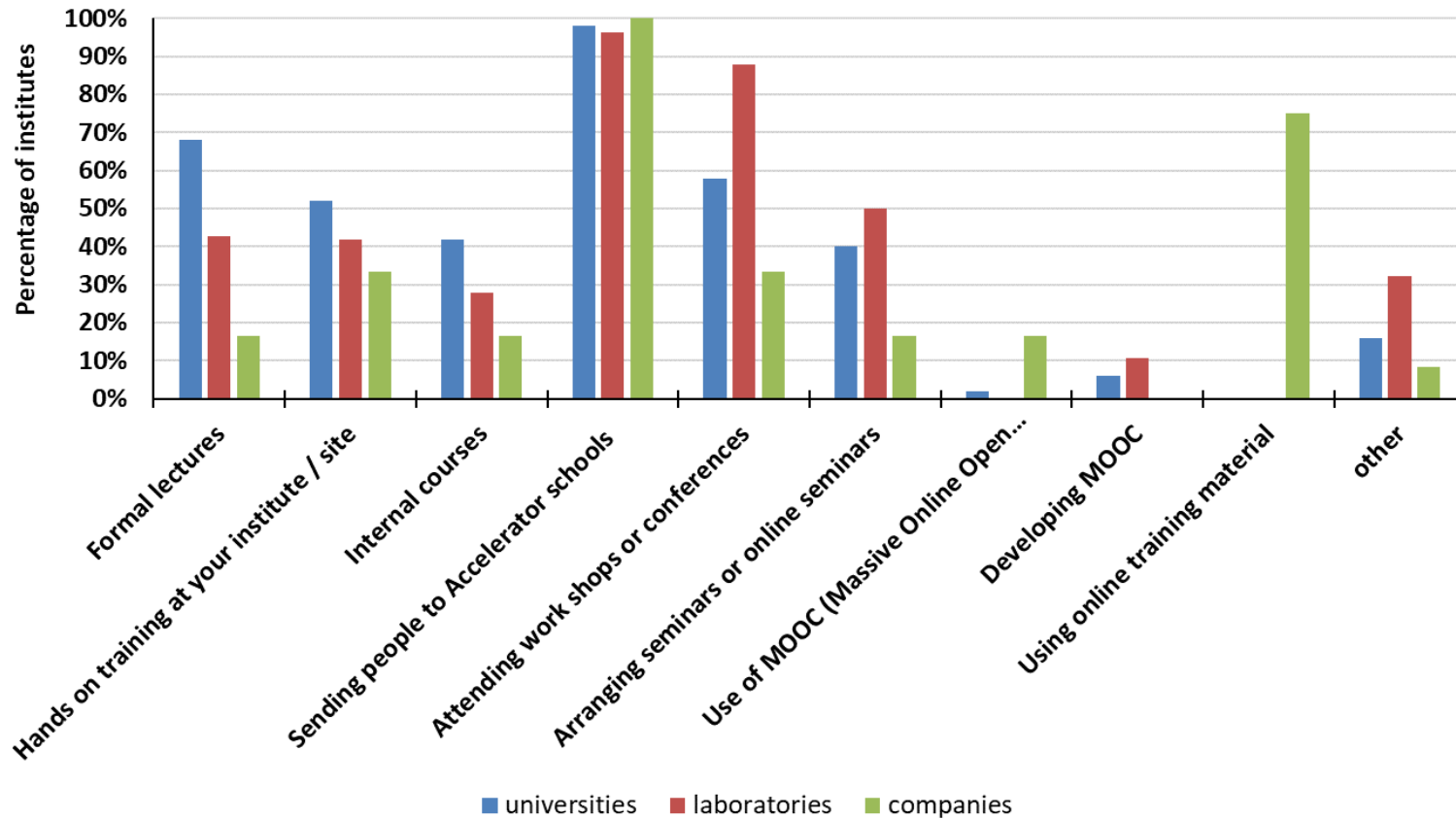


TIARA SURVEY IN 2011



The largest number of institutes that offer training are present in the UK (17), followed by Germany (10) and Italy (7).

Training provisions

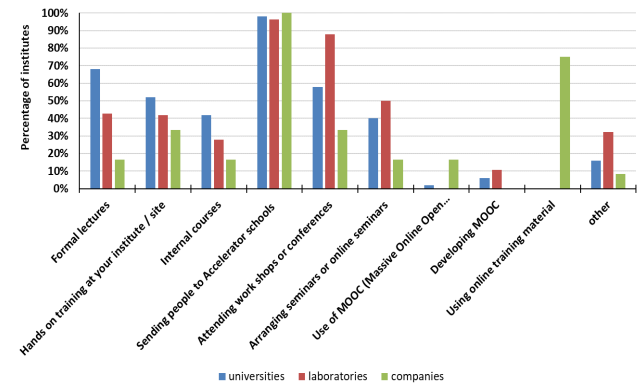


Training: by Universities

As expected, Universities provide a large and diversified amount of training on accelerators.

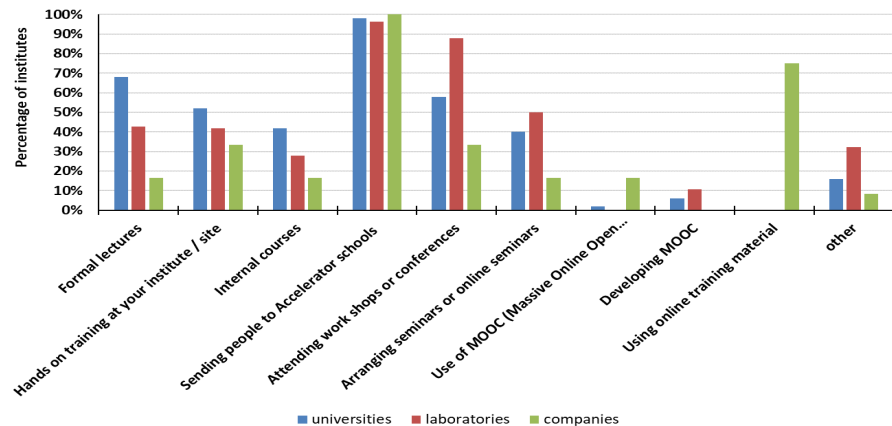
Out of the responding Universities, 68% provide formal lectures, 52% provide hands on training at their campus or at site, 40% provide internal courses, 98% send their people to attend the accelerator schools, 58% send people to attend conferences or workshops, 40% provide seminars or on-line seminars, 1% are using MOOC (Massive Online Open Course) for training, 6% have contributed to MOOC development and no one uses online training material.

On top, 16% offer other methods of training that include buying formal courses from nearby universities, use of thesis (bachelor's, Master's or PhD), developing training networks, involving students in accelerator projects, etc.



Training: by laboratories and companies

- Laboratories provide training mainly by attendance to workshops or conferences (88%) and by sending people to accelerator schools (96%).
- The preferred training for companies is sending people to accelerator schools (100%), the second most used training tool is using online material (75%), an approach exclusively used by companies.



Need for future training activities

81% of the companies have expressed need for additional training, even though all the companies send their personnel to the accelerator schools.

Training needs:

- Basic introductory training for new employees
- Constant updated retraining for the experts and engineers
- Some more expert courses for specific subjects
- Faster dissemination of the latest scientific findings
- A full university curriculum in Particle Accelerator Physics at the University

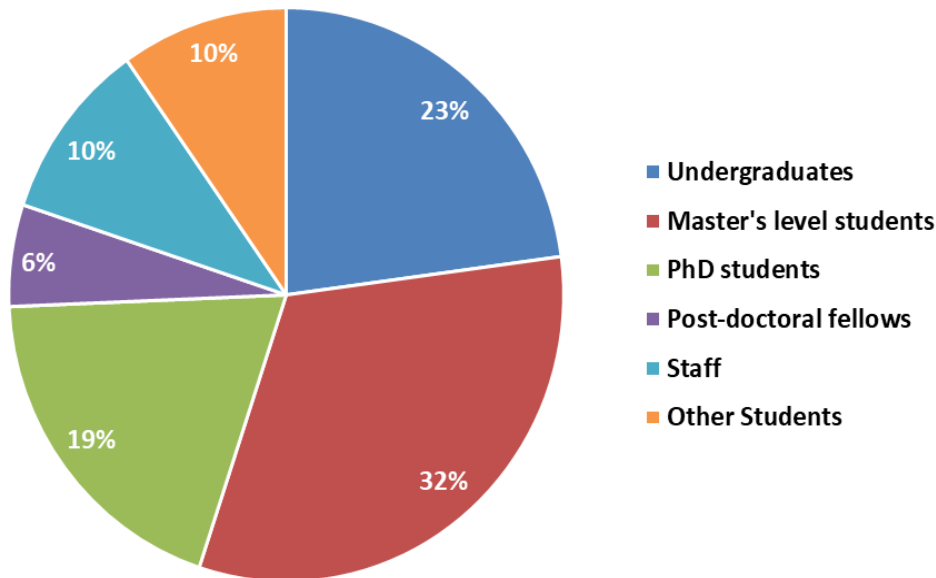
Planned future training activities

8 Institutes have planned future training activities:

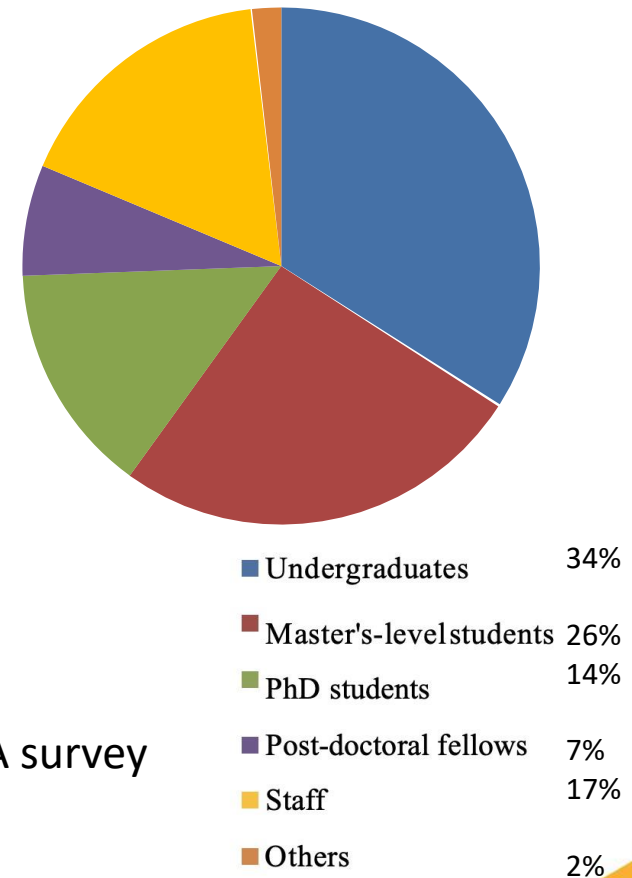
- Doctoral programs on accelerator science, and
- Master program in accelerator science.

Relative proportion of trainee type

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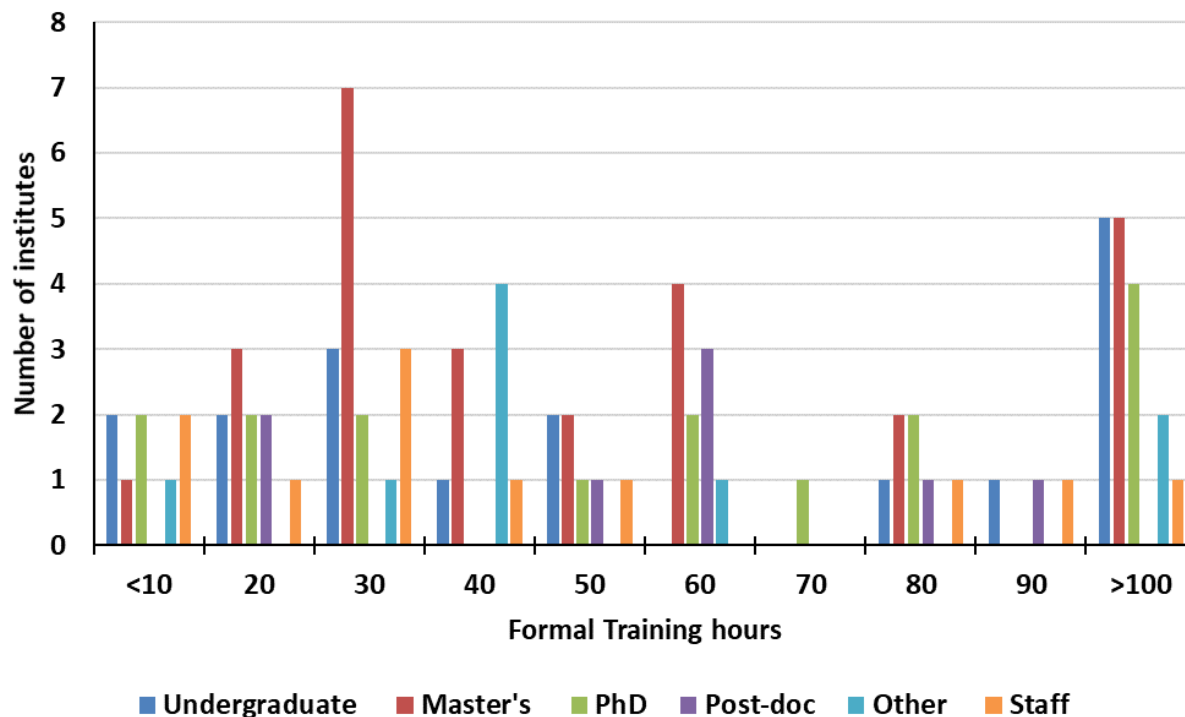


TIARA survey in 2011



Outcome of ARIES survey is more or less same as TIARA survey

Formal training hours

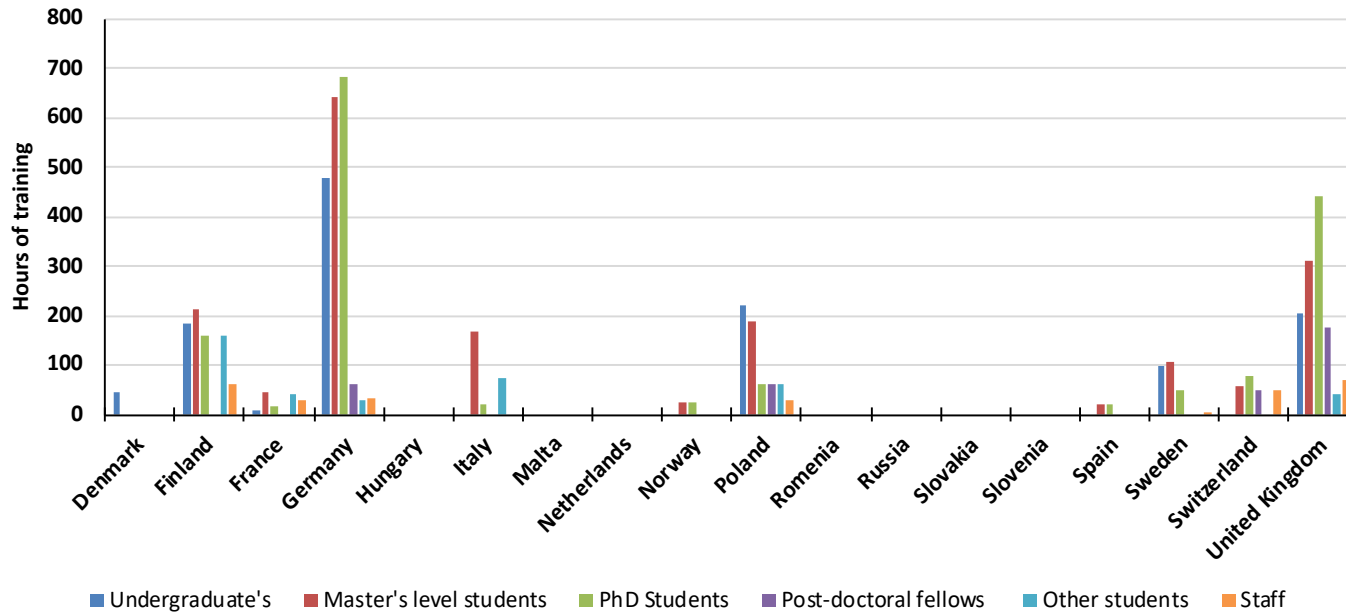


36 institutes did not provide data on the number of formal training hours. The numbers reported here represent a lower bounds, and the real total will be larger.

42 institutes reported a total formal training time of 6,555 hours per year, with an average of 156 hours per institute per year.

18% of training time is given to undergraduates, 27% to master's students, 27% to PhD students, 18% to staff and 5% to post-doctoral fellows.

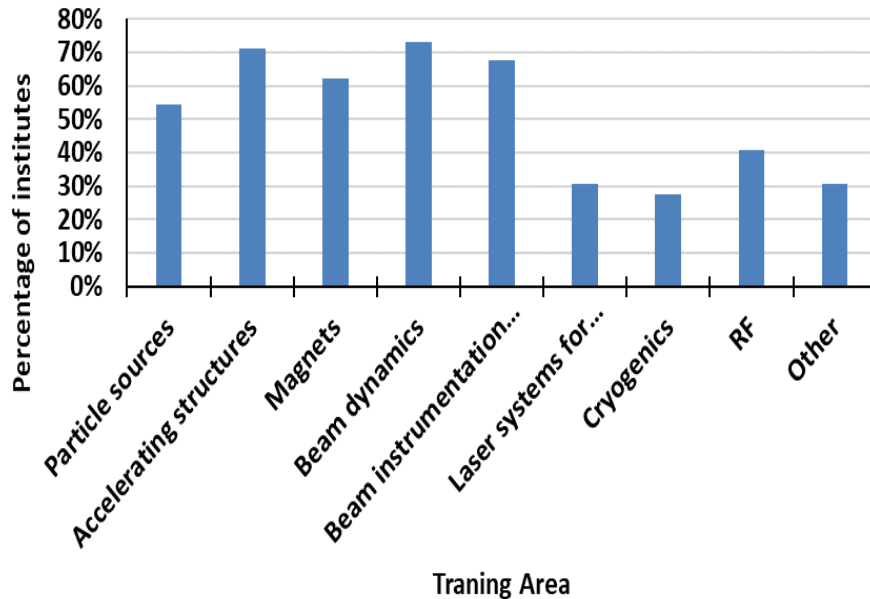
Formal training hours



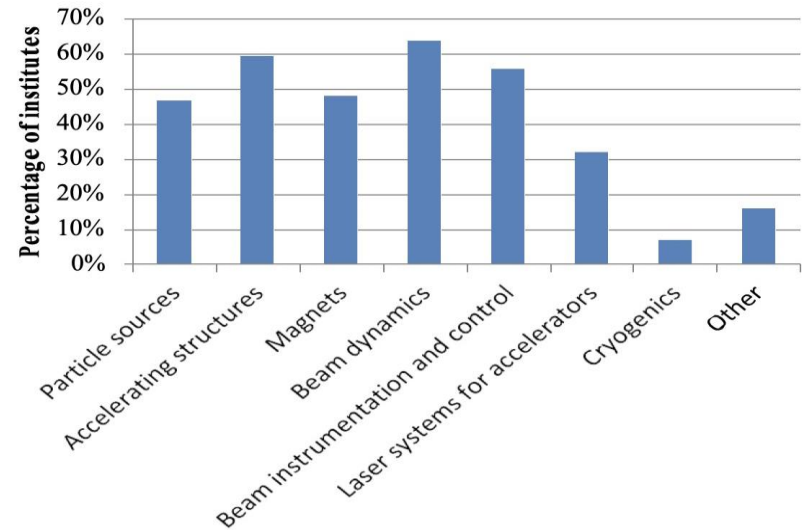
- Germany and United Kingdom are the countries providing more formal training in accelerator science, in particular to PhD students.
- Finland and Poland provide more formal training to Master students
- Accelerator science typically represents a small fraction of total training time, which reflects the fact that it is often a small component of a more general training in physics and/or engineering disciplines. This is particularly evident for undergraduate, master's and PhD students.

Training Areas

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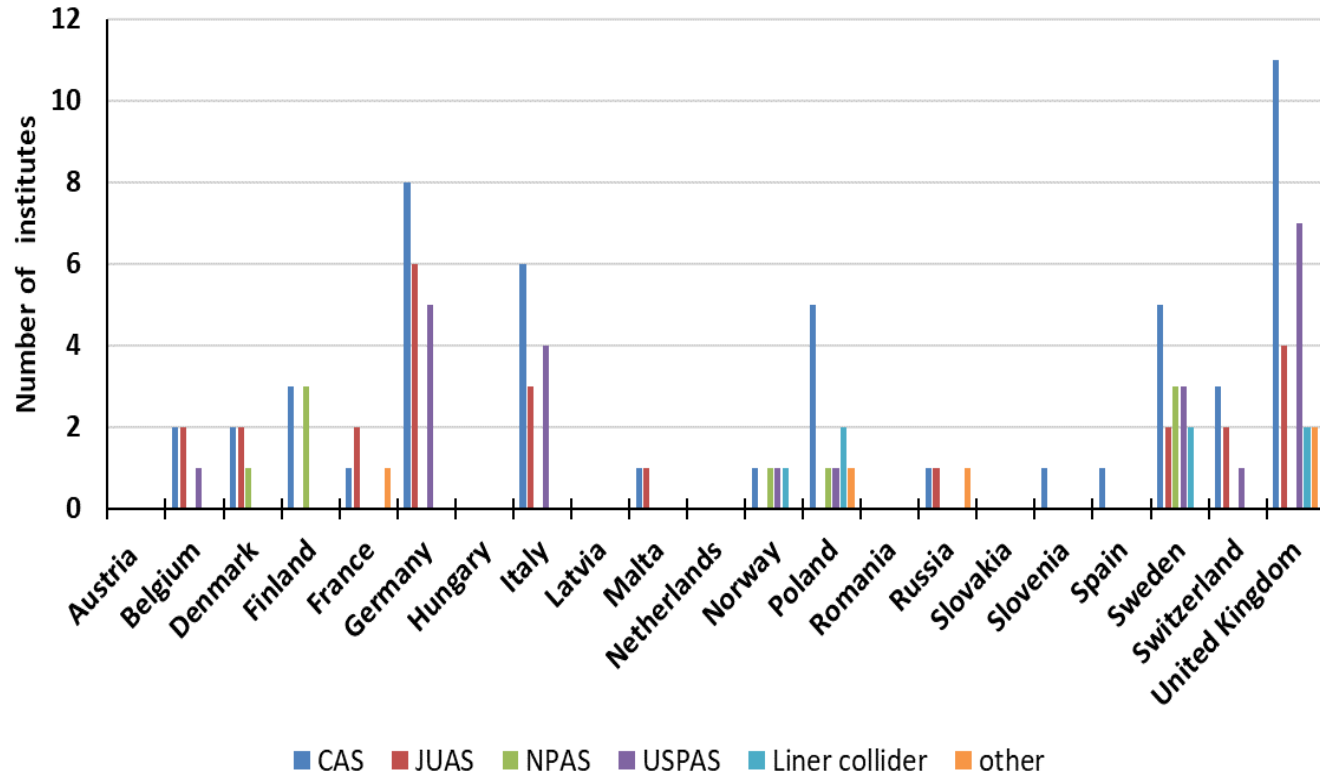


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A significant fraction of institutes offer training in laser systems, cryogenics, and RF for accelerators. This last part is particularly significant because it indicates a shift of training towards superconducting RF and laser based acceleration technologies.

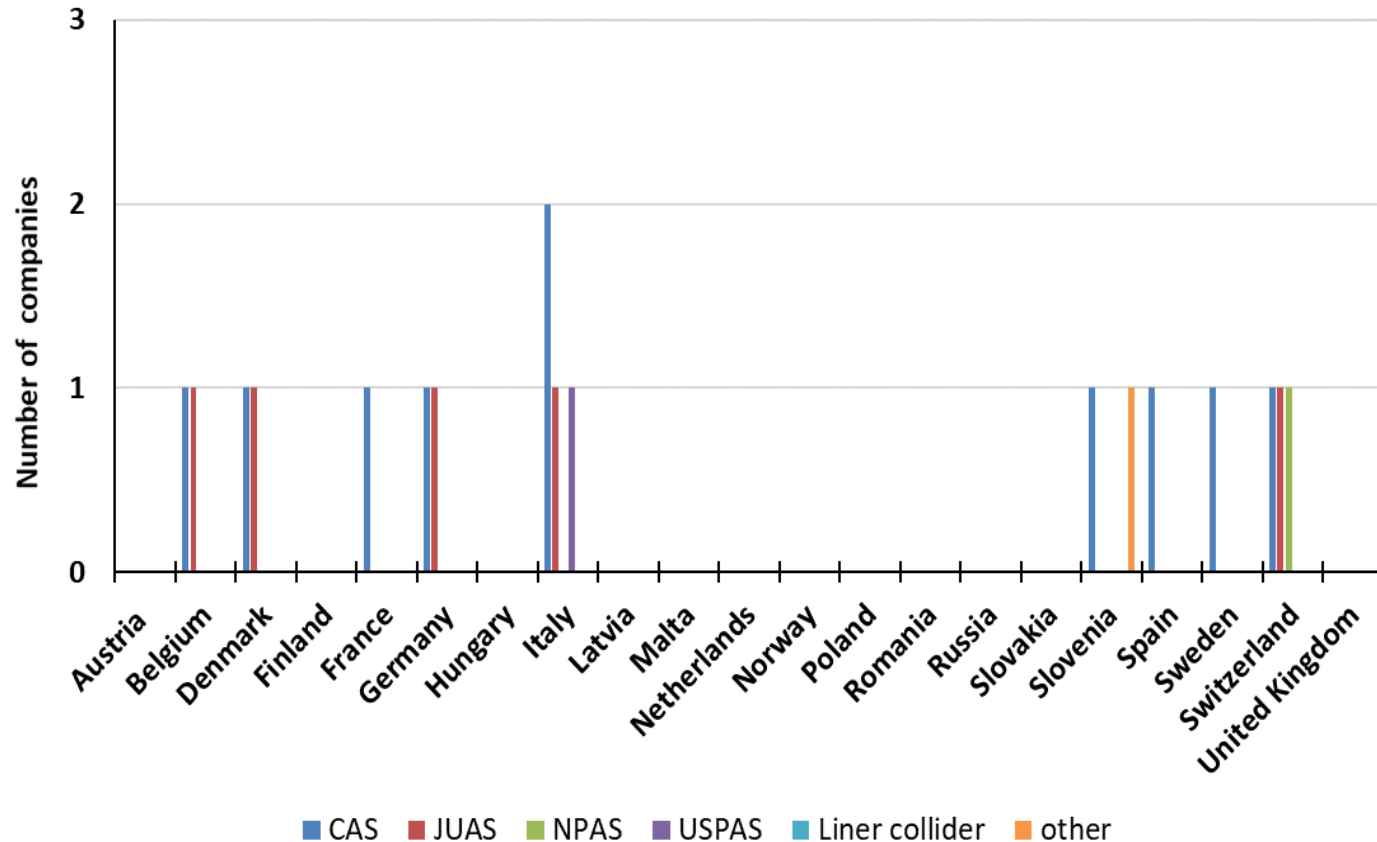
Accelerator Schools : Data from institutes



More than 90% of the responding institutes sent their personnel to accelerator schools.

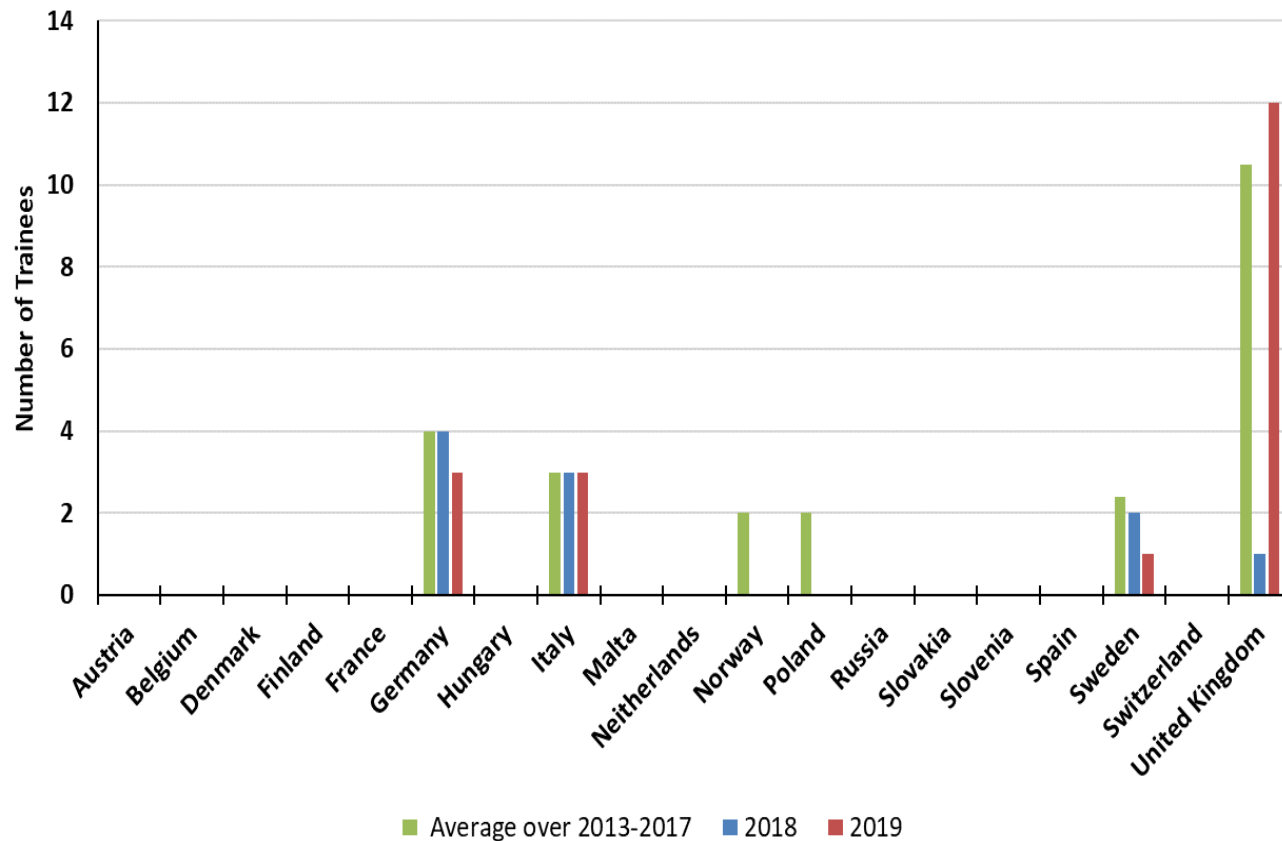
The most attended international schools are the CERN Accelerator Schools (CAS), the Joint Universities Accelerator School (JUAS), the U.S. Particle Accelerator Schools (USPAS) and the Linear Collider School.

Accelerator Schools : Data from companies



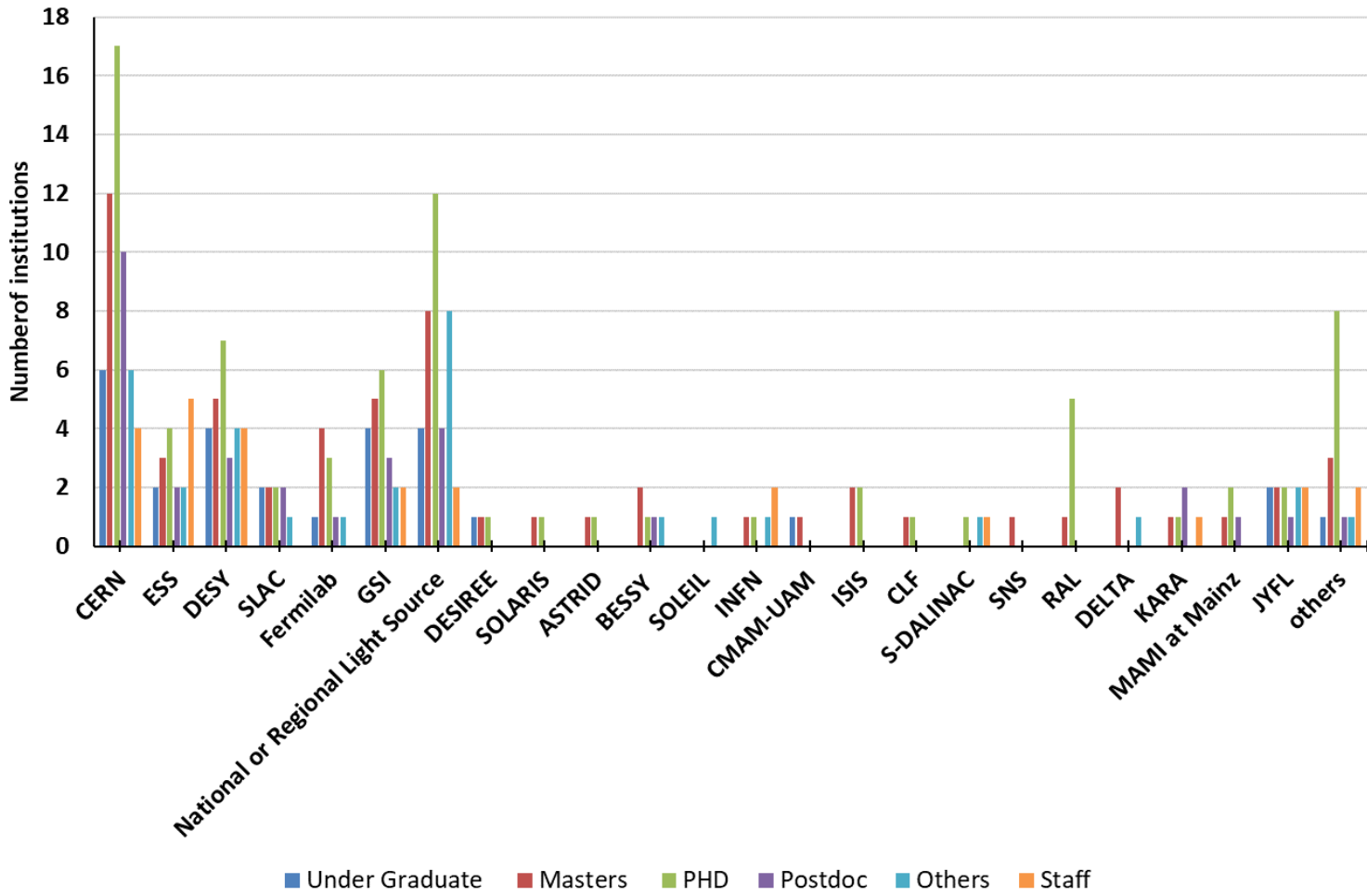
The most attended international schools are the CERN Accelerator Schools (CAS), the Joint Universities Accelerator School (JUAS), the U.S. Particle Accelerator Schools (USPAS) and Nordic Particle Accelerator School (NPAS).

CERN Doctoral Student Programme



Numbers of trainees reported as participating in the ‘CERN Doctoral Student Programme’ by country

Training using international and national facilities



Facilities used for training by two or more institutes are shown in above graph



Training using international and national facilities

ARIES SURVEY IN 2018

73 institutes (81% of total) reported on their use of national and/or international laboratories and facilities for hands-on activities and visits as part of their training programs. A total of 51 such facilities were reported

TIARA SURVEY IN 2011

59 (67%) institutes reported on their use of national and/or international laboratories and facilities as part of their training programs. A total of 51 such facilities were reported



MOOC (Massive Open Online Course)

MOOC: an online course aimed at unlimited participation and open access via the web. It is a recent development in distance education, which is gaining popularity.

The responding institutes have reported the following MOOCs related to training in accelerators.

1. ARIES MOOC :An online course about particle accelerators, (<http://particle-accelerators.eu/>)
2. Nordic particle accelerator project (NPAP) MOOC (<https://www.mooc-list.com/tags/npap>)
3. Cockcroft Institute Education Programme MOOC (<https://www.cockcroft.ac.uk/lectures>)
4. MOOC from Poland (<https://ekursy.okno.pw.edu.pl/>)
5. Russian MOOC



Summary

The analysis leads to identifying some possible actions to improve accelerator training to meet the interests of the community at large, and in particular of its industrial part:

- Favour movement of students within countries and across Europe to reach critical mass for university courses on accelerators.
- Support the European Accelerator Schools as primary tools for training and integration of the accelerator community.
- Organise general and specialised courses for industry personnel.
- Spread training initiatives beyond the usual high-technology countries .
- Continue the development of MOOC courses and integrate the requirements of accelerator companies in the preparation of online training material.
- Organize outreach activities at bachelors level or even at school level, so as to develop “Accelerator related interest” among the students .
- Include latest accelerator related findings in Accelerator bulletin (may be Accelerator News). Include companies in the distribution list.



Thank you

- ESS for opportunity
- All the reporting institutes and the contact persons
- All the National contacts for coordinating with the institutes in your country
- Thank you WP 2,3 members and Work-package coordinator for discussions
- Thank you project coordinator for ideas and support