Present CAS Activities and Experience

Outlook to future CAS

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Based primarily on slides of R.Bailey and W.Herr
CERN Accelerator School (CAS) established in 1983, with the mandate:

"To preserve and transmit knowledge accumulated, at CERN and elsewhere, on particle accelerators and colliders of all kind"

Takes place in different member states of CERN, member states (22) visited at least once, except Israel (member state since 2014), Romania (member state since 2016)

Participants and lecturers from CERN member states and other countries world-wide
Provide framework for a series of courses:

- General accelerator physics (annually), alternating "Introductory" and "Advanced" course
  Very diversified programme to give an overview, but strong emphasis on beam dynamics (≈ 2/3)

- Topical schools specialized in a field, yearly up to 2013, now 2 or 3 per year due to high demand and TIARA outcome. (Usually no dedicated courses on beam dynamics)

- Occasional courses within framework of Joint Accelerator School (JAS) together with USPAS, Japan, and Russia
  → next JAS: RF technologies: Japan, October 2017
Previous Schools

General courses (33 since 1983):
Residential courses, 2 weeks (50-60 hrs). Lectures, exercises, group projects and hands-on courses

Specialized topics (32 since 1983, 2 courses per year):
Residential courses, 1 week. Lectures, case studies

Joint Accelerator School (JAS, 13 schools since 1985):
Residential courses, 1 - 2 weeks. Lectures, homework, case studies
Introductory course:
- Lectures largest part of the programme (typically \( \approx 45 \))
  
  Core topics: linear beam dynamics and related themes
- Complemented by tutorials and dedicated discussion sessions

Advanced course:
- Strong focus on hands-on courses (all afternoons, lectures the only in morning)
- New core topics: Advanced beam dynamics concepts (in particular non-linear dynamics, collective effects, light sources)
Previous topical schools - training the skills


cont’d:

- Ion Sources: (2012)
- Accelerators for medicine and industry: (2001, 2015)
- Colliding beam facilities (1983)
- Plasma Wake Acceleration (2014)
- Intensity Limitations (2015)
- Injection, extraction and beam lines (2017)
Organization of CAS schools and programme:

CAS management staff, $\approx 2.5$ FTE (since 2011):

- Roger Bailey (head of school, full time)
- Werner Herr (deputy head of school, presently 50%)
- Barbara Strasser (administrative assistance, full time)
- Bernhard Holzer (for part of topical courses organizes the preparation and running of the school, part time, $\approx 20\%$)
- Hermann Schmickler (appointed as head of school from 2018)

Not part of CERN departmental structure, reports to CERN Directorate

Consultation with supporting bodies
Evolution of the programme:

Schools are regularly revised to adapt to evolution in the field and improved teaching methods.

Recent (since 2016): updated common syllabus for general schools (Introductory and Advanced level)

Purpose:
- Ensure a coherent set of lectures, with advanced course as follow up of introductory course
- Take into account advancement in the field
- Input from lecturers and students, single programme committee for both schools
- Provide a well-defined foundation for topical courses
Financing

- Try to be cost neutral with students’ fees: for running of the school, this includes accommodation, all meals, course material (fees strongly depend on local costs and country)

- All expenses for lecturers covered by CAS, but no remuneration for lecture

  (relying on good will and dedication of lecturers, has not been a problem so far)

- Financial support for students (covers only fees, no travel): typically up to 5 students per school
**Attendance:**

Unlike USPAS/JUAS: much less focused on University Students

Staff of laboratories and universities (physicists, engineers, technicians), undergraduate and PhD students, post docs, staff from in industry working with accelerators

**General schools:**
- Introductory level: 110 - 130 participants (aim for 120)
- Advanced level: limited to 75 - 80 participants (due to afternoon courses)

**Topical schools:**
- Depends on topic: 60 - 100 participants

General schools often oversubscribed (up to 60%), then CV and reference letter required
**Origin: Participants**

<table>
<thead>
<tr>
<th></th>
<th>General schools</th>
<th>Topical schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratories:</td>
<td>78 %</td>
<td>80 %</td>
</tr>
<tr>
<td>Universities:</td>
<td>20 %</td>
<td>16 %</td>
</tr>
<tr>
<td>Industry:</td>
<td>max 2 %</td>
<td>4 - 10 *) %</td>
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<tr>
<td>Non-member states:</td>
<td>8 %</td>
<td>12 %</td>
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<tr>
<td>(by affiliation)</td>
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</table>

*) depending on topic
Education and background: Participants

As example: Introductory course, Budapest 2016

Participants with post-graduate university degree *) (Physics or engineering) 85 %

Where:

Without PhD: 49 %
With PhD: PhD students: 29 % 22 %

Others: Technical engineers, technicians, operators, undergraduate students, BSc

*) Minimum: MSc/Diploma ⇒ BSc not counted
Level, prerequisites for participants (I)

**Introductory Course:**

- Basic knowledge in physics or engineering and mathematics (1st year university level) *)
- No training in accelerator physics expected

**For this Course:** typically rather large spread of background:

(technicians, engineers, physicists (various disciplines), senior staff)

**Short recapitulation of background knowledge:** Classical Electrodynamics, Special Relativity

*) Basics of differential equations recommended
Level, prerequisites for participants (II)

Advanced Course, all Topical schools:

- Good knowledge in mathematics (1st year university level) *) and physics or engineering.
- Basic training in accelerator physics or experience in Accelerator Operation or Technology
- Reference letter always required

In general: material based on Introductory Course

*) Basics of complex calculus and differential equations recommended
Evaluation of the schools

- Participants are asked to evaluate quality and benefit of lectures (level, contents and presentation) (standard questionnaires and additional comments)
  Evaluation includes organization and running of the school
- Encourage feedback from teaching staff (not yet very successful)

CAS Committees include evaluation to propose topics, lectures and lecturers
- Typical result (overall), separate for each lecture(r) as well
- Individual results available to the lecturer concerned
Dissemination of material

- Proceedings for General and Topical schools:
  - So far: 36 proceedings in printed form
  - General schools: only when programme/contents have changed significantly, most recent: Advanced Course 2013
  - Topical schools: every school

- On-line:
  - On-line versions of written proceedings available since 1983 (CERN Document Server), on arXiv since 2010
  - On INDICO since 2007/2009 (all slides and handouts)
  - Material for hands-on courses (including software downloads) since 2003
  - Budapest 2016: all lectures recorded for the first time

- All free of charge, but CERN copyright (ISBN, ISSN, DOI)
More details on Advanced courses:

- Strong focus on hands-on courses
- All afternoons, lectures only in the morning
- Students choose one of 3 courses:
  - Optics design
  - RF measurements techniques
  - Beam measurements
Hands-on courses: Optics Development

Personal Computer for each participant
Limited to 25 participants
Typically 3 to 5 tutors

Software installed:
Methodical Accelerator Design (MAD)
PTC, TPSA package (CAS version)
LINUX operating system
(WINDOWS versions available)
Hands-on courses: RF Measurement Techniques

- RF measurement techniques with modern equipment
- Typically 2 - 3 tutors for 25 participants
Hands-on courses: Beam Measurement

- Understand basics of measurement principles and their implementation
- Working in small groups and present the outcome
- Interactive simulation tools are available
Upcoming Schools

<table>
<thead>
<tr>
<th>Course</th>
<th>Location</th>
<th>Date</th>
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<tbody>
<tr>
<td>Vaccum</td>
<td>Lund, Sweden</td>
<td>Jun-17</td>
</tr>
<tr>
<td>Advanced Accelerator Physics</td>
<td>Egham, UK</td>
<td>Sep-17</td>
</tr>
<tr>
<td>JAS: Rf technology</td>
<td>Japan</td>
<td>Oct-17</td>
</tr>
<tr>
<td>Introduction to Future Colliders</td>
<td>Switzerland</td>
<td>Mar-18</td>
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<tr>
<td>Beam Instrumentation</td>
<td>Finnland</td>
<td>Jun-18</td>
</tr>
<tr>
<td>Introduction Accelerator Physics</td>
<td>Romania</td>
<td>Sep/Oct 2018</td>
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<tr>
<td>Simulation tools for Acc. Design</td>
<td>?</td>
<td>Dec-18</td>
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Proposed as future topical CAS

- Digital Signal Processing
- Material Science and Precision Engineering

Proposed for future JAS

- Advanced Future Collider beam dynamics 2019
- Advanced Future Collider technologies 2021
Next topical school: Future Colliders; Spring 2018; Switzerland

- Teach all present projects of future high energy colliders…linear and circular
- No parallel teaching; every student gets the full picture
- Show beam dynamics aspects as well as main technologies

"naturally" followed by two other topical schools (target years 2020 and 2022)

1) Advanced beam dynamics of Future Colliders
2) Advanced technologies of Future Colliders

Non authorized tentative school poster

Further details on upcoming new CAS website

Next slide: Tentative program (still under discussion)
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speakers</th>
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<tbody>
<tr>
<td>9:20</td>
<td>Discussion</td>
<td></td>
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<tr>
<td>10:30</td>
<td>Coffee</td>
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<tr>
<td>11:50</td>
<td>Discussion</td>
<td></td>
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<tr>
<td>12:00</td>
<td>Linear Collider studies operation</td>
<td>S. Stapnes, H. Schmickler, B. Holzer, M. Syphers, K. Oide, B. Holzer, E. Jensen, W. Bartmann, B. Holzer, A. Seryi, M. Kuriki</td>
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<tr>
<td>13:00</td>
<td>Lunch</td>
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<td>16:30</td>
<td>Coffee</td>
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<tr>
<td>17:00</td>
<td>The big picture</td>
<td>F. Giannoti, P. Lebrun, J. Wenninger, L. Kersevan, L. Bottura, P. Muggli, M. Seidel, W. Herr/B. Holzer</td>
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<tr>
<td>18:00</td>
<td>Extended Discussion</td>
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<td>19:30</td>
<td>Dinner</td>
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Outlook:

- No revolution...but steady evolution
- Adopt a scheme of 4 schools/year
- Presently under discussion:
  Introductory school every year
  Advanced School as topical school less frequent
  “Even more advanced school “ even less frequent

- New website operational end June 2017
- Complement CAS by MOOCs
  specifically targeted at recapitulating the expected
  starting level for the (yearly) introductory courses