Welcome to Constanta (Romania) to the general CAS course on Introduction to Accelerator Physics and Technology
Why are we here in Constanta?

• CAS visits all CERN memberstates and associated member states in turn. First time in Romania!

• One year ago we have chosen the hotel:
  - in the Carpathian Mountains?
  - in Bucharest?
  - on the Black Sea?

→ best compromise between access, quality and price.
The CERN Accelerator School holds courses in all of the Member States of CERN.

Have been to all except Israel (joined 2014) and Romania (joined 2016).
The CERN Accelerator School

• Established at the beginning of 1983
  – To preserve and transmit knowledge accumulated, at CERN and elsewhere, on particle accelerators and colliders of all kinds

• This provided a framework for a series of courses
  – General accelerator physics
    • Introduction to Accelerator Physics
    • Advanced Accelerator Physics
  – Specialized topic in the field
  – 50 to 70 hours teaching in 1-2 week intensive residential courses

• About 70 courses held so far

• Occasional courses in the framework of the US-CERN-Japan-Russia Joint Accelerator School (JAS)
  – 14 schools held so far (since 1985)
Scope

**Accelerator Physics**
- Relativity / Electro-Magnetic Theory / Transverse Beam Dynamics / Longitudinal Beam Dynamics / Linear Imperfections and Resonances / Synchrotron Radiation / Electron Beam Dynamics / Multi-Particle Effects / Non-Linear Dynamics Beam Instabilities / Landau Damping / Beam-Beam Effects

**Accelerator Systems**
- Particle Sources / RFQ / LEBT RF Systems / Beam Measurement / Feedback Systems / Beam Injection and Extraction / Beam Transfer Power Convertors / Warm Magnets / Superconducting Magnets / Vacuum Systems Machine Protection Systems Radiation and Radioprotection

**Accelerators**
- Linear Accelerators
- Synchrotron Light Machines
- FELs
- FFAGs
- Cyclotrons
- Synchrotrons
- Colliders

**Applications**
- High Energy Physics
- Nuclear Physics
- Industrial Applications
- Medical Applications
- Cancer Therapy
The CERN Accelerator School holds courses in all of the Member States of CERN.

2018

• Beam Dynamics and technologies for future colliders
  » Zürich, Switzerland

• Beam Instrumentation
  » Helsinki, Finland

• Introduction to AP
  » Constanta, Romania

• Numerical Methods and Simulations
  » Thessaloniki, Greece

Have been to all except Israel (joined 2014) and Romania (joined 2016)
What’s new at CAS?

• More courses/year
  - Introductory General Course every year (September)
  - Advanced General Course remains every second year (June)
  - Basic (non-residential) course in the vicinity of CERN every year (also open for people from outside CERN)
• Joint Accelerator School course every second year
• Major topical courses every 4-5 years (beam instrumentation, RF, vacuum, magnets...)
• New topical courses never done at CAS (i.e. mechanical engineering...)

• 10 students grants for every course
• New splendid website http://cas.web.cern.ch/
## Course Program 2018 - 2021

<table>
<thead>
<tr>
<th>Period I</th>
<th>Period II</th>
<th>Period IIb</th>
<th>Period III</th>
<th>Period IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb-April</td>
<td>May-June</td>
<td>End June</td>
<td>Sept-Oct</td>
<td>Nov-Dec</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Topic</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td><strong>Future Colliders</strong></td>
<td>Switzerland</td>
</tr>
<tr>
<td></td>
<td><strong>Beam Instrumentation</strong></td>
<td>Finland</td>
</tr>
<tr>
<td></td>
<td><strong>Short Introduction</strong></td>
<td>France (local)</td>
</tr>
<tr>
<td></td>
<td><strong>General Introduction</strong></td>
<td>Romenia</td>
</tr>
<tr>
<td></td>
<td><strong>Comp. Methods</strong></td>
<td>Greece</td>
</tr>
<tr>
<td>2019</td>
<td><strong>Wakefield Acceleration</strong></td>
<td>Portugal (Sesimbra)</td>
</tr>
<tr>
<td></td>
<td><strong>General Advanced</strong></td>
<td>Denmark (Metalskolen)</td>
</tr>
<tr>
<td></td>
<td><strong>Short Introduction</strong></td>
<td>France (local)</td>
</tr>
<tr>
<td></td>
<td><strong>General Introduction</strong></td>
<td>Slovakia (High Tatras)</td>
</tr>
<tr>
<td></td>
<td><strong>JAS: Ion Colliders</strong></td>
<td>Russia (Dubna)</td>
</tr>
<tr>
<td>2020</td>
<td><strong>RF</strong></td>
<td>Lithuania (Vilnius)</td>
</tr>
<tr>
<td></td>
<td><strong>Mechanical Engineering</strong></td>
<td>Holland</td>
</tr>
<tr>
<td></td>
<td><strong>Short Introduction</strong></td>
<td>France (local)</td>
</tr>
<tr>
<td></td>
<td><strong>General Introduction</strong></td>
<td>Ukraine earmarked</td>
</tr>
<tr>
<td></td>
<td><strong>Warm magnets</strong></td>
<td>Austria</td>
</tr>
<tr>
<td>2021</td>
<td><strong>Controls &amp; Digital Signal Processing</strong></td>
<td>tbd</td>
</tr>
<tr>
<td></td>
<td><strong>JAS: Very Advanced Beam Dynamics</strong></td>
<td>Canada (Saskatoon)</td>
</tr>
</tbody>
</table>

* CAS@ESI (Archamps)
This course

• Organized in collaboration with ELI-NP
  - Professor Dan Ghita
  - Cristina Comanescu

• Last course in Budapest (2016)

• Teaching Method:
  - no parallel teaching
  - large number of internationally known experts as teachers, determined by a large program committee
  - during the mornings classical lecturing plus discussion sessions
  - during most of the afternoons of the first week
deeper understanding of linear beam dynamics by programming
  - no final examination (like all CAS courses)
WHAT IS NEW IN THE INTRODUCTORY COURSE?

• Now given every year
  → better timing for newcomers; fewer students
• Larger focus on beam dynamics
  - course one day longer
  - 3 hours less of technology
  - 9 hours more on beam dynamics
• Core teaching: (blue in time table)
  Interaction between lecturers before course in order to streamline sequence, avoid too much overlap.
• Technology focus shifted to Advanced Course (next June)
Core Teaching

• My personal wish what you should learn here at the very minimum:
  - how a particle beam moves within dipoles and quadrupoles (bending and focusing)
  - how a particle beam is accelerated and focused longitudinally by an RF system
  - to understand the meaning of the beta-function and the phase advance in a circular accelerator
  - to understand the beam emittance and the change of beam envelope along an accelerator
  - to associate the right thing to the following buzz-words: beta function, phase advance, betatron tunes, synchrotron tune, closed orbit, dispersion, chromaticity.
  - To understand the main concepts of “collective effects”, i.e. when the particle beams get more and more intense:
    → space charge, wakefields & impedances, coherent instabilities
<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:30</td>
<td>Opening</td>
<td>Transverse Linear Beam Dynamics I</td>
<td>Linear Accelerators I</td>
<td>Longitudinal Beam Dynamics in Circular Machines II</td>
<td>Luminosity and Colliders</td>
<td>Collective Effects I</td>
</tr>
<tr>
<td>09:00</td>
<td>Schmickler</td>
<td>Hillert</td>
<td>Alesini</td>
<td>Tecker</td>
<td>Herr</td>
<td>Li</td>
</tr>
<tr>
<td>09:45</td>
<td>Accelerator Applications</td>
<td>Transverse Linear Beam Dynamics II</td>
<td>Linear Accelerators II</td>
<td>Transverse Linear Beam Dynamics V</td>
<td>Injection and Extraction</td>
<td>Collective Effects II</td>
</tr>
<tr>
<td>10:00</td>
<td>Hillert</td>
<td>Alesini</td>
<td>Hillert</td>
<td>Fraser</td>
<td>Li</td>
<td></td>
</tr>
<tr>
<td>10:45</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
</tr>
<tr>
<td>11:30</td>
<td>Electromagnetic Theory</td>
<td>Particle motion in Hamiltonian formalism</td>
<td>Transverse Linear Beam Dynamics III</td>
<td>Discussion transverse BD</td>
<td>FFAs</td>
<td>Advanced accelerator concepts</td>
</tr>
<tr>
<td>12:15</td>
<td>Herr</td>
<td>Sheehy</td>
<td>Hillert</td>
<td>Hillert</td>
<td>Sheehy</td>
<td>Ferrario</td>
</tr>
<tr>
<td>12:45</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
</tr>
<tr>
<td>14:45</td>
<td>Electromagnetic Theory</td>
<td>Particle motion in Hamiltonian formalism II</td>
<td>Transverse Linear Beam Dynamics IV</td>
<td>Kickers, Septa and Beam Transfer</td>
<td>Warm Magnet/powers converters</td>
<td>Linear Imperfections I/Corrections</td>
</tr>
<tr>
<td>15:00</td>
<td>Sheehy</td>
<td>Hillert</td>
<td>Fraser</td>
<td>de Rijk</td>
<td>Ziemann</td>
<td>Papaphilippou</td>
</tr>
<tr>
<td>15:30</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
</tr>
<tr>
<td>16:00</td>
<td>Kinematics of Particle Beams, Relativity</td>
<td>Hands-On Lattice calculations - Introduction</td>
<td>Longitudinal Beam Dynamics in Circular Machines I</td>
<td>Discussion longitudinal BD</td>
<td>Superconducting Magnets</td>
<td>Linear Imperfections I/Corrections</td>
</tr>
<tr>
<td>16:30</td>
<td>Ziemann</td>
<td>Ziemann/Herr/Sterbin</td>
<td>H. Schmickler</td>
<td>Ziemann/Herr/Sterbin</td>
<td>Ziemann</td>
<td>Ziemann/Herr/Sterbin</td>
</tr>
<tr>
<td>17:00</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
<td>Coffee</td>
</tr>
<tr>
<td>17:30</td>
<td>Statistical Description of Particle Beams</td>
<td>Hands-On Lattice calculations II</td>
<td>Hands-On Lattice calculations II</td>
<td>Hands-On Lattice calculations IV</td>
<td>Hands-On Lattice calculations VI</td>
<td>Cyclotrons I</td>
</tr>
<tr>
<td>18:00</td>
<td>Ziemann/Herr/Sterbin</td>
<td>Ziemann/Herr/Sterbin</td>
<td>Ziemann/Herr/Sterbin</td>
<td>Ziemann/Herr/Sterbin</td>
<td>Ziemann/Herr/Sterbin</td>
<td>Cyclotrons II</td>
</tr>
<tr>
<td>19:00</td>
<td>Welcome Reception</td>
<td>Welcome Reception</td>
<td>Welcome Reception</td>
<td>Welcome Reception</td>
<td>Welcome Reception</td>
<td>Welcome Reception</td>
</tr>
<tr>
<td>19:30</td>
<td>Dinner at Hotel</td>
<td>Dinner at Hotel</td>
<td>Dinner at Hotel</td>
<td>Dinner at Hotel</td>
<td>Dinner at Hotel</td>
<td>Dinner at Hotel</td>
</tr>
<tr>
<td>21:00</td>
<td>Poster Preparation</td>
<td>Poster Preparation</td>
<td>Poster Preparation</td>
<td>Poster Preparation</td>
<td>Poster Preparation</td>
<td>Poster Preparation</td>
</tr>
</tbody>
</table>

H. Schmickler, CAS
...more on this course...

- The lecturers stay (if possible) a little longer than just for their lecture. Spend this time with them...  
  ...make friends...find a subject for your thesis?...  
  ...find a job?....

- Networking is an essential part of each CAS course.  
  ➔ one slide-one minute  
  ➔ excursion  
  ➔ film evening  
  ...need volunteers for “program committee”
Feedback

- Please, please, please
  – Give us your feedback
Online evaluation

---

### Evaluation form for CAS course in Tuusula, 2018

Please share your impressions on the programme: rank lectures by level, content and presentation; leave your comments about the course. You can save and reopen partly-completed questionnaire. Completed questionnaire can be submitted just once.

#### BID Requirements Overview / Measurement Principles I, II, III

<table>
<thead>
<tr>
<th>Level</th>
<th>Content</th>
<th>Prac.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Completely uninteresting</td>
<td>Poor</td>
</tr>
<tr>
<td>Just right</td>
<td>Uninteresting</td>
<td>Fair</td>
</tr>
<tr>
<td>Too high</td>
<td>Interesting</td>
<td>Good</td>
</tr>
<tr>
<td>Much too high</td>
<td>Very interesting</td>
<td>Very good</td>
</tr>
</tbody>
</table>

Other comments on this lecture...

#### Transverse Beam Dynamics Recap I, II

<table>
<thead>
<tr>
<th>Level</th>
<th>Content</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Completely uninteresting</td>
<td>Very poor</td>
</tr>
<tr>
<td>Just right</td>
<td>Uninteresting</td>
<td>Poor</td>
</tr>
<tr>
<td>Too high</td>
<td>Interesting</td>
<td>Good</td>
</tr>
<tr>
<td>Much too high</td>
<td>Very interesting</td>
<td>Very good</td>
</tr>
</tbody>
</table>

Other comments on this lecture...
Evaluation form: access

Access to web-form is granted to participants using the email addresses indicated in their Indico registrations

Step 1:
email with the link has been sent to all participants
If you did not receive the email, contact Anastasiya.Safronava@cern.ch

Step 2:
to login use the same email account; it will certainly work for CERN and for Google accounts, but not only
If you can not login, contact Anastasiya.Safronava@cern.ch

Solutions: provide your Google account if you have one, or a temporary CERN account will be created for you
CAS Promotional Actions

• Testimonials for the web:
  - all you need is a photo and a sentence.
  Have a look at: http://cas.web.cern.ch/

What our students say about us

“CAS provides opportunities: I gained new knowledge and friends, met with important people from the field, arranged for an interesting sabbatical, improved my future possibilities.”

— Jiri Kral, CERN
Student of Advanced Accelerator Physics, UK 2017

“ This school has served with all kinds of aspects which an accelerator learner would seek. Interaction with speakers and school members was of great help to clear my concepts. Case study has been of great use which let us think about broader aspect of accelerators.”

— Krutika Natu, SAMEER
Student of Future Colliders course, Zürich 2018
On the organizational side...

• Registration with Delphine & Floriane... → badge, bag, program, info....still possible

• During the first week of the course we will organize in detail the departure day.

• Cristina knows “everything” about practical arrangements

• Anastasiya (for the online feedback) will be here from Thursday this week.

• CAS office open every day during a few hours. The CAS office is close to the place where we have the coffee breaks...