

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

The twenty two Member States of CERN *Les vingt-deux États membres du CERN*

Member States (date of accession)
États membres (date d'accession)

| | |
|---|---|
|  Austria (1959) <i>Autriche</i> |  Italy (1953) <i>Italie</i> |
|  Belgium (1953) <i>Belgique</i> |  Netherlands (1953) <i>Pays-Bas</i> |
|  Bulgaria (1999) <i>Bulgarie</i> |  Norway (1953) <i>Norvège</i> |
|  Czech Republic (1993) <i>République tchèque</i> |  Poland (1991) <i>Pologne</i> |
|  Denmark (1953) <i>Danemark</i> |  Portugal (1986) <i>Portugal</i> |
|  Finland (1991) <i>Finlande</i> |  Romania (2016) <i>Roumanie</i> |
|  France (1953) <i>France</i> |  Slovakia (1993) <i>République slovaque</i> |
|  Germany (1953) <i>Allemagne</i> |  Spain (1961-1968, 1983-) <i>Espagne</i> |
|  Greece (1953) <i>Grèce</i> |  Sweden (1953) <i>Suède</i> |
|  Hungary (1992) <i>Hongrie</i> |  Switzerland (1953) <i>Suisse</i> |
|  Israel (2014) <i>Israël</i> |  United Kingdom (1953) <i>Royaume-Uni</i> |



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

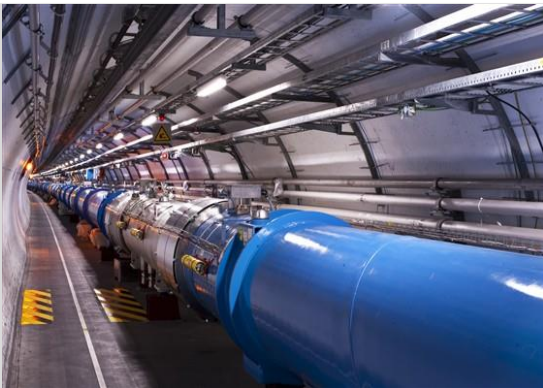
Particle Sources / RFQ / LEBT
RF Systems / Beam Measurement / Feedback Systems / Beam Injection and Extraction / Beam Transfer Power Convertors / Warm Magnets / Superconducting Magnets / Vacuum Systems Machine Protection Systems Radiation and Radioprotection

Accelerators

Linear Accelerators
Synchrotron Light Machines
FELs
FFAGs
Cyclotrons
Synchrotrons
Colliders

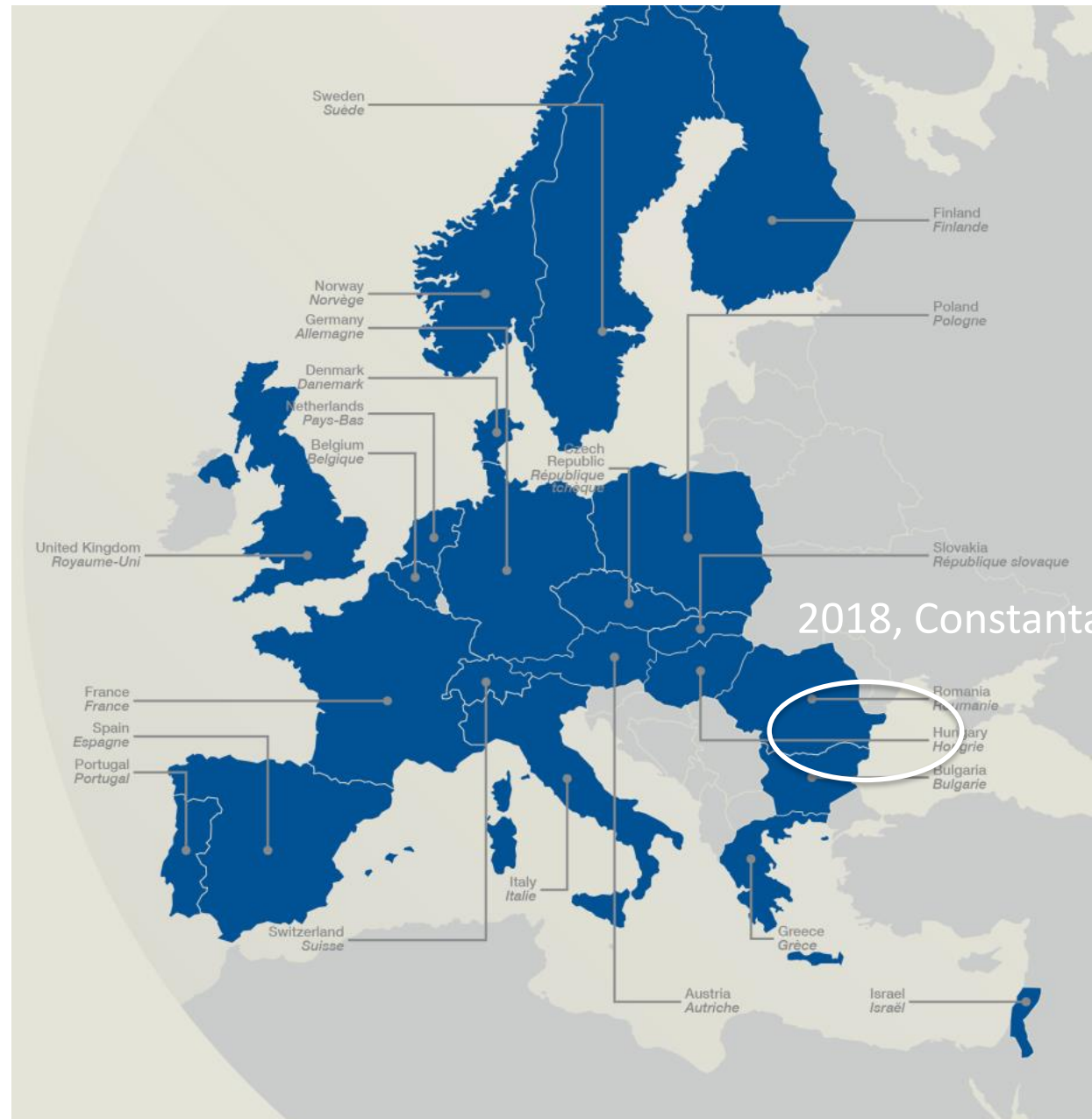
Applications

High Energy Physics
Nuclear Physics
Industrial Applications
Medical Applications
Cancer Therapy



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



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

| | Period I Feb-April | Period II May-June | Period IIb End June | Period III Sept-Oct | Period IV Nov-Dec | JAS 2017: RF Japan (Hayama) |
|------|--|--|---|---|---|--------------------------------|
| 2018 | Future Colliders Switzerland | Beam Instrumentation Finland | Short Introduction France (local) | General Introduction Romania | Comp. Methods Greece | |
| 2019 | Wakefield Acceleration Portugal (Sesimbra) | General Advanced Danmark (Metalskolen) | Short Introduction France (local) | General Introduction Slovakia (High Tatras) | JAS: Ion Colliders Russia (Dubna) | |
| 2020 | RF Lithuania (Vilnius) | Mechanical Engineering Holland | Short Introduction France (local) | General Introduction Ukraine earmarked | Warm magnets Austria | |
| 2021 | Controls & Digital Signal Processing tbd | General Advanced tbd | Short Introduction France (local) | General Introduction tbd | JAS: Very Advanced Beam Dynamics Canada (Saskatoon) | |

* 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

Program for the 2018 CAS - introduction to Accelerator Physics - Constanta

| | Su,16.9. | Mo, 17.9 | Tu, 18.9 | We, 19.9 | Th, 20.9. | Fr, 21.9 | Sa,22.9 | Su, 23.9 | Mo, 24.9 | Tu, 25.9 | Me, 26.9 | Th, 27.9 | Fr, 28.9. | Sa, 29.9. | |
|-------|----------|---|--|---|--|--|--|-----------|-------------------------------------|--|---|--|--|------------------------------------|-------------------------|
| 08:30 | | Opening local/Schmickler | Transverse Linear Beam Dynamics I Hillert | Linear Accelerators I Alesini | Longitudinal Beam Dynamics in Circular Machines II Tecker | Luminosity and Colliders Herr | Collective Effects I Li | | Collective Effects III Li | Electron Beam Dynamics II Rivkin | Free | Sources Faircloth | Secondary beams and targets Knie | Bus transfer to Bukarest, EU visit | |
| 09:30 | | | | | | | | | | | | | | | |
| 09:45 | | Accelerator Applications Sheehy | Transverse Linear Beam Dynamics II Hillert | Linear Accelerators II Alesini | Transverse Linear Beam Dynamics V Hillert | Injection and Extraction Fraser | Collective Effects II Li | | Collective Effects IV Li | Discussion electron beam dynamics Rivkin | | RF systems I Damerau | RF systems II Damerau | | |
| 10:45 | | Coffee | | | | | | | Coffee | | | Coffee | | | |
| 11:15 | | Electromagnetic Theory I Herr | Particle motion in Hamiltonian Formalism I Sheehy | Transverse Linear Beam Dynamics III Hillert | Discussion transverse BD Hillert | FFA's Sheehy | Advanced accelerator concepts Ferrario | | Discussion collective effects Li | Linear Imperfections III/Corrections Ziemann | | Ion acceleration via ultra-intense laser Domenico | Machine & People Protection Issues Forck | | |
| 12:15 | | Lunch | | | | | | | Lunch | | | | | | |
| 13:45 | | Electromagnetic Theory II Herr | Particle motion in Hamiltonian Formalism II Sheehy | Transverse Linear Beam Dynamics IV Hillert | | Kickers, Septa and Beam Transfer Fraser | Warm Magnets/power converters de Rijk | excursion | Linear Imperfections I Ziemann | A first taste of Non-Linear Beam Dynamics I Papaphilippou | A first taste of Non-Linear Beam Dynamics II Papaphilippou | Beam Instrumentation Forck | Introduction to Non-Linear longitudinal Beam Dynamics Damerau | | late lunch at ELI |
| 14:45 | | | | | | | | | | | | | | | |
| 15:00 | | Kinematics of Particle Beams - Relativity Ferrario | Hands-ON Lattice calculations - Introduction Ziemann/Herr/Sterbin | Longitudinal Beam Dynamics in Circular Machines I Tecker | | Discussion longitudinal BD Tecker/Alesini | Superconducting Magnets de Rijk | | | Linear Imperfections II/Corrections Ziemann | Cyclotrons I Seidel | Synchrotron light machines &FELs Diaconescu | Beam Diagnostics Forck | | Q&A/study time V all |
| 16:00 | | Coffee | | | | | | | | Coffee | | | | | |
| 16:30 | | Statistical Description of Particle Beams Ferrario | Hands-ON Lattice calculations I Ziemann/Herr/Sterbin | Hands-ON Lattice calculations II Ziemann/Herr/Sterbin | | Hands-ON Lattice calculations IV Ziemann/Herr/Sterbin | Hands-ON Lattice calculations VI Ziemann/Herr/Sterbin | | | Electron Beam Dynamics I Rivkin | Cyclotrons II Seidel | Designing a synchrotron - a real life example Papaphilippou | Q&A/study time IV all | closing Schmickler | |
| 17:30 | | 1 slide 1 minute all | | Hands-ON Lattice calculations III Ziemann/Herr/Sterbin | | Hands-ON Lattice calculations V Ziemann/Herr/Sterbin | Posters all | | | Q&A/study time I all | Q&A/study time II all | Q&A/study time III all | A critical view on cultural heritage conservation by ionizing radiation - need, option, adherence and reluctance Cornelia Perta | | |
| 18:30 | | Welcome Reception | | | | | | | | | | | | | |
| 19:30 | | Dinner at Hotel | | | | | | | | | | | | | |
| 21:00 | | poster preparation | | | | | | | | cinema event | | | Banquet | | |

...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”

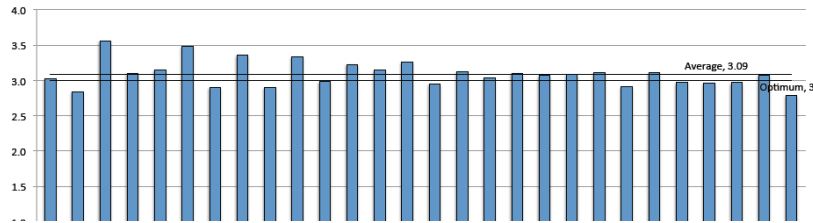
Feedback

- Please, please, please
– Give us your feedback

| LEVEL | CONTENT | PRESENTATION |
|-------------------|------------------------------|---------------|
| 1 – Much too low | 1 – Completely uninteresting | 1 – Very poor |
| 2 – Low | 2 – Uninteresting | 2 – Poor |
| 3 – Just right | 3 – Of some interest | 3 – Fair |
| 4 – Too high | 4 – Interesting | 4 – Good |
| 5 – Much too high | 5 – Very interesting | 5 – Very good |

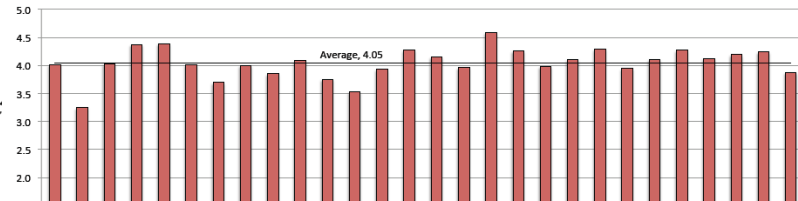
CERN Accelerator School, Superconductivity for Accelerators, Eric, Apr/May 2013 - Replies from 60/94 students

Level



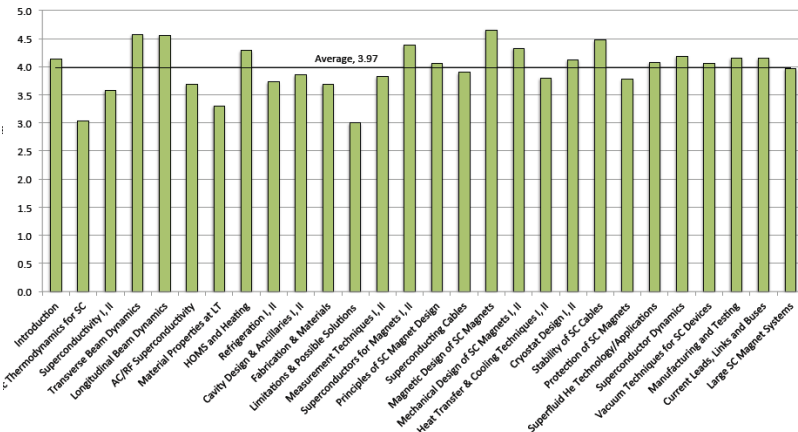
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Content



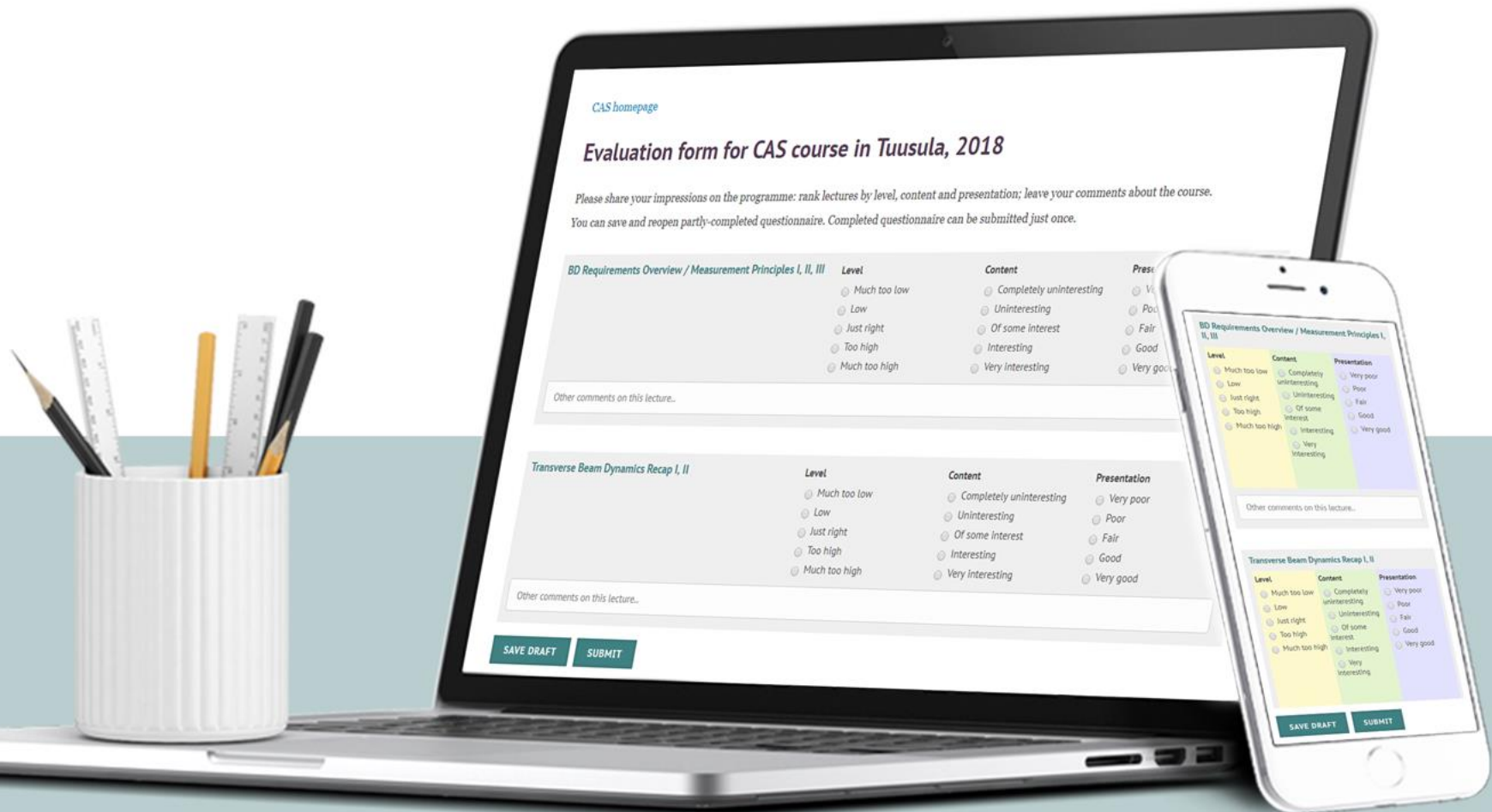
CERN Accelerator School, Superconductivity for Accelerators, Eric, Apr/May 2013 - Replies from 60/94 students

Presentation



| TITLE | LEVEL | CONTENT | PRESENTATION |
|--|-------|---------|--------------|
| Recap. Transverse Beam Dynamics I, II | | | |
| Introduction to RF Measurement Techniques | | | |
| Introduction to Beam Instrumentation and Diagnostics I, II | | | |
| Introduction to Optics Design | | | |
| Introduction to Lattice Cells | | | |
| Recap. Longitudinal Beam Dynamics I, II | | | |
| Introduction to Insertions | | | |
| Wakefields and Impedances | | | |
| Space Charge in Linear Machines | | | |
| Introduction to Non-Linear Dynamics | | | |
| Beam Instabilities - Longitudinal | | | |
| Space Charge in Circular Machines | | | |
| Energy Recovery Linacs | | | |
| Landau Damping I, II | | | |
| Beam Instabilities - Transverse | | | |
| Instabilities in Linacs | | | |
| Feedback Systems I, II | | | |
| Electron Cloud and Instabilities | | | |
| Advanced Concepts for Beam-Driven Acceleration | | | |
| Beam-Beam Effects | | | |
| Timing and Synchronisation | | | |
| NLD Methods I, II, III | | | |
| Beam Cooling | | | |
| NLD Phenomenology I, II | | | |
| Advanced Magnet Technologies | | | |
| High Brightness Beam Diagnostics | | | |
| Low Emittance Machines I, II | | | |
| Insertion Devices | | | |
| Advanced Concepts for Laser-Driven Acceleration | | | |

Online evaluation



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...