The CERN Accelerator School

WiFi: CERN Participants
W3lc0m3@#

Introduction to Accelerator Physics

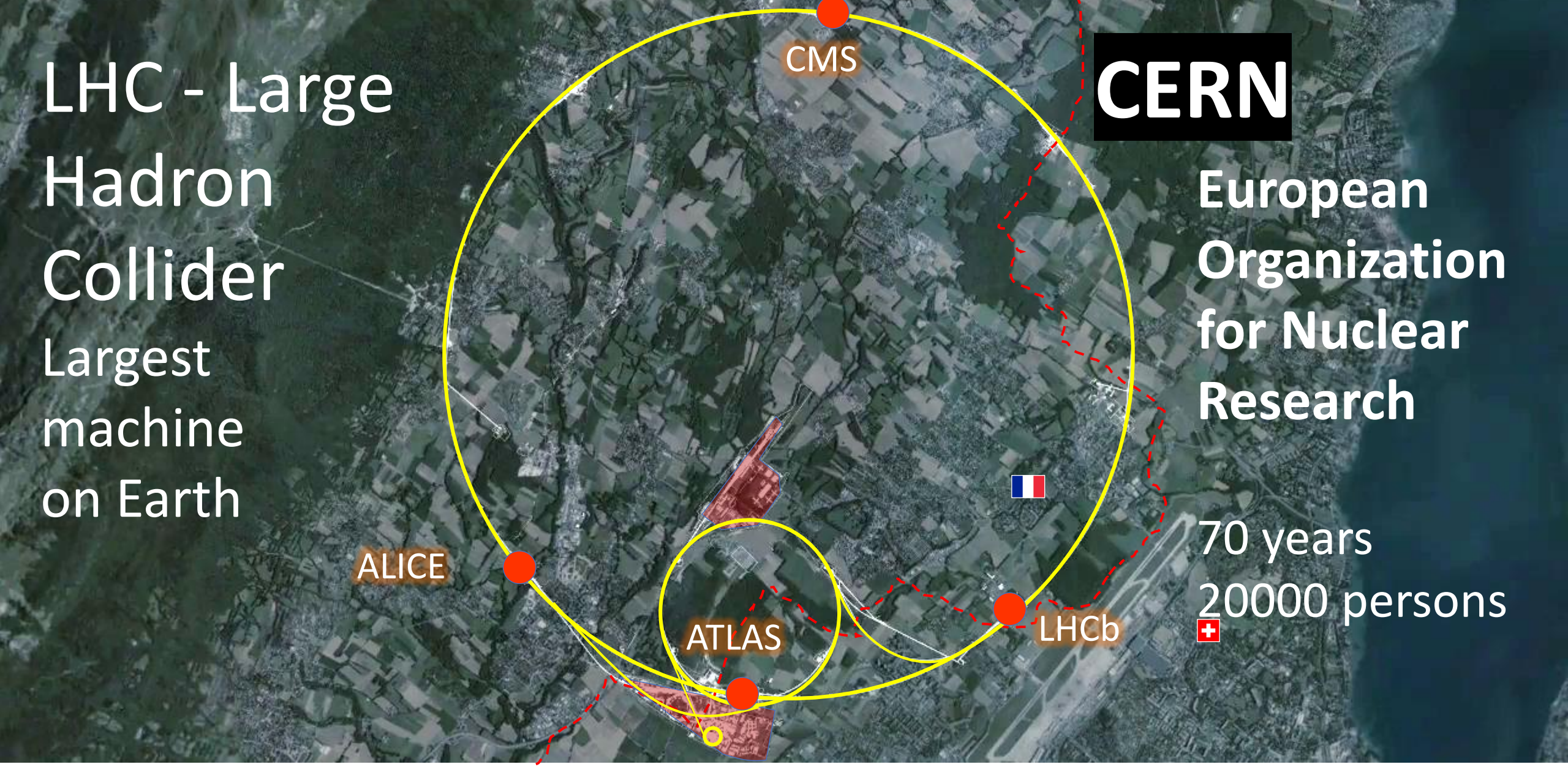
22 September – 5 October 2024

Hotel Indalo Park, Santa Susanna, Spain

WELCOME!

LHC - Large Hadron Collider

Largest machine on Earth



CERN

European Organization for Nuclear Research

70 years

20000 persons

Credit: François Briard

The CERN Accelerator School - CAS

- Established at the beginning of 1983 => 41 years this year!
  - 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 topics in the field (RF, BI, magnets, vacuum, colliders, beam dynamics, plasma,…)
  - 50 to 70 hours teaching in ~2 week intensive residential courses
- About 90 courses held so far
- Occasional courses in the framework of the US-CERN-Japan-Russia Joint Accelerator School (JAS), from 2022: IAS (International Accelerator School)
  - 15 schools held so far (since 1985), lately: Superconductivity in July 2023, next Australia

The CERN Accelerator School

Scope

Accelerator Physics

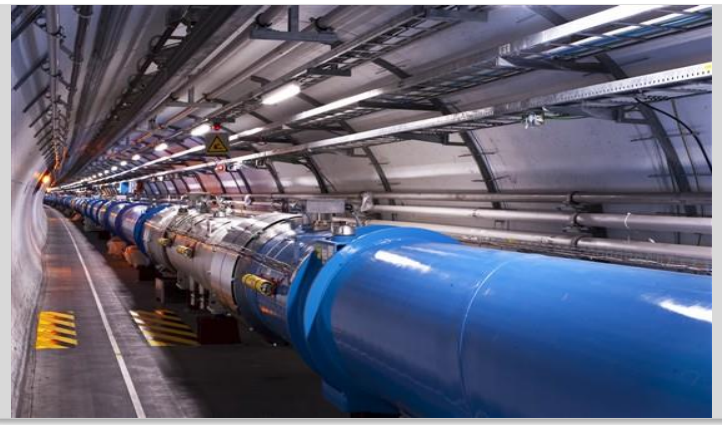
Relativity / Electro-Magnetic Theory / Transverse Beam Dynamics / Longitudinal Beam Dynamics / Linear Imperfections and Resonances / Synchrotron Radiation / Electron Beam Dynamics / Multi-Particle Effects / Non-Linear Dynamics / Beam Instabilities / Landau Damping / Beam-Beam Effects

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 / Sustainability

Accelerators

Linear Accelerators
Synchrotron Light Machines
FELs
FFAs
Cyclotrons
Synchrotrons
Colliders



Applications

High Energy Physics
Nuclear Physics
Industrial Applications
Medical Applications
Cancer Therapy

Residential CAS Courses

- **Introduction to Accelerator Physics** (yearly – in September)
  - 22 Sep – 5 Oct 2024 (in Santa Susanna) – next year in Türkiye
  - Hands-on exercises in transverse and longitudinal beam dynamics

- **Advanced Accelerator Physics**
  - 10 – 22 Nov 2024 in Spa, Belgium
  - Hands-on in RF, Beam Instrumentation and Beam Dynamics

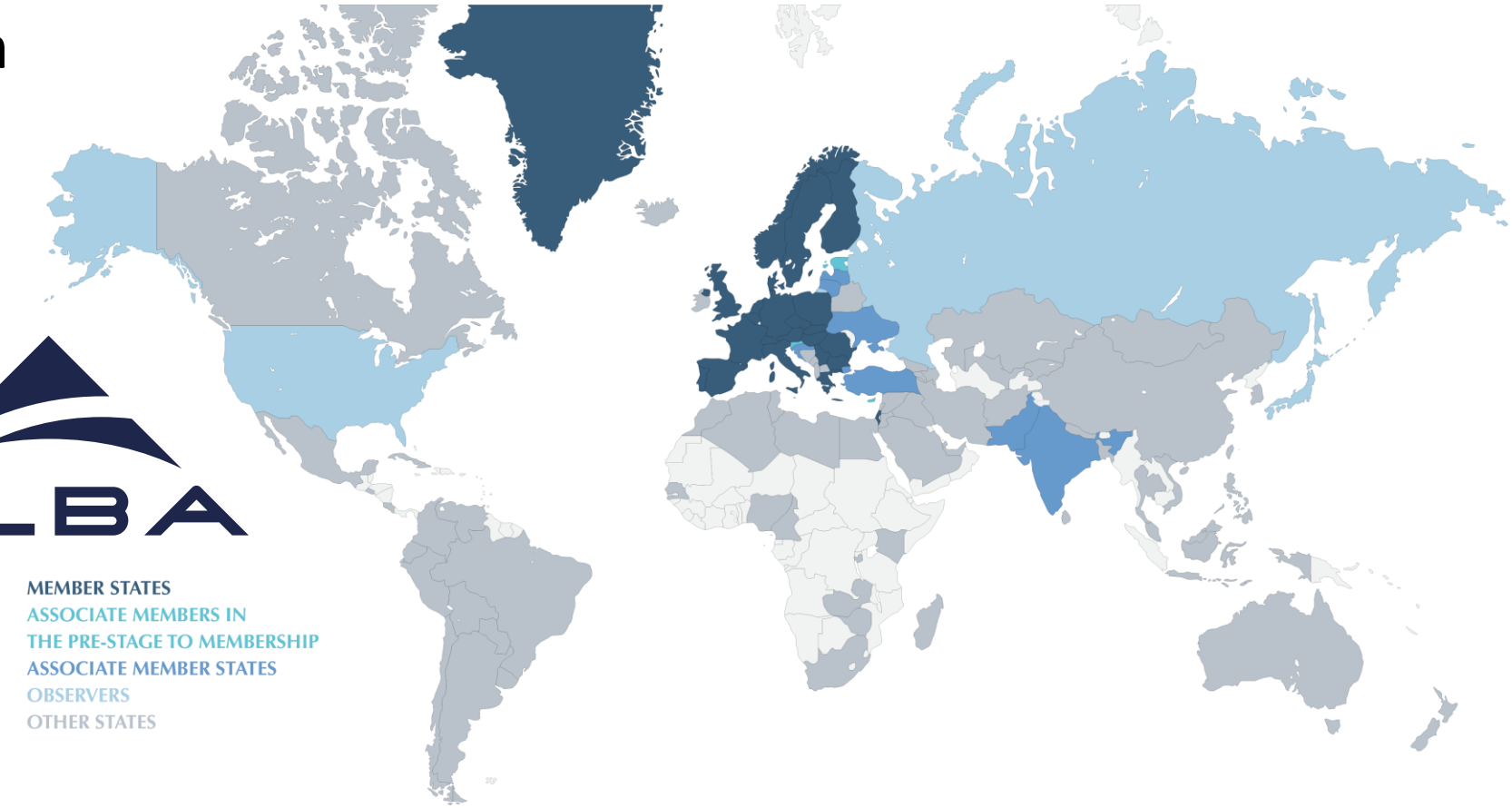
- 2023: Radiofrequency, Magnets
- 2024: Mechanical and Material Engineering
- 2025: **Intensity Limitations for Hadron Beams**, **Beam Instrumentation**
- **Basic course** (non-residential) near CERN – open for external participants

- Networking is an essential part of each CAS course!

Why are we in Spain now?

- CERN is financed by 24 member states and 10 associated member states
- CAS visits all CERN member states and associated member states in turn
- Previous school in Spain in ~~2012~~ 2023
- School organized with the ALBA Synchrotron

  Many thanks to:
  - **Caterina Biscari**
  - **Francis Pérez**
  - **Daimí Pérez**



Introduction to Accelerator Physics

Organization of the Course

Program for the 2024 CAS - Introduction to Accelerator Physics

	Sun 22/09	Mon 23/09	Tue 24/09	Wed 25/09	Thu 26/09	Fri 27/09	Sat 28/09	Sun 29/09	Mon 30/09	Tue 01/10	Wed 02/10	Thu 03/10	Fri 04/10	Sat 05/10
08:30	Arrival day and registration	Opening / ALBA presentation Tecker et al.	Transverse Linear Beam Dynamics II Hillert	Transverse Linear Beam Dynamics III Hillert	ALBA visit	Linear imperfections - corrections Ziemann	Electron Beam Dynamics II Riviin	Excursion	Cyclotrons Seidel	Beam Diagnostics I Forck	Free	Time and Frequency domain signals I Schmickler	Synchrotron light circular machines & FELs I Prat	Departure day
09:30														
09:35		Electromagnetic Theory Shreyber	Warm Magnets de Rijk	Linear Accelerators I Alesini		Longitudinal BD in Circular Machines II Tecker	Collective Effects III Li		RF systems I Völlinger	Introduction to Non-Linear longitudinal Beam Dynamics Damerau		A first taste of Non-Linear Beam Dynamics I Bartosik	Synchrotron light circular machines & FELs II Prat	
10:35		Coffee				Coffee			Coffee			Coffee		
11:05		History of particle acceleration Sheehy	Sources Faircloth	Transverse Linear Beam Dynamics IV Hillert		Collective Effects I Li	Injection and Extraction Arnutia		Sustainability for Accelerators Seidel	Beam Diagnostics II Forck		Time and Frequency domain signals II Schmickler	Particle motion in Hamiltonian Formalism II Papaphilippou	
12:05					Lunch						Lunch			
12:10		Kinematics of Particle Beams - Relativity Shreyber	Secondary beams and targets Faircloth	Linear Accelerators II Alesini		Electron Beam Dynamics I Riviin	Collective Effects IV Li		RF systems II Völlinger	Advanced accelerator concepts I Ferrario		A first taste of Non-Linear Beam Dynamics II Bartosik	Putting it all together Schmickler	
13:10		Lunch			Transverse Linear Beam Dynamics VI Hillert	Lunch			Lunch		Computational tools I Latina	Lunch		
14:45														
14:50		Transverse Linear Beam Dynamics I Hillert	Superconducting Magnets de Rijk	Transverse Linear Beam Dynamics V Hillert	Linear Imperfections I Ziemann	Collective Effects II Li	Vacuum Seidel		Hands-ON calculations (longitudinal) - Intro Damerau et al.	Hands-ON calculations (longitudinal) - III Damerau et al.	Advanced accelerator concepts II Ferrario	Particle motion in Hamiltonian Formalism I Papaphilippou	Designing a synchrotron - a real life example Papaphilippou	
15:50		Coffee							Coffee					
16:20		Accelerator Applications Sheehy	Hands-ON Lattice calculations I Gamba et al.	Hands-ON Lattice calculations III Gamba et al.	Longitudinal BD in Circular Machines I Tecker	Hands-ON Lattice calculations V Gamba et al.	Discussion session		Hands-ON calculations (longitudinal) - I Damerau et al.	Hands-ON calculations (longitudinal) - IV Damerau et al.	Computational tools II Latina	Discussion session	Closing Tecker	
17:20														
17:25		1 slide 1 minute	Hands-ON Lattice calculations II Gamba et al.	Hands-ON Lattice calculations IV Gamba et al.	Linear Imperfections II Ziemann	Hands-ON Lattice calculations VI Gamba et al.	Study time all		Hands-ON calculations (longitudinal) - II Damerau et al.	Hands-ON calculations (longitudinal) - V Damerau et al.	Colliders and luminosity Schmickler	Study time all		
18:25														
18:45		Welcome reception	Poster session		Discussion session	** Seminar **								
19:25														
19:45														
20:15		Dinner at Hotel											Banquet	
21:00										Cinema event			Show	

The CERN Accelerator School

This course

- 84 participants (27 CERN, 54 external, 3 grants) – 31 nationalities!!
- Lectures 45-50 minutes + discussion (don’t be shy!)
- Discussion sessions with lecturers and hands-on colleagues
- Hands-on courses for transverse and longitudinal optics

- Poster session tomorrow, Tuesday after hands-on

- Entertaining seminar by local lecturer
  - **The Hypatia Mission: Opening Space to Women, by Prof. Neus Sabaté Vizcarra**

- **1 slide – 1 minute** today followed by Welcome drink (outside)

This course

- Breakfast from 7:30
- Lunch and coffee breaks between the lectures
- Dinner buffet from 20:15 until 21:30, special dinner show last evening
- use this for networking
- **ALBA visit**
  - Thu 26/09: **Buses leave at 8:30 !!!**
- **Excursion** to Barcelona (La Pedrera, lunch, free time)
  - Sun 29/09: **buses leave at 9:15 !!!**
  - no lunch in the hotel that day
  - Bus back at 18:00 from Barcelona
- **Cinema evening** next week on Tuesday 1/10

The CERN Accelerator School

Hands-on courses

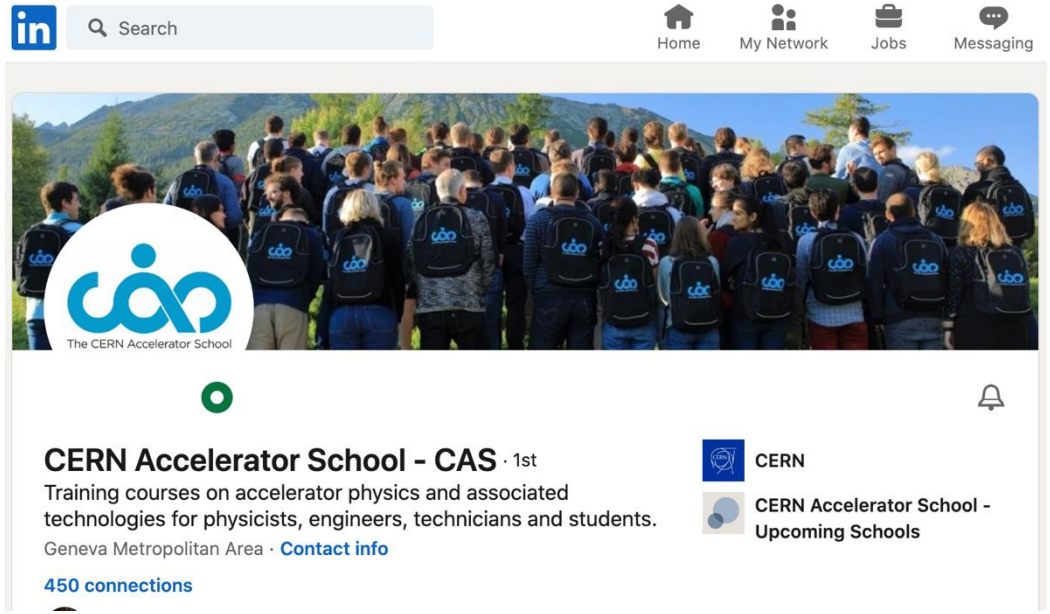
- Transverse Optics (this week)
- Longitudinal Optics (next week)

- Python
  - You should have this installed by now
  - otherwise please follow instructions on the web site before tomorrow

Networking

- Next to the course teaching the most important aspect of the school
  " digital training cannot replace CAS courses"

  - people socialising (and even working) up to late in the evenings
  - lots of interactions students <-> teachers
  - cinema evening, CASaoke
  - excursion



- LinkedIn
  - From the CAS web page
  - CAS profile: https://www.linkedin.com/in/cern-cas/

Networking

- **Castellers**

- **WhatsApp Group**

The CAS Team

Noemi Caraban Gonzalez

CASopedia, Social media

Christine Völlinger

Deputy Director

Maria Filippova

Administrative Assistant

Frank Tecker

Director

Delphine Rivoiron

Administrative Manager

Hermann Schmickler

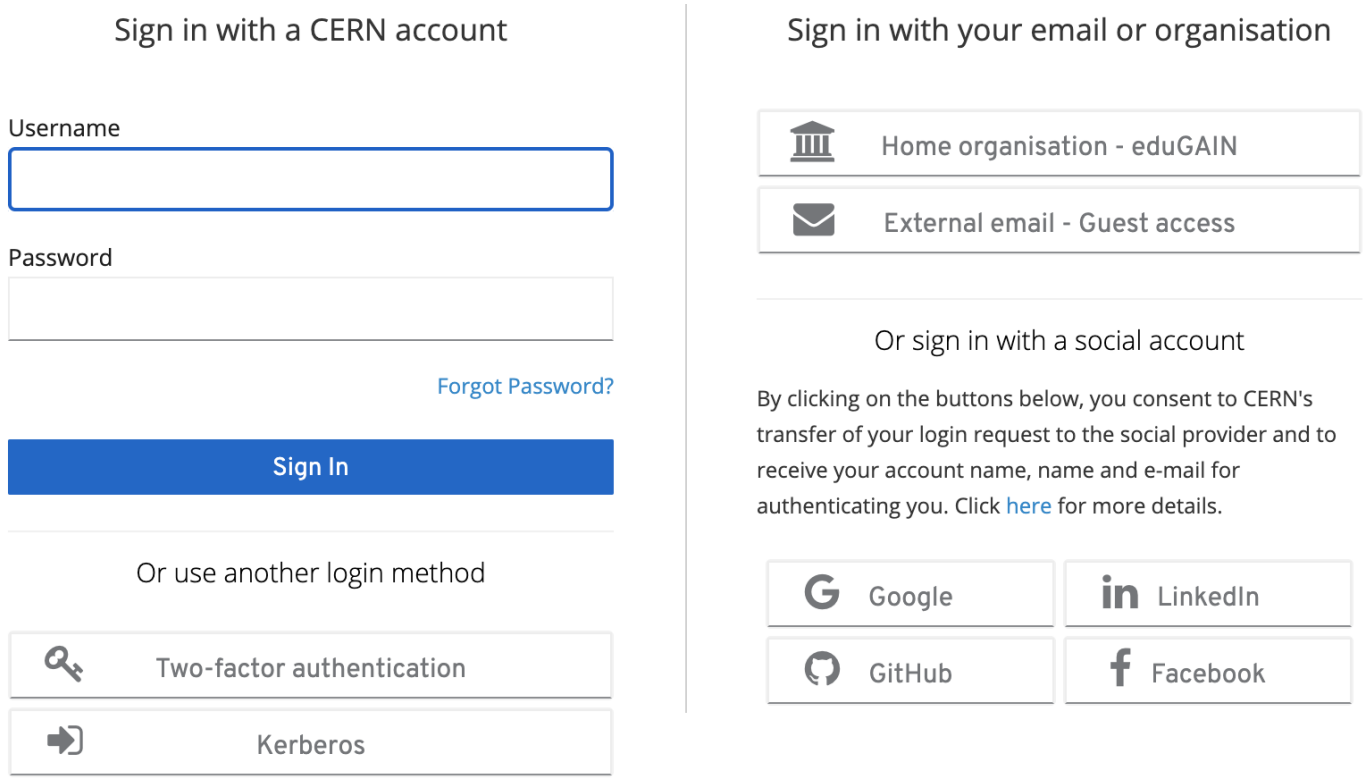
previous Director

Ron Suykerbuyk

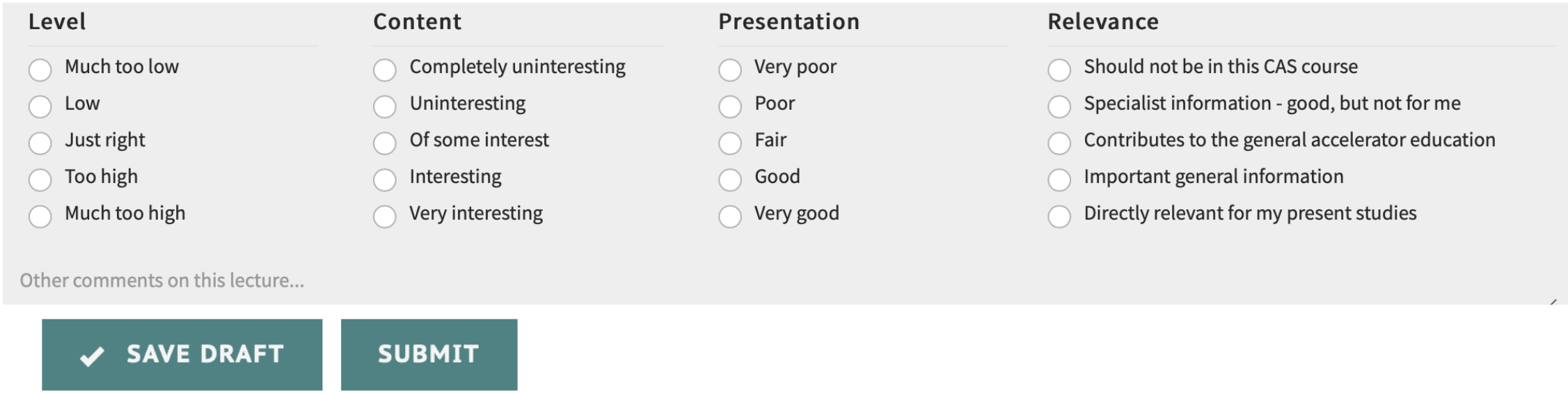
Filming system support

Online Evaluation Form

- Important to maintain / improve the high quality of teaching
- https://cas.web.cern.ch/evaluation/spain-2024
- Log in with CERN account or many other ways (Google, LinkedIn, …)



Online Evaluation Form



- Please **fill it in** ideally **daily** during the course, when your memory is fresh
- You can **save it** and come back to it later at any time
- Just **DON'T submit it until** you have completed your evaluation at **the end**

Introduction to Accelerator Physics

Enjoy the course!

http://cern.ch/cas