Advanced Accelerator Physics

10 – 22 November 2024

Hotel Silva, Spa, Belgium

WELCOME (back)!

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

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Scope

Accelerator Physics

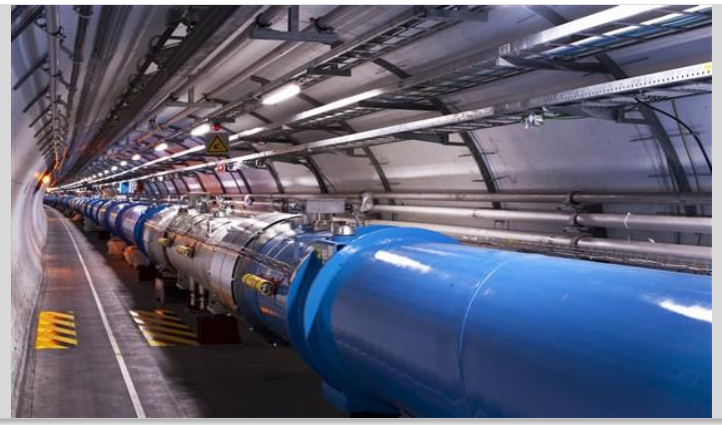
Relativity / Electro-Magnetic Theory / Transverse Beam Dynamics / Longitudinal Beam Dynamics / Linear Imperfections and Resonances / Synchrotron Radiation / Electron Beam Dynamics / Multi-Particle Effects / Non-Linear Dynamics Beam Instabilities / Landau Damping / Beam-Beam Effects

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
FFAs
Cyclotrons
Synchrotrons
Colliders



Applications

High Energy Physics
Nuclear Physics
Industrial Applications
Medical Applications
Cancer Therapy

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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

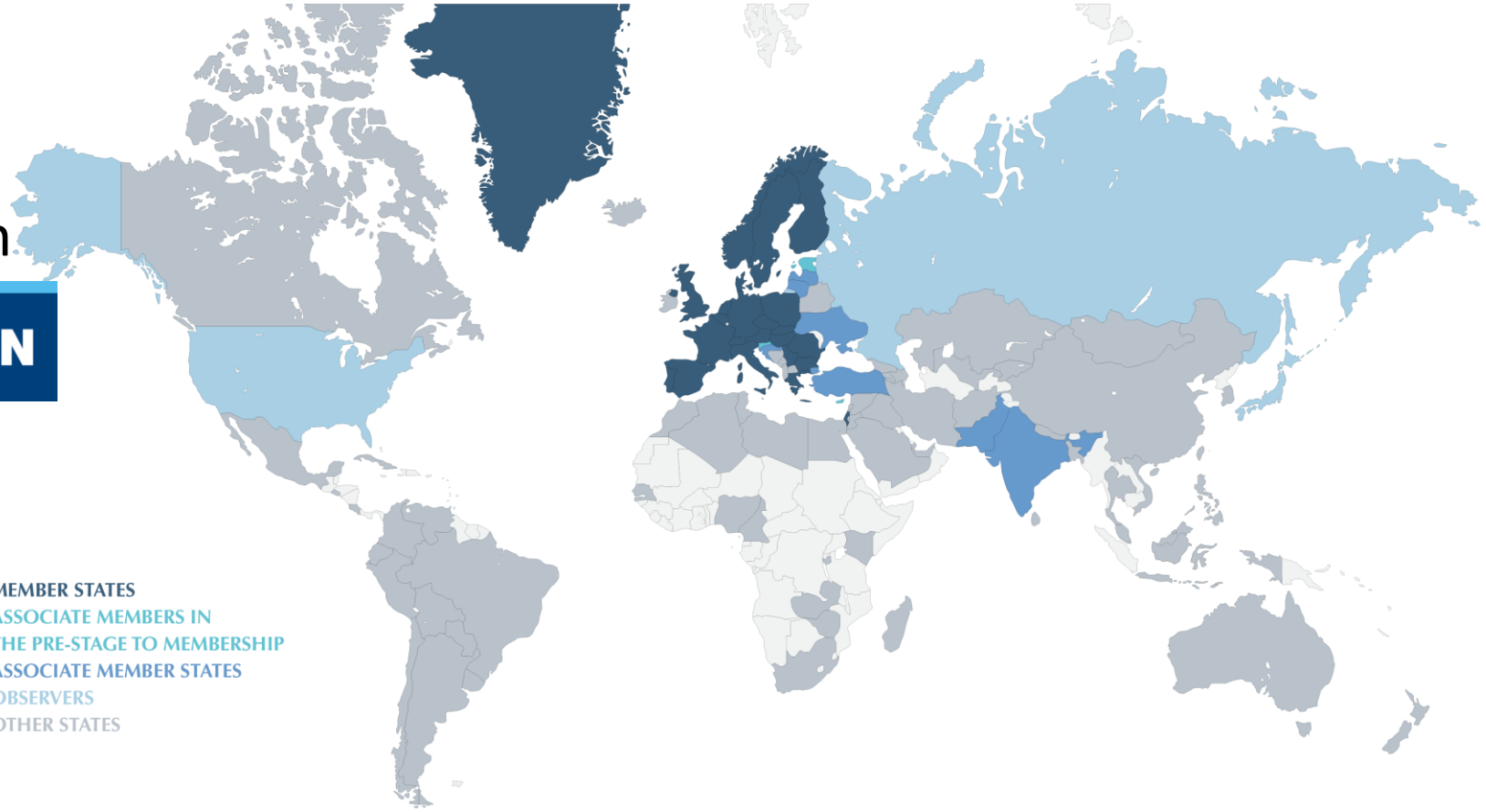
- **Advanced Accelerator Physics** (every two years)
  - 10 – 22 Nov 2024 in Spa, Belgium – here and now!
  - Hands-on in RF, Beam Instrumentation and Beam Optics

- 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 Belgium 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 residential CAS in Belgium in 2009
- School organized with UCLouvain and KU Leuven



Many thanks to:

- Filip Moortgat
- Thomas Cocolios
- Eduardo Cortina Gil
- Christophe Delaere
- Agi Koszorus

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Advanced Accelerator Physics

Organization of the Course

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This course

- 67 participants (32 CERN, 34 external, 1 grant)
- Lectures 45-50 minutes + discussion
- Discussion sessions with lecturers
- Hands-on courses for RF measurements, Beam Instrumentation and Beam Optics

- Lunch and coffee breaks between the lectures
- arrival at dinner buffet 19:30 – 20:30, buffet until 21:30
- use this for networking
- 1 slide – 1 minute today followed by Welcome drink
- Excursion to F1 racetrack on Sunday, followed by lunch and time in Liège
- Cinema evening next week on Tuesday
- entertaining seminar by local professor: Hervé Vanderschuren (KU Leuven)

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Program for the 2024 CAS - Advanced Accelerator Physics

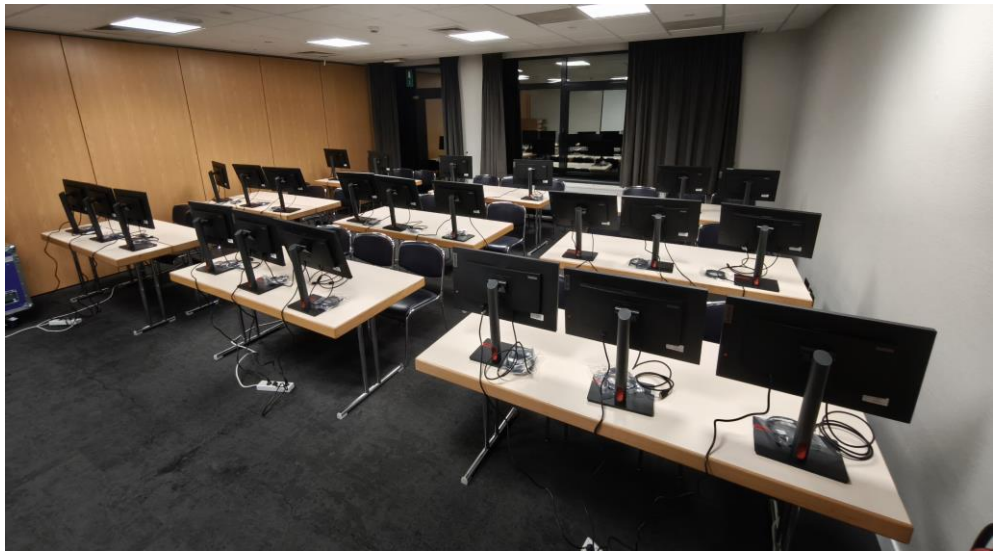
	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
	10/11	11/11	12/11	13/11	14/11	15/11	16/11	17/11	18/11	19/11	20/11	21/11	22/11
08:00	Arrival day and registration	Opening	Lattice Cells	Recap Longitudinal Beam Dynamics I	Space charge in linear machines	Beam instabilities - Transverse	Beam loading	Excursion	Optics calculations	Landau Damping I	Free	Non Linear Dynamics - Phenomenology I	Departure day
		Tecker	Sterbini	Tecker	Ferrario	Li	Damerau		Sterbini	Buffat		Papaphilippou	
09:00		Recap Introductory course I	Accelerator issues overview	Recap Longitudinal Beam Dynamics II	Wakefields and Impedances	Instabilities in Linacs	Beam Dynamics with Synchrotron Radiation		High Brightness Beam Diagnostics	Muon Colliders I		Collimation	
		Schmickler	Tecker	Tecker	Rumolo	Ferrario	Martin		Bobb	Rogers		Redaelli	
10:00		Coffee							Coffee			Coffee	
11:00		Intro to RF measurement techniques I	Intro to RF measurement techniques II	RF Manipulations I	Space charge in circular machines	Electron Cloud and Instabilities	Insertion devices - Radiation		FEL I	Landau Damping II		Non Linear Dynamics - Phenomenology II	
		Wendt	Wendt	Timko	Ferrario	Li	Clarke		Hillert	Buffat		Papaphilippou	
12:00		Intro to Beam Instrumentation and Diagnostics I	Intro to Beam Instrumentation and Diagnostics II	RF Manipulations II	Beam Instabilities - Longitudinal	Discussion on Instabilities	Low emittance lattices		Longitudinal beam diagnostics	Muon Colliders II		Discussion on Non Linear Dynamics	
		Krupa	Krupa	Timko	Rumolo	Rumolo/Li	Martin		Bobb	Rogers		Papaphilippou	
13:00		Lunch							Lunch				
14:00		Recap Introductory course II	Insertions & Dispersion Suppressors	RF Feedbacks	Free	Overview of Wakefield Acceleration	Insertion devices - Technology		FEL II	ERL	Non Linear Dynamics - Methods and Tools I	Collimation + technical implementation	
		Schmickler	Sterbini	Damerau		Ferrario	Clarke		Hillert	Jankowiak	Papaphilippou	Redaelli	
15:00		Intro to Optics Design	C1/C2/C3	C1/C2/C3		C1/C2/C3	C1/C2/C3		C1/C2/C3	C1/C2/C3	Beam-Beam effects	RF show	
		Sterbini									Buffat		
16:00		Coffee				Coffee			Coffee				
17:00		151M	C1/C2/C3	C1/C2/C3		C1/C2/C3	C1/C2/C3		C1/C2/C3	C1/C2/C3	Non Linear Dynamics - Methods and Tools II	Closing	
18:00		Welcome Drink									Papaphilippou	Tecker	
18:30											HL-LHC Challenges		
19:00				18:30 Seminar							Zerlauth		
										21:00 Cinema evening			
19:30		Dinner										Gala Dinner	

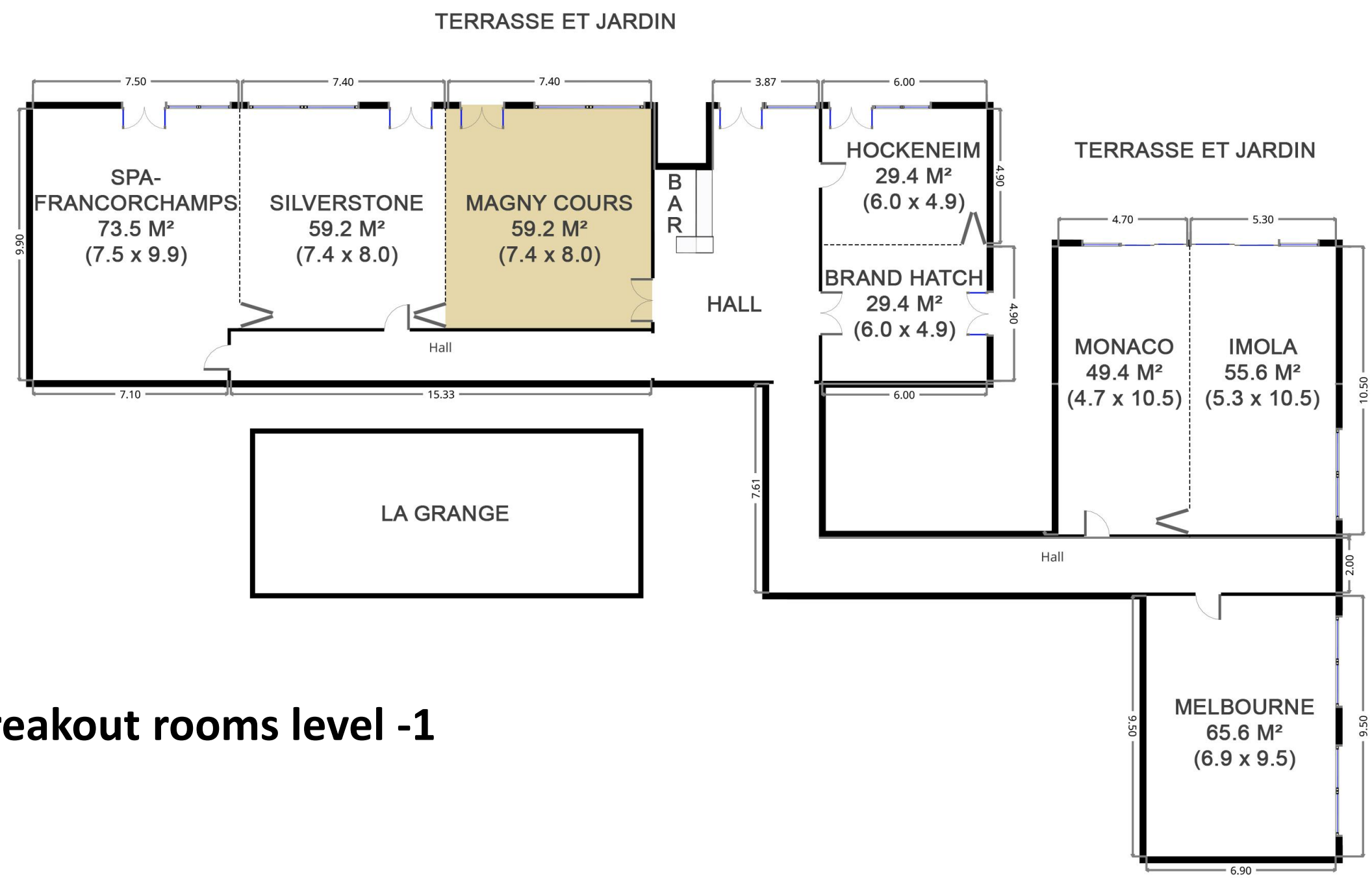
Hands-on courses

- **Beam Optics Design and Correction**
  - Python and Xsuite (on your own computer)
    - You should have this installed by now
    - In case of problems: Contact Guido, Sofia, or Max today
  - in this auditorium

- **RF measurements**
  - in “Spa Francorchamps” and “Silverstone”
  - will use computers in “Magny Cours” on Friday 15/11

- **Beam instrumentation and diagnostics**
  - Computer lab in “Magny Cours”
    - You should have installed Beam_Instrumenation_Simulator
  - other experiments in “Monaco” and “Imola”



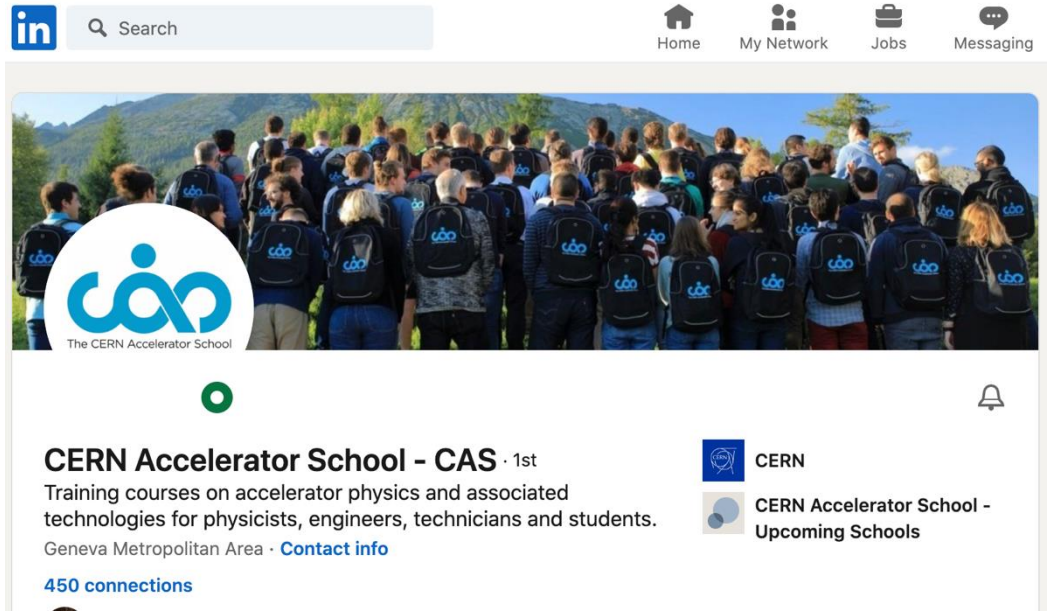


Breakout rooms level -1

Networking

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

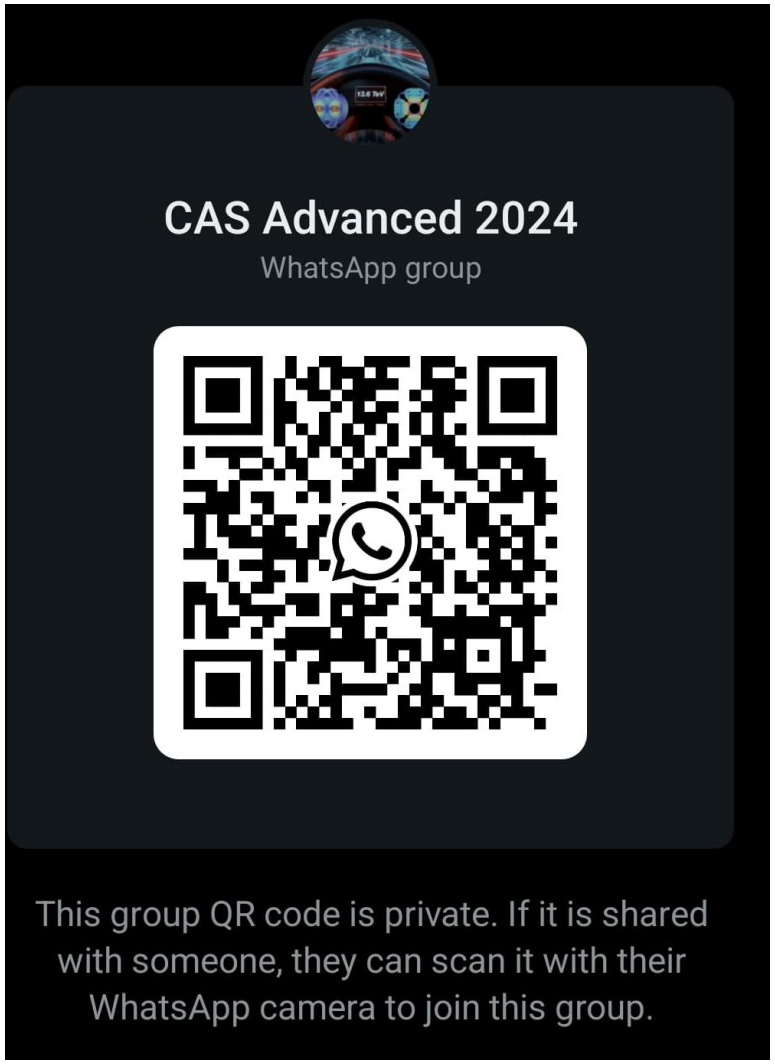
  - people socialising (and even working) up to late in the evenings
  - lots of interactions students <-> teachers
  - cinema evening, ~~Kara~~CASaoke
  - excursion



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

Networking

- WhatsApp group to facilitate organizing of activities:



- LinkedIn

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School etiquette

For the benefit of everyone, we kindly ask you to respect the following basic rules of the school:

- **Participate**:
  - Attendance at all lectures and exercises is expected
  - social activities are optional but strongly recommended
- **Be on time** for classes, transport, etc… If you are late, we won't wait.
- **Please wear your badge**: It will help you and everyone to know who is who!

The CAS Team

Noemi Caraban Gonzalez
CASopedia, Social media

Christine Völlinger
Deputy Director

Maria Filippova
Administrative Assistant

Frank Tecker
Director

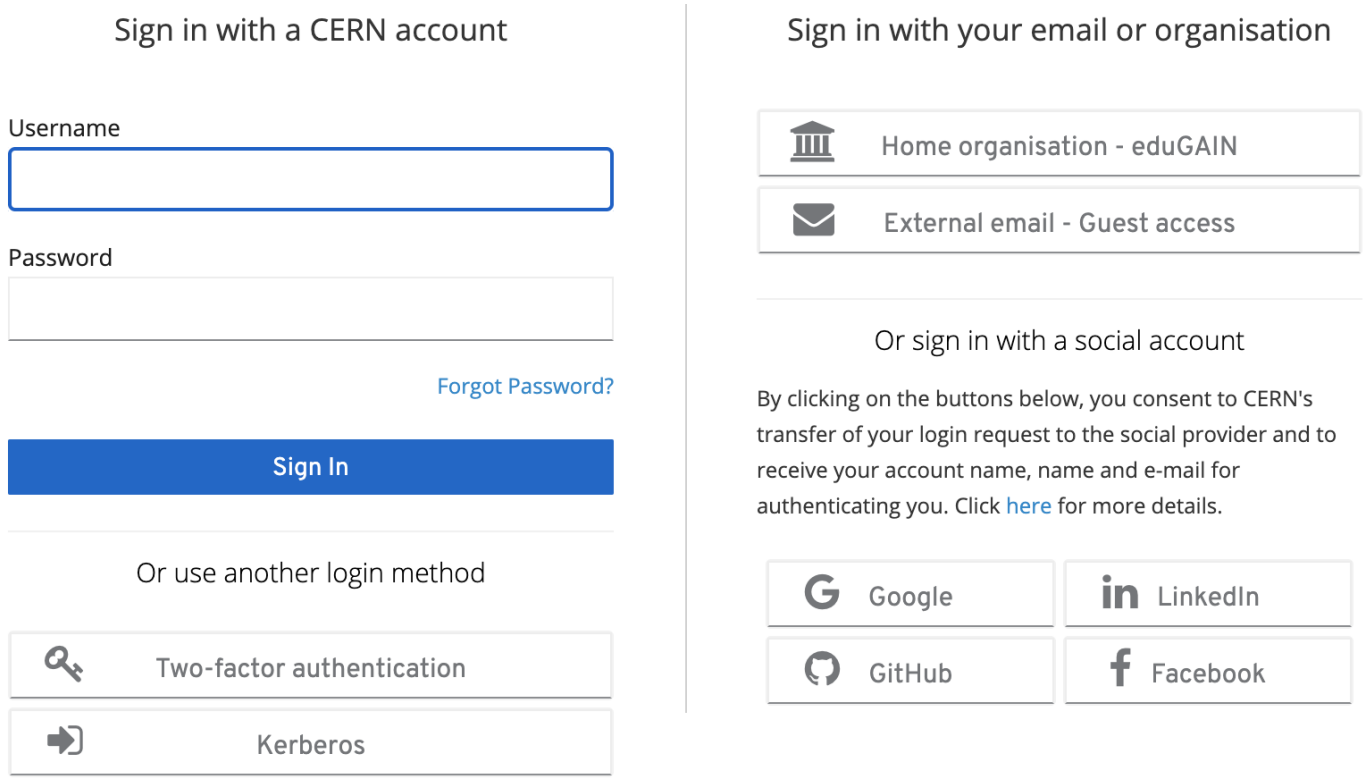
Delphine Rivoiron
Administrative Manager

Hermann Schmickler
previous Director

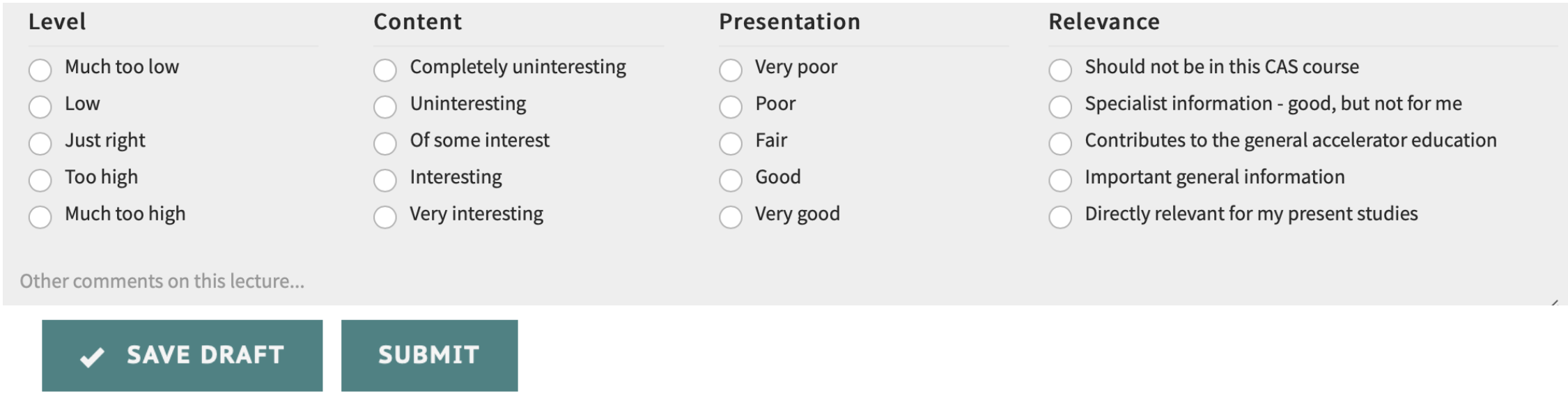
Ron Suykerbuyk
Filming system

Online Evaluation Form

- Important to maintain / improve the high quality of teaching
- https://cas.web.cern.ch/evaluation/spa-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**

Advanced Accelerator Physics

Enjoy the course!

http://cern.ch/cas