



The CERN Accelerator School

WiFi: CERN Participants  
W3lc0m3@#

# Introduction to Accelerator Physics

25 September – 8 October 2023

Hotel Indalo Park, Santa Susanna, Spain

# WELCOME!

LHC - Large  
Hadron  
Collider  
Largest  
machine  
on Earth

ALICE

ATLAS

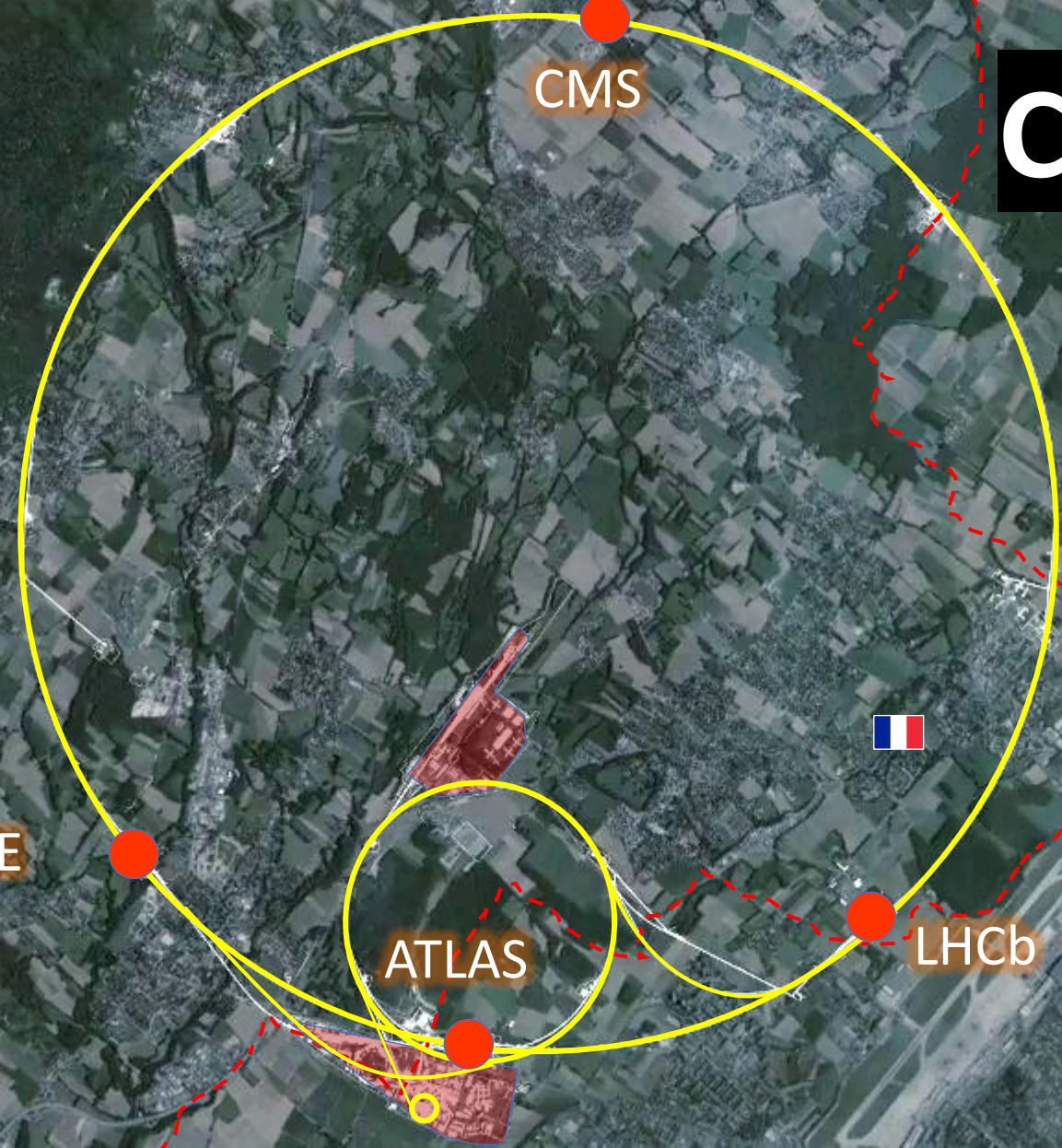
CMS

**CERN**

European  
Organization  
for Nuclear  
Research

20000 persons

LHCb



# The CERN Accelerator School - CAS

- Established at the beginning of 1983 => 40 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 course in July 2023

# Scope

## Accelerator Physics

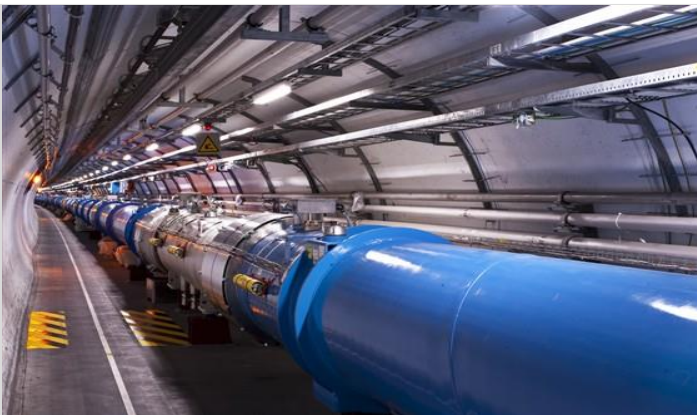
Relativity / Electro-Magnetic Theory /  
Transverse Beam Dynamics /  
Longitudinal Beam Dynamics / Linear  
Imperfections and Resonances /  
Synchrotron Radiation / Electron  
Beam Dynamics / Multi-Particle  
Effects / Non-Linear Dynamics / Beam  
Instabilities / Landau Damping /  
Beam-Beam Effects

## Accelerator Systems

Particle Sources / RFQ / LEPT  
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)
  - 25 Sep – 8 Oct 2023 (in Santa Susanna) – next year in Serbia (Belgrade)
  - Hands-on exercises in transverse and longitudinal beam dynamics
- **Advanced Accelerator Physics**
  - 6 – 18 Nov 2022 in Sévrier (near Annecy), France – next in 2024
  - Hands-on in RF, Beam Instrumentation and Beam Dynamics
- 2023: Radiofrequency, Magnets
- 2024: Mechanical and Material Engineering, ...
- **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 23 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

- School organized with the ALBA Synchrotron

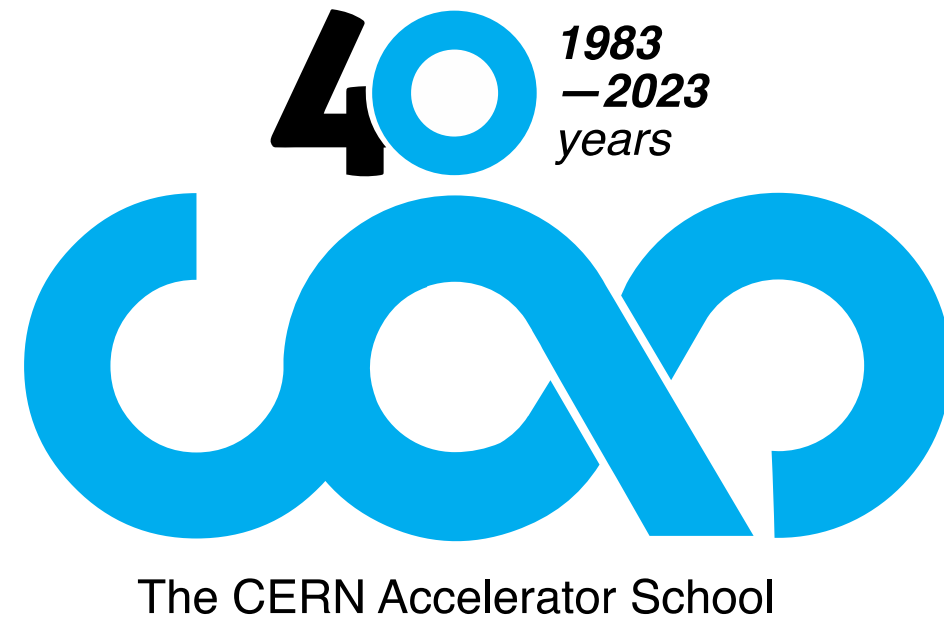
## Many thanks to:

- Caterina Biscari
- Francis Pérez
- Daimí Pérez



MEMBER STATES  
ASSOCIATE MEMBERS IN  
THE PRE-STAGE TO MEMBERSHIP  
ASSOCIATE MEMBER STATES  
OBSERVERS  
OTHER STATES

- **Many thanks to the Catalan Government**



# Introduction to Accelerator Physics

## Organization of the Course

## Program for the 2023 CAS - Introduction to Accelerator Physics

Program for the 2023 CAS - Introduction to Accelerator Physics																			
	Mon 25/09	Tue 26/09	Wed 27/09	Thu 28/09	Fri 29/09	Sat 30/09	Sun 01/10	Mon 02/10	Tue 03/10	Wed 04/10	Thu 05/10	Fri 06/10	Sat 07/10	Sun 08/10					
08:30	Arrival day and registration	Opening Tecker et al.	Kinematics of Particle Beams - Relativity Shreyber	Transverse Linear Beam Dynamics IV Hillert	Free	Beam Instrumentation Forck	Electron Beam Dynamics I Rivkin	Excursion --- Bus will leave at 8:00 AM!!!	Cyclotrons Seidel	Vacuum Seidel	Free / ALBA visit Bus will leave at 8:00 AM!!!	A first taste of Non-Linear Beam Dynamics I Bartosik	Advanced accelerator concepts II Ferrario	Departure day					
09:30																			
09:45		Electromagnetic Theory I Shreyber	Warm Magnets de Rijk	Computational tools I Latina		Computational tools II Latina	Electron Beam Dynamics II Rivkin		RF systems I Damerau	Collective Effects I Li		Secondary beams and targets Knie	Particle motion in Hamiltonian Formalism II Papaphilippou						
10:45		Coffee				Coffee			Coffee										
11:15		History of particle acceleration Sheehy	Transverse Linear Beam Dynamics II Hillert	Transverse Linear Beam Dynamics V Hillert		Beam Diagnostics Forck	Injection and Extraction Dutheil		Sustainability for Accelerators Seidel	Introduction to Non-Linear longitudinal Beam Dynamics Damerau		A first taste of Non-Linear Beam Dynamics II Bartosik	Synchrotron light circular machines & FELs I Prat						
12:15		Lunch																	
13:45		Electromagnetic Theory II Shreyber	Linear Accelerators I Alesini	Longitudinal BD in Circular Machines I Tecker		Longitudinal BD in Circular Machines II Tecker	Colliders and luminosity Schmickler		Machine & People Protection Issues Forck	RF systems II Damerau		Collective Effects II Li	Collective Effects III Li		Advanced accelerator concepts I Ferrario	Synchrotron light circular machines & FELs II Prat			
14:45																			
15:00		Transverse Linear Beam Dynamics I Hillert	Transverse Linear Beam Dynamics III Hillert	Time and Frequency domain signals I Schmickler		Linear Imperfections I Ziemann	Linear Imperfections - corrections Ziemann		ALBA presentation Discussion session Biscari	Hands-ON calculations (longitudinal) - Intro Damerau et al.		Hands-ON calculations (longitudinal) - III Damerau et al.	Sources Knie		Particle motion in Hamiltonian Formalism I Papaphilippou	Designing a synchrotron - a real life example Papaphilippou			
16:00		Coffee																	
16:30		Accelerator Applications Sheehy	Linear Accelerators II Alesini	Hands-ON Lattice calculations I Gamba et al.		Time and Frequency domain signals II Schmickler	Hands-ON Lattice calculations III Gamba et al.		Hands-ON Lattice calculations V Gamba et al.	Hands-ON calculations (longitudinal) - I Damerau et al.		Hands-ON calculations (longitudinal) - IV Damerau et al.	Collective Effects IV Li		Study time	Closing Tecker			
17:30																			
17:45		1 slide 1 minute	Superconducting Magnets de Rijk	Hands-ON Lattice calculations II Gamba et al.		Linear Imperfections II Ziemann	Hands-ON Lattice calculations IV Gamba et al.		Hands-ON Lattice calculations VI Gamba et al.	Hands-ON calculations (longitudinal) - II Damerau et al.		Hands-ON calculations (longitudinal) - V Damerau et al.	Discussion session all						
18:45		Welcome reception				Discussion session									Poster session	** Seminar ** Fusion for Energy Paco Sánchez			
20:15	Dinner at Hotel												Banquet						
21:00									Cinema event			Show							



# This course

- 85 participants (38 CERN, 42 external, 5 grants) – 30 nationalities!!
- Lectures 45-50 minutes + discussion
- Discussion sessions with lecturers and hands-on colleagues
- Hands-on courses for transverse and longitudinal optics
- Poster session next week Thursday after discussion session
- Entertaining seminar by local lecturer
  - **Fusion for Energy - Paco Sánchez**
- **1 slide – 1 minute** today followed by Welcome drink (outside)

# This course

- Breakfast from 7:30 (before the excursion and ALBA visit from 7:00)
- Lunch and coffee breaks between the lectures
- Dinner buffet from 20:15 until 21:30, special dinner show last evening
- use this for networking
- hotel offers sport activity at 7:00 (stretching, yoga, Pilates,...)
- **ALBA visit**
  - Thu 5/10: **Buses leave at 8:00 !!!** Breakfast from 7:00
- **Excursion** to Barcelona (Liceu, lunch, Sagrada Familia)  
Visits sponsored by the Catalan Government
  - Mon 2/10: **buses leave at 8:00 !!!** Breakfast from 7:00
  - no lunch in the hotel that day
- **Cinema evening** next week on Wednesday 4/10 => need selection committee

# 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 Thursday

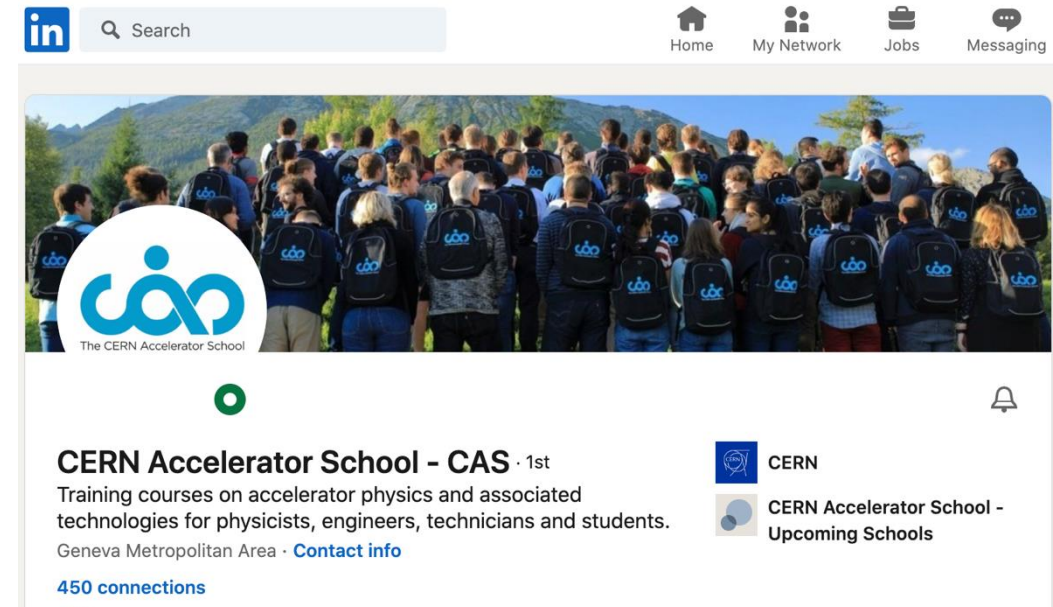
# Networking

- 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, karaoke
- excursion

- LinkedIn

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

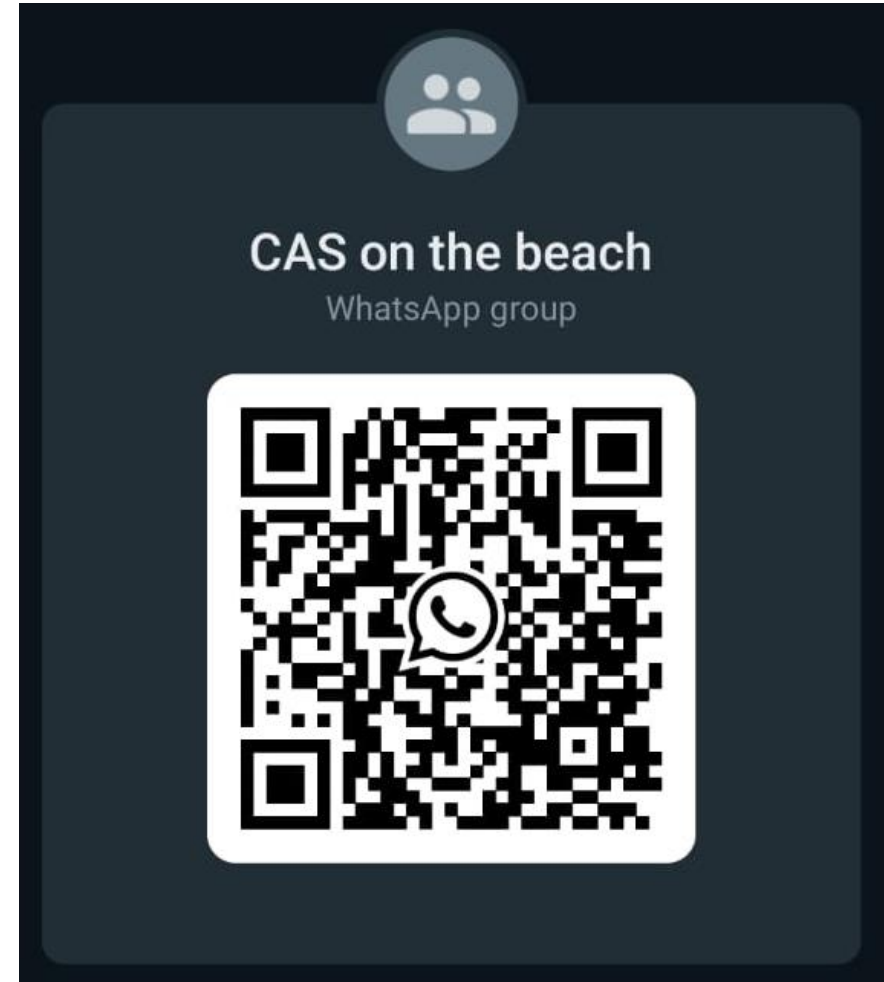


# Networking

- **Castellers**



- **WhatsApp Group**



# The CAS Team

**Anastasiya Safronava**

Web pages



**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

Frank Tecker, Opening CAS 2023

# Online Evaluation Form

- Important to maintain / improve the high quality of teaching
- <https://cas.web.cern.ch/evaluation/santa-susanna-2023>
- Log in with CERN account or many other ways (Google, LinkedIn, ...)

Sign in with a CERN account

Username


Password


[Forgot Password?](#)

**Sign In**


---


Or use another login method

 Two-factor authentication

 Kerberos

Sign in with your email or organisation


 Home organisation - eduGAIN


 External email - Guest access


---


Or sign in with a social account

By clicking on the buttons below, you consent to CERN's transfer of your login request to the social provider and to receive your account name, name and e-mail for authenticating you. Click [here](#) for more details.

 Google

 LinkedIn

 GitHub

 Facebook

# Online Evaluation Form

Level	Content	Presentation	Relevance
<input type="radio"/> Much too low	<input type="radio"/> Completely uninteresting	<input type="radio"/> Very poor	<input type="radio"/> Should not be in this CAS course
<input type="radio"/> Low	<input type="radio"/> Uninteresting	<input type="radio"/> Poor	<input type="radio"/> Specialist information - good, but not for me
<input type="radio"/> Just right	<input type="radio"/> Of some interest	<input type="radio"/> Fair	<input type="radio"/> Contributes to the general accelerator education
<input type="radio"/> Too high	<input type="radio"/> Interesting	<input type="radio"/> Good	<input type="radio"/> Important general information
<input type="radio"/> Much too high	<input type="radio"/> Very interesting	<input type="radio"/> Very good	<input type="radio"/> Directly relevant for my present studies

Other comments on this lecture...

✓ SAVE DRAFT

SUBMIT

- 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**





The CERN Accelerator School

## Introduction to Accelerator Physics

**Enjoy the course!**

<http://cern.ch/cas>

