

*Welcome to the CAS course on*

# Beam dynamics and technologies for future colliders

*In Zürich (CH), Crowne Plaza Hotel*



...fortunately the collider at Zürich has very low luminosity with only a few events of almost elastic scattering...



# 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

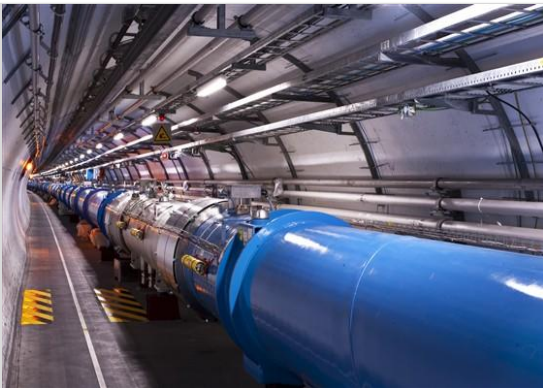
Particle Sources / RFQ / LEBT  
RF Systems / Beam Measurement / Feedback Systems / Beam Injection and Extraction / Beam Transfer Power Convertors / Warm Magnets / Superconducting Magnets / Vacuum Systems Machine Protection Systems Radiation and Radioprotection

## Accelerators

Linear Accelerators  
Synchrotron Light Machines  
FELs  
FFAGs  
Cyclotrons  
Synchrotrons  
Colliders

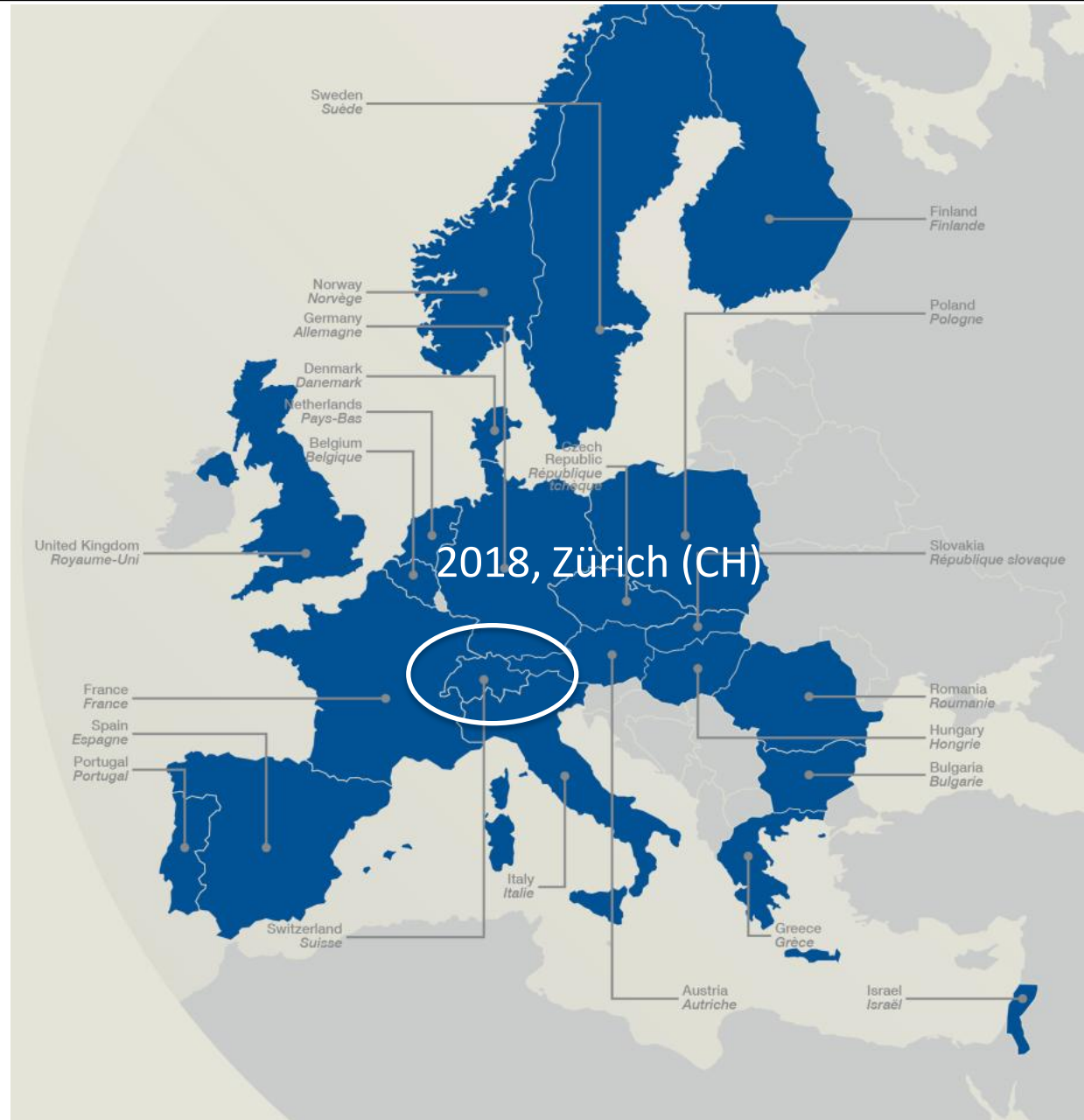
## Applications

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
- Computing and Simulation  
» 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)
- JAS course every second year
- Major topical courses every 4-5 years (beam instrumentation, RF, vacuum, magnets...)
- New topical courses (mechanical engineering...)
- 10 students grants for every course
- New splendid website <http://cas.web.cern.ch/>

## And the next years...

	Period I Feb-April	Period II May-June	Period IIb End June	Period III Sept-Oct	Period IV Nov-Dec	
2018	Future Colliders Switzerland	Beam Instrumentation Finland	Short Introduction local	General Introduction Romania	Comp. Methods Greece	JAS 2017: RF Japan (Hayama)
2019	Advanced Acc. Concepts Portugal (Lisbon)	General Advanced Danmark	Short Introduction local	General Introduction Slovakia	tbd associate member state	JAS: Ion Colliders Russia
2020	RF	Mechanical Engineering	Short Introduction local	General Introduction	Warm magnets	
2021	Digital Signal Processing	General Advanced	Short Introduction local	General Introduction	tbd associate member state	JAS: Very Advanced Beam Dynamics Canada (Saskatoon)???



# This course

- Organized in collaboration with PSI Villingen
  - Professor Leonid Rivkin
  - Marlen Bugman
- Initiative developed during 10 years of “Linear Collider School”; last issue 2016 in Teijin (Japan) + FCC weeks (last Berlin 2017)
- Teaching Method:
  - no parallel teaching
  - large number of internationally known experts as teachers, determined by a large program committee
  - mainly frontline teaching, plus discussion sessions and case studies
  - no final examination (like all CAS courses)

# Course Program

	Wed, 21.2.2018	Thu, 22.2.2018	Fri 23.2.2018	Sat, 24.2.2018	Sun, 25.2.2018	Mon, 26.2.2018	Tue, 27.2.2018	Wed, 28.2.2018	Thu, 1.3.2018	Fri, 2.3.2018	Sat, 3.3.2018	Sun, 4.3.2018	Mon, 5.3.2018	Tue, 6.3.2018			
Aerial day and registration	08:30	Course Opening / Seminar H.Schmickler / L. Rivkin	Detectors for high energy colliders/Machine detector interface I L.Linssen	Recap of long. BD F.Tecker	Collider Diagnostics / Measurement of critical beam parameters I J.Weninger	Beam-Beam Effects/Beamstrahlung I W.Herr	Instabilities in high energy colliders and their mitigation O.Boine-Fr...		Superconducting RF systems I E.Jensen	Normalconducting & permanent magnets T. Zickler	Low Level RF challenges/timing systems I A. Gallo	Interaction of particles with matter N. Mokhov	Normal conducting high gradient RF systems II W.Wuensch				
	09:20	Discussion							Discussion								
	09:30	High energy physics at colliders M. Mangano	Recap of transverse BD I H.Schmickler	Large colliders critical technologies to be announced	Circular Hadron Collider beam dynamics I M.Syphers	Circular Lepton Collider beam dynamics/damping rings I K. Olde	Circular Lepton Collider beam dynamics/damping rings II K. Olde		positron production M. Kuriki	Superconducting RF systems III E.Jensen	Low Level RF challenges/timing systems II A. Gallo	Normal conducting high gradient RF systems I W.Wuensch	kickers & Septa M.Paraliev				
	10:30	Coffee							Coffee								
	11:00	Luminosity goals, critical parameters B. Muratori	Detectors for high energy colliders/Machine detector interface II L.Linssen	Circular Hadron Collider beam dynamics III D. Schulte	Collider Diagnostics / Measurement of critical beam parameters II J.Weninger	Beam-Beam Effects/Beamstrahlung II W.Herr	Instabilities in high energy colliders and their mitigation II O.Boine-Fr...		Superconducting RF systems II E.Jensen	magnet vibration and feedbacks A.Seryi	RF power systems, CLIC drive beam S. Doebert	machine protection concepts N. Mokhov	alignment&metrology/requirements and realization D. Misslaen				
	11:50	Discussion							Discussion								
	12:00	Introduction to a Muon Collider and Gamma Collider W.Chou	Recap of transverse BD II H.Schmickler	Discussion Session I B. Holzer	Circular Hadron Collider beam dynamics II M.Syphers	injection and extraction M.Alba	Discussion Session II B. Holzer		large colliders civil engineering and siting J.Osborne	Lessons learnt from SLIC F. Zimmermann	Discussion III B. Holzer	Final Focus layouts and stability considerations A. Seryi	High Energy Ion Colliders J. Jowett				
	13:00	Lunch							Lunch								
	14:30	Linear Collider studies overview S.Stapnes	Linear Collider Beam dynamics I D.Schulte	Case Studies Introduction WH/BH/DS		Case Studies II WH/BH/DS	Case Studies IV WH/BH/DS		Superconducting material/cables C. Senatore	Case Studies VI WH/BH/DS		Case Studies VIII WH/BH/DS	Reliability Engineering/Availability of a large collider complex M.Zerlauth				
	15:30	Large circular colliders overview(Including h-e option) M.Benedikt	Emittance Preservation in Hadron Machines H. Schmickler	Case Studies I WH/BH/DS	Free	Case Studies III WH/BH/DS	Case Studies V WH/BH/DS		Superconducting magnets /low temperature Superconductors L. Bottura	Case Studies VII WH/BH/DS	Free	Case Studies IX WH/BH/DS	Case Studies Presentations I WH/BH/DS				
	16:30	Coffee							Coffee								
	17:00	Lessons learnt from LEP/LHC M.Lamont	Linear Collider Beam dynamics II D.Schulte	polarized electron beams/energy calibration J.Weninger		SwissFEL, the X-ray free electron laser at PSI H. Braun	Vacuum Challenges R.Kersevan		Superconducting magnets /High temperature Superconductors L. Bottura	Advanced future Collider Concepts P. Muggli		collimators & Dumps & Masks M.Seidel	Case Studies Presentations II WH/BH/DS				
	18:00	Reception															
	18:30	Podium discussion: Future of high energy colliders															
	19:30	late dinner (20h)															
		dinner							Dinner							Gala Dinner	Dinner
									Excursion							Departure day	

## ...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.
  - case studies
  - excursion
  - film evening (date still to be confirmed)  
...need volunteers for “program committee”

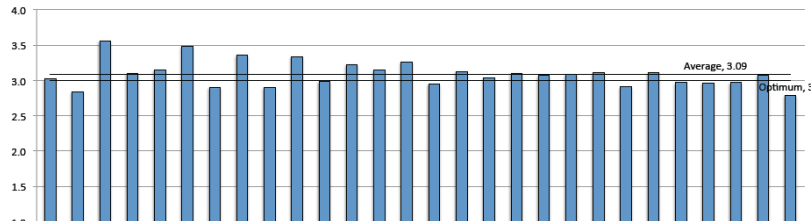
# Feedback

- 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

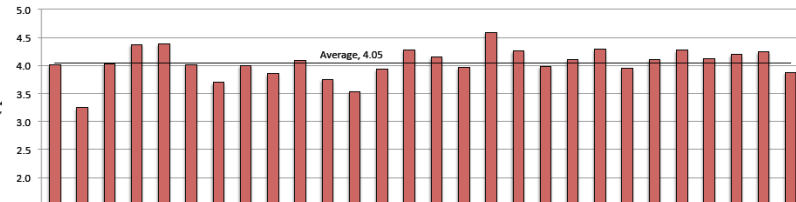
CERN Accelerator School, Superconductivity for Accelerators, Eric, Apr/May 2013 - Replies from 60/94 students

Level



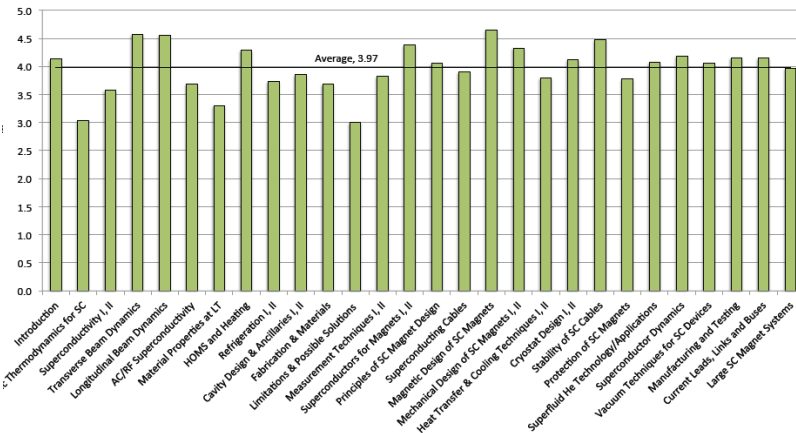
CERN Accelerator School, Superconductivity for Accelerators, Eric, Apr/May 2013 - Replies from 60/94 students

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			

# Feedback and Promotional Actions

- This course:
  - first time feedback through webform  
(Anastasiya will explain details (link) per email)
- 3 days of filming  
(those who do not want to be filmed, please tell us)  
Those who want to be interviewed, tell us...
- Testimonials for the web:
  - all you need is a photo and a sentence.

<http://cas.web.cern.ch/>

## On the organizational side...

- Registration with Anastasiya...  
→ badge, bag, program, info....still possible
- CAS office (in a rather remote place...open every day during a few hours, details will be communicated)
- The hotel management is very sorry about the inconvenience caused by the delays of the construction work....  
but this should not be a major problem.

Follow the red line

blocked / private Areas

Lunch & Dinner Area

Conference Area

Breakout Room «Patio»

Holmes Place Fitness & Spa – fully complimentary for all participants

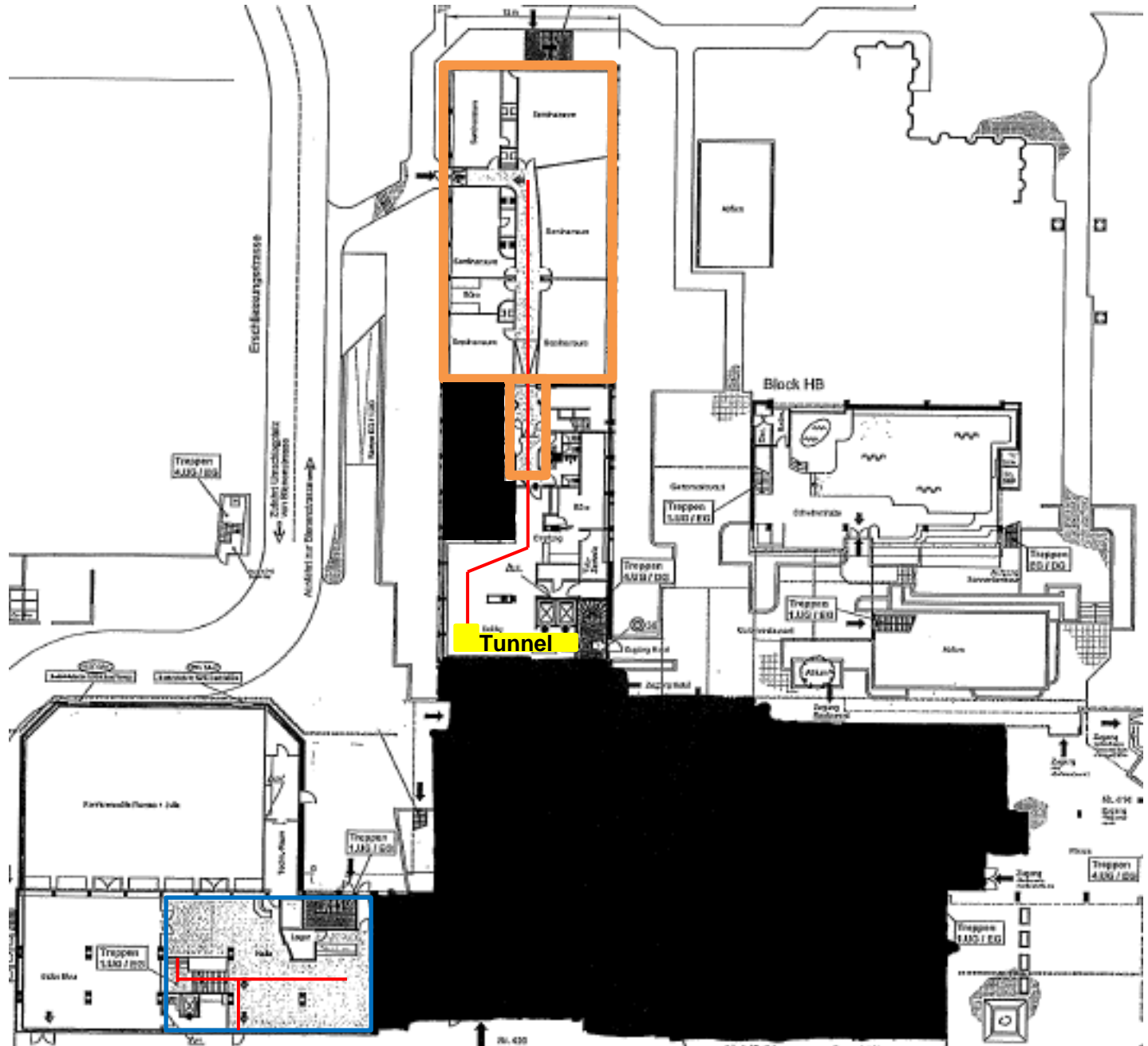


Floorplan -1

Follow the red line

Reception

Workshop Center  
with 2 Breakout  
Rooms  
& CERN Office



Floorplan  
Groundfloor

Entrance