

# The CERN Accelerator School holds courses in all of the Member States of CERN

## The twenty one Member States of CERN

### Member States (Dates of accession)

	Austria (1959)
	Belgium (1953)
	Bulgaria (1999)
	Czech Republic (1993)
	Denmark (1953)
	Finland (1991)
	France (1953)
	Germany (1953)
	Greece (1953)
	Hungary (1992)
	Israel (2014)
	Italy (1953)
	Netherlands (1953)
	Norway (1953)
	Poland (1991)
	Portugal (1986)
	Slovakia (1993)
	Spain (1/1961-12/1968-1/1983)
	Sweden (1963)
	Switzerland (1953)
	United Kingdom (1953)



- Since 1983
- 62 schools
- All MS - 1
- 13 JAS

# 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, **now yearly**, alternating between
    - [Introduction to Accelerator Physics](#)
    - [Advanced Accelerator Physics](#)
  - Specialized topic in the field, **was yearly, now two per year**
- 62 schools held so far
  - 50 to 60 hours teaching in **1-2 week intensive residential courses**
- Occasional courses in the framework of the US-CERN-Japan-Russia Joint Accelerator School (JAS)
  - 13 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

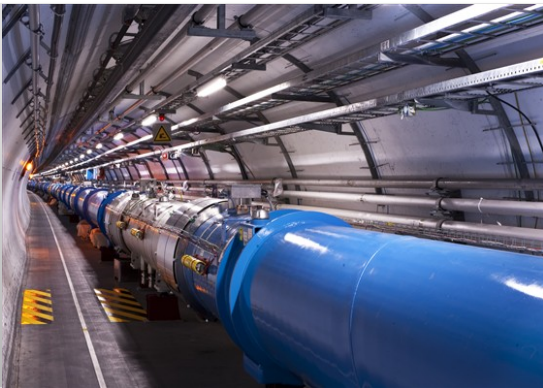
Particle Sources / RFQ / LEBT RF Systems / Beam Instrumentation / Feedback Systems / Beam Injection and Extraction / Beam Transfer Power Convertors / Warm Magnets / Superconducting Magnets / Vacuum Systems Machine Protection Systems Radiation and Radioprotection

## Accelerators

Linear Accelerators  
Synchrotron Light Machines  
FELs  
FFAGs  
Cyclotrons  
Synchrotrons  
Colliders

## Applications

High Energy Physics  
Nuclear Physics  
Industrial Applications  
Medical Applications  
Cancer Therapy



# Schools 1983-1998

Year	Topic	Town	Country	Level	Proceedings
1998	General Accelerator Physics	Oxford	UK	Introduction	
1997	Measurement and Alignment of Accelerator and Detector Magnets	Anacapri	Italy	Specialised	CERN-98-05
1997	General Accelerator Physics	Gjøvik	Norway	Intermediate	
1996	Synchrotron Radiation and Free Electron Lasers	Grenoble	France	Specialised	CERN-98-04
1996	General Accelerator Physics	Cascais	Portugal	Introduction	
1995	Superconductivity in Particle Accelerators	Hamburg	Germany	Specialised	CERN-96-03
1995	General Accelerator Physics	Eger	Hungary	Intermediate	
1994	Cyclotrons, Linacs and Their Applications	La Hulpe	Belgium	Specialised	CERN 96-02
1994	General Accelerator Physics	Baden	Austria	Introduction	
1993	RF Engineering for Particle Accelerators	Anacapri	Italy	Specialised	
1993	General Accelerator Physics	Rhodes	Greece	Advanced	CERN 95-06 v1, 95-06 v2
1992	General Accelerator Physics	Jyvaskyla	Finland	General	CERN-94-01-V-1, CERN-94-01-V-2
1992	Magnetic Measurement and Alignment	Montreux	Switzerland	Specialised	CERN-92-05
1991	RF Engineering for Particle Accelerators	Oxford	United Kingdom	Specialised	CERN-92-03-V-1, CERN-92-03-V-2
1991	General Accelerator Physics	Noordwijkerhout	Netherlands	Advanced	CERN-92-01
1990	Power Converters for Particle Accelerators	Montreux	Switzerland	Specialised	CERN-90-07
1990	General Accelerator Physics	Julich	Germany	General	CERN-91-04
1989	Synchrotron Radiation and Free Electron Lasers	Chester	United Kingdom	Specialised	CERN-90-03
1989	General Accelerator Physics	Uppsala	Sweden	Advanced	CERN-90-04
1988	Superconductivity in Particle Accelerators	Hamburg	Germany	Specialised	CERN-89-04
1988	General Accelerator Physics	Salamanca	Spain	General	CERN-89-05
1987	General Accelerator Physics	Berlin	West Germany	Advanced	CERN-89-01
1986	Applied Geodesy for Particle Accelerators	Geneva	Switzerland	Specialised	CERN-87-01
1986	General Accelerator Physics	Aarhus	Denmark	General	CERN-87-10
1985	General Accelerator Physics	Oxford	United Kingdom	Advanced	CERN-87-03-V-1, CERN-87-03-V-2
1984	General Accelerator Physics	Gif-sur-Yvette	France	General	CERN-85-19-V-1, CERN-85-19-V-2
1983	Antiprotons for Colliding Beam Facilities	Geneva	Switzerland	Specialised	CERN-84-15

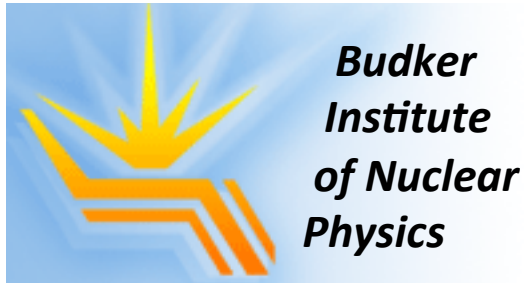
# Schools 1999-2014

Year	Topic	Town	Country	Level	Proceedings
2014	Plasma Wake Acceleration	CERN	Switzerland	Specialised	CERN-2015-
2014	Power Convertors	Baden	Switzerland	Specialised	CERN-2015-
2014	General Accelerator Physics	Prague	Czech Rep	Introduction	
2013	Superconductivity	Erice	Italy	Specialised	CERN-2014-005
2013	General Accelerator Physics	Trondheim	Norway	Advanced	CERN-
2012	Ion Sources	Senec	Slovakia	Specialised	CERN-2013-007
2012	General Accelerator Physics	Granada	Spain	Introduction	
2011	High Power Hadrons Machines	Bilbao	Spain	Specialised	CERN-2013-001
2011	General Accelerator Physics	Chios	Greece	Intermediate	
2010	RF for Accelerators	Ebeltoft	Denmark	Specialised	CERN-2011-007
2010	General Accelerator Physics	Varna	Bulgaria	Introduction	
2009	Magnets	Bruges	Belgium	Specialised	CERN-2010-004
2009	General Accelerator Physics	Darmstadt	Germany	Intermediate	
2008	Beam Diagnostics	Dourdan	France	Specialised	CERN-2009-005
2008	General Accelerator Physics	Frascati	Italy	Introduction	
2007	Digital Signal Processing	Sigtuna	Sweden	Specialised	CERN-2008-003
2007	General Accelerator Physics	Daresbury	UK	Intermediate	
2006	Vacuum in Accelerators	Platja d'Aro	Spain	Specialised	CERN-2007-003
2006	General Accelerator Physics	Zakopane	Poland	Introduction	
2005	Small Accelerators	Zeegse	Netherlands	Specialised	CERN-2006-012
2005	General Accelerator Physics	Trieste	Italy	Intermediate	
2004	Power Converters	Warrington	UK	Specialised	CERN-2006-010
2004	General Accelerator Physics	Baden	Austria	Introduction	
2003	Synchrotron Radiation and Free Electron Lasers	Brunnen	Switzerland	Specialised	CERN-2005-012
2003	General Accelerator Physics	Zeuthen	Germany	Intermediate	
2002	Superconductivity for Accelerators and Detectors	Erice	Italy	Specialised	CERN-2004-008
2002	General Accelerator Physics	Sesimbra	Portugal	Introduction	
2001	Particle Accelerators for Medicine and Industry	Pruhonic	Czech Republic	Specialised	Unpublished
2001	General Accelerator Physics	Seville	Spain	Intermediate	
2000	RF Engineering	Seeheim	Germany	Specialised	CERN-2005-003
2000	General Accelerator Physics	Loutraki	Greece	Introduction	
1999	Vacuum Technology	Snekersten	Denmark	Specialised	CERN-99-05
1999	General Accelerator Physics	Bénodet	France	Intermediate	

# Joint Accelerator Schools

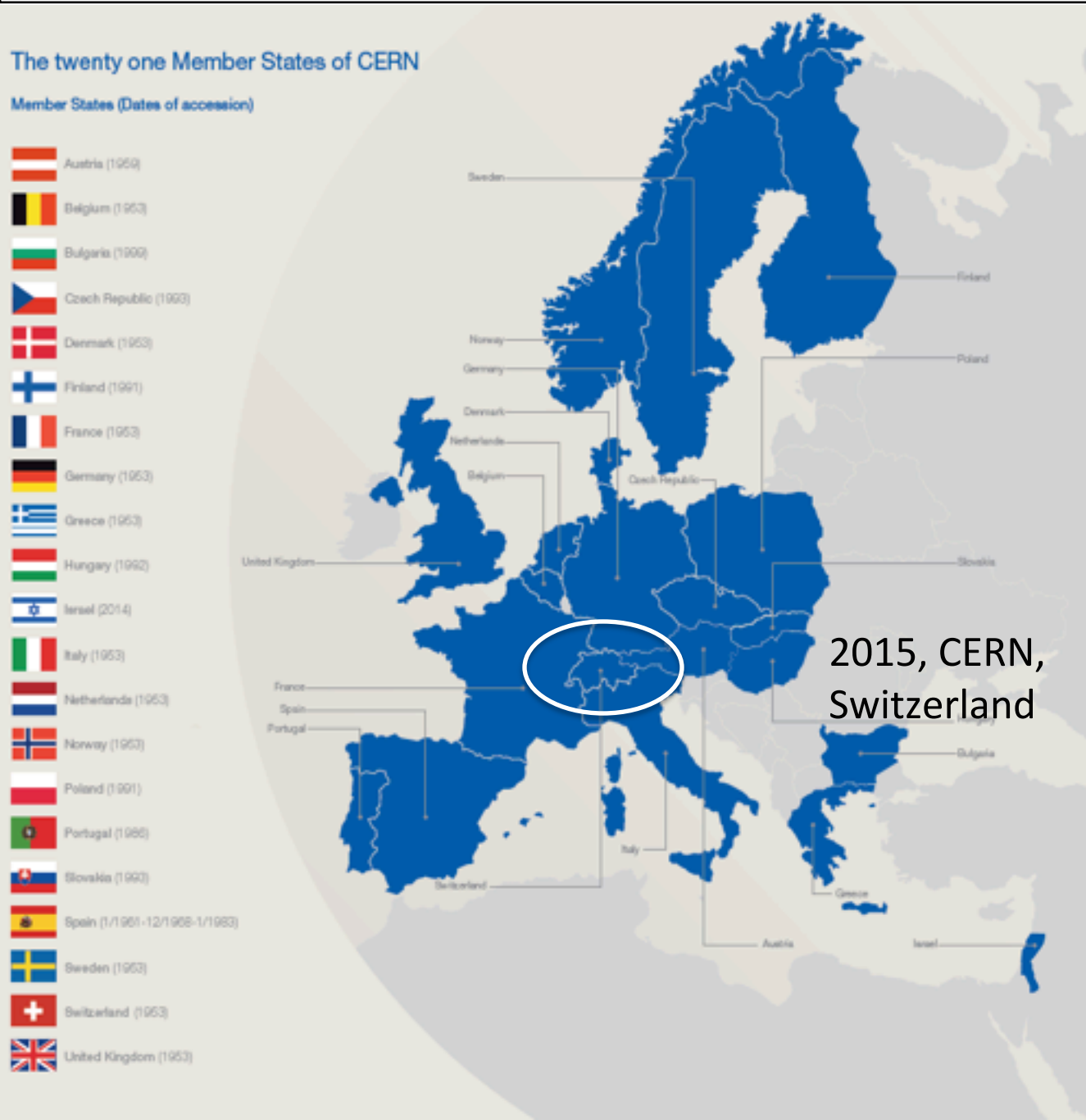


The CERN Accelerator School



1985	Santa Margherita di Pula, Sardinia, Italy	Nonlinear Dynamics	Lecture Notes in Physics No. 247 Springer-Verlag
1986	South Padre Island, Texas, USA	Frontiers of Particle Beams	Lecture Notes in Physics No. 296 Springer-Verlag
1988	Anacapri, Italy	Frontiers of Particle Beams: Observation, Diagnosis and Correction	Lecture Notes in Physics No. 343 Springer-Verlag
1990	Hilton Head, South Carolina, USA	Frontiers of Particle Beams: Intensity Limitations	Lecture Notes in Physics No. 400 Springer-Verlag
1992	Benalmadena, Spain	Frontiers of Particle Beams: Factories with e+e- Rings	Lecture Notes in Physics No. 425 Springer-Verlag
1994	Maui, Hawaii, USA	Frontiers of Accelerator Technology	World Scientific, 1996 ISBN 981-02-2537-7
1996	Hayama-machi, Japan	Frontiers of Accelerator Technology: RF Engineering for Particle Accelerators	World Scientific, 1999 ISBN 981-0203838-X
1998	Montreux, Switzerland	Beam Measurement	World Scientific, 1999 ISBN 981-02-3881-9
2000	St. Petersburg, Russia	Frontiers of Accelerator Technology: High Quality Beams	AIP, 2001 ISBN 0-7354-0034-2
2002	Long Beach, California, USA	Frontiers of Accelerator Technology in Linacs	World Scientific, 2004
2011	Erice, Italy	Synchrotron Radiation and Free Electron Lasers	No proceedings
2013	Shizuoka, Japan	Introduction to Particle Accelerators (Regional session)	
2014	Newport beach, California, USA	Beam Loss and Accelerator Protection	CERN-2015-

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## 2015

- Medical Applications
  - Vienna, Austria
- Advanced AP
  - Otwock, Poland
- Intensity Limitations
  - CERN

## 2016

- ERLs and FELs
  - DESY, Germany
- Introduction to AP
  - Turkey
- Injection & Extraction
  - CERN

## 2017

- Vacuum systems
  - ESS, Sweden
- Advanced AP
  - UK
- Beam cooling
  - CERN

The CERN Accelerator School is organizing a course on

# INTENSITY LIMITATIONS IN PARTICLE BEAMS

2 -11 November, 2015

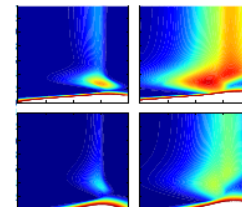
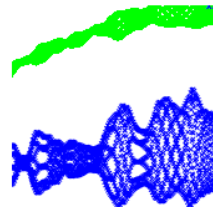
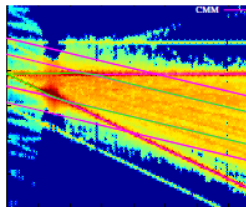
CERN, Geneva, Switzerland

This course will mainly be of interest to staff in accelerator laboratories, university departments and companies manufacturing accelerator equipment.

Many accelerators and storage rings, whether intended for particle physics experiments, synchrotron light sources or industrial applications, require beams of high brightness and highest possible intensities.

A good understanding of possible limitations is required to achieve the desired performance.

The programme of this course will treat the interaction of beams with the surroundings, with other beams and further collective effects. The lectures on the effects and possible mitigations are complemented by tutorials.





# Program

Draft Programme  
Intensity Limitations in Particle Beams, CERN, Geneva, Switzerland, 2-11 November, 2015

Time	Monday 2 November	Tuesday 3 November	Wednesday 4 November	Thursday 5 November	Friday 6 November	Saturday 7 November	Sunday 8 November	Monday 9 November	Tuesday 10 November	Wednesday 11 November		
8:30	A R R I V A L D A Y  Registration	Opening Talks	Bench Measurements and Simulations of Beam Coupling Impedance	Beam Instabilities in Linear Machines II	Observations and Diagnostics in High Brightness Beams	Space Charge Effects in Linacs	E X C U R S I O N	Electron Cloud I	High Brightness Photo Injectors	D E P A R T U R E		
9:30			U. Niedermayer	M. Ferrario	A. Cianchi	I. Hofmann		G. Rumolo	E. Chiadroni			
9:30			Introduction and Needs for High Intensity and High Brightness	Beam Dynamics with High Intensity II	Beam-Beam Effects in Hadron Colliders I	Sources and Low Energy Beam Transfer		Intrabeam Scattering	Beam-Beam Effects in Linear Colliders		Electron Cloud II	A F T E R  B R E A K F A S T
10:30			L. Rivkin	A. Chao	T. Pieloni	R. Scrivens		M. Martini	D. Schulte		G. Rumolo	
11:00			COFFEE	COFFEE	COFFEE	COFFEE		COFFEE	COFFEE		COFFEE	
11:00			Overview of Limitations	Beam Based Impedance Measurements	Effects near Transition	Space Charge and Impedances		Space Charge in Circular Machines	Passive Mitigation		Active Mitigation	
12:00			W. Herr	E. Shaposhnikova	E. Metral	O. Boine-Franckenheim		G. Franchetti	V. Kornilov		H. Schmickler	
12:00			Wakefields and Impedances I	Beam Instabilities in Circular Machines II	Beam-Beam Effects in Hadron Colliders II	Numerical Methods I			Machine Protection		Beam Loss Consequences	
13:00			R. Wanzenberg	A. Chao	T. Pieloni	K. Li			R. Schmidt		F. Cerutti	
			LUNCH	LUNCH	LUNCH	LUNCH		LUNCH	LUNCH		LUNCH	
14:30			Beam Dynamics with High Intensity I	Beam Instabilities in Linear Machines I	F R E E	Coherent Beam-Beam Effects			Study	Ions		
15:30			A. Chao	M. Ferrario		X. Buffat		C E R N		R. Nagaoka		
			TEA	TEA		TEA			TEA	TEA		
16:00			Wakefields and Impedances II	Observations and Diagnostics in High Intensity Beams	A F T E R	Beam-Beam Effects in Circular Lepton Colliders			Vacuum Issues	Numerical Methods II		
17:00			M. Dohlus	V. Kornilov	R E S O N	C. Milardi		V I S I T	P. Chiggiato	K. Li		
17:00			Beam Instabilities in Circular Machines I	Study		Tutorial			Tutorial	Seminar Design Options for High Intensity Linacs		
18:00			A. Chao							D. McGinnis		
			Welcome Drink									
19:00		DINNER	DINNER	DINNER	DINNER	DINNER		DINNER	Special Dinner	DINNER	DINNER	

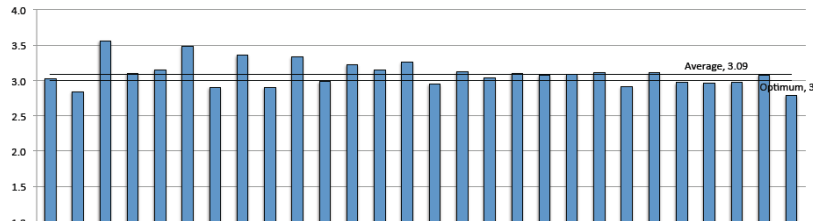
# Feedback

- 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

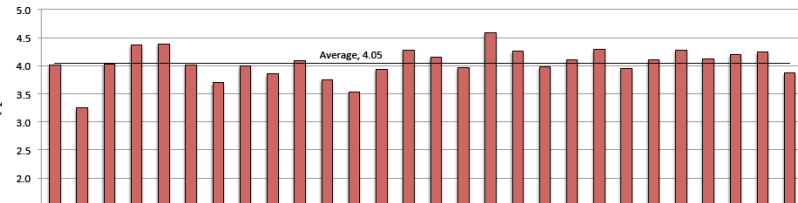
CERN Accelerator School, Superconductivity for Accelerators, Erice, Apr/May 2013 - Replies from 60/94 students

Level



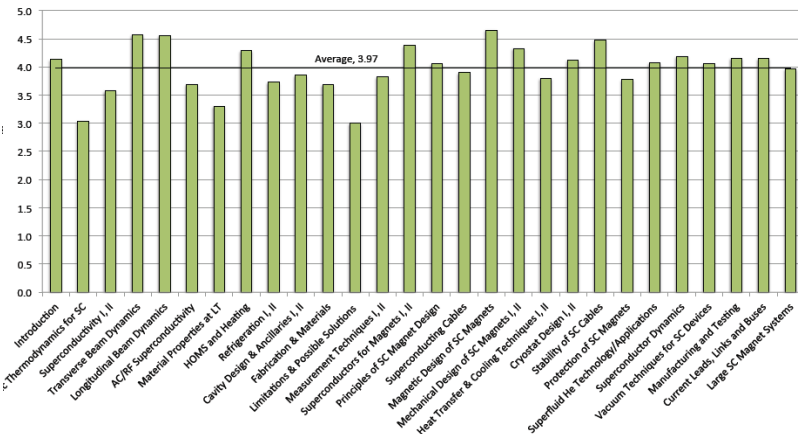
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Content



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

Presentation



TITLE	LEVEL	CONTENT	PRESENTATION
Recap on Transverse Dynamics I, II			
Recap on Longitudinal Dynamics I, II			
Introduction to Beam Instrumentation			
Lattice Cells			
RF Measurement Concepts			
Introduction to Beam Diagnostics			
Insertions			
Tools for Non Linear Dynamics I, II			
Beam Instabilities I, II			
Space Charge Dominated Beams			
SC for Accelerators			
Insertion Devices			
Non Linear Dynamics I, II			
Instabilities in Linacs			
Beam-Beam Effects			
Energy Recovery Linacs			
Advanced Concepts			
Landau Damping I, II			
Low Emittance Machines I, II, III			
Beam Cooling			
Electron Cloud Effects and Cures			
High Brilliance Beam Diagnostics			
Accelerating Polarized Beams			
Timing and Synchronisation			
Feedback Systems I, II			

## Few words of explanation on the following

- Program and material on the indico site
- Study periods and tutorials
- CERN visit
- Excursion
  
- Lunch and dinner
- Coffee and tea breaks
- Welcome drink
- Photo