



CERN School of Computing (CSC)

7th Scientific Computing Forum

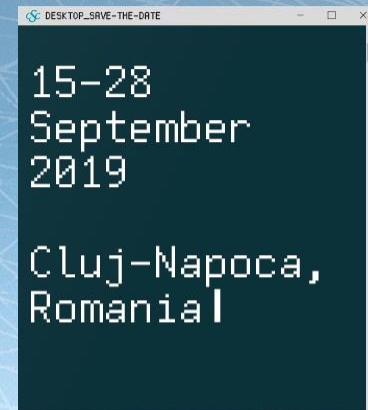
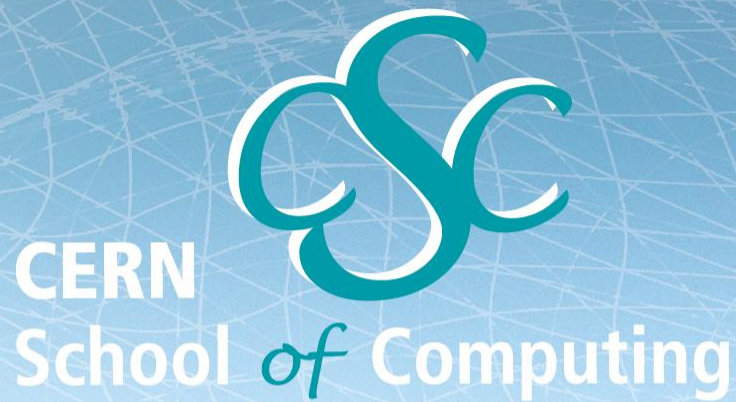
2 October 2019

<https://indico.cern.ch/event/851050/>

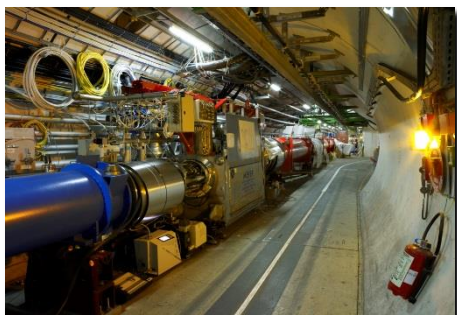
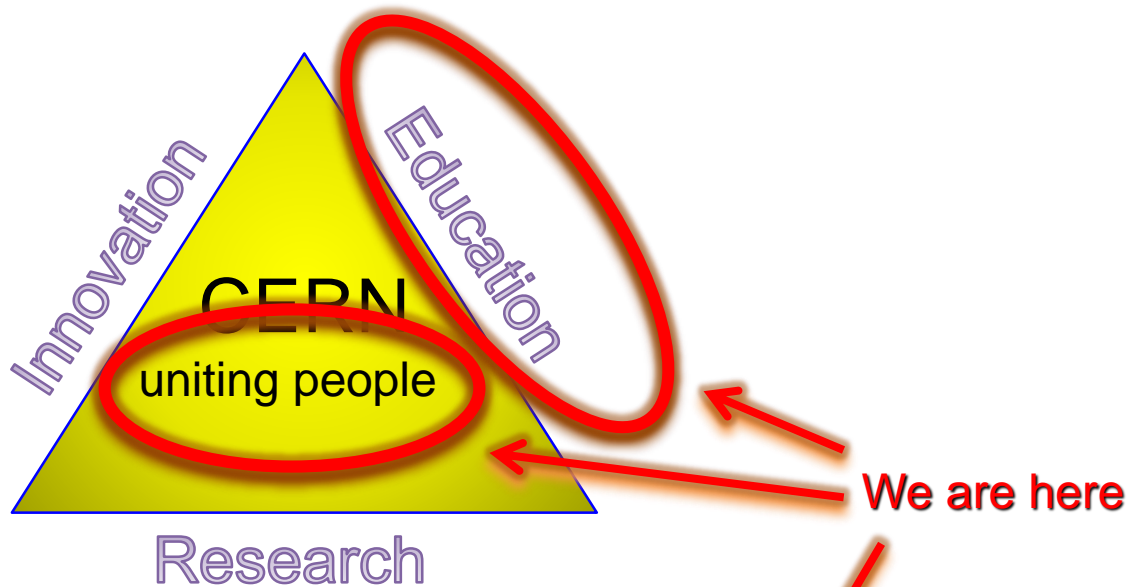
Sebastian Lopienski, CERN

CSC Director

We have just finished CSC 2019 hosted in Cluj-Napoca, Romania



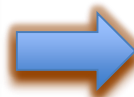
CERN's mission



Accelerating beams
(accelerators)



Detecting particles
(experiments)



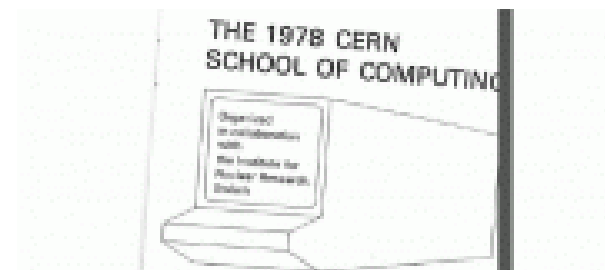
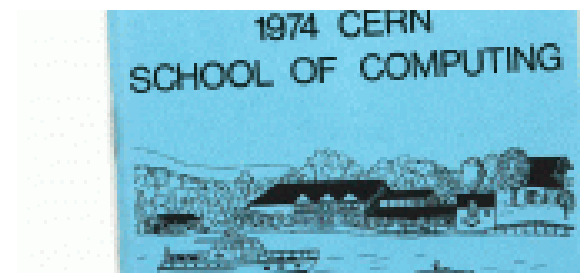
Large-scale
computing
(analysis)



Discovery

CERN School of Computing

- The school was created in **1970**
 - 42nd edition in 2019
- Organized by **CERN**, together with the hosting University
- Visited 23 countries
 - <http://cern.ch/CSC/past-schools>
 - recently: Romania, Israel, Spain, Belgium, Greece, Portugal, Cyprus, Sweden ...
- 2800 students of ~80 different nationalities attended CSC
 - usually around 100 students per year
 - postgraduate engineers and scientists, often PhD students



Mandate and mission

Create a common culture in scientific computing among young scientists and engineers involved in particle physics or other sciences

Bridging science and computing

- Technological evolution in computing empowers science
 - especially in data-intensive domains such as High Energy Physics
 - **computing is the main strategy** for many scientific fields to do research efficiently on a large scale
- It is nowadays essential that:
 - **scientists master computing technologies** as a main tool for their research
 - **computer engineers understand the scientific needs** in order to deliver computing services to research projects

Academic dimension

CSC is **not a conference**

- lecturers do not present their work or promote their projects



CSC is **not a training session**

- not a replication of training courses commonly available at home institutes
- focus on persistent knowledge, less on know-how



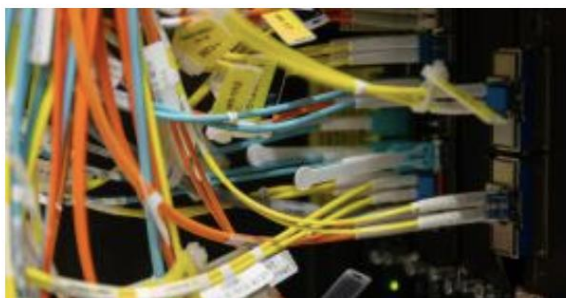
CSC is **a summer university**

- programme audited by the hosting university
- final exam, diploma and ECTS points



Three CSC schools per year

iCSC 2019



Inverted school

4 Mar - 6 Mar 2019

CERN

tCSC 2019



Thematic school

12 May - 18 May 2019

MEDILS

Split | Croatia

CSC 2019



Main school

15 Sep - 28 Sep 2019

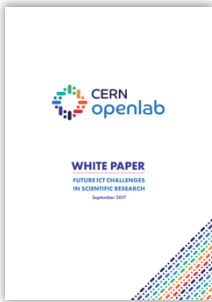
Babeş-Bolyai University

Cluj-Napoca | Romania

Academic programme

Academic programme

- **Main School (CSC)** – 2 weeks, [broad spectrum of topics](#)
 - **Physics Computing** (intro, data analysis, machine learning)
 - **Software Engineering** (design, parallelism, tools, security)
 - **Data Technologies** (storage, data workflows, visualization, network)
- **Thematic CSC (tCSC)** – 1 week, **more advanced / focused**
2019: [“High Throughput Distributed Processing of Future HEP Data”](#)
 - **Technologies+platforms** (efficient computing, data oriented design)
 - **Parallel and optimised scientific software development**
 - **Effective I/O for scientific applications** (data storage, I/O)
- **Inverted CSC (iCSC)** – 3-4 days, at CERN
 - various topics, as proposed by selected lecturers (CSC alumni)2019: [ML, Big Data, containers, FPGAs, track finding etc.](#)



CERN openlab whitepaper

Future ICT challenges in Scientific Research (Sept. 2017)

http://openlab.cern/publications/technical_documents/cern-openlab-white-paper-future-it-challenges-scientific-research

DATA-CENTRE TECHNOLOGIES AND INFRASTRUCTURES

NETWORKING

- High-bandwidth links from detectors to the data centre
- Automation of network configuration and 'white-boxing'
- IoT for FRU tracking, data centre environmental monitoring...
- Integration of Wi-Fi and 5G: data security and protection

DATA-CENTRE ARCHITECTURES

- Rack disaggregation: rack-scale design
- Hierarchical storage buffers
- Software-defined infrastructure and tool-chain integration

DATA STORAGE

- Investigation of models for expansion of storage-capacity
- 'Cold storage' evolution

DATABASE TECHNOLOGIES

- Data size and rates
- Hardware evolution and consolidation
- Technologies for developer productivity
- Data-stream processing
- Time-series database workloads
- Scale-out databases and cloud resources

CLOUD INFRASTRUCTURES

- Orchestration and automation of compute provisioning
- Scalable clouds and global scientific clouds

COMPUTING PERFORMANCE AND SOFTWARE

CODE MODERNISATION

- Storage-layer optimisations for low-latency NVRAM
- Performance-analysis tools for software
- Use of standard library facilities in C++
- Use of alternative concurrency models
- Verifying code and checking quality automatically

HETEROGENEOUS PLATFORMS AND ALTERNATIVE ARCHITECTURES

- Hybrids CPUs
- Optimising code distribution using lightweight containers

DEDICATED HARDWARE AND CO-PROCESSING SYSTEMS

- Optimising code performance using coprocessors and GPUs

MACHINE LEARNING AND DATA ANALYTICS

DATA ACQUISITION

- Monitoring of accelerators and detectors
- Monitoring data quality
- Fast inference technology for 'trigger' systems
- Anomaly detection and the search for new physics

DATA PROCESSING

- Simulation
- Jet identification and image-based event identification

BIG DATA

- Data reduction and refresh for analysis
- Optimisation of computing infrastructure

DATA ENGINEERING

- Solutions from industry, challenges and opportunities

APPLICATIONS IN OTHER DISCIPLINES

PLATFORMS FOR OPEN COLLABORATION

- A smart data-analysis platform

LIFE SCIENCES AND MEDICAL APPLICATIONS

- Simulating biological systems in the cloud
- Large-scale analysis of genomic data
- Large-scale analysis of healthcare data

ASTROPHYSICS

- Exascale data processing at future astrophysics infrastructures

SMART EVERYTHING

- Environmental monitoring
- Traffic and mobility

HSF Community White Paper

<https://hepsoftwarefoundation.org/organization/cwp.html>

2 Software and Computing Challenges

3 Programme of Work

- 3.1 Physics Generators
- 3.2 Detector Simulation
- 3.3 Software Trigger and Event Reconstruction
- 3.4 Data Analysis and Interpretation
- 3.5 Machine Learning
- 3.6 Data Organisation, Management and Access
- 3.7 Facilities and Distributed Computing
- 3.8 Data-Flow Processing Framework
- 3.9 Conditions Data
- 3.10 Visualisation
- 3.11 Software Development, Deployment, Validation and Verification
- 3.12 Data and Software Preservation
- 3.13 Security

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- **Main School (CSC)** – 2 weeks, [broad spectrum of topics](#)
 - **Physics Computing** (intro, data analysis, machine learning)
 - **Software Engineering** (design, parallelism, tools, security)
 - **Data Technologies** (storage, data workflows, visualization, network)
- **Thematic School (TSC)** – 1 week, [focused on “Big Data”](#) (e.g. distributed design)
 - Te
 - Pa
 - Eff
- **Inverted School (ISC)** – 3-4 days, at CERN
 - various topics, as proposed by selected lecturers (CSC alumni)
 - 2019: [ML, Big Data, containers, FPGAs, track finding etc.](#)

CSC Programme Committee welcomes feedback to the academic programme
(what topics should CSC teach) as well as **suggestions for possible lecturers**

Academic activities (CSC 2018)



Opening ceremony



Scientific visits at Tel Aviv University

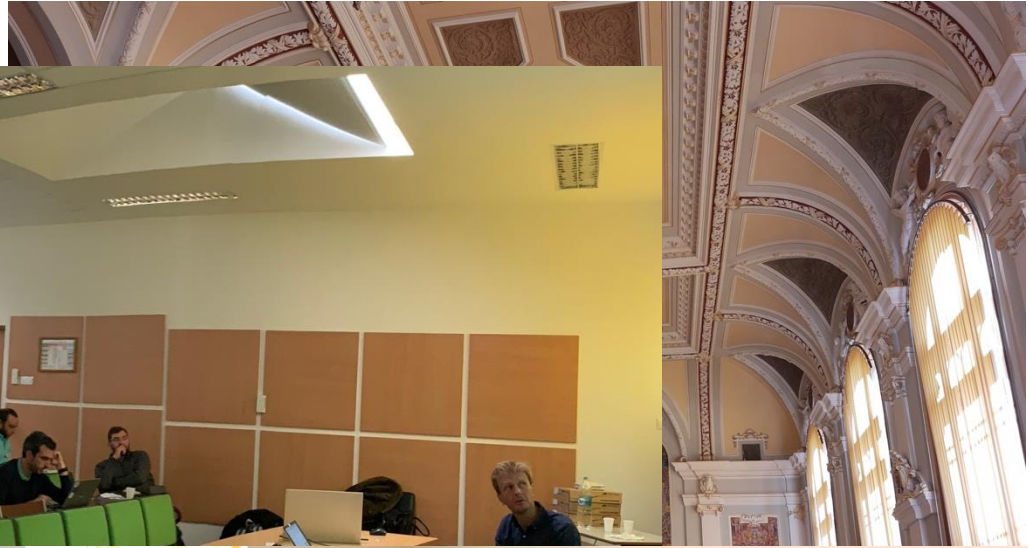


Lectures



Exercises

Academic activities (CSC 2019)



Social and sport activities (CSC 2017)



Student feedback: very positive

- *The school was awesome! Both in terms of academic growth and interpersonal development. It was great to meet people from different backgrounds and to work and socialise together. The quality of the organisation was especially good and I was very impressed by the enthusiasm and dedication of the lecturers. Overall, I would highly recommend the school [...] Thank you!*
- *Extremely valuable 2 weeks, thank you all for organising it so well!*
- *I'd like to thank all of you for organising a fantastic school! I had an amazing time, made a lot of friends, and learned more than I'd imagined possible. The university, city and country were also very welcoming to us. All in all this has been an experience I'll take with me the rest of my life. THANK YOU!!!*
- *With only small details where it can improve I consider this school to be (almost) perfect!*
- *Best school I have ever been to! Thank you [...] for all of your hard work!*
- *Excellent! Already told friends, colleagues, to apply for the next school!*
- **Can I repeat?**

**Role of the hosting
institute/university
(Local Organiser)**

=> Opportunities

Responsibilities

CERN School of Computing

- Scientific programme
 - by the Programme Committee
- Lecturers
 - from CERN and academia
- Budget
 - student fees + CERN subsidy
- Student registration and selection
- Booklet
- Exam
- etc.

Hosting University (LOC)

- Facilities and infrastructure
 - rooms, network, transport etc.
- Additional lectures
 - for the programme + guest
- Scientific visits
- Social activities
 - incl. excursion and sport
- ECTS points
- Welcome bag
- *Accommodation proposals*

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Guest scientific lectures

Lectures by local experts/professors

- the goal is to have an **engaging and entertaining talk**
- **any computing- or science-related topic**

Examples from previous schools:

- *“Computational Science: Third Pillar of Science?”* (CSC 2019)
- *“Sequence Alignment for Ride Sharing”* (CSC 2018)
- *“The Israeli cyber landscape”* (CSC 2018)
- *“Codes, shuffles and cards”* (CSC 2017)
- *“Future computing security challenges”* (CSC 2016)
- *“Fuel cells energy”* (tCSC 2016)

Scientific visits

- An outreach opportunity for the local science (facilities, experiments)
- CSC 2016 at SCK*CEN, Belgium
 - BR1 (the first Belgian nuclear reactor, from 1956)
 - HADES underground laboratory (radioactive waste disposal study)
- CSC 2017 at UPM, Spain
 - wind tunnel

Sebastian Lopienski – CERN School of Computing



Welcome pack example: a book (csc 2009)

Arnulf Quadt and
Michael Uhrmacher (Eds.)

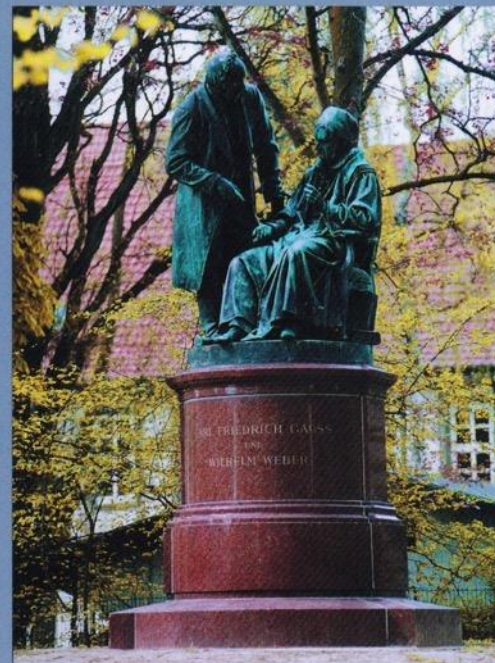
Famous Scientists in Göttingen

Biographies, collected for the
CERN School of Computing 2009



The annual CERN School of Computing (CSC) comes back to
Germany after 20 years and is being held in Göttingen
(17. – 28. August 2009).

The book gives an incomplete collection of the biographies of
the most famous physicists and mathematicians who studied
and / or taught at the University of Göttingen.



Outreach for the local organizer



CSC 2015 (Kavala, Greece)

tCSC 2016 (Split, Croatia)

Outreach for CERN

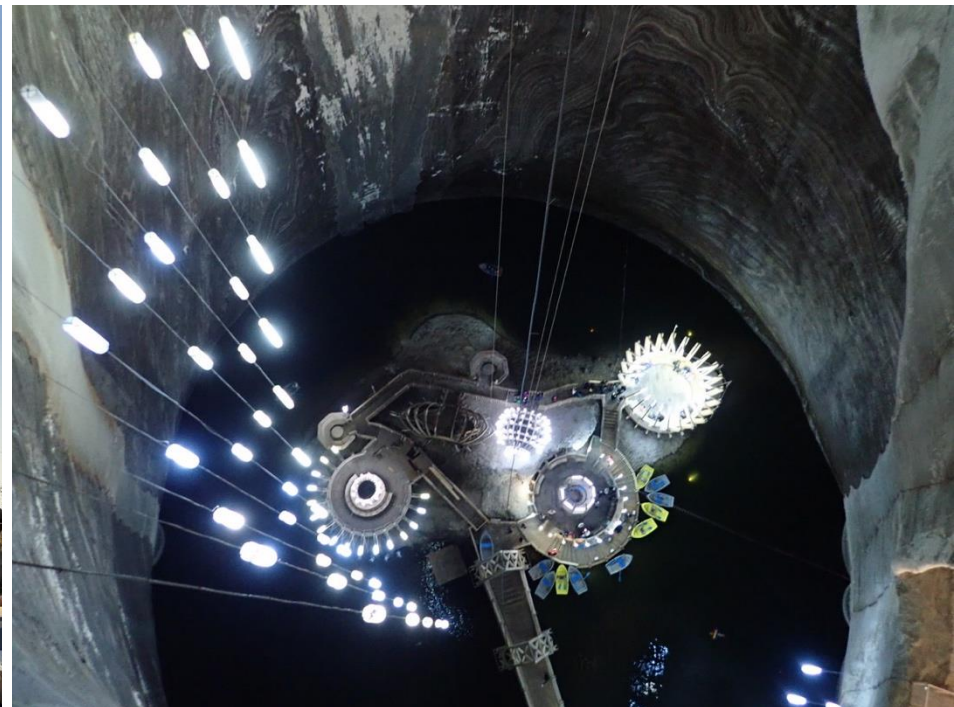


CSC 2014 (*Braga, Portugal*) – CERN's 60 anniversary celebrations

Discovering the country

Students discover what the country has to offer

- history? food? nature? modern cities? culture? outdoor?
- Sunday excursion



More information

- More information is available on the CSC website:
 - hosting the CSC:
<http://csc.web.cern.ch/host-school>
 - role of the Local Organizing Committee (LOC):
<http://csc.web.cern.ch/local-organising-committee>

Don't hesitate to contact us, if you
consider hosting a future CSC

CSC schools next year

iCSC 2020



Inverted school

16 Mar - 19 Mar 2020

[CERN](#) | Geneva | Switzerland

tCSC 2020



Thematic school

7 Jun - 13 Jun 2020

[MedILS](#) | Split | Croatia

CSC 2020



Main school

23 Aug - 5 Sep 2020

[University of Science and Technology \(AGH\)](#),
[and Institute of Nuclear Physics \(IFJ PAN\)](#) |
Kraków | Poland

Thank you

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