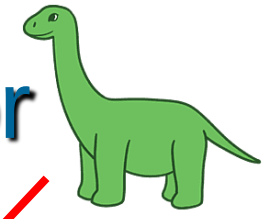

CERN

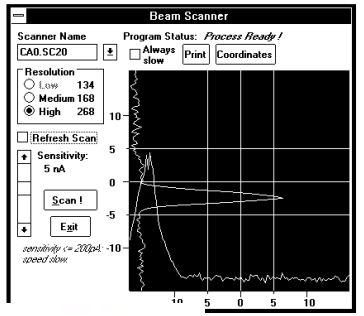
Welcome to the thematic CERN School of Computing

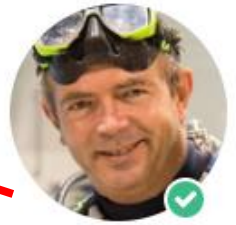
Alberto Pace, school director

Who am I ? Alberto – your school director



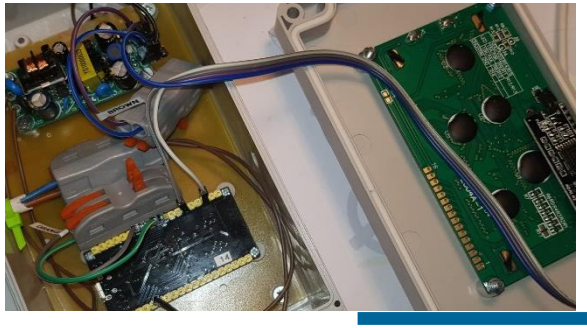
- Electronic Engineering (Politecnico di Milano), at CERN since 1986
- I have led 5 groups and various sections at CERN, currently the IT-CD group. I have many years experiences in computing services, infrastructure, software engineering, accelerator control and accelerator operation.
- I am passionate of mathematics, electronics, volleyball, scuba diving and sailing



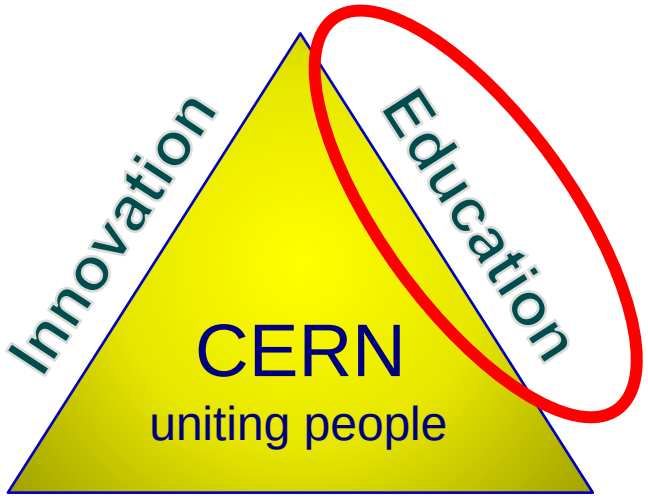


Alberto Pace

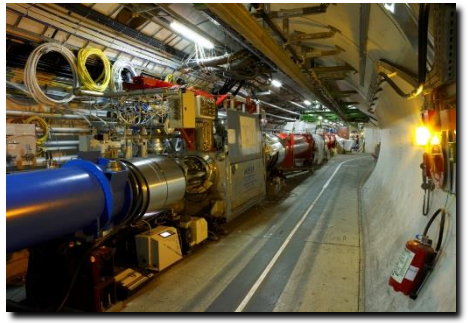
p-adic numbers
https://youtu.be/tRaq4aYPzCc



CERN's mission



The CERN School of Computing is here …



Accelerating beams (accelerators)

Detecting particles (experiments)

Large-scale computing (Analysis)

Discovery

A school with a long history

- The school was created in 1970, 2023 will be the 44th edition
- This is the 12th edition of the Thematic School
- The school has visited 22 countries
  - all member states (except Bulgaria, Slovak Republic) + Croatia, Cyprus, India
- 84 different nationalities, 155 last year (2022)
- 3145 students have followed the school

Mandate and mission

- Create a *common culture* in *scientific computing* among young scientists and engineers involved *in particle physics or other sciences*, as a strategic direction to *promote mobility* and to facilitate the development of large computing-oriented *transnational projects*.
  - http://cern.ch/csc
- Participants come from worldwide laboratories and universities with typically 20 to 30 different nationalities (61 different nationalities in the past 10 years).
  - http://cern.ch/csc/alumni

Bridging science and computing

- The unprecedented technological evolution in computing has profited directly to several scientific research projects, in particular in high energy physics
  - Computing is today the main strategy for many sciences to boost their research productivity
- It is nowadays essential that:
  - Scientists master computing technologies as the main tool for their research
  - Computer scientists understand the scientific domain of the investigation to deliver computing services that meet the needs of the research project

An additional side effect …

- … knowledge transfer of (CERN) skills and (CERN) know-how in computing to academic, national laboratories, research institutes, institutional and industrial circles in Member States and other countries
  - With direct or potential applications up to all spheres of the society (as exemplified with the Web, and the Grid).

The CERN Schools of computing

- The Main School
  - Two weeks, ~ 60 participants *(82 last year)*
  - Multiple topics on scientific computing
- The Thematic schools
  - Goes more in depth on a particular topic
  - Smaller participation, shorter duration (one week), clear goals
  - Last year, two schools 35 + 38 participants
  - This school: 23 participants
- The Inverted school
  - It is frequent to find among students real experts on specific topics, and the cumulated knowledge of the students exceeds the one of lecturers.
  - At the end of each school, we invite students to propose some lectures, and we organize an “inverted” school. *“Where students turn into teachers”*
  - In 2023, the 14th edition had 14 lecturers and more than hundred participants

The School Academic Dimension

- The school …
  - … is not a conference
  - … is not a place for lecturers to present their work, promote their projects
  - Does not replicate of common training available at home institutes, or in member state's universities
  - Does not delivering "technical training" courses

- Focus on **persistent knowledge**, less notions and knowhow

Focus on Knowledge

- Knowledge versus Knowhow

Knowledge	Knowhow
Articulated to other knowledge of the learner	Generally stand-alone information
By nature, when taken by the learner, different between learners	Initially, the same for every learner
Transferable, adaptable to other environments	Transfer requires effort
When taken by the learner, persistent	Will be forgotten if not practiced
Requires related knowledge pre-exist	Limited pre-requirements

An outreach opportunity

- For the local organizers

ΚΑΘΗΜΕΡΙΝΗ **ΚΑΒΑΛΑ**

ΚΑΘΗΜΕΡΙΝΗ ΕΦΗΜΕΡΙΔΑ ΤΗΣ ΚΑΒΑΛΑΣ

Χρόνος 41ος · Αριθμός Φύλλου 11097 Παρασκευή 11 Σεπτεμβρίου 2015 Τιμή φύλλου 0,50 EURO

Θερινό Σχολειό Ηλεκτρονικής με 75 μεταπτυχιακούς φοιτητές θα διοργανώσει το ΤΕΙ Καβάλας

Μεγάλη διοργάνωση, πολλαπλά τα κέρδη

SLOBODNA DALMACIJA

An outreach opportunity

- For CERN

Thematic CSC 2022

Academic Programme

- Theme: “Scientific Software for Heterogeneous Architectures”
  - Introduction lecture
    “Preparing for the HL-LHC computational challenge”
    by Danilo Piparo (CERN)
  - Track 1: Technologies and Platforms
    by Andrzej Nowak
  - Track 2: Parallel and Optimised Scientific Software
    by Sebastien Ponce (CERN)
  - Track 3: Programming for Heterogeneous Architectures
    by Dorothea vom Bruch (CPPM/CNRS)
    and Daniel Campora (University of Maastricht)





Drinking yellow liquids in Split

CSC Organizers

Kristina Gunne
Administrator

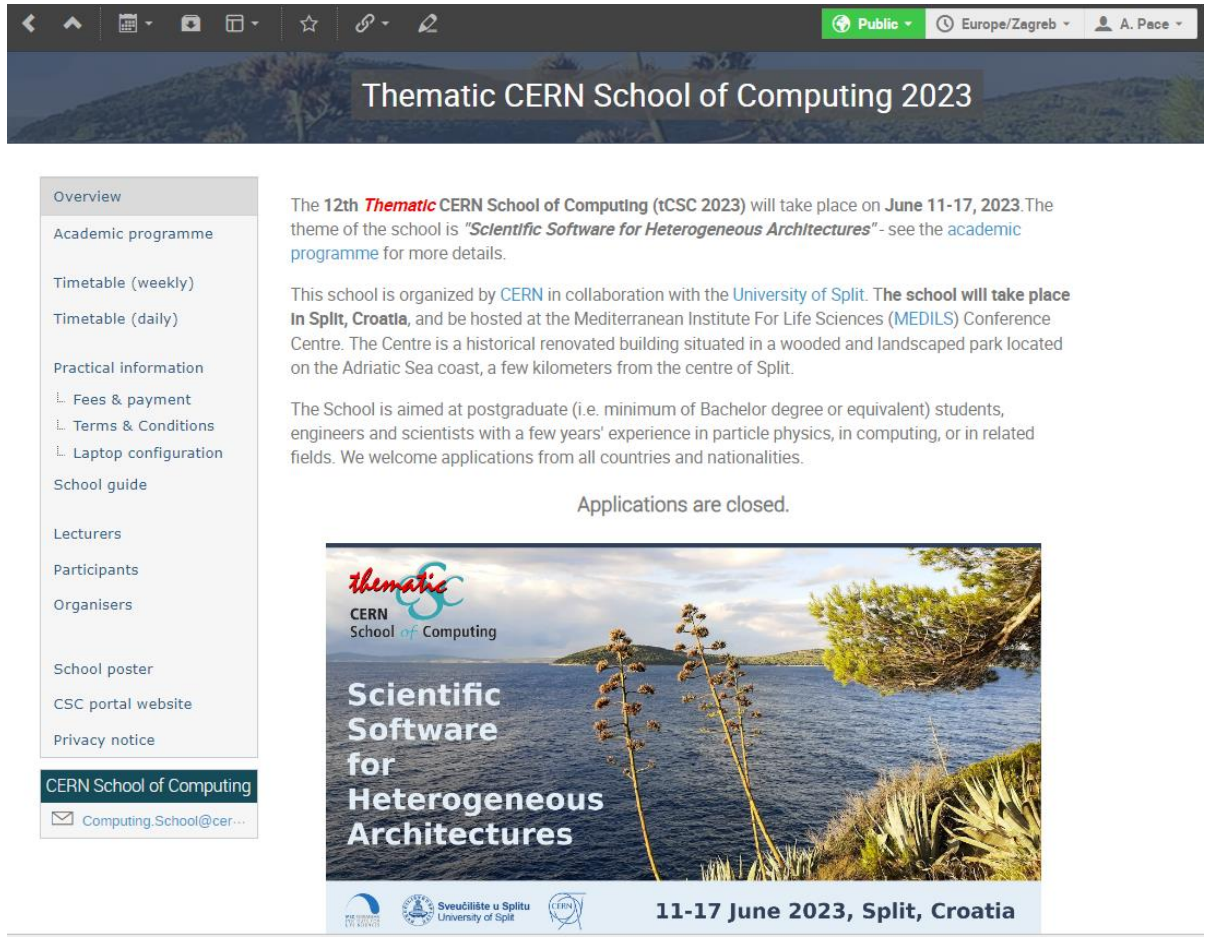
Jarek Polok
Technical Manager

Alberto Pace
Director

… and the MEDILS staff !

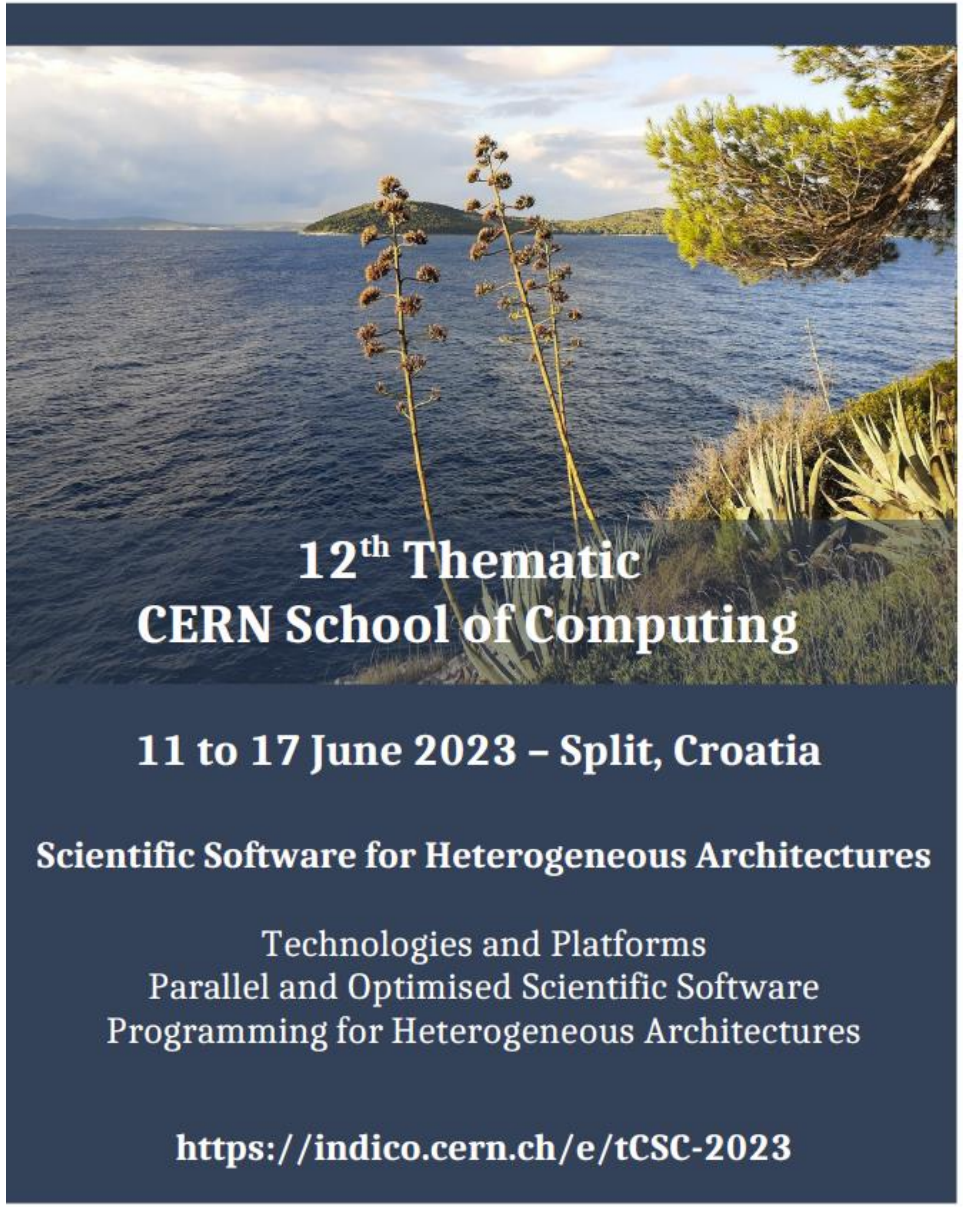
The School site is on indico

- https://indico.cern.ch/event/1244566/
- Check it regularly for updates



School booklet

- Printed version for those who asked for it
- Electronic version (PDF) Linked from school main page on Indico
- Contains pictures and short biographies of all participants



WhatsApp group

- Unofficial communication channel
- We recommend you to join the group
- Autojoin link:
  - https://chat.whatsapp.com/Gc6zA6wEG4BLKbNm12tmD2

School rules …

School rule #1

- **Participate**
  - Attendance at all lectures and exercises is mandatory
  - You should attend all meals and coffee breaks
  - Taking part in social and sports events is optional
    - You must let us know whether you participate or not

School rule #2

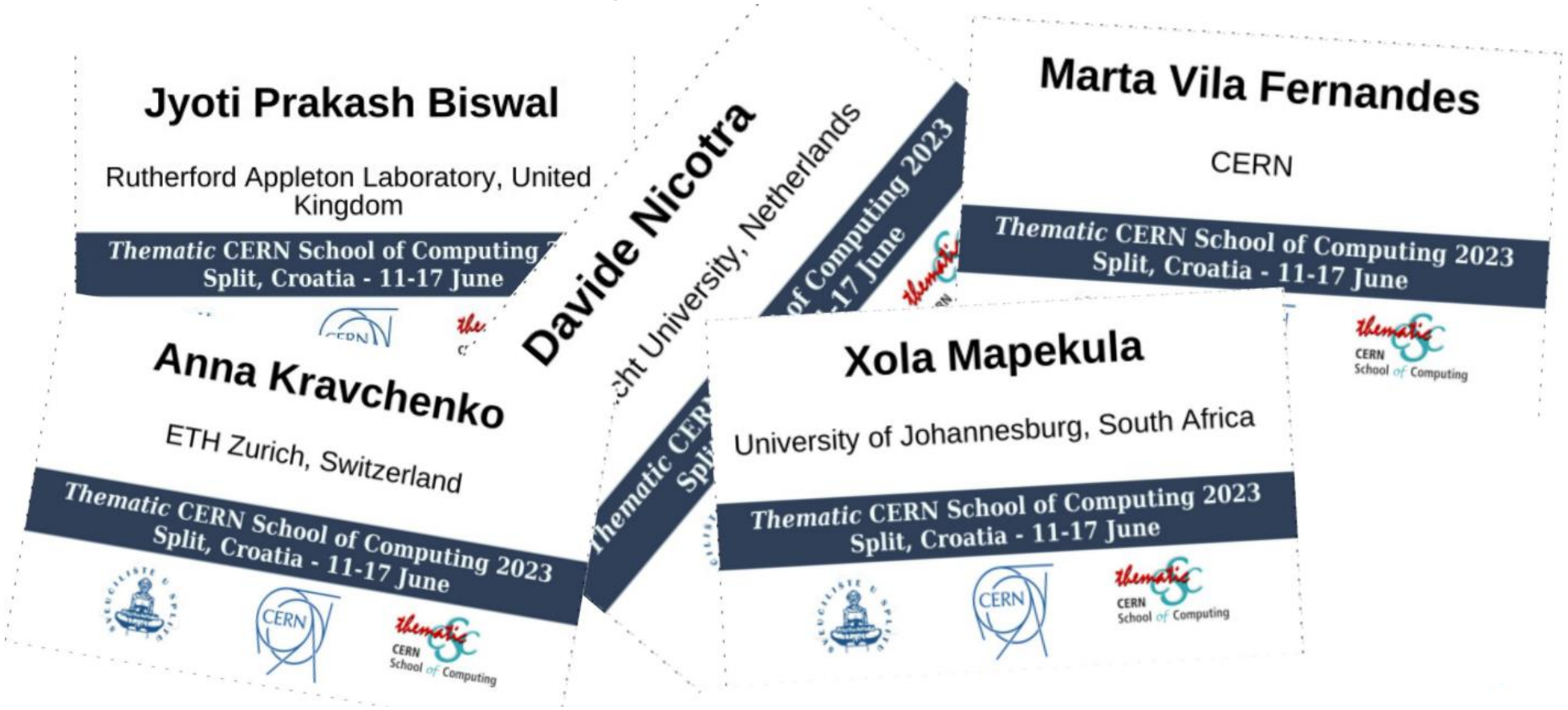
- **Be on time**
- Check what the schedule says:
  - “Lecture starts at 9:00” => You must be in the room before 9:00
  - Sign the presence sheet beforehand – it will be removed at 9:00
  - “The bus leaves at 18:00” => It will leave at 18:00
- If you’re late, we won’t wait

https://www.youtube.com/watch?v=1dZveoBfiww

Spaceballs, Mel Brooks, 1987

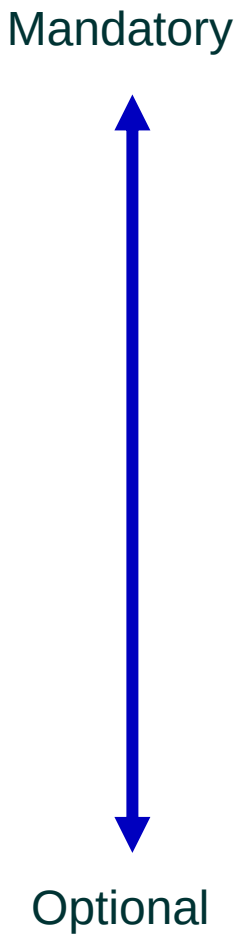
School rule #3

- **Wear your badge**
  - At least until I have learnt all your names !



The school learning process

- Learning process
  - Lectures
  - Exercises
  - Exam
- Meet special persons,
  Build trusts with colleagues across the world
  - Lunches, dinners, coffee breaks, evenings
  - Excursions
  - Music events
  - Sport programme



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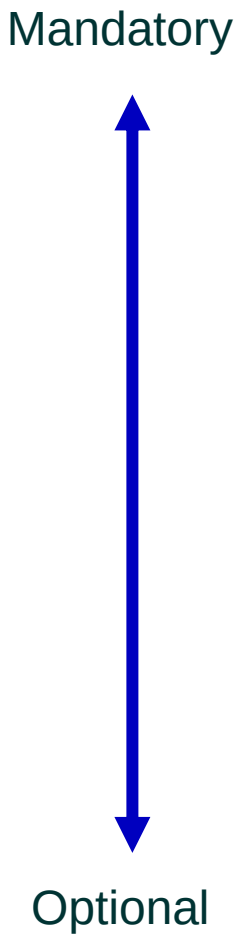
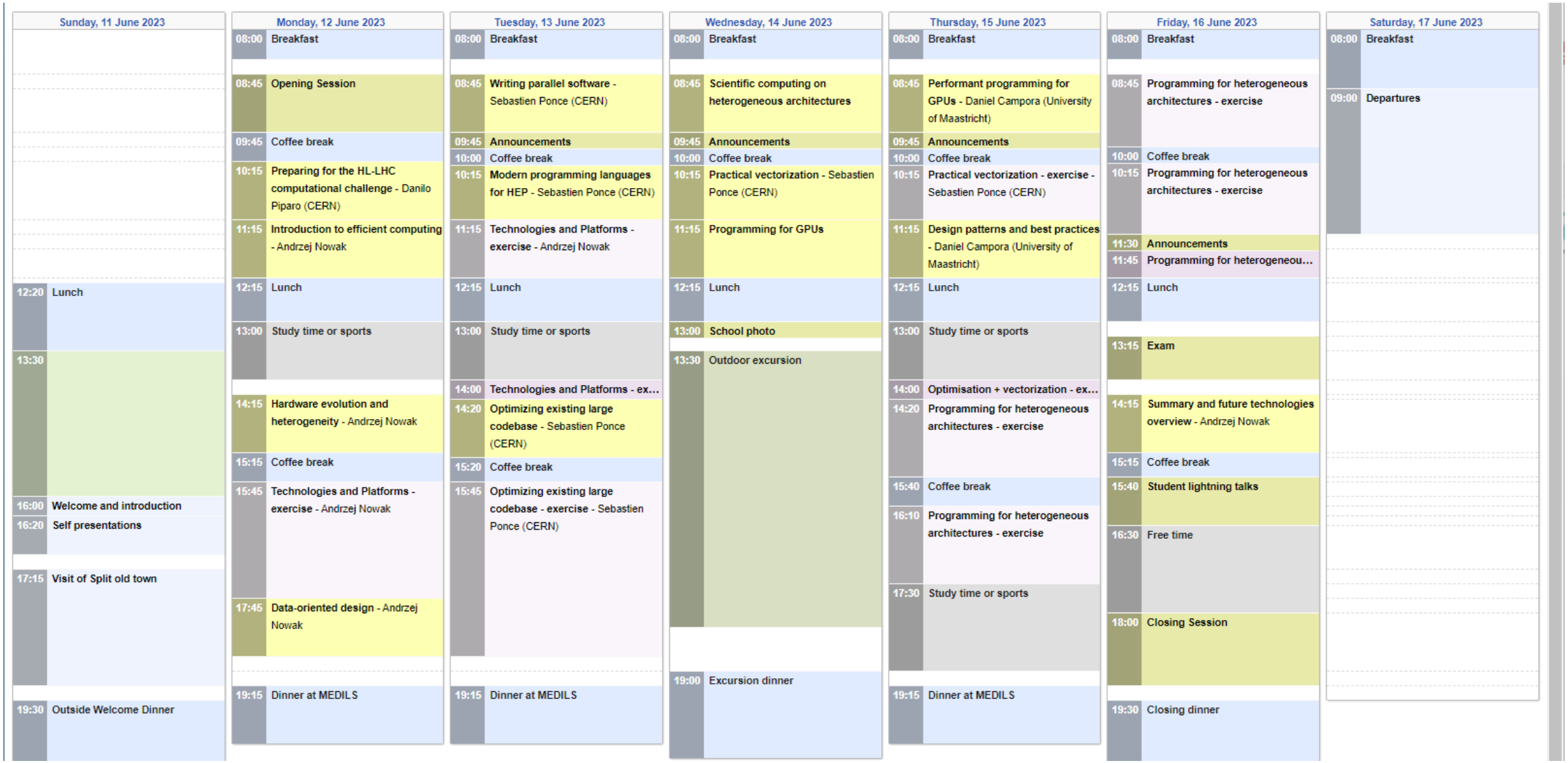


The tuition programme



Sunday, 11 June 2023

- 12:20 Lunch
- 13:30
- 16:00 Welcome and introduction
- 16:20 Self presentations
- 17:15 Visit of Split old town
- 19:30 Outside Welcome Dinner

Monday, 12 June 2023

- 08:00 Breakfast
- 08:45 Opening Session
- 09:45 Coffee break
- 10:15 Preparing for the HL-LHC computational challenge - Danilo Piparo (CERN)
- 11:15 Introduction to efficient computing - Andrzej Nowak
- 12:15 Lunch
- 13:00 Study time or sports
- 14:15 Hardware evolution and heterogeneity - Andrzej Nowak
- 15:15 Coffee break
- 15:45 Technologies and Platforms - exercise - Andrzej Nowak
- 17:45 Data-oriented design - Andrzej Nowak
- 19:15 Dinner at MEDILS

Tuesday, 13 June 2023

- 08:00 Breakfast
- 08:45 Writing parallel software - Sebastien Ponce (CERN)
- 09:45 Announcements
- 10:00 Coffee break
- 10:15 Modern programming languages for HEP - Sebastien Ponce (CERN)
- 11:15 Technologies and Platforms - exercise - Andrzej Nowak
- 12:15 Lunch
- 13:00 Study time or sports
- 14:00 Technologies and Platforms - ex...
- 14:20 Optimizing existing large codebase - Sebastien Ponce (CERN)
- 15:20 Coffee break
- 15:45 Optimizing existing large codebase - exercise - Sebastien Ponce (CERN)
- 19:15 Dinner at MEDILS

Wednesday, 14 June 2023

- 08:00 Breakfast
- 08:45 Scientific computing on heterogeneous architectures
- 09:45 Announcements
- 10:00 Coffee break
- 10:15 Practical vectorization - Sebastien Ponce (CERN)
- 11:15 Programming for GPUs
- 12:15 Lunch
- 13:00 School photo
- 13:30 Outdoor excursion
- 19:00 Excursion dinner

Thursday, 15 June 2023

- 08:00 Breakfast
- 08:45 Performant programming for GPUs - Daniel Campora (University of Maastricht)
- 09:45 Announcements
- 10:00 Coffee break
- 10:15 Practical vectorization - exercise - Sebastien Ponce (CERN)
- 11:15 Design patterns and best practices - Daniel Campora (University of Maastricht)
- 12:15 Lunch
- 13:00 Study time or sports
- 14:00 Optimisation + vectorization - ex...
- 14:20 Programming for heterogeneous architectures - exercise
- 15:40 Coffee break
- 16:10 Programming for heterogeneous architectures - exercise
- 17:30 Study time or sports
- 19:15 Dinner at MEDILS

Friday, 16 June 2023

- 08:00 Breakfast
- 08:45 Programming for heterogeneous architectures - exercise
- 10:00 Coffee break
- 10:15 Programming for heterogeneous architectures - exercise
- 11:30 Announcements
- 11:45 Programming for heterogeneou...
- 12:15 Lunch
- 13:15 Exam
- 14:15 Summary and future technologies overview - Andrzej Nowak
- 15:15 Coffee break
- 15:40 Student lightning talks
- 16:30 Free time
- 18:00 Closing Session
- 19:30 Closing dinner

Saturday, 17 June 2023

- 08:00 Breakfast
- 09:00 Departures

The school governance

- … is discussed at the School Advisory Committee
  - http://csc.web.cern.ch/advisory-committe
  - Includes several fulltime university professors from different countries
    - Currently: Belgium, Estonia, Germany, Croatia, Italy, Norway, Poland, Spain
  - Two meetings per year

The School Advisory Committee

Arnulf Quadt
Advisory Committee Chair, Programme Committee
Universität Göttingen

Alberto Pace
School Director, Advisory Committee , Programme Committee
CERN

Enrica Porcari
Advisory Committee, CERN IT Department Head
CERN

Kristina Gunne
School Administrative Manager, Advisory Committee
CERN

Jarek Polok
School Technical Manager, Advisory Committee
CERN

Frédéric Hemmer
Advisory Committee, Programme Committee
CERN

Sebastian Łopieński
Advisory Committee
CERN

Pere Mato
Advisory Committee, Programme Committee
CERN

Danilo Piparo
Advisory Committee, Programme Committee
CERN

Are Strandile
Advisory Committee, Programme Committee
CERN

Veronika Zadin
CSC 2023 Local Organising Committee
University of Tartu Institute of Technology

Tauno Tiirats
CSC 2023 Local Organising Committee
University of Tartu Institute of Technology

Margit Meiesaar
CSC 2023 Local Organising Committee
University of Tartu Institute of Technology

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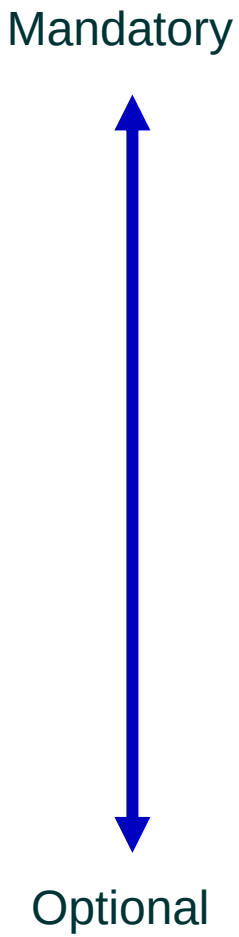

The School culture in “exercises”

- The school has an entire computing infrastructure for exercises. Remotely accessible to the students
  - The quality of the computing infrastructure is a shop window for CERN
- Students works in pair (2-student teams). If possible:
  - 1 student with physics background
  - 1 student with computing background

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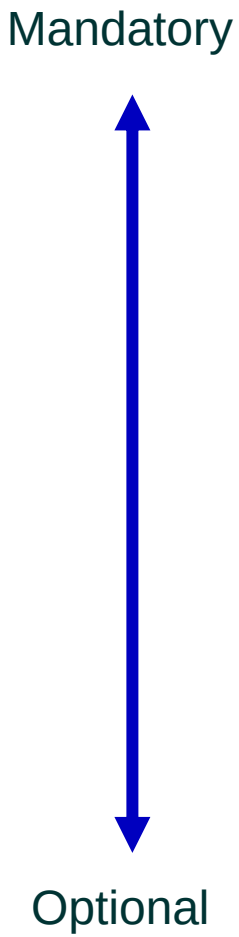

The exam

- A serious and difficult exam, which delivers the diploma
- Evaluate knowledge in two fields
  - Physics
  - Computing

An exam part of the learning process

- The test statistic is usually a single number whose value ...
  - ... reflects an agreement between the data and the hypothesis.
  - ... is equivalent to the mean value of the data sample.
  - ... must be equal to the most probable value of the distribution in question.
  - ... is never larger than the difference between values of variances of two competing hypotheses.

An exam part of the learning process

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An exam part of the learning process

- In the process of hypotheses testing, we often define the null and the alternative hypotheses. The most robust final results are obtained for ...
  - ... the acceptance of the alternative hypothesis.
  - ... the rejection of the difference between null and alternative hypothesis.
  - ... the acceptance of the ratio of null and alternative hypothesis.
  - ... the rejection of the null hypothesis.

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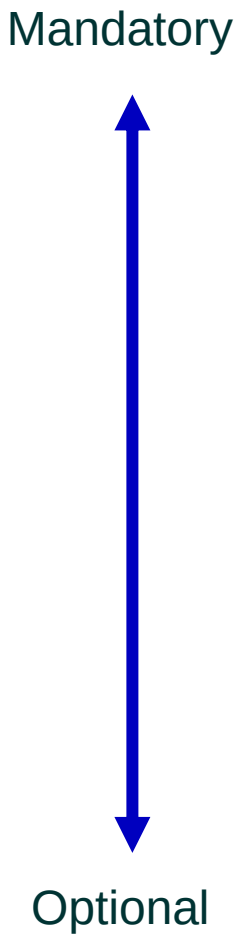


Lunch and Dinners

- Mix of Students + lecturers
- Tables of 8 - 12 persons

(Optional) Social programme

- Excursions
  - Culture
  - History
  - Nature

- Social games

(Optional) Music events

- Many students have hidden talents
- Music values are universal across all cultures

This year

Sten

Christof

Bernardo

Marcel

(Optional) Sport programme

Sport programme

At the CERN School of Computing an optional two to three hours sport programme is proposed every afternoon to those who are interested. The aim of the programme is not only to provide a healthy work-life balance before the late afternoon working sessions begin, but it also provides additional opportunities for interactions between students, lecturers and organizers. Several of the lecturers act as sport instructors or organizers.

Sports depend on the local facilitiesare and are usually proposed in the afternoon of teh first week and the first two days of the second week (the other afternoons being usually reserved for free time, the examination and the closing session).

Optional … but exceptionally popular

The sports programme is obviously optional, and no student should feel embarrassed if not interested. It is however particularly appreciated and usually more than 90% of the students participate. In particular, the possibility to discover new sport or to improve early skills through lessons given by school lecturers or by external instructors is appreciated.

Optional Sports ….

This year at the tCSC

- Basket

This year at the tCSC

- Badminton

This year at the tCSC

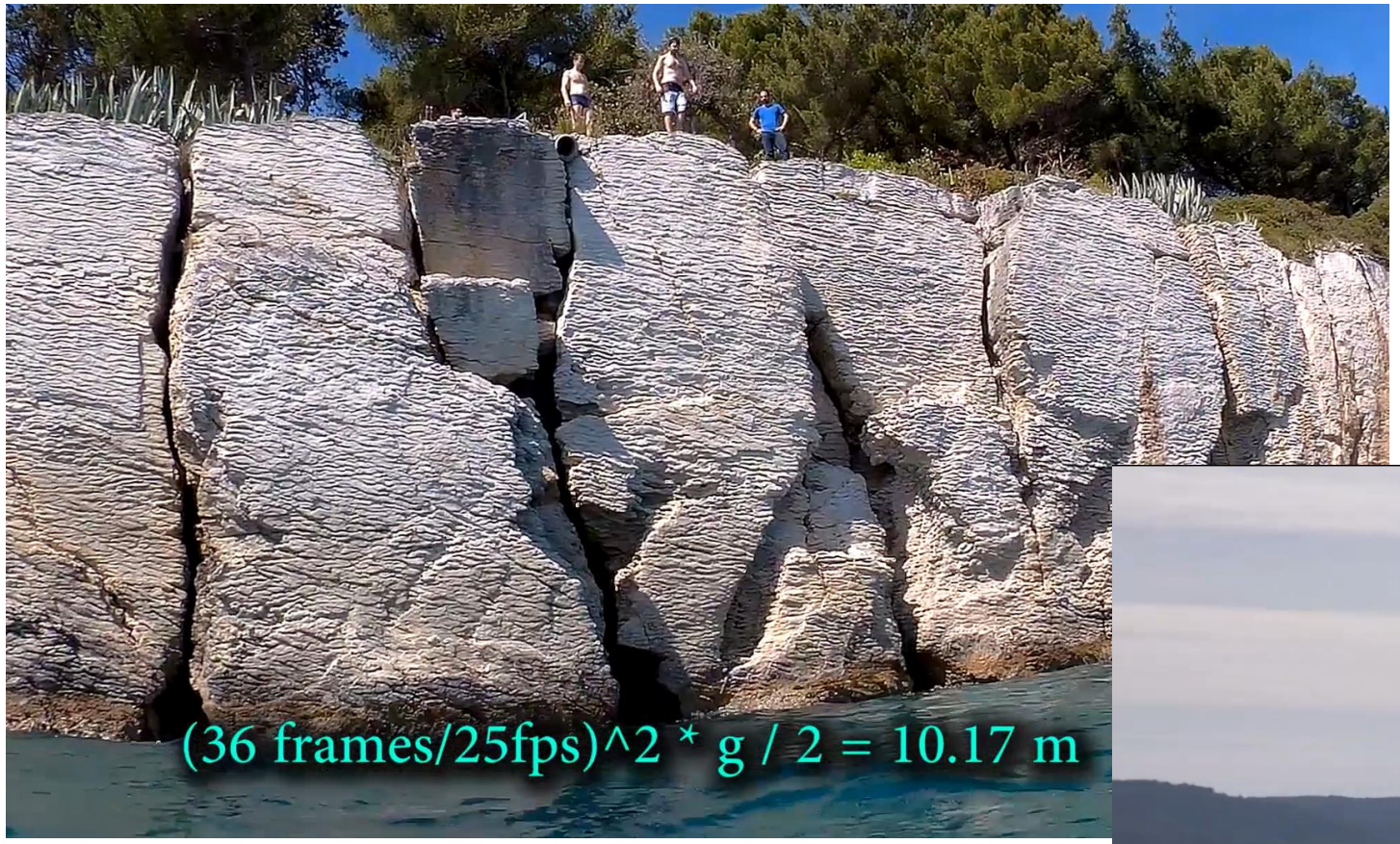
- Table tennis

This year at the tCSC

- Farniente

This year at the tCSC

- Swimming and sun bathing
- Careful when you jump from the cliff in the sea
  - Then you will have to swim ~ 100 meters to come out
- The rocks to walk on to get in and out of the water are extremely sharps
  - Wear shoes is possible


(36 frames/25fps)^2 * g / 2 = 10.17 m


(30 frames/25fps)^2 * g / 2 = 7.06 m

the participants give the most value to the school !

Why ?

For example, this year main school (2023)

- 135 applicants participants, 42 nationalities
  - Algeria, Austria, Belgium, Brazil, Canada, China, Croatia, Ecuador, Egypt, Estonia, Germany, Greece, India, Iran, Italy, Jordan, Lebanon, Malaysia, Mexico, Morocco, Netherlands, Oman, Pakistan, Palestinian Territories, Peru, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Turkey, Uganda, Ukraine, United Kingdom, United States.
- 32 % female participants (43/135)
- 84 institutes !!

The 84 applying institutes (2023)

- AGH - University of Science and Technology, Airbus, Albert Ludwigs University of Freiburg, American University of Beirut, Beirut Arab University, Cairo university, Center for High Energy Physics, Tsinghua University, Centre de Physique des Particules de Marseille (CPPM, France), IFIN-HH Bucarest (Romania), CERN, Charles University, Institute of Particle and Nuclear Physics, CMA CGM, ENSIAS, Mohammed V University in Rabat, ETH Zürich, Faculty of Mathematics and Physics, Charles University, Faculty of Sciences, Ibn Tofail University, Federal University of Rio Grande do Sul (UFRGS), Hassan II University of Casablanca, Helsinki Institute of Physics, University of Helsinki, HEPHY, Ibn Tofail, Indian Institute of Technology Bhubaneswar, INFN and University of Ferrara, INFN and University of Milan, Institute for Gravitational and Subatomic Physics (GRASP), Institute for Particle Physics and Astrophysics (IPA), Institute for Research in Fundamental Sciences (IPM), Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN), Institute of Particle and Nuclear Physics, Charles University, Institute of Technology, University of Tartu, ISIS Neutron and Muon Source, Jan Kochanowski University, Jordan university of science and technology, Jozef Stefan Institute, Karlsruhe Institute of Technology, KTH Royal Institute of Technology, Laser and Plasma Research Institute (LAPRI), Shahid Beheshti University, Lund University, Marmara University, MerQ (merq.ai), Mohammed VI Polytechnic University UM6P, National School of Mines, New York University Abu Dhabi, Nicolaus Copernicus Astronomical Center, Ositcom, Paris-Saclay University / IJCLab, Polytechnic of Milan, Red Hat, Rheinische Friedrich-Wilhelms-Universität Bonn, RWTH Aachen University, Sapienza University of Rome/INFN Roma1/CERN, Science and Technology Facilities Council, Southern Methodist University - SMU ATLAS Group, Technical University of Munich, Technische Universitaet Dortmund, The British University in Egypt, The Henryk Niewodniczański Institute of Nuclear Physics , Polish Academy of Sciences., The Institute for Research in Fundamental Sciences (IPM), Tsinghua University, TU Wien, Uni Bonn, United Arab Emirates University, Universität Hamburg, Universität Heidelberg, Université Saint-Joseph, University of Bern, University of California, Berkeley, University of Cape Town, University of Geneva, University of Ljubljana, Faculty of Mathematics and Physics, University of Malaya (UM), University of Moratuwa, University of Rome Tor Vergata and INFN, University of Rome, La Sapienza, University of Sharjah, University of Tartu, University of Technology & Applied Science-Shinas, University of Turin and INFN Turin, university of Ulster, University of Victoria, University of Virginia, University Politehnica of Bucharest, Valoores.


University of
BRISTOL


ÖAW
Austrian Academy
of Sciences



AGH

中央研究院
ACADEMIA SINICA




HELSINKI
INSTITUTE OF
PHYSICS


CERN
School of Computing

KIT
Karlsruhe Institute of Technology

UHH

INFN
Istituto Nazionale
di Fisica Nucleare

FCT
FACULDADE DE
CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

KIT
Karlsruhe Institute of Technology



HEPHY
Institut für Hochenergiephysik



BULGARIAN
ACADEMY
OF SCIENCE
1869




Universidad de Oviedo

HELSINKI
INSTITUTE OF
PHYSICS

Universiteit Utrecht

Universidad de Oviedo

HØGSKOLEN
I BERGEN
BERGEN UNIVERSITY COLLEGE






National
Technical
University of
Athens

BERGISCHE
UNIVERSITÄT
WUPPERTAL

JAEA
独立行政法人
日本原子力研究開発機構
Japan Atomic Energy Agency

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GÖTTINGEN




LABORATÓRIO DE INSTRUMENTAÇÃO E
FÍSICA EXPERIMENTAL DE PARTICULAS

NIKHEF


UNIVERSITÀ
DELLA CALABRIA




University of
BRISTOL

eli
extreme light infrastructure

GSI
GSI Helmholtzzentrum für Schwerionenforschung

Science & Technology
Facilities Council


ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

DESY


ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

KTH
VETENSKAP
OCH KONST

Technische Universität München

tifr

University of
Zurich[UZH]

GOETHE
UNIVERSITÄT
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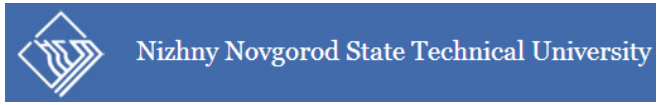
UNIVERSITÄT MAINZ

Technische
Universität
Braunschweig

Nizhny Novgorod State Technical University

PAN
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los Andes

PHYSIKALISCHES
INSTITUT

Universidade do Minho 1974-2014

So …

We have quite some diversity

But where is the value?

Excerpts from reference letters

- Starting at school, all his marks have been the best possible.
- He was the top student in my elementary and advanced particle physics courses as well in my data analysis course and labs
- In comparison to the many other Ph.D. students I had or have in my group, I rank him at the very top, among the best 2%
- He was by far one of the best undergraduate students involved in …
- She stood out as by far the strongest candidate among our applicants…

Excerpts from reference letters

- … I would place him in the top () of all physics graduate students that I have known, which includes all fields of physics
- … she graduated top of her class and stayed as a scientist in different research projects …
- … his thesis got the highest possible mark “very good (1.0)” with the overall mark including three oral exams, of 1.3
- … he ranks among the best of all diploma students in (omiss)…

Excerpts from reference letters

- … I can indeed state that she is a top-level student, easily among the best 5% I ever met
- He finished his master thesis with a mark of 1.1 (marks range from 1.0 (best) to 5 (failed) and he ranks among the best of the successful master students in Physics.
- His diploma work was given the highest possible mark …
- … compared to the PhD students in my group so far, he ranks among the very best, with exceptional maturity concerning computing and software and a clear view on and experience in data analysis.

Who are the CSC participants ?

- You are young, diverse, come from many countries, from different institutes …
- You have all an outstanding potential and a passion for both computing and science.
- You will work together one weeks to widen your skills but also establish lifetime links with other participants and research institutes across the world that will be useful throughout your future career.
- This is what gives the highest value to the school

It is a small world …

- All top scientists knows each other very well

CSC 2023, Krakow, Poland

tCSC 2023, Split, Croatia

- Are you ready to write history ?


CERN