Introduction meeting
FYST17 VT20

Else Lytken

Today's agenda

- Why do particle physics?
- Learning outcomes and prerequisites
- Course plan
- Litterature and lecturers
- Evaluation
- Introducing the Particle Physics division
- Summer schools
- Remaining questions

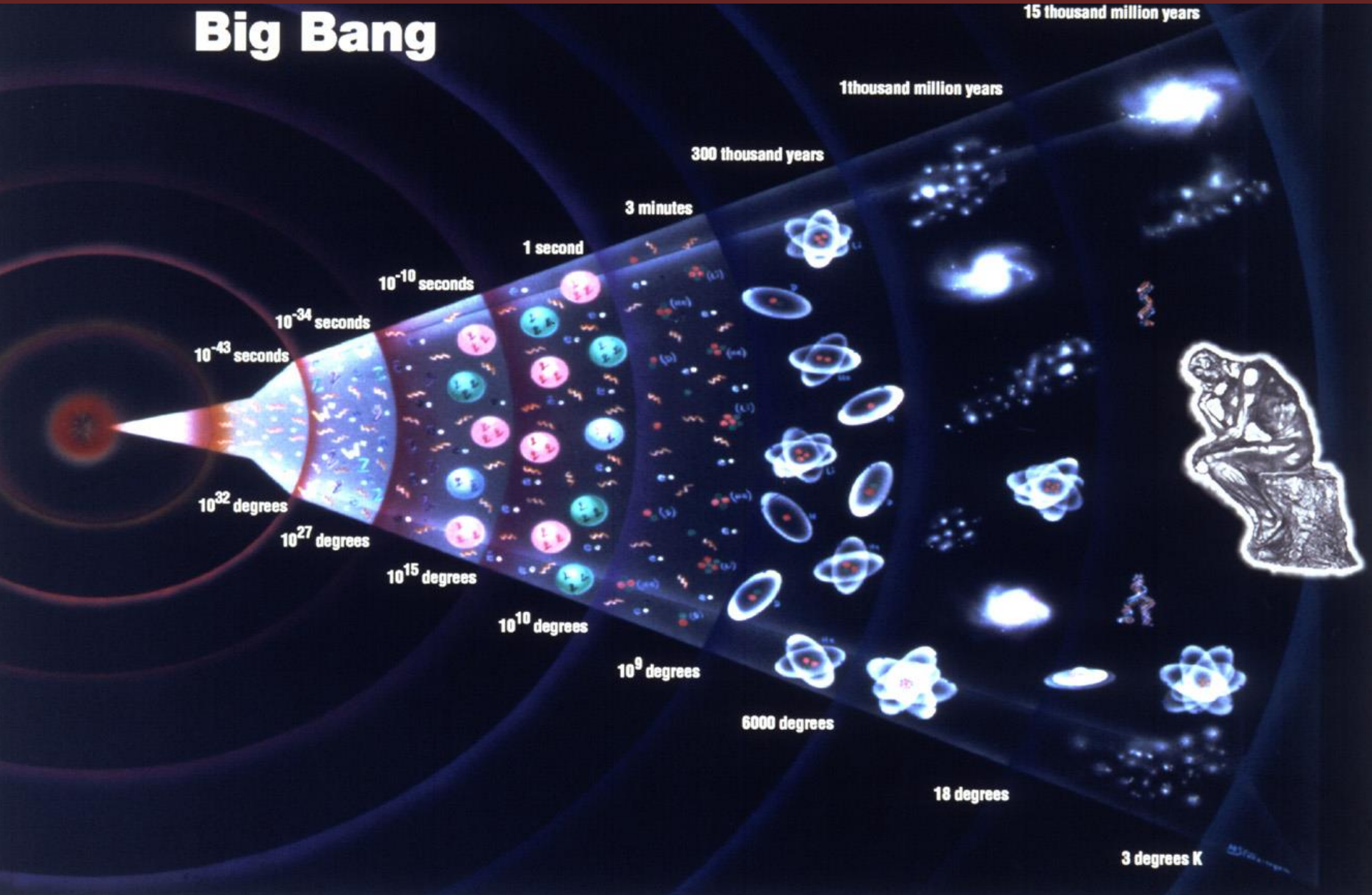
Why do Particle Physics?

- For the big questions: Particle physicists probably asks some of the biggest scientific questions imaginable and then looks for ways to answer them.
- If the tools are not there, develop new tools!

H. White: "It provides us with the capacity to solve problems we don't even know we have yet"

- Curiosity-driven rather than use-case-driven but that doesn't mean it is not useful!
- Along the way, PP has had significant impacts on other fields of science, improved life for people around the world and educated the new generation of scientists and computing professionals.
- Particle physicists end up in academia, banking/insurance, programming&design, accelerator&material science, data scientists, etc etc. For some international examples, see for instance CERN Alumni

About particle physics



Some questions to be answered

What happens at high energies where our model breaks down?

What is mass?

Do the forces unify ?

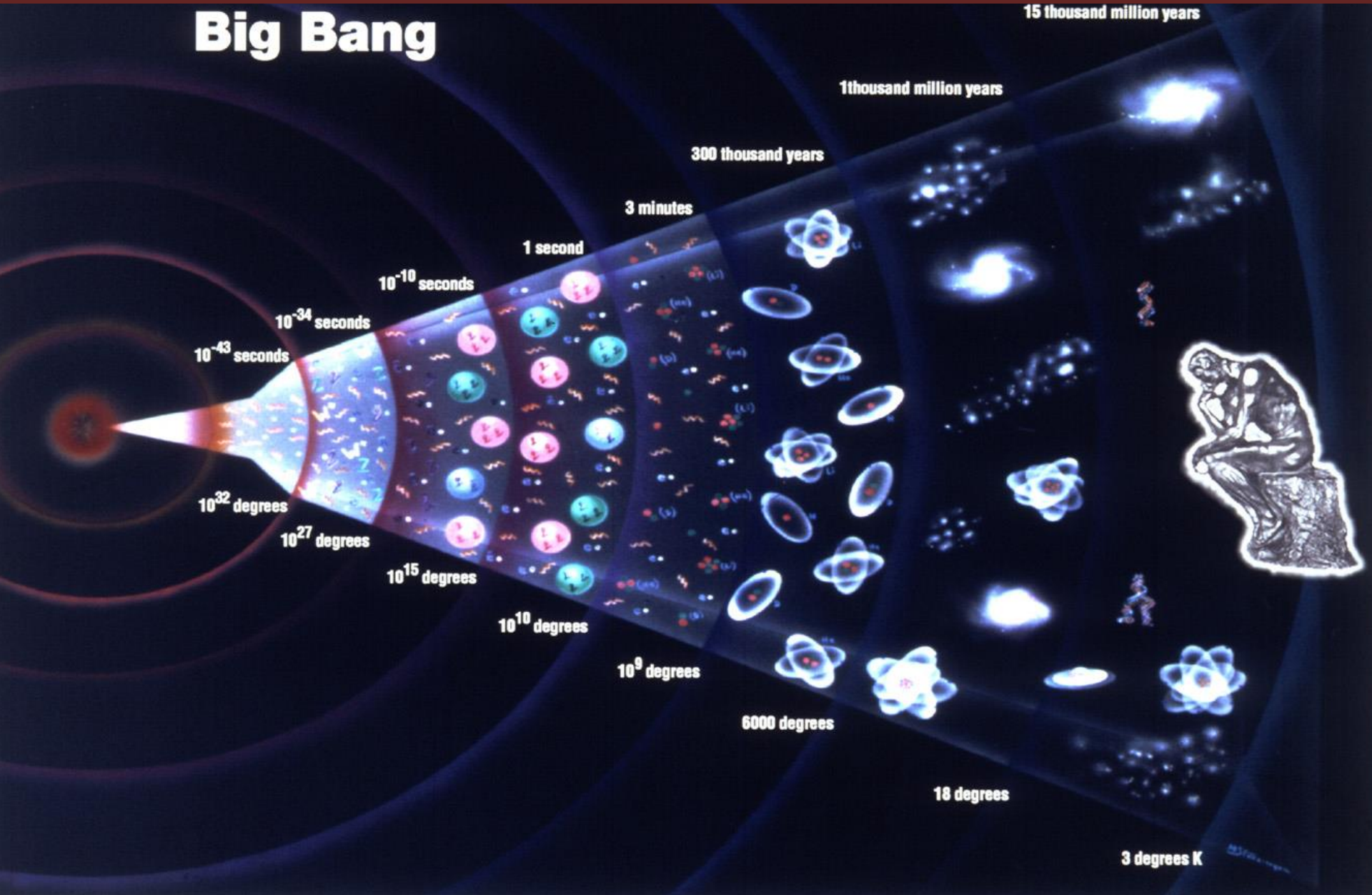
Where does gravity fit in?

Where has all the anti-matter gone?

Is dark matter a particle?

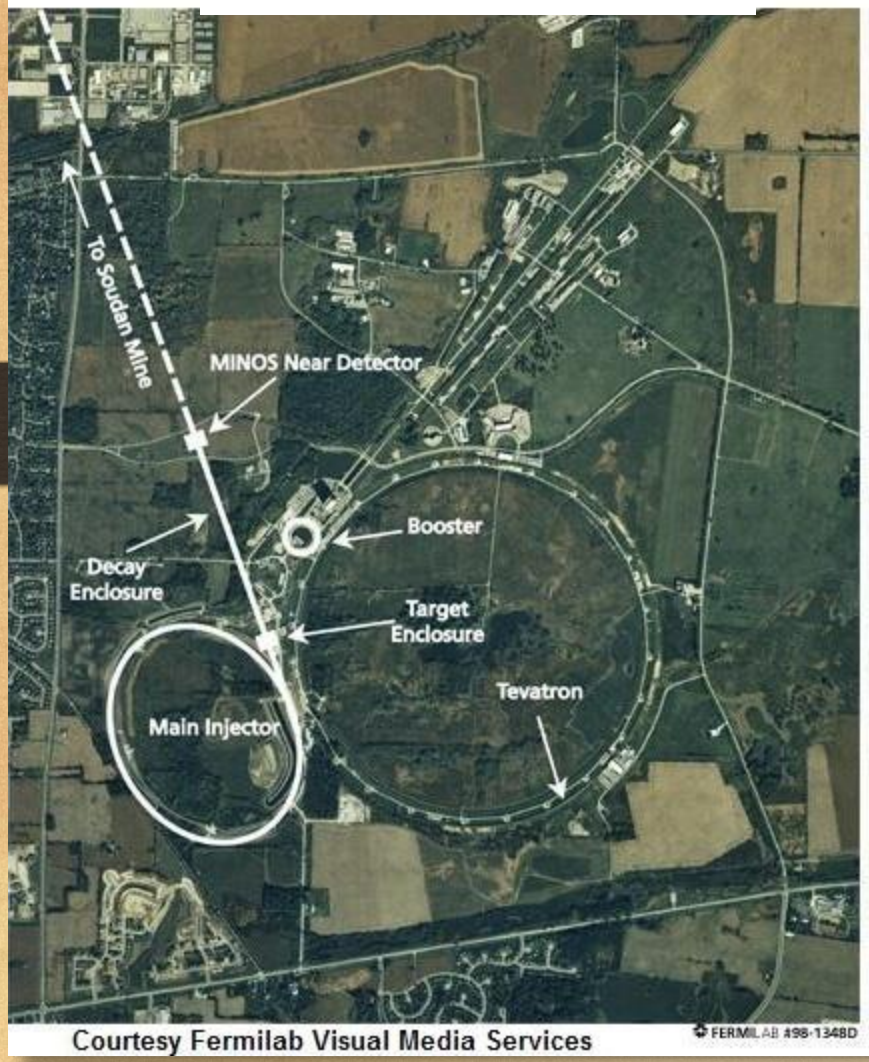
Are there new space-time symmetries?

Where to find answers

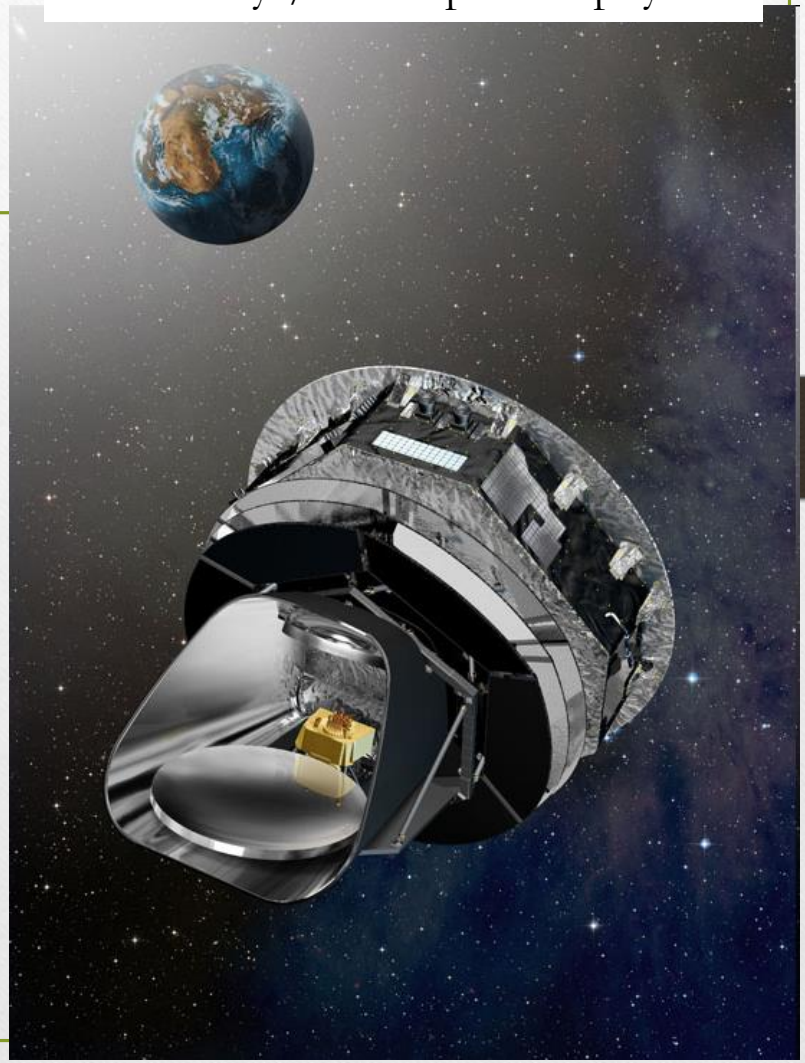


Two standard approaches

Ground-accelerator-based



Cosmic rays/ Astro-particle physics



ESA's Planck satellite, courtesy ESA

Learning outcomes

- The purpose of this course is to provide advanced knowledge of current aspects of experimental particle physics
  - Current status and challenges
  - Experimental programs current and future
  - Basic statistical methods in particle physics
- Students should also:
  - Learn to acquire scientific knowledge, including reading scientific papers
  - Improve their problem solving skills in the area, including analysis
  - Improve communication skills, both written and oral

Prerequisites

- Basic knowledge of quantum mechanics and four-vectors and relativistic mechanics
  - More info on the homepage ”Notes on particle kinematics, cross-sections etc”
- Basic knowledge of the Standard Model of particle physics
  - For local students I assume you have taken the Physics 3 course FYSC14: High energy physics, accelerators and cosmology
  - Other useful courses are FYSN11, 15 ; FYTN04, MNXB01

Course content

- See detailed lecture schedule online
  - More details on the Standard Model, Beyond the Standard Model, and experimental techniques
  - Including special lectures on heavy ion physics, dark matter, and beam dynamics
  - Statistical tests and analysis examples
  - Hopefully a visit to the ESS site – more details from Emanuele when the beam dynamics lectures start
- **3** sets of written exercises
  - SM physics, Simple statistics, Heavy ion physics.
  - BD exercises as well but in-class
- Student project work
  - Read up on topic, present to rest of class + computer exercise

Student projects

- Group work. For the preparations and presentation group size can be ~4 . For the computing exercise we will try to get enough virtual machines set up to split you into groups of 2
- Day 1: Pick and read outreach level article (will be provided) and prepare short (< 5mins) presentation
- End of day 2: present to class
- Day 3: Computing exercise: ATLAS open data, access to data through virtual machine. Get basic analysis code (python) to work and extend to your own analysis selection

Canvas

- First time using Canvas in this course, so please bear with me (and the other teachers) as we figure it out
- All slides should appear there, and also on the old-style webpage
- You can turn in home work via Canvas or on paper directly to the teacher

A slide about previous student evaluations

- 5 students! So no real conclusions, but:
- Generally happy
  - They asked for a bit more introduction to the exercises and the guest lectures, we will try to incorporate that
  - They liked the extra exercise so we keep that
  - The computer exercise moved to another room, this worked well last year but this year there were also software updates. Hopefully everything will work well again.
- Do you want a course representative?

Lecture plan (preliminary)

Schedule Spring 2020 / PRELIMINARY!

Modern Experimental Particle Physics FYST17

Date	Location	Topic	Lecturer
Tue, Jan 21	K262	Introductory meeting	E. Lytken
Thu, Jan 23	K262	The Standard Model I	E. Lytken
Mon, Jan 27	K262	The Standard Model II	E. Lytken
Tue, Jan 28	K262	Neutrinos	E. Lytken
Thu, Jan 30	L315	Detectors	E. Lytken
Mon, Feb 3	K262	LHC physics I	E. Lytken
Tue, Feb 4	K262	LHC Physics II Deadline PP exercise 1	E. Lytken
Thu, Feb 6	K262	MC and simulation	E. Lytken
Mon, Feb 10	K262	PP 1 exercises back	E. Lytken
Tue, Feb 11	K262	Statistics: fitting and hypothesis testing	E. Lytken
Thu, Feb 13	K262	Statistical methods in Particle Physics	E. Lytken
Mon, Feb 17	K262	Heavy Ion Physics I	P. Christiansen
Tue, Feb 18	K262	The Higgs discovery	E. Lytken
Thu, Feb 20	K262	Heavy Ion Physics II	P. Christiansen
Mon, Feb 24	K262	Beam Dynamics I	E. Laface
Tue, Feb 25	H322	Dark Matter	R. Poettgen
Thu, Feb 27	K262	Beam Dynamics II Deadline PP exercise 2	E. Laface
Mon, Mar 2	K262	Beam dynamics III	E. Laface
Tue, Mar 3	K262	BSM and the Cosmic Connection	E. Lytken
Thu, March 5	K262	Beam Dynamics IV	E. Laface
Mon, Mar 9	K262	Student work	C. Doglioni, E. Lytken
Tue, Mar 10	K262	@ 14:00 Student presentations	C. Doglioni, E. Lytken
Thu, Mar 12	Astro computing lab	Computing exercise	C. Doglioni, E. Lytken

Important dates So far

- Lectures Mon-Tue- Thu 13:15 to 15:00 starting this Wednesday.
  - Most days we are here, see TimeEdit for latest updates
- Feb 4: turn in of first HW
- Feb 27: turn in of second HW
- March 9, 10, 12: project work
- March 17: hand-out exam
- March 19: hand-in exam

Litterature

- Main material covered in G. Barr et al. "Particle Physics in the LHC Era", Oxford Masters Series in Particle Physics, 2016
- Additional litterature: chapters 3, 8, and 10 in "Data analysis in high energy physics: a practical guide", O. Bahnke et al
- e-book links on homepage
- Additional lecture notes/material will be distributed at the lectures
- Slides will be posted on the homepage of course and on Canvas

Lecturers

Main responsible: Else Lytken

Office A426, Else.Lytken@hep.lu.se

Peter Christiansen

Lecturer

Heavy ion physics

Caterina Doglioni

Instructor

project work

Emanuele Laface

Lecturer

ESS/beam dynamics

Ruth Pöttgen

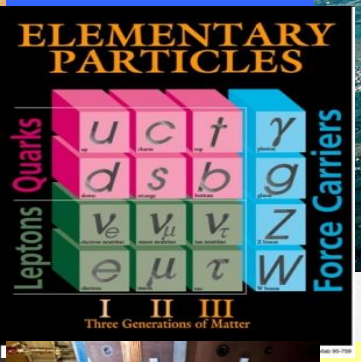
Guest lecturer

Dark Matter

Evaluation

- FYST17 gives 7.5 ECTS credits
- **Final exam** is a take-home written exam, will be passed out March 17 (tentatively) and turn-in date is March 19 (tentatively). *It must be the work of the individual student, no collaboration*
- **Home work**: *must* be passed before examination. PP and HI homework grade counts as 30% in the final grade. Collaboration on ideas encouraged but each student should write down individual solutions
- **Project work** *must* be passed before final examination. P/NP grade . Talk to me well in advance for alternatives if you think this could be a problem for you

CERN Summer Student Programme 2020



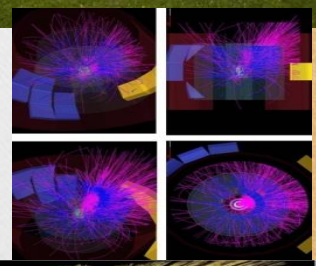
Apply to experience CERN first-hand !

Participants in the CERN Summer Student programme join research activities and have lectures about particle physics from gifted lecturers

Every Summer about 100 students from around the world come to CERN as Summer students, to learn about fundamental physics, participate in research, enjoy the location near Geneva on the border of France and Switzerland, and to form new friendships.
Places are awarded on a competitive basis, to students who have finished the first years of their university education that Summer (typically bachelor in Science/engineering/computer science)

Application deadline is 31 January 2020

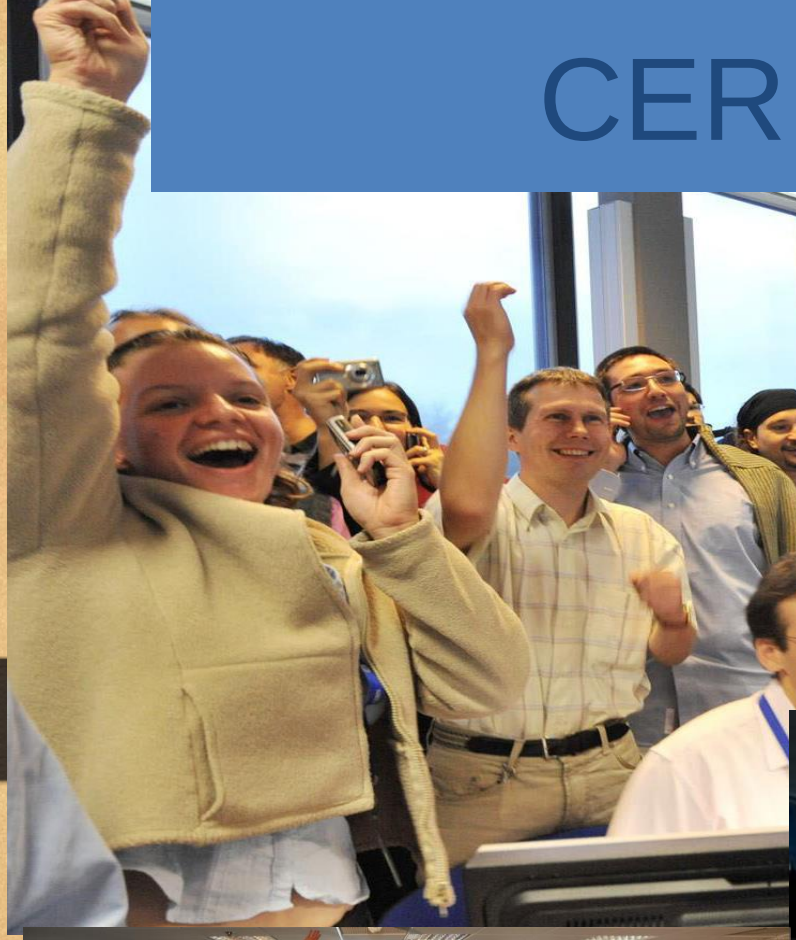
Travel + generous stipends paid
8-13 weeks in the Summer of 2020



Summer student programs

- Both CERN and DESY labs have summer student programs – find programs online
- Deadline every January – next deadlines is 31/1
- Need letters of recommendation
  - Preferably from project supervisors – not necessarily particle physicists.
- Intended for university students in physics, engineering, and computer science
- You need at least 3 years of university studies and a good knowledge of English
- CERN: Preference for students from CERN member states

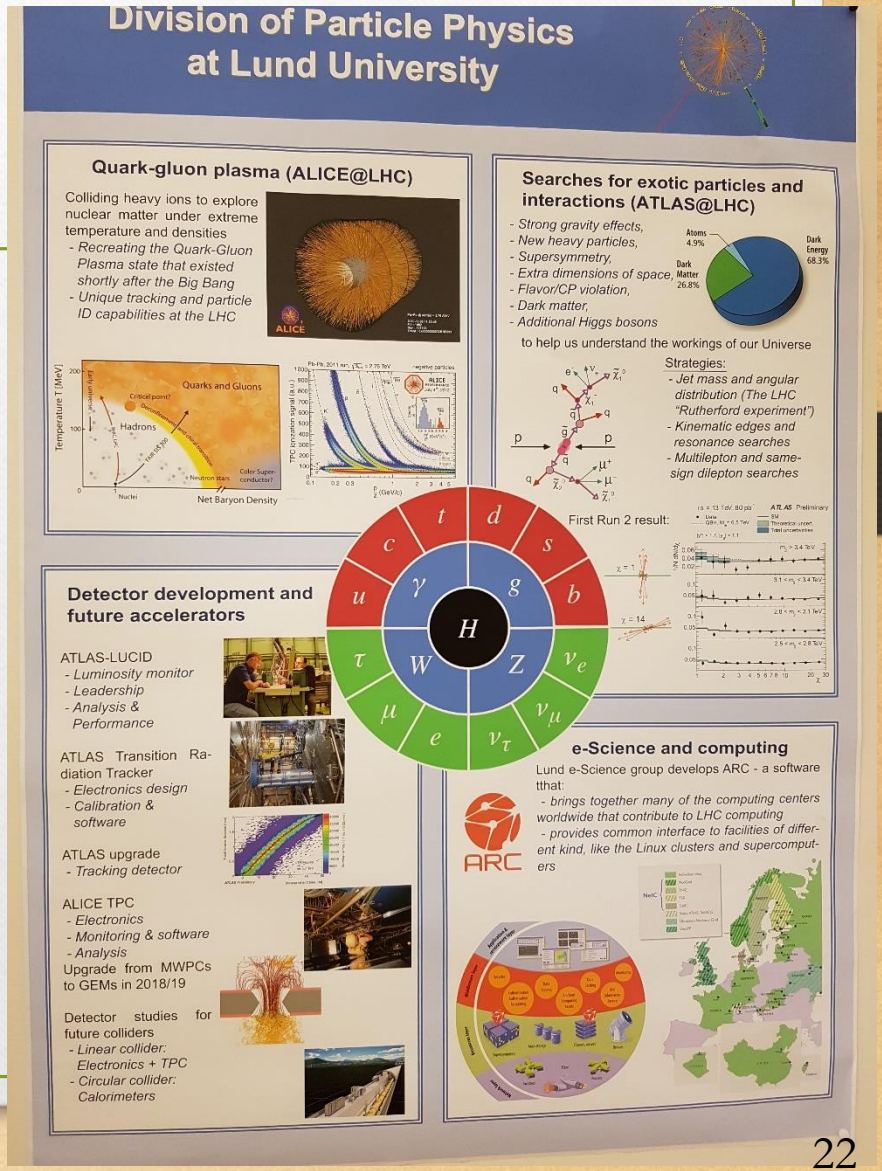
CERN researchers



The Lund Particle Physics division

Mainly involved in the LHC experiments ALICE and ATLAS but also in the design of new experiments (for instance the light dark matter experiment, LDMX) and e-Science

Come to the A400 corridor and ask about possible projects!



If you haven't signed up for this course yet

- and want to, check with Stina if it is possible. (in person or via studentadministration@fysik.lu.se)

Your expectations

- What is your background?
- Why (experimental) particle physics?
- What are some things you hope to learn from this course?