

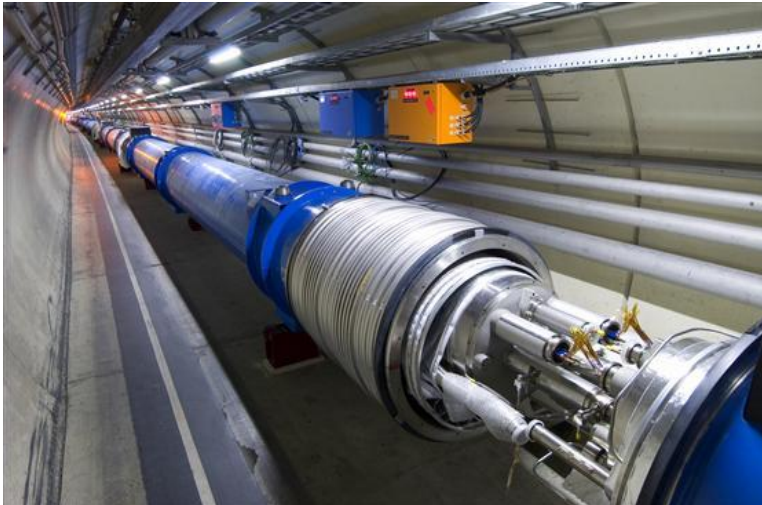
A large, complex particle detector, likely the ATLAS detector at CERN, is shown in a large industrial hall. The detector is composed of many layers of sensitive components, with a prominent green metal structure on the left. The background shows the high ceiling and structural beams of the hall, with bright lights illuminating the scene.

Summer at CERN?

*Emilia Veikkola & Nico Toikka
Helsinki Institute of Physics (HIP)*



- The **Helsinki Institute of Physics** (HIP, www.hip.fi) is a physics research institute that is operated jointly by
 - the University of Helsinki
 - Aalto University
 - the University of Jyväskylä
 - the Lappeenranta-Lahti University of Technology
 - the Tampere University
 - with the Finnish Radiation and Nuclear Safety Authority (STUK)
- The research activity at the institute covers an extensive range of subjects in theoretical physics and experimental subatomic physics.



- HIP is also the link between international collaborations and Finland
 - Opportunities in multiple fields of physics: summer student programme (for all students in Finland!), thesis', work as a graduate etc.
 - **LHC** (Large Hadron Collider) is the world's largest particle collider situated at **CERN** (the European Organization for Nuclear Research) on the border of Switzerland and France

- Multiple experiments at CERN that HIP works with (each measuring collision produced at the LHC):
 - CMS
 - TOTEM
 - ALICE
 - Isolde
- ESRF at Grenoble, France

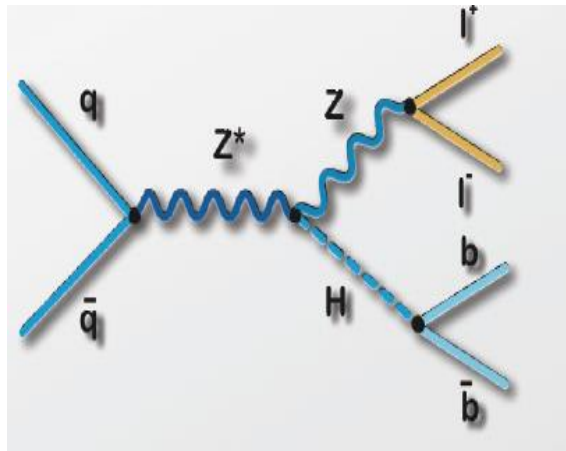


CERN and ESRF locations

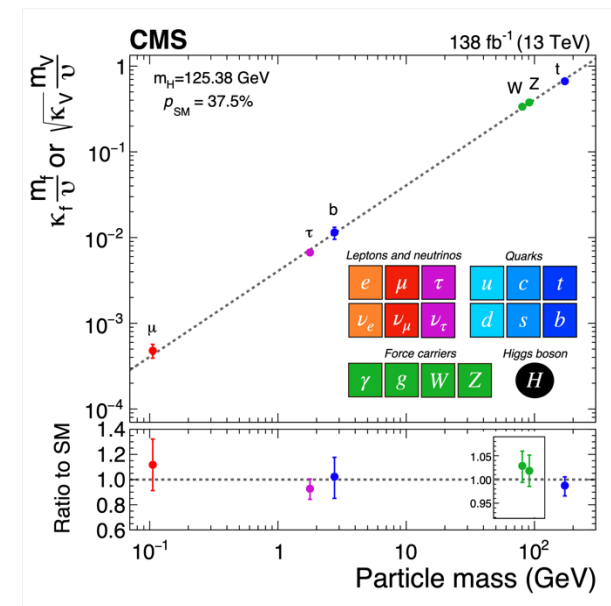
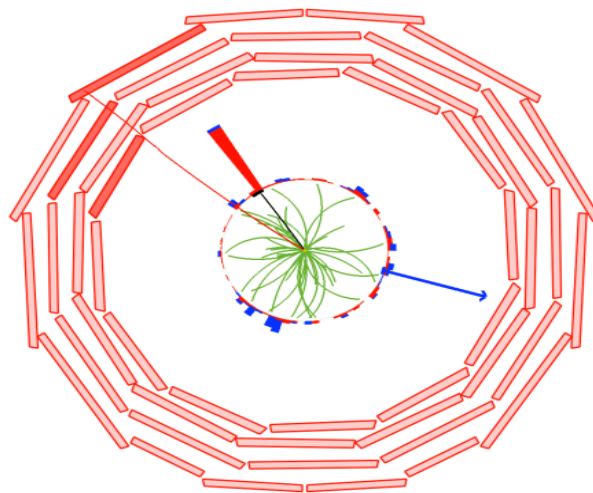


Aerial view of ESRF

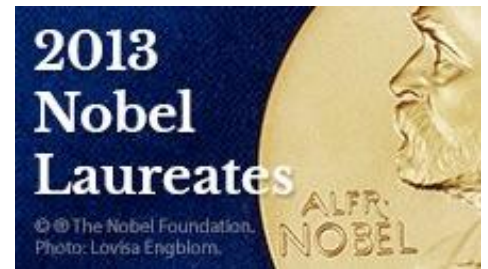
- New particles and phenomena – rare decays – precision measurements
- **Higgs particles** – electroweak symmetry breaking ✓
- **Supersymmetry** – solution to dark matter?
- **Exotic particles** – new theories?
- **CP violation, rare decays** – are they in the standard model?
- **Precision measurements** – indirect method for studying physics at different energy scales



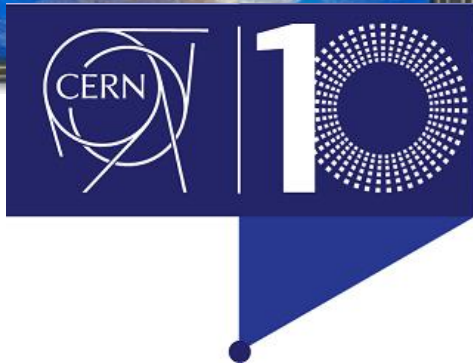
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"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"



François Englert and Peter W. Higgs



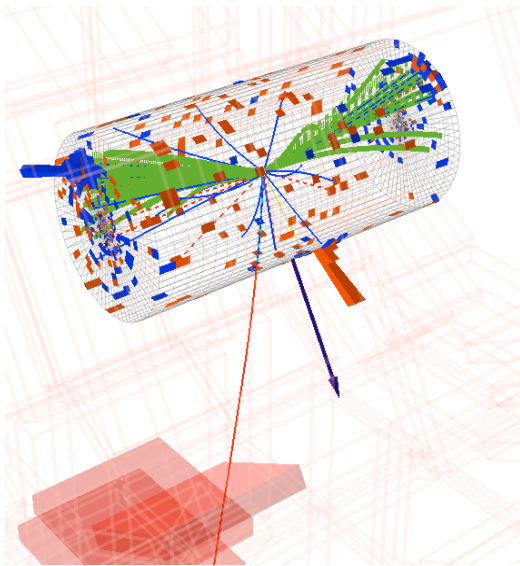
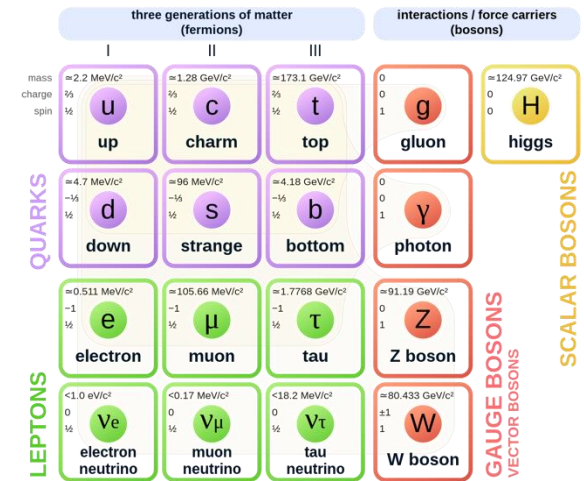
10 years
HIGGS boson
discovery

- *Collaborations* are the ones building, taking care of and using the experiments – combinations of hundreds of universities and institutes
- **CMS** (Compact Muon Solenoid): Around 200 members from 46 different countries, over 3500 physicists, engineers, other staff and even students
- Various responsibilities and fields of expertise
 - Detectors
 - Physics analysis
 - Communication and open data



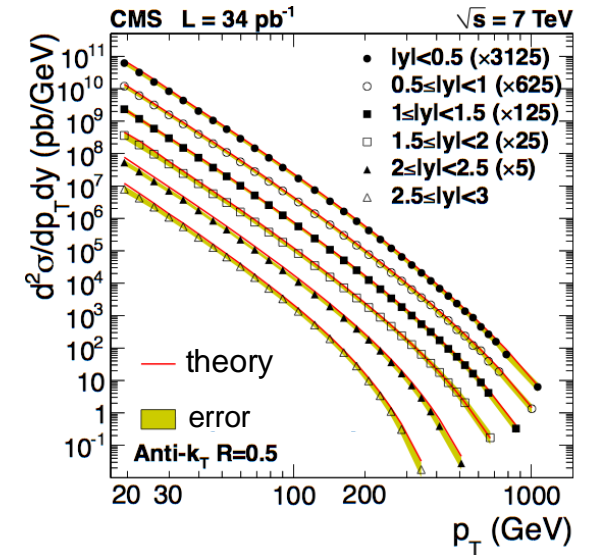
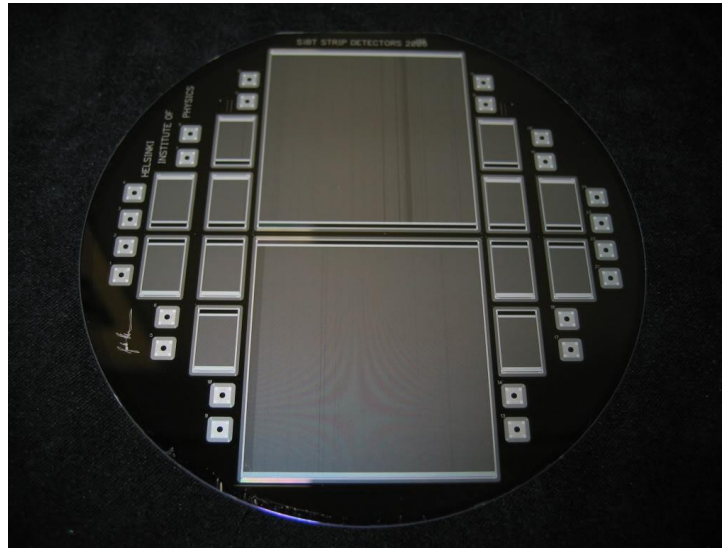
- **...charged Higgs and beyond standard model**
 - Develop techniques for discovery i.e. what collisions to include, where to search, how to search (cuts, AI/ML?)
- **...particle sprays, jets**
 - Jets are born in almost every collision, used in analysis but measurements also need to be accurate
- **...instrumentation and computation**
 - New components for future measurements
 - Help CMS with their computational clusters

Standard Model of Elementary Particles

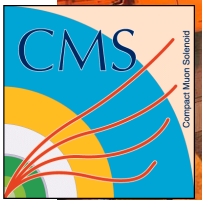
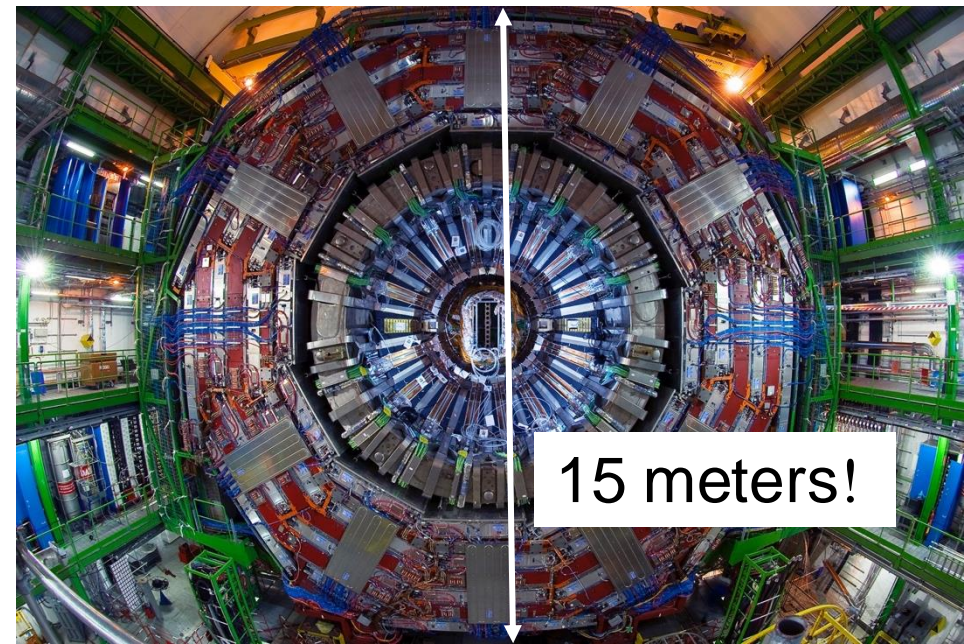
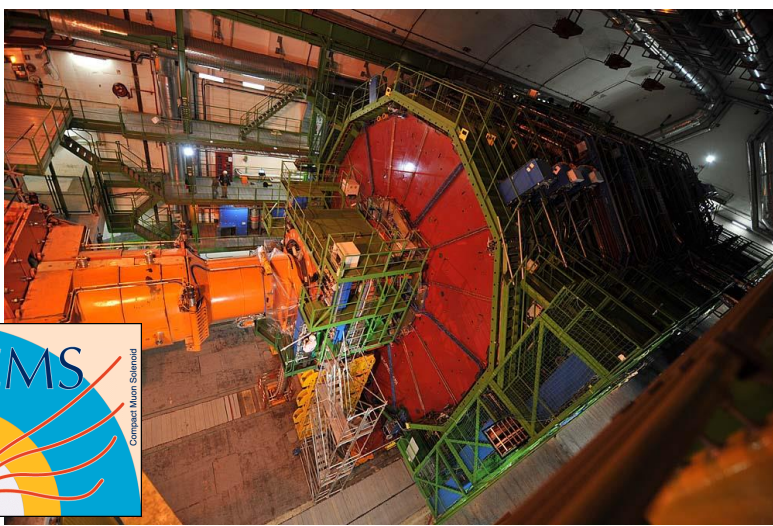
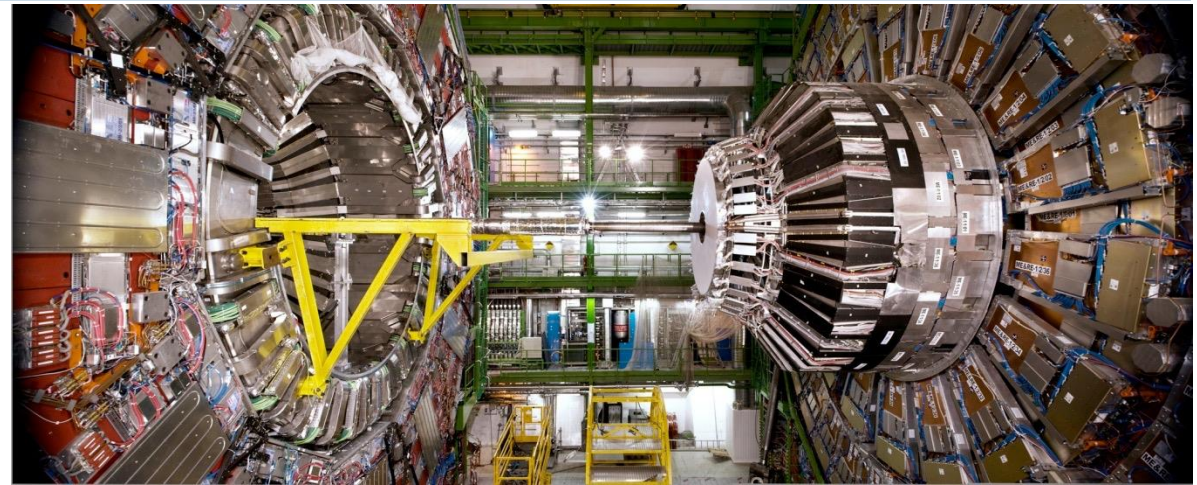


A collision happens...

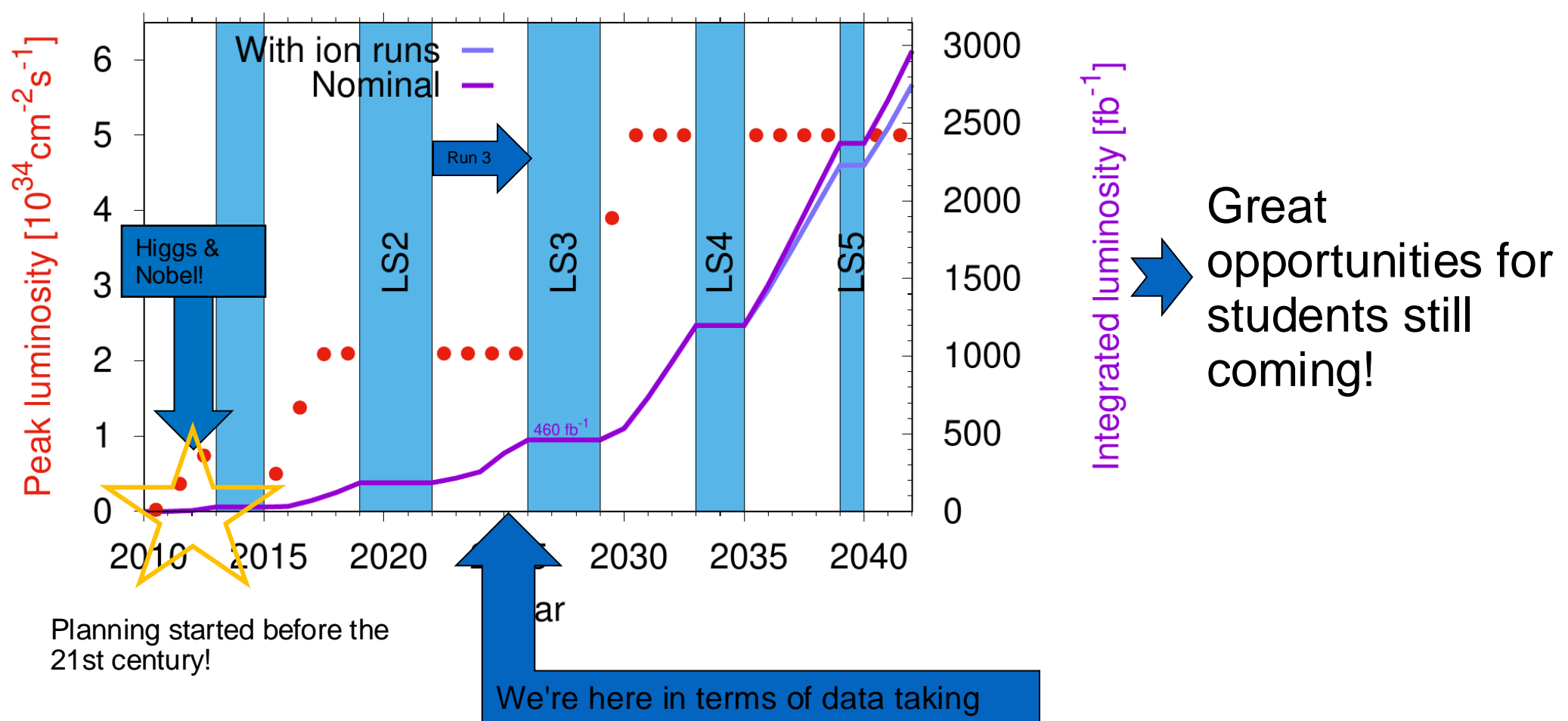
...is measured by the detector...



...and then analyzed



Run 3 started in 2022 and will keep running and producing new data!



www.hip.fi → Graduate Education
www.hip.fi/summies

- Particle physics:
 - Higgs physics at the LHC
 - Jet physics at the LHC
 - Higgs physics with boosted jets at the LHC
 - Data-based PF hadron calibration for the CMS experiment
 - Vector boson scattering and [quantum] machine learning
 - Operation and Calibration of CMS Experiment at LHC
 - Discovery physics with CMS-TOTEM at the LHC
 - Experimental particle physics in ALICE
 - Open data in use
- Instrumentation – detectors and accelerators
 - R & D of gaseous detectors
- Nuclear physics:
 - Research and development for instrumentation in nuclear physics at ISOLDE
- Mechanical engineering:
 - Mechanical engineering (Design, Manufacture, Testing)
- European Synchrotron Radiation Facility ESRF (Grenoble, France):
 - Research at the synchrotron light source ESRF (www.esrf.eu)

SUMMER JOBS @ CERN
 organized by Helsinki Institute of Physics

#Higgs
 #Quarks
 #Jets
 #PlanckScale
 #ParticlePhysics
 #NuclearPhysics
 #HeavyIons

#Technology
 #MachineLearning
 #QuantumComputing
 #OpenData
 #Engineering
 #Instrumentation

APPLY BEFORE 31.1.2025 @
www.hip.fi/summies

Info Session in Zoom
 Fri 17.1.2025 at 14:15-15:00

The poster features a map of Europe with a red pin at CERN and a red arrow pointing to the application website. The bottom of the poster shows a large group of people posing in front of the ATLAS detector.

- CERN Summer student programme:
 - Lectures from high profile physicists
 - Visits to experiments
- Hundreds of students from around the world
 - Local events between students
 - Travel company (great location to go see Europe!)
- Great way to be introduced to the community and the field of particle physics and to establish connections for future (career *and* friends)



HIP summies of 2022 organized the first Meyrin molkky tournament!

- Travel is paid
- Salary ~1400 € per month
+ travel allowance ~1200 € per month
- Accommodation isn't provided, but HIP office will help with this
 - CERN has two hostels near and at the site and students can also look to share houses/apartments
- Training period June 1st to August 31st (negotiable)
- Detailed information in the HIP Summer Student Guide, <https://www.hip.fi/jobs-vacancies/summer-jobs/summer-jobs-at-cern/>

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Applications:

www.hip.fi/summies

- Physics positions:
 - ~3 years of studies by the summer
 - Knowledge of particle physics an advantage, not a requirement
 - Programming skills (C/C++, Python, UNIX) an advantage
- Contact persons will help you with information, feel free to contact them
- Application deadline **31.1.2025**
- Application includes a **motivation letter**, a **study record** and a **resume**
- Chosen people will be informed in February-March and they can start preparing for the summer

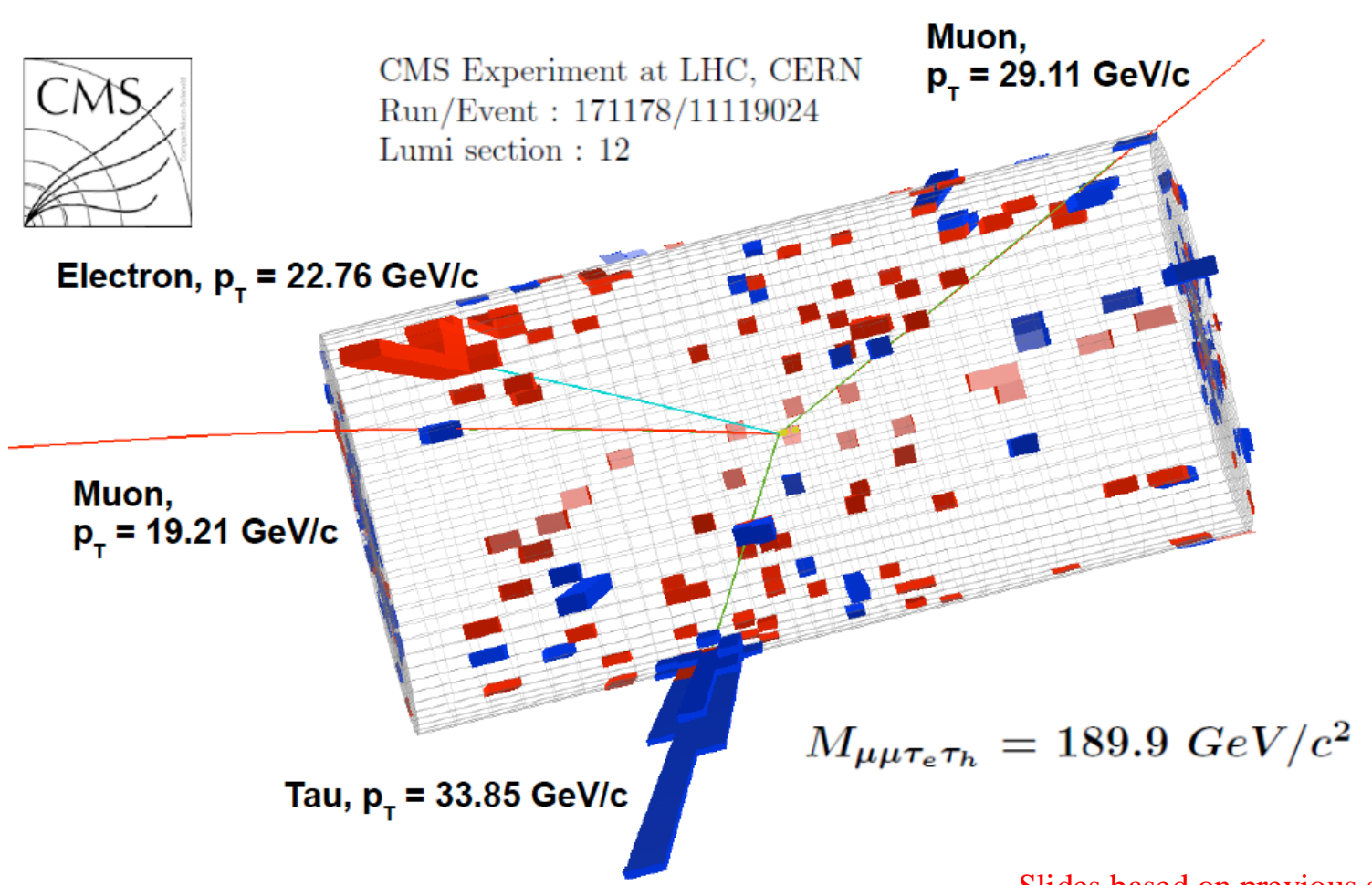


- 2–3 month internship in CERN's own international program (not associated with HIP) www.cern.ch/summies
- Aimed for physics, engineering and mathematics students. Many projects in different experiments encompassing the whole CERN ecosystem
- Deadline **26.1.2025**. Requires a **letter of recommendation**

Other opportunities

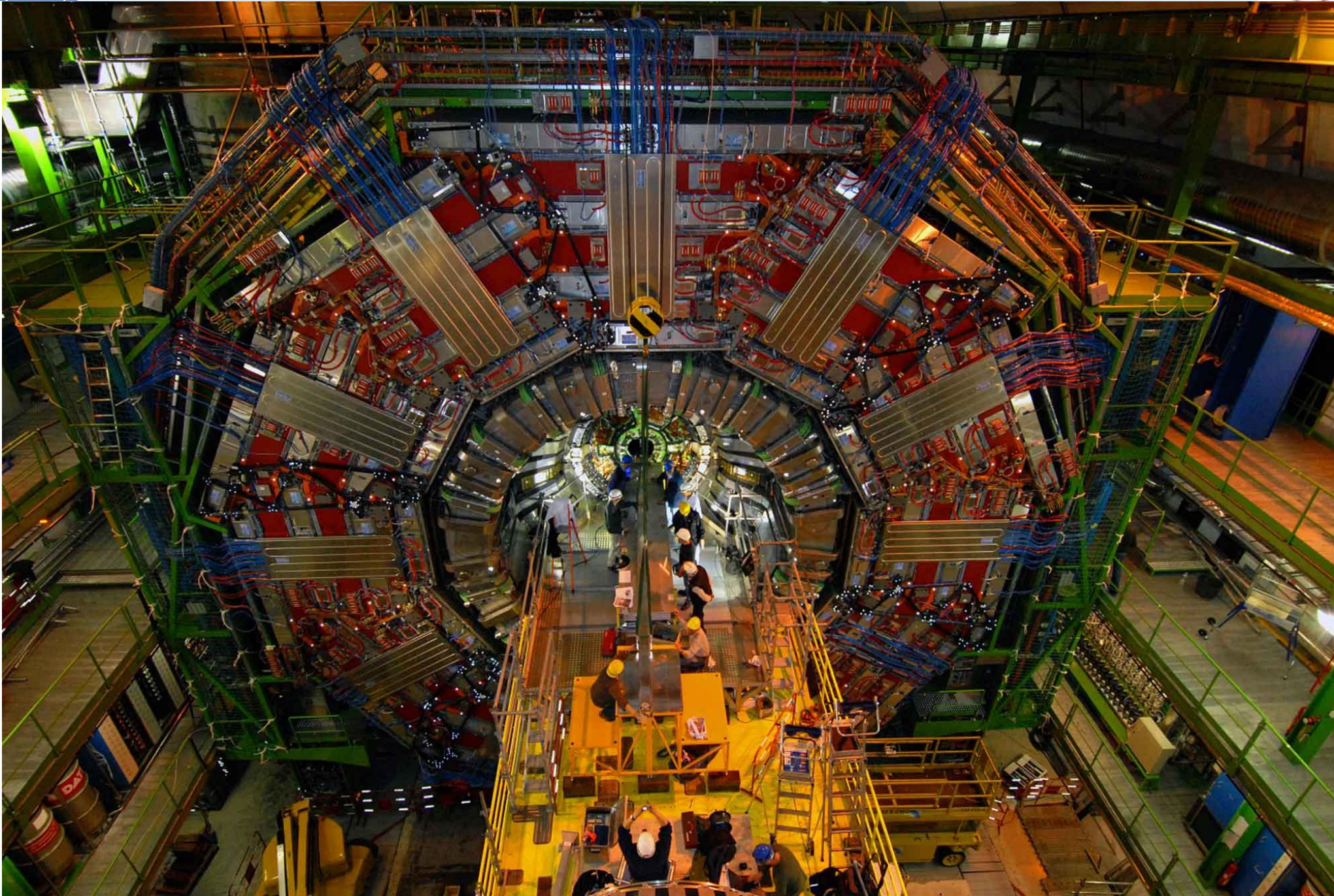
- **CERN Openlab**
 - 2 full months (9 weeks) in June - August
 - <https://openlab.cern/education/cern-openlab-summer-student-programme>
- **Bootcamp**
 - Intensive one-week course CERN Bootcamp (<https://www.hip.fi/cern-bootcamp/>), not organized in 2025

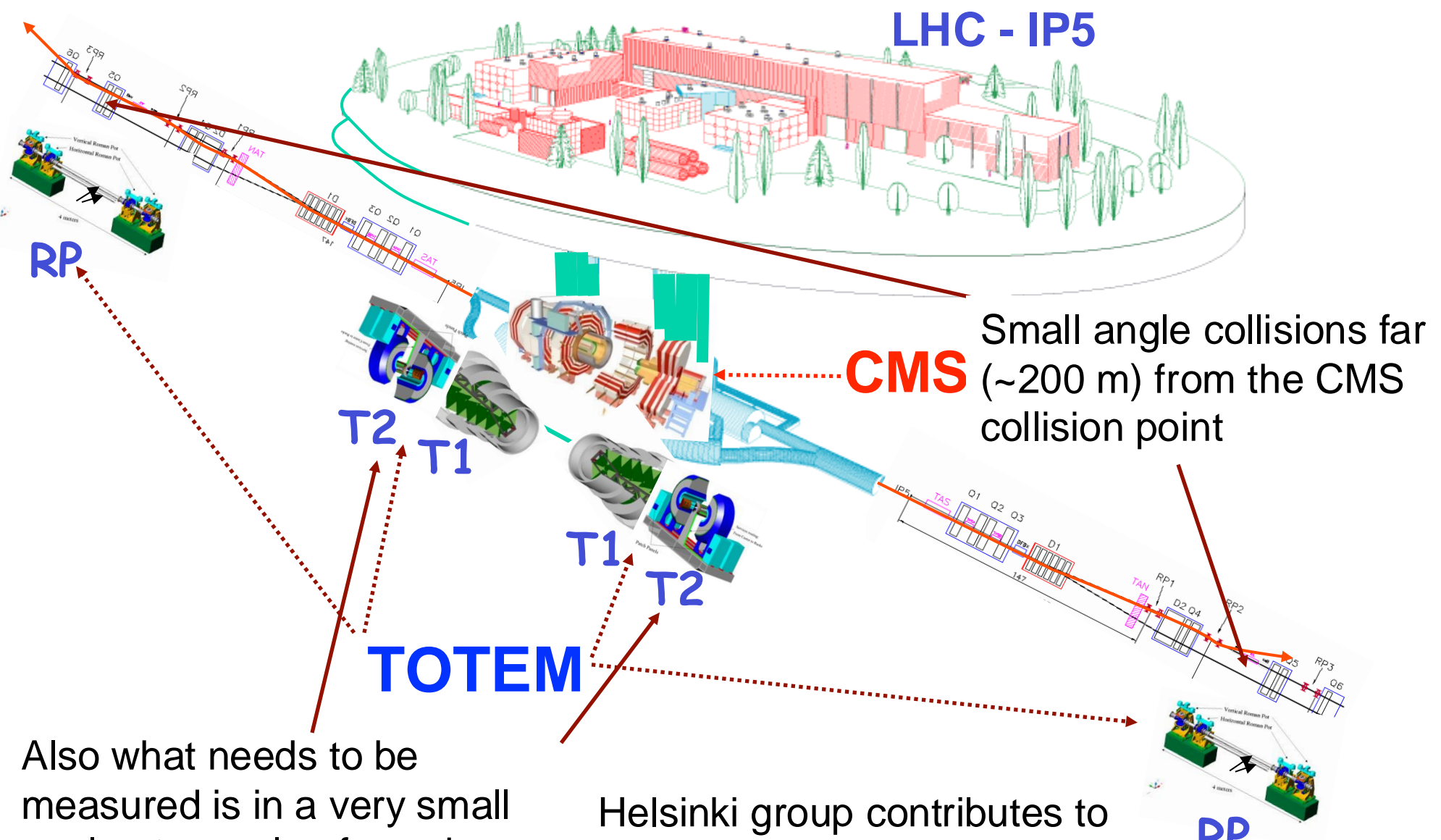
THANK YOU FOR FOLLOWING!



Slides based on previous slides created by:
M. Voutilainen, S. Laurila, L. Martikainen and
H. Siikonen

BACKUP / PREVIOUS YEARS

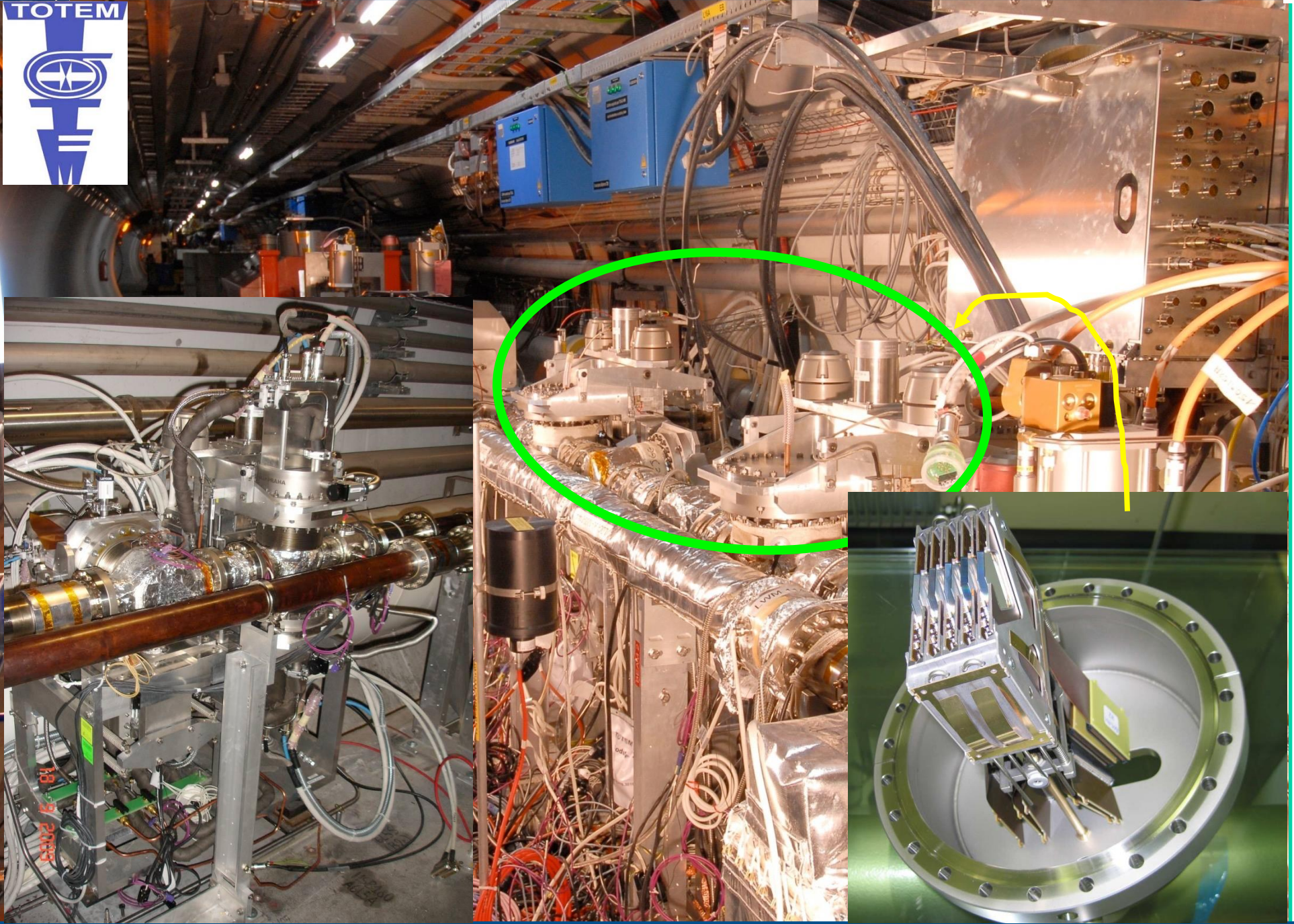
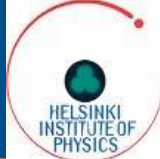


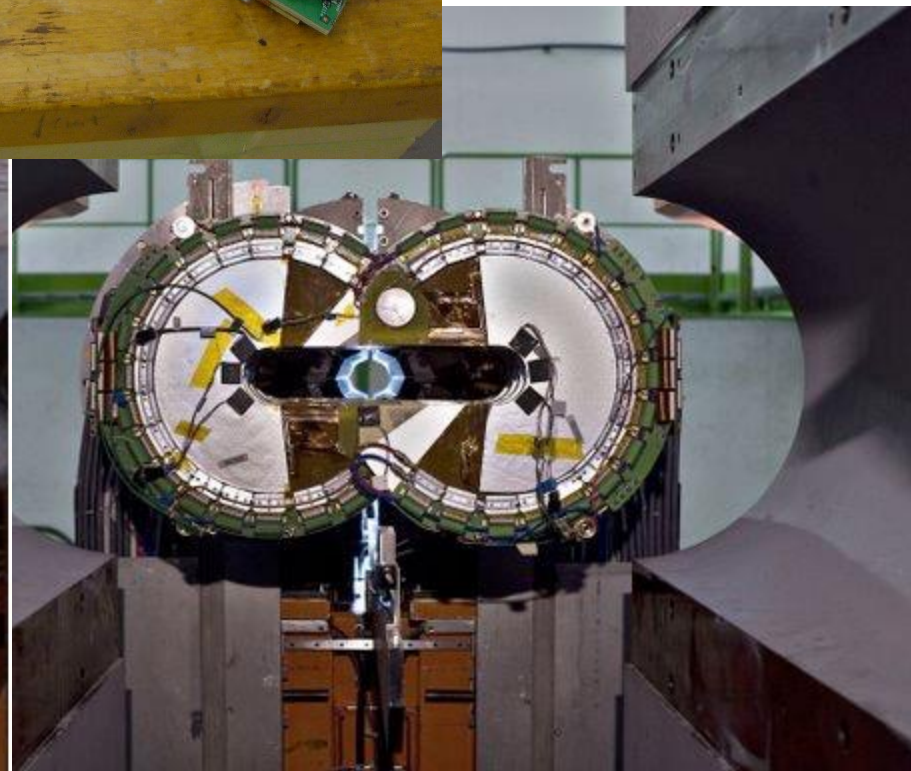
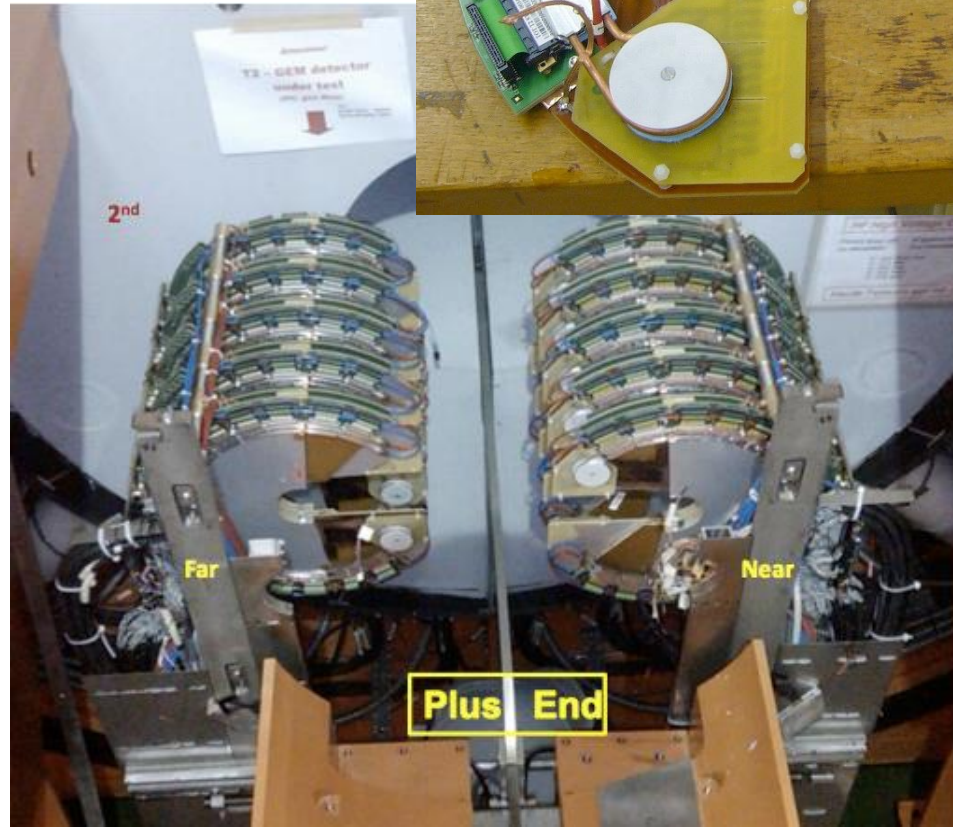
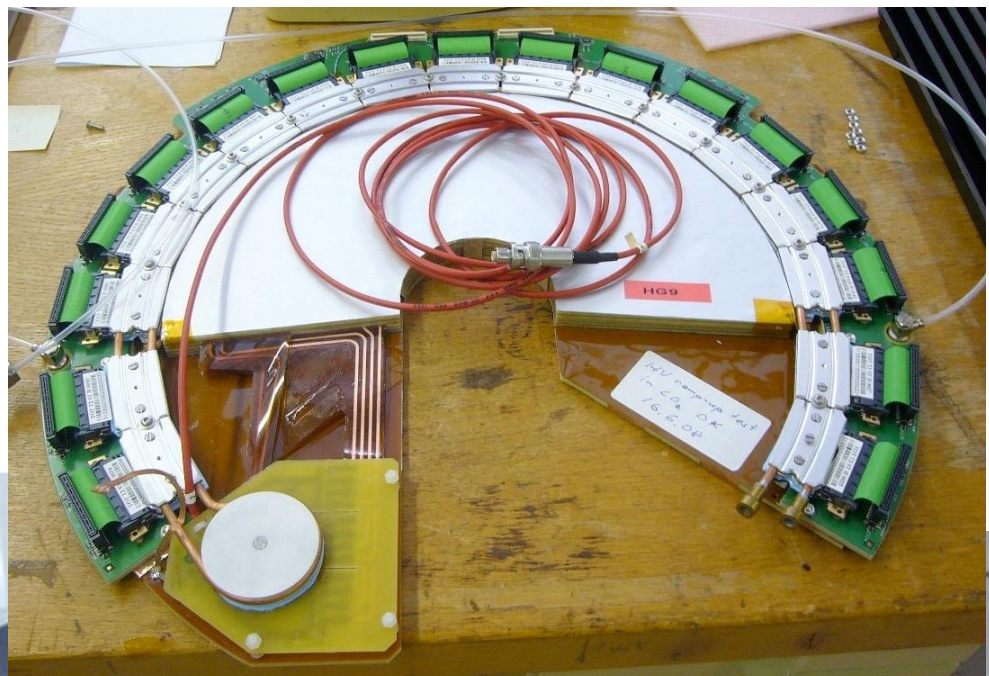


Also what needs to be measured is in a very small angle at a scale of mrad

- Helsinki group contributes to
- Building the T2 tracker
 - Software and physics analysis

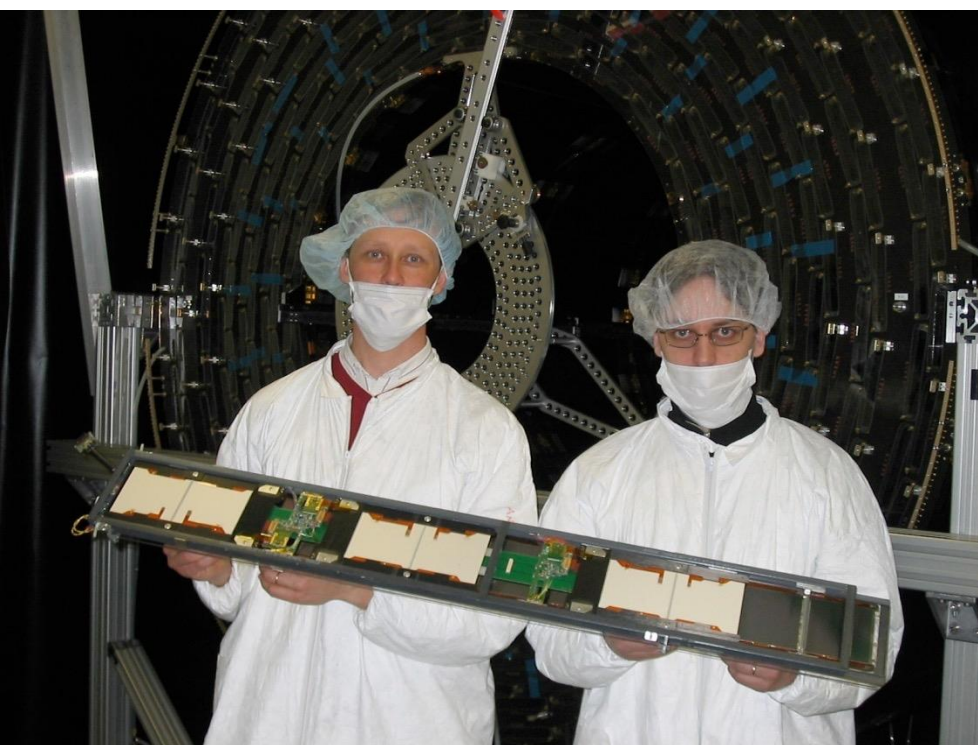






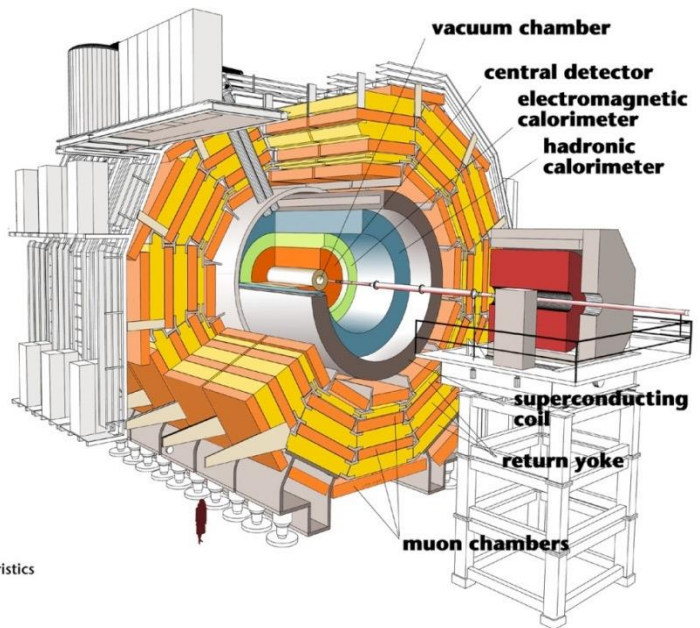
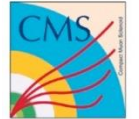


Jälki-ilmaisimien koostuu pii-ilmaisimista, joista muodostuu 10 miljoonaa tiedonlukuyksikköä.

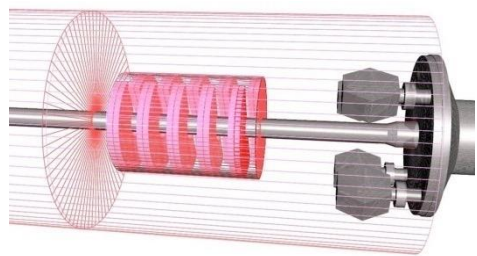
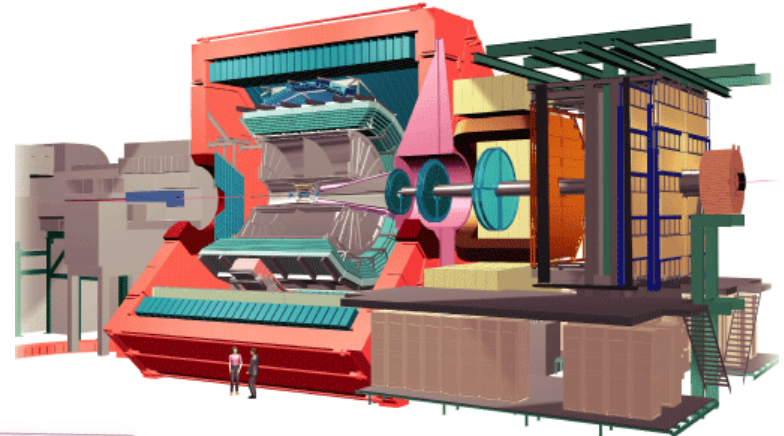


P. Eerola

- Suomalaiset ovat mukana kolmessa kokeessa:
 - CMS – Compact Muon Solenoid – ns. yleiskoe,
 - ALICE – tutkii raskaiden atomiytimien törmäyksiä,
 - TOTEM – tutkii protonien törmäyksiä, joissa törmäysten lopputuotteet siroavat vain vähän suihkun suuntaan verrattuna



Detector characteristics
 Width: 22m
 Diameter: 15m
 Weight: 14'500t



- Higgsin ja topin massat vihjaavat vakuumin olevan epästabiili
 - antrooppinen periaate vai uutta fysiikkaa?
- Pimeän aineen etsinnät vetäneet vesiperän, toistaiseksi
 - onko löytö ihan kulman takana LHC:lle ja suorille etsinnöille?

