

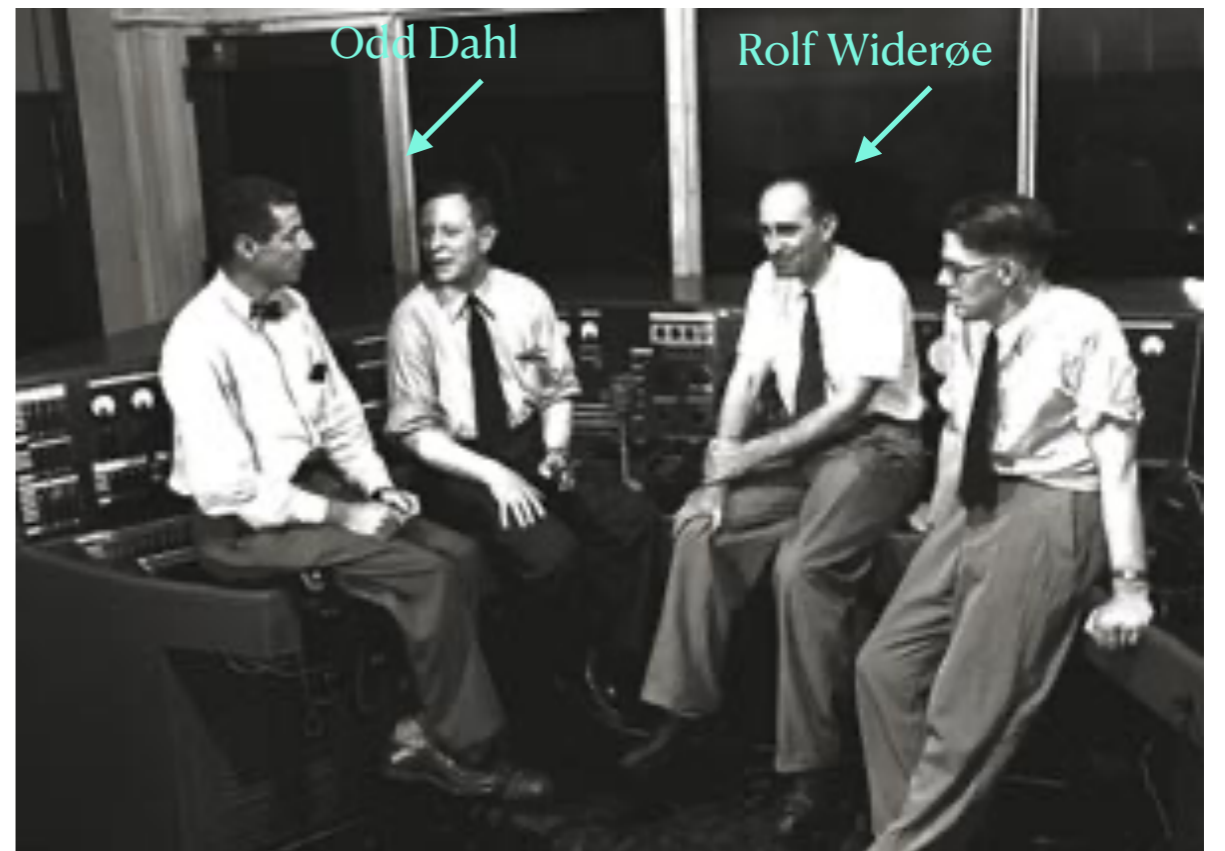


NorCC - Norwegian Centre
for CERN-Related Research

Heidi Sandaker

About CERN

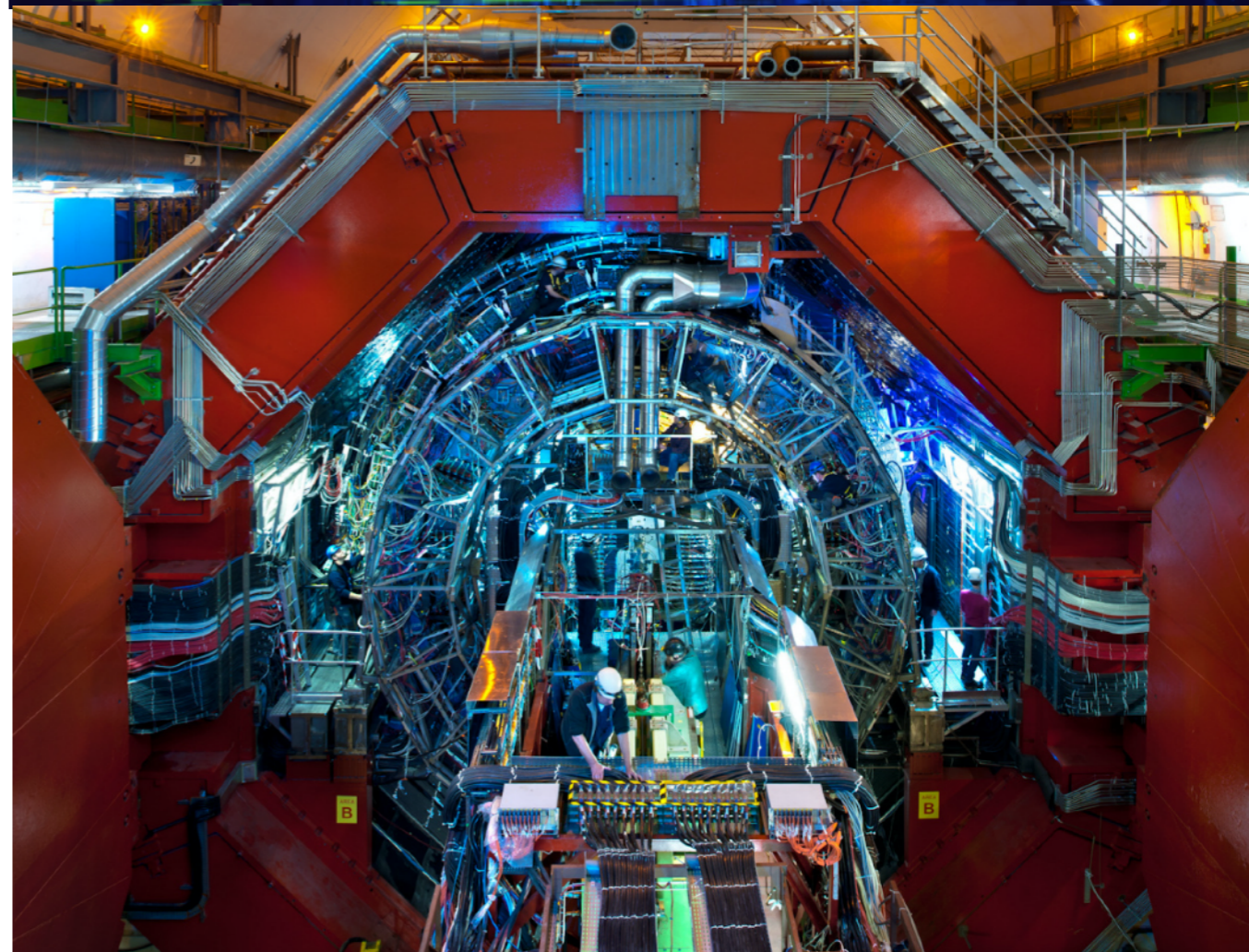
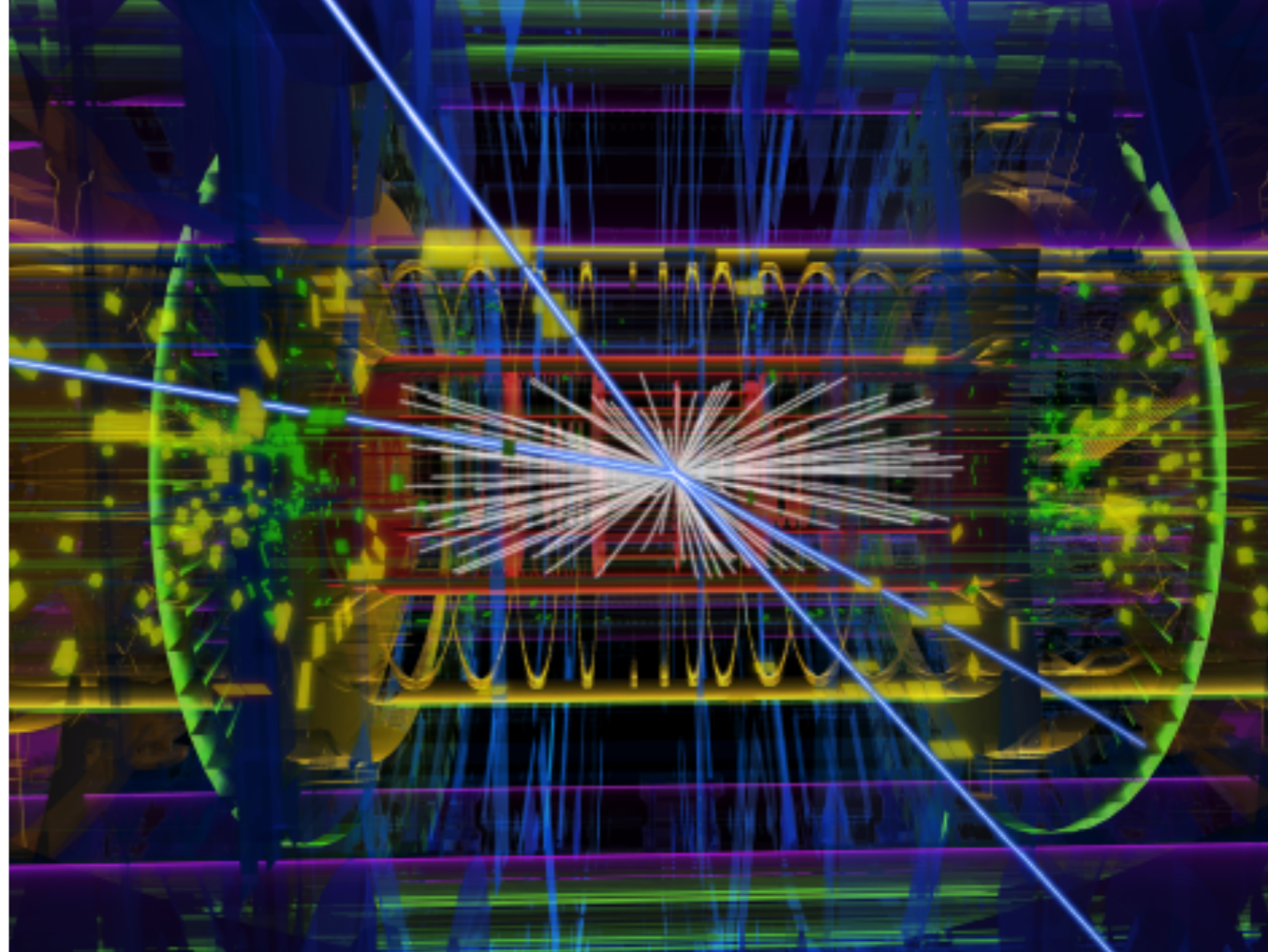
- CERN was established in 1954 - European Organization for Nuclear Research - **the largest particle physics laboratory in the world**
- 23 member states, Norway has been member from the start
- **CERN provide the particle accelerators** and other infrastructure needed for high-energy physics research (**Norwegian CERN membership**)
- **Large international collaborations provides the experiments**, their operation and corresponding fundamental physics research (**NorCC ++**)
- **Unite people** from all over the world to push the frontiers of science and technology **to the benefit of all**



Left to right: George Collins from Brookhaven National Laboratory with the provisional CERN delegation in 1952, Odd Dahl, Rolf Widerøe and Frank Goward. Image credit: BNL.

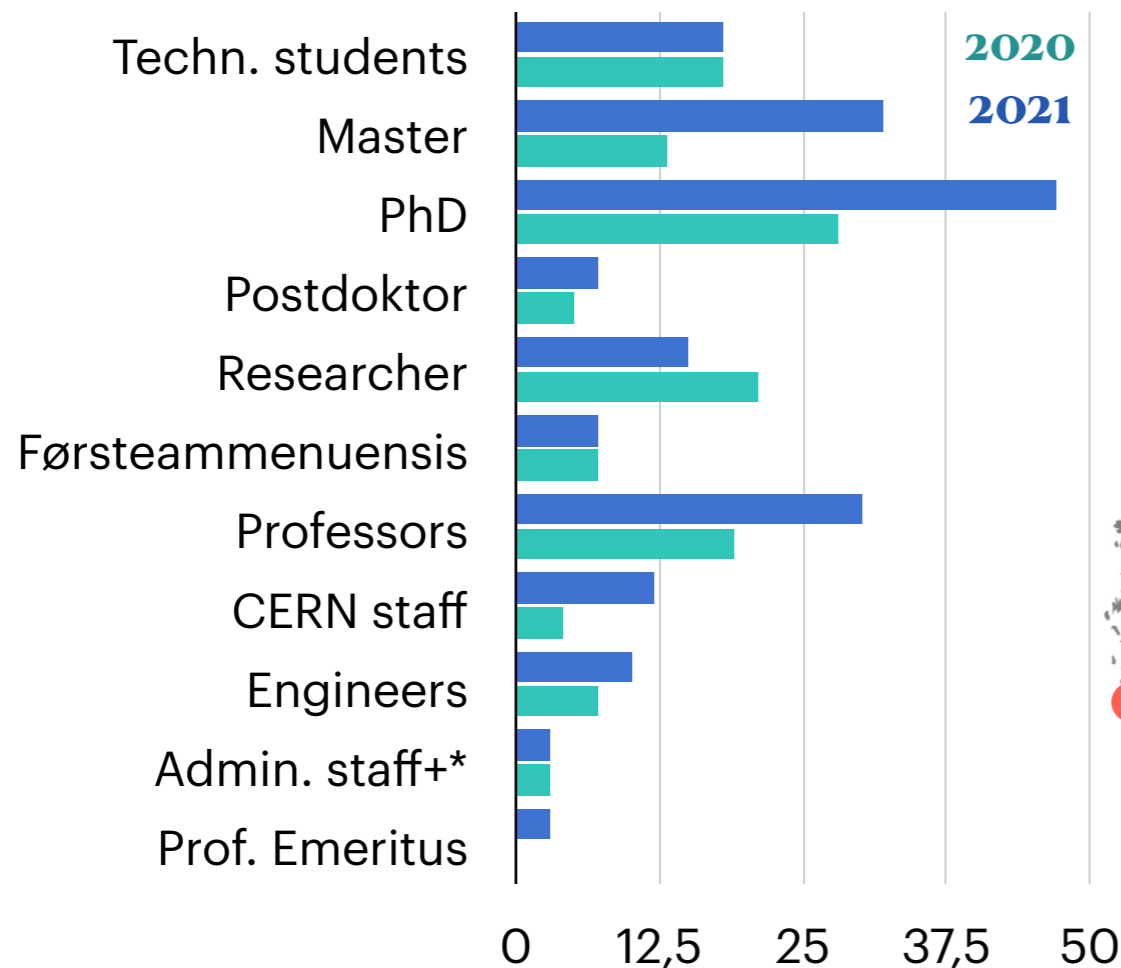
About NorCC

- Established in 2020, collecting several Norwegian CERN-related research projects in one **Norwegian Centre for CERN-related research**
- The centre is financed 50% by NFR, 50% own contribution from the universities
- This contribution from NFR is covering **long-term commitments to experiments at CERN** (30+ years !)
- Also financed are work aimed at the **best possible use of the Norwegian CERN membership**
- The research was opened to include more institutes/universities !
- Host is UiO and the leader of the centre is from UiO, UiB is chairing the centre board



Who participates in NorCC

- 6 institutes: **UiO, UiB, HVL, USN, NTNU, UiA**
- Number of people is growing, now ~166 persons
- In addition about 25 staff and fellows at CERN



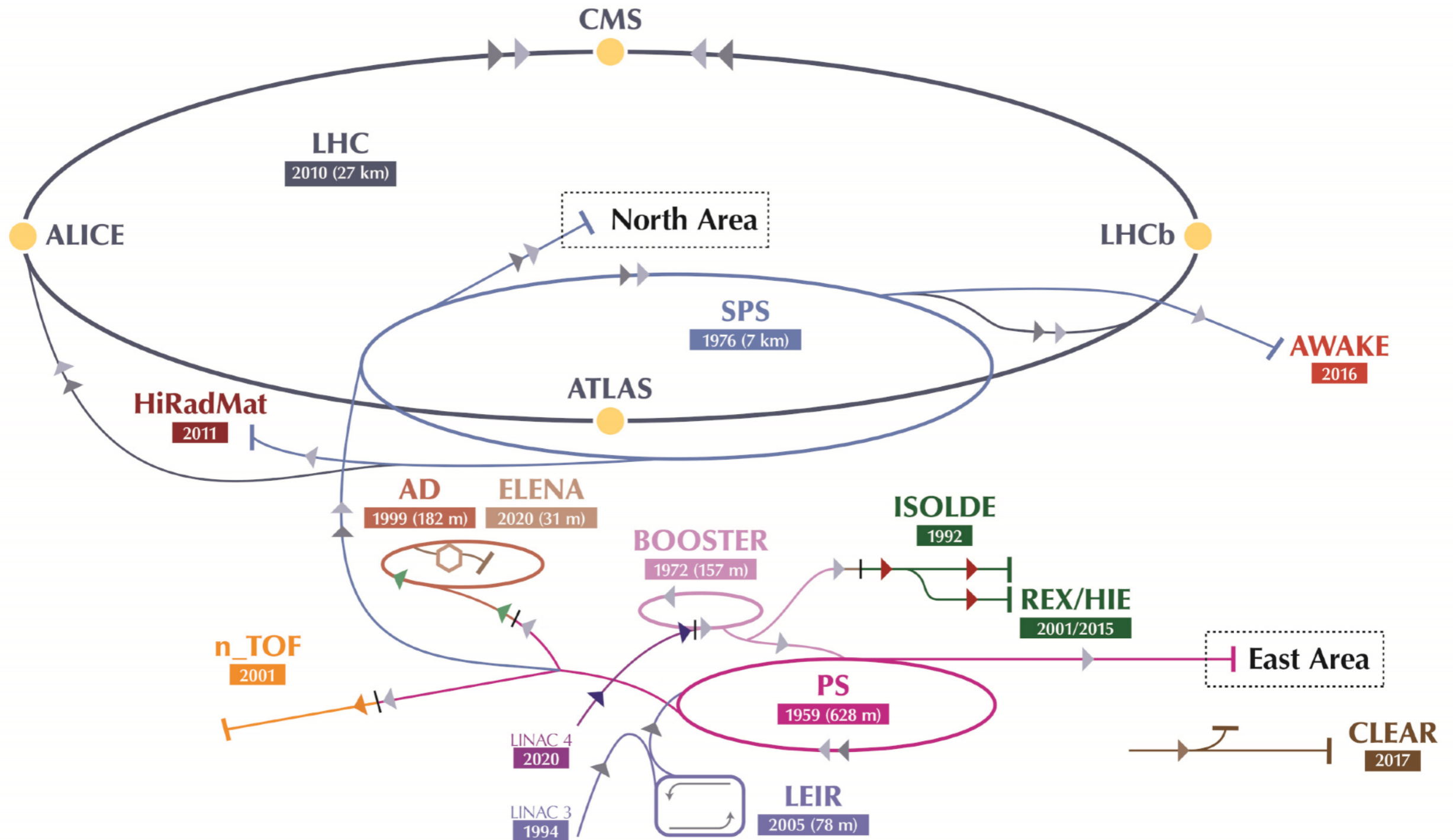
CERN, maybe today best known for the LHC

Large Hadron Collider (LHC)

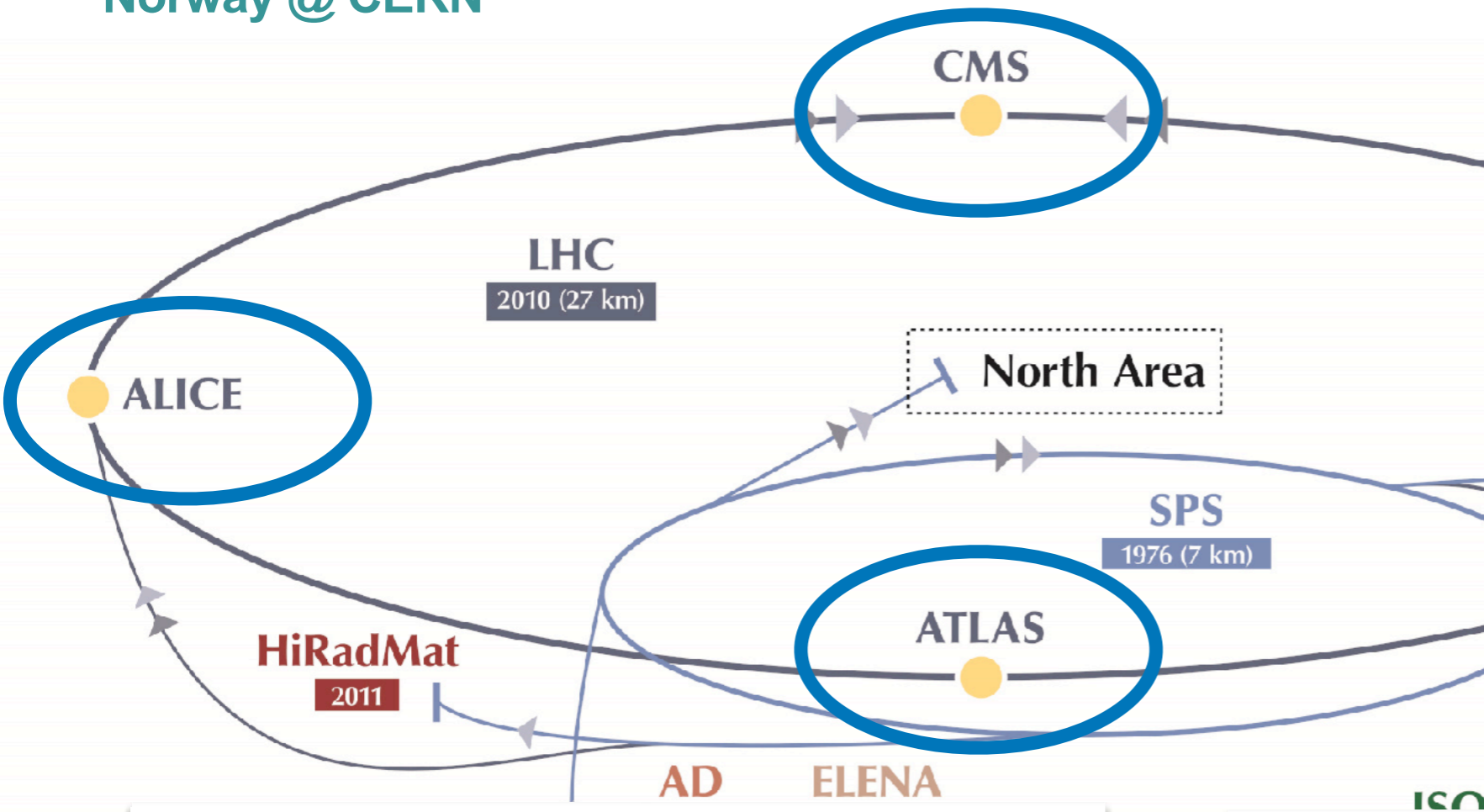
27 km in diameter

collides particles (almost) at the speed of light
more than one billion proton-proton collisions
per second

CERN accelerator complex



Norway @ CERN



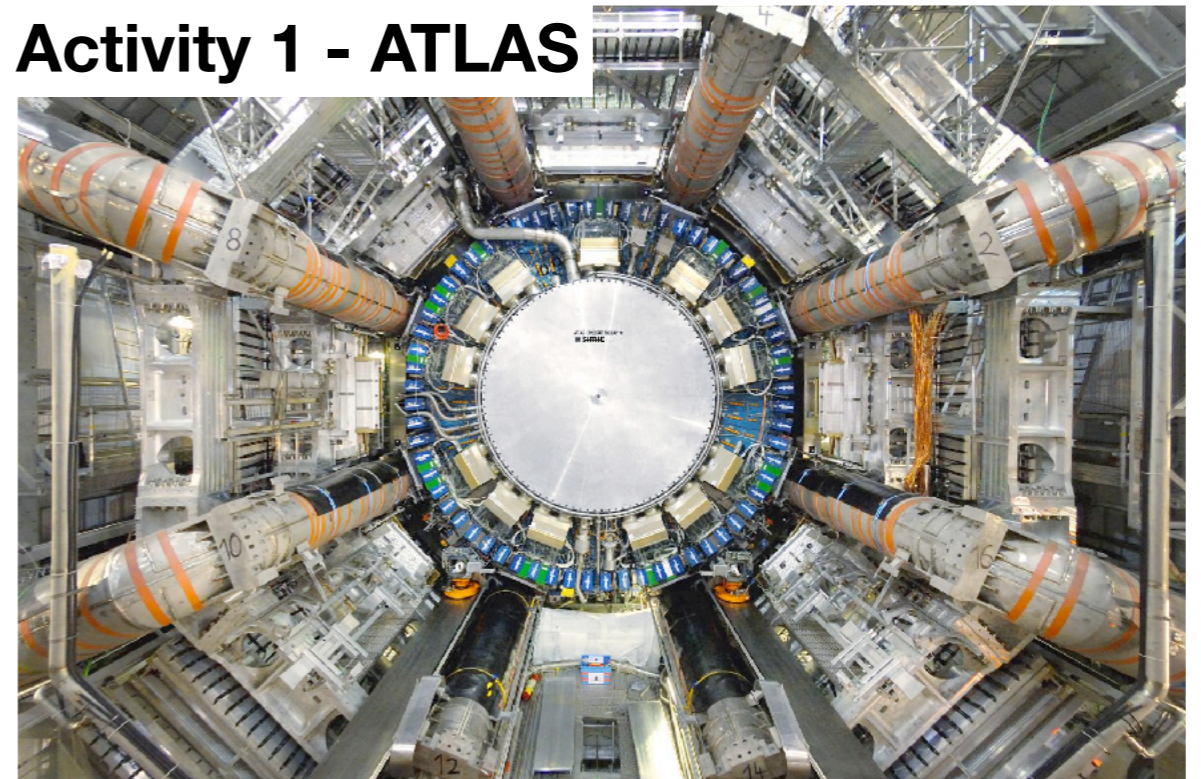
Activity 5 - CMS



Activity 2 - ALICE

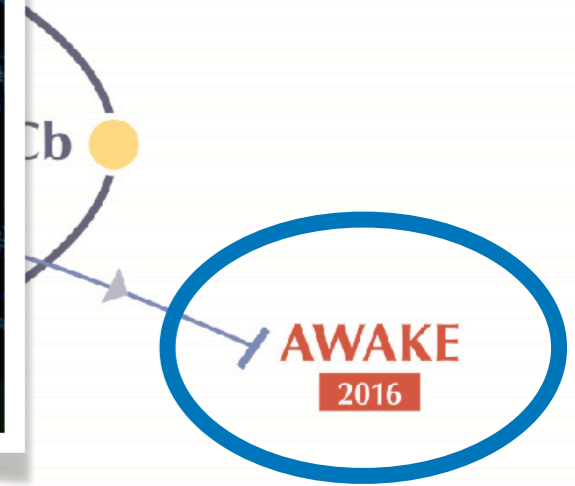
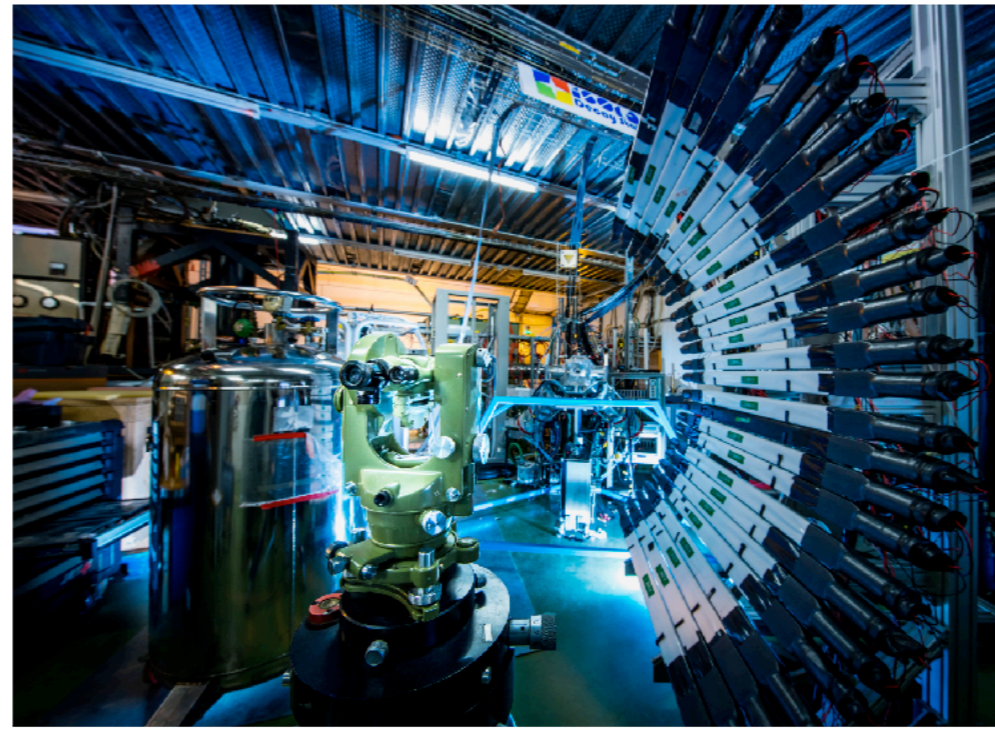
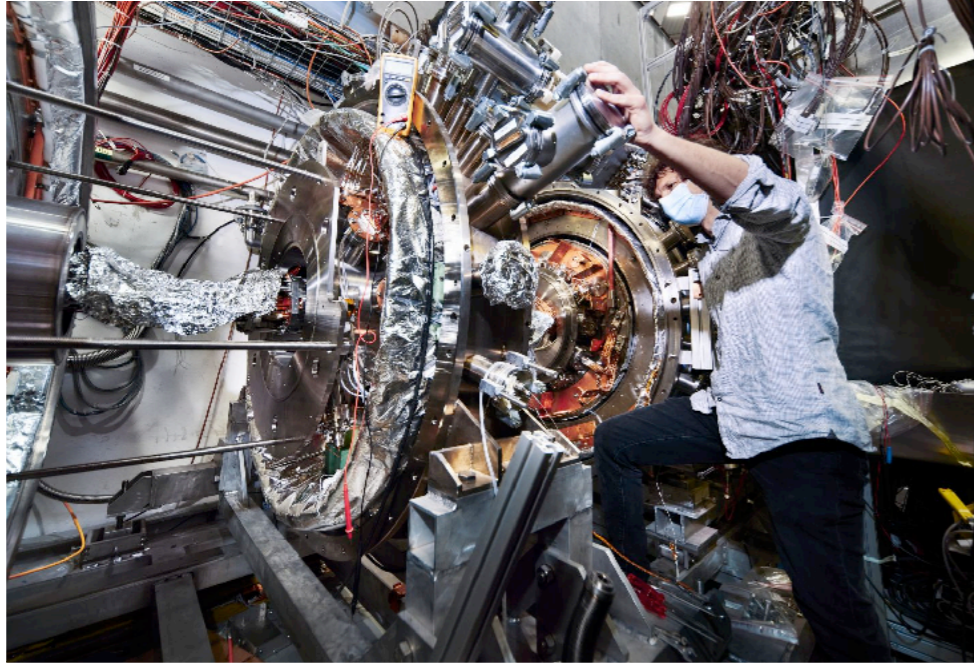


Activity 1 - ATLAS

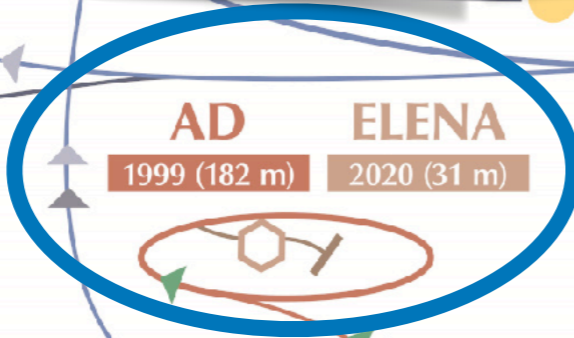


Norway @ CERN

Activity 4 - ISOLDE, AEGIS



2011



BOOSTER
1972 (157 m)



n_TOF
2001

LINAC 4
2020

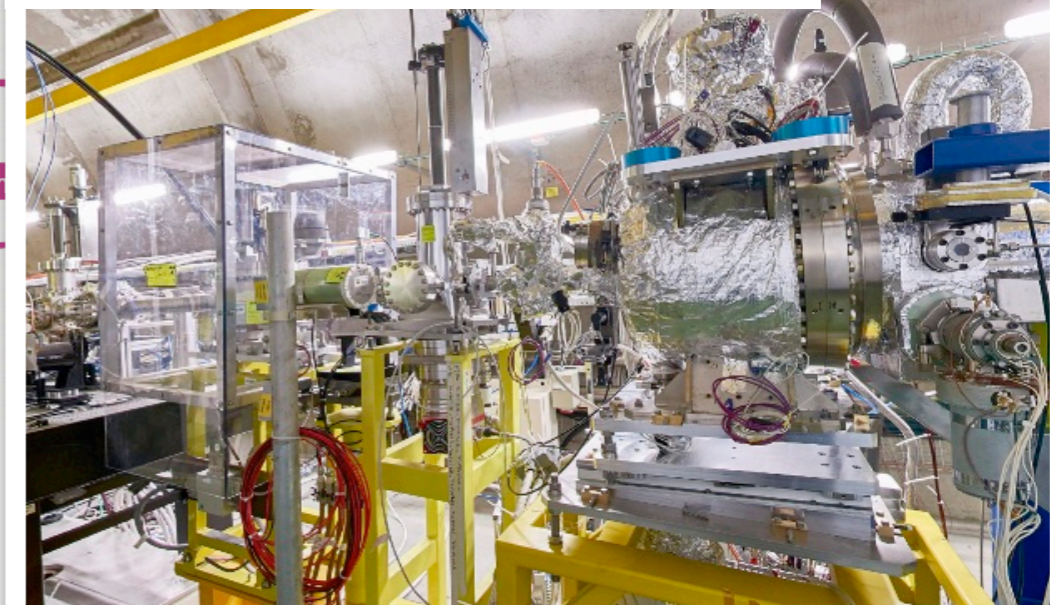
LINAC 3
1994



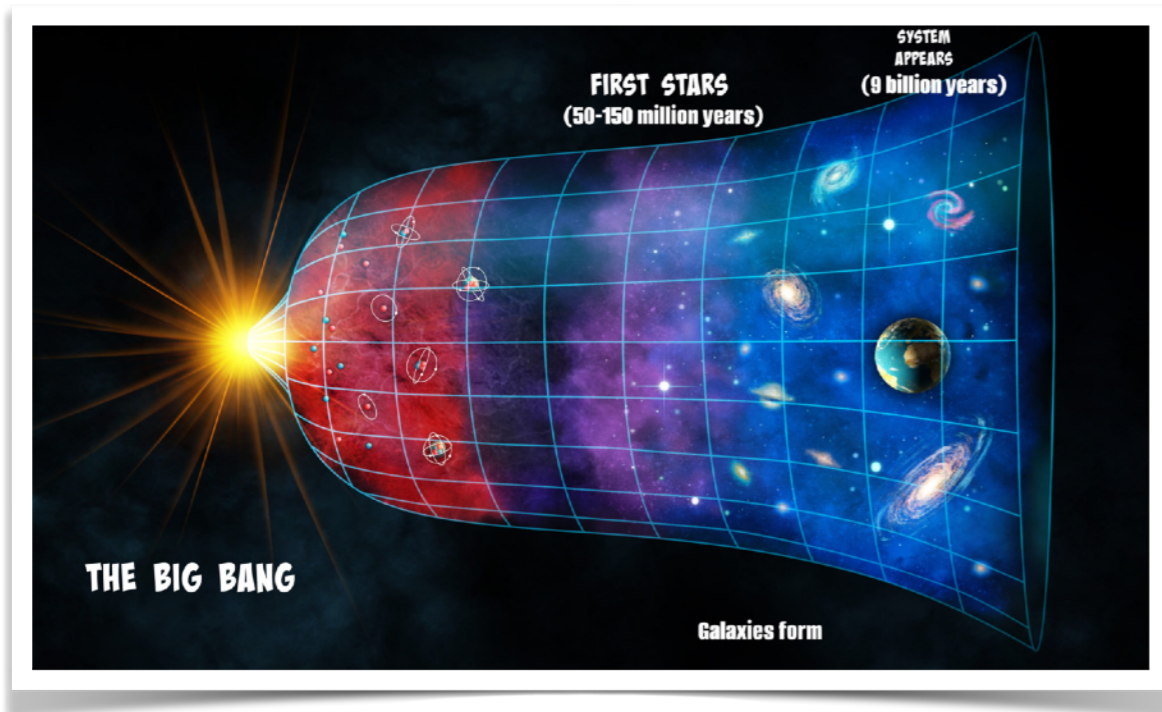
LEIR
2005 (78 m)

PS
1959 (628 m)

Activity 3 - CLIC, AWAKE



The big Science Questions



What happened in the big bang and after

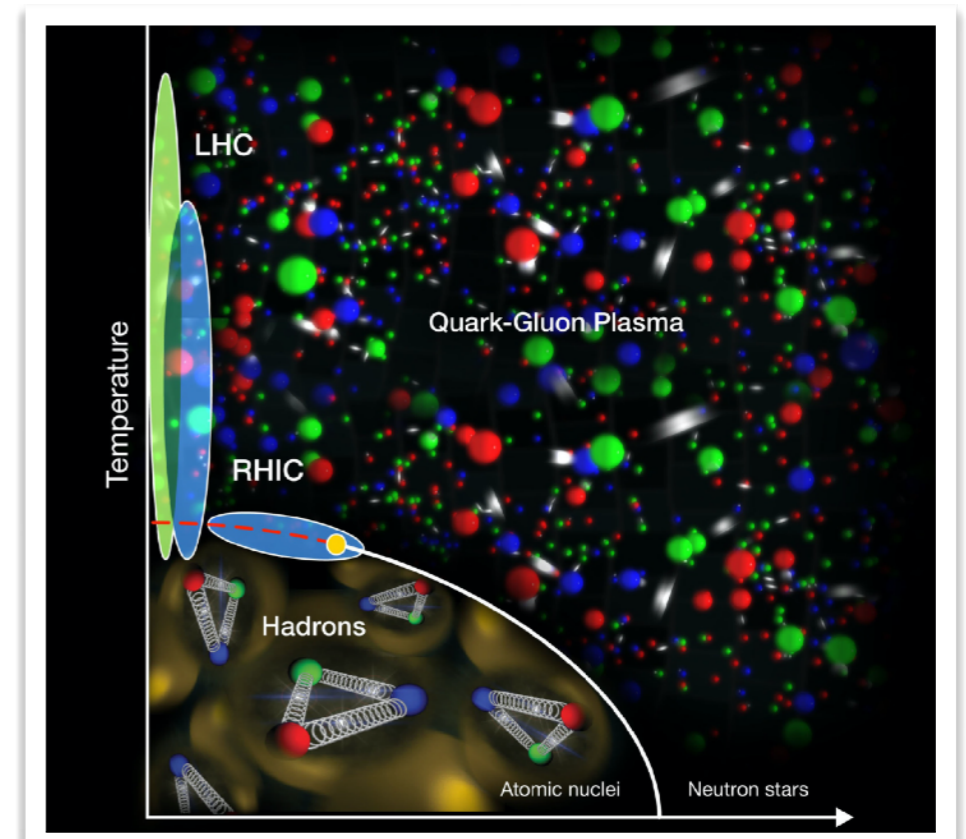


What is Dark Matter

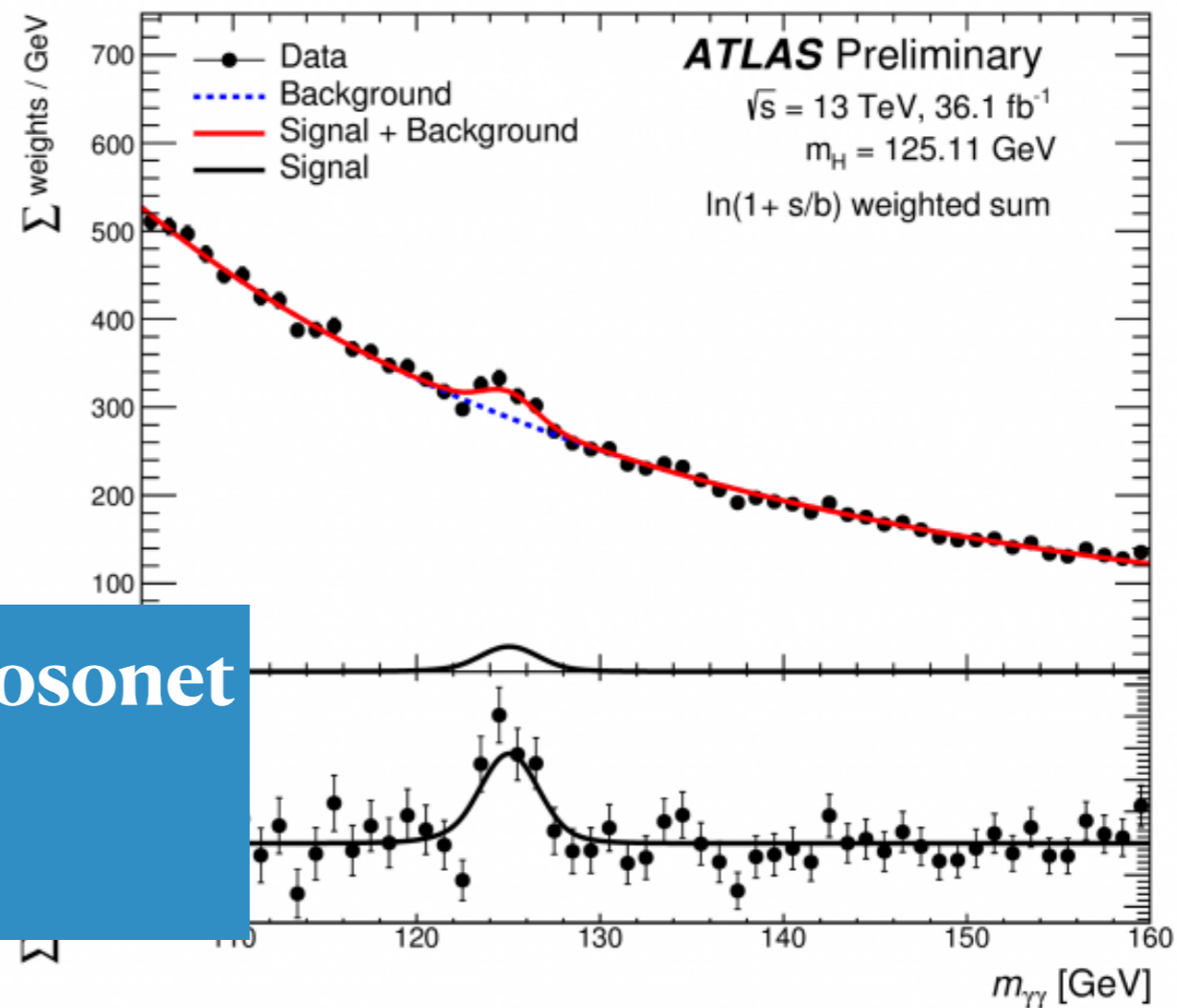
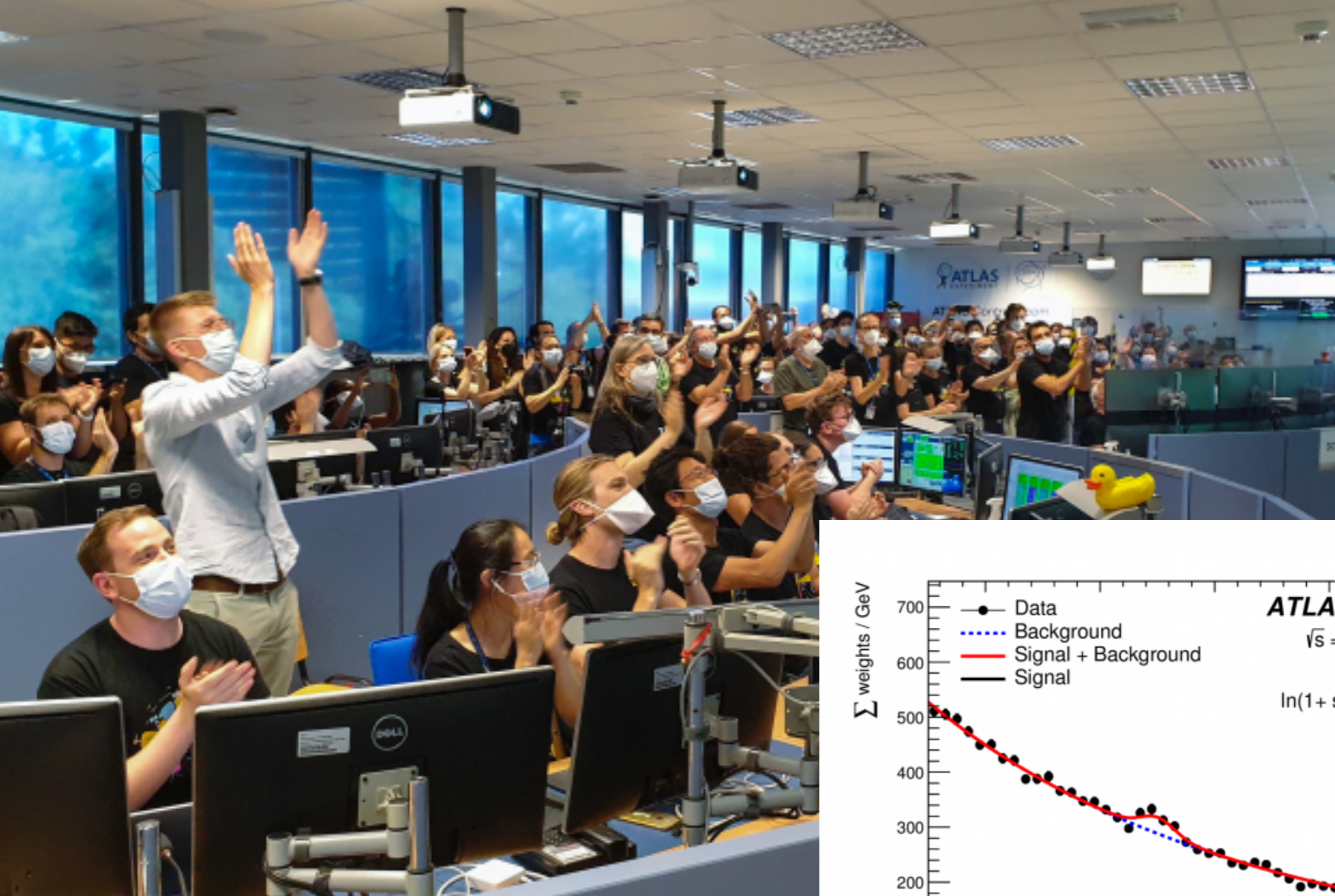
Studies of the the new Higgs boson

	I	II	III		
mass	$\approx 2.2 \text{ MeV}/c^2$	$\approx 1.28 \text{ GeV}/c^2$	$\approx 173.1 \text{ GeV}/c^2$	0	$\approx 124.97 \text{ GeV}/c^2$
charge	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$	0	0
spin	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	0
QUARKS	u up	c charm	t top	g gluon	H higgs
	$\approx 4.7 \text{ MeV}/c^2$	$\approx 96 \text{ MeV}/c^2$	$\approx 4.18 \text{ GeV}/c^2$	0	
	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	0	
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	
	d down	s strange	b bottom	γ photon	
LEPTONS	$\approx 0.511 \text{ MeV}/c^2$	$\approx 105.66 \text{ MeV}/c^2$	$\approx 1.7768 \text{ GeV}/c^2$	$\approx 91.19 \text{ GeV}/c^2$	
	-1	-1	-1	0	
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	
	e electron	μ muon	τ tau	Z Z boson	
NEUTRINOS	$< 1.0 \text{ eV}/c^2$	$< 0.17 \text{ MeV}/c^2$	$< 18.2 \text{ MeV}/c^2$	$\approx 80.433 \text{ GeV}/c^2$	
	0	0	0	± 1	
				W BOSONS	SCALAR BOSONS

+ many more



How do we best understand quark-gluon plasma



Eksempel: Oppdagelsen av Higgs bosonet
En helt ny partikkel!

2012

[Voir en français](#)

Results !

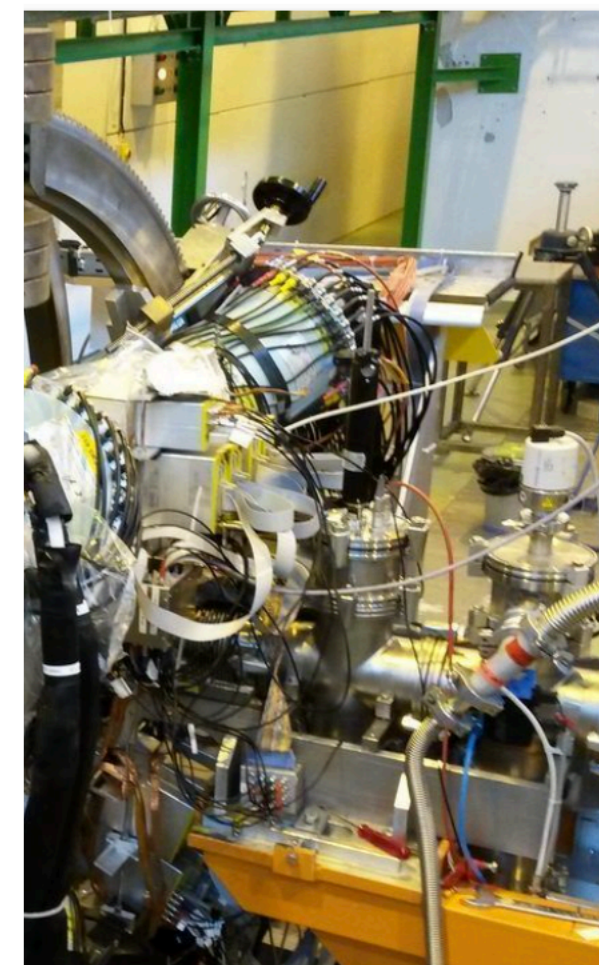
First physics experiment at HIE-ISOLDE begins

Installation of the second cryomodule at HIE-ISOLDE means unique, upgraded machine is now ready to take physics measurements at higher energies

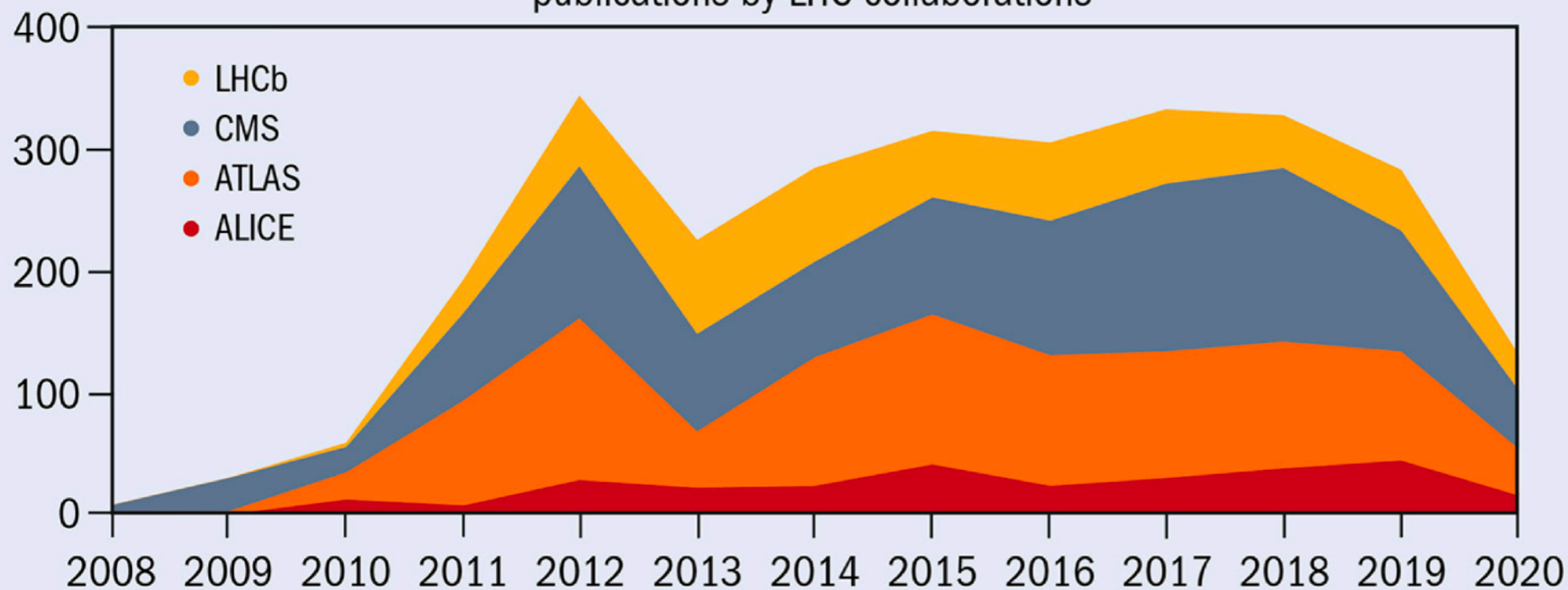
9 SEPTEMBER, 2016 | By [Harriet Jarlett](#)

ALICE makes first direct observation of a fundamental effect in particle physics

The observation provides direct experimental access to the mass of an elementary particle known as the charm quark

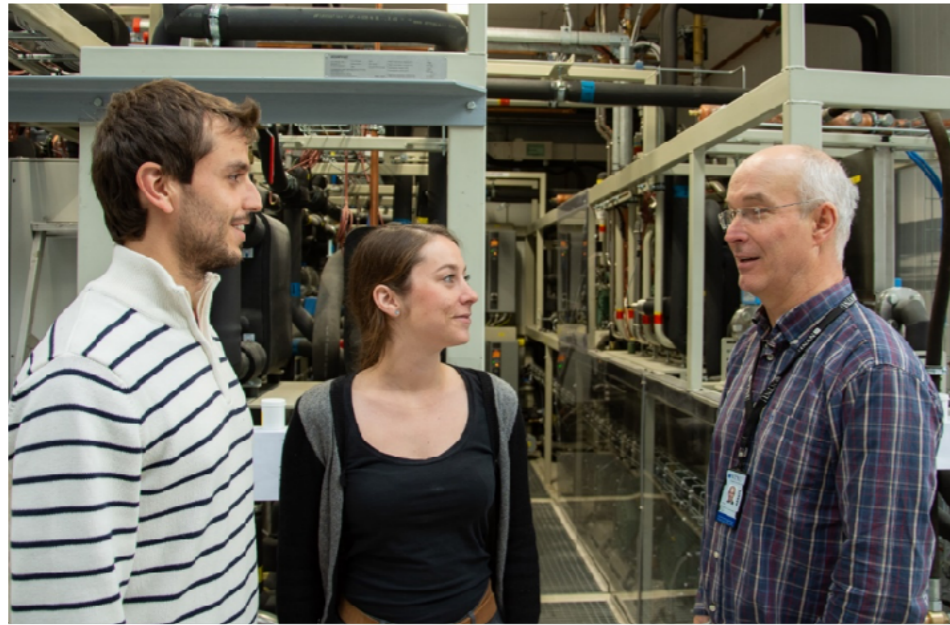


publications by LHC collaborations



Technology Research

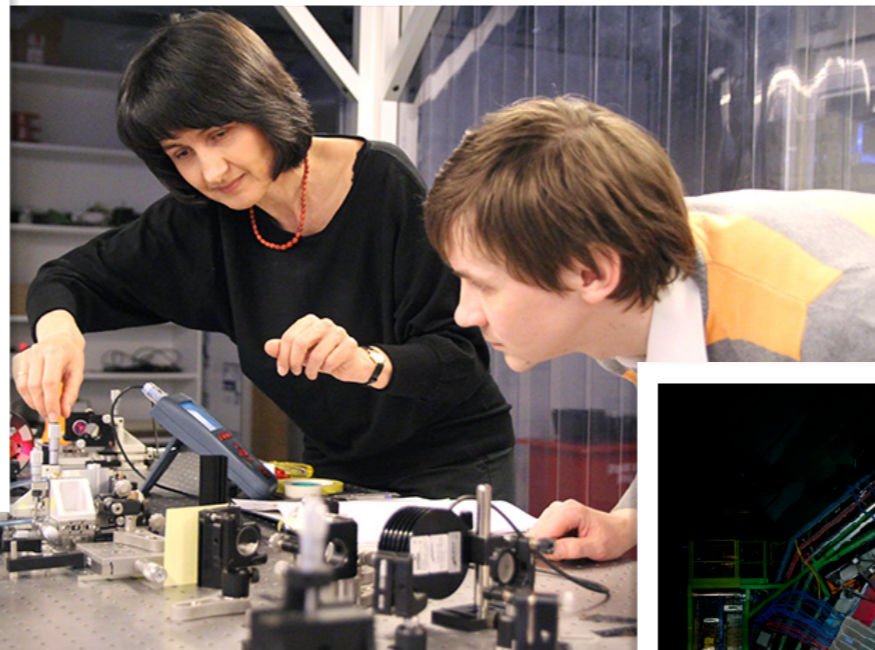
Activity 5 - Technology



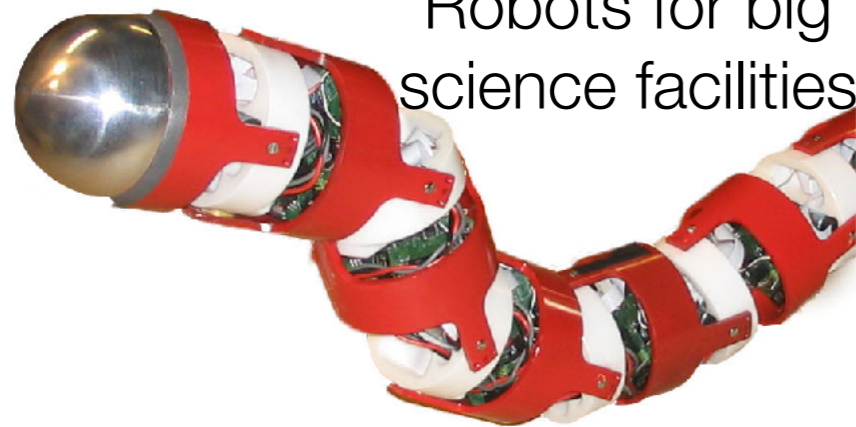
Advanced laser research



Entrepreneurship

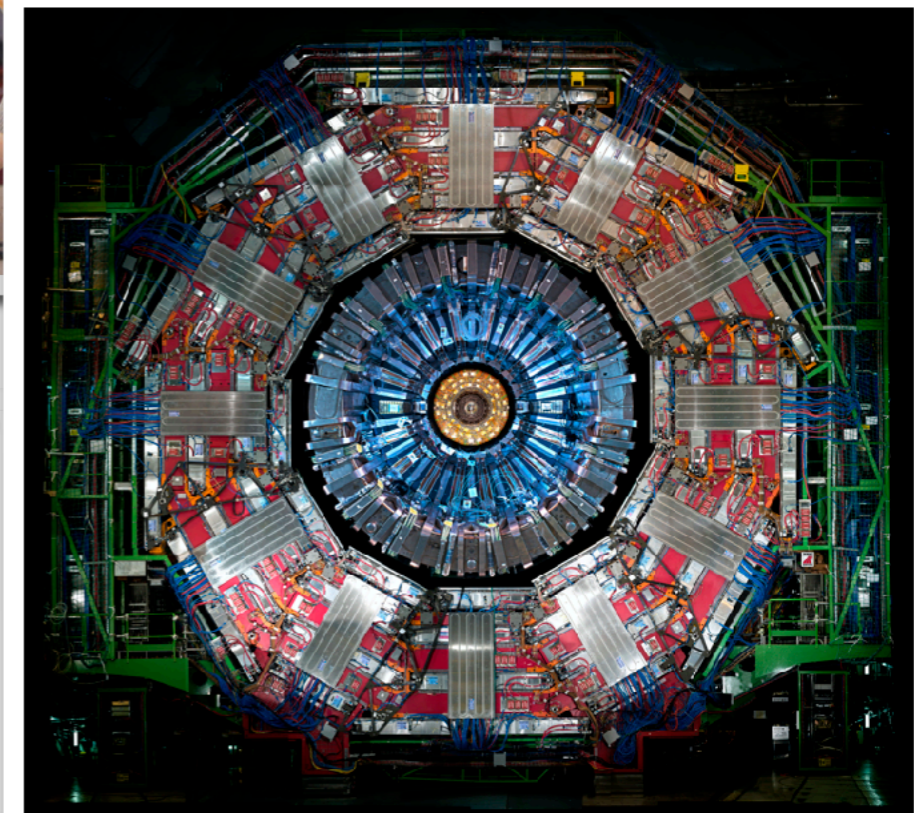
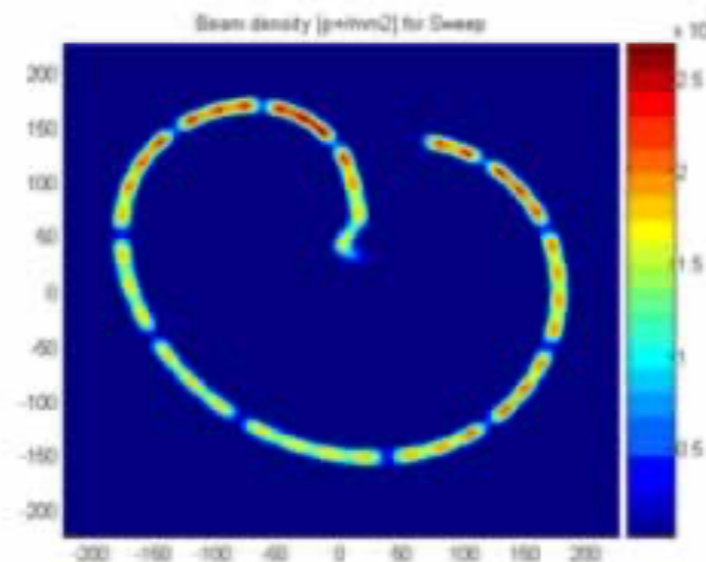


CO2 cooling systems



Robots for big science facilities

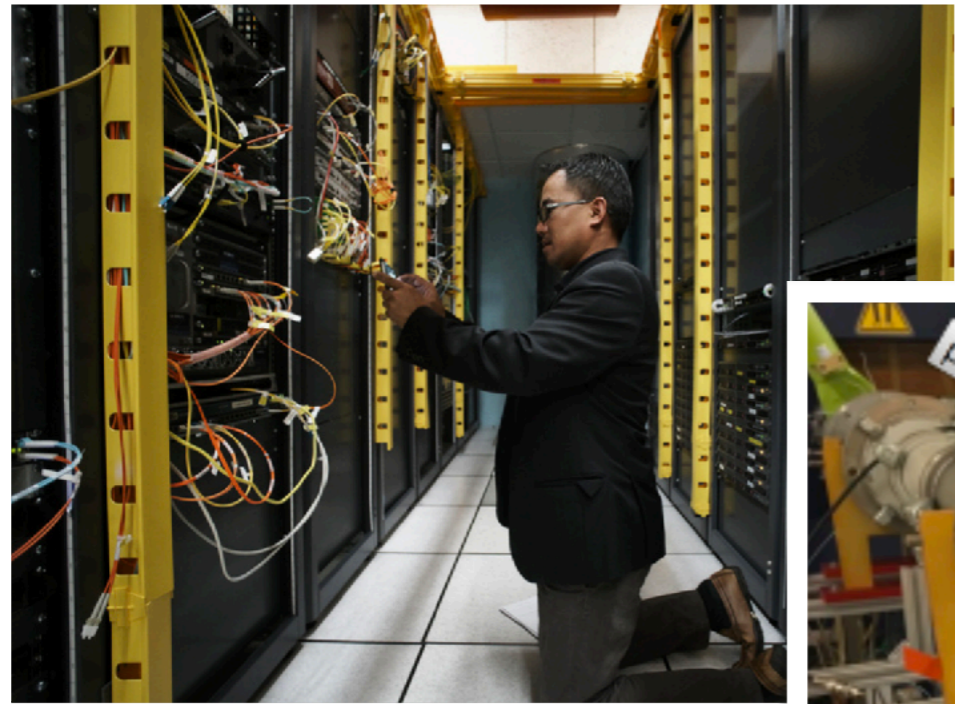
Material studies



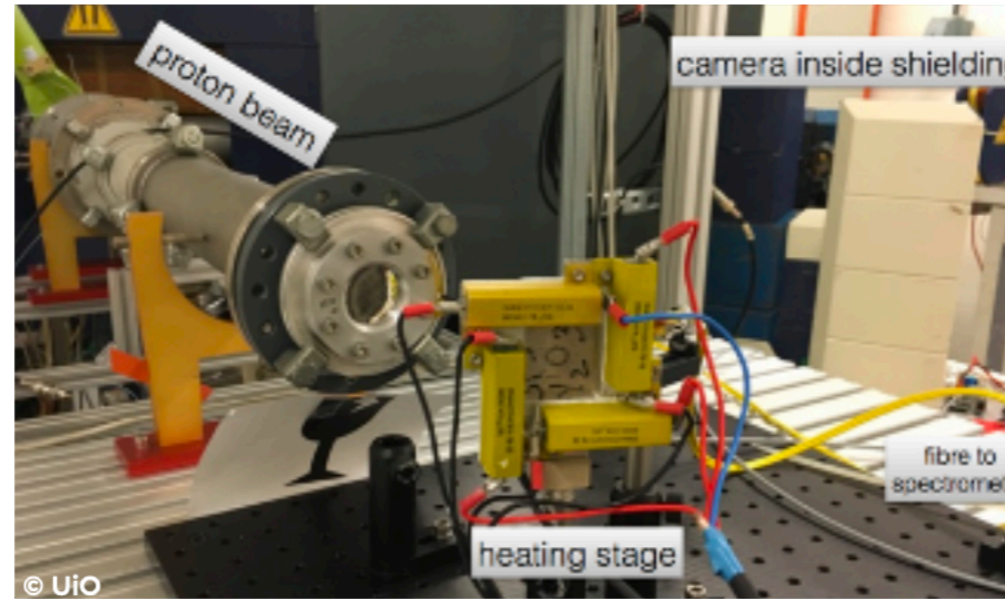
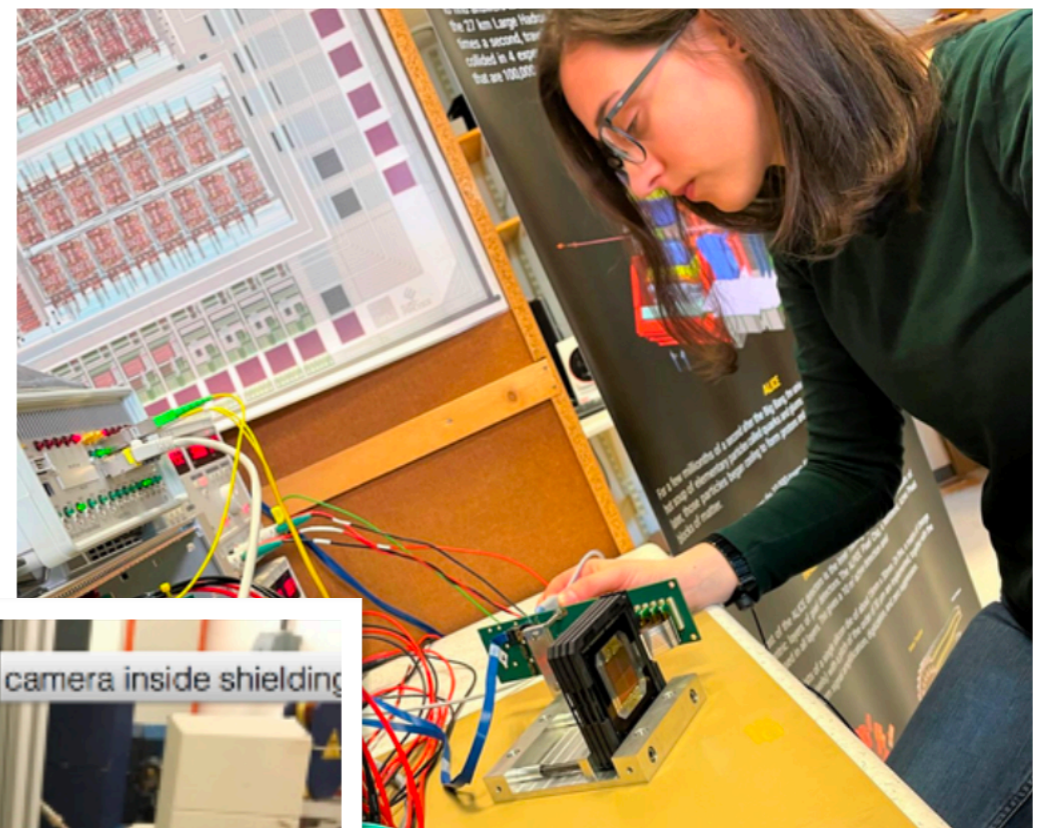
Detector Control Systems and Machine Learning

Currently 8 PhD students co-financed with CERN

Advanced laboratories in Norway



Oslo
Cyclotron
Laboratory

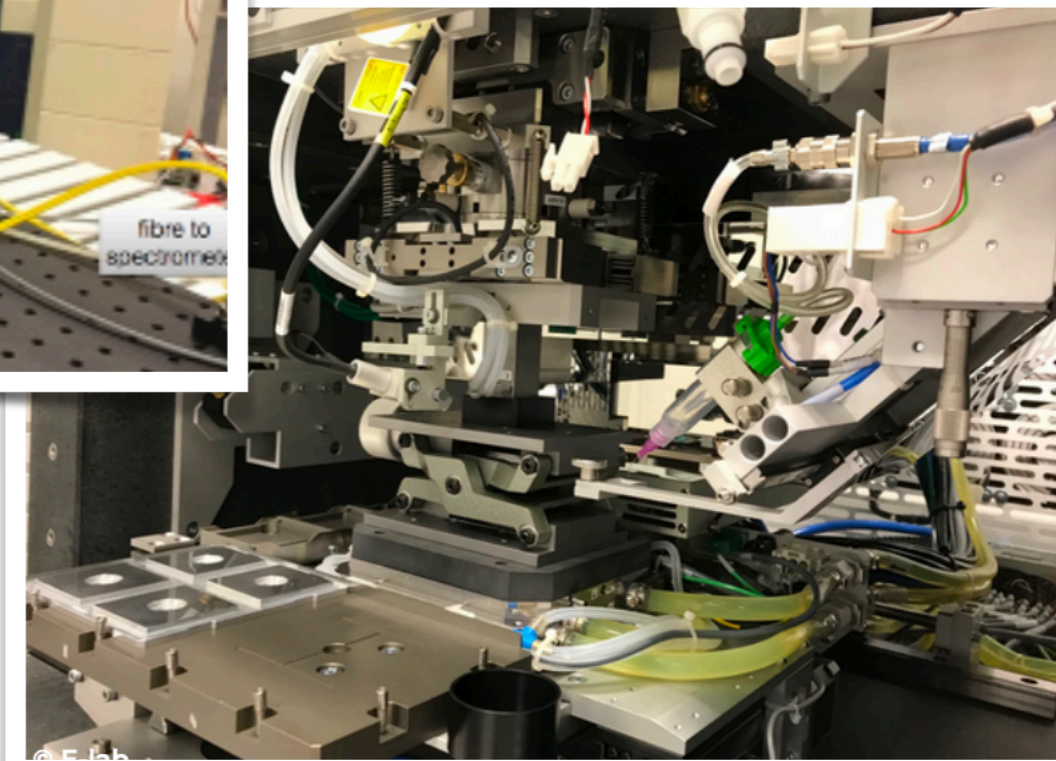


Advanced computing



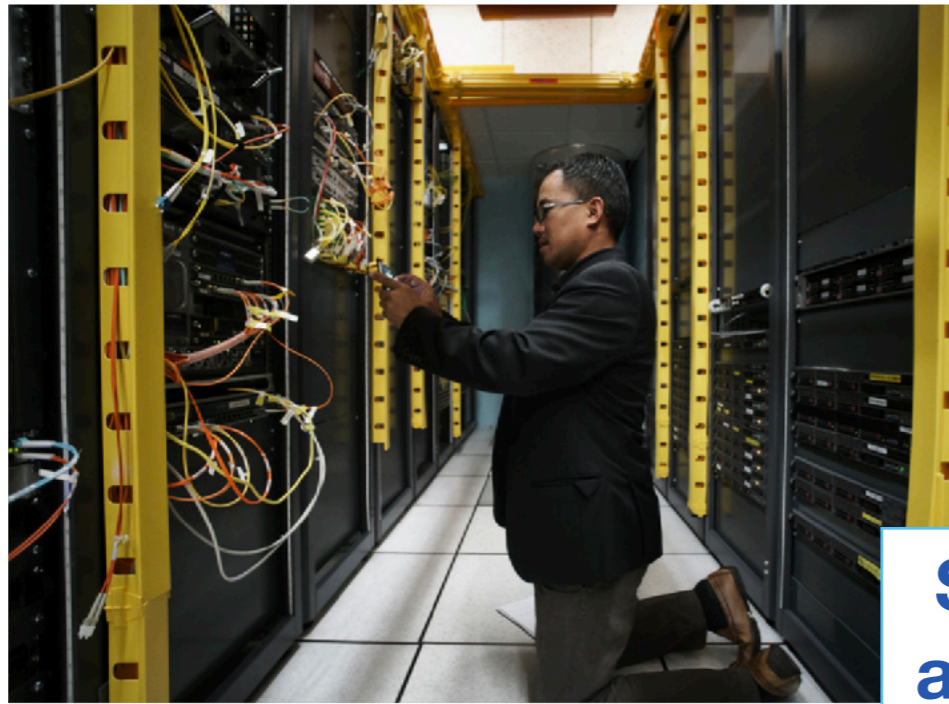
NorFab USN

++



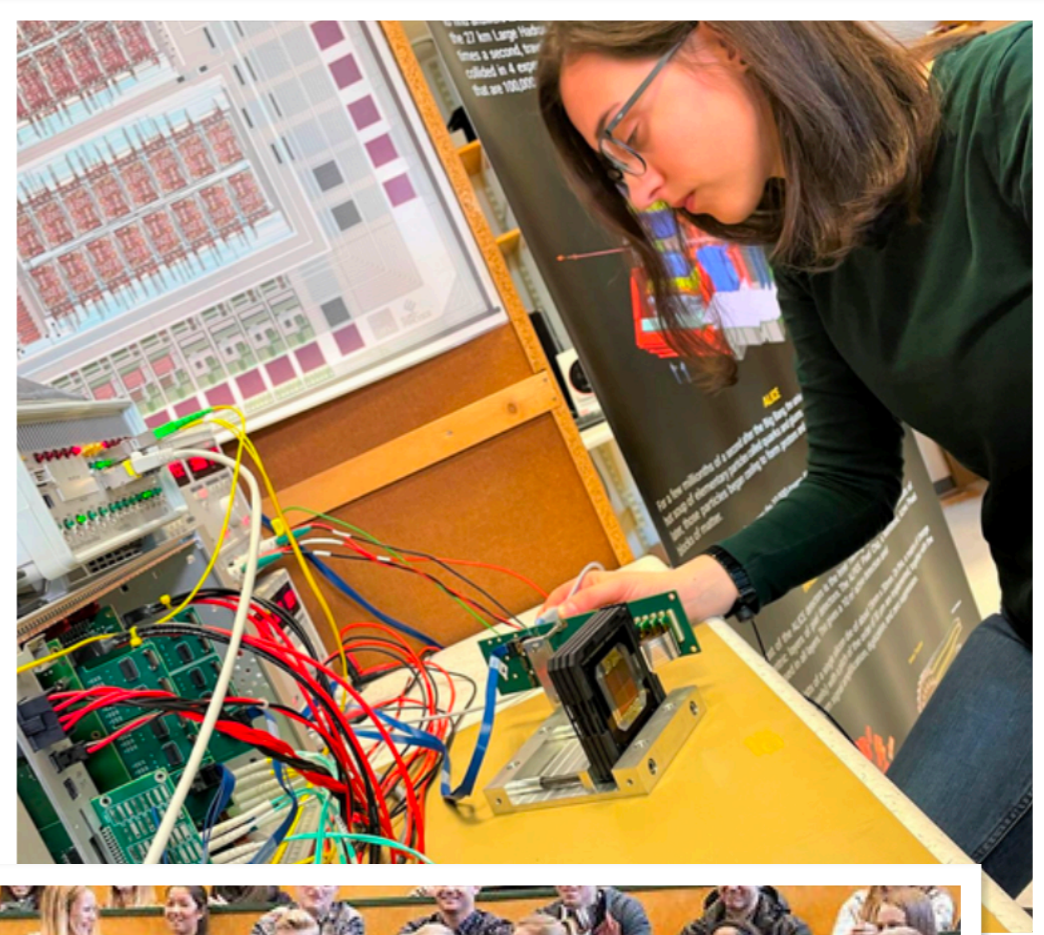
Electronics and
instrumentation laboratories

Enhanced activities in Norway



Electronics and
instrumentation
laboratories

Oslo Cyclotron
Laboratory



**Student
activities**



Advanced computing



© USN

Use of other infrastructures as NorFab

Collaborations with e.g. SINTEF, Ideas, Hospitals

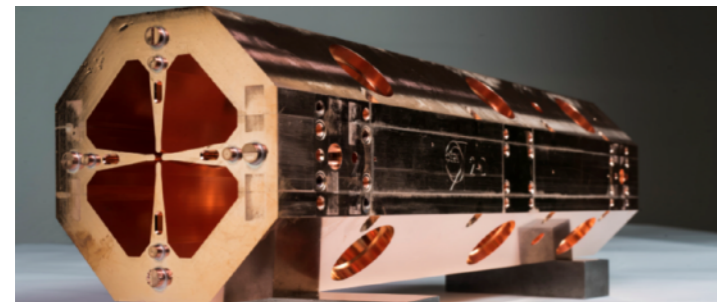
Benefit for society (examples)

Communication

between researchers in the world



Better control system for accelerator operation



High Frequency Compact Linear Proton Accelerator

For use in proton therapy
- improved **medical technology**



Future plan: CERN green village, for testing **green innovations**



Education and forming the workforce of tomorrow

Education, Dissemination, Exploitation

- More than **1200 High School students** from Norway visits CERN every normal year - help needed !
- **Norwegian teachers program** - every second year, 20 Norwegian teachers, lectures and activities presented by Norwegian scientists
- We have our own **ILO/TTO** working hard on improving the Norwegian industrial return and technology transfer. In 2021 the **Norwegian industrial return** was 60%. This is the highest industrial return registered to date for Norway.
- **CERN student programs**, technical student program, special programs for Entrepreneurship with NTNU, summer@CERN for all
- **NorCC Young Researchers program**, summer@CERN, common courses, young researcher council (first yesterday)



Are you studying physics, computer science, engineering or mathematics?

Are you taking a bachelor's or master's degree?

Do you want a practical summer at CERN?

With some of the world's greatest experiments?

CERN SUMMER STUDENT

Attend lectures, visit the CERN facility, take part in discussions and workshops with people who are frontiers in their fields.

This will be an experience of a lifetime!

Application deadline
January 31, 2022



Images: CERN

The poster features a large circular image of the LHC tunnel interior on the left. On the right, there are smaller circular images: one showing a person looking at a glowing particle detector component, and another showing a group of people at an outdoor event. The background is yellow with blue and white text.

Thank you !

Overall organisational structure

◆ 5 research activities

- A1 - Particle Physics
- A2 - Nuclear Physics
- A3 - Accelerator Physics
- A4 - Low Energy Physics
- A5 - Technology

◆ 2 supporting activities

- A6 - Education, Dissemination and Exploitation
- A7 - Management

◆ 2 networks enabling synergies across the research activities

- N1 - R&D Detector and Electronics
- N2 - R&D Computing, Machine Learning and Artificial Intelligence

ORGANIGRAM



- Collision rate **5 times bigger** than LHC
- More statistics needed to find rare phenomena (BSM, dark matter)
- **Norway participates in the upgrades of ATLAS and ALICE**
- **Both detector upgrade and computing upgrade**
- Part of the ESFRI - roadmap
- Financed by RCN infrastructure (NorLHC og NorLHC-II)

