« WELCOME TO CERN »

to all the participants of the INSS 2021!
Introduction to the Virtual Visits

Albert De Roeck   CERN

Virtual visits and CERN

Unfortunately our school is still during (hopefully the tail) of the pandemic and traveling is compromised, hence the school is online

Nevertheless, with CERN being the centre of gravity for organizing this school we like you to get a flavor of the laboratory

So two virtual visits are planned:

Next Thursday: A visit to the Neutrino Platform (noblese oblige: this is a neutrino school!)

Today: A visit to the CMS experiment

But let’s talk first about CERN..

Science for peace

CERN was founded in 1954 with 12 European Member States

CERN's annual budget is 1200 MCHF (equivalent to a medium-sized European university)

As of 31 December 2020
Employees:
2635 staff, **756** fellows

Associates:
11 399 users, **1687** others

23 Member States

Austria – Belgium – Bulgaria – Czech Republic
Denmark – Finland – France – Germany – Greece
Hungary – Israel – Italy – Netherlands – Norway
Poland – Portugal – Romania – Serbia – Slovakia
Spain – Sweden – Switzerland – United Kingdom

3 Associates Member States in the pre-stage to membership

Cyprus – Estonia – Slovenia

7 Associate Member States

Croatia – India – Lithuania – Pakistan – Turkey – Ukraine
Latvia

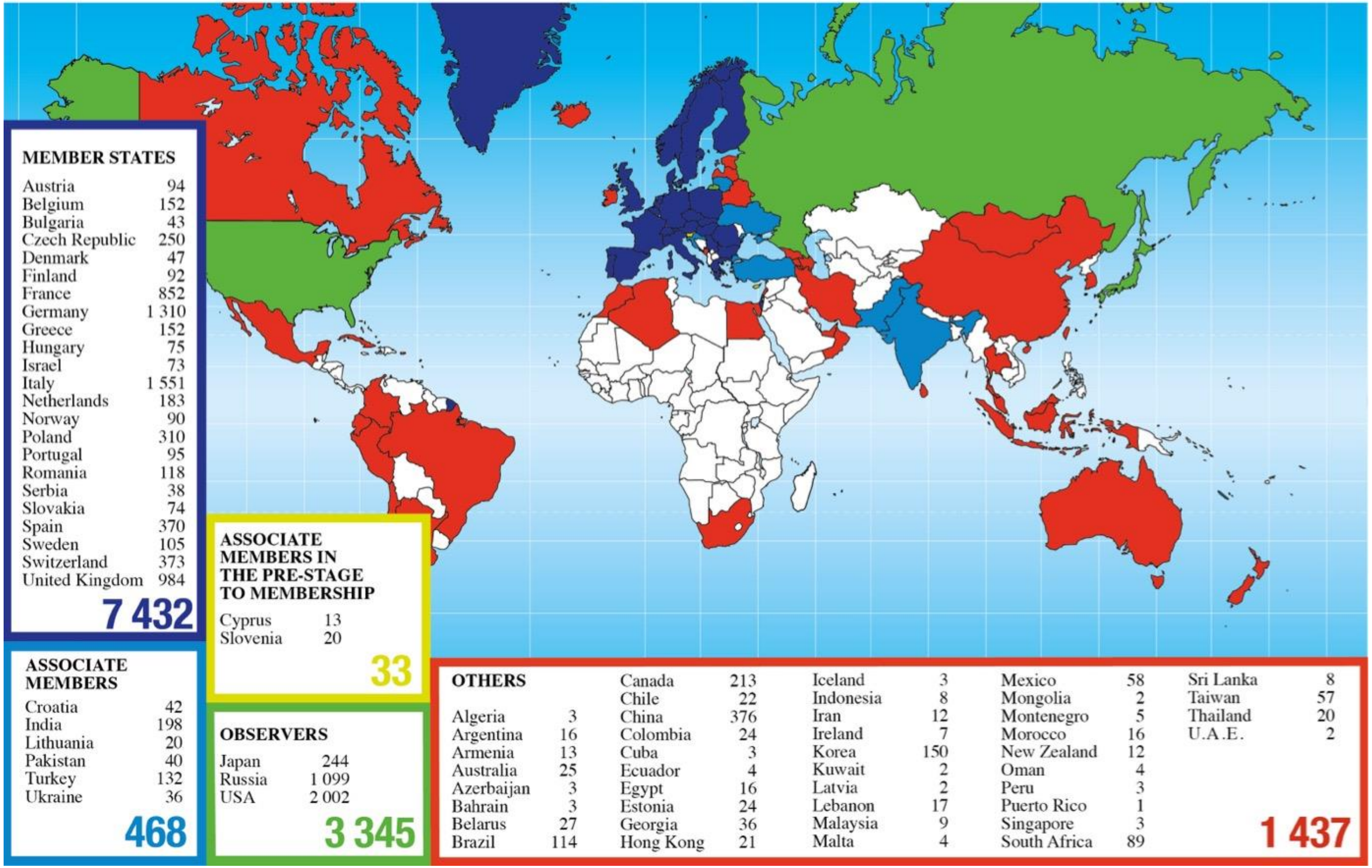
6 Observers

Japan – Russia – USA
European Union – JINR – UNESCO

35 Non-Member States with Co-operation agreements with CERN

Albania – Algeria – Argentina – Armenia – Australia – Azerbaijan – Bangladesh – Belarus – Bolivia
Bosnia and Herzegovina – Brazil – Canada – Chile – China – Colombia – Costa Rica – Ecuador – Egypt
North Macedonia – Georgia – Iceland – Iran – Jordan – Korea – Malta – Mexico – Mongolia – Montenegro
Morocco – New Zealand – Peru – Saudi Arabia – South Africa – United Arab Emirates – Vietnam

Distribution of All CERN Users by Location of Institute on 9 December 2019



MEMBER STATES

Austria	94
Belgium	152
Bulgaria	43
Czech Republic	250
Denmark	47
Finland	92
France	852
Germany	1 310
Greece	152
Hungary	75
Israel	73
Italy	1 551
Netherlands	183
Norway	90
Poland	310
Portugal	95
Romania	118
Serbia	38
Slovakia	74
Spain	370
Sweden	105
Switzerland	373
United Kingdom	984
	7 432

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP

Cyprus	13
Slovenia	20
	33

ASSOCIATE MEMBERS

Croatia	42
India	198
Lithuania	20
Pakistan	40
Turkey	132
Ukraine	36
	468

OBSERVERS

Japan	244
Russia	1 099
USA	2 002
	3 345

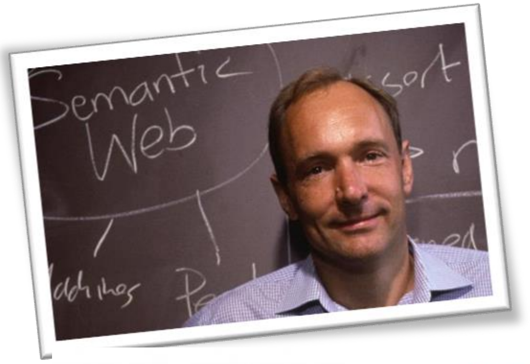
OTHERS

Algeria	3
Argentina	16
Armenia	13
Australia	25
Azerbaijan	3
Bahrain	3
Belarus	27
Brazil	114
Canada	213
Chile	22
China	376
Colombia	24
Cuba	3
Ecuador	4
Egypt	16
Estonia	24
Georgia	36
Hong Kong	21
Iceland	3
Indonesia	8
Iran	12
Ireland	7
Korea	150
Kuwait	2
Latvia	2
Lebanon	17
Malaysia	9
Malta	4
Mexico	58
Mongolia	2
Montenegro	5
Morocco	16
New Zealand	12
Oman	4
Peru	3
Puerto Rico	1
Singapore	3
South Africa	89
Sri Lanka	8
Taiwan	57
Thailand	20
U.A.E.	2
	1 437

CERN World Wide coverage of CERN users

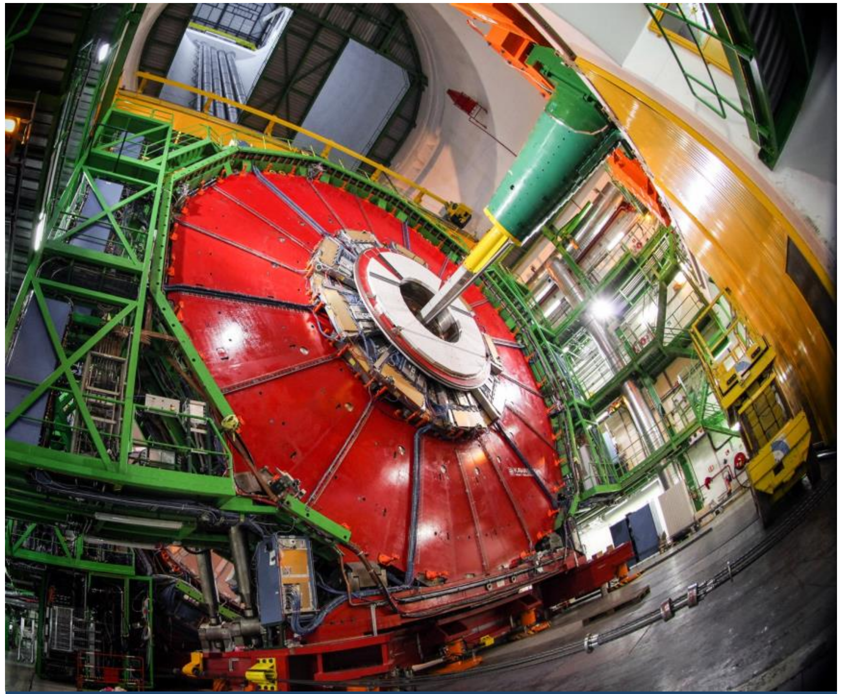
"The sun never sets on the CERN users"

Easy to imagine a World-Wide-Web was needed (1990)

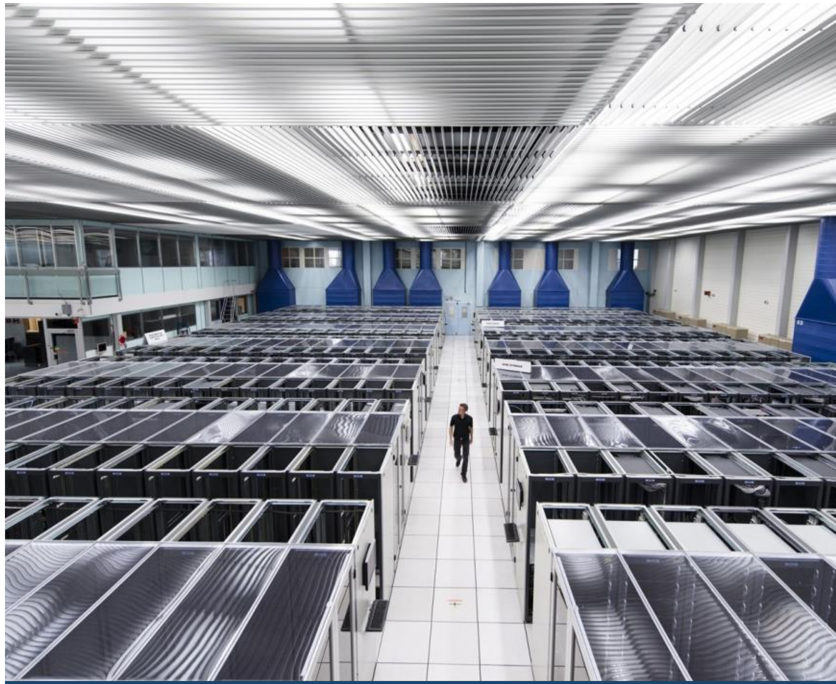


What is needed to do the science?

ACCELERATORS



DETECTORS



COMPUTING

… and people!!

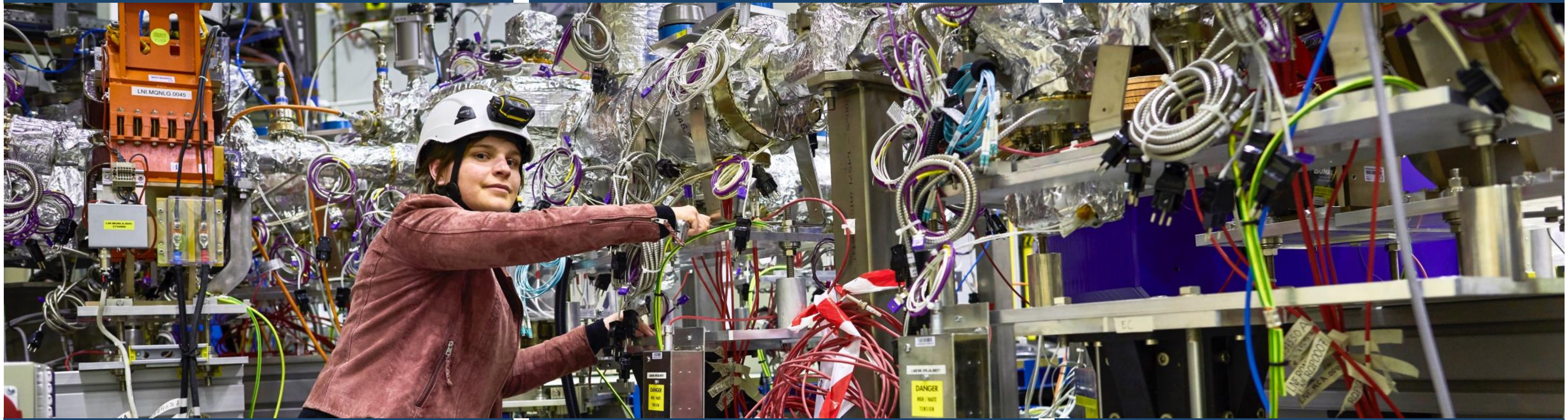
-> More than 3000 scientists and engineers in the large LHC experiments ATLAS and CMS..

CERN has a diverse scientific programme

Theoretical Particle Physics

Nuclear Physics (ISOLDE)

Antimatter Research (Antiproton Decelerator)



Cosmic rays and cloud formation (CLOUD)

Fixed-target experiments, which include searches for rare phenomena

Contribution to the Long Baseline Neutrino Facility in the USA (LBNF)

Particle Physics @ CERN

November 2021
M. Krammer

APPROVED Experiments

- **LHC:** **ALICE**, **ATLAS**, **CMS**, **LHCb**, FASER, MoEDAL, **TOTEM**, LHCf
- **SPS:** COMPASS, NA61, **NA62**, NA63, NA64, NA65
- **PS:** CLOUD
- **AD:** **AEgIS**, ALPHA, ALPHA-g, ASACUSA, BASE, GBAR
- **Neutrino Platform:** **ProtoDUNE**, T2K/ND280, ENUBET
- **R&D:** RD42, **RD50**, **RD51**, **RD53**, Crystal Clear, UA9
- **Non-accelerator experiments:** CAST, OSQAR
- **ISOLDE** and nTOF facilities

Experiments and Projects under Study

- **FCC**
- **BDF facility /** SHiP
- **LHC:** SND
- **SPS:** NA64μ, MUonE, AMBER, MadMax
- **AD:** PUMA

CERN-EP involvement
Substantial
Significant
Limited
None

Also added: ICARUS, SND@LHC

Recognized experiments (Astrophysics etc.)

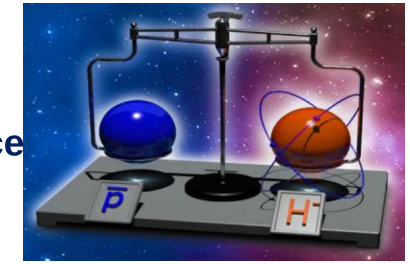
Use of CERN resources should be marginal

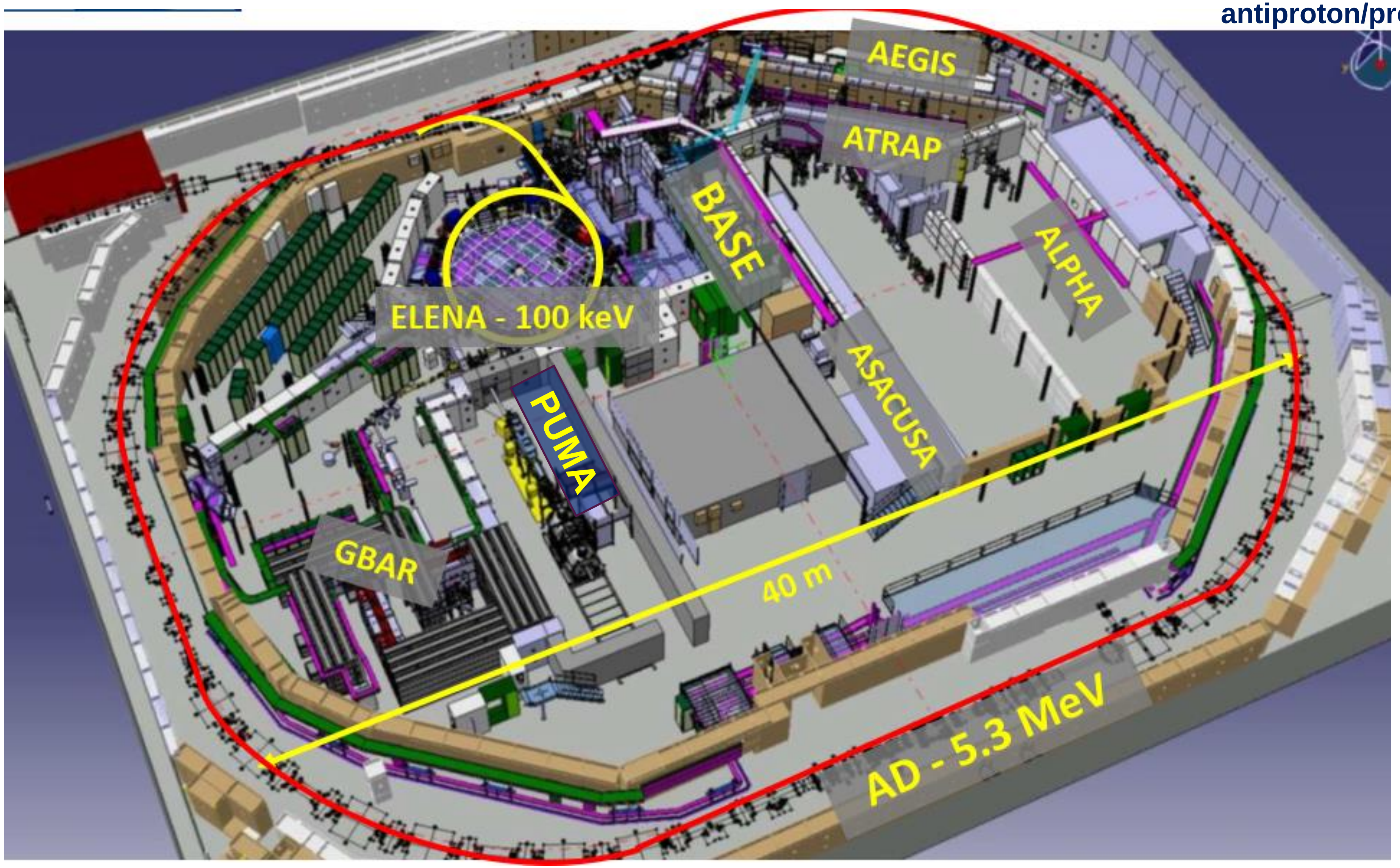
- RE1 AMS
- RE2b Pamela
- RE3 Auger
- RE6 Antares
- RE7 Fermi
- RE8 LISA-PF
- RE10 IceCube
- RE11 MICE
- RE12 MEG
- RE13 T2K
- RE14 Katrin
- RE17 Magic
- RE18 ArDM
- RE19 CREAM
- RE20 Belle II
- RE21 CBM
- RE22 Panda
- RE23 CTA-PP
- RE25 CALET
- RE26 Borexino
- RE27 NEXT
- RE28 Virgo
- RE29 DAMPE
- RE30 KM3NeT
- RE31 Euclid
- RE33 LIGO
- RE34 JUNO
- RE35 SNO+
- RE36 Mu3e
- RE37 DarkSide-20k
- RE38 DAMIC-M
- RE39 sPHENIX
- RE40 POLAR-2

The AD/ELENA-Facility

Six collaborations, pioneering work by Gabrielse, Oelert, Hayano, Hangst, Charlton et al.

antiproton/proton balance





BASE,
Fundamental properties of the antiproton and test of clock WEP.

ALPHA,
Spectroscopy of 1S-2S in antihydrogen

ASACUSA, ALPHA
Spectroscopy of GS-HFS in antihydrogen

ASACUSA
Antiprotonic helium spectroscopy

ALPHA, AEgIS, GBAR
Test free fall weak equivalence principle with antihydrogen

PUMA
Antiproton/nuclei scattering to study neutron skins

60 Research Institutes/Universities – 350 Scientists – 6 Active Collaborations

M. Hori, J. Walz, Prog. Part. Nucl. Phys. 72, 206-253 (2013).

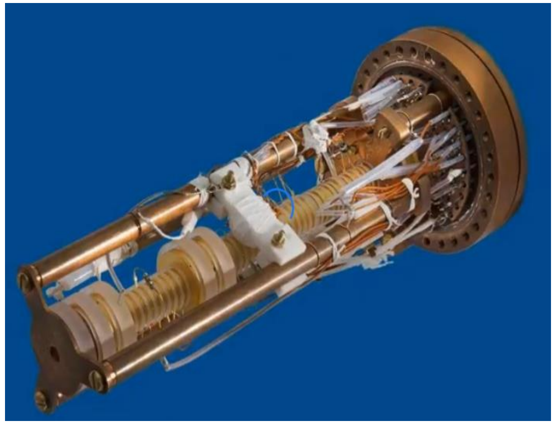
Methods and Achievements

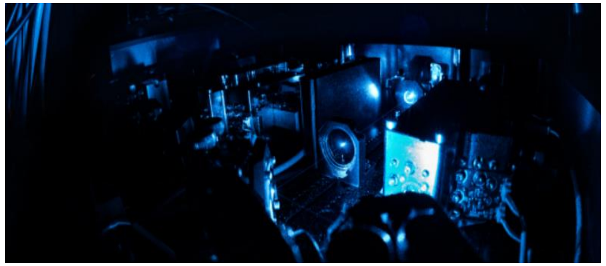
This community is performing measurements using quantum technologies at world leading precision…

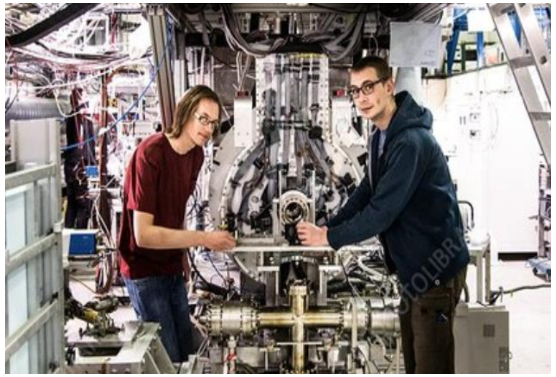
Clocks

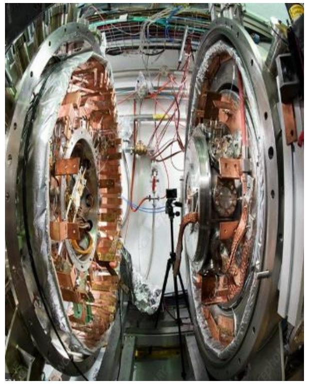
Traps

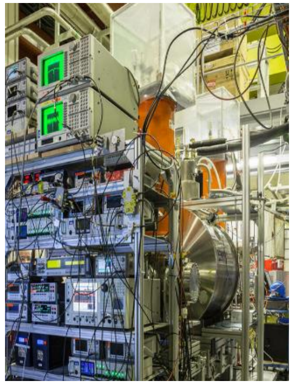
Lasers

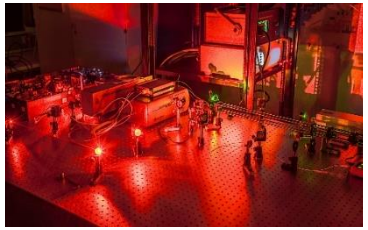


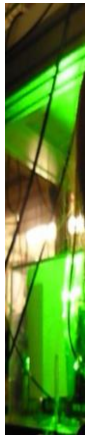


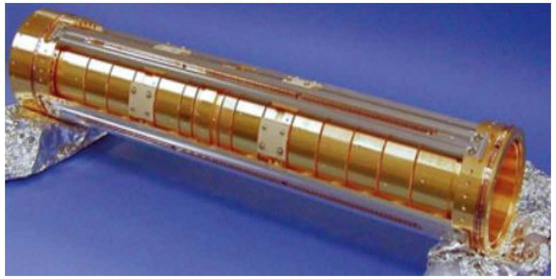












Innovation and Technology

- Antihydrogen traps
- Advanced Multi Penning trap systems
- Ultra-stable ultra-high power lasers
- Transportable antimatter traps and reservoir traps
- Advanced magnetic shielding systems
- Quantum Logic Spectroscopy

matter sector 2016

proton lifetime (direct)	>1.67 e34 y
proton m	90 p.p.t.
proton magn. moment	3.3 p.p.b.
hydrogen 1S/2S	0.004 p.p.t.
hydrogen GSHFS	0.7 p.p.t.

antimatter sector 2016

antiproton lifetime	>1.2 y
antiproton m	120 p.p.t.
antiproton m. moment	4.4 p.p.m.
antihydrogen 1S/2S	?
antihydrogen GSHFS	?

matter sector 2021

proton lifetime (direct)	>1.67 e34 y
proton m	**30 p.p.t.**
proton magn. moment	**0.3 p.p.b.**
hydrogen 1S/2S	0.004 p.p.t.
hydrogen GSHFS	0.7 p.p.t.

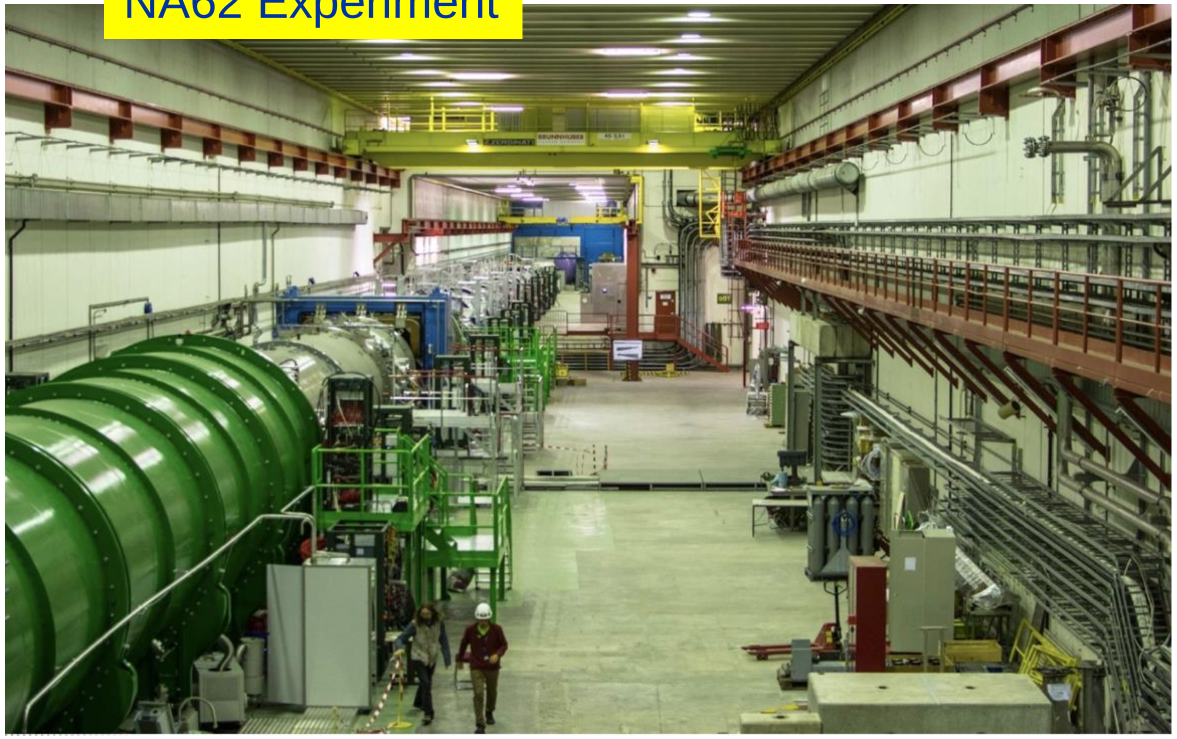
antimatter sector 2021

antiproton lifetime	**>30 y**
antiproton m	**30 p.p.t.**
antiproton m. moment	**1.5 p.p.b.**
antihydrogen 1S/2S	**2 p.p.t.**
antihydrogen GSHFS	**400 p.p.m.**

…and is a vital part of the low energy precision physics community…

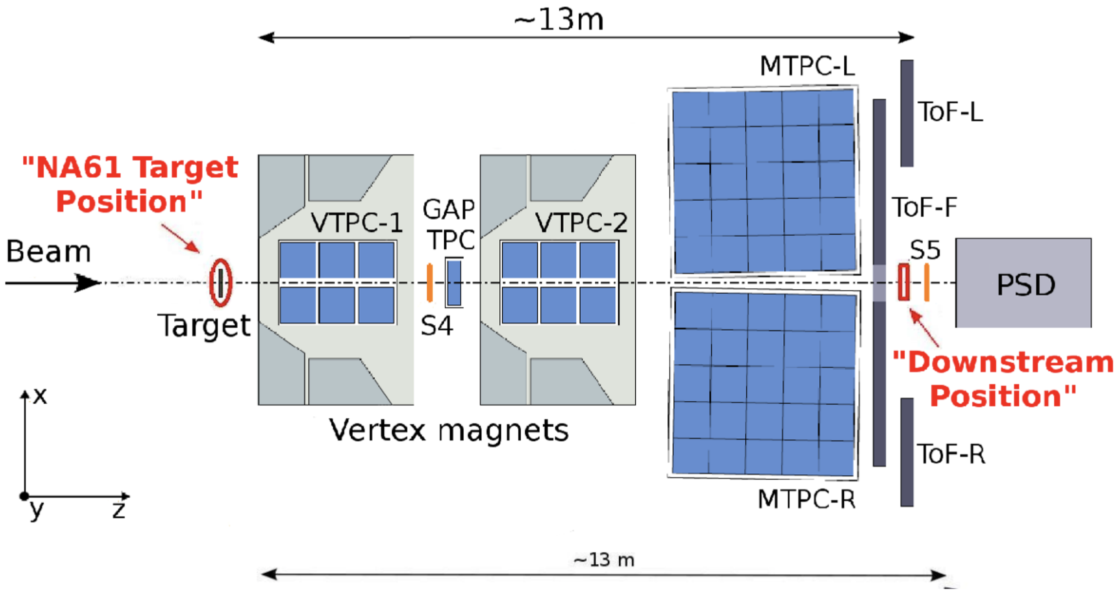
Examples: Fixed Target Experiments

NA62 Experiment



Precision tests of the Standard Model by studying rare decays of charged kaons. Searches for exotica such as heavy neutral leptons

NA61/SHINE Experiment



Hadron-nucleus interactions are used to determine neutrino beam properties within the T2K experiment and in Future also for the DUNE experiment

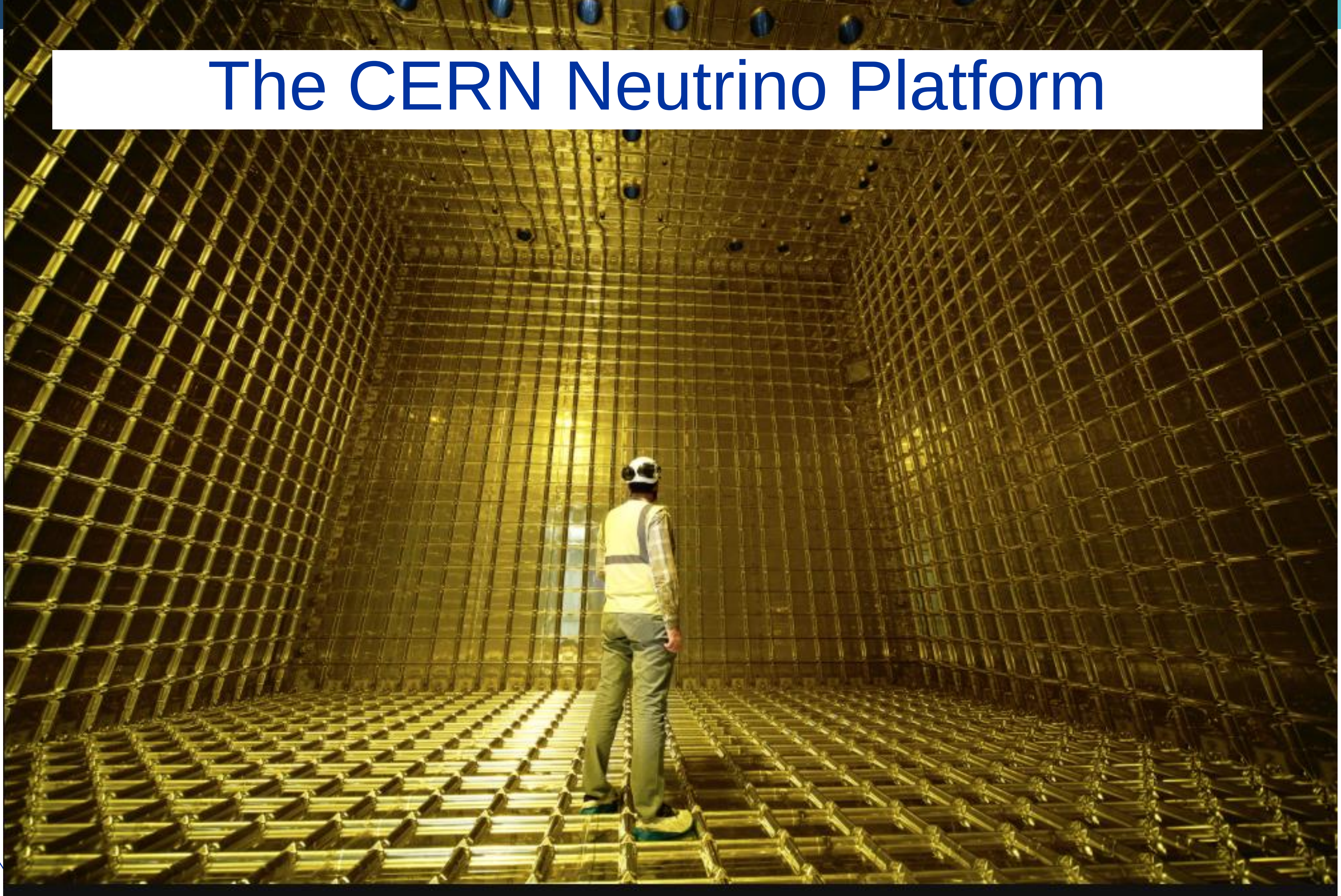
See also M. Bishai's talk on Tuesday

Since 2016: Physics beyond colliders initiative

Physics Beyond Colliders

For BSM studies: arXiv:1901.09966

The CERN Neutrino Platform



Some history ……

M. Nessi

1963 : Start of the first neutrino experiments at CERN in June. During seven weeks a total of 4000 events were observed in a spark chamber and 360 in a bubble chamber

2000 : CERN neutrino group was closed. No participation in OPERA/ICARUS. The TOSCA short baseline project stopped around the same time.

2012 : A project was presented for a neutrino new short baseline at CERN (LOI presented in March 2013).

At the same time a European long baseline, pointing to Finland from CERN was under discussion.

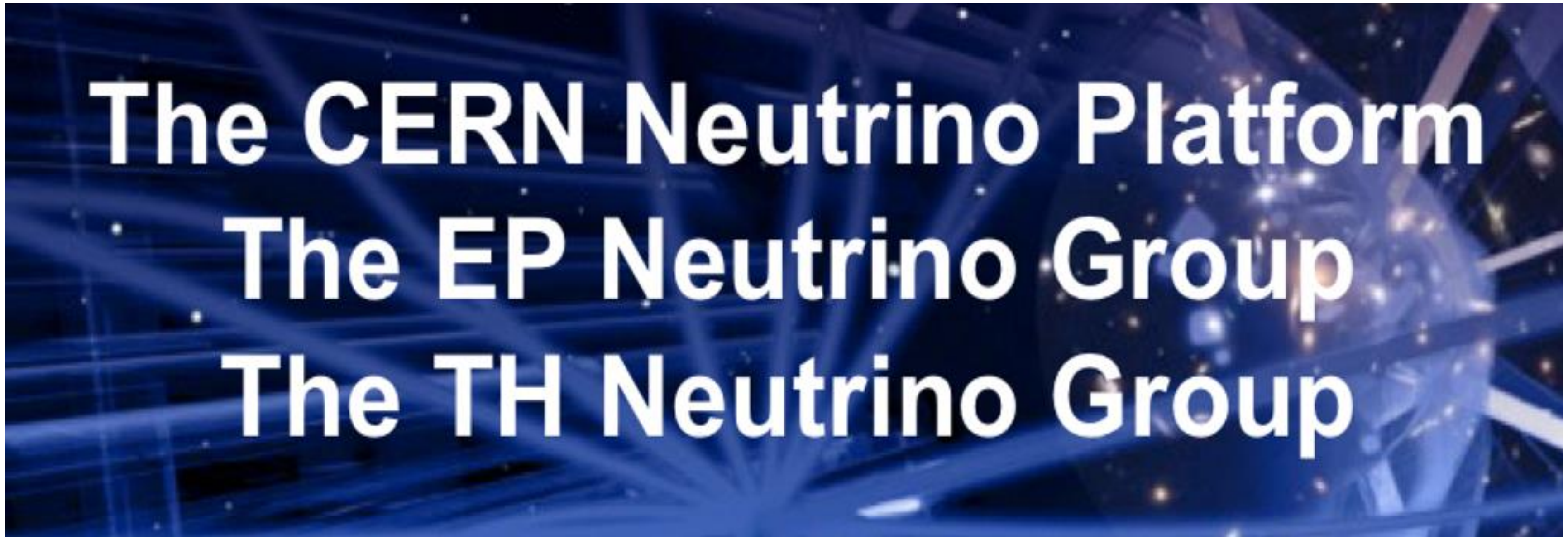
In all these proposals, LAr TPCs technologies were among the main options.

2013 : the European strategy priorities put CERN neutrino among the 4 CERN priorities : "….. ***pave the way*** *for a substantial European role in future long-baseline experiments. Europe should explore the possibility of major participation in leading long-baseline neutrino projects in the US and Japan."*

June 2014 Paris APPEC meeting: we announced that CERN would stop any plan for a CERN based Neutrino beam, in favour of an active cooperation with the USA and Japan programs: -> The CERN Neutrino Platform was created

CERN Neutrino Platform

The Neutrino Platform is CERN’s undertaking to foster and contribute to fundamental research in neutrino physics at particle accelerators worldwide



Present status of NP activities

7 MOUs signed:

- ✓ NP01: ICARUS overhauling + FNAL activities
- ✓ NP02: R&D on a double phase LAr TPC technology (including protoDUNE DP)
- ✓ NP03: generic R&D on neutrino detectors and facilities
- ✓ NP04: R&D on a single phase LAr TPC technology (protoDUNE SP)
- ✓ NP05: Baby Mind muon spectrometer for a T2K near detector
- ✓ NP06: ENUBET, R&D on a neutrino beta beam
- ✓ NP07: ND280, a new T2K Near Detector

Cooperation agreements

- CERN participation in the USA LBNF/DUNE project
- CERN delivery in kind to USA of the first large LBNF cryostat
- CERN participation in the FNAL short baseline Neutrino program
- CERN technical participation in the Darkside project at LNGS

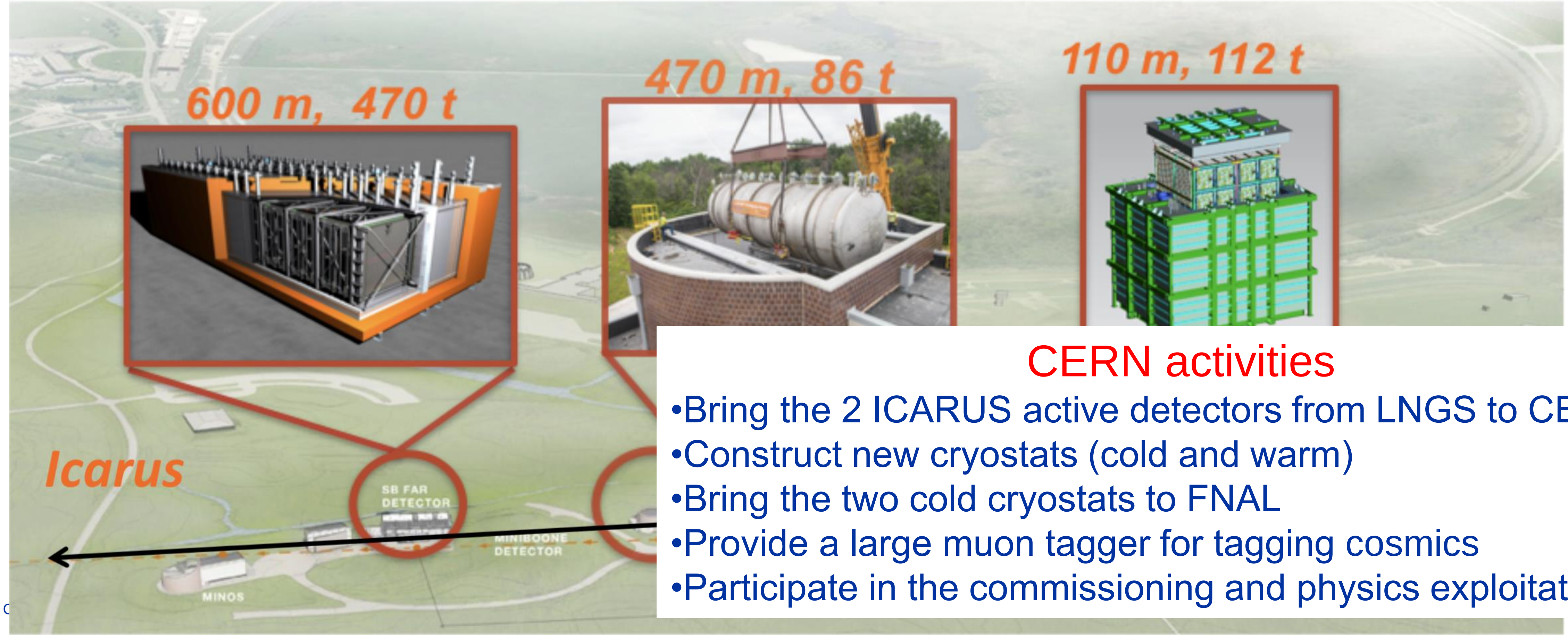
Other activities

- NP participation in the CERN FASER and SND@LHC project

NP01: ICARUS

SBN will verify the sterile neutrino hypothesis both in appearance and disappearance channels

ICARUS was a detector operational at the LNGS, Gran Sasso, and was refurbished to operate on surface at CERN and transported to FNAL in 2017



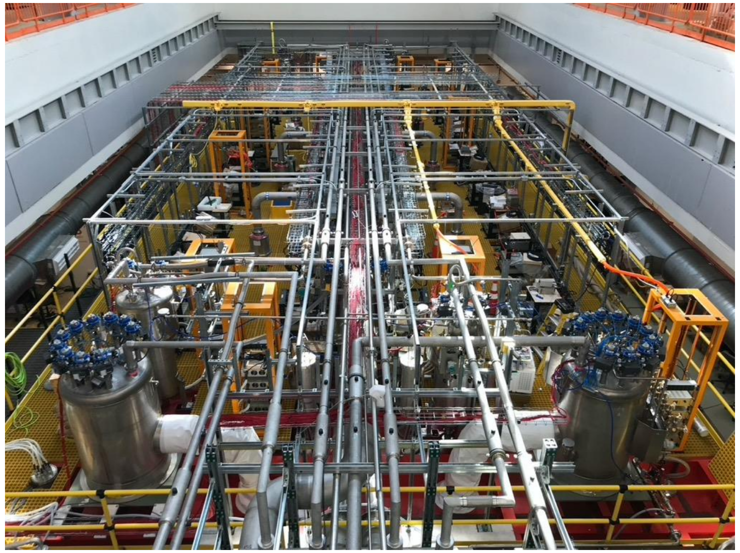
CERN activities

- Bring the 2 ICARUS active detectors from LNGS to CERN
- Construct new cryostats (cold and warm)
- Bring the two cold cryostats to FNAL
- Provide a large muon tagger for tagging cosmics
- Participate in the commissioning and physics exploitation

ICARUS at FNAL

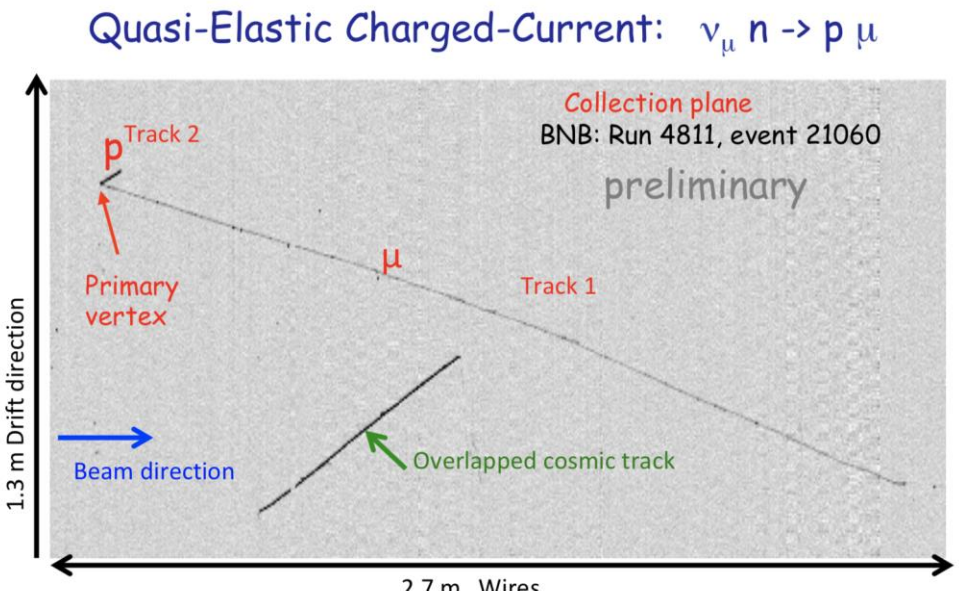
Leaving CERN 12 June 2017

Positioning of the two ICARUS modules (cold cryostats) in final position in a new building at FNAL



ICARUS filled with liquid argon in 2020

First neutrino BNB candidates in ICARUS June 2021
First production run will start in October

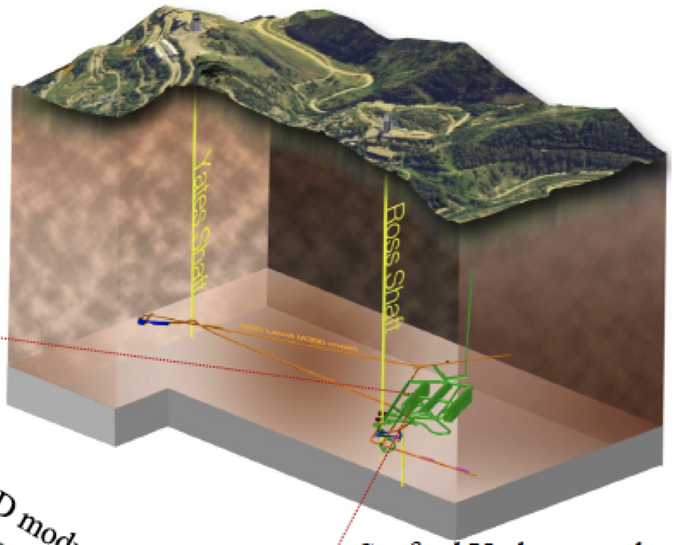


NP02 and NP04: DUNE Prototypes

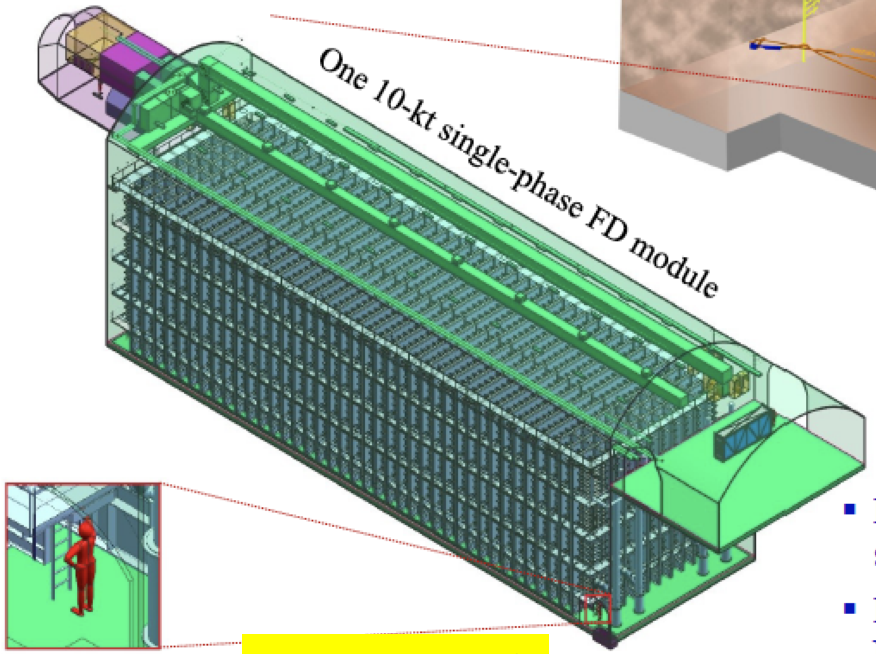
1.5 km underground

DUNE Far Detector

- **40-kt (fiducial)** LAr TPC
- Installed as four 10-kt modules at 4850' level of SURF

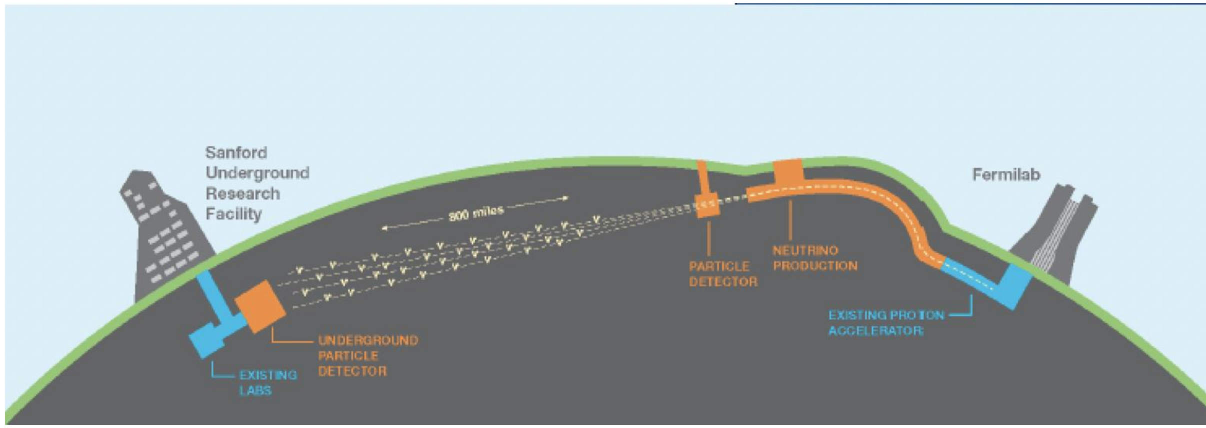


Sanford Underground Research Facility (SURF)



16x16x60m^3

- First module will be a **single phase LAr TPC**
- Modules installed in stages. Not necessarily identical



DUNE

Deep **U**nderground
Neutrino **E**xperiment

A next generation experiment for **neutrino science**, **nucleon decay**, and **supernova physics**

Next step : ~800 ton LAr prototypes

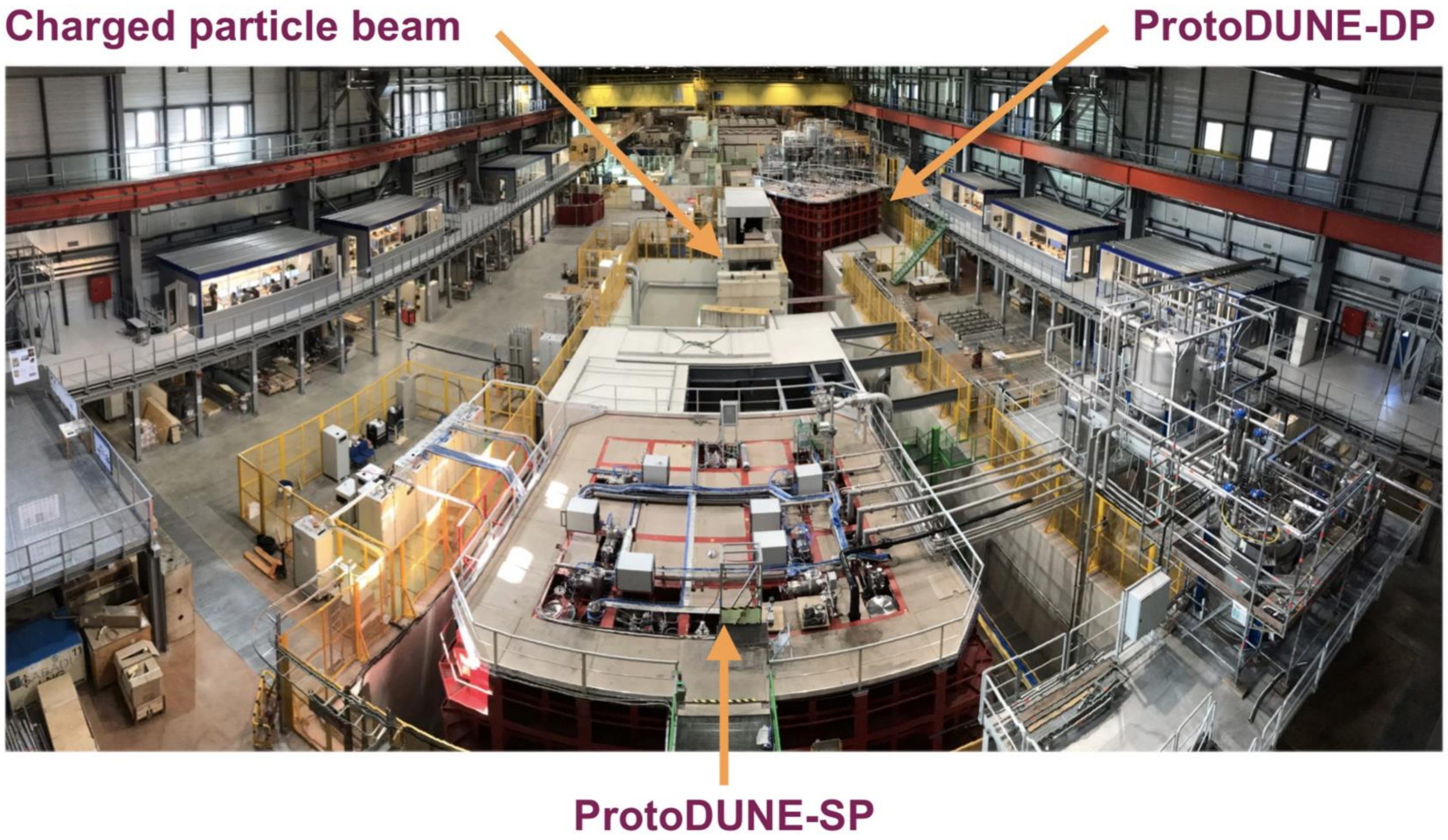
The EHN1 hall at CERN

The Neutrino Platform hall

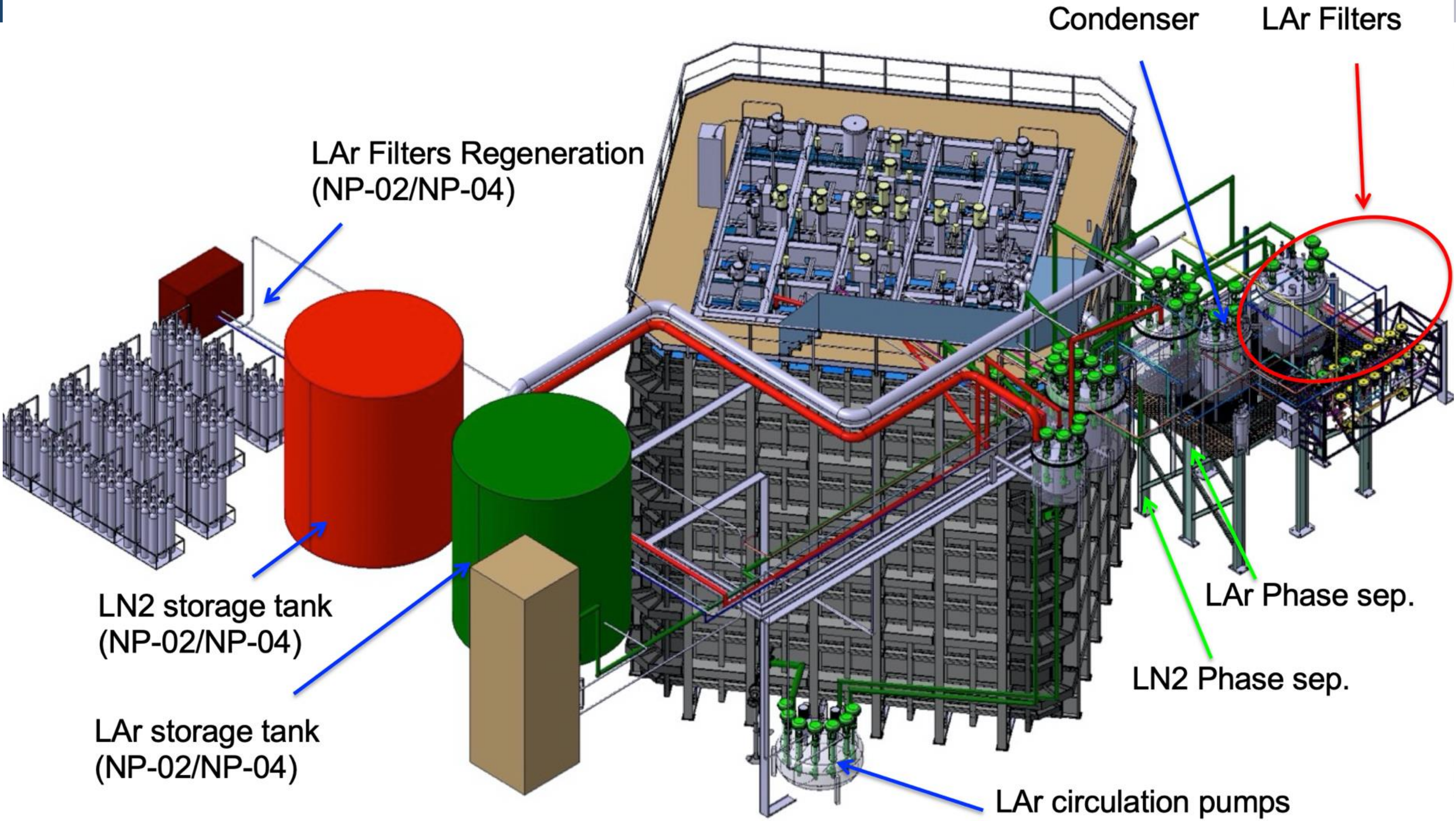
We visit that on Thursday next week

ProtoDUNE as the necessary step to demonstrate the feasibility of the LAr technology for large detectors

- Largest liquid argon time projection chambers (LArTPCs) ever built



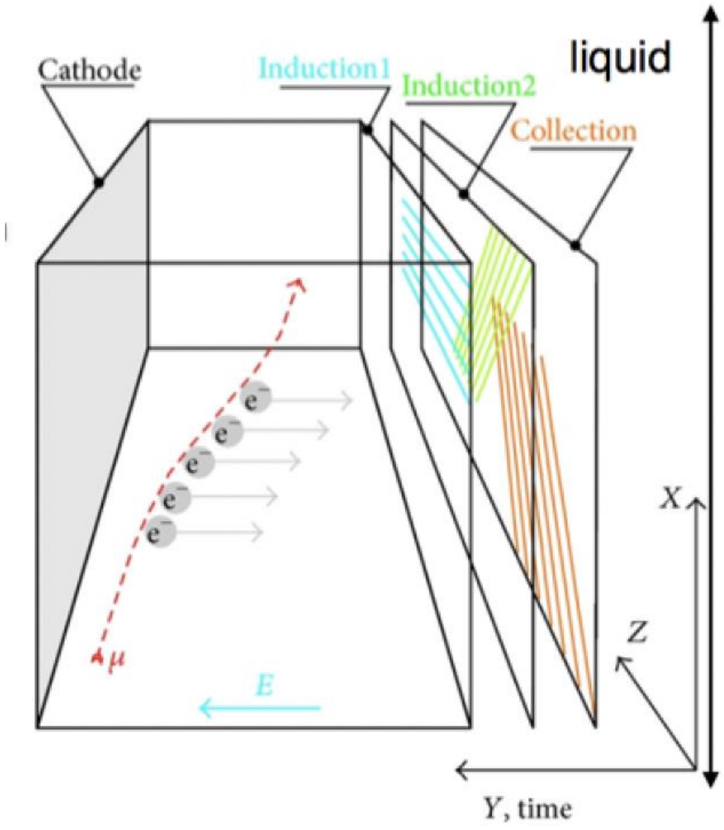
- **Prototypes at the scale 1:20, with modules at the DUNE scale**
- **Two technologies investigated (LAr single phase, LAr double phase)**


Condenser
LAr Filters
LAr Filters Regeneration
(NP-02/NP-04)
LN2 storage tank
(NP-02/NP-04)
LAr storage tank
(NP-02/NP-04)
LAr Phase sep.
LN2 Phase sep.
LAr circulation pumps

NP02 and NP04: ProtoDUNEs

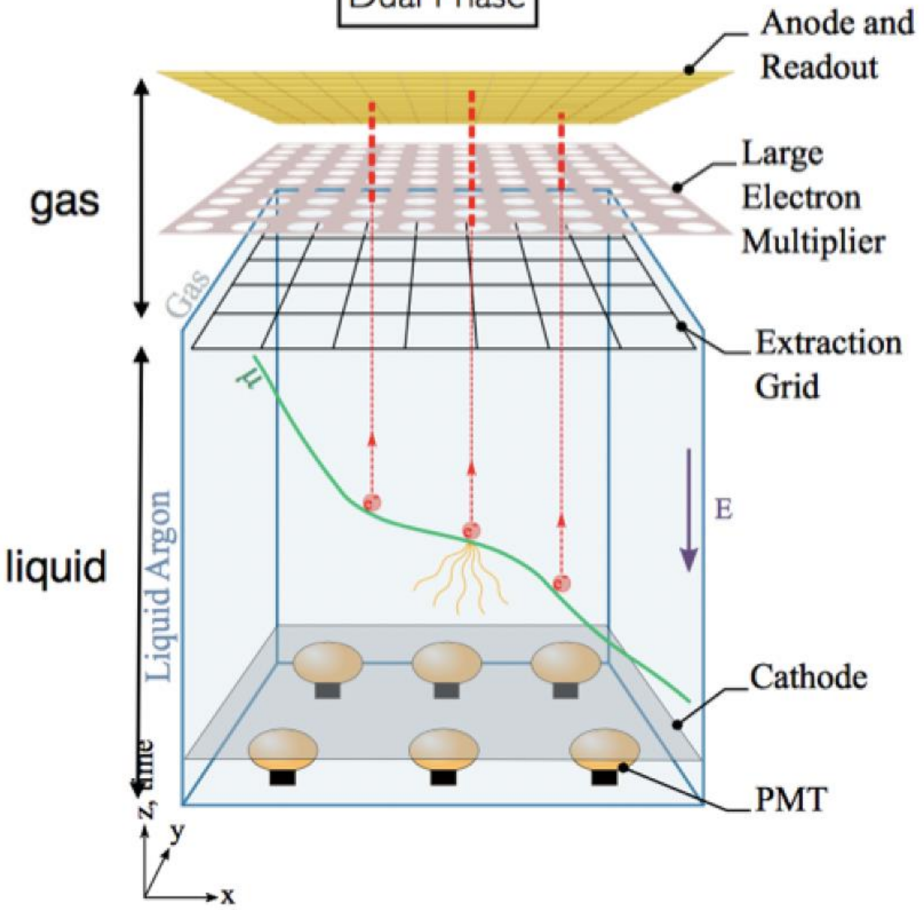
- ionisation charges are drifted horizontally and readout by wires.
- No amplification of the signal.

Single Phase



- ionisation charges are drifted vertical and readout by PCB anodes.
- amplification of the signal in LEMs

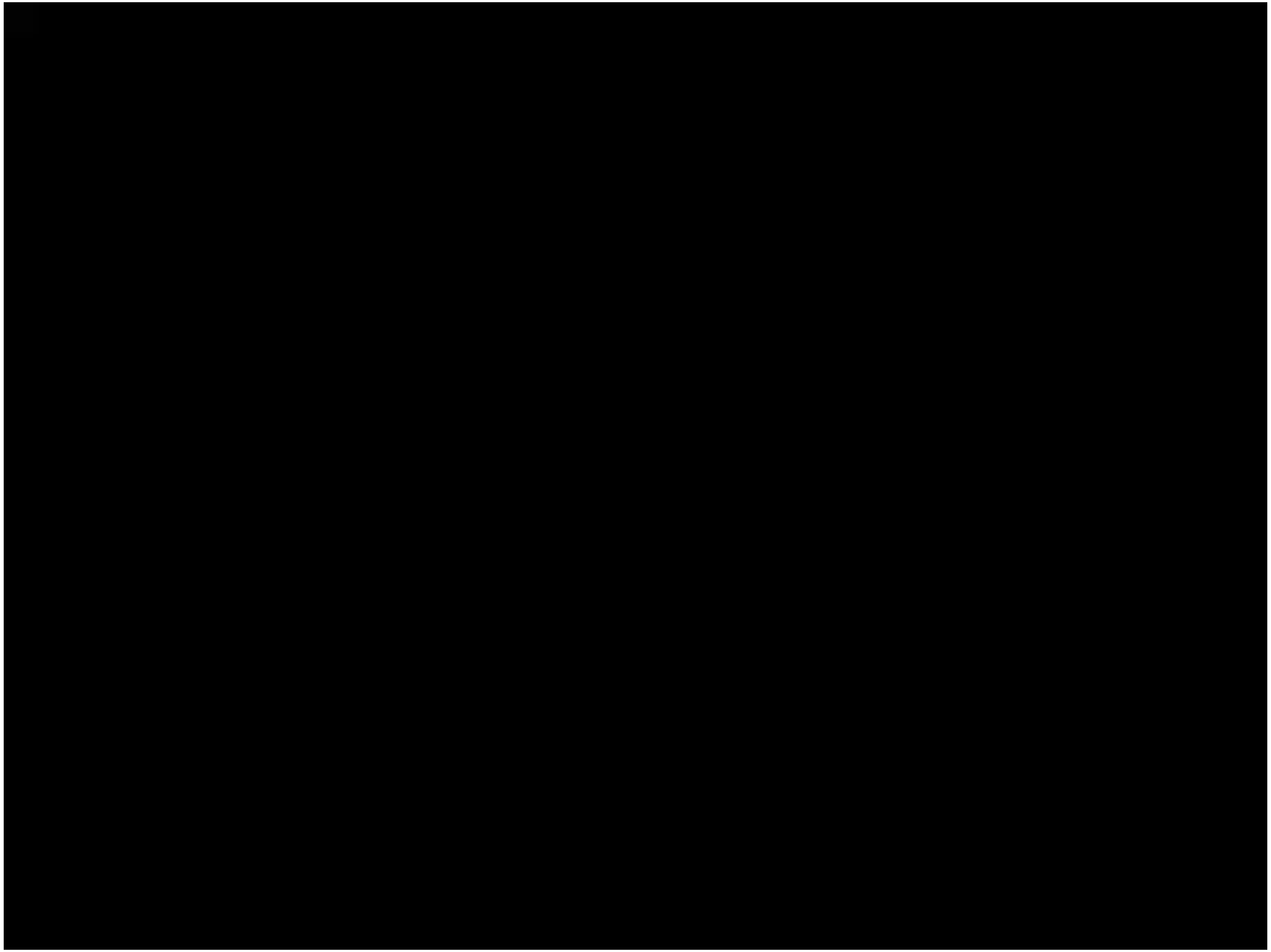
Dual Phase



The Dual Phase turned out to be very complex and this idea for the technology has now been replaced by a so called ”vertical drift” LArTPC technque

This new idea wil be fully tested within 1-2 years using the NP02

More in Flavio Cavanna’s talk on Thursday

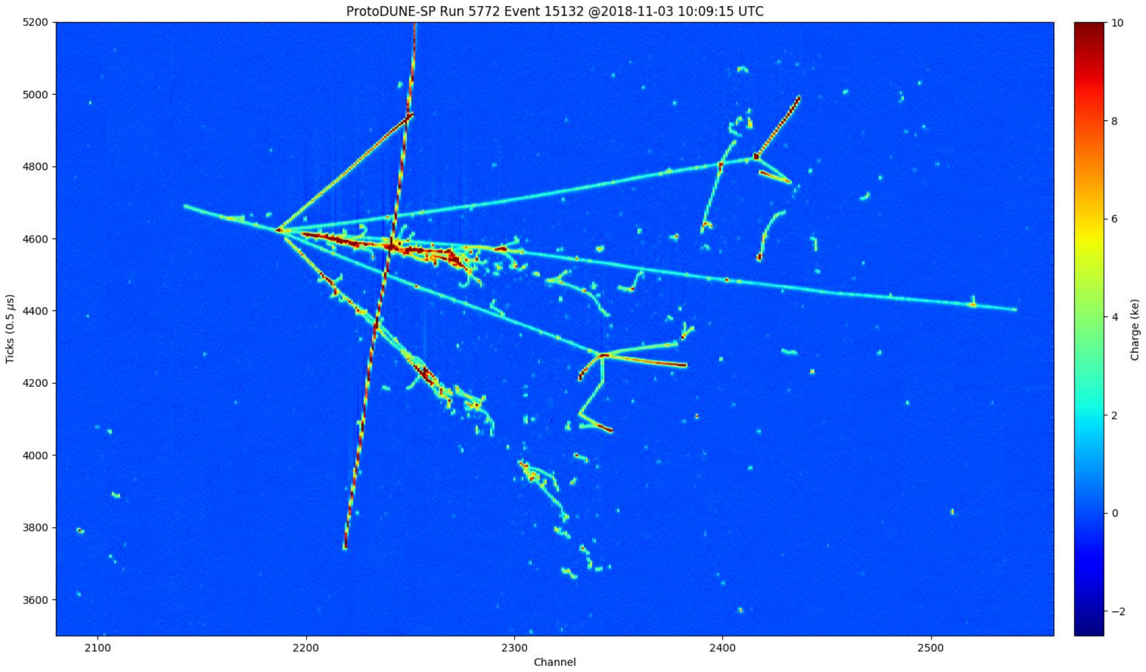


Charged hadron analyses

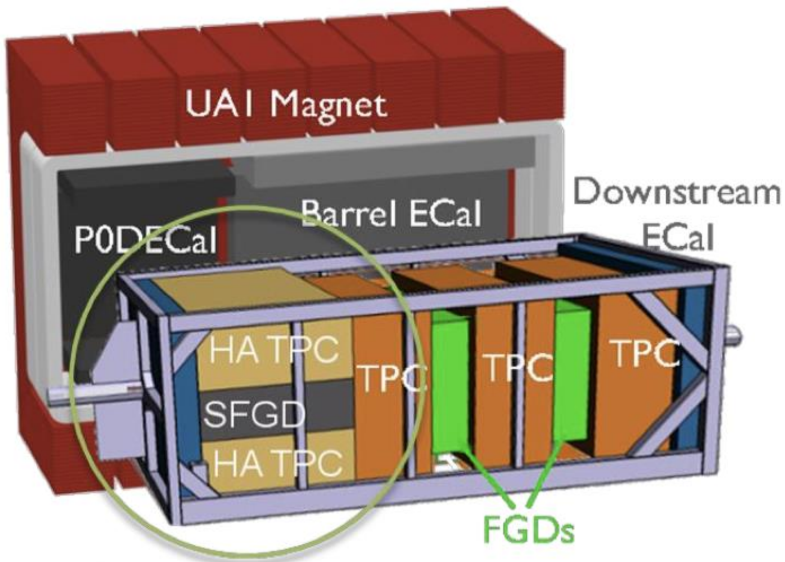
- Main physics goal for ProtoDUNE-SP: hadron - LAr cross sections

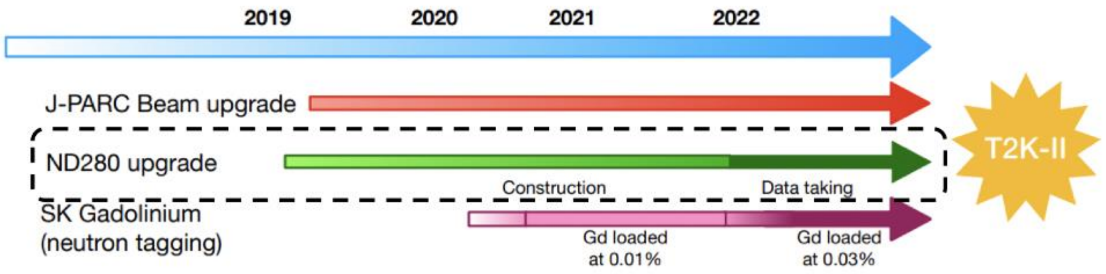
- Large number of analyses underway
  - Charged pions (at 1GeV/c)
    - Inclusive, absorption, and charge exchange cross sections
    - Transverse kinematic imbalance
  - Protons (at 1GeV/c)
    - Inclusive cross section
    - Transverse kinematic imbalance
  - Charged kaons (at 6GeV/c)
    - Inclusive cross section
  - Neutrons
    - Cross section using protons produced by secondary neutrons

Hadron beam (π,K,p) on LArTPC
Physics analysis of hadron-LAr interactions ongoing…



NP07: T2K Near Detector Upgrade

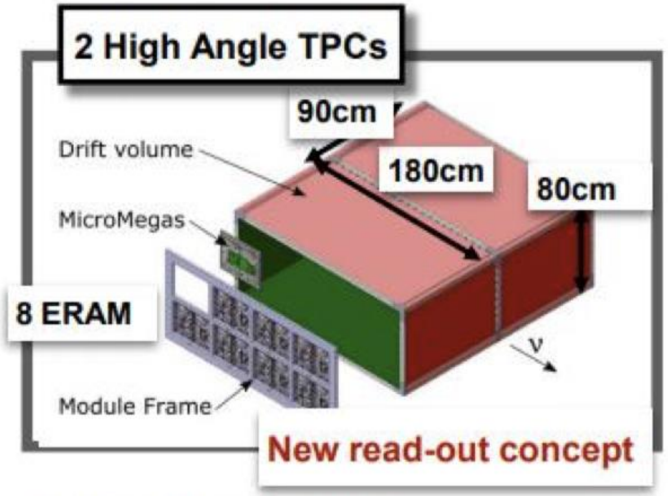




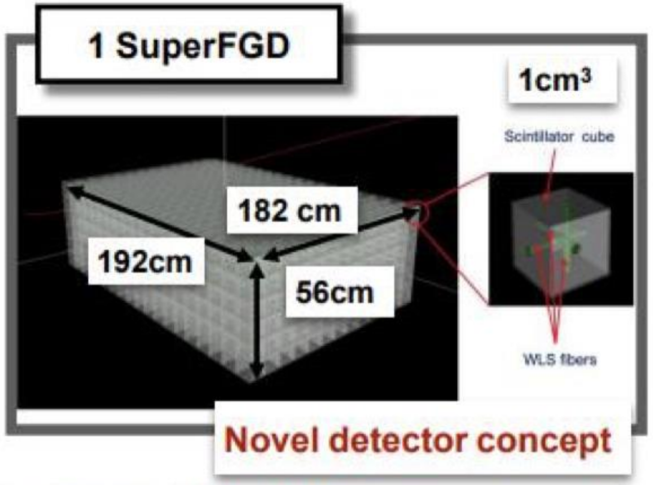
CERN involved in
- HA TPCs
- SuperFGD

Much of the assembly done at CERN as we speak..

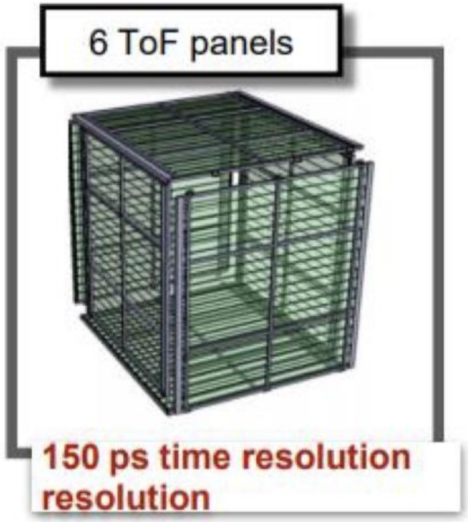
Transport CERN -> Tokai early next year



NIM A 957 163286 (2020)

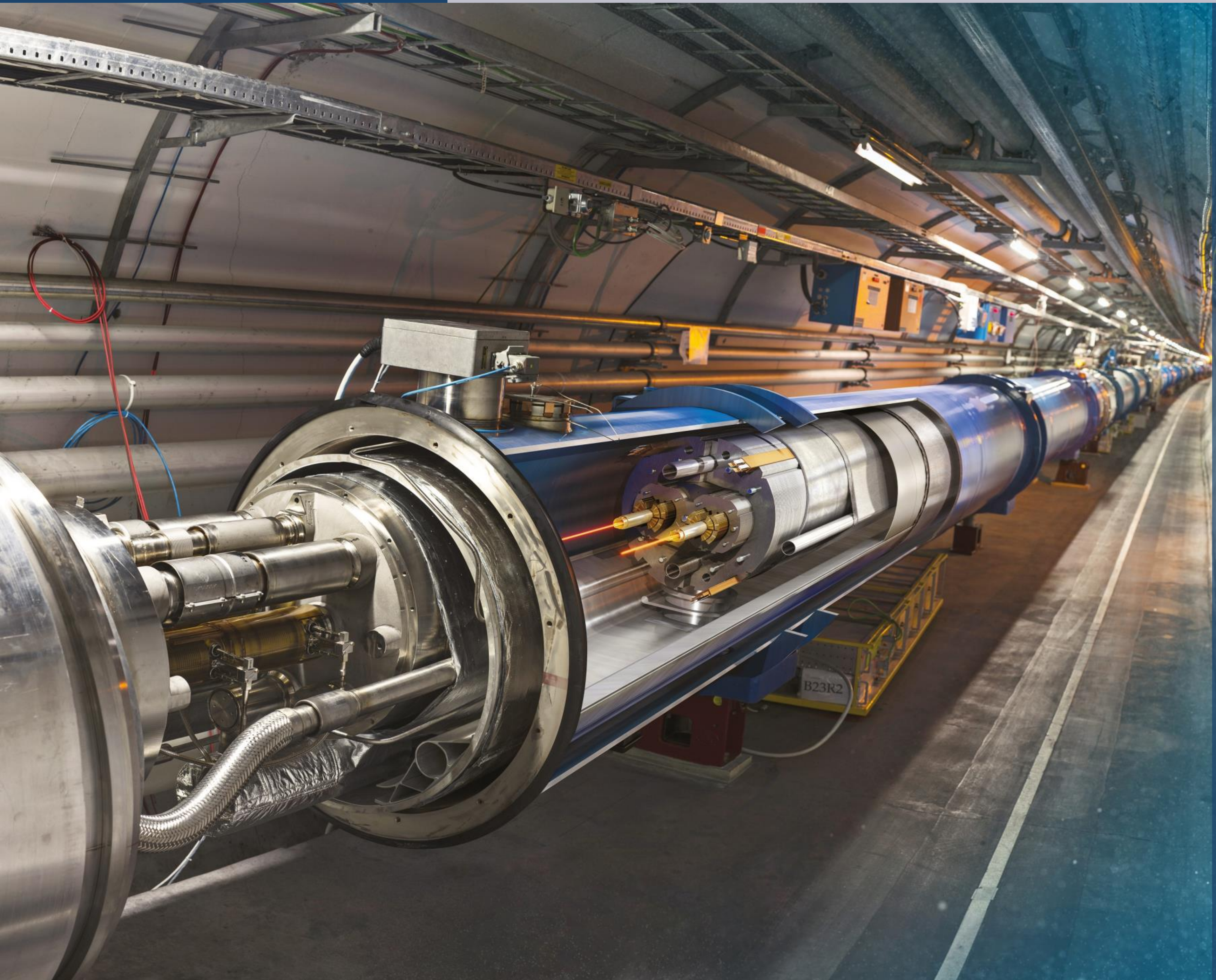


JINST 13, P02006 (2018)
JINST 15 P12003 (2020)



JPS Conf. Proc. 27, 011005 (2019)

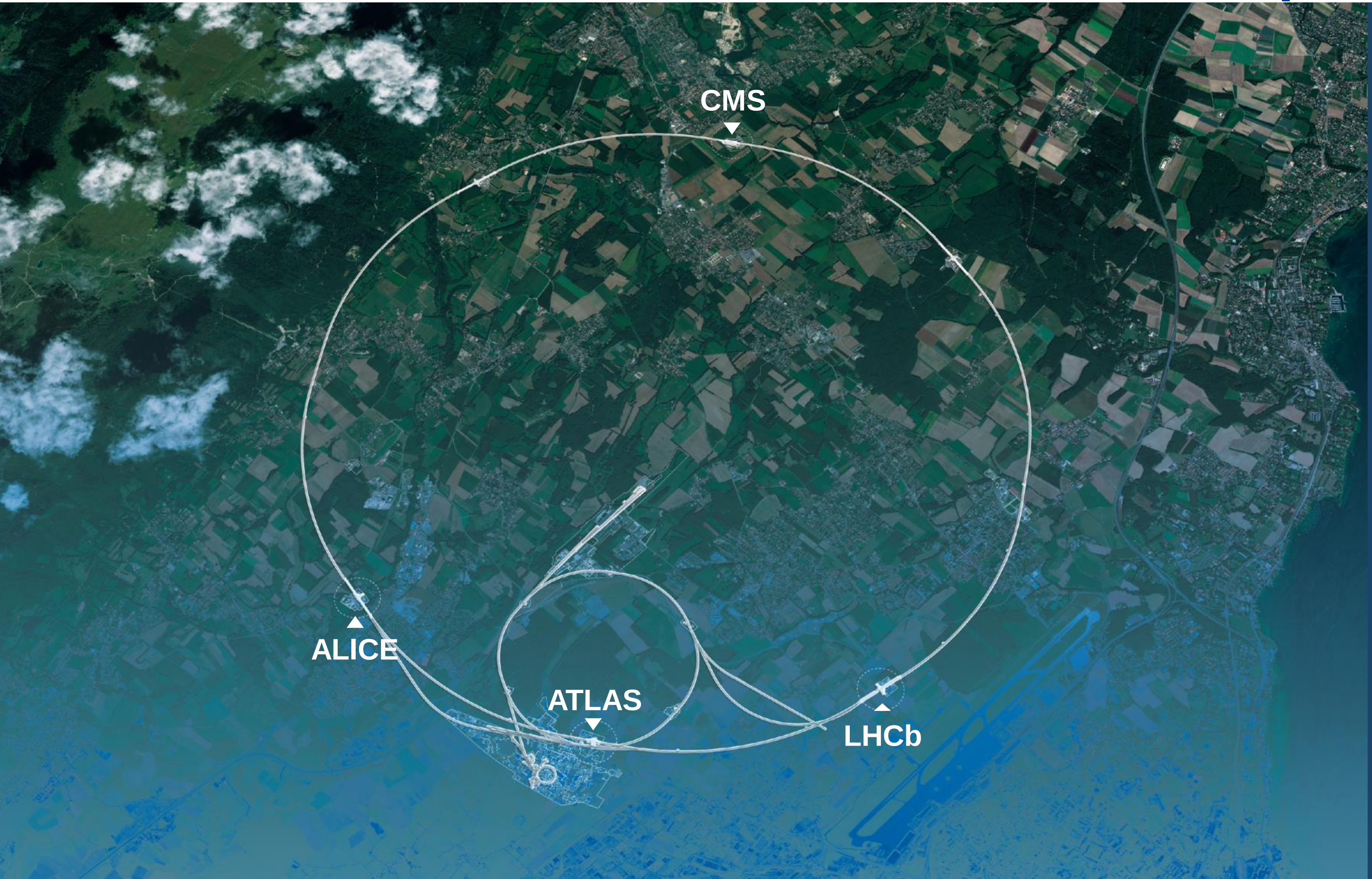
See also S. Dolan's talk on Tuesday

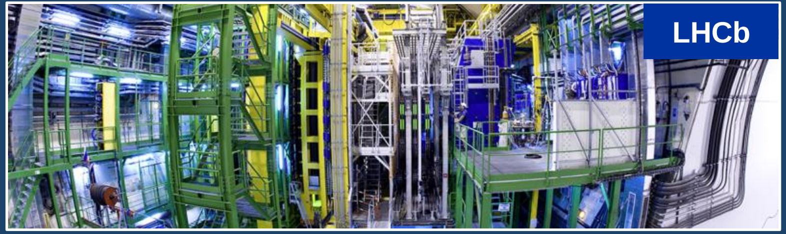


Large Hadron Collider (LHC)

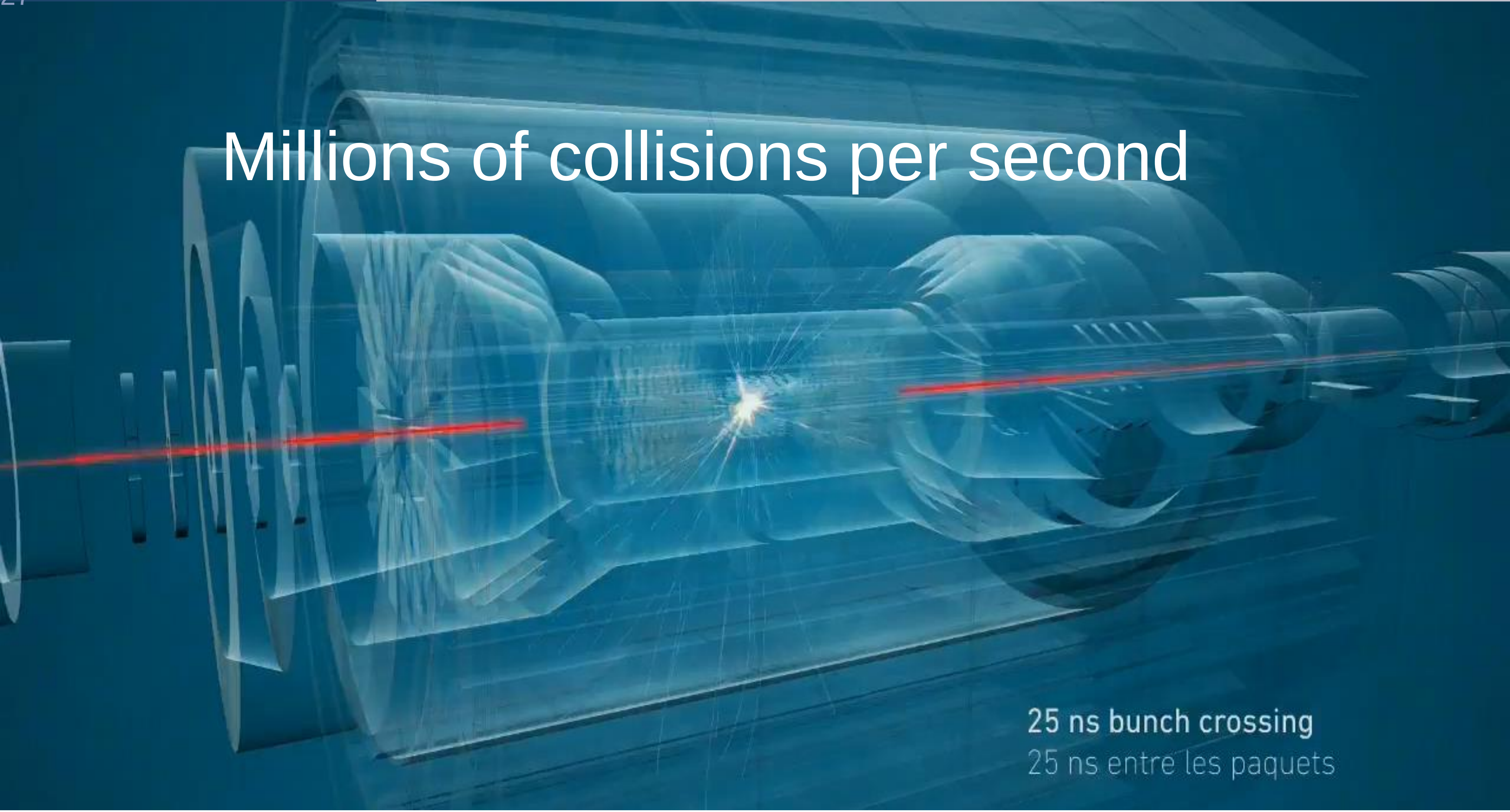
- 27 km in circumference
- About 100 m underground
- Superconducting magnets steer the particles around the ring
- Particles are accelerated to close to the speed of light
- Centre of mass energy of pp collisions at the LHC now 13 TeV (i.e. 6.5 TeV/beam)

Giant detectors record the particles formed at the four collision points

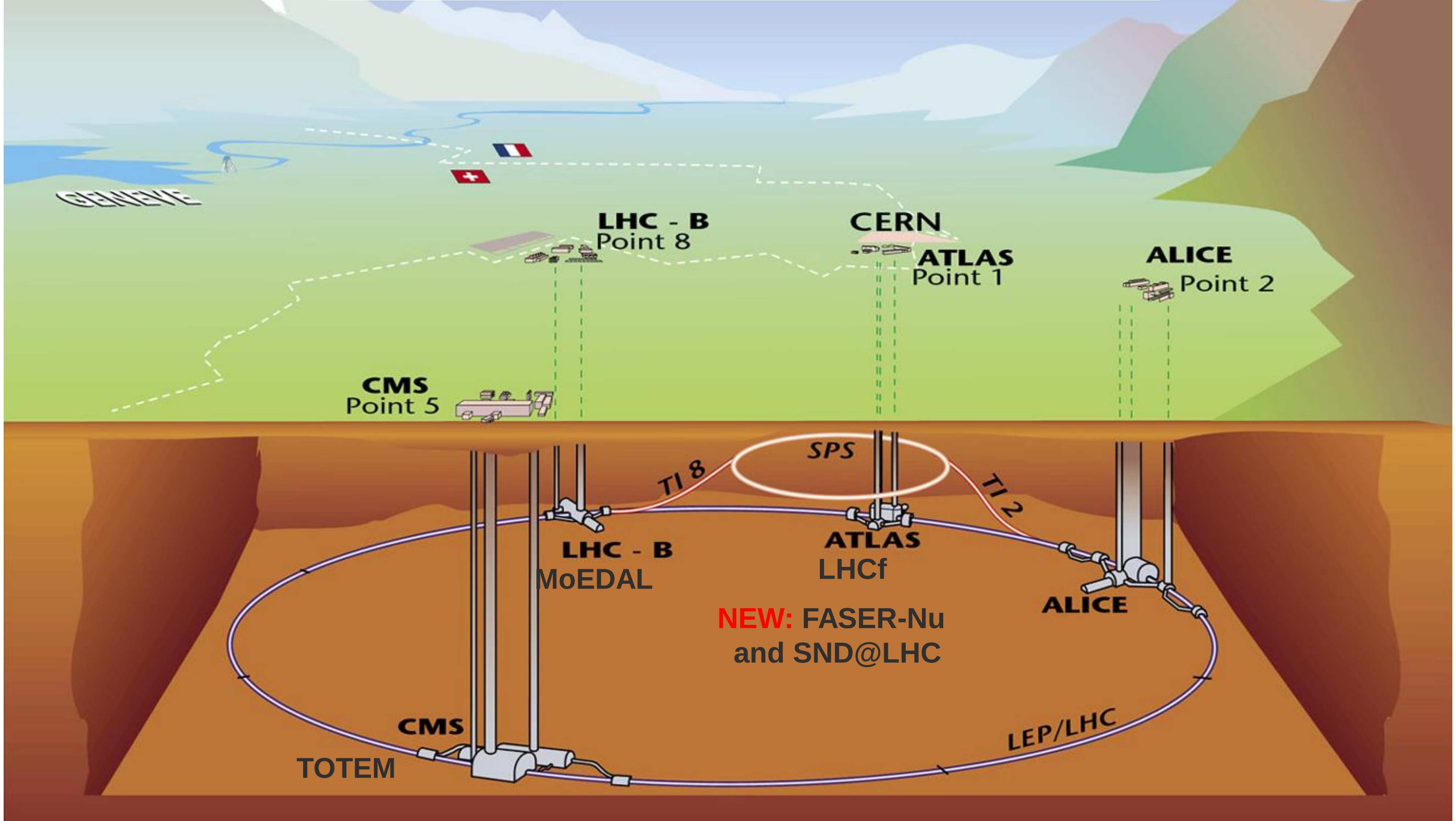




Millions of collisions per second



The LHC Machine and Experiments



Run-3 (2022->…) of the LHC will have nine experiments

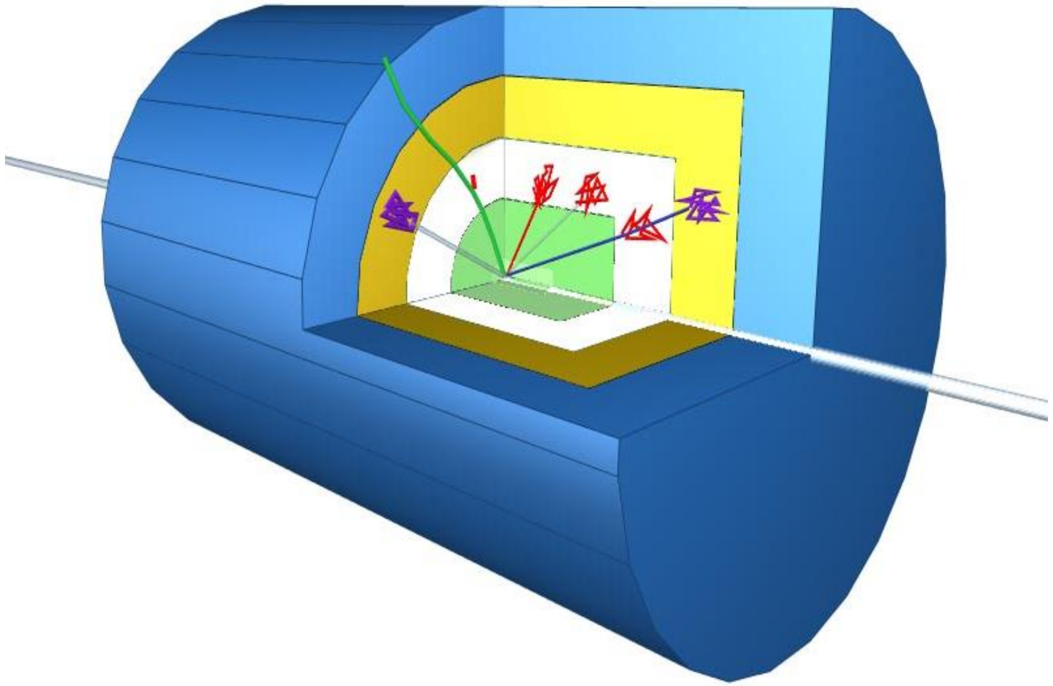
Schematic of a Central LHC Detector

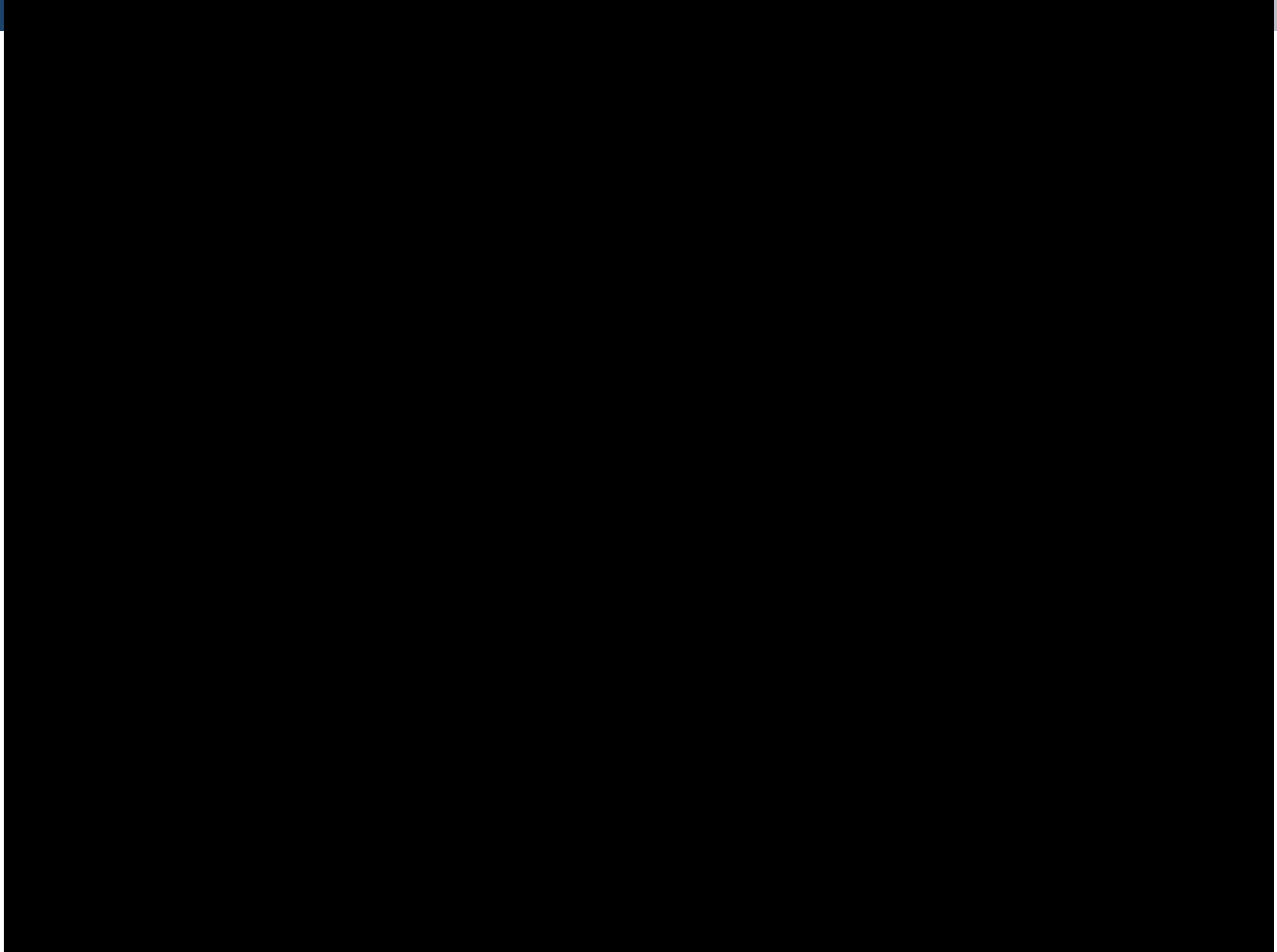
Physics requirements drive the design!

Analogy with a cylindrical onion:

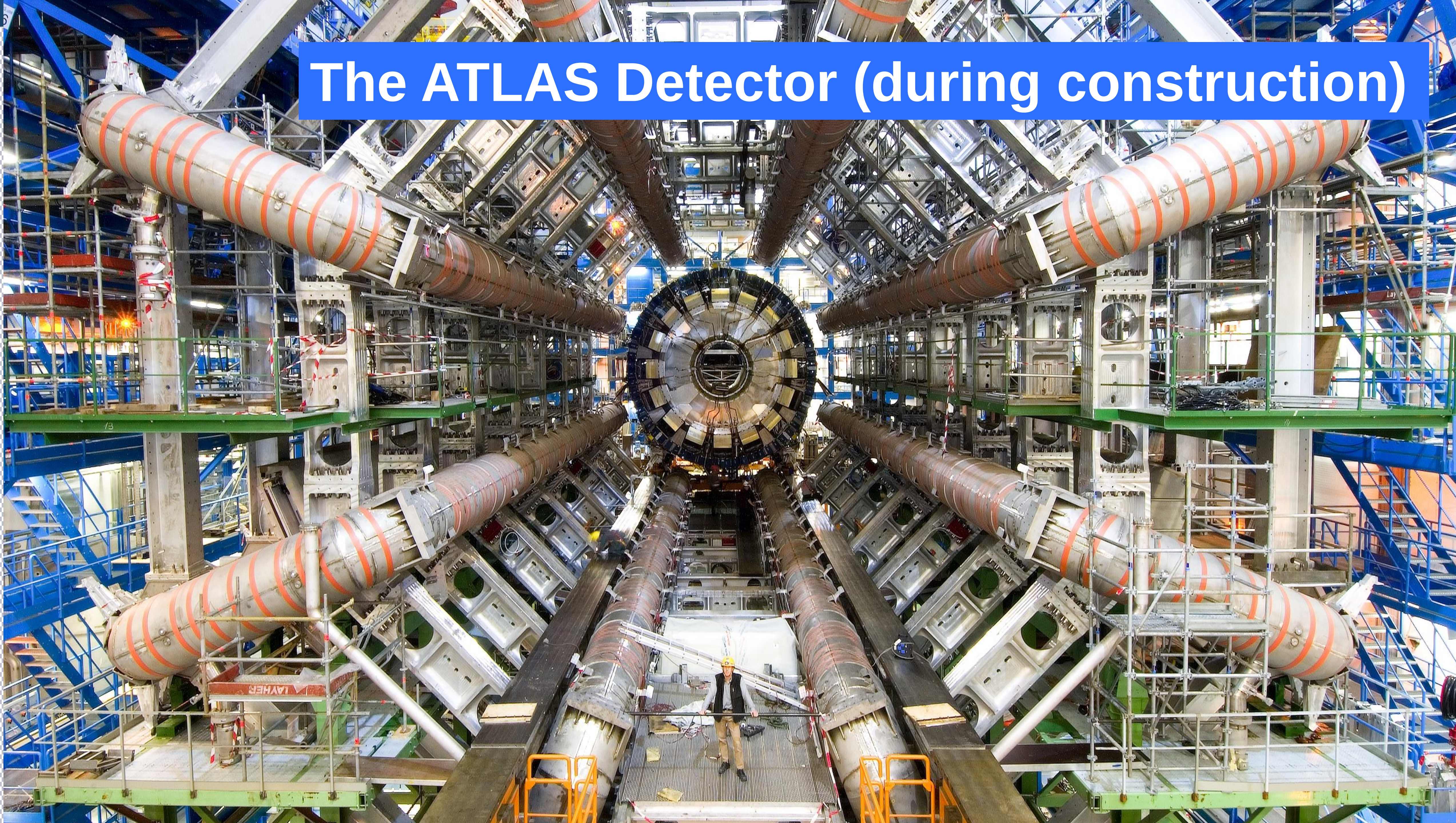
Technologically advanced detectors comprising many layers, each designed to perform a specific task.
Together these layers allow us to identify and precisely measure the energies and directions of all the particles produced in collisions.

Such an experiment has ~ 100 Million read-out channels!! Checked every 25 ns

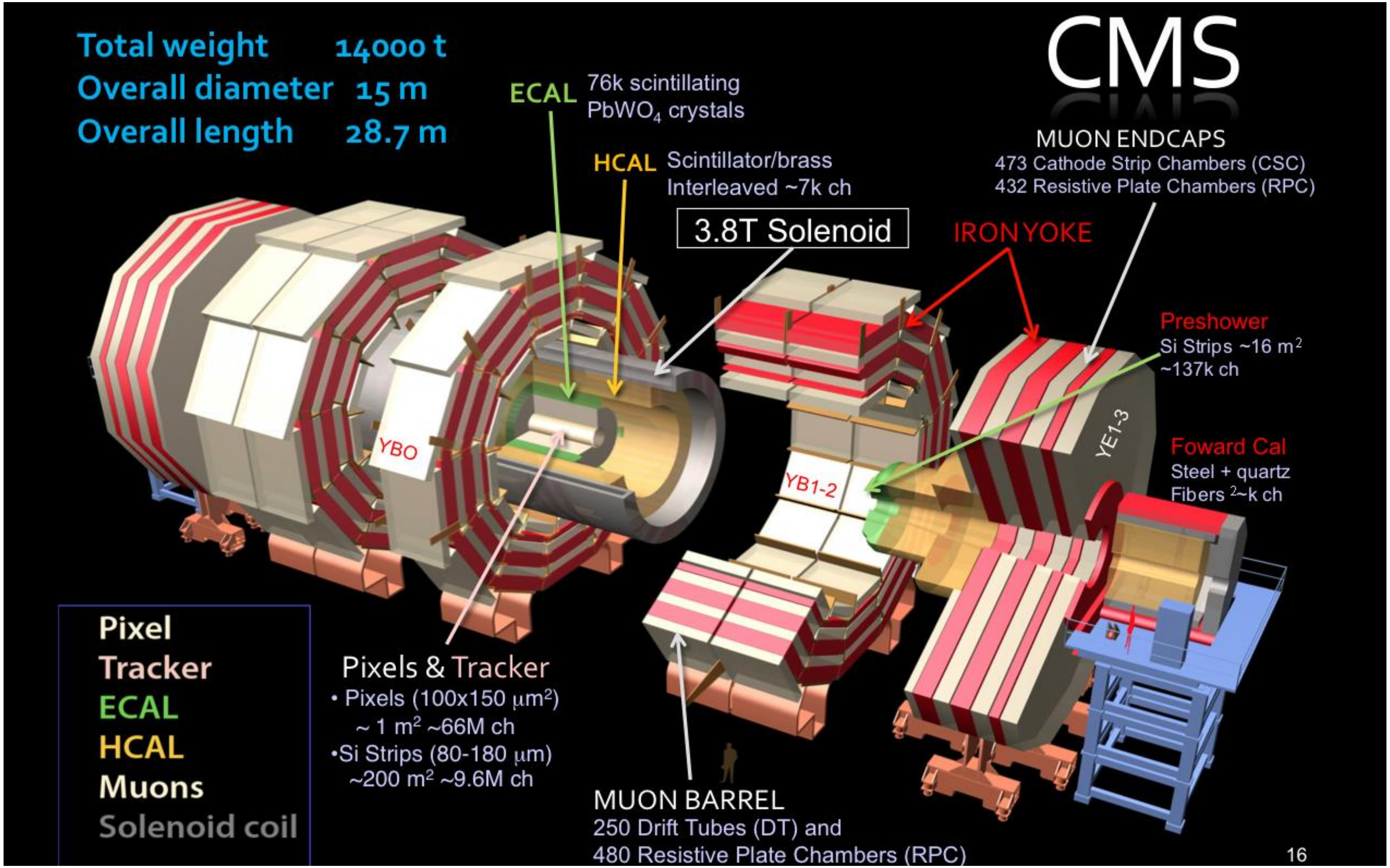


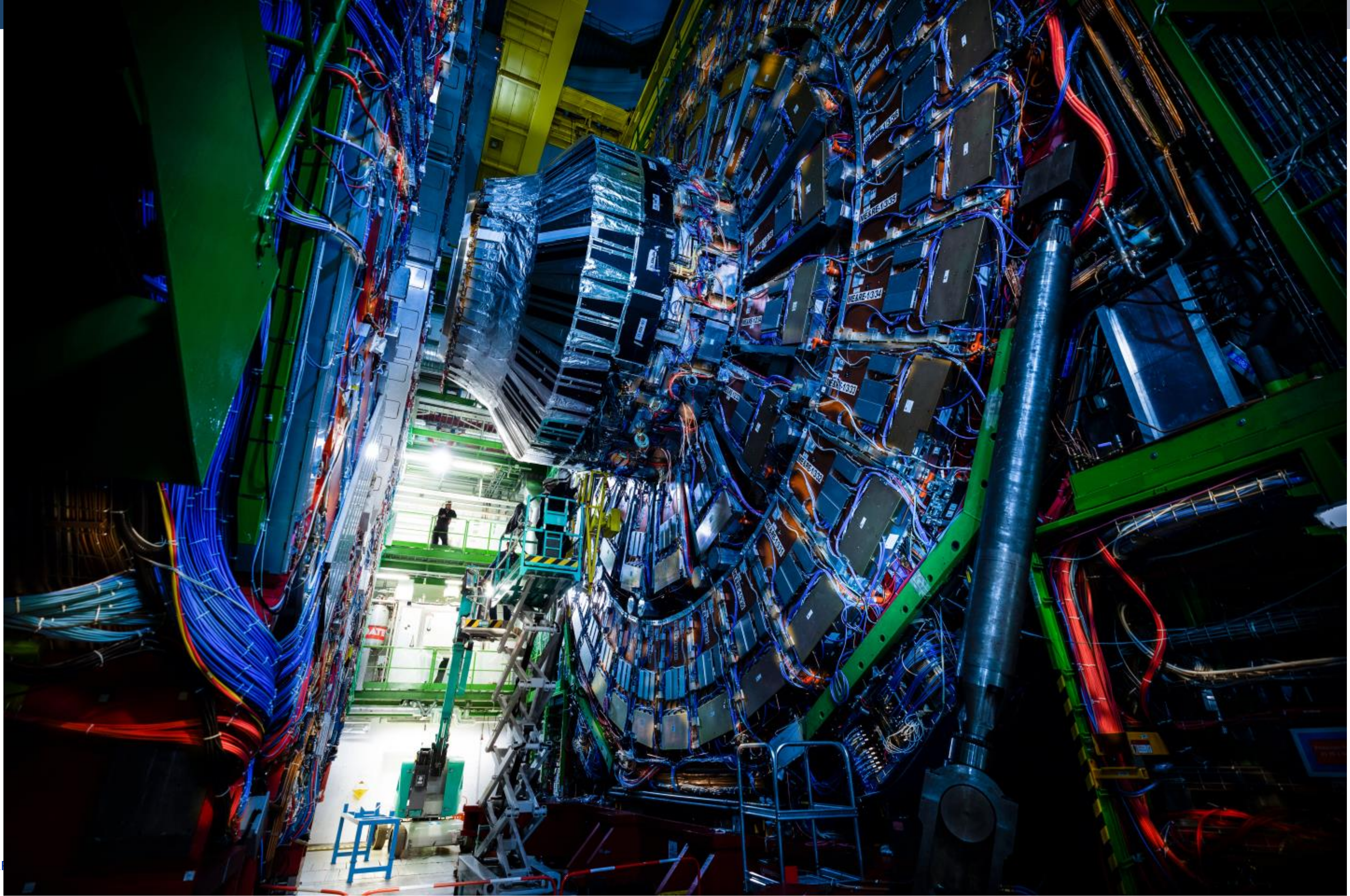


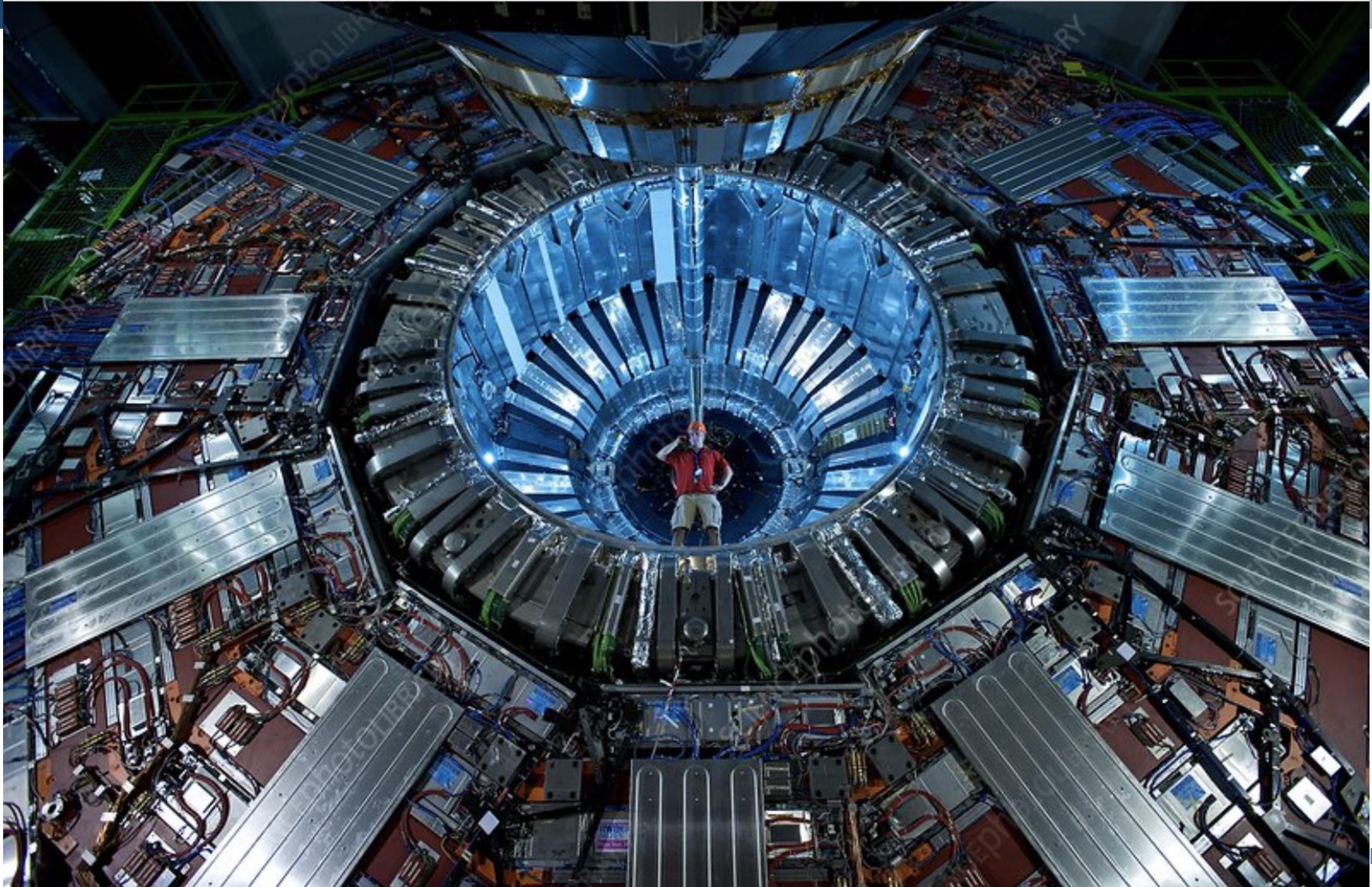
The ATLAS Detector (during construction)



The Compact Muon Solenoid Experiment

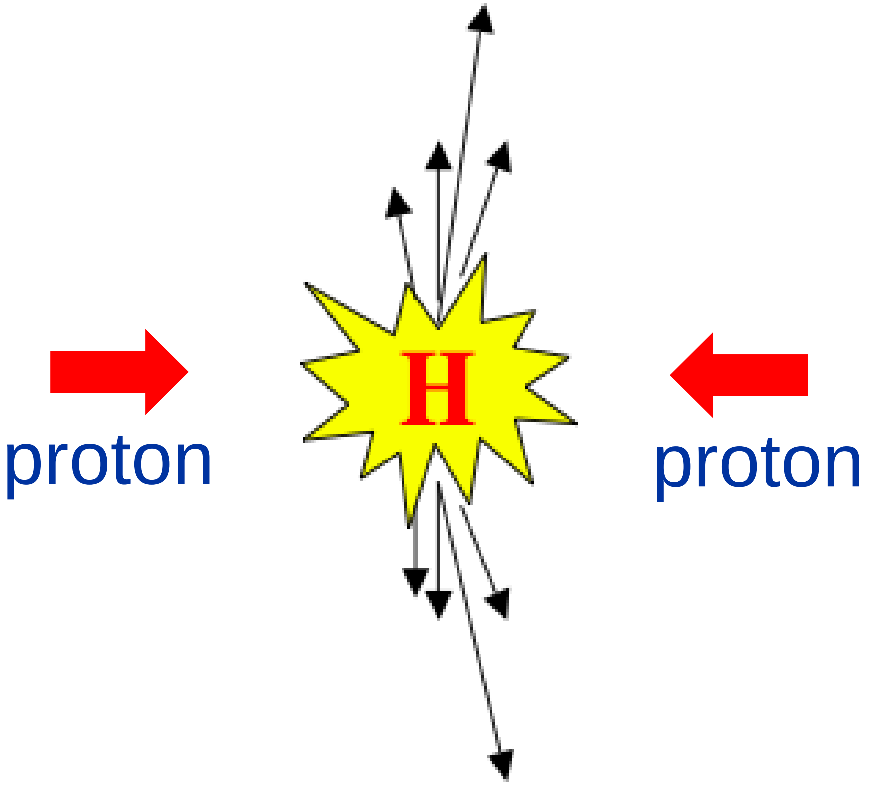


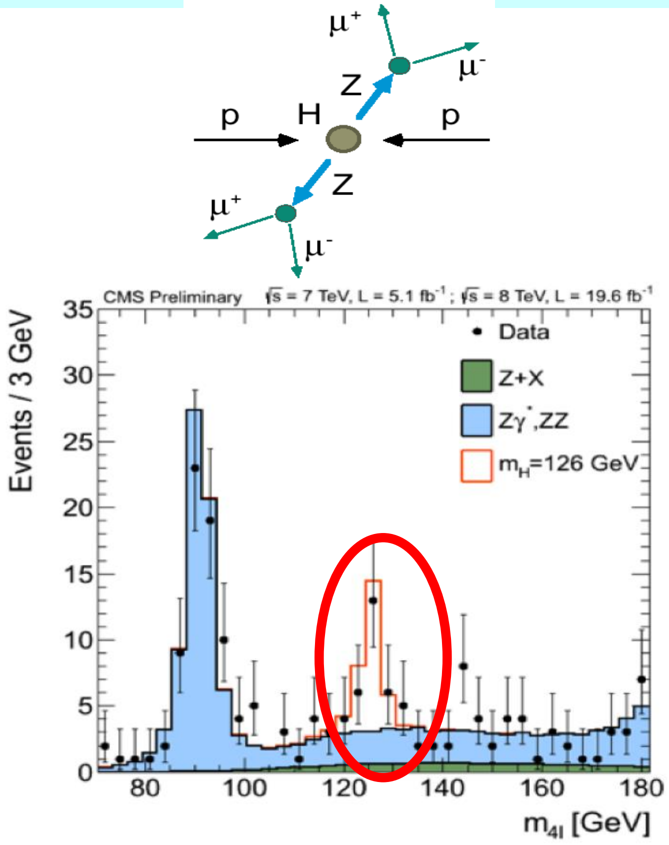




2012: A Milestone in Particle Physics

Observation of a Higgs Particle at the LHC, after about 40 years of experimental searches to find it

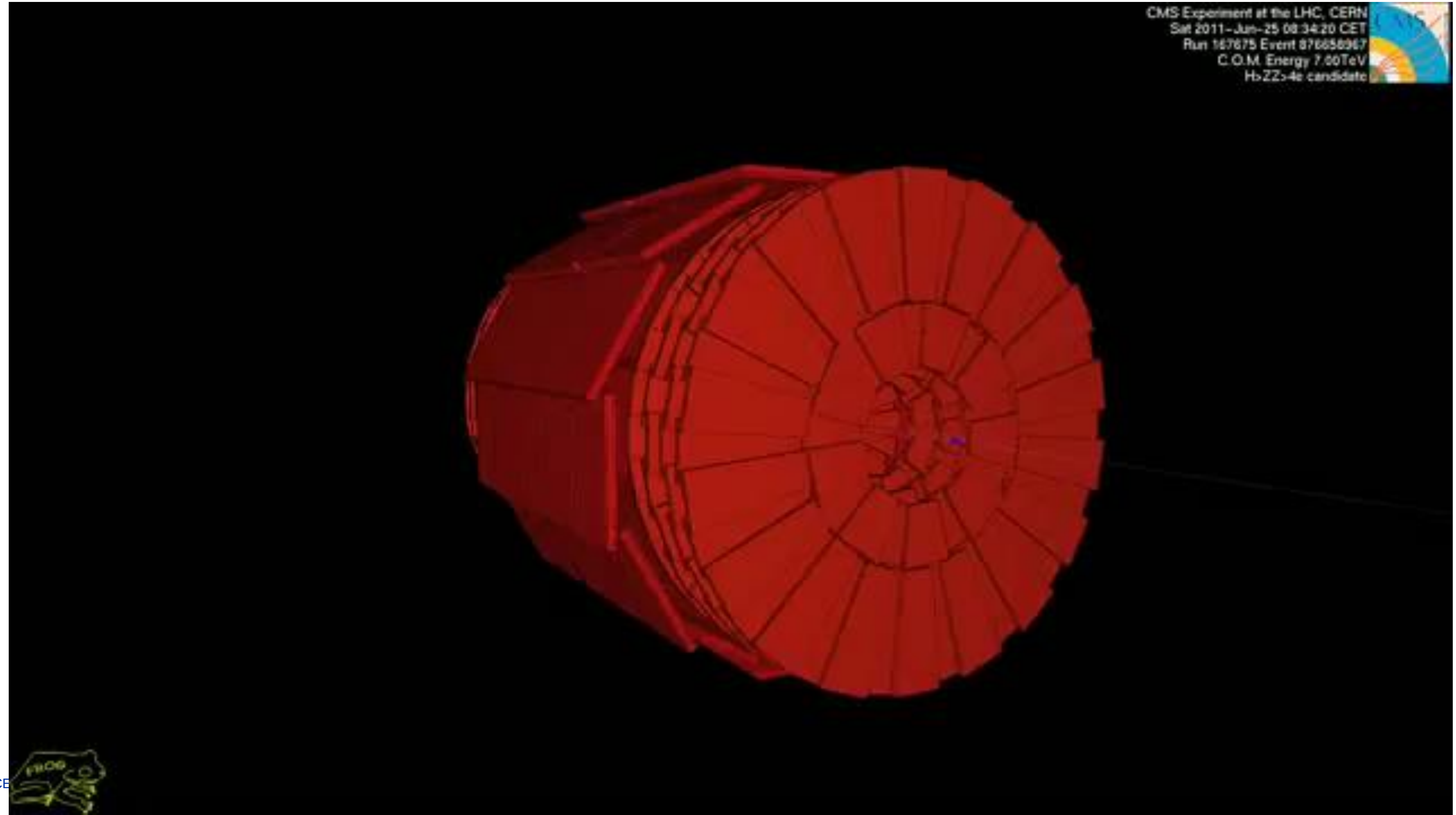




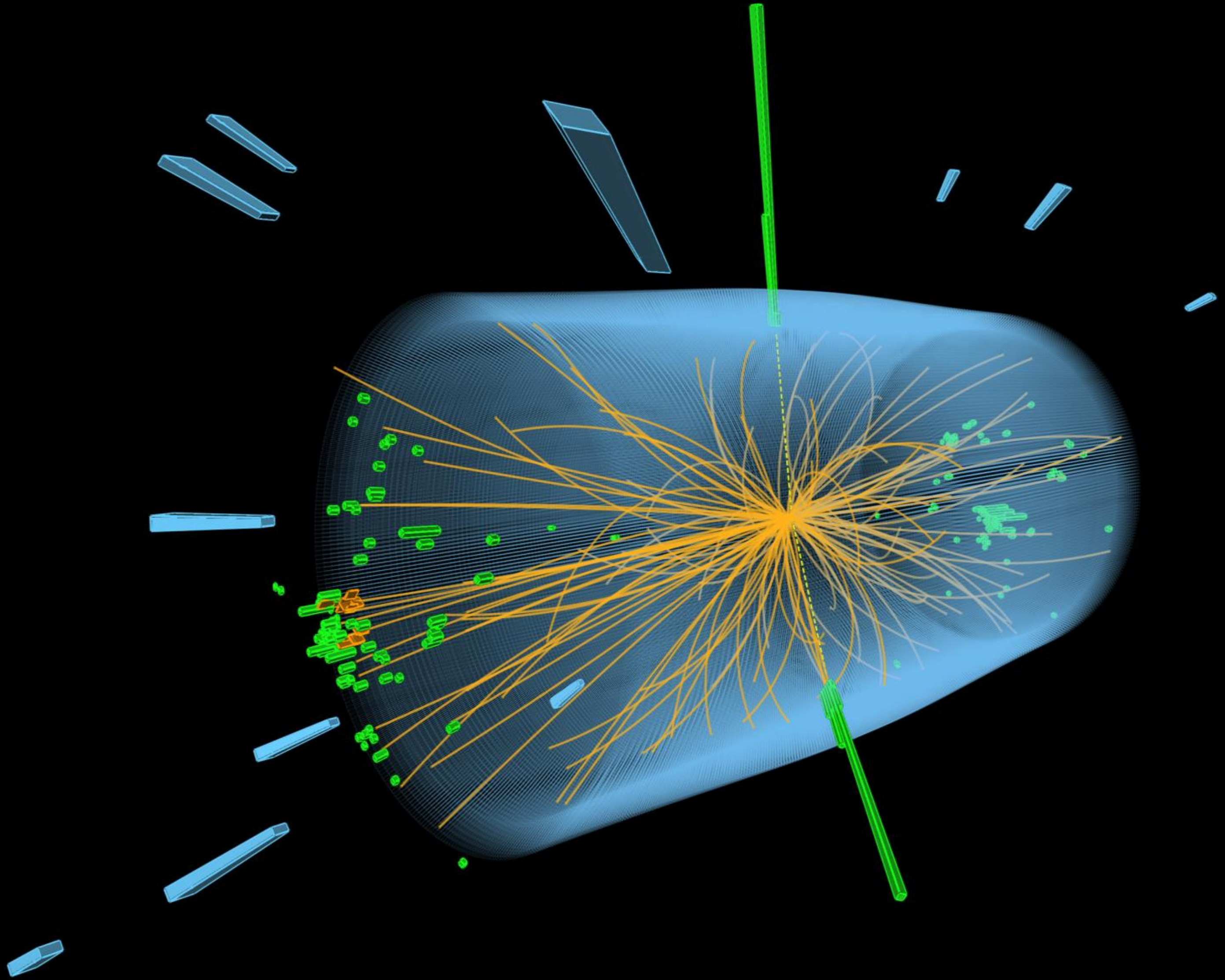
2013

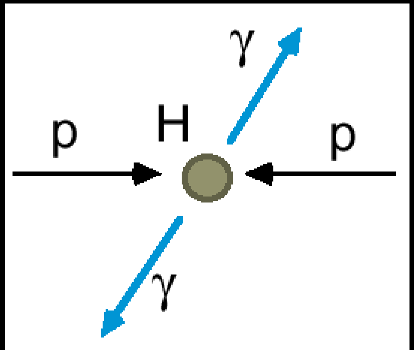
The Higgs particle was the last missing particle in the Standard Model and possibly our portal to physics Beyond the Standard Model

A Higgs Particle Candidate…



A Higgs → γγ Decay Candidate

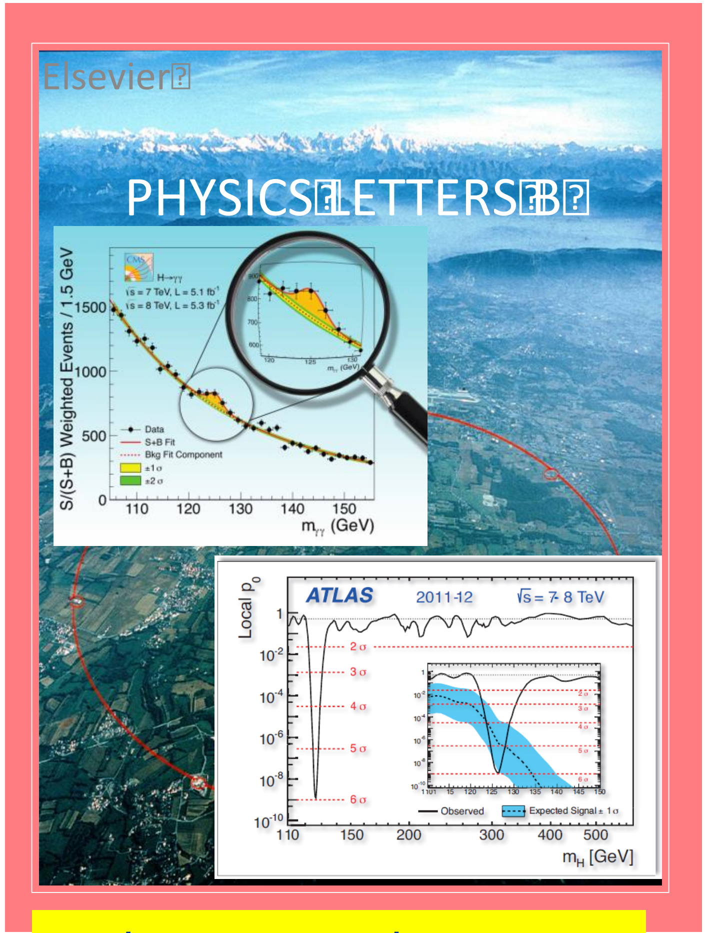




Two photons are identified in the central part of the detector, and have an invariant mass around 125 GeV, so in the right mass range

Most Cited LHC Papers so far

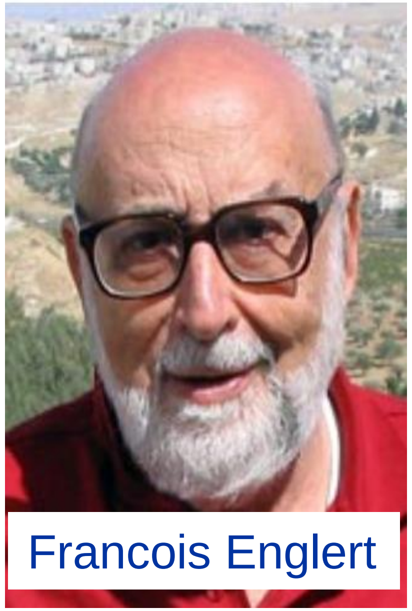
The ATLAS and CMS Higgs Discovery 2012!



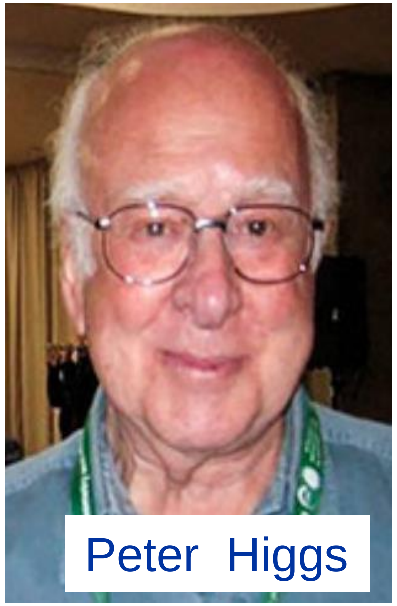
Both ATLAS and CMS papers cited more than 12,000 times each to date

Popular science version of the discovery papers

Tuesday 8 October 2013



Francois Englert

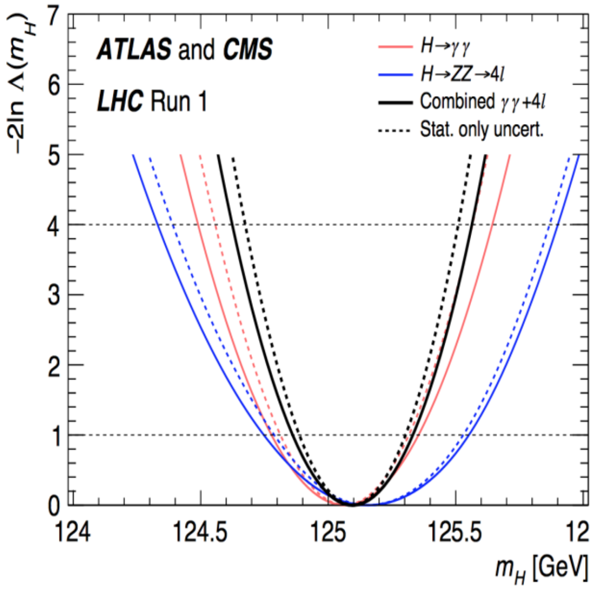


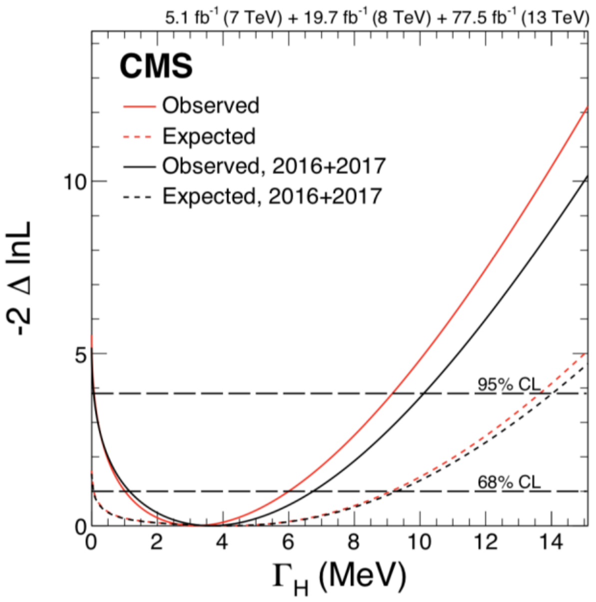
Peter Higgs

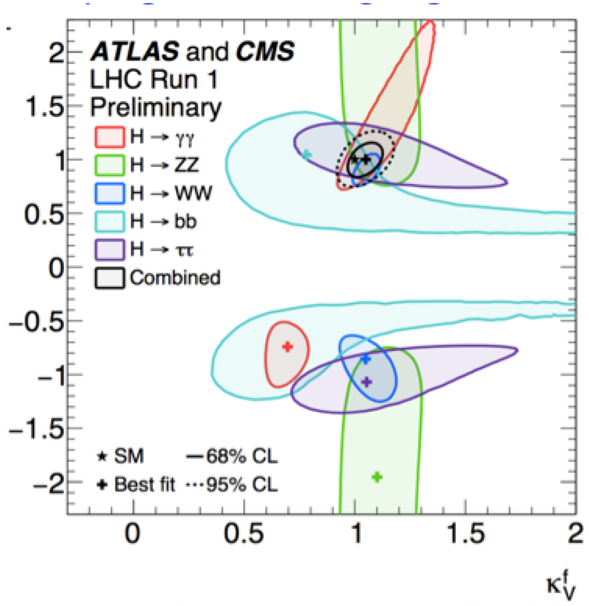
Congratulations!!!!

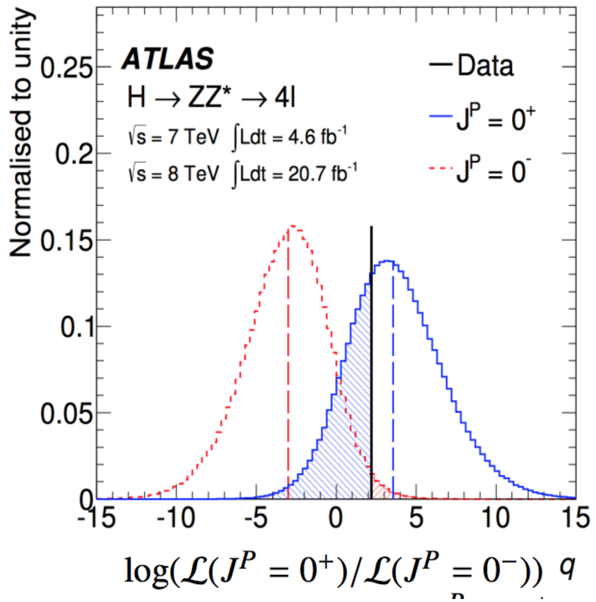
Higgs Summary so far

We know already a lot on this Brand New Higgs Particle!!









Mass = CMS+ATLAS
125.09 ±0.21(stat)
±0.11(syst) GeV

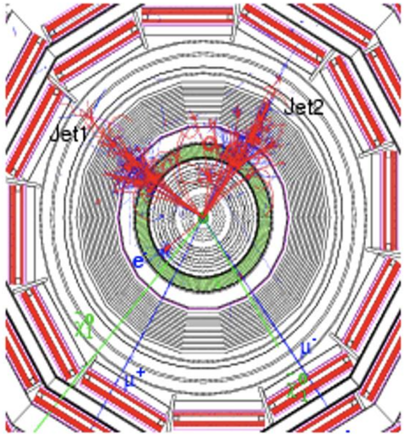
Width =
< 9 MeV (95%CL)

Couplings are within ~10-20% of the SM values

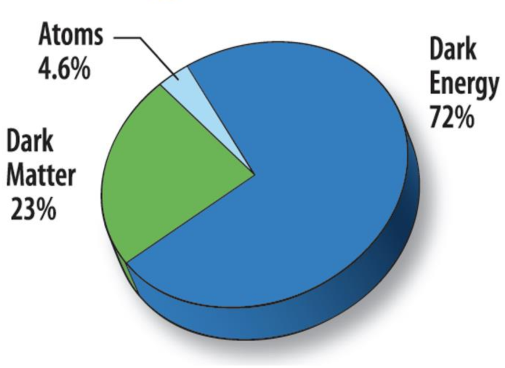
Spin =
$0^{+(+)}$ preferred over 0^{-},1,2

Next LHC Physics Targets

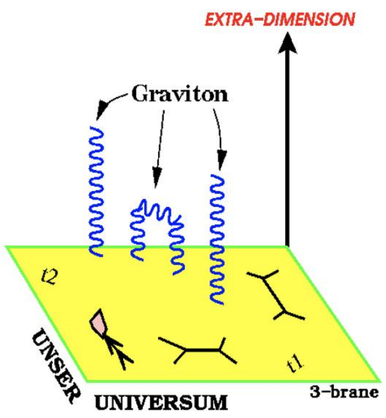
A detailed study of the Higgs can be key to understanding the next step in fundamental physics



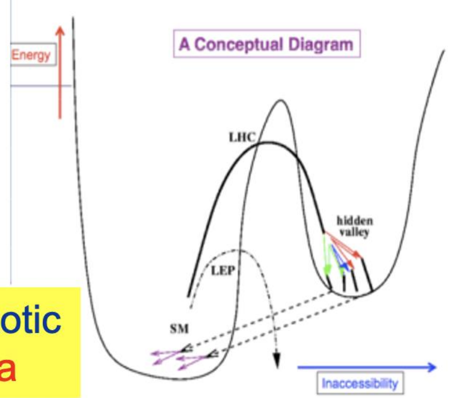
Searching for Supersymmetric Particles



Searching for Dark Matter

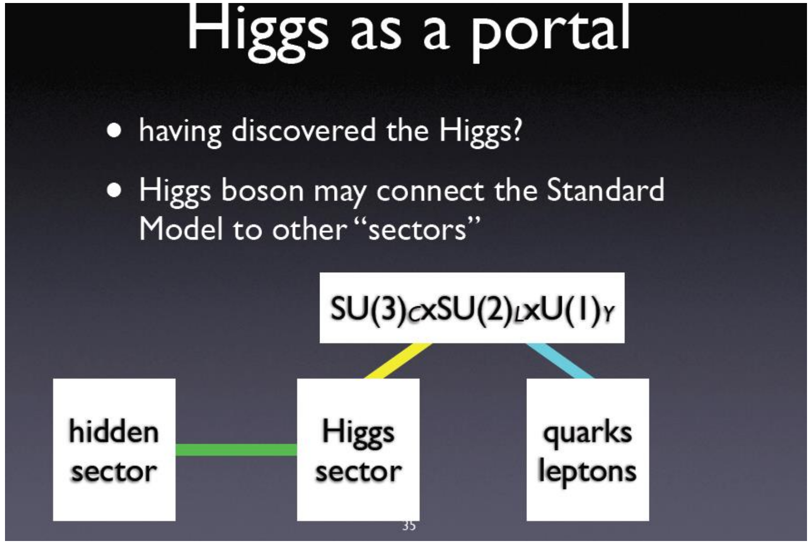


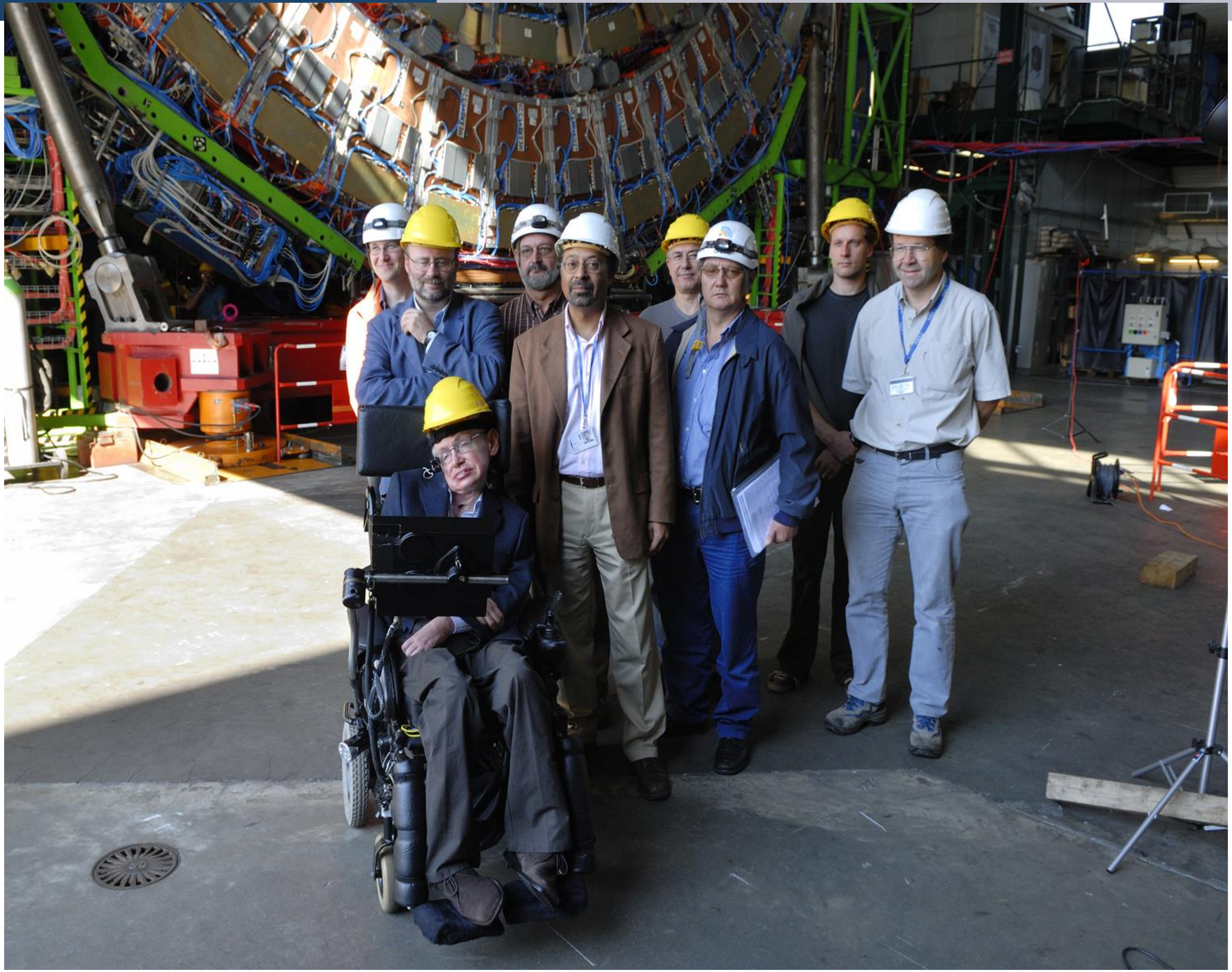
Searching for Extra Dimensions



Searching for Exotic BSM Phenomena

And many more topics…





”Black Hole” hunters at the LHC

This became “popular” In the years before the switching on of the LHC

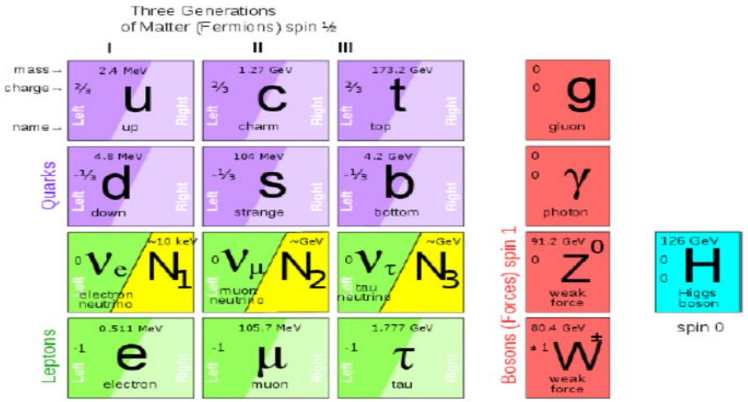
Hawking was convinced that if these exist they would evaporate in particles immediately. We too

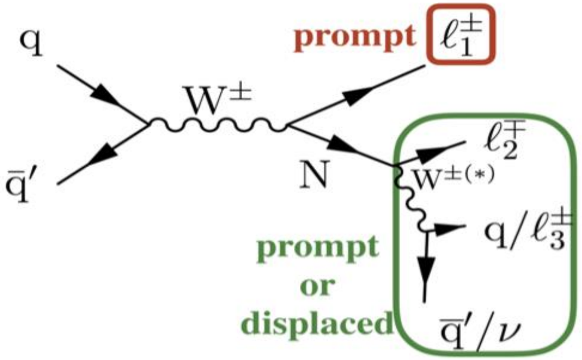
The data of the LHC never showed any sign of black holes. So far…

Neutrinos @ the LHC: Examples

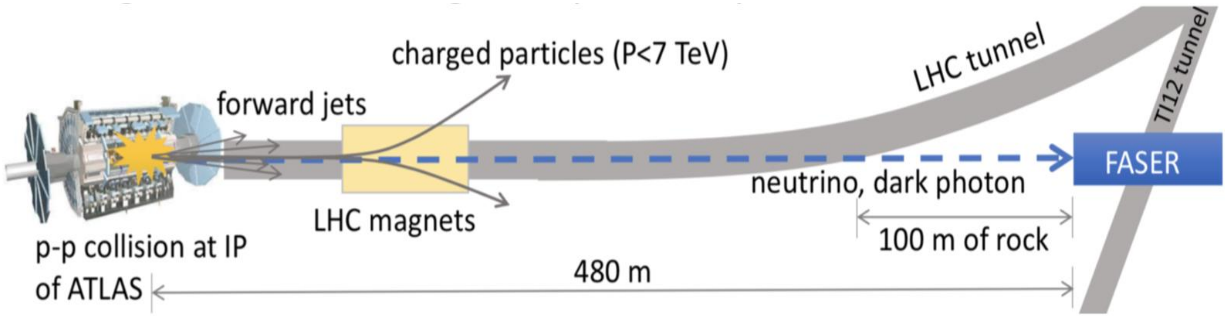
Searches for right-handed neutrinos at the LHC: mass range from 1 GeV to ~ 6 TeV

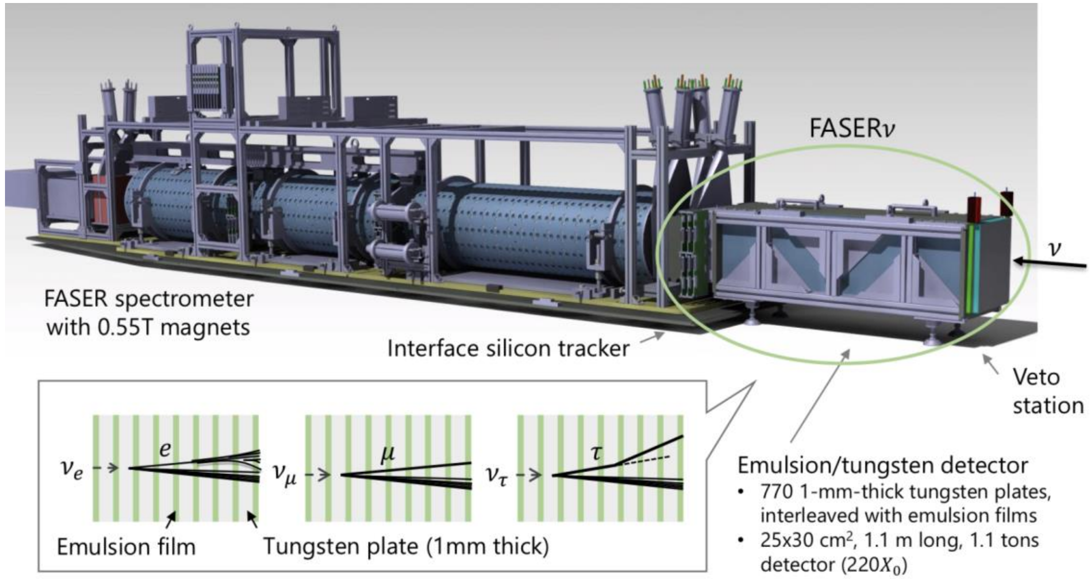
Example νMSM (Neutrino Minimal Standard Model)





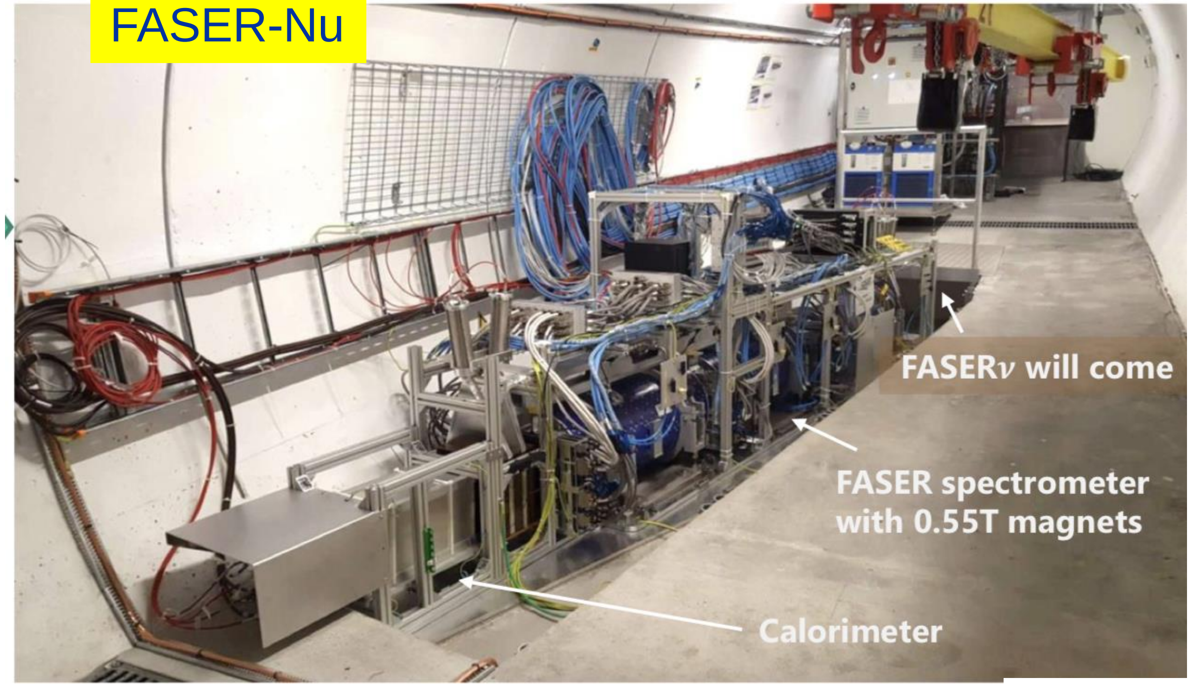
First experiments @ LHC to measure neutrinos! SND@LHC and FASER-Nu at 400m forward of the IPs and study TeV-neutrinos with emulsion detectors and tracking+muon/calo detectors





LHC Neutrino Experiments

FASER-Nu



SND@LHC

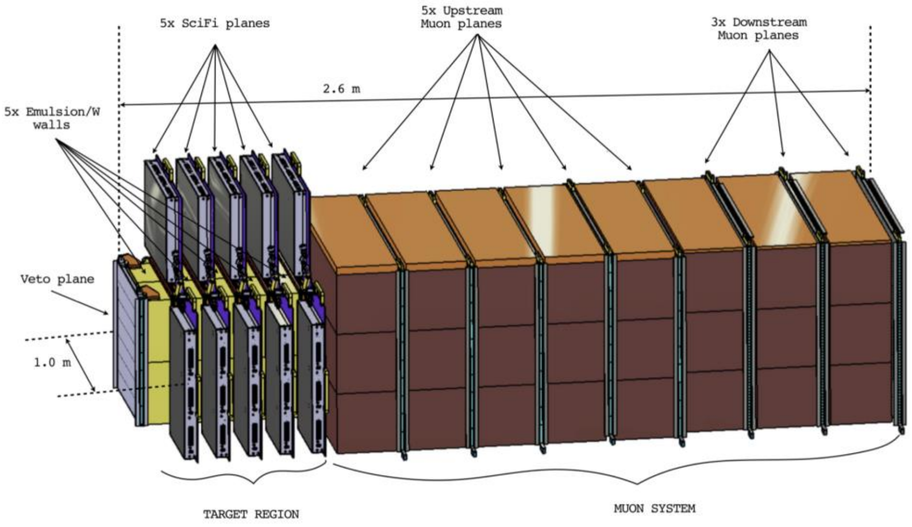
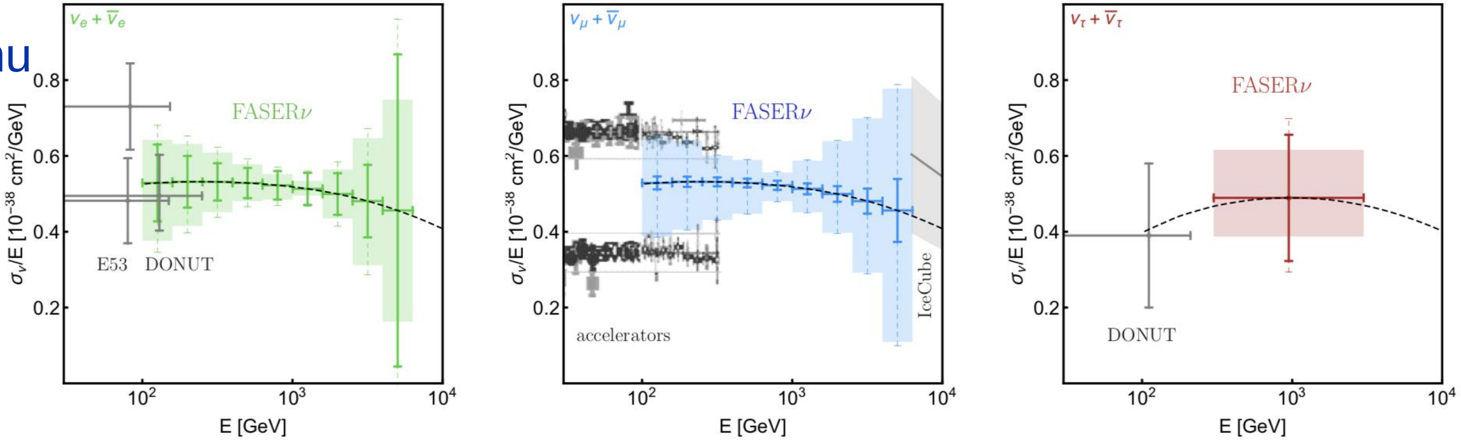


Figure 5: Layout of the proposed SND@LHC detector.

Propspects for neutrino FASER-nu neutrino measurements

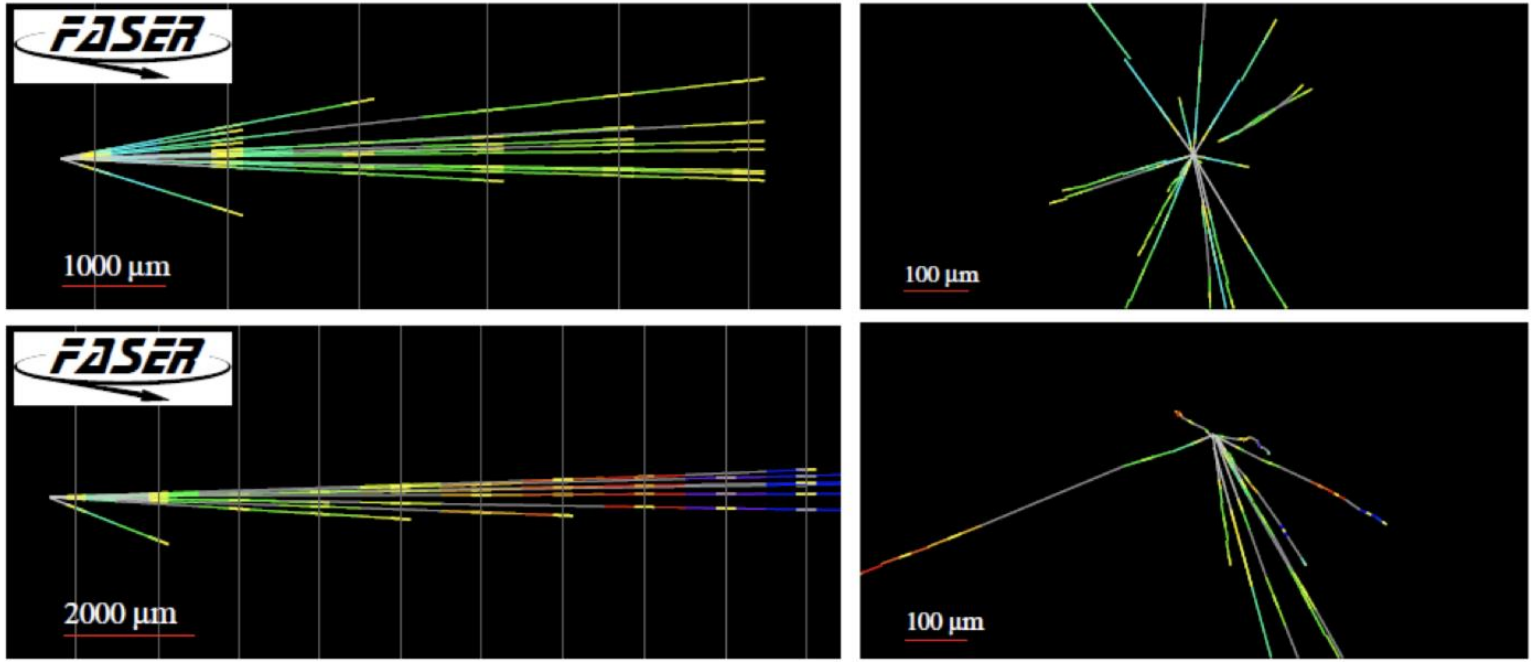


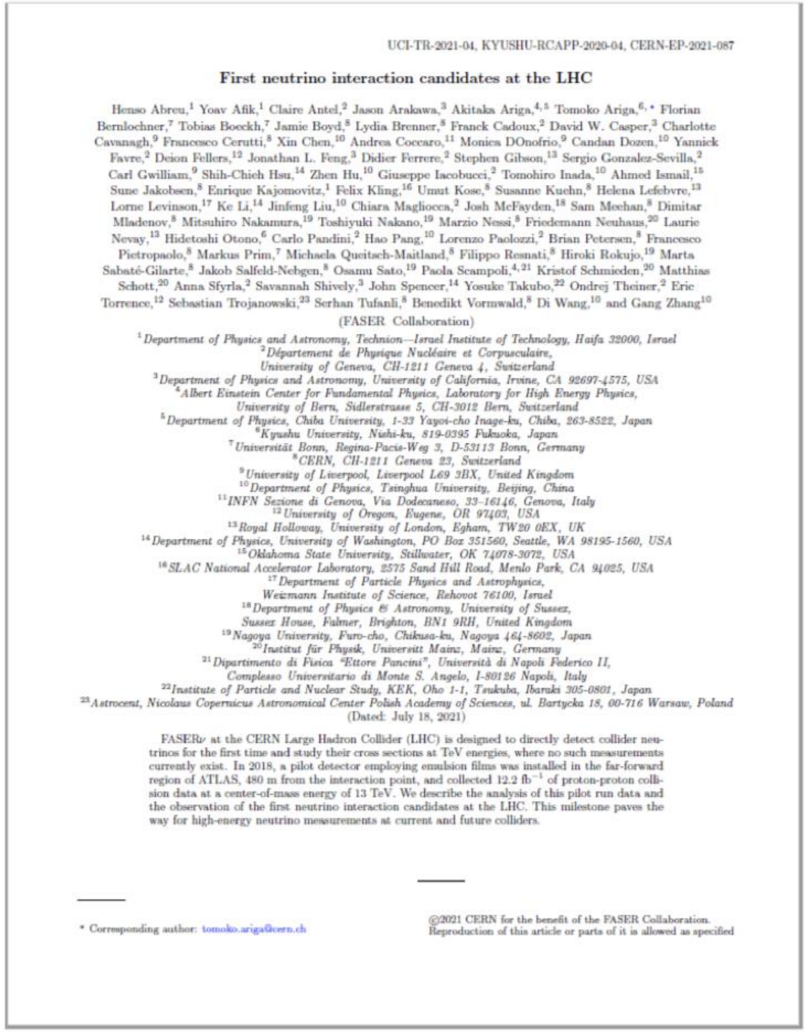
Both SND@LHC and FASER-Nu are under construction now, and aim to be ready for the LHC run March 2022

Neutrino interaction candidates

First neutrino interaction candidates at the LHC, arXiv:2105.06197

Data collected with a test set-up of emulsions in 2018
First time neutrino interactions are (likely) observed @ LHC





UCI-TR-2021-04, KYUSHU-RCAPP-2020-04, CERN-EP-2021-087

First neutrino interaction candidates at the LHC

Henso Abreu,[1] Yoav Afik,[1] Claire Antel,[2] Jason Arakawa,[3] Akitaka Ariga,[4,5] Tomoko Ariga,[6,*] Florian Bernlochner,[7] Tobias Boeckh,[7] Jamie Boyd,[8] Lydia Brenner,[8] Franck Cadoux,[2] David W. Casper,[3] Charlotte Cavanagh,[9] Francesco Cerutti,[8] Xin Chen,[10] Andrea Coccaro,[11] Monica DOnofrio,[9] Candan Dozen,[10] Yannick Favre,[2] Deion Fellers,[12] Jonathan L. Feng,[3] Didier Ferrere,[2] Stephen Gibson,[13] Sergio Gonzalez-Sevilla,[2] Carl Gwilliam,[9] Shih-Chieh Hsu,[14] Zhen Hu,[10] Giuseppe Iacobucci,[2] Tomohiro Inada,[10] Ahmed Ismail,[15] Sune Jakobsen,[8] Enrique Kajomovitz,[1] Felix Kling,[16] Umut Kose,[8] Susanne Kuehn,[8] Helena Lefebvre,[13] Lorne Levinson,[17] Ke Li,[14] Jinfeng Liu,[10] Chiara Magliocca,[2] Josh McFayden,[18] Sam Meehan,[8] Dimitar Mladenov,[8] Mitsuhiro Nakamura,[19] Toshiyuki Nakano,[19] Marzio Nessi,[8] Friedemann Neuhaus,[20] Laurie Nevay,[13] Hidetoshi Otono,[6] Carlo Pandini,[2] Hao Pang,[10] Lorenzo Paolozzi,[2] Brian Petersen,[8] Francesco Pietropaolo,[8] Markus Prim,[7] Michaela Queitsch-Maitland,[8] Filippo Resnati,[8] Hiroki Rokujo,[19] Marta Sabaté-Gilarte,[8] Jakob Salfeld-Nebgen,[8] Osamu Sato,[19] Paola Scampoli,[4,21] Kristof Schmieden,[20] Matthias Schott,[20] Anna Sfyrla,[2] Savannah Shively,[3] John Spencer,[14] Yosuke Takubo,[22] Ondrej Theiner,[2] Eric Torrence,[12] Sebastian Trojanowski,[23] Serhan Tufanli,[8] Benedikt Vormwald,[8] Di Wang,[10] and Gang Zhang[10]

(FASER Collaboration)

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[19] *Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8602, Japan*
[20] *Institut für Physik, Universitt Mainz, Mainz, Germany*
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[23] *Astrocent, Nicolaus Copernicus Astronomical Center Polish Academy of Sciences, ul. Bartycka 18, 00-716 Warsaw, Poland*

(Dated: July 18, 2021)

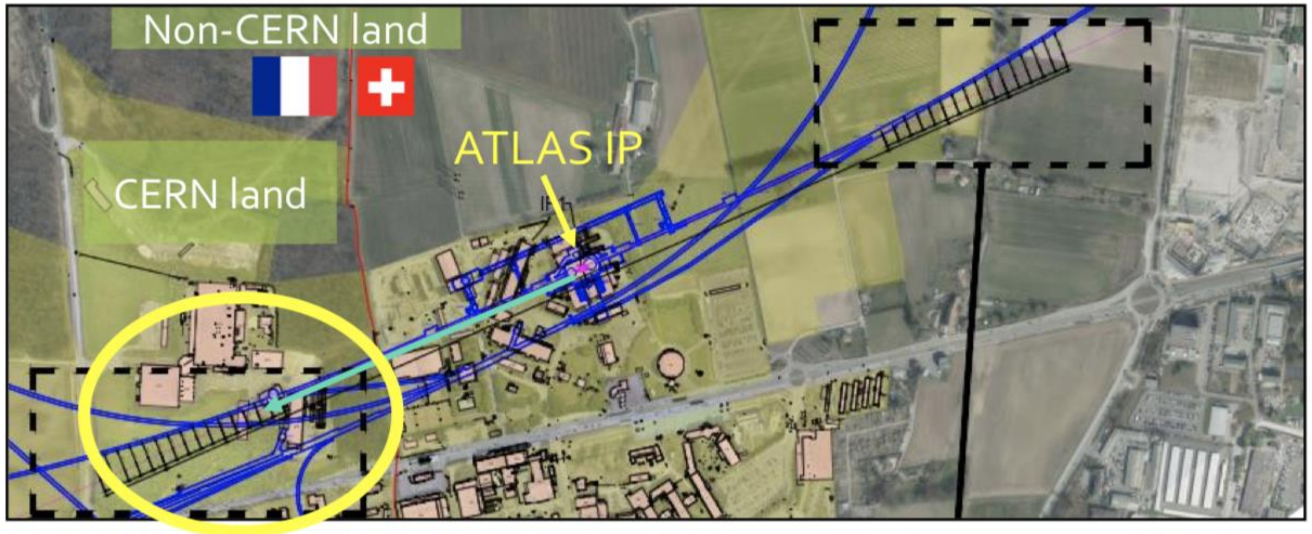
FASERν at the CERN Large Hadron Collider (LHC) is designed to directly detect collider neutrinos for the first time and study their cross sections at TeV energies, where no such measurements currently exist. In 2018, a pilot detector employing emulsion films was installed in the far-forward region of ATLAS, 480 m from the interaction point, and collected 12.2 fb^{-1} of proton-proton collision data at a center-of-mass energy of 13 TeV. We describe the analysis of this pilot run data and the observation of the first neutrino interaction candidates at the LHC. This milestone paves the way for high-energy neutrino measurements at current and future colliders.

* Corresponding author: tomoko.ariga@cern.ch

Proof or principle for FASER-Nu and SND@LHC

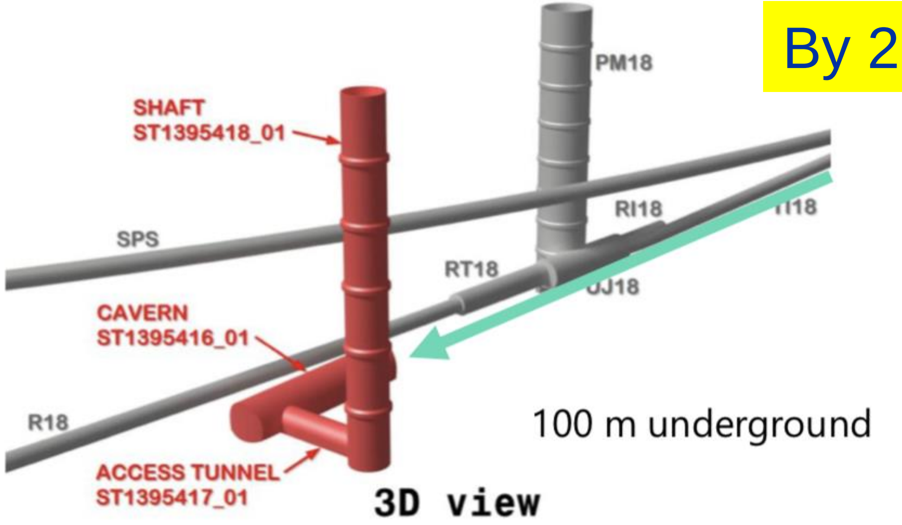
The new FPF facility and FASERν2

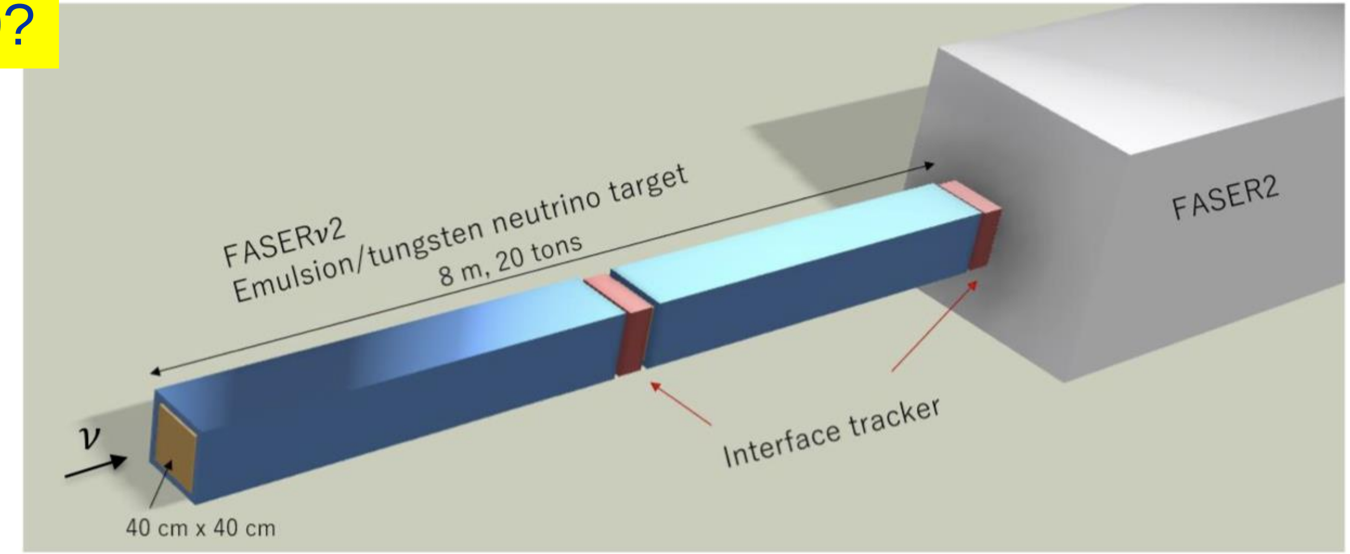
A new experimental hall in the forward region to contain several experiments??

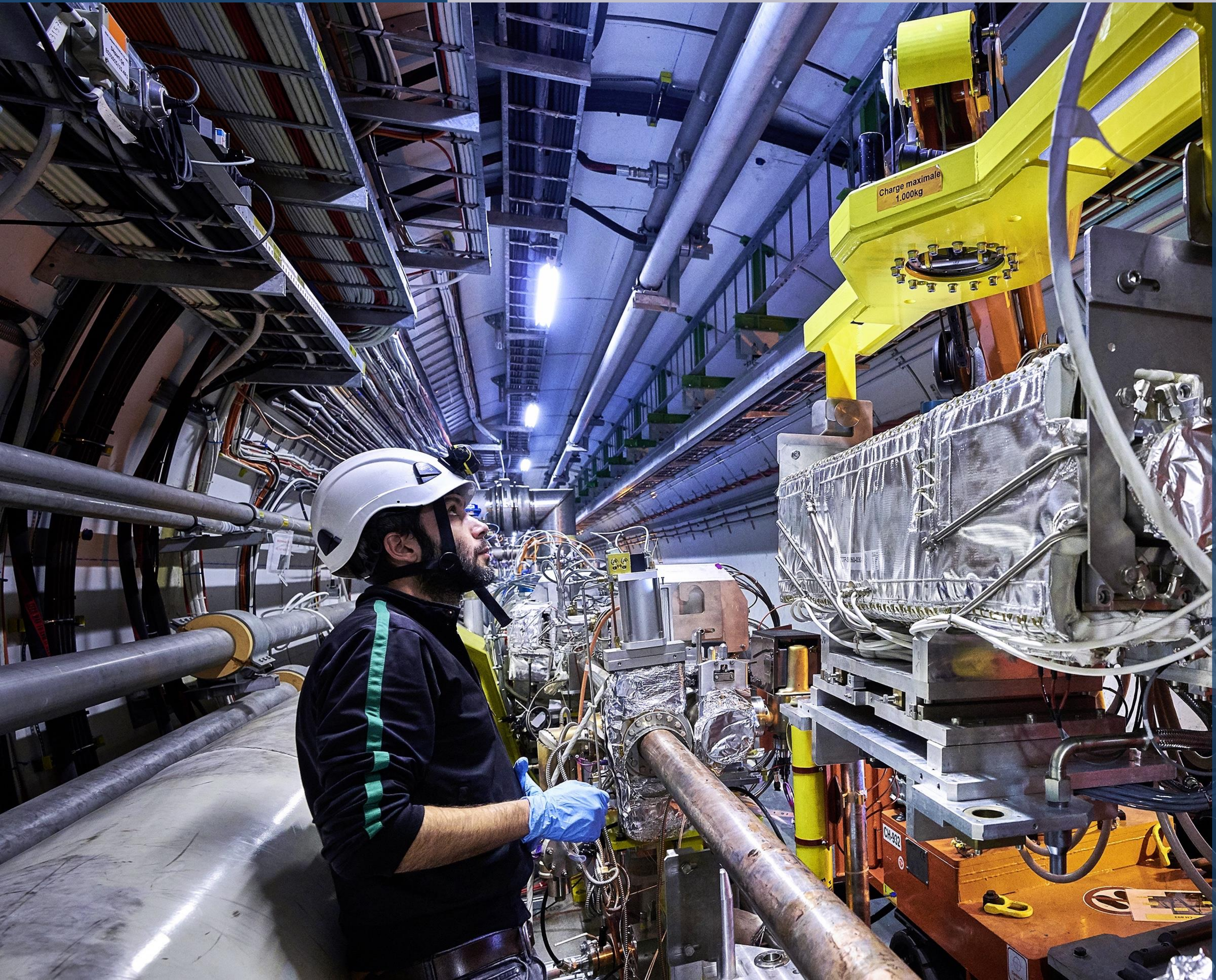


- The Forward Physics Facility (FPF) for the HL-LHC is a proposed facility that could house a suite of experiments to **greatly enhance the LHC's physics potential for BSM physics searches, neutrino physics and QCD**.
  - The background muon rate may be able to be reduced with a sweeper magnet (studies ongoing).
- **FASERν2 is designed to carry out precision ν_τ measurements** and heavy flavor physics studies
  - ~2300 (SIBYLL) / ~20000 (DPMJET) ν_τ interactions are expected.

By 2028-2030?

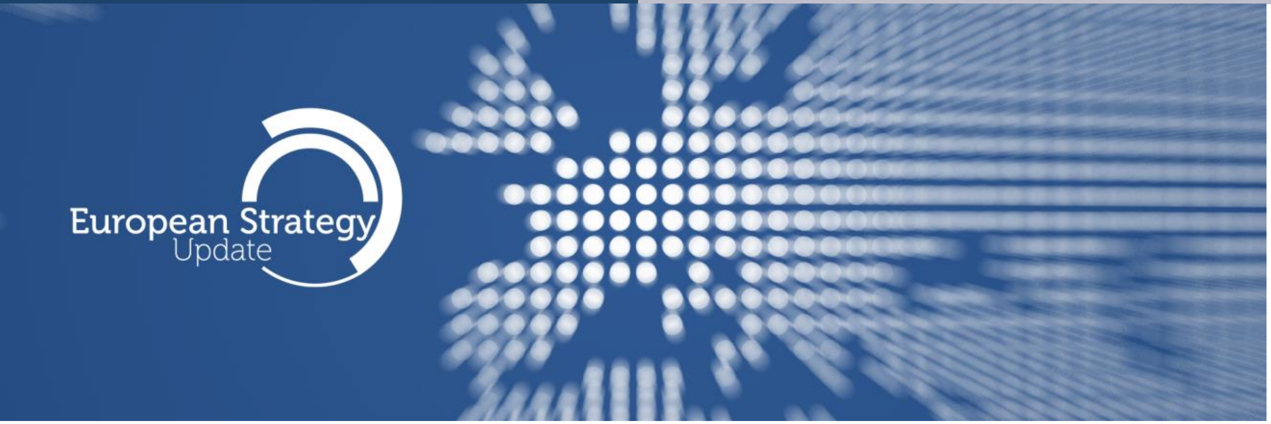


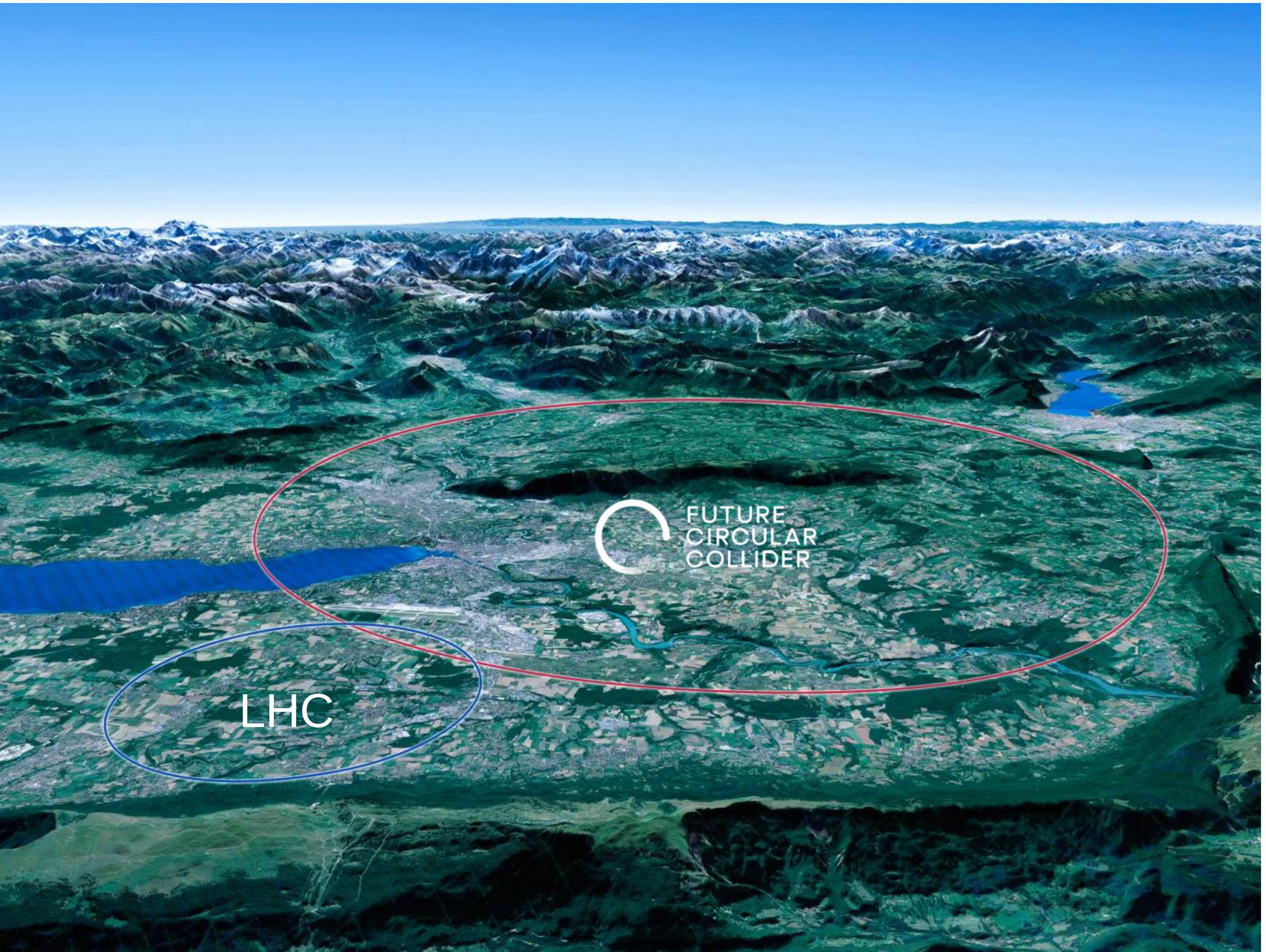




Upgrade to the High-Luminosity LHC is under way

- The HL-LHC will use new technologies to provide 10 times more collisions than the LHC.
- It will provide greater precision and discovery potential.
- It will start operating in 2027, and run until 2040.





Scientific priorities for the future

Implementation of the recommendations of the **2020 Update of the European Strategy for Particle Physics**:

- Fully exploit the HL-LHC
- Build a Higgs factory to further understand this unique particle
- Investigate the technical and financial feasibility of a future energy-frontier 100 km collider at CERN
- Ramp up relevant R&D
- Continue supporting other projects around the world

Visit to CMS today

The visit will start today at 17:30

Please ensure you have updated to the most recent version of the Zoom client to ensure a good quality webcast

Please connect to the zoom room that you received in the ’daily mail’ of Joachim that you received this morning

The zoom room will open around 17:20, ie 10 minutes before we start the visit.

Q/A will be via the Q/A button on the zoom screen