

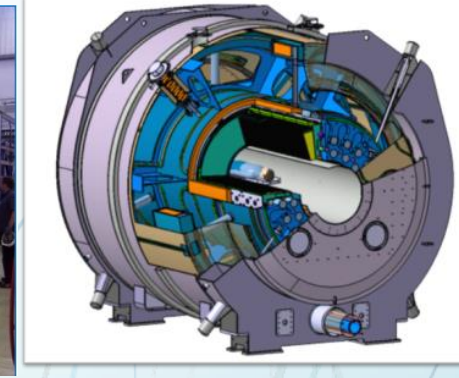
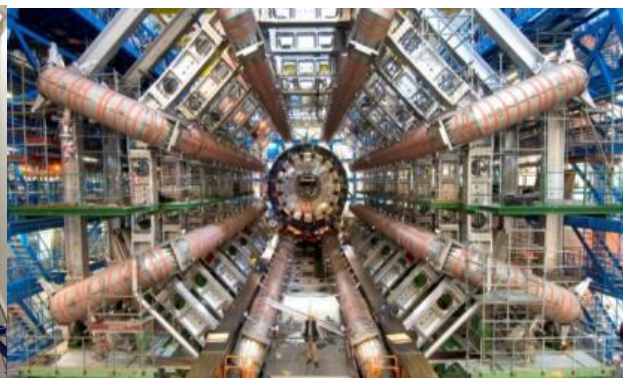
DE LA RECHERCHE À L'INDUSTRIE



The CEA/DRF/IRFU

I have presented the CEA and DRF structure, in
the Joint Workshop 2018 at Nara,

Therefore I will skip this part



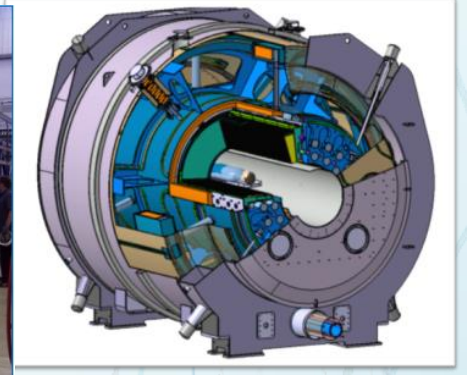
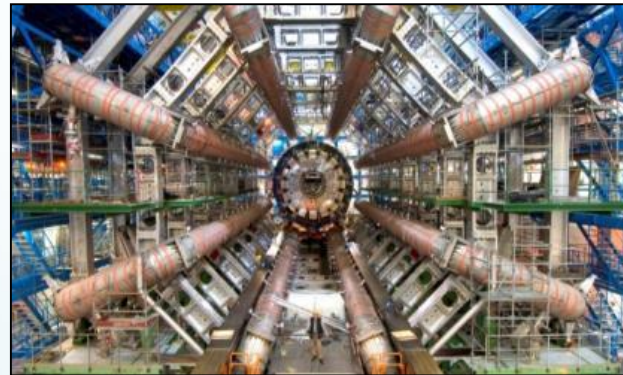
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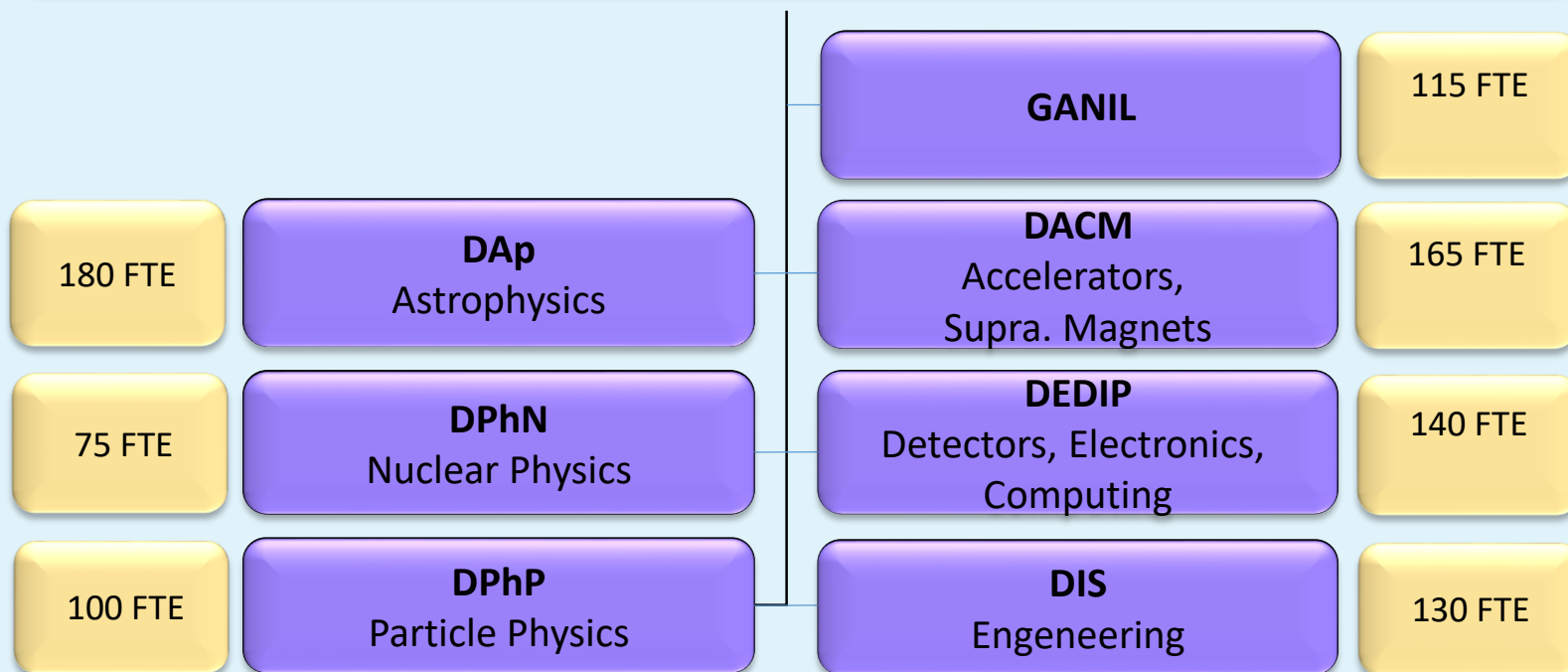
IRFU

The Institute of Research into the
Fundamental laws of the Universe



www.cea.fr

Institut de recherche sur les lois fondamentales de l'univers



~ 950 FTE

- 17 ERC
- 975 publications
- 65 active patents



Basic Research in Physics in link with large scale facilities

Researches into the fundamental laws of the Universe

Co-Leader in France with CNRS (INSU & IN2P3), Universities

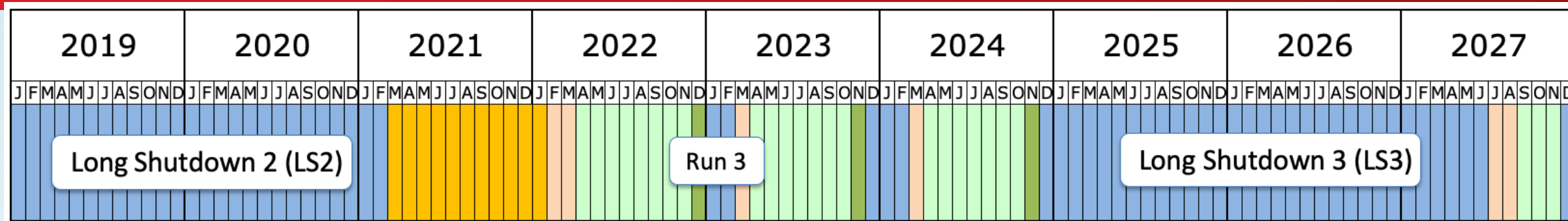
Goals: 4 key questions and associated technology

- *What are the ultimate constituents of matter?*
- *What is the energy content of the Universe?*
- *How is the Universe structured?*
- *What are nuclear matter self-organization processes?*

Sampling of some of our latest highlights in the domain of Physics, Magnets & Accelerators

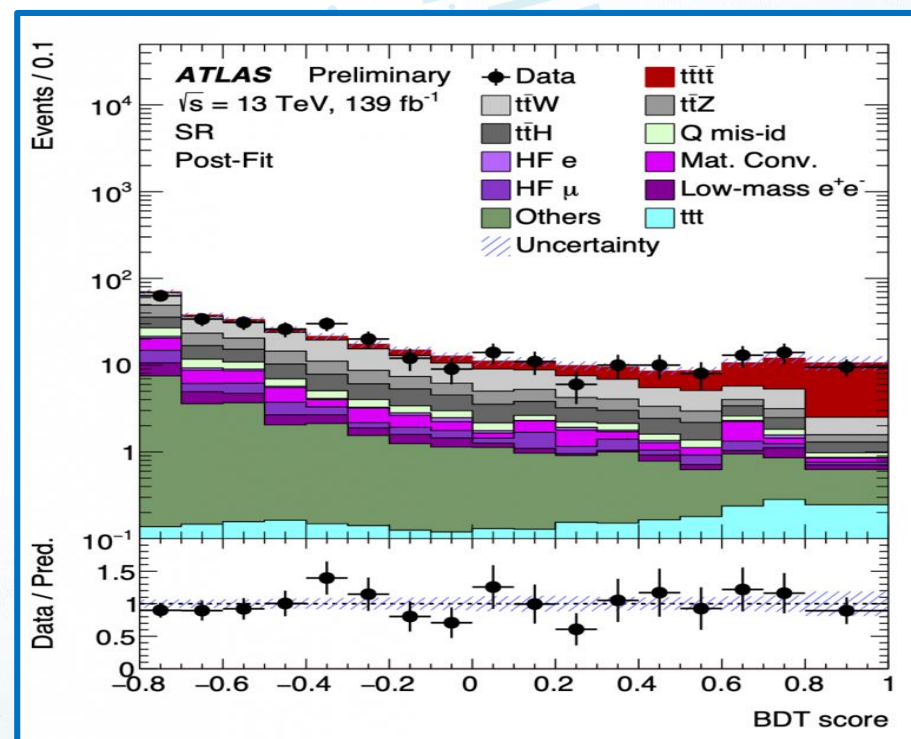
- **LHC Results:** (**ATLAS, CMS, ALICE**) No new physics observations,...but measurements of unparalleled precision ... **Upgrades phase 1 and phase 2 – few examples.**
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ATLAS Exploiting the RUN 2 data:



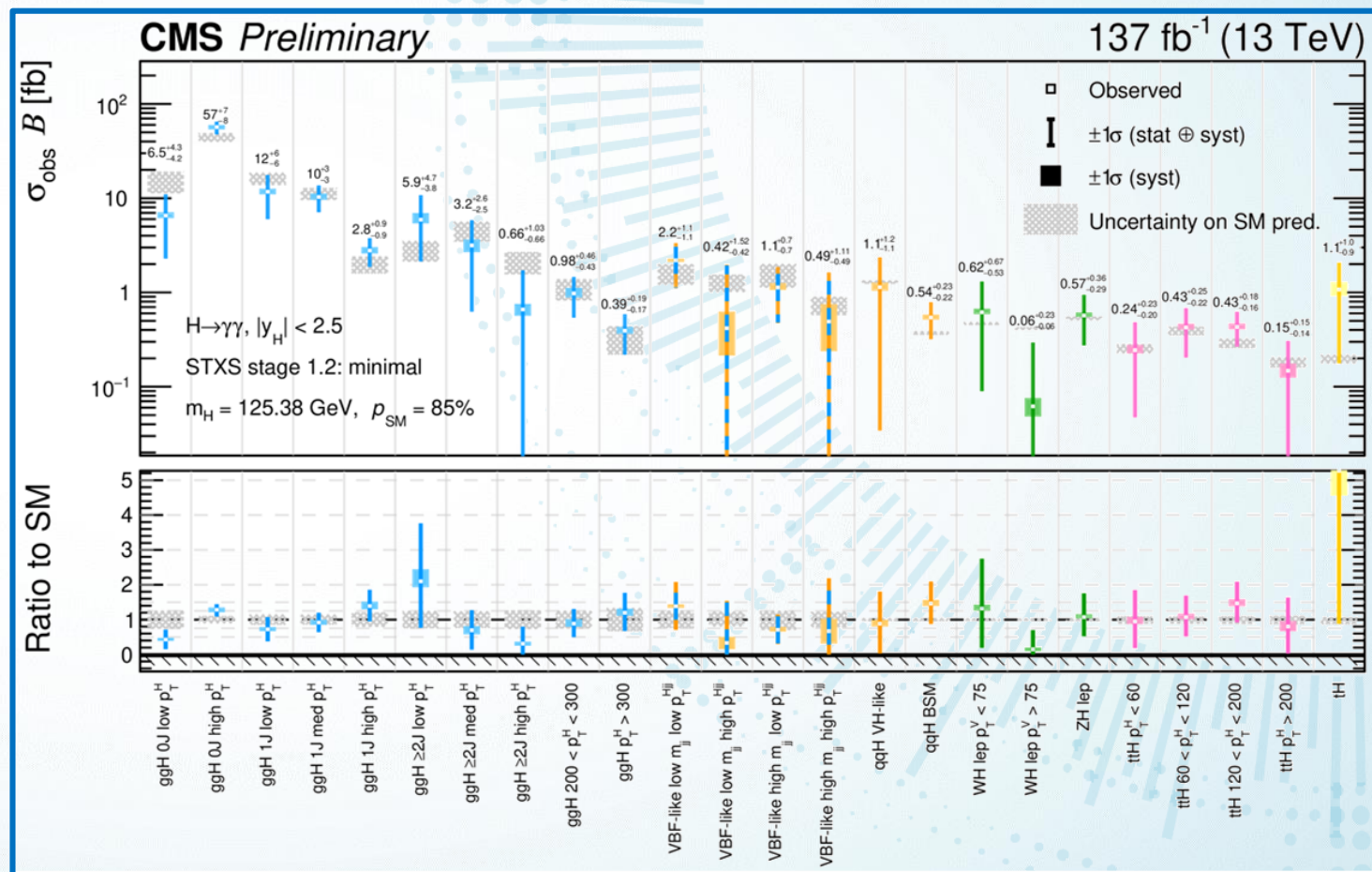
production of 4 tops ... 4000 times more rare than Higgs production.

The analysis, coordinate by IRFU allows highlighting for the first time this rare final state with a result at more than three standard deviations.

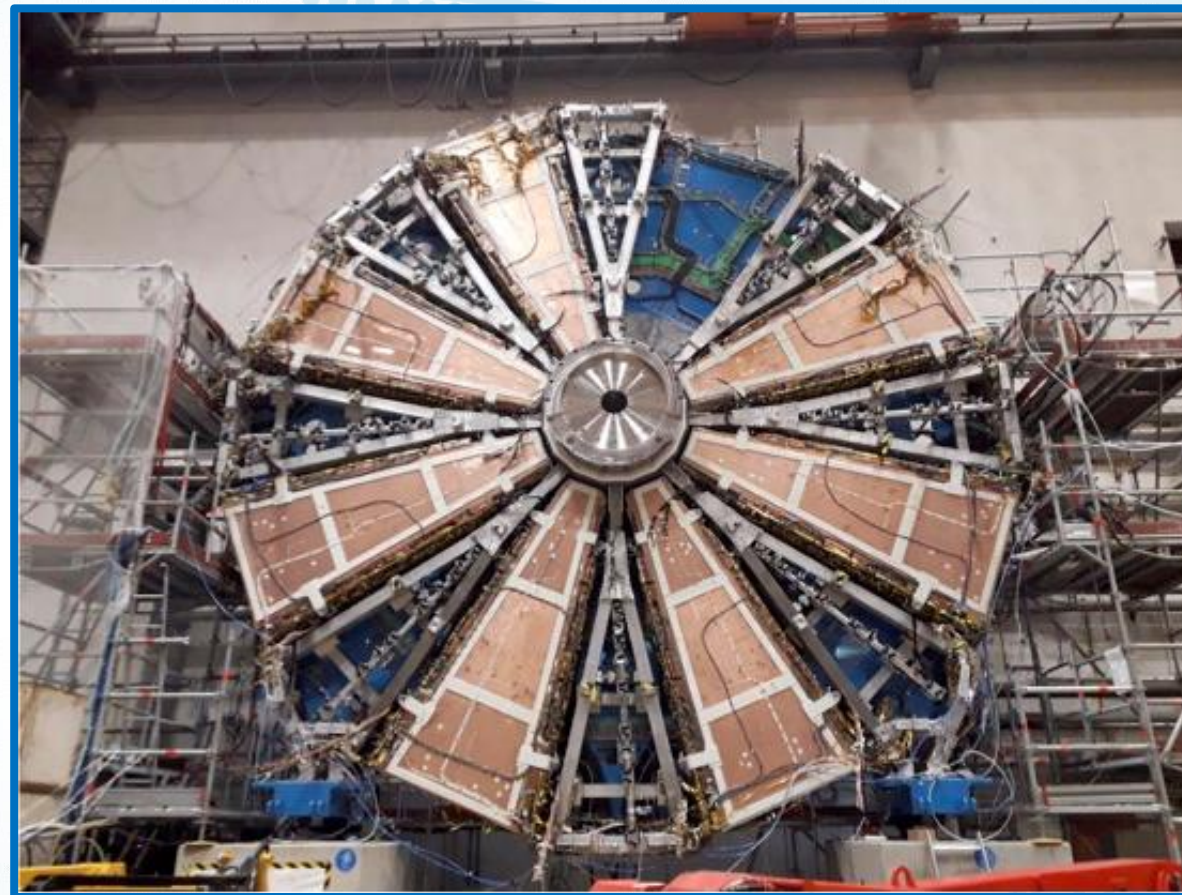
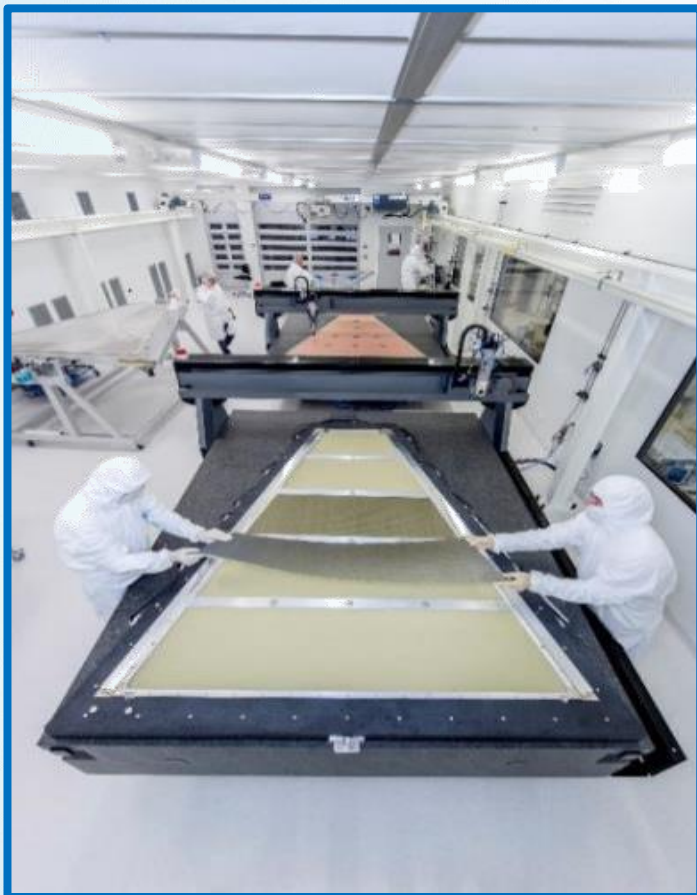


.... The bottom figure shows the ratio between the measured cross sections and those predicted by the SM.

.... precise measurements of the properties of the Higgs boson permit to test further the SM

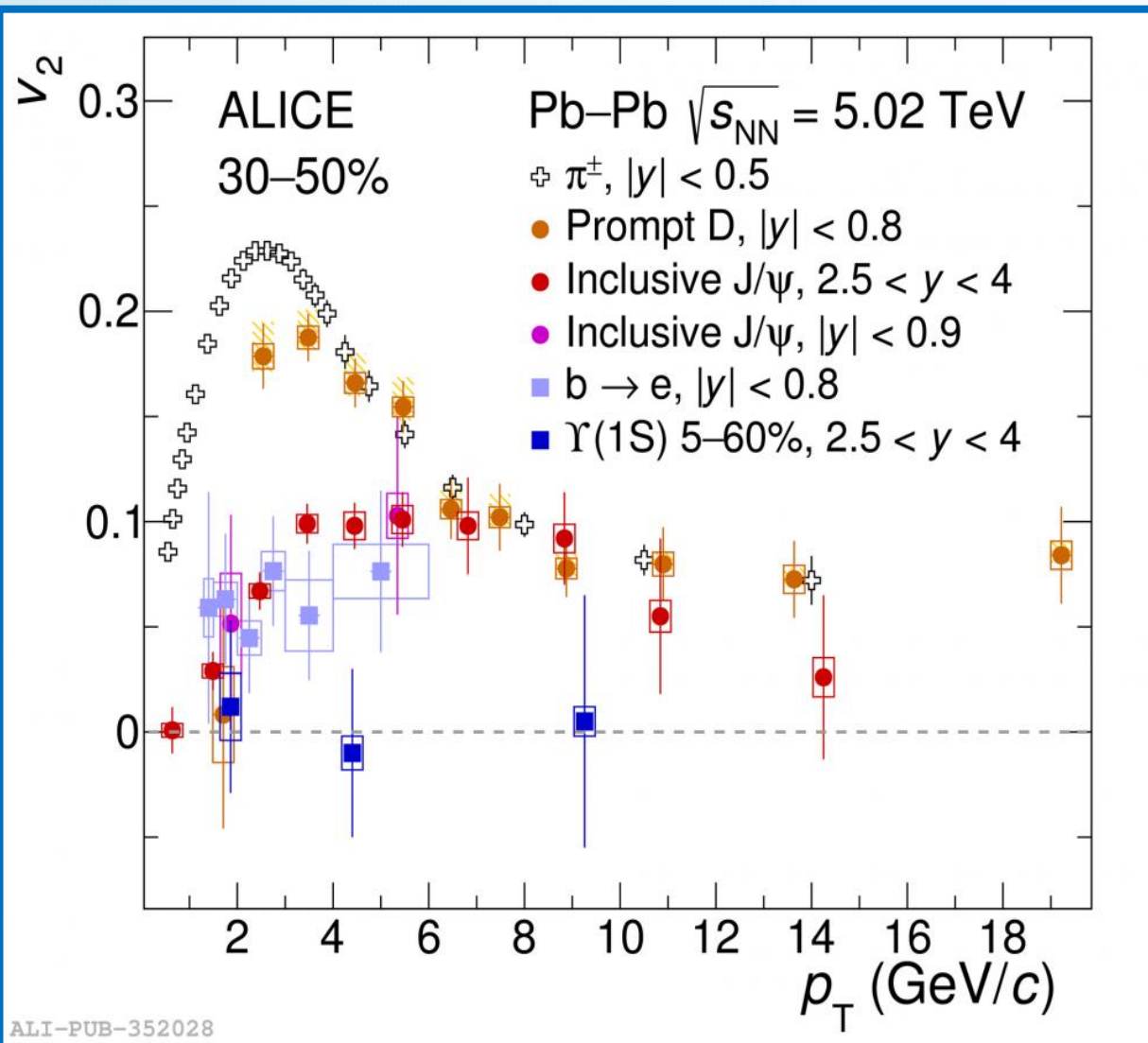


Upgrade LHC Phase 1



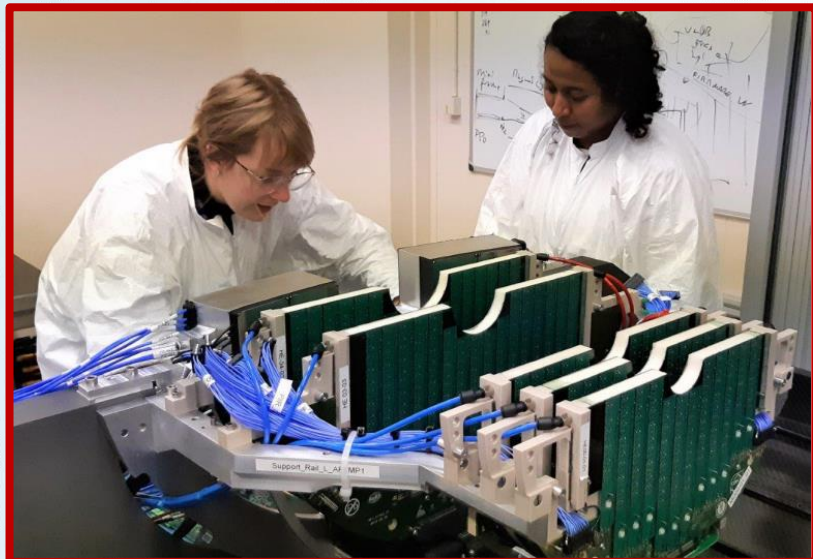
Construction of The ATLAS/NSW (The CICALAD clean room): ***End of NSW production***

ALICE: The elliptical flow of various particles in collisions between lead nuclei at the LHC.



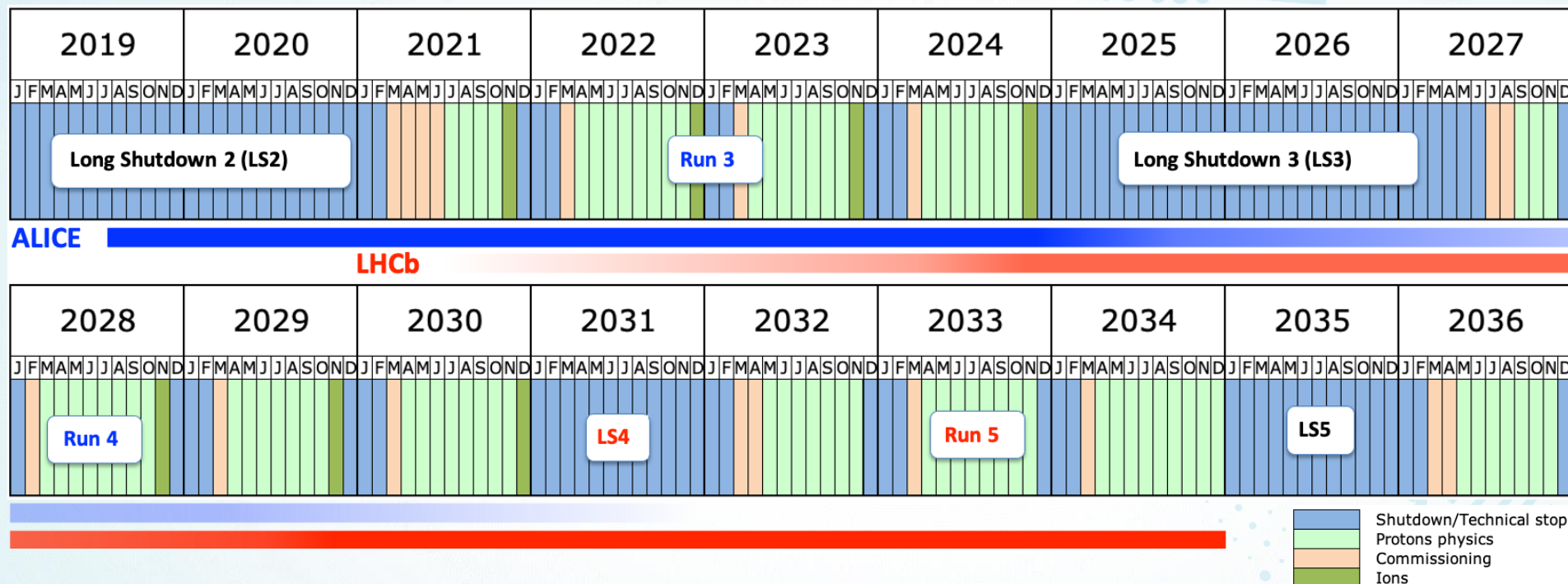
The ALICE collaboration presented new results showing how charmed particles - those containing quarks, the elementary components of matter, known as c-particles - can act as 'messengers' of the plasma of quarks and gluons, which would have existed in the primordial Universe.

Upgrade LHC Phase 1: The Muon Forward Tracker



Transition from ALICE to LHCb during Run4

100% involvement at LHCb in run 5



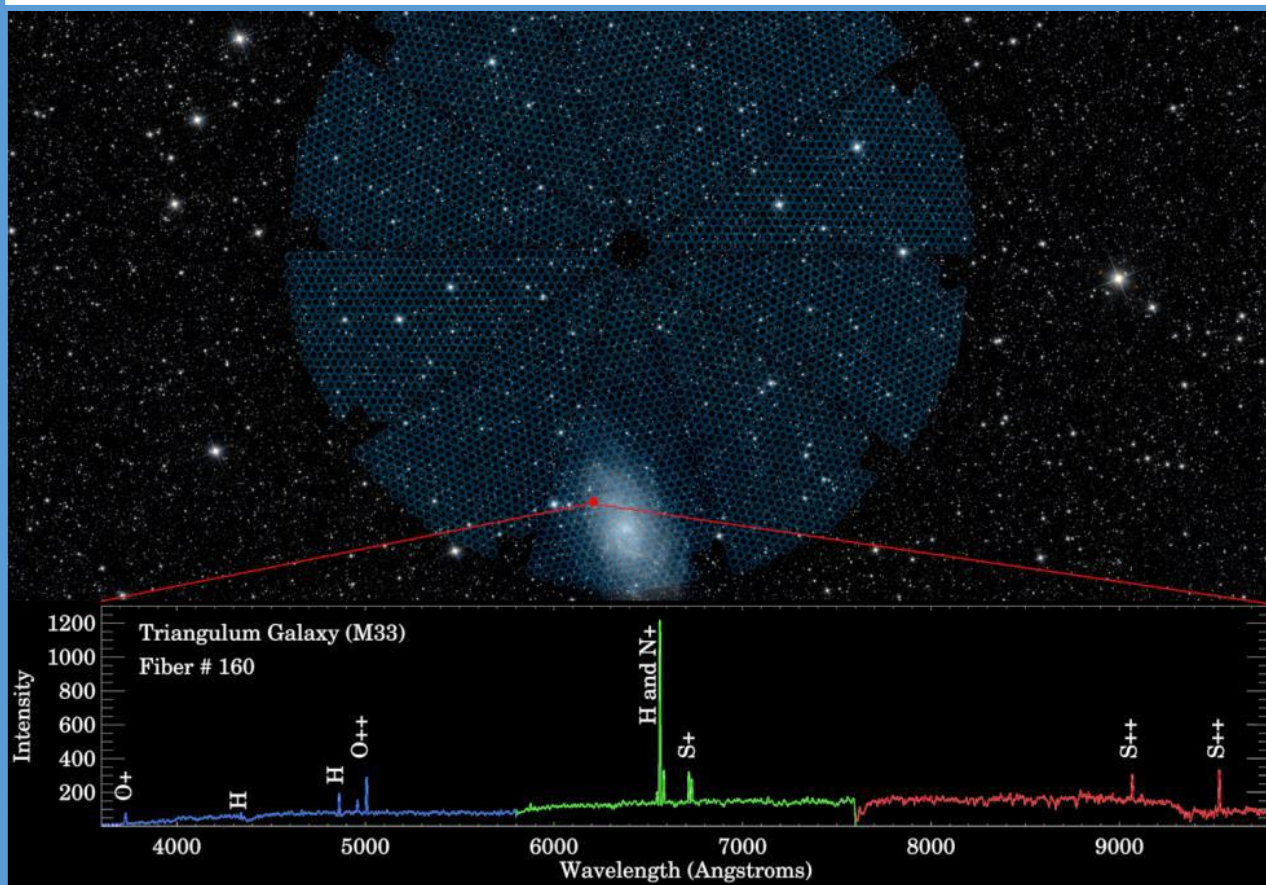
- Precision study of heavy flavours and quarkonia (including χc)
- Study of small systems (including high multiplicity pp)
- Upgrade LHCb to a multi-use detector (including heavy ions) in fixed target and collider mode

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DESI Study of dark energy and the formation of structures in the Universe

2019: Installation in Mayall, first light and first data of excellent quality



Irfu: Assumed the responsibility of the realization of the cryo-mechanical systems of the 10 spectrographs

After 10 years of technical effort, from 2020 and within 5 years of measurements (~2025) : a 3D map of 35M galaxies and 2.4M quasars that is on a third of the sky should be observed.

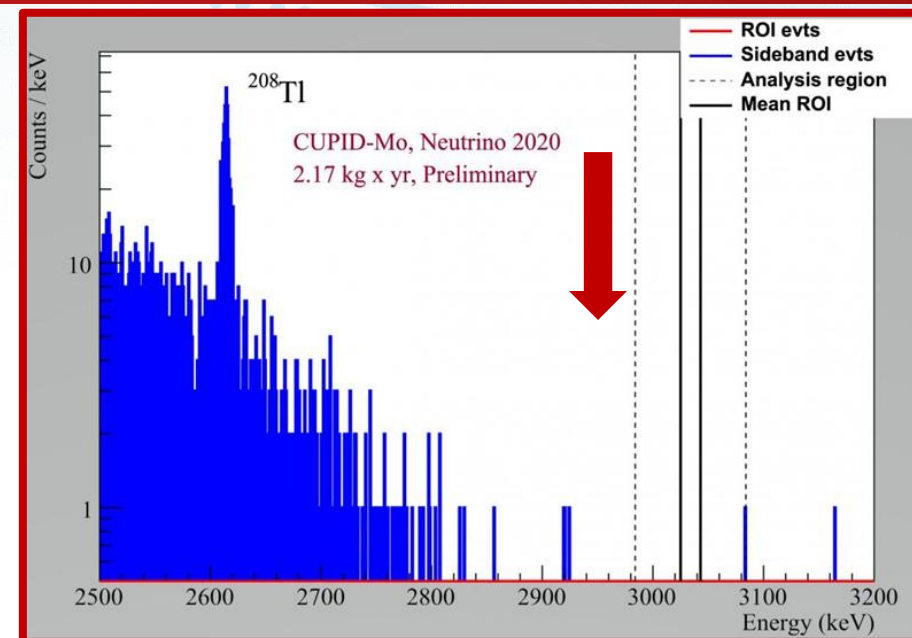
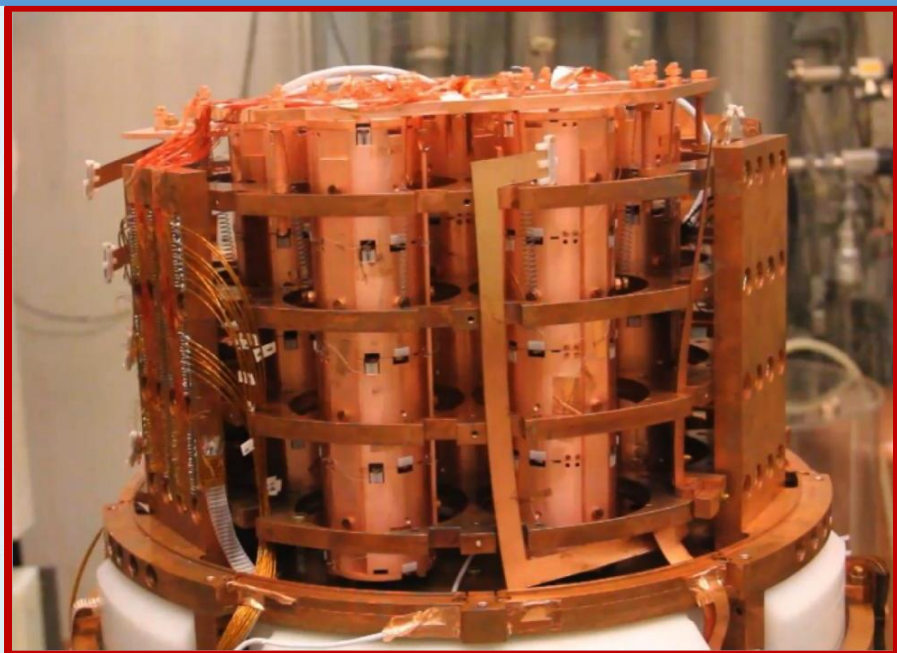
An outstanding recognition

In March 2020 Nathalie Palanque Delabrouille, IRFU Physicist, co-spokesperson of DESI, was elected as a member of the French Academy of Sciences.





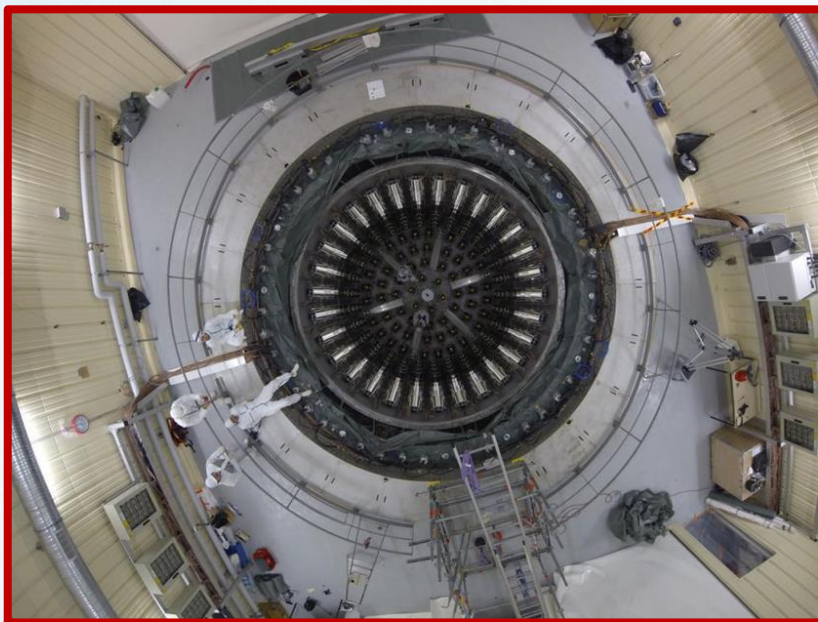
Photo of the CUPID-Mo detector installed inside the EDELWEISS cryostat at LSM



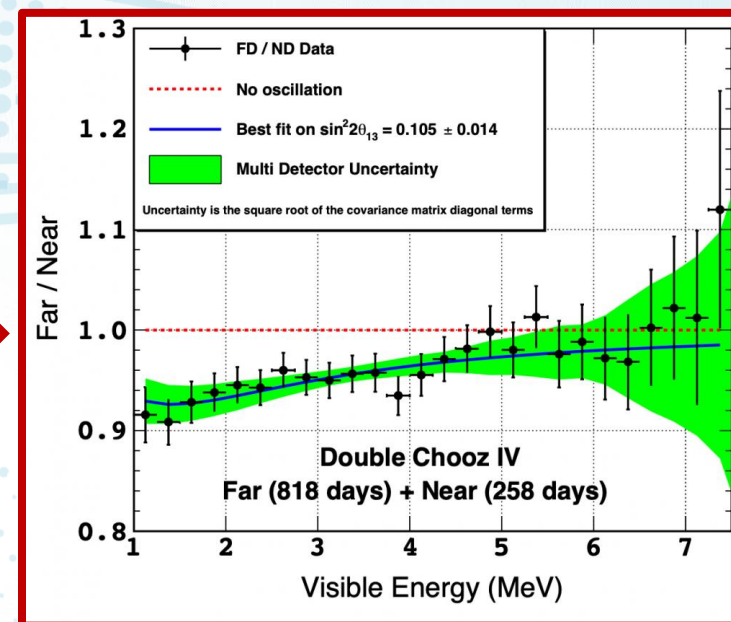
Zooming in on the energy spectrum in the region of interest

CUPID set a **new global limit** for the detection of the $0\nu\beta\beta$ signature: the 100Mo decay of 1.4×10^{24} yr, significantly better than the previous one obtained by the NEMO3

View of
the
detector



*absence of
oscillation.*



A high precision on the value of the angle θ_{13} characterizing neutrino oscillations is reached with $\sin^2(2\theta_{13}) = 0.105 \pm 0.014$.

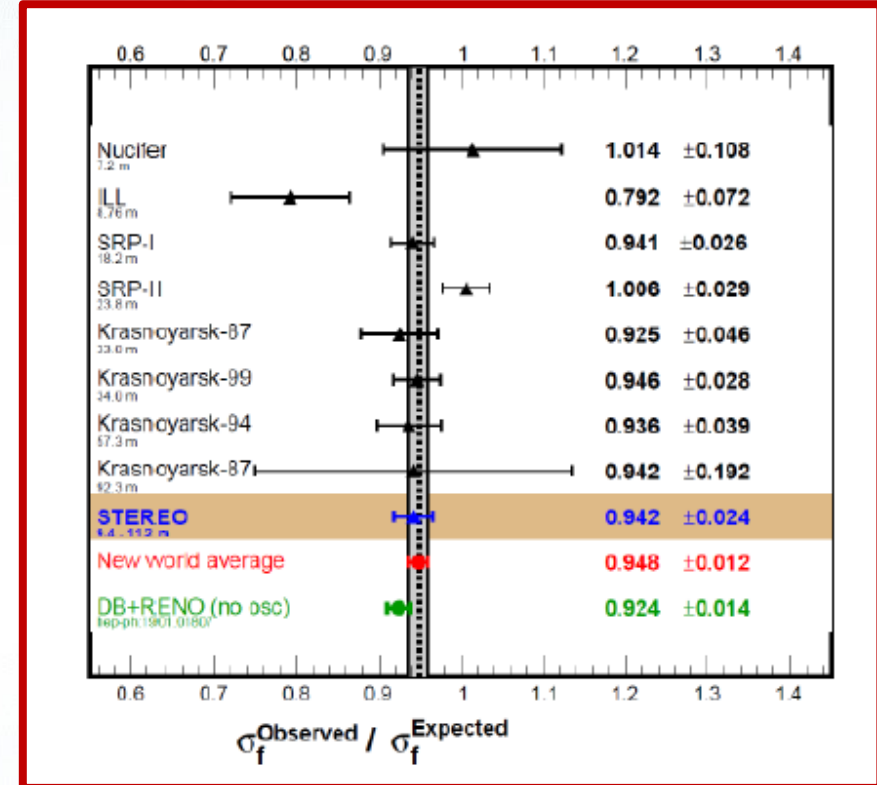
Ratio between the shape of the energy spectra of the far and near detectors of Double Chooz. The measurements are represented by the crosses.

This measurement enters into the extraction of the δCP parameter by the T2K experiment.

Reactor Neutrinos - The STEREO experiment



The STEREO detector has been installed since the end of 2016 at 10 m from the core of the Institut Laue-Langevin (ILL) reactor in Grenoble. It precisely measures the rates and energy spectra of neutrinos emitted by the core in 6 identical detection cells. If a 4th neutrino exists, it may 'oscillate' with the standard neutrinos, inducing a unique pattern of spectral distortions from one cell to the next.



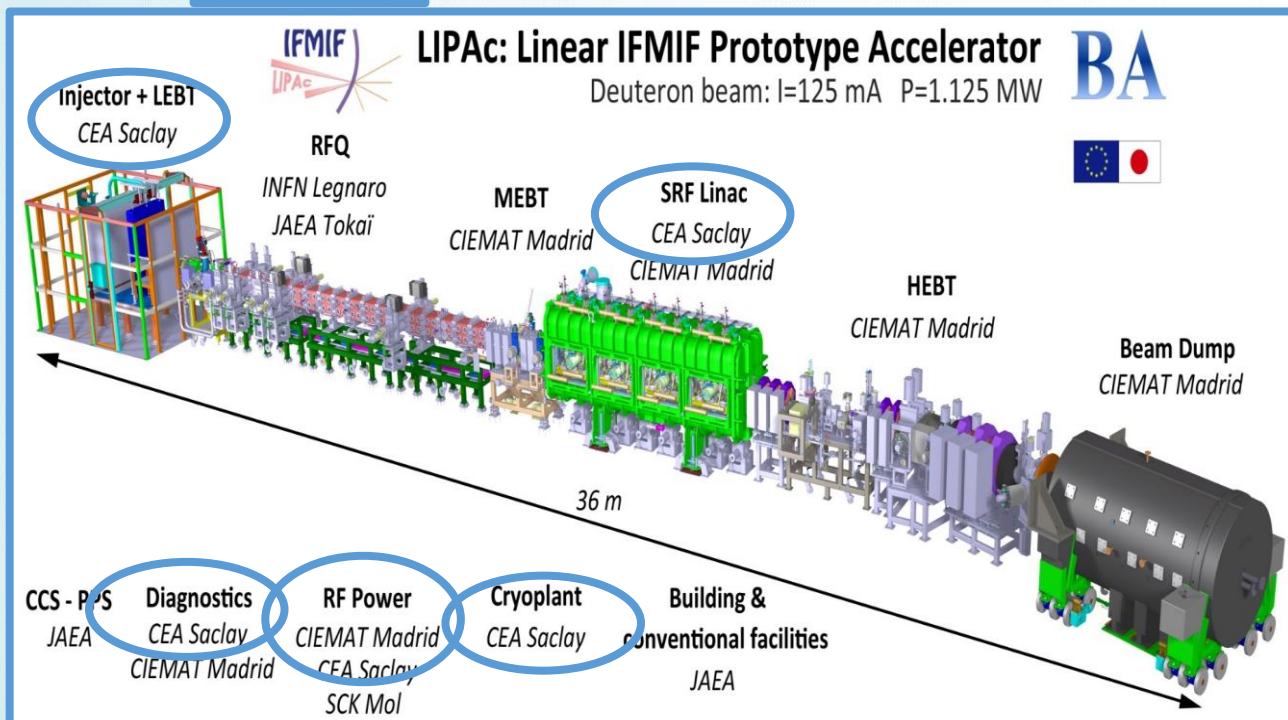
After careful analysis the spectra measured in the 6 cells of the STEREO detector have compatible shapes. This result considerably reduces the domain of existence of the 4th neutrino.

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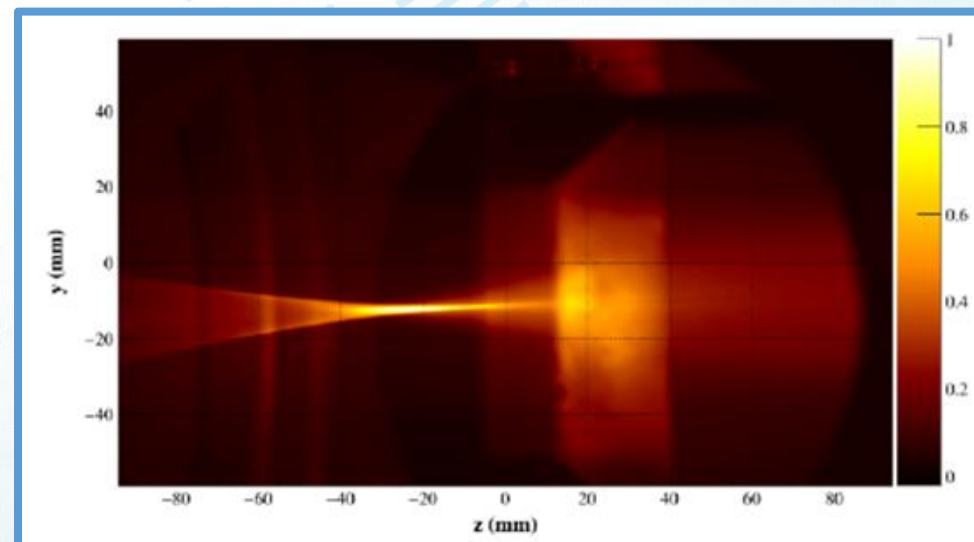
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Rokkasho



The Injector



Commissioning of the source and the LBE in Japan



Delivery of the source and the LBE of the proton Linac. The injector is now being dismantled before being sent to GSI.

The low energy line of the FAIR injector. The beam runs from left to right. The line is equipped with two Allison emittance meters developed by CNRS/IPHC and by CEA/Irfu



SARAF: Delivery of the medium energy line, MEBT to SOREQ-Israel



The Saraf MEBT is fully integrated at Saclay just before it is packed for transport to Israel. Part of the team in charge of mechanical integration and control still on site at the end of July 2020

i) Delivery of RFQ to Lund, commissioning in progress, ii) Diagnostics under development, iii) Cryomodules: delivery of the first one to Lund, integration of the next ones in Saclay



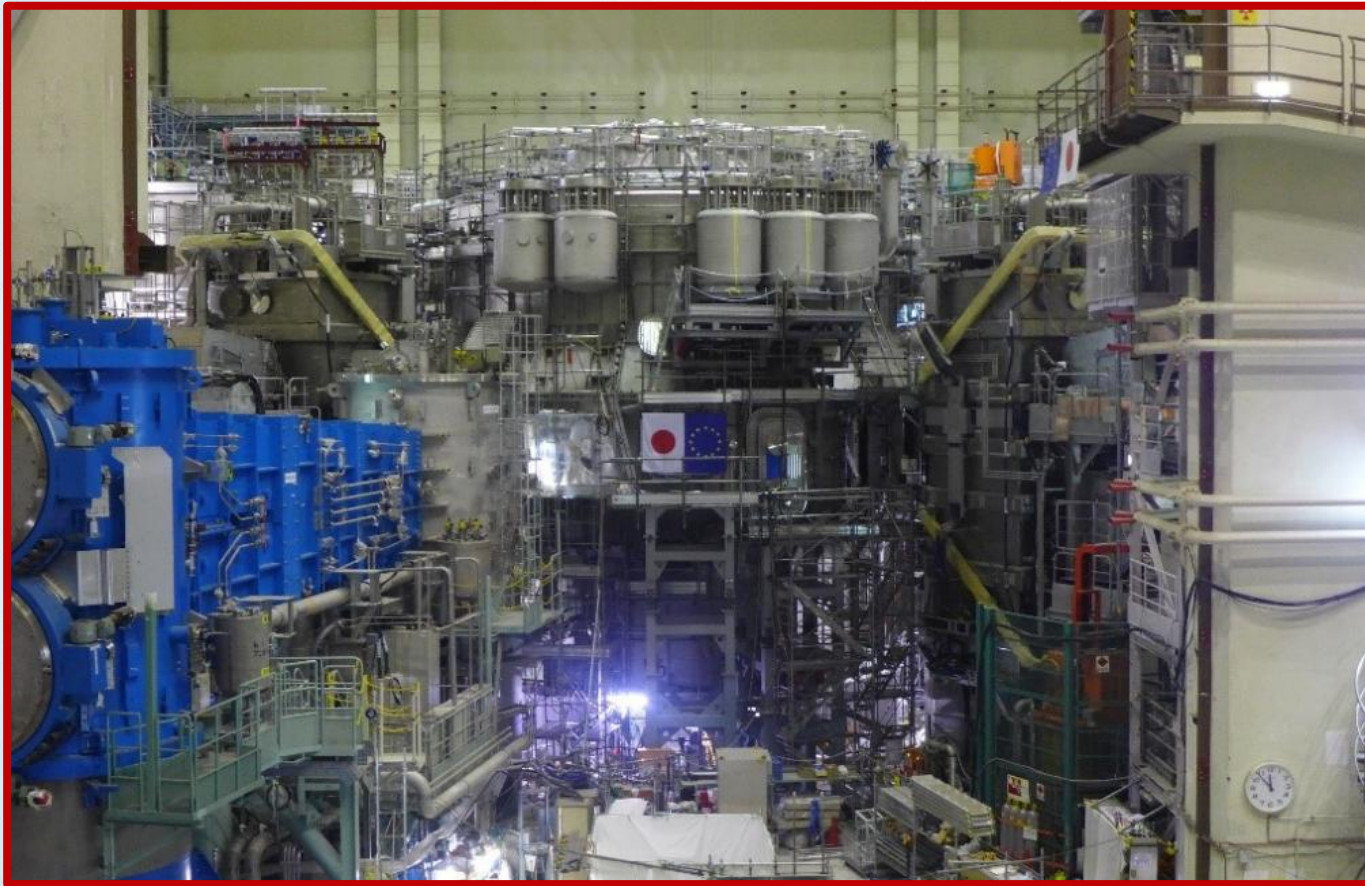
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Departure of the last coils from Vatry airport to Japan 15/02/2018



Magnets : The assembly of JT-60SA was completed in Japan on 30 March 2020 after 15-year effort.



Yutaka Kamada, director of the
project

"Let me inform you that the tokamak assembly has been completed today. Please enjoy the attached photo !! This result was achieved by big effort of all the team members for these 13 years.

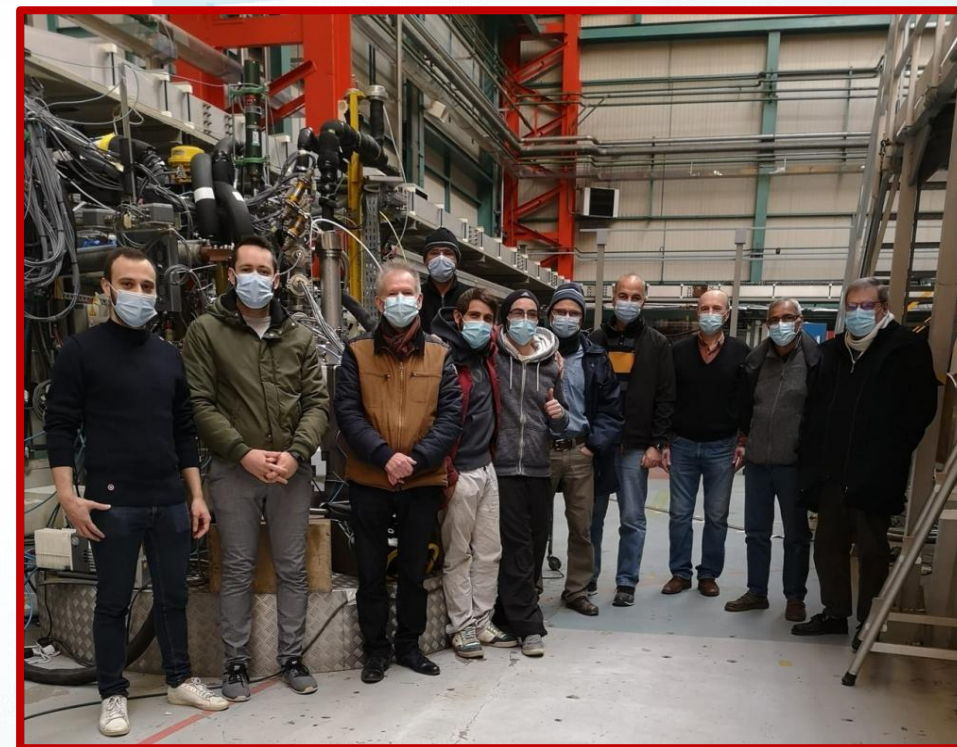
Thank you very much . Let's move on to the integrated commissioning phase".

First successful test of the "MQYYM" NbTi insertion quadrupole for the LHC high luminosity project

The large-aperture (90 mm) quadrupole superconducting electromagnet for Cern's HL-LHC project, reached its nominal gradient of 120 T/m on 5 March 2021



Operating Gradient	120 T/m
Operating current	4550 A
Bpeak at operation	6.42 T

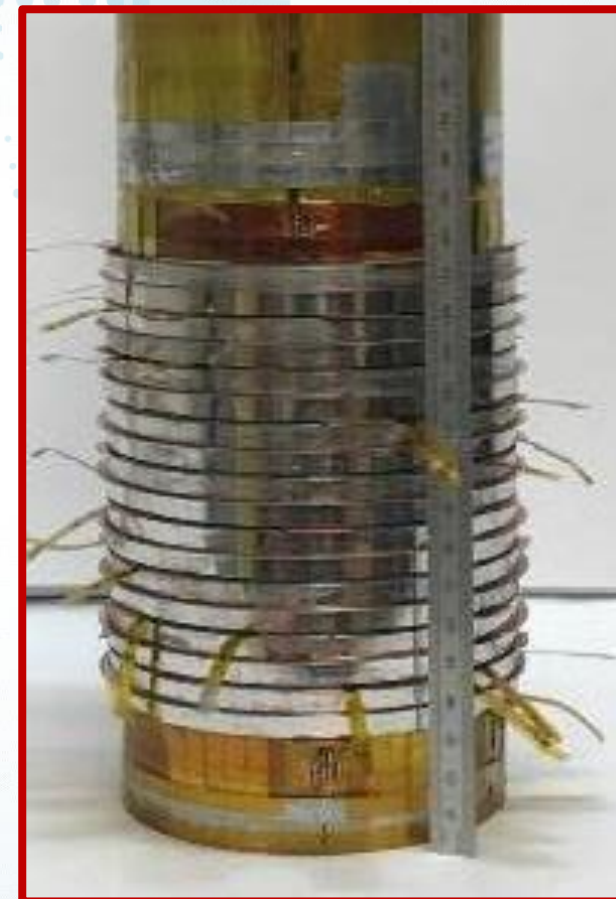


The magnet assembled in its yoke at CERN by the CEA team, ready for the connection box

Magnets : Nougat, the high critical temperature superconducting (SHT) insert.



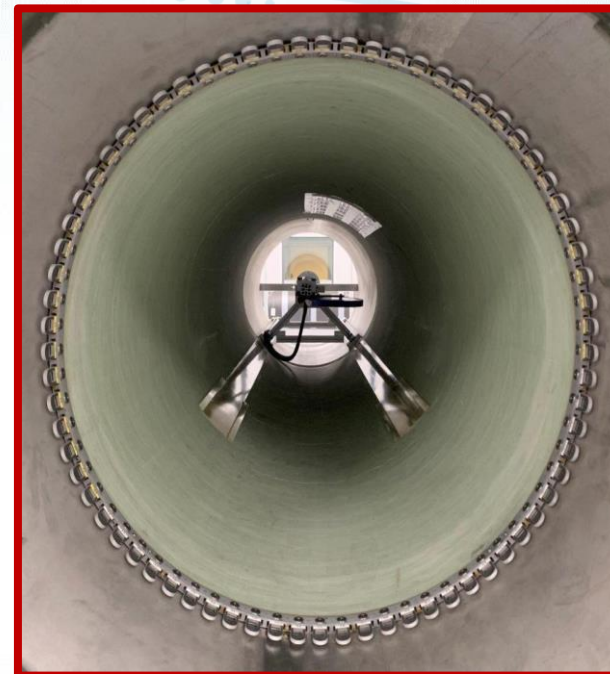
The result of a CEA-CNRS collaboration, reached a central magnetic field of 32.5 Teslas, setting a new world record in the high field range for a superconducting winding with a useful diameter of 38 mm.



Iseult reaches its nominal field of 11.72T for the first time in July 2019



The magnetic field must be homogeneous at 0.5 PPM (parts per million) around the patient's brain.



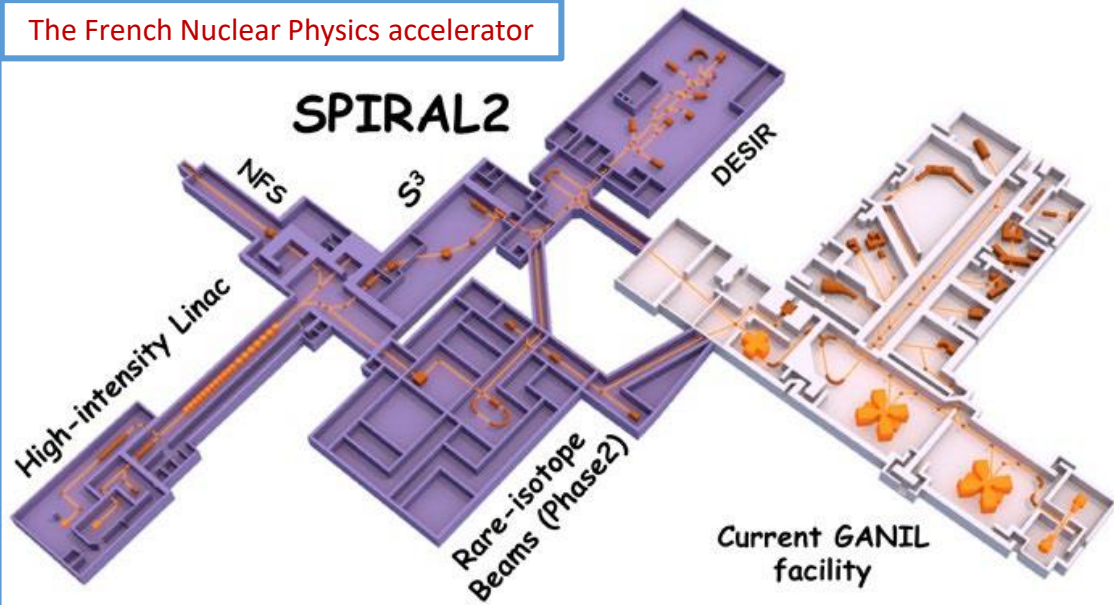
To meet this challenge.. 5904 pieces of shim (small iron pellets) were thus screwed onto their rails and installed inside the magnet tunnel.

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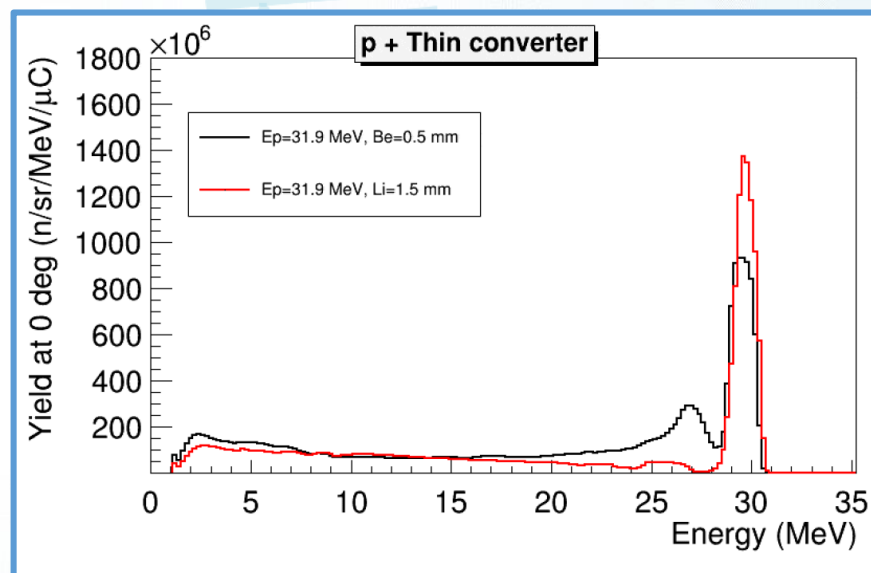


The French Nuclear Physics accelerator



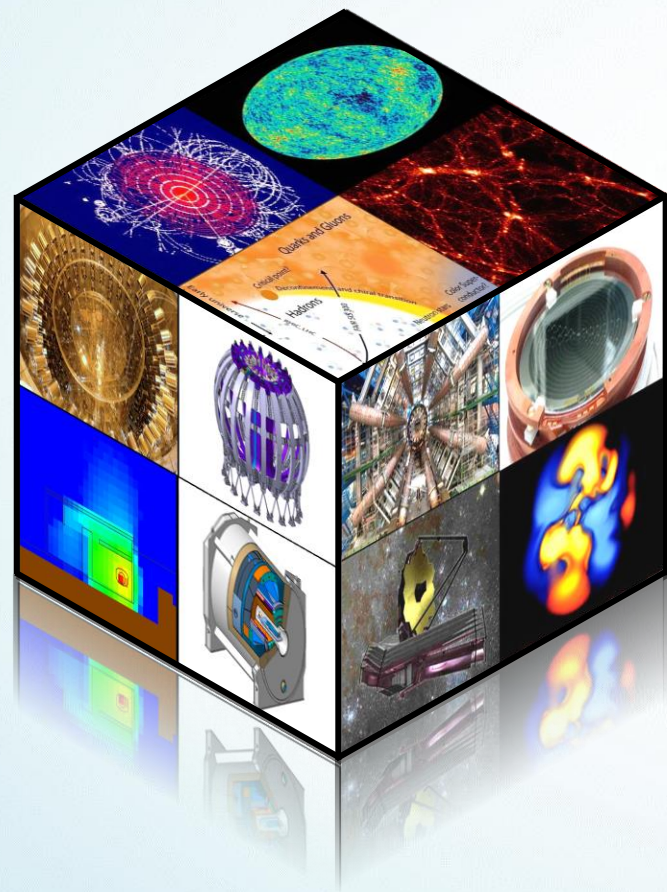
Goal : 5mA Proton and Deuteron beam up to 33 and 40MeV respectively

A 16kW proton beam (**10% of full power**) was delivered by the SPIRAL2 LINAC at the end of November 2020.



Virtually **mono-energetic spectrum of neutrons** produced at 0° during interaction of a 31.9 MeV proton beam with thin lithium and beryllium converters.





Thank you for your
attention