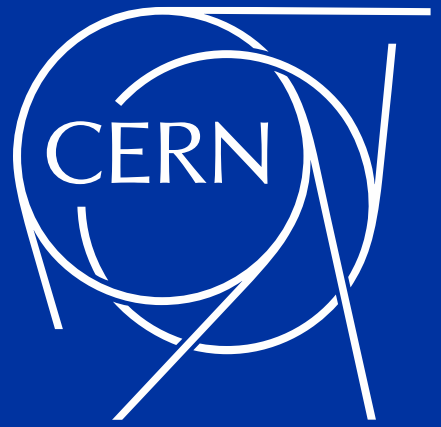


Report from CERN

114th Plenary ECFA Meeting

Joachim Mnich

July 4h, 2023

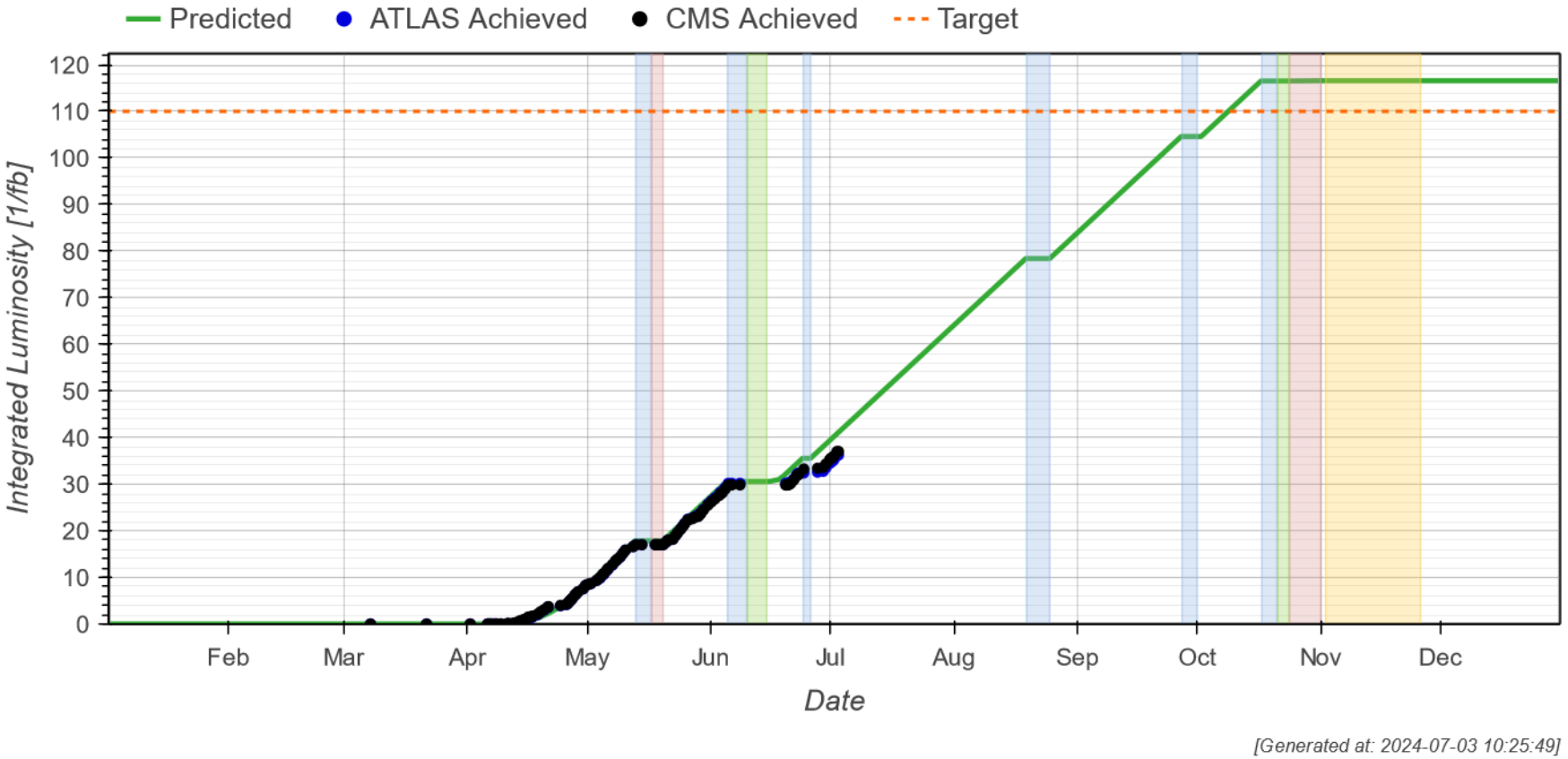
Topics not covered here:

- ❑ FCC (see talk by Frank)
- ❑ ESPP (see talk by Karl)
- ❑ DRD collaborations (see talk by Ines)

Status 2024 LHC Run

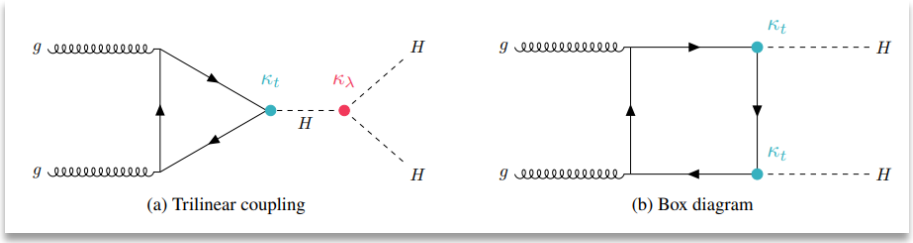
- Very good start and excellent prospects for the rest of the year
- >37 fb^{-1} pp delivered to ATLAS and CMS in 2024
  up to 1.3 fb^{-1} in a day
- Luminosity target 110 fb^{-1} increased because of the additional 4 weeks in 2024

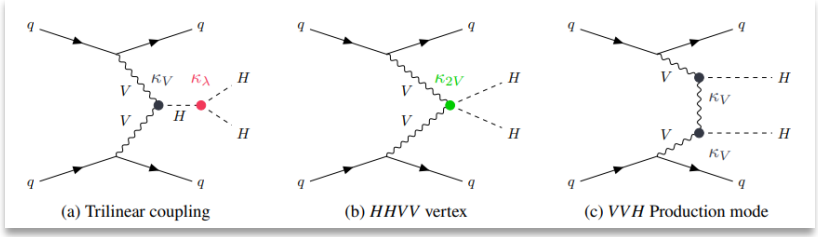
- Total LHC luminosity delivered so far:
  ≈ 300 fb^{-1}
  incl. ≈ 270 fb^{-1} at $\sqrt{s} \geq 13$ TeV

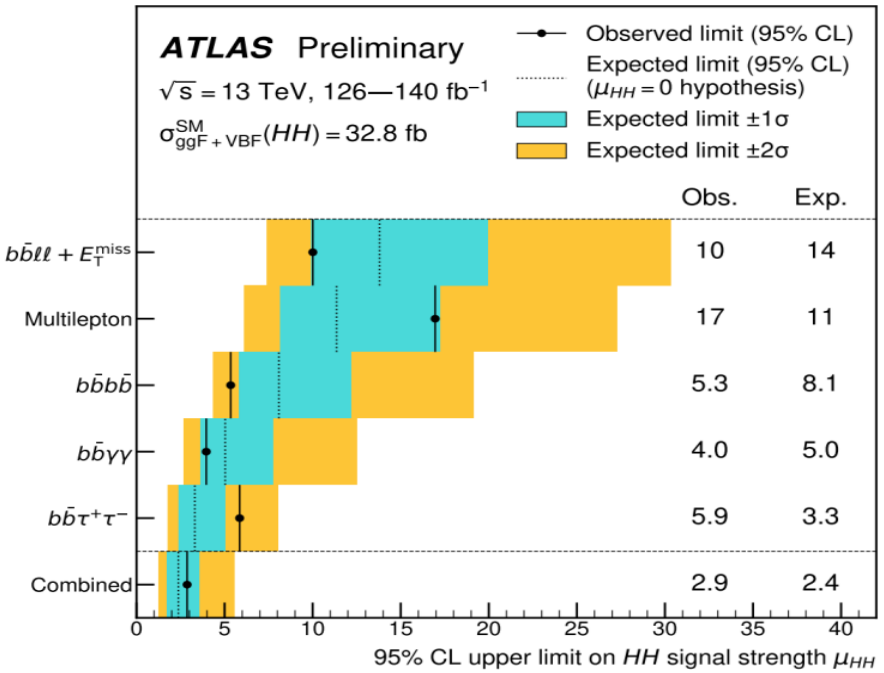


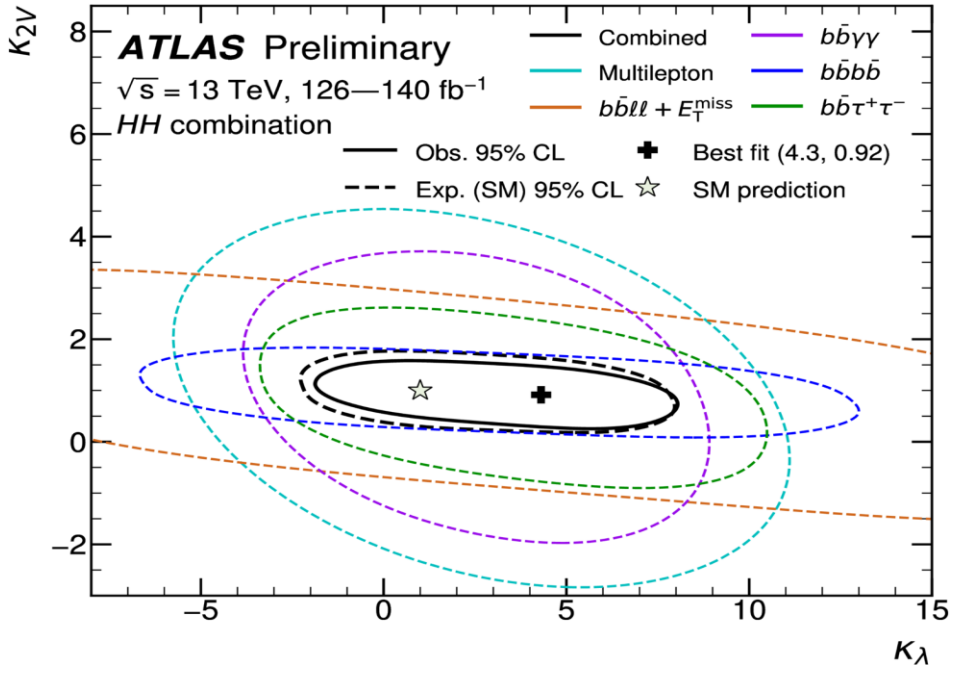
ATLAS Update on Di-Higgs

New combination of updated Di-Higgs searches using full Run 2 dataset









Constraints on Higgs coupling modifiers set at 95% CL:

$-1.2 < \kappa_\lambda < 7.2$

$0.57 < \kappa_{2V} < 1.48$

ATLAS-CONF-2024-006

CMS Quantum Entanglement in $t\bar{t}$

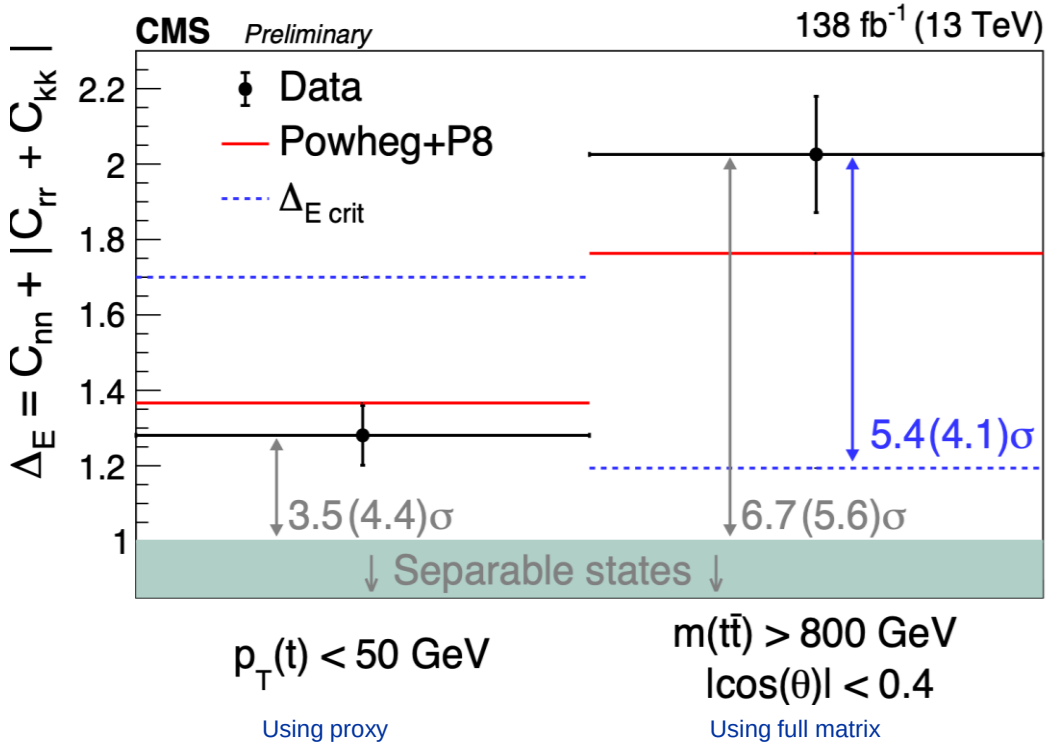
Spin correlation matrix in single-leptonic $t\bar{t}$ events

- Coefficiants of polarization vectors and correlation matrix from fit to the angles of decay products
  - Using NN to reconstruct the $t\bar{t}$ system in each event
- Entaglement probed using the measured matrix: $\Delta_E = C_{33} + |C_{11} + C_{22}| > 1$, or with proxies

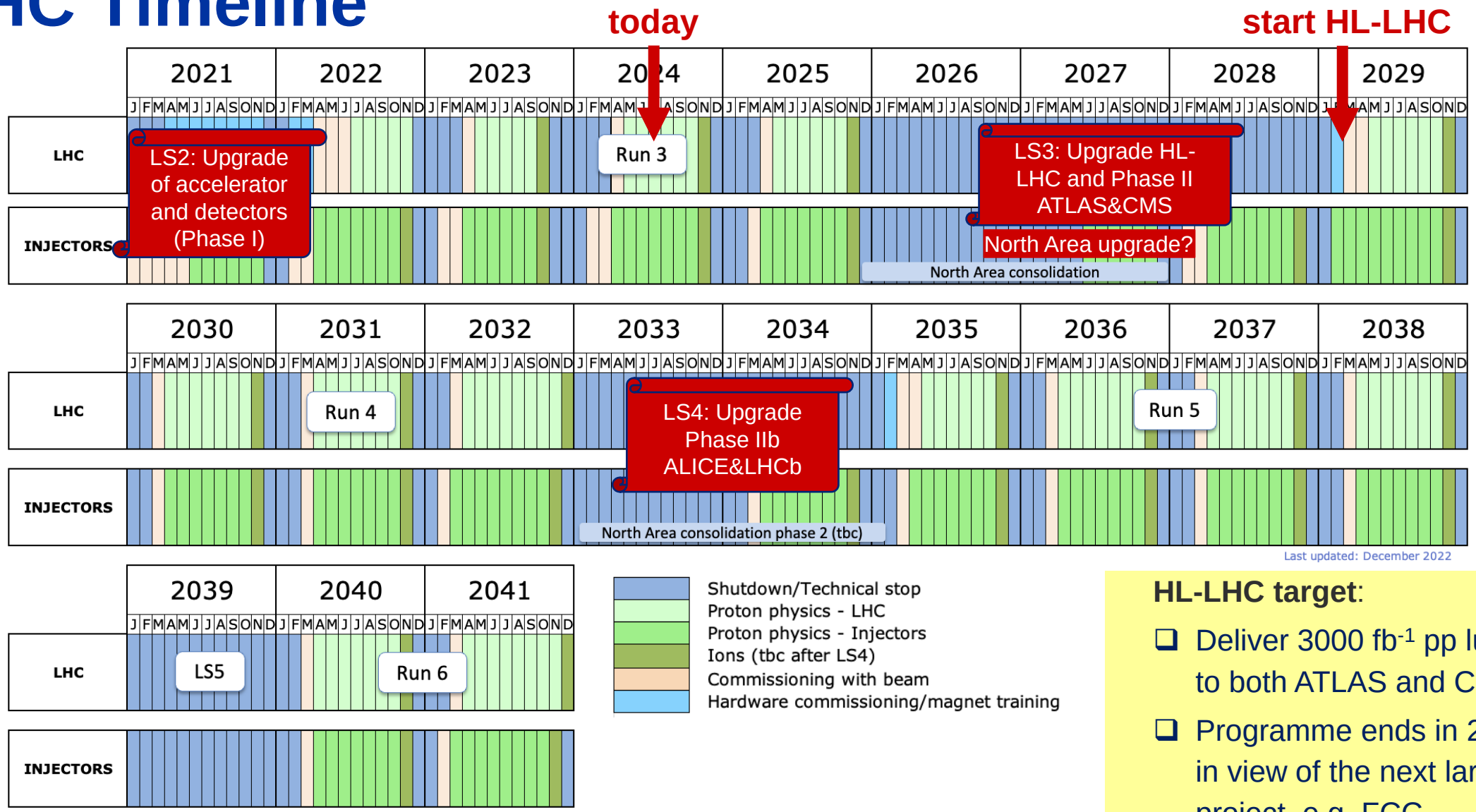
First observation of entanglement at high m($t\bar{t}$)

- Maximum level of entanglement explained by exchange of information at speed of light: “critical entanglement criterion
- Complements & extends CMS analysis of di-lepton events (arXiv:2406.03976)

CMS-PAS-TOP-23-007



LHC Timeline

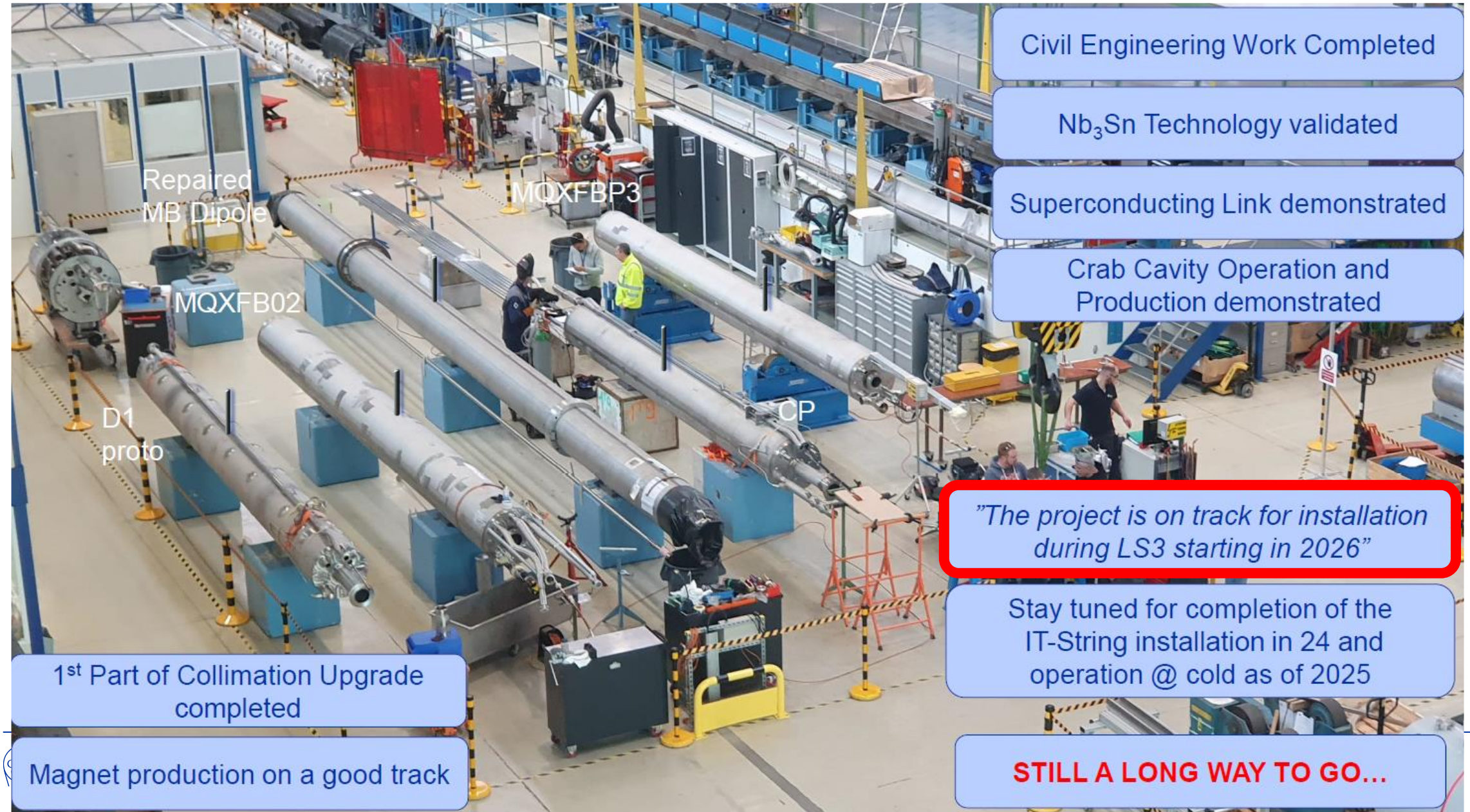


HL-LHC target:

- Deliver 3000 fb^{-1} pp luminosity to both ATLAS and CMS
- Programme ends in 2041 in view of the next large CERN project, e.g. FCC

Status HL-LHC Project

Summary M. Lamont 21.06.24



Civil Engineering Work Completed

Nb_3Sn Technology validated

Superconducting Link demonstrated

Crab Cavity Operation and Production demonstrated

"The project is on track for installation during LS3 starting in 2026"

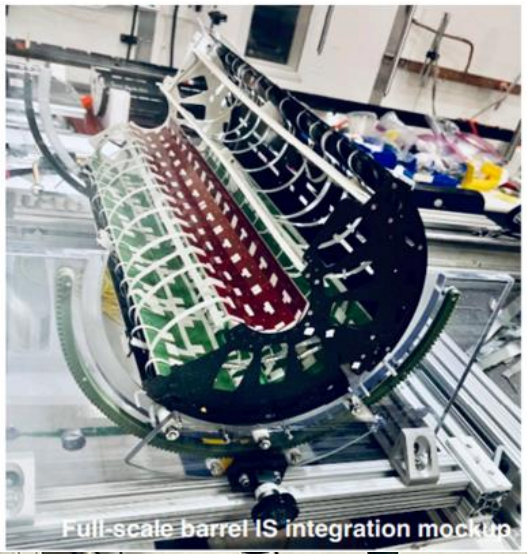
Stay tuned for completion of the IT-String installation in 24 and operation @ cold as of 2025

1st Part of Collimation Upgrade completed

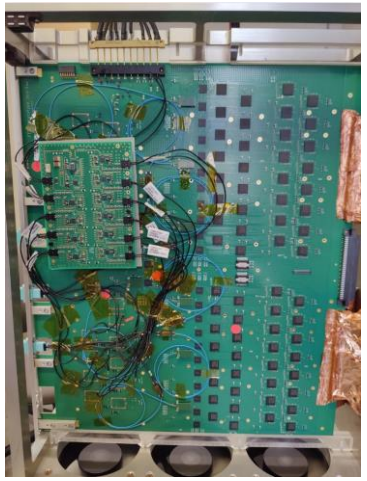
Magnet production on a good track

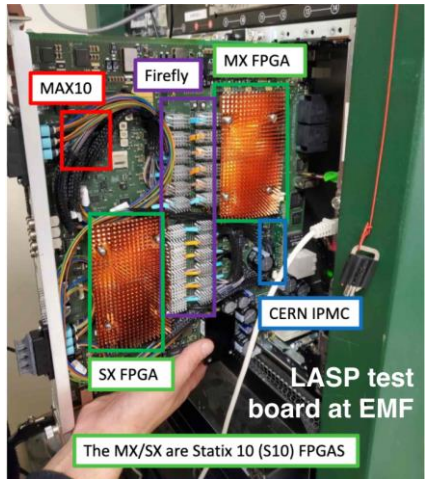
STILL A LONG WAY TO GO…

Progress ATLAS Phase II

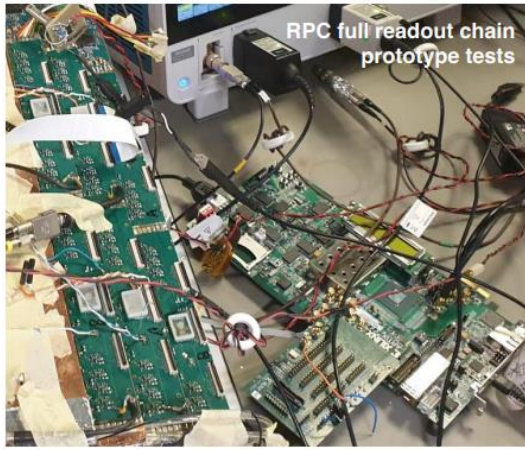

Full-scale barrel IS integration mockup


SR1 ITk surface assembly cleanroom at CERN

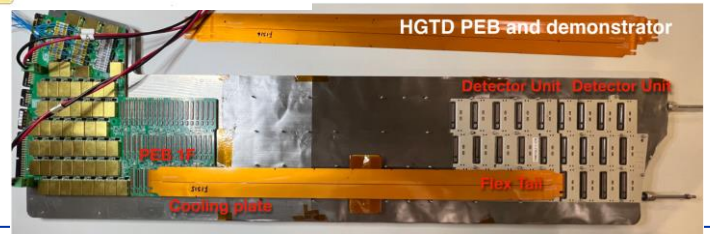


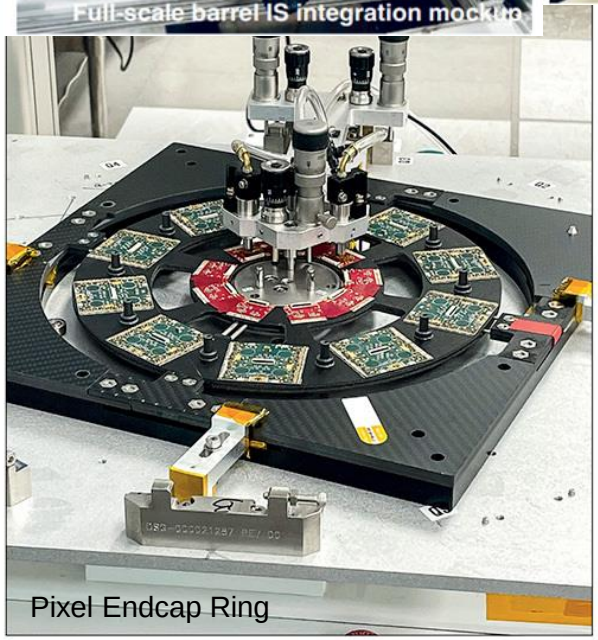


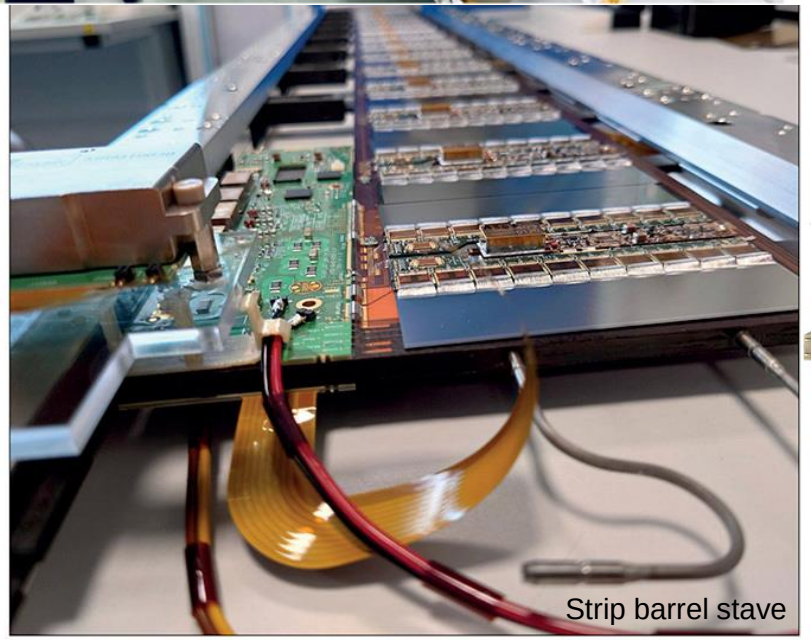

sMDT chambers at CERN


RPC full readout chain prototype tests

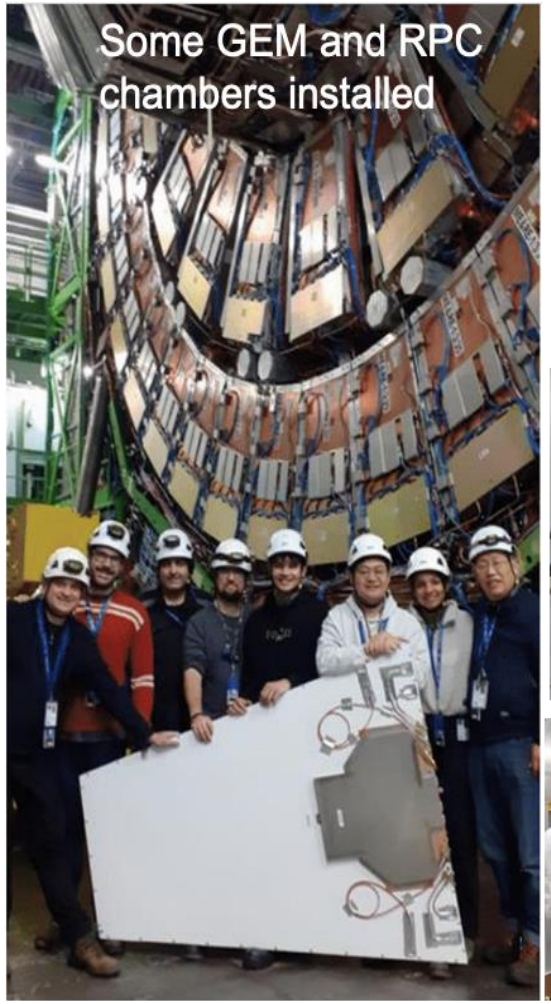

FELIX prototype



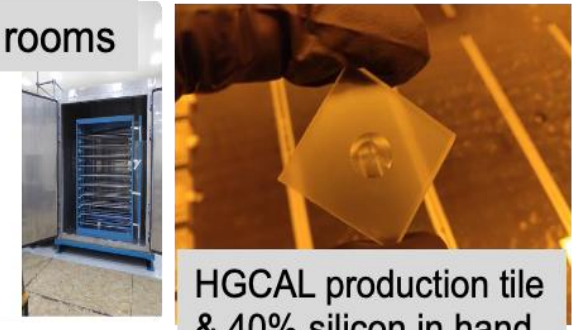

Pixel Endcap Ring


Strip barrel stave

CMS Phase II Upgrade

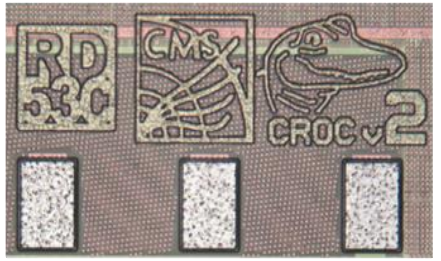


HGCAL cold rooms

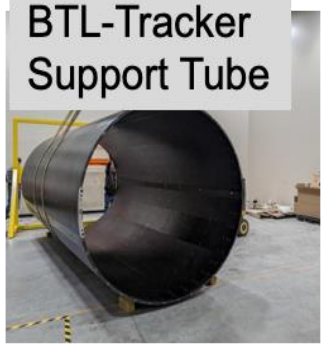


HGCAL production tile & 40% silicon in hand

Inner Tracker ASIC

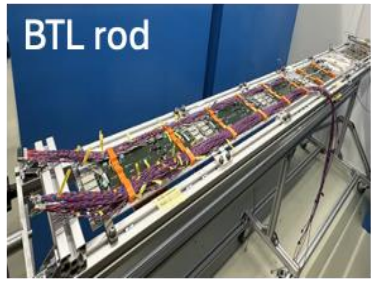


BTL-Tracker Support Tube



Tracker integration test

Barrel Calo insertion tool - enfourneur

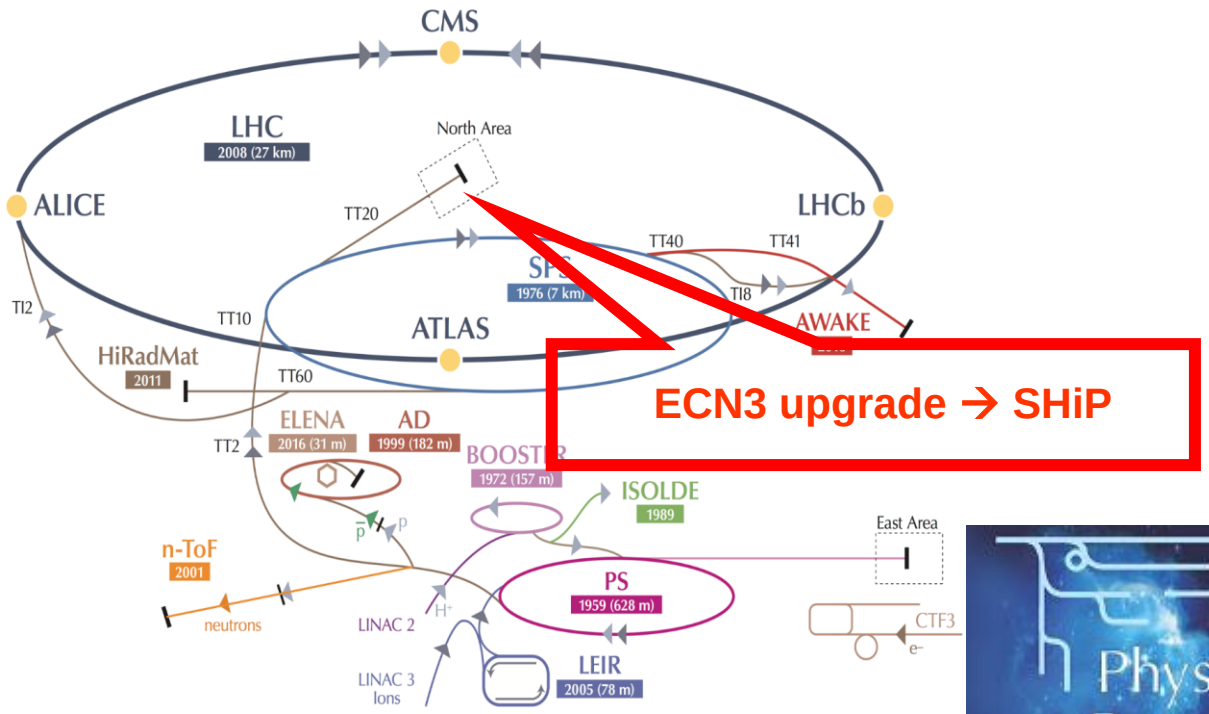


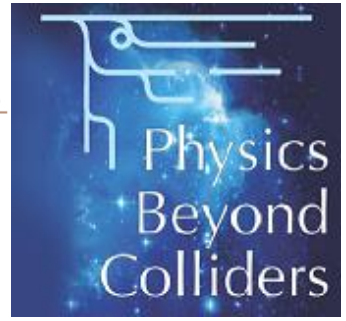
Summary Phase II Upgrades

- ATLAS and CMS continue to make good progress, with projects transitioning to (pre-)production
- Technical problems resulted in additional delays, which have eliminated the contingency on some critical subsystems
- Examples:
  - ATLAS ITk strip sensors
  - CMS HGCAL HGCROC ASIC
- Significant risks on the schedule still remain
- **Severe concerns about the schedule expressed by review committees LHCC, P2UGs, SPC, …**

Preparing LS3 Cost and Schedule Review for September 2024

CERN Diversity Programme





Future of the diversity programme discussed in the Physics Beyond Collider study

Topics include:

- ❑ LHC injectors
- ❑ Low energy facilities
- ❑ High energy fixed target
- ❑ Opportunities gamma-factory
- ❑ Precision measurement and rare decays
- ❑ High energy beam dumps
- ❑ Low energy hidden sector (axions, EDM)
- ❑ QCD and Heavy Ion

AD Experiments: Antiproton Decelerator for antimatter studies

AWAKE: proton-induced plasma wakefield acceleration

CLOUD: impact of cosmic rays on aeorosols and clouds

COMPASS → AMBER: hadron structure and spectroscopy

ISOLDE: radioactive nuclei facility

NA61/SHINE: ions and neutrino targets

NA62: rare kaon decays

NA63: radiation processes in strong EM fields

NA64: search for dark photons

NA65: study of tau neutrino production

Neutrino Platform: ν detector R&D for experiments in the US, Japan

n-TOF: n-induced cross-sections

~20 projects with > 1200 scientists

SHiP

Search for Hidden Particles (SHiP)

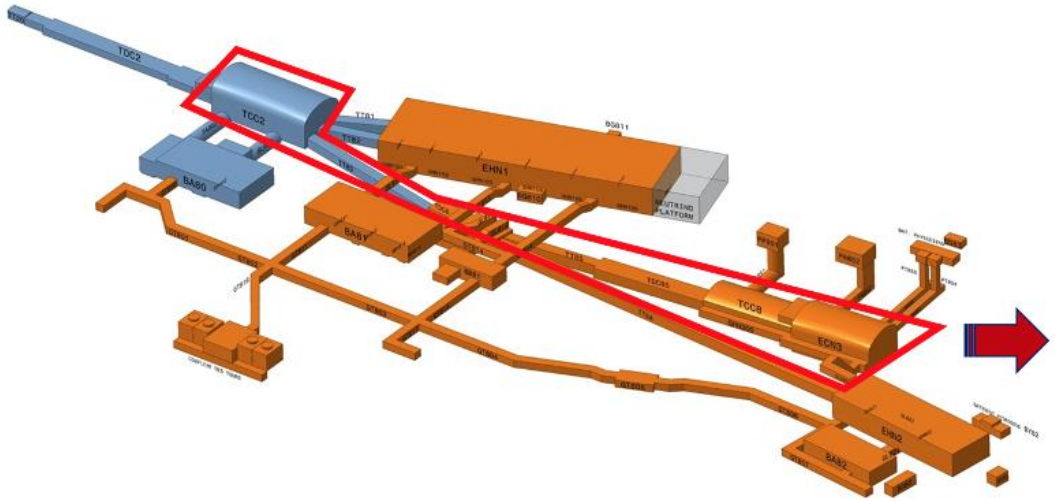
Selected for operation at upgrade ECN3:

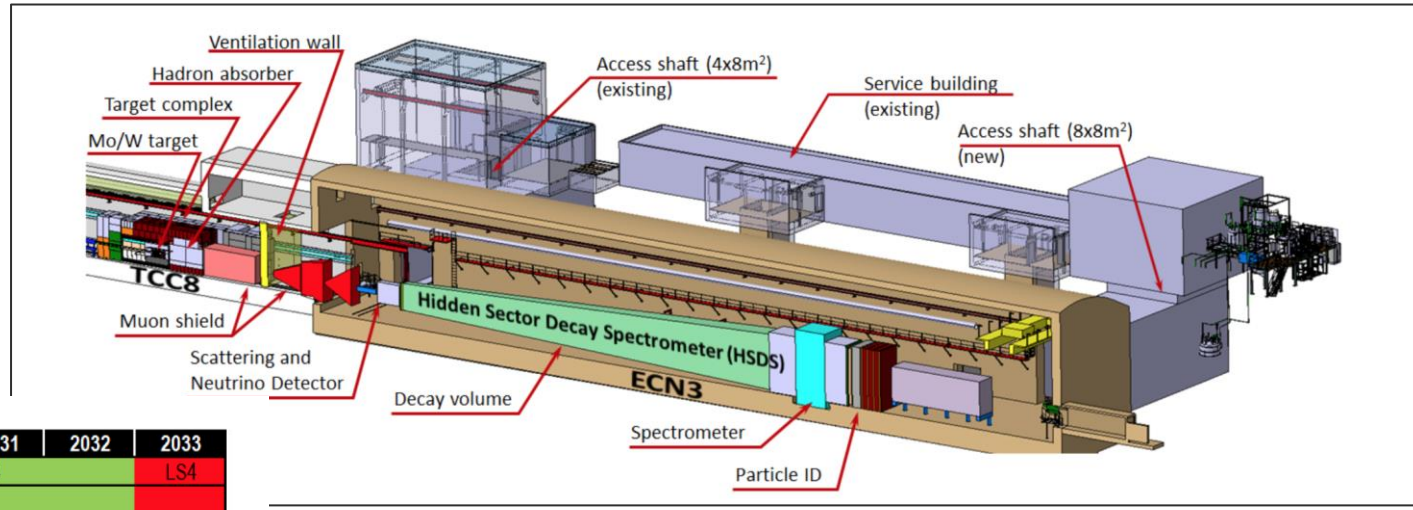
4×10^{19} POT/year

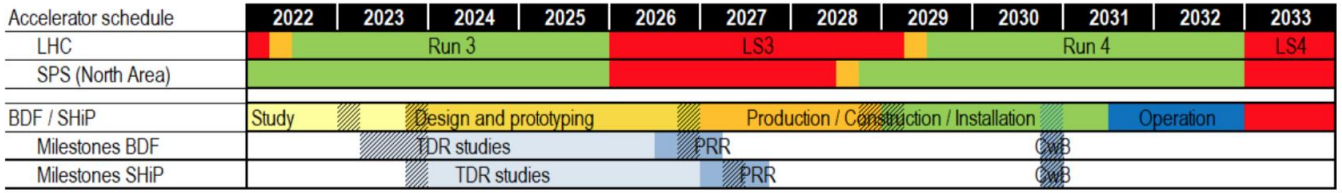
- ❑ Beam dump experiment
- ❑ Main scientific goal:
  search for feebly interacting
  GeV-scale particles (0.5 – 5 GeV)
- ❑ Details see:

https://cds.cern.ch/collection/SHiP%20Reports

Expected to start ≈ 2031 and last for ≈ 15 years





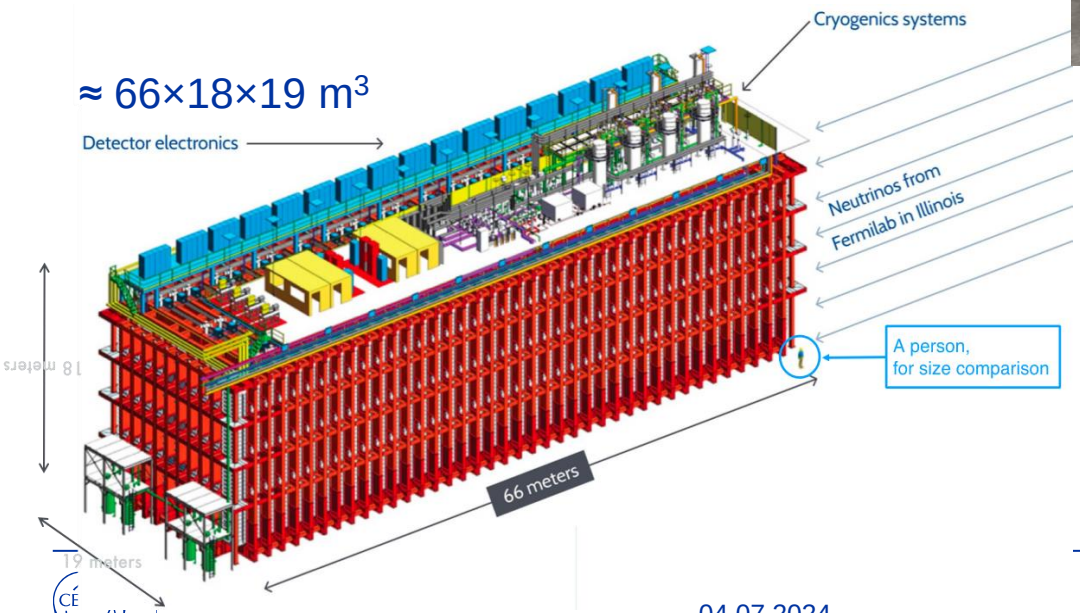


Neutrino Platform and LBNF/DUNE

At CERN two main activities for the LBNF/DUNE project in the US:

1) **Construction of two large cryostats for the DUNE far detectors**

- ❑ Production of warm steel structure completed for cryostat #1
- ❑ Arrived in Houston (TX) on board of a cargo ship early June
  ≈150 trucks to Rapid City (SD)



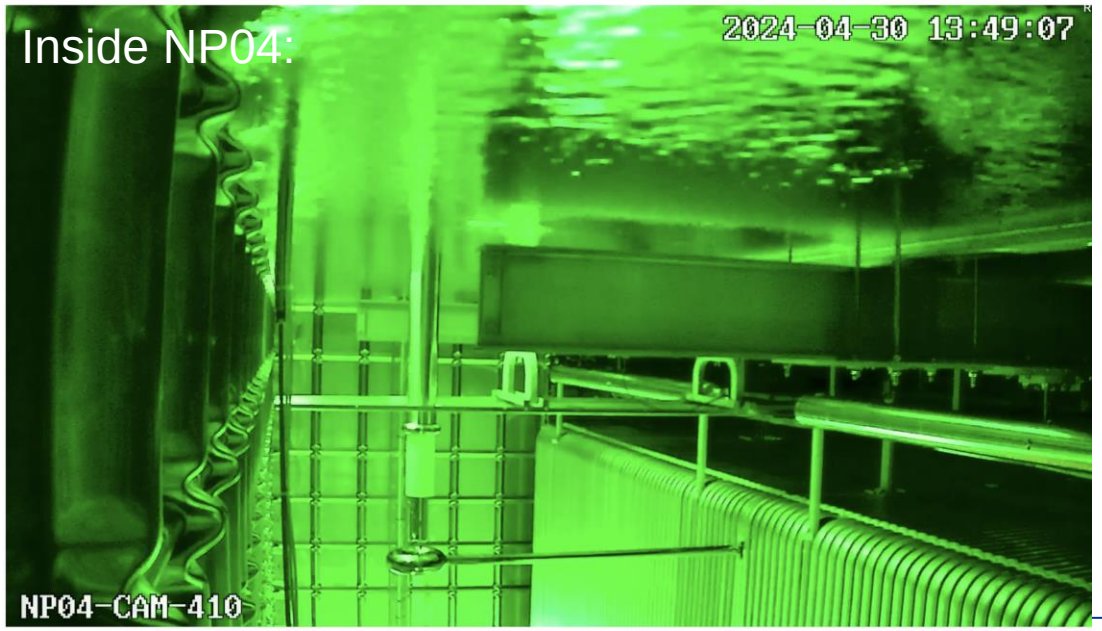
Neutrino Platform Activities

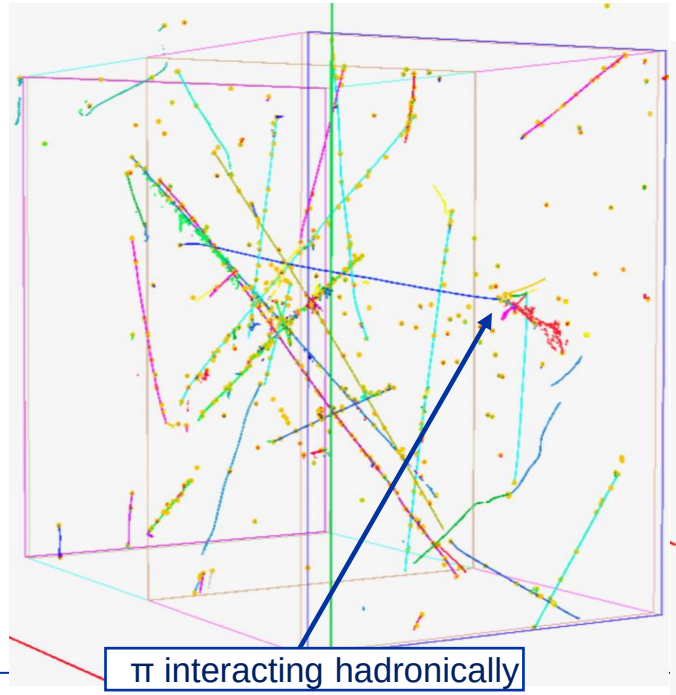
2) ProtoDUNE: Validation of the final prototypes of the DUNE far detectors (Horizontal and Vertical Drift concepts)

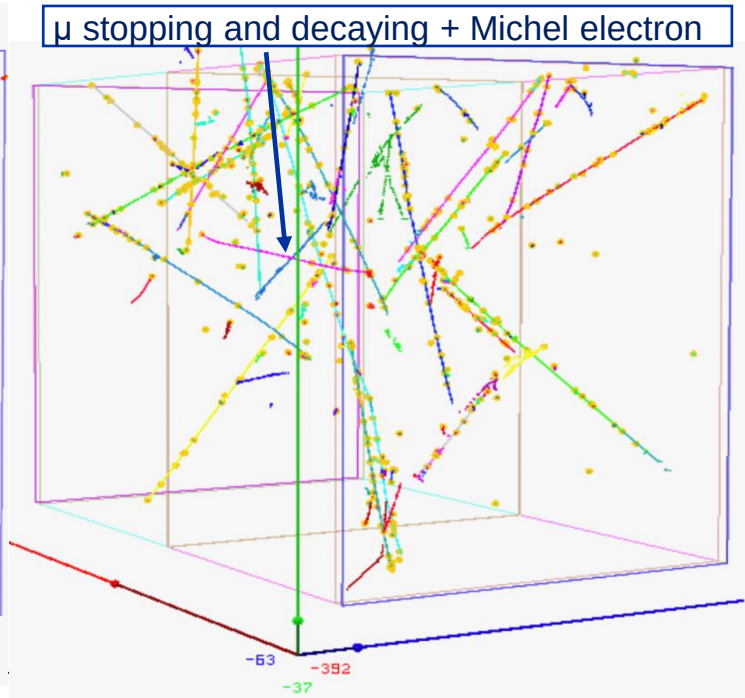
Status NP04 (Horizontal Drift concept)

- ❑ NP04 cryostat filling completed end April
- ❑ First week of beam (June 19th-26th), >3M events collected
- ❑ NP02 (Vertical Drift concept) will follow end 2024, early 2025

Filling stopped at 13:30 on the 30th of April

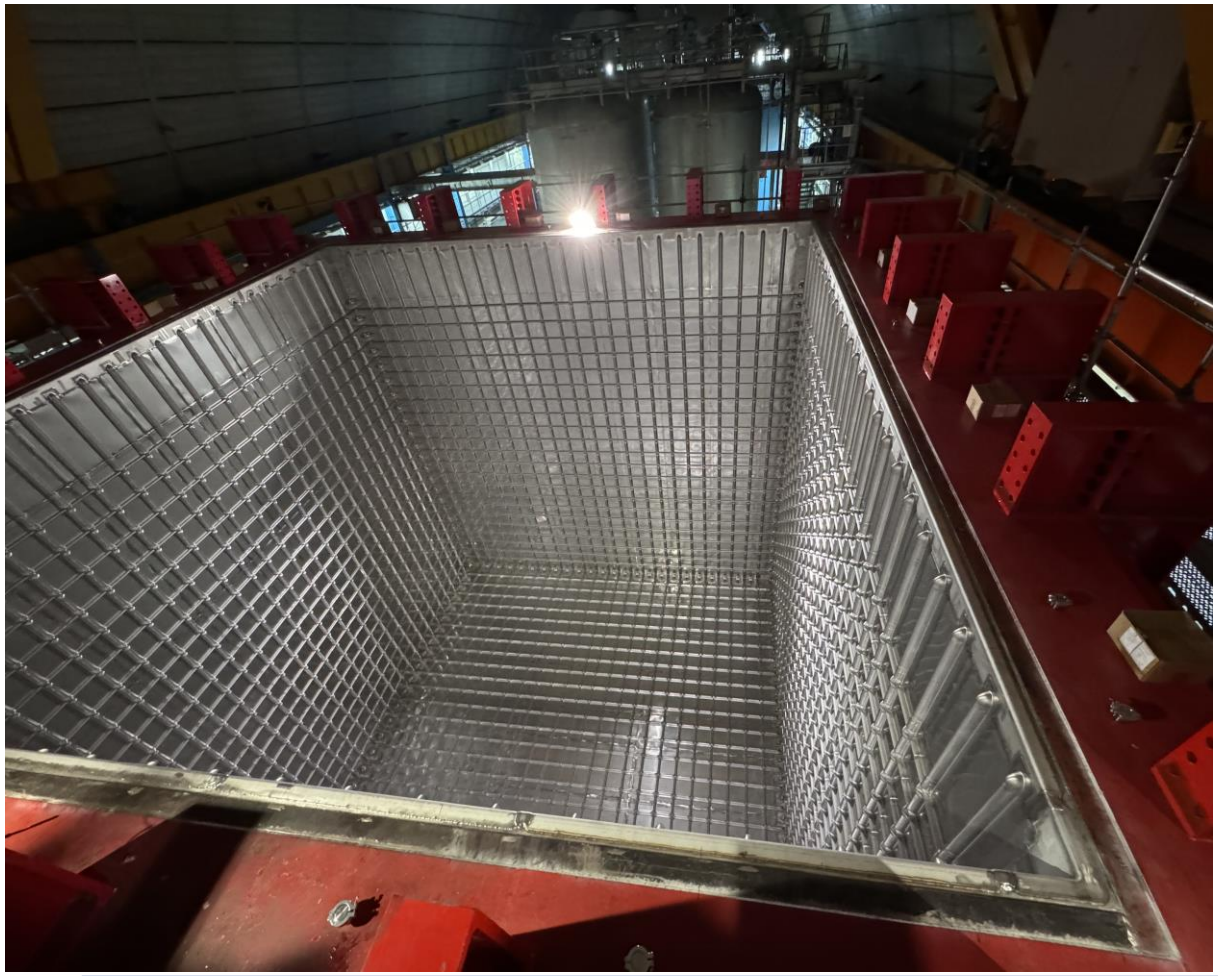




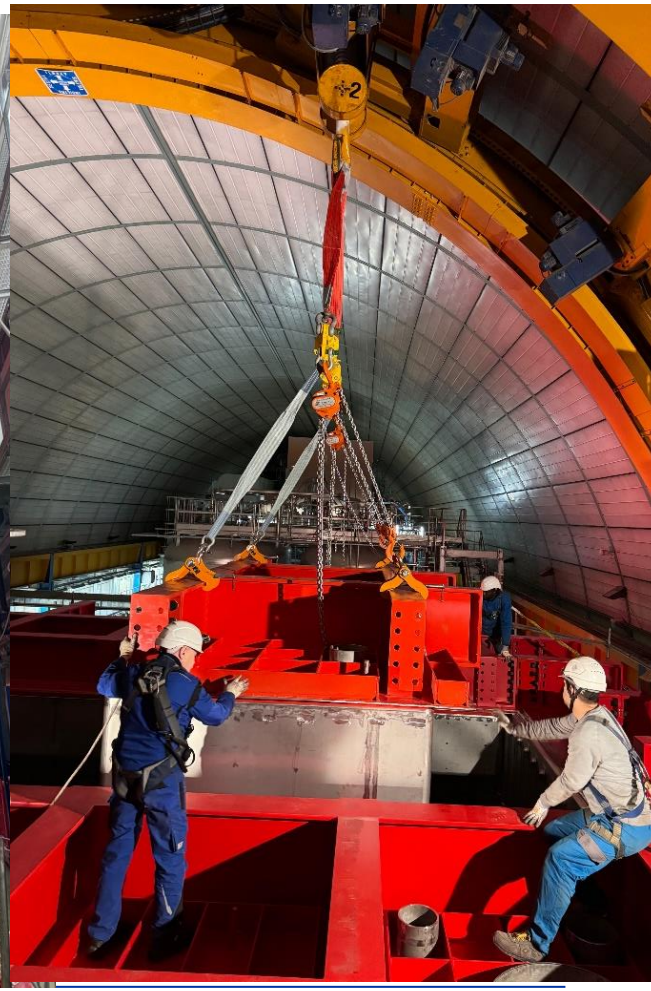


DarkSide Cryostat

CERN completed the construction of the cryostat for the DarkSide experiment at Gran Sasso



Early June 2024: Installation of the top-caps

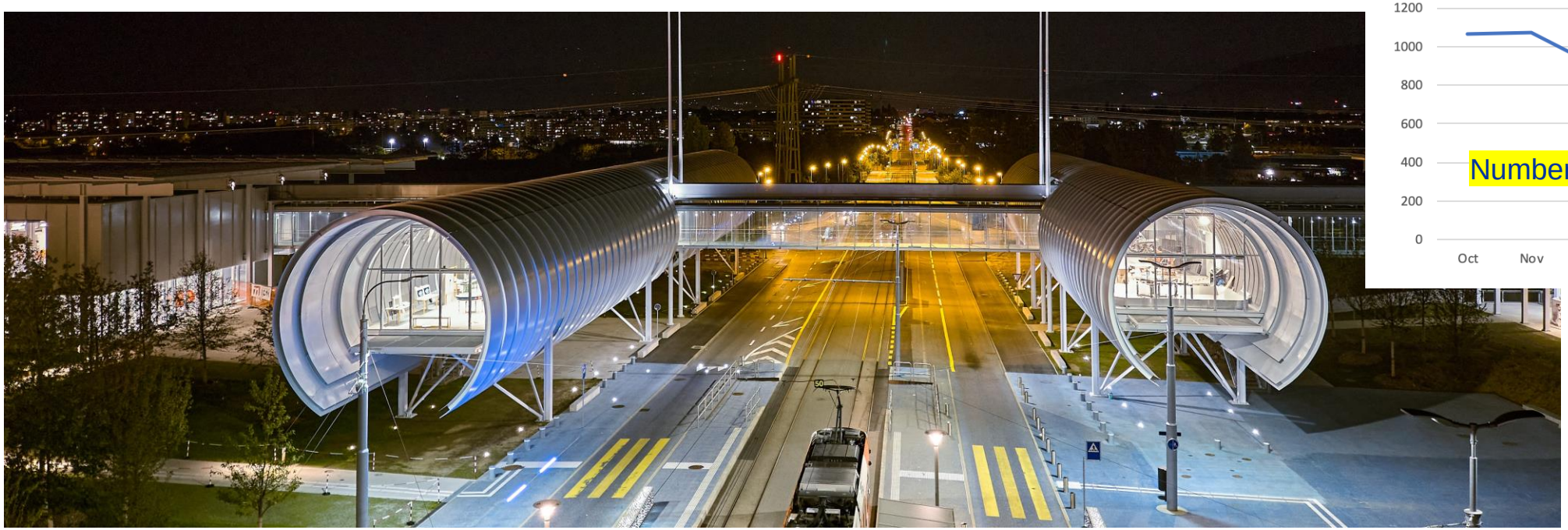


Prévessin Data Centre

- Phase 1 for 4 MW was completed successfully at the beginning of 2024
  - Inauguration February 23rd, 2024
- Heat recovery for Prévessin site
- Preparing for the next phase (8 MW for HL-LHC)

The inauguration of the new data centre in Prévessin. From left to right: Pippa Wells, CERN's Deputy Director for Research and Computing; Charlotte Warakaulle, CERN's Director for International Relations; Aurélie Charillon, Mayor of Prévessin-Moëns; Joachim Mnich, CERN's Director for Research and Computing; Yves Nussbaum, Director Marché Industrie, AXIMA; and Enrica Porcari, Head of Information Technology Department at CERN. (Image: CERN)

Science Gateway



- To date > 263 000 visitors since 8 October 2023 (day of opening to the public) from 159 countries, ≈ 60% individuals and families, ≈ 26% groups
- Extrapolation gives > 350 000 visitors/year as compared to ≈ 150 000/year before

- 4843 trainings given to 1440 individual guides (mostly users and staff)

→ **many thanks to all colleagues who volunteered!**

News from the CERN Family

23 Member States:

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

11 Associate Member States:

Brazil (joined in March 2024), Croatia, Cyprus, Estonia*, India, Latvia, Lithuania, Pakistan, Slovenia*, Turkey, Ukraine

* in the pre-stage to Membership

4 Observers:

Japan, USA, European Union, UNESCO (status of Russian Federation and JINR suspended)

~ 60 ICA (International Cooperation Agreements):

with non-Member States, some with countries with developing particle physics communities (CERN mission is also to help build capacity and foster growth of particle physics worldwide).

In addition:

- ❑ Estonia has been admitted by the Council as a Member State
- ❑ Chile and Ireland have submitted applications for Associate Membership

CERN Cooperation with Russia, Belarus and JINR

Council Resolution December 15th, 2023:

- terminate the International Cooperation Agreement (ICA) between CERN and the Russian Federation, together with all related protocols and addenda, with effect from **30 November 2024**
- terminate all other agreements and experiment memoranda of understanding allowing the participation of the Russian Federation and its national institutes in the CERN scientific programme, with effect from 30 November 2024;
- these measures concern the relationship between CERN and Russian and Belarusian institutes and do not affect the relationship with scientists of Russian nationality affiliated with other institutes;

See https://council.web.cern.ch/en/content/resolutions

Equivalent resolution decided for Belarus: **ICA termination date 27 June 2024**

No contributions from Russian institutes to experiments to be expected from 2025 onwards

Council June 2024:

ICA with JINR will **NOT** be terminated next January

- JINR and people affiliated to JINR can **continue** to be members of the **ongoing experiments**
- Note: all previous Council resolutions remain in force:
  - suspension of granting of contracts of association as associated members of the CERN personnel to any new individuals affiliated to home institutions in Russia and Belarus
  - no new projects, suspension of mutual observer status, suspension of participation of CERN scientists in JINR scientific committees and vice versa, no jointly organised events

Summary

- Promising start of the LHC in 2024
  - On track for ≈ 110 fb^{-1} delivered pp luminosity
- Good progress in HL-LHC and Phase II upgrades
  - But challenges and significant risks remain on the Phase II schedule
  - LS3 schedule discussion in September
- WLCG is running smoothly
  - Prévessin Data Centre in operation
- Good progress at Neutrino Platform and for LBNF/DUNE cryostats
- Science Gateway attracts many visitors to CERN!
- Termination of scientific collaboration with Russian and Belarus
  - Continue ongoing collaborations with JINR (Dubna)

Thank you for your attention!