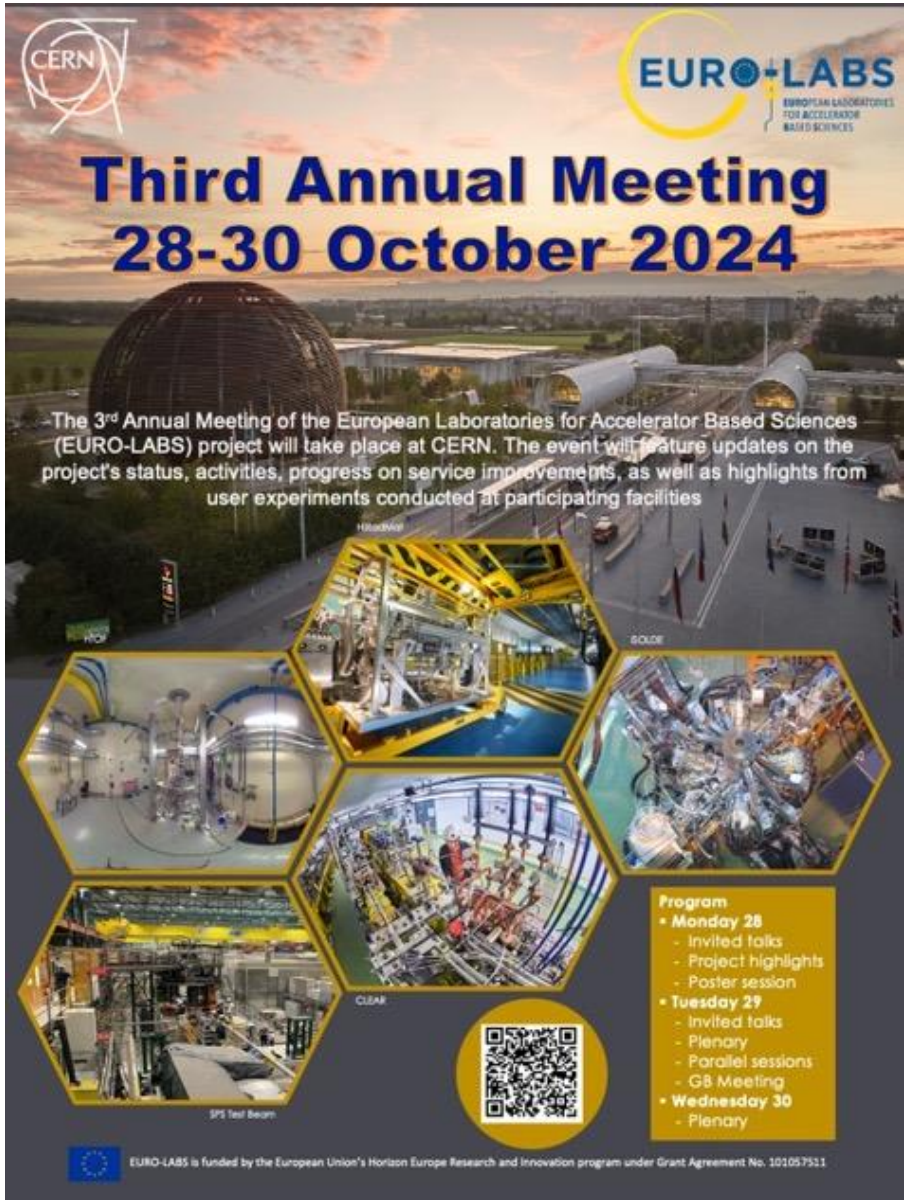


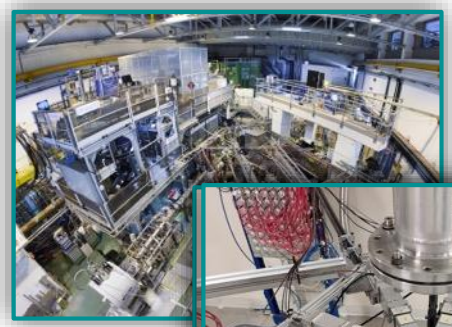
Welcome address

Few words to say as introductions:

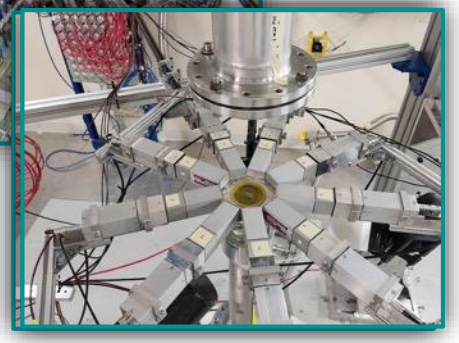
- Pleased to have and host the EURO-LABS 3rd annual meeting at CERN
- EURO-LABS is a unique project in two key ways:
  - First: it is a combined project in three communities/pillars: Nuclear Physics, Accelerators, HEP detectors,
  - Second : embraces numerous leading Research Infrastructures across Europe, offering a wide spread of beam energies, particle types, offering Transnational Access to teams to perform experiments and do research work, from fundamental physics (nuclear or high-energy) to accelerator R&D and applications (medical or industrial)
- CERN is a key partner in EURO-LABS participating with facilities in all three pillars (see next slide). Pleased to welcome the collaboration here at CERN.
- In particular, the young students and early carrier researchers who will have the opportunity to present the results of their work within EURO-LABS in talks of posters, some supported by CERN

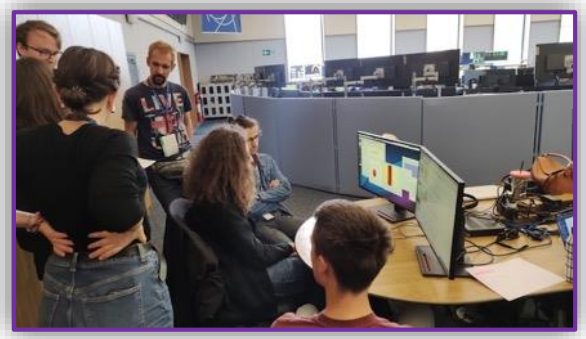
EURO-LABS @ CERN

ISOLDE

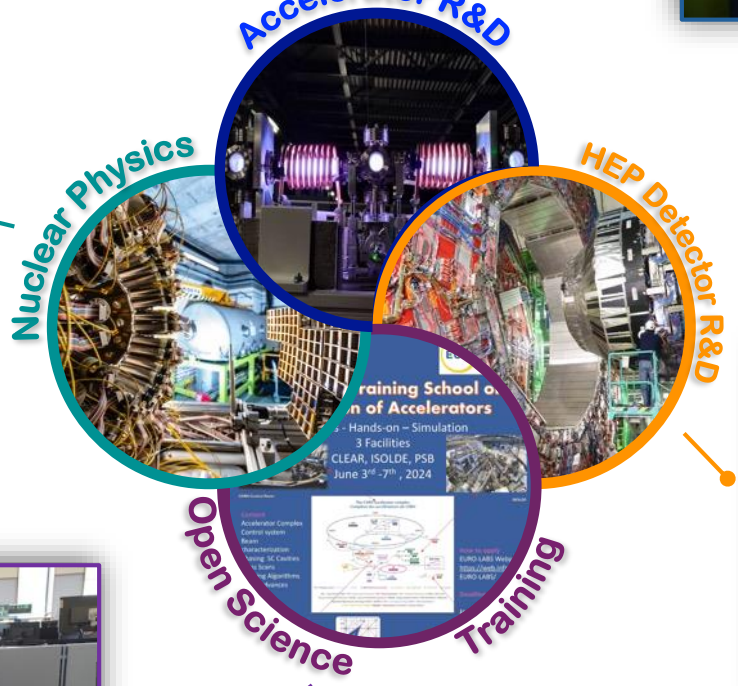


n-TOF





Hands-on Training School on CERN Accelerators : ISOLDE, PS-booster, CLEAR



CLEAR

HiRadMat

XBOX

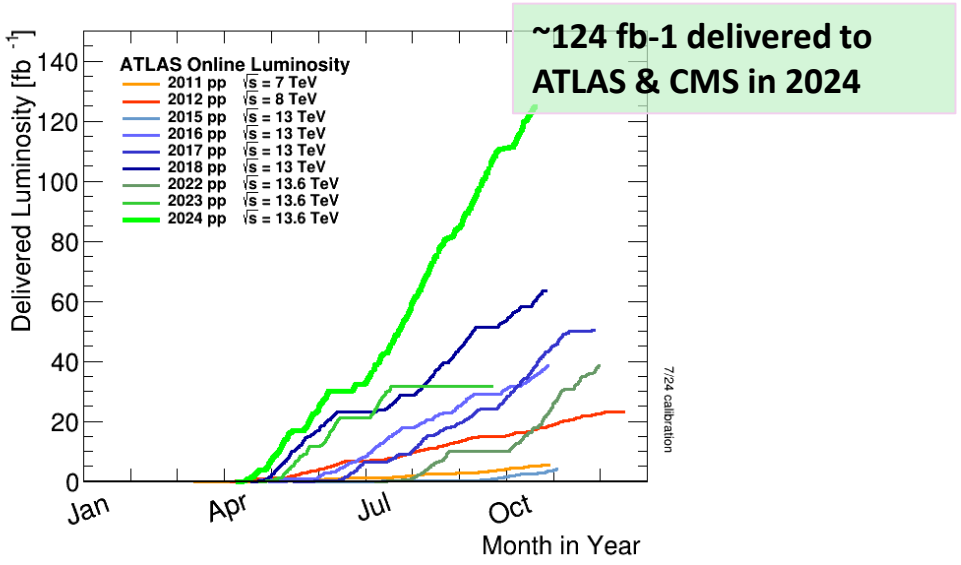
PS&SPS test beams

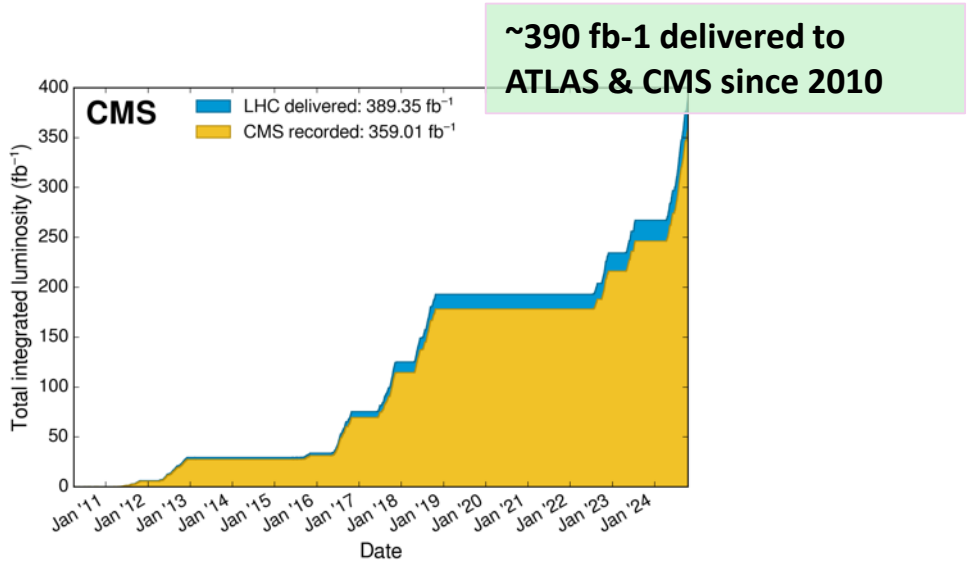
GIF++

IRRAD

CERN Present and Future - LHC

- Successfully completed the p-p program with record luminosity delivered in LHC experiments (Run 3)



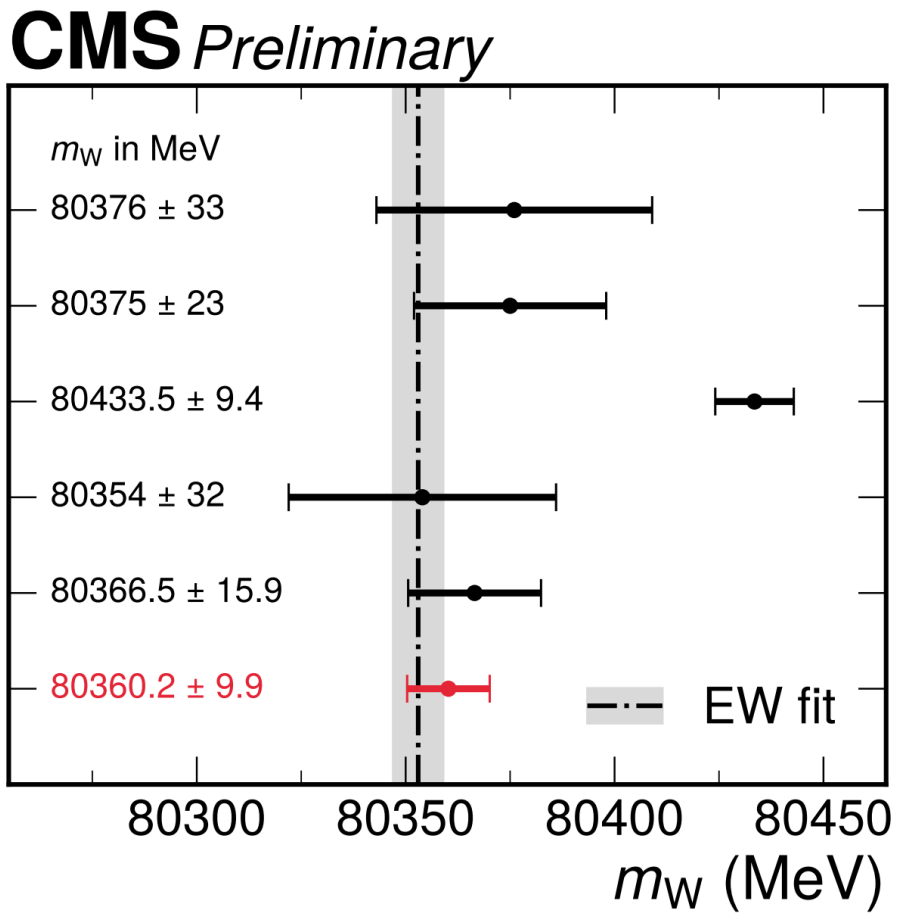


- This critical dataset enables numerous physics studies within the experiments, leading to significant results that scrutinize the Standard Model and explore searches beyond it.

CMS: Measurement of the W Mass

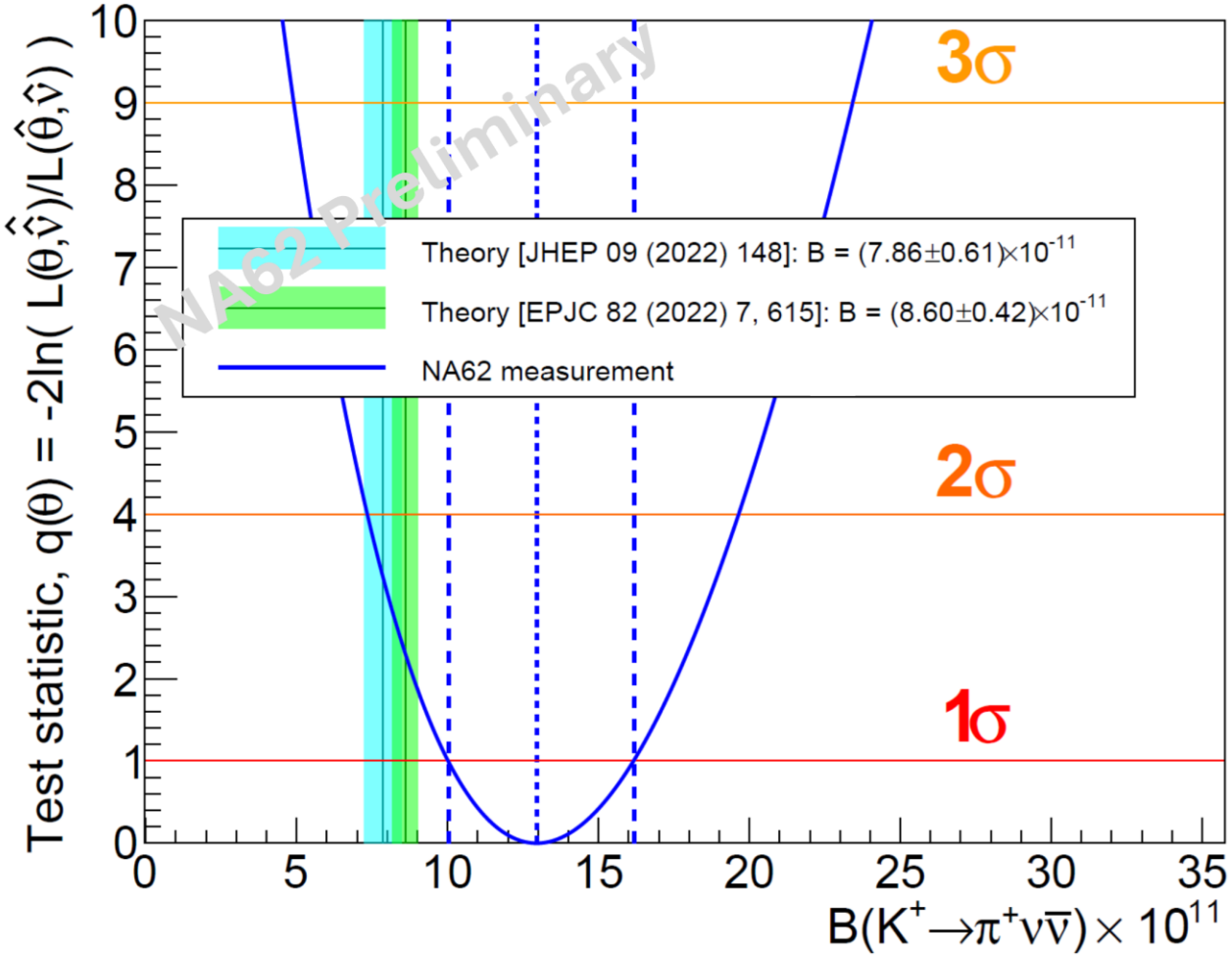
- Use well-understood subset of 13 TeV data: 16.8 fb^{-1} from later part of 2016 run
  (~ 30 mean interactions per crossing)
- Focus on muon channel
- Larger experimental systematics for electrons and hadronic recoil, especially with higher pileup
- Result:
  - m_W = 80 360.2 ± 9.9 MeV
- This is compatible with the Standard Model expectation and with other measurements
- Clear tension with CDF measurement

LEP combination
Phys. Rep. 532 (2013) 119
D0
PRL 108 (2012) 151804
CDF
Science 376 (2022) 6589
LHCb
JHEP 01 (2022) 036
ATLAS
arxiv:2403.15085, subm. to EPJC
CMS
This Work



$K^+ \to \pi^+ \nu\bar{\nu}$: NA62 Combined Result 2016-22 Data

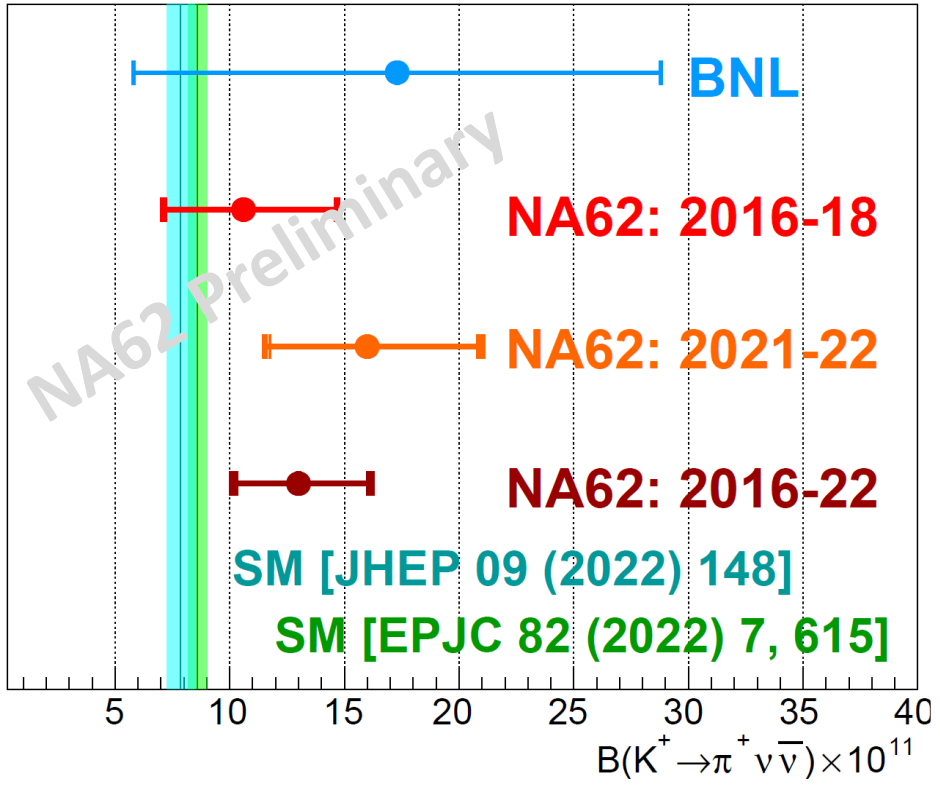
Single Event Sensitivity	$(0.42 \pm 0.02) \times 10^{-11}$
Expected background	18^{+3}_{-2}
Observed	**51**



b-only hyp. rejection significance: $Z = 5\sigma$

$$\mathcal{B}_{\pi\nu\nu} = \left[13.0\left(^{+3.0}_{-2.7}\right)_{stat}\left(^{+1.3}_{-1.2}\right)_{syst}\right] \times 10^{-11}$$

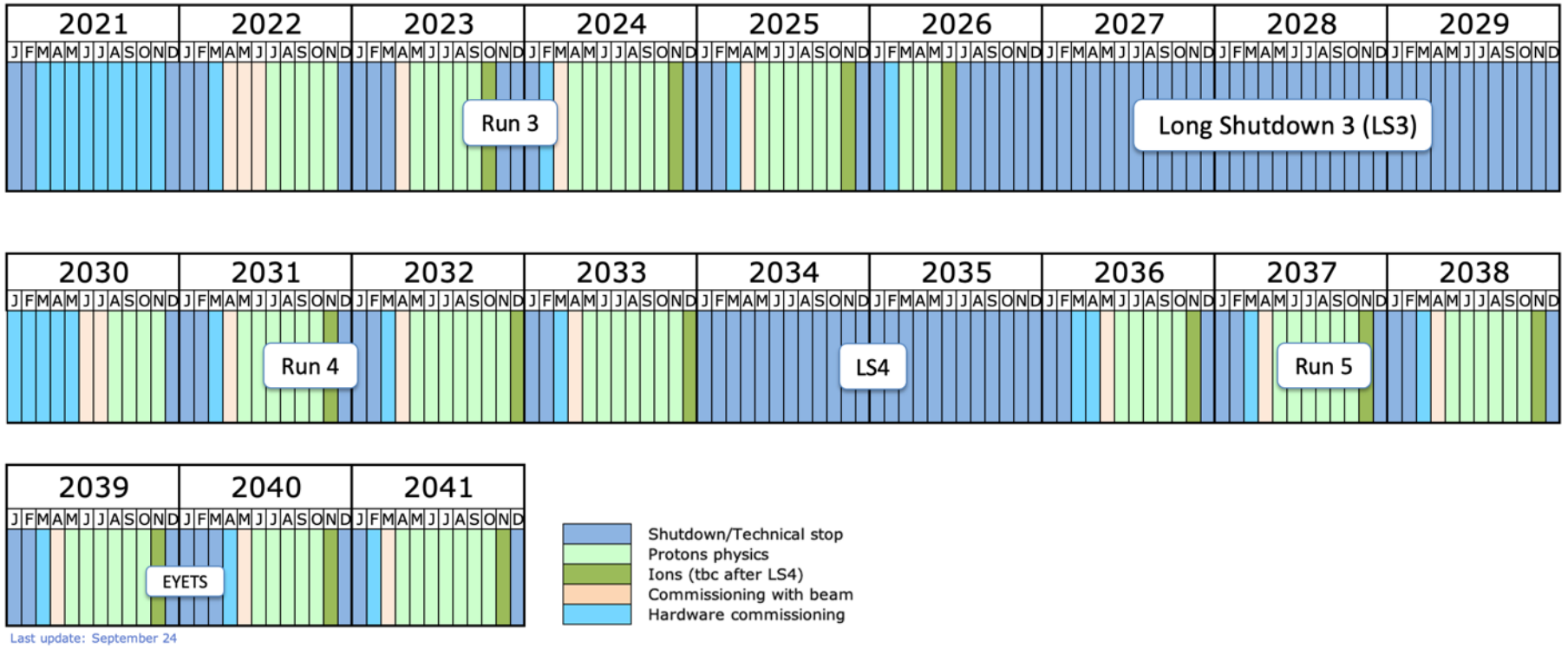
$$\mathcal{B}_{\pi\nu\nu} = \left(13.0^{+3.3}_{-2.9}\right) \times 10^{-11}$$



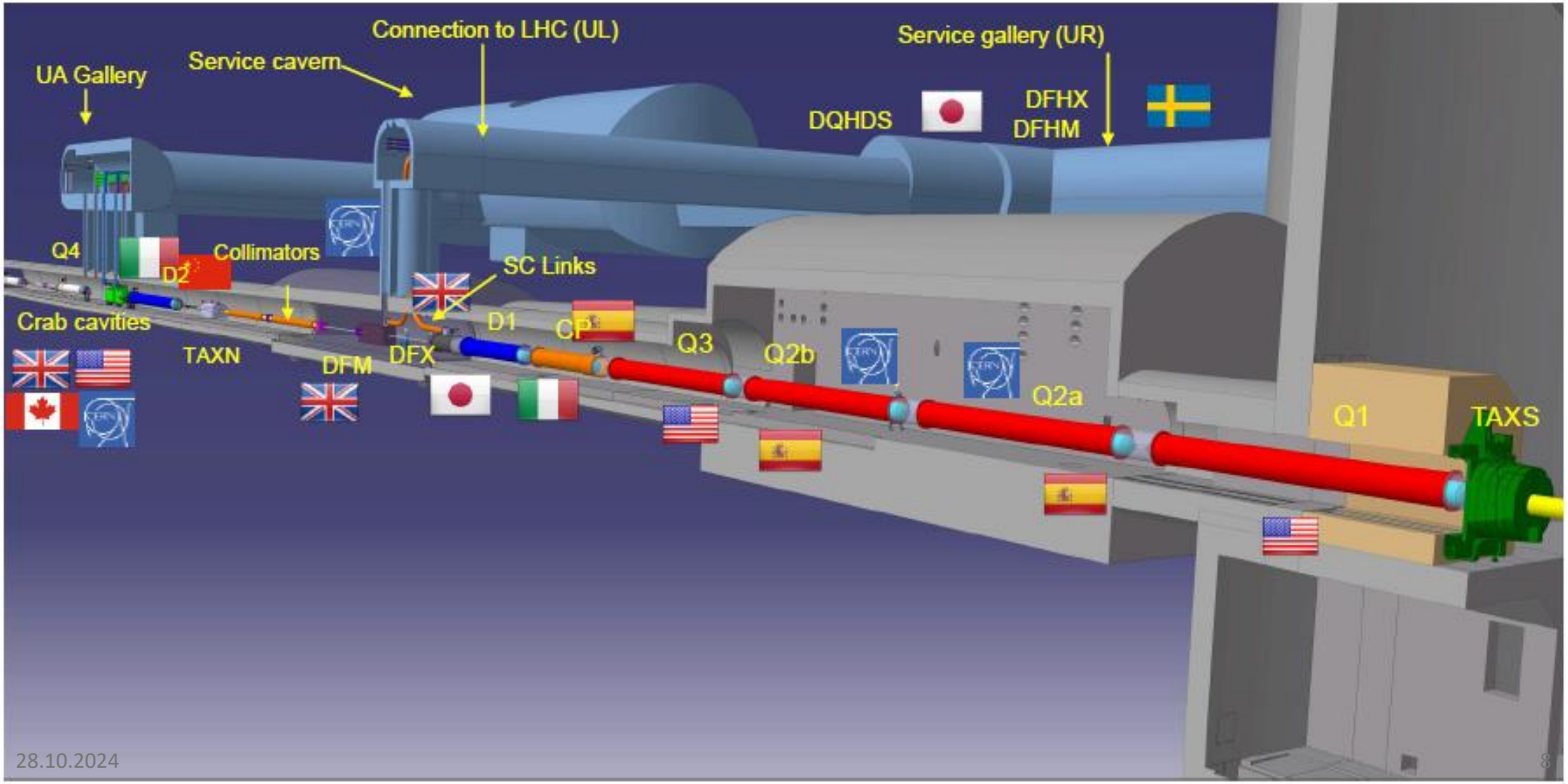
CERN Present and Future – HL-LHC

- The lab is preparing for the HL-LHC program aimed to deliver ~3000 fb^{-1} p-p to the experiments – updated schedule

- The HL-LHC operation includes major upgrades to the LHC experiments
- The extension in 2026 allows the facilities participating in EURO-LABS to provide Access until the end of the project (August 26)



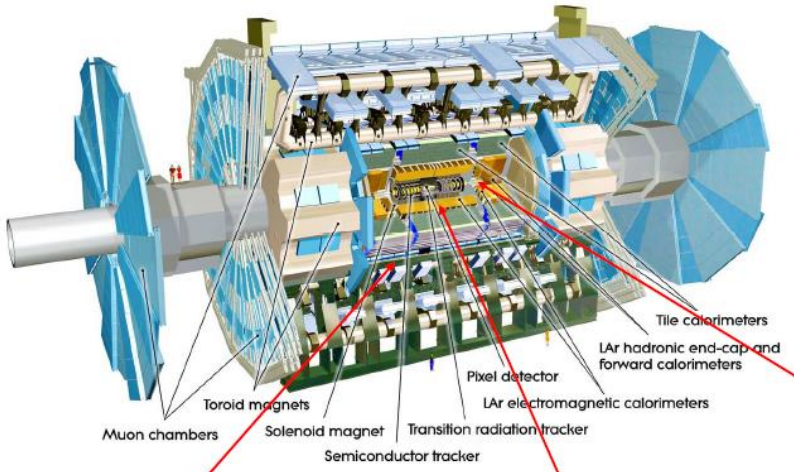
HL-LHC collaboration



Detector Upgrades

2 major detector upgrade projects

ATLAS



New Muon Chambers

Inner barrel region with new RPC and sMDT detectors

New Inner Tracking Detector (ITk)

All silicon, up to $|\eta| = 4$

Upgraded Trigger and Data Acquisition system

Level-0 Trigger at 1 MHz

Improved High-Level Trigger (150 kHz full-scan tracking)

Electronics Upgrades

LAr Calorimeter

Tile Calorimeter

Muon system

High Granularity Timing Detector (HGTD)

Forward region ($2.4 < |\eta| < 4.0$)

Low-Gain Avalanche Detectors (LGAD) v

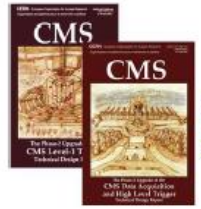
30 ps track resolution

Additional small upgrades

Luminosity detectors (1% precision goal)

HL-ZDC

CMS

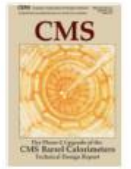


L1-Trigger HLT/DAQ

https://cds.cern.ch/record/2714892

https://cds.cern.ch/record/2759072

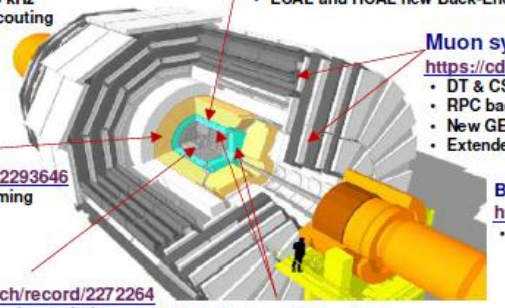
- Tracks in L1-Trigger at 40 MHz
- PFlow selection 750 kHz L1 output
- HLT output 7.5 kHz
- 40 MHz data scouting



Barrel Calorimeters

https://cds.cern.ch/record/2283187

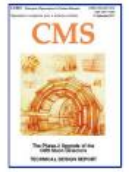
- ECAL crystal granularity readout at 40 MHz with precise timing for e/γ at 30 GeV
- ECAL and HCAL new Back-End boards

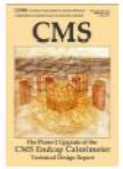


Muon systems

https://cds.cern.ch/record/2283189

- DT & CSC new FE/BE readout
- RPC back-end electronics
- New GEM/RPC $1.6 < \eta < 2.4$
- Extended coverage to $\eta \simeq 3$





Calorimeter Endcap

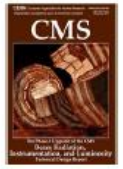
https://cds.cern.ch/record/2293646

- 3D showers and precise timing
- Si, Scint+SiPM in Pb/W-SS

Beam Radiation Instr. and Luminosity

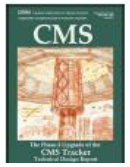
http://cds.cern.ch/record/2759074

- Bunch-by-bunch luminosity measurement: 1% offline, 2% online



Tracker https://cds.cern.ch/record/2272264

- Si-Strip and Pixels increased granularity
- Design for tracking in L1-Trigger
- Extended coverage to $\eta \simeq 3.8$

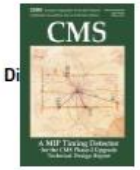


MIP Timing Detector

https://cds.cern.ch/record/2667167

Precision timing with:

- Barrel layer: Crystals + SiPMs
- Endcap layer: Low Gain Avalanche Di



CERN Present and Future – Beyond HL-LHC

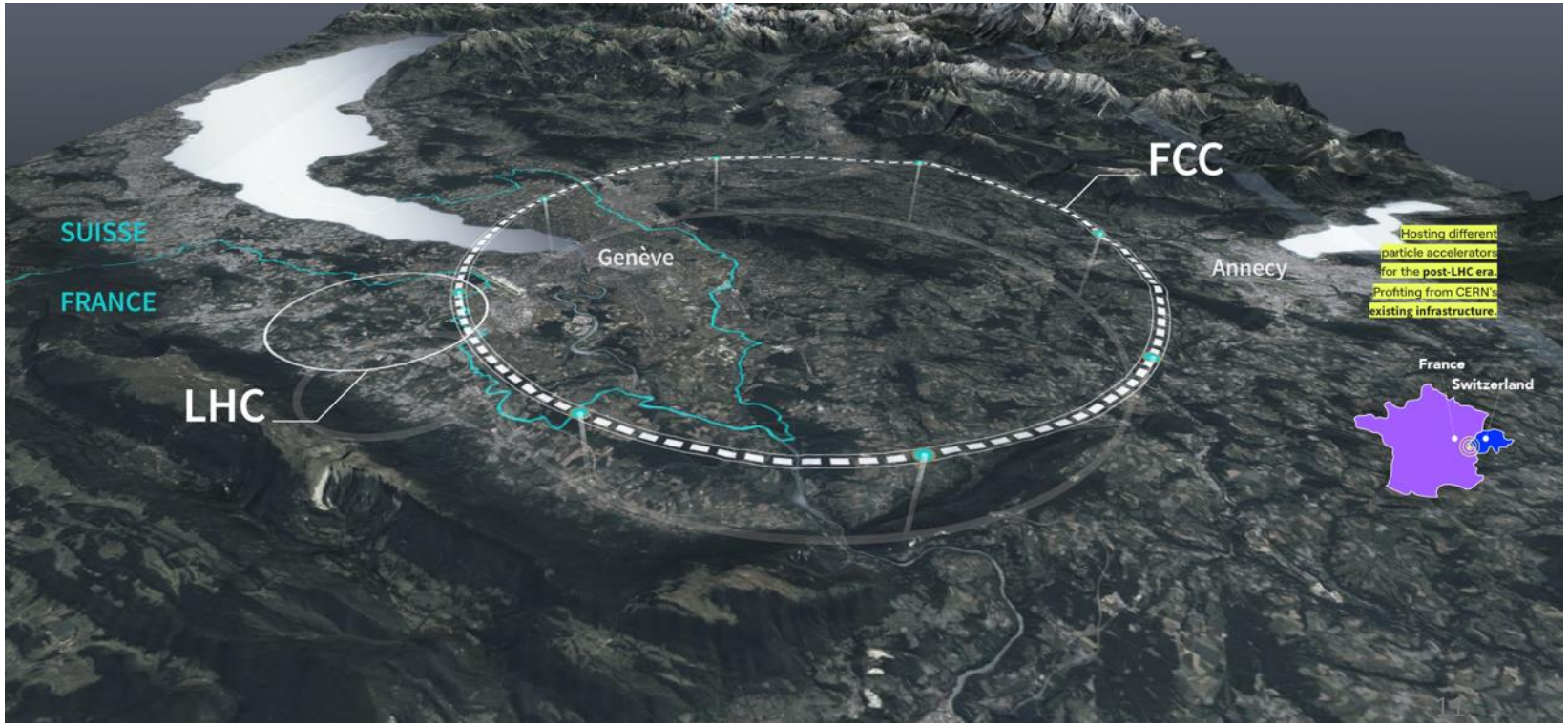
- European Strategy Third Update : 2024 – 2026
- Goals : develop a visionary and concrete plan that greatly advances knowledge in fundamental physics through the realisation of the next flagship collider at CERN, and to prioritize alternative options to be pursued if the preferred plan turns out not to be feasible or competitive.

- Details in the following talk by Paris

CERN Present and Future – FCC Study

- Ongoing study for the post-LHC, next generation era
- Physics case: configuration FCC-e+e- to precisely study the heaviest particles of the SM, their interactions and couplings, Z, W, H, top. Followed by an FCC-hh for a 100 TeV proton collider to explore the energy frontier.

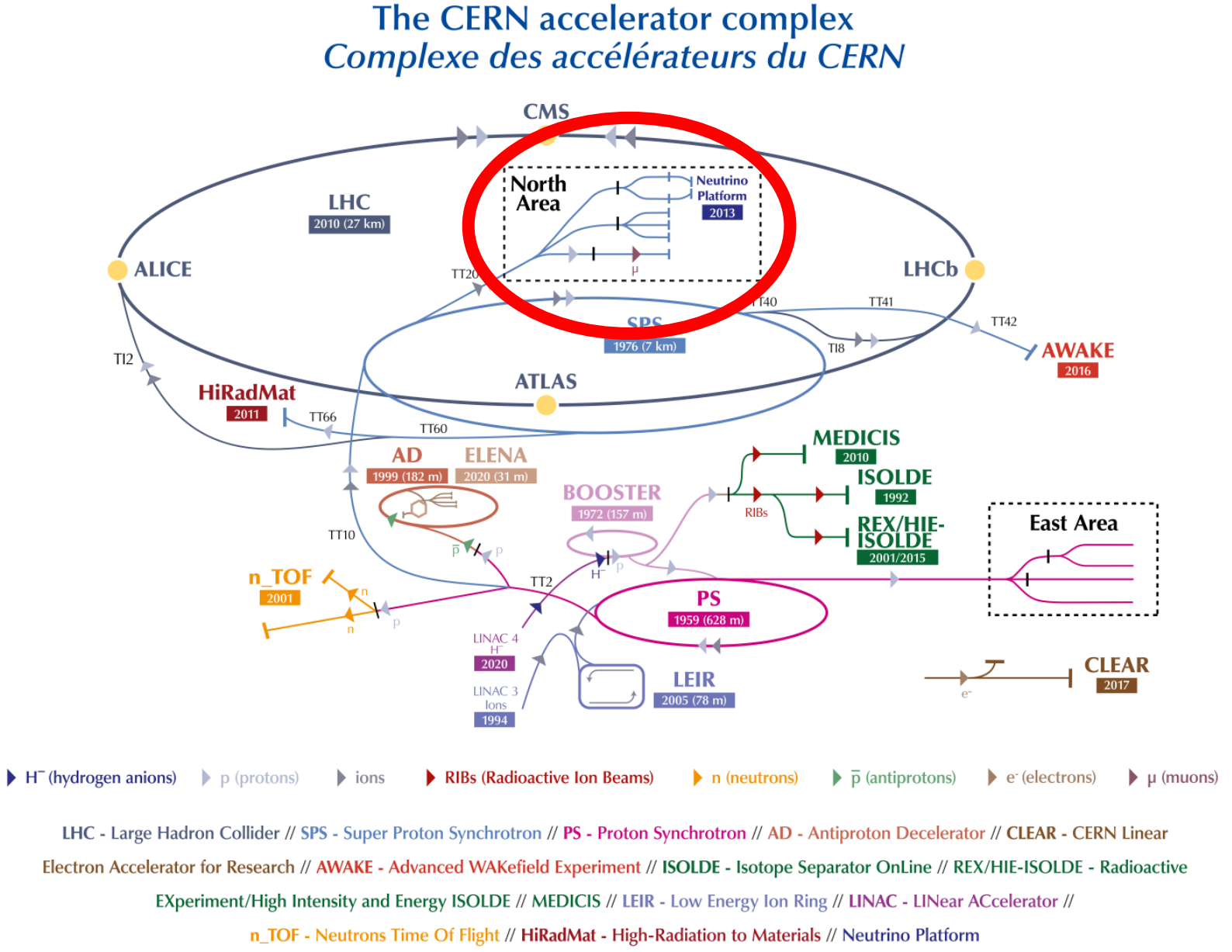
Details on the challenges for the Fcc-ee collider in the following presentation by Jacqueline



CERN Present and Future – Beyond LHC

- Rigorous and diverse scientific program in various fronts
  - ISOLDE, nTOF (of particular interest for EURO-LABS)
  - SHIP
  - AD
  - Neutrino Platform – DUNE experiment in U.S.A
  - SPS upgrade and PS/SPS test beams (again of interest to EURO-LABS)
- All these are expected to continue during HL-LHC operation

- Scientific diversity remains one of the main strengths of CERN
- Accelerator complex needed for the LHC serves a broad scientific program ranging from atomic to nuclear and particle physics
- Focus on areas unique to CERN infrastructure
- Below 2 examples from the North Area



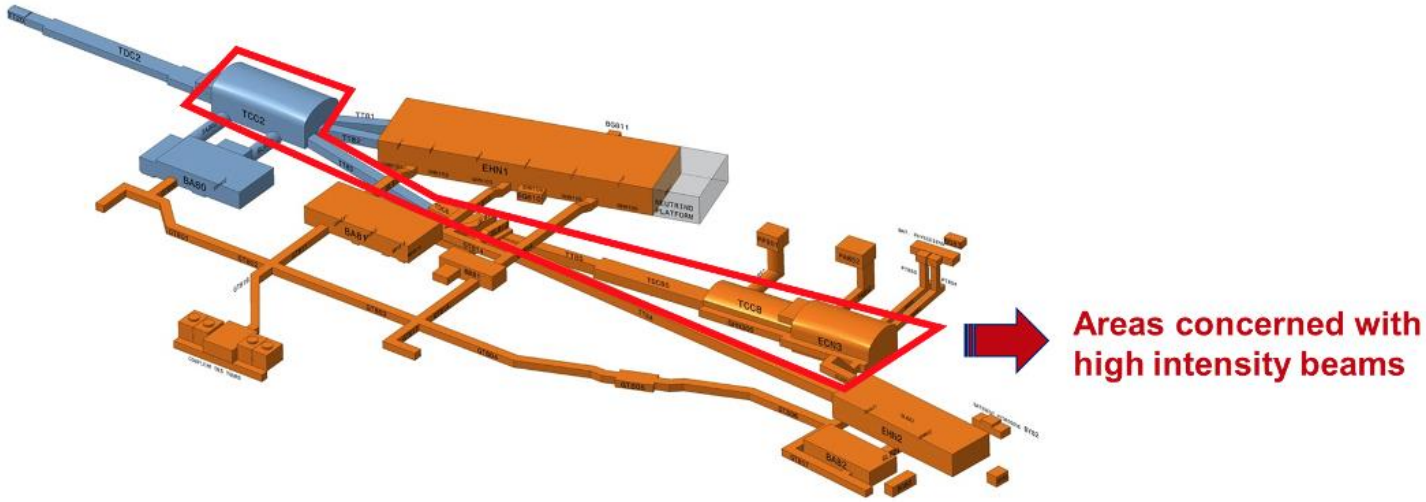
SHiP

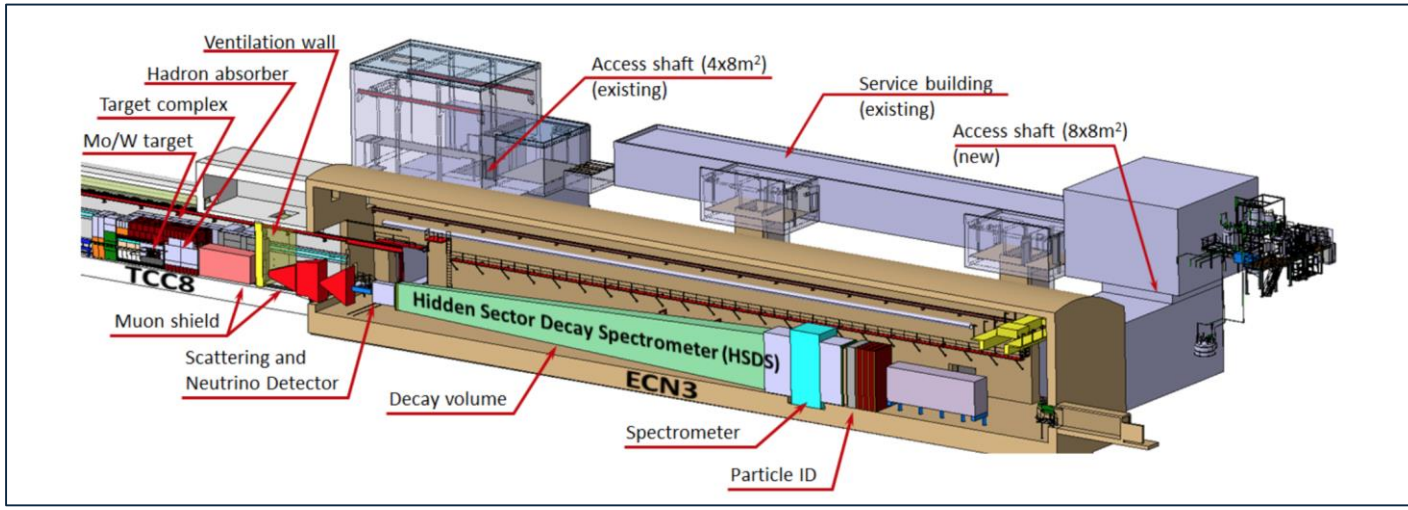
Search for Hidden Particles (SHiP)

- ❑ Selected by CERN directorate for operation at upgraded ECN3:
  Beam dump experiment: 4×10^{19} POT/year
- ❑ 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 ≈ 2032 and last for ≈ 15 years





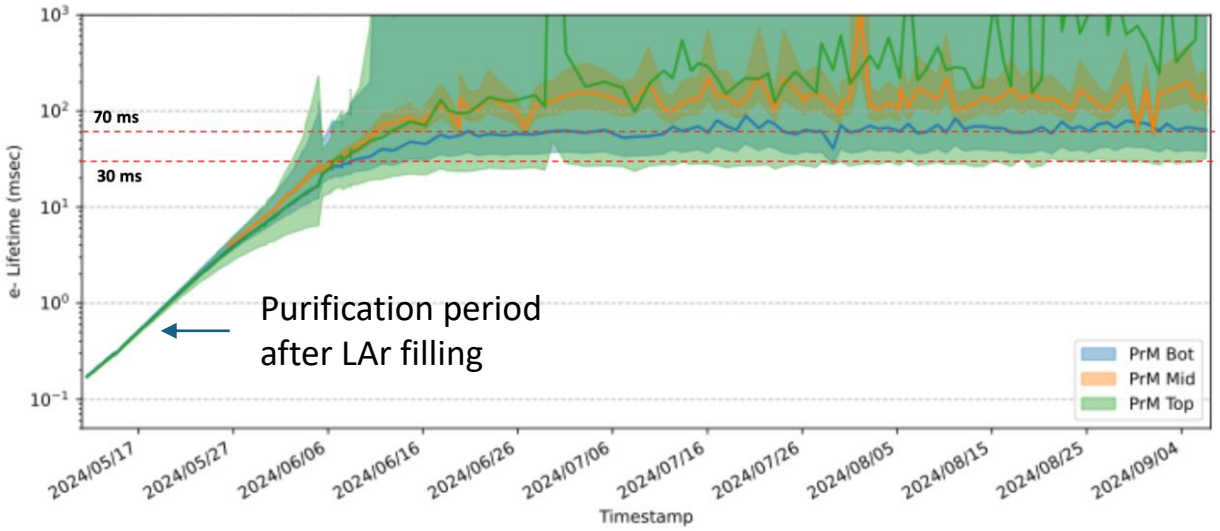
Neutrino Platform

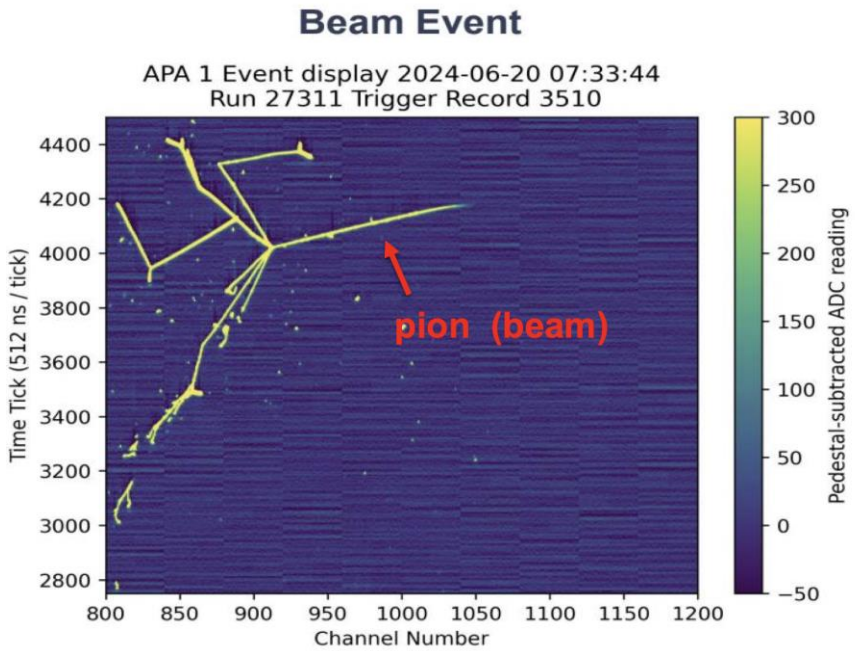
Final tests of large LAr TPC concepts for DUNE:

- ❑ NP04 (horizontal drift) in operation since beginning of May
- ❑ Extremely pure: drifting electron lifetime exceeding 50 ms (Note: requirement is 3 ms)
- ❑ Very low electronic noise and only ~1 ‰ channels loss or problematic
- ❑ Stable HV >99.9% uptime at nominal field
- ❑ DAQ throughput exceeding DUNE requirements
- ❑ Validation of changes/improvements from ProtoDUNE-1

About 30 million triggers from beam events:

- ❑ Beam scans: 1-7 GeV/c with both polarities
- ❑ Most data at 1 GeV/c for pion cross-section measurement
- ❑ 2 million beam trigger with 5 GeV/c K and p (+/-)
- ❑ Unique sample for physics
- ❑ 4.2 PB of beam data, 0.8 PB of cosmics





Thank you for your attention!