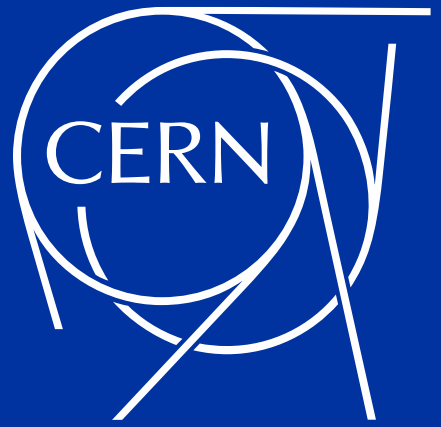
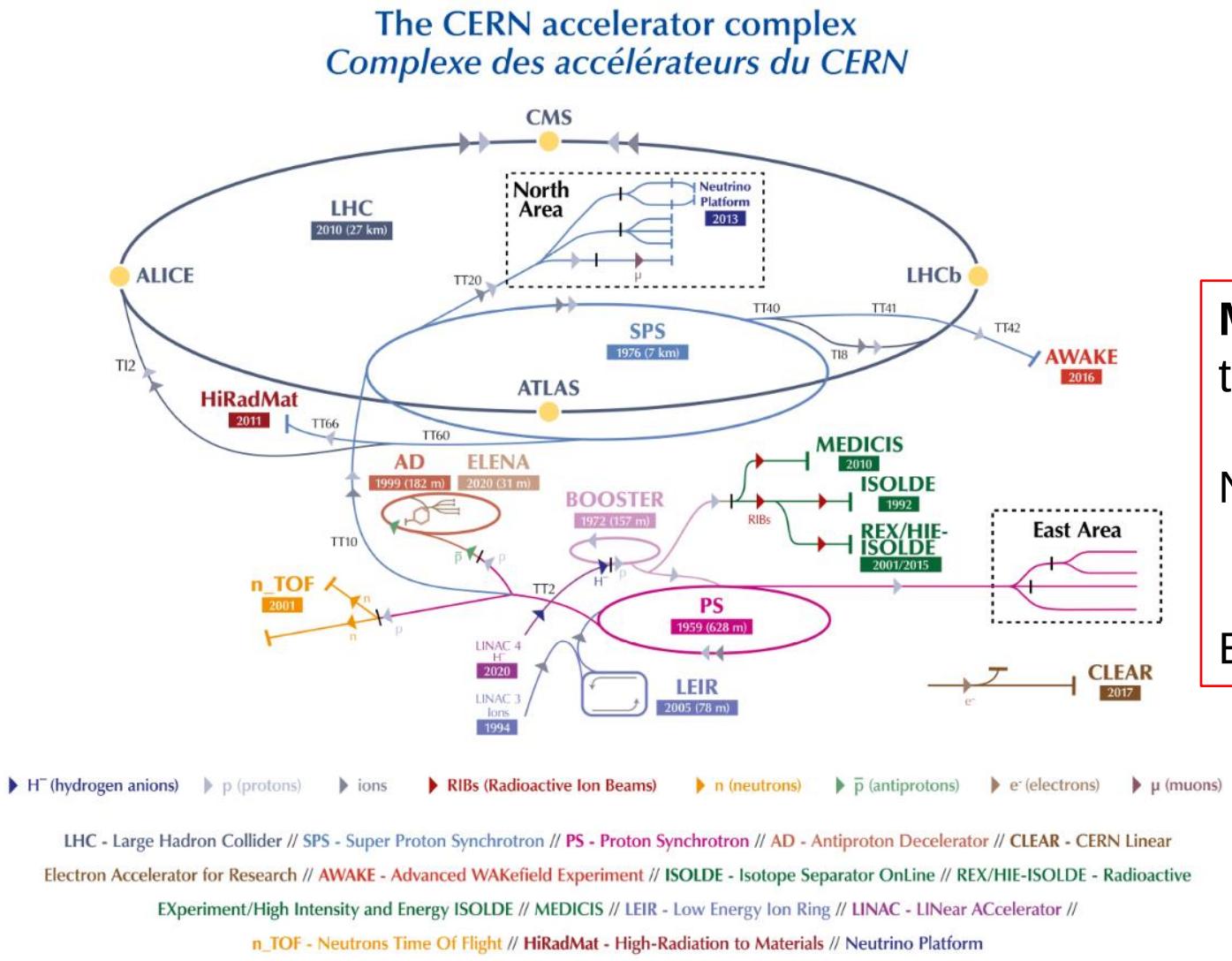


CERN Secondary Beamlines and Test Beams Facilities Overview

F. Metzger, E. Andersen, D. Banerjee, A. Baratto Roldan, J. Bernhard, M. Brugger, N. Charitonidis, M. van Dijk, L. Dyks, A. Goillot, M. Jebramcik, R. Murphy, L. Nevay, E. Parozzi, B. Rae, S. Schuh, F. Stummer (BE-EA)

15.04.2024

CERN Accelerator Complex



SPS: protons @ $400\mathrm{GeV}$; ions @ $380\mathrm{GeV}/Z$
PS: protons / ions @ $24\mathrm{GeV}/Z$

Maximum momenta available to the users in the PS/SPS Test Beam Facilities:

North Area → $\leq 360\mathrm{GeV}/Z$ (secondary beam) or primary beams

East Area → $\leq 16\mathrm{GeV}$ (secondary beam only)

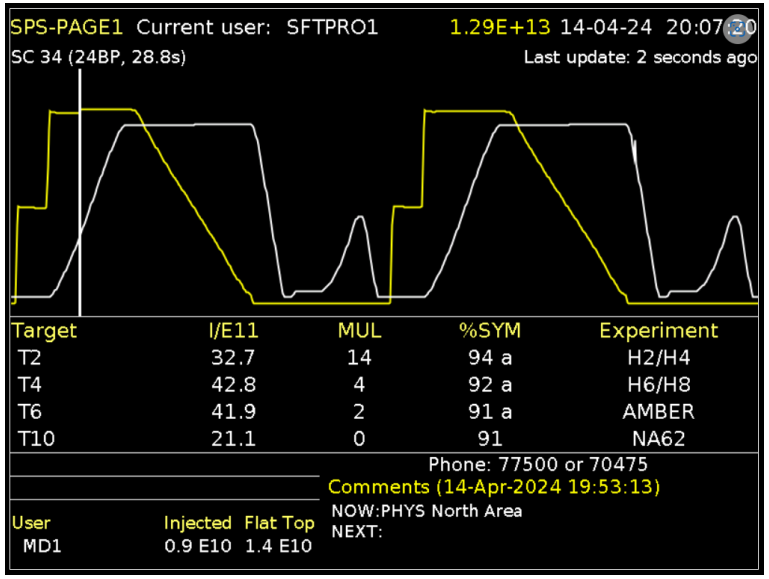
North Area

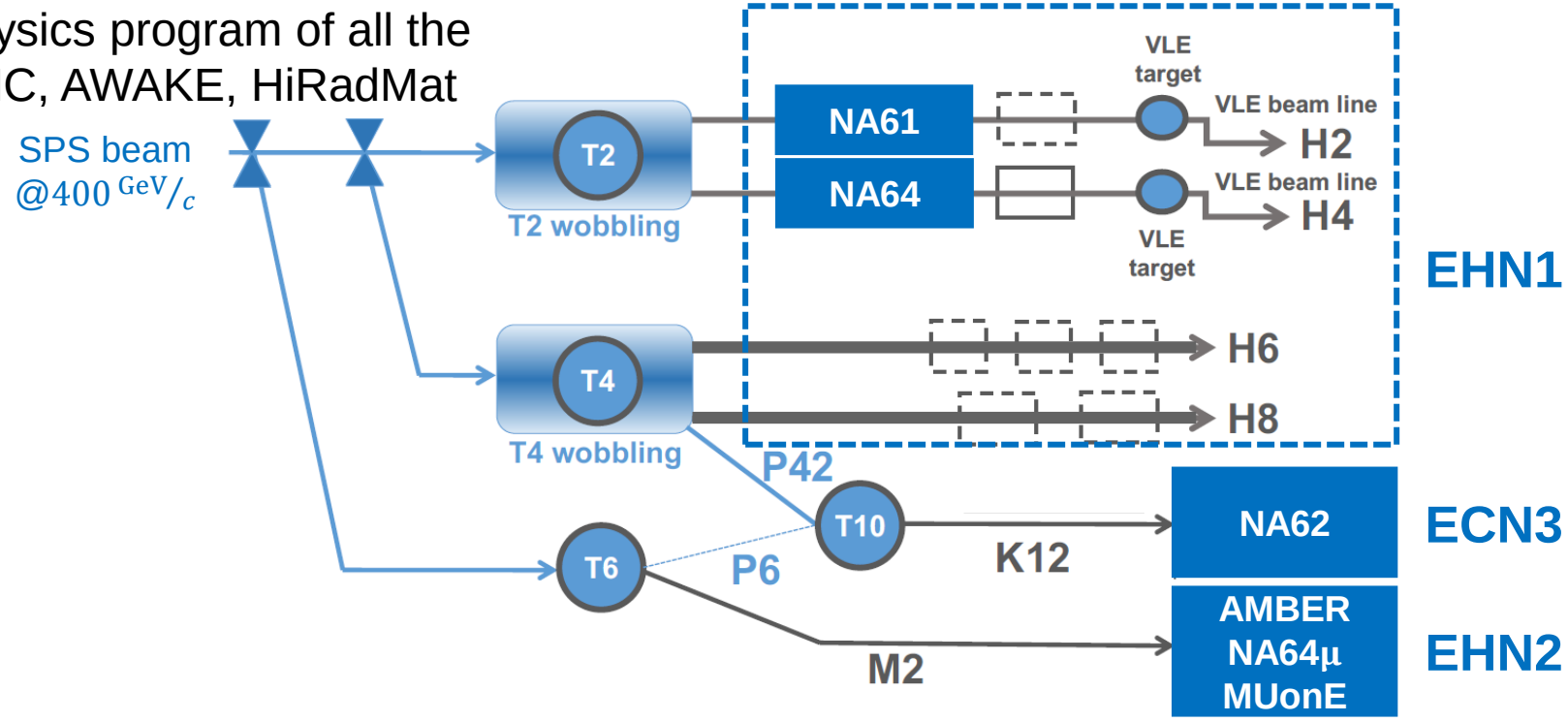
North Area Secondary Beamlines

Spill duration: $4.8s$ flat top
Typically : **2 cycles / SPS supercycle** for NA and
~ 3000 spills/day

The $400\ ^{GeV}/_{c}$ primary beam is slowly extracted to three primary targets → T2, T4 and T6

Supercycle structure depends on the physics program of all the facilities served by the SPS including LHC, AWAKE, HiRadMat and the Machine Development program





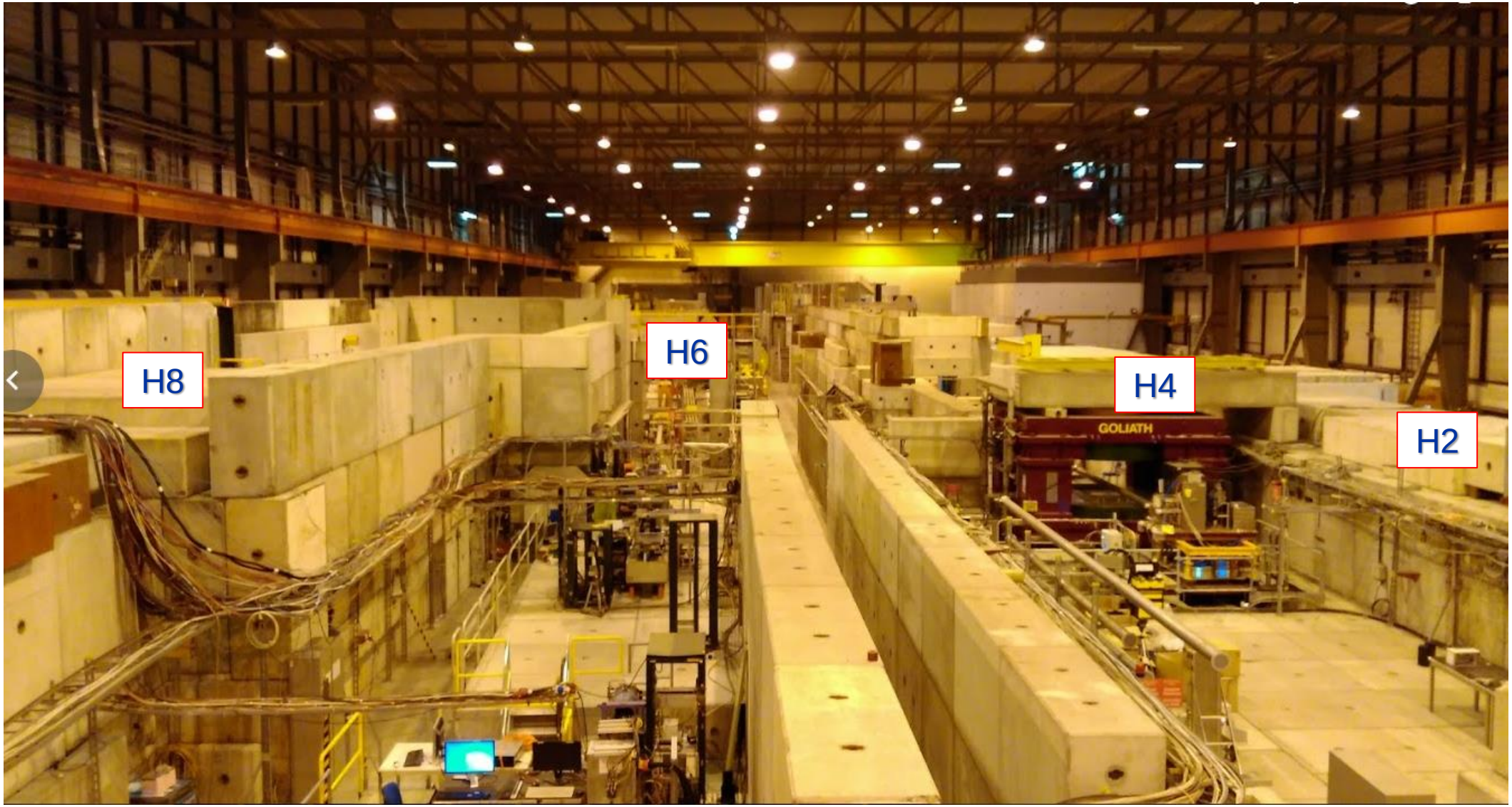
Characteristics of the beams

Parameter	T2 Target		T4 Target	
Beamline	H2	H4	H6	H8
p attenuated primary / secondary beam in $^{\mathrm{GeV}}/_{c}$	$400/360$	$400/360$	$-/205$	$400/360$
Maximum $\Delta p/p$ in %	± 2.0	± 1.4	± 1.5	± 1.5
Maximum intensity/spill (hadrons/electrons)	$10^7/10^6$	$10^7/10^7$	$10^7/10^5$	$10^7/10^5$
Available particle types	Primary protons or pure electrons or pure/mixed hadrons or pure muons			
Ion beam availability	Yes	Yes	No	Yes

- **T6 target** → Serves the **M2** beam that is currently used for the AMBER experiment
  - $< 4.8 \times 10^8$ hadrons/spill with $< 280\ ^{\mathrm{GeV}}/_{c}$ (requires additional shielding around target); increase to 10^9 with improved shielding in future
  - $< 2 \times 10^8$ muons/spill with $< 280\ ^{\mathrm{GeV}}/_{c}$
  - NA64μ and MUonE will continue physics and test runs

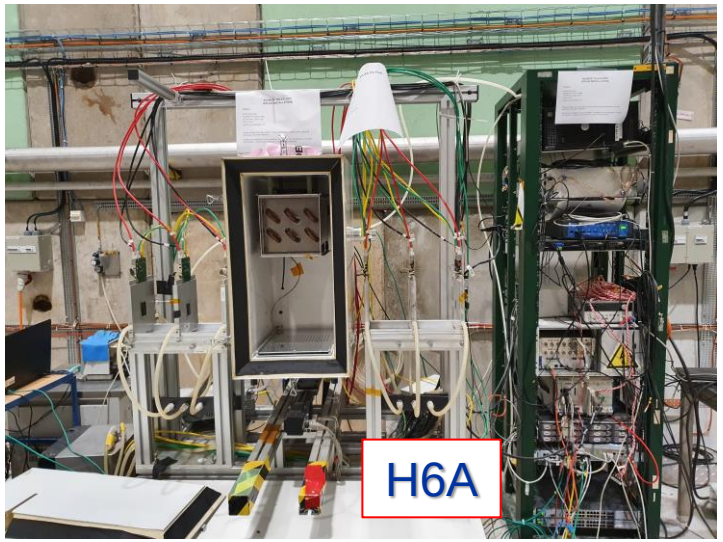
- **P42** beam also originates from the T4 target and transports the proton beam that has not interacted onto the T10 target to produce typically $75\ ^{\mathrm{GeV}}/_{c}$ kaon beams guided via **K12** to NA62

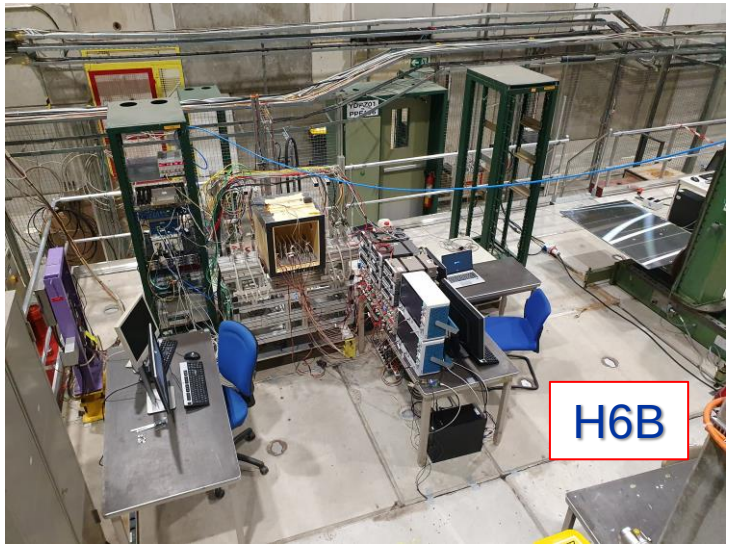
EHN1 (B-887, Prevessin Site)



Telescopes in CERN North Area (SPS)

- **Two telescopes installed permanently (not managed by BE-EA):**
  - ACONITE in H6A
  - AIDA telescope in H6B
  - A mobile telescope AZALEA is also available
  - **Contact: Andre Rummler or PS/SPS physics coordinator**
- **Properties:**
  - 6 Mimosa-26 planes
  - TLU/EUDAQ based
  - Dedicated remote control PCs in control huts
  - High degree of usage and increasingly simultaneously
  - Separate $x - y$ table can be booked and installed behind telescopes serving larger DUTs
  - Remote controlled high voltage (ISEG modules with 8 channels up to -500V and 8 channels up to -2000V)





Large aperture magnets for tests with beam

GOLIATH
- EHN1, H4 beamline
- Large classical dipole
- $160 \times 240 \times 360\,\mathrm{cm}^3$
- 1.5T field

Morpurgo
- EHN1, H8 beamline
- Superconducting dipole
- $1.6\,\mathrm{m}$ diameter, $4\,\mathrm{m}$ length
- 1.5T field

CMS M1 magnet
- EHN1, H2 beamline
- Superconducting dipole
- $82\,\mathrm{cm}$ gap, $1.4\,\mathrm{m}$ diameter
- 3.0T field

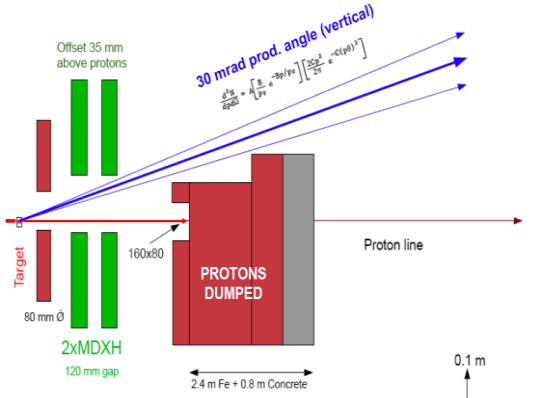
North Area

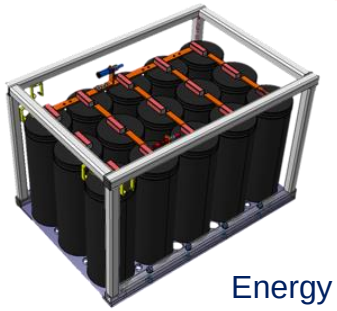

Marc Jebramcik
Laurie Nevay
Anna Baratto Roldan
Dipanwita Banerjee
Fabian Metzger
Nikos Charitonidis
Bastien Rae
Maarten Van Dijk
Luke Dyks
Johannes Bernhard
H2
Beam physicist: Nikos Charitonidis
Deputy: Laurie Nevay
Operational Support: Bastien Rae
H6
Beam physicist: Laurie Nevay
Deputy: Dipanwita Banerjee
Operational Support: Luke Dyks
H4
Beam physicist: Nikos Charitonidis
Deputy: Dipanwita Banerjee
Operational Support: Bastien Rae
H8
Beam physicist: Maarten Van Dijk
Deputy: Johannes Bernhard
Operational Support: Fabian Metzger Marc Jebramcik
M2
Beam physicist: Dipanwita Banerjee
Deputy: Johannes Bernhard
Operational Support: Bastien Rae Fabian Metzger
P42/K12
Beam physicist: Johannes Bernhard
Deputy: Nikos Charitonidis
Operational Support: Bastien Rae
North Area
General Questions
Beam physicists: Nikos Charitonidis Johannes Bernhard

East Area

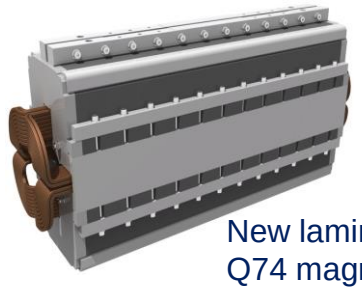
East Area Renovation

- **The renovation was complected during LS2 and included:**
  - Full refurbishment of East Hall with its beamlines and infrastructures
    - Upgrade of heating/ventilation, improved thermal insulation, wall and roof cladding, separated cooling for primary and secondary beamlines
  - Improved radiation protection
    - Improved equipment accessibility and faster repair times, primary beam dump just downstream of the primary target
  - Change in the beamline layout
    - Higher maximal p and improved selectivity of particle types
  - Completely new magnet powering scheme
    - Cycled powering leading to reduction of annual power consumption from 11 to $0.6\mathrm{GWh}$
    - Less magnet types for better maintenance



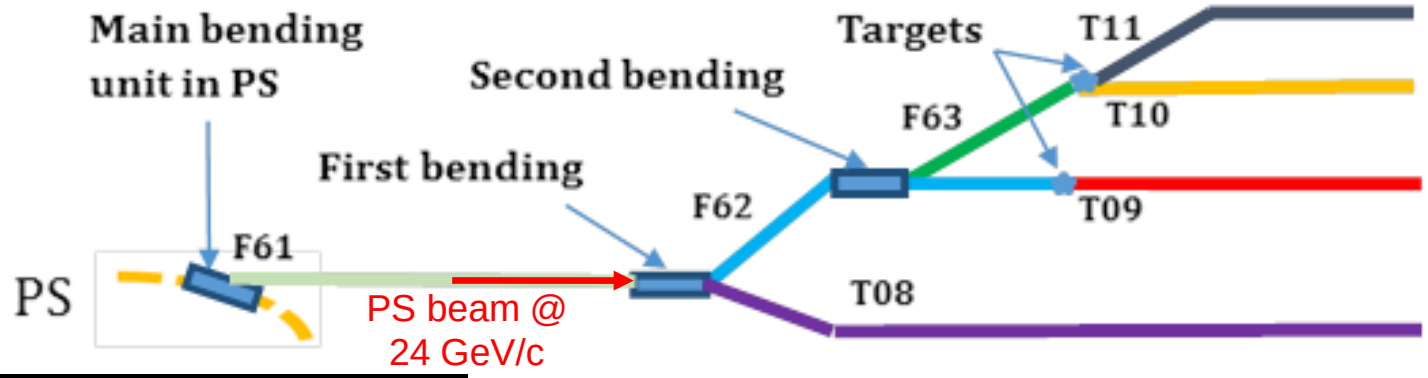


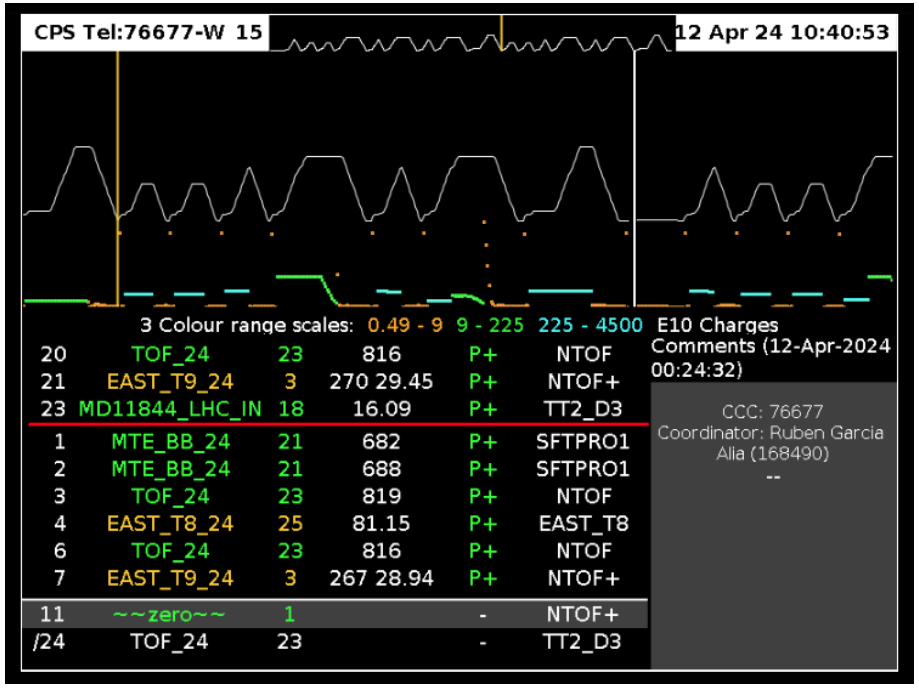
Energy storage unit



New laminated Q74 magnet

East Area Secondary Beamlines





Spill duration: $0.4s$ flat top
Usually : $\mathbf{1-2}$ **cycles per minute per East Destination**
Max $\mathbf{3.3 \times 10^{10}}$ **protons/second per destination**
(limited by RP for secondary lines)
Max $\mathbf{6.6 \times 10^{10}}$ **protons/second** for T08

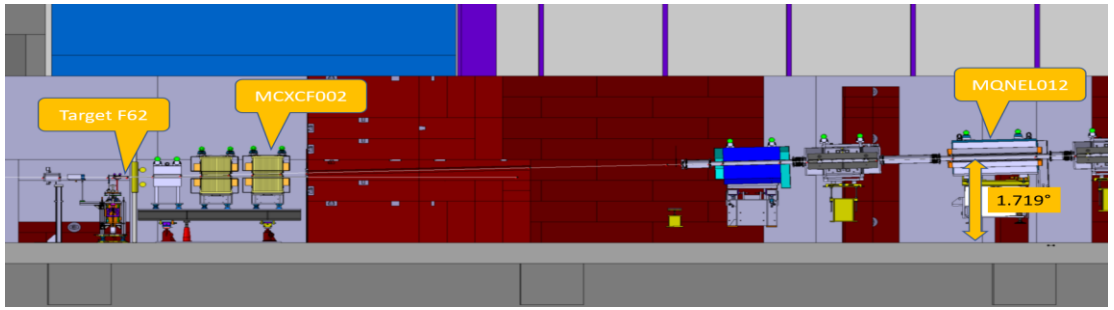
Supercycle structure dependent on all users (SPS, nTOF, …)

Characteristics of the beams

Parameter	T09	T10	T11
$p_{\max}$ of secondary beam in $^{\mathrm{GeV}}/_{c}$	16	12	3.5
$\Delta p/p$ in %	± 0.7 to ± 15		
Maximum intensity/spill (hadrons/electrons)	10^6		
Available particle types	Pure electrons (T09 only) or mixed electrons (T10) or mixed/pure hadrons or pure muons		

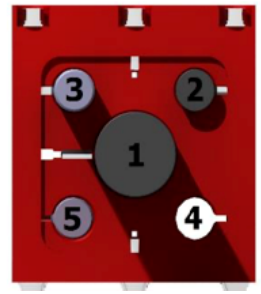
- **T11 serves the CLOUD experiment which is a permanent installation**

$30 - 35\mathrm{mrad}$ vertical production angle

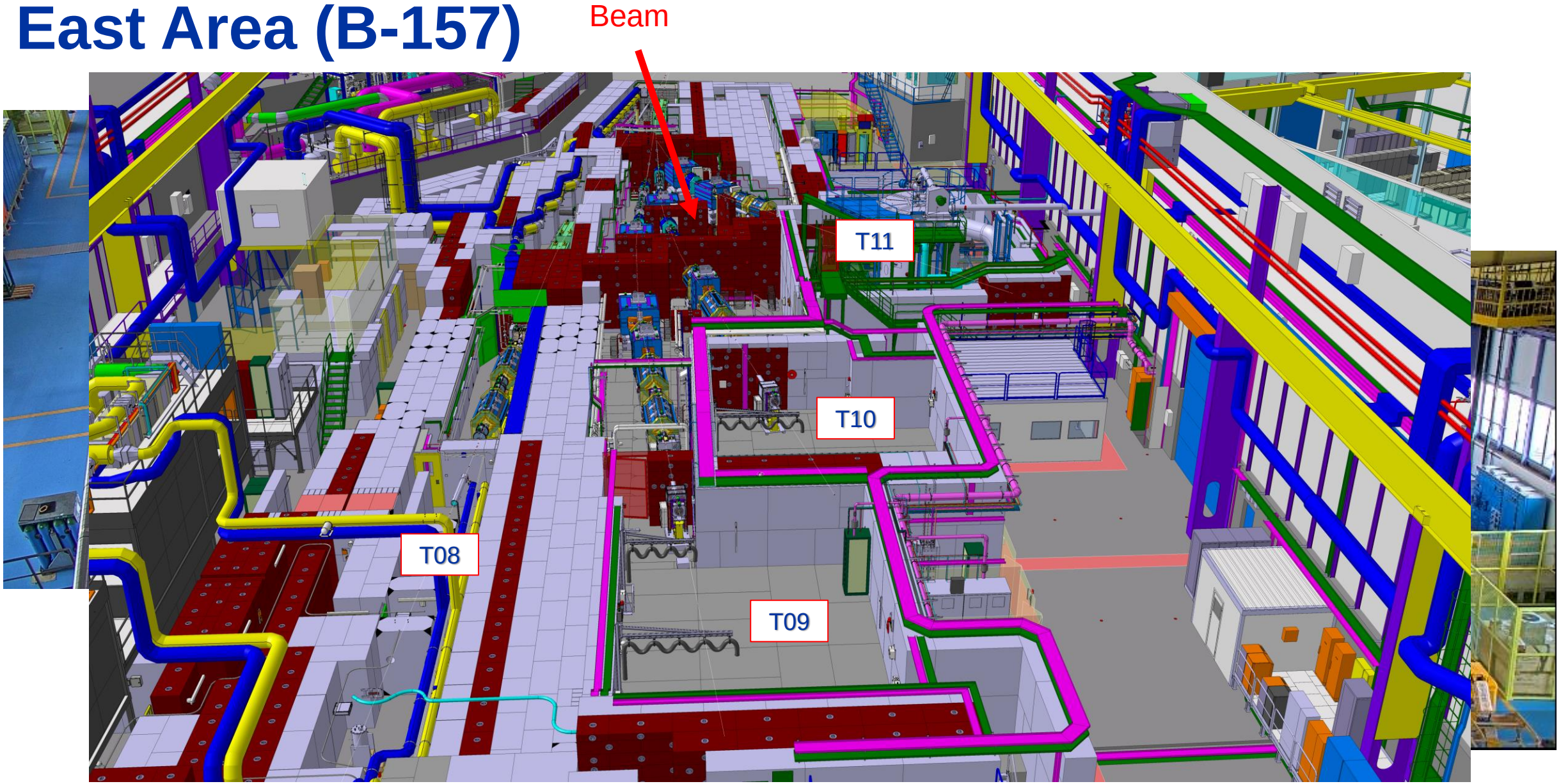


Multi-target configuration

Head	Material	Length (mm)	Diameter (mm)	Comments
1	Be	200	10 + Al case	Electron enriched
	W	3		
2	Al	100	10	Electron enriched
	W	3		
3	Al	200	10	Hadron
4	Air	-	-	Empty
5	Al	20	10	Hadron



East Area (B-157)

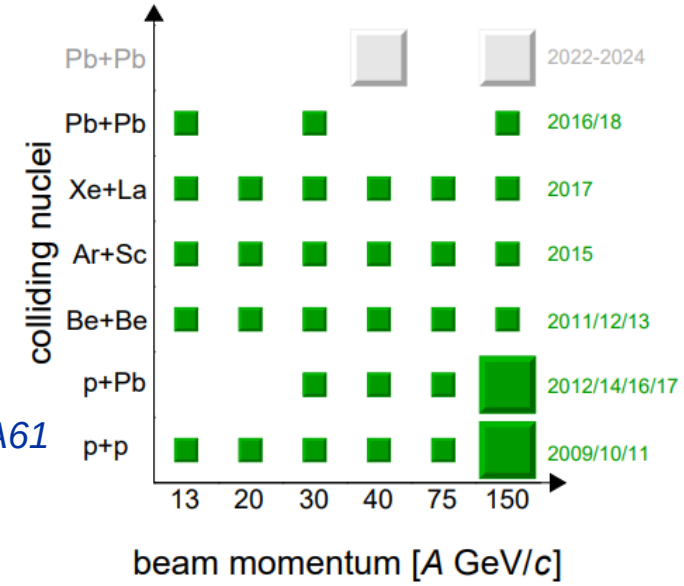


East Area

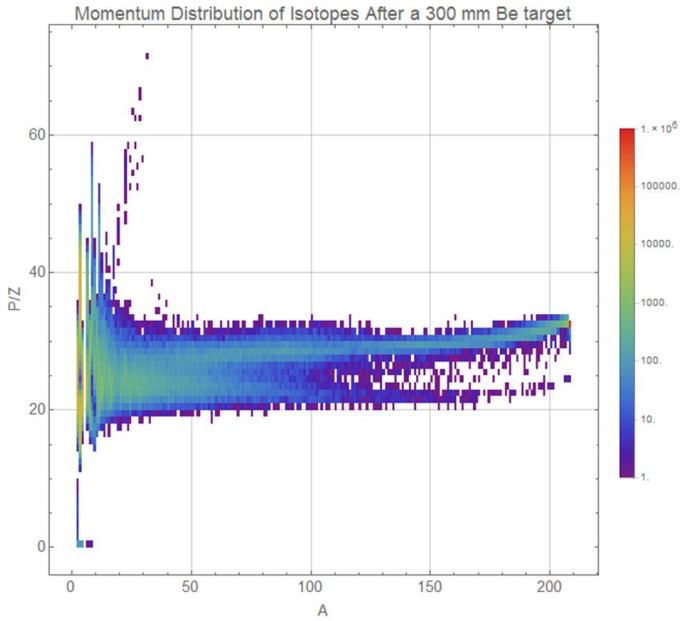

Marc Jebramcik
Dipanwita Banerjee
F61/62/63
Beam physicist: Dipanwita Banerjee
Deputy: Johannes Bernhard
Operational Support: Bastien Rae
T10
Beam physicist: Maarten Van Dijk
Deputy: Laurie Nevay
Operational Support: Elisabetta Parozzi
T11
Beam physicist: Laurie Nevay
Deputy: Johannes Bernhard
Operational Support: Bastien Rae
T09
Beam physicist: Dipanwita Banerjee
Deputy: Maarten Van Dijk
Operational Support: Elisabetta Parozzi
Laurie Nevay
East Area
General Questions
Beam physicist: Dipanwita Banerjee
Johannes Bernhard
Nikos Charitonidis
T08
Beam physicist: Nikos Charitonidis
Deputy: Dipanwita Banerjee
Operational Support: Bastien Rae
Maarten Van Dijk
Johannes Bernhard
Elisabetta Parozzi
Bastien Rae

Ion beams

- **Ion beams are available in the North and the East Area**
  - Ion beam time needs to be defined for the future
- **Primary and fragmented ion beams are available**
- Availability for test beam users in **H2/H4/H8 and T08**
- **NA61** has ion beam programs in the North Area
- Test beam users like **Medipix, Nucleon**, **HERD, PAN** request ion beams
- HEARTS/CHIMERA requested low energy ions in T08

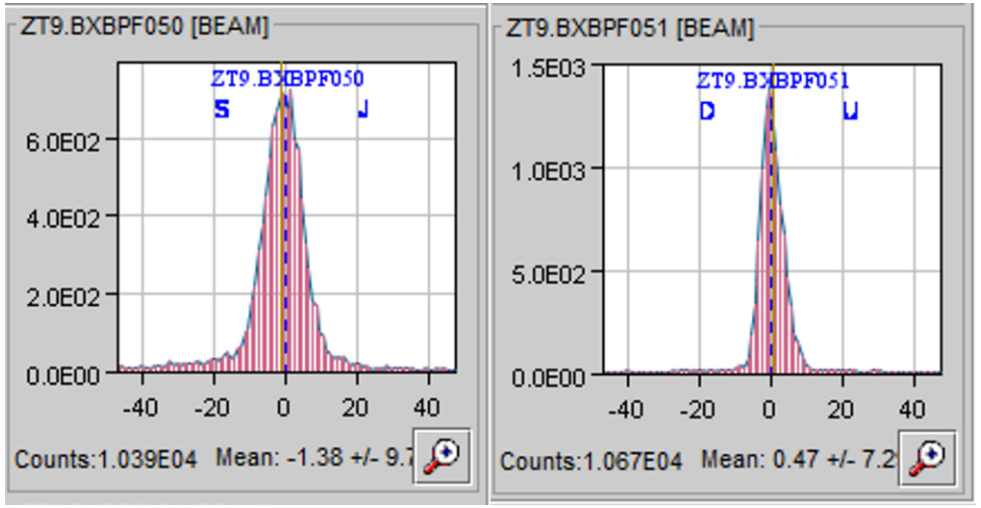


Courtesy: NA61



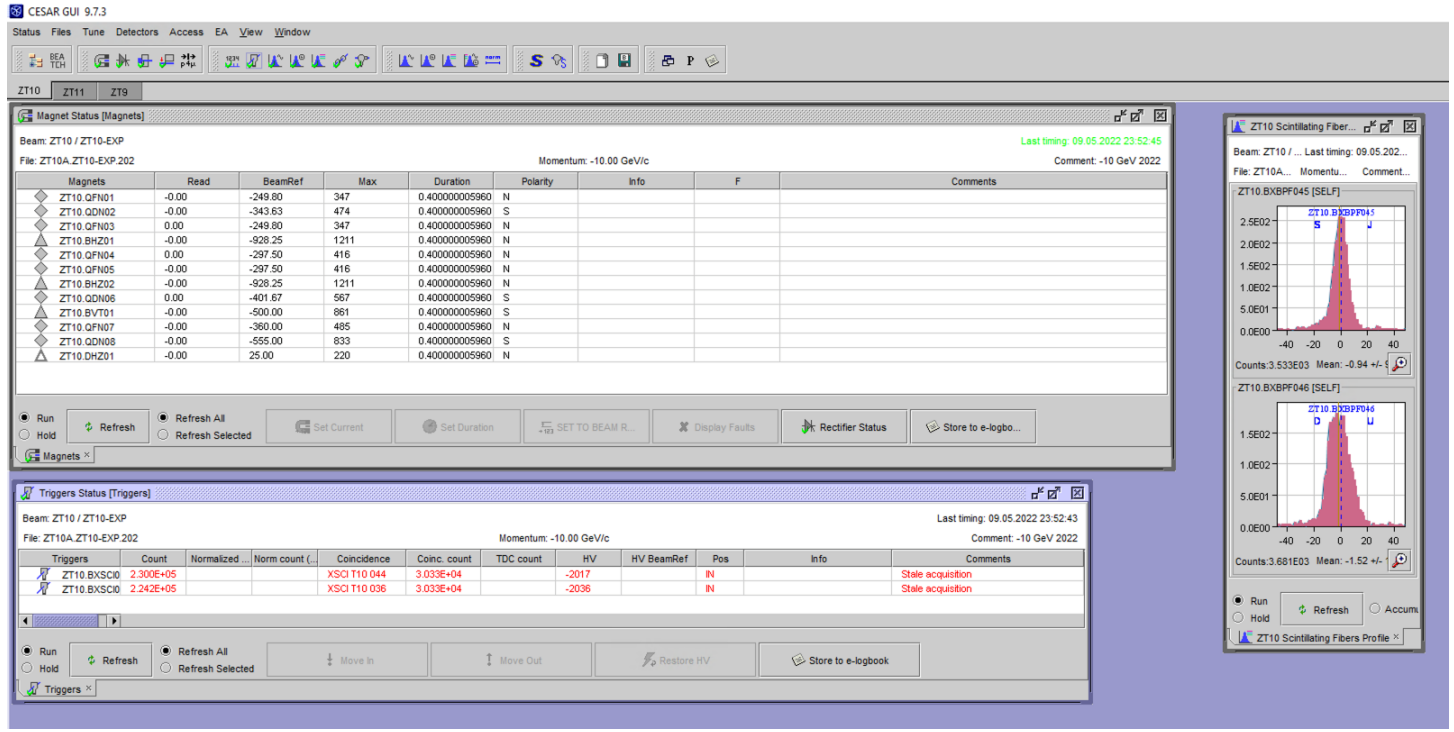
Beam Instrumentation in the North and East Area

- **Threshold Cherenkov gas counters (XCET) and CEDARs → used for particle tagging**
  - In the East Area new high pressure XCETs are available that go up to 15bar
  - Refrigerant gases like R218 and R134a can be used for low momenta particle tagging
- **Beam profile & intensity monitors:**
  - Scintillators & Analog / Delay Multi Wire Chambers are installed in several positions along the beamlines
  - In the East Area Scintillating Fibre Hodoscopes (XBPF) are used as profile monitors
  - As part of the consolidation efforts under NACONS all Analog / Delay Wire Chambers will be replaced by XBPFs
- **FISC scanners (only North Area):**
  - Precise slower profile monitors
  - Can also be used for measurements of beam divergence



Access and Beam Control Software

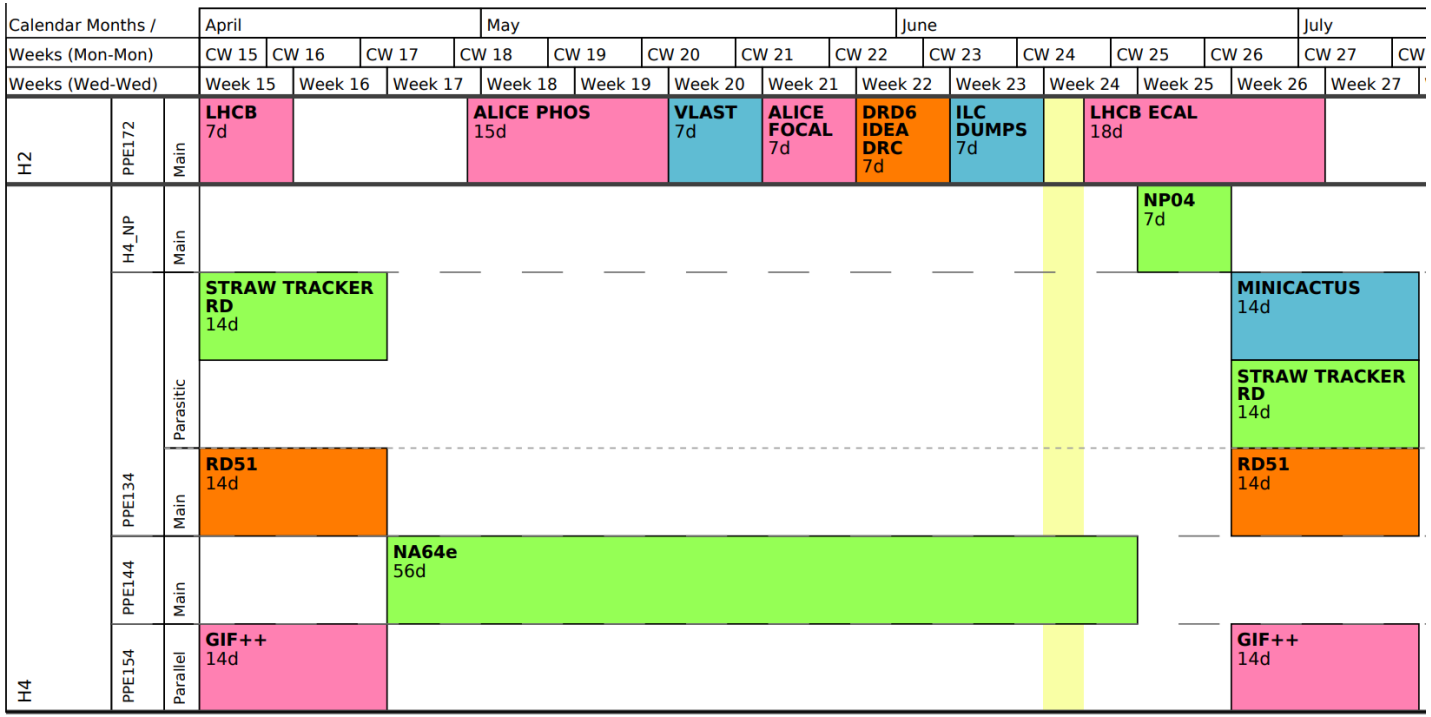
- **The beam can be controlled using the CESAR interface**
  - Magnet currents can be changed, collimators can be controlled, Threshold Cherenkov pressure can be set, beam files can be loaded, beam profiles and trigger information can be accessed etc.,
- **A demo version of upgraded control software to be rolled out for test (not operation); beyond LS3 full implementation planned**
- **The zone can be accessed with a dosimeter and safety equipment without any other special access request**
- **2-3 members from each user group are given the patrol rights following an on-site training to be able to close the zone for beam**



Schedule and planning

- **The beam time request must be sent to the PS/SPS physics coordinator ~ September/October for the following year (depends on injector schedule availability)**
  - Short (< 1 week @ SPS or < 2 weeks @ PS) requests can be handled by the PS/SPS physics coordinator directly
  - Longer requests require recommendation by CERN physics committees (SPSC, LHCC, DRDC, INTC, RB)

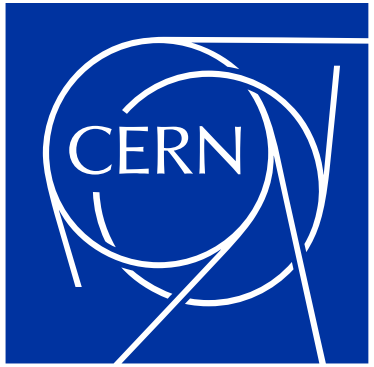
The scheduling is based on priorities of different experiments and is defined by the SPS coordinator & scientific committees and approved by the CERN research board



Summary

- **CERN offers a great variety of test beam options with beams ranging between $100\,^{\mathrm{MeV}}/_{c}$ to $400\,^{\mathrm{GeV}}/_{c}$**
- **The Experimental Areas include:**
  - EHN1, EHN2 and ECN3 in the North Area
  - T9, T10 and T11 in the East Area
- **Please contact in advance Sps.Coordinator@cern.ch and sba-operation@cern.ch to optimally use your beam time and the facilities**
  - Visit https://ps-sps-coordination.web.cern.ch/ps-sps-coordination/ for the updated version of the schedule and other useful information
  - Subscribe to *ps-sps-users* e-group
  - Visit https://be-dep-ea.web.cern.ch/experimental-areas/beamline-responsibles for further information on the various beamlines

Looking forward to seeing you at CERN!



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