CERN Secondary Beamlines and Test Beams facilities overview

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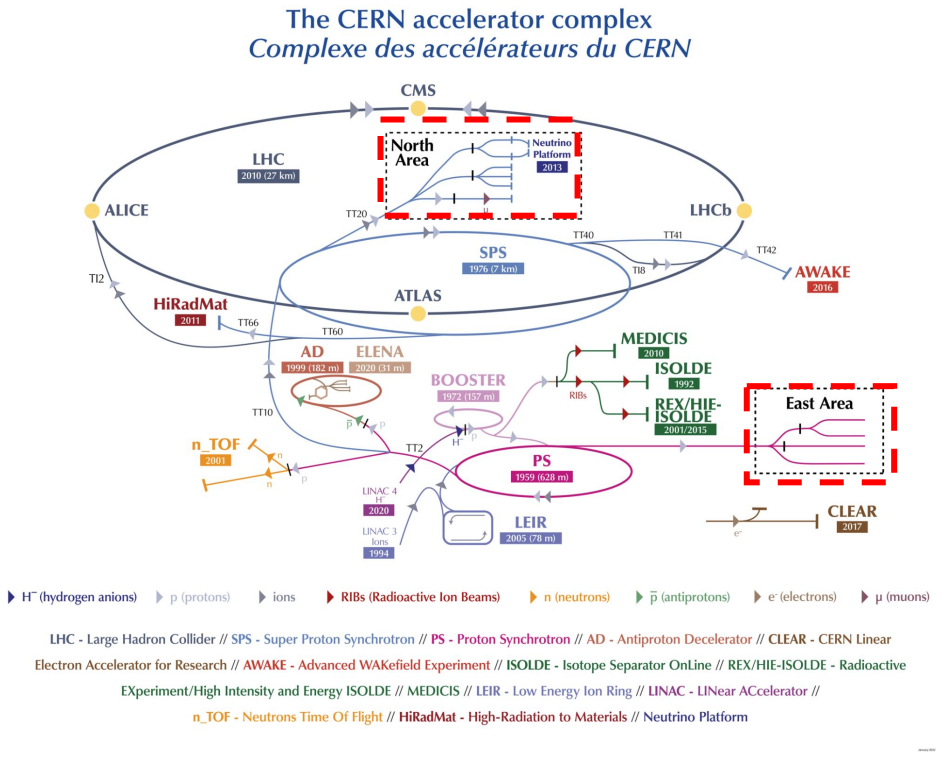
CERN Accelerator Complex



Maximum Momenta at the accelerator:

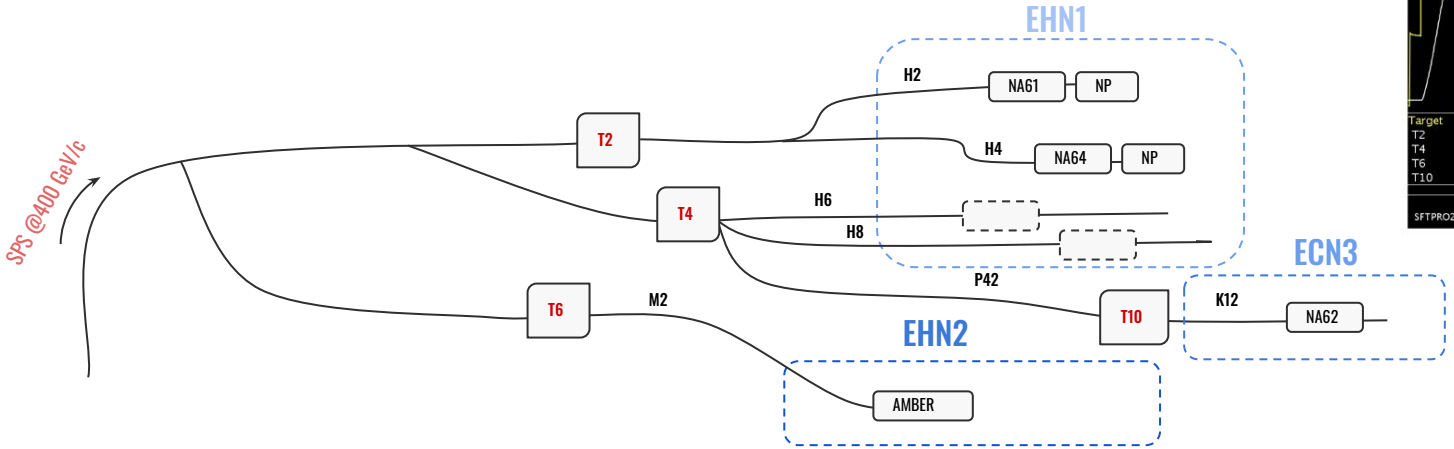
SPS : protons/ions @ 450 GeV/c/Z
PS: protons /ions @ 28 GeV/c/Z

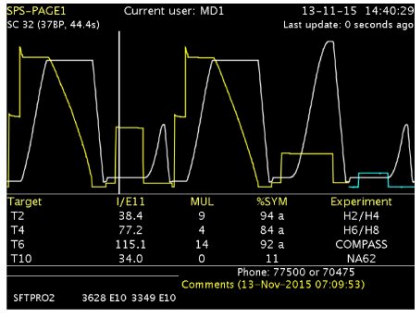
Maximum Momenta to users at the PS/SPS TB Facilities:

North Area → ≤ 400 GeV/c (primary beam)
≤ 360 GeV/c (secondary beam)

East Area → ≤ 16 GeV/c (secondary beam only)

North Area Secondary Beamlines





The 400 GeV/c primary beam is **slowly extracted** to 3 primary targets → **T2, T4, and T6**

Spill duration: 4.8 second flat top
at least 1 cycle / SPS supercycle for NA and up to 3000 spills/day

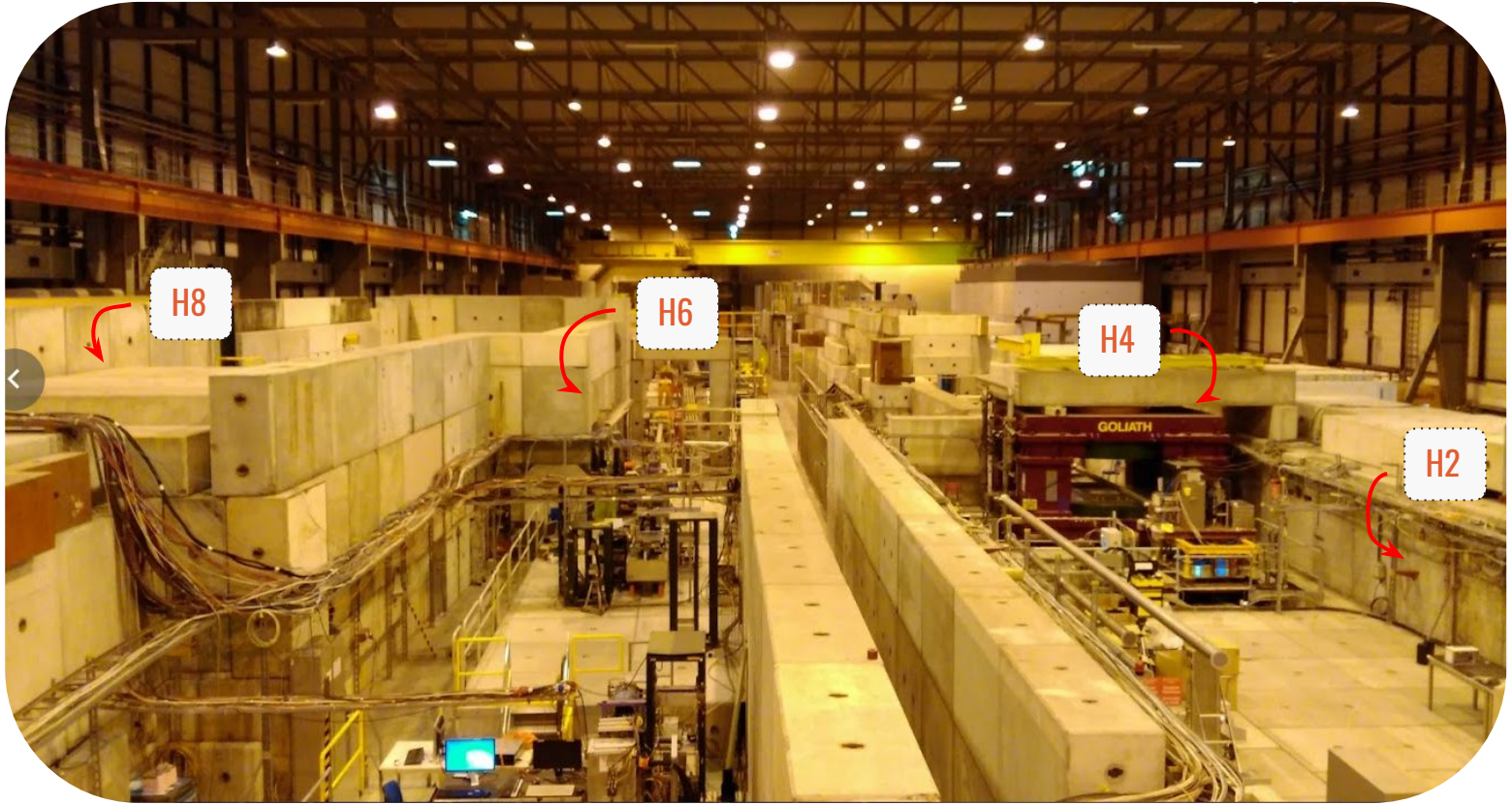
Supercycle structure depends on the physics program of all the facilities served by the SPS including LHC, AWAKE, HiRadMat and the Machine Development program.

Characteristics of the Beam

Parameter	T2		T4	
Beam Line	H2	H4	H6	H8
Attenuated Primary proton / Secondary beam	400/360	400/360	-/205	400/360
Maximum Δp/p (%)	±2	±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 / e+ / hadrons /μ +			
Ion Beam Availability	Yes	Yes	No	Yes

- T4 Target → P42 carries the non-interacting primaries to the T10 target → 75 GeV/c Kaons beam to NA62
- T6 Target → M2 beamline that is currently used for the COMPASS/AMBER experiment, as well as NA64mu, and MUonE.
  - < 10^8 hadrons/spill < 280 GeV/c.
  - < 3 x 10^8 muons/spill < 250 GeV/c.

EHN1 (B-887, Prevessin Site)



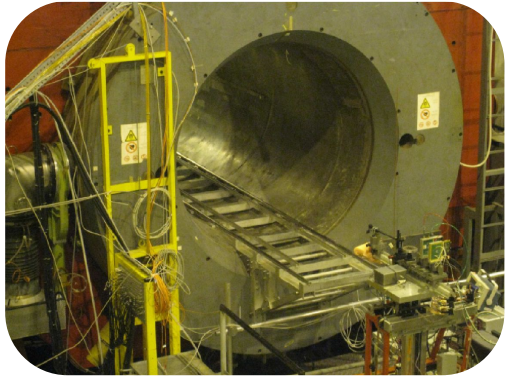
Large aperture magnets available in the North Area for tests with beam

GOLIATH

- EHN1, H4 beam line
- Large classical dipole
- 1.6 x 2.4 x 3.6 m
- 0.85T field

Morpurgo

- EHN1, H8 beam line
- Superconducting dipole
- 1.6 m diameter, 4 m length
- 1.5 T field



CMS M1 magnet

- EHN1, H2 beam line
- superconducting dipole
- 0.82 m gap, 1.4m diameter
- 3.0 T field

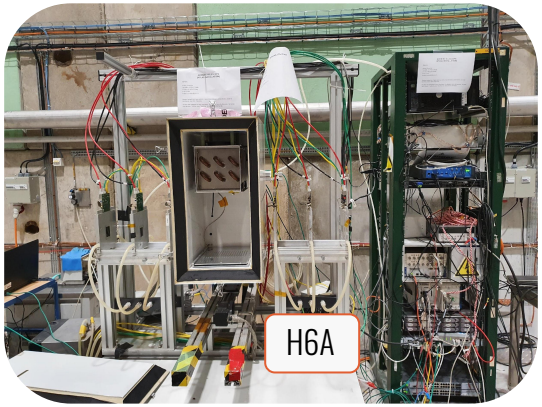
Telescopes in CERN North Area (SPS)

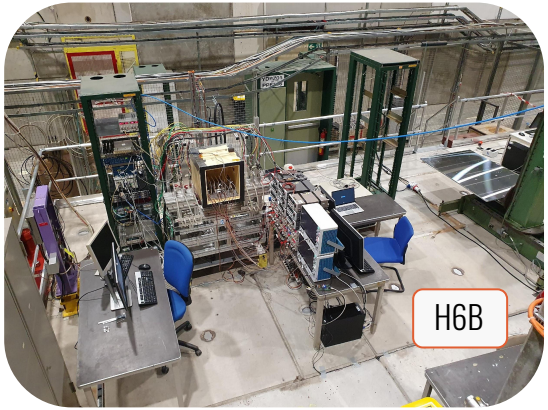
Two telescopes installed permanently in the North Area (not managed by BE-EA):

- ACONITE in H6A
- AIDA (ACONITE) telescope in H6B
- A Mobile telescope AZALEA is also available
- Contact: Andre Rummler /PS-SPS Coordinator.

Properties:

- 6 Mimosa-26 planes
- TLU/EUDAQ based
- Dedicated remote control PCs in control huts
- High degree of usage and increasingly simultaneous
- 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)





North Area Beam Physicists

East Area Renovation 2016-2022

EAST AREA RENOVATION

The East Area Renovation was completed during the LS2
Main purpose → ensure long-term operation in PS EA-experimental facility.

New beamline layout, new cycled powering scheme, refurbished infrastructure.

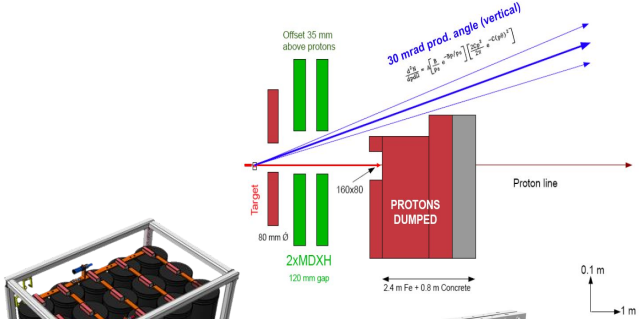
Infrastructure:

- Upgrade of B157 → Heating/ventilation improved. thermal insulation improved.
- Improved radiation protection.
- Accessibility.

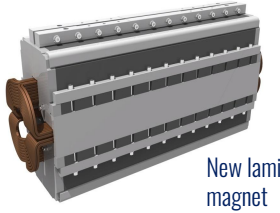
Beamlines:

- Magnets' lamination → less magnet types for better maintenance.
- Reduction of energy consumption → cycling magnet current, hence recovering and storing the magnet energy after each cycle.

Overall saving from 11 to 0.6 GWh per year.

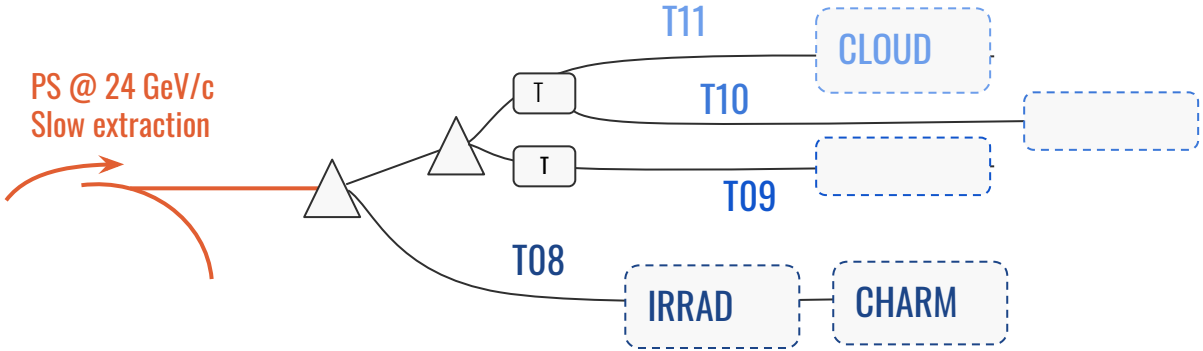


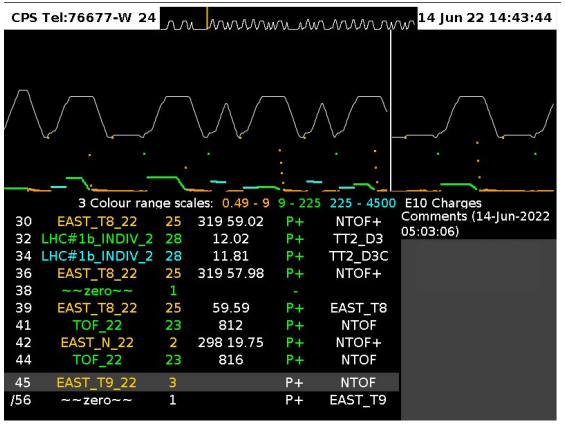
Energy storage unit

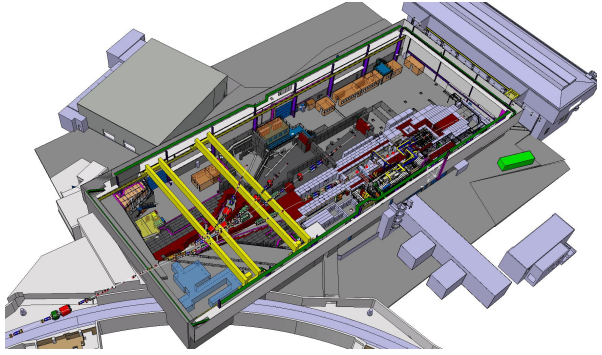


New laminated Q74 magnet

East Area Secondary Beamlines







Spill duration: 0.4 second flat top
Usually: **1-2 cycles per minute per East Destination**
Max 6 East cycles (3 each T10/T09) / 40 seconds → RP Limit

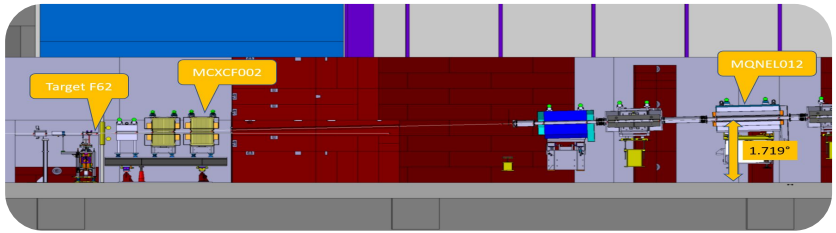
Super-cycle structure dependent on all users (SPS, nTOF …)

Characteristics of the Secondary Beams

Parameter	T09 Target	T10/T11 Target	
Beam Line	T09	T10	T11
Secondary beam Max Momentum (GeV/c)	16	12	3.5
Δp/p (%)	±0.7 to ±15.0	±0.7 to ±15.0	±0.7 to ±15.0
Maximum intensity/spill (hadrons/electrons)	10^6	10^6	10^6
Available particle types	Pure e- (only T09) or hadrons /μ +		

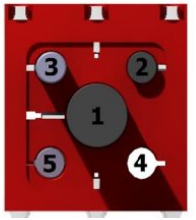
- **T11** → **CLOUD experiment** which is a **permanent** installation.
- **T09** → in 2024 **Water Cherenkov Test Experiment** aims to use the line for ~ **13 weeks** for testing their 4 x4 m^2 50-ton tank.

30-35 mrad vertical production angle

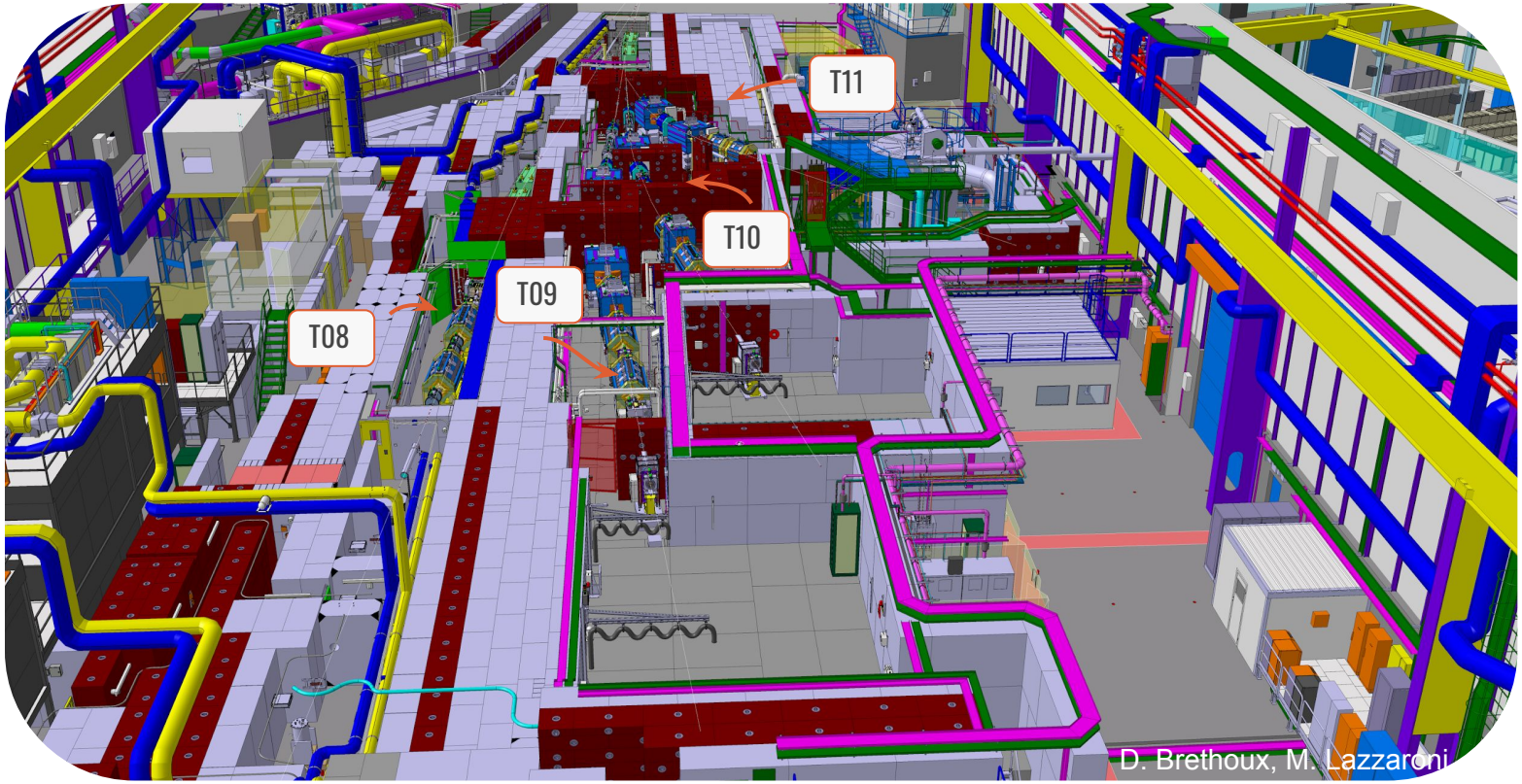


Multi-target configuration

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

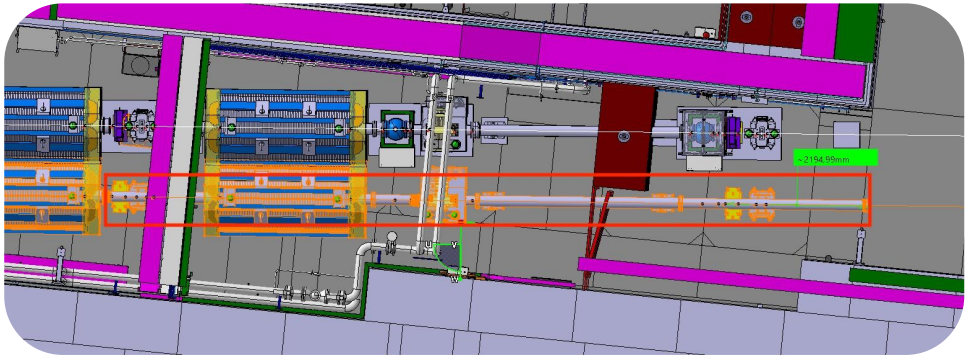


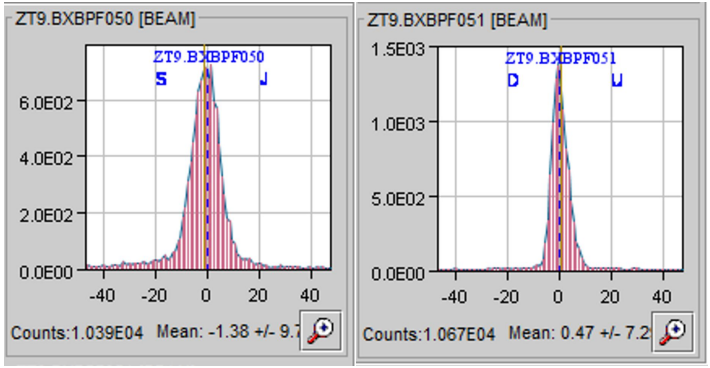
Current Layout



First Beams to the Renovated East Area

- The first beams were provided in T9-T11 in 2021 when East Area restarted after the renovation.
- The beams were commissioned at the maximum momenta and the transmission was checked. The maximum rate observed was ~ few 10^6/spill as expected.
- Then they were scaled to the lowest momenta of ~ 0.1 GeV/c. A low momentum configuration is also available in T09.
- The new test beam schedule started at the beginning of the month without any delay.

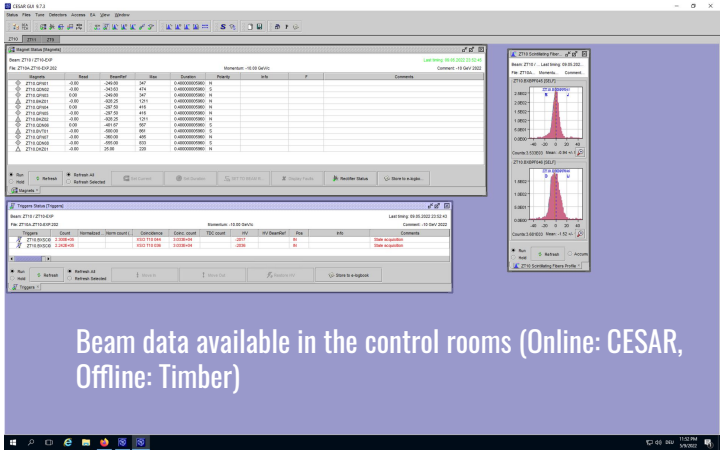




East Area Beam Physicists

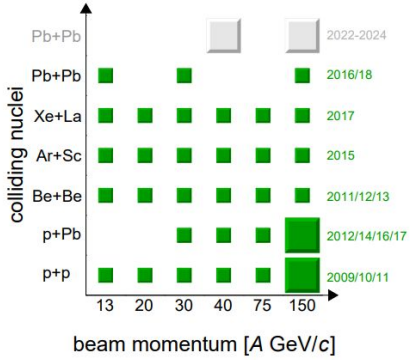
Beam Instrumentation in the North and East Area

- Depending on the beam line and the zone :
  - **Threshold Cherenkov gas counters (XCET) and CEDARs** → particle tagging
    - In the east area new high pressure XCETs are available that go up to 15 bars with the option of using refrigerant gases like R218 and R134a for low momenta particle tagging.
  - **Beam profile & intensity monitors:**
    - scintillators & analog/delay multi wire chambers are installed in several positions along the beam line.
    - In the East Area scintillating fibre hodoscopes (XBPF) are used as profile monitors.
    - all analog/delay wire chambers are replaced by XBPFs in the EA.
  - **FISC scanners (only North Area)** → precise slower profile monitors – can also be used for angular measurements

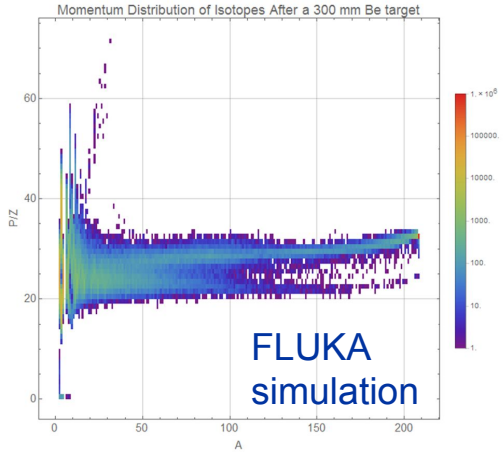


Ion Beams

- Ion beams are available in the North and the East Area
  - **2022:** Pb
  - **2023:** Pb
  - **2024 and later**: to be defined
- Primary and Fragmented ion beams are available.
- Availability for test beam users in **H2/H4/H8** and **T08**.
- Experiments like NA61 have ion beam programs in the North Area.
- Test-beam users like Medipix, HERD, PAN also request ion beams.
- CHIMERA requested ion beam at T08.



Ion collisions data-set in the past years
Courtesy: NA61

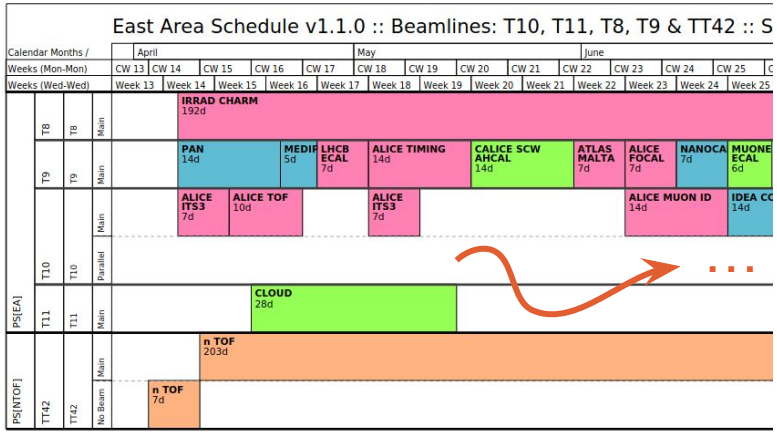


Schedule and planning

The beam time request must be sent to the PS-SPS coordinator ~ November for the following year.

- Short (<1 week @ SPS or < 2 weeks @ PS) requests can be scheduled by the PS-SPS coordinator only.
- Longer requests require recommendation by CERN physics committees (SPSC, LHCC, REC, RB)

EA 2023



The scheduling is based on priorities of different experiments and is discussed with the scientific committees. The draft schedule is presented at the CERN research board for approval.

Summary

- CERN offers a great variety of test-beam options with beams ranging between 0.1 GeV/c – 400 GeV/c.
- The experimental areas include:
  - EHN1, EHN2 and ECN3 in the North Area.
  - T08, T09, T10 and T11 in the East Area.
- Please contact in advance sps.coordinator@cern.ch and mail to: sba-operation@cern.ch
- in order 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.

Looking forward to seeing you at CERN!

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