



CERN Secondary Beamlines and Experimental Areas

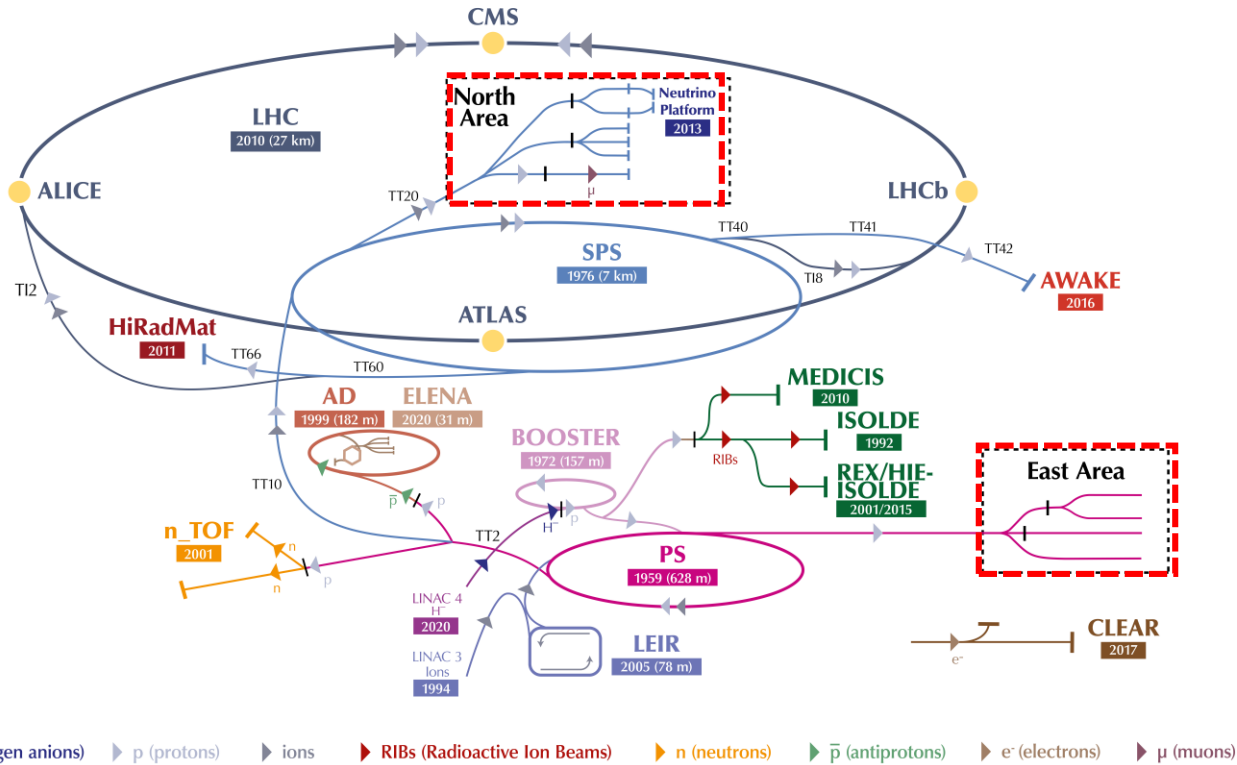
D. Banerjee, J. Bernhard, N. Charitonidis, A. Gerbershagen, , B. Rae, S. Schuh-Erhard, M. Van Dijk and M. Brugger
on behalf of the CERN BE-EA group

20.06.2022



CERN Accelerator Complex

The CERN accelerator complex
Complexe des accélérateurs du CERN



SPS : protons/ions @ **400 GeV/c/Z**
 PS: protons /ions @ **24 GeV/c/Z**

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

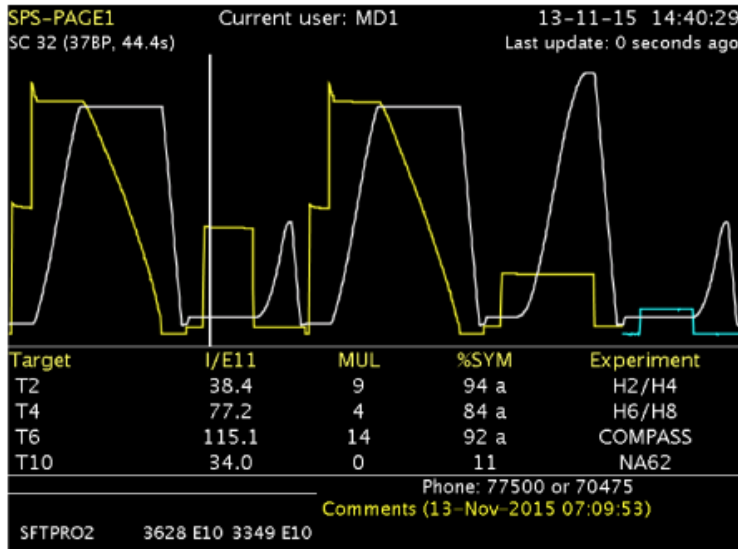
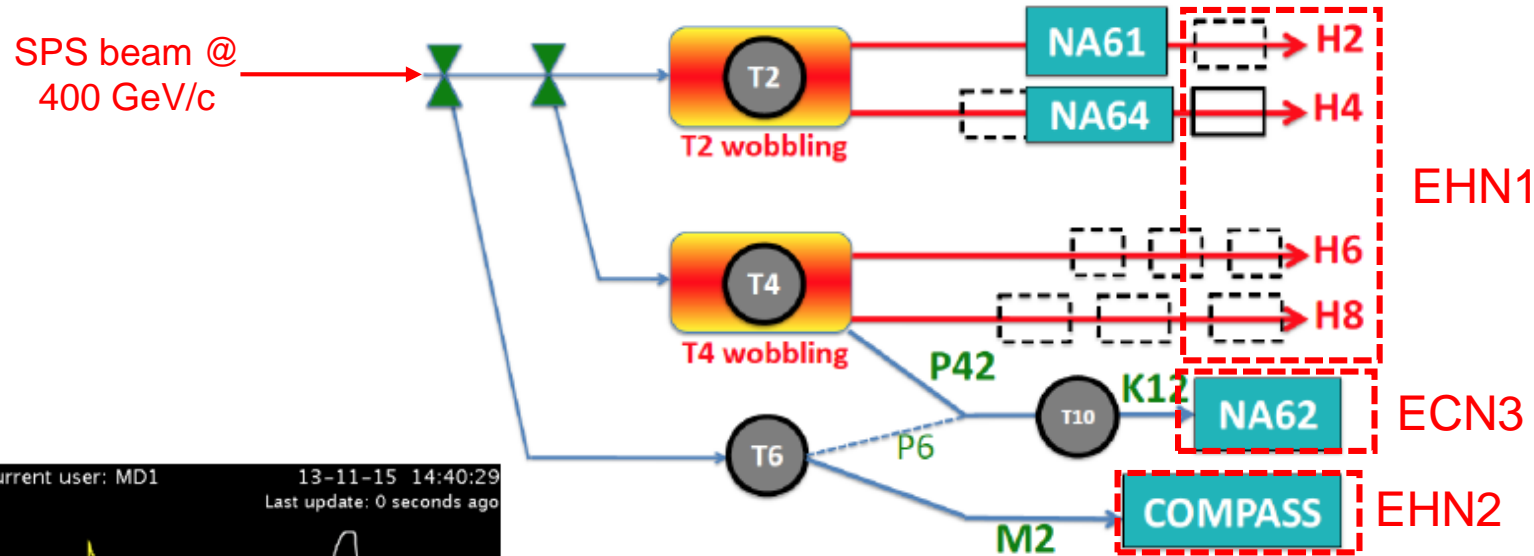
North Area $\rightarrow \leq 400 \text{ GeV/c/Z}$ (primary beam) or $\leq 360 \text{ GeV/c/Z}$ (secondary beam).

East Area $\rightarrow \leq 16 \text{ GeV/c}$ (secondary beam only).

LHC - Large Hadron Collider // SPS - Super Proton Synchrotron // PS - Proton Synchrotron // AD - Antiproton Decelerator // CLEAR - CERN Linear Electron Accelerator for Research // AWAKE - Advanced WAKEfield Experiment // ISOLDE - Isotope Separator OnLine // REX/HIE-ISOLDE - Radioactive Experiment/High Intensity and Energy ISOLDE // MEDICIS // LEIR - Low Energy Ion Ring // LINAC - LINear ACcelerator // n_TOF - Neutrons Time Of Flight // HiRadMat - High-Radiation to Materials // Neutrino Platform

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
 Typically : **2 cycles / SPS supercycle** for NA and
 ~ **3000 spills/day**

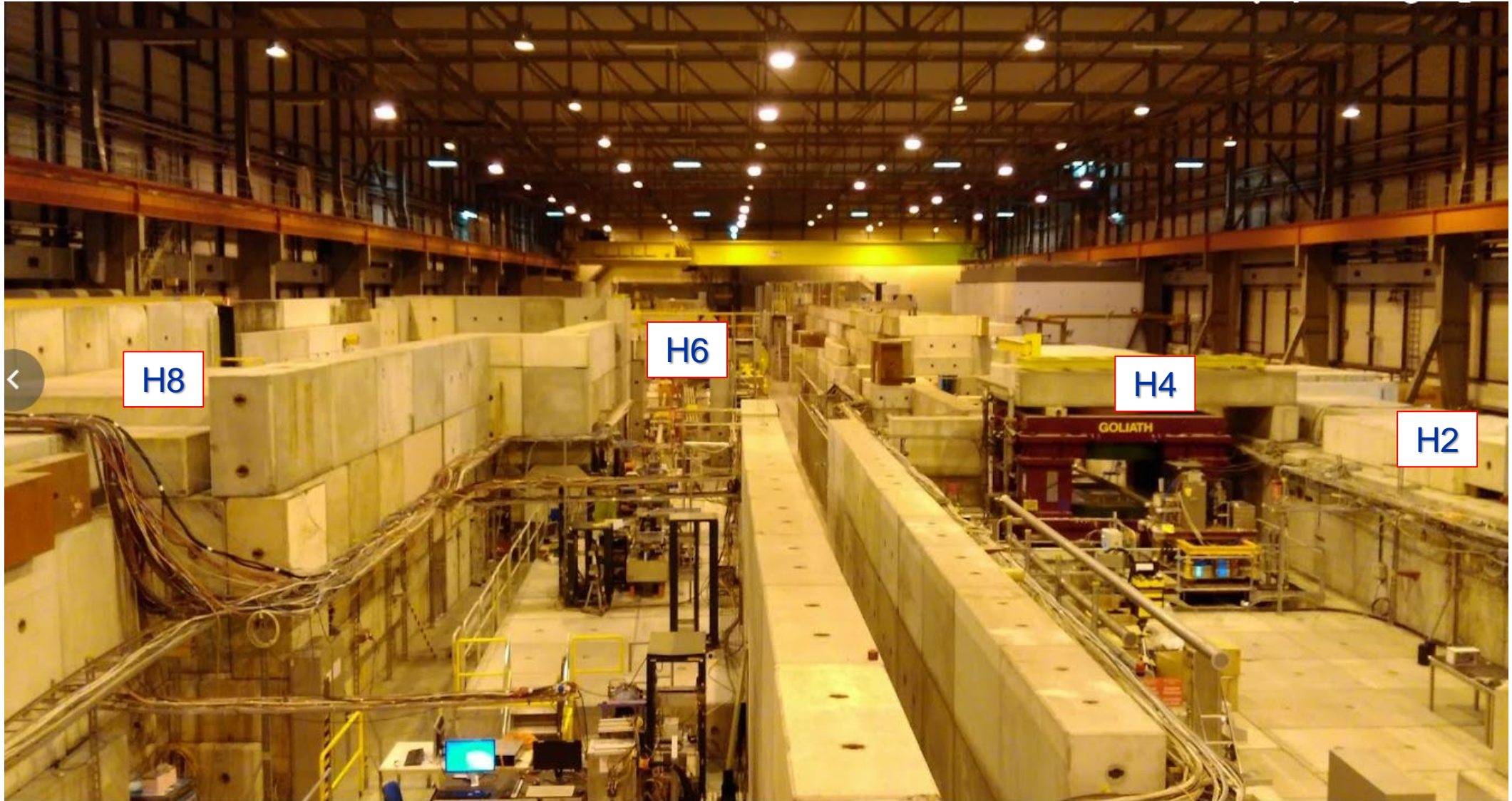
Supercycle structure depends on the physics program of all the facilities served by the SPS including LHC, AWAKE, HiRadMat and the Machine Development program.

Characteristics of the Beam

Parameter	T2 Target		T4 Target	
	H2	H4	H6	H8
Beam Line				
Attenuated primary proton / Secondary beam	400/360	400/360	-/205	400/360
Maximum $\Delta p/p$ (%)	± 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 COMPASS experiment.
 - $< 10^8$ hadrons/spill < 280 GeV/c.
 - $< 3 \times 10^8$ muons/spill < 250 GeV/c.
 - COMPASS will finish their physics program this year and new proponents including NA64 μ , MUonE and AMBER aim to run in M2 and had pilot runs in 2021 and 2022.
- **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 GeV/c kaon beam for NA62.

EHN1 (B-887, Preveessin Site)



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

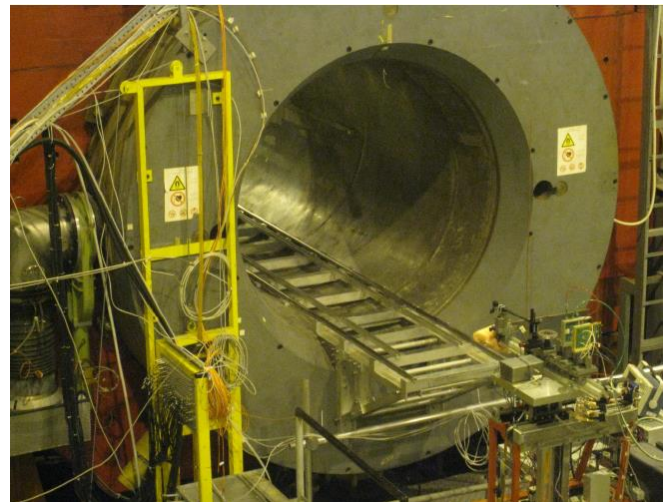


GOLIATH

- EHN1, H4 beam line
- Large classical dipole
- 160 x 240 x 360 cm
- 0.85T field

Morpurgo

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

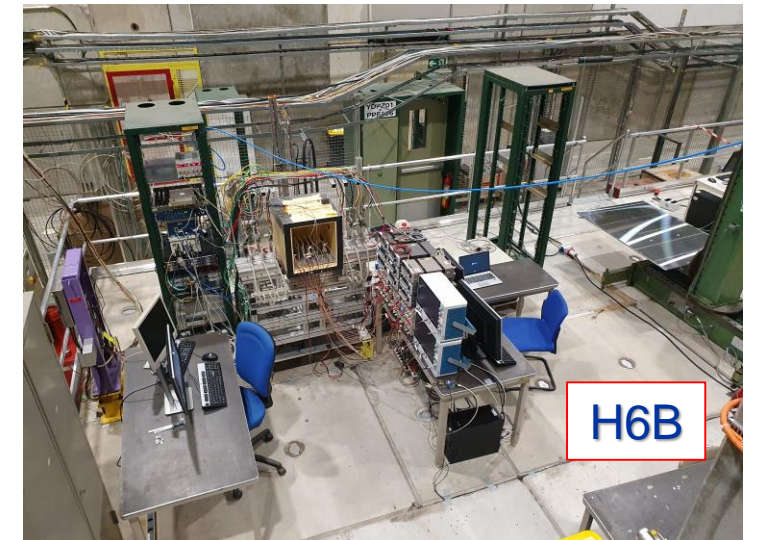
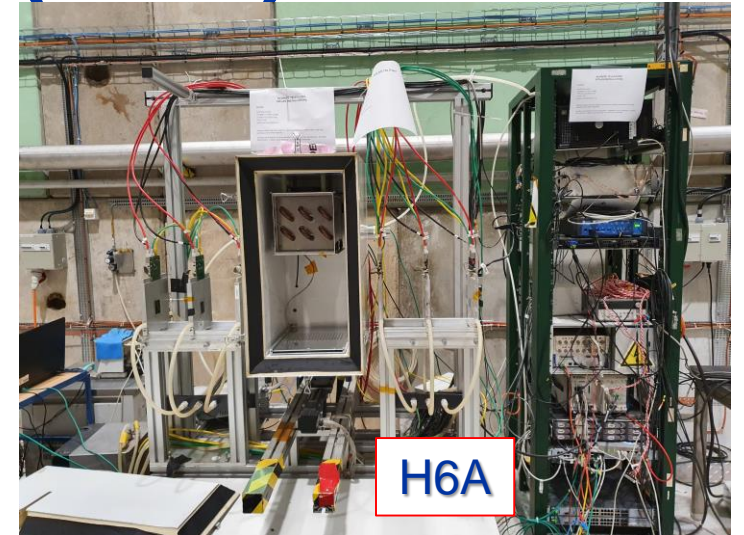


CMS M1 magnet

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

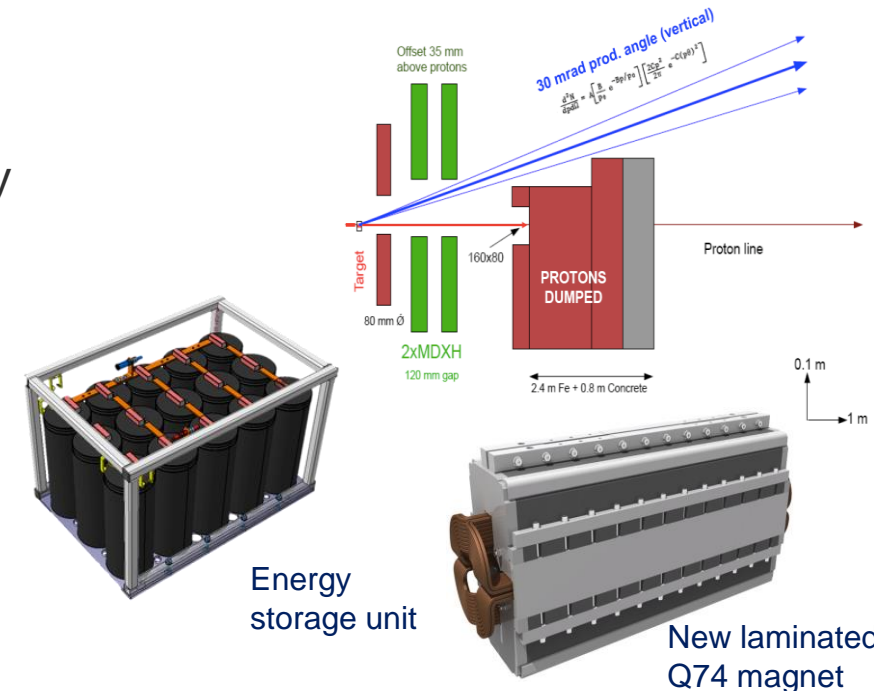
Telescopes in CERN North Area (SPS)

- Two telescopes installed permanently in the North Area (not managed by BE-EA):
 - ACONITE in H6A
 - AIDA telescope in H6B
 - A Mobile telescope AZAELA 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 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 $-2000V$)

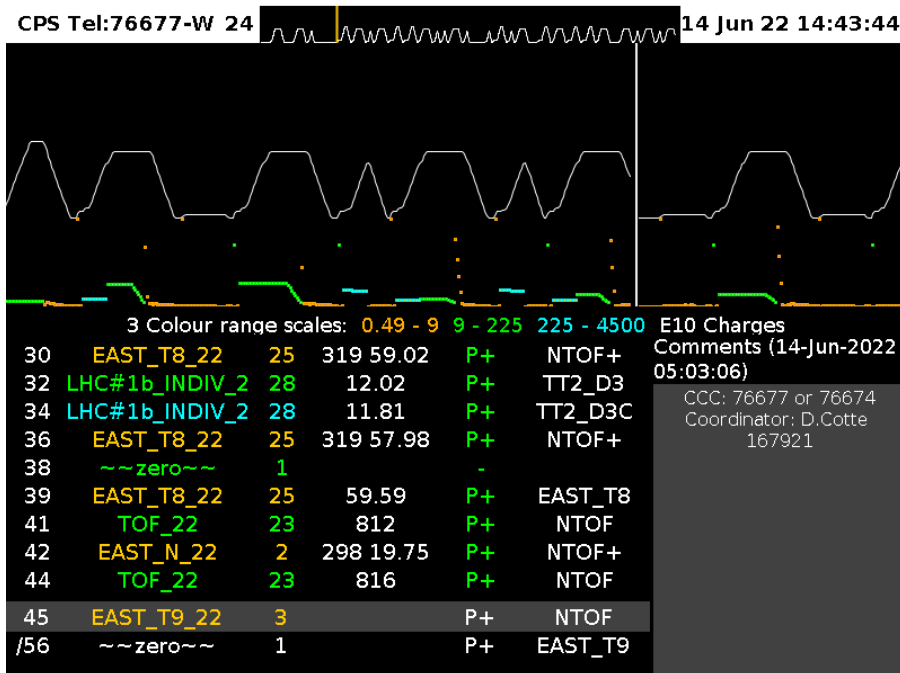
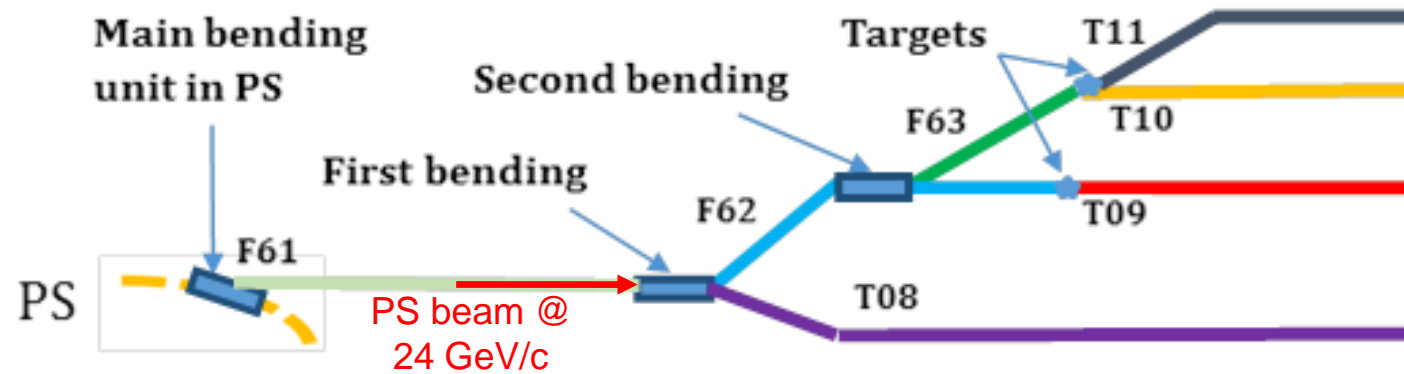


East Area Renovation

- The East Area Renovation was completed during the LS2.
- The renovation included
 - Full refurbishment of the East Hall with its beamlines and infrastructures
 - Upgrade of B157, its heating/ventilation, improved thermal insulation, wall and roof cladding (asbestos), 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 max. 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 GWh, less magnet types for better maintenance.



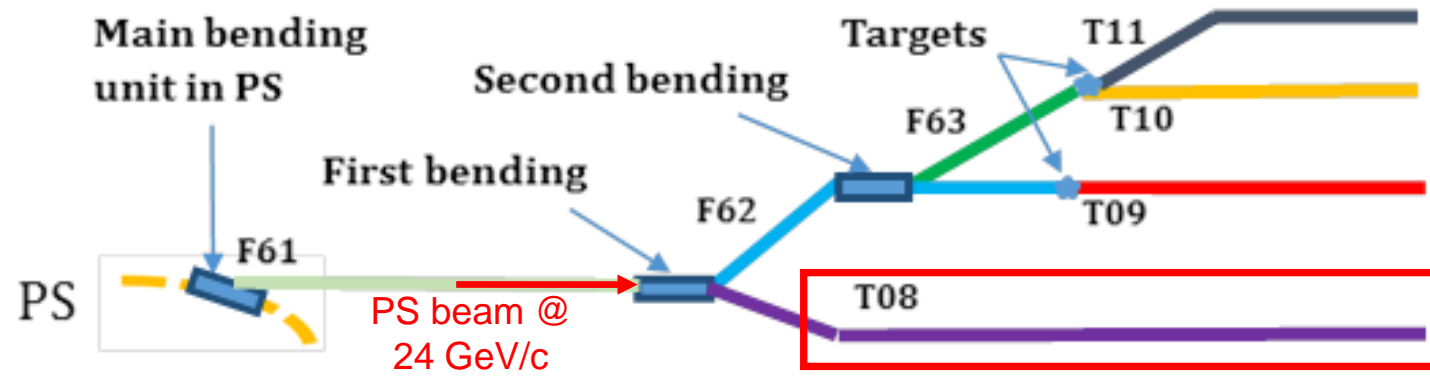
East Area Secondary Beamlines



Spill duration: 0.4 second flat top
 Usually : 1-2 cycles per minute per East Destination
 Max 6 East cycles / 40 seconds → RP Limit

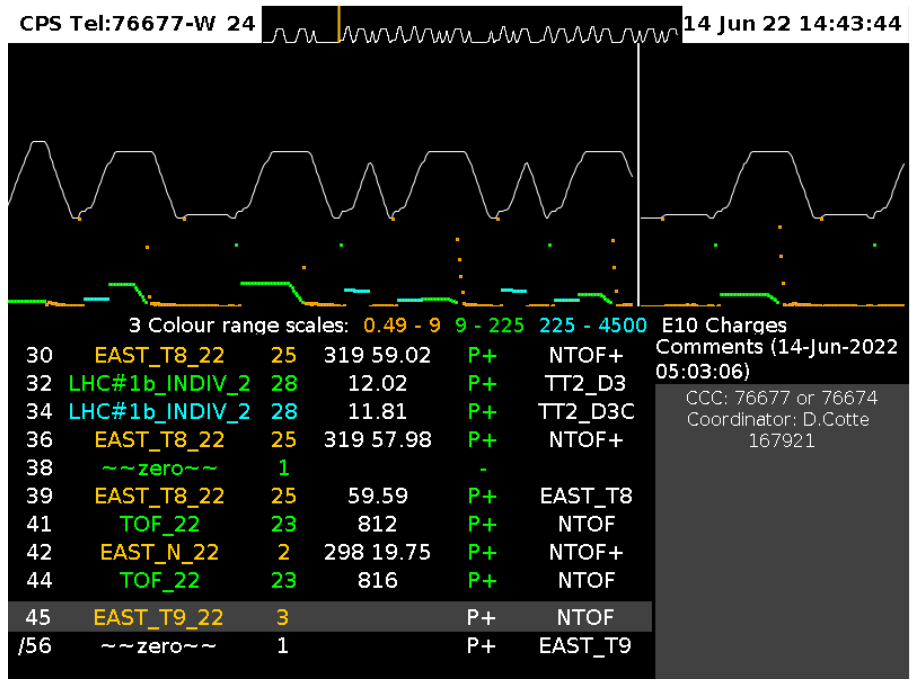
Super-cycle structure dependent on all users (SPS, nTOF ...)

East Area Secondary Beamlines



See B. Gkotse's talk

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



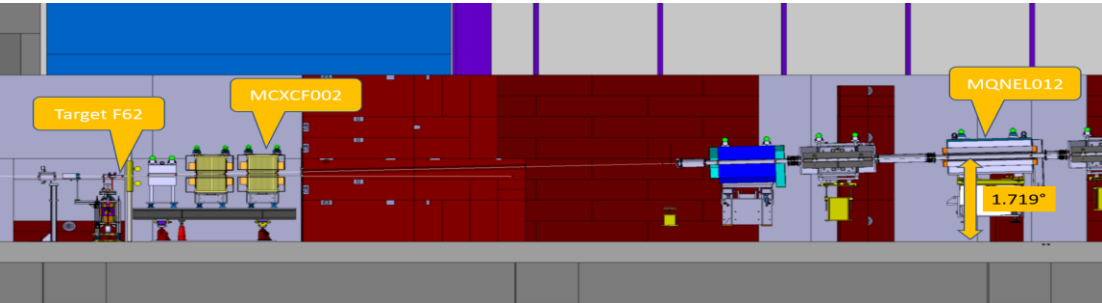
Characteristics of the Secondary Beams

Parameter	T09 Target	T10/T11 Target	
Beam Line	T09	T10	T11
Secondary beam Max Momentum (GeV/c)	16	12	3.5
$\Delta p/p$ (%)	± 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 electrons (T09) or mixed/pure hadrons or pure muons		

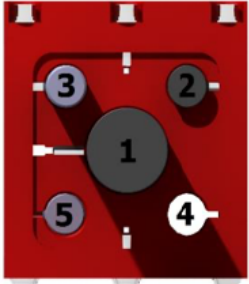
- T11 serves the CLOUD experiment which is a permanent installation.
- The Water Cherenkov Test Experiment aims to use the T09 beamline in 2024 for ~ 13 weeks for testing their 4 m diameter 4 m height 50-ton tank .

30-35 mrad vertical production angle

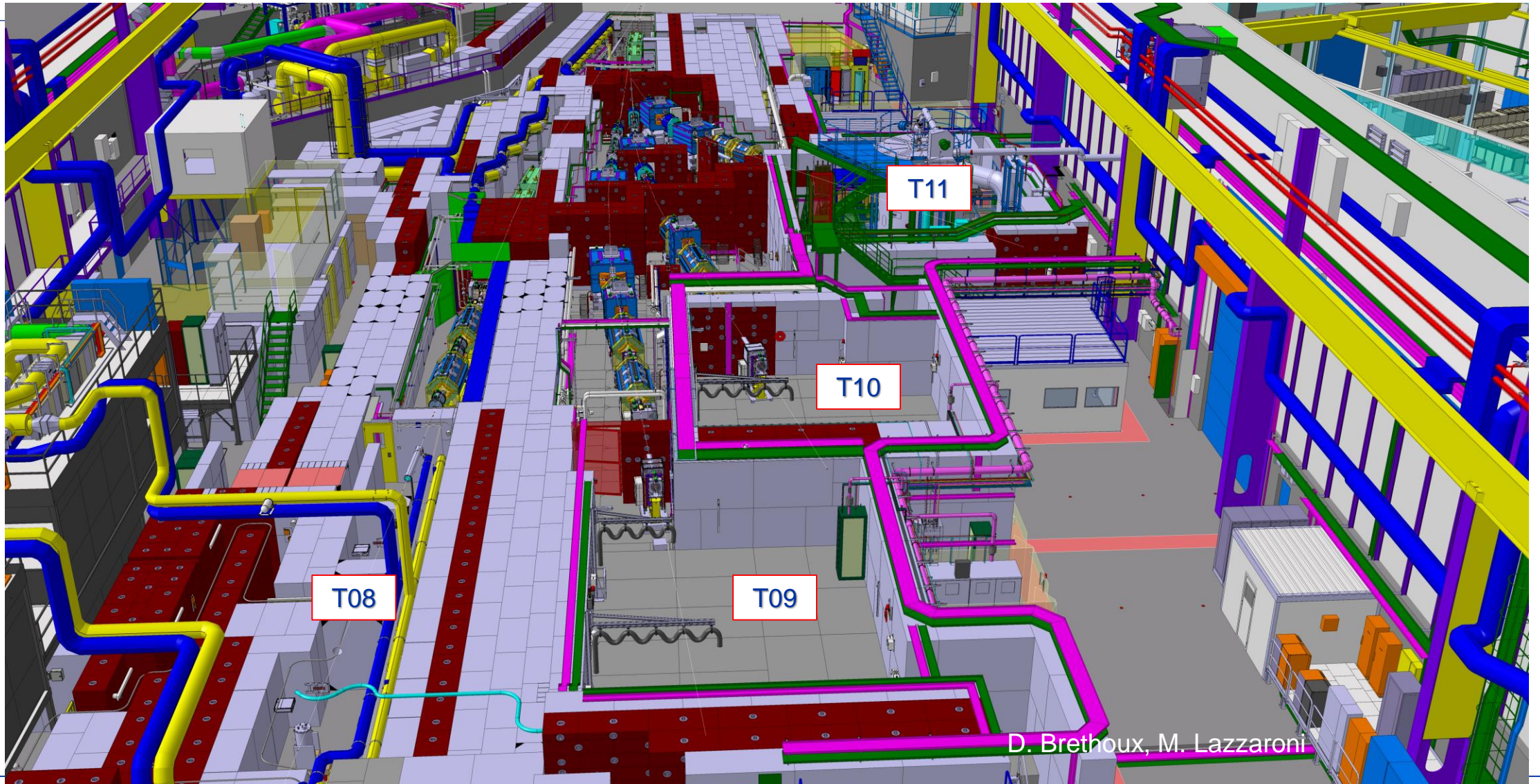
Multi-target configuration



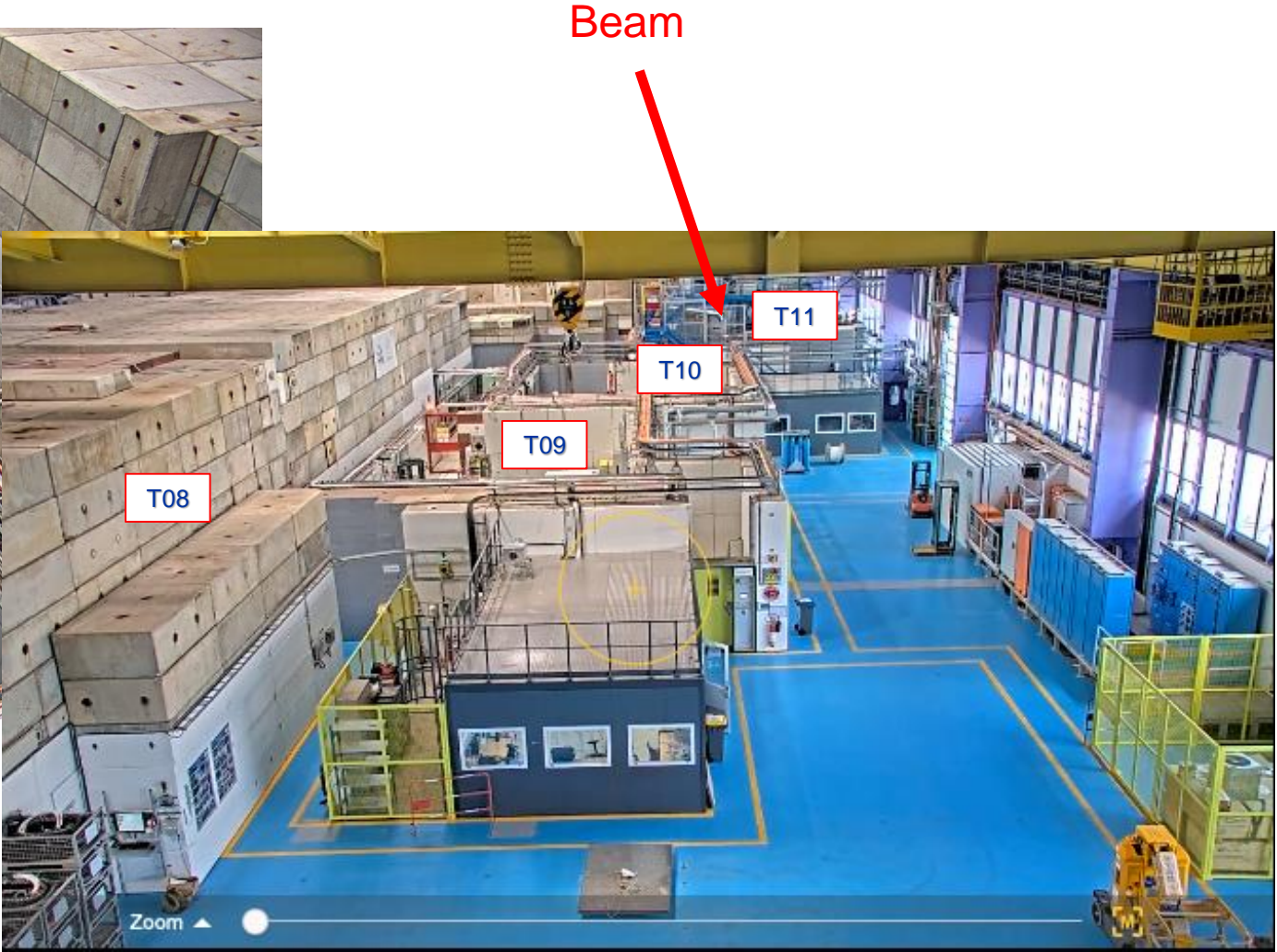
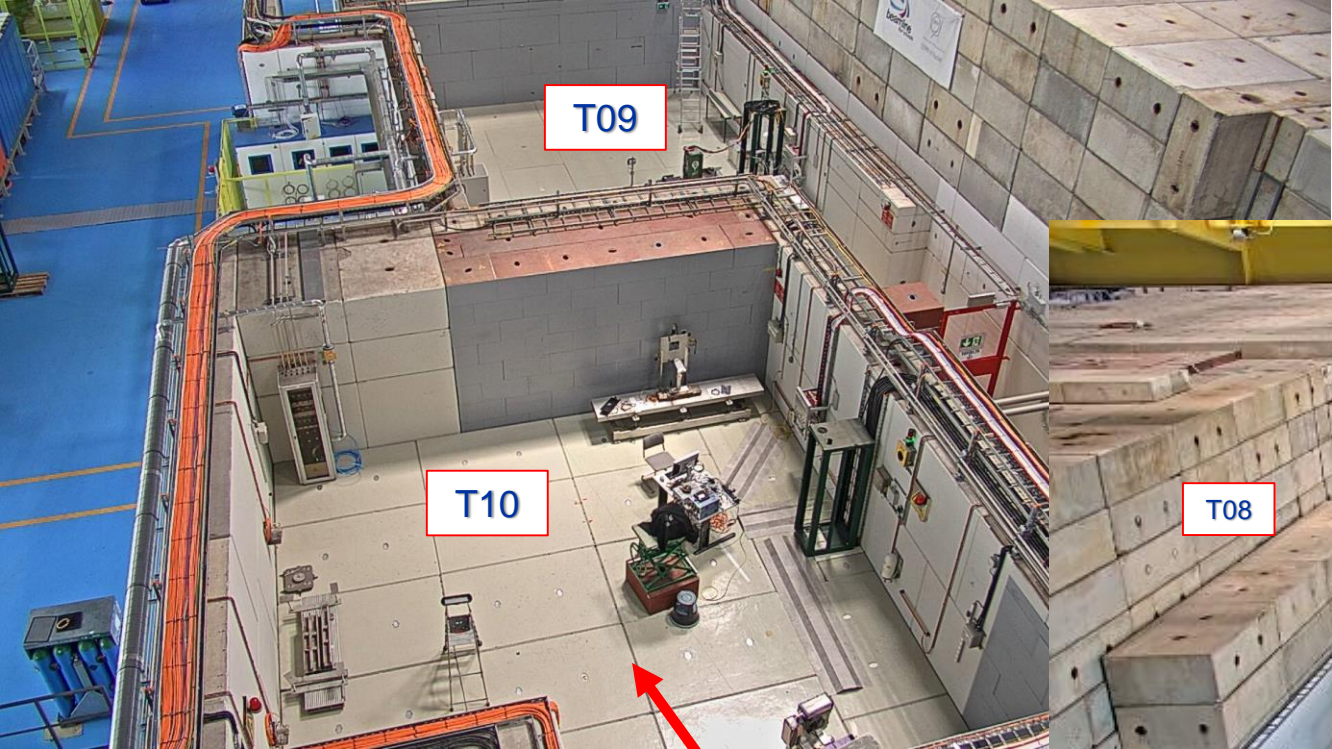
Head	Material	Length (mm)	Diameter (mm)	Comments
1	Be	200	10 + Al case	Electron enriched
	W	3		
2	Al	100	10	Electron enriched
	W	3		
3	Al	200	10	Hadron
4	Air	-	-	Empty
5	Al	20	10	Hadron



Current Layout

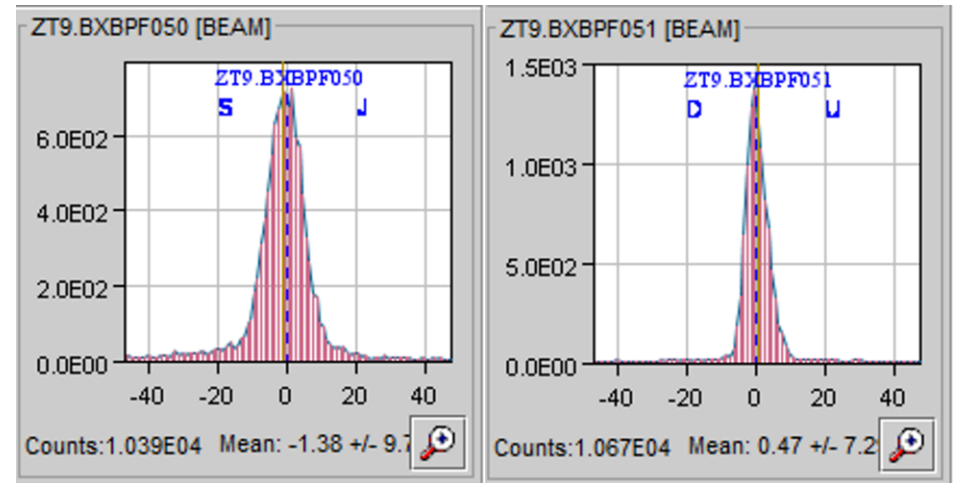
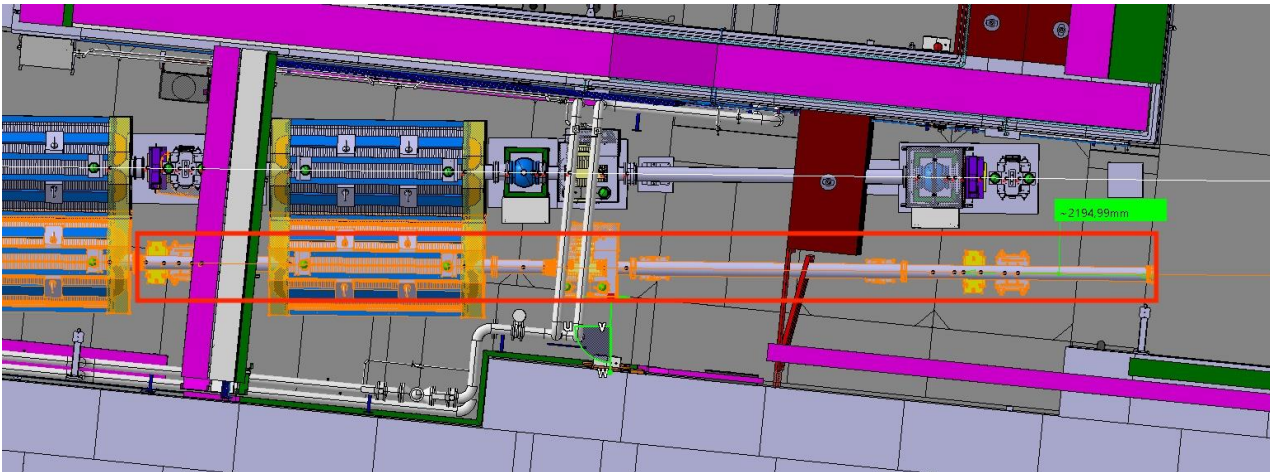


Current Layout



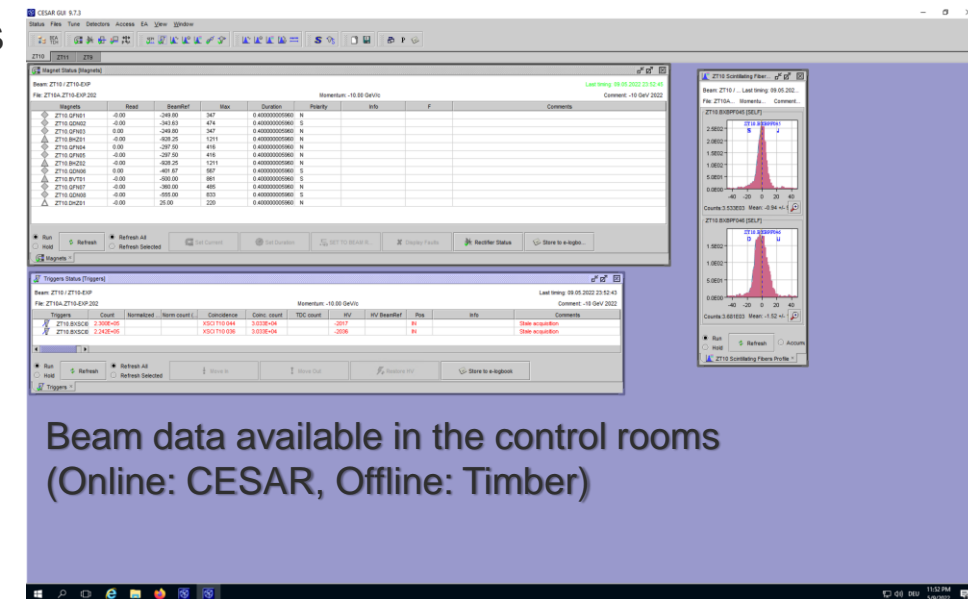
First Beams to the Renovated East Area

- 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 \sim few 10^6 /spill as expected.
- Then they were scaled to the lowest momenta of \sim 0.1 GeV/c. A low momentum configuration is also available in T09 from this July when the vacuum can be completed until the user setup.
- The users are taking physics data since October 2021 as scheduled without any delays.



Beam Instrumentation in the North and East Area

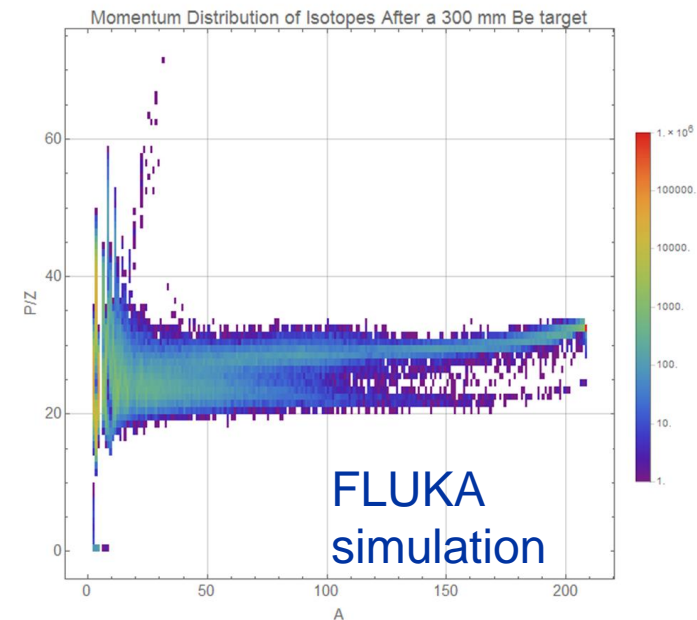
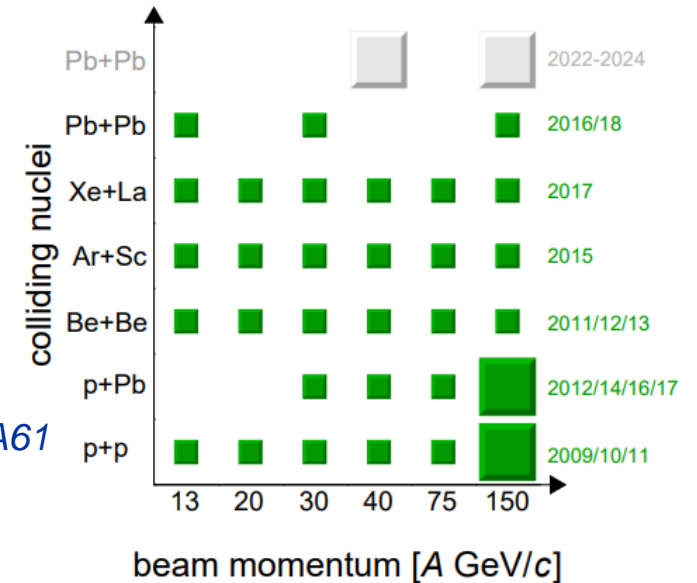
- Depending on the beam line and the zone :
 - Threshold Cherenkov gas counters (XCET) and CEDARs → used for particle tagging
 - In the east area new high pressure XCETs are available that go up to 15 bars with the option of using refrigerant gases like [R218](#) and [R134a](#) for low momenta particle 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.
 - **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 angular measurements**



Ion Beams

- Ion beams are available in the North and the East Area
 - 2021: No ions
 - 2022: Pb
 - 2023 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** and **NA60+** have ion beam programs in the North Area.
- Test-beam users like **Medipix**, **Nucleon** (satellite experiments), **HERD**, **PAN** also request ion beams.
- In 2022 CHIMERA also plans to take low energy ions in T08 (See *B. Gkotse's talk*).

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 handled by the PS-SPS coordinator only.
 - Longer requests require recommendation by CERN physics committees (SPSC, LHCC, REC, RB)

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.

Testbeam: June 2022

schedule issue date: 30-May-2022 Version: 1.10

		Mon 30	Tue 31	Wed 1	Thu 2	Fri 3	Sat 4	Sun 5	Mon 6	Tue 7	Wed 8	Thu 9	Fri 10	Sat 11	Sun 12	Mon 13	Tue 14	Wed 15	Thu 16	Fri 17	Sat 18	Sun 19	Mon 20	Tue 21	Wed 22	Thu 23	Fri 24	Sat 25	Sun 26	Mon 27	Tue 28	Wed 29	Thu 30	Fri 1	Sat 2	Sun 3					
Week		22					23					24					25					26																			
Machine																																									
East Area	T8 - Irrad	F. Ravotti																																							
	T9	X. Wu					PAN					M. Rauch					ALICE FOCAL					STORM setup					L. Bandiera					SHERPA									
	T10	M. Suljic					ALICE ITS3																																		
T2 - H2		NA61 SHINE					H. Schindler PPE172					LHCb ECAL					V. Boudry PPE172					Calice SW ECAL					S. Kowalski 31 GeV/c PPE152					NA61 SHINE									
T2 - H4		GIF RD51					M. R. Jäkel PPE154					GIF					U. Uggerhøj PPE134					NA63					H. Schindler PPE134					LHCb ECAL					CMS BRIL				
H6 parallel												R. Froeschl/F. Pozzi PPE126					CERF					P. Martinengo PPE156					ALICE ITS					D. Lazic PPE134									
H6 parallel																						RD42																			
H6 ACONITE parallel		Rummler PPE146					ATLAS ITK PIXEL																																		
T4 - H8		LHCb (TOTEM)					L. Esposito PPE128, PPE138					STI					D. Lazic PPE158					CMS MTD					A. Rummler PPE158					ATLAS Tilecal									

For further information contact the PS/SPS-Coordinator. Email: Sps.Coordinator@cern.ch, Tel: +41 75 411 5275.

The latest version of the schedule are available here: <https://cern.ch/ps-sps-coordination>
 This schedule is synchronized with injector schedule v1.1.
 No beam to the North Area during Technical Stops (TS), Coldex and Machine Developments (MD).
 For TS a RP cool down time is needed and will be announced in the days preceding the stop.
 Submit your ISIEC at least 2 weeks before your allocated beam time using <https://ep-th-safety.web.cern.ch/isiec-safety-clearance>

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.
 - T9, T10 and T11 in the East Area.
- Please contact in advance Sps.Coordinator@cern.ch and sba-physicists@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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