

# Overview over CERN test beam facilities and LS2 modifications



**8th Beam Telescopes and Test Beams Workshop**

27th – 31st January 2020  
Tbilisi, Georgia  
<https://indico.cern.ch/e/bttb8>

Abstract Submission Deadline 15 November 2019  
Registration Deadline 13 December 2019

**Topics**  
Beam lines & infrastructure  
Simulations & software packages  
Test beam data analysis for tracking detectors, calorimeters & timing detectors

**International Organizing Committee**  
Hendrik Jansen (DESY)  
Maria Soledad Robles Manzano (Uni Mainz)  
Paul Schütze (DESY)  
Simon Spannagel (CERN)

**Local Organizing Committee**  
Gela Devidze (TSU), Tamar Djobava (TSU)  
Archil Durglishvili (TSU), Merab Elashvili (TSU)  
Jemal Khubua (TSU), Irakli Minashvili (TSU & IINR)  
Mikheil Nioradze (TSU), Edisher Tskhadadze (TSU)  
Tamar Zakareishvili (TSU)



ENGINEERING  
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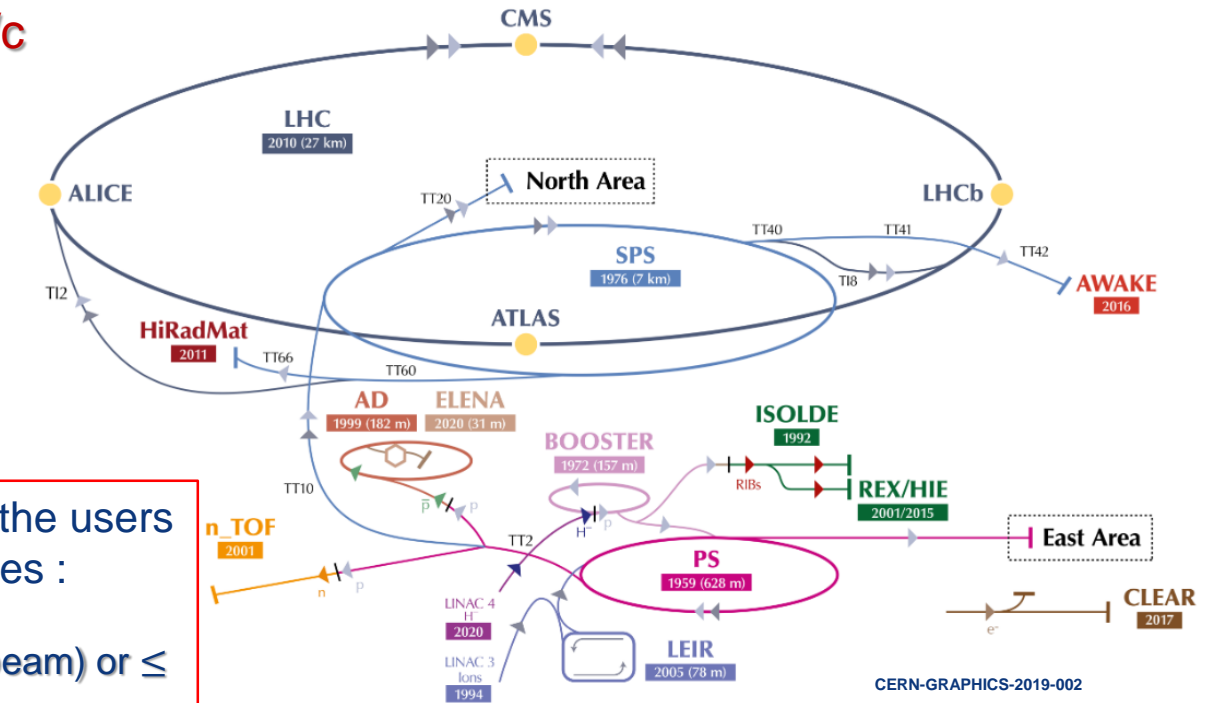
Bastien Raë

On behalf of CERN Experimental Areas Group

# CERN Accelerator Complex

SPS : protons/ions @ 400 GeV/c

PS: protons /ions @ 24 GeV/c

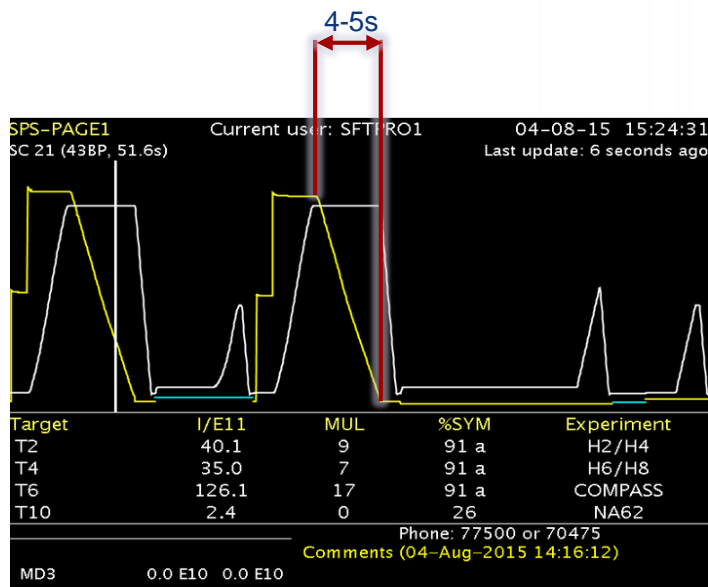
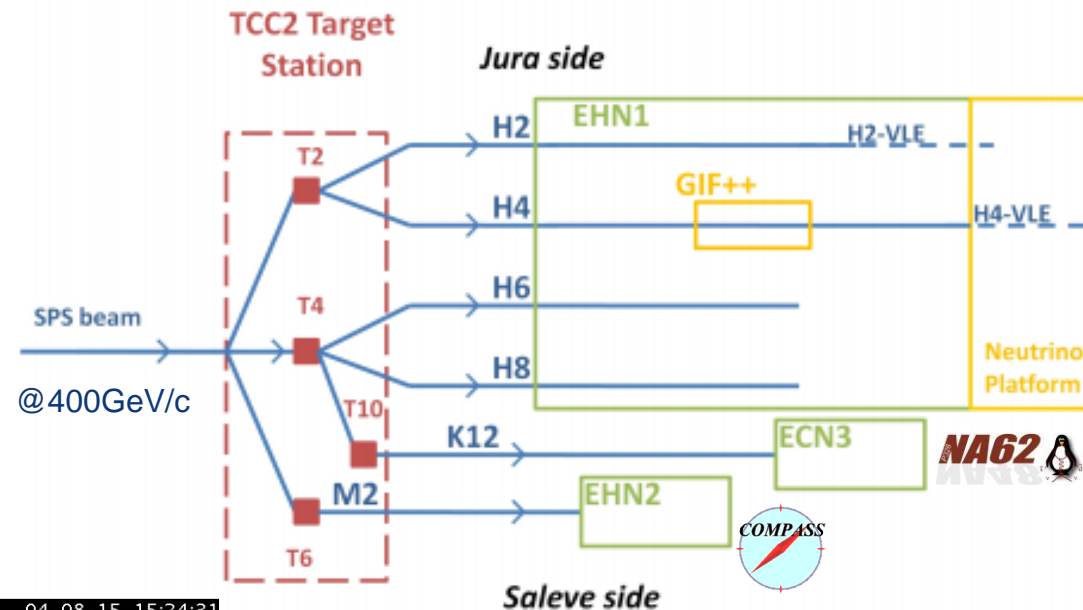


Maximum momenta available to the users in the PS/SPS Test Beam Facilities :

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

East Area (after renovation)  $\rightarrow \leq 15 \text{ GeV/c}$  (secondary beam)

# North Area Layout



- Slow extraction → Spill duration approx. 5 seconds
  - Usually every 20-40s
  - Spill length / repetition frequency dependent on the physics program of all the facilities served by SPS and LHC
- Variability to be expected.

# North Area Beam characteristics

Parameters	T2		T4	
Beam Line	H2	H4	H6	H8
Maximum Momentum [GeV/c]	400 / 380	400 / 380	- / 205	400 / 360
Maximum Acceptance [uSr]	1.5	1.5	2	2.5
Maximum $\Delta p/p$ [%]	$\pm 2.0\%$	$\pm 1.4\%$	$\pm 1.5\%$	$\pm 1.5\%$
Maximum Intensity / spill * (Hadrons / Electrons)	$10^7/10^5$	$10^7/10^7$	$10^7^{**}/10^5$	$10^7^{**}/10^5$
Available Particle Types	Primary protons <sup>***</sup> OR electrons OR muons OR mixed hadrons (pions, protons, kaons)			
Other / Special requests	<a href="mailto:sba-physicists@cern.ch">sba-physicists@cern.ch</a> & <a href="mailto:sps.coordinator@cern.ch">sps.coordinator@cern.ch</a>			

\* Imposed by Radio Protection, and not available to every zone

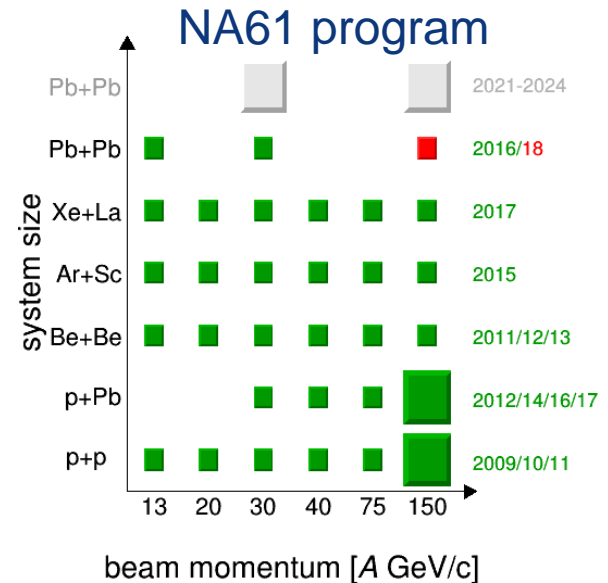
\*\* In some zones can be elevated up to  $10^8$  subject to certain restrictions

\*\*\* Not available in H6

Nota Bene : The particle momenta in H2/H4 and in H6/H8 are coupled. Send your beam request and discuss in advance with the SPS coordinator and the responsible liaison physicists.

# North Area Ion Beams

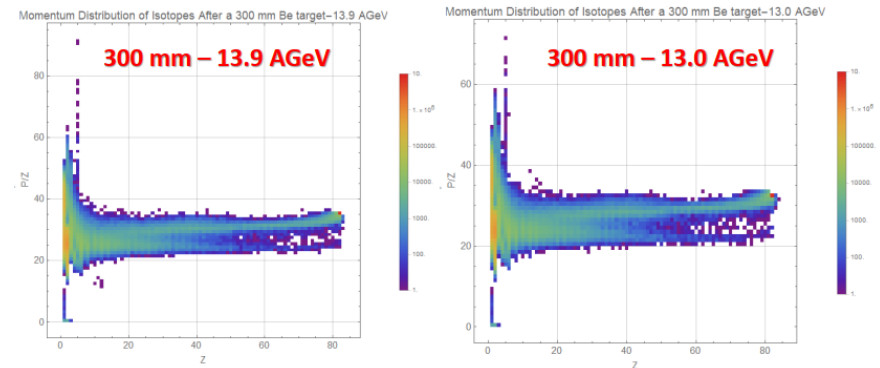
- Ion beams available in North Area
  - 2017: Xe
  - 2018: Pb (150 AGeV/c to 13 AGeV/c)
  - Next ion beams : to be confirmed



- Availability for test beam users in H4/H8
- Interest for test beam use by experiments CALET (ISS), Medipix/Timepix, Nucleon (satellite experiments), R2E....
- Fragmented ion beam available

## Fluka simulation

P/Z with Z – 13.9 AGeV/c





# North Area Magnets

## Goliath

- EHN1, H4 beam line
- Large classical dipole
- 160x240x360cm
- 1.5T field



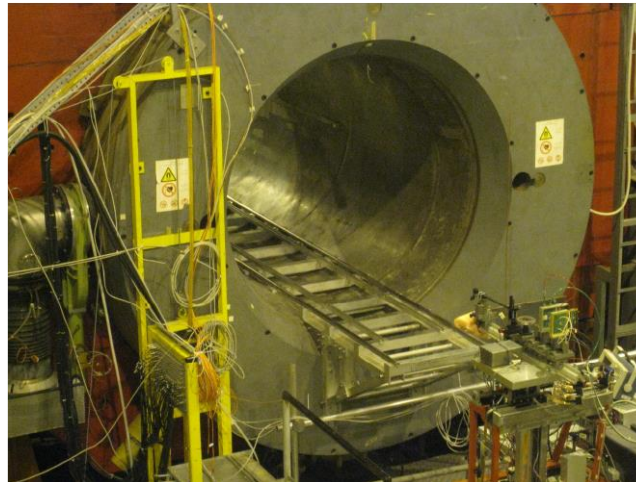
## CMS M1 magnet

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



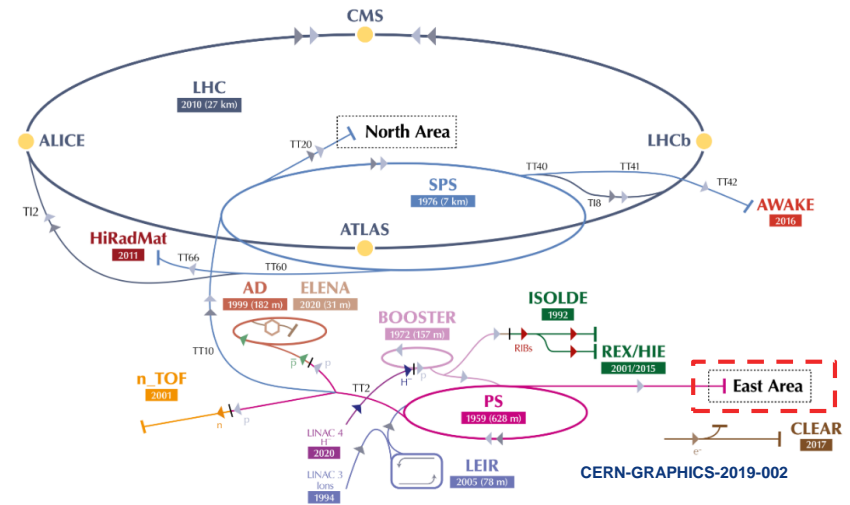
## Morpurgo

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



# The CERN East Area

- Since the 1960's, the CERN East Area is a **beam facility** using protons derived from the **Proton Synchrotron (PS)** for:
  - Primary beam Irradiation facilities (T8)
  - Secondary beam R&D tests of detectors (T9/T10)
  - Secondary beam Experiments (T11 : CLOUD)
  - Outreach
- Because of the ageing of the area, the **East Area Renovation Project** has been launched in 2016.

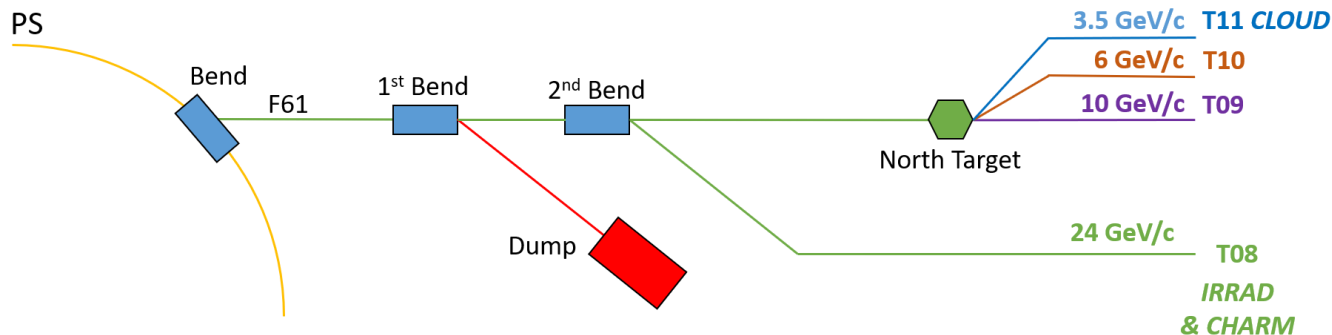


# East Area New Test Beam characteristics

- Increase of the top momentum of both test beams

Testbeam	Previous p (GeV/c)	Future p (GeV/c)
T9	10	15
T10	6	12

2014-2018:



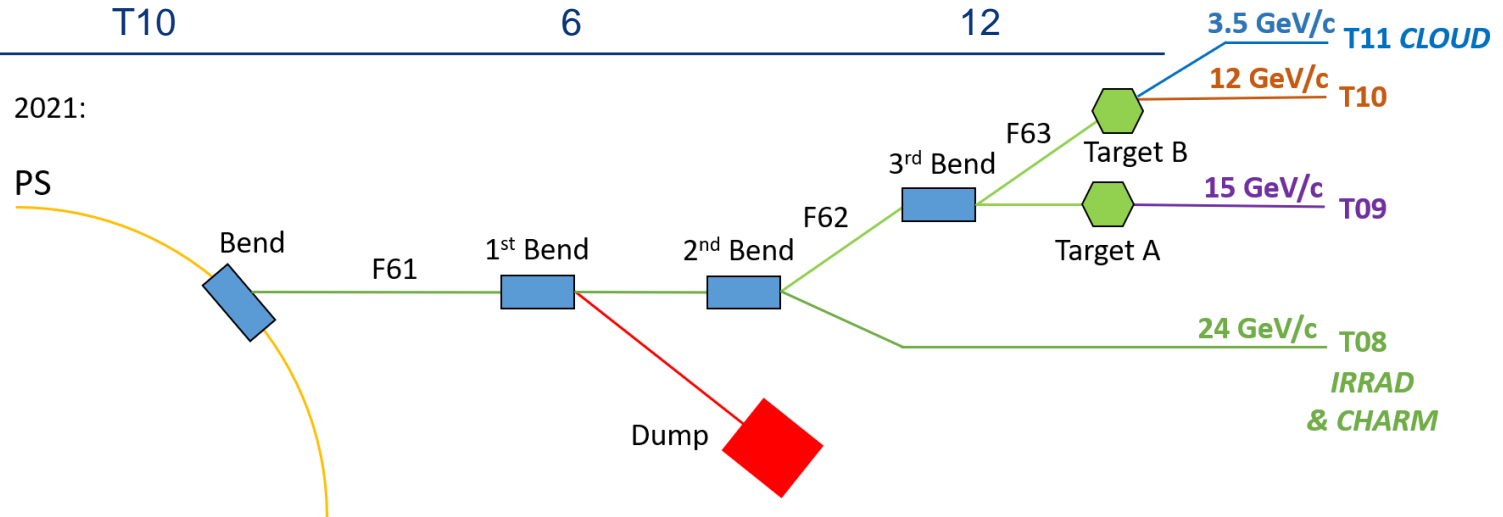
- Higher flexibility with 2 North Targets (instead of one):
  - T9
  - T10/T11
- Better energy overlap with North Area



# East Area New Test Beam characteristics

- Increase of the top momentum of both test beams

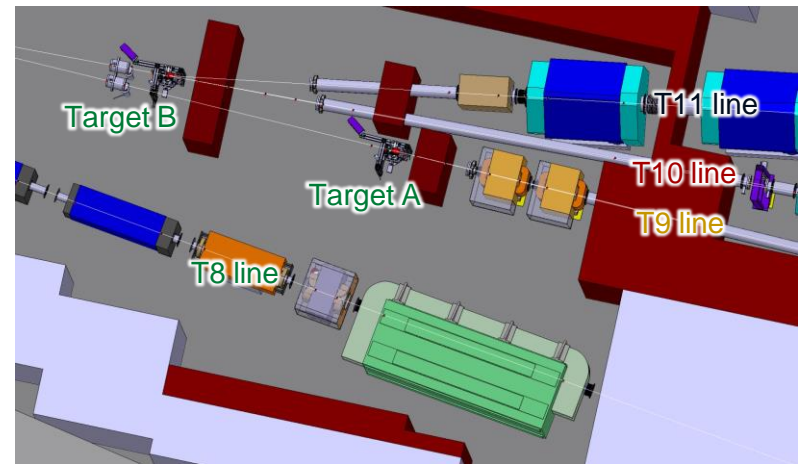
Testbeam	Previous p (GeV/c)	Future p (GeV/c)
T9	10	15
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- Higher flexibility with 2 North Targets (instead of one):
  - T9
  - T10/T11
- Better energy overlap with North Area

# East Area Target

- The primary beam will be switch to:
  - The irradiation area (T8-IRRAD/CHARM)
  - Target A (T9)
  - Target B (T10/T11-CLOUD)

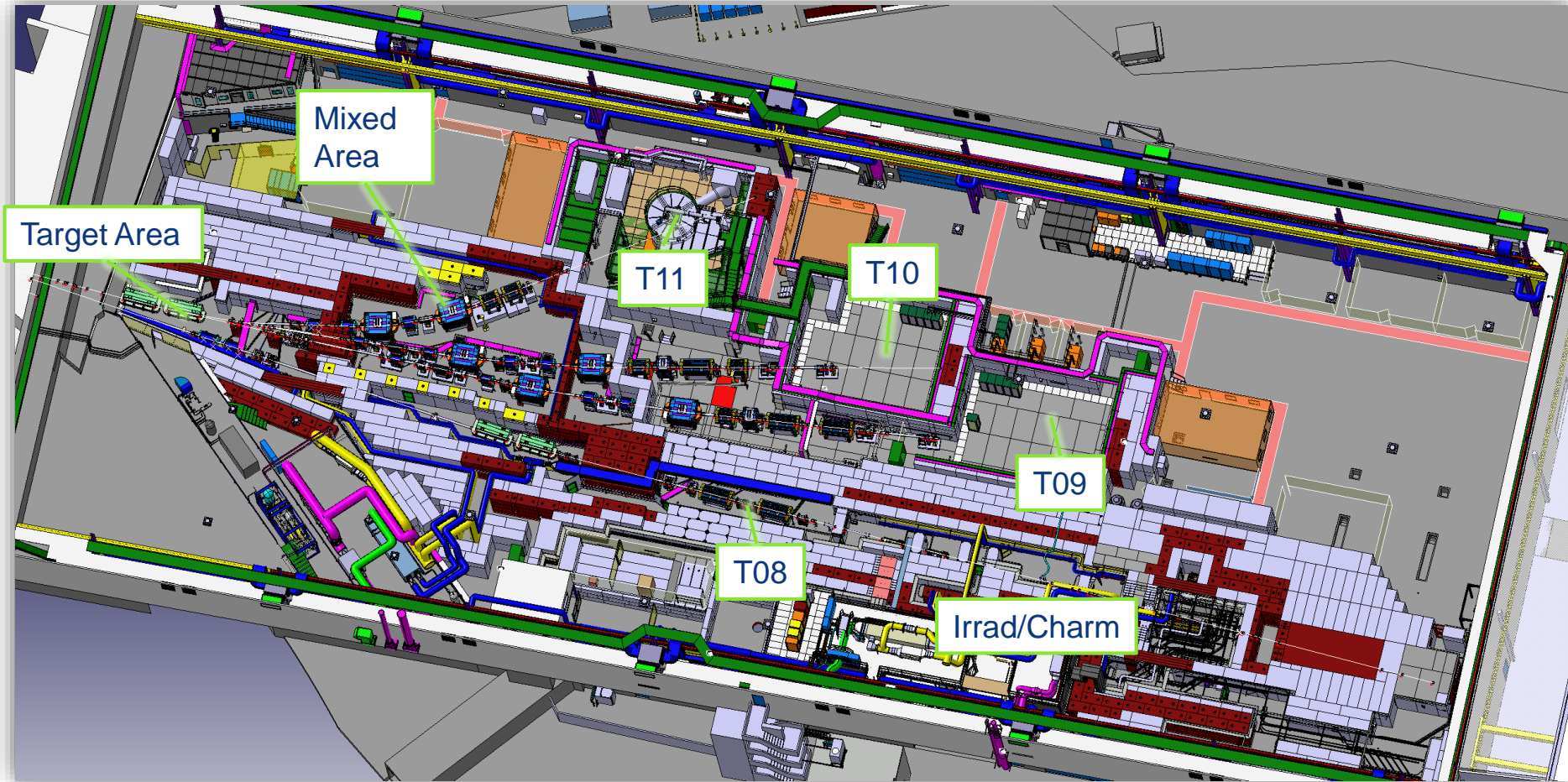


Target Head	Material	Length (mm)	Diameter (mm)	Comments
1	Be W	200 3	10	Electron enriched
2	Be Al	100 3	10	Electron enriched
3	Al	200	10	Hadron
4	air	-	-	Empty
5	Al	20	10	Hadron (thin target)

# East Area Hall Layout

## New features:

- New gas distribution (N<sub>2</sub>, Ar, CO<sub>2</sub>, He, C<sub>2</sub>H<sub>2</sub>F<sub>4</sub>, SF<sub>6</sub>)
- Refurbished control rooms
- New beam instrumentations
- Same beam height in T9 & T10





# East Area Current Status

- Dismantling phase finished end of 2019
- Installation phase on going
- First magnets already installed on the PS side

Beam commissioning  
planned for May 2021



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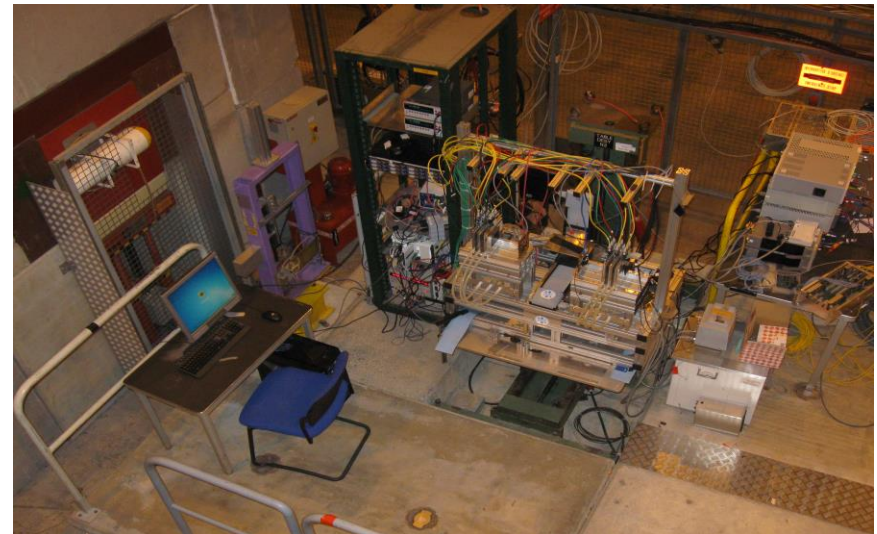


# AIDA Telescopes in CERN Experimental Areas

- North Area:
  - ACONITE in H6A
  - AIDA telescope in H6B
- East Area :
  - AZALEA ( Currently @DESY)



For more information :  
<https://telescopes.desy.de>  
Or contact :  
[Andre.Rummler@cern.ch](mailto:Andre.Rummler@cern.ch)  
[Henric.Wilkins@cern.ch](mailto:Henric.Wilkins@cern.ch)

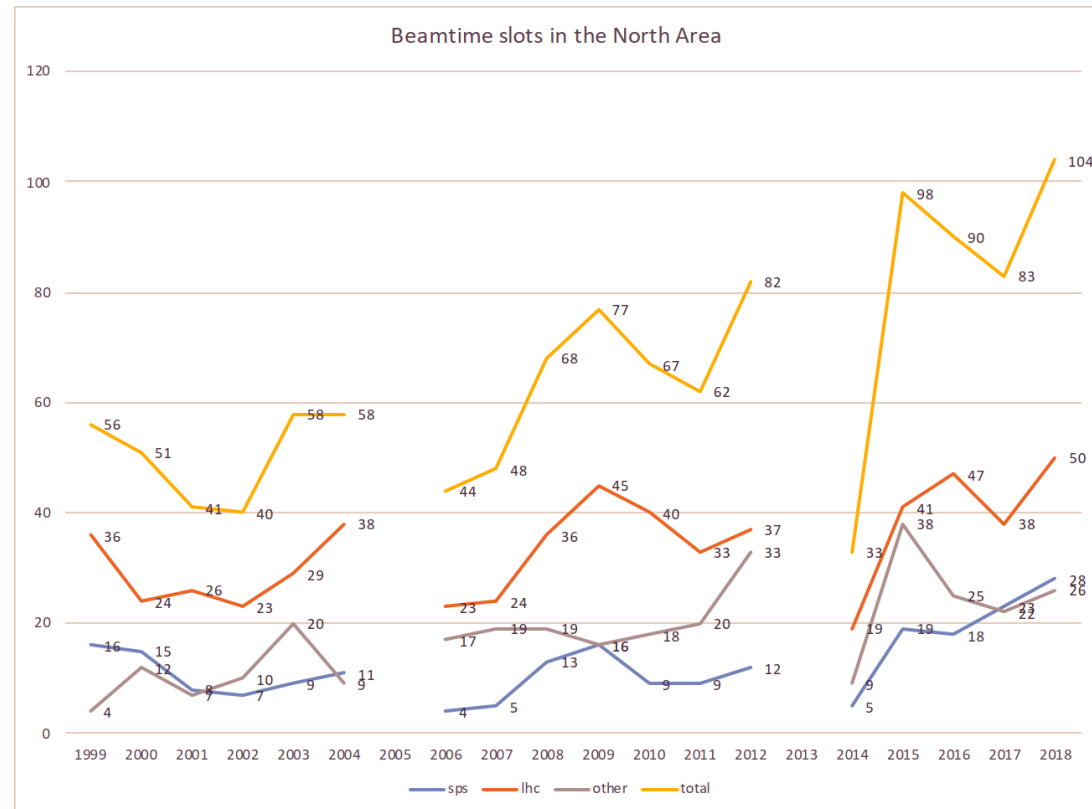




# Schedule and Planning

The beam time request has to be sent to the SPS coordinator  
~ November for the following year  
(To be confirmed).

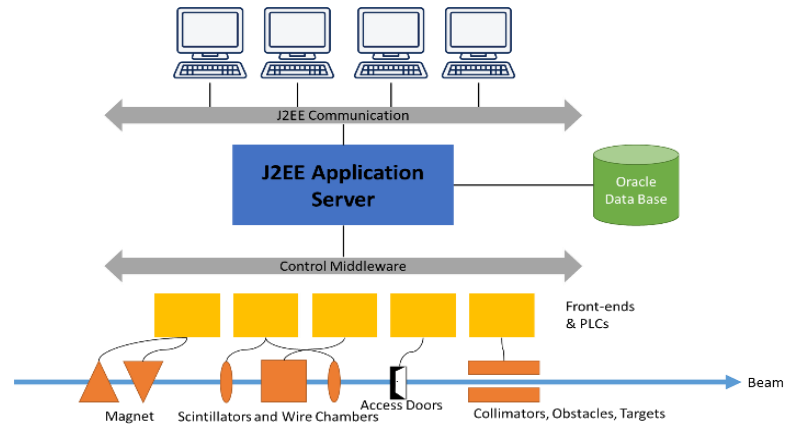
- Short ( $\leq 1$  week @ SPS or  $\leq 2$  weeks @ PS) requests can be approved by the SPS coordinator alone.
- Longer requests require recommendation by CERN physics committees (SPSC, LHCC, REC, RB)
- Physics restart planned for :
  - North Area : 19 April 2021
  - East Area : TBC



# Software for users - CESAR

- Allow users to:

- Control the beam position and intensity
- Check the beam parameters
- Connect their detector to it
- Load prepared beam files for changing beam parameters
- Control the access to the zones



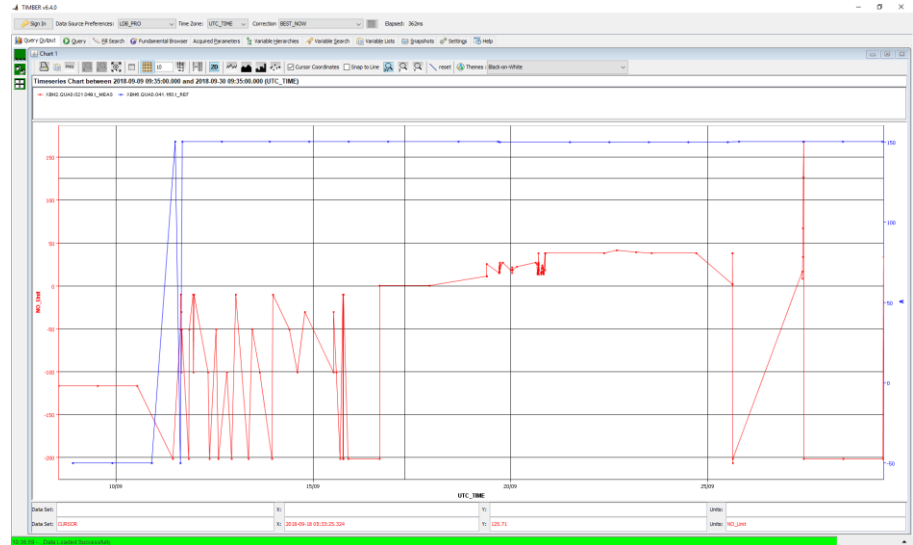
Beamline	Component	Particle Type	Momentum	Expan.	Diam.	Beam pos.	Label E.	Beam.	Flow E.	Last M.	Creation Date	Parent Access
HCA CHS 000	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+14.61	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 001	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 002	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 003	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+9.98	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 021	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 022	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 023	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 048	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 052	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 083	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00
HCA CHS 085	HGF4E.FF01.2017	ELECTRON	+100.00	CM5	HCA	Scandium	+100.00	+0.00	+10.00	2017.C	2017.C	HCA.CHS.00.00

CESAR East will have the same functionalities as North after renovation.

# Software for users – TIMBER + Beam Line status

## TIMBER :

- Can extract time series data from multiple data sources simultaneously
- All beam parameters saved permanently
- Users Detectors connected to CESAR saved



## SBA-Beams :

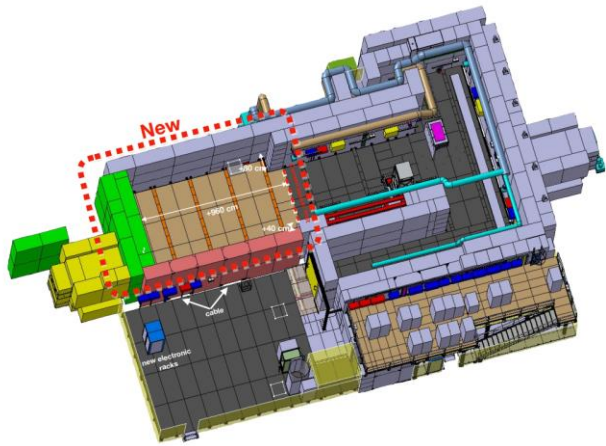
- Website extract “live” beam status
- Wire chamber profile available
- Time series for some values available
- Can be accessed from anywhere!

FILE	MAGNETS	COLLIMATORS	SCINTILLATORS
BEAMLAST_FILE_LOADED	BEND 021 0271 MEAS. - REF.	KCSH 021 045 POS_JAW1 MEAS. - REF.	XSCI 021 131 COUNTS - XSCI 021 264 COUNTS -
QUAD 021 0381 MEAS. - REF.	QUAD 021 0411 MEAS. - REF.	KCSV 021 046 POS_JAW1 MEAS. - REF.	XSCI 021 461 COUNTS - XSCI 021 492 COUNTS -
QUAD 021 0491 MEAS. - REF.	BEND 021 0651 MEAS. - REF.	KCHV 021 068 POS_JAW1 MEAS. - REF.	XSCI 021 521 COUNTS - XSCI 021 628 COUNTS -
BEND 021 0831 MEAS. - REF.	QUAD 021 0871 MEAS. - REF.	KCHV 021 132 POS_JAW1 MEAS. - REF.	
QUAD 021 0991 MEAS. - REF.	QUAD 021 1191 MEAS. - REF.	KCHV 021 068 POS_JAW2 MEAS. - REF.	
BEXTUPOL_021 1371 MEAS. - REF.	TRIM 021 1381 MEAS. - REF.	KCSV 021 184 POS_JAW1 MEAS. - REF.	
TRIM 021 1391 MEAS. - REF.	QUAD 021 1701 MEAS. - REF.	KCHV 021 201 POS_JAW1 MEAS. - REF.	
QUAD 021 1821 MEAS. - REF.	TRIM 021 2021 MEAS. - REF.	KCHV 021 202 POS_JAW2 MEAS. - REF.	
QUAD 021 3031 MEAS. - REF.	QUAD 021 3141 MEAS. - REF.	KCSV 021 218 POS_JAW1 MEAS. - REF.	
BEND 021 3191 MEAS. - REF.	BEND 021 3371 MEAS. - REF.	KCHV 021 398 POS_JAW1 MEAS. - REF.	
QUAD 021 4001 MEAS. - REF.	TRIM 021 4021 MEAS. - REF.	KCHV 021 398 POS_JAW2 MEAS. - REF.	
QUAD 021 4471 MEAS. - REF.	QUAD 021 4071 MEAS. - REF.	KCHV 021 599 POS_JAW1 MEAS. - REF.	
BEND 021 4051 MEAS. - REF.	TRIM 021 4401 MEAS. - REF.	KCSH 021 429 POS_JAW1 MEAS. - REF.	
QUAD 021 4701 MEAS. - REF.	QUAD 021 4871 MEAS. - REF.	KCSH 021 514 POS_JAW2 MEAS. - REF.	
QUAD 021 4891 MEAS. - REF.	TRIM 021 4911 MEAS. - REF.	KCSV 021 549 POS_JAW1 MEAS. - REF.	
TRIM 021 4921 MEAS. - REF.	QUAD 021 5901 MEAS. - REF.		
QUAD 021 5111 MEAS. - REF.	BEND 021 5911 MEAS. - REF.		
QUAD 021 5241 MEAS. - REF.	QUAD 021 5641 MEAS. - REF.		
QUAD 021 5661 MEAS. - REF.	TRIM 021 5671 MEAS. - REF.		
TRIM 021 5681 MEAS. - REF.	BEND 021 5961 MEAS. - REF.		



# Changes After LS2

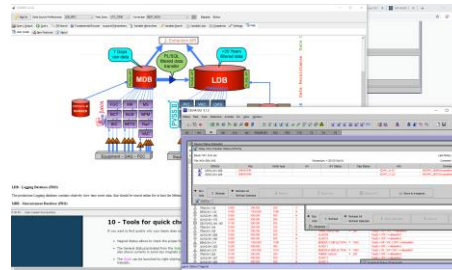
GIF++ Extension ✓  
(see next presentation)



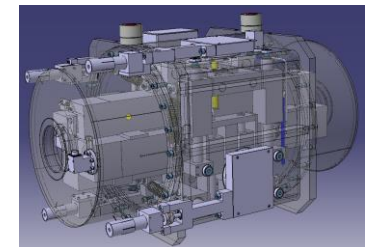
- New Gas Patch panel (Ar,N2,CO2,He)
- Gas distribution monitoring



## Software development



## Collimators, XTDTV and Cerenkov renovation



# Summary

- North and East Area offer a great variety of beams
  - Energy from 1-2GeV/c to 400GeV/c
  - Intensity up to  $10^7$  per spill
  - Particles available : primary protons, electrons, muons and mixed hadrons (pions, protons, kaons)
- Software support of the beam line makes them even more flexible for the users
- The facilities continuously change and upgrade.
- Don't hesitate to contact [sps.coordinator@cern.ch](mailto:sps.coordinator@cern.ch) and [sba-physicists@cern.ch](mailto:sba-physicists@cern.ch)

# Thanks for your attention



## QUESTIONS ?

Acknowledgements to G. L. D'Alessandro, D. Banerjee, J. Bernhard, M. Brugger, N. Charitonidis, L. Gatignon, A. Gerbershagen, E. Montbarbon, A. Rummler, M. Van Dijk, B.M. Veit, H. Wilkens

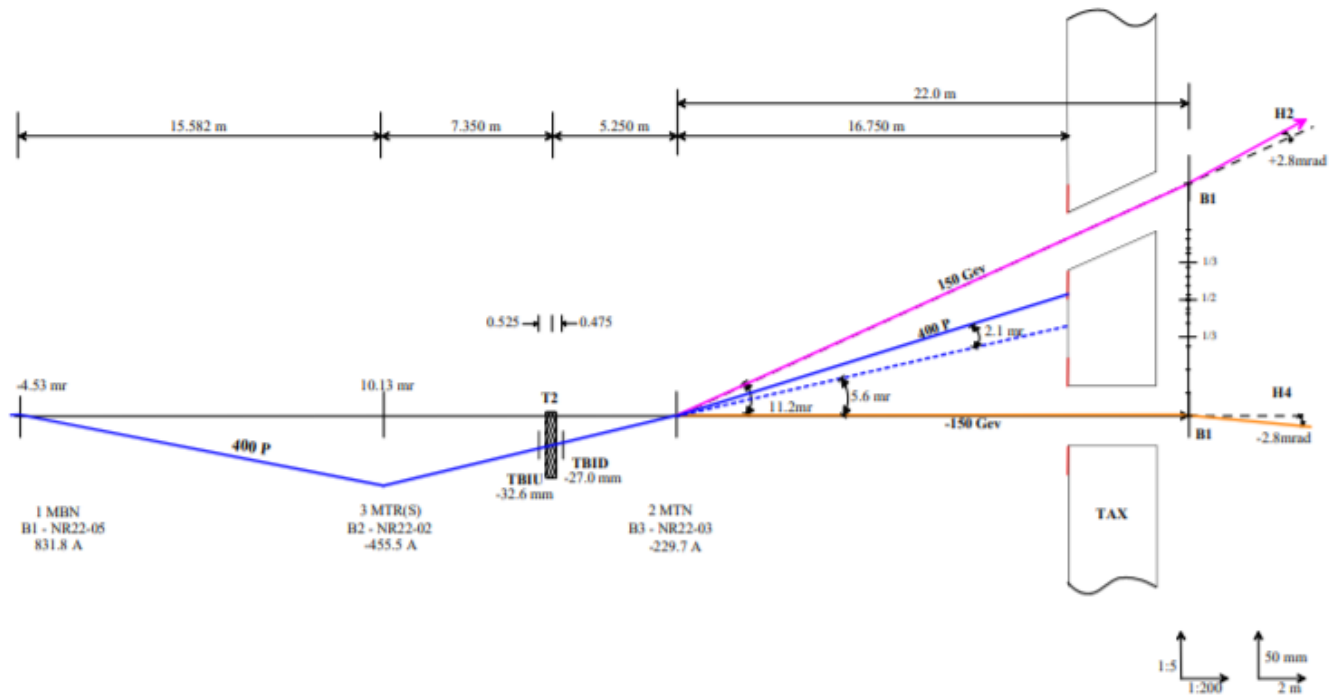


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**BACK UP SLIDES**

# Wobbling

## “Multi-purpose” T2 wobbling





# Instrumentation (available to users)

- Depending on the beam line and the zone :
  - **Beam profile & intensity monitors** (scintillators & analog/delay multi wire chambers), installed in several positions along the beam line
  - **FISC scanners** (precise slower profile monitors – can be used for angular measurements)
  - **Cherenkov gas counters** (used for particle species tagging)

# Timing distribution

The SPS timing signals are distributed in each counting room, available in a little module in one of the racks of the barrack.

There are three available signals:

- WWE (warning-warning-extraction) : typically ~1sec before particles arrive,
- WE (warning extraction) : typically few 10msec before particles arrive,
- EE (extraciton-end) : at the end of the extraction.

The signals are 2us TTL signals, adjusted each time to the SPS super-cycle timing.