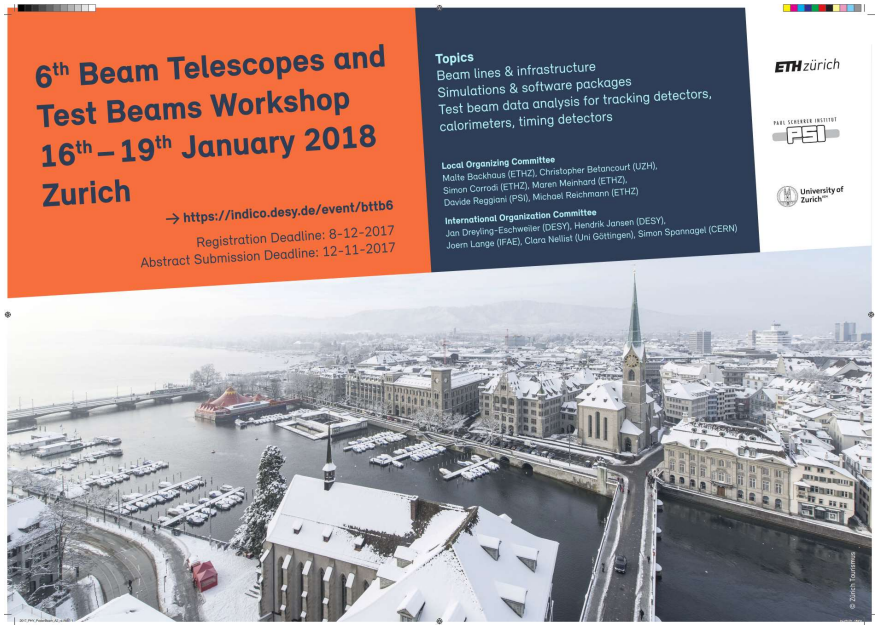
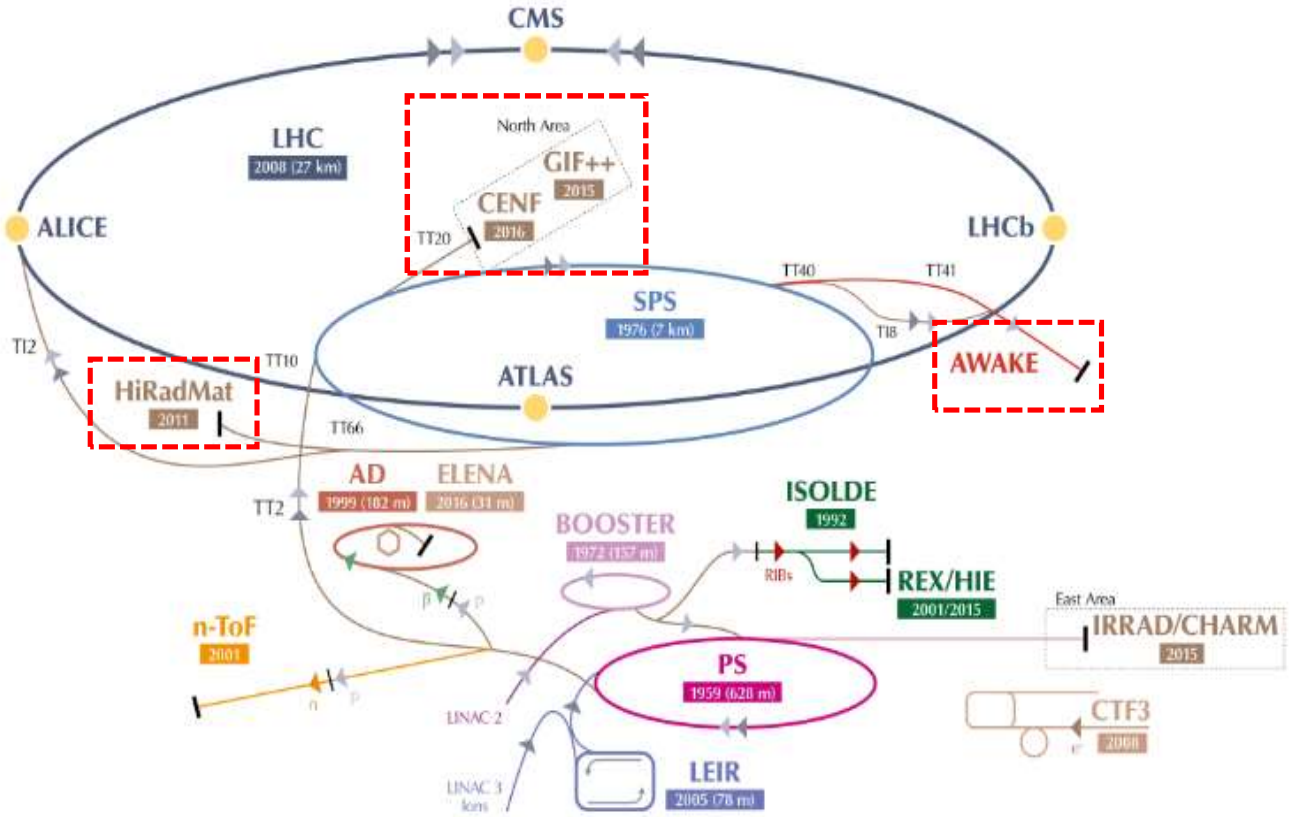
Overview over CERN SPS test beams



A. Gerbershagen

On behalf of CERN Experimental Areas Group

CERN Accelerator Complex



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

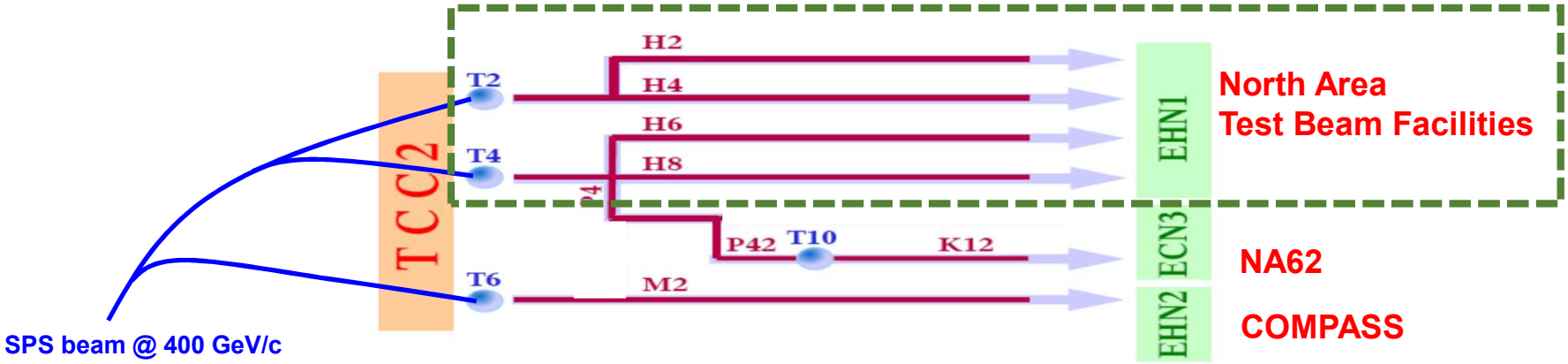
Maximum momenta available to the users in the PS/SPS Test Beam Facilities :

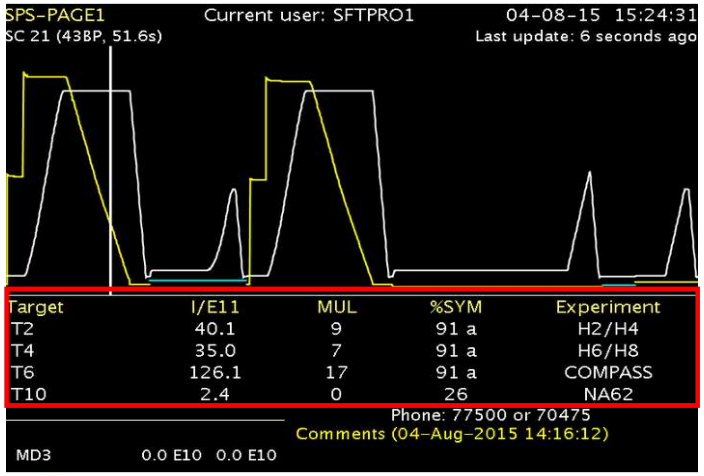
North Area → ≤400 GeV/c/Z (primary beam) or ≤ 360 GeV/c/Z (secondary beam)

Reference: **OPEN-PHO-ACCEL-2016-013**

North Area Secondary Beam Lines

The 400 GeV/c primary beam is *slowly* extracted onto *3 'primary' targets*





- Spill duration approx. 5 seconds
- Usually : 2 cycles / SPS supercycle for NA
- Spill length / repetition frequency dependent on the physics program of all the facilities served by SPS and LHC
  → Variability to be expected.

EHN1 (building 887, Prevessin site)

North Area Test Beam Facilities Characteristics

Primary mode Secondary mode

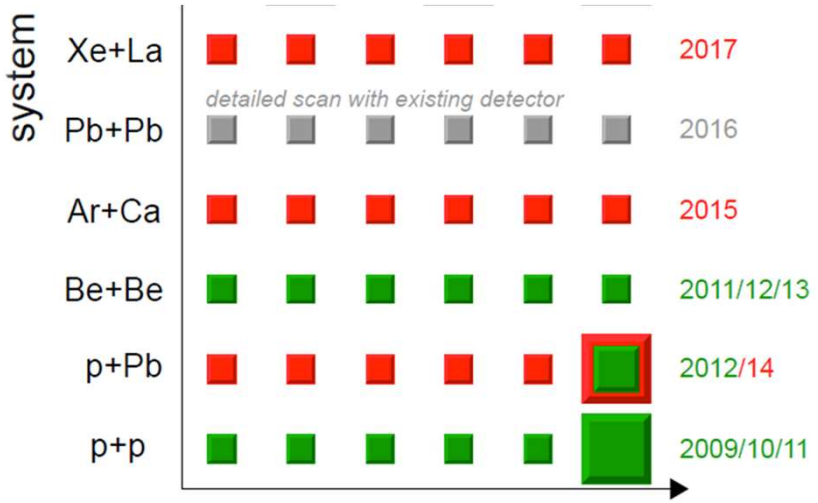
Parameters	T2		T4	
Beam Line	H2	H4	H6	H8
Maximum Momentum [GeV/c]	400 / 360	400 /330	- / 205	400 / 360
Maximum Acceptance [uSr]	1.5	1.5	2	2.5
Maximum Δp/p [%]	± 2.0%	± 1.4 %	±1.5%	±1.5%
Maximum Intensity / spill * (Hadrons / Electrons)	$10^7/10^5$	$10^7/10^6$	$10^{7\,**}/10^5$	$10^{7\,**}/10^5$
Available Particle Types	Primary protons*** OR electrons OR muons OR mixed hadrons (pions, protons, kaons)			
Other / Special requests	sba-physicists@cern.ch & sps.coordinator@cern.ch			

* 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.

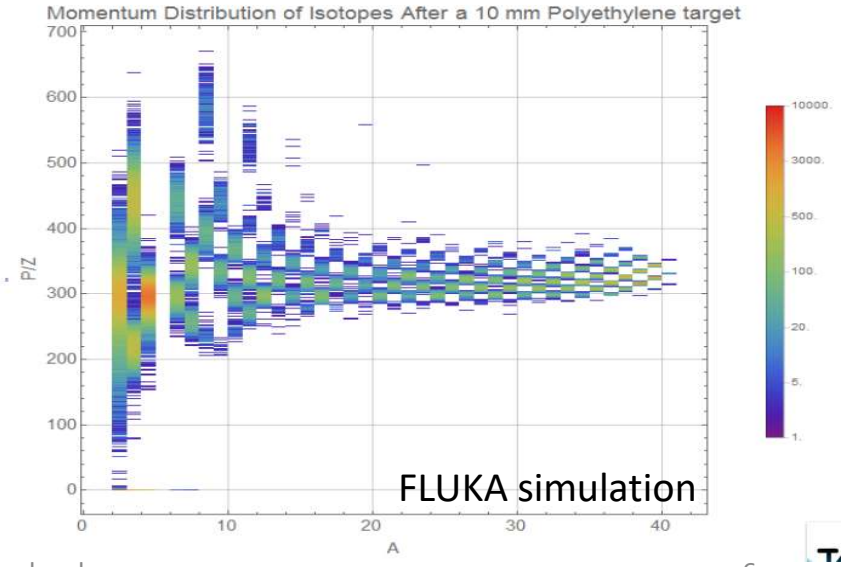
Ion beams availability

- Ion beams available in North Area
  - 2017: Xe
  - 2018: Pb



NA61 program

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



Large aperture magnets available for tests with beam

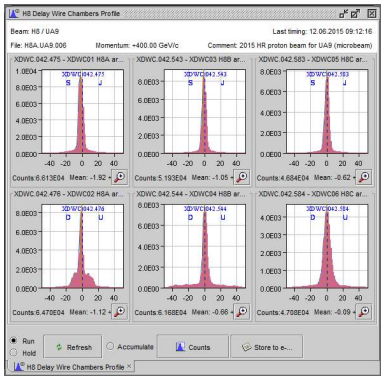
Goliath
- EHN1, H4 beam line
- Large classical dipole
- 160x240x360cm
- 0.85T field

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

Instrumentation (available to users)

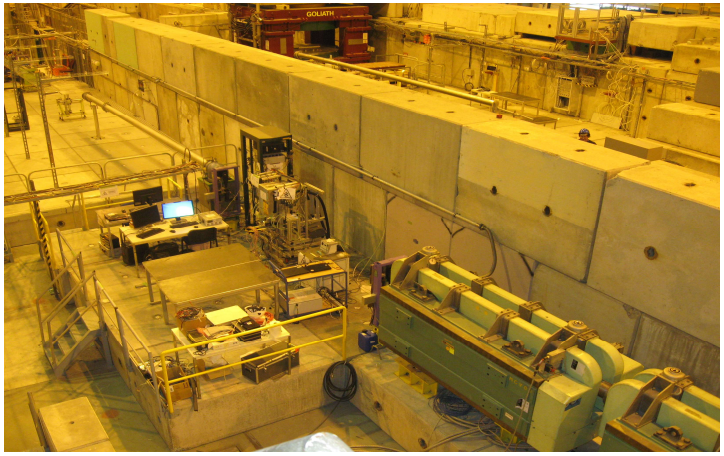
- Depending on the beam line and the zone :
  - Beam profile & intensity monitors (scintillators & analog/delay multi wire chambers), installed in several positions along the beam line
  - FISC scanners (precise slower profile monitors – can be used for angular measurements)
  - Cherenkov gas counters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

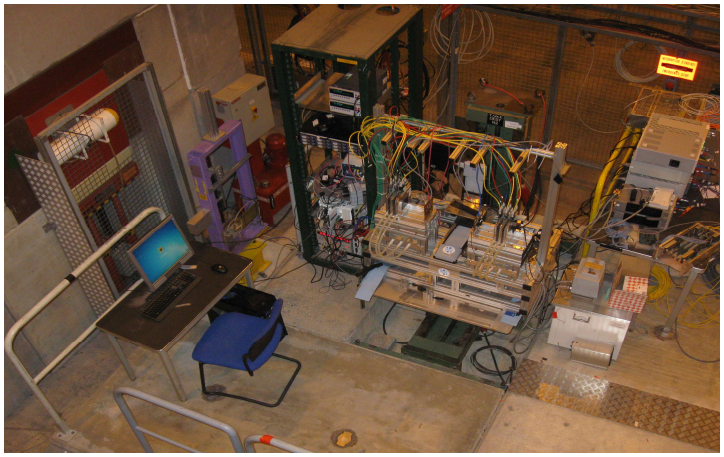


Beam data available in the counting rooms (CESAR, Timber)

AIDA Telescopes in CERN North Area (SPS)

- Two AIDA telescopes installed permanently in the North Area:
  - ACONITE in H6A
  - AIDA telescope in H6B
- 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)
  - Temperature and humidity monitoring available



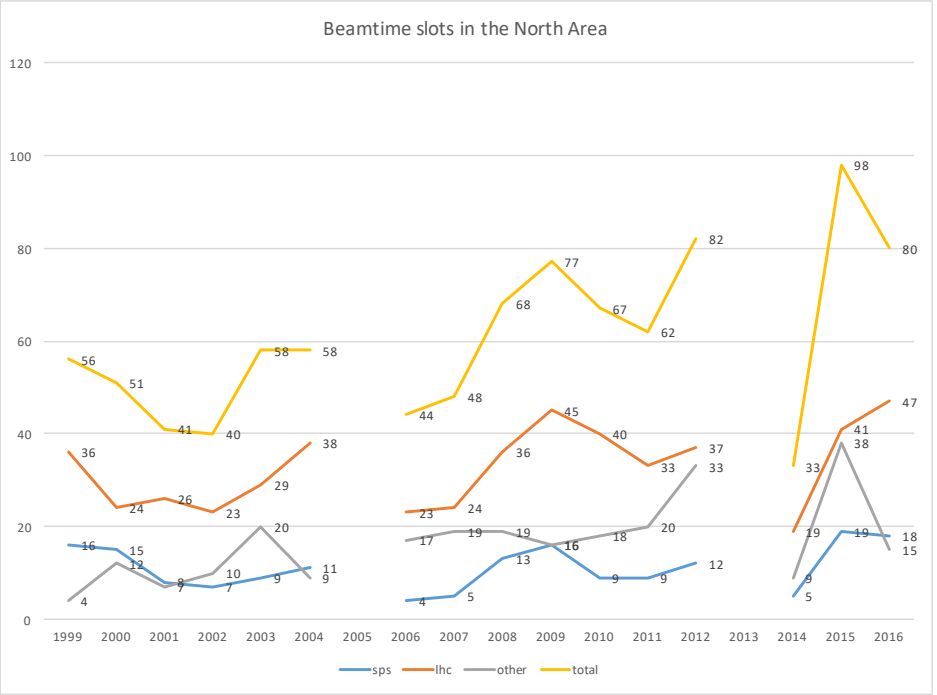


Schedule and planning

The beam time request has to be sent to the SPS coordinator @ ~ November for the following year.

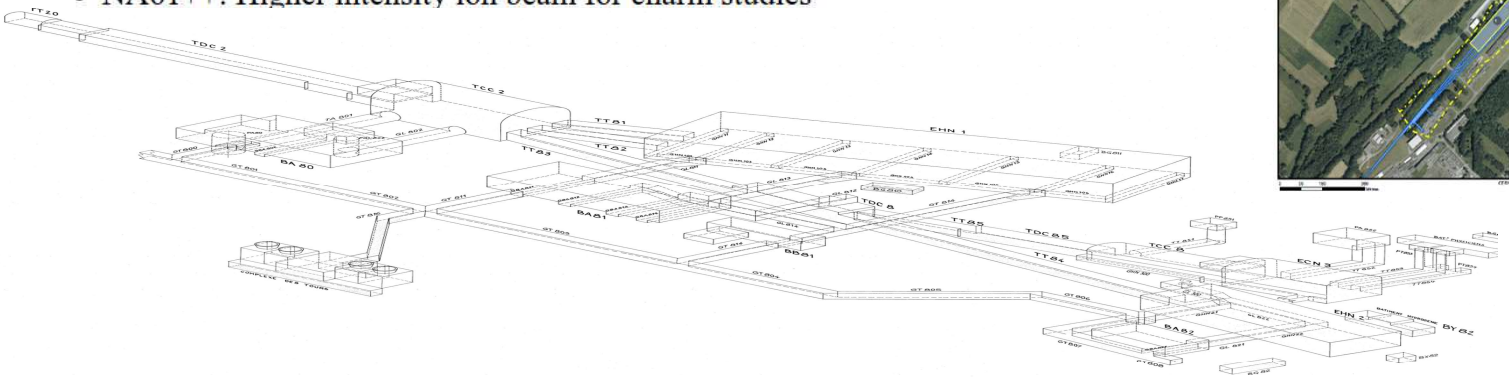
- Short (<1 week @ SPS or < 2 weeks @ PS) requests can be approved by the SPS coordinator only.
- Longer requests require recommendation by CERN physics committees (SPSC, LHCC, REC, RB)
- Long Shutdown 2 from Dec 2018 to May 2021

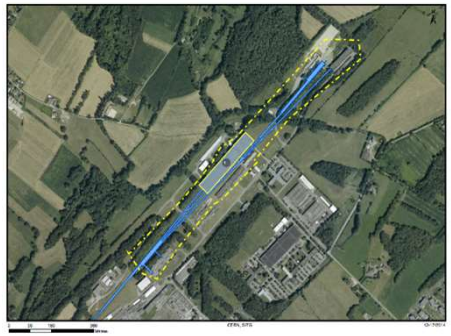
The scheduling is based on priorities of different experiments and is discussed with the committees' chairs. The draft schedule is presented at CERN's research board for approval.



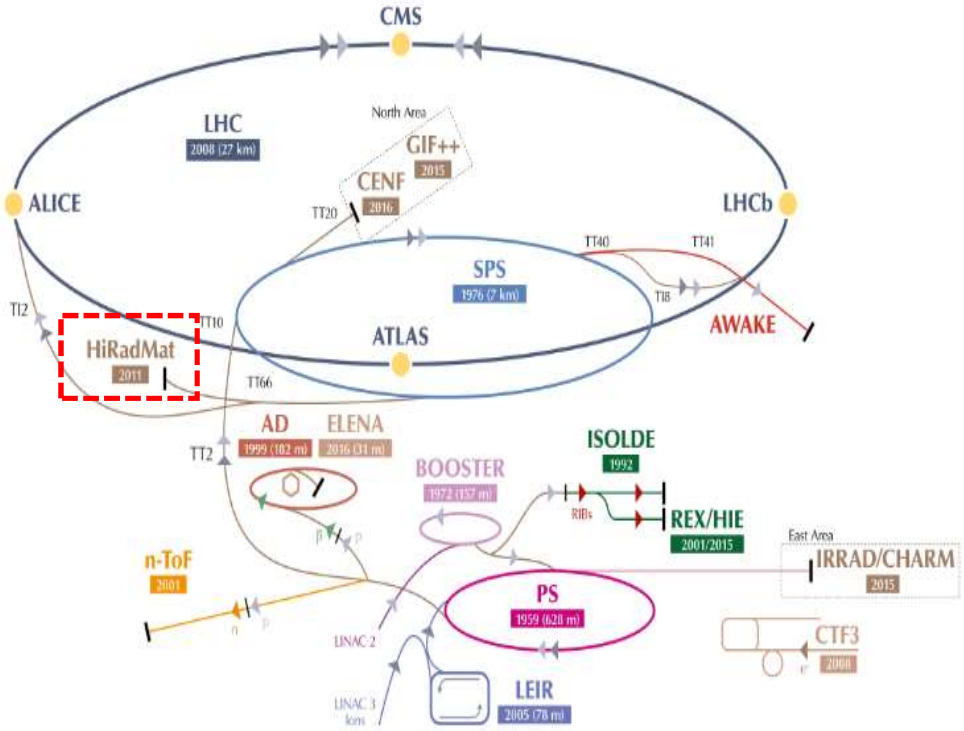
North Area consolidation

- Undertake the necessary consolidation actions required prior and during LS2 in order to guarantee a stable and reliable beam operation until LS3.
- Prepare cost estimates for a more profound consolidation of the existing facilities, to be executed in (or after) LS3, if approved.
- Prepare for alternative scenarios covering increased performance linked to the “Physics Beyond Collider” future requirements:
  - NA62: proposal to operate in beam-dump mode
  - NA64++: High intensity electron, muon and hadron beams for dark particles searches
  - KLEVER: high intensity KL beam (high flux, pencil beam, new target) for rare decays
  - COMPASS++: RF separated beams for hadron structure and spectroscopy
  - Mu-e: 150 GeV muon beams for high preicion hadron vacuum polarisation for g(mu)
  - DIRAC++: DIRAC@SPS for high statistic mesonic atoms
  - NA60++: Heavy ion beams for dimuon physics
  - NA61++: Higher intensity ion beam for charm studies





HiRadMat

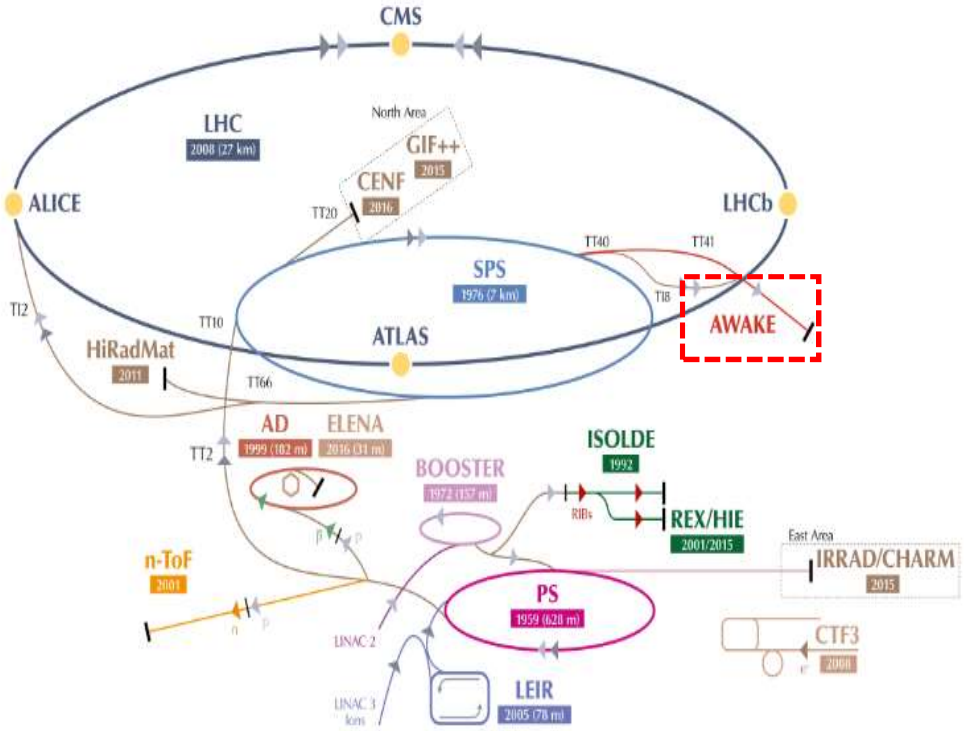


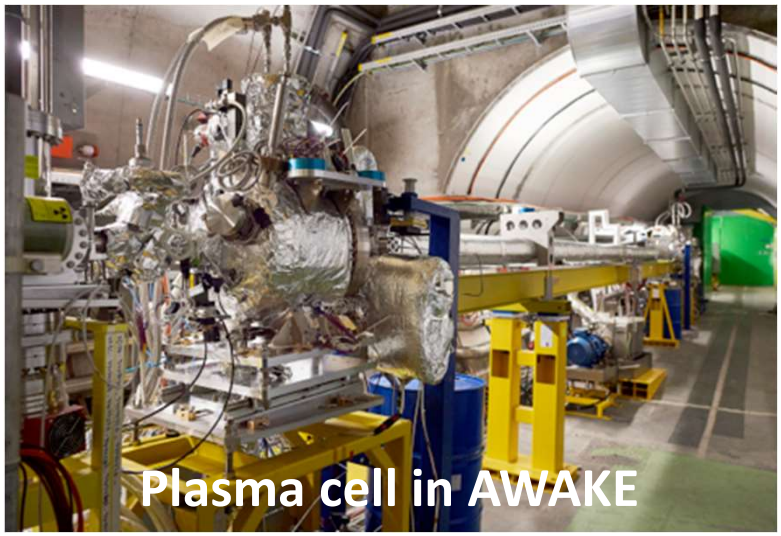
Proton & Ion Beam Parameters		
Beam parameter	**Protons**	**Pb^{82+}**
Nominal energy	440 GeV	173.5 GeV/nucleon
Pulse Energy	up to 3.4 MJ	up to 21 kJ
Bunch Intensity [protons]	$5.0 \cdot 10^{9}$ - $1.7 \cdot 10^{11}$	$3 \cdot 10^{7}$ to $7 \cdot 10^{7}$
Number of bunches per pulse	1— 288	52
Bunch spacing [ns]	25, 50, 75 or 150	100
Pulse length [µs]	7.2	5.2
Beam size at target	Variable around 1 mm^2	

- A dedicated facility for state-of-the art experiments of material samples and accelerator components
- Annual proton budget : 10^{16} protons to be shared amongst 10 experiments / year approximately
- No large integrated doses can be accumulated !

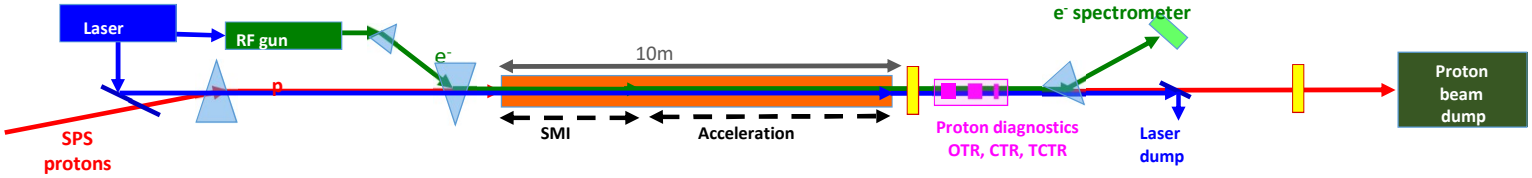
- High Radiation to Materials

AWAKE: Advanced Proton driven Plasma Wakefield





Investigates the use of plasma wakefields driven by a proton beam to accelerate electrons to high energies at GeV level



Summary

- CERN offers a great variety of experimental areas with beams from SPS
  - Test beam facilities in the North Area
  - Fixed target experiments in the North Area
  - HiRadMat – a special high energy, single pulse irradiation facility
  - AWAKE experiment on plasma wakefield acceleration

- Contact in advance sps.coordinator@cern.ch and sba-physicists@cern.ch in order to optimally exploit your beam time and the facilities.
  - Visit often https://sps-schedule.web.cern.ch/sps-schedule/ for the updated version of the schedule and other useful information

- Acknowledgements to D. Banerjee, J. Bernhard, M. Brugger, N. Charitonidis, L. Gatignon, E. Gschwendtner, F. Harden, Y. Kadi, B. Rae, M. Rosenthal, A. Rummler, M. Van Dijk, H. Wilkens

We are looking forward to seeing you at CERN !!