Overview on
CERN Test Beam Facilities

On behalf of the CERN SPS/PS test beam coordinator:
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Courtesy:
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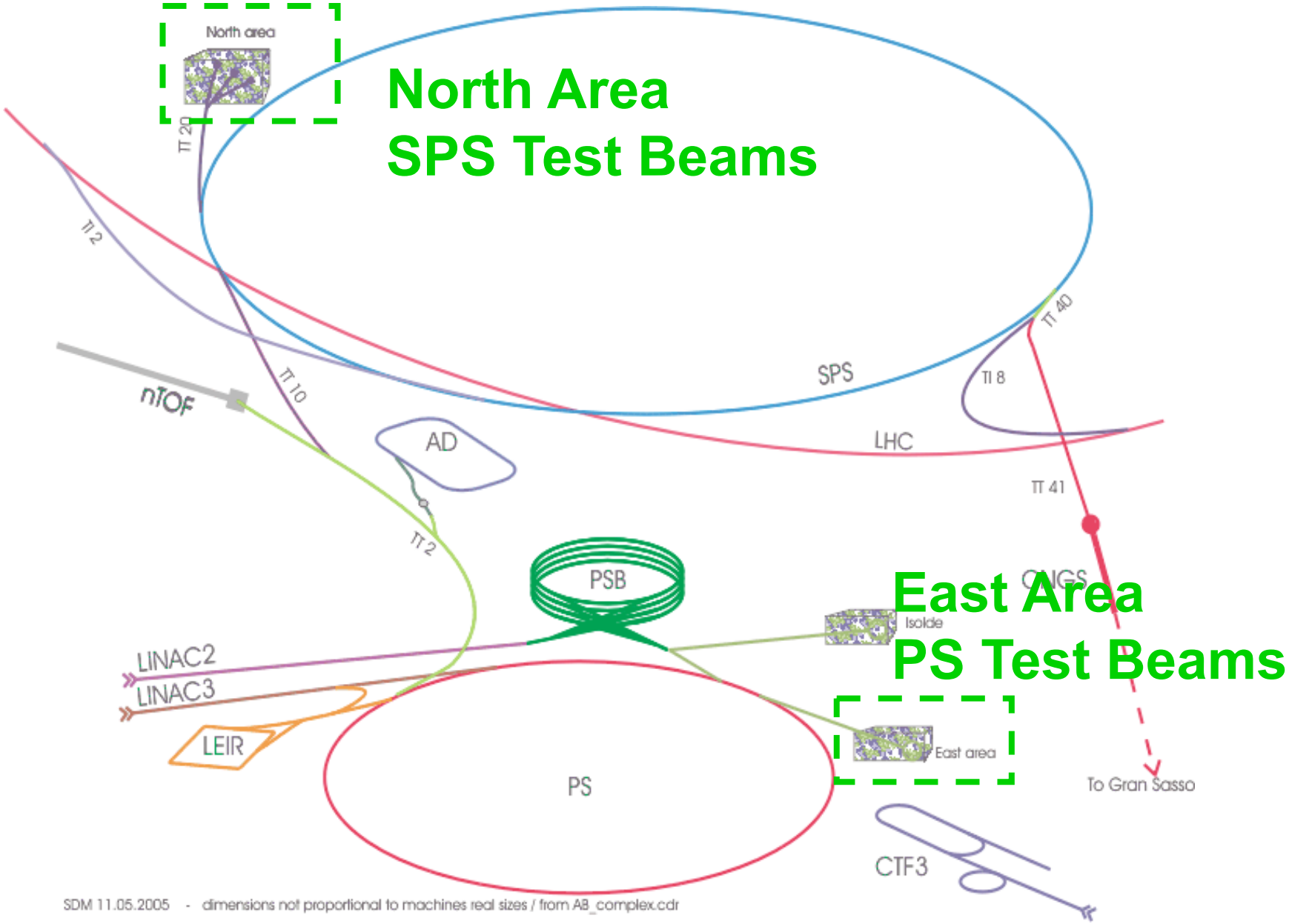
Overview

- East Area Test Beam Facility
- North Area Test Beam Facility
- Test beam magnets
- Example of RD51 common infrastructure
- Short-term test plans LCD group at CERN
- Summary

Test Beam Facilities at CERN



North Area
SPS Test Beams

East Area
PS Test Beams

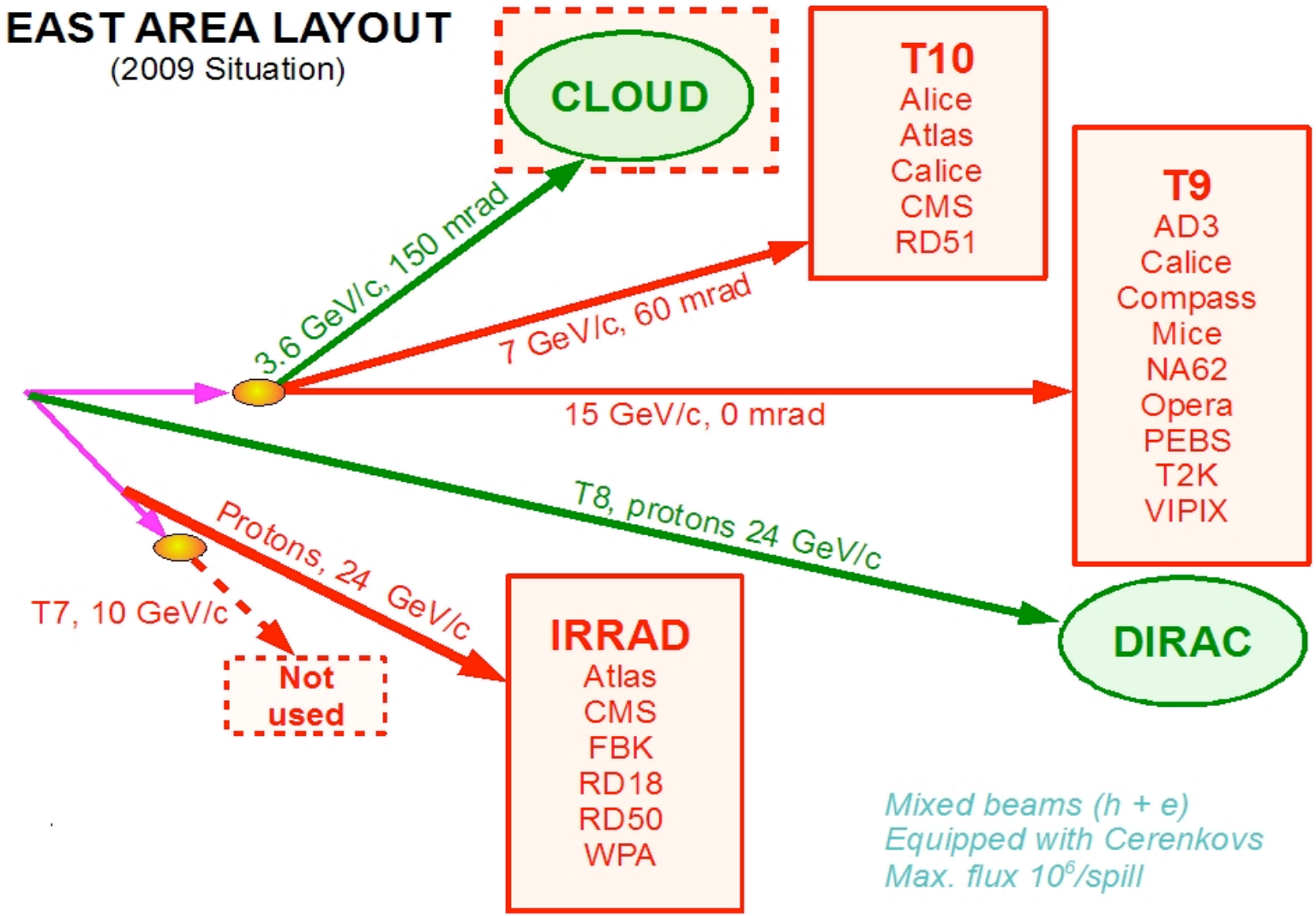
PS East Area

5 beam lines

total length 300m

300 scientists / year performing experiments and tests

The East Experimental Areas at the PS



East Area Beam Characteristics

- Momentum range
  - Secondary beam: 1 GeV/c – 15 GeV/c
- Particle type and intensity
  - electrons, hadrons, muons
  - max. 1-2*10^6 particles per spill

    typically 10^3 - 10^4 used
- Spill structure from PS
  - 400 ms spill length
  - typically 1 spill every 33.6 s, more on request

SPS North Area

7 beam lines

total length 5.8 km

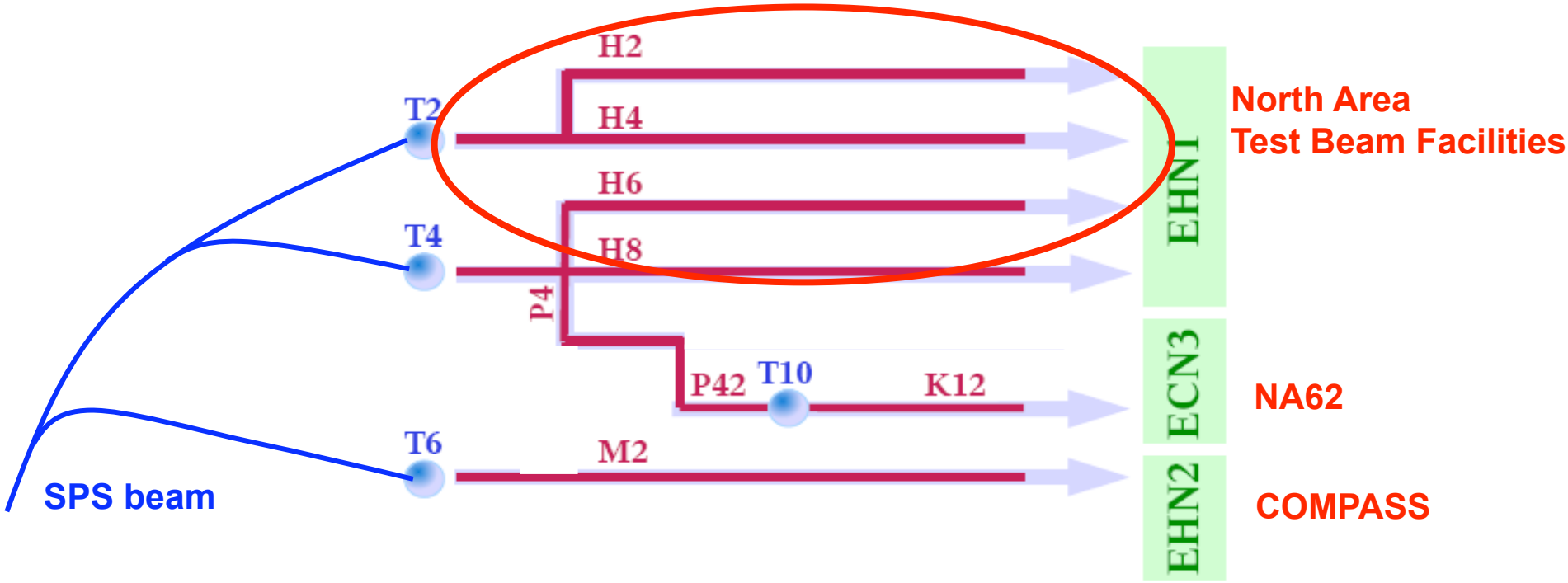
Three experimental halls : **EHN1**, EHN2, ECN3

~2000 scientists / year

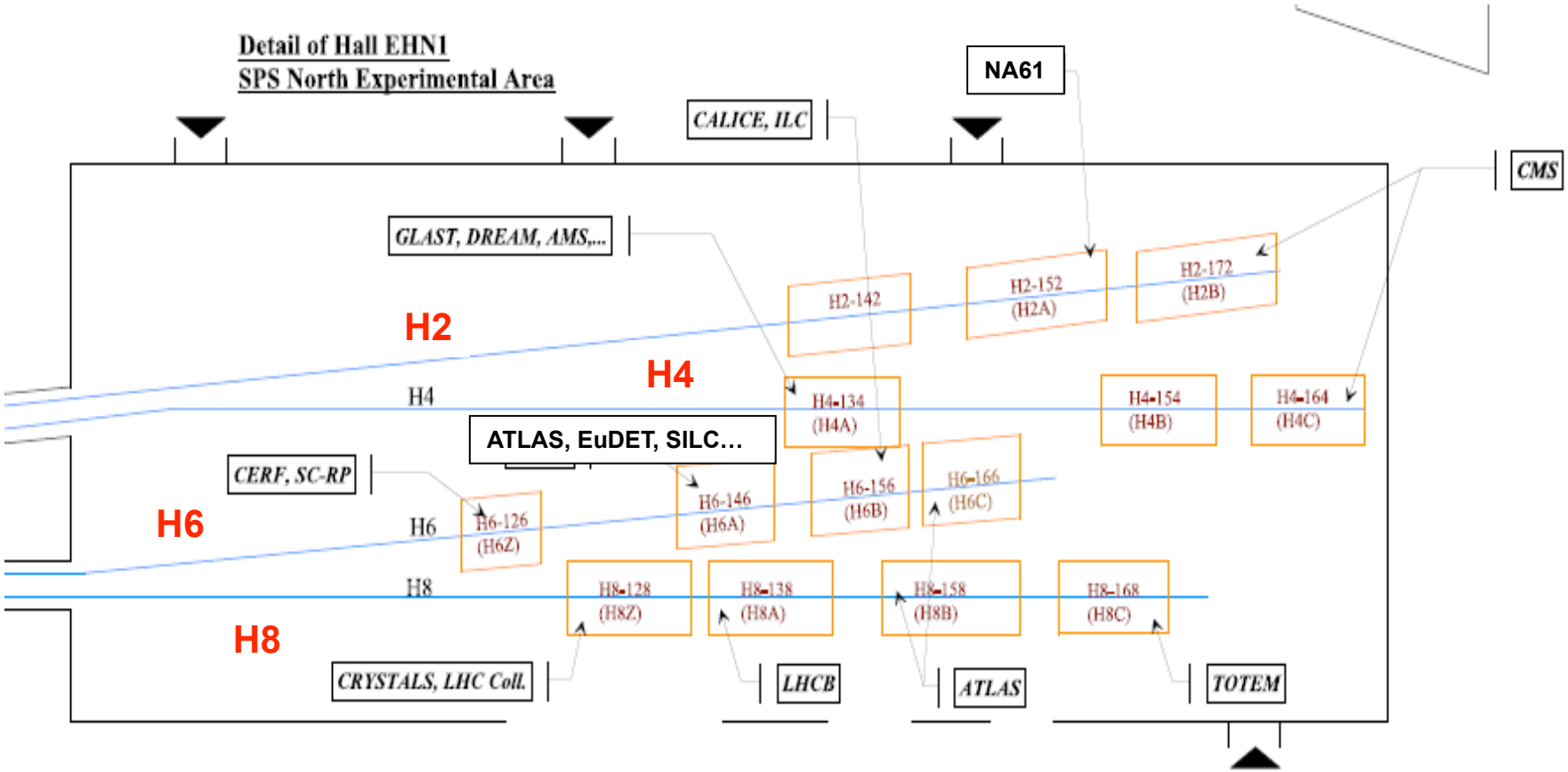
The North Experimental Areas at the SPS

- The SPS proton beam (400/450 GeV/c) slowly extracted to North Area
- Directed towards the three North Area primary targets T2, T4 and T6
- From the primary targets:
  - T2 → H2 and H4 beam lines
  - T4 → H6 and H8 beam lines

    and P42/K12 beam line (NA62)
  - T6 → M2 beam line (NA58/COMPASS)



North Area Test Beams



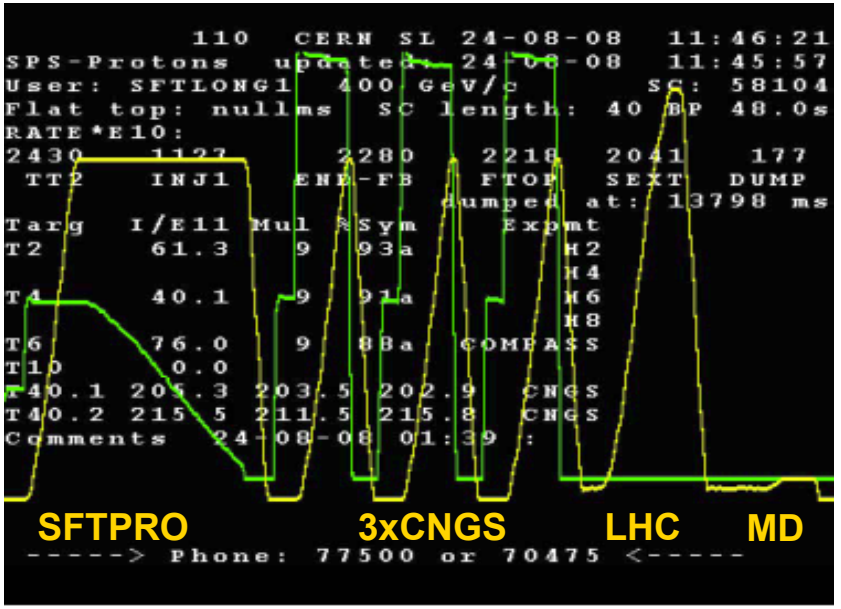
Up to 4 user areas per beam line

Possibility to take parasitic muons behind main user

Some areas permanently occupied by LHC users (ATLAS, CMS, LHCb, TOTEM)

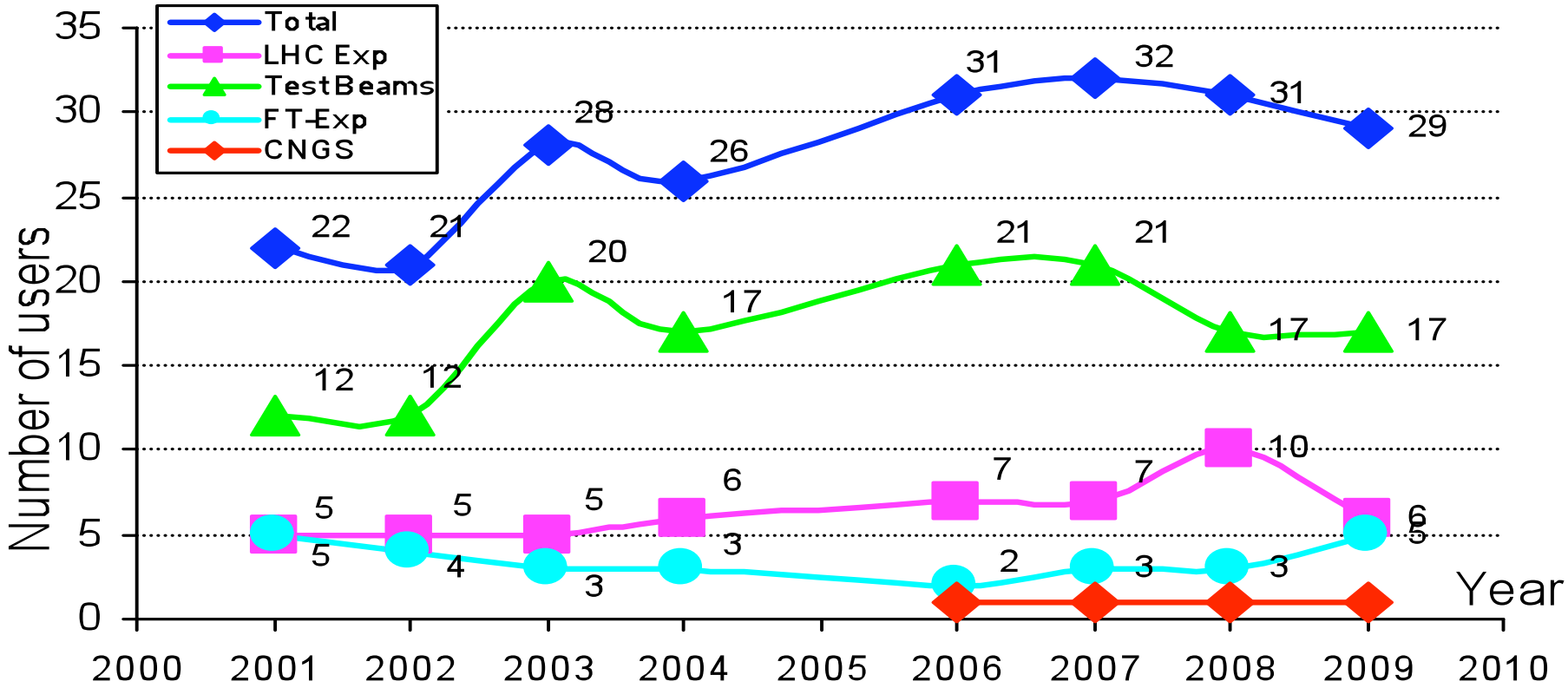
North Area Beam Characteristics

- Momentum range
  - H2, H4, H8:
    - 10 – 400 GeV/c (secondary beam)
    - primary proton beam at 400 (450) GeV/c
  - H6:
    - 5 – 205 GeV/c
- Particle type
  - electrons, hadrons, muons
    → secondary target→ tertiary beam
- Particle intensity
  - max. $2*10^8$ particles per spill
- Spill structure from SPS
  - 4.8s – 9.6s spill length, debunched
  - 1 spill every 14s – ~48s
  - spill length/repetition frequency depend on number of facilities which need SPS extraction (CNGS, LHC)



User Requests for SPS

- SPS Secondary Beams – Experiments and Tests



Coordination:

- Weekly PS/SPS user meetings
- Beam requests to SPS coordinator:
  - Request < 1week agreed and recommended by SPS coordinator
  - >1 week: discussed and recommended by SPSC
  - LHC related request often discussed and recommended by LHCC
  - Final approval by Research Board

Infrastructure

What is (could be) provided

- Counting houses (barracks) with racks and network connections
- Beam instrumentation:
  - Scintillator for beam intensity measurement
  - XDWC for beam profile measurement
  - Threshold Cherenkov counter for particle ID
  - CEDAR counter for particle ID
  - Electromagnetic calorimeter for particle ID
  - Spectrometer for beam momentum measurement
- Scanning table (XSCA)
- Magnets - see slides later
- Cryogenics installation

Irradiation Facilities

http://irradiation-facilities.web.cern.ch/irradiation-facilities/

- PS East Area : T7 line
  - Protons and mixed field irradiation
  - 1-10*10^{13} protons/(cm^2hr) on a 2*2 cm^2 surface
  - 3-10*10^{11} neutrons/(cm^2hr) on a 30*30 cm^2 surface (1 MeV equiv.)
- SPS North Area: CERF facility
  - Mixed field irradiation
  - In H6 beam line : <1*10^8 ppp @120 GeV/c
- GIF
  - 137Cs source irradiation over large surfaces, 740 MBq (in 1997)
  - Combined with SPS West area beam (until 2004)

Plans for improved facilities (protons, mixed-field, GIF++), end 2010

14-August-2009 2009 PS Fixed Target Programme

Version 3.0

Colour code: green = PS/SPS-exp ; purple = LHC-exp ; dark blue = Outside exp ; yellow = not allocatable or Machine Development

		P1	P2	P3	P4	P5	P6
		35 30 Apr 4 Jun	35 4 Jun 9 Jul	35 9 Jul 13 Aug	35 13 Aug 17 Sep	35 17 Sep 22 Oct	32 22 Oct 23 Nov
T7	Setup 7	Irradiation 35	35	30	5 — Irradiation 35	Irradiation 35	Irradiation 32
T8	Setup 21	DIRAC 21	DIRAC 35	DIRAC 35	DIRAC 35	DIRAC 35	DIRAC 32
T9	Setup 7	T2K-ECAL 35	T2K ECAL 14 / CALICE RPC 17	4 2 COMPASS CALO 16 / MICE EMR 14	MICE EMR 7 / MICE EMR-AD3 7 3 OPERA Bricks 13 8	COMPASS ECAL 11 15 VIPIX 9	NA62 15 PEBS 17
T10	Setup 7	ALICE PMD 18 2 CALICE MMEGAS 15	ALICE TOF 14 / ALICE VHMPID 13 / CMS BCM 8	ALICE TOF 15 / RD51 CALICE 10 / MICE EMR-AD3 10	MICE EMR-CAL 14 11 ATLAS GOSSIP 10	ATLAS BCMP 5 CALICE MMEGAS 15 ALICE VHMPID 7 ALICE TOF 8	ALICE TOF 7 ALICE HPTD 16 ALICE VHMPID 9
T11	Setup 7	35	18 CLOUD 17	CLOUD 35	35	CLOUD 35	CLOUD 32

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24-August-2009 — 2009 SPS Fixed Target Programme — Version 3.0

Colour code: green = SPS-exp ; purple = LHC-exp ; dark blue = Outside exp ; yellow = not allocatable or Machine Development

	P1	P2	P3	P4	P5	P6
	35 30 Apr 4 Jun	35 4 Jun 9 Jul	35 9 Jul 13 Aug	35 13 Aug 17 Sep	35 17 Sep 22 Oct	32 22 Oct 23 Nov
T2 -H2	3 CMS CASTOR 7 CREAM 7 3	TR 4 CMS HCAL 10 WCALO 11 CMS 10	4 CMS HCAL 14 NA61 17	NA61 35	NA61 11 CREAM 7 NA61 17	NA61 24 NUCLEON 8
T2 -H4	3 CMS BCM 7 CMS ECAL 6 4	4 SITRD 6 SiTRD 8 RD51 14 3	CMS ECAL 7 DREAM 15 CALICE RPC 10 3	COMPASS CALO 8 CALET 7 3 INSURAD 11 CMS ECAL 6	CMS ECAL 5 NA63 20 UA9 10	RD51 10 CMS ECAL 9 LHCf 13
T4 -H6	0 CERN 5 5 MonoPix 7 3	MMEGAS 7 ATLAS BCM 7 RD42 7 ATLAS 7 ATLAS LUCID 7	ATLAS LUCID 6 ATLAS STRAW 8 EUDET 14 CERN 6 1	LCFI 6 SiLC 12 EUDET MIMOSA 7 ATLAS 8 2	RD42 7 ATLAS BCM 7 ATLAS LUCID 13 ATLAS FP420 8	ATLAS 3DSi-SBF 14 MonoPix 8 MMEGAS 7 ICM 3
T4 -H8	3 3DSi 16 11	5 ATLAS 9 ATLAS Gossip 8 3 MDT Roma 9	MDT Roma 4 GOSSIP 13 3 UA9 9 ATLAS RP 6	ATLAS RP-MDT-MPI 14 2 4 MDT Roma 15	UA9 28 CONE 4 RP 3	ATLAS RP 7 3 AMS 22
T4 -P0	NA Setup 10	NA62 10 NA62 7 7 NA62 9 19	28	35	29 NA62 6	NA62 10 22
T6 -M2	3 COMPASS 17	COMPASS 35	COMPASS 35	COMPASS 35	COMPASS 35	COMPASS 32
CNGS	3 CNGS 17	CNGS 35	CNGS 35	CNGS 35	CNGS 35	CNGS 32

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Comments:
- no comments

Fixed-target running in 2009: approx. 28 weeks
Fixed-target running in 2010: approx. 20 weeks

CERN test beam magnets

- **PS east hall:**
  - TPC-90 magnet (last used by HARP), solenoid diam. cm, 224 cm long, 0.7 T (~1.3 T in pulsed mode).
- **EHN1, H2 beam line:**
  - M1 magnet, superconducting, large dipole, 82 cm gap, 1.4 m diameter, Field 3T,used by CMS
  - MNP22A, C-shaped classical dipole, 50 cm gap, 1 m width, 1 m depth, 1.37 T (presently 0.7 T)
- **EHN1, H4 beam line:**
  - Goliath (last user NA57), large classical dipole, ~160*240*360 cm, 0.85 T field
- **EHN1, H8 beam line:**
  - Superconducting dipole, diam. 1.6 m, ~4 m overall length, 1.56 T field at 5000A, used by ATLAS, contains a rail system for inserting detectors

http://project-fp7-detectors.web.cern.ch/project-FP7-detectors/TEST%20BEAM%20LINKS.htm

Example: RD51 common test beam infrastructure

- In H4 beam line, used a few weeks per year

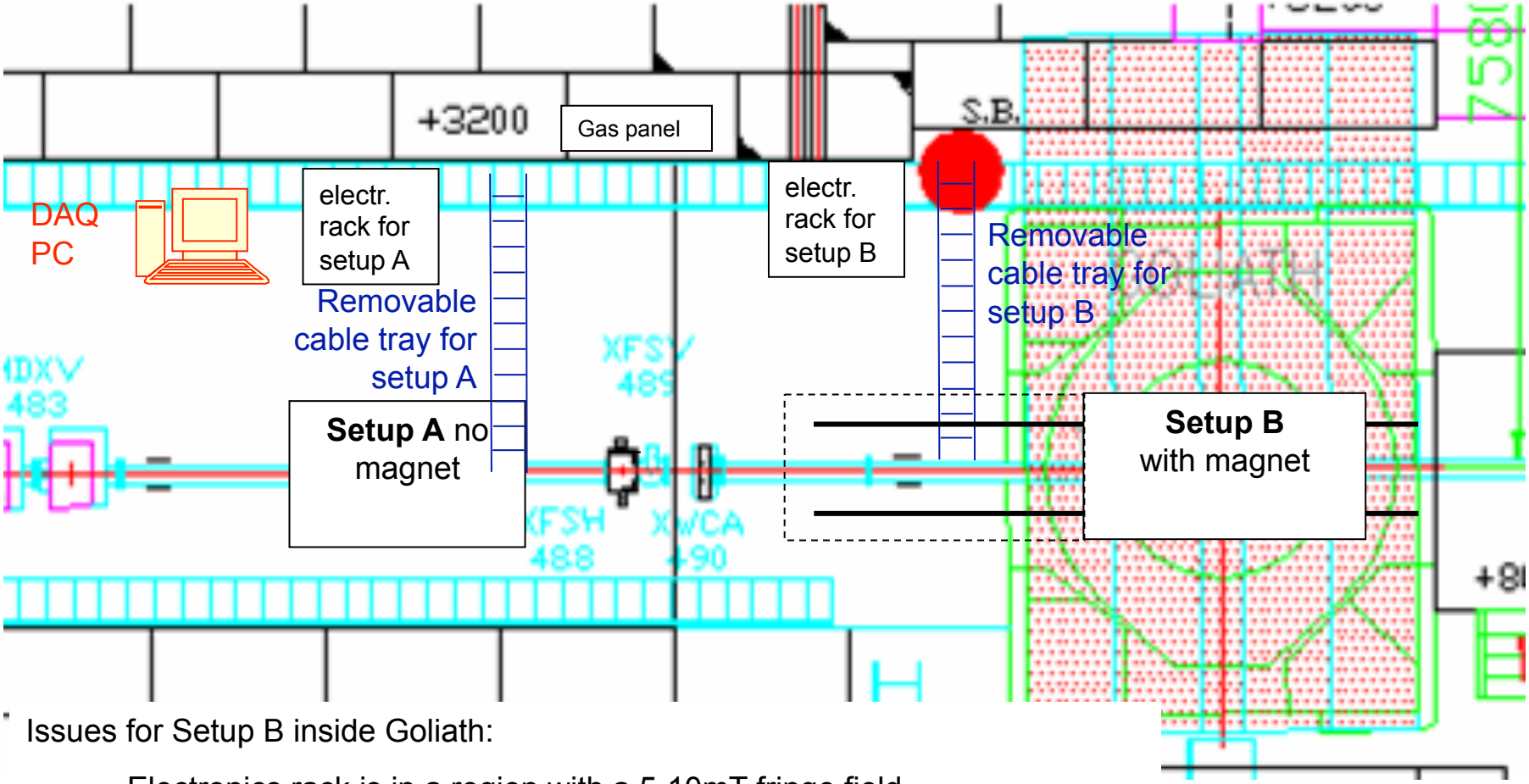
Common infrastructure in:

- Support mechanics
- Large magnet (Goliath)
- Gas system
- Cables, trigger
- Reference tracker
- HV, Electronics

Semi-permanent infrastructure

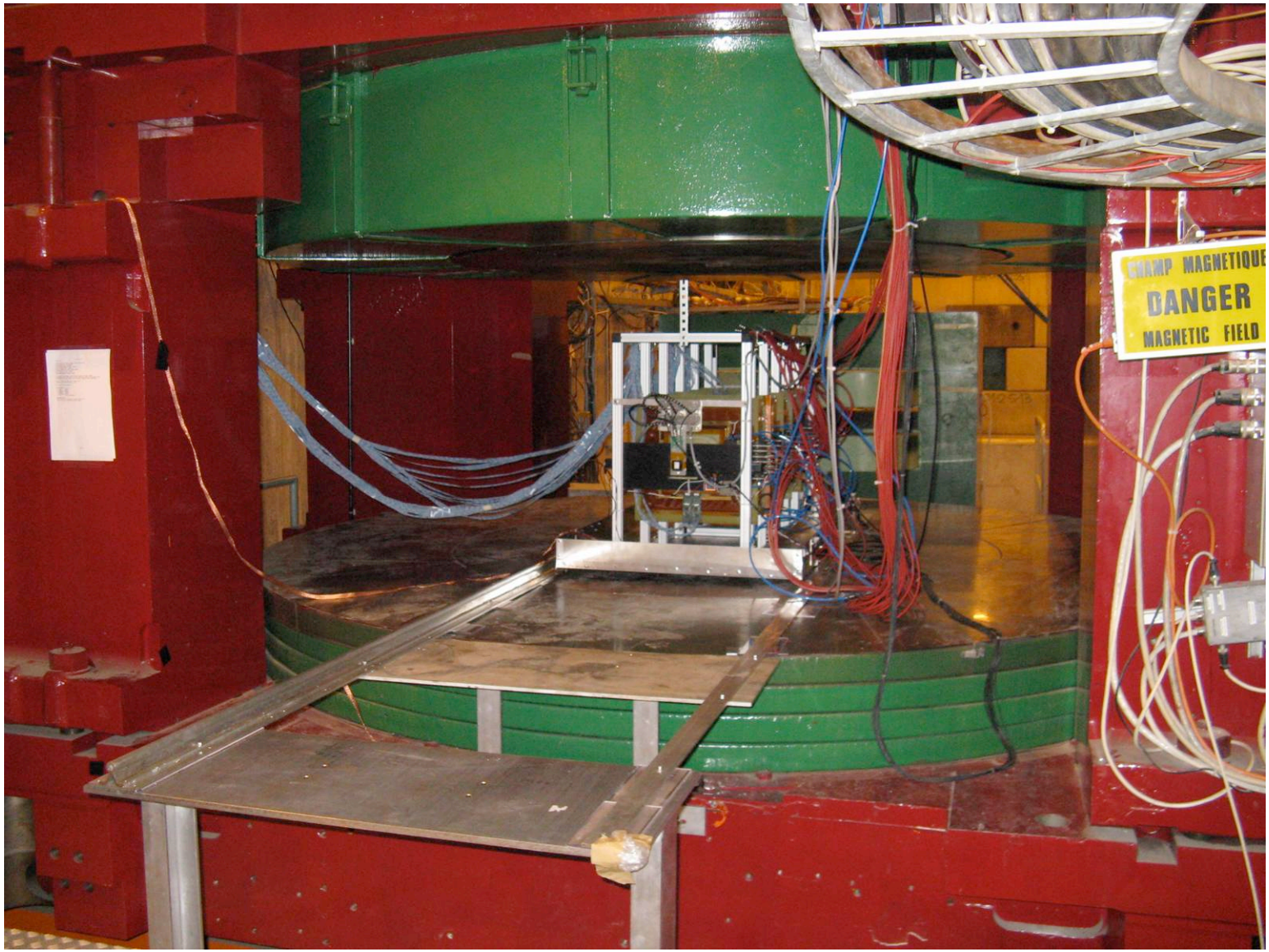
Common effort by the collaboration

The RD51 installation @ SPS/H4



- Issues for Setup B inside Goliath:
  - Electronics rack is in a region with a 5-10mT fringe field
  - Cables lenght can arrive up to more than 8 m

RD51 in H4 line



Motivation for Tungsten-based HCAL test

- Physics at CLIC with a center of mass energy of 3 TeV requires to build a calorimeter system with rel. small energy leakage.

  => Design value for $\lambda_{int} \geq 1$ (ECAL) + 7 (HCAL)

- Space available for barrel HCAL inside (reasonable sized) coil: $\Delta r \approx 1.40$ m

  => need to use a more dense material than Fe

- Why not use W as absorber material in HCAL??

Motivation (2)

- No experience with W as absorber material in HCAL
- λ_{int} (W) = 10 cm , X_0(W) = 0.35 cm
- λ_{int} (Fe) / λ_{int} (W) = 1.7, X_0(Fe) / X_0(W) = 5
- For a W absorber:
  - less visible energy (ionization)
  - more neutrons (spallation)
- For calorimeter design simulations need to be reliable and understood to a rather precise level.

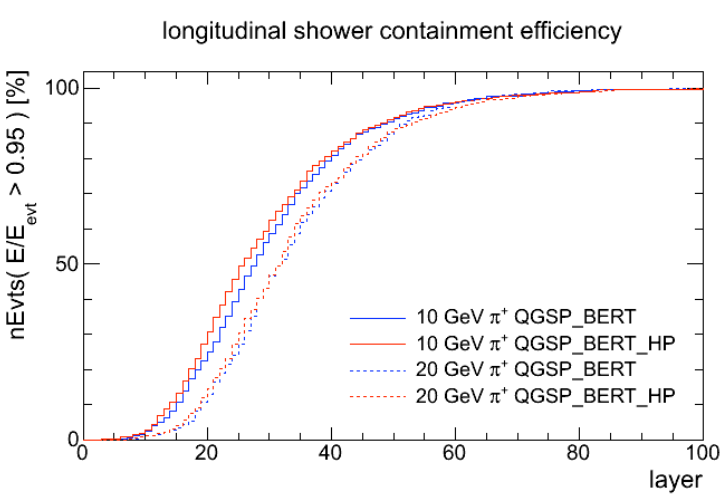
Goals and Objectives for a W HCAL Prototype

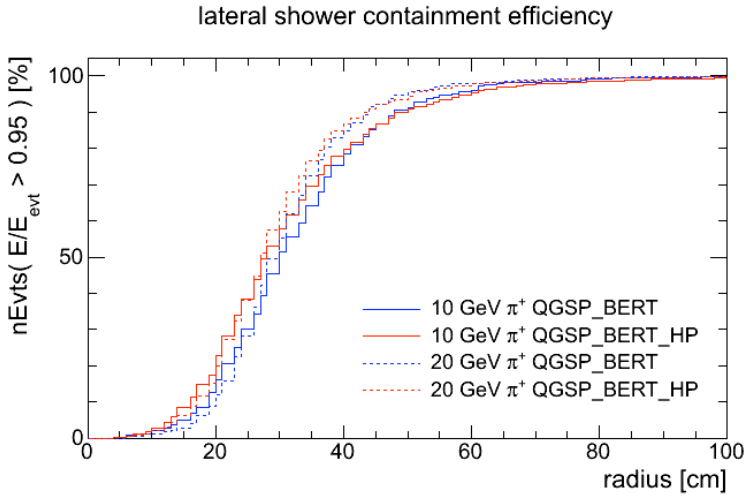
- Validate and adjust simulations for HCAL performances
  - Linearity / energy
  - Resolution /energy
  - Shower structure in comparison to Fe
  - Time structure of signal (neutrons)
  - Compare scintillator with gaseous detectors
  - Experience with W plates

  Later
  - Other detector technologies
  - Combine with ECAL proto
  - …

Proposal for a W HCAL Prototype

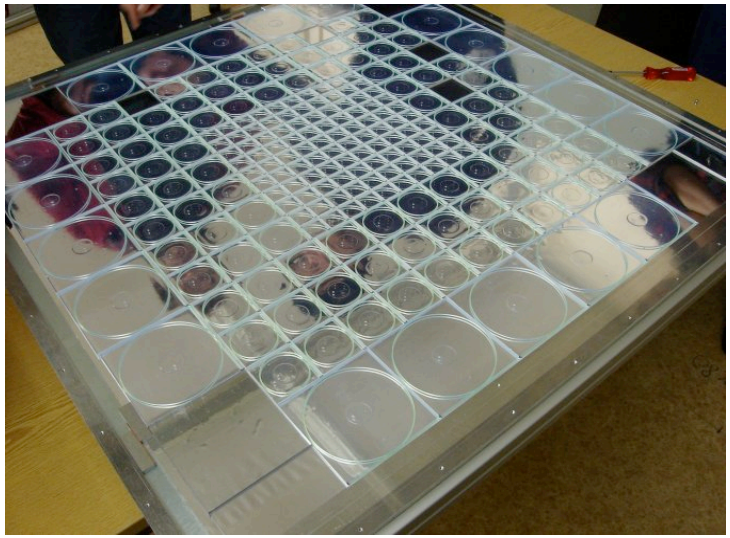
- Start 2010 with a “small” prototype:
  - Start with ~20 W plates size 80x80 cm^2, 1 cm thick
  - Use as much as possible existing equipment from CALICE (detector planes, readout electronics, DAQ, mechanical infrastructure…..)
  - First test beam at PS in autumn 2010 (T9, π ≤ 12GeV)
  - Later increase depth to 40 or more layers and go to SPS





Detectors to be used

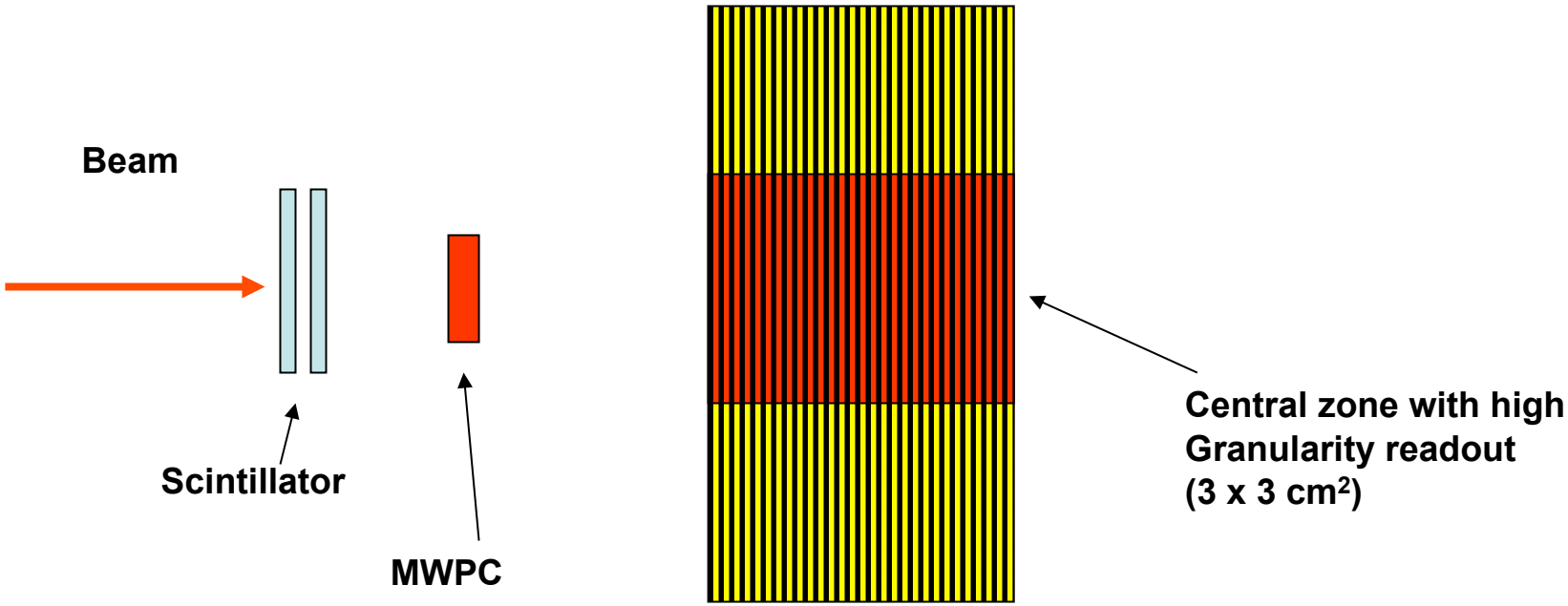
- In 2010 start with existing CALICE scintillator cassettes



Overall size 90 x 90 cm^2
Central area equipped with small (3 x 3 cm^2) cells

Equipped with readout and calibration

Experimental Setup (very preliminary)



Summary

- CERN has worldwide unique opportunity for detector and physics tests
  - PS and SPS beam-lines
  - Technical support and infrastructure provided by CERN
- Facilities are heavily used
  - Always fully booked
  - Already much used by the linear collider community
- ILC-type time structure seems possible at PS

- Possibility for LC semi-permanent testbeam infrastructure
  - Will require common effort
  - Will require common motivated request to SPSC committee
  - H6 location most likely, as already used by LC community
  - However 200 GeV limit is a problem for CLIC detector tests