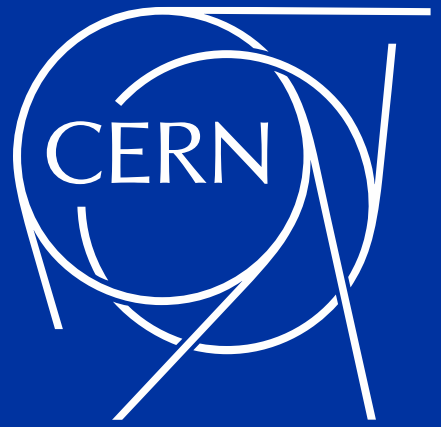
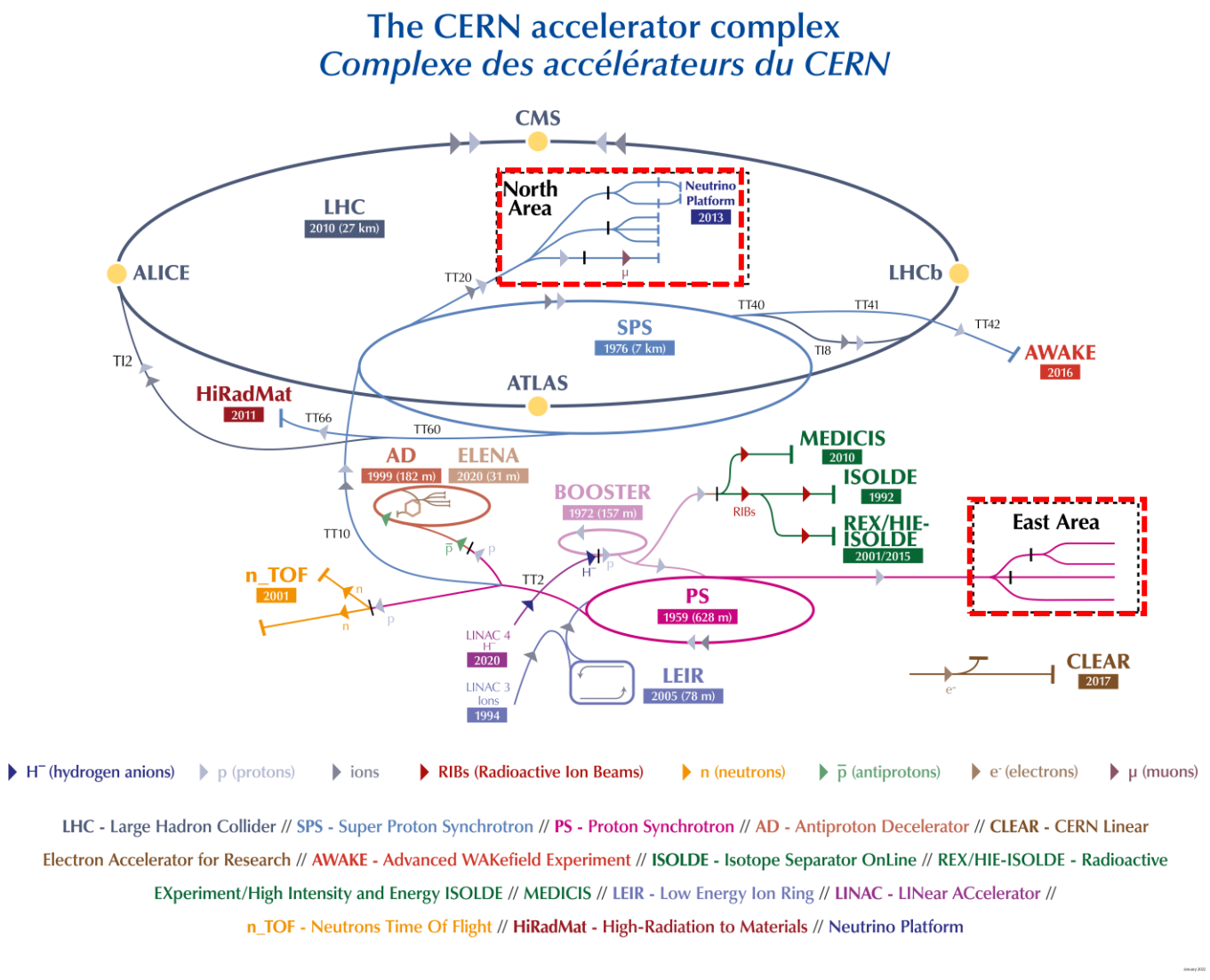


CERN EHN1 Test Beam Facility

D. Banerjee, **N. Charitonidis** on behalf of the CERN BE-EA group

01.02.2024

CERN Accelerator Complex



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

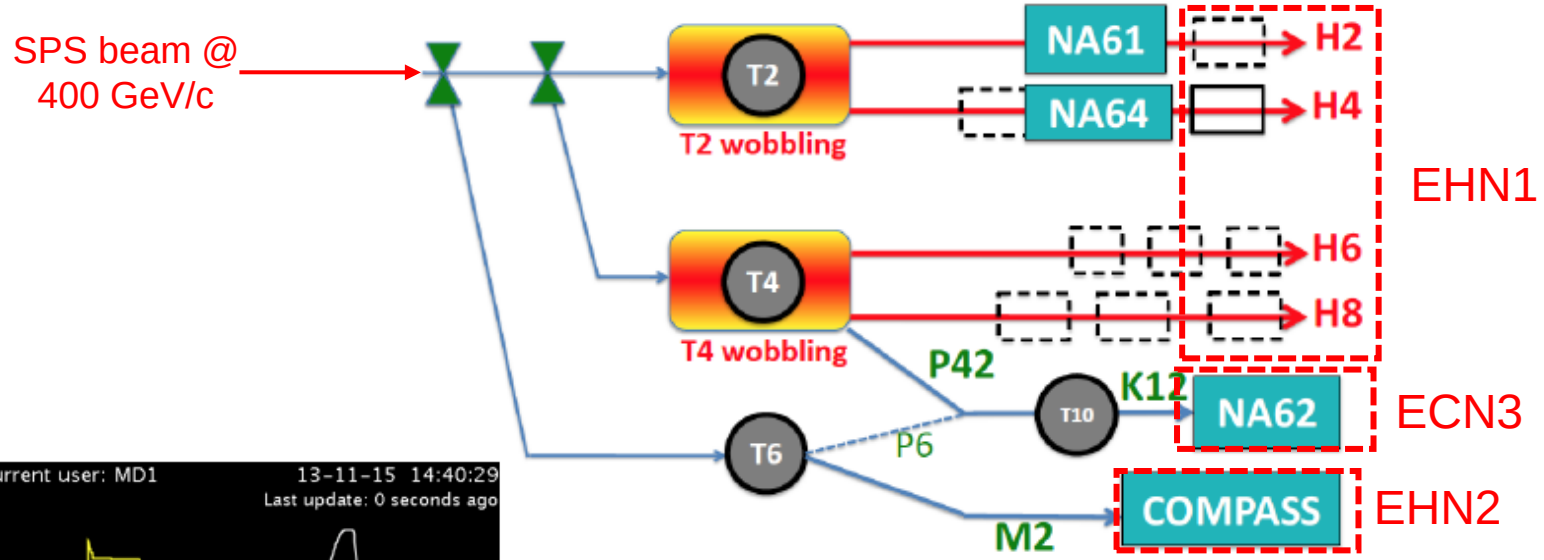
Maximum momenta available to the users in the PS/SPS Test Beam Facilities :

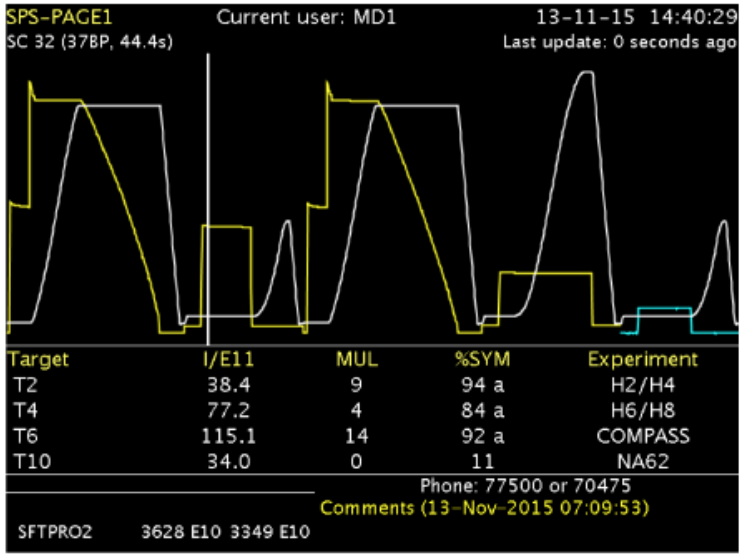
North Area → ≤400 GeV/c/Z (primary beam) or
≤ 360 GeV/c/Z (secondary beam).

East Area → ≤ 15 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
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.

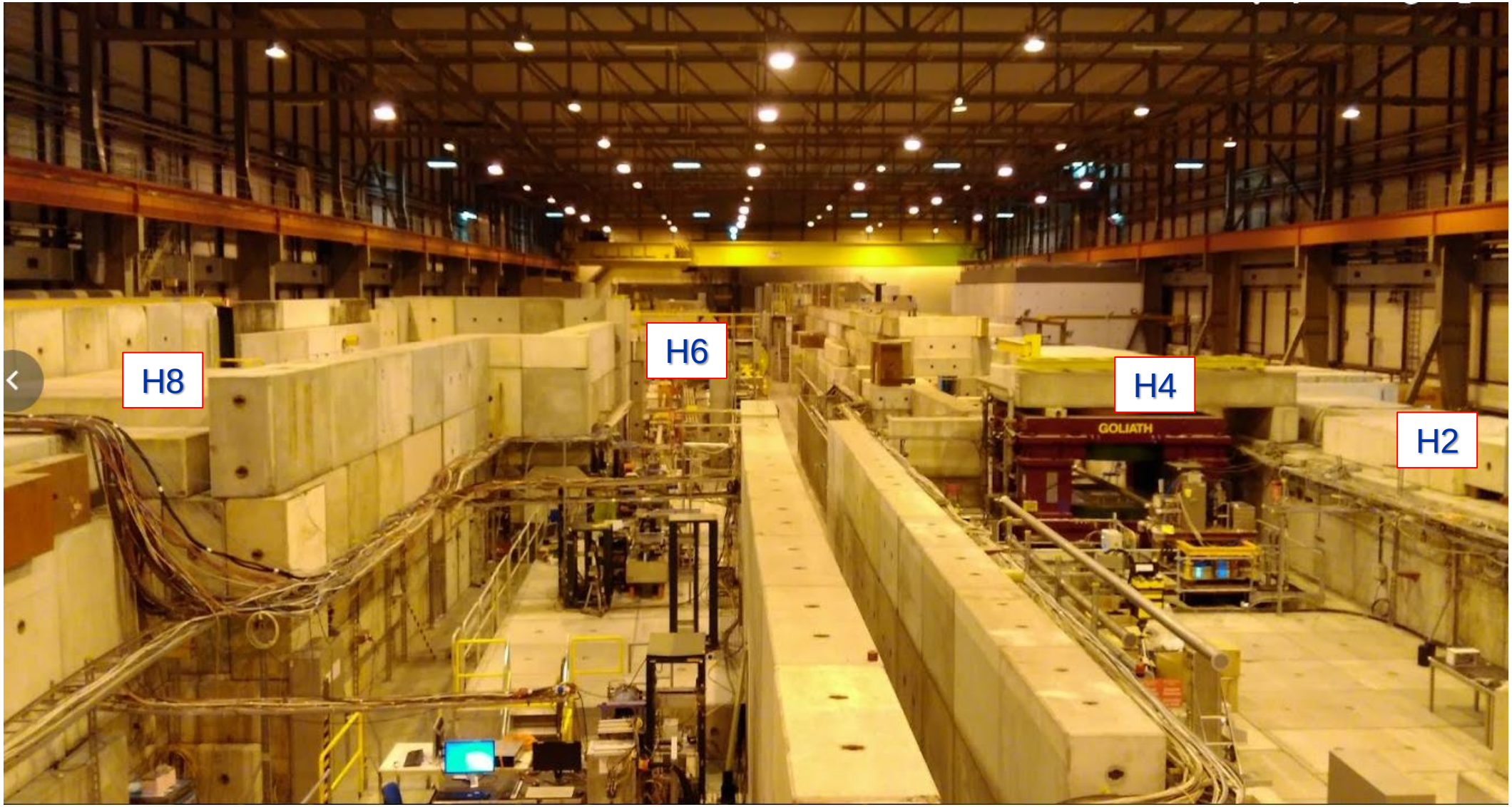
Characteristics of the Beam

Parameter	T2 Target		T4 Target	
Beam Line	H2	H4	H6	H8
Attenuated primary proton / Secondary beam	400/360	400/360	-/205	400/360
Maximum Δp/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 was used by the COMPASS experiment until 2022 for 20 years and is currently used by AMBER, NA64mu and MUonE.
  - < 10^8 hadrons/spill < 280 GeV/c.
  - < 2 x 10^8 muons/spill < 250 GeV/c.

- **P42** beam shares the T4 target (with H6/H8) 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, Prevessin 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
- 1.5 T max field
- Use of GOLIATH via CESAR (please contact B. Rae)

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

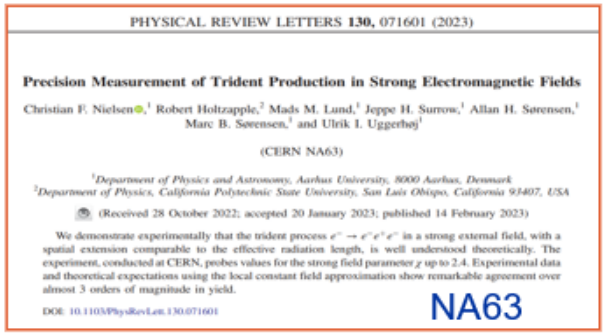
Beam Instrumentation in the North Area

- **Depending on the beam line and the zone :**
  - **Threshold Cherenkov gas counters (XCET) and CEDARs** → used for particle tagging
  - **Beam profile & intensity monitors:**
    - scintillators & analog/delay multi wire chambers are installed in several positions along the beam line.
    - As part of the consolidation efforts under NACONS all analog/delay wire chambers will be replaced by XBPFs.
  - **FISC scanners** → precise slower profile monitors – can also be used for angular measurements

H4 Beamline

H4

- **Quite “famous” for the high intensity, high purity electron beam that it can offer.**


PHYSICAL REVIEW LETTERS 130, 071601 (2023)

Precision Measurement of Trident Production in Strong Electromagnetic Fields

Christian F. Nielsen, Robert Holtzapple, Mads M. Lund, Jeppe H. Surrow, Allan H. Sørensen, Marc B. Sørensen, and Ulrik I. Uggerhøj

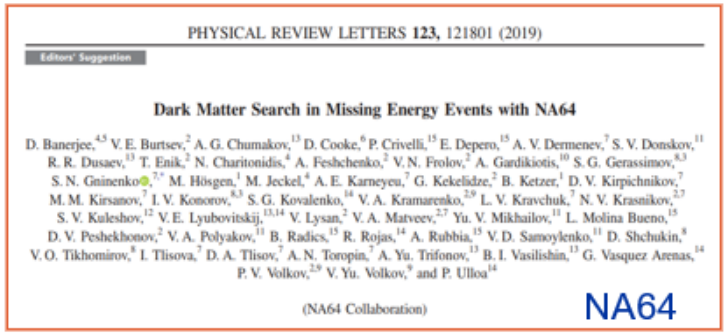
(CERN NA63)

(Received 28 October 2022; accepted 20 January 2023; published 14 February 2023)

We demonstrate experimentally that the trident process $e^- \to e^- e^+ e^-$ in a strong external field, with a spatial extension comparable to the effective radiation length, is well understood theoretically. The experiment, conducted at CERN, probes values for the strong field parameter χ up to 2.4. Experimental data and theoretical expectations using the local constant field approximation show remarkable agreement over almost 3 orders of magnitude in yield.

DOI: 10.1103/PhysRevLett.130.071601

NA63


PHYSICAL REVIEW LETTERS 123, 121801 (2019)

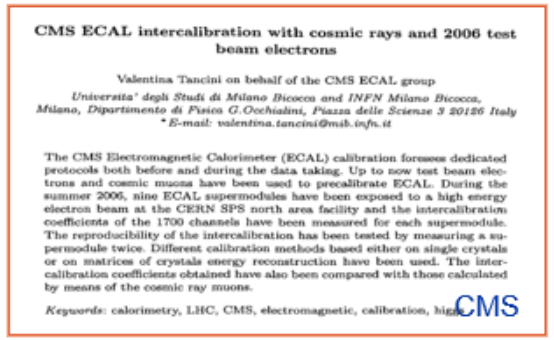
Editors' Suggestion

Dark Matter Search in Missing Energy Events with NA64

D. Banerjee, V. E. Burtsev, A. G. Chumakov, D. Cooke, P. Crivelli, E. Depero, A. V. Dermenev, S. V. Donskov, R. R. Dusaev, T. Enik, N. Charitonidis, A. Feshchenko, V. N. Frolov, A. Gardikiotis, S. G. Gerassimov, S. N. Gninenko, M. Hösgen, M. Jeckel, A. E. Karneyeu, G. Kekelidze, B. Ketzer, D. V. Kirpichnikov, M. M. Kirsanov, I. V. Konorov, S. G. Kovalenko, V. A. Kramarenko, L. V. Kravchuk, N. V. Krasnikov, S. V. Kuleshov, V. E. Lyubovitskij, V. Lysan, V. A. Matveev, Yu. V. Mikhailov, L. Molina Bueno, D. V. Peshekhonov, V. A. Polyakov, B. Radics, R. Rojas, A. Rubbia, V. D. Samoylenko, D. Shchukin, V. O. Tikhomirov, I. Tlisova, D. A. Tlisov, A. N. Toropin, A. Yu. Trifonov, B. I. Vasilishin, G. Vasquez Arenas, P. V. Volkov, V. Yu. Volkov, and P. Ulloa

(NA64 Collaboration)

NA64


CMS ECAL intercalibration with cosmic rays and 2006 test beam electrons

Valentina Tancini on behalf of the CMS ECAL group

Universita' degli Studi di Milano Bicocca and INFN Milano Bicocca, Milano, Dipartimento di Fisica G.Occhialini, Piazza delle Scienze 3 20126 Italy
** E-mail: valentina.tancini@mib.infn.it*

The CMS Electromagnetic Calorimeter (ECAL) calibration foresees dedicated protocols both before and during the data taking. Up to now test beam electrons and cosmic muons have been used to precalibrate ECAL. During the summer 2006, nine ECAL supermodules have been exposed to a high energy electron beam at the CERN SPS north area facility and the intercalibration coefficients of the 1700 channels have been measured for each supermodule. The reproducibility of the intercalibration has been tested by measuring a supermodule twice. Different calibration methods based either on single crystals or on matrices of crystals energy reconstruction have been used. The intercalibration coefficients obtained have also been compared with those calculated by means of the cosmic ray muons.

Keywords: calorimetry, LHC, CMS, electromagnetic, calibration, high

CMS


Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment

ELSEVIER

Volume 1024, 1 February 2022, 166129

Muon detection in electron-positron annihilation for muon collider studies

N. Amapane, M. Antonelli, F. Anulli, G. Ballerini, L. Bandiera, N. Bartosik, M. Bauce, A. Bertolin, C. Blino, O.R. Blanco-Garcia, M. Boscolo, C. Brizzolari, A. Cappati, F. Casaburo, M. Casarsa, G. Cavato, G. Cesarini, F. Collamati, G. Cotta, C. Curatolo, M. Zanetti

LEMMA

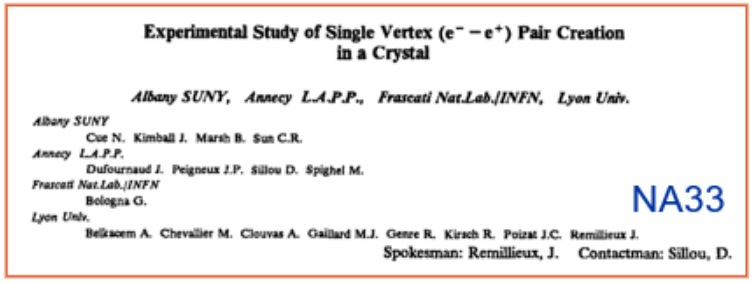

Eur. Phys. J. C (2021) 81:238
https://doi.org/10.1140/epjc/s10052-021-09021-y

THE EUROPEAN PHYSICAL JOURNAL C

Regular Article - Experimental Physics

Investigation on steering of ultrarelativistic $e^{\pm}$ beam through an axially oriented bent crystal

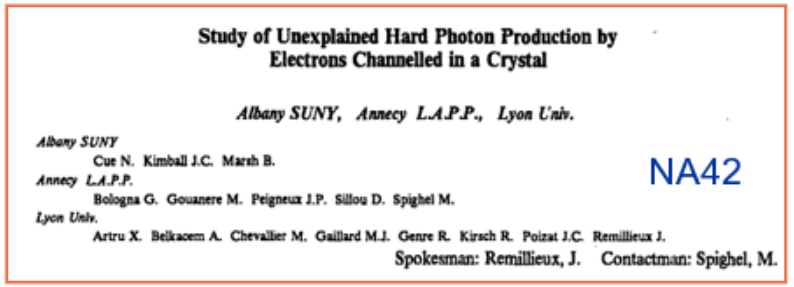
L. Bandiera, I. V. Kyryllin, C. Brizzolari, R. Camattari, N. Charitonidis, D. De Salvador, V. Guidi, V. Mascagna, A. Mazzolari, M. Prest, M. Romagnoni, N. F. Shul'ga, M. Soldani, A. Sytov, E. Vallazza


Experimental Study of Single Vertex ($e^- - e^+$) Pair Creation in a Crystal

Albany SUNY, Annecy L.A.P.P., Frascati Nat.Lab./INFN, Lyon Univ.

Albany SUNY
Cue N. Kimball J. Marsh B. Sun C.R.
Annecy L.A.P.P.
Dufournaud J. Peigneux J.P. Sillou D. Spighel M.
Frascati Nat.Lab./INFN
Bologna G.
Lyon Univ.
Belkacem A. Chevallier M. Clouvas A. Gaillard M.J. Genre R. Kirsch R. Poizat J.C. Remillieux J.
Spokesman: Remillieux, J. Contactman: Sillou, D.

NA33


Study of Unexplained Hard Photon Production by Electrons Channelled in a Crystal

Albany SUNY, Annecy L.A.P.P., Lyon Univ.

Albany SUNY
Cue N. Kimball J.C. Marsh B.
Annecy L.A.P.P.
Bologna G. Gouanere M. Peigneux J.P. Sillou D. Spighel M.
Lyon Univ.
Artru X. Belkacem A. Chevallier M. Gaillard M.J. Genre R. Kirsch R. Poizat J.C. Remillieux J.
Spokesman: Remillieux, J. Contactman: Spighel, M.

NA42

H4 - Experimental Zones

- **Experimental zones :**
  - H4A → PPE134, very long and broad area, equipped with GOLIATH magnet. Has an XTDV (beam dump) to separate from PPE144.
  - H4B → PPE144, houses the NA64 experiment and upstream of GIF++. Has an XTDV (beam dump) to separate from PPE154.
  - H4C → PPE154, GIF++ bunker. Separated from PPE164 with an XTDV.
  - H4D → PPE164, Dedicated CMS zone downstream of GIF++.

PPE134

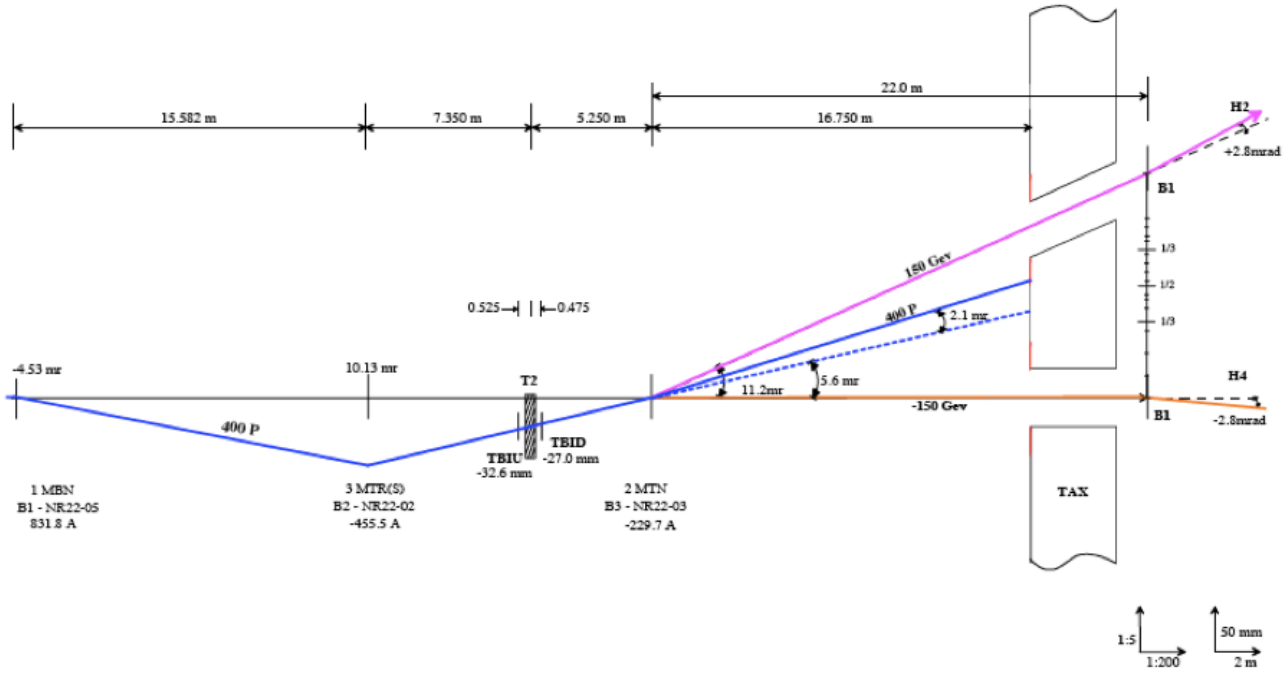
PPE144

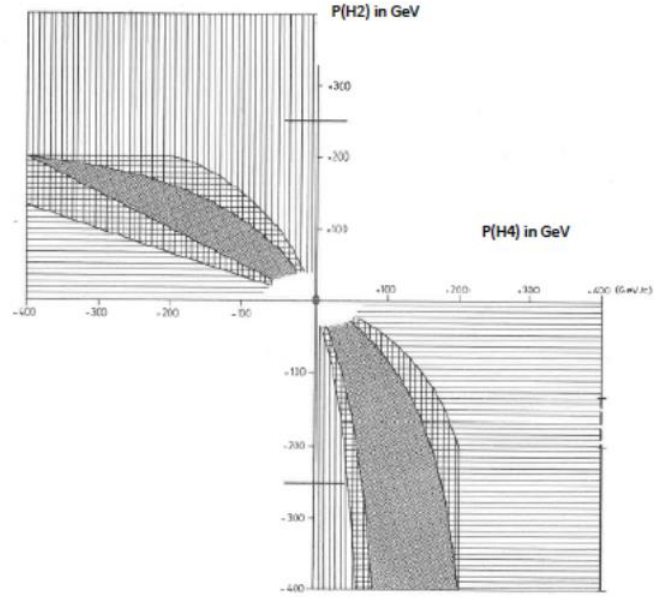
GIF++

H4 – Available beam modes

- **H4 shares the target T2 with H2. Therefore, there are some coupling between the momenta available in H2 and H4.**

- **Available beam modes - High energy hadrons (~5E6/spill), muons (1E4/spill) and electrons (7E6/spill) are available upon request**





H4 Electron beams

- **Mechanism : Production of electrons / positrons from the neutral channel (π0→ γγ and then, in a Pb converter γ → e+e-)**

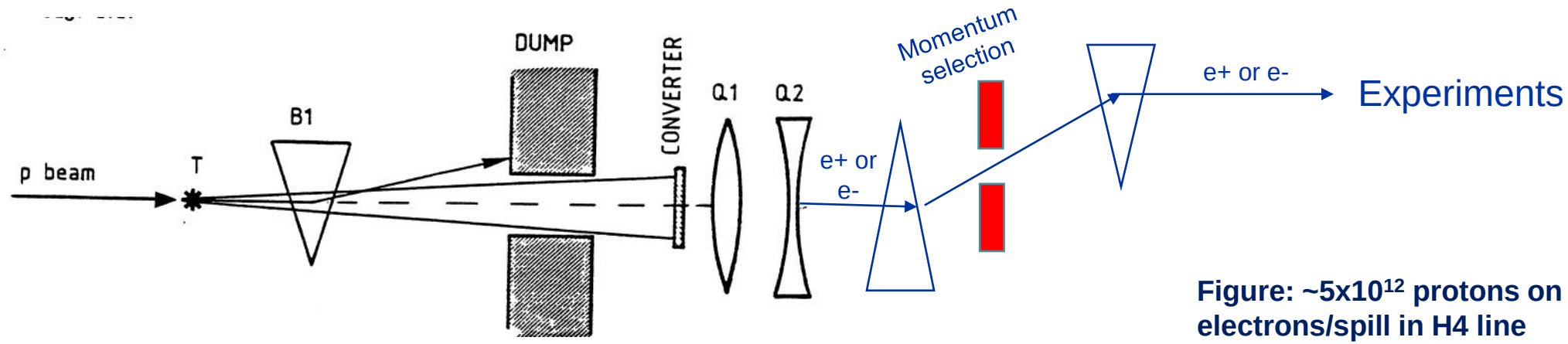


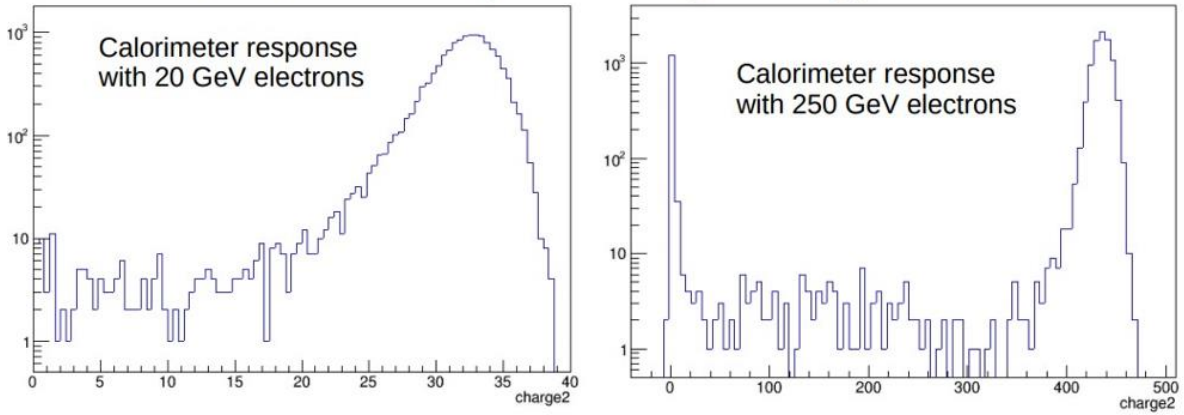
Figure: ~5x10^{12} protons on target ~1E7 electrons/spill in H4 line

- **Intensities between 10^3 – 10^7 particles per spill, depending on the collimation & momentum selection precision**
- **Purity between 50 – 100% depending on the momentum & exact target station configuration**
- **Converter: Pb, 4mm thickness**
- **Only available in H2 / H4 lines – H6 & H8 don't have this option**

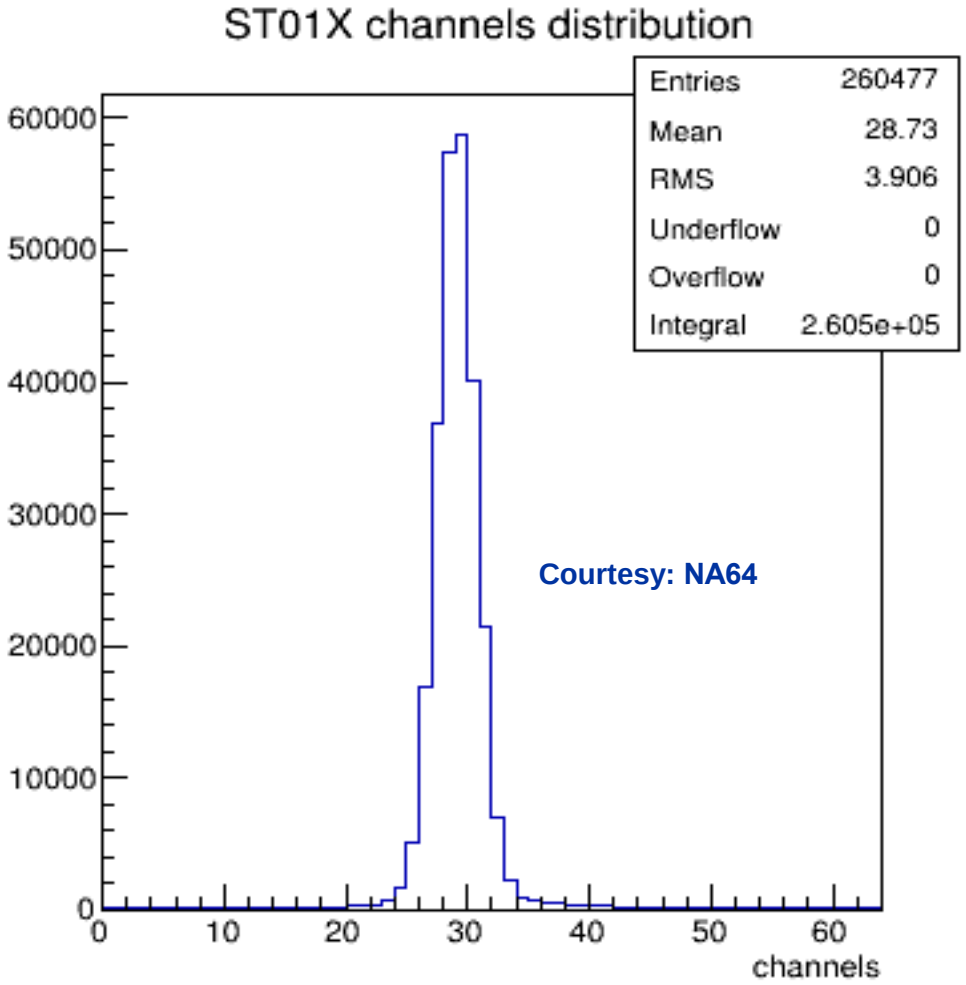
H4 electron beams - Examples

Beam Quality

- Had excellent beam quality for electrons, muons, pions
  - Very high purity achieved after wobbling change of Friday
- Adjusted momentum collimators for some runs to reduce momentum spread at high energy



Courtesy: FASER



Courtesy: NA64

H4 muon beams

- **In 2022, a new muon target has been installed in PPE124. This greatly improved the muon purity in PPE134 and downstream.**

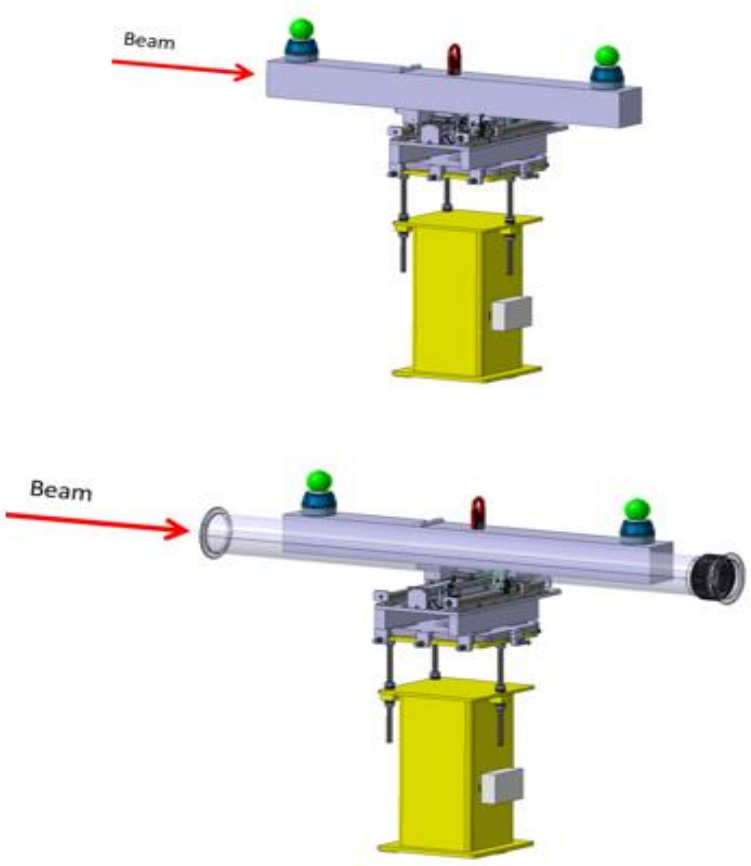
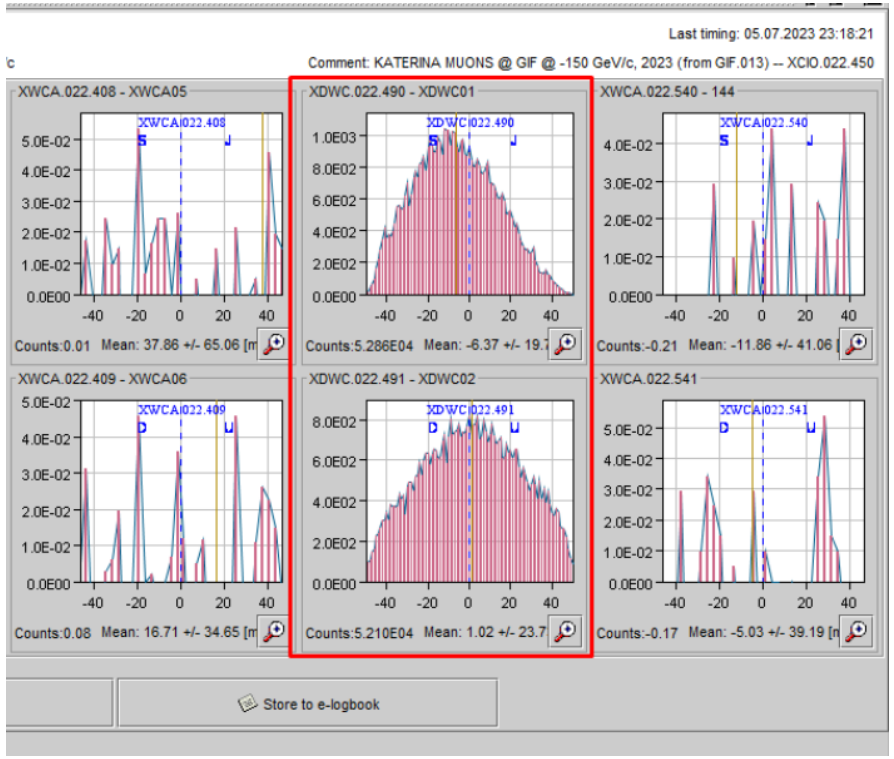


Figure 10 – Installed XCIO on the line.



Remember: Muon beams are big ;)

H4 hadrons beams

- **Mixed secondary hadron beams coming from the protons on target are transported to the experimental zones.**

- **Various optics options possible.**

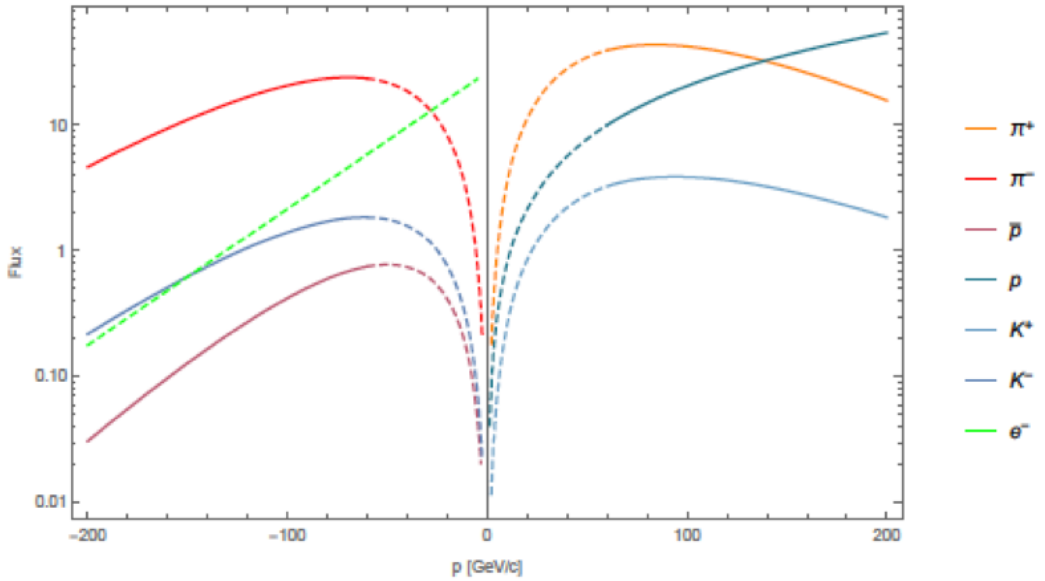
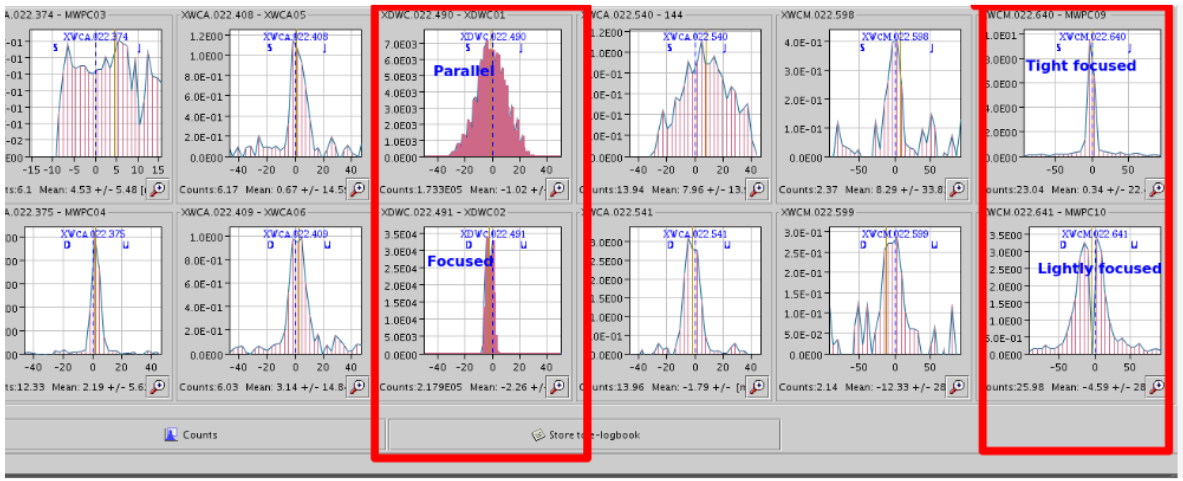


Figure 4.2: *Particle production curves at 0 mrad for pions, kaons and (anti-)protons. The incident proton momentum is 400 GeV/c and negative momentum values indicate the momentum for negative particles.*

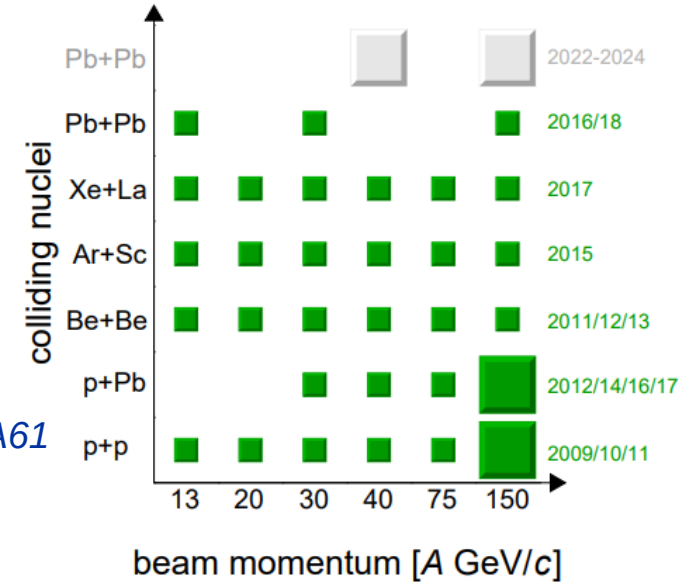


H4 Contact Persons

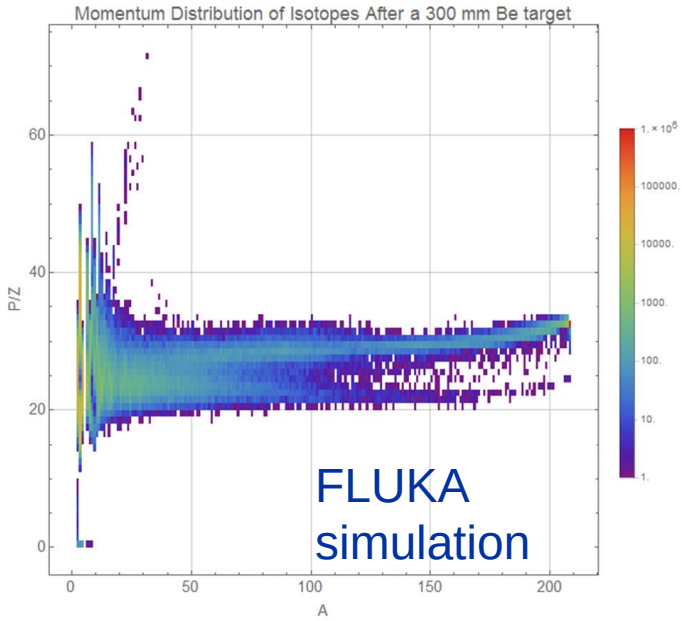
- **Responsible liaison physicist – N. Charitonidis (62102/169887)**
  - Beam composition, intensity, spot-size, PID, vacuum, Cherenkov gases, general layout, possibilities, beam tuning.
- **Beam line support – B. Rae (63625/167388)**
  - CESAR training, patron rights training, beam control, file loading, beam tuning…
- **In the event of absence of both N. Charitonidis and B. Rae (highly unlikely ☺)**
  - Deputy beam physicist: D. Banerjee (164065)
  - BE-EA-LE Section Leader: J. Bernhard (164896)
- **Technical Support – M. Lazzaroni (162407)**
  - “I want help with transport”, “ I need a special table”, “my zone has less blocks than last year and I need them”, “something is broken in the zone”….

Ion Beams

- **Ion beams are available in the North and the East Area**
  - 2021: No ions
  - 2022 - 2024: Pb
  - 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 and 2023 CHIMERA also took low energy ions in T08.

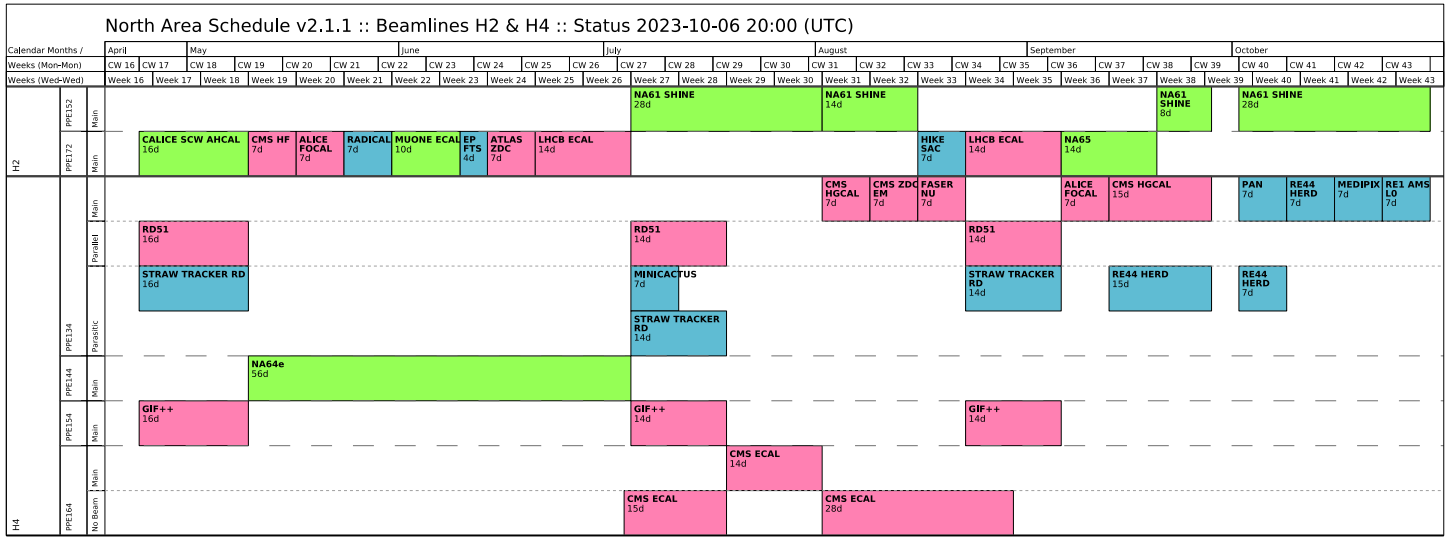


Courtesy: NA61



Schedule and planning

- **The beam time request must be sent to the PS-SPS coordinator ~ November for the following year via the link https://ps-sps-users.web.cern.ch.**
  - **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)**

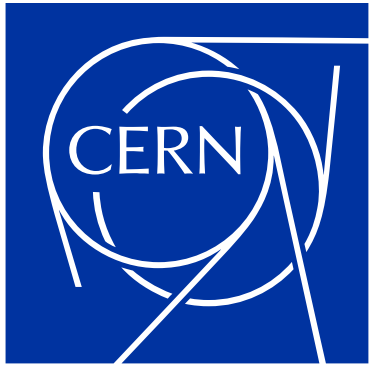


The scheduling is based on priorities of different experiments and is discussed with the scientific committees. The draft schedule is presented at the CERN research board for approval.

Summary

- **CERN offers a great variety of test-beam options with beams ranging between 0.1 GeV/c (East Area) – 400 GeV/c (North Area).**
- **H4 in the North Area is notable for the high intensity, high purity electron beam that it can offer.**
- **Additionally muon and hadron beams are also available.**
- **Please contact in advance Sps.Coordinator@cern.ch and 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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