Carlo and accelerators

A seminar to celebrate the 90th birthday of Prof Carlo Rubbia

Lyn Evans, Imperial College London

ISR

Interaction point
with crossing angle

10 FEBRUARY 1971

Council commissions the Super Proton Synchrotron

Seven kilometres in circumference, the Super Proton Synchrotron (SPS) was the first of CERN's giant underground rings. It was also the first accelerator to cross the Franco-Swiss border.

Eleven of CERN's member states approved the construction of the SPS in February 1971, and it was switched on for the first time on 17 June 1976, two years ahead of schedule. The SPS quickly became the workhorse of CERN's particle physics programme, providing beams to two large experimental areas. Advances in technology during the building period meant that not only was construction finished early, it was able to operate with a beam energy of 400 GeV - 100 GeV higher than the original design energy.

The SPS operates today at up to 450 GeV, and has handled many different kinds of particles. Research using SPS beams has probed the inner structure of protons, investigated nature's preference for matter over antimatter, looked for matter as it might have been in the first instants of the universe and searched for exotic forms of matter.

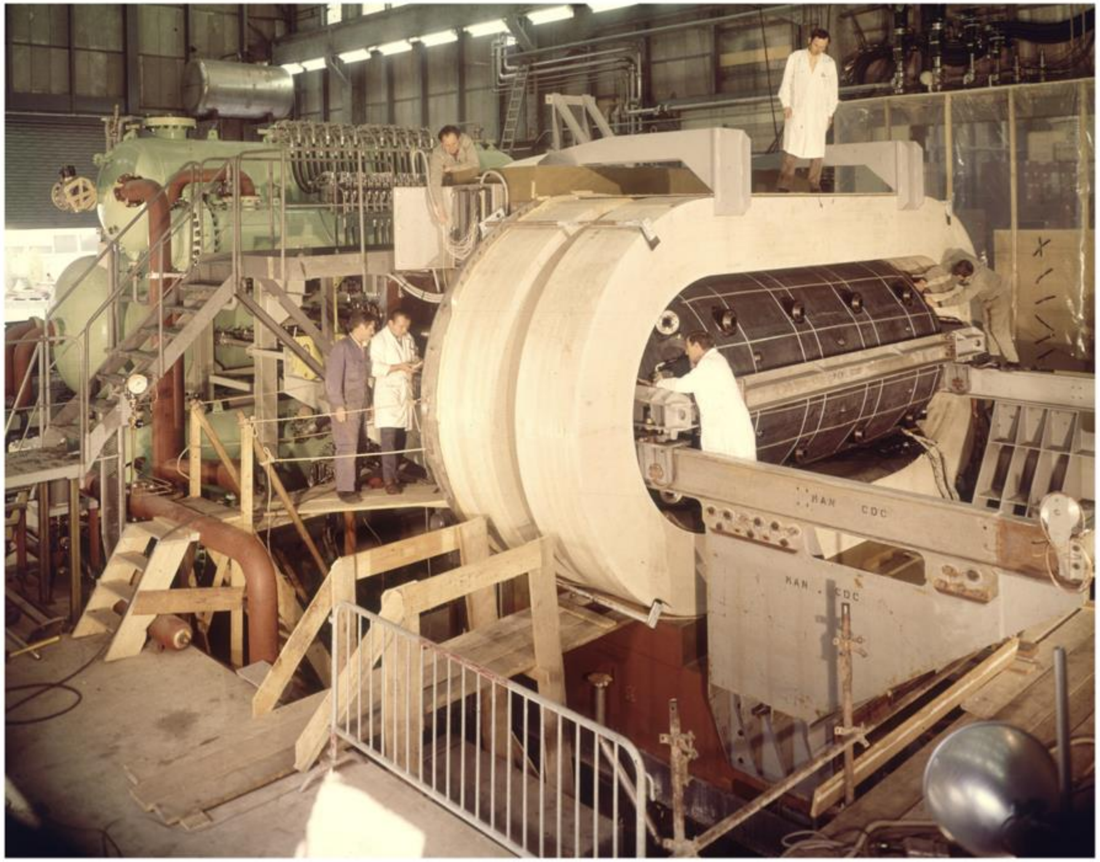
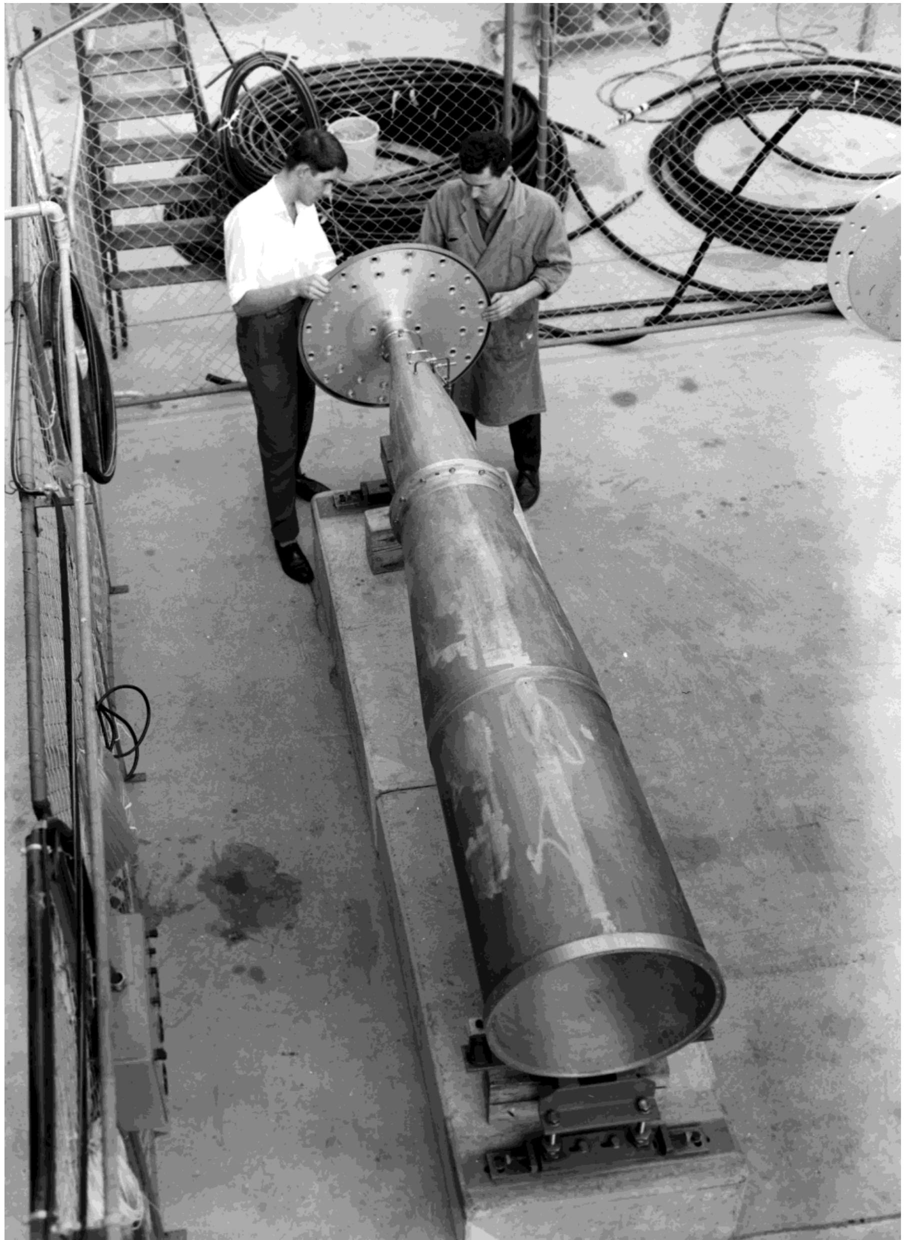


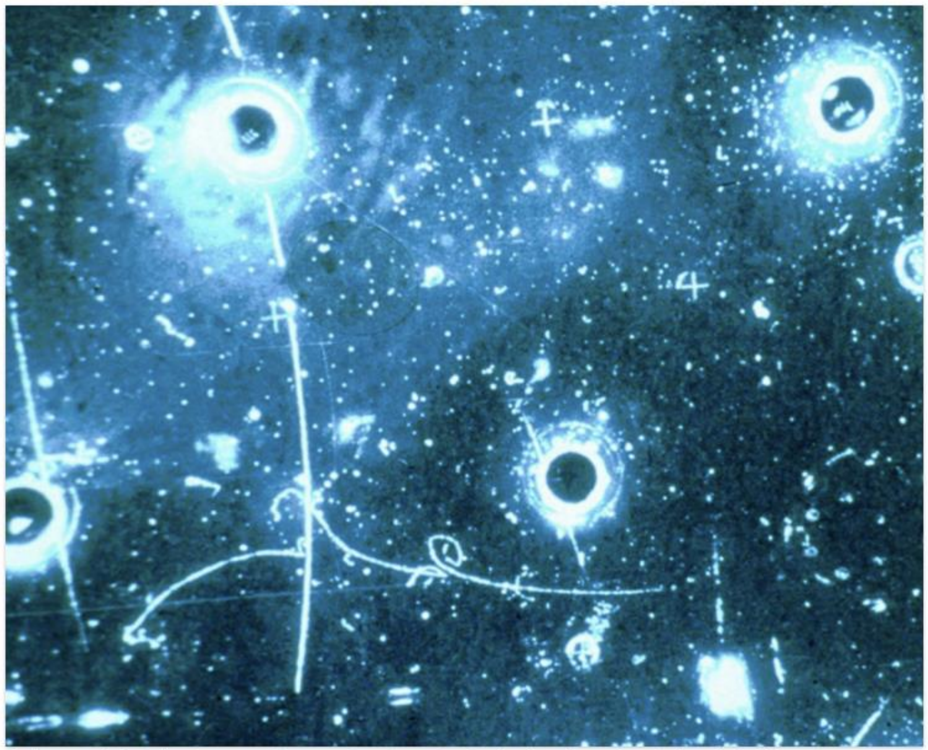
Fig. 3. The body of Gargamelle installed inside the magnetic coils.

Van der Meer's neutrino horn



On 19 July 1973, physicists working with the Gargamelle bubble chamber at CERN presented the first direct evidence of the weak neutral current

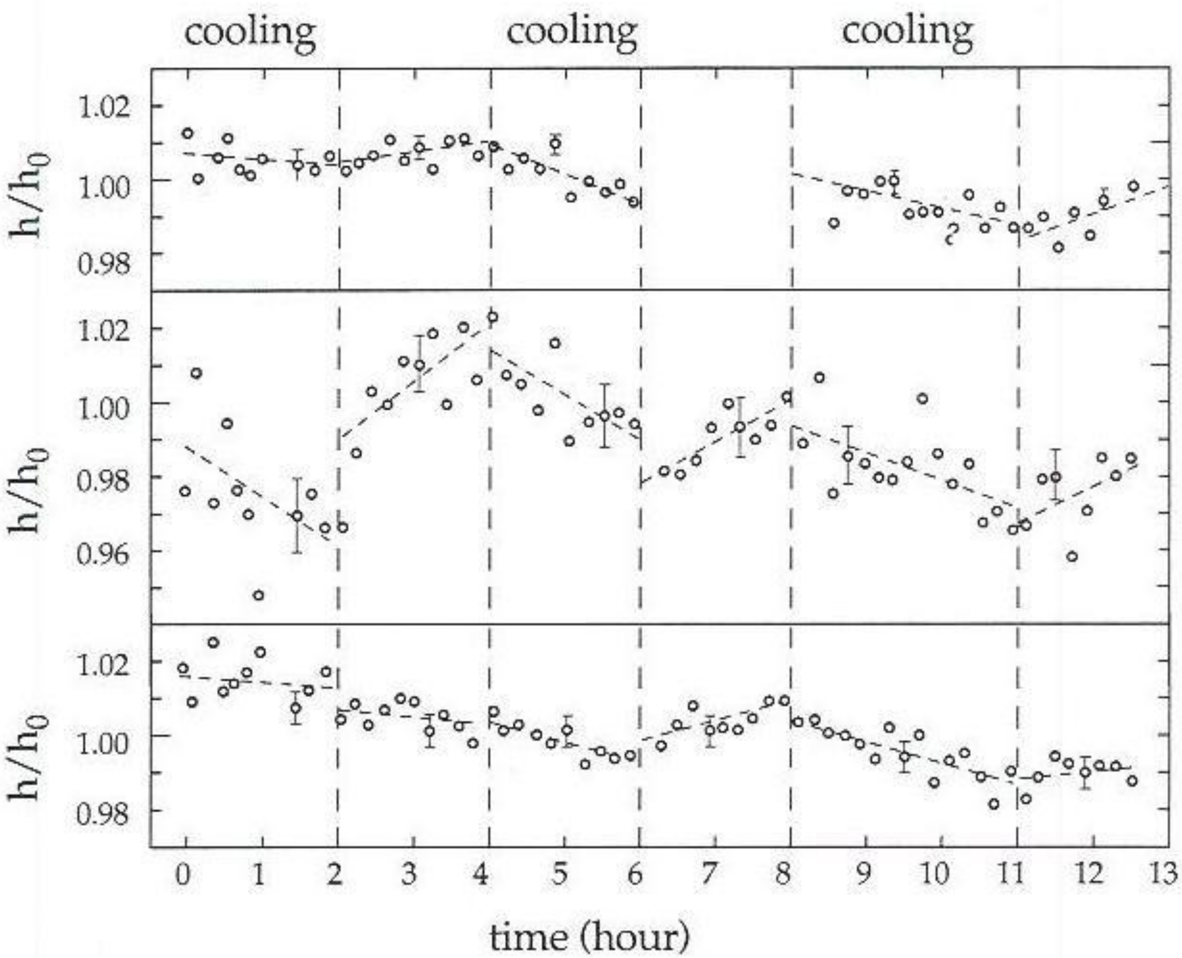
19 JULY, 2013 | By Cian O'Luanaigh



The first example of a single-electron neutral current. An incoming antineutrino knocks an electron forwards (towards the left), creating a characteristic electronic shower with electron–positron pairs (Image: Gargamelle/CERN)

4. <u>FINAL NOTE</u>

This work was done in 1968. The idea seemed too far-fetched at the time to justify publication. However, the fluctuations upon which the system is based were experimentally observed recently. Although it may still be unlikely that useful damping could be achieved in practice, it seems useful now to present at least some quantitative estimation of the effect.



cooling
cooling
cooling
h/h0
1.02
1.00
0.98
0.96
0 1 2 3 4 5 6 7 8 9 10 11 12 13
time (hour)

Seminar Carlo November 1976

AIMS OF THE EXPERIMENT.

- COLLIDE p AND $\bar{p}$ IN SPS (NAL - ED)
  TO ACHIEVE ENERGIES OF UP TO 500 GeV
  IN CENTRE OF MASS (2000 GeV FOR ED) AND
  A LUMINOSITY OF 10^{30} cm^{-2} sec^{-1}
  (CFR: ISR, LSR $\geq 10^{32}$ cm^{-2} sec^{-1})

- ONE OR MAYBE TWO COLLISION POINTS

- A FIRST EXPLORATORY PROGRAM E?
  - SEARCH FOR Z^0, $W^{\pm}$ $\quad \ell^+ \ell^- \rightarrow \psi \rightarrow$

  00 + 200
  100,000 GeV OTHER INTERESTING RESULTS POSSIBLE
  (QUARKS, NEW HADRON PHENOMENA, JETS....)

- MODEST COST: FEW MEGA FRANCS

- SHORT TIMETABLE ~ 3 YEARS.

Table 4-2. Main parameters of the $\bar{p}$ front end,

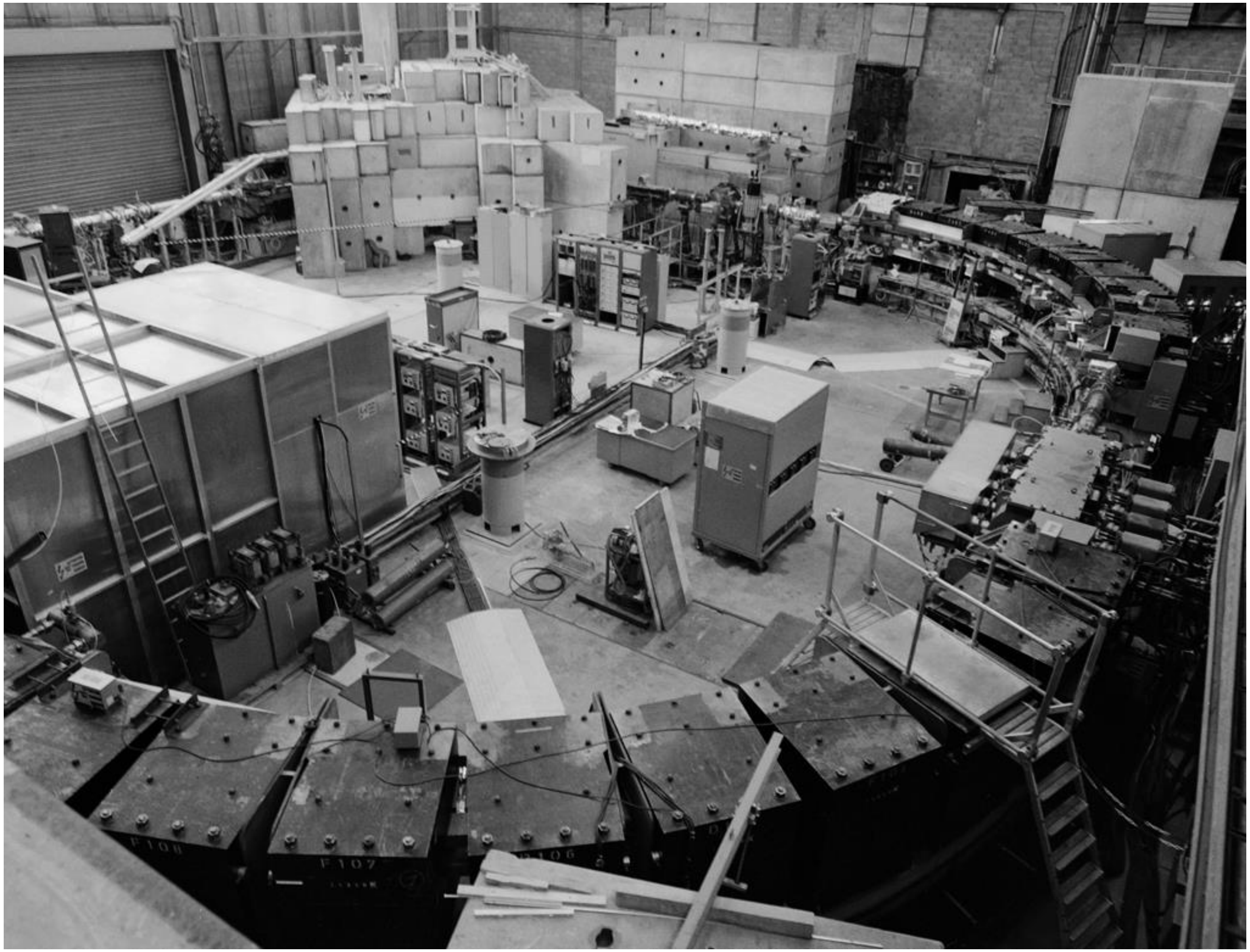
Antiproton momentum	p_0	3.5 GeV/c
Minimum of beta function (at ~~[illegible]~~ centre of target for $p = p_0$)	β_0	1.5 cm
Storage ring acceptance	A_0	$28.5\ 10^{-6}\ \pi$ rad
Target length	ℓ	8 cm
Target diameter		1 mm
Focal length of lens $(p = p_0)$	f_0	40 cm
Target material		Tungsten
Target absorption length	λ_{abs}	10 cm
Maximum, theoretical acceptance	$\hat{\eta}_t \cdot \langle \Omega \rangle$	1.79×10^{-3} ~~[illegible]~~, ster
Actual acceptance for $\frac{\Delta p}{p} = \pm 3\%$ and all absorption effects included	$\eta_t \langle \Omega \rangle$	1.20×10^{-3} ~~[illegible]~~, sterad
~~[illegible]~~ Lens half-aperture	a	1.75 cm
Value of beta function at exit of lens	β_{MAX}	10.68 m

b) It would be most attractive to replace the entire electron cooling and stacking process by a stochastic cooling system. No deceleration would then be required, and a single ring, operated d.c., would be sufficient.

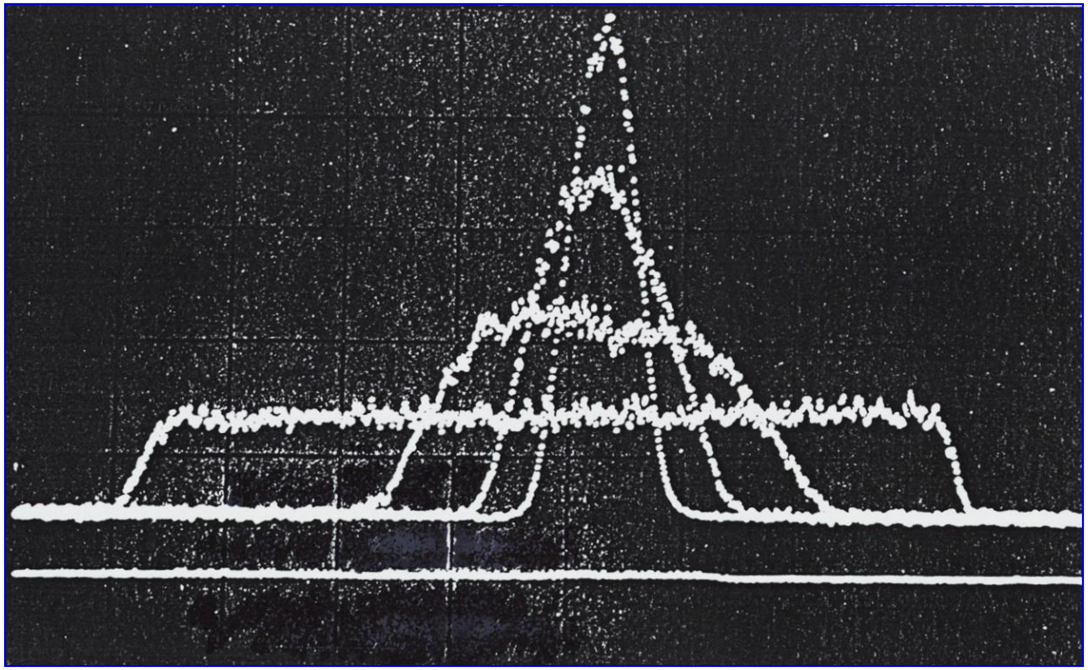
Studies have shown that it would probably be possible to cool and stack a limited number of pulses (say 100). The stacking would be done by momentum cooling. Betatron cooling of the stack would seem to be feasible because the noise problem is then less severe than for single pulses.

However, the problem of stacking, say, 10^4 pulses and simultaneously cooling the injected pulses in the same ring, has not yet been solved. Although a solution is not quite excluded, it seems more reasonable at present to base the design on electron cooling, which requires much less extrapolation into unknown regions.

Initial Cooling Experiment



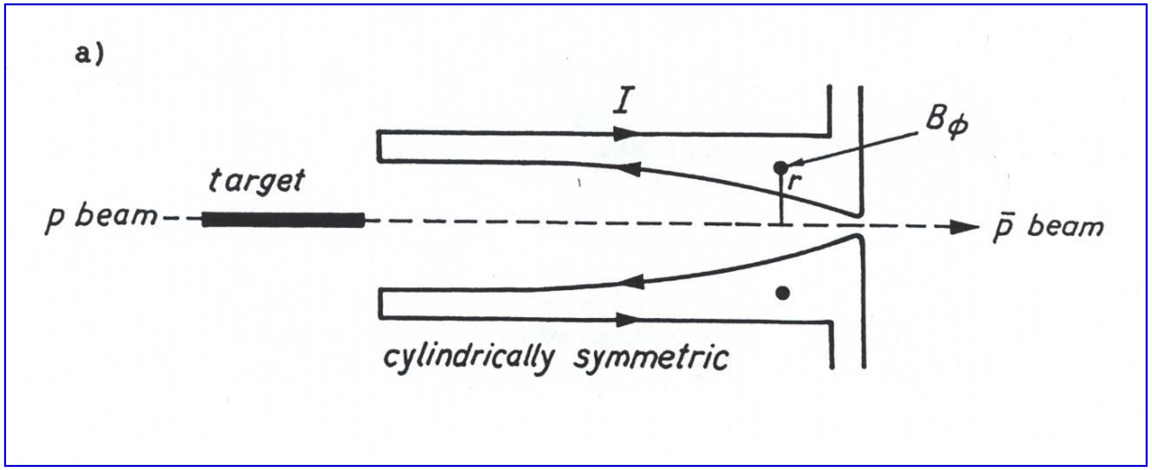
Momentum Cooling in ICE

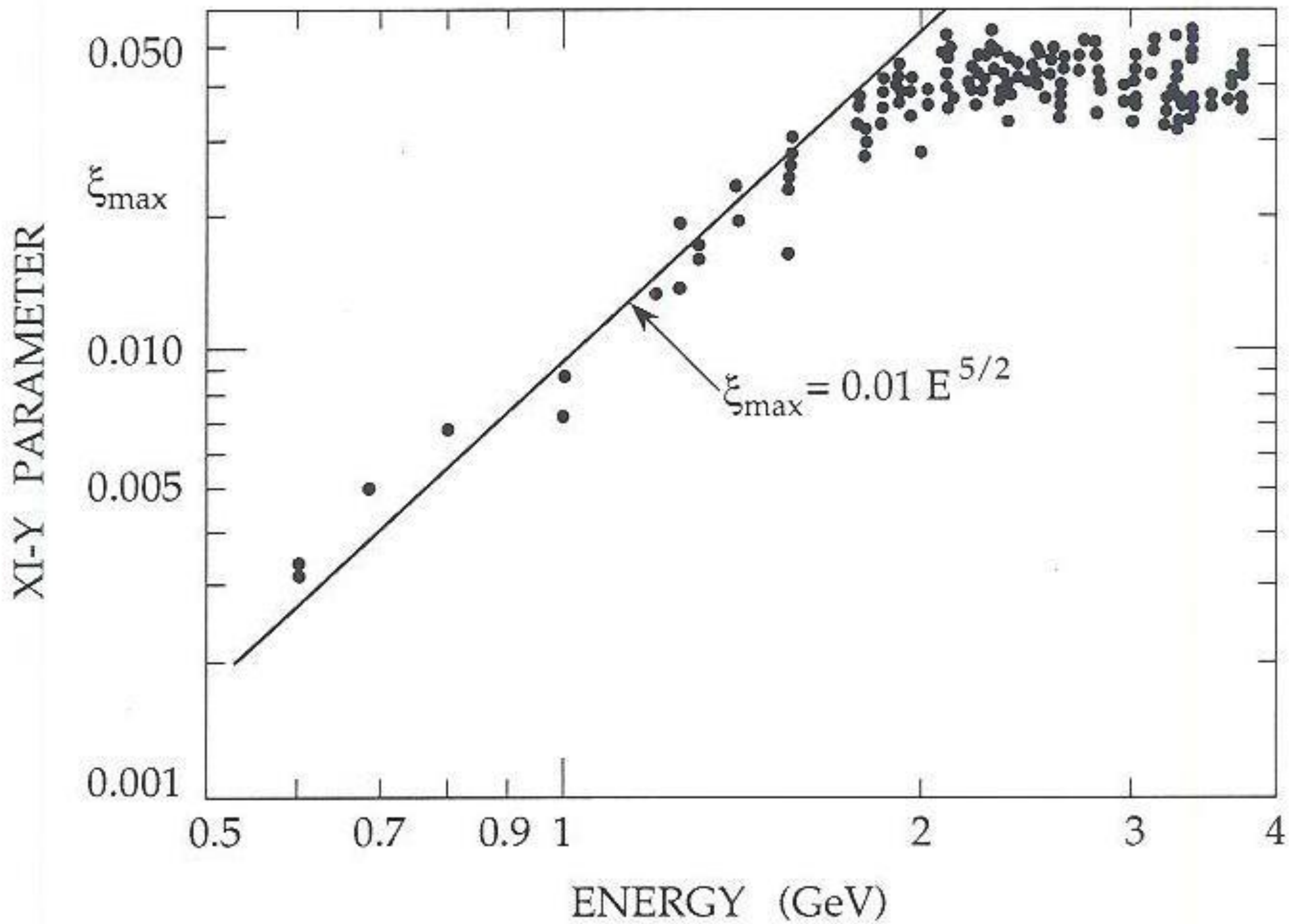


Schottky scan after 1, 2 and 4 min.

Signal height proportional to the square root of density and width proportional to Δ p/p.

Antiproton Collection with Horn




0.050
0.010
0.005
0.001
ξ_{max}
XI-Y PARAMETER
$\xi_{max} = 0.01\ E^{5/2}$
0.5
0.7
0.9
1
2
3
4
ENERGY (GeV)

THIS MORNING AT
4.15 AM.
PROTONS AND ANTIPROTONS
COLLISIONS HAVE BEEN
PRODUCED IN SPS AND
CLEARLY DETECTED IN
THE FORWARD TELESCOPES
OF EXPERIMENT UA1.


EXTINCTEUR
FIRE EXTINGUISHER

History

1977 Thorndahl invents filter method of fast momentum cooling. Theory, Hereward and Sacherer. Thorndahl cooling tested on ICE. SPS storage experiments started.

1978 Second design report based entirely on stochastic cooling. Authorisation of p-pbar project (June 1978).

1980 Start eleven-month shutdown for SPS modifications. Protons circulating in AA (June).

1981 10^{th} July first proton-antiproton collisions in SPS (4 a.m.). November first technical run (0.2 inverse nanobarns).

1982 First real physics run October – December (28 inverse nanobarns). Peak luminosity 5 x $10^{28}cm^{-2}s^{-1}$. W found.

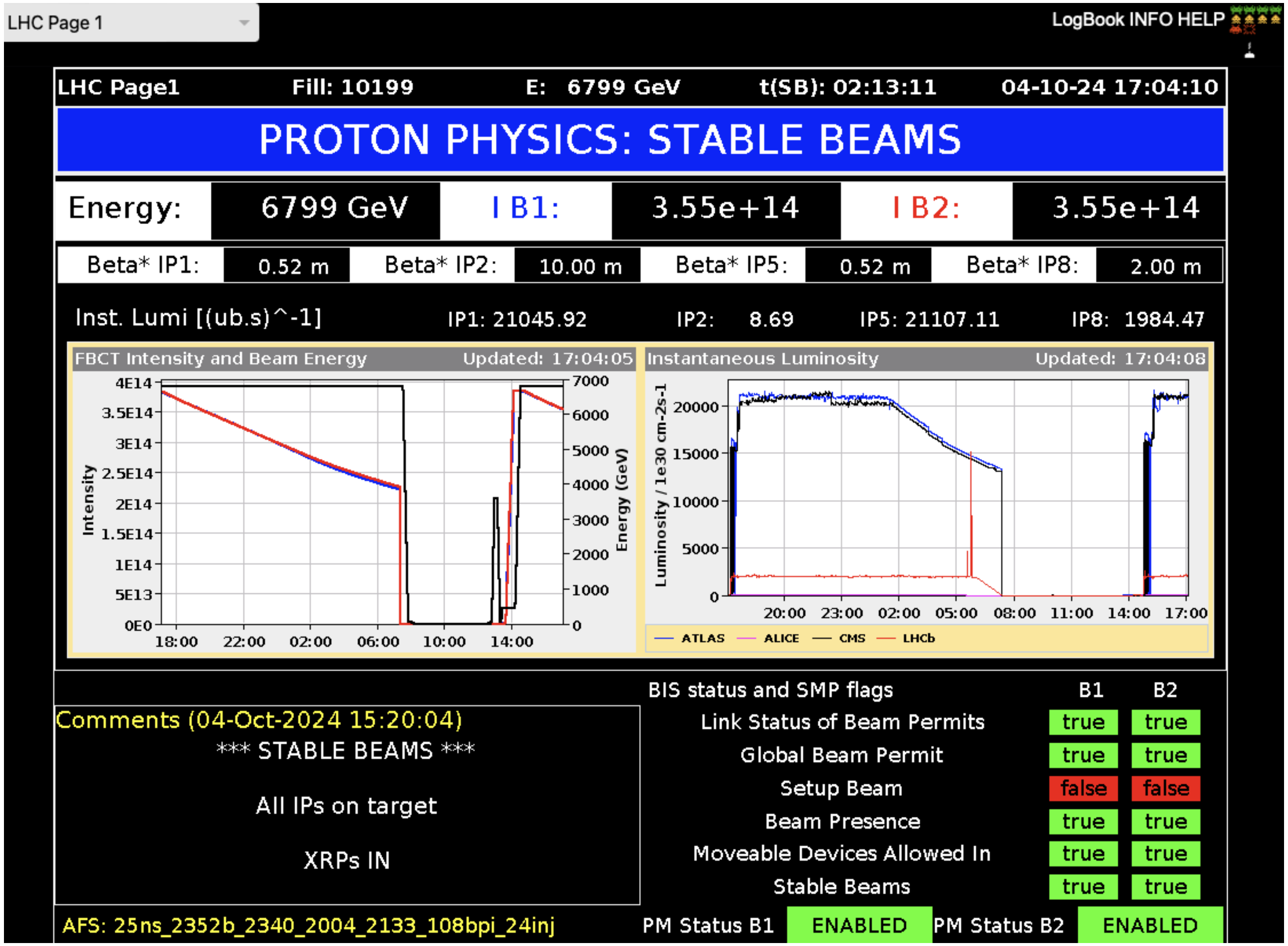
1983 January W annoucement.
April – July collider run. Luminosity 1.6 x $10^{29}cm^{-2}s^{-1}$. Z_0 found.

LARGE HADRON COLLIDER IN THE LEP TUNNEL

Vol. I

PROCEEDINGS OF THE ECFA–CERN WORKSHOP

held at Lausanne and Geneva,
21–27 March 1984


LHC Page 1
LogBook INFO HELP
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PROTON PHYSICS: STABLE BEAMS
Energy: 6799 GeV
I B1: 3.55e+14
I B2: 3.55e+14
Beta* IP1: 0.52 m
Beta* IP2: 10.00 m
Beta* IP5: 0.52 m
Beta* IP8: 2.00 m
Inst. Lumi [(ub.s)^-1] IP1: 21045.92 IP2: 8.69 IP5: 21107.11 IP8: 1984.47
FBCT Intensity and Beam Energy Updated: 17:04:05
Intensity
Energy (GeV)
Instantaneous Luminosity Updated: 17:04:08
Luminosity / 1e30 cm-2s-1
ATLAS ALICE CMS LHCb
BIS status and SMP flags B1 B2
Link Status of Beam Permits true true
Global Beam Permit true true
Setup Beam false false
Beam Presence true true
Moveable Devices Allowed In true true
Stable Beams true true
Comments (04-Oct-2024 15:20:04)
*** STABLE BEAMS ***
All IPs on target
XRPs IN
AFS: 25ns_2352b_2340_2004_2133_108bpi_24inj
PM Status B1 ENABLED
PM Status B2 ENABLED