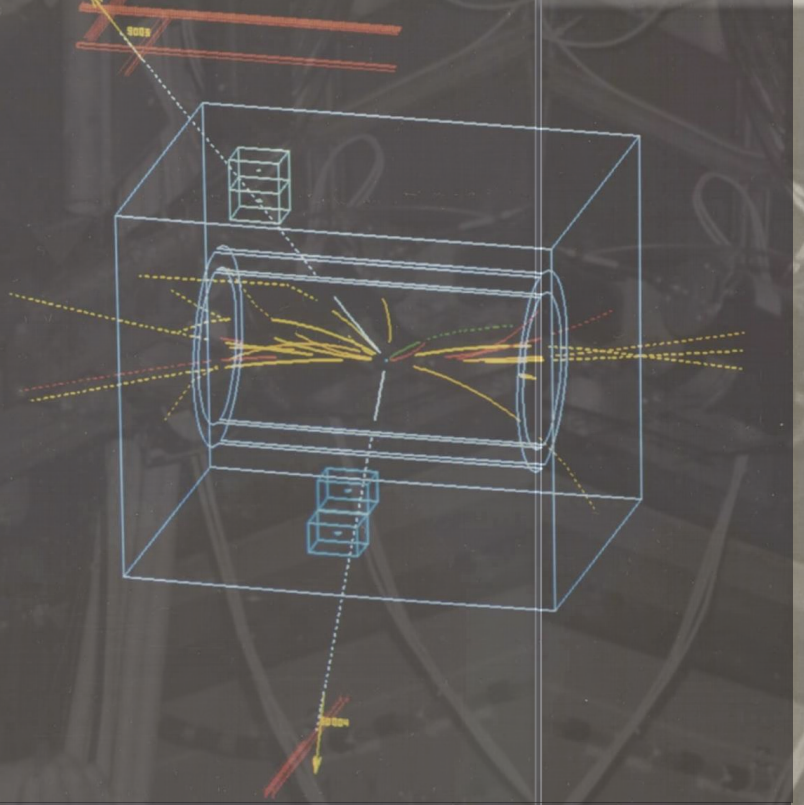
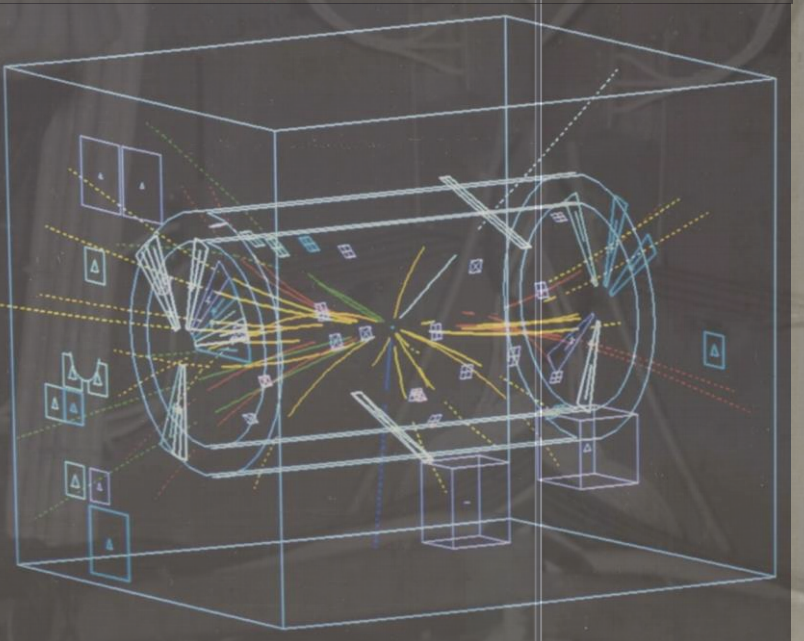
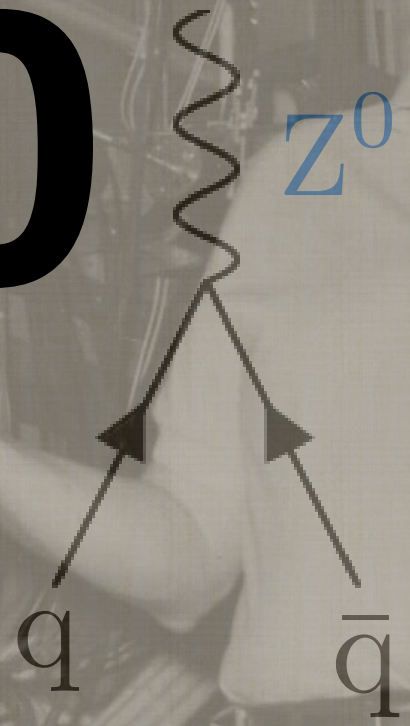
Underground Area 1
with Carlo Rubbia





90

GeV



Jim Rohlf
Boston University

Path to CERN

1962- Senior Physicist, CERN, Geneva, Switzerland
1970- Professor of Physics, Harvard University

Publications

Rubbia's first papers

1. Methods of fast triggering of track detectors. With S. Focardi et al., Nuovo Cimento (Ser. 10) 5 (1957).
2. On the applicability of ^{4}He gas scintillators as analysers of neutron energy and polarization. With M. Toller, Nuovo Cimento 10, 410-11 (1958).
3. A search for particles of 550 Me. With M. Conversi et al., Nuovo Cimento 9, 740-4 (1958).
4. A new type of pulse-height analyser for rapid pulses. Nuovo Cimento 12, 144-7 (1959).
5. A device for dynamical measurements of pressure. With P. Bassi et al., Nuovo Cimento 11, 589-92 (1959).
6. Investigation of the existence of particles of mass about 550 m in cosmic rays. With M. Conversi et al., Nuovo Cimento 12, 55 (1959).
7. Mass-550 particle. With M. Conversi et al., Phys. Rev. 114, 1150-1151 (1959).
8. Neutron asymmetry from mu capture in magnesium. With W. F. Ba Phys. Rev. Letters 3, 179-181 (1959).
9. Search for electrons from muon capture. With M. Conversi et al., Nuovo Cimento 18, 1283-86 (1960).
10. Nuclear capture of negative muons with electron emission. With M. Conversi et al., Nuovo Cimento 19, 987-98 (1961).
11. Investigation of the process $\mu^- + N = e^- + N$. With M. Conversi et al., Nuovo Cimento 19, 853-63 (1961).

IL NUOVO CIMENTO 1° Gennaio 1957

Metodi di comando rapido di rivelatori di tracce (*).

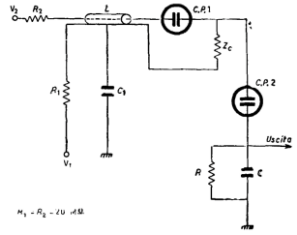
S. FOCARDI, C. RUBBIA e G. TORELLI

Istituto di Fisica dell'Università - Pisa
Sottosezione di Pisa dell'Istituto Nazionale di Fisica Nucleare

F. BELLA

Istituto di Fisica dell'Università - Roma

Coincidenze rapide.



Fermi

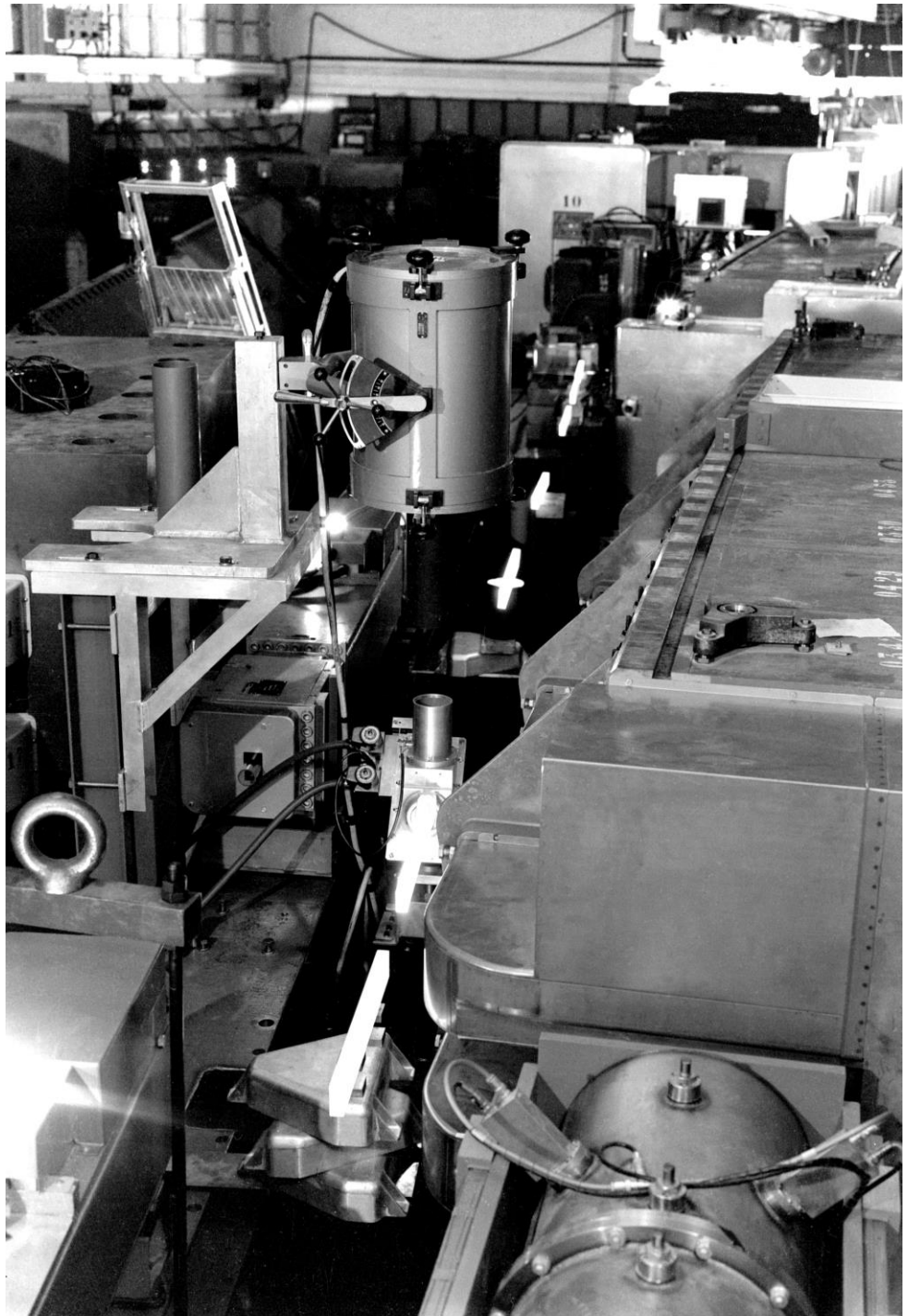
Rainwater Conversi

NEUTRON ASYMMETRY FROM MU CAPTURE IN MAGNESIUM*

W. F. Baker and C. Rubbia†
Columbia University, New York, New York
(Received July 27, 1959)

Nevis Synchro-cylcotron

Chien-Shiung Wu's observation of *parity violation* was Dec. 1956 at Columbia



CERN Proton Synchrotron (PS): 200 m, 25 GeV p in 1959

THE DESIGN OF ACCELERATING MACHINES

J.B. ADAMS

CERN, Genève

ICHEP 1956

The conference ended with a visit to the CERN Laboratories in Geneva and to the CERN site at Meyrin where a 600 Mev synchro-cyclotron and the 25 Gev proton-synchrotron are in course of construction.

If any conclusion can be drawn from the conference, it must be that accelerating machine projects are in no way dying from lack of nourishment. More money seems to be available to build machines nowadays than ever before, more physicists and engineers seem to be working on accelerator designs than one remembers in the past and there is no lack of ideas for new machines and new projects. There seems every reason to expect that the next conference on this subject, to be held in Geneva in 1958, will be just as exciting.

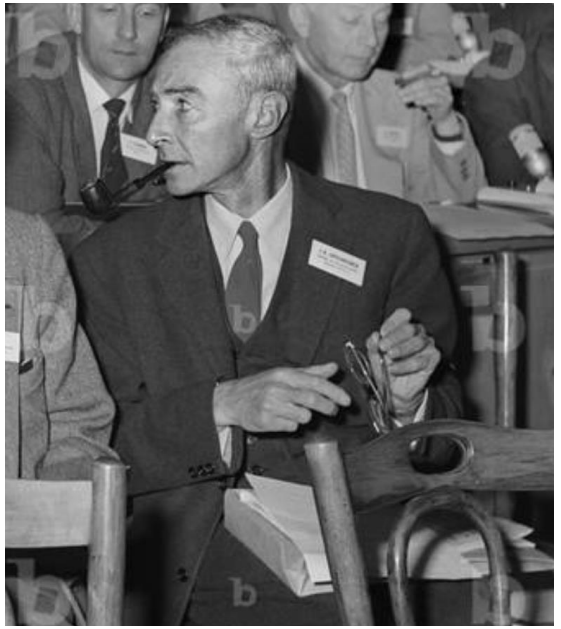
R. K. Adair, Brookhaven
L. W. Alvarez, Berkeley
C. D. Anderson, Caltech
P. M. S. Blackett, Imperial
H. Bethe, Cornell
A. Bohr, Copenhagen
O. Chamberlain, Berkeley
J. Cockcroft, Harwell
M. Conversi, Pisa
R. H. Dalitz, Chicago
S. Drell, Stanford
R. P. Feynman, Caltech
M. Gell-Mann, Caltech
M. Goldhaber, Brookhaven
W. Heisenberg, Max-Planck
R. Hofstadter, Stanford
J. D. Jackson, Illinois
E. O. Lawrence, Berkeley
L. M. Lederman, Columbia
T. D. Lee, Columbia
L. Leprince-Ringuet
A. M. L. Messiah
A.. Y. Nambu, Chicago

L. B. Okun, Moscow
J. R. Oppenheimer
W. K. H. Panofsky
W. Paul, Bonn,
W. Pauli, Zurich
R. E. Peierls, Birmingham
D. H. Perkins, Bristol
J. C. Polkinghorne, Edinburgh
C. F. Powel, Bristol
N. F. Ramsey, Harvard
G. D. Rochester, Durham
C. Rubbia, Pisa
A. Salam, Imperial
H. Schopper, Mainz
J. Schwinger, Harvard
E. Segre, Berkeley
J. Steinberger, Columbia
V. Telegdi, Chicago
S. Treiman, Princeton
R. R. Wilson, Cornell
C. S. Wu, Columbia
H. Yukawa, Kyoto

+ CERN staff

ICHEP 1958

25 present and future
Nobel Prize winners



CERN Synchro-Cyclotron (SC): 15.7 m, 600 MeV p in 1957

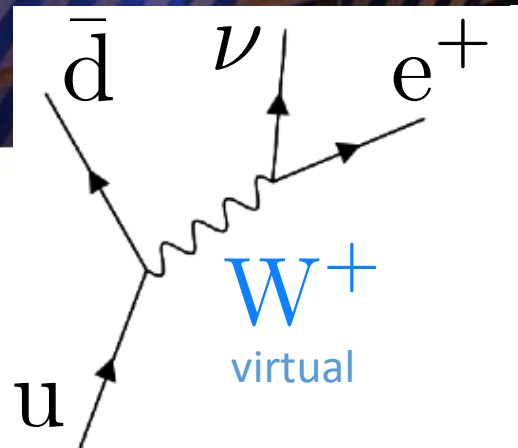
CERN's first major result

$$\pi^+ \rightarrow \pi^0 e^+ \nu$$

PHYSICS LETTERS OCTOBER 1, 1958

ELECTRON DECAY OF THE PION

T. Fazzini, G. Fidecaro, A. W. Merrison,
H. Paul, and A. V. Tollestrup*
CERN, Geneva, Switzerland
(Received September 12, 1958)



PHYSICS LETTERS August 1962

DETERMINATION OF THE $\pi^+ - \pi^0 + e^+ + \nu$ DECAY RATE

P. DEPOMMIER *, J. HEINTZE, A. MUKHIN **, C. RUBBIA,
V. SOERGEL and K. WINTER
CERN, Geneva

Received 7 July 1962

Wursthaus

Coffee Brewing Institute of Massachusetts' prize
"for the cleanliness of utensils used in the making
of the coffee." "link" *The Cambridge Chronicle*, 4 June 1964, p.15.

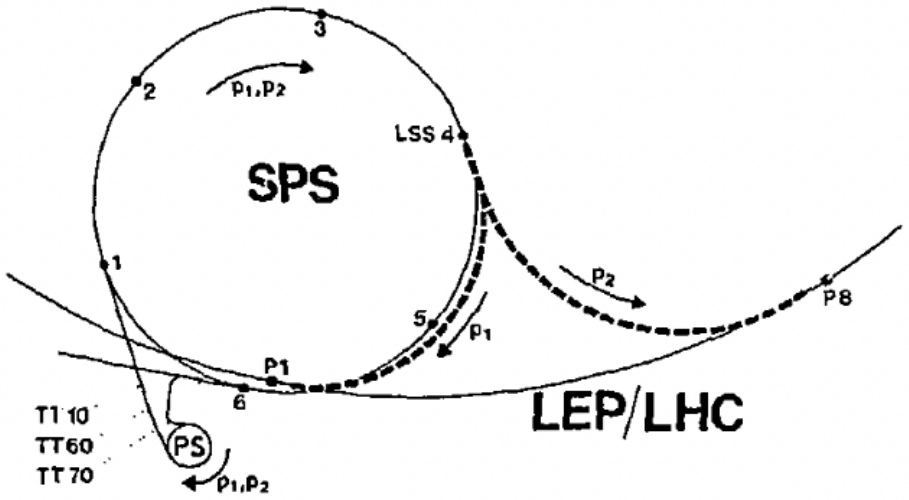
"Notable patrons of Wursthaus included
Harvard President Derek C. Bok,
The Aga Khan, and
Labor Secretary Robert B. Reich."

… and Carlo Rubbia

“I sung my song to Mr. Jimmy”

You Can't Always Get What You Want

Mick Jagger and Keith Richards, The Rolling Stones



Radius of LEP tunnel

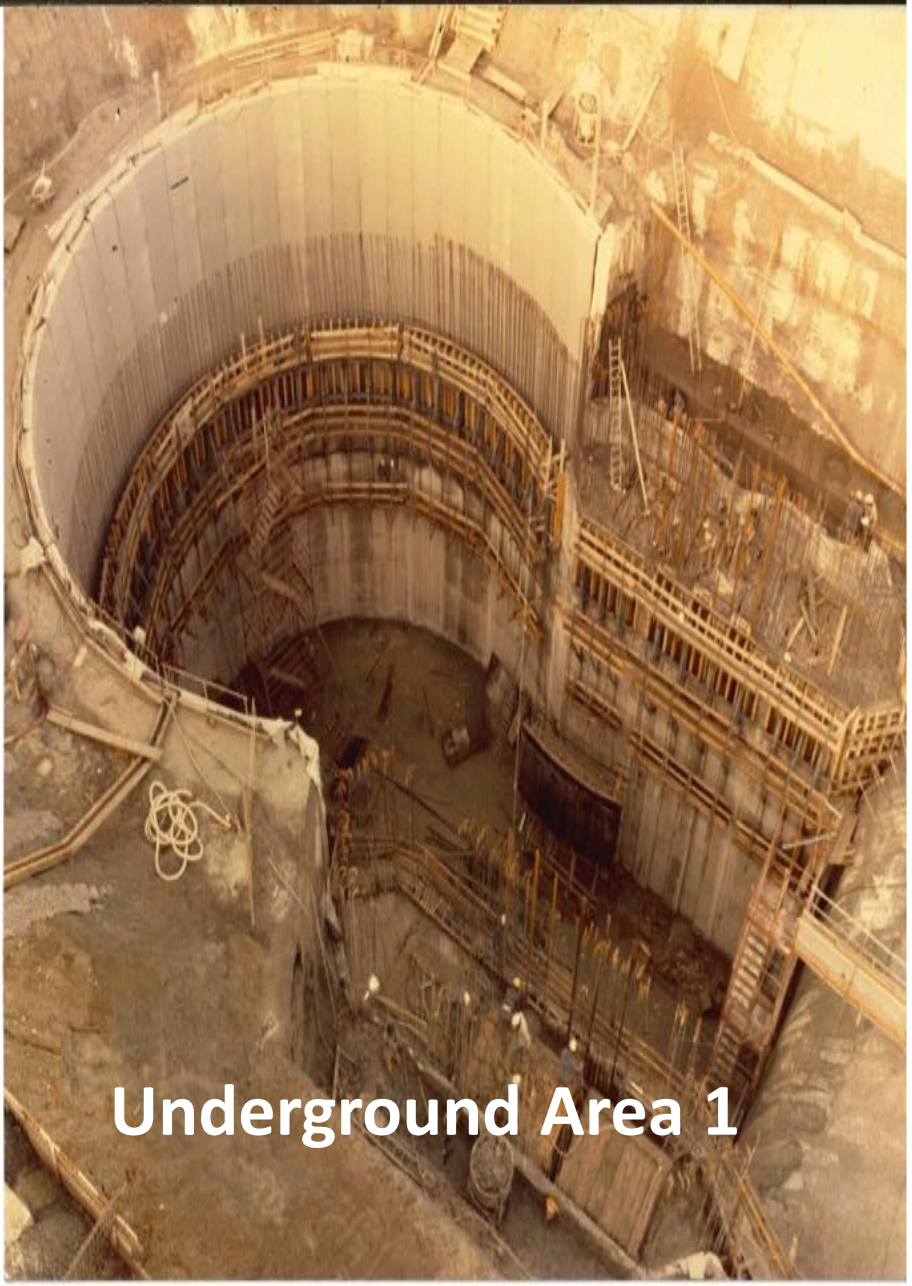
```
In[39]:= UnitConvert[e c (26659. m)/(2 π), TeV/T]

Out[39]= 1.27199 TeV/T
```

Juan Carlos Norero Borguenson (JCNorero)

"" CARLO RUBBIA ""

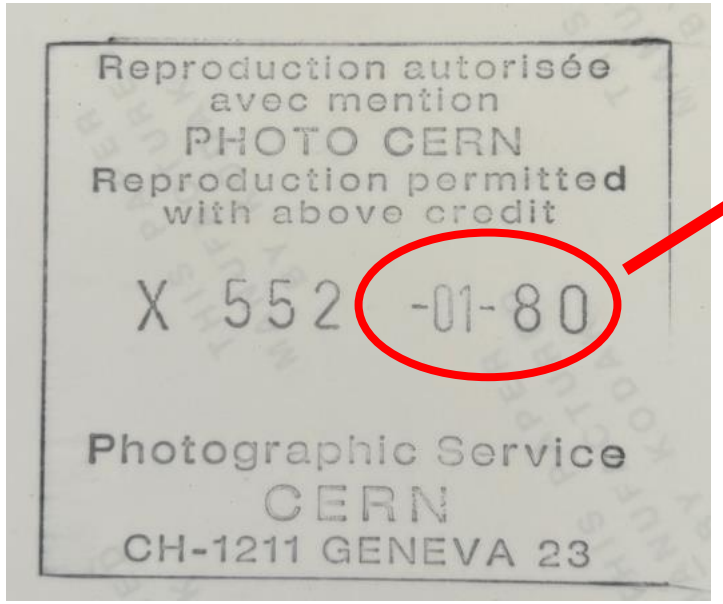
Ink on Paper | 22.1×35.4 in



"And I went down to the demonstration
To get my fair share of abuse"

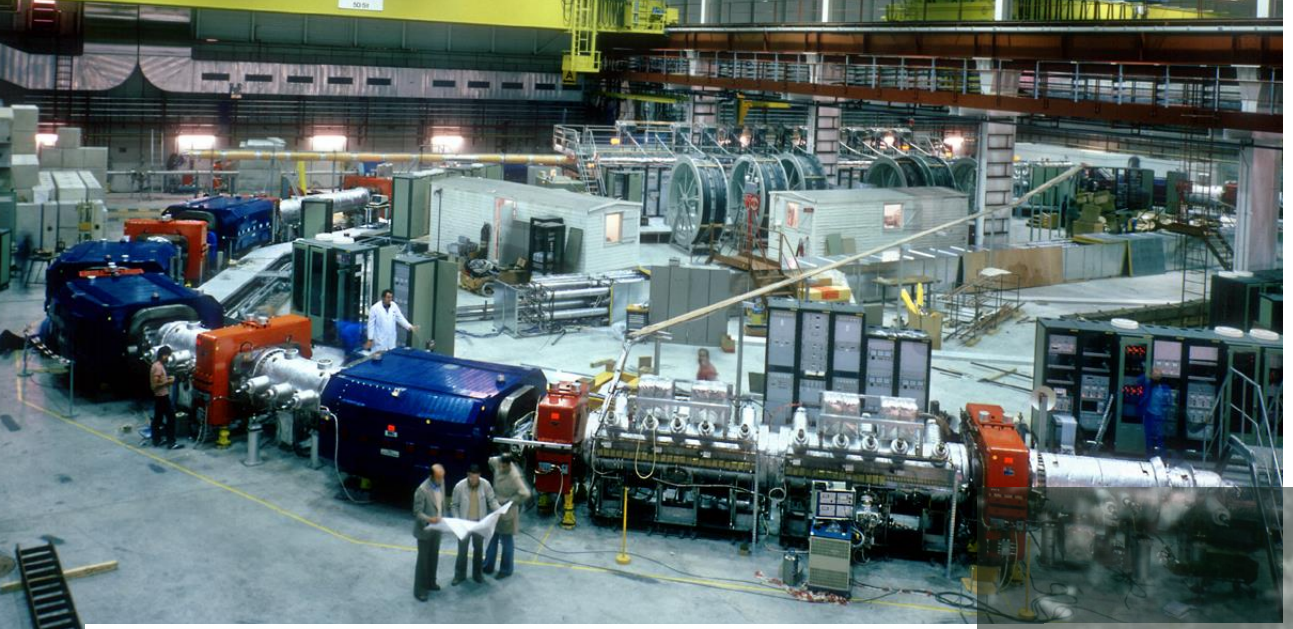
You Can't Always Get What You Want

Mick Jagger and Keith Richards, The Rolling Stones

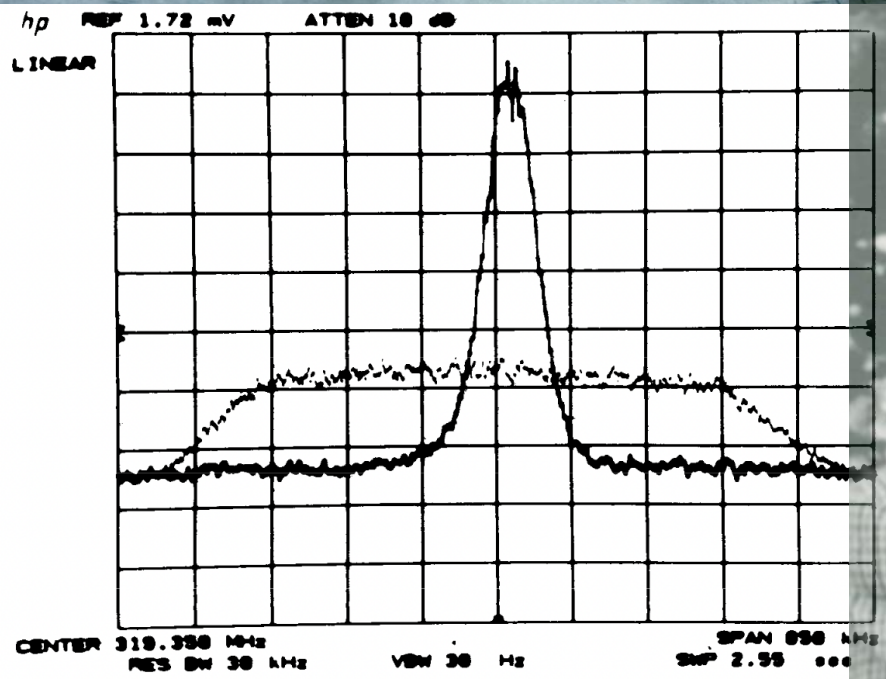


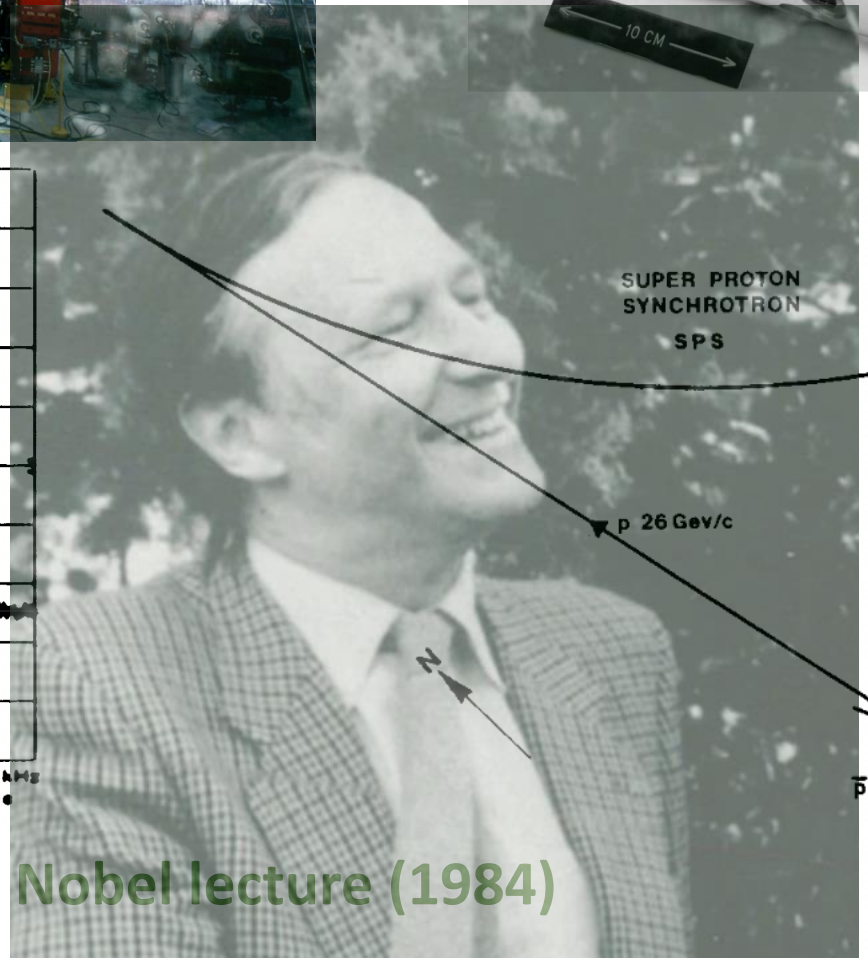
There were to be proton-antiproton collisions there in 18 months!

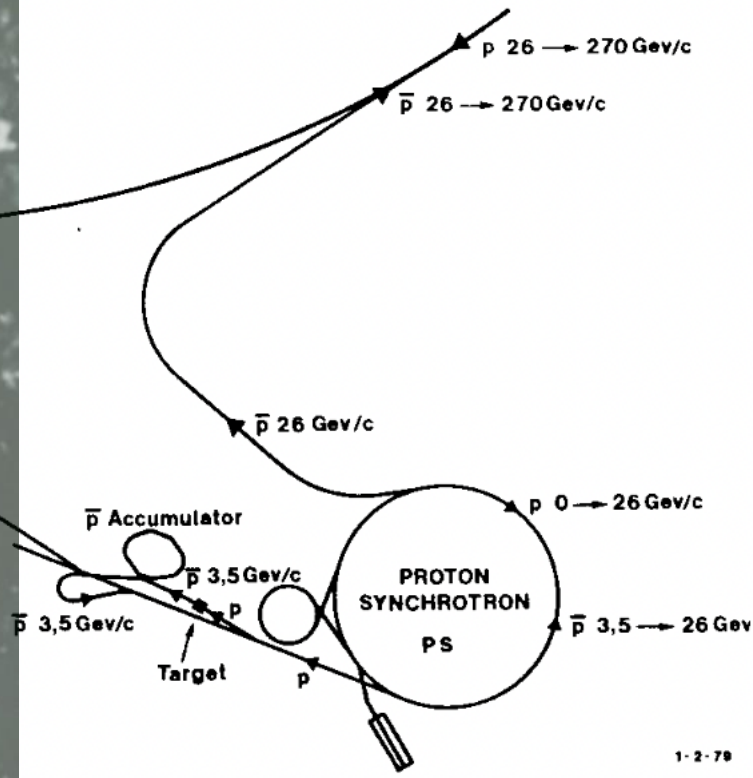
CERN Antiproton Accumulator



target

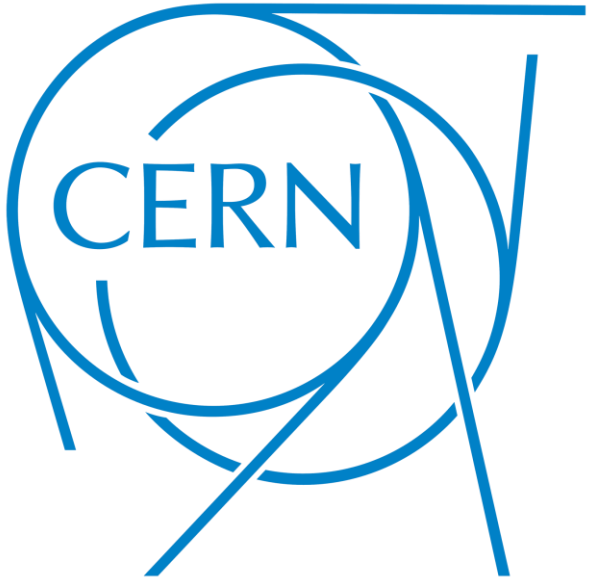






From Simon Van der Meer, Nobel lecture (1984)

UA1 Collaboration (1983)



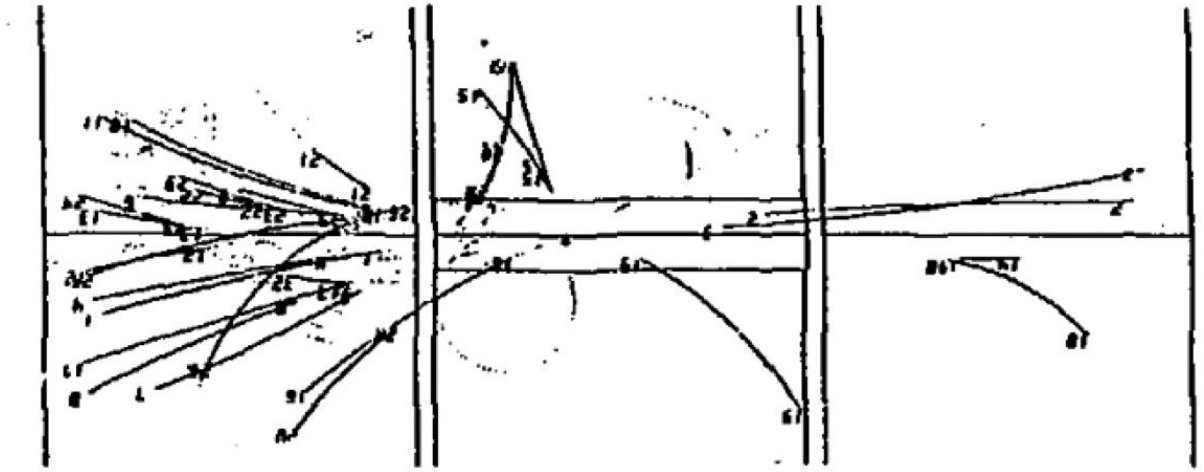
UA1 Proposal 30 Jan 1978

CERN-SPSC-78-6 ; CERN-SPSC-78-06 ; SPSC-P-92

A 4π solid angle detector for the SPS used as a proton-antiproton collider at a centre of mass energy of 540 GeV

Astbury, Alan (Rutherford) ; Aubert, Bernard (Annecy, LAPP) ; Benvenuti, Alberto C (CERN) et al.

First collision 10 July 1981

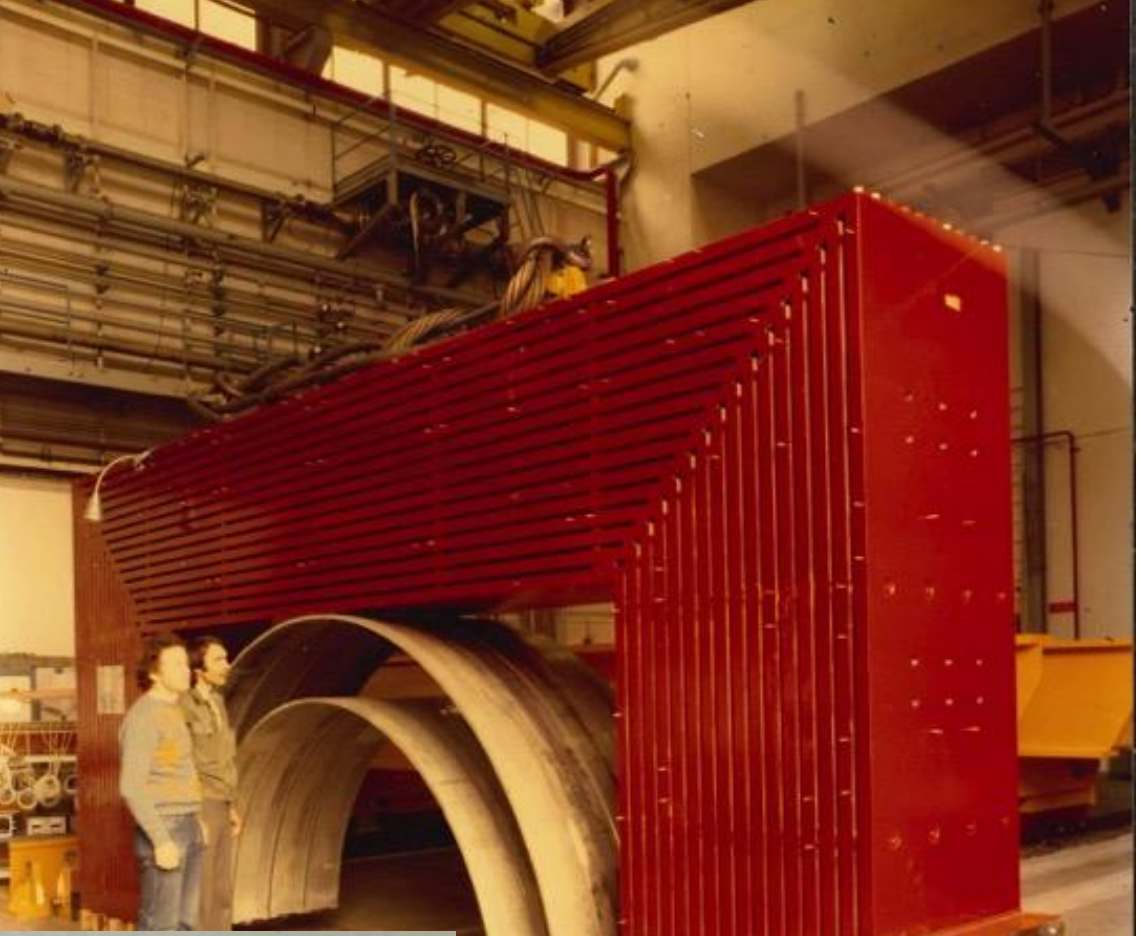


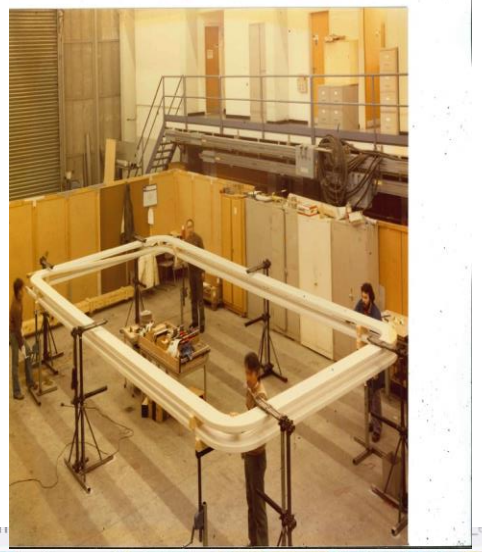
W 1982, Z 1983, Nobel Prize 1984

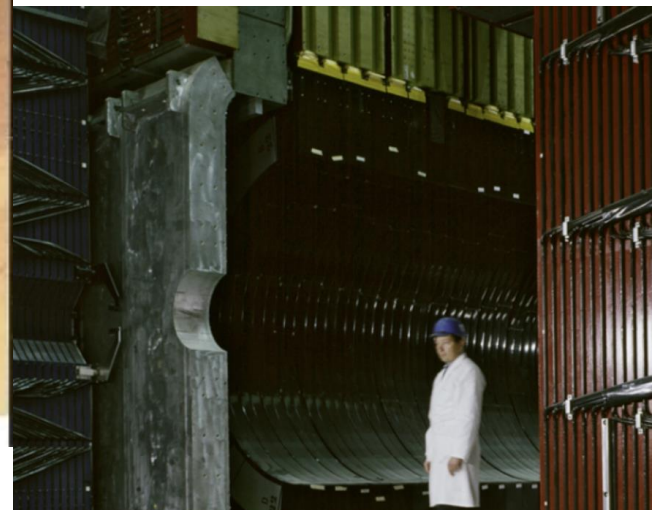
“My favorite flavor, cherry red”

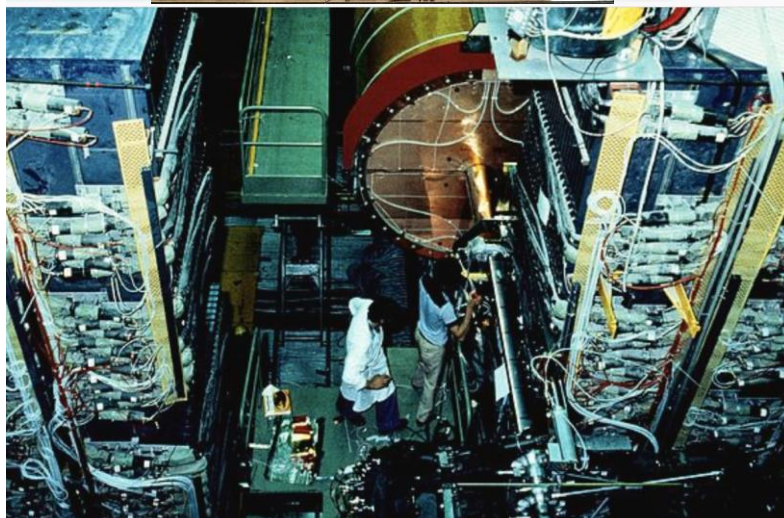
You Can't Always Get What You Want

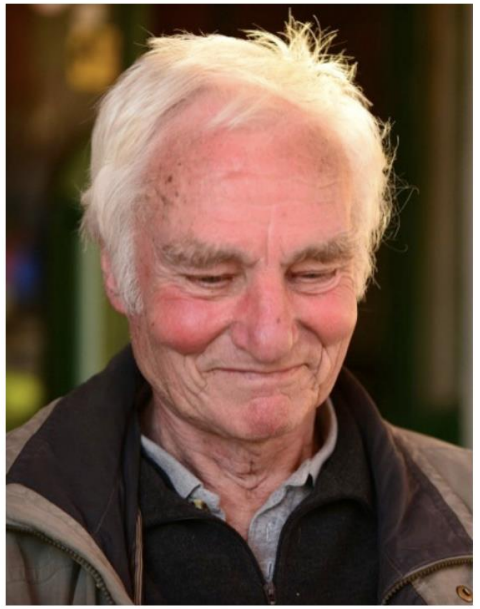
Mick Jagger and Keith Richards, The Rolling Stones

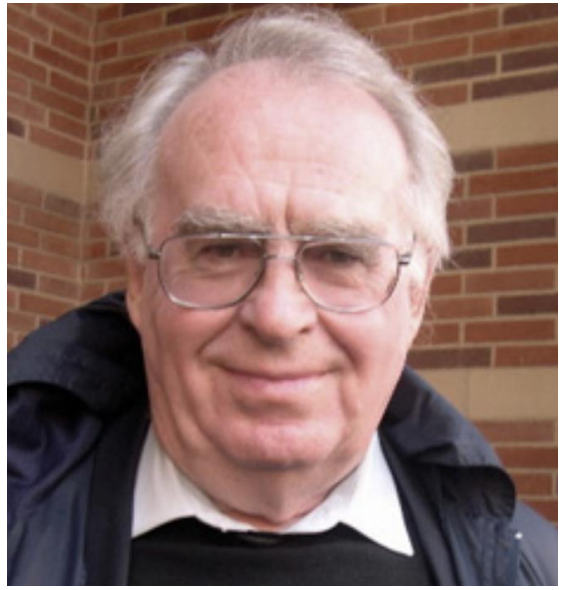








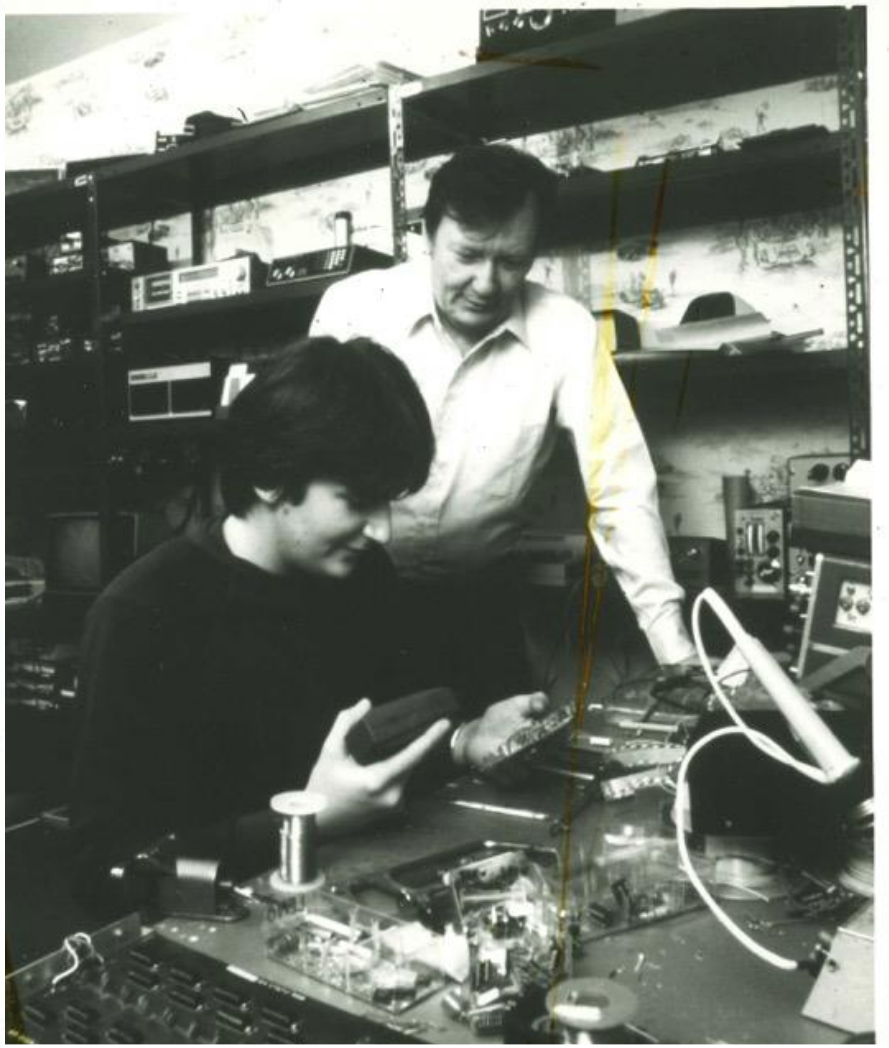




Antoine Lévêque
Helmut Faissner
Ginette Jorat
Francis Muller
Eric Eisenhandler
Jean-Pierre Vialle
Hugh Muirhead

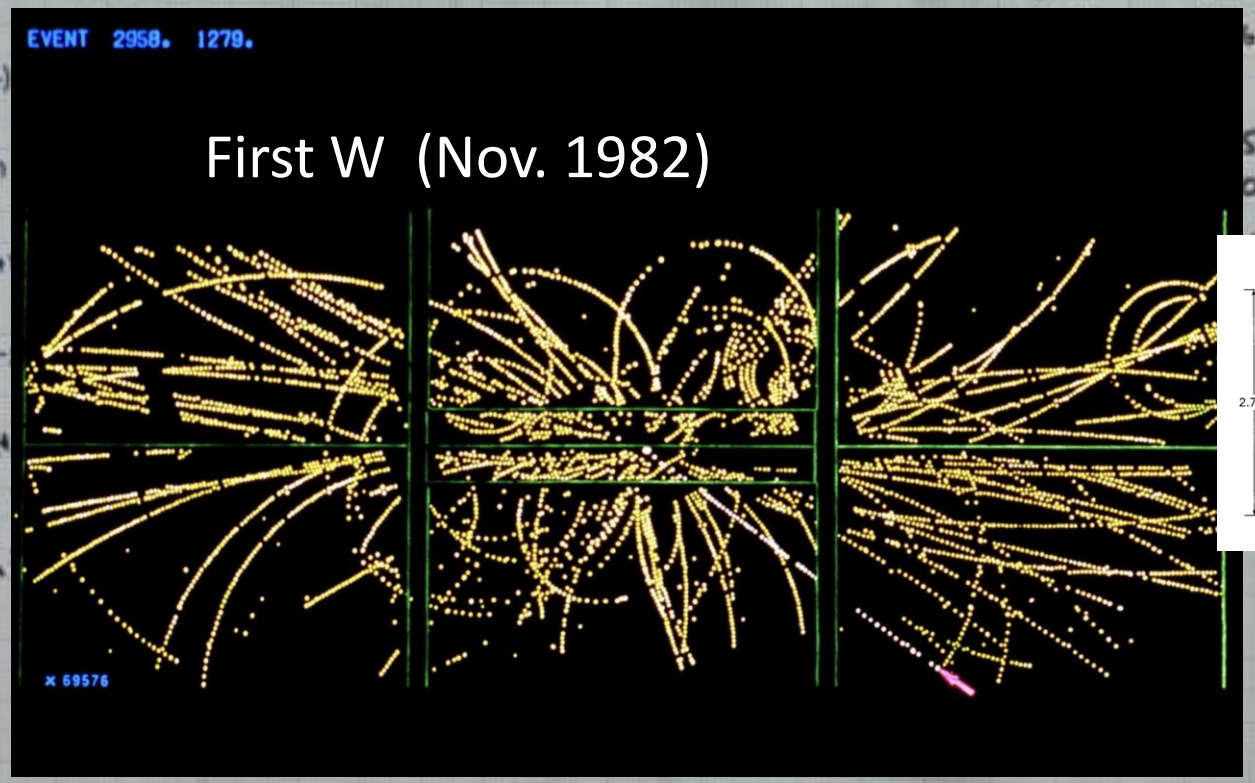
Heard 10 times a day, echoing through Bat. 168
“Mirella! Cosa succede?!”

Bat. 168

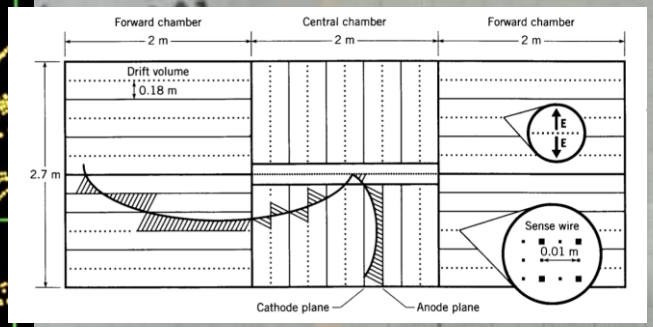


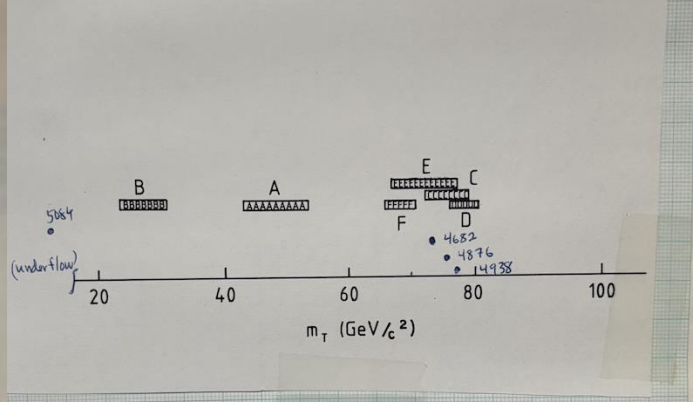
SPS Inauguration (1977)

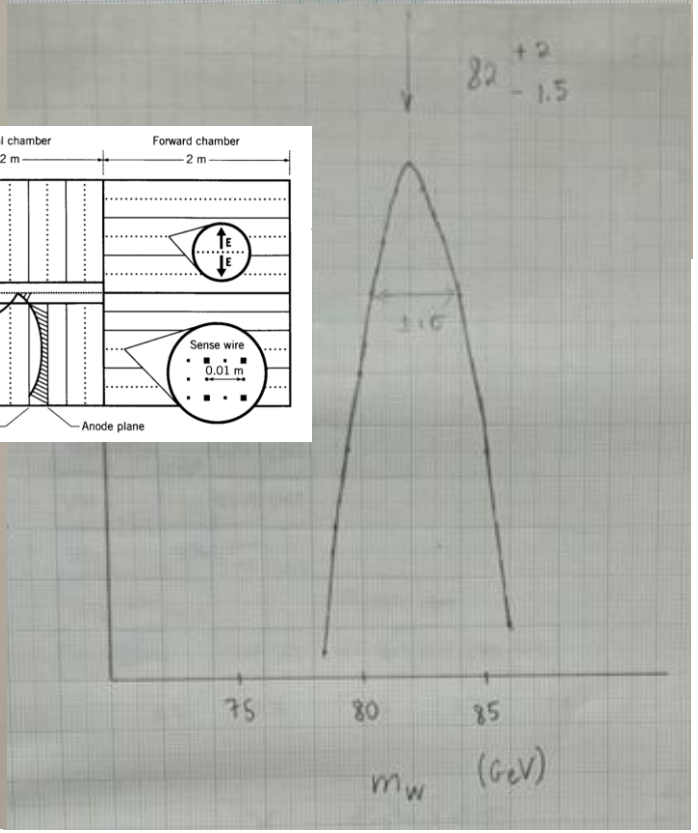
Burt Richter,
letter to Carlo Rubbia,
“if you are lucky enough and the machine runs well, I believe you will find the Z... but you will never be able to observe the W”



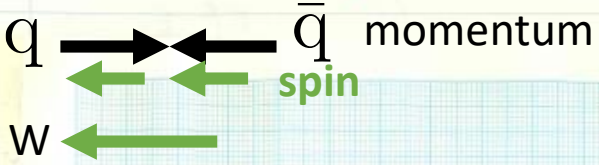
First W (Nov. 1982)

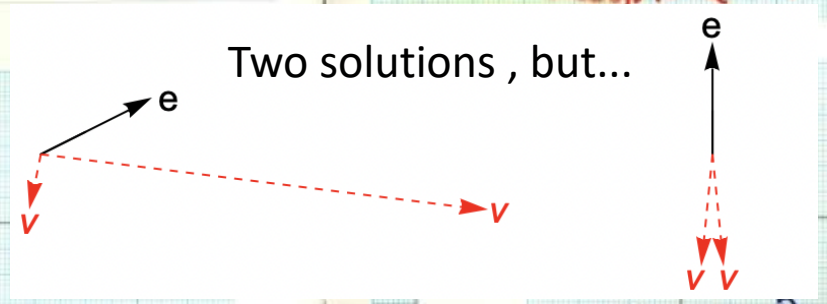






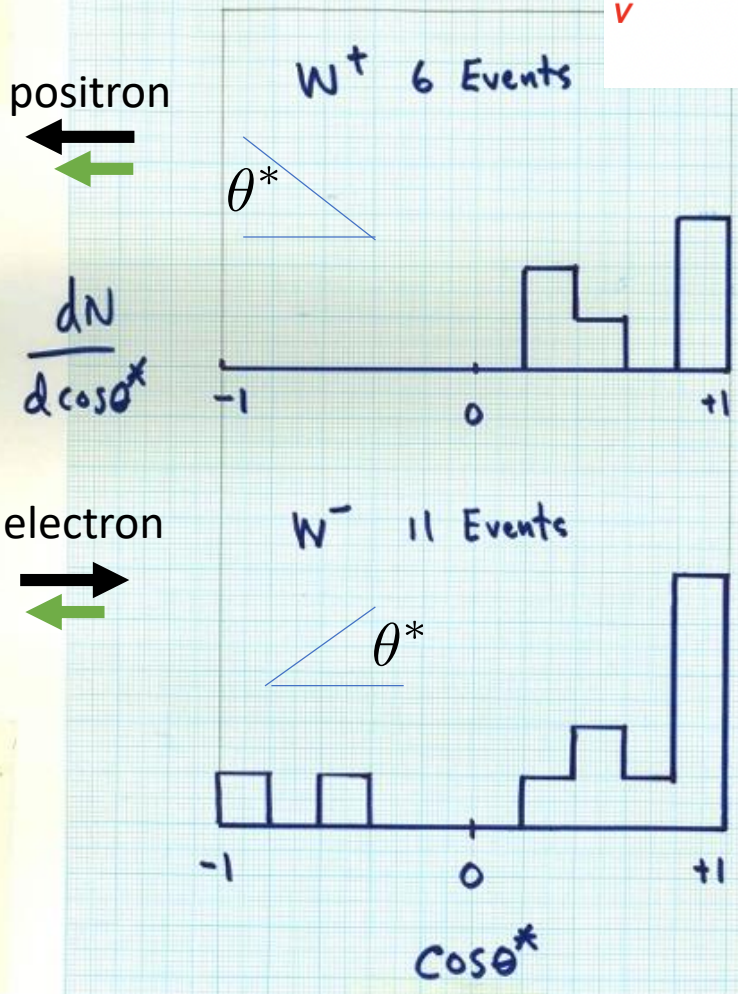
22/7/83 Unambiguous solutions



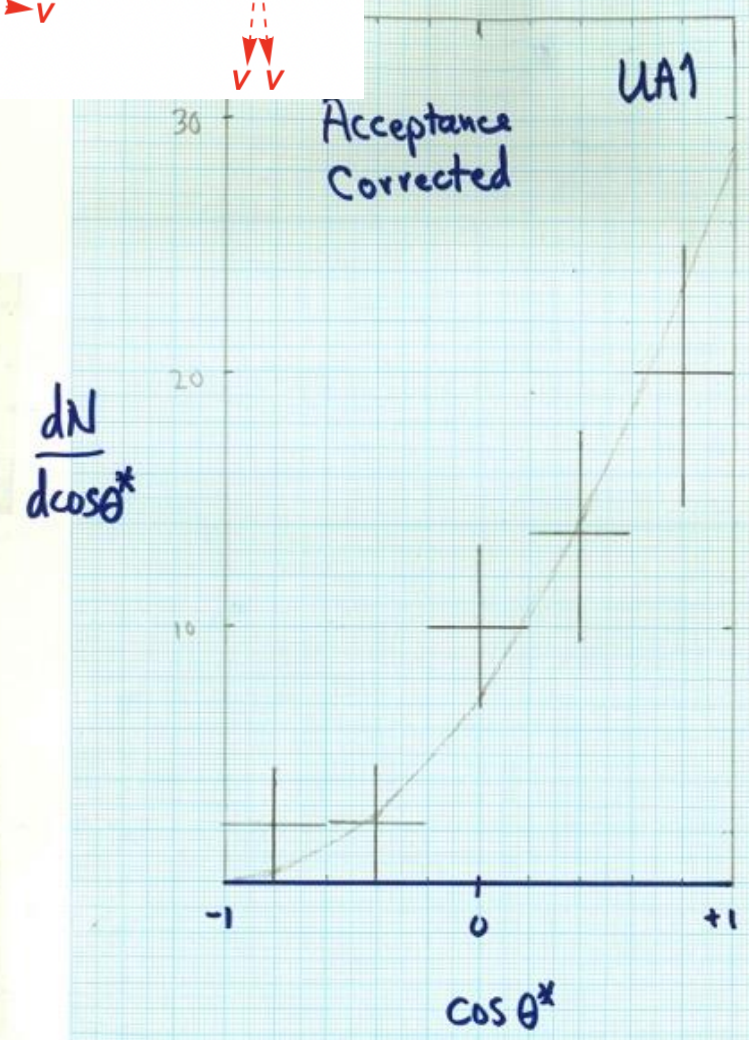


positron

electron



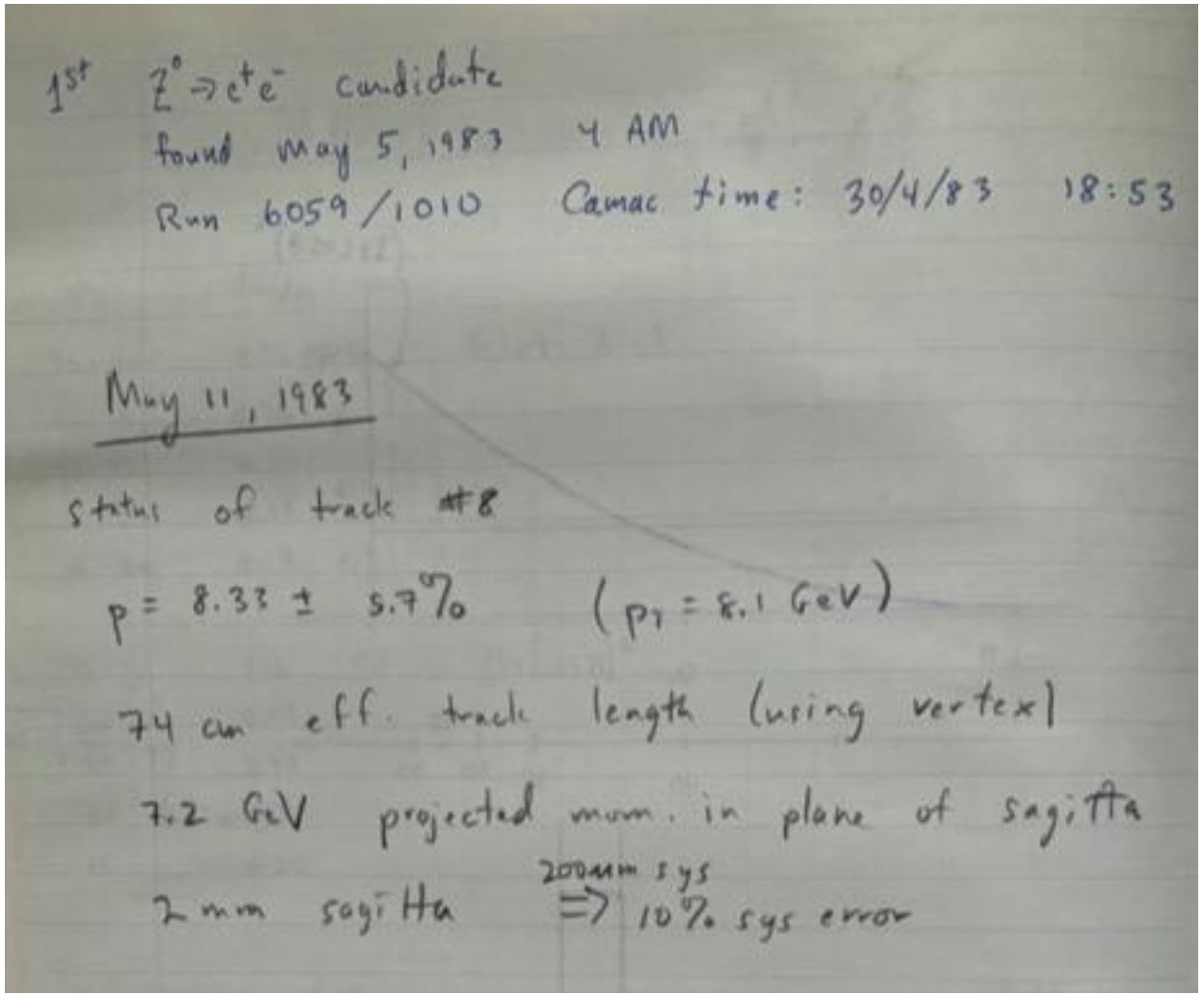
Acc. corrected using $|\cos\theta^*|$ from 43 evts.
acceptance is symmetric in $\cos\theta^*$.

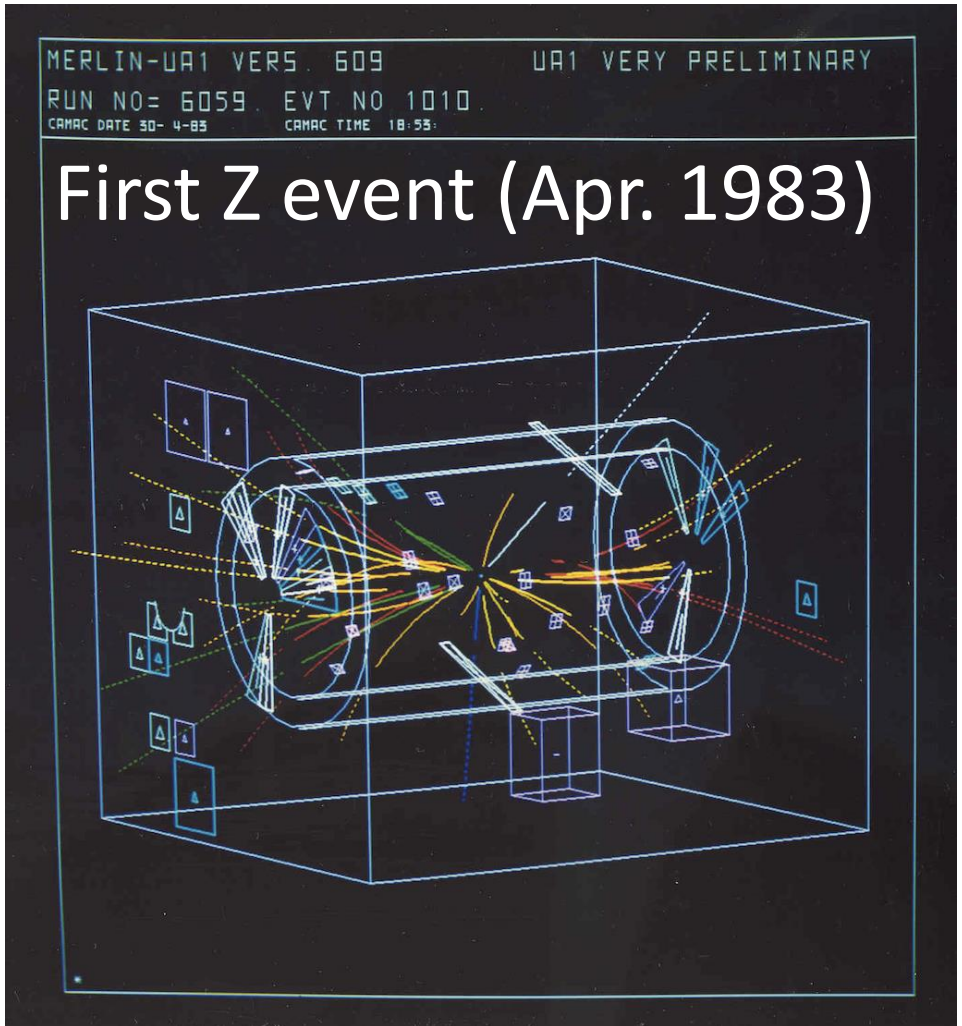


“We're gonna vent our frustration
If we don't we're gonna blow a fifty-amp fuse”

You Can't Always Get What You Want

Mick Jagger and Keith Richards, The Rolling Stones





Radiative Corrections to Z^0

16/5/83

$$\frac{2\alpha}{\pi}\left[\ln\left(\frac{Q^2}{m^2}\right) - 1\right]$$

2 is for 2 elec. or muons (not there for W)

$$\int_x^1 \frac{dk}{k}\left(1 - k + \frac{3}{4}k^2\right) = \left[\ln k - k + \frac{3}{8}k^2\right]_x^1$$

$$= 0 - 1 + \frac{3}{8} - \ln x + x - \frac{3}{8}x^2$$

$$= \ln\left(\frac{1}{x}\right) + x - \frac{3}{8}x^2 - \frac{5}{8}$$

$$P(k)dk = \left[\frac{\alpha}{\pi}\left(\ln\frac{Q^2}{m^2} - 1\right) + \frac{1}{\ln 2}\frac{t}{X_0}\right] \times \frac{dk}{k}\left(1 - \frac{k}{E} + \frac{3}{4}\frac{k^2}{E^2}\right)$$

internal = 5.4% for e
3% for μ

external = 4.7% for e at 90°
down by $\frac{m_e^2}{m_\mu^2} \simeq 0$ for muon

J. D. Bjorken Ann. Phys. 24, 201 (1963)
elec scat.

G. Furlan et al., Phys. Lett. 12, 262 (1964)
$e^+e^- \to \mu^+\mu^-$

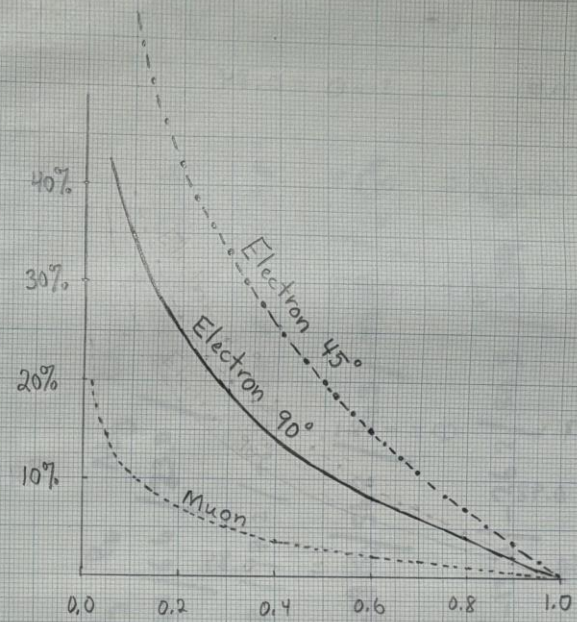


Fig 1: Probability of radiating energy fraction f for $Z^0 \to e^+e^-$ (solid line) and $Z^0 \to \mu^+\mu^-$ (dashed line), for particles at 90° to the beam axis. The same probability is shown for an electron at 45° (dot-dashed curved).

30/5/83

Z° Candidates

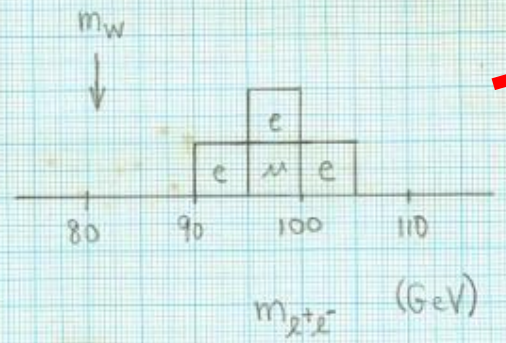
1. 6059 /1010 e^+e^- track radiates?, $p \neq E$
   $m \sim 103$ GeV

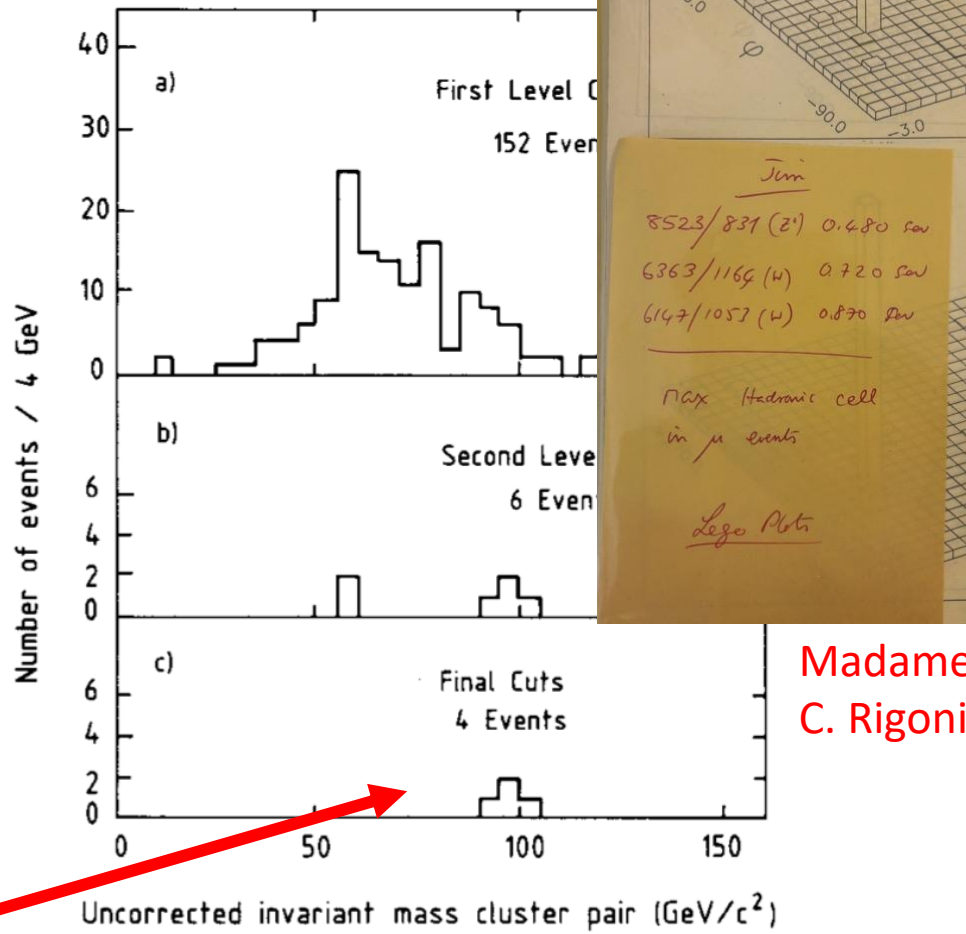
2. 6600 /222 $\mu^+\mu^-$
   $m \simeq 95.4 \pm 9.6$ GeV

3. 7433/1001 e^+e^-
   $m \sim 93$ GeV

4. 7434 /746 e^+e^-
   $m \sim 98$ GeV

} recorded 12 minutes apart!





Madame
C. Rigoni

Fig. 1. Invariant mass distribution (uncorrected) of two electromagnetic clusters: (a) with $E_T > 25$ GeV; (b) as above and a track with $p_T > 7$ GeV/c and projected length >40 cm pointing to the cluster. In addition, a small energy deposition in the hadron calorimeters immediately behind (<0.8 GeV) ensures the electron signature. Isolation is required with $\Sigma p_T < 3$ GeV/c for all other tracks pointing to the cluster. (c) The second cluster also has an isolated track.

$$m_W = \frac{38.5}{\sin\theta_W} \quad \text{at } m_W \quad \text{(see e.g. Marciano + Parsa, Snowmass)}$$

$$\sin^2\theta_W = 0.226^{+0.012}_{-0.011} \quad \text{for} \quad m_W = 81 \pm 2$$

$$\sin^2\theta_W = 0.23 \pm 0.01 \pm 0.01$$

$$m_Z = 97.6 \pm 5 \quad \text{GeV}$$

$$\rho = \frac{m_W^2}{m_Z^2}\,\frac{1}{\cos\theta_W} = 0.9 \pm 0.1$$

$$\Gamma(Z^0 \to \text{all}) = \frac{G_\mu m_Z^3 (1 - 4s^2 + 8s^4)}{12\sqrt{2}\,\pi} \qquad s = \sin\theta$$

$$(1 - 4s^2 + 8s^4) = \begin{matrix} 0.50 \\ 0.50 \end{matrix} \qquad \begin{matrix} s^2 = 0.23 \\ 0.24 \end{matrix}$$

$$\Delta = 0.12 \pm 0.1$$

$$\frac{m_W^4}{m_Z^4}$$

31/5/83

$$\frac{B_{Z\to e^+e^-}}{B_{W\to e\nu}}\,\frac{\sigma_Z}{\sigma_W} = \frac{N_Z}{N_W}$$

$$B_{Z\to e^+e^-} = B_{W\to e\nu}\times\frac{\sigma_W}{\sigma_Z}\times\frac{N_Z}{N_W}$$

$$B_{Z\to e^+e^-} \approx 0.083 \times 4 \times \frac{3}{30} = 0.033 \pm 0.02$$

$$B_{Z\to e^+e^-} = \frac{\Gamma_{Z\to e^+e^-}}{\Gamma_{Z\to \text{all}}} = \frac{0.092}{3.4 + (0.18\times N_\nu)}$$

$$N_\nu = \left[\frac{0.09}{0.033 \pm 0.02} - 3\right] \times \frac{1}{0.18}$$

$$\Gamma_Z^{7.7} = 3.4 + 0.18 \times N_\nu$$

extra ν: $N_\nu < 18$ 68% c.l.

$$\Gamma_Z = \frac{0.09}{0.033} = 2.7 \pm 1.6 \quad \text{GeV}$$

$$\Gamma_Z \sim m_Z^3 \Rightarrow \frac{0.10}{0.033} = 3.0^{+4.7}_{-1.1} \quad \text{GeV}$$

total width

Werner Heisenberg, 1973

J. H. Martin, jr.

The Dalai Lama visits the UA1 Megatek 1983

CERN 2004

Photo courtesy Claudia-Elisabeth Wulz

Unidentified woman, Emilio Segrè, and Carlo Rubbia at Segrè's home

Summary | Full Description

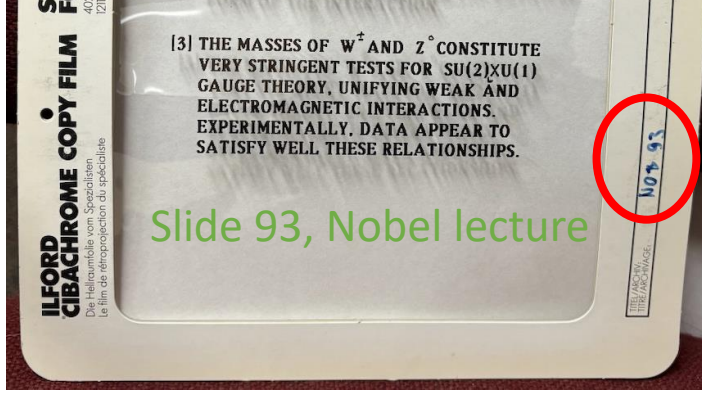
Niels Bohr Library &

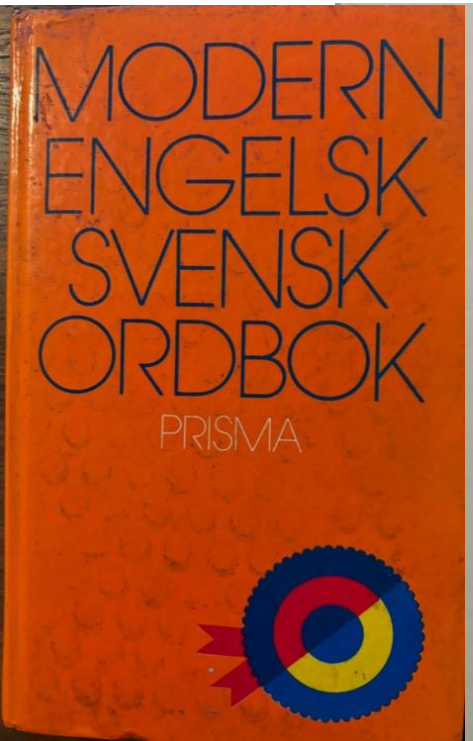
Archives

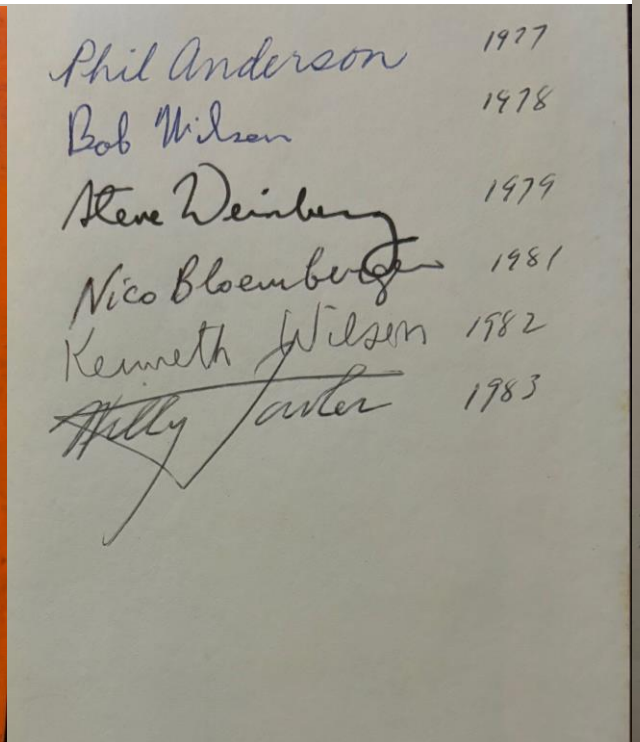
“You can't always get what you want
But if you try sometimes, well, you might find
You get what you need
Ah, yeah”

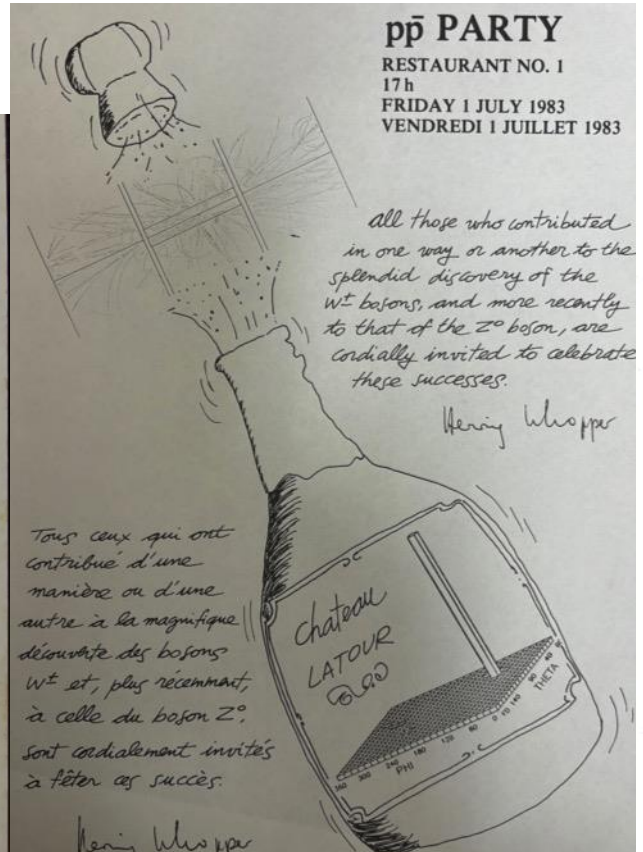
You Can't Always Get What You Want

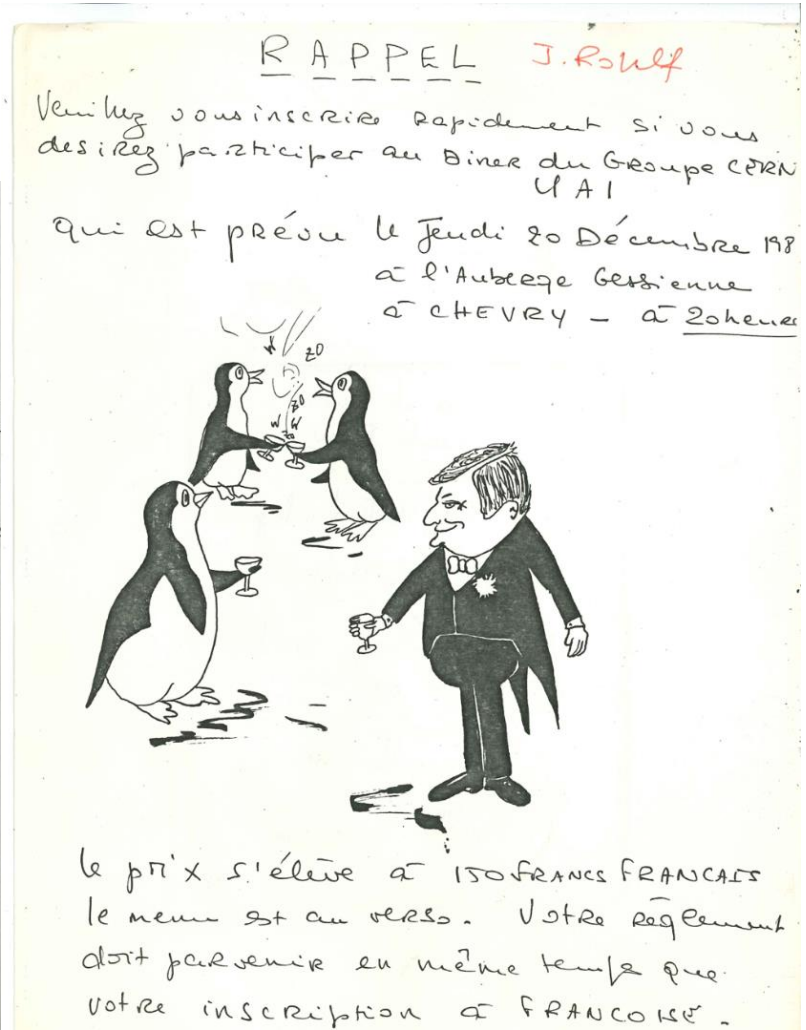
Mick Jagger and Keith Richards, The Rolling Stones



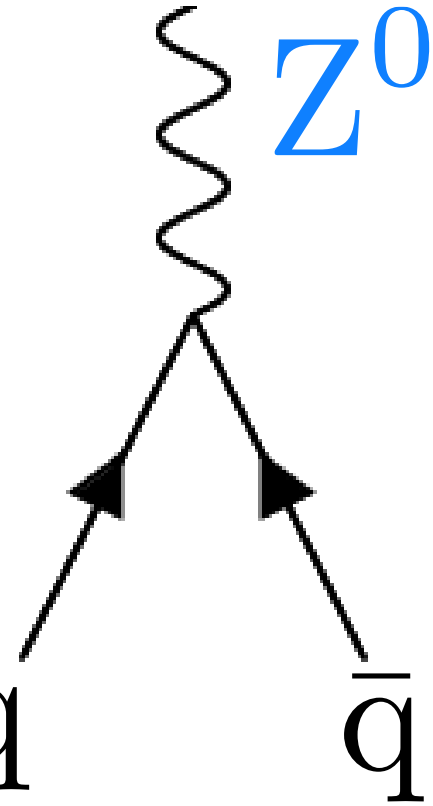








90



Grandioso

esploratore

di **V**erità