Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Beauty

Truth

The Discovery of the Heavy Quarks

Experimental Foundations of Particle Physics

Michael Reichmann

14th November 2017

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Section 1

Introduction

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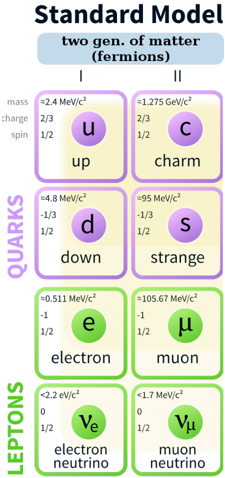

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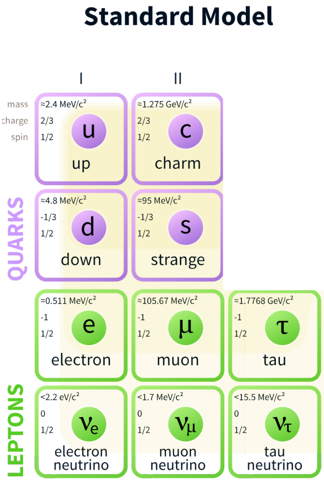
- in 1973 6-plet proposed by Kobayashi and Maskawa to describe CP violation
- in 1975 Perl et al. discovered τ-lepton and its neutrino
- indiction of another pair of quarks



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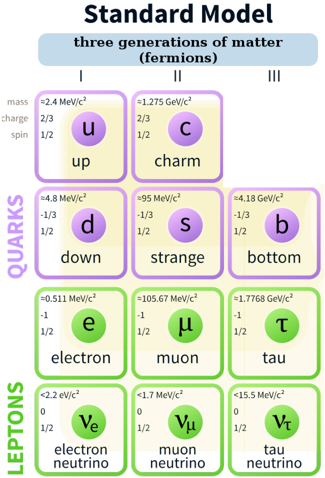

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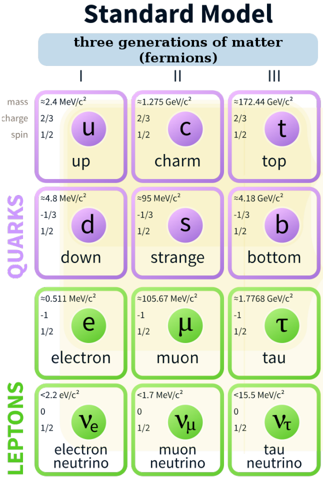
- in 1995 discovery of the top (truth) quark
- complete set of fermions until now



Section 2

The Beauty Quark

Discovery Paper

Observation of a Dimuon Resonance at 9.5 GeV in 400-GeV Proton-Nucleus Collisions

S. W. Herb, D. C. Hom, L. M. Lederman, J. C. Sens,[a] H. D. Snyder, and J. K. Yoh
Columbia University, New York, New York 10027

and

J. A. Appel, B. C. Brown, C. N. Brown, W. R. Innes, K. Ueno, and T. Yamanouchi
Fermi National Accelerator Laboratory, Batavia, Illinois 60510

and

A. S. Ito, H. Jöstlein, D. M. Kaplan, and R. D. Kephart
State University of New York at Stony Brook, Stony Brook, New York 11974
(Received 1 July 1977)

Accepted without review at the request of Edwin L. Goldwasser under policy announced 26 April 1976

Dimuon production is studied in 400-GeV proton-nucleus collisions. A strong enhancement is observed at 9.5 GeV mass in a sample of 9000 dimuon events with a mass $m_{\mu^+\mu^-} > 5$ GeV.

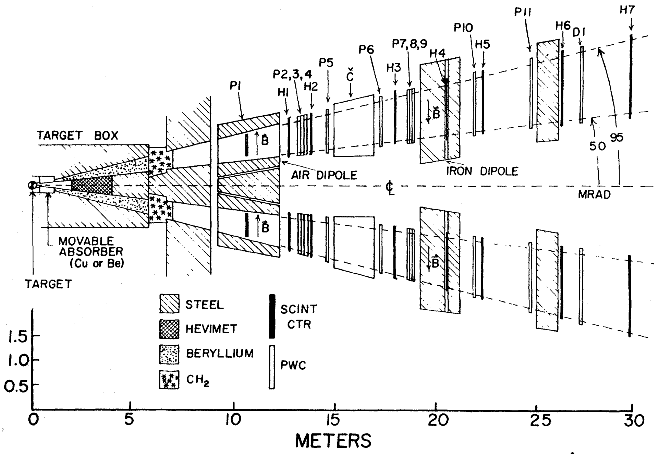
We have observed a strong enhancement at 9.5 GeV in the mass spectrum of dimuons produced in 400-GeV proton-nucleus collisions. Our conclusions are based upon an analysis of 9000 dimuon events with a reconstructed mass $m_{\mu^+\mu^-}$ greater than 5 GeV corresponding to 1.6×10^{16} protons incident on Cu and Pt targets:

$$p + (\mathrm{Cu}, \mathrm{Pt}) \to \mu^+ + \mu^- + \text{anything}.$$

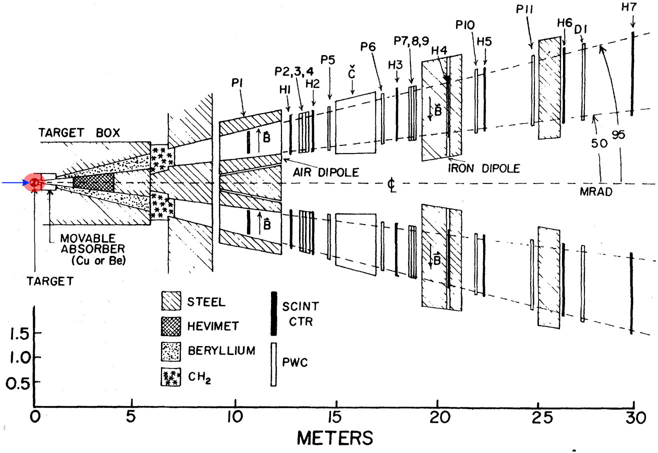
The produced muons are analyzed in a double-arm magnetic-spectrometer system with a mass resolution $\Delta m/m$ (rms) $\approx 2\%$.

The experimental configuration (Fig. 1) is a modification of an earlier dilepton experiment in the Fermilab Proton Center Laboratory.[1-3] Narrow targets (~0.7 mm) with lengths corresponding to 30% of an interaction length are employed.

Setup

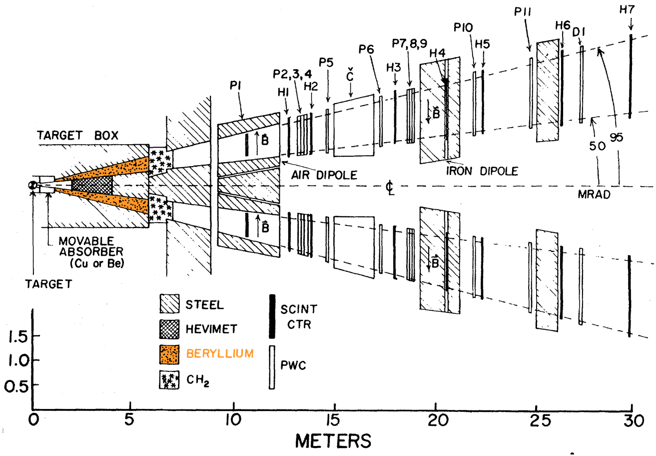

TARGET BOX
MOVABLE ABSORBER (Cu or Be)
TARGET
P1
P2,3,4
H1
H2
P5
Č
P6
P7,8,9
H3
H4
P10
H5
P11
H6
D1
H7
B
AIR DIPOLE
IRON DIPOLE
50
95
MRAD
STEEL
HEVIMET
BERYLLIUM
CH2
SCINT CTR
PWC
1.5
1.0
0.5
0
5
10
15
20
25
30
METERS

Setup



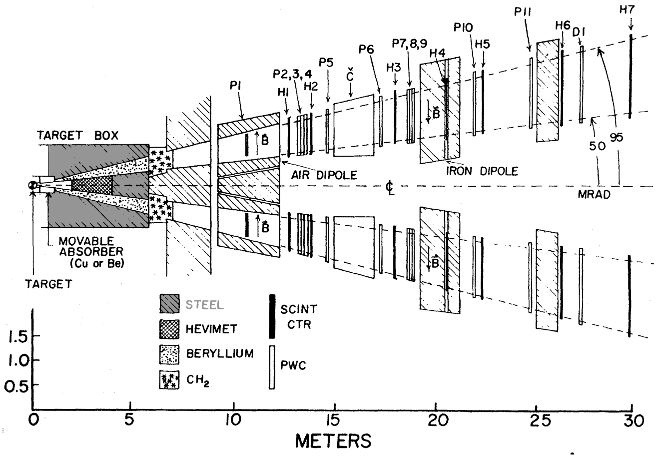
- 400 MeV proton beam shot on narrow target (Pt/Cu) with 30 % interaction length

Setup



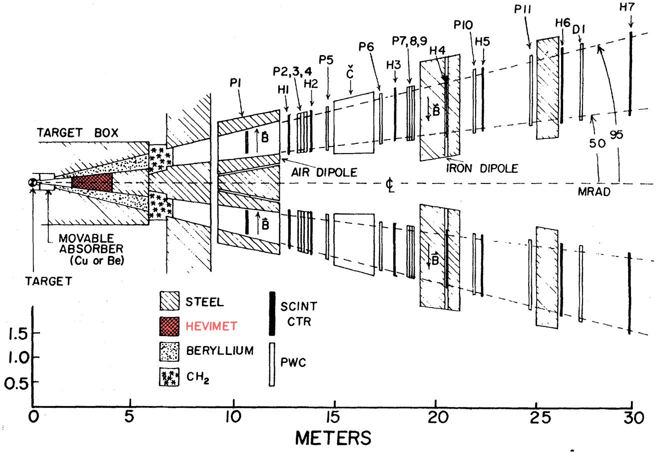
- hadron filter out of Be with 18 interaction length (3 $^\circ$ to 5 $^\circ$ horiz. and ± 0.5 $^\circ$ vert.)

Setup



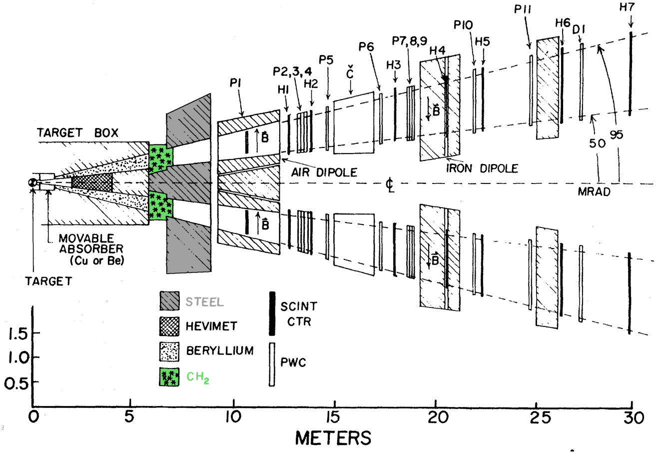
- heavy metal (Steel, W) shielding to minimise particle leakage

Setup



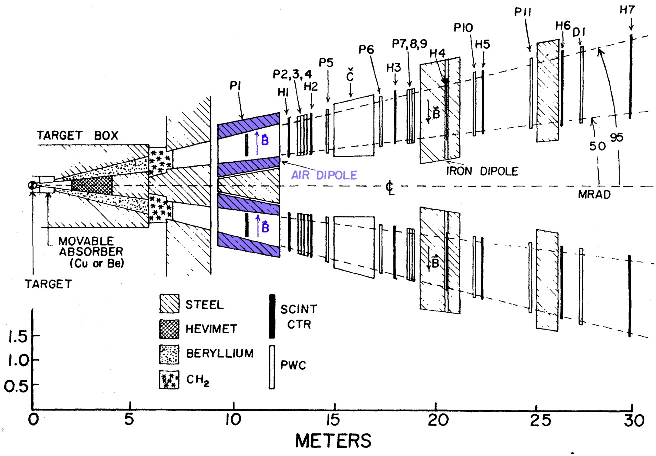
- tungsten beam dump

Setup



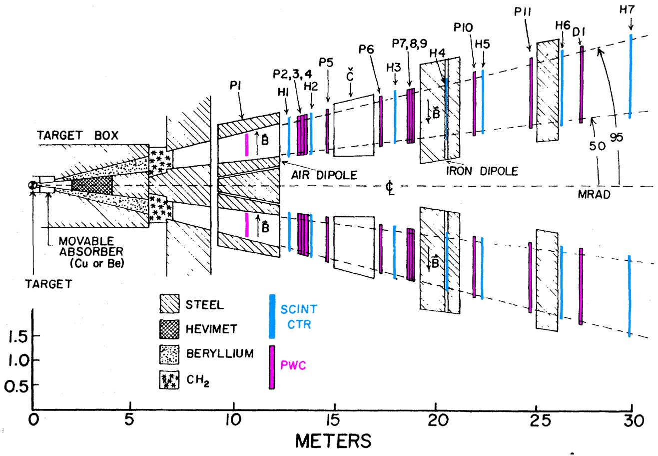
- additional shielding out of polyethylene and more steel

Setup



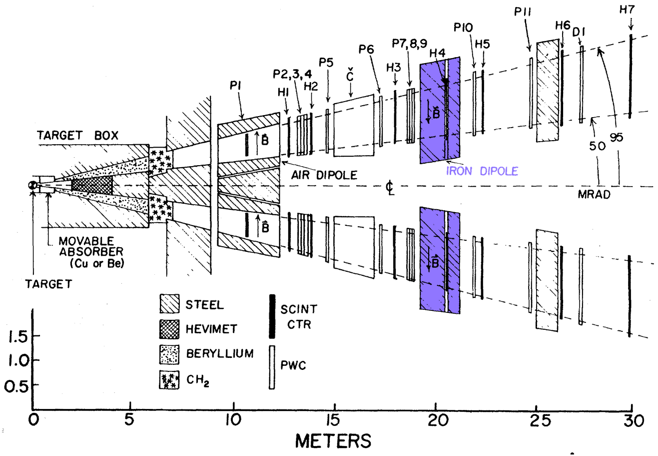
- spectrometer dipole magnets with horizontal field
- both arms are symmetric to drawing plane and detect μ^+ and μ^-

Setup



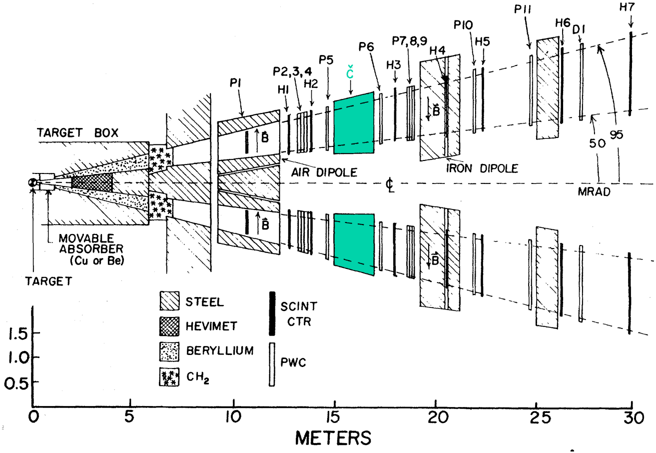
- scintillation hodometers and wire chambers for tracking (limit of 10×10^7 counts/s)

Setup



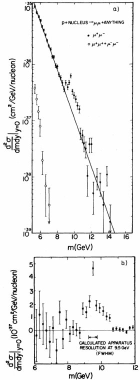
- solid iron magnet to partially refocus and redetermine muon momentum

Setup

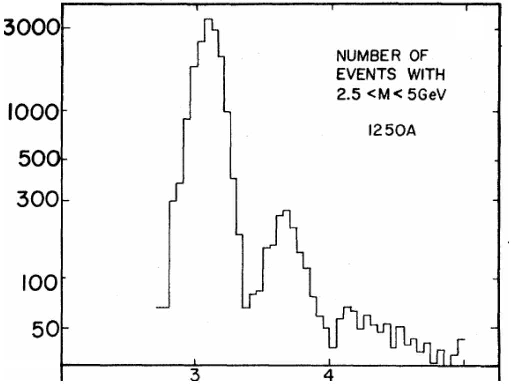


- Čerenkov counter to prevent low momentum muon triggers

Results


a.)
p+NUCLEUS → μμ+ANYTHING
m(GeV)
b.)
CALCULATED APPARATUS RESOLUTION AT 9.5 GeV (FWHM)
m(GeV)

Error Reduction



Section 3

Conclusion

Conclusion

- empty
- moreempty
- moremoreempty