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PROGRESS REPORT

ON

EUROPEAN MUON COLLABORATION

E. Gabathuler

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PROGRAMME OF PHYSICS STUDIED

1) Single Arm. Expts on H_2 & D_2 – SCAT. MUON DET^{ED}.

2) " " " Heavy Targets – " " "

3) " " " Polarised Targets " " "

4) Multi-muon production ——— 3 MUONS. DET^{ED}.

5) Inclusive γ, π^0 and W. A. Bonus
– SCAT. MUON. + γ's.

6) Inclusive charged pa. (hadrons)
– SCAT. MUON + HADRONS.

* SCATTERED MUON. COMMON. TO. ALL

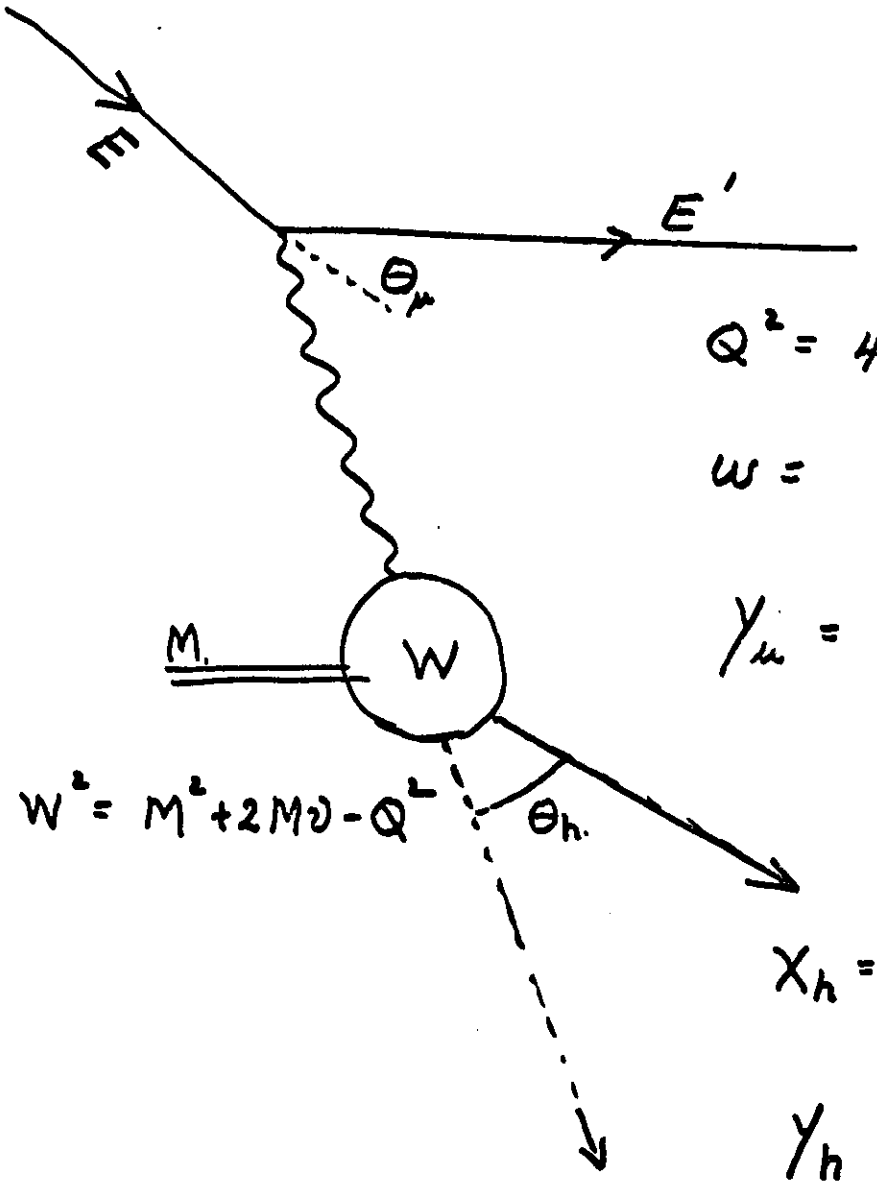
AIMS OF COLLABORATION

1). Design an apparatus which is able to identify muon + measure its momum to ~ 1% at 100 GeV/c.

2) Assist in design of special beam hodoscopes which will operate in beams of 10^7 - 10^8 muons/sec. for. momum measurement ~ ∓ ½ %

3) To use as far as possible well tried & existing techniques for. PARTICLE detection etc.

4) To build up apparatus progressively starting with a <u>basic kit</u> which can "produce" physics when beam is available, which acts as basis for all expts.



$\nu = E - E'$

$Q^2 = 4EE' \sin^2 \frac{\theta_\mu}{2}$

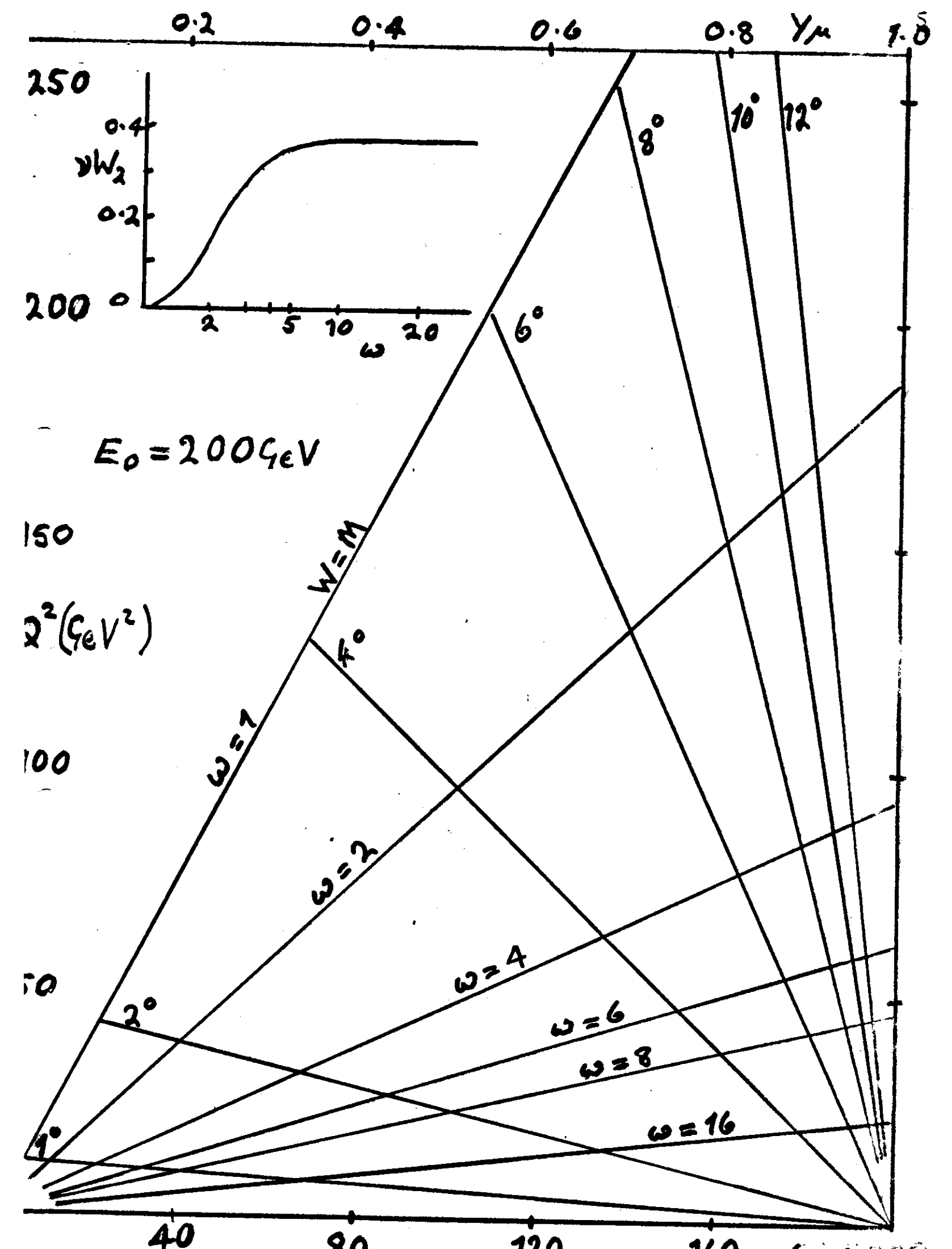
$\omega = \frac{2M\nu}{Q^2}$, $x_\mu = 1/\omega$.

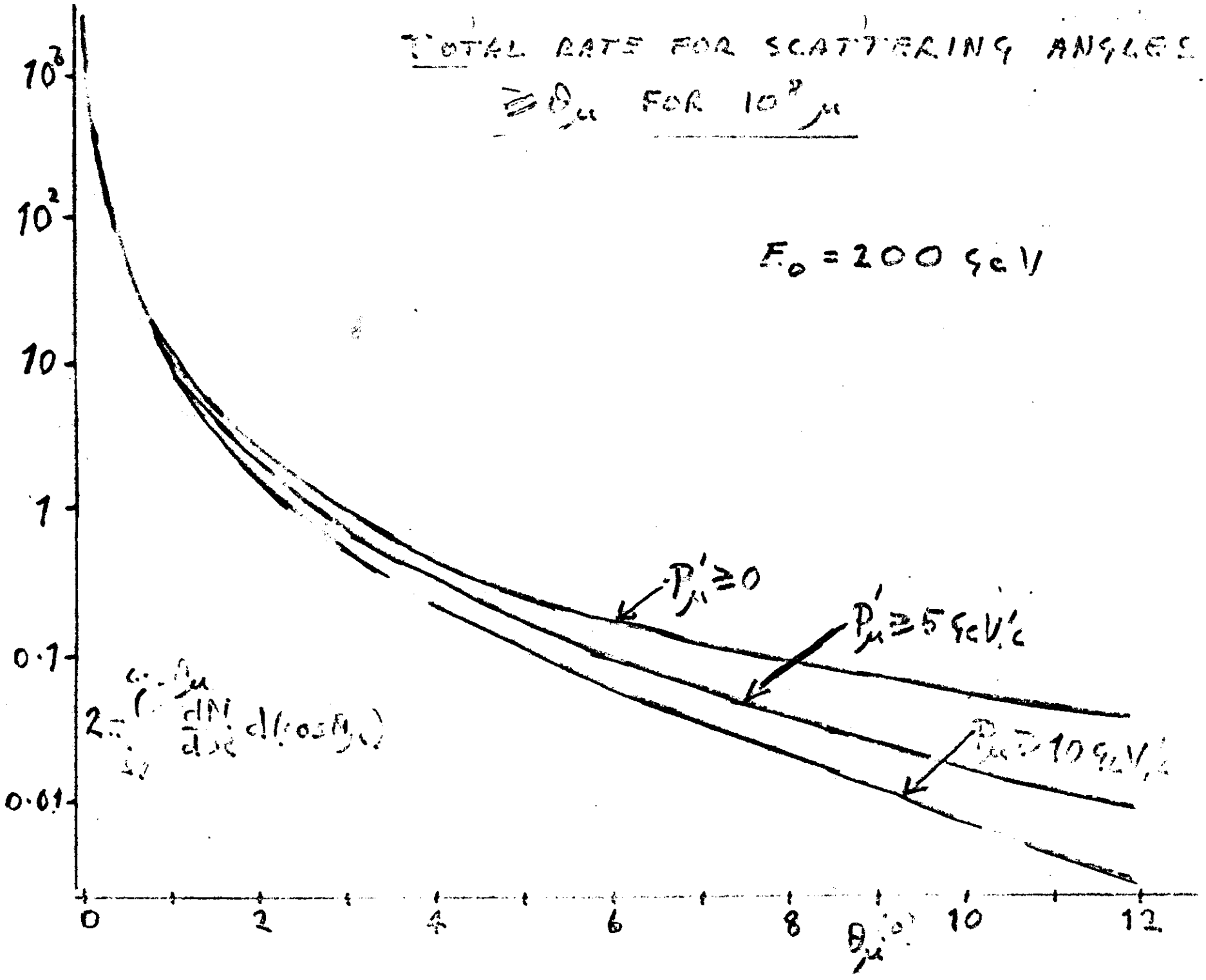
$y_\mu = \nu/E$

$S = W^2 = M^2 + 2M\nu - Q^2$

$x_h = p_{11}^* / p_{MAX}^*$

$y_h = \frac{1}{2} \log \left\{ \frac{E^* + p_{11}^*}{E^* - p_{11}^*} \right\}$


0·2
0·4
0·6
0·8
Y_M
1·0
250
200
150
100
50
$Q^2(GeV^2)$
νW_2
0·4
0·2
0
2
5
10
20
ω
$E_0 = 200 GeV$
W=M
1°
2°
4°
6°
8°
10°
12°
ω=1
ω=2
ω=4
ω=6
ω=8
ω=16
40
80
120


TOTAL RATE FOR SCATTERING ANGLES
≥ θμ FOR 10^P μ
F0 = 200 GeV
P'μ ≥ 0
P'μ ≥ 5 GeV/c
P'μ ≥ 10 GeV/c
10^3
10^2
10
1
0·1
0·01
0
2
4
6
8
10
12
θμ (°)

FIRST PHASE OF EXPERIMENTS

1) STUDY of single arm. MUON. DEEP. INELASTIC SCATTERING OFF H_2 / D_2.

To Test SCALING - LARGE Q^2 AS POSSIBLE

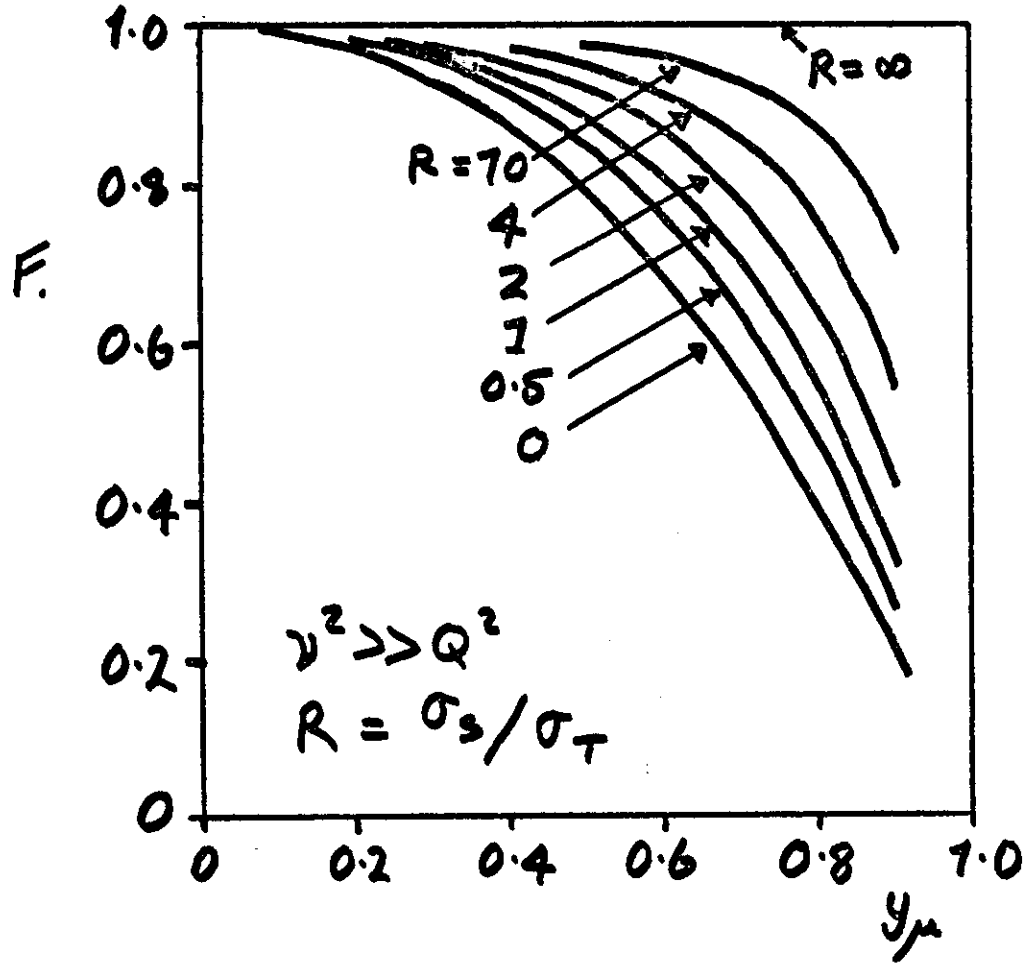
- highest energy. - 10^7./ pulse. gain arm. 10^8 @ 200 GeV. (300 GeV)

2). A MEASUREMENT of. R.

$$R = \frac{\sigma_S}{\sigma_T}$$ = INELASTIC X-S. for. SCALAR & TRANSVERSE VIRTUAL PHOTONS.

- change Pol^n. at fixed Q^2 by changing energy of INCIDENT. MUON.

- IMPORTANT FOR TESTING SCALING.

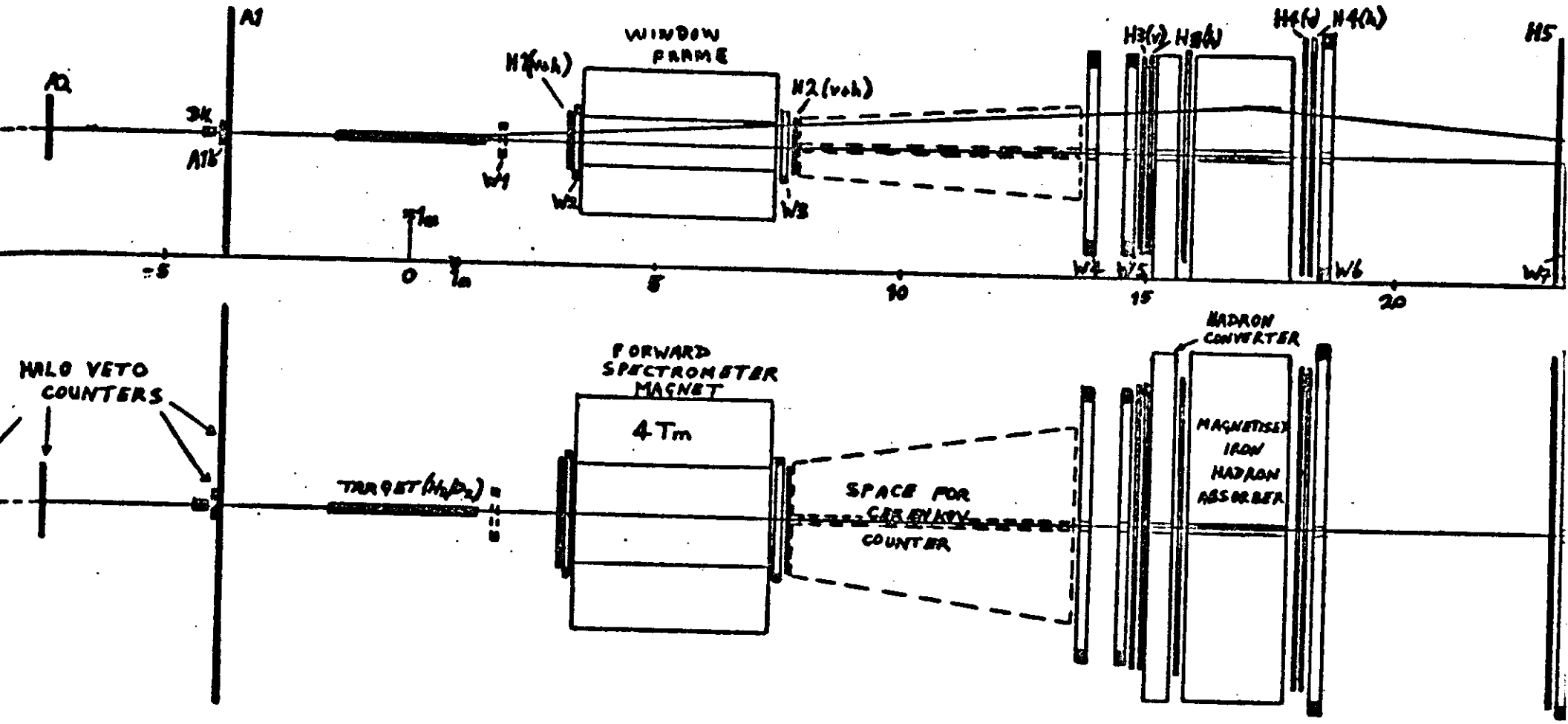


F- FACTOR BY WHICH THE MEASURED CROSS SECTION $\nu \, d^2\sigma/d\Omega/d\epsilon'$ HAS TO BE

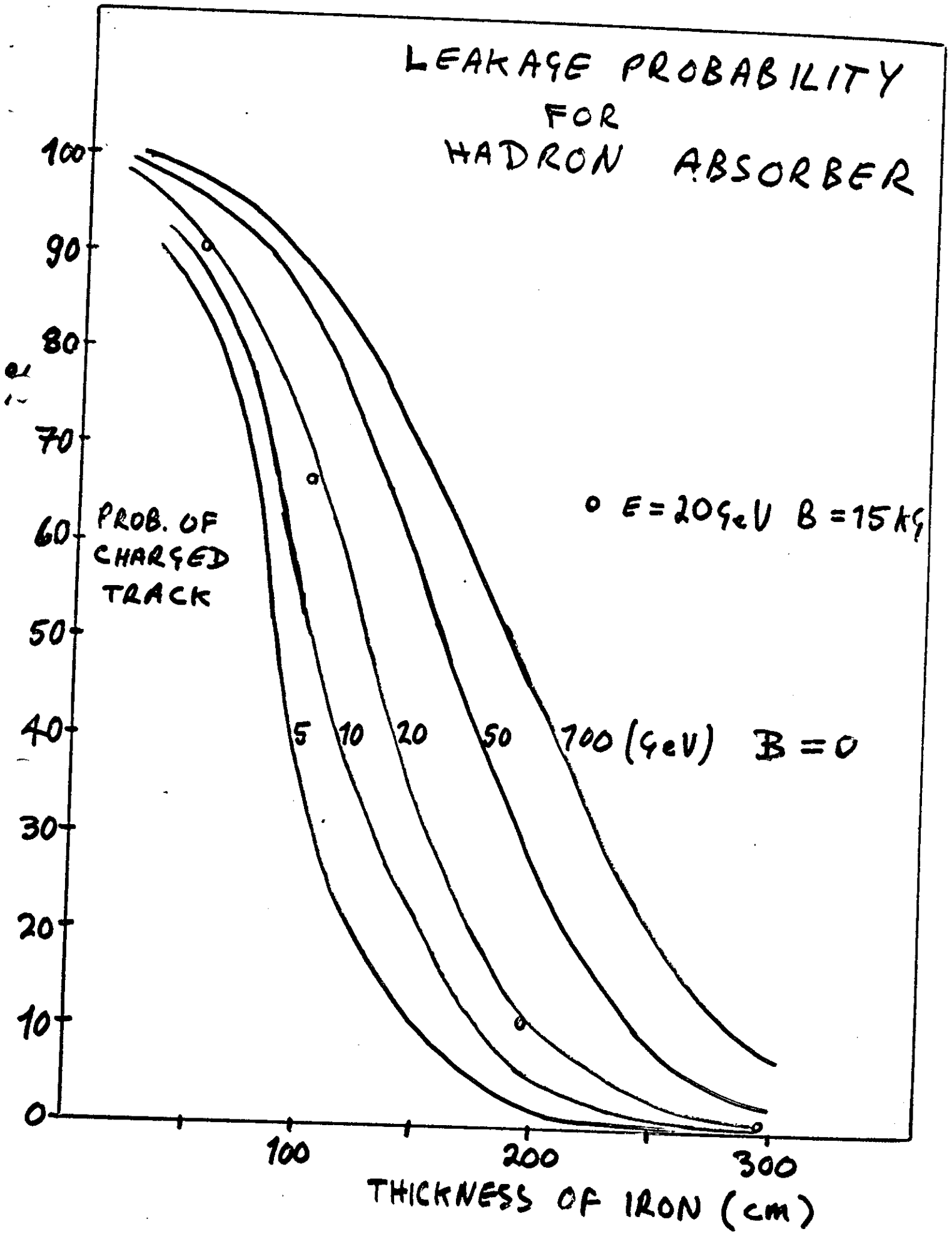
σ_{MOTT}

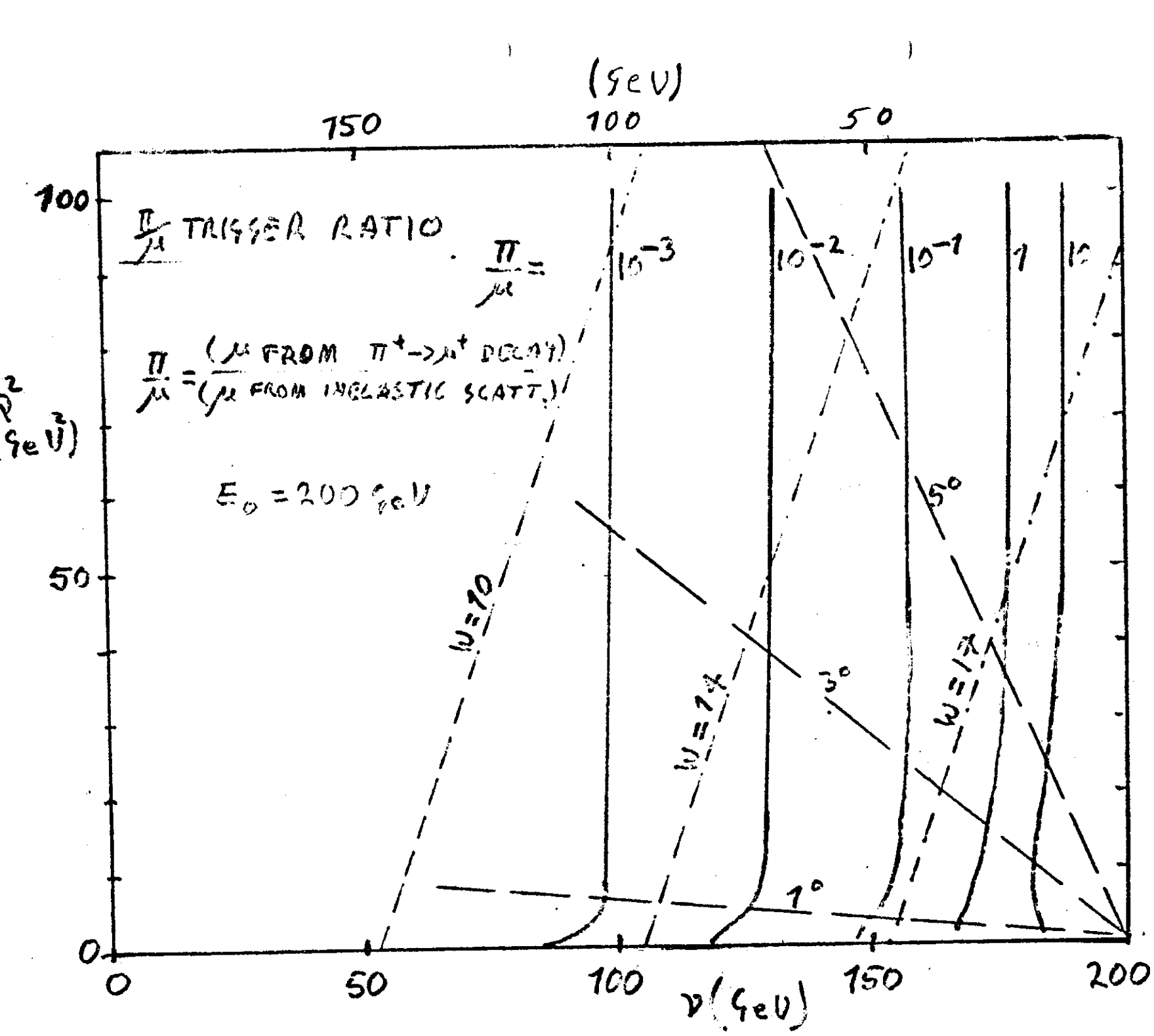
MULTIPLIED IN ORDER TO DETERMINE

νW_2.



SINGLE ARM MUON EXPERIMENT

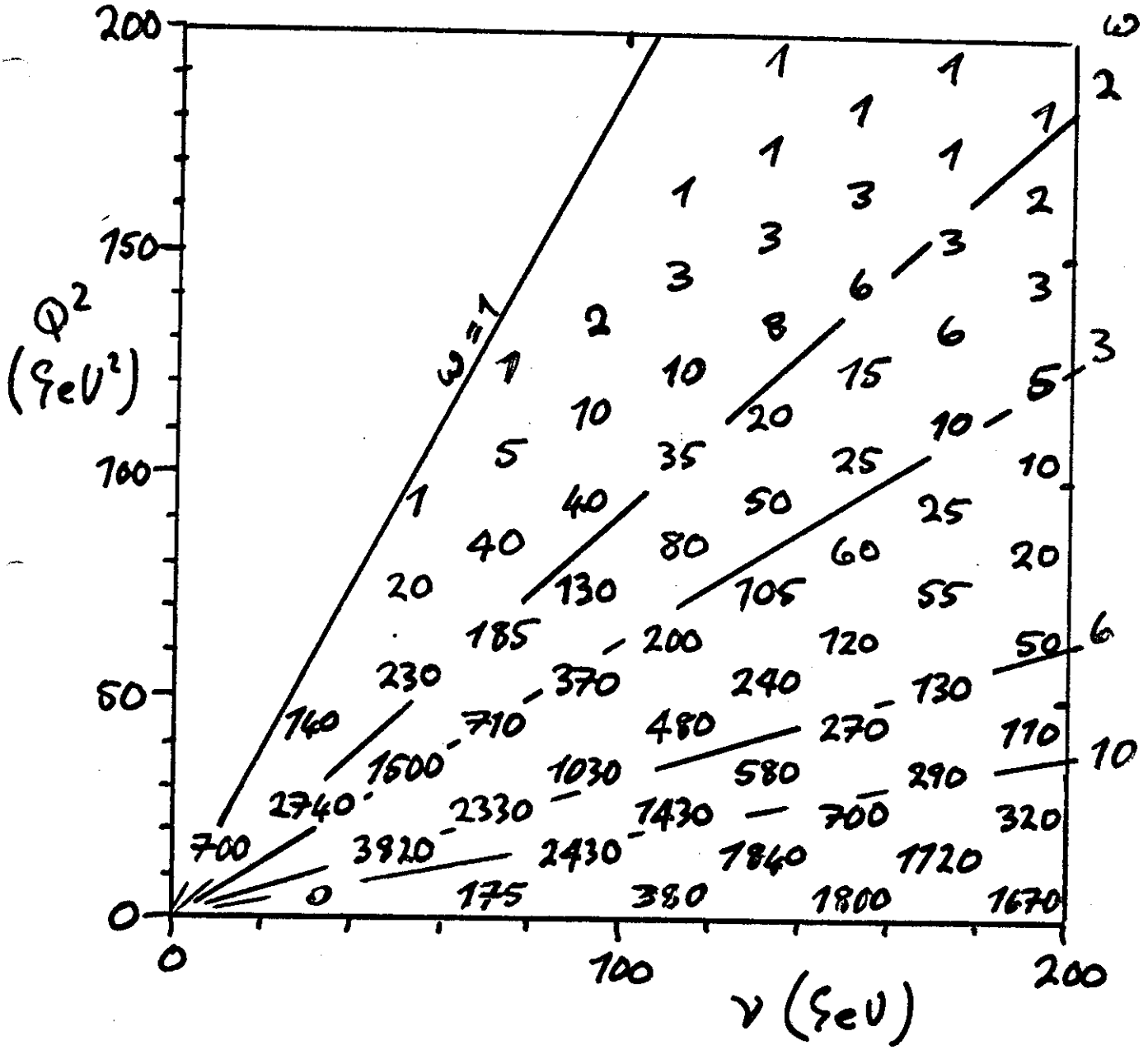

LEAKAGE PROBABILITY
FOR
HADRON ABSORBER
100
90
80
70
60
50
40
30
20
10
0
PROB. OF
CHARGED
TRACK
o E = 20 GeV B = 15 kG
5
10
20
50
100 (GeV) B = 0
100
200
300
THICKNESS OF IRON (cm)


(GeV)
150
100
50
100
50
0
0
50
100
150
200
ν (GeV)
Q² (GeV²)
π/μ TRIGGER RATIO
π/μ =
π/μ = (μ FROM π⁺→μ⁺ DECAY)/(μ FROM INELASTIC SCATT.)
E₀ = 200 GeV
10⁻³
10⁻²
10⁻¹
1
W=10
W=7
W=4
5°
3°
1°

COUNTING RATES

PER $\Delta\nu = 20$ GeV
$\Delta Q^2 = 10$ GeV^2
AT $E = 250$ GeV
TARGET 3m H_2

3×10^7 μ/PULSE
7 PULSES/MIN
100 hours.



TOTAL EVENTS 62 000

HEAVY TARGETS

(1) Increase in luminosity

3m. H_2 – 50 cm. W. – × 50.

Test of scaling - extended

(2) Interference effects – parity violating amplitudes

presence of neutral bosons

Effects using existing models ~ 0·3% – 2·0%

Could be much bigger

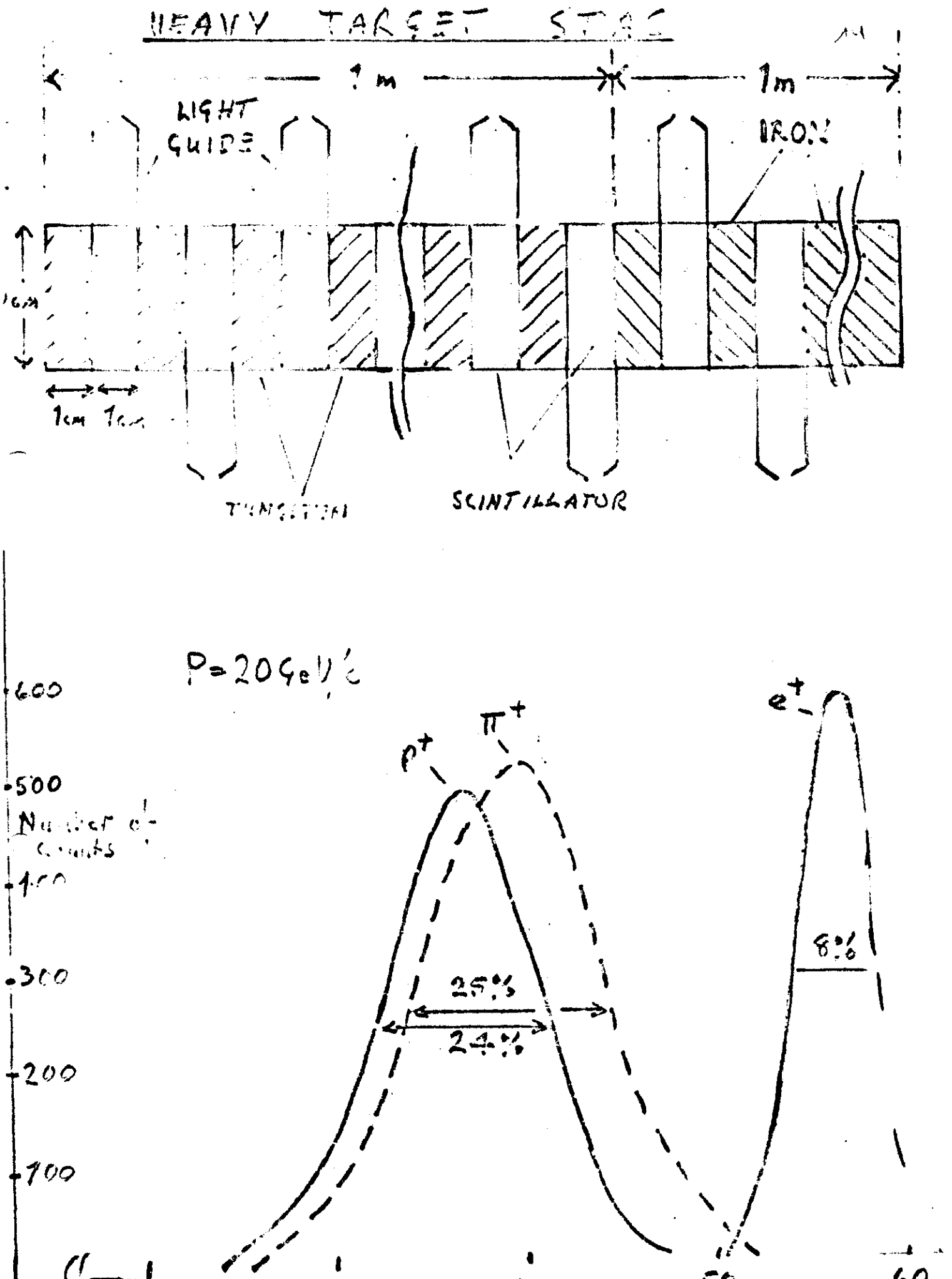
USE OF S.T.A.C

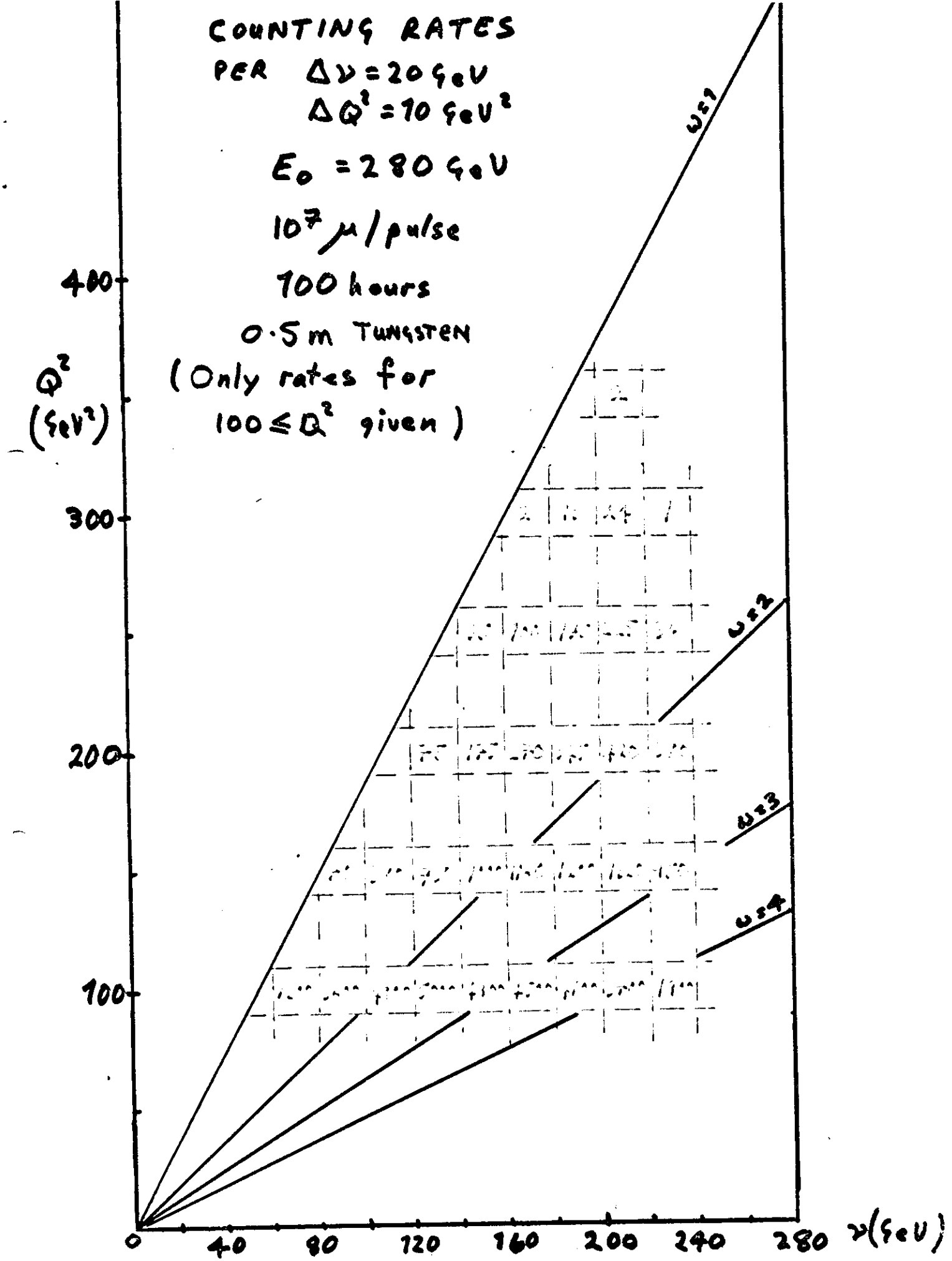
Advantages of STAC

1) It enables trigger level to be set on true inelastic event.

2. It allows consistency check between total hadron energy & muon energy loss

3. Defines region on target where event occurs along beam direction


HEAVY TARGET STAC
1 m
1m
LIGHT GUIDE
IRON
16cm
1cm 1cm
TUNGSTEN
SCINTILLATOR
P=20GeV/c
600
500
300
200
100
Number of counts
p+
π+
e+
25%
24%
8%
20
30
40
50
60


COUNTING RATES
PER Δν = 20 GeV
ΔQ² = 10 GeV²
E₀ = 280 GeV
10⁷ μ/pulse
100 hours
0·5 m TUNGSTEN
(Only rates for
100 ≤ Q² given)
Q²
(GeV²)
400
300
200
100
0
40
80
120
160
200
240
280
ν(GeV)
W=1
W=2
W=3
W=4

NEXT MAJOR DEVELOPMENT.

- ADD. VERTEX MAGNET. & CERENKOV COUNTERS FOR HADRON DETECTION.

PHYSICS INTEREST

(1) ± multiplicities

Existing data gives

$\langle n_{ch} \rangle = 0.36 + 1.05 \log s - 0.15 \log Q^2$

Does this continue to high s, high Q^2.

(2) Inclusive Pa. Distribⁿ

$\frac{N(\pi^+)}{N(\pi^-)}$, $\frac{N(K^+)}{N(\pi^+)}$ - show increase with Q^2 $x > 0$

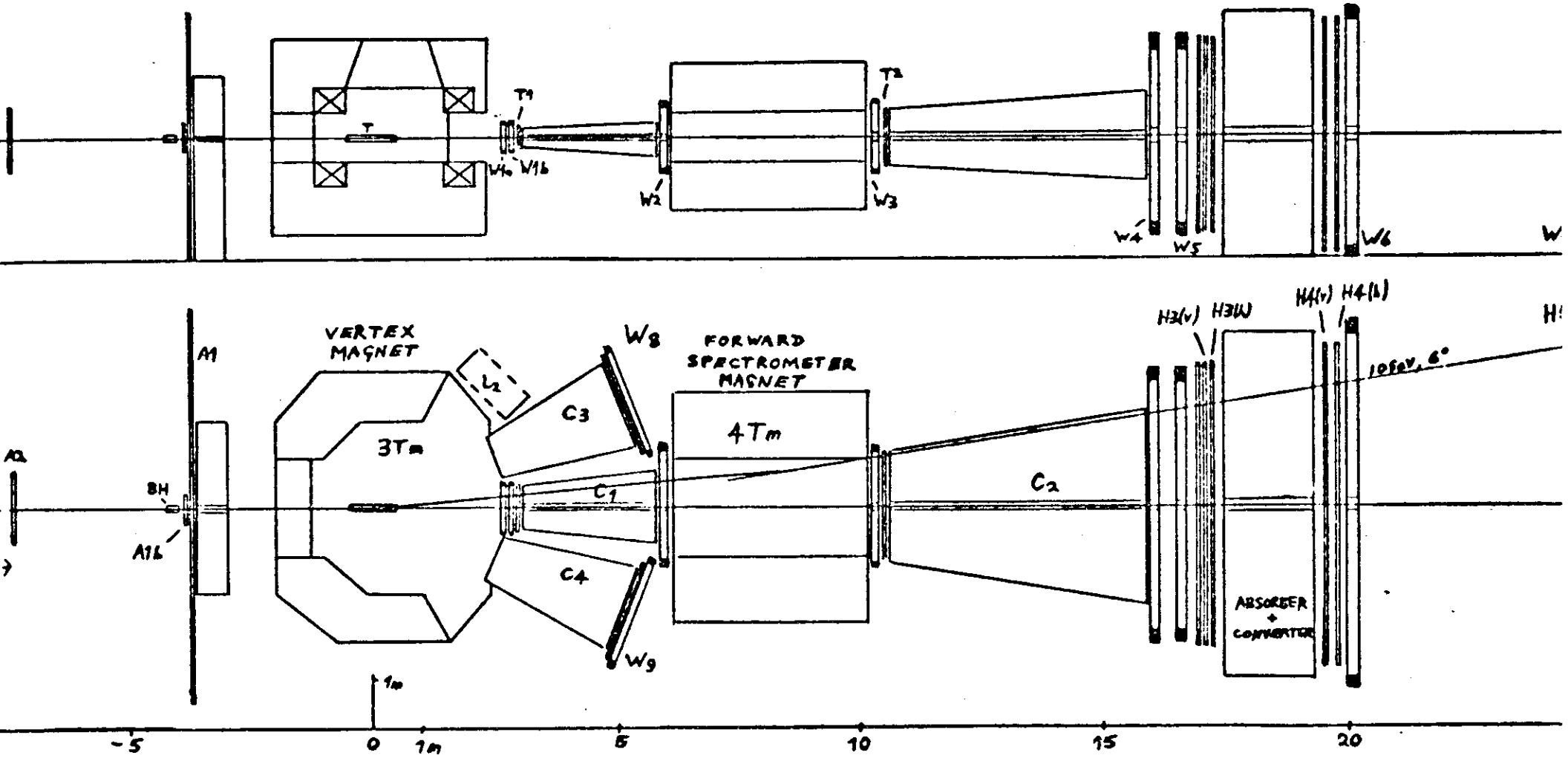
Does this continue

Particle pair studies - inclusive vector mesons

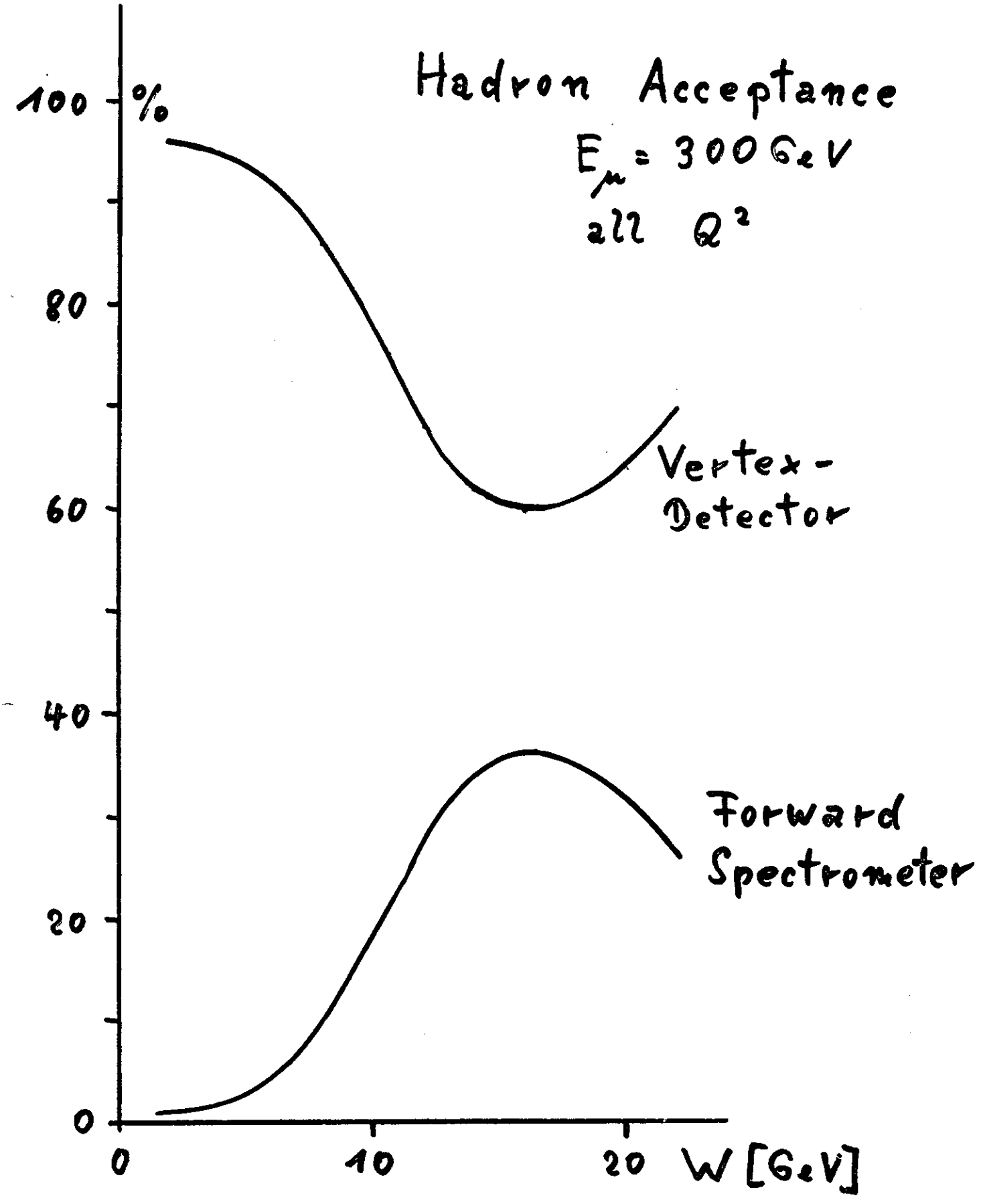
Particle distribⁿ as a function of y - plateau?

(3) Particle correlation studies

Does the correlation between particles change with the "mass" of the photon.



VARIOUS M.
TRACKS.


Hadron Acceptance
E_μ = 300 GeV
all Q^2
100
%
80
60
40
20
0
Vertex-
Detector
Forward
Spectrometer
0
10
20
W [GeV]

Requirements of vertex detector system

1. Operate in beams of 10^7 - 10^8 muons / pulse.
2. Measure ~ 10 - 15 hadron tracks (if Log s dep. holds)
3. Reconstruct tracks at large angles of low momentum.
4. Handle spiralling K. o.n. electrons
   10^{-2} / muon / 1m. H_2. at energies > 100 MeV.
5. Distinguish particles of energy < 1Gev which do not leave magnet.
6. multi-track efficiency known to produce inclusive partial X-sections.

↓

STREAMER CHAMBER

Properties

(1) 100% multi track efficiency

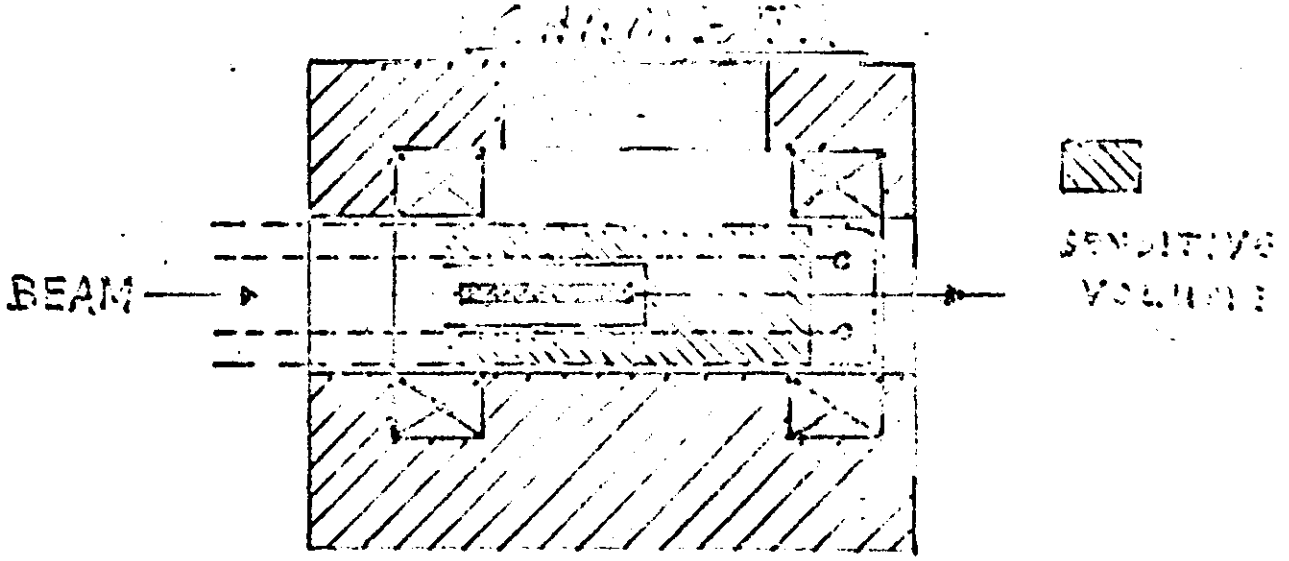
(2) $\frac{\Delta p}{p}$ ~ 1% @ p = 5 Gev/c.

(3) π - P sep^n up to 1Gev/c

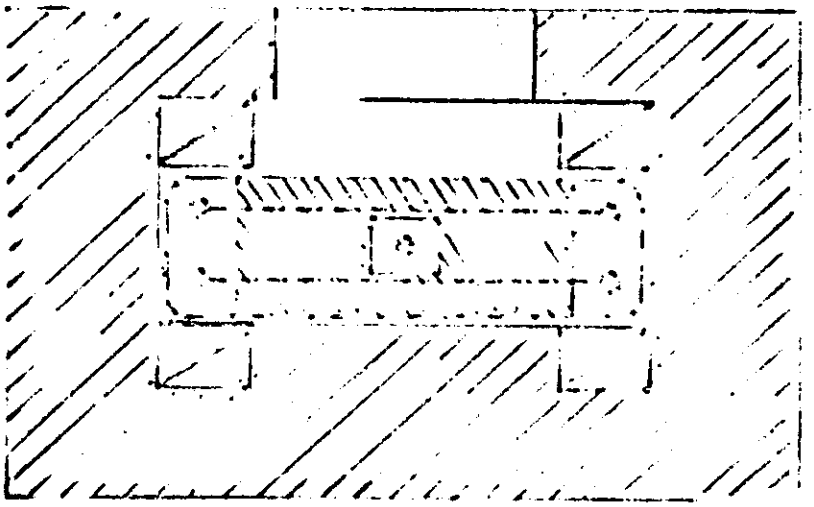
(4) Analysis time ~ 350K events / year / LAB (automatic means)

(5) Max. Trigger rate - 10/sec.

VERTEX MAGNET + STRAWS

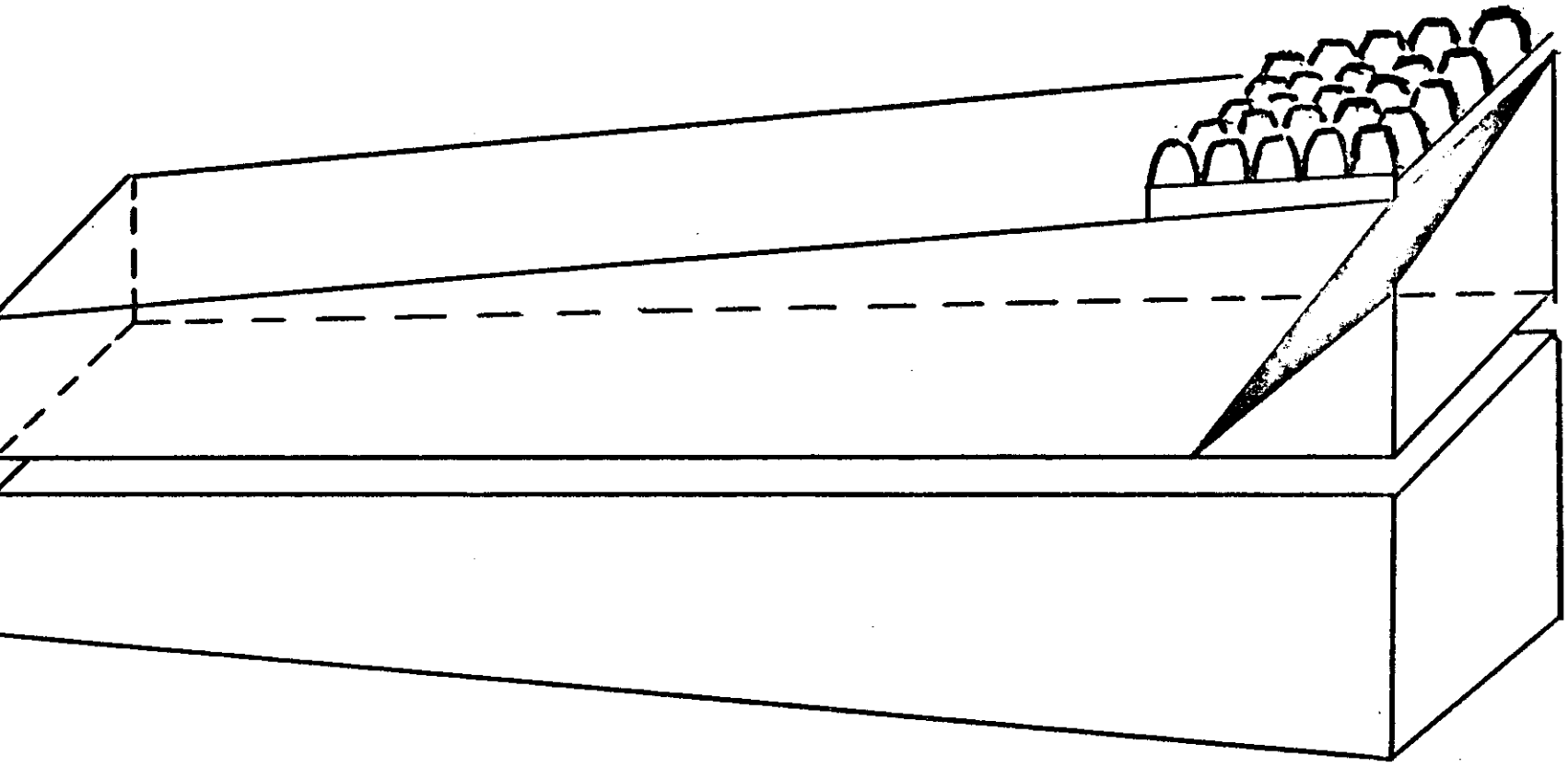


SIDE VIEW



1m

VIEW ALONG BEAM



CERENKOV (C_1, C_2)

Physics Expts which can be fitted into the programme using mainly FORWARD SPECT MAGNET depending on interest & time scales.

(1) Polarised target expt. — to study spin dependent sub-structure of nucleon.

$$A = \frac{\frac{d^2\sigma}{d\omega dE'}(\uparrow\uparrow) - \frac{d^2\sigma}{d\omega dE'}(\uparrow\downarrow)}{\frac{d^2\sigma}{d\omega dE'}(\uparrow\uparrow) + \frac{d^2\sigma}{d\omega dE'}(\uparrow\downarrow)} \propto \tan^2\theta/_2 \left[G_1 + G_2 \cdot q^2\right]$$

small

A ~ STATISTICAL ACC^Y of 0·1 → 1% in measured value.

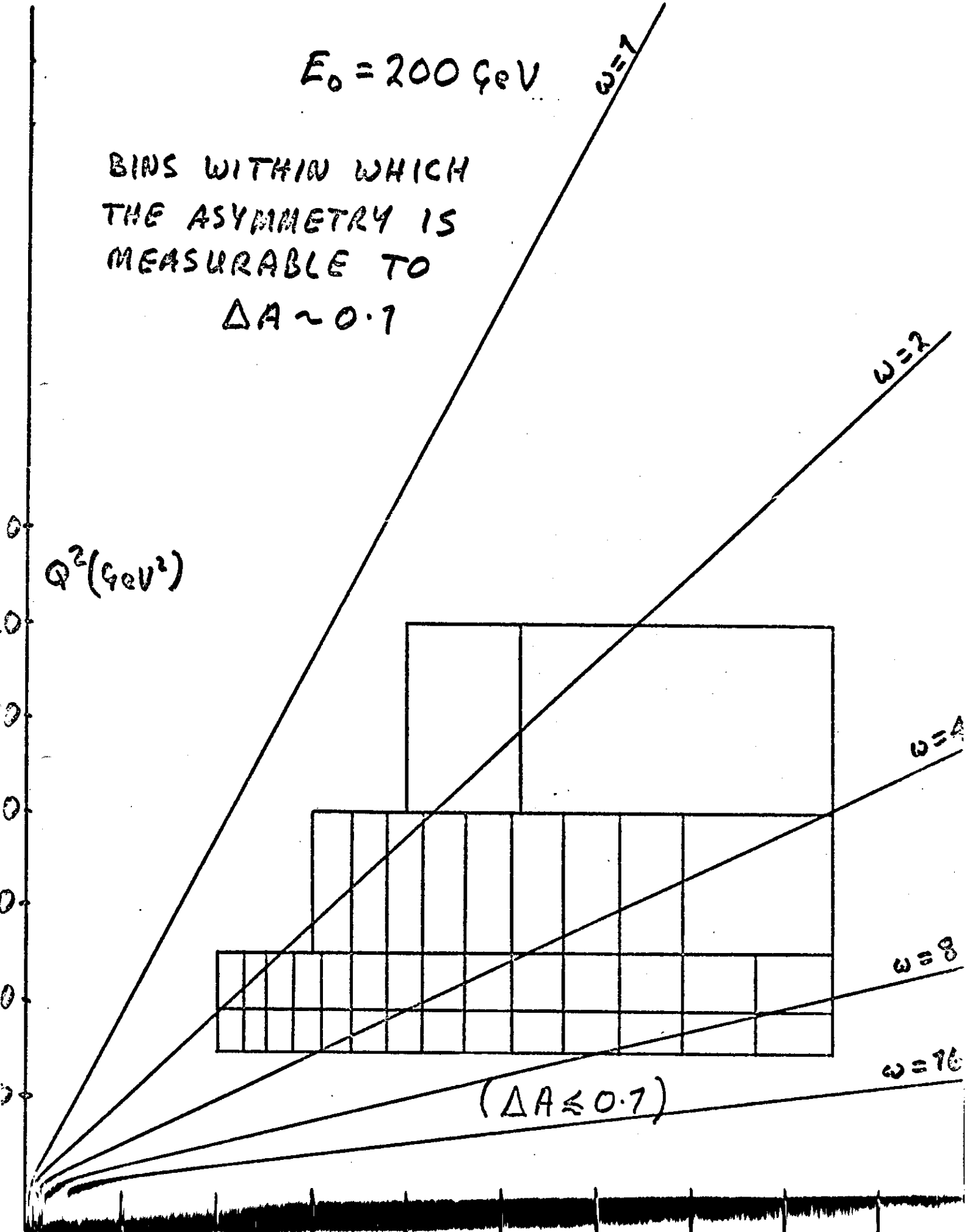
Development.

(1) Long. target - 5 cm. chain × 1 m.

with solenoid to give H ~ 10^4.

(2) NH_3 - possible CH_4

(3) target in sections ↑|↓ for long relaxation times


$E_0 = 200$ GeV
BINS WITHIN WHICH THE ASYMMETRY IS MEASURABLE TO $\Delta A \sim 0.1$
Q^2 (GeV^2)
$\omega = 1$
$\omega = 2$
$\omega = 4$
$\omega = 8$
$\omega = 16$
$(\Delta A \lesssim 0.1)$

STUDY OF γ, π^0 INCLUSIVE, W.A. Blomss[6]

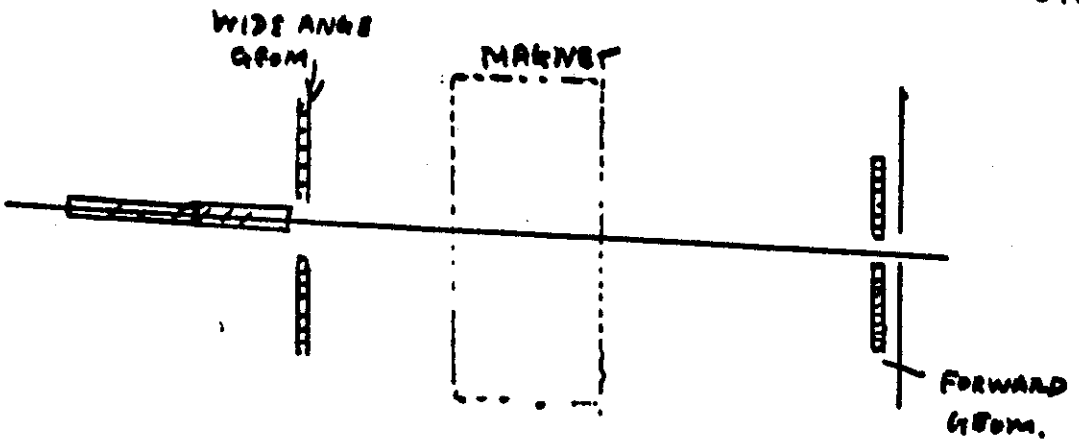
SEARCH FOR CHARGED HEAVY LEPTONS

APPARATUS

BASIC MUON DETECTOR +

2. EXISTING LEAD GLASS HODOSCOPE ARRAYS COVERING AREA OF 1.2m x 1.3m EACH.

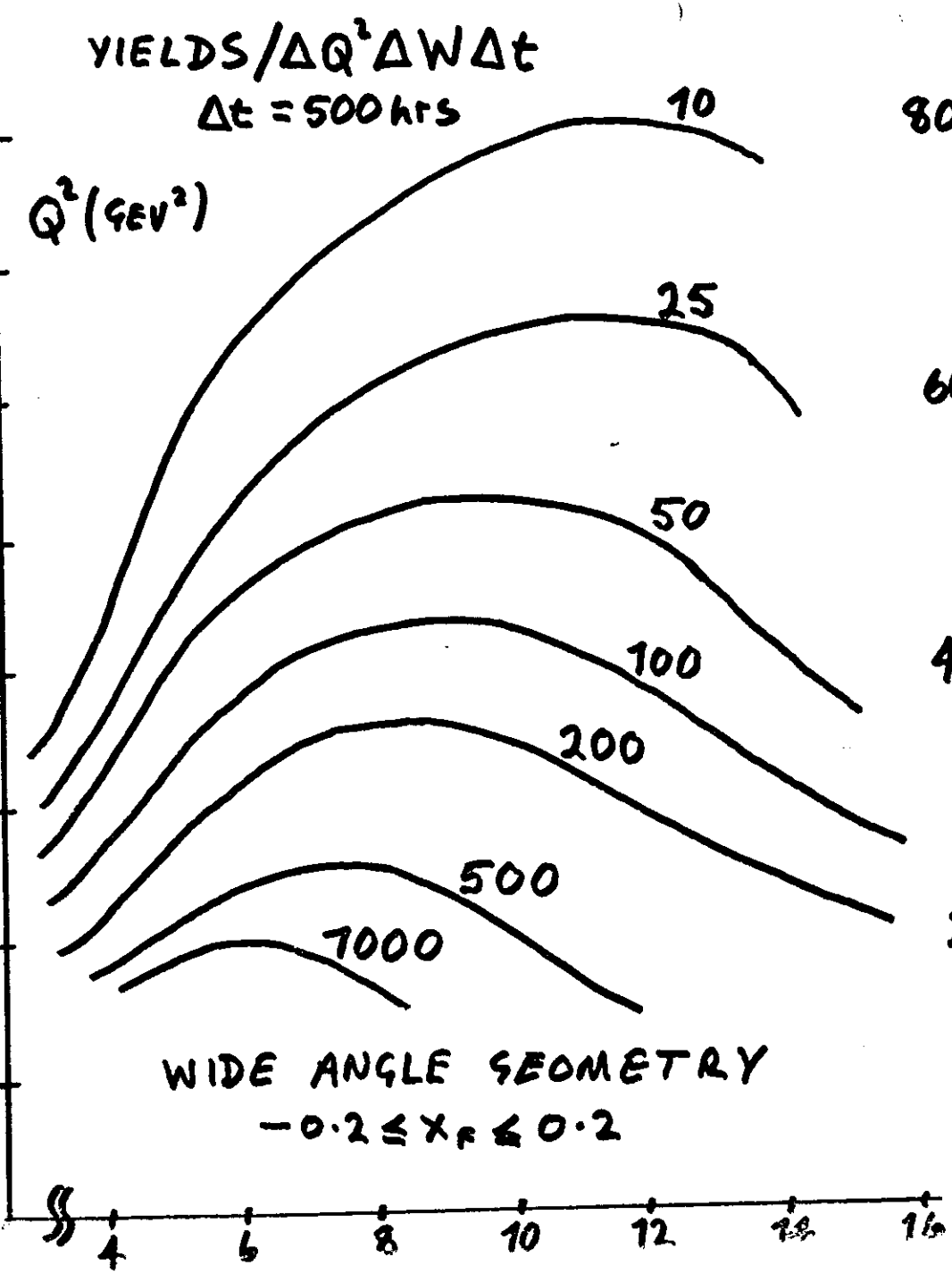
π^0 MASS RESOL^N ~ 5%. USING SHOWER CONVERTER & SPATIAL DETECTOR (0.5cm)

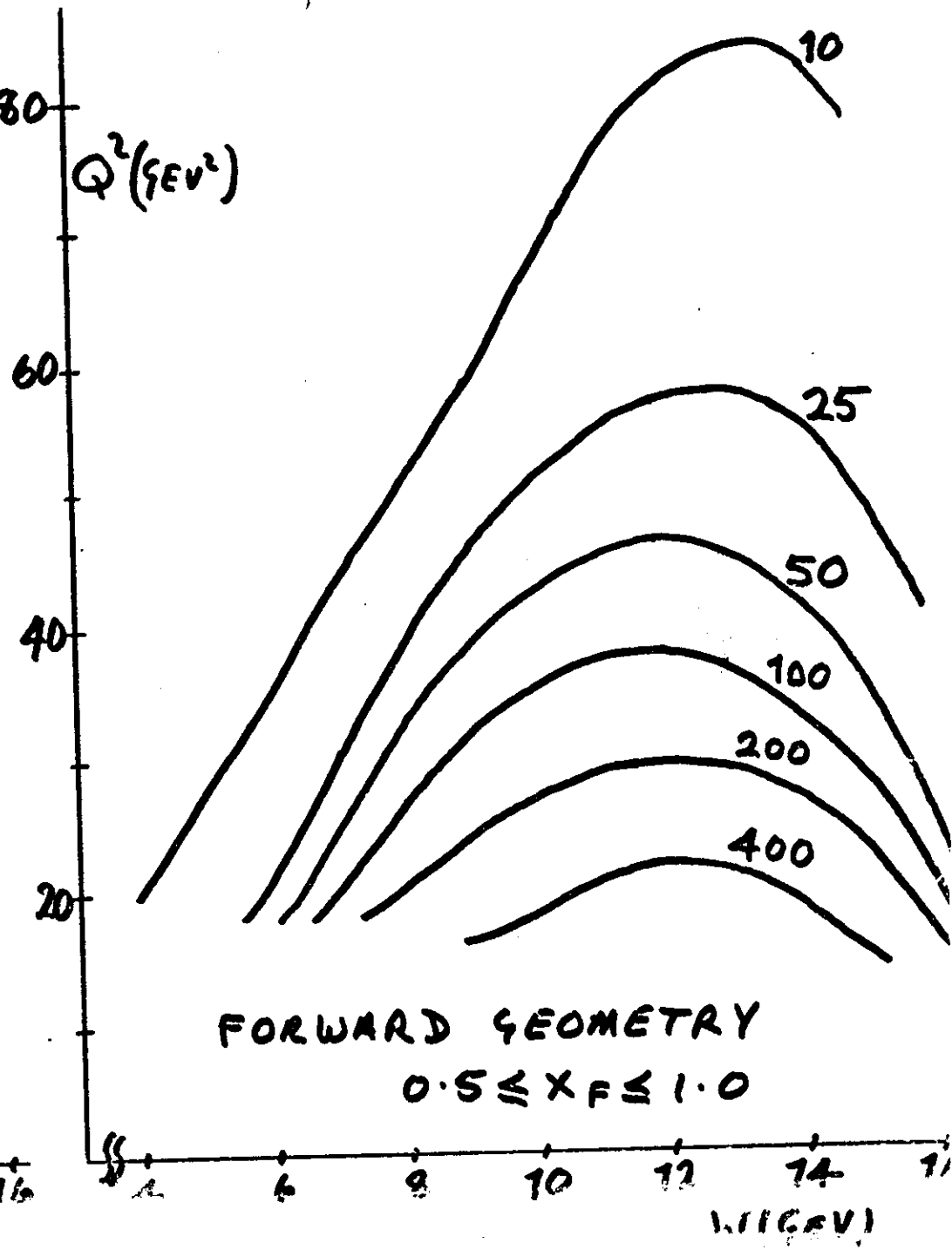


TEST OF W. ANGLE BREMSS FOR HEAVY LEPTON SEARCH. — 15 - 20 GeV POSSIBLE

H_2 \ HEAVY TGT.

STUDY OF DEEP INELASTIC COMPTON USING INTERFERENCE. ($\mu^+ - \mu^-$)


YIELDS/ΔQ²ΔWΔt
Δt = 500 hrs
Q²(GEV²)
10
25
50
100
200
500
7000
WIDE ANGLE GEOMETRY
−0·2 ≤ X_F ≤ 0·2
4
6
8
10
12
14
16


Q²(GEV²)
80
60
40
20
10
25
50
100
200
400
FORWARD GEOMETRY
0·5 ≤ X_F ≤ 1·0
6
8
10
12
14
W(GEV)

STUDY OF MULTIMUON PRODUCTION

BOSON PRODUCTION

USE THICK TARGETS.

FOR X-S

TRIDENT. Q.E.D

- DOMINATES @ LOW. MASSES

- SMALL TARGETS FOR LOW. MOM MUONS

STILL UNDER STUDY