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M E M O R A N D U M

To/A : B. Wiik

From/De : C. Zupancic

Subject/Objet : NA4 Status Report

Copy to/Copie à:
I. Mannelli
J. May

Enclosed you shall find the NA4 Note 80-1 containing copies of the transparencies shown in our Status Report. Naturally, much of it is rather meaningless without oral comments. For this reason, I should be obliged to you if you treated the Note as confidential information accessible only to the SPSC.

CERN/EP/NA4 Note 80-1
17 January 1980

These are transparencies prepared for and shown in the NA4 Status Report to the SPSC on January 15, 1980. Only pages containing the text are paginated. The pages 11 and 12 were not shown because time ran out and the SPSC did not accept the offer to show them during the discussion.

Let us hope that the report ending with page 13 is a good omen for the work in 1980.

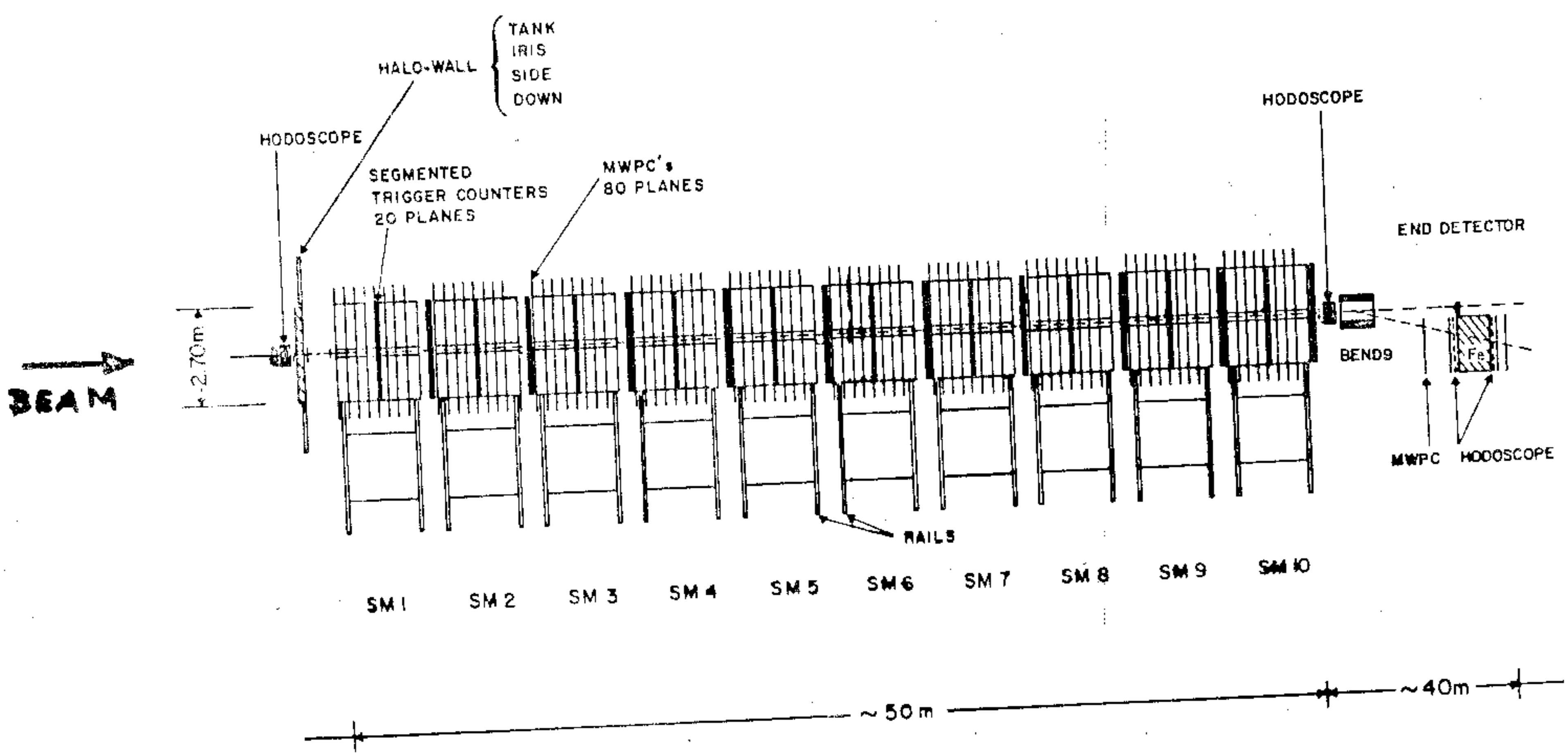
NA 4 – An experiment to measure deep-inelastic muon scattering at high Q^2 and multimuon production at large masses

U. of BOLOGNA – CERN –
JINR DUBNA – U. of MUNICH –
C.E.N. SACLAY

Equipment: magnetized torus
- halo wall
- hodoscopes
- trigger counters + tag counters
- MWPC's
- end-detector

slides
drawing

EXPERIMENTAL SET-UP (TOP-VIEW)



Advantages of apparatus:

repetitiveness
redundancy
azimuthal symmetry
high luminosity for H_2, D_2, C
large acceptance for high Q^2

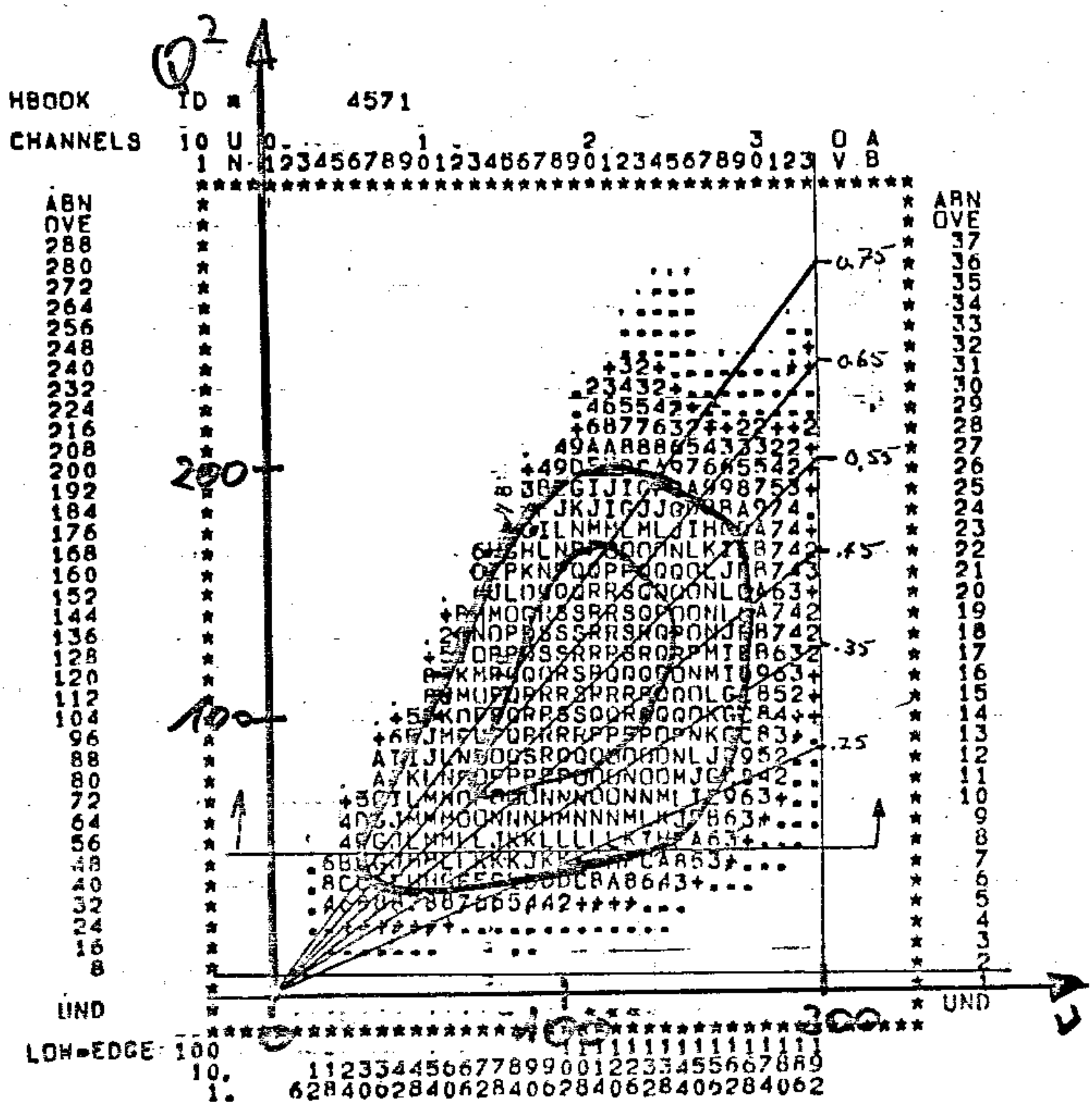
Disadvantages of apparatus:

$.1\, Q_{max} \lesssim Q^2$ acceptance

sees only muons

Conclusion:

it is predestinated for
high precision experiments
at high Q^2



—— 40 % efficancy

—— 60 % efficancy

Status

	E_μ (GeV)	N_μ	good events	analyzed good events
	280	5×10^{11}	8×10^5	$.3\times10^5$
(±)	240	3×10^{11}	5×10^5	$.4\times10^5$
(±)	200	2.5×10^{11}	5×10^5	$.9\times10^5$
	120	2×10^{11}	5×10^5	$.5\times10^5$

BEAM TIME USAGE

15% SPS AND BEAM LINE FAULTS

13% SPECIAL TESTS AND CALIBRATIONS

10% CHECKS BETWEEN RUNS AND LOST TIME

62% NET DATA TAKING

NOTE THESE FIGURES ARE BASED ON PERIOD 6a RUNNING, THE BEST OF THE YEAR FOR WHAT IT CONCERNS MACHINE PERFORMANCE.

Where do we stand?

1. Are data on tape OK? YES
   redundancy! event display

2. Are good events selected reliably and without losses? YES
   (eye scanning of ~5%)

3. Do we know the acceptance? YES
   (but Monte-Carlo statistics not yet sufficient

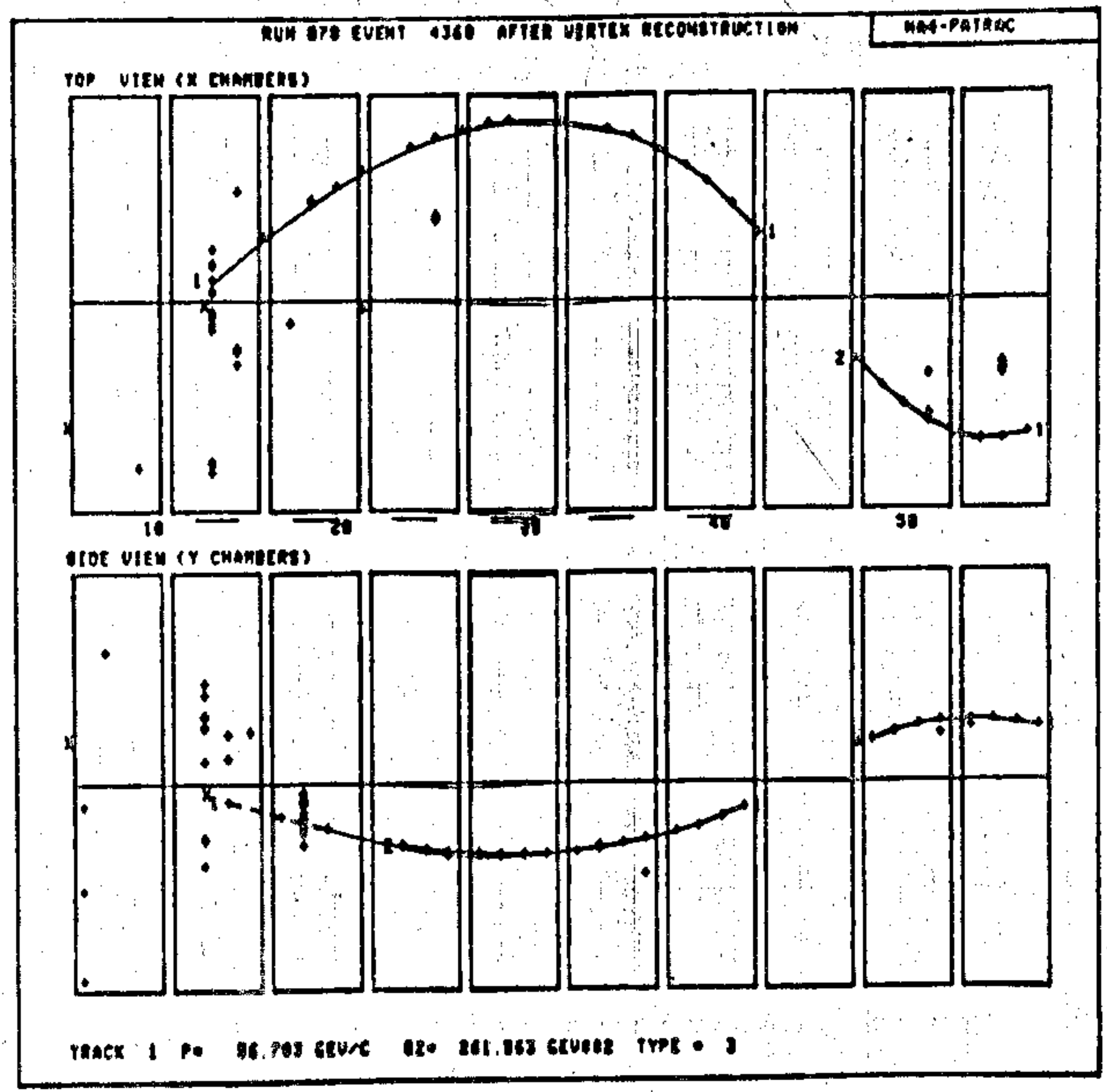
4. Do we know the luminosity?
   At present to $\pm 10\%$
   In the near future much better $\sim \pm 1\%$

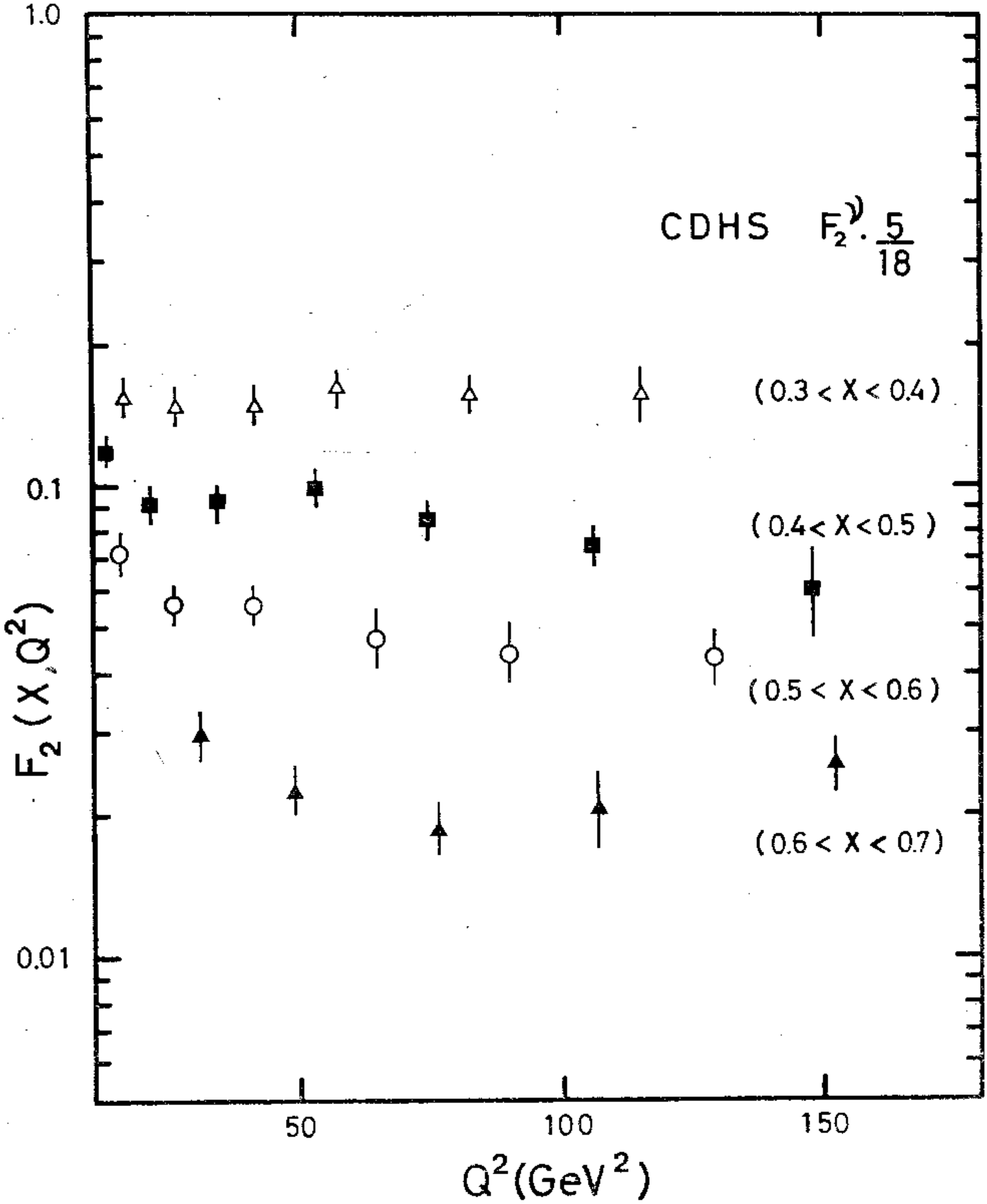
5. Can we present our results for posterity?
   „smearing removed" ≡ experimental "resolution unfolded YES approx.
   contrary to EPS + Batavia

radiative corrections	YES
Fermi-motion unfolded	NO
$R = .22$	ASSUMED

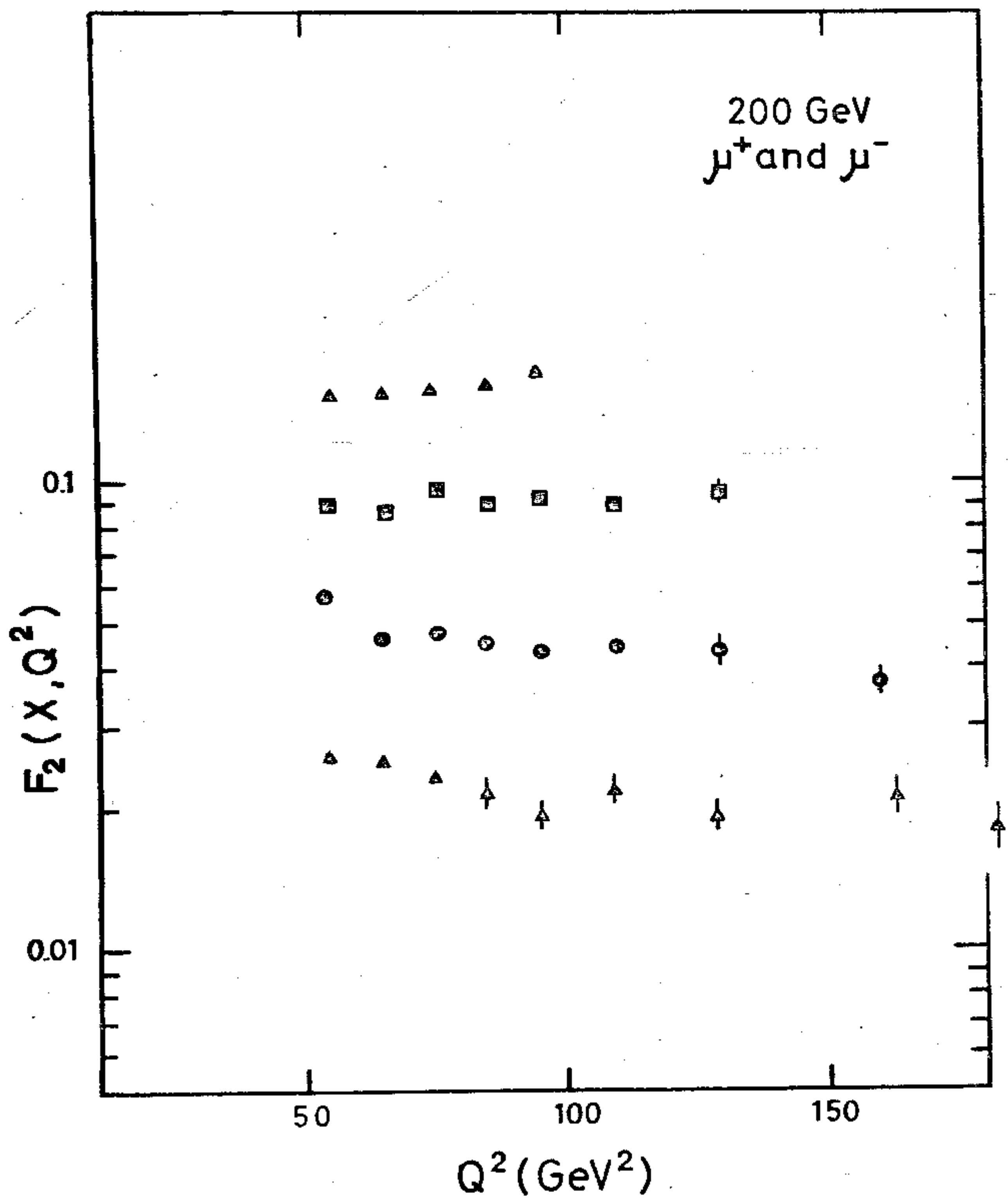
results from ~2 + ~2 days of net running time

PLOT FRAME 184
TV CMD =

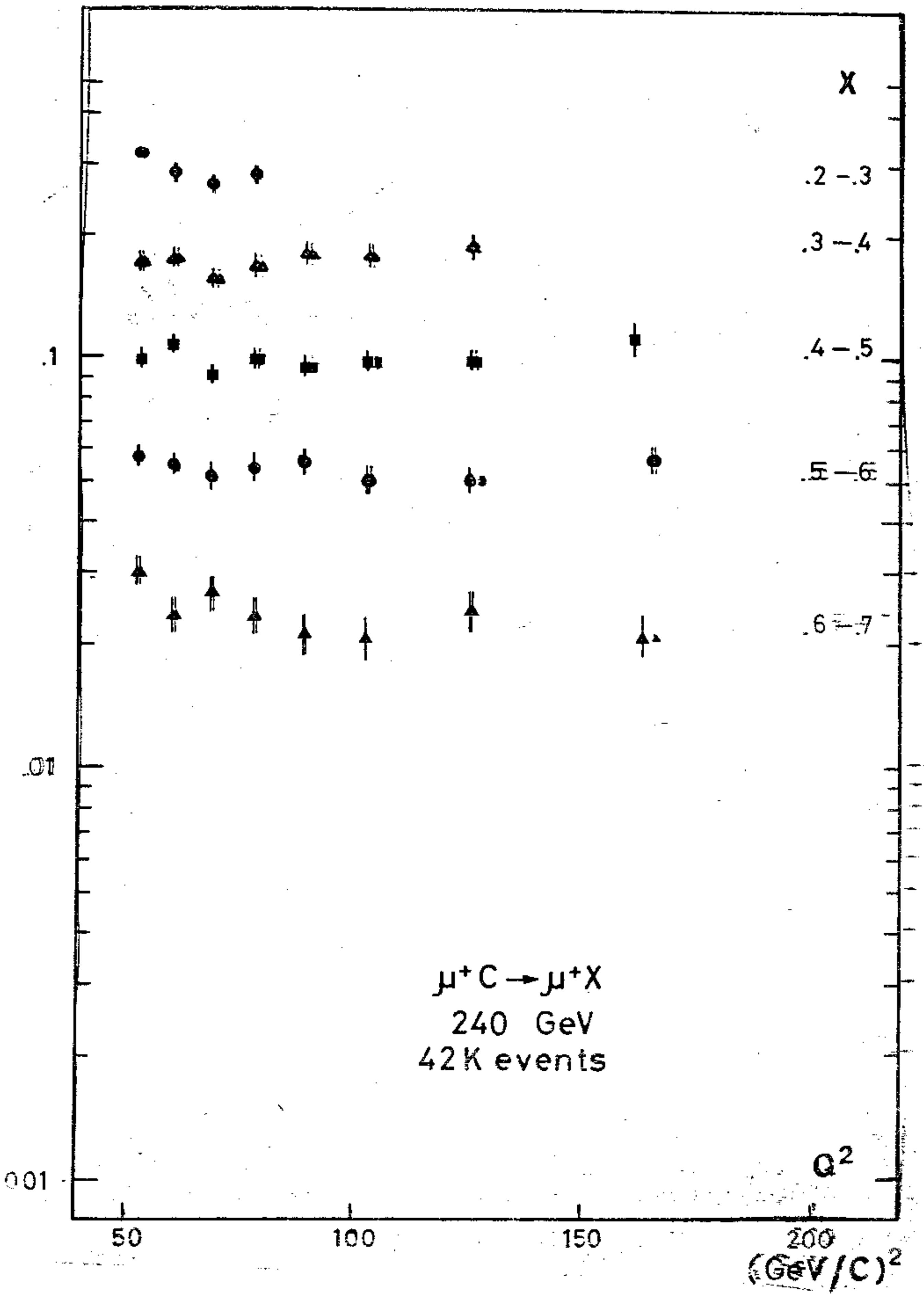




1.0
0.1
0.01
50
100
150
CDHS $F_2^{\nu} \cdot \frac{5}{18}$
(0.3 < X < 0.4)
(0.4< X < 0.5)
(0.5 < X < 0.6)
(0.6 < X < 0.7)
$F_2(X,Q^2)$
$Q^2(GeV^2)$



200 GeV
μ^+ and μ^-
0.1
0.01
$F_2(X,Q^2)$
50
100
150
Q^2 (GeV^2)



X
.2 –.3
.3 –.4
.4 –.5
.5 –.6
.6 –.7
.1
.01
0.01
$\mu^+ C \rightarrow \mu^+ X$
240 GeV
42 K events
Q^2
50
100
150
200
$(GeV/C)^2$

$\mu^+ - \mu^-$ test at 200 GeV

4.5 10^{10} μ^+ at $\sim 10^7$/burst

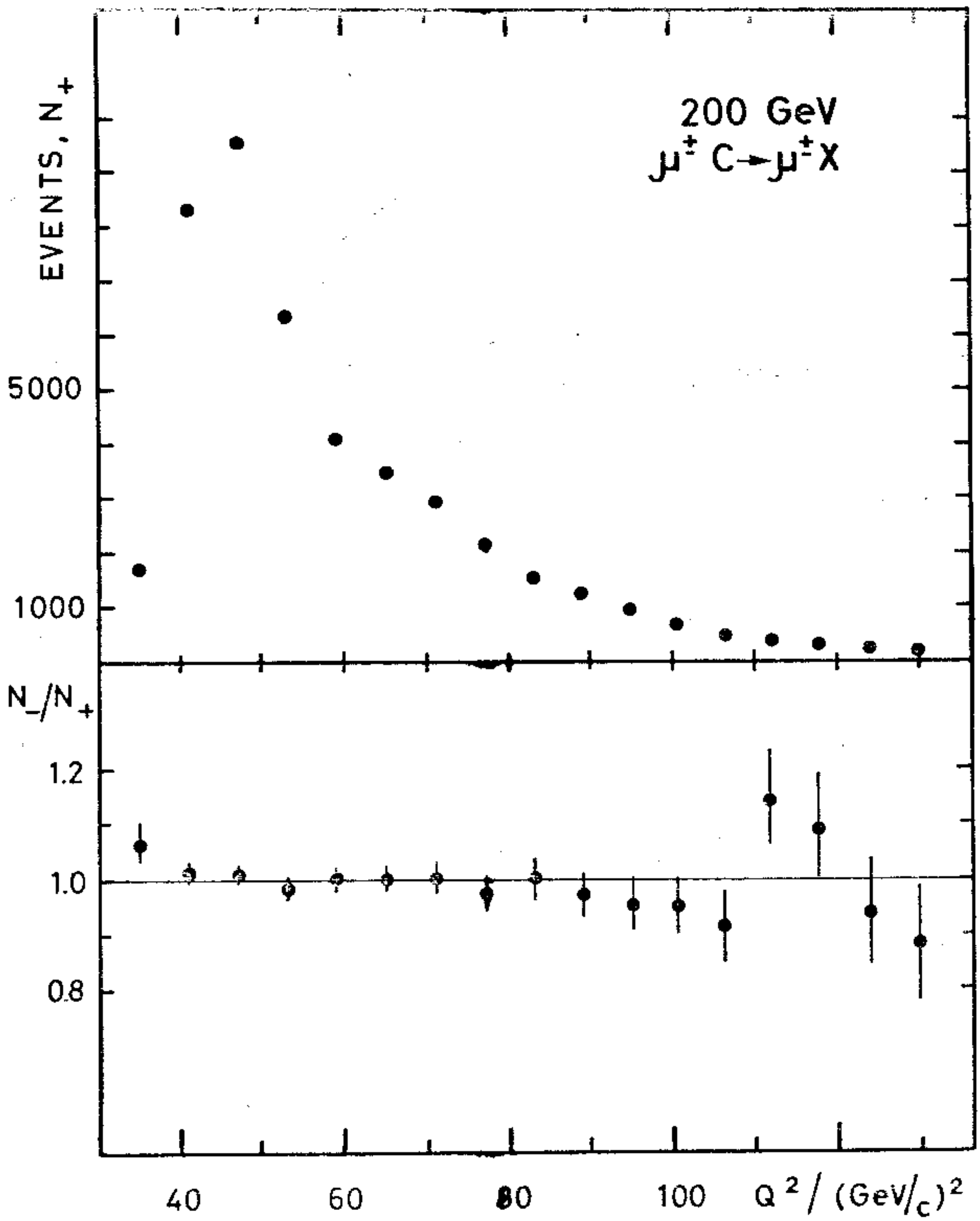
2.5 10^{10} μ^- partly at $\sim 10^7$/burst

— " — $\sim .5\ 10^7$/burst

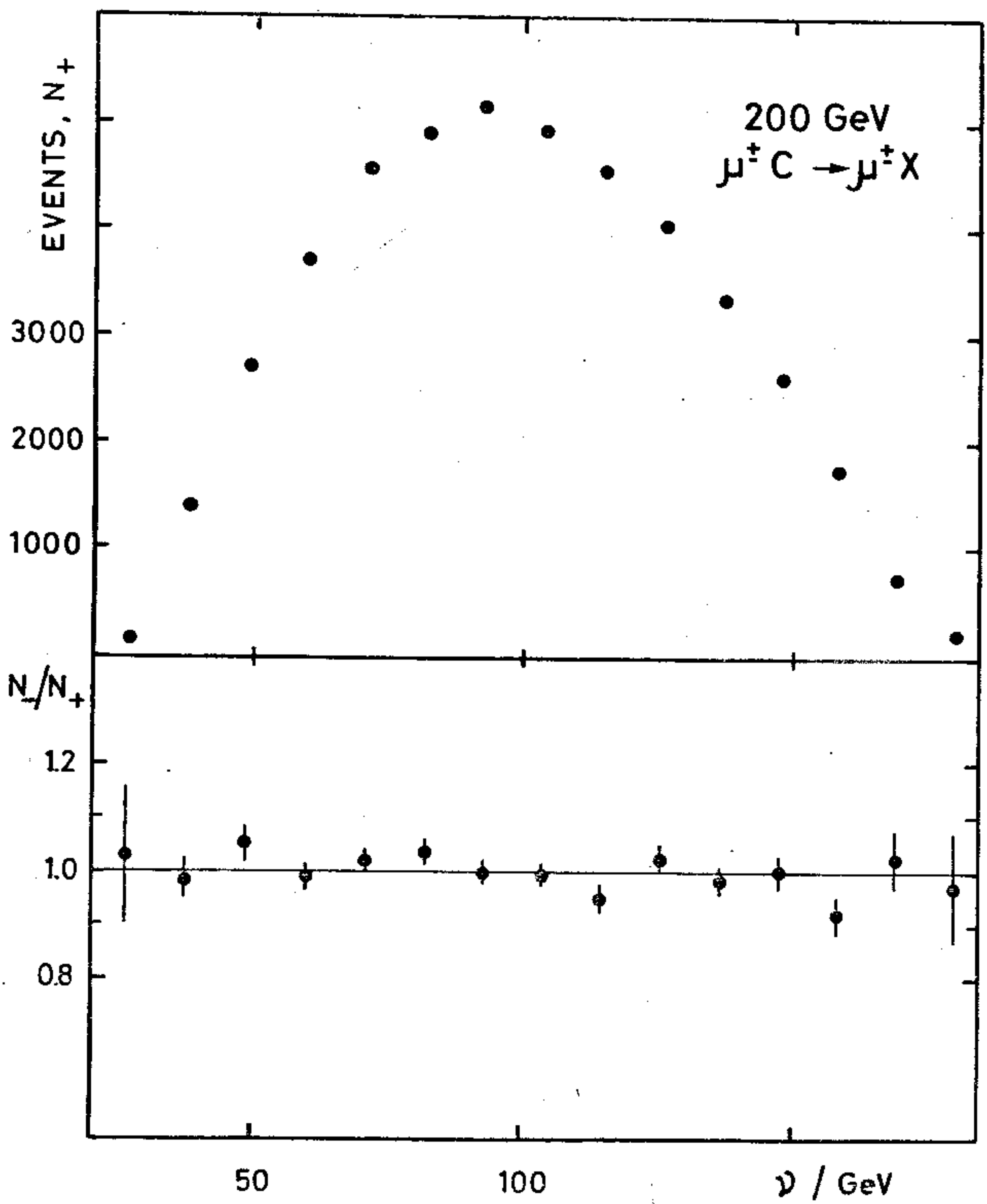
- $\lesssim 2$ days net data taking total

NO SPECIAL EFFORT TO CONTROL SYSTEMATIC ERRORS!

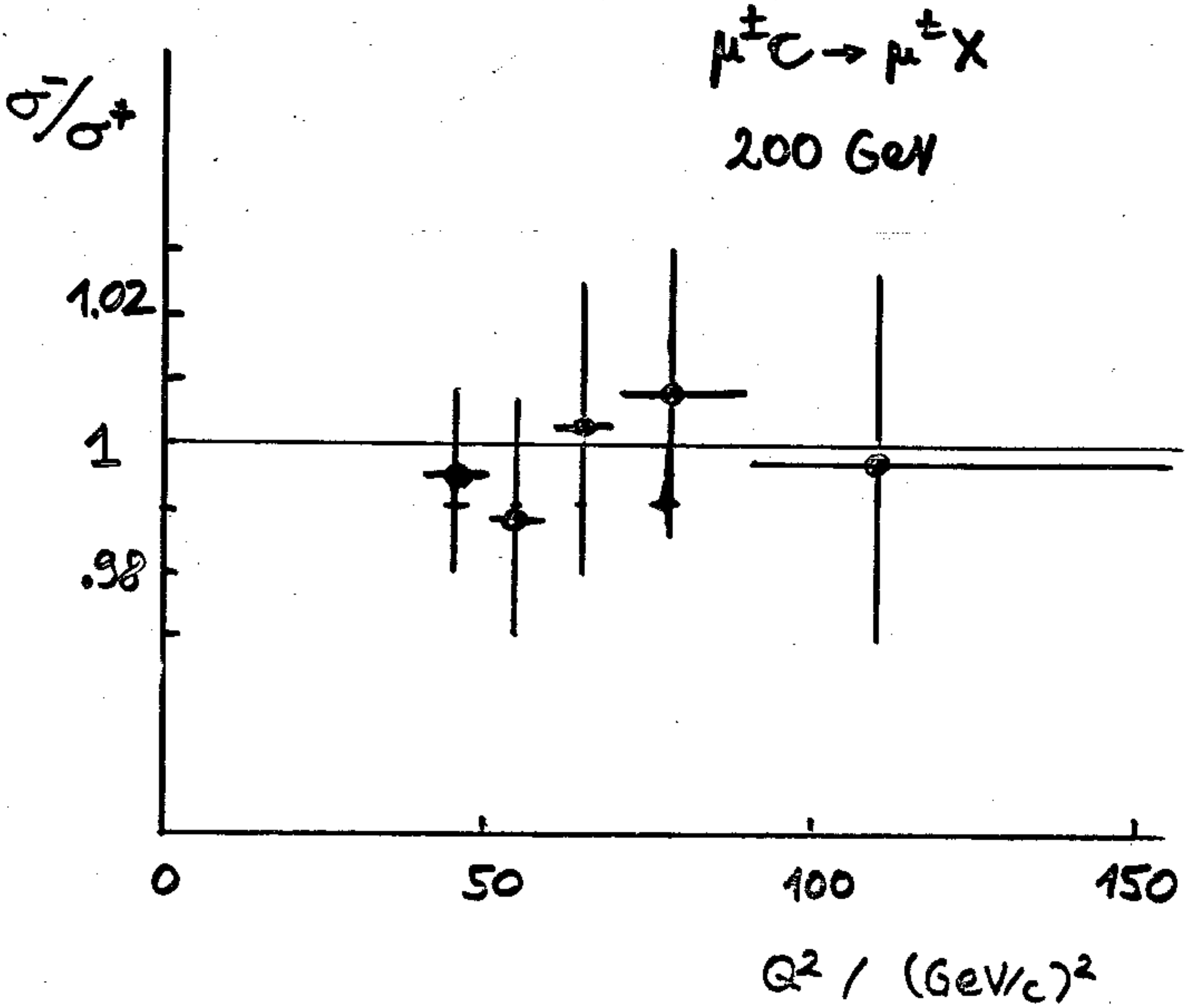
- distributions in Q^2, ν



200 GeV
$\mu^{\pm}$ C → $\mu^{\pm}$X
EVENTS, N_+
5000
1000
N_-/N_+
1.2
1.0
0.8
40
60
80
100
$Q^2/(GeV/c)^2$



EVENTS, N_+
200 GeV
$\mu^\pm C \rightarrow \mu^\pm X$
3000
2000
1000
N_-/N_+
1.2
1.0
0.8
50
100
ν / GeV


$\mu^{\pm} C \rightarrow \mu^{\pm} X$
200 GeV
σ^-/σ^+
1.02
1
.98
0
50
100
150
Q^2 / $(GeV/c)^2$

Experiment:

$$B \equiv \frac{(d\sigma/d\chi)_+ - (d\sigma/d\chi)_-}{(d\sigma/d\chi)_+ + (d\sigma/d\chi)_-}$$

χ „optimal" kinematical variable

- Theory:

$$B = -1.8\ 10^{-4}\ Q^2 g(y)\ (a - |\lambda| v)\ A + R.C$$

$$g(y) = \frac{1-(1-y)^2}{1+(1-y)^2} \implies \chi \equiv Q^2 g(y)\ !$$

$\lambda_+ = -\lambda_- = |\lambda|$ beam polarization

- a axial } muonic weak neutral current
  v vector } coupling constant

(W.S. $a = -\frac{1}{2}$ $v = -\frac{1}{2} + 2\sin^2\theta_W$
i.e $|v| \lesssim .1$)

$A \sim$ hadronic axial structure function

(QPM: $A \simeq -1.8$ independent of x for isoscalar targets)

The dominant radiative corrections should involve only photon exchanges ⟶ scaling ⟶ $f(x,y)$
up to $\log(E/m)$ terms

However those concerning photon - hadron coupling are model - dependent ⟶ calculations perhaps unreliable

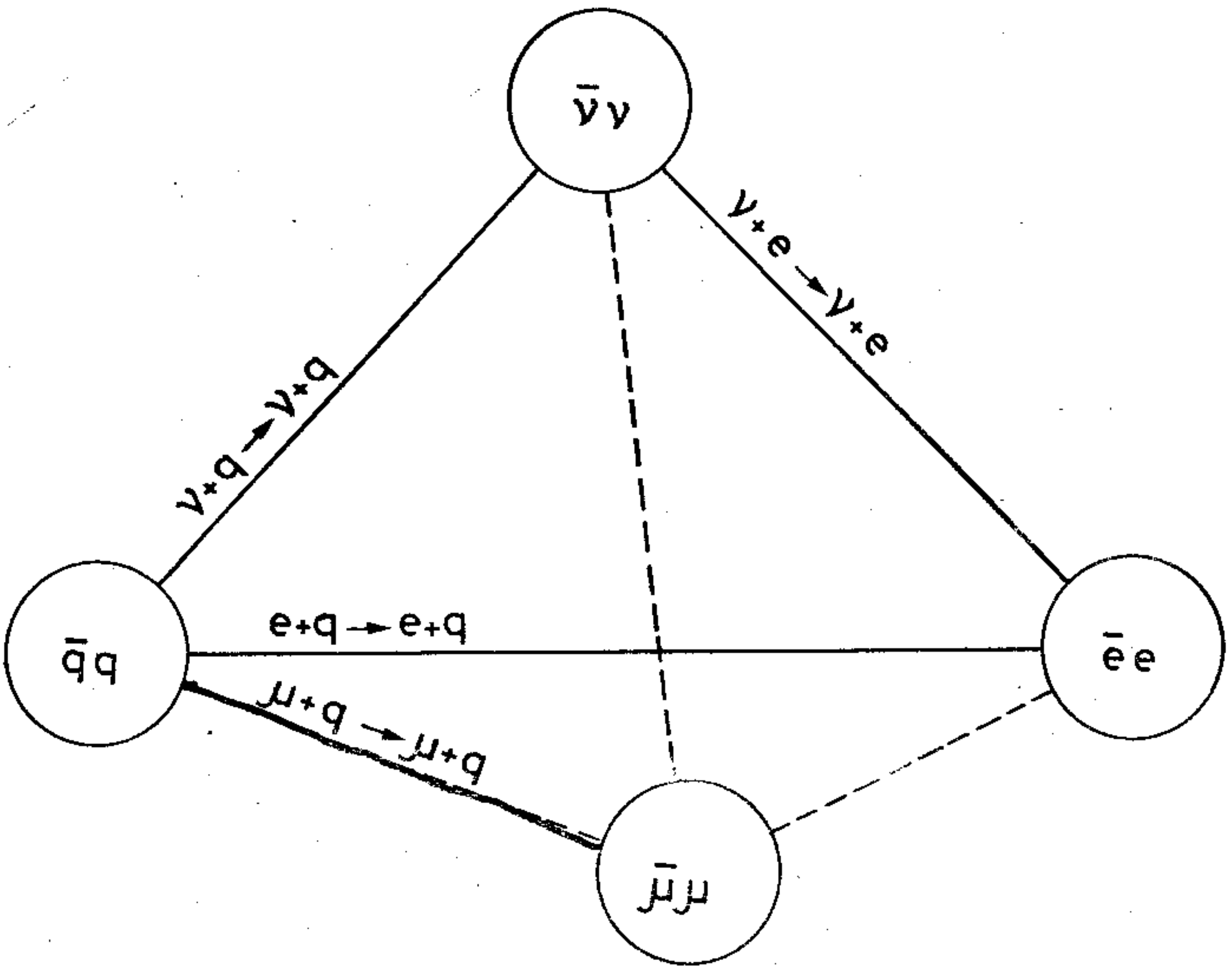
Conclusion:

Measure at 2 widely separated incident energies in order to separate B_{WEAK} from $B_{R.C.}$

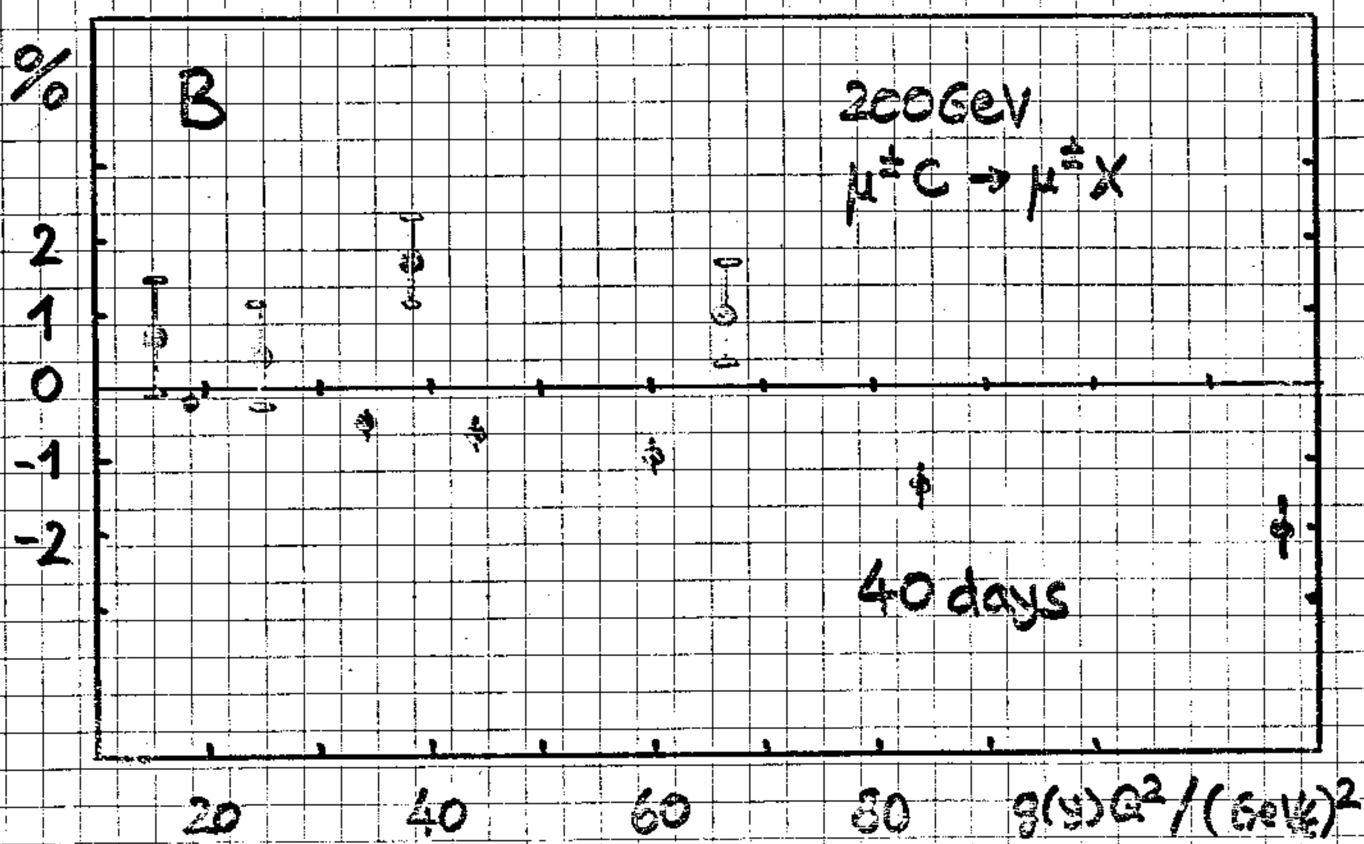
<u>Is it an interesting experiment?</u>

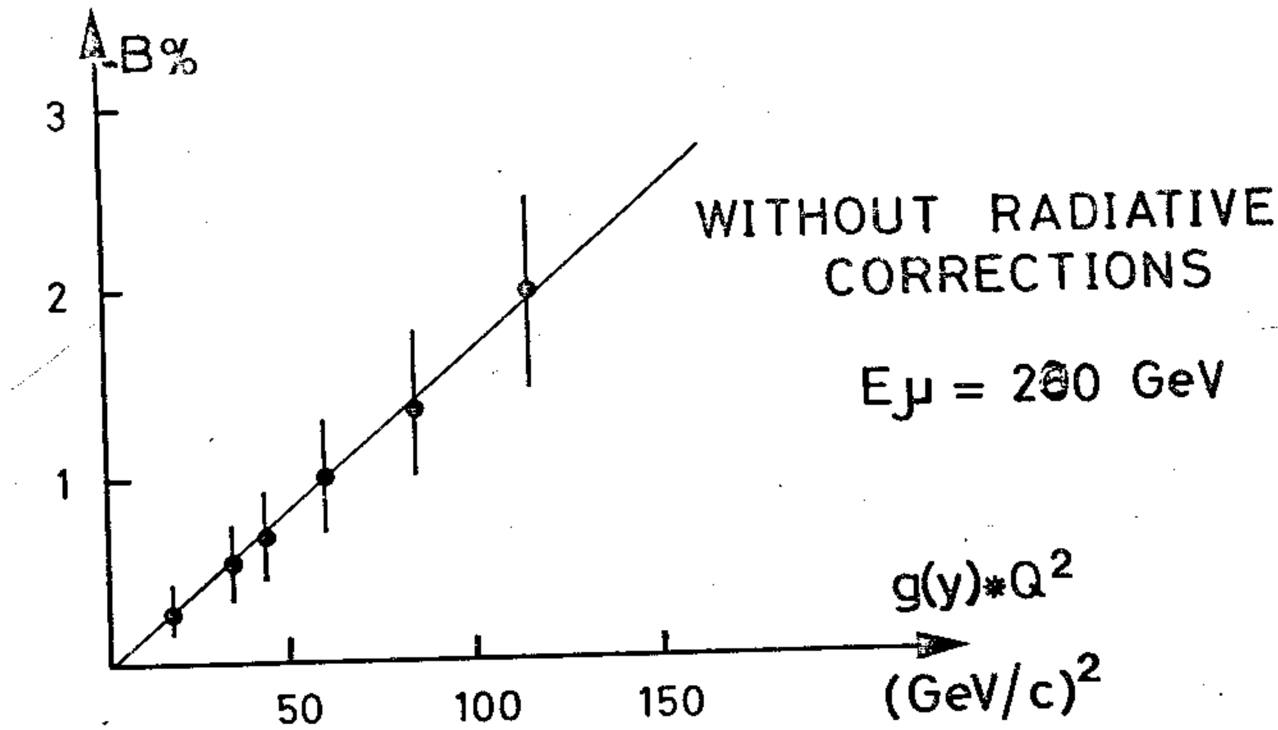
Test of μ-e universality
Sakurai tetrahedron

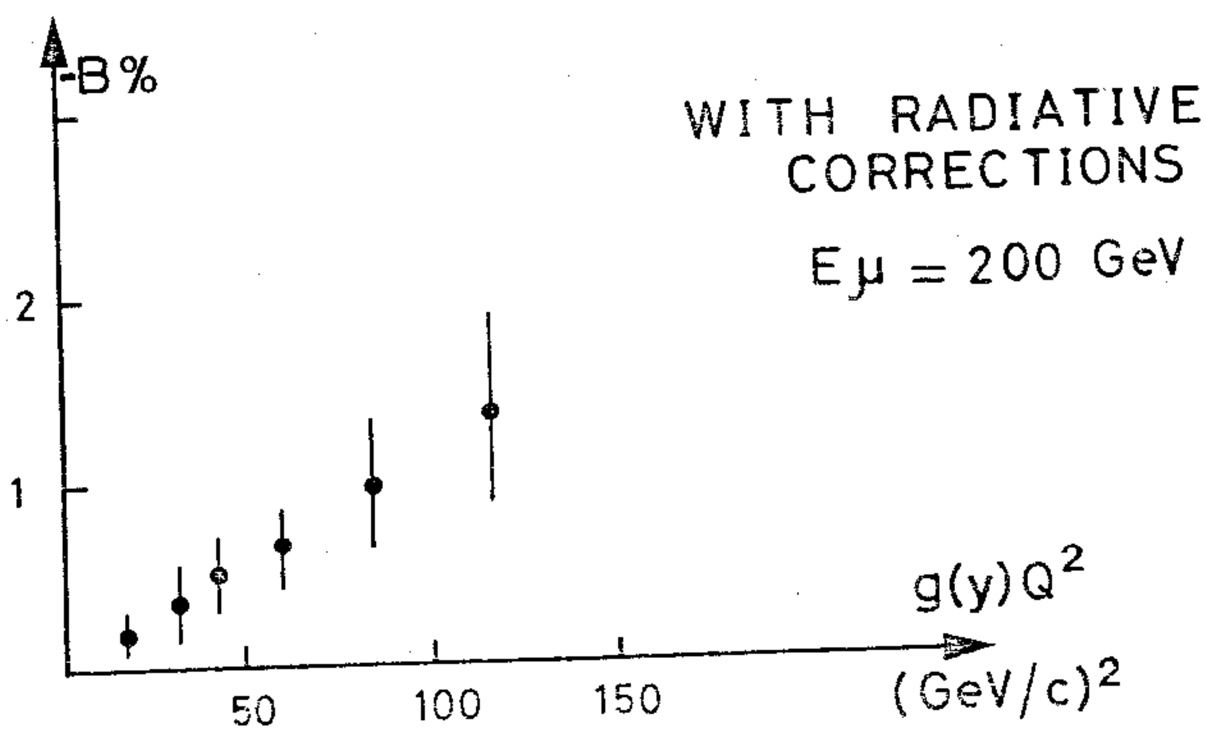
Specifically: is μ_R singlet?
other assignements

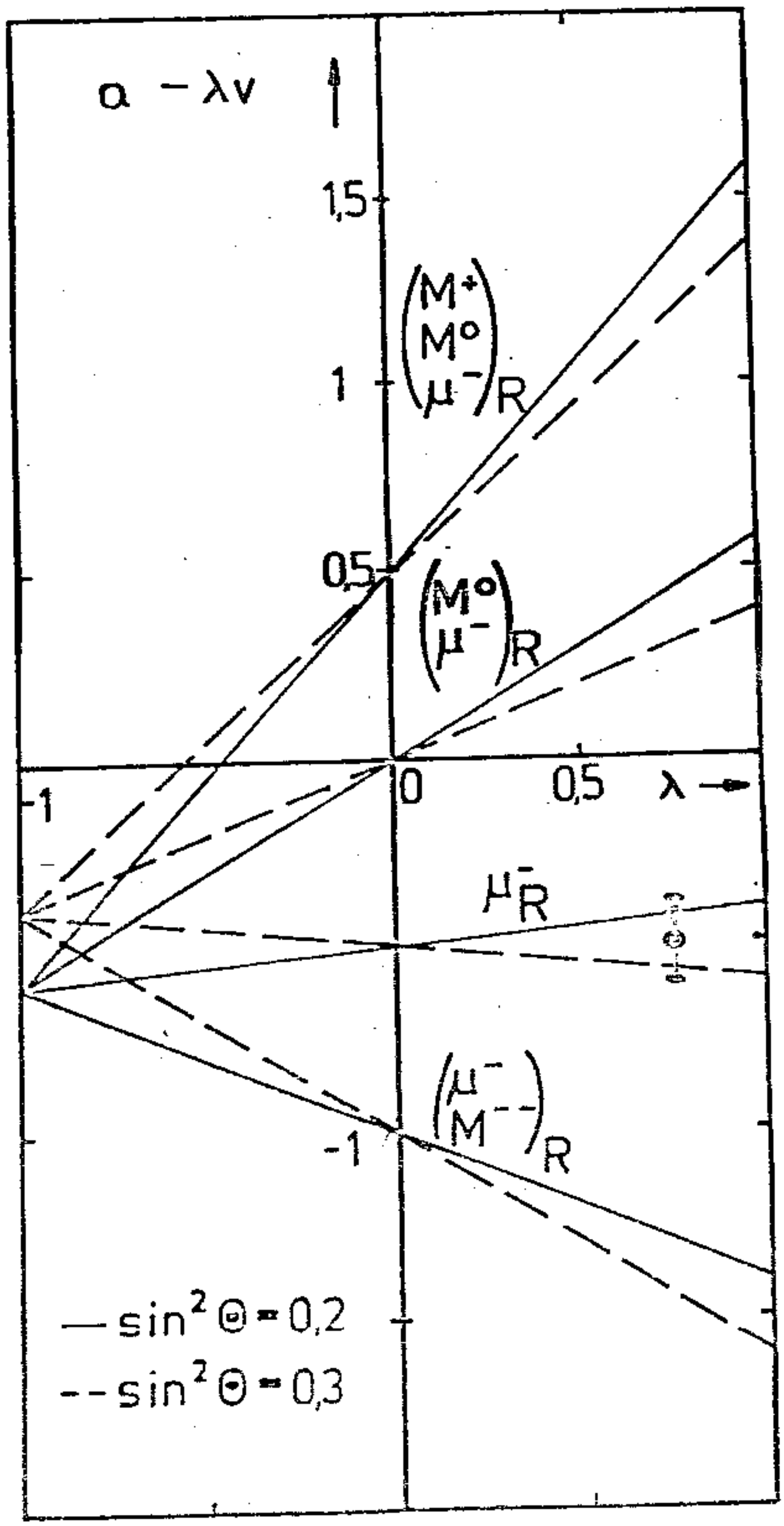


$\bar{\nu}\nu$
$\nu + e \rightarrow \nu + e$
$\nu + q \rightarrow \nu + q$
$e + q \rightarrow e + q$
$\bar{q}q$
$\bar{e}e$
$\mu + q \rightarrow \mu + q$
$\bar{\mu}\mu$


%
B
200GeV
μ±C → μ±X
2
1
0
-1
-2
40 days
20
40
60
80
g(y)Q²/(GeV/c)²


-B%
3
2
1
WITHOUT RADIATIVE
CORRECTIONS
Eμ = 200 GeV
g(y)*Q²
50
100
150
(GeV/c)²


-B%
2
1
WITH RADIATIVE
CORRECTIONS
Eμ = 200 GeV
g(y)Q²
50
100
150
(GeV/c)²



a − λv
1,5
1
0,5
−1
0
0,5
λ →
-1
$\begin{pmatrix} M^+ \\ M^0 \\ \mu^- \end{pmatrix}_R$
$\begin{pmatrix} M^0 \\ \mu^- \end{pmatrix}_R$
μ^-_R
$\begin{pmatrix} \mu^- \\ M^{--} \end{pmatrix}_R$
— $\sin^2\Theta = 0{,}2$
-- $\sin^2\Theta = 0{,}3$

REQUEST

No. of days	Energy	Intensity	Purpose
50	200 GeV	50% μ^+ 50% μ^- 10^7/sec	main B run
30	~100 GeV	50% μ^+ 50% μ^- 10^7/sec	R.C. run
10	200 GeV	μ^+, μ^- 10^7/sec	empty target run
10	280 GeV	μ^+ 10^7/sec	improving quality of data at high E_μ

Important conditions

Intensity (μ^+) = Intensity (μ^-)

As long a flat top as possible in order to maximize number of muons without exceeding 10^7/s

As frequent +/- switching as feasible, but at least +/-/+ or -/+/- sandwiching during any 10 day period

THIS EXPERIMENTS STANDS OR FALLS WITH CONTROL OF SYSTEMATIC ERRORS

Systematic errors

1. On slope
2. On absolute values

physical quantity	experimental parameters	ampl. factor	origin of error + + controls

1. On slope

E' (energy of scattered μ)	geometry of MWPC's $\vec{B}$ in torus	5	$\Delta B_{+/-} \approx 10^{-4}$ Hall probes loops etc. saturation

expected error $< 10^{-3}$

2. On absolute value

E (energy of incident μ)	geometry of E-defining hodoscopes $\vec{B}$ in B6 bending magnet	3	$\Delta \vec{B}_{+/-} \approx 2 \times 10^{-4}$ Hall probes

Θ_{scatt}	geometry of MWPC's beam angle + divergence	1	$\Delta\Theta_{sc} < 3\times10^{-4}$ hodoscopes azimuthal sym. ↓ no linear terms
• L^+/L^- luminosity ratio	No. of incident μ's Effective target traversed probably the decisive error for absolute values	1	$\Delta(L^+/L^-) \approx 10^{-3}$ random source scalers + + deadtime from hodoscopes beam MWPC's hodoscopes

- expected total error $\approx 2\cdot10^{-3}$

Frequent switching and constant (not too high) intensity important

FINAL COMMENT

B-measurement (nearly) necessary step on the way to our goal in 1981-82: **absolute** precision 1-2% on F_2 in H_2 and D_2

Last opportunity:
mounting H_2 needs 3 months each time