INITIAL APPEAL OF A $\mu\mu$ COLLIDER

→ POSSIBLE PATH TO A FEW-TeV $\ell^+\ell^-$ COLLIDER TO ADDRESS THE GREAT QUESTION OF OUR AGE, THE MECHANISM FOR EWSB

POSSIBLY A LESS COSTLY WAY TO A MODEST ENERGY $\ell^+\ell^-$ MACHINE

MANY INTERESTING POSSIBILITIES TO CONTEMPLATE

- Z^0 FACTORY
- Higgs Factory
- W^+W^- THRESHOLD
- $t\bar{t}$ THRESHOLD
- LE Hadrons
- LE μ source
- INTENSE ν SOURCE
- μp COLLIDER

~ ½ TeV (SUSY / Techni) LAB

2-4 TeV Collider

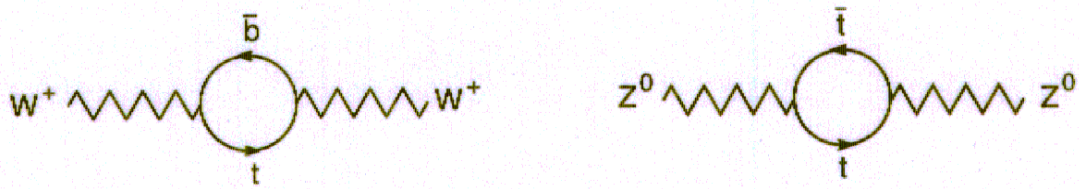
MOST IMPORTANT OBSERVATION

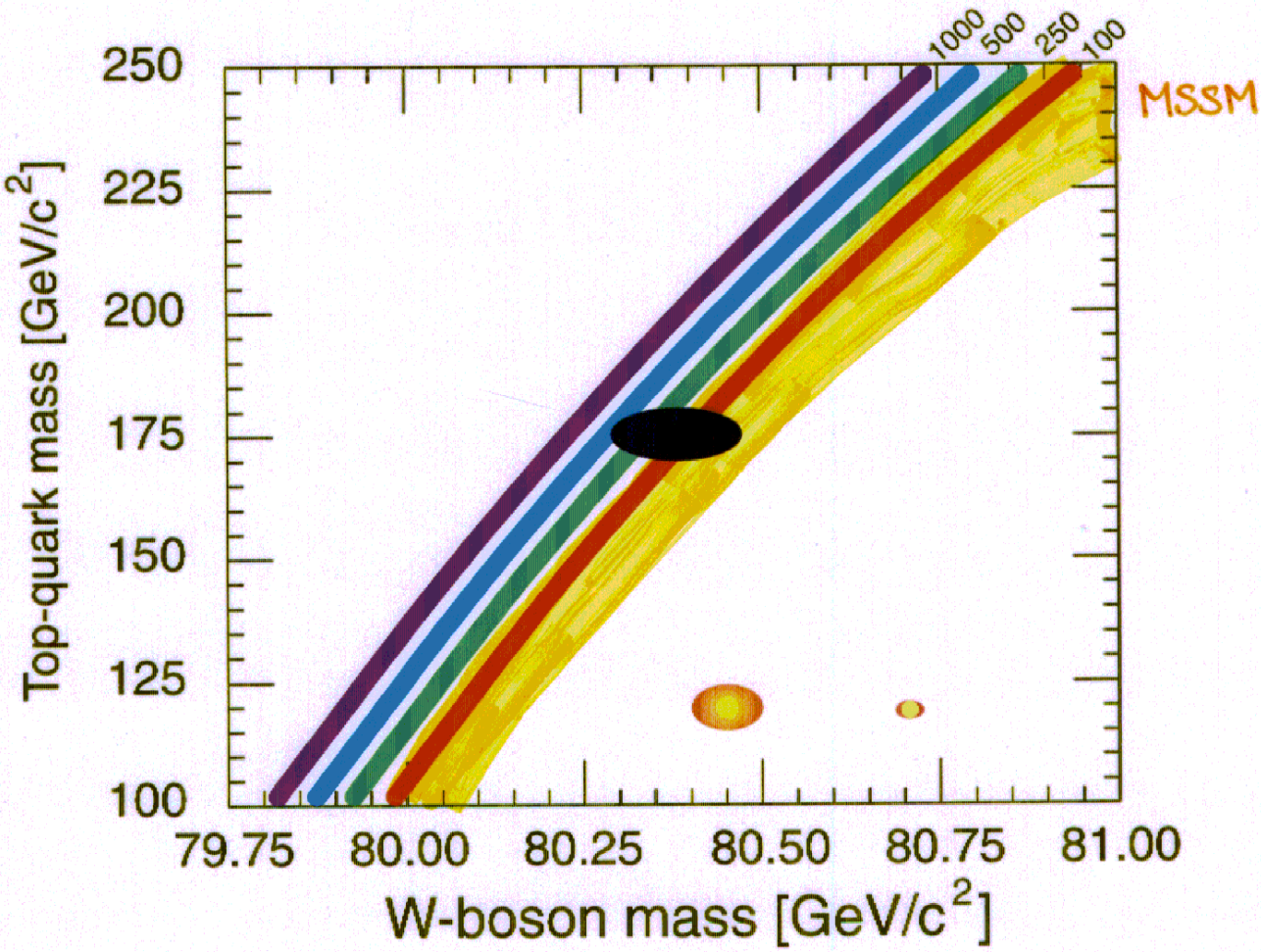
PLENTY OF INTERESTING PHYSICS TOPICS TO THINK ABOUT.

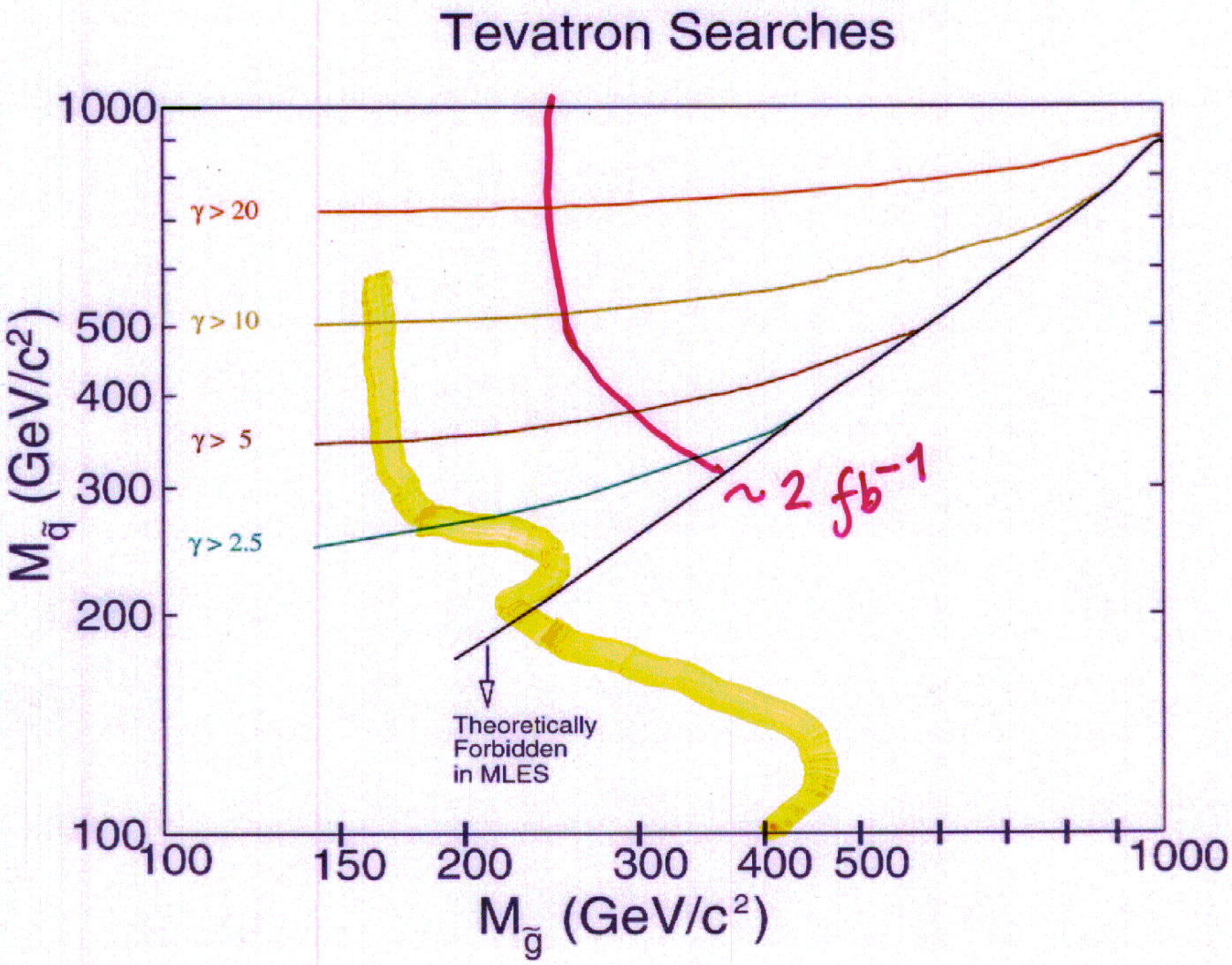
BIG QUESTIONS

- WHAT MACHINES ARE POSSIBLE?
  WHEN?
  AT WHAT COST?
- WHAT ARE THE PHYSICS OPPORTUNITIES?
- CAN WE DO PHYSICS IN THE ENVIRONMENT?
- HOW WILL THESE EXPERIMENTS ADD TO EXISTING KNOWLEDGE WHEN THEY ARE DONE?

$$M_W^2 = M_Z^2(1-\sin^2\theta_W)\left(1 + 3G_F m_t^2/8\pi^2\sqrt{2} + \ldots\right)$$






Tevatron Searches
1000
500
400
300
200
100
$M_{\tilde{q}}$ (GeV/c^2)
γ > 20
γ > 10
γ > 5
γ > 2.5
~ 2 fb^{-1}
Theoretically
Forbidden
in MLES
100
150
200
300
400
500
1000
$M_{\tilde{g}}$ (GeV/c^2)

GENERAL IMPRESSIONS

- THE VARIOUS MACHINES DISCUSSED AS THE FIRST MUON COLLIDER / NEXT LEPTON COLLIDER ARE LUMINOSITY POOR

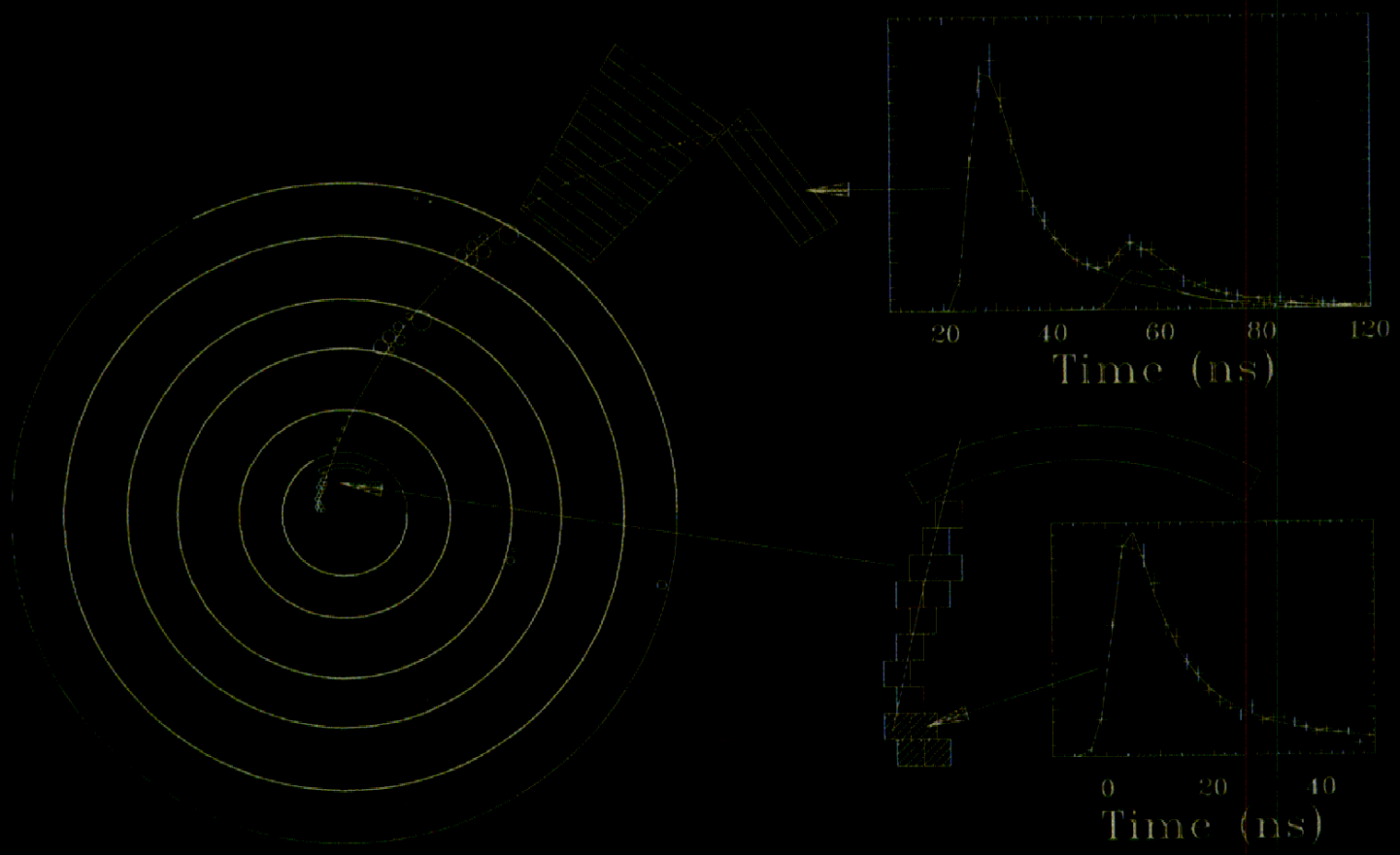
- AN n-RING COMPLEX WILL NOT OPERATE ALL ELEMENTS AT ONCE
  → SEQUENTIAL (OR INTERLEAVED) EXPERIMENTS

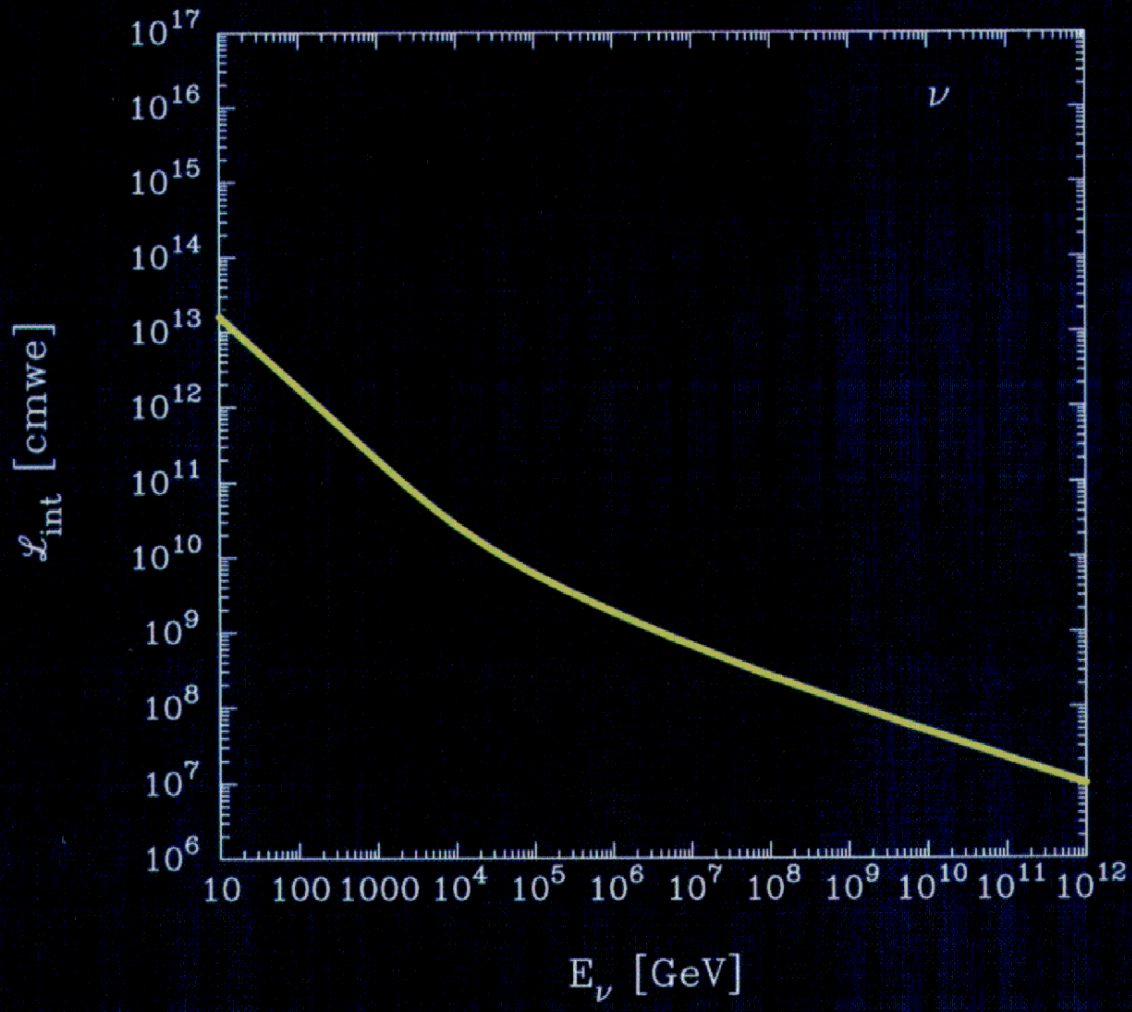
- EVEN MODEST POLARIZATION CAN BE HIGHLY USEFUL, ESPECIALLY IF IT CAN BE CONTROLLED FLEXIBLY / SEPARATELY FOR $\mu^{\pm}$, REVERSIBLE AT WILL.

- SINGLE-MUON-RING DEVICES DO NOT SEEM TO LACK INTENSITY. CAPABILITIES SEEM MUCH BETTER MATCHED TO THE DEMANDS OF THE PHYSICS.

BNL E-787

$K^+ \rightarrow \pi^+ \nu \bar{\nu}$




ν
$\mathscr{L}_{int}$ [cmwe]
10^{17}
10^{16}
10^{15}
10^{14}
10^{13}
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10 100 1000 10^4 10^5 10^6 10^7 10^8 10^9 10^{10} 10^{11} 10^{12}
E_ν [GeV]

INTENSE NEUTRINO SOURCE

FOR DIS AND NEUTRINO STUDIES

FEW GeV – 100 GeV AND BEYOND

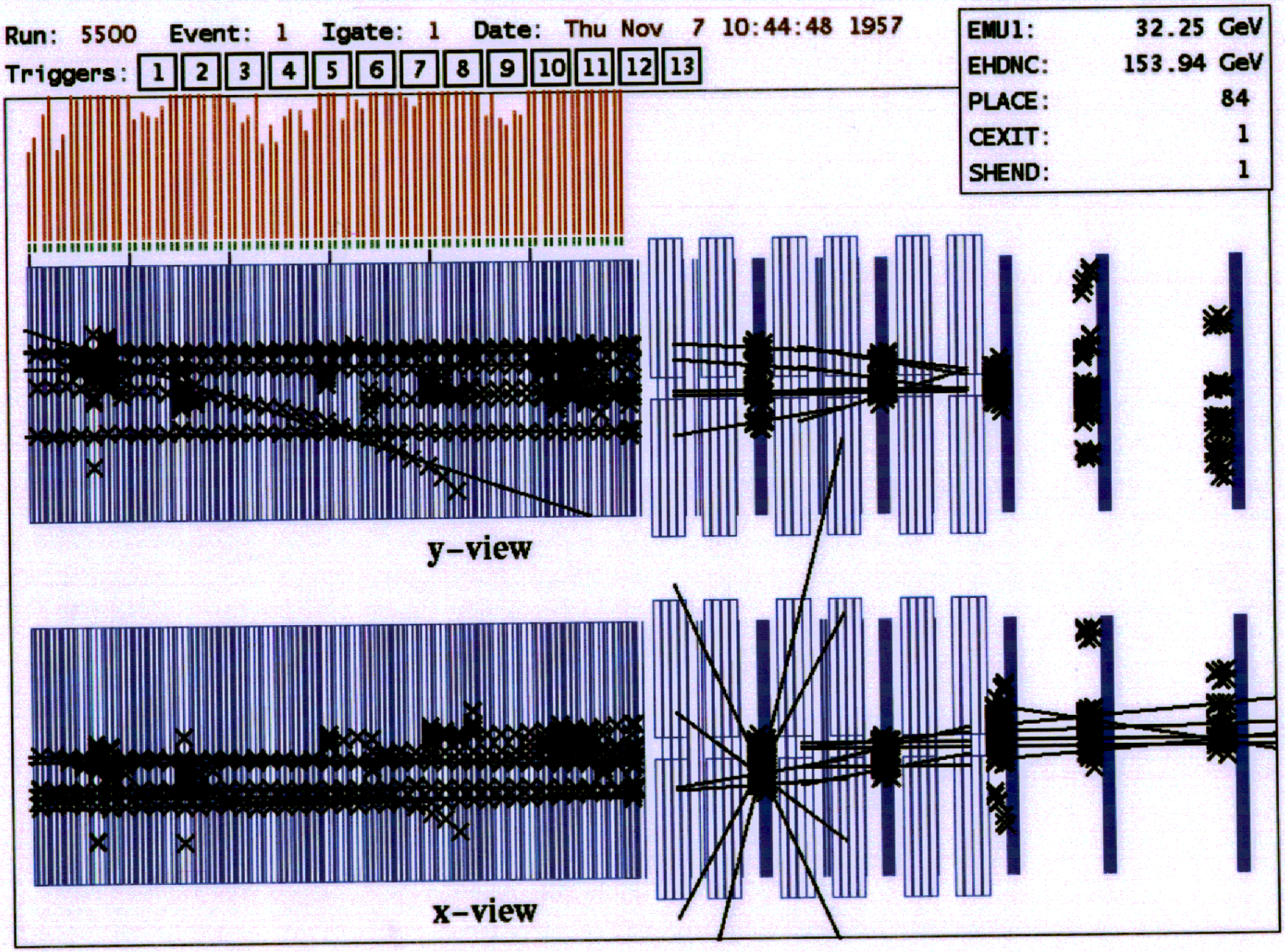
$\nu_\mu \bar{\nu}_e$ OR $\bar{\nu}_\mu \nu_e$ FROM 10^{20-21} μ/YR

- OSCILLATION STUDIES, INCLUDING L-O-O-NG BASELINE SOUDAN / GRAN SASSO
- DIS IN THIN TARGETS (POLARIZED!)

15'

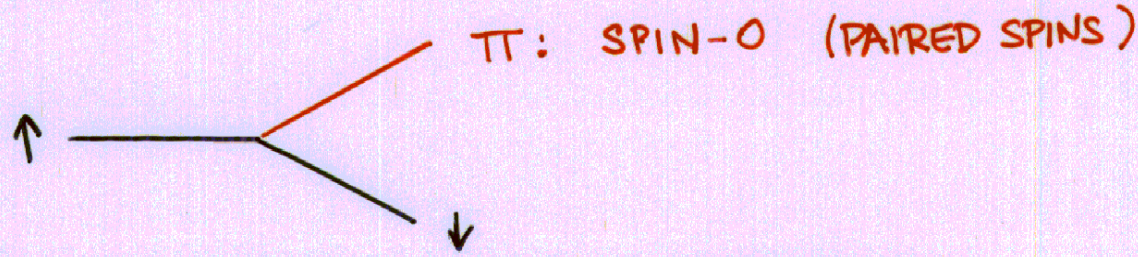
Argonaut

⋮


Run: 5500 Event: 1 Igate: 1 Date: Thu Nov 7 10:44:48 1957
Triggers: 1 2 3 4 5 6 7 8 9 10 11 12 13
EMU1: 32.25 GeV
EHDNC: 153.94 GeV
PLACE: 84
CEXIT: 1
SHEND: 1
y-view
x-view

OTHER IMPLICATIONS OF THIS PICTURE

DISTRIBUTION OF SPIN IN POLARIZED p



REDUCES SPIN-FRACTION CARRIED BY VALENCE QUARKS

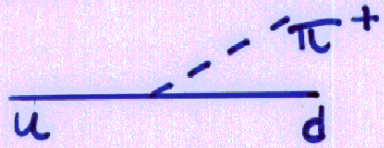
INTERESTING SPECIAL CASE:

$$q_v^{\uparrow} \longrightarrow s^{\downarrow} + K$$

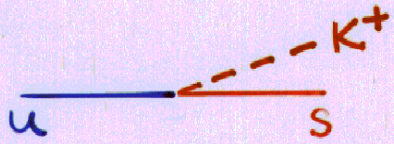
$$\Rightarrow s^{\uparrow} - s^{\downarrow} < 0$$

INVALIDATES ASSUMPTION OF POLARIZATION SUM RULES (GOURDIN-ELLIS-JAFFE):
SPINS IN THE SEA ARE PAIRED

HOW LARGE AN EFFECT? XFT ESTIMATE

IF 

IS 12%

THEN 

IS 8%

$$\Delta s \approx -0.08$$

TOY MODEL FOR SPINS

START WITH SU(6) WAVEFUNCTION FOR VALENCE QUARKS:

$$p_\uparrow = \frac{5}{3}u_\uparrow + \frac{1}{3}u_\downarrow + \frac{1}{3}d_\uparrow + \frac{2}{3}d_\downarrow$$

ONE ITERATION (FOR SU(3) OCTET GOLDSTONES) GIVES SPIN STRUCTURE

$$\begin{aligned} p_\uparrow = & \left(\frac{5}{3} - \frac{19a}{18}\right)u_\uparrow + \left(\frac{1}{3} + \frac{55a}{18}\right)u_\downarrow \\ & + \left(\frac{1}{3} + \frac{11a}{9}\right)d_\uparrow + \left(\frac{2}{3} + \frac{13a}{9}\right)d_\downarrow \\ & + as_\uparrow + 2as_\downarrow \\ & + \cancel{a\bar{u}_\uparrow + a\bar{u}_\downarrow} + \cancel{\frac{4a}{3}\bar{d}_\uparrow + \frac{4a}{3}\bar{d}_\downarrow} + \cancel{\frac{5a}{3}\bar{s}_\uparrow + \frac{5a}{3}\bar{s}_\downarrow} \end{aligned}$$

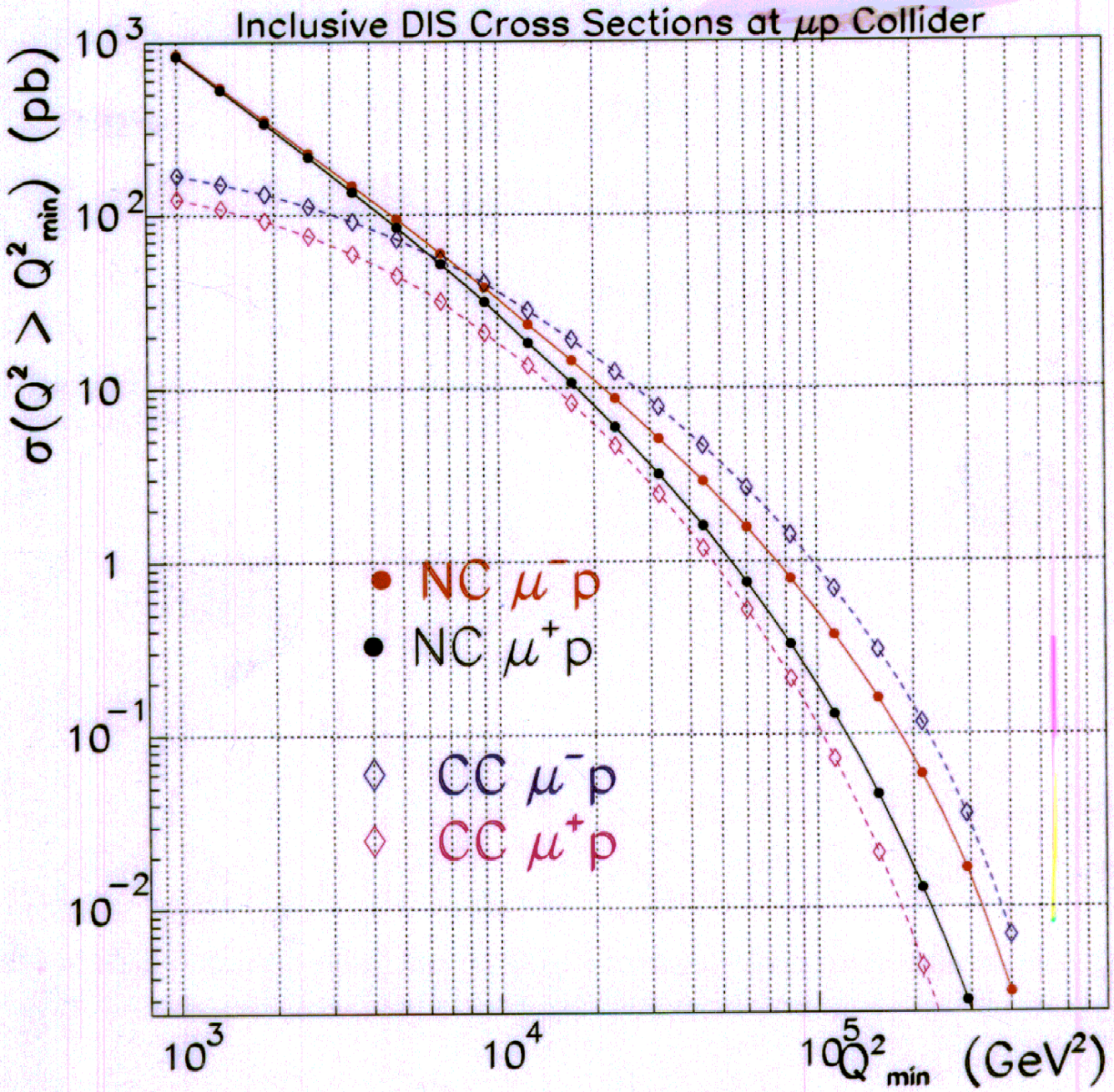
SPIN ASYMMETRIES

$$\Delta_u = \frac{4}{3} - \frac{37a}{9}$$

$$\Delta_d = -\frac{1}{3} - \frac{2a}{9}$$

$$\Delta_s = -a$$

10 fb^{-1} (1 YR) $\Rightarrow$ 10^6 evts
$Q^2 > 5000$ GeV^2

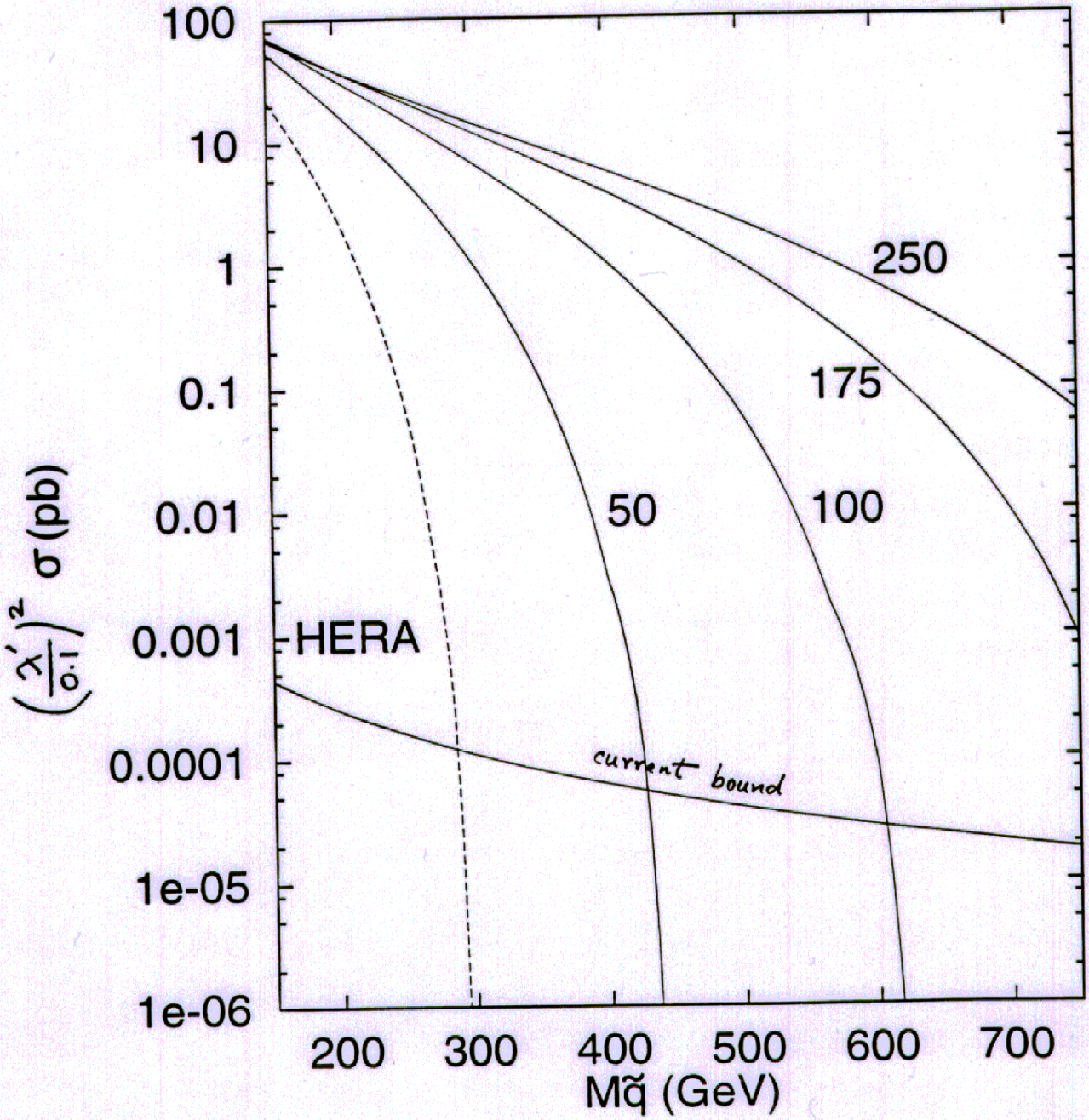


for HERA (e^+p) : λ'_{1j1}

for μ^+p : λ'_{2j1}

S. Raychaudhuri

$\not{R}$ $\tilde{q}$ production



HIGGS

Many possibilities for detailed studies.

Need attention to

$\mathcal{L}$ (TIME TO DO)

ENVIRONMENT

SVX / PARTICLE ID

SUPERSYMMETRY

SUGRA

GAUGE-MEDIATED

= CHILDREN AT PLAY
(GAELIC)

RICH POSSIBILITIES FOR DETAILED STUDY AT ½ TeV

$\mathcal{L}$ AN ISSUE, ESPECIALLY FOR SLEPTONS.

STUDY BEST USE OF POLARIZATION

STRONG DYNAMICS

NANOBARN CROSS SECTIONS!

$\mu\mu \rightarrow \pi_T^0$ FACTORY

SIGNIFICANT SENSITIVITY TO COMPOSITENESS

CONCLUSIONS

- THIS IS SERIOUS.

NEED MACHINE STUDIES

REALISTIC EXPT SIMULATIONS

KEEP THE IDEAS COMING!

2010 SEEMS A LONG TIME AWAY
FOR THE FIRST STEP

How soon could we imagine an

INTENSE NEUTRINO SOURCE

OR

μp COLLIDER?

All this is but a dream.

Still, examine it by a few experiments.

Nothing is too wonderful to be true,
if it be consistent with the laws of nature
and in such things as these,
Experiment is the best test of such
consistency.

Michael Faraday
Research notes, 19th March 1849