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Scientific Spokesman:

B. Barish
California Institute of Technology
Pasadena, California 91109

(213)795-6846, X2684

STUDIES OF DEEP INELASTIC DIFFERENTIAL DISTRIBUTIONS AT HIGH ENERGIES FOR ν, $\bar{\nu}$ BEAMS

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STUDIES OF DEEP INELASTIC DIFFERENTIAL DISTRIBUTIONS* AT HIGH ENERGIES FOR ν, $\bar{\nu}$ BEAMS

B. C. Barish, J. F. Bartlett, A. Bodek, K. W. Brown, D. Buchholz,
F. S. Merritt, F. J. Sciulli, L. Stutte, H. Suter†

California Institute of Technology
Pasadena, California 91125

and

E. Fisk and G. Krafczyk

Fermilab, Batavia, Illinois

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Spokesmen: B. Barish and F. Sciulli

Abstract

We propose as the initial experiment in the new dichromatic ν detector to make a systematic study of deep inelastic cross sections. This experiment will use the present target-detector remounted. A new magnet spectrometer system will be installed giving both better resolution and acceptance. An improved dichromatic beam will also give better information on the incident neutrino energy. We propose 1000 hours of running with $\geqslant 10^{13}$ ppp for this experiment.

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So far, the knowledge of deep inelastic distributions at high energies is mainly qualitative. However, the simple picture of "scaling" structure functions with the same form as seen at SLAC for e-p and e-n scattering prevail.

The Q^2 distribution shows a form which is inconsistent with a large breakdown of scaling and in fact (see fig. 1) indicates that the distributions require $\Lambda > 10.4$ GeV for a propagator type breakdown. Although, this probably is not the form of an actual scaling breakdown, it is a useful way of showing that scaling approximately holds.

For ν's the y distributions are expected to have the form $\frac{d\sigma}{dy} \sim$ const. Figure 2 shows that $0 < y < .6$, the distribution is quite flat. Unfortunately, the present magnet aperture has small acceptance at large angles, which is reflected in a lack of acceptance at large y (see fig. 3). Therefore, the behavior at large y (or large Q^2) is still unknown.

Antineutrinos are expected to approximately behave like $\frac{d\sigma}{dy} \propto (1-y)^2$ in the scaling region. This qualitative behavior is seen (though we are not inconsistent with some deviation at small $x < .1$, as has been reported by EIA).

The x-distributions (see fig. 4) are badly distorted by both resolution and acceptance in the present experiment. It can only be concluded that the observed distribution is consistent with F_2^{ed} observed at SLAC.

We propose here to measure these distributions more quantitatively both with better acceptance and resolution. The new magnet spectrometer (described in the facility memo) will have reasonable acceptance out to $y \sim 0.8$. Beyond that the events can still be analyzed; θ_μ and E_h are enough to resolve the dichromatic beam ambiguity. Therefore, x and y can be determined (albeit with poor resolution) since $E_\mu = E_\nu - E_h$.

The expected resolutions for this experiment are expected to be:

$$\frac{\Delta p_\mu}{p_\mu} \sim .14 \qquad \text{(presently} \sim .21)$$

$$\frac{\Delta E_\nu}{E_\nu} \sim .10 \qquad \text{(presently} \sim .30)$$

For 1000 hours of running we should collect approximately

$\sim$ 10000 ν events

$\sim$ 3000 $\bar{\nu}$ events

in these distributions.

This sample should well match our systematic errors and provide a significant step toward <u>quantitative</u> deep inelastic neutrino and antineutrino distributions.

One would expect from this sample to make a truly significant test of scaling in both the Q^2 and x distributions. Also the quantitative fits and comparisons of y distributions will also be made.

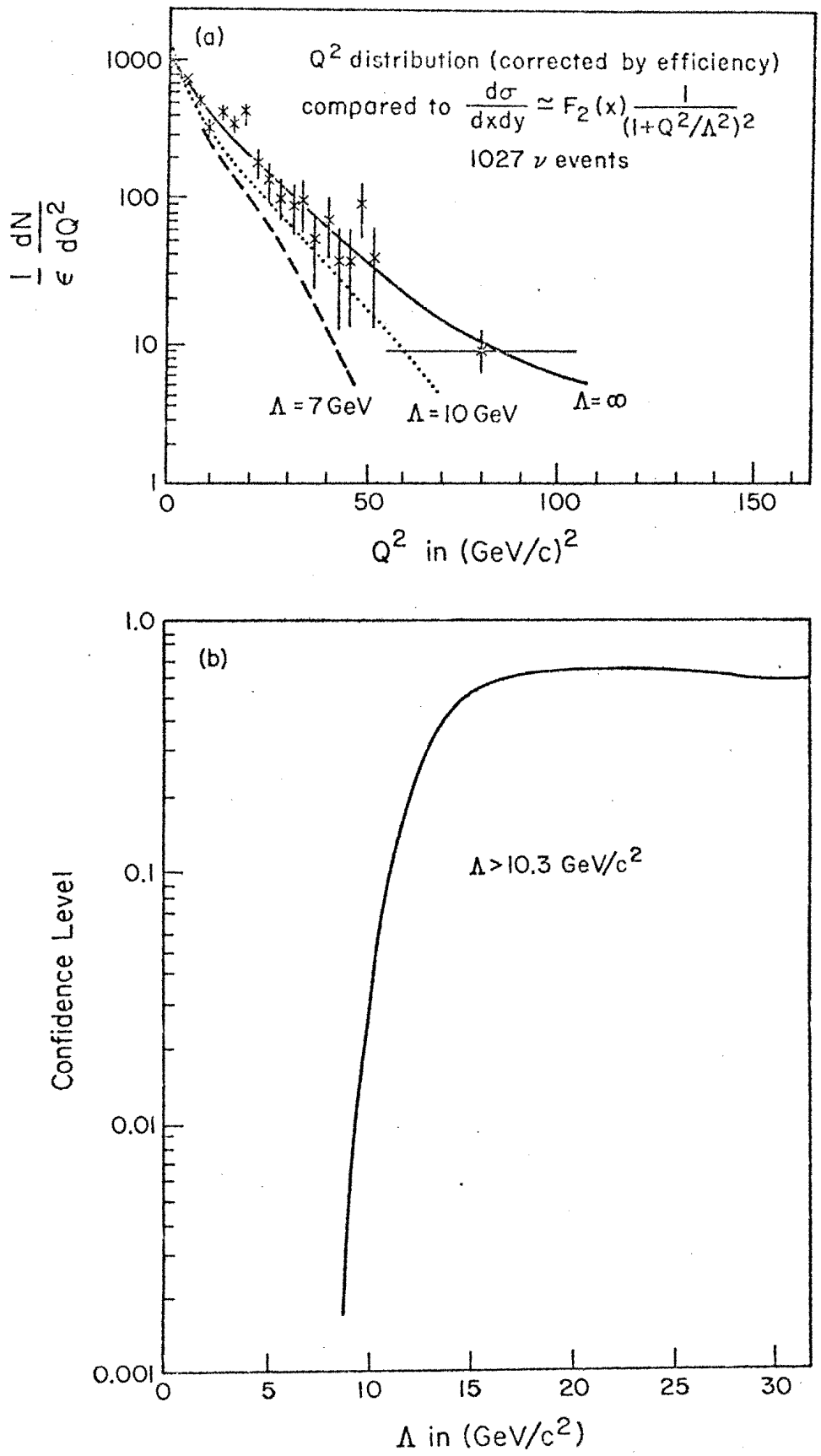
(a)
Q^2 distribution (corrected by efficiency)
compared to $\frac{d\sigma}{dxdy} \simeq F_2(x) \frac{1}{(1+Q^2/\Lambda^2)^2}$
1027 ν events
$\frac{1}{\epsilon}\frac{dN}{dQ^2}$
1000
100
10
1
0
50
100
150
Λ = 7 GeV
Λ = 10 GeV
$\Lambda = \infty$
Q^2 in $(GeV/c)^2$
(b)
Confidence Level
1.0
0.1
0.01
0.001
0
5
10
15
20
25
30
$\Lambda > 10.3$ GeV/c^2
Λ in (GeV/c^2)

Fig. 1

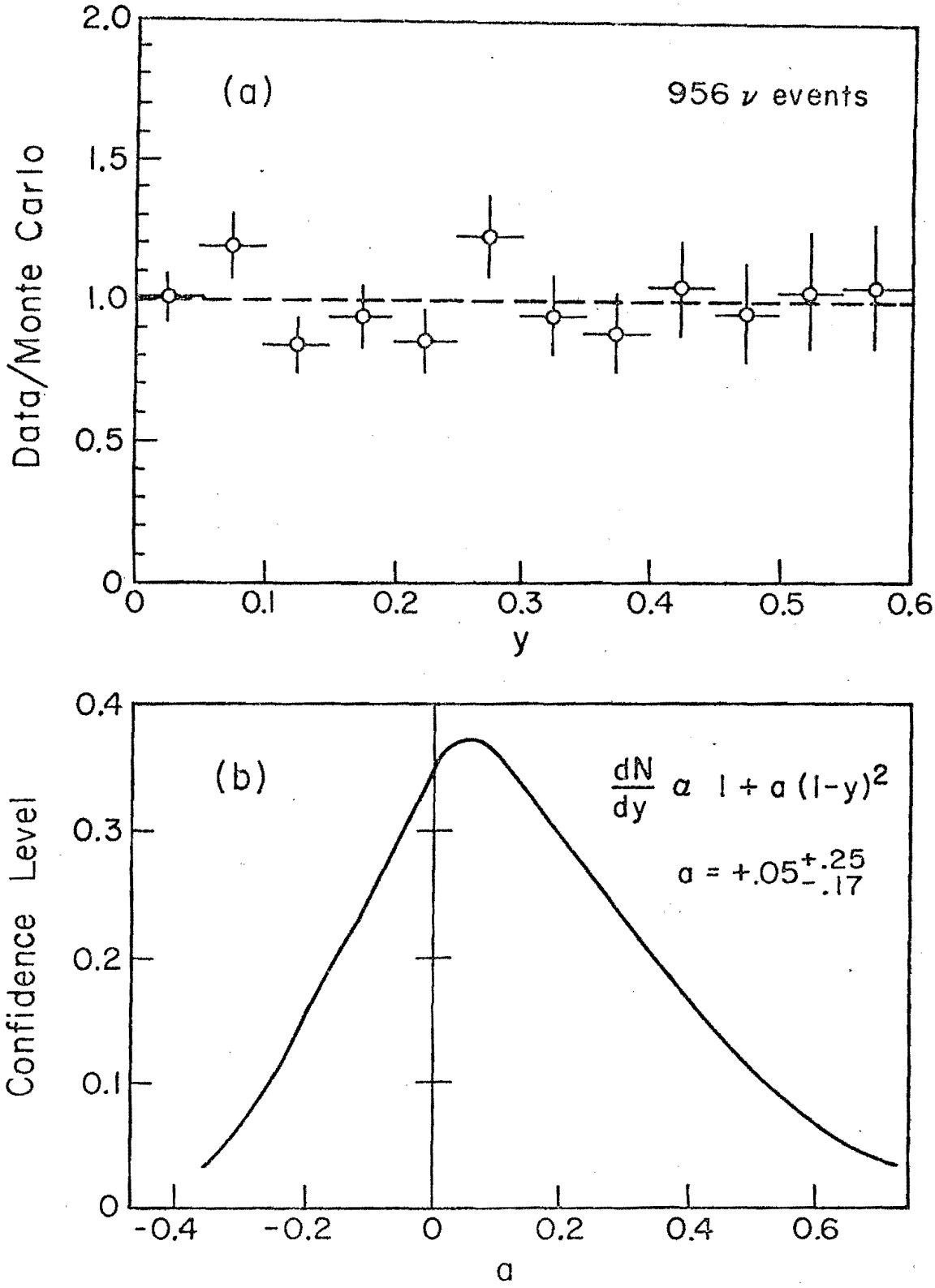
(a)
956 ν events
Data/Monte Carlo
2.0
1.5
1.0
0.5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
y
(b)
dN/dy ∝ 1 + a (1-y)²
a = +.05 +.25 -.17
Confidence Level
0.4
0.3
0.2
0.1
0
-0.4
-0.2
0
0.2
0.4
0.6
a

Fig. 2

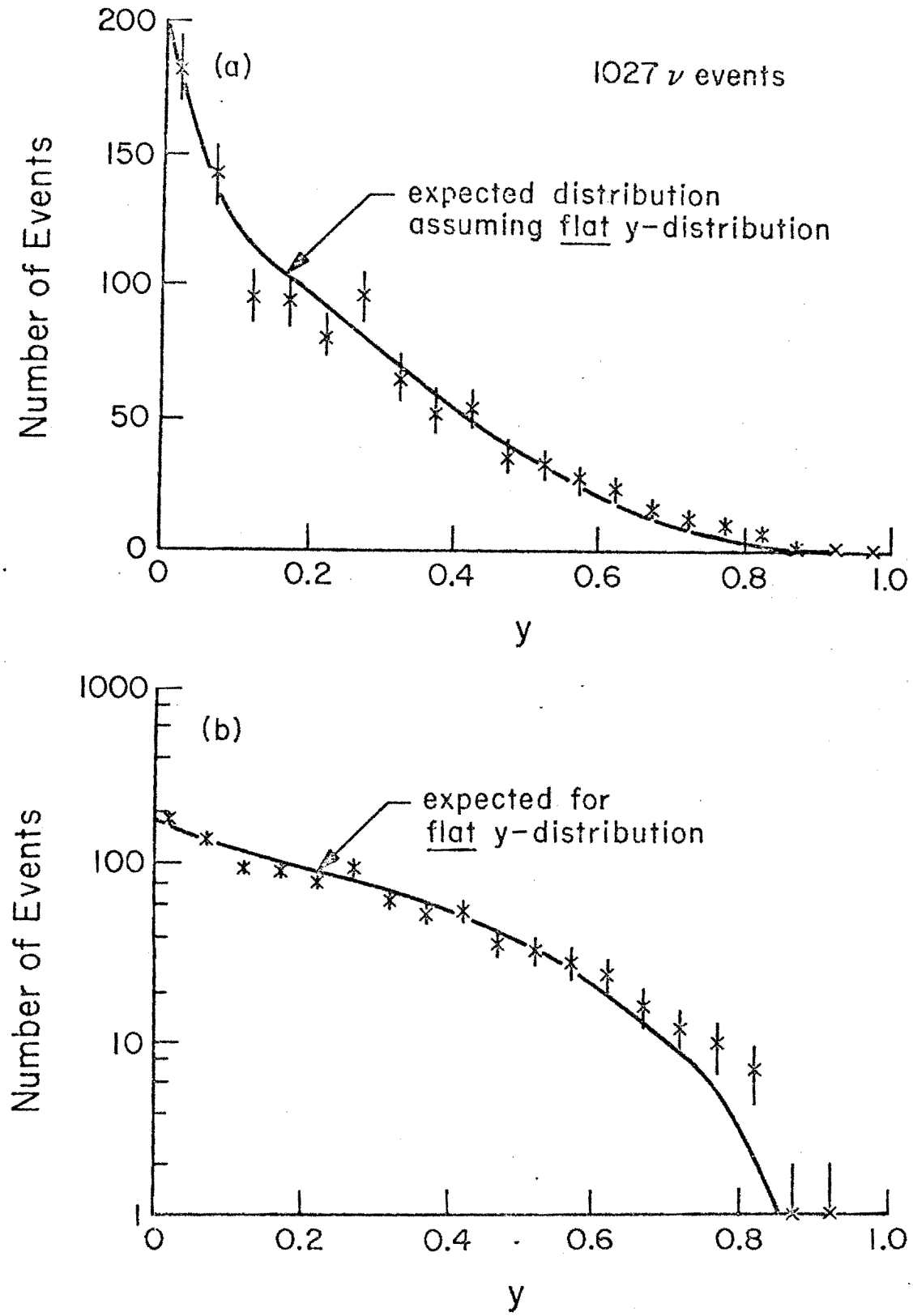
(a)
1027 ν events
expected distribution
assuming flat y-distribution
Number of Events
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1.0
y
(b)
expected for
flat y-distribution
Number of Events
1000
100
10
1
0
0.2
0.4
0.6
0.8
1.0
y

Fig. 3

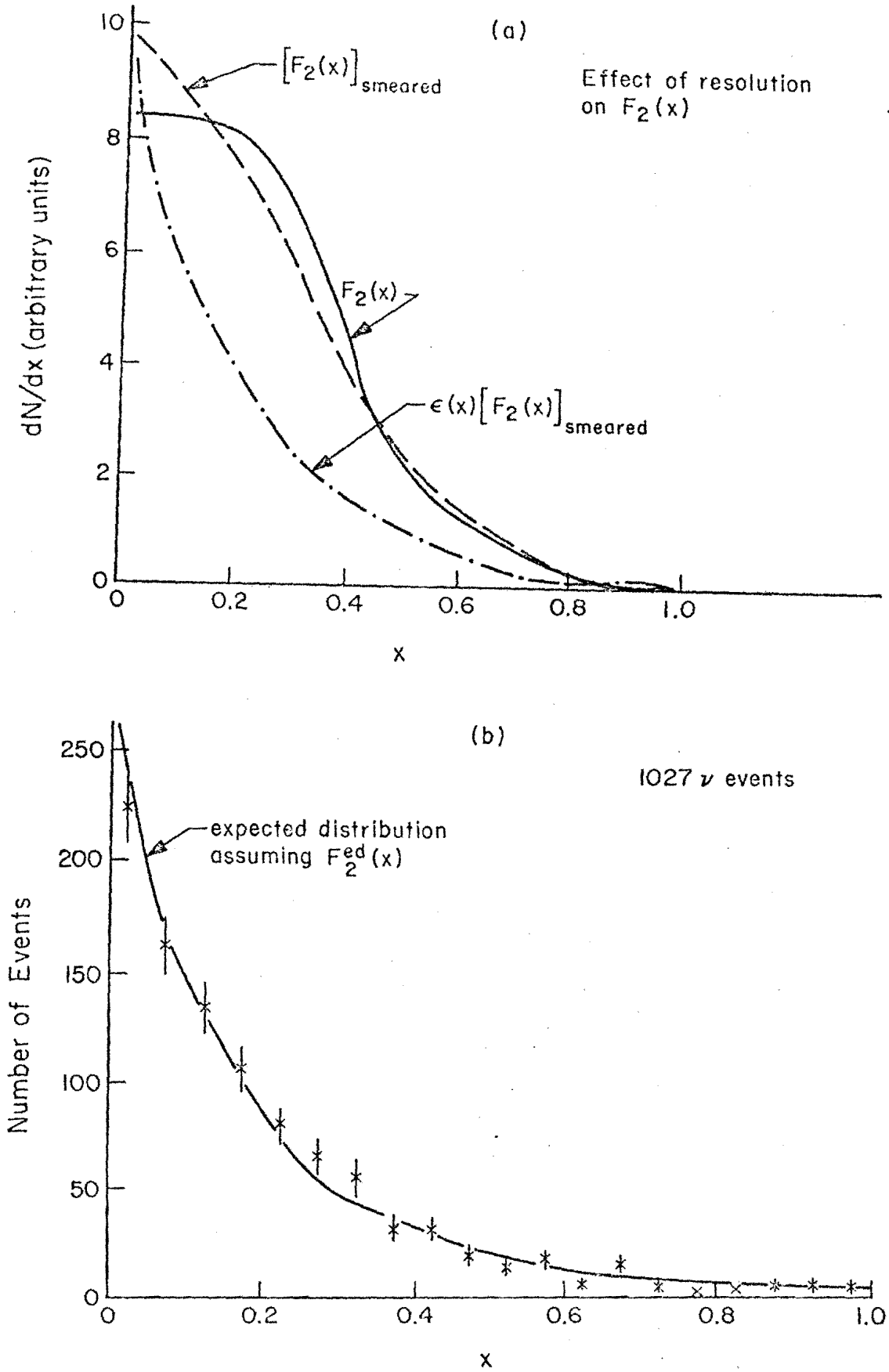
(a)
Effect of resolution on $F_2(x)$
$[F_2(x)]_{smeared}$
$F_2(x)$
$\epsilon(x)[F_2(x)]_{smeared}$
dN/dx (arbitrary units)
x
(b)
1027 ν events
expected distribution assuming $F_2^{ed}(x)$
Number of Events
x

Fig. 4