

DUMAND Internal Report

DIR-9-91

30-April-1991
M. Lynn Stevenson

"Seattle Transparencies of "Parameterization of (Anti)Neutrino Cross Sections""

(Talk based mainly on my DUMAND Internal Report, DIR-5-91)

DUMAND Seattle Collaboration Meeting

M. Lynn Stevenson
19 April 1991

Parameterization of (Anti)Neutrino Cross Sections
of

Quigg, Reno, and Walker (PRL 57, 774 (1986), PR D37, 657(1988))

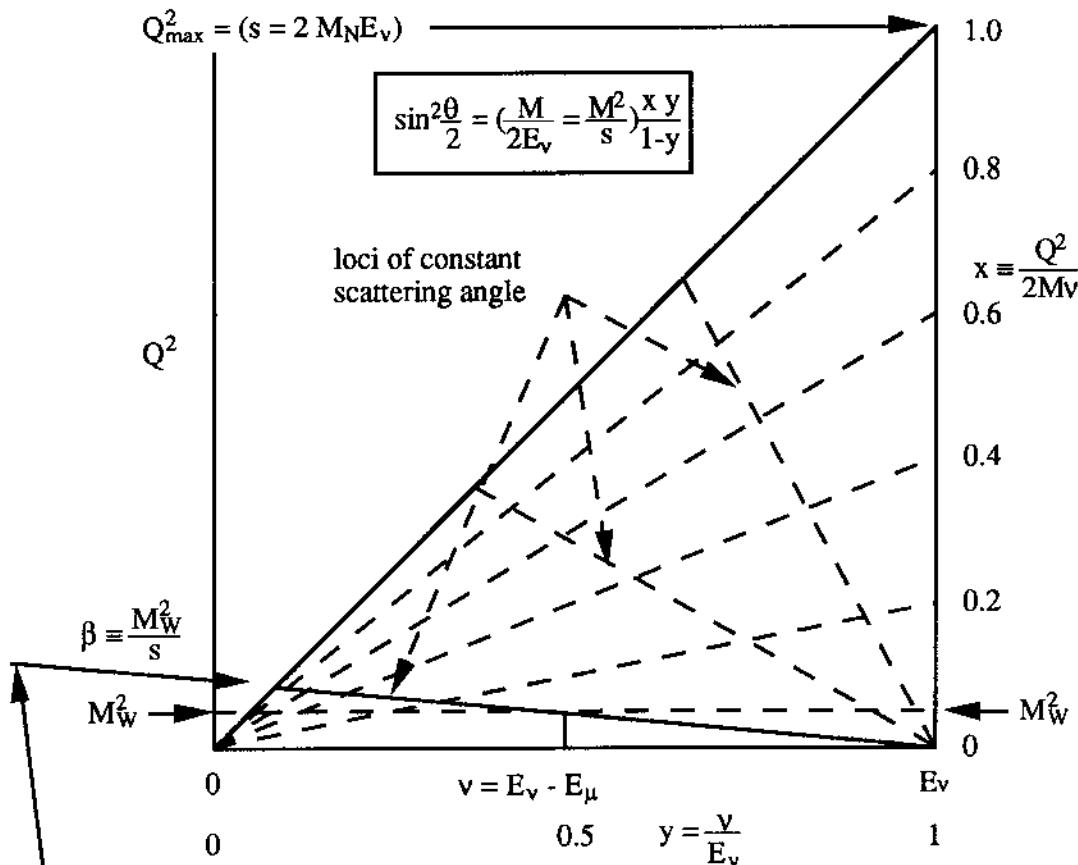
- $d\sigma/dx dy$ versus E_ν with the W propagator
- Total Charged Current(CC) Cross Sections, σ

Neutrinos
Antineutrinos

- Differential CC Cross Section $d\sigma/dy$
- Total (CC+NC) Cross Sections

Neutrinos
Antineutrinos

The Kinematics of Very High Energy Inelastic Neutrino Scattering



The propagator, $(\frac{M_W^2}{M_W^2 + Q^2} = \frac{\beta}{\beta + xy})^2$, effectively kills all scattering above

$Q^2 = M_W^2$ (or $xy = \beta$). Thus the typical scattering angle is less than, θ_W ,

(with $y \leq 1/2$), where, $\sin^2 \theta_W / 2 \leq (\frac{M^2}{s}) \frac{(xy = \beta)}{1-(y=0.5)} = 2\beta^2 (\frac{M^2}{M_W^2})$

$$\theta_W = 2^{3/2} \beta \frac{M}{M_W} = 0.0332 \beta \text{ radians}$$

For $E_v = 1 \text{ PeV} = 10^6 \text{ GeV}$, $\theta_W = (0.0332)(\beta = 3.41 \times 10^{-3}) = 1.13 \times 10^{-4} \text{ radians} = 6.49 \text{ milli-deg.}$

Fig.A

Where the Propagator Kills Scattering

in

x-y Space

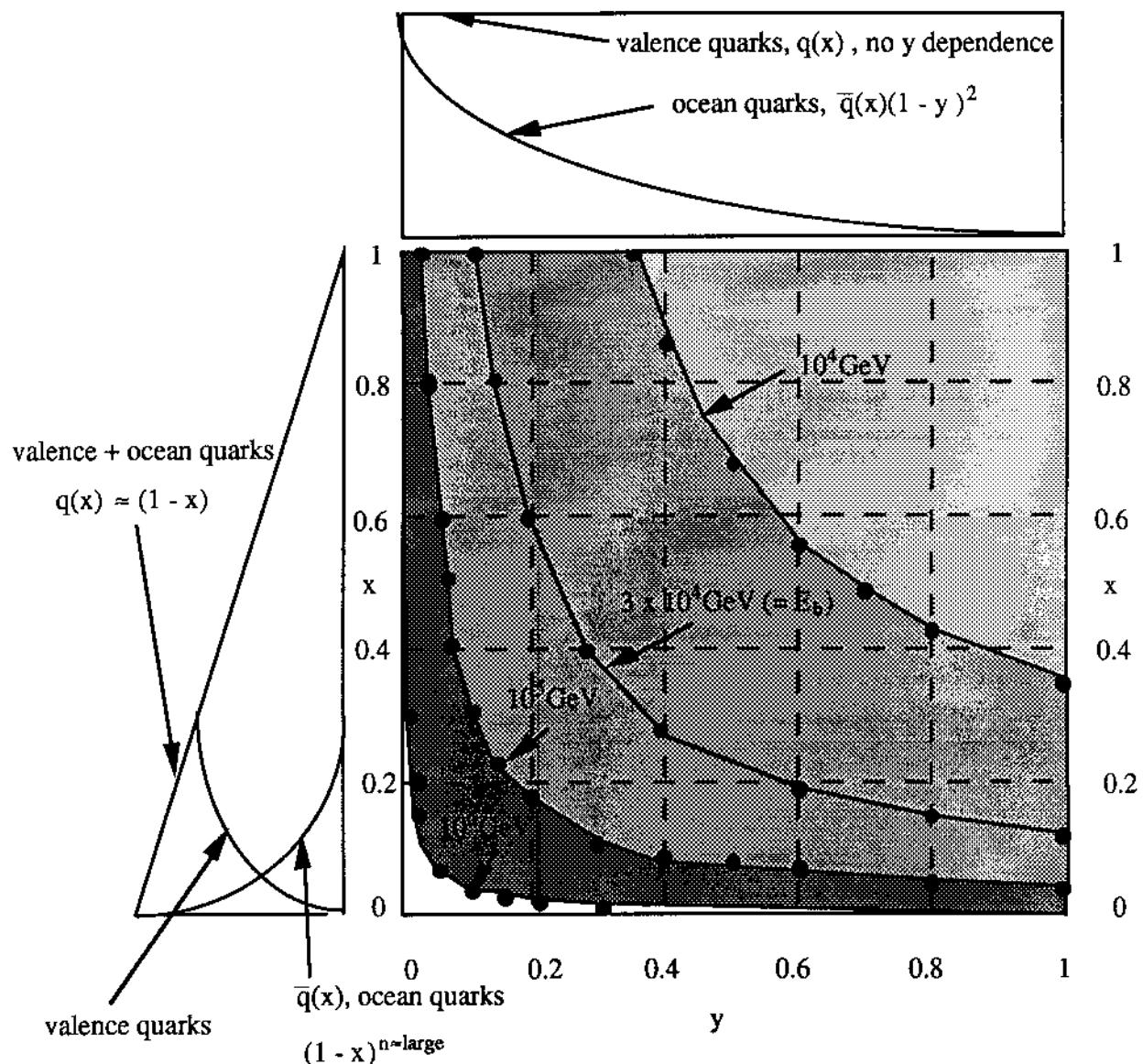


Fig. B

Double differential Cross Section. See Halprin and Oakes (DUMAND '78 Workshop, pg. 43)

$$\frac{d\sigma}{dxdy} = \left[\frac{\beta}{\beta + xy} \right]^2 \frac{G^2}{2\pi} (s = 2M_N E_V) [q(x) + \bar{q}(x)(1 - y)^2] \quad (\text{eq. 1})$$

where x and y are the Bjorken scaling variables,
and $\beta = (M_W)^2 / (s = 2M_N E_V)$.

My crude approximation for neutrinos;

$$q(x) = 1 - x, \text{ and } \bar{q}(x) = 0$$

yields a simple form for the total CC cross section;

$$\sigma = \left[\frac{(GM_W)^2}{2\pi} \right] = 5,468 \times 10^{-38} \text{ cm}^2 [(1+\beta)\ln(\beta^{-1}+1) - 1] \quad (\text{eq. 2})$$

At low energy (large β),

$[(1+\beta)\ln(\beta^{-1}+1) - 1] \approx \beta^{-1} = (s = 2M_N E_V)/(M_W)^2$
and the cross section rises linearly with E_V .

At high energy (small β),

$[(1+\beta)\ln(\beta^{-1}+1) - 1] \approx \ln(\beta^{-1} = 2M_N E_V/(M_W)^2)$
and the cross section rises logarithmically with E_V .

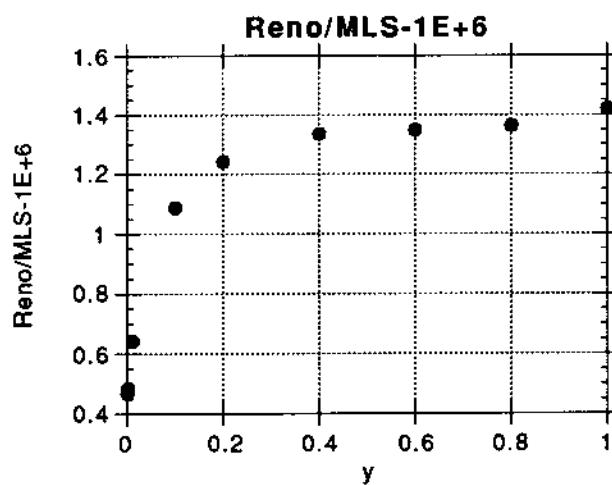


Fig. 7c

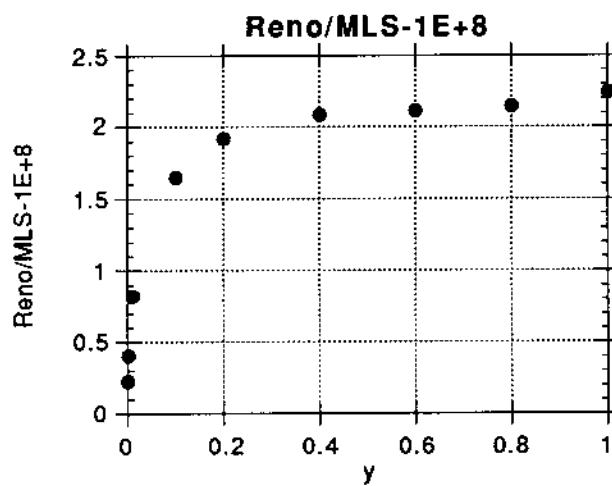


Fig. 7d

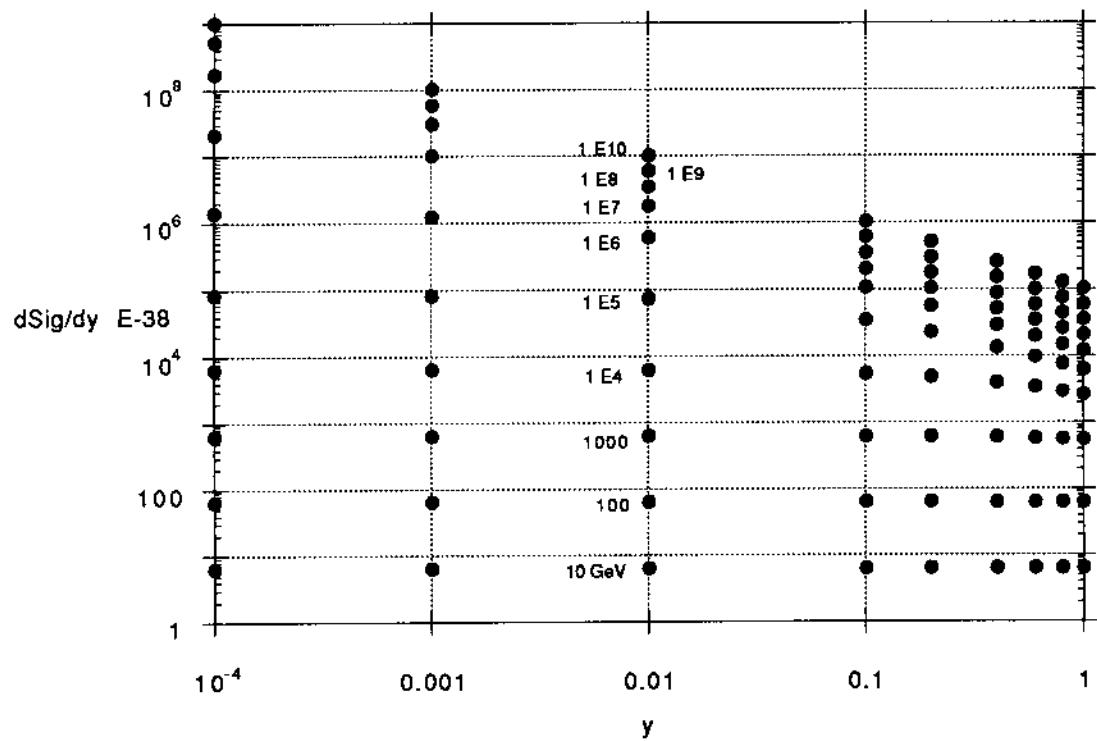


Fig. 7e

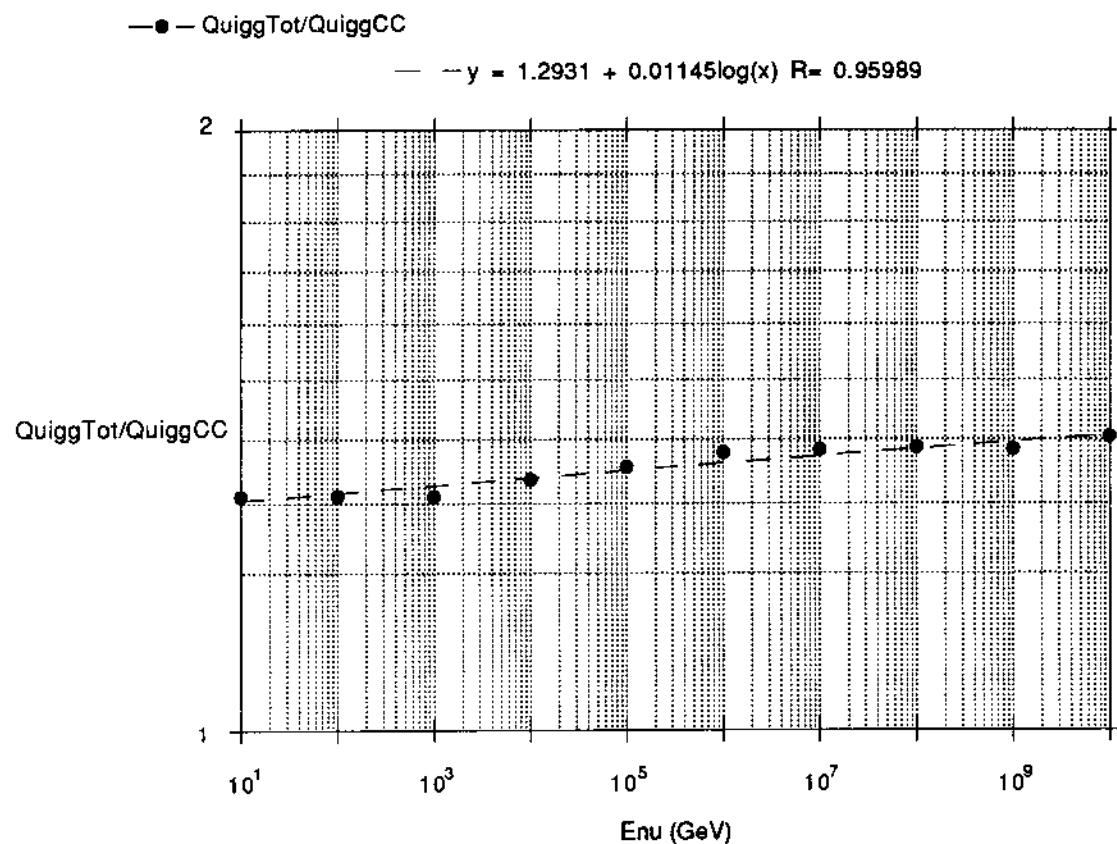


Fig. 8

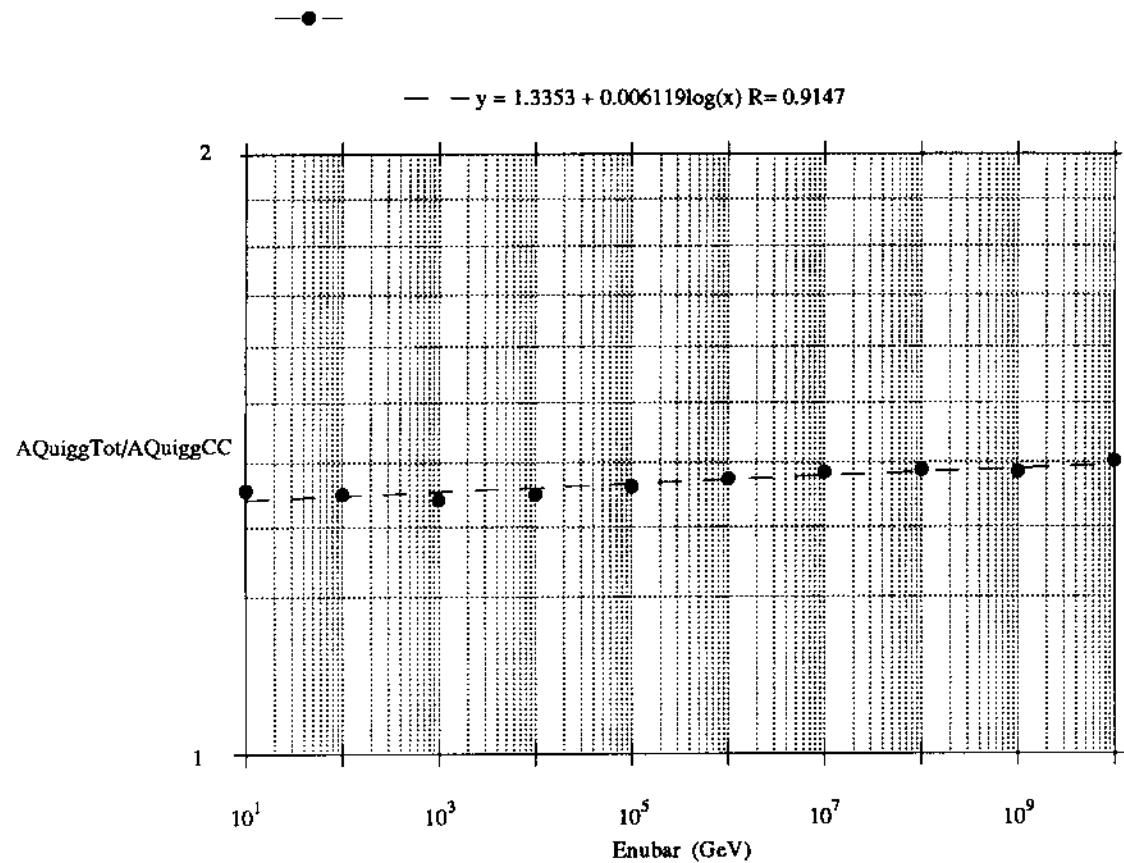


Fig. 9

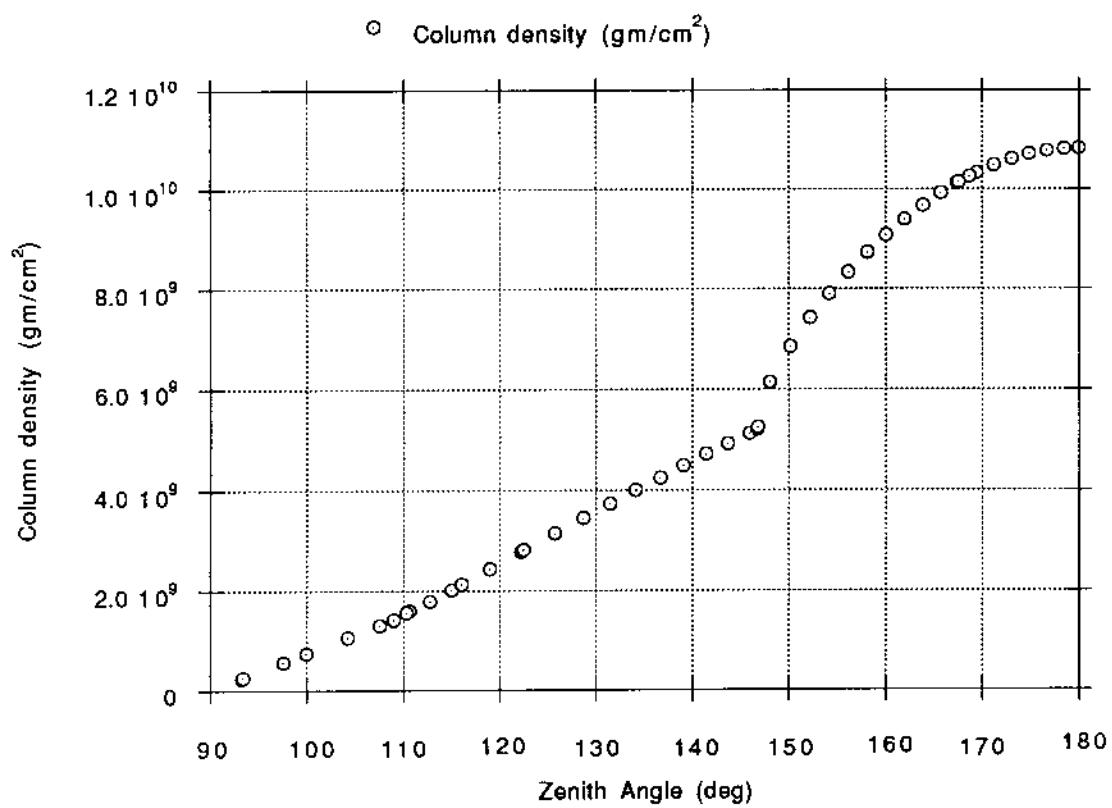


Fig. 10 a

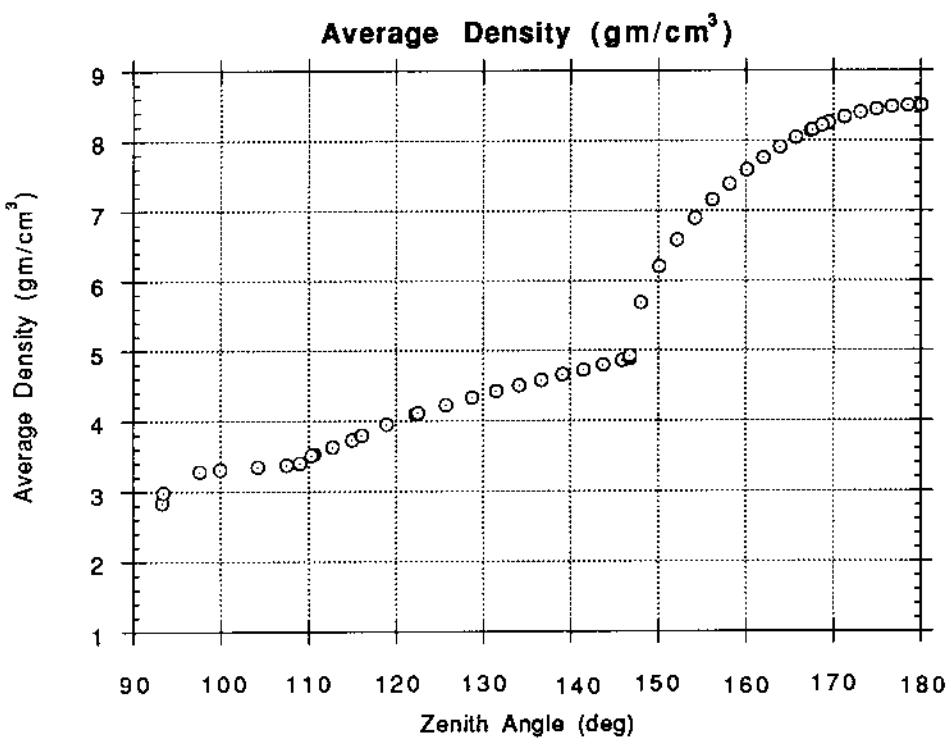


Fig. 10 b

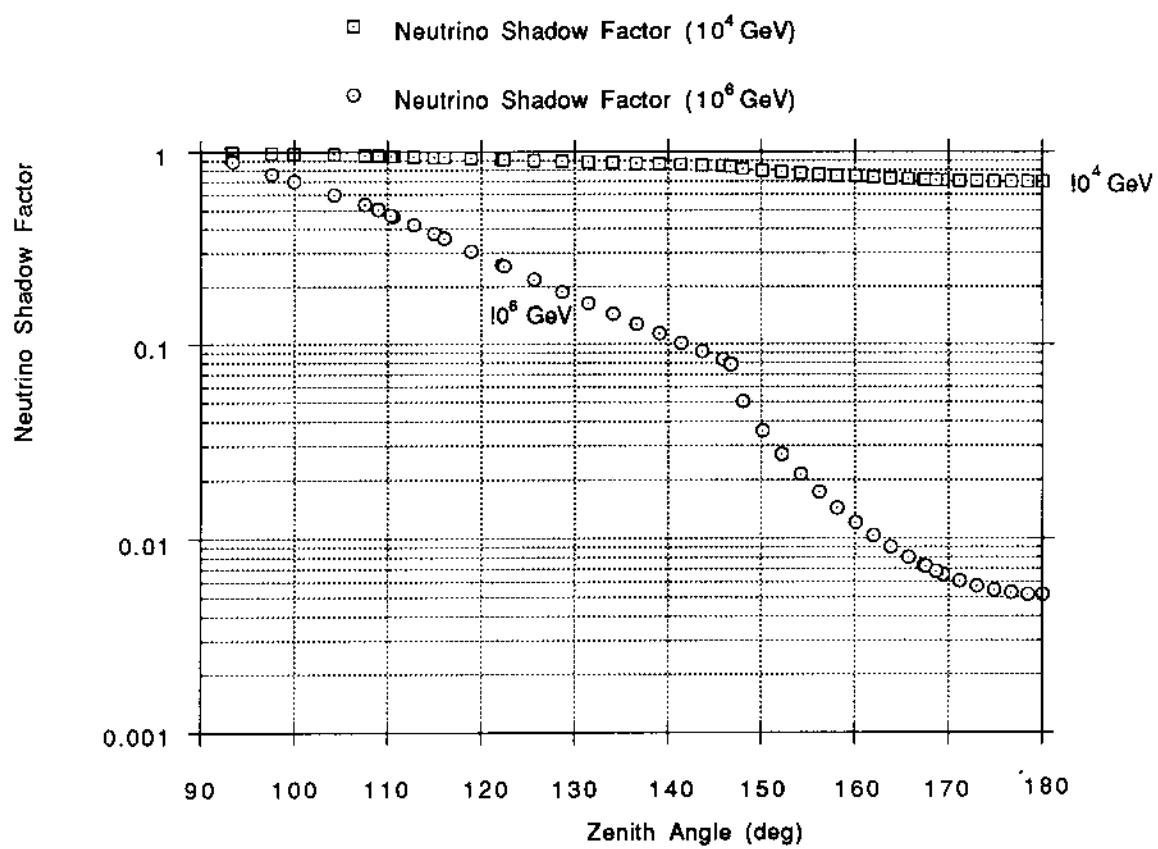


Fig. 11

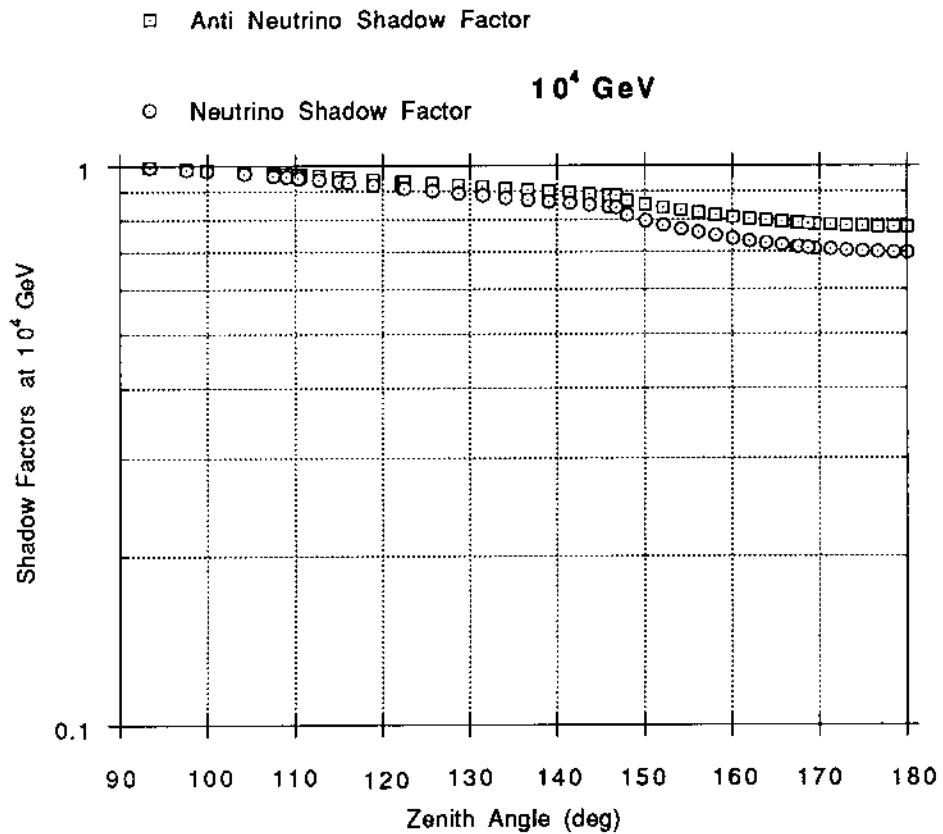


Fig. 12

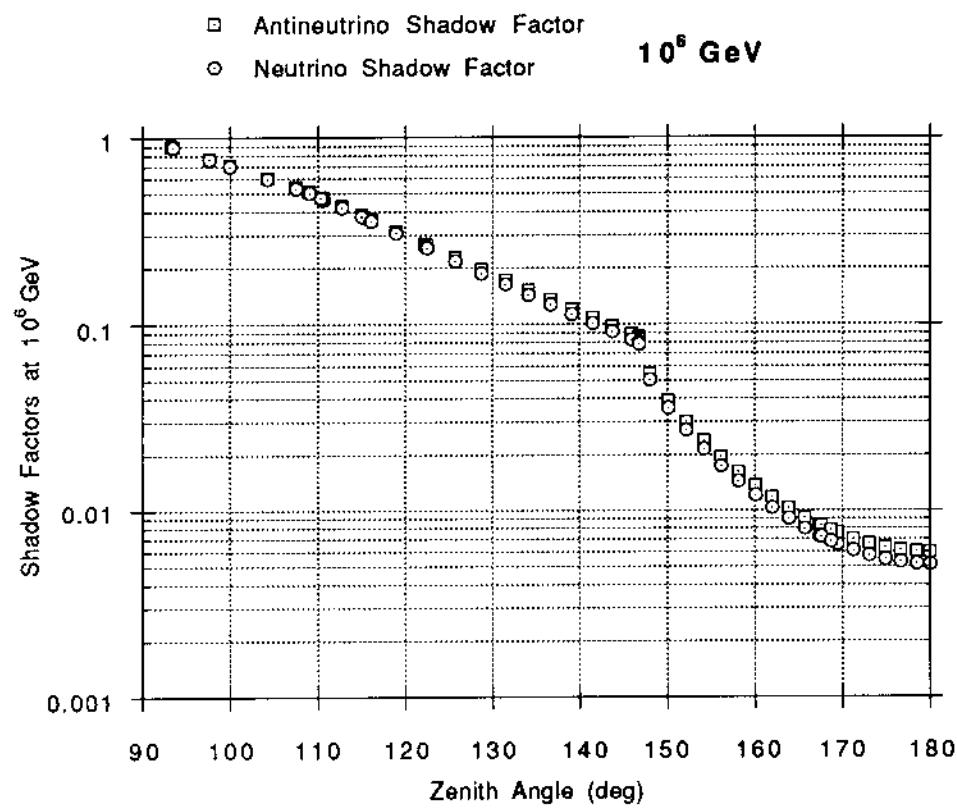


Fig. 13

Quigg/FactorC

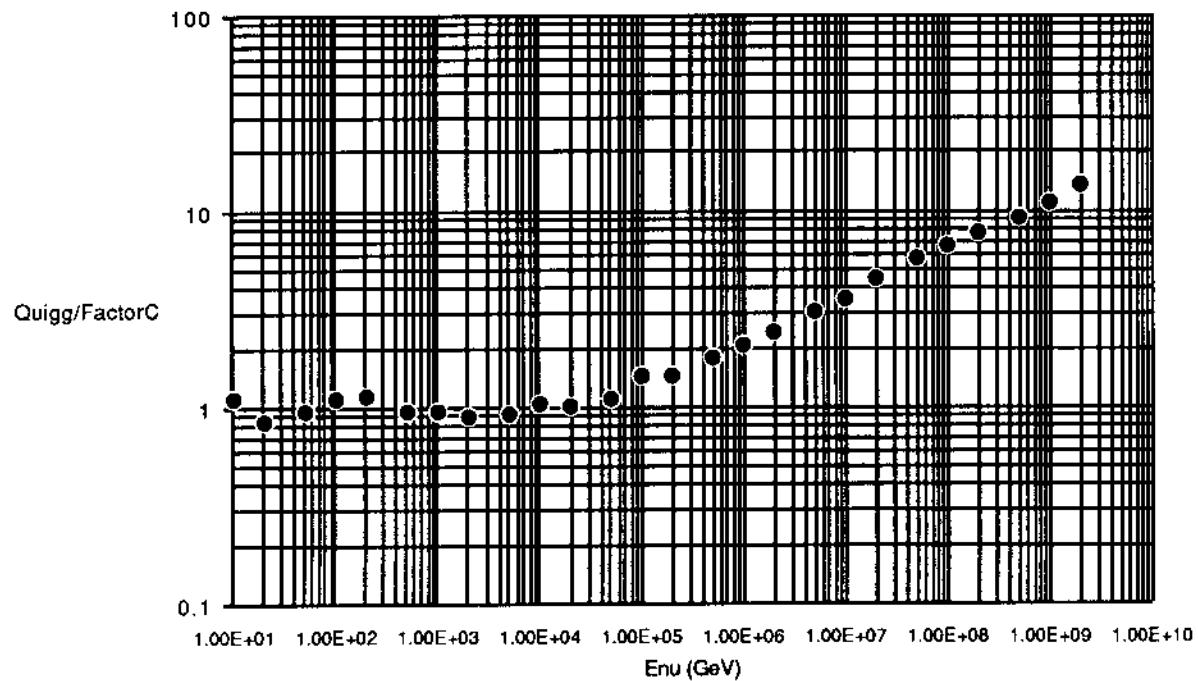


Fig. 1

The agreement below $E_b = 3 \times 10^4$ improves by using $M_W = 90$ GeV rather than 80 GeV. However, the constant, $[(GM_W)^2/2\pi] = 5,468 \times 10^{-38} \text{ cm}^2$, is evaluated using $M_W = 80$ GeV.

Quigg/Corr"(E/Eb)^0.23 above Eb = 3E4 GeV

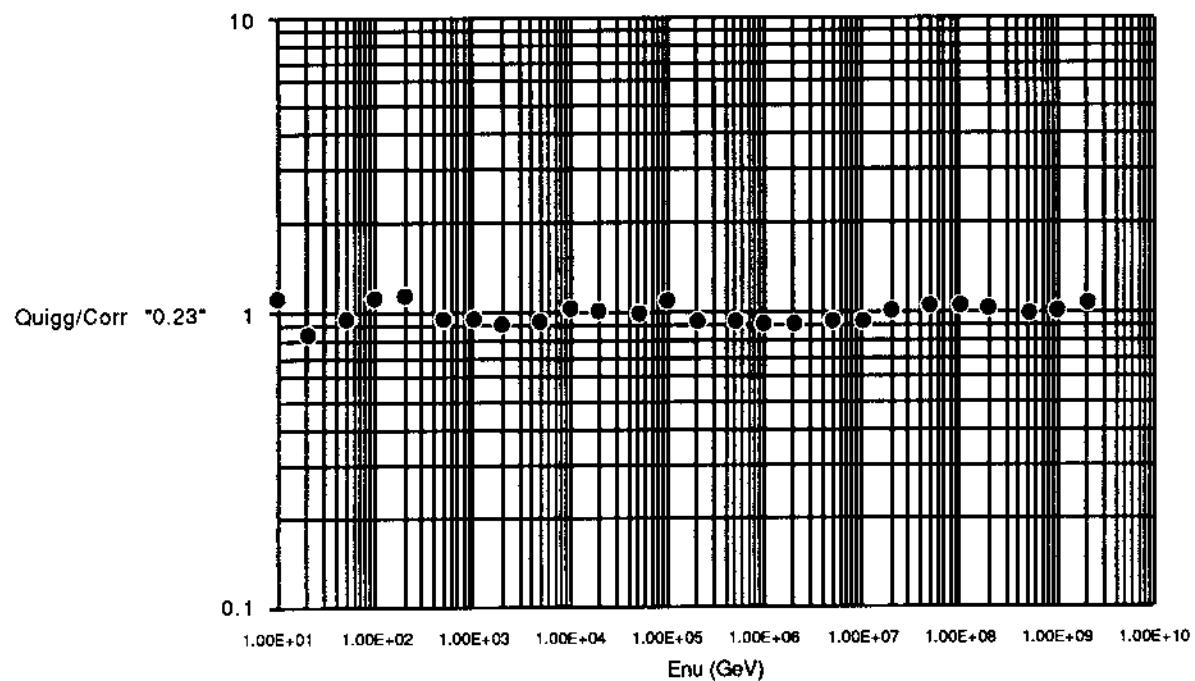


Fig. 2

Corr*0.23**5468

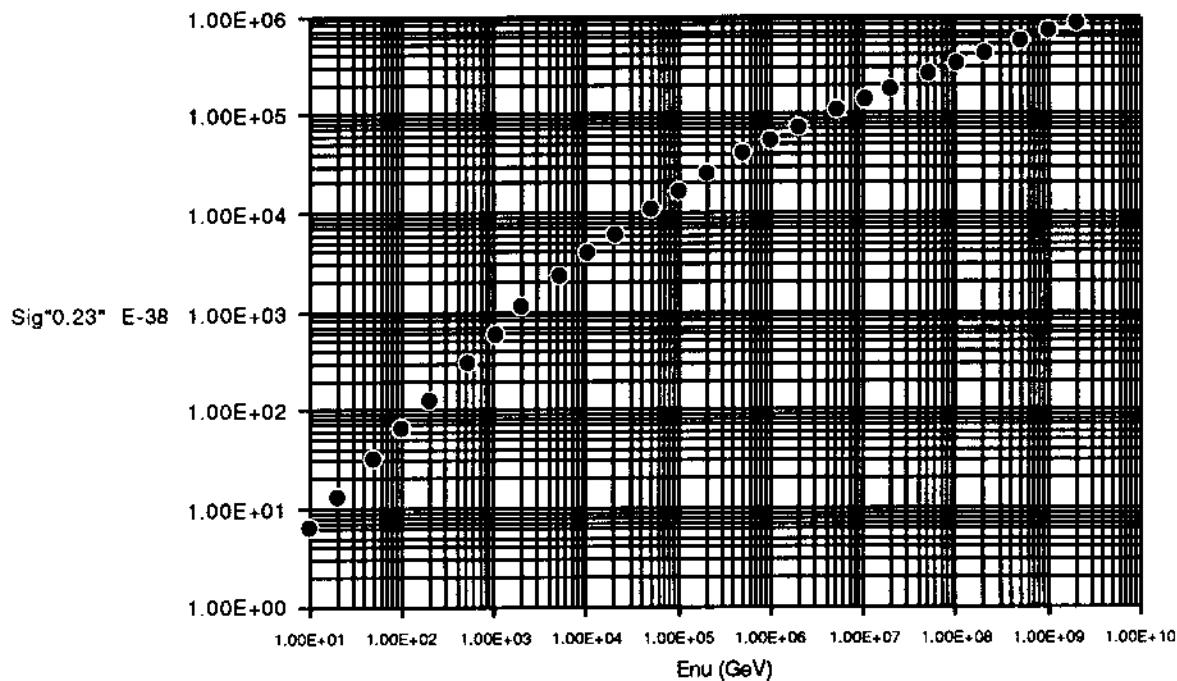


Fig. 3

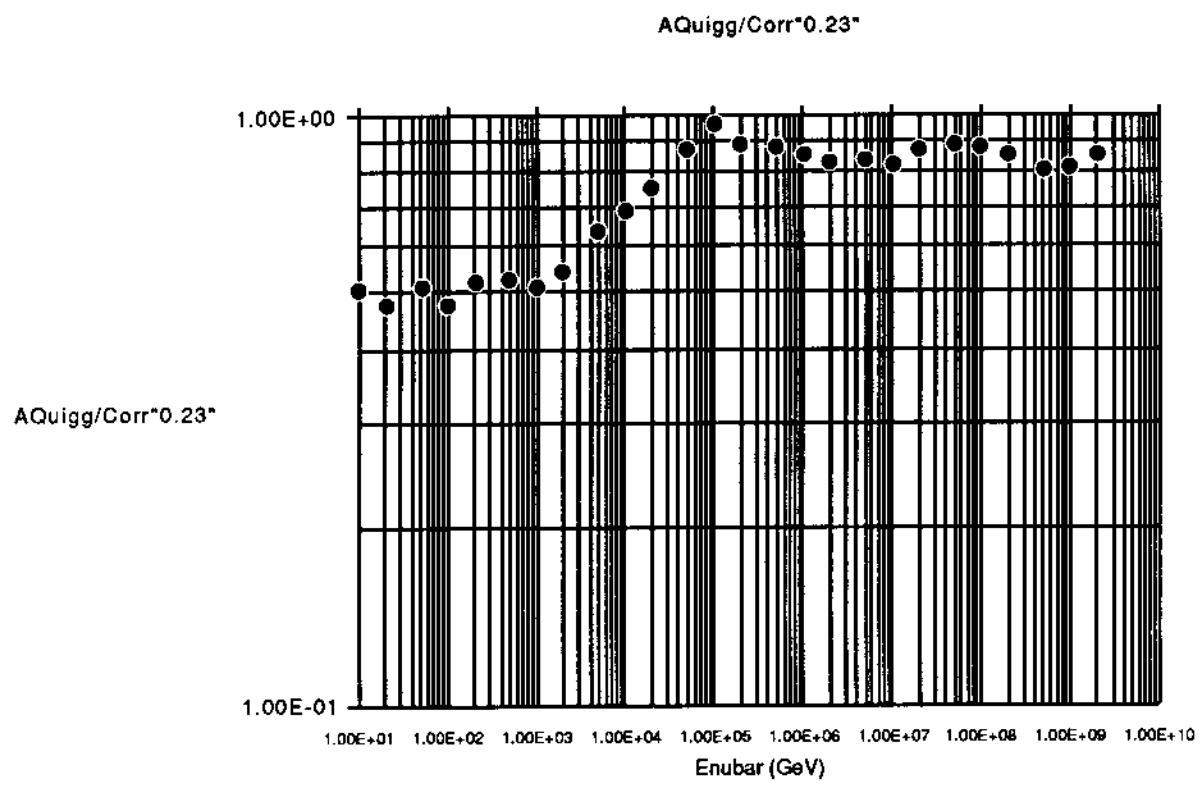


Fig. 4

AQuigg/FactorC:Parameters= 0.5, "0.1505, 0.23 powers"

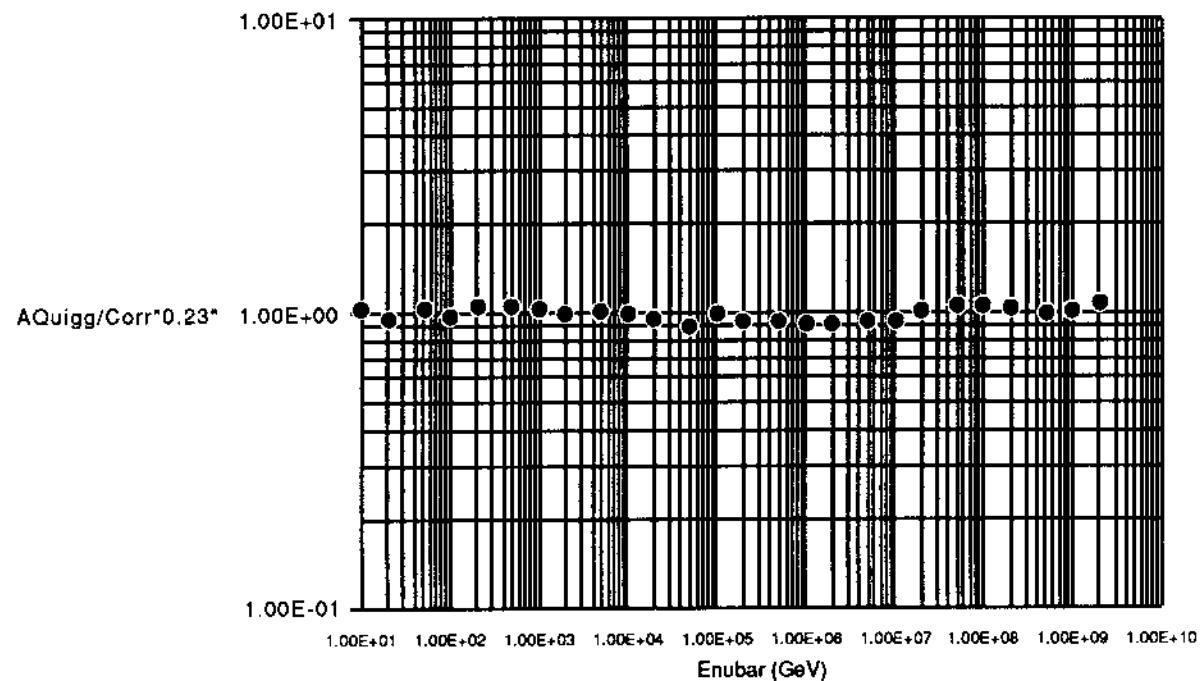


Fig.5

ASig:Correction parameters = 0.5, "0.1505, 0.23"

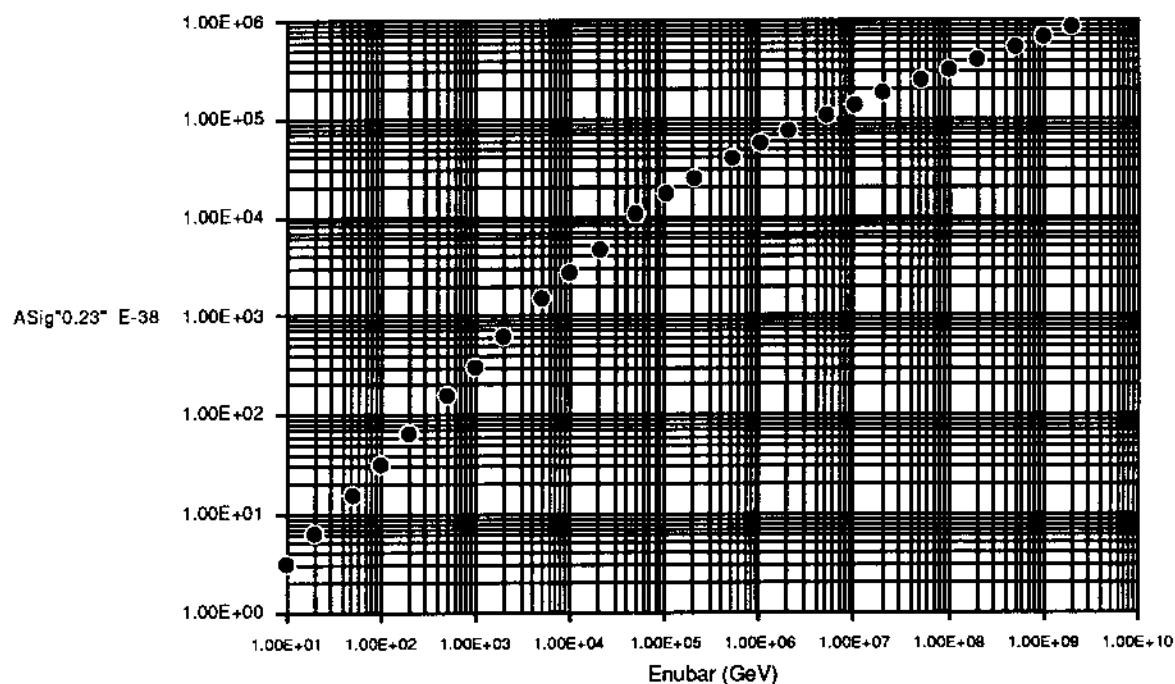


Fig. 6

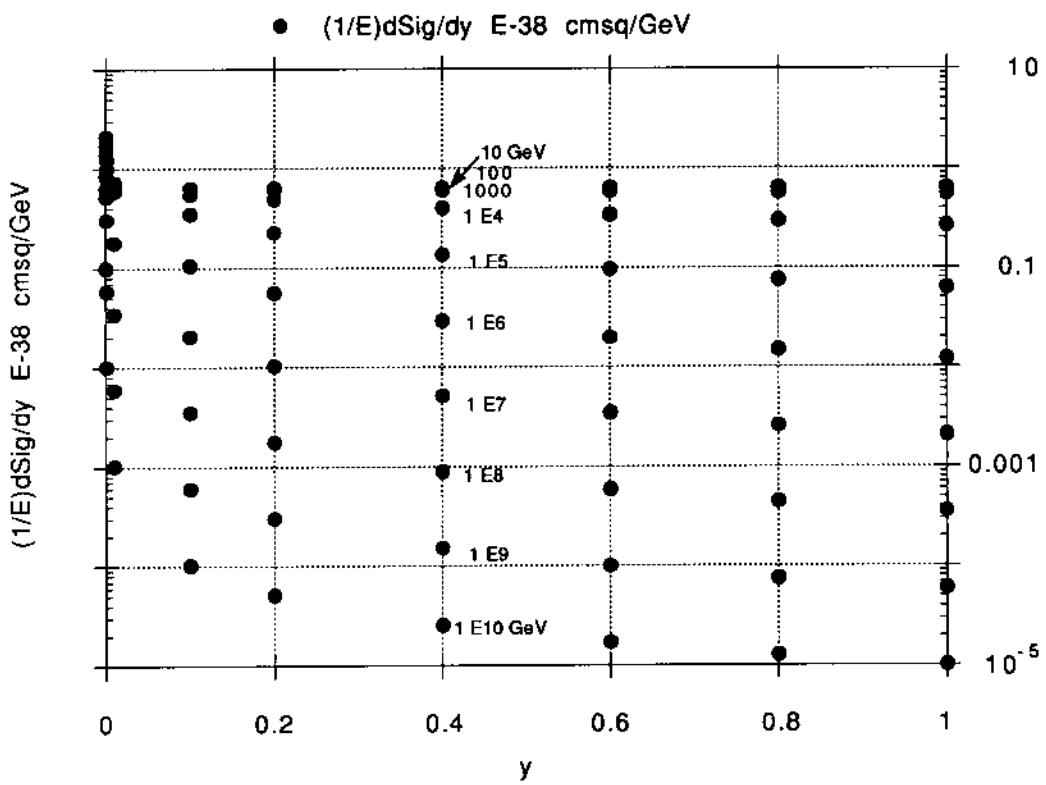


Fig. 7a

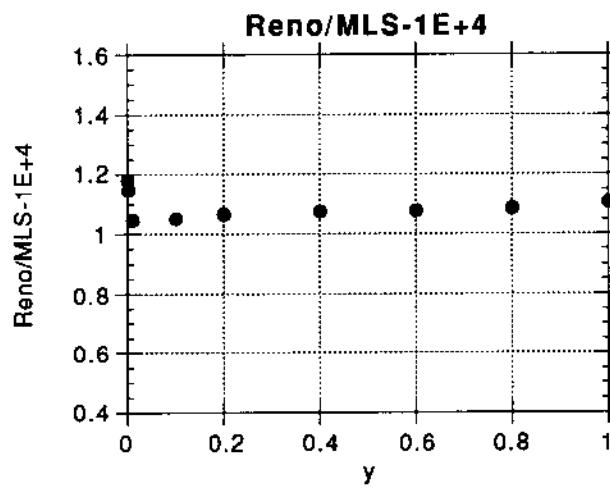


Fig. 7b