EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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MEMORANDUM

To : SPSC Members

From : Spokesmen for Experiments WA 19 (D.C. Cundy) and WA 22 (B. Tallini).

Subject : The Case for 60 GeV Narrow Band Running for Experiments WA 19/22

The results on total neutrino cross sections from BEBC and from the CALTECH/FNAL experiments both presented at Hamburg (Fig. 1), show that σ/E for neutrinos decreases by some 20% between Gargamelle PS neutrino energies (2-10 GeV) and those in the SPS (FNAL narrow-band beams $E_\nu(\max) = 200$ GeV). It appears that most of the decrease occurs between 10 GeV and 50 GeV, where there is little data. In addition, the forward ($y \sim 0$) cross sections (say at $q^2 \sim 2$ GeV^2) have been evaluated for both high energy experiments and are in excellent agreement with GGM in the same q^2 range. Our conclusion is that there is a change in σ/E, that most of the change is in a region not covered by any experiment, and this gap should be filled by 60 GeV/c narrow-band runs. 20 days of ν running could yield 100.000 pictures, and assuming a proton intensity of 5×10^{12} on target, then we calculate a yield of 1500 ν_π events (10-25 GeV) and 300 ν_k events (50-60 GeV).

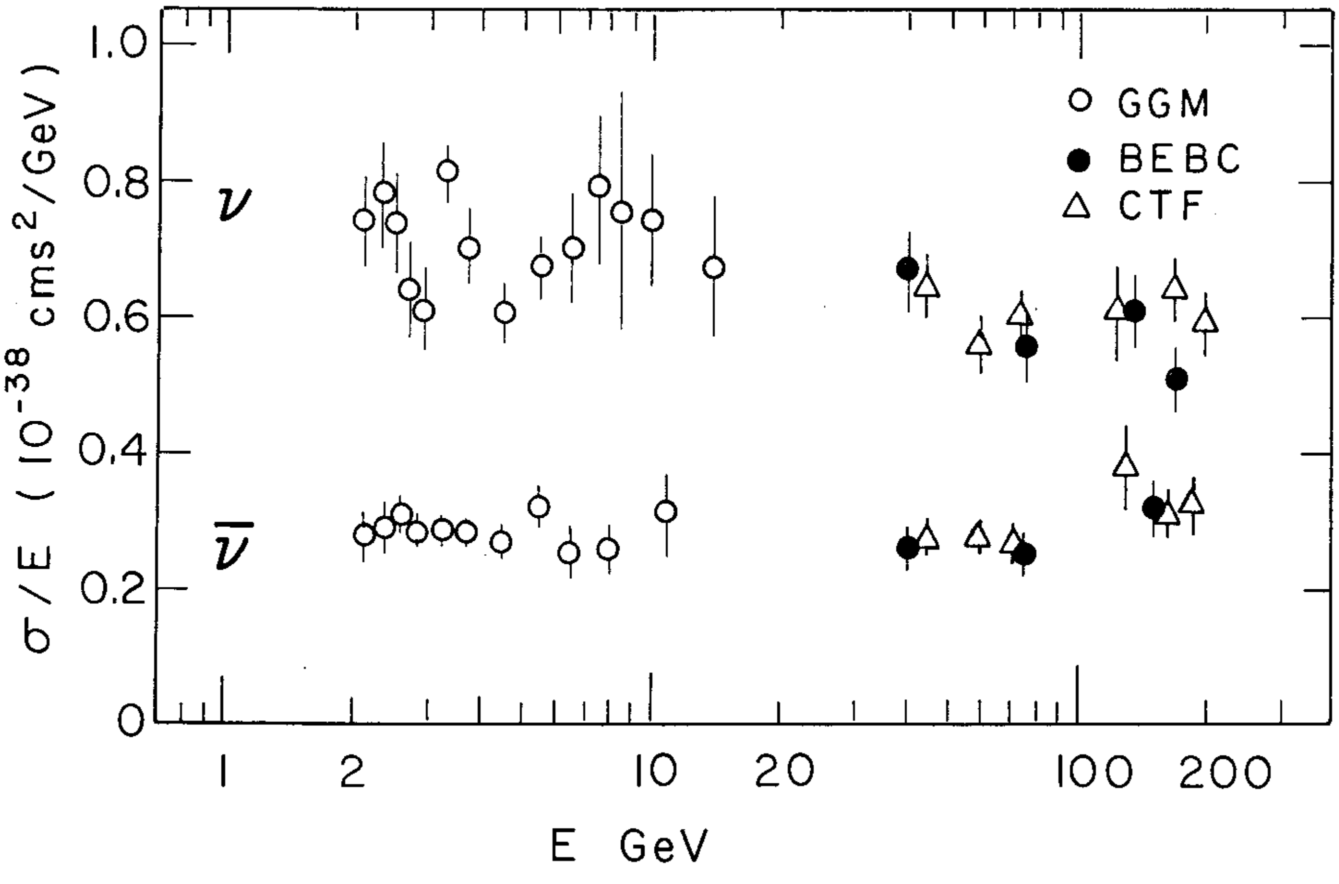
Similarly 20 days of $\bar{\nu}$ running would yield 500 $\bar{\nu}_\pi$ and 60 $\bar{\nu}_k$ events. Note that the systematic ν_π flux error is $\sim$ 5%, and therefore, the statistics are adequate for neutrinos.

The $\bar{\nu}$ run is essentially to determine the structure functions. The question can be asked, why not do the running in a much shorter time with a wide-band beam? We stress that, in an experiment with a wide-band beam, the energy resolution from event measurement errors will be of order of 20%; whereas the resolution in the ν_π peak in a 60 GeV/c NB run will be better than 10% and in the ν_k peak, better than 5% ($\Delta p/p$). However, the most important point is that, in a narrow-band run, the distribution of the event in energy is almost flat. Thus, the effects of resolution on the cross sections are far less severe than in the wide-band experiment, where the event rate varies rapidly with energy. It seems to us therefore that a proper evaluation of the 10-50 GeV cross sections is best carried at using the narrow-band beam. It may also be emphasized that the absolute calibration of neutrino fluxes should be inherently more reliable in NB than in WB running, and most important identical to the 200 GeV run.

We are engaged in a systematic analysis of the q^2 dependence of the structure functions using both the BEBC and GGM data. Our results for F_2 (extracted on the assumption $2 \times F_1 \equiv F_2$) were presented at the Hamburg Conference and are shown in figs 2 and 3. The data show significant q^2 dependences. However, the GGM data come from a broad band experiment which are dominated by systematic biases which are difficult to estimate. The 60 GeV NB run would provide bias free data on F_2 of comparable statistical precision to the GGM data for $Q^2 = 1\text{-}10 \text{GeV}^2$.

The structure functions F_1 and F_3 enter in the cross section with factors $y^2/2$ and $\pm\, y(1-y/2)$ respectively and therefore contribute only at high-y. For this reason low energy data (as provided by the 60 GeV run) are indispensable for a detailed determination of the q^2 dependence of F_1 and F_3 in q^2 range 2-20 GeV^2, to study the interesting behaviour suggested by the combination of the present BEBC and GGM data (fig. 4). With these data it will be possible to obtain several values for $\int x\, F_3$ in this q^2 range with statistical errors of approximately 10%. This will be the best information available anywhere on a pure non-singlet structure function (valence quarks only).

Finally we would like to point out that a measurement of the cross sections in the energy range 10-40 GeV will make it possible to analyse in terms of the structure functions existing wide-band data from FNAL performed without detailed flux monitoring. Also the 60 GeV ν running has been approved [SPSC/76-73/SPSC 36] and we feel that considering the present interest in scaling violations in lepton-nucleon scattering, it should be done at the earliest possible time.



σ/E (10^-38 cms^2/GeV)
1.0
0.8
0.6
0.4
0.2
0
ν
ν̄
GGM
BEBC
CTF
1
2
10
20
100
200
E GeV

fig. 1

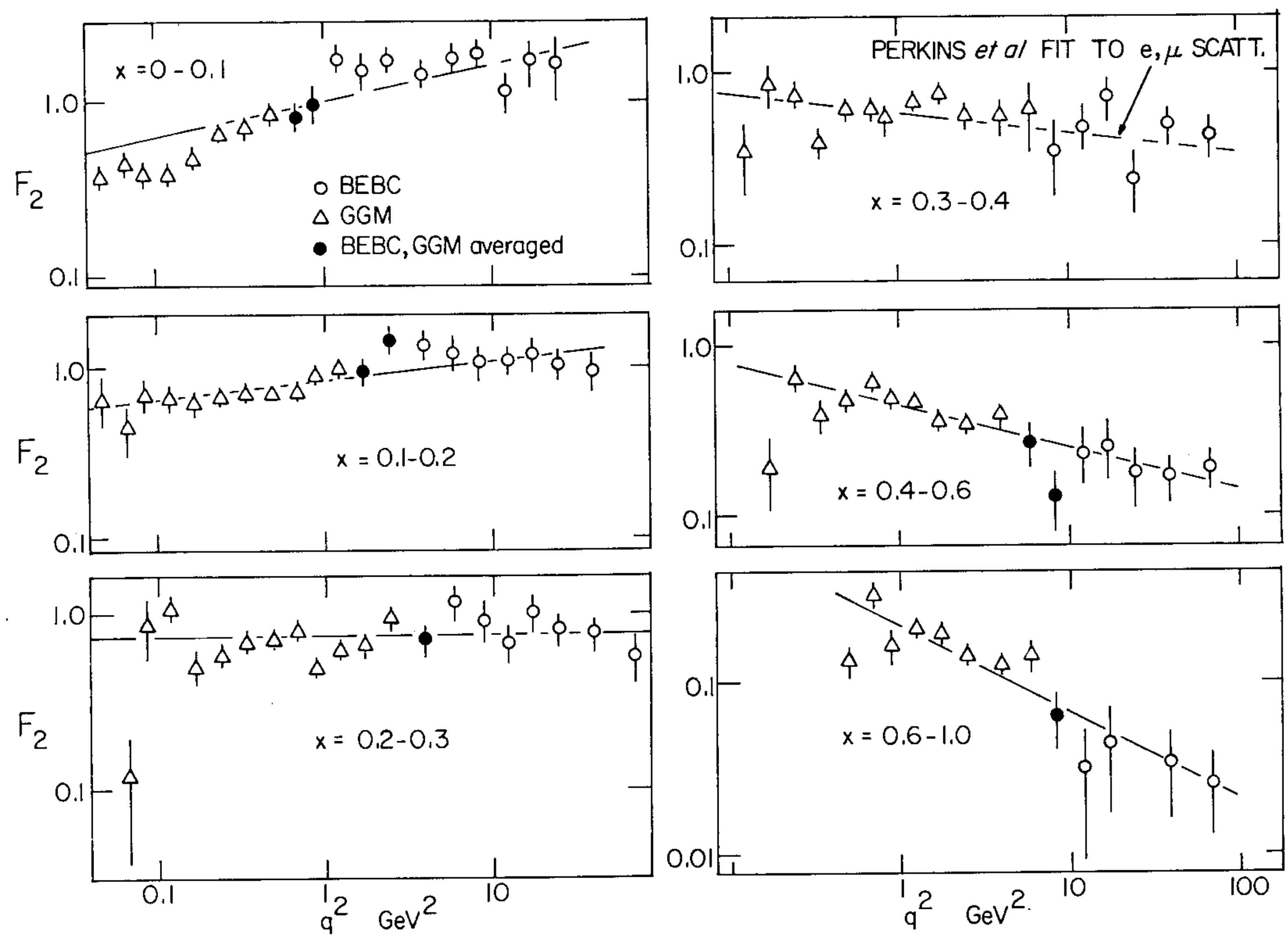

x = 0 - 0.1
o BEBC
Δ GGM
● BEBC, GGM averaged
x = 0.1-0.2
x = 0.2-0.3
PERKINS et al FIT TO e,μ SCATT.
x = 0.3-0.4
x = 0.4-0.6
x = 0.6-1.0
F2
q2 GeV2

fig. 2

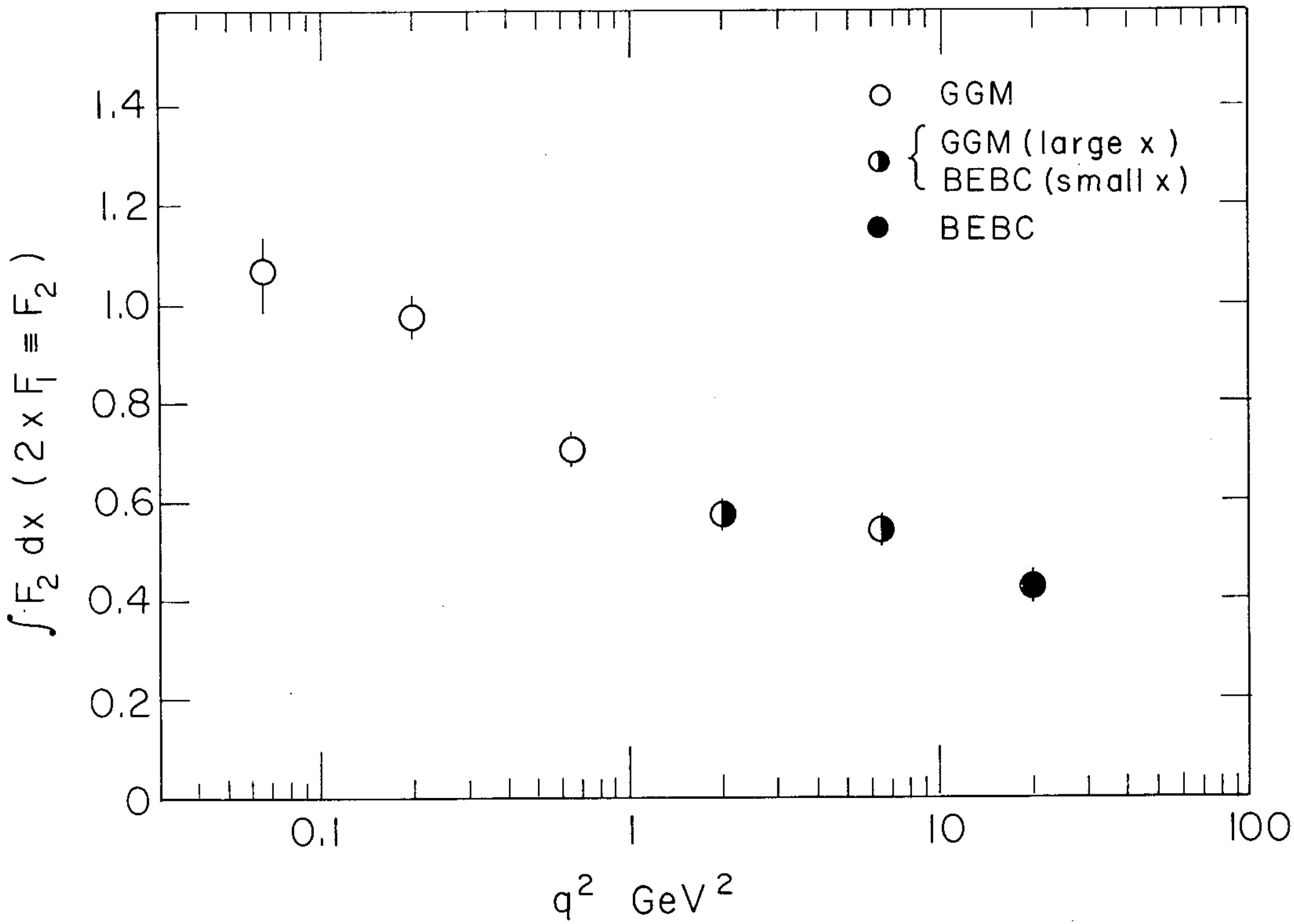
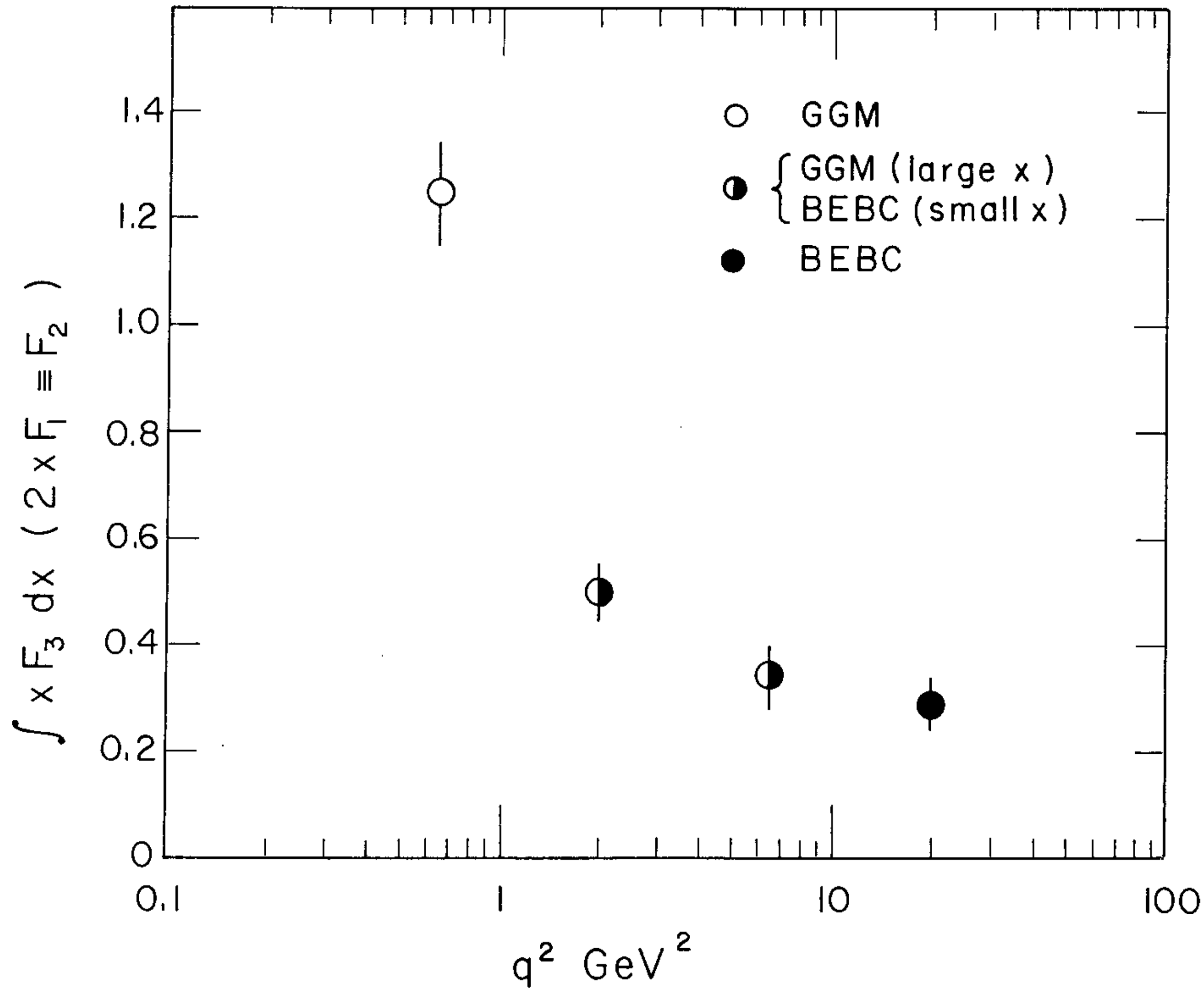

GGM
GGM (large x)
BEBC (small x)
BEBC
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0.1
1
10
100
$\int F_2\,dx$ ($2xF_1 \equiv F_2$)
q^2 GeV^2

fig. 3



GGM
GGM (large x)
BEBC (small x)
BEBC
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0.1
1
10
100
q² GeV²
∫ x F₃ dx (2 x F₁ ≡ F₂)

fig. 4