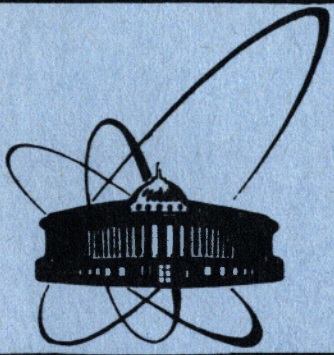

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E1-84-626

STUDY OF NUCLEAR EFFECTS IN THE DETERMINATION OF NUCLEON STRUCTURE FUNCTIONS WITH HEAVY TARGETS

Bologna-CERN-Dubna-Münich-Saclay Collaboration

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The first evidence that a nucleon confined in a nucleus is not equivalent to a free nucleon, apart from effects of Fermi motion, was presented by the EMC collaboration (EMC effect) in 1982 [1]. The effect has been subsequently confirmed, albeit at much lower Q^2, by a reanalysis [2] of the old SLAC data on electron deep inelastic scattering and more recently by a dedicated experiment [3] at SLAC where the A-dependence of the EMC effect was investigated for several nuclei.

In this paper we present preliminary results obtained with a high luminosity muon spectrometer at the CERN-SPS. The experimental apparatus in its present configuration is shown in Fig. 1 and has been extensively described in Ref. [4]. It consists of two external targets, each 5 m long, followed by a system of hexagonal multiwire proportional chambers and a 40 m long toroidal spectrometer made of eight sections of magnetized iron instrumented with MWPCs and trigger counters. The central bore of the first five toroids contains target vessels which, together with the two external ones, provide a 35 m long target.

The modularity of the spectrometer allows to take data simultaneously with different target materials thus minimizing the influence of systematic effects of momentum calibrations and flux monitoring.

The data were collected in the fall of 1983, using muons of 280 GeV energy and replacing the target section in the third toroid by a 75 cm long stainless steel target. An integrated flux of $1.08\ 10^{12}$ muons was obtained with the following target combinations:

D_2 - Fe - D_2, $(6.54\ 10^{11})$, N_2 - Fe - N_2, $(1.95\ 10^{11})$,

N_2 - empty - N_2 $(0.24\ 10^{11})$, empty - Fe - empty $(0.82\ 10^{11})$,

entirely empty targets $(1.22\ 10^{11})$.

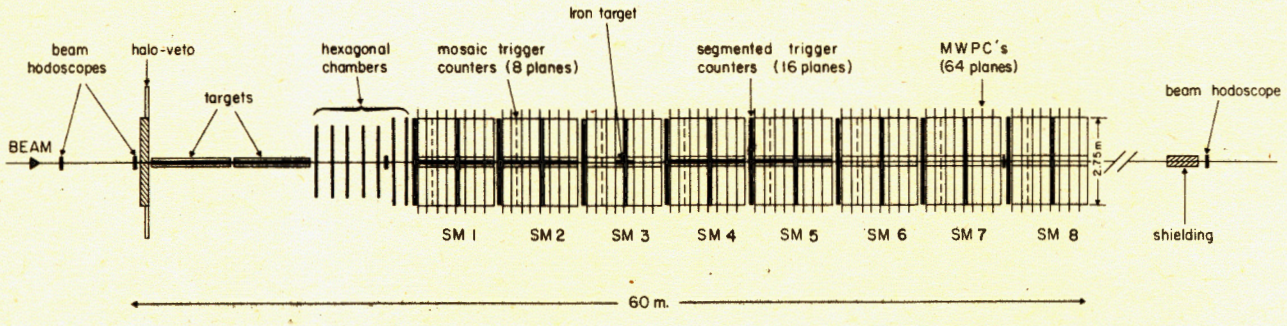

Fig. 1. BCDMS spectrometer

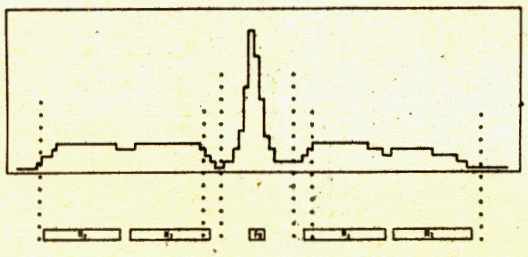

Fig. 2. N_2-Fe-N_2 vertex distribution after cuts in Q^2 showing the target regions used.

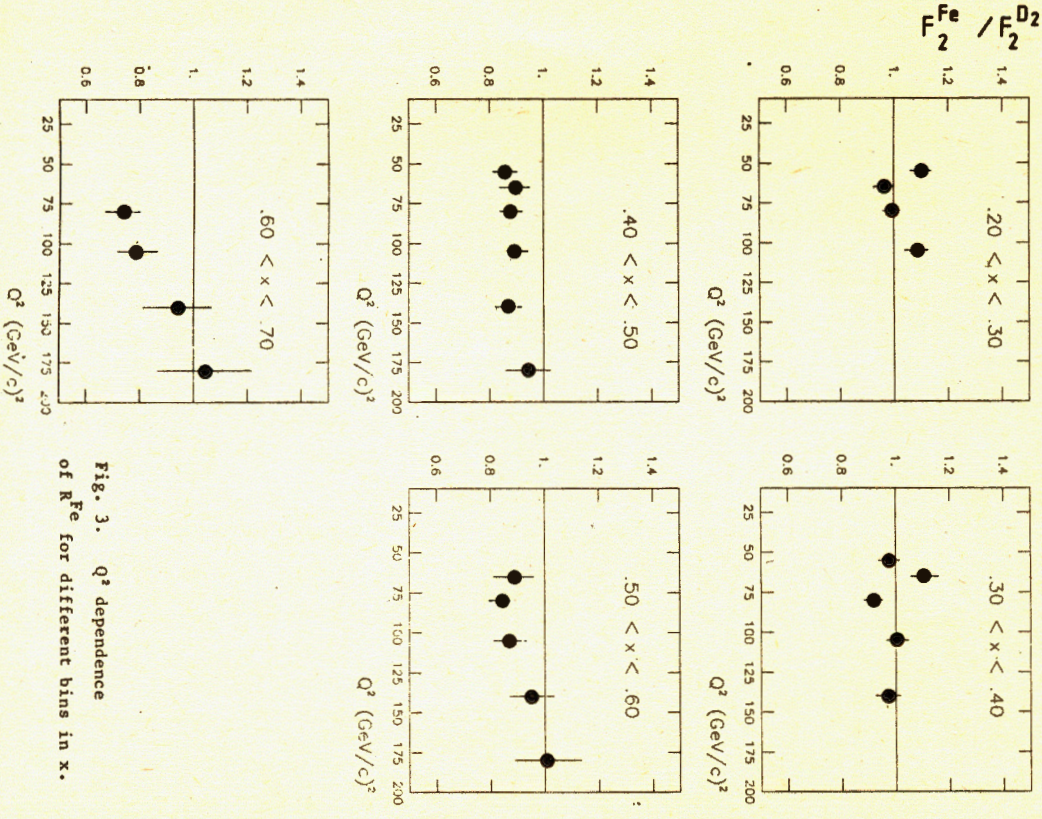

Fig. 3. Q^2 dependence of R^{Fe} for different bins in x.

The N_2 - empty - N_2 and empty - Fe - empty combinations permit to measure the mutual contamination of event samples from different targets due to the finite vertex resolution of the spectrometer.

In the following we present results from the target sections inside the iron toroids which permit to study the high Q^2/high x behaviour of the EMC effect.

Vertex cuts were applied to minimize the feed-through from target to target with moderate event losses as shown in fig. 2. The contribution of Fe events to the D_2 and N_2 samples is 1.4% and 0.3% respectively, while that of D_2 events to the iron sample is 0.5%. This background and the contribution of target wall interactions to the data (2.3% for D_2, 0.5% for N_2) have been corrected for.

In the Fe - D_2 comparison, we only use data from the simultaneous measurement correcting for acceptance and spectrometer resolution by Monte-

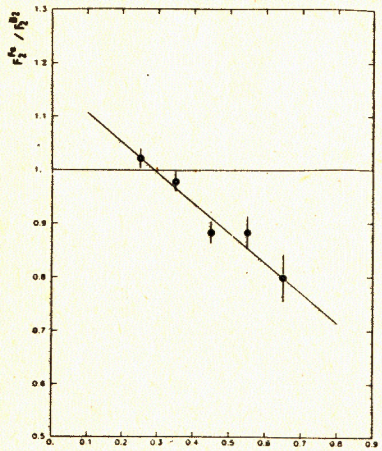

Fig. 4. x dependence or R^{Fe}.

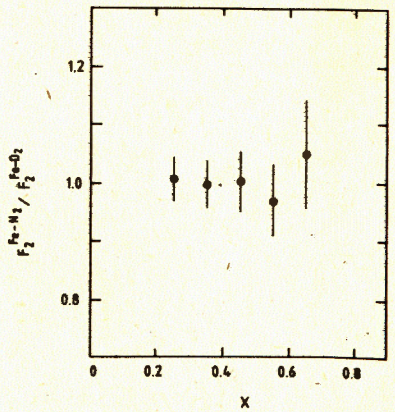

Fig. 5. ratio of F_2^{Fe} measured with the N_2 - Fe - N_2 target combination to F_2^{Fe} from D_2 - Fe - D_2.

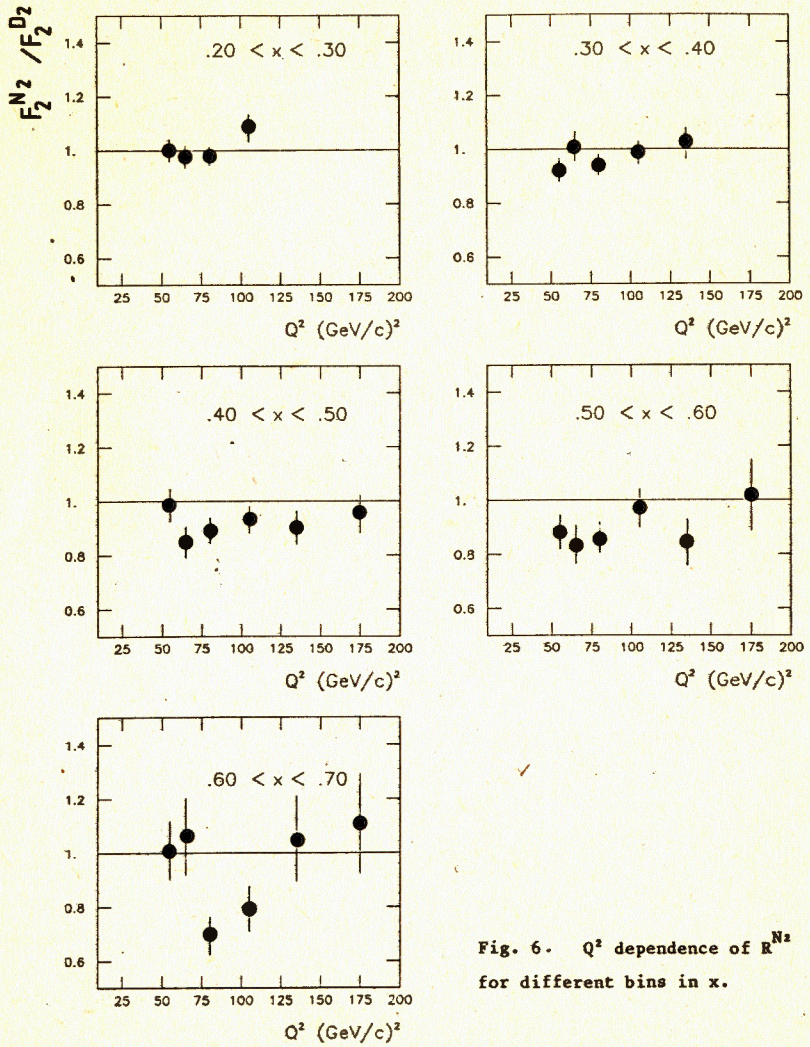

Fig. 6. Q^2 dependence of R^{N_2} for different bins in x.

Carlo simulation. The ratio of the structure functions $R^{Fe} \equiv F_2^{Fe} / F_2^{D_2}$, after a small correction for non isoscalarity, is shown in fig. 3 for the kinematical domain $50 < Q^2 < 200$ GeV^2 and $0.2 < x < 0.7$ and does not indicate any Q^2 dependence within the accuracy of the data. The value of R^{Fe} averaged over Q^2, shown in fig. 4 as a function of x, is well represented by a linear parametrization

$$R^{Fe}(x) = a^{Fe} + b^{Fe}\, x$$

with $a^{Fe} = 1.16 \pm 0.03$ and $b^{Fe} = -0.56 \pm 0.08$,

the errors being only statistical.

The data with N_2, D_2 were taken at different times using different fillings for the same targets therefore the geometrical acceptance of the detector is the same for the two materials. The resolution smearing however depends on the steepness of the structure functions and therefore affects differently the N_2 and D_2 data; hence it has to be corrected by Monte-Carlo simulation.

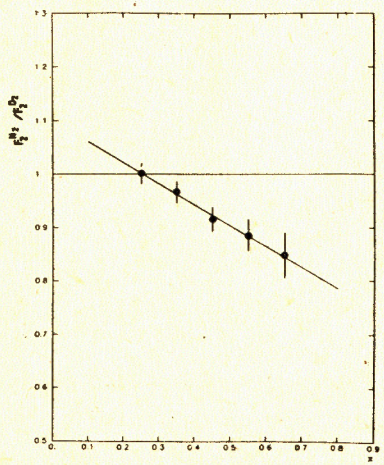

Fig. 7. x dependence or R^{N_2}.

The performance of the detector during the D_2 and N_2 data taking can be monitored by comparing the Fe structure function measured with the two target fillings. The ratio of the two measurements of F_2, given in fig. 5, does not present any appreciable deviation from unity and indicates that the relative normalization of D_2 to N_2 structure functions is better than 2%.

The ratio $R^{N_2} \equiv F_2^{N_2}/F_2^{D_2}$, shown in fig. 6 for the same Q^2 - x domain as for R^{Fe}, does not manifest any Q^2 dependence within the experimental errors. R^{N_2} averaged over Q^2 is shown in fig. 7 as a function of x and is also well represented by a linear fit

$$R^{N_2}(x) = a^{N_2} + b^{N_2}\, x$$

with $a^{N_2} = 1.10 \pm 0.04$ and $b^{N_2} = -0.39 \pm 0.09$,

the errors being only statistical.

In conclusion, the EMC effect has been studied for iron and nitrogen nuclei at high Q^2. The comparison of the structure functions F_2^{Fe} and $F_2^{D_2}$ shows the same behaviour as observed by the EMC collaboration although the present results are based on interactions at larger Q^2. The comparison of $F_2^{N_2}$ and $F_2^{D_2}$ shows a similar behaviour to the iron-deuterium case but with a softer x dependence in agreement with the results of Arnold et al. [3] which were obtained at much lower Q^2 and primary energy.

REFERENCES

[1] J.J. Aubert et al., Phys. Lett. 123B (1983) 275.

[2] A. Bodek et al., Phys. Rev. Lett. 50 (1983) 1341.

[3] R.G. Arnold et al., Phys. Rev. Lett. 52 (1984) 727.

[4] D. Bollini et al., Nucl. Instr. and Methods 204 (1983) 333;
A.C. Benvenuti et al., CERN-EP/84-31;
Nucl. Instr. and Methods, in print.

Received by Publishing Department
on September 13, 1984.

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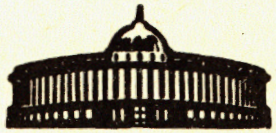

Бенвенути А.С. и др. E1-84-626

Исследование ядерных эффектов в опытах по измерению структурных функций нуклона на тяжелых мишенях

Приводятся результаты эксперимента по глубоконеупругому рассеянию мюонов с энергией 280 ГэВ на ядрах дейтерия, азота, железа. Цель измерений состояла в сравнении поведения структурных функций нуклона, полученных в опытах на различных ядрах, в зависимости от бьеркеновской переменной x и квадрата передаваемого 4-импульса Q^2. Результаты эксперимента указывают на отсутствие Q^2-зависимости отношений $F_2^{Fe}/F_2^{D_2}$ и $F_2^{N_2}/F_2^{D_2}$. Зависимость этих отношений от переменной x имеет линейный характер $R = a + bx$. Параметры линейной зависимости для отношения железо/дейтерий составляют: $a = 1,16 \pm 0,03$, $b = -0,56 \pm 0,08$, а для отношения азот/дейтерий - $a = 1,10 \pm 0,04$, $b = -0,39 \pm 0,09$.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1984

Benvenuti A.S. et al. E1-84-626

Study of Nuclear Effects in the Determination of Nucleon Structure Functions with Heavy Targets

Results of the experiment on deep inelastic scattering of 280 GeV muons on deuterium, nitrogen and iron nuclei are presented. The purpose of the measurements was to compare the x-dependence of nucleon structure functions obtained in experiments on different nuclei and also Q^2-dependence of structure functions. The results of the experiments do not indicate any Q^2-dependence of the $F_2^{Fe}/F_2^{D_2}$ and $F_2^{N_2}/F_2^{D_2}$ ratios. These ratios depend linearly on the parameter x: $R = a + bx$. The parameters of the linear fit for the iron/deuterium ratio are $a = 1.16 \pm 0.03$, $b = -0.56 \pm 0.08$; and for the nitrogen/deuterium ratio, $a = 1.10 \pm 0.04$, $b = -0.39 \pm 0.09$.

The investigation has been performed at the Laboratory of High Energies, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna 1984