"The II International Workshop on Theory of Hadronic Matter Under Extreme Conditions" in Dubna, September 16 - 19, 2019

"The cold super dense baryon component of the nuclear matter (CsDBM)"

S.S. Shimanskiy (JINR, Dubna)

PLAN

1. Cumulative processes
2. Cumulative particles spectra
3. DIS in the cumulative region and probability of hard components
4. High p_T processes and CsDBM
5. Future

Cumulative processes

SOVIET PHYSICS JETP VOLUME 6 (33), NUMBER 5 MAY, 1958

ON THE FLUCTUATIONS OF NUCLEAR MATTER

D. I. BLOKHINTSEV

Joint Institute for Nuclear Research

Submitted to JETP editor July 1, 1957

J. Exptl. Theoret. Phys. (U.S.S.R.) 33, 1295-1299 (November, 1957)

It is shown that the production of energetic nuclear fragments in collisions with fast nucleons can be interpreted in terms of collisions of the incoming nucleon with the density fluctuations of the nuclear matter.

1. INTRODUCTION

THE motion of nucleons in nuclei can result in short-lived tight nucleon clusters, in other words, in density fluctuations of nuclear matter. Since such clusters are relatively far removed from the other nucleons of the nucleus, they become atomic nuclei of lower mass in a state of fluctuating compression.

In their study of the scattering of 675-Mev protons by light nuclei, Meshcheriakov and coworkers[1,2] observed recently certain effects which confirm the existence of such fluctuations, at least for the simplest nucleon-pair fluctuations, which lead to the formation of a compressed deuteron.

СБОРНИК

КРАТКИЕ СООБЩЕНИЯ ПО ФИЗИКЕ

…it is possible to obtain the record high energy particle beams by means of accelerating the heavy nuclei with large charges

№ 1 январь 1971

АКАДЕМИЯ НАУК СССР

Ордена Ленина

Физический институт им П.Н. Лебедева

January 1971

МАСШТАБНАЯ ИНВАРИАНТНОСТЬ АДРОННЫХ СТОЛКНОВЕНИЙ И ВОЗМОЖНОСТЬ ПОЛУЧЕНИЯ ПУЧКОВ ЧАСТИЦ ВЫСОКИХ ЭНЕРГИЙ ПРИ РЕЛЯТИВИСТСКОМ УСКОРЕНИИ МНОГОЗАРЯДНЫХ ИОНОВ

А. М. Балдин

Пучки частиц высоких энергий до последнего времени получались исключительно на протонных и электронных ускорителях, т.е. при ускорении частиц, обладающих единичным зарядом. Ускорение частиц, обладающих зарядом большим единицы, как известно, в принципе дает возможность получить энергию ускоряемых частиц (при одинаковых параметрах ускорителя) большую, чем энергия протонов, в число раз, равное кратности заряда. Так, например, на Дубненском синхрофазотроне, рассчитанном на получение протонов с энергией 10 Гэв, можно получить ядра гелия с энергией 20 Гэв, а ядра неона (заряд 10 е) с энергией 100 Гэв. Возникает естественный вопрос, не получатся ли в результате столкновения с мишенью ядер, например, неона, обладающих энергией 100 Гэв, пучки вторичных частиц, полученные пока только на Серпуховском ускорителе? Утвердительный ответ на этот вопрос означал бы, что с помощью ускорения тяжелых ядер, обладающих более высоким зарядом, можно было бы сравнительно дешевым способом в короткие сроки получить пучки частиц рекордно высоких энергий.

Цель настоящей заметки – рассмотреть этот вопрос и сделать определенные предсказания.

Обычно на вопрос о возможности передачи большой энергии составным ядром отдельному (например, сво-

The first introduction of the term “cumulative effect”

Выражаю глубокую благодарность С. Б. Герасимову, А. Б. Говоркову и Г. Н. Флерову за обсуждение изложенных соображений. Как мне стало известно, Г. Н. Флеров еще несколько лет назад высказывал мысль о возможных кумулятивных эффектах при соударении релятивистских ядер.

Поступила в редакцию
11 ноября 1970 г.

ОБЪЕДИНЕННЫЙ
ИНСТИТУТ
ЯДЕРНЫХ
ИССЛЕДОВАНИЙ
Дубна

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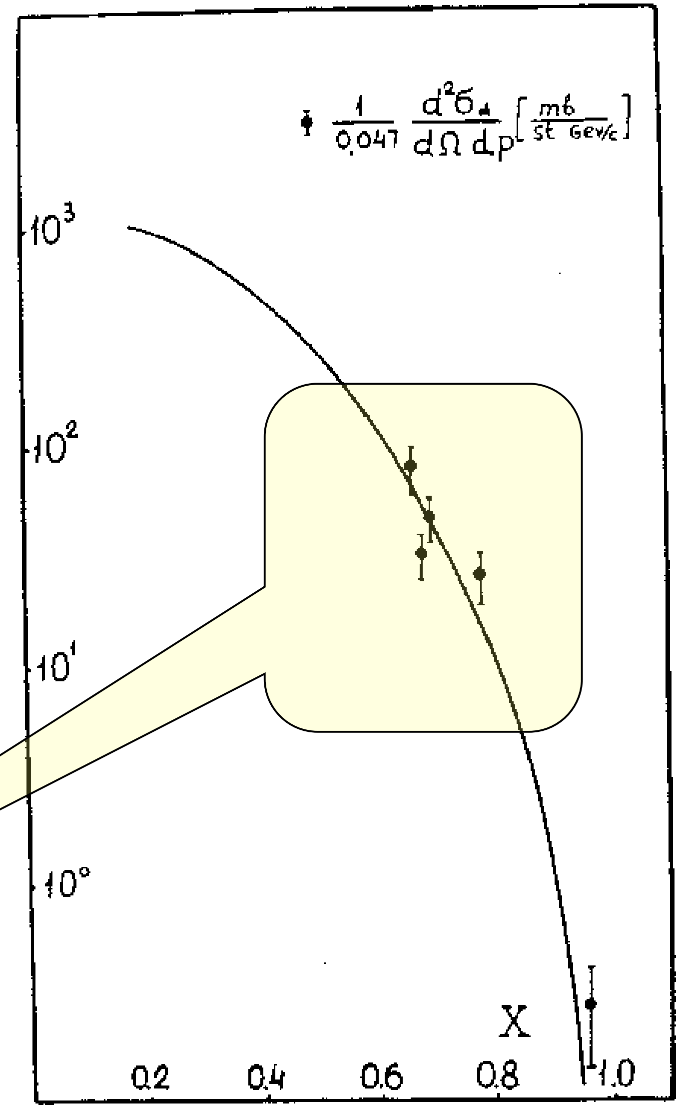
ЛАБОРАТОРИЯ ВЫСОКИХ ЭНЕРГИЙ

А.М. Балдин, Н. Гиордэнеску, В.Н. Зубарев,
А.Д. Кириллов, В.А. Кузнецов, Н.С. Мороз,
В.Б. Радоманов, В.Н. Рамжин, В.А. Свиридов,
В.С. Ставинский, М.И. Яцута

НАБЛЮДЕНИЕ ПИОНОВ
ВЫСОКОЙ ЭНЕРГИИ
ПРИ СТОЛКНОВЕНИИ РЕЛЯТИВИСТСКИХ
ДЕЙТОНОВ С ЯДРАМИ

1971



The first experimental data

Рис. 3. Сравнение экспериментальных данных по сечению рождения пионов дейтронами с теоретической функцией, описывающей сечение рождения пионов протонами.

SPECTRA

A.V. Efremov (1976) Parton description

A + B → C + X

$$\varepsilon \frac{d^3\sigma}{d^3p} = \int dx dy dz F_B(y) F_A(x) G_C(z) v(xys, t\frac{x}{z}, u\frac{y}{z})$$

$x_{||}$ $x_{\perp}$

ТЕОРИЯ

LARGE MOMENTUM PION PRODUCTION IN PROTON NUCLEUS COLLISIONS AND THE IDEA OF "FLUCTUONS" IN NUCLEI

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and

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Received 27 January 1977

It is shown that in proton-nucleus collisions, the production of pions with large momenta can be explained by the assumption of the existence of nuclear density fluctuations ("fluctuons") at short distances of the nucleon core radius order, with the mass of several nucleons.

The purpose of this note is to realize the idea [4] that the cumulative effect is connected largely with a suggestion on the existence in nuclei of the so-called fluctuons. Earlier fluctuons were proposed [7] in order to understand the nature of the "deuteron peak" in the pA-scattering cross section at large momentum transfers [8] and also to interpret the pd-scattering cross section [9]. Compressional fluctuations of mass $M_k = km_p$ of nucleons in the small volume $V_\xi = \frac{4}{3}\pi r_\xi^3$ where r_ξ is the fluctuon radius were assumed.

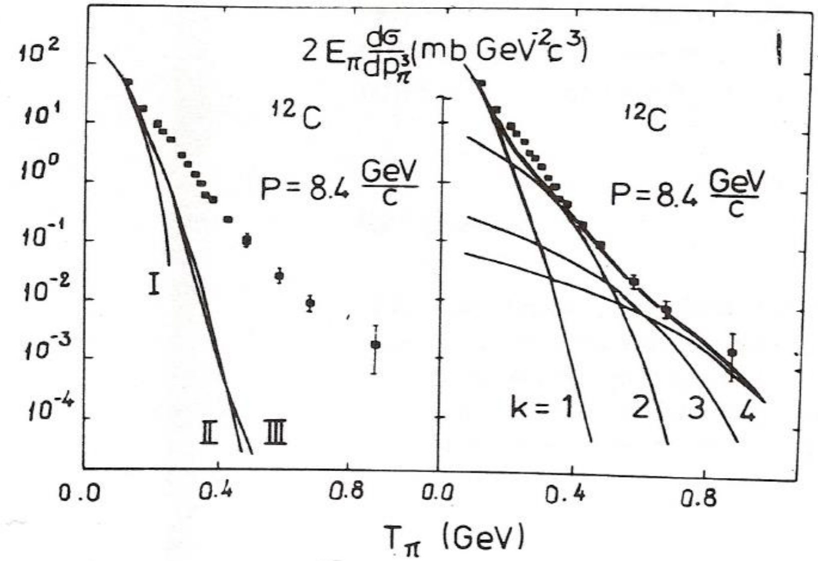


Fig. 1. (a) Calculations of the invariant pion production cross section for ^{12}C: I – for the free proton target; II – with fermi motion; III – the relativization effect. (b) The contributions of separate fluctuons with mass $M_k = km_p$ where k is the order of cumulativity.

Fluctons Probability inside nuclei

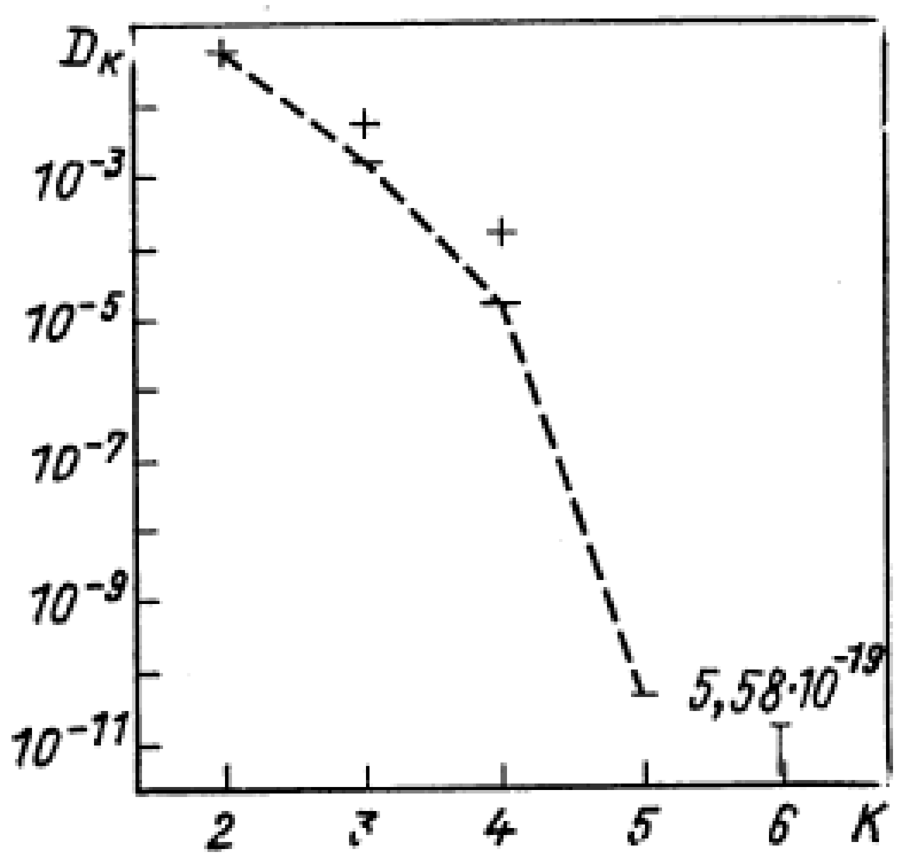


Рис. 19. Вероятность существования флуктонов с k нуклонами в ядрах

Schroeder L.S. et al. // Phys. Rev. Lett. 1979. V. 43, n. 24. P. 1787

[6] A.M.Baldin et al., Yad.Fiz., 20, 1975, p.1201

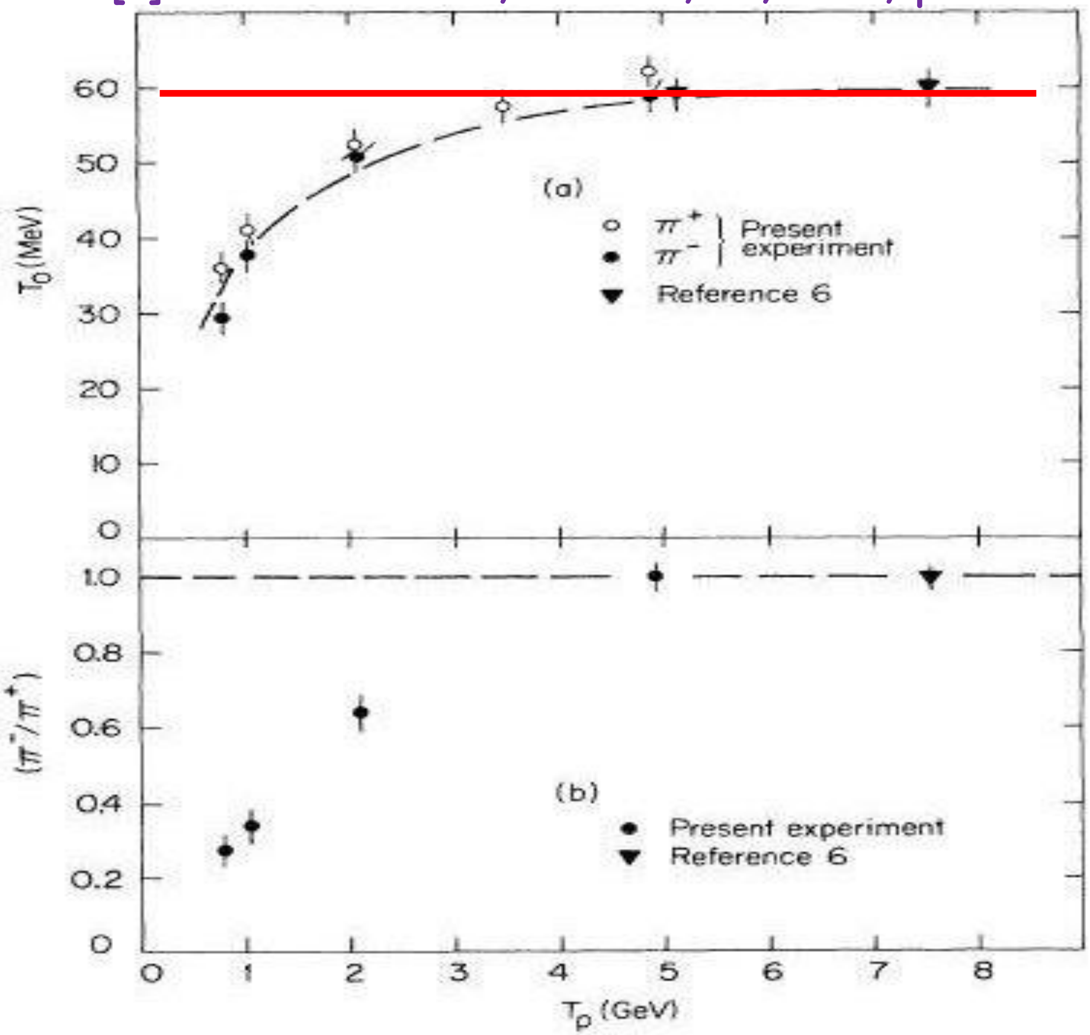


FIG. 1. Energy dependence of (a) T_0 parameter for pions, and (b) the π^-/π^+ ratio at 180° obtained by integrating each spectra up to 100 MeV for p-Cu collisions from 0.8 to 4.89 GeV. The dashed curve in both cases refers to the predictions of the "effective-target" model (Refs. 3 and 4).

Leksin G.A.
Physics of Atomic Nuclei, Vol. 65, No. 11, 2002, pp. 1985–1994

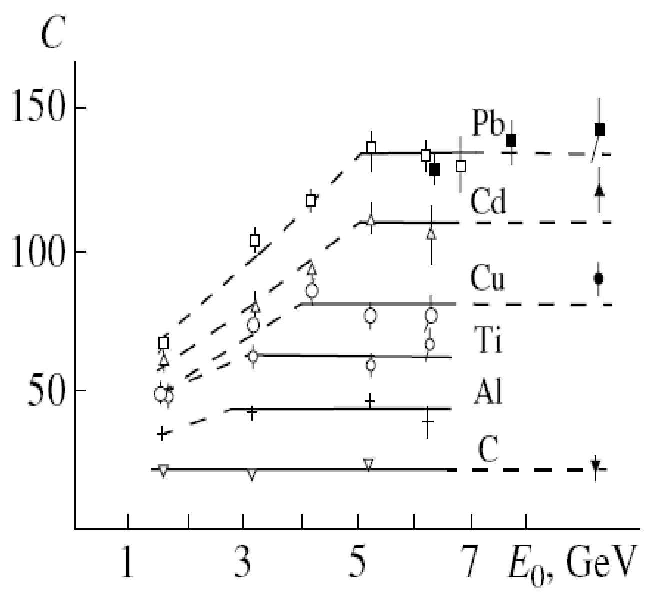


Fig. 3. The coefficient $C(T_0 = 125$ MeV) in the parametrization of the invariant function $f = C\exp(-T/T_0)$ in the reaction pA(C, Al, Ti, Cu, Cd, Pb) $\to pX$ for a proton escape angle of 120° in the laboratory frame versus the incident-proton energy. The filled circles refer to the initial energy of 400 GeV.

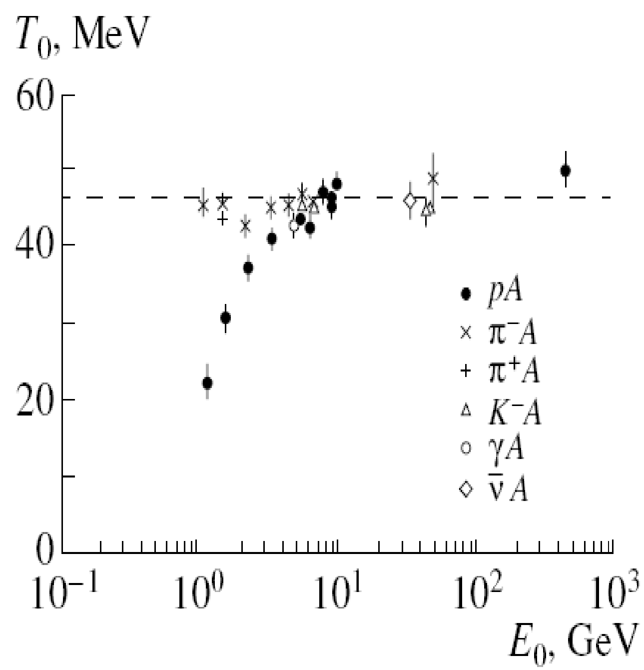
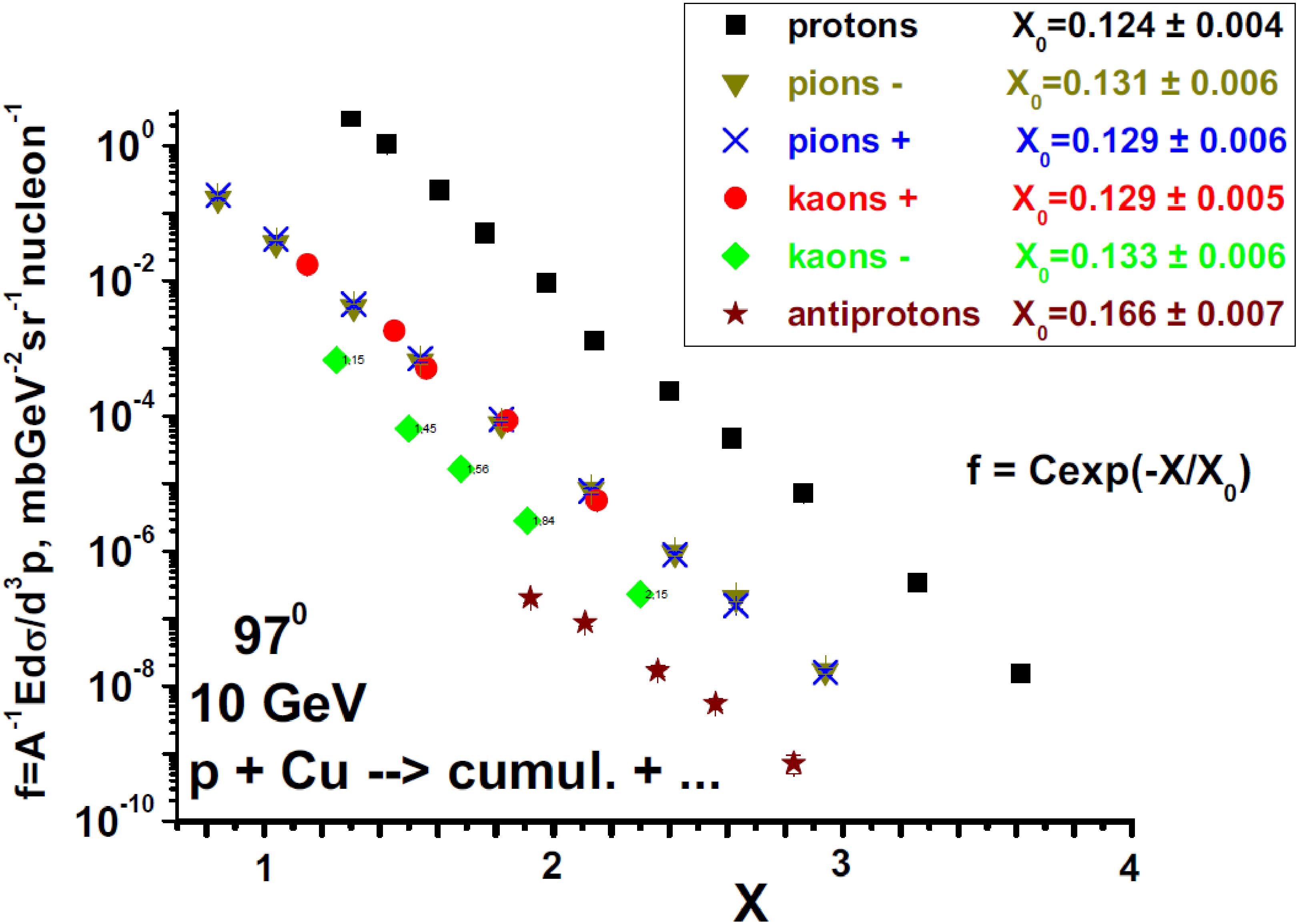


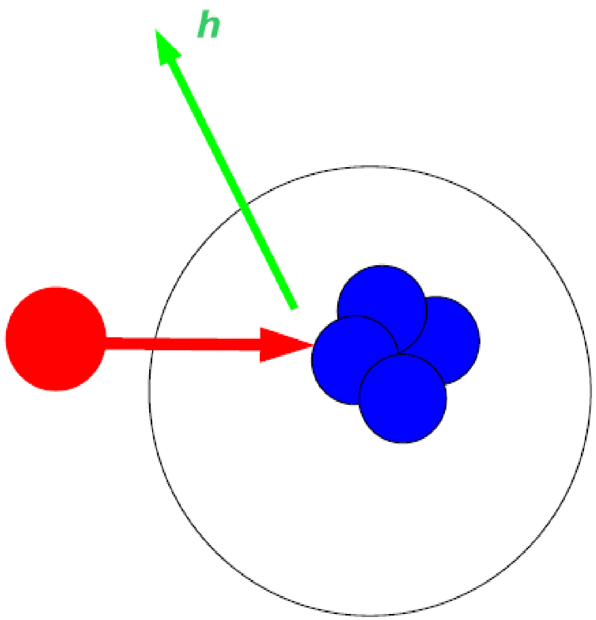
Fig. 5. Dependence of the slope parameter T_0 for the invariant function of the protons escaping under the action of $p, \pi^{\pm}, K^-, \gamma, \bar{\nu}$ with various energies E_0; the escape angle is 120° in the laboratory frame.

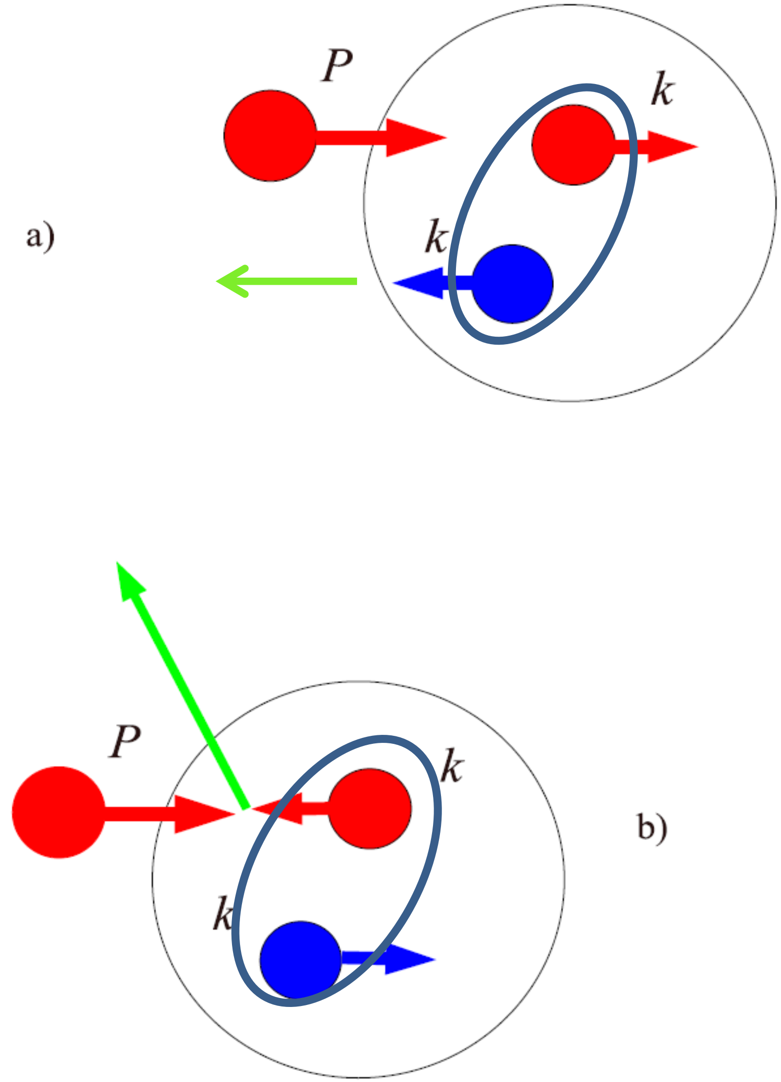
FHS, ITEP, S.Boyarinov et al.



"SRC"

"Flucton"





Краткие сообщения ОИЯИ 3[54]-92 *JINR Rapid Communications No.3[54]-92*
УДК 539.12+539.17

ВОЗМОЖЕН ЛИ ЕДИНЫЙ ПОДХОД К ПОДПОРОГОВЫМ И КУМУЛЯТИВНЫМ ПРОЦЕССАМ В РЕЛЯТИВИСТСКИХ ЯДЕРНЫХ СТОЛКНОВЕНИЯХ?

А.А.Балдин*

Предлагается единый подход к описанию подпороговых, кумулятивных и дважды кумулятивных процессов на основе гипотезы об автомодельности релятивистских ядерных столкновений. Расчеты, проведенные в рамках предложенной модели, сравниваются с разнообразными экспериментальными данными.

Работа выполнена в Институте ядерных исследований РАН, Москва.

Is the Universal Approach to the Subthreshold and Cumulative Processes in Relativistic Nuclear Collisions Possible?

A.A.Baldin

The universal approach to the description of subthreshold, cumulative and twice-cumulative processes based on the self-similarity hypothesis is presented and applied to the various reactions. Large experimental material including nucleus-nucleus and proton-nucleus interactions is analyzed.

The investigation has been performed at the Institute for Nuclear Research, Russian Academy of Sciences, Moscow

A.A. Baldin's parameterization

Phys. At. Nucl. 56(3), p.385(1993)

$$\Pi = \frac{1}{2}(X_I^2 + X_{II}^2 + 2 \cdot X_I \cdot X_{II} \cdot \gamma_{I,II})^{\frac{1}{2}} = \frac{1}{2 \cdot m} \cdot S_{\min}^{\frac{1}{2}}$$

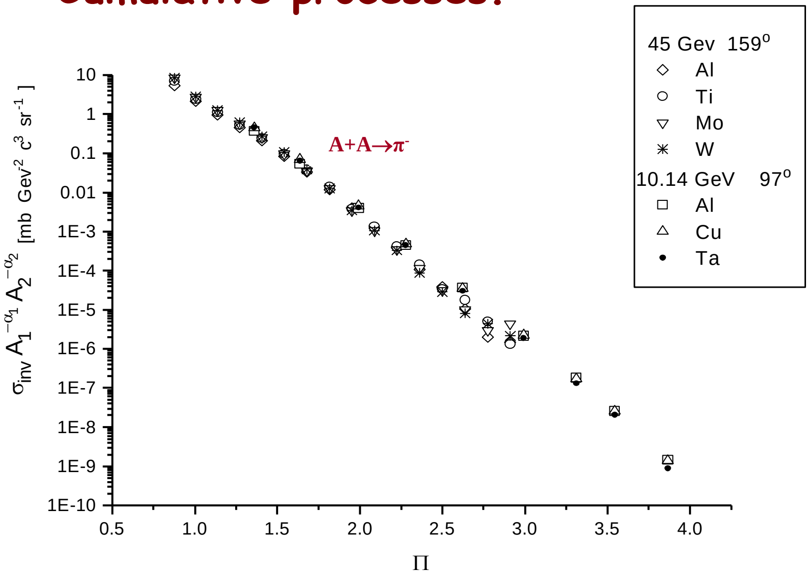
$$\gamma_{I,II} = \frac{(P_I \cdot P_{II})}{M_I \cdot M_{II}}$$

Inclusive data parameterization

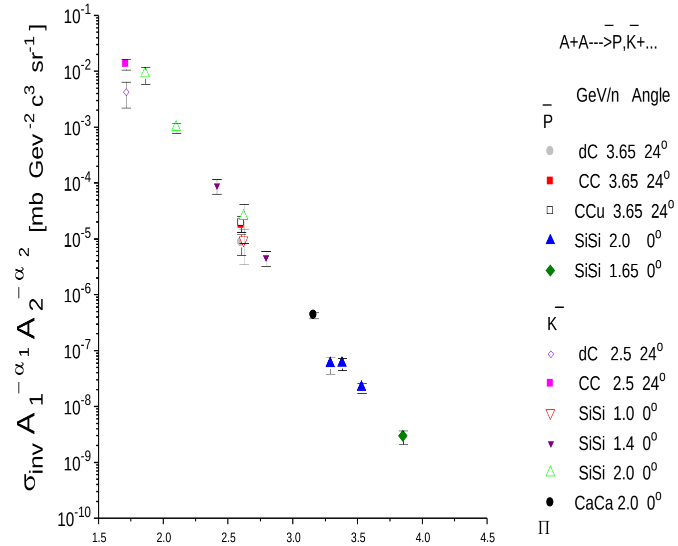
$$E \cdot \frac{d^3\sigma}{dp^3} = C_1 \cdot A_I^{\frac{1}{3}+\frac{X_I}{3}} \cdot A_{II}^{\frac{1}{3}+\frac{X_{II}}{3}} \cdot \exp(-\frac{\Pi}{C_2}),$$

$$C_1 = 2200[mb \cdot GeV^{-2} \cdot c^3 \cdot sr^{-1}], C_2 = 0.127$$

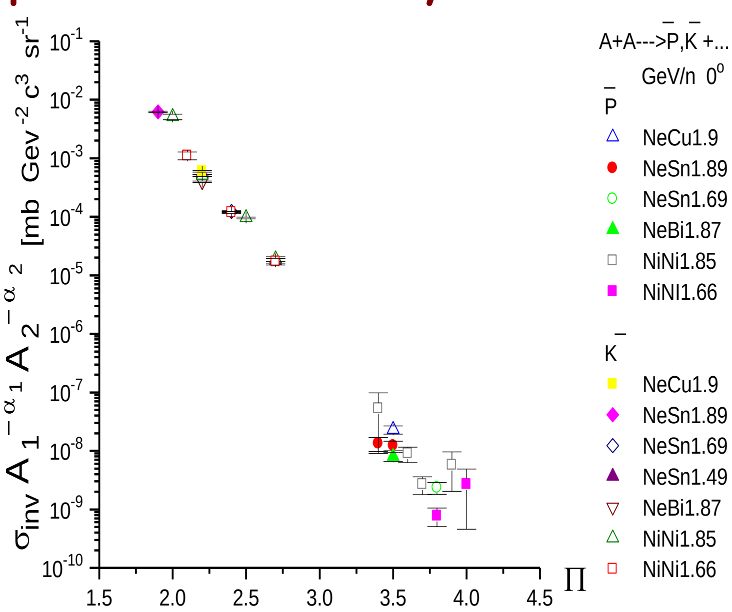
Cumulative processes.



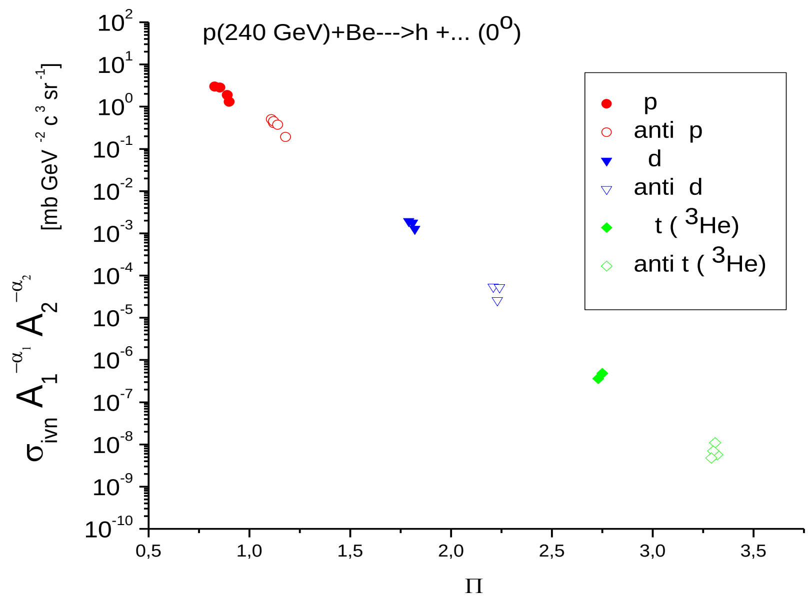
Twice cumulative processes.



Twice cumulative deep subthreshold processes with heavy nuclei.

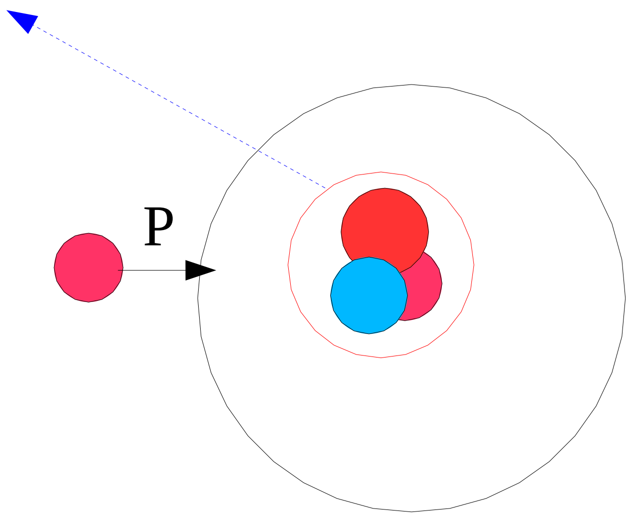


Antimatter production.



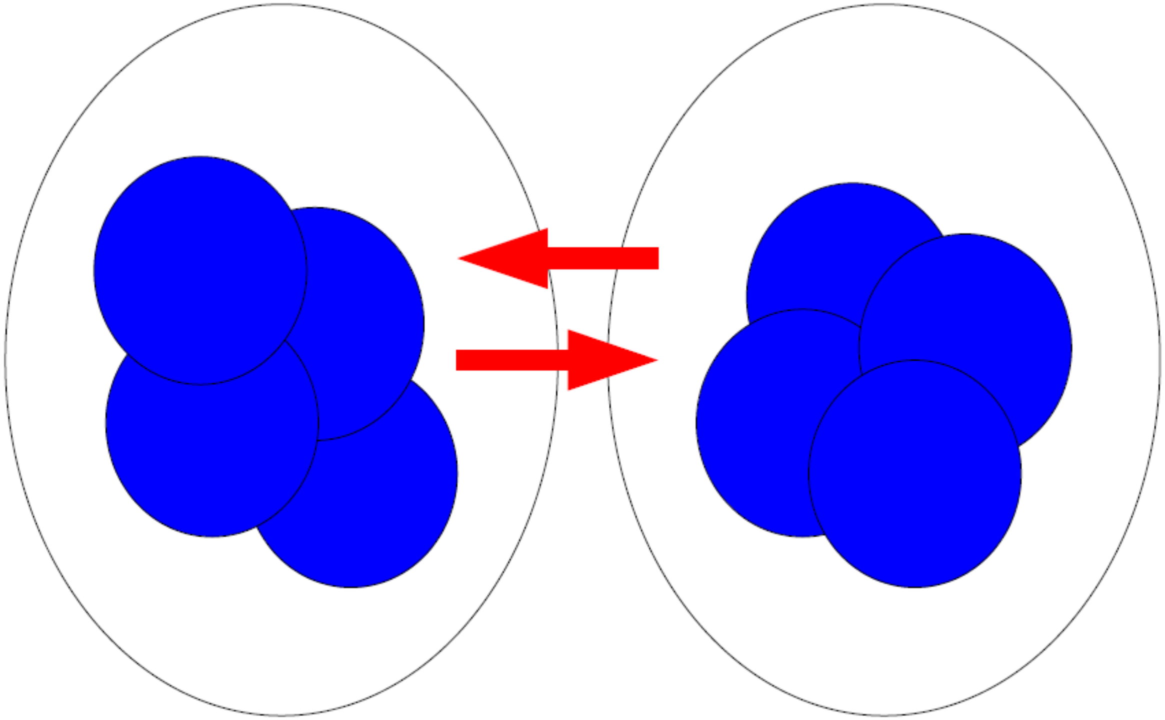
Fluctons
(cumulative particle production)

$pA \to h + X$



$$\sigma_h \sim P_K \cdot G_{h/K}(K)$$

Subthreshold flucton-flucton production



$$\sigma_h \sim P^2{}_K \cdot G^2{}_{h/K}(K)$$

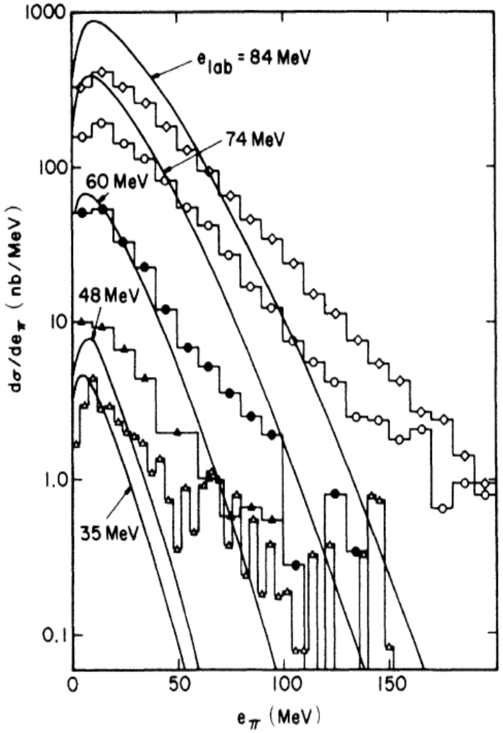


FIG. 2. Comparison of calculated and experimenta spectra. The input π^0 absorption cross sections are those by the upper solid curve in Fig. 1. For the lower solid cu that figure, the results shown here must be scaled dow factor of about 2. The data are taken from Refs. 6 and the reaction $^{12}C+^{12}C$ (upper four curves) and from Ref. the reaction $^{14}N + Ni$ (open triangles).

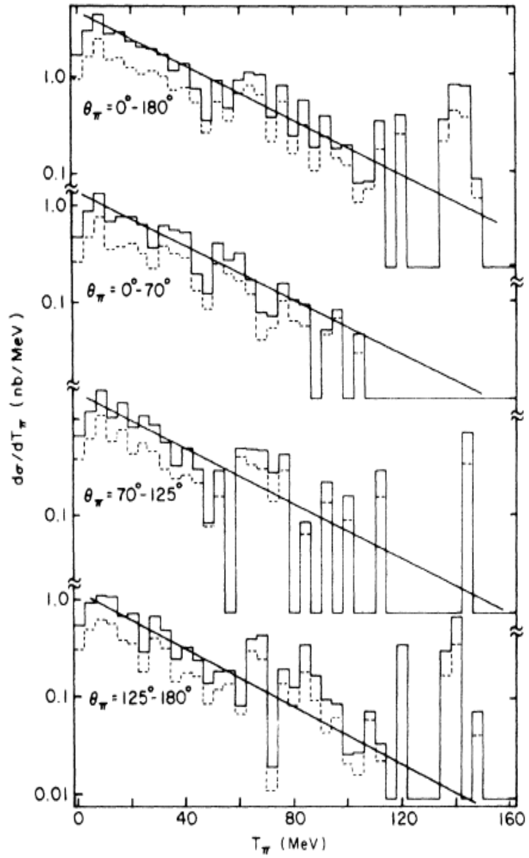


FIG. 3. Pion kinetic energy spectrum (solid histogram) in the laboratory frame for 35 MeV/nucleon $^{14}N+Ni$ integrated over all pion emission angles θ_π (top) and for various θ_π bins. For the meaning of the dashed histograms see the text. The straight lines represent an exponential with an inverse slope constant of 23 MeV.

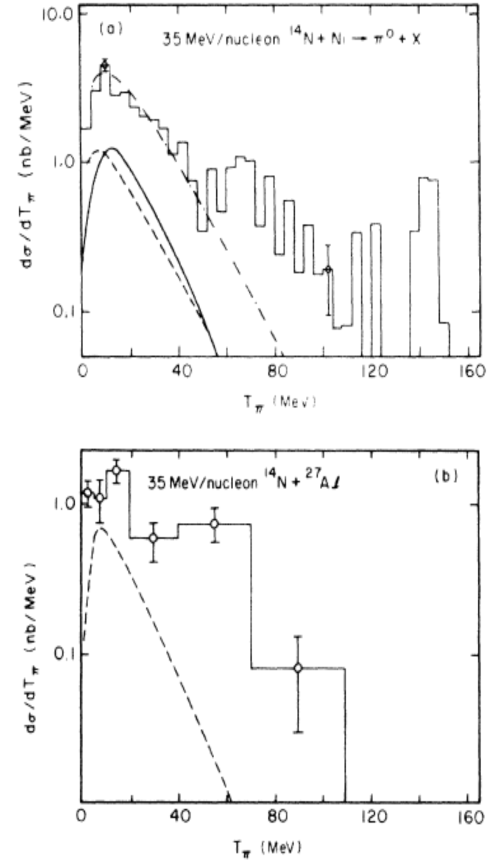
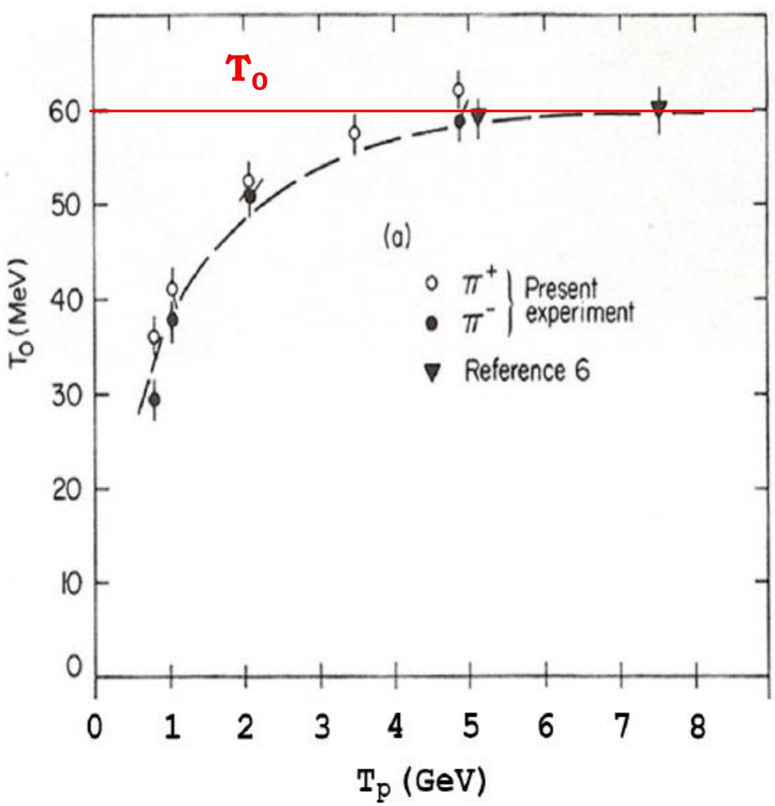
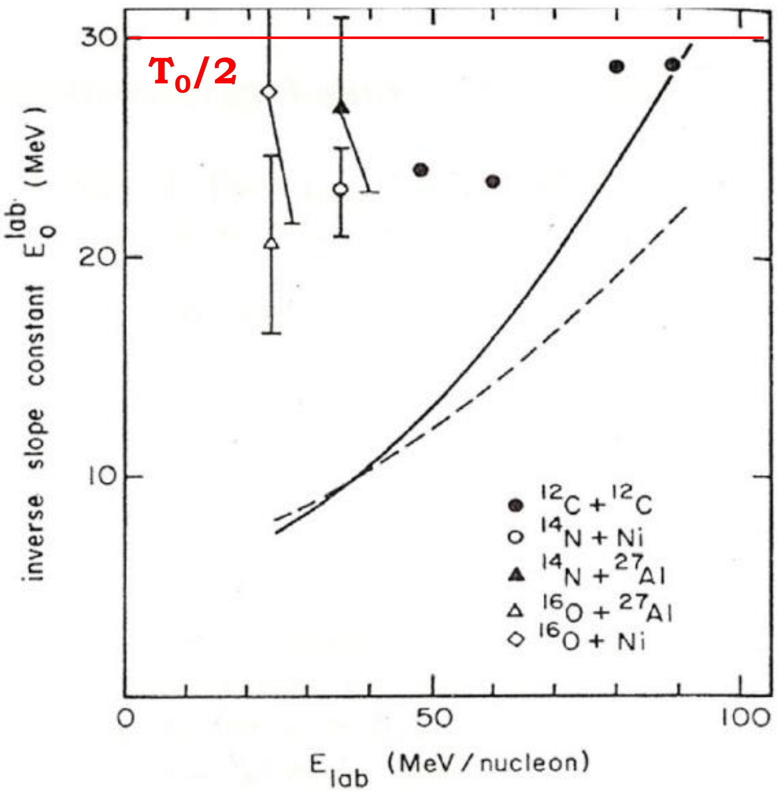


FIG. 4. Experimental pion kinetic energy spectra at 35 MeV/nucleon for the Ni and Al target. The spectrum for the Al target corresponds to the same measurements as shown in Ref. 6 but differs from the spectrum shown there by subtraction of the cosmic-ray background and use of the energy dependent conversion efficiency as discussed in the text (as compared to no cosmic subtraction and $\epsilon_c=0.7$). The solid and dashed lines are predictions of Refs. 27 and 30, respectively. The dashed dotted line corresponds to a thermal spectrum (Ref. 20) with $T=12.2$ MeV and is normalized to the data at low kinetic energies (10–60 MeV).

Inverse slope for subthreshold production must be the less then $T_0/2$ (near the phase space border).



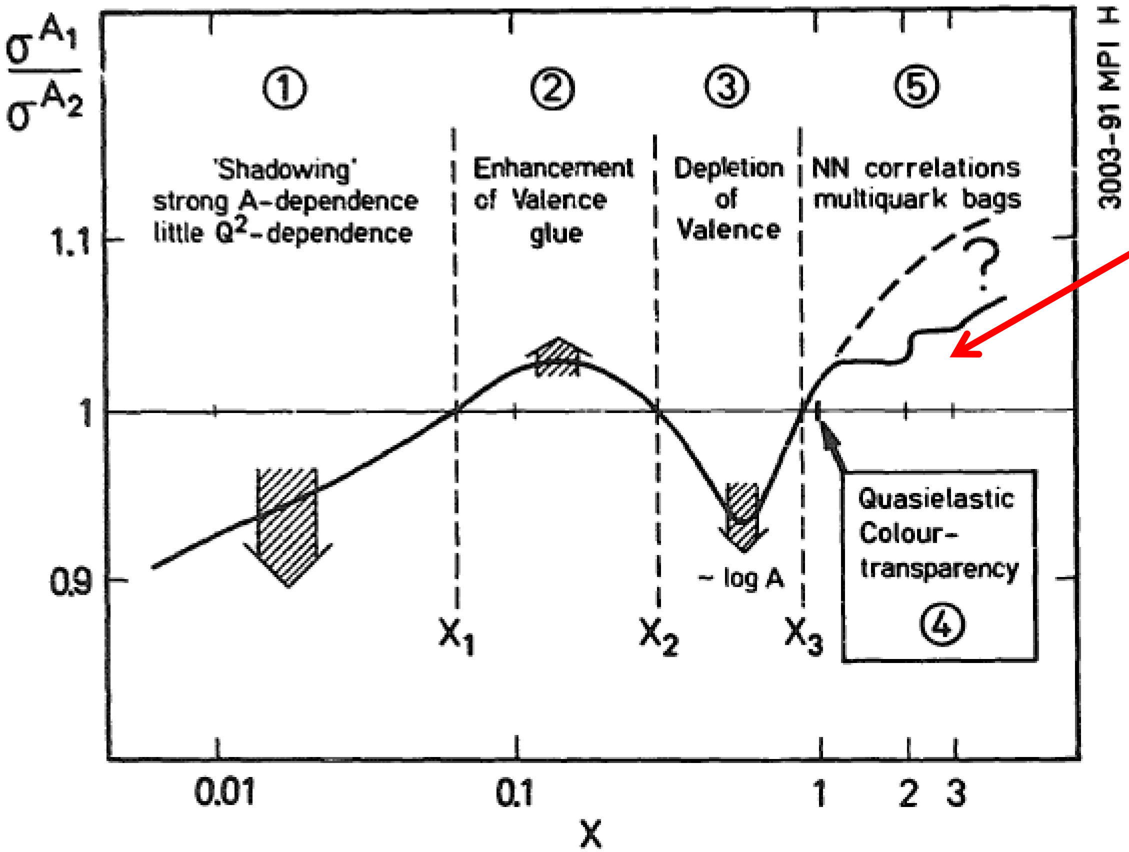


$$P_{cum} \sim \exp(-T/T_0) \quad \Rightarrow \quad P_{subthresh} \sim \exp(-T/T_0) \cdot \exp(-T/T_0) \sim \exp(-T/(T_0/2))$$

DIS in the cumulative region.

Nuclear Physics A532 (1991) 3c – 14c

K.Rith



Cumulative kinematical region

Region 5: $x_3 < x < x_A$

For a nucleus with atomic mass A the quark distributions can in principle extend to $x_A = A$. $R^A(x)$ is bigger than one. Its behaviour is strongly influenced by Fermi-motion, final state interactions, nucleon-nucleon correlations, or the formation of multiquark clusters. Experimentally this region is essentially unexplored.

PHYSICAL REVIEW C VOLUME 45, NUMBER 4 APRIL 1992

Nuclear structure functions at $x > 1$

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Institute of Nuclear and Particle Physics and Department of Physics, University of Virginia, Charlottesville, Virginia 22901

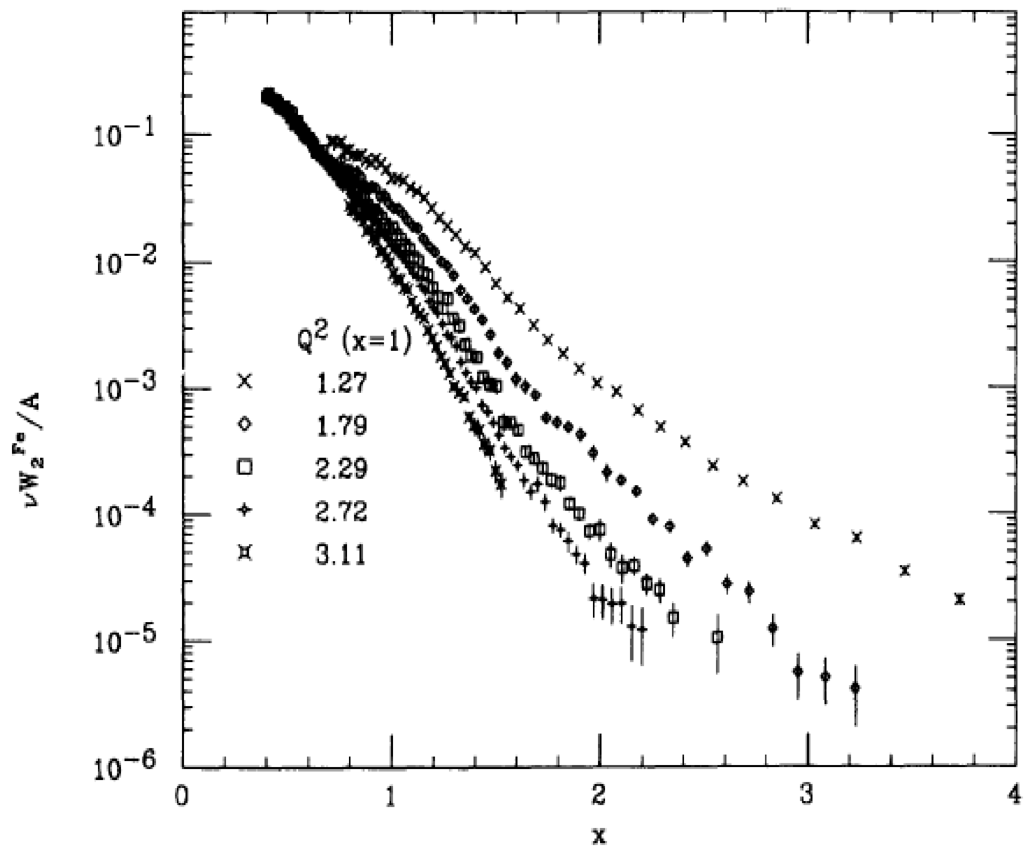

FIG. 1. Measured structure function per nucleon for Fe vs x. The Q^2 value at $x = 1$ is also listed for the different kinematics.

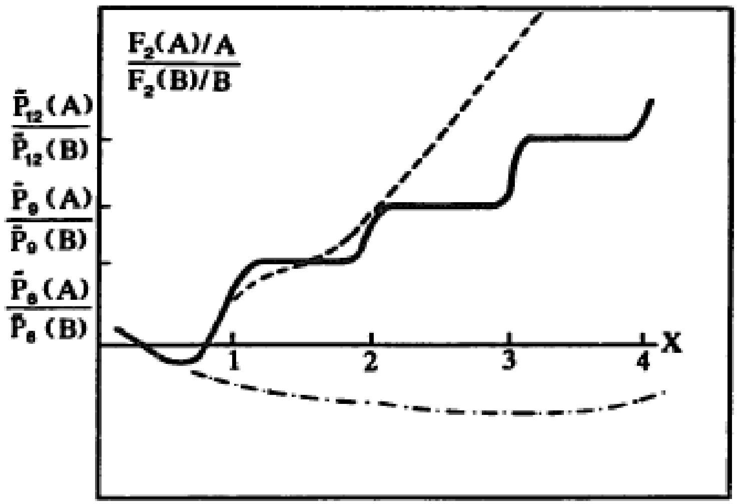

Figure 5. Theoretical predictions for nuclear structure functions at x > 1

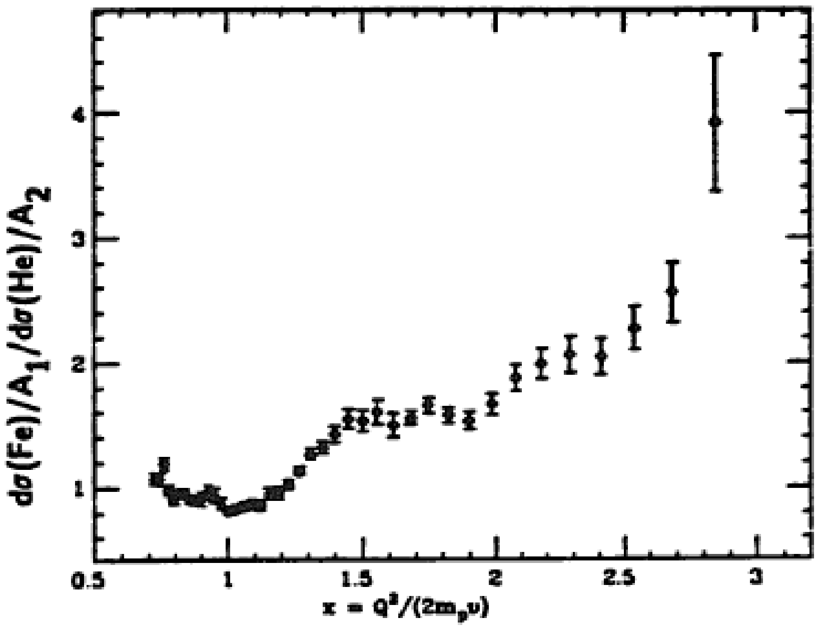

Figure 6. Preliminary results for σ^{Fe}/σ^{He} from NE-2 at SLAC

32 J. Vary, Proceedings of the 7th Int. Conf. on High Energy Physics problems, Dubna 1984,147.

N.P. Zotov, V.A. Saleev, V.A. Tsarev (Lebedev Inst.)
Published in JETP Lett. 40 (1984) 965-968, Pisma Zh.Eksp.Teor.Fiz. 40 (1984) 200-203

Z. Phys. C 63, 29–36 (1994)

ZEITSCHRIFT
FÜR PHYSIK C

Nuclear structure functions in carbon near $x = 1$

BCDMS Collaboration

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Received: 1 March 1994

Abstract. Data from deep inelastic scattering of 200 GeV muons on a carbon target with squared four-momentum transfer $52\,\mathrm{GeV}^2 \leq Q^2 \leq 200\,\mathrm{GeV}^2$ were analysed in the region of the Bjorken variable close to $x = 1$, which is the kinematic limit for scattering on a free nucleon. At this value of x, the carbon structure function is found to be $F_2^C \approx 1.2 \cdot 10^{-4}$. The x dependence of the structure function for $x > 0.8$ is well described by an exponential $F_2^C \propto \exp(-sx)$ with $s = 16.5 \pm 0.6$.

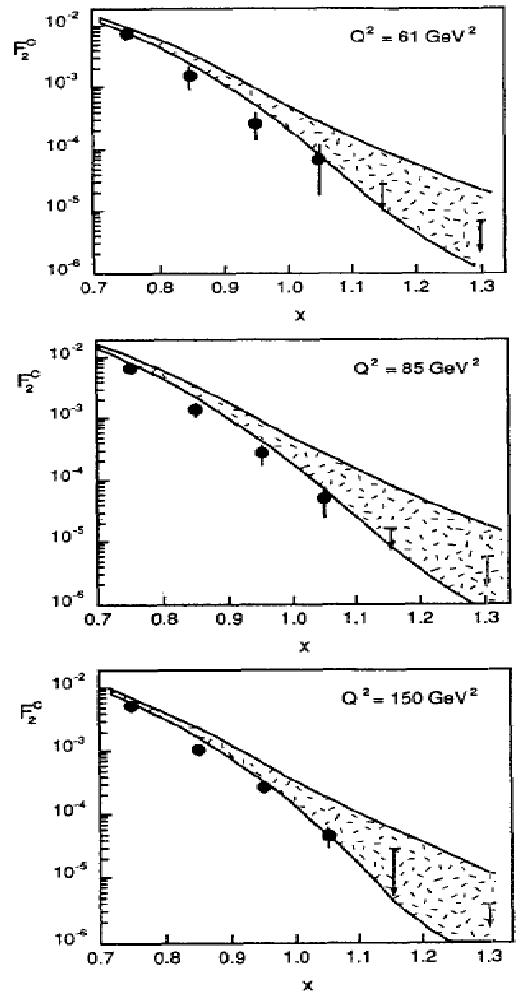

Fig. 7. The nuclear structure function $F_2^C(x)$ as a function of x, at three different values of Q^2. The hatched regions show the range of predictions of [26]

Phys.Rev.Lett. 96 (2006) 082501

Measurement of 2- and 3-Nucleon Short Range Correlation Probabilities in Nuclei

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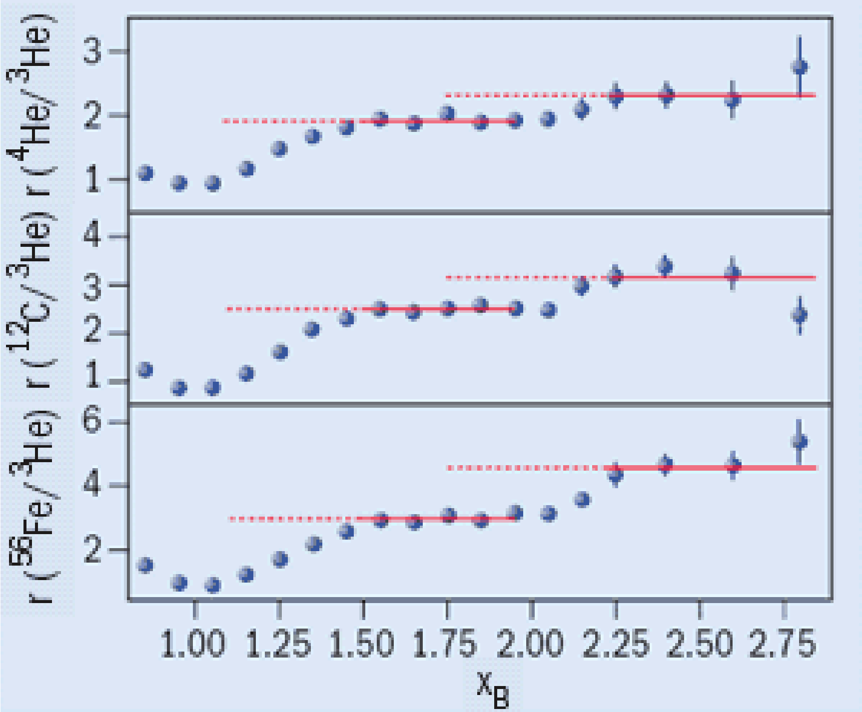
$$r(A,{}^3\mathrm{He}) = \frac{A(2\sigma_{ep}+\sigma_{en})}{3(Z\sigma_{ep}+N\sigma_{en})}\frac{3\mathcal{Y}(A)}{A\mathcal{Y}({}^3\mathrm{He})}C^A_{\mathrm{rad}}, \qquad (2)$$

where Z and N are the number of protons and neutrons in nucleus A, σ_{eN} is the electron-nucleon cross section, $\mathcal{Y}$ is the normalized yield in a given (Q^2, x_B) bin [30] and C^A_{rad} is the ratio of the radiative correction factors for A and ^{3}He ($C^A_{\mathrm{rad}} = 0.95$ and 0.92 for ^{12}C and ^{56}Fe respectively). In our Q^2 range, the elementary cross section correction factor $\frac{A(2\sigma_{ep}+\sigma_{en})}{3(Z\sigma_{ep}+N\sigma_{en})}$ is 1.14 ± 0.02 for C and ^{4}He and 1.18 ± 0.02 for ^{56}Fe. Fig. 1 shows the resulting ratios integrated over $1.4 < Q^2 < 2.6$ GeV^2.



Having these data, we know almost full (≈99%) nucleonic picture of nuclei with $A \leq 56$

Fractions / Nucleus	Single particle (%)	2N SRC (%)	3N SRC (%)
^{56}Fe	**76** ± 0.2 ± 4.7	**23.0** ± 0.2 ± 4.7	**0.79** ± 0.03 ± 0.25
^{12}C	**80** ± 02 ± 4.1	**19.3** ± 0.2 ± 4.1	**0.55** ± 0.03 ± 0.18
^{4}He	**86** ± 0.2 ± 3.3	**15.4** ± 0.2 ± 3.3	**0.42** ± 0.02 ± 0.14
^{3}He	**92** ± 1.6	**8.0** ± 1.6	**0.18** ± 0.06
^{2}H	**96** ± 0.8	**4.0** ± 0.8	-----

Using the published data on (p,2p+n) [PRL,90 (2003) 042301] estimate the isotopic composition of 2N SRC in ^{12}C

$a_{pp}(^{12}C) \approx 4 \pm 2$ %

$a_{2N}(^{12}C) \approx 20 \pm 0.2 \pm 4.1$ % → $a_{pn}(^{12}C) \approx 12 \pm 4$ %

$a_{nn}(^{12}C) \approx 4 \pm 2$ %

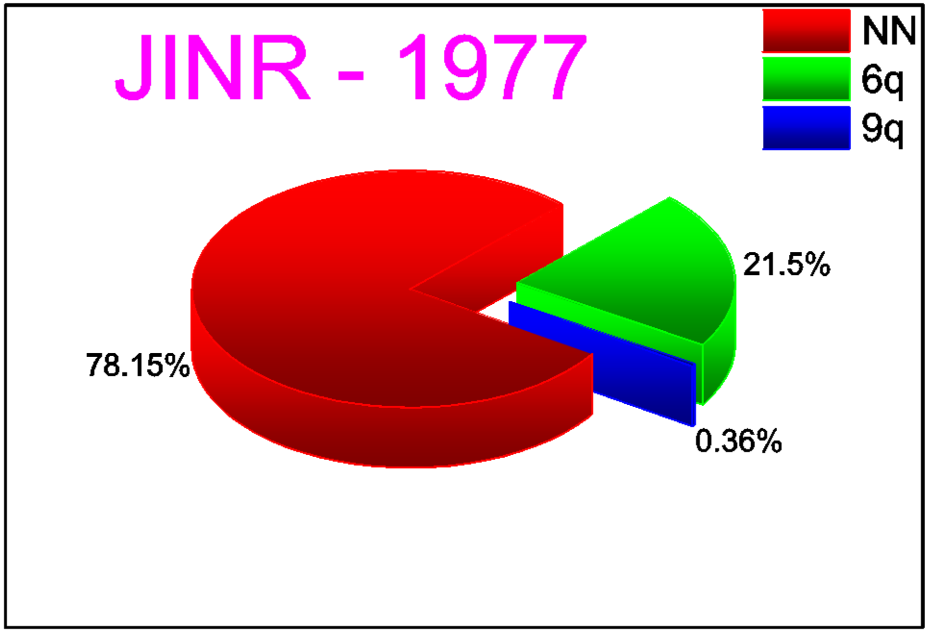
^{12}C - structure

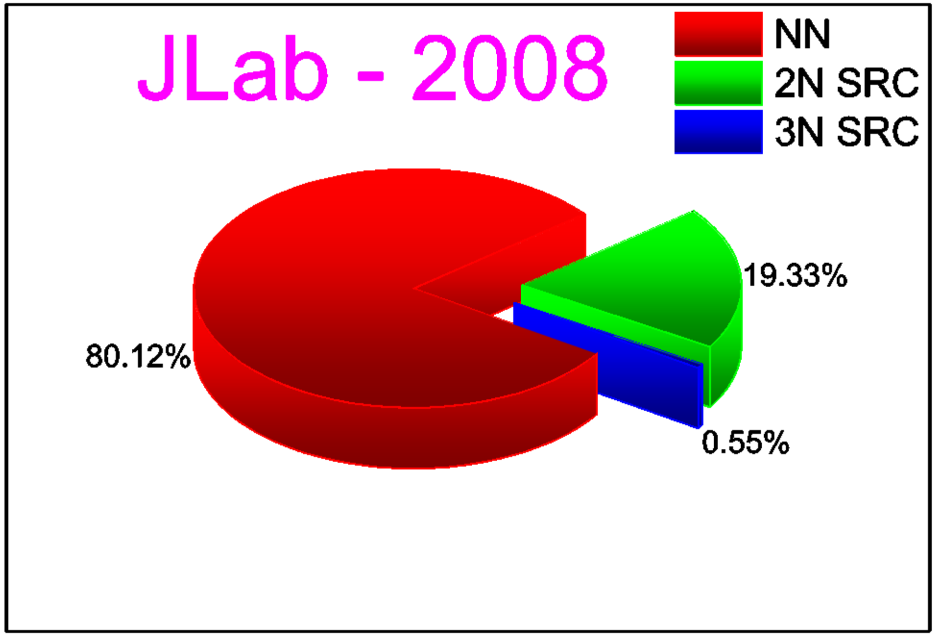
RNP - program at JINR

V.V.Burov, V.K.Lukyanov, A.I.Titov, PLB, 67, 46(1977)

eA - program at JLab

R.Subedi et al., Science 320 (2008) 1476-1478
e-Print: arXiv:0908.1514 [nucl-ex]





High p_T processes

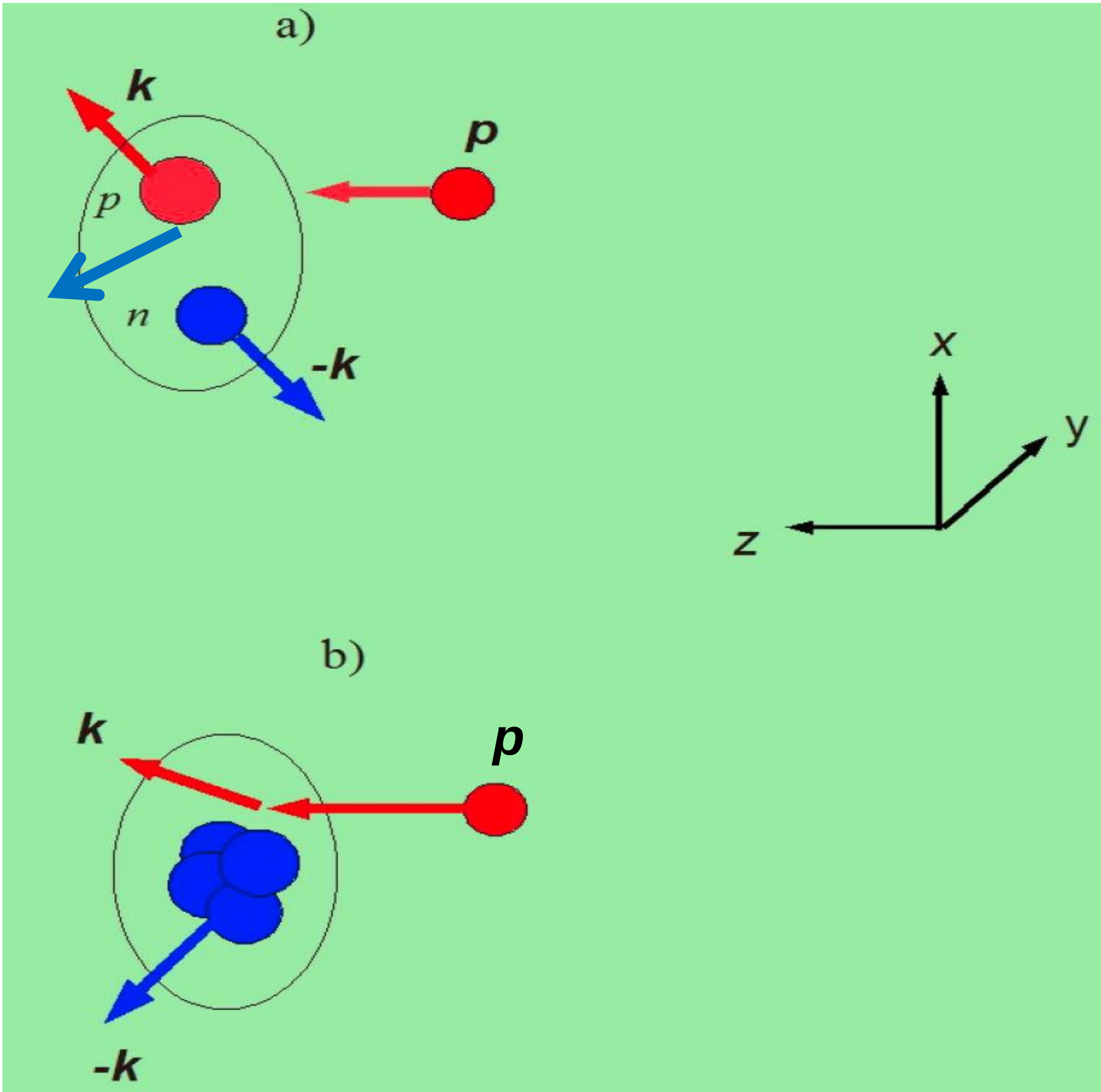
Knot out cold dense nuclear configurations

SRC configuration

<B> ~ 1

<B> ?

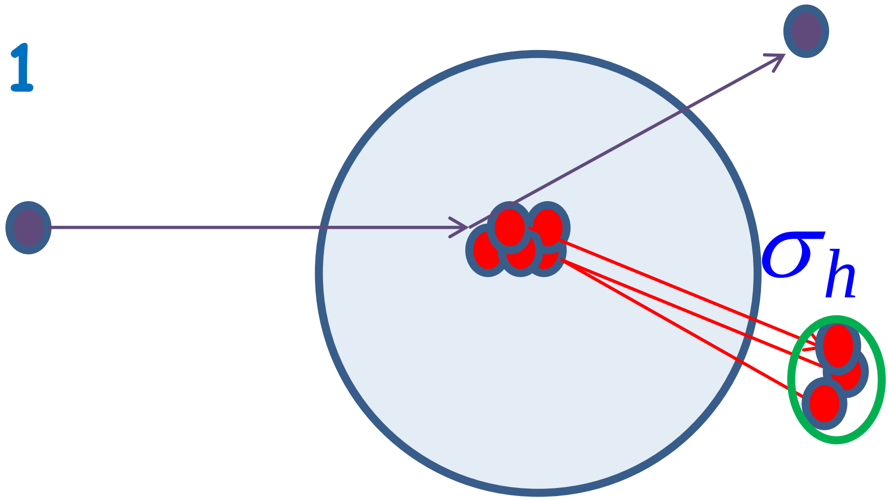
Multiquark configuration



Flucton case

Knock out of a nuclear fragment

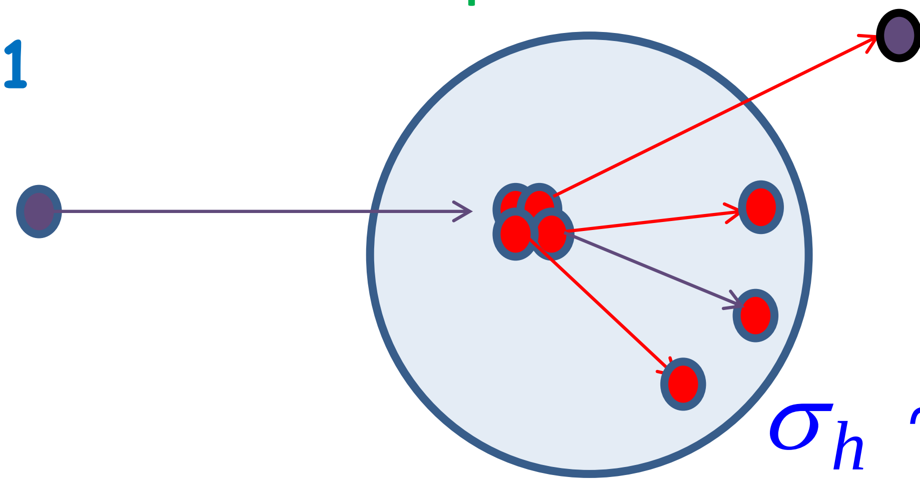
<B> > 1



$$\sigma_h \sim P_K \cdot \frac{d\sigma_{"el"}(K)}{dt}$$

Collision with hot flucton - small explosion

<B> < 1

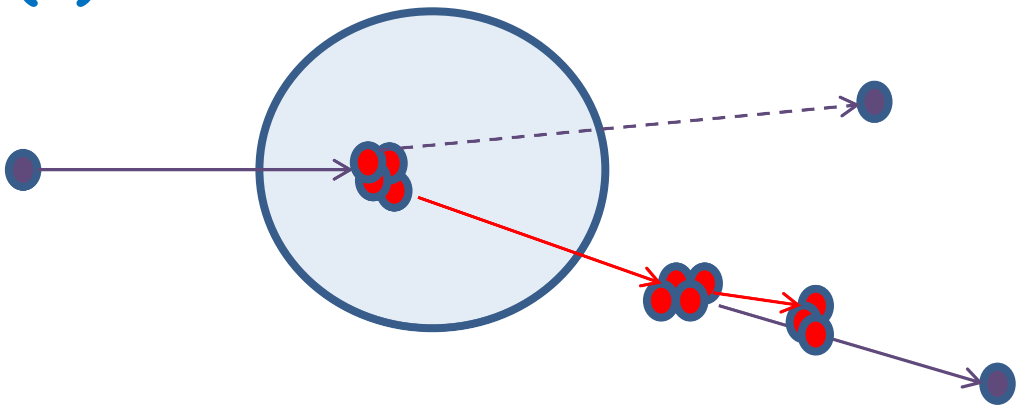


$$\sigma_h \sim P_K \cdot \frac{d\sigma_{inel}(K)}{dt}$$

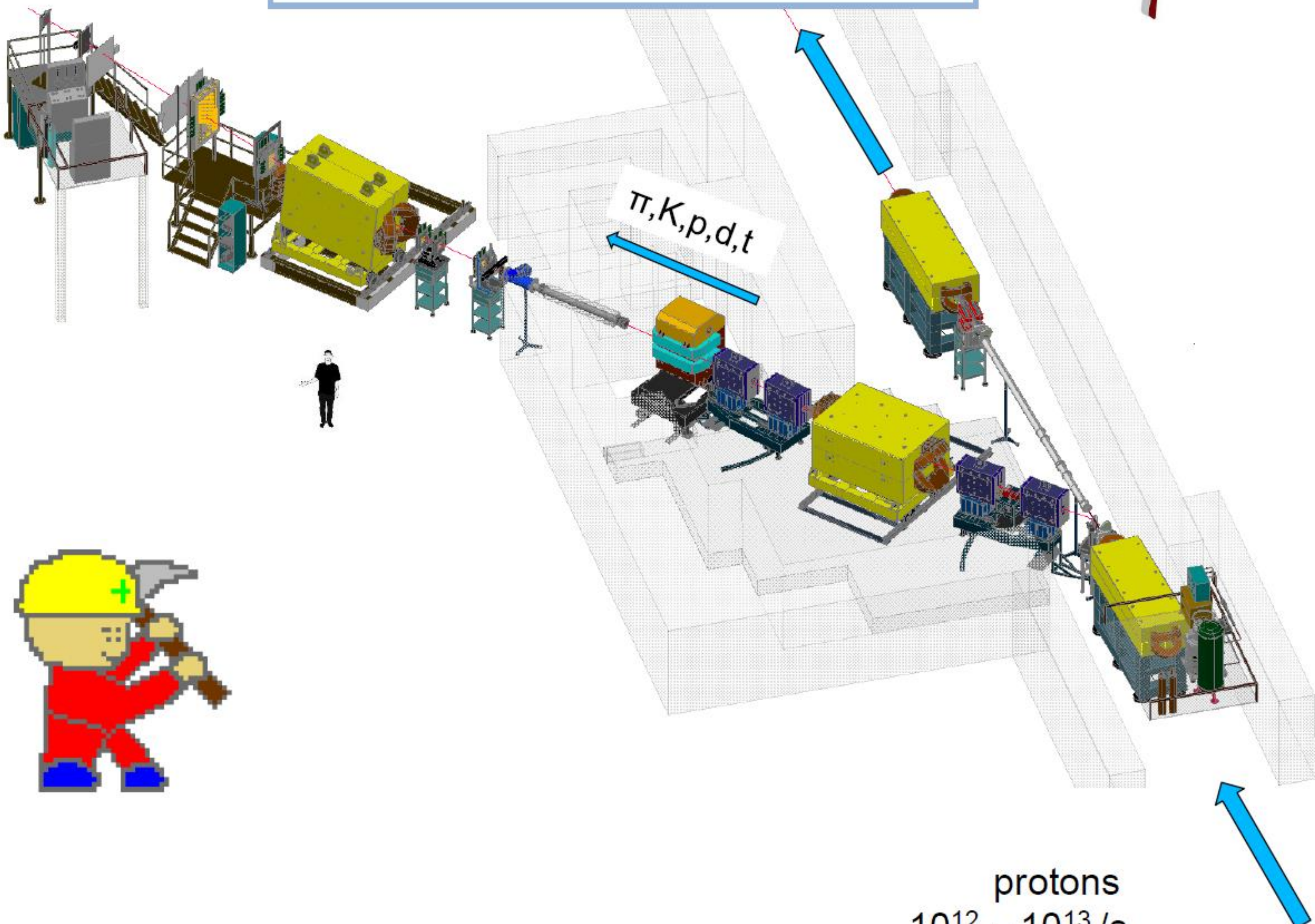
Flucton case

Knock out of a flucton in an excited state

<B> > 1 (?)



SPIN – narrow acceptance spectrometer, beam line #8

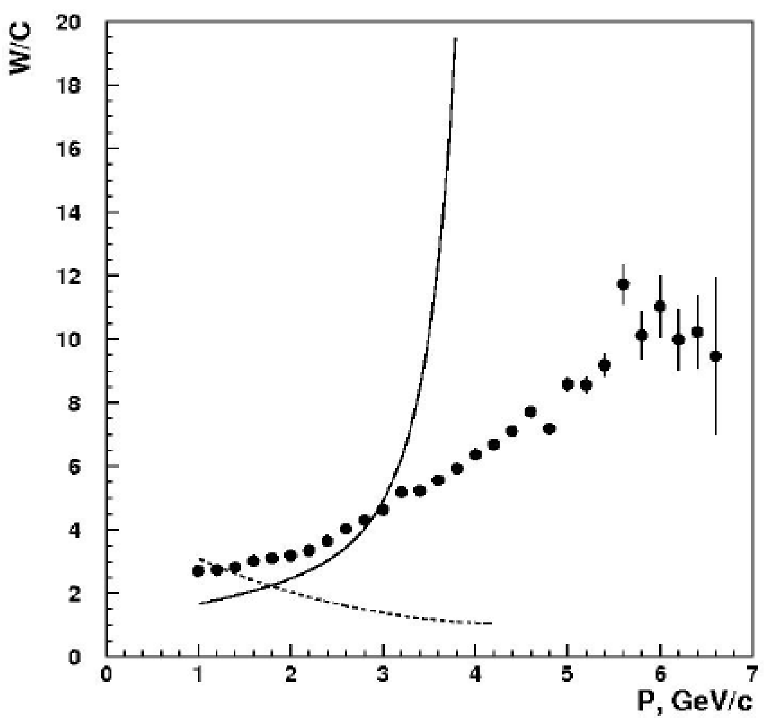


Physics of Atomic Nuclei, 2013, Vol. 76, No. 10, pp. 1213–1218

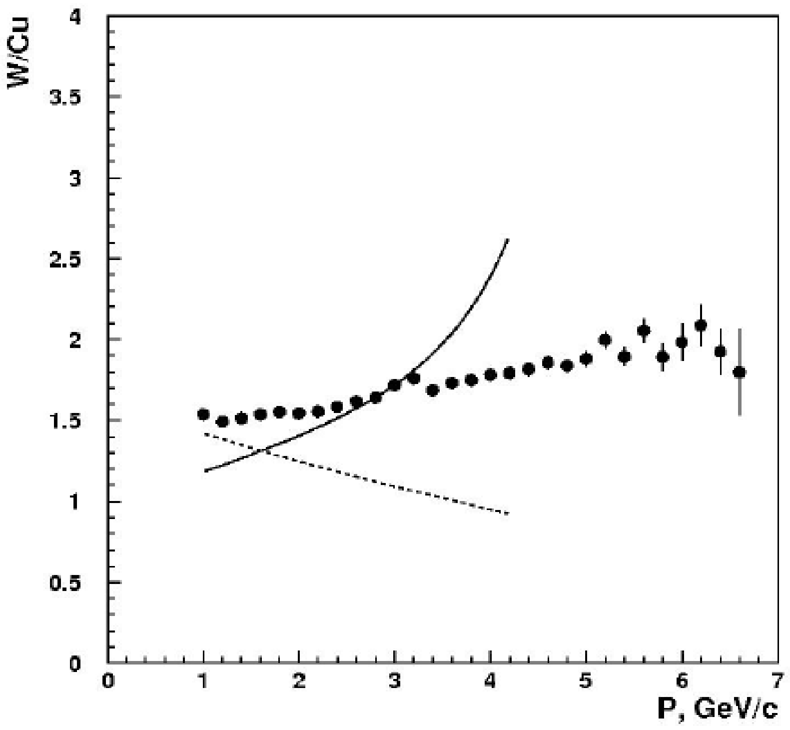
h^+ – spectrum

Сплошные кривые: HIJING 1.3 http://www-nsdth.lbl.gov/~xnwang/hijing/doc.html
Пунктирные кривые: UrQMD 3.3 http://urqmd.org/

W / C



W / Cu



$$\frac{f_{(p+A_I)}}{f_{(p+A_{II})}} \times \left(\frac{A_I}{A_{II}}\right)^{-(\frac{1}{3}+\frac{X_2}{3})} = 1$$

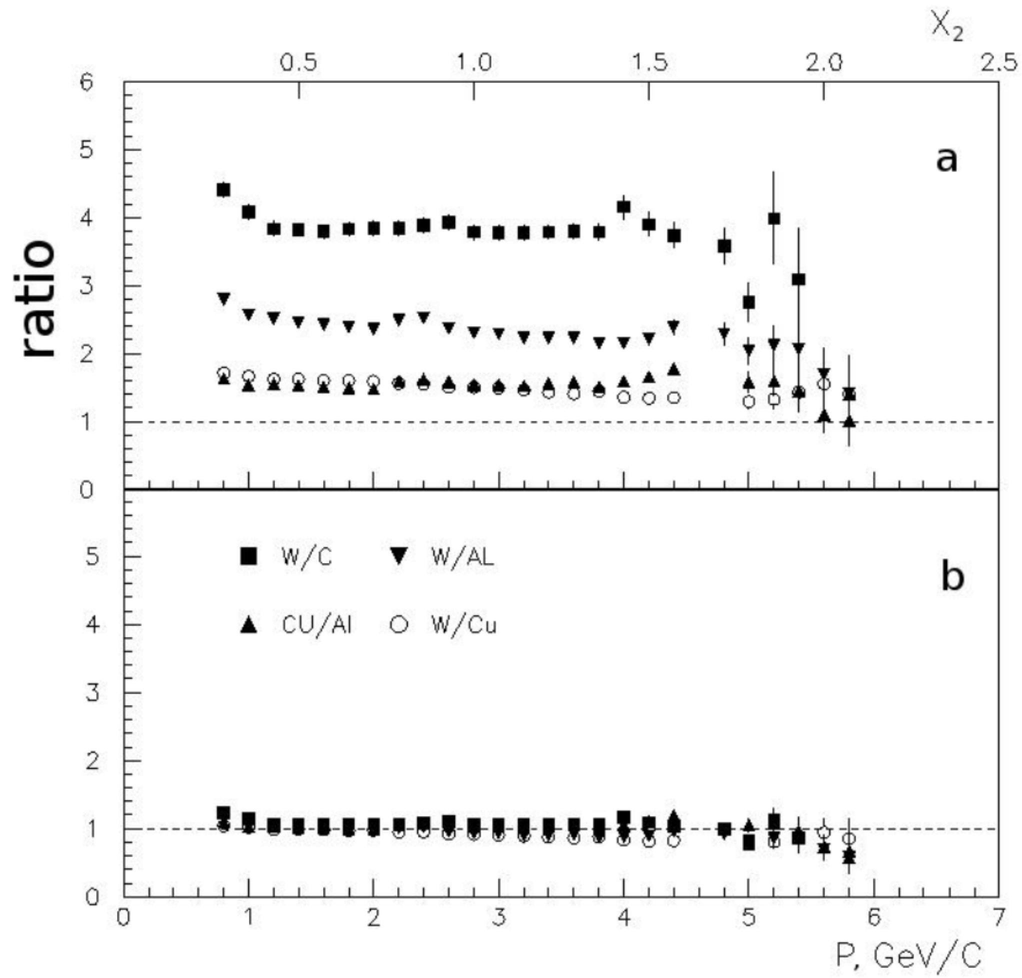
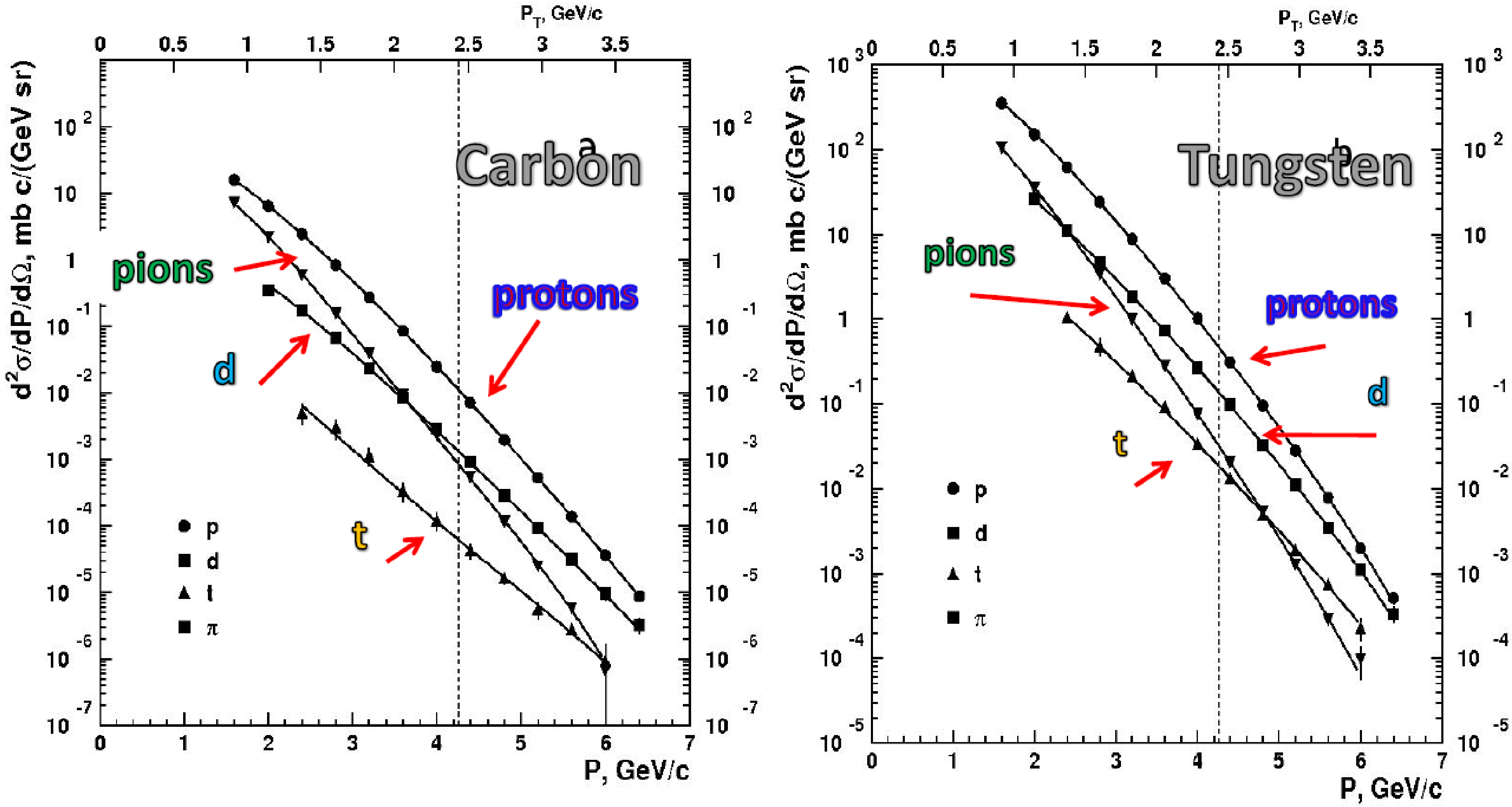


Fig.5 Ratio of cross sections of negative pion production on different nuclei multiplied by inverse A-dependence (see the text). The lower axis shows the momentum, the upper axis, X_2. (a) The ratios are obtained using the A-dependence in the form [8] $A^{(1+X_2)/3}$, (b) the ratios are obtained using the A-dependence in the form $A^{(2.45+X_2)/3}$.

$$A^{-(2.45+X_2)/3}$$

N.N. Antonov et al., *JETP Letters*, Vol.101, No.10, pp.670-673(2015)



Invariant function found for positive pion, proton, deuteron and triton.

The vertical dashed lines indicate the kinematical limit for elastic nucleon–nucleon scattering. The upper horizontal scale shows values of the transverse momentum p_T .

Particle Production at Large Angles by 30- and 33-Bev Protons Incident on Aluminum and Beryllium*

V. L. Fitch, S. L. Meyer,† and P. A. Piroué
Palmer Physical Laboratory, Princeton University, Princeton, New Jersey

(Received February 12, 1962)

A mass analysis has been made of the relatively low momentum particles emitted from Al and Be targets when struck by 30- and 33-Bev protons. Measurements were made at 90°, 45°, and $13\frac{1}{4}$° relative to the direction of the Brookhaven AGS proton beam. Magnetic deflection and time-of-flight technique were used to determine the mass of the particles.

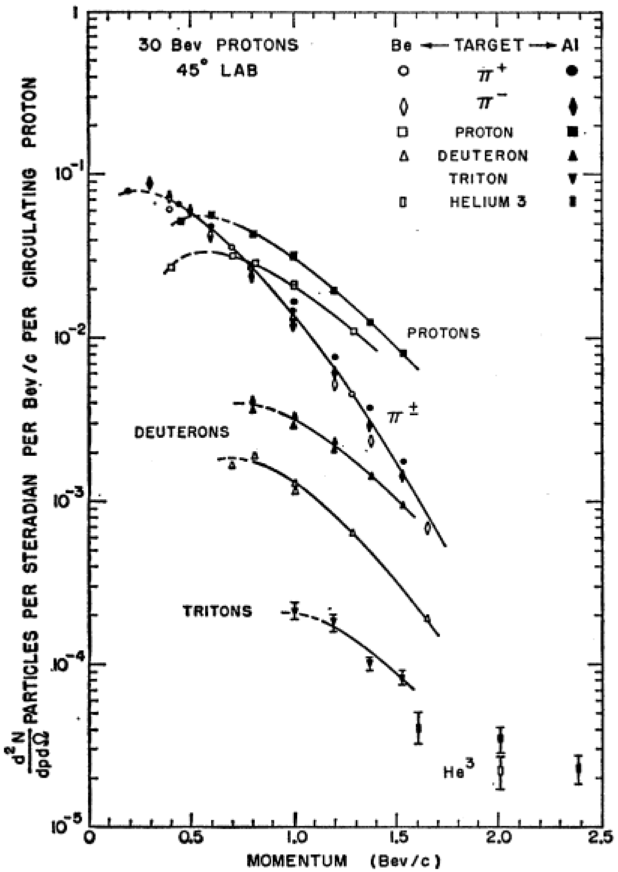


Fig. 3. Momentum spectra of particles emitted at 45° from aluminum and beryllium targets when struck by 30-Bev protons. Tritons from Be were not measured. For general remarks refer to Fig. 2 caption.

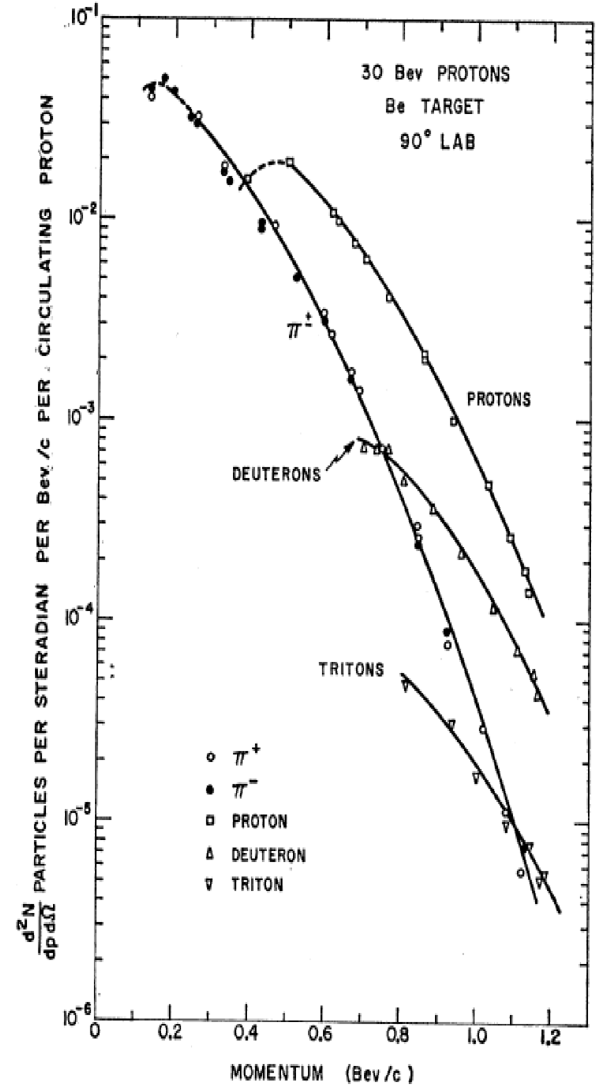
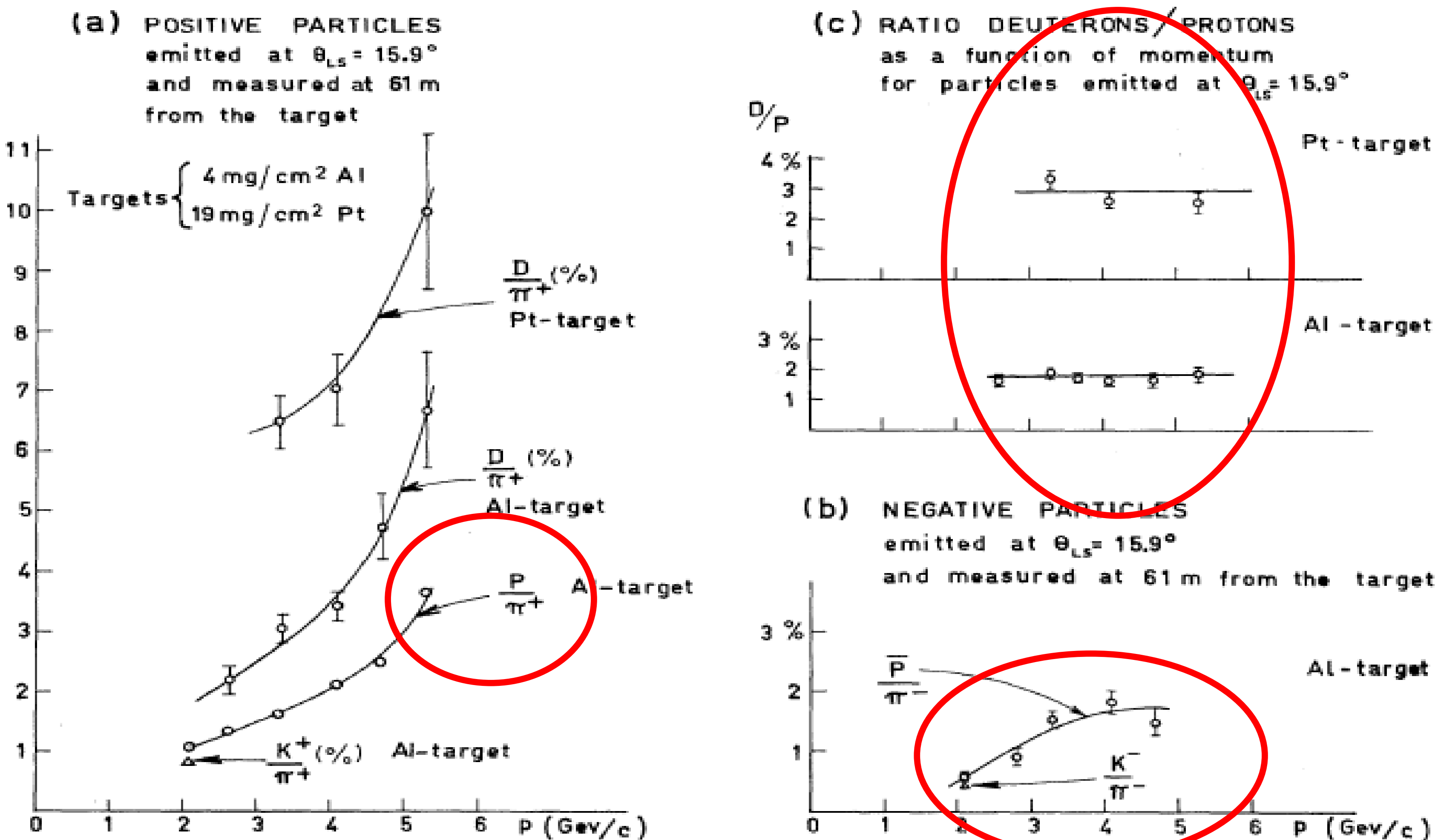


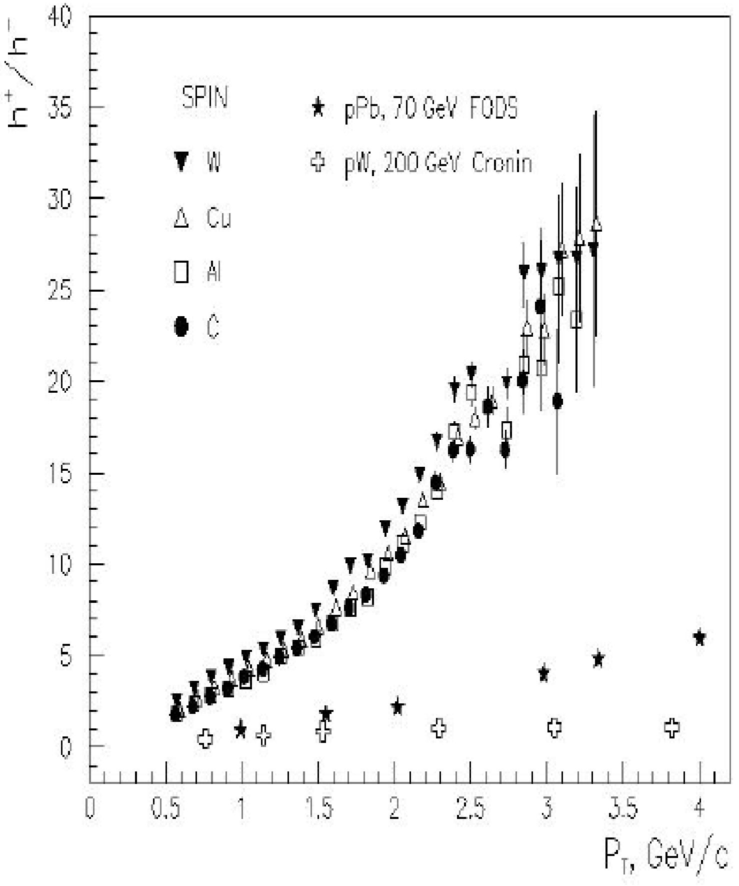
Fig. 2. Momentum spectrum of particles emitted at 90° from a beryllium target struck by 30-Bev protons. The ordinate is the number of particles produced at the target per steradian per Bev/c per circulating proton. The dashed portions of the curves indicate regions where the corrections due to multiple scattering exceed 15%. At the time these data were taken no effort was made to detect He³.

MASS ANALYSIS OF THE SECONDARY PARTICLES PRODUCED BY THE 25-GEV PROTON BEAM OF THE CERN PROTON SYNCHROTRON

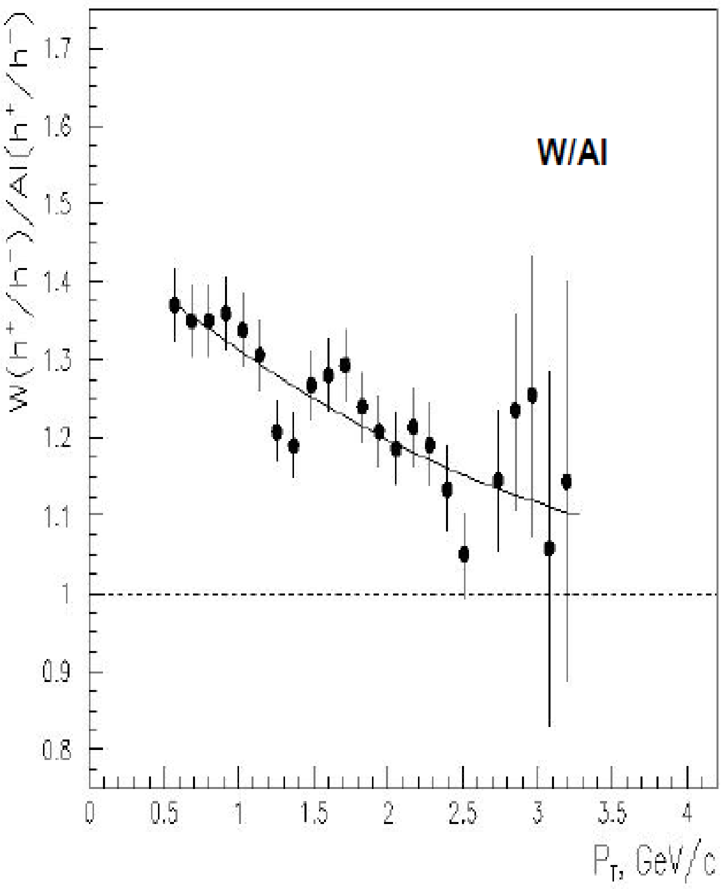
V. T. Cocconi,* T. Fazzini, G. Fidecaro, M. Legros,† N. H. Lipman, and A. W. Merrison
CERN, Geneva, Switzerland



Ratios



h^+/h^-
SPIN
W
Cu
Al
C
pPb, 70 GeV FODS
pW, 200 GeV Cronin
0
5
10
15
20
25
30
35
40
0
0.5
1
1.5
2
2.5
3
3.5
4
P_T, GeV/c

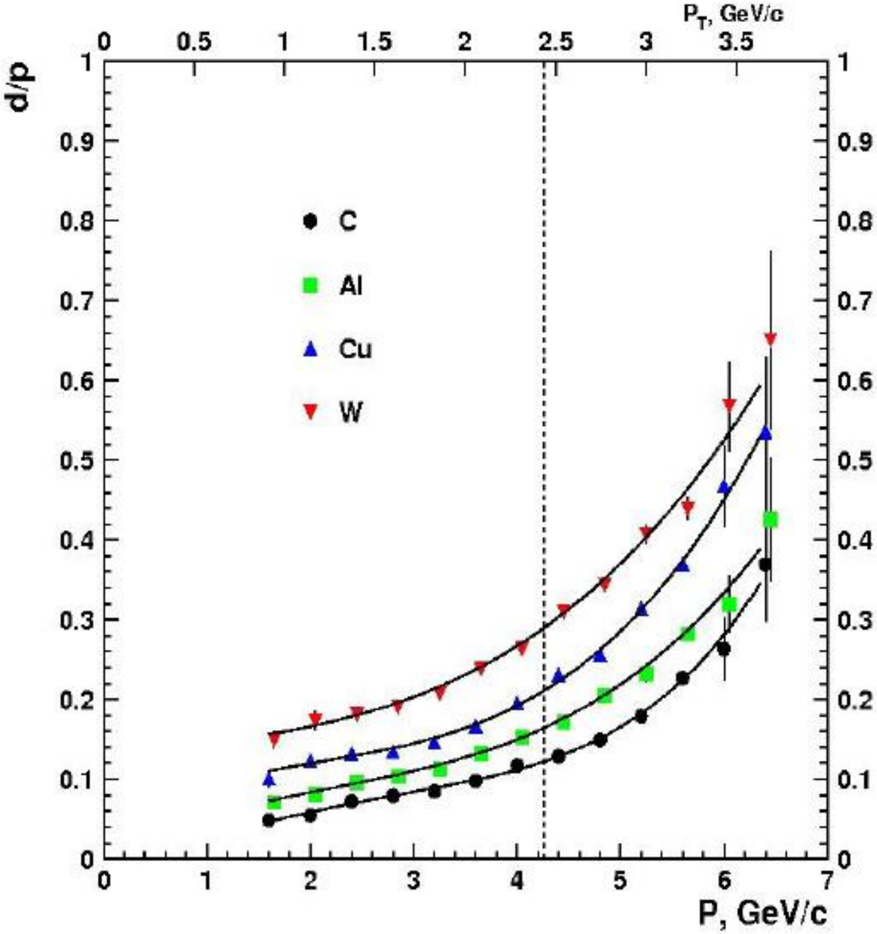


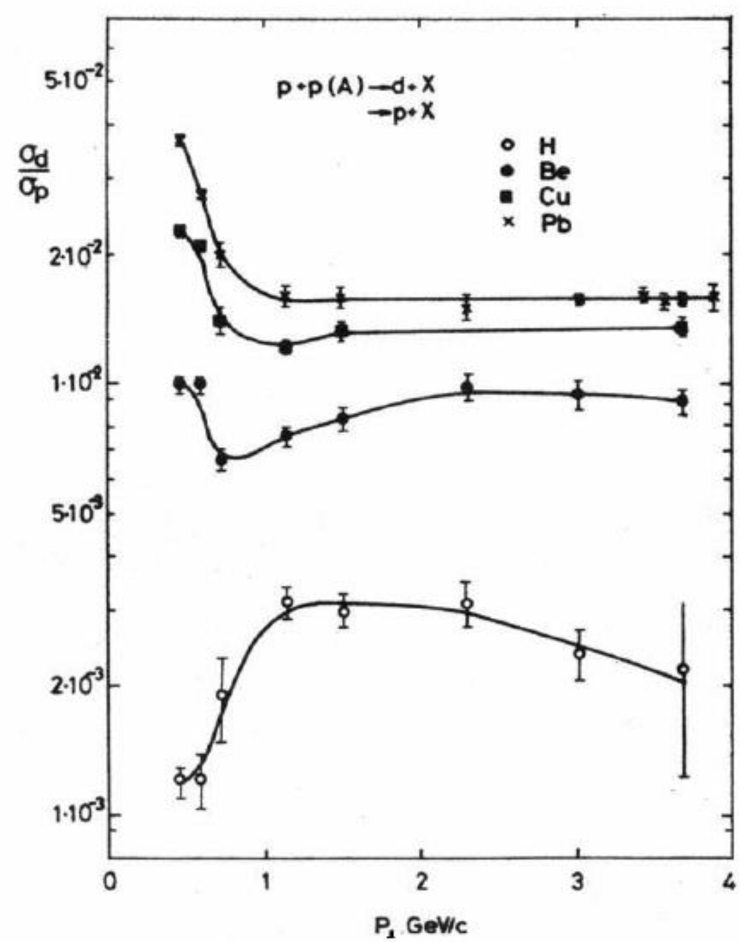
$W(h^+/h^-)/Al(h^+/h^-)$
W/Al
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
0
0.5
1
1.5
2
2.5
3
3.5
4
P_T, GeV/c

SPIN data

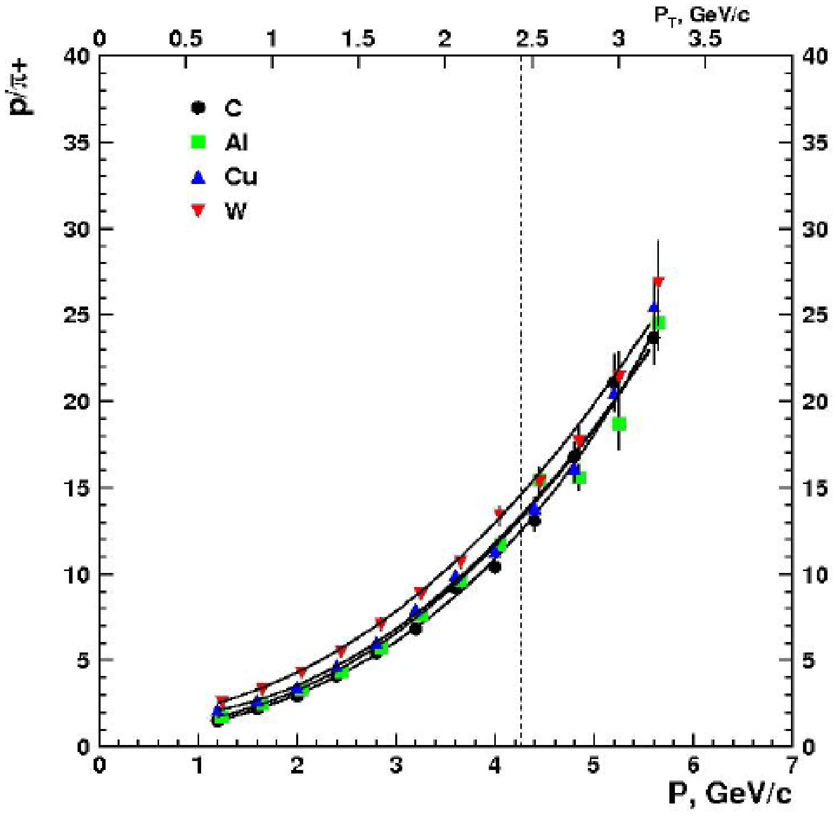
Ratio d/p

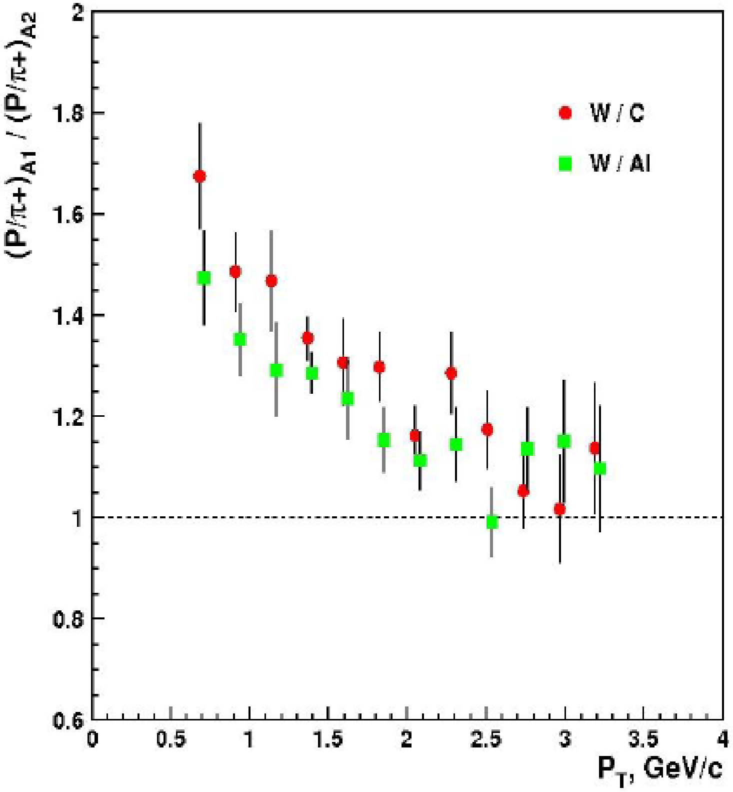
ФОДС В.В.Абрамов и др., ЯФ 45(5) (1987), 845–851





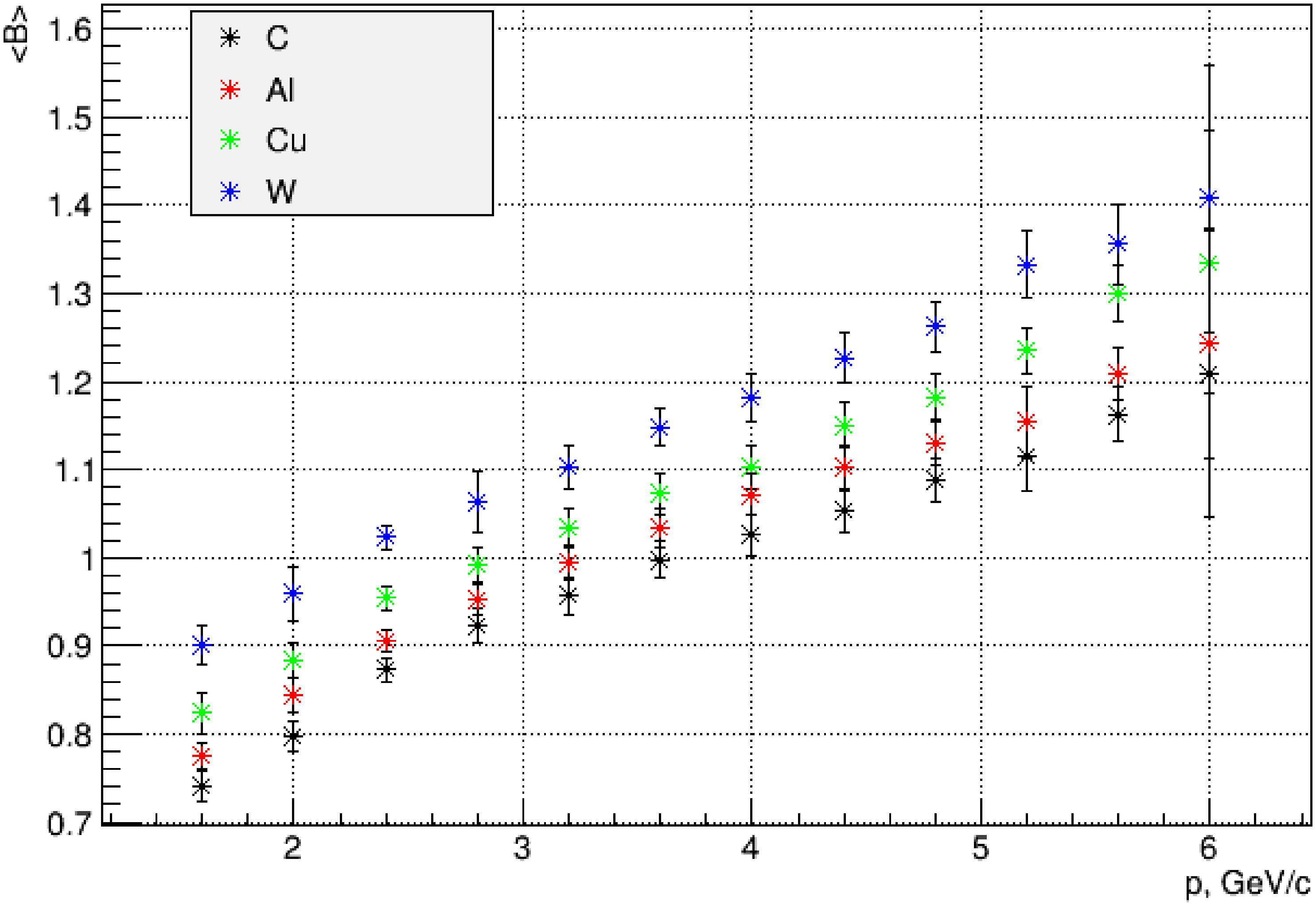
Ratio p/π^+ (2015)





N.N. Antonov et al., JETP Letters, Vol.101, No.10, pp.670-673(2015)

Average baryon number <B>



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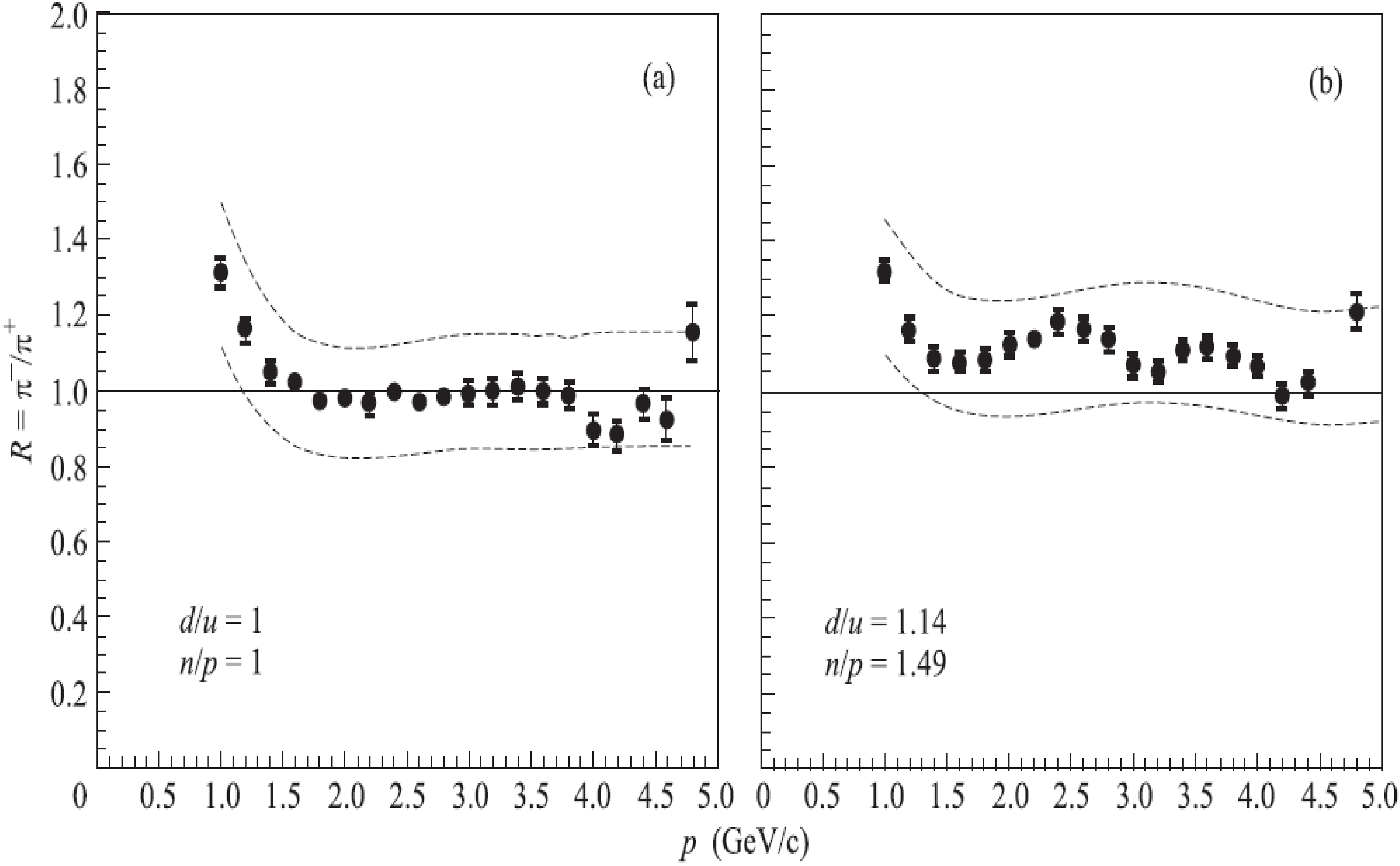
π^-/π^+



ISSN 0021-3640, JETP Letters, 2016, Vol. 104, No. 10, pp. 662–665. © Pleiades Publishing, Inc., 2016.
Original Russian Text © N.N. Antonov, A.A. Baldin, V.A. Viktorov, V.A. Gapienko, G.S. Gapienko, V.N. Gres', M.A. Ilyushin, V.A. Korotkov, A.I. Mysnik, A.F. Prudkoglyad, A.A. Semak, V.I. Terekhov, V.Ya. Uglekov, M.N. Ukhanov, B.V. Chuiko, S.S. Shimanskii, 2016, published in Pis'ma v Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki, 2016, Vol. 104, No. 10, pp. 678–681.

FIELDS, PARTICLES, AND NUCLEI

Knockout of Deuterons and Tritons with Large Transverse Momenta in *pA* Collisions Involving 50-GeV Protons

N. N. Antonov[a], A. A. Baldin[b], V. A. Viktorov[a], V. A. Gapienko[a, *], G. S. Gapienko[a], V. N. Gres'[a], M. A. Ilyushin [a], V. A. Korotkov[a], A. I. Mysnik[a], A. F. Prudkoglyad[a], A. A. Semak[a], V. I. Terekhov[a], V. Ya. Uglekov[a], M. N. Ukhanov[a], B. V. Chuiko[a†], and S. S. Shimanskii[b]

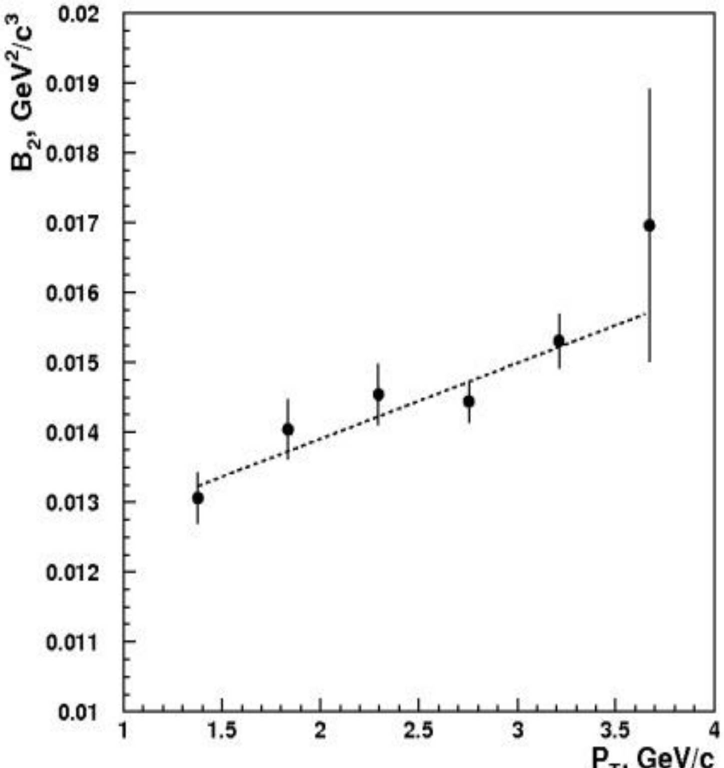
$$\frac{E_d}{\sigma_{inel}}\frac{d^3\sigma_A}{dp_A^3} = B_A \times \left(\frac{E_p}{\sigma_{inel}}\frac{d^3\sigma_p}{dp_p^3}\right)^A$$

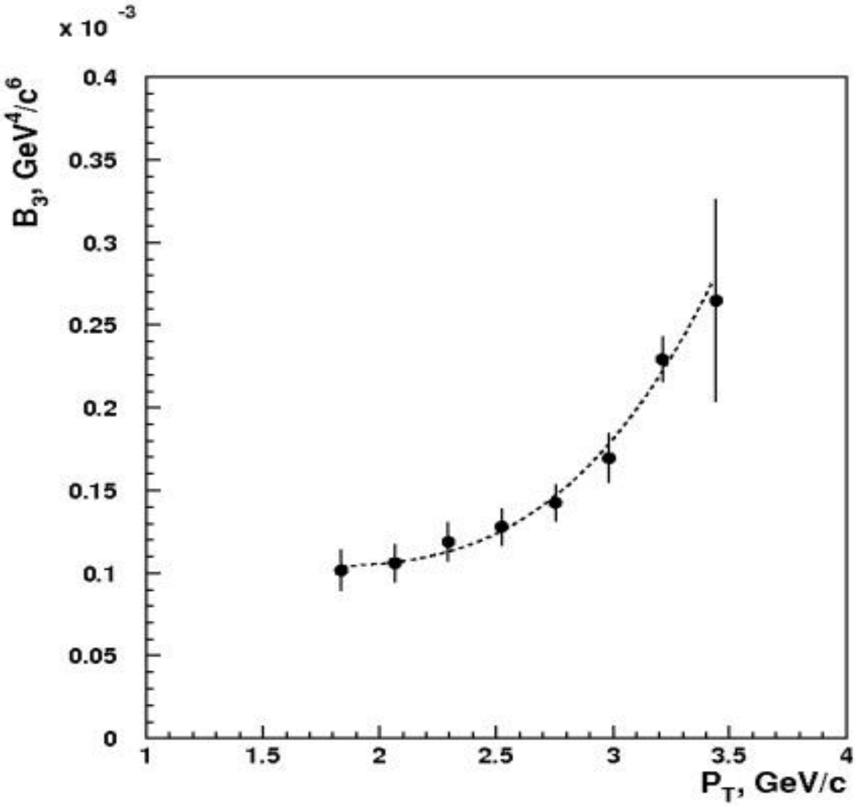
Mean values of the B_2 parameter

Target	C	Al	Cu	W
$B_2 \times 10^2$, GeV$^2/c^3$	1.41 ± 0.10	1.56 ± 0.08	1.51 ± 0.07	1.41 ± 0.06

SPIN data

$B_2 \sim V^{-1}$ $B_3 \sim V^{-2})$





Why CDBM?

CsDBM

1.Cold - exists inside ordinary nuclear matter as a quantum component of the wave function (with some probability and life time).

2. superDense - several nucleons can be in a volume less than the nucleon volume. The mass will be several nucleon masses. The small size means that the multinucleon(multiquark) configuration seeing as point like objects in processes with high transfer energy.

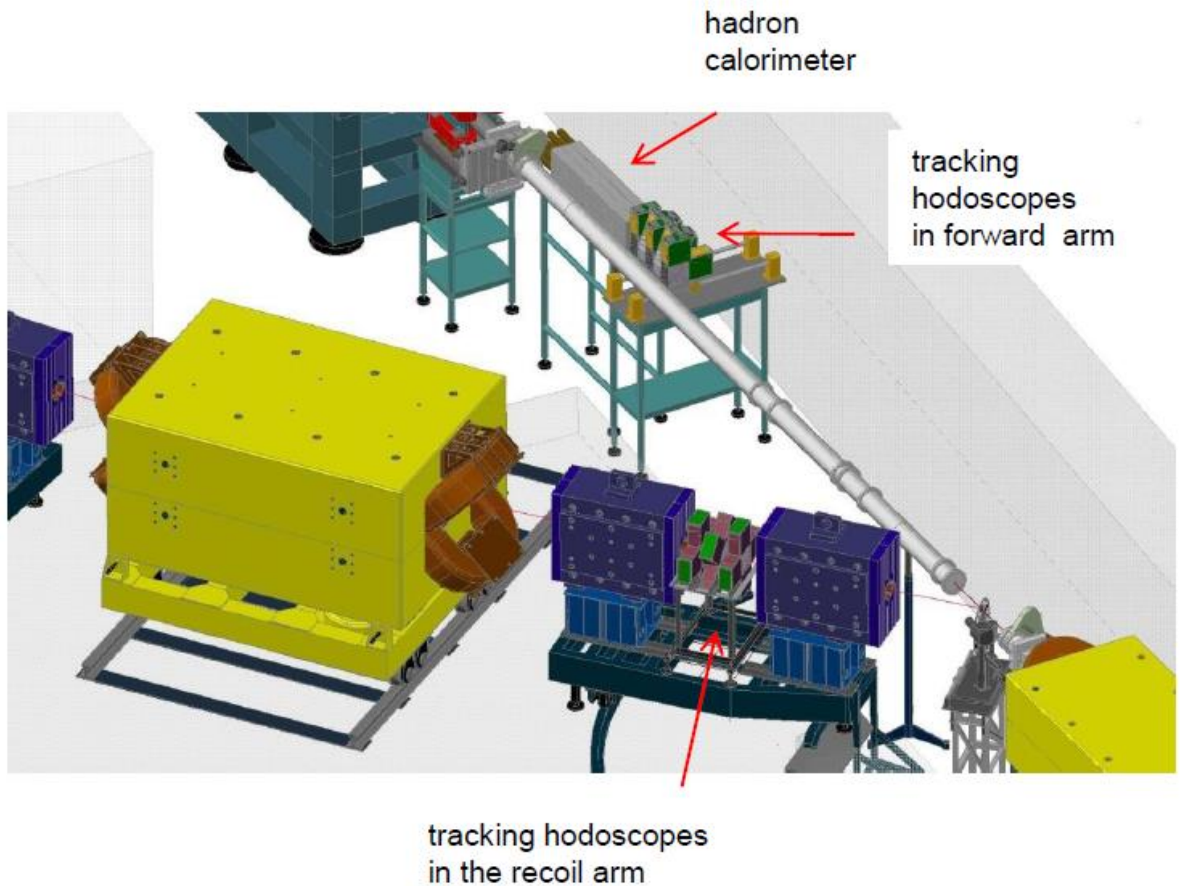
3. Baryonic Matter – enhancement of baryonic states and suppression of sea and gluon degrees of freedom (mesons and antiparticles production).

FUTURE

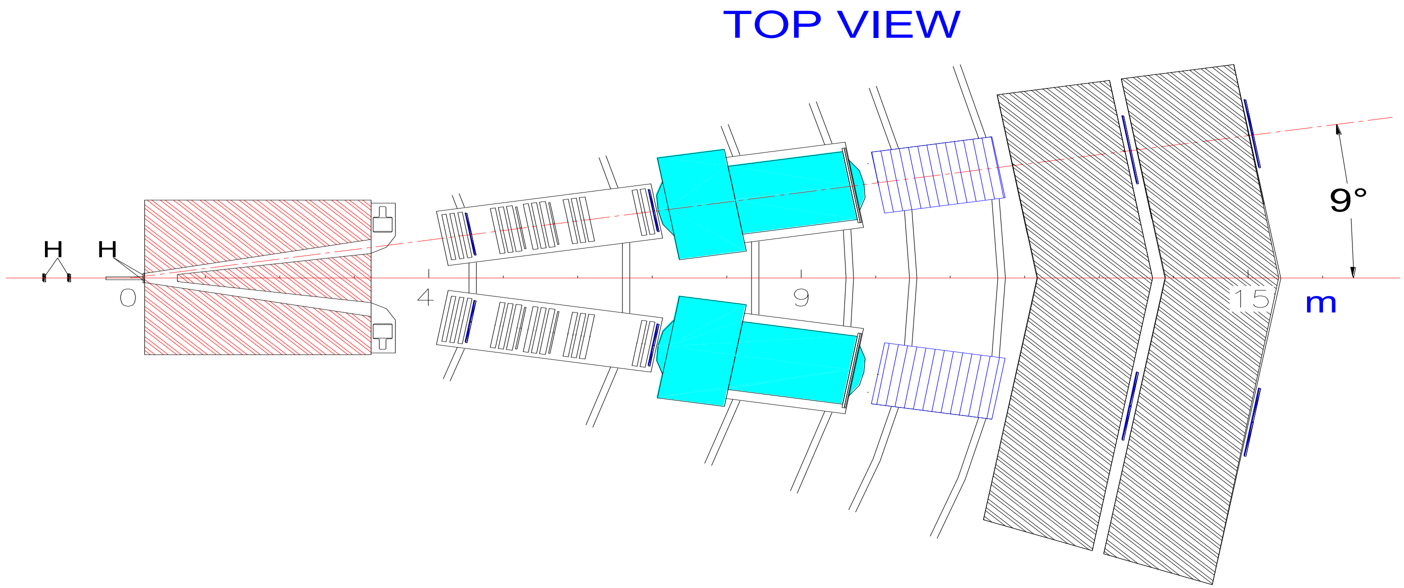
From the inclusive experiments to the correlations and the exclusive experiments

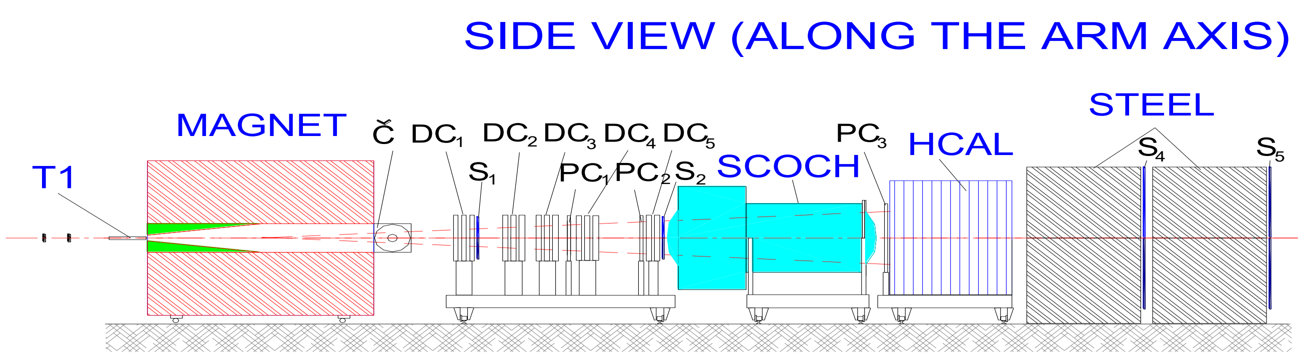
FLUKTON

Recoil arm: will be almost similar to existing SPIN arm but added with tracking system based of hodoscopes
Forward arm: consists of several hodoscope stations and 100 modules of hadron calorimeter. Distance between target and calorimeter – 700 cm

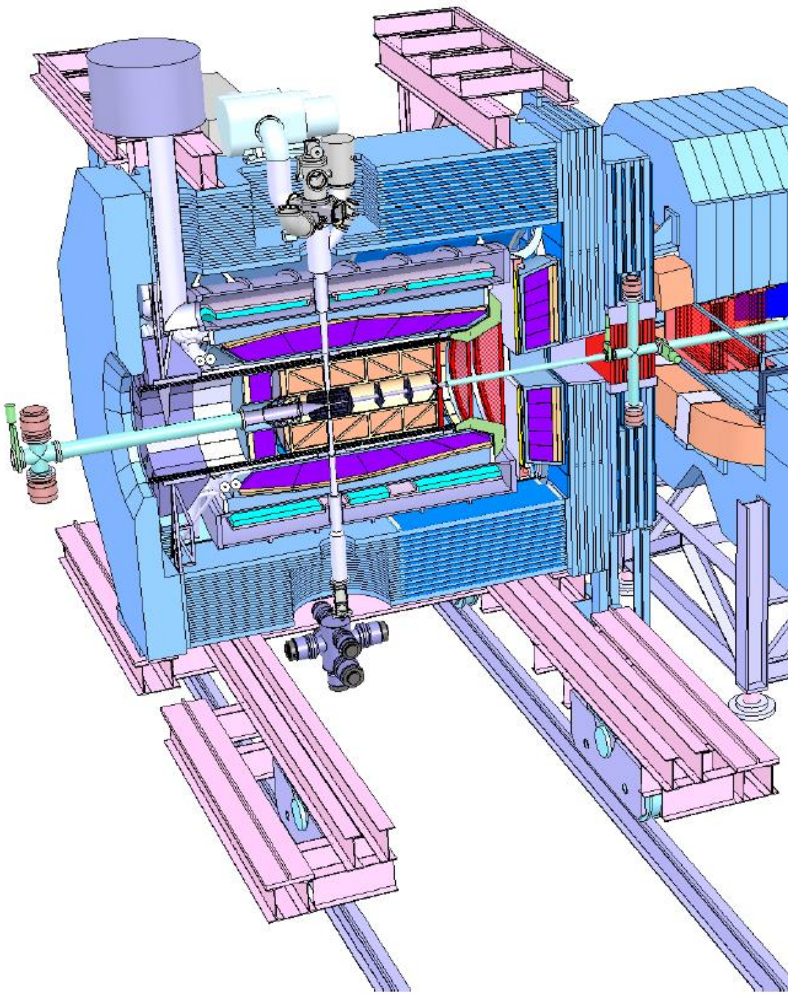


FODS
(proton energy 20-50 GeV and nuclear beams up to 30 GeV/u)





PANDA Spectrometer



Detector requirements:

- 4π acceptance
- High rate capability: $2 \times 10^7\ s^{-1}$ interactions
- Efficient event selection

➔ *Continuous acquisition*

- Momentum resolution ~1%
- Vertex info for D, K^0_S, Y ($c\tau$ = 317 μm for $D^{\pm}$)

➔ *Good tracking*

- Good PID (γ, e, μ, π, K, p)

➔ *Cherenkov, ToF, dE/dx*

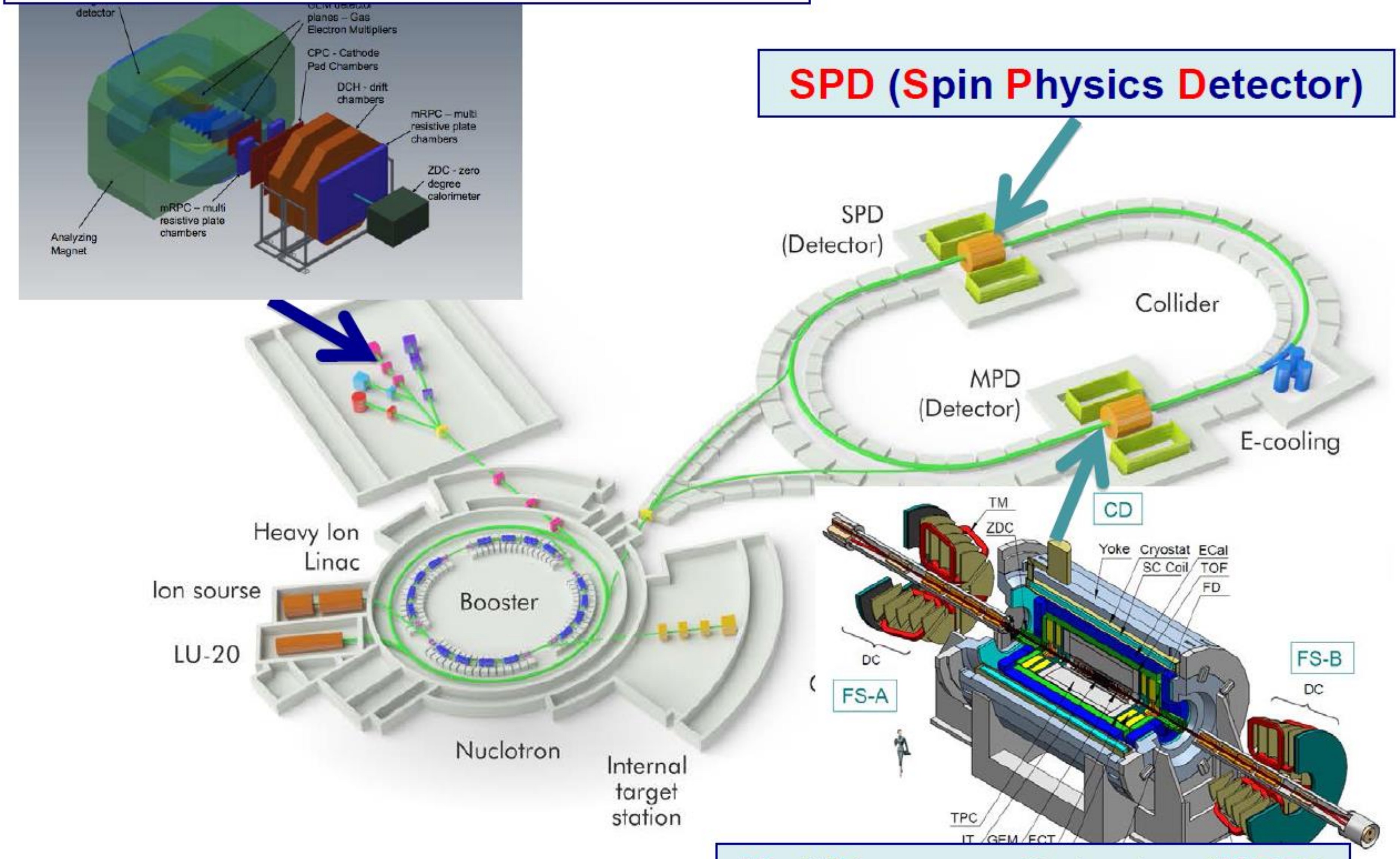
- γ-detection MeV – 15 GeV

➔ *Crystal Calorimeter*

NICA Complex

Baryonic Matter at Nuclotron (BM@N)

SPD (Spin Physics Detector)



MultiPurpose Detector (MPD)

END

«ФИЗИКА ЭЛЕМЕНТАРНЫХ ЧАСТИЦ И АТОМНОГО ЯДРА», 1980,
ТОМ 11, ВЫП. 3

УДК 539.171.1

РАССЕЯНИЕ ЧАСТИЦ ВЫСОКОЙ ЭНЕРГИИ КАК МЕТОД ИССЛЕДОВАНИЯ МАЛОНУКЛОННЫХ КОРРЕЛЯЦИЙ В ДЕЙТОНЕ И ЯДРАХ

М. И. Стрикман, Л. Л. Франкфурт

Ленинградский институт ядерной физики им. Б. П. Константинова, Ленинград

МАТЕРИАЛЫ XIII ЗИМНЕЙ ШКОЛЫ ЛИЯФ

1978

141

КУМУЛЯТИВНЫЕ НУКЛОНЫ И КОРОТКОДЕЙСТВУЮЩИЕ КОРРЕЛЯЦИИ В ЯДРЕ

М.И.Стрикман и Л.Л.Франкфурт

малых расстояний в ядрах и о способе их описания представляет самостоятельный интерес. Цель обзора — показать, что отбор событий, содержащих кумулятивные частицы, увеличивает относительный вклад от конфигураций в волновой функции ядра, содержащих несколько нуклонов (два, три) на малых относительных расстояниях *. (Кумулятивными частицами мы, следуя [6], называем вторичные частицы, образующиеся в кинематической области, запрещенной для рассеяния на свободном нуклоне. Независимо от теоретической интерпретации этот термин удобен для обозначения указанной кинематической области.)

6. Балдин А. М.— Краткие сообщ. по физике, 1971, т. 1, с. 35.

Тема	Re: Cumulative at high p_T
От	Boris Kopeliovich
Кому	Stepan
Ответить	bzk@mpi-hd.mpg.de
Дата	23.01.2012 7:42

«I think that the main problem in understanding of high p_T hadrons at the energies of Serpukhov is why you see more protons than pions. This was claimed long time ago by the Sulyaev's group and I remember hot debates in that back in the 80s. Those debated ended up with no clear conclusion. Much later an excess of baryons was observed by the STAR at RHIC and was called "baryon anomaly". Again, no good explanation has been proposed so far. I might have my own explanation, but haven't written anything so far. Anyway, my point is, if we do not understand the mechanism of production of baryons dominating at high p_T, we should not make any certain conclusions about the cumulative mechanisms».

Local processes in NN kinematic

Production of anti-protons in the proton - nucleus interactions at 10.1-Gev/c. A.A. Sibirtsev, G.A. Safronov, G.N. Smitnov, Yu.V. Trebuchovsky (Moscow, ITEP). 1991. Published in Yad.Fiz. 53 (1991) 191-199

$$p + A \rightarrow h(0^0) + X$$

ИЗМЕРЕНИЕ СЕЧЕНИЙ ОБРАЗОВАНИЯ АДРОНОВ С ИМПУЛЬСОМ ДО 2 ГэВ/c В ПРОТОН-ЯДЕРНЫХ СТОЛКНОВЕНИЯХ ПРИ 70 ГэВ

Sov.J.Nucl.Phys.37:732,1983

БАРКОВ Л. М., ЗОЛОТОРЁВ М. С., КОТОВ В. И.[1], ЛЕБЕДЕВ П. К., МАКАРЬИНА Л. А.[2], МИШАКОВА А. П.[2], ОХАПКИН В. С., РЗАЕВ Р. А.[1], САХАРОВ В. П.[1], СМАХТИН В. П., ШИМАНСКИЙ С. С.

ИНСТИТУТ ЯДЕРНОЙ ФИЗИКИ СО АН СССР

(Поступила в редакцию 2 августа 1982 г.)

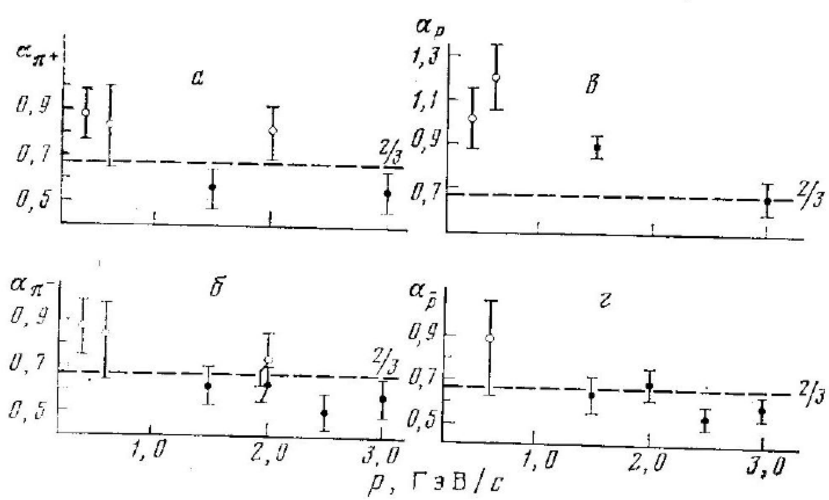


Рис. 4. Зависимость показателя α от импульса для положительных пионов (а), отрицательных пионов (б), протонов (в) и антипротонов (г) (● – [11], ○ – данная работа)

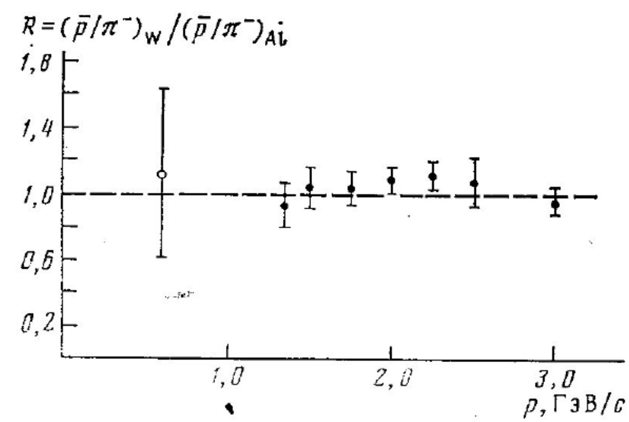
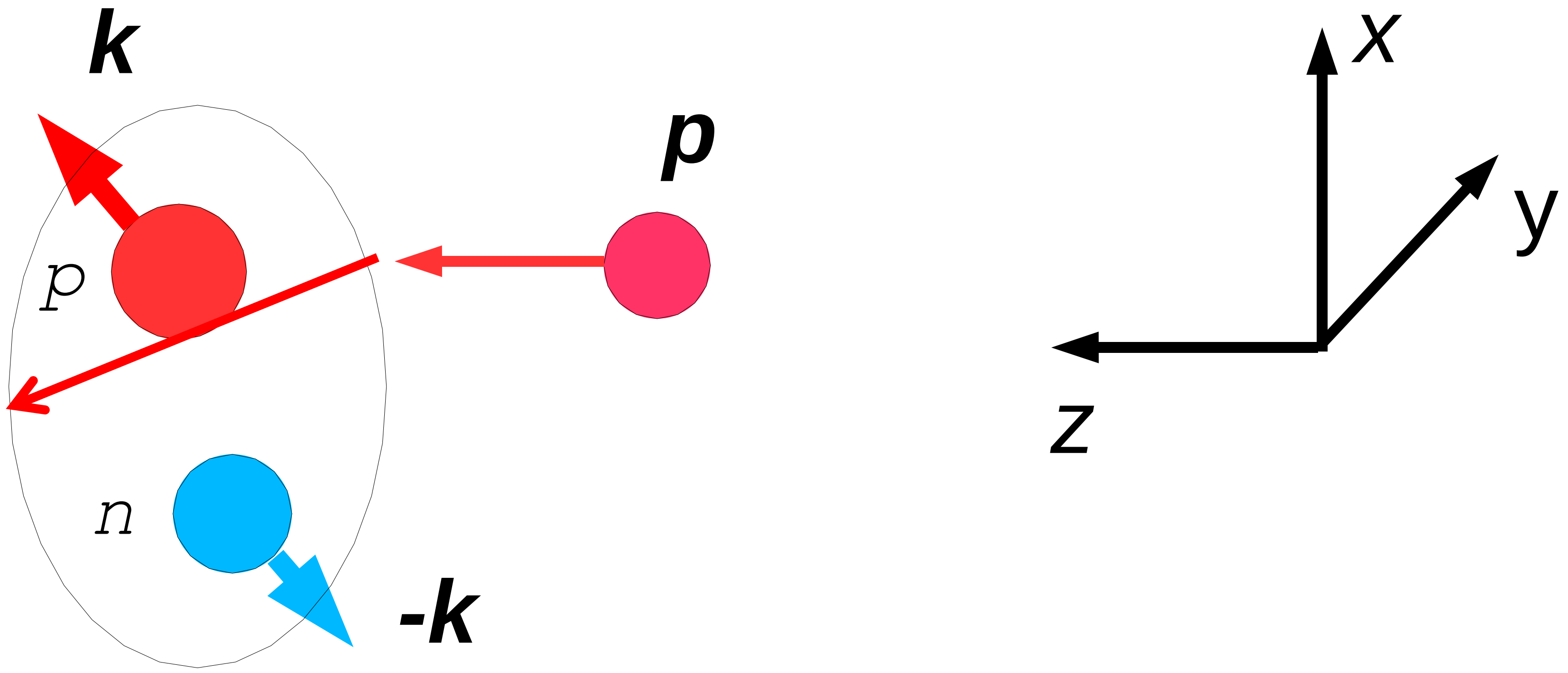


Рис. 6. Сравнение отношений выходов антипротонов и отрицательных пионов для W и Al мишеней в зависимости от импульса частиц (● – [11], ○ – данная работа)

E850/EVA (BNL) p +"D"



E850/EVA (BNL)

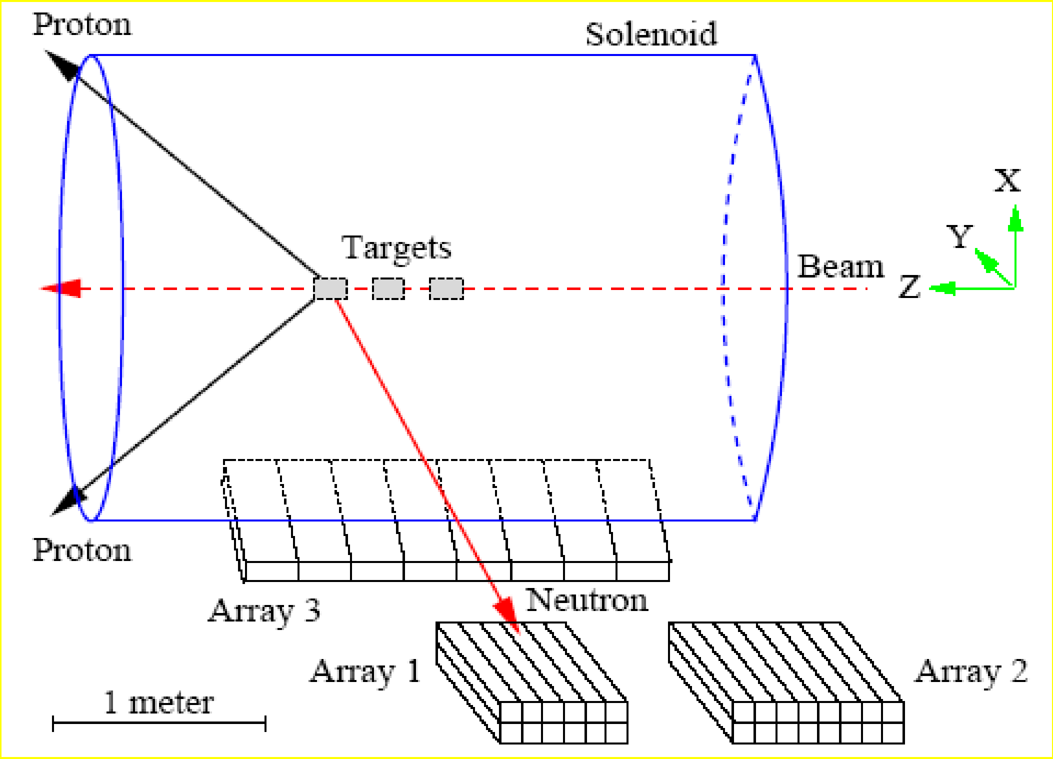


Figure I.3: A schematic view of the EVA solenoid and the neutron counters in the 1998 measurement.

VOLUME 90, NUMBER 4 PHYSICAL REVIEW LETTERS week ending 31 JANUARY 2003

n-p Short-Range Correlations from $(p, 2p + n)$ Measurements

A. Tang,[1] J. W. Watson,[1] J. Aclander,[2] J. Alster,[2] G. Asryan,[4,3] Y. Averichev,[8] D. Barton,[4] V. Baturin,[6,5] N. Bukhtoyarova,[4,5] A. Carroll,[4] S. Gushue,[4] S. Heppelmann,[6] A. Leksanov,[6] Y. Makdisi,[4] A. Malki,[2] E. Minina,[6] I. Navon,[2] H. Nicholson,[7] A. Ogawa,[6] Yu. Panebratsev,[8] E. Piasetzky,[2] A. Schetkovsky,[6,5] S. Shimanskiy,[8] and D. Zhalov[6]

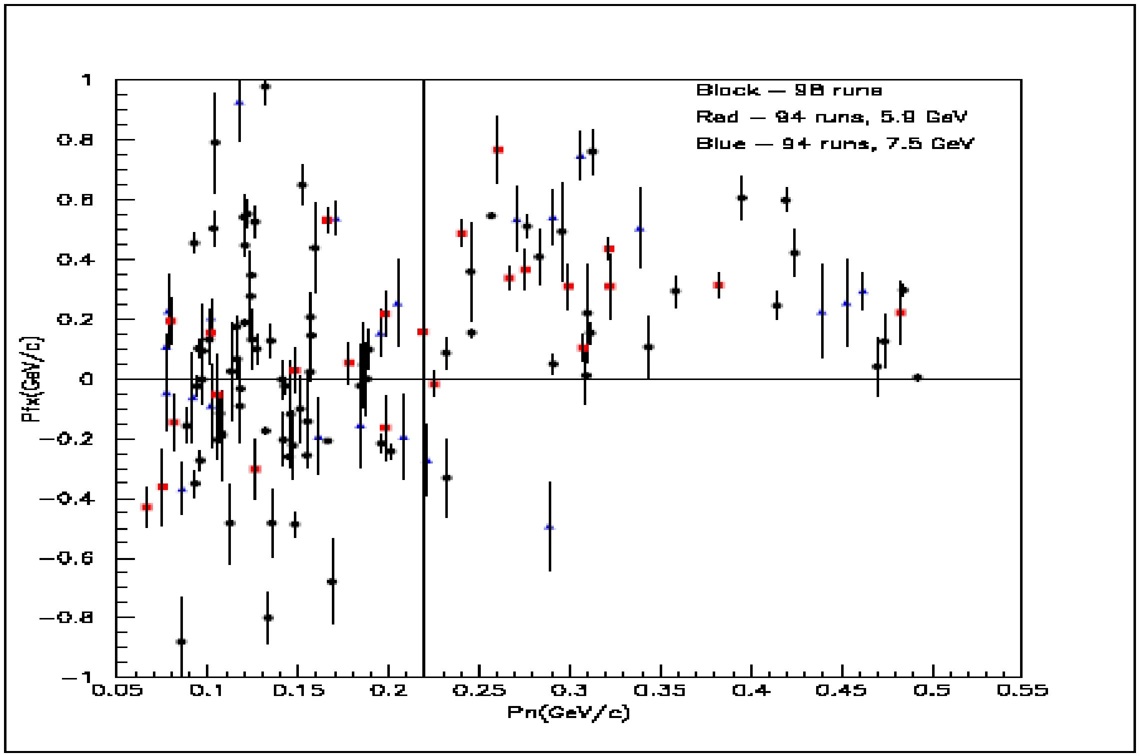


Figure I.5: The vertical component of the target nucleon momentum vs. the total neutron momentum.The positive vertical axis is the upward direction. The events shown are for triple coincidences of the neutron with the two high energy protons emerging from the QE $C(p, 2p)$ reaction. The squares are for the 5.9 GeV/c incident beam and the triangles are for 7.5 GeV/c. The dots are preliminary unpublished data from the 1998 runing period. We associate the events in the upper right corner with NN SRC.

THERMODYNAMICS OF STRONG INTERACTIONS

V.I.Yukalov, E.P.Yukalova

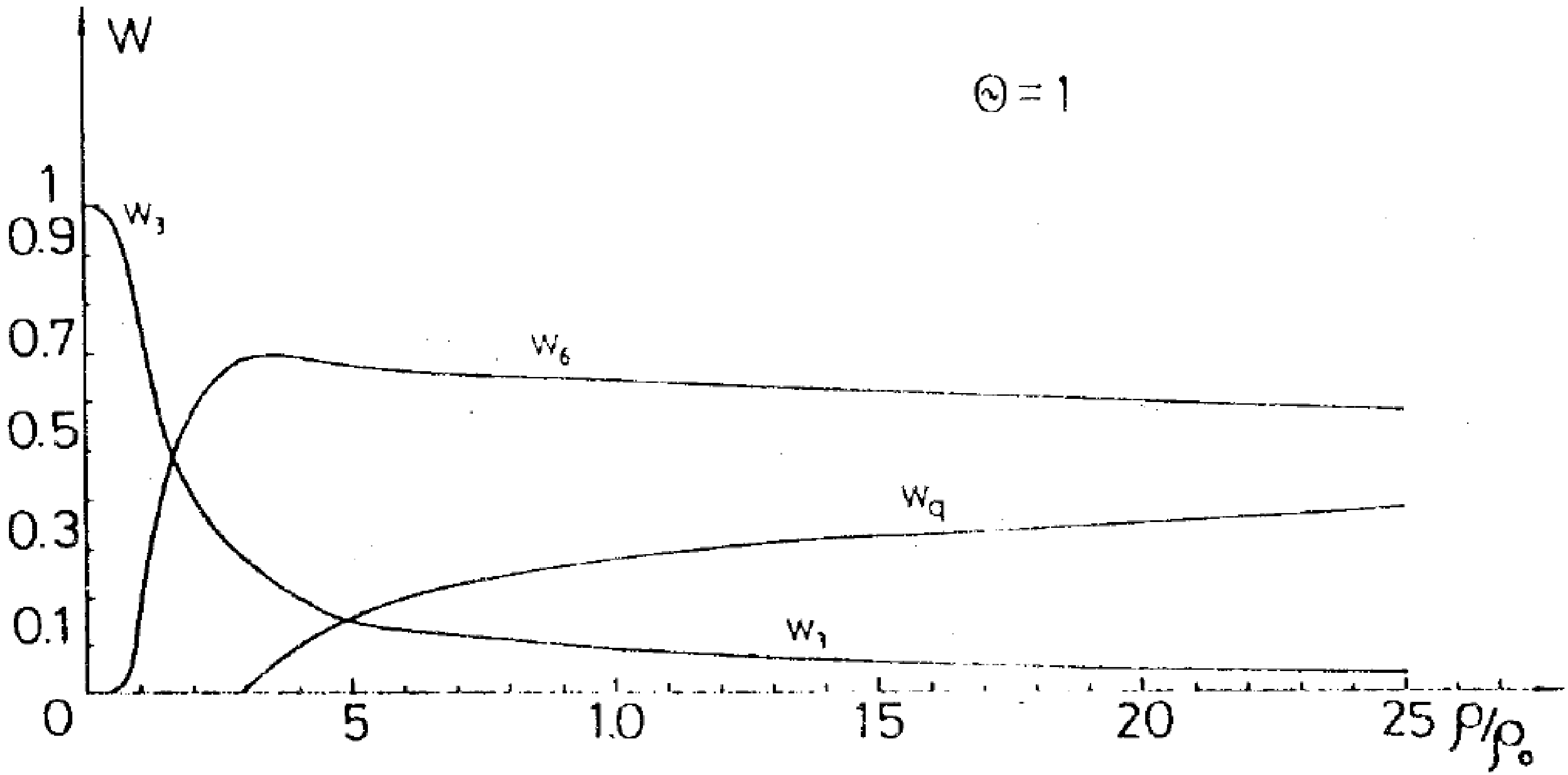
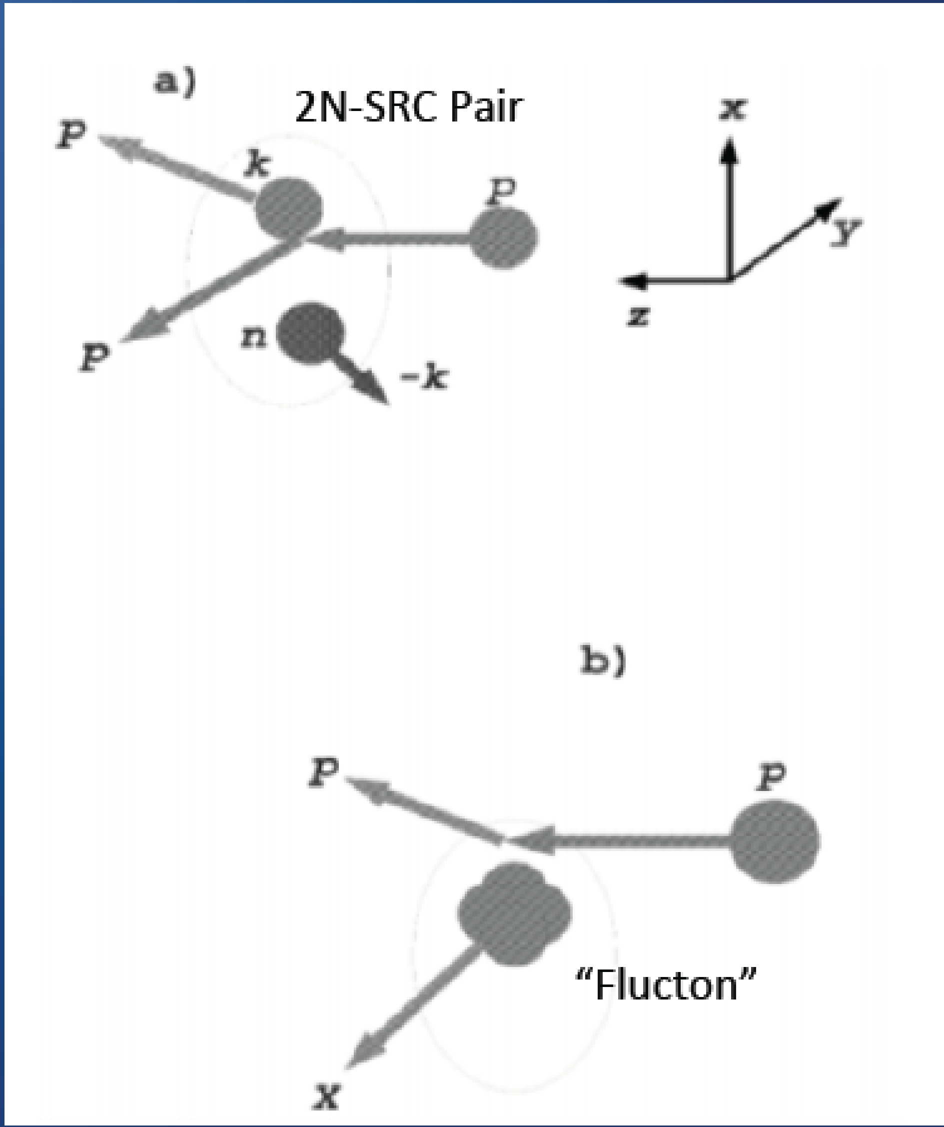


Fig.6. Nucleon, $6q$–cluster, and unbound quark probabilities as functions of the relative density at $\Theta = 0$

SRC in VBLHEP

SRC and Fluctons

- Cold Dense Nuclear Matter (CDNM) fluctuations can come in various forms.
- We deal with nucleonic degrees of freedom at medium densities ($\rho \approx 2\text{-}3\rho_0$)
- At higher densities ($\rho \approx 5\text{-}10\rho_0$) partonic degrees of freedom dominate (i.e. Fluctons).



From S. S. Shimanskiy, arXiv 1411.7211 (2014)

Color Transparency

arXiv:1208.3668v1 [nucl-th] 17 Aug 2012

Gerald A. Miller

Physics Department, Univ. of Washington, Seattle, Wa. 98195-1560, USA

Abstract. Color transparency is the vanishing of nuclear initial or final state interactions involving specific reactions. The reasons for believing that color transparency might be a natural consequence of QCD are reviewed. The main impetus for this talk is recent experimental progress, and this is reviewed briefly.

The basic idea is that some times a hadron is in a color-neutral point-like configuration PLC. If such undergoes a coherent reaction, in which one sums gluon emission amplitudes to calculate the scattering amplitude, the PLC does not interact with the surrounding media. A PLC is not absorbed by the nucleus. The nucleus casts no shadow. This is a kind of quantum mechanical invisibility.

Progress in Particle and Nuclear Physics 69 (2013) 1–27

Review

Color transparency: Past, present and future

D. Dutta [a,*], K. Hafidi [b], M. Strikman [c]

RHIC Physics: 3 Lectures*

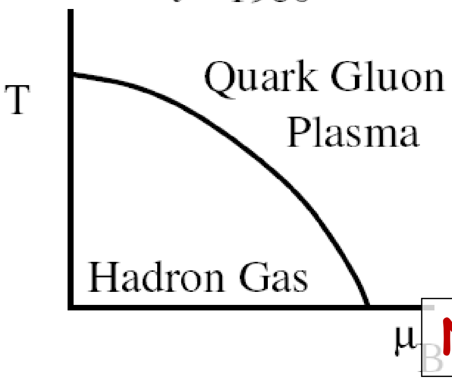
Larry McLerran
Physics Department PO Box 5000 Brookhaven National Laboratory Upton, NY 11973 USA

September 13, 2003

+ CERN Yellow Report 2007-005, p.75 2008-005

The Evolving QCD Phase Transition

t ~ 1980



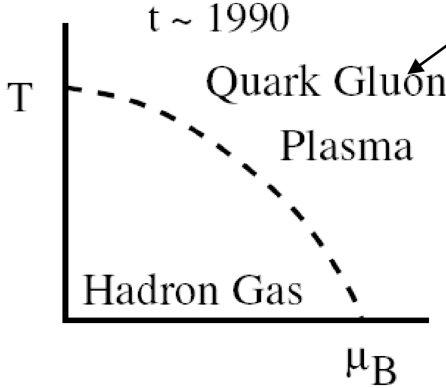
Critical Temperature 150 - 200 MeV ($\mu_B = 0$)
Critical Density 1/2-2 Baryons/Fm^3 ($T = 0$)

Nuclear Physics A 837 (2010) 65–86

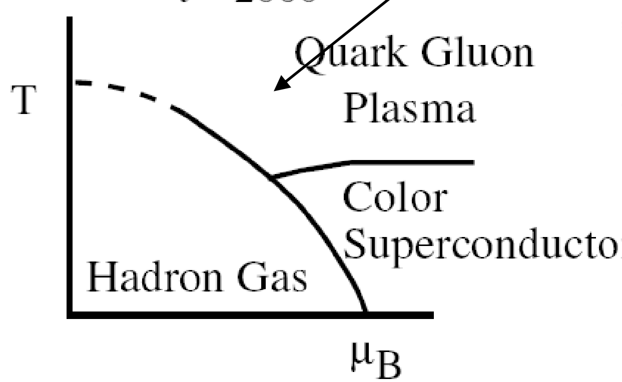
RHIC Time(BNL)

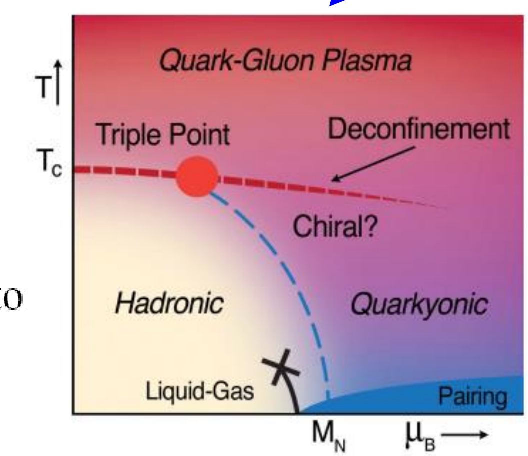
Nuclotron-SPS Time (CERN)

t ~ 1990

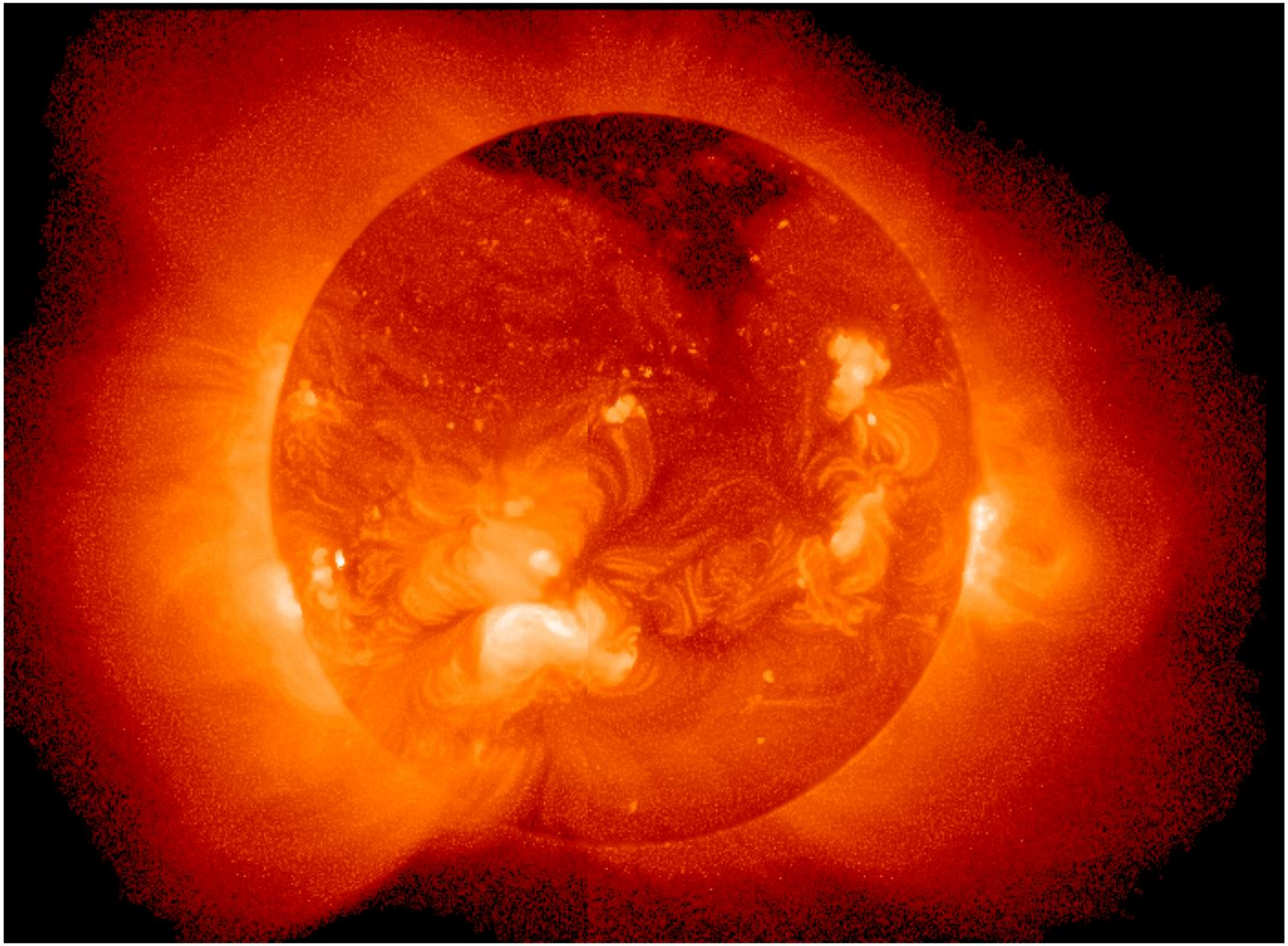


t ~ 2000





Temperature at the centre of the Sun ~ 15 000 000 K



A medium of 170 MeV is more than 100 000 times hotter !!!