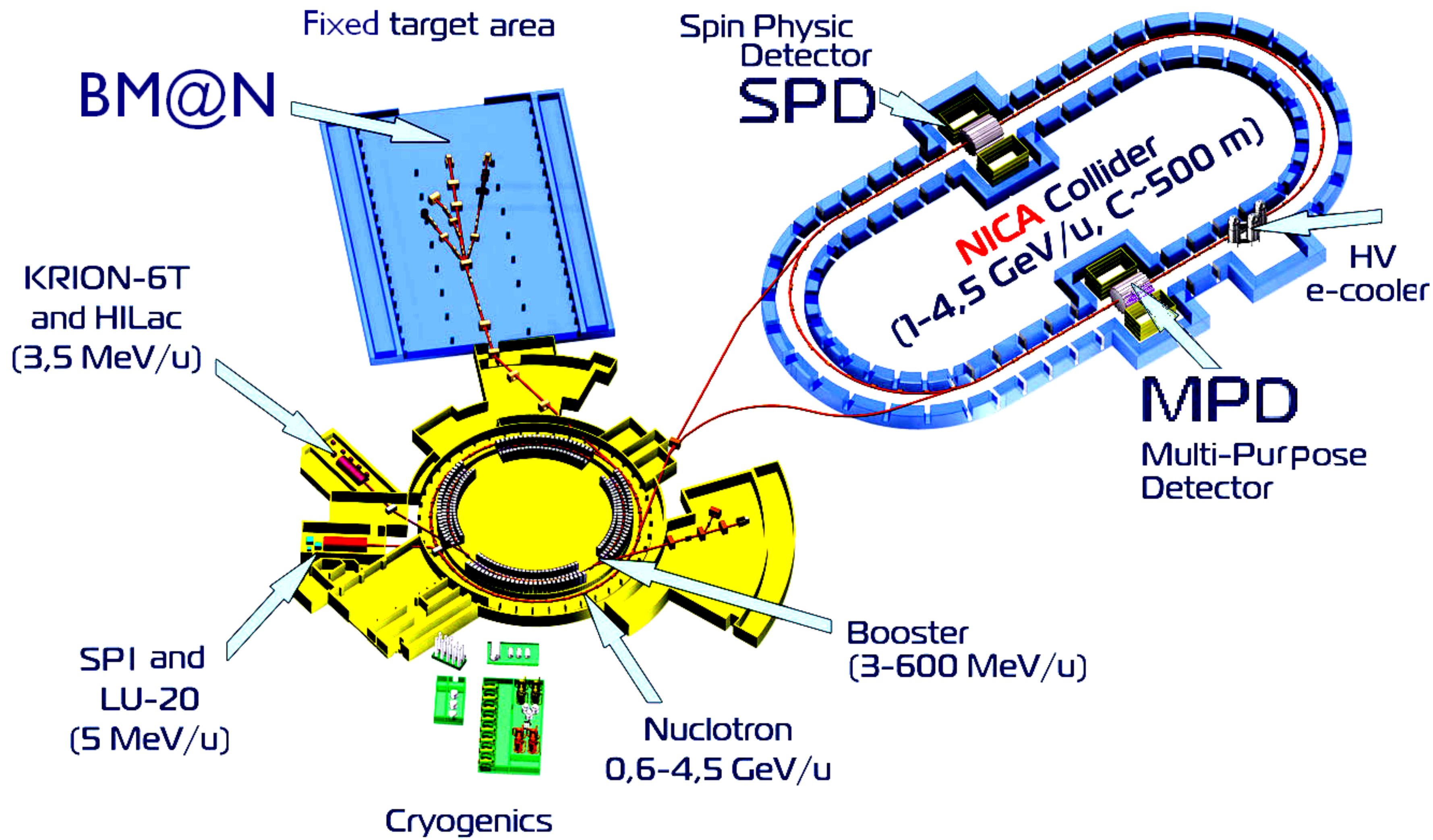
Ускорение поляризованных пучков и поляриметрия

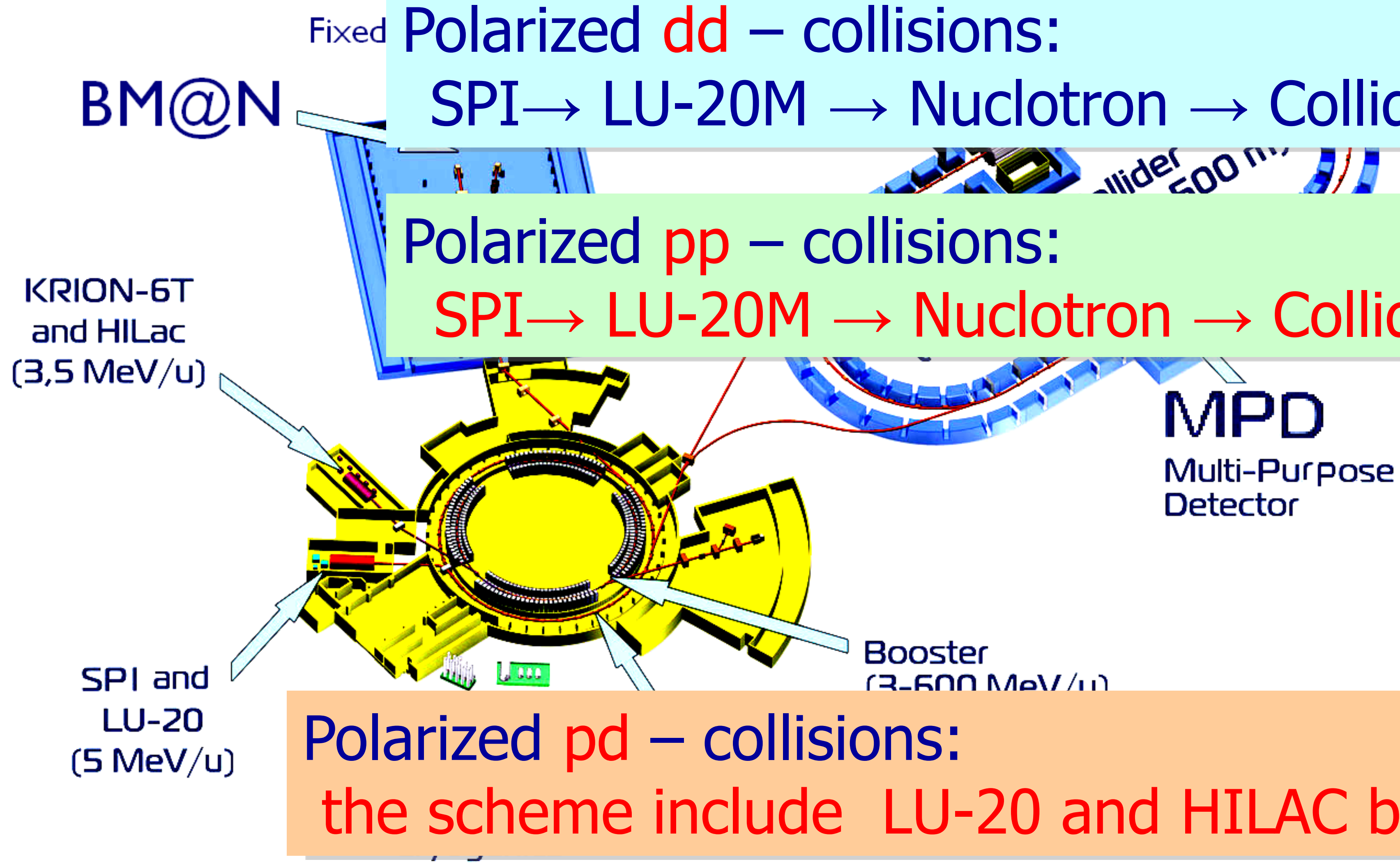
“New directions in science are launched by new tools much more often than by new concepts.
The effect of a concept-driven revolution is to explain old things in new ways.
The effect of a tool-driven revolution is to discover new things that have to be explained”

From Freeman Dyson ‘Imagined Worlds’

Superconducting accelerator complex NICA
(Nuclotron based Ion Collider fAcility)



NICA operation in Polarized Mode

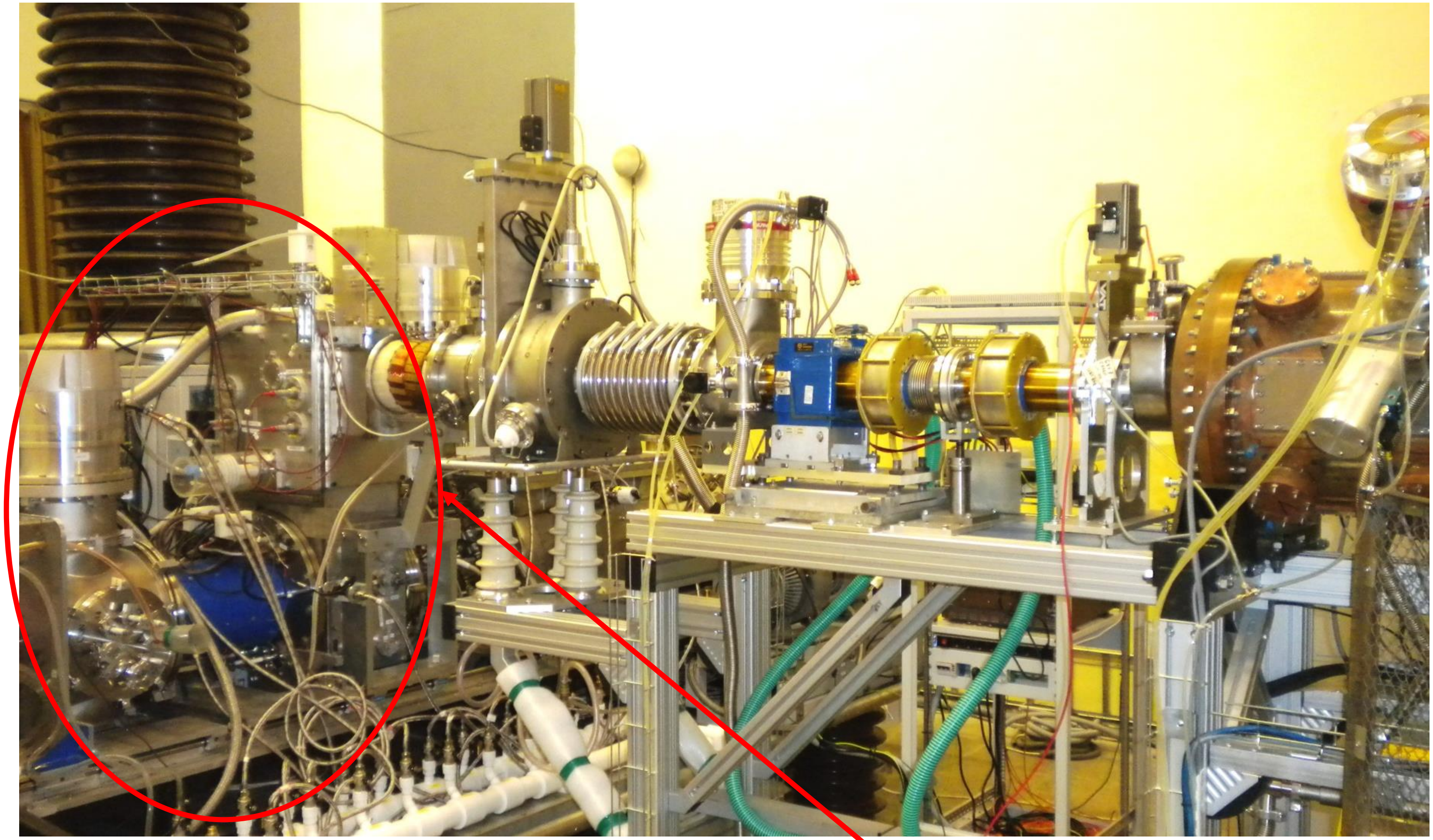


Polarized dd – collisions:
SPI→ LU-20M → Nuclotron → Collider

Polarized pp – collisions:
SPI→ LU-20M → Nuclotron → Collider

Polarized pd – collisions:
the scheme include LU-20 and HILAC both

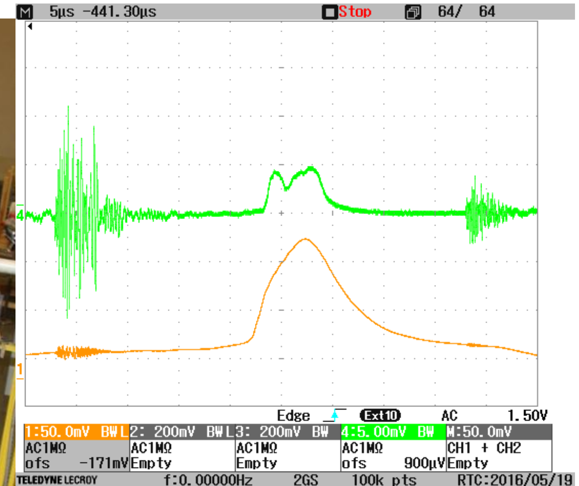
Implementation of polarized beam program

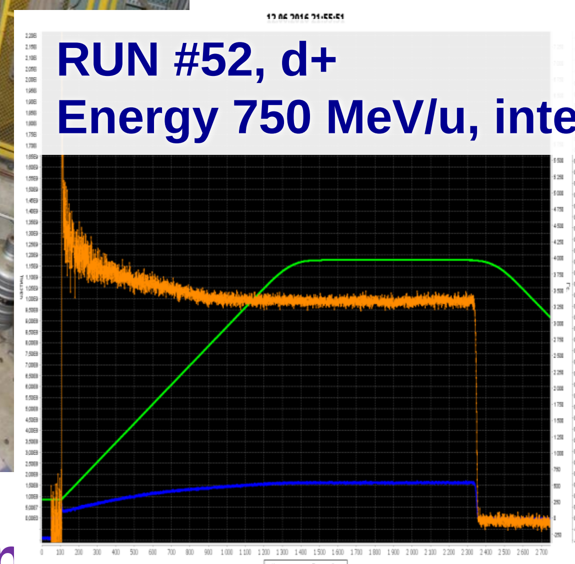


Equipment of new polarized ion source SPI and LEBT part of beam channel to RFQ section

A.D.Kovalenko

New for-injector LU-20 & SPI

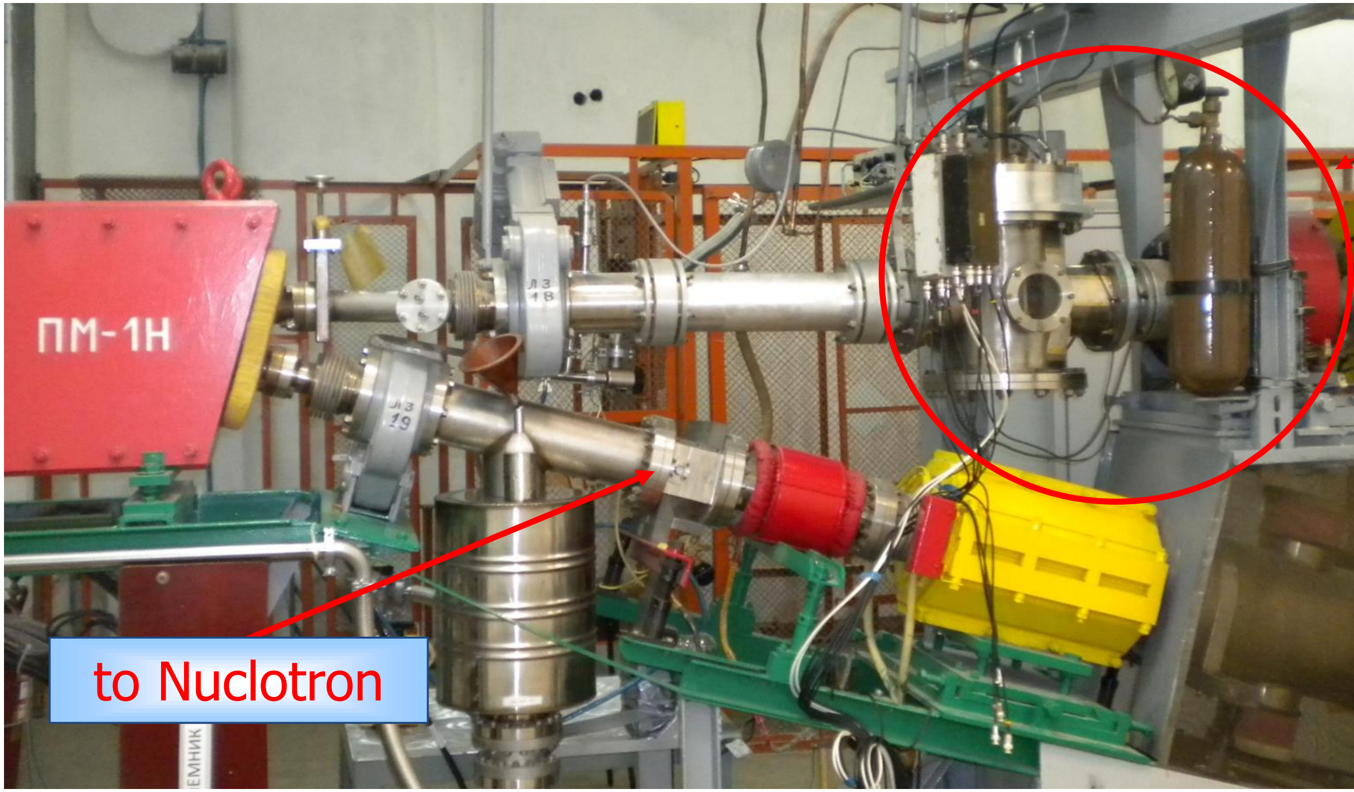




RUN #52, d+
Energy 750 MeV/u, intensity 10^9

May 16 2016: 1st beam in
June 12 2016: 1st beam from the SPI

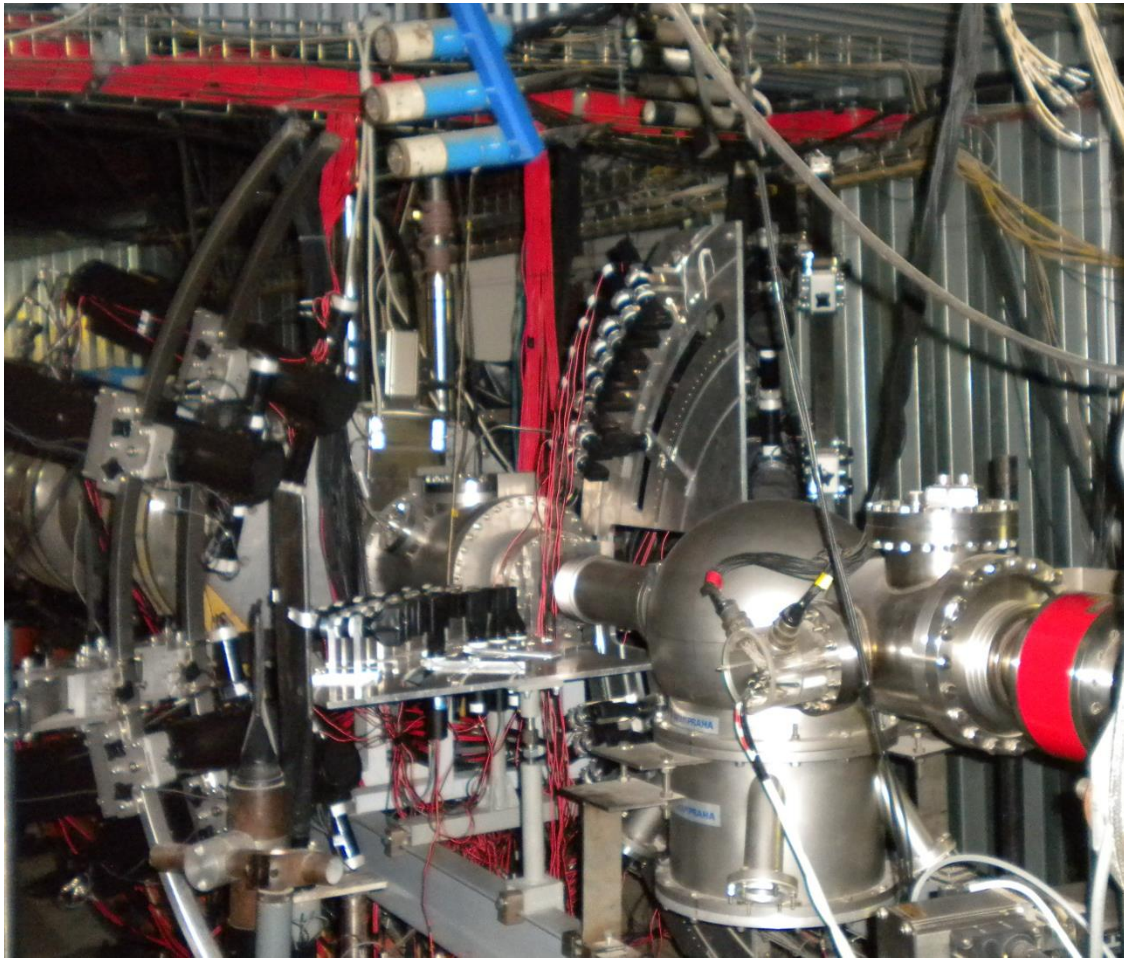
Implementation of polarized beam program



D.Krivenkov
L.Zolin,
V.Nikitin,
V.Avdeichikov
M.Aver'yanov
et al.

Output beam channels from linac LU-20

Implementation of polarization program



V.Ladygin
et al.

Proton and deuteron polarimeter at Nuclotron ring

Implementation of polarization program

N.Piskunov
R.Shindin
K.Legostaeva
A.Livanov

et al.

Proton and deuteron polarimeter at Nuclotron extracted beam (focus F3 point)

НИКА

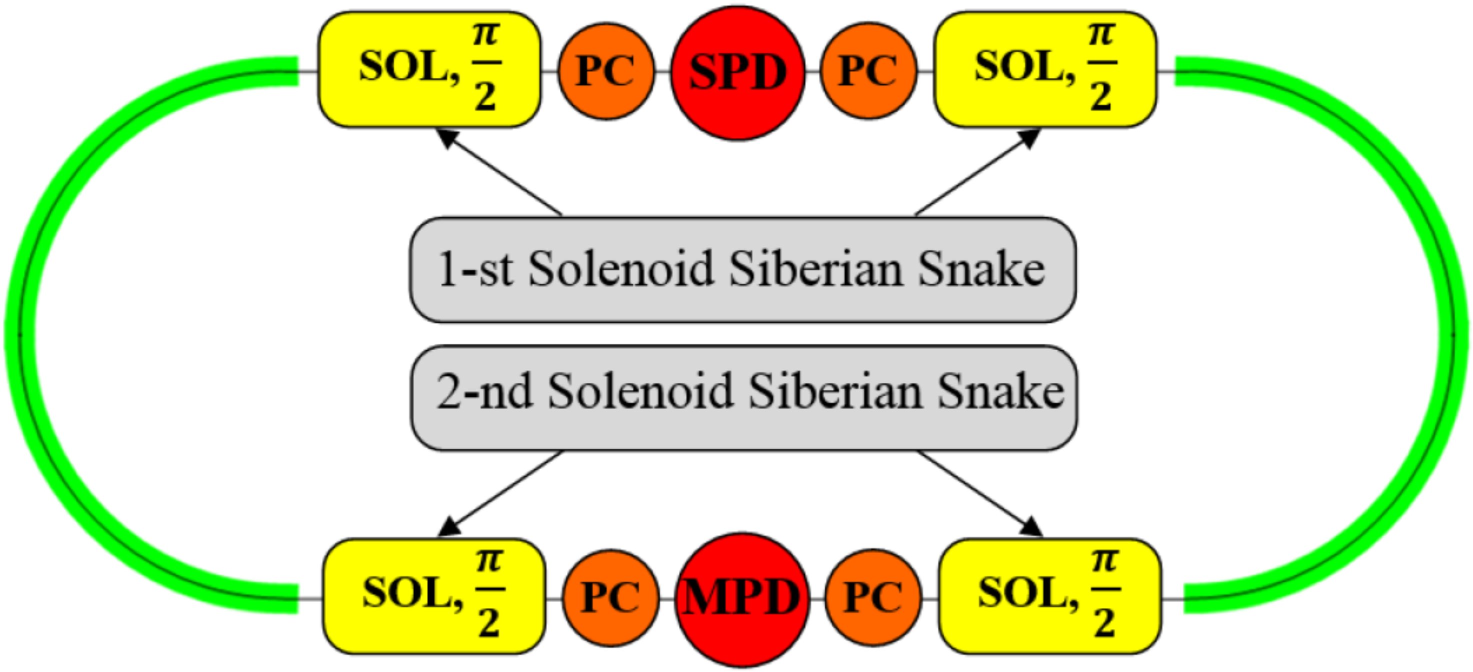
Requirements to the facility in polarized mode

- **polarized and non-polarized p-; d–collisions**
- **p↑p↑(p)** at $\sqrt{s_{pp}}$ **= 12 ÷ 27 GeV** (5 ÷ 12.6 GeV kinetic energy)
- **d↑d↑(d)** at $\sqrt{s_{NN}}$ **= 4 ÷ 13 GeV** (2 ÷ 5.5 GeV/u kinetic energy)
- $\mathbf{L_{average}}$ ≈ 1·10E32 $cm^{-2}s^{-1}$ (at $\sqrt{s_{pp}} \geq 27$ GeV)
- sufficient lifetime and degree of polarization
- longitudinal and transverse polarization in MPD/SPD
- asymmetric collision mode, pd, should be possible

We concentrate design efforts at the pp-mode that need extremely high the peak and average luminosity

Spin Transparency Mode in NICA Collider

Spin transparency ⇔ spin tune $\nu = 0$



SOL, $\frac{\pi}{2}$ — Solenoid for spin transparency mode:

$BL = 5 \div 25$ T·m (protons)

$BL = 15 \div 80$ T·m (deuterons)

PC — Polarization control insertion based on "weak" solenoids with maximum field integral $BL < 0.6$ T·m (protons, deuterons)

Colliders with polarized ions

Collider	Momentum range, GeV/c	Colliding particles	Spin Tune	Spin Transparency
RHIC (*BNL*)	25-250	***pp***	1/2	–
JLEIC (*JLAB*) (figure-8)	25-100	***eN***	0	+
NICA (*JINR*)	2.5-13.5	*NN*	0	+

Ion Polarization Control

Collider	Spin Rotators based on	Polarization Direction at IP	Spin Flipping: Reversal Time	Spin Flipping: Orbital Parameters
RHIC *(BNL)*	'**strong**' magnetic fields	Transversal Longitudinal (**w/o deuterons**)	Few **min**	Change
JLEIC *(JLAB)*	'**weak**' solenoids	Any directions (**any particles:** ***p, d, He^3, …***)	Few **ms**	Do not change
NICA *(JINR)*	'**weak**' solenoids	Any directions (**any particles:** ***p, d, He^3, …***)	Few **ms**	Do not change

Spin Flipping System allows one to make spin reversal during an experiment (high precision experiments with polarized ions).

Summary

- Spin transparency mode in the NICA collider provide unique opportunity for efficient spin manipulation of any particle species (*p*, *d*, ^{3}He, …) in any orbit place without affecting of the collider orbital characteristics.
- Both vertical and longitudinal directions of the beam polarization in MPD and SPD detectors are available.
- Spin flipping system allows one to carry out high quality experiments with polarized proton and deuteron beams.

1. Работа на NICA со спин-флипперами

а) новый режимы заполнение колец (все банчи с одной поляризацией в обоих кольцах) и работы (поочерёдное включение спин-флипперов в кольцах):

1-е кольцо +++... |xxx| - - -... |----| - - -... |xxx| +++ |----| +++...

1-е кольцо +++... |----| +++... |xxx| - - -... |----| - - - |xxx| +++...

(+ +) (- +) (- -) (+ -) (+ +)

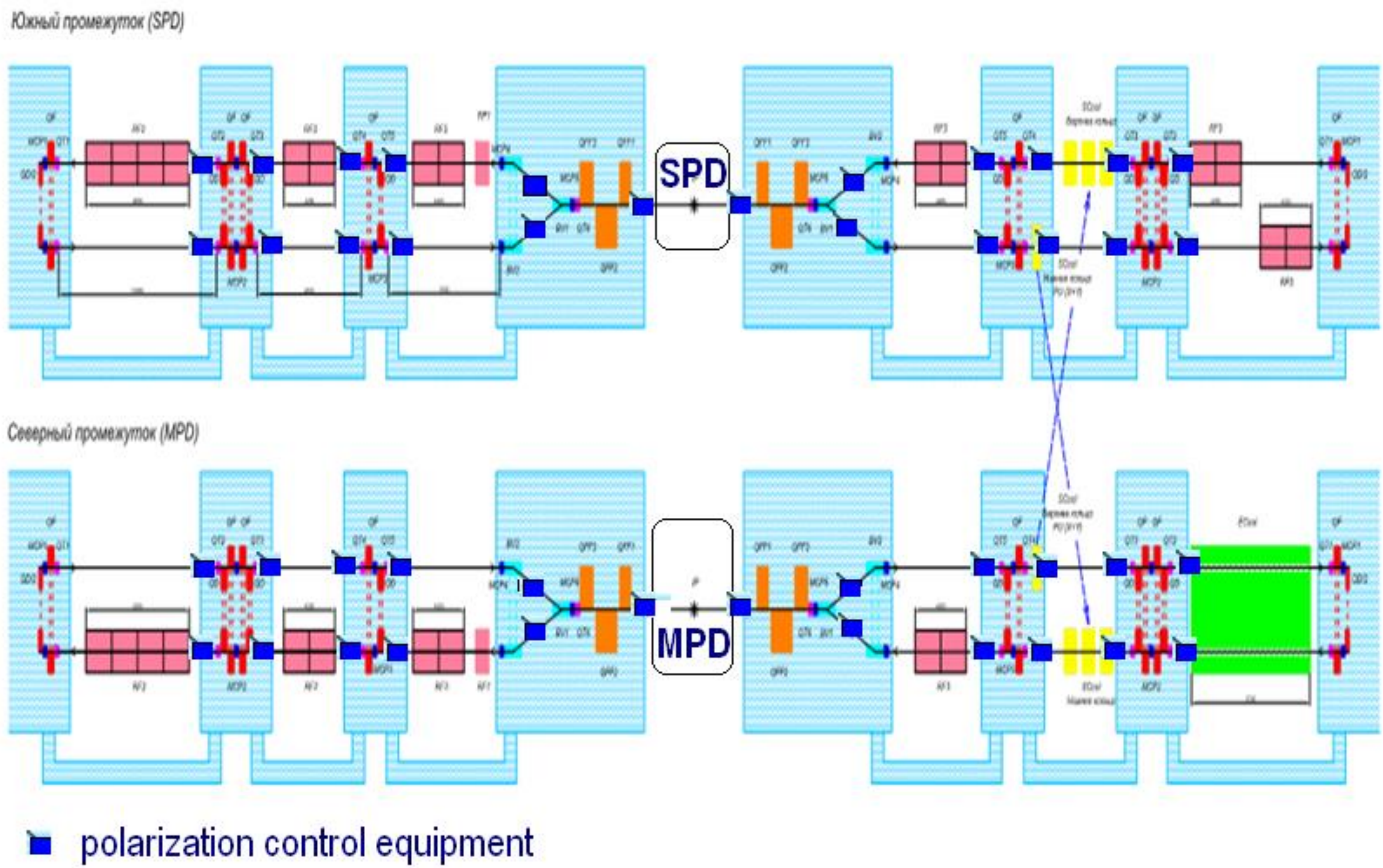
|xxx| - ротатор включён, нет набора данных

|----| - ротатор не включён, нет набора данных

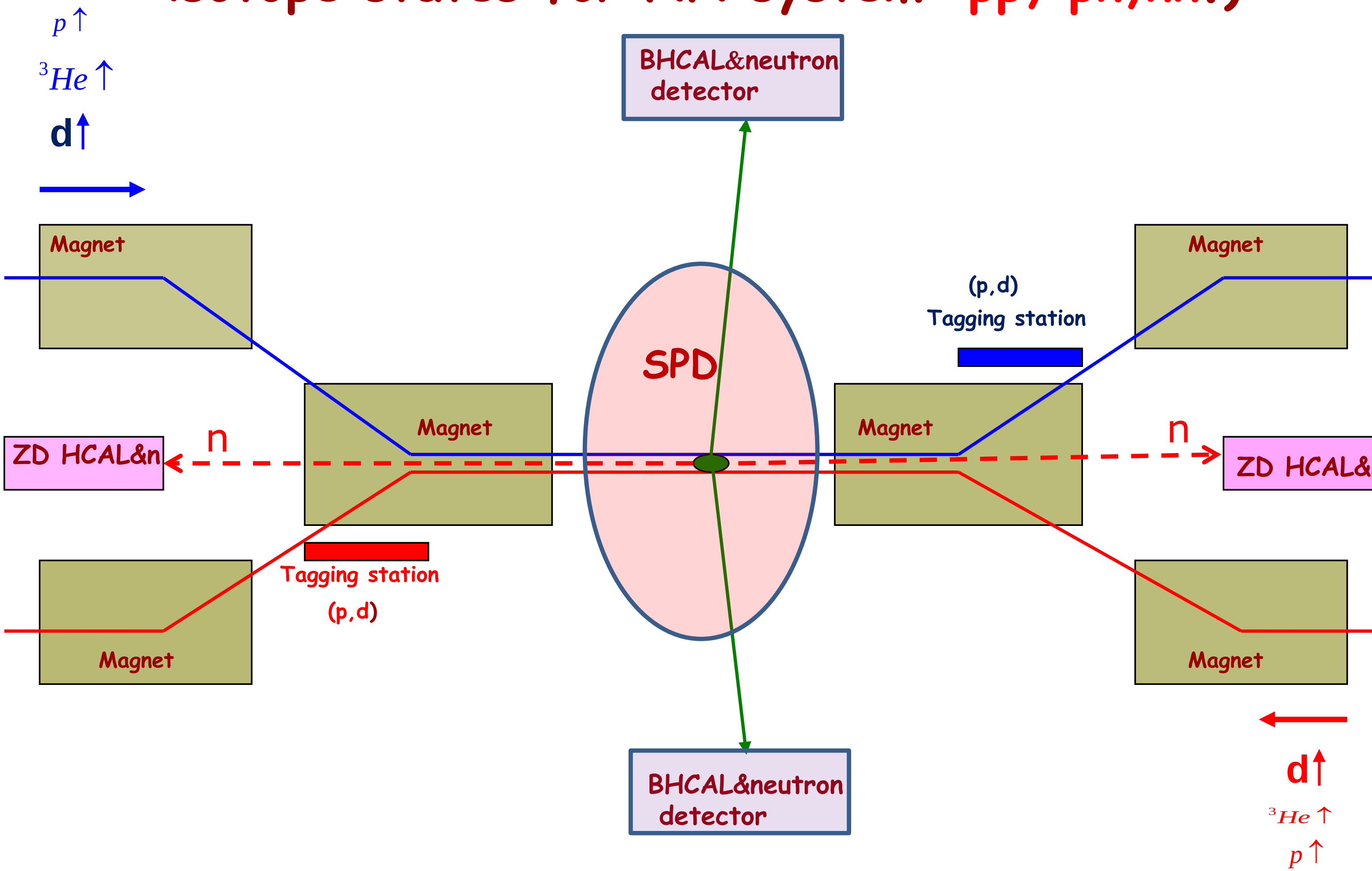
б) нет проблемы измерения межбанчивой светимости, нет проблемы с разной поляризацией в разных модах при работе источника!

Polarization control in the Collider at $\nu_s = 0$

option 1: combination of the solenoids and RF



NICA Collision place for SPIN physics (deuteron and other beams, the first time all isotope states for NN system: pp, pn,nn.)

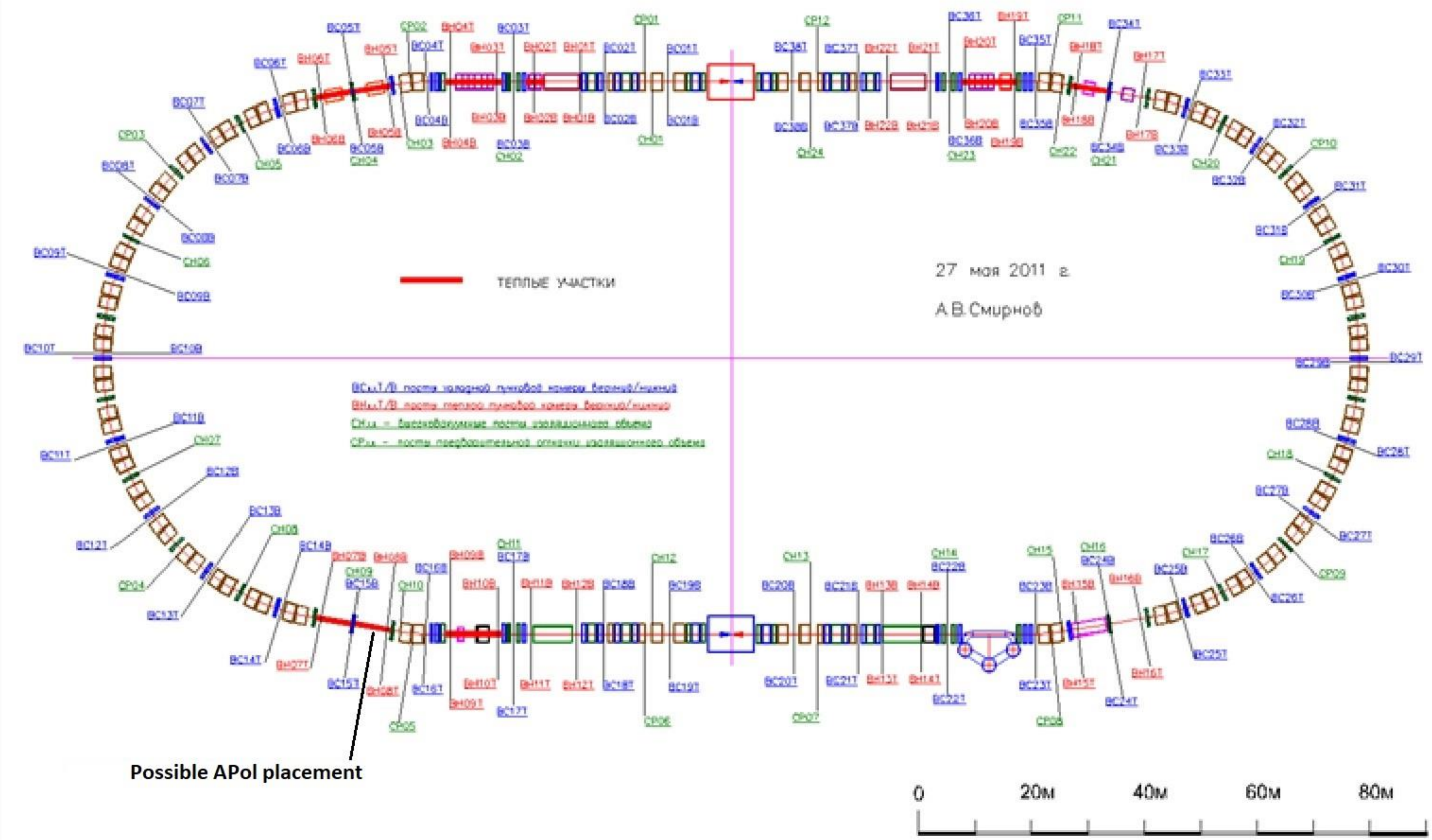


The tagging stations can be used as polarimeter!

NICA proton polarimetry

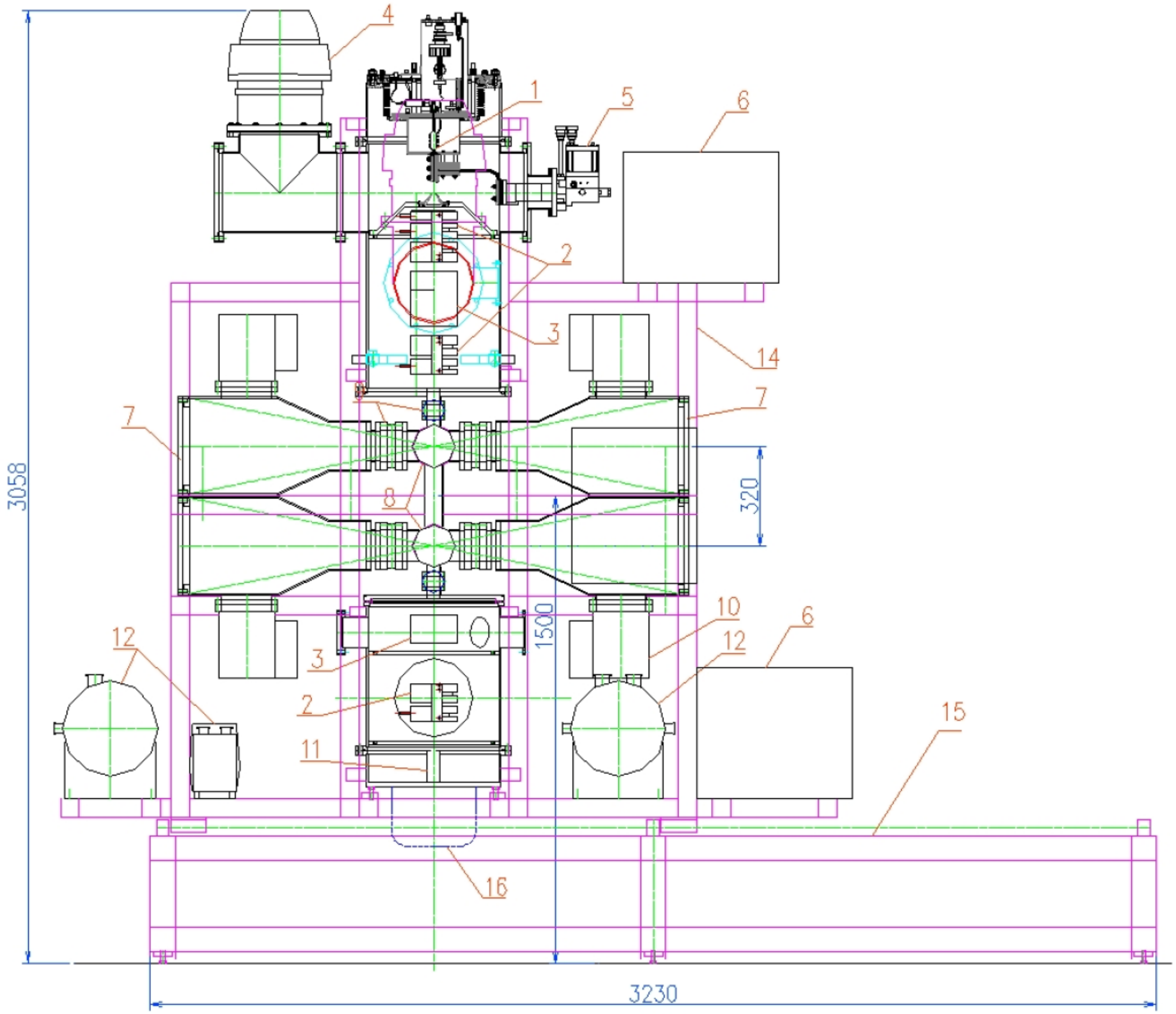
- The proton beam polarization measurement in the energy range of NICA can be done using pC CNI polarimeters.
- Since the hadronic spin-flip part of the amplitude at NICA energies is non negligible, CNI polarimeter is not absolute one!
- To improve the systematic error and to calibrate the CNI polarimeter, an absolute polarimeter based on $\vec{p}\vec{p}$ elastic scattering is required.

  Therefore, the special interaction point inside NICA ring is necessary to install the polarized jet target.
- We need to obtain own experience in the CNI polarimetry at Nuclotron as soon as possible.



ТЕПЛЫЕ УЧАСТКИ
27 мая 2011 г.
А.В. Смирнов
Possible APol placement
0
20м
40м
60м
80м

Design and main dimensions of APol



Parts of APol:

1. Dissociator
2. Sextupole magnets
3. Nuclear polarization cells
4. Turbomolecular pumps 2200 l/s
5. Cryocooler (78K)
6. Cryocooler compressor
7. Detector arm
8. Collider rings
9. UHV valves
10. Turbomolecular pumps 450 l/s
11. Mass-spectrometer
12. Forepumps
14. Movable frame
15. Fixed frame
16. Cryopump 3200 l/s

Caclulated target thickness

10^{12} atoms/cm^{2}

“Физика больших p_T”
(непертурбативная КХД)

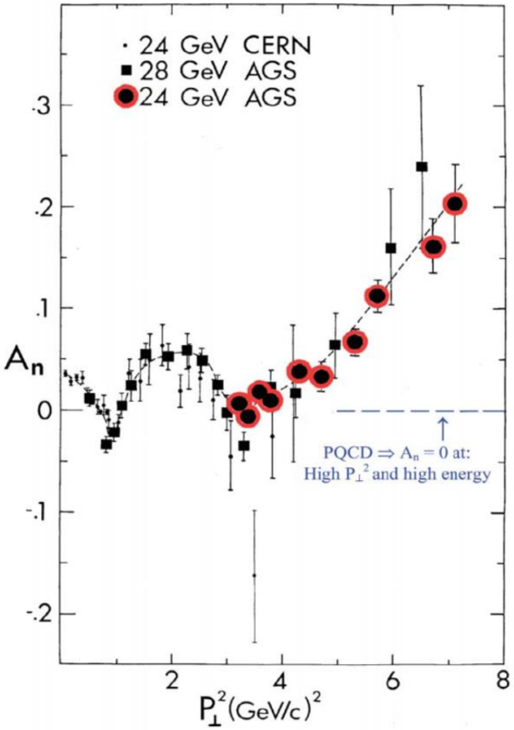
DEUTERON STATIC PROPERTIES FROM NN-POTENTIALS

Таблица 1: Статические свойства дейтрона

	$E_D(MeV)$	$P_D(\%)$	$< r_D^2 >^{1/2} (fm)$	$Q(fm^2)$	$\eta = \frac{A_D}{A_S}$	$f_{\pi NN}^2$	$\mu_D(n.m)$
Exp.	2.224579(9)	–	1.9560(68)	0.2859(3)	0.0271(4)	0.0776(9)	0.857406(1)
MU	2.2246	6.78	1.9611	0.2860	0.0271	0.07745	0.843
Paris	2.2250	5.77	1.9716	0.2789	0.0261	0.078	0.853
RHC	2.2246	6.50	1.9602	0.2770	0.0259	0.0757	0.840
RSC	2.2246	6.47	1.9569	0.2796	0.0262	0.0757	0.843
Bonn	2.225	4.58	1.86	0.2856	0.0267	–	–

Table 1: Deuteron properties in the dressed bag model.

Model	E_d(MeV)	$P_D(\%)$	r_m(fm)	Q_d(fm^2)	$\mu_d\,(\mu_N)$	A_S(fm$^{-1/2}$)	$\eta(D/S)$
RSC	2.22461	6.47	1.957	0.2796	0.8429	0.8776	0.0262
Moscow 99	2.22452	5.52	1.966	0.2722	0.8483	0.8844	0.0255
Bonn 2001	2.224575	4.85	1.966	0.270	0.8521	0.8846	0.0256
DBM (1) $P_{\text{in}} = 3.66\%$	2.22454	5.22	1.9715	0.2754	0.8548	0.8864	0.0259
DBM (2) $P_{\text{in}} = 2.5\%$	2.22459	5.31	1.970	0.2768	0.8538	0.8866	0.0263
experiment	2.224575		1.971	0.2859	0.8574	0.8846	0.0263



AGS 1985-1990 A_n

PERTURBATIVE QCD ⇒

A_n = 0 at HIGH $P_\perp^2$ and HIGH ENERGY

$A_n \neq 0$ ⇒

PROBLEM with PQCD?

NO MODEL can EXPLAIN ALL

HIGH-$P_\perp^2$ SPIN EFFECTS (A_n & A_{nn})

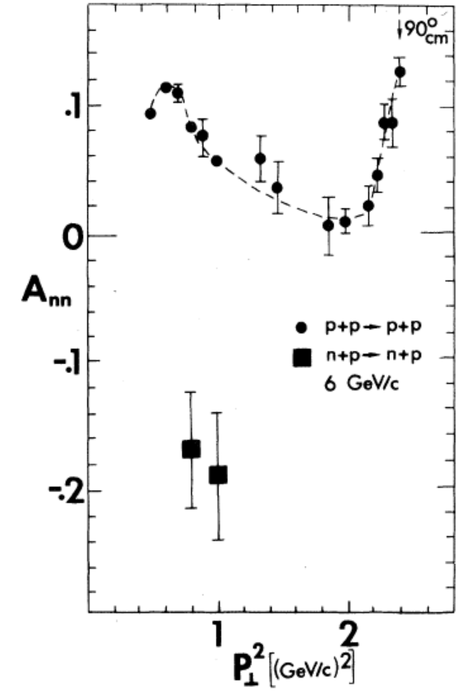
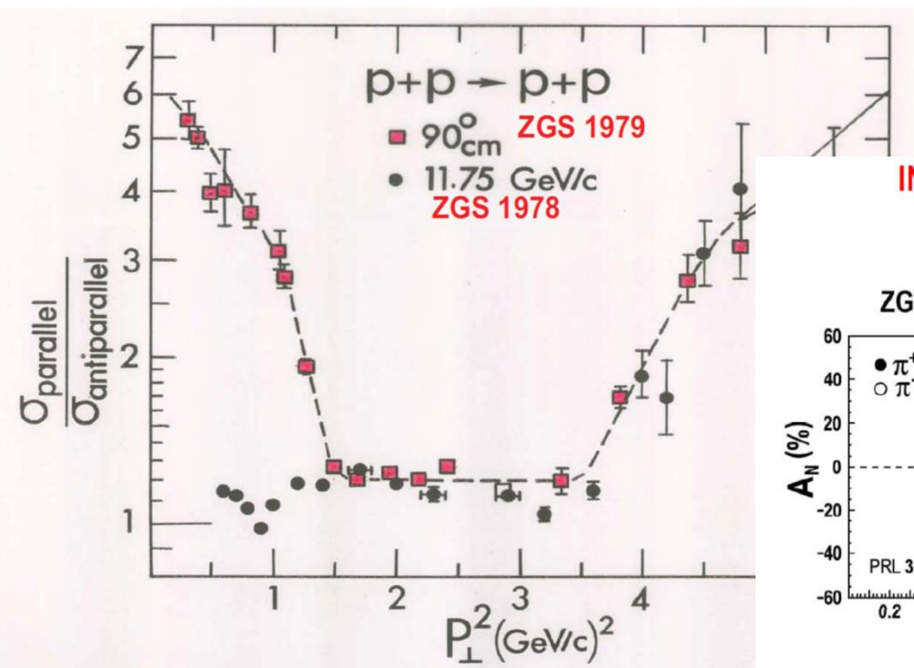
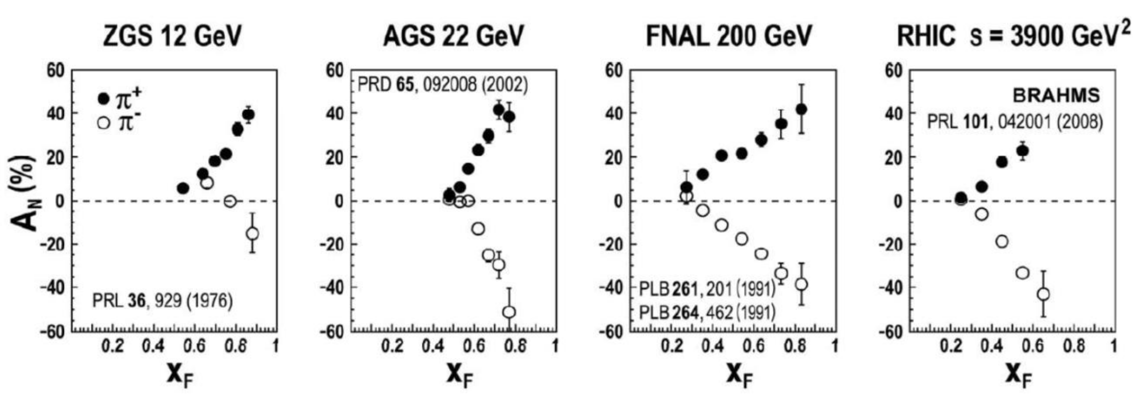


FIG. 2. The spin-spin correlation parameter, A_{nn}, for pure-initial-spin-state nucleon-nucleon elastic scattering at 6 GeV/c is plotted against the square of the transverse momentum. The proton-proton and neutron-proton data are quite different.

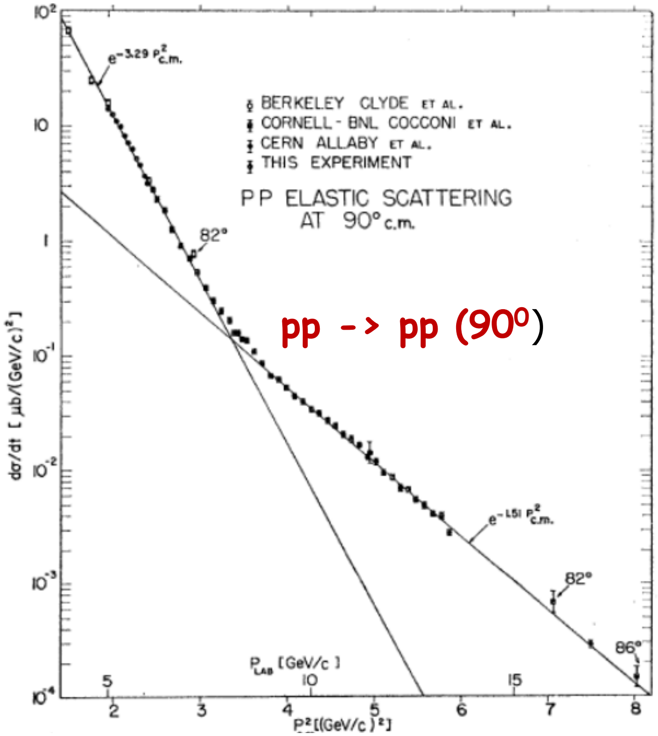


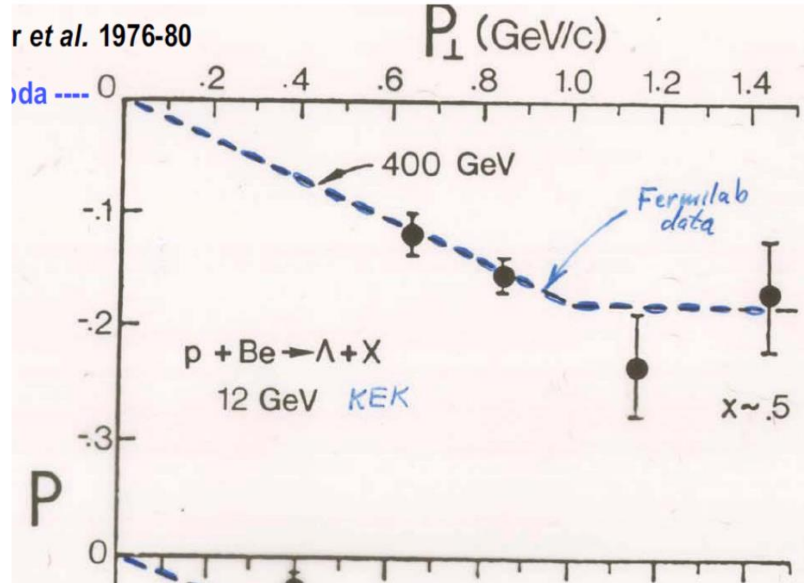
INCLUSIVE PION ASYMMETRY IN PROTON-PROTON COLLISIONS

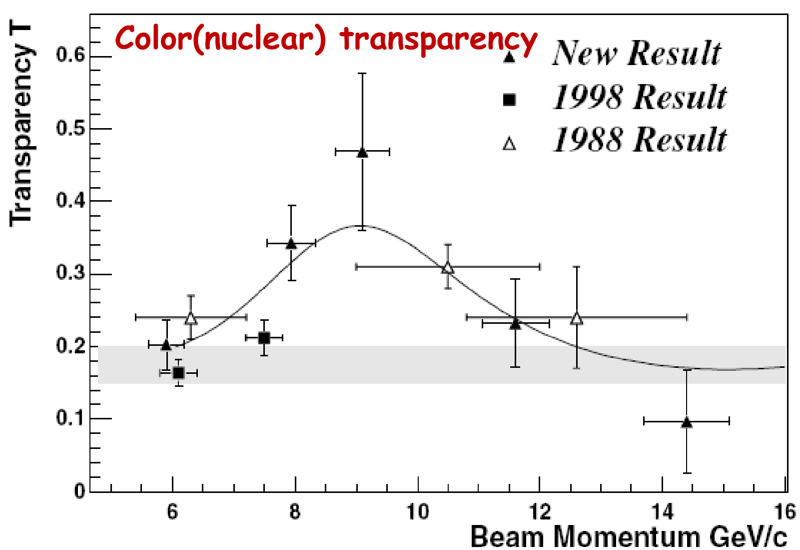
C. Aidala SPIN 2008 Proceeding and CERN Courier June 2009



Nonpolarized beams







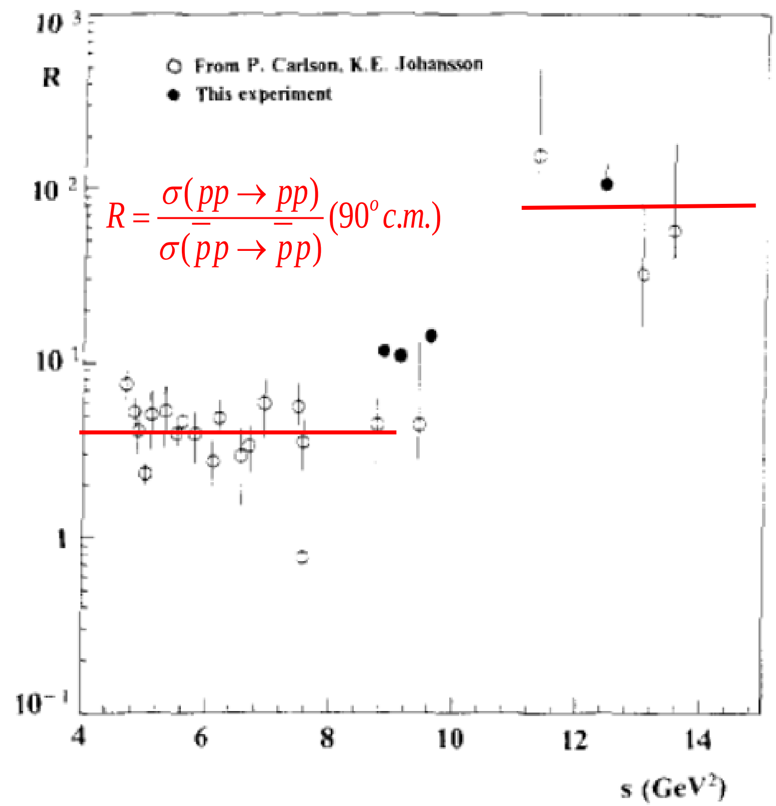


TABLE I. Proton-proton elastic scattering cross sections at 90° in the center-of-mass system.

$P_{c.m.}^2$ $(GeV/c)^2$	P_0 (GeV/c)	$(d\sigma/d\Omega)_{c.m.}$ $(\mu b/sr)$	$(d\sigma/dt)_{c.m.}$ $\mu b/(GeV/c)^2$	Error in $d\sigma/d\Omega$ & $d\sigma/dt$ %
1.946	5.0	8.51	13.74	2.9
1.993	5.1	7.90	12.45	3.3
2.039	5.2	7.09	10.93	3.1
2.086	5.3	6.49	9.77	3.6
2.132	5.4	5.53	8.15	3.1
2.178	5.5	4.90	7.07	3.4
2.223	5.6	4.47	6.32	3.1
2.270	5.7	3.72	5.15	3.3
2.316	5.8	3.37	4.57	3.3
2.363	5.9	2.74	3.64	3.5
2.409	6.0	2.44	3.18	3.1
2.456	6.1	2.19	2.80	3.7
2.503	6.2	1.83	2.30	3.7
2.595	6.4	1.50	1.82	3.7
2.686	6.6	1.07	1.25	4.7
2.779	6.8	0.796	0.900	4.7
2.873	7.0	0.645	0.706	4.1
2.965	7.2	0.515	0.546	4.0
3.059	7.4	0.386	0.396	4.8
3.151	7.6	0.305	0.304	5.4
3.247	7.8	0.253	0.245	4.5
3.338	8.0	0.217	0.204	4.5
3.386	8.1	0.169	0.157	3.9
3.434	8.2	0.172	0.157	4.4
3.480	8.3	0.154	0.139	3.8
3.527	8.4	0.153	0.136	4.6
3.618	8.6	0.127	0.110	4.6
3.713	8.8	0.103	0.0871	4.8
3.806	9.0	0.0809	0.0667	4.6
3.897	9.2	0.0780	0.0629	4.3
3.992	9.4	0.0676	0.0532	5.3
4.084	9.6	0.0589	0.0453	4.9
4.178	9.8	0.0536	0.0403	4.7
4.272	10.0	0.0468	0.0344	4.9
4.364	10.2	0.0441	0.0318	4.8
4.461	10.4	0.0386	0.0272	4.7
4.554	10.6	0.0356	0.0246	4.8
4.644	10.8	0.0303	0.0205	4.9
4.739	11.0	0.0284	0.0188	5.5
4.831	11.2	0.0255	0.0166	5.4
4.924	11.4	0.0202	0.0129	5.4
5.018	11.6	0.0190	0.0119	5.2
5.112	11.8	0.0153	0.00940	5.4
5.208	12.0	0.0143	0.00862	5.4
5.299	12.2	0.0118	0.00699	5.3
5.392	12.4	0.0116	0.00676	5.4
5.490	12.6	0.00953	0.00545	6.3
5.579	12.8	0.00867	0.00488	5.7
5.674	13.0	0.00739	0.00409	5.9
5.770	13.2	0.00722	0.00393	7.1
5.861	13.4	0.00525	0.00281	5.7

The rate for $L \sim 10^{30}\ cm^{-2}c^{-1}$:

(row P_0 = 8.0) → $\sim 0.2\ c^{-1}$

(row P_0 = 12.0) → $\sim 0.01\ c^{-1}$

ДИКВАРКИ

Multiquark states have been discussed since the 1st page of the quark model

A SCHEMATIC MODEL OF BARYONS AND MESONS *

M. GELL-MANN
California Institute of Technology, Pasadena, California

Received 4 January 1964

If we assume that the strong interactions of baryons and mesons are correctly described in terms of the broken "eightfold way" [1-3], we are tempted to look for some fundamental explanation of the situation. A highly promised approach is the purely dynamical "bootstrap" model for all the strongly interacting particles within which one may try to derive isotopic spin and strangeness conservation and broken eightfold symmetry from self-consistency alone [4]. Of course, with only strong interactions, the orientation of the asymmetry in the unitary space cannot be specified; one hopes that in some way the selection of specific components of the F-spin by electromagnetism and the weak interactions determines the choice of isotopic spin and hypercharge directions.

Even if we consider the scattering amplitudes of strongly interacting particles on the mass shell only and treat the matrix elements of the weak, electromagnetic, and gravitational interactions by means

ber $n_t - n_{\bar{t}}$ would be zero for all known baryons and mesons. The most interesting example of such a model is one in which the triplet has spin $\frac{1}{2}$ and $z = -1$, so that the four particles d^-, s^-, u^0 and b^0 exhibit a parallel with the leptons.

A simpler and more elegant scheme can be constructed if we allow non-integral values for the charges. We can dispense entirely with the basic baryon b if we assign to the triplet t the following properties: spin $\frac{1}{2}$, $z = -\frac{1}{3}$, and baryon number $\frac{1}{3}$. We then refer to the members $u^{\frac{2}{3}}$, $d^{-\frac{1}{3}}$, and $s^{-\frac{1}{3}}$ of the triplet as "quarks" [6] q and the members of the anti-triplet as anti-quarks $\bar{q}$. Baryons can now be constructed from quarks by using the combinations (qqq), $(qqqq\bar{q})$, etc., while mesons are made out of $(q\bar{q})$, $(qq\bar{q}\bar{q})$, etc. It is assuming that the lowest baryon configuration (qqq) gives just the representations **1**, **8**, and **10** that have been observed, while the lowest meson configuration $(q\bar{q})$ similarly gives just **1** and **8**.

that it would never have been detected. A search for stable quarks of charge $-\frac{1}{3}$ or $+\frac{2}{3}$ and/or stable di-quarks of charge $-\frac{2}{3}$ or $+\frac{1}{3}$ or $+\frac{4}{3}$ at the highest energy accelerators would help to reassure us of the non-existence of real quarks.

Reviews of Modern Physics, Vol. 65, No. 4, October 1993

Diquarks

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Among the useful phenomenological ideas is the notion of a diquark. Gell-Mann (1964) first mentioned the possibility of diquarks in his original paper on quarks. Later, Ida and Kobayashi (1966) and Lichtenberg and Tassie (1967) introduced diquarks in order to describe a baryon as a composite state of two particles, a quark and diquark. Around the same time, states having some or all of the quantum numbers of diquarks were introduced in certain group-theoretical schemes by Bose (1966), Bose and Sudarshan (1967), and Miyazawa (1966, 1968).

Aside from questions of principle, lattice calculations suffer because an enormous amount of computer time is necessary to achieve very modest results. Thus, at present, calculations with lattice gauge theory are not a satisfactory substitute for calculations with phenomenological models.

arXiv:1007.4705v5 [hep-ph] 25 Sep 2010
Carlos Granados and Misak Sargsian

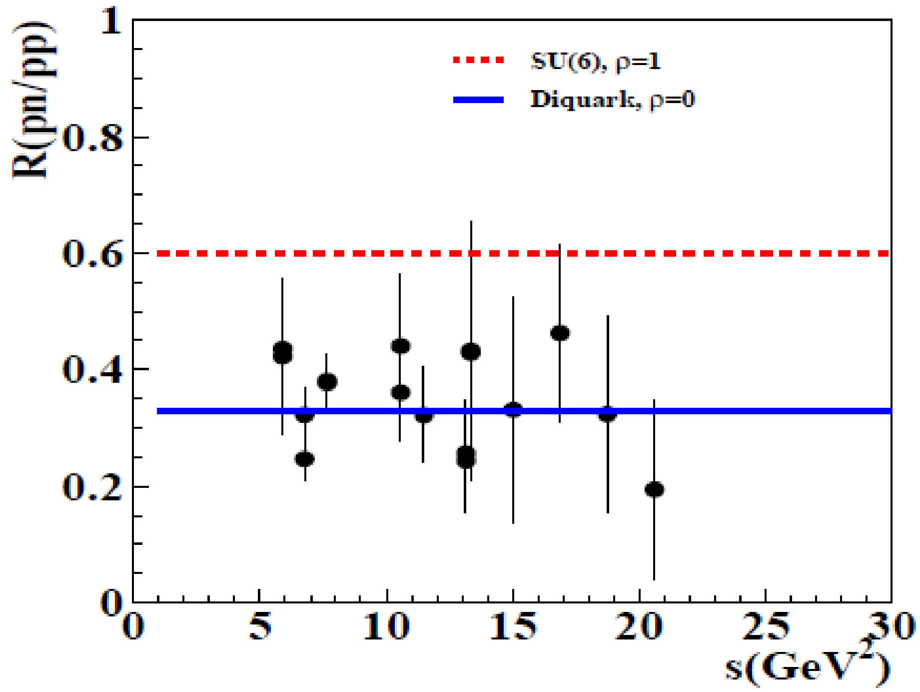


FIG. 2: (Color online) Ratio of the $pn \to pn$ to $pp \to pp$ elastic differential cross sections as a function of s at $\theta^N_{c.m.} = 90^0$.

Diquarks

V.T. Kim (1987)

pp -> p+X, pp -> pp+X

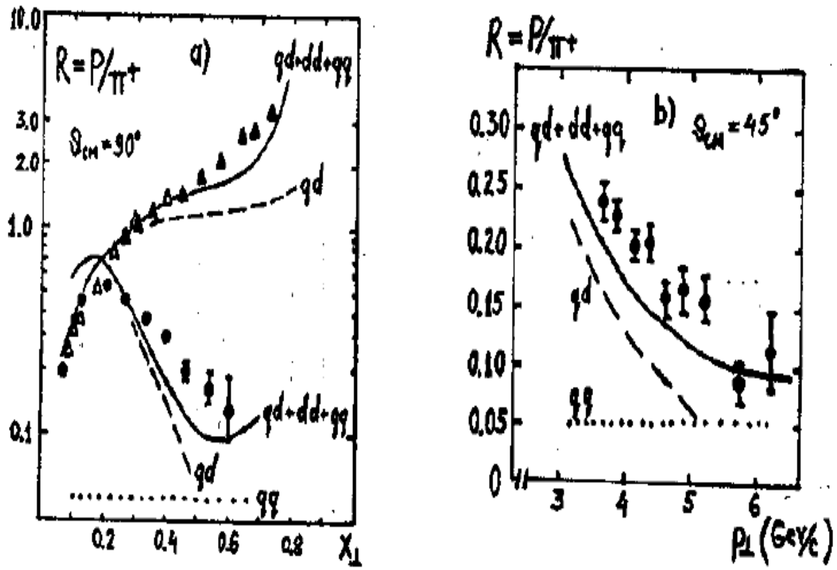


Fig. 1. $R = P/\pi^+$ -ratio in pp-collisions. a) $\vartheta_{CM} = 90°$: ● – FNAL data /16/ at $\sqrt{s} = 23.4$ GeV (E_L = 300 GeV); Δ , ▲ – IHEP (Serpukhov) data/19,20/ at $\sqrt{s}$ = 11.5 GeV (E_L = 70 GeV). b) $\vartheta_{CM} = 45°$: ● – ISR CERN data /18/ at $\sqrt{s}$ = 62 GeV ($E_L \simeq$ 1900 GeV).

The result of calcuations of $pp \to ppX$ processes/29/ (symmetric -proton-pair production) according to the formula in work/30/ for the double inclusive cross section, which in general must be applied carefully/31/ , is shown in Fig.2. The main contribution to the cross section of production of proton pairs with transverse momenta opposite and equal in values is given by diquark-diquark scattering.

NN Elastic scattering with polarized deuteron beams :

$$p\uparrow + p\uparrow \to p\uparrow + p\uparrow$$ for calibration

$$p\uparrow + n\uparrow \to p\uparrow + n\uparrow$$

$$n\uparrow + n\uparrow \to n\uparrow + n\uparrow$$

New data!

By the way we will have the counting rules verification!

pd, nd and dd – too!

Exclusive NN study at $x_T \sim 1$

$$N\uparrow + N\uparrow \rightarrow BB + MM$$

$B\,(p, n, \Lambda, \Delta \ldots)$, $M\,(\pi, K, \ldots)$

Mechanisms of hyperons polarization

$$N\uparrow N\uparrow \rightarrow NN$$

The counting rules and isotopic symmetry studies, $p_T \sim 2$ GeV/c anomaly

$$N\uparrow N\uparrow \rightarrow BB + \pi\pi(KK)$$

$$N\uparrow N\uparrow \rightarrow \Delta\Delta$$

Detail vertexes studies and spin structure of the interaction vertex:

$$q + (q) - (quark - quark)$$

$$q + (qq) - (quark - diquark)$$

$$(qq) + (qq) - (diquark - diquark)$$

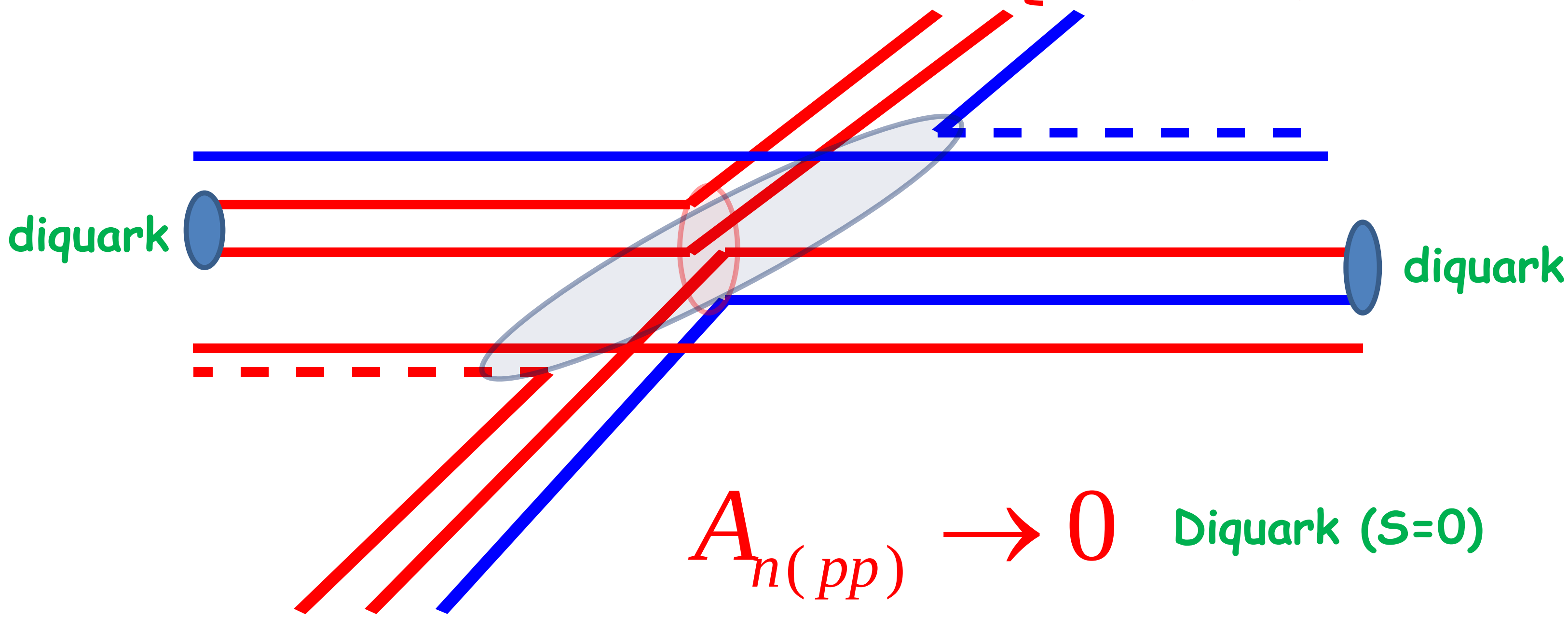
High p_T exclusive reactions -> MPI

$$p\uparrow + p\uparrow \rightarrow B + B + M\overline{M}$$

$$p\uparrow + p\uparrow \rightarrow p + p + \pi^0\pi^0(\pi^+\pi^-)$$

$$R = \frac{N(\pi^+\pi^-)}{N(\pi^0\pi^0)} = \frac{2}{7}$$ Without diquark

$$R = \frac{N(\pi^+\pi^-)}{N(\pi^0\pi^0)} \rightarrow 0$$ diquark



$$A_{n(pp)} \rightarrow 0$$ Diquark (S=0)

CsDBM investigation

Поляризованные D

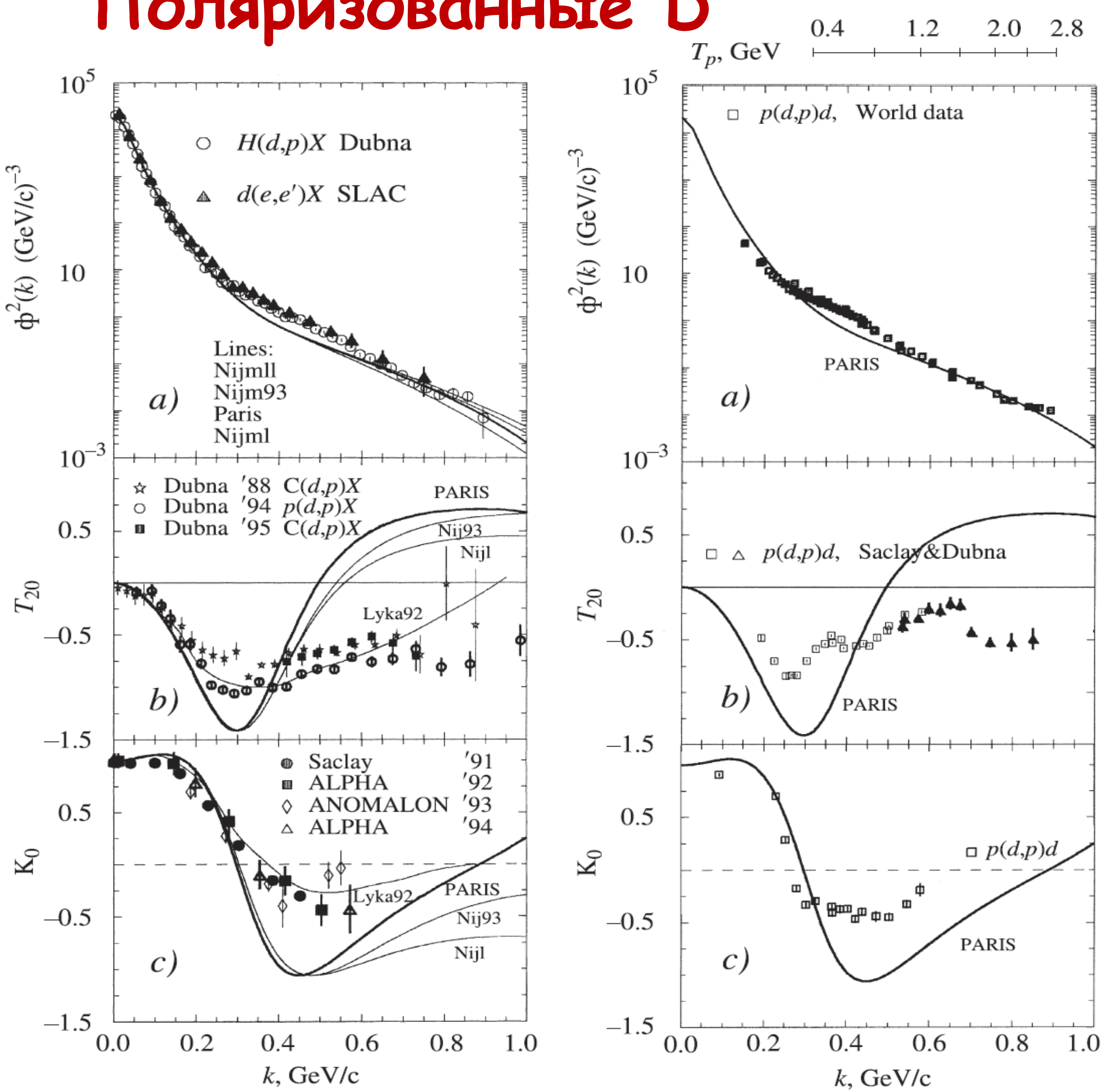
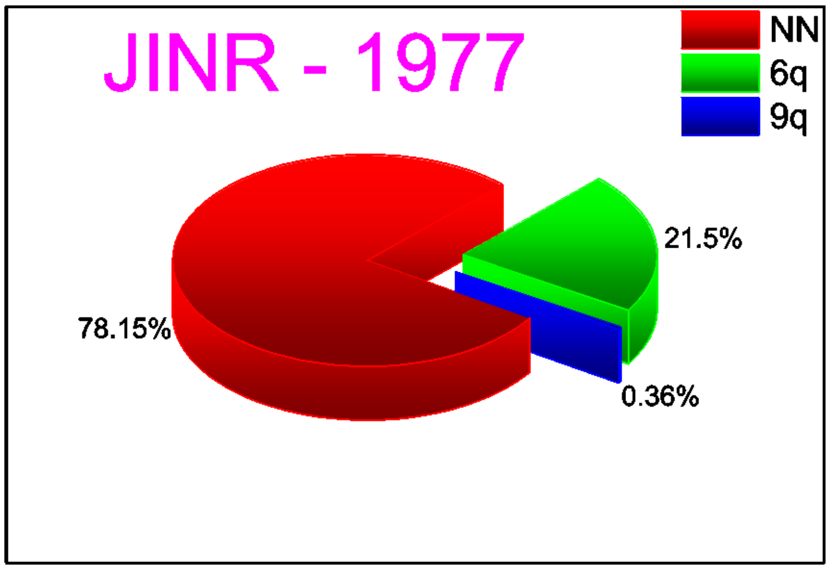


Рис. 5. Сводка данных экспериментов по фрагментации (слева) и упругому рассеянию «назад» (справа) поляризованных и неполяризованных дейтронов

^{12}C - structure

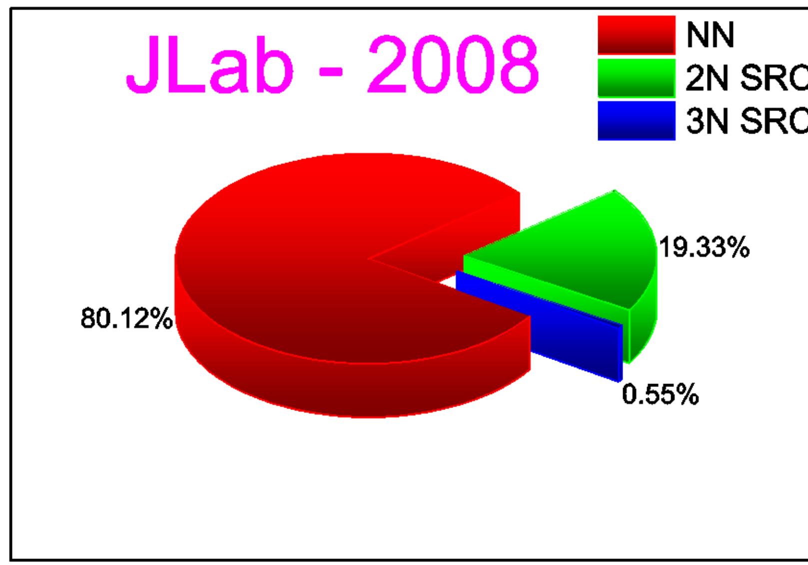
RNP – program at JINR

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



eA – program at JLab

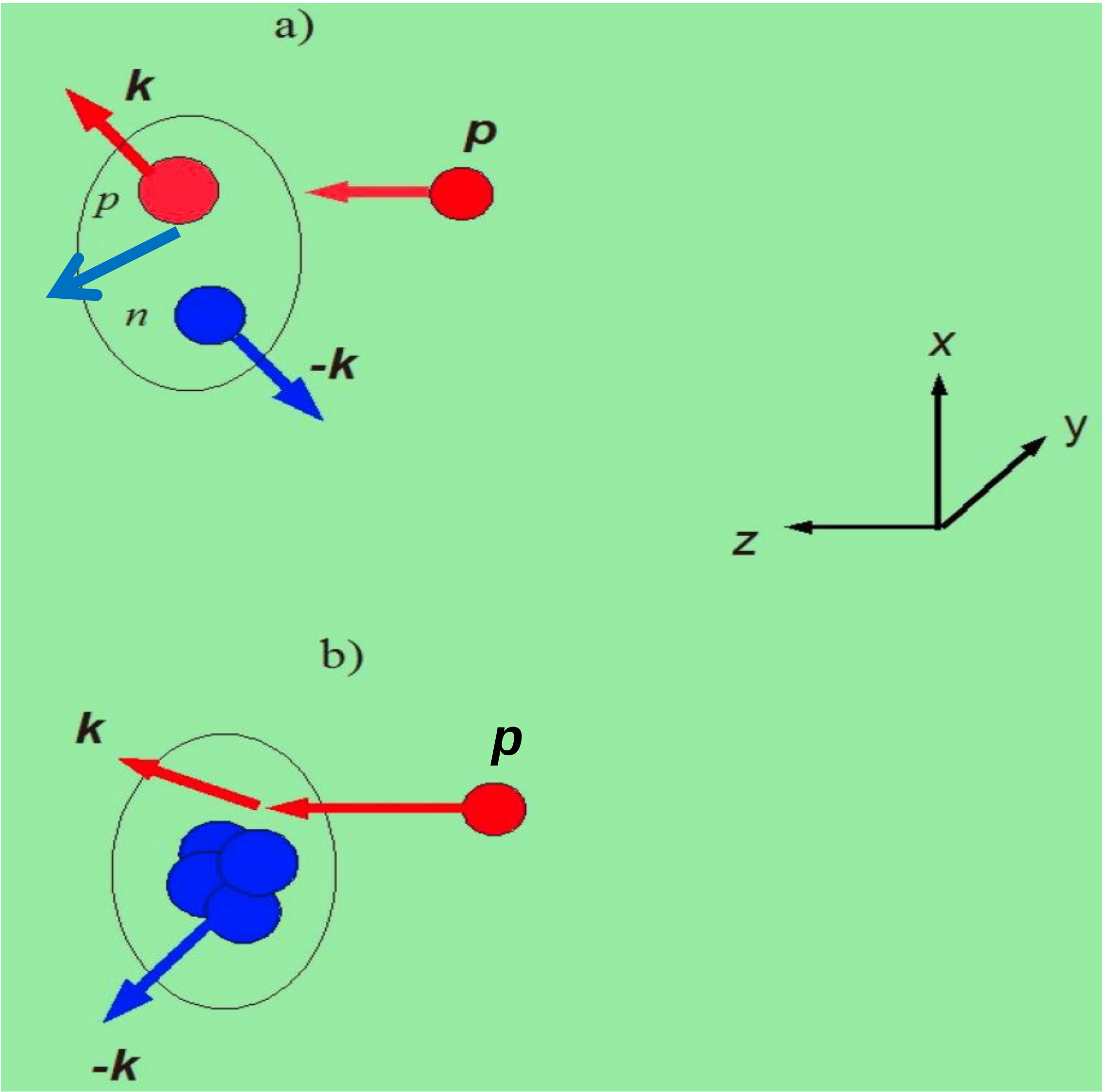
R.Subedi et al., Science 320 (2008) 1476-1478
e-Print: arXiv:0908.1514 [nucl-ex]



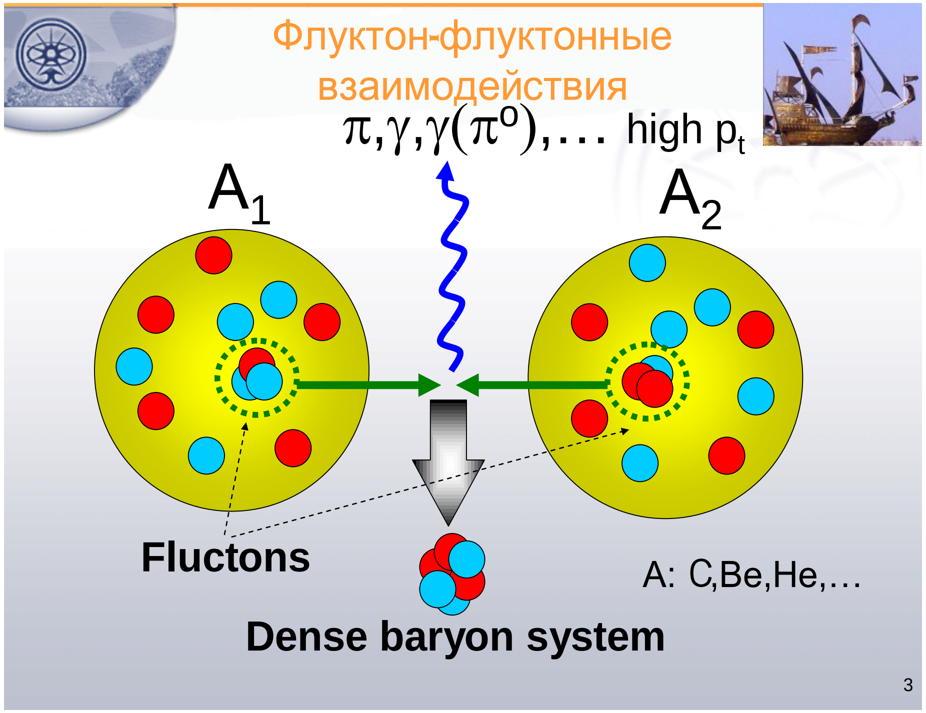
Knot out cold dense nuclear configurations

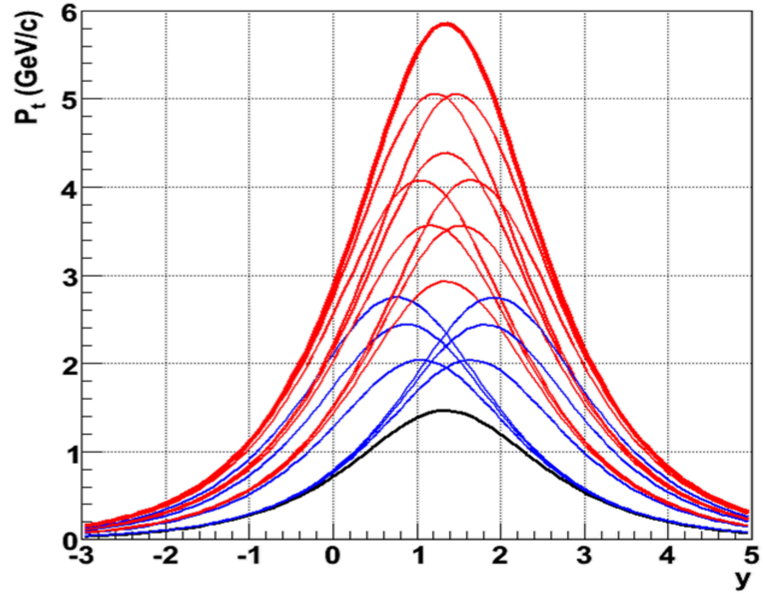
SRC configuration

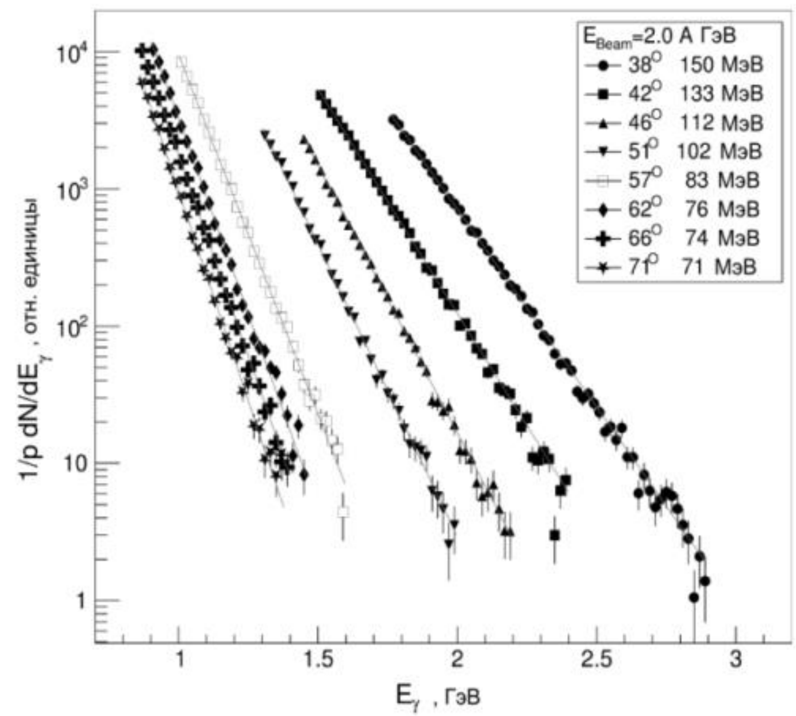
Multiquark configuration



ITEP high p_T data



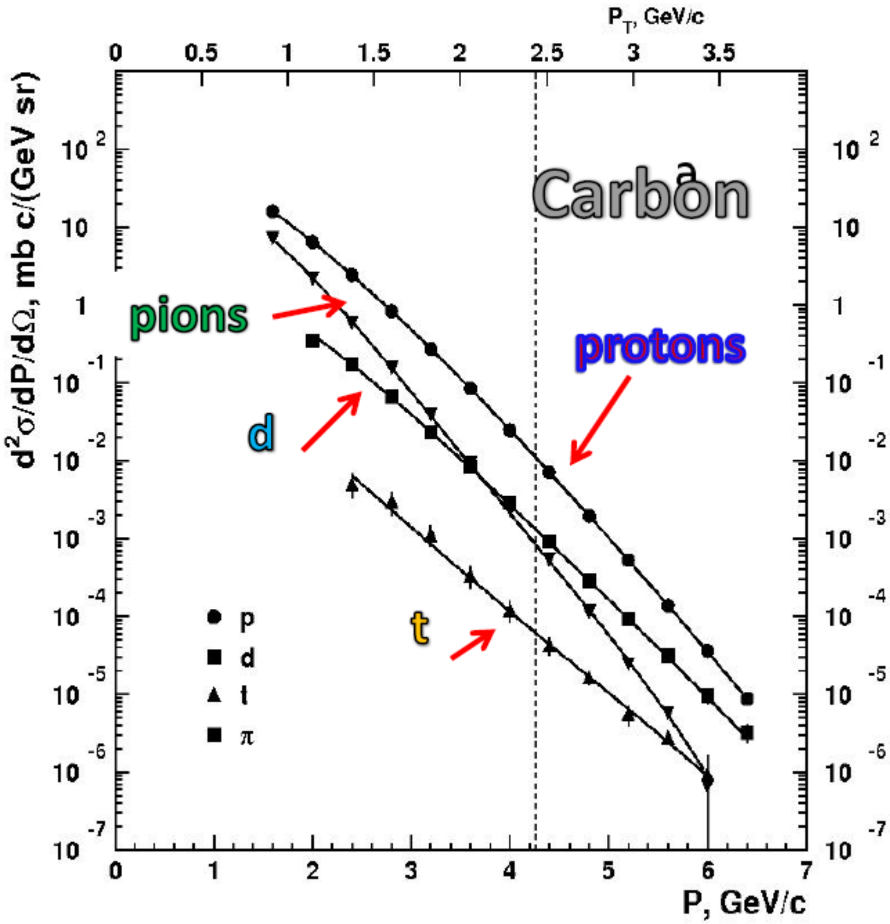


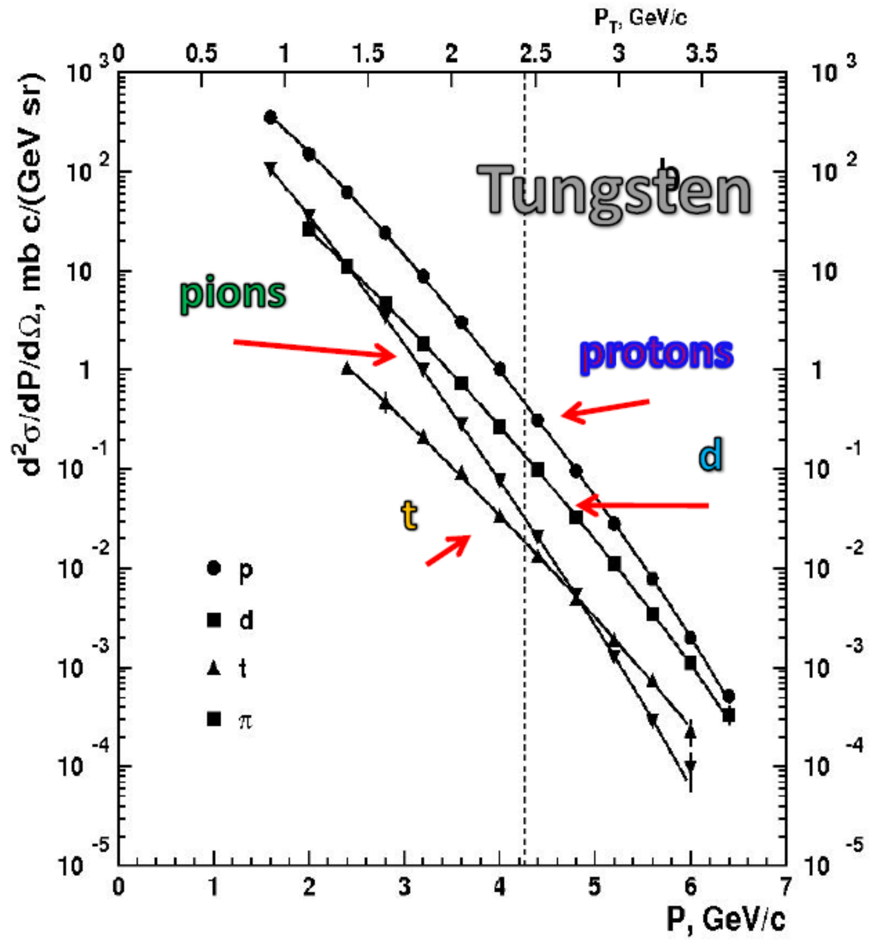


I.G.Alekseev et.al.(FLINT), ЯФ 71(2008)1;
A.Stavinskiy, EPJ Web Conf. 71 (2014) 00125;
K.R. Mikhailov et al.,_Phys.Atom.Nucl. 77 (2014) 576;
ЯФ 77 (2014) 610

SPIN data

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 .

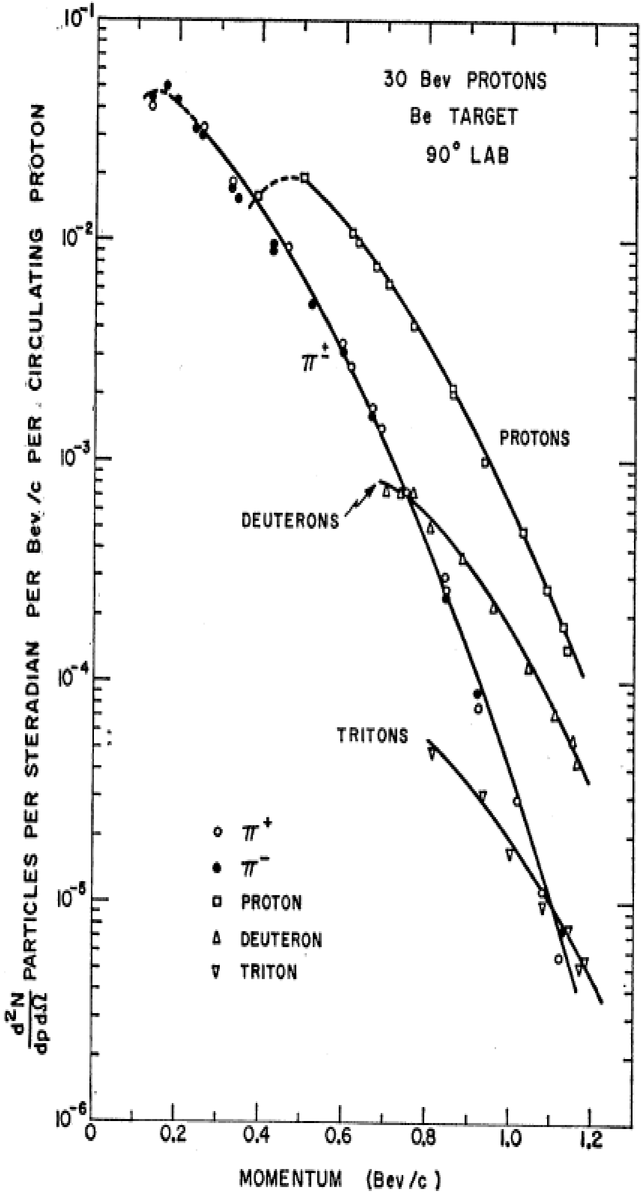
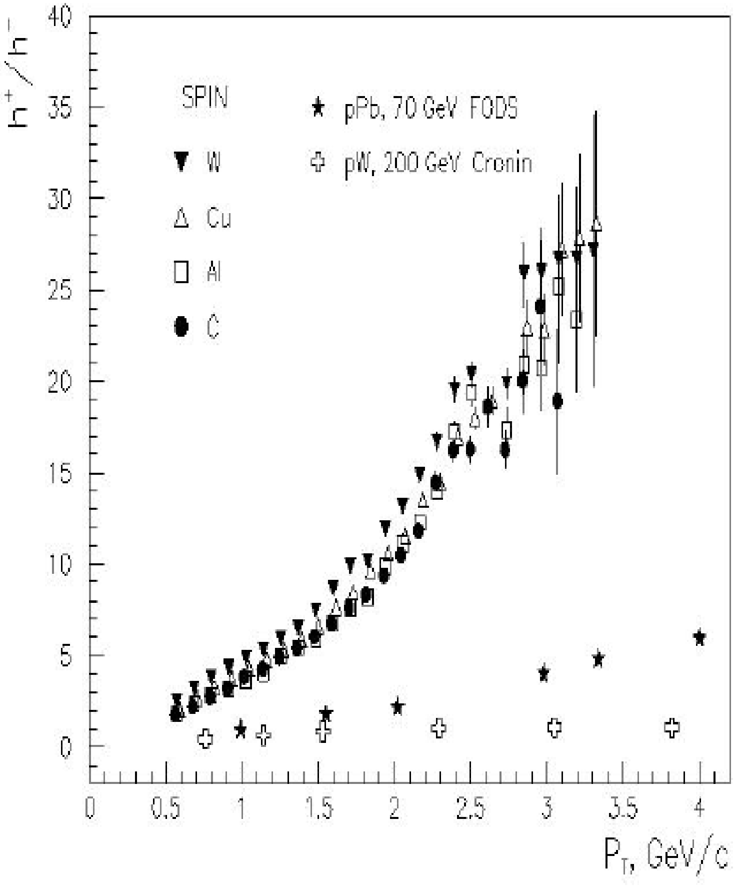
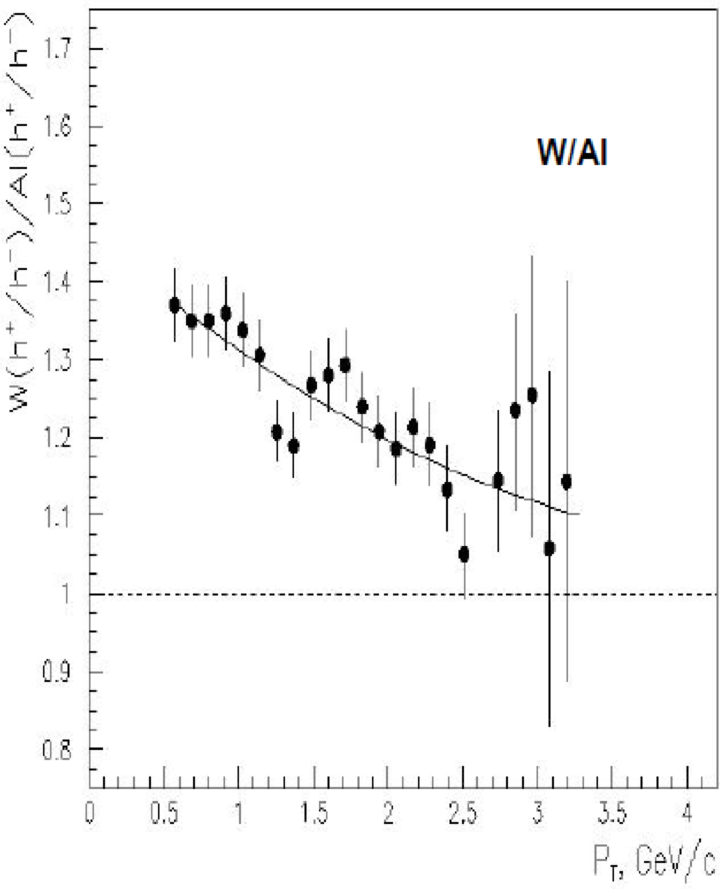


FIG. 2. Momentum spectrum of particles emitted at 90° from a beryllium target struck by 30-Bev protons. The ordinate is the number of particles produced at the target per steradian per Bev/c per circulating proton. The dashed portions of the curves indicate regions where the corrections due to multiple scattering exceed 15%. At the time these data were taken no effort was made to detect He^3.

Ratios



h+/h−
SPIN
W
Cu
Al
C
pPb, 70 GeV FODS
pW, 200 GeV Cronin
P_T, GeV/c



W(h+/h−)/Al(h+/h−)
W/Al
P_T, GeV/c

Study of the phase diagram of dense two-color QCD within lattice simulation

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[1]*Institute for High Energy Physics NRC "Kurchatov Institute", Protvino, 142281 Russia*
[2]*Institute for Theoretical and Experimental Physics NRC "Kurchatov Institute", Moscow, 117218 Russia*
[3]*School of Biomedicine, Far Eastern Federal University, Sukhanova 8, Vladivostok, 690950 Russia*
[4]*Moscow Institute of Physics and Technology, Institutskii per. 9, Dolgoprudny, Moscow Region, 141700 Russia*
[5]*Joint Institute for Nuclear Research, BLTP, Dubna, 141980 Russia*
[6]*National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Kashirskoe Highway, 31, Moscow 115409, Russia*

In this paper we carry out a low-temperature scan of the phase diagram of dense two-color QCD with $N_f = 2$ quarks. The study is conducted using lattice simulation with rooted staggered quarks. At small chemical potential we observe the hadronic phase, where the theory is in a confining state, chiral symmetry is broken, the baryon density is zero and there is no diquark condensate. At the critical point $\mu = m_\pi/2$ we observe the expected second order transition to Bose-Einstein condensation of scalar diquarks. In this phase the system is still in confinement in conjunction with nonzero baryon density, but the chiral symmetry is restored in the chiral limit. We have also found that in the first two phases the system is well described by chiral perturbation theory. For larger values of the chemical potential the system turns into another phase, where the relevant degrees of freedom are fermions residing inside the Fermi sphere, and the diquark condensation takes place on the Fermi surface. In this phase the system is still in confinement, chiral symmetry is restored and the system is very similar to the quarkyonic state predicted by SU(N_c) theory at large N_c.

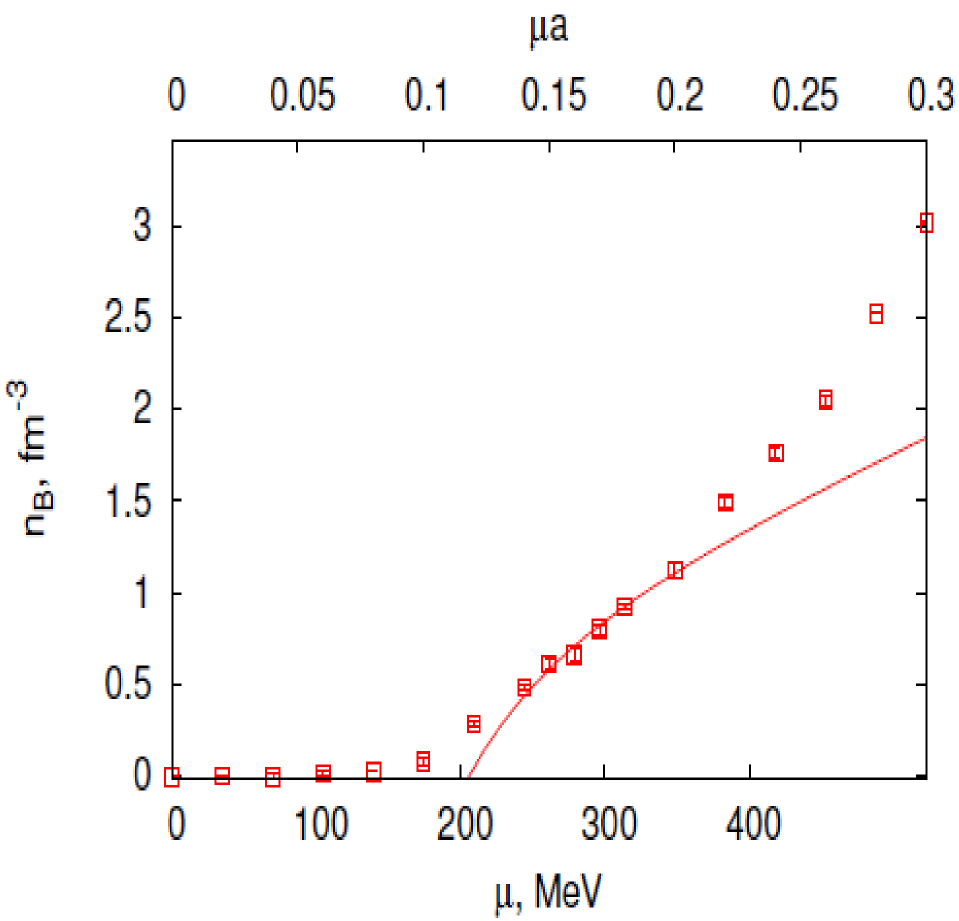


FIG. 10: The baryon density n_B in physical units, as a function of μ. The chemical potential is expressed in physical units (lower scale) and in lattice units (upper scale).

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).

EXOTICS

Status of the pentaquark problem

- 1^{st} relatively certain theoretical suggestion
  of mass ~1530 MeV and width < 15 MeV :

  Diakonov, Petrov, Polyakov, Z.Phys., A**359** (1997) 305.

- Experiment : about ten papers with positive evidences;
  about ten papers with negative results
  (some of them with higher statistics).

- Common opinion and PDG position
  (since edition of 2008) :

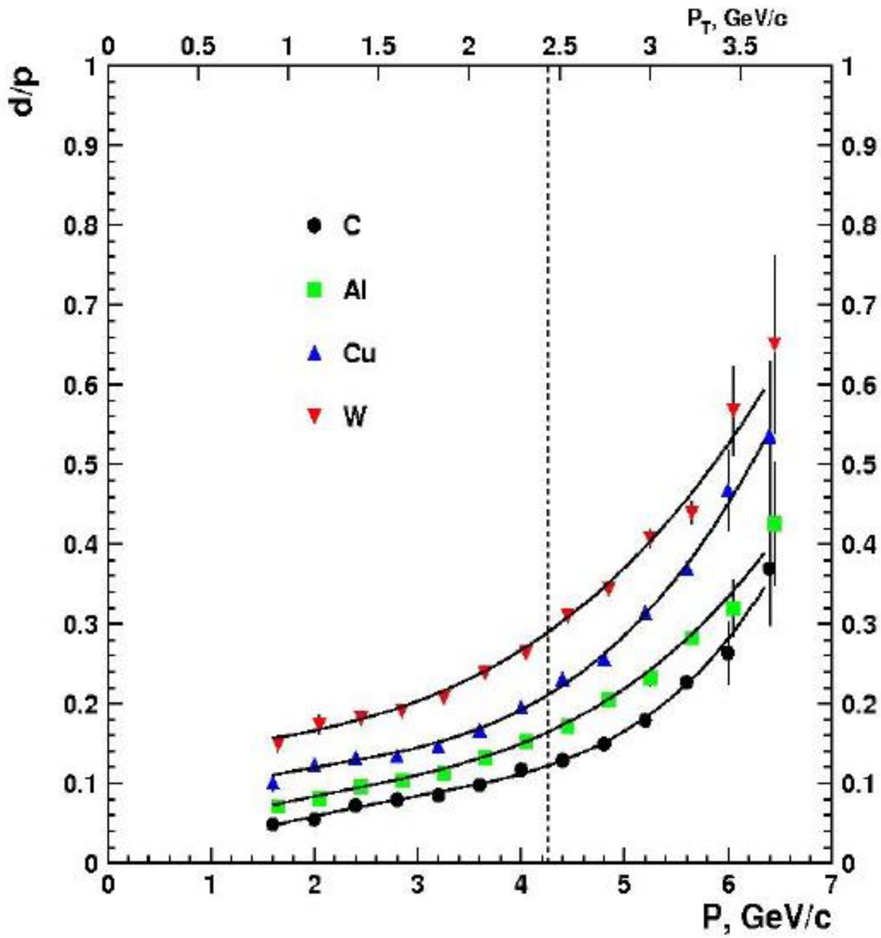
  Pentaquark is dead !

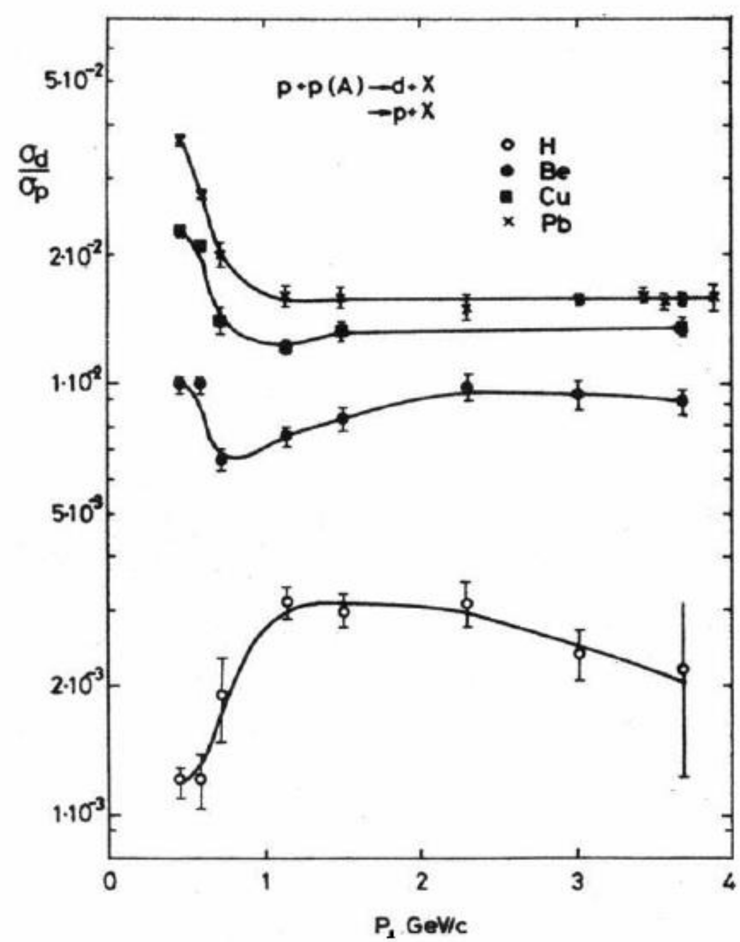
  (Note, at the same time, great enthusiasm
  in searches for tetraquarks !)

SPIN data

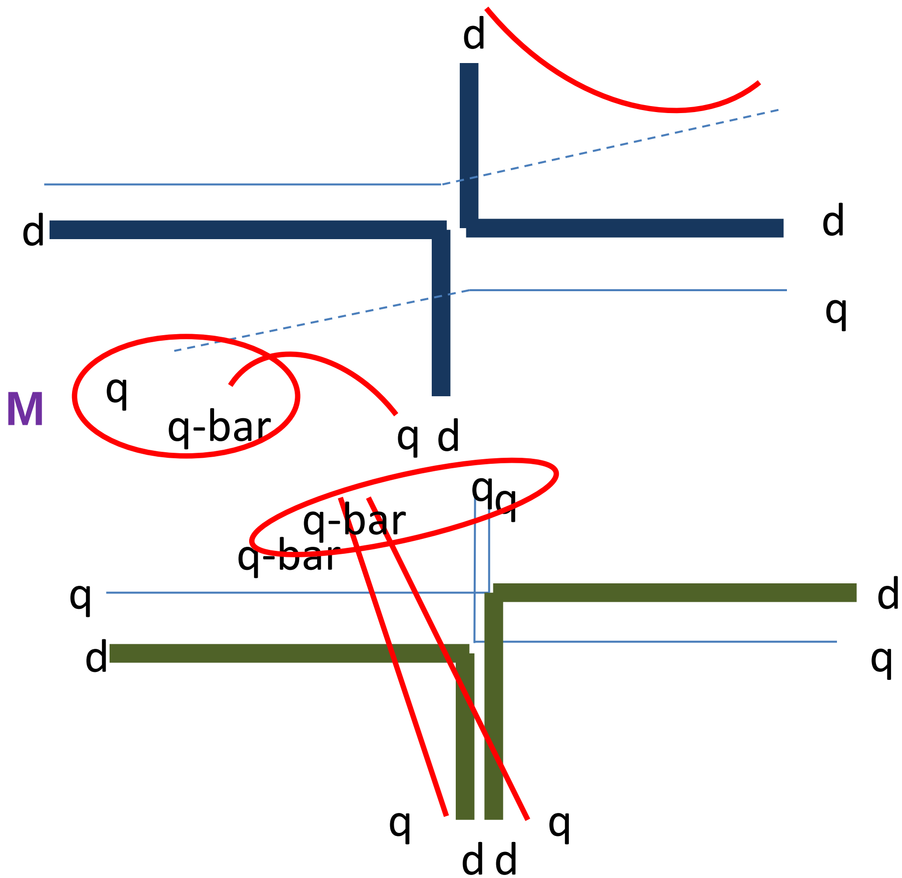
Ratio d/p

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



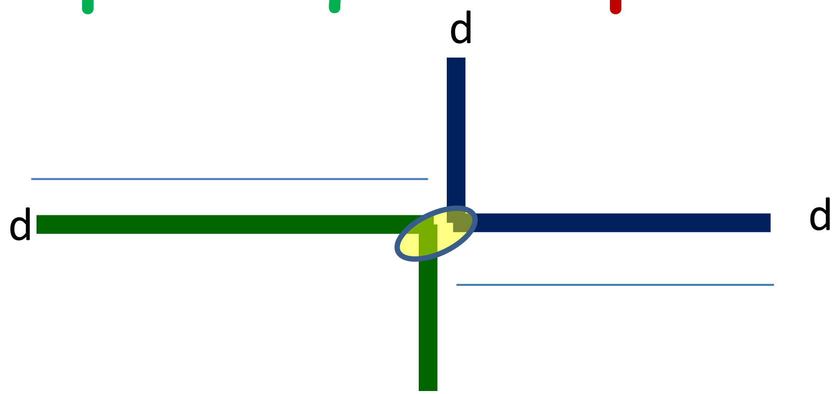


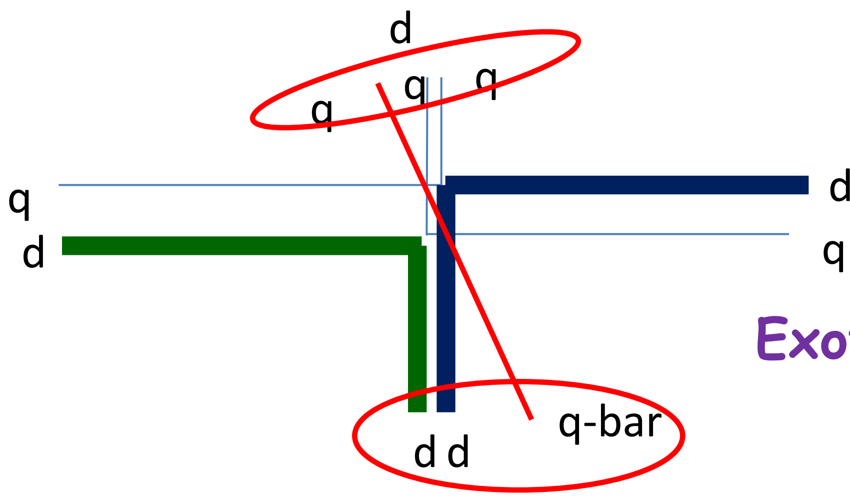
pp - reactions with diquarks and тетракварки



Kim's mechanisms

Exotic states production
pp - reactions with
pentaquarks production





Kim's mechanisms

ISSUES

1. Diquark properties.
2. The Confinement laws.
3. Nature of the spin effects.
4. The Deuteron spin structure.
5. FSI (with s,c-quarks participation).
6. Nature of CsDBM.
7. np dilepton production anomaly.
8. Exotic states.
9. Subthreshold J/Ψ production.

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END