Scientific Council
108th meeting,
23-24 September 2010

Progress of implementation of the Seven-Year Plan for the Development of JINR (2010-2016) in particle physics and high-energy heavy-ion physics

R. Lednicky

JINR, Dubna

JINR Activities in Particle Physics

High energy physics program is carried out in four JINR laboratories: VBLHEP, DLNP, BLTP and LIT.

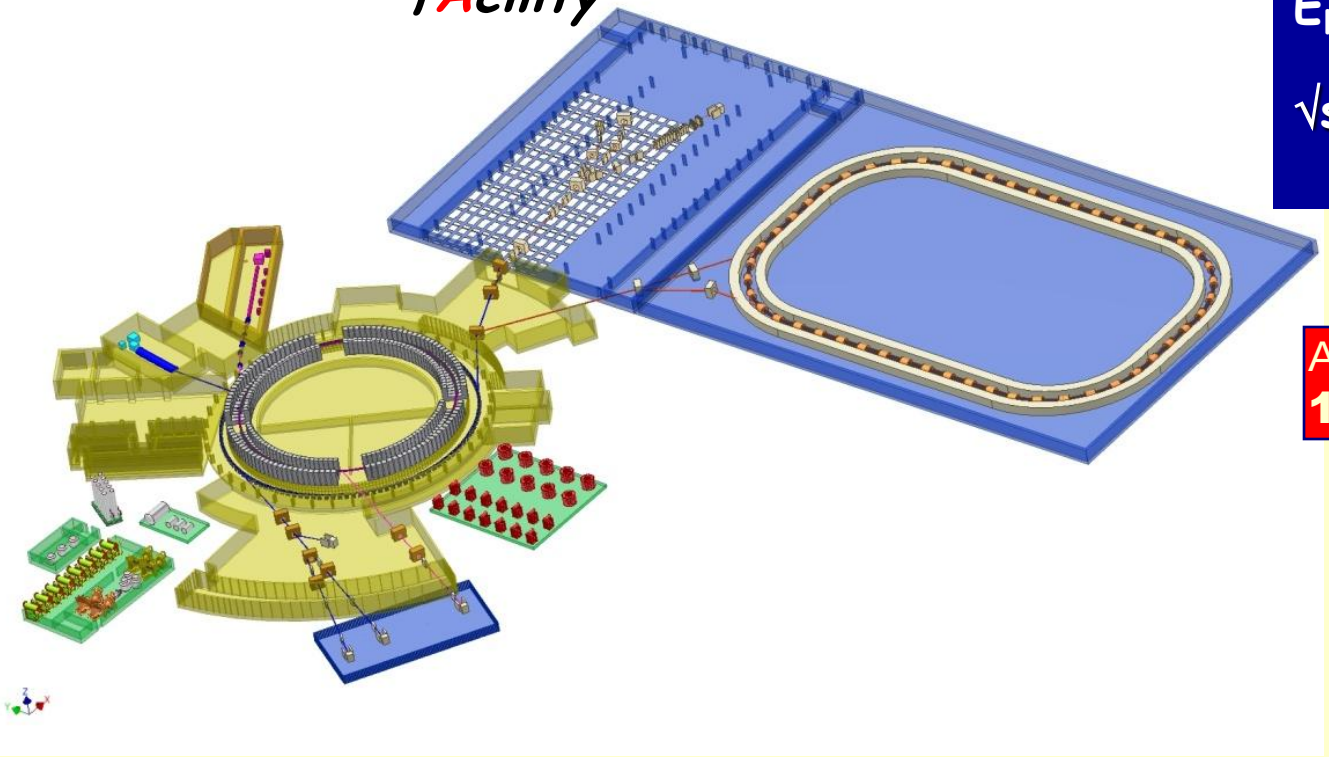
The research is performed in the following main directions:

- physics of new states of nuclear matter;
- nucleon structure and its spin dependence;
- non-perturbative QCD;
- physics of rare processes;
- tests of fundamental symmetries;
- Standard Model and beyond;
- neutrino physics.

Study of nuclear matter at extreme conditions at JINR

NICA/MPD

***N**uclotron-based **I**on **C**ollider f**A**cility*



E_{lab} < 60 GeV/n

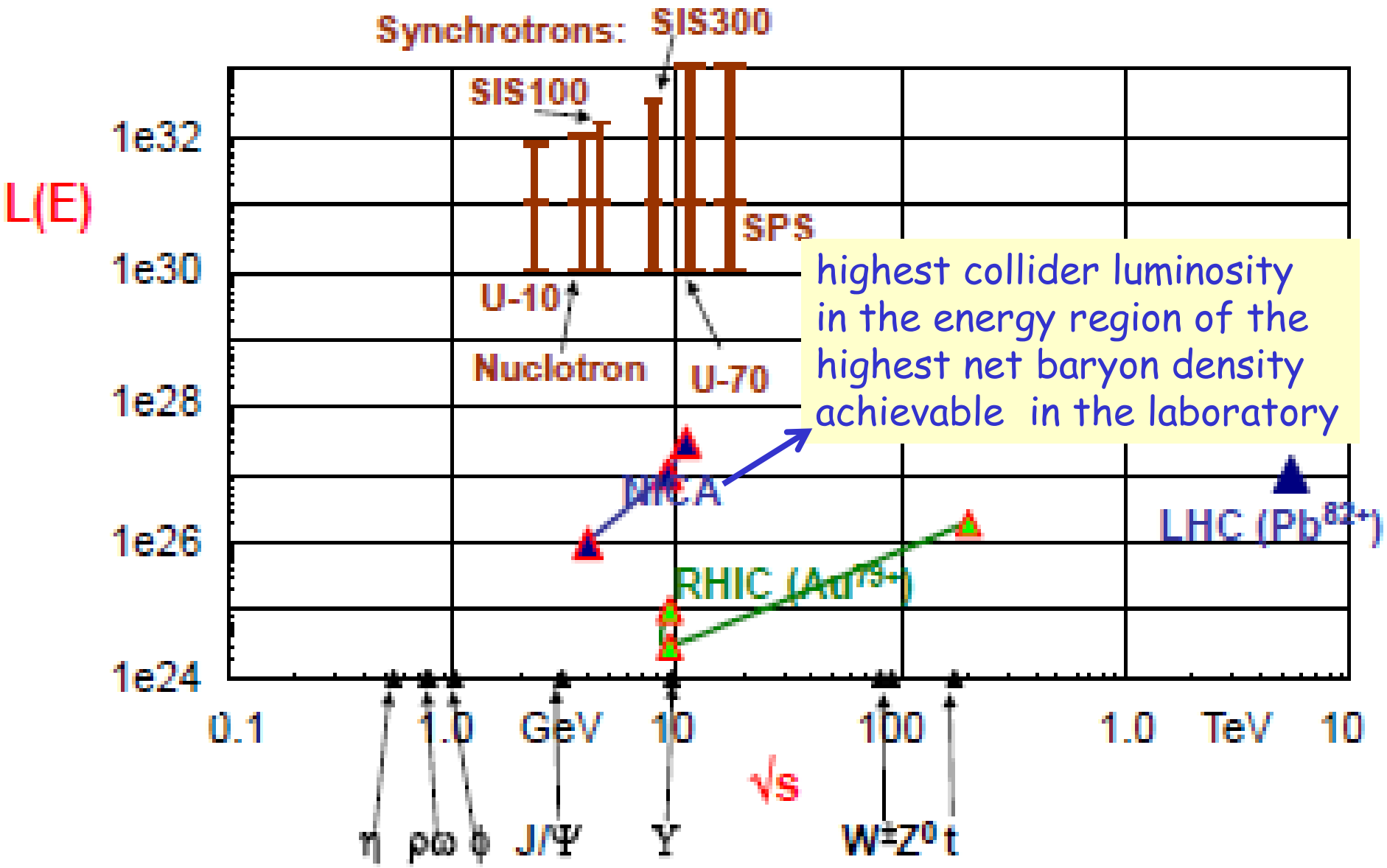
$\sqrt{s_{NN}}$ = 4 ÷ 11.0 GeV/n

Average luminosity
$10^{27} sm^2 s^{-1}$ (!!!) Au x Au

The flagship program of JINR & primary objective of the LHEP

Project status: special talks by G. Trubnikov (Nuclotron-M)
and V. Kekelidze (NICA/MPD)

Ion Colliders & Synchrotrons: Luminosity vs Energy (√s)



Nuclotron-M: Main results of the 41st run (25 Feb. - 25 March 2010)

For the first time at Nuclotron!

Generated and accelerated ions with Z/A ratio ~1/3:

C (A=12, Z=4), and A>100 **Xe (A=124, Z=42)**

Xe beam was accelerated up to 1.5 GeV/u and slowly extracted at 570 MeV/u & 1 GeV/u

Main magnet
was inc
Next stage -
to 1.9 - 2T (
full-scale commissioning of the new power supply system)

Project Nuclotron-M is close to completion at the end of 2010

Upgrade of the cryogenic supply system towards NICA. Additional screw compressor for helium (6000m^3/h) from HELIIMASH (~1MEuro).

Theoretical support

Interdisciplinary character of research at BLTP is particularly important for BLTP participation in the **physics program of the NICA/MPD project**.

High energy heavy ion physics is an area of research where coherent use of the methods of quantum field theory, models of QCD vacuum structure, condensed matter and nuclear physics is required.

Phase structure of strongly interacting matter: Study of in-medium properties of hadrons and nuclear matter equation of state, including a search for possible signs of deconfinement and chiral symmetry restoration phase transitions and QCD critical endpoint.

Spin physics at NICA: Extraction of unknown (poor known) PDF, Spin effects in baryon, meson and photon productions, Spin effects in various exclusive reactions, Diffractive processes, Helicity amplitudes & double spin asymmetries in elastic reactions, Spectroscopy of quarkonia.

The work of JINR theorists related to hadron physics under extreme conditions and lattice QCD calculations (in connection with experimental programs of the NICA/MPD project at JINR, current and future experiments at RHIC, LHC and FAIR is being intensified.

Viscosity behaviour near Tc

A.Khvorostukhin, V.Toneev, D.Voskresensky, Nucl. Phys. A845 (2010)

It is shown that near the critical temperature Tc from the HADRONIC side the ratio of shear viscosity to entropy density within the "Scaled Hadron Masses and Couplings model" reaches the lower AdS/CFT bound, predicted for the quark phase. This is in accord with the almost ideal liquid behavior of the new state of matter observed at RHIC.

Solid line: results for the relativistic mean-field model with σ-field dependent hadron masses and couplings, the **Scaled Hadron Masses and Couplings (SHMC)**

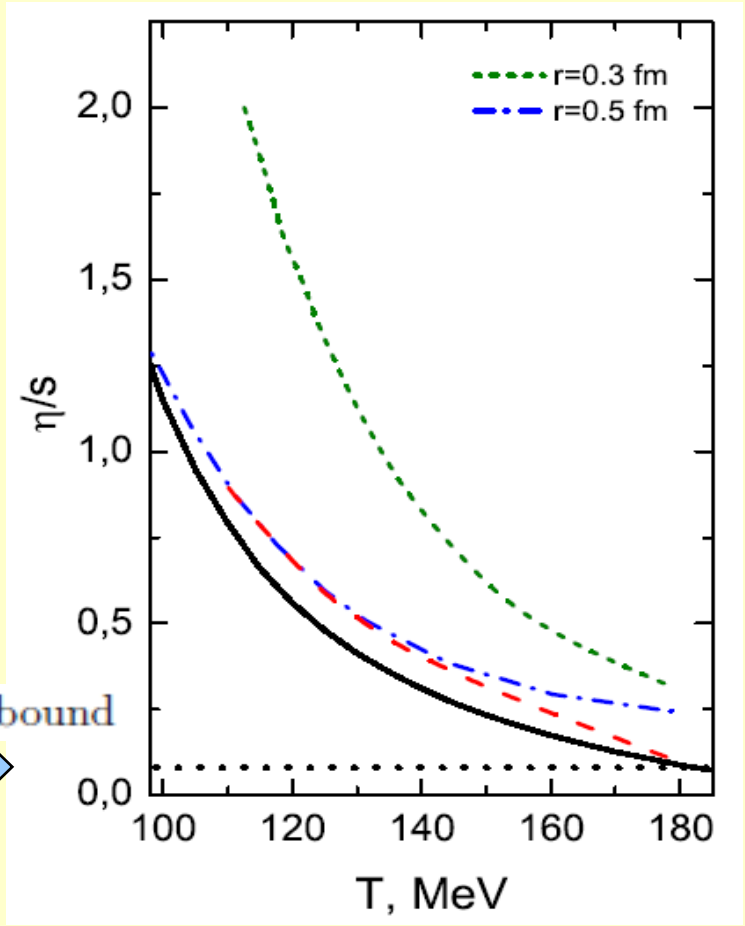
Excluded-volume hadron gas model:
M. Gorenstein et al., Phys. Rev. **C77** (2008)

$$\eta = \frac{5}{64\sqrt{\pi}} \frac{\sqrt{mT}}{r^2}$$

Resonance gas with Hagedorn states:
J.Naronha-Hostler et al., Phys. Rev. Lett. **103** (2009)

lower AdS/CFT bound

$\eta/s = 1/4\pi$

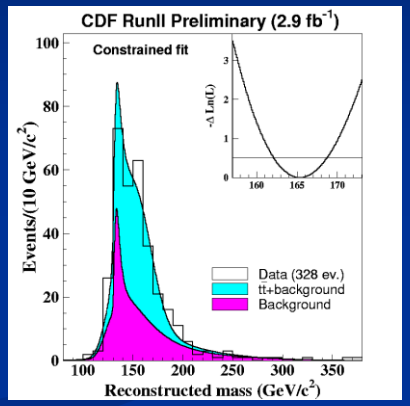


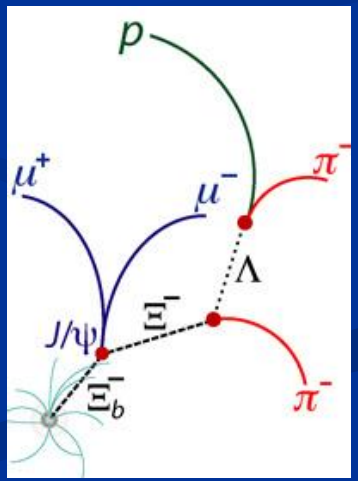
JINR participation in world particle physics centers: FERMILAB

Tevatron p p-bar 2 TeV collider at FNAL

JINR participatation in CDF and D0

Standard Model and SuperSymmetry





JINR physicists participate in the experiments at the Tevatron collider. With detector CDF and D0 they have already obtained physics results of fundamental importance. Experience gained by these scientists under the Tevatron program will be extremely important for their future participation in similar experiments at the LHC.

Dominant JINR contribution to CDF for 2009-2010 years :

1. Maintenance of the JINR created hardware & software to perform efficient CDF operation:

   scintillation counters of the μ- trigger CDF

   preshower for E.M. calorimter

   Si - vertex trigger for secondary vertex recognition

2. JINR participation in the data analyses focuses on the physics frontier

   High precision top mass measurement were marked by 2009 JINR award and reach for CDF combined value now with 0.7% precision

   Mtop = 173.13 $\pm$ 0.67 (stat) $\pm$ 0.95 (syst) GeV/c^2

JINR in D0 experiment at FNAL

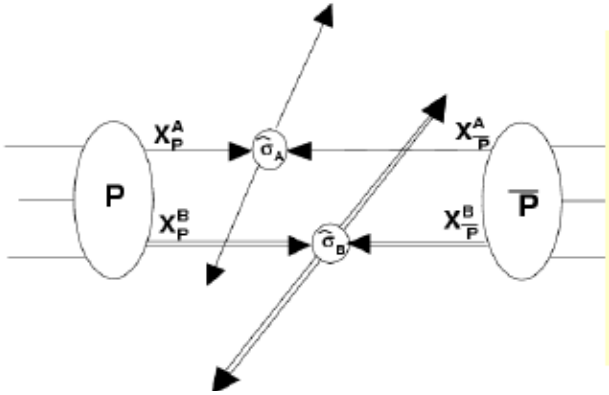
Phys. Rev. D **81**, 052012 (2010)

Double parton scattering in $\gamma + 3$ jet events

New: DØ Collab., prelim., DØ note 5910-CONF

$\mathcal{L} = 1.0$ fb^{-1}

- Complementary information about proton structure: Spatial distribution of partons
  $\Rightarrow$ Possible parton-parton correlations. Impact on PDF's?
- Background in signal events (important for rare processes)
- Especially important at high luminosities (additional $p\bar{p}$ interactions)

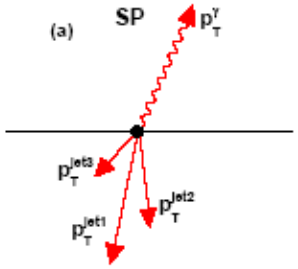


Event selection:

- $60 < p_T^{\gamma} < 80$ GeV
- Isolated
- $p_T^{\text{1st jet}} > 25$ GeV
- $p_T^{\text{2nd, 3rd jet}} > 15$ GeV

Main background:

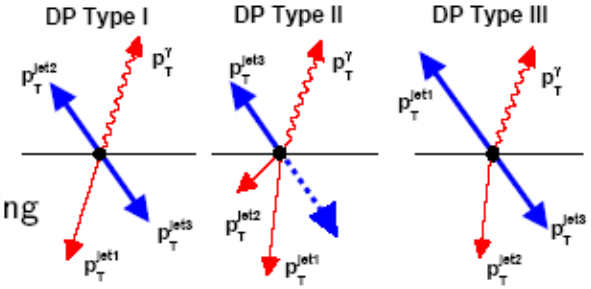
Single parton scattering



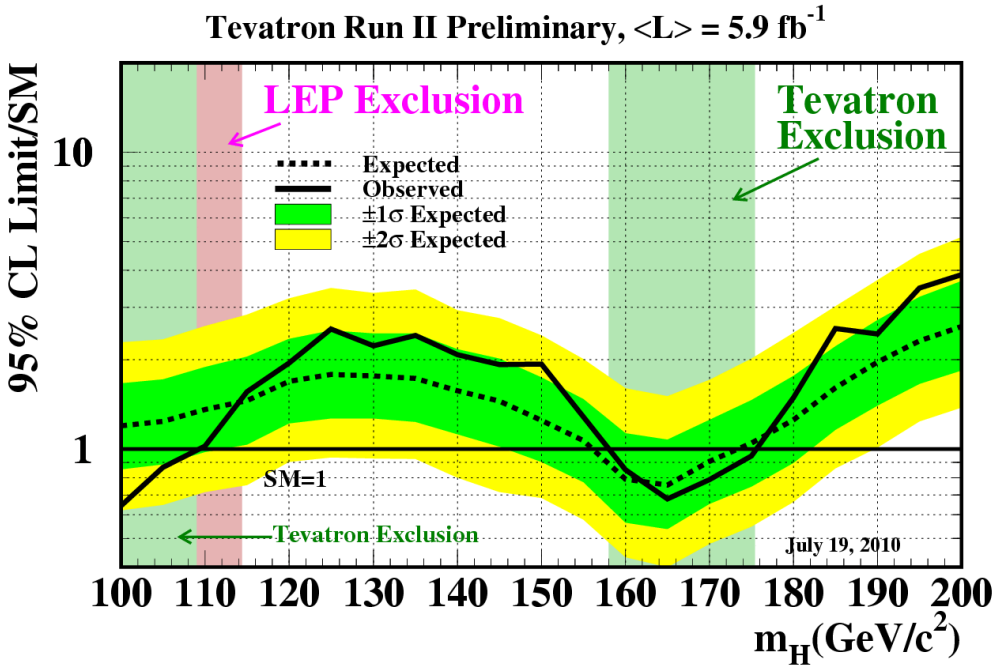
***Fraction of DP events** is measured in the interval **23-47%** and must be taken into account as a noticeable background in searches for the New Physics.*

Signal:

Double parton scattering



SM Higgs search or/and exclusion



Combined CDF&D0 95% C.L. exclusion for SM Higgs masses of 158-175 GeV/c^2 and 100-109 GeV/c^2

Fermiab Physics Advisory Committee at August 27, 2010 strongly endorses the extension of the Tevatron run for three years during 2011–2014.

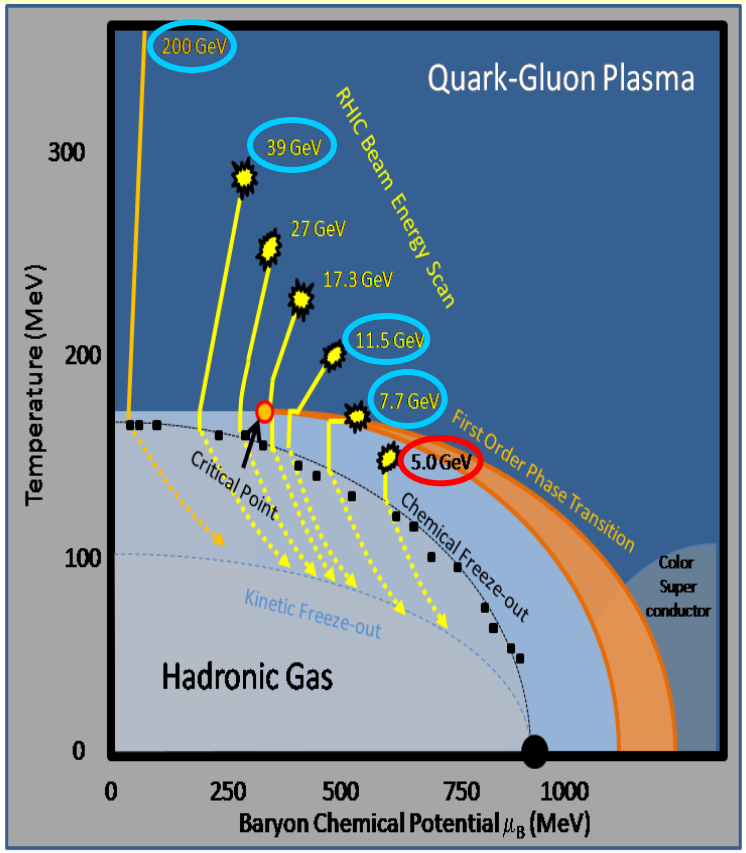
JINR participation in world particle physics centers: BNL

Physics of heavy ion interactions at RHIC in BNL:

- a new extremely dense form of matter,
- quite possibly the postulated quark-gluon plasma,
- RHIC luminosity upgrade is foreseen
- energy scan started
- Plans to build up the electron-nucleus collider eRHIC.

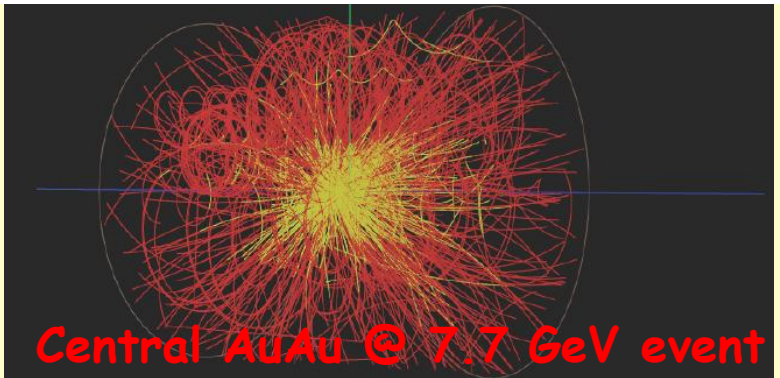
JINR participation: STAR experiment →
the unique experience for NICA heavy ion and spin programs

Energy Scan Program at RHIC
STAR experiment



- Search for phase transition and critical point
  - Elliptic & directed flow
  - Azimuthally-sensitive femtoscopy
  - Fluctuation measures
- Search for turn-off of new phenomena seen at higher RHIC energies
  - Constituent-quark-number scaling of *v2*
  - Hadron suppression in central collisions
  - Ridge
  - Local parity violation

STAR Note SN0493
STAR: Phys. Rev. C 81, 024911 (2010)



AuAu Beam Energy Scan Program at RHIC

Experimental Study of the QCD Phase Diagram
and Search for the Critical Point

STAR Run 10 Plan & Results (October 5 - June 8)

Beam Energy	μ_B (MeV)	Event Rate	8-hr Days/1M Events	Events proposed	8-hr days proposed
5	550	0.8	45	(100 k)	5
7.7	410	3	11	5M	56
11.5	300	10	3.7	5M	19
17.3	230	33	1.1	15M	16
27	150	92	0.4	33M	12
39	110	190	0.2	24M	5

Expected range of CP: μ_B = 150-600 MeV

Beam energy $\sqrt{s}$, GeV	Events proposed (Million)	Events taken (Million)
5.5	0.1	Not done
7.7	5	5
11.5	5	~7.8
17.3	15	Not done
27	33	Not done
39	24	~250
62.4	5	~170
200		~800

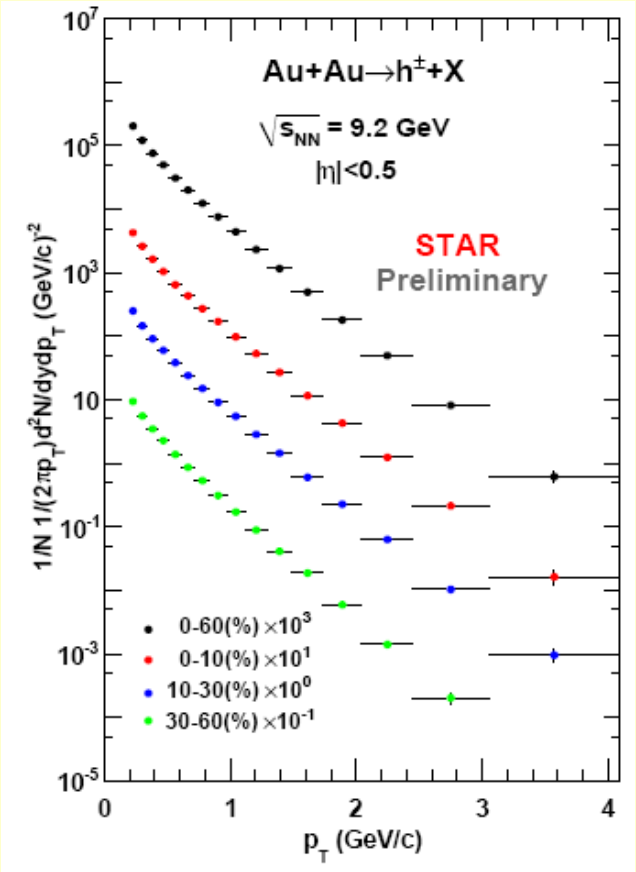
The goals significantly exceeded for some data points

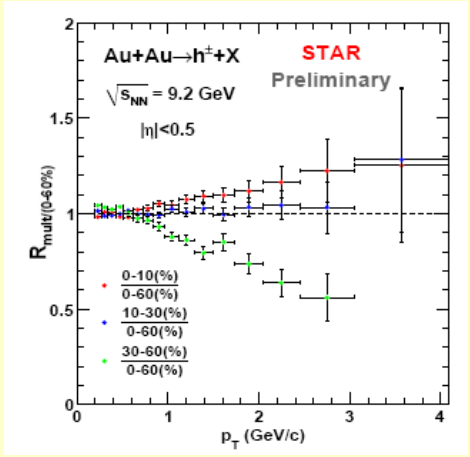
STAR Note SN0493
STAR: Phys. Rev. C 81, 024911 (2010)

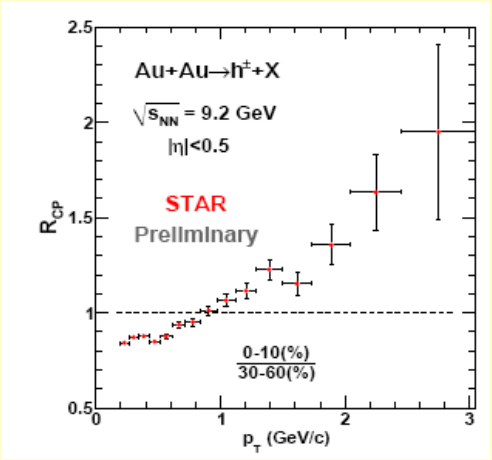
High-p_T Spectra of Charged Hadrons in Au+Au Collisions at $\sqrt{s_{NN}}$ = 9.2 GeV in STAR

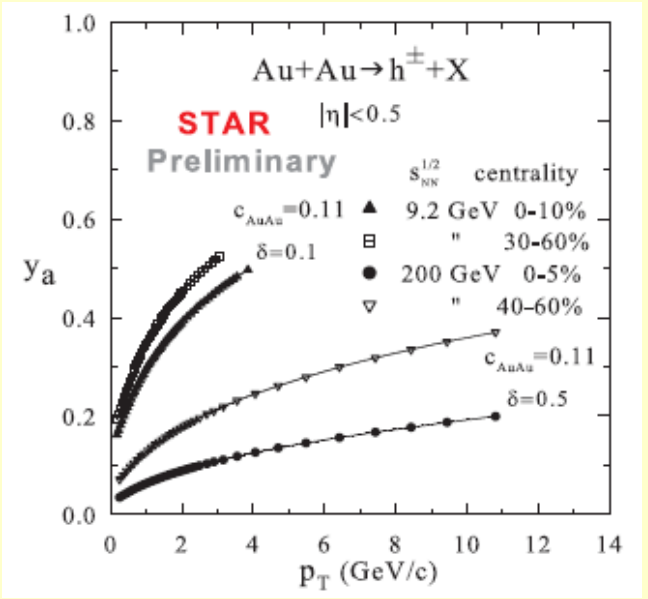
JINR group results presented at the Plenary session of RAS

STAR nucl-ex/1004.5582v1









Data sample (2008)
~ 4000 events

- High-p_T spectra vs. centrality
- R_{CP} ratio vs. p_T
- Energy loss vs. p_T, $dN/d\eta$

JINR participation in world particle physics centers: CERN SPS & PS

NA49 -> NA61

Study of hadron production in hadron-nucleus and nucleus-nucleus collisions at the CERN SPS.

COMPASS

Traditional interest of Dubna particle physicists to nucleon spin physics. To complete the picture of the nucleon spin structure, there are plans to study Drell-Yan processes and deeply virtual Compton scattering.

DIRAC

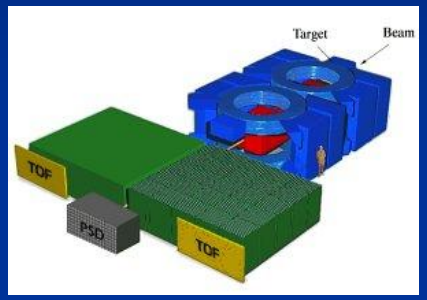
Pionnium and Kπ-atom lifetime measurements

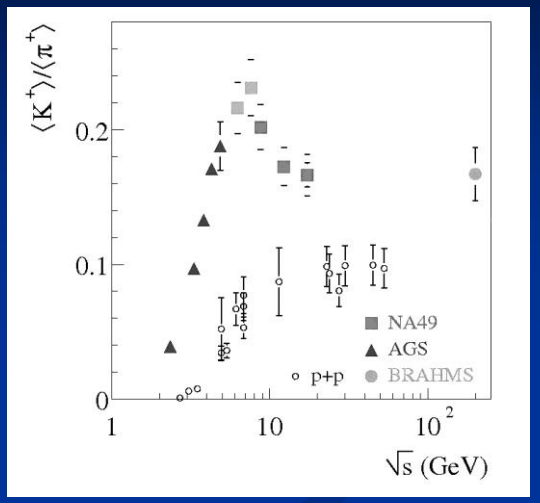
NA48 -> NA62

From a study of CPV in neutral kaon decays to a study of ultra-rare decay of the charged kaon into a charged pion and two neutrinos.

NA61 : Interaction of Nuclei at 20-158 GeV

- continues a series of experiments at the NA49 -> Horn effect ? deconfinement
- interactions of nuclei of various size (A) at the energies 20-158 GeV/n
- phase transition from hadron matter to quark-gluon plasma and mixed phase
- hadron production for neutrino and cosmic ray experiments
- JINR team will participate in this program for the period preceding the start-up of the NICA accelerator complex.

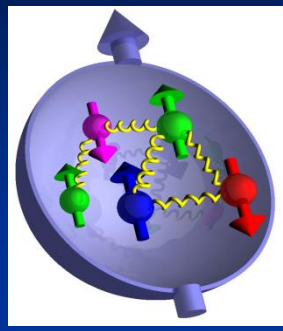




The beam run started in July 2010 with data taking in p+C interactions at 31 GeV/c which are extremely important for the neutrino oscillation experiment T2K in Japan.

Presently, the p+p data taking of high statistics at top SPS energy of 158 GeV started. It is of great importance to be used as reference data for better understanding of nucleus-nucleus reactions.

COMPASS : HADRON SPIN STRUCTURE



Despite efforts of HERMES and COMPASS the Spin crisis still with us

COMPASS goals in 2010-2016:

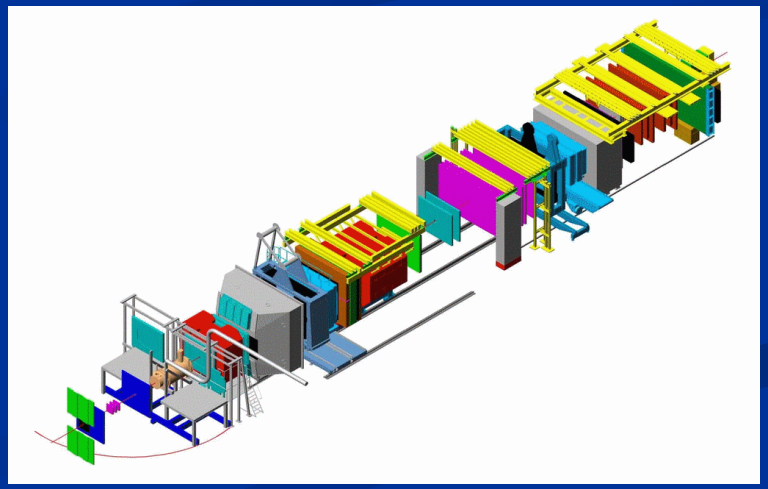
study of the transverse structure of the nucleon;

continued study of the longitudinal spin structure of the nucleon ($\Delta G/G$, parton distribution functions etc.);

measurement of exclusive processes with the aim of obtaining data on Generalized Parton Distributions;

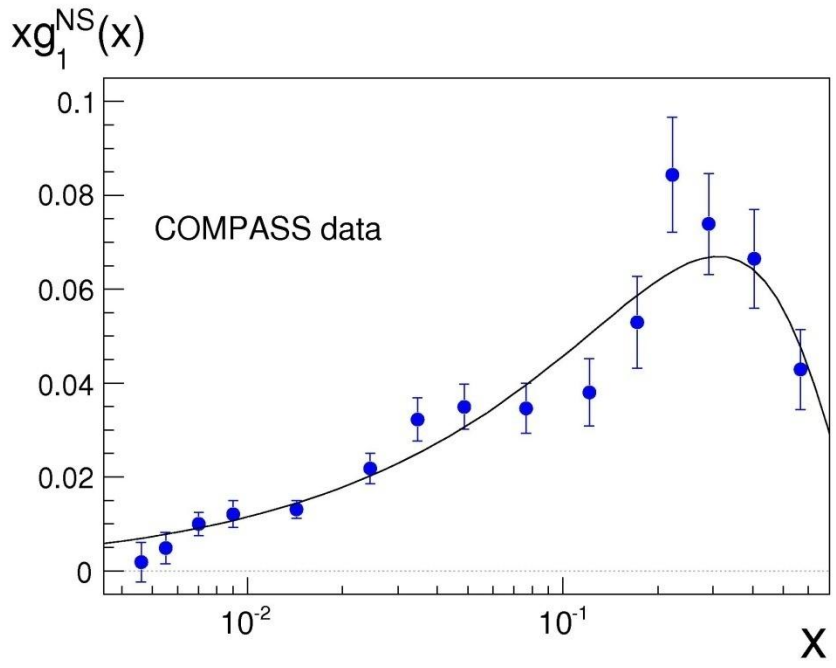
measurement of the MMTDY processes.

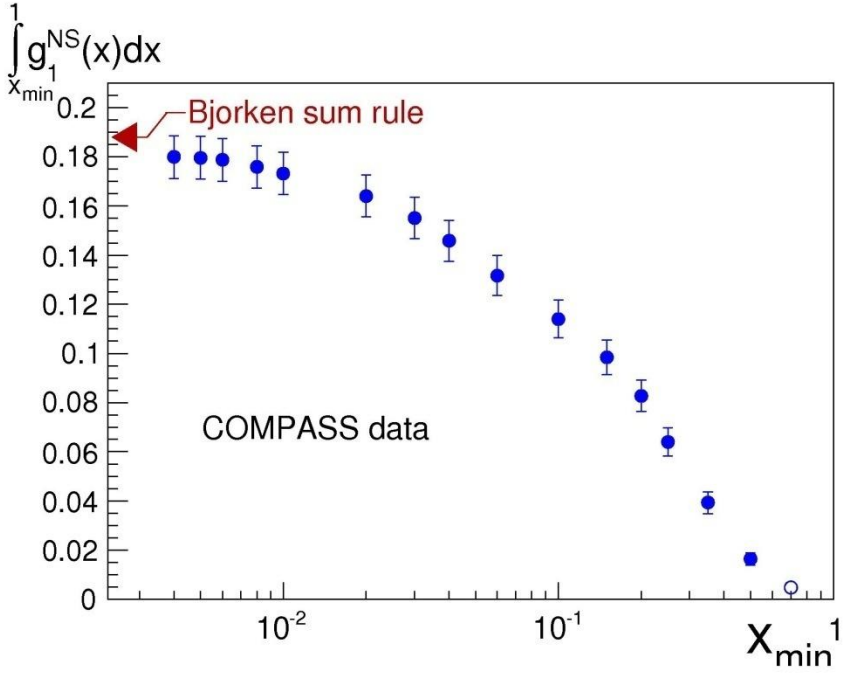
$$\tfrac{1}{2} = \tfrac{1}{2}\Delta\Sigma + \Delta G + \langle L_z \rangle$$



The Spin-dependent Structure Function of the Proton & Neutron SF's g_1 and a Test of the Bjorken Sum Rule

(PLB 690 (2010) 466-472)





$$\Gamma_1^{NS}(Q^2) = \frac{1}{6}\left|\frac{g_A}{g_V}\right| C_1^{NS}(Q^2) \qquad g_1^{NS}(x,Q^2) = g_1^p(x,Q^2) - g_1^n(x,Q^2)$$

$$|g_A/g_V| = 1.28 \pm 0.07(\text{stat.}) \pm 0.10(\text{syst.})$$

from neutron β decay

$$|g_A/g_V| = 1.269$$

DIRAC experiment

The preliminary value of the $\pi\pi$ atoms lifetime

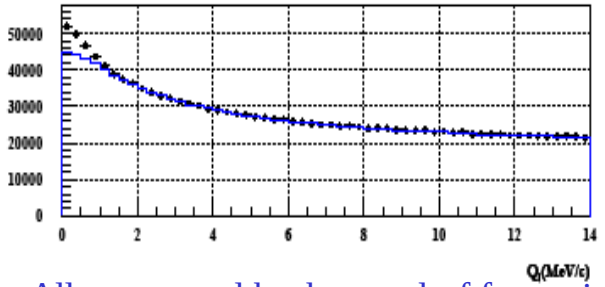
$$\tau = \left(2.98\ ^{+0.18}_{-0.17}\Big|_{\text{stat}}\ ^{+0.19}_{-0.17}\Big|_{\text{syst}}\right)\times 10^{-15}\text{s} = \left(2.98\ ^{+0.26}_{-0.24}\Big|_{\text{tot}}\right)\times 10^{-15}\text{s}$$

This value is in a good agreement with prediction of CHPT

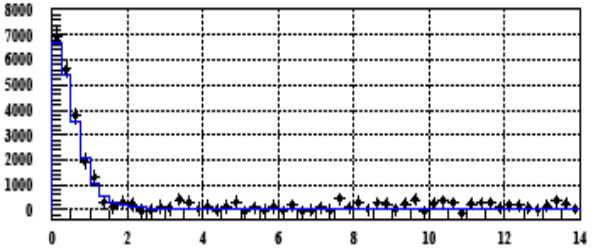
$$\tau = (2.9 \pm 0.1)\times 10^{-15}\text{s}$$

The accuracy in the $\pi\pi$ atom lifetime is better than 10% declared for that stage of the experiment.

Q_L distribution of observed $\pi\pi$ pairs



All events and background of free pairs



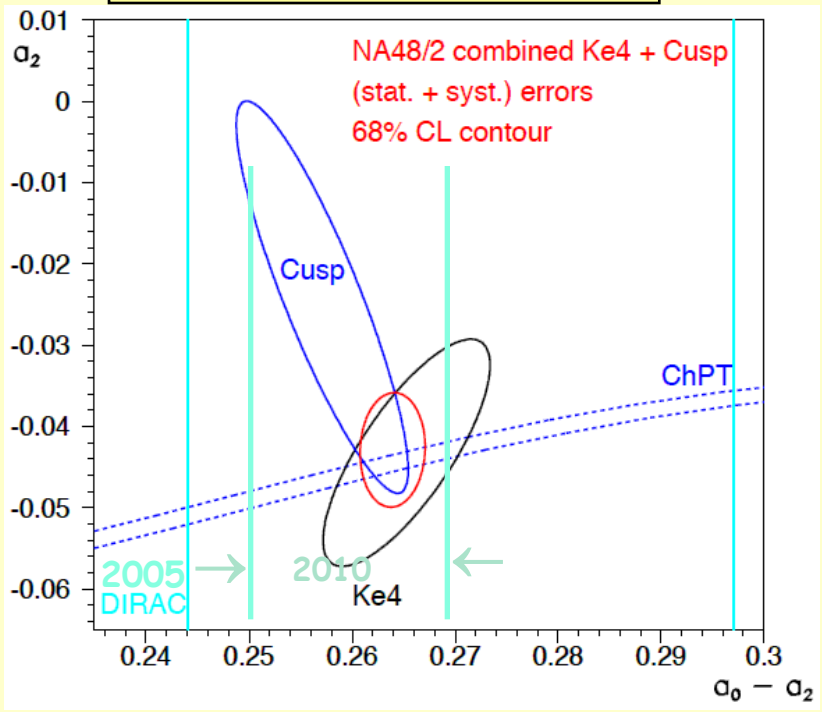
$\pi\pi$ atomic pairs after background subtraction and MC simulation

The corresponding difference of the s-wave $\pi\pi$ scattering lengths:

$$|a_0 - a_2| = 0.261 \pm 0.008|_{\text{stat}} \pm 0.008|_{\text{syst}} = 0.261 \pm 3\%|_{\text{stat}} \pm 3\%|_{\text{syst}} = 0.261 \pm 4.2\%|_{\text{tot}}$$

NA-48/NA-62 (a_0, a_2) measurements

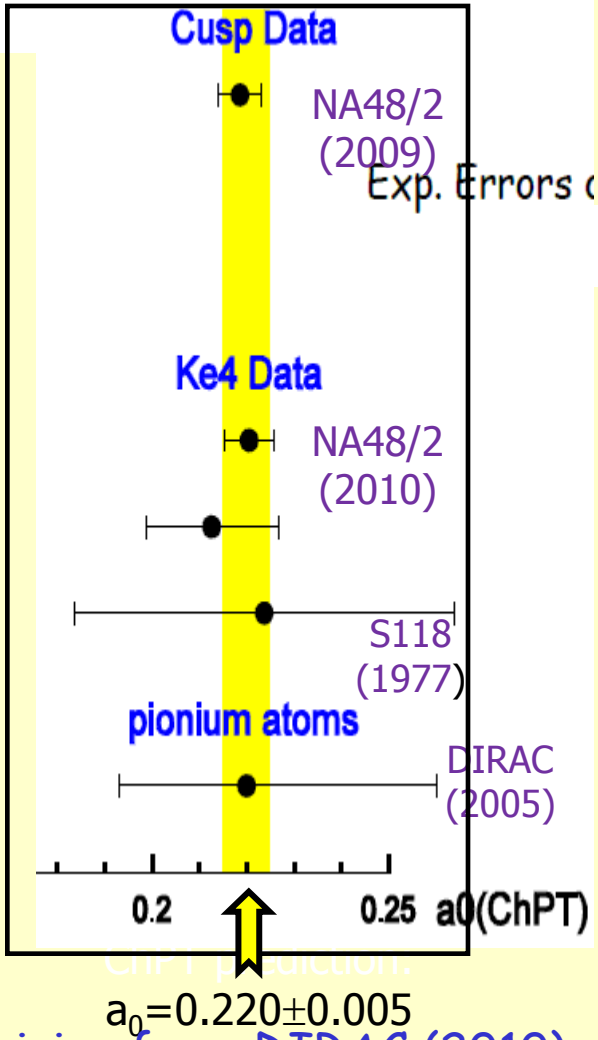
Combination of Ke4+Cusp NA48 measurements



NA48/2: two independent measurements with different samples, theory and systematics. For the first time, good sensitivity to a_2.

$$
\begin{aligned}
a_0 &= 0.2210 \pm 0.0047_{\text{stat}} \pm 0.0040_{\text{syst}} \\
a_2 &= -0.0429 \pm 0.0044_{\text{stat}} \pm 0.0028_{\text{syst}} \\
a_0 - a_2 &= 0.2639 \pm 0.0020_{\text{stat}} \pm 0.0015_{\text{syst}}
\end{aligned}
$$

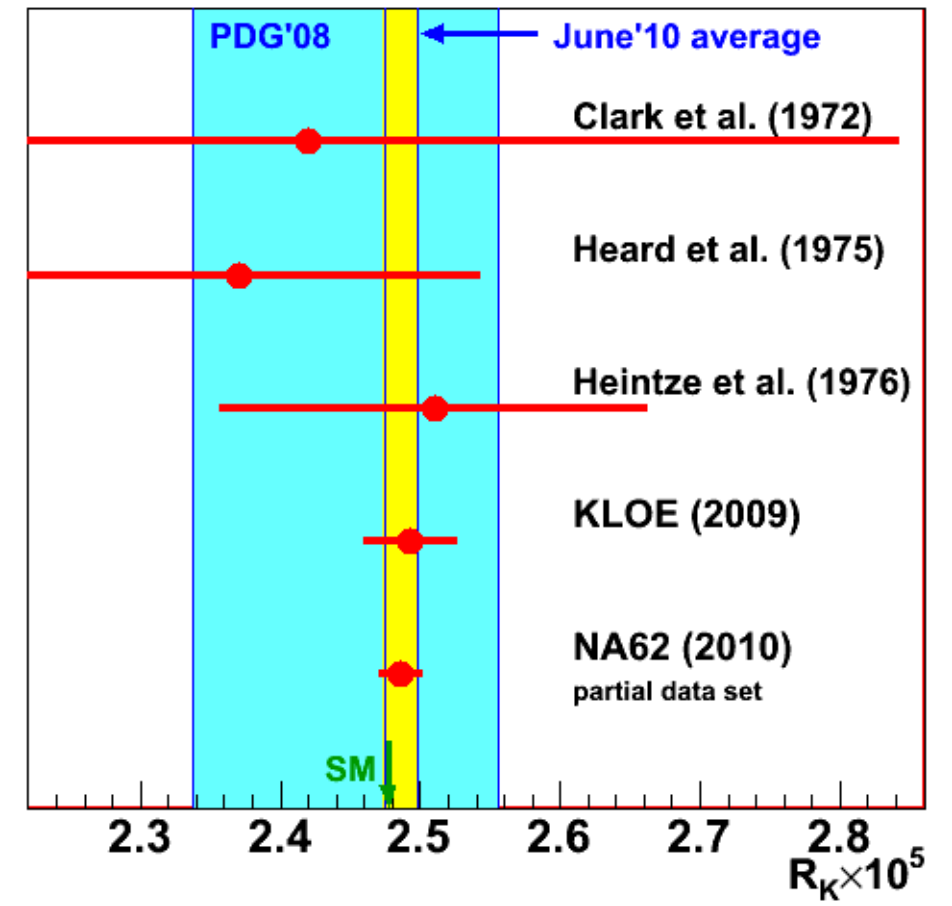
Measurements of a_0



a_0=0.220±0.005

→4x worse precision from DIRAC (2010) - obtained however with very small Δ-theor

NA-48/NA-62 R_K=K→eν/K→μν: world average



World average	$\delta R_K \times 10^5$	Precision
March 2009	2.467±0.024	0.97%
June 2010	2.487±0.012	0.48%

←twice better after NA-48/62 measurement

HARP experiment

2009 - 2010 results

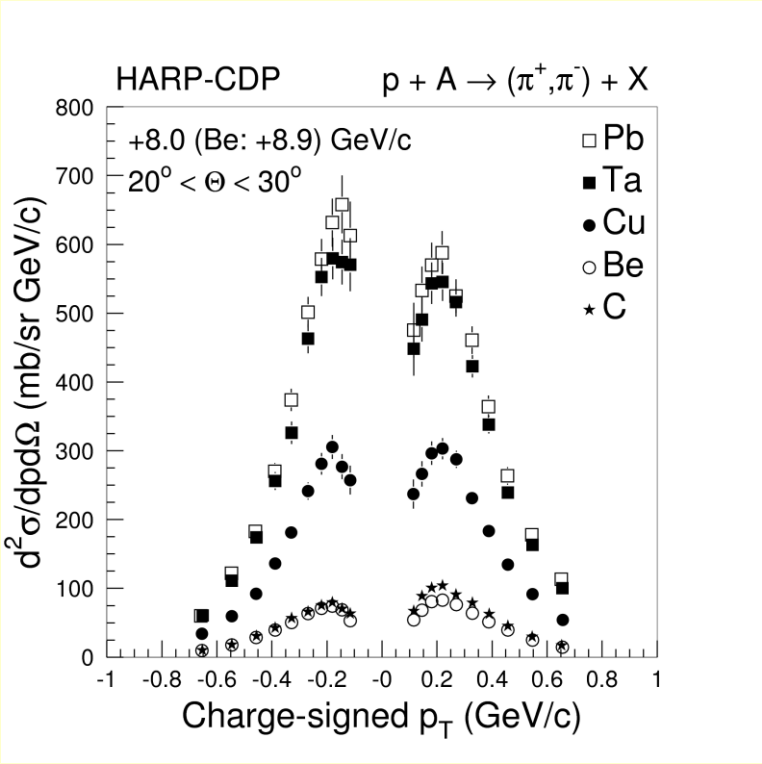
Double-differential inclusive cross-sections of pion, proton and deuteron production on targets:

- Cu
- Pb
- C

The comparison with simulations by the Monte Carlo tool kits:

- FLUKA
- Geant4

HARP reports 2010



1. ICHEP 2010, Hadroproduction on nuclei: inclusive cross-sections and parametrizations.

2. ICHEP 2010, Hadroproduction in FLUKA and Geant4:
   agreement with data?

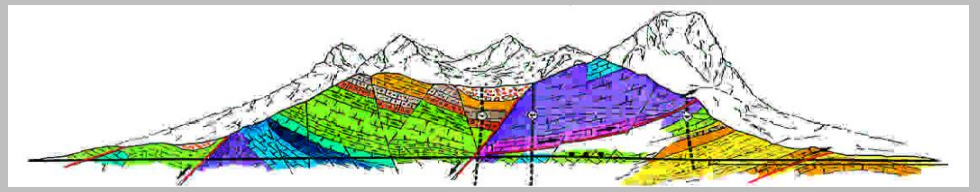
3. ICHEP 2010, Is there "LSND anomaly"?

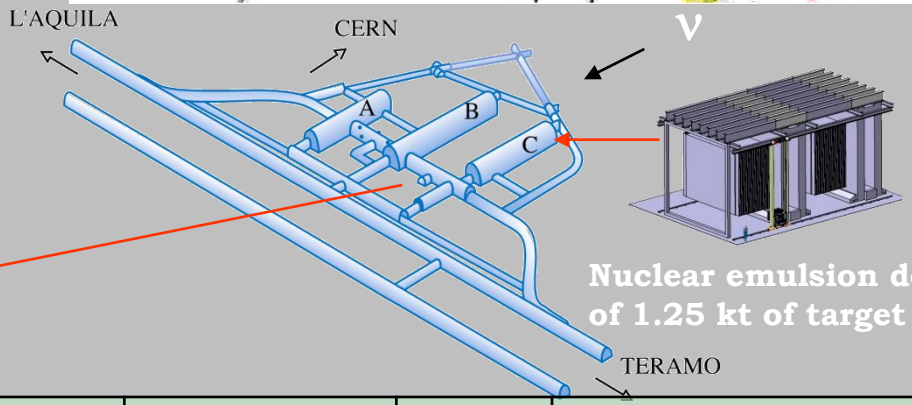
4. CERN Joint EP/PP Seminars, Recent results from HARP-CDP and the "LSND anomaly".

Neutrino physics

OPERA experiment:

Direct search for $\nu_\mu \rightarrow \nu_\tau$ oscillations
ν oscill. predicted in JINR by B. Pontecorvo





Nuclear emulsion detector of 1.25 kt of target mass

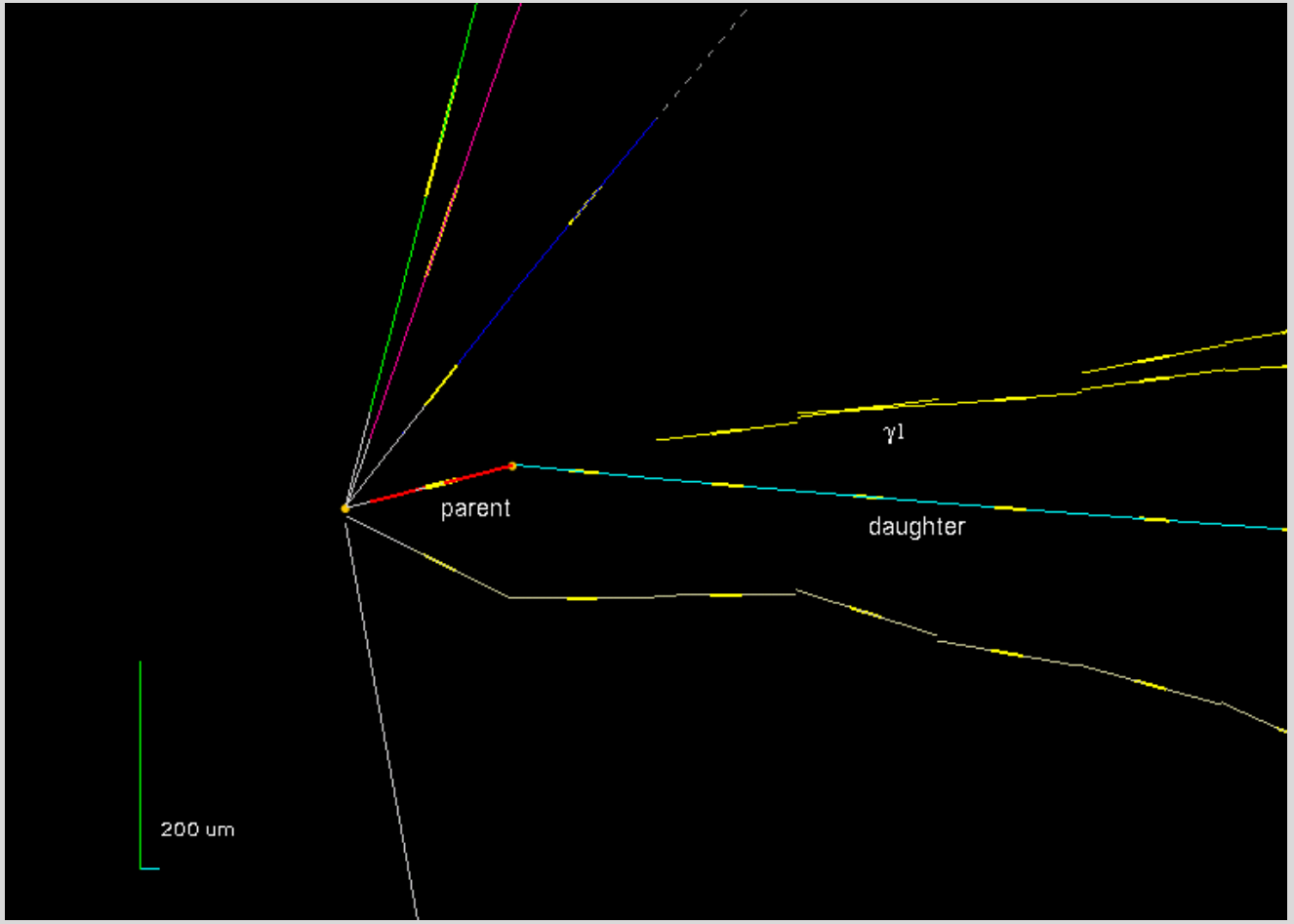
2007	0.082x10^{19} pot	38 int.	Commissioning
2008	**1.78x10^{19}** pot	1663 int.	First physics run
2009	**3.52x10^{19}** pot up to now (Sep 6th)	3693 int.	Extrapolation is **3.5x10^{19}** pot at end of the run. (~**2 tau expected** in total)
2010	1.74x 10^{19} (july)	1856 int	
Nominal	4.5 x 10^{19} pot x 5 year. total 22.5 x 10^{19} pot		

Experiment is taking data now

Expected produced interactions (22.5x10^{19}):
~25400 ν_μ CC + NC
~170 $\nu_e + \overline{\nu}_e$ CC
~125 ν_τ CC ($\Delta m^2 = 2.5 \times 10^{-3}$ eV^2)

~10 tau decays are expected to be observed
Less than 1 background after 5 years running

Observation of a first ν_τ candidate event in the OPERA experiment



- First candidate of ν_τ event was registered recently ($\tau \rightarrow$ 1-prong hadron decay topology)

- This result is an important step towards the long awaited discovery of neutrino oscillations in direct appearance mode (in next 3-4 years)

Neutrino physics

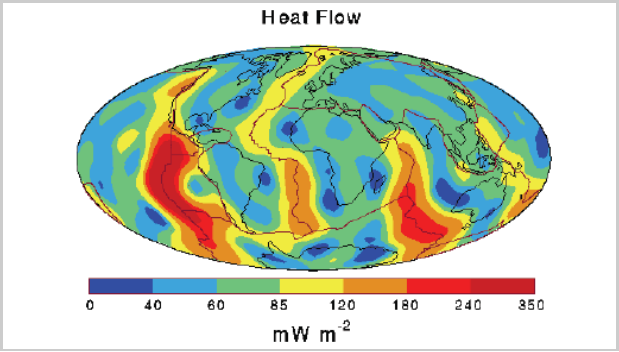
BOREXINO experiment:

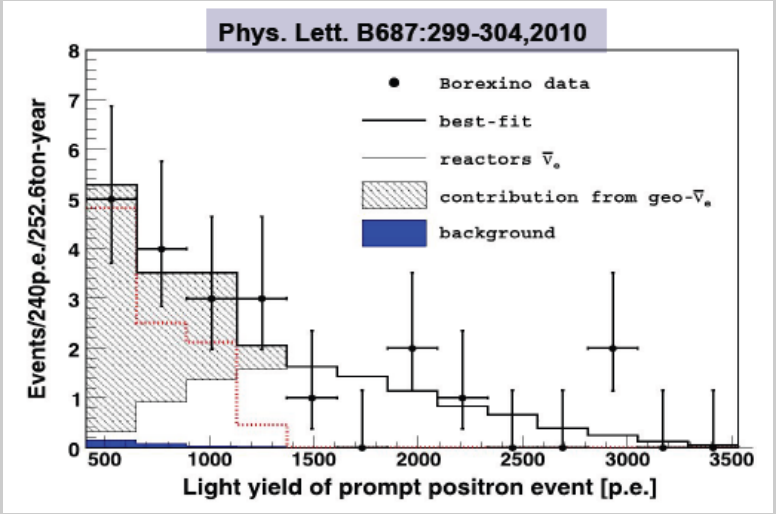
Solar neutrino flux measurement:

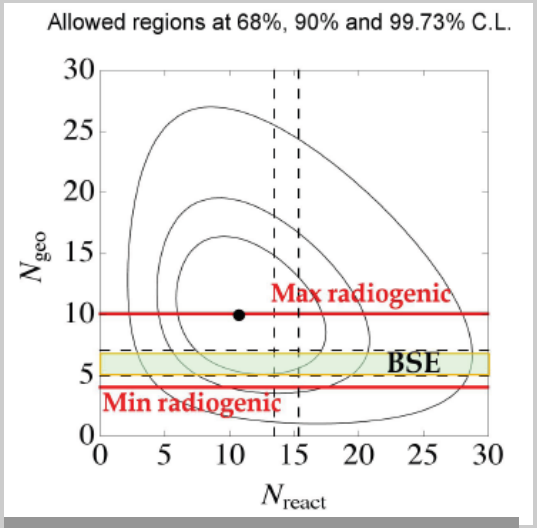
measured to 10% in agreement with MSW theory of ν-oscillations in the matter.

To be improved to 5% in future running.

2010: detection of geoneutrinos with Borexino

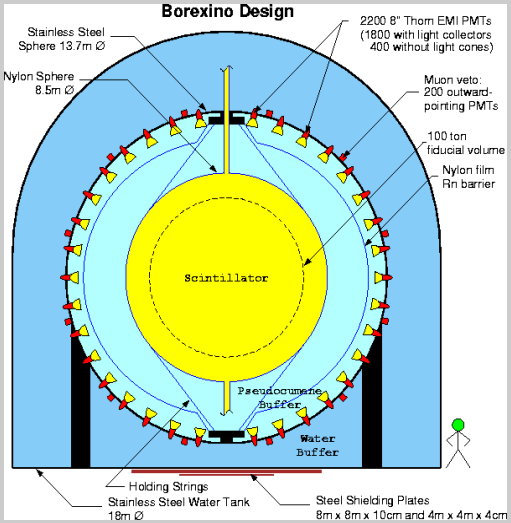






$$N_{geo} = 9.9^{+4.1}_{-3.4}$$

$$N_{react} = 10.7^{+4.3}_{-3.4}$$



More than 100 reactors contribute, closest at ~1000 km

Null hypothesis rejected at 99.997% C.L.

e^+e^- collider physics

The first BES-III results

Luminosity of 3.2 x10^{32} $cm^{-2}s^{-1}$ achieved in May 2009

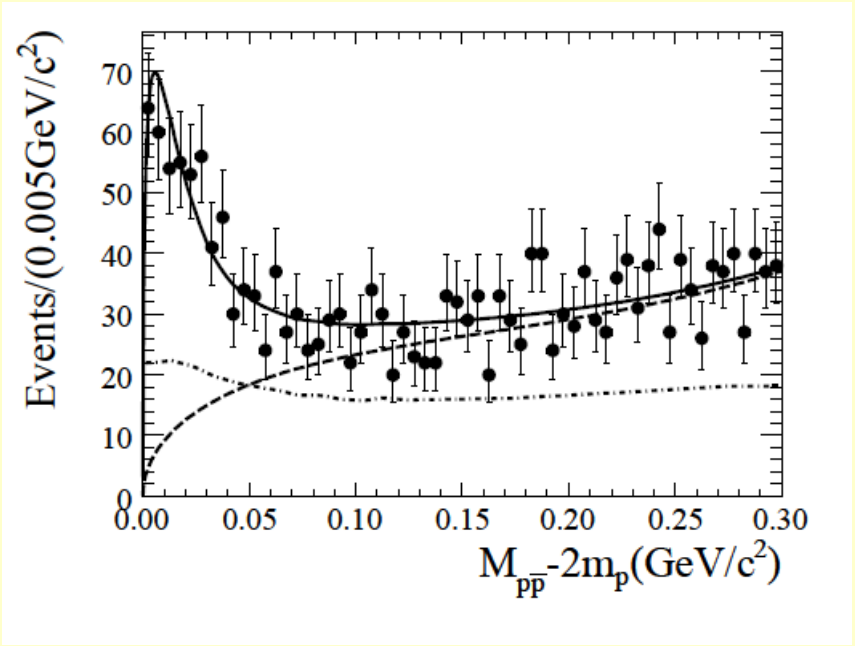
Chinese Phys.C, 2010, 34(4): 421-426

Phys.Rev.Lett.104, 132002 (2010)

Phys.Rev.D81,052005(2010)

With ~110M of ψ' decays and ~220M J/ψ decays:

- pp threshold enhancement, reported by BES-II, is confirmed in $J/\psi\to\gamma pp$ decay. This effect is absent in $\psi'\to\gamma pp$ decay.



- The first measurement of $\mathbf{Br(\Psi'\to\pi^0 h_c)}$, $\mathbf{Br(h_c\to\gamma\eta_c)}$ and $\mathbf{\Gamma(h_c)}$. Improved measurement of $\mathbf{h_c}$ mass
- The world best measurement of $\chi_{c0}\to\pi^0\pi^0$, $\eta\eta$, $\chi_{c2}\to\pi^0\pi^0$,$\eta\eta$ branshing ratios
- The first observation of decays $\chi_{cJ}\to\phi\phi$, $\omega\omega$, $\omega\phi$

Participation in the LHC projects

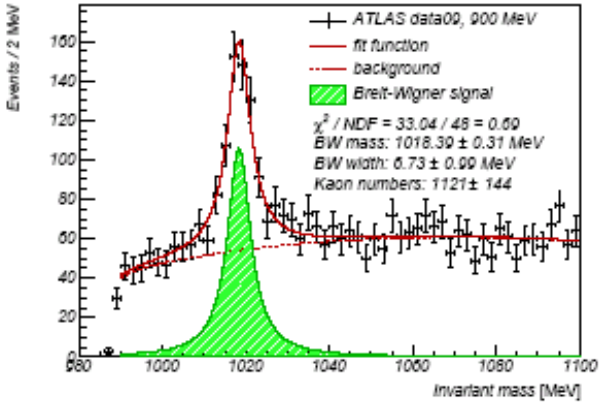
JINR teams fulfilled all obligations in the LHC projects: ATLAS, CMS & ALICE.

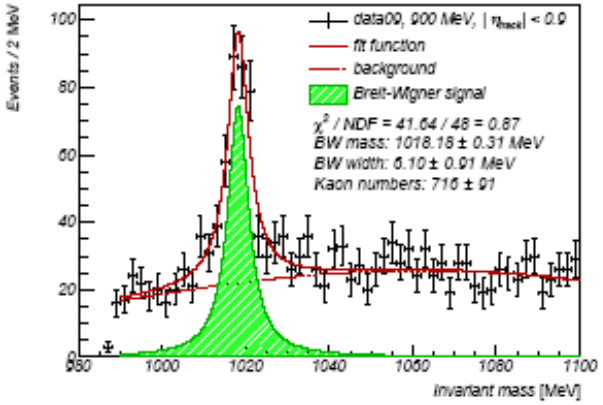
Now actively exploiting excellent physics capabilities offered by the LHC data.

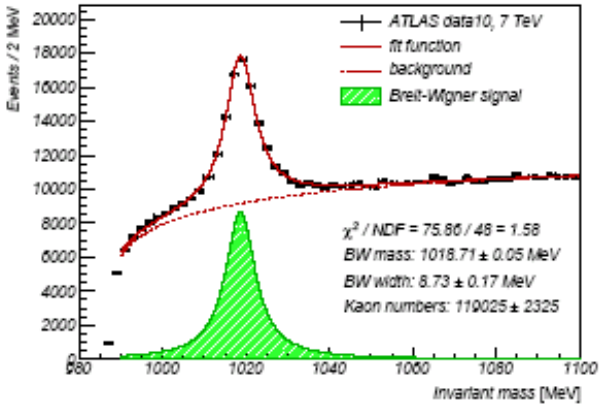
ATLAS JINR participation

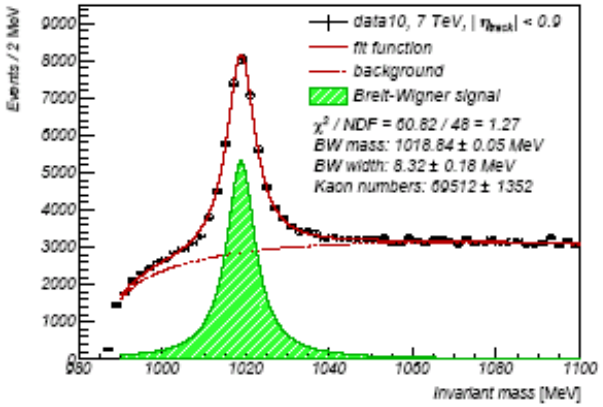
ATLAS grid at LIT CCIC used!

Among the first JINR physics results is the Φ-meson observation









Φ(1020) is correctly reconstructed using the data from Tile and LiqAr calorimeters

ATLAS Notes under preparation by JINR:

on ρ(770)-meson observation with ATLAS at 7 TeV,
on φ(1020)-meson observation with ATLAS at 7 TeV,
on VHM minimum-bias study at 900 GeV,
on jet cross section measurements …

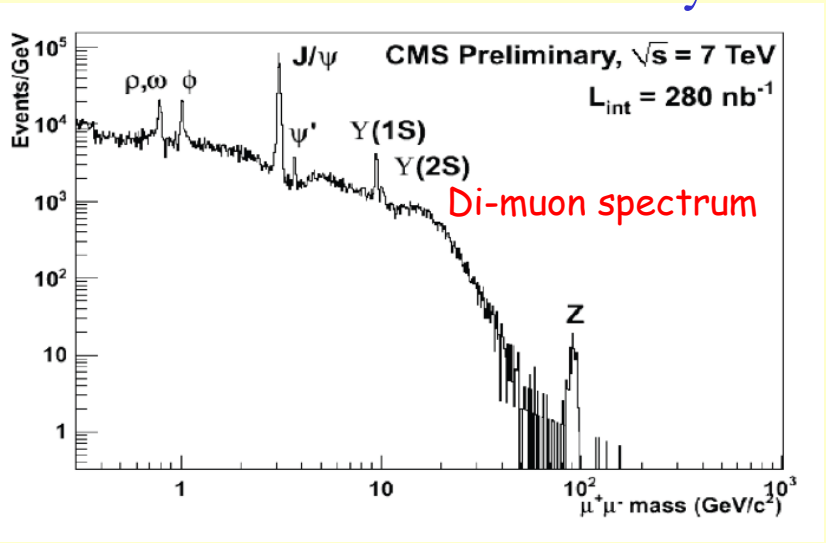
ATLAS Higgs workshop at JINR (Dubna, May 11-13)
Decided to become regular Dubna meeting

C.Potter said: "Thanks again to the local organizers and everybody who participated in this *(by any standard)* successful workshop."

CMS 2010 Results: Standard Model Rediscovery

JINR GRID Computing Facilities based on the special RDMS Tier-1 centre at CERN and Tier-2 in Dubna (associated priority with Exotica and Muon Working Group) provide fast access to data, data can be analyzed rapidly:

- all CMS data are processed and analyzed within a week after recording
- dimuon analysis is performed by JINR group in one-two days (!!!)

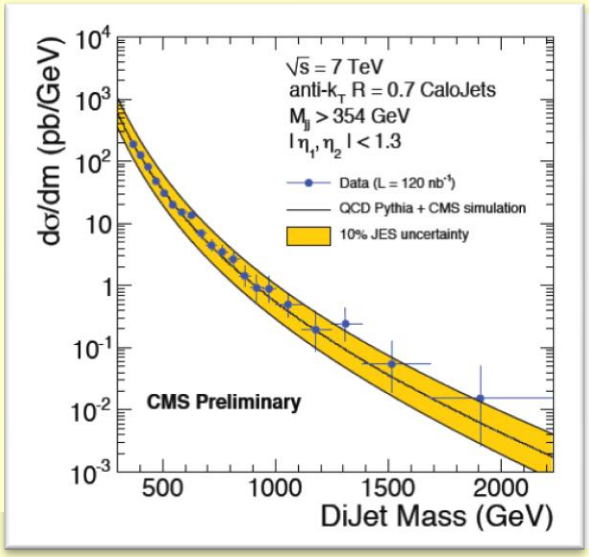


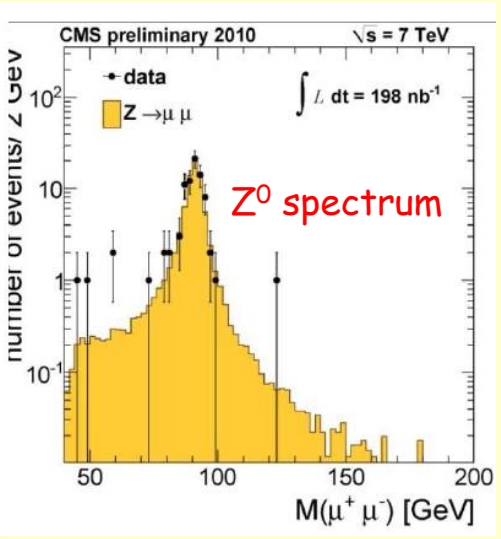
details @ http://cmsinfo.jinr.ru/

In 2010 Standard Model was rediscoverd @ 7 TeV ⇒

- measurements of muons and jets: good agreement Data and MC
- particle identification: pions, hyperons, J/ψ, Υ, W, Z

Good reconstruction performance of CMS software was shown





CMS Results were published in 5 papers and over 60 CMS Physics Analysis papers, 12 CMS ICHEP reports.

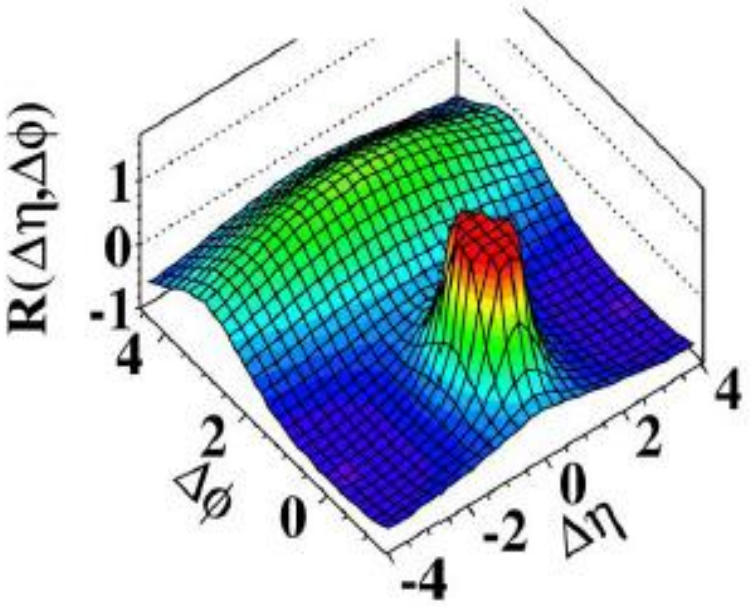
JINR Participation in CMS. I.Golutvin, A.Zarubin

First observation of the ridge structure in pp collisions at CMS

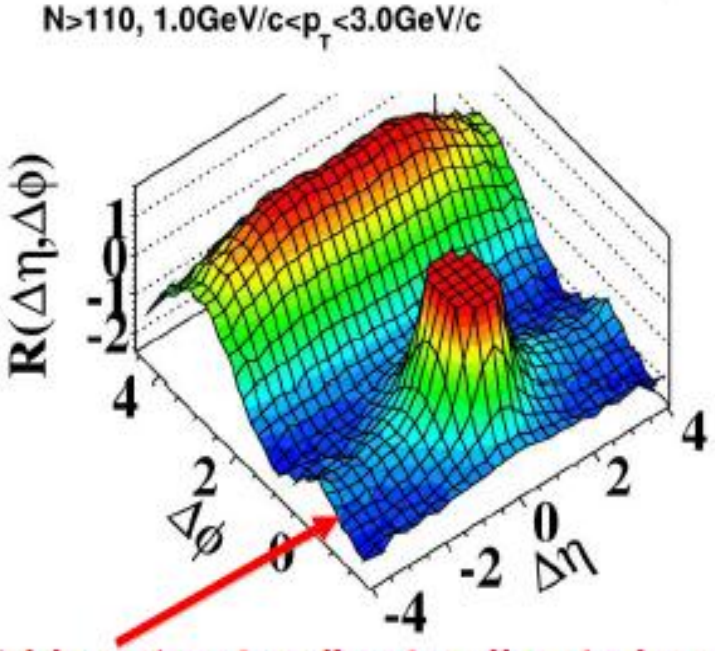
The new feature is clearly seen for large rapidity differences $2 < |\Delta\eta| < 4.8$ in events with N ~ 90 or higher. The enhancement is most evident in the intermediate p_T range $1 < p_T < 3$ GeV/c.

$$R(\Delta\eta,\Delta\varphi) = \left\langle (N-1)\left(\frac{S_N(\Delta\eta,\Delta\varphi)}{B_N(\Delta\eta,\Delta\varphi)} - 1\right)\right\rangle_N$$

MinBias, 1.0GeV/c<p_T<3.0GeV/c



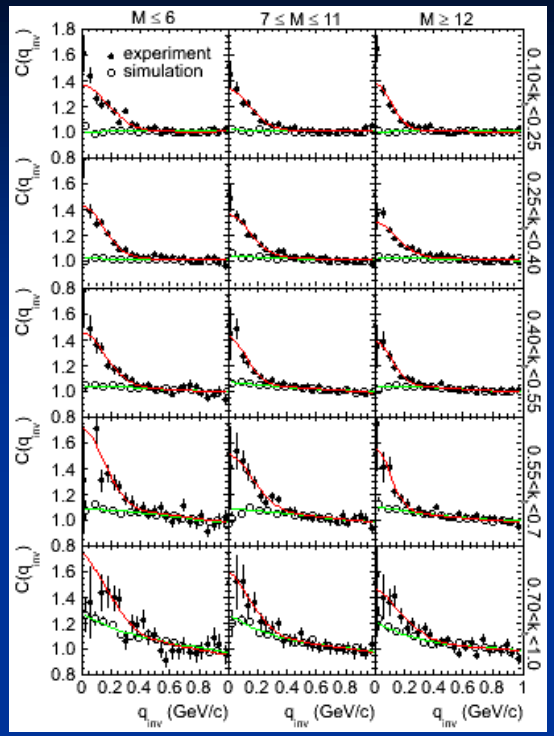
N>110, 1.0GeV/c<p_T<3.0GeV/c

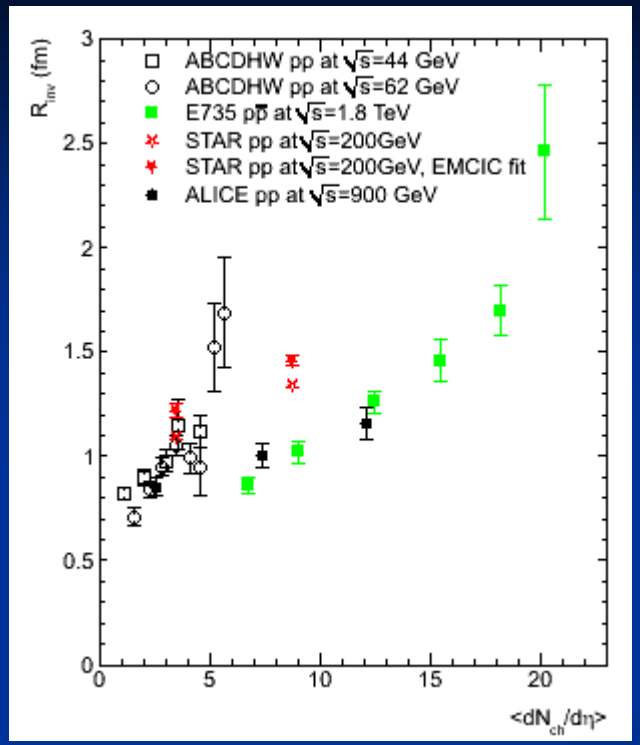


New "ridge structure" extending to large $\Delta\eta$ at $\Delta\phi \sim 0$

This is the first observation of such a long-range, near-side feature in two-particle correlation functions in pp or $p\bar{p}$ collisions.

ALICE

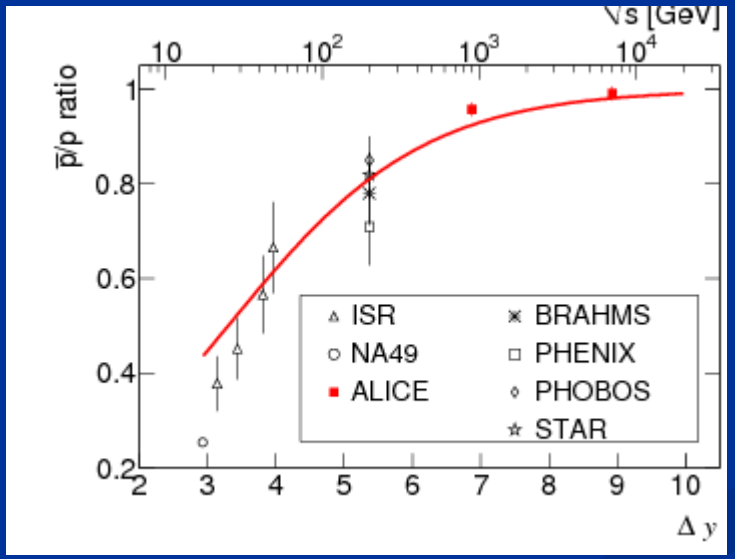




"Two-pion Bose-Einstein correlation in pp collisions at 900 GeV".

The correlation radius increases with event multiplicity like in AA collisions.

Similar result obtained by CMS: PRL 105 (2010) 032001



"Midrapidity antiproton-to-proton ratios in pp collisions at 900 GeV and 7 TeV".

Described well by Pomeron exchange, i.e with a standard model of baryon transport, thus setting tight limits on any additional contributions to baryon number transfer over large rapidity gaps (e.g. string junction)

Supporting activities

- IT & Telecommunications

  JINR Central Information and Computing Complex – JINR grid-site

- Theoretical physics

JINR Central Information and Computing Complex -JINR-LCG2 grid-site

In 2010, the CICC performance equals 2800 kSI2K and the disk storage capacity 1068 TB

(Plans at the end of 2010 – 2500 kSI2K and 1200

WLCG - Tier-2 Accounting Report
January - August 2010
top 11 Tier2-sites from 133 worldwide;
JINR site is the 10th in this list

WLCG - Tier-2 site	Normalised CPU time [HEPSPEC06.Hours]
US-AGLT2	25180899
SE-SNIC-T2	19962804
FR-GRIF	18686029
FR-IN2P3-CC-T2	13077885
DE-DESY-HH	11475150
US-MWT2_UC	10933873
US-WT2	10545270
UKI-SCOTGRID-GLASGOW	8898037
US-UCSDT2	8154047
JINR-LCG2	8116787
CA-SCINET-T2	7352856

System of remote access in real time (SRART) for monitoring and quality assessment of data from the ATLAS at JINR

One of the most significant results of the team TDAQ ATLAS at LIT during the last few years was the participation in the development of the project TDAQ ATLAS at CERN. The system of remote access in real time (SRART) **for monitoring and quality assessment of data from the ATLAS at JINR was put in operation.**

At present the system of remote access in real time is debugged on real data of the ATLAS experiment.

The work was supported by the Federal Agency on Science and Innovations of Russia, state contract No. 02.514.11.4083

The JINR CMS Regional Operation Centre

- JINR ROC was founded
- Tested in 2009
  - ✓ in August-September during the cosmic test
  - ✓ in October CMS data analysis exercise
  - ✓ during first LHC Collisions at 0.9 and 2.36 TeV in November-December

- 30th March of 2010 JINR ROC took part actively in 7 TeV Media Events devoted the first collision at 7 TeV
- Since March of 2010 the centre has been involved in CMS operations at 3.5 TeV beams.

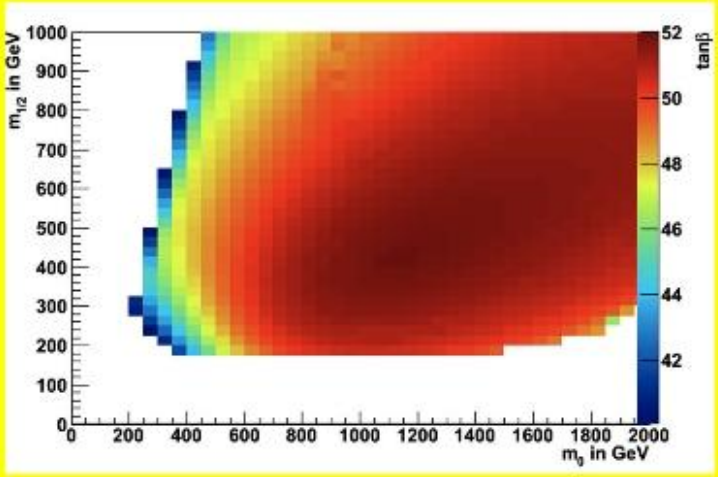
Theoretical support

Higgs Production at LHC

W.de Boer et al (Karlsruhe Uni), D.Kazakov (BLTP JINR)

Relic Density of DM

$$\Omega h^2 = 0.1131 \pm 0.0034$$

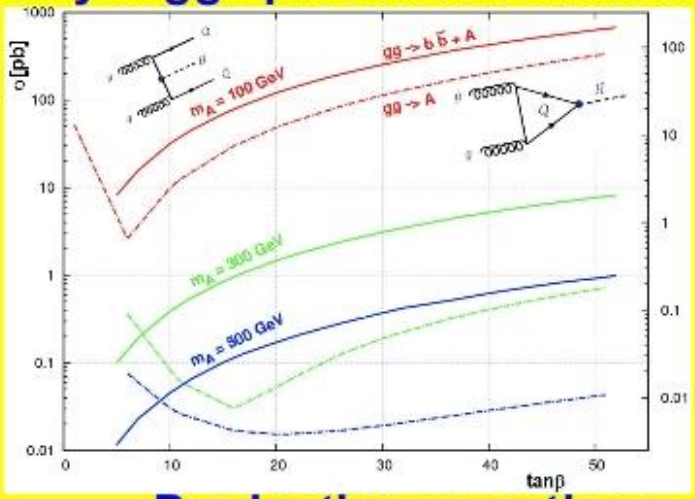


High

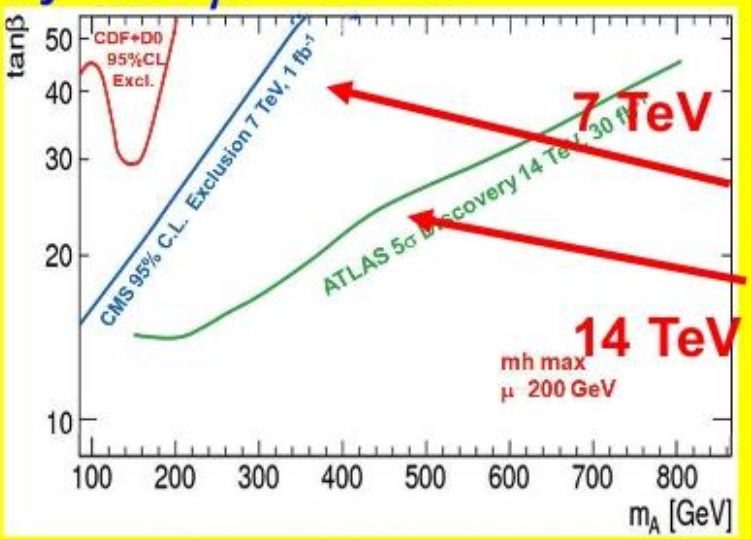
$$\tan\beta = \frac{v_2}{v_1} \sim \frac{m_{top}}{m_{bottom}}$$

preferable

Heavy Higgs production enhanced by $\tan^2\beta \sim 10^3$ **!**



Production x-sections



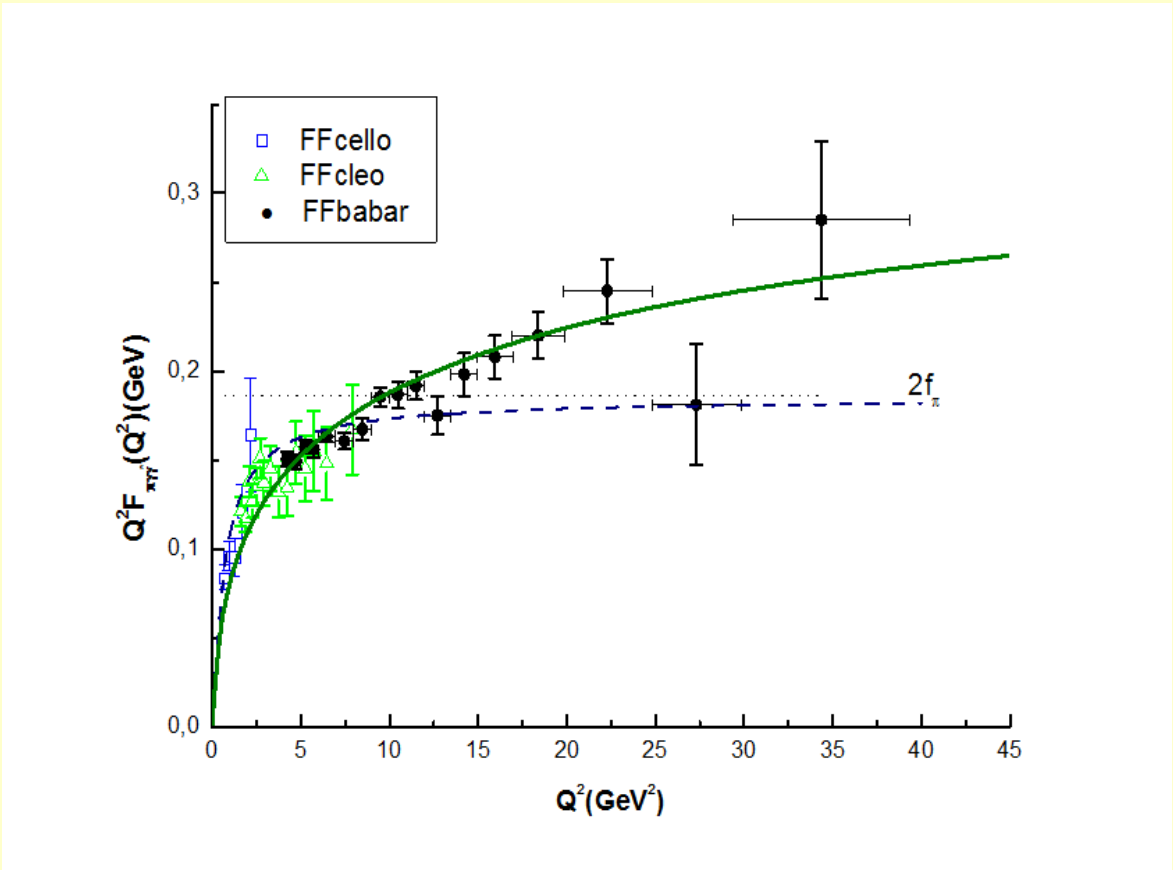
LHC reach

Gluonic component in pion and anomalous behavior of pion transition form factor at large momentum transfer

N. Kochelev, V. Vento, Phys. Rev. D 81 034009 (2010)

New surprising result from BaBar Collaboration for pion transition form factor:

High momentum behaviour (solid green line) contradicts to expectations of the QCD factorization!



It is demonstrated that gluonic contribution to the pion transition form factor induced by strong vacuum fluctuations of gluon fileds called instantons may be responsible for the BaBar effect.

Axial Anomaly and BaBar puzzle

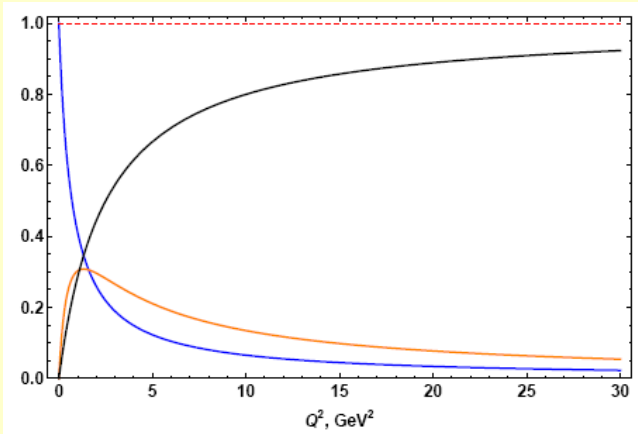
Ya.Klopot , O. Teryaev (JINR), A.Oganesian (ITEP)

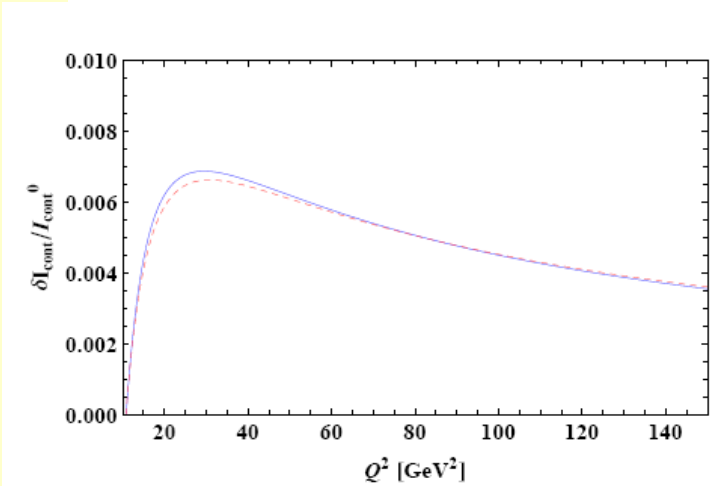
Talk by O. Teryaev at ICHEP2010

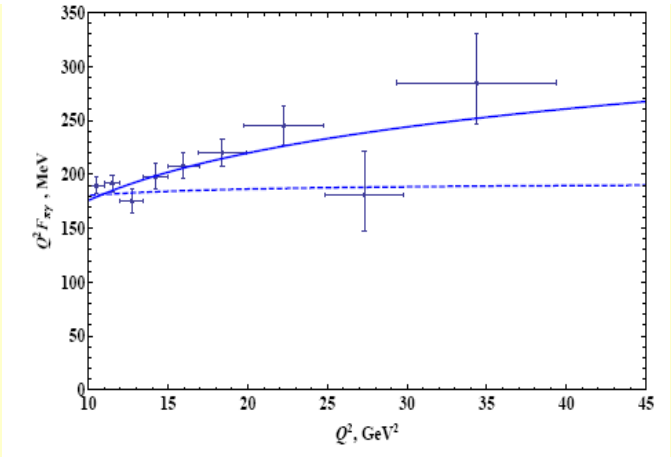
A new non-pertrubative QCD method is suggested allowing to apply QCD even in the absence of factorization .

- Application of exact Anomaly Sum Rule
- (J. Horejsi, O. Teryaev, 1994) to mesons: Anomaly as a collective effect of meson spectrum – continuum dominant at Q^2 ~15 GeV

Sum rule results in amplification of the small relative corrections to continuum leading to the large relative corrections to pion transition formfactor

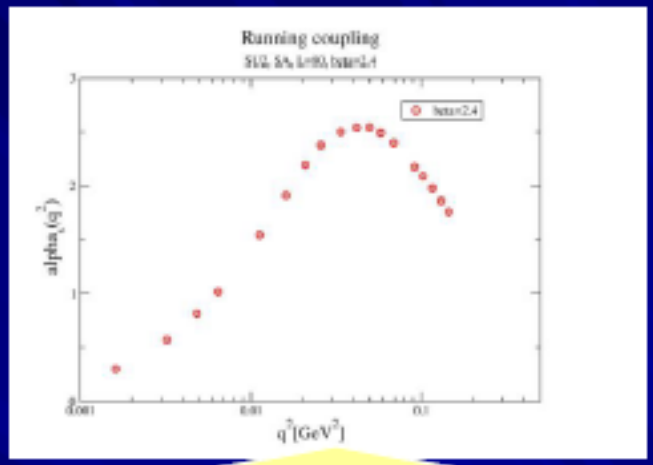






Gluon propagator in IR Gluodynamics: Study of Continuum Limit

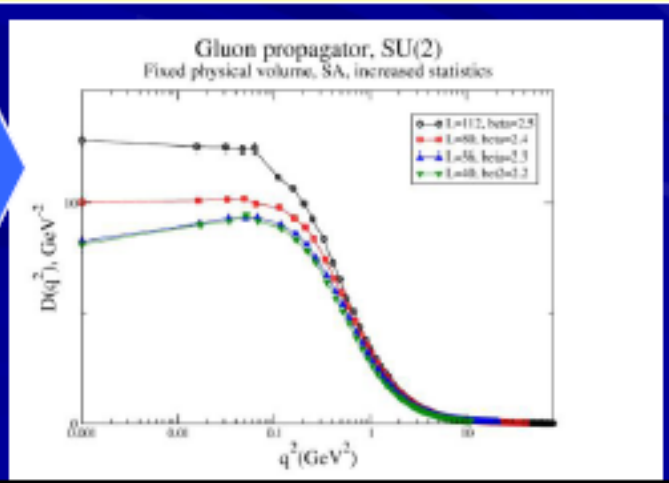
- Studies of Infrared Gluodynamics on parallel supercomputer in a lattice approach have been continued in collaboration with Prof. M.Mueller-Preussker, Dr.E.-M.Ilgenfritz (Humboldt University, Berlin) and Dr. A.Sternbeck(Regensburg Univ.). Extensive QCD simulations from first principles on huge lattices confirmed very interesting and even somewhat surprising results obtained by the authors earlier. Namely, that gluon and ghost propagators behave in accordance with the so-called "decoupling" solutions. Such a behaviour qualitatively differs from the well-known and commonly accepted "conformal" solution, first found in a semianalytical Dyson-Schwinger approach by Alkofer and Smekal.



It is remarkable that the behaviour of the running coupling constant (α_s) for decoupling solutions does not show any existence of the well-known "fixed-point" picture. Instead, α_s tends to zero for vanishing momenta ($q^2 \to 0$).

Some quite recent simulations dealt with the issue of approaching a continuum limit. With this purpose, simulations were performed on lattices with a various lattice volume ($V=L^4$, L is the linear extension given by a number of sites in each of 4 directions), but keeping physical volume ($V_{phys} = L^*a$, where "a" is the length of the lattice link) fixed with a good accuracy.

As a result, it has been found that one is already pretty close to the continuum limit, and the gluon propagator for small momenta unambigously demonstrates a clear plateau behaviour.



Oral talk at parallel session of ICHEP-2010, presented by I. Bogolubsky (JINR LIT)

ICHEP 2010 July 22-28, Paris

> 1000 participants from ~ 50 countries

20 physicists from JINR took part in the Conference!

6 oral contributions and a number of posters accepted – a good image of JINR!

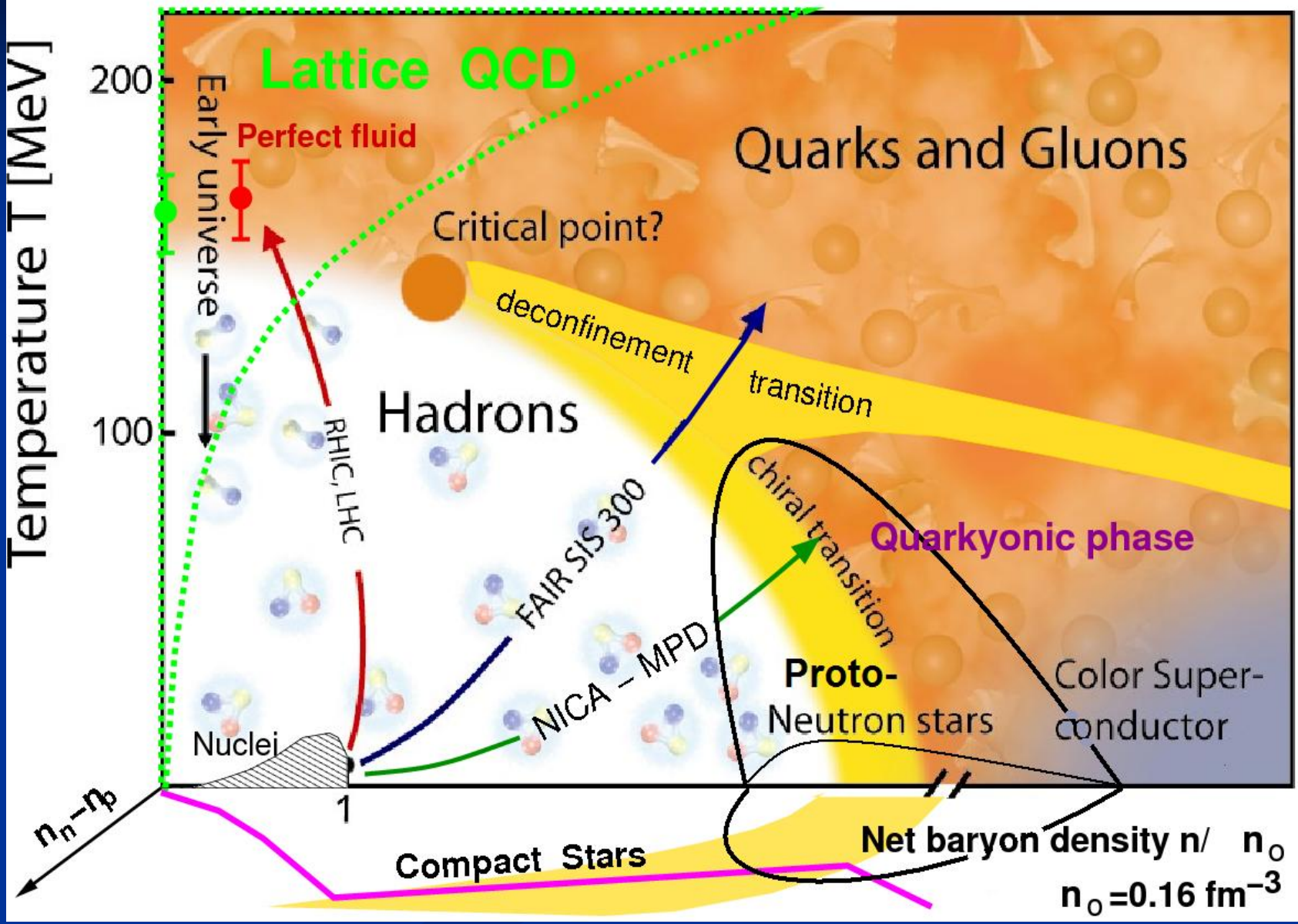
Thank you for your attention!

Spare slides

JINR Seven-year plans

DIRECTIONS	Acc./Lab.	Experiment	2010	2011	2012	2013	2014	2015	2016
SM & beyond: hadron and lepton collider physics	TEVATRON	CDF,D0	?						
	BEPC-II	BES-III		?					
	CERN LHC	ATLAS, CMS							
	ILC	?							?
Neutrino physics, Astrophysics	GRAN SASSO	OPERA, Borexino							
	Daya Bay	Daya Bay							
	JPARC-KAMIOKA	T2K							
	Space	NUCLEON, TUS							
Rare processes: CP-violation, K-decays	CERN SPS	NA48/1-3 NA62		?					
	KEK	E391a							
	JPARC	JPARC		?					
	U-70	KLOD		?					
Spin Physics & Nucleon Structure	Nuclotron/NICA	LNS, pHe3, Δ-Σ, …							
	HERA	HERMES, H1							
	SPS	COMPASS							
	RHIC	STAR							
	FAIR	PAX			?				
Non-p. QCD	Nuclotron	NIS							
	PS/SPS	DIRAC							
	FAIR	PANDA			?				
Relativistic Nuclear Physics: Phase trans., 3N-forces Particles in Nuclear Medium	Nuclotron/NICA	MPD				?			
	RHIC	STAR							
	SPS, LHC	NA61, ALICE							
	SIS, FAIR	Hades, CBM							

Heavy ion physics at NICA

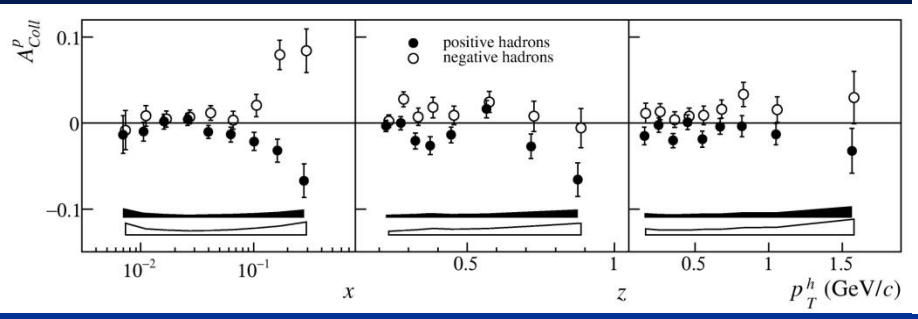


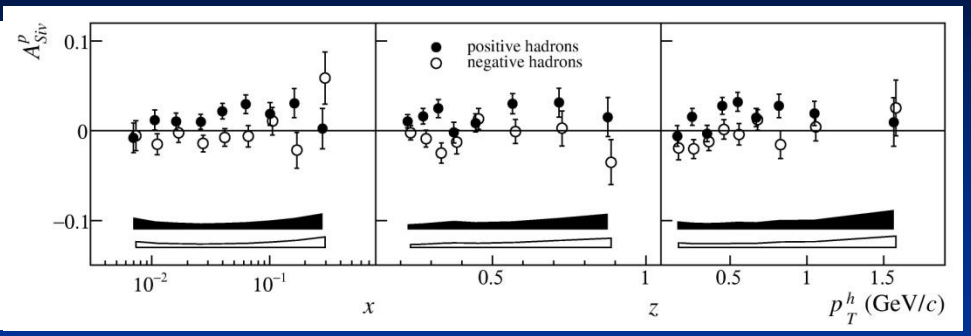
NICA main objectives in 2010

TASKS	Collaborators	Status (Sept 2010)
1. Elaboration of Collider TDR (to be finished by the end of 2010)	BINP, FNAL, CERN, GSI, ITEP,	In progress
2. Technical project of civil engineering of the collider layout (we expect GlavGosExpertise at the beginning of 2011)	GSPI	In progress
3. Heavy Ion LINAC TDR	IHEP (Protvino), BINP/Sarov	Negotiations
4. Prototypes of the dipole magnets for NICA Booster and NICA Collider	Machinery plant "ATOM"	In progress
5. Booster RF system	BINP, Novosibirsk	Contract
6. New cryo-magnetic factory (manufacturing, assembling, cryo and vacuum tests) for SC magnets for NICA and FAIR	Industrial companies GSI/FAIR	Civil works in progress
7. MAC meeting	04-05 Oct.'10	

COMPASS results in 2010

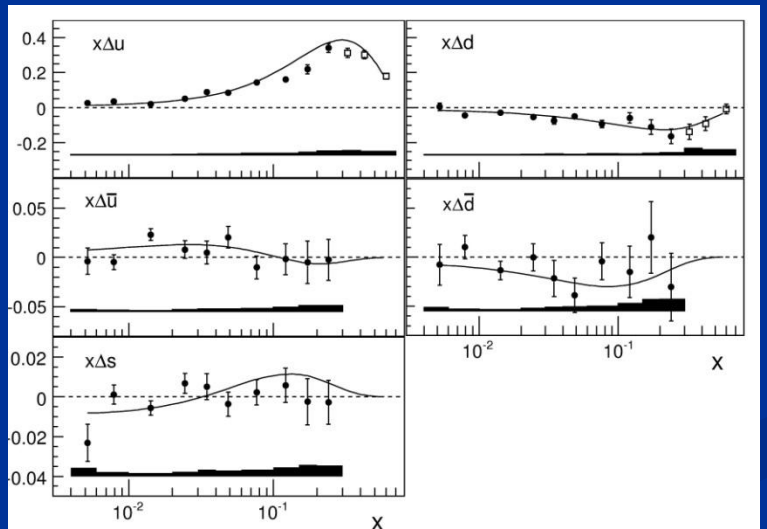
1. **Measurement of the Collins and Sivers asymmetries on transversely polarised target** (PLB 692 (2010) 240–246)

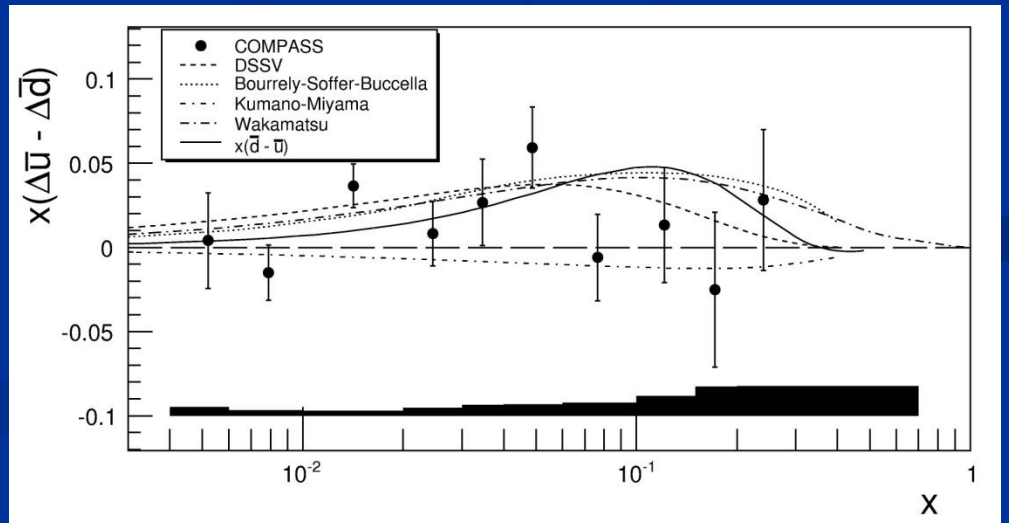




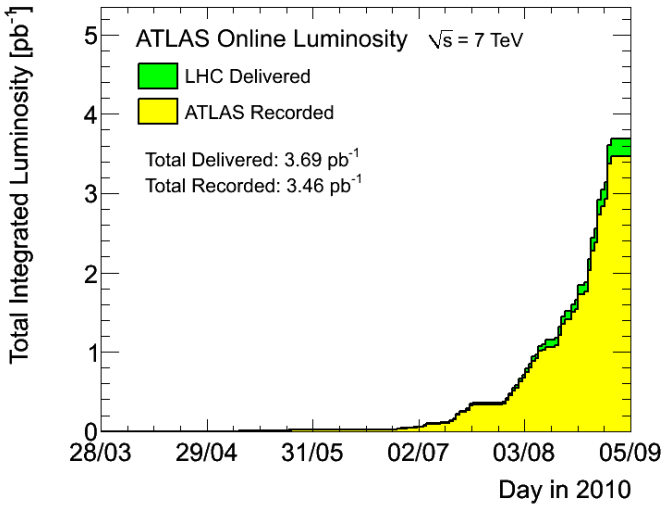
The Collins and Sivers asymmetries for charged hadrons produced in DIS on transversely polarised protons have been extracted from the data collected in 2007 with the CERN SPS μ beam at 160 GeV/c. At large values of the Bjorken x variable non-zero Collins asymmetries are observed both for positive and negative hadrons while the Sivers asymmetry for positive hadrons is slightly positive over almost all the measured x range. These results nicely support the present theoretical interpretation of these asymmetries, in terms of leading-twist quark distribution and fragmentation functions.

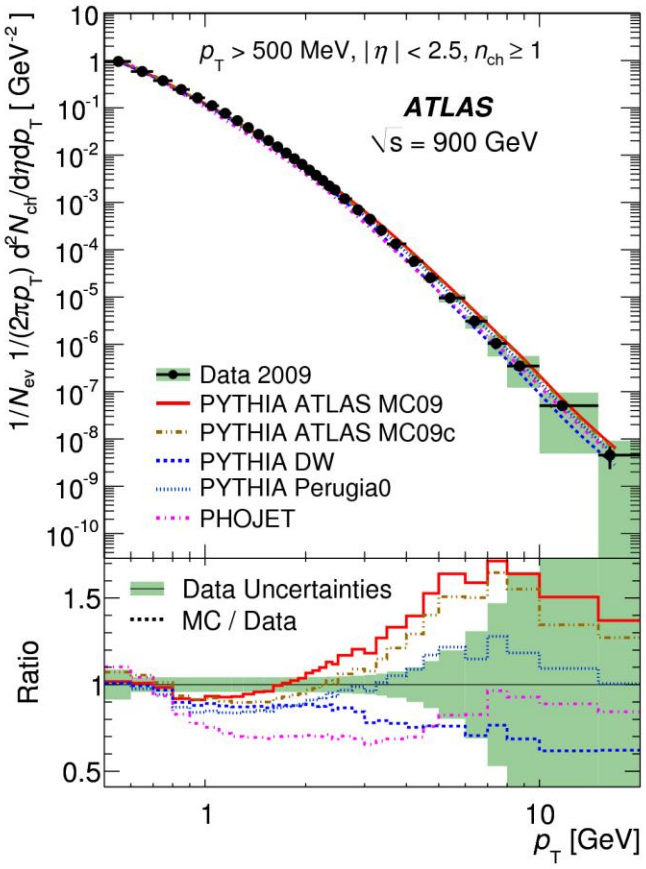
2. **Quark helicity distributions from longitudinal spin asymmetries in μ-proton and μ-deuteron scattering** (hep-ex/1007.4061, acc. PLB)

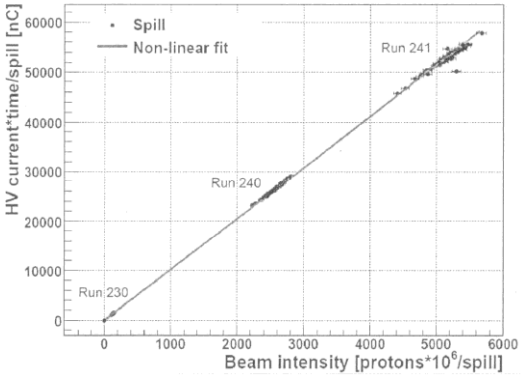




ATLAS (LHEP)







Charged-particle multiplicities in pp interactions at sqrt(s) = 900 GeV measured with the ATLAS detector at the LHC. By ATLAS Collaboration (*G. Aad et al.*) **Phys.Lett.B688:21-42,2010.**

Relative luminosity measurement of the LHC with the ATLAS forward calorimeter. Published in **JINST 5:P05005,2010.**

Long-Range, Near-Side Angular Correlations in P-P Interactions in CMS

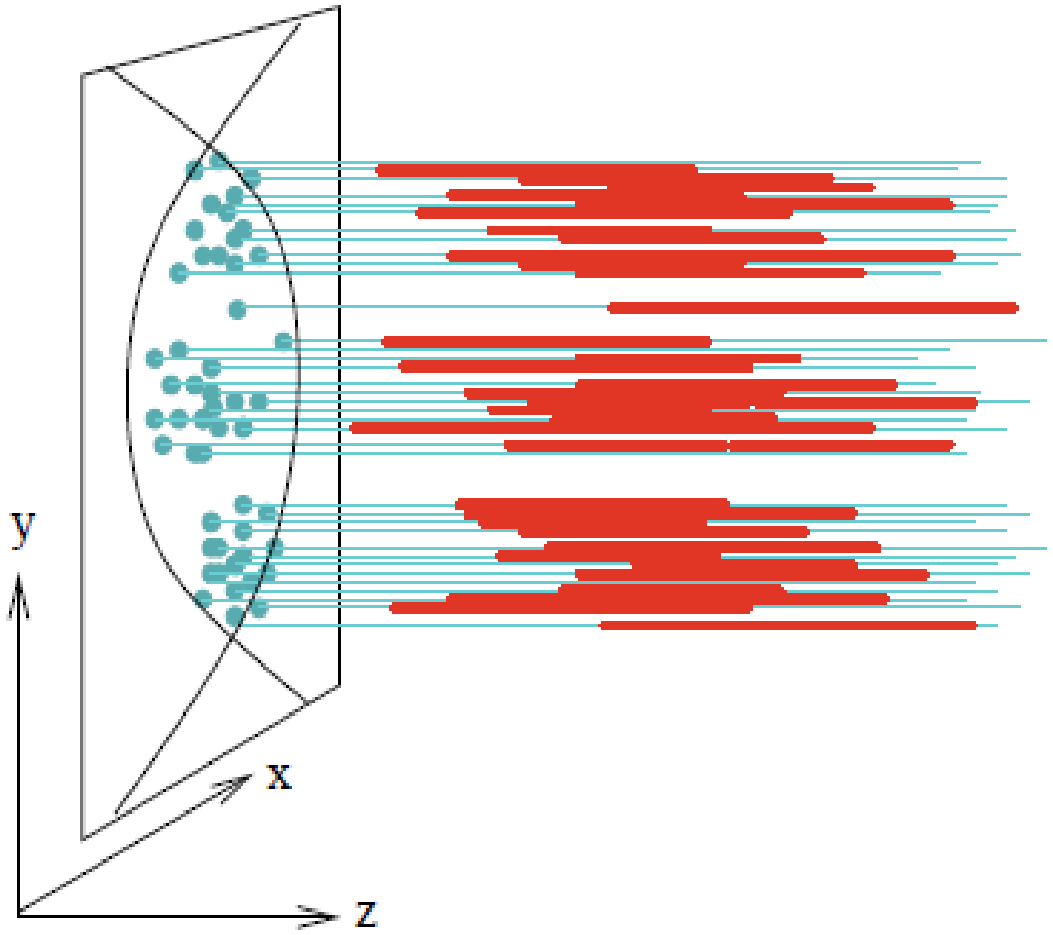
The CMS Collaboration at CERN released on September 21 a paper entitled "Observation of Long-Range Near-Side Angular Correlations in in Proton-Proton Collisions at LHC" CERN-PH-EP-2010-031 to arXiv and JHEP

that details signs of a new phenomenon in proton-proton collisions.

A study of "high multiplicity" collisions, where a hundred or more charged particles are produced, has revealed indications that some particles are somehow "correlated" – associated together when they were created at the point of collision.

This the first observation was widely discussed at joint *CERN LPCC/EP/PP Seminar on September 21 with overfull main CERN auditorium, and joint JINR and RDMS CMS Seminar "Physics at LHC" on September 22*. The CMS Statement also published in Press-release at http://cms.web.cern.ch/cms/News/2010/QCD-10-002/index.html

This observation demonstrates the power and versatility of the CMS detector, as well as of the physicists exploiting it. CMS are now on our way to exploring, inch by inch, the new territory made accessible by the LHC

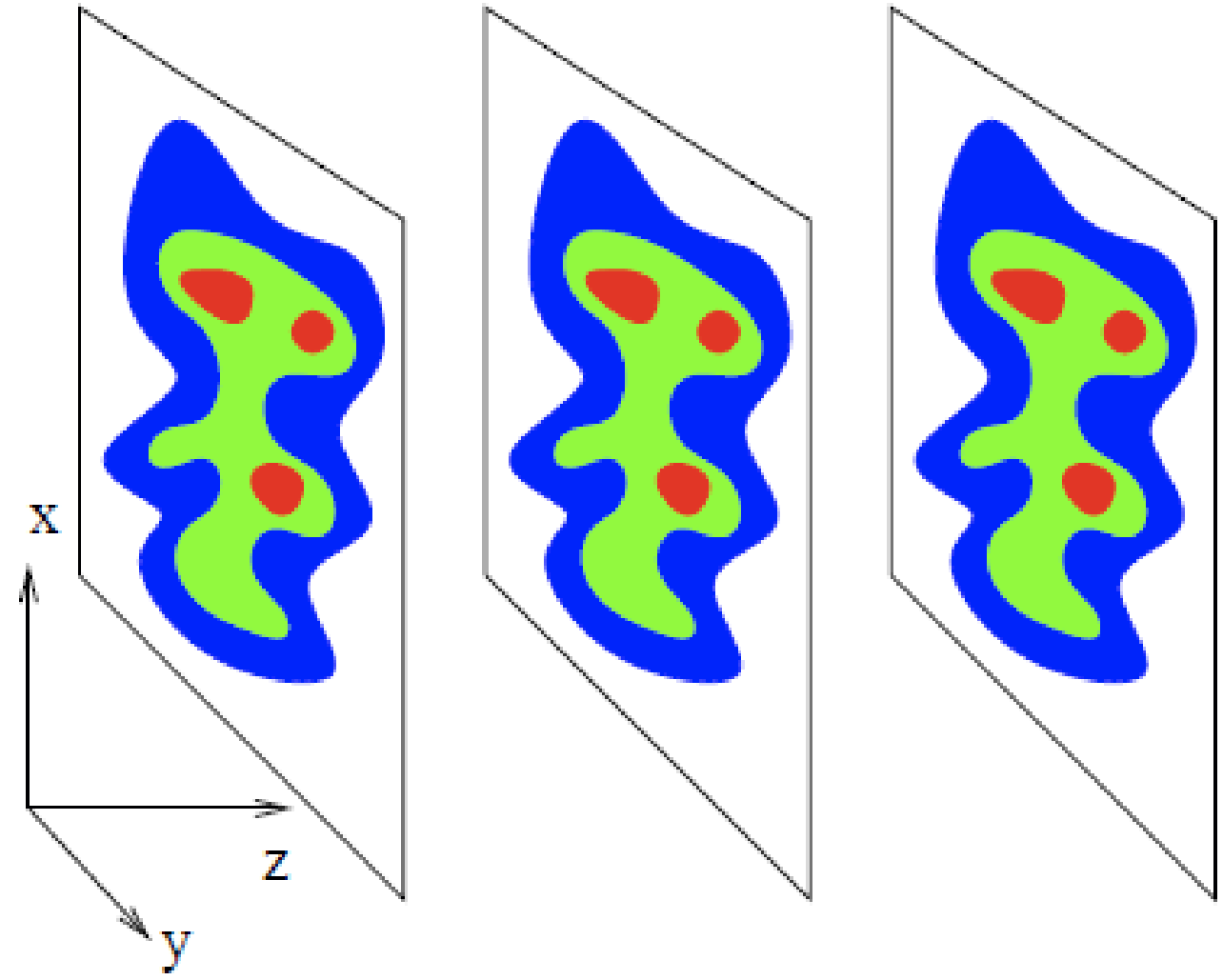


Projection of the positions of nucleon-nucleon scattering to the transverse (x, y) plane, which defines "possible transverse positions" of the flux tubes (thin lines).

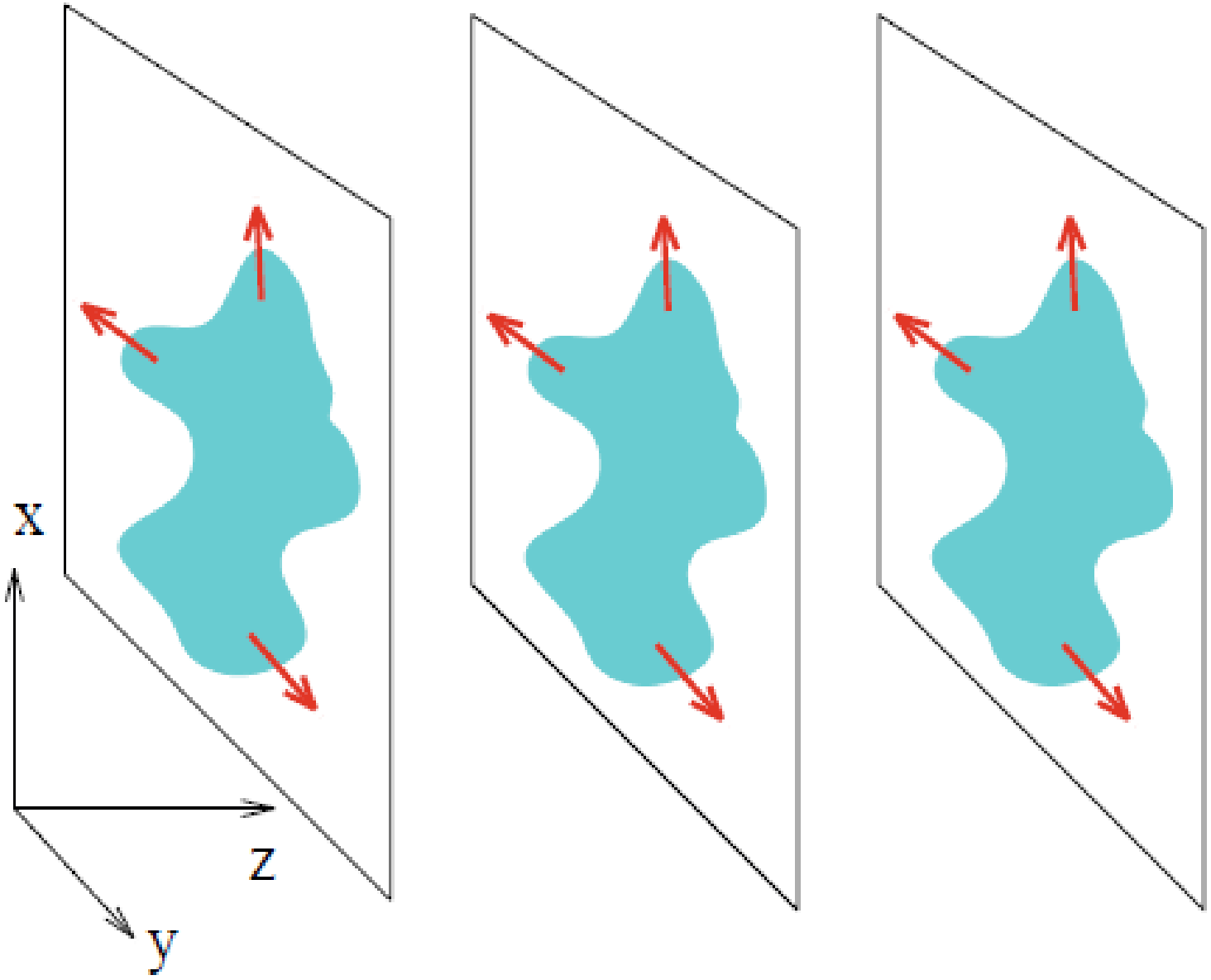
The actual flux tubes (thick red lines) fluctuate concerning their longitudinal positions (but nevertheless add up to sub-flux-tubes)

RIDGE summary

1) bumpy structure of energy density in transverse plane,
but translational invariance



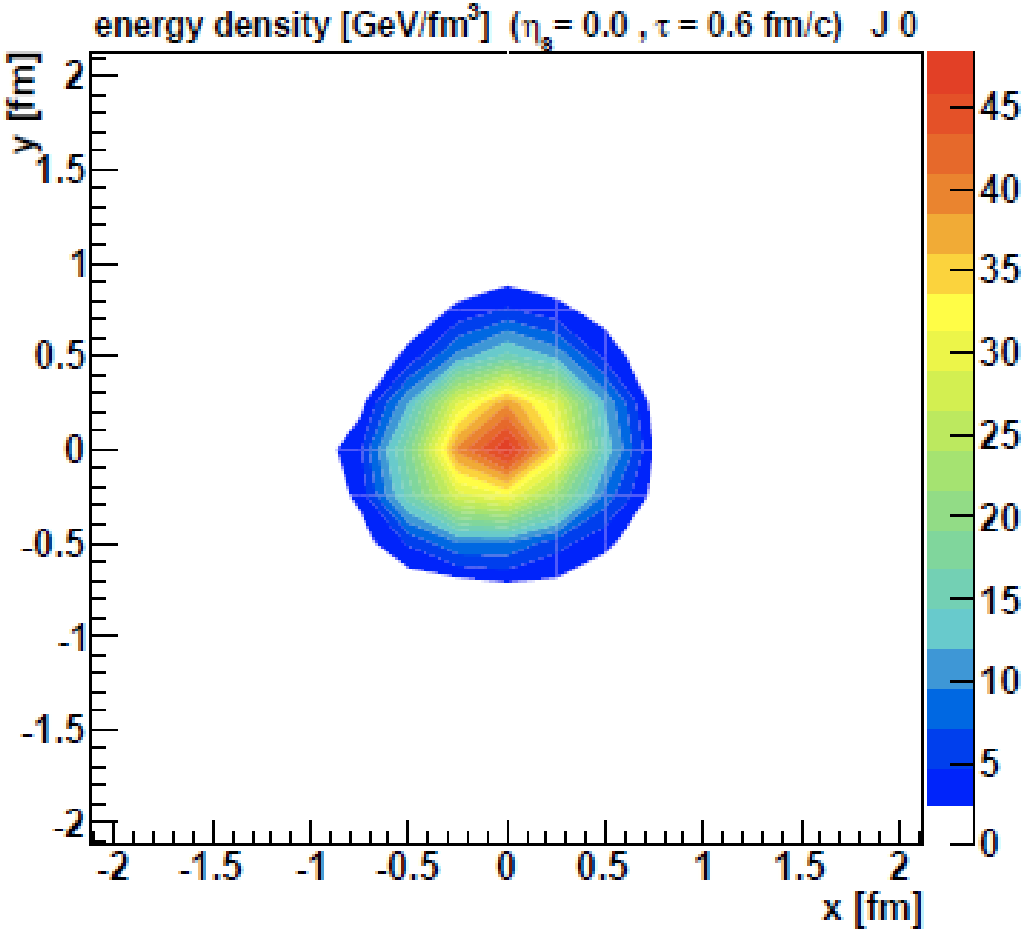
2) this leads to translational invariance of transverse flows



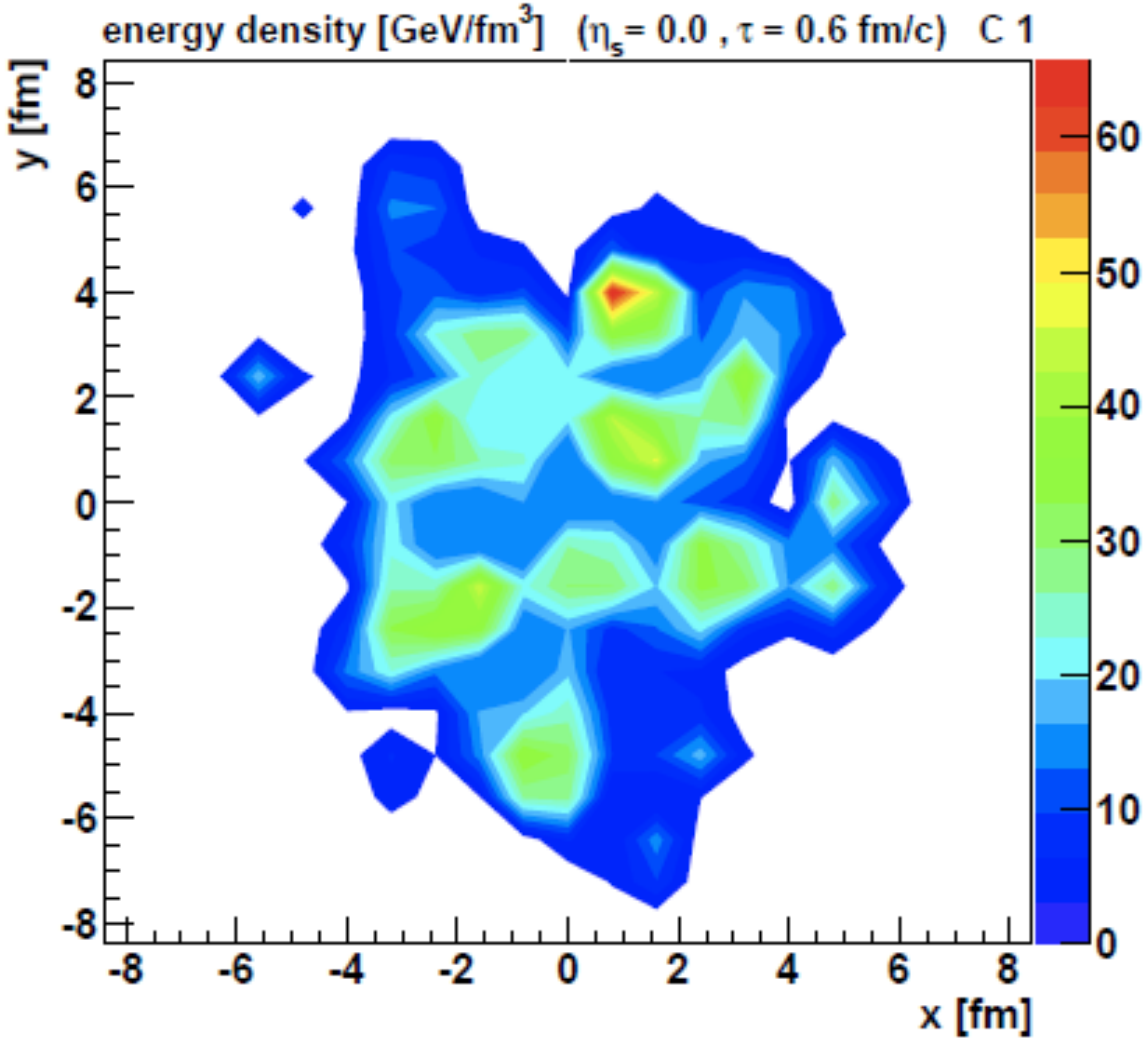
3 pp@LHC

high multiplicity pp at 900 GeV $(dn/d\eta(0) = 12.9)$

multiple scattering → many flux tubes → high densities



AuAu at 200 GeV, central event



Size of the fluctuations in AuAu small, similar to sizes in pp@LHC

If hydro is applicable for AuAu@RHIC, it should be so for pp@LHC ...

so:
let's do hydro for pp