# Spin Physics Experiments at NICA-SPD. From LoI to TDR.

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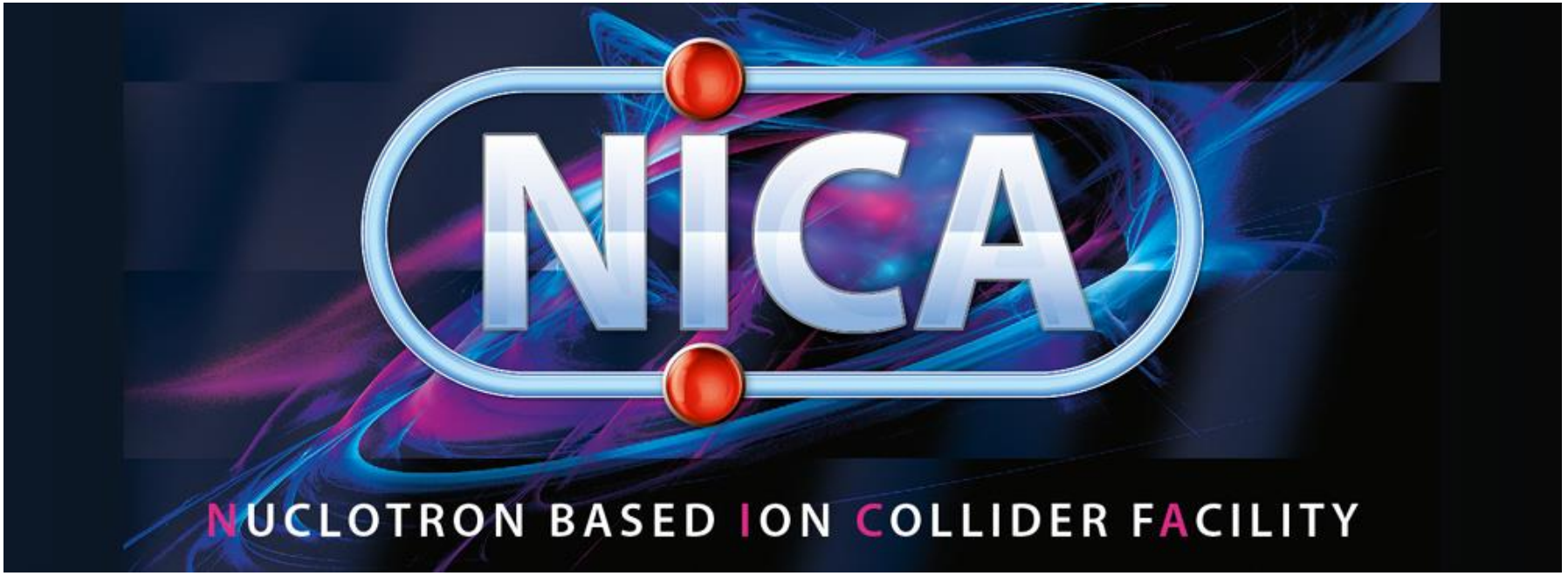
# MEGAPROJECT NICA




**The NICA project which is under implementation at the Joint Institute for Nuclear Research underlies the “NICA Complex” megaproject.**

**The international intergovernmental organization Joint Institute for Nuclear Research (JINR) was founded on March 26, 1956. 12 countries pooled their efforts in order to conduct joint investigations of the fundamental properties of matter. The status of JINR has been confirmed recently. On January 2, 2000 President of the Russian Federation V.V. Putin signed the Federal Law on ratification of The Agreement between the Russian Federation and the Joint Institute for Nuclear Research on the location and terms of activity of the Joint Institute for Nuclear Research in the Russian Federation.**

# MEGAPROJECT NICA

| | |
|---|---|
| Australia | Moldova |
| Azerbaijan | Mongolia |
| Armenia | Poland |
| Belarus | Romania |
| Bulgaria | Russia |
| Brazil | Serbia |
| Vietnam | Slovakia |
| Germany | USA |
| Greece | Czech Republic |
| Georgia | Ukraine |
| India | Uzbekistan |
| Italy | France |
| Kazakhstan | SAR |
| China | Japan |
| DPRK | CERN |

At present, JINR has 18 full member states from Europe, Asia and Latin America. Thus, the NICA project approved by the JINR international bodies is in fact already an international project. 30 countries are interested and taking part in its implementation. Additional agreements are signed with Germany, China, the US, CERN and SAR. Contracts are signed with many organizations from Russia, Czech Republic, Austria, Bulgaria and Ukraine.

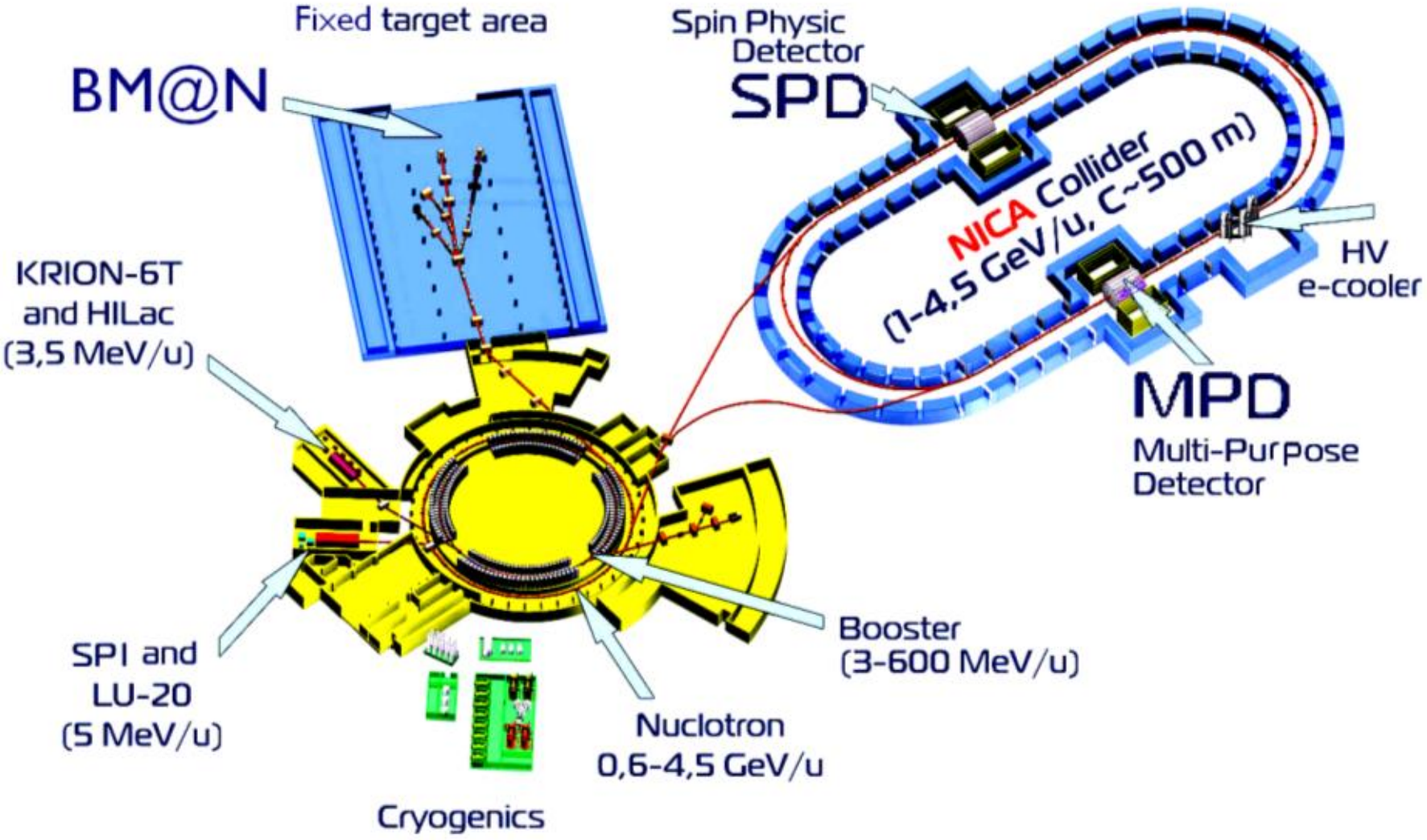
6 countries – Belarus, Bulgaria, Germany, Kazakhstan, Russia and Ukraine expressed their readiness to participate in the implementation of the “NICA Complex” megaproject during the meeting held on August 8, 2013. Germany has already its first contribution in the sum of EUR 9.5 mn.

On April 27, 2016 the Government of the Russian Federation made the order (number 783-p) "On signing the Agreement between the Government of the Russian Federation and international intergovernmental research organization the Joint Institute for Nuclear Research on the establishment and operation of the complex superconducting rings with colliding beams NICA heavy ion".

# NICA COMPLEX

## Superconducting accelerator complex NICA

(Nuclotron based Ion Collider fAcility)



# NICA SPD LoI

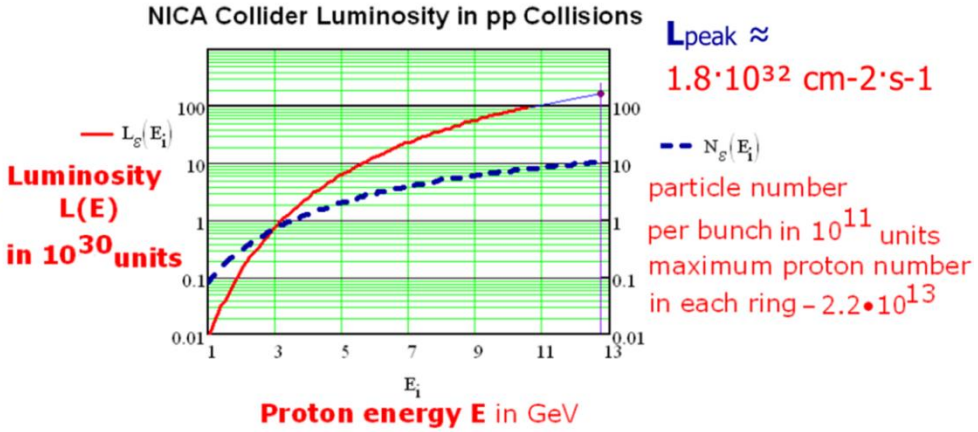
## Requirements to the facility in polarized mode

- **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 )
- $L_{average} \approx 1 \cdot 10E32\ cm^{-2}s^{-1}$ (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**



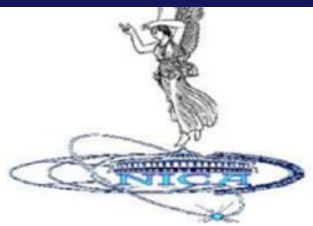
## NICA pp-collisions peak luminosity (1)




- IP parameters: **β** = 35 cm, bunch length **σ** = 60 cm (not optimized), **bunch number** – 22, collider perimeter **C** = 503 m

from I.N.Meshkov 29/11/2012





Nec sine te, nec tecum vivere possum. (Ovid)*

## Spin Physics Experiments at NICA-SPD with polarized proton and deuteron beams.

Compiled by the Drafting Committee:
I.A. Savin, A.V. Efremov, D.V. Peshekhonov, A.D. Kovalenko, O.V.Teryaev,
O.Yu. Shevchenko, A.P. Nagajcev, A.V. Guskov, V.V. Kukhtin, N.D. Topilin.

(Letter of Intent presented at the meeting of the JINR Program Advisory Committee (PAC) for Particle Physics on 25–26 June 2014.)

ABSTRACT

We propose to perform measurements of asymmetries of the DY pair's production in collisions of non-polarized, longitudinally and transversally polarized protons and deuterons which provide an access to all leading twist collinear and TMD PDFs of quarks and anti-quarks in nucleons. The measurements of asymmetries in production of J/Ψ and direct photons will be performed as well simultaneously with DY using dedicated triggers. The set of these measurements will supply complete information for tests of the quark-parton model of nucleons at the QCD twist-two level with minimal systematic errors.

**PAC Recommendations:**

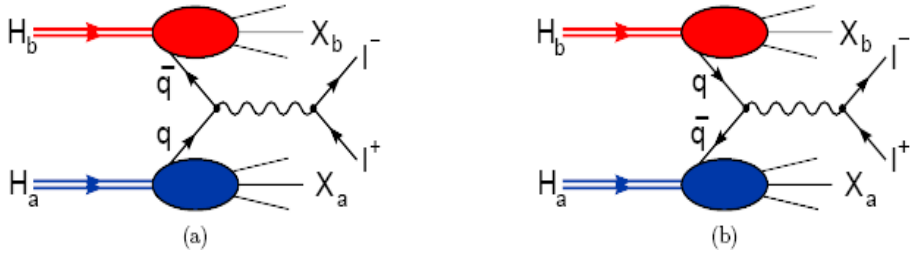
….The PAC heard with interest a report on the preparation of the Letter of Intent "Spin physics experiments at NICA-SPD with polarized proton and deuteron beams" presented by I. Savin. The PAC is pleased to see the first steps toward formation of an international collaboration around the SPD experiment. The PAC regards the SPD experiment as an essential part of the NICA research program and encourages the authors of the Letter of Intent to prepare a full proposal and present it at one of the forthcoming meetings of the PAC. …

*) Neither without you, nor with you one can live.

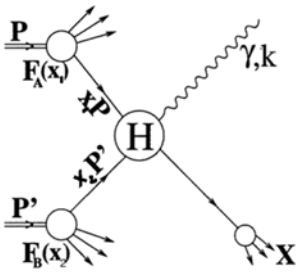
# NICA SPD LoI

## The main physical tasks proposed for spin program at NICA are as follows:

- Nucleon spin structure studies using the Drell-Yan reactions.




- Direct photons.





- New nucleon PDFs and J/ψ production.
- Spin-dependent effects in elastic pp,pd and dd scattering.
- Spin effects in one and two hadron production processes.
- Spin-dependent high-$p_T$ reactions.
- Spin-dependent reactions in heavy ion collisions.

# NICA SPD LoI

**Required characteristics of the experimental setup:**
**- Geometry close to 4π,**
**- high-precision (better than 50 μm) and fast vertex detector,**
**- a tracking system that provides high accuracy (~200 μm) along the track,**
**- DAQ- data taking rate for luminosity> $10^{32}$,**
**- minimum of material,**
**- measurement of neutral ($\pi^0$ etc.) secondary particles,**
**- Identification of charged particles with efficiency close to 100%,**
**- fast and modern trigger system,**
**- Modularity and access to the elements of the setup, which will allow to upgrade and modify detectors for new research.**

**<u>Tracking detectors</u>:**
**- Vertex detector - several coordinate silicon layers with resolution of the order of 30 μm;**
**- central and end track detectors - several groups of layers of straw tubes;**
**- In addition, you can use the space between the windings of the toroidal magnet for coordinate planes.**
**<u>Trigger detectors:</u>**
**- electromagnetic calorimeter;**
**- scintillation planes;**
**- RPC planes.**
**<u>PID detectors:</u>**
**- Time-of-flight system Vetrex Detector- RPC planes;**
**- electromagnetic calorimeter;**
**- muon system.**

# From LoI to TDR

**This year, the next stage in the realization of the SPD project was started - the preparation of the Conceptual Design Report .**
**The coordinator of the work is**

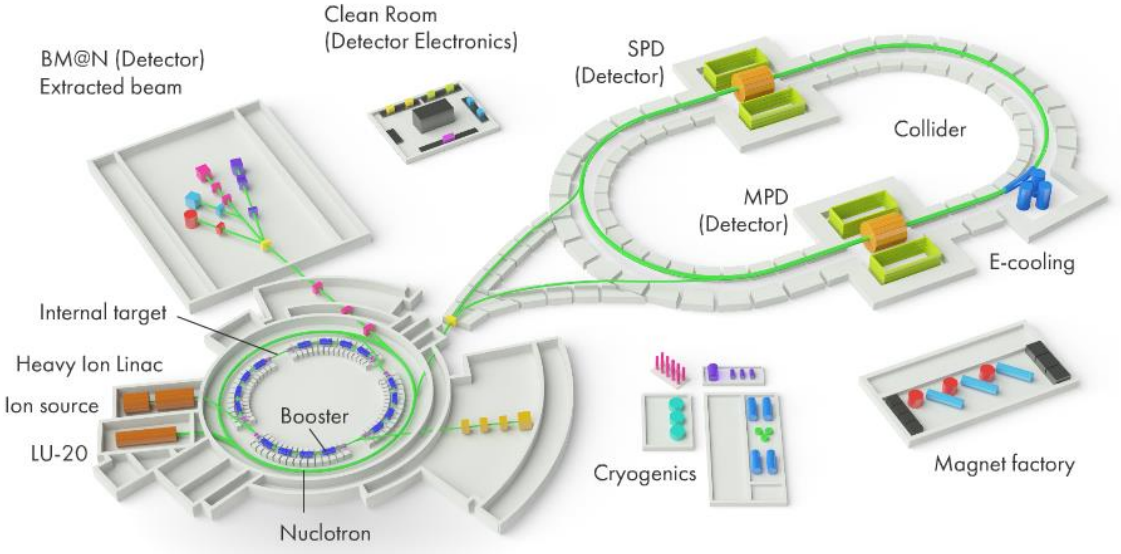
**Prof. Rumen Tsenov, Bulgaria , email: tsenov@jinr.ru**

**“Regulation for the organization of experiments conducted by international collaborations using the capabilities of the JINR basic facilities”, http://www.jinr.ru/docs-en/**

**The first version of CDR is planned to be done by the January 2019.**

**Technical Design Report by the end of 2021.**

## Welcome to SPD Collaboration!





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