

Referee report on Project ‘Conceptual and technical design of the Spin Physics Detector (SPD) at the NICA collider’ by HHG

NICA has been designed to have a spin physics program together with the heavy ion program since the first days. The ‘SPD Proto Collaboration’ had been formed already in 2012. A concept was presented as early as 2012 and a letter of intent was presented in 2014. Detector concepts have been presented already in quite some detail. There, the magnet system was discussed as to the benefit of Toroid versus Solenoid magnet. The physics program, requirements for the detector and the design ideas are based on the submitted in 2014 Letter of Intent, that was endorsed by the JINR Physics Advisory Committee (PAC) for Particle Physics

This proposal is for the ***‘Elaboration of a design concept for a detector capable to exploit the broad spin physics potential of the high luminosity NICA collider’***.

Goals of detector performance look to me quite reasonable and a good pragmatic approach is to keep in close contact with the detector R&D at BM@N and FAIR detectors. The requested performances could be achieved with present state technologies.

However, I see a great need to start the elaboration of the concept again from the beginning. The presented SPD detector consists now of three modules: two end-caps and a barrel section. Each part has an individual magnet system: the end caps - solenoidal coils, the barrel - toroidal magnetic system. The authors state: *The basic requirements for the SPD Magnetic System (MS) are the following:*

- *Universality, i.e. the field generating elements should be reconfigureable so the magnetic pattern of the set-up could be changed according to the needs of the physics tasks.*

This is in my view a very dangerous concept and could jeopardize the early physics discover potential:

- a) The SPD detector should cover the geometry from the beginning in most of 4π . MPD has been presented in the beginning also covering 4π , but the physics permits to start with a smaller coverage. This is why MPD is missing the forward detector components still today. I see no need that SPD should be in a start version; on the contrary I see the need of SPD having full coverage from the beginning. One should not forget that MPD can also do spin physics to a certain degree.

- b) The magnetic system is supposed to provide field integral of 1 to 2 Tm along the particle tracks. Furthermore, the magnetic field should be close to zero (or minimized) along the beam axis inside the SPD. In the Letter of Intent the proposed setup was for a total Toroid magnetic system and arguments were given for and against a central solenoid.

To see now at large pseudo-rapidities two solenoids and in the central rapidity region a toroid, is to me very puzzling. The needed integrated field integral at large rapidities for good momentum determination, can it be achieved in a solenoid?

Probably not!

Can the polarized beam tolerate the solenoid field? If so, why not having a full azimuthal coverage of solenoid at mid-rapidities?

The presented concept surely has opened many questions.

As to the manpower for the SPD, it is fine that there are so many people available from JINR. Host institute of the project is the Laboratory of High-Energy Physics of the Joint Institute for Nuclear Research. The main part of the human resources engaged with the project comes from there (74 researchers, 24.4 FTE). The Laboratory of Nuclear Problems is the other laboratory of the JINR that participates in the project with substantial number of researchers (30 researchers, 11.3 FTE). So in average, people work with 30% of their time. This could be fine but shows also that many are just passengers on the SPD train.

One should truly have the full international SPD collaboration working on the design concept and see them carrying responsibilities. Also from the beginning, one needs a core team of about 20-30 persons working 100% on SPD.

The time line should follow the steps requested of any CERN proposal: The present proposal for writing a conceptual design does not exist at CERN, but I understand it is needed at Dubna. So the CERN timeline would be based on work of this proposal and with super ambition could look like:

- **January 2019:** Proposal for Elaboration of a design concept for a detector capable to exploit the broad spin physics potential of the high luminosity NICA collider'
- **January 2019** possible approval of that proposal
- **Early Spring 2019** setting up of the SPD collaboration and election of its management bodies (2019); preparation of MoUs

- only, signing later after TDR acceptance.
- ***Late summer of 2019*** submission of the Conceptual Design Report including Physics performance evaluation and integration issues
 - ***January 2020 Presentation of Conceptual Design Report to PAC***
 - ***January 2020*** Green light for Conceptual Report and for going towards Technical Design Report
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 - ***April 2020*** Submission of TDRs for some sub detectors
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 - ***June 2020*** Presentation to PAC of first Technical Design reports for sub systems, like magnets, and green light possible to go for construction of subsystem
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 - ***September 2020*** Submission of rest of TDRs for evaluation
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 - ***January 2021*** Final TDRs approved

No construction other than prototyping would be allowed at CERN before TDRs are having green light and Readiness for Production'.

I am fully supporting the proposal of starting the conceptual design of SPD and encourage the collaboration to go for that ambitious time-line.

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