

Resume of the NICA Machine Advisory Committee at JINR (Dubna)

October 17-18, 2013

The progress in the NICA project developments is generally good. The MAC members congratulate the NICA team for attaining the important mile-stone of the success of stochastic cooling at the Nuclotron. MAC appreciates the results of experimental operation of the control system segment based on the TANGO concept at the Nuclotron. MAC is satisfied with the progress achieved in the Nuclotron performance.

In general, MAC is satisfied with the answers to the requests of the previous MAC meeting. MAC agrees with the proposed correction scheme for the collider. A reasonable preliminary concept of the collider feed-back system was noted. Progress in the description of quadrupole, sextupole, octupole magnets was achieved. The required tunability of the collider rings was reported. Some details of the injection/extraction system elements were presented. The development of the ion sources is satisfactory. The progress in the construction of HILac is well progressing. Information about the status of designer stages and project time-table was presented. However a lot of important tasks are not completed yet, correspondingly for the next MAC meeting the following requests were expressed:

- to examine the possibility to improve the momentum acceptance up to $\pm 1\%$ that requires more non-linear correctors,
- to provide the scheme of the vertical dispersion correction (one-page functional specification for all correctors should be prepared and presented),
- to present full report about instabilities, specifications of the RF system together with feed-back for the beam load compensation, functional specification of the feed-back systems – transverse and longitudinal,
- to consider the possibility to use the turbines instead of the Joule-Thompson valves in the nitrogen liquefier and in the nitrogen refrigerators (re-liquefiers),
- to present concepts of machine and radiation protection system for NICA,
- to present work-chart distribution of various responsibilities, assigned personal to specific tasks starting with the project chef engineer,
- the work on time table development has to be continued and the results have to be presented to the next MAC meeting in details.

Answers of MAC for JINR directorate charge-list

1. How MAC does estimate, in general, the extent of project development and progress achieved since previous MAC meeting (ion sources, injectors, SC magnets, beam cooling systems, power supply, RF systems, vacuum systems, diagnostics, design workflow, CF&S, etc.)?

In general a steady progress was demonstrated. But it is different in different areas.

2. How does MAC estimate progress on collider beam dynamic simulations, lattice, and questions of beam instabilities? How do MAC experts estimate the extent of the development of NICA collider composition and diagnostics?

The lattice design based on single-particle analysis is nearly finished. However, matching it with real magnets is at an initial stage for the straight lines. Urgent work is required. At the next stage it is necessary to provide simulations with account of collective effects, space charge and beam-beam effects.

3. How do MAC experts estimate proposed conceptual design of the SCS, simulation results and technical feasibility of the SCS?

Concept of the system was presented, but conceptual design is in a preliminary stage. The work has to be intensified with the help of outside leading experts. The conceptual design has to be presented to the next MAC meeting.

4. How does MAC estimate start configuration of the complex NICA proposed at this MAC.

The proposed start-up version of the accelerator complex and MPD at luminosity of $10^{25} \text{ cm}^{-2} \cdot \text{s}^{-1}$ satisfies the requirements of the NICA experimental program at the beginning.

5. How do MAC experts estimate technical feasibility of the construction of the Booster injection/extraction system, namely extraction electromagnetic pulse septum and fast kicker?

The presented conceptual project seems to be reasonable. For analysis of technical feasibility MAC needs detailed information.

6. How does MAC estimate progress in development of the concept for NICA complex diagnostics and control/timing systems?

The presented project of control system looks adequate. MAC appreciates the results of experimental operation of the control system segment at the Nuclotron. The functional specifications of diagnostics including for the start-up configuration have to be presented for the next MAC meeting and documented.

Are these risks recognized and addressed effectively in the R&D plan?

– Does the execution strategy NICA project meet the requirements of NICA project?

– What recommendations and modifications to the R&D program, strategy of would be effective?

– Are there other approaches, beyond those being explored in the NICA sub-projects R&D program that should be investigated as the front end of the NICA facility?

MAC strongly supports the staging of the collider commissioning. The proposed execution strategy meets the requirements of the NICA experimental program.

MAC doesn't see show-stoppers in the proposed technical solutions for the collider systems. In the presented collider lattice presently there is an interference between electron and stochastic cooling location, it has to be resolved before the next MAC meeting. MAC recommends extending efforts in increasing the longitudinal acceptance and suppression of vertical dispersion.

The proposed solution for the NICA cryogenic system is based on maximum usage of the existing equipment, which has to be supplemented by similar equipment and by creation of autonomous liquid nitrogen system. MAC believes that it is an optimal choice and it will satisfy the requirements of the NICA accelerators and detectors.

For the start-up configuration of the NICA collider MAC recommends the following restraints to a minimal set of equipment

- no electron cooling,
- reduced version of stochastic cooling, however the longitudinal cooling is mandatory,
- reduced RF system has to include BB cavity and a minimum of 2 cavities of RF2 or RF3 per ring,
- no feed-back systems.

The start-up configuration and harmonic number of RF2, RF3 systems has to be chosen together with the start-up configuration of MPD. Chosen start-up configuration (and beam dynamic simulations for it) has to be presented to the next MAC meeting.

MAC recommends providing some tests of the diagnostics at the Nuclotron to demonstrate the resolution required for the collider at the design parameters and at beam parameters corresponding to the start-up configuration.

In the development of the electron and stochastic cooling strategy MAC recommends to concentrate efforts on the start-up version and to provide more careful simulations of cooling for the start-up regimes.

The stochastic cooling is one of the key technical issues for the NICA project, and the further study of stochastic cooling at the Nuclotron, especially for the bunched beam cooling is mandatory. The simulation of two processes directly related to the stochastic cooling, firstly the beam

accumulation with barrier bucket system and secondly the short bunch formation with RF, are essential. Simulation codes for these processes should be developed and the results should be cross-checked with the ones available from other institutes. The CDR should be finalized after analyzing several cooling possibilities, for example Palmer, Filter and TOF cooling methods, with realistic parameters of the start version. The MAC recommends to analyze the HESR slot-ring couplers scaled to the NICA-aperture and the beam parameters as pickup and kicker structures. Two scenarios should be simulated: First using the same 2-4 GHz band and secondly using the 3-6 GHz band. The risk of a mechanical redesign could be rather low for such small changes. A construction of stochastic cooling system needs a high level RF technology, and it is strongly recommended to continuously explore the collaboration with other institutes to receive their expertise and helpful detailed advice.

MAC appreciates efforts of JINR directorate for consolidation of human and financial resources on the NICA project and this strategy has to be continued.

MAC recommends to strengthen the role of the Project engineer who is responsible for the technical supervision of the development, production or operation of an engineering phase of a project. As a team leader, the project engineer works with other managerial staff to ensure the project completion in an efficient manner. He/she oversees each phase of the design, integration, construction, installation, and commissioning so that the team meets project specifications and complies with federal regulations and JINR engineering manual standards and procedures.

MAC appreciates efforts of JINR directorate for extension of NICA to Russian Federation Mega-science project and to provide another additional funding.