

Referee report on the NA61/SHINE project (JINR participation)

A group of physicists from JINR has been actively participating in NA61 experiment for quite a long period of time.

Set-up NA61 operates with heavy ion beams of the Super Proton Synchrotron (SPS) at the energy of 158 A·GeV and uses more light secondary nuclei.

In the due time the group from the Laboratory of High Energy Physics made a time-of-flight detector which has become one of the key detectors to identify charged particles.

The research programme has performed the search for phase transition of the hadron matter to quark-gluon plasma and deconfinement in the hot dense matter in the collisions of relativistic heavy ions.

The key problem was identification of experimental signatures of QGP production. Several of these signatures of forming the transient QGP state during the early stage of the collision have been proposed: enhanced strangeness production and suppression of the open charm. The lately results on the energy dependence of hadron production in central Pb+Pb collisions at 20-158 A·GeV coming from the energy scan program at the CERN SPS can serve as evidence for the existence of transition to the QGP state.

It is necessary to emphasize that the results of the experiment have inspired some theoretical studies, especially those which refer to the proof of the beginning of deconfinement on SPS at the reduced energy. These studies are planned to be continued further.

Besides, they have stimulated measurements at low energies in experiments STAR and PHENIX at RHIC set-up at the Brookhaven National Laboratory (USA) and realization of the priority projects on the programme NICA/MPD at JINR and CBM at GSI.

Project NA61 presents a wide research programme: searching for the critical point in strongly interacting nuclear matter, studies of the deconfinement phenomenon, physics at high transversal momenta and analysis of hadron spectra for neutrino experiments and experiments with cosmic particles.

In the framework of the ion programme the NA61 experiment plans to carry out a wide range of two-dimension scanning in dependence on the size of the system and collision energy to search for the critical point. A complex study of the phase diagram of strong interaction of matter to search for the proof of the critical point is an extremely important task.

There is no doubt that the JINR contribution is important for operation of the developed time-of-flight system and construction of a new time-of-flight system based on RPC detectors.

The JINR employees have contributed significantly to measuring and analysis of the processes with light nuclei production. This part of the experiment was

totally a responsibility of the LHEP group from data taking, data analysis, and publication of the physical results.

The collaboration in the framework of NA61 is very efficient and simultaneously fruitful for the both institutions: CERN and JINR. In total, according to the experiment NA49/NA61, three candidate and two doctoral dissertations have been defended.

Continuation of this collaboration will provide a deeper understanding of the nuclear matter properties at relativistic energies.

The JINR participation in experiment NA61 is also very important for training the young scientists at JINR for the future project NICA, whose physics programme contains complementary tasks being solved in the framework of project NA61. The experience of work of the JINR team with different detectors on SPS ion beams at CERN can be hardly overestimated as well as their participation in data processing and analysis.

The present project has been prepared taking into account recommendations of the 47-th JINR PAC meeting for Particle Physics, June 26-27, 2017. The optimization of the number of the project members and their participation shares in the project were made, taking into account employment on the NICA project. The participation of the JINR group in the data analysis was increased. Additionally three young employees have been involved in the data analysis. A detailed program R&D for time-of-flight on the mRPC base for the period of 2019-2021 has been presented.

From the mentioned above it follows that participation of the JINR group in experiment NA61 is fruitful. The relatively modest financial requests are fully justified by good physical results which, no doubt, would promote the scientific reputation of JINR. Besides, the expected results are sure to be recognized a significant contribution to the development of the long-term research programmes in the field of heavy ion relativistic physics at JINR, (Dubna).

I would like to recommend approving prolongation of the JINR participation in NA61 experiment in 2019-2021 with the first priority within requested resources.

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