# Review of NA61/SHINE project: Proposal for Extension of JINR Participation

The NA61/SHINE experiment was approved at CERN in June 2007 and started data taking in 2008. The physics program of the experiment consists of three main subjects:

1. Study of nucleus-nucleus collisions with the aim to identify the properties of the onset of deconfinement and find evidence for the critical point of strongly interacting matter.
2. Study of proton-proton and proton-nucleus interactions needed as reference data for better understanding of nucleus-nucleus reactions.
3. Measurements of hadron production in hadron-nucleus interactions needed for neutrino (T2K) and cosmic ray experiments (Pierre Auger Observatory and KASCADE).

The NA61/SHINE experiment has collected significant amount of data with different beams and targets: p+p, p+C, p+Al, p+Be, p+Pb, Be-Be, Ar+Sc, Pb+Pb, π++C, π++Be, see Figure 1: NA61/SHINE data taking (presentation @ QM2017) for graphical representation of a part of collected data at different energies.



Figure : NA61/SHINE data taking (presentation @ QM2017)

According to [Inspirehep](http://inspirehep.net/search?ln=fr&ln=fr&p=find+cn+NA61&of=hb&action_search=Recherche&sf=earliestdate&so=d&rm=&rg=250&sc=0) the NA61/SHINE collaboration has published 128 papers, 101 are conference proceedings. Such ratio is typical for established experiments in heavy ion physics. The project mentions two recent published results:

* Measurements of π±, K±, K0S, Λ and proton production in proton–carbon interactions at 31 GeV/c with the NA61/SHINE spectrometer at the CERN SPS” Eur. Phys. J. C (2016) 76:8. Inelastic and production cross-sections as well as spectra of π, K, p, K0S and Λ have been measured with a high precision. These measurements are essential for predictions of the initial neutrino and antineutrino fluxes in the T2K long baseline neutrino oscillation experiment in Japan. They have already been used for the updated T2K results presented during 2016 summer conferences. Furthermore, these measurements provide important input to improve hadron production models needed for the interpretation of air showers initiated by ultrahigh energy cosmic particles.
* "Production of deuterium, tritium, and 3He in central Pb+Pb collisions at 20A, 30A, 40A, 80A, and 158A GeV at the CERN SPS" Phys. Rev. C 94 044906 (2016). The result is an illustration of the good particle identification capabilities of the experiment. It was shown that thermal model calculations were capable of reproducing the energy dependence of the cluster multiplicities not only qualitatively but also quantitatively.

According to the MoU the LHEP group of physicists from JINR is responsible for:

* Maintenance of the TOF-L/R detector and its upgrade;
* Software coordination, development and release management;
* DAQ support and on-line data quality control during data taking;
* Raw data processing for calibration and analysis;
* DST production;
* Data analysis**.**

The combined plan of JINR group from both laboratories includes:

* Participation in the data taking runs;
* Commitment to the MoU responsibilities;
* R&D for TOF MRPC;
* Analysis: light (anti) nuclei production in Xe+La collisions at 13-158A GeV, analysis for the Fermilab neutrino program.

**The reviews of the referees V.V.Burov and P.I.Zarubin are positive and support the prolongation of the program.** They underline the quality of the physics program, the fact that NA61/SHINE studies are complementary to the studies being carried out at the Nuclotron (JINR), RHIC (BNL) and that the obtained experimental results are needed for planning the research at the acceleration complexes of NICA (JINR) and FAIR (GSI). In addition the referees point to the modest financial requests fully justified by the expected results. The participation in NA61 is considered as a significant contribution to the development of the long-term research programs in the field of heavy ion relativistic physics at JINR in Dubna. It has also important impact on the training of young scientists at JINR in preparation for the future ambitious project NICA.

**I completely agree with the opinion of both referees and propose to extend the JINR participation in the NA61/SHINE experiment in 2018-2020**. At the same time I have some remarks and criticism concerning the abstract of the project:

* The introduction is outdated. It probably was written 10 years ago for the first presentation of the project and does not take into account the recent developments in this area. The reviewers of the project would benefit from an updated introduction where for example the results from the beam energy scan at RHIC are take into account;
* The description of the physics program is also obsolete. There for example we find the phrase “Within a data-taking period (2014-2017) data at all energies can be recorded with a typical event statistics of about 10 times the one of the NA49 data.” however it is already 2017 and the considered period is in the past. It would be much more informative to summarize the NA61 results during the first 9 years of data taking and to underline the contribution of JINR team to the most important results;
* The description of the experimental setup does not refer to the highly cited paper “NA61/SHINE facility at the CERN SPS: beams and detector system”, JINST 9 (2014) P06005;
* It is not clear what is the contribution of the JINR team to the two recent publications described in the abstract of the project and why exactly these two publications have been selected. I considered them as main achievements of the JINR group, since otherwise they are irrelevant to the discussion, however it is useful to make such statements explicitly;
* A summary of all the data taking in the past together with references to the corresponding published results would be really beneficial for the project;
* The list of expected contributions under the MoU is not updated, for example there we see “EVO meetings”, but Vidyo replaced the EVO videoconferencing around 2008. The full chapter looks like done in a hurry, some parts are written with different font and size;
* The abstract gives the impression that the JINR team is focused mainly on the support, maintenance and upgrade of the hardware and software of the NA61 experiment, while the physics analysis has lower priority. This is in a way confirmed by the conference proceedings where we have 2 out of 101 contributions from members of JINR team. There is also inconsistency between the list of people in the project (17 from both laboratories) and the [CERN Grey book](https://greybook.cern.ch/greybook/experiment/detail?id=NA61), where the total number of JINR participants is 11 (6 authors and 5 non-authors out of 114 authors and 111 non-authors).

PS. During the presentations of [M. Gazdzicki](http://indico.jinr.ru/getFile.py/access?contribId=10&resId=0&materialId=slides&confId=260) and [V. Kireyev](http://indico.jinr.ru/getFile.py/access?contribId=10&resId=1&materialId=slides&confId=260) and the discussion with the authors of the project most of these comments were clarified. The JINR contribution to published papers is above the share of the team in the experiment, however the participation in conferences is indeed insufficient due to budget constrains. I would suggest searching for additional possibilities to increase this participation since this may improve the visibility of the JINR team.

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