

Referee Report on JINR participation in the BESIII Project

The BESIII experiment is located at the beams of the electron-positron collider BEPCII in Beijing. The experiment has proved itself as a world-leading project in the c-tau region. This energy range is complementary to the one of B-factories and provides unique opportunities to investigate various aspects of QCD and precision tests of standard model. The investigation of XYZ particles is also complimentary to the recent LHCb results. Currently, the BESIII Collaboration consists of about 500 from 16 countries and remains very active: it has published more than 350 papers overall and more than 150 during the last three years.

The physics potential of the experiment has been expanded after the recent upgrade of the BEPCII collider and a further upgrade has been approved to be commissioned in 2025. This ensures the BESIII experiment to be active within the time span of this project and afterwards. Among the achievements of BESIII one can mention the measurement of asymmetry parameter in the decay

$$\alpha(\Lambda \rightarrow p\pi^-) = +0.750 \pm 0.009 \pm 0.004,$$

first reported at DSPIN2019 conference and which affected the results of all the polarization measurements in hadronic and heavy-ion collisions.

The JINR group has been successfully participating in the experiment since 2005. It has been focused on the data analysis. A number of important results have been obtained in the fields of light hadron spectroscopy and search for glueball states, charm physics, study of charmonia states of have been obtained since that time. Another important activity of the JINR group is software development and support of computational infrastructure. The group is one of the leading developers of the core software, distributed computing, and physics analysis tools.

The objectives of the project are mostly based on previously obtained results and experience. The previously published evidence of the scalar glueball production is intriguing and might provide a solution for the long-standing problem in QCD. The analysis of proposed channels should support or disprove this observation. The quarkonia production is an important probe of hadron gluon structure suggested in many approved and proposed projects like SPD, AFTER, LHCSpin, EIC, etc. A good understanding of charmonia production mechanisms would be crucial to interpret experimental results. In the context, the proposed measurements of charmonia polarization and production cross-section for different states would be extremely helpful for validation of different theoretical approaches. The study of the $e^+e^- \rightarrow \pi^+\pi^-\eta$ process is important for clarification of properties not well understood $\rho(1450)$, $\rho(1700)$, and $\rho(2150)$. The c-quark fragmentation functions have never been probed below the energies of B-factories. Such measurements would be extremely important for a precise interpretation of future measurements with open charm at SPD.

The group will continue to develop and support the software and the physics analysis tools. Moreover, the BESIII data will be used for the development and validation of new machine learning algorithms for pattern recognition.

It should be noted, that the JINR group consists of young scientists and skilled experts sharing their knowledge. The young generation scientists acquire valuable experience of working in the world-class project.

The incorporation of new MSC and PhD students requested by the project management would support the mparticipation in data analysis and, maybe, in new physical problems, like, say, pseudoscalar glueballs.

The project is especially important in the current situation, when collaboration of JINR with China is of tantamaount importance.

Financial requirements are reasonable. Importantly, the Dubna group has access to the unique experimental data without substantial hardware and financial contributions to the experiment.

I recommend approval of the presented JINR BESIII group status report and strongly recommend further support of JINR participation in the BESIII project in 2022-2025 with the highest priority.



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