Review of the JINR project
"Development of the physics program and detectors for experiments at CEPC"

A new stage in particle physics began with the discovery of the Higgs boson in the ATLAS and CMS experiments at the LHC announced in July 2012. The Standard Model (SM), despite its great success in describing experimental data on a wide scale - covering processes over 15 orders of magnitude, is not considered a complete theory. Among drawbacks of the SM are: it does not include gravitation, it does not explain hierarchy of elementary particle masses, it does not answer the question of the number of generations, it has a problem of fine tuning with respect to Higgs boson mass, it is not compatible with the observed value of baryon asymmetry, it has no candidate on the dark matter and it has no explanation for the dark energy. Though the Higgs boson processes measured up to now are in excellent agreement with the SM, we know the Higgs boson couplings only to the 3rd generation particles (top quark, taon) and to Z and W bosons. The only particle of the 2nd generation with a measured Higgs coupling is muon (cca 20% uncertainty). In addition, to understand the nature of the electroweak phase transition or to know if Higgs boson is truly the SM elementary particle rather than a composite, we need to measure the Higgs boson couplings to other SM particles and its self-couplings, i.e. parameters of the Higgs boson potential, with a high precision. At the same time, the Higgs self-coupling λ_3 will be known, also after HL-LHC phase, with only 50% accuracy.

To solve aforementioned problems and potentially to discover a physics beyond the SM, it is necessary to obtain extremely precise measurements of the properties of the Higgs boson and to carry out highly precision top quark and electroweak physics. Among important tasks there will be also the CP violation studies using B-physics processes. Achieving the high accuracy will require the construction of a Higgs boson factory, which is being to be implemented at the Circular Electron-Positron Collider (CEPC) at energies of $\sqrt{s}\sim$240-250 GeV. The development of the physics program and detectors for the CEPC experiments are urgent and extremely important scientific tasks. The goal of the physics program of the CEPC experiments is to measure with high precision the properties of the Higgs bosons produced in the process $e^+e^-\to$ZH at given energies. For this purpose, the Monte Carlo method will be used to simulate the experimental setup's response to signal and background events when studying the reaction $e^+e^-\to$ZX with Z-boson decay in the modes $Z\to\ell^+\ell^-$ (ℓ = e, μ). An important task is to create software and mathematical support for collecting experimental data and analyzing physical information in order to achieve the specified accuracy characteristics.

Designing modern particle detectors that guarantee reliable operation and provide the necessary characteristics under conditions of high luminosity, strong magnetic field and high radiation background, is one of the main goals of the project. The use of innovative structural materials is becoming an important requirement for achieving the necessary characteristics when designing particle detectors. Thus, the project under consideration is aimed at developing promising detectors and innovative approaches to detecting and identifying particles. A prototype of the Double-Readout hadron calorimeter will be developed, which will improve the energy resolution for hadrons and jets by two times. The creation of new innovative electromagnetic calorimeters for modern experimental setups is also a topical task in particle physics for studying e^+e^- interactions. An important part of the project is a detailed Monte Carlo simulation of hadron and electromagnetic calorimeters in various configurations in order to optimize their parameters. Another important task is the development of precision methods for analyzing calorimetric information and the creation of appropriate software. Therefore, the global goal of the project is to solve some of the current problems that exist in experiments at e^+e^- colliders.

The JINR Dubna group is planning to contribute to the project. The group activities are aimed at the Higgs boson physics – to carry out detail studies of the Higgs boson production and reconstruction using MC simulations with full detector simulations for signal and background events, with a goal to develop algorithms for the optimal signal-to-background ratio.

An important task is connected with high-granular hadronic and electromagnetic calorimeters. The group will simulate, build and test a hadron calorimeter prototype based on the SiPM readout as well as prototypes of crystal-based electromagnetic calorimeter.

I know many members of JINR group in person from their activities at CERN and at Fermilab, even having cooperation with them, therefore I am justified to state that they are highly qualified and competent to make the project successful.

To implement this project, it seems to me that the authors request for financial support is reasonable.

I propose to approve the project and approve the requested financial support for two years, 2026-2027.

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