**APPROVED**

**JINR DIRECTOR**

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**PROJECT PROPOSAL FORM**

Opening/renewal of a research project/subproject of the large research infrastructure project within the Topical plan of JIN

**1. General information on the research project of the theme/subproject of the large research infrastructure project (hereinafter LRIP subproject)**

* 1. **Theme code / LRIP**

02-2-1151-1-2025 Development of advanced detectors and analysis methods, hadronic and rare leptonic processes

**1.2 Project/LRIP subproject code** (for extended projects)

02-2-1151-2-2026/2027

**1.3 Laboratory**

Dzhelepov Laboratory of Nuclear Problems

**1.4 Scientific field**

Elementary Particle Physics and High-Energy Heavy-Ion Physics (02)

**1.5 Title of the project/LRIP subproject**

Development of a physics program and detectors for experiments at CEPC

**1.6 Project/LRIP subproject leader(s)**

Yuri Davydov

Alexey Zhemchugov

**1.7 Project/LRIP subproject deputy leader(s) (scientific supervisor(s))**

Yuri Kulchitsky

Andrej Arbuzov

**2 Scientific case and project organization**

**2.1 Annotation**

The discovery of the Higgs boson at the LHC marked the beginning of a new era in high-energy physics. Precision measurements of the properties of the Higgs boson and the exploration of new physics beyond the Standard Model (BSM) using the Higgs boson as an instrument seem to be a natural next step after the LHC and High Luminosity LHC (HL-LHC). Most attractive for this are electron-positron colliders, several projects of which – ILC, CLIC, and FCC-ee – have been put forward in the last two decades. In 2012, a circular electron-positron collider (CEPC) project with a circumference of 100 km was proposed in China. CEPC is an e+e- Higgs factory for the production of Higgs/W/Z bosons, which is designed for unprecedentedly accurate Higgs measurements, verifying predictions of electroweak theory, flavor physics, and QCD, and exploring new physics BSM. After an upgrade and increase of beam energy, CEPC will be capable of top-quark pair production and could also be converted into a proton-proton machine in the future. CEPC is currently at the stage of the technical design of the accelerator being accomplished and the baseline detector configuration being close to completion. It is expected that the CEPC project will be submitted to the Chinese government for approval in the fall of 2025, and a decision will be made in early 2026.

The JINR group has a strong interest in participating in experiments at CEPC and a wealth of experience in this field, gained in the ATLAS and CMS experiments at the LHC, as well as at the HERA and LEP accelerators~~,~~ and in the CDF and BESIII experiments. For several years, the JINR group has been successfully cooperating with the Institute of High Energy Physics of the Chinese Academy of Sciences in the preparation of the program of physics research at CEPC, theoretical support of the forthcoming experiments, and software development. However, the possibility of starting the realization of the CEPC project from 2026 and the related preparation for the establishment of international collaborations of experiments at CEPC require the increase of JINR participation in the project.

This project is a continuation and development of the project No. 02-2-1151-1-2025/2025 “Development of a particle registration technique in future experiments with the participation of JINR” within the framework of the JINR Topical Plan for 2025 with specific goals and objectives, including the development of a physics program for performing the tasks of the CEPC experiments.

*The aim of this project is to make proposals for the physics research program, to participate in software and computing development, and to carry out a series of detector R&D aimed at further use in CEPC. Thus, during the next two years, laying a keystone for future full-fledged participation of JINR in experiments at CEPC, provided the construction of this accelerator is approved by the Chinese government.*

**2.2 Scientific case** (aim, relevance and scientific novelty, methods and approaches, techniques, expected results, risks)

The SM of particle physics is a theory that describes with high precision an enormous amount of independent physical observables. At the same time, SM is believed to be an effective low-energy approximation of a more fundamental theory. Besides the fact that there should be new physical phenomena at higher energy scales, there remain many questions about the SM itself, first of all on the origin of the Higgs mechanism. The discovery of the spin-zero Higgs boson in 2012 marked the beginning of a new era in particle physics and at the same time exacerbated new questions. Obviously, resolving these issues will require further experimental and theoretical studies at the electroweak energy scale frontier. Precise measurement of the properties of the Higgs boson, of the top quark, and of all other parameters of the SM will be the major goal in high-energy physics in the coming decades. Direct discovery of BSM physics would be a great success, but also its indirect exploration via observation of deviations from SM expectations is of ultimate importance.

The HL-LHC will measure the Higgs boson production cross sections with an accuracy of about 5%. Probing new physics well beyond the LHC's reach will require measurements of the Higgs boson's properties to sub-percentage-level precision. To achieve such precision, we will need new instruments such as the proposed electron-positron colliders, the Circular Electron-Positron Collider (CEPC) in China and the Future Electron-Positron Collider (FCC-ee) at CERN, which are Higgs boson factories. The CEPC will operate at center-of-mass energies of √s = 240 GeV, around 91.2 GeV, around 160 GeV and, after upgrade, at ~360 GeV, acting as a Higgs factory, Z factory, WW threshold scan, and ~~a~~ top quark factory, respectively.

Scientific programs for future colliders, including CEPC, are well developed. The main goals are study of Higgs boson physics, high-precision measurements at the Z pole energy, study of top quark physics, and searches for new physics phenomena [1–4].

The Higgs boson provides a unique, sensitive probe of physics BSM, which may manifest itself as observable deviations in the Higgs boson couplings relative to the SM expectations. At the CEPC, most Higgs boson couplings can be measured with precision at a sub-percent level. The CEPC will be able to measure many of the key Higgs boson properties, such as the total width and decay branching ratios, in a model-independent way, greatly enhancing the coverage of new physics searches. The clean event environment of the CEPC will allow the detailed study of known decay modes and the identification of potential unknown decay modes that are impractical to test at the LHC. A comparison with the HL-LHC is only possible with model-dependent assumptions (see Figure 1). Even with this set of restrictive assumptions, the advantage of the CEPC is still significant. The measurement of κZ is more than a factor of 10 better. The CEPC can also significantly improve the precision on a set of κ parameters that are affected by large backgrounds at the LHC, such as κb, κc, and κg. The direct search for the Higgs boson decay to invisible particles from BSM physics is well motivated and closely connected to the dark sectors.

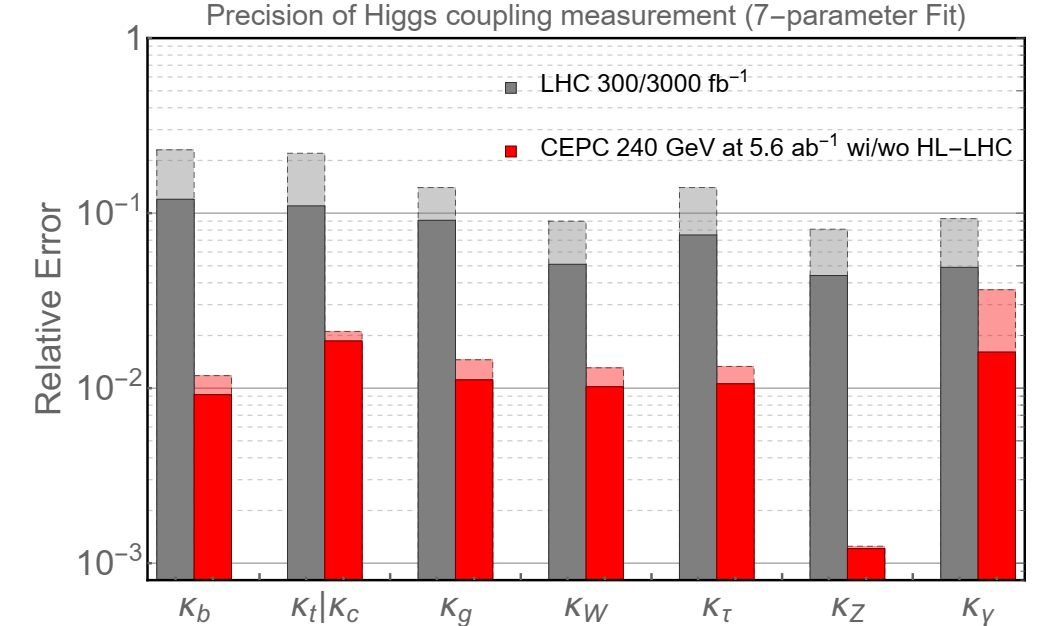


Figure 1. The coupling measurement precision for the CEPC and the HL-LHC [5]. The projections for the CEPC at 240 GeV with an integrated luminosity of 5.6 ab-1 are shown. The CEPC results without combination with the HL-LHC input are shown as light red bars. The LHC projections for an integrated luminosity of 300 fb-1 are shown in light gray bars.

The Higgs boson can be an important portal to new BSM physics. Such new physics could manifest itself through the exotic decays of the Higgs boson if some of the degrees of freedom are light. The Higgs boson BSM decays have a rich variety of possibilities. Two-particle decays of the Higgs boson into BSM particles, H→X1X2, are considered, where the BSM particles Xi can subsequently decay. These processes are well-motivated by BSM models such as singlet extensions of the SM, two-Higgs-doublet models, SUSY models, Higgs portals, gauge extensions of the SM, and so on [6–8]. For the Higgs boson decaying into long-lived particles, novel search strategies have to be developed in the future, using also the latest advances in detector development [9]. Selected results for channels, which are hard to constrain at the LHC presented in Figure 2. In comparison with the HL-LHC, the improvement on the Higgs boson exotic decay branching ratios is significant, varying from one to four orders of magnitude for the channels considered. For the Higgs boson exotic decays into hadronic final states plus missing energy, bb+MET, jj+MET and τ+τ-+MET, the CEPC improves the HL-LHC sensitivity by three to four orders of magnitude.

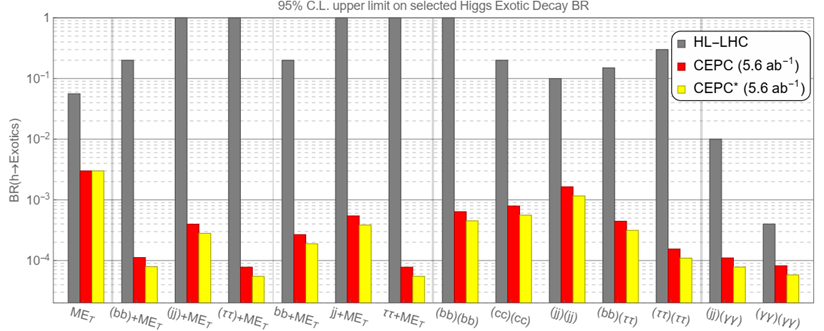


Figure 2. The 95% C.L. upper limits on selected Higgs boson exotic decay branching ratios at the HL-LHC and the CEPC [10]. The red bars correspond to the results using a leptonically decaying spectator Z-boson alone. The yellow bars further include extrapolation with the inclusion of the hadronically decaying Z-bosons.

**CEPC Accelerator.**

The accelerator is a 100-km double-ring collider with two beam interaction points and a synchrotron radiation power of 30 MW as a baseline, with the possibility of upgrading to 50 MW and operating at higher center-of-mass energies up to 360 GeV to produce top-quark pairs [11]. The cross section of the tunnel is 6 meters wide and 5 meters high, allowing the booster, CEPC, and future SppC to be housed in the same tunnel. The collider is designed to operate at center-of-mass energies of 240 GeV (Higgs boson factory), about 91.2 GeV (Z factory), about 160 GeV (WW threshold scan), and a possible upgrade to 360 GeV (top-quark pair). The facility is expected to produce large samples of Higgs bosons (~4M), WW (~20M), and Z (~4T), allowing their properties to be measured with unprecedented precision and to explore physics beyond the SM up to 10 TeV.

**CEPC Detectors**

At present, the designs of the two detectors to be installed at the CEPC collider interaction points have not been finalized yet. Instead, a few possible detector configurations are being considered, the choice between which will be made later, at the stage of establishing the experiment's collaboration and technical design of the detector setups, according to available technologies and results of R&D studies.

The CEPC detector concept is based on the high-performance requirements necessary to implement the precision physics program associated with SM tests and the search for new physics phenomena over a wide range of center-of-mass energy and at high beam luminosity. These requirements include large and well-defined solid angle acceptance, excellent particle identification, accurate particle energy and momentum measurements, precise vertex reconstruction, excellent jet reconstruction, and flavor tagging. The physics program requires that all possible final states from decays of intermediate vector bosons, W and Z, and Higgs bosons be separately identified and reconstructed at high resolution. In particular, to clearly distinguish between the final states H→ZZ\* →4j and H→WW→4j, the energy resolution of the CEPC calorimetric system for hadronic jets should be better than existing systems. Higgs decays into two photons, and the search for invisible Higgs decays imposes additional requirements on the resolution of energy and missing energy measurements. Measuring the Higgs boson coupling to the charmed quark requires CEPC detectors to distinguish b-jets, c-jets, and light jets from each other~~,~~ with high efficiency. The sensitivity to Higgs decays to muon pairs requires high momentum resolution. The latter two demands define the requirements for the vertex detector and tracking system.

The CEPC conceptual design [1] contains three possible detector configurations. The basic CEPC detector concept was developed based on the ILD detector concept of the ILC project, optimized for CEPC conditions. It uses an ultra-high granular calorimetry system to efficiently separate the final state particle showers, a low material tracking system to minimize final state particle interactions, and a 3 Tesla solenoid that surrounds the entire calorimetric system. Two variants of the track system are considered. The default option is a combination of a silicon tracker and a time projection chamber (TPC). The other option is an all-silicon tracker. An alternative detector concept, IDEA, uses a dual-readout calorimeter to achieve excellent energy resolution for both electromagnetic and hadronic showers. Compared to the baseline detector, IDEA has a lower solenoidal field of 2 Tesla~~,~~ but is compensated by the large volume of the track system. IDEA has also been proposed as a reference detector for FCC-ee studies [12].

In addition, a new PFA calorimeter-based detector design has recently been developed to further improve the boson mass resolution from 4% to 3% [13]. The basic idea is to use long crystals for ECAL to obtain a much better electromagnetic resolution (~3%/√E), and to use a high-density scintillating glass as the active material of HCAL to achieve a better sampling factor and hence better hadronic energy resolution (~40%/√E). The main goal of the PFA calorimeter system is to achieve a jet energy resolution of about 30-40%/√E to meet the requirements of the physics program. Combining a silicon tracker with a TPC or a drift chamber allows improving the charged track momentum resolution and achieving better particle identification (~3 sigma pi/K separation for momentum up to 20 GeV/c).

**Workplan of the JINR group**

*1. Development of the experimental program*

A physics performance study of several physics topics will be performed for CEPC using Monte Carlo simulation, and the relevant analysis procedures will be elaborated.

The Higgs boson physics is the main task of the experiments at CEPC for all 10 years of data collection. The processes occurring with the formation of the Higgs boson at the CEPC at the energy √s∼240−250 GeV are e+e− → ZH, e+e− → νH, and e+e− → e+e−H. Higgs boson candidates can be identified using a mass recoil method, without labeling their decays. The branching ratios of the Higgs boson decay can be determined by studying its individual decay modes. Higgs boson decays, which can be identified by their unique signatures, will be studied in the following modes: H → bb ̅/cc ̅/gg, H → WW\*, H → WZ\*, H → Wγ, H → τ+τ-, H → µ+µ-, H → inv. A systematic study of the *e+e−→ZX* processes will be carried out with the aim of determining the properties of the Higgs boson~~s~~ with the best possible accuracy and new physics BSM searches using Monte Carlo generations for full detector simulations of signal and background events. As a result, algorithms will be developed for the best signal-to-background ratio in the selected events. Based on this analysis, values ​​of the Higgs boson characteristics are expected to be obtained with accuracy an order of magnitude better than in the experiments at the HL-LHC, and new physics phenomena BSM will be discovered.

A large sample of and mesons allows us to measure CP-violating phase *ϕ*s in decay  → *J*/*ψ ϕ*(1020) with unprecedented accuracy. The excellent particle identification, accurate track and vertex reconstruction, and extensive geometric acceptance of the planned detectors at the CEPC will make it possible to measure the phase *ϕ*s in another decay channel → J/*ψπ*+*π*−.

Besides this, there is considerable interest in the processes occurring with the formation of heavy (*c, b*) flavors and their bound states in *e+e-* annihilation in general. Such processes, in particular, are background for many processes of new physics BSM, which will be studied at the CEPC. Their cross sections are huge; for example, near the *Z*-boson mass, they are two orders of magnitude larger than the cross section of the process *e+e-→e+e-Z*. It is important that direct information on the fragmentation functions of heavy quarks into mesons can be obtained as a result of precision measurements of the total and differential cross sections for the production of *D* and *B* mesons in *e+e-* annihilation, which will allow us to qualitatively improve the accuracy of measuring the fragmentation functions. Experimental studies of reactions in collisions of virtual photons produced in *e+e-* interactions, along with the study of the processes of formation of bound states of heavy quarks (quarkonia), will allow us to obtain information on the dynamics of the quark-gluon interaction in a new kinematic region. It is by studying these reactions that we can extract new information on the behavior of electromagnetic form factors in the time-like region of transferred momenta, *Q2* > 0.

Finally, two photon collisions offer a variety of physics phenomena that can be studied at future electron-positron colliders [14]. Using the planned CEPC parameters as a benchmark, we will consider several topics within two-photon collisions. With the fully integrated luminosity, Higgs boson photoproduction can be reliably observed, and large statistics on various quarkonium states can be collected. The LEP results for the photon structure function and tau lepton anomalous magnetic moment can be improved by 1-2 orders of magnitude.

*2. High-precision theory calculations, theory support of experiments*

The theoretical support of the collider experiments focuses on precision modeling of processes in electron-positron accelerators, achieving accuracy up to the two-loop level. The JINR group already has ~~a~~ significant experience in theoretical support for experiments in high-energy physics: ZFITTER (LEP1, LEP2) and HECTOR (HERA). The integrator MCSANC and generator ReneSANCe are used in the analysis of Drell-Yan data in the ATLAS experiment.

The SANC (Support for Analytic and Numeric Computations) system, developed by the JINR group, is already widely used for calculations in the scope of CEPC physics studies [15-19]. However, further enhancements are necessary, implementing new processes within the computational framework, evaluating corrections beyond the leading order, and incorporating polarization effects into the modeling process. In the scope of this project, the development will be focused on the following studies:

* Theoretical support for luminosity estimation. Precision measurement of the Higgs boson mass.
* Measurement of the top quark polarization and determination of the anomalous top quark form-factors.
* The development of the Monte Carlo generator ReneSANCe, taking into account initial and final polarization states for the processes e+e− → e+ e− (μμ, ττ, tt̄, HZ, Hγ,
* ZZ, Zγ, Hμμ, Hνν, ffγ, γγ), γγ → γγ(Zγ, ZZ).
* Development of additional building blocks of the higher-order radiative corrections.

*3. Software and computing*

The significant amount of data to be produced at CEPC requires a large distributed computing infrastructure for data storage and data processing. Moreover, this infrastructure will be needed long before the data taking starts due to the large-scale simulation needed for the development of the experimental program and performance studies. Based on the experience gained in the ATLAS experiment and in the design of the computing system for NICA/SPD, the JINR group is going to participate in the design, development, and commissioning of the CEPC computing system. Options for JINR joining the CEPC computing, possibly integrating with the NICA data processing system, will be worked out. Participation in the simulation of physics processes, modeling detectors, and developing algorithms and offline software for the experiments at CEPC is planned as well.

*4. Detector R&D*

A calorimetry system is employed in the CEPC detectors to provide hermetic coverage for high-resolution energy measurements of electrons, photons, taus, and hadronic jets. Two different approaches are used for the CEPC calorimetry system. The first one is aimed at measuring individual particles in a jet using a calorimetry system with a very high granularity based on the particle flow algorithm (PFA), and the second one is aimed at a homogeneous and integrated solution based on the dual-readout concept.

To distinguish the hadronic decays of W and Z bosons, a 3–4% invariant mass resolution for two-jet systems is required. Such a performance needs a jet energy resolution of ~ 30%/, at energies below 100 GeV.

A PFA-based high-granularity HCAL with scintillation glass/absorber steel is proposed as a baseline detector for the CEPC. Scintillation glass has a density of about 6.0 g/cm3, a light yield of more than 1000 ph/MeV, and a decay time of more than 100 ns. There are no technologies yet for producing large-size samples (more than 10x10 cm2). The HCAL has 48 layers of steel absorbers/scintillation glass tiles with a total depth of 6*λI*, as shown in Fig. 3. The scintillation layer consists of glass tiles measuring 4x4x1 cm3.



Figure 3. The HCAL module has 48 layers of steel absorbers/scintillation glass tiles; the total depth is 6*λI*.

The crystal calorimeter is considered the baseline ECAL design. The length of the ECAL barrel is 580 cm, and the inner and outer diameters are 366 cm and 426 cm. The barrel is composed of individual modules of trapezoid shapes. The endcap modules are made from 1x1x40 cm3 beryllium germanium oxide (BGO) crystal bars (BSO crystals are considered as an alternative option) arranged orthogonally in every two layers, providing fine segmentation. The modules have a thickness of 24 radiation lengths. The ECAL endcap module schematic is presented in Figure 4.

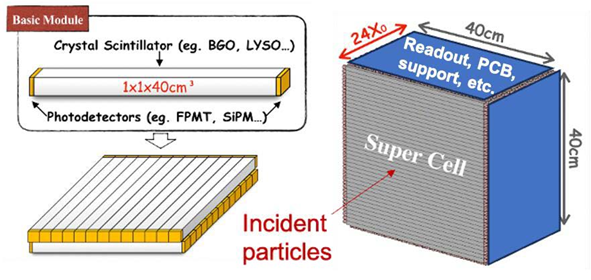


Figure 4. ECAL endcap module schematic.

10x10x400 mm3 BGO crystal bars provide 10x10 mm2 transverse granularity. An alternative option of using crystals measuring 15x15x400 mm3 is currently being considered. This option significantly reduces the total readout channels, saves costs on electronics and SiPM, and greatly decreases power dissipation. However, this leads to some degradation of the ECAL parameters. The Higgs decay into two photons, H→𝛾𝛾, is a physical criterion that is crucial for ECAL. 15 mm granularity shows slightly degraded performance in gamma separation efficiency. 𝜋0 performance is degraded in high energy with a 15×15 mm2 crystal cross-section but can be improved by the 𝛾/𝜋0 discrimination technique. Further simulation of the ECAL calorimeter and prototype testing are required to optimize performance. In addition, it is necessary to conduct studies on the radiation hardness of the BGO crystals.

The project participants have extensive experience in the creation, characterization, and maintenance of electromagnetic and hadron calorimeters [20], in the development of various methods for calibrating of calorimeters [21, 22], in the characterization of crystals and crystal calorimeters [23], and in the study of their radiation resistance [24]. All these stages will be completed during the project, including development of calorimeter calibration methods, full simulation of the calorimeter system, production of prototypes, and their testing on benches and in accelerator beams.

Outside the solenoid is an iron yoke serving as the magnetic flux return. The yoke will be instrumented with a muon detector designed for muon identification. However, it could also be used to detect the leakage of HCAL and can be used for trigger and other tasks. The muon detector should provide solid angle coverage of 0.98×4𝜋, detection efficiency >95%, position resolution ~1 𝑐𝑚, and time resolution ~1 𝑛𝑠. In the baseline option, the muon detector will use plastic scintillation strips with WLS fibers and SiPM readout. Resistive Plate Chambers (RPC) and μ-RWELL detector technology are also being considered as alternatives.

Extruded plastic scintillator technology will be used to produce scintillator strips. Various strip designs are being considered: rectangular, square, or triangular cross-sections with fibers glued into grooves or placed into holes inside the scintillation strips (Figure 5). The scintillation strips are assembled into superlayers in orthogonal directions (X, Y), and two superlayers (each approximately half the length of the yoke) are inserted into each gap between the iron layers.

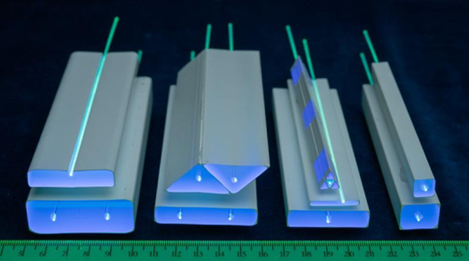


Figure 5. Scintillation strips with WLS fibers as candidates for use in the muon system.

To improve the characteristics of the muon detector and select the optimal detector parameters, additional simulation and testing of prototypes is required. Currently, a strip with a cross-section of 10x40 mm2 with a fiber glued in a groove is the basic option. To increase light collection from strips, options for using larger-diameter WLS fibers are being considered. Various prototypes with these options will be simulated, created, and tested. The project participants have extensive experience in the development and characterization of muon systems based on the long scintillation strips with WLS fiber readout [25, 26].

The CEPC Tracking Detector System uses silicon vertex detectors in combination with a gas detector to track and identify particles (PID). The Time Projection Chamber (TPC) is the default outer tracker option of the CEPC baseline detector concept.

The TPC has a cylindrical drift volume with an inner radius of 0.63 m, an outer radius of 1.8 m, and a full length of 4.7 m. The central cathode plane is held at a potential of 50 kV, and the two anodes at the two end plates are at ground potential, with a highly homogeneous electrical field of 300 V/cm between the electrodes. The drift volume is filled with Ar/CF4/iC4H10 in the ratio of 95%/3%/2%. The CEPC TPC will operate at atmospheric pressure, providing a material budget of less than 1%X0 in the central region.

Pixelated Micromegas readout TPC is the baseline track detector in CEPC. It can provide **<3%** dN/dx resolution by cluster counting and 5.4% dE/dx resolution by charge measurement. Preliminary simulation results show that 3σ π/K separation at 20 GeV with a 50 cm drift distance can be achieved. However, some key issues should be modeled and tested on prototypes.

The project participants have extensive experience in the design, creation, and research of Micromegas detectors. We plan to produce prototypes of the Micromegas microstructured gas detector and test them in the CEPC TPC prototype. The JINR group participants have full expertise to fulfill these tasks [27].

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**2.3 Estimated completion date**

2027

**2.4 Participating JINR laboratories**

DLNP

BLTP

LHEP

MLIT

**2.4.1** **MICC resource requirements**

|  |  |  |
| --- | --- | --- |
| **Computing resources** | **Distribution by year** | |
| 1st year | 2nd year |
| Data storage (TB)  - EOS  - Tapes | 10 | 20 |
| Tier 1 (CPU core hours) | - | - |
| Tier 2 (CPU core hours) | 20000 | 20000 |
| SC Govorun (CPU core hours)  - CPU  - GPU | - | - |
| Clouds (CPU cores) | - | - |

**2.5. Participating countries, scientific and educational organizations**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Organization** | **Country** | **City** | **Participants** | **Type**  **of agreement** |
| IHEP | China | Beijing | Y.F. Wang  M.Q. Ruan  W.D. Li  X.C. Lou  M. Chen | Cooperation Agreement |
| Shandong University | China | Qingdao | X.T. Huang | Cooperation Agreement |
|  |  |  |  |  |
| Fudan University | China | Shanghai | X. Wang | Cooperation Agreement |
| LPI RAS | Russia | Moscow | T. Aushev  P. Pakhlov | Cooperation Agreement |
| BINP RAS | Russia | Novosibirsk | A.Barnyakov | Cooperation Agreement |
| IP NASB | Belarus | Minsk | Yu.A. Kurochkin | Cooperation Agreement |
| INP BSU | Belarus | Minsk | O.V. Misevich  V.V. Makarenko | Cooperation Agreement |
| IE NASB | Belarus | Minsk | V.G. Baev | Cooperation Agreement |
|  |  |  |  |  |

**2.6. Key partners** *(those collaborators whose financial, infrastructural participation is substantial for the implementation of the research program. An example is JINR's participation in the LHC experiments at CERN).*

IHEP CAS

**3. Manpower**

**3.1. Manpower needs in the first year of implementation**

|  |  |  |  |
| --- | --- | --- | --- |
| **№№**  **n/a** | **Category of personnel** | **JINR staff,**  **amount of FTE** | **JINR Associated**  **Personnel,**  **amount of FTE** |
| 1. | research scientists | 25.1 | 0 |
| 2. | engineers | 1.8 | 0 |
| 3. | specialists | 0 | 0 |
| 4. | office workers | 0 | 0 |
| 5. | technicians | 0.1 | 0 |
|  | **Total:** | **27.0** | **0** |

**3.2. Available manpower**

**3.2.1. JINR staff**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Category of personnel** | **Full name** | **Division** | **Position** | **Amount**  **of FTE** |
| 1. | research scientists | Yuri Davydov | DLNP | Head of department Project co-leader | 0.7 |
| 2. |  | Alexey Zhemchugov | DLNP | Deputy head of department  Project co-leader | 0.4 |
| 3. |  | Yuri Kulchitsky | DLNP | Head of sector  Deputy project leader | 0.7 |
| 4 |  | Lidia Kalinovskaya | DLNP | Head of sector | 0.8 |
| 5 |  | Alexi Gongadze | DLNP | Head of sector | 0.4 |
| 6 |  | Ivan Eletskikh | DLNP | Head of sector | 0.3 |
| 7 |  | Gennady Lykasov | DLNP | Chief Researcher | 0.5 |
| 8 |  | Akram Artikov | DLNP | Leading researcher | 0.7 |
| 9 |  | Igor Boyko | DLNP | Senior researcher | 0.7 |
| 10 |  | Davit Chokheli | DLNP | Senior researcher | 0.6 |
| 11 |  | Igor Suslov | DLNP | Senior researcher | 0.5 |
| 12 |  | Nazim Huseinov | DLNP | Senior researcher | 0.5 |
| 13 |  | Vladimir Lyubushkin | DLNP | Senior researcher | 0.5 |
| 14 |  | Aleksandr Simonenko | DLNP | Senior researcher | 0.6 |
| 15 |  | Leonid Gladilin | DLNP | Senior researcher | 0.3 |
| 16 |  | Yahor Dydyshka | DLNP | Senior researcher | 0.8 |
| 17 |  | Vitaly Yermolchyk | DLNP | Senior researcher | 0.8 |
| 18 |  | Andrey Sapronov | DLNP | Senior researcher | 0.8 |
| 19 |  | Renat Sadykov | DLNP | Senior researcher | 0.8 |
| 20 |  | Leonid Rumyantsev | DLNP | Senior researcher | 0.3 |
| 21 |  | Andrey Prokhorov | DLNP | Senior researcher | 0.8 |
|  |  | Roman Lee | DLNP | Senior researcher | 0.1 |
| 22 |  | Konstantin Afanaciev | DLNP | Researcher | 0.7 |
| 23 |  | Vladimir Malyshev | DLNP | Researcher | 0.6 |
| 24 |  | Nikolay Atanov | DLNP | Researcher | 0.7 |
| 25 |  | Ilia Zimin | DLNP | Researcher | 0.7 |
| 26 |  | Elena Plotnikova | DLNP | Researcher | 0.5 |
| 27 |  | Pavel Tsiareshka | DLNP | Researcher | 0.5 |
| 28 |  | Vladimir Baranov | DLNP | Researcher | 0.7 |
| 29 |  | Ilya Vasilyev | DLNP | Researcher | 0.7 |
| 30 |  | Viktoriya Moskalenko | DLNP | Junior researcher | 0.7 |
| 31 |  | Aleksandr Boikov | DLNP | Junior researcher | 0.5 |
| 32 |  | Viktoria Kiseeva | DLNP | Junior researcher | 0.6 |
| 33 |  | Oksana Dolovova | DLNP | Junior researcher | 0.5 |
| 34 |  | Anastasiya Tropina | DLNP | Junior researcher | 0.6 |
| 35 |  | Tatiana Lyubushkina | DLNP | Junior researcher | 0.3 |
| 36 |  | Alexey Kampf | DLNP | Junior researcher | 0.8 |
|  |  |  |  |  |  |
| 37 |  | Andrej Arbuzov | BLTP | Head of sector  Deputy project leader | 0.4 |
| 38 |  | Serge Bondarenko | BLTP | Head of sector | 0.3 |
| 39 |  | Vladimir Zykunov | BLTP | Leading researcher | 0.1 |
| 40 |  | Maria Savina | BLTP | Senior researcher | 0.1 |
| 41 |  | Uliana Voznaya | BLTP | Trainee researcher | 0.3 |
|  |  |  |  |  |  |
| 42 |  | Vladimir Karzhavin | VBLHEP | Head of department | 0.1 |
| 43 |  | Valery Chmill | VBLHEP | Leading researcher | 0.4 |
| 44 |  | Faig Ahmadov | VBLHEP | Senior researcher | 0.4 |
| 45 |  | Alexander Lanyov | VBLHEP | Senior researcher | 0.1 |
| 46 |  | Vyatcheslav Shalaev | VBLHEP | Senior researcher | 0.1 |
| 47 |  | Viktor Perelygin | VBLHEP | Senior researcher | 0.1 |
| 48 |  | Ilya Zhizhin | VBLHEP | Researcher | 0.1 |
|  |  |  |  |  |  |
| 49 |  | Sergey Shmatov | MLIT | Director | 0.1 |
| 50 |  | Nikolay Voytishin | MLIT | Deputy director | 0.1 |
| 51 |  | Alexander Nikitenko | MLIT | Leading researcher | 0.1 |
| 52 |  | Olga Kodolova | MLIT | Leading researcher | 0.1 |
| 53 |  | Danila Oleynik | MLIT | Senior researcher | 0.1 |
| 54 |  | Artem Petrosyan | MLIT | Senior researcher | 0.1 |
| 55 |  | Igor Pelevanyuk | MLIT | Researcher | 0.1 |
| 56 |  | Kirill Slizhevsky | MLIT | Trainee researcher | 0.1 |
| 57 |  | Yury Korsakov | MLIT | Trainee researcher | 0.1 |
|  |  |  |  |  |  |
| 58 | engineers | Olga Atanova | DLNP | engineer | 0.5 |
| 59 |  | Vyacheslav Rogozin | DLNP | engineer | 0.6 |
| 60 |  | Andrey Shalyugin | DLNP | Senior engineer | 0.4 |
| 61 |  | Dmitry Budkovsky | VBLHEP | Engineer | 0.1 |
| 62 |  | Andrey Golunov | VBLHEP | Leading engineer | 0.1 |
| 63 |  | Yury Ershov | VBLHEP | Leading engineer | 0.1 |
|  | specialists |  |  |  |  |
| 64 | technicians | Dmitry Kozlov | VBLHEP | laborant | 0.1 |
|  | **Total:** |  |  |  | **27.0** |

**3.2.2. JINR associated personnel**

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Category of personnel** | **Partner organization** | **Amount of FTE** |
| 1. | research scientists |  | 0 |
| 2. | engineers |  | 0 |
| 3. | specialists |  | 0 |
| 4. | technicians |  | 0 |
|  | **Total:** |  | **0** |

**4. Financing**

**4.1 Total estimated cost of the project/LRIP subproject**

The total cost estimate of the project (for the whole period, excluding salary).

The details are given in a separate table below.

600 kUSD

**4.2 Extra funding sources**

Expected funding from partners/customers – a total estimate.

**Project (****LRIP subproject) Leader** \_\_\_\_\_\_\_\_\_\_/\_\_\_\_\_\_\_\_\_\_\_/

Date of submission of the project (LRIP subproject) to the Chief Scientific Secretary: \_\_\_\_\_\_\_\_\_

Date of decision of the laboratory's STC: \_\_\_\_\_\_\_\_\_ document number: \_\_\_\_\_\_\_\_\_

Year of the project (LRIP subproject) start: \_\_\_2026\_\_\_\_\_\_

(for extended projects) – Project start year: \_\_\_\_\_\_\_

**Proposed schedule and resource request for the Project / LRIP subproject**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Expenditures, resources,**  **funding sources** | | | **Cost (thousands**  **of US dollars)/**  **Resource requirements** | **Cost/Resources,**  **distribution by years** | |
| 1st year | 2nd year |
|  | | International cooperation | 200 | 100 | 100 |
| Materials | 100 | 50 | 50 |
| Equipment, Third-party company services | 300 | 150 | 150 |
| Commissioning | - | - | - |
| R&D contracts with other research organizations | - | - | - |
| Software purchasing | - | - | - |
| Design/construction | - | - | - |
| Service costs (*planned in case of direct project affiliation)* | - | - | - |
| **Resources required** | **Standard hours** | Resources |  |  |  |
| * the amount of FTE, | 27.1 | 27.1 | 27.1 |
| * accelerator/installation, | - | - | - |
| * reactor,… | - | - | - |
| **Sources of funding** | **JINR Budget** | JINR budget *(budget items)* | 600 | 300 | 300 |
| **Extra fudning (supplementary estimates)** | Contributions by  partners  Funds under contracts with customers  Other sources of funding | 0 | 0 | 0 |

Project (LRIP subproject) Leader\_\_\_\_\_\_\_\_\_/\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/

Laboratory Economist \_\_\_\_\_\_\_\_\_/\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_/

**APPROVAL SHEET FOR PROJECT / LRIP SUBPROJECT**

TITLE OF THE PROJECT/LRIP SUBPROJECT

SHORT DESIGNATION OF THE PROJECT / SUBPROJECT OF THE LRIP

PROJECT/LRIP SUBPROJECT CODE

THEME / LRIP CODE

NAME OF THE PROJECT/ LRIP SUBPROJECT LEADER

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | |  | | |
| AGREED |  |  | |  | | |
| JINR VICE-DIRECTOR | \_\_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | | \_\_\_\_\_\_\_\_\_  DATE | |  |
| CHIEF SCIENTIFIC SECRETARY | \_\_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | | \_\_\_\_\_\_\_\_\_  DATE | |  |
| CHIEF ENGINEER | \_\_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | | \_\_\_\_\_\_\_\_\_  DATE | |  |
| LABORATORY DIRECTOR | \_\_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | | \_\_\_\_\_\_\_\_\_  DATE | |  |
| CHIEF LABORATORY ENGINEER | \_\_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | | \_\_\_\_\_\_\_\_\_  DATE | |  |
| LABORATORY SCIENTIFIC SECRETARY  THEME / LRIP LEADER | \_\_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | | \_\_\_\_\_\_\_  DATE | |  |
| PROJECT / LRIP SUBPROJECT LEADER | \_\_\_\_\_\_\_\_\_\_  SIGNATURE | \_\_\_\_\_\_\_\_\_  NAME | | \_\_\_\_\_\_\_\_\_  DATE | |  |
|  |  |  | |  | |  |
| APPROVED BY THE PAC | \_\_\_\_\_\_\_\_\_  NAME | | \_\_\_\_\_\_\_\_\_  DATE | |