Opponent review

on proposal for the prolongation of the project

≪THE PRECISION LASER METROLOGY FOR ACCELERATORS AND DETECTOR COMPLEXES≫

During the development and creation of laser measuring system for metrological support of modern accelerators and large-scale detector complexes, the authors have reached record parameters for all components of the complex. Based on achieved progress they propose to extend the Project with the aim of creation of the distributed network with six Precision Laser Inclinometers in the LHC location area. The obtained data on the deformation of the Earth surface with sensitivity of $2.4 \cdot 10^{-11}$ rad/Hz$^{1/2}$ in 10^{-6} – 4 Hz frequency band can be used by the feedback system to correct online the operation parameters of the collider and to stabilize the spatial position of the beam focuses in the collision area.

The relevance of seismic protection of LHC and detector complex is related with a constant seismic activity in various regions of the Earth. The seismic wave propagation deform the Earth surface that may cause divergence in the focus position in the collision zone.

The authors propose to create a seismically isolated from the Earth surface angular oscillations the research platform to solve the challenge of the maximum attenuation of inertial seismic loads on the equipment of the measuring complex. The Project envisage a creation of its laboratory prototype in common with the Precision Laser Inclinometer. To be noted that the design of the platform construction should exclude influence of the resonance from seismic.

The authors justify the necessity of the platform as well as its interest for scientific community. To find a solution to this problem, according to my information, the first international meeting is scheduled for this autumn (in Italy or in England).

The researches executed with laboratory prototype can be used for the seismic isolation of LHC and ATLAS spectrometer where the high-precision reproduction of the mutual position of the spectrometers subsystems and structures is required.

If the authors will successfully solve the tasks specified in the Project than JINR, doubtless, will become the "owner" of a new key technology that allows conducting of physical experiments on a fundamentally new level. Moreover, the practical realization will increase the sensitivity of experiments on colliding beams and provide new quality to scientific research that will bring the experimental results closer to their actual values.

The second part of the Project is dedicated to accomplishing the works of the creation of the Interferometric Distance Meter and the Laser Fiducial Line. The authors of Project associate these works with the commissioning of the DLNP Metrological Laboratory.

Using of Laser Interferometer in a wide band it would be possible to measure everything that affects the optical length of the measuring arm: linear movements, velocities, accelerations, etc. The interferometer is needed for the precision connection of coordinate systems of two LHC accelerators with ATLAS experiment in between. The high stability of Interferometer will allow providing the on-line long-term control on a distance up to 16 m with measurement accuracy better than 10 μm.

In the third part of Project the authors propose a new way of distance measuring using the high-frequency amplitude modulation of the laser beam. This method deserves a patent by itself as far as it will significantly simplify the distance measuring procedure preserving the independence of the measurements from the environment condition. But should be noted there are some difficulties with the electronics in the GHz- band (modulation of laser radiation power and signal processing by operational amplifiers).

With a commissioning of the DLNP Metrological Laboratory the authors are going to start the researches on Laser Fiducial Line that will be executed in a few stages with a line length of 20, 60 and 130 meters. With a length limitation of Laboratory (23 m) the length of 60 and 130 meters are possible only with reflecting prisms.

Also note that it is advisable to make a prototype of the Laser Fiducial Line with a full length in most realistic conditions. This will significantly simplify a construction of vacuum system and increase its reliability. All the more so such “long room” is already exist and recently transferred to the DLNP from the IBR30. But of course, as a methodological study, it is necessary to study LFL in the DLNP Metrological Laboratory.

In connection with above achievements of the authors in connection with JINR Precision Laser Inclinometer, I consider it necessary to approve the extension of the Project “The Precision Laser Metrology for Accelerators and Detector Complexes” as a first priority research in JINR Topical Plan 2019-2021 y.y.

«13» March 2018 Zalikhanov B.