Review of the report on the implementation of the project phase in 2019-2020

STUDY OF THE POSSIBILITY OF MODERNIZATION OF THE READING SYSTEM FOR ELECTROMAGNETIC CALORIMETER PHOS ALICE

(JINR participation)

The main problems that determine the need to modernize the recording electronics of the PHOS ALICE ELECTROMAGNETIC CALORIMETER in conditions of an increase in the LHC luminosity and an increase in the maximum energy of registered photons are:

- the need to increase the dynamic range of the EM - shower energy measurement up to 200 GeV;
- the need to increase the time resolution of the EM - calorimeter;
- the need to replace the outdated element base (the existing PHOS measuring electronics was developed in 2004 on the basis of the ALTRO microcircuit, which is not produced);
- to develop a version of registration electronics capable of working together with crystals and a photodetector at a temperature of + 18 ° C and satisfying the requirements of the experiment in terms of noise and speed.

Since 2014, the staff of VBLHEP JINR and the NRC "Kurchatov Institute" have carried out research aimed at solving the above problems. In particular, the expediency of replacing a 5 × 5 mm2 APD with an APD with an area of 10 × 10 mm2 experimentally shown to replace a PWO-based photodetector (APD - avalanche photodiode) with an APD with an area of 10 × 10 mm2.

Replacing the photodetector with an APD with a 4 times larger sensitive area made it possible to obtain the energy resolution of the calorimeter prototype (the results of beam tests on electrons in the range of 1-10 GeV) at a temperature of + 18 ° C, no worse than at a temperature of -25 ° and an APD with an area of 5 × 5 mm2. As a result, the possibility of using the HAMAMATSU S8664-1010 avalanche photodiode for amplitude and time measurements as a part of registering electronics. When tested on an electron beam with a momentum of 1 GeV, the time resolution was 500 ps at a discriminator threshold equivalent to 200 MeV. This result achieved at a temperature of +18 degrees, which greatly simplifies the operation of the recording electronics. After conducting research in 2017 and 2018, the results

obtained that finally determined the type of APD photodetector (HAMAMATSU S8664-1010) and the characteristics of the recording electronics.

The FEE_8 board tested in the 2018 run meets all the requirements for the electronics of the PHOS electromagnetic calorimeter, providing a dynamic range of gamma-ray energy measurements from 5 MeV to 200 GeV with a time resolution better than 500 ps. The results of laboratory and beam tests made it possible to start at the 2019-2020 stage. to the development of a pre-production sample of a 32-channel board with two measurement paths: amplitude and time. The development of the board will be based on the use of microcircuits (ADC) ADS52J90 and (TDC) HPTDC (High Performance Time to Digital Converter).

As a result of work during the 2019-2020 stage the technical documentation for a pre-production FEE sample was developed, two prototypes were made with 32 channels for recording signals from PWO crystals, and at the end of 2020 they will be tested. After testing, this version of the FEE planned to be submitted for consideration by the ALICE collaboration.

The development of electronics of this level meets modern requirements in the measuring technique of a physical experiment; undoubtedly, it is interesting and can be in demand when creating experimental installations at the NICA complex.

I propose to NTS LHEP to approve the report on the work of the 2019-2020 stage of the project "STUDY OF THE POSSIBILITY OF MODERNIZATION OF THE READING SYSTEM FOR ELECTROMAGNETIC CALORIMETER PHOS ALICE" (JINR participation)

N.I. Zamyatin

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