Referee report

on the project

Upgrade of the ATLAS detector

(within the JINR theme 02-0-1081-2009/2019)

The ATLAS detector has been developed and constructed with a large participation of the JINR scientists and engineers. The important contributions have been done in different detector systems: muon detector, liquid-argon calorimeter, tile calorimeter, in development of trigger, DAQ, procedures of calibration and data analysis etc. Excellent performance of the detector made it possible to obtain outstanding physics results, the most significant and resonant of which was discovery of the Higgs boson.

CERN approved the LHC upgrade program, with Phase-I upgrade starting in 2019-2020 and Phase-II in 2024-2026. The LHC upgrade requires a relevant upgrade of the ATLAS detector in order to conform to conditions of much higher luminosity what leads to increase of detector rates. Besides, irradiation of some parts of the detector during the past years of the ATLAS operation already resulted in partial degradation of their performance. Participation of the JINR group in the ATLAS upgrade would be a natural extension of their previous activity in detector development.

In the project under consideration, the authors present the obtained in 2015-2017 results and propose their plans of participation in the ATLAS upgrade program. These plans include upgrade of the Calorimeters and the Muon Spectrometer. Some of these works have started already.

Works on calorimetry.

For the LAr Calorimeter, several options of upgrade were considered. Extensive works on simulation were done in order to estimate the degradation effect due to electronics irradiation. It was shown that the energy non-linearity

increase is negligible. This result allowed the Collaboration to avoid the cryostat opening.

For the FCal, the option of thinner LAr gaps was investigated, and it was demonstrated that there is no need in replacement of the FCal.

There were many irradiation tests fulfilled at the IBR-2 reactor and the U-70 accelerator in Protvino, where various components of the mini-FCal and HEC calorimeters were tested, and conclusions about the promising sensors and materials for future applications have been done.

Much attention is given to development of the LAr calorimeter electronics including radiation tolerant front-end electronics as well as readout and trigger electronics. Some prototypes have been developed and tested already.

Radiation-hard plastic scintillators were proposed by the JINR group for installation in the endcup area of the LAr calorimeter, and there is in progress the study of radiation hardness of plastic scintillators for Inter-TileCal counters.

Another big field of activity is upgrade of the ATLAS Muon Spectrometer.

A significant achievement of the JINR group is construction of the workshop for production of Micromegas detectors and for the quadruplets assembly. Micromegas detectors will be used in the New Small Wheels which will replace the current Small Wheels in the endcup Muon Spectrometer. The production site was commissioned and mass-production of the Micromegas chambers has started in 2017. The whole complex includes clean rooms for production and assembling, test stand for semi-automatic measurements of geometrical characteristics, gas leakage stand, high voltage stand for readout panels, cosmic ray stand for testing of the quadruplet quality control, and other equipment.

The novel technology of GaAs-based semiconductor pixel detectors has been implemented by the JINR group for monitoring of the neutron fluence in the ATLAS cavern.

Concluding, the JINR group fulfilled a huge work on construction of the ATLAS detector in the past, and has extensive plans of participation in the ATLAS upgrade. The experience of participants leaves no doubt that the goals of this upgrade will be reached.

The requested resources are reasonable for this large-scale project.

I recommend to approve the project "Upgrade of the ATLAS detector" with the first priority.

Head of Sector, DLNP JINR
Doctor of Science

A.Kulikov