Referee Report

on the project

"Upgrade of CMS Detector through 2020. Project prolongation 2018-2020"

Report on the implementation of the project "Upgrade of CMS Detector through 2020. Project prolongation 2018-2020" includes a detailed description of the project status and the results achieved during its implementation.

The upgrade of the CMS detector in 2009-2020 was aimed at improving the detector sub-systems to operate at full energy of LHC in Run2 and Run3, as well as preparing for high luminosity running (HL-LHC). The JINR group was responsible for the upgrade of the Forward Muon Stations *ME* and endcap hadron calorimeters *HE*.

During the implementation of the project, the JINR group carried out a significant amount of work to upgrade the CMS detector. Significant contributions to CSC aging research should be noted. These works are of particular importance in connection with the limitation of the use of greenhouse gases in the world, including CF_4. A study of the aging of CSC with a decrease in the proportion of CF_4 in the gas mixture from 10% to 2% using the GIF ++ facility showed that the chambers remain operational at high absorbed doses. These results are quite important and can be used in other experiments using CF_4 gas. An important stage in the work is the study of scintillation detectors to improve the performance of the hadron calorimeters *HE* under high-intensity conditions. The study of radiation damage of plastic scintillators was carried out at the IREN facility (FLNP JINR). As a result of the tests carried out, changes were proposed to the scintillation tiles of the calorimeter, which ensure reliable operation of the calorimeter under high intensity conditions (HL-LHC). These studies may also be of great interest to other experimental groups.

In conclusion, it should be noted that the JINR group has successfully fulfilled all the undertaken obligations to participate in the upgrade of the CMS detector and successfully completed the project. The achievements of the team demonstrate the highest expert level of the JINR participants in the experiment. The valuable experience of the group can and certainly should be used in the future when preparing the CMS detector sub-systems for operation in high luminosity conditions (HL-LHC).

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