Referee report

on the project

Upgrade of the CMS Detector through 2020

(JINR TOPIC 02-0-1083-2009/2019)

The JINR group made an important contribution to the development and construction of the CMS Detector from the very beginning what allowed obtaining outstanding physics results.

Since 2011, when CERN approved upgrade of the CMS Detector, the JINR group actively participates in Phase I of detector sub-systems upgrade. JINR group has responsibility for the Forward Muon Stations ME1/1 and Endcap Hadron Calorimeters. The group participates in R&D necessary for preparation of further upgrade at Phase II as well.

Plans for 2018-2020 include R&D for the Endcap Muon System and Endcap Hadron Calorimeter upgrades.

ME1/1 chambers were already dismounted, refurbished with new electronics and tested during Long Stop 1. New ME4/2 chambers allowed to improve efficiency. Readout electronics of muon stations are developed and ready for mass-production in 2018. Mass production of already developed by JINR group low voltage distribution boards planned for 2018 as well. Replacement of readout electronics on all internal muon stations MEx/1 (x=2,3,4) and installation of CSC with new electronics scheduled for 2019-2020 during a Long Stop 2. Very important tests are planned with new CSC gas mixture because of limitation of use of CF_4 gas. Lowering of CF_4 fraction from 10% to 2% requires tests of aging effects to ensure that chambers still have a long term stability and safe to use at worst radiation environment. These tests are in progress at GIF++ facility at CERN.

Upgrade of the Endcap Hadron Calorimeter foresees replacement of HPD with SiPM. Front-end and back-end electronics, readout modules will be replaced during technical stop of LHC in 2018 and the Long Stop 2 as well. Using SiPM instead of HPD allows to increase dynamic range and rate capability, to improve longitudinal segmentation. Group is developing stand for quality control and long term stability tests of front-end modules. New SiPMs were tested, calibrated and commissioned, that work still is in progress.

JINR group actively involved in the R&D of Phase II of CMS upgrade as well. That upgrade aimed to achieve an excellent performance of all detector sub-systems at High Luminosity LHC operation.

Goal of R&D for the Endcap muon system upgrade Phase II is to study of aging of detectors and radiation hardness of electronics at high luminosity. It was shown that ME1/1 station is able to work at high luminosity without visible aging effects. Some Endcap muon system electronics needs to be replaced for operation in high luminosity conditions. These tests are in progress and will continue during next three years.

R&D for the Endcap Hadron Calorimeter upgrade Phase II is aimed for increase a granularity of calorimeter. It was suggested to replace tails in the Endcap calorimeter with finger-strip plastic scintillators. Such a replacement increases granularity of calorimeter and has advantages at high luminosity, but requires more readout channels. Study of plastic scintillators and SiPMs damage caused by radiation have been carried out at IREN facility at JINR as well as in collaborating institutes. Those R&D with scintillators and SiPMs will continue next three years. The group is considering the possibility of creating a scintillator module in Dubna in cooperation with RDMS institutes and DESY and CERN for production of High Granularity Calorimeter.

Finally, the JINR CMS group completed a huge amount of R&D and prototyping works for Phase I of the CMS upgrade. The group has a balanced team of experts in all areas, where it participates. I have no doubt that the group will successfully fulfill all the tasks for the CMS Detector upgrade scheduled for the next 3 years.

The requested resources look reasonable taking into account group's contribution in the development of the detectors and electronics during the previous preparation periods.

Considering the foregoing, the participation of the JINR group in continuation of the CMS Detector upgrade program looks absolutely natural. I recommend prolongation of the project "Upgrade of the CMS Detector through 2020" with the first priority.

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