Report on the project „Upgrade of the CMS detector“

(for the years 2022-2026)

The experiment CMS (Compact Muon Solenoid) is a large general-purpose particle physics detectors built on the Large Hadron Collider (LHC) at CERN. The goal of the CMS experiment is to investigate a wide range of physics, including the production and study of the Higgs boson, extra dimensions, supersymmetry and particles that could make up dark matter. The experiment can also study some aspects of heavy-ion physics.

In 2012, signals of Higgs boson production, the last particle expected and missing in the Standard Model table, was recorded in the CMS experiment and also in another LHC experiment ATLAS. The existence of this particle was subsequently safely proven by both experiments. Based on its experimental confirmation, the Nobel Prize was awarded in 2013 to François Englert and Peter W. Higgs, whose theoretical research predicted this particle.

Therefore, the CMS experiment is currently one of the world's most important projects in particle physics, and it is right that the JINR Group has its share in its implementation. Further significant results can be expected in the next period, the preparation of which is the focus of this project.

The JINR, with the participation of several other Member States (RDMS CMS collaboration), has been involved in the experiment from the very beginning. The project was concentrated on the design, construction, commissioning, operation and upgrade of the CMS inner Endcap detectors, where the RDMS bears full responsibility on Endcap Hadron Calorimeter (HE) and First Forward Muon Station (ME1/1).

For the next phase, it is necessary to ensure a complete upgrade of detectors, especially with regard to their high load with a multiple increase (10x) of luminosity (HL-LHC, from 2027).

The main goals of this project are to contribute to the construction:

1. Highly Granularity Calorimeter (HGCal)
2. Upgrade of the ME1/1 Cathode Strip Chambers (CSC) of the CMS.

The project precisely defines the activities and costs for the production and purchase of the necessary components, for which JINR is responsible according to the MoU. In my opinion, both goals are achievable and correspond to the conditions and possibilities of JINR.

Many highly experienced and qualified JINR scientists are involved in the project (see the table Employment of JINR participants), which is a guarantee of meeting the commitments. The total number of employees is 44 (21.5 FTE), but 9 employees participate in only 0.1 FTE. I do not consider the present age structure to be optimal. This is a project that will continue beyond 2026, so the proportion of young scientists should be higher. The project envisages attracting the students and postgraduates, for example from Dubna University.

Further people from other laboratories participate in the RDMS CMS collaboration: Yerevan (5), Minsk(7), Kharkov (8), Tashkent (3).

The section “Project benefits” summarizes all positive aspects of participation in the CMS project. I consider as particularly important the transfer of methods and technologies applied at CERN, for the needs of JINR, specifically for the BM@N experiment.

In the section “Project weaknesses and risks”, the problems that may occur during the project implementation are realistically evaluated. Some delays cannot be ruled out however, successful completion of the project is highly likely.

The estimated costs of 3489kUS $ for the years 2022-2026 are, in my opinion, reasonable and will ensure the continuation of the CMS project in JINR.

Based on all the above arguments, I can recommend that the project be supported with the highest priority.

Petr Zavada

Institute of Physics, ASCR, Prague

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