

## **CMS PHASE I PIXEL DETECTOR UPGRADE**

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Helsinki Institute of Physics CMS Upgrade project is responsible of the Finnish hardware contribution to the CMS experiment at CERN. Since 2013 the main activity in the project has been the Phase I Upgrade of the pixel detector that will be installed to the experiment during the winter technical stop in the beginning of 2017.

Luminosity of the LHC accelerator will increase significantly in the coming years and consequently, radiation induced defects will severely affect the silicon sensor performance especially in the pixel region. However, a prerequisite for the new physics discoveries with CMS is its capability of recording the continuously increasing rate of particle collisions provided at the LHC. Thus, the detector has to go through several upgrades during its operation in order to meet the requirements for the ever increasing luminosity.

The first upgrade of the CMS detector, so called Phase I Upgrade, will be installed during the winter technical stop in the beginning of 2017. In this phase the CMS Pixel detector will be completely replaced, partly because of the increasing amount of data that the current readout electronics cannot handle and partly due to the radiation damage that has already occurred in the current pixel detector. In this upgrade HIP CMS Upgrade group committed to deliver 50% of the bare pixel detector modules on the third layer (L3) of the barrel pixel detector, which counts as 250 silicon pixel detector modules of the 1900 modules in total, and 4000 individual ROCs flip-chip bonded to the detectors. The project started in 2013 with a successful pre-series module production together with Advacam Ltd in Micronova Centre for Micro and Nanotechnology in Espoo, Finland. The actual production took place from autumn 2014 until the beginning of 2016 and was successfully finished in the expected time and budget frame with an excellent quality of the module flip-chip bonding.

All the flip-chip bonded modules were shipped from Helsinki to CERN to the shared CERN/NTU/HIP module production center at CERN after their preliminary quality assurance with a probe station setup in the HIP Detector Laboratory. In the production center the bare modules were integrated into full modules containing all the interconnections and mechanics needed for their integration into the barrel support structure and full pixel detector data acquisition. The last full module of the HIP quota was produced by the end of July and all the modules were successfully shipped to Zürich in the end of summer 2016 for their electrical reception tests and final integration to the pixel barrel support structure.