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Software for implementing trigger algorithms on the upgraded CMS Global Trigger System

The Global Trigger is the final step of the CMS level-1 trigger and implements a trigger menu, a set of selection requirements applied to the final list of objects from calorimeter and muon triggers to meet the physics objectives. The conditions for trigger object selection, with possible topological requirements on multi-object triggers, are combined by simple combinatorial logic (AND-OR-NOT) to form the algorithms. The most basic algorithms consist of applying E_T or p_T threshold to single objects. The present Global Trigger is comprised of several VME modules with FPGAs.

When the LHC resumes its operation in 2015, the collision-energy will be increased from 8 TeV to 13 TeV, with the luminosity expected to go up from 0.75 x 10^{34} cm^{-2}s^{-1} to 2 x 10^{34} cm^{-2}s^{-1}. These operating environments will provide new challenges for the CMS trigger system. The CMS level-1 trigger system will be upgraded to improve its performance for selecting interesting physics events and to operate within the predefined data-acquisition rate.

Together with the upgrade of other level-1 trigger systems, the Global Trigger will be re-implemented on modern FPGAs on an Advanced Mezzanine Card in MicroTCA crate. The upgraded system will benefit from the ability to process complex algorithms with DSP slices and increased processing resources with optical links running at 10 Gbit/s, enabling more algorithms at a time than previously possible and allowing CMS to be more flexible in how it handles the trigger bandwidth. CMS also will be able to match different objects, e.g. muons with jets, with higher resolution and efficiency and be able to calculate more sophisticated quantities such as the mass of a pair of objects. In 2015, CMS plans to keep the present triggers running and commission the new ones simultaneously. Detailed comparisons will be performed between both to test everything from technical implementation to whether the new triggers perform better, before the older system will be turned off.

A software for handling trigger menu implementation on the present system is strongly coupled with the current hardware design. In order to handle the increased complexity of the trigger menu implemented on the upgraded Global Trigger, a set of new software has been developed. The software allows a physicist to define a menu with analysis-like triggers using intuitive user interface. The menu is then realised on FPGAs with further software processing, instantiating predefined firmware blocks. The menu plays a central role in trigger selection and is shared by the second level trigger, known as the High Level Trigger as well as a trigger emulating software in an offline software environment. The menu information is stored in either an XML file or in a database for sharing information with other systems.

The design and implementation of the software for preparing a menu for the upgraded CMS Global Trigger system will be presented.

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