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Level1 Calorimeter Trigger: from Xilinx Virtex7 to Ultrascale+

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With the restart of the LHC in 2021 the ATLAS experiment will cope with high luminosity beams (2.5 x 10 34 cm -2 s -1). A new Level-1 Calorimeter trigger system (see Fig.1) will be introduced exploiting a finer calorimeter readout granularity. The new system consists of three Feature EXtractors (FEXs), electron (eFEX), jet (jFEX) and global (gFEX), that use FPGAs to reconstruct different physics objects used for the trigger selection and that gather data from the calorimeters through a Fibre Optical Plant. The Trigger Objects produced by the algorithms running on the FEXs are optically sent to the Level-1 Topological Trigger where interesting physics events are selected by applying kinematic and angular requirements on electromagnetic clusters, jets and total energy.

This contribution will focus on the new jFEX system and on the upgrade of the L1Topological trigger giving an overview of the hardware as well as the algorithmic firmware.

The jFEX (see Fig. 2) and the upgraded L1Topological Trigger are Ultrascale+ based ATCA boards that cope with input data rates of up to 3.6 Tb/s for a maximum of 120 Multi Giga Transceivers (MGTs) per FPGA. To achieve the high transmission speed and high component density for these boards, a number of challenges in power management, voltage distribution and signal integrity had to be addressed in the design.

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The latest generation Ultrascale+ FPGAs provide large processing resources for sophisticated trigger algorithms. The jFEX will allow to reconstruct small- and large-area jets including high-granularity substructure observables. Energy from pile-up interactions can be determined on an event-by-event basis and subtracted for jets and MET. On the L1Topological Trigger, kinematic reconstruction of full events will be performed within 50ns, and even exotic triggers mixing information from different bunch crossings will be possible.

This contribution will present the design, integrated tests programming of the jFEX and L1Topological Trigger modules.

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