Contribution ID: **10** Type: **Short talk**

Neural network based primary vertex reconstruction with FPGAs for the upgrade of the CMS level-1 trigger system

Thursday 12 May 2022 16:40 (15 minutes)

The CMS experiment will be upgraded to maintain physics sensitivity and exploit the higher luminosity of the High Luminosity LHC. Part of this upgrade will see the first level (Level-1) trigger use charged particle tracks within the full outer silicon tracker volume as an input for the first time and new algorithms are being designed to make use of these tracks. One such algorithm is primary vertex finding which is used to identify the hard scatter in an event and separate the primary interaction from additional simultaneous interactions. This work presents a novel approach to regress the primary vertex position and to reject tracks from additional soft interactions, which uses an end-to-end neural network. This neural network possesses simultaneous knowledge of all stages in the reconstruction chain, which allows for end-to-end optimisation. The improved performance of this network versus a baseline approach in the primary vertex regression and track-to-vertex classification is shown. A quantised and pruned version of the neural network is deployed on an FPGA to match the stringent timing and computing requirements of the Level-1 Trigger.

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Session Classification: Workshop