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Real-Time AI for the Particle Flow and PUPPI Algorithm in the CMS Level-1 Trigger Upgrade

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The Particle Flow algorithm has proven highly effective in the offline reconstruction of events in the CMS detector. Combined with Pile-Up Per Particle Identification (PUPPI), the two algorithms provide the necessary basis for the construction of higher-level physics options, such as jets and taus. With the upcoming High Luminosity upgrade of the Large Hadron Collider (HL-LHC), implementing the PF and PUPPI algorithms in the Level-1 (L1) trigger has become a way to significantly improve trigger performance. The integration of these elements in the L1 trigger allows for the implementation of machine learning algorithms, such as b-tagging and tau-tagging, which can be implemented on the FPGAs using the hls4ml framework. This allows for greater sensitivity to multiple signals, including di-Higgs events, which are essential for measuring the Higgs self-coupling, by resulting in a sharper and earlier trigger turn-on as well as increased signal acceptance.

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