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Online Particle Detection by Neural Networks Based on Topologic Calorimetry Information

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Electrons and photons are among the most important signatures in ATLAS. Their identification against jets background by the online trigger system relies very much on calorimetry information. The ATLAS online trigger comprises three cascaded levels and the Ringer is an alternative set of algorithms that uses calorimetry information for electron detection at the second trigger level (L2). It is split into two parts: the feature extraction algorithm (FEX), which represents particle interaction as a set of concentric ring sums, and the hypothesis test (HYPO), which implements a multilayer perceptron neural network to perform final particle identification. The neural network may also be used to implement a Fisher discriminant, in case linear processing is desired in this stage.

The Ringer FEX starts by searching the most energetic cell (hot cell) in each calorimeter layer from the Region of Interest (RoI) previously selected by the ATLAS level-1 trigger. The hot cell energy becomes the first ring and it is also considered the center of all further rings, which are formed as the sum of the energies from the outer cells of the inner ring. A total of 100 rings are computed. The Ringer HYPO normalizes the ring values in order to fit them to the neural network dynamic range. After propagating the rings through the network, a single output node provides the incoming event classification.

Optimizations, guided by detailed time performance analysis, were made at the Ringer algorithm core, in order to make it prepared for operation in ATLAS. Studies showed that the execution time was improved by a factor of 50, while its payload necessary to store the Ringer information represents only 1.2% of the present total HLT amount. Also, Monte Carlo simulations of 14 TeV proton-proton collisions at 2x10ˆ34 luminosity were used to evaluate the Ringer performance over pile-up.

Primary author: Mr CIODARO XAVIER, Thiago (Univ. Federal do Rio de Janeiro (UFRJ))

Co-authors: Mr DAMAZIO, Denis (Brookhaven National Lab. BNL); Ms DEVA, Dhiana (Univ. Federal do Rio de Janeiro (UFRJ)); Mr DE SEIXAS, José Manoel (Univ. Federal do Rio de Janeiro (UFRJ))

Presenter: Mr DE SEIXAS, José Manoel (Univ. Federal do Rio de Janeiro (UFRJ))

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