Motivation for Triggering on Jets

Jets are the most common physics objects which are produced at a hadron collider such as the LHC. With luminosities up to $3.65 \times 10^{35} \text{cm}^{-2}\text{s}^{-1}$ in 2011 and 7.73 $\times 10^{35}\text{cm}^{-2}\text{s}^{-1}$ in 2012 as well as a bunch crossing rate of 200Hz, the excellent performance of the jet trigger is fundamental to achieving the physics goals of the ATLAS experiment.

Jet Signatures

Jets, consisting of varying numbers of hadrons from the fragmentation of high-energy quarks or gluons, leave both tracks in the inner detector and energy deposits in the calorimeter. The display shows an event with 9 jets above 55GeV and 7 jets even above 80GeV.

Trigger Efficiency, Resolution and Performance of L2FS

Pile-up and Noise Suppression

Multiple interactions, around 35 in 2012, can occur at the same crossing of proton bunches as the interesting event which triggers the readout. The recorded event consists of a superposition of the interesting collision with several additional pile-up interactions (in-time pile-up) and even signals from particles generated a few bunch crossings before or after (out-of-time pile-up).

Since May 2011, a noise suppression tool implemented at L2 and EF considers electronics and pile-up noise. The combined noise level is used to determine the threshold energies for the calorimeter cells considered in the jet reconstruction, resulting in a more precise measurement of the jet energy, and thus improving the resolution and the efficiency turn-on of the jet triggers.

Jet Trigger in Heavy Ion Collisions

In Pb-Pb collisions, centrality describes the central or tangential nature of the heavy ion collisions. More central collisions involve a larger number of colliding nucleons and thus a larger number of created particles. In central collisions, the creation of a hot, dense medium, the quark-gluon plasma, is predicted by QCD. Since higher particle multiplicity leads to a higher activity in the calorimeters, as a result, a decrease in trigger efficiency is expected with increased centrality of the collision.

Dedicated underlying event subtraction algorithms are applied at the EF to correct the EF jet energies for underlying energy densities and thus reduce the effect of high detector occupancy on the trigger efficiency.

Summary

The extensions to the ATLAS jet trigger system in 2011 - full calorimeter unpacking at EF, L1r trigger, dedicated pile-up and noise suppression, underlying event subtraction - have shown excellent performance during data taking with p-p and Pb-Pb collisions in 2011 and further improved the high performance of the jet trigger system. The improved performance especially in multijet events and in a high pile-up environment presents an important requirement for data-taking in 2012.