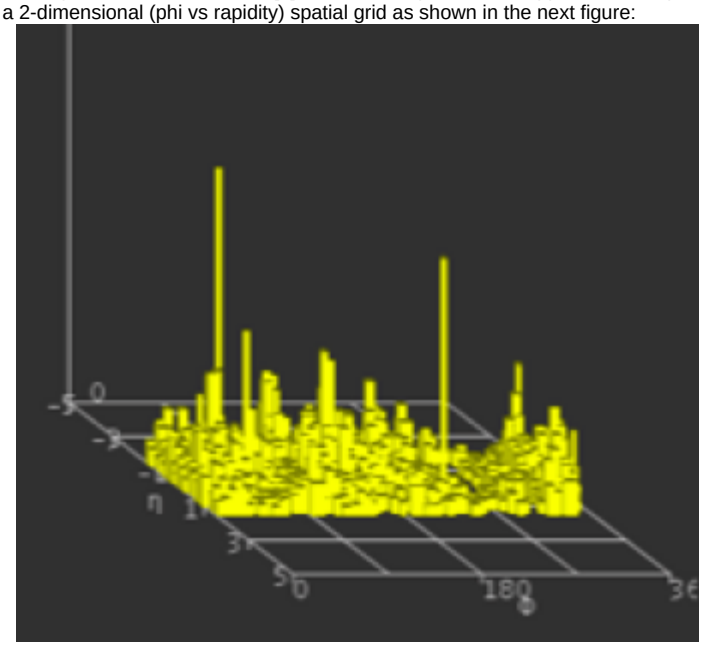
Multi-resolution jet reconstruction analysis

Quarks and gluons produced at the LHC result in a pattern of energy depositions in the calorimeters. Algorithms designed to cluster calorimeter energy depositions into hadronic "jets" have been the standard tool to identify and reconstruct the energy of quarks and gluons in hadron colliders [1].

At the LHC, large number of jets are expected from the increased initial state radiation, larger underlying event (UE), and by the presence many additional minimum bias (MB) collisions from other proton pairs in the same bunch crossing. This new jet environment at the LHC poses not only experimental challenges related to the reconstruction, calibration, and identification of hadronic jets, but it also demands a detailed understanding of multi-jet final signatures involving configurations of non-isolated jets across a very large transverse momentum and rapidity ranges.

In addition, some models of new physics (like Hidden Valley [2]) predict events with extremely high multiplicity of hard partons, resulting in exceptionally busy final states where the association between jets and partons may break down and novel hadronic signature reconstruction will be required.

Alternative methods to interpret LHC data in busy hadronic final states may involve the use of image processing techniques (Fourier, Wavelets) to find energy patterns simultaneously at different spacial resolution scales [3]. Such techniques can be applied to the input calorimeter signals in ATLAS, represented by energy depositions in a 2-dimensional (phi vs rapidity) spatial grid as shown in the next figure:



This project consists of studying the performance of Fourier-based jet reconstruction algorithms in multi-jet events, and its application to the study of simulated Hidden Valley signals in the ATLAS detector.

References:

[1] "Quantifying the performance of jet definitions for kinematic reconstruction at the LHC", M. Cacciari, J. Rojo and G. P. Salam, arXiv:0810.1304v1 [hep-ph]

[2] "Echoes of a Hidden Valley at Hadron Colliders", M. J. Strassler and K. M. Zurek (2006) hep-ph/0604261.

[3] "FFTJet: A Package for Multiresolution Particle Jet Reconstruction in the Fourier Domain", I. Volobouev, arXiv:0907.0270v1 [hep-ex]