A New HLT Trigger Based on Track Multiplicity for SUEPs Analysis

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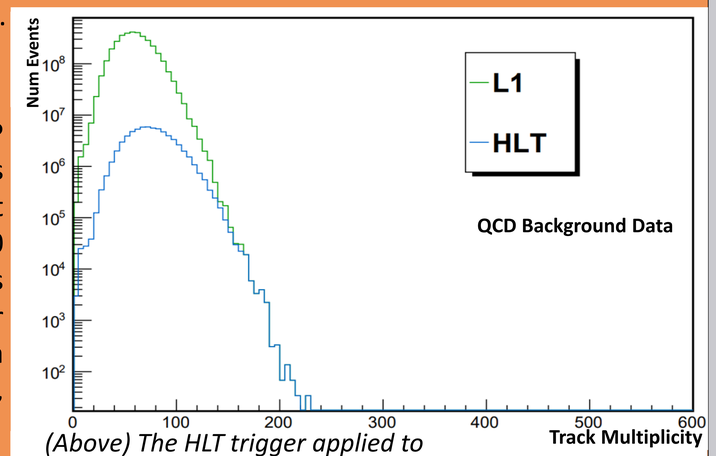
The CMS Trigger System:

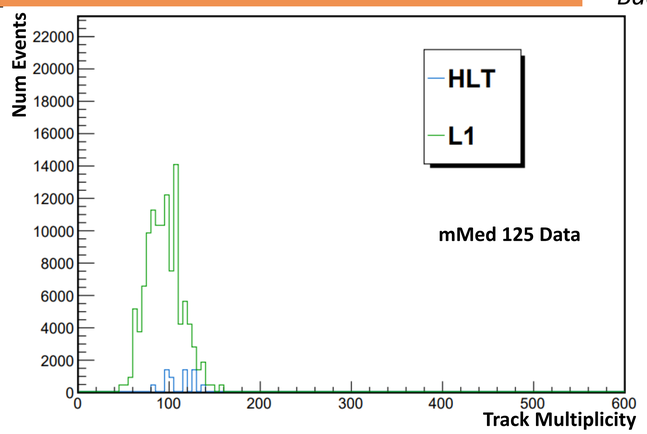
The CMS trigger system is a method of narrowing the dataset that is recorded in the CMS experiment. Many terabytes of data would be recorded every second if CMS attempted to record all events inside of the collider, and the two-tiered trigger system allows us to narrow that dataset into a more manageable portion. The two tiers are the Level One (L1) Trigger and the High Level Trigger (HLT). The trigger system's goal is to be able to cut as much background data out of the reading as possible while leaving a large portion of signal data. While the L1 Trigger is built into the hardware of the collider, the HLT trigger is a software trigger. Because of this, it is more flexible, and can be more easily adjusted to fit our needs.

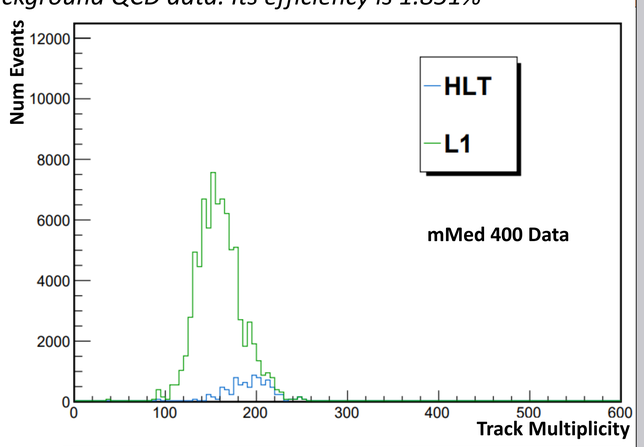
Current HLT Trigger:

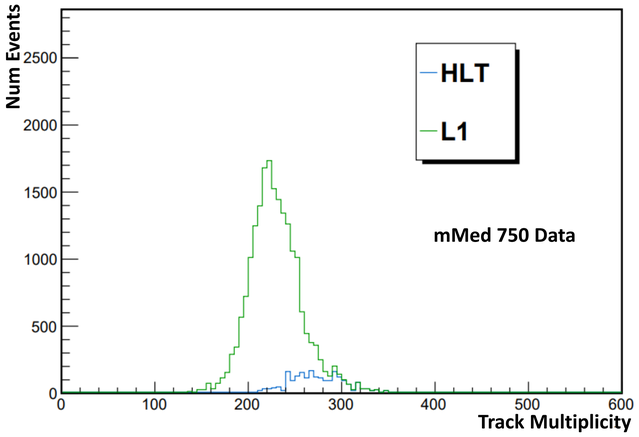
Previously, when searching for SUEP signatures, the HLT cut measured an event's total transverse energy. The result was kept as data if the total energy exceeded 1200 GeV. To the right and below are histograms detailing the events kept by the HLT trigger along with its efficiency in background data and signal data with Mediator masses of 125, 400, 750, and 1000 GeV/c^2

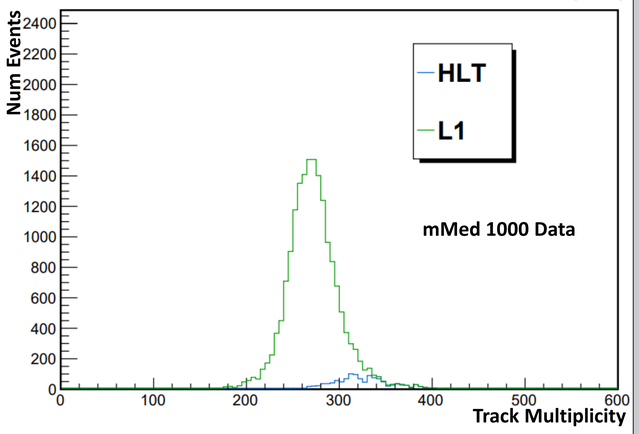


(Above) The HLT trigger applied to Background QCD data. Its efficiency is 1.851%







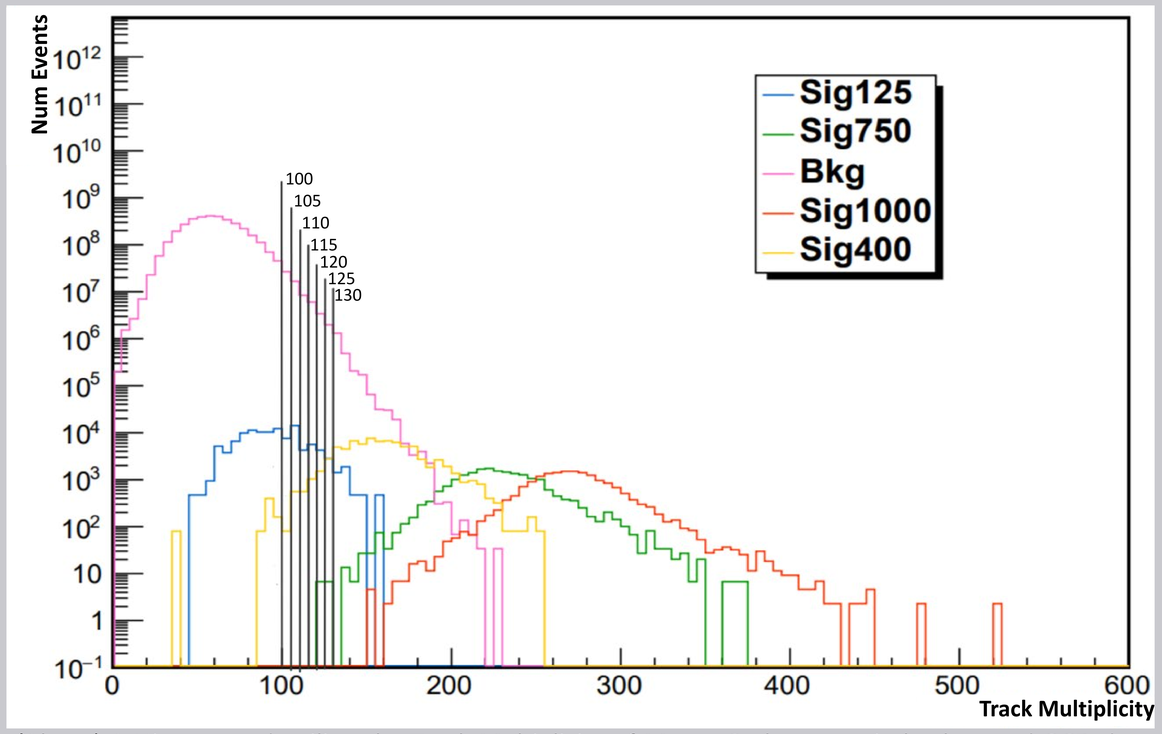


SUEPs:

SUEPs are a type of supercollider event with high track multiplicity and a more spherical shape as opposed to the traditional jet shape. In previous Runs, the trigger system used only Transverse Energy (HT) to record candidate events. These triggers cut out a large amount of signal data, making it more difficult to find SUEP signatures. However, an HLT trigger based on track multiplicity can produce better results by allowing more signal to pass as recorded data.

Proposed HLT Trigger:

A new HLT cut based on track multiplicity can cut a similar amount of background data out of the recorded data while leaving more of the signal data together. In the Monte Carlo simulation, a cut at a track multiplicity of 100 has an efficiency of 1.855% in background QCD data, a very similar amount to the current HLT cut. In the Signal, this multiplicity cut has efficiencies of 37.71%, 99.11%, 100%, and 100% for ascending mediator masses. In order to meet bandwidth restrictions, other multiplicity cuts have also been listed which cut more and more background, while all leaving large amounts of signal data. These cuts are multiples of 5 above multiplicity 100 until multiplicity 130. Each of these cuts leaves more than 90% of Signal data for all mediator masses examined except 125 GeV/c^2, while leaving as little as 0.066% of Background QCD data. Details in histogram and table below.



(Above) A Histogram detailing the Track Multiplicity of Monte Carlo events in background QCD data and Signal QCD data. Lines are various Multiplicity cuts with multiplicity listed alongside.

(Left) The HLT trigger applied to Signal data, from left to right, top to bottom, mediator masses of 125, 400, 750, 1000 GeV/c^2. Their efficiencies are 5.238%, 10.594%, 10.708%, and 6.594%, respectively.

Multiplicity Cut:	100	115	130	Current HLT
Bkg Efficiency:	1.855%	0.388%	0.066%	1.851%
mMed 125 Eff:	37.705%	15.164%	4.098%	5.238%
mMed 400 Eff:	99.109%	97.624%	90.990%	10.594%
mMed 750 Eff:	100%	100%	99.933%	10.708%
mMed 1000 Eff:	100%	100%	100%	6.951%

(Left) A table showing efficiencies of selected multiplicity cuts in background data and all signal datasets.