Update on Trigger Studies for 2015 (Legacy System)

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Today's presentation

Topics

- HLT Seed study.
- ECAL TT, HCAL TT and RCT Region saturation.
- ECAL TT peak investigation.

Neutrino Gun (reminder)

Base idea

For studying of L1T Rates the normal procedure is using neutrino gun samples. :

- Hard process is invisible (only a neutrino is fired through the experiment)
- Event consists only of PU (overlapped Minimum/Zero bias events)
- Recreated the vast majority of events at the fire the L1T
- Caveat: Does not contain any real hard scattering events therefore HLT studies cannot be done with them.

Method

- Determine algorithm event selection efficiency, this will be the probability of a bunch firing.
- Each bunch firing will represent 11246 Hz, so we apply efficiency and obtain rate per bunch.
- We multiply per number of bunches on the machine to obtain algorithm pure rate (no overlapping with other algorithm)

HLT Seeds

Information

- For full documentation purposes I have included what are the seeds for each one of our triggers available on the samples
- While looking into the menu details I have notices the presence of 2 additional prompt-like triggers with PFMETnoMu75. I added them to the study.
- Notice that all prompt triggers are seeded only by L1_ETM40 and all parked by some combination of L1_ETM and L1_HTT.

Map of seeds

HLT Path	ETM Seeds	HTT Seeds
HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v		L1_ETM40
HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v		L1_ETM40
HLT_DiPFJet40_PFMETnoMu75_MJJ800VBF_AllJets_v		L1_ETM40
HLT_DiPFJet40_PFMETnoMu75_MJJ600VBF_LeadingJets_v		L1_ETM40
HLT_DiJet20_MJJ650_AllJets_DEta3p5_HT120_VBF_v	L1_HTT200, L1_HTT175	L1_ETM40, L1_ETM50
HLT_DiJet30_MJJ700_AllJets_DEta3p5_VBF_v	L1_HTT200, L1_HTT175	L1_ETM40, L1_ETM50
HLT_DiJet35_MJJ650_AllJets_DEta3p5_VBF_v	L1_HTT200, L1_HTT175, L1_HTT150	L1_ETM40
HLT_DiJet35_MJJ700_AllJets_DEta3p5_VBF_v	L1_HTT200, L1_HTT175	L1_ETM40
HLT_DiJet35_MJJ750_AllJets_DEta3p5_VBF_v	L1_HTT200, L1_HTT175	L1_ETM40

VBF Invisible - Efficiency

L1T

L1T	PU20bx25	PU40bx50	PU40bx25
L1_ETM30	0.592926	0.618057	0.649159
L1_ETM36	0.522186	0.543433	0.572288
L1_ETM40	0.480770	0.498892	0.526785
L1_ETM50	0.389255	0.402511	0.426774
L1_ETM70	0.254493	0.262797	0.280257
L1_ETM100	0.136494	0.139298	0.150268
L1_HTT150	0.146744	0.270042	0.480381
L1_HTT175	0.102455	0.198686	0.390660
L1_HTT200	0.071823	0.145055	0.313576

Notes

- Notice that from L1_ETM40 to L1_ETM70 the signal efficiency drops by $\sim$ 50% on all scenarios
- Also notice the decrease of efficiency on parked triggers as PU goes up and separation goes down.

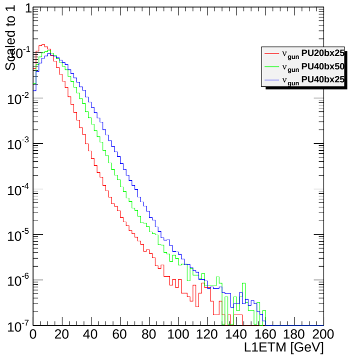
HLT

HLT	PU20bx25	PU40bx50	PU40bx25
HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	0.084993	0.087952	0.091972
HLT_DiPFJet40_PFMETnoMu75_MJJ800VBF_AllJets_v	0.082599	0.085310	0.089228
HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	0.107917	0.109334	0.116750
HLT_DiPFJet40_PFMETnoMu75_MJJ600VBF_LeadingJets_v	0.104735	0.105818	0.112964
HLT_DiJet20_MJJ650_AllJets_DEta3p5_HT120_VBF_v	0.149766	0.137726	0.105392
HLT_DiJet30_MJJ700_AllJets_DEta3p5_VBF_v	0.127966	0.125063	0.077578
HLT_DiJet35_MJJ650_AllJets_DEta3p5_VBF_v	0.124930	0.119819	0.079295
HLT_DiJet35_MJJ700_AllJets_DEta3p5_VBF_v	0.114779	0.110012	0.069185
HLT_DiJet35_MJJ750_AllJets_DEta3p5_VBF_v	0.106152	0.102060	0.062001

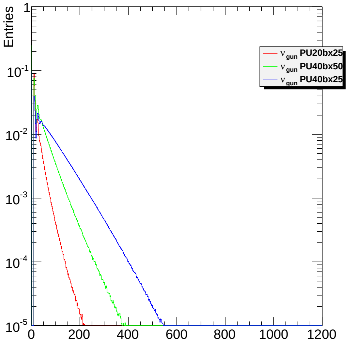
Neutrino Gun - L1 Quantities

Here we can see the relevant seed L1 quantities evolution for each scenario:

L1T ETM



L1T HTT



As expected with increasing PU and decreasing separation, is is more likely to get higher of getting ETM and HTT. Still ETM seams less affected then HTT.

Neutrino Gun - Efficiency per bunch

L1T

L1T	PU20bx25	PU40bx50	PU40bx25
L1_ETM30	0.010483	0.048612	0.099152
L1_ETM36	0.003418	0.018527	0.044528
L1_ETM40	0.001750	0.009856	0.025847
L1_ETM50	0.000418	0.002087	0.006257
L1_ETM70	0.000058	0.000194	0.000427
L1_ETM100	0.000009	0.000023	0.000028
L1_HTT150	0.001237	0.024361	0.136941
L1_HTT175	0.000645	0.014350	0.095888
L1_HTT200	0.000349	0.008607	0.066854

Notes

- We can see that going from L1_ETM40 to L1_ETM70 reduced significantly the amount of event passing (more than a factor 30)
- Again we see a strange effects on the efficiency of parked VBF HLT Paths
- We can separate by seed to try to disentangle.

HLT (Just for indicative purposes)

HLT	PU20bx25	PU40bx50	PU40bx25
HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	0.000002	0.000008	0.000034
HLT_DiPFJet40_PFMETnoMu75_MJJ800VBF_AllJets_v	0.000002	0.000006	0.000025
HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	0.000004	0.000012	0.000060
HLT_DiPFJet40_PFMETnoMu75_MJJ600VBF_LeadingJets_v	0.000002	0.000008	0.000046
HLT_DiJet20_MJJ650_AllJets_DEta3p5_HT120_VBF_v	0.000140	0.000422	0.000247
HLT_DiJet30_MJJ700_AllJets_DEta3p5_VBF_v	0.000094	0.000238	0.000118
HLT_DiJet35_MJJ650_AllJets_DEta3p5_VBF_v	0.000095	0.000224	0.000132
HLT_DiJet35_MJJ700_AllJets_DEta3p5_VBF_v	0.000077	0.000176	0.000093
HLT_DiJet35_MJJ750_AllJets_DEta3p5_VBF_v	0.000064	0.000148	0.000072

Neutrino Gun - Efficiency per bunch per seed (% of total)

HLT - ETM Seed only

HLT	PU20bx25	PU40bx50	PU40bx25
HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	1.000000	1.000000	1.000000
HLT_DiPFJet40_PFMETnoMu75_MJJ800VBF_AllJets_v	1.000000	1.000000	1.000000
HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	1.000000	1.000000	1.000000
HLT_DiPFJet40_PFMETnoMu75_MJJ600VBF_LeadingJets_v	1.000000	1.000000	1.000000
HLT_DiJet20_MJJ650_AllJets_DEta3p5_HT120_VBF_v	0.690012	0.416898	0.354374
HLT_DiJet30_MJJ700_AllJets_DEta3p5_VBF_v	0.703839	0.518568	0.347299
HLT_DiJet35_MJJ650_AllJets_DEta3p5_VBF_v	0.540395	0.375059	0.222709
HLT_DiJet35_MJJ700_AllJets_DEta3p5_VBF_v	0.680045	0.496372	0.317571
HLT_DiJet35_MJJ750_AllJets_DEta3p5_VBF_v	0.660027	0.514039	0.320958

HLT - HTT Seed only

HLT	PU20bx25	PU40bx50	PU40bx25
HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	0.000000	0.000000	0.000000
HLT_DiPFJet40_PFMETnoMu75_MJJ800VBF_AllJets_v	0.000000	0.000000	0.000000
HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	0.000000	0.000000	0.000000
HLT_DiPFJet40_PFMETnoMu75_MJJ600VBF_LeadingJets_v	0.000000	0.000000	0.000000
HLT_DiJet20_MJJ650_AllJets_DEta3p5_HT120_VBF_v	0.176614	0.361160	0.319160
HLT_DiJet30_MJJ700_AllJets_DEta3p5_VBF_v	0.160878	0.244295	0.266695
HLT_DiJet35_MJJ650_AllJets_DEta3p5_VBF_v	0.238779	0.300333	0.317775
HLT_DiJet35_MJJ700_AllJets_DEta3p5_VBF_v	0.175028	0.227328	0.261956
HLT_DiJet35_MJJ750_AllJets_DEta3p5_VBF_v	0.187251	0.215983	0.258501

HLT - Both ETM and HTT Seeds

HLT	PU20bx25	PU40bx50	PU40bx25
HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	0.000000	0.000000	0.000000
HLT_DiPFJet40_PFMETnoMu75_MJJ800VBF_AllJets_v	0.000000	0.000000	0.000000
HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	0.000000	0.000000	0.000000
HLT_DiPFJet40_PFMETnoMu75_MJJ600VBF_LeadingJets_v	0.000000	0.000000	0.000000
HLT_DiJet20_MJJ650_AllJets_DEta3p5_HT120_VBF_v	0.133374	0.221942	0.326466
HLT_DiJet30_MJJ700_AllJets_DEta3p5_VBF_v	0.135283	0.237136	0.386006
HLT_DiJet35_MJJ650_AllJets_DEta3p5_VBF_v	0.220826	0.324607	0.459516
HLT_DiJet35_MJJ700_AllJets_DEta3p5_VBF_v	0.144928	0.276300	0.420473
HLT_DiJet35_MJJ750_AllJets_DEta3p5_VBF_v	0.152722	0.269978	0.420541

Notes:

- It looks like as we go move up in scenario:
  - L1_ETM only seed percentage goes down
  - L1_HTT only goes up from PU20bx25 to PU40bx50 but does not change much to PU40bx25
  - Bith L1_ETM and L1_HTT goes up
- So it looks that the global behavior comes from the different trends of the seed components

Neutrino Gun - Rate per bunch

L1T

L1T	PU20bx25	PU40bx50	PU40bx25
L1_ETM30	117.886507	546.690500	1115.065568
L1_ETM36	38.441378	208.359154	500.764801
L1_ETM40	19.675335	110.841428	290.679881
L1_ETM50	4.701373	23.475891	70.363804
L1_ETM70	0.648532	2.176153	4.799886
L1_ETM100	0.101032	0.263196	0.309625
L1_HTT150	13.911678	273.965555	1540.037268
L1_HTT175	7.251238	161.375070	1078.359393
L1_HTT200	3.929679	96.799919	751.844350

Notes

- Here we just apply the neutrino gun efficiency to the rate per bunch

HLT (Just for indicative purposes)

HLT	PU20bx25	PU40bx50	PU40bx25
HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	0.027904	0.092119	0.385831
HLT_DiPFJet40_PFMETnoMu75_MJJ800VBF_AllJets_v	0.019244	0.062210	0.285916
HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	0.040413	0.130402	0.674852
HLT_DiPFJet40_PFMETnoMu75_MJJ600VBF_LeadingJets_v	0.023093	0.088530	0.517923
HLT_DiJet20_MJJ650_AllJets_DEta3p5_HT120_VBF_v	1.579954	4.743511	2.781258
HLT_DiJet30_MJJ700_AllJets_DEta3p5_VBF_v	1.052661	2.673833	1.327124
HLT_DiJet35_MJJ650_AllJets_DEta3p5_VBF_v	1.071905	2.513522	1.481513
HLT_DiJet35_MJJ700_AllJets_DEta3p5_VBF_v	0.863105	1.978756	1.050522
HLT_DiJet35_MJJ750_AllJets_DEta3p5_VBF_v	0.724547	1.661724	0.813435

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Neutrino Gun - Maximum Pure Rate

L1T

L1T	PU20bx25	PU40bx50	PU40bx25
L1_ETM30	331025.311467	754432.890247	3131104.113764
L1_ETM36	107943.388769	287535.632691	1406147.559908
L1_ETM40	55248.339555	152961.170678	816229.106391
L1_ETM50	13201.456723	32396.730191	197581.560547
L1_ETM70	1821.076920	3003.090874	13478.080613
L1_ETM100	283.698927	363.210551	869.425758
L1_HTT150	39063.991260	378072.466354	4324424.649249
L1_HTT175	20361.477254	222697.596469	3028033.175055
L1_HTT200	11034.537302	133583.887783	2111178.934776

Notes

- We can now apply the maximum number of bunch for each configuration which is 2808 for 25 ns and 1380 for 50 ns and calculate maximum pure
- As seen before the rates explode the unmanageable values.

HLT

HLT	PU20bx25	PU40bx50	PU40bx25
HLT_DiPFJet40_PFMETnoMu65_MJJ800VBF_AllJets_v	78.354942	127.123693	1083.413866
HLT_DiPFJet40_PFMETnoMu75_MJJ800VBF_AllJets_v	54.037891	85.849767	802.851679
HLT_DiPFJet40_PFMETnoMu65_MJJ600VBF_LeadingJets_v	113.479571	179.954318	1894.983579
HLT_DiPFJet40_PFMETnoMu75_MJJ600VBF_LeadingJets_v	64.845469	122.170822	1454.326586
HLT_DiJet20_MJJ650_AllJets_DEta3p5_HT120_VBF_v	4436.510835	6546.044703	7809.773395
HLT_DiJet30_MJJ700_AllJets_DEta3p5_VBF_v	2955.872627	3689.889007	3726.563274
HLT_DiJet35_MJJ650_AllJets_DEta3p5_VBF_v	3009.910518	3468.660762	4160.087330
HLT_DiJet35_MJJ700_AllJets_DEta3p5_VBF_v	2423.599402	2730.682961	2949.865697
HLT_DiJet35_MJJ750_AllJets_DEta3p5_VBF_v	2034.526589	2293.179342	2284.124916

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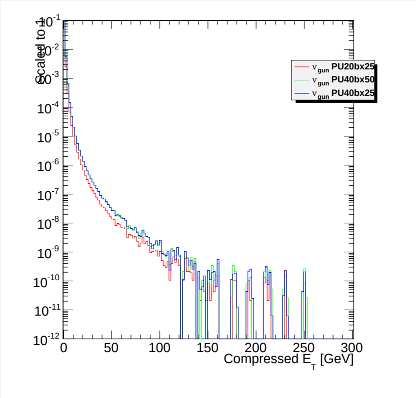
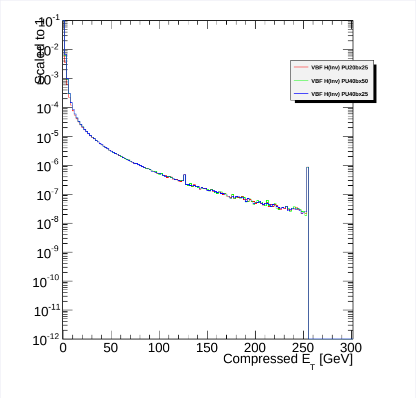
ECAL TT Compressed $E_\perp$

Looking for ECAL TT saturation on Neutrino gun events and VBF H(inv) signal.

Neutrino Gun



VBF H(Inv)



- ECAL TT saturation will not be a problem for us since is is an effect that cannot even be observed in neutrino gun samples.
- But we can clearly see saturation effects on our signal sample (much more energy available)
  - The 255 peak is the expected saturation of 8 bit ECAL TT.
  - As for 127 peak, after contacting several experts no one can really explain it!?

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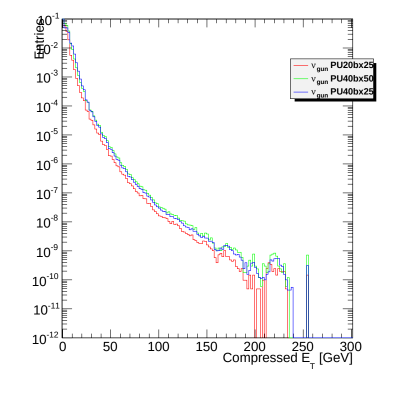
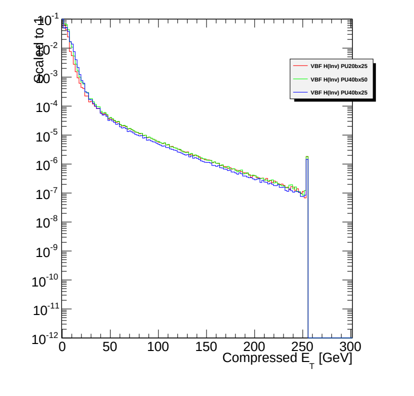
HCAL TT Compressed $E_\perp$

Looking for HCAL TT saturation on Neutrino gun events and VBF H(inv) signal.

Neutrino Gun



VBF H(Inv)

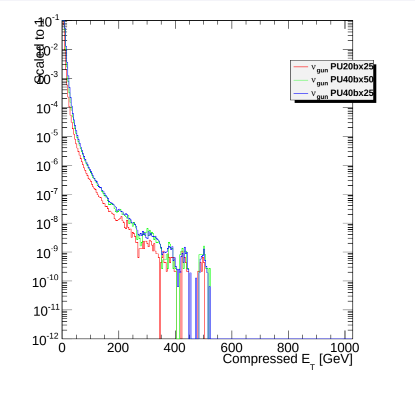


- HCAL TT saturation will not be a problem for us since is is an effect can barely be observed in neutrino gun samples.
- But we can clearly see saturation effects on our signal sample (much more energy available again)
  - The 255 peak is the expected saturation of 8 bit HCAL TT.

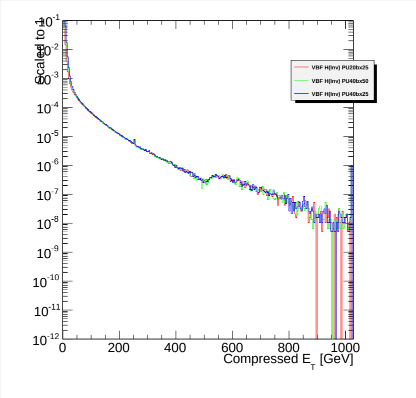
RCT Region Compressed $E_\perp$

Looking for RCT saturation on Neutrino gun events and VBF H(inv) signal.

Neutrino Gun



VBF H(Inv)

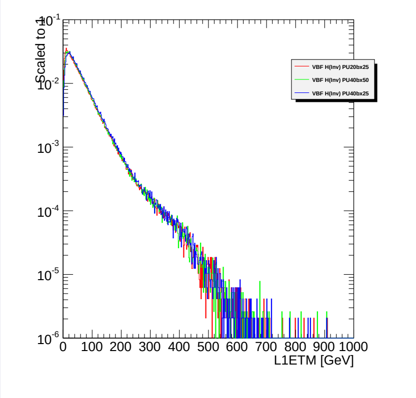


- RCT Region saturation cannot also be observed on the neutrino gun so I think it will not be a problem.
- But we can clearly see saturation effects on our signal sample (much more energy available again)
  - The 255 peak is the expected saturation of 8 bit HCAL and ECAL TT.
  - Above 511 we start seeing the effect of at least one RCT Region saturated.

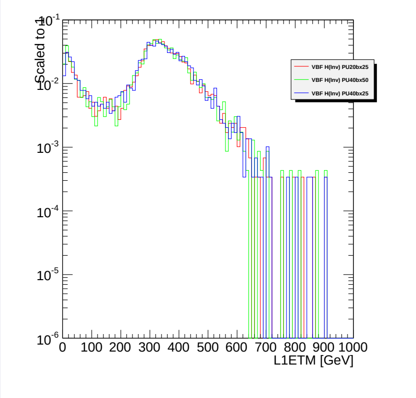
Loking at ETM on saturated events I

Now we can have a look at the properties of events of saturated ECAL TT (value=255), HCAL TT (value=255) or RCT Regions (value=511):

Neutrino Gun



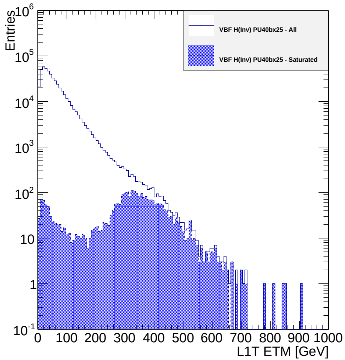
VBF H(Inv)



As expected events with at least on part of the calorimeter system saturated show higher L1_ETM.

Loking at ETM on saturated events II

Neutrino Gun



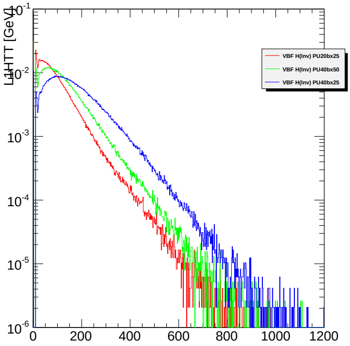
Notes

- We can see that at about L1_ETM300 about %50 of the events are saturated
- We can see that at about L1_ETM400 almost all events are saturated
- This is not a problem now but can be with increasing PU. More saturated events will happen.

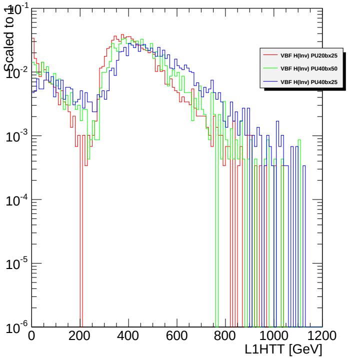
Loking at HTT on saturated events

Now we can have a look at the properties of events of saturated ECAL TT (value=255), HCAL TT (value=255) or RCT Regions (value=511):

All events



VBF H(Inv)

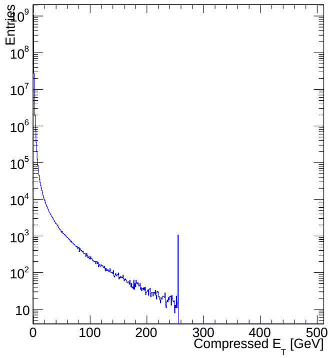


In the case of HTT events of saturated calorimeter parts are more rare and do not influence the shape so much. Also (for now) we are not considering this variable for seed.

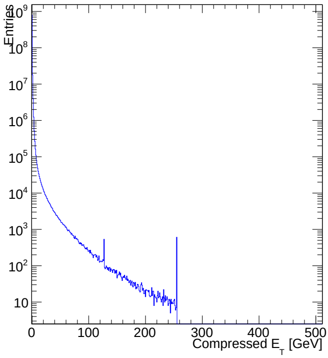
Investigating ECAL TT peak at 127

First suggestion was to look at ECAL TT at between barrel and endcaps

Barrel (TT *ieta* < 17)



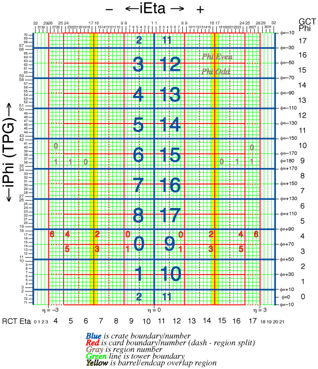
Endcap (TT *ieta* $>= 17$)



We can see that the effect is confined to endcaps!

TT Mapping

TT and RCT regions map



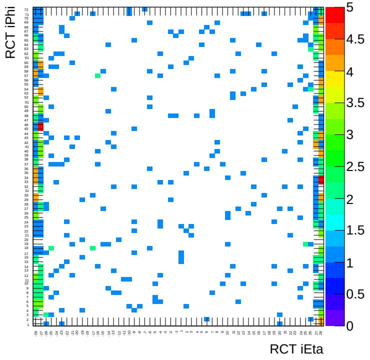
Notes

- For future reference this is the map of the RCT regions and ECAL/HCAL TT.
- This allows for conversion from ieta and iphi units and eta and phi.
- We can see that the barrel/encap overlap region is at $|ieta| = 16, 17$
- We can see that ECAL ends at $eta = 3.0$ which is $|ieta| = 28$

Investigating ECAL TT peak at 127

Mapping of all events that have ECAL TT equal to 127

Distribution of TT



We can see that a large concentration of event at the end of the endcaps $ieta = 27, 28$

- Is there anything special about this ECAL TT? I know they have strange geometries and less then 25 crystals... but should also have 8 bits coming out no?
- This can be a real effect (also present on data) or just a simulation effect (just on MC)
- If this is a real saturation (no more that 127 is possible in those towers) this will be easier to saturate specially by VBF like jets, making basically VBF+jets signature at L1... this may be a problem.

Summary and next steps

Summary:

- Different trends in parked triggers beginning to be understood.
- Saturation will not be a problem for rates (neutrino gun studies) but will change a small fraction of our signal shapes at L1 (more L1_ETM40 better? even if from saturation?).
- Investigation of ECAL TT 127 peak study underway, apparently found an unknown problem in the detector or simulation.

Next Steps:

- Look at L1_ETM70 + HLT path to calculate signal efficiency if we do nothing.
- Calculate VBF signal efficiency assuming SUSY L1 proposals (some are very interesting using MHT/HTT which should work for us).
- Re-calculate everything for UCT L1 objects.
- Investigate the ECAL TT 127 peak and pass information to the relevant group.

Backup Slides