

Dark SUSY Trigger

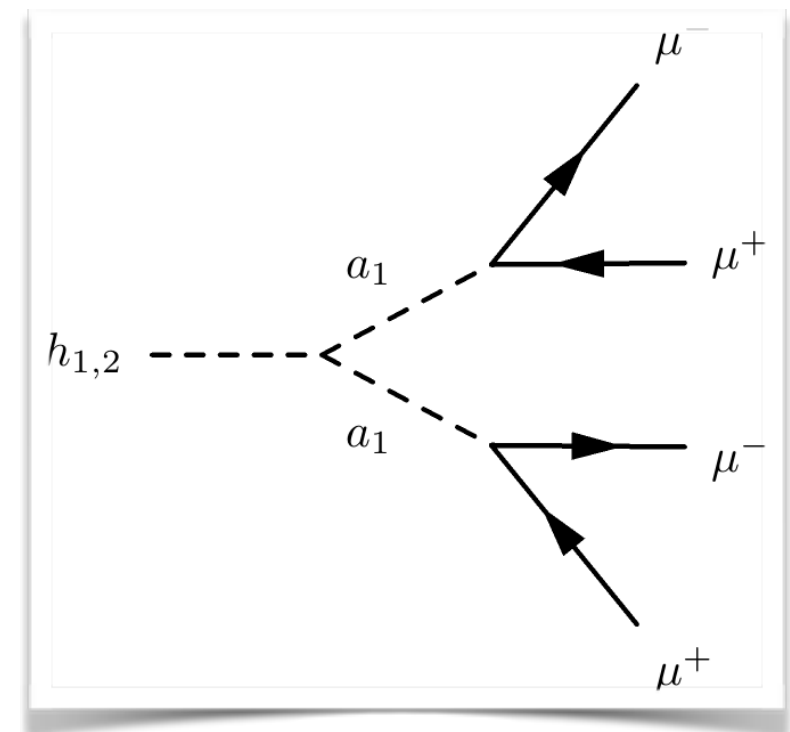
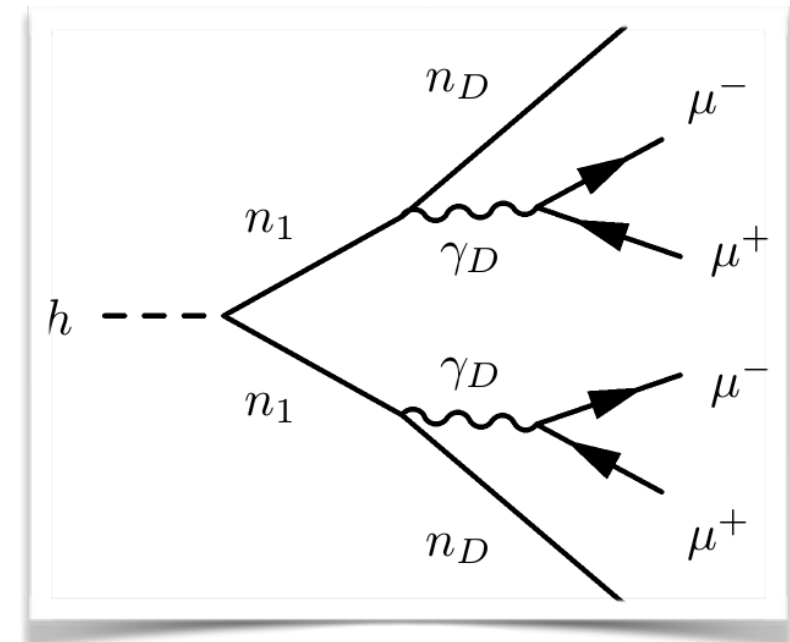
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on behalf of TAMU-Rice dark SUSY analysis group

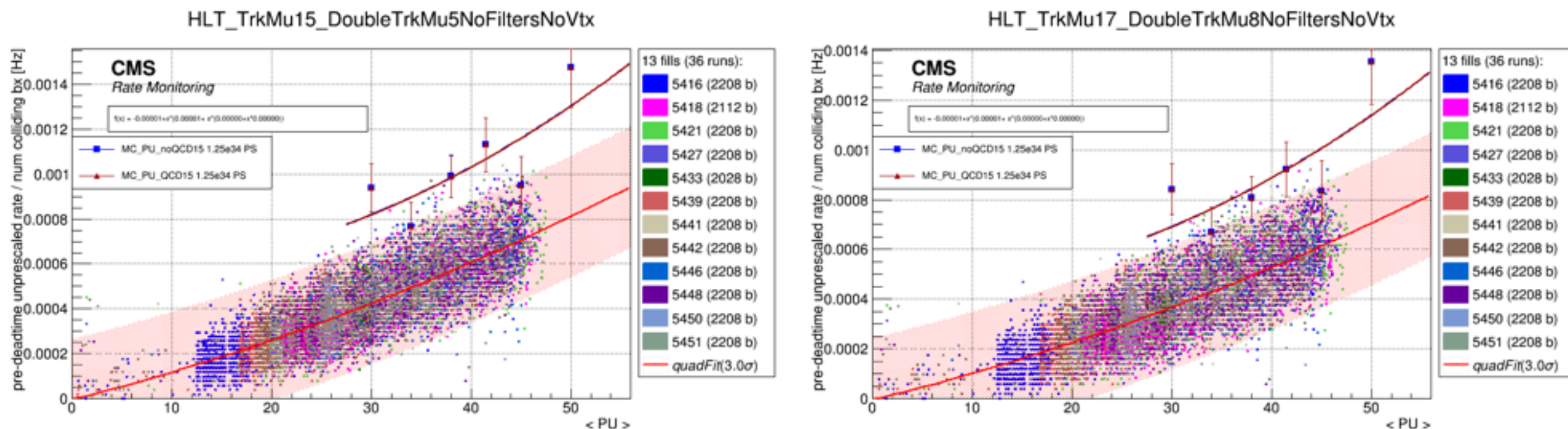
Trigger Studies Group Meeting

Signature searches

- 2 non-SM Higgs decay signatures under study “NMSSM” and “dark SUSY”
 - 4 muons in final event state with relatively low momentum
 - muons can be displaced in case of dark SUSY model
- Trigger algorithm in 2016
 - Double L1 muons with lowest pT cuts (11-4, 12-5)
 - Use “NoVtx” reconstruction sequences
 - 2 L3 muons used as seed for 3 tracker muons
 - Require 3 non-isolated tracker-muons
- Main trigger:
[**HLT_TrkMu15_DoubleTrkMu5NoFiltersNoVtx**](#)
- Backup trigger:
[**HLT_TrkMu17_DoubleTrkMu8NoFiltersNoVtx**](#)
- Both have been in DoubleMuon dataset since Spring 2015



Expected rate from data for 2015-2016 triggers



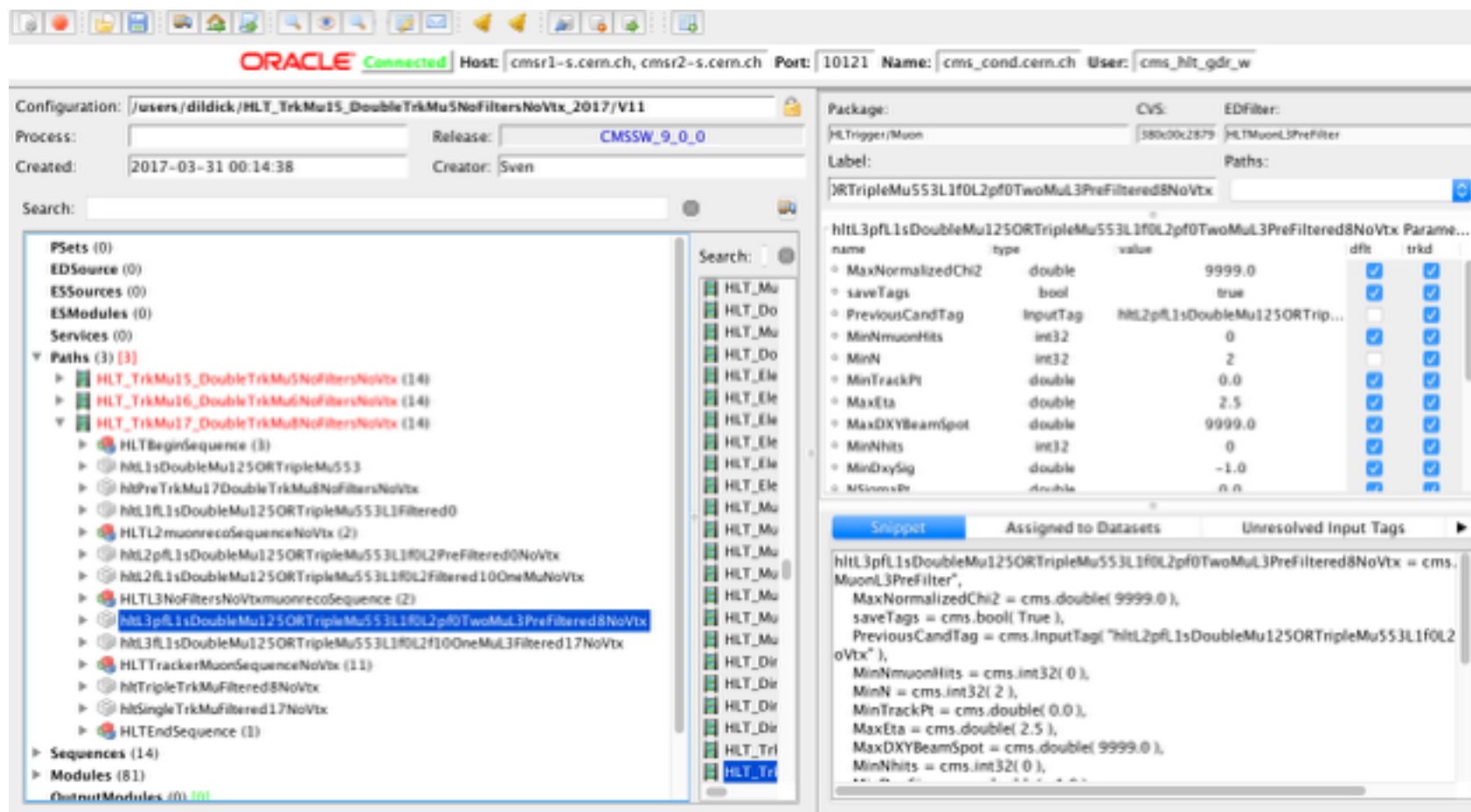
- Extrapolation of 2016 final version of signal trigger (15-5-5) to PU55 (extreme case for 2017)
- Signal trigger: $F(N) = 0.00001 + 0.000016 * N$ Hz/bunch
- At PU55: $F(N=55) = (0.000016 * 55 - 0.00001) = 0.000870000$ Hz/bunch
- $\text{Rate(PU)} = F(\text{PU}) * \text{\#bunches} = 0.000870000 * 2592 = \mathbf{2.25504 \text{ Hz}}$
- The rate budget for the dark SUSY triggers is 2 Hz
- Reduction factor of 0.89 is needed. Is achieved by increasing HLT

Trigger proposal 2017

- Similar approach as in 2015/2016.
- “OR” the lowest pT cut DoubleMu and TripleMu trigger available in the L1 menu, e.g.
 - **L1_DoubleMu_11_4 OR L1_TripleMu_4_4_4**
 - according to https://docs.google.com/spreadsheets/d/1jkl7WTNmjmT8iTxxjEd_P6UzhoJYGvUJHqcOA3cH8sM/edit#gid=0
- Reconstruct L2 displaced muons (NoVtx sequence)
- Require 2 muons, with pT cuts: 10-0 GeV
- Reconstruct L3 displaced muons (NoVtx sequence)
- Require 2 muons, with pT cuts: 16-6 (signal) 17-8 (backup) GeV
- Reconstruct displaced tracker muons (NoVtx sequence)
- Require 3 non-isolated tracker-muons, with pT cuts: 16-6-6 (signal) 17-8-8 (backup) GeV
- Main trigger: **HLT_TrkMu16_DoubleTrkMu6NoFiltersNoVtx**
- Backup trigger: **HLT_TrkMu17_DoubleTrkMu8NoFiltersNoVtx**

Implementation in ConfDB

- 3 Trigger paths were implemented in project directory:
- /users/dildick/HLT_TrkMu15_TrkMu5NoFiltersNoVtx_2017
 - HLT_TrkMu15_DoubleTrkMu5NoFiltersNoVtx
 - HLT_TrkMu16_DoubleTrkMu6NoFiltersNoVtx
 - HLT_TrkMu17_DoubleTrkMu8NoFiltersNoVtx
- They currently use **L1_DoubleMu_12_5 OR L1_TripleMu_5_5_3** as L1 seed
 - Needs to be updated to which the lowest pT triggers are
- The 15-5-5 trigger not expected to take data

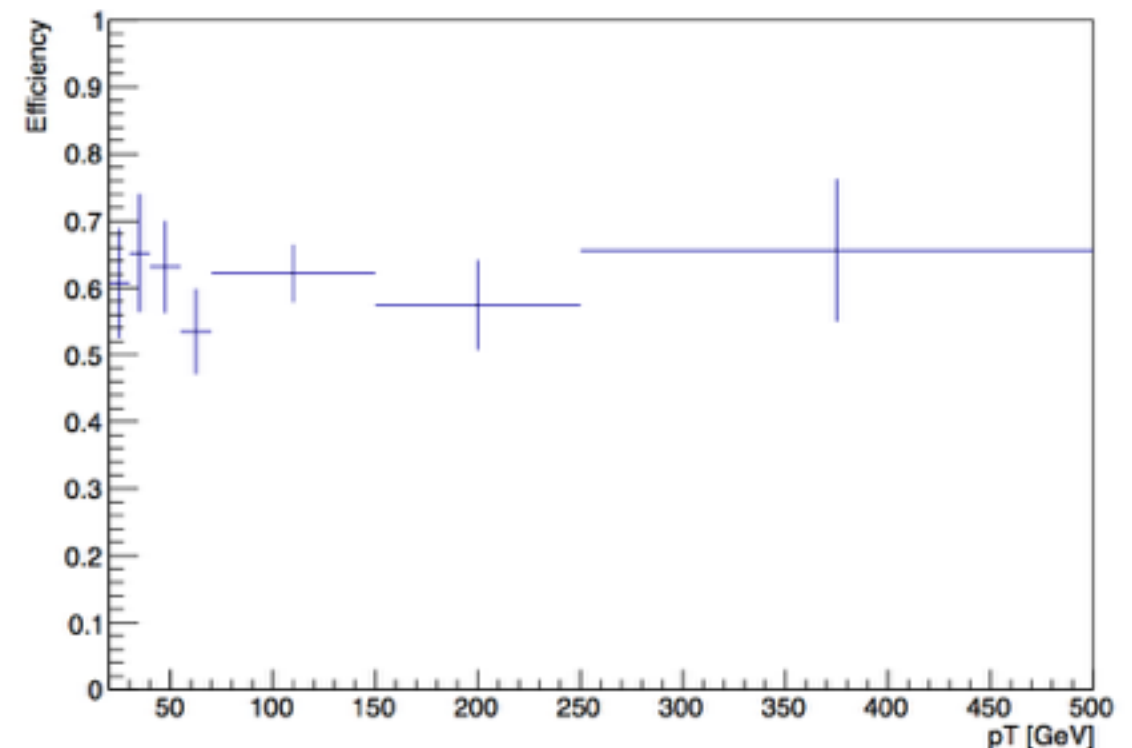


Expected rate from MC

- Following instructions on https://twiki.cern.ch/twiki/bin/view/CMSPublic/SWGuideGlobalHLT#Running_the_HLT_with_CMSSW_9_0_2 on CERN lxplus machine + <https://raw.githubusercontent.com/cms-steam/HLTrigger/master/HLTanalyzers/macros/rateMC.C> macro to estimate rates
- Results:
 - 1.25e34**
 - HLT_TrkMu15_DoubleTrkMu5NoFiltersNoVtx : 1.39868 +/- 0.269984 Hz
 - HLT_TrkMu16_DoubleTrkMu6NoFiltersNoVtx : 1.24213 +/- 0.260931 Hz
 - HLT_TrkMu17_DoubleTrkMu8NoFiltersNoVtx : 0.954088 +/- 0.233126 Hz
 - 1.8e34**
 - HLT_TrkMu15_DoubleTrkMu5NoFiltersNoVtx : 2.0141 +/- 0.388777 Hz
 - HLT_TrkMu16_DoubleTrkMu6NoFiltersNoVtx : 1.78867 +/- 0.375741 Hz
 - HLT_TrkMu17_DoubleTrkMu8NoFiltersNoVtx : 1.37389 +/- 0.335701 Hz
 - 2.0e34**
 - HLT_TrkMu15_DoubleTrkMu5NoFiltersNoVtx : 2.23789 +/- 0.431975 Hz
 - HLT_TrkMu16_DoubleTrkMu6NoFiltersNoVtx : 1.98741 +/- 0.41749 Hz
 - HLT_TrkMu17_DoubleTrkMu8NoFiltersNoVtx : 1.52654 +/- 0.373001 Hz
- We will opt for the combination 16-6-6 (signal trigger) 17-8-8 (backup trigger) to stay within the rate budget of 2 Hz

Efficiency on data

- We measure the HLT efficiency on 2016 data with the orthogonal method on MET dataset.
- Pre-selection: Events in 2016 MET B-H AOD datasets that pass pure MET triggers (i.e. no muons in the trigger, no cross-triggers)
- Denominator: events 4 offline-muons (3 with $p_T > 8$ GeV, 1 with $p_T > 17$ GeV and $|\eta| < 0.9$) - current baseline selection in physics analysis
- Numerator: events in denominator + pass signal trigger 15-5-5
- Trigger efficiency on data $\sim 65\%$
- Requiring in denominator that muons are paired into high quality dimuons, and that they are sufficiently isolated (additional selections in physics analysis), the trigger efficiency increases to 95%.
- However, statistics is very limited < only 42 events in MET dataset pass denominator



Todo list:

- Determine efficiency on signal MC
- Purity studies
- Timing studies
- Determine offline monitoring

Backup