Proposal for an additional trigger for Hadronic SUSY search

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The Rockefeller University
USCMS Trigger Meeting
May 14, 2008

All the work is done by Gheorghe Lungu. I am just presenting it.

Inclusive SUSY Production

- PTDRII mSUGRA LM1 study by M. Spiropulu, T. Yetkin, AN 2006/089
- $m_{gluino} \sim 600$ GeV/c^2, $m_{squark} \sim 520$ GeV/c^2, $\tan\beta = 10$

- Dominated by gluino and squark productions

  $pp \rightarrow \tilde{g}\tilde{q}$ (47%), $\tilde{q}\tilde{q}$ (27%), $\tilde{g}\tilde{g}$ (9%), $\tilde{q}\tilde{\chi}^{0(\pm)}$, $\tilde{t}\tilde{t}$, $\tilde{b}\tilde{b}$, *etc.* (16%)

  - $\tilde{g}\tilde{q}_L$ (22%)
  - $\tilde{g}\tilde{q}_R$ (25%)
    - $\tilde{q}_L\tilde{q}_L$ (8%)
    - $\tilde{q}_L\tilde{q}_R$ (11%)
    - $\tilde{q}_R\tilde{q}_R$ (8%)

  $\Rightarrow$ $\sigma_{LO} = 47$ pb

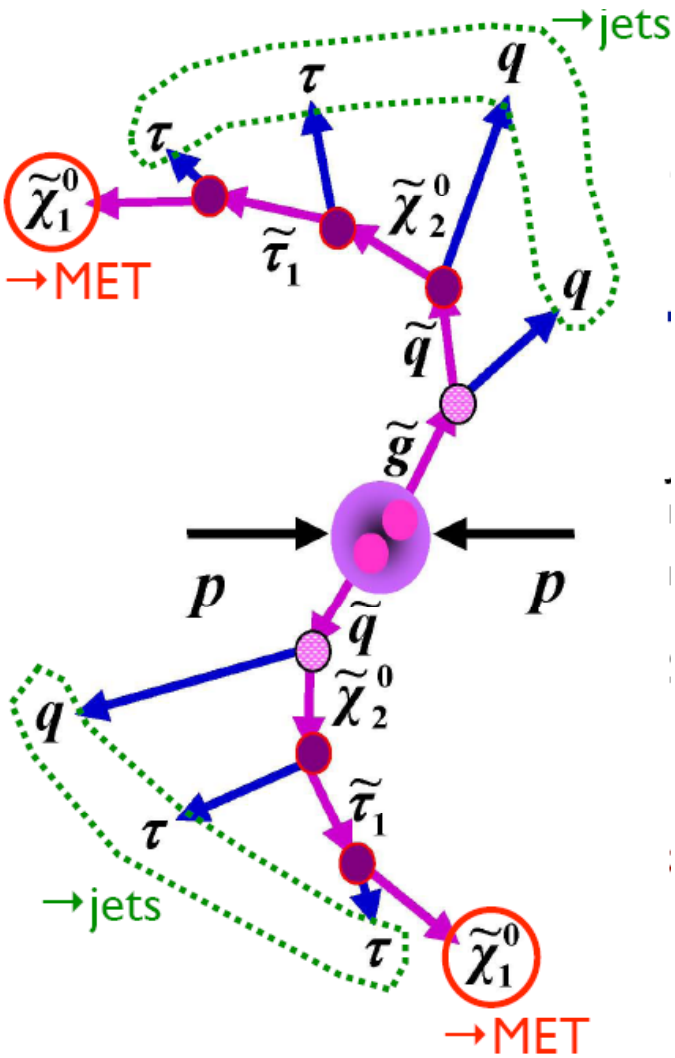
- Cascade decays lead to complex final states

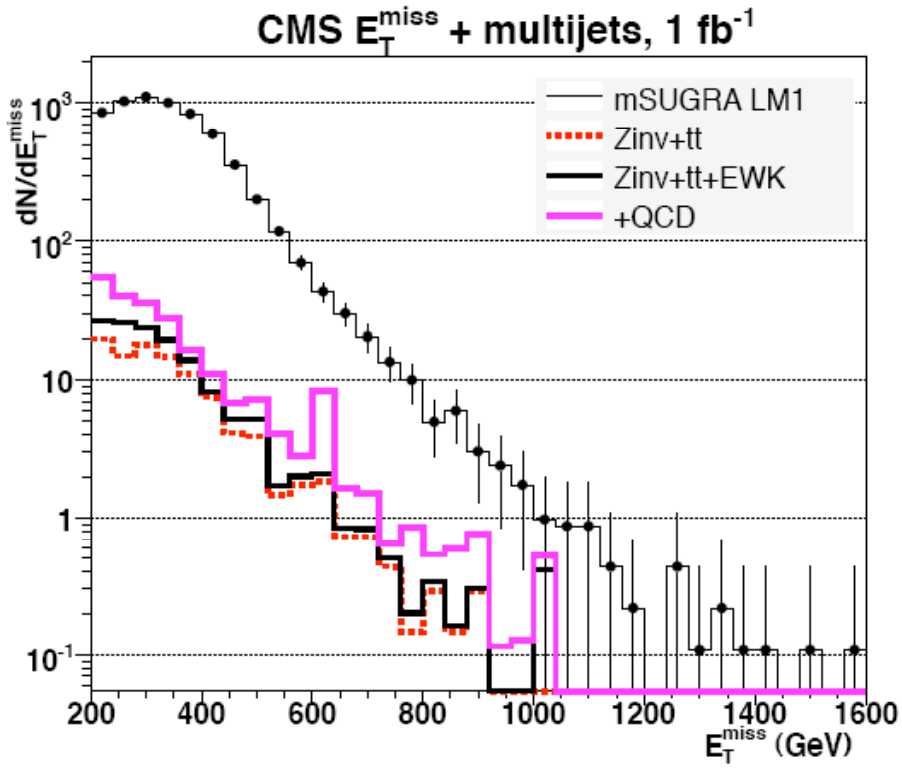
  $\tilde{g} \rightarrow \tilde{q}_L q$ (27%) $\quad \tilde{q}_L \rightarrow \tilde{\chi}_1^0 q + \nu l$(34%), $\tau\nu$(29%), $\tau\tau$(15%), $\nu\nu$(13%)

  $\rightarrow \tilde{q}_R q$ (42%) $\quad \tilde{q}_R \rightarrow \tilde{\chi}_1^0 q$ (98%)

Final state contains ≥2 jets and 2 stable LSPs (⇒MET)

Squark/Gluino Signal at CMS





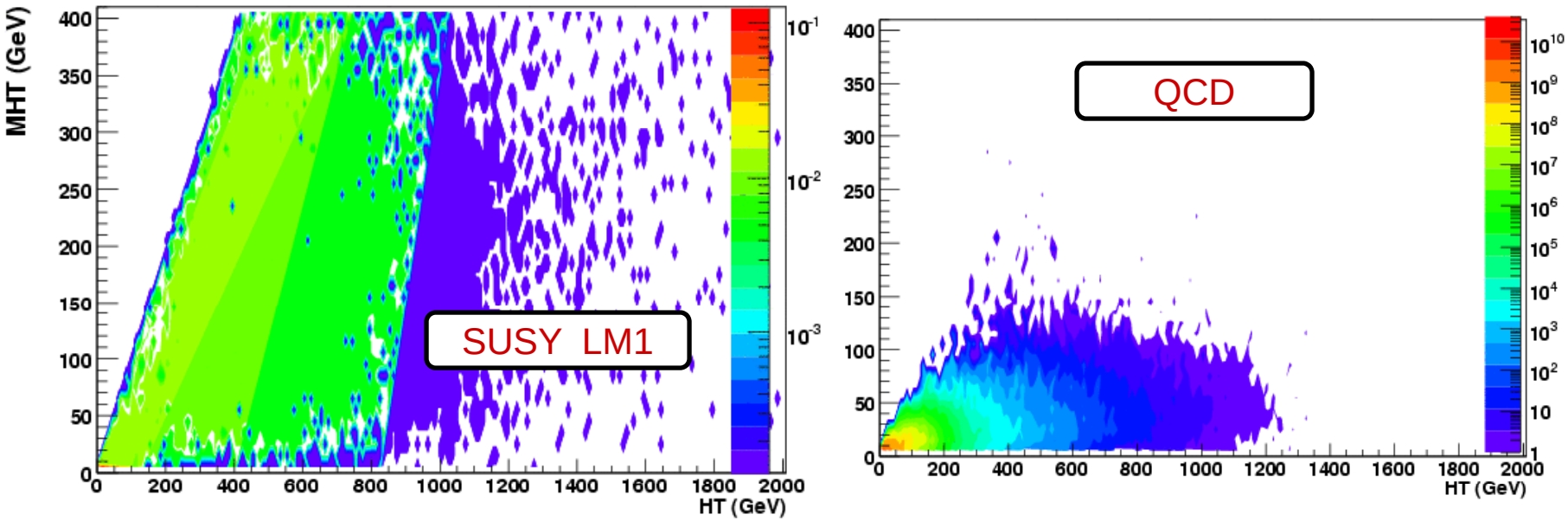
Datasets used for trigger studies.

- Samples used
  - CSA07 QCD ~210k events (21 pt_hat bins, 10k per bin)
  - SUSY LM1 ~25k events (private sample generated in CMSSW 152)
    - Calo Jets: Iterative Cone R=0.5, MC corrected
    - HLTrigger code from CMSSW 167
- Beam parameters
  - Inst. Luminosity=1E32
- Definitions

$$HT = \sum_{JetPt > PtMin} |\vec{P}_T^{Jet}|; MHT = -\sum_{JetsPt > PtMin} \vec{P}_T^{Jet}$$

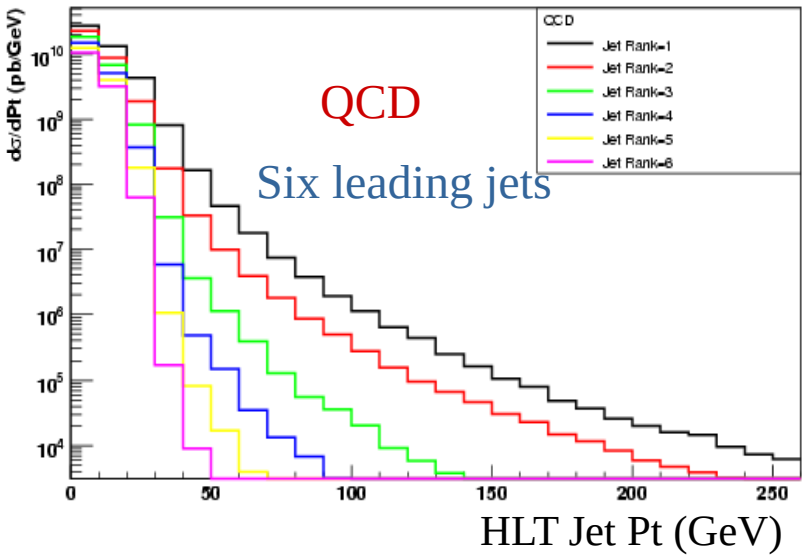
- Current Trigger: **HT & MET** (CMS AN 2007/009)
  - **L1:** L1HT>300 GeV Rate 0.65 kHz
  - **HLT:** HT>350, MET>65 Rate 4.4 Hz.
- Proposed Trigger : **HT&MHT**
  - **L1:** L1HT, no MET/MHT
  - **HLT:** Simultaneous cut on HT and MHT

MHT vs HT for QCD and SUSY LM1

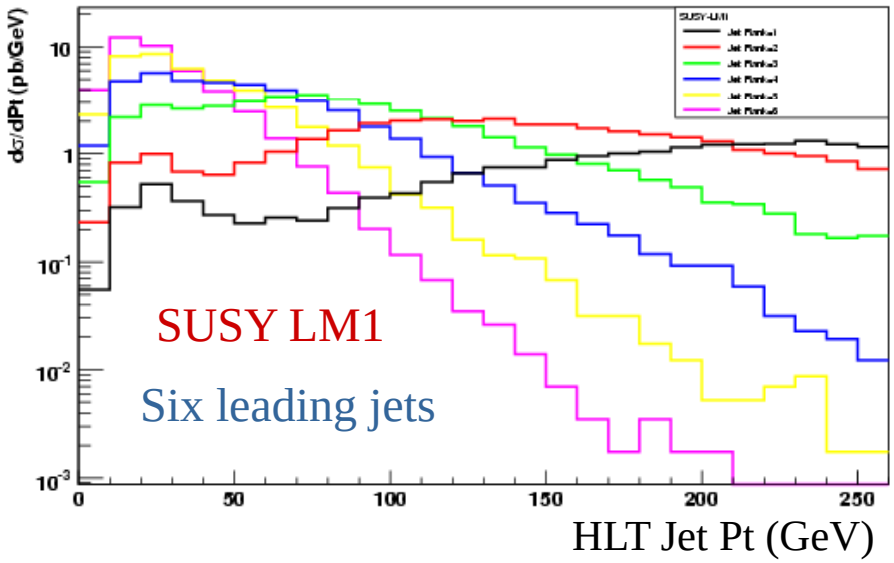


A large fraction of QCD events have small HT and MHT.

Jet Pt Distributions in QCD and SUSY LM1

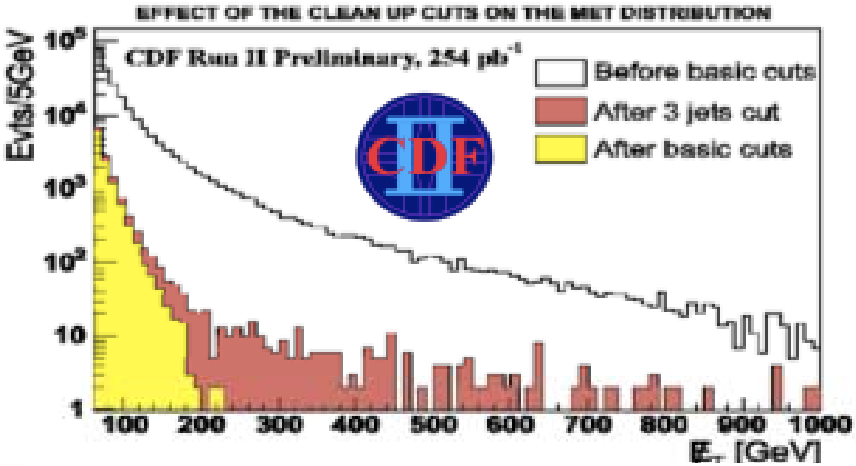


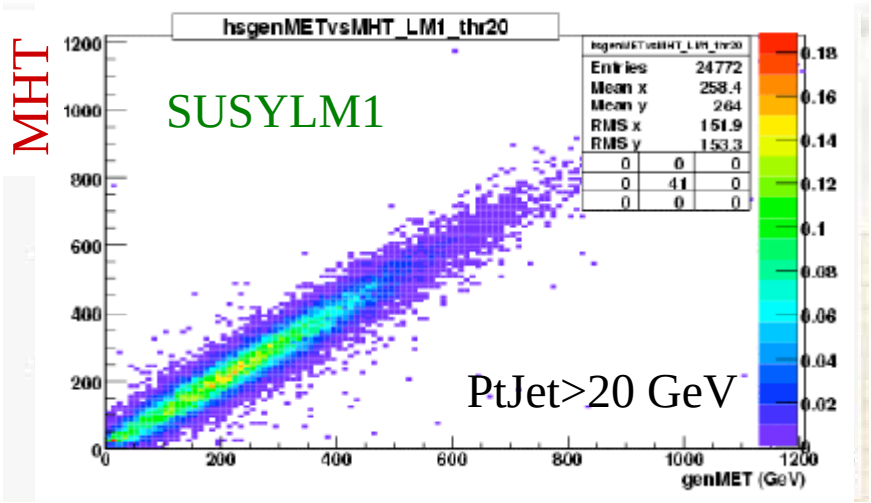
Jets in SUSY LM1 sample have substantially higher Pt.



MHT vs MET

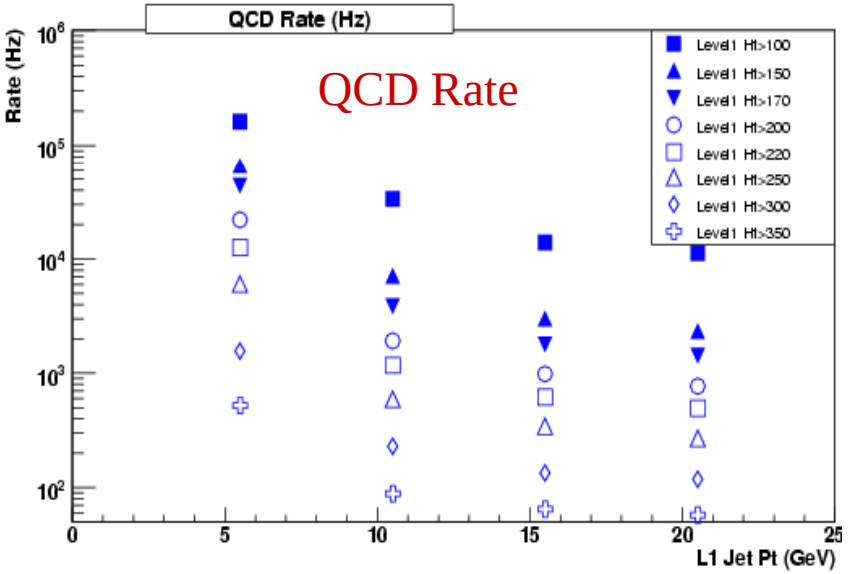
- MET = negative vector sum of CaloTower transverse energies
- Tevatron studies show that MET needs significant clean-up due to:
  - Instrumental effects
    - e.g. dead/hot towers
  - Includes UE/pile-up
- MHT = negative of vector sum of jets
  - Expected to be less affected by detector noise
  - Less affected by low-pt pile-up
  - Can use jet energy corrections

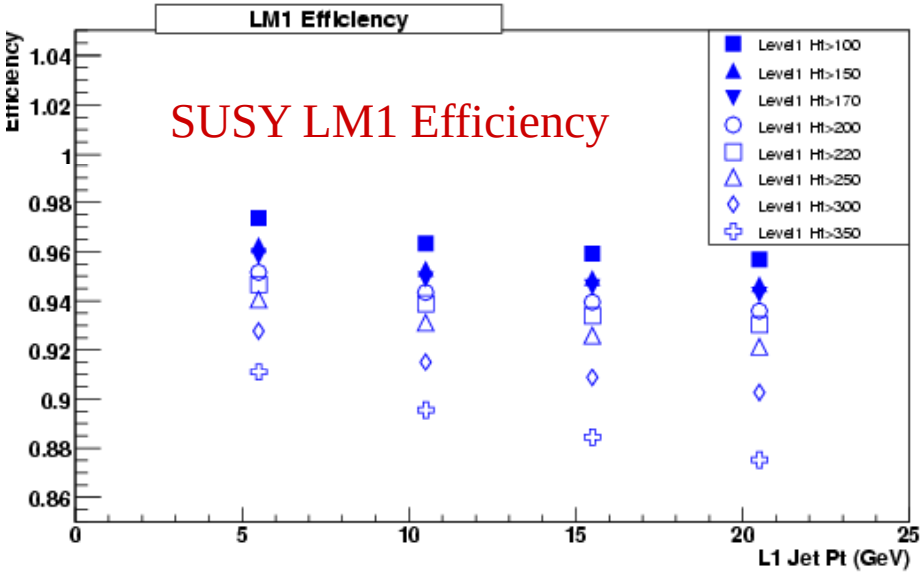




GenMET

Proposal L1 Trigger

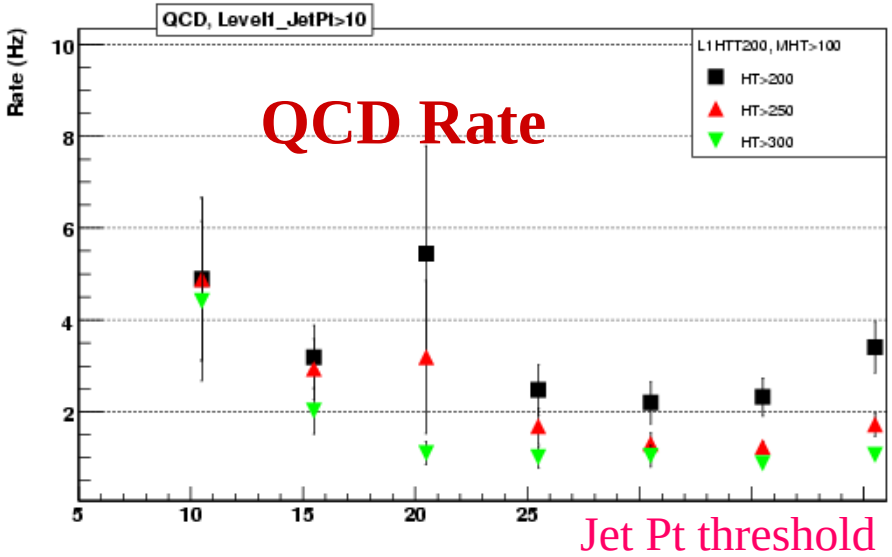


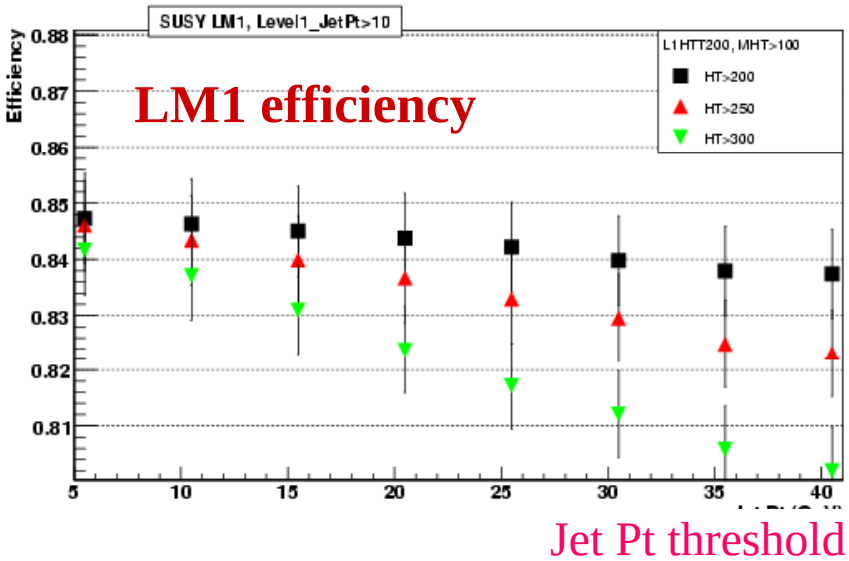


Proposed Trigger HTT200

- L1JetPt ¤ 10 GeV, L1HT>200 GeV, No MHT cut
- SUSY LM1 Efficiency 94%
- Rate ~2 kHz
- HTT200 rate not included in Single Jet150 and HTT250 GeV triggers ~1.3kHz

Proposed HLT Trigger





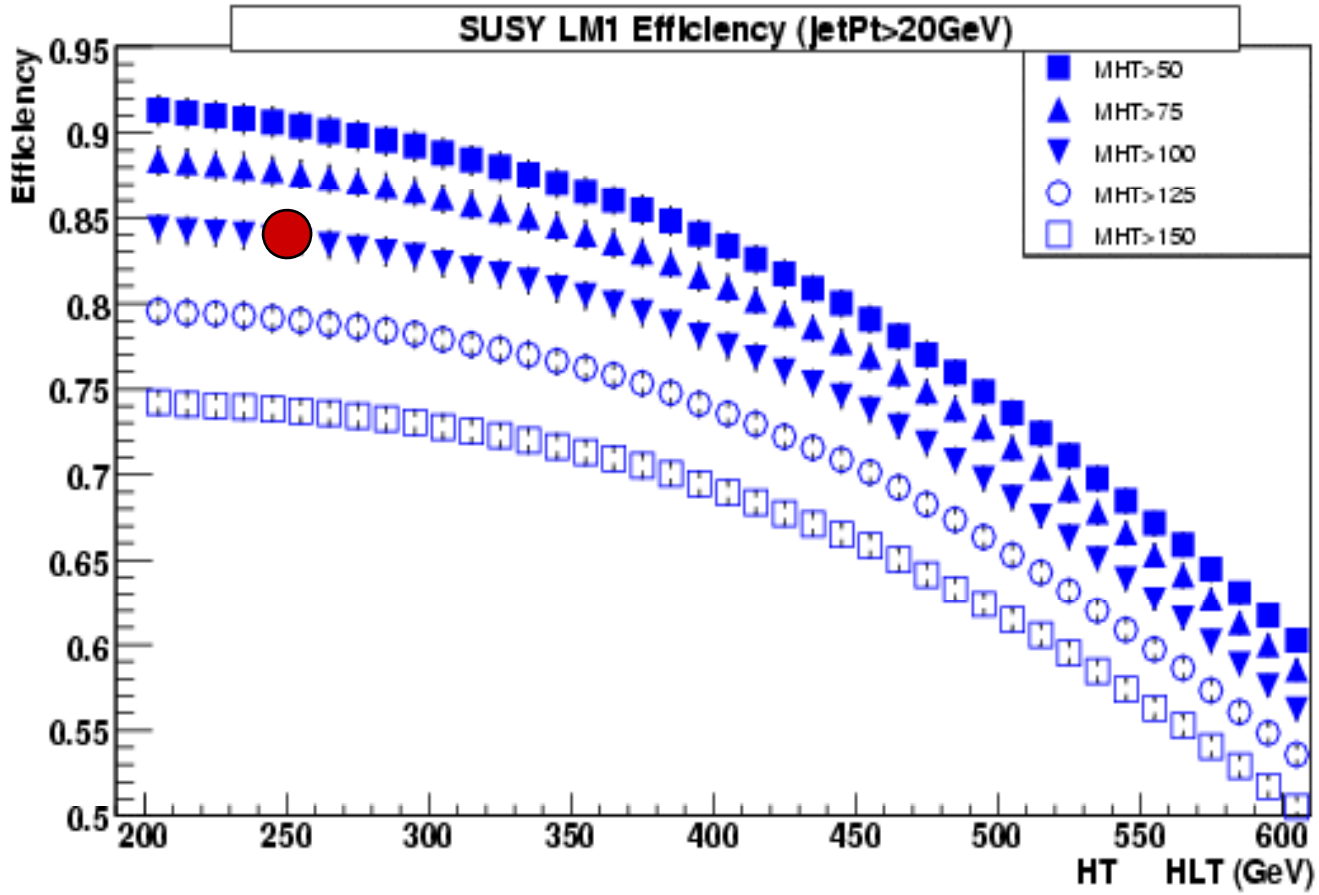
L1: **L1HT > 200 GeV , PtJet>10 GeV for L1HT**

QCD rate ~ 2.0 kHz, SUSY LM1 efficiency ~ 94%

HLT: **HT > 250 & MHT > 100, PtJet>20 GeV for HT/MHT calculation**

- QCD rate ~ 3.2Hz, SUSY LM1 efficiency ~ 84%
- Rate in addition to current QCD triggers ~ 2.5 Hz

SUSY LM1 Efficiency



If the trigger rate is too high, HT threshold can be increased with a small loss of SUSY LM1 signal

Backup Trigger

- We propose a trigger to check the QCD background
  - **L1 trigger**
    - HT>200 GeV, JetPt>10 GeV (same as main trigger)
  - **HLT**
    - HT>200 GeV, MHT>50 GeV, JetPt>15 GeV
      - PS=500, Rate= 0.7 Hz, LM1 Efficiency =91.5%

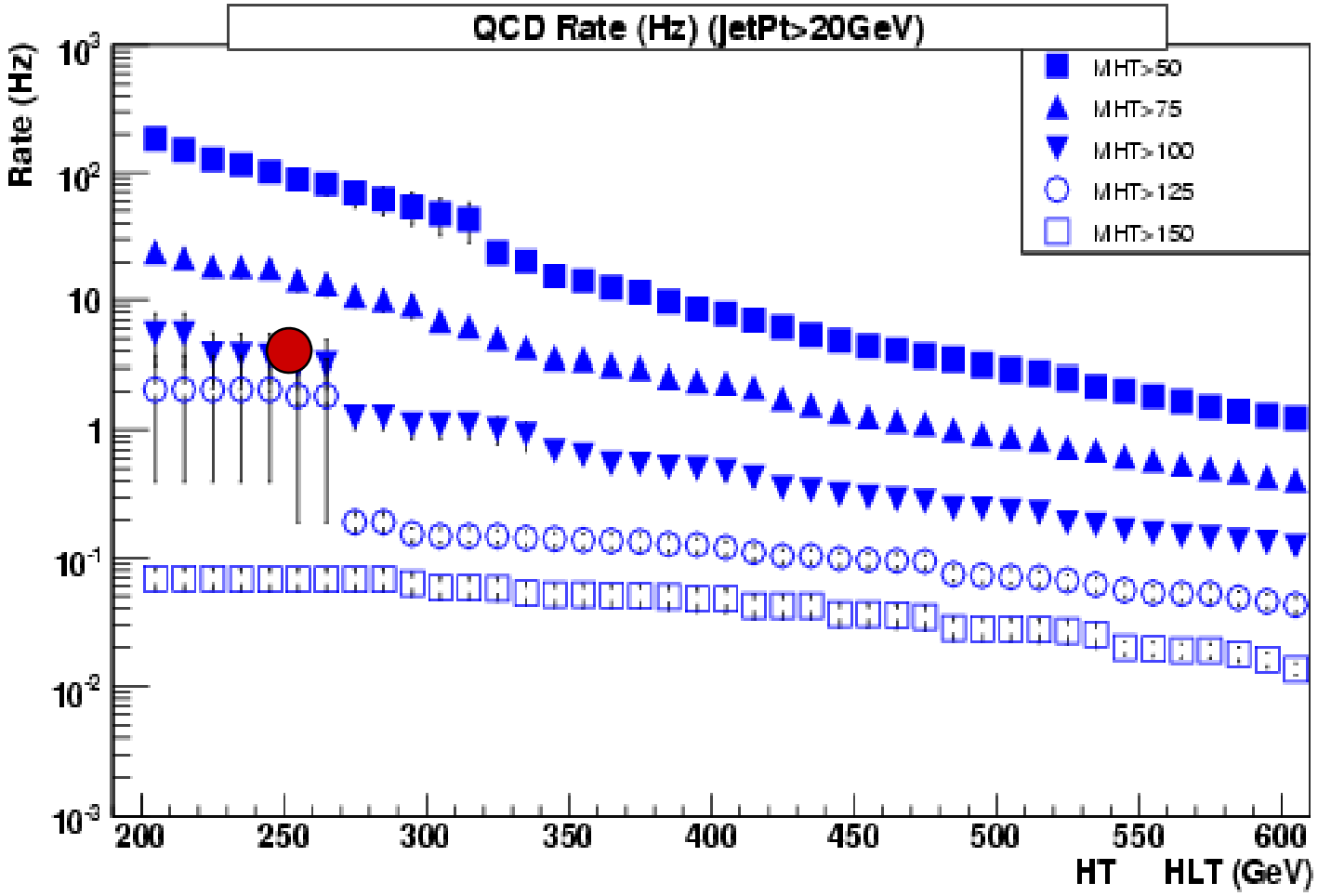
Summary

- We propose to add a new trigger for hadronic SUSY search
  - **L1:** JetPt>10 GeV, HT>200 GeV;
  - **HLT:** JetPt>20 GeV, HT>250 GeV, MHT>100 GeV
- We propose a backup trigger with PS=500
  - **L1 trigger** HT>200 GeV, JetPt>10 GeV (same as main trigger)
  - **HLT** HT>200 GeV, MHT>50 GeV, JetPt>15 GeV
- These triggers require one new L1 bit and two new HLT bits and

  ~ 1 kHz L1 and 2.5 Hz HLT band width provided we keep the current menu.
  - There are 4 L1 bits for L1HTT triggers (250, 300, 400, 500) and we can trade one threshold for L1HTT200 trigger.
- This trigger can be used for other analysis which require missing Et including lepton+Jet+MHT analyses. It has high efficiency for SUSY models having low Pt leptons.

This new trigger is expected to be robust against detector noise and pile-up.

QCD Rates



We plan to add more data to improve statistical accuracy.