

# CMS Performance Note

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## Data Parking and Data Scouting at the CMS Experiment

CMS Collaboration

### **Abstract**

This note describes the current strategy for data parking and data scouting at the CMS experiment during the 2012 data taking at  $\sqrt{s} = 8$  TeV.

# Data Parking and Data Scouting at the CMS Experiment

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# Core Physics and Data Parking at CMS

- The “core” proton-proton (pp) physics program of CMS at  $\sqrt{s}=8$  TeV is realized using collision data collected at an average event rate of 300-350 Hz [corresponding to a peak (average over-the-fill) LHC instantaneous luminosity of approximately  $7 \times 10^{33}$  ( $4 \times 10^{33}$ )  $\text{cm}^{-2} \text{s}^{-1}$ ]
- The core data are promptly reconstructed at CERN Tier0 and are generally available within 48 hours for physics analysis
- Extra 300-350 Hz of “parked” data are collected to extend the physics program: standard model measurements and searches for new physics
- The triggers defining the parked datasets are either a looser version of the core physics triggers (for instance with reduced  $p_T$  thresholds on the reconstructed objects) or brand-new triggers with small overlap with the rest
- These data are temporarily “parked”, waiting to be reconstructed towards the end of the 2012-13 data taking (or earlier, if computing resources are available)
- This provides a complementary set of collision events to perform new physics analyses or improve the existing ones (thanks to the increased acceptance) during the 2013-14 LHC shutdown

# Data Parking Triggers (1)

Trigger Selection for Data Parking	Main Physics Motivation	Average Rate (Hz) over typical LHC fill	Tighter / complementary version in the “core” trigger menu
$M_{jj} > 650 \text{ GeV}$ , $ \Delta\eta_{jj}  > 3.5$	Generic final state produced via Vector Boson Fusion (VBF)	130	QuadJet75_55_38_20: 1 b-jet + 2 “VBF” jets
At least 4 jets with $p_T > 50 \text{ GeV}$ (QuadJet50)	Pair production of stops $\rightarrow$ top (hadronic decay) + neutralino in models with small mass splitting between stop and neutralino	75	QuadJet60 + DiJet20 OR QuadJet70
$R^2 * M_R > 45 \text{ GeV}$ + $R^2 > 0.09$	Extend SUSY hadronic searches with “razor” variables ( $M_R, R^2$ ): compressed mass spectra and light stop searches	20	$R^2 * M_R > 55 \text{ GeV}$ + $R^2 > 0.09$ + $M_R > 150 \text{ GeV}$
$H_T > 200 \text{ GeV}$ , $\alpha_T > 0.57$	Extend SUSY hadronic searches with $\alpha_T$ variable	10	$H_T > 250 \text{ GeV}$ , $\alpha_T > 0.55$ $H_T > 250 \text{ GeV}$ , $\alpha_T > 0.57$ $H_T > 300 \text{ GeV}$ , $\alpha_T > 0.53$ $H_T > 350 \text{ GeV}$ , $\alpha_T > 0.52$ $H_T > 400 \text{ GeV}$ , $\alpha_T > 0.51$
Dimuon: $p_T(\mu_1) > 13 \text{ GeV}$ , $p_T(\mu_2) > 8 \text{ GeV}$	PDF constrains using Drell-Yan events at low $M_{\mu\mu}$	10	$p_T(\mu_1) > 17 \text{ GeV}$ $p_T(\mu_2) > 8 \text{ GeV}$
DiTau: $p_T(\tau_{1,2}) > 35 \text{ GeV}$ , $ \eta(\tau_{1,2})  < 2.1$ , isolation, $N_{\text{trk}}(\Delta R < 0.15) < 5$	Include 3-prong tau decays. $h \rightarrow \tau\tau$ measurements: i.e. spin, parity, CP measurement	25	1-prong decay ( $N_{\text{trk}} < 3$ ) OR “same” but $p_T(\tau_{1,2}) > 30 \text{ GeV}$ + 1 jet $p_T > 30 \text{ GeV}$

# Data Parking Triggers (2)

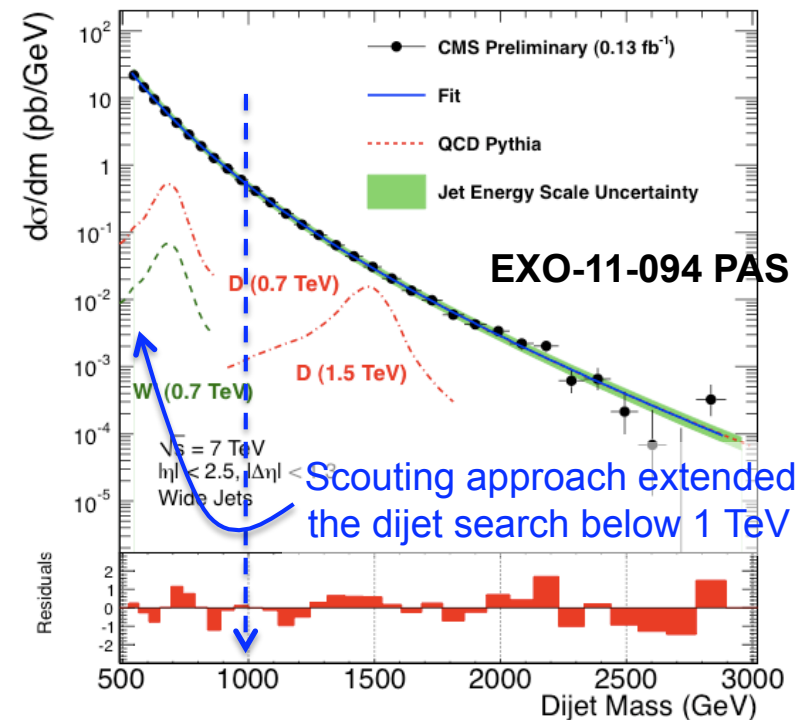
Trigger Selection for Data Parking	Main Physics Motivation	Average Rate (Hz) over typical LHC fill	Tighter / complementary version in the “core” trigger menu
$\mu^+\mu^- : p_T(\mu\mu) > 5 \text{ GeV},$ $ \eta(\mu\mu)  < 2.5, \Delta R < 2,$ $m_{\mu\mu} \approx m_{\Psi'} \rightarrow [3.35, 4.05] \text{ GeV}$	Quarkonium physics (polarization, $\chi_c, \chi_b,$ exotic states, etc..)	5	Dimuon triggers $p_T(\mu_{1/2}) > 17/8 \text{ GeV}$ (high $p_T \Psi'$ )
$\mu^+\mu^- : p_T(\mu\mu) > 8 \text{ GeV},$ $ \eta(\mu\mu)  < 2.5, \Delta R < 2,$ $m_{\mu\mu} \approx m_{J/\Psi} \rightarrow [2.8, 3.35] \text{ GeV}$	As above	35	Dimuon triggers (high $p_T$ J/ $\Psi$ ) or displaced triggers for J/ $\Psi$ from B decays
$\mu^+\mu^- : p_T(\mu\mu) > 5 \text{ GeV},$ $ \eta(\mu\mu)  < 2.5, \Delta R < 2,$ $m_{\mu\mu} \approx m_\gamma \rightarrow [8.5, 11.5] \text{ GeV}$	As above	10	$p_T(\mu^+\mu^-) > 7 \text{ GeV}$
$\mu^+\mu^- : p_T(\mu) > 3.5 \text{ GeV},$ $ \eta(\mu) < 2.2 , p_T(\mu\mu) > 6.9 \text{ GeV},$ displaced vertex wrt beam, $m_{\mu\mu} = [1.0, 4.8] \text{ GeV}$	Rare B decays with low mass dimuons (displaced)	20	$p_T(\mu) > 4 \text{ GeV}$ $m_{\mu\mu} \approx m_{J/\Psi} \rightarrow [2.9, 3.3] \text{ GeV}$
<b>1 jet + 1 muon:</b> $p_T(\text{jet}) > 20 \text{ (60) GeV},$ $p_T(\mu) > 4 \text{ GeV}, \Delta R(\mu, \text{jet}) < 0.4$ <b>Prescale = 300 (30)</b>	Select unbiased sample of signal (hadronic decays of D's, B's) using the recoil of a triggered b-jet	10 (5)	2 jets + 1 muon: $p_T(\text{jet}) > 20, 40, 70 \text{ GeV}$ $p_T(\mu) > 5 \text{ GeV},$ $\Delta R(\mu, \text{jet}) < 0.4,$ larger prescale

# Data Scouting



- Special strategy to look at the data that CMS cannot normally record on tape due to trigger rate constraints
  - explore new physics channels that need very low trigger thresholds
  - possibility to extend the standard trigger setup for core physics or data parking in case something interesting shows up in the data scouting analyses
- First implementation: new physics searches in hadronic final states at “low jet  $p_T$  /  $H_T$ ”
- **Novel** trigger and data acquisition strategy applied to physics analysis
  - Trigger:  $H_T > 250$  GeV , high event rate ( $\sim 10^3$  Hz)
  - **Reduced event content** (i.e. store calo jets reconstructed during High Level Trigger online processing, no raw data from CMS detector, no offline reconstruction of data possible)
  - Bandwidth (rate x event size) under control

Test Feasibility of Data Scouting in 2011:  
Dijet Resonance Search ( $0.13 \text{ fb}^{-1}$ )



In 2012, we can benefit from almost the full integrated luminosity ( $> 15 \text{ fb}^{-1}$ )