PRS: Physics Reconstruction and Selection
HCAL/JetsMET group

HCAL/JetMET Status

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http://computing.fnal.gov/cms/jpg/Default.htm

PRS Milestones
for DAQ TDR HLT section

Complete online selection for low-luminosity:	*Dec 2001*	**Update**
Determination of calibration methods and samples:	Mar 2002	
Data rates, data formats, online clustering:	Mar 2002	
CPU analysis for low-luminosity selection:	Mar 2002	
Complete online selection for high-luminosity:	Jun 2002	
Repeat online selection for low-luminosity:	Jun 2002	
CPU analysis of online selection:	Jun 2002	
B physics results (B_s->J/psi phi; B_s->D_spi):	Jun 2002	
DAQ TDR ready (PRS part):	Sep 2002	
L1: DAQ TDR submission (DAQ milestone)	Nov 2002	

Calibration Scenario (HB)

(similar to HE/HF)

1) Before megatile insertion

- megatile scanner: all tiles
- moving wire source: all tiles

2.1) After megatile insertion

- moving wire source: all tiles / 2 layer
- UV laser: 2 layers/wedge

2.2) After megatile insertion

- test beam: a few wedges.

→ Absolute calib. Accuracy of 2% for single particle

3) Before closing the CMS

- moving wire source: all tiles
- UV laser & blue LED: all RBX

(do 3, about once/year)

4) Beam off times

- moving wire source: 2layer/wedge
- UV laser: 2 laer/wedge
- UV laser & blue LED: all RBX

→ Monitor for change with time Accuracy < 1%

once/month

a few times/day (?)

5) Beam on (in situ)

- jets / tau / MET ECAL+HCAL

In-situ Calibration

A) Min−bias events trigger

- estimation of pile−up energy.
- normalization within each eta−ring.
- isolated low E_T charged tracks ($|\eta|<2.4$)

2% accuracy with 1k events in HF

B) QCD Jet trigger (pre−scaled)

- normalization within each eta−ring
- normalization at the HB−HE−HF boundary
- test on uniformity over full η range.
- dijet balancing to normalize E_T scale in η rings.

($|\eta|<5$)

C) tau trigger

- isolated high Et charged tracks (Et>30GeV) ($|\eta|<2.4$)

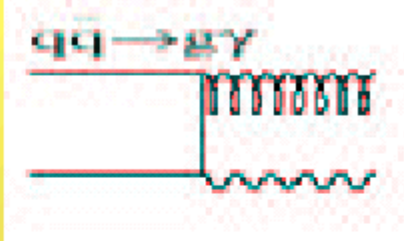
D) muon trigger (isolated)

- good for monitoring. ($|\eta|<2.4$)
- probably too small energy deposit for calibration.

In-situ calibration (2)

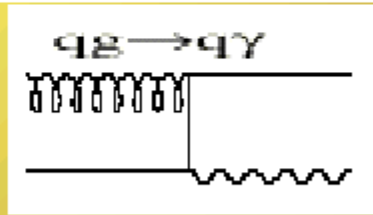
E) 1 photon + 1 jet (Victor Konopliniakov)

- E_T Scale over full η range by photon−jet balancing ($|\eta|<5$)



F) Z (−> ee, $\mu\mu$) + 1 jet (Anarbay Urkinbaev)

- E_T Scale over full η range by Z−jet balancing ($|\eta|<5$)



G) Top trigger (1 lepton + jets + 2 b−tags) (Suman Bala(?))

- E_T scale by Mass(jj) for W in Top decay. ($|\eta|<5$)

Trigger for E) (A.Oulianov)

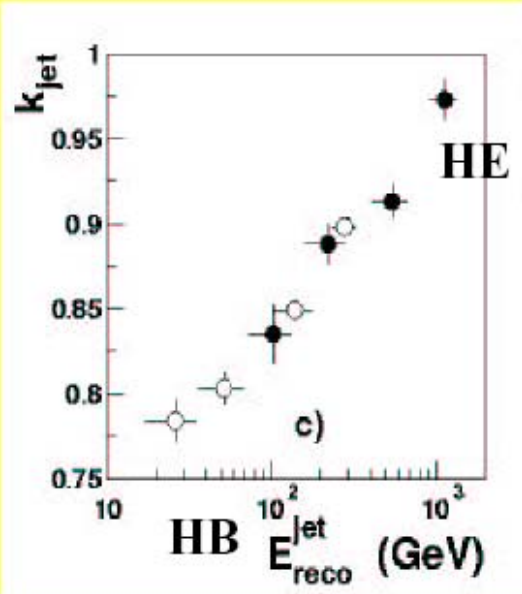
For ET>80GeV:

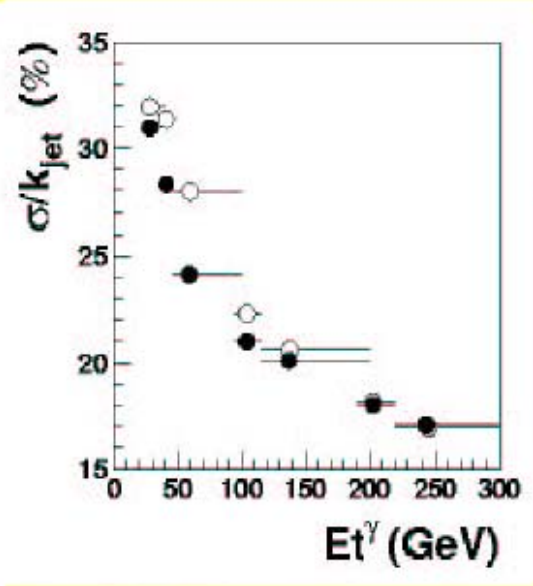
- HLT single photon

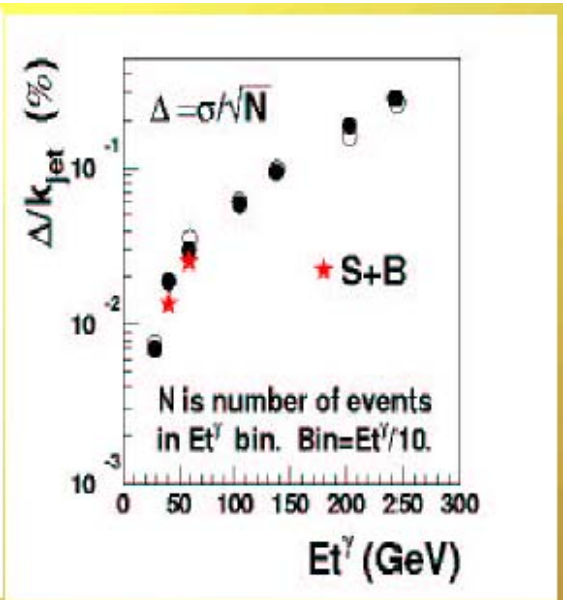
For ET<80GeV

- L1 egamma (ET>23GeV)
- HLT: no pixel line in R=1.0 around gamma (CPU 50mssec)
- γ isolation (less than 1.2GeV in 0.07<R<0.5)
- pre-scale depending on γ energy.

γ-jet balance







*For 3 months – 2.5*10⁶ sec (5 fb⁻¹)* $E_T^{\gamma} = 20 - 300$ GeV

Signal efficiency (%)	*Number of event*	*S/B*	*error (σ/(k*sqrt(N)) %*
50.00%	$10^8 - 10^4$	1	0.008 – 0.3
10.00%	$2*10^7 - 10^3$	2	0.015 – 0.5

No pixel isolation *Time will increase considering trigger condition*

(V.Konopliniakov)

Data Format

http://ohm.bu.edu/~hazen/hcal/dfmt.pdf

A possible data format:

	Byte 3	Byte 2	Byte 1	Byte 0
Link Header	EV# b8-15		Zeroes (Reserved)	Event# b0-7
Ext. Header 1	#Trig Twr	HTR Card#	Spare	BX # b0-11
Ext. Header 2	Spare	Spare	Trigger type	Orbit #
Trig Towers 1-4	Tower 4	Tower 3	Tower 2	Tower 1
Trig Towers				
Trig Feature bits	bits 24-31	bits 16-23	bits 7-15	bits 0-7
Channel mask				
Channel Data				
Channel Data ...				
FE Link Errors				
Cap Errors				
Other Errors				
Link Trailer	Event# b0-7	Zeroes (Reserved)		

HCAL Data

Data Format Update for HTR to DCC Communication
January 29, 2001 – E. Hazen

Data to be transmitted:

Description	Bits	Notes
Event Number	24	low 8 bits in link header
BX number	12	
Orbit Number	8	
Trigger Type	8	physics / laser / VME etc tbd
HTR card number	5	
No. trigger towers (NTT)	5	maybe only in run header
Zero-Supression on	1	channel data zero supressed
Raw Data on	1	raw channel data is present
Samples per channel	4	number of samples for L2 filter input
Trigger primitives	8 * NTT	
Trigger feature bits	1 * NTT	
Channel Mask	32	zero-supression mask for channel data
L2 Filter Data	16 / ch	L2 Filter output
Raw data	16*10 /ch or 9*10 /ch	L2 Filter inputs (10 samples)
FE Link Errors	32	
Cap errors	32	
Other status/errors	tbd	

Items in **bold** are always present. Items in ***italics*** are needed only at start of run and could be downloaded by the CPU. Items in standard print are optional, depending on whether the feature is enabled.

64KB/event

200MB/s → DAQ
20MB/s → L2 (trig primitive)
2MB/s → SPY

L2 CPU Usage

(A.Nikitenko)

for Pentium III (Coppermine), cpu MHz : 600 MHz

JetMet HLT with $L = 2 \times 10^{33}\ cm^{-2}s^{-1}$ data

time to build towers ~ 200 ms / ev !!!

time for SUSY (global jet finding + MET) ~ 20 ms / ev

time for Taus from Higgs (regional jet finding) ~ 8 ms / ev

~90 % of total time is taken to build towers.
this has to be reduced with smart navigation.

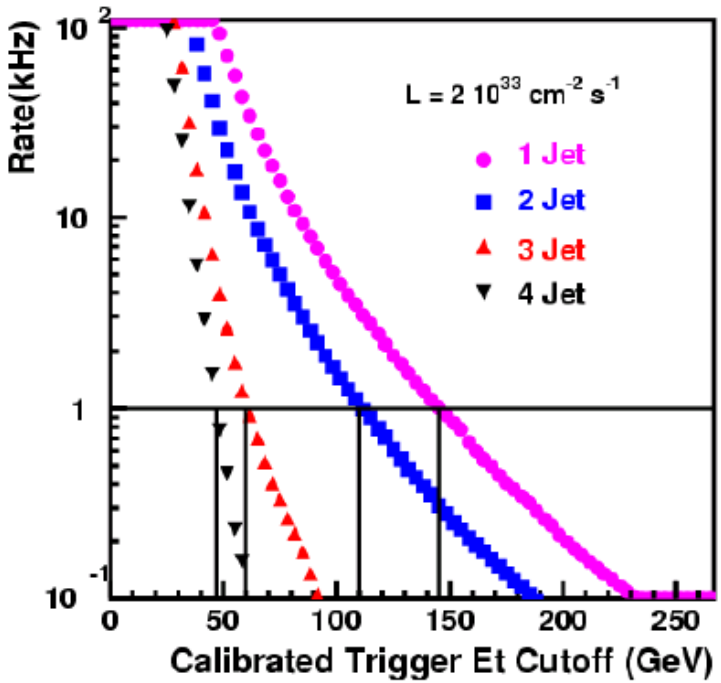
time to do pixel Rhits (3+2 pxl) ~ 60 ms/ev (qcd 120-170)

time to reconstruct lines /vertices ~ 60 ms/ev (qcd 120-170)

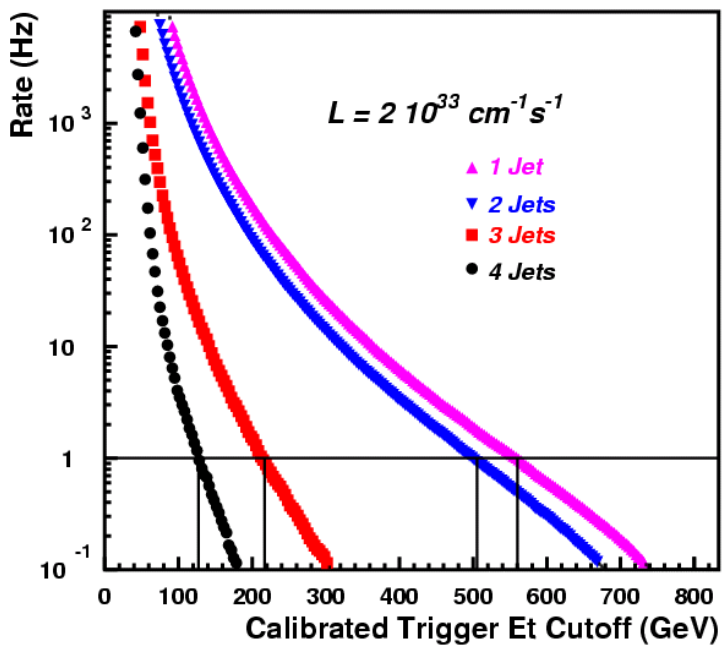
L1 & L2: Jets

(A.Krokhotine)

L1



L2



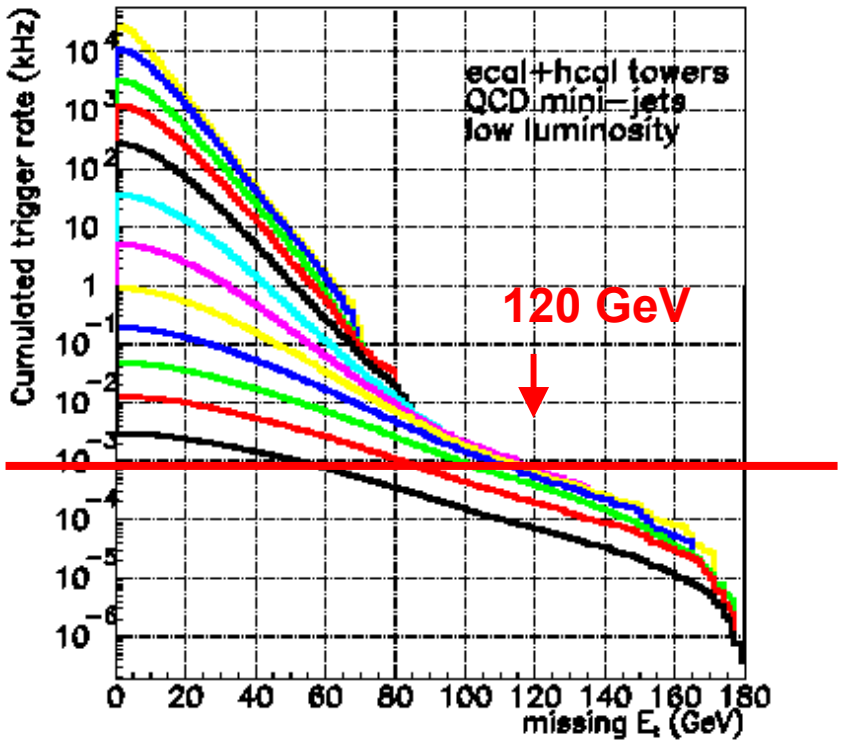
# of jet	L1 (1kHz)	L2 (1Hz)
1	145 GeV	560 GeV
2	110 GeV	505 GeV
3	60 GeV	217 GeV
4	47 GeV	127 GeV

Large QCD rates

→ Lower cuts with prescale

L2 MET

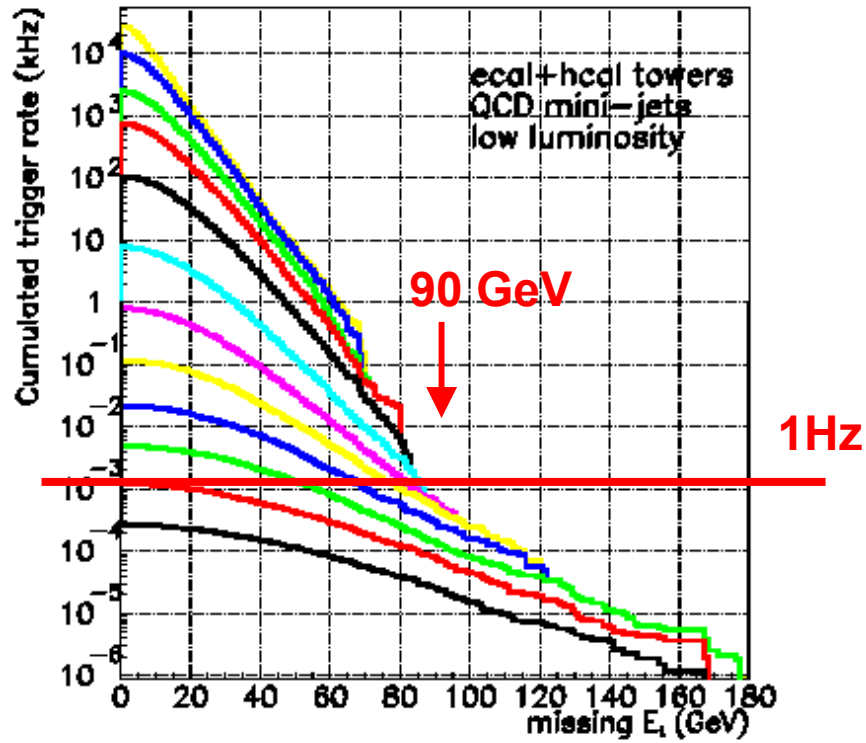
No veto



MET Threshold

back-to-back jets veto

$\Delta\phi(1,2) > \pi - 0.5$ (veto)



MET Threshold

$\Delta\phi$: angle between 1st and 2nd largest ET jets in transverse plane.
~ 10 reduction with the veto.

(P.Hidas)

Alternative HLT for Invisible Higgs

(A.Nikitenko)

with cut on :

$E_T^J > 40$ GeV

$|\Delta\eta_{JJ}| > 4.4$,

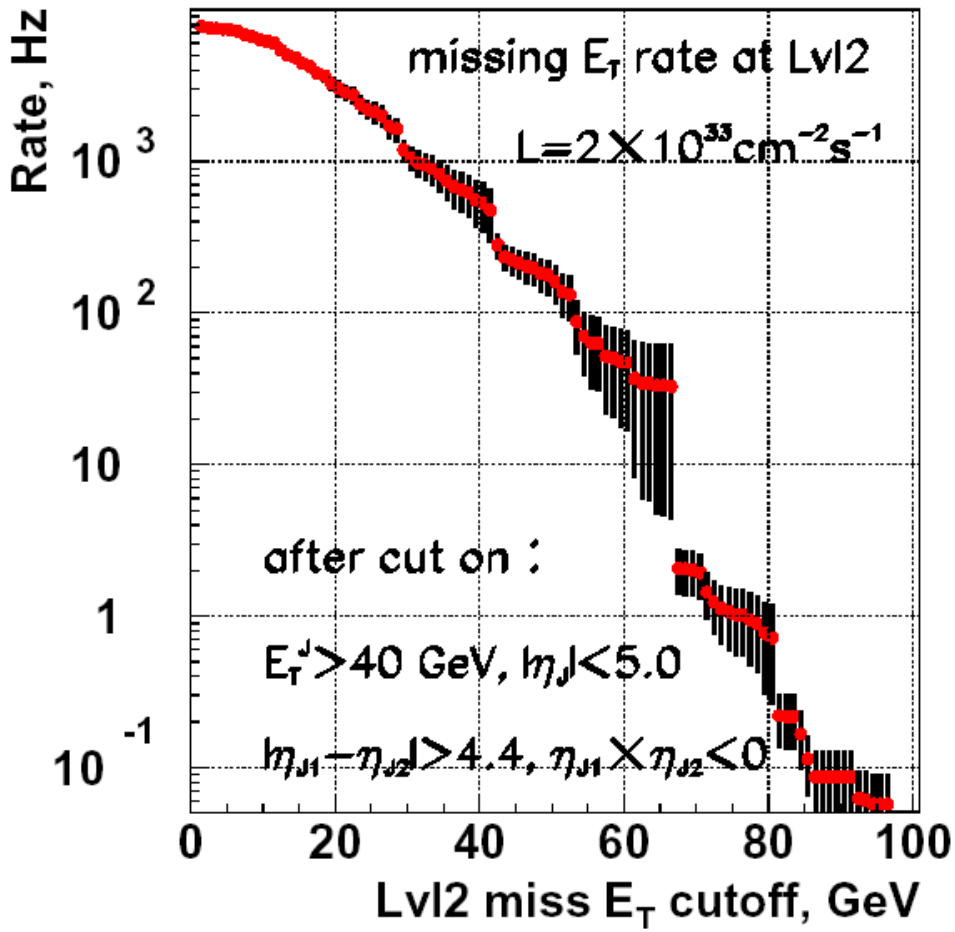
$\eta_{j1}\,\eta_{j2} < 0$

rate is 7.9 kHz

with additional cut

MET > 80 GeV

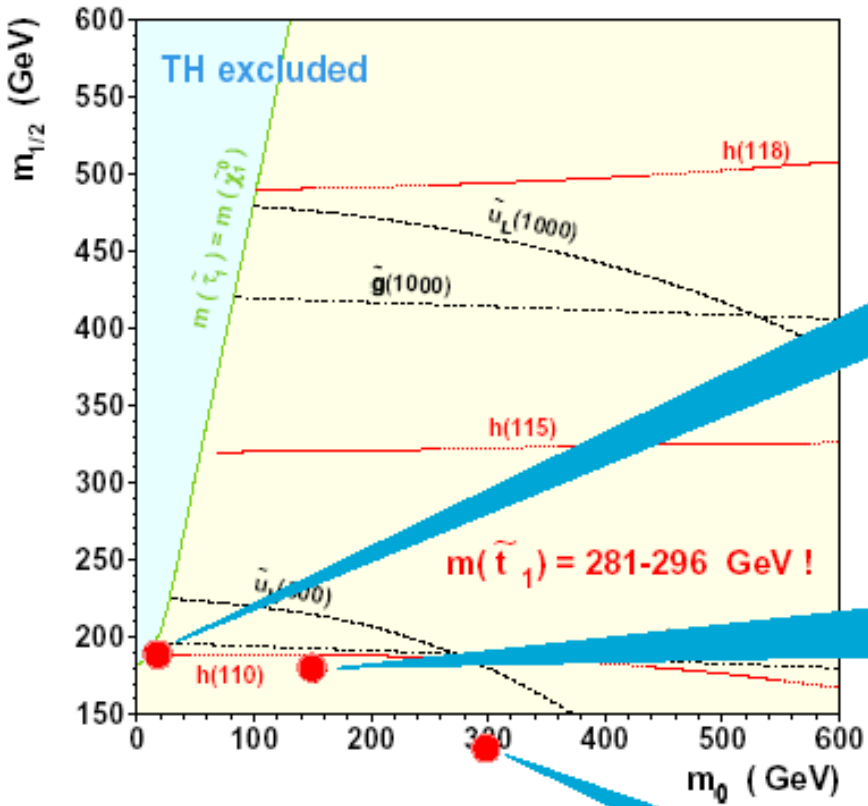
rate is ~ 1 Hz



SUSY: Low Mass Points

(S. Abdullin)

$A_0 = 0,\ \tan\beta = 10,\ \mu > 0$



$m(\tilde{\chi}_1^0) = 70$ GeV $m(h) = 110$ GeV
$m(\tilde{g}) = 466$ GeV $m(\tilde{u}_L) = 410$ GeV
$\sigma \sim 181$ pb tau-enriched, quite enough sleptons
4 20,190

$m(\tilde{\chi}_1^0) = 66$ GeV $m(h) = 110$ GeV
$m(\tilde{g}) = 447$ GeV $m(\tilde{u}_L) = 415$ GeV
$\sigma \sim 213$ pb nothing special
5 150,180

$m(\tilde{\chi}_1^0) = 45$ GeV $m(h) = 106$ GeV
$m(\tilde{g}) = 349$ GeV $m(\tilde{u}_L) = 406$ GeV
$\sigma \sim 500$ pb $\tilde{q} \to \tilde{g} + X$, $\tilde{g} \to$ 3 body, more jets, less MET
6 300,130

- Require $\int Ldt < 10\ pb^{-1}$

SUSY: L1

Jets and MET E_T cuts (GeV) for optimal signal effficiency @ L1

		MET	J1	J2	J3	J4	J1 + MET
		90	190	150	70	50	80 + 70
signal efficiency (%)	Point 4	71.4(71.4)	81.7(64.8)	82.5(42.5)	86.5(50.2)	86.8(31.5)	89.7 (79.3)
	Point 5	67.4(67.4)	79.2(65.2)	80.5(45.4)	85.6(54.2)	86.4(35.4)	89.4 (78.0)
	Point 6	40.8(40.8)	60.1(47.7)	62.2(33.8)	74.1(57.2)	75.3(42.9)	78.9 (55.5)
	Point 4R	32.6(32.6)	77.6(74.7)	81.2(65.3)	90.5(83.2)	91.4(69.9)	92.1 (46.0)
	Point 5R	21.7(21.7)	76.9(75.4)	80.2(65.9)	91.6(84.4)	92.2(71.1)	92.7 (35.3)
	Point 6R	14.1(14.1)	55.0(53.5)	60.0(47.0)	81.8(75.8)	84.0(64.8)	84.5 (24.0)
Background rate (kHz)	QCD	0.05(0.05)	0.69(0.65)	0.77(0.27)	1.70(1.20)	1.79(0.34)	2.01 (0.31)
	$t\bar{t}$, W j ($\ell\nu$)	irrelevant !					

SUSY: L2 Cuts

		MET 140	J1 + MET 210 + 0	J2 + MET 150 + 0	J3 + MET 30 + 100	J4 + MET 50 + 70	eff. w.r.t. L1 $\Delta\phi$ (J1,J2) < 125°	L2 rate (Hz)
signal efficiency w.r.t. L1 (%)	Point 4	45.0(45.9)	58.6(42.1)	60.8(31.1)	65.4(49.8)	66.0 (24.3)	0.704*	0.21
	Point 5	38.8(38.8)	54.3(42.5)	56.3(32.4)	61.1(46.4)	62.5 (27.0)	0.685	0.24
	Point 6	19.5(19.5)	42.8(34.8)	47.1(28.7)	53.6(32.7)	57.5 (29.1)	0.698	0.45
	Point 4R	7.1(7.1)	49.8(49.0)	55.2(44.6)	56.6(16.0)	58.6 (21.3)	0.692	0.20
	Point 5R	3.6(3.6)	52.7(52.6)	58.0(47.0)	58.6(10.0)	59.8 (15.7)	0.719	0.24
	Point 6R	2.0(2.0)	36.4(36.0)	42.9(34.9)	43.6(5.5)	45.5 (10.0)	0.708	0.38
Background rate (Hz)	QCD	0.01(0.01)	1.16(0.68)	2.10(1.79)	2.15(0.12)	2.35 (0.37)	0.098	
	$t\bar{t}$	0.03(0.03)	0.03(0.01)	0.04(0.01)	0.08(0.01)	0.09 (0.03)	0.343	
	W j ($l\nu$)	0.06(0.06)	0.07(0.04)	0.08(0.01)	0.09(0.02)	0.09 (-)	0.695	
						Σ 2.53		

* 125/180 = 0.694

Production Request

QCD Bins "HLT sample" E34 (2E33?) **total 272k**

100k events/bin:	0-50,	
60k ev/bin:	50-80, 80-120	(overlap with b/t group)
12k ev/bin	120-170	(overlap with b/t group)
10,8,6,4k ev/bin:	170-230, 230-300, 300-380, 380-470	
2k events/bin:	470-600, 600-800, 800-1000, 1000-1400, 1400-1800, 1800-2000	

- Process 2k events/bin first for calibration -

Signal **total 56k**

6k	SUSY	@
10k	qqH(120) → invisible	@2E33, E34
10k	qqH(120) → WW → lνlν	
10k, 10k	qqH(135) → ττ → l+j, ll	
10k	ttH, H(120)→bb	