DAQ TDR "Patchwork"

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SUSY Trigger : Preamble

- **Low luminosity study** : CMS IN-2002/036

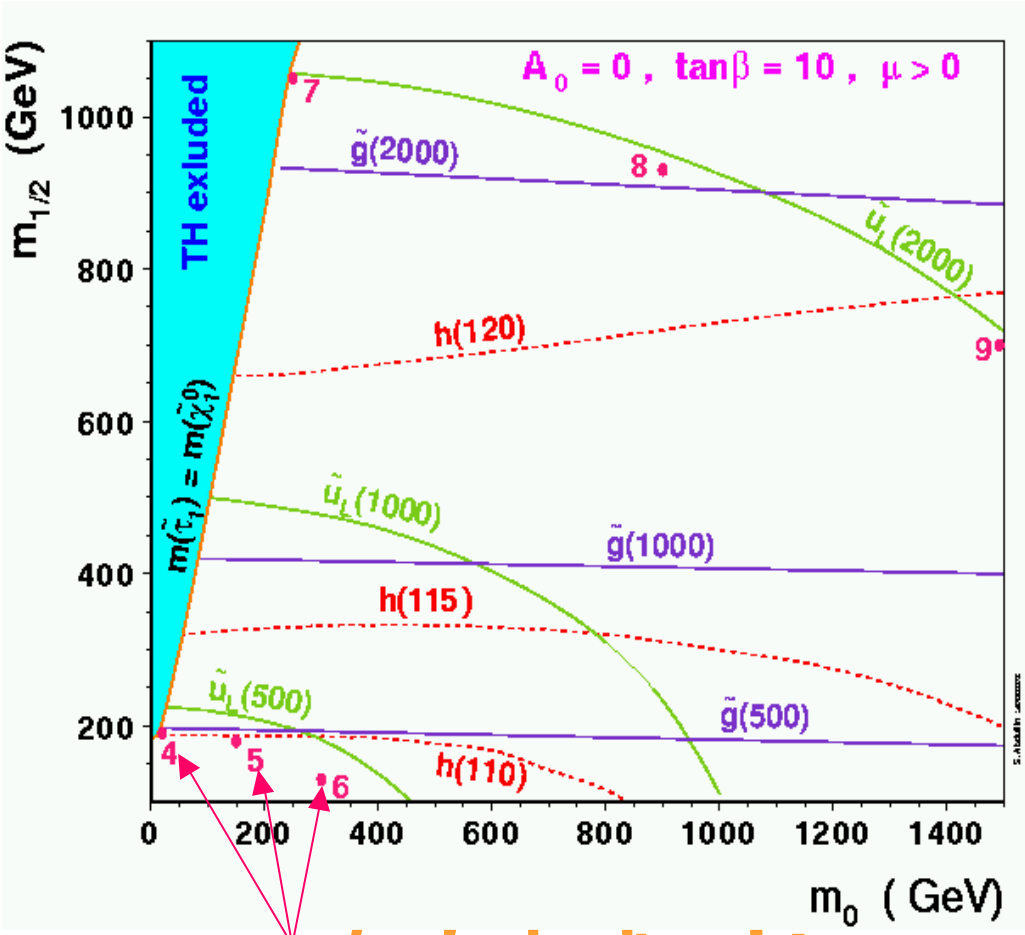
  http://cmsdoc.cern.ch/~abdullin/events/talks/acat2002.pdf

  - Probing points studied at the Tevatron II reach limit (along squark isomass curve of $\approx$ 400 GeV)
  - Given 2 kHz @ L1 and 3Hz @ L2
  - Hybrid genetic algorithm written for cuts optimization
  - 6 essential combinations of L1 and L2 channels (out of 18)
  - R-parity violation scenario yields marginal efficiency @ L2

- **High luminosity**

  - Probing points chosen at mass scale of $\approx$ 2 TeV

SUSY Trigger : Probing Points



low-luminosity points

$m(\tilde{\chi}_1^0) = 445$ GeV $m(h) = 122$ GeV
$m(\tilde{g}) = 2235$ GeV $m(\tilde{u}_L) = 1986$ GeV
$\sigma \sim 17$ fb tau and sneutrino – enriched
7 **250,1050**

$m(\tilde{\chi}_1^0) = 391$ GeV $m(h) = 121$ GeV
$m(\tilde{g}) = 2032$ GeV $m(\tilde{u}_L) = 1962$ GeV
$\sigma \sim 22$ fb "spoiling" dcays of chargino–neutralino
8 **900,930**

$m(\tilde{\chi}_1^0) = 293$ GeV $m(h) = 120$ GeV
$m(\tilde{g}) = 1625$ GeV $m(\tilde{u}_L) = 1975$ GeV
$\sigma \sim 59$ fb more jets, less MET
9 **1500,700**

SUSY Trigger : R-Parity Violation

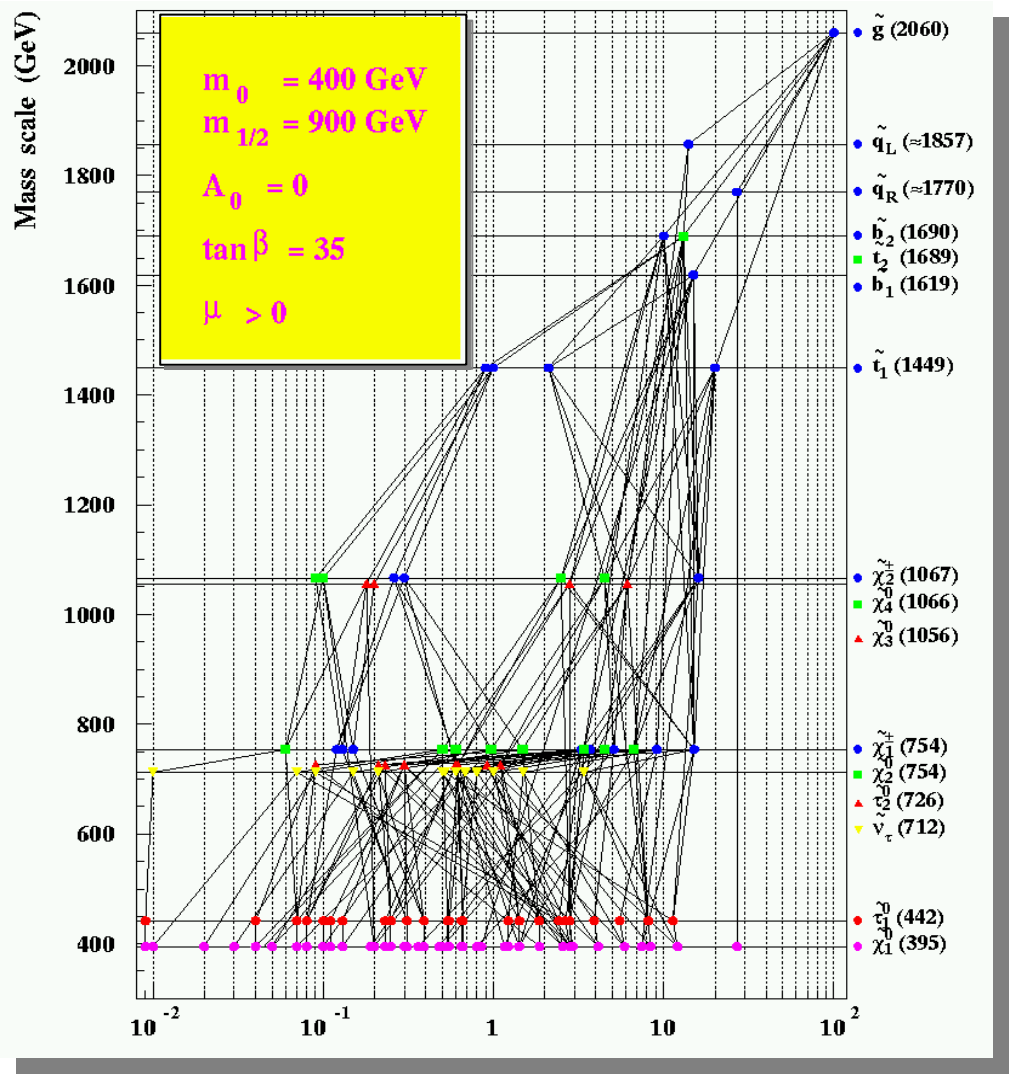
- **Most challenging scenario (?)**
  - $\tilde{\chi}_1^0 \rightarrow$ 3 quarks
  - 6 additional jets, not necessarily soft :

    $\tilde{\chi}_1^0$ mass $\approx$ 300-450 GeV
  - Missing ET shrinks, still some amount remains
    - copious b-jets, W/Z, taus and neutralinos

- **ISAJET 7.58 – ISAWIG 1.104 – HERWIG 6.301**

Points 7R 8R 9R

SUSY Trigger : Many Jets Expected ...



gluino branching ratio chart

similar to point 7

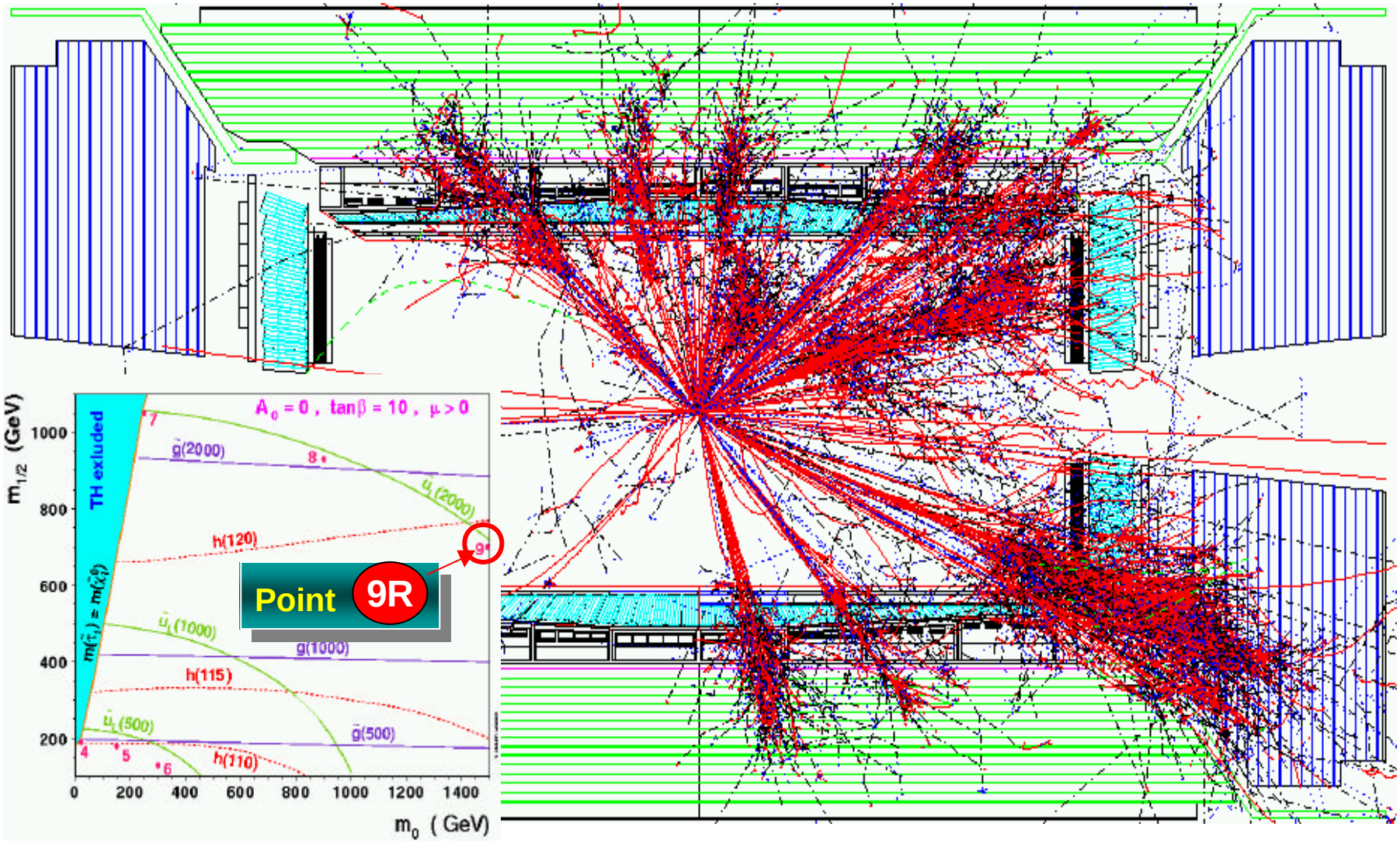
$\tilde{\chi}_1^0$ qq	(27.0 %)	$\tilde{\chi}_1^0$ $\tau\nu$WWWbb	(4.1 %)
$\tilde{\chi}_1^0$ $\tau\nu$Wbb	(12.1 %)	$\tilde{\chi}_1^0$ $\tau\tau$bb	(2.9 %)
$\tilde{\chi}_1^0$ $\tau\tau$WWbb	(8.4 %)	$\tilde{\chi}_1^0$ $\tau\tau$qq	(2.9 %)
$\tilde{\chi}_1^0$ WWbb	(7.4 %)	$\tilde{\chi}_1^0$ $\tau\nu$ZWbb	(2.8 %)
$\tilde{\chi}_1^0$ $\tau\nu$qq	(5.9 %)	$\tilde{\chi}_1^0$ $\tau\nu$hWbb	(2.6 %)

- squarks yield less jets
- more jets if squarks decay via gluino

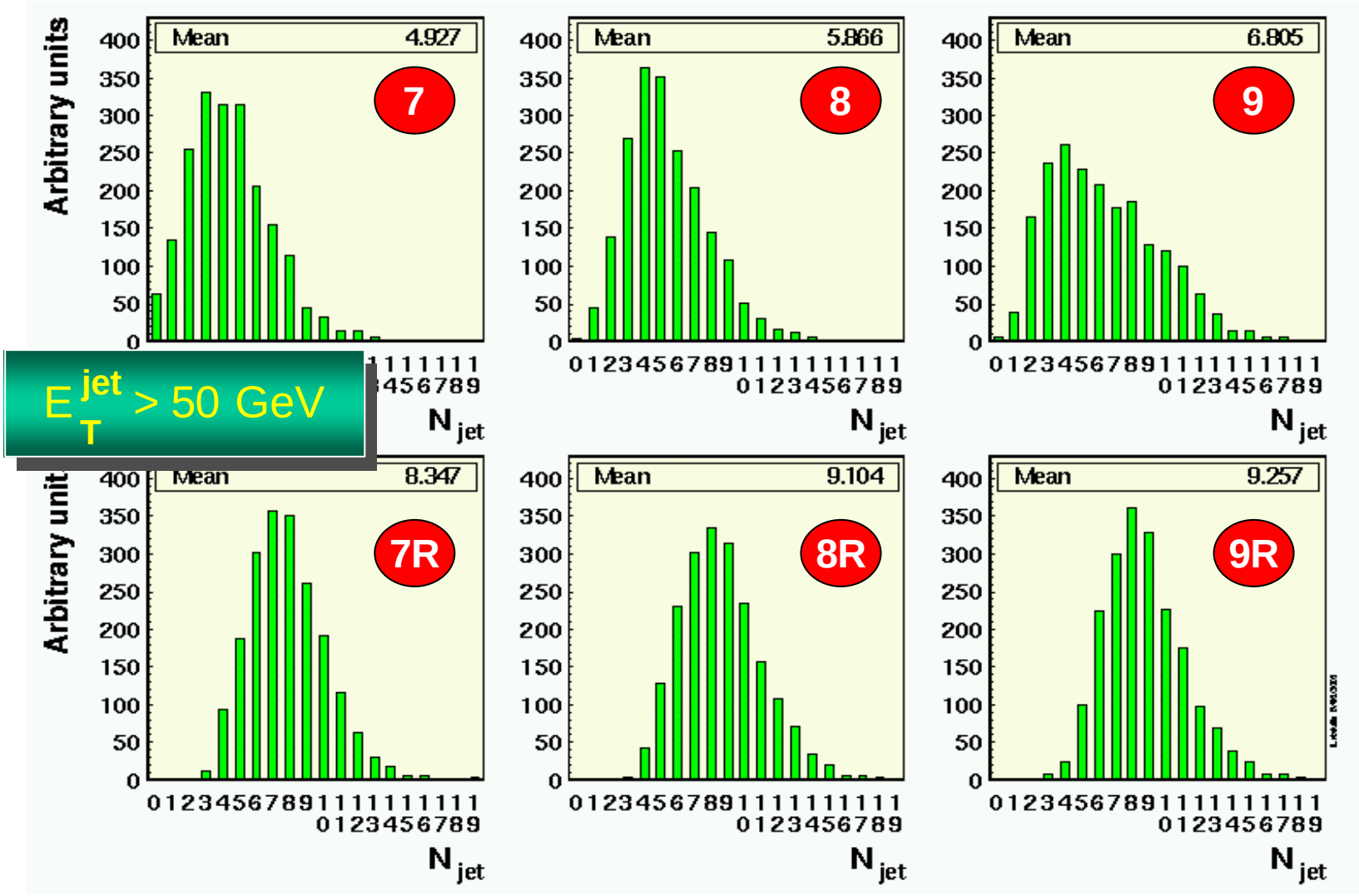
9

9R

SUSY Trigger : Event Display

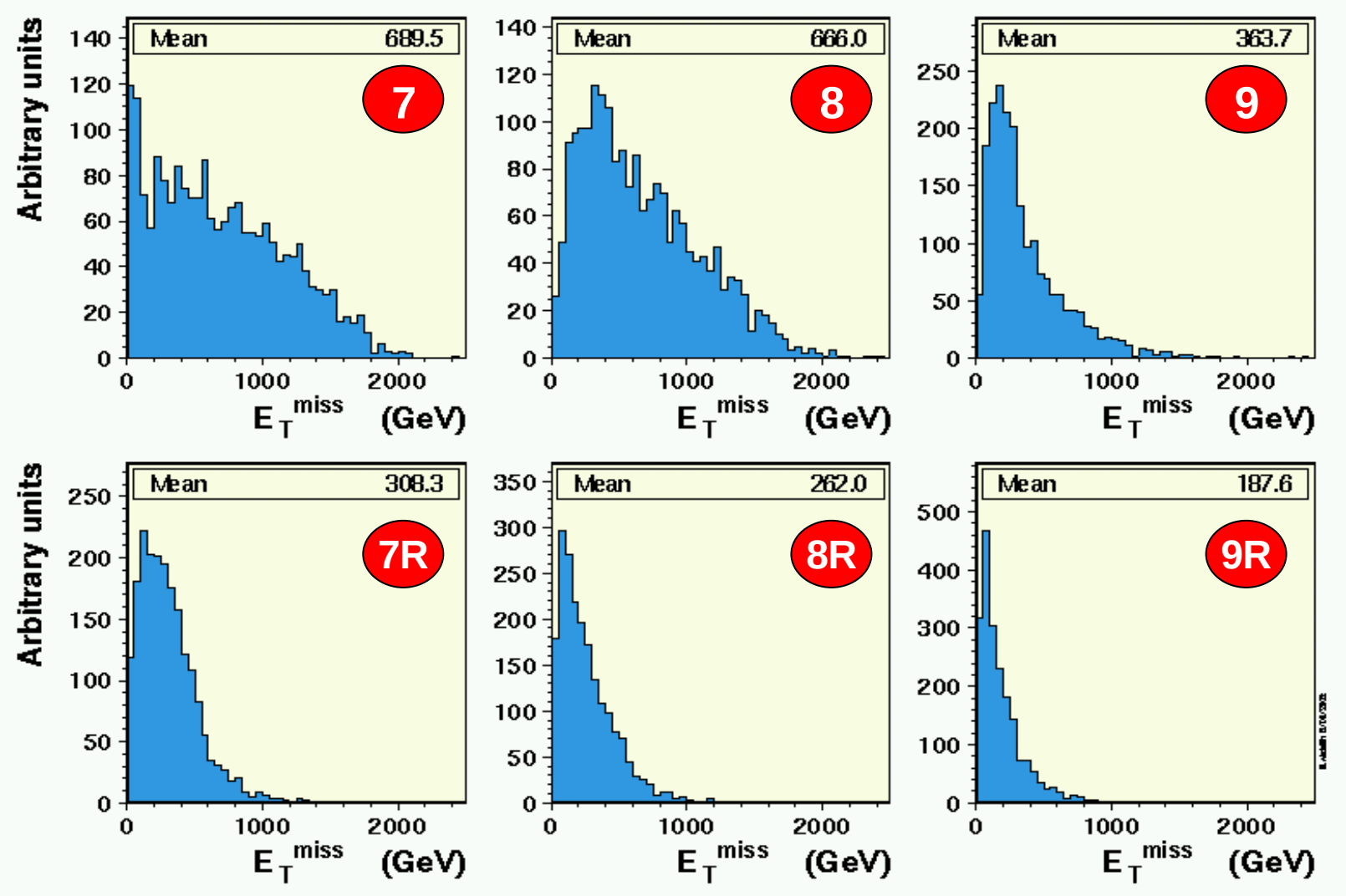


SUSY Trigger : Jet # @ L2



$E_T^{jet} > 50$ GeV

SUSY Trigger : Missing ET @ L2



SUSY Trigger : Data Samples

- **6 mSUGRA samples**
  - spring 2002 production
  - 2000 events each
  - high-lumi energy corrections from Andrei Krokhotine
- **3 SM backgrounds**
  - spring 2002 production (high lumi)
    - QCD (with HF filter) $\approx$ 1,050,000 events
  - autumn 2001 production (low lumi, rescaled)
    - Wj ($W \rightarrow l\,\nu$) $\approx$ 150,000 ev.
    - $t\,\bar{t}$ $\approx$ 46,000 ev.
  - high-lumi jet energy corrections

SUSY Trigger : L1 and L2 cuts

- **L1 cuts :**
  - MET || J1 || J2 || J3 || J4 || (J1 && MET)

- **L2 cuts :**
  - {(J1 && MET) || (J2 && MET) || (J3 && MET) || (J4 && MET) || Meff || MET } ||

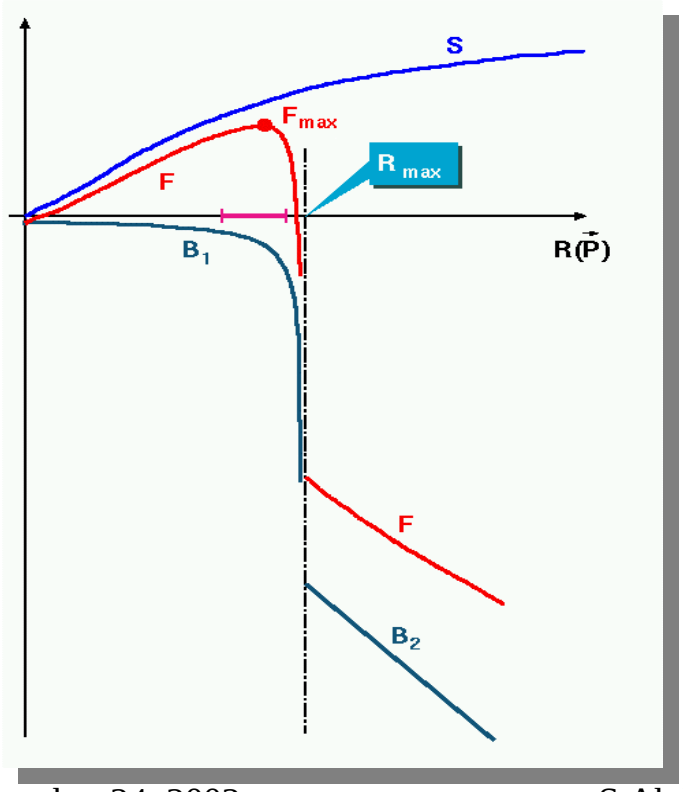
    {
    {(J1 && MET) || (J2 && MET) || (J3 && MET) || (J4 && MET) || Meff || MET } && $\Delta\phi$(J1,J2)
    }

SUSY Trigger : Hybrid GA* (I)

* Genetic Algorithm

"Society of individuals

- Fixed-size population (100-1000 individuals)
- Each individual has a unique combination of genes (cuts) $\vec{P}$
- Hierarchy is established according to evaluation function $F(\vec{P})$



- Maximal signal efficiency $S(\vec{P})$
- Rate $R(\vec{P})$ is close to R_{max}

SUSY Trigger : Hybrid GA (II)

- **Act of Creation (random)**
- **Breeding**
  - random ("uniform") crossover of genes between parents, offspring is added, parents retained;
  - probability to participate ~ place in the hierarchy.
- **Mutation**
  - random change by one bit (up/down) of a random gene; mutation probability is significant (10-20 %) and independent from hierarchy;
  - Initial individual retained, the result of mutation added.
- **Selection**
  - removal of clones (repl. with newly created individ.);
  - descending ordering according to the evaluation func.;
  - removal of redundant individuals;
  - separate "Top 10" list update (if any);
- **Cataclysmic update**
  - complete random renewal of the population, except the best individual; "Top 10" is not affected also.
  - applied in case of stagnation (50-100 generations) a few times.

SUSY Trigger : L1 Results

		J1&&MET 90	J1&&MET 80	J3 90
Signal efficiency (%)	7	89 (89)		**90** (59)
	8	97 (97)		**98** (72)
	9	88 (88)		**92** (62)
	7R	89 (89)		**100** (99)
	8R	84 (84)		**100** (100)
	9R	70 (70)		**99** (97)
Rate (kHz)	QCD	1.53		**1.94** (0.45)
	W j			-
	$t\bar{t}$			-

SUSY Trigger : L2 Results

		MET 170	J4 150	
Signal efficiency w.r.t L1 (%)	7	93 (93)	**95** (20)	
	8	92 (92)	**94** (29)	
	9	79 (79)	**83** (31)	
	7R	70 (70)	**90** (76)	
	8R	58 (58)	**89** (78)	
	9R	42 (42)	**65** (53)	
Rate (Hz)	QCD	1.23	**2.79** (1.60)	**3.12**
	W j		0.11	
	$t\bar{t}$		0.22	

SUSY Trigger : L1+L2 Combined

Table 1: L1+L2 cuts combinations for high lumi SUSY ...

	L2 Trigger cuts (GeV)	
	MET 170	J4 80
L1 J3 (90)	**1 1**	**1 2**
L1 J1&&MET (90&&80)	**2 1**	~~2 2~~

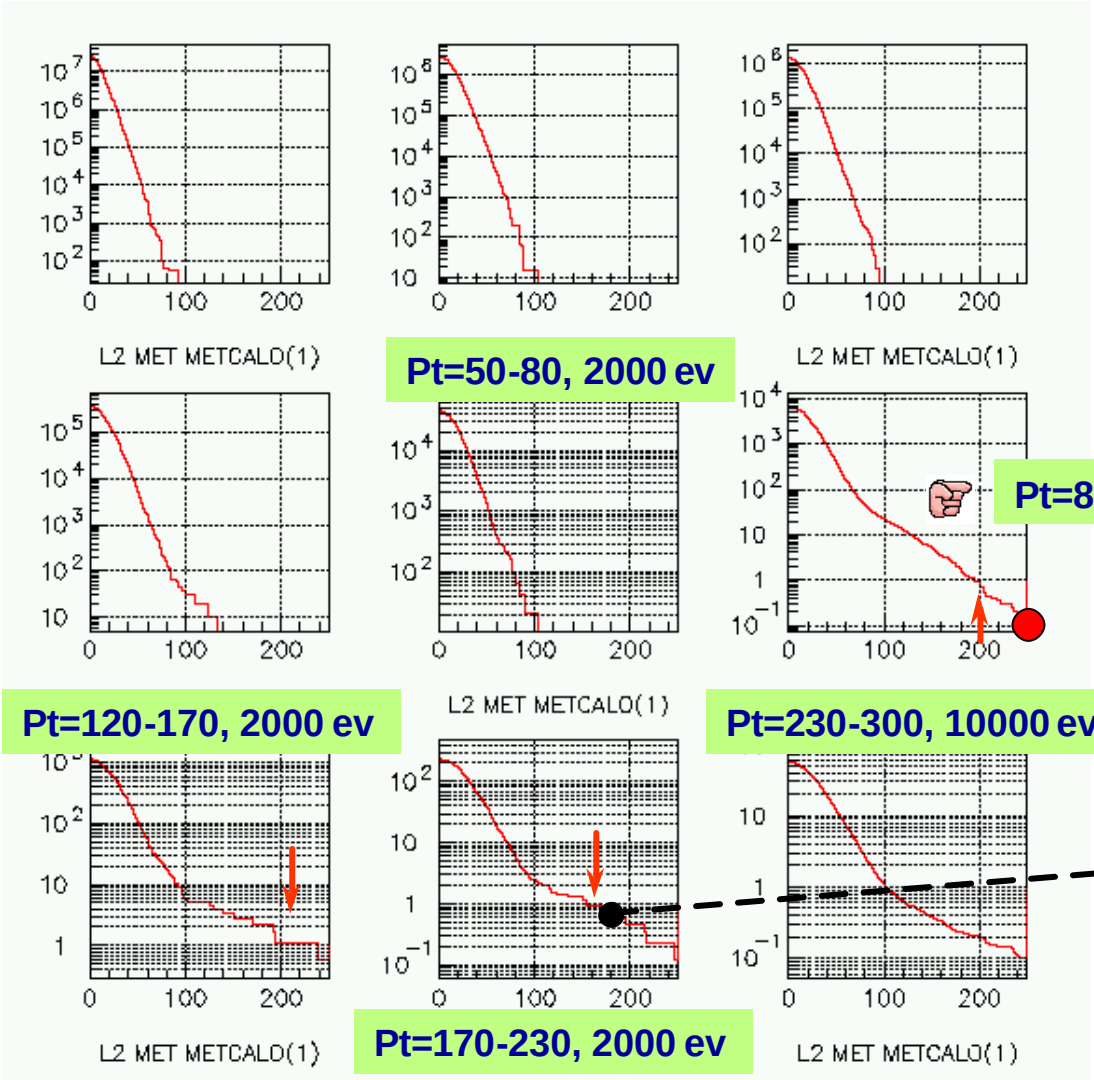
Table 2: Partial and cumulative efficiencies (%) for signal points 7,8,9

7			8			9		
L1 L2	part.	cumul.	L1 L2	part.	cumul.	L1 L2	part.	cumul.
2 1	83.5	83.5	2 1	90.2	90.2	2 1	72.3	72.3
All 4 combinations :		84.6	All 4 combinations :		91.7	All 4 combinations :		76.0

Table 3: Partial and cumulative efficiencies (%) for signal points 7R,8R,9R

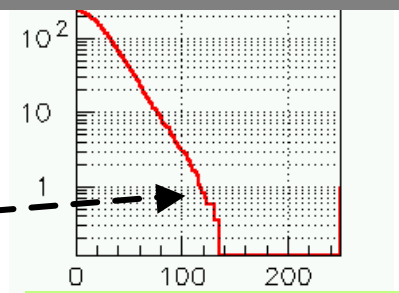
7R			8R			9R		
L1 L2	part.	cumul.	L1 L2	part.	cumul.	L1 L2	part.	cumul.
1 2	75.3	75.3	1 2	77.8	77.9	1 2	52.3	52.3
1 1	68.8	88.8	1 1	57.9	88.1	2 1	40.3	64.3
All 4 combinations :		89.6	All 4 combinations :		88.3	All 4 combinations :		64.3

HF Bugfix : Reminder



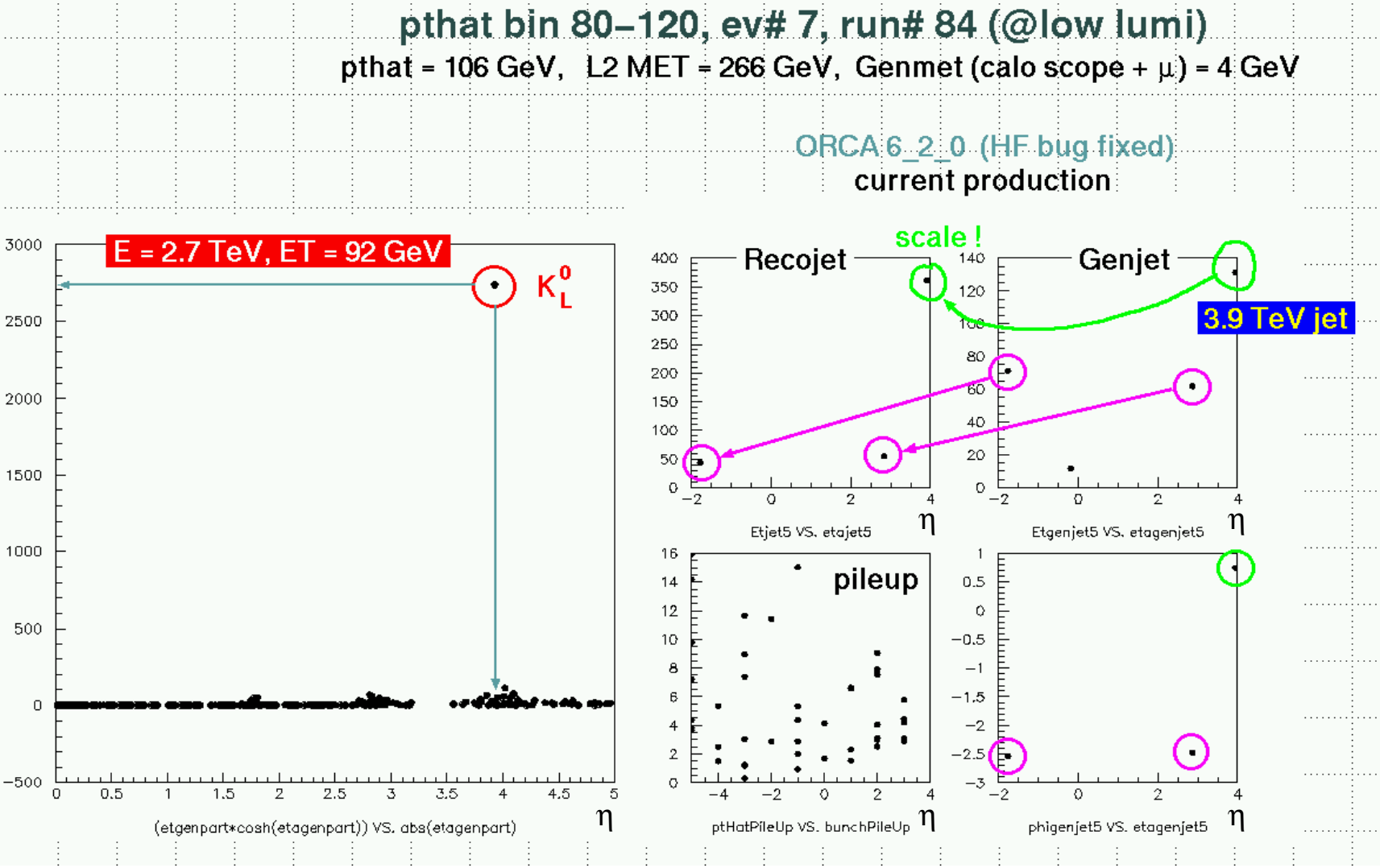
- Problem at high MET in new Ntuples
- ORCA_6_2_0 HF bug fixed :
  - scale and position correction

Previous production (May)



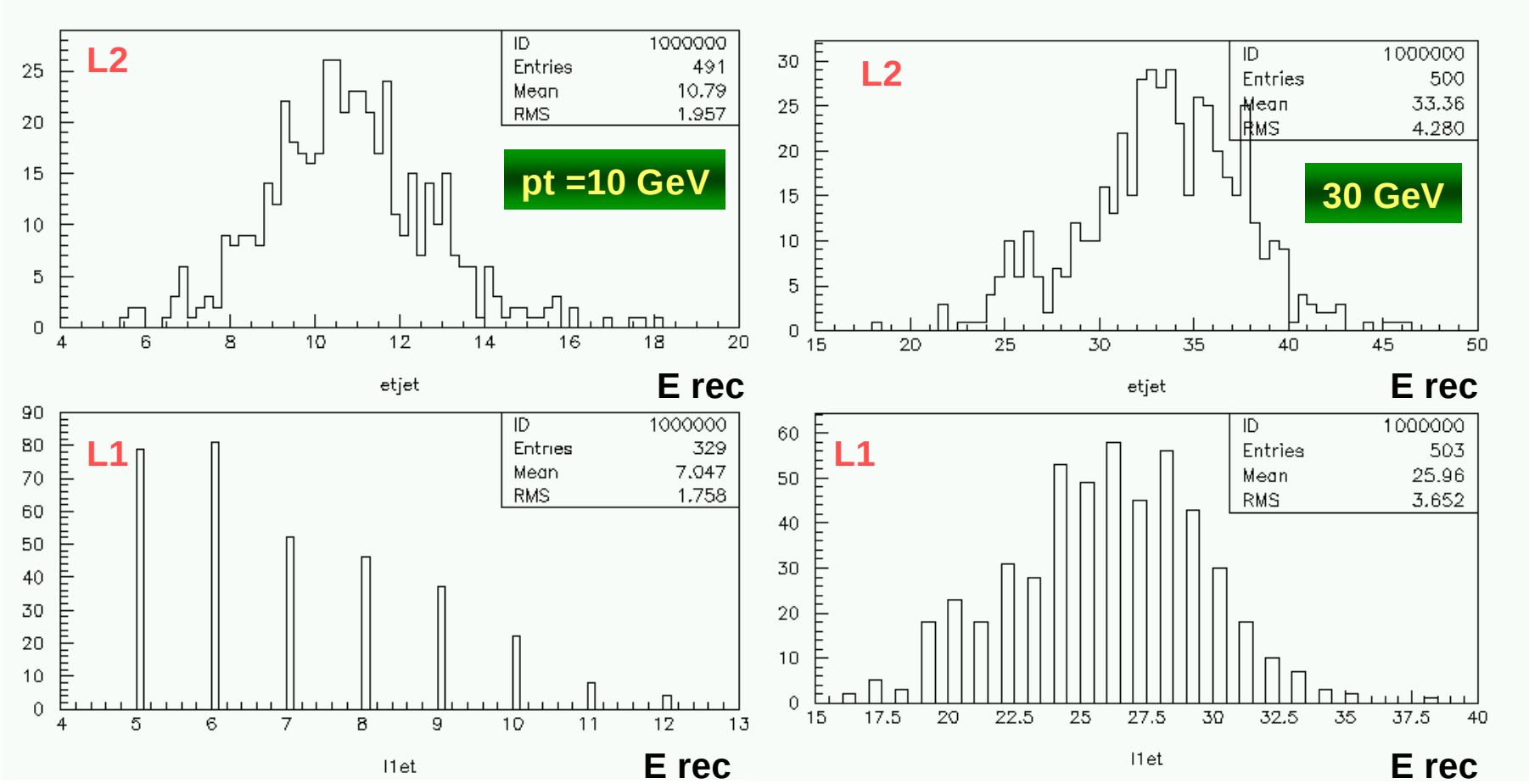
Pt=170-230, 2000 ev

HF Bugfix : ● Event (e.g.)



HF Bugfix : Single-p Shooting at HF (I)

☞ h = 3.88-3.92



HF Bugfix : Single-p Shooting at HF (II)

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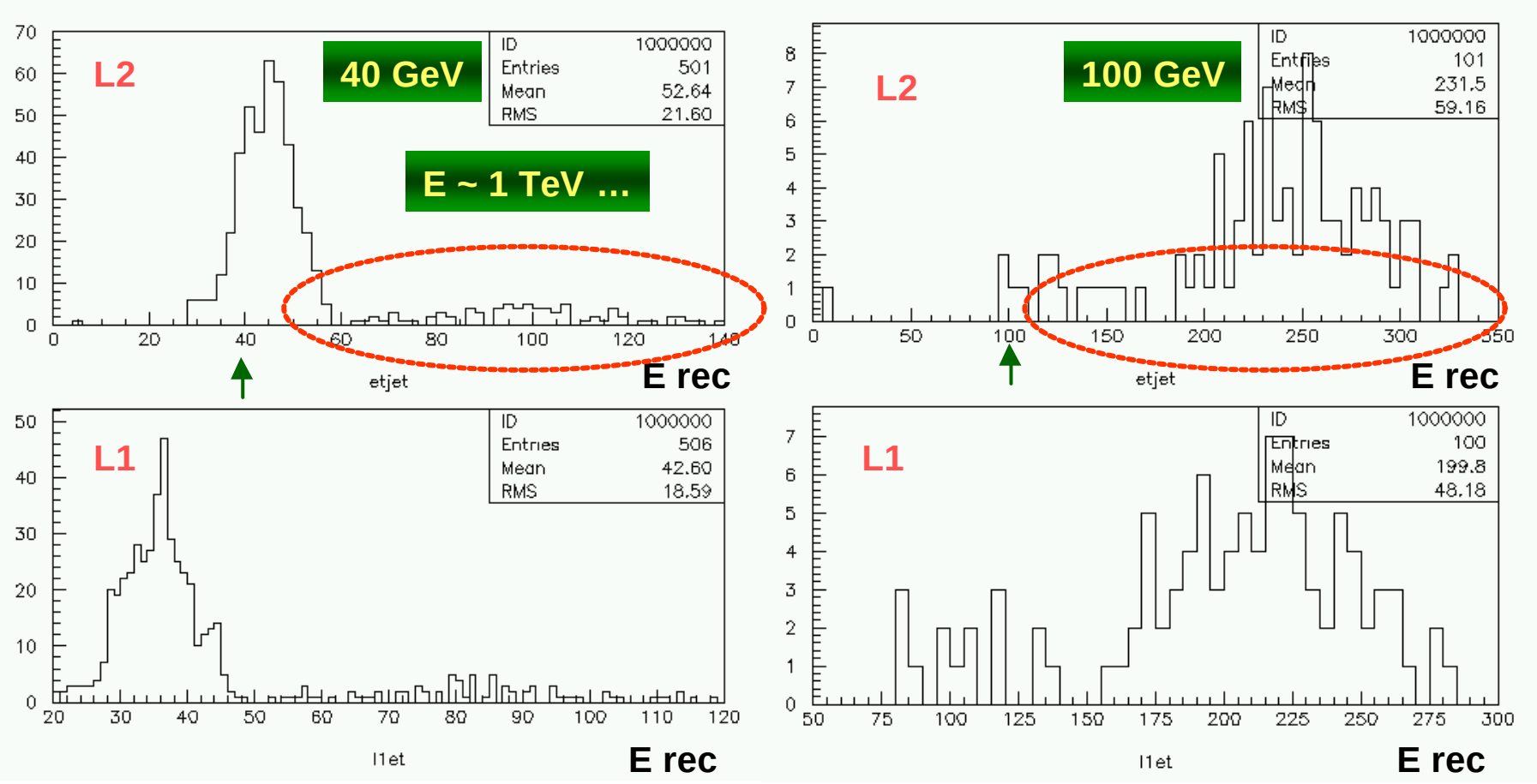
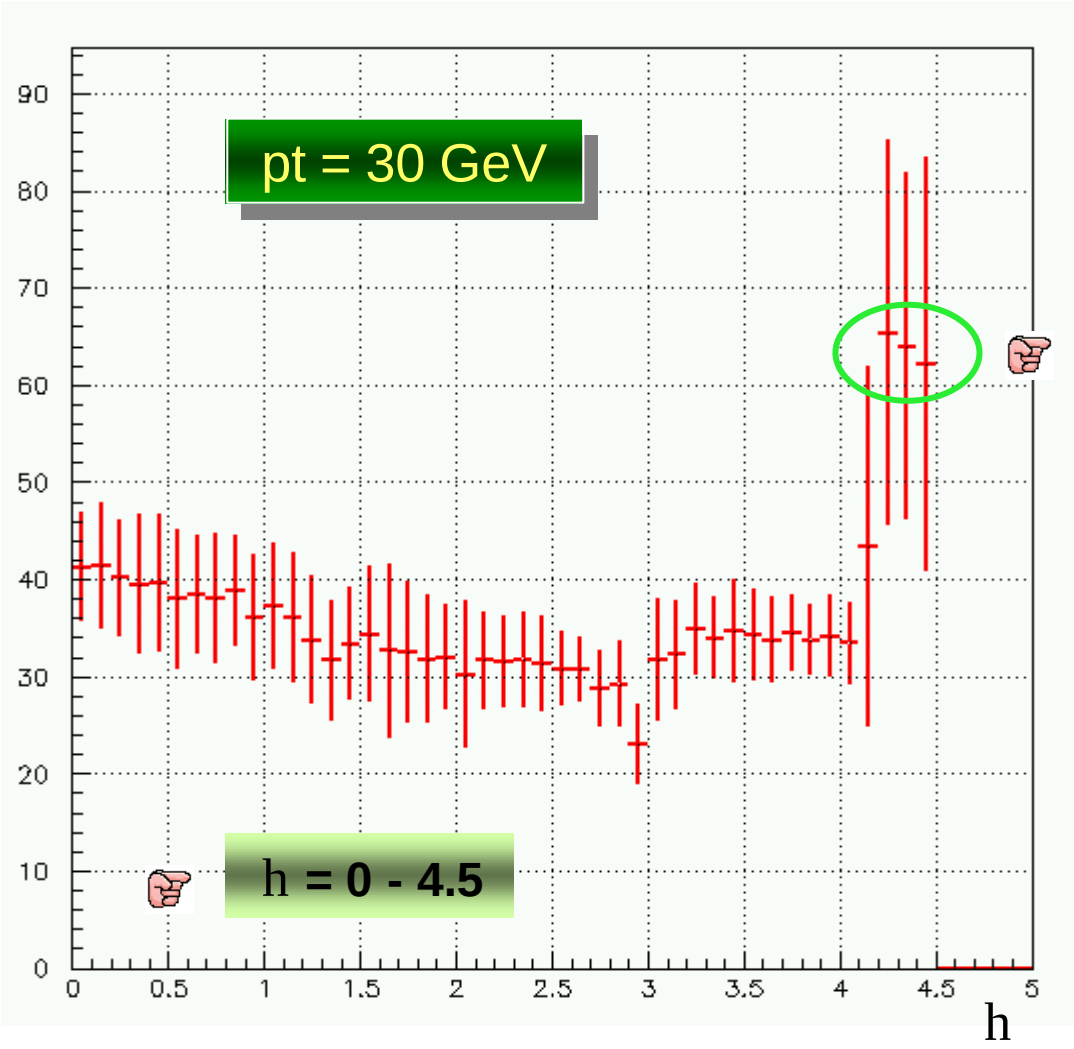


HF Bugfix : Single-p Shooting ...



- No pileup

E > 1 TeV

HF Bugfix : ORCA or CMSIM ?

- **Event-by-event analysis (single pions)**
  - Printout of RecHits from Ntuples :
    both HF layers contain too high signal,
    transverse profile (eta-phi) look OK …
  - Printout of SimHits at the “entrance”
    of ORCA (just after GEANT gfhits) : too much !
  - All steps of the signal evaluation in ORCA
    followed closely (printed) :
    what comes from fz file is treated properly
- **Evidence in favor of CMSIM origin …**
- **Finally CMSIM tests showed problems with particles above 1 TeV …**

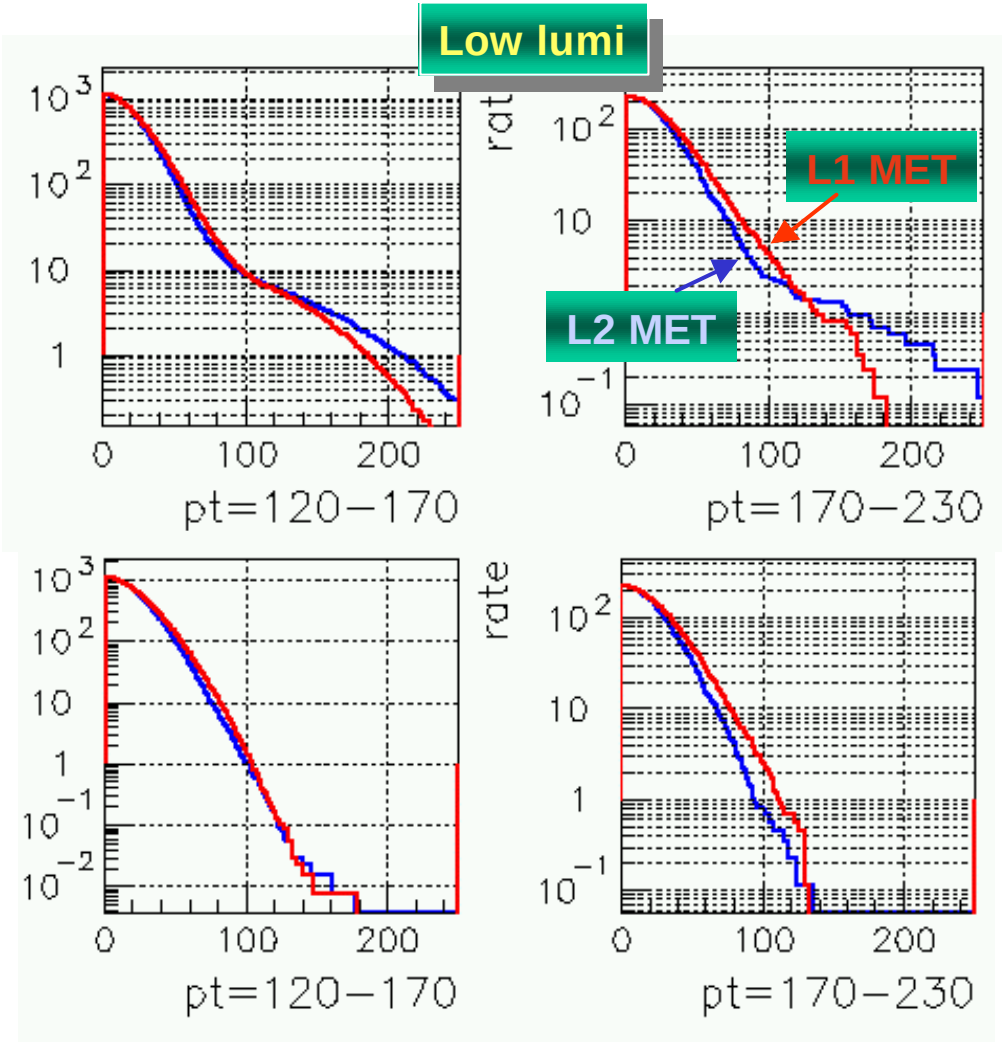
HF Bugfix : Simple(st) HF Filter

Reject those events with at least one stable particle with E > 1 TeV pointing to HF (signal/trigger event particles are available …)

HF Bugfix : Filtering out the Tails ...

without filter

with filter



HF Bugfix : HLT Data Filtering

- **Filtering of the signal events :**
  ~ 0.8 % of events filtered out

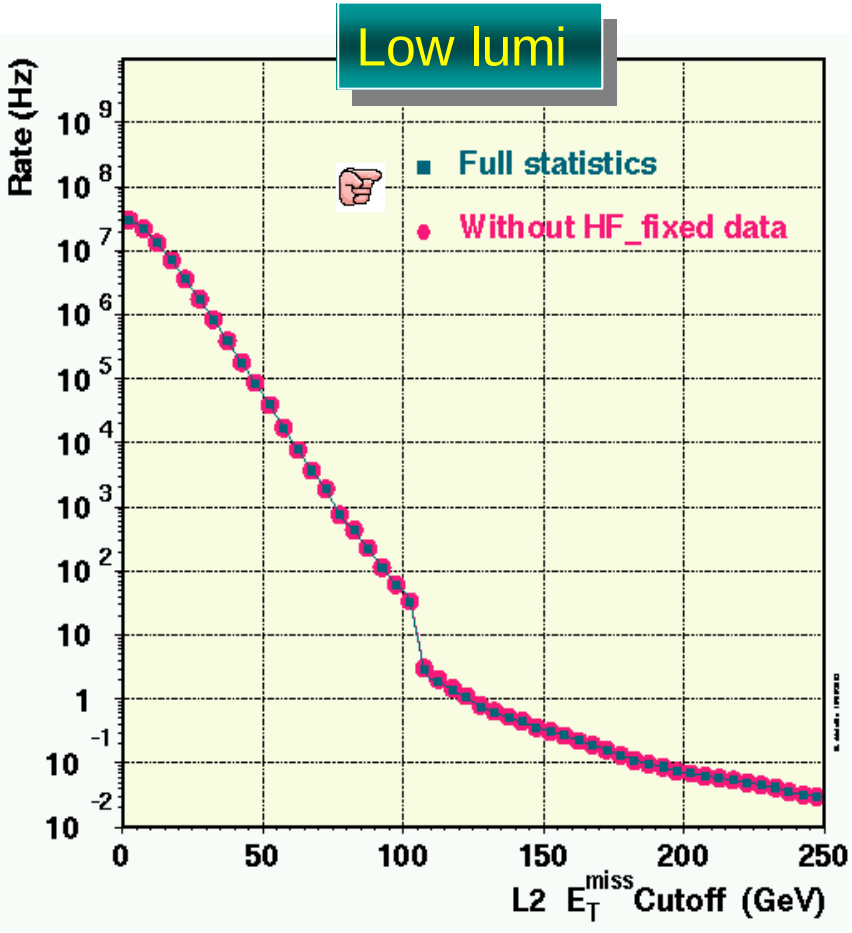
- **Mostly in pt = 50-80-120-170-230 GeV bins**

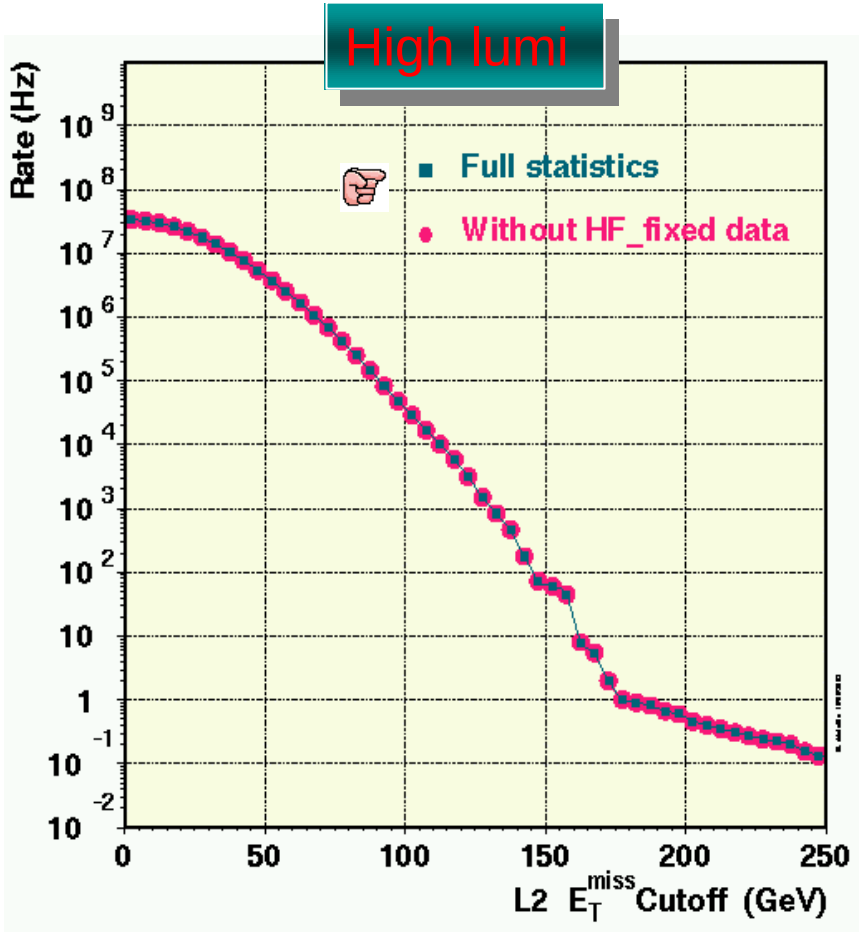
- **More ~ 0.06 % of events rejected due to in-time min.bias events filtering :**
  (recycled) 10 events out of ~200,000 events

HF Bugfix : Bringing Back Events …

- Can we recuperate those (filtered out) events ?
- Yes (to some extent : not exactly those rejected)
- "Inversed" HF filter made for CMKIN to produce only events with particles above 1 GeV in HF
- Approximately the same amount of events was produced in each pt bin
- CMSIM version with fixed HF bug was used to process these events
- "Auxiliary" Ntuples were produced (~ 5,500 ev)

HF Bugfix : Effect of “Recuperattion”

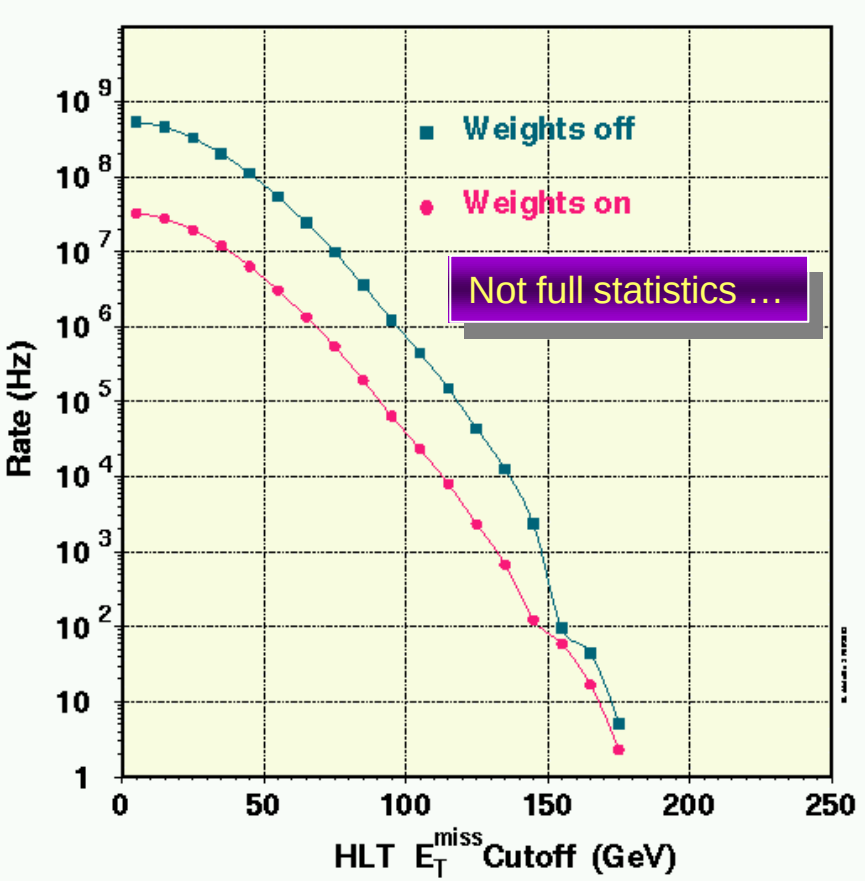


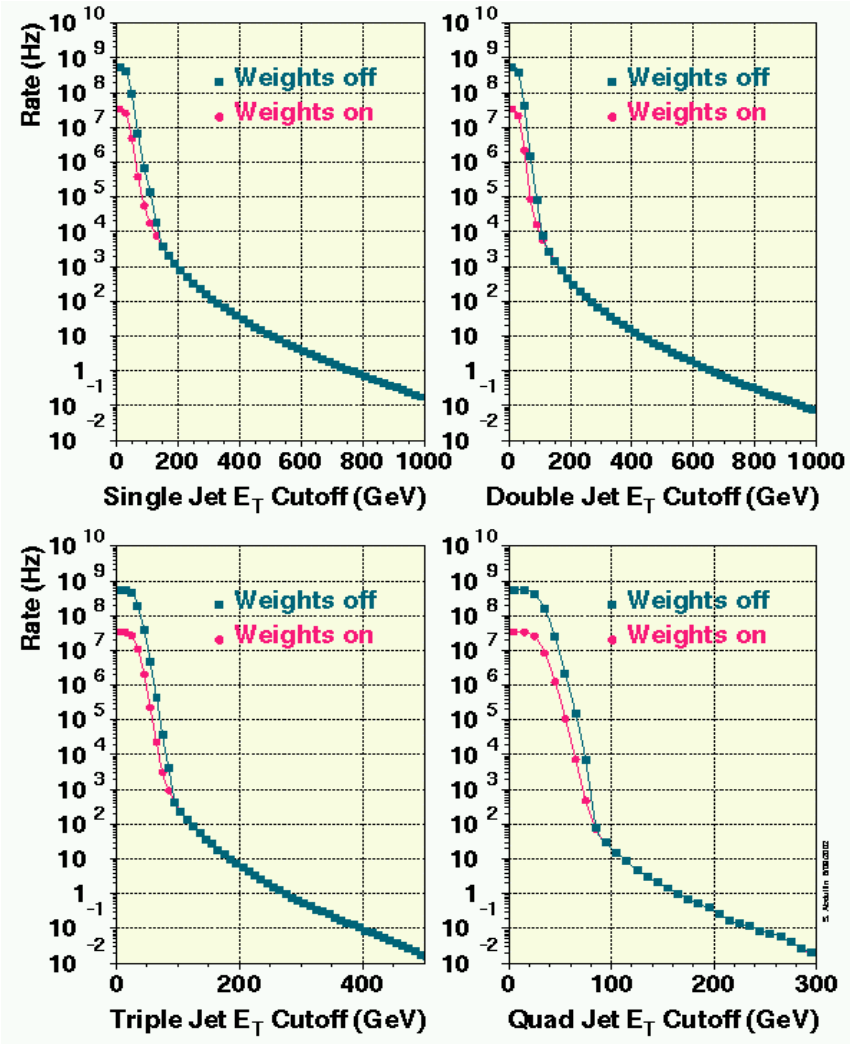


No difference ...

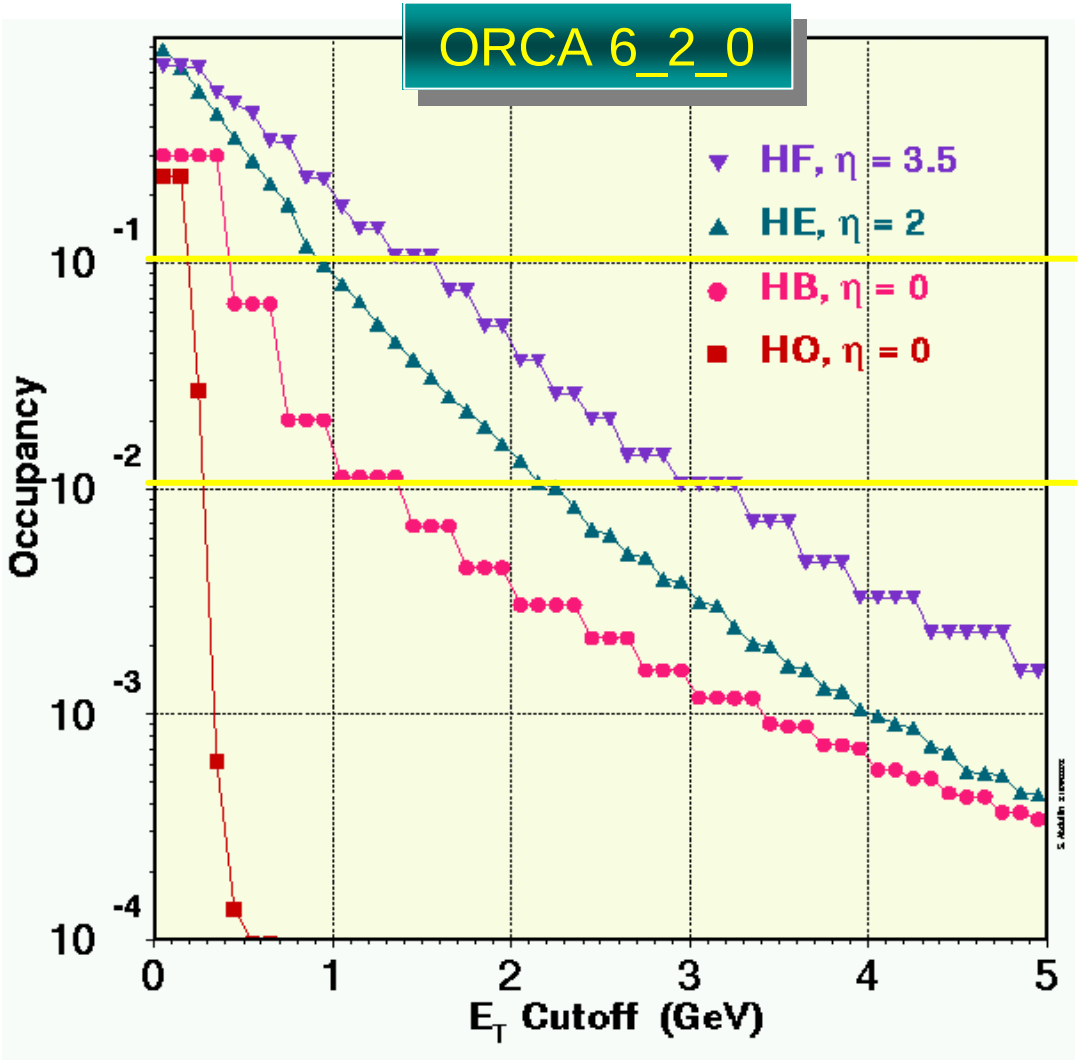
BX Weights : on/off

High lumi





Radout Occupancy @ High Lumi



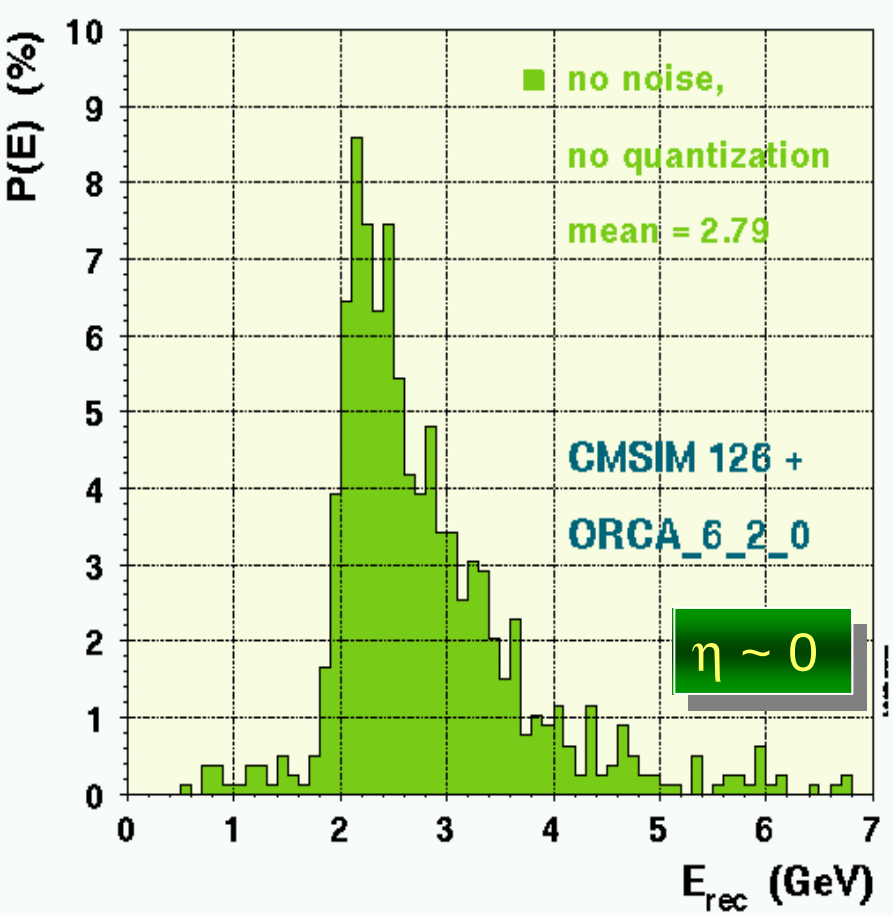
10 %

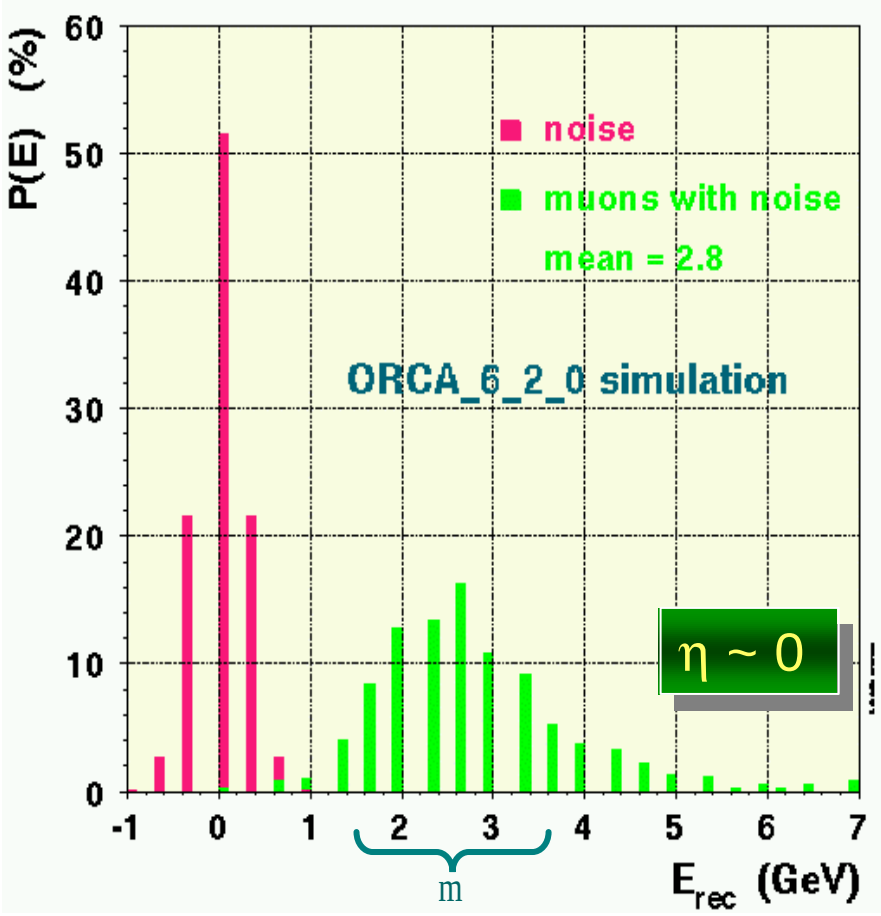
1 %

- 10,000 high-lumi events
- HF : long fiber (Layer 0)

Muons in HB

With current sampling factors …

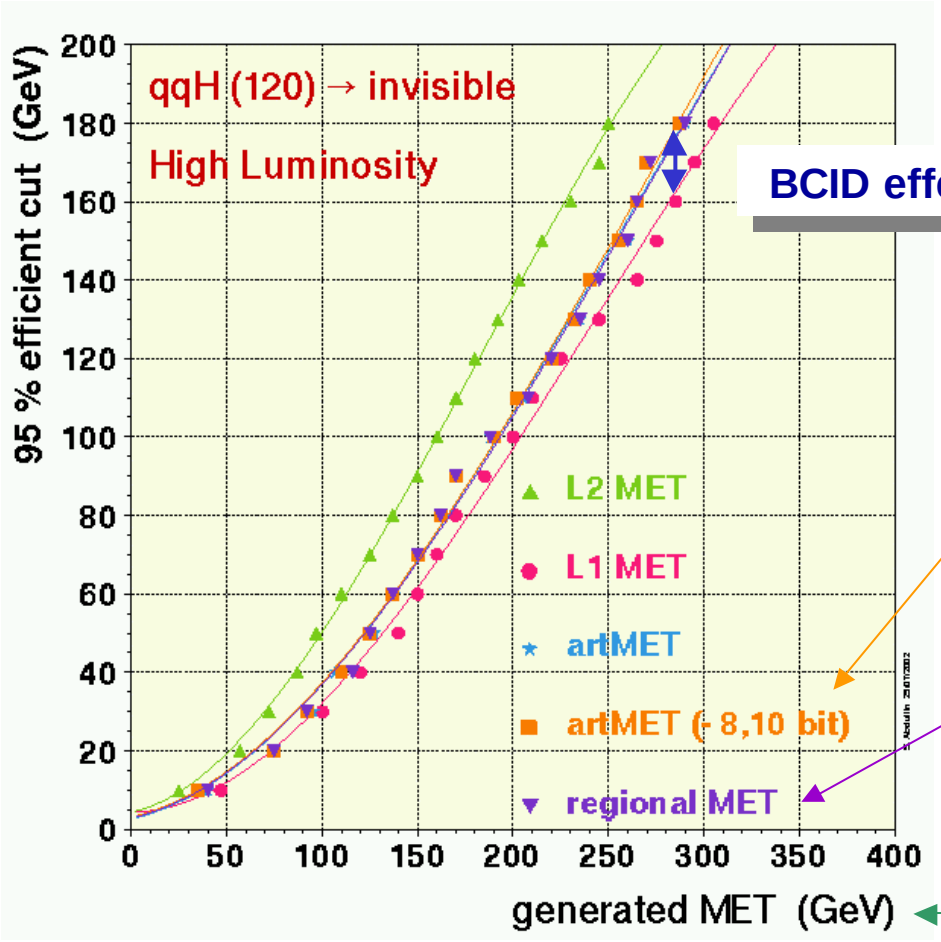




bit window ?

Invisible Higgs @ High Lumi (I)

- H(120) → invisible



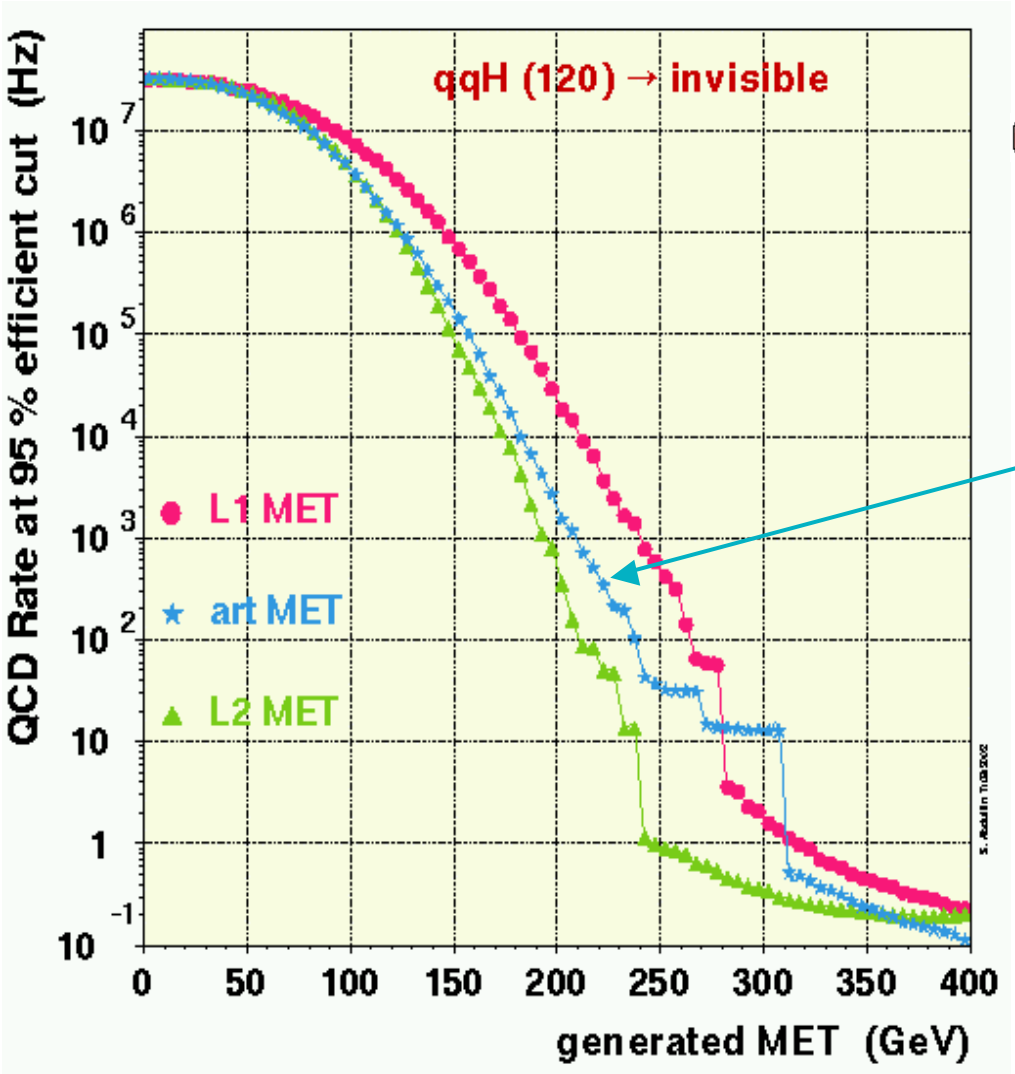
BCID effect ?

L1 granularity and LSB=1 GeV

All known tricks L2 → L1 except BCID

Calo scope + μ (in-time)

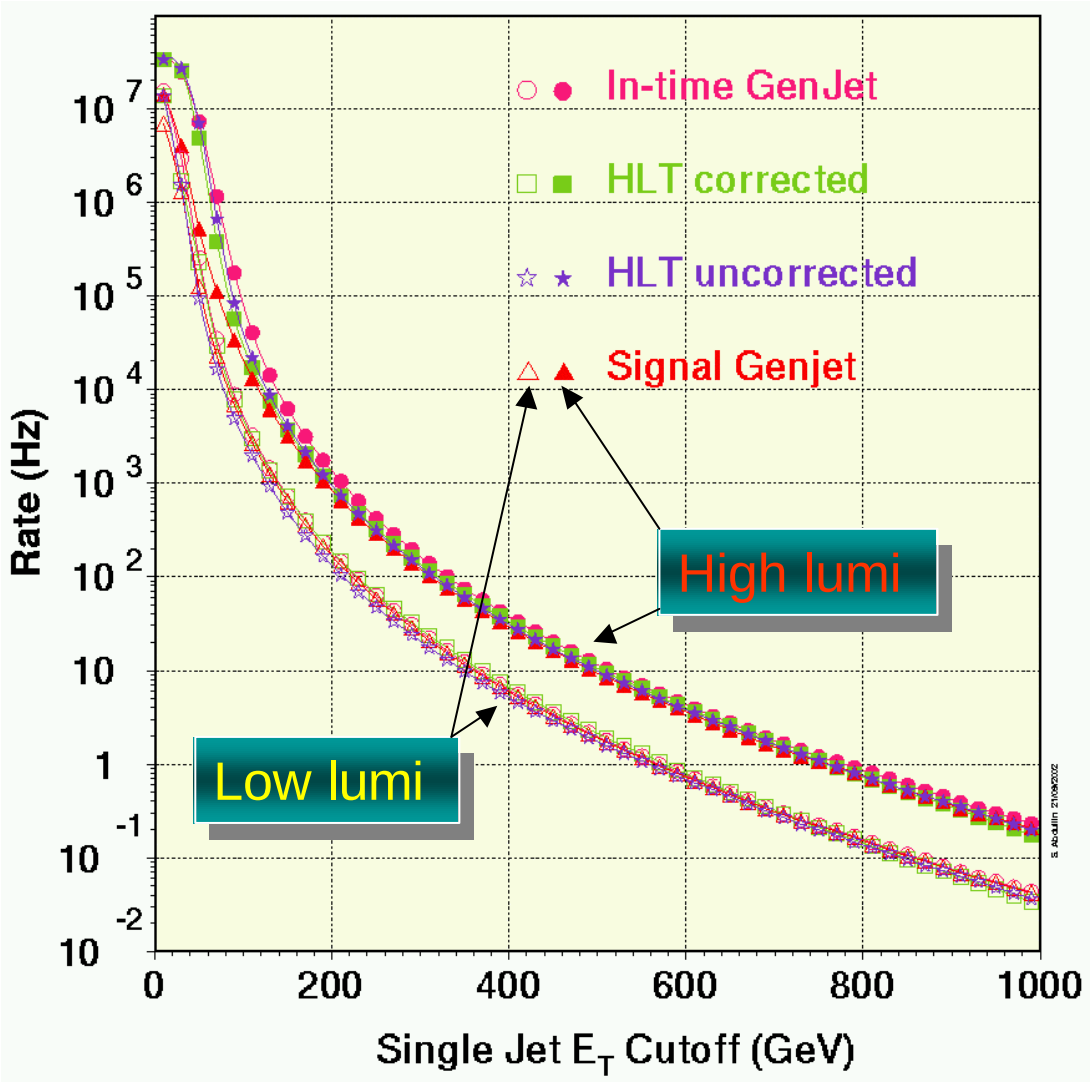
Invisible Higgs @ High Lumi (II)



☞ **Part of the full HLT stat.**

L1 granularity
L1 LSB = 1 GeV
L1 8/10 bit dynamic range

Various Jet Species @ Low/High Lumi



SUMMARY

- High-mass SUSY points considered
  - Both with/without R-parity violation
  - Cuts are optimised with a hybrid GA
  - A few simple cuts do the job
  - Efficiency is high enough
- HF bugs are fixed
  - ORCA (position and scale)
  - CMSIM (bad extrapolation for E>1 TeV)
  - Event filter(s) applied
  - Full statistics recuperated
- A number of other items considered/calculated …