Squarks Searches Using Neural Network

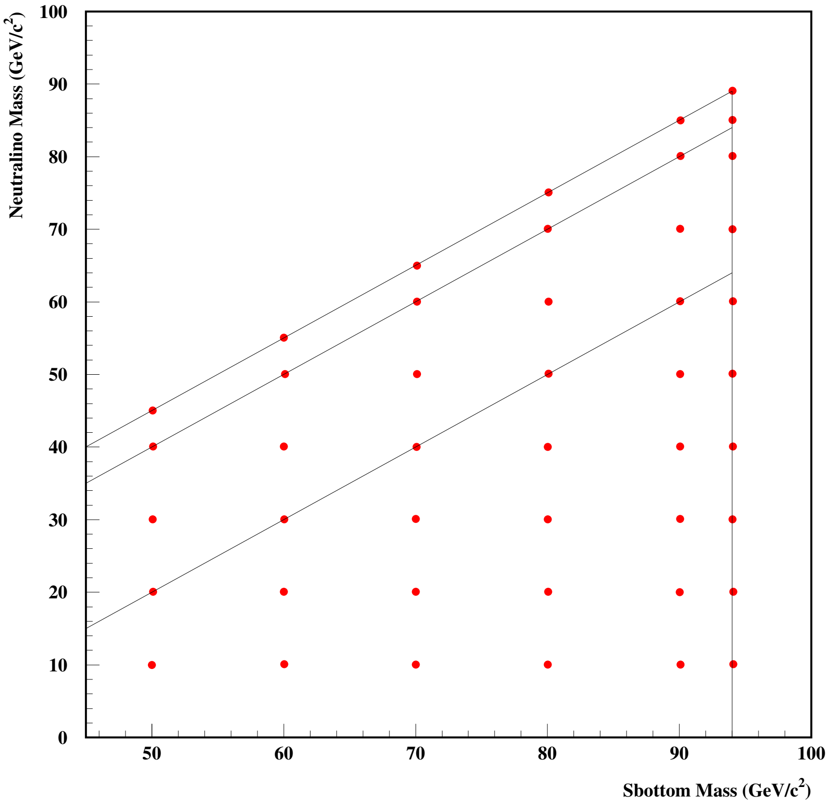
R-parity Conservation

$\tilde{q} \longrightarrow q\widetilde{\chi}^o_1$

- Searching for Sbottom : $\tilde{b}_1 \longrightarrow b\widetilde{\chi}^o_1$.
  - Mass analysis windows.
  - MAD with the **C2 processing**.
  - **Neural networks**.
  - **Exclusion limits**.
- Searching for Stop : $\tilde{t}_1 \longrightarrow c\widetilde{\chi}^o_1$.

General :

- Topology : two b-tagged and acoplanar jets, and missing energy.
- Signal : 45 points in the plane $(m_{\tilde{b}_1}, m_{\tilde{\chi}^o_1})$, using **SUSYGEN 2.3**
- Detector Simulation : Full **DELSIM** + **DELANA** version 98.1
- Mass windows :
  - $\Delta M \geq 30$
  - $10 < \Delta M < 30$
  - $\Delta M \leq 10$



- Clusterisation Forcing in 2 jets with Durham algorithm.

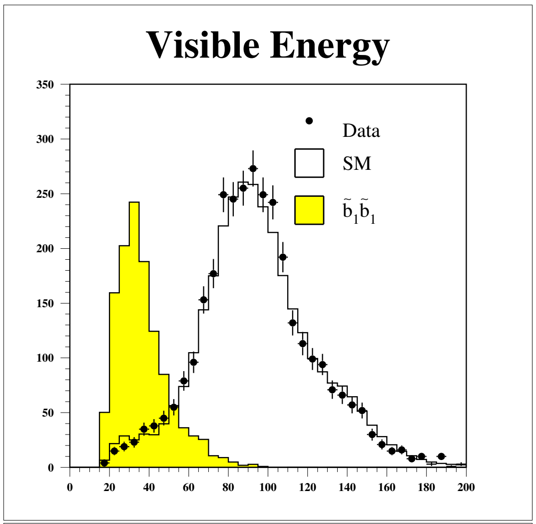
C2 Processing

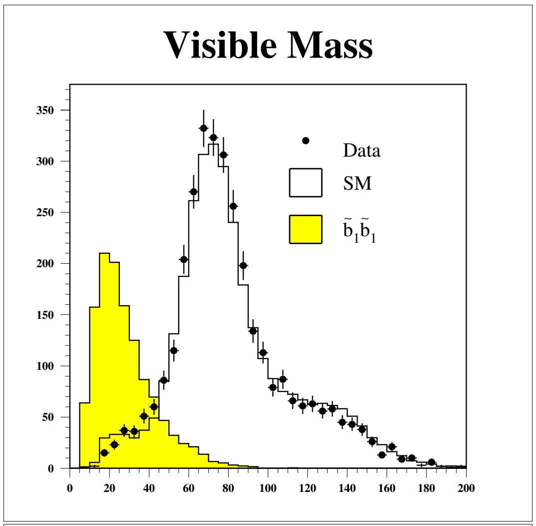
- Track Selection : cf. Chris Parkes selection criteria for hadronic analysis.

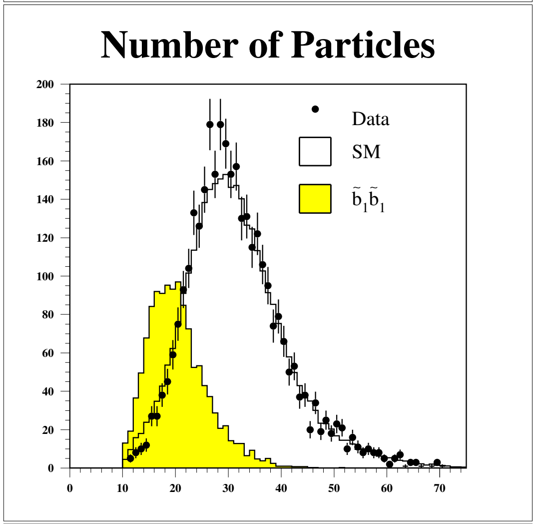
Variables	$\Delta M > 10$	$\Delta M \leq 10$
$N_{ch.\,part.}$	≥ 7	≥ 5
$N_{part.}$	≥ 10	-
$E_{visible}$	-	≤ 50
$E_{charged}$	-	≤ 40
$\sqrt{s'}$	≤ 180	
$P_t\, jet\, 1$	≥ 4	-
$P_t\, jet\, 2$	≥ 2	-
$\theta_{jets\, 1,2}$	-	$\in [30, 150]$
E_{HPC}	≤ 40	≤ 20
E_{FEMC}	≤ 25	≤ 10
E_{STIC}	≤ 20	≤ 20
$E_{<30^o}/E_{vis.}$	≤ 0.7	
$E_{<30^o}$	≤ 50	
$P_t^{charg.}\, max$	≥ 1.5	-
P_t^{miss}	≥ 5	-
E_t	≥ 15	≥ 6
$Probz0$	≥ -2	

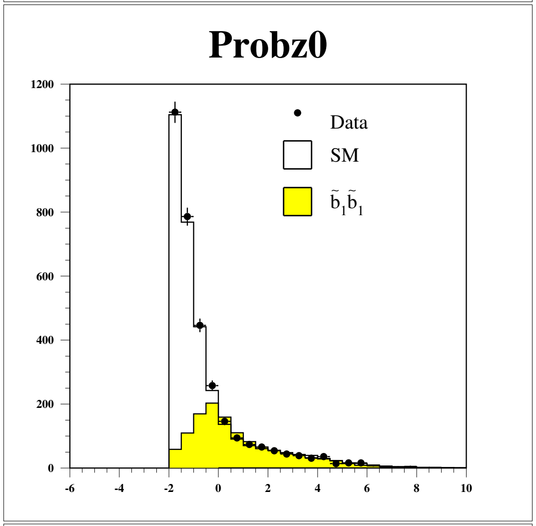
Monte-Carlo	3217.	3111.
Data	3257	2690
Average efficiency on signal	84.7%	55.5%

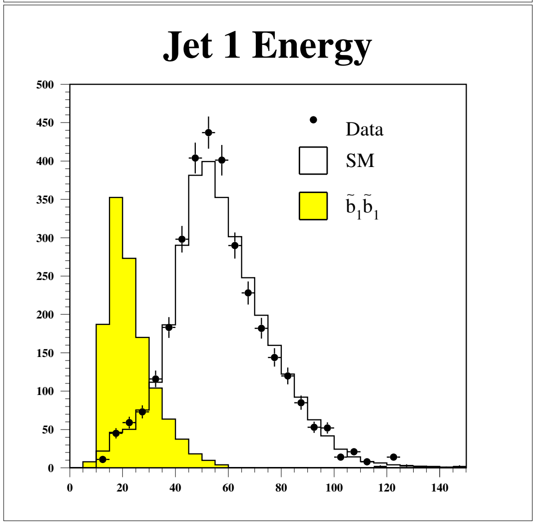
$\tilde{b}_1$: $\Delta M > 10$

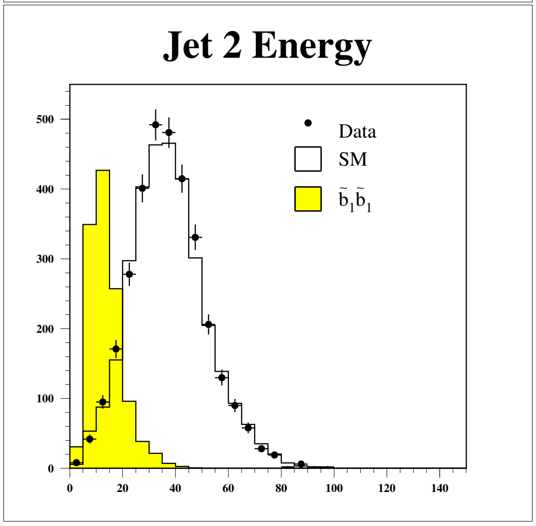


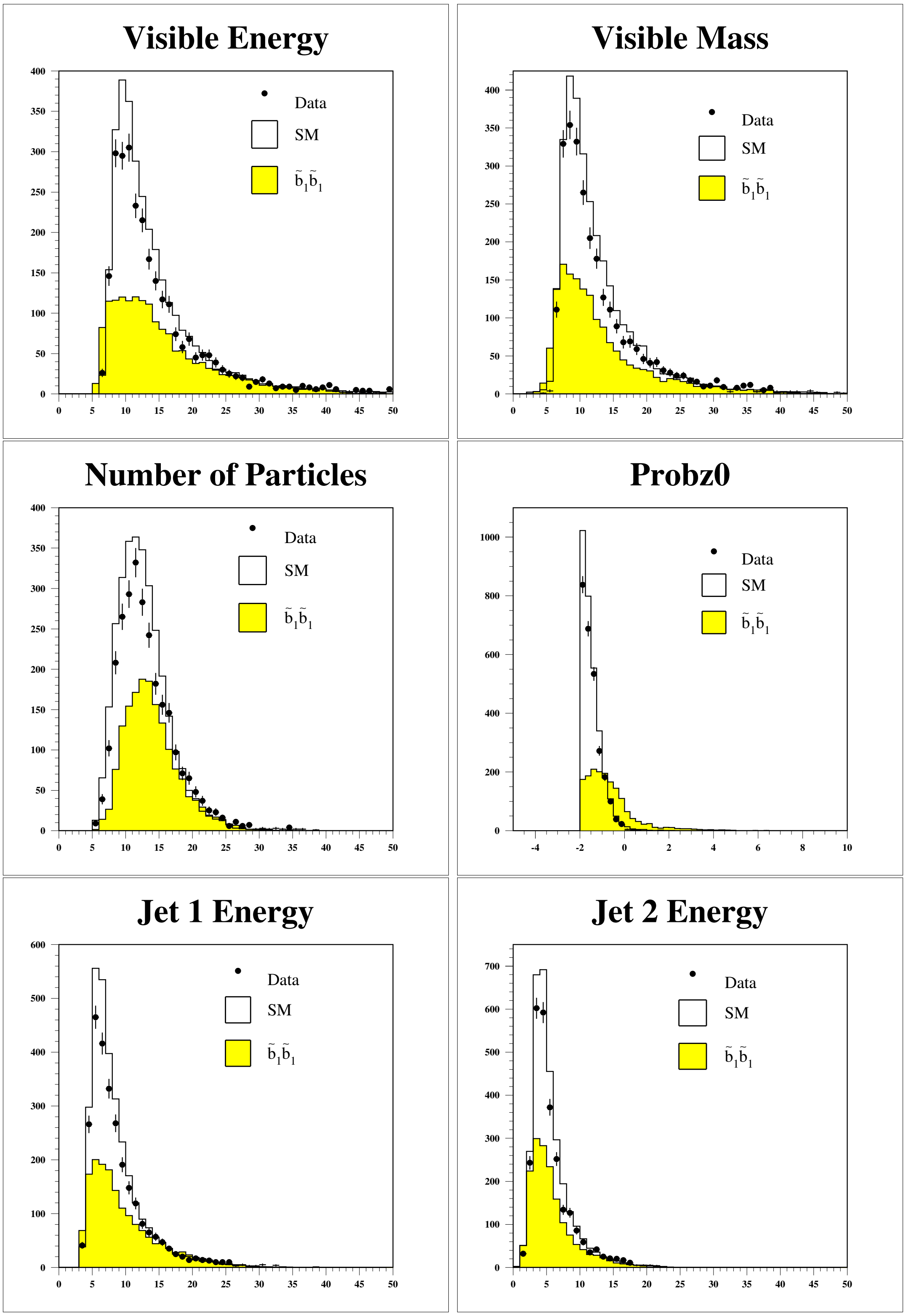












Visible Energy
Data
SM
$\tilde{b}_1\tilde{b}_1$
Visible Mass
Data
SM
$\tilde{b}_1\tilde{b}_1$
Number of Particles
Data
SM
$\tilde{b}_1\tilde{b}_1$
Probz0
Data
SM
$\tilde{b}_1\tilde{b}_1$
Jet 1 Energy
Data
SM
$\tilde{b}_1\tilde{b}_1$
Jet 2 Energy
Data
SM
$\tilde{b}_1\tilde{b}_1$

$\tilde{b}_1$: Neural Network

$\Delta M > 30$ **and** $10 < \Delta M \leq 30$

- Number of inputs : 17
- Number of hidden nodes : 17
- Number of Outputs : 3

- Input variables : E_{vis}, $E_{charg.}$, E_t, M_{vis}, P_t, E_t^{jet1},E_t^{jet2}, $N^{jet1}_{charg.part.}$, $N^{jet2}_{charg.part.}$, $\theta_{jet1-jet2}$, $\theta^{trans.plane}_{jet1-jet2}$, Y_2,Y_3, acolin., acoplan., probz0, $probz0^{durham}_{2jets}$.
- Output :

Output node	node 1	node 2	node 3
Signal	1	0	0
$q\bar{q}\gamma$ W^+W^- Z^oZ^o $W^{\pm}e\nu$ $\nu\nu qq$	0	1	0
$\gamma\gamma QCD$ $\gamma\gamma QPM$	0	0	1

The mass window , ($\Delta M > 30$ and $10 < \Delta M \leq 30$) are trained with the corresponding signal samples.

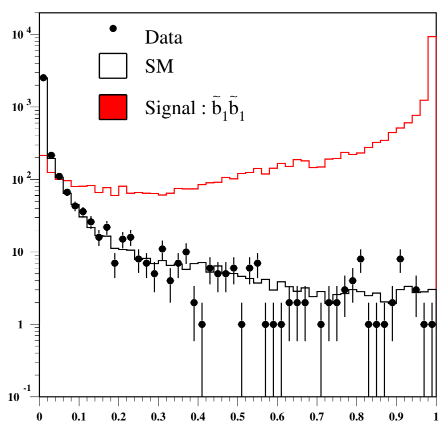
$\boxed{\Delta M \ \leq 10}$

- Number of inputs : 9
- Number of hidden nodes : 9
- Number of Outputs : 1
- Input variables : E_t,P_t, Y_2,θ_{jet1}, θ_{jet2}, acolin., acoplan.,probz0, $probz0^{durham}_{2jets}$.
- Output :

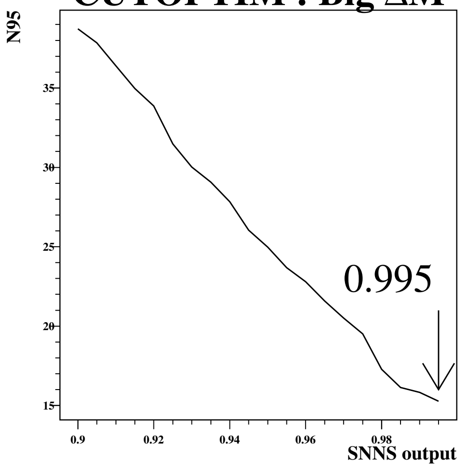
Output node	node 1
Signal	1
$\gamma\gamma QCD$ $\gamma\gamma QPM$	0

$\tilde{b}_1$: Optimisation

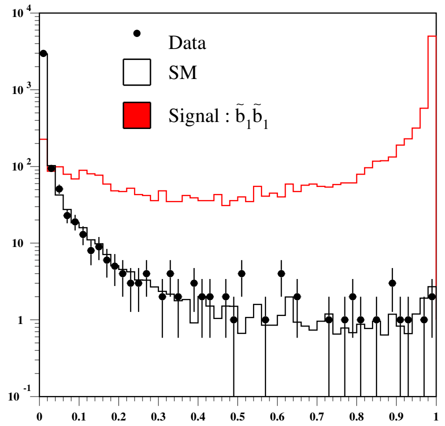
SNNS : Big ΔM



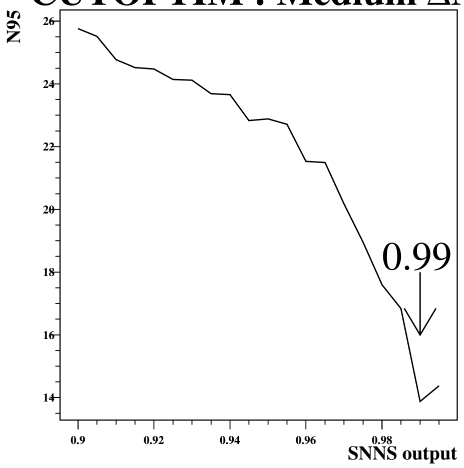
CUTOPTIM : Big ΔM



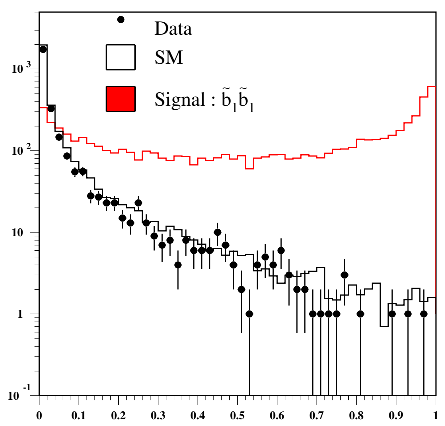
SNNS : Medium ΔM



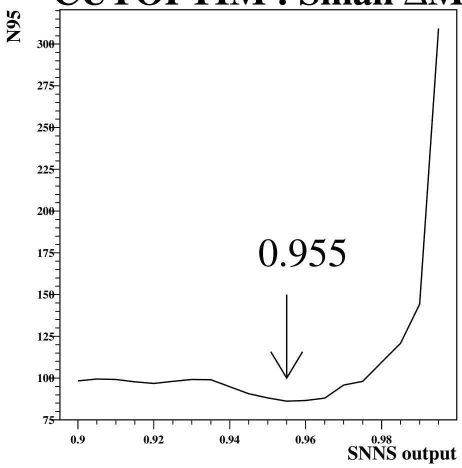
CUTOPTIM : Medium ΔM



SNNS : Small ΔM



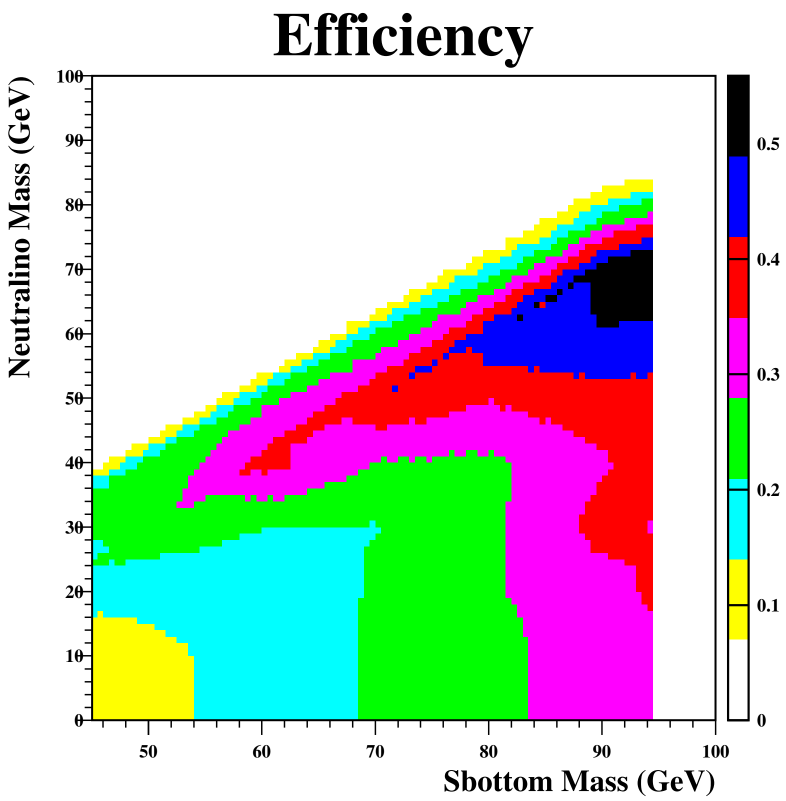
CUTOPTIM : Small ΔM



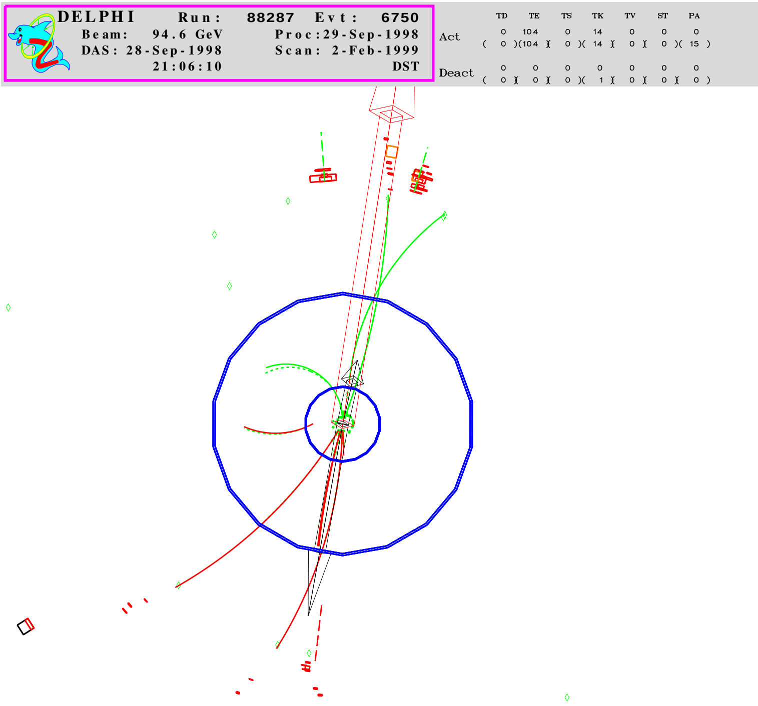
	$\Delta M > 30$	$10 < \Delta M \leq 30$	$\Delta M \leq 10$
SNNS cut	0.995	0.99	0.955
Ndata	0	0	1
Nmonte-carlo	0.89	1.29	3.34

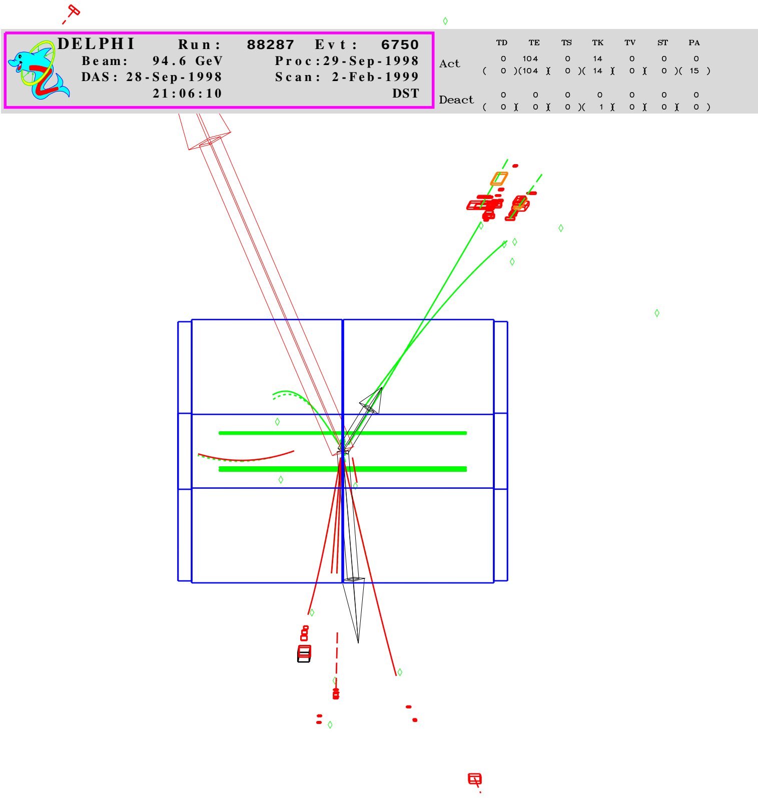
	$q\bar{q}\gamma$	$\gamma\gamma$	Z^oZ^o	$\nu\nu qq$	$W^{\pm}e\nu$
$\Delta M > 30$	0.263	0.330	0.123	0.164	0.010
$10 < \Delta M \leq 30$	0.482	0.660	0.055	0.071	0.026
$\Delta M \leq 10$	0.310	2.99	0.010	0.021	0.015

- Candidate : RUN 88287, EVENT 6750

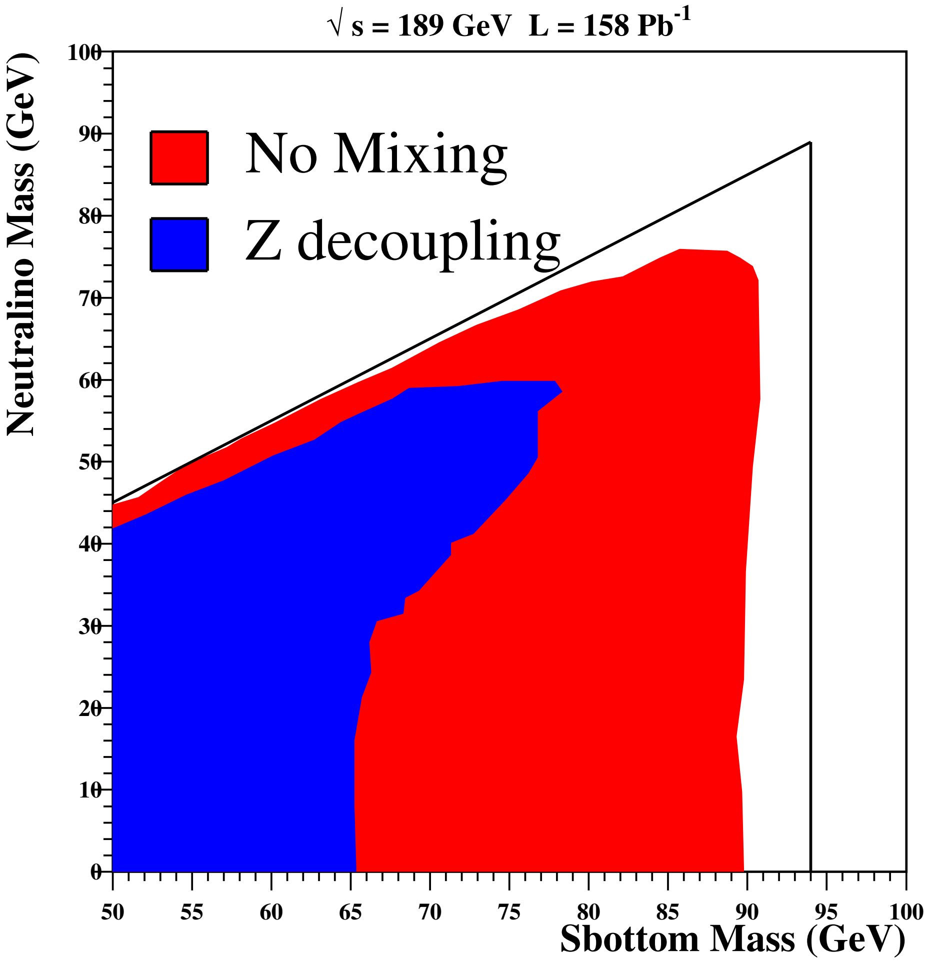


$\widetilde{b}_1$: Candidate





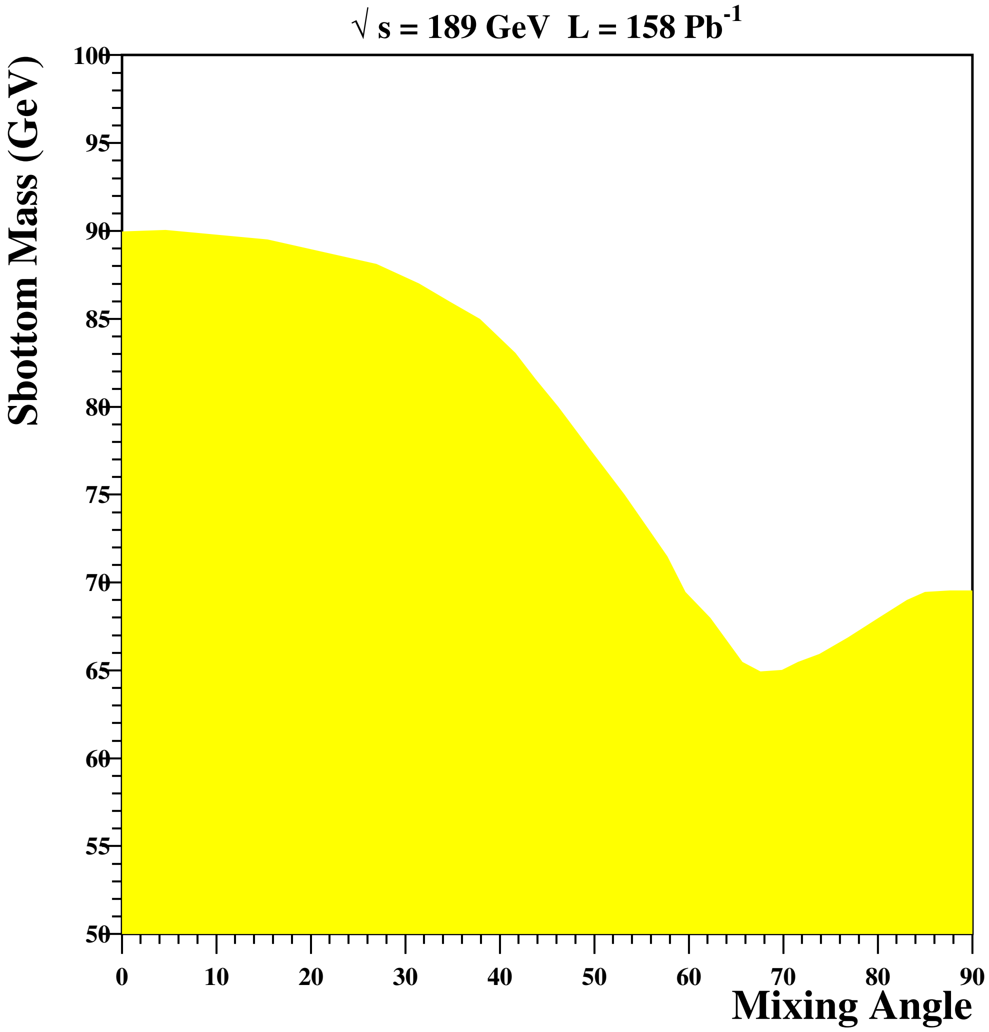
$\tilde{b}_1$: Results



	$\Delta M \geq 15$	$\Delta M \geq 10$
m($\tilde{b}_1$) (No mixing)	≥ 89.5	$\geq 86.$
m($\tilde{b}_1$) (Z decoupling)	≥ 65.5	≥ 65.5

Improvement compared to 183 GeV : +22 GeV

$$\boxed{\Delta M \geq 15}$$



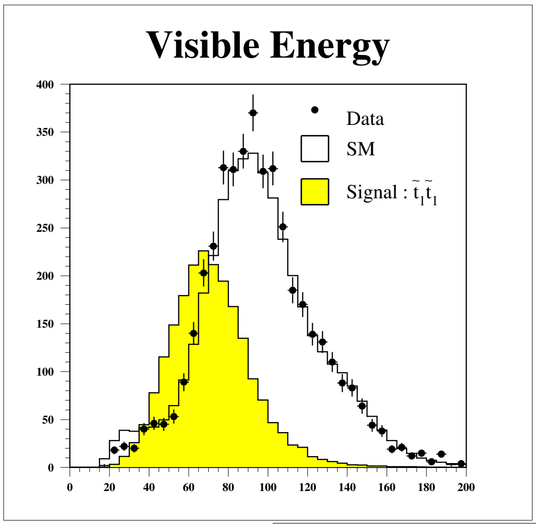
General :

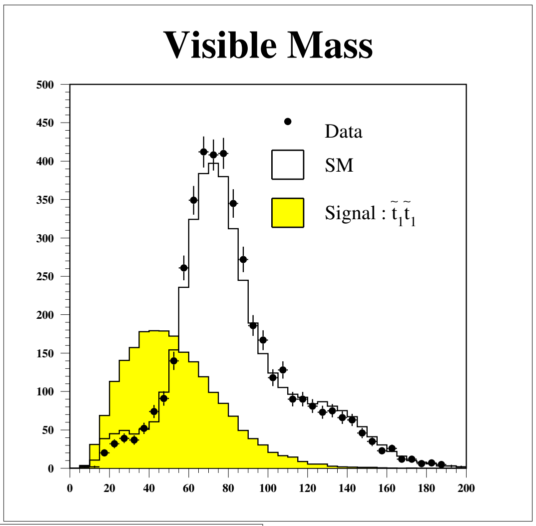
- Topology : two acoplanar jets, and missing energy.
- Signal : Generated by Marc Besançon (including the stop hadronization.)
- Mass windows :
  - $\Delta M \geq 30$
  - $10 < \Delta M < 30$
  - still to do : $\Delta M \leq 10$
- Preselection : Same cuts as for the sbottom analysis, except for the b-tag variable.
- b-tagging : Events with medium b-tag are required.

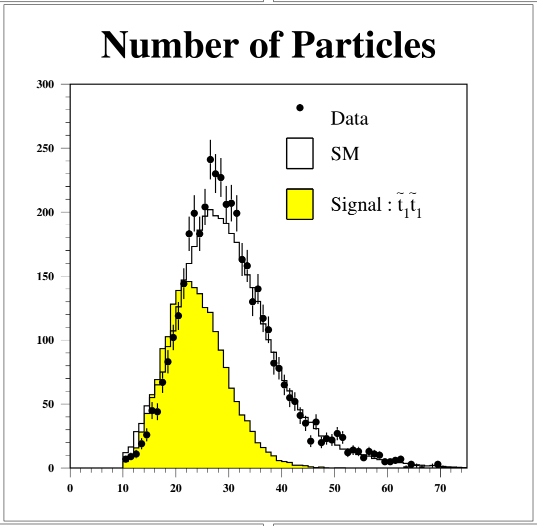
Variables	$\Delta M > 10$
$Probz0$	≥ -3 and ≤ 2

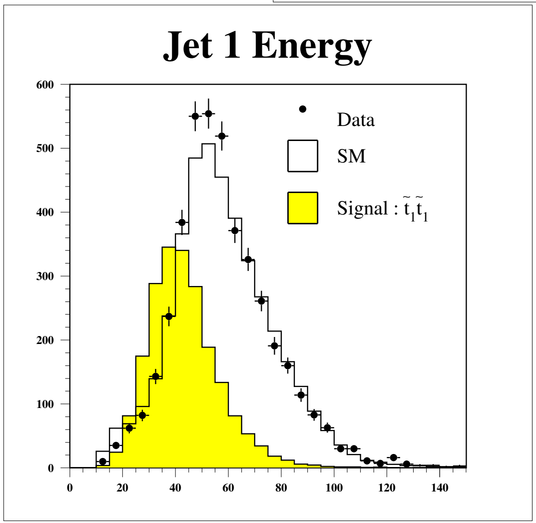
Monte-Carlo	4187.
Data	4270
Average Efficiency on signal	75 %

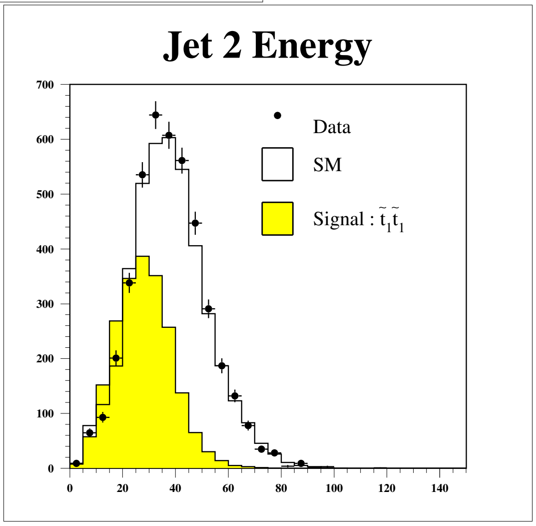
$\tilde{t}_1$: $\Delta M > 10$









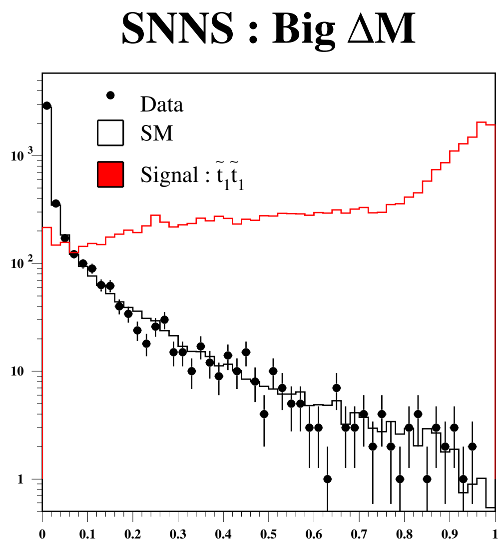


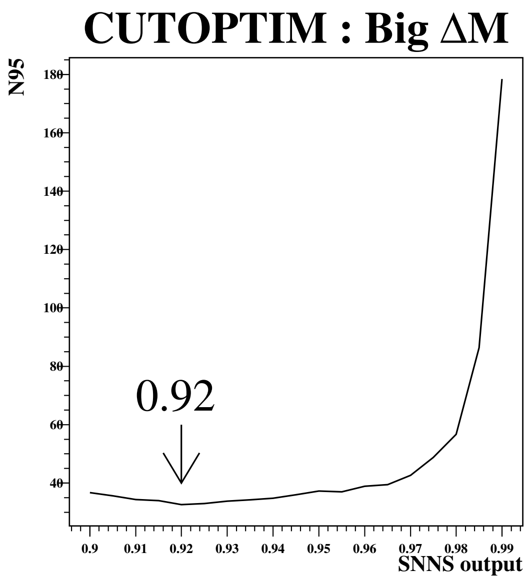
$\Delta M > 30$ and $10 < \Delta M \leq 30$

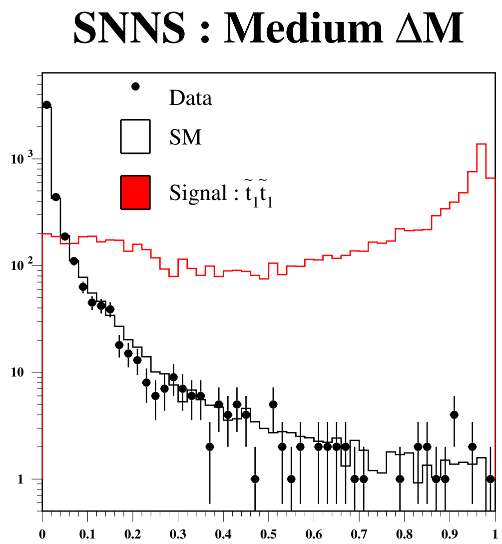
- Number of inputs : 14
- Number of hidden nodes : 14
- Number of Outputs : 1

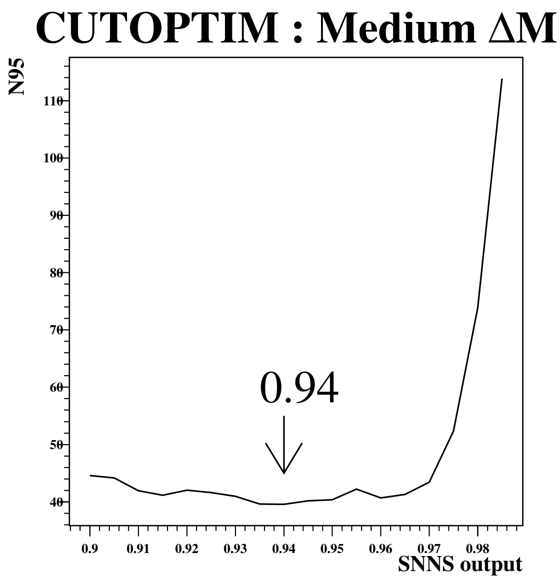
- Input variables : $E_{charg.}$, E_t,M_{vis}, P_t, E^{jet1}, E_t^{jet2}, $\sqrt{s'}$, $\theta_{jet1-jet2}$, $\theta_{jet1-jet2}^{trans.plane}$, Y_2, Y_3, acolin., acoplan., acolin. w.r.t. sphericity axe
- Output :

Output node	node 1
Signal	1
$q\bar{q}\gamma$ W^+W^- Z^oZ^o $W^{\pm}e\nu$ $\nu\nu qq$ $\gamma\gamma QCD$ $\gamma\gamma QPM$	0









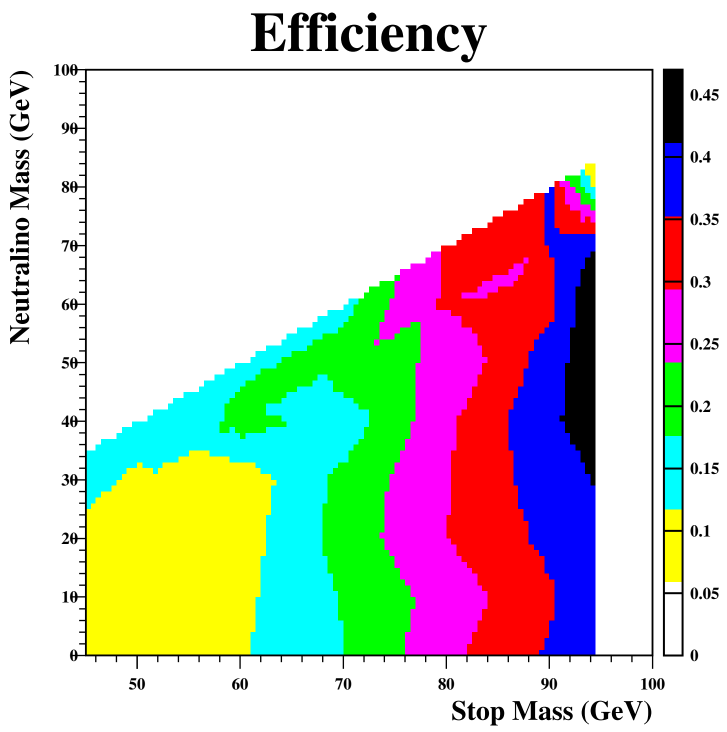
	$\Delta M > 30$	$10 < \Delta M \leq 30$
SNNS cut	0.92	0.94
Ndata	3	3
Nmonte-carlo	3.20	3.26

$\tilde{t}_1$: Results

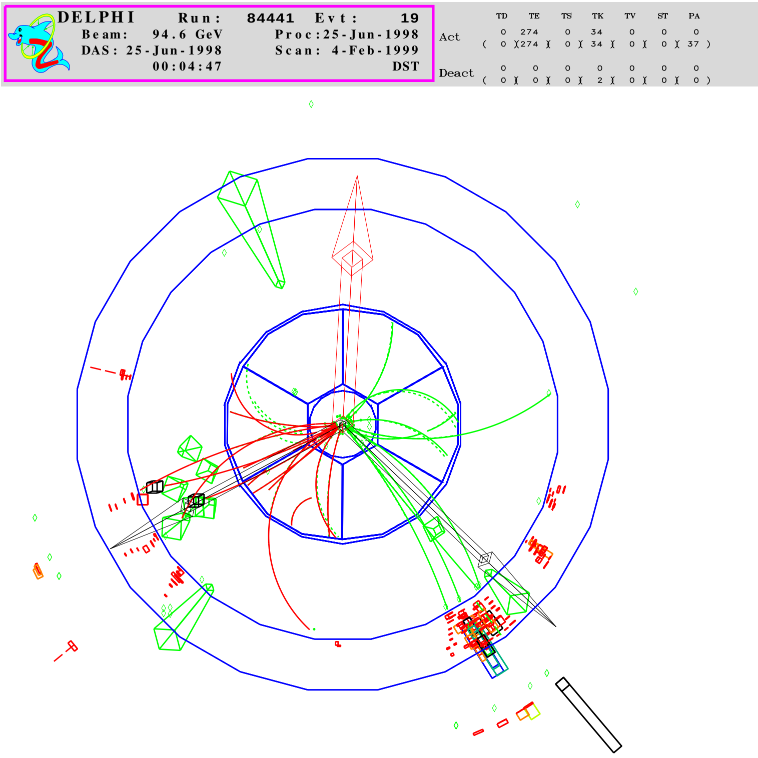
	$q\bar{q}\gamma$	$\gamma\gamma$	Z^oZ^o	$\nu\nu qq$	$W^{\pm}e\nu$	WW	Z^oee
$\Delta M > 30$	0.744	0.110	0.587	0.706	0.540	0.381	0.132
$10 < \Delta M \leq 30$	0.525	1.983	0.150	0.202	0.180	0.173	0.044

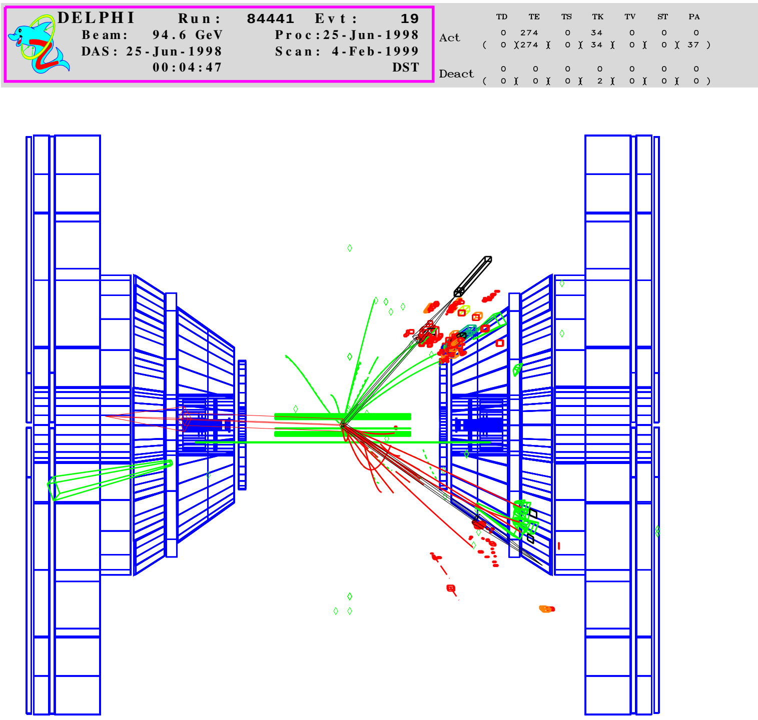
- Candidates :

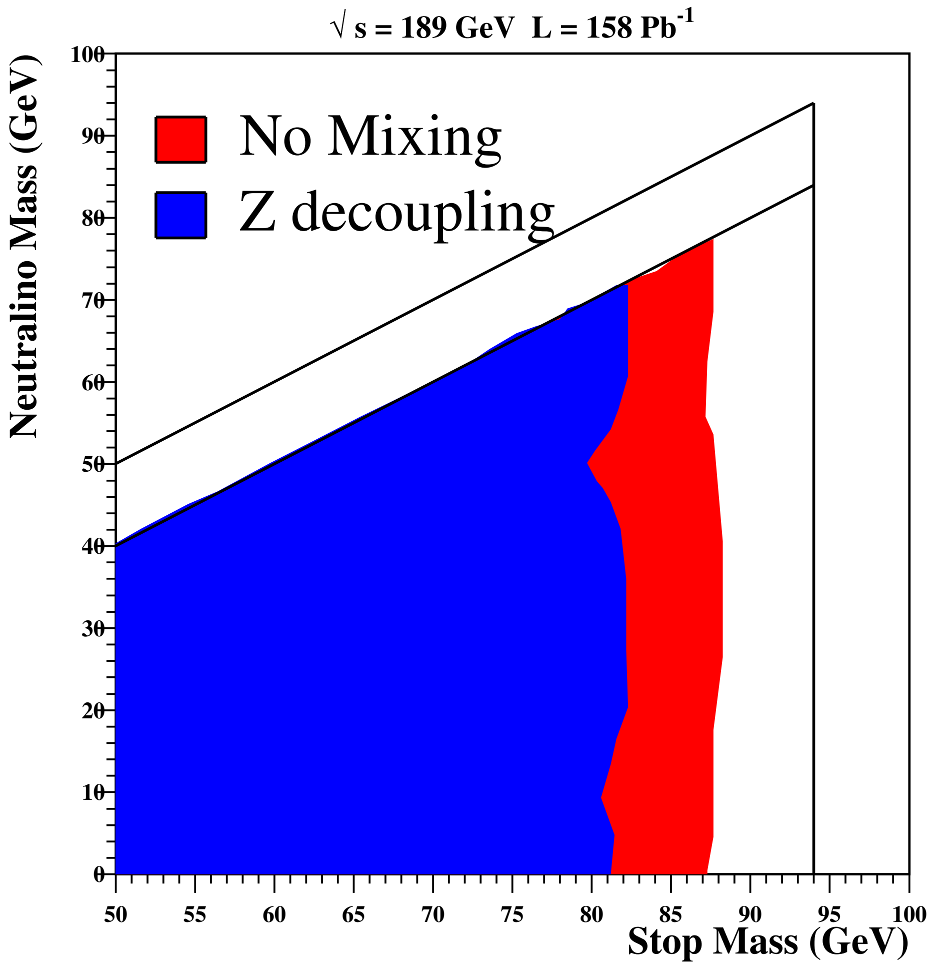
	RUN	EVENT
$\Delta M > 30$	84441	19
	86056	835
	87420	30419
$10 < \Delta M \leq 30$	83498	5728
	84455	19520
	87211	6585



$\tilde{t}_1$: Candidate







	$\Delta M \geq 15$
m($\tilde{t}_1$) (No mixing)	≥ 86.5
m($\tilde{t}_1$) (Z decoupling)	$\geq 80.$

Improvement compared to 183 GeV : +11.5 GeV

Conclusion

- No excess has been seen.
- Results : $\Delta M \geq 15$

	No mixing	Z decoupling
$\mathbf{m}(\tilde{b}_1)$	≥ 89.5	≥ 65.5
$\mathbf{m}(\tilde{t}_1)$	≥ 86.5	$\geq 80.$

- Work to do :

- Run on the D2 processing.
- $\gamma\gamma$ samples at 189 GeV.
- Stop analysis for $\Delta M \leq 10$.
- Run the analysis on the 183 GeV data to add the 53 pb^{-1}.
- Generate new $\tilde{t}_1\tilde{t}_1$Monte-Carlo samples.
- Optimise the neural networks for the Z^o decoupling case ($m_{\tilde{b}_1} = 70$ GeV).