Search for $\tilde{t}_1\tilde{t}_1 \longrightarrow bb\mu\tau\not{E}_T$

Ph.Gris
LPC Clermont-Ferrand
IN2P3/CNRS

- *SUSY and Stop*
- *Stop and taus*
- *Final state*
- *Stop production*
- *Skims, triggers and background*
- *Object definitions and correction factors*
- *μτ Preselection stage*
- *QCD estimation*
- *Outlook*

SUSY and Stop

Supersymmetry: space-time symmetry bosons <-> fermions

gluon (spin 1) <-> gluino (spin ½)

Quark (spin ½) <-> squark (spin 0)

$$q_R \rightarrow \tilde{q}_R \qquad q_L \rightarrow \tilde{q}_L \qquad \tilde{q}_1 = \cos\theta_q\, \tilde{q}_L + \sin\theta_q \tilde{q}_R \qquad \tilde{q}_2 = -\sin\theta_q\, \tilde{q}_L + \cos\theta_q \tilde{q}_R$$

$$\Delta m^2 = m^2_{\tilde{q}_2} - m^2_{\tilde{q}_1} = \sqrt{(M^2_{\tilde{q}_L} - M^2_{\tilde{q}_R})^2 + 4(A_q - \mu\cot\beta)^2 m_q{}^2}$$

Soft SUSY breaking terms

Trilinear coupling

quark mass

Negligible for the two first generations
-> Δm small
-> squarks are mass-degenerate

3rd generation: m_{top}, m_{bottom}
-> Δm non neglible (high tanβ for sbottom)
-> $\tilde{t}_1$ or $\tilde{b}_1$ light

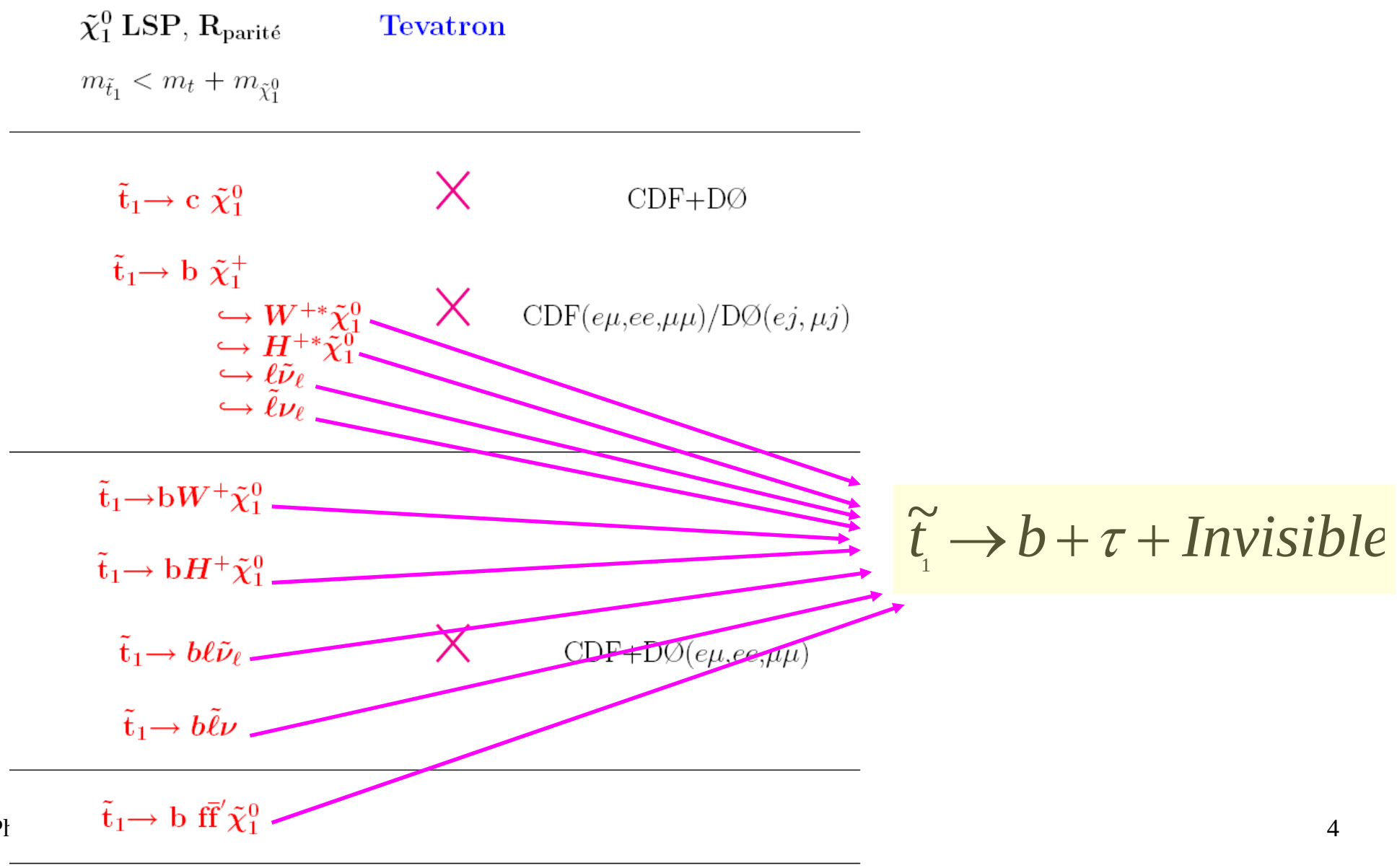
Squarks and gluinos searches

Stop and sbottom searches

Stop and taus

$\tilde{\chi}_1^0$ LSP, $R_{parité}$	Tevatron	
$m_{\tilde{t}_1} < m_t + m_{\tilde{\chi}_1^0}$		
$\tilde{t}_1 \to c\ \tilde{\chi}_1^0$	X	CDF+DØ
$\tilde{t}_1 \to b\ \tilde{\chi}_1^+$ $\hookrightarrow W^{+*}\tilde{\chi}_1^0$ $\hookrightarrow H^{+*}\tilde{\chi}_1^0$ $\hookrightarrow \ell\tilde{\nu}_\ell$ $\hookrightarrow \tilde{\ell}\nu_\ell$	X	CDF($e\mu$,ee,$\mu\mu$)/DØ($ej, \mu j$)
$\tilde{t}_1 \to bW^+\tilde{\chi}_1^0$		
$\tilde{t}_1 \to bH^+\tilde{\chi}_1^0$		
$\tilde{t}_1 \to b\ell\tilde{\nu}_\ell$	X	CDF+DØ($e\mu$,ee,$\mu\mu$)
$\tilde{t}_1 \to b\tilde{\ell}\nu$		
$\tilde{t}_1 \to b\ f\bar{f}'\tilde{\chi}_1^0$		

Stop and taus



Stop and taus

$\tilde{\chi}_1^0$ LSP, $R_{parité}$ Tevatron

$m_{\tilde{t}_1} < m_t + m_{\tilde{\chi}_1^0}$

$\tilde{t}_1 \to c\ \tilde{\chi}_1^0$	X	CDF+DØ
$\tilde{t}_1 \to b\ \tilde{\chi}_1^+$ $\hookrightarrow W^{+*}\tilde{\chi}_1^0$ $\hookrightarrow H^{+*}\tilde{\chi}_1^0$ $\hookrightarrow \ell\tilde{\nu}_\ell$ $\hookrightarrow \tilde{\ell}\nu_\ell$	X	CDF($e\mu$,ee,$\mu\mu$)/DØ(ej, μj)
$\tilde{t}_1 \to bW^+\tilde{\chi}_1^0$		
$\tilde{t}_1 \to bH^+\tilde{\chi}_1^0$		
$\tilde{t}_1 \to b\ell\tilde{\nu}_\ell$	X	CDF+DØ($e\mu$,ee,$\mu\mu$)
$\tilde{t}_1 \to b\tilde{\ell}\nu$		
$\tilde{t}_1 \to b\ f\bar{f}'\tilde{\chi}_1^0$		

τ enhancement

$\tilde{\chi}_1^+$ Higgsino−like

Stop and taus

$\tilde{\chi}_1^0$ LSP, $R_{parité}$ — Tevatron

$m_{\tilde{t}_1} < m_t + m_{\tilde{\chi}_1^0}$

$\tilde{t}_1 \to c\ \tilde{\chi}_1^0$	×	CDF+DØ
$\tilde{t}_1 \to b\ \tilde{\chi}_1^+$ $\hookrightarrow W^{+*}\tilde{\chi}_1^0$ $\hookrightarrow H^{+*}\tilde{\chi}_1^0$ $\hookrightarrow \ell\tilde{\nu}_\ell$ $\hookrightarrow \tilde{\ell}\nu_\ell$	×	CDF($e\mu$,ee,$\mu\mu$)/DØ(ej, μj)
$\tilde{t}_1 \to bW^+\tilde{\chi}_1^0$		
$\tilde{t}_1 \to bH^+\tilde{\chi}_1^0$		
$\tilde{t}_1 \to b\ell\tilde{\nu}_\ell$	×	CDF+DØ($e\mu$,ee,$\mu\mu$)
$\tilde{t}_1 \to b\tilde{\ell}\nu$		
$\tilde{t}_1 \to b\ f\bar{f}'\tilde{\chi}_1^0$		

τ enhancement

$$\text{light } \tilde{\tau}_1$$

$$m(\tilde{\chi}_1^0) \le m(\tilde{\tau}_1) \le m(\tilde{t}_1)$$

Stop and taus

$\tilde{\chi}_1^0$ LSP, $R_{parité}$ Tevatron

$m_{\tilde{t}_1} < m_t + m_{\tilde{\chi}_1^0}$

$\tilde{t}_1 \to c\ \tilde{\chi}_1^0$	X	CDF+DØ
$\tilde{t}_1 \to b\ \tilde{\chi}_1^+$ $\hookrightarrow W^{+*}\tilde{\chi}_1^0$ $\hookrightarrow H^{+*}\tilde{\chi}_1^0$ $\hookrightarrow \ell\nu_\ell$ $\hookrightarrow \tilde{\ell}\nu_\ell$	X	CDF($e\mu$,ee,$\mu\mu$)/DØ(ej, μj)
$\tilde{t}_1 \to bW^+\tilde{\chi}_1^0$		
$\tilde{t}_1 \to bH^+\tilde{\chi}_1^0$		
$\tilde{t}_1 \to b\ell\tilde{\nu}_\ell$	X	CDF+DØ($e\mu$,ee,$\mu\mu$)
$\tilde{t}_1 \to b\tilde{\ell}\nu$		
$\tilde{t}_1 \to b\ f\bar{f}'\tilde{\chi}_1^0$		

τ enhancement

$$H^+ \to \tau\nu$$

Stop and taus

$\not{R}_p$ modes via λ'_{33i}

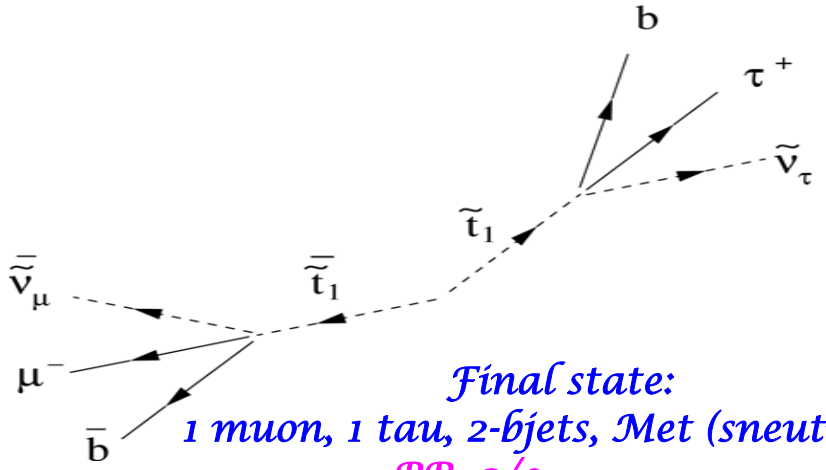
$\tilde{t}_1 \to d\tau \quad \lambda'_{331}$

$\tilde{t}_1 \to s\tau \quad \lambda'_{332}$

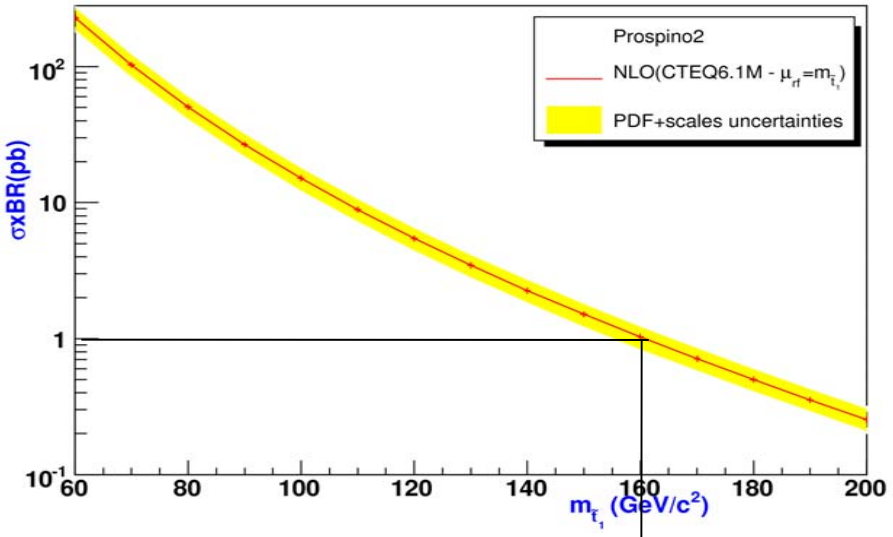
$\tilde{t}_1 \to b\tau \quad \lambda'_{333}$

CDF – 322 pb^{-1} – PRL 101 (2008) 071802

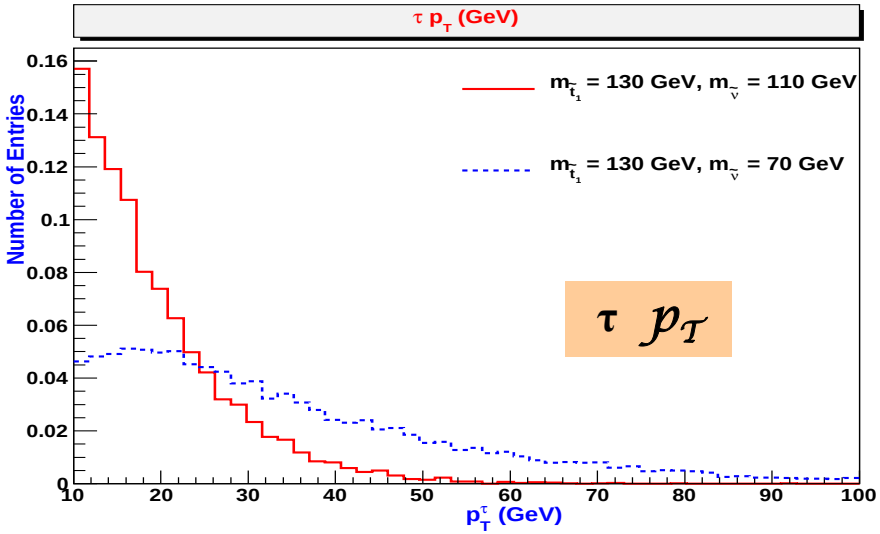
Stop pair production: final state

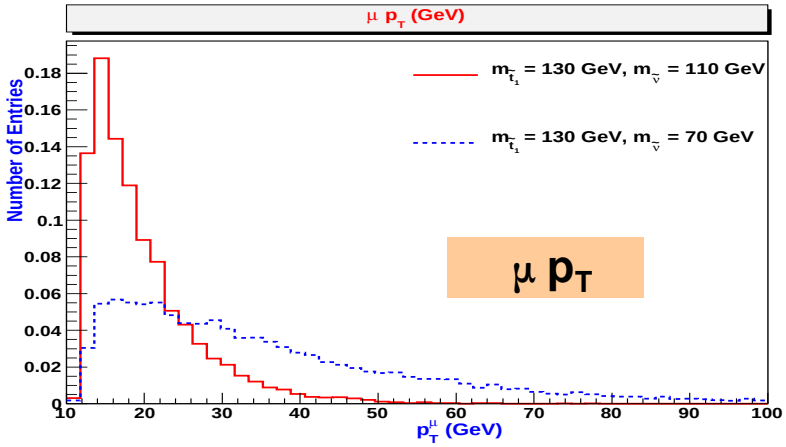


Final state:
1 muon, 1 tau, 2-bjets, Met (sneutrinos)
BR=2/9

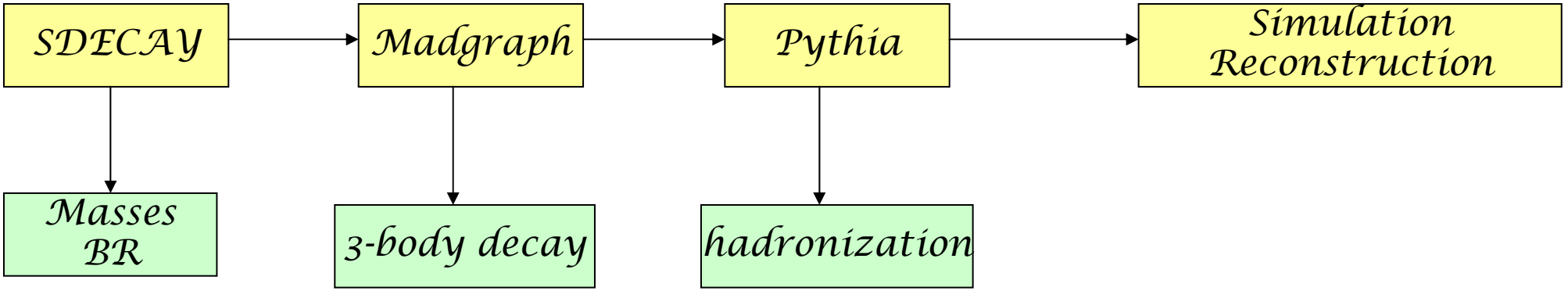


Mstop=160 GeV: 1111 stop pairs in 5 fb¹





Stop production



- Madgraph files have been produced
  Thanks to Dennis Mackin for
  providing SDECAY files.

- Caf trees have been produced
  Thanks to Alan Wilson

Mstop	Msneutrino
200	50
200	60
200	70
200	90
200	110
200	130
200	150
200	160

Skims, triggers and background

- Data skim: Muinclusive $\mathcal{L}$~4.2 fb^{-1}
- Trigger: single mu or triggers

Back.	Kfactor	σ(pb)
Z-> μμ	1.29	390.7/184.8/99.7
Z-> ττ	1.28	390.7/184.8/99.7
ttbar	1.43	5.1
Wjets	1.27	6191
WW	1	11.62
WZ	1	3.2
ZZ	1	1.33

m_{top}=172 GeV

Object definitions

Muon

- medium nseg3
- $\chi^2 < 4$
- DCA < 0.02 (0.2), SMT > 0 (=0)
- E_T trkcone < 4 GeV (NP_loose)
- P_T > 15 GeV

Jet

- standard jet-id cuts
- good JCCB jets
- P_T >15 GeV

MET

Corrected for em calo cells, muons , JES and taus

Electron

- LooseElectron selection
- P_T > 15 GeV

Tau

- P_T > 10 GeV
- $|\eta| < 1$

- Type 1
  - P_T (track) > 7 GeV
  - NN > 0.9

- Type 2:
  - P_T (track) > 5 GeV
  - NN_{elec} > 0.85
  - NN > 0.9

- Type 3:
  - P_T (lead. track) > 5 GeV
  - P_T (nnlead. track) > 2 GeV
  - ΣP_T (tracks) > 10 GeV
  - NN > 0.95

- GoodJCCB jets matching taus are removed from the jet list
  ΔR (tau, jet) > 0.5

MC corrections and Event selection

MC Corrections

- muoncorr_id
- muoncorr_deltaR
- muoncorr_track
- Beamreweighting
- Luminosity reweighting
- Trigger
- Zpt reweighting: p20Alpgen_njet15
- Smearing for electrons and muons
- Tau correction factors (NN, track)
- Tau Energy Scale

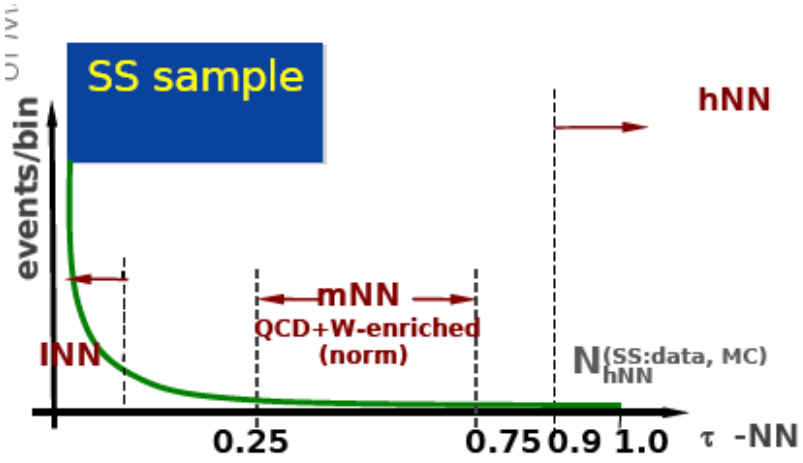
Analysis with vjets_cafe v03-04-00
release p21.13.00

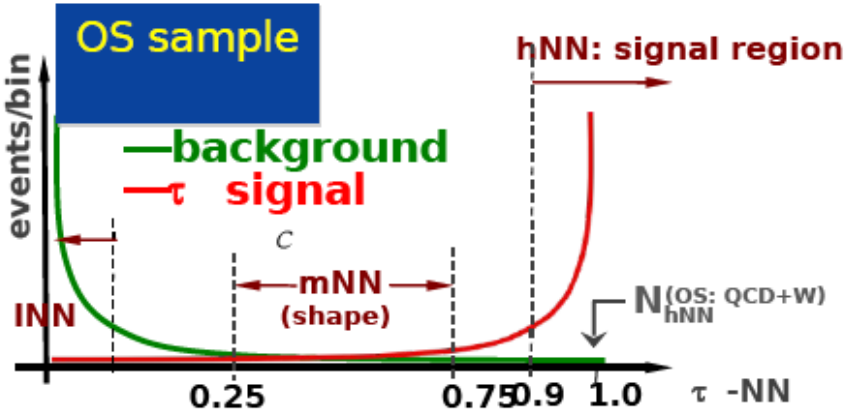
Event selection

- One muon, one tau, no electron
- OS (muon, tau)
- ΔR (muon,tau) > 0.5
- ΔR (muon, jet) > 0.5

Instrumental background estimation

- Apply the same method as h->ττ search (Tammy et al.)





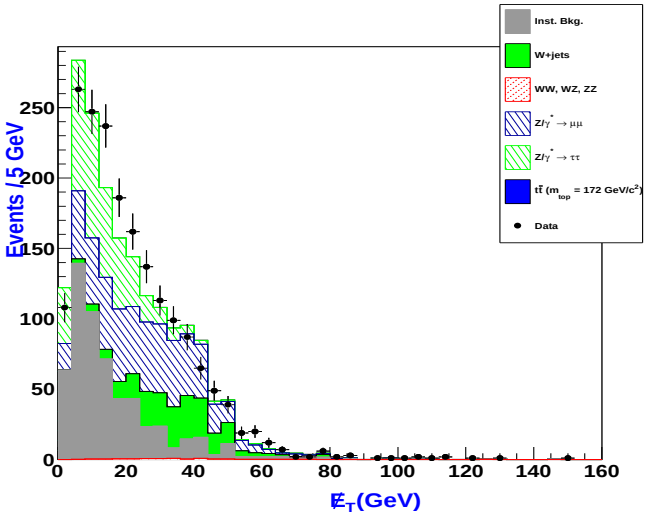
see Tammy's presentation:
http://www-do.hef.kun.nl//askArchive.php?base=agenda&categ=a091488&id=a091488s2t3/transparencies

Shape: $N_{hNN}^{OS:QCD} = \rho_1 \times (N_{mNN}^{OS:data} - N_{mNN}^{OS:MC})$

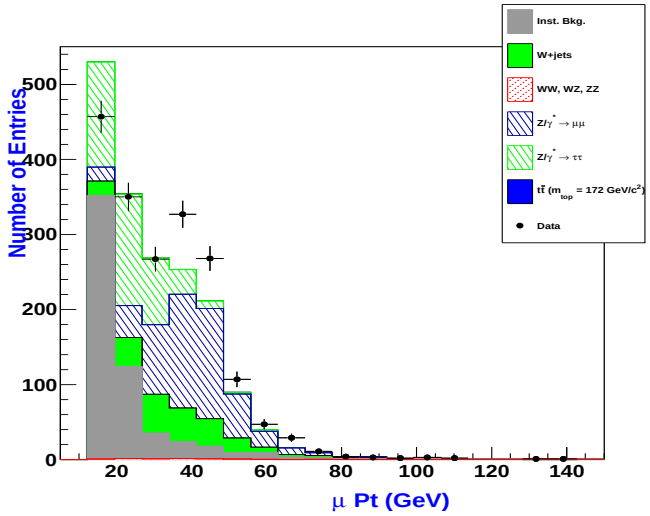
Norm: $\rho_1 = \dfrac{N_{hNN}^{SS:data} - N_{hNN}^{SS:MC}}{N_{mNN}^{SS:data} - N_{mNN}^{SS:MC}}$

Type	ρ
1	0.36±0.02
2	0.19±0.01
3	0.16±0.01
all	0.22±0.01

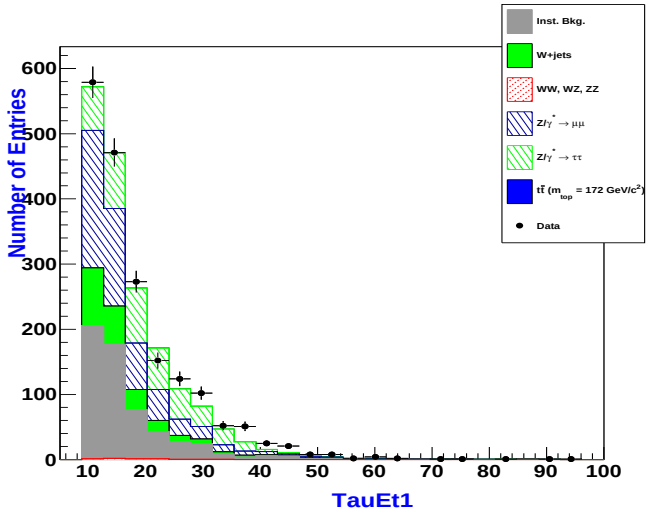
μτ preselection stage: tau type 1



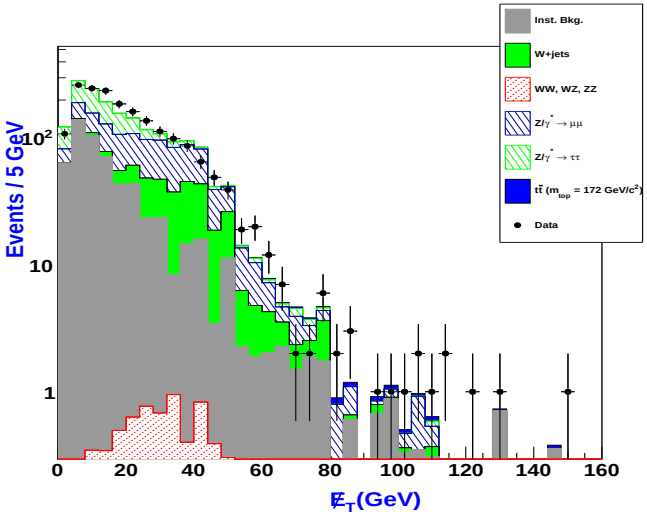
MET

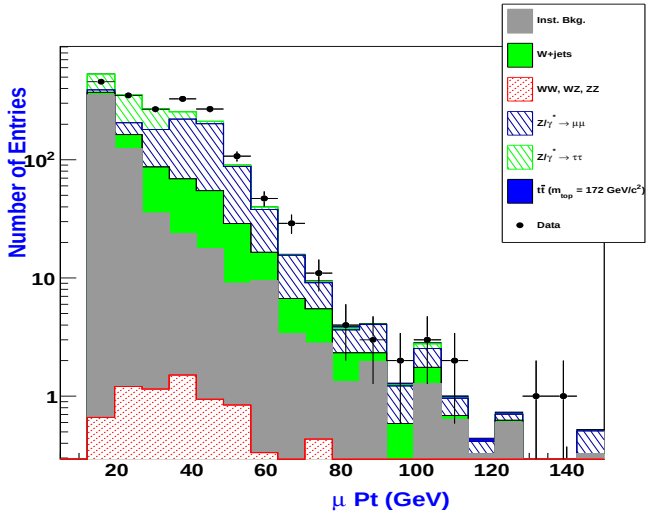


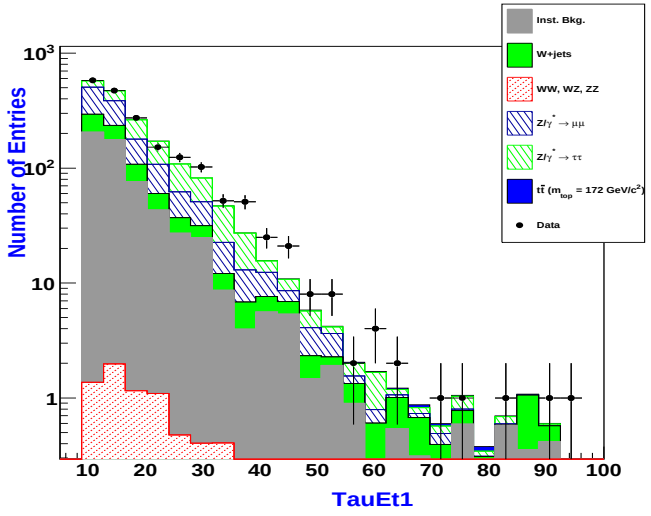
Muon p_T



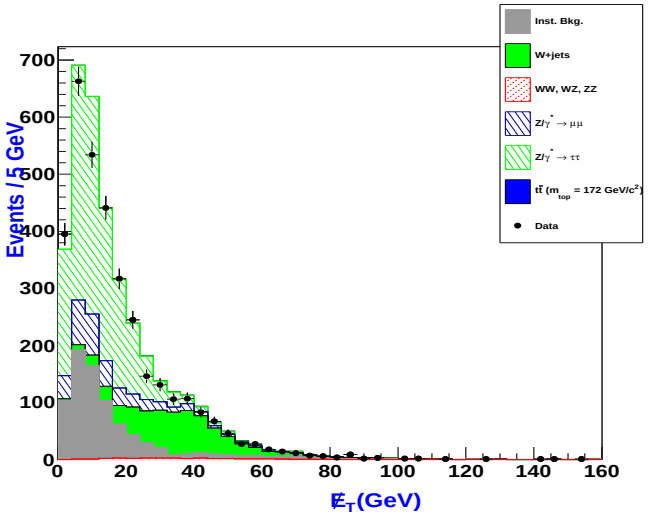
Tau p_T



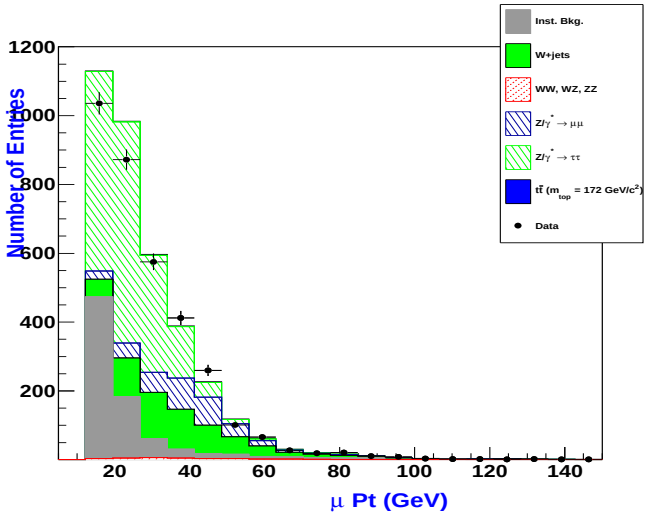




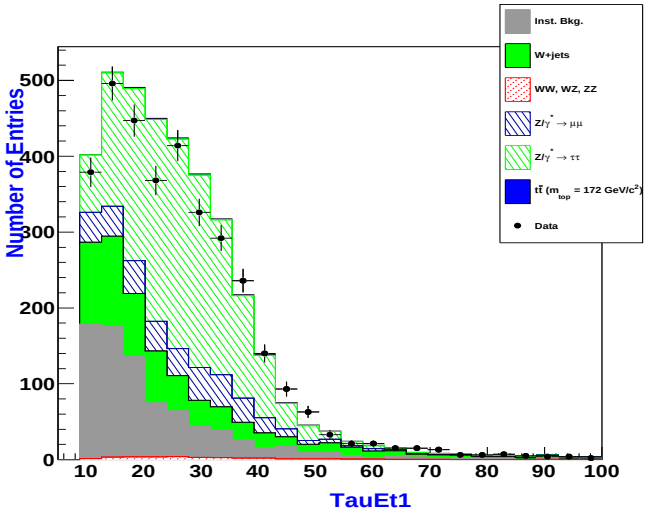
μτ preselection stage: tau type 2



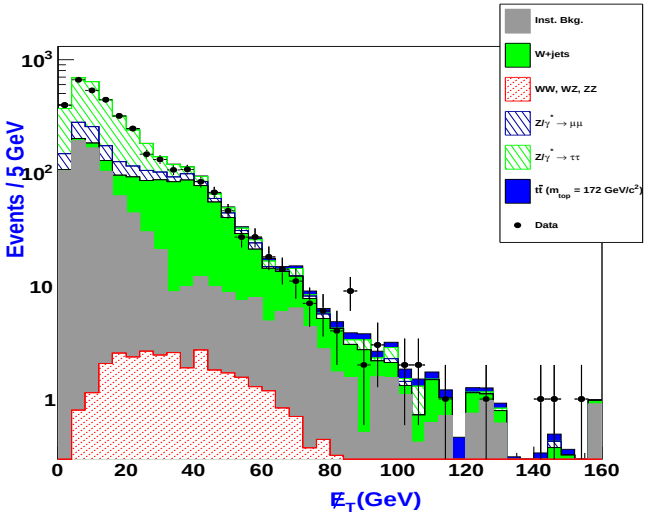
MET

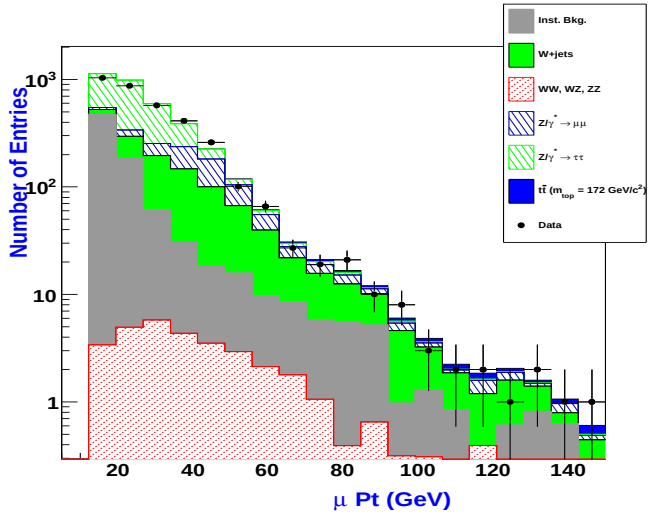


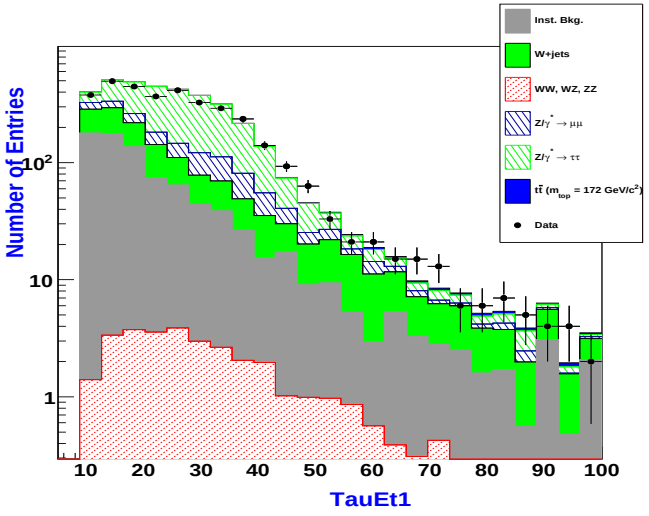
Muon p_T



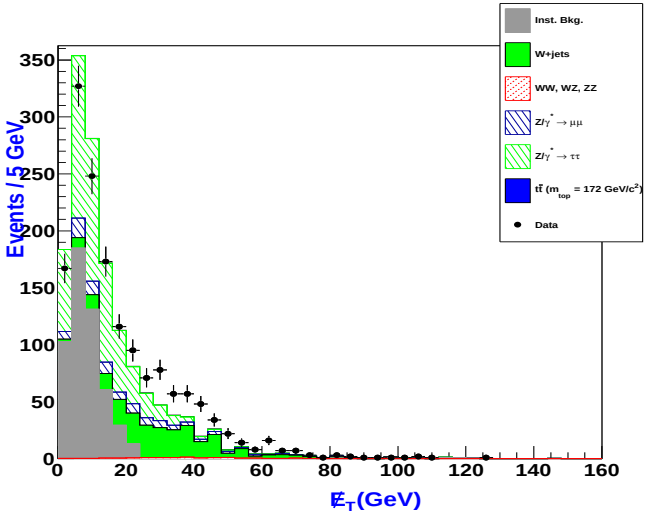
Tau p_T



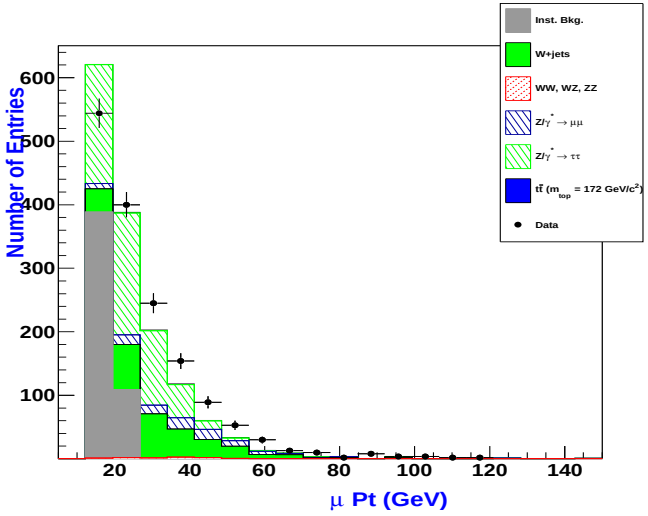




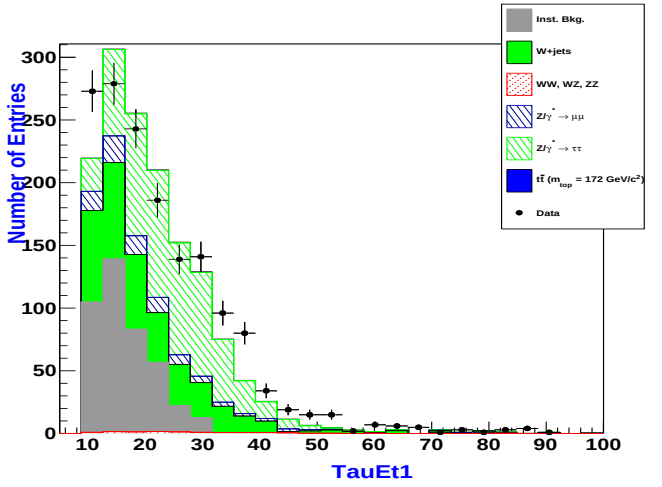
μτ preselection stage: tau type 3



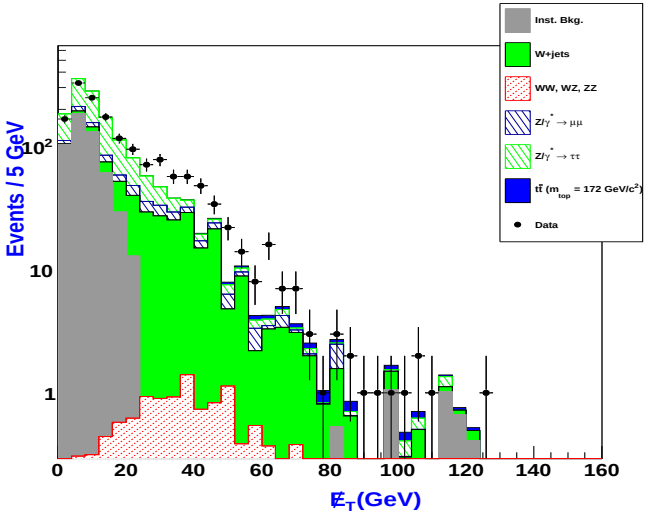
MET

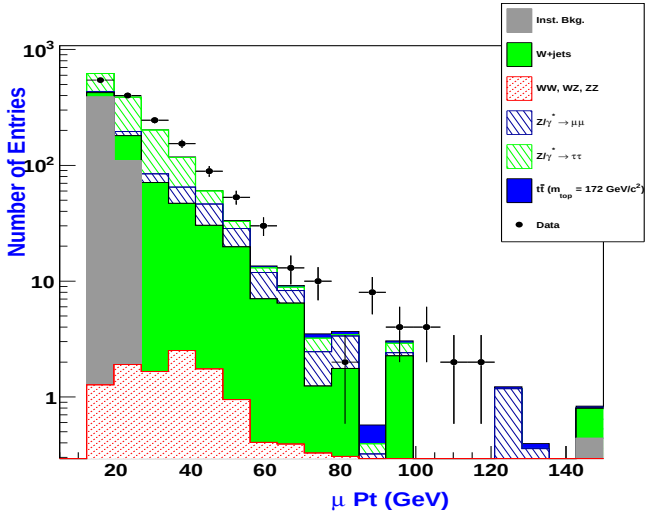


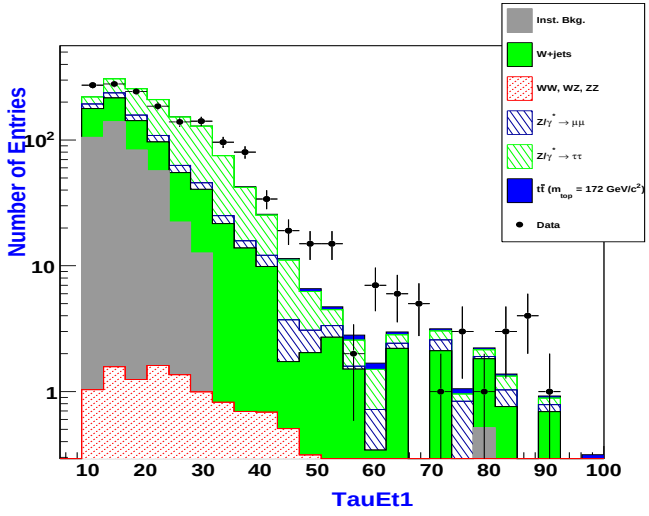
Muon p_T



Tau p_T





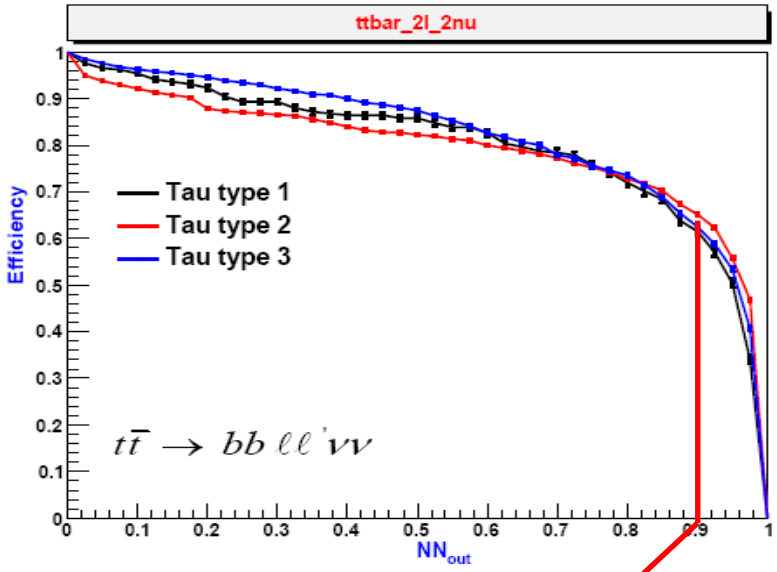


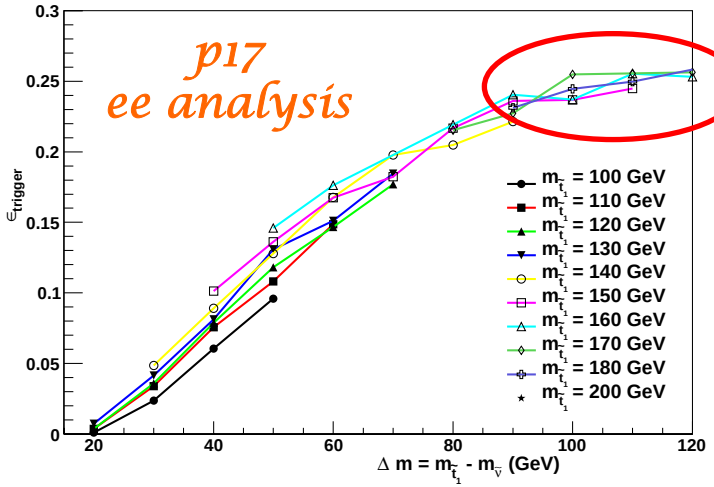
μτ preselection stage

	Type 1	Type 2	Type 3	All types
Z -> ττ	424±6	1778±11	570±6	2772±14
Z -> μμ	550±6	366±5	91±2	1007±9
diboson	7.8±0.4	33.1±0.6	12.3±0.5	56.5±0.9
ttbar	3.48±0.05	18.9±0.1	6.92 ±0.08	29.3±0.1
W+jets	227±3	623±5	408±4	1258±7
QCD	577±28	792±39	371±18	1741±87
All MC	1790±30	3611±42	1459±20	6861±89
Data	1881	3427	1562	6870
Stop (200,50)	1.18±0.04	6.64±0.09	1.84±0.05	9.7±0.1

Stop efficiencies

Mstop	Msneutrino	ε
200	50	4.0%
200	60	4.0%
200	70	3.9%
200	90	3.6%
200	110	3.3%
200	130	2.8%
200	150	1.9%
200	160	1.3%





τ hadronic decay

*Expected efficiency: 0.25*0.66*0.60=0.10 (high Δm)*

The signal efficiency seems low. Under investigation

Outlook

- *Analysis status:*
  - *problems with tau type 3*
  - *reasonable agreement for tau type1 and type 2*
  - *Stop production has started*
  - *tau id efficiencies seem small for the signal (around 3-4% would expect 10%)*

  -> under investigation
- *Next steps:*
  - *include E/P corrections*
  - *include new muon corrections*
  - *include new trigger curves*
  - *fake rate jet/tau study in progress (nearly done)*
  - *analysis (selection+efficiencies) at least for types 1 and 2*