Search for MSSM

$H \rightarrow \tau\tau \rightarrow \mu + \tau_{jet}$

Artur Kalinowski
Institute of Experimental Physics, Warsaw University

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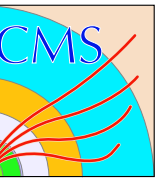
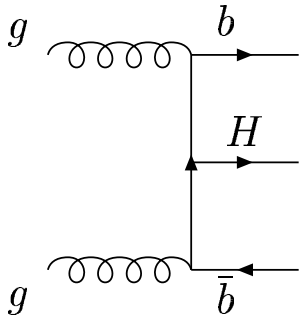


Outline

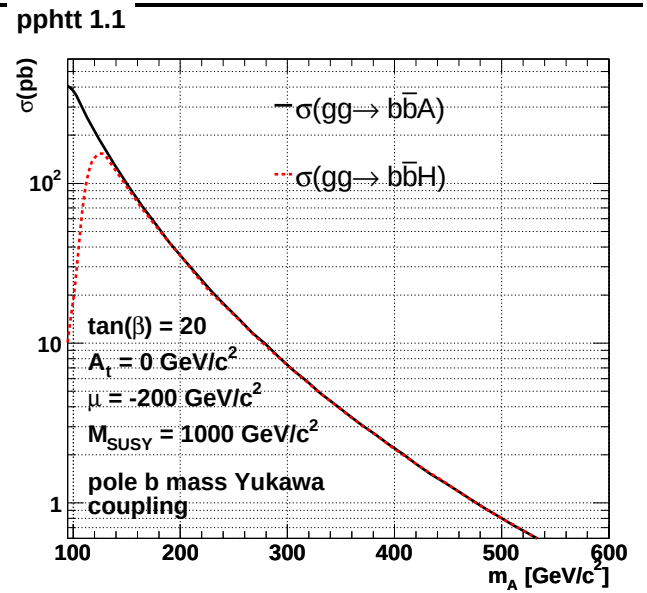
- Physics motivation
- Trigger cuts: L1, HLT
- First look at the offline reconstruction for signal
- Conclusions

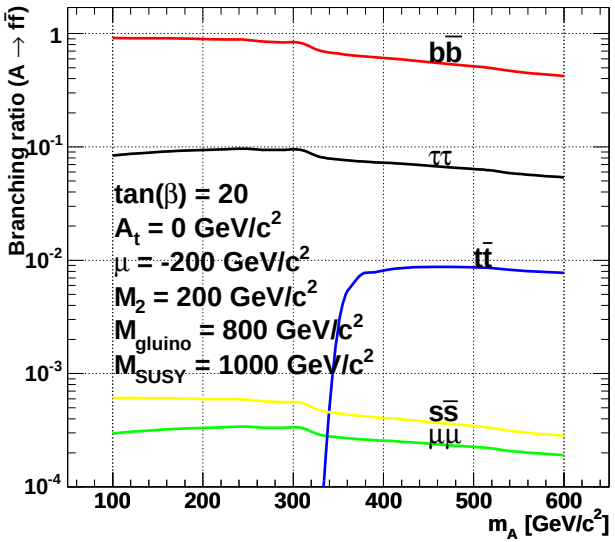
Physics motivation



For large $tan(\beta)$: BR($H/A \to \tau\tau$) $\simeq 0.1$ with BR($\tau\tau \to \mu + \tau_{jet} + \nu$) = 0.22 and associated production channel one gets isolated muon and pair of b quarks in the final state.

This signature allows for a efficient QCD background rejection.



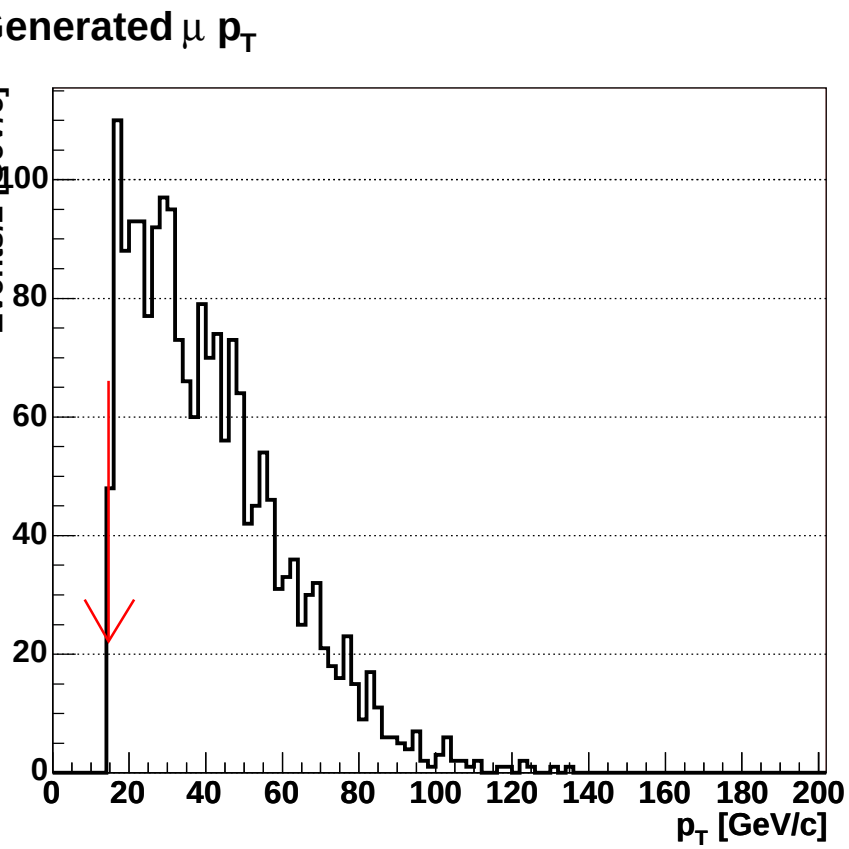


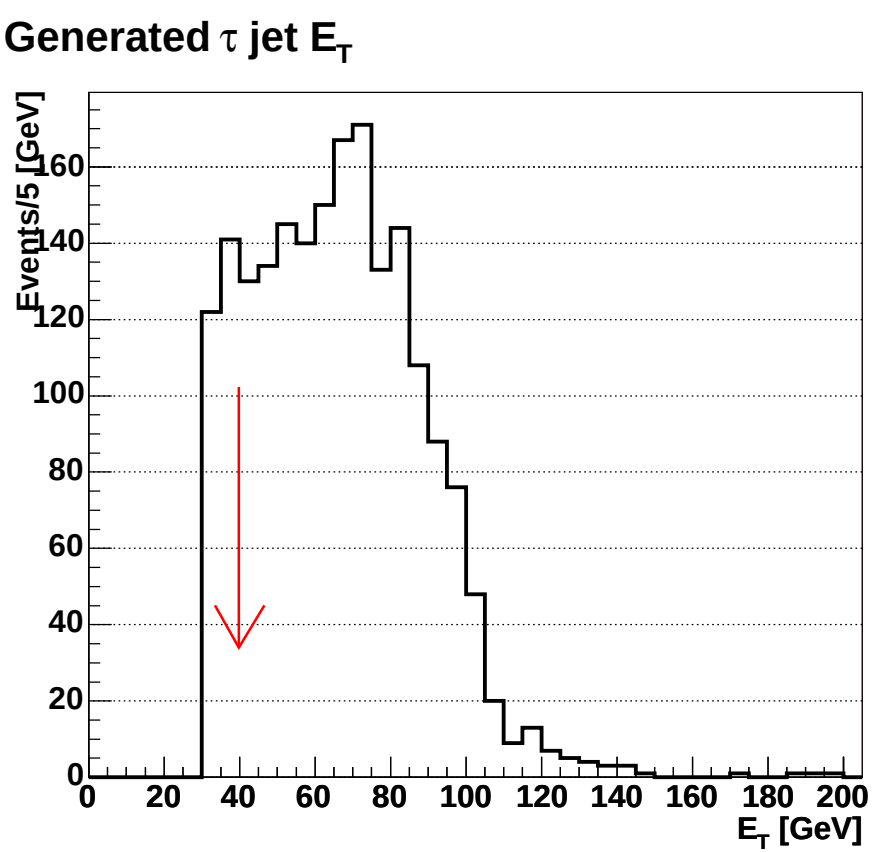
ll results shown here are done with $H \rightarrow \tau\tau \rightarrow \mu + \tau_{jet}$ sample of 2000 events
ith $m_A = 200\ GeV/c^2$, with NO pileup.
aus were forced to decay to desired decay channels.
he sample had been preselected on the Pythia level with cuts:

- at least one isolated μ with $p_T \geq 15\ GeV/c$ and $|\eta| \leq 2.4$
- one tau-like jet with $E_T \geq 30\ GeV$ and $|\eta| \leq 2.4$

ll trigger cuts correspond to the DAQ TDR analysis for low luminosity
$\mathcal{L} = 2 \cdot 10^{33} \frac{1}{s \cdot cm^2}$)
econstruction was done with ORCA 8.0.0.

Generated p_T/E_T spectrum





Arrows correspond to the off-line cuts.

1 selection:

MT mu with $p_T \geq 12\ GeV/c$ OR L1 Tau jet with $E_T \geq 93\ GeV$ OR
MT mu with $p_T \geq 14\ GeV/c$ AND L1 Tau jet with $E_T \geq 47\ GeV$

2 selection(E_T/p_T cuts same as off-line):

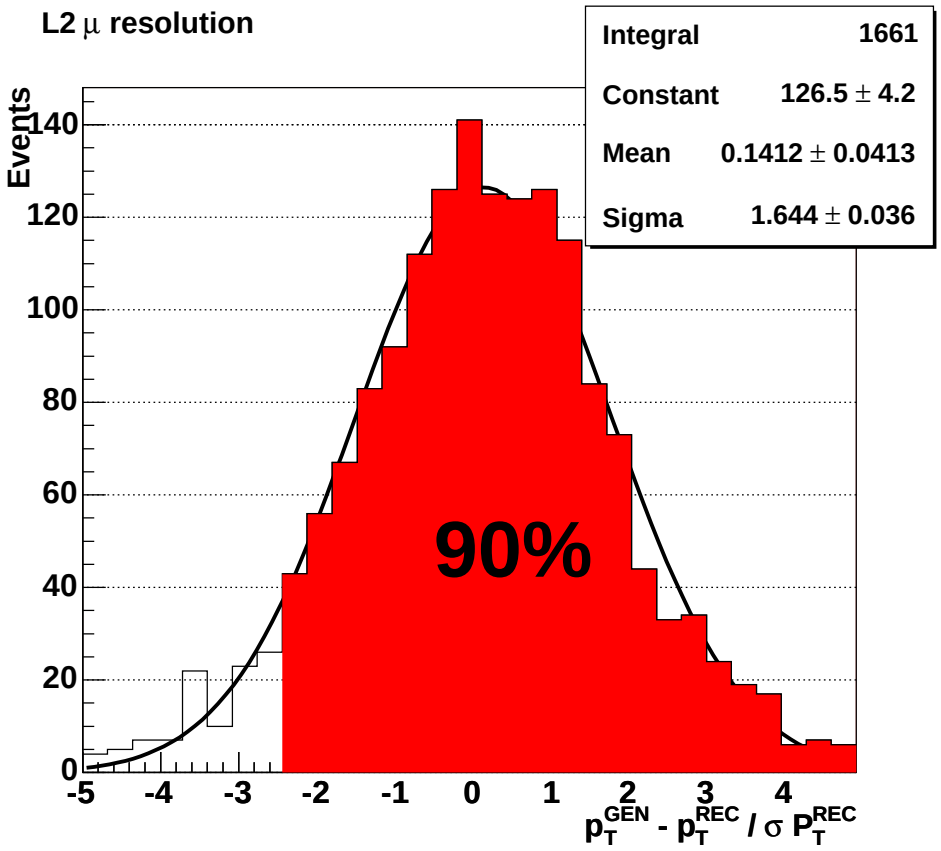
2 mu with $p_T@90\% \geq 15\ GeV/c$,
alorimetry isolation with $isol < 0.97$ AND
2 tau jet with $E_T@95\% \geq 40\ GeV$,
alorimetry isolation with $P_{isol} \leq 5.6\ [GeV]$

3 selection(E_T/p_T cuts same as off-line):

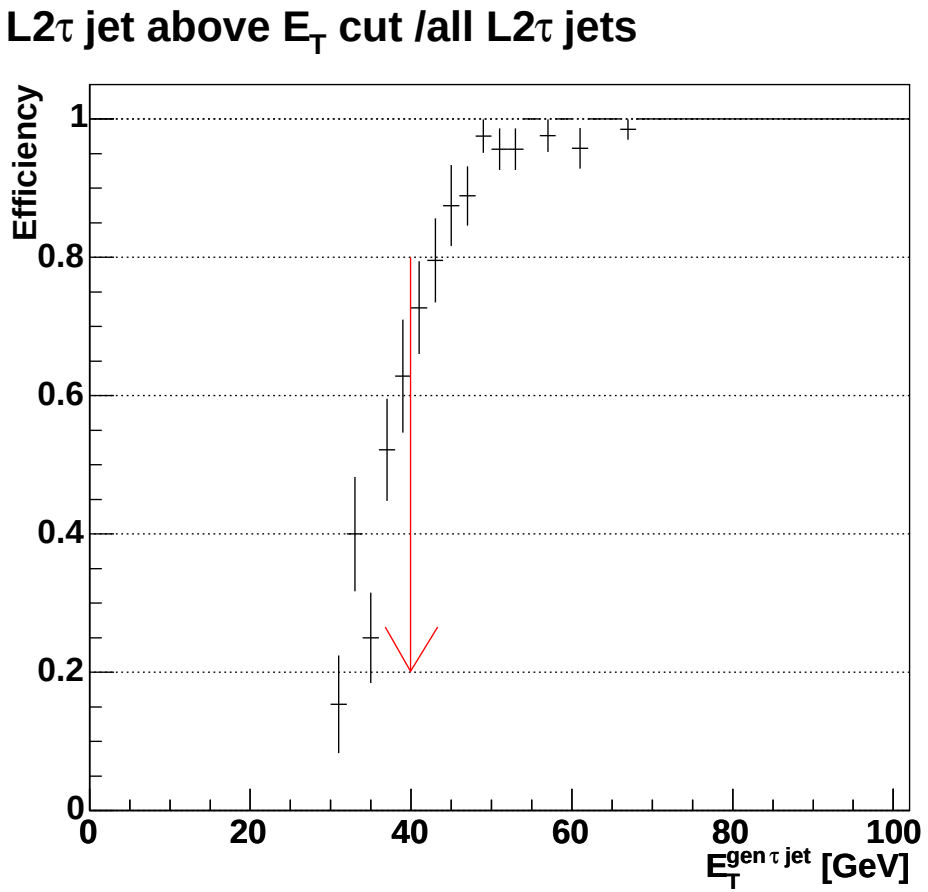
3 muon with $p_T@90\% \geq 15\ GeV/c$,
acker isolation with $isol < 0.97$ AND
2 tau jet isolated with pixels

L2 90% scale has been defined as cale at which 90% of muons with $_T^{gen} \geq p_T^{cut}$ go through. We cut on the alue of $p_T^{thr} = p_T^{rec} + \alpha \cdot \sigma_{p_T}$ this study $\alpha = 2.3$ (TDR: 3.5) or gaussian distribution $\alpha = 1.3$.

omment: $\sigma = 1.6$ of the gaussian fitted the $\frac{p_T^{rec} - p_T^{gen}}{\Delta_{p_T^{rec}}}$ means that the error on e p_T is underestimated.



L2 95% scale had been taken from
AQ TDR analysis. We cut on the
alue of $E_T^{thr} = 1.05 * E_T^{rec} + 5.7$
ow efficiency on the threshold needs
rther investigation. (similar problem
ppeared also in DAQ TDR studies)

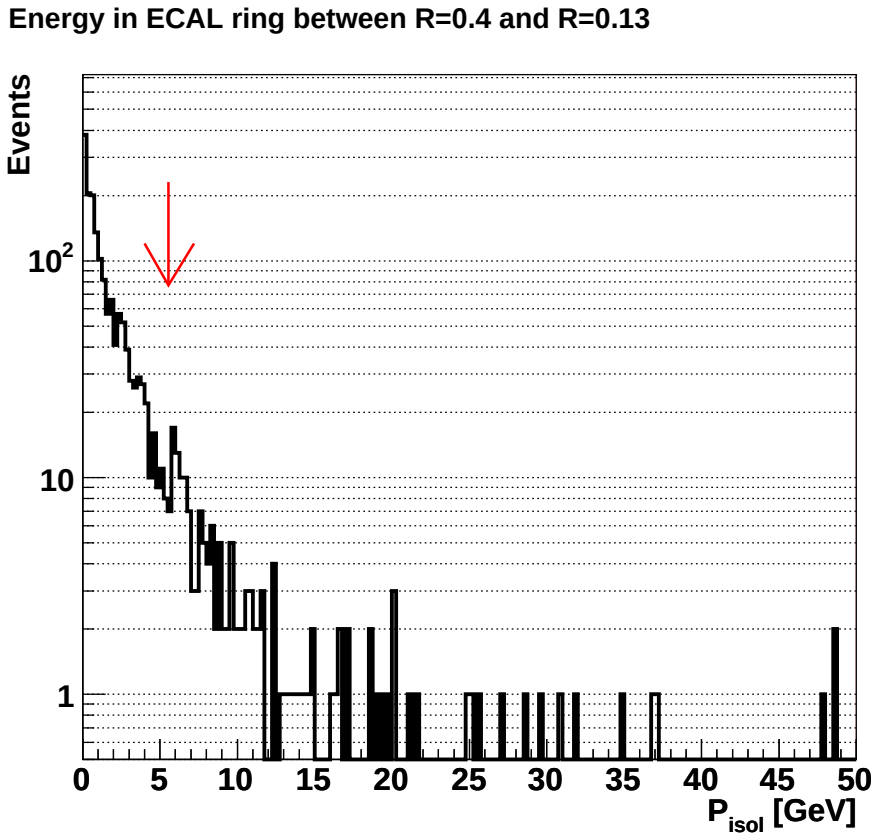


Only events with $dR(L2\ jet, gen\ jet) < 0.1$ are considerded.

L2 calo tau isolation

n isolation variable is defined as en-
rgy deposited in ECAL in a ring around
e L2 jet direction with
$_n = 0.13$ and $r_{out} = 0.4$

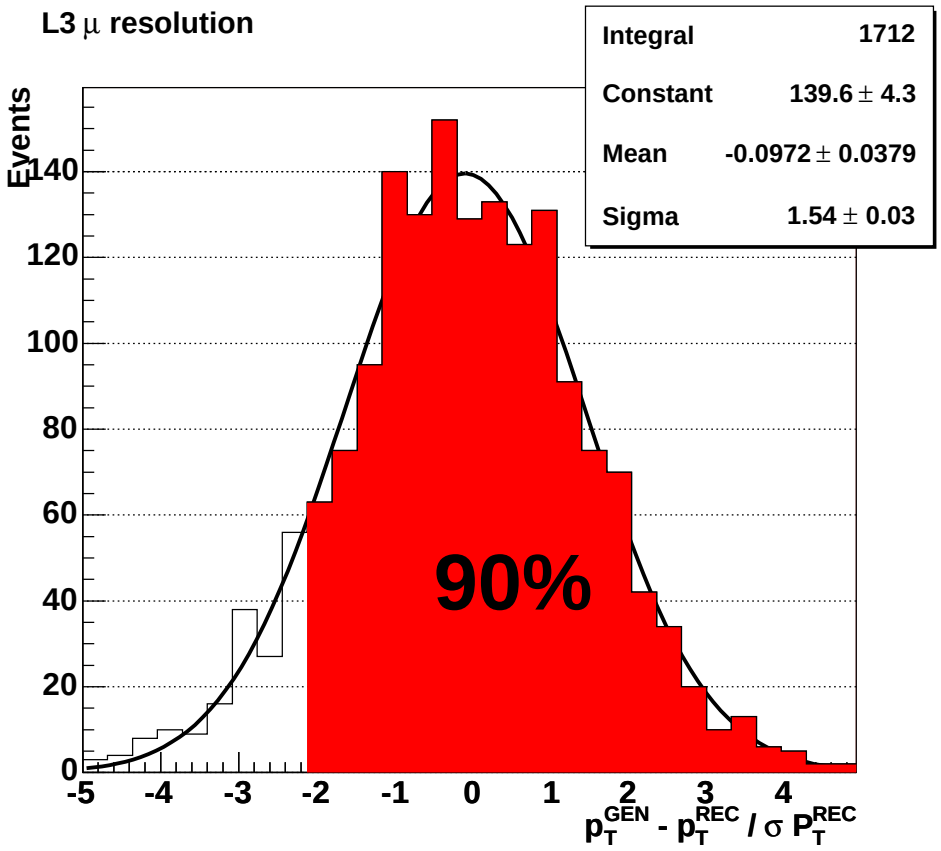
etails can be found in
Eno et al, CMS-NOTE 2000/055



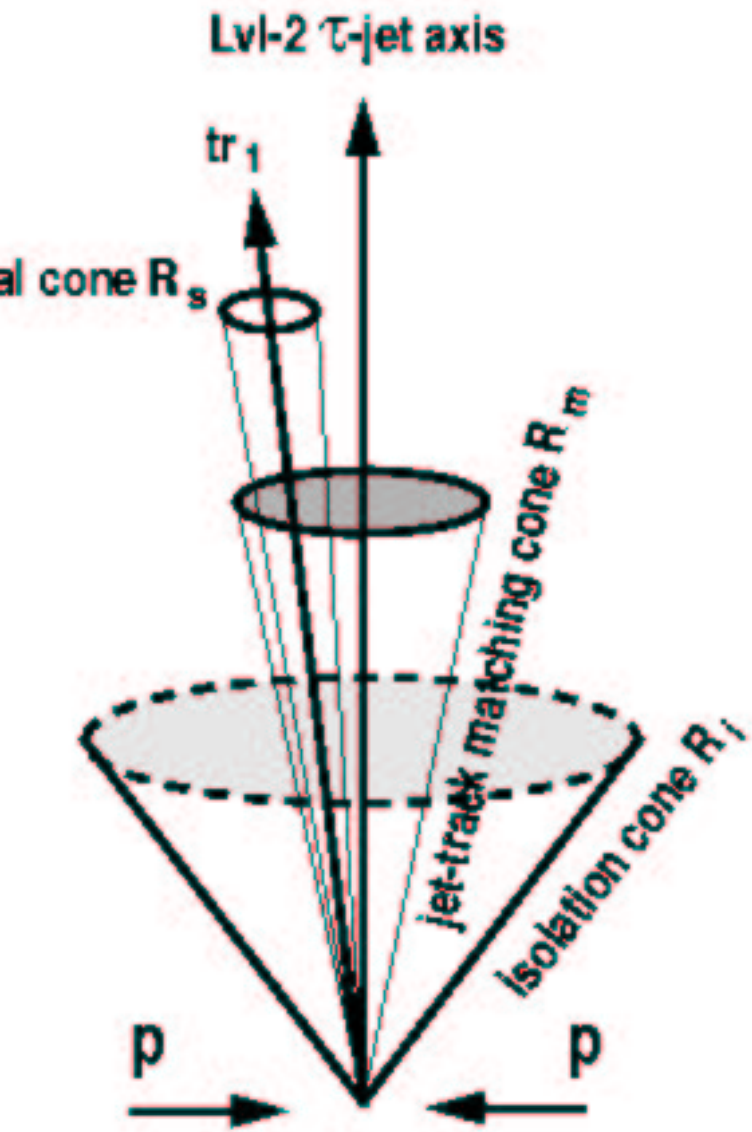
L3 trigger cuts. Muon 90% scale

L3 90% scale has been defined as
cale at which 90% of muons with
$^{gen}_{T} \geq p_T^{cut}$ go through. We cut on the
alue of $p_T^{thr} = p_T^{Rec} + \alpha \cdot \sigma_{p_T}$
this study $\alpha = 2$ (TDR: 2.3)
or gaussian distribution $\alpha = 1.3$.

omment: $\sigma = 1.5$ of the gaussian fitted
the $\frac{p_T^{rec} - p_T^{gen}}{\Delta_{p_T^{rec}}}$ means that the error on
e p_T is underestimated.



L3 trigger cuts. Pixel tau jets isolation

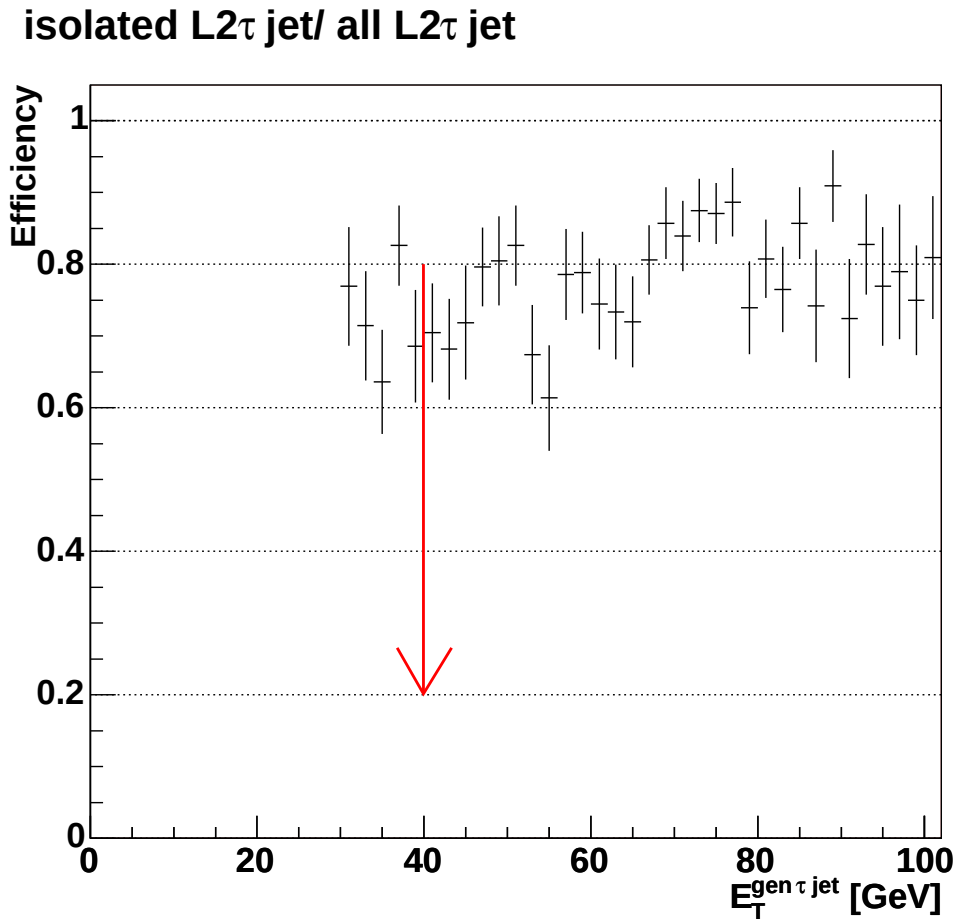


PixelConeTrigger:SignalCone = 0.05
PixelConeTrigger:JetTkMatchCone = 0.1
PixelConeTrigger:IsolCone = 0.3
PixelConeTrigger:PtIsolCut = 1.0
PixelConeTrigger:LeadingTkPtCut = 3.0
PixelConeTrigger:SignalSumPtCut = 3.0
PixelConeTrigger:PVDeltaZCut = 0.2
PixelConeTrigger:doPairRecovery = false

Details can be found in

D. Kotliński et al. CMS-NOTE 2001/017

fficiency of the L3 pixel isolation. Only vents with good L2-Gen jet matching: $R(L2\ jet, gen\ jet) < 0.1$ contribute to e plot. No cut on the jet E_T is set.



fficiencies w.r.t events passing
ythia level preselection cuts:

- at least one isolated μ with $p_T \geq 15\ GeV/c$, $|\eta| \leq 2.4$
- one tau-like jet with $E_T \geq 30\ GeV$, $|\eta| \leq 2.4$

Preselection efficiency:
(w.r.t all $H \rightarrow \tau\tau$ events)
$\epsilon_{pres} = 0.097$

Total efficiency:
$\epsilon_{total} = 0.048$

	Efficiency
events passing L1 μ OR single τ OR combined	0.99
events passing L1 combined, but not selected by single triggers	0.07
L2 identification and E_T/p_T cuts	0.73
L2 with calo tau isolation	0.65
L2 with muon calo isolation	0.72
L2 combined	0.65
L3 tau identification and μ p_T cut	0.49
L3 with muon isolation	0.64
L3 combined	0.49

o strong additional off-line cuts were applied now. Cuts know in the literature
re:

- cut on the $m_T(l, \not{E}_T)$
- b-tagging
- veto on additional jets wrt b and tau tagged ones
- cut on impact parameter for τ decay products

dditional applied cuts are (will be explained later) :

- $0.5 < cos(\varphi_{\mu-jet}) < 0.997$
- $E_\nu > 0$

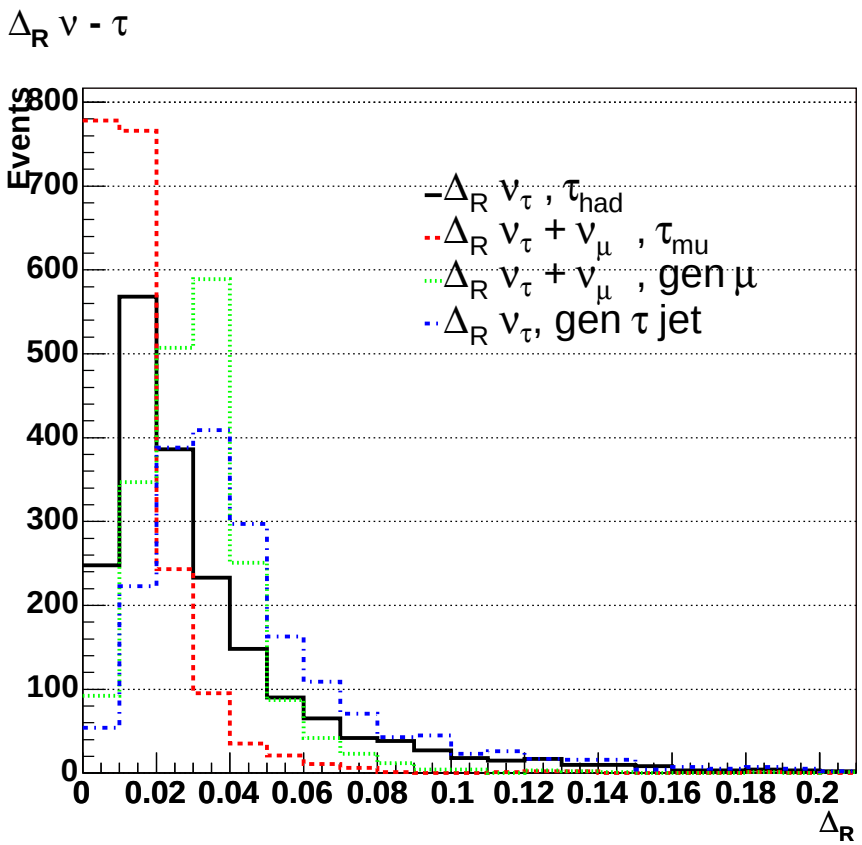
We can assume that neutrinos from τ's decays go along the τ's momentum:

$\vec{p}_{\nu_1} \simeq E_\nu \cdot \hat{e}_{\tau_1} \simeq E_\nu \cdot \hat{e}_{jet}$

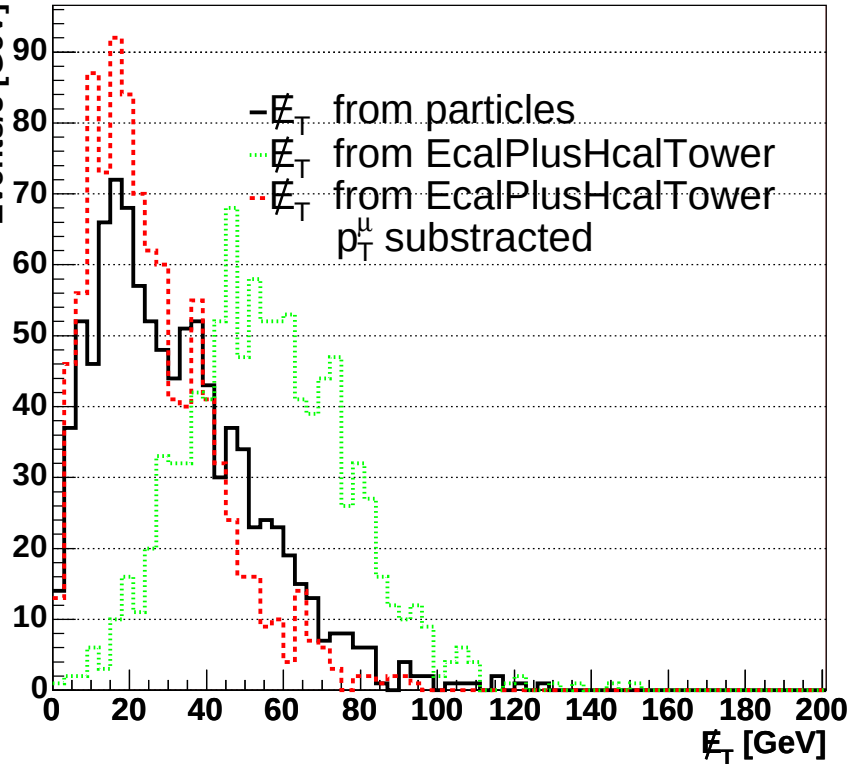
$\vec{p}_{\nu_2} = \vec{p}^{\,\tau}_{\nu_2} + \vec{p}^{\,\mu}_{\nu_2} \simeq (E_\nu + E_\nu) \cdot \hat{e}_{\tau_2}$

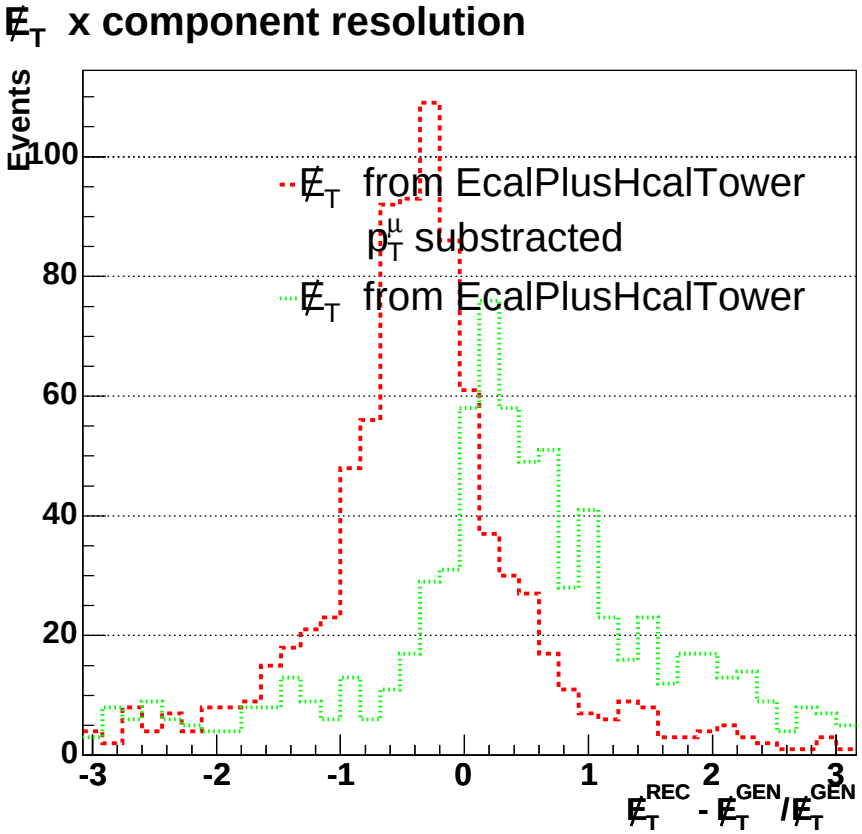
$(E_\nu + E_\nu) \cdot \hat{e}_{mu}$

Since $M\vec{E}T \simeq p^{\tau}_{T\nu_1} + p^{\tau}_{T\nu_2} + p^{\mu}_{T\nu_2}$ by projecting $M\vec{E}T$ on the directions of the p^{μ}_{T} and $p^{\tau\ jet}_{T}$ we can reconstruct p_T of both "neutrinos", and with the knowledge of polar angles θ_{mu} and $\theta_{\tau jet}$, their energies.



issing E_T from EcalPlusHcalTower includes default tower corrections.

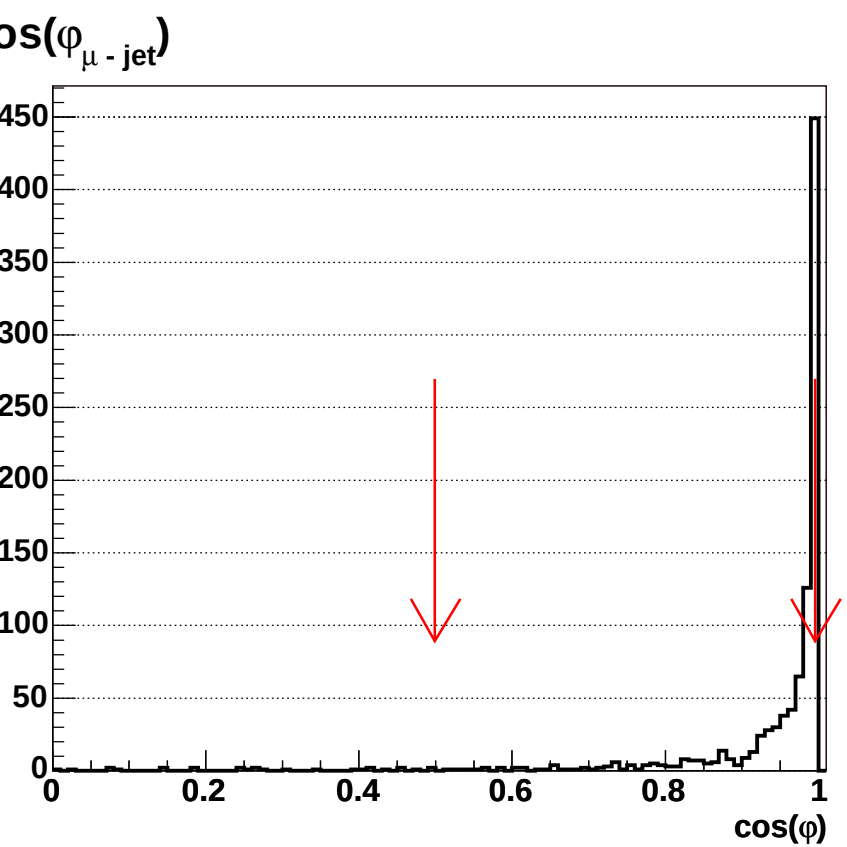


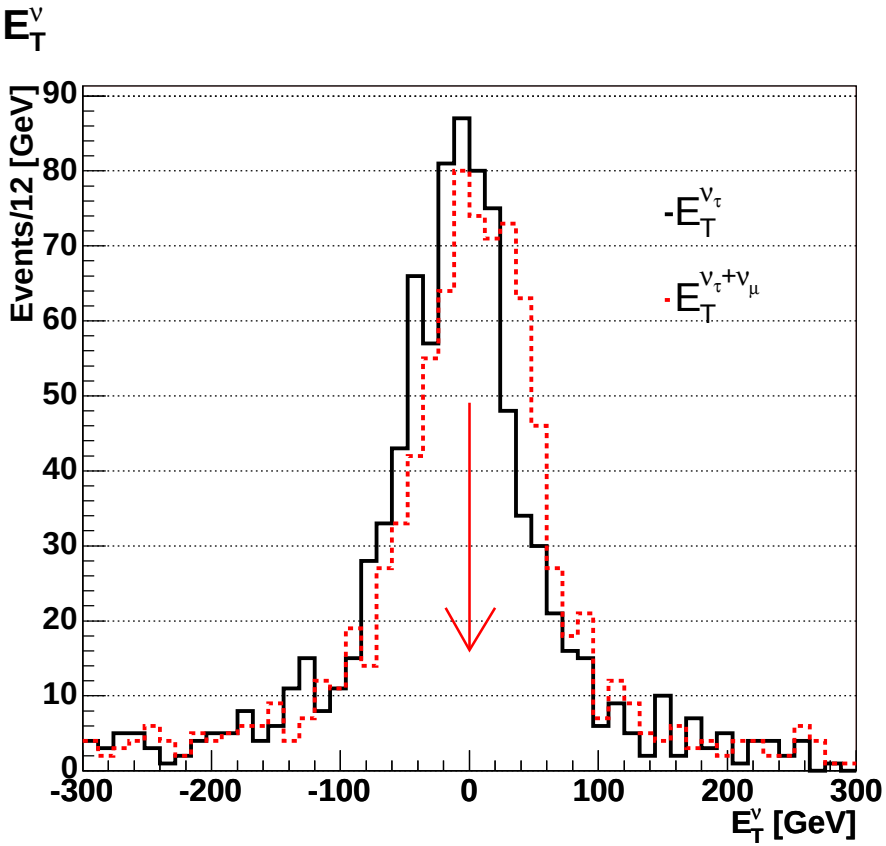


we define $\hat{e}_{Tjet} = \frac{\vec{p}_T^{\,\tau\ jet}}{p_T^{\tau\ jet}}$, $\hat{e}_{T\mu} = \frac{\vec{p}_T^{\,\mu}}{p_T^{\mu}}$, $cos(\varphi_{\mu-jet}) = \hat{e}_{Tjet} \cdot \hat{e}_{T\mu}$, we get:

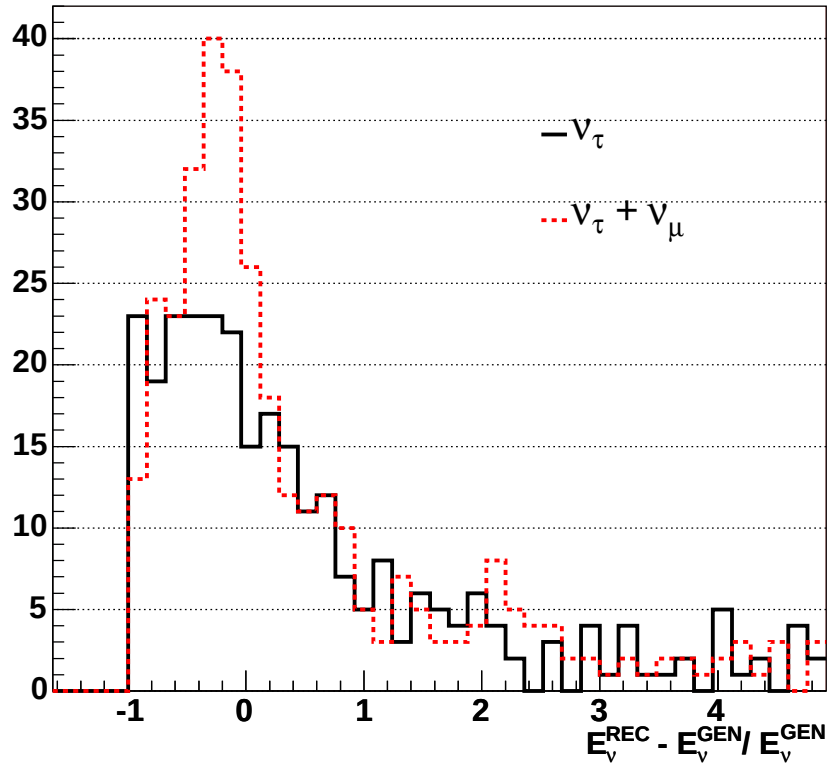
$$E^{\tau}_{\nu_1} = M\vec{E}T \cdot \frac{(\hat{e}_{Tjet} - \hat{e}_{T\mu} \cdot cos(\varphi_{\mu-jet}))}{sin(\theta_{jet}) \cdot (1 - cos^2(\varphi_{\mu-jet}))} \qquad E^{\tau}_{\nu_2} = M\vec{E}T \cdot \frac{(\hat{e}_{Tmu} - \hat{e}_{Tjet} \cdot cos(\varphi_{\mu-jet}))}{sin(\theta_{mu}) \cdot (1 - cos^2(\varphi_{\mu-jet}))}$$

Reconstrucion done for $0.5 < cos(\varphi_{\mu-jet}) < 0.997$

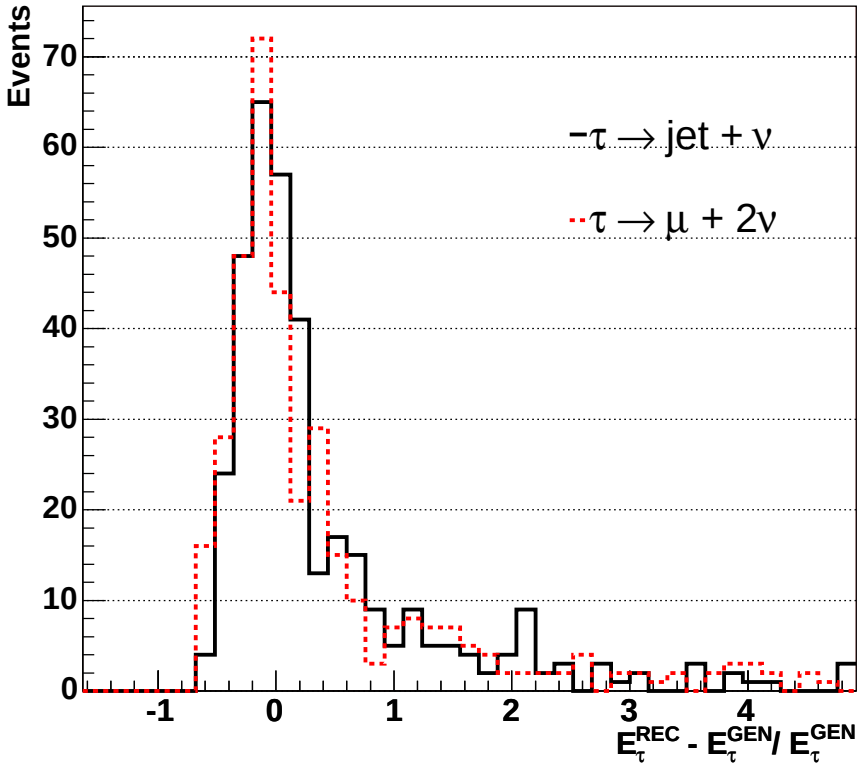




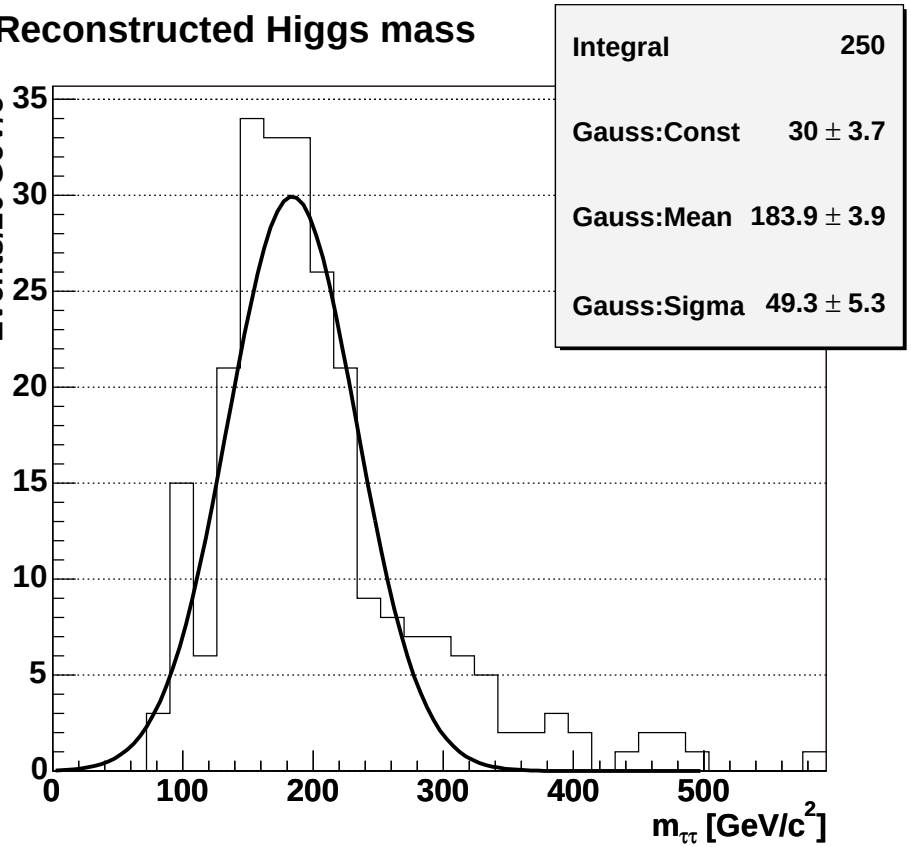
E_ν resolution

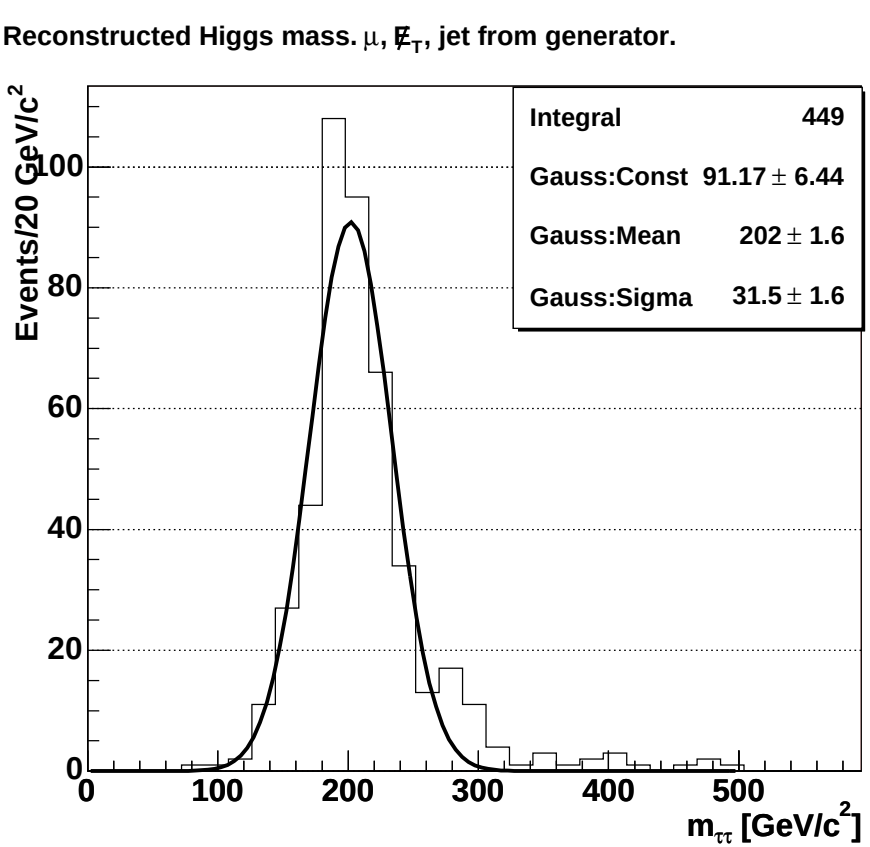


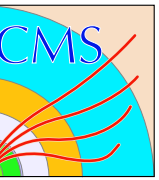
Rec τ energy resolution



Higgs mass reconstruction







Conclusions

o do:

- check efficiencies, reconstruction with Pile Up
- Off-line: use more sophisticated Jets/MET, like Jet E_T corrections, JetPlusTrack corrections - all that is under investigation now
- implement off-line selection cuts
- check background rejection - waiting for official MC production