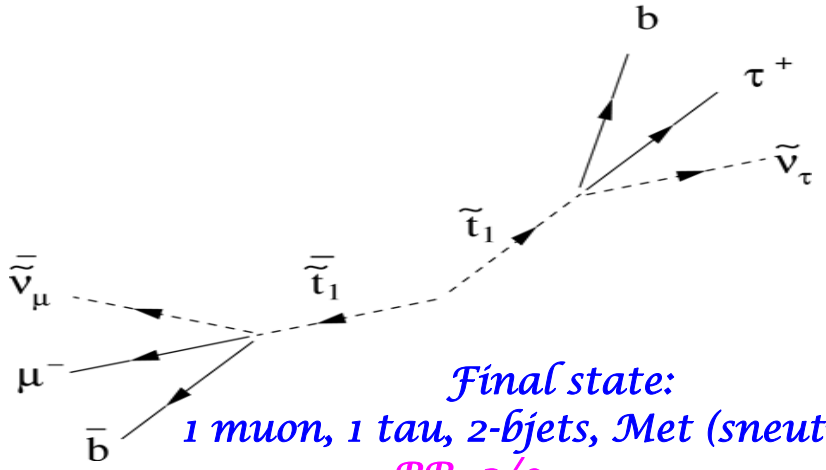
Search for $\tilde{t}_1\tilde{t}_1 \longrightarrow bb\mu\tau\not{E}_T$

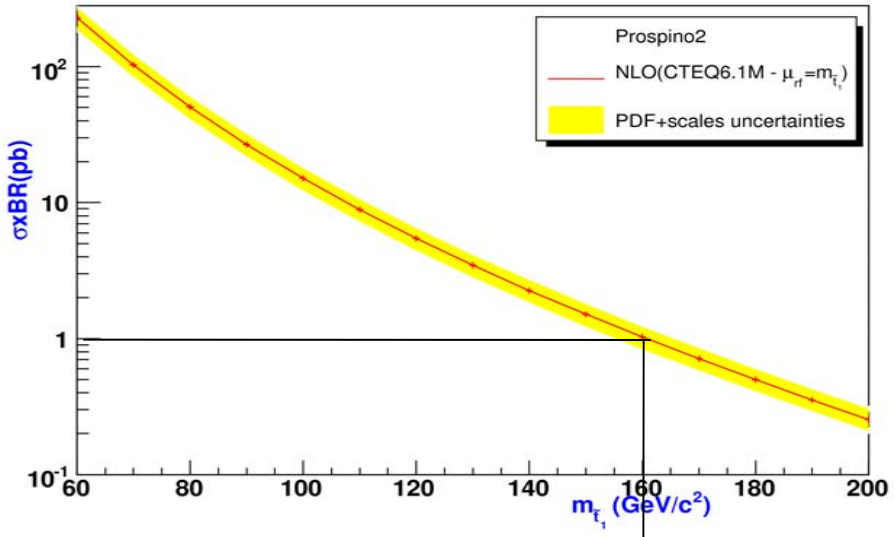
Ph.Gris
LPC Clermont-Ferrand
IN2P3/CNRS

- *Final state*
- *Stop production*
- *Skims, triggers and background*
- *Object definitions and correction factors*
- *QCD estimation*
- *Analysis*
- *Outlook*

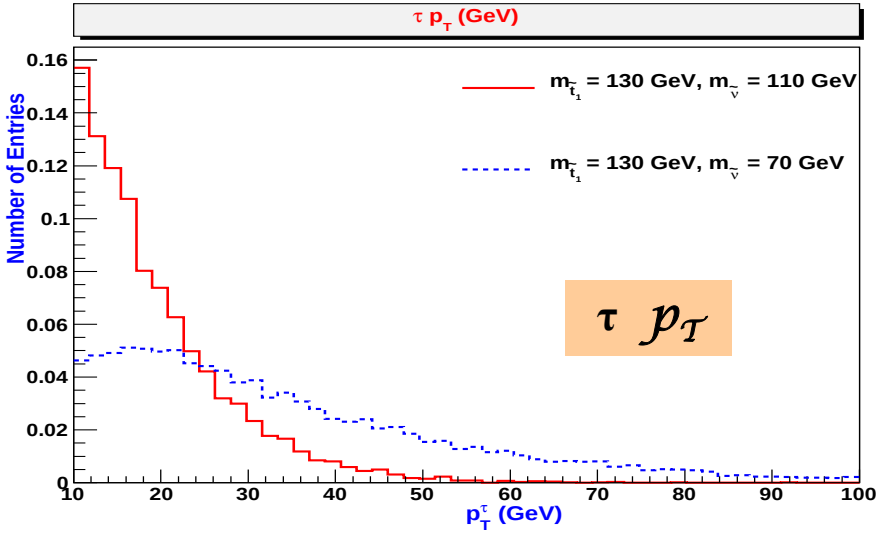
Stop pair production: final state

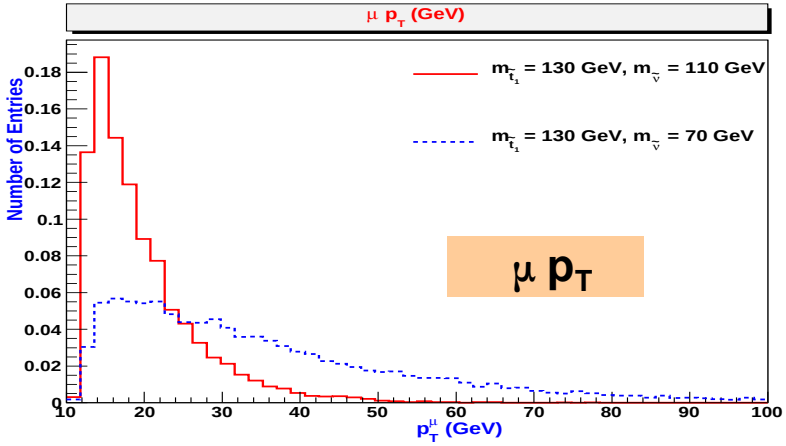


Final state:
1 muon, 1 tau, 2-bjets, Met (sneutrinos)
BR=2/9

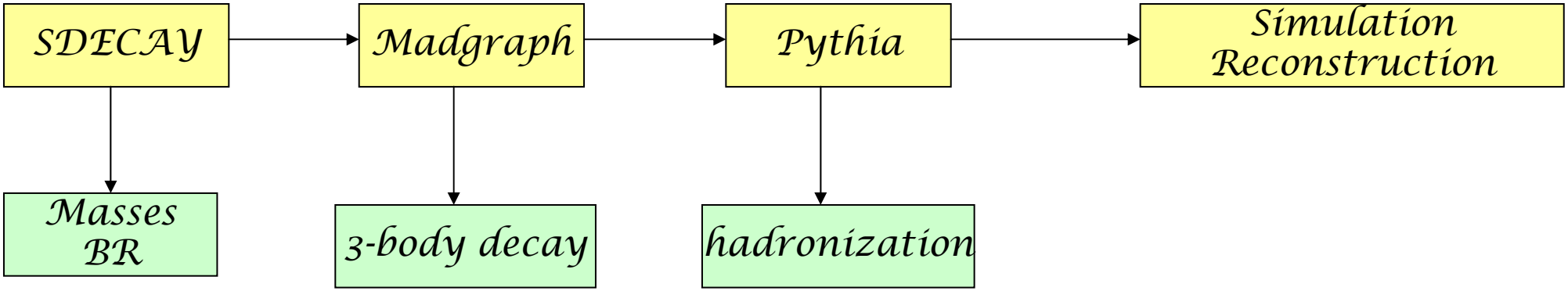


Mstop=160 GeV: 1111 stop pairs in 5 fb⁻¹





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 (step=10)
200	50-180
180	40-160
160	40-140
140	40-120
120	40-100
100	40-80

Skims, triggers and background

- Data skim: sub-skim (mu+tau) from Romain extracted from the Muinclusive skim
- $\mathcal{L}$~7.3 fb^{-1} : RunIIa, RunIIb1-RunIIb3
- Trigger: single mu or triggers

Back.	Kfactor	σ(pb)
Z-> μμ	1.3	390.7/184.8/99.7
Z-> ττ	1.3	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

Period	$\mathcal{L}$ (fb^{-1})	MC version
RunIIa	1.08	v10
RunIIb1	1.22	v10
RunIIb2	3.05	v4
RunIIb3	1.94	v4

m_{top}=172 GeV

Object definitions

Muon

- medium nseg3
- $\chi^2 < 4$
- DCA < 0.02 (0.2), SMT > 0 (=0)
- $E_T$trkcone/Pt<0.15 (top_scaled_medium)
- ET halo /Pt < 0.15
- P_T > 15 GeV

Jet

- standard jet-id cuts
- Vertex-cinfirmed jets
- P_T >15 GeV

MET

Corrected for em calo cells, muons , JES and taus

Electron

- LooseElectron selection
- P_T> 15 GeV

Tau

- track_loose

- Type 1
  - P_T(track) > 7 GeV
  - NN > 0.9
  - P_T> 12.5 GeV
  - E/P > 0.65

- Type 2:
  - P_T(track) > 5 GeV
  - NN_{elec} > 0.85
  - NN > 0.9
  - P_T> 12.5 GeV
  - E/P > 0.5

- Type 3:
  - P_T(lead. track) > 7 GeV
  - ΣP_T(tracks) > 10 GeV
  - NN > 0.95
  - P_T> 15 GeV
  - E/P > 0.5

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

Matching with loose muons

MC corrections and Event selection

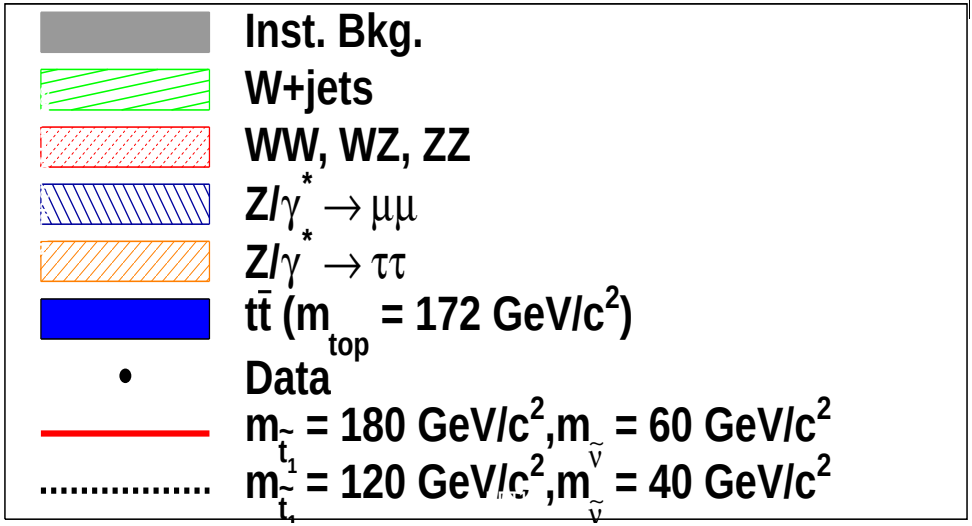
MC Corrections

- 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 v05-05-12c release p21.20.00

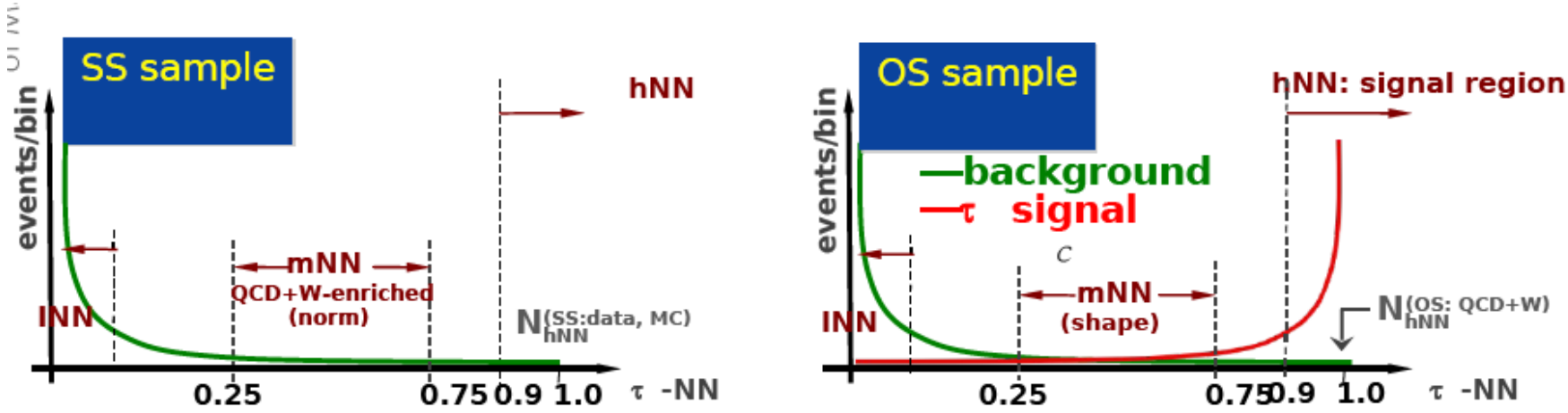
Event selection

- One muon, one central tau, no electron
- OS (muon, tau)
- ΔR (muon,tau) > 0.5
- ΔR (muon, jet) > 0.5
- $\Delta\Phi$ (muon,Met) > 0.5
- $\Delta\Phi$ (tau,Met) > 0.5



Instrumental background estimation

- Shape given by OS events with $0.3 < NN_\tau < 0.85$

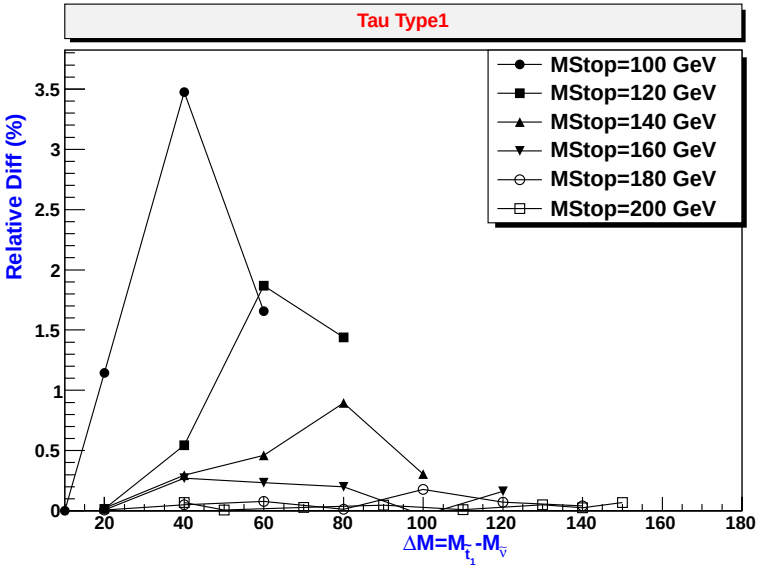


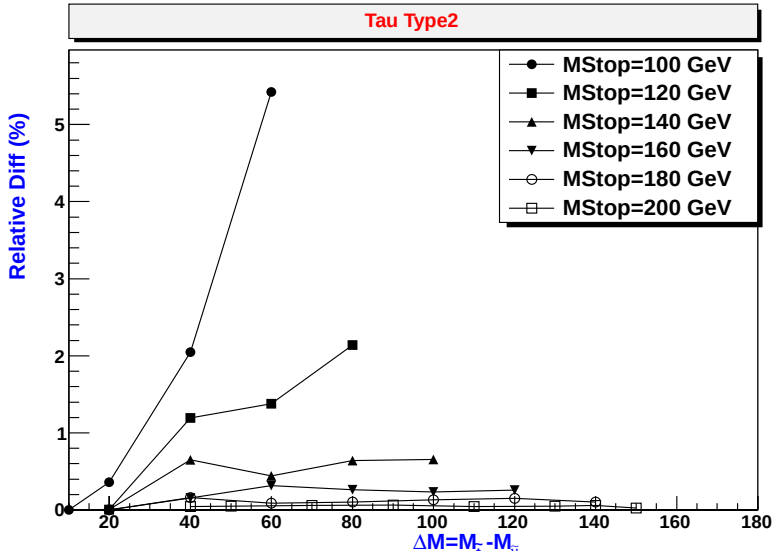
- Norm.: in a control region: same as the signal except $\Delta\Phi$ (tau,Met) < 0.5

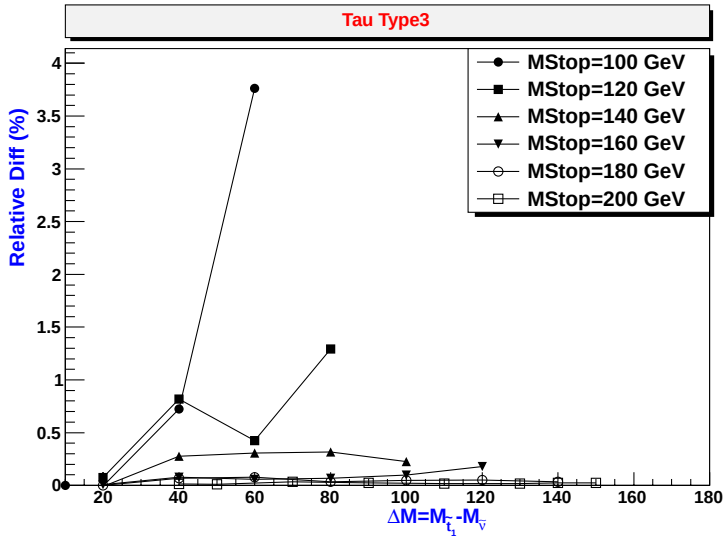
	Norm factor
τ Type	RunIIa+RunIIb
1	0.28±0.03
2	0.35±0.03
3	0.11±0.01

Instrumental background estimation – impact of stop

- Re-estimate the normalization factors with stop signals







The effect does not exceed 5%.
-> Systematic uncertainty
(on the shape: ~10%)

μτ analysis strategy

- Selection:
  - preselection: one muon, one central tau
  - at least one jet
  - Three sub-samples depending on the number of jets:
    - njets=1
    - njets=2
    - njets>=3
- BDTs are estimated for each sub-sample

(MC samples were divided in two parts: 2/3 for the BDT computations, 1/3 for the analysis).

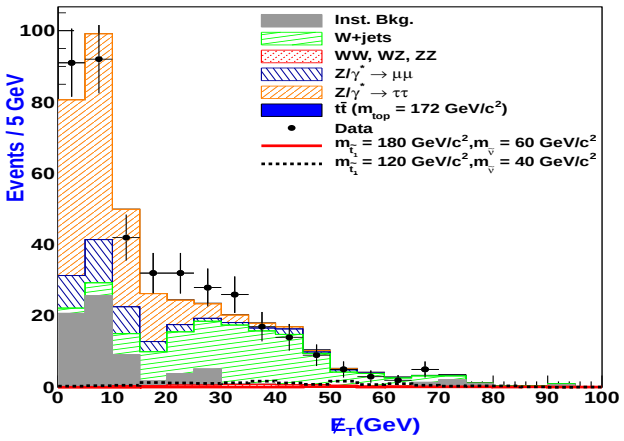
- BDT outputs are used to estimate the limits with Collie

- N.B: a tau-jet fake rate has been performed and results included. Will not be shown here (see the DØ note).

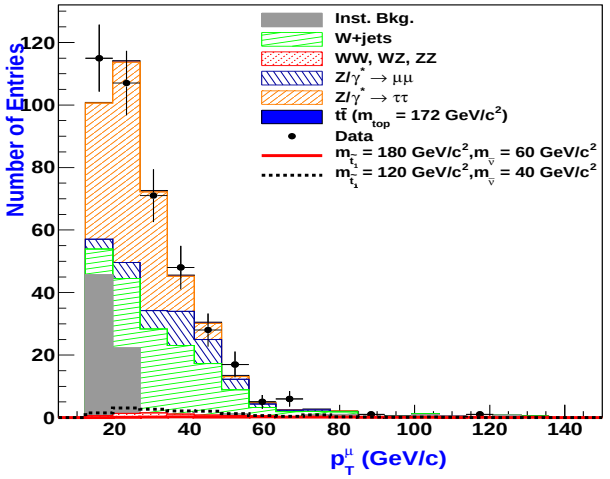
μτ preselection stage

	Type 1	Type 2	Type 3	All types
Z -> ττ	164±4	999±10	355±6	1518±12
Z -> μμ	39±2	92±3	49±2	180±4
diboson	7.6±0.3	41.1±0.6	17.1±0.4	65.8±0.8
ttbar	3.3±0.2	28.1±0.6	10.9±0.4	42.3±0.8
W+jets	118±3	586±6	390±5	1094±8
QCD	63±3	320±15	161±8	544±24
All MC	394±6	2067±20	983±11	3444±31
Data	399	1980	1086	3465
Stop (120,40)	16±1	95±3	36±2	147±4

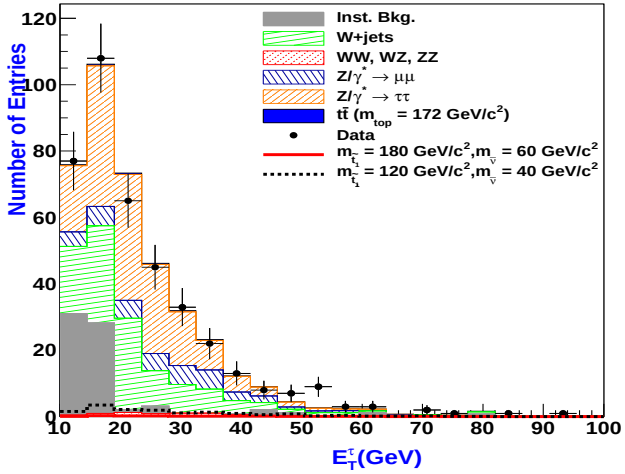
μτ preselection stage: tau type 1



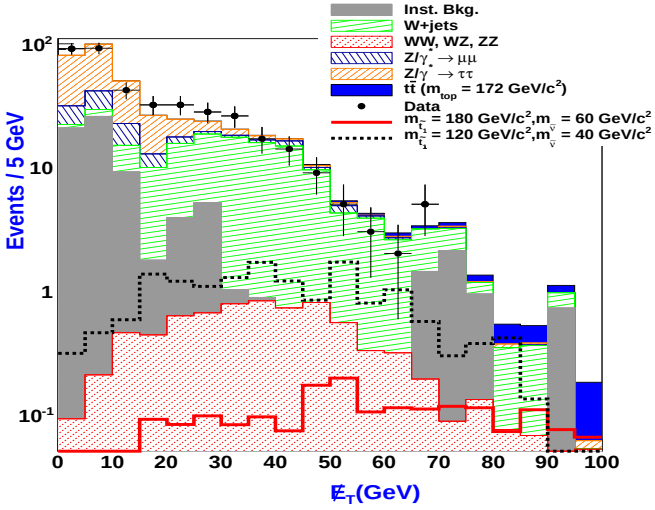
MET

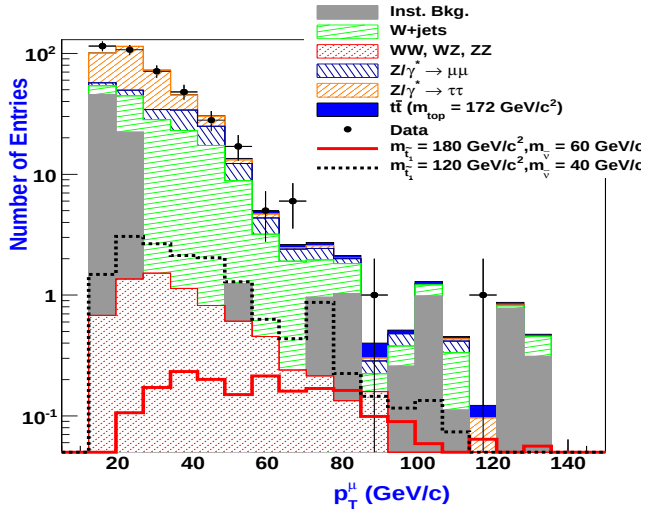


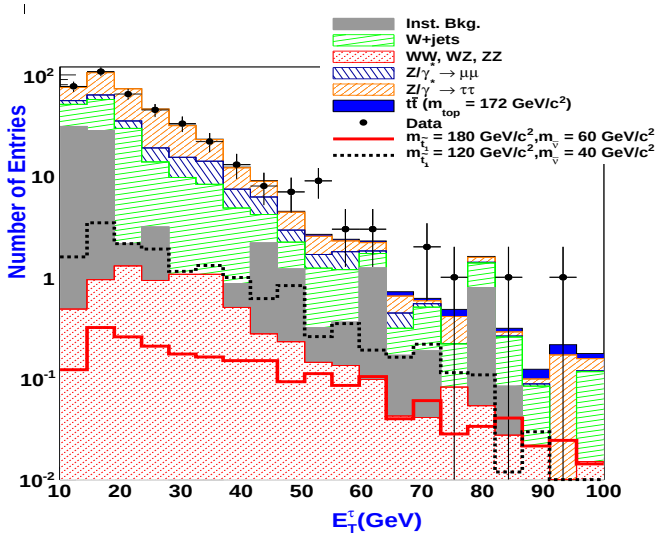
Muon p_T



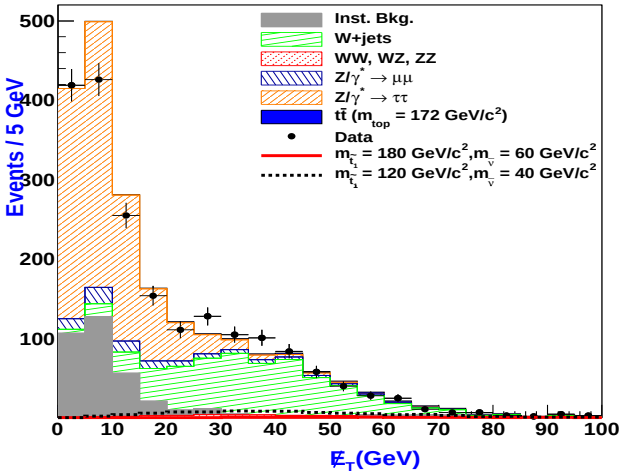
Tau p_T



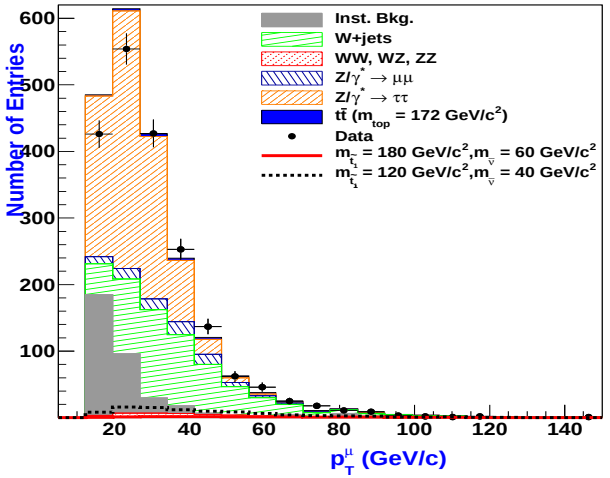




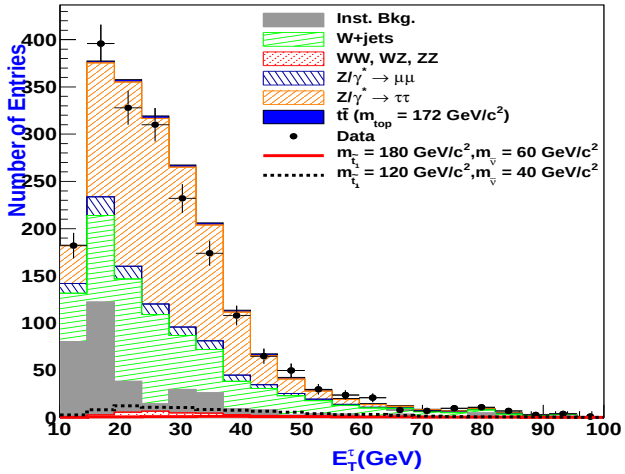
μτ preselection stage: tau type 2



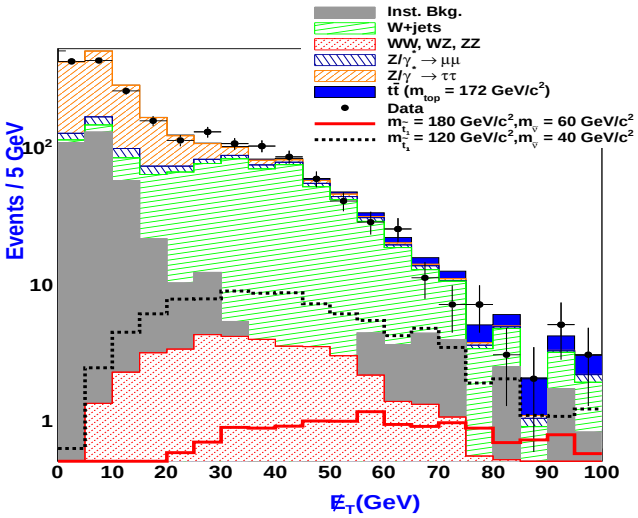
MET

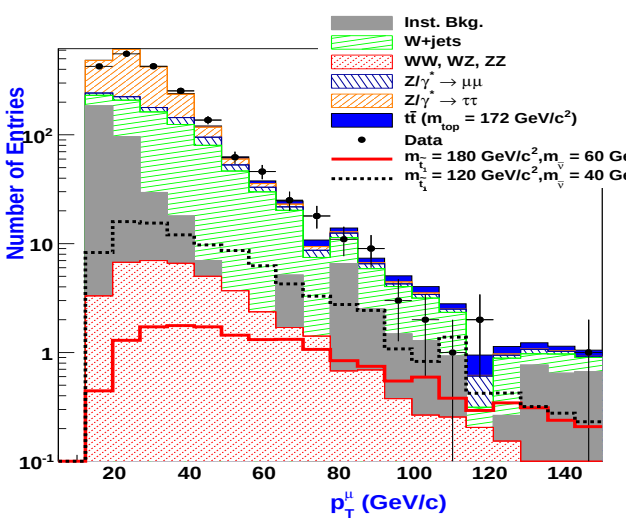


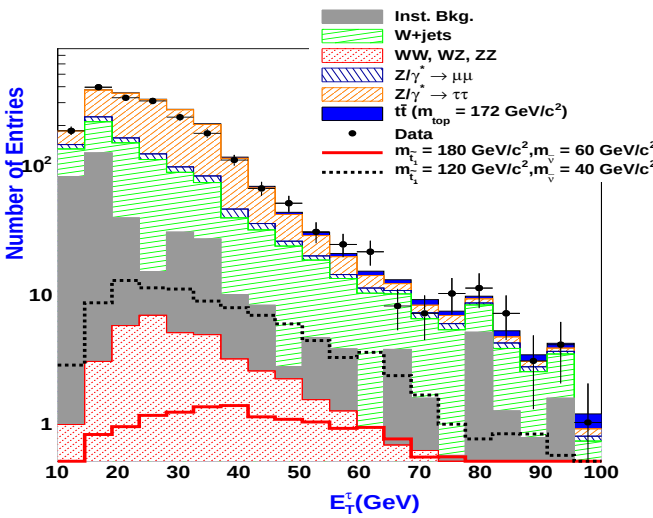
Muon p_T



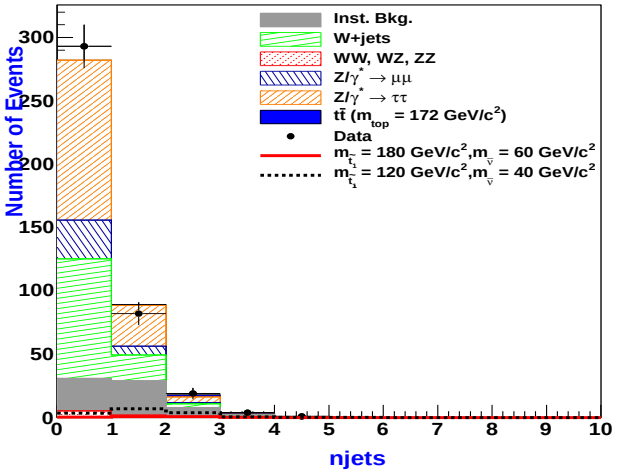
Tau p_T



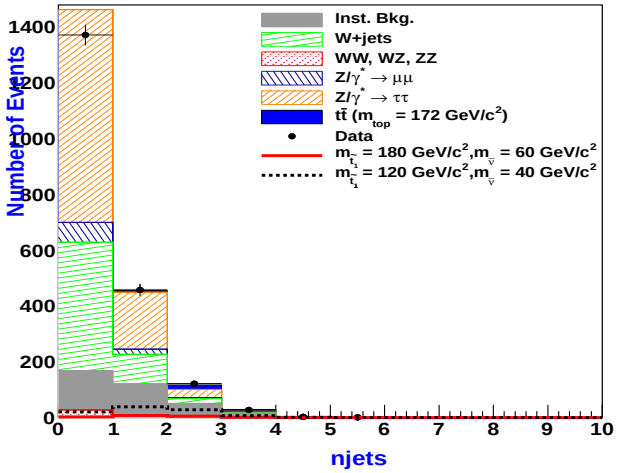




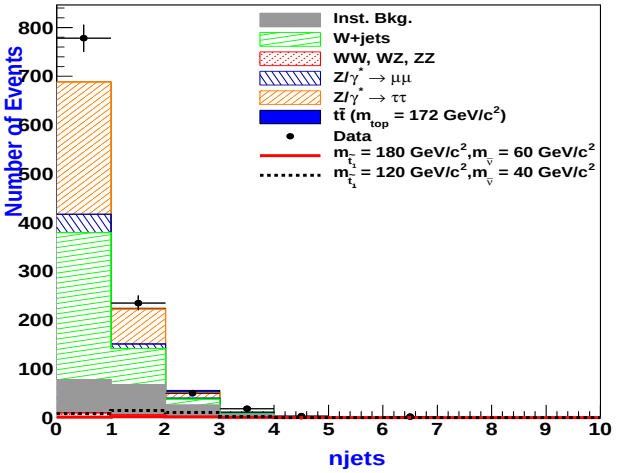
μτ *preselection stage: njets*



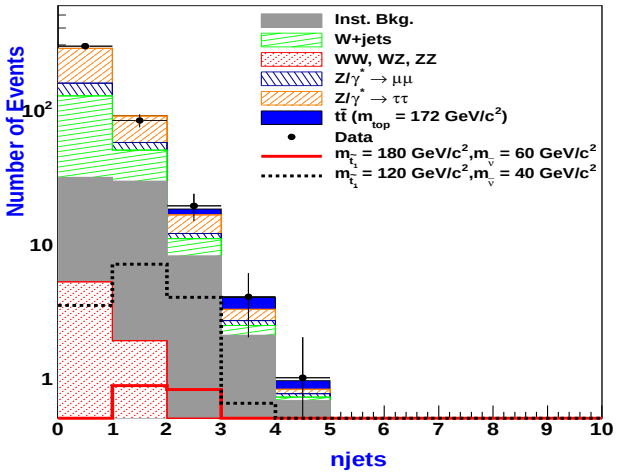
type1

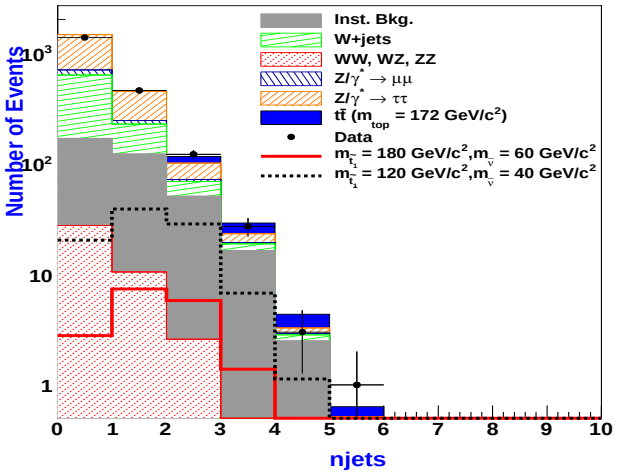


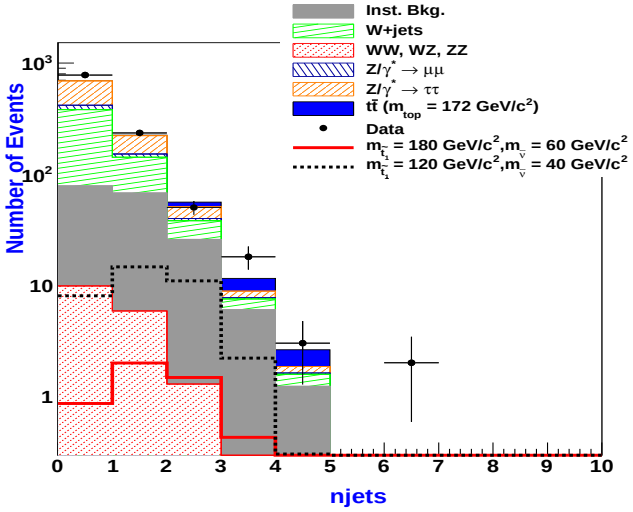
type2



type3



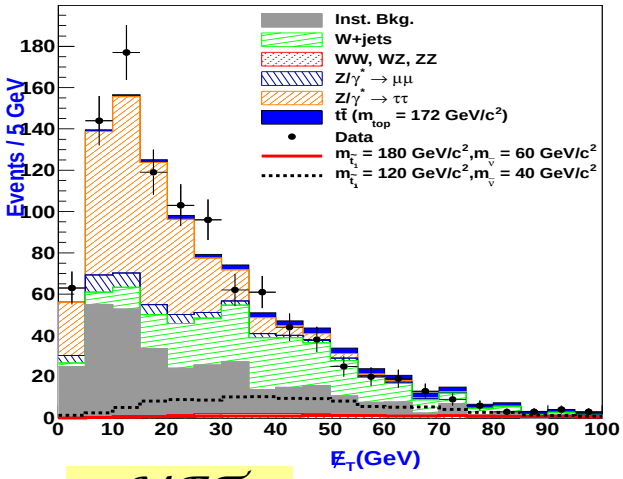




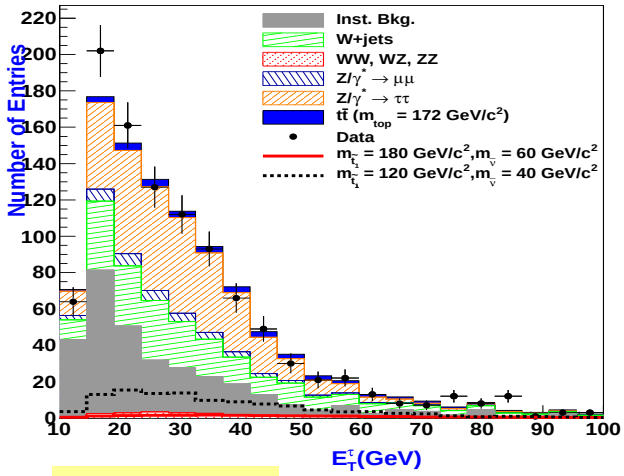
μτ selection : njets≥1

Process	type 1	type2	type3	all types
$Z/\gamma^* \rightarrow \tau^+\tau^-$	37 ± 1	237 ± 4	83 ± 2	358 ± 5
$Z/\gamma^* \rightarrow \mu^+\mu^-$	8.3 ± 0.7	22 ± 1	11.7 ± 0.7	41 ± 1
diboson	2.4 ± 0.1	13.5 ± 0.4	7.4 ± 0.3	23.3 ± 0.5
$t\bar{t}$	3.3 ± 0.2	27.5 ± 0.6	10.7 ± 0.3	41.6 ± 0.8
W+jets	23 ± 1	126 ± 2	89 ± 2	239 ± 3
QCD	38 ± 2	178 ± 9	94 ± 4	308 ± 15
Total MC	112 ± 3	605 ± 10	295 ± 5	1012 ± 16
Data	106	609	308	1023
$m_{\tilde{t}_1}$=120 GeV/c^2 $m_{\tilde{\nu}}$=40 GeV/c^2	12 ± 1 $(\pm\ )\%$	75 ± 3 $(\pm\ )\%$	28 ± 1 $(\pm\ )\%$	115 ± 3 $(\pm\ )\%$
$m_{\tilde{t}_1}$=180 GeV/c^2 $m_{\tilde{\nu}}$=60 GeV/c^2	1.9 ± 0.1 $(\pm\ )\%$	14.8 ± 0.4 $(\pm\ )\%$	3.9 ± 0.2 $(\pm\ )\%$	20.7 ± 0.4 $(\pm\ )\%$

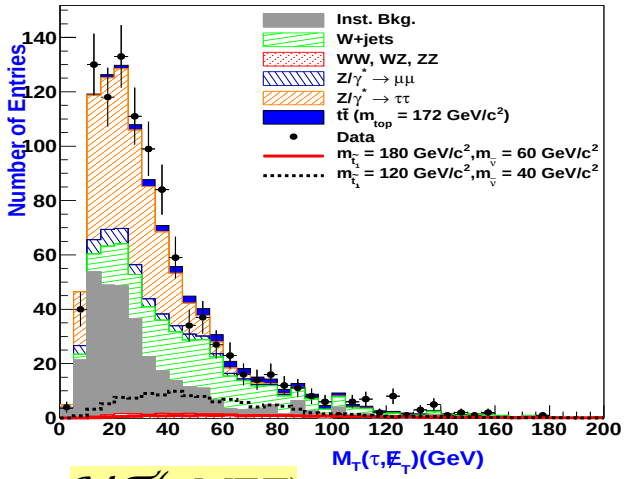
μτ selection : njets≥1 – all types



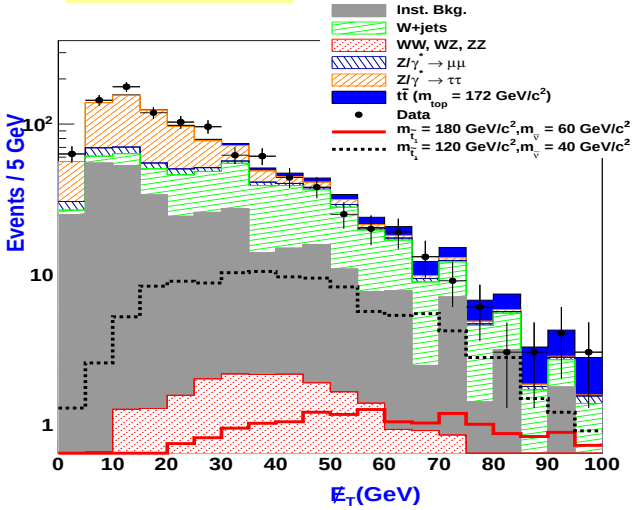
MET

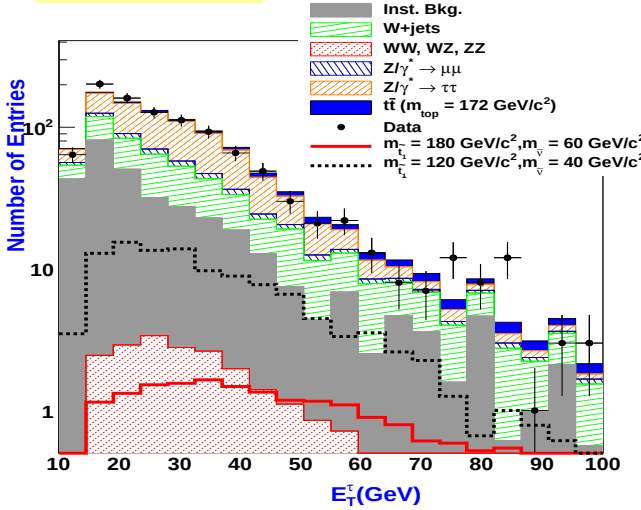


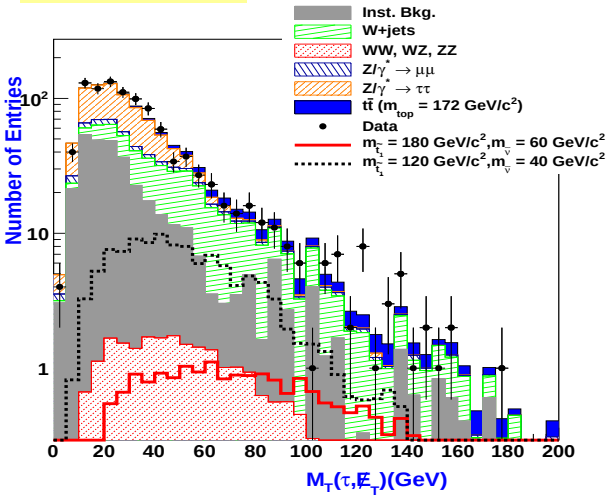
ET(τ)



MT(τ,MET)







μτ selection : 3 sub-samples (jet multiplicity)

Process	n_{jets}=1	n_{jets}=2	n_{jets}=3
$Z/\gamma^* \rightarrow \tau^+\tau^-$	306 ± 4	47 ± 1	5.9 ± 0.4
$Z/\gamma^* \rightarrow \mu^+\mu^-$	33 ± 1	4.9 ± 0.3	1.1 ± 0.2
diboson	18.2 ± 0.4	4.2 ± 0.2	0.91 ± 0.09
$t\bar{t}$	8.3 ± 0.3	22.1 ± 0.5	11.2 ± 0.5
W+jets	206 ± 3	33 ± 1	4.8 ± 0.4
QCD	212 ± 10	65 ± 3	24 ± 1
Total MC	784 ± 12	177 ± 4	48 ± 1
Data	774	190	59
$m_{\tilde{t}_1}$=120 GeV/c^2 $m_{\tilde{\nu}}$=40 GeV/c^2	59 ± 2 (±)%	43 ± 2 (±)%	11.2 ± 0.9 (±)%
$m_{\tilde{t}_1}$=180 GeV/c^2 $m_{\tilde{\nu}}$=60 GeV/c^2	9.9 ± 0.3 (±)%	6.3 ± 0.2 (±)%	2.2 ± 0.1 (±)%

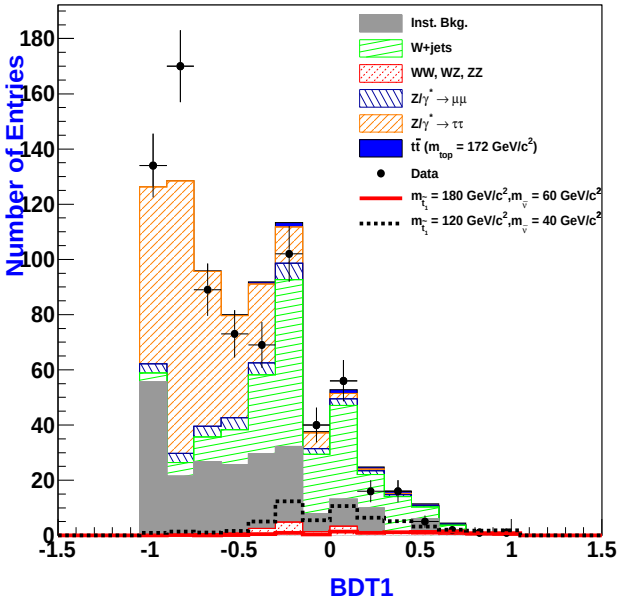
μτ analysis : BDTs

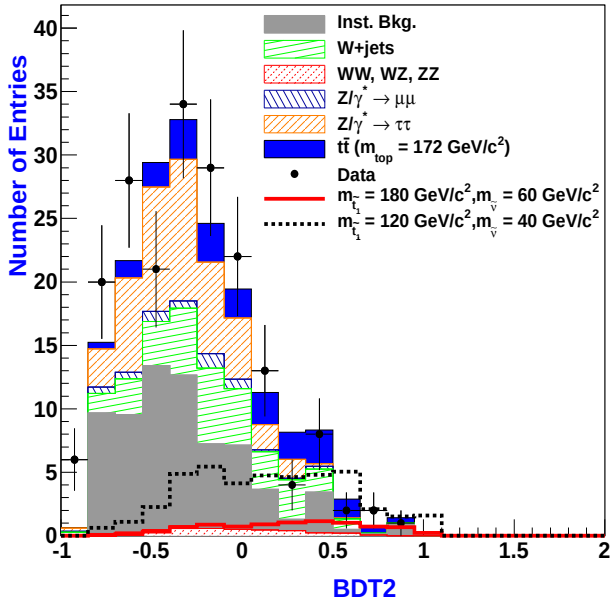
- BDT computed within the TMVA package - Root version: 5.27
- Input variables:

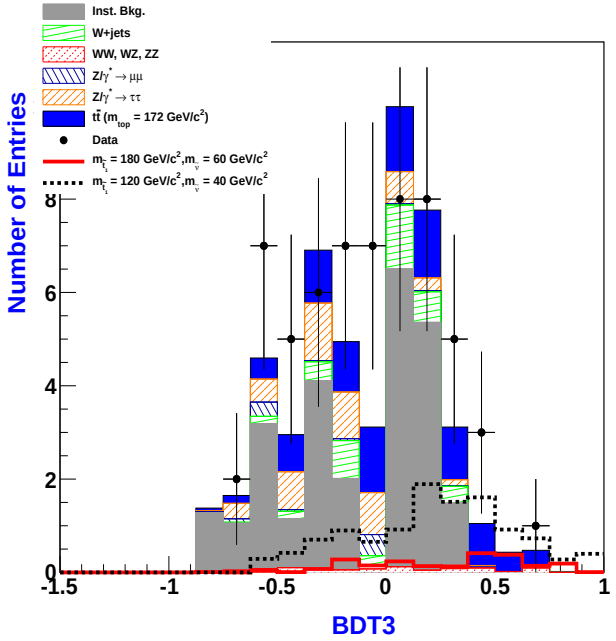
njets=1	njets=2	njets>=3
MET	H_T	P_T(jet 2)
Sig(MET)	ΔR(muon,jet)	ΔRmin(muon,jet)
P_T(muon)	ΔR(tau,jet)	ΔRmax(muon,jet)
E_T, η,Φ (tau)	P_T(jet)	ΔRmin(tau,jet)
ΔΦ(tau,MET)		ΔRmax(tau,jet)
M_T(Tau,MET)		ΔΦ(jet1,jet2)
ΔΦ(mu,MET)		
M_T(muon,MET)		
ΔR(mu,tau)		
ΔΦ(mu,tau)		
Mass(mu,tau)		
S_T		

μτ analysis : BDTs

- BDT computed within the TMVA package – Root version: 5.27





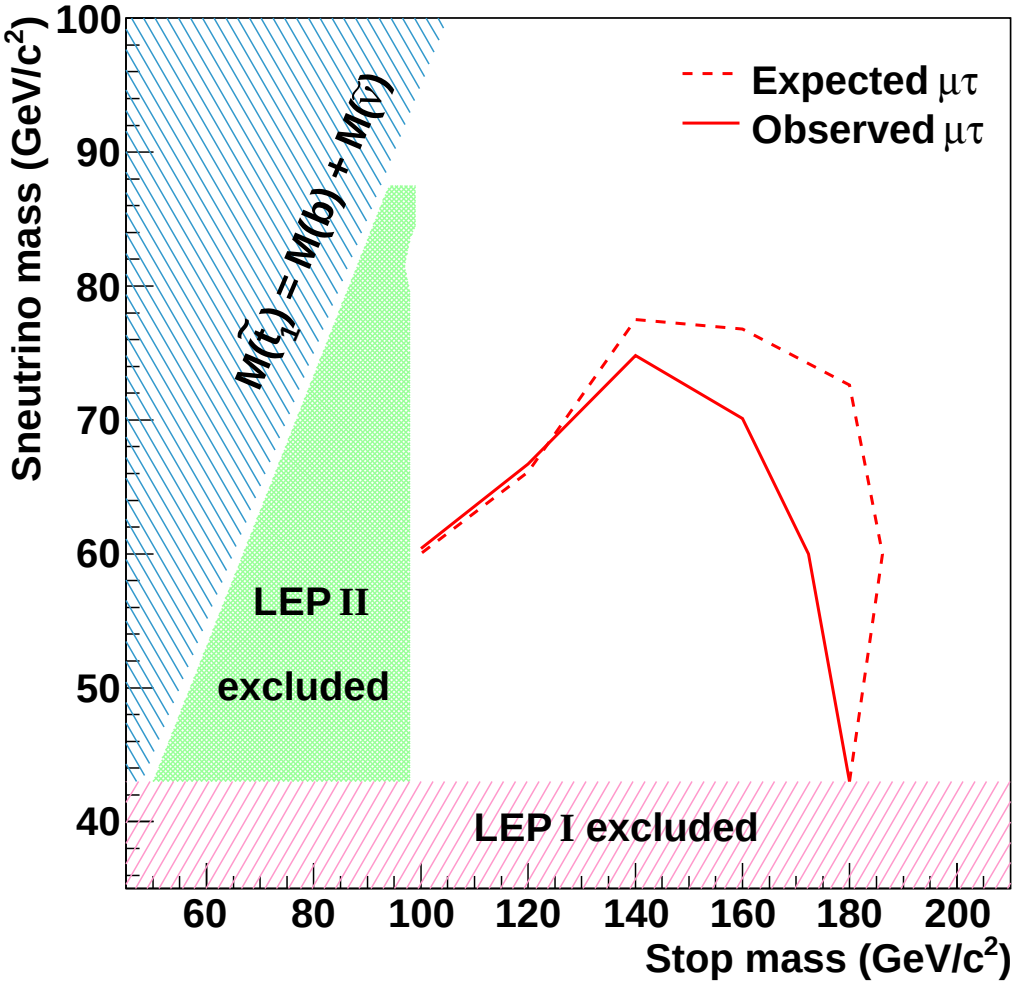


μτ analysis: systematic uncertainties

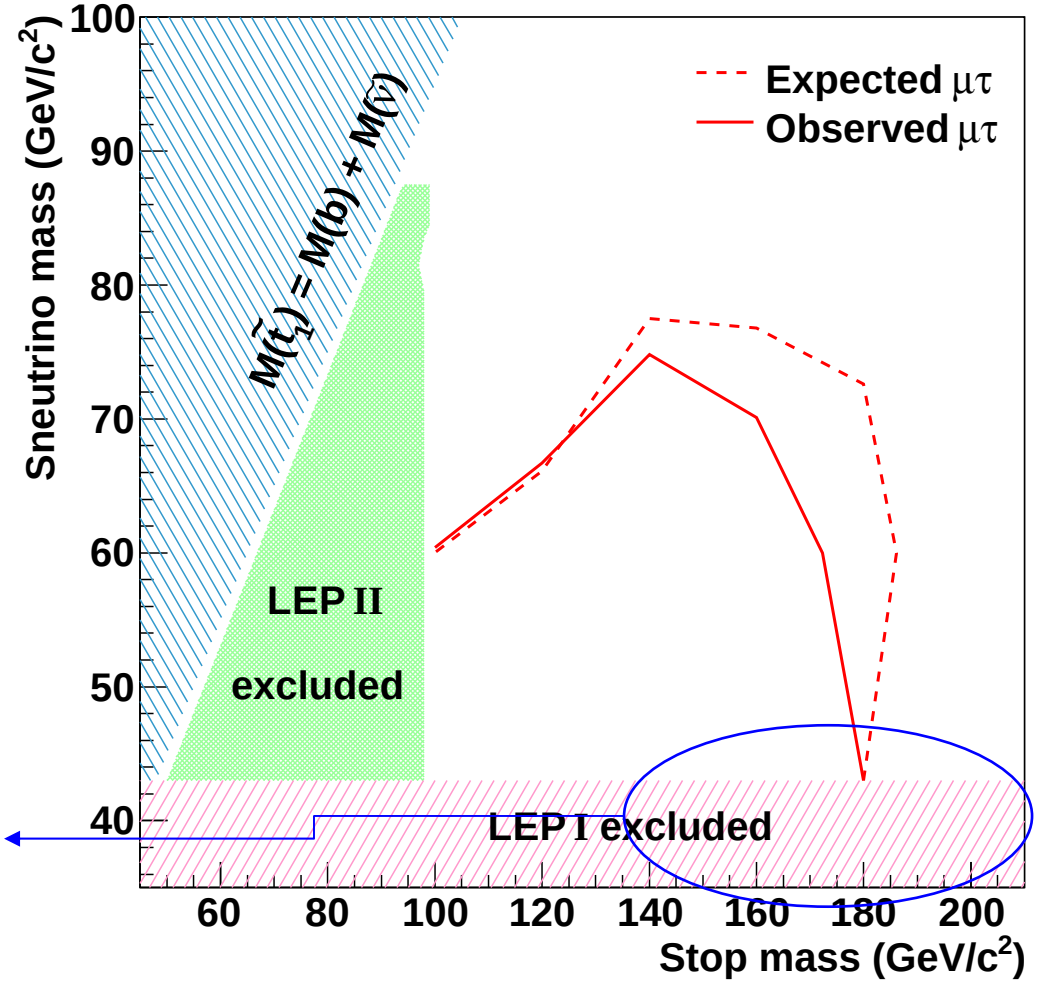
- Systematic uncertainties considered (up to now):
  - Luminosity (6.5%)
  - Jets: jetid, jssr, jetreso,jes
    -> estimated on RunIIb2 by reprocessing all the MC samples.
  - Taus (track+NN): 10/4/5% for types 1/2/3 from the τ-id group
  - Muons: isolation (1%),track(0.6%), quality (2%) from DØ note 6025.

- Systematics uncertainties not included yet:
  - theoretical cross sections(background)
  - QCD
  - Trigger

μτ analysis status



μτ analysis status



Missing SUSY point (200,40)

Outlook

- Next steps:
  - include the remaining systematics
  - analysis note in progress…should come out very soon…