FCNC channel: pp → t →lvb

(details of what is in fcniplhc/Analysis/SingleTop/FCNConeTop/results4paper)

Caroline

(15/04/15)

Selection

- = 1 lepton pT>30 GeV (no other lepton pT>20),
- 1 or 2 jets : first one with pT(j1)>30 GeV, other jets with pT>20 GeV, all with $|\eta|<2.4$
- MET>30 & $M_T(W)>50$ GeV from ATLAS paper, used for multijet suppression.
- b-tagging : Medium criteria for j1.
  - Modification of the AnalysisHelper class to return the efficiency of b-tagging per jet -> used as a weight to avoid lack of statistics in my case for DY.

Cut&Count

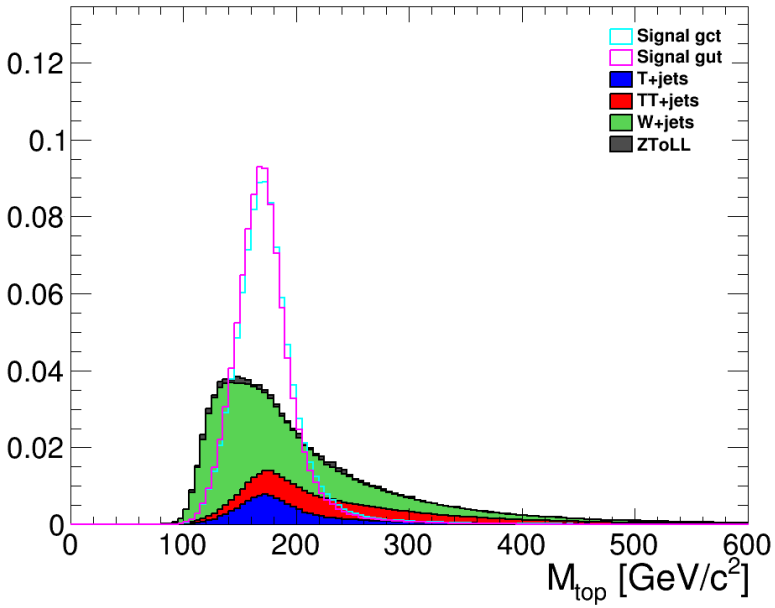
100 fb^{-1}

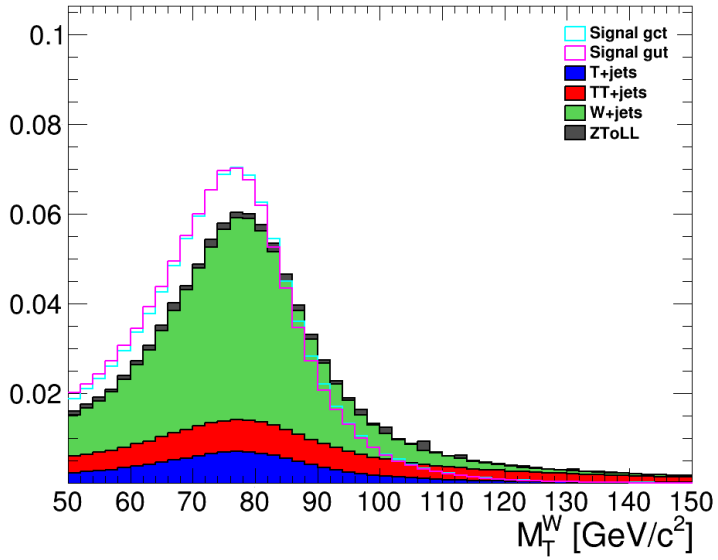
Cut	Sum Bg	Signal gct	Signal gut	T+jets	TT+jets	W+jets	ZToLL
= 1 lepton	1365879080 ± 436451	243085 ± 150	173582 ± 121	3380814 ± 5455	13094378 ± 4557	1212020864 ± 252487	137383024 ± 355934
>= 1 jet with $pT(j_1) > 30$	258595014 ± 264773	188193 ± 132	121321 ± 101	2951626 ± 5023	12821832 ± 4520	192003856 ± 66047	50817700 ± 256314
$MET > 30$	134868083 ± 132497	134166 ± 111	86849 ± 85	2216143 ± 4331	10452940 ± 4054	112844192 ± 50369	9354808 ± 122406
$mTw > 50$	108863544 ± 100794	108146 ± 100	68167 ± 76	1703800 ± 3842	7531914 ± 3412	94473056 ± 47005	5154774 ± 89015
b-tagged j_1	7777716 ± 13228	55473 ± 59	30879 ± 42	826610 ± 2371	3283684 ± 1846	3447627 ± 3128	219796 ± 12497
1 or 2 jets	5210432 ± 11114	51150 ± 57	28628 ± 41	639292 ± 2143	1152822 ± 999	3242427 ± 3071	175891 ± 10416
no photon	5082828 ± 10894	50691 ± 57	28363 ± 40	625003 ± 2126	1083224 ± 975	3208169 ± 3055	166431 ± 10192

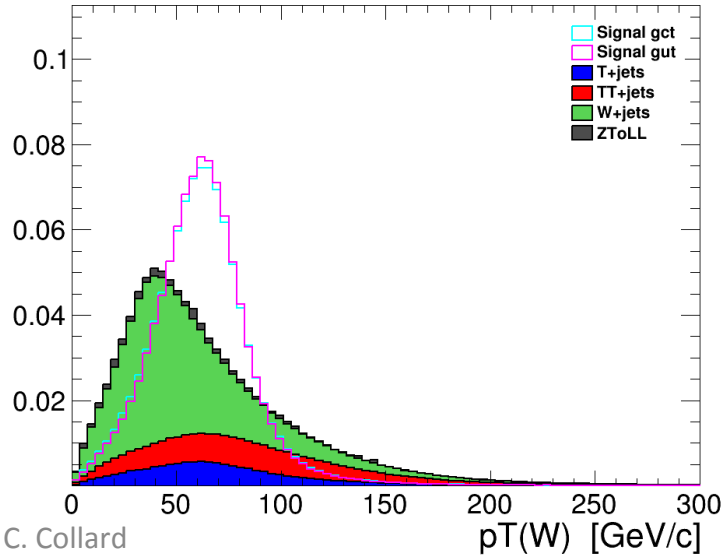
	Yields
Signal gct	50691 ± 57
Signal gut	28363 ± 40
Signal t+H K_{hct}	241 ± 0
Signal t+H K_{hut}	580 ± 1
Signal t+γ K_{act}	862 ± 3
Signal t+γ K_{aut}	270 ± 2
Signal t+γ/inv K_{gct}	494 ± 2
Signal t+γ/inv K_{gut}	354 ± 2
Signal t+inv K_{zct}	59 ± 0
Signal t+inv K_{zut}	591 ± 2
Signal t+inv Z_{zct}	31 ± 0
Signal t+inv Z_{zut}	190 ± 1

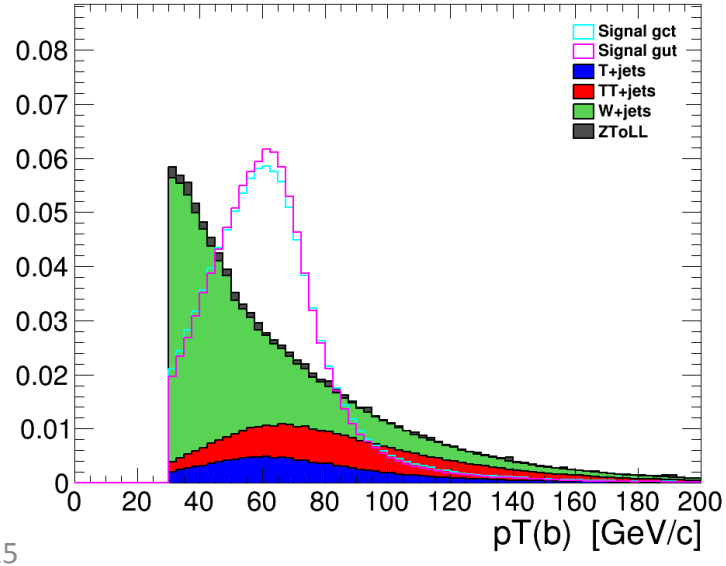
Sig = S/sqrt(S+B)
22.4 for gct,
12.545 for gut

TMVA: BDT

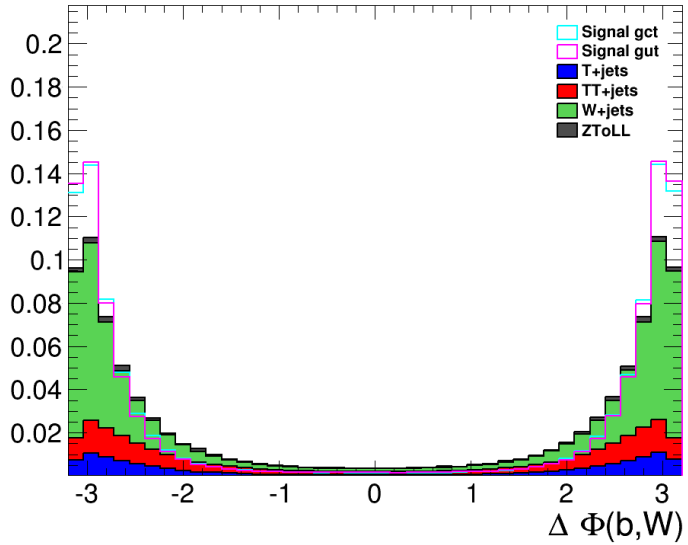

Signal gct
Signal gut
T+jets
TT+jets
W+jets
ZToLL
0.12
0.1
0.08
0.06
0.04
0.02
0
0
100
200
300
400
500
600
M_{top} [GeV/c^2]

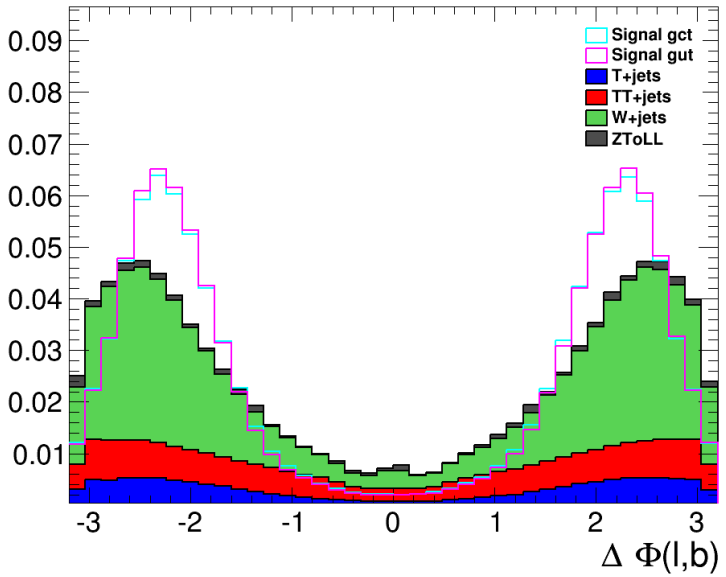

Signal gct
Signal gut
T+jets
TT+jets
W+jets
ZToLL
0.1
0.08
0.06
0.04
0.02
50
60
70
80
90
100
110
120
130
140
150
M_T^W [GeV/c^2]

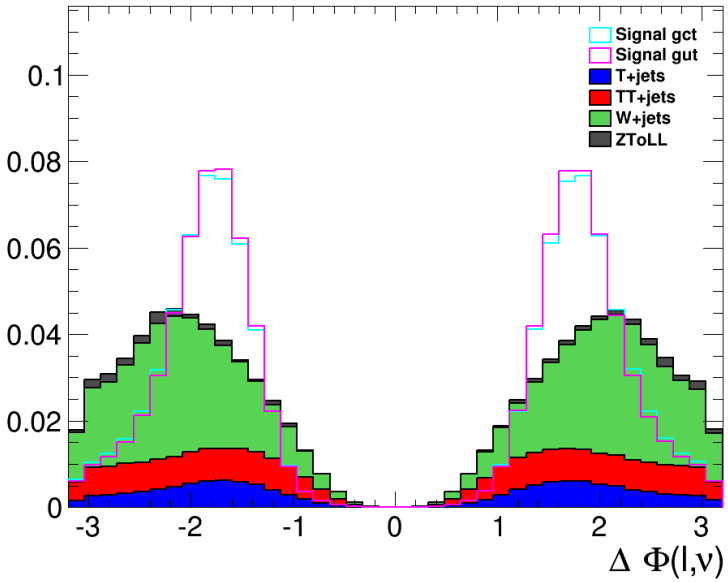

Signal gct
Signal gut
T+jets
TT+jets
W+jets
ZToLL
0.1
0.08
0.06
0.04
0.02
0
50
100
150
200
250
300
pT(W) [GeV/c]

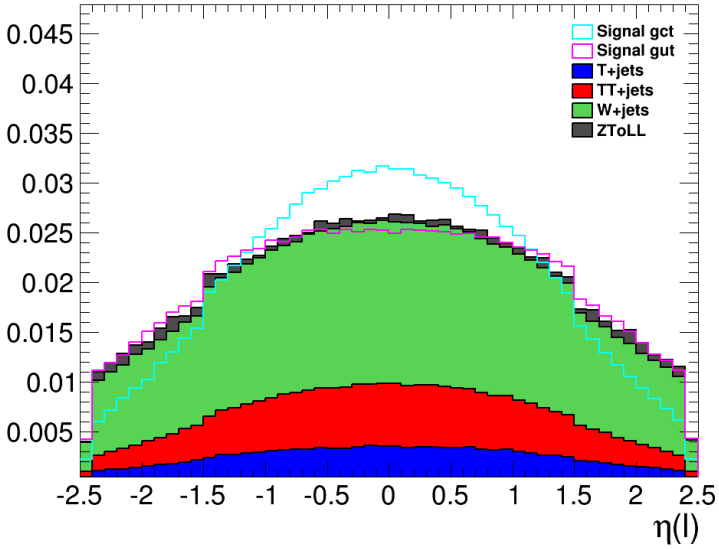

Signal gct
Signal gut
T+jets
TT+jets
W+jets
ZToLL
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
120
140
160
180
200
pT(b) [GeV/c]

TMVA: BDT

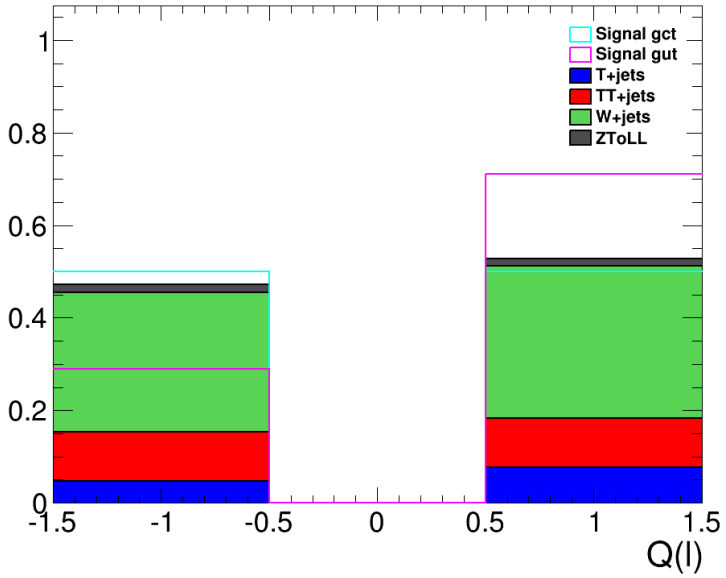

Signal gct
Signal gut
T+jets
TT+jets
W+jets
ZToLL
Δ Φ(b,W)


Signal gct
Signal gut
T+jets
TT+jets
W+jets
ZToLL
Δ Φ(l,b)


Signal gct
Signal gut
T+jets
TT+jets
W+jets
ZToLL
Δ Φ(l,ν)

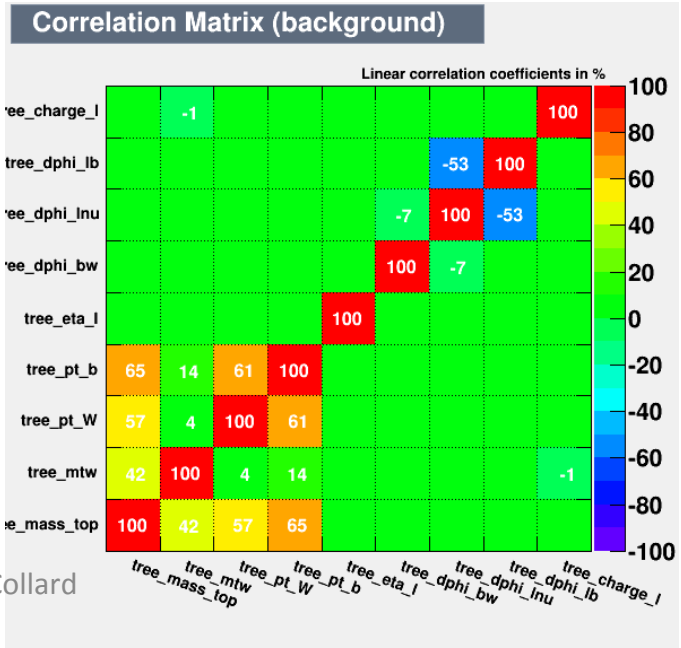

Signal gct
Signal gut
T+jets
TT+jets
W+jets
ZToLL
η(l)

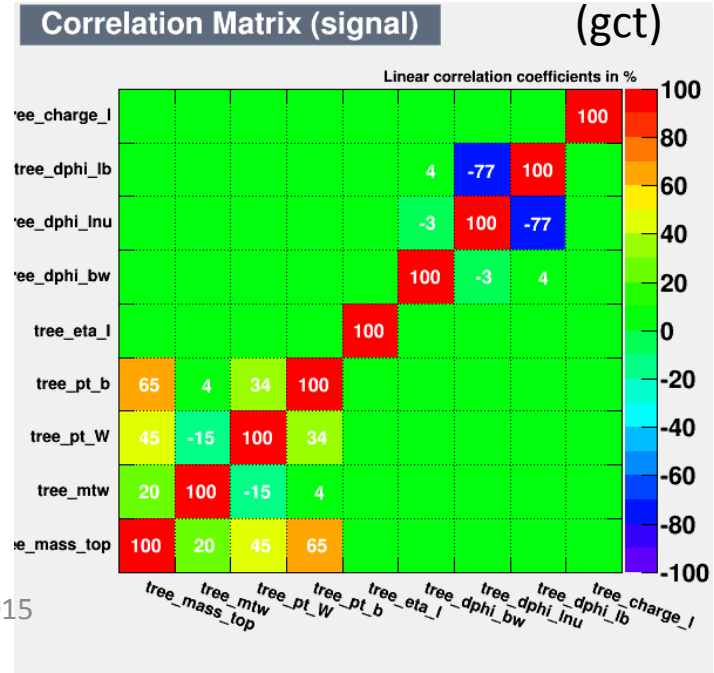
TMVA: BDT



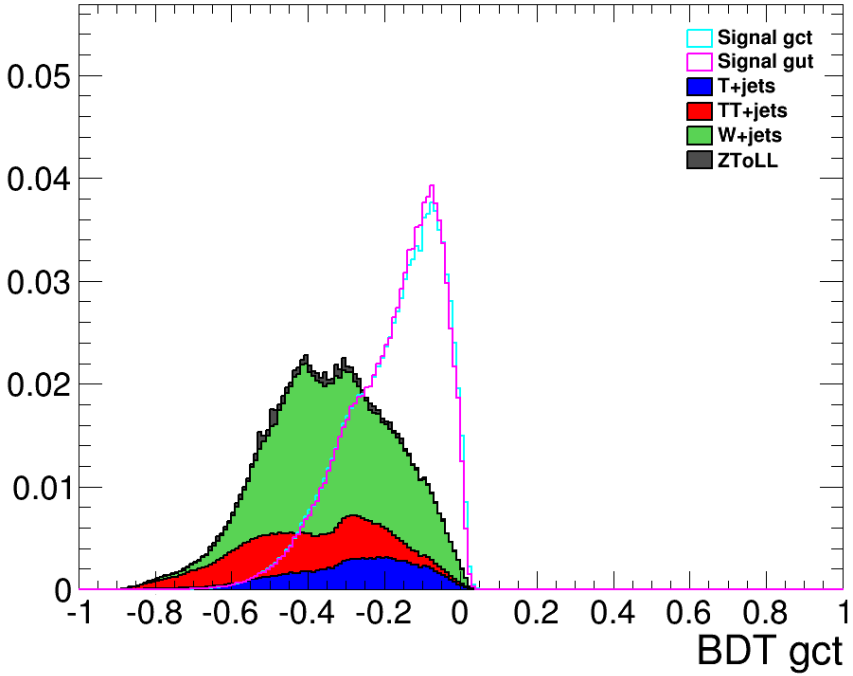
9 variables in BDT

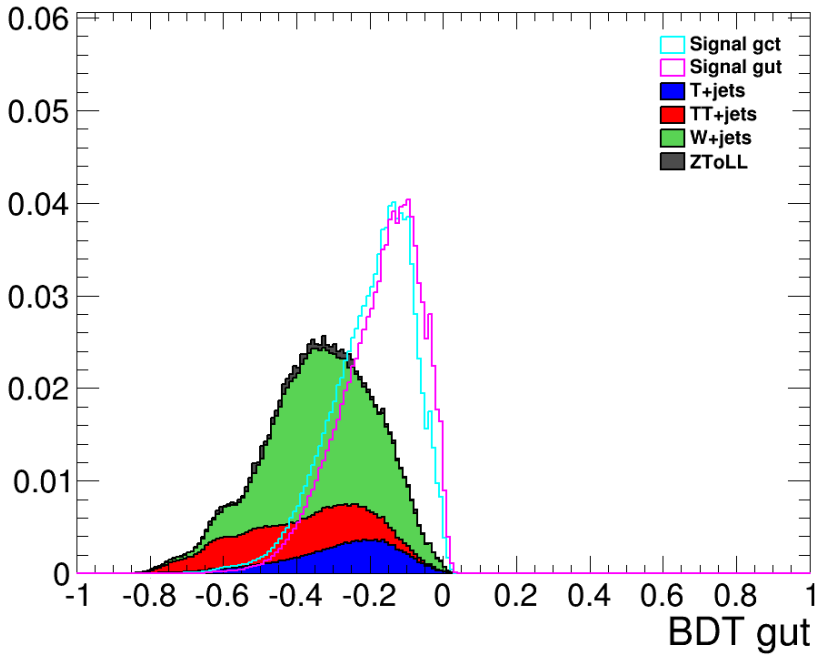
[start from 21 variables. I remove the variables with too large correlations. I keep the most discriminating ones and also the variables which present very different correlations in signal and in background.]





TMVA: BDT





Sig = S/sqrt(S+B)	gct	gut
Cut&Count	22.4	12.5
BDT	30.5	18.5

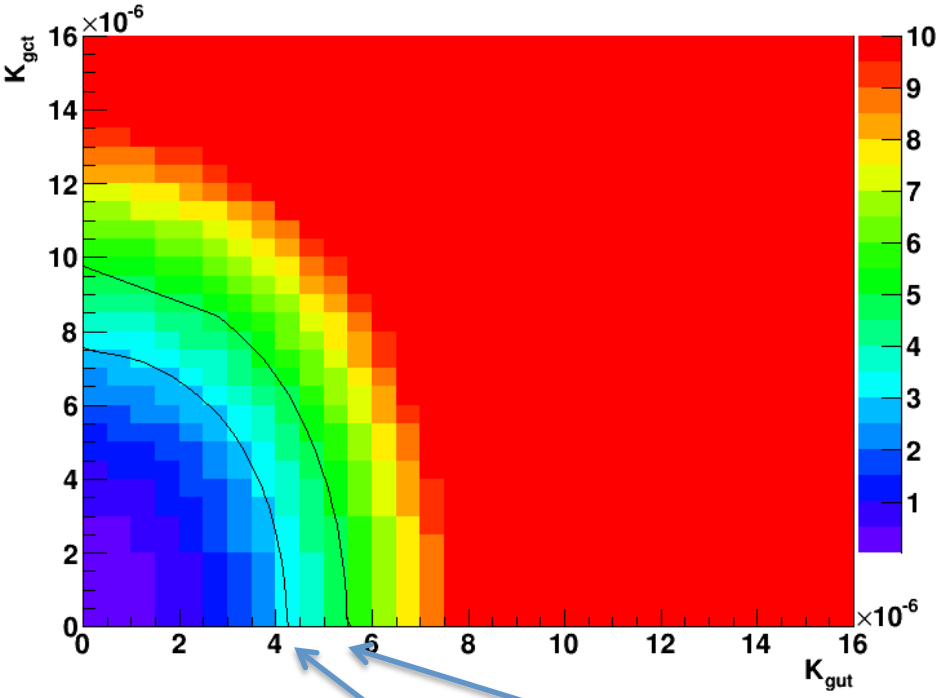
Limits

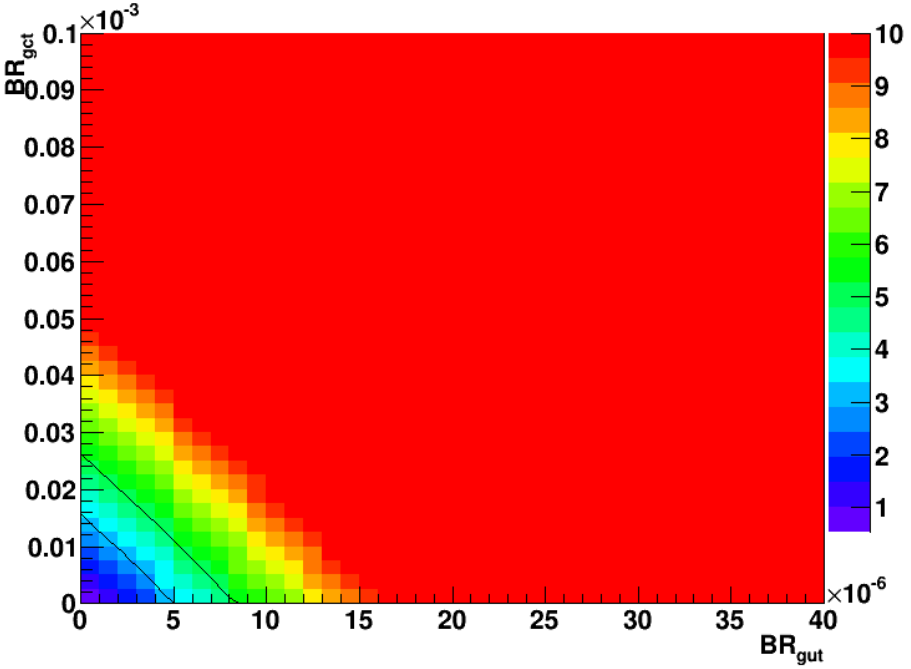
→1D limit values (based on BDT results):

Sig = S/sqrt(S+B)	2sigma,	3 sigma,	5 sigma
K(gut)	3.55e-06	4.25e-06	5.55e-06
K(gct)	6.15e-06	7.55e-06	9.75e-06
BR(gut)	3.5e-06	5.1e-06	8.5e-06
BR(gct)	1.075e-05	1.575e-05	2.625e-05

Acutal limit @8TeV from ATLAS:
BR(gut) < 3.1e-05 (excluded @95%)
BR(gct) < 1.6e-04 (excluded @95%)

Limits





Contours @ 3sigma and 5 sigma

Acutal limit @8TeV from ATLAS:
BR(gut) < 3.1e-05 (excluded @95%)
BR(gct) < 1.6e-04 (excluded @95%)

Limits

→1D limit values (based on BDT results):

Sig = S/sqrt(S+B)	2sigma,	3 sigma,	5 sigma
K(gut)	3.55e-06	4.25e-06	5.55e-06
K(gct)	6.15e-06	7.55e-06	9.75e-06
BR(gut)	3.5e-06	5.1e-06	8.5e-06
BR(gct)	1.075e-05	1.575e-05	2.625e-05

→ Multijet :15% → Sig' = S/sqrt(S + 1.15*B)

Sig’	2sigma	3 sigma	5 sigma
K(gut)	3.65e-06	4.45e-06	5.75e-06
K(gct)	6.35e-06	7.75e-06	1.005e-05
BR(gut)	3.7e-06	5.5e-06	9.1e-06
BR(gct)	1.125e-05	1.675e-05	2.775e-05

Acutal limit @8TeV from ATLAS:
BR(gut) < 3.1e-05 (excluded @95%)
BR(gct) < 1.6e-04 (excluded @95%)

Limits

→1D limit values (based on BDT results):

Sig = S/sqrt(S+B)	2sigma,	3 sigma,	5 sigma
K(gut)	3.55e-06	4.25e-06	5.55e-06
K(gct)	6.15e-06	7.55e-06	9.75e-06
BR(gut)	3.5e-06	5.1e-06	8.5e-06
BR(gct)	1.075e-05	1.575e-05	2.625e-05

→ uncertainty→ Sig'' = S/sqrt(S+ B + (x*B)**2) [with new BDT cut optimization]

Sig''	2sigma	3 sigma	5 sigma	
with x=0.10				
BR(gut)	8.25e-05	0.0001225	0.0002025	
BR(gct)	0.000475	0.000675	0.001125	
with x=0.30				
BR(gut)	0.0002325	0.0003525	0.0005825	<--- limit @2 sigma > actual
BR(gct)	0.001325	0.001925	0.003225	limit by a factor 10 :(

Comparison w/ ATLAS

Different selection: ATLAS@8TeV= exactly 1 jet, tight b-tagging criterium.

- the =1jet is not appropriate in our case (pp->t with up to 1 parton).
- the tight b-tagging criteria leads to a similar significance than using the medium b-tagging criteria →no improvement on the pheno side, but a tighter cut will certainly help in reducing the remaining multijet background in the experimental life.

Different choice of variables for MVA: ATLAS= pT(b), pT(W), Delta Phi (W, MET) in the top rest frame, Q(l), eta(l), Delta Phi (l, b), eta(top), Delta Phi (l, W), Delta Phi (b, top), Delta Phi (l, top), Delta Phi (W, top), MET, eta(nu).

- Using ATLAS's set of variables on top of my selection leads to significance of 28.8 for gct and 17.2 for gut, which is a bit lower than the values obtained with a BDT trained over the 9 variables on slide 7 (with the mass(top) having the best ranking in both gct and gut scenarios).

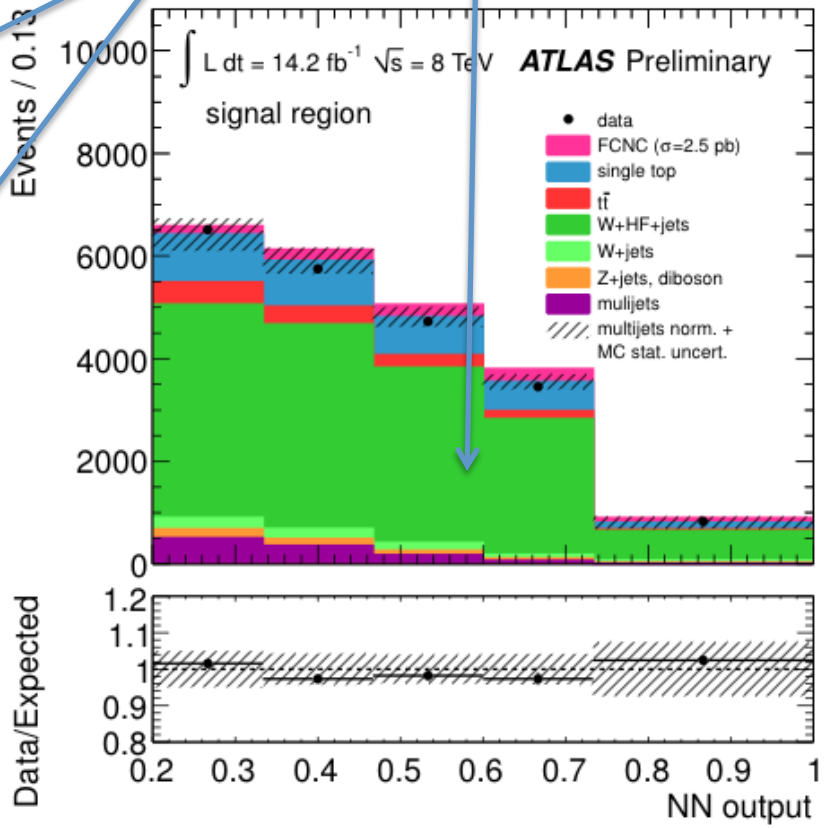
Comparison w/ ATLAS

Table 4: Uncertainties on the number of expected candidate events on each signal and background source for the systematic variations explained in Section 5.

Systematic	Signal	W+jets	W+HF+jets
Jet energy scale	< ±1%	±13%	±3%
Jet energy resolution	±4%	±20%	±3%
b-tagging efficiency	±5%	±1%	±1%
c-tagging efficiency	< ±1%	±3%	±20%
Mistag rate	< ±1%	±26%	< ±1%
Muon momentum scale	< ±1%	< ±1%	< ±1%
Muon identification	±1%	±1%	±1%
Electron energy scale	< ±1%	< ±1%	< ±1%
Electron identification	±1%	±1%	±1%
Missing transverse momentum	< ±1%	< ±1%	< ±1%
PDF	±3%	±4%	±8%
W+jets modelling	—	< ±1%	< ±1%
Cross section	—	24%	55%

Systematic	$t\bar{t}$	single-top	Z + jets
Jet energy scale	±13%	±4%	±4%
Jet energy resolution	±1%	±2%	±6%
b-tagging efficiency	±5%	±5%	±4%
c-tagging efficiency	< ±1%	< ±1%	±5%
Mistag rate	< ±1%	< ±1%	±3%
Muon momentum scale	< ±1%	< ±1%	< ±1%
Muon identification	±1%	±1%	±1%
Electron energy scale	< ±1%	< ±1%	< ±1%
Electron identification	±1%	±1%	< ±1%
Missing transverse momentum	< ±1%	< ±1%	±3%
PDF	±4%	±2%	±5%
ISR/FSR	±3%	±5%	—
Cross section	8%	10%	24%

Larger background is W+HF



(hatched = stat error + multijet norm uncert)