Top FCNC at FCC-hh

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on behalf of the study group

FCC-hh physics analysis meeting, 24 May 2017

Top FCNC Search (tqγ and tqg)

OC, H.Denizli, A.Senol, A.Yilmaz, I.Turk Cakir, FCC-hh PA2017

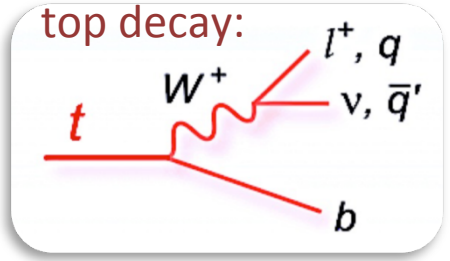
Process: pp→W±bγ+X

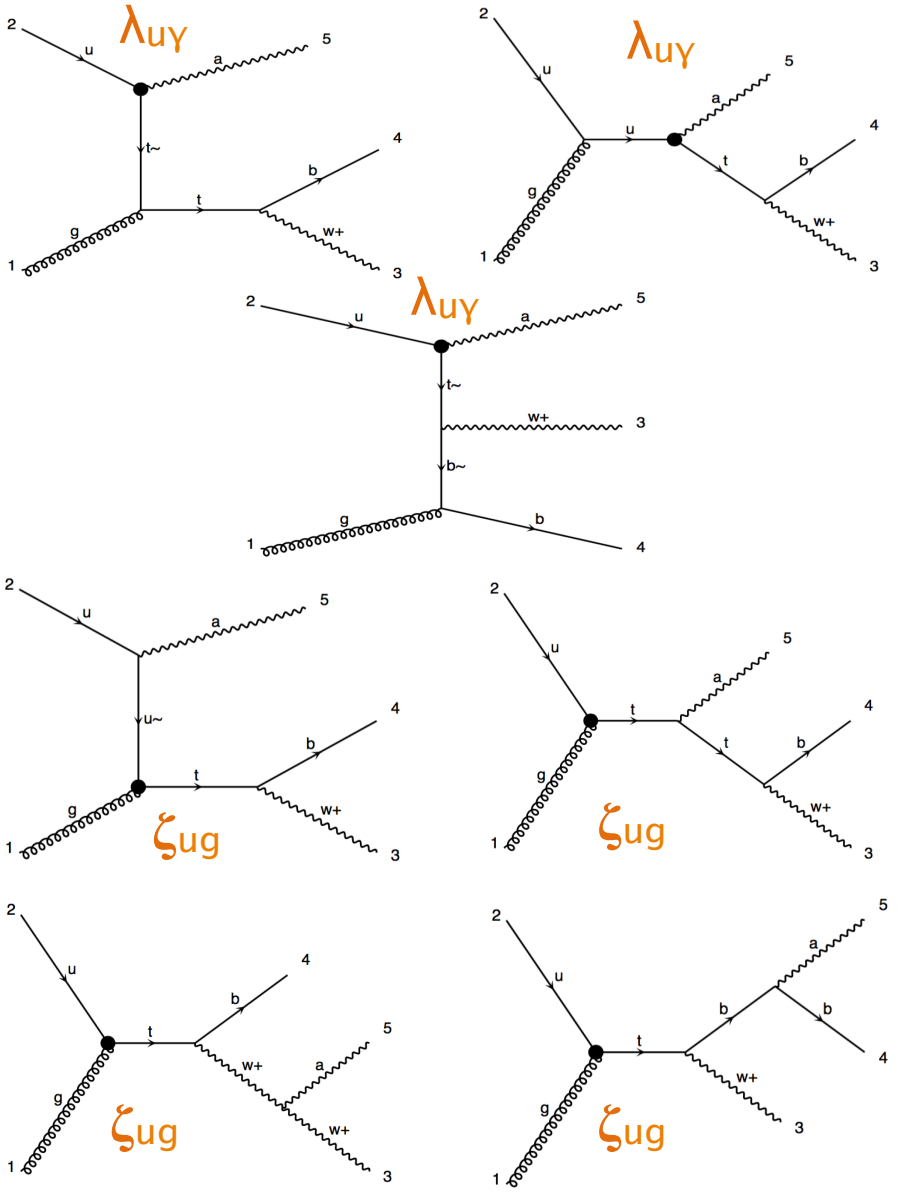
with off-shell top quark, further decays W±→hadronic / leptonic

- Taking $\lambda_{q\gamma}^{L}=\lambda_{q\gamma}^{R}$ and $\zeta_{qg}^{L}=\zeta_{qg}^{R}$, we have four couplings $\lambda_{u\gamma}$, $\lambda_{c\gamma}$, ζ_{ug}, ζ_{cg}.
- Cross section: 15.14 pb for $\lambda_{q\gamma}=0.01$ and $\zeta_{qg}=0.01$ at FCC-hh.

Signal: Wbγ *- two channels:*

- *photon+1bjet+2jets (hadronic)*
- *photon+1bjet+1l+MET (single lepton)*

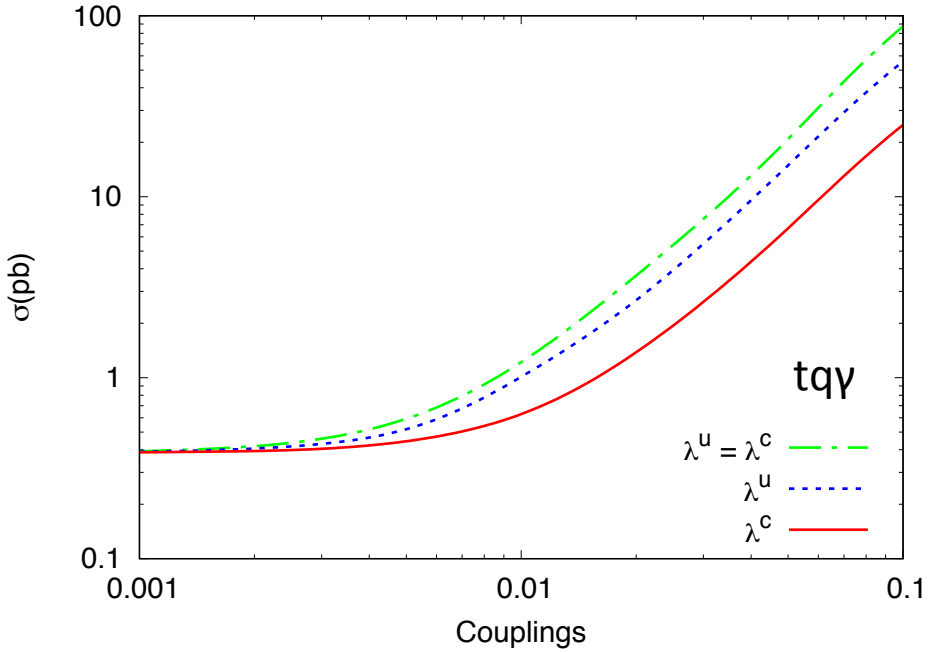


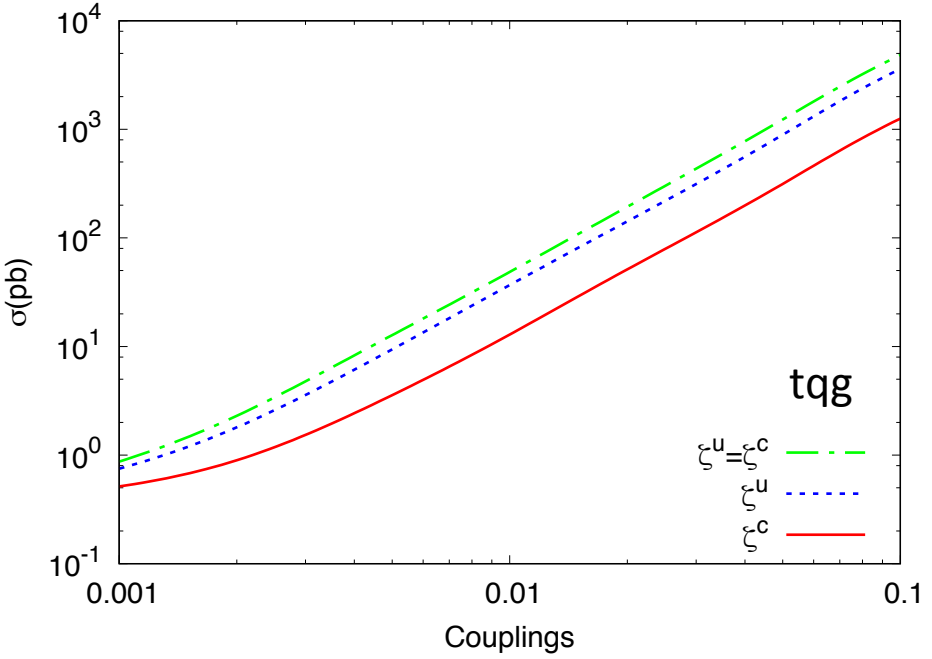


+ similar diagrams for tcγ and tcg vertices

Top Effective Interactions: JAA-S, NPB812(2009)181

Top FCNC Search (tqγ and tqg)

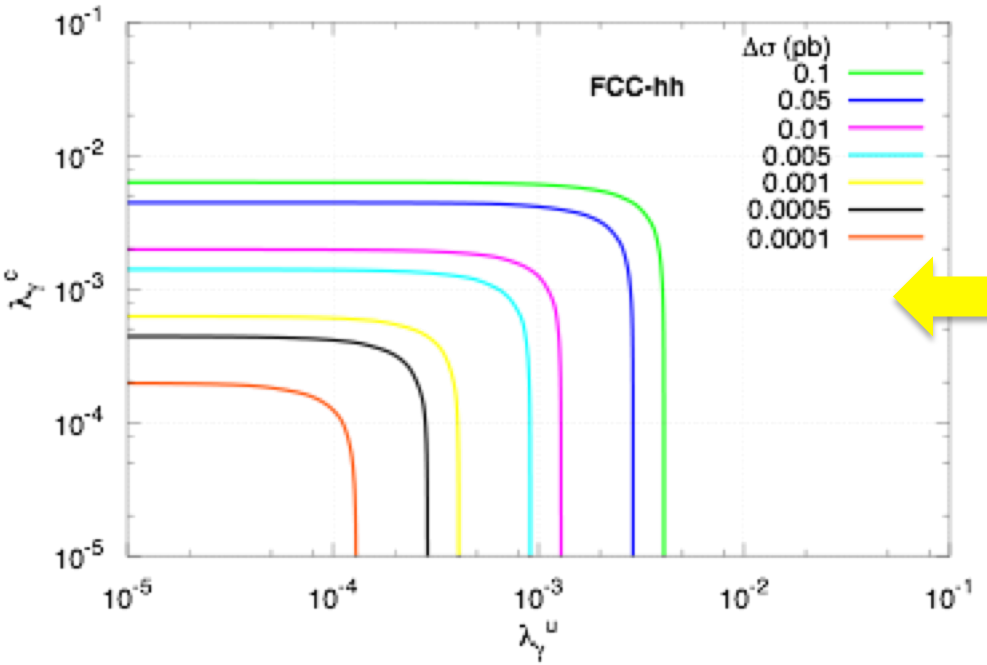




Cross sections depending on FCNC couplings, here process pp→Wbγ includes both signal and interfering background.

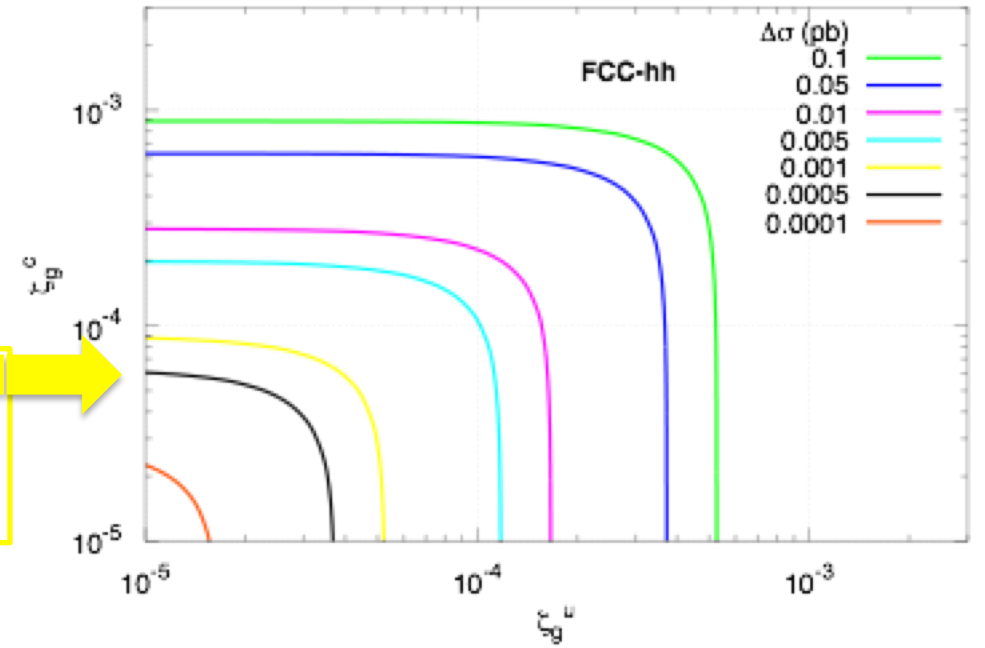
Top FCNC Search (tqγ and tqg)

Contour plot of tqγ and tqg couplings for the cross section of the process pp->Wbγ+X.



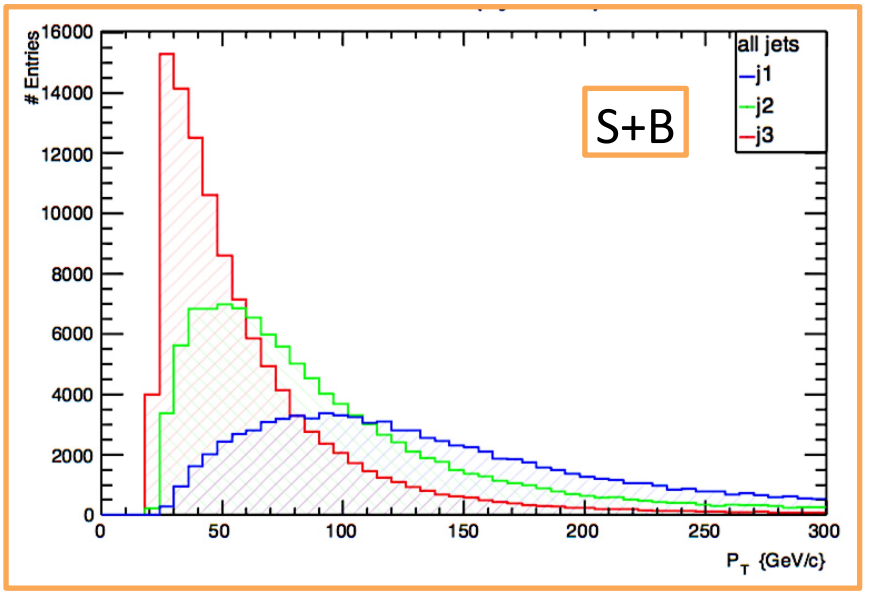
As a reference value of signal cross section is taken as 0.5 fb, then branching x eff x luminosity gives 6.6 events / year with 100/fb, at this value of signal cross section the corresponding FCNC coupling λ_u=3.5x10^{-4} and λ_c=5x10^{-4}, which presents more sensitivity to λ_u at FCC-hh.

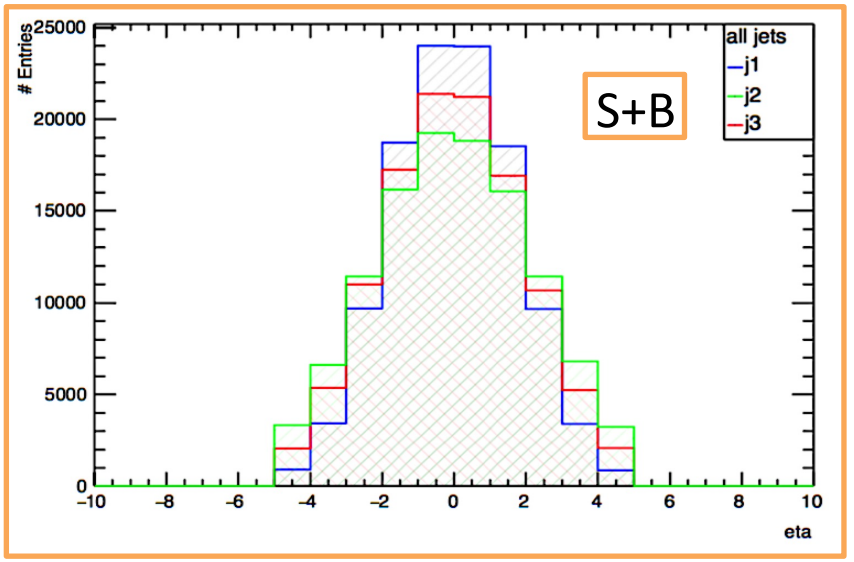
For similar case, the corresponding FCNC coupling ζ_u=3.5x10^{-5} and ζ_c=6x10^{-5}, which presents more sensitivity to ζ_u at FCC-hh.

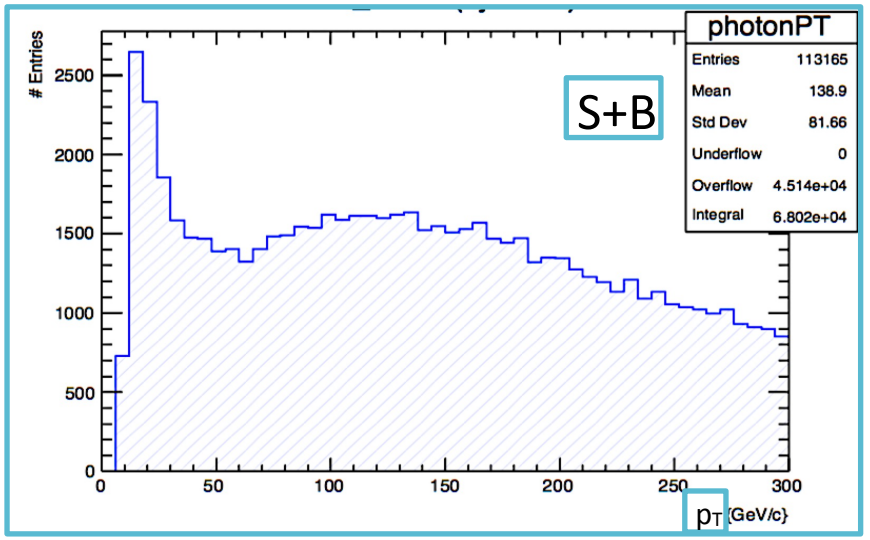


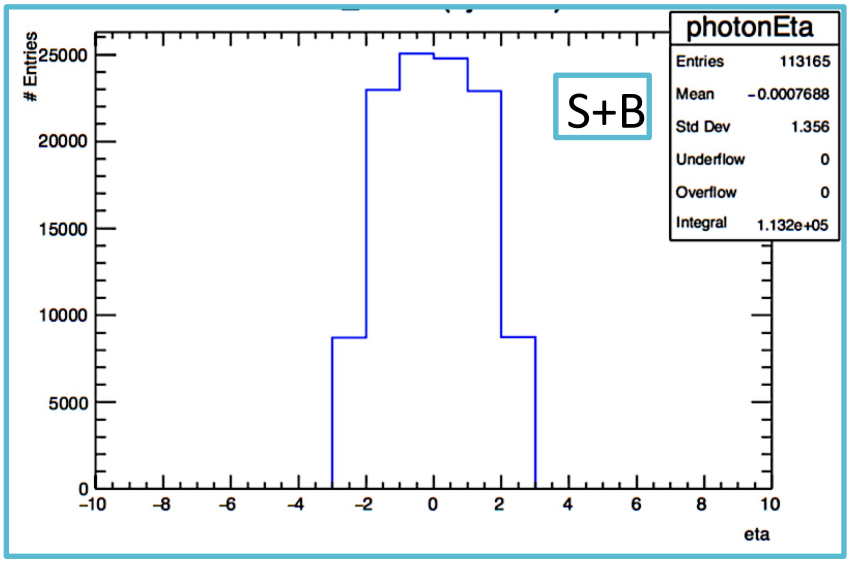
Distributions (W(→2j)bγ, λ=0.01)

Hadronic channel







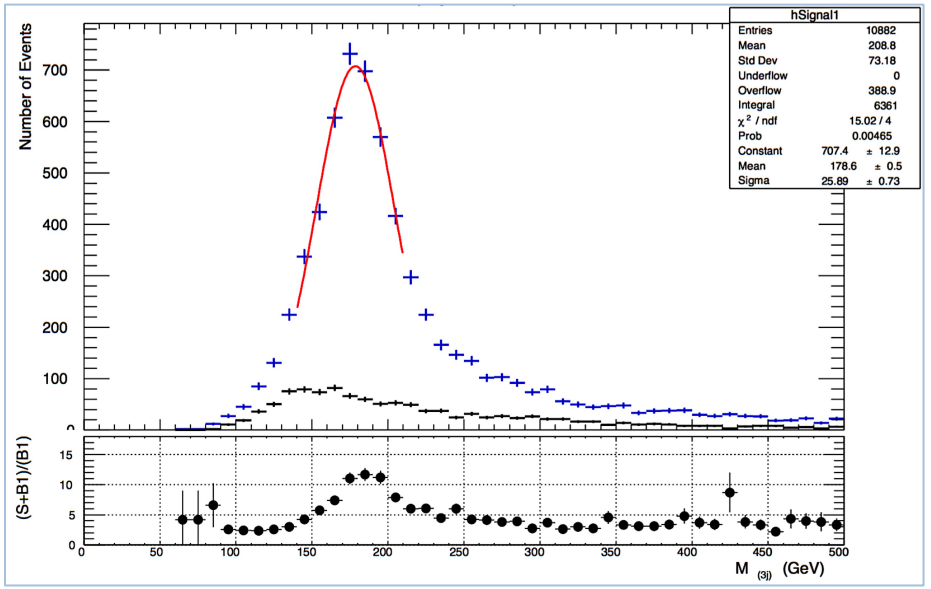


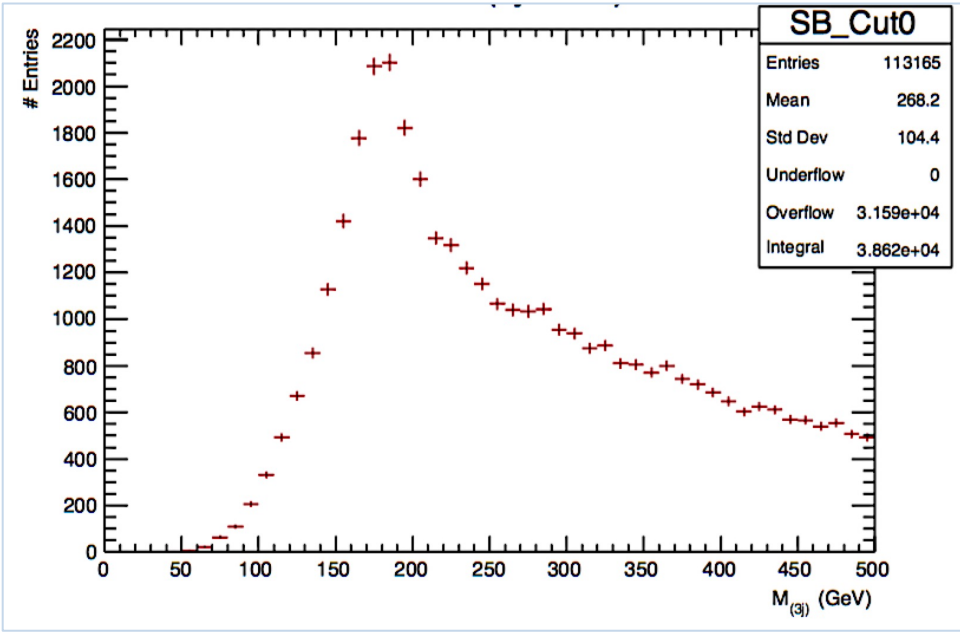
Invariant mass m_{bjj} distribution

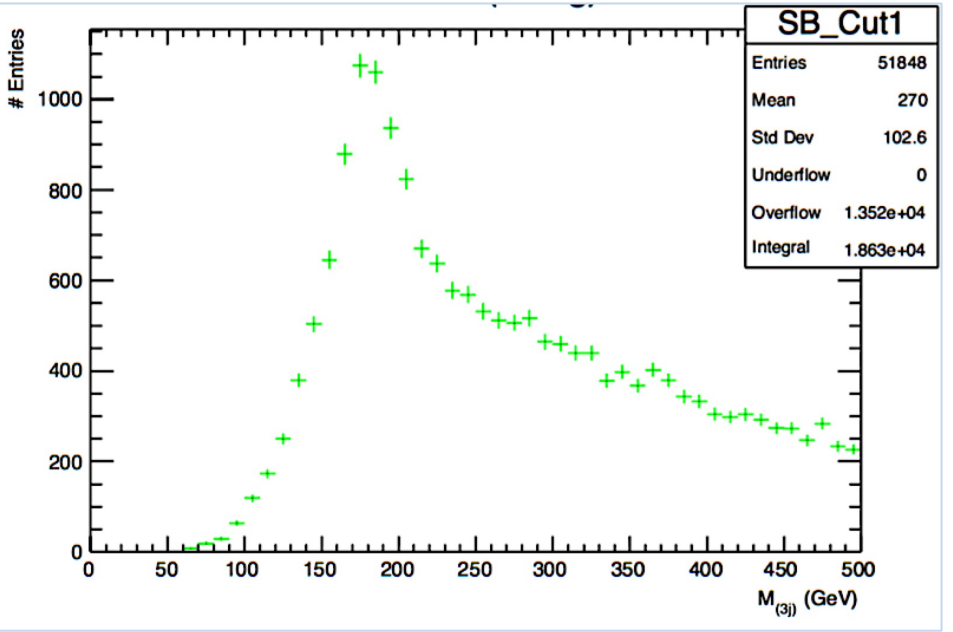
Hadronic channel

Event selection and cuts:

Cut-0: number of jets>2, photon>0
Cut-1: 1 b-tag
Cut-2: $p_T(j)>30$ GeV, $p_T(\gamma)>30$ GeV
Cut-3: $|\eta(j)|<2.5$, $|\eta(\gamma)|<2.5$
Cut-4: W mass range ($50<m_{jj}<110$ GeV)
Cut-5: top mass range ($100<m_{jjj}<220$ GeV)

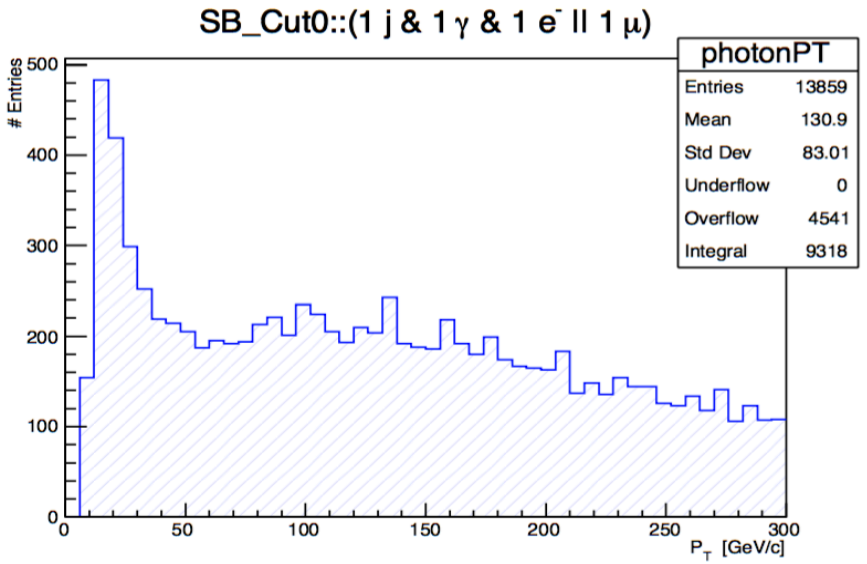


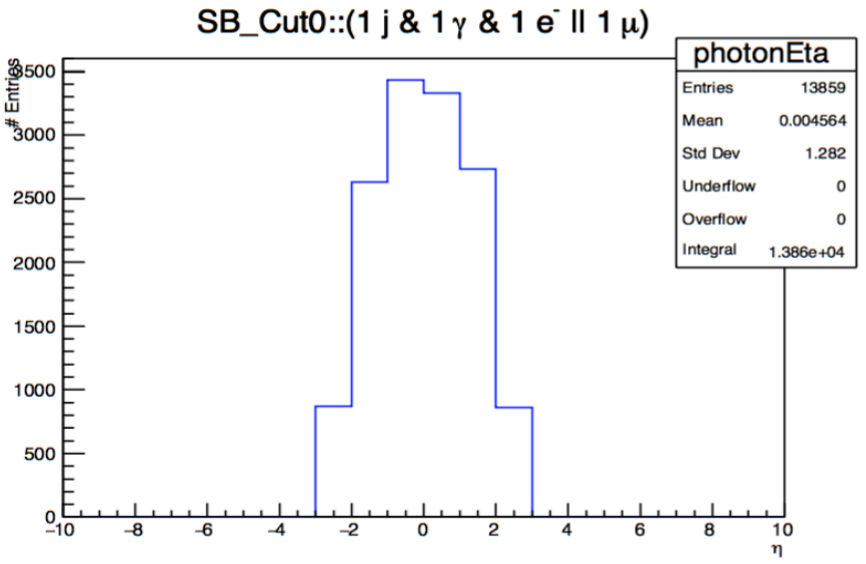


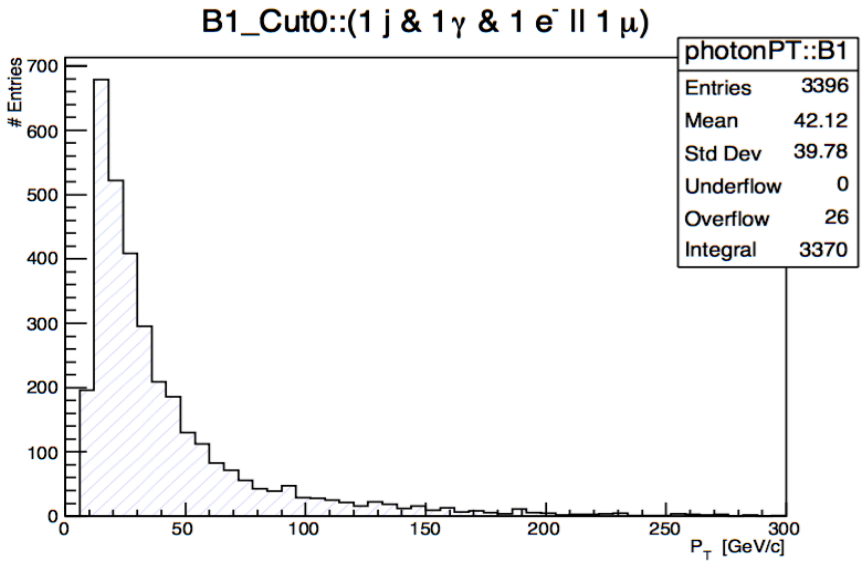


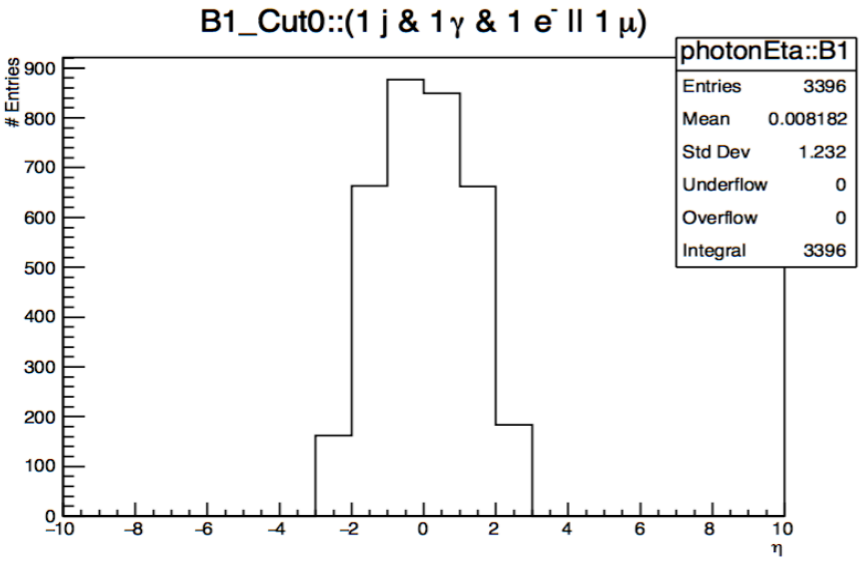
Distributions (W(→lν)bγ, λ=0.01)

Leptonic channel









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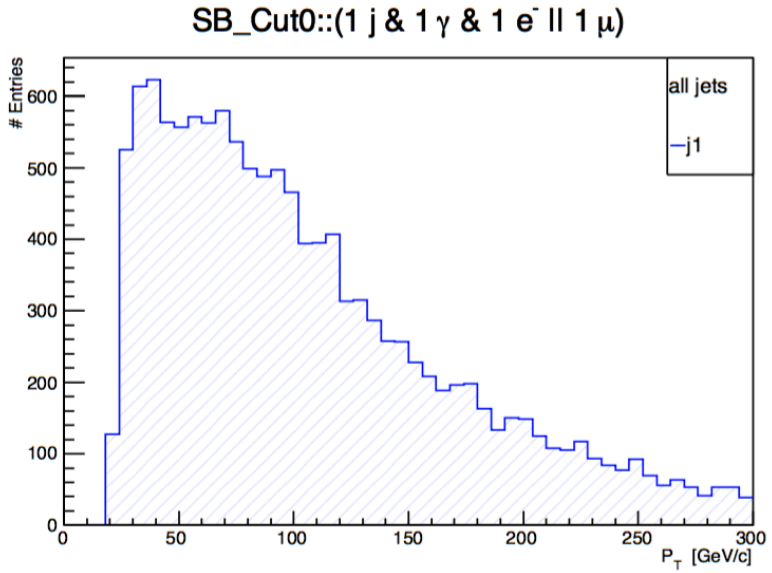

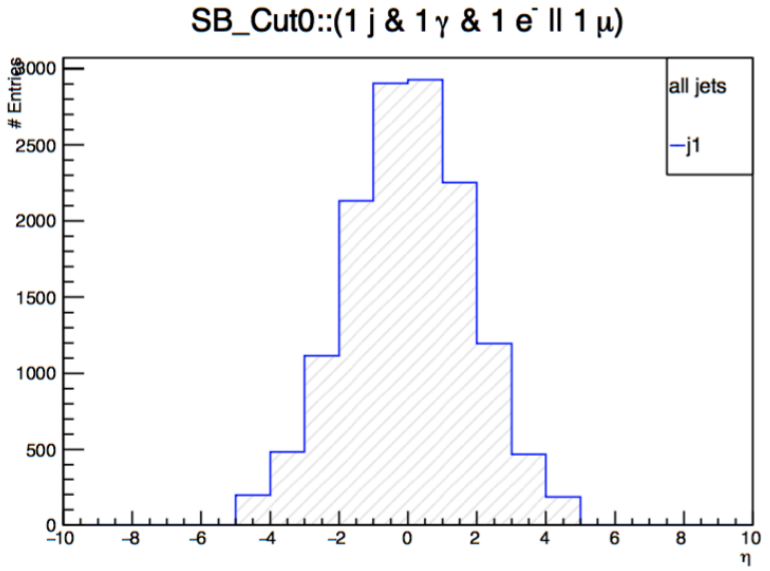

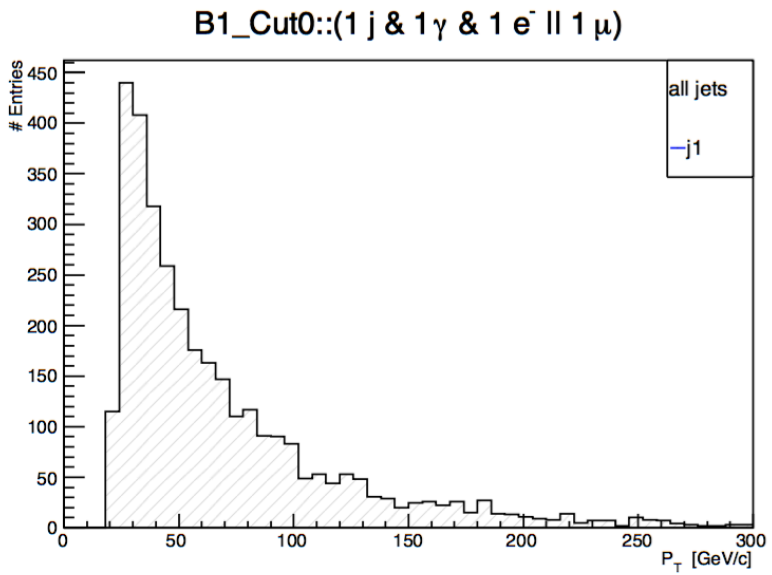

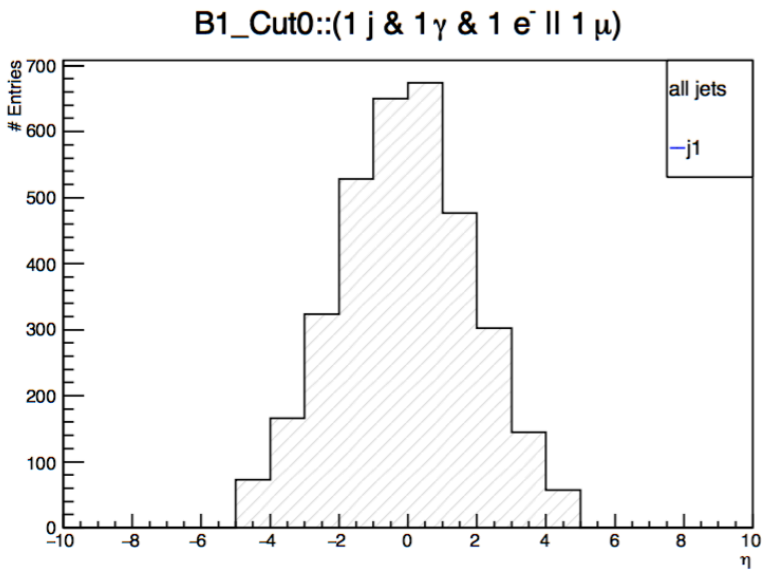

Distributions (W(→lν)bγ, λ=0.01)

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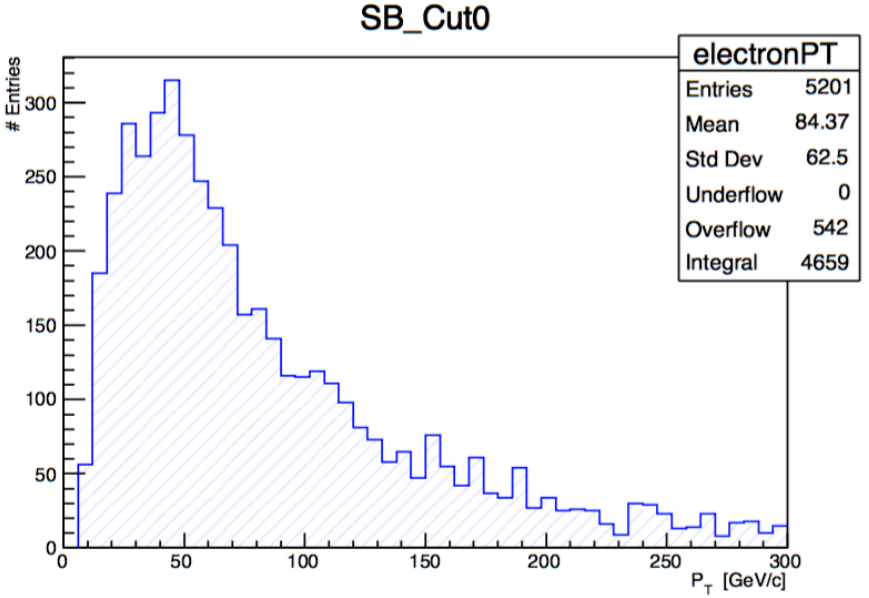
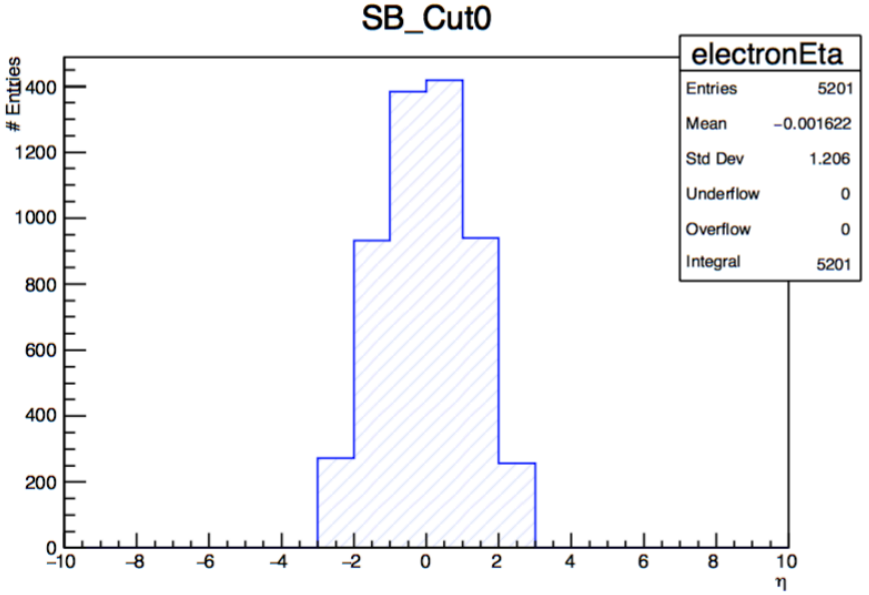
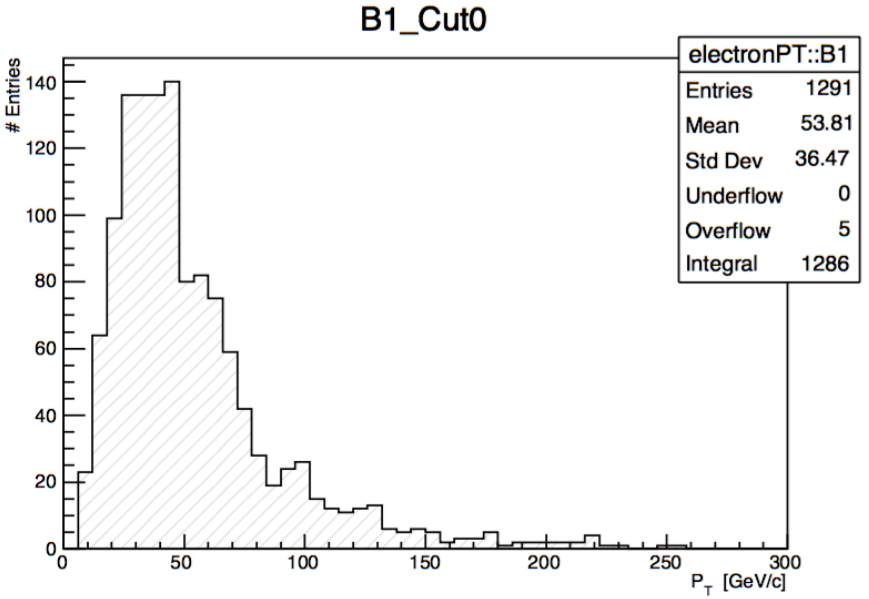
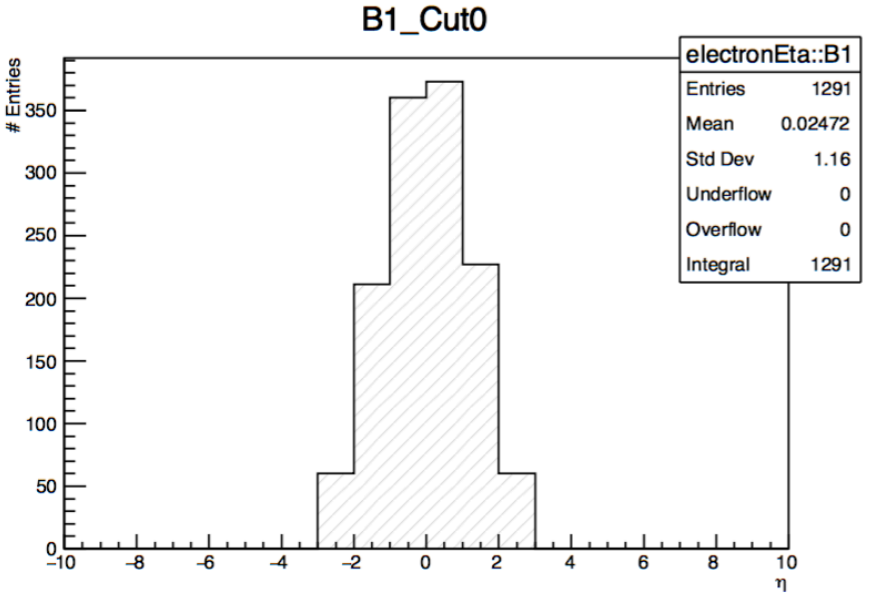






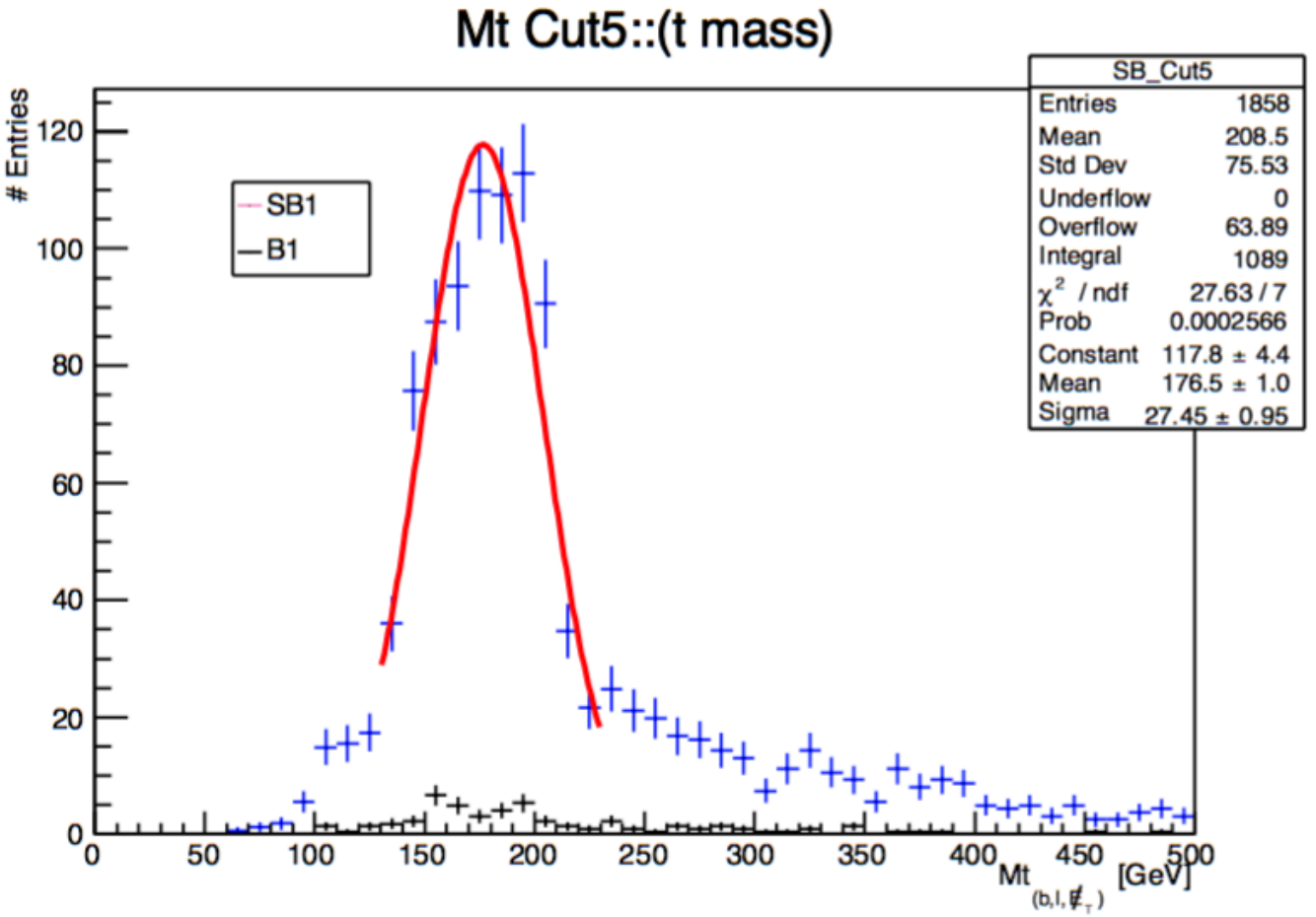


Invariant mass m_{blv} distribution

Number of events after cut-5:
(Lint = 100/fb)

Hadronic channel:
N(S+B) = 5070
N(B) = 380
S/√S+B = 65.8

Single lepton channel:
N(S+B) = 2736
N(B) = 202
S/√S+B = 48.4



Top FCNC "tug" and "tcg" Searches at FCC-hh

M.Perfilov *et al.*
FCChh PA 2017

Effective tgq Interaction

Process: pp→tj+X

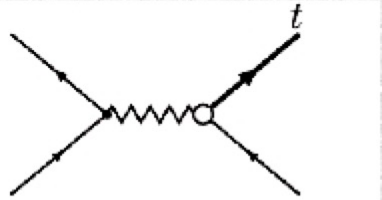
$$\frac{k_f}{\Lambda} g_s \bar{f} \sigma^{\mu\nu} \frac{\lambda^a}{2} t G^a_{\mu\nu}$$

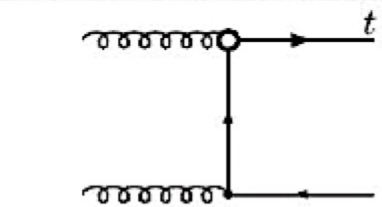
G: gauge field tensor of gluon

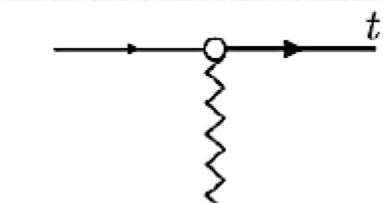
κ : strength of *tug* or *tcg* couplings

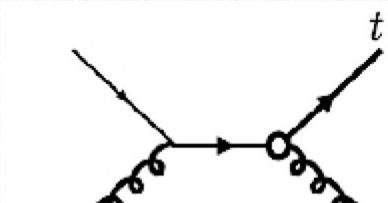
Λ: scale of new physics ← related to the mass cutoff above which the effective theory breaks down

- **Wbj** (representative diagrams)









- Top FCNC@LHC searches: constraints on FCNC parameters

CMS

$k_{tug}/\Lambda < 4.1 \times 10^{-3}$,

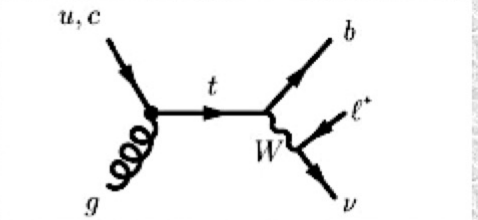
$k_{tcg}/\Lambda < 1.8 \times 10^{-2}$

JHEP 02 (2017) 028

ATLAS EXPERIMENT

$k_{tug}/\Lambda < 5.8 \times 10^{-3}$,

$k_{tcg}/\Lambda < 1.3 \times 10^{-2}$



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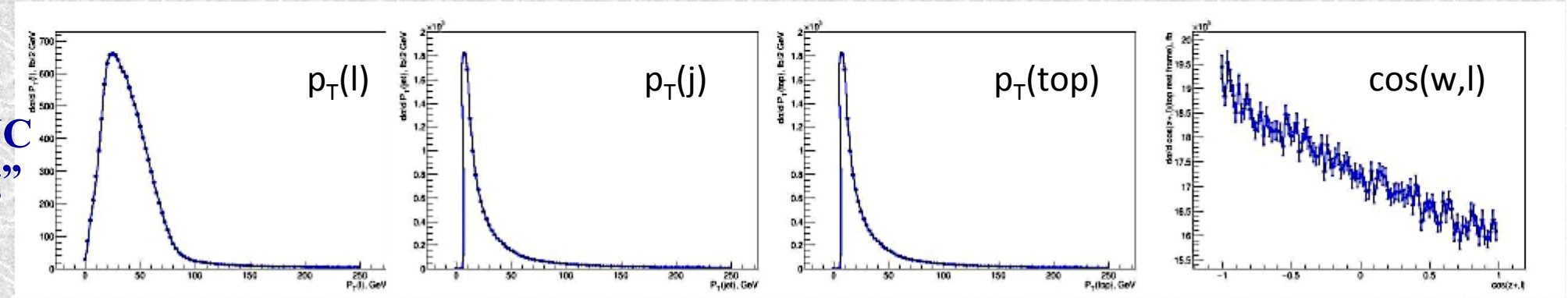
FCNC "tug" and "tcg" Searches at FCC-hh

M.Perfilov *et al.*
FCChh PA 2017

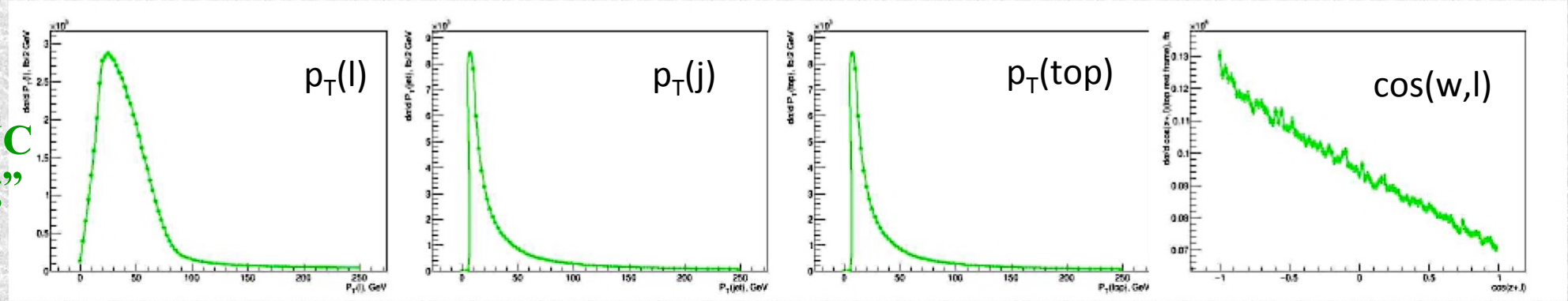
- CompHEP-based generators:
  - two event samples for values of FCNC parameters:
  - all necessary diagrams $k^u/\Lambda = 0.03$ TeV^{-1} , $k^c/\Lambda = 0.03$ TeV^{-1}
  - samples with other FCNC coupling values can be obtained with the quadratic normalization of the existing samples to the new values

➢ Representative distributions

FCNC "tcg"



FCNC "tug"



Top FCNC Searches at FCC-hh: Outlook

For process pp->Wbγ+X, we generate the events with MadGraph5, hadronization and decays within Pythia8, and fast simulation with Delphes 3.4. We have the cross sections and kinematical distributions of jets, electron, muon, MET and photon. Here, we take W+bjet+photon as the main background. We estimate that the FCNC couplings down to $\lambda_{q\gamma}=10^{-3}$ and $\zeta_{qg}=10^{-4}$ can be probed at the FCC-hh.

For process pp→tj+X, CompHEP-based MC generators are prepared for FCNC “tgc” and “tgu” searches at FCC-hh. This can significantly improve the constraints on “tgu” and “tgc” FCNC couplings. After event generation further processing has been performed with Delphes to simulate detector response. For this process, an estimation of the background and systematic uncertainties are necessary to provide a better sensitivity.