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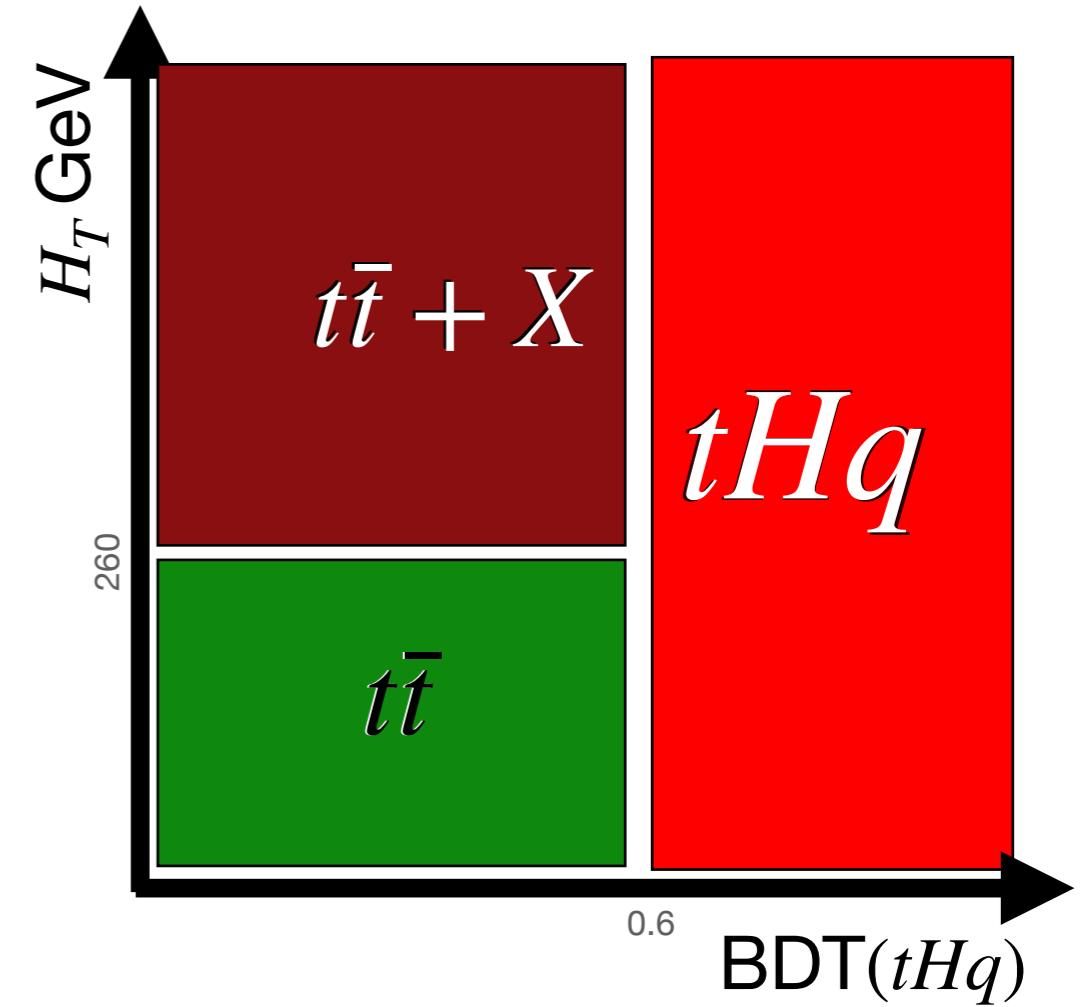
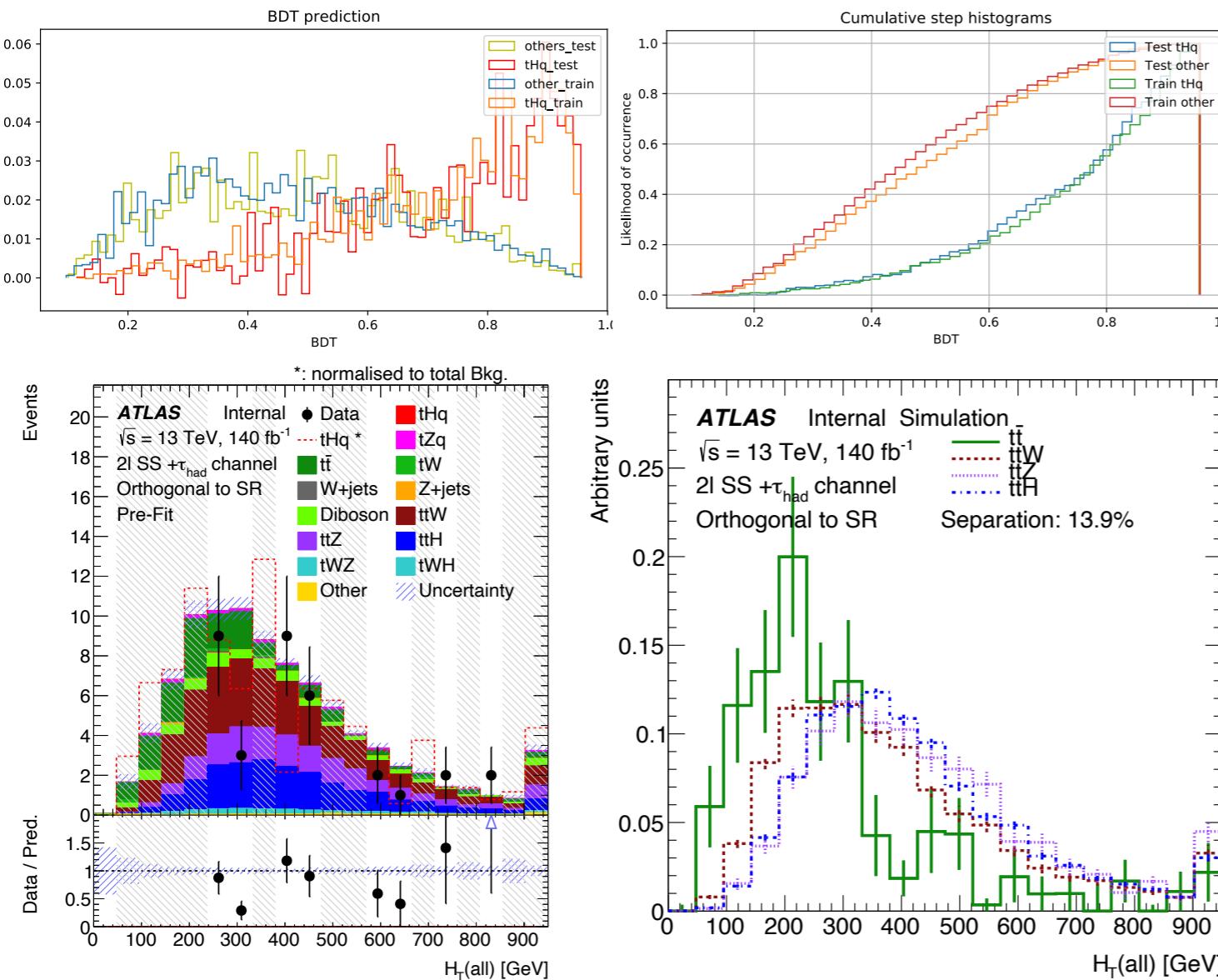
HTop tH meeting

Discussing the fit strategy for $t\bar{H}q \ 2\ell(SS) + \tau_{had}$



Regions

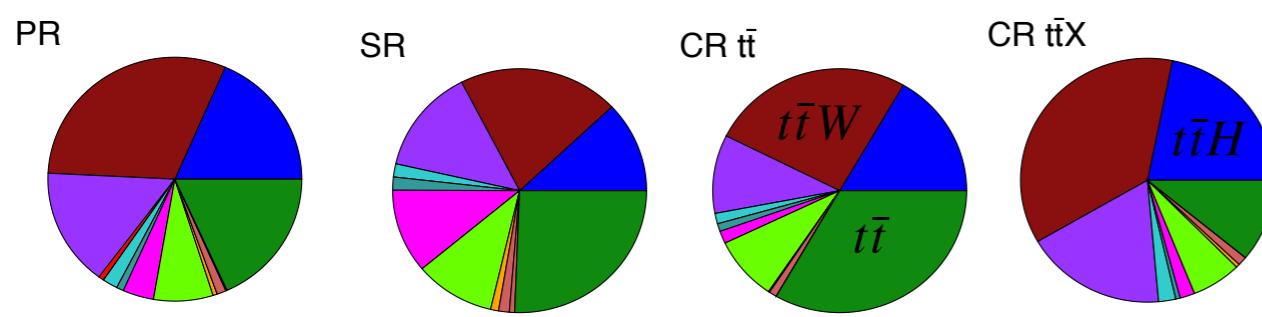
- Preliminary region definitions cutting in $BDT(tHq)$ and H_T



Regions

- Cuts on the variables related to the number of jets are explored to clean the VR($t\bar{t}$) from $t\bar{t}W$ events

	PR	SR	CR($t\bar{t}$)	CR ($t\bar{t}X$)
tHq	1.22 ± 0.31	0.86 ± 0.22	0.102 ± 0.029	0.26 ± 0.06
tWH	0.95 ± 0.21	0.20 ± 0.04	0.104 ± 0.026	0.65 ± 0.13
tWZ	2.6 ± 1.7	0.5 ± 0.5	0.34 ± 0.32	1.7 ± 1.4
$t\bar{t}$	24.8 ± 0.9	8.0 ± 0.4	8.1 ± 0.5	8.71 ± 0.33
$t\bar{t}W$	42 ± 29	6 ± 5	6 ± 4	29 ± 21
$t\bar{t}Z$	21 ± 9	4 ± 4	2.5 ± 1.7	14 ± 6
$t\bar{t}H$	25 ± 9	4 ± 4	4.0 ± 2.0	17 ± 7
tZq	5.4 ± 1.4	3.5 ± 2.8	0.4 ± 0.8	1.5 ± 1.6
tW	1.2 ± 1.0	0.5 ± 1.0	0.25 ± 0.19	0.5 ± 0.4
$Z+jets$	0.73 ± 0.08	0.32 ± 0.05	0.037 ± 0.012	0.373 ± 0.019
Diboson	10 ± 6	3.2 ± 1.8	2.1 ± 1.2	5.0 ± 3.4
minor bkgs	1.6 ± 0.9	0.43 ± 0.24	0.24 ± 0.13	0.9 ± 0.5
Total background	137 ± 34	32 ± 8	25 ± 5	80 ± 24

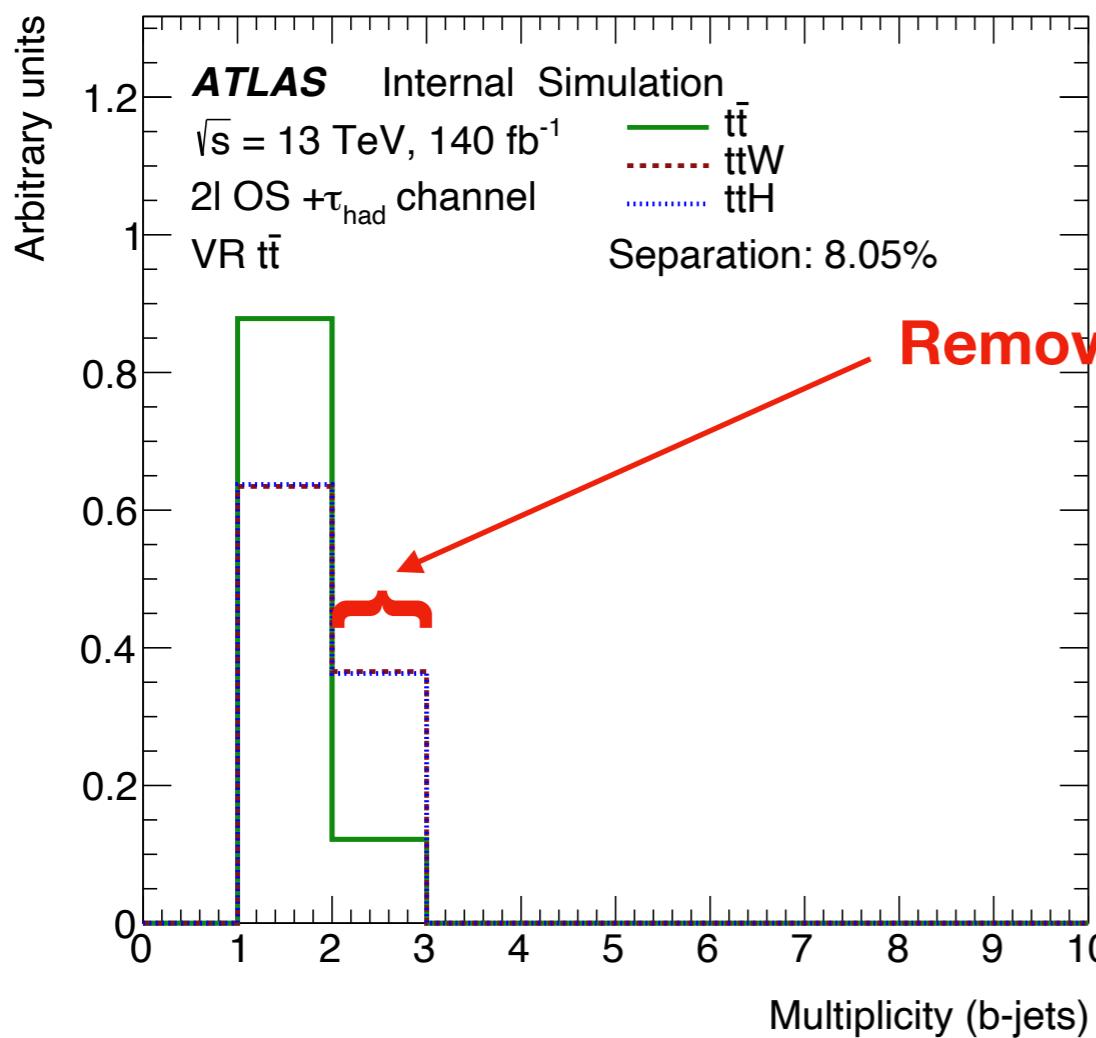


tHq
 tZq
 tt
 tW
 W+jets
 Z+jets
 Diboson
 ttW
 ttZ
 ttH
 tWZ
 tWH
 Other

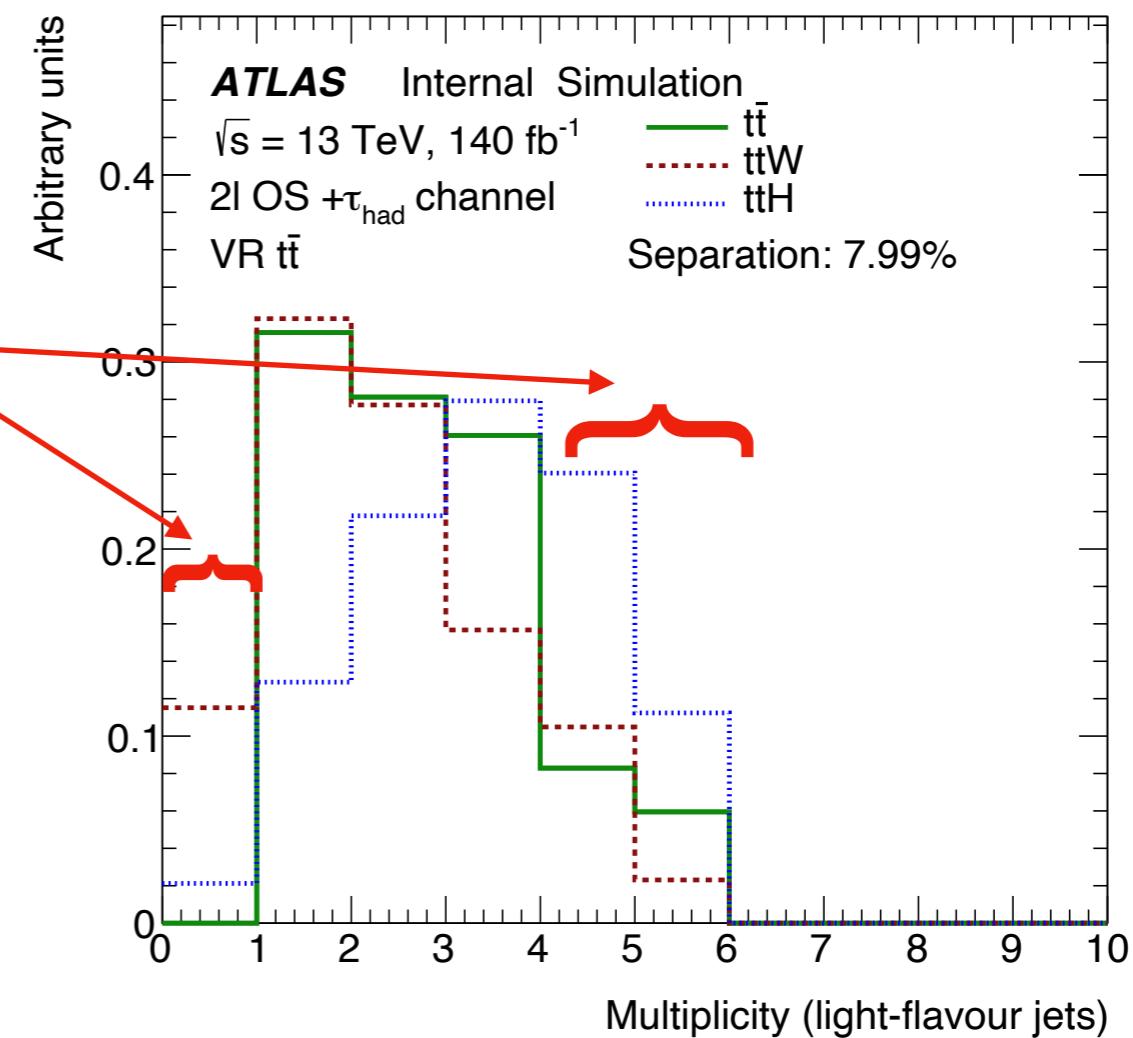
Region: SR_BDT_tHq	Type: SIGNAL	Type: CONTROL	Type: CONTROL
	DataType: DATA	DataType: DATA	DataType: DATA
	Label: SR	Label: "CR t#bar{t}bar"	Label: "CR t#bar{t}bar{X}"
	VariableTitle: "BDT(tHq)"	VariableTitle: "H_{T} [GeV]"	VariableTitle: "H_{T} [GeV]"
	Variable: bdt_tHq,9,0.65,1	Variable: HT/1000,2,100,260	Variable: HT/1000,3,260,800
	Binning: 0.65,0.75,0.85,1	Binning: 100,210,260	Binning: 260,380,500,800
	Selection: "bdt_tHq>=0.65"	Selection: "bdt_tHq<0.65 && HT/1000<260"	Selection: "bdt_tHq<0.65 && HT/1000>260"

Improving the VR($t\bar{t}$)

- Cuts on the variables related to the number of jets are explored to clean the VR($t\bar{t}$) from $t\bar{t}W$ events



bdt_tHq<0.65 && HT/1000<260

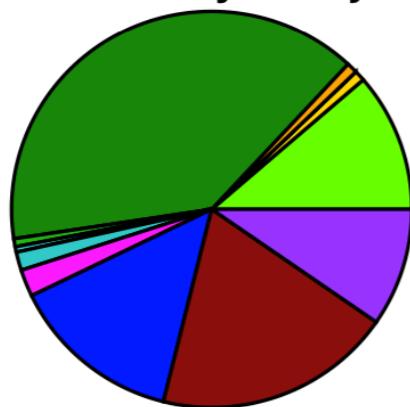


bdt_tHq<0.65 && HT/1000<260

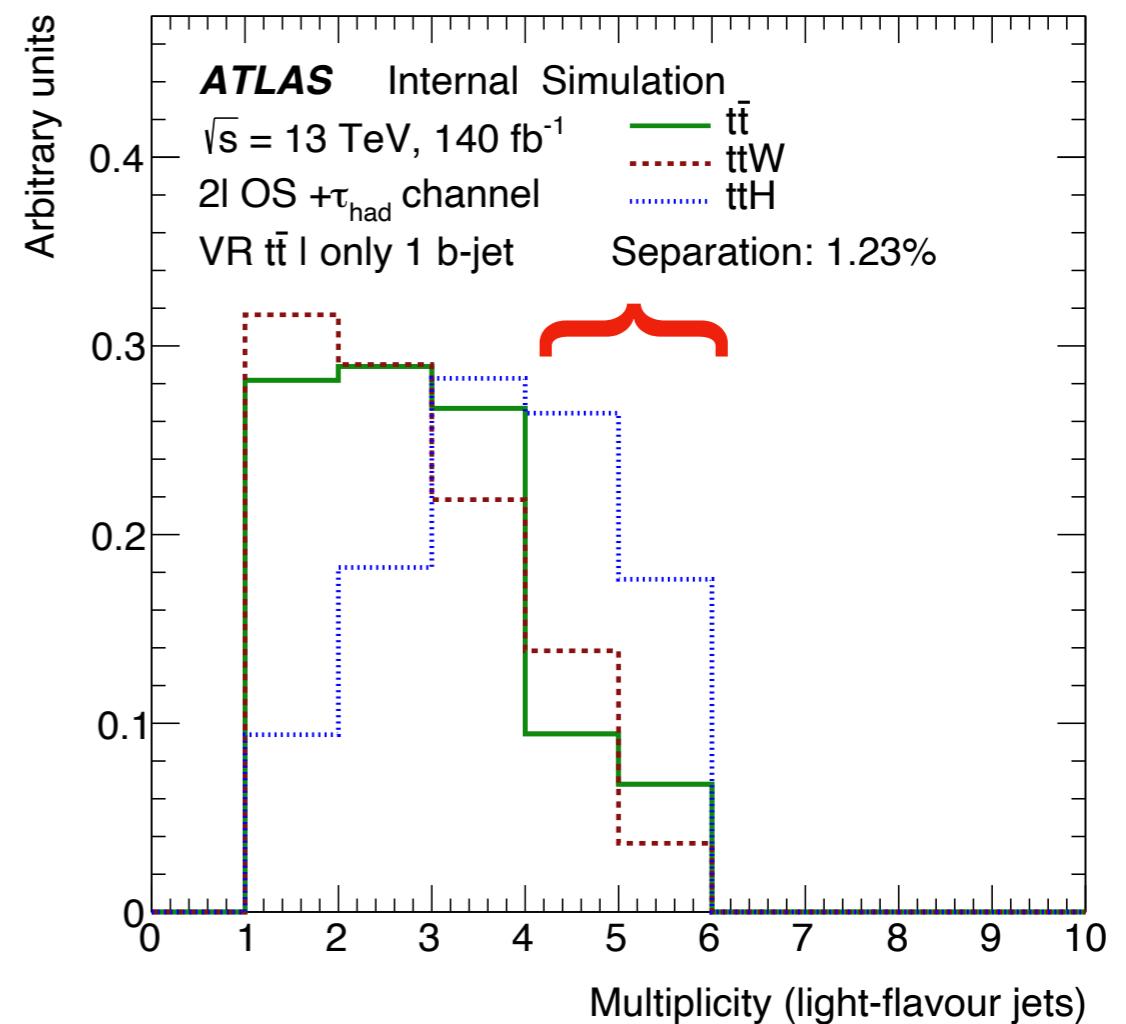
Improving the VR($t\bar{t}$)

- After requiring that events in VR($t\bar{t}$) only have 1 b -jet, the purity of the VR($t\bar{t}$) increases.
- This can further be further improved by removing events with many light-flavoured jets.

VR $t\bar{t}$ I only 1 b -jet



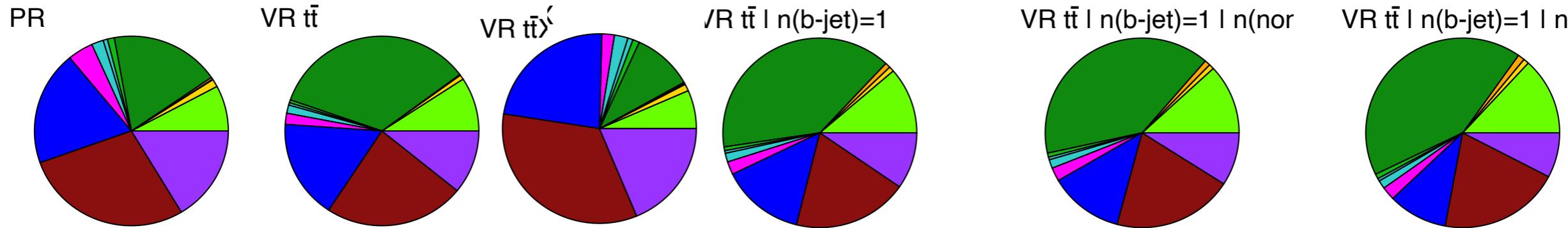
bdt_tHq<0.65 && HT/1000<260 && m_nbjets ==1



Improving the VR($t\bar{t}$)

- VR($t\bar{t}$) to have $n(\text{bjets})=1$ and $n(\text{non-b-jet}) < N$. $N = 4$ or 5

tHq
 tZq
 tt
 tW
 W+jets
 Z+jets
 Diboson
 ttW
 ttZ
 ttH
 tWZ
 tWH
 Other



	PR	VR $t\bar{t}$	VR $t\bar{t}X$	VR $t\bar{t}$ — $n(\text{b-jet})=1$	VR $t\bar{t}$ — $n(\text{b-jet})=1$ — $n(\text{non-b-jet}) \leq 5$	VR $t\bar{t}$ — $n(\text{b-jet})=1$ — $n(\text{non-b-jet}) \leq 4$
tHq	1.26 ± 0.09	0.113 ± 0.006	0.265 ± 0.005	0.084 ± 0.006	0.080 ± 0.006	0.074 ± 0.006
tZq	5.70 ± 0.24	0.469 ± 0.025	1.629 ± 0.029	0.422 ± 0.032	0.407 ± 0.033	0.34 ± 0.04
tt	24.4 ± 0.5	8.6 ± 0.5	7.92 ± 0.15	7.5 ± 0.5	7.0 ± 0.5	6.3 ± 0.5
tW	1.55 ± 0.06	0.125 ± 0.013	0.880 ± 0.021	0.125 ± 0.022	0.125 ± 0.024	0.13 ± 0.04
Z+jets	0.474 ± 0.016	0.0348 ± 0.0021	0.184 ± 0.004	0.169 ± 0.023	0.169 ± 0.024	0.17 ± 0.04
Diboson	10.41 ± 0.26	2.29 ± 0.14	5.13 ± 0.09	2.17 ± 0.17	2.10 ± 0.17	1.98 ± 0.17
ttW	37.7 ± 0.8	5.81 ± 0.30	26.4 ± 0.5	3.68 ± 0.24	3.55 ± 0.24	3.04 ± 0.23
ttZ	21.9 ± 0.4	2.69 ± 0.14	14.65 ± 0.26	1.85 ± 0.13	1.60 ± 0.12	1.15 ± 0.11
ttH	26.1 ± 0.5	4.19 ± 0.22	17.95 ± 0.33	2.67 ± 0.20	2.20 ± 0.16	1.49 ± 0.14
tWZ	2.66 ± 0.06	0.349 ± 0.018	1.771 ± 0.032	0.287 ± 0.026	0.261 ± 0.027	0.21 ± 0.04
tWH	0.971 ± 0.020	0.102 ± 0.005	0.677 ± 0.012	0.085 ± 0.018	0.081 ± 0.020	0.068 ± 0.034
Triboson	0.402 ± 0.010	0.0424 ± 0.0022	0.259 ± 0.005	0.037 ± 0.017	0.037 ± 0.020	0.032 ± 0.033
ttt	0.1349 ± 0.0029	0.0099 ± 0.0005	0.1122 ± 0.0022	0.007 ± 0.017	0.004 ± 0.019	0.002 ± 0.033
tttt	0.636 ± 0.014	0.0442 ± 0.0023	0.544 ± 0.010	0.020 ± 0.017	0.008 ± 0.019	0.004 ± 0.033
Total	135.0 ± 2.8	24.9 ± 1.3	78.5 ± 1.4	19.2 ± 1.3	17.7 ± 1.3	15.1 ± 1.4



Region: SR_BDT_tHq_2L1TAU_SS

Type: SIGNAL

DataType: DATA

Label: SR

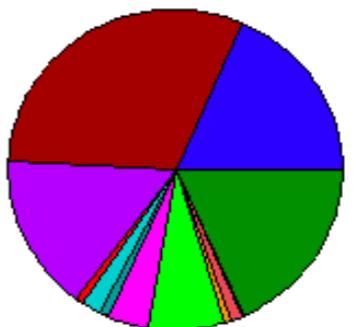
VariableTitle: "BDT(tHq)"

Variable: bdt_tHq,9,0.65,1

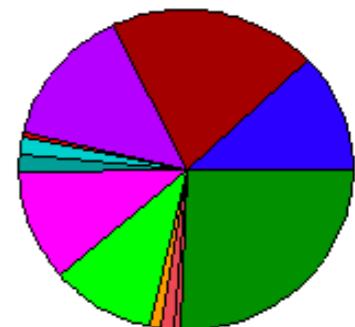
Binning: 0.65,0.75,0.85,1

Selection: "bdt_tHq>=0.65"

PR



SR



Region: VR_ttbar_2L1TAU_SS

Type: VALIDATION

DataType: DATA

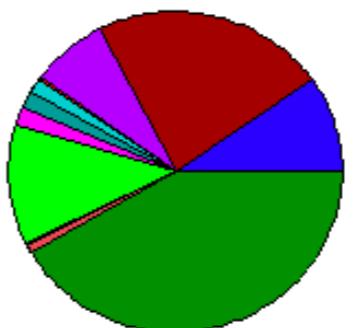
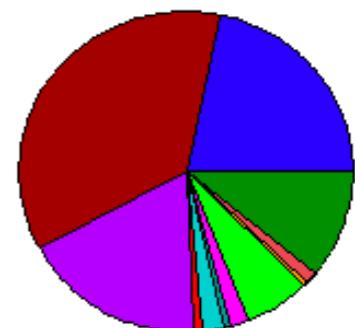
Label: "VR t#bar{t}"

VariableTitle: "H_{T} [GeV]"

Variable: HT/1000,2,100,260

Binning: 100,210,260

Selection: "bdt_tHq<0.65 && HT/1000<260 && m_nbjets==1 && m_nNoBjets<4"

VR ttCR ttX

Region: CR_ttX_2L1TAU_SS

Type: CONTROL

DataType: DATA

Label: "CR t#bar{t}X"

VariableTitle: "H_{T} [GeV]"

Variable: HT/1000,3,260,800

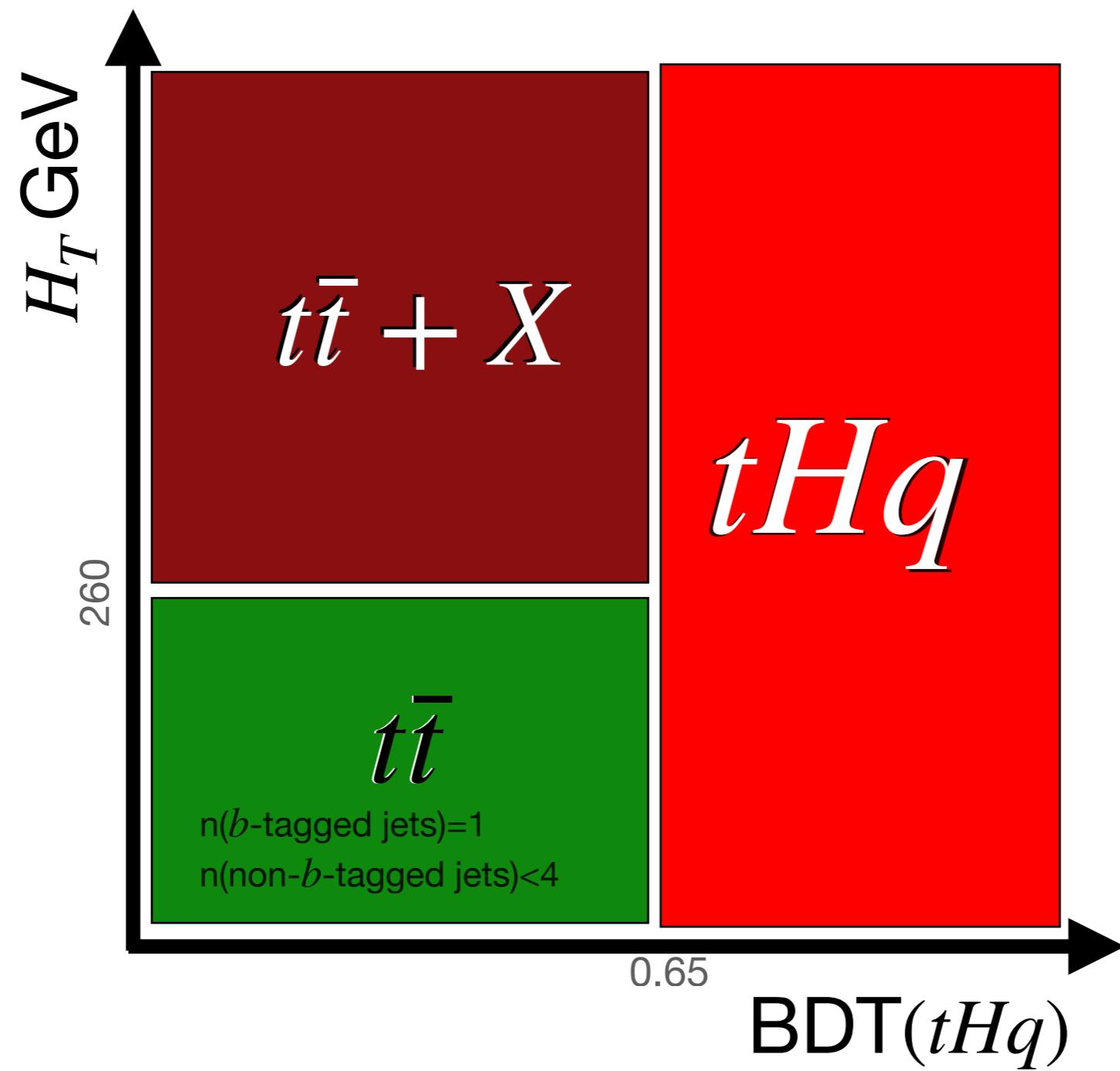
Binning: 260,380,500,800

Selection: "bdt_tHq<0.65 && HT/1000>260"

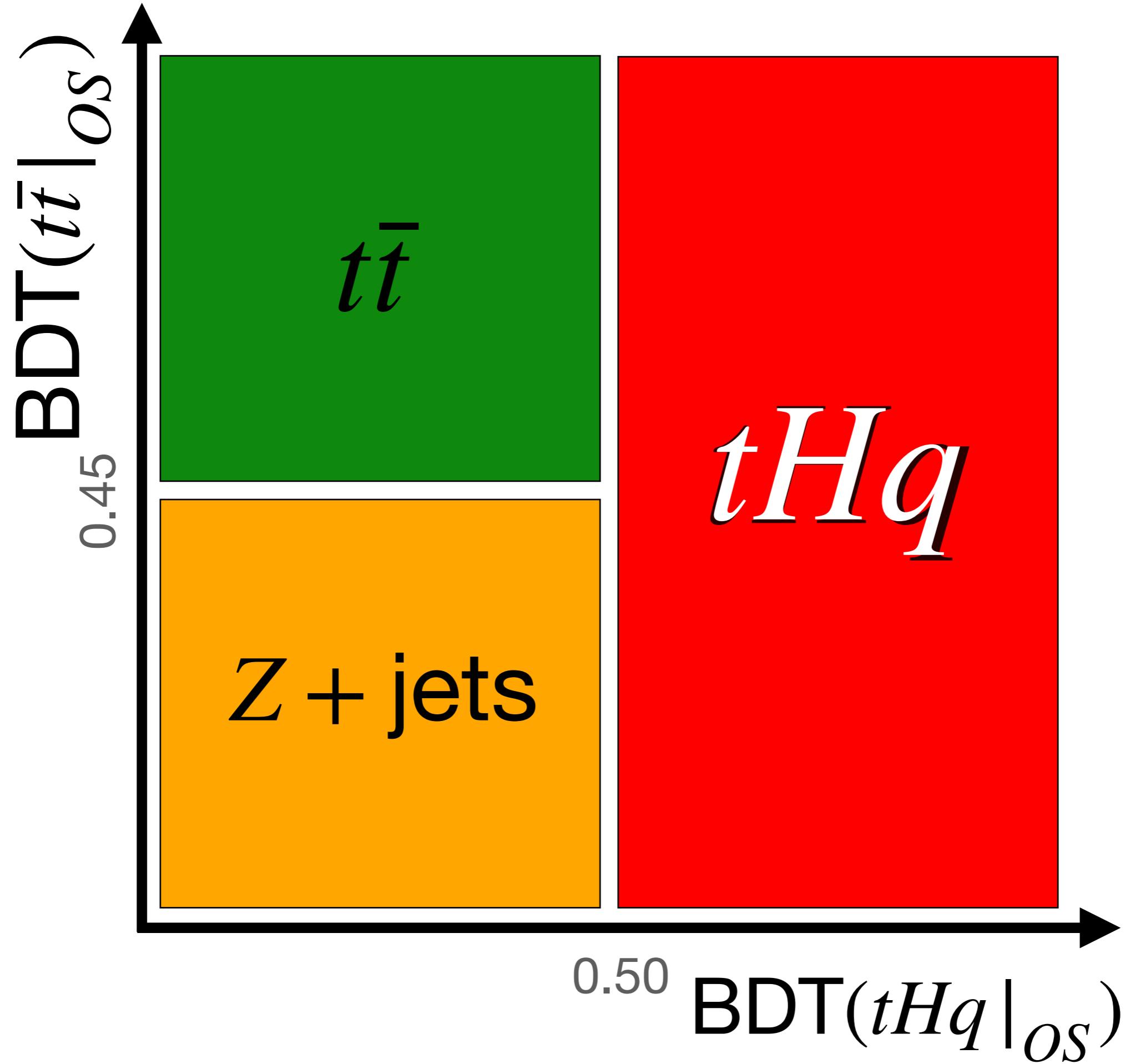
	PR	SR	VR tbart	CR tbartX
tHq	1.22 ± 0.05	0.86 ± 0.04	0.066 ± 0.005	0.259 ± 0.005
tWH	0.953 ± 0.016	0.198 ± 0.008	0.063 ± 0.005	0.651 ± 0.011
tWZ	2.62 ± 0.04	0.543 ± 0.021	0.199 ± 0.014	1.741 ± 0.030
tbart	24.8 ± 0.4	7.99 ± 0.32	6.0 ± 0.4	8.71 ± 0.16
ttW	41.7 ± 0.7	6.40 ± 0.26	3.28 ± 0.23	29.0 ± 0.5
ttZ	21.18 ± 0.35	4.34 ± 0.17	1.07 ± 0.08	14.31 ± 0.25
ttH	25.2 ± 0.4	3.76 ± 0.15	1.42 ± 0.10	17.36 ± 0.31
tZq	5.37 ± 0.16	3.47 ± 0.15	0.281 ± 0.020	1.498 ± 0.026
tW	1.249 ± 0.028	0.542 ± 0.022	0.253 ± 0.020	0.454 ± 0.009
Z+jets	0.727 ± 0.015	0.317 ± 0.014	0.0099 ± 0.0009	0.373 ± 0.007
Diboson	10.30 ± 0.19	3.20 ± 0.13	1.75 ± 0.12	5.04 ± 0.09
minor bkgs	1.609 ± 0.032	0.427 ± 0.019	0.132 ± 0.012	0.940 ± 0.018
Total background	137.2 ± 2.3	32.3 ± 1.3	14.6 ± 1.0	80.4 ± 1.4

Table 1: Yields of the analysis

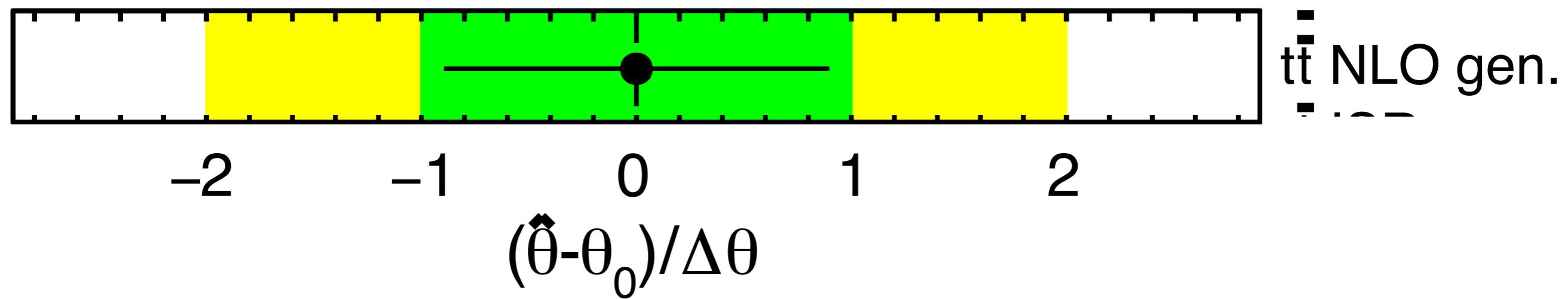
Regions



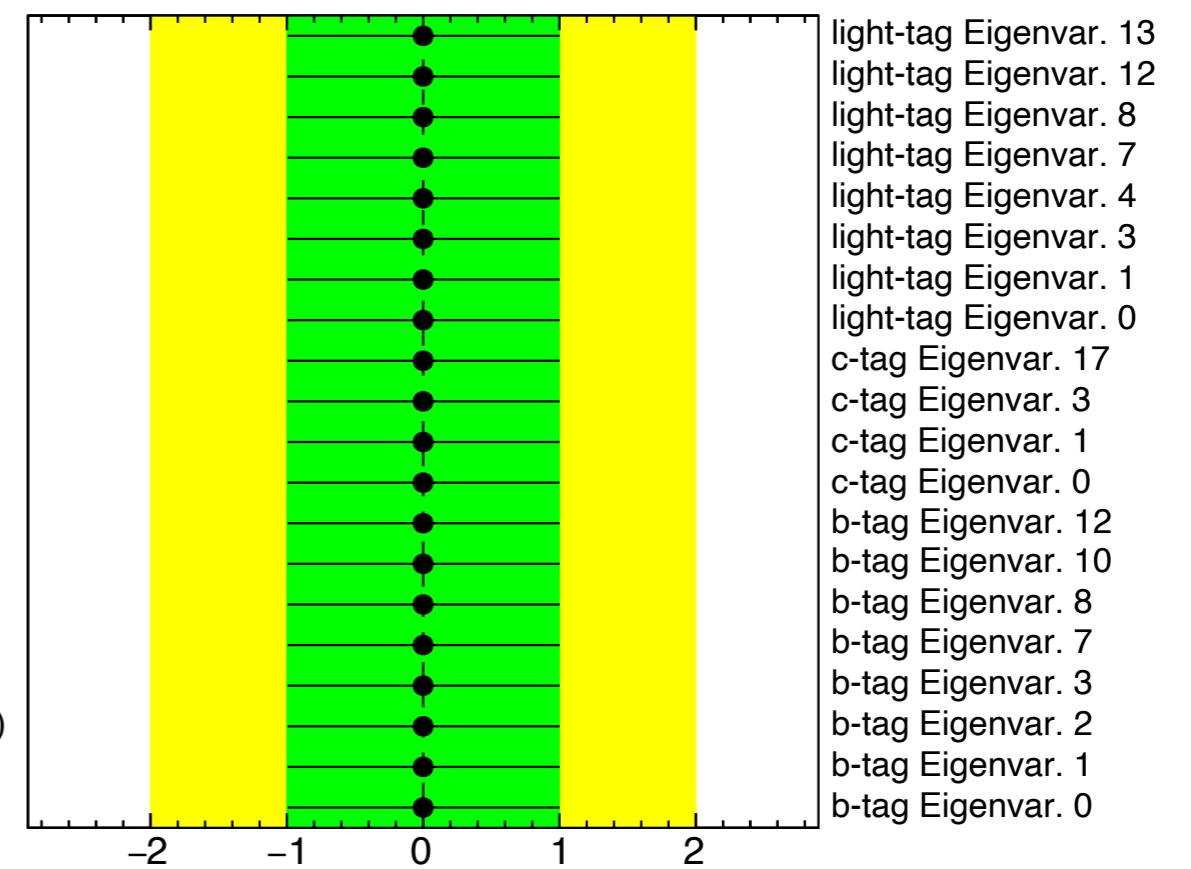
Backup



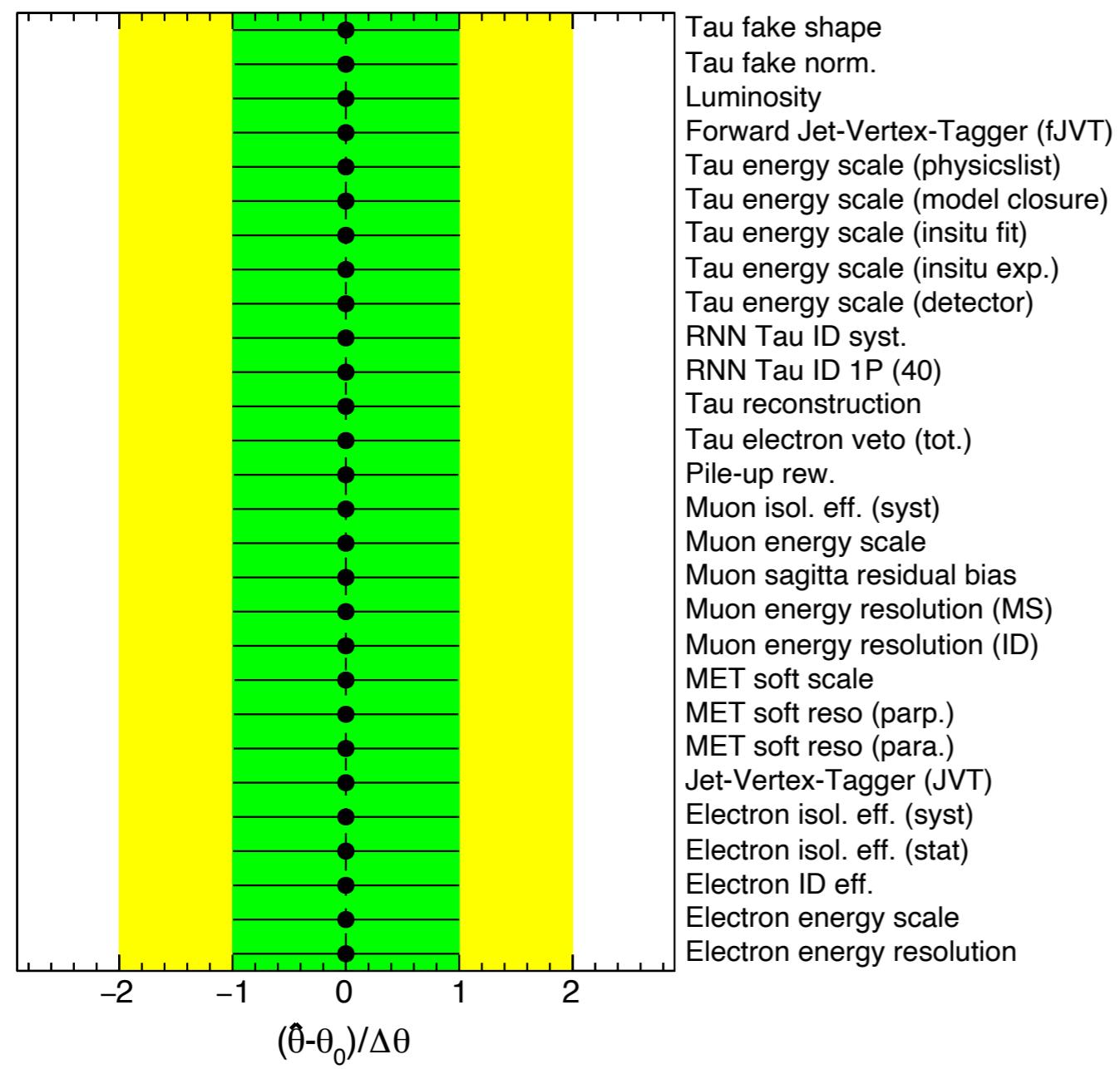
Theory
tt NLO gen.



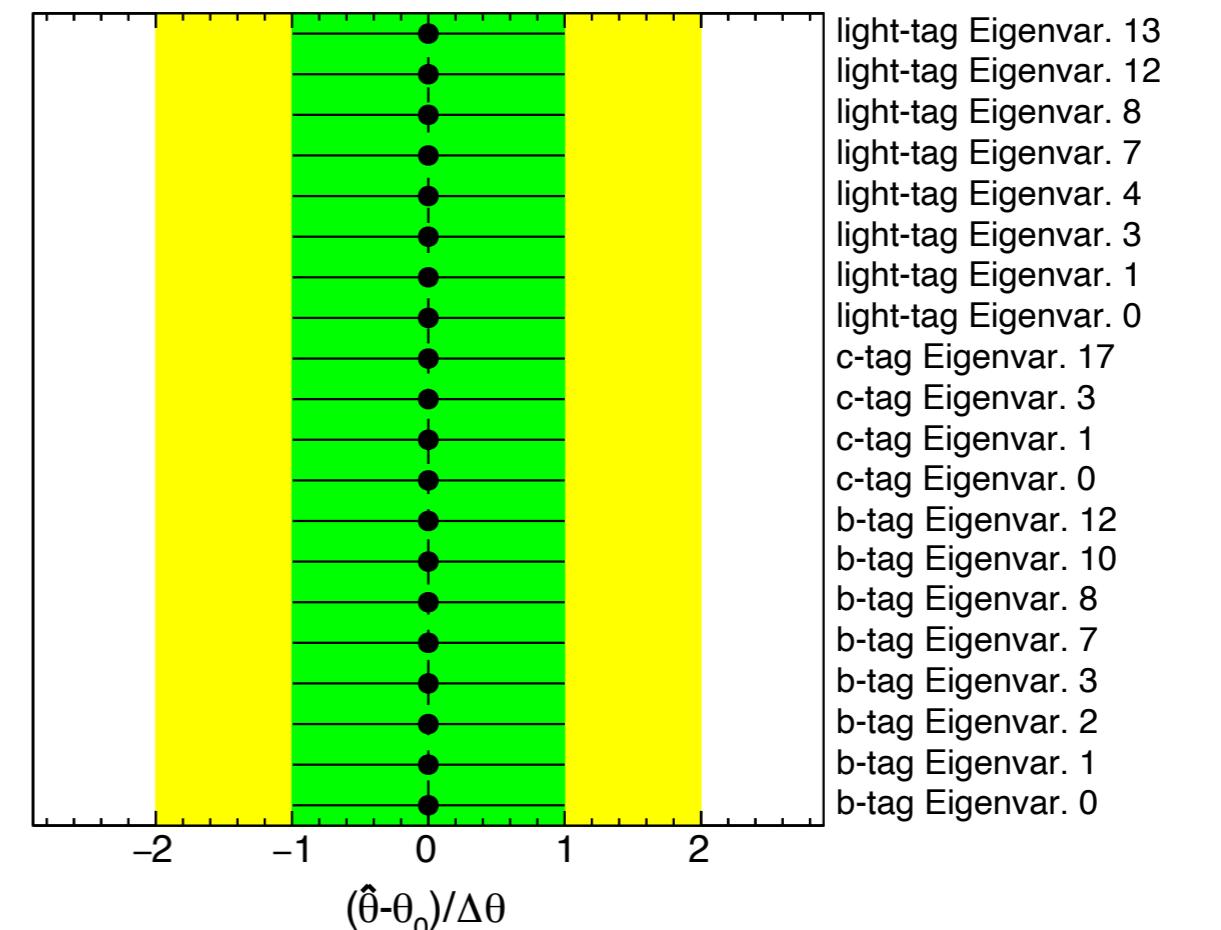
Instrumental_FTAG

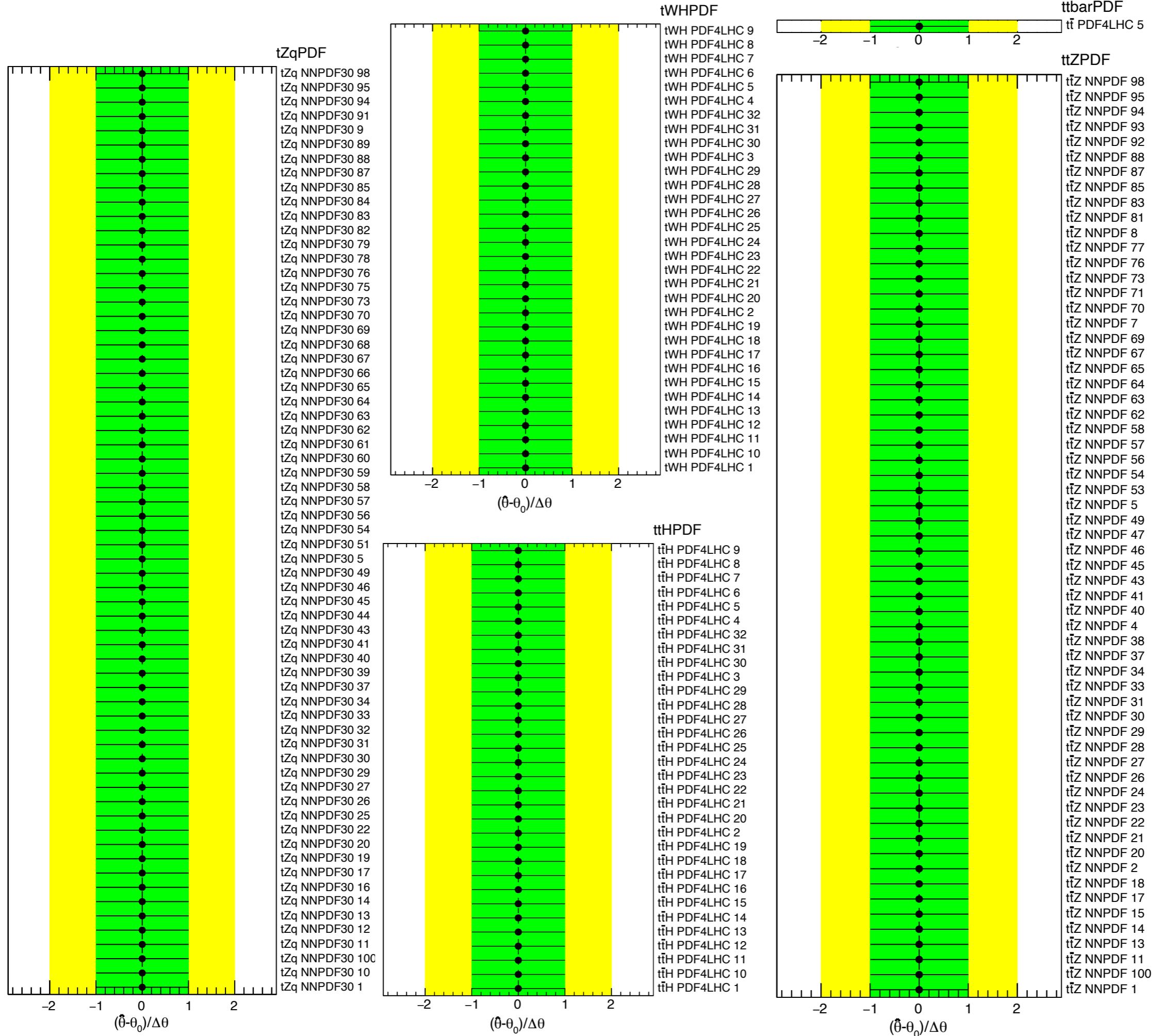


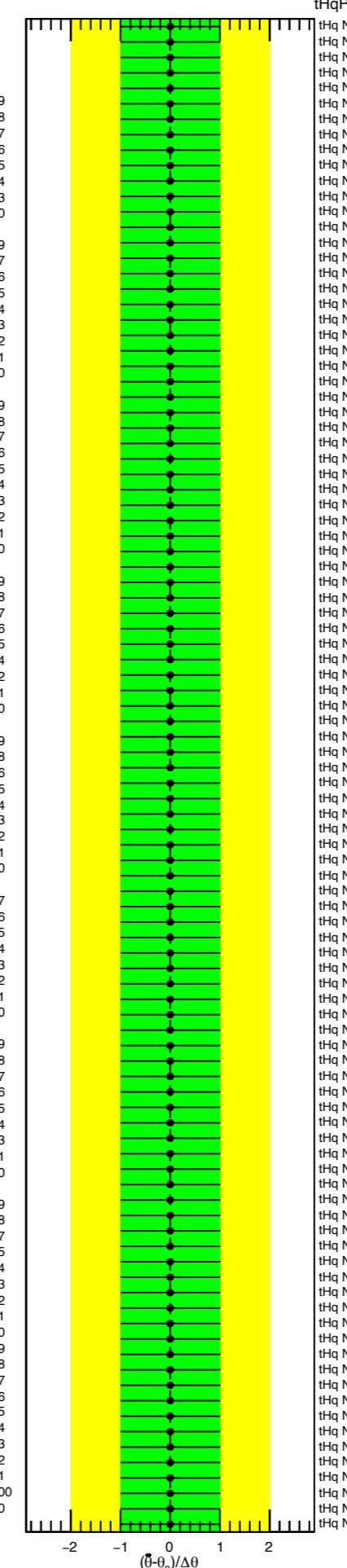
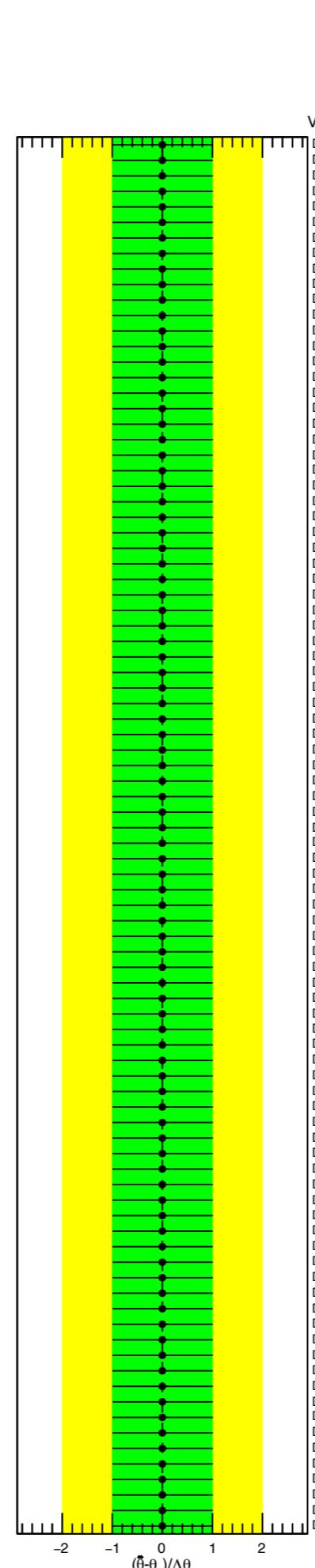
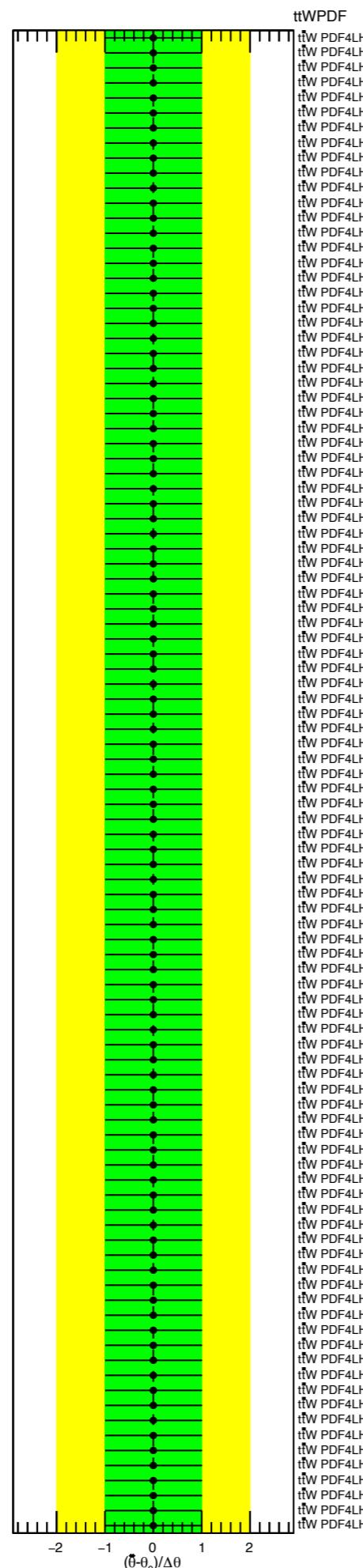
Instrumental

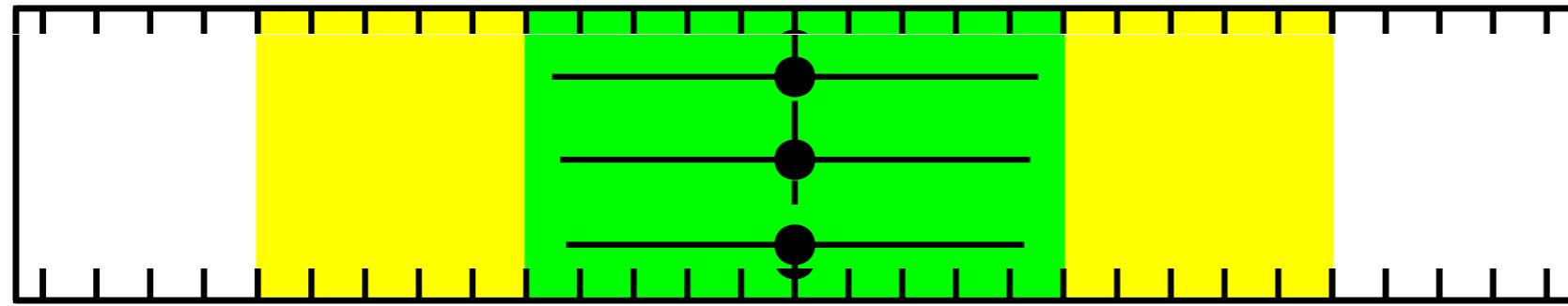


Instrumental_FTAG







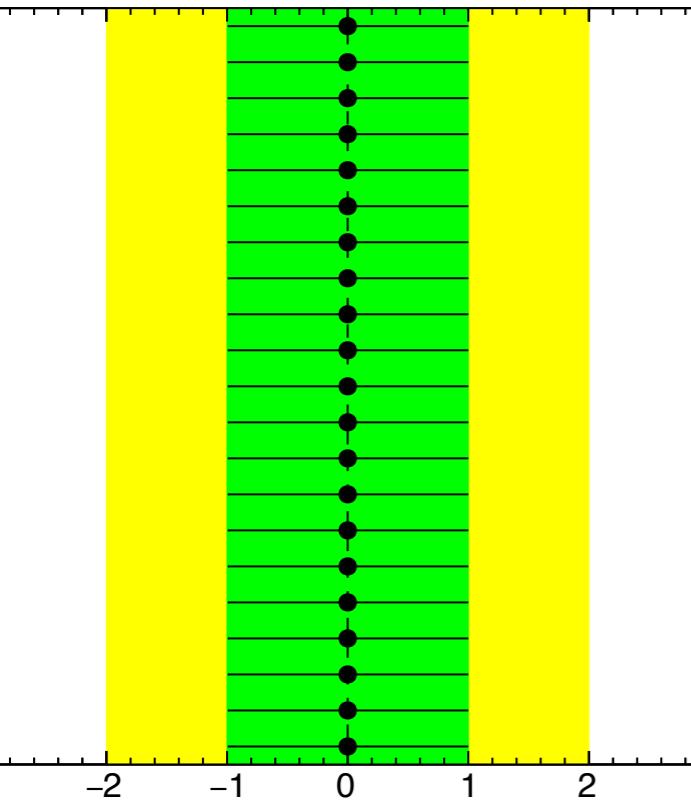


$-2 \quad -1 \quad 0 \quad 1 \quad 2$

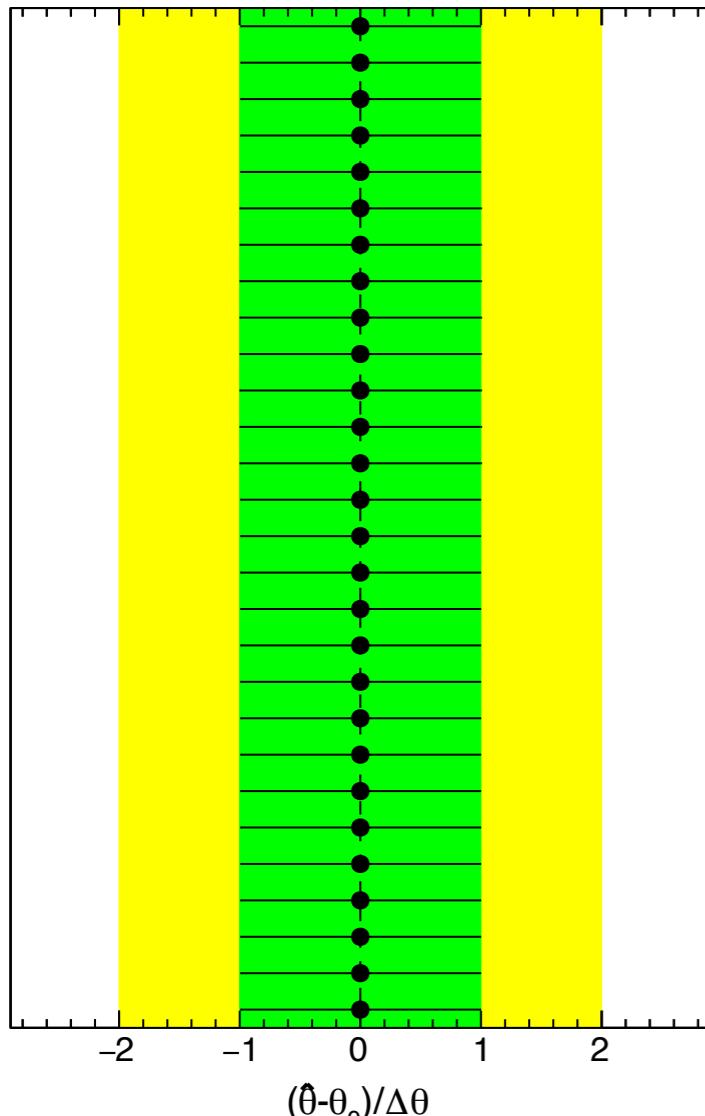
$$(\hat{\theta} - \theta_0) / \Delta \theta$$

- $t\bar{t}$ PS + had.
- $t\bar{t}$ NLO gen.
- $t\bar{t}Z$ NLO gen. + PS + had.

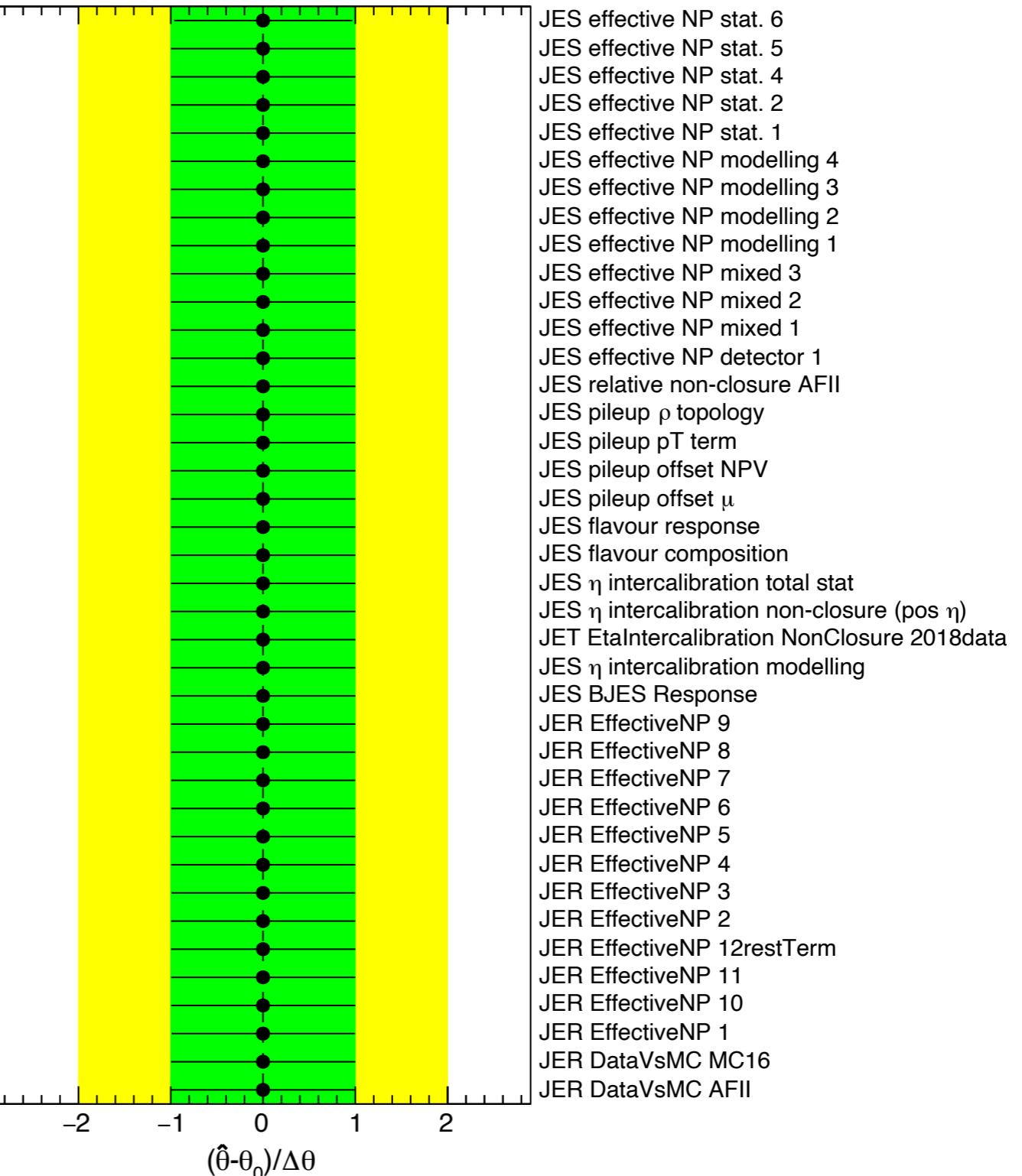
Instrumental_FTAG

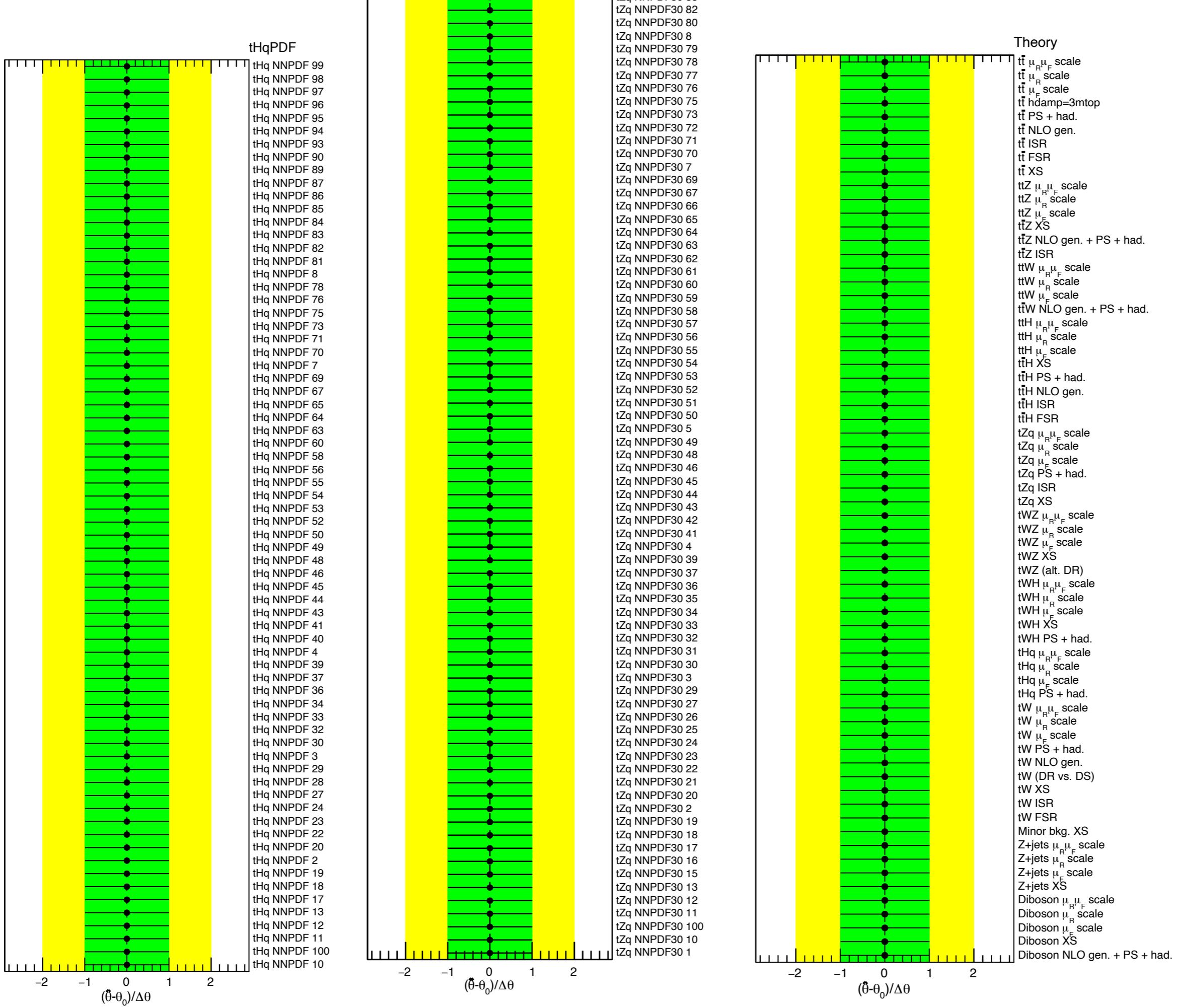


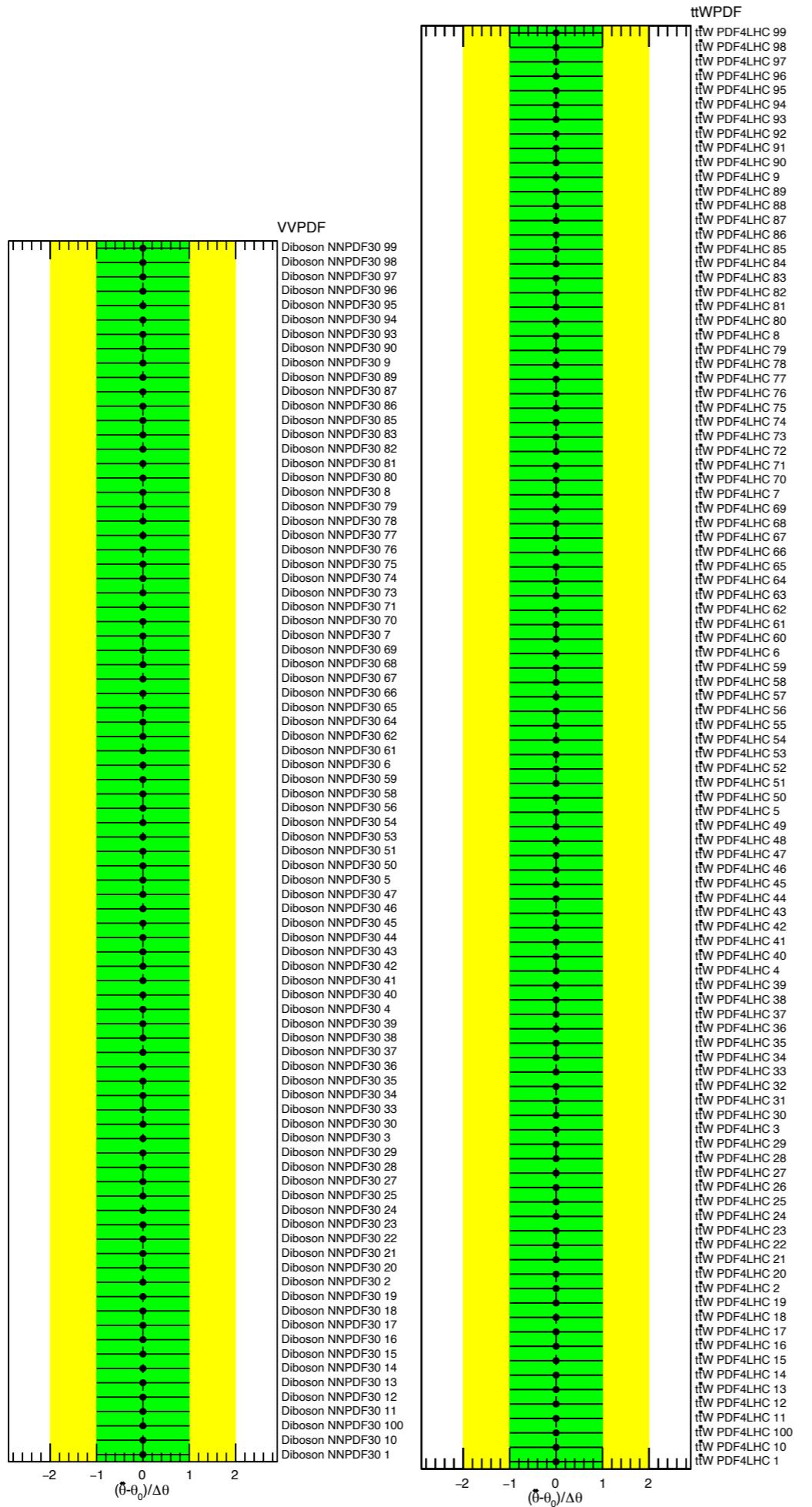
Instrumental

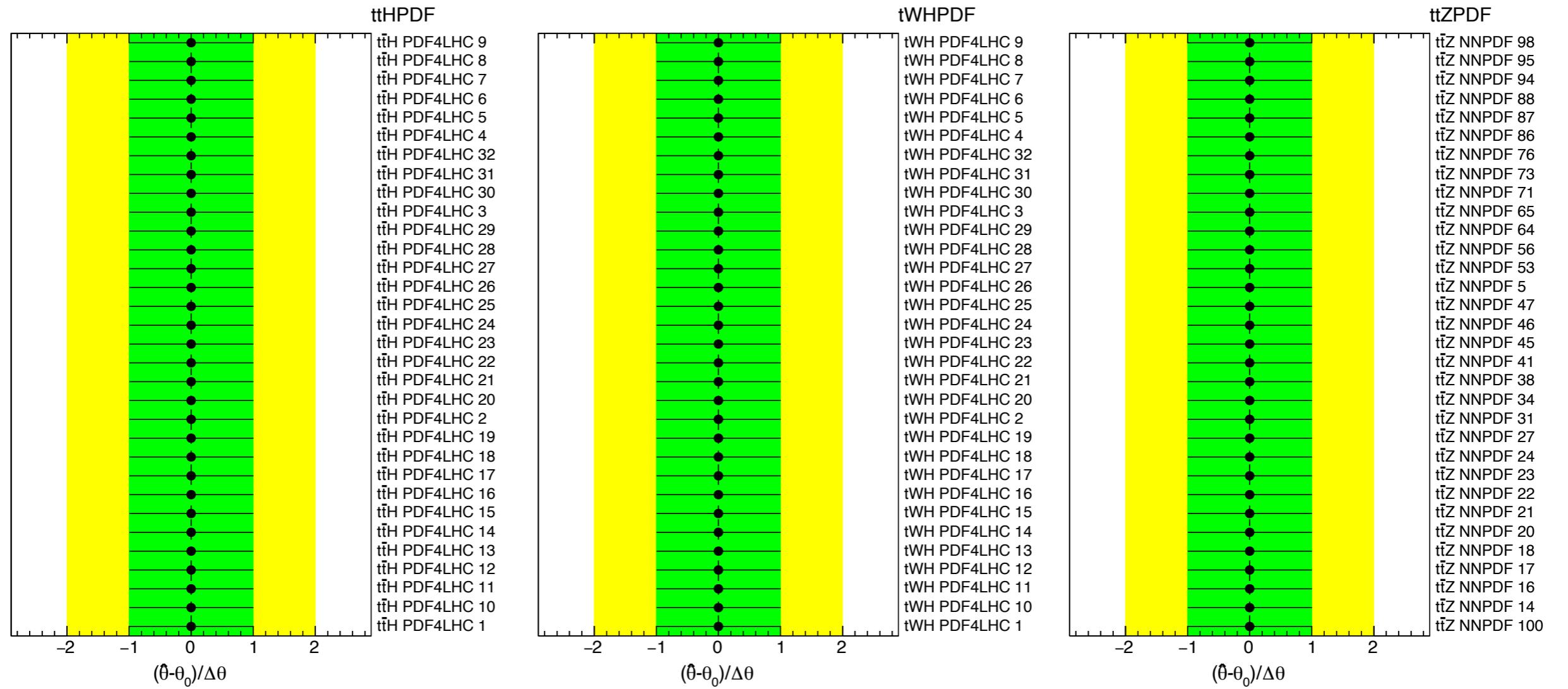


Instrumental_JESR









Normalised events

