Single top + $t\bar{t}$
$TH \to 3b$ and $TZ \to 3\ell$

Lorenzo Basso

$$TH \rightarrow 3b$$

Optimisation

- $p_\ell^T > 20$ GeV, $p_j^T > 40$ GeV
- isolation: `CONE04` with threshold $= 0.20$
- $N_J \geq 1$ ($J =$ light and b jets)
- $N_\ell = 1$
- $N_b = 3$

✗ H candidate as pair of b jets closest to M_H

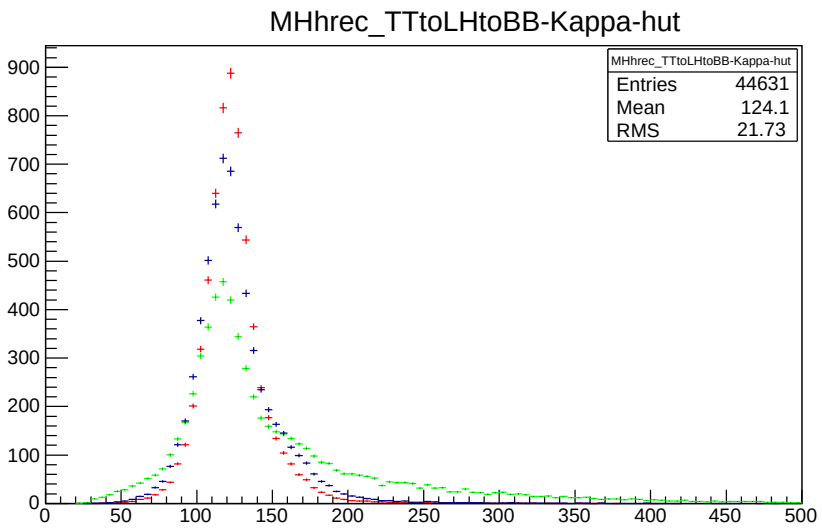
✗(?) t candidate as b with closest $M^T(\ell\, b)$ to M_t

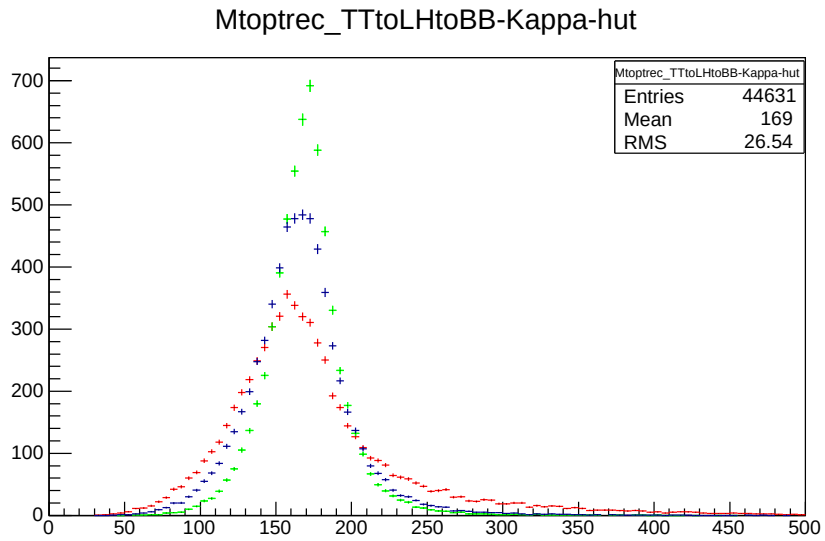
✓(?) together

- 80 GeV $< |M(bb) - M_H| < 180$ GeV
- loose top reco: $M^T(b\,\ell) < 210$ GeV

? W reco? (still to run)

Higgs and top reco





Red: H reco only

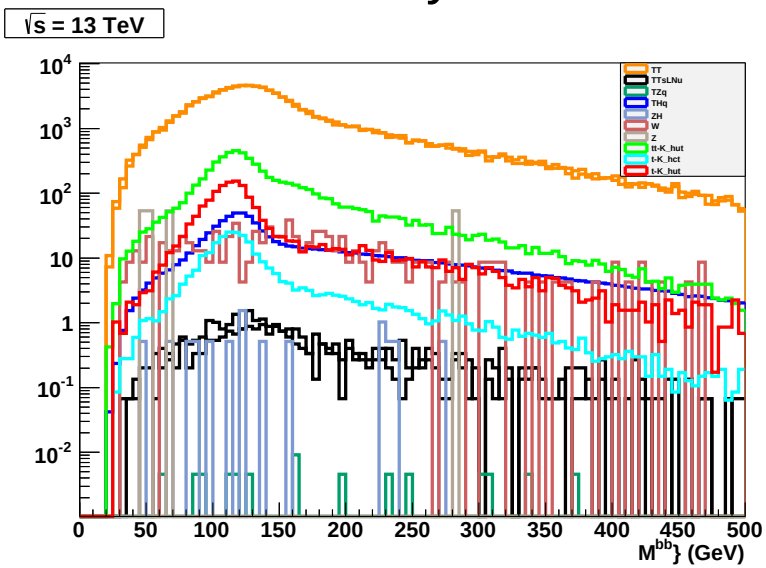
Green: t reco only

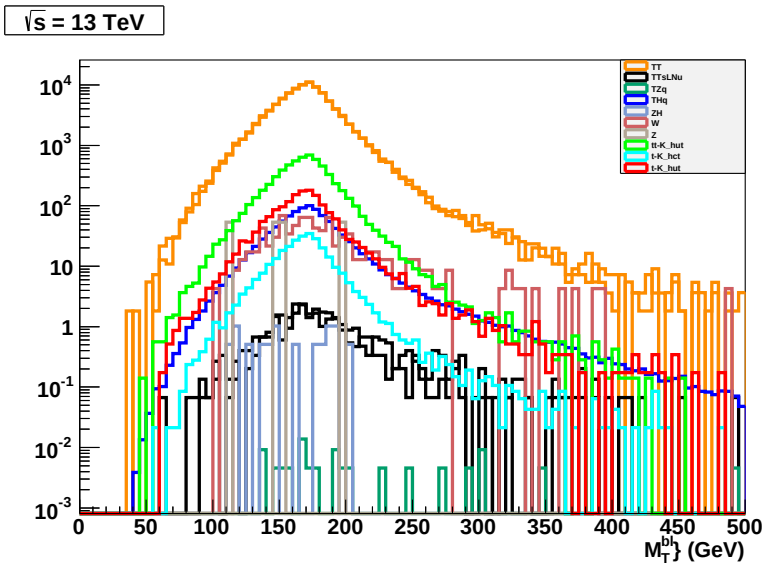
Blue: simultaneously

```
if( (abs(MTallin - 173.0) + abs(MHallin - 125.0)) <
(abs(MTall - 173.0) + abs(MHall - 125.0)) )
MTall = MTallin;
MHall = MHallin;
```

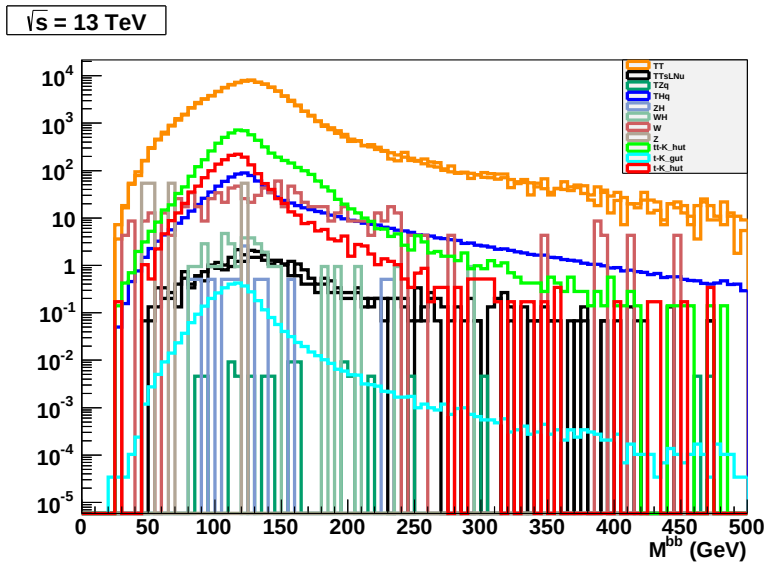
Shaping signal?

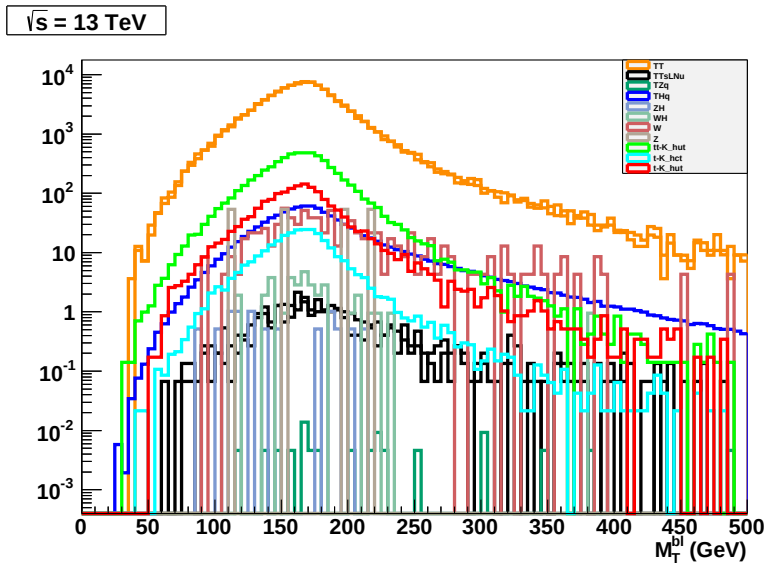
t reco only



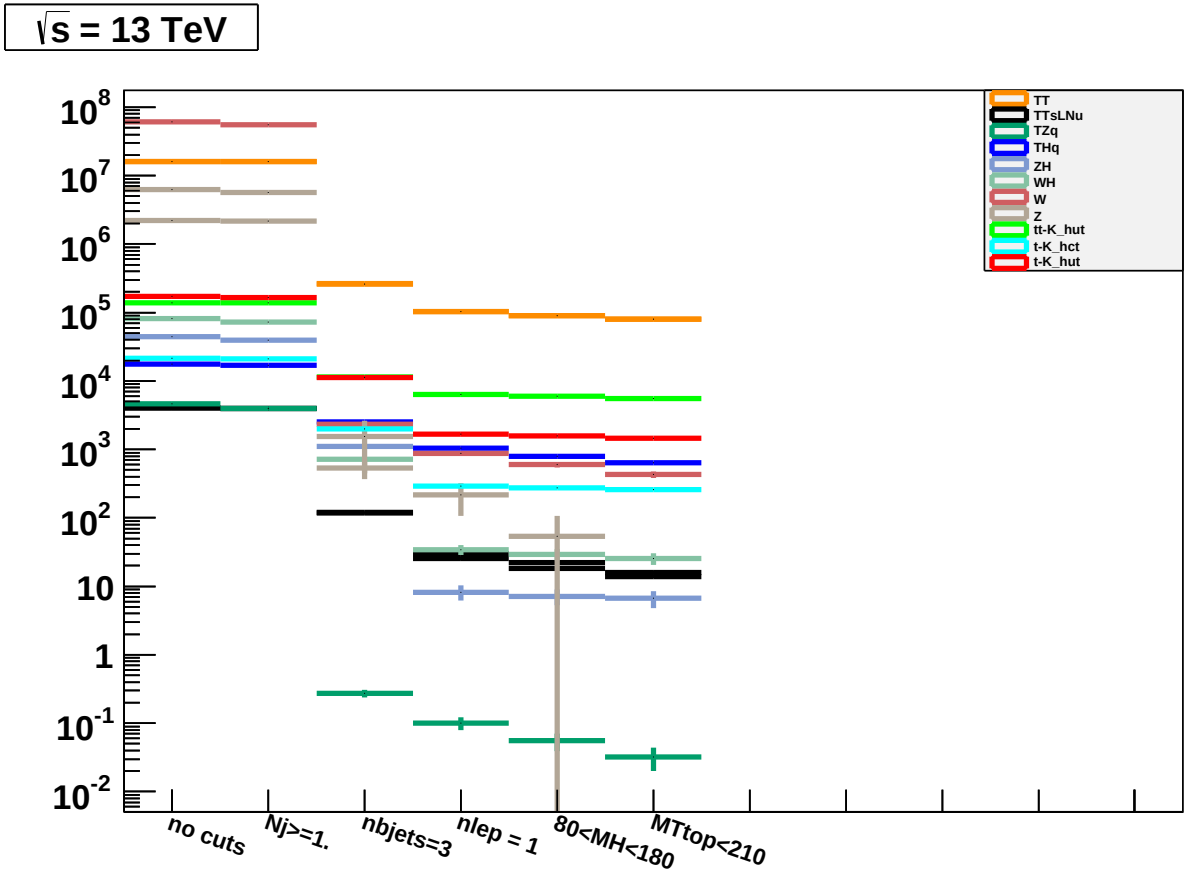


simultaneous





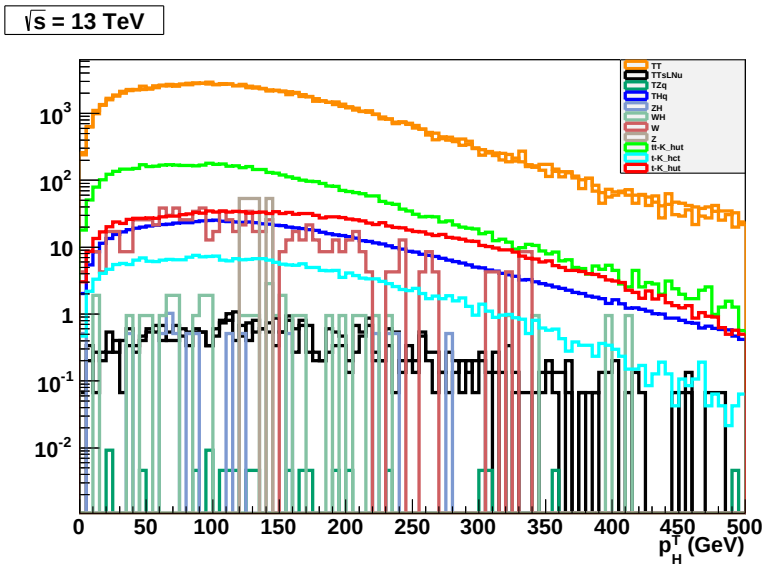
CutFlow

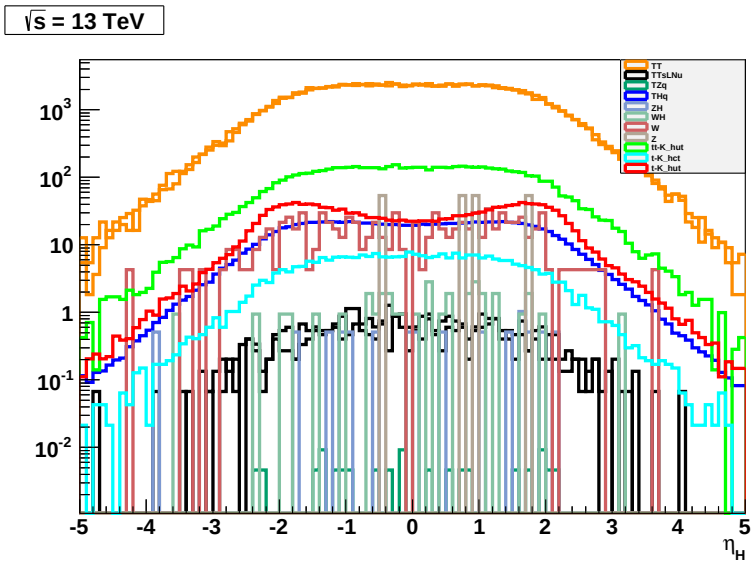


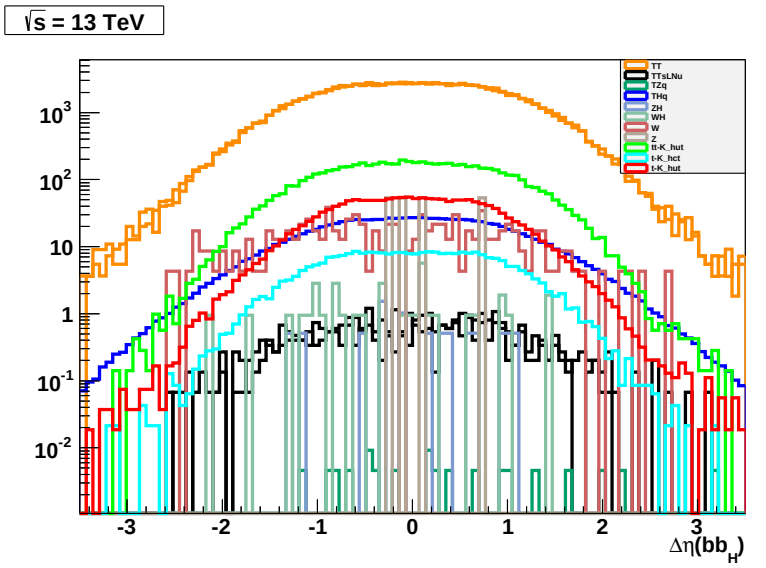
Cut	Sum Bg	Signal gct	Signal gut	Signal ttbar	THq	TT+V+jets	TT+jets	VH	W+jets	ZToLL
$nocuts$	102374306 ± 48253	21261 ± 21	173700 ± 172	139891 ± 141	17526 ± 6	8033 ± 23	32322460 ± 7322	126199 ± 317	61478064 ± 15417	8422024 ± 45133
$N_j >= 1.$	95851947 ± 47415	21016 ± 21	166291 ± 169	137840 ± 140	17081 ± 6	7992 ± 23	31967096 ± 7284	112118 ± 298	55856312 ± 14757	7891348 ± 44466
$N_b = 3$	533789 ± 1474	1988 ± 7	11213 ± 44	11364 ± 40	2525 ± 2	239 ± 4	524811 ± 976	1820 ± 35	2319 ± 100	2075 ± 1100
$N_\ell = 1$	208013 ± 624	290 ± 2	1672 ± 17	6301 ± 30	1038 ± 1	56 ± 2	205788 ± 611	42 ± 6	875 ± 61	215 ± 108
$80 < M_H < 180$	180029 ± 574	277 ± 2	1583 ± 17	5937 ± 29	800 ± 1	41 ± 2	178498 ± 569	37 ± 6	600 ± 51	54 ± 54
$M_t^T < 210$	162219 ± 543	259 ± 2	1452 ± 16	5511 ± 28	633 ± 1	30 ± 1	161095 ± 541	32 ± 5	429 ± 43	0 ± 0

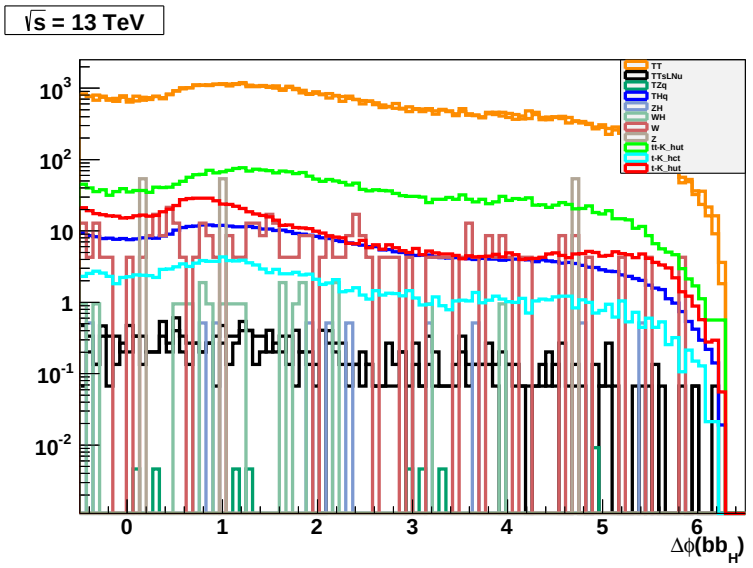
$\varepsilon(1\ell 3b) \sim 4\%$: 34% (3b-tag), $60\% \cdot 78\% = 47\%$ ($1\ell = e,\ \mu$) $\Rightarrow 25\%$ (3b kin)

Distributions - I



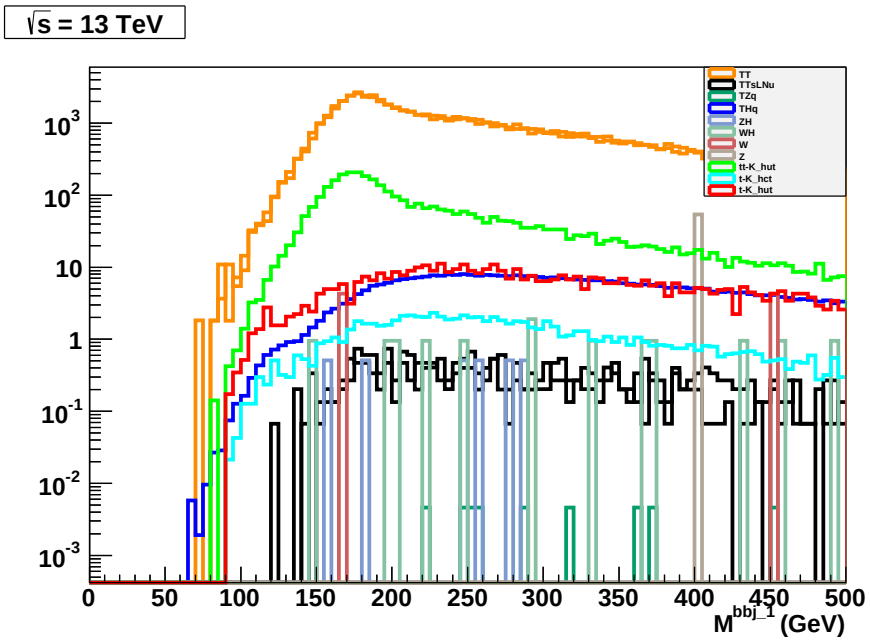




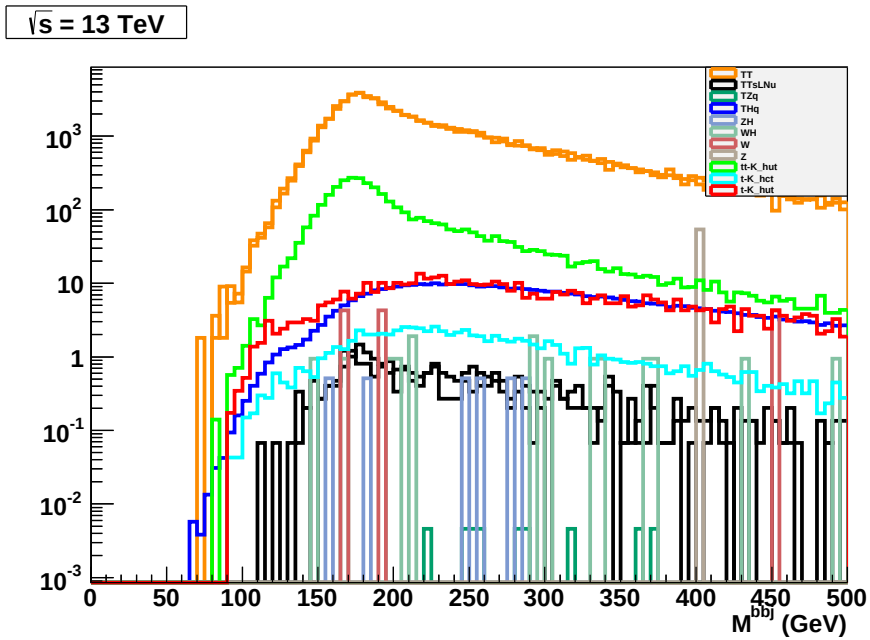


Distributions - II

leading light jet



light jet best top reco

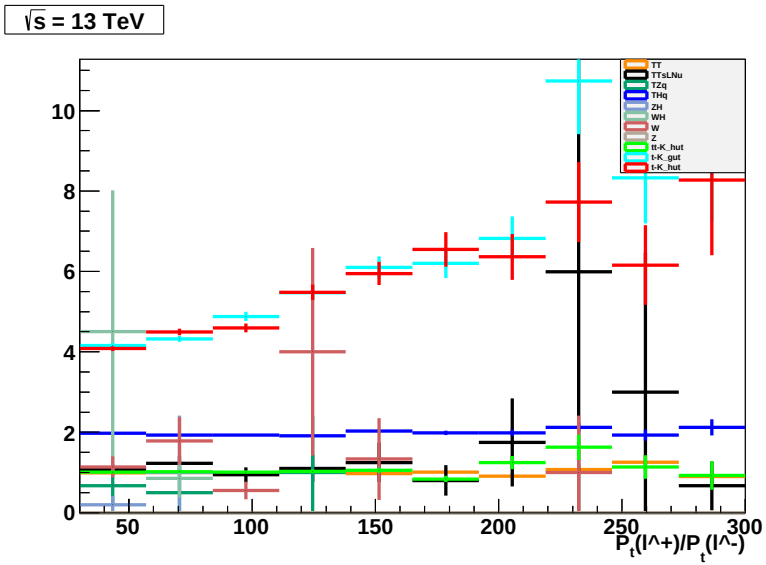


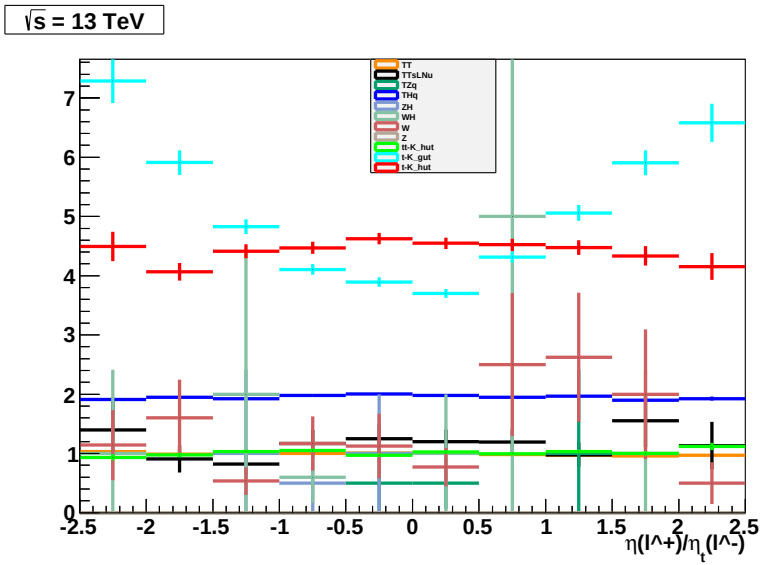
Maybe useful to disentangle $t\bar{t}$-mediated signal from single-top one?

Distributions - III

arxiv:1402.3073

$p^T(\ell^+)/p^T(\ell^-)$ and $\eta(\ell^+)/\eta(\ell^-)$





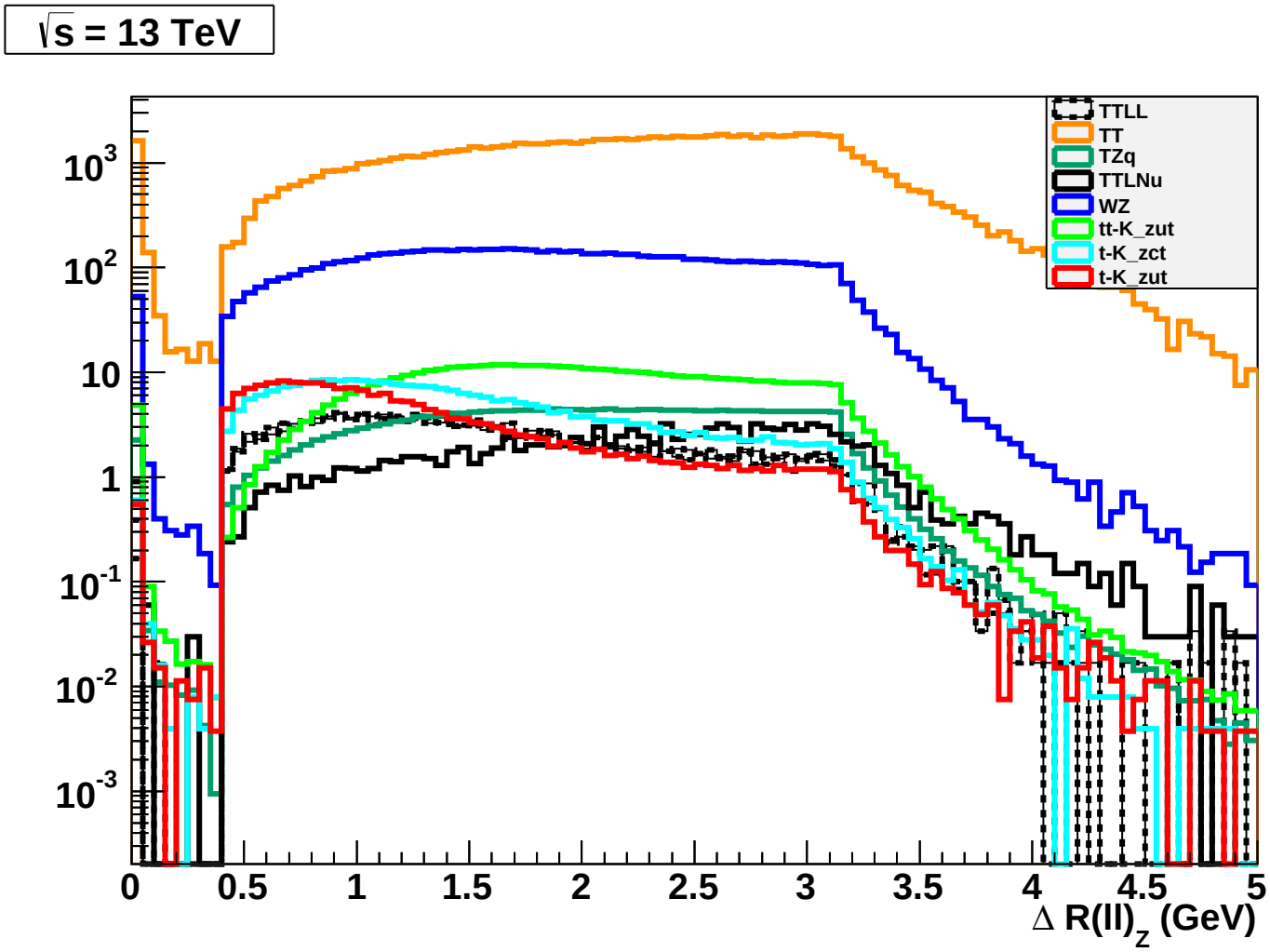
Significant only for $\kappa(gut)$ (too much suppressed) and single-top type of signal

$$TZ \rightarrow 3\ell$$

Optimisation - almost matched Isis's

- $p_\ell^T > 20$ GeV, $p_j^T > 40$ GeV
- isolation: `CONE04` with threshold $= 0.20$
- $N_J \geq 1$ ($J =$ light and b jets)
  dropped $N_J \leq 3$: no real gain
- $N_b \geq 1$ to reduce WZ, $N_b \leq 1$ once WZ is removed $\Rightarrow N_b \equiv 1$
- Z candidate as pair of $e^+e^-(\mu^+\mu^-)$ closest to M_Z
  and $|M_{\ell\ell} - M_Z| < 15$ GeV
- loose W reco: $10 < M^T(\ell_W)/\text{GeV} < 150$
- loose top reco: $M^T(b\,\ell_W)/\text{GeV} < 215$

Fakes - isolation problem



Solution: Cut $\Delta R(\ell_i \ell_j) > 0.4 \; \forall i, j = 1..3$

CutFlows

Mine

Cut	Sum Bg	κ_{tZc}	κtZu	$t\bar{t} - \kappa tZu$	TT+V+jets	TT+jets	TZq	VV+jets	ZToLL
$Initial$	630956982 ± 587722	2386 ± 3	2263 ± 3	2086 ± 1	6087 ± 11	7439298 ± 2305	2097 ± 1	286524 ± 87	623222976 ± 587717
$N_j >= 1.$	109686797 ± 175815	2078 ± 3	1848 ± 3	1984 ± 1	5944 ± 11	7010238 ± 2245	1851 ± 1	112084 ± 56	102556680 ± 175801
$N_\ell = 3$	33725 ± 2010	262 ± 1	190 ± 1	474 ± 0	525 ± 3	5158 ± 62	194 ± 0	7941 ± 14	19907 ± 2009
$OSSF > 0$	32364 ± 2010	261 ± 1	189 ± 1	473 ± 0	475 ± 3	3880 ± 54	193 ± 0	7908 ± 14	19907 ± 2009
$N_b = 1$	3873 ± 280	171 ± 1	115 ± 1	244 ± 0	245 ± 2	2210 ± 41	114 ± 0	328 ± 3	976 ± 277
$\|M(\ell\ell) - M_Z\| < 15$	2065 ± 264	157 ± 1	104 ± 1	232 ± 0	167 ± 2	645 ± 22	104 ± 0	296 ± 3	853 ± 263
$M^T(\ell) < 150$	1755 ± 213	149 ± 1	97 ± 1	223 ± 0	146 ± 1	537 ± 20	100 ± 0	276 ± 3	698 ± 212
$M^T(\ell b) < 220$	1211 ± 189	143 ± 1	92 ± 1	210 ± 0	89 ± 1	320 ± 16	94 ± 0	148 ± 2	560 ± 188

Isis's

	Initial	3 leptons	At least 2 jets	At least 1 CSVL	At least 1 OSSF pair	Inv Mass Z	High pt b jet	Inv Mass FCNC top
TTsemilep Kappa Zct Ztoll	2.09e+03 ± 0.718	242 ± 0.239	159 ± 0.193	134 ± 0.178	72.1 ± 0.13	55.1 ± 0.113	32.7 ± 0.0874	26.5 ± 0.0788
TTdilep WToLNu	1.93e+03 ± 7.6	149 ± 2.11	85 ± 1.6	77.9 ± 1.53	33.3 ± 0.999	7.74 ± 0.482	5.1 ± 0.391	3.51 ± 0.325
TTdilep ZToLL	803 ± 2.54	209 ± 1.29	121 ± 0.988	112 ± 0.949	55.2 ± 0.667	34.9 ± 0.53	26.5 ± 0.462	11.4 ± 0.303
TTdilep	6.78e+06 ± 3.44e+03	4.04e+03 ± 82.1	1.41e+03 ± 48.5	1.23e+03 ± 45.2	379 ± 25.1	71.7 ± 10.9	45.1 ± 8.67	28.4 ± 6.88
TTsemilep HToZZ 2	267 ± 0.34	2.64 ± 0.0339	0.00174 ± 0.00087	0.00174 ± 0.00087	0.00087 ± 0.000615	0.00087 ± 0.000615	0.00087 ± 0.000615	0.00087 ± 0.000615
TTsemilep ZToLL 1	1.68e+03 ± 5.3	110 ± 1.36	82.8 ± 1.18	73.5 ± 1.11	38.5 ± 0.804	28 ± 0.685	17.4 ± 0.54	6.56 ± 0.332
TTsemilep ZToLL 2	1.68e+03 ± 5.3	111 ± 1.37	84.4 ± 1.19	74.4 ± 1.12	38 ± 0.799	27.2 ± 0.675	17.1 ± 0.536	6.79 ± 0.338
WZToLLLNu	2.57e+05 ± 60.5	1.53e+04 ± 15.5	1.73e+03 ± 5.17	497 ± 2.77	268 ± 2.04	199 ± 1.75	92.9 ± 1.2	32.8 ± 0.712
ZToLL50-3Jets	6.28e+06 ± 3.39e+03	3.13e+03 ± 76.1	777 ± 37.9	250 ± 21.5	137 ± 15.9	124 ± 15.1	72.2 ± 11.6	35.2 ± 8.07
ZToLL50-4Jets	2.16e+06 ± 1.49e+03	1.66e+03 ± 40.9	959 ± 31.1	323 ± 18	186 ± 13.7	172 ± 13.2	97.8 ± 9.93	26.2 ± 5.14
ZZToLLJJ	2.12e+05 ± 480	83.7 ± 9.54	14.1 ± 3.92	6.53 ± 2.66	1.09 ± 1.09	1.09 ± 1.09	1.09 ± 1.09	1.09 ± 1.09
ZZToLLLL	3.59e+04 ± 135	2.75e+03 ± 37.3	181 ± 9.58	51.3 ± 5.1	30 ± 3.9	21.8 ± 3.33	9.65 ± 2.21	5.59 ± 1.68