Search for top anti-top resonances in the semi-leptonic final state

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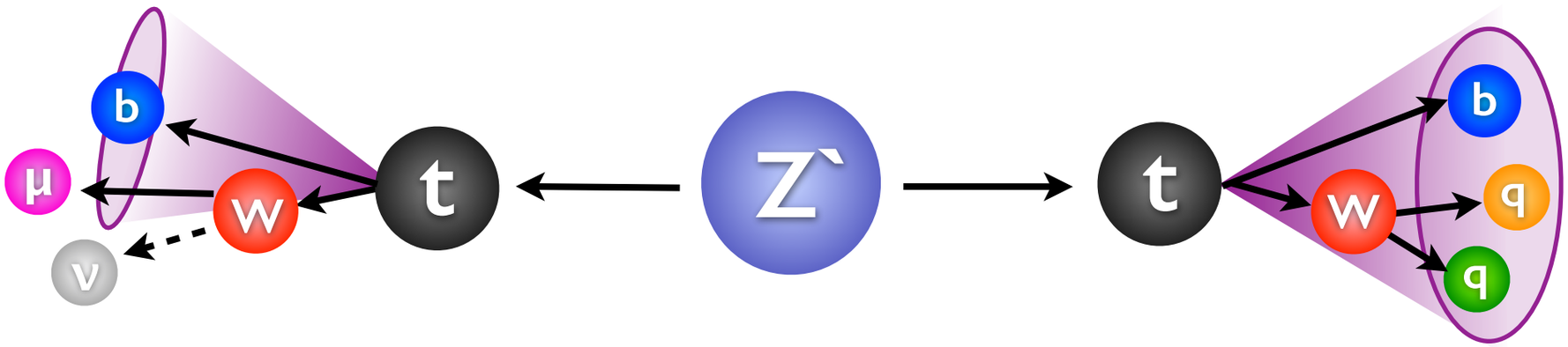
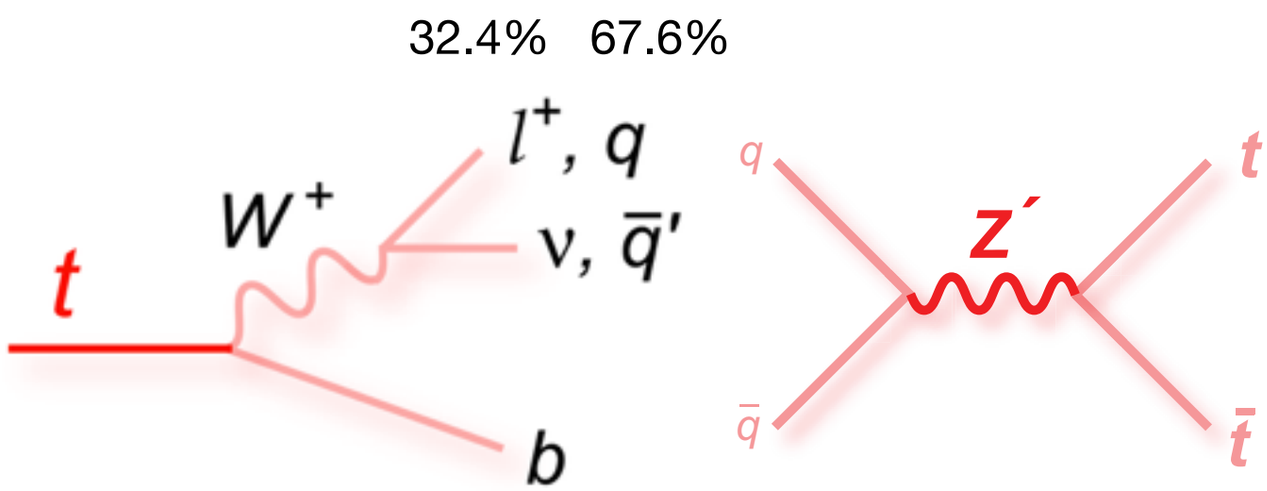
Introduction



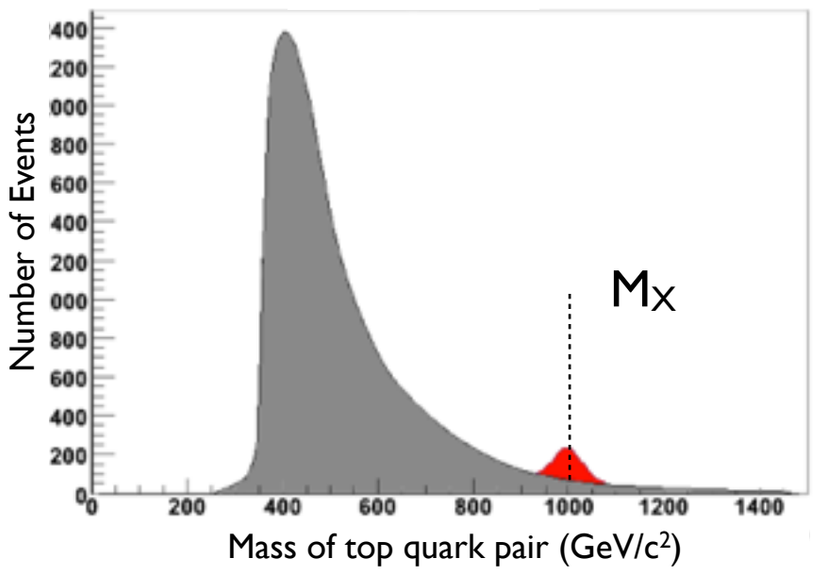
- Search for a heavy particle which decays to a top anti-top quark pair
  - Search for a bump in the m_{tt} spectrum
- Choose the semileptonic channel
  - What are the advantages?



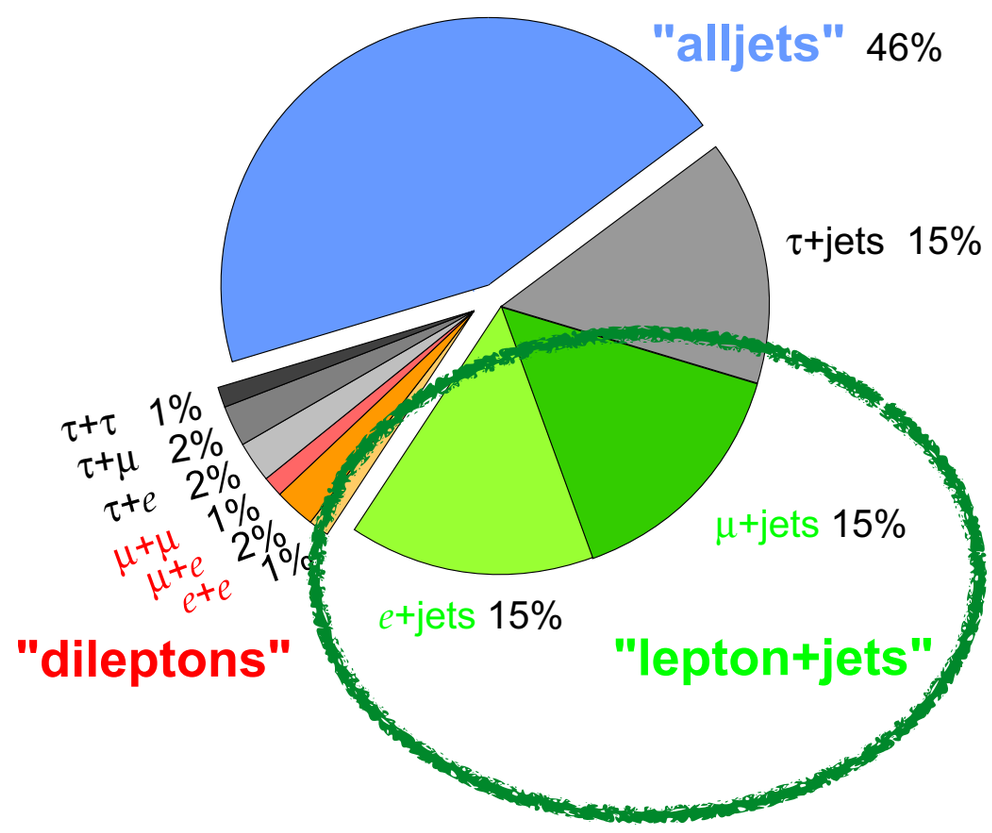
Introduction

$$m_{t\bar{t}} = \sqrt{(E_t + E_{\bar{t}})^2 - (\vec{p}_t + \vec{p}_{\bar{t}})^2}$$

Observed top pair invariant mass distribution

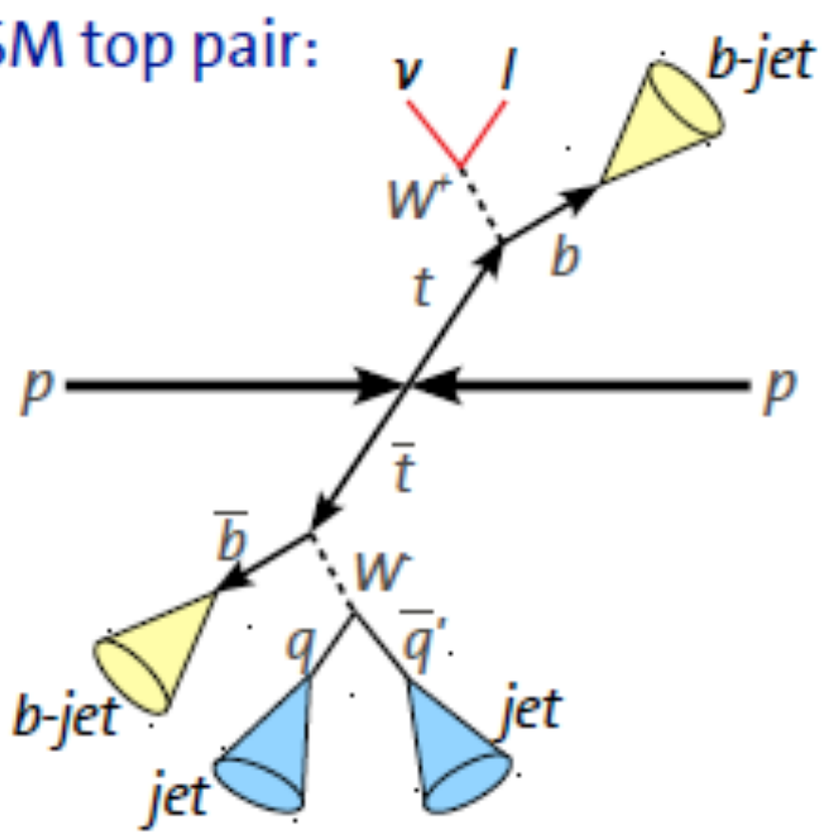


Top Pair Branching Fractions



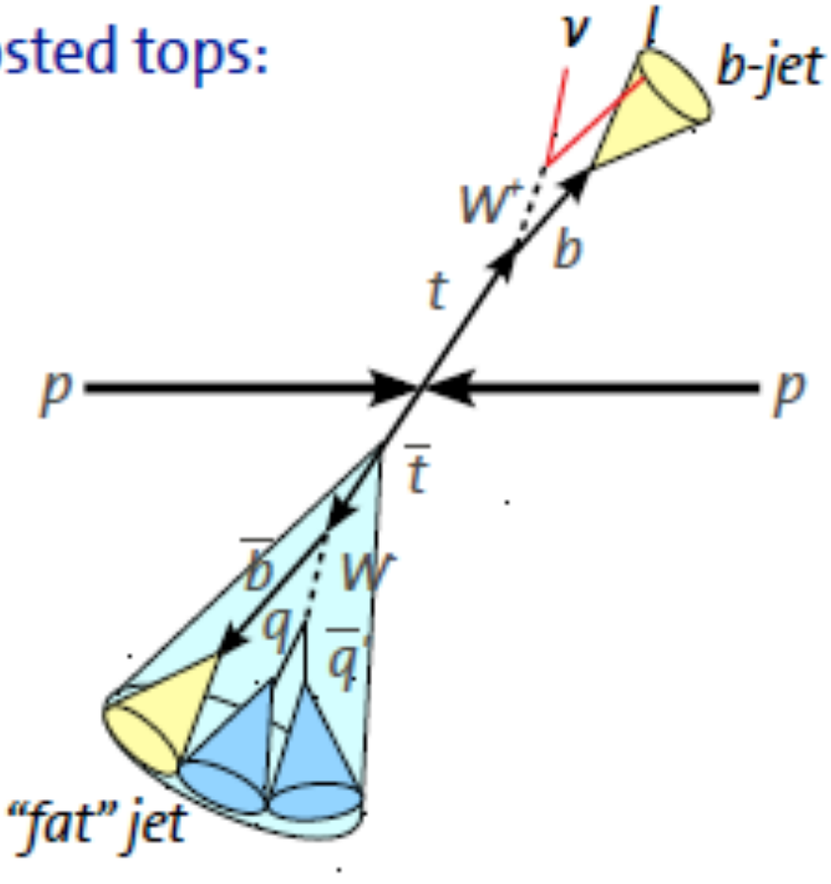
Introduction

SM top pair:



- One lepton, missing energy & 4 jets

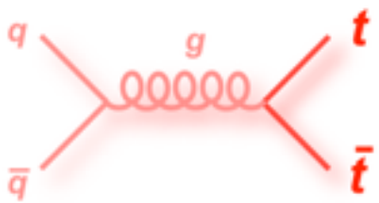
Boosted tops:

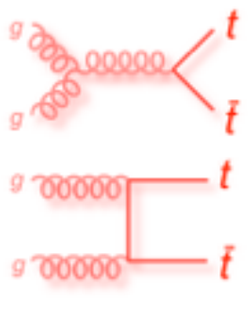


- One lepton (frequently non-isolated) , missing energy & at least 2 jets [Boosted products]

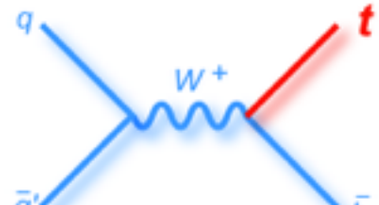
Sample for Background estimation

- ttbar :

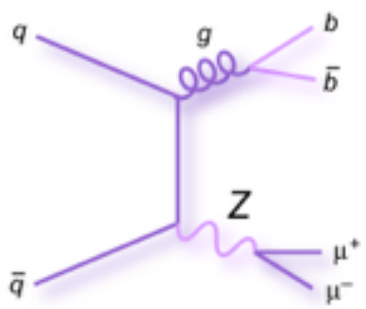


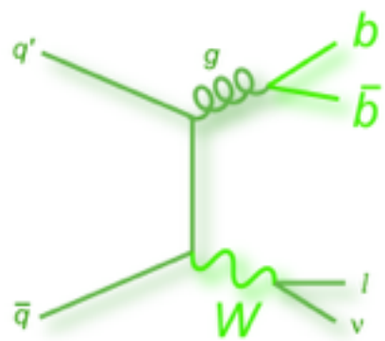


- single top :



- W+jets & Z+jets: MADGRAPH+PYTHIA

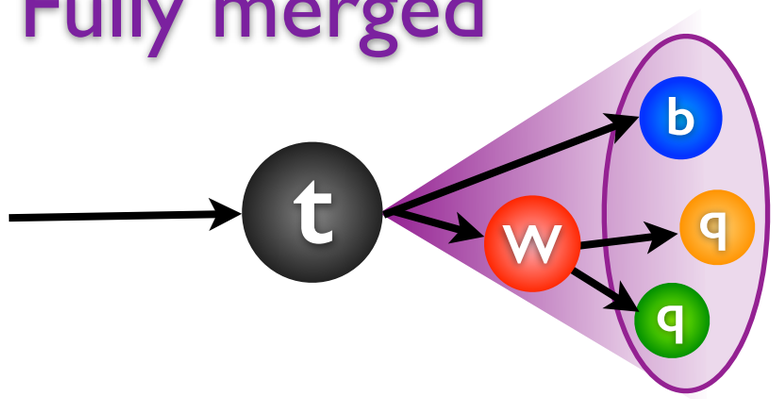




Non-isolated leptons

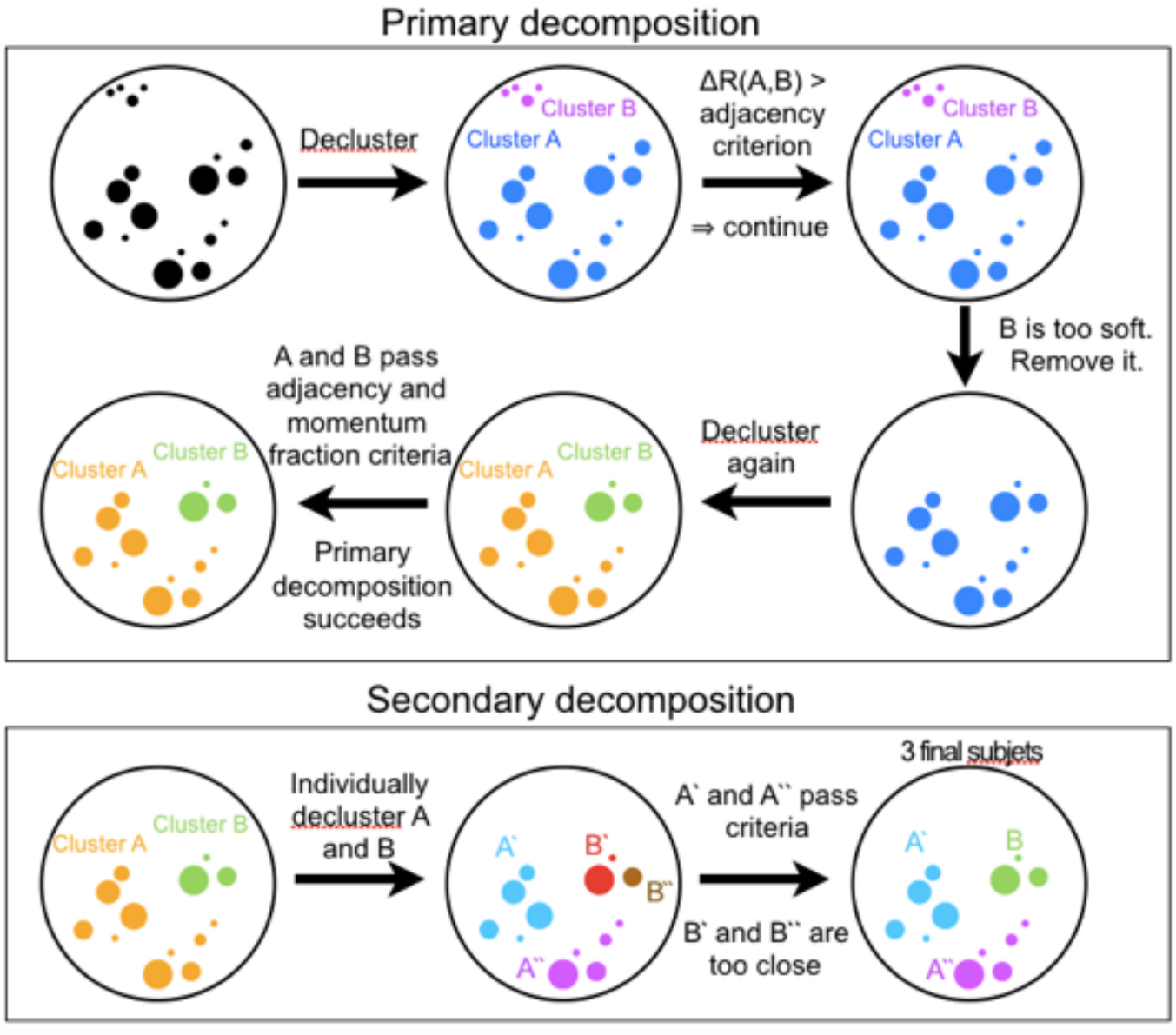
- Selections leptons based on the 2D plane defined by pTrel (lepton, closest jet) and ΔR(lepton, closest jet)

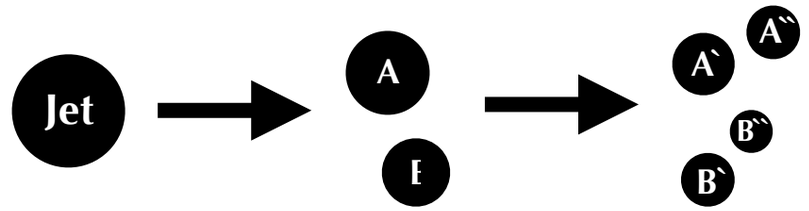
Fully merged

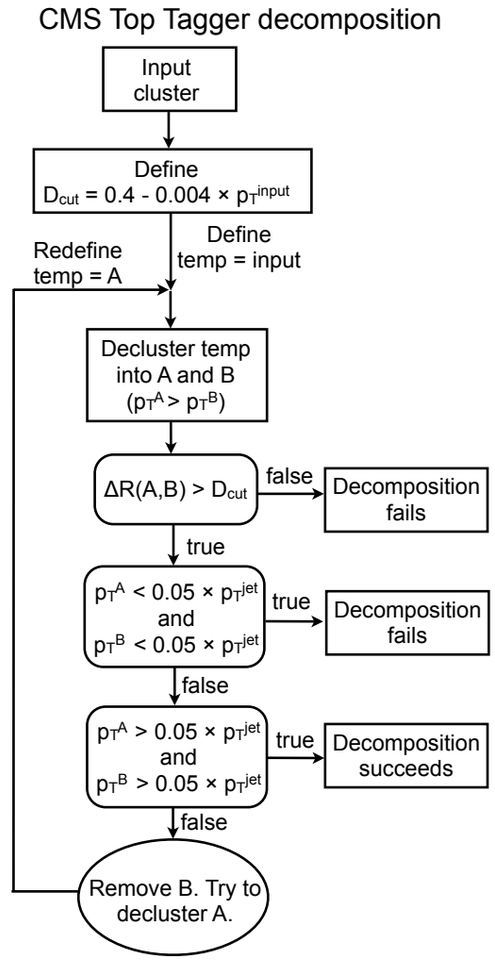


- DeltaR >0.4 or pTrel >20 GeV
- pTrel = transverse component of jet momentum relative to the lepton momentum vector

CMS Top Tagger

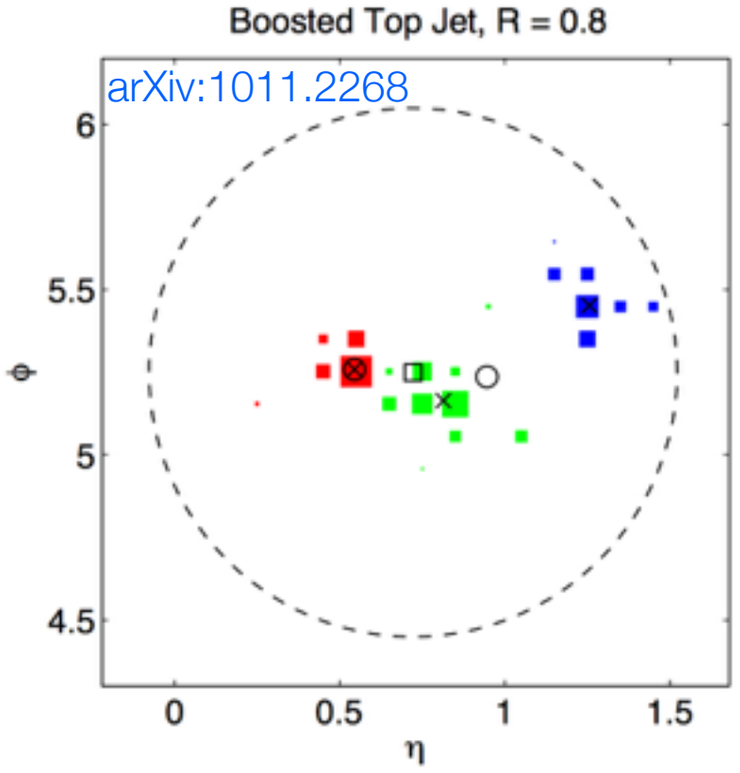






- Jet shape variable which determines how consistent a jet is with having N or fewer subjets
  - $\tau_N \rightarrow 0$ if jet has N or fewer subjets (energy spread is close to the subjet axes)

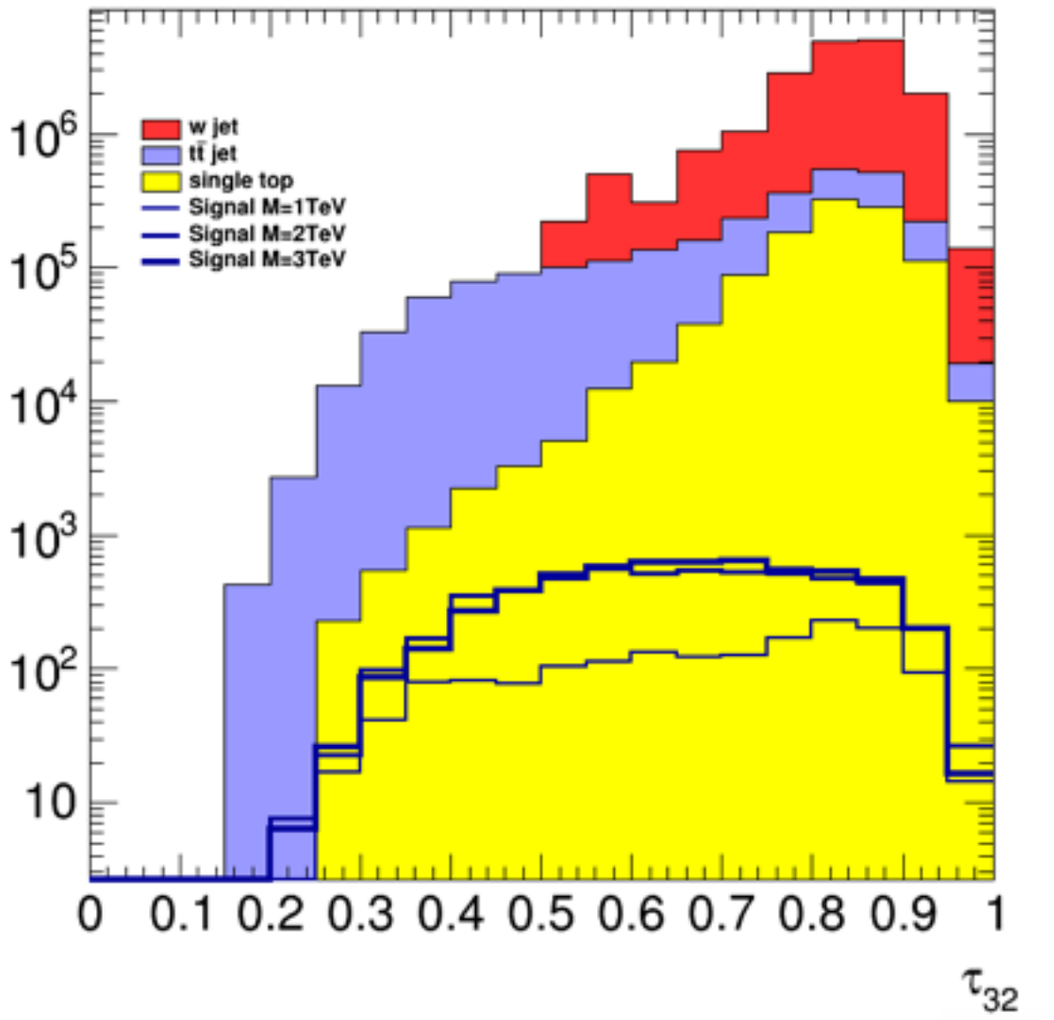
$$\tau_N = \frac{\sum_{i=1}^{n_{\text{constituents}}} p_{\text{T},i} \min\{\Delta R_{1,i}, \Delta R_{2,i}, ..., \Delta R_{N,i}\}}{\sum_{i=1}^{n_{\text{constituents}}} p_{\text{T},i} R}$$

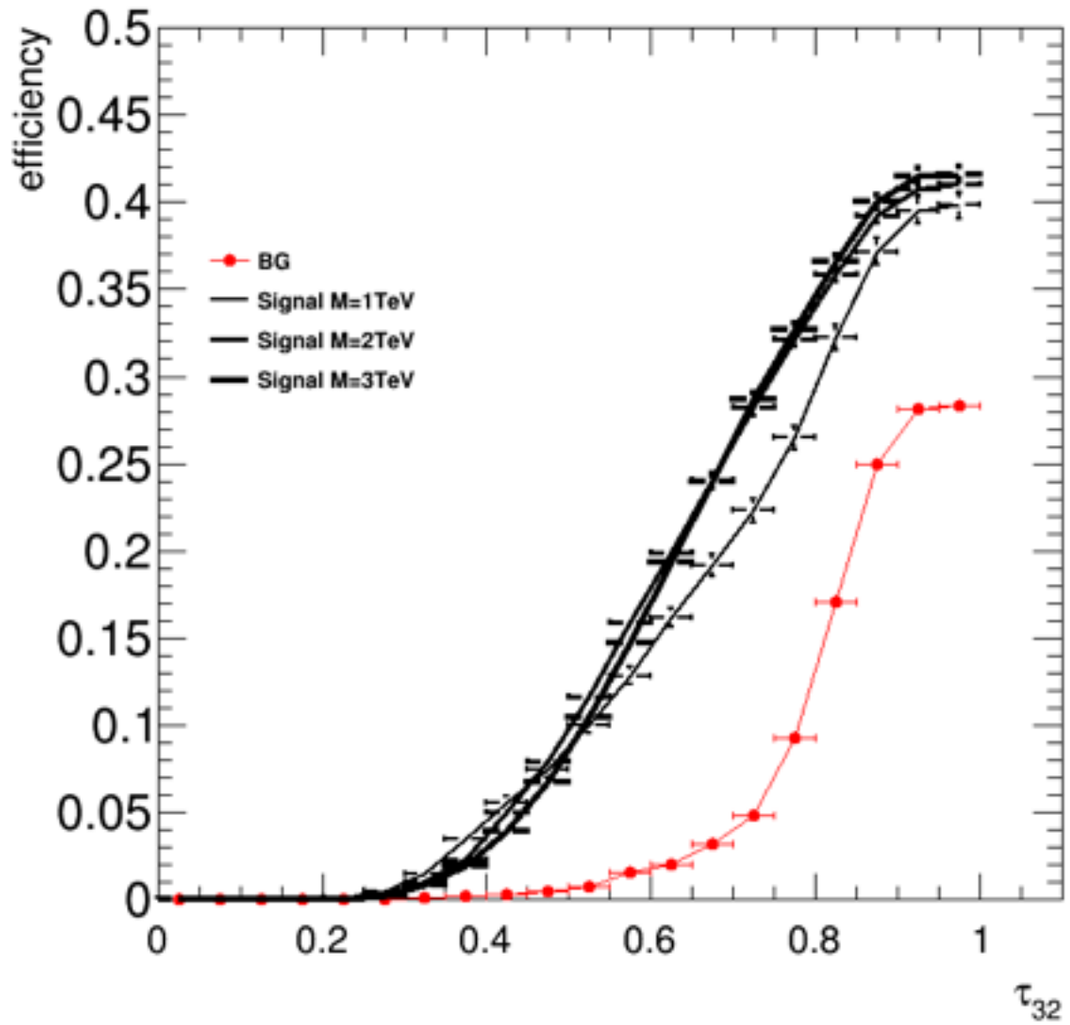


Cut Flow (without MC weight)

	tt + jet	w + jet	single top	signal m=1TeV	signal m=2TeV	signal m=3TeV
Original	6238259	25192800	32840508	98560	97600	98668
preselection	130909	4037	43942	4006	13034	13538
preselection efficiency	2.1%	0.2%	0.1%	4.1%	13.4%	13.7%
only one good μ	83836	2482	27128	2596	9588	10845
b, t Tag cut	13887	7	238	473	1697	1492
good μ and b, t Tag efficiency %	10.6%	0.2%	0.5%	11.8%	13.0%	11.0%

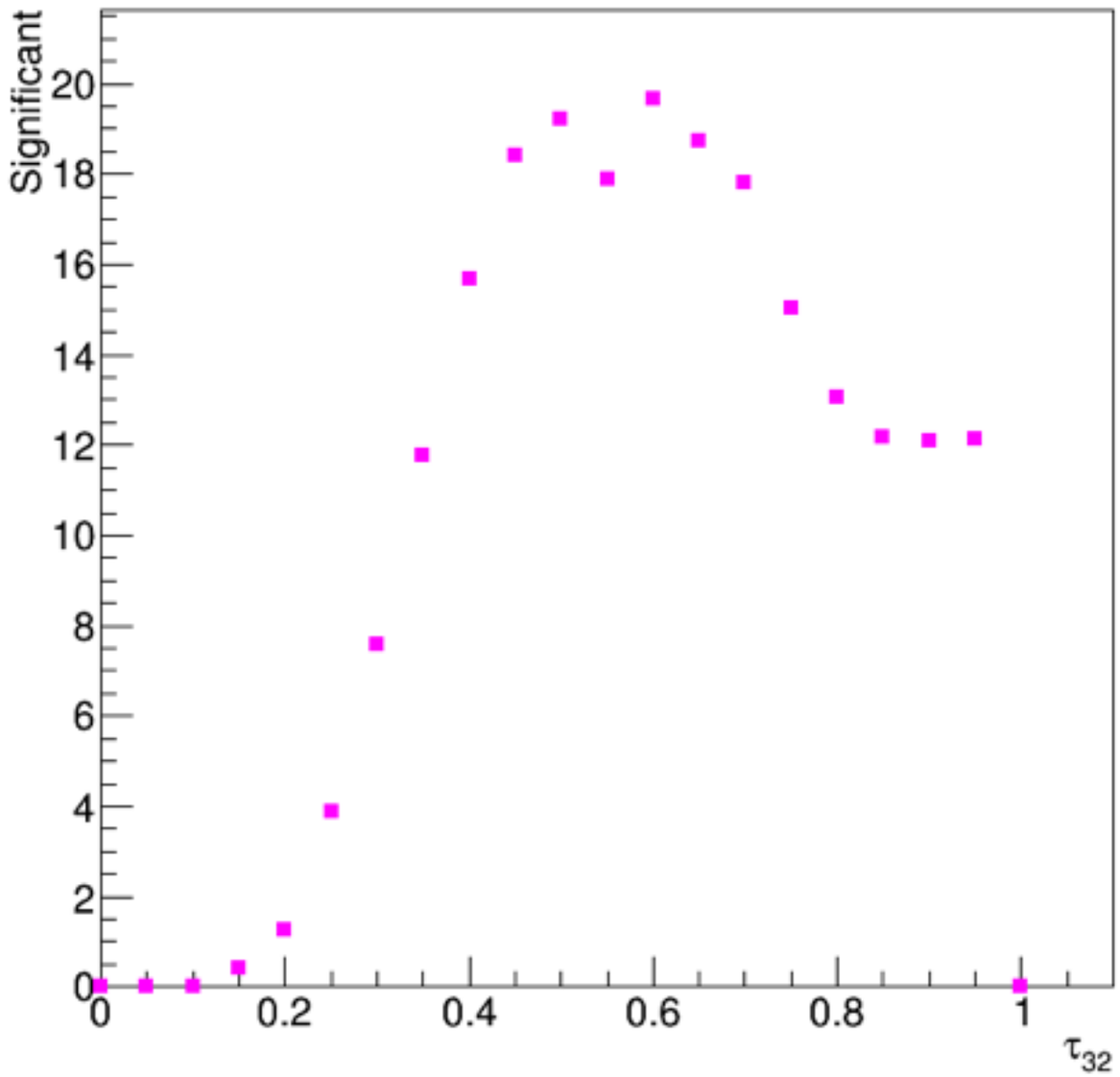
T_{32} selection efficiency





T_{32} optimization

tau 32	Significant
0	0
0.05	0
0.1	0
0.15	0.41095
0.2	1.26409
0.25	3.87393
0.3	7.59391
0.35	11.755
0.4	15.6888
0.45	18.4323
0.5	19.2103
0.55	17.8721
0.6	19.6813
0.65	18.7199
0.7	17.8241
0.75	15.0337
0.8	13.0413
0.85	12.1608
0.9	12.08
0.95	12.1236



Top-Tagging Efficiency

	ttbar	700~1000	>1000	ttbar> 700	>700	data
	0.191126± 0.0014	0.221294± 0.00235	0.30278±0 .00235	0.19304±0 .394684	0.297153± 0.001169	0.103019± 0.006431

systematic uncertainty

- oral!!

Cut Flow (with MC weight)

electron

ttbar	ST	Wjets	RS1.5TeV	RS2TeV	RS3TeV	data
1572.90+/-10.94	310.79+/-6.21	3425.18+/-27.32	356.66+/-8.79	103.47+/-2.46	11.08+/-0.30	10159.00+/-100
1572.90+/-10.94	310.79+/-6.21	3425.18+/-27.32	356.66+/-8.79	103.47+/-2.46	11.08+/-0.30	10159.00+/-100
425.90+/-5.56	25.26+/-2.06	78.64+/-4.04	126.20+/-5.27	31.74+/-1.38	3.30+/-0.16	536.00+/-23.15
422.40+/-5.54	25.26+/-2.06	78.14+/-4.03	124.62+/-5.24	30.86+/-1.36	3.17+/-0.16	527.00+/-22.96
268.93+/-4.38	9.73+/-1.26	10.18+/-1.43	87.14+/-4.39	20.07+/-1.09	2.04+/-0.13	253.00+/-15.91
79.94+/-2.03	5.17+/-0.91	6.03+/-1.09	56.62+/-3.55	15.78+/-0.97	1.59+/-0.11	74.00+/-8.60

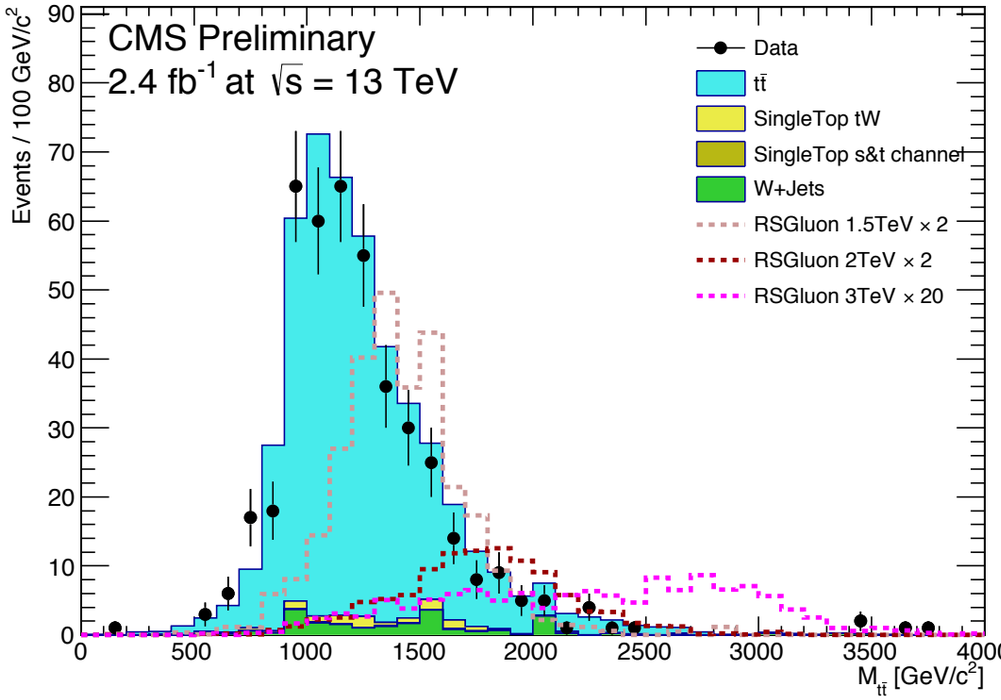
muon

2746.37+/-14.24	458.57+/-7.34	5029.62+/-45.65	787.12+/-13.11	294.45+/-4.15	44.60+/-0.59	25213.00+/-15
2746.37+/-14.24	458.57+/-7.34	5029.62+/-45.65	787.12+/-13.11	294.45+/-4.15	44.60+/-0.59	25213.00+/-15
761.28+/-7.29	33.57+/-2.31	131.58+/-9.50	255.01+/-7.42	95.66+/-2.38	12.17+/-0.31	1123.00+/-33.51
672.02+/-6.90	31.45+/-2.23	103.69+/-6.21	215.19+/-6.84	78.76+/-2.16	10.19+/-0.29	864.00+/-29.39
441.88+/-5.54	12.13+/-1.33	22.10+/-4.50	145.62+/-5.64	53.62+/-1.78	6.41+/-0.23	438.00+/-20.93
151.44+/-2.79	5.92+/-0.97	12.59+/-3.53	95.26+/-4.55	47.46+/-1.68	5.85+/-0.22	145.00+/-12.04

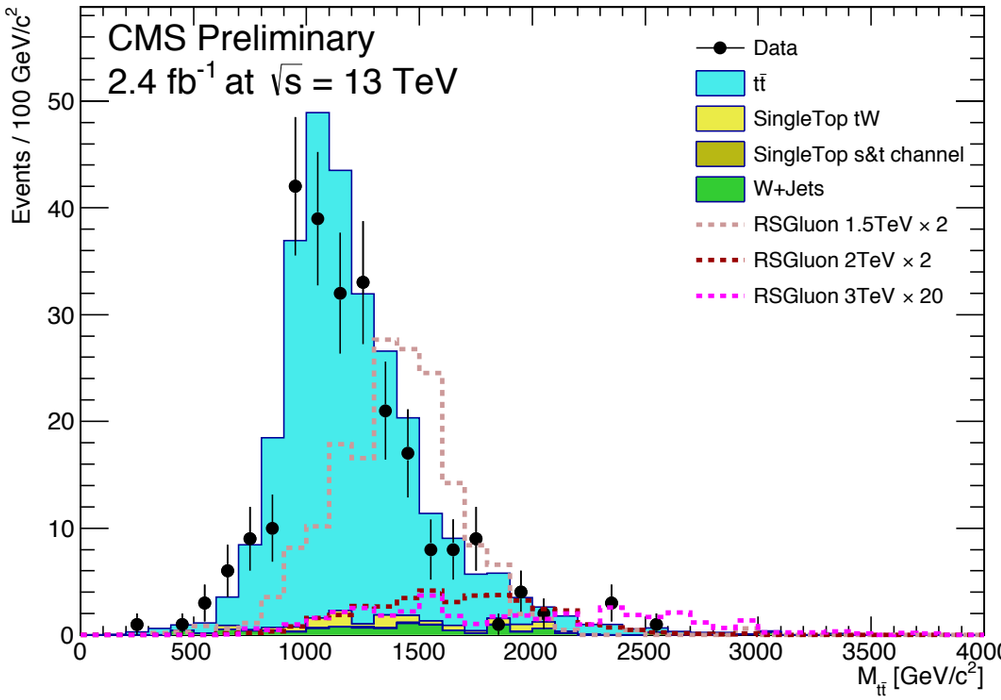
```
preselection
        passKin = hadTopCandP4.Perp() > 400.
        passTopTag = tau32 < 0.6 and mass_sd > 110. and mass_sd < 250.
        pass2DCut = LeptonPtRel[0] > 55. or LeptonDRMin[0] > 0.4
        passBtag = bdisc > 0.7
    passWindow = mttbar > 1300.
```

ttbar invariant mass

after apply all the cuts except m_ttbar cut



μ channel



e channel

Conclusion

- We have performed the following work
  - cuts optimization
  - signal and background uncertainty from JES,JER
  - cutflow and discriminant distributions
- The observed data is consistent with SM prediction. No evidence for significant excess for RSgluon signal.