

# Top Tagging

work with Tilman Plehn, Michihisa Takeuchi, Michael Spannowsky

Felix Kling

Universität Heidelberg

DPG-Frühjahrstagung, 29th Feb. 2012

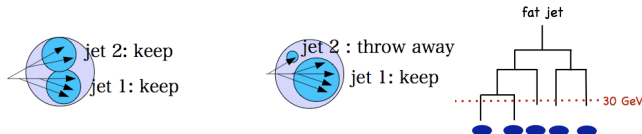
## Top quark

- copiously produced via strong interaction at LHC  
 $\sigma_{t\bar{t}}^{14\text{TeV}} = 918 \text{ pb}$ ,  $\sigma_{t\bar{t}}^{7\text{TeV}} = 165 \text{ pb}$ ,  $\sigma_{t\bar{t}}^{\text{Tevatron}} = 7.5 \text{ pb}$
- window to new physics: top partners,  $A_{FB}^t$ ,  $\sigma_t/\sigma_s$  for single top
- strongly coupled to Higgs sector

## Top tagger

- idea: reconstruct tops like bottoms at Tevatron
- several top taggers available  
[John Hopkins Tagger, Thaler-Wang Tagger, N-Subjettiness Tagger, etc.]
- low  $p_T$  critical  
 $\sigma_{t\bar{t}}^{14\text{TeV}}(p_T > 500) \sim 100 \text{ fb}$ ,  $\sigma_{t\bar{t}}^{14\text{TeV}}(p_T > 200) \sim 9000 \text{ fb}$

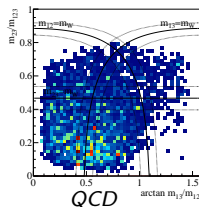
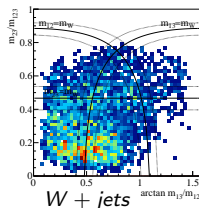
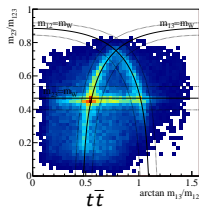
1. **fat jets** – Cambridge-Aachen ( $R = 1.5$ ),  $p_T^{\text{fat jet}} > 200$  GeV
2. **mass drop criterion**
  - find hard sub-jets  $m_j < 30$  GeV,  $m_{j1} < 0.8m_j$  to keep  $j_1$  and  $j_2$



3. **choose 3 hard sub-jets with best filtered mass** [Phys. Rev. Lett. 100, 242001 (2008).]
  - $|m_{jjj}^{\text{filt}} - m_t| < 25$  GeV and  $p_T^{\text{rec}} > 200$  GeV → **top candidate**

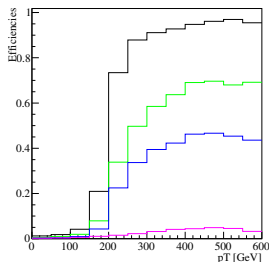
## 4. check mass ratios

- $W$  mass condition, soft-collinear cut → **tagged top**



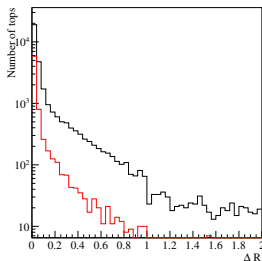
## efficiency

- tagging rate:  $\sim 35\%$  for hadronic tops
- mis-tag rate:  $W$ +jets: 4%, QCD: 2%
- validation by ATLAS Heidelberg  
[Sebastian Schätzel, Gregor Kasieczka (talk at DPG)]



## momentum reconstruction

- momentum well reconstructed
- better reconstruction for large  $p_T$ 
  - black:  $p_T^{\text{rec}} > 200\text{GeV}$
  - red:  $p_T^{\text{rec}} > 300\text{GeV}$
- 95 % in  $\Delta R < 0.5$



Motivation

HEPTopTagger

Performance

Single top production

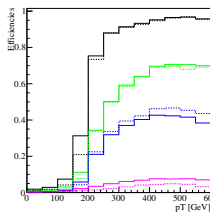
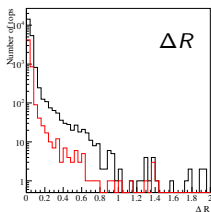
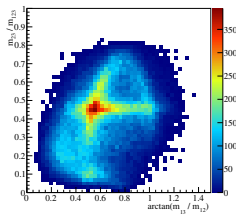
Summary

## fast detector simulation: Delphes

- detector geometry
- momentum smearing
- isolated lepton identification

## performance study for $t\bar{t}$

- topology of mass plane unchanged
- after Delphes: tagged tops with same kinematics as before
- tagging efficiency: 35%



Motivation

HEPTopTagger

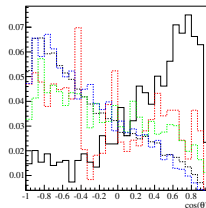
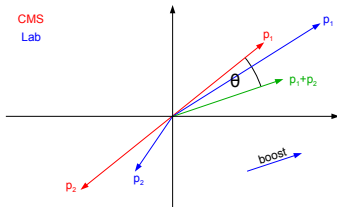
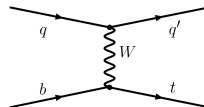
Performance

Single top production

Summary

## selection cuts for t-channel single top production

- b-tag inside tagged top
- pruning + filtering
- angular correlation between tagged top and recoil jet  
[Collins-Soper angle, arXiv:0906.1803]
- kinematic cuts on recoil jet and top



- preliminary results at 8 TeV:

	$t\bar{t}$ -BG	QCD-BG	Single top	S/B
hadronic events $\sigma[fb]$	$98 \cdot 10^3$	$652 \cdot 10^6$	$46 \cdot 10^3$	0.00007
tagged top $\sigma[fb]$	$4.9 \cdot 10^3$	$209 \cdot 10^3$	$0.27 \cdot 10^3$	0.001
b-tag $\sigma[fb]$	$1.6 \cdot 10^3$	$4.1 \cdot 10^3$	$0.1 \cdot 10^3$	0.017
pruning $\sigma[fb]$	$1.1 \cdot 10^3$	$1.5 \cdot 10^3$	$0.08 \cdot 10^3$	0.028
$\cos \theta$ $\sigma[fb]$	$0.13 \cdot 10^3$	$0.22 \cdot 10^3$	$0.04 \cdot 10^3$	0.097

## HEPTopTagger

- focus on moderate  $p_T$  tops ( $p_T > 200\text{GeV}$ ), testable in SM
- hadronic top reconstruction well understood
- performance stays unchanged under detector simulation

analysis on single top in progress

Motivation

HEPTopTagger

Performance

Single top production

Summary