Top Jets @ the LHC

(Boosted but less collimated)

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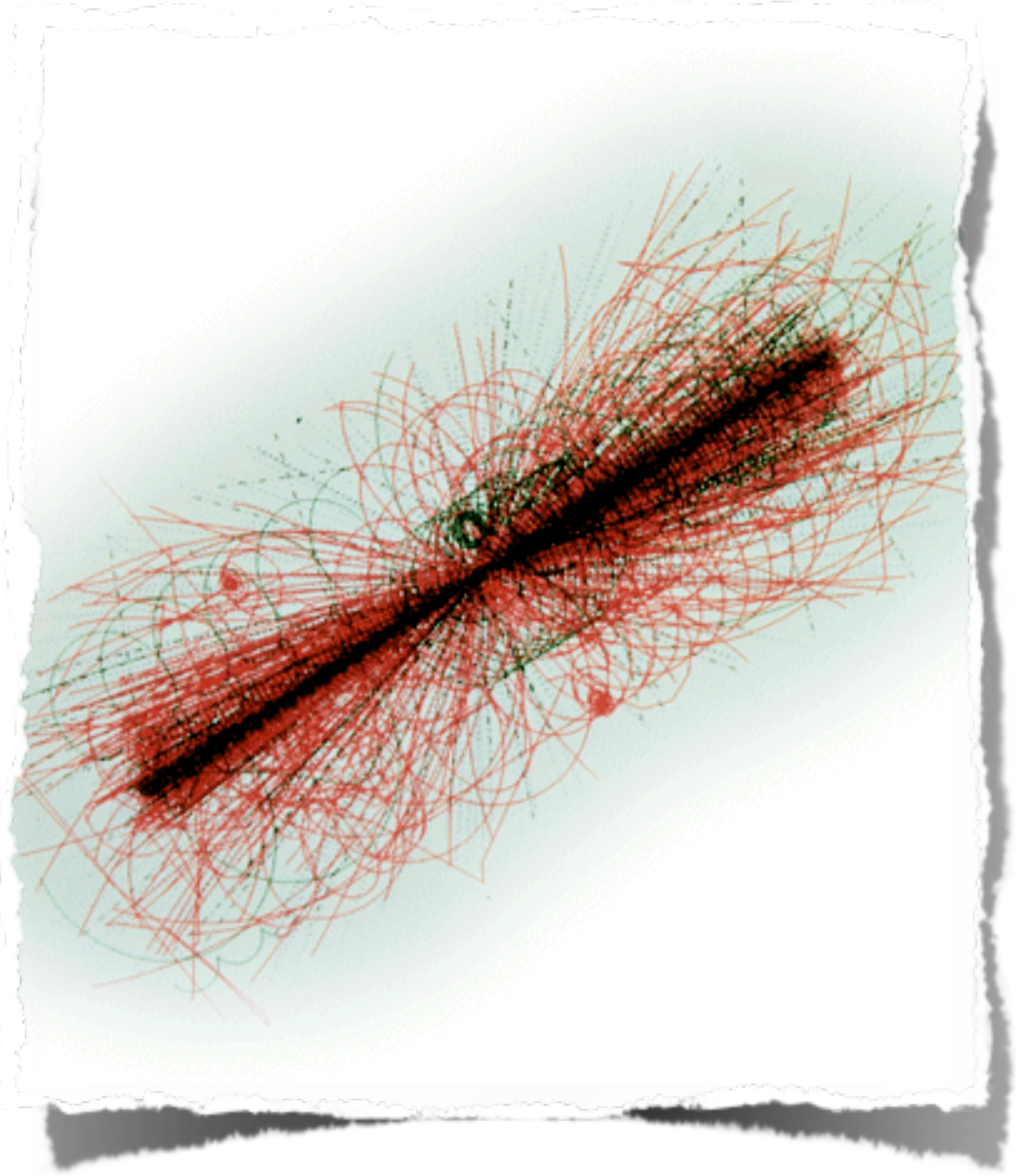
with L. Almeida, G. Perez, G. Sterman, I. Sung, J. Virzi (2008)
with L. Almeida, G. Perez, I. Sung, J. Virzi (2008)
with G. Perez, A. Weiler, J. Zupan (work in progress)

Outline

- Introduction
- Living on the tail
- Simple-minded analysis
- Summary



Introduction

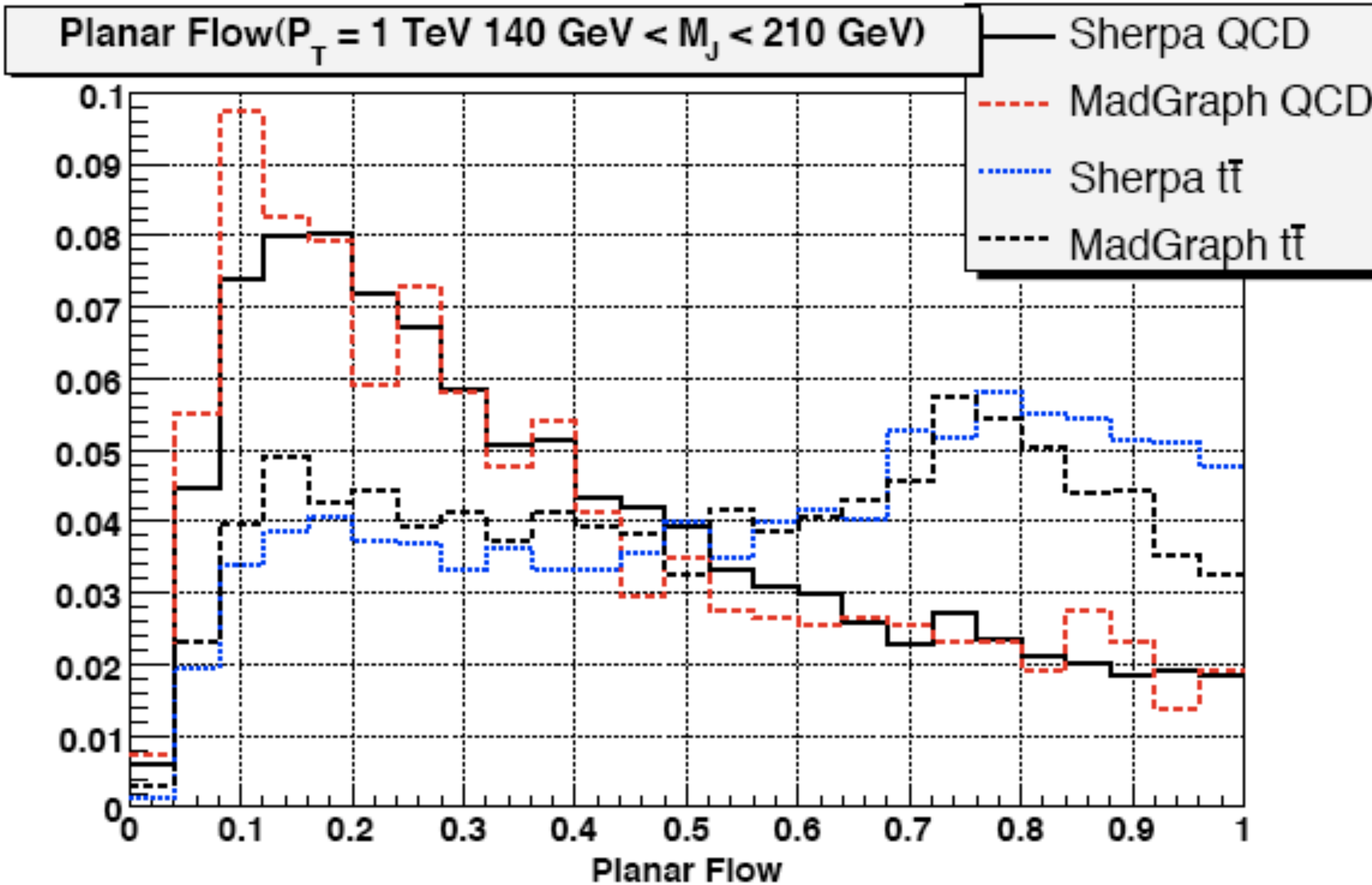
- Very collimated top jets (R < 0.4) are challenging due to detector resolution and meson showers

- In this case, can use jet mass + jet shapes, which are robust, but less efficient.

For jet mass+planar flow:

Rejection $=(1:20)*(1:2.5)^2 \sim 1:125$

Planar Flow



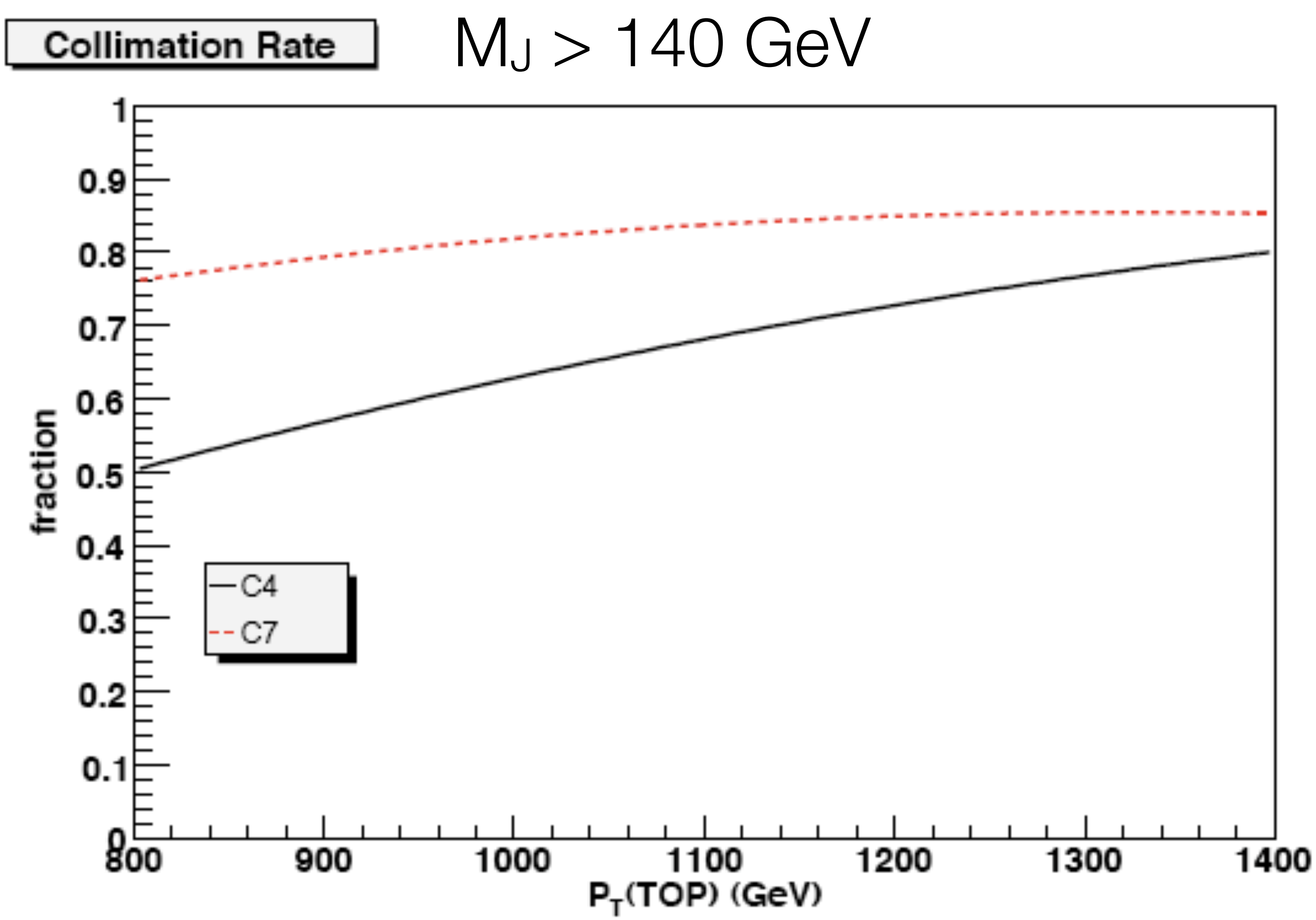
Planar Flow(P_T = 1 TeV 140 GeV < M_J < 210 GeV)
Sherpa QCD
MadGraph QCD
Sherpa $t\bar{t}$
MadGraph $t\bar{t}$
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Planar Flow

Living on the tail

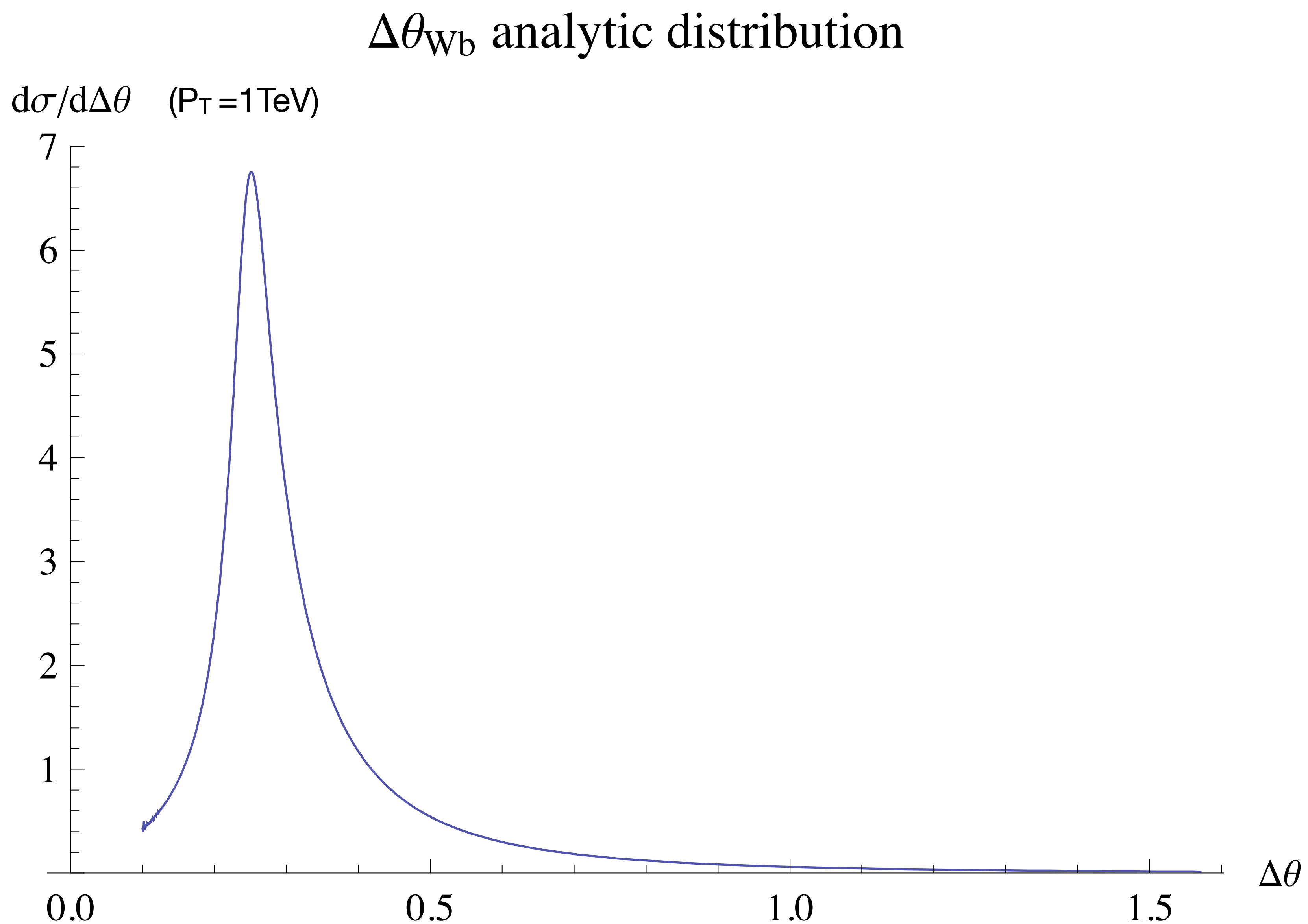
SL, Perez, Weiler & Zupan.

Boosted, but less collimated

✦Kinematically, top is a two body decay, hence, sometimes one of the daughter product is soft => large separation



Tail of semi-collimated boosted tops



$$R_{\mathrm{col}}^{Wb} \sim 0.8 \Rightarrow \ \mathrm{non-collimated\ frac} \sim 1 - \left(R_{\mathrm{col}}^{Wb}\right)^2 \sim 0.4!$$

SL, Perez, Weiler, Zupan.

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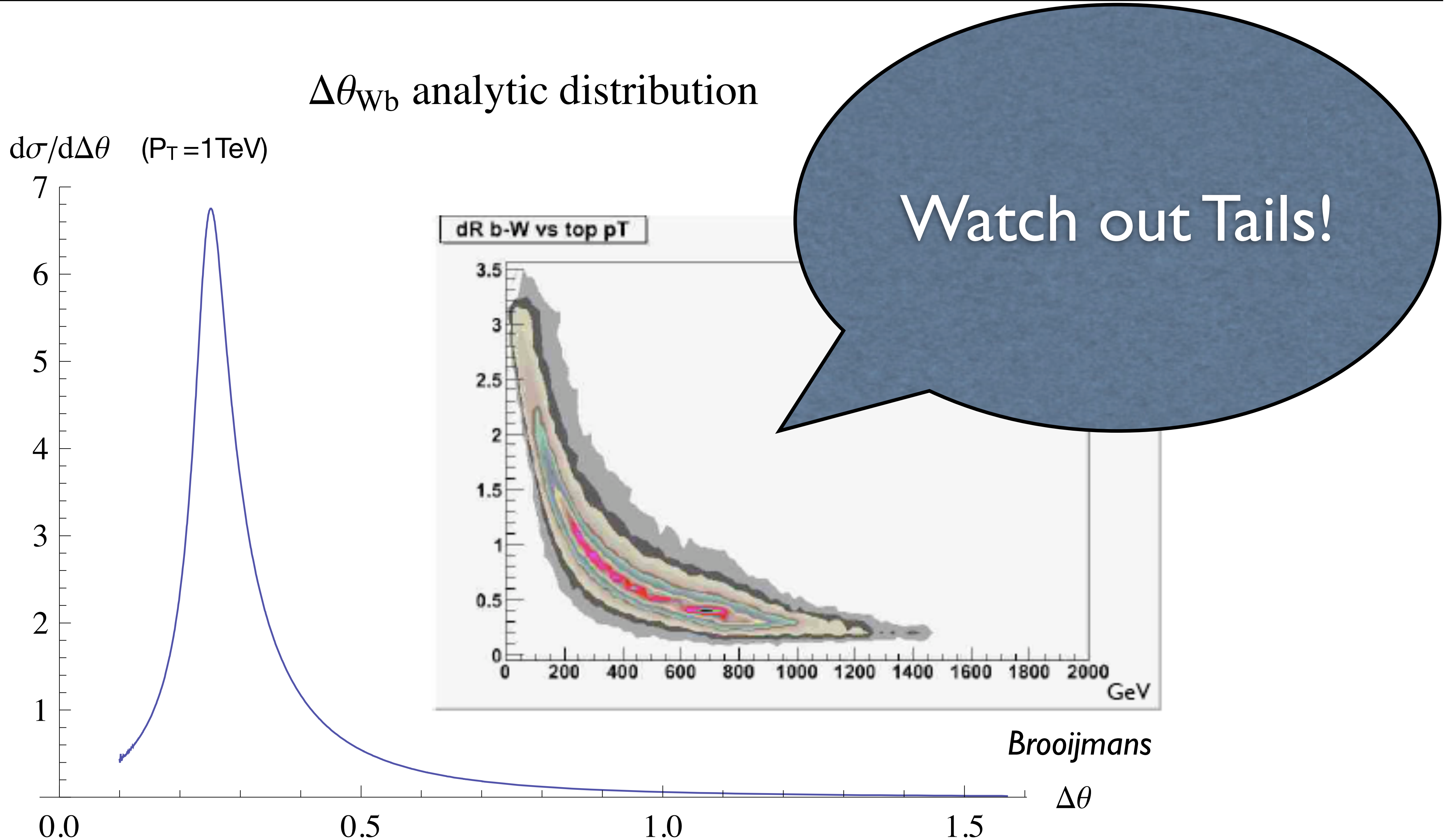

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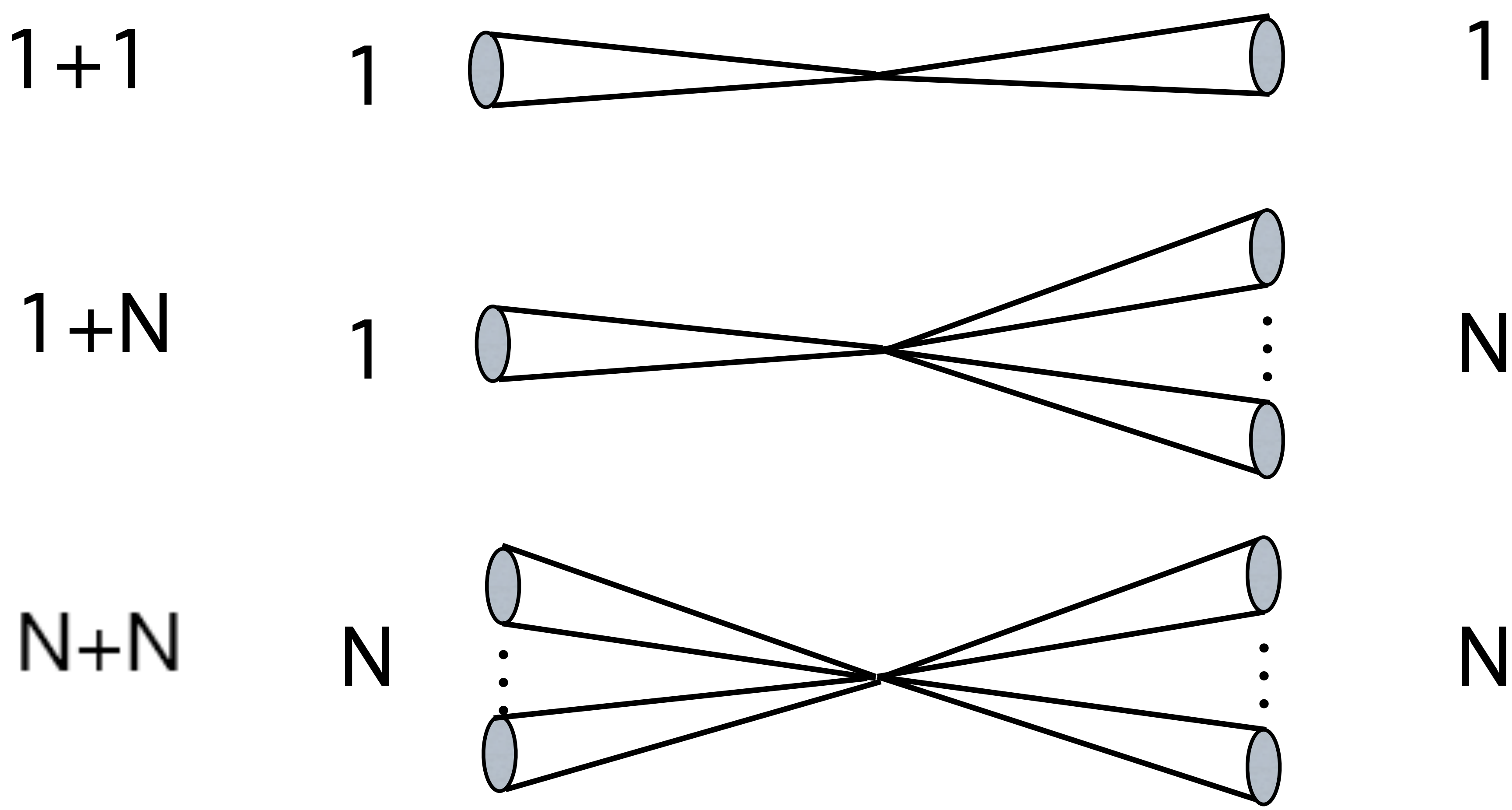
SL, Perez, Weiler, Zupan.

Boosted, but less collimated

- ttbar events can be classified according to their topology (more than 2 jets)
- Easier for detector & good for BG rejection



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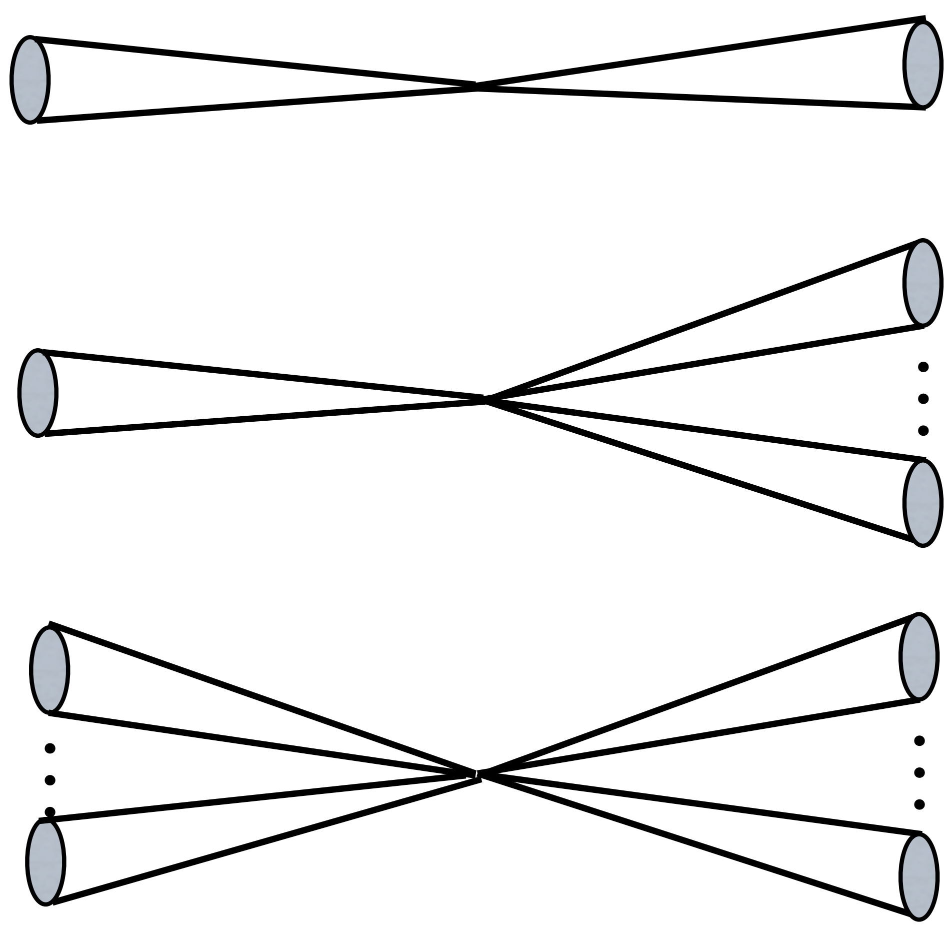


			P_T >1 TeV	P_T >1.5 TeV
1+1	1	1	17%	22%
1+N	1	N	49%	55%
N+N	N	N	34%	23%

An efficient IRC-safe algorithm (for ttbar) is constructed, adapted to detector

SL, Perez, Weiler & Zupan.

- Acceptance: PT > 1TeV for R=0.8, etc
- Jet finder: R=0.4; look for 140 GeV > m_{top}
- Classify: (requiring top mass)

  1+1 (fully collimated): 2 separated jets with 140 GeV < m_j

  1+N (partly collimated): 1 jet with 140 GeV < m_j

  N+N (fully un-collimated): 0 jet with 140 GeV < m_j
- For 1+2:

  Look for W + b jet (requiring W-mass as well)

  Can narrow top mass window to get higher rejection

ttbar signal efficiency vs QCD jets fake rate

Preliminary

- varying top mass window: **140 GeV < m < 250 GeV**
  160 GeV< m < 190 GeV

(# of reconstructed)/(# of events passing pre-selection)

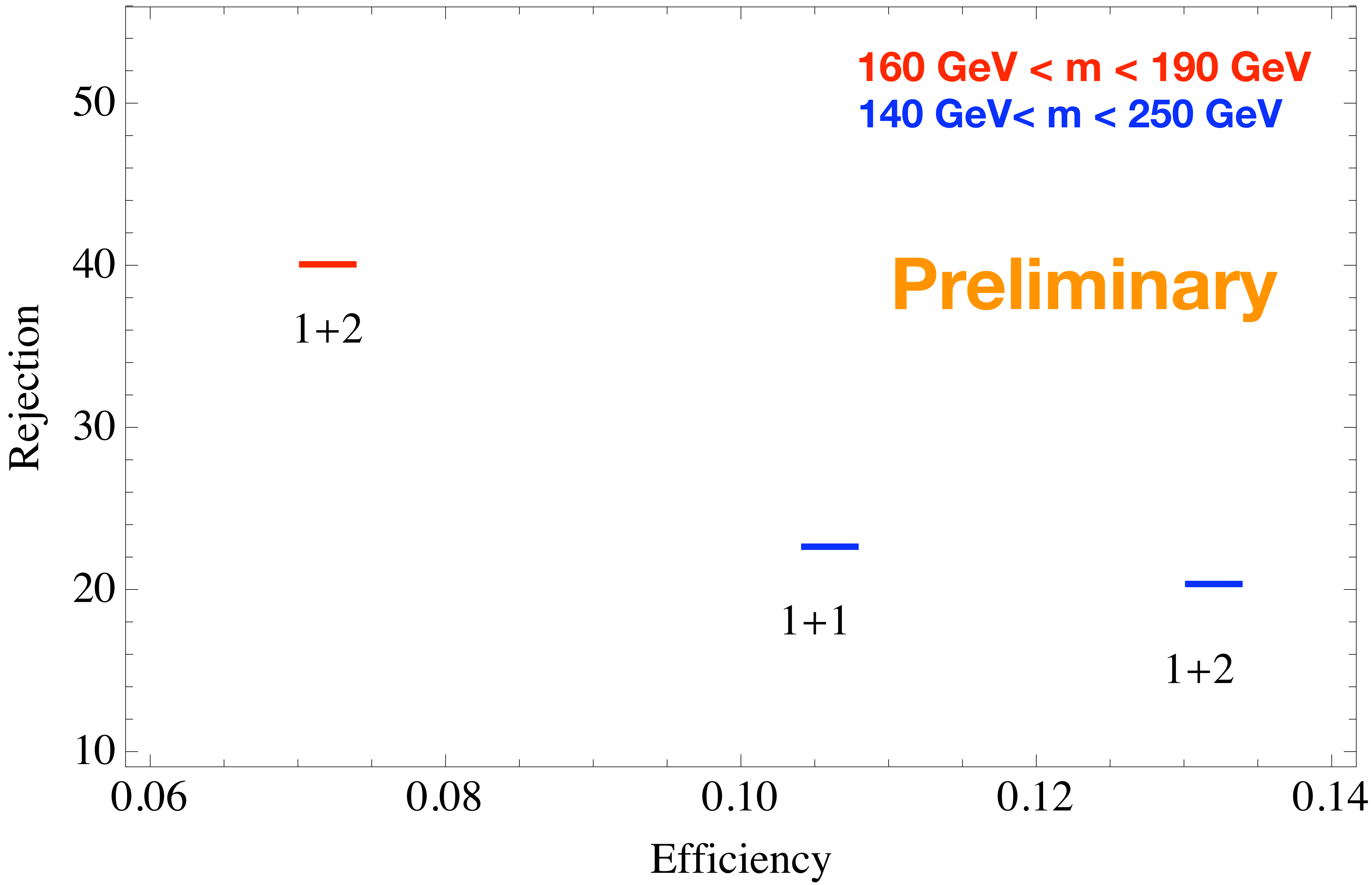
(ALPGEN-MLM matching)

top	ttbar+X
1+1	0.064
	0.145
1+2	0.072
	0.106
...	...

QCD	2j	3j	4j	5j
1+1	0.0018	0.0037	0.0019	0.0022
	0.098	0.0015	0.016	0.024
1+2	0.0004	0.0026	0.0049	0.0075
	0.0014	0.0073	0.014	0.027
...	...	...	...	...
	...	...	...	...

Efficiency vs Rejection (ALPGEN)

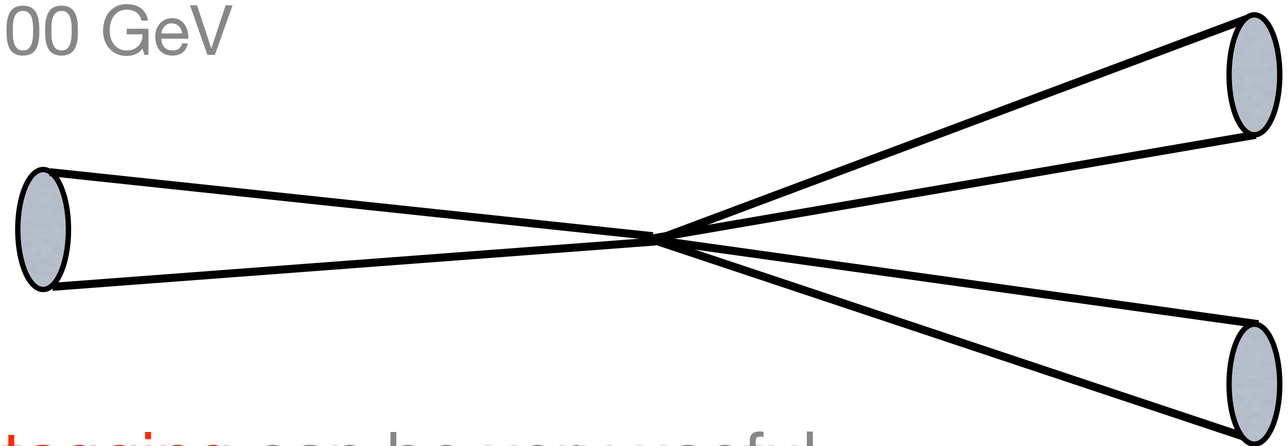
SM ttbar continuum against QCD jets
(PT> 1 TeV)



1+2 jet topology and b-tagging

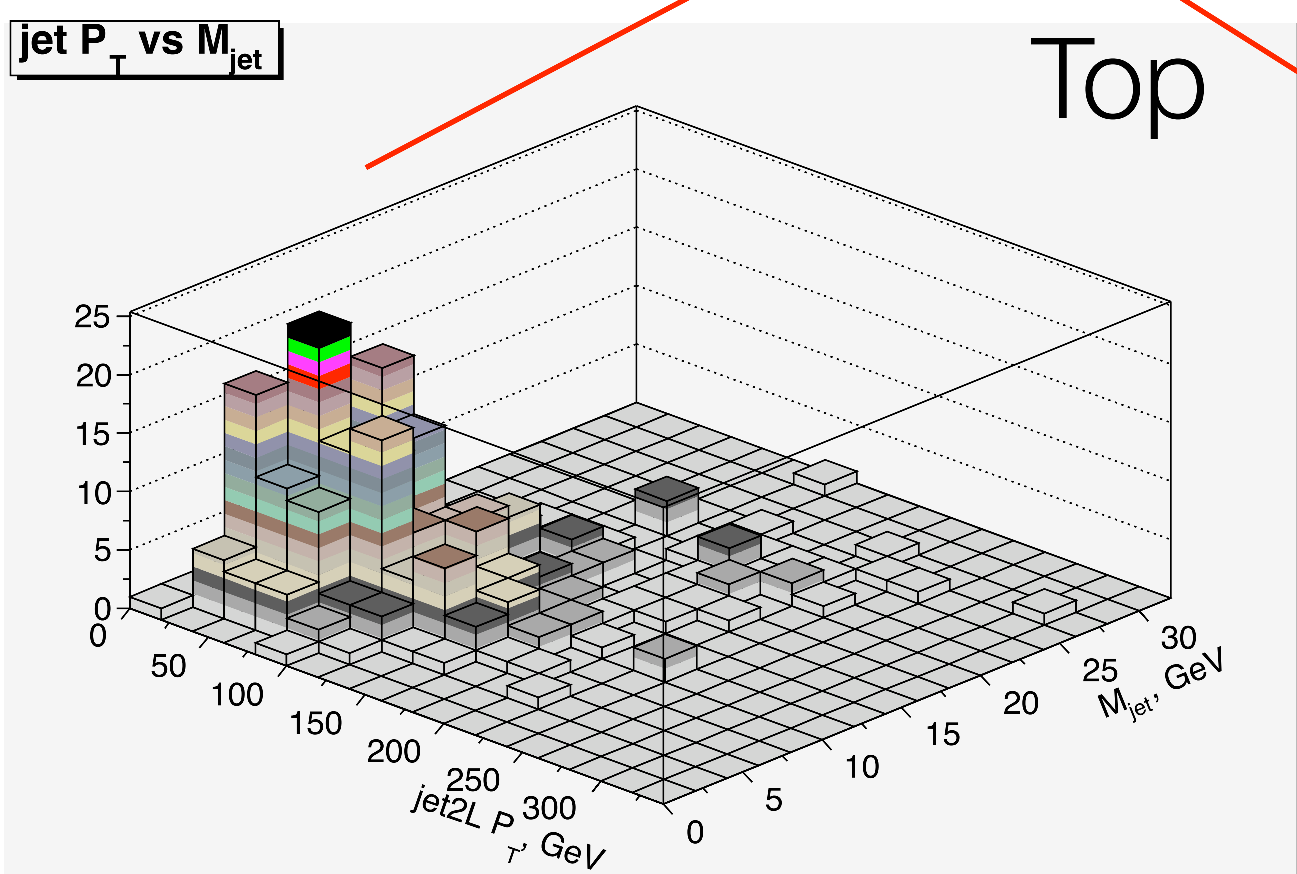
- With 70 GeV $< M_W <$ 100 GeV

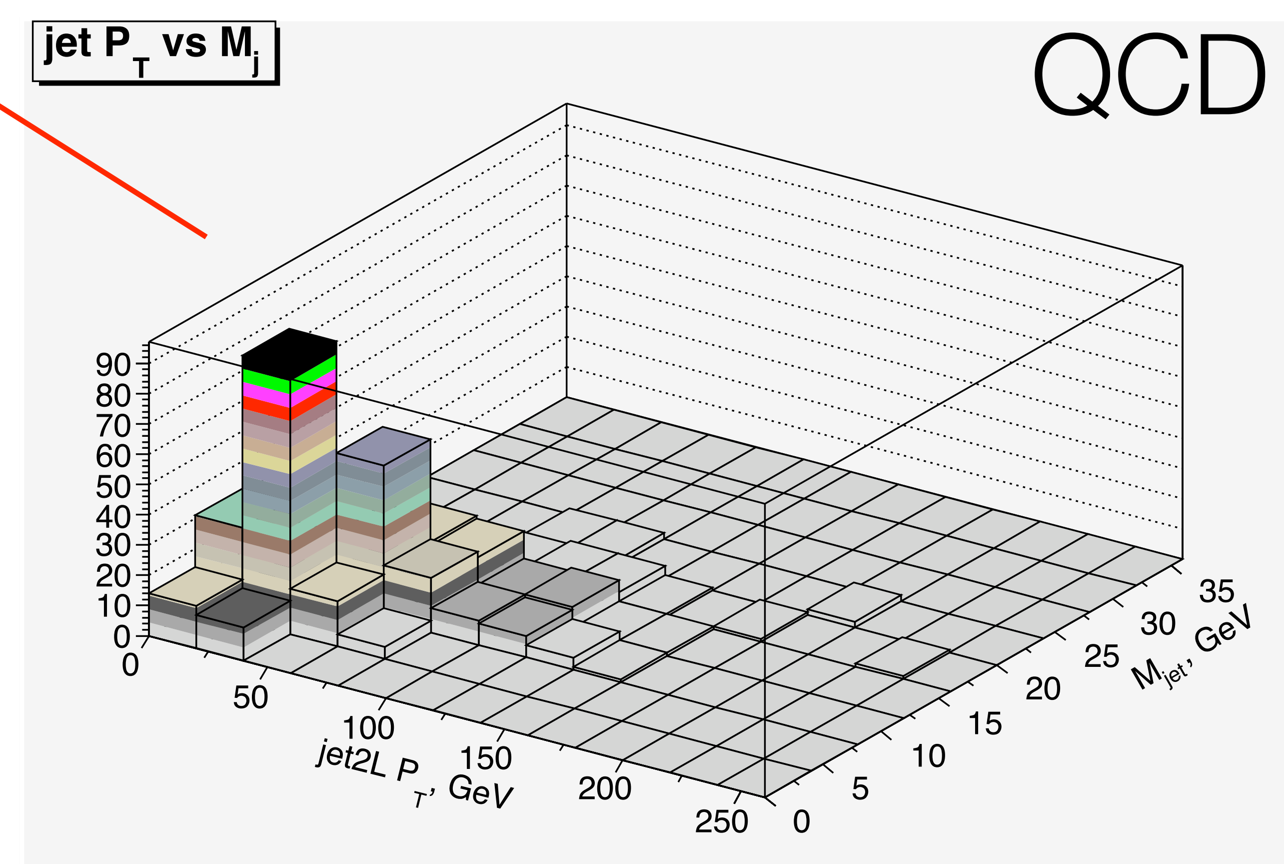
1+2: 1



N=2

- lighter jet P_T is soft: b-tagging can be very useful





Summary

✦Final Efficiency (rejection):

- Additional efficiency is coming from 1+1, 1+2, 1+3, 2+2, etc.

- “b-tagging” is promising (can use p_T of b-jet to probe top polzrization) Almeida, SL, Perez, Sung, Virzi

- Can use jet-shapes (Angularity for W-jet, Planar flow for single top-jet, etc) to further increase efficiency

$$\epsilon_{final} = \sqrt{\epsilon^2_{1+1} + \epsilon^2_{1+2} + \epsilon^2_{1+3} + \cdots}$$