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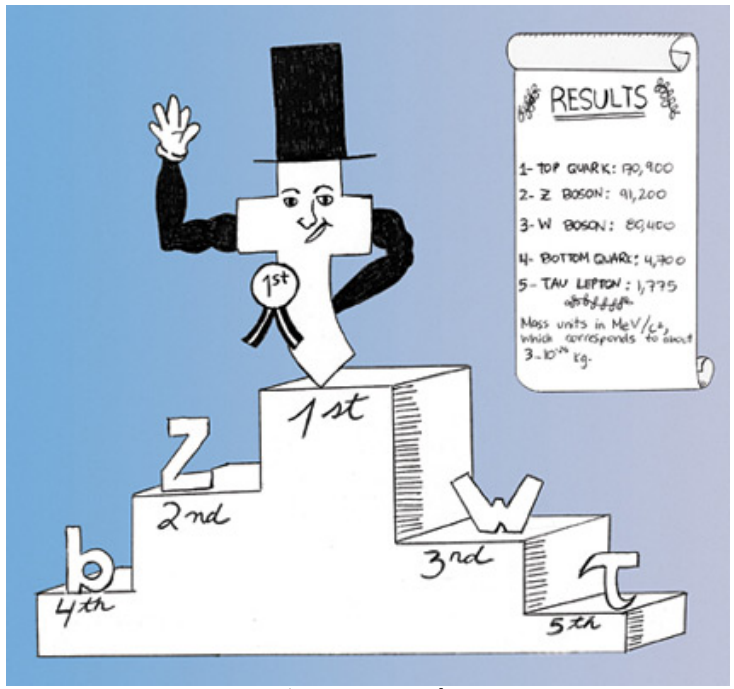
The Top Mass In The Fully Hadronic Decay

Paul Seidler
Max-Planck-Institut für Physik
Atlas HEC Group / IMPRS

The Top Quark



www.symmetrymagazine.org

Top Quark discovered in 1995:
F. Abe et al, Phys. Rev. Lett. 74. 2626 (1995)

Present State of the Art:
CDF and D0 results combined in:
http://arxiv.org/pdf/0903.2503

Heaviest Observed Elementary Particle Up to Date
Combined M(top) = 173.1 +- 1.3 GeV
Full had M(top) = 175.1 +- 2.6 GeV

Top Expectations @ LHC

Production Xsection for $t\bar{t}$ at 7TeV ~ 100pb

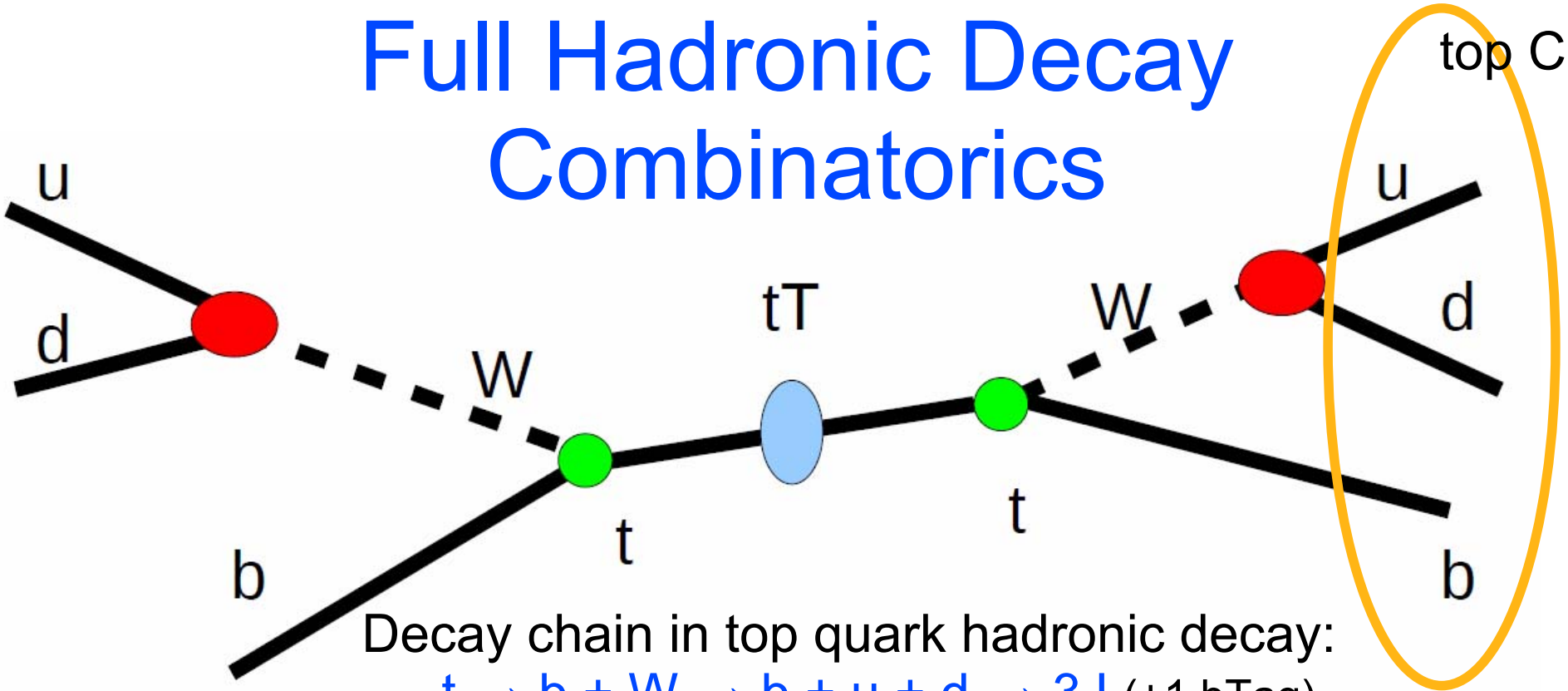
Expected data until end of run 2011 ~ 1000 pb^{-1}
Results in 100k $t\bar{t}$ pairs in next run period

Fully hadronic decay Branching Fraction:

$$\frac{\sigma(t\bar{t} \to q\bar{q}bq\bar{q}\bar{b})}{\sigma(t\bar{t})} \approx 0.4$$

Expect up to 40000 Fully Hadronic Decays

Full Hadronic Decay Combinatorics



Decay chain in top quark hadronic decay:

$t \rightarrow b + W \rightarrow b + u + d \rightarrow 3J$ (+1 bTag)

t produced in $t\bar{t}$ pairs → 6 Jets → LARGE QCD BG!!!

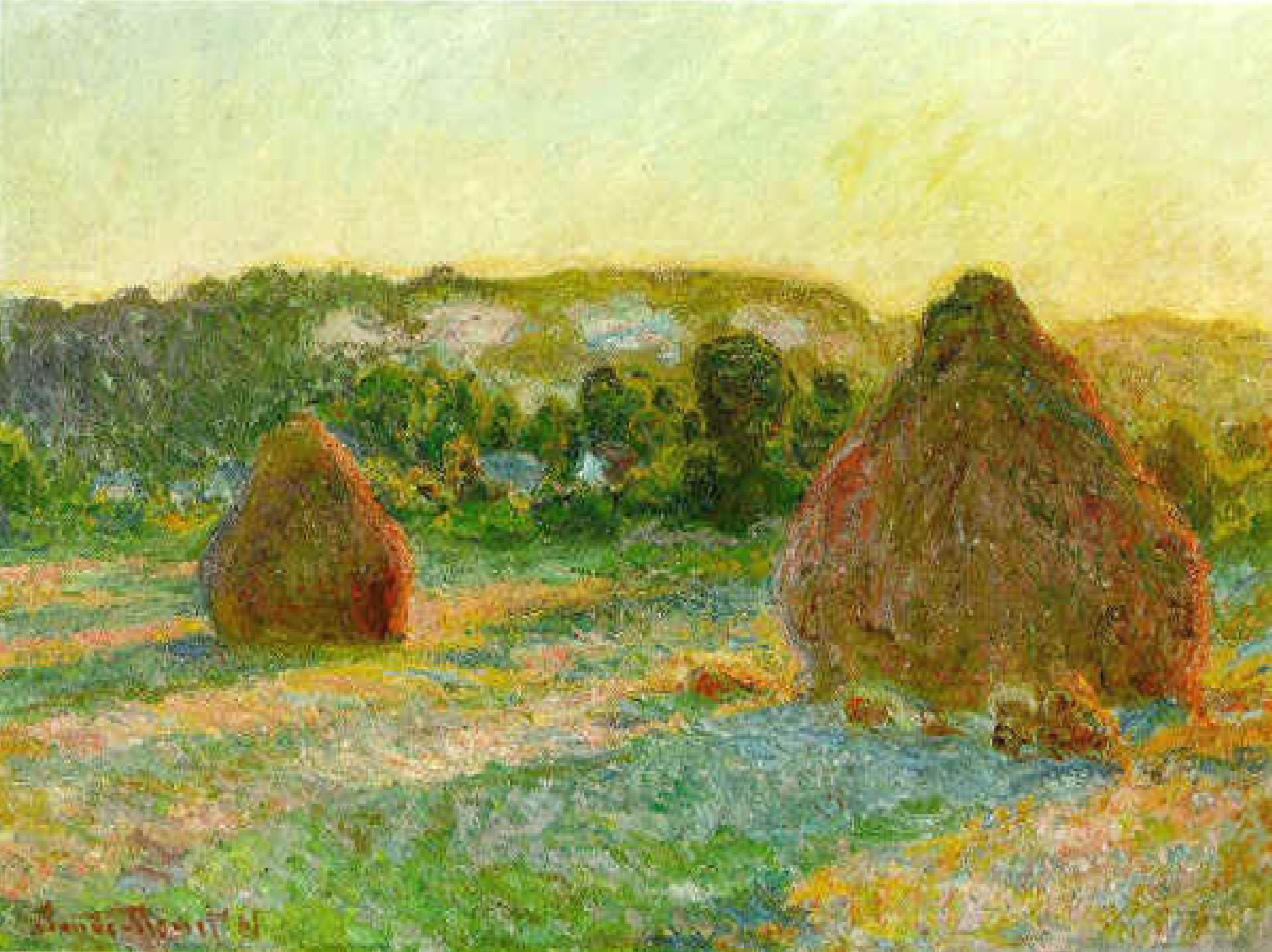
Preselection cuts:

6J20, 4J40, $|\eta(J)| < 2.5$

S/B ~O(1/1000)!!!

Build top candidates of 3 Jets each:

(6 over 3) / 2 = 10 $t\bar{t}$ cand / event



Signal Selection – LOME M(ethod)

IDEA:
Use the LO $\sigma\left(gg \rightarrow t\bar{t}\right)$ prod Xsec (ME):
Ref: Combridge 1979 (Nucl. Phys. B151, p. 439)

Reminder:
Θ^* =
angle of top vs
z in $t\bar{t}$ restframe

Advantage of FH decay:
Decay fully reconstructable, with s,t,u and m_{top}
can calculate diff. Xsec of decay.

→need to choose a top mass (NOT MC Top Mass!)

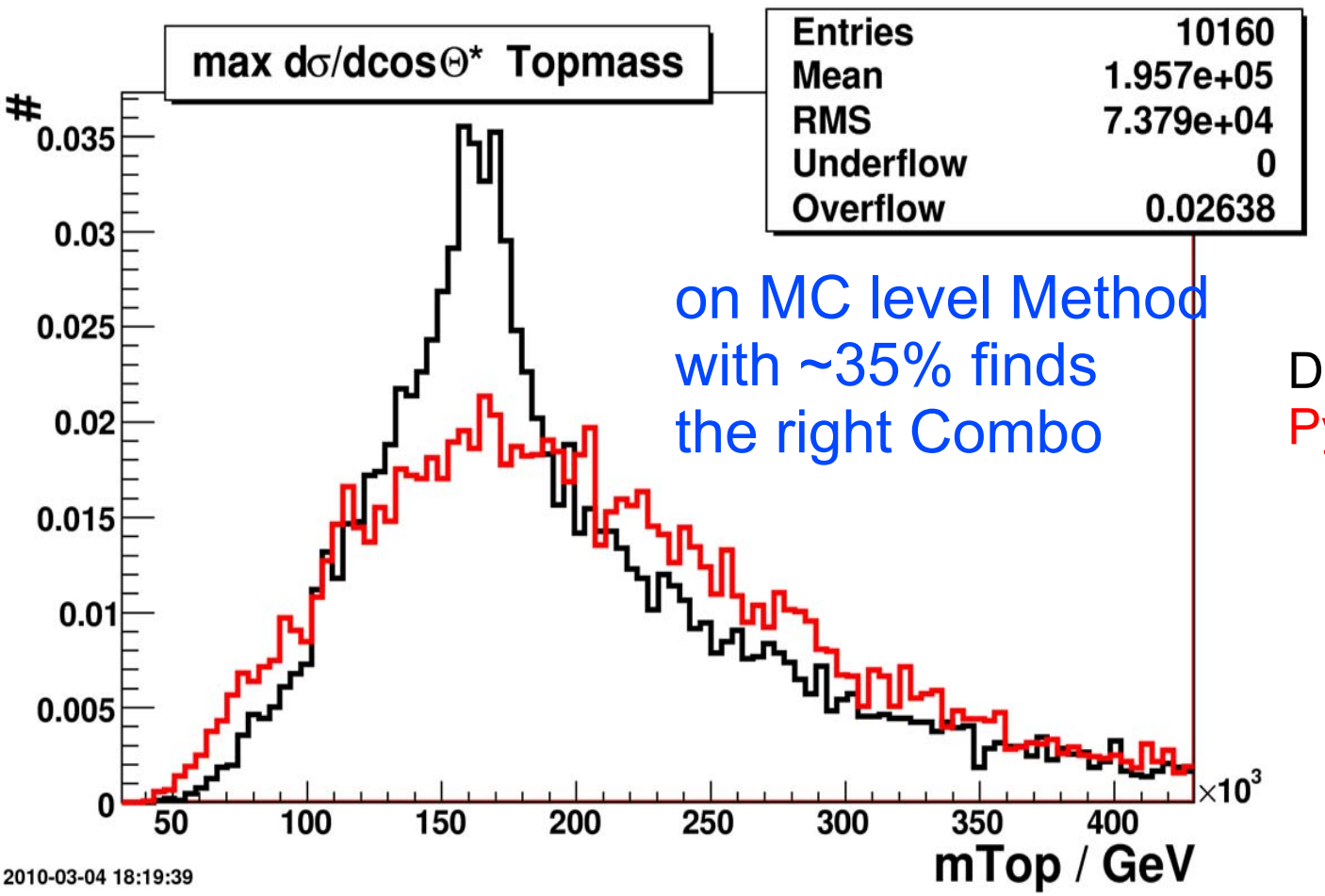
Method:
take $t\bar{t}$ candidate,
determine s,t,u,
calculate diff. Xsec,
choose maximizing combo

$$\frac{d\sigma(gg \rightarrow t\bar{t})}{d\cos(\Theta^*)}\left(s,t,u,m_{Top}\right)$$

LOME Method – Top Mass

Signal (black) vs Bgrd (red) normalized (area = 1):

Mass of top candidates



on MC level Method with ~35% finds the right Combo

Data:

Pythia generated samples:

Signal = $t\bar{t}$ full hadronic

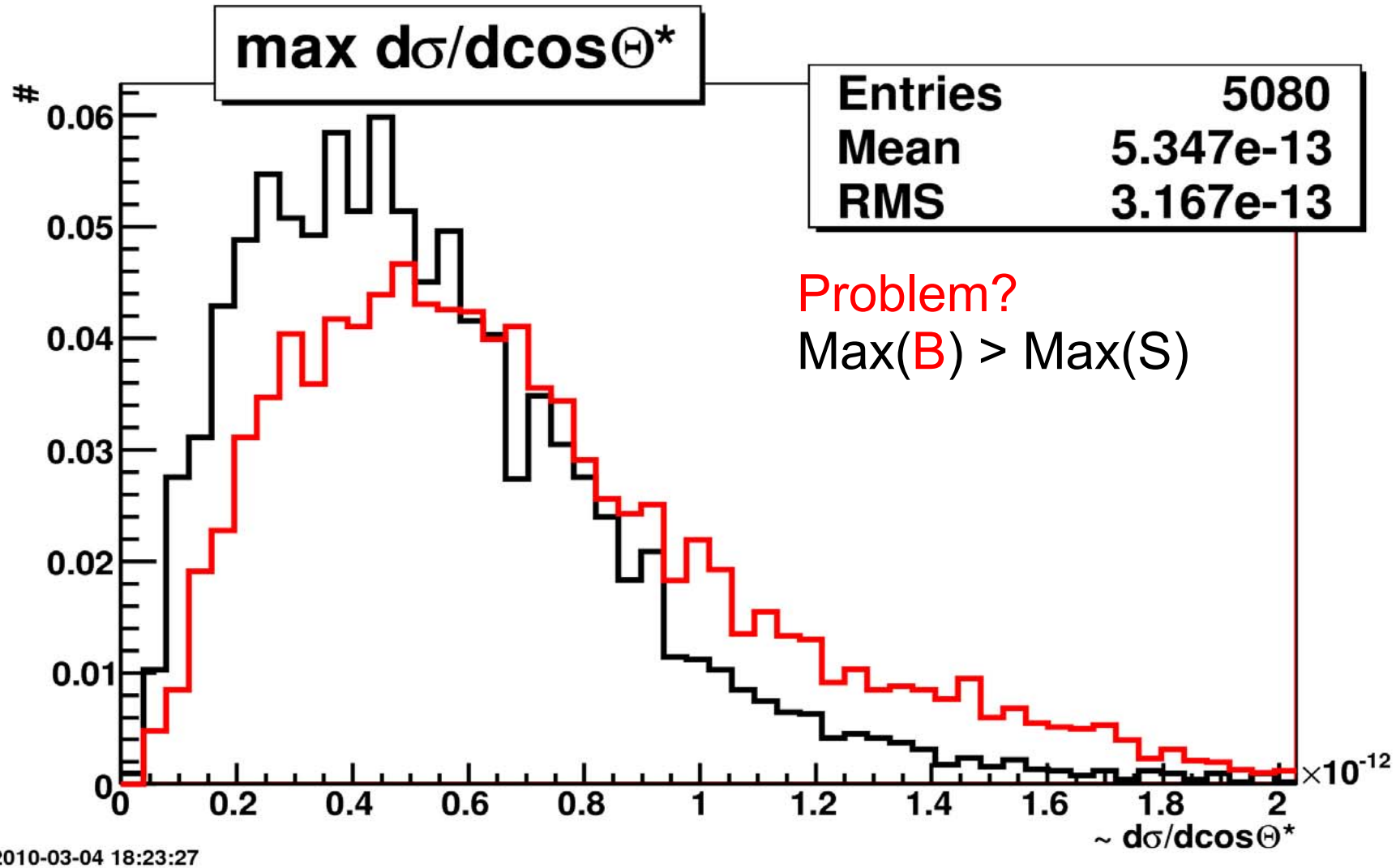
BG = dijet

$\sqrt{s}$ = 7TeV

6J20, 4J40 + (J)< 2.5

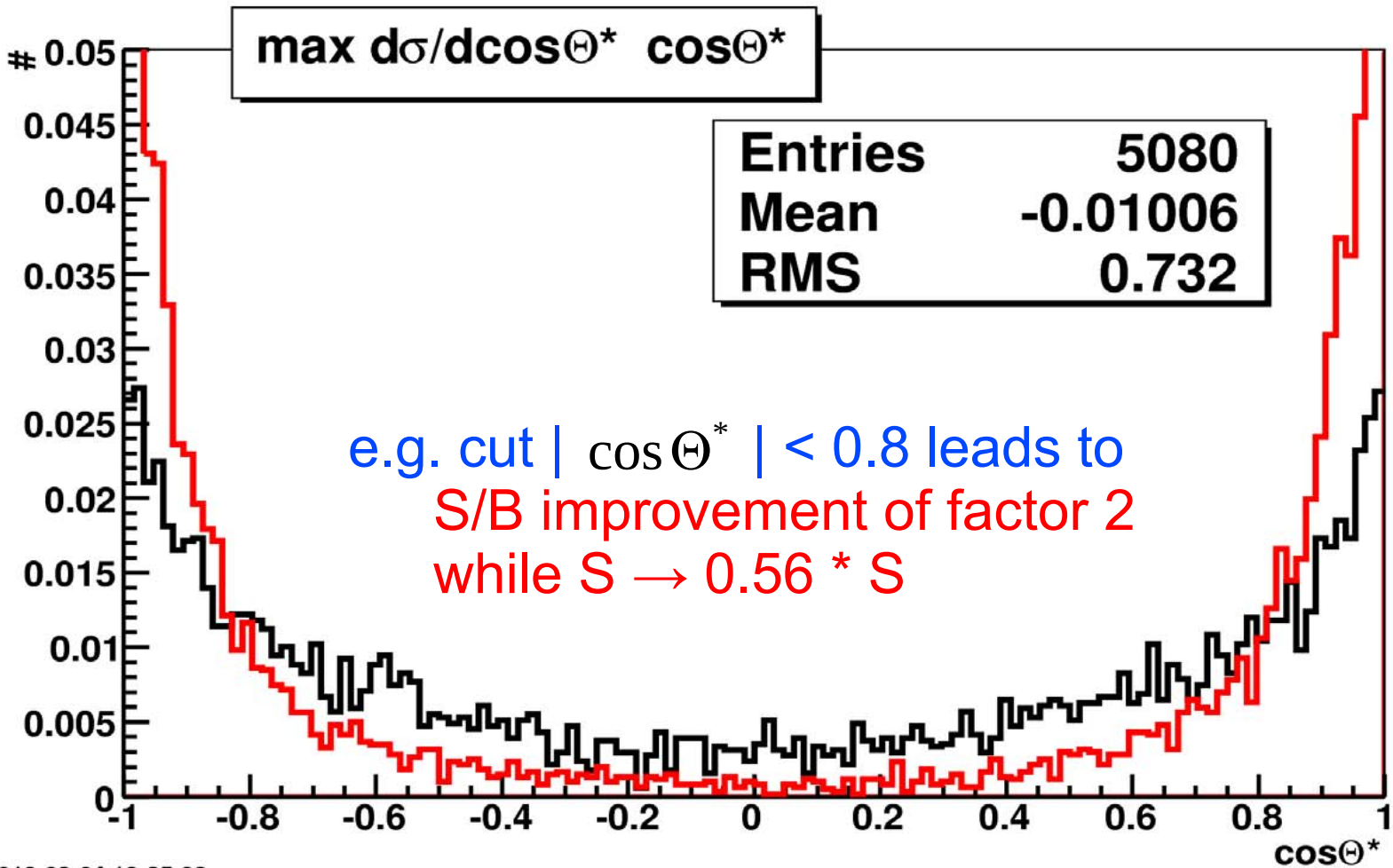
LOME Method – ds/dcosth*

Signal (black) vs Bgrd (red) both norm. area: $d\sigma/d\cos\Theta^*$ of top candidates

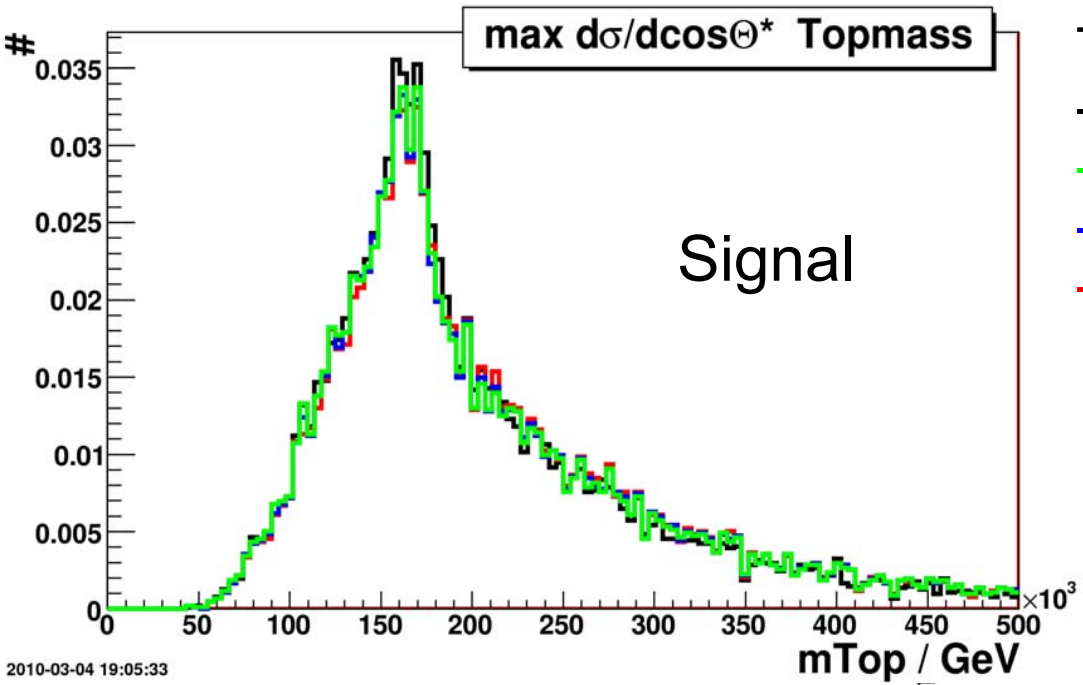


LOMEM – cos Θ^*

Signal (black) vs Bgrd (red) both norm. area: $\cos\Theta^*$ of top candidates

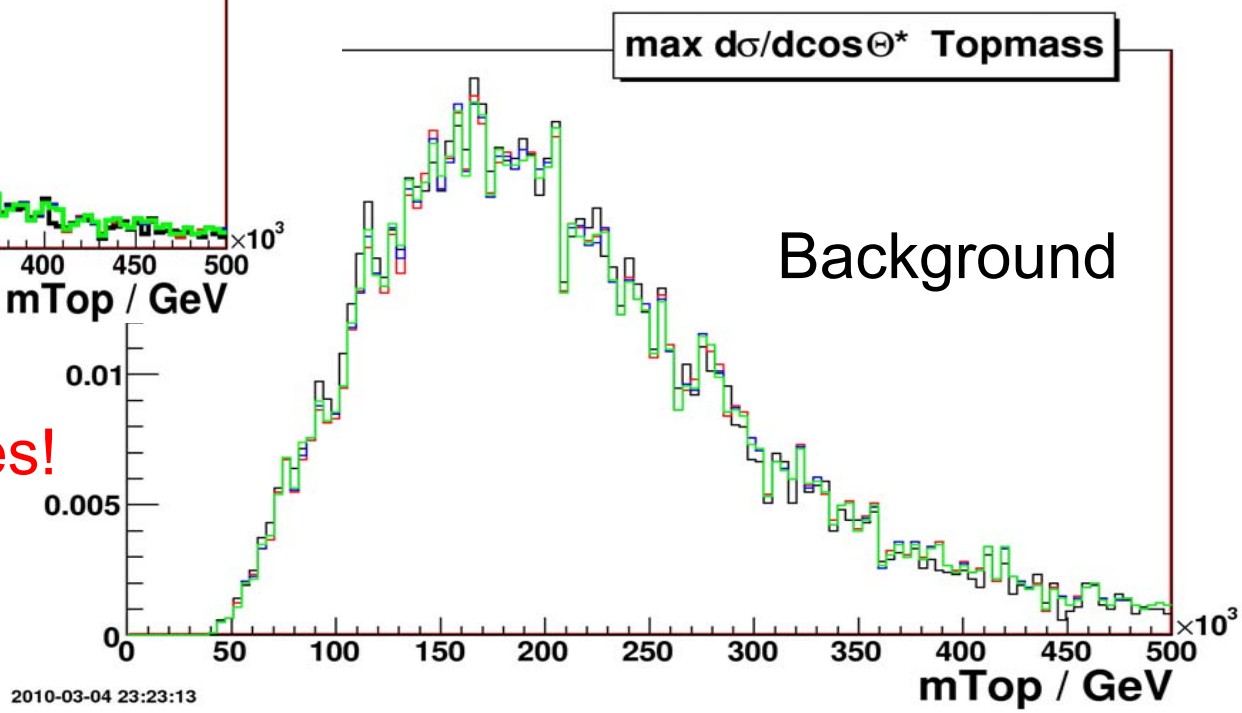


LOMEM – Top Mass Dependence



Signal

Top masses used in diff Xsec (not MC!)
-black mTop = average of hemispheres
-green mTop = 160 GeV
-blue mTop = 170 GeV
-red mTop = 180 GeV



Background

No big influence on masses!

b Tagging

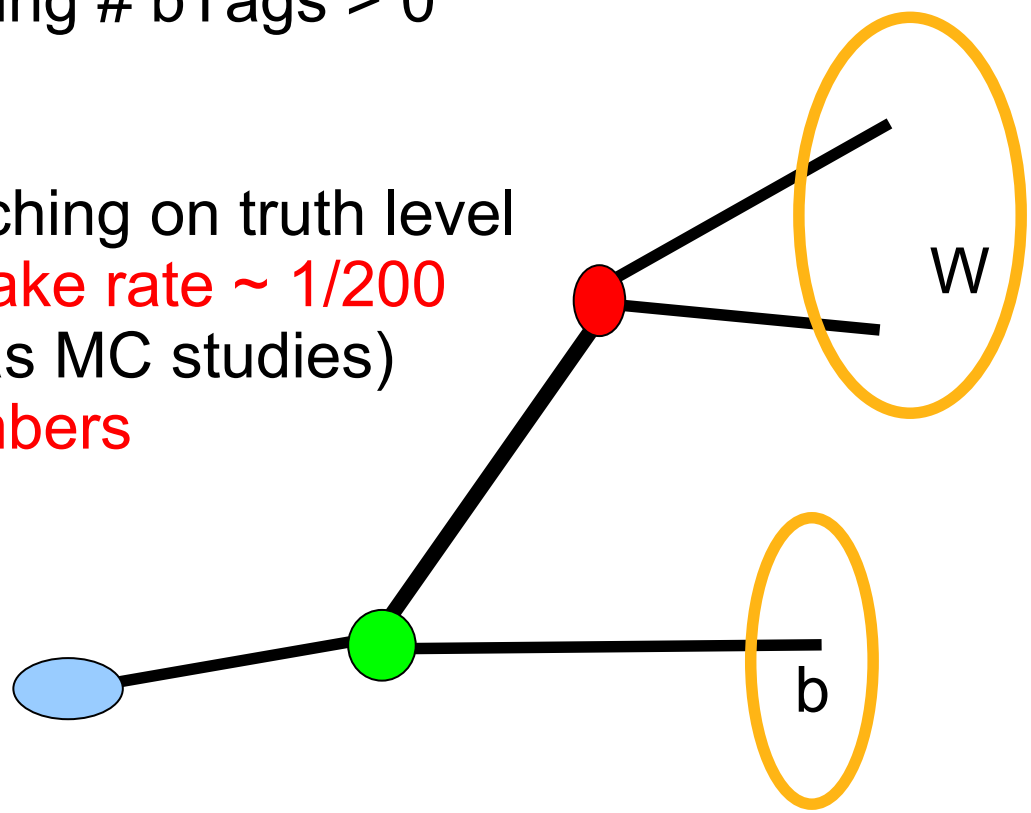
#btags	0	1	2
# tt pairs	10	10*	6**

Apply b tagging:

reduce combinatorics to find $t\bar{t}$
reduce ambiguaties to select W's (by *3)
improve S/B when requiring # bTags > 0

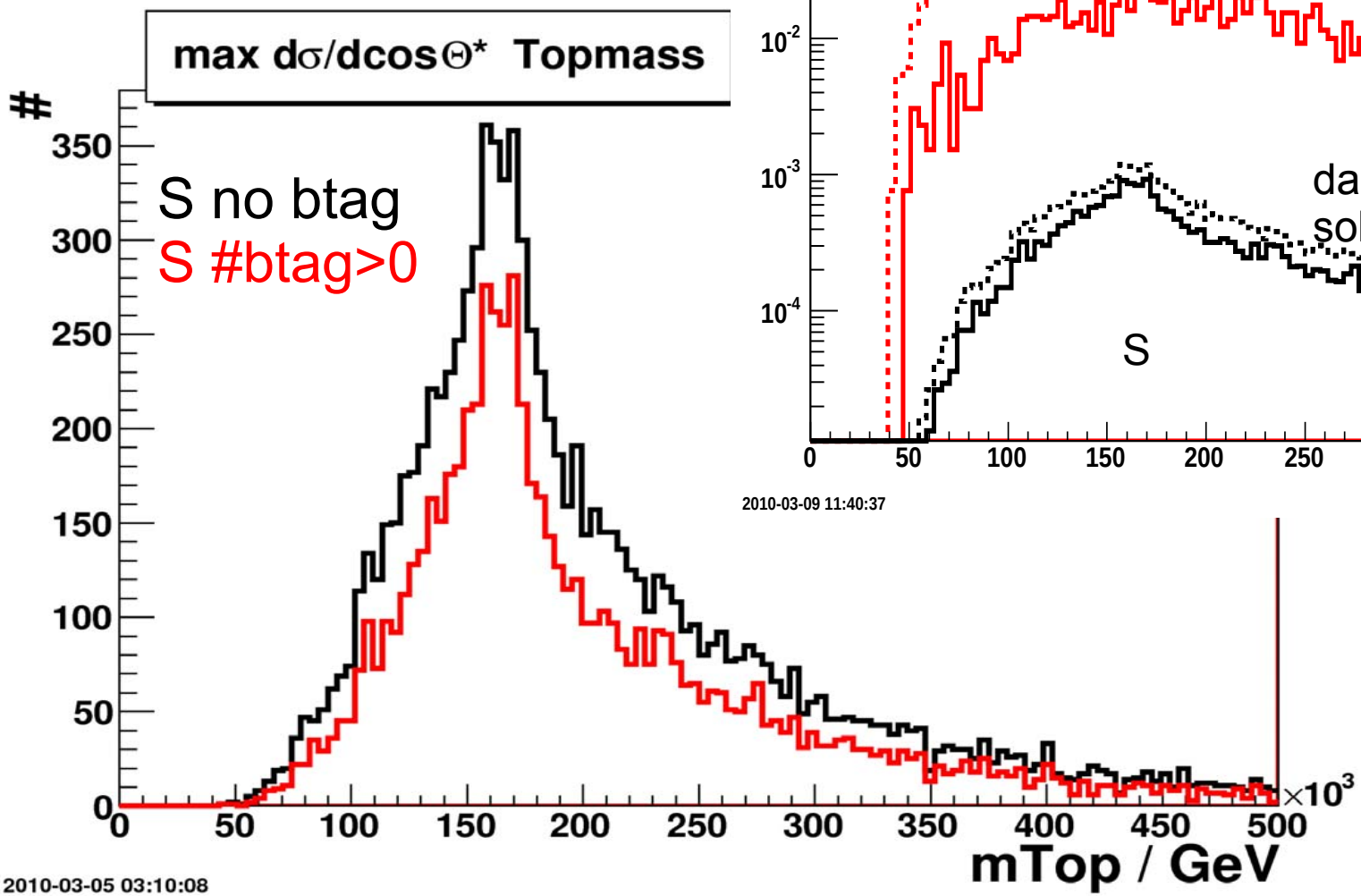
bTag Toy Study:

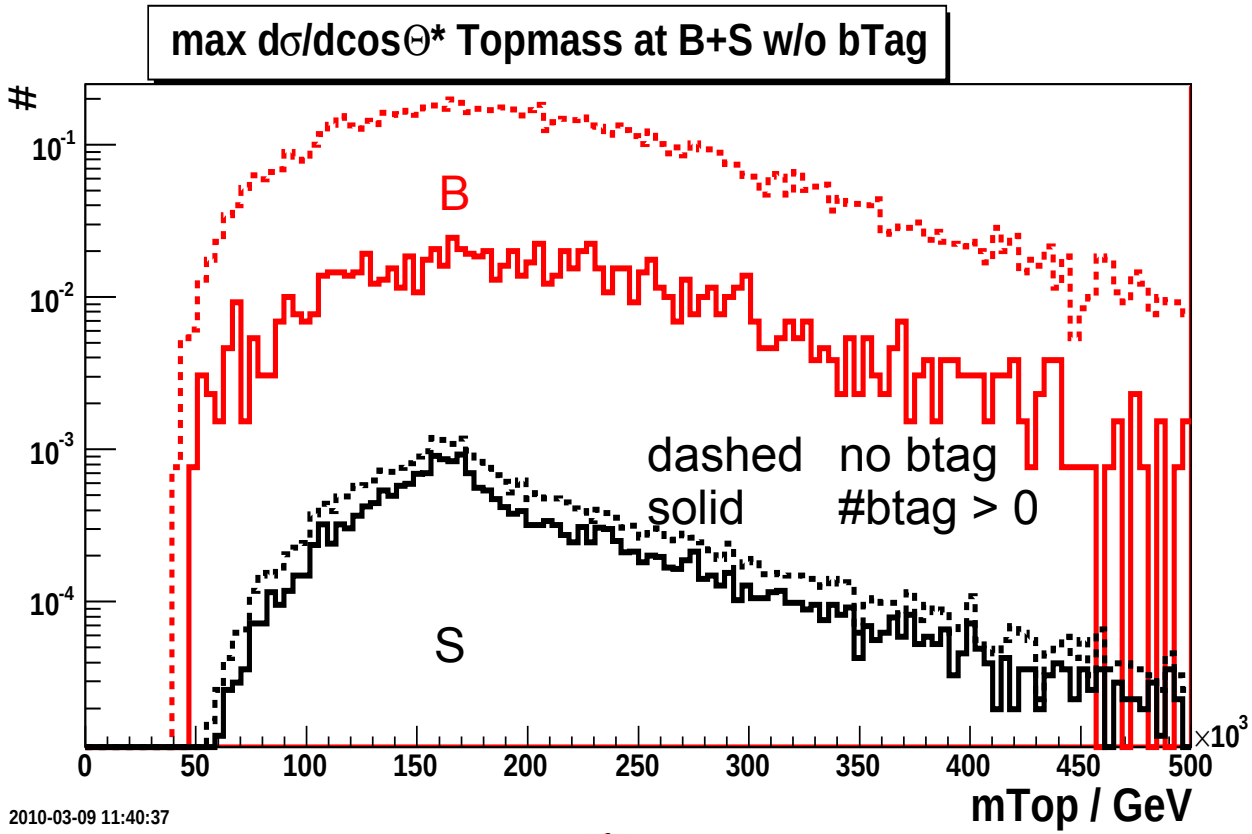
with MC info do bjet matching on truth level
assume bTag eff = 0.6, fake rate ~ 1/200
(estimate taken from Atlas MC studies)
tag jets with random numbers



Top Mass with b-Tagging

bTags > 0
S/B → 7 * S/B
S → 0.7 * S





Shape stays
S/B improves

Summary and Plans

Investigate Fully Hadronic Decay Channel of Top Quark pairs

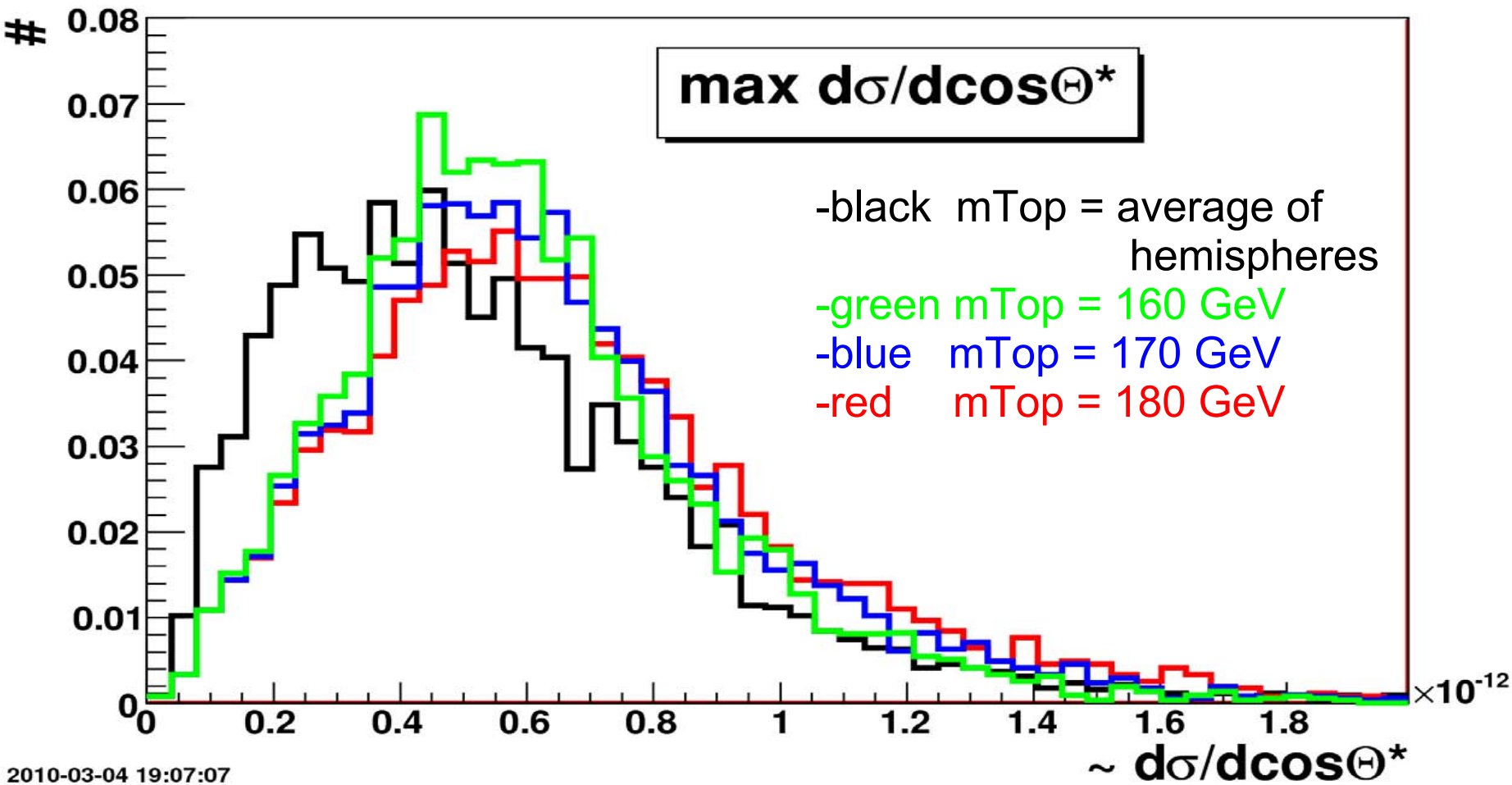
Introduced Method for Event Selection using LO ME:

- LOMEM finds correct combo to 35% on full (10) combinatorics
- No strong Top mass dependence of LOMEM observed
- Cut on $\cos\Theta^*$ allows S/B improvement
- b tagging powerful tool, improves S/B by ~7

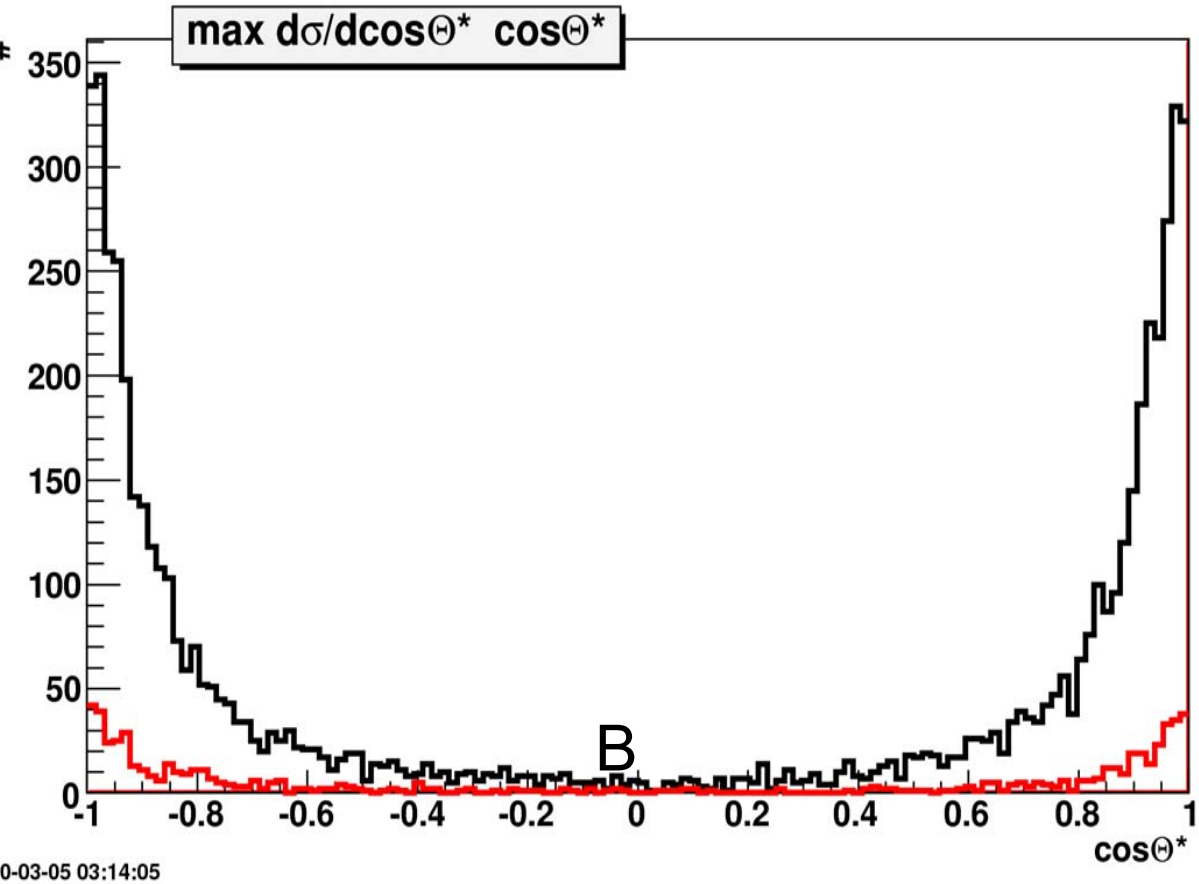
To Come:

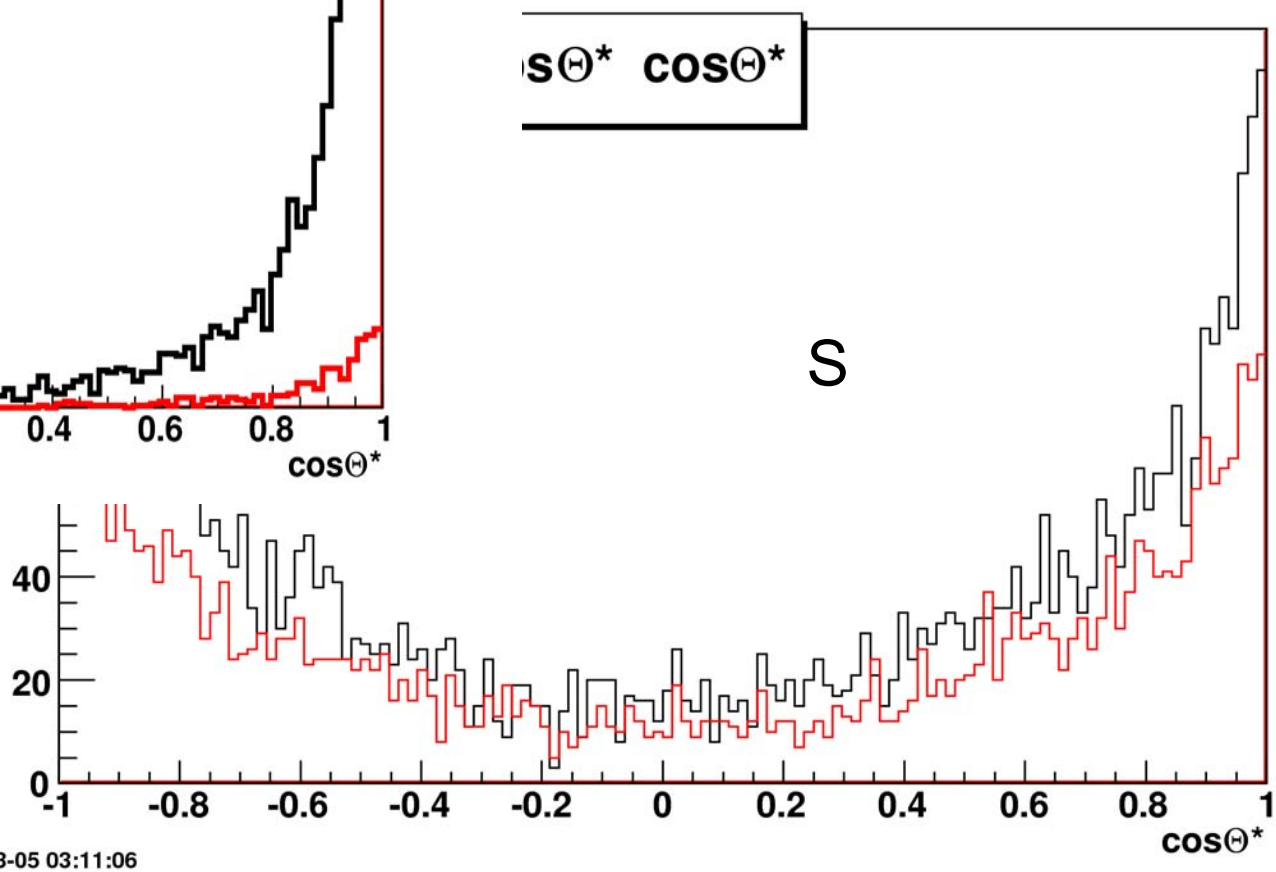
- Combine bTags with requirements to W mass
  - Leads to new BG!
- Compare results with other method e.g. pT max
- Switch to reconstructed Jets
- Determine absolute value of S/B!
- Apply on (sufficient) real data!

LOME Method – Mass Dependence



Costheta* btag development





pseidler@mpp.mpg.de

Signal Jet Pt Spectrum