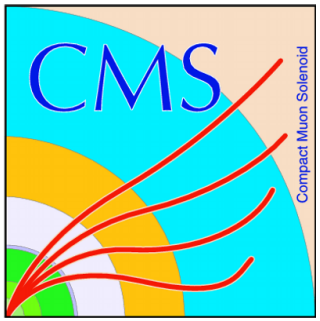
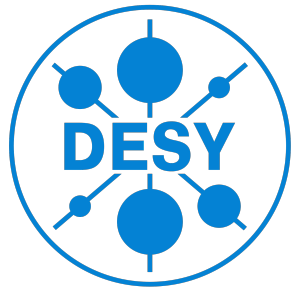




Top-quark topology definition of the boosted regime at 13TeV.

Daniela Dominguez, Paolo Gunnellini, Hannes Jung

Deutsches Elektronen Synchrotron

March 2017

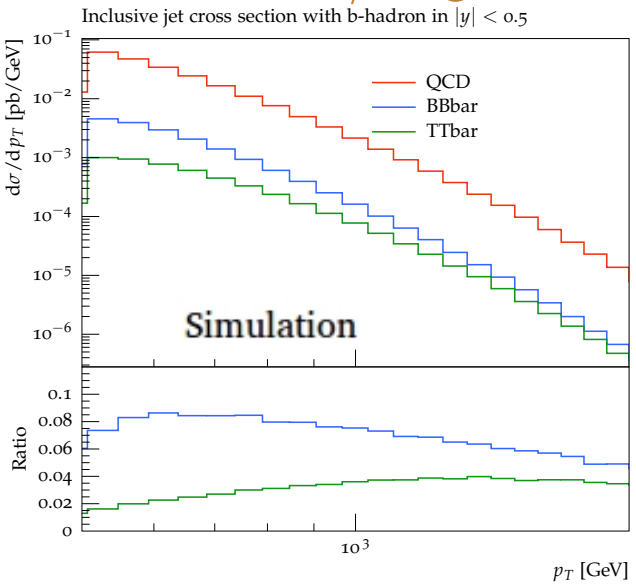
DPG

Motivation

- Measurements of $\Delta\phi$ azimuthal decorrelation with top jets in the back to back region (sensitive to soft resummation effects)
- Demonstrate the flavour-blindness of QCD (production of bottom and top quarks should be the same at high p_T)

$\rightarrow$ First look at jet cross section clustered with large cone size (R = 0.8)

PYTHIA 8 $b\bar{b}$ /$t\bar{t}$ generation starting from $\hat{p}_T \sim 450$ GeV

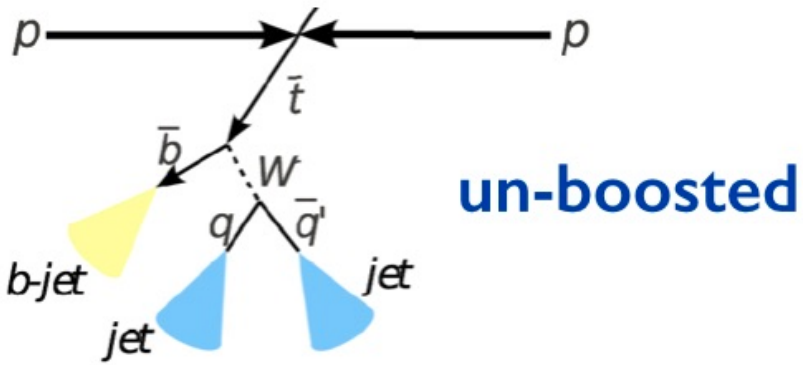


Inclusive jet cross section in central region

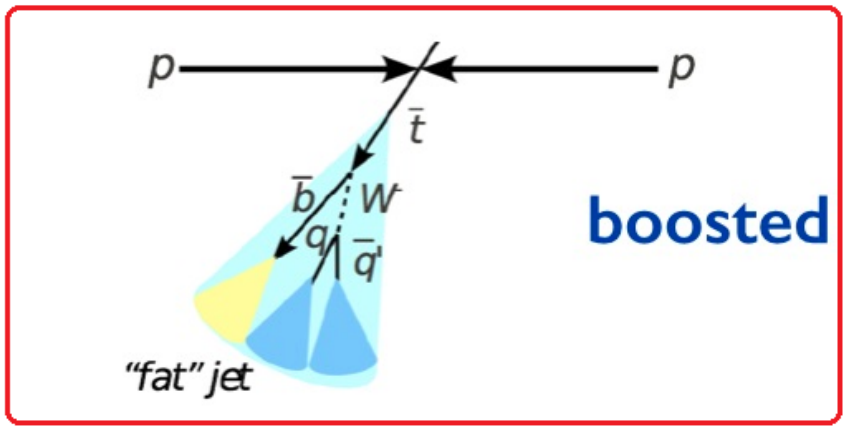
QCD includes $b\bar{b}$ production

Goal of our analysis:

- Regime of boosted topologies because of high p_{T}^{Top}
- Considered only hadronic top decays for better p_{T} resolution
- Overwhelming QCD background to deal with



un-boosted



boosted

Analysis strategy

Phenomenological studies to define top boosted topologies

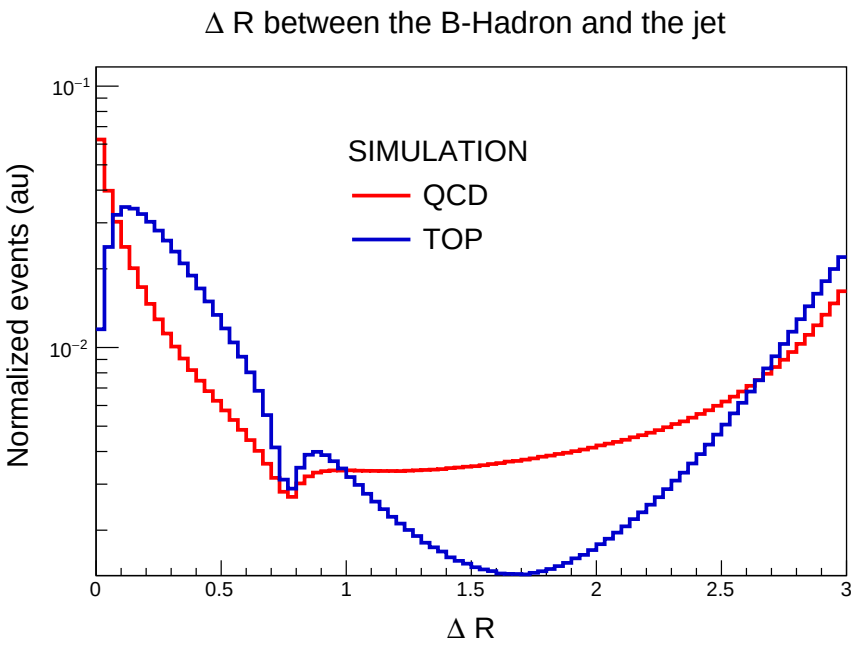
- Anti-k$_T$ fat (R=0.8) jets with $p_T > 400$ GeV
- b-hadron with $p_T > 10$ GeV inside the cone (b-tagging)
- Top generation with $p_T > 450 GeV$

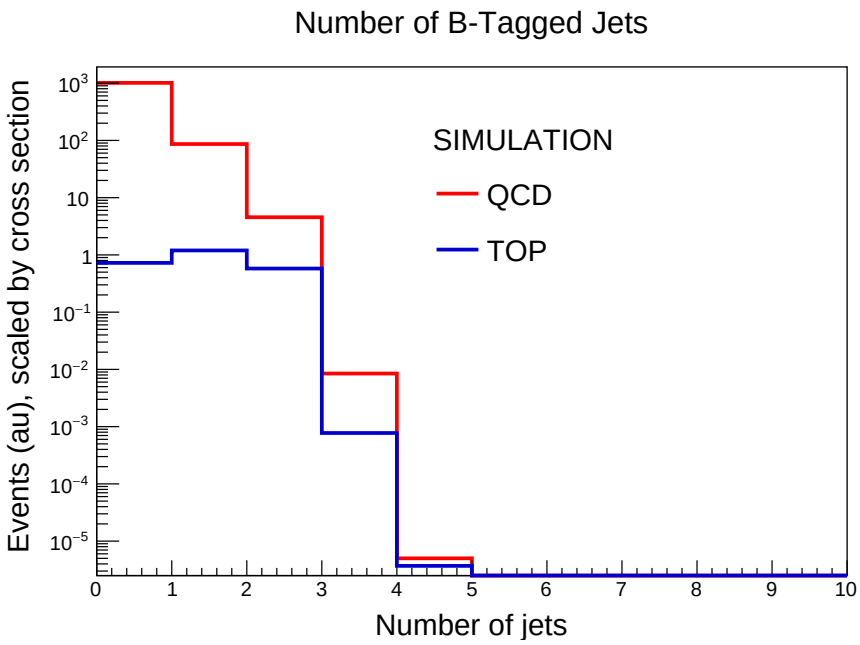
$\rightarrow$ **CONSIDERED VARIABLES :**

ΔR between the two subjets
jet mass
jet masses of the two subjets

Analysis Strategy: B-tagging inside the fat jet

- ΔR between the B-Hadrons ($p_T > 10 GeV$) and the fat jets ($R = 0.8$).
- B-Tagging efficiency (B-Hadron inside the jet with $\Delta R < 0.4$)

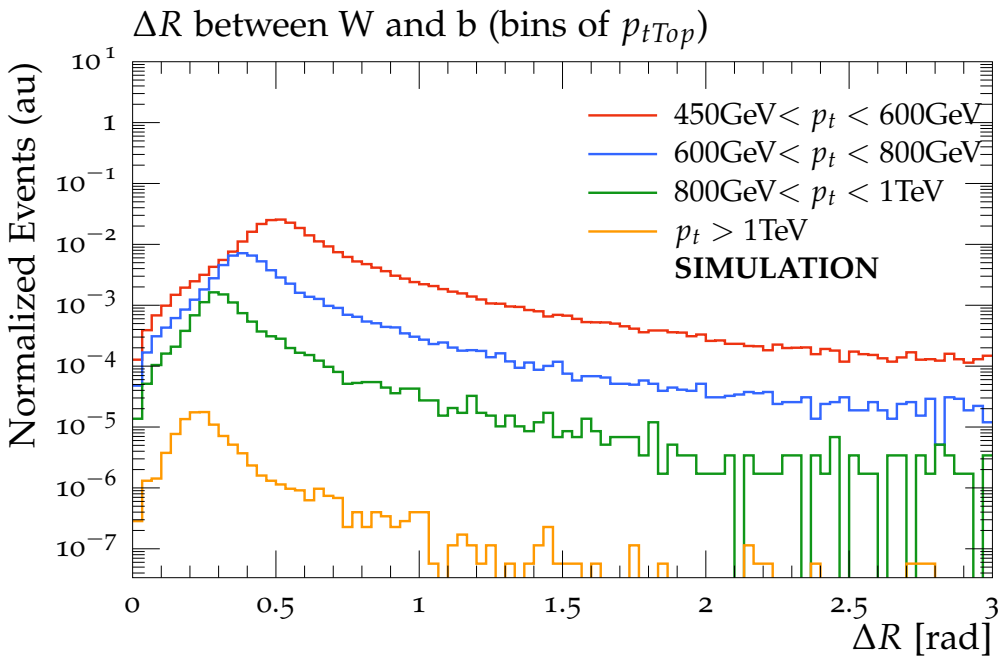


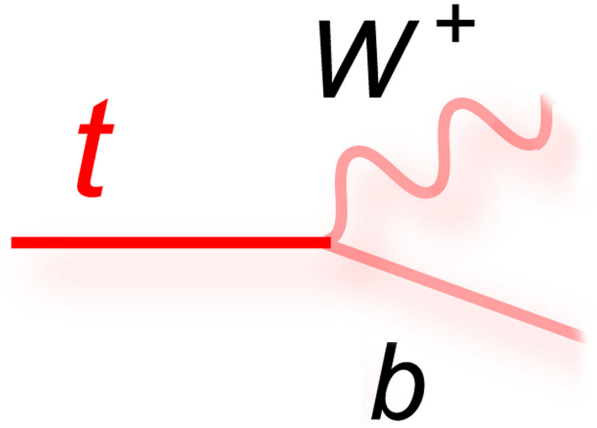


- QCD: the b-jet is more likely clustered in the fat jet ($\Delta R \sim 0$)
- Two b-tagged jets required, but the background still high.

Analysis Strategy: Particle Level Studies

$\Delta\phi$ between the top decay products at particle level.



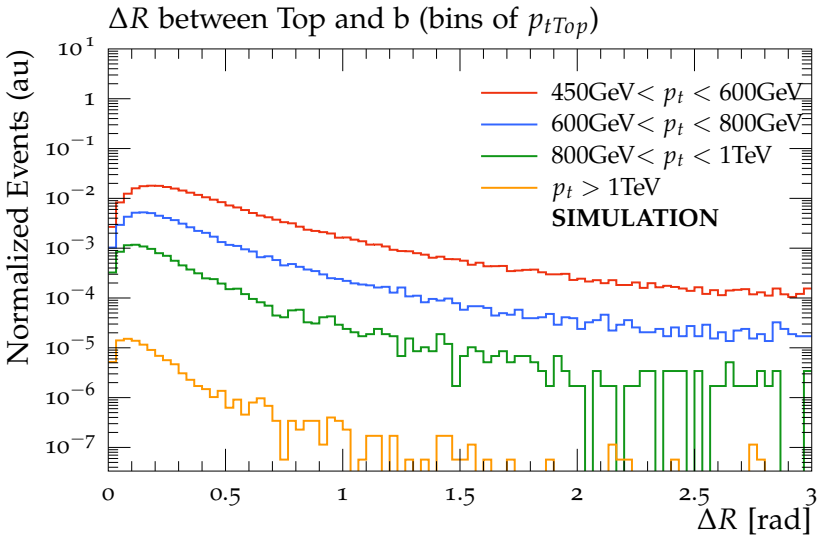


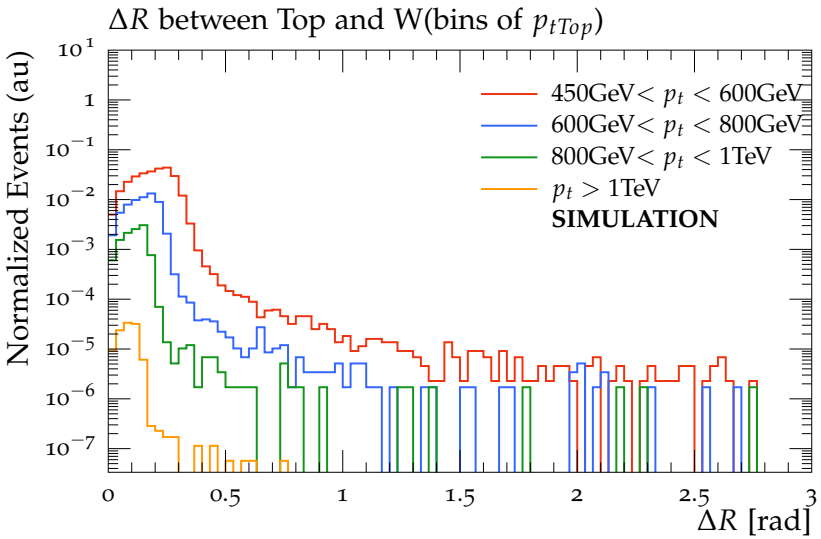
The high p_t of the top, the close products are (boosted topologies).

For $p_t^{top} \sim 450\,GeV$ there is still a considerable contribution where the W and the b can't be clustered at the same time inside the fat jet

Which one is more likely to be outside the fat jet?

Analysis Strategy: B-tagging Efficiency and Cross Sections





Signal/Background Ratio (Cross Section)

Requiring at least two b-tagged jets in the event.

- $\sigma_S/\sigma_B = 0.08$

p_t^{TOP}	1Btag %	2Btag %
400GeV	79.8	31.8
1TeV	98	74

- Low b-tagging efficiency at $p_t \sim 450\,GeV$
- Not possible to discriminate background yet

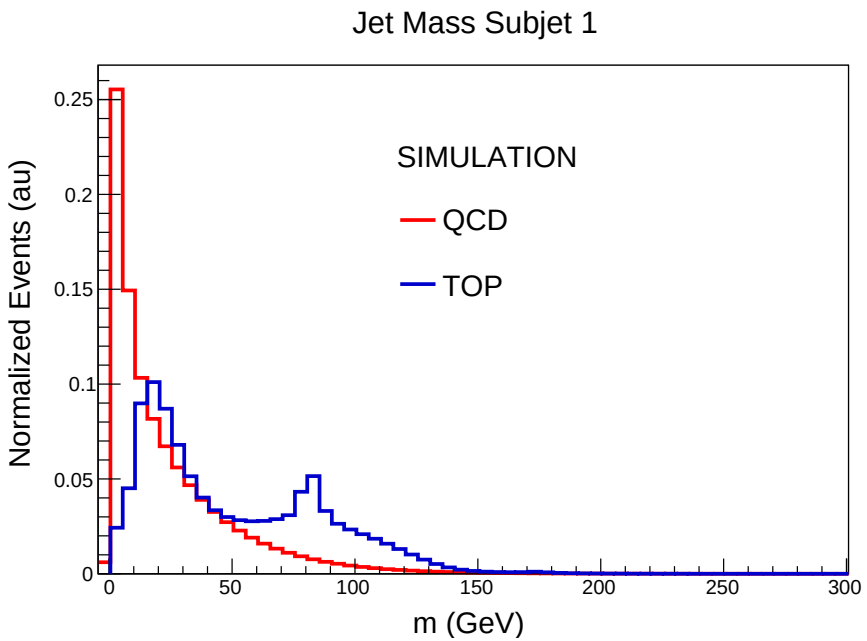
Soft Drop Mass Mechanism

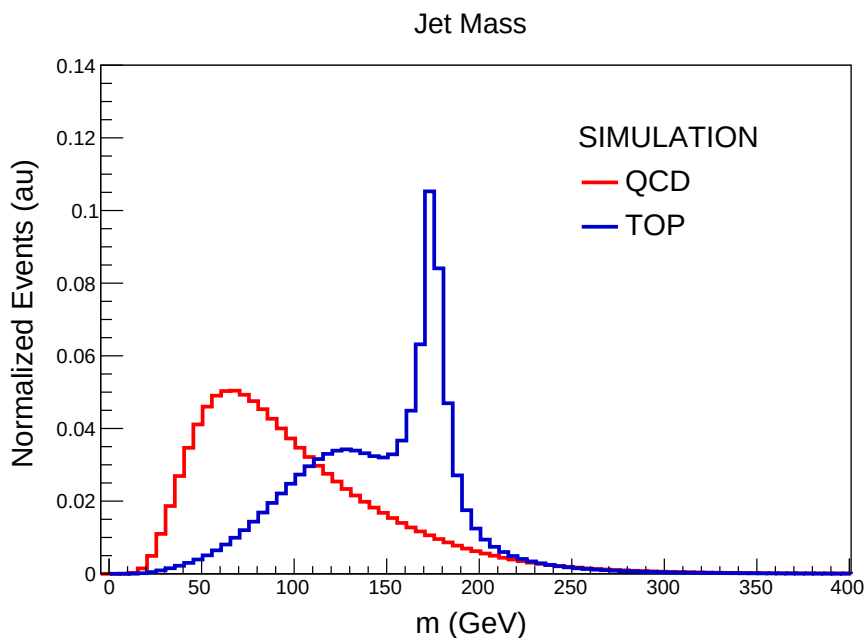
Soft Drop Mass algrithm is used to decluster the fat jet in two sub-jets removing soft radiation

Decluster and drop softer constituent unless

Soft Drop Condition: $\frac{\min(p_{T1}, p_{T2})}{p_{T1} + p_{T2}} > z_{\text{cut}} \left(\frac{\Delta R_{12}}{R_0} \right)^{\beta}$

i.e. remove wide-angle soft radiation from a jet



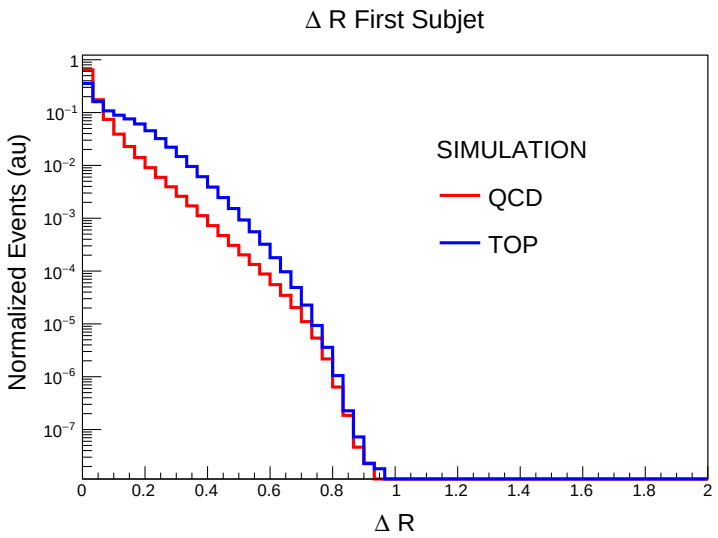


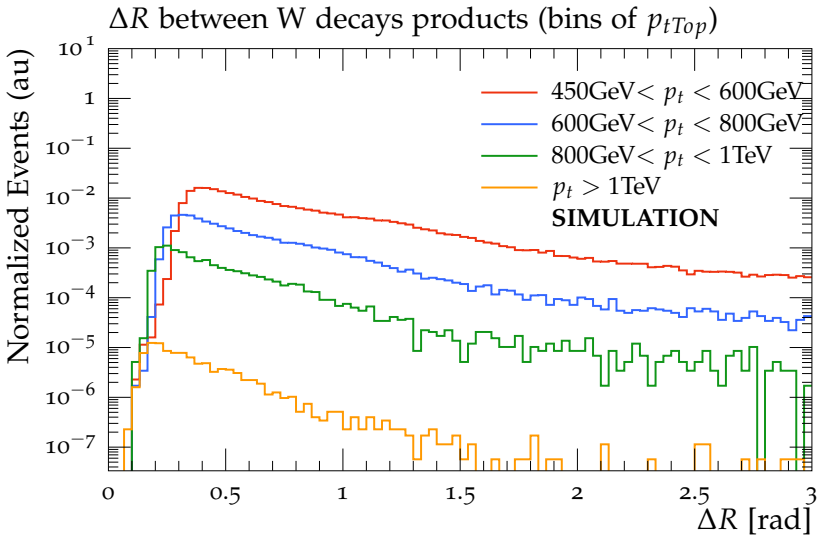
- $70\,GeV < Mass_{SubJet1} < 90\,GeV$
- $150\,GeV < Mass_{Jet} < 200\,GeV$

Particle Level Studies

$p_{tTop} > 450\,GeV$ (particles above 10GeV)

Particle Level ΔR distribution of the decay products of the W.





$p_{tTop} > 450\,GeV \Rightarrow \Delta R_{FirstSubjet} < 0.5.$

There is a big contribution from the region $\Delta R > 0.5$ in the distribution of the decay products.

Optimizing Mass Cuts
$\Delta R < 0.4$ (BHadron and Fat Jet)

Requiring at least two jets satisfying the specific conditions

BHadron $\Delta R < 0.4$
$70\,GeV < M_{subjet0} < 90\,GeV$
$150\,GeV < M_{Jet} < 200\,GeV$

- Efficiency 0.9%
- $\sigma_S/\sigma_B = 16.28$

BHadron $\Delta R < 0.4$
$30\,GeV < M_{subjet0} < 150\,GeV$
$150\,GeV < M_{Jet} < 200\,GeV$

- Efficiency 8.4%
- $\sigma_S/\sigma B = 4$

BHadron $\Delta R < 0.4$ $30\,GeV < M_{subjet0} < 150\,GeV$

- Efficiency 17.1%
- $\sigma_S/\sigma B = 0.62$

The best option when tagging the bHadron inside the jet mass cuts: $30\,GeV < M_{subjet0} < 90\,GeV$ and $150\,GeV < M_{Jet} < 200\,GeV$.

Optimizing Mass Cuts
$\Delta R < 1.5$ (BHadron and Fat Jet)

Requiring at least two jets satisfying the specific conditions

BHadron $\Delta R < 1.5$
$30\,GeV < M_{subjet0} < 150\,GeV$

- Efficiency 39.5%
- $\sigma_S/\sigma_B = 0.56$

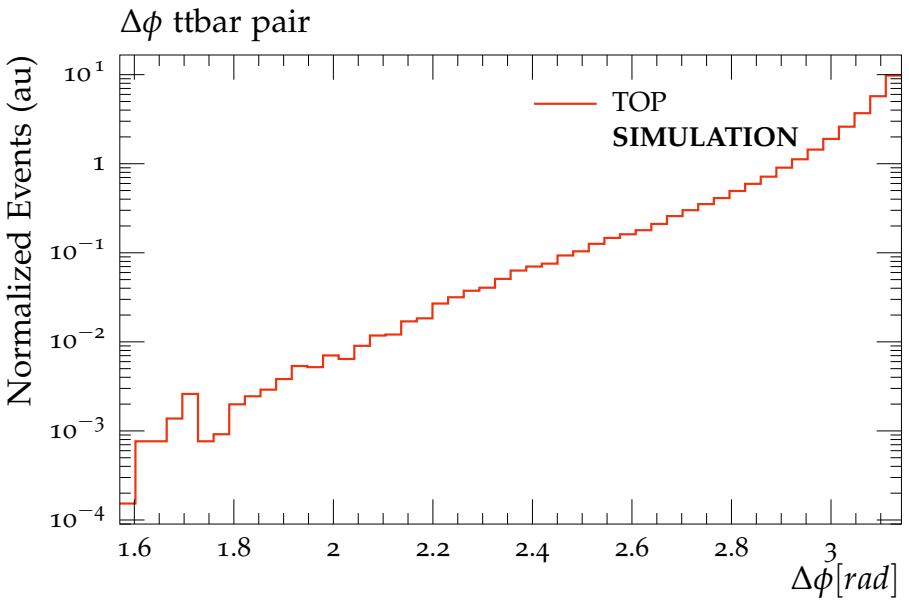
BHadron $\Delta R < 1.5$
$30\,GeV < M_{subjet0} < 150\,GeV$
$150\,GeV < M_{Jet} < 200\,GeV$

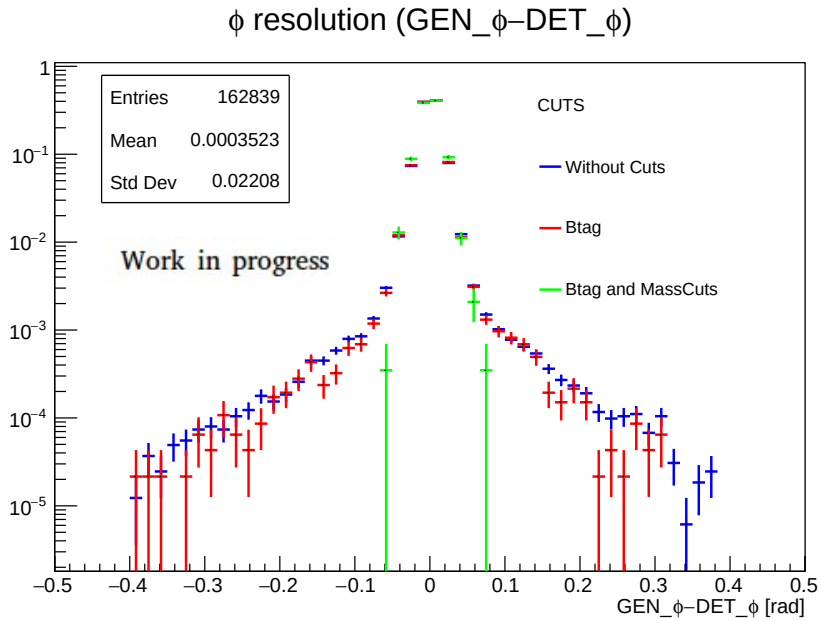
- Efficiency 19.6%
- $\sigma_S/\sigma_B = 3.05$

The best option when tagging the bHadron outside the jet is mass cuts: $30\,GeV < M_{subjet0} < 90\,GeV$ and $150\,GeV < M_{Jet} < 200\,GeV$.

$\Delta\phi$ azimuthal decorrelation (top pair)

The azimuthal angular correlation of the *ttbar* system at high p_t in the back to back region could be sensitive to soft gluon resummation effects.





- Resolution at Detector Level of 3°
- With a proper definition of the top topology the resolution is not affected.

Summary

- Feasibility studies to separate top jets from pure QCD jets (non top).
- A Top definition at hadron level has been defined.
- The angular resolution at detector level appears promising for the measurement of azimuthal angular correlation of the ttbar system.

Thanks for your attention!!!