Gluon→$b\bar{b}$ Tagging

Ariel Schwartzman
SLAC

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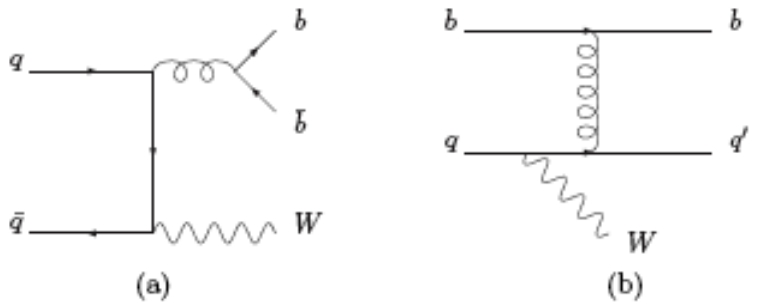
Introduction (I)

Production of W boson in association with b-quarks is a major background to new physics searches, single-top and Higgs.

At LO, b quarks produced in association with W bosons may originate from gluon splitting, at small DR angles, resulting -experimentally- in a merged (bb) jet.

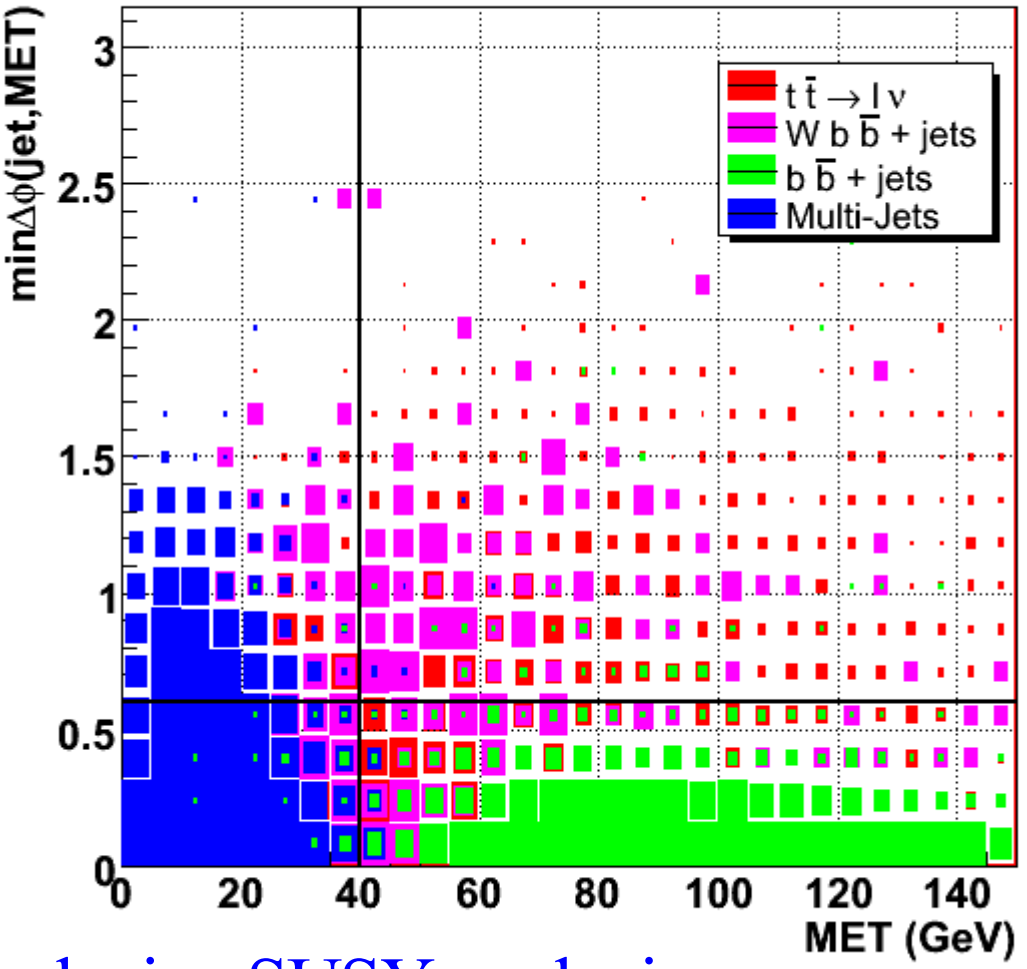


NLO cross sections (pb): (hep-ph/0611348)

LHC:	Wbb: 14.3,	W(bb): 27.0,	Wbj: 96.2
Tevatron:	Wbb: 3.14,	W(bb): 0.89,	Wbj: 2.54

pT>25GeV,
|eta|<2.5
>=2 jets

Introduction (II)



4 or more jets
pT>25 GeV,
|Eta|<2.5

MET+b-jets inclusive SUSY analysis:

Top and Wbb+jets populate the same region of the Dphi vs MET plane.
Tagging g(bb) may be used to separate the two contributions.

Tagging (bb)-jets from Gluon Splitting

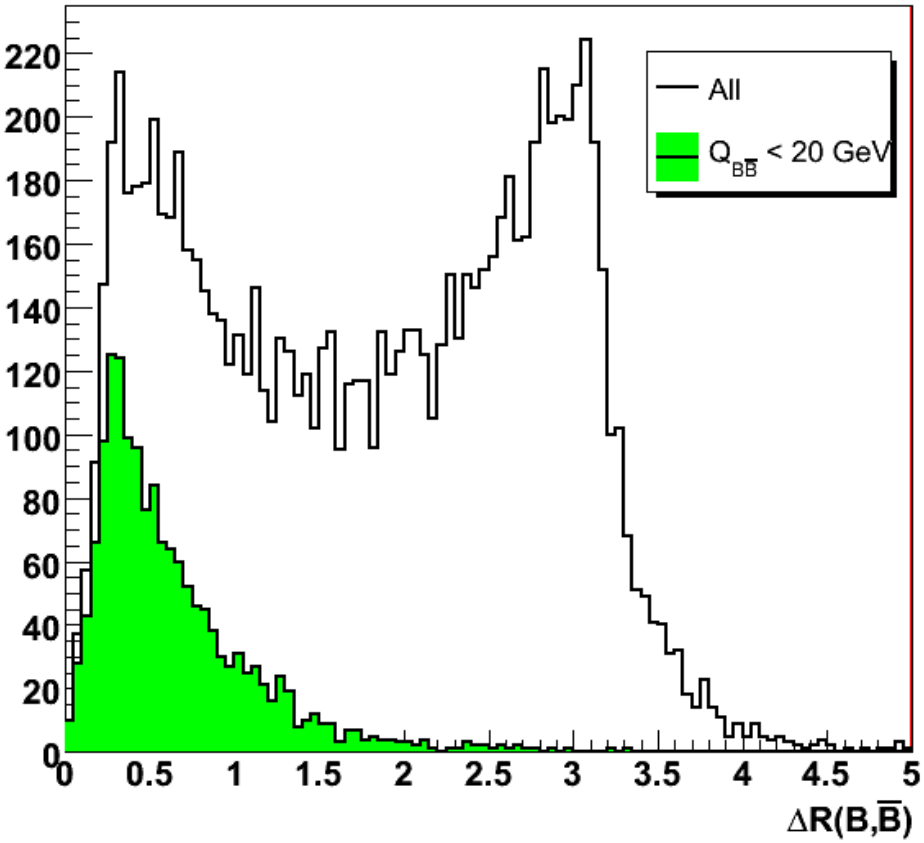
Merged (bb)-jets should have a characteristic signature, distinct from single b-jets:

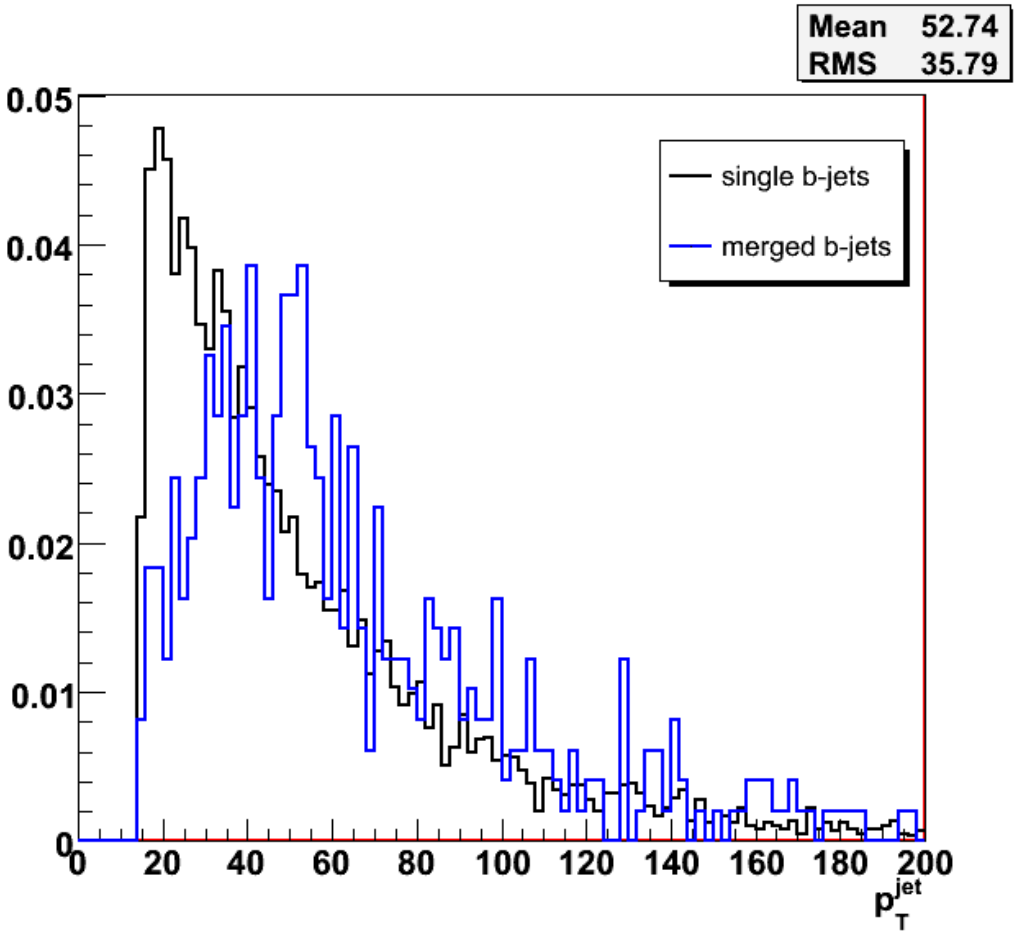
It is not obvious that tagging background estimations derived from single b-jet samples apply to merged bb-jets.

Develop a technique to *tag* b-jets from gluon splitting, so that these jets can be treated separately. (Idea not explored at the Tevatron)

Part of a more general program of Physics-Jets objects, exploiting track-vertex jet composition.

Wbb+jets Monte Carlo Kinematics





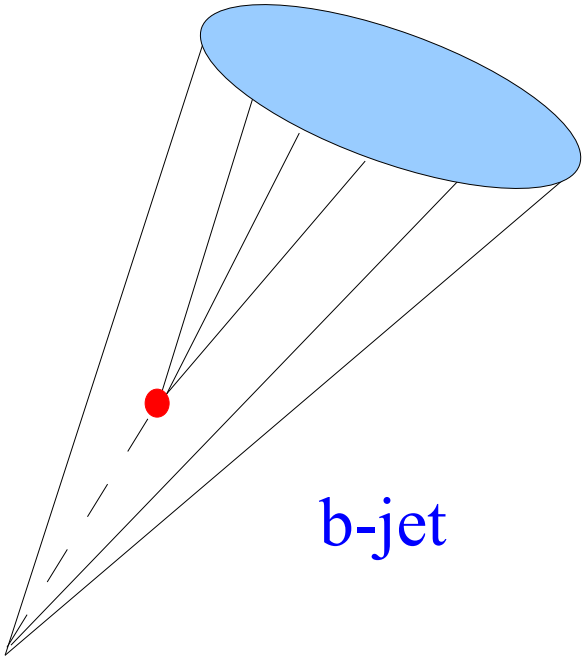
DR(b,bbar)>0.2 during generation!
Double peak structure not yet understood.

b and (bb) Jet Selection

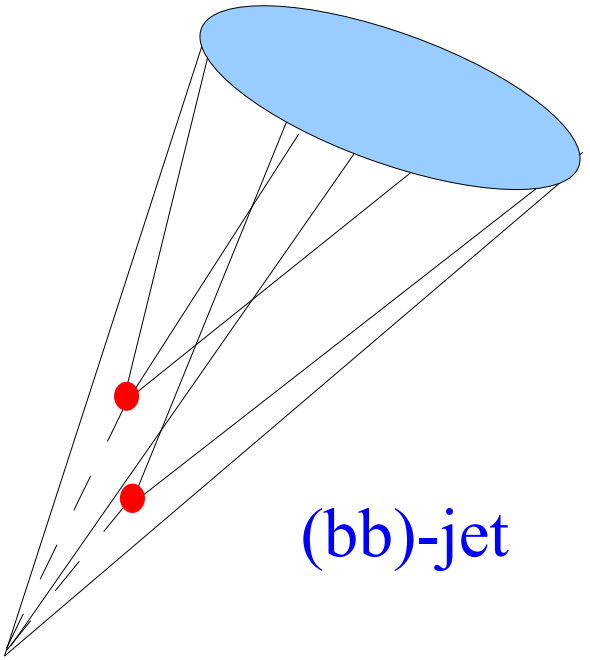
Use Monte Carlo Truth information to classify jets into b, and (bb) categories:

b: one stable B hadron within DR<0.3 of a reconstructed Jet.

(bb): two stable B hadrons within DR<0.3 of a same reconstructed Jet. (Topological Cone R=0.4 Jets + H1 calibration)

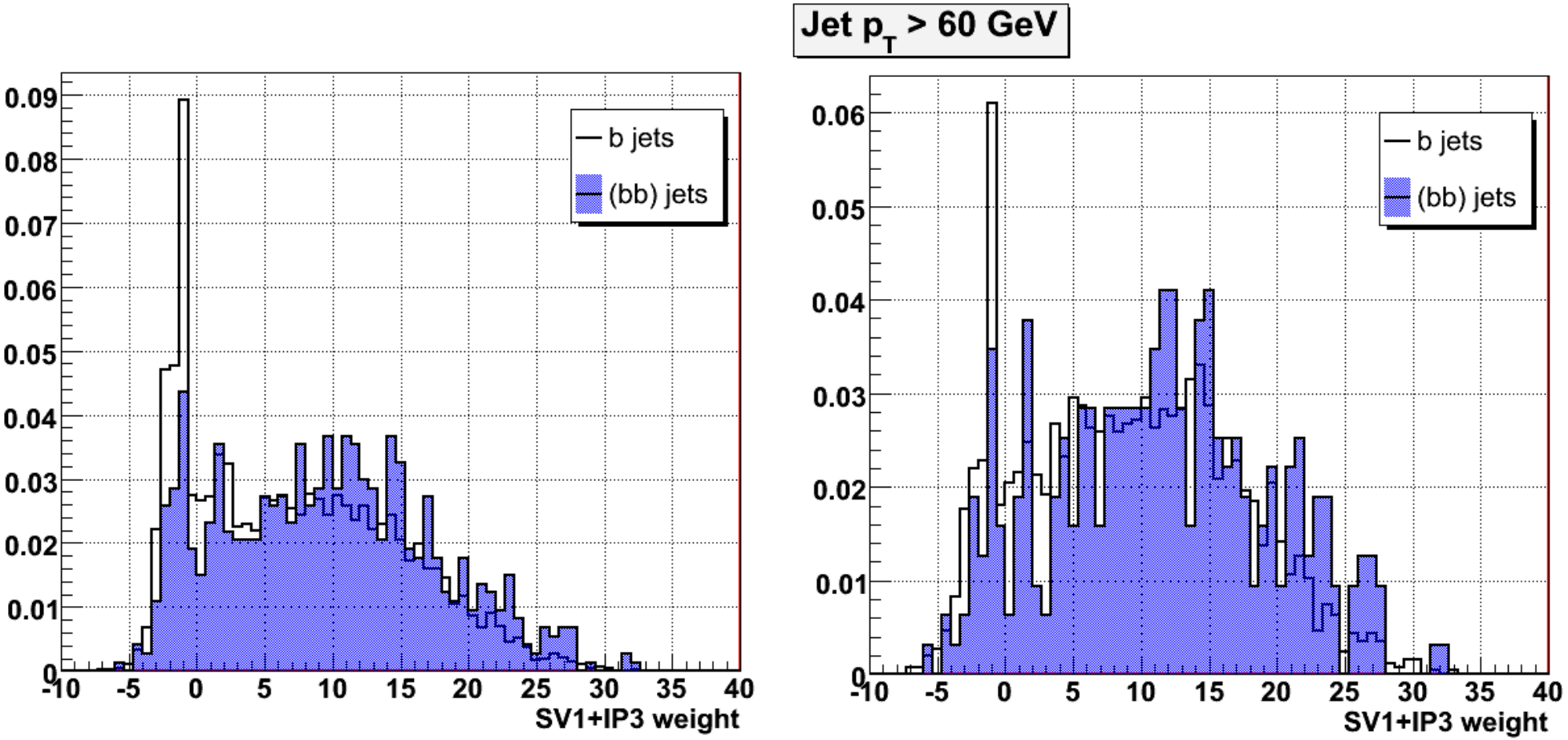


b-jet



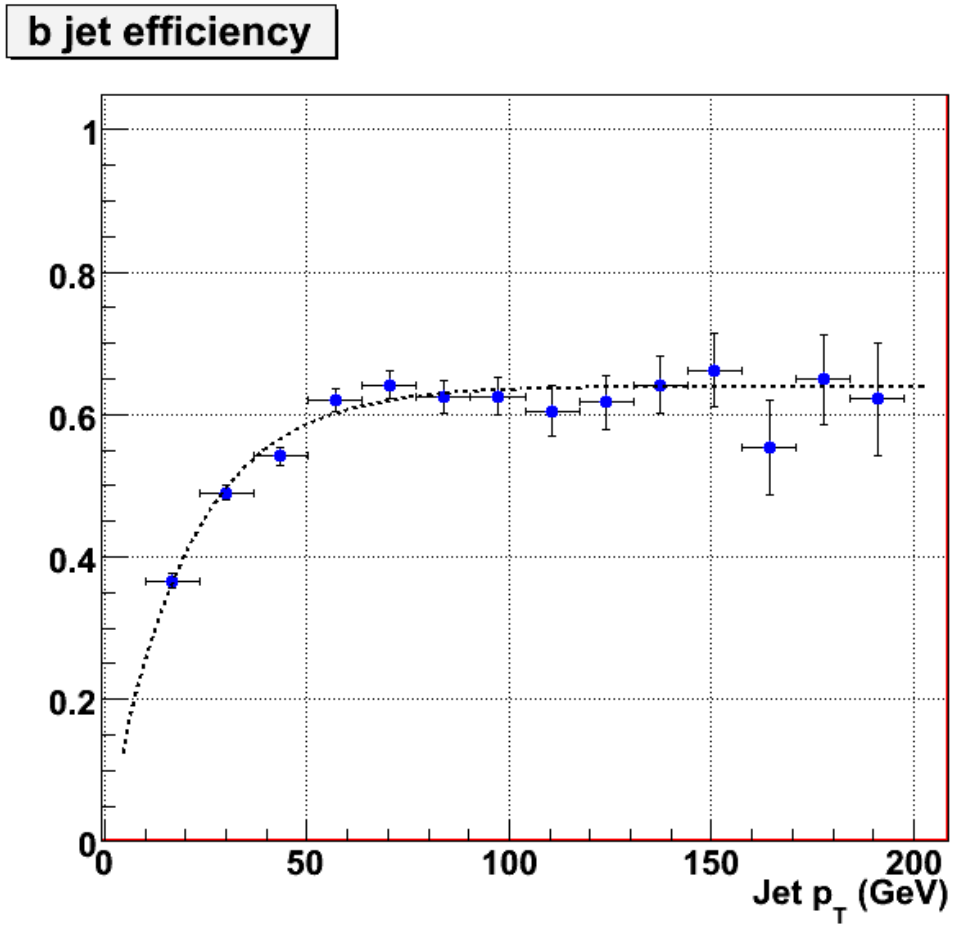
(bb)-jet

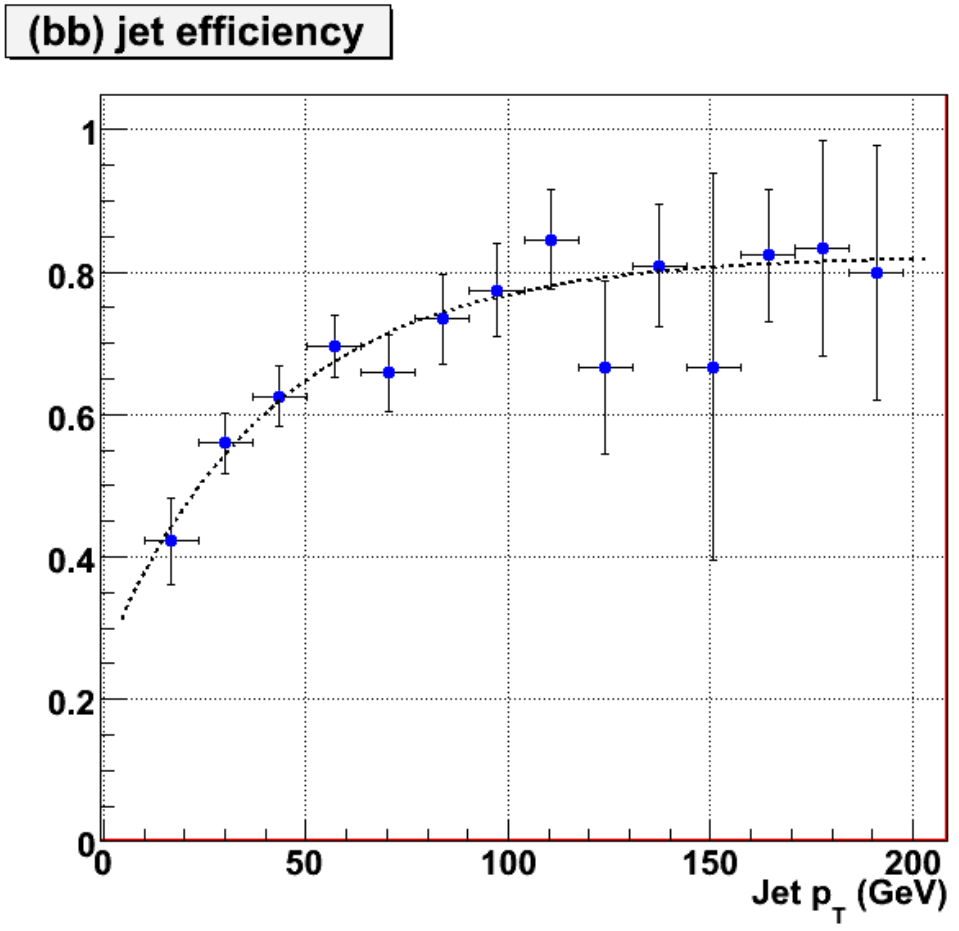
b-tagging Performance in Wbb Events (I)



Likelihood weight systematically higher for merged g(bb) jets.

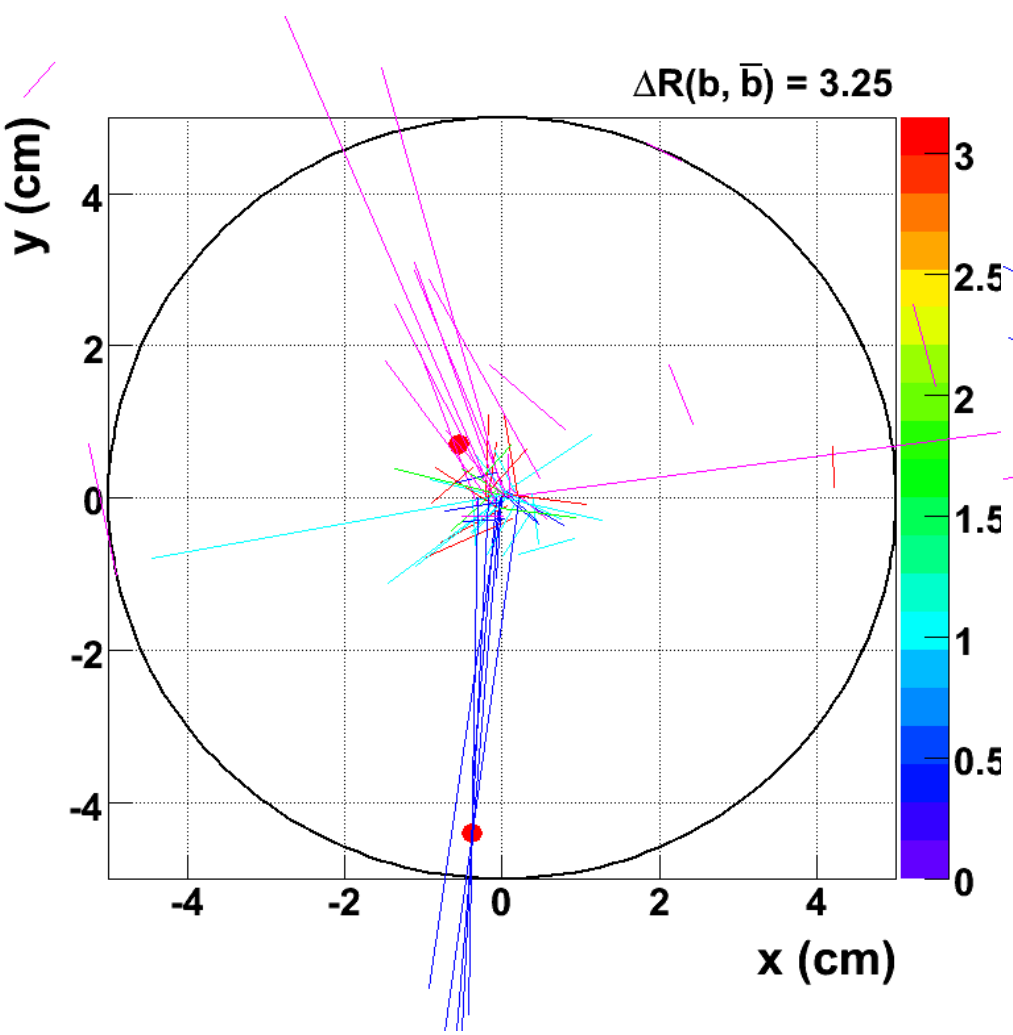
b-tagging Performance in Wbb Events (II)

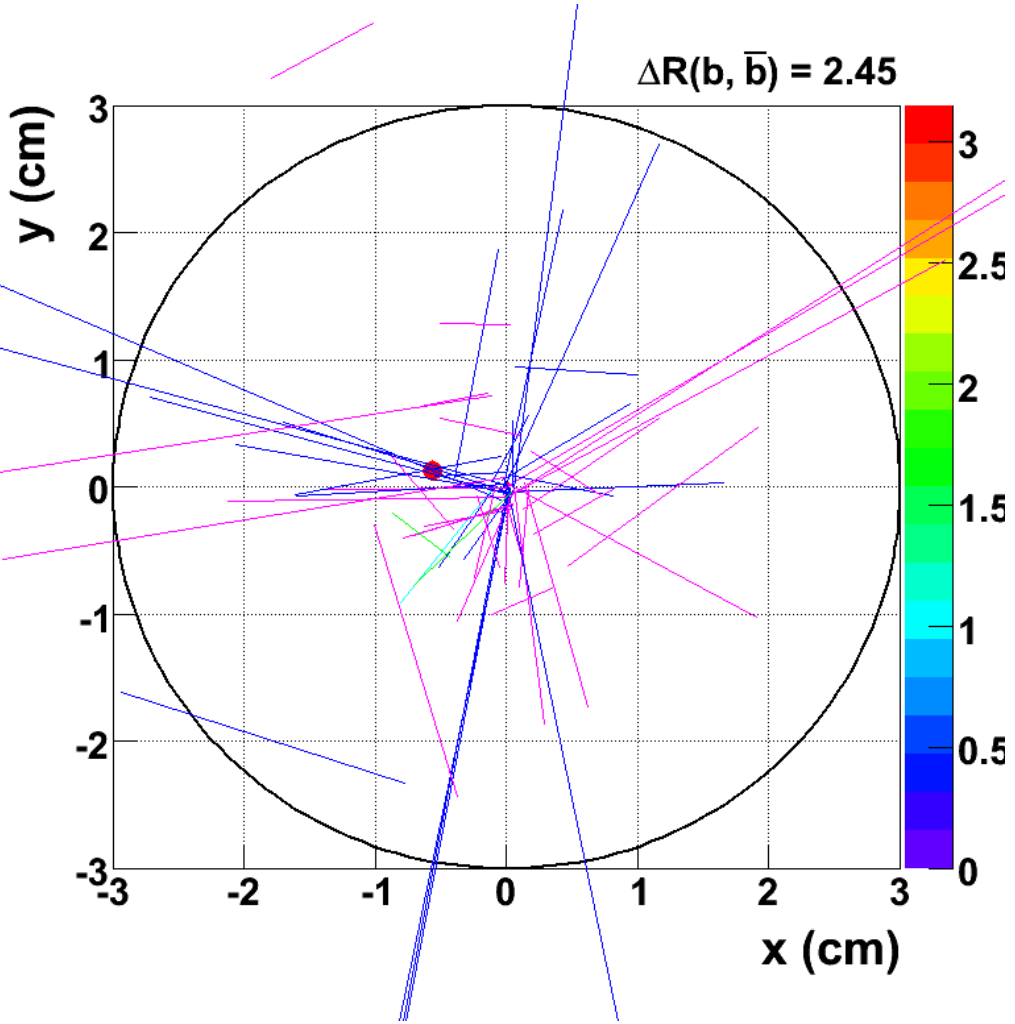




Higher b-tagging efficiency for merged g(bb) jets.
Different jet pT dependence.
(SV1+IP3 weight > 6)

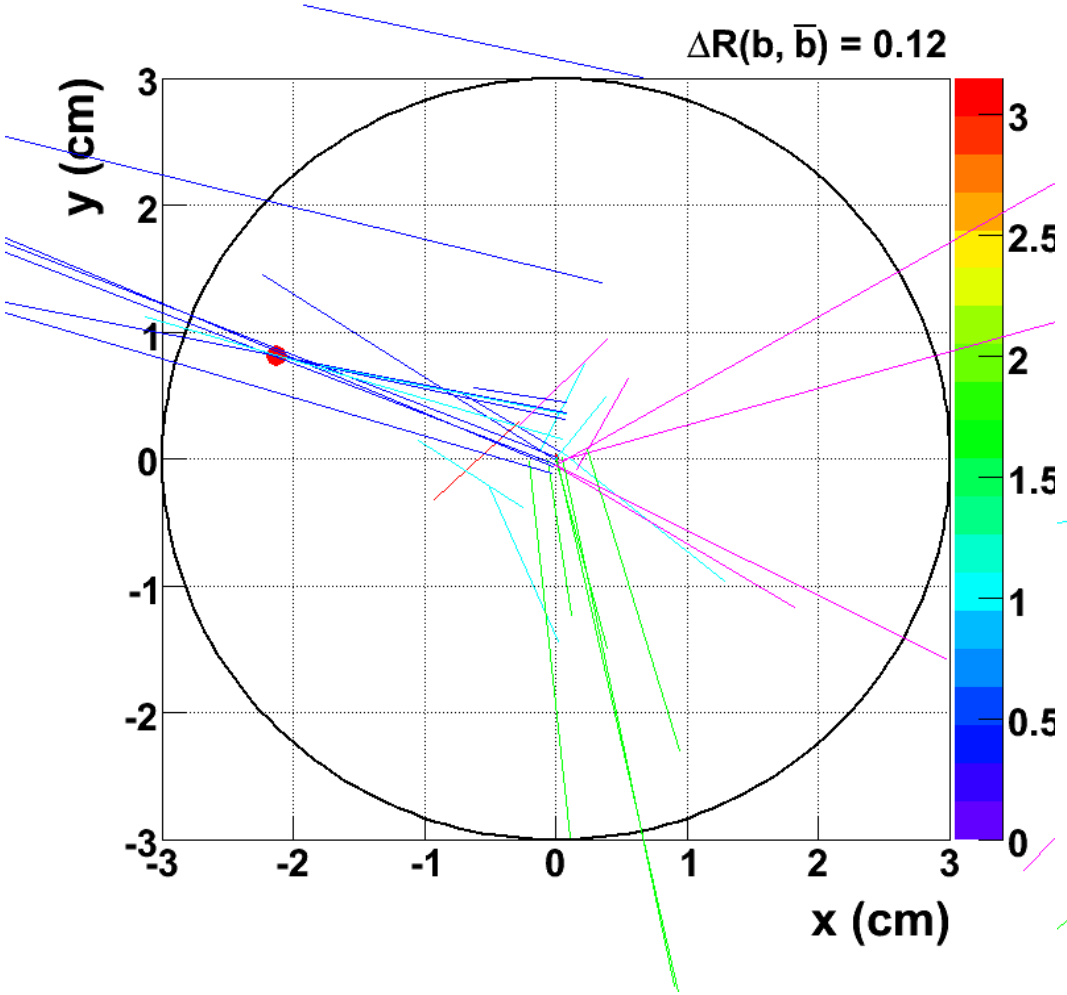
Single b-jets



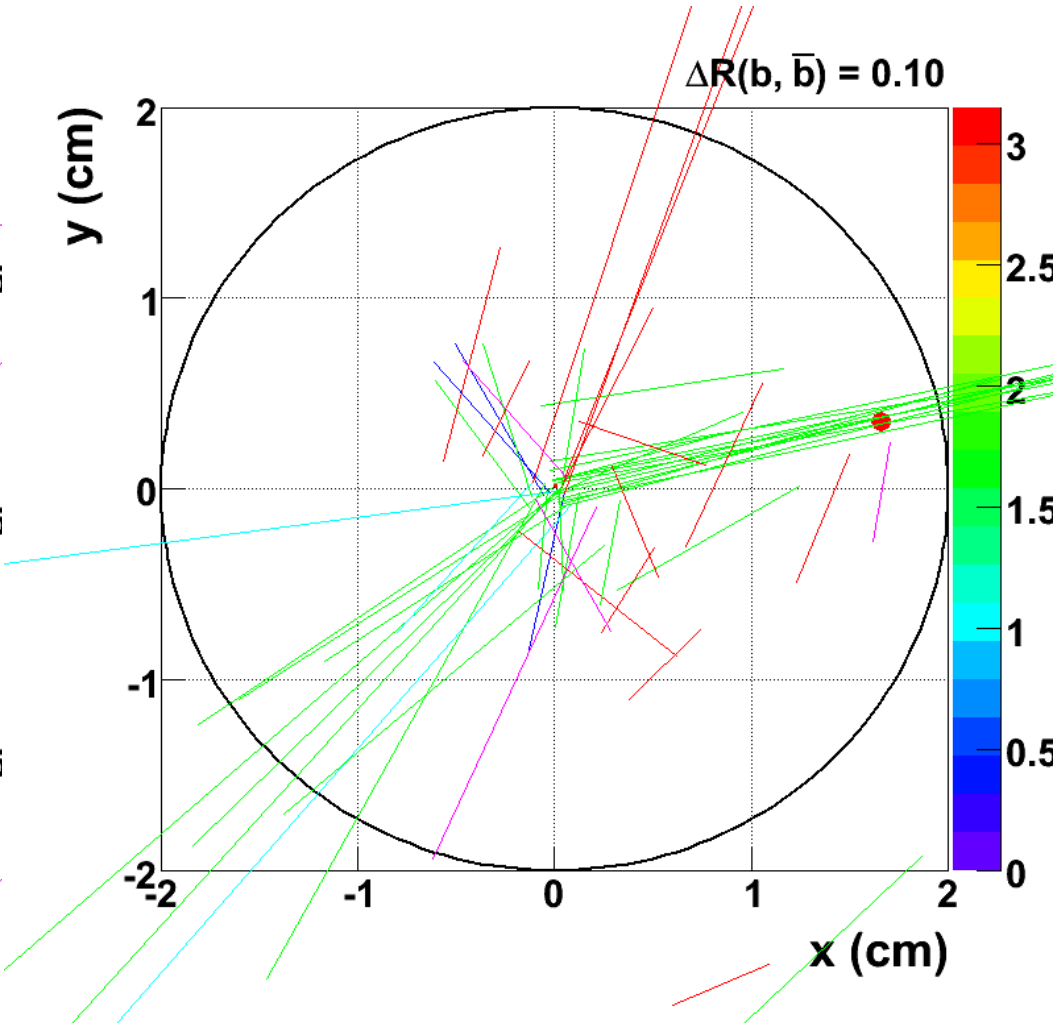


Dopler-colored event displays indicate theta (0-pi).
Length proportional to pT.

Merged (bb)-jets

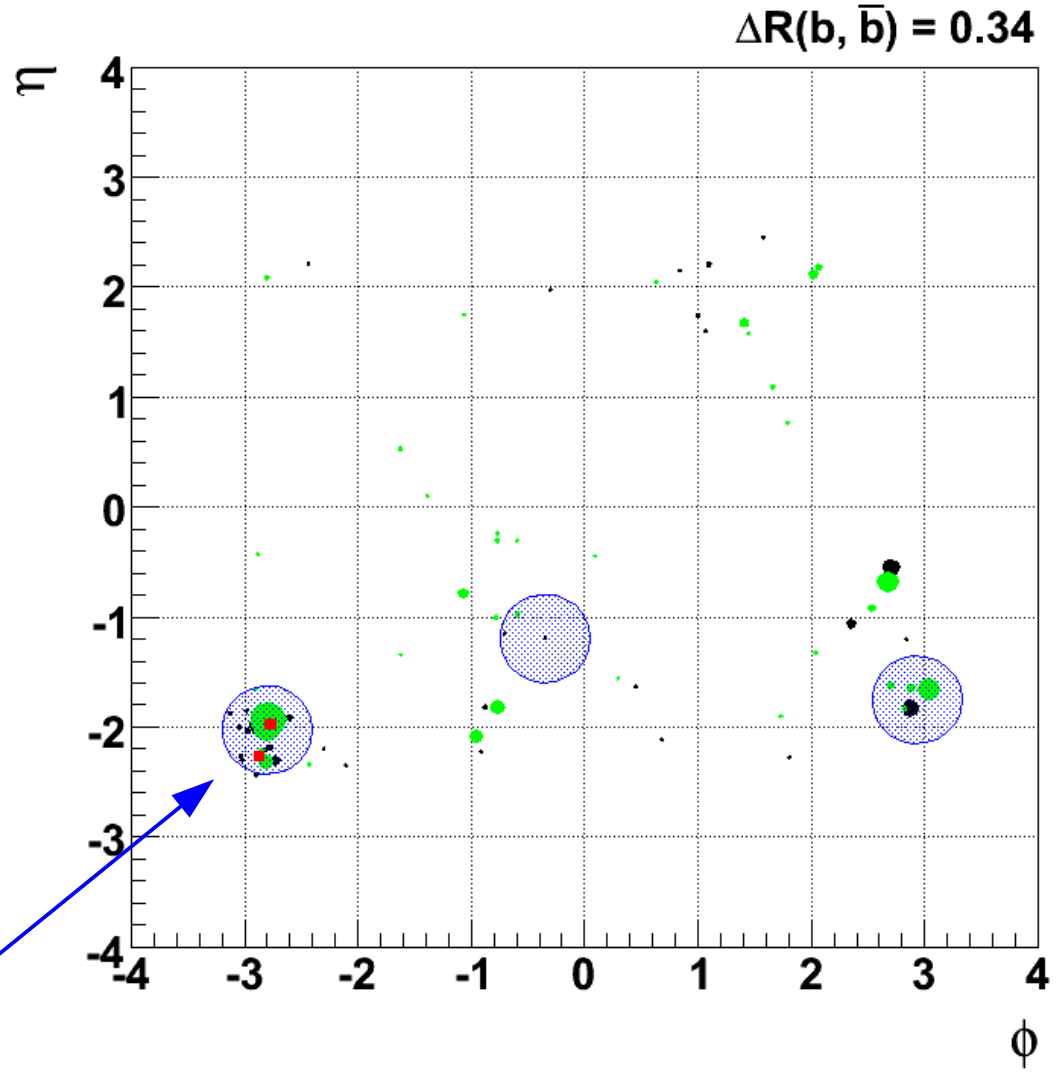


sub-track-jet structure visible.
Larger opening angles.



Large track multiplicity
(SV tagger does not find multiple vertices in jets)

Merged (bb) jets



Red dots: B mesons

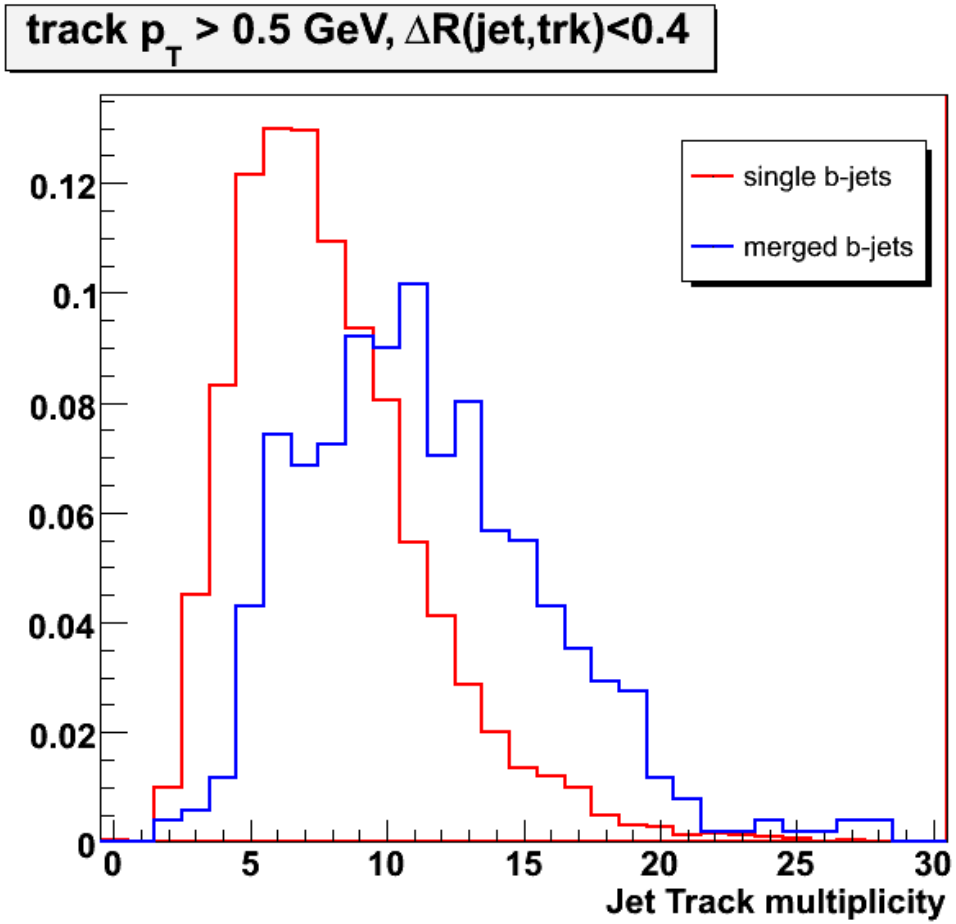
Black: PV tracks.

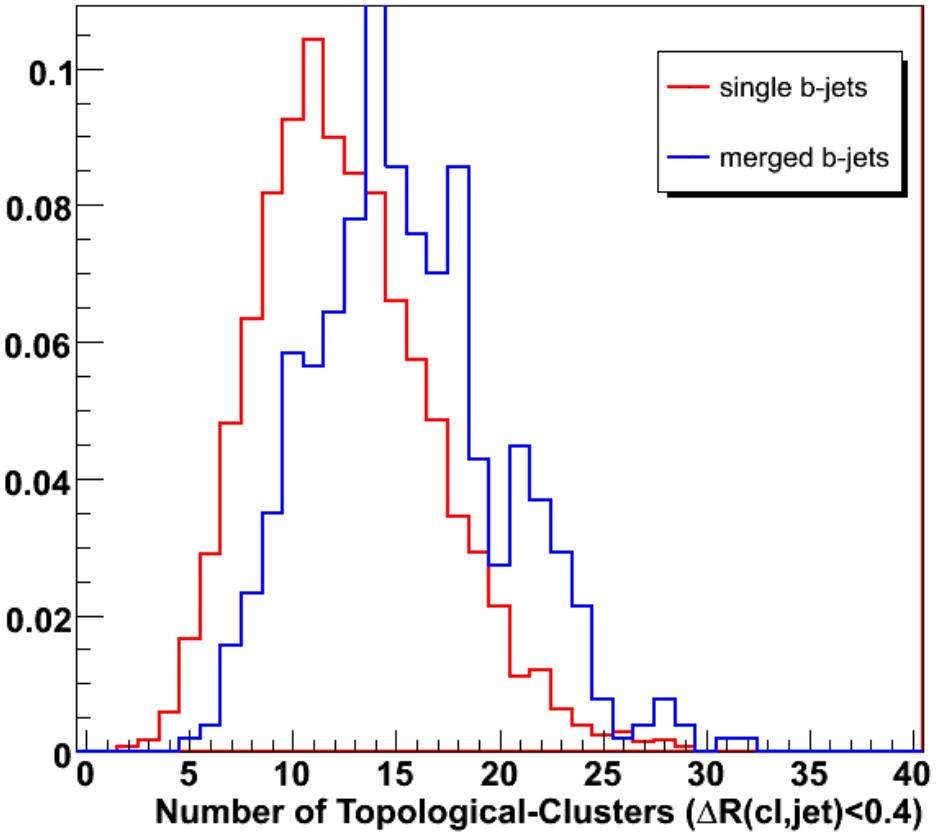
Green: tracks not attached to PV.

Blue: jets.

Sub-track jet structure

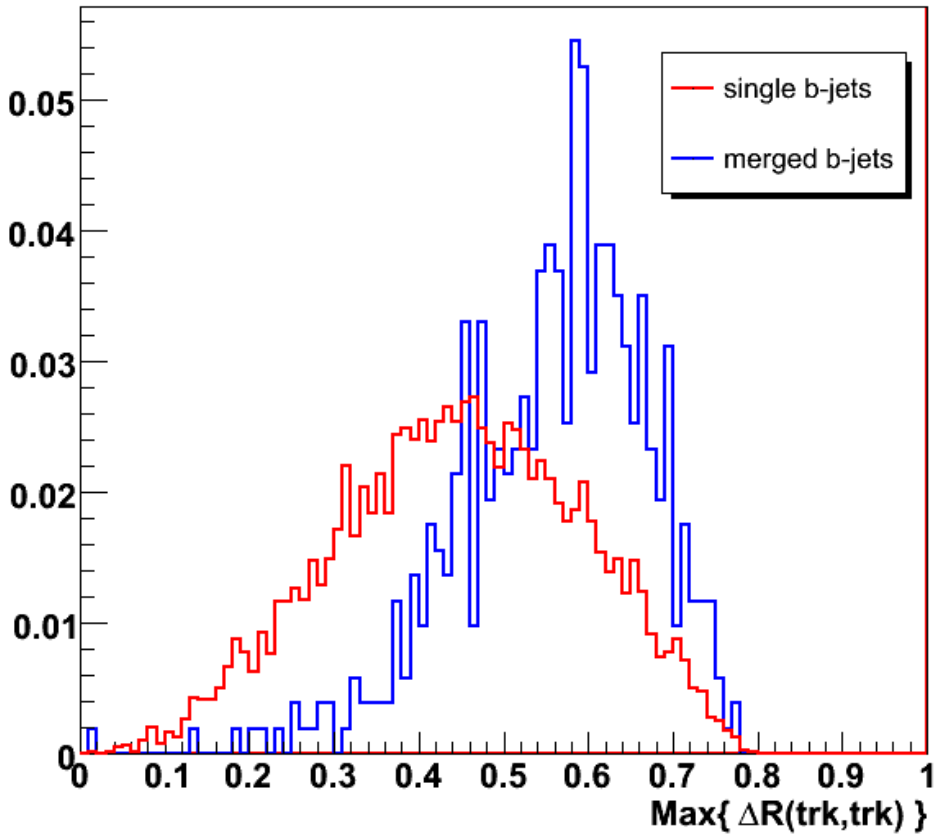
Kinematics of b and (bb)-jets (I)





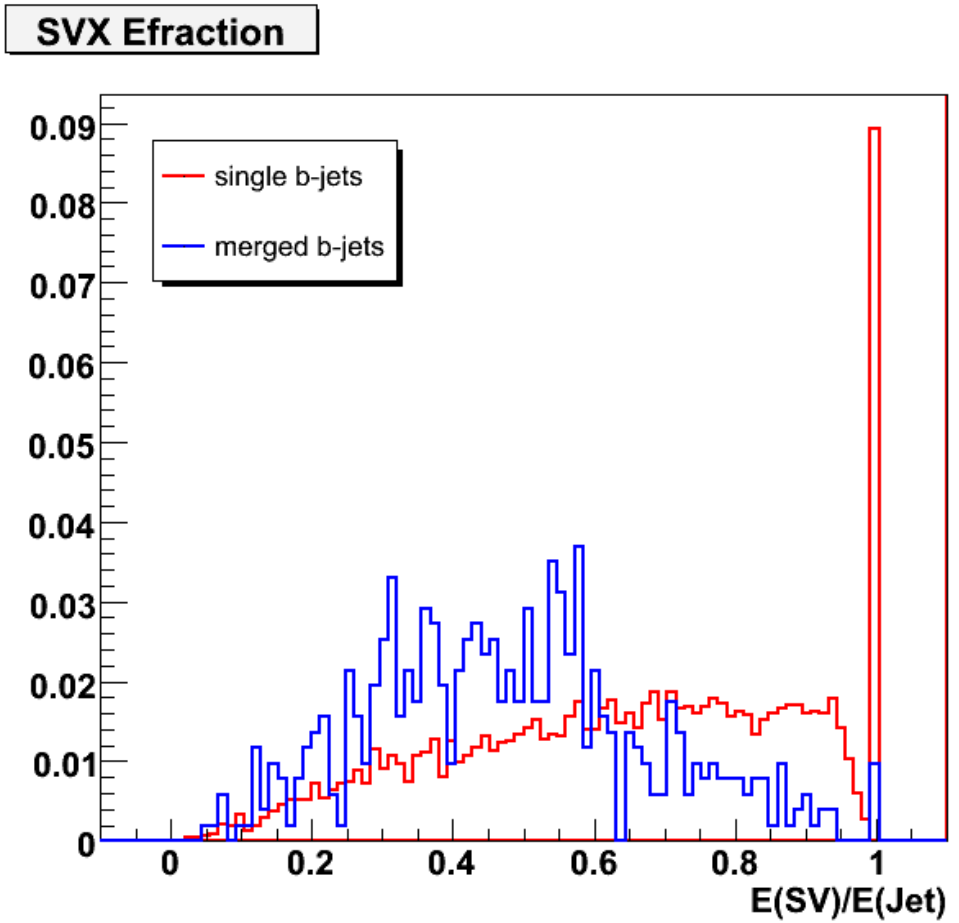
4:2:0 uncorrected topological clusters

Kinematics of b and (bb)-jets (II)



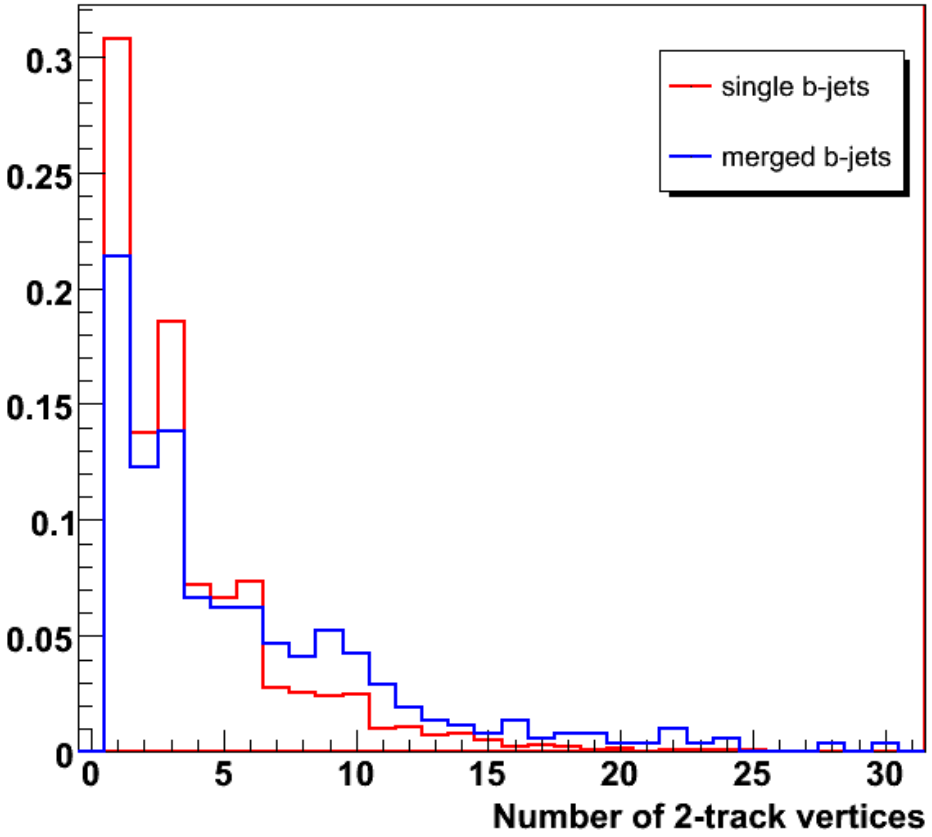
Track-Jet opening angle

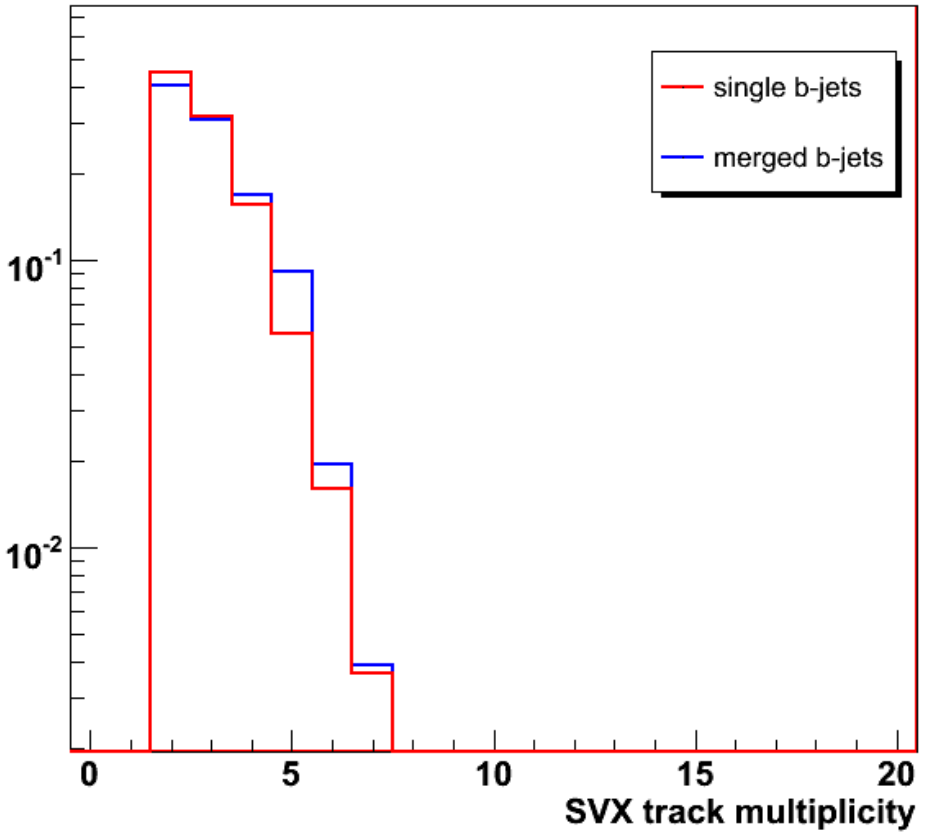
Pair of tracks with the largest DeltaR between them (range 0-0.8 for 0.4 cone jets)



Shape driven by single SV finding algorithm.

Kinematics of b and (bb)-jets (I)

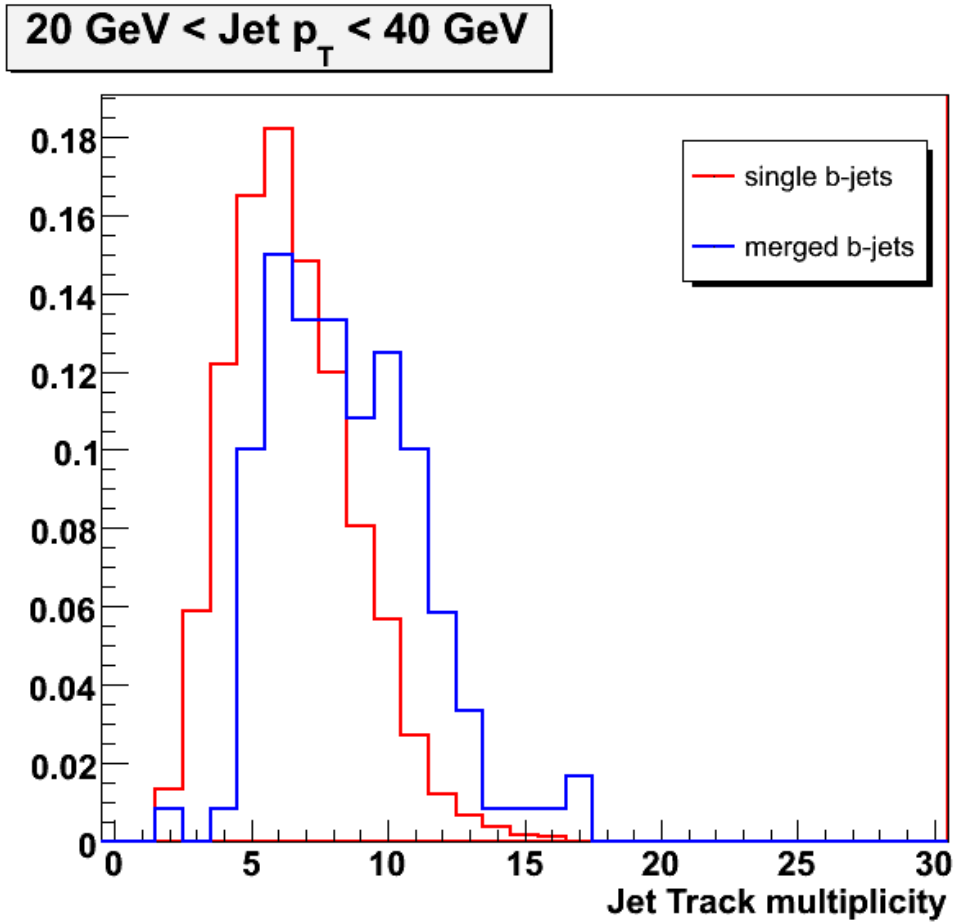


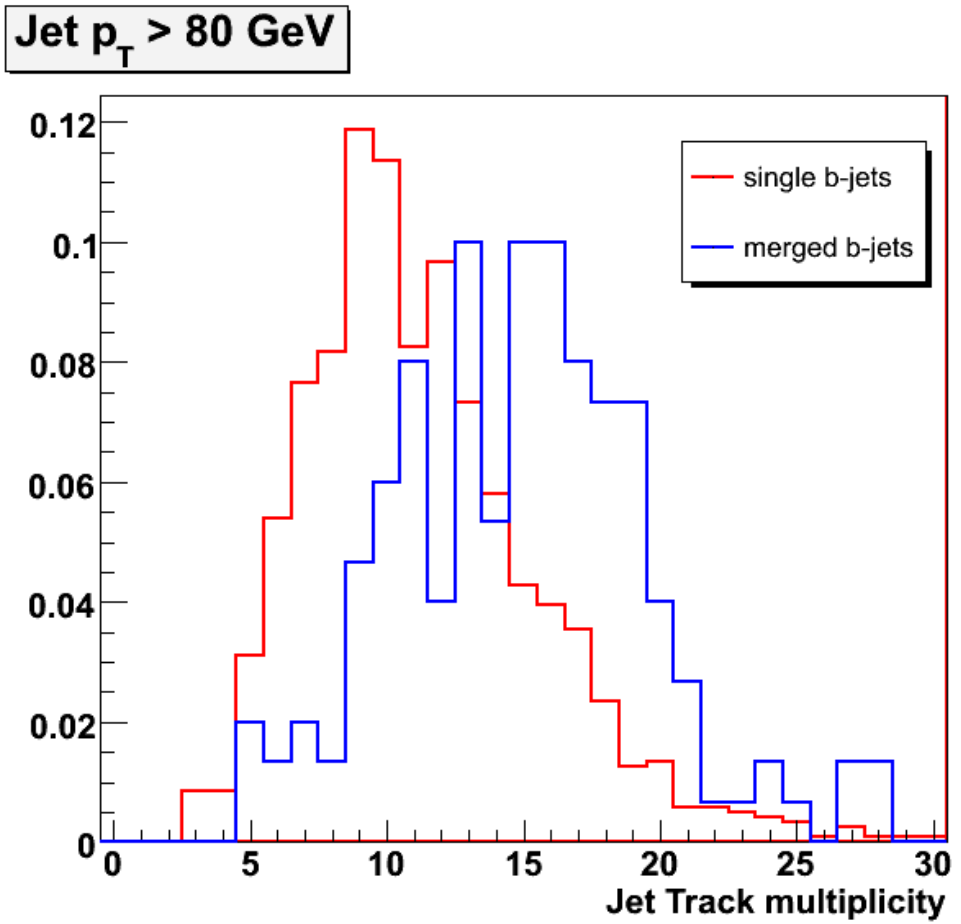


SV-based variables do not show significant discrimination:

room for improvements: multiple SV reconstruction, sub-track-jet finding.

Jet Pt – Track Multiplicity Correlation





Jet track-multiplicity highly correlated with jet pT.
Need to take both into account.

g(bb) Neural Network Tagger

Built Neural Network discriminator using the following variables:
Jet Pt, track-multiplicity, cluster-multiplicity, and track DRmax.

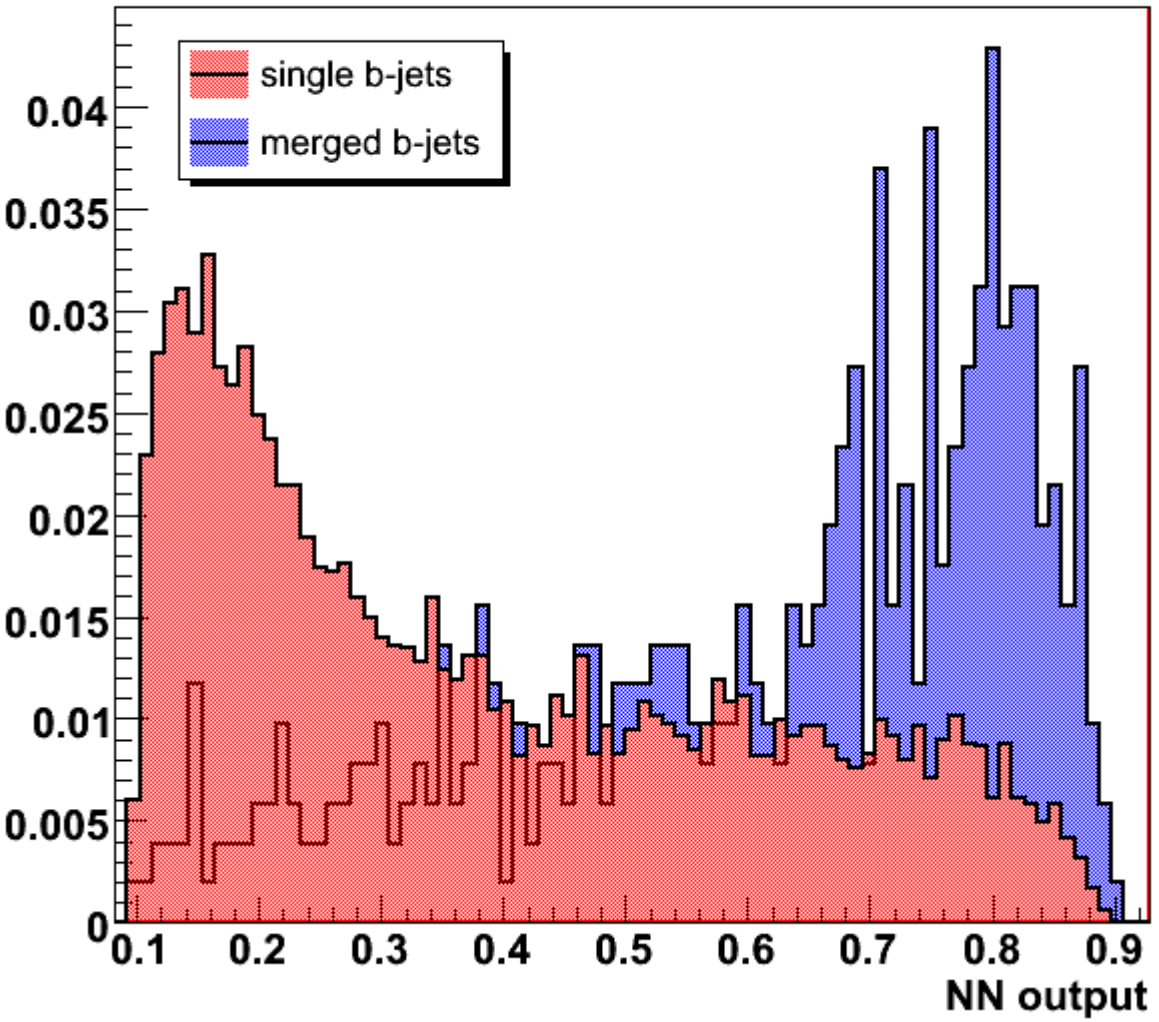
bb-jets:

	Pt	Ntrk	Ncl	Drmax
Pt	1.00	0.73	0.27	-0.01
Ntrk	0.73	1.00	0.49	0.33
Ncl	0.27	0.49	1.00	0.25
Drmax	-0.01	0.33	0.25	1.00

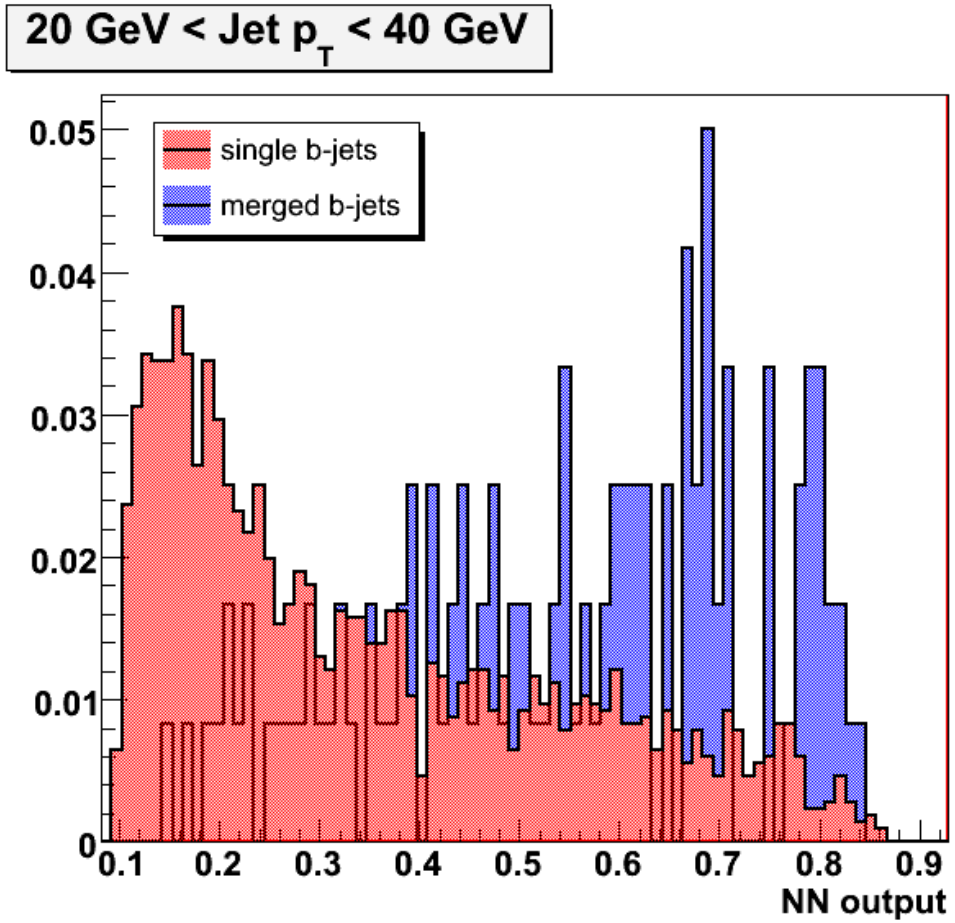
b-jets:

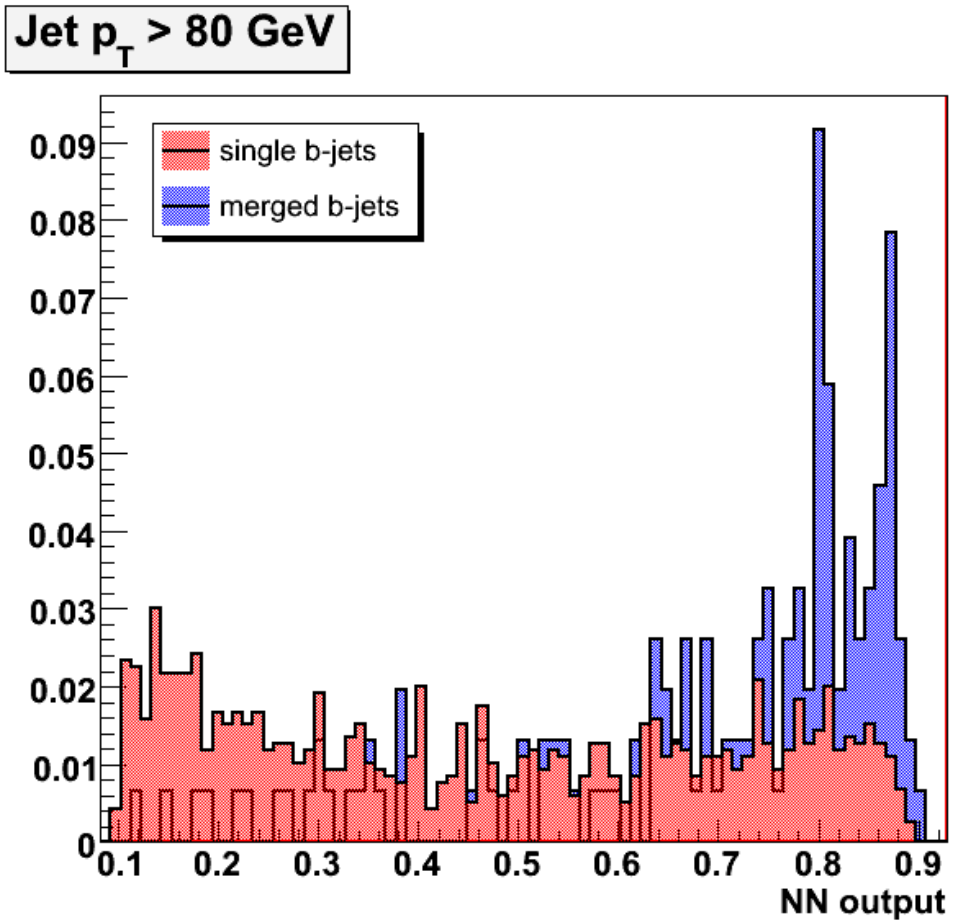
	Pt	Ntrk	Ncl	Drmax
Pt	1.00	0.59	0.26	-0.02
Ntrk	0.59	1.00	0.51	0.43
Ncl	0.26	0.51	1.00	0.19
Drmax	-0.02	0.43	0.19	1.00

g(bb) Tagger Performance (I)



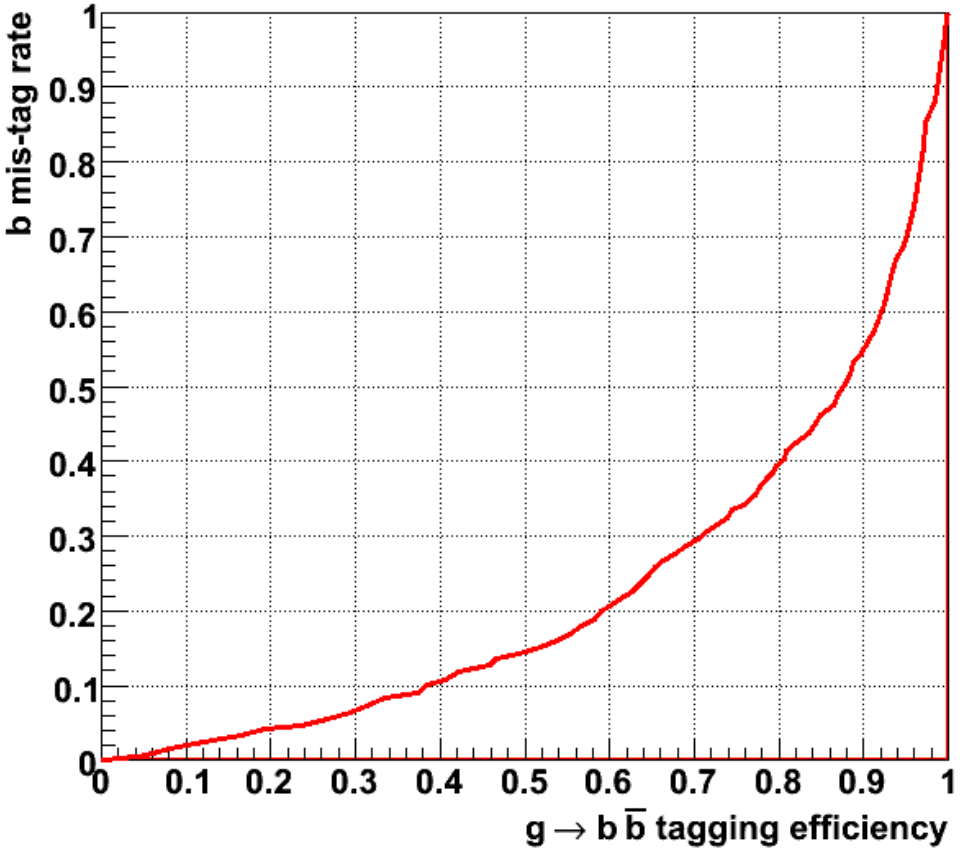
g(bb) Tagger Performance (II)

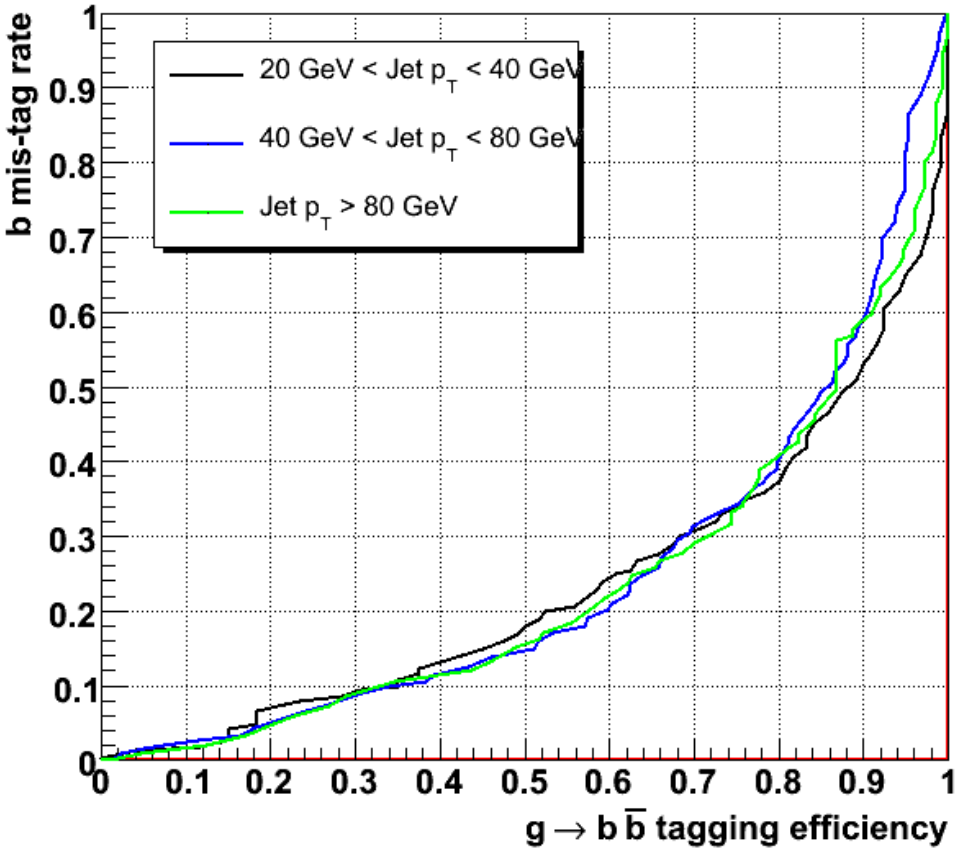




As jet Pt increases, gbb peak becomes sharper and b peak spreads out.

g(bb) Tagger Performance (III)





Preliminary discrimination performance:

40% efficiency @ 10% b mis-tag rate.

Summary and Plans

First implementation of a g(bb) tagging algorithm:

Use of track-vertex based kinematic variables to build a NN discriminant against single b-jets.

Using secondary multi vertex finding algorithms and better vertex mass calculation may improve the discrimination power.

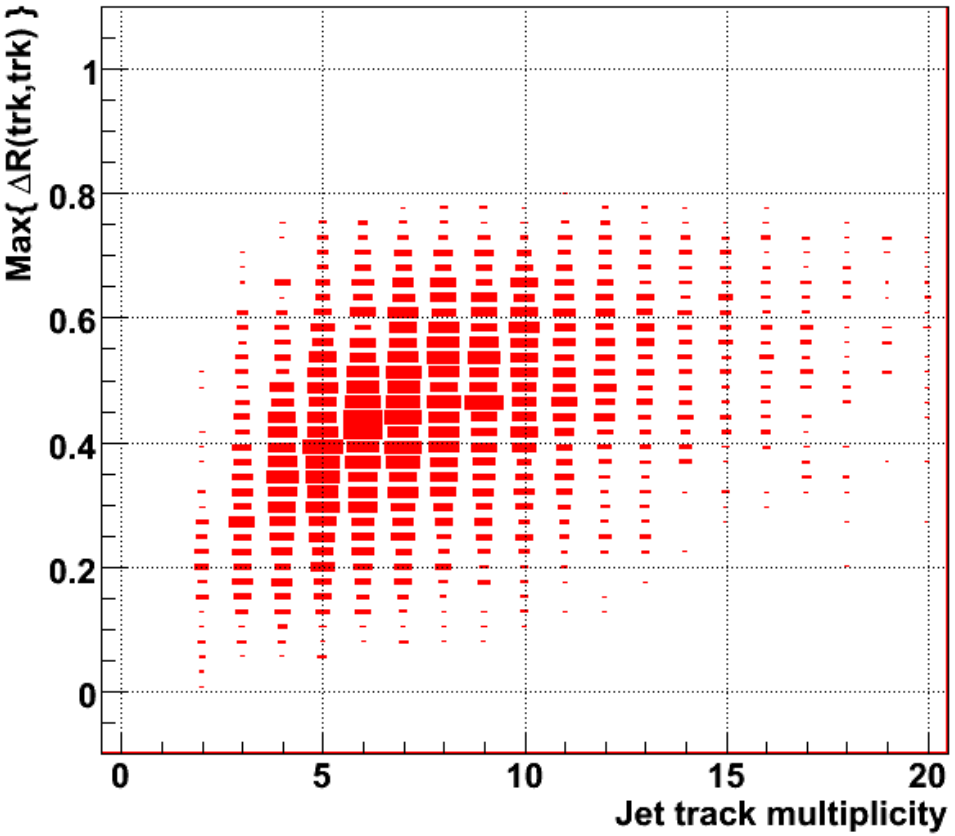
Use of Track-Jet sub-clustering: “displaced” track-jets in (eta-phi-IP) plane to obtain jet sub-structure information.

Impact in physics analyses:

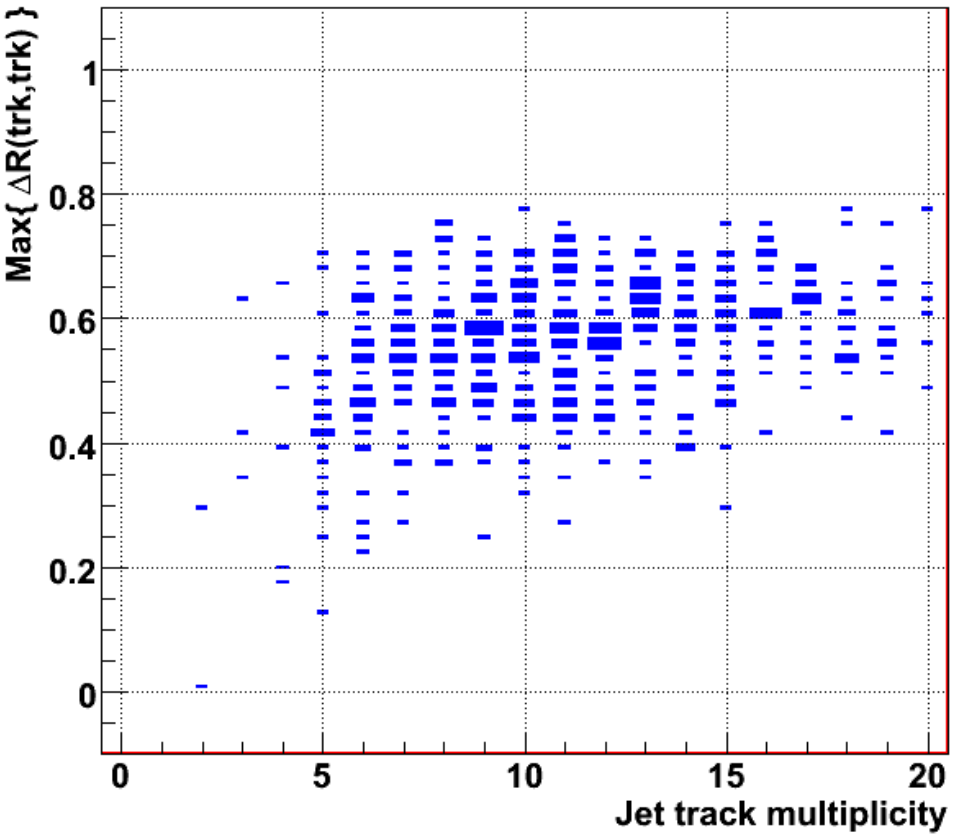
Use of g(bb) discriminant and g(bb) Tag Rate Functions. Study performance in g(qq) events.

Back up slides

b and (bb)-jets Correlations (I)

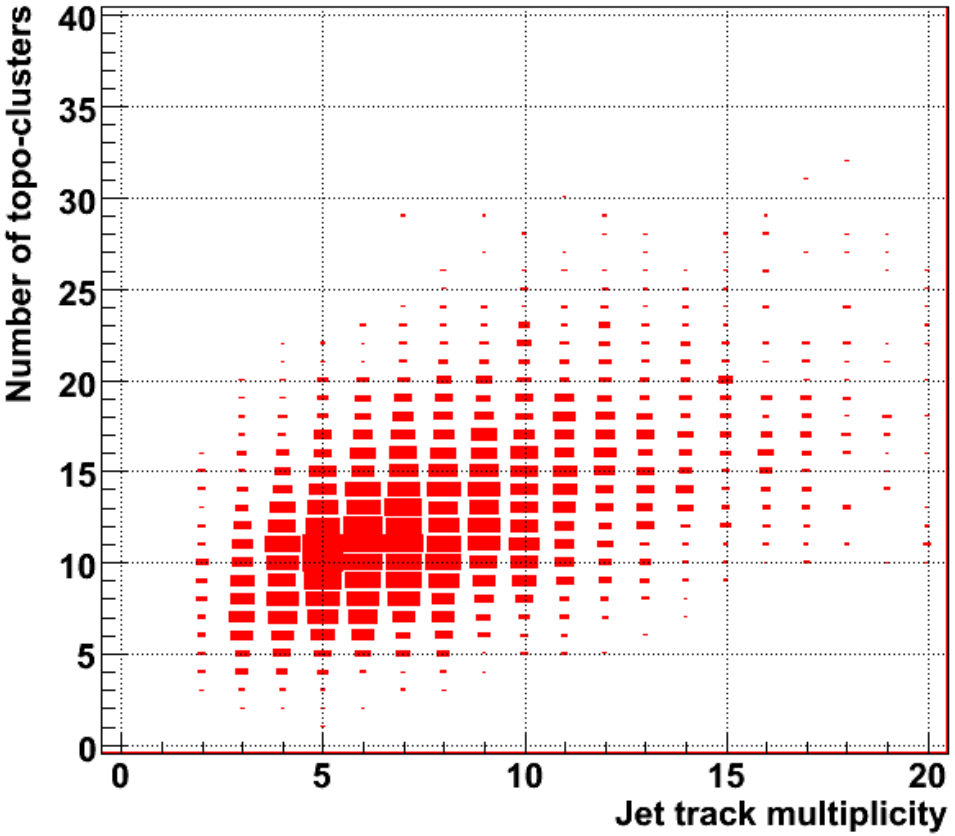


b-jets

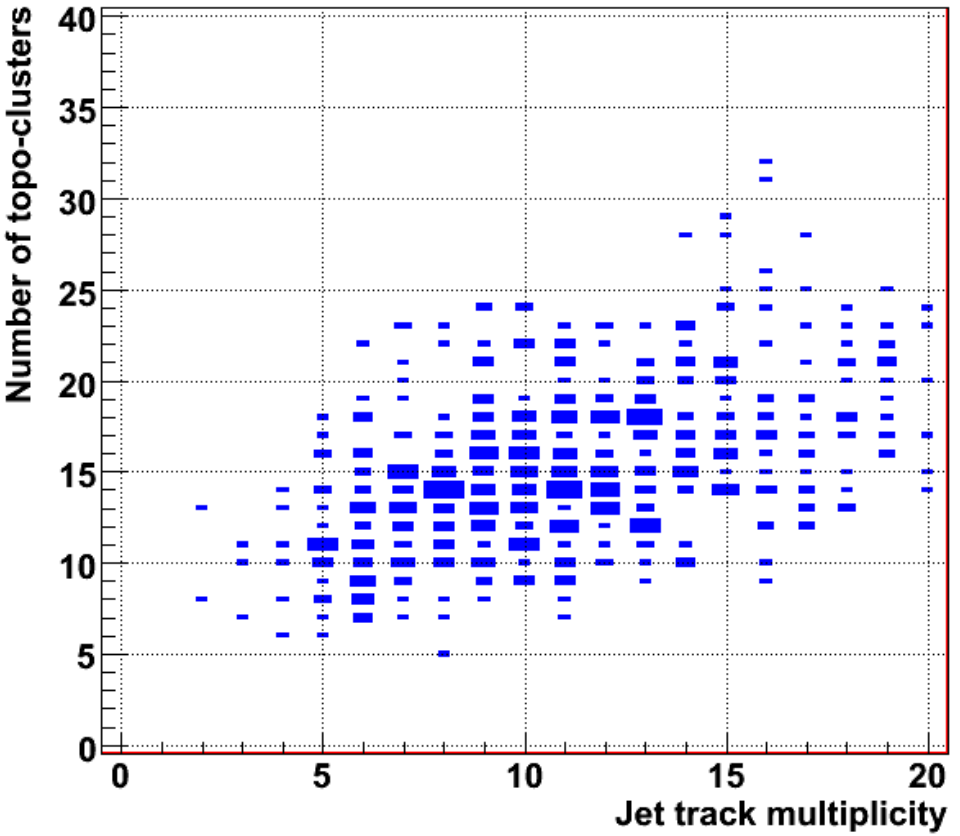


bb-jets

b and (bb)-jets Correlations (II)

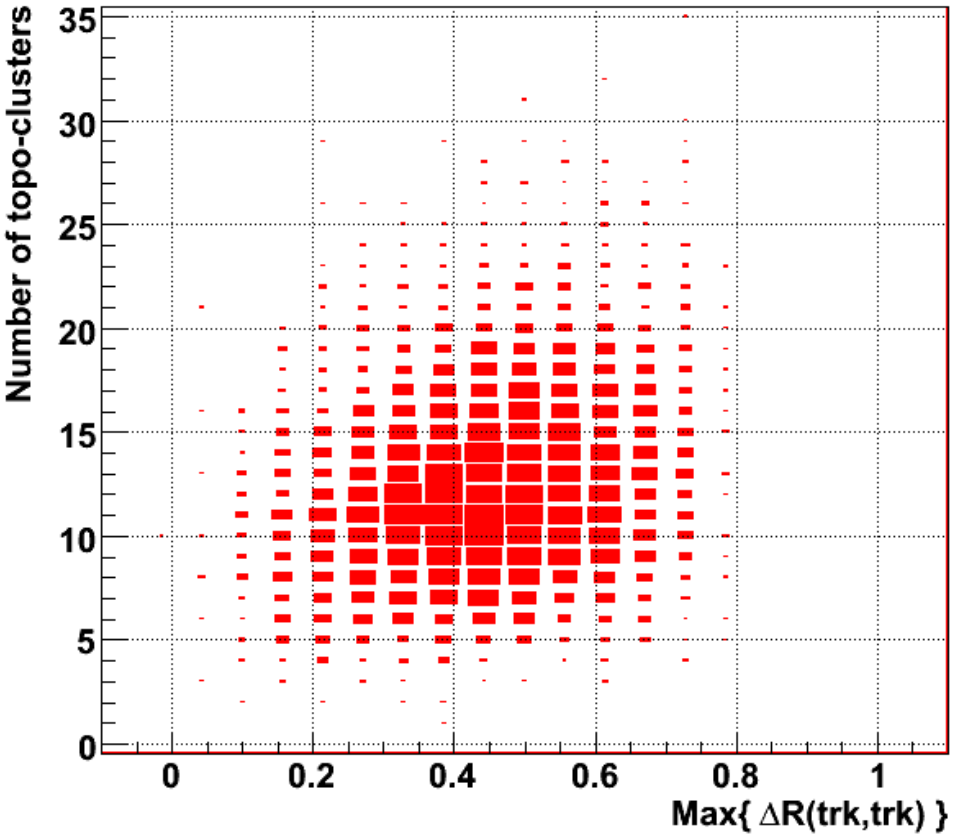


b-jets

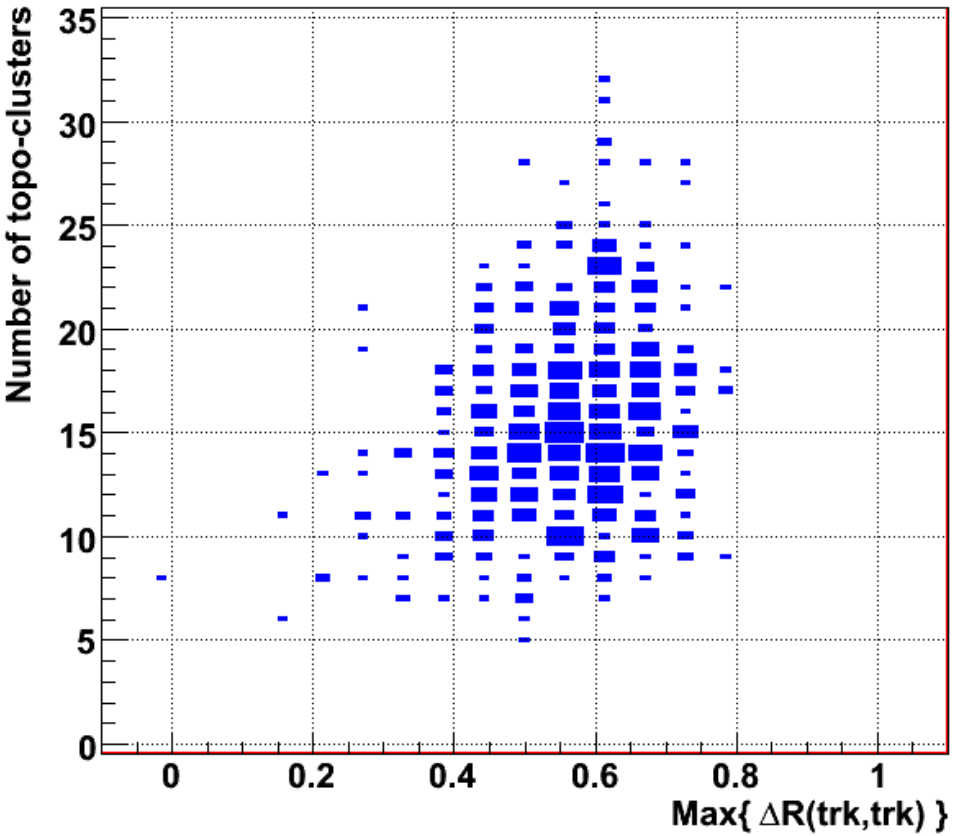


bb-jets

b and (bb)-jets Correlations (III)



b-jets



bb-jets