b-Tag Track Studies

Laurie McClymont
(with Andreas and Tim)

Flav Tag Weekly
24 March 2015

Aims of Study

- To study the track selection of IP3D, SV1 and Jet Fitter Algorithms when applied to truth b-jets.
- Move towards harmonisation of track selections for release 21
- Optimise flavour tagging performance for high P_T by adjusting track selection

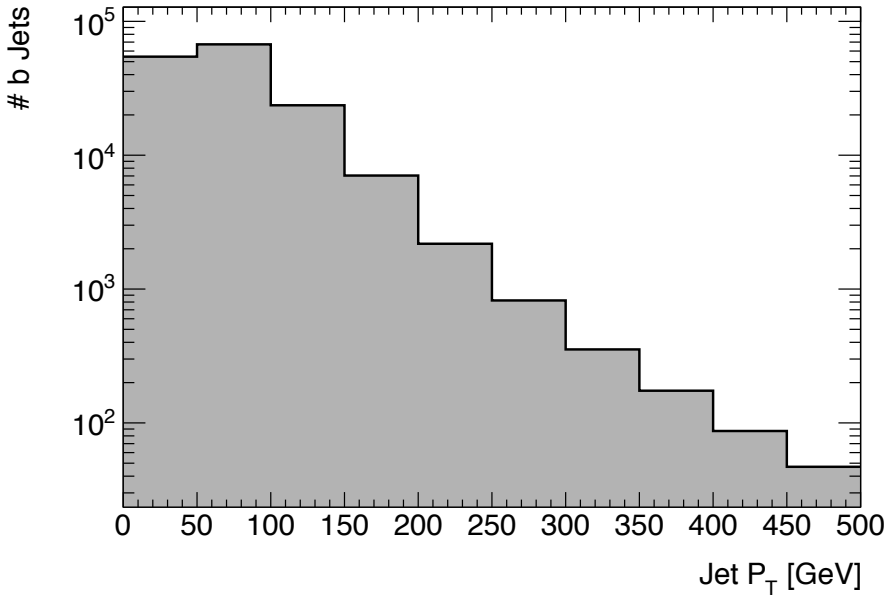
Sample Used for Studies

valid3.110401.PowhegPythia_P2012_ttbar_nonallhad.recon.AOD.e3099_s2579_r6162/

Validation Sample for r20.1.3.2

96,980 events

pile up = 0



Track Cuts and Some Definitions

Track Cuts

From Talk by R. Zaidan at Flav Tag Workshop 2015

In this study I have applied these cuts manually in my analysis code.

	IP3D	SV1	JFit
$p_T \geq$	1000	700	769.2
$\lvert\eta\rvert \leq$	2.5	2.5	2.5
$N_{SI} \geq$	7	7	7
$N_{SCT} \geq$	-	4	4
$N_{PIX} \geq$	2	1	1
$N_{IBL} \geq$	1	-	-
$N_{IBL} + N_{BL} \geq$	-	-	-
$N^{SH}_{PIX} + \frac{N^{SH}_{SCT}}{2} \leq$	-	-	1
$N^{HOLE}_{SI} \leq$	-	-	-
$N^{HOLE}_{PIX} \leq$	-	-	-
$d_0 \leq$	1	5	3.5
$z_0 * \sin(\theta) \leq$	1.5	25	5
$\sigma(d_0) \leq$	-	1	0.35
$\sigma(z_0) \leq$	-	5	2.5
$\chi 2/NDF \leq$	-	-	3.5

Definitions

From B = Any track associated to the decay of the B Hadron

From Geant = Any track created by a GEANT interaction.

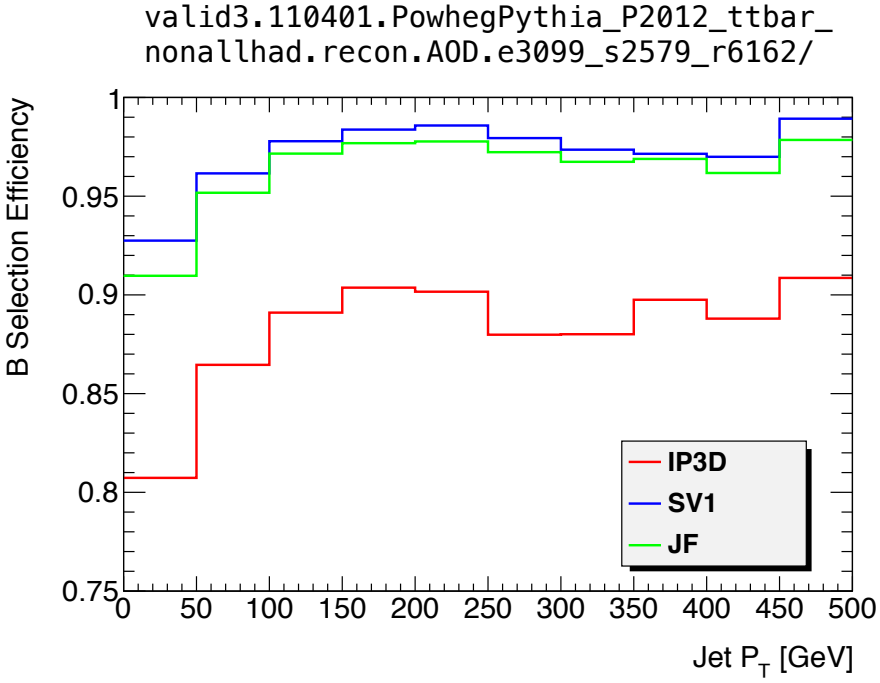
From Frag = Any track not From B or From Geant

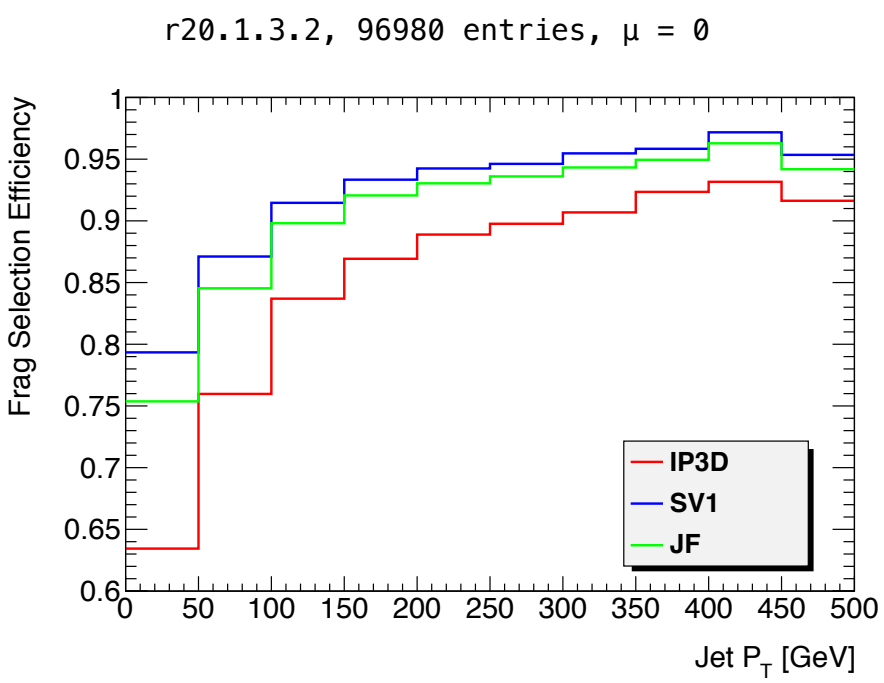
From Other = Any track not From B

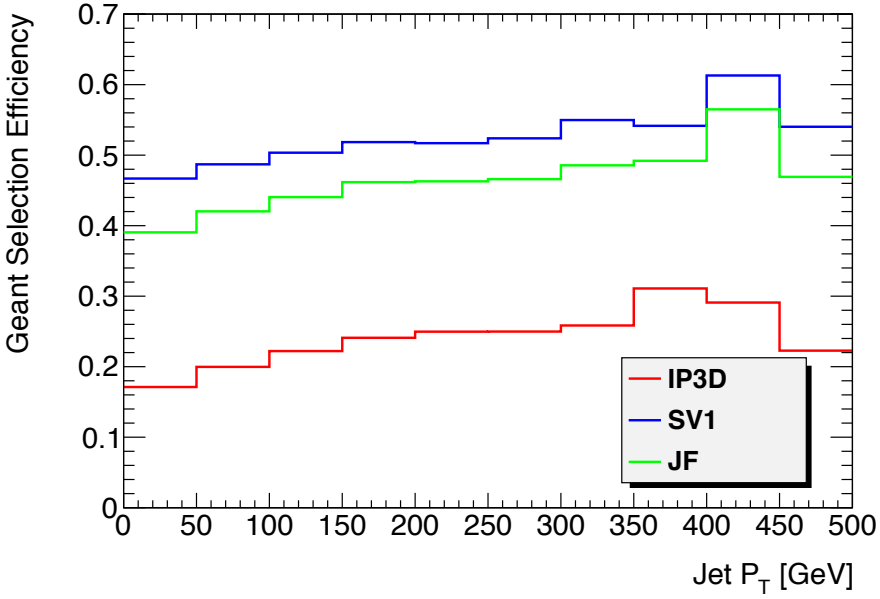
Selection Efficiency = $\frac{\text{\# Tracks FromX Selected By a Cut}}{\text{\# Truth Tracks From X}}$

Fraction of Tracks = $\frac{\text{\# Tracks FromX Selected By a Cut}}{\text{Total \# Tracks Selected by a Cut}}$

Selection Efficiencies





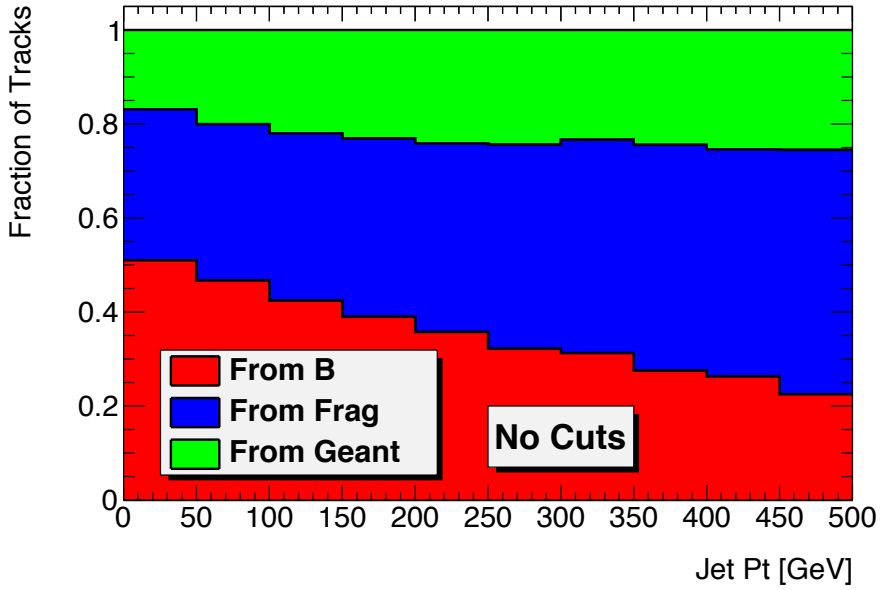


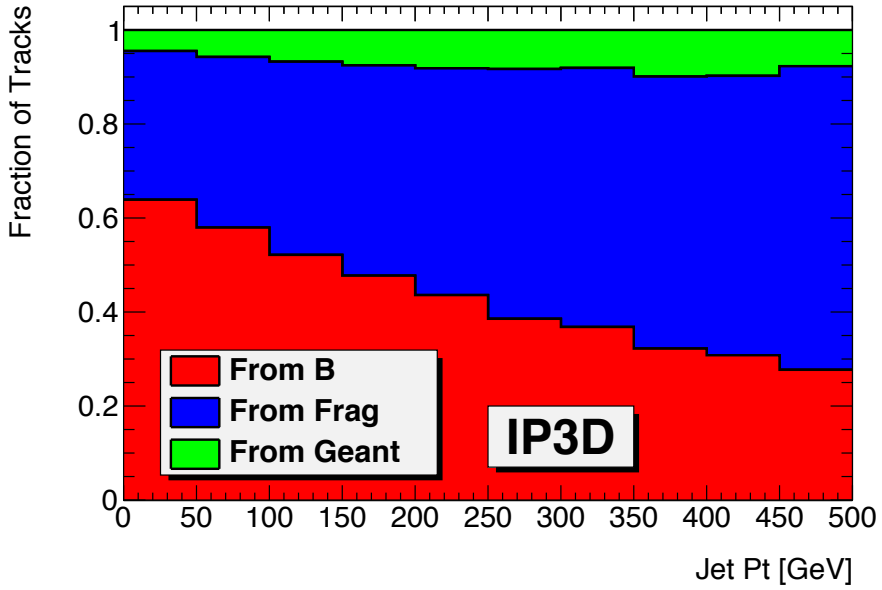
Selection Efficiency = $\frac{\text{\# Tracks FromX Selected By a Cut}}{\text{\# Truth Tracks From X}}$

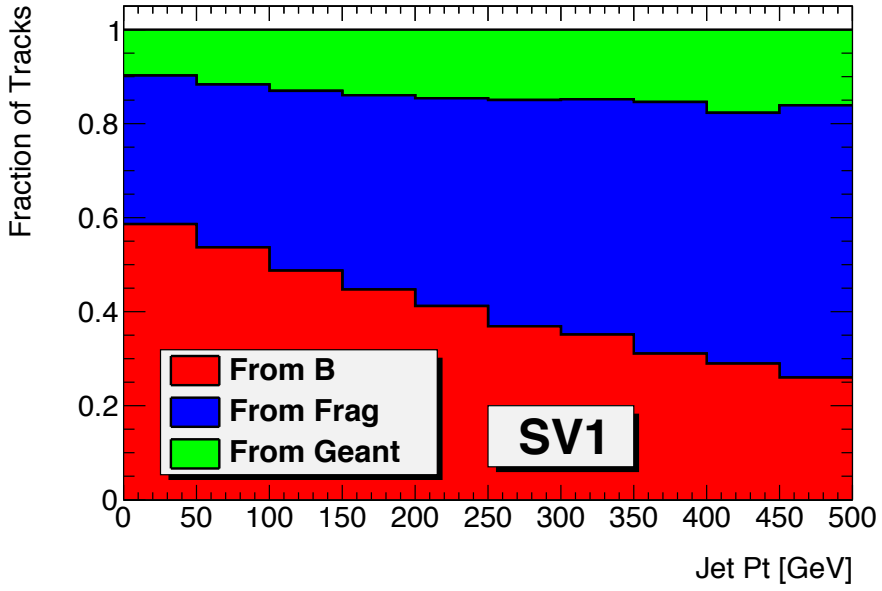
Analysis of Fraction of Tracks From X After Cuts

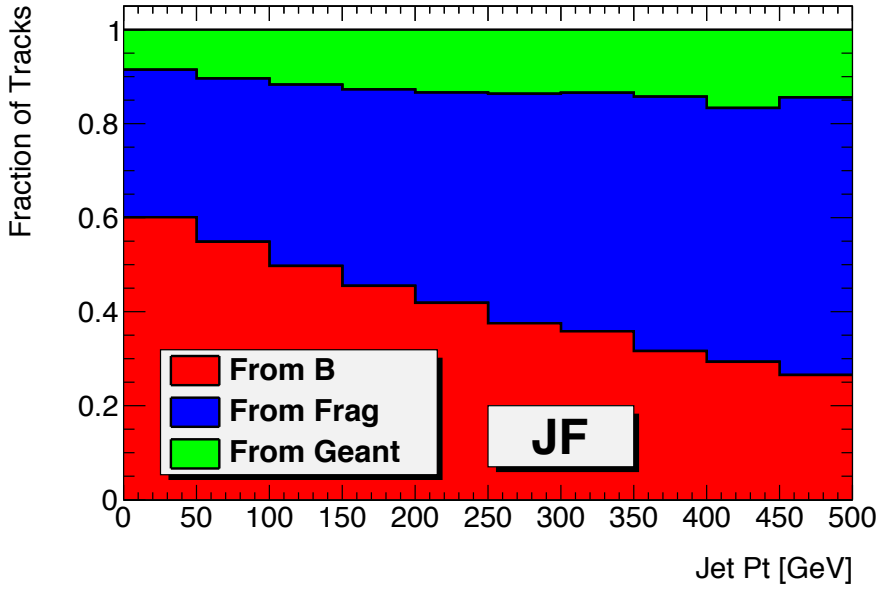
valid3.110401.PowhegPythia_P2012_ttbar_nonallhad.recon.AOD.e3099_s2579_r6162/

r20.1.3.2, 96980 entries, μ = 0





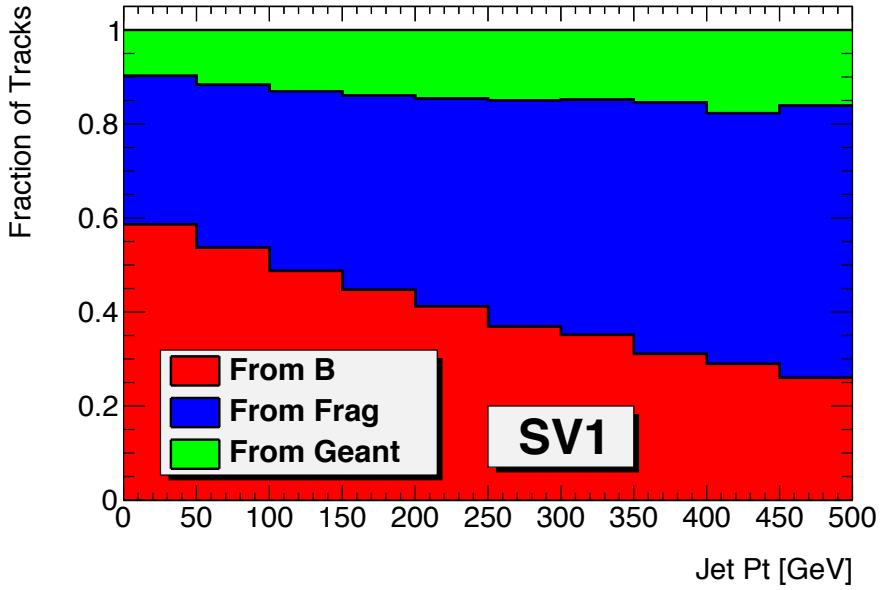


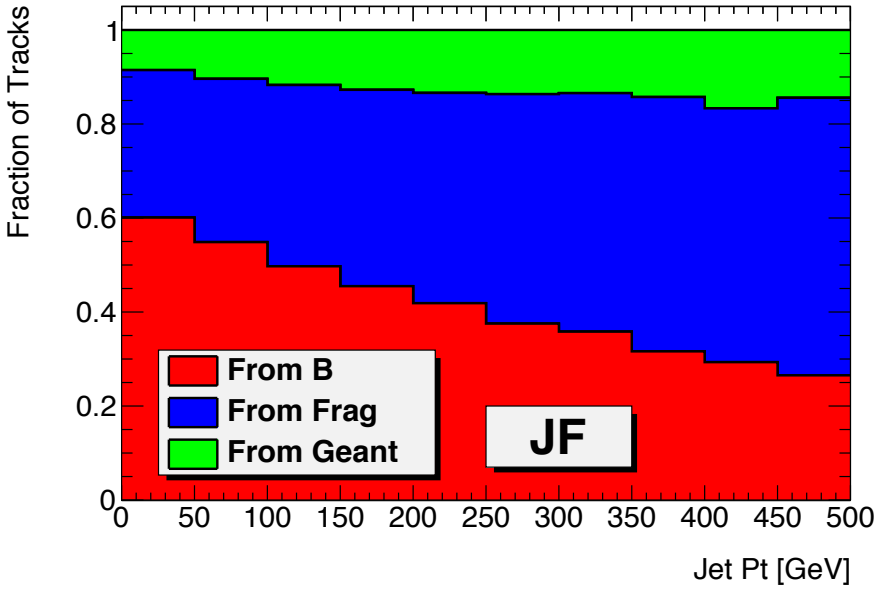


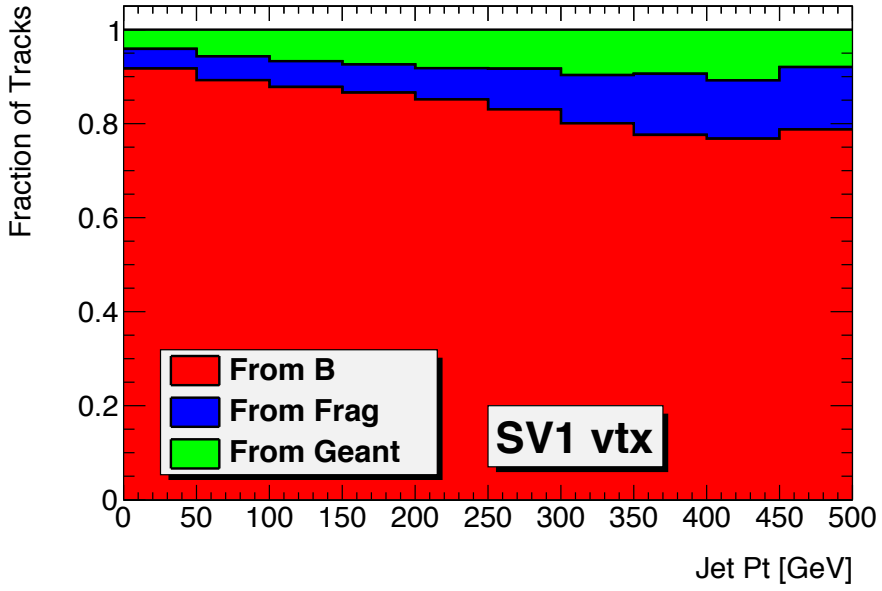
Analysis of Fraction of Tracks From X With Verticies

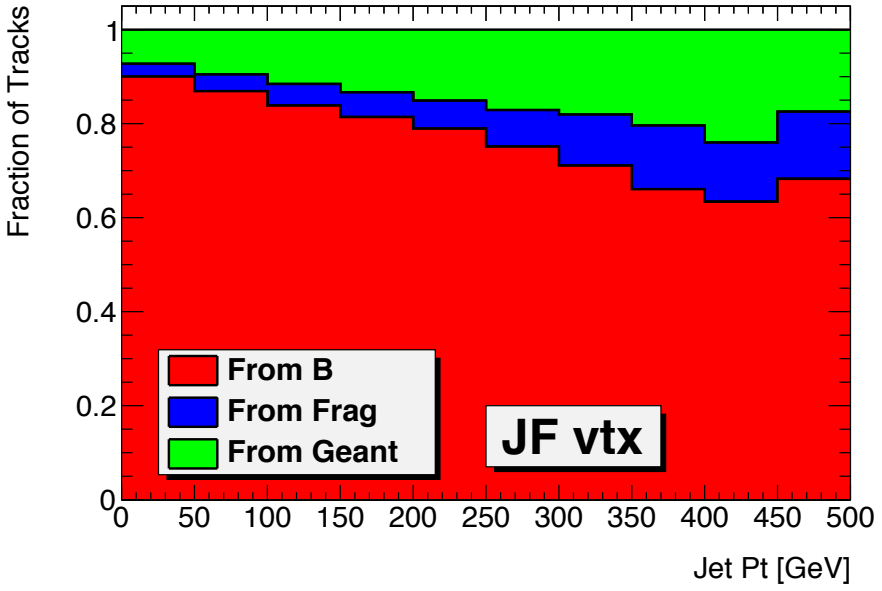
valid3.110401.PowhegPythia_P2012_ttbar_nonallhad.recon.AOD.e3099_s2579_r6162/

r20.1.3.2, 96980 entries, μ = 0





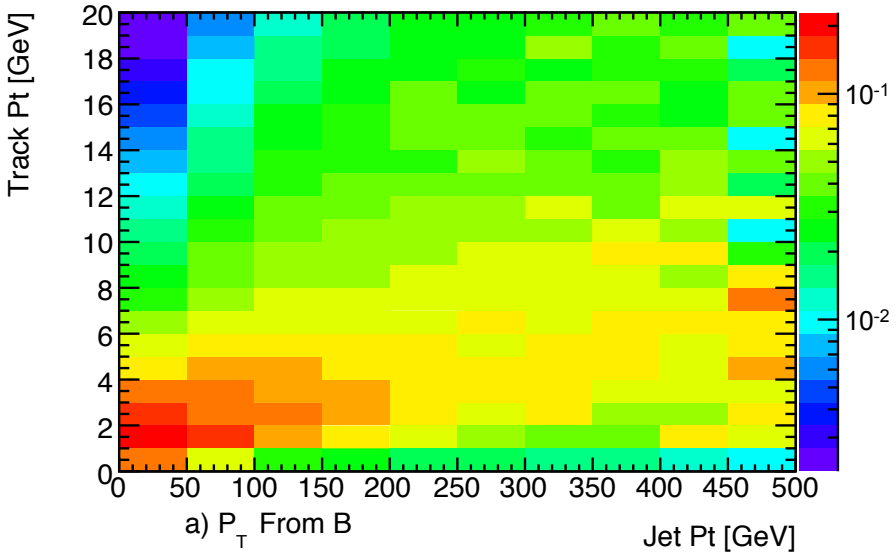


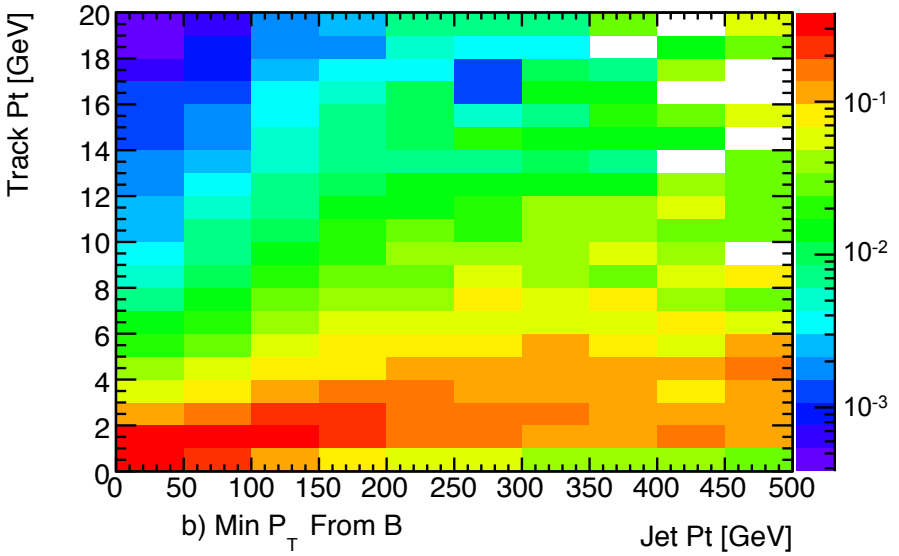


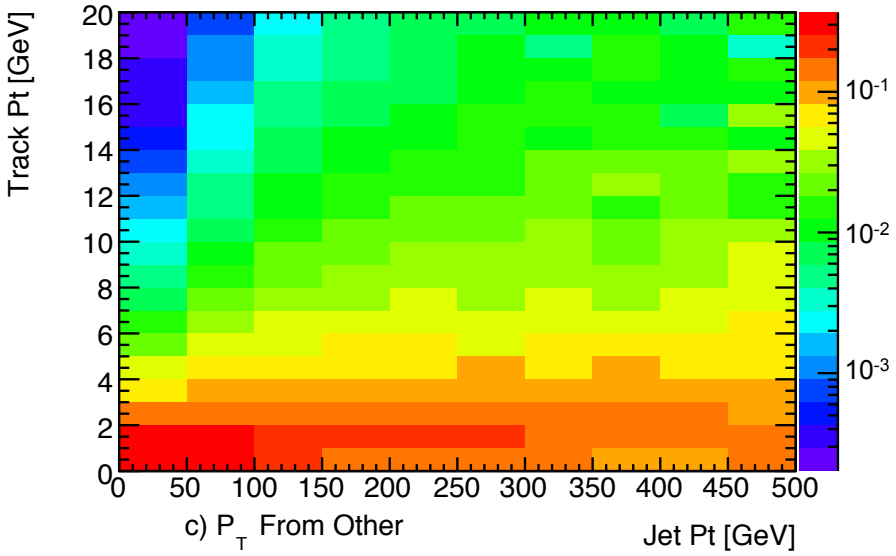
Track P_T Distributions for a given Jet P_T

valid3.110401.PowhegPythia_P2012_ttbar_nonallhad.recon.AOD.e3099_s2579_r6162/

r20.1.3.2, 96980 entries, μ = 0





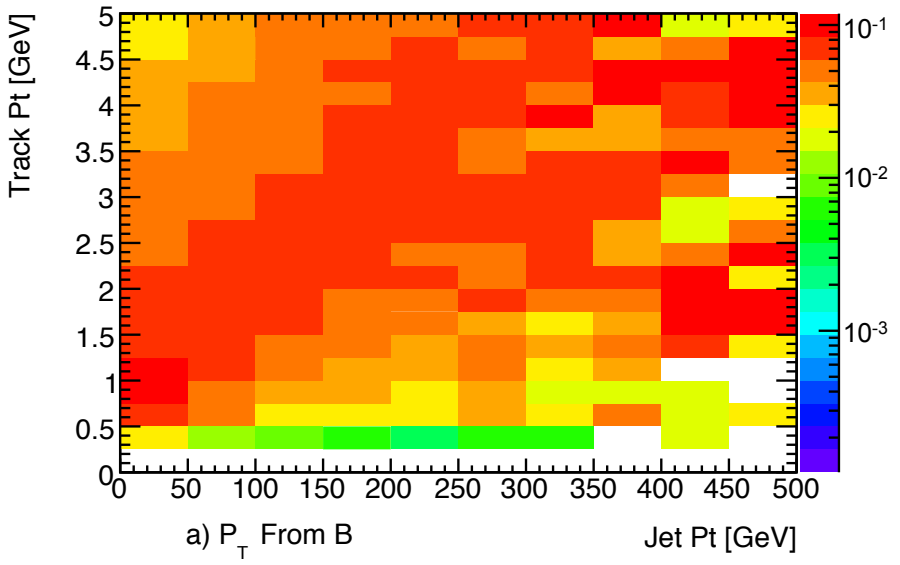


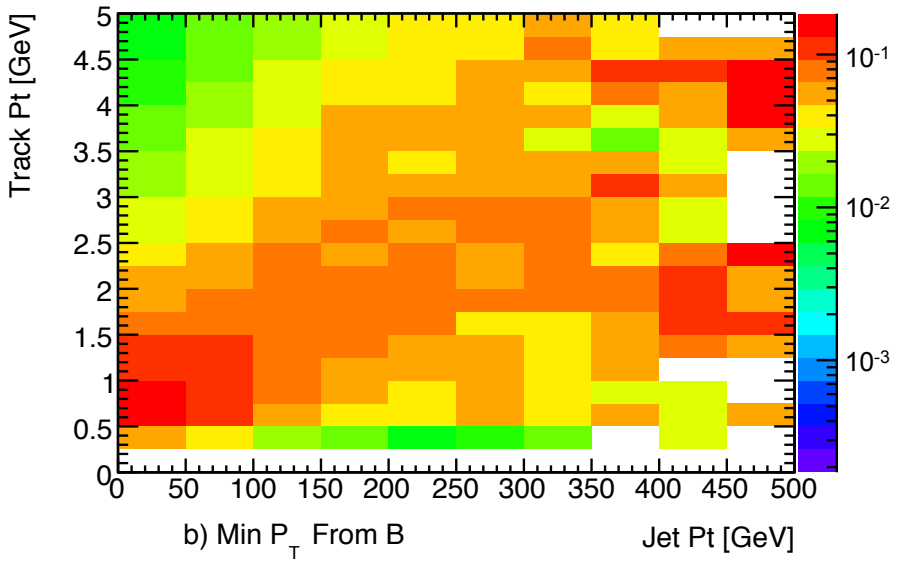
- Normalised for a given Jet P_T (vertical slices)
- (a) contains all tracks from a B hadron decay and (b) contains all tracks from Other (any tracks not From B).
- Plot c) is only filled with the track from B with the minimum track P_T for each b-jet.

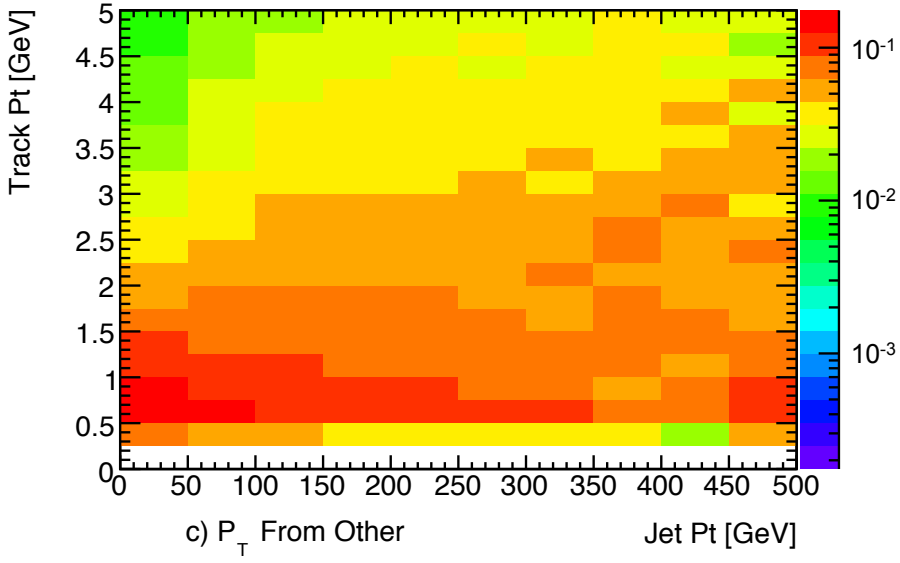
Track P_T Distributions for a given Jet P_T - Zoom

valid3.110401.PowhegPythia_P2012_ttbar_nonallhad.recon.AOD.e3099_s2579_r6162/

r20.1.3.2, 96980 entries, μ = 0

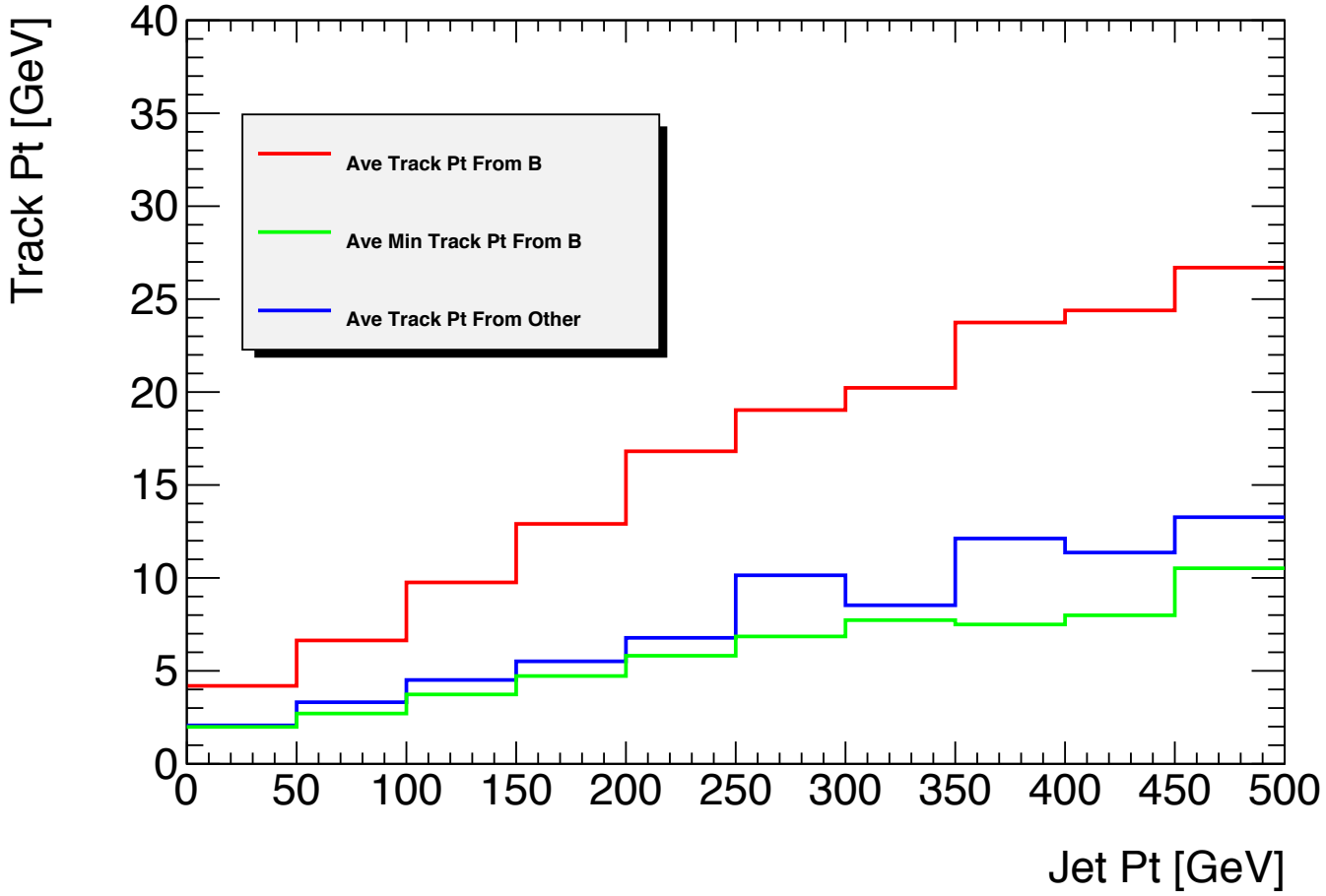






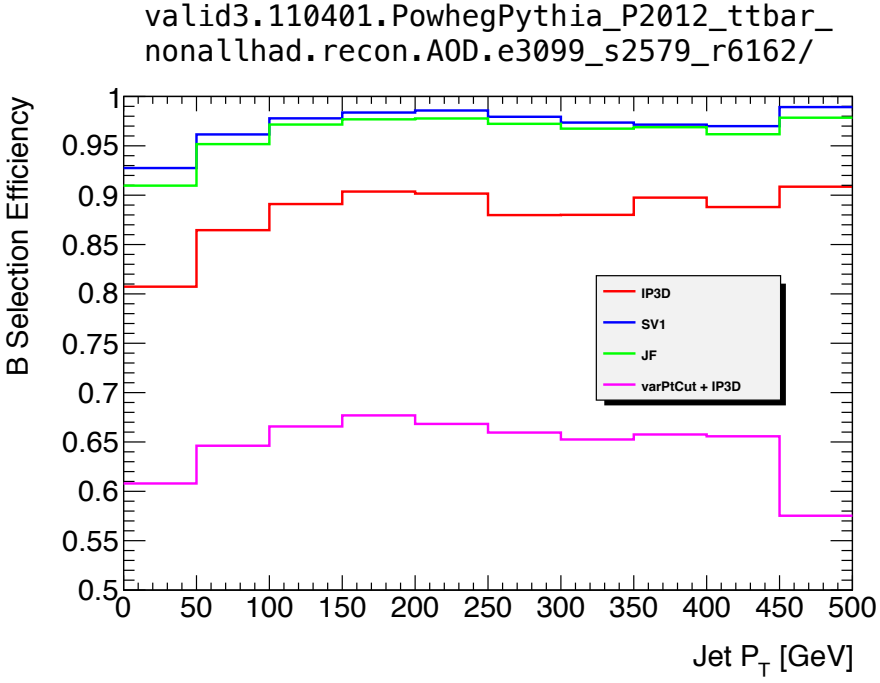
- Normalised for a given Jet P_T (vertical slices)
- (a) contains all tracks from a B hadron decay and (b) contains all tracks from Other (any tracks not From B).
- Plot c) is only filled with the track from B with the minimum track P_T for each b-jet.

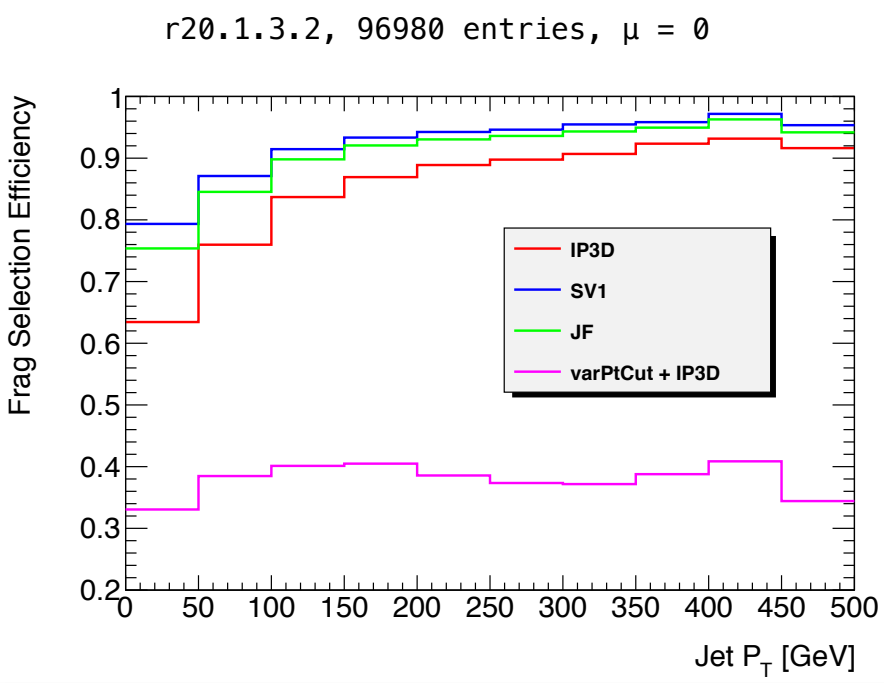
A Variable P_T Cut Initial Test

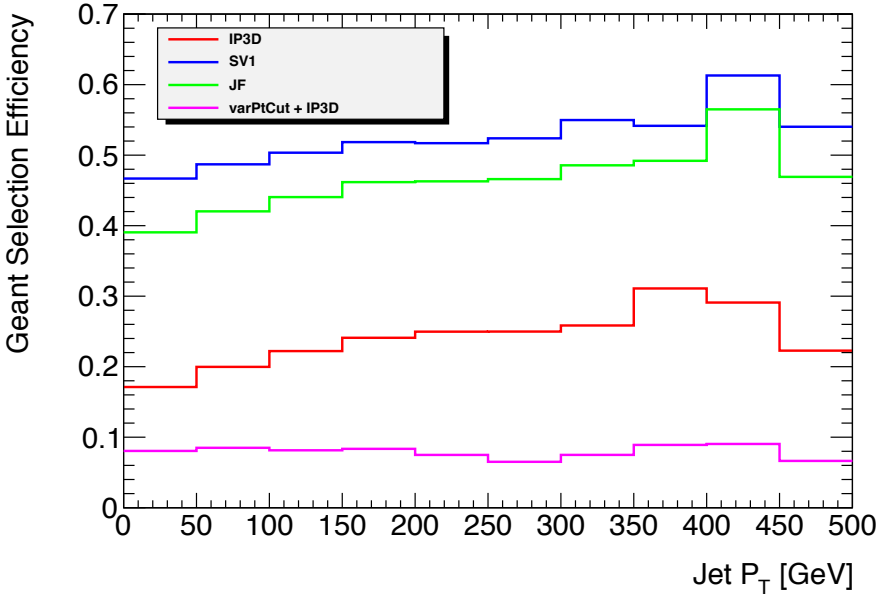


- This shows the P_T distributions for the average P_T of all tracks from B, average minimum P_T track from B, and average P_T of all tracks from other.
- Shows great opportunity for a track P_T cut that depends on jet P_T.
- As a first test I have used the min P_T from B (green line) as a test cut, probably too tight.

Selection Efficiencies with VarPtCut







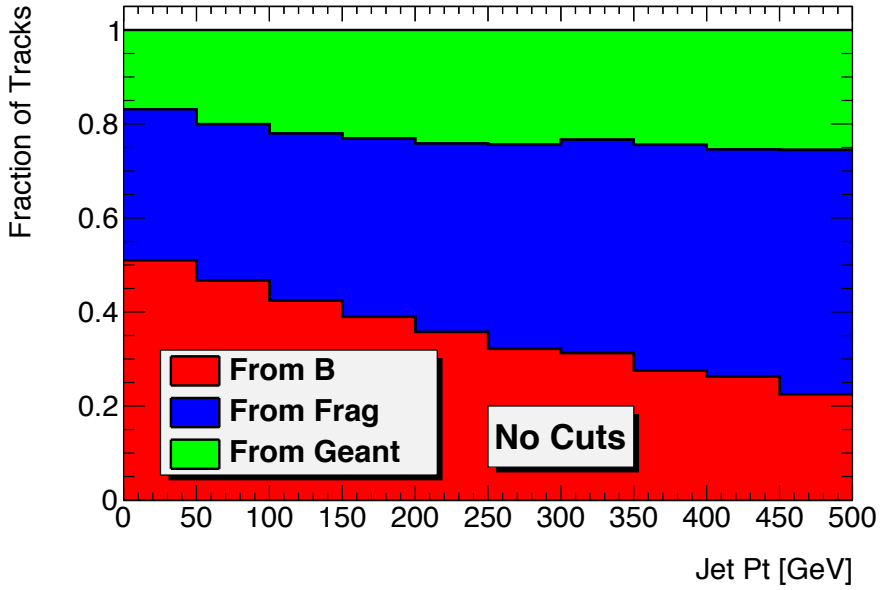
Selection Efficiency = $\frac{\text{\# Tracks FromX Selected By a Cut}}{\text{\# Truth Tracks From X}}$

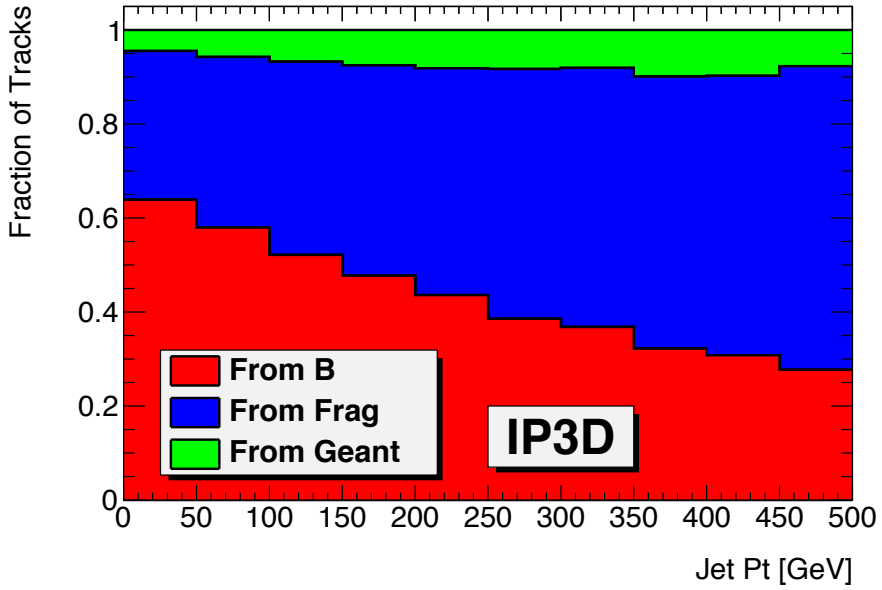
- varPtCut + IP3D is cutting the green line from the previous slide, applied alongside IP3D cuts from slide 3.
- varPtCut is very harsh.
- But there are flat Frag and Geant selection efficiencies, a desirable property.

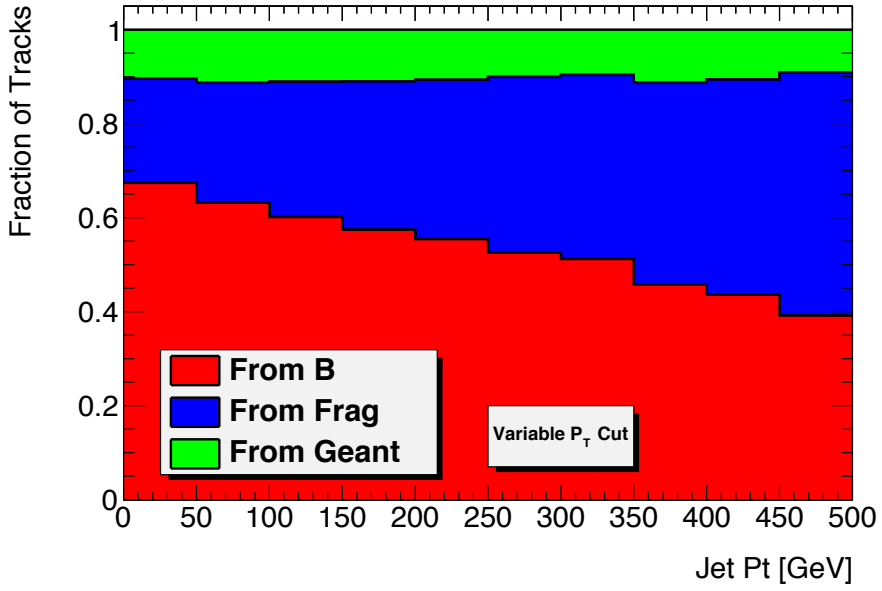
Analysis of Fraction of Tracks with VarPtCut

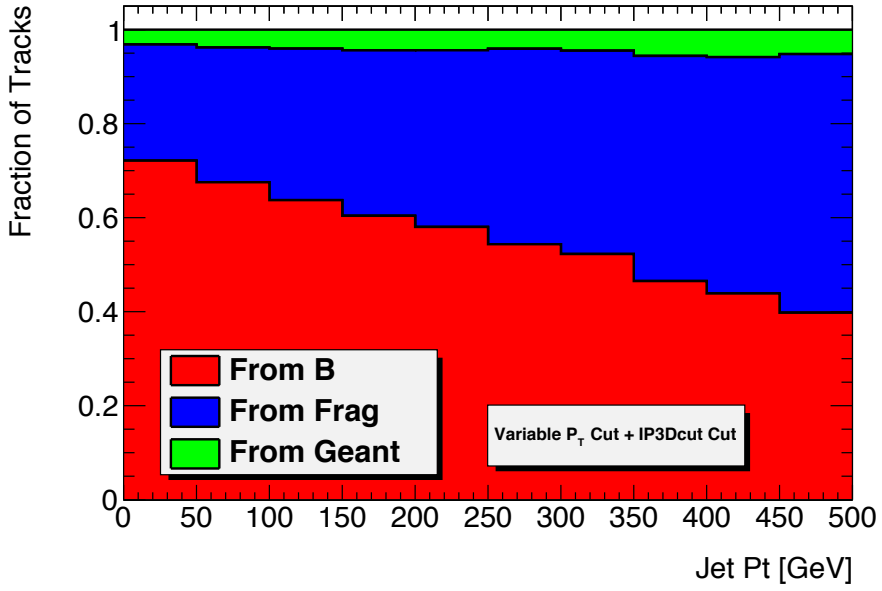
valid3.110401.PowhegPythia_P2012_ttbar_nonallhad.recon.AOD.e3099_s2579_r6162/

r20.1.3.2, 96980 entries, μ = 0





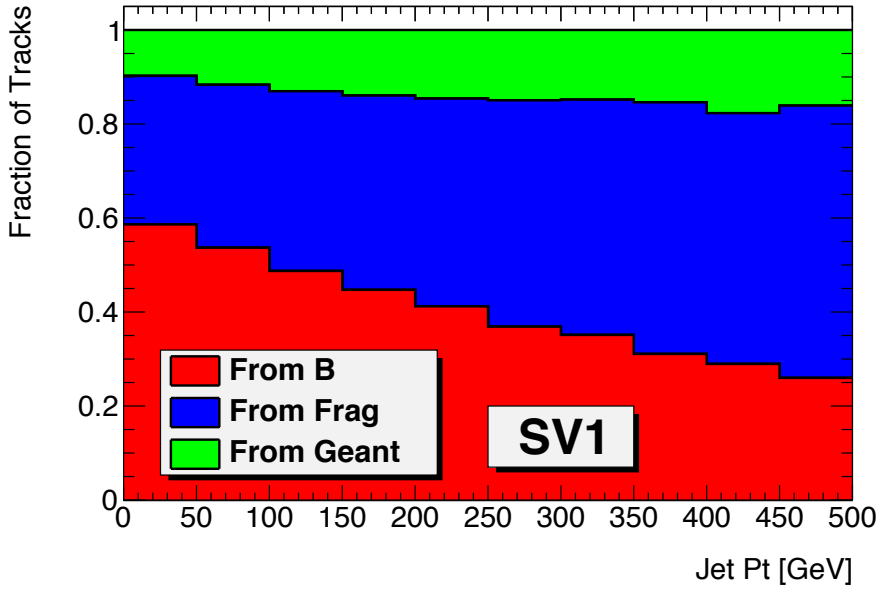


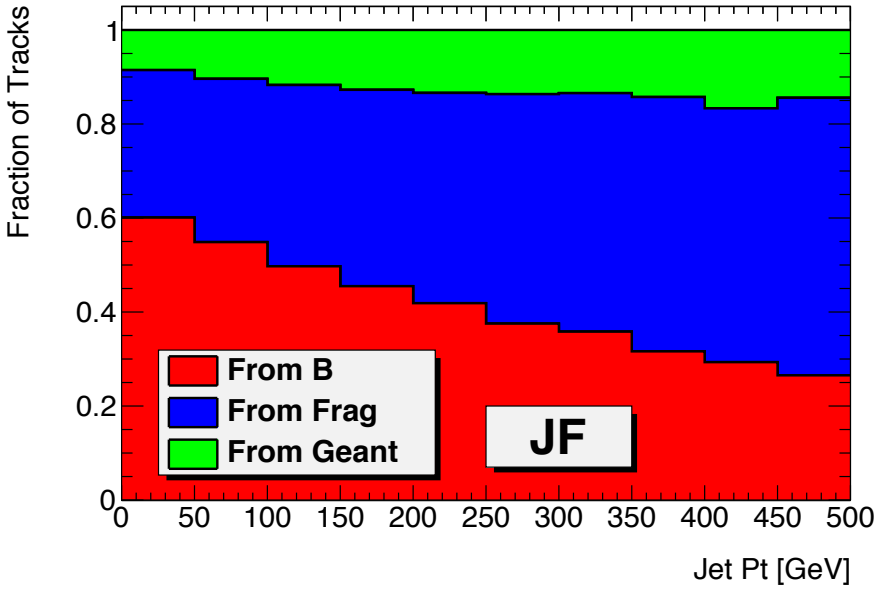


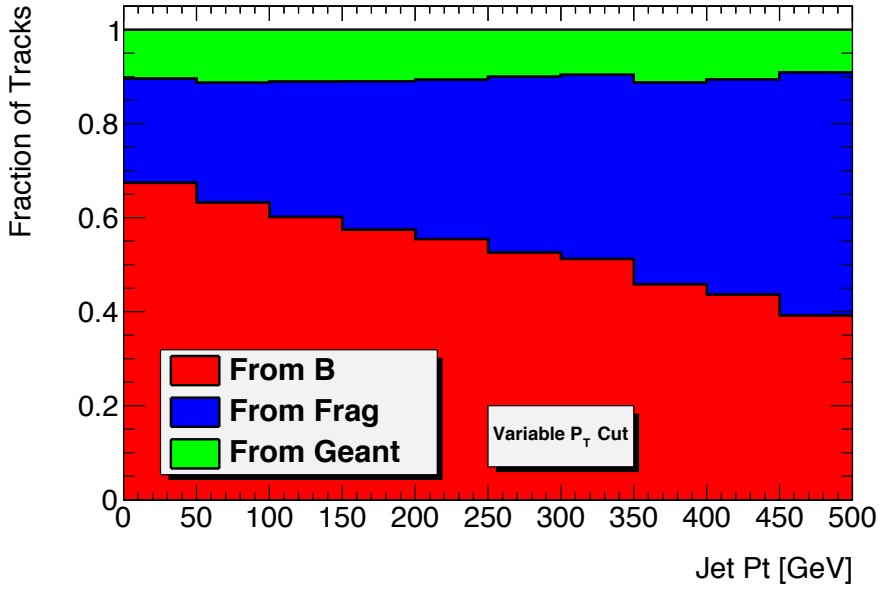
Analysis of Fraction of Tracks with VarPtCut

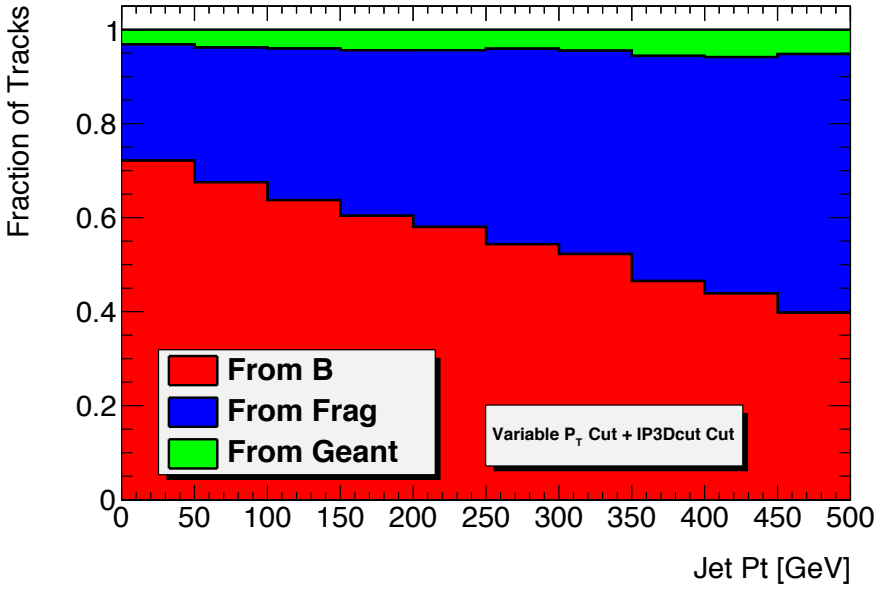
valid3.110401.PowhegPythia_P2012_ttbar_nonallhad.recon.AOD.e3099_s2579_r6162/

r20.1.3.2, 96980 entries, μ = 0





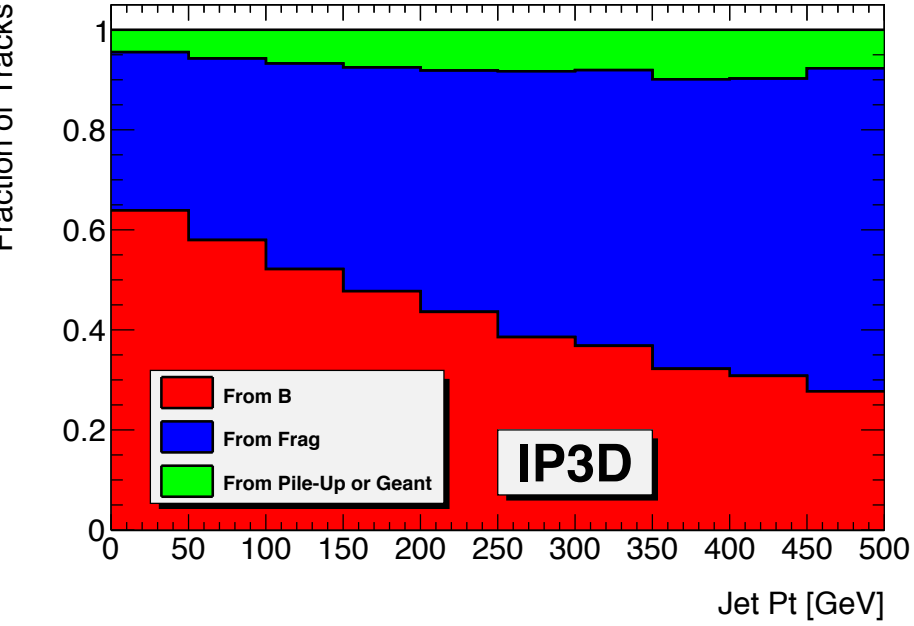




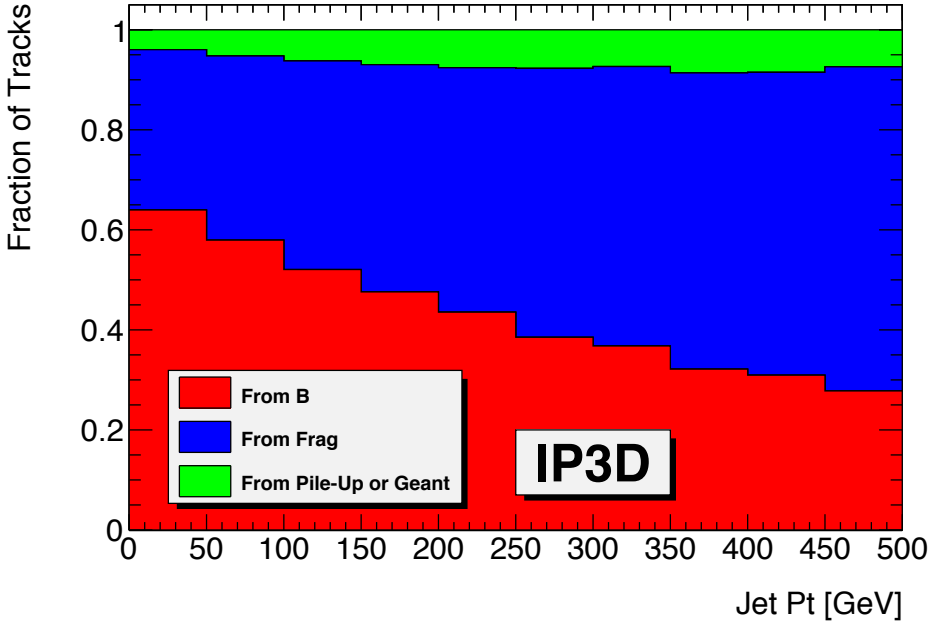
Conclusions

- We aimed to study tracks accepted by IP3D, SV1 and Jet Fitter
  - To consider harmonisation of the track selections for release 21
  - To optimise track selections for high-P_T.
- Set-up tools to analyse tracks for harmonisation in r21
- There is promise for Jet P_T dependant cut for high-P_T.
  - Work is needed to tune and optimise.
  - Also need to optimise other cuts at high-P_T such as d0 and z0 cuts.
- Need to run on a larger data set which includes pile-up.
  - A request for release r20.1.4.1 sample with pile up and 500,000 events.
  - Final analysis will be done on 5,000,000 event sample.

Back Up!



Manual Cut



Algo Flag