b-Tag Track Studies

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(with Andreas and Tim)

UCL ATLAS Meeting
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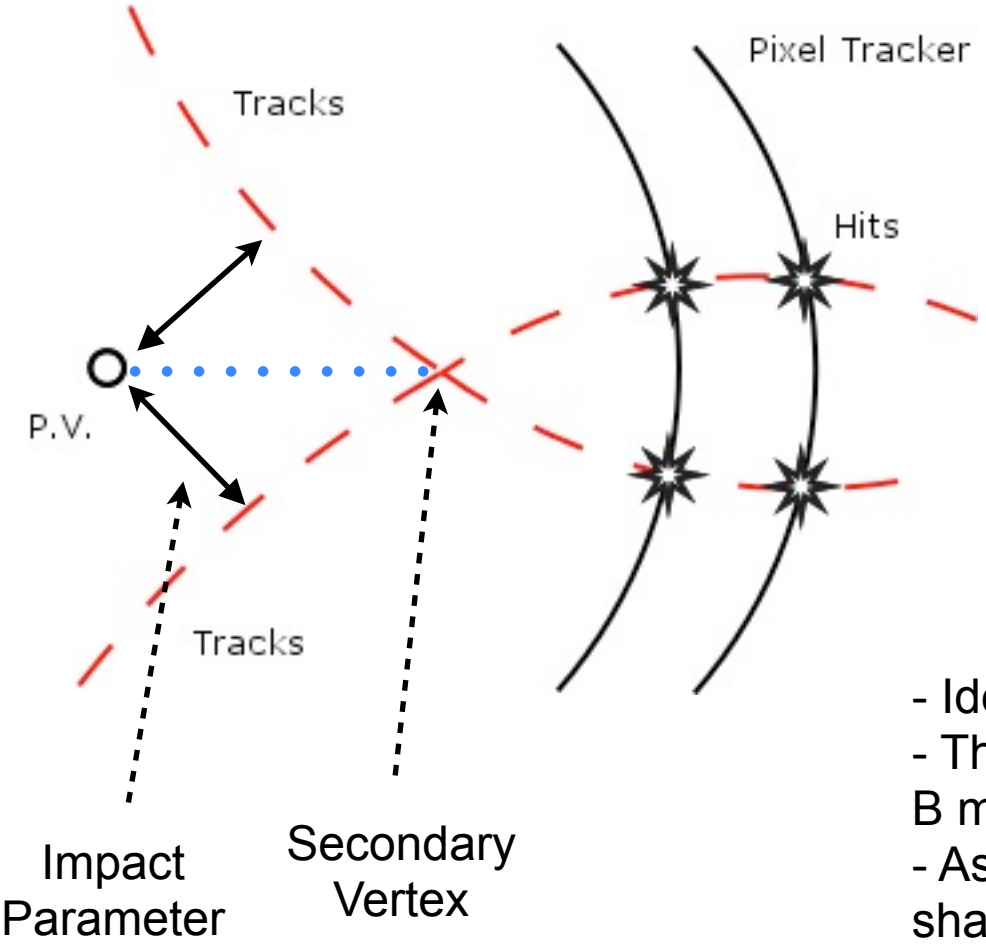
B-tagging - IP3D, SV1, JF



IP3D

- Look for tracks with a large impact parameter significance = (I.P. / σ)

SV1

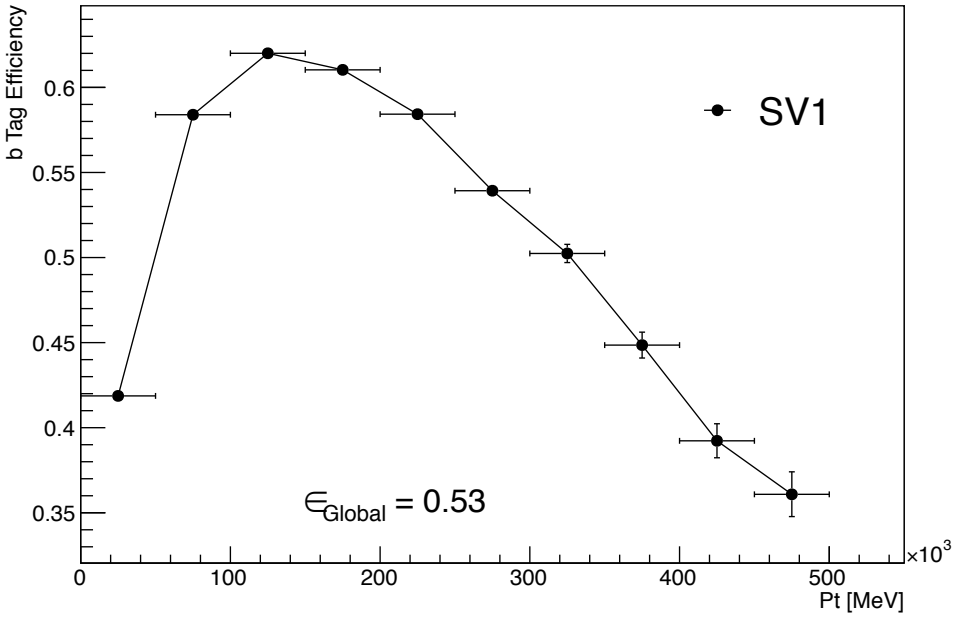
- Identify a secondary vertex
- Look for large flight path significance = (F.P. / σ)

JF

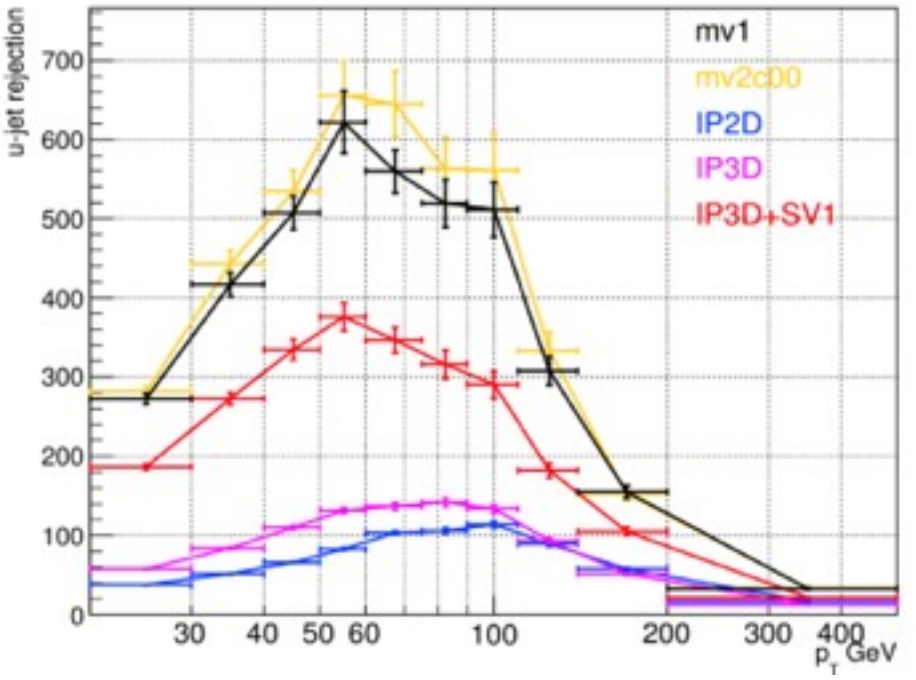
- Identify Second and Tertiary Vertices.
- These vertices correspond to decay of B meson and decay of D meson.
- Assumes these vertices lie on an shared B flight axis

Problems at High P_T

First Look at R20 - Yulia Rodina



- Global Cut Efficiency = 0.53
- For a fixed discriminant cut SV1_llr > 4.5
- 13TeV ttbar



- Flat Cut Efficiency = 0.7
- 13TeV ttbar

- Longer decay length of B at high P_T
- Higher boosted jets at high P_T

Aims of Study

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

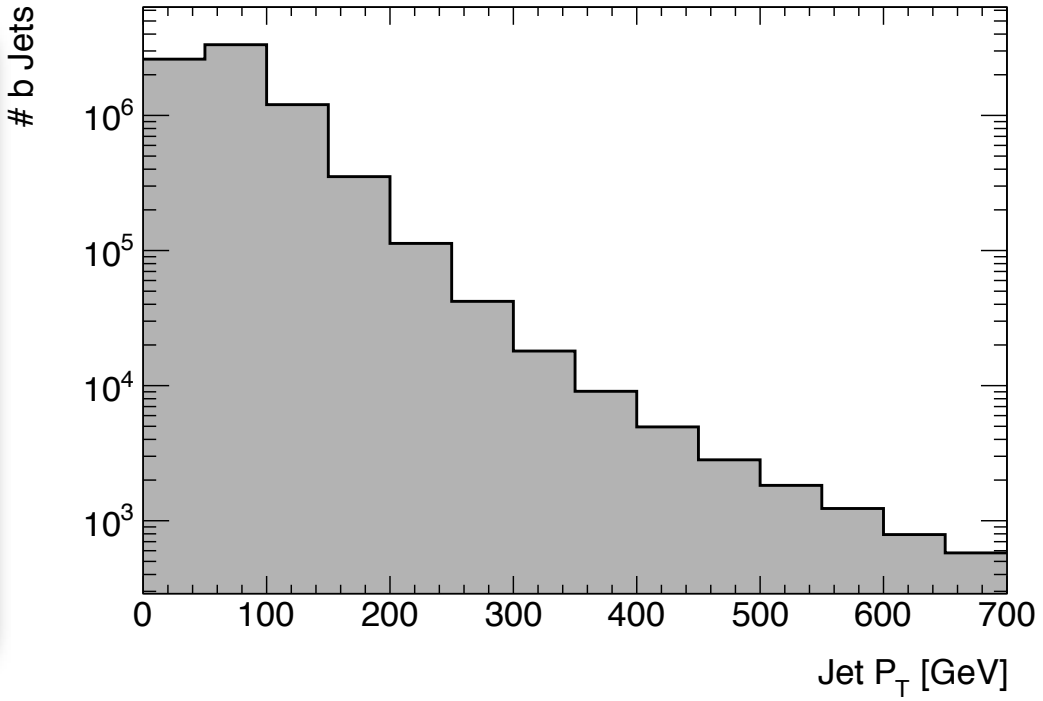
Sample Used for Studies

`mc14_13TeV.110401`
`.PowhegPythia_P2012_ttbar`
`_noallhad.merge`
`.e2928_s1982_s2008_r6114_r6104`

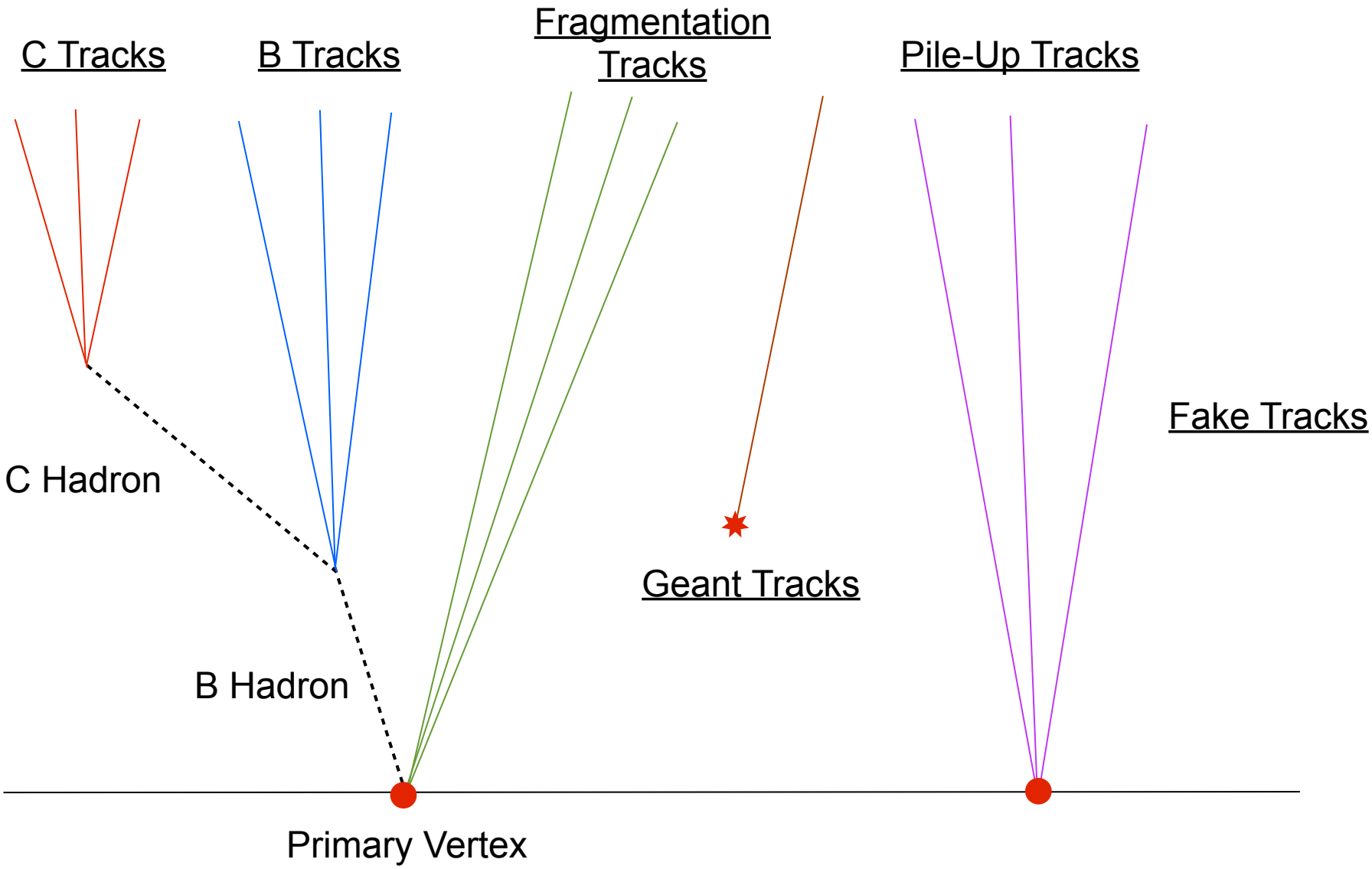
Validation Sample for r20.1.0.3

5m events

Pile-Up On



Origins of Tracks in a b-jet



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 or C Hadron

From PuFake = Any track without a well matched truth particle.

From Geant = Any track created by a GEANT interaction.

From Frag = Any track not From B or From Geant

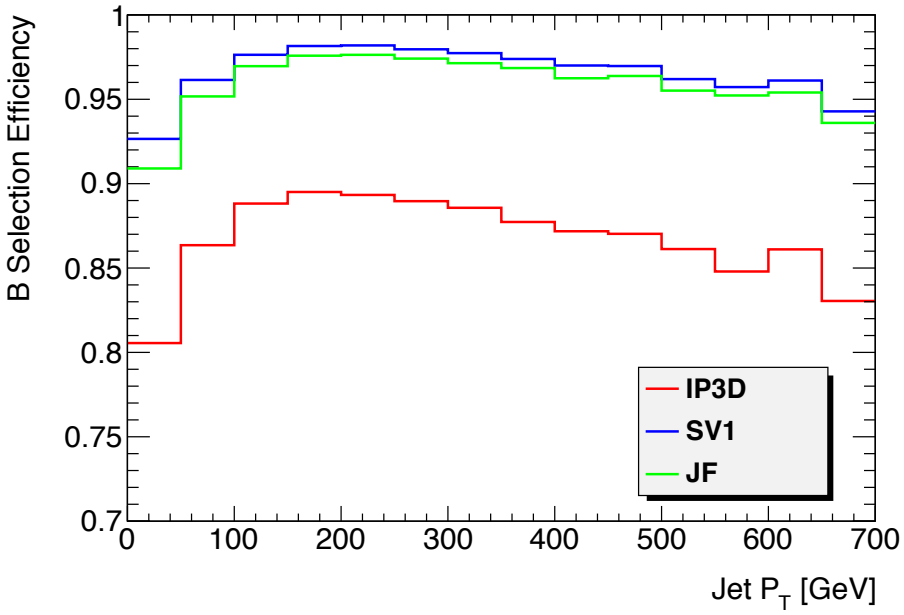
From Other = Any track not From B

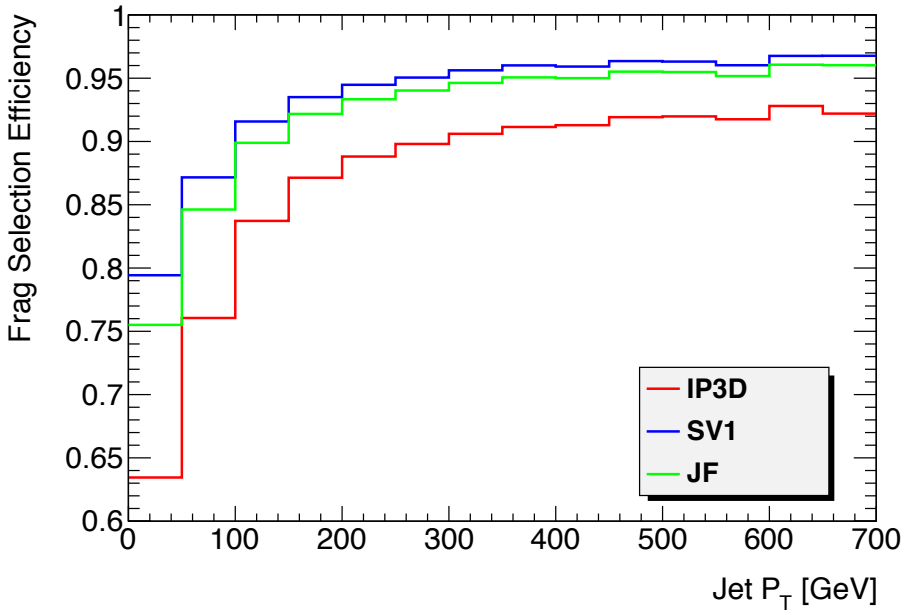
Selection Efficiency = $\frac{\text{\# Tracks FromX Selected By a Cut}}{\text{\# Truth Tracks From X}}$

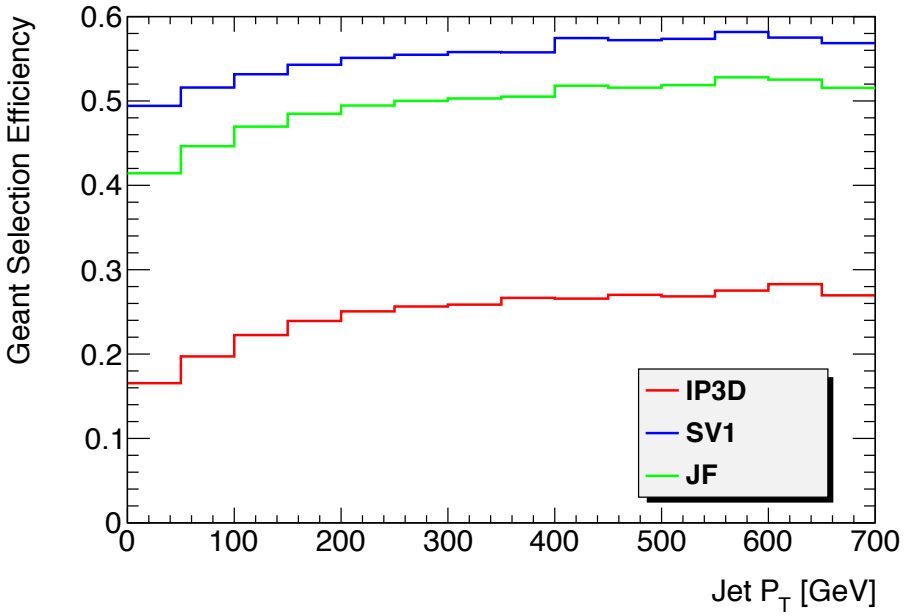
Fraction of Tracks = $\frac{\text{\# Tracks FromX Selected By a Cut}}{\text{Total \# Tracks Selected by a Cut}}$

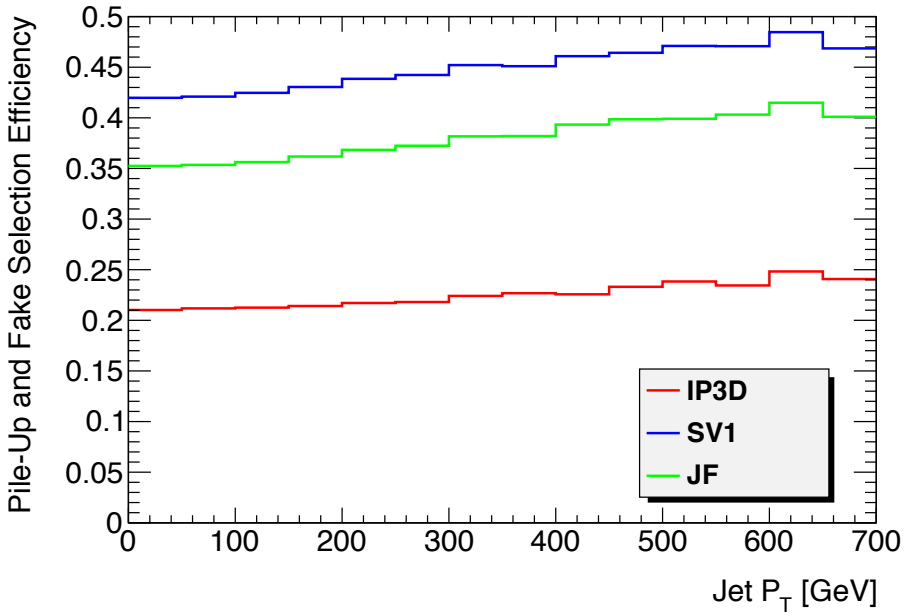
Selection Efficiencies

user.vdao.mc14_13TeV.110401.PowhegPythia_s1982_s2008_r6114_r6104 r20.1.0.3, 5m entries, μ = YES



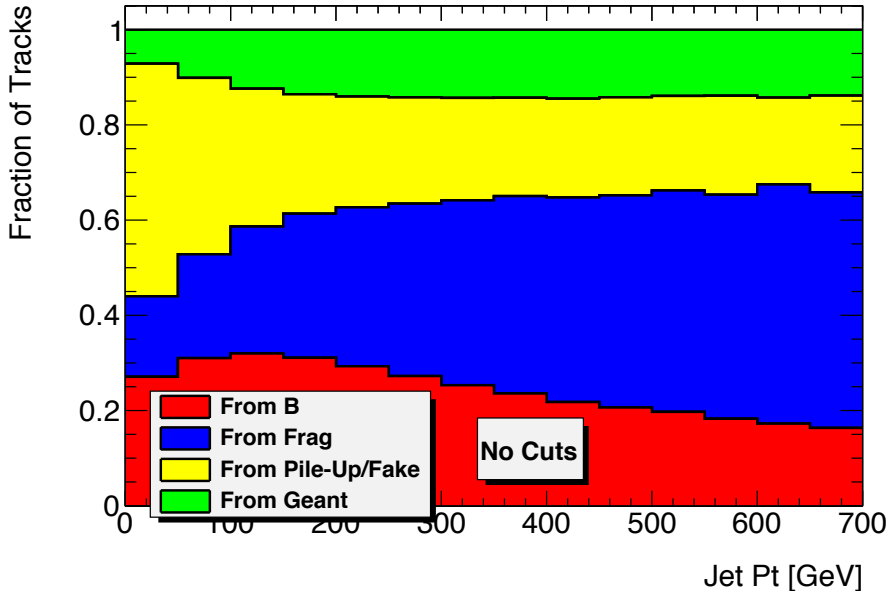


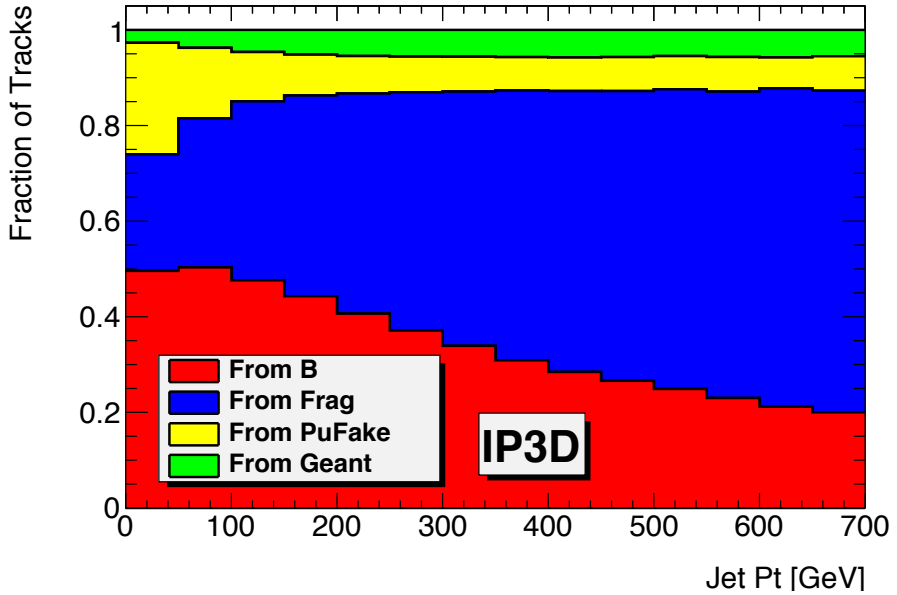


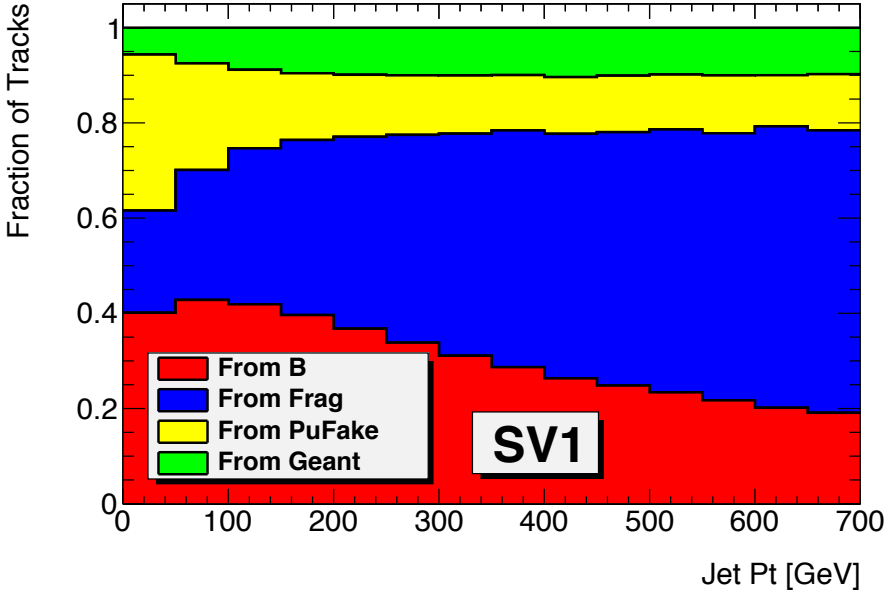


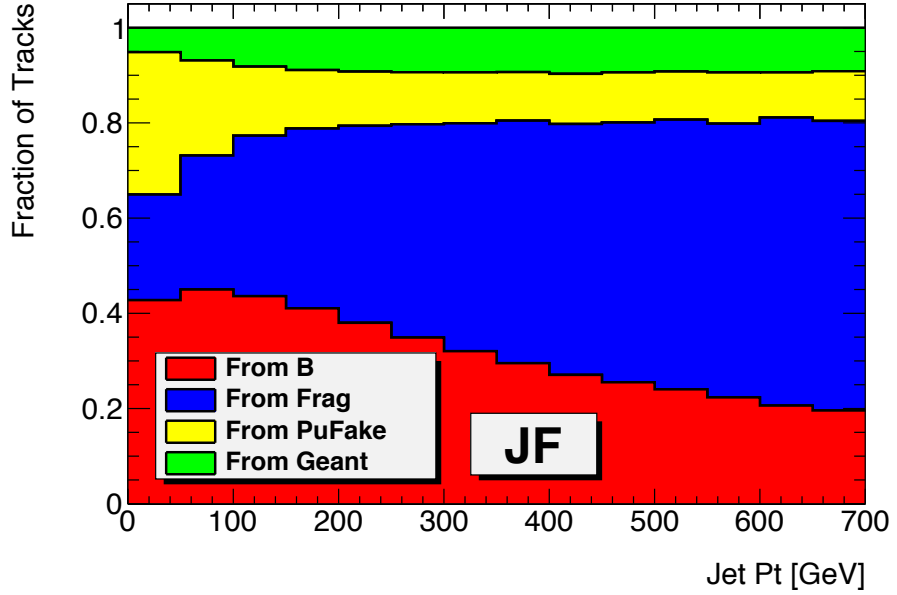
Fractional Make Up of b-Jets

user.vdao.mc14_13TeV.110401.PowhegPythia_s1982_s2008_r6114_r6104 r20.1.0.3, 5m entries, μ = YES

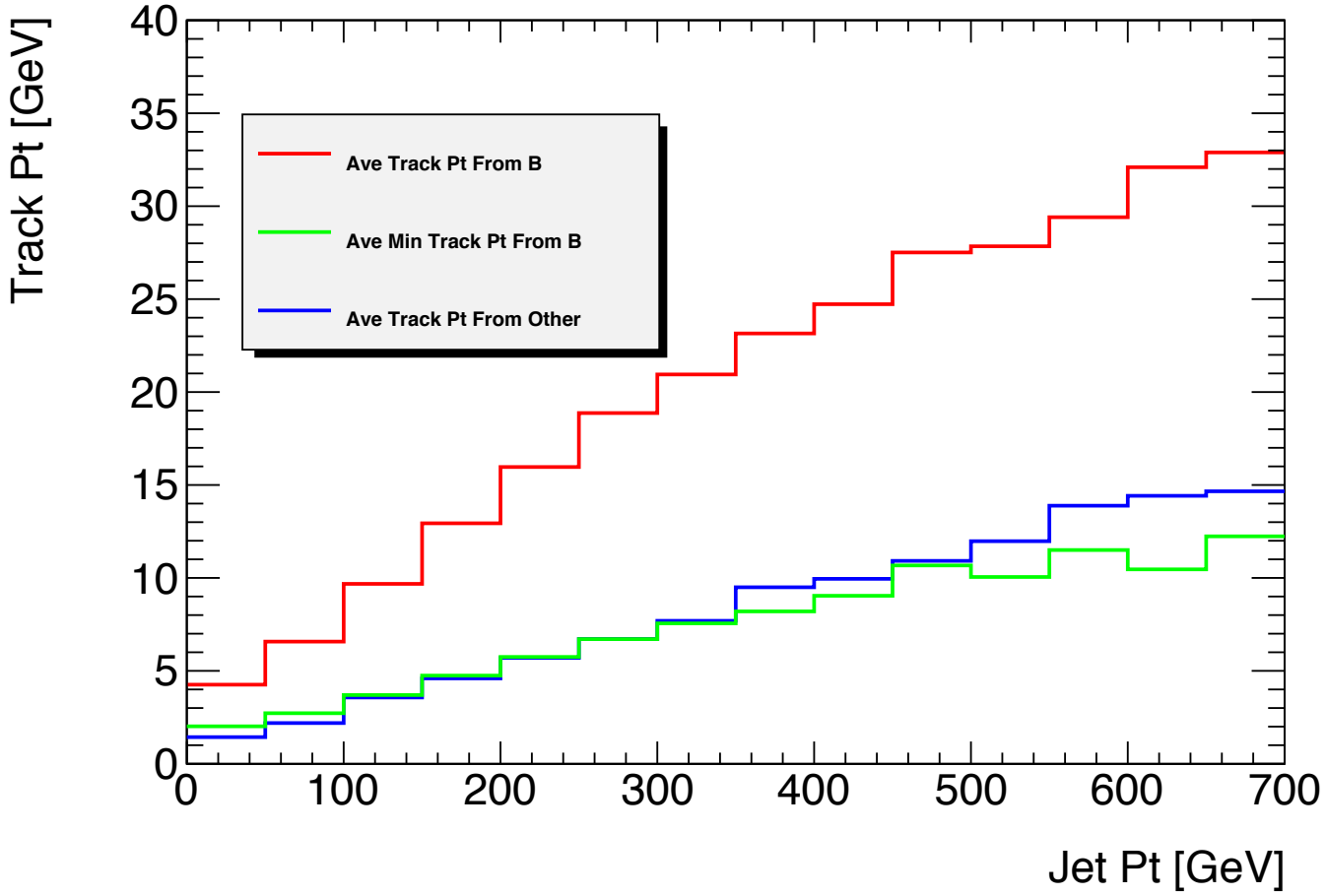








A Variable P_T Cut?



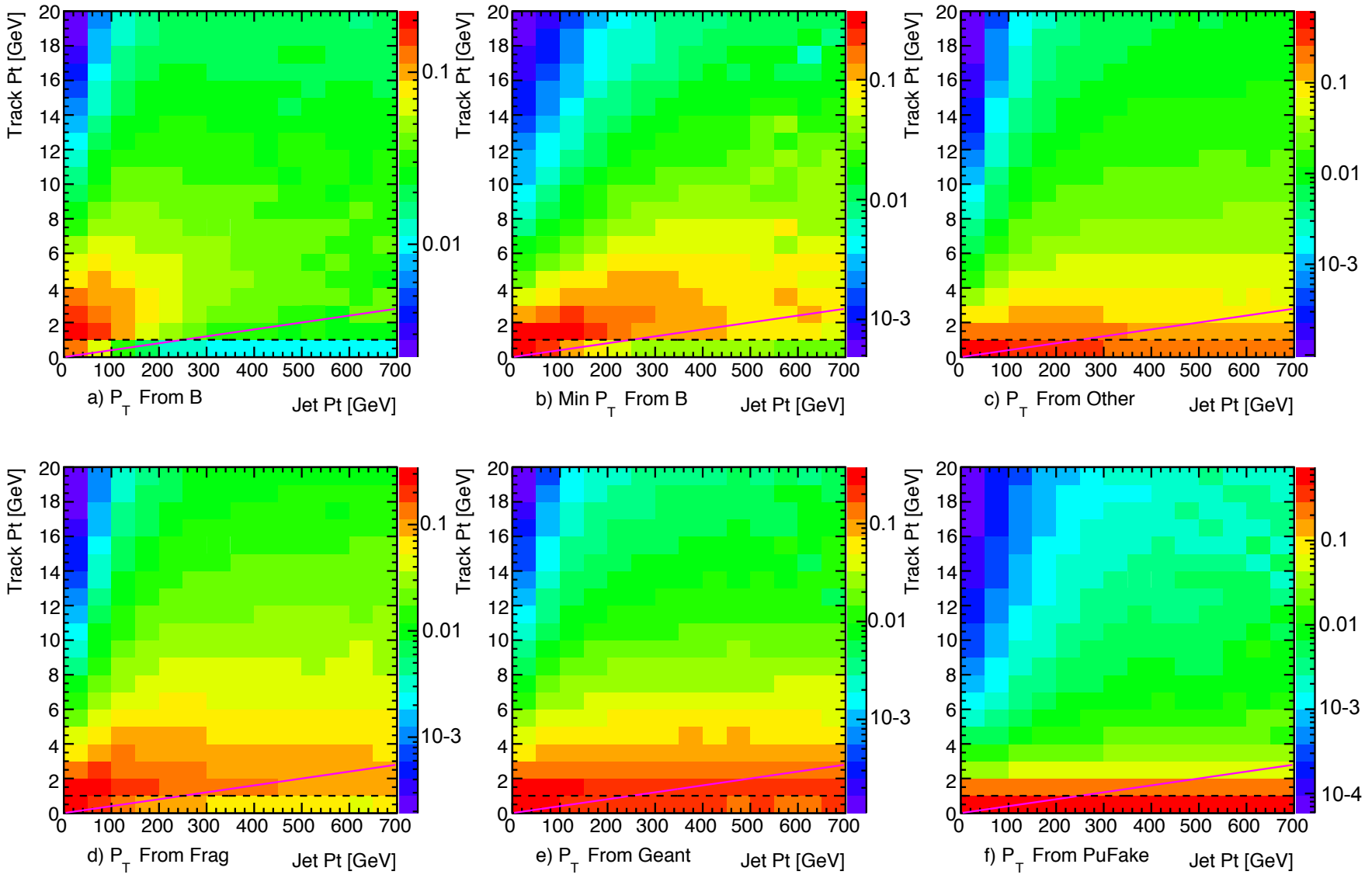
user.vdao.mc14_13TeV.
110401.PowhegPythia_s1982_s2008_r6114_r6104
r20.1.0.3, 5m entries, μ = YES

- 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 (anything but not from P_T).

- Shows great opportunity for a track P_T cut that depends on jet P_T.

Track P_T Distributions for a given Jet P_T

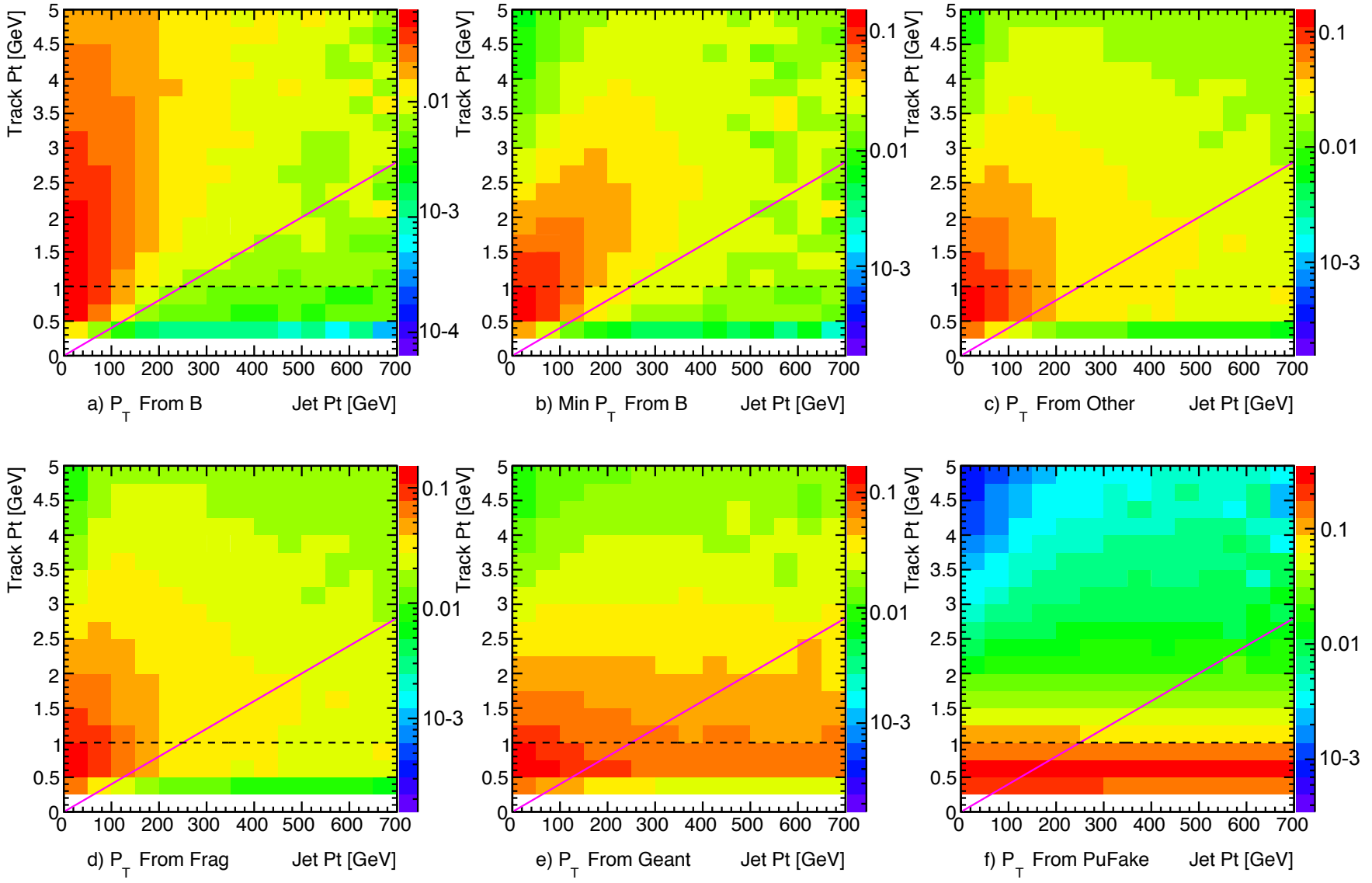
user.vdao.mc14_13TeV.110401.PowhegPythia_s1982_s2008_r6114_r6104 r20.1.0.3, 5m entries, μ = YES



Track P_T distributions normalised for a given Jet P_T (vertical slices) including overfill bin.

Track P_T Distributions for a given Jet P_T

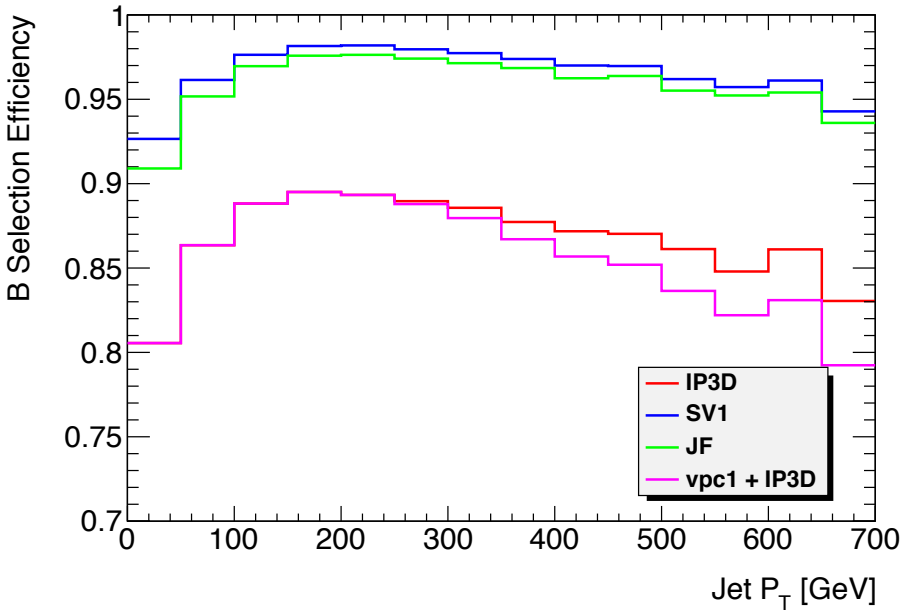
user.vdao.mc14_13TeV.110401.PowhegPythia_s1982_s2008_r6114_r6104 r20.1.0.3, 5m entries, μ = YES

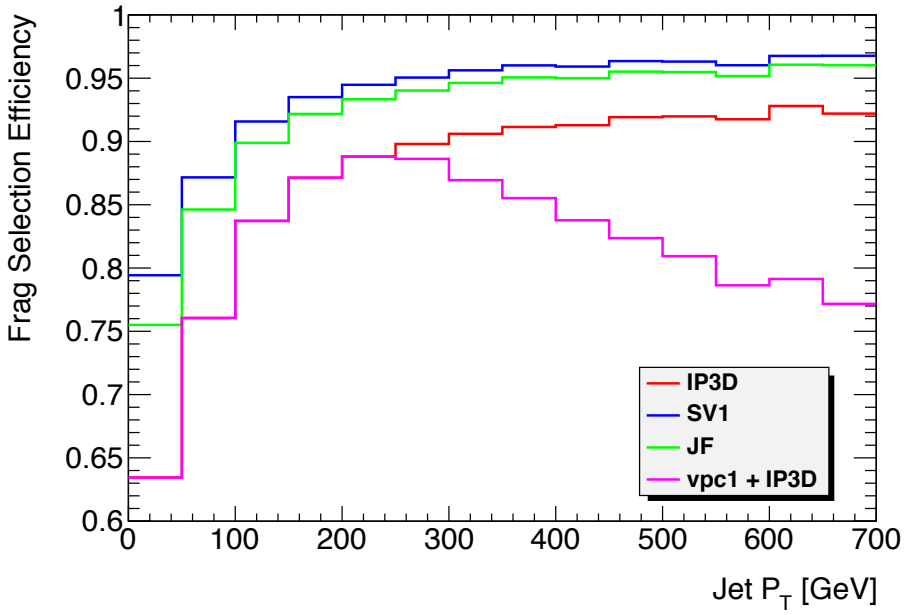


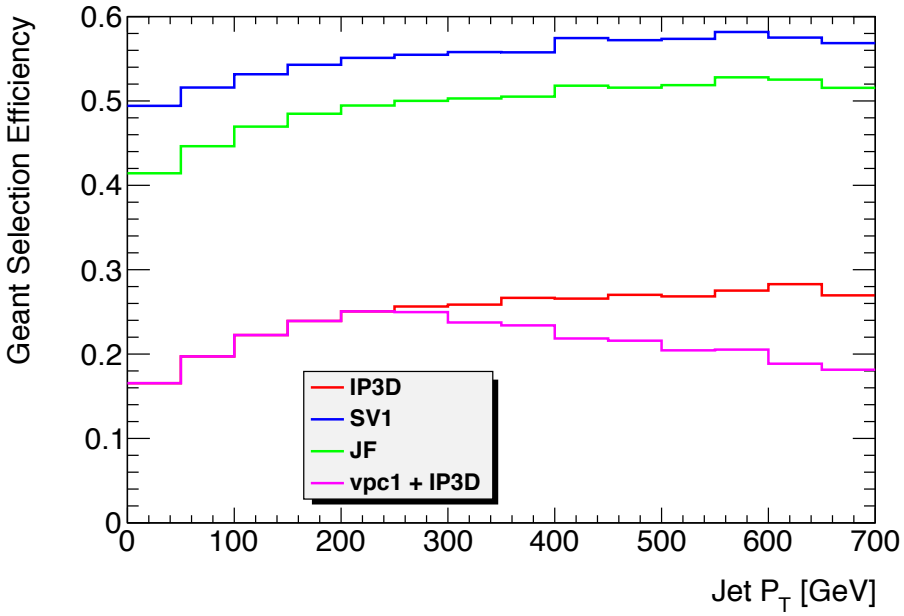
Track P_T distributions normalised for a given Jet P_T (vertical slices) including overfill bin.

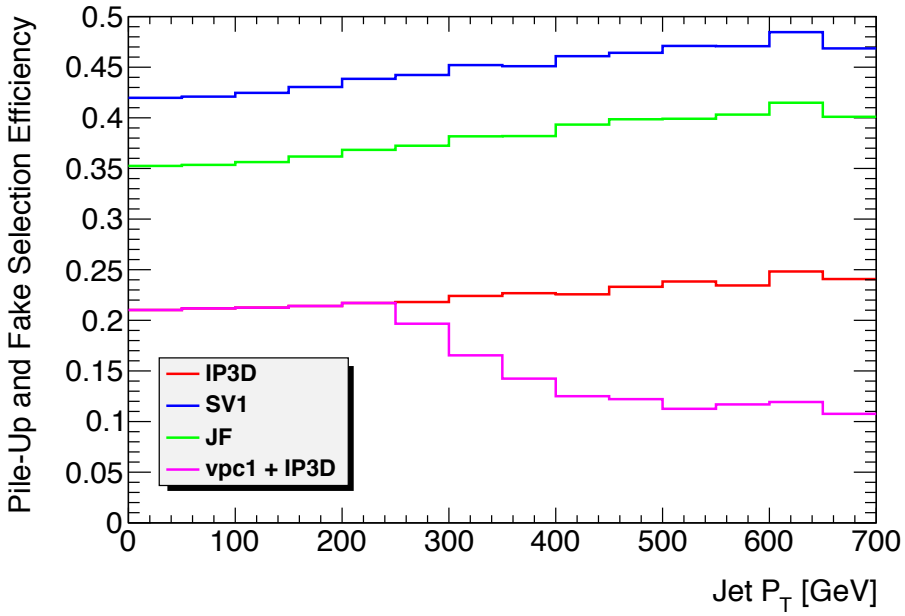
Selection Efficiencies with VarPtCut

user.vdao.mc14_13TeV.110401.PowhegPythia_s1982_s2008_r6114_r6104 r20.1.0.3, 5m entries, μ = YES



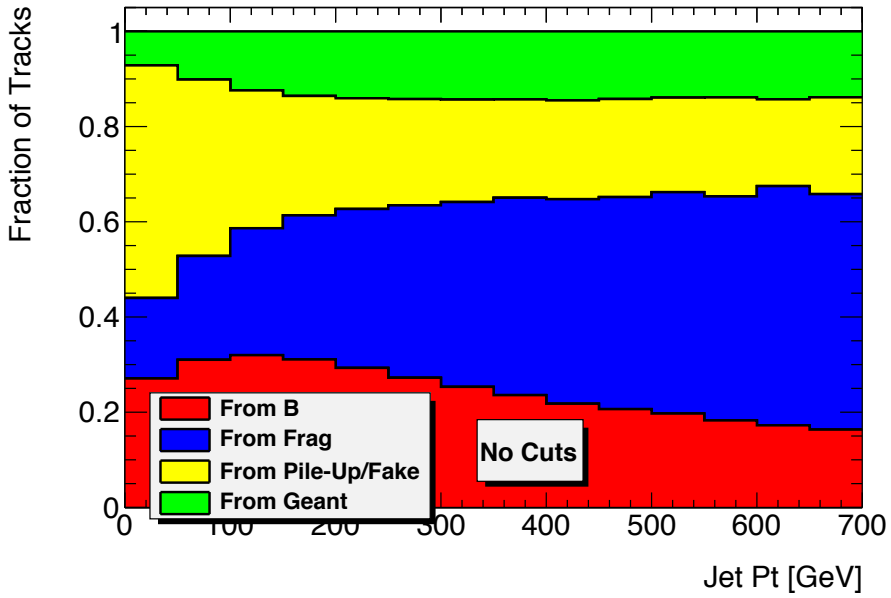




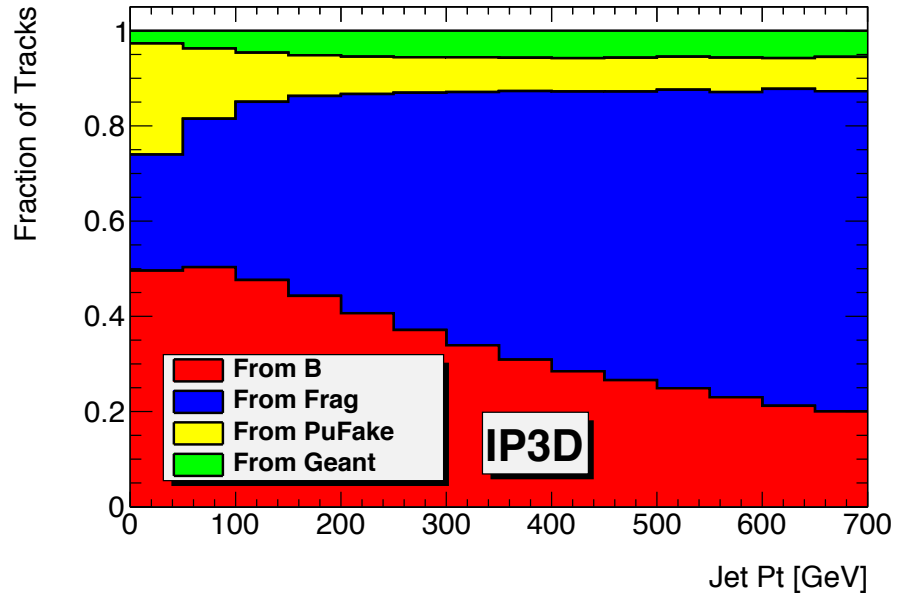


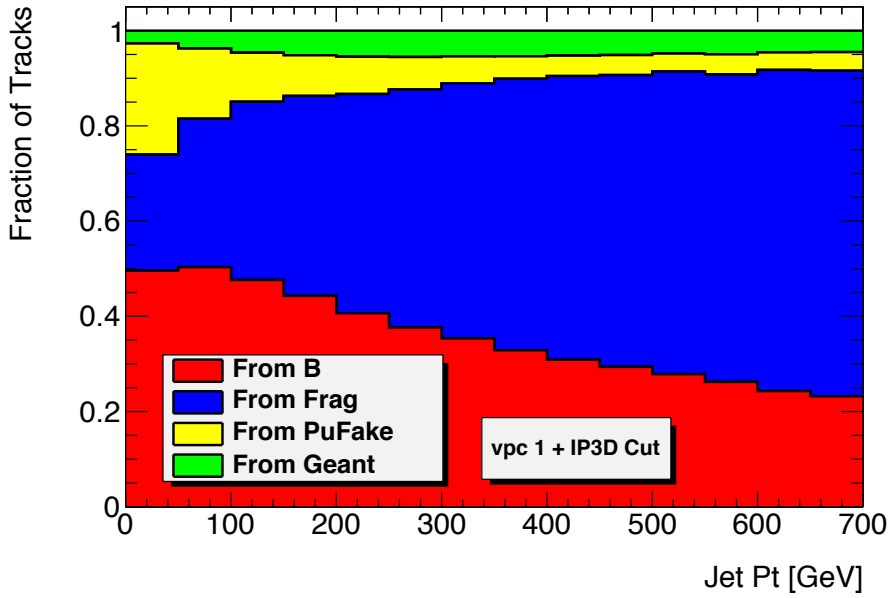
Fractional Make Up of b-Jets with Var-P_T Cut

user.vdao.mc14_13TeV.110401.PowhegPythia_s1982_s2008_r6114_r6104 r20.1.0.3, 5m entries, μ = YES



- Applying a variable P_T cut reduces the fraction from Geant and PuFake at High P_T
- The fraction from B is increased, but only slightly.





Conclusions

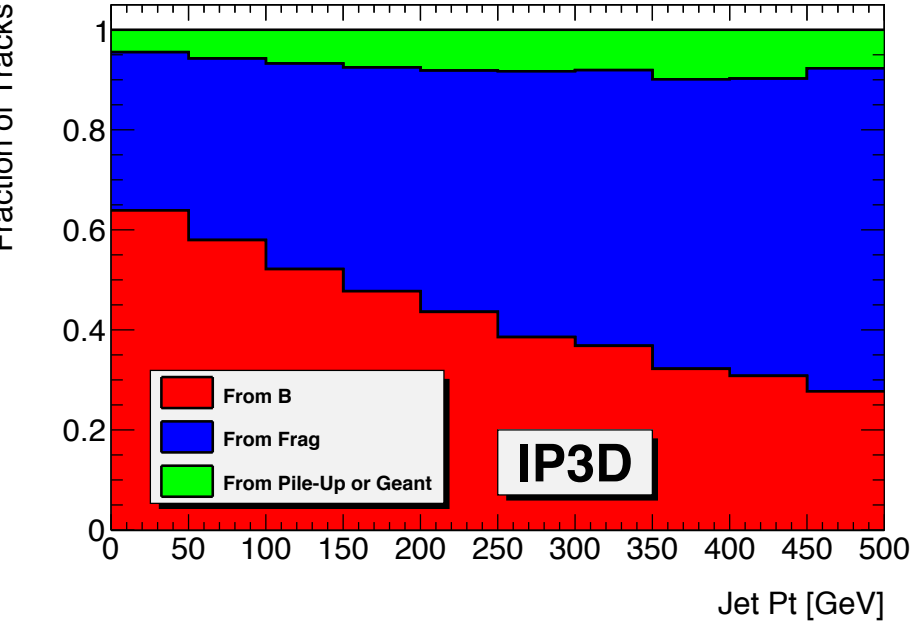
- I have studied track selection to improve b-tagging algorithms at high P_T.
- There is potential for a jet-P_T dependant cut that can improve performance at high P_T.

Next Steps

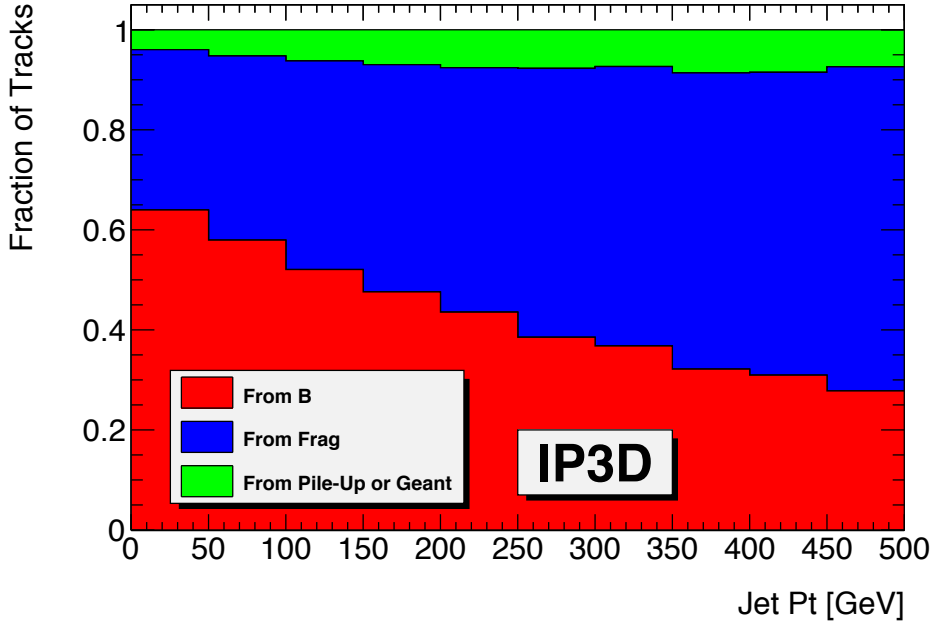
- Re-tag after the jet-P_T dependant cuts to see how b-tagging performance is ultimately improved by creating ROC curves.
- Try other slopes and offsets to optimise the variable P_T cut.
- Study other cuts, such as d_0, to see if the current set of cuts can be optimised at high-P_T.

Back Up!

valid3.110401.PowhegPythia_P2012_ttbar_nonallhad.recon.AOD.e3099_s2579_r6162/ r20.1.3.2, 96980 entries, μ = 0



Manual Cut



Algo Flag