Qualification Task AFT 455:

Optimization of Inputs for High Level Discriminants (DL1 and MV2) to Improve Performance of B-Tagging in Heavy Ion Collisions

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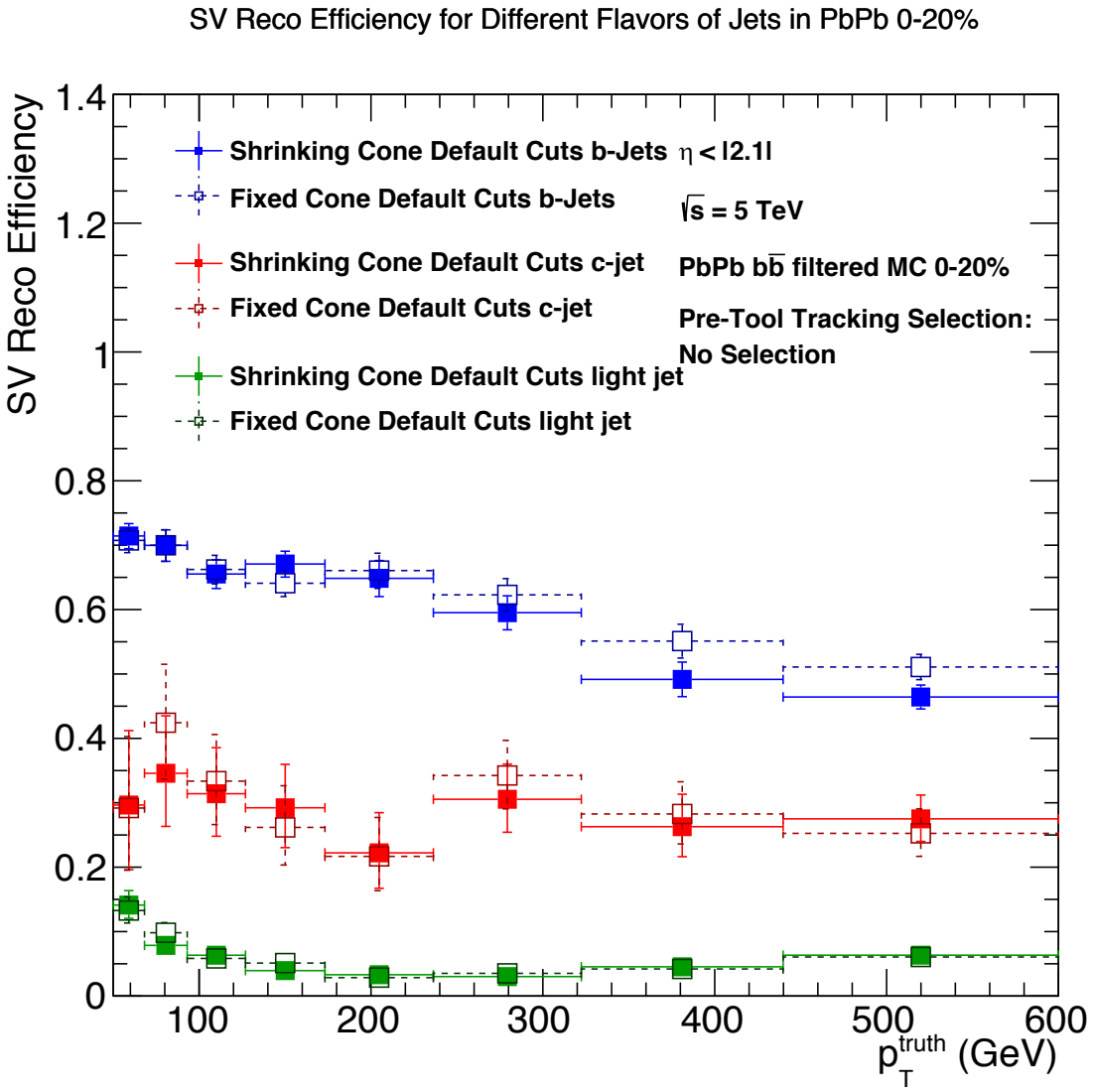
Effects of Cuts on Overlay

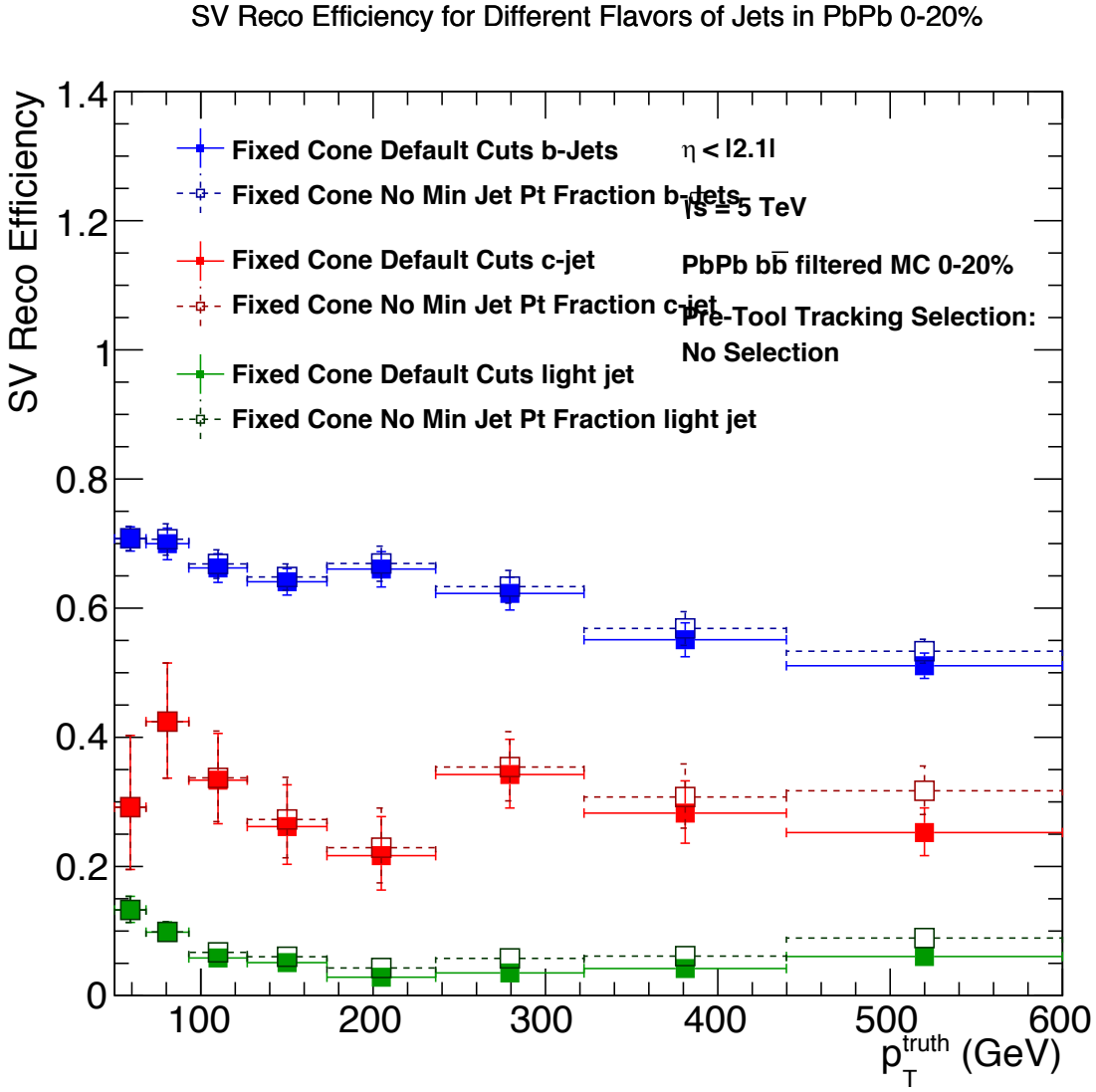
- Cuts those are effective in improving efficiency at pp MC were used in overlay.
- Fixed Cone: Using Fixed cone at 0.4 for tracks to jet association in contrast to shrinking cone algorithm optimized for pp.
- Minimum pT fraction: (wrong understanding previously)
  - 2-trk vertices candidates are created.
  - For tracks those are not in the candidates' tracks, if they pass minfraction*jet_Pt, then the common fitting algorithm will also use them.
  - Correction: minimum fraction of Pt used to select tracks used to form 2-trk vertices; misunderstood one of the selections last time (see back-up).
- Anti Pile Up tool:
  - Remove tracks with small xy impact parameter and big z impact parameter those are presumably from pileup.
- IP Selection:
  - Maximum xy-plane and z-plane impact parameter selections.

- This week:
  - looked at comparison with pp with SVF
  - A first look at JetFitter efficiency
- Things to look at :
  - Min number of shared hits. (the algorithm seems to not be using it? But there is an effect…)

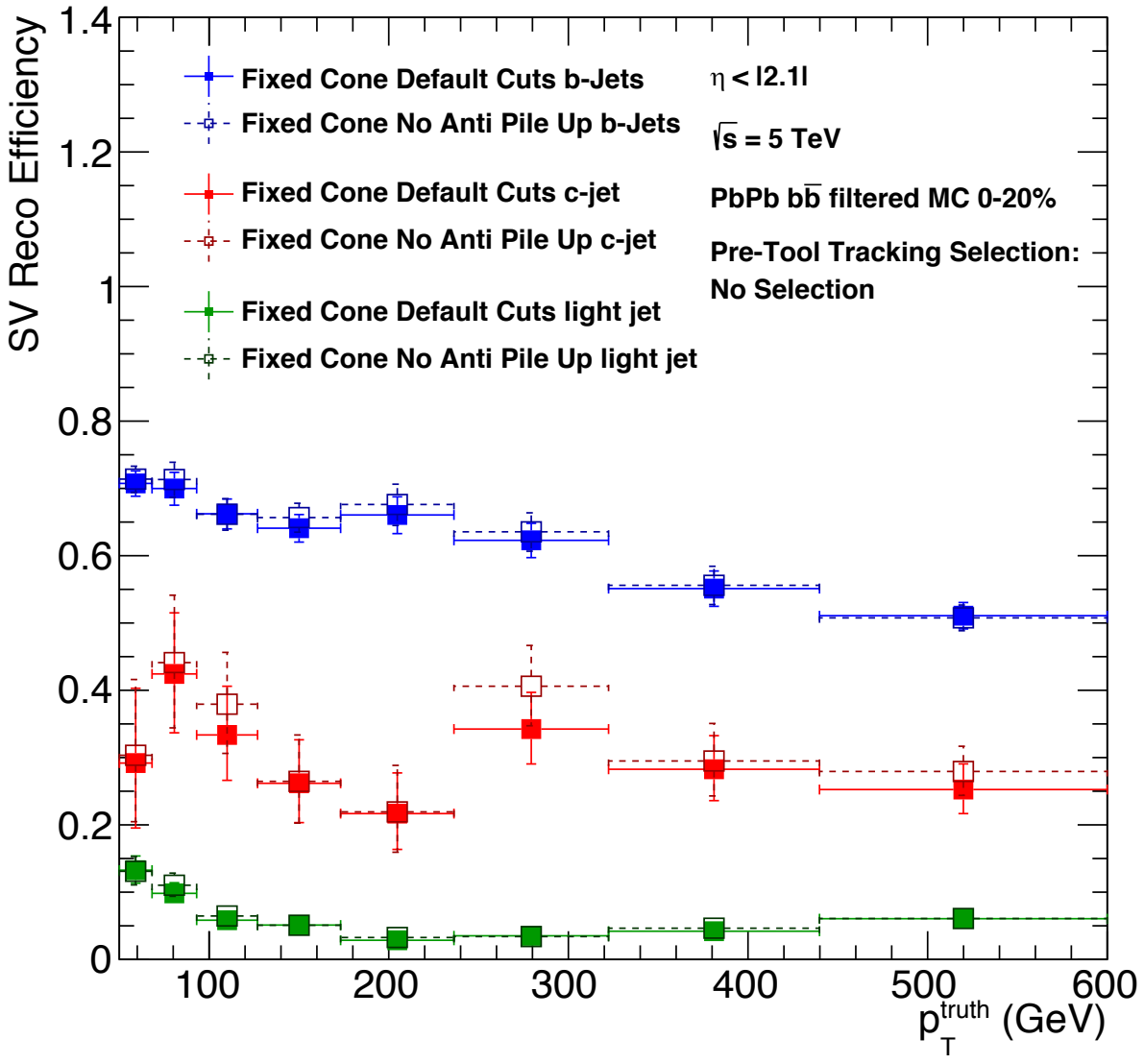
Summary of Effects of Cuts on Overlay (0-20%)

Cuts (original) **(New)**	Efficiency	Purity	Comment	Action
Fixed Cone (0.4)	+(~5%) at high pT	No change	Safer to use for HI jets	Keep using
Min pT Fraction(0.01) (0.00)	+(~2%) at high pT b +(~3%) at high pT c	+(~3%) fake ☹		Do not change
Anti Pile Up tool (On) (Off)	+(~2%) at high pT c	No change	Does it make sense to use in HI?	Keep using
IP Selection(On) (Off)	No significant Effect	No change		Do not change

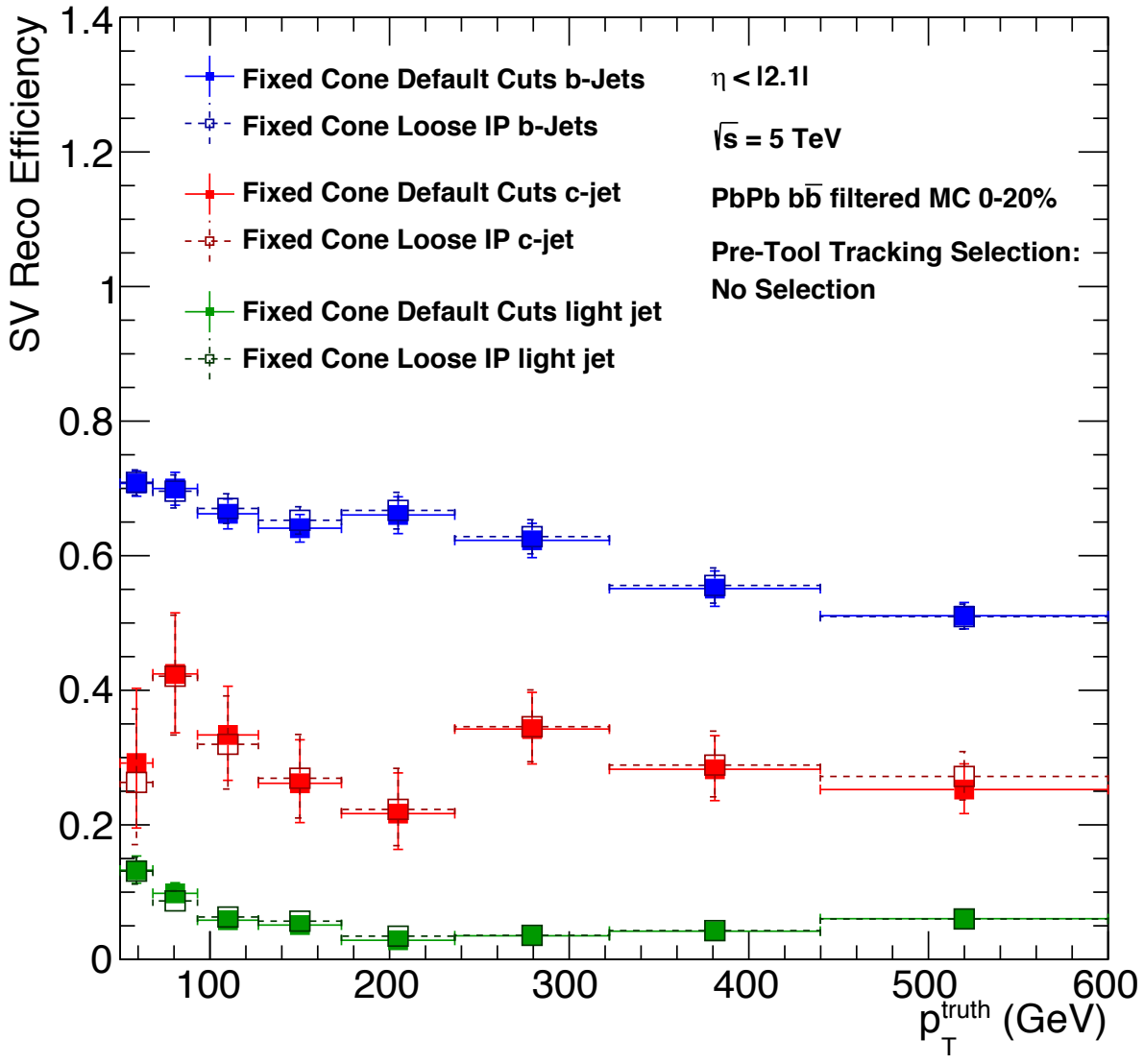

SV Reco Efficiency for Different Flavors of Jets in PbPb 0-20%
SV Reco Efficiency
Shrinking Cone Default Cuts b-Jets
Fixed Cone Default Cuts b-Jets
Shrinking Cone Default Cuts c-jet
Fixed Cone Default Cuts c-jet
Shrinking Cone Default Cuts light jet
Fixed Cone Default Cuts light jet
η < |2.1|
√s = 5 TeV
PbPb bb̄ filtered MC 0-20%
Pre-Tool Tracking Selection:
No Selection
p_T^truth (GeV)


SV Reco Efficiency for Different Flavors of Jets in PbPb 0-20%
SV Reco Efficiency
Fixed Cone Default Cuts b-Jets
Fixed Cone No Min Jet Pt Fraction b-jets
Fixed Cone Default Cuts c-jet
Fixed Cone No Min Jet Pt Fraction c-jet
Fixed Cone Default Cuts light jet
Fixed Cone No Min Jet Pt Fraction light jet
η < |2.1|
√s = 5 TeV
PbPb bb̄ filtered MC 0-20%
Pre-Tool Tracking Selection:
No Selection
p_T^truth (GeV)

SV Reco Efficiency for Different Flavors of Jets in PbPb 0-20%

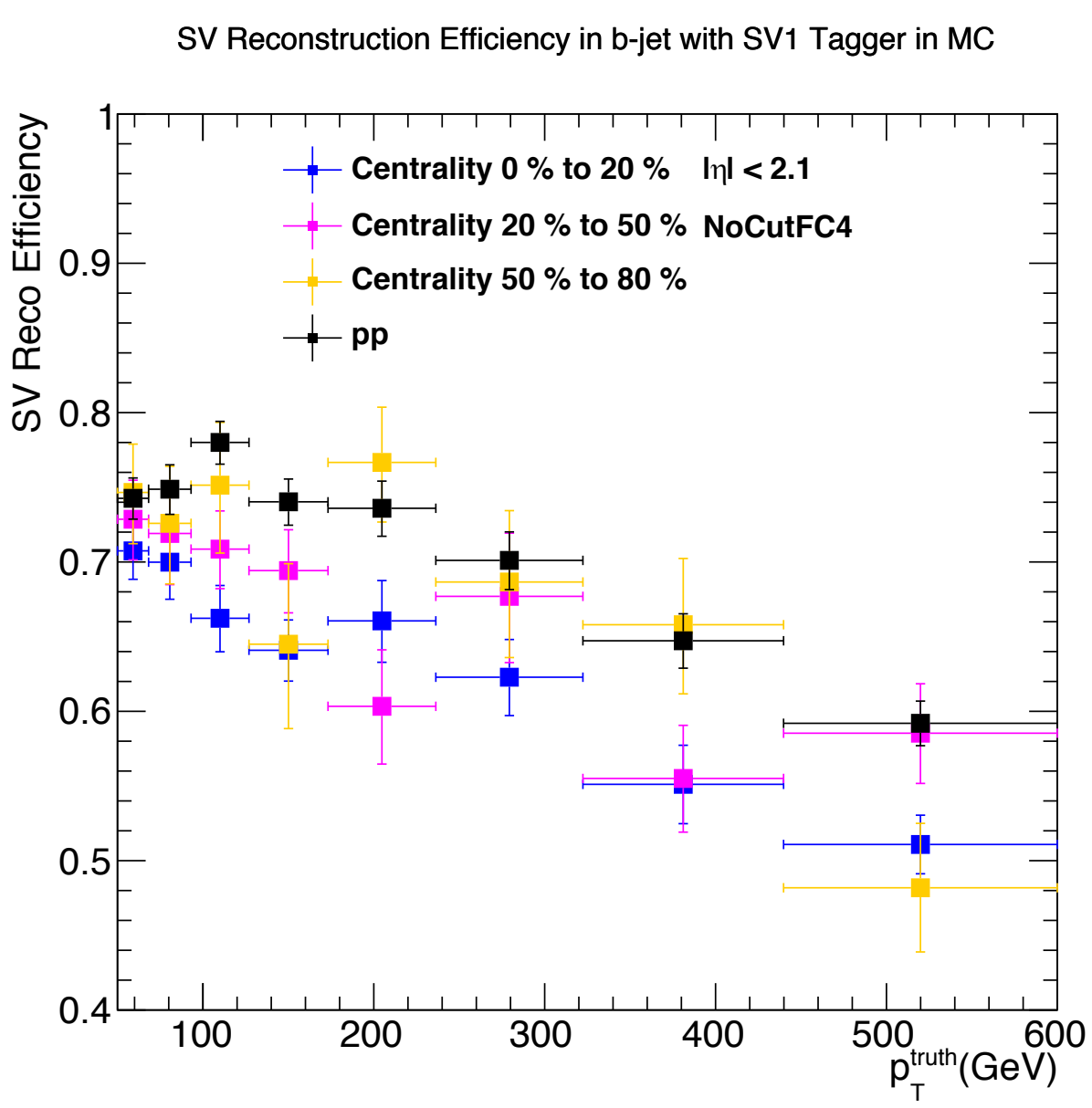


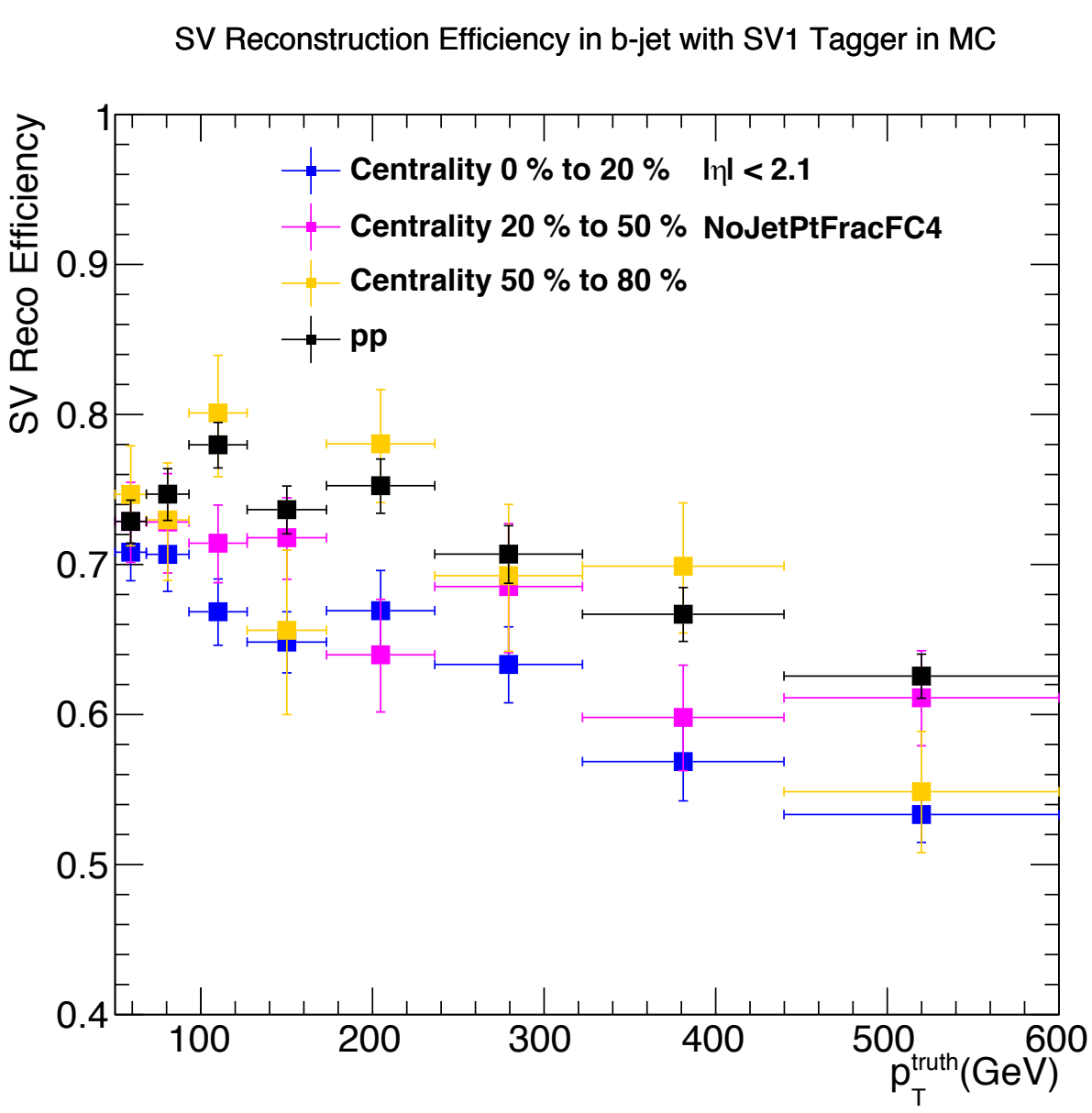
SV Reco Efficiency for Different Flavors of Jets in PbPb 0-20%

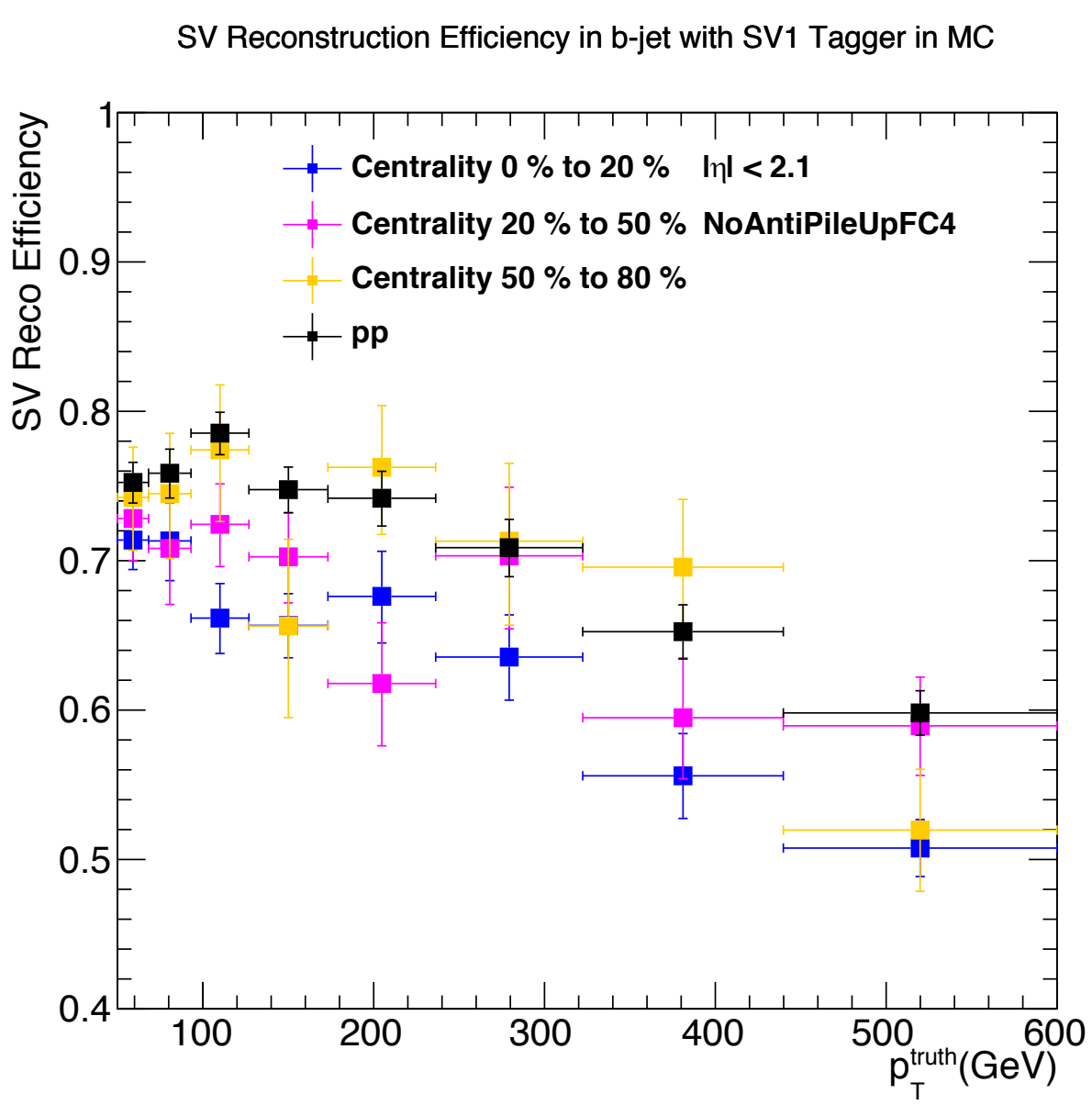


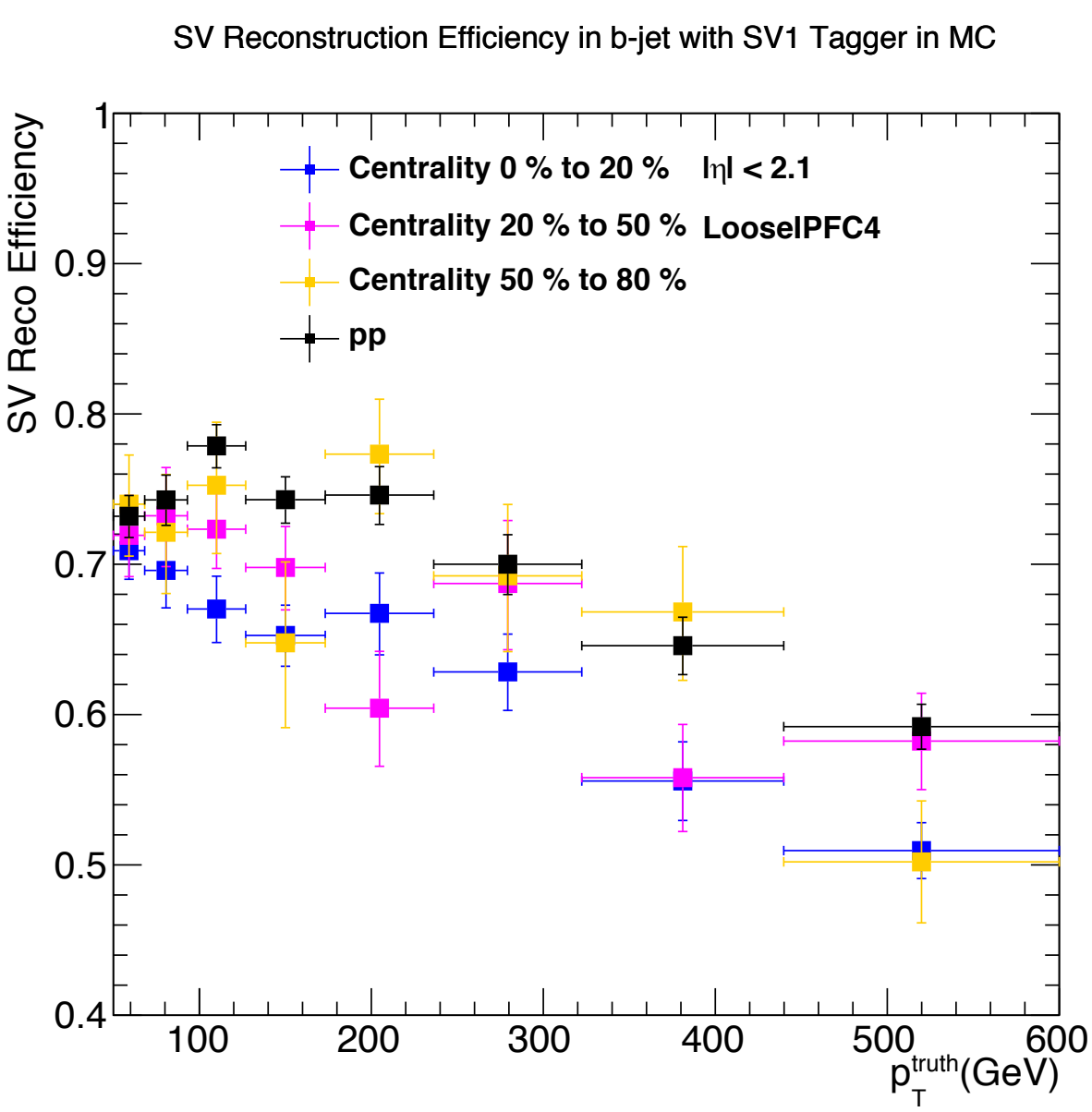
Comparison to pp

- Most of the points follow the trend (worse in central, similar to pp in peripheral)
- Due to limit in statistics, not clear.
- Will try change binning so lower pT range is clear.


SV Reconstruction Efficiency in b-jet with SV1 Tagger in MC
SV Reco Efficiency
Centrality 0 % to 20 %
Centrality 20 % to 50 %
Centrality 50 % to 80 %
pp
|η| < 2.1
NoCutFC4
1
0.9
0.8
0.7
0.6
0.5
0.4
100
200
300
400
500
600
p_T^truth(GeV)


SV Reconstruction Efficiency in b-jet with SV1 Tagger in MC
SV Reco Efficiency
Centrality 0 % to 20 %
Centrality 20 % to 50 %
Centrality 50 % to 80 %
pp
|η| < 2.1
NoJetPtFracFC4
1
0.9
0.8
0.7
0.6
0.5
0.4
100
200
300
400
500
600
p_T^truth(GeV)

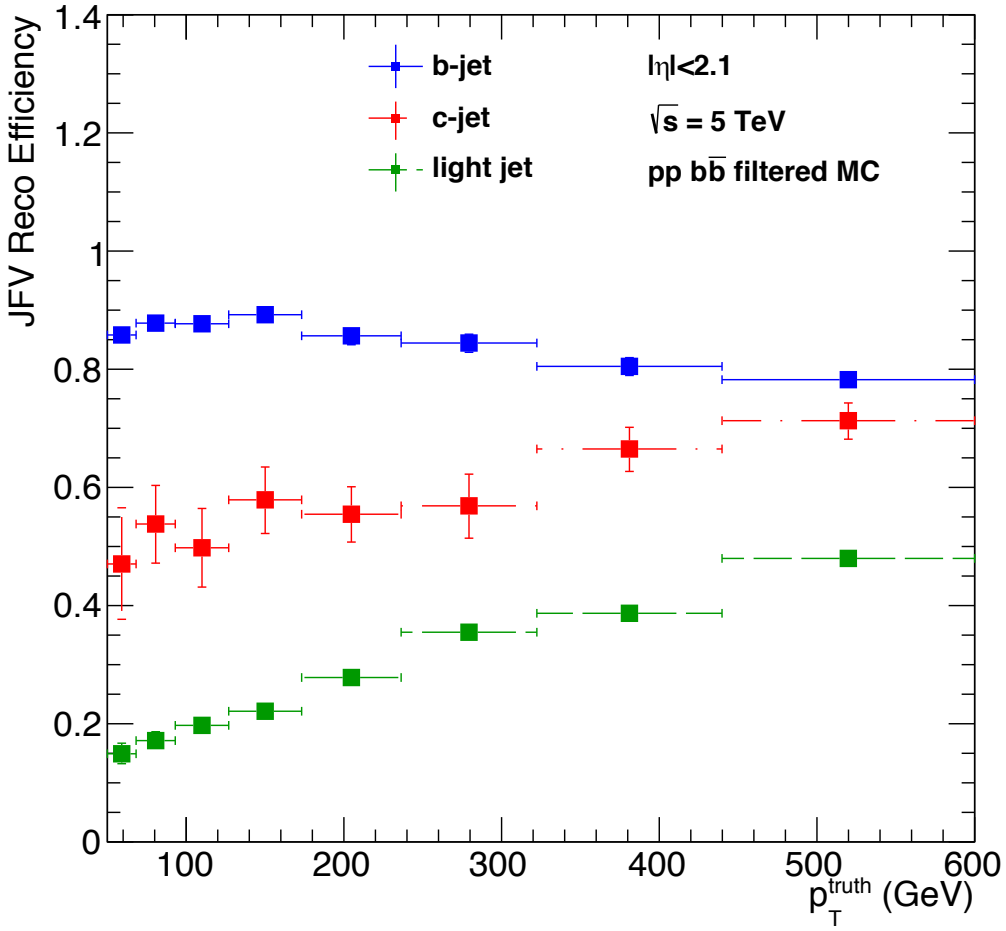

SV Reconstruction Efficiency in b-jet with SV1 Tagger in MC
SV Reco Efficiency
Centrality 0 % to 20 %
Centrality 20 % to 50 %
Centrality 50 % to 80 %
pp
|η| < 2.1
NoAntiPileUpFC4
1
0.9
0.8
0.7
0.6
0.5
0.4
100
200
300
400
500
600
p_T^truth(GeV)

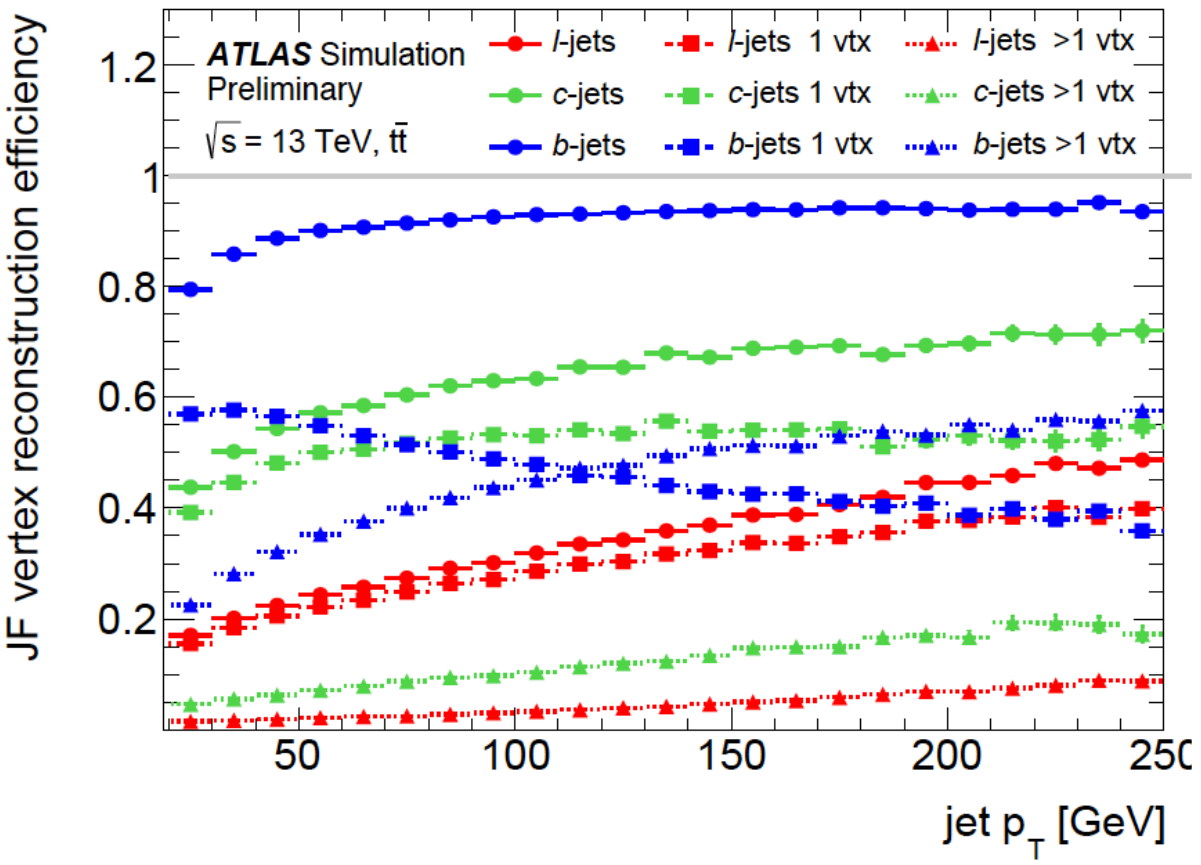

SV Reconstruction Efficiency in b-jet with SV1 Tagger in MC
SV Reco Efficiency
Centrality 0 % to 20 %
Centrality 20 % to 50 %
Centrality 50 % to 80 %
pp
|η| < 2.1
LooseIPFC4
1
0.9
0.8
0.7
0.6
0.5
0.4
100
200
300
400
500
600
p_T^truth(GeV)

JetFitter Algorithm—i.e., not only one vertex but also decay chain

- 1. Select Tracks
  - Form all possible 2-track vertices, and exclude tracks compatible with primary vertex, and hadronic material interactions.
- 2. Fitting and Merging
  - Initialize B-hadron flight direction as jet direction.
  - Initialize vertices candidates as closest approach position of each of the selected tracks to this direction.
  - Iteratively merge vertices and reject tracks with χ^2 cut.
  - Meanwhile iteratively align vertices with a common B-hadron flight direction and reject vertices with χ^2 cut.
  - Output a list of vertices aligned at common B-hadron flight axis
- Performance Paper: https://cds.cern.ch/record/2645405/files/ATL-PHYS-PUB-2018-025.pdf

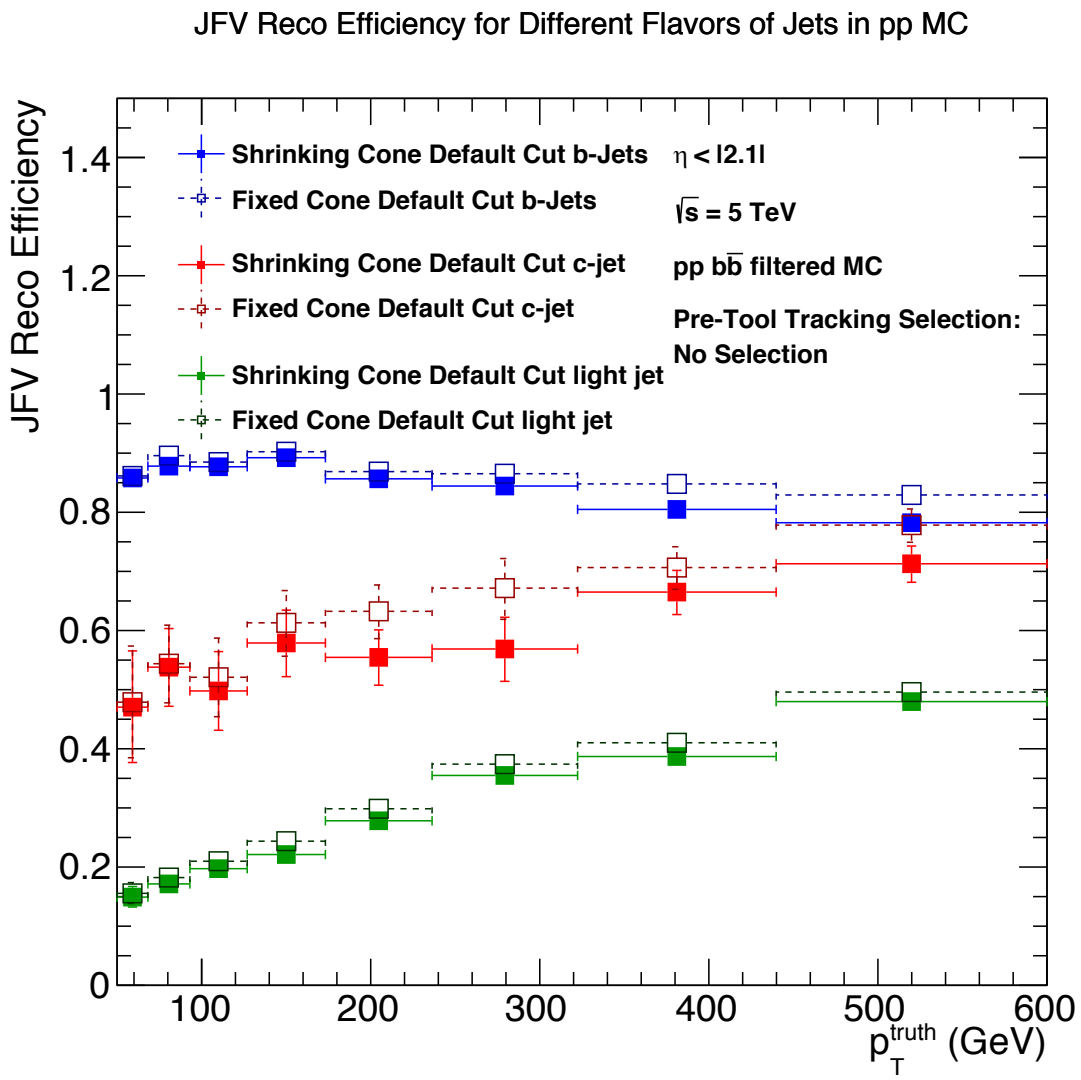
Efficiency Comparison to pp at 13 TeV

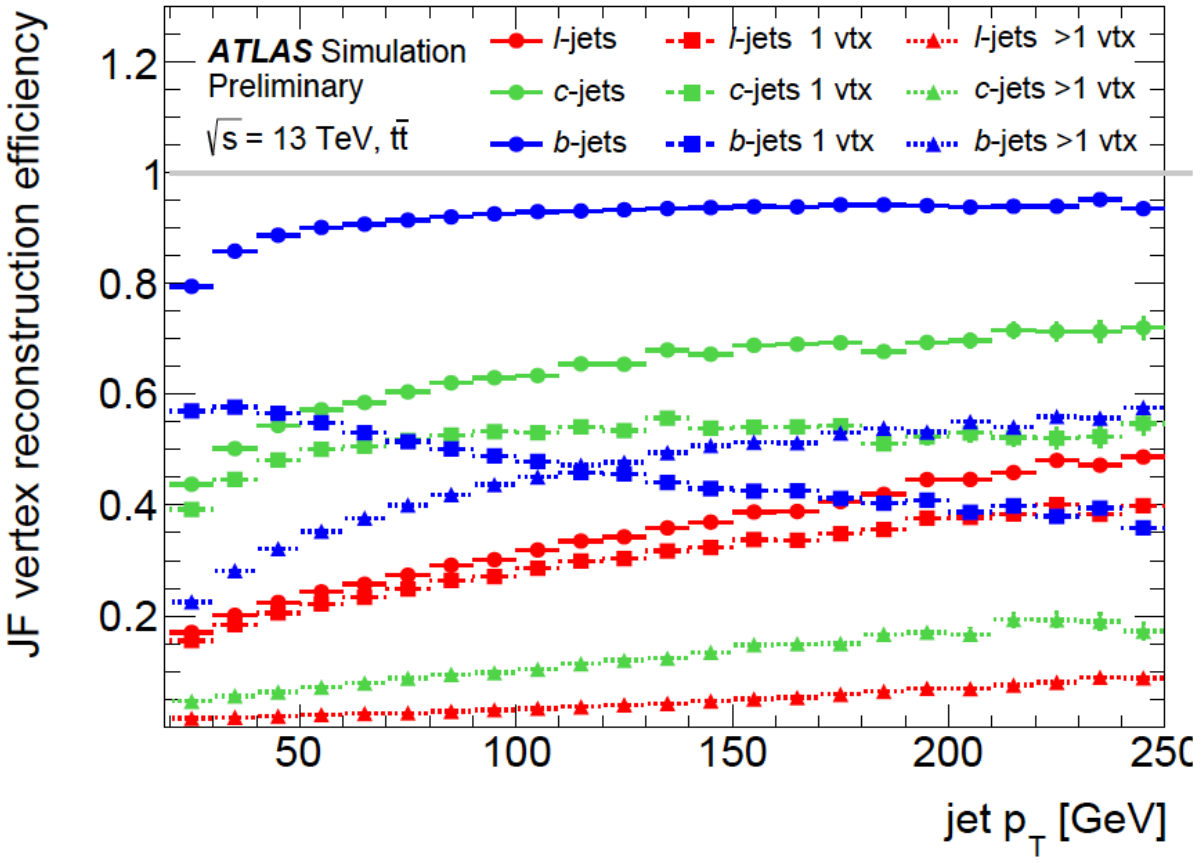




- Observed a minor decrease in efficiency at higher pT
- Higher than 250 GeV results are not shown in the performance paper
- 50-250 range is relatively flat.

Does Fixed Cone still work wit JetFitter?





Default JetFitter Results and Fixed Cone Results

Default Cuts

Integrated Efficiency (pT >20 GeV)	0-20%	20-50%	50-80%	pp
B-jet	0.939	0.901	0.844	0.865
C-jet	0.708	0.553	0.519	0.496
Light-jet (fake)	0.645	0.409	0.152	0.165

Fixed Cone at 0.4

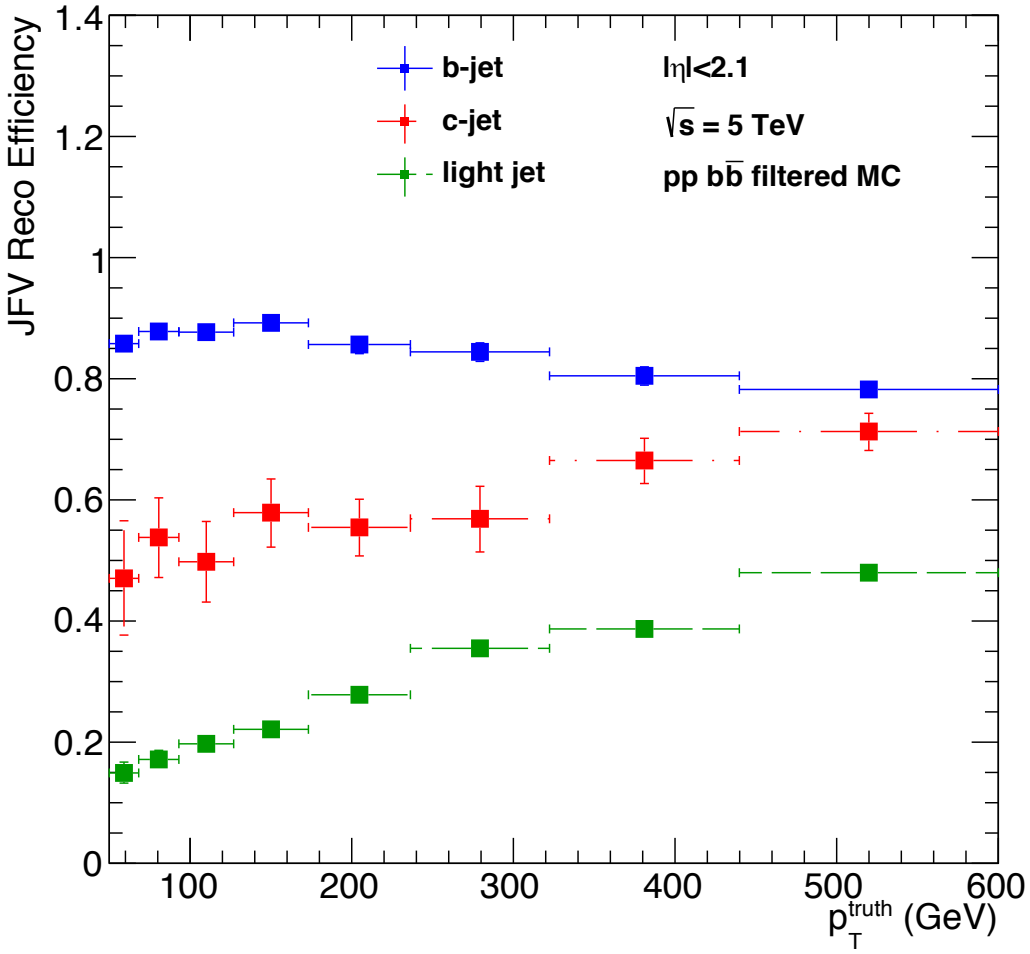
Integrated Efficiency (pT >20 GeV)	0-20%	20-50%	50-80%	pp
B-jet	0.954	0.907	0.860	0.872
C-jet	0.716	0.579	0.507	0.507
Light-jet (fake)	0.723	0.468	0.160	0.174

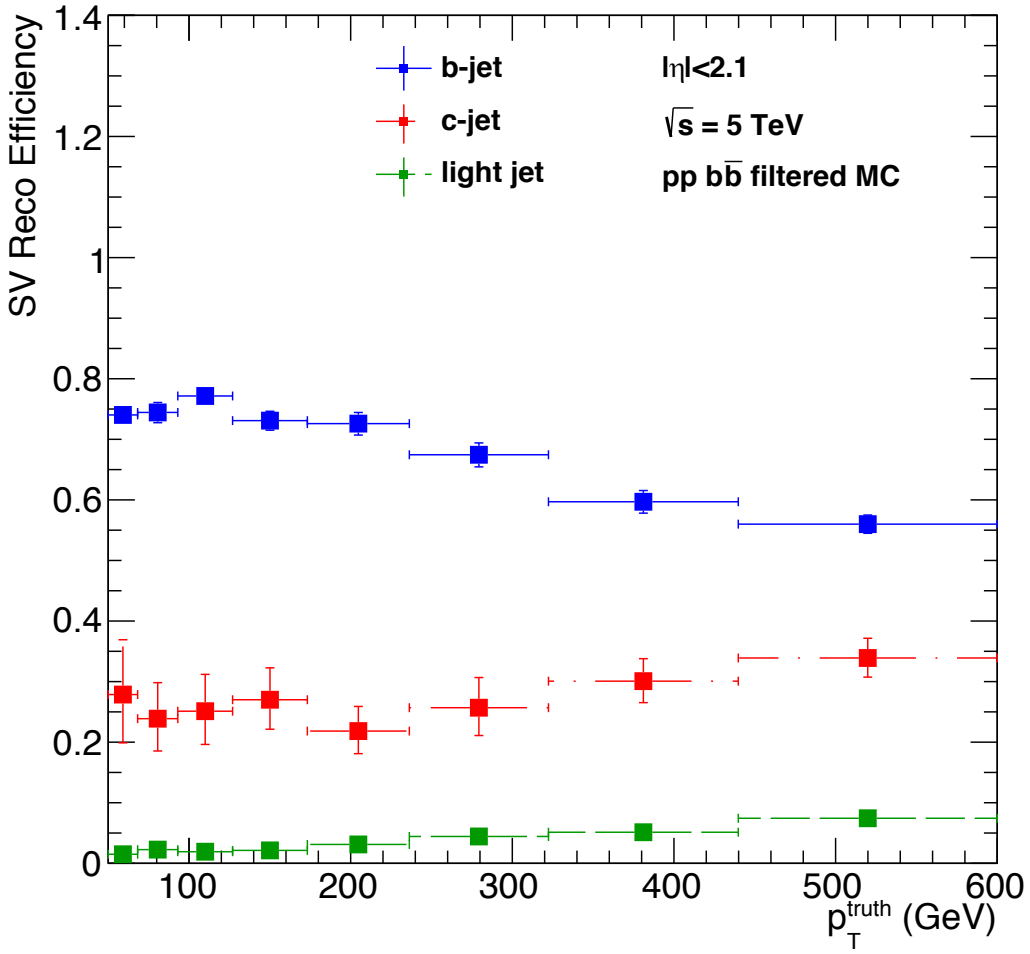
Performance Paper results:

	JF Vertices All
b-jets	0.893
c-jets	0.556
light jets	0.234

Back-up

Back-up: compare to SV





Minimum Jet Pt Fraction

- Algorithm overview:
  - 1. Select list of good particles
    - A0 Z0 track error cuts (Perigee quality)
    - For tracks with p > 10 GeV, stdev < 50%
    - Min Pixel hits, SCT hits and IBL hits requirement should be met
    - within 0.4 of JetDir
  - 2. Select list of two track vertices using selected good particles
    - Vertices are not in material layer and invariant mass is not a V^0 decay
    - Both track passes Jet Pt Fraction and vertex fitting quality

Other to-do

- Reproduce plots from JetFitter performance with our MC.
- Plan on summary of progress for flavour tagging group.