

# Qualification Task AFT 455:

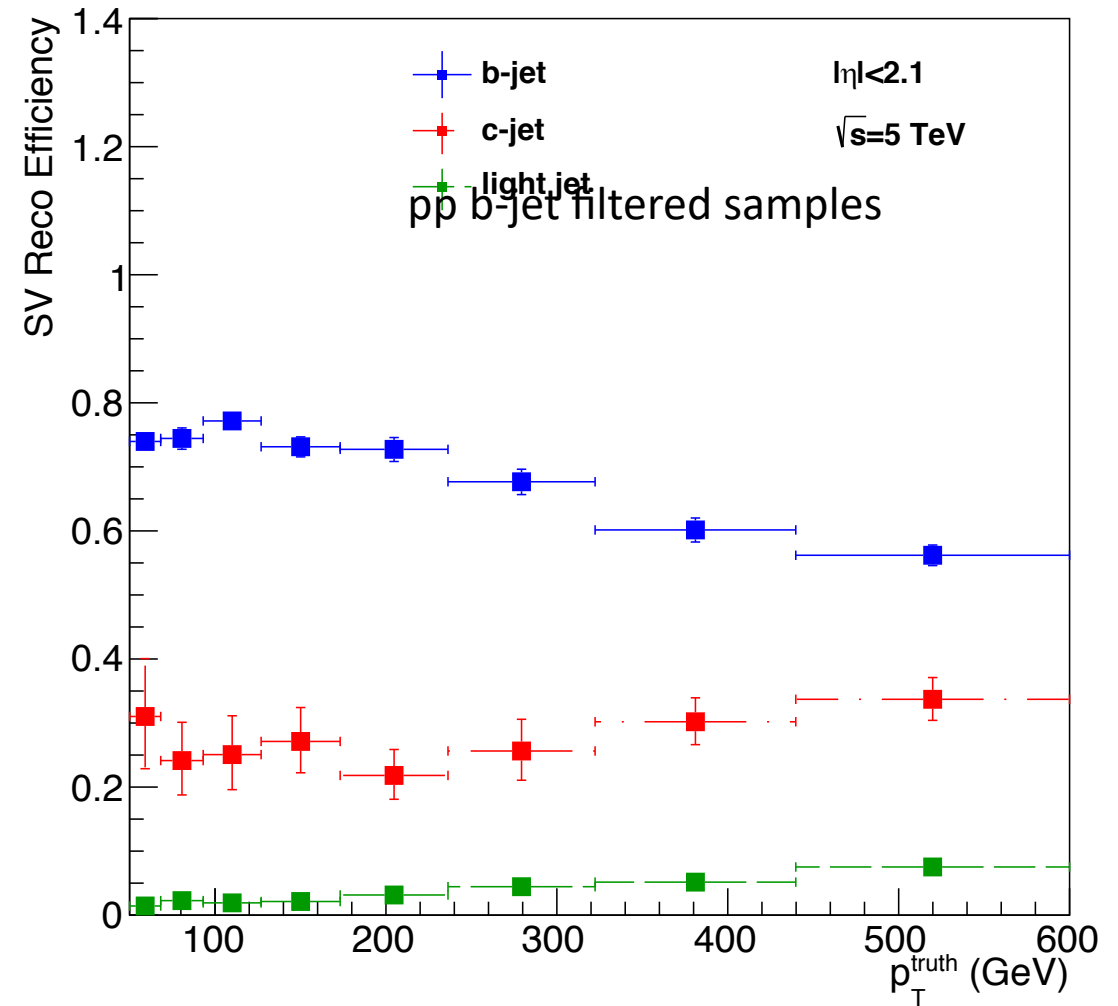
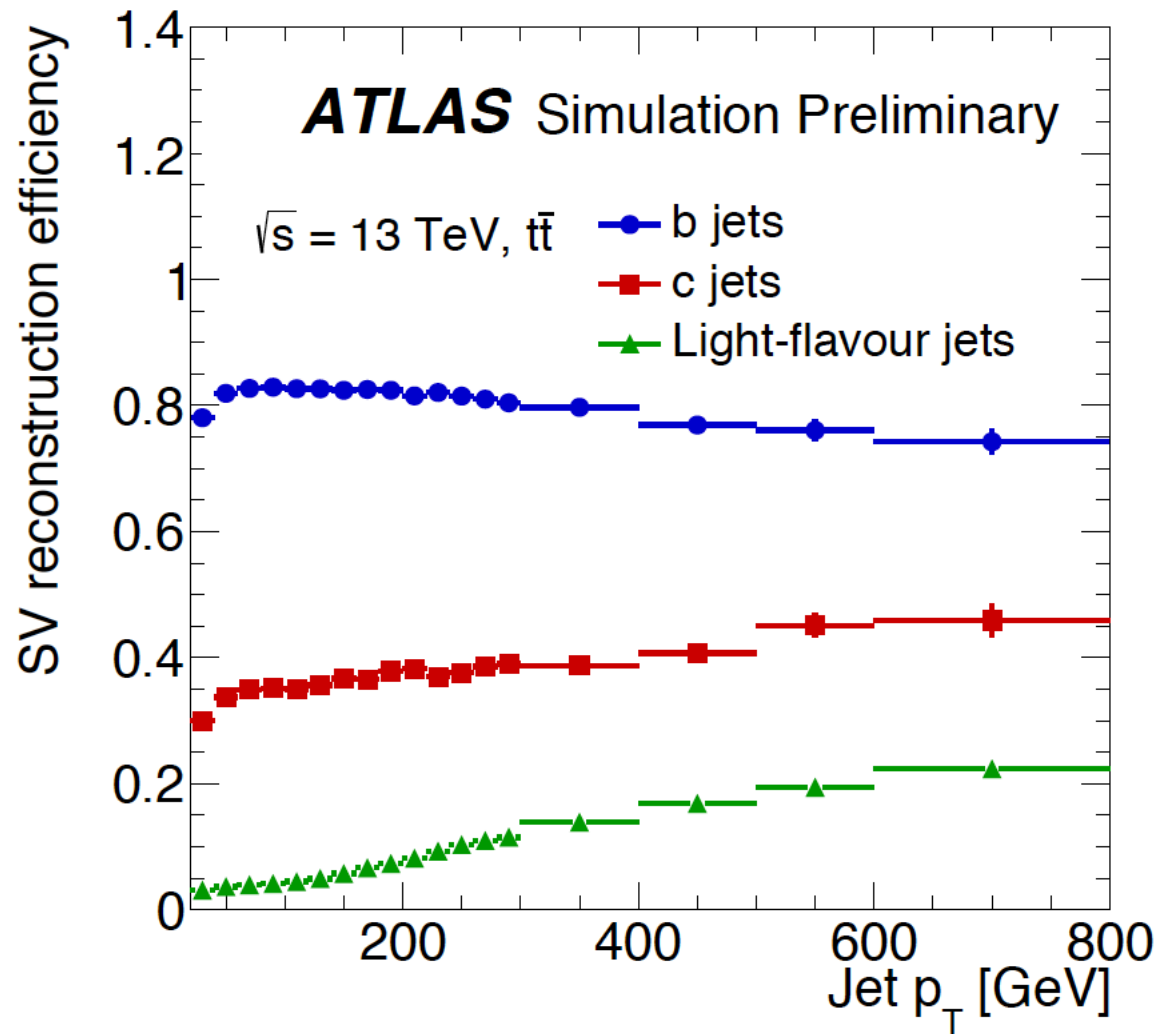
Optimization of Inputs for High Level Discriminants (DL1 and MV2) to  
Improve Performance of B-Tagging in Heavy Ion Collisions

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March 2, 2020

Issue: Observed a difference in efficiency from SVF tool Performance Paper and our result.



- ATL-PHYS-PUB-2017-011: <https://cds.cern.ch/record/2270366>

# List of Things to Check

- Do we have same definition of efficiency?
- Are we looking at same physics process?
- Do we have the correct selections?

# Do we have same efficiency definition?

- “the fractions of jets which have a reconstructed secondary vertex, for different jet flavours” (✓)
- “The jets are flavour labeled by matching them to weakly decaying b- and c-hadrons in the event generator record. If a b-hadron is found within a distance of  $dR < 0.3$  from the jet axis, then the jet is labeled as a b-jet. If no b-hadron is found, the search is repeated for c-hadrons, if a c-hadron is found and no leptons are found, the jet is then labeled as a c-jet. If no match is found for c, b, or , the jet is labeled as a light-flavour jet.” (✓)

# Are we looking at Same Physics Process?

- Not exactly.
  - Only  $t\bar{t}$  events: performance paper
  - $b\bar{b}$  filtered inclusive events: our result

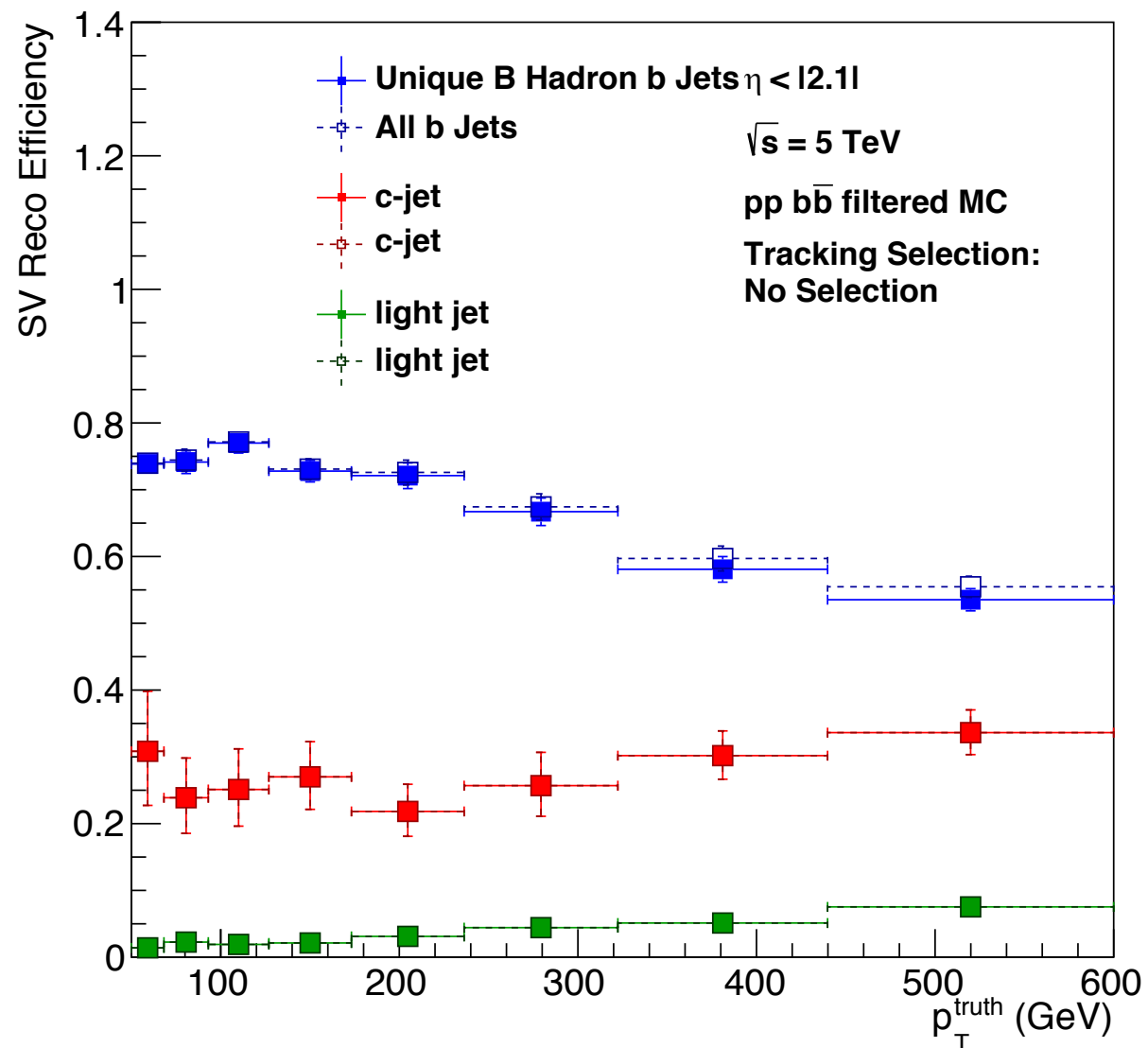
- Email from Chris Pollard:

We don't expect b-jets originating from different physics processes to have the same b-tagging efficiency. b-jets in inclusive dijet events can be quite different from b-jets in  $t\bar{t}$  events. For instance you'll likely have more jets with  $>1$  b-hadron inside, which have a lower SV-finding efficiency. These types of jets become more common at high  $p_T$  in inclusive jet production, so I would say your plot makes a lot of sense!

- There're more multi-B hadron jets in higher  $p_T$  region. (see back up)
- However, only using single b-hadron jets did not improve the results. (see next slide)
- Different physics processes could still be a reason.

# SV Reconstruction Efficiency for Unique and Multiple B Hadron Jets

SV Reco Efficiency for Different Flavors of Jets in pp

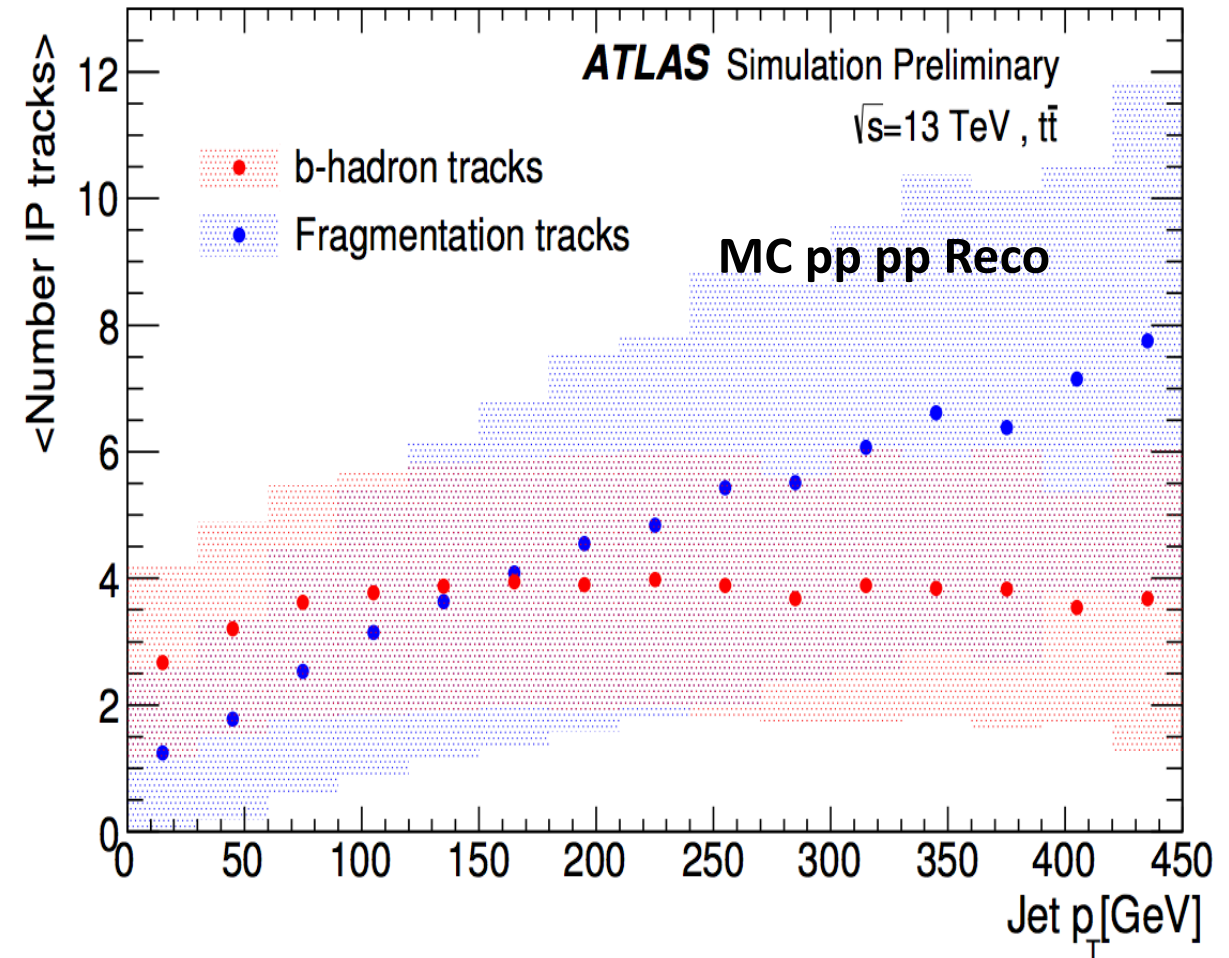
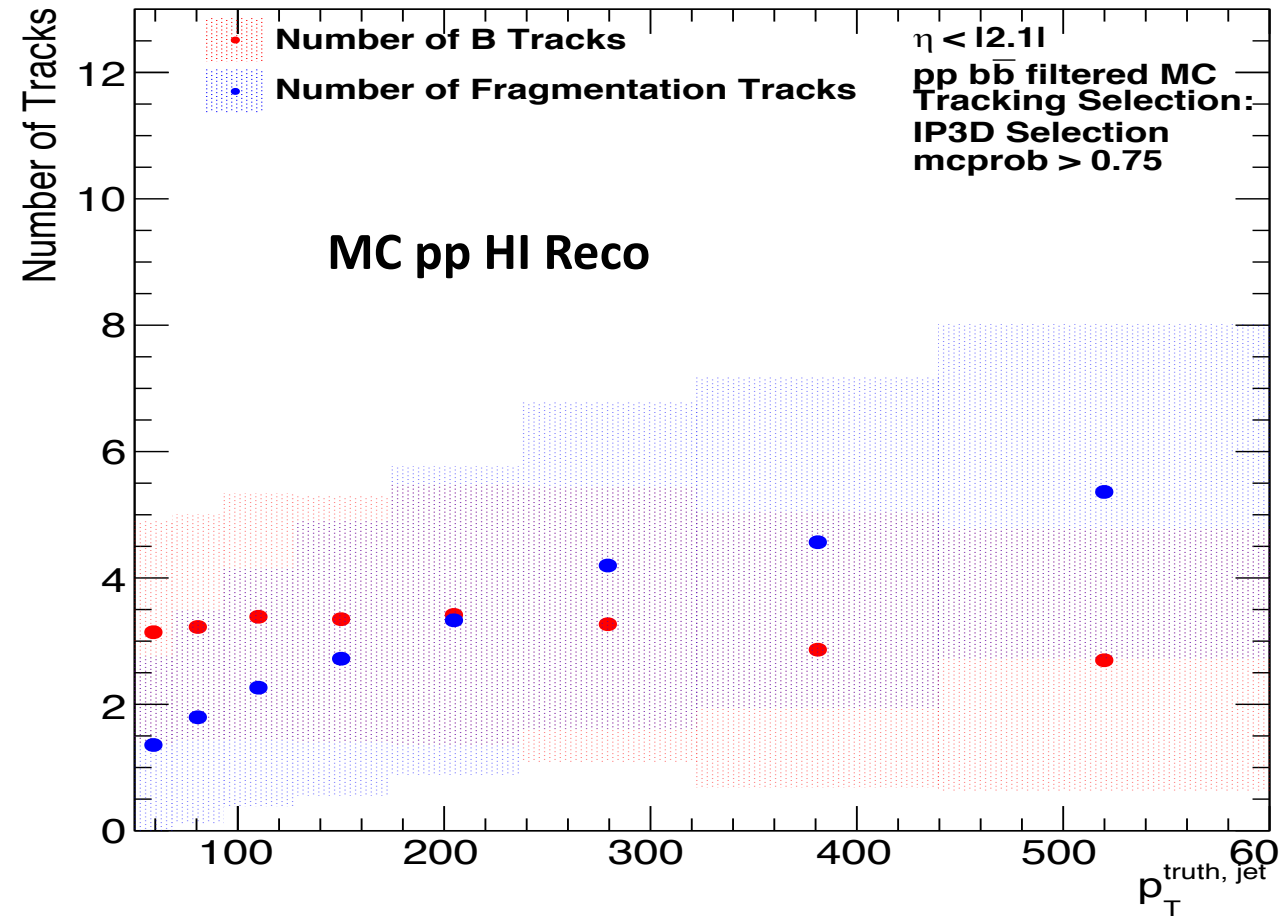


- Almost no difference in low pt region.
- Slight decrease of SV for unique b hadron jets in high pt.

# Comparison of Tracks from B & from Fragmentation

- Loop over tracks associated with a jet using shrinking cone.
- Select tracks that pass IP3D selections:
  - $p_T^{trk} > 1 \text{ GeV}$ ;
  - $|d0| < 1 \text{ mm}$ ;
  - $|z0*\sin(\theta)| < 1.5 \text{ mm}$ ;
  - Pixel Hits + SCT Hits  $\geq 7$ ;
  - Pixel Holes  $\leq 1$ ;
  - Pixel Holes + SCT Holes  $\leq 2$ ;
- Select tracks with  $mcprob > 0.75$ .
- Look at matched truth track's production vertex (trk\_orig)
- B tracks:
  - $trk\_orig == \text{truth B decay vertex}$
  - or  $trk\_orig == (\text{truth C decay vertex})$  and (this C decays from B)
- Fragmentation tracks: other truth tracks in jet

# Comparison of Tracks from B & from Fragmentation



- Similar overall trend.
- Fewer tracks.
- More obvious in high  $p_T$  (drop in SV efficiency)

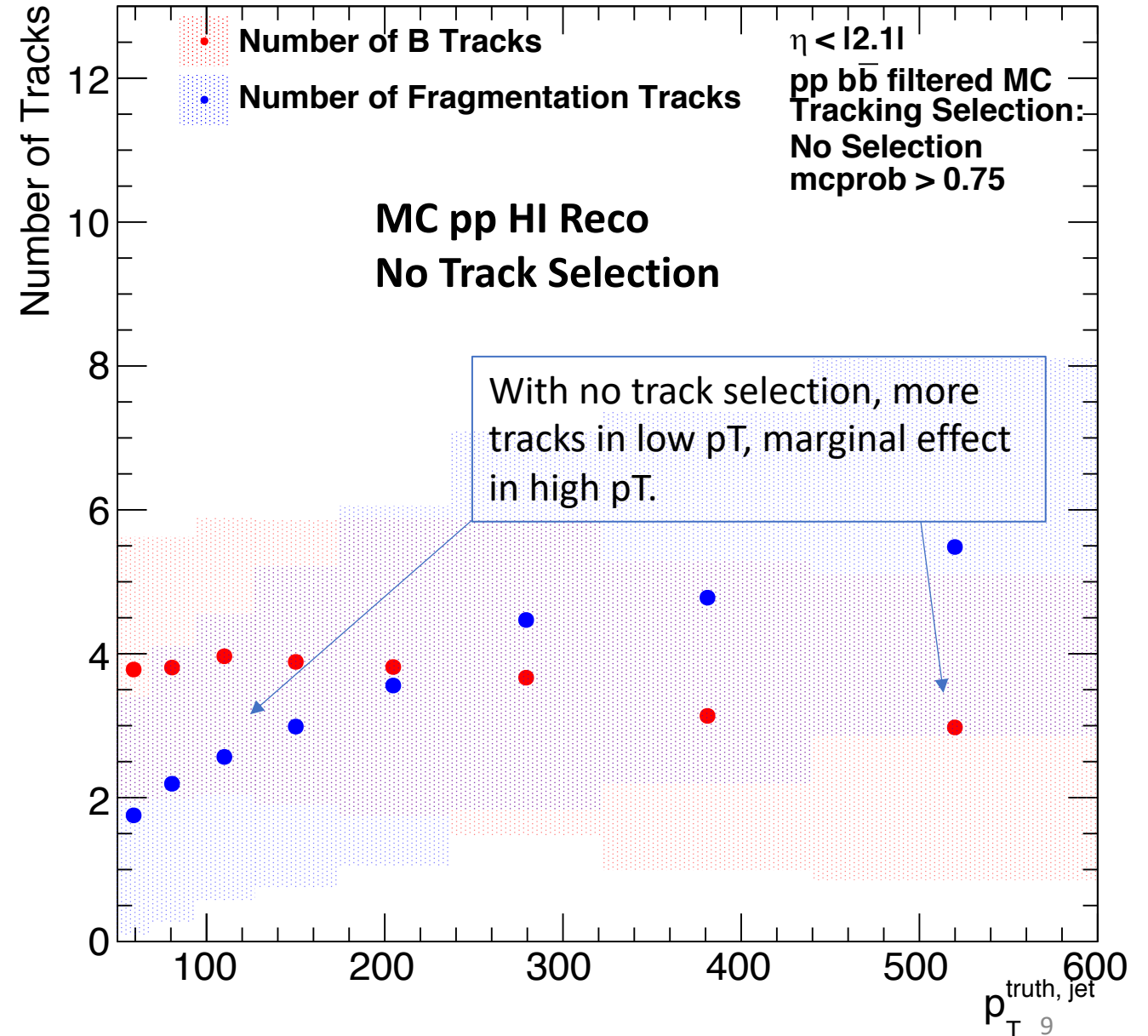
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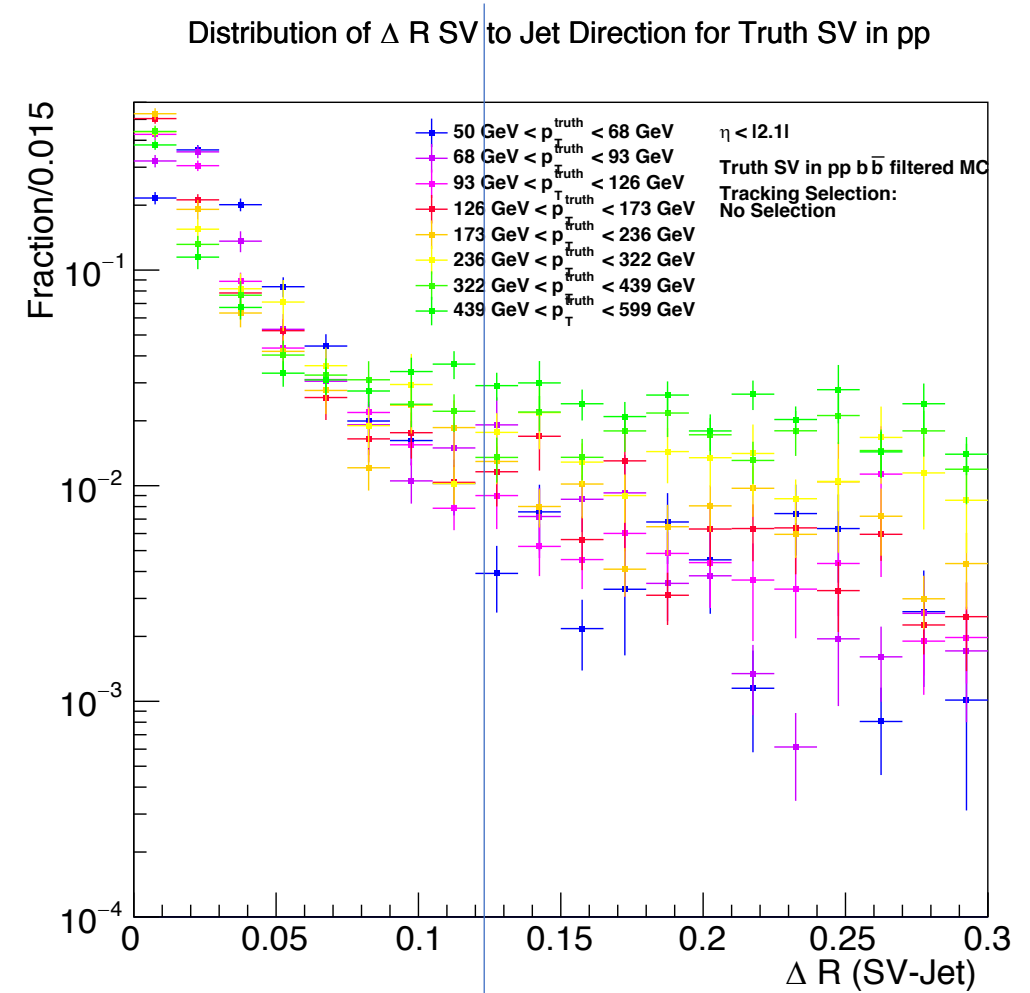
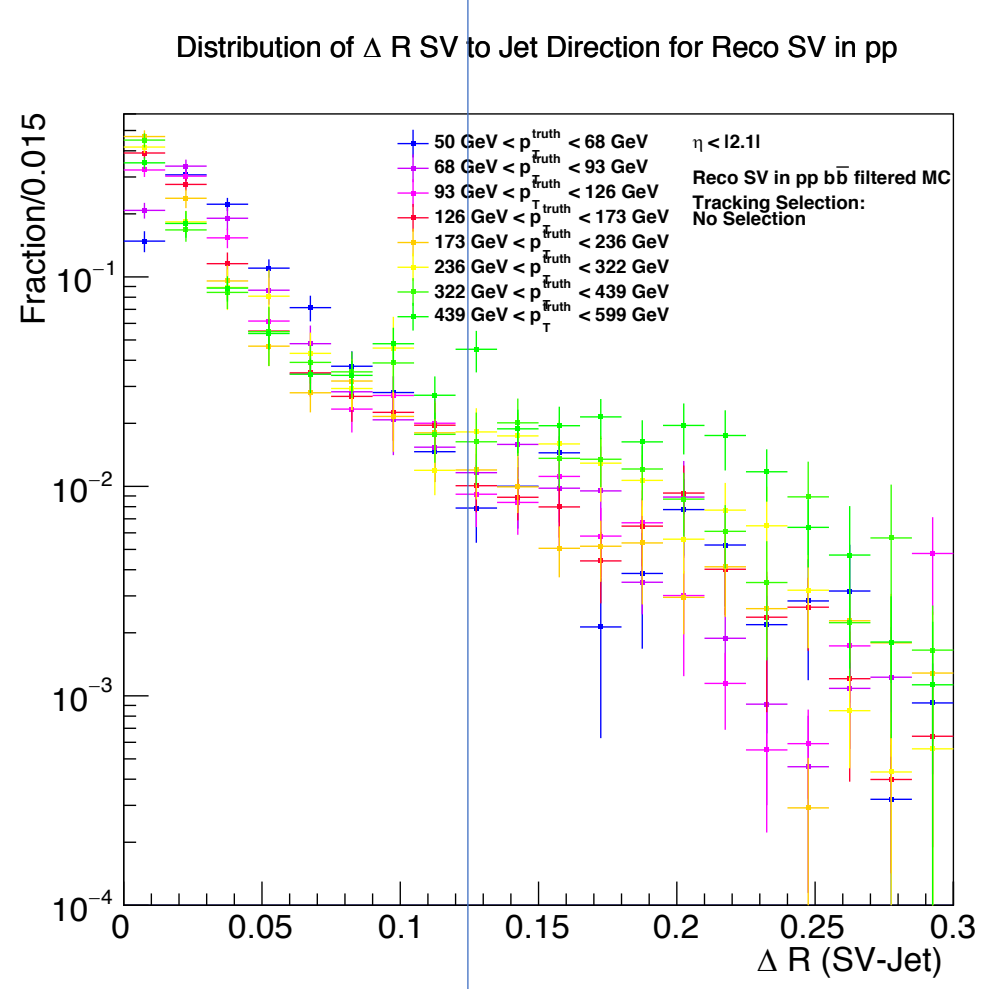
# Ideas?

- Less tracks are associated with jets using IP3D cut. Consider wider cone of association?
  - Will check cone size at high pT.
- Loosening selections at SV selection.
  - Tighter pT cuts.
  - loosening track quality?

## Average Number of Tracks in b-jet



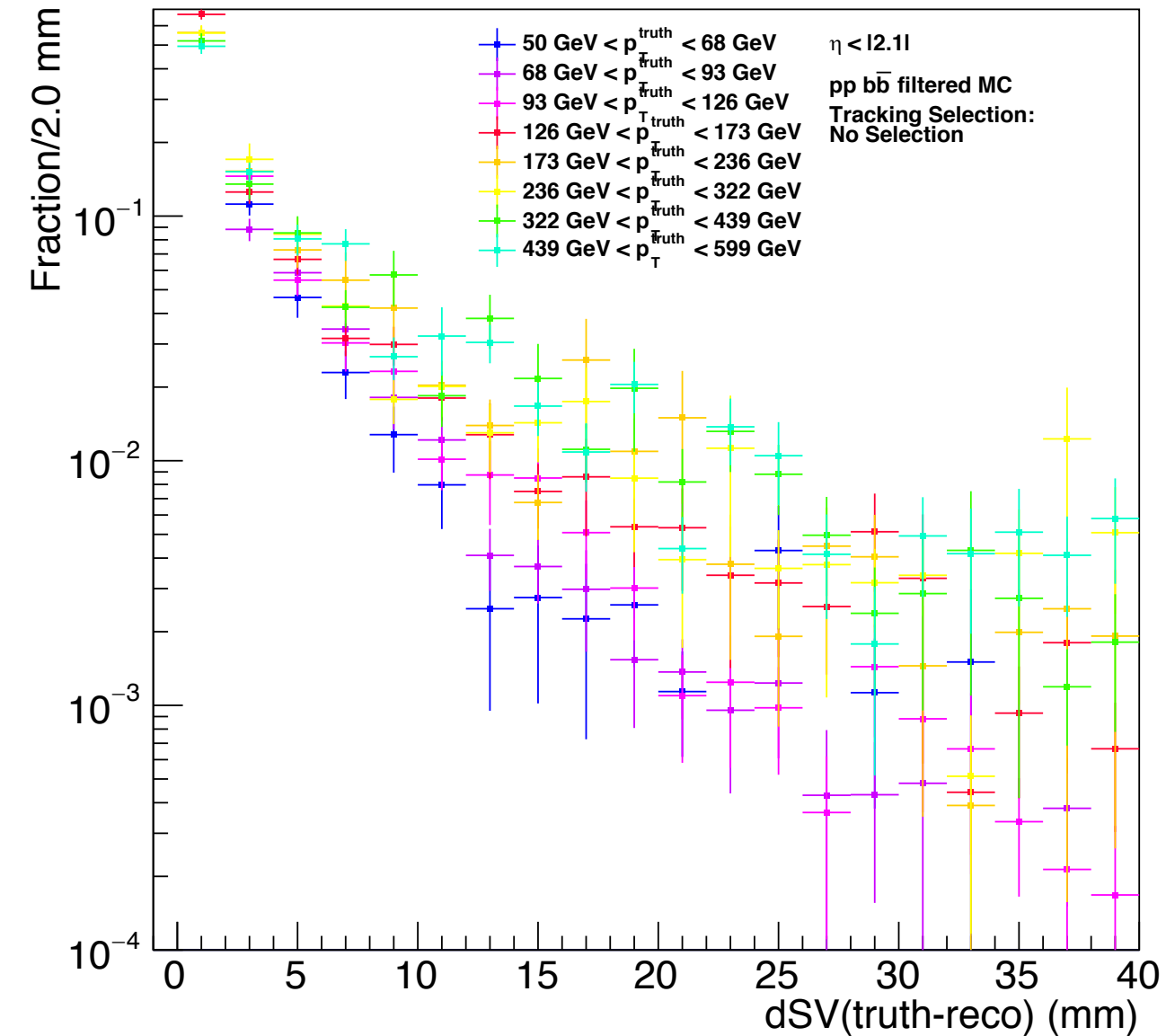
# pT Dependence of SV-Jet Distance



- Narrower distribution at high p<sub>T</sub>.

# Distribution of Distance between SV Truth and Reco as a function of pT

Distribution of 3D Distance between Truth SV and Reco SV for pp



- Wider separation at higher pT.

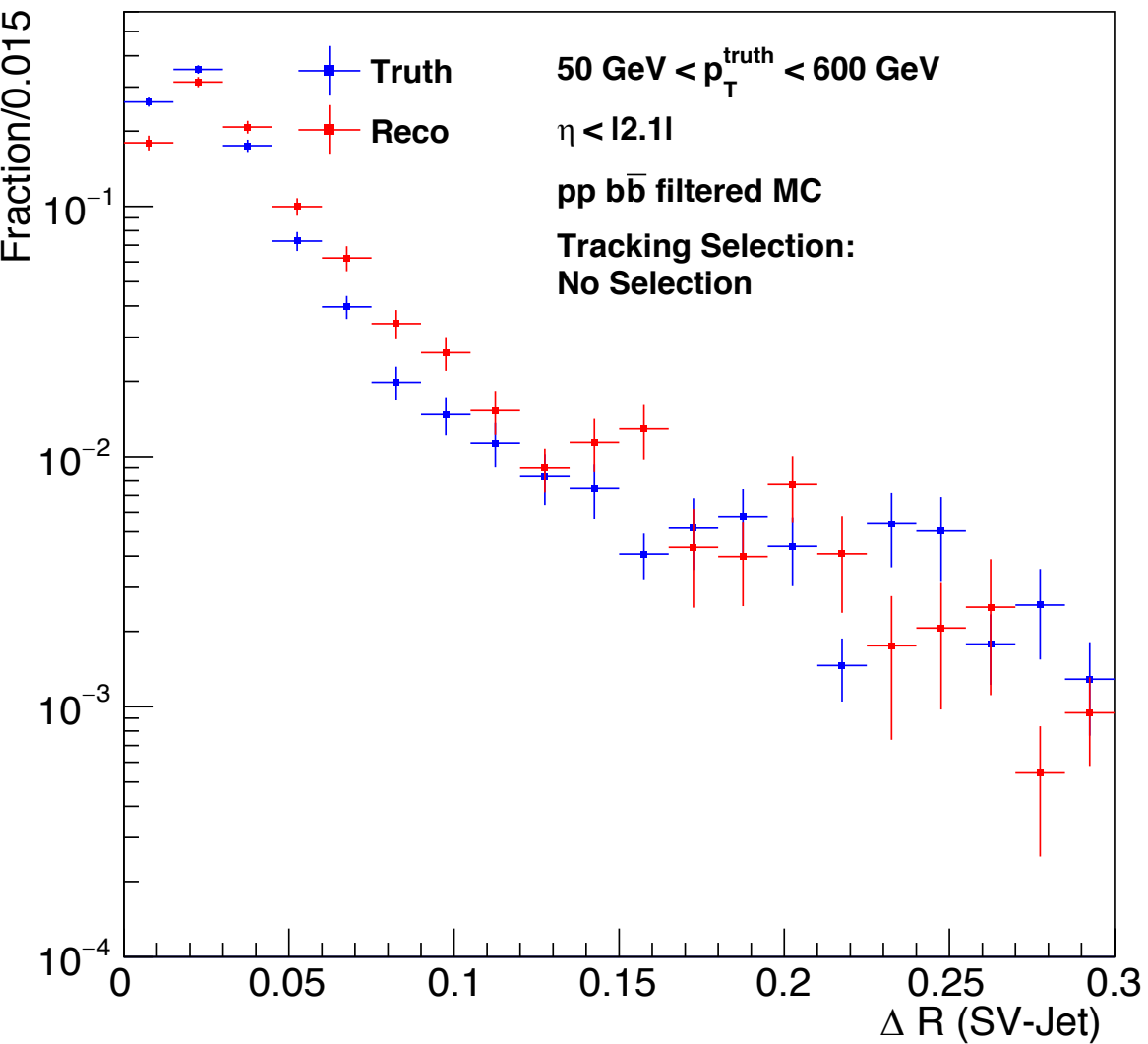
# Back-up

# Plot dR of truth and reco SV?

- Reco SV direction: reco PV to reco SV
- Truth SV direction: truth PV to truth SV

# From homework list: $\Delta R(\text{SV-Jet})$ in Reco SV and Truth SV

Distribution of  $\Delta R$  SV to Jet Direction for reco and truth SV in pp



- Question raised: is there a resolution issue with reco jet direction?
- Reco SV has a broader distribution.
- Peaks are both at  $\sim 0.03$ .

# Plan

- Working on plotting b-hadron tracks vs fragmentation tracks. (done)
- Compiled packages needed for changing hard-coded track selections, will play with selections.
- Check whether there're papers on performances of SVF on  $b\bar{b}$  events and compare.

# Plan for homework List

- talk to Ogul & SV1 expert for how to implement track selections in SVF tool.
  - SV1 expert Vadim responded with new homework: reproduce this plot from the 2016 b-tagging performance paper: <http://cdsweb.cern.ch/record/2160731/files/ATL-PHYS-PUB-2016-012.pdf>
  - The way our framework works did not involve a configuration file for SV tracking selections.
    - Have installed the package, will play with change the hard-coded job options in the package.
  - Started a new repository on gitlab for the codes we're running
- Things to plot:
  - Reco SV dR from jet axis comparing to truth SV dR from jet axis. (for different  $p_T$ )

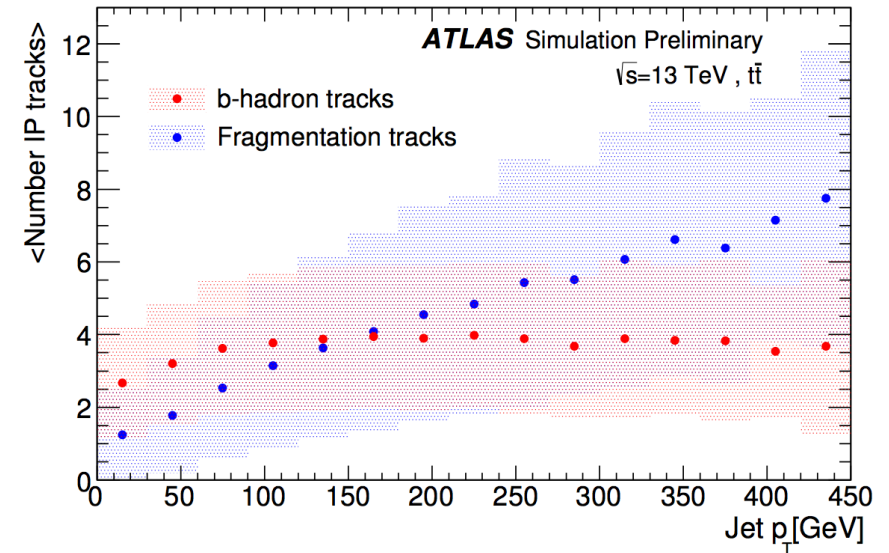


Figure 5: Average number of  $b$ -hadron and jet fragmentation tracks selected for the IP algorithm as a function of the jet  $p_T$ . The shaded band around the two contributions represents the RMS for each  $p_T$  bin.





Distribution of Number of B Hadrons in b-jets in pp

