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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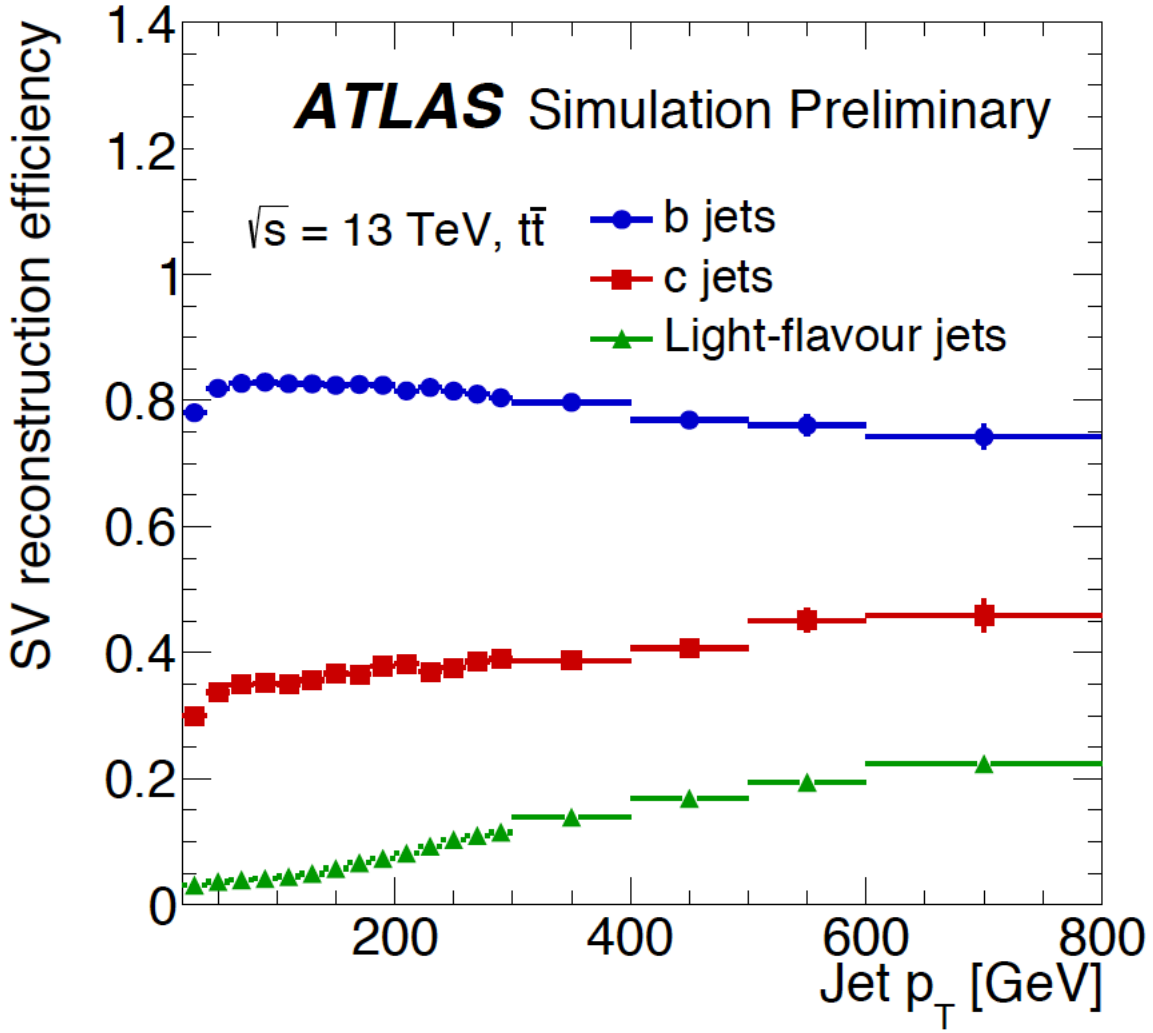
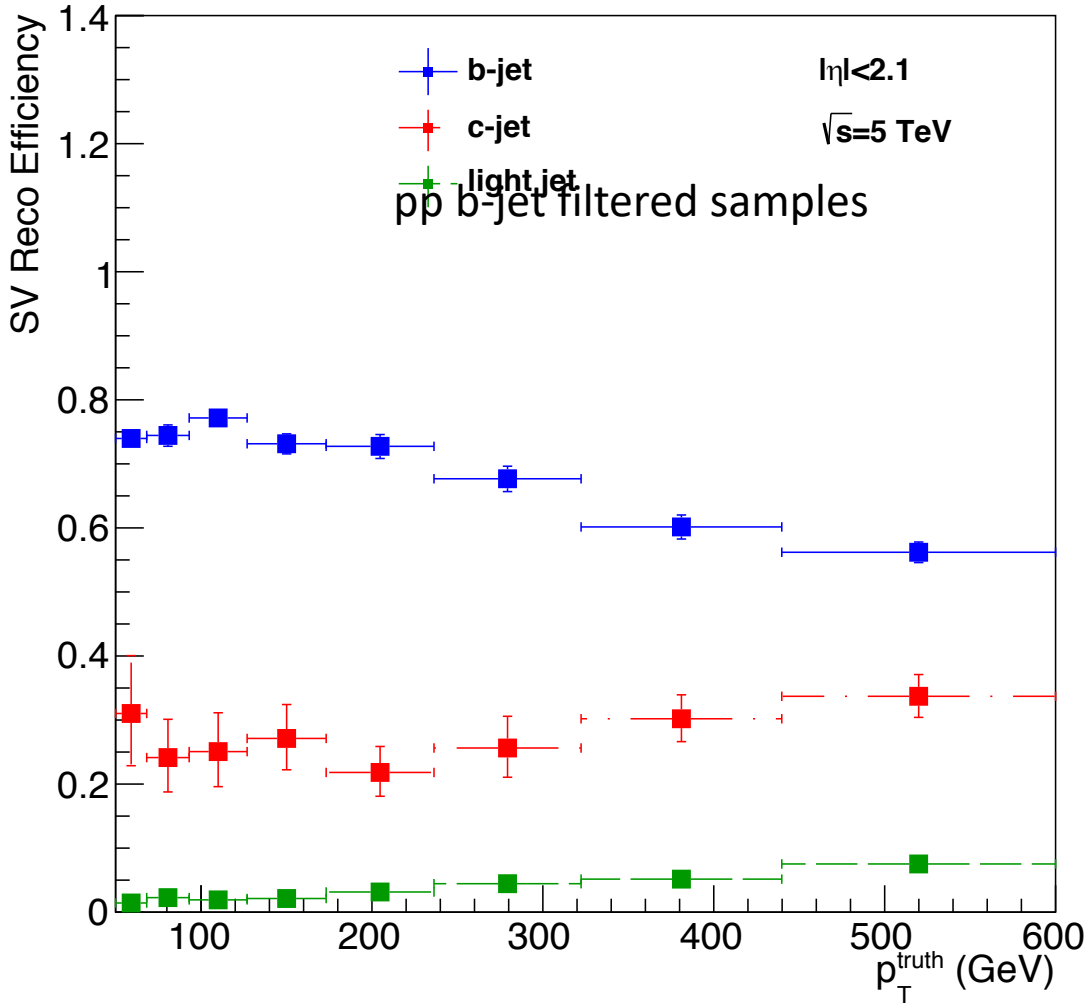
March 2, 2020

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.” (✓)

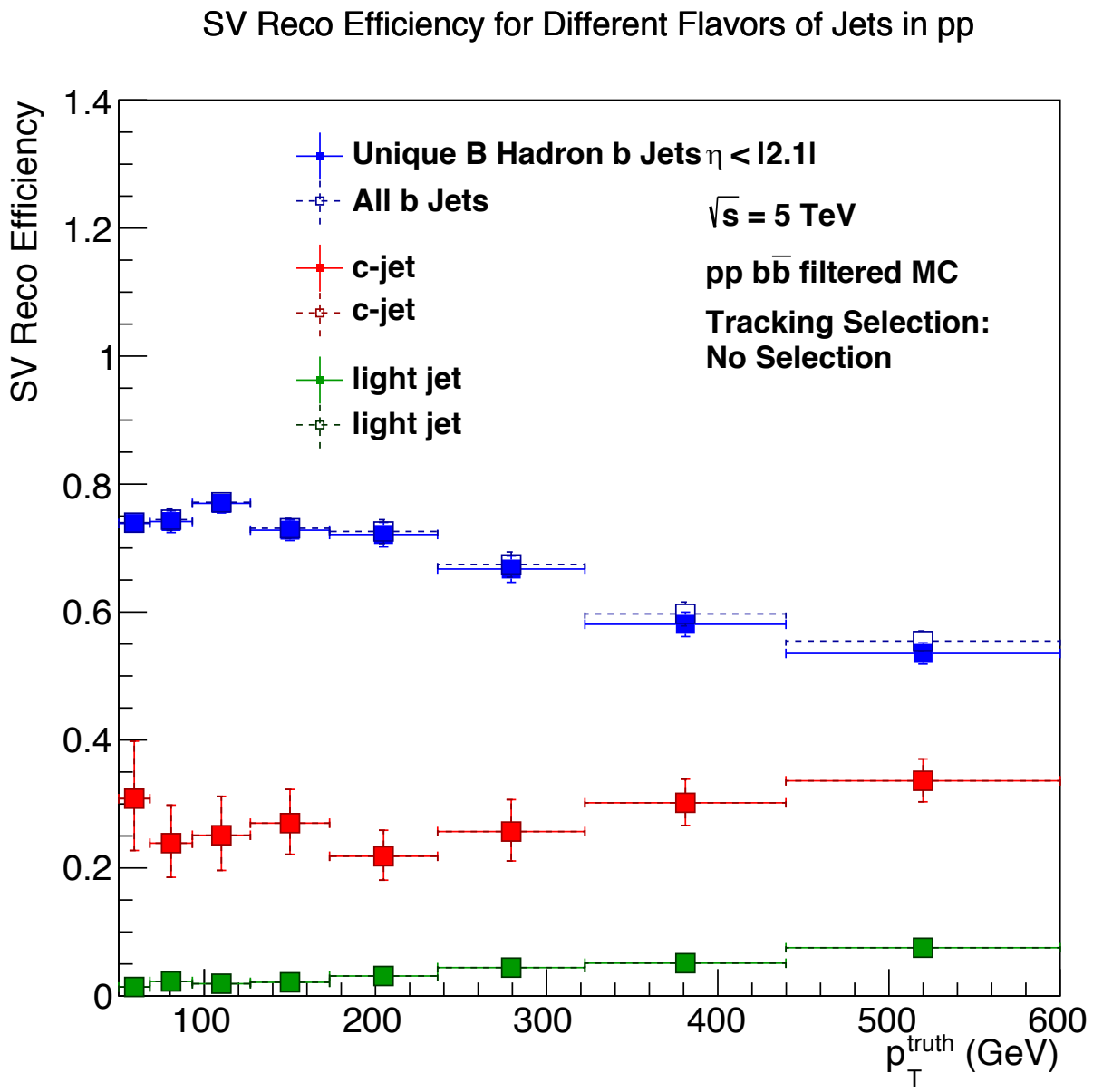
Are we looking at Same Physics Process?

- Not exactly.
  - Only ttbar events: performance paper
  - bbar 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 ttbar 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 pT in inclusive jet production, so I would say your plot makes a lot of sense!

  - There’re more multi-B hadron jets in higher pT 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

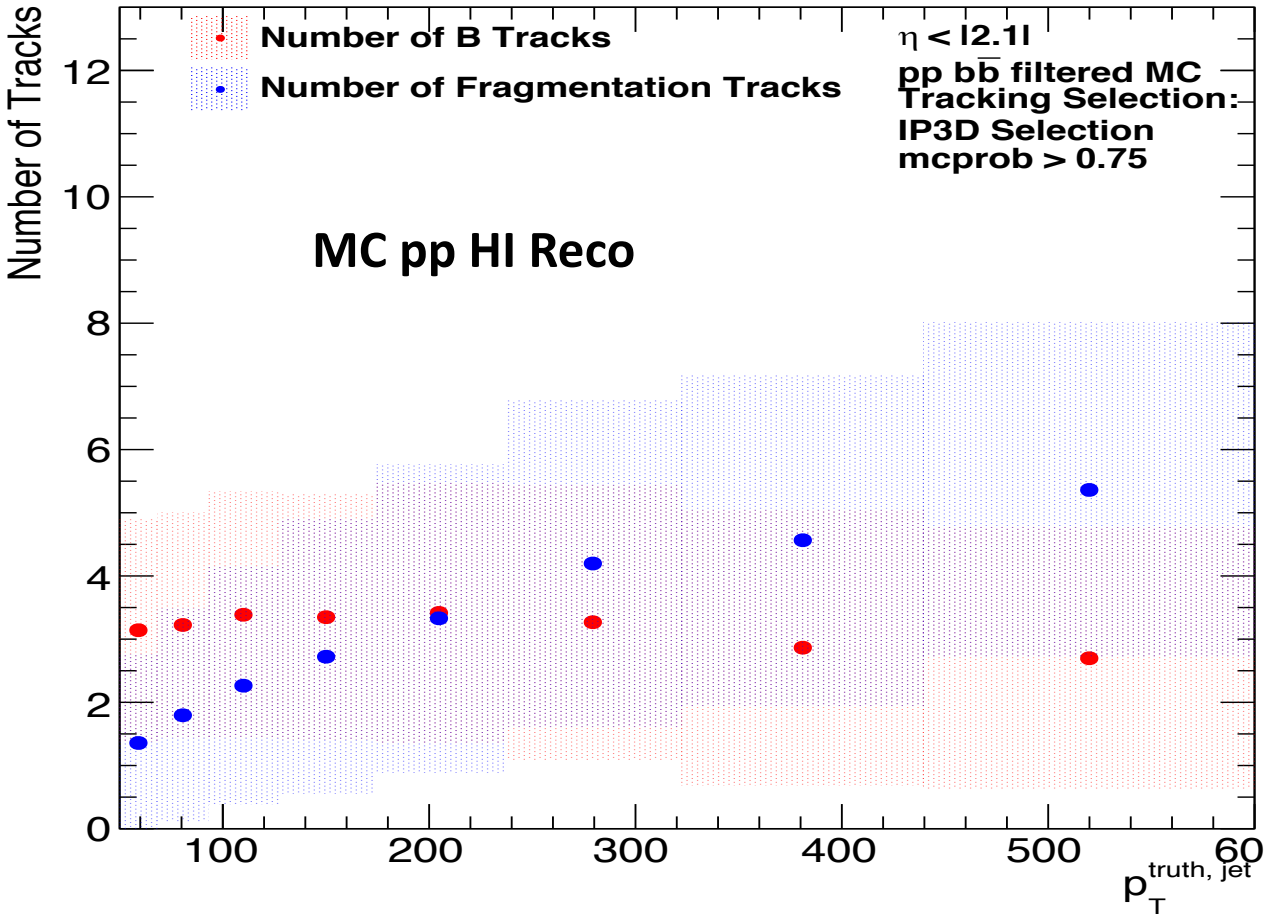


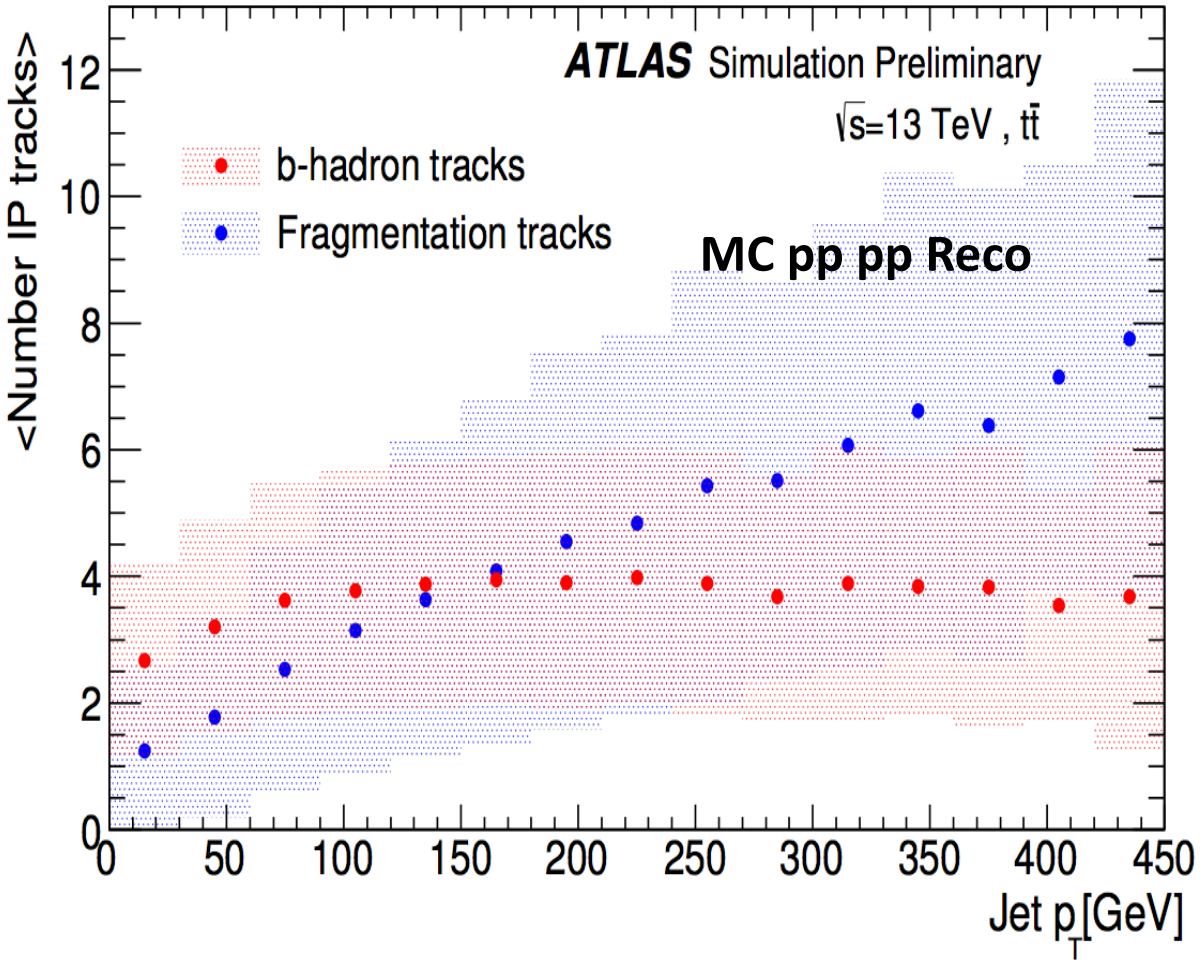
- Almost no difference in low pt region.
- Slight decrease of SV for unique b hadron jets in high pt.

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 GeV;
  - |d0| < 1 mm;
  - |z0*sin(θ)| < 1.5 mm;
  - Pixel Hits + SCT Hits >=7;
  - Pixel Holes <=1;
  - Pixel Holes + SCT Holes <=2;
- Select tracks with mcprob > 0.75.
- Look at matched truth track's production vertex (trk_orig)
- B tracks:
  - trk_orig == truth B decay vertex
  - or trk_orig == (truth C decay vertex) and (this C decays from B)
- Fragmentation tracks: other truth tracks in jet

Comparison of Tracks from B & from Fragmentation



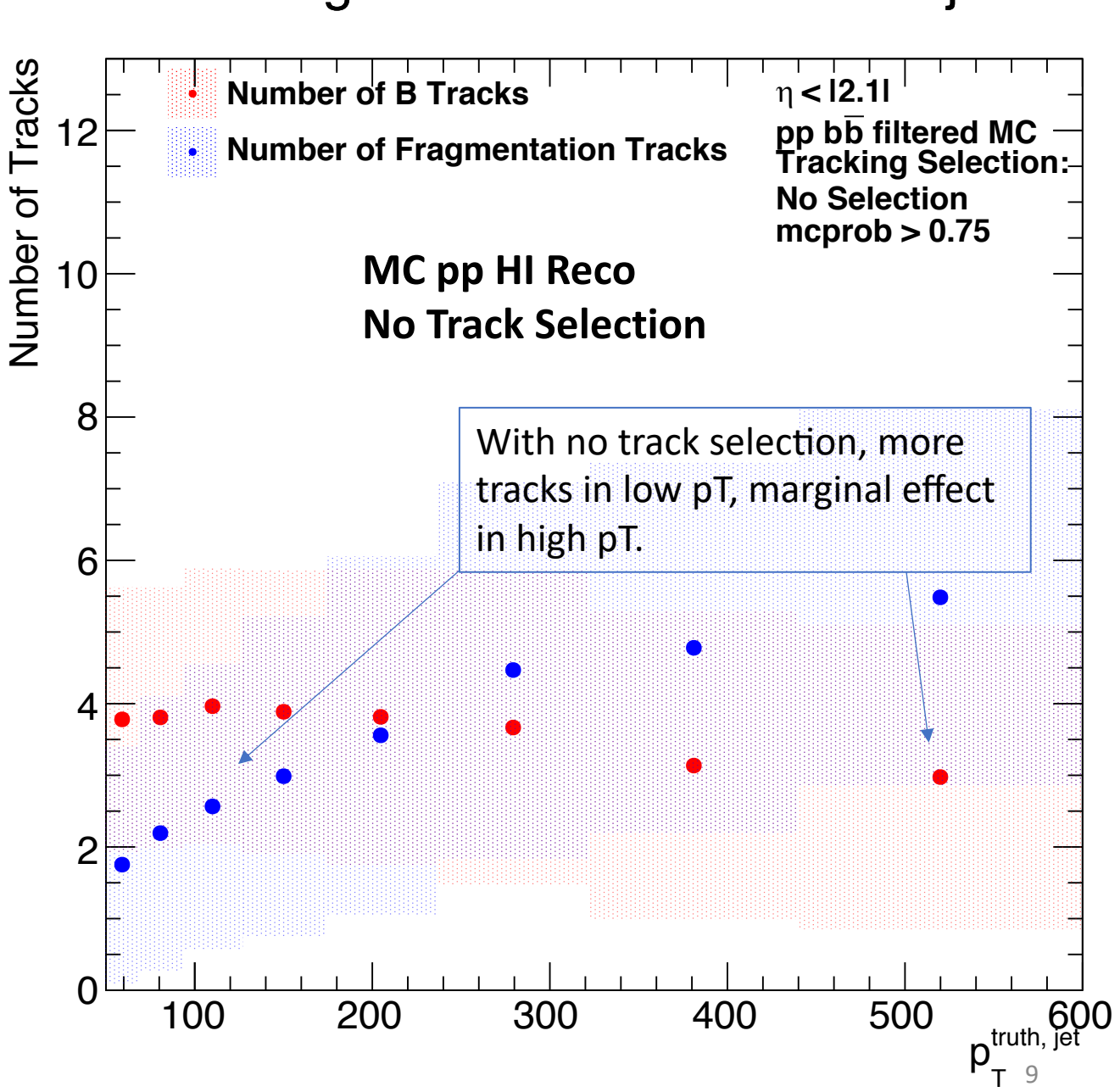


- Similar overall trend.
- Fewer tracks.
- More obvious in high pT (drop in SV efficiency)

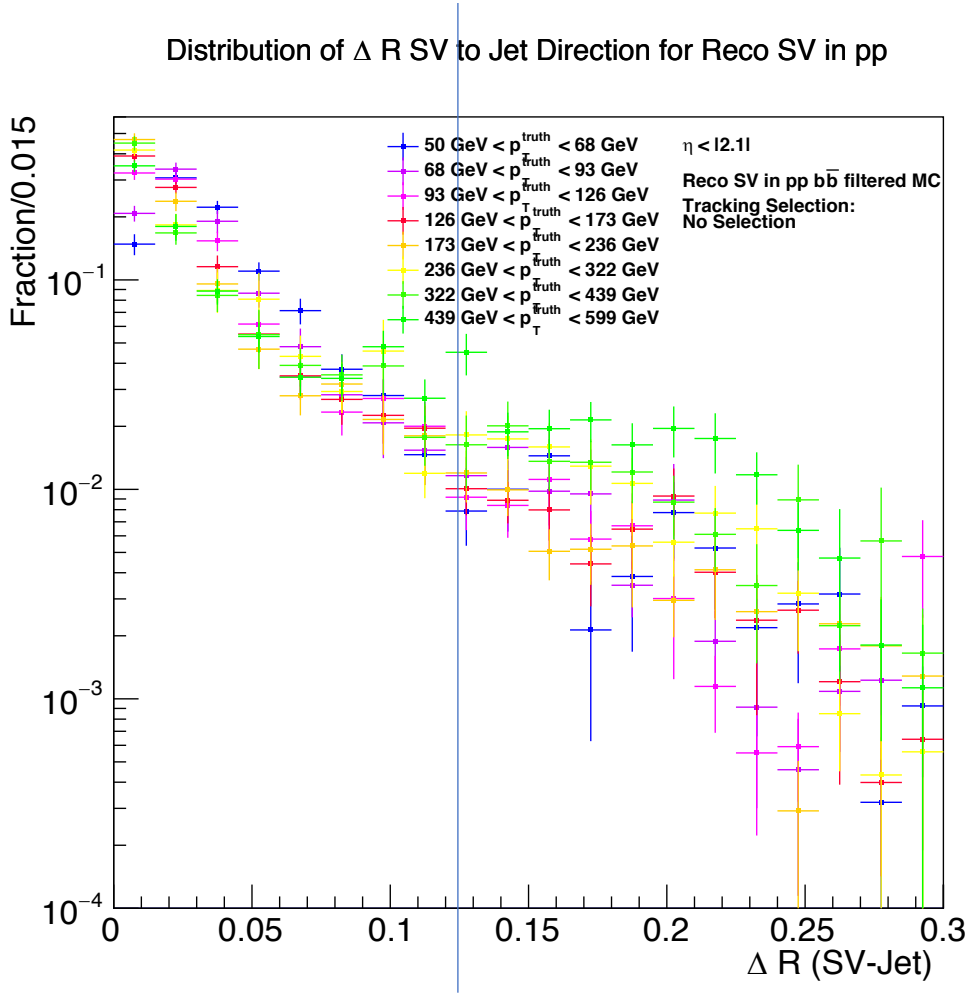
ATL-PHYS-PUB-2016-012

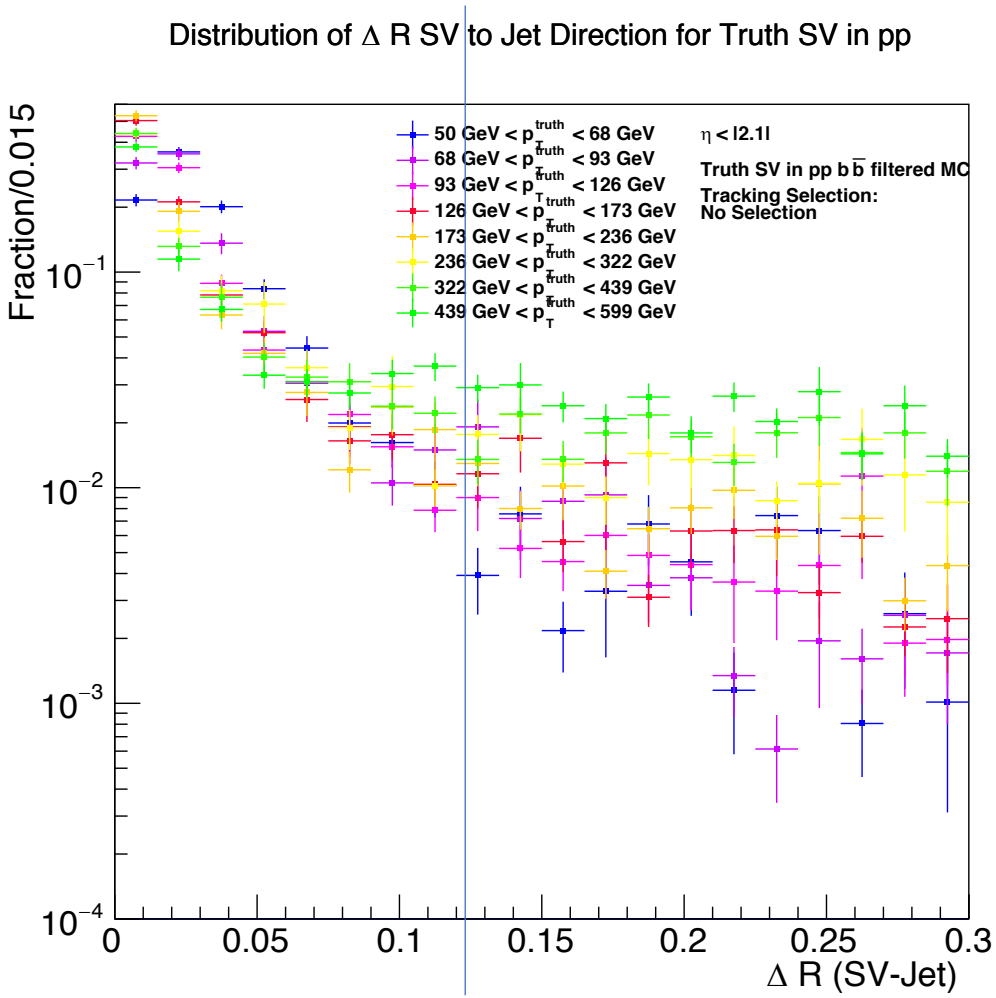
Ideas?

- 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?



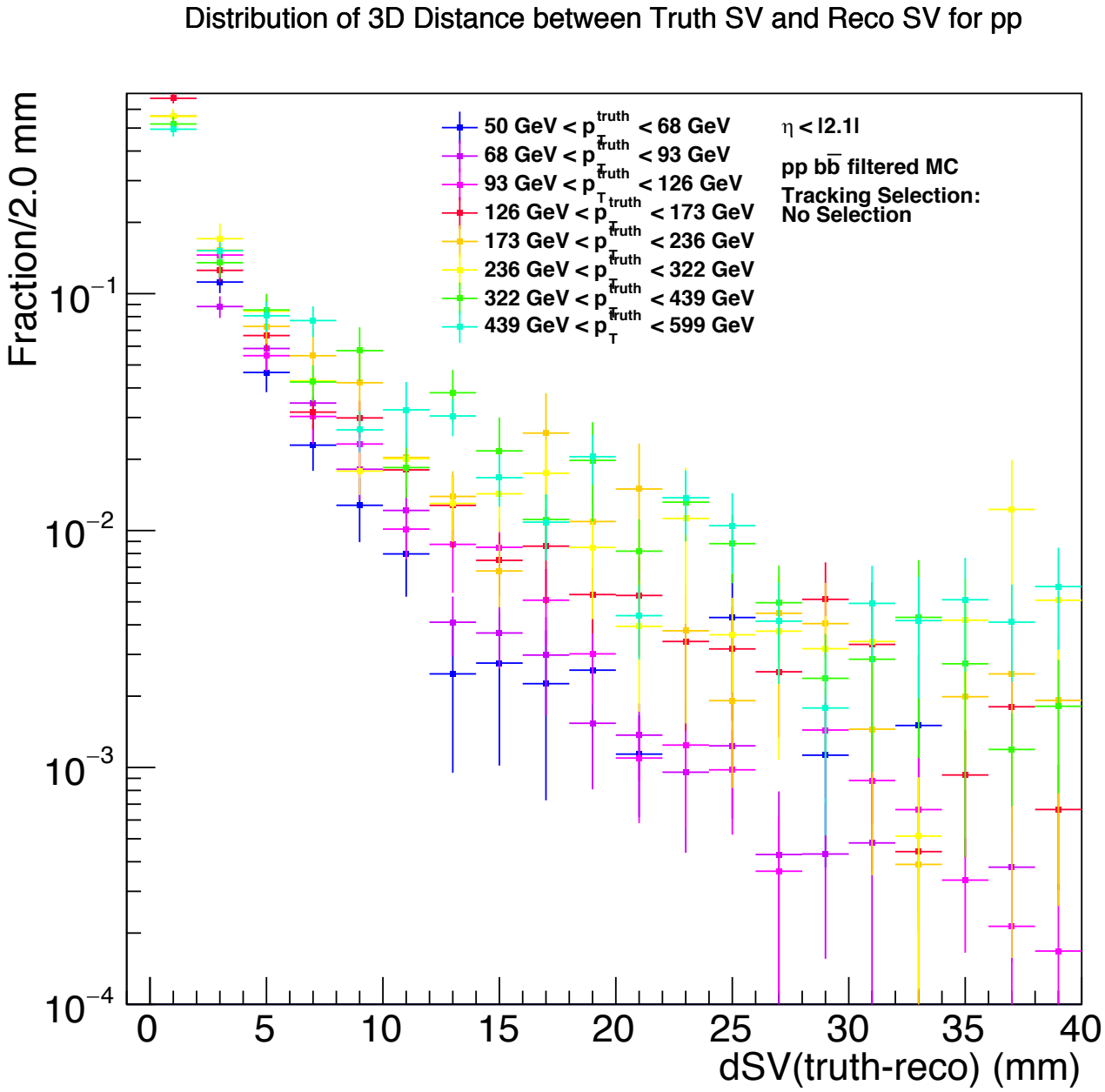
pT Dependence of SV-Jet Distance





- Narrower distribution at high pt.

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

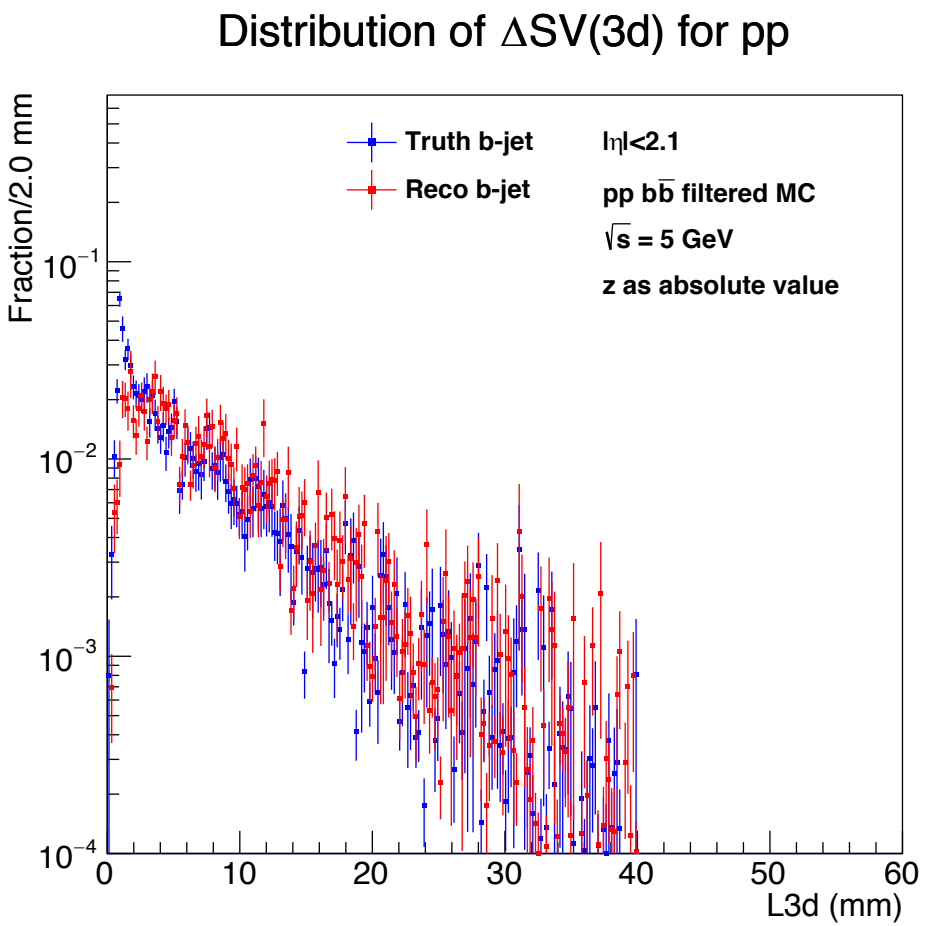


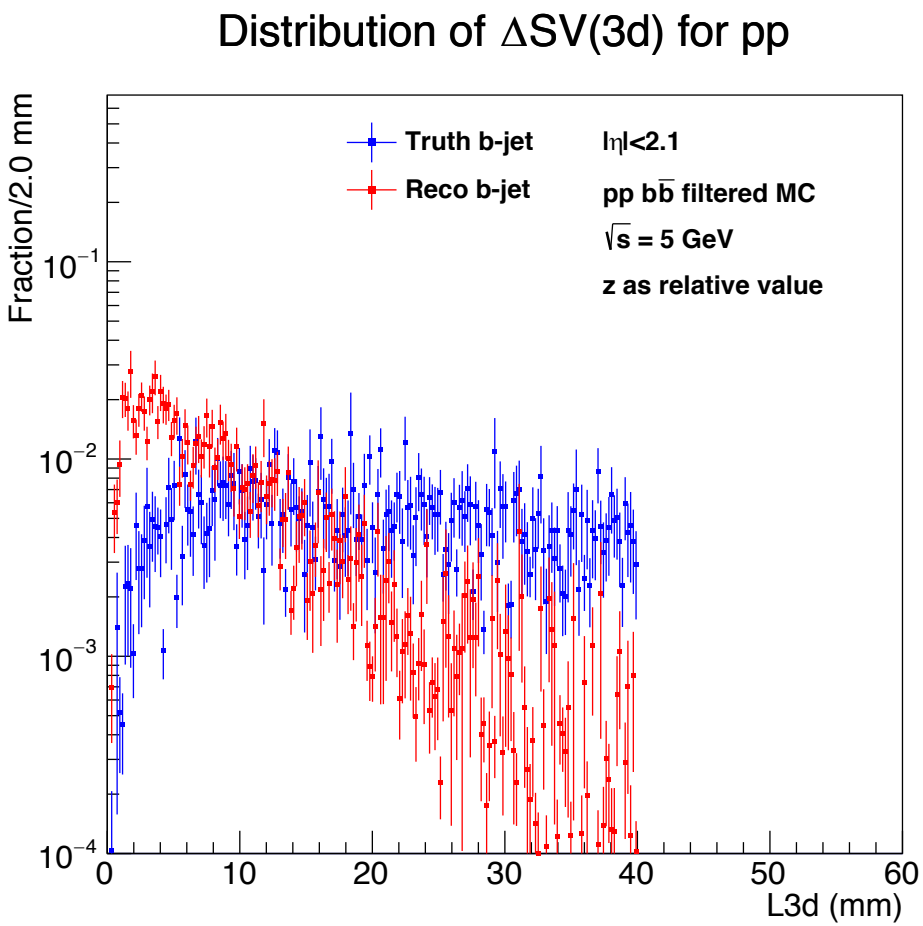
- Wider separation at higher pT.

Back-up

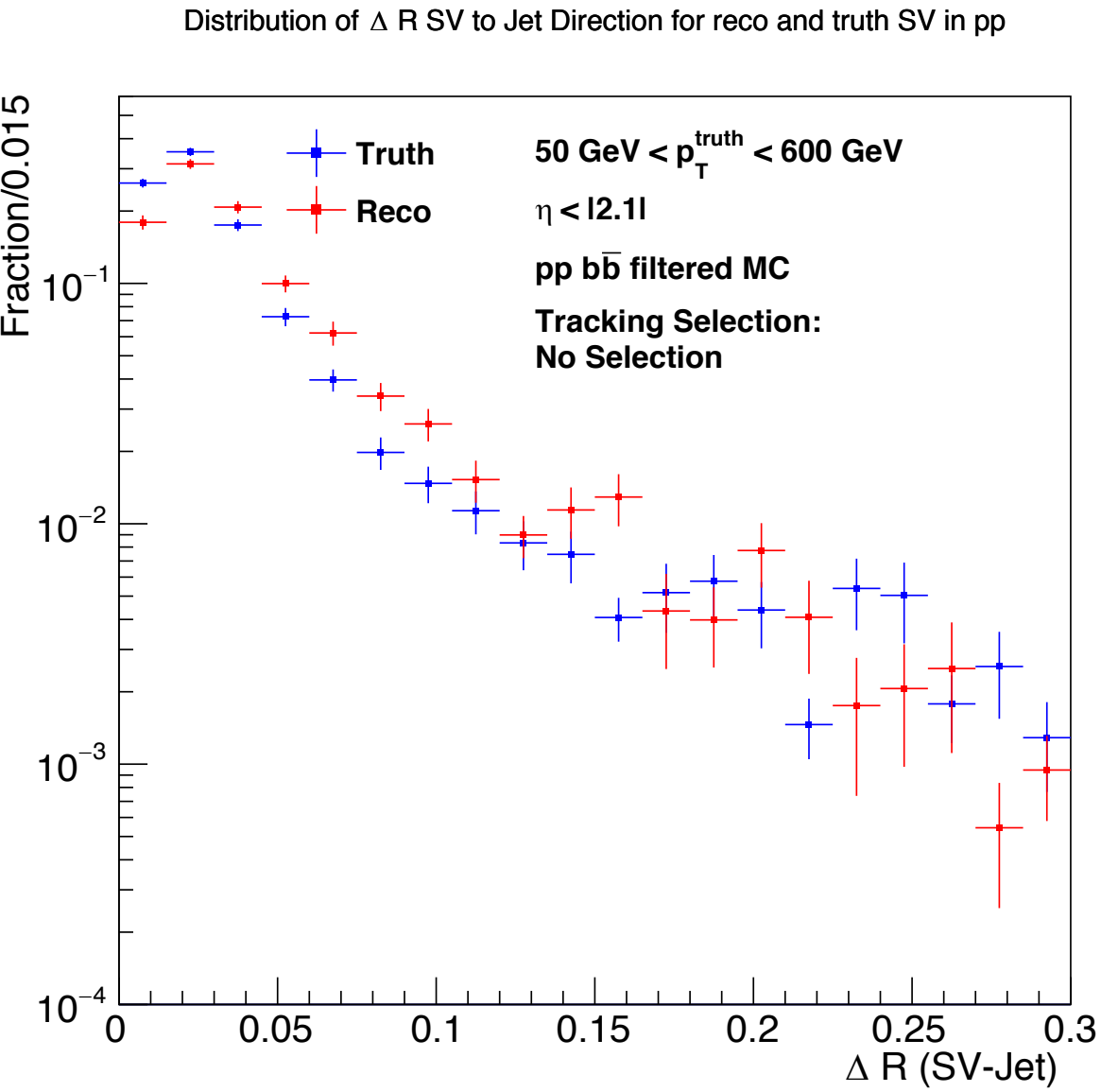
Plot dR of truth and reco SV?

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





From homework list: ΔR(SV-Jet) in Reco SV and Truth SV



- Question raised: is there a resolution issue with reco jet direction?
- Reco SV has a broader distribution.
- Peaks are both at ~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 bbar 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 pT)

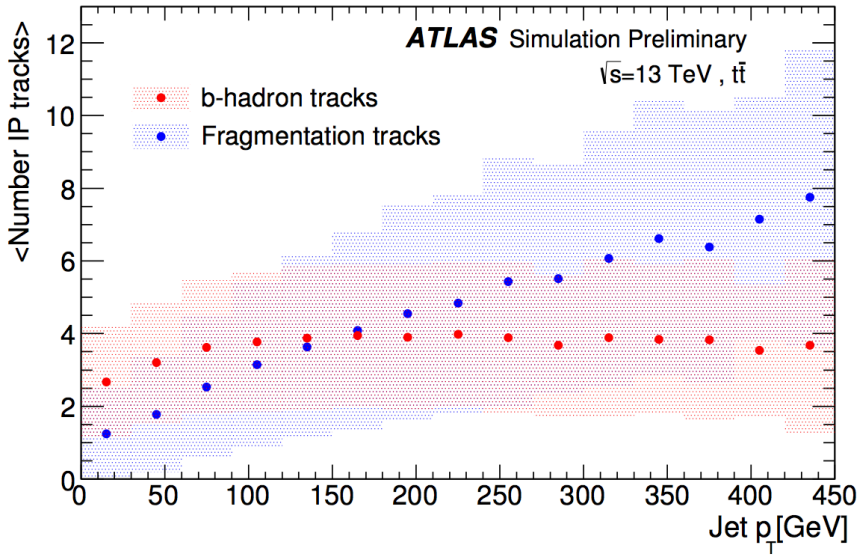
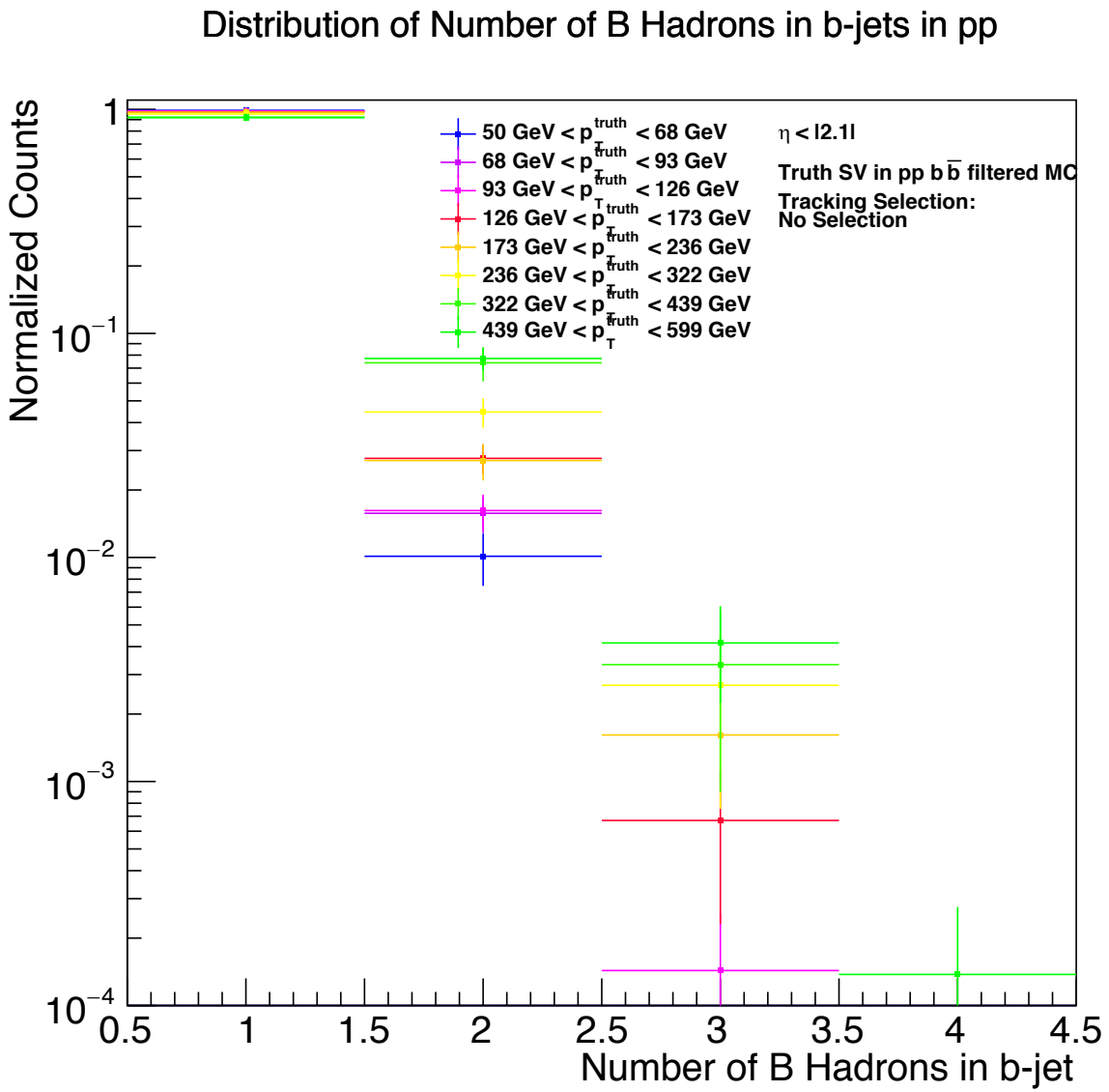


Figure 5: Average number of b-hadron and jet fragmentation tracks selected for the IP algorithm as a function of the jet p_T. The shaded band around the two contributions represents the RMS for each p_T bin.


Distribution of Number of B Hadrons in b-jets in pp
Normalized Counts
Number of B Hadrons in b-jet
50 GeV < p_T^truth < 68 GeV
68 GeV < p_T^truth < 93 GeV
93 GeV < p_T^truth < 126 GeV
126 GeV < p_T^truth < 173 GeV
173 GeV < p_T^truth < 236 GeV
236 GeV < p_T^truth < 322 GeV
322 GeV < p_T^truth < 439 GeV
439 GeV < p_T^truth < 599 GeV
η < |2.1|
Truth SV in pp b b̄ filtered MC
Tracking Selection:
No Selection