Study of the effect of the Double Layer filter on tracks coming from a B

Giacomo Da Molin, Donatella Lucchesi, Lorenzo Sestini, Laura Buonincontri, Luca Giambastiani, Alessio Gianelle

Motivation

I am doing my Master thesis on flavour (b and c) jet tagging with a DNN.

Unexpected results in vertexing drove us to look at the tracking and today I am presenting a study on the effects the Double Layer filter introduce on the displaced tracks, which form the SV used also for jet tagging.

This study has been performed using 1000 events of H->bb at 3 TeV without BIB, reconstructing them with the same tracking configuration except for the DL filter (DL).

Tracking configuration

The tracking configuration chosen to be as similar as possible (except for regional tracking) to the BIB one.

*3 steps (details in backup)

*no cut on track chi-square or number of hit requirements on tracks

Settings of the DL filter

Barrel		
Layer	dX max [mm]	dTheta max [mrad]
0-1	0.55	0.3
2-3	0.55	0.2
4-5	0.5	0.15
6-7	0.4	0.12

Endcap		
Layer	dX max [mm]	dTheta max [mrad]
0-1	0.7	0.11
2-3	0.7	0.09
4-5	0.4	0.06
6-7	0.3	0.042

Difference in track reconstruction

Only tracks **coming from B**, found by using LCRelations between recoparticles, MCparticles and tracks.

Results checked with a matching through an handmade"chi-square", which found analogous distributions with a little less statistics (less efficient).
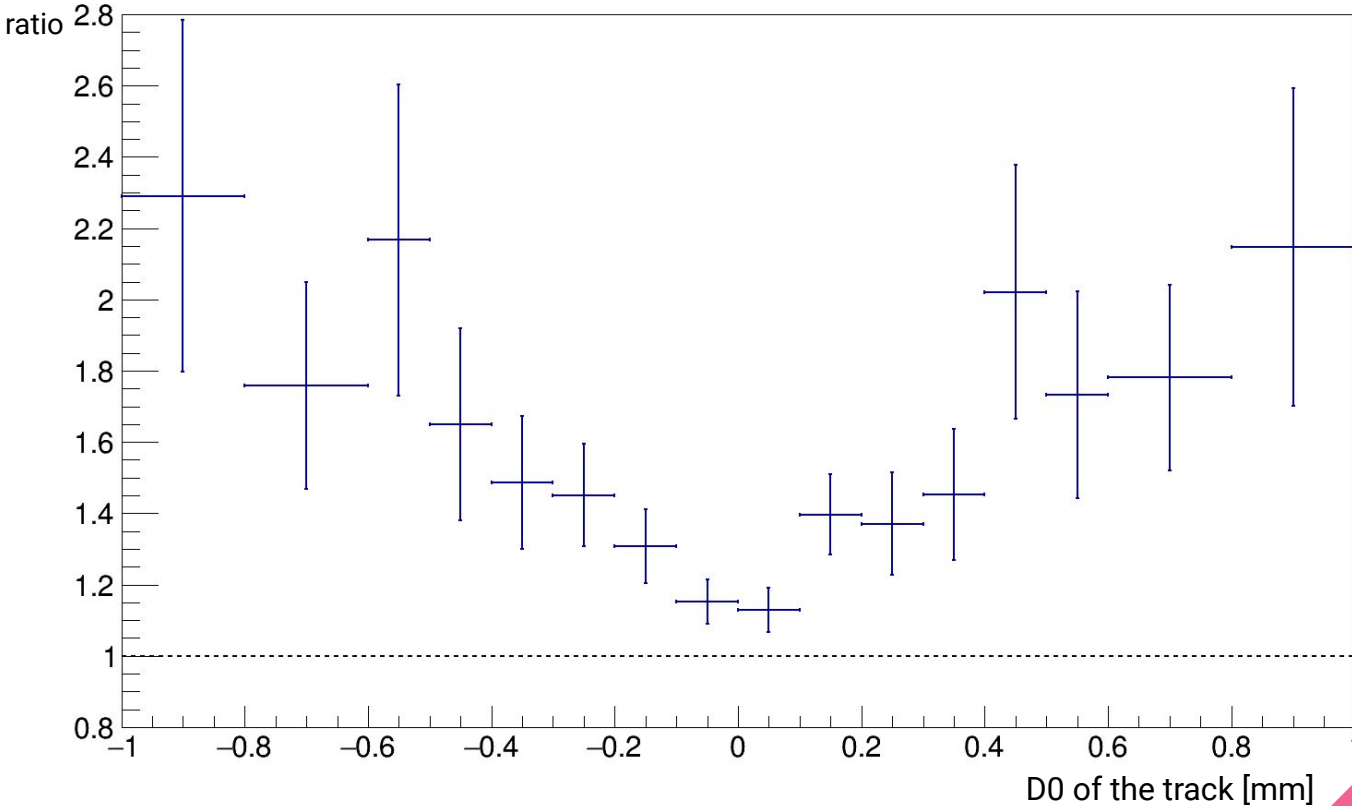
First inclusive result: 4042 tracks found without DL vs 2887 found with DL filter on.

In the following slides differential <u>ratios</u> of tracks found without DL over tracks found with DL in function of some kinematic variables.
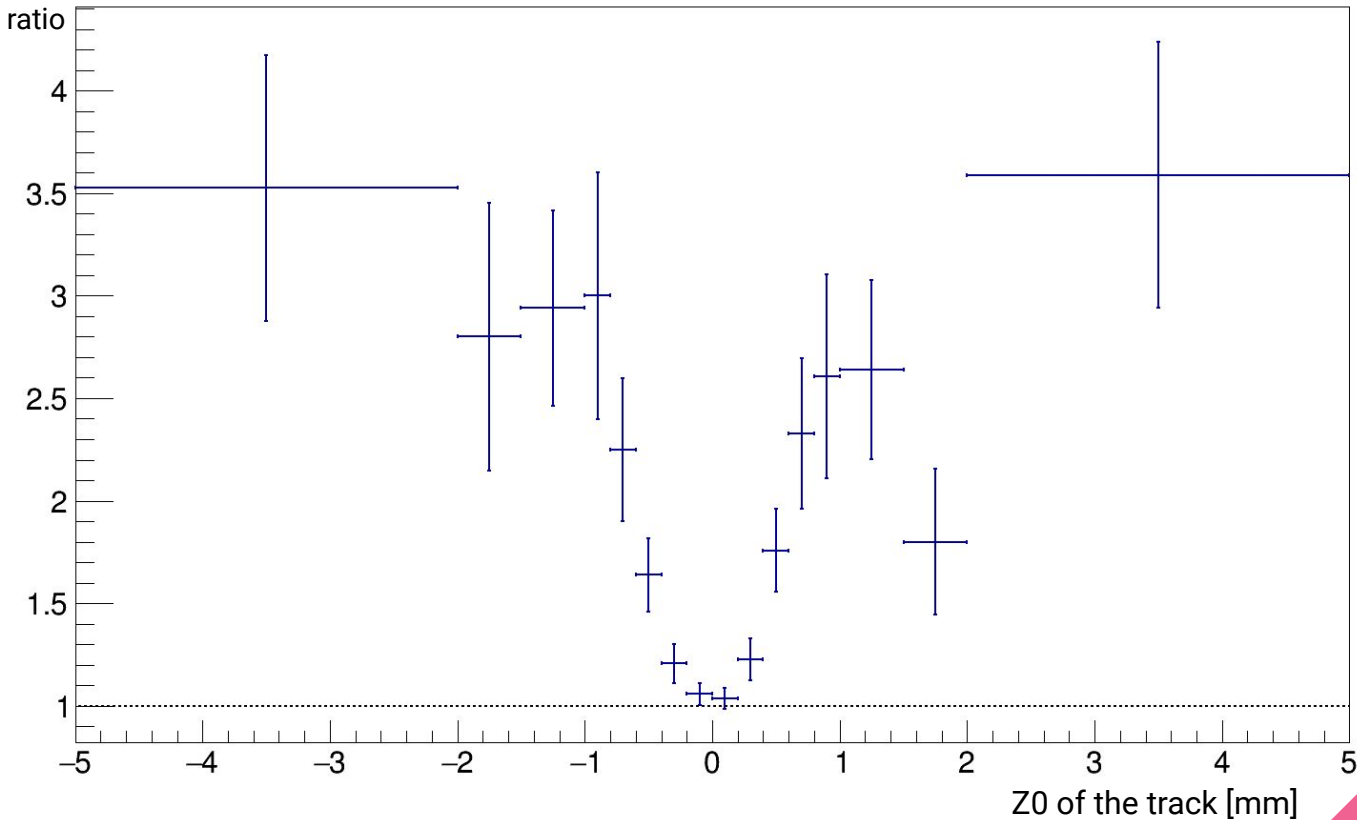
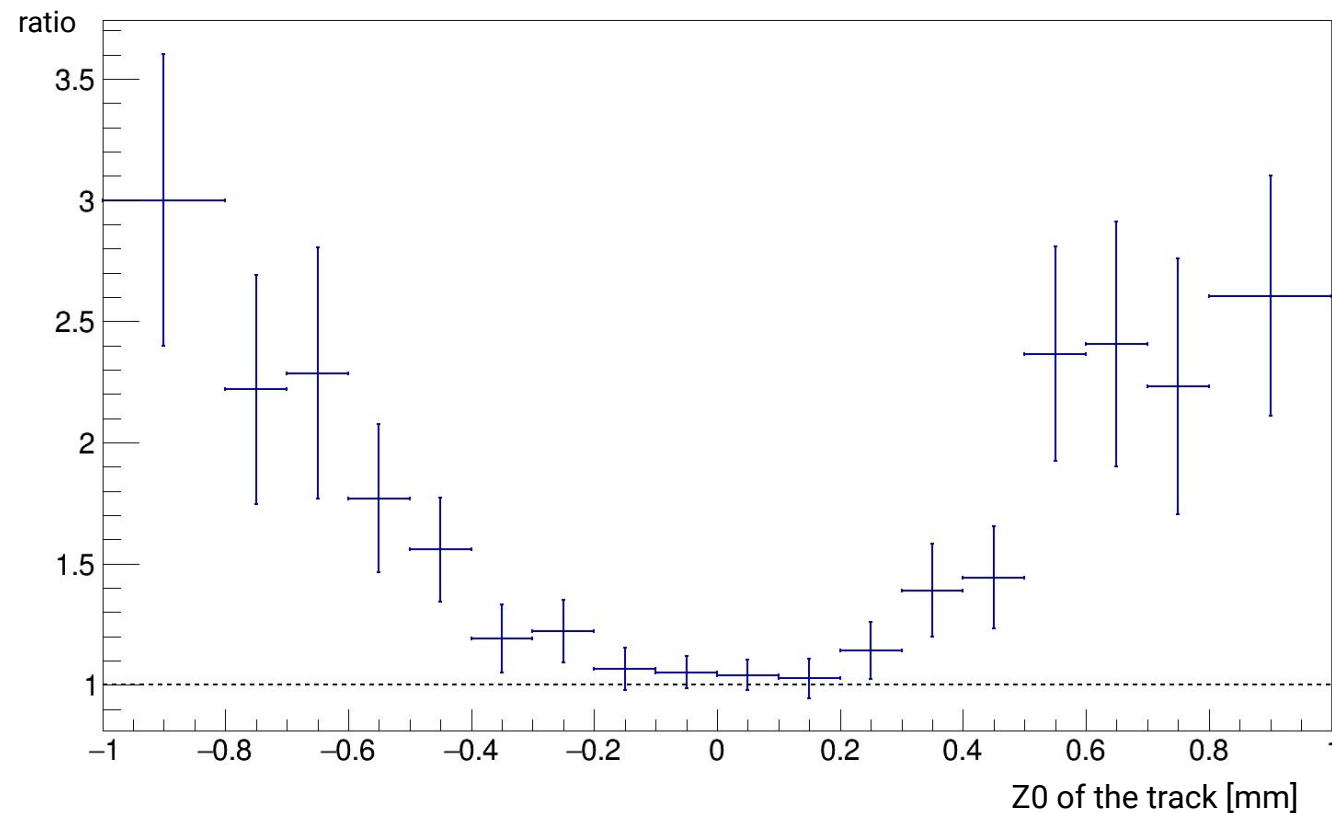# Ratio of number of tracks NoDL/DL vs **D0 of tracks**
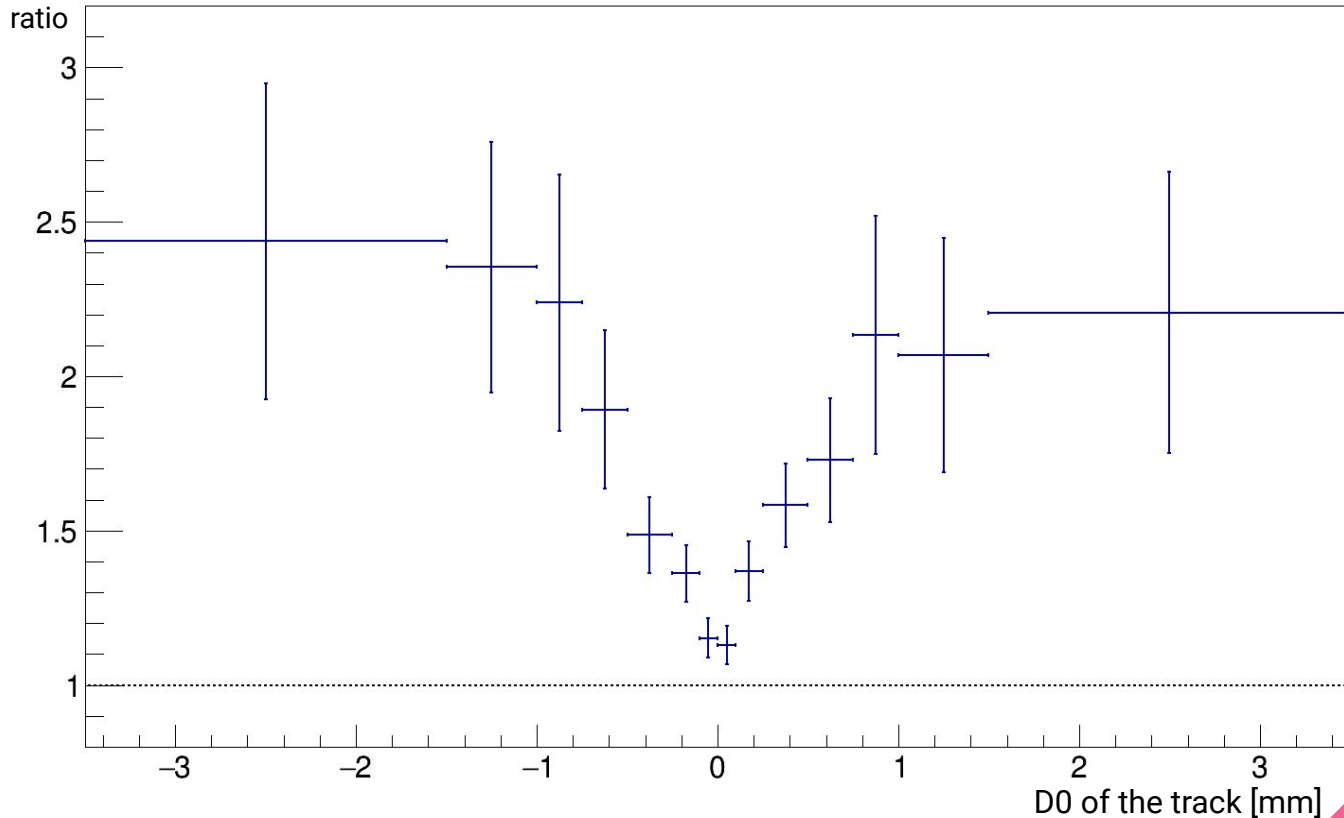
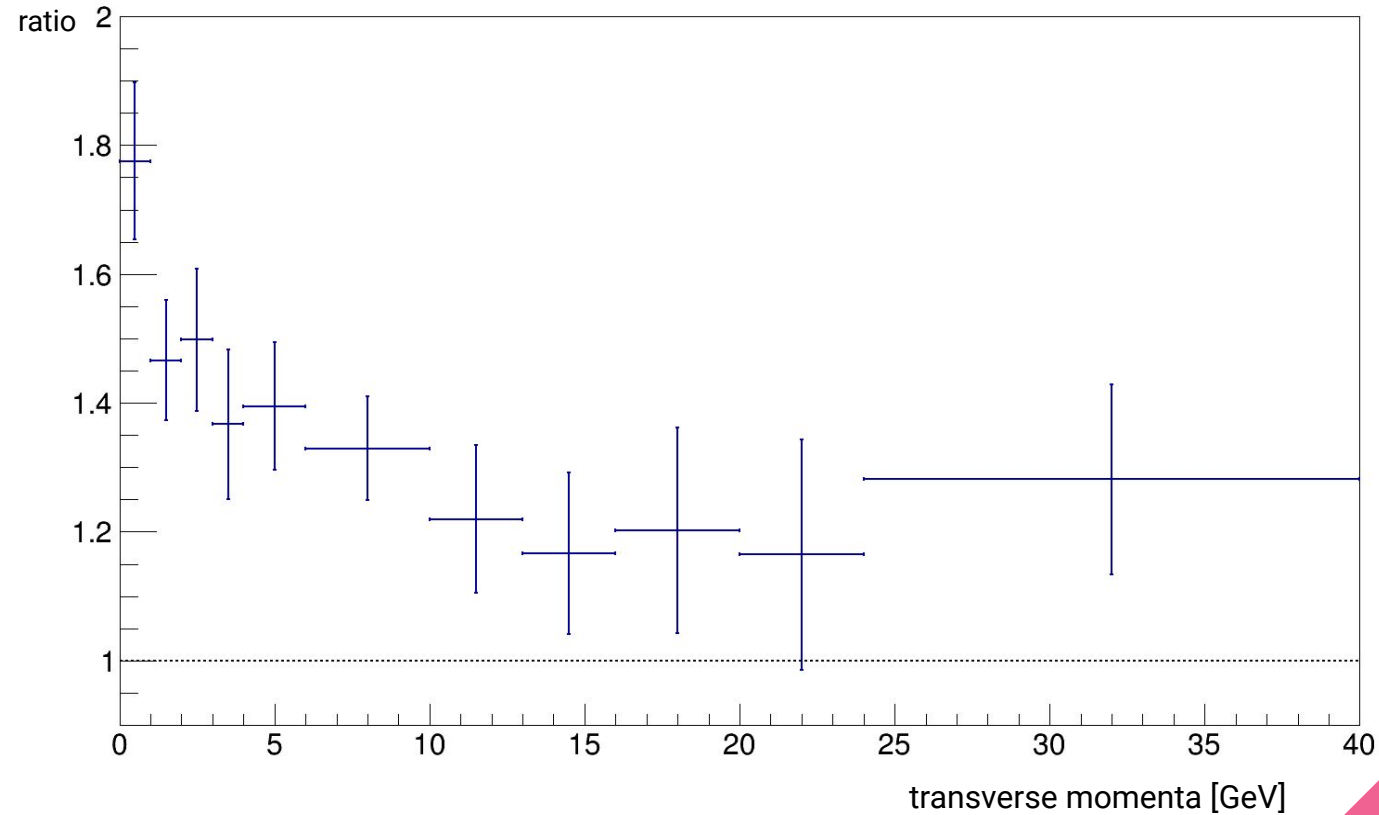# Ratio of number of tracks NoDL/DL vs **D0 of tracks**; **zoomed**
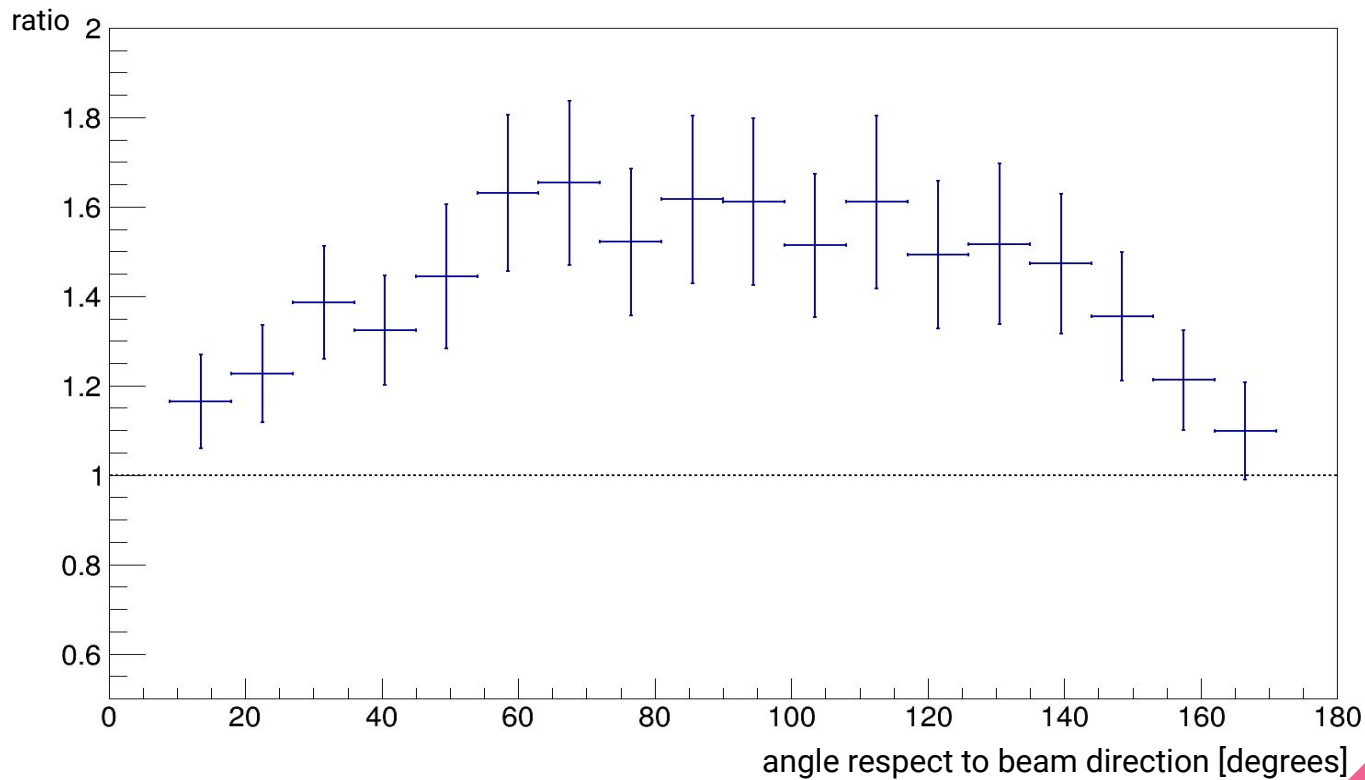
Ratio of number of tracks NoDL/DL vs **Z0 of tracks**

Ratio of number of tracks NoDL/DL vs **Z0 of tracks**; **zoomed**

Ratio of number of tracks NoDL/DL vs **p_T of tracks**

Ratio of number of tracks NoDL/DL vs **theta of tracks**

Difference in SV tagging efficiency

$$Efficiency = \frac{truth - and - tagged}{truth}$$

Vertex and Jets with same default configurations (Backup).

Different SV-tagging efficiencies with and without DL:

DL: total efficiency: 0.58±0.01, efficiency for jets tagged by NSV>1: 0.12±0.01

NoDL: total efficiency: 0.69±0.01, efficiency for jets tagged by NSV>1: 0.21±0.01
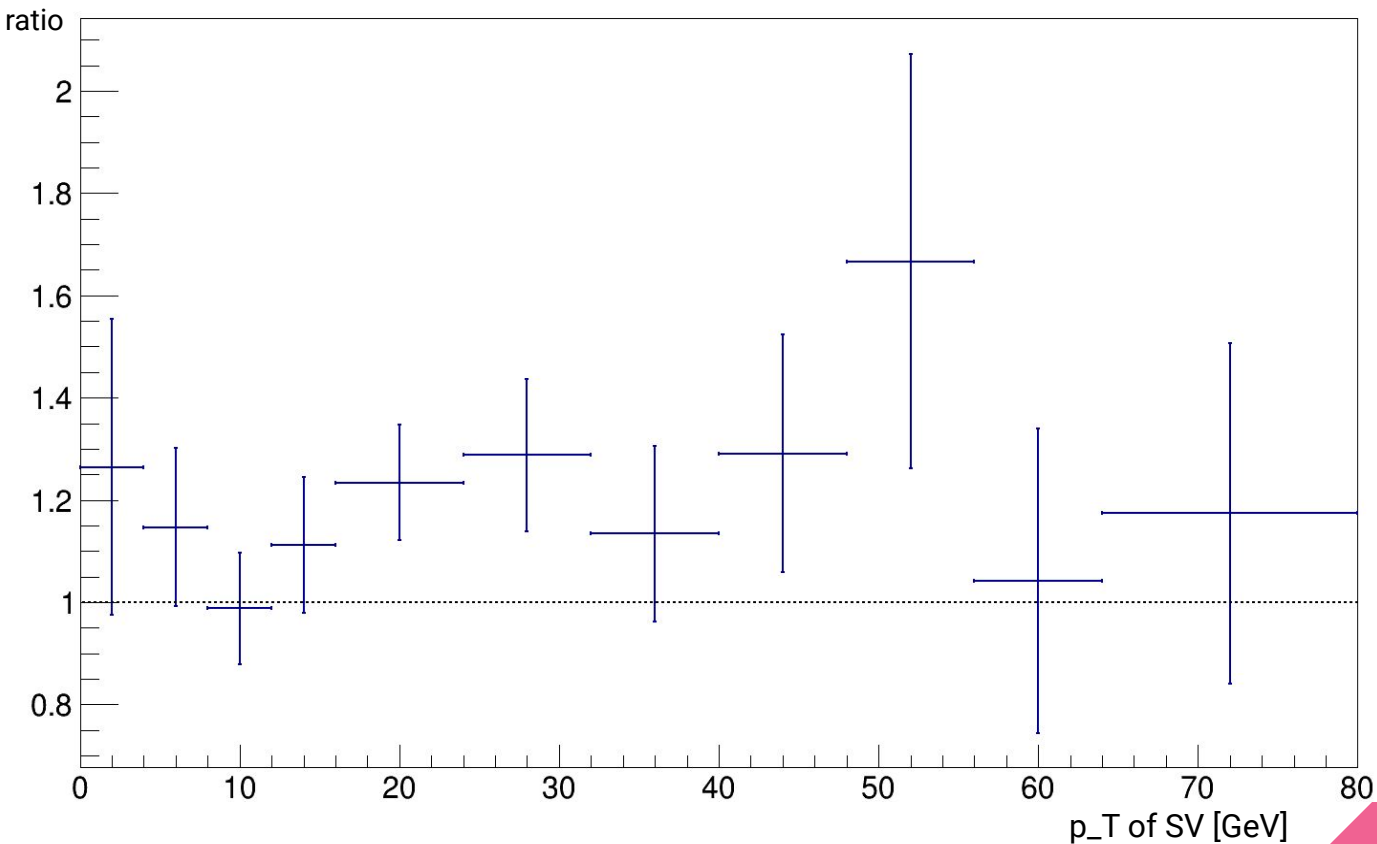
Also very different number of SVs:

DL: 1603 SVs (~18% out of any jet cone)
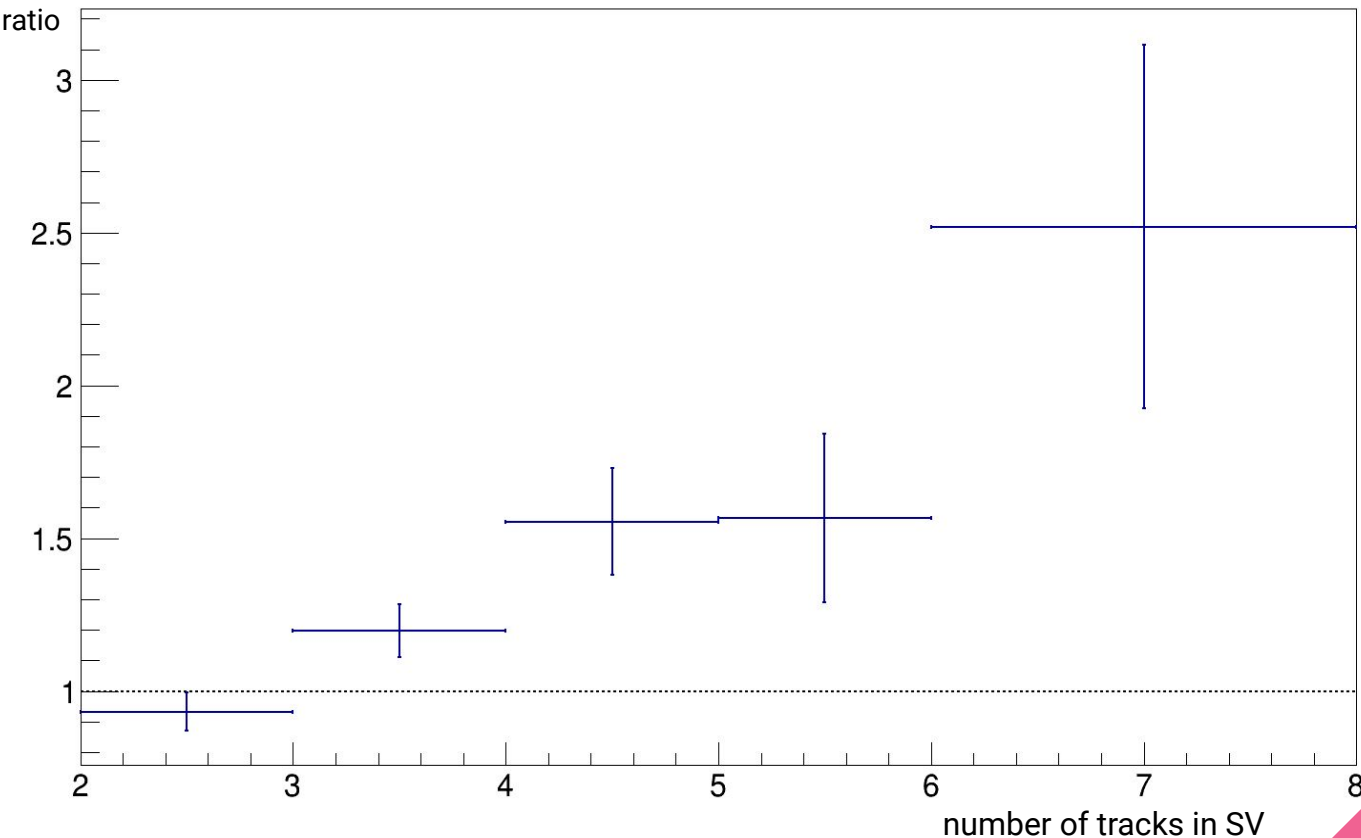
NoDL: 2030 SVs (~15% out of any jet cone)

In the following slides, <u>ratio</u> (NoDL over DL) between number of tagged jets in function of some SV variables. If more SVs are present in the same jet, the with highest pT is used.

Ratio of tagged jets NoDL/DL vs **p_T of SV**

Ratio of tagged jets NoDL/DL vs **number of tracks in SV**

Future strategy

DL requirement cuts some displaced B-track. To take into account the bias introduced we plan to:

*Estimate efficiency loss (as a function of pT and other kinematics variables) due to Double Layer filter in signal without BIB

*Reconstruct the Signal+BIB samples with DL on and then correct for efficiency loss found in Signal only

*Since we expect that the DL filter will remove even more displaced track when the BIB is added, our method should lead to a conservative estimation.
(i.e. if without BIB DL cuts 10% of efficiency, we expect with BIB will cut 15 % and so by correcting with 10 % we are doing a conservative estimation.)

This study will be repeated on b- and c-dijets to increase statistics.
Also a study on light jets with and without DLfilter will be performed to gain intel on fakes.

Thank you!

[VXD]

@Collections : VXDTrackerHits_DLFiltered

@Parameters : MaxCellAngle : 0.025; MaxCellAngleRZ : 0.025; Chi2Cut : 100; MinClustersOnTrack : 4; MaxDistance : 0.015; SlopeZRange: 5.0; HighPTCut: 0.5;

@Flags : HighPTFit

@Functions : CombineCollections, BuildNewTracks

[VXDALL]

@Collections : VXDTrackerHits_DLFiltered, VXDEndcapTrackerHits_DLFiltered

@Parameters : MaxCellAngle : 0.025; MaxCellAngleRZ : 0.025; Chi2Cut : 100; MinClustersOnTrack : 4; MaxDistance : 0.015; SlopeZRange: 10.0; HighPTCut: 0.5;

@Flags : HighPTFit

@Functions : CombineCollections, BuildNewTracks

[Tracker]

@Collections : ITrackerHits, OTrackerHits, ITrackerEndcapHits, OTrackerEndcapHits

@Parameters : MaxCellAngle : 0.05; MaxCellAngleRZ : 0.05; Chi2Cut : 2000; MinClustersOnTrack : 4; MaxDistance : 0.02; SlopeZRange: 10.0; HighPTCut: 0.5;

@Flags : HighPTFit, RadialSearch, VertexToTracker

@Functions : CombineCollections, ExtendTracks

Tracking steps

The hit collections are not DLFiltered for the sample without DL, but the rest of parameter are the same

DLfilter parameters

Track origin:

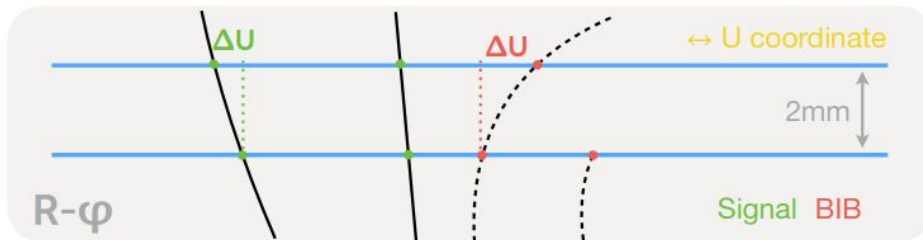BIB hits are not aligned in Θ coordinate
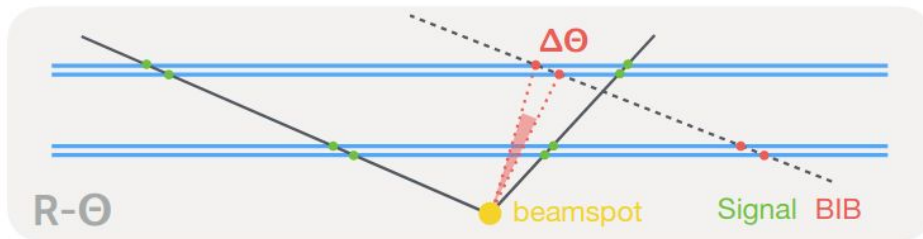
R-Θ   beamspot   Signal   BIB

selection:

pairs of hits in two layers with ΔΘ < threshold

Track momenta:

soft BIB tracks can stop in the first sublayer

soft BIB tracks are bent more by the B field

ΔU   ΔU   ↔ U coordinate

2mm

R-φ   Signal   BIB

selection:

pairs of hits in two layers with ΔU < threshold