The effect of doubling the length of the vertex barrel on SiD

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All our plots were made using the same 30000 ZPole events with:

- 10000 $Z \to b\bar{b}$
- 10000 $Z \to c\bar{c}$
- 10000 $Z \to q\bar{q}$ $(q \in \{u, d, s\})$

Taken from the Stanford FTP server here:
`ftp://ftp-lcd.slac.stanford.edu/lcd/ILC/ZPole/stdhep/pythia/`

Note that NO flavour tagging or tracking training was done on the modified detector so things can only get better!

Section 1

Tracking studies

Included as track efficiency and purity are a decent proxy for flavour tag efficiency and purity (and as we have many tracks per jet the same graphs can be plotted having simulated far fewer events).

Needed to be fairly careful about the definition of a findable particle and the difference between a good and fake track (an example of a possible problem is on the next few slides).

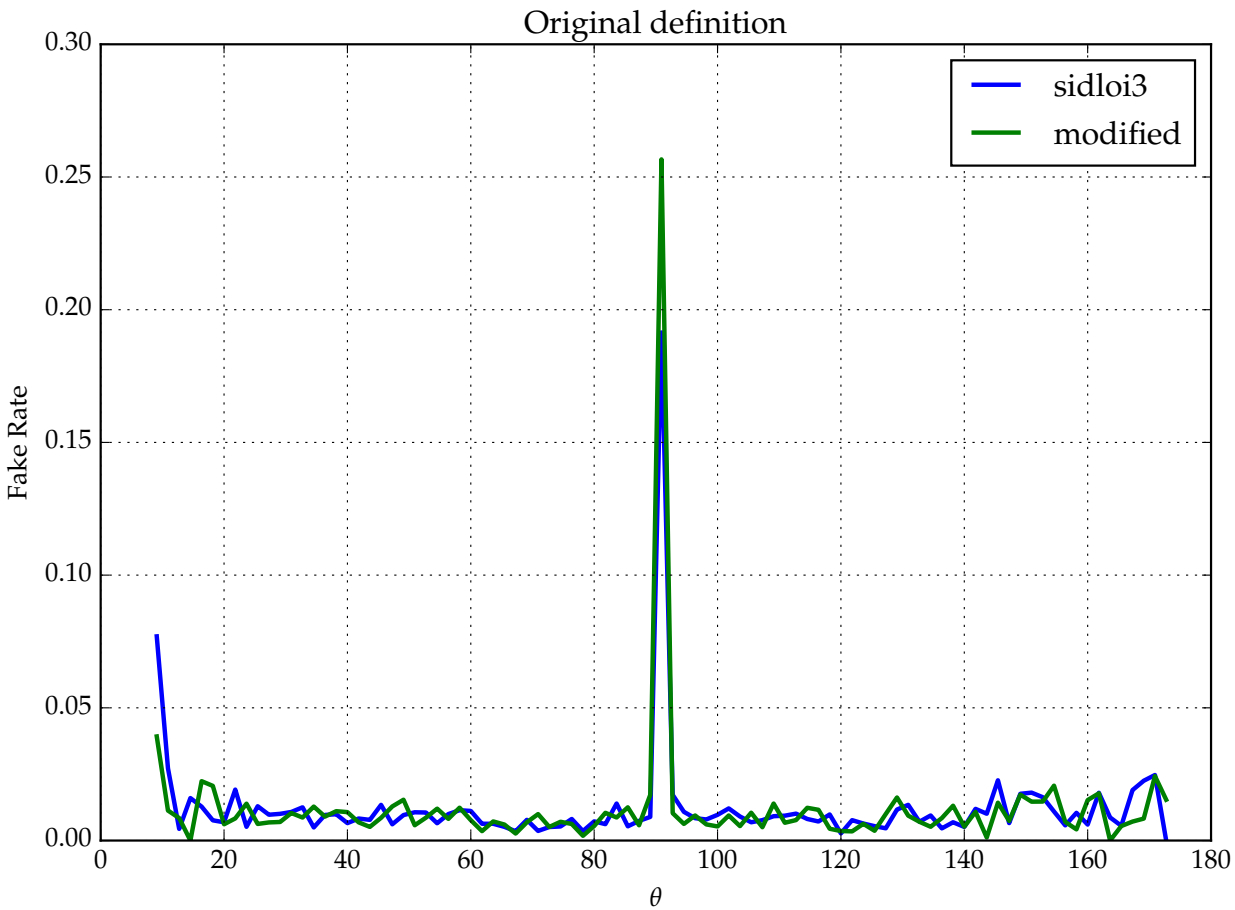
There isn't a correct definition here so you just have to pick one (and be consistent).

Fake rate with a naive definition of a fake track

Here a track is considered good if it is the best track for it's mc particle (has the most good hits) and fake otherwise.

This leads to a spike in the fake rate where we have particles causing very many tracks.

The efficiency is identical to that for the improved defintion so is included in the backup slides below.



Particles at $\theta = \frac{\pi}{2}$ can go round in circles

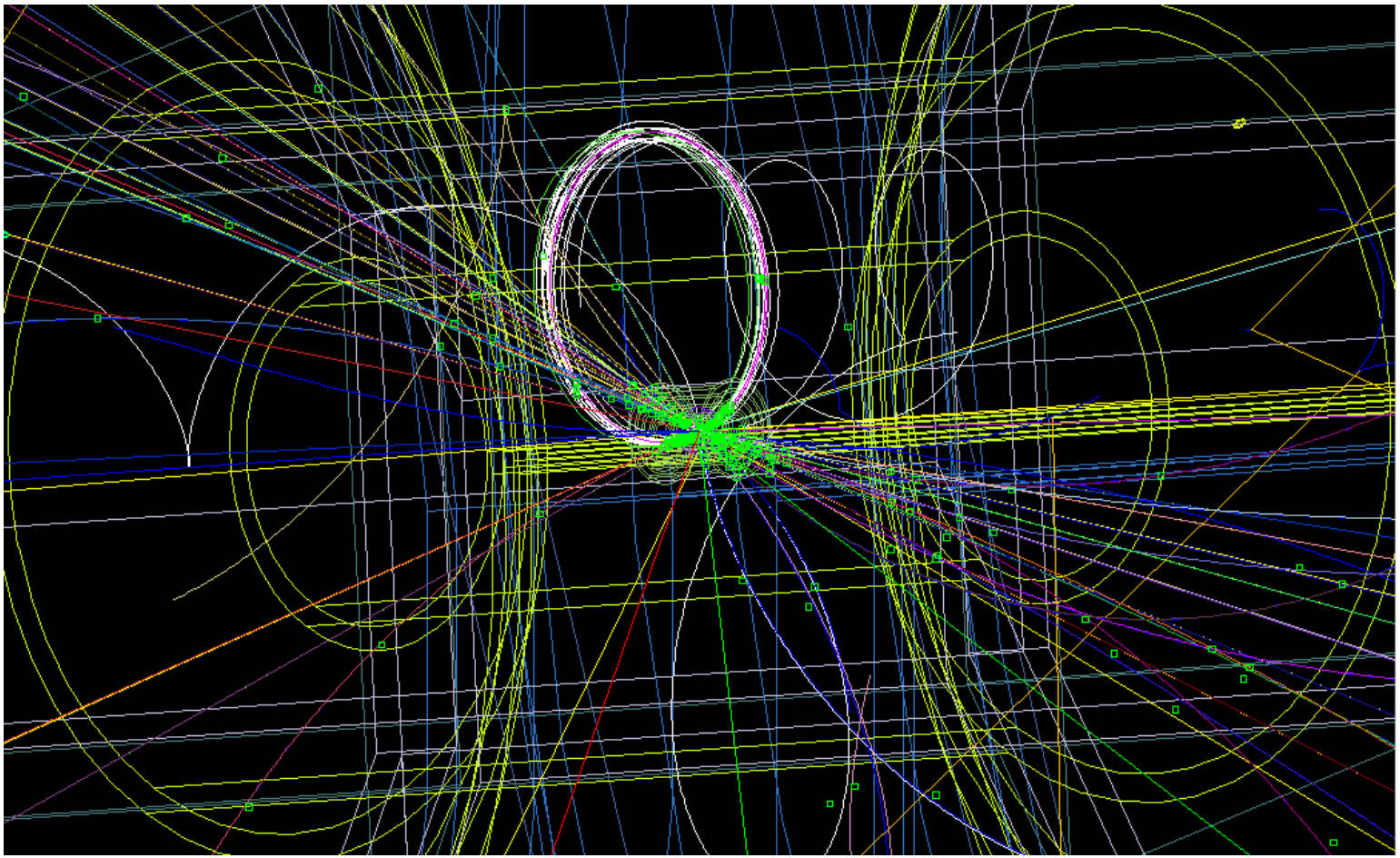


Figure: A sidloi3 $z \to b\bar{b}$ event. The orbiting particle was reconstructed into 12 tracks.

Fake rate with a different definition of fake track

A track is good if it is the best track for its MCParticle (has the most good hits).

A track is fake if it has more than 1 hit from a different MCParticle.

Because we have so few fake tracks noise is a problem so the efficiency plot is more interesting.

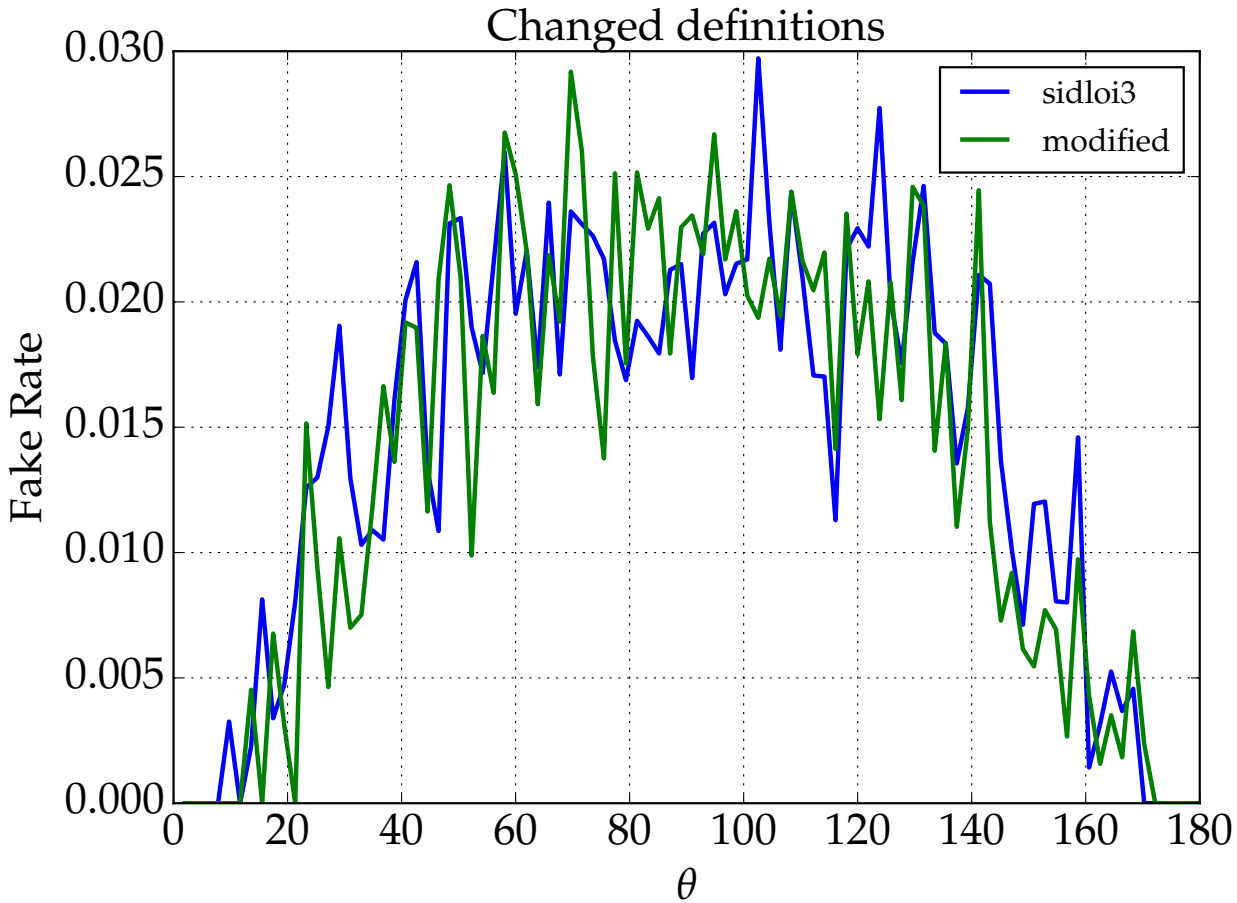


Figure: Comparison of the tracking fake rate as a function of θ

Efficiency with the different definition of a fake track

The sudden drops in efficiency at the intersection ofthe barrel and endcap can be easily seen in both cases

Possibly this could be improved with changes to the tracking algorithm

It may be an unavoidable consequence of having that much material at the intersection

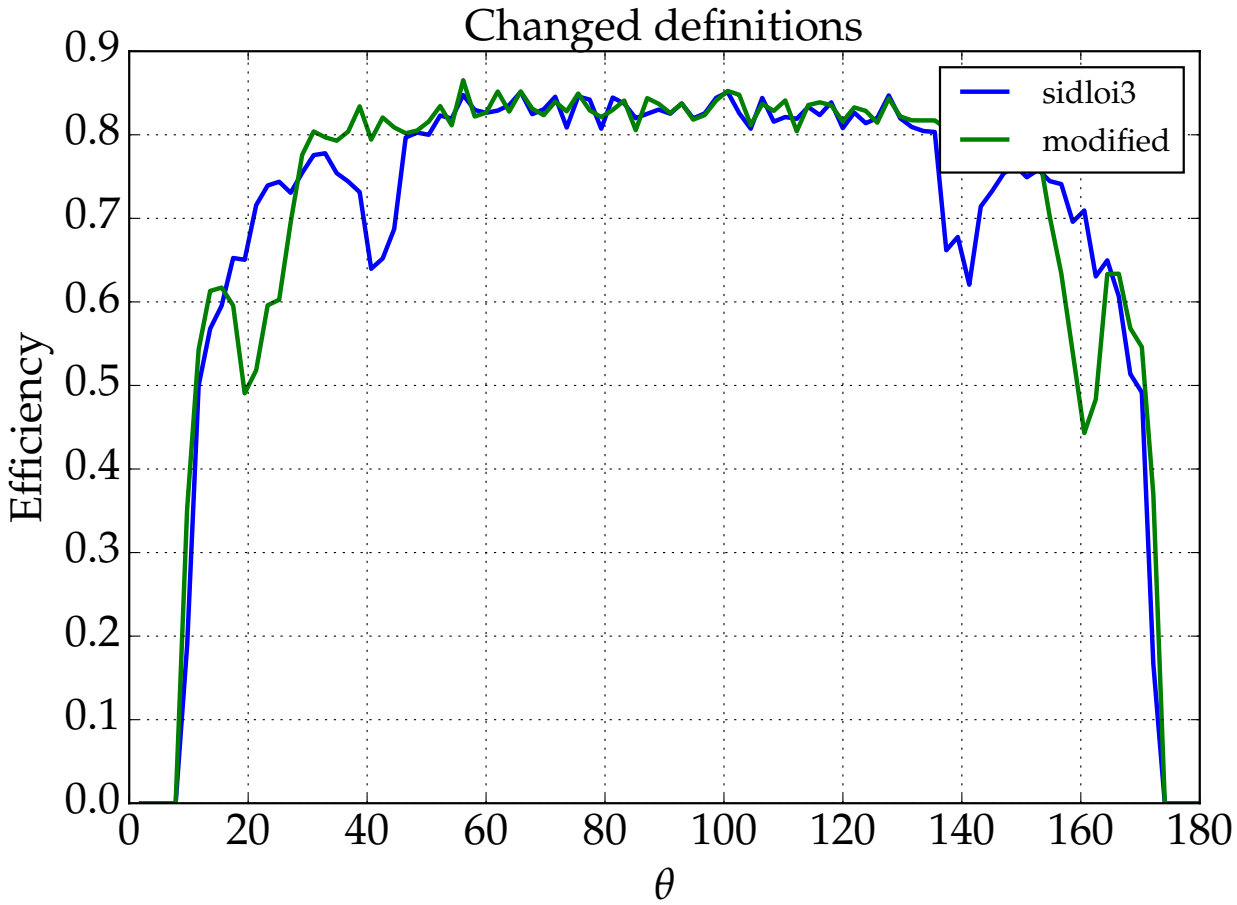


Figure: Comparison of the tracking efficiencies as a function of θ

Integrated efficiency with the different definition of a fake track

The sudden drops in efficiency at the intersection of the barrel and endcap can be easily seen in both cases

Possibly this could be improved with changes to the tracking algorithm

It may be an unavoidable consequence of having that much material at the intersection

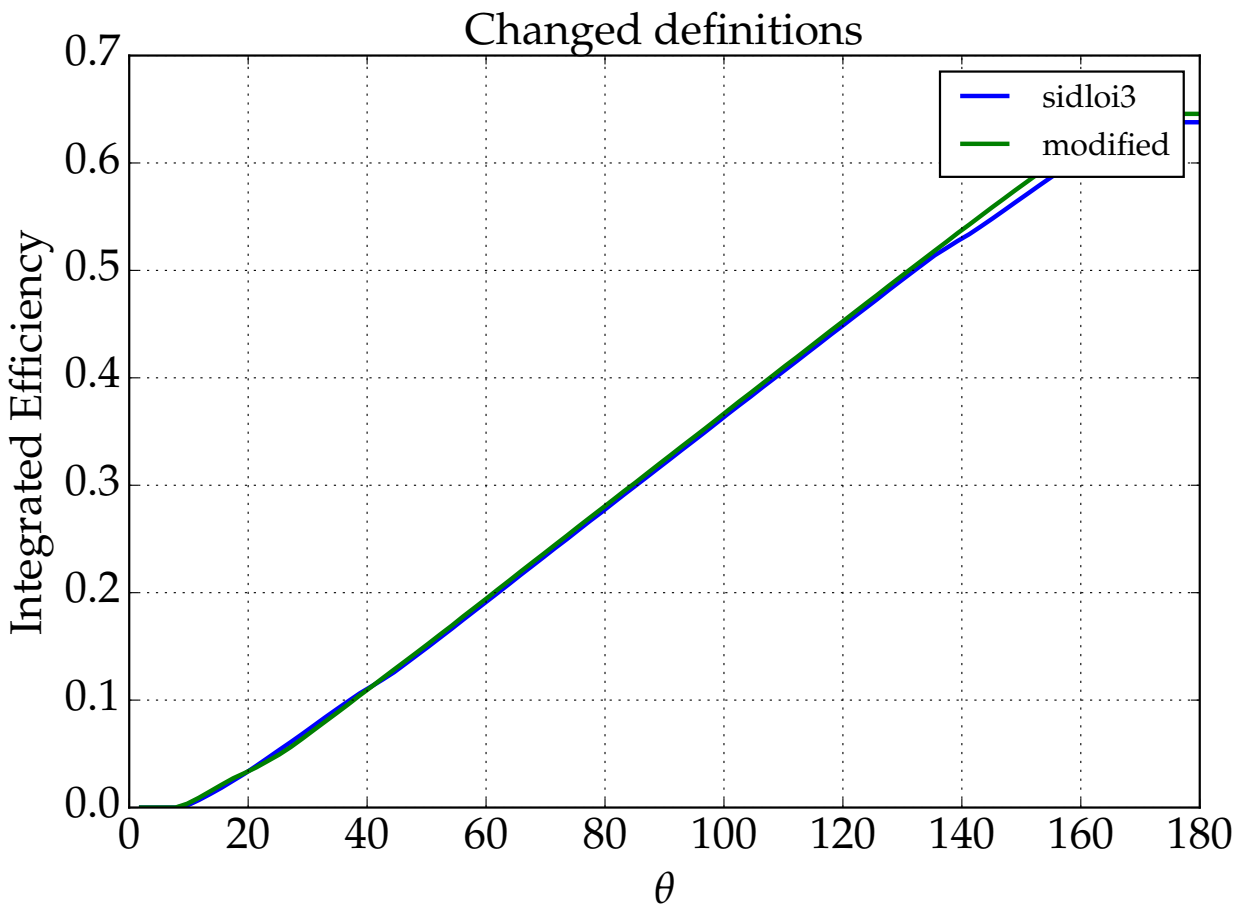


Figure: Comparison of the integrate tracking efficiencies as a

modified integrated efficiency - sidloi3 integrated efficiency

Overall the modified performs better

The changes at the endcap - barrel intersections can clearly be seen

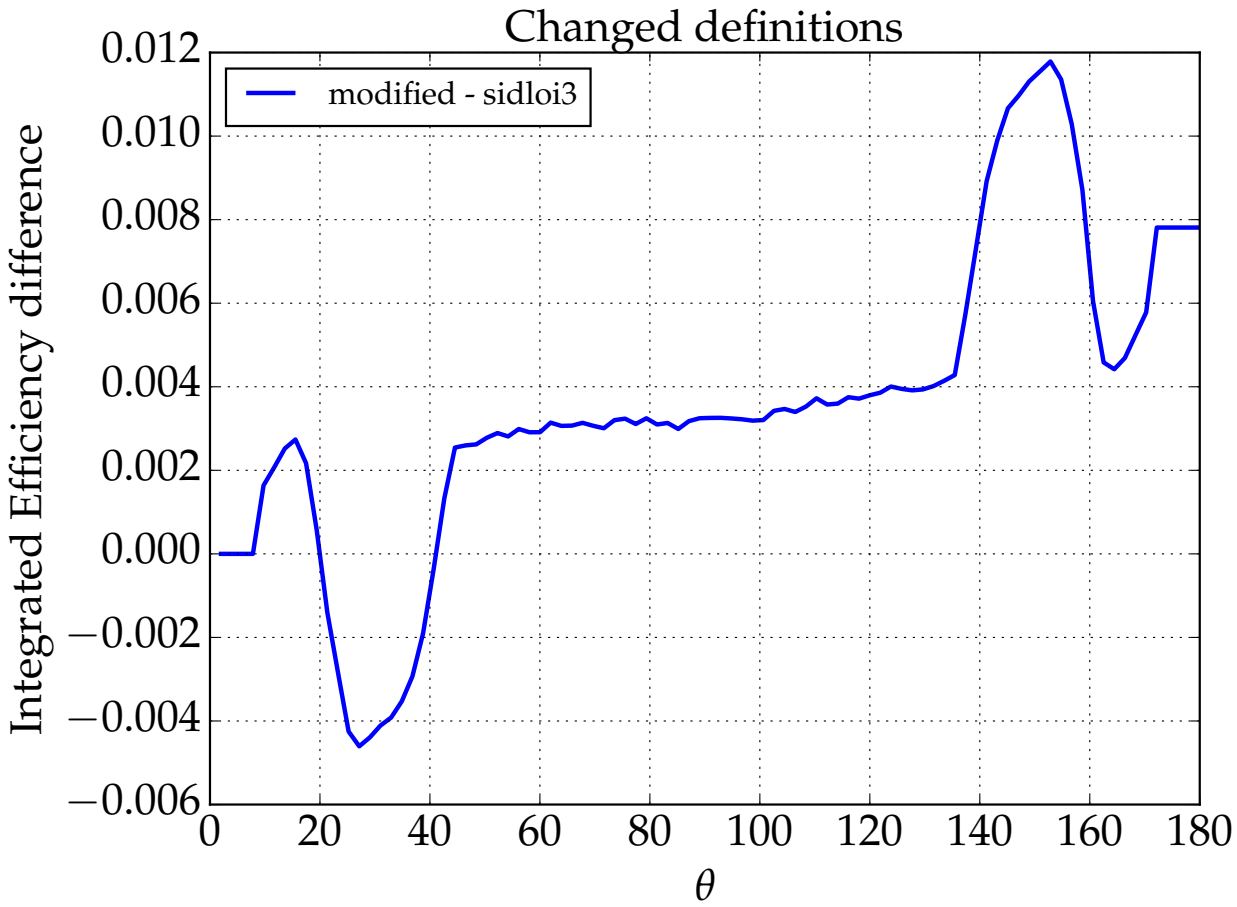


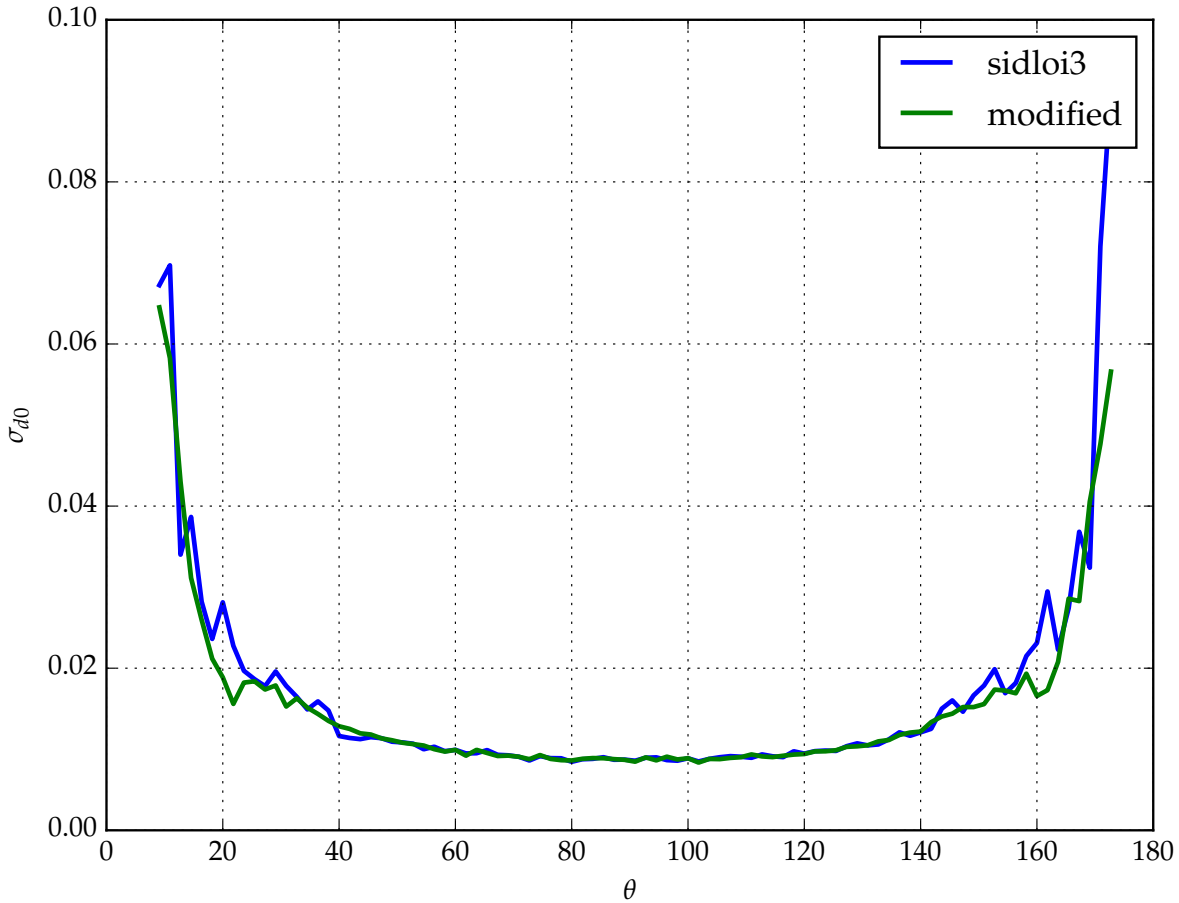
Figure: Difference of the integrated tracking efficiencies

D_0 resolution as a function of θ

Found by binning all the data in theta, creating a histogram for each bin, fitting a Gaussian to each histogram and plotting the σs as a function of θ

A selection of the sub histograms is in the backup slides at the end

We see the performance degrade as the particles have to move through more detector material with disconitunities at the barrel - endcap intersections



Section 2

Flavour tagging

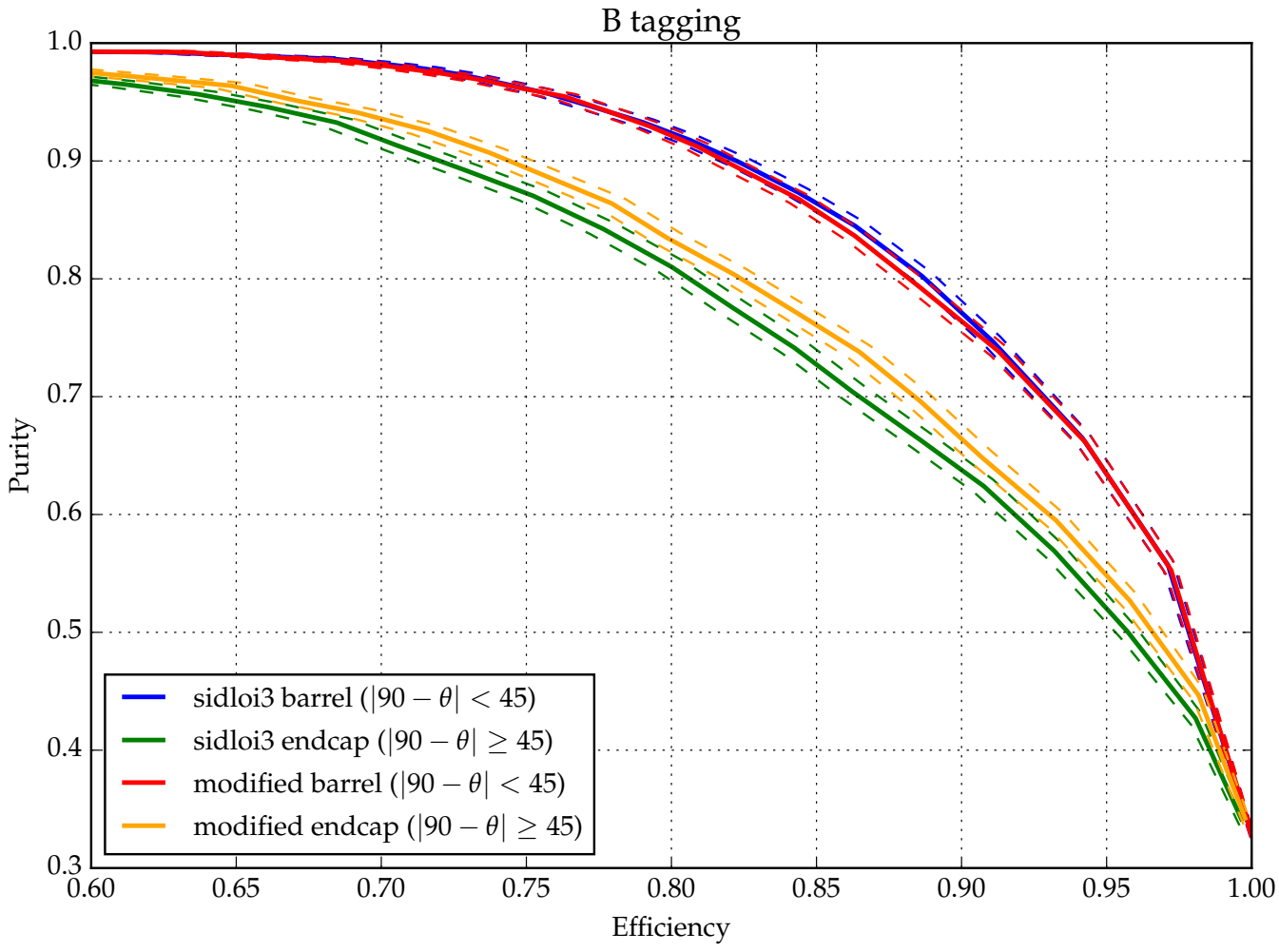
B split tagging comparison

Barrel much better than endcap region.

Modification makes little to no difference to the barrel (as expected).

Small but measurable improvement in the endcap region

The full plot (on $\varepsilon \in [0, 1]$ is in the backup slides at the end)

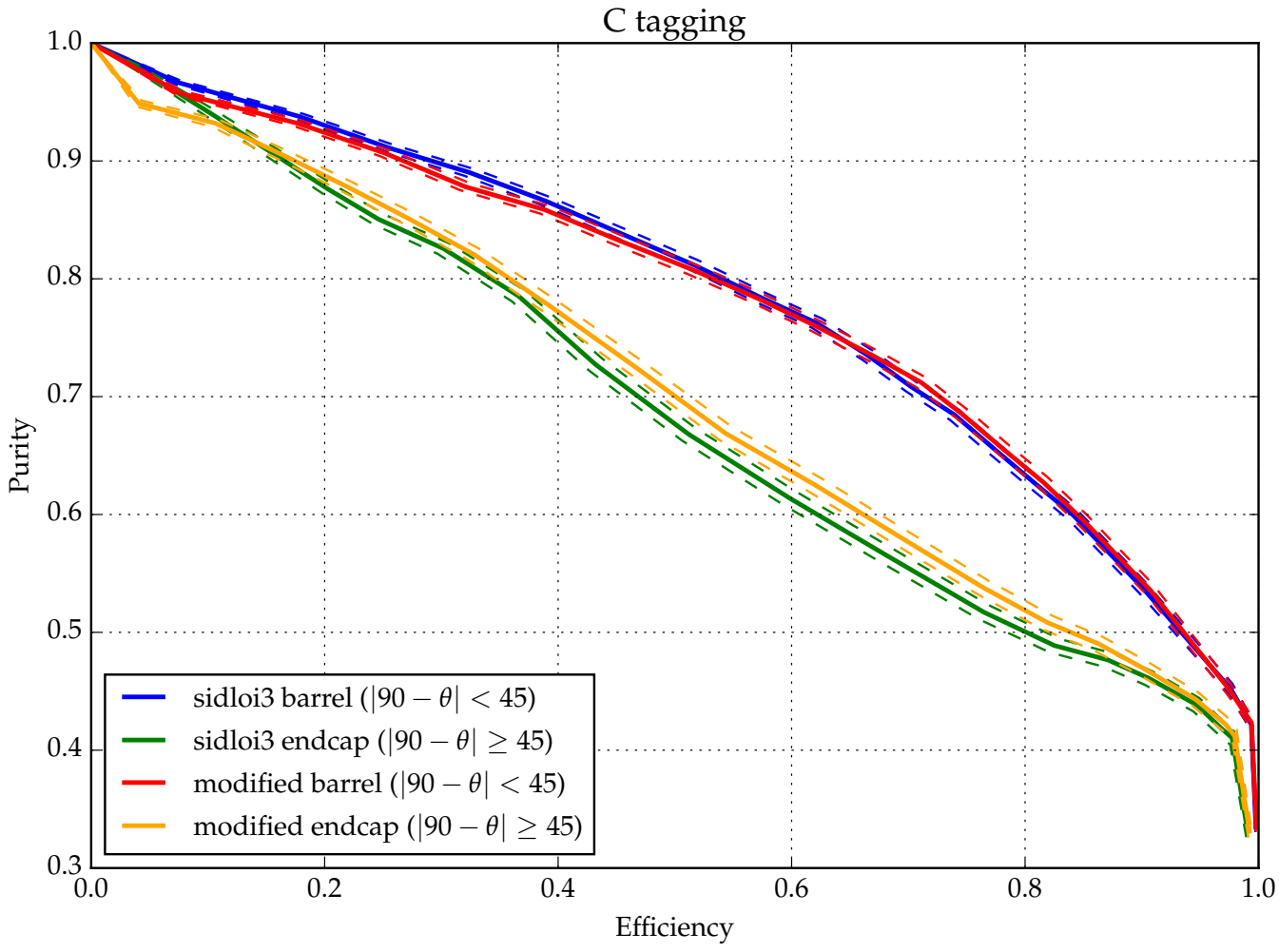


C split tagging comparison

c jet tagging much more difficult than b.

Again modifications improve endcap region.

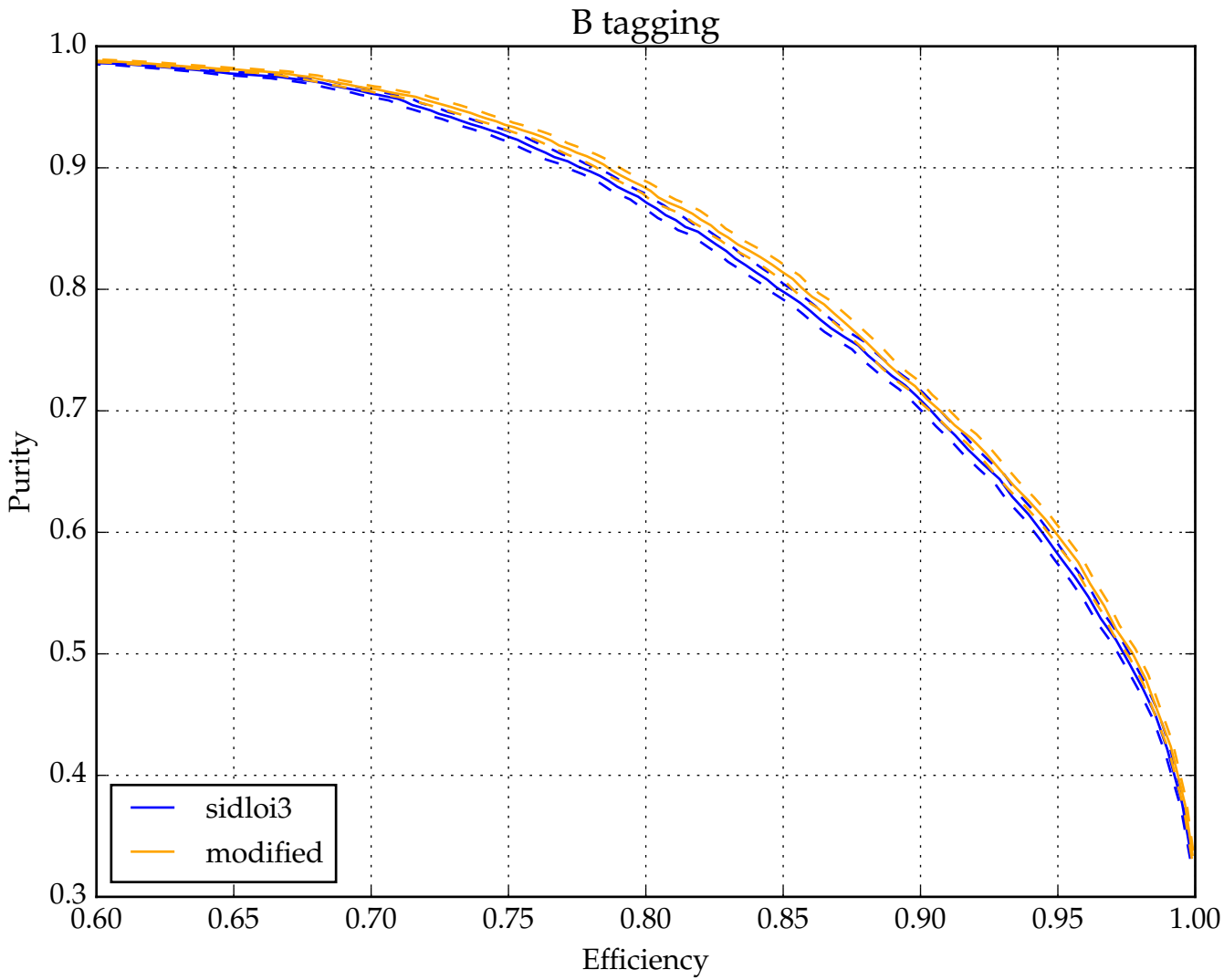
The modified detector seems to be slightly *worse* in the barrel at low efficiencies and I have no idea why.



B combined tagging comparison

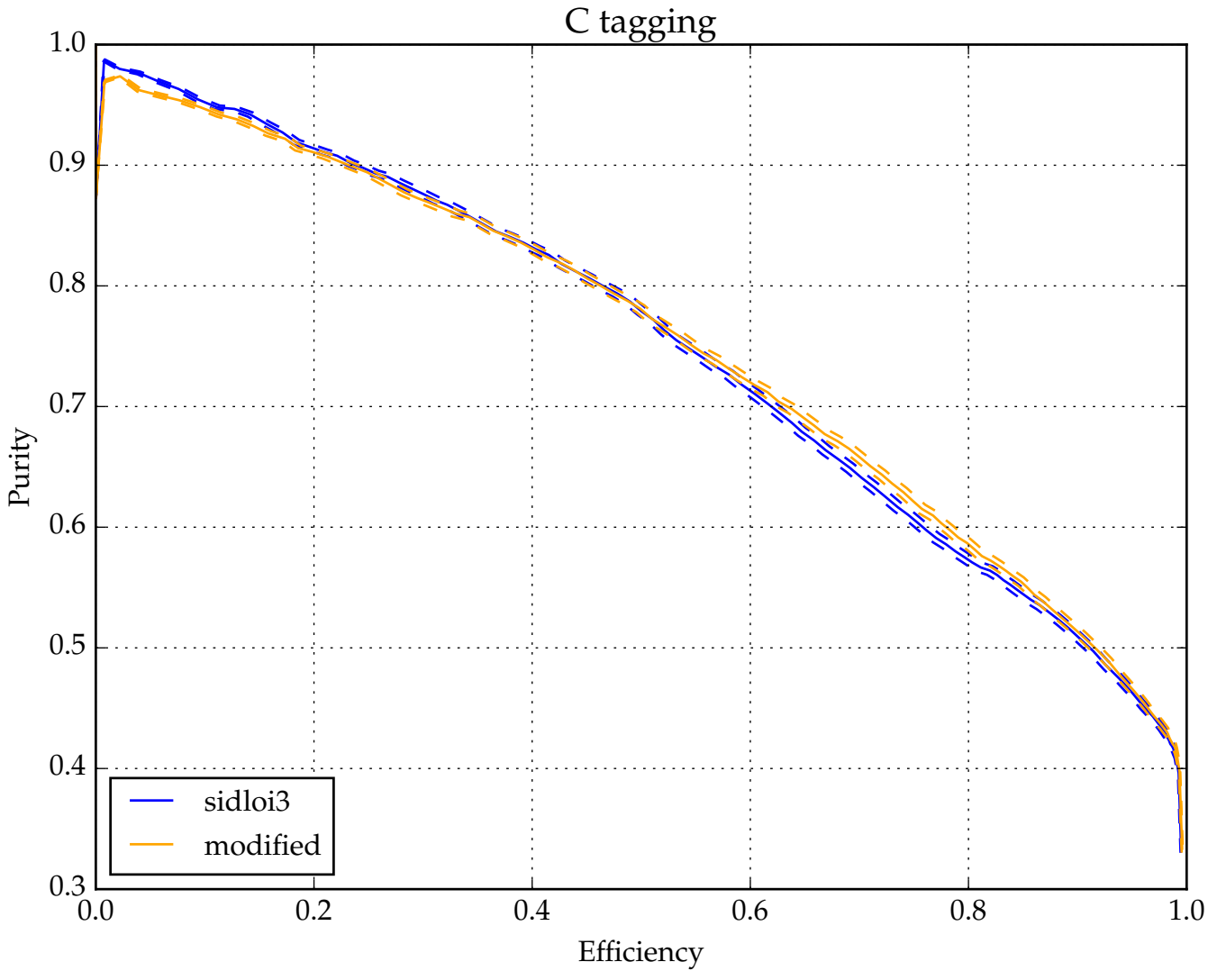
The modified detector performs better overall (as we'd expect from the split plot)

The full plot (on $\varepsilon \in [0, 1]$ is in the backup slides at the end)



C combined tagging comparison

Consistent with the split plot the modified detector performs better hat high efficiencies and slightly worse at lower.



Summary

We found doubling the length of the barrel *slightly* improved b and c tagging.

The endcap track efficiencies and fake rates are not vastly worse than those the barrel. The bad zone is the intersection between them.

Changing the barrel lengthjust moves the bad zone around. Moving it to an area with fewer particles improves things!

Section 3

misc

ILC Dirac

I only touched this once Martin had gone through the process once.

There seems to be several areas where running a program through ILCDirac changes how it functions in unintuitive ways (eg slicpandora deleting detector geometry info).

He wrote up a set of idiot proof instructions (link below) that I followed last Thursday and allowed me to sucessfully run jobs within an hour (having acquired the certificates earlier).

`https://github.com/Bristol-SiD-Development/scripts/tree/master/ILC-DIRAC`

TrackSubdetectorHitNumbersDriver

Previously this driver used hardcoded information about the detector so gave incorrect results if (for example) your vertex barrel wasn't the same length as sidloi3's.

The previous version also assumed hit.getType() $==$ 1 $\iff$ the hit was in the vertexer. This lumped "SiTrackerForward" hits in with "SiVertexEndcap" ones.

I only found out about this because the old version (deliberately) threw a runtime error if your detector name wasn't "sidloi3" so its possible that there are similar drivers using hardcoded (and possibly invalid) information!

Documentation

I'm going to spend my last few days finishing documenting everything.

Currently all our documentation is in our github repo. Obviously this is bad (more fragmentation).

Where (if anywhere) would you like me to move it?

The End

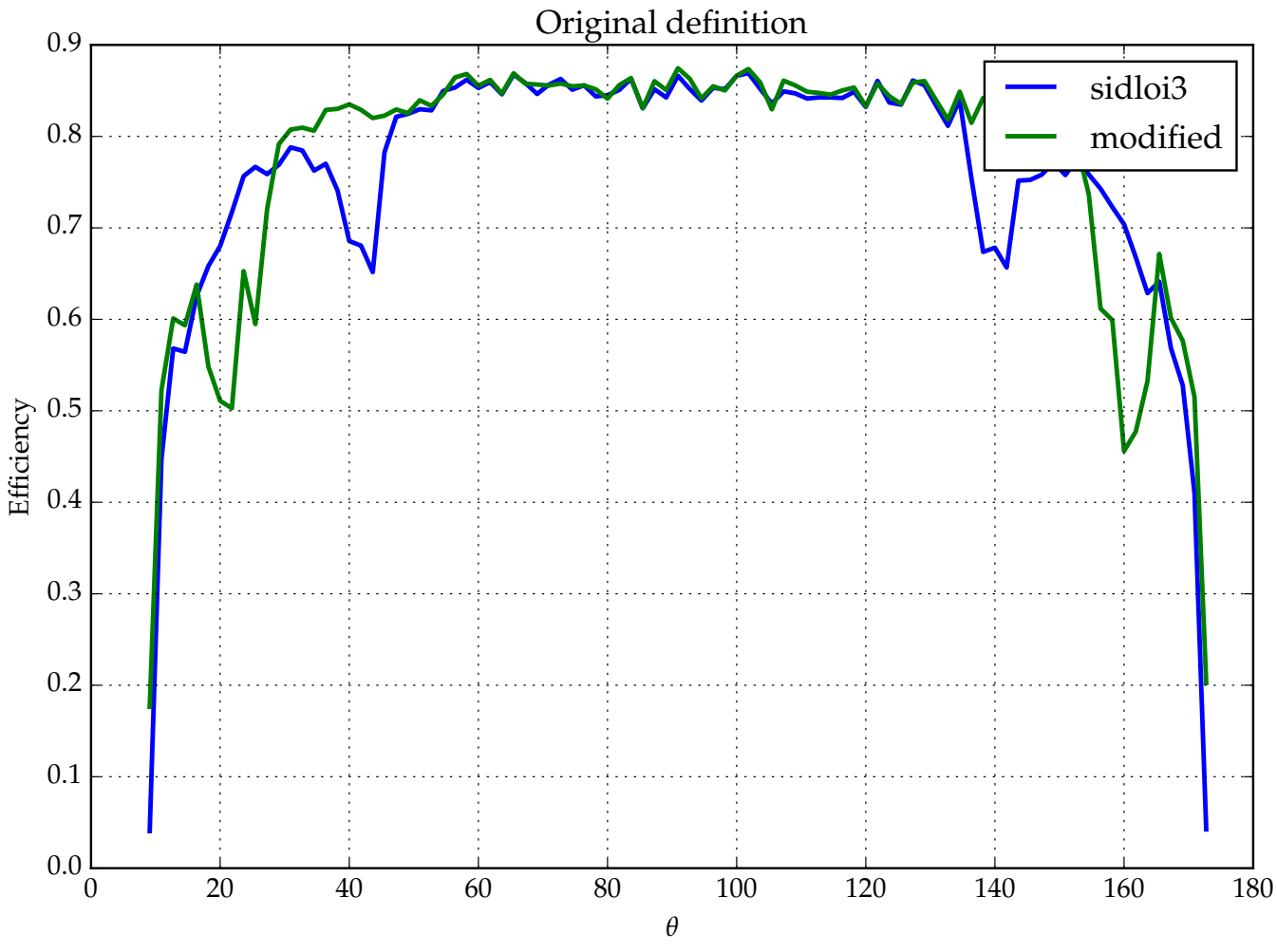
Section 4

Backup slides

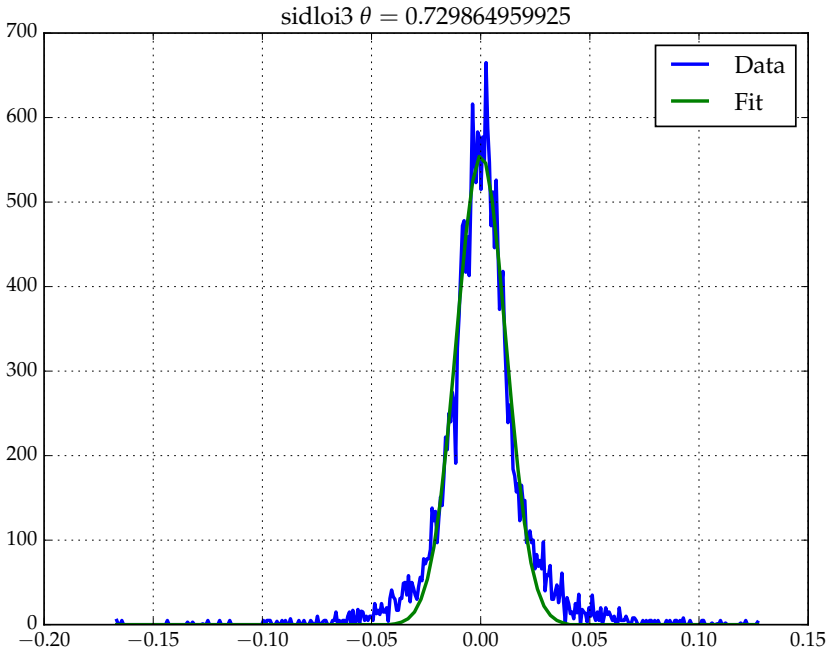
Track efficiency with the original definitions

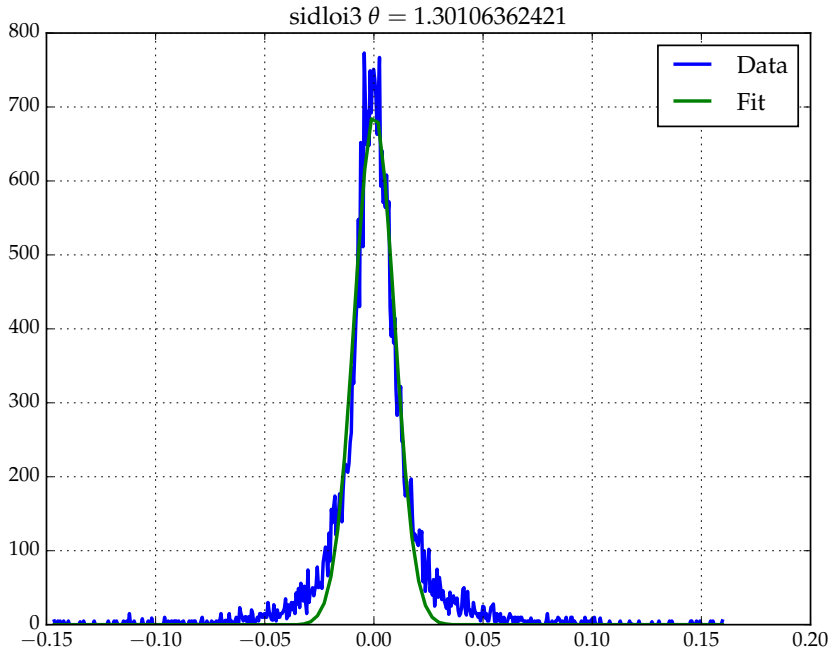
Here a track is considered good if it is the best track for it's mc particle and fake otherwise.

As you can see changing the definitions didn't change the efficiency much (despite the dramatic effect on the fake rate).

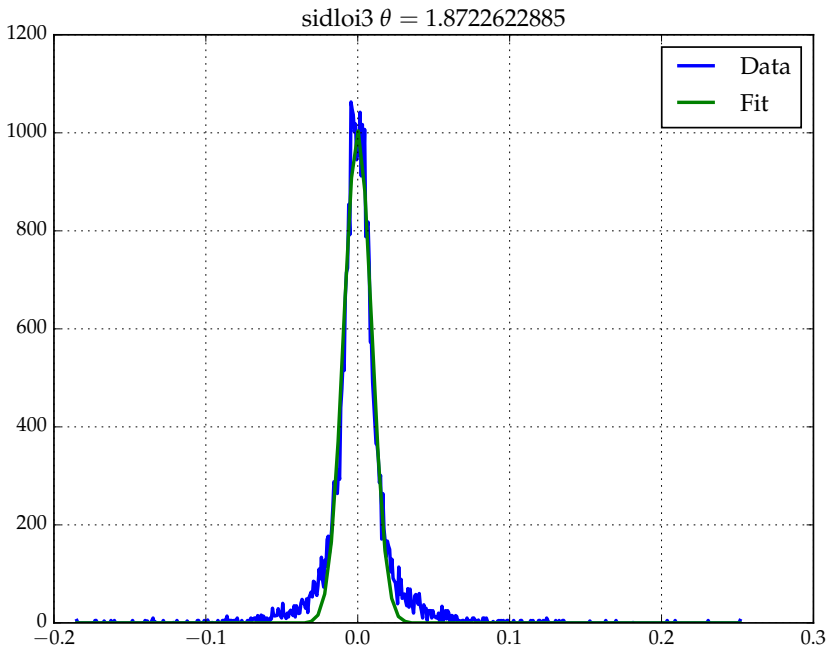


sidloi3


sidloi3 $\theta = 0.729864959925$
Data
Fit
700
600
500
400
300
200
100
0
−0.20
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15


sidloi3 $\theta = 1.30106362421$
Data
Fit
800
700
600
500
400
300
200
100
0
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15
0.20

sidloi3


sidloi3 $\theta = 1.8722622885$
Data
Fit
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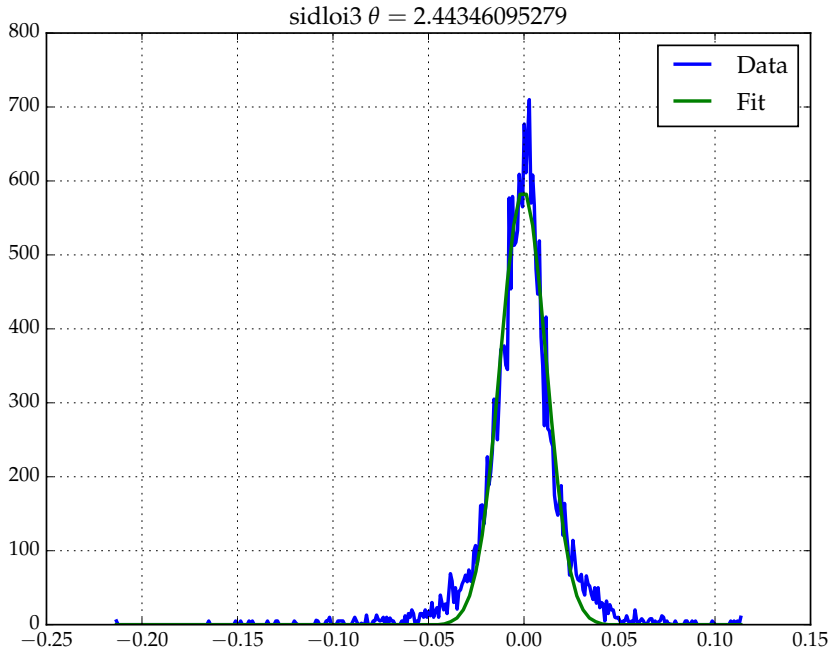
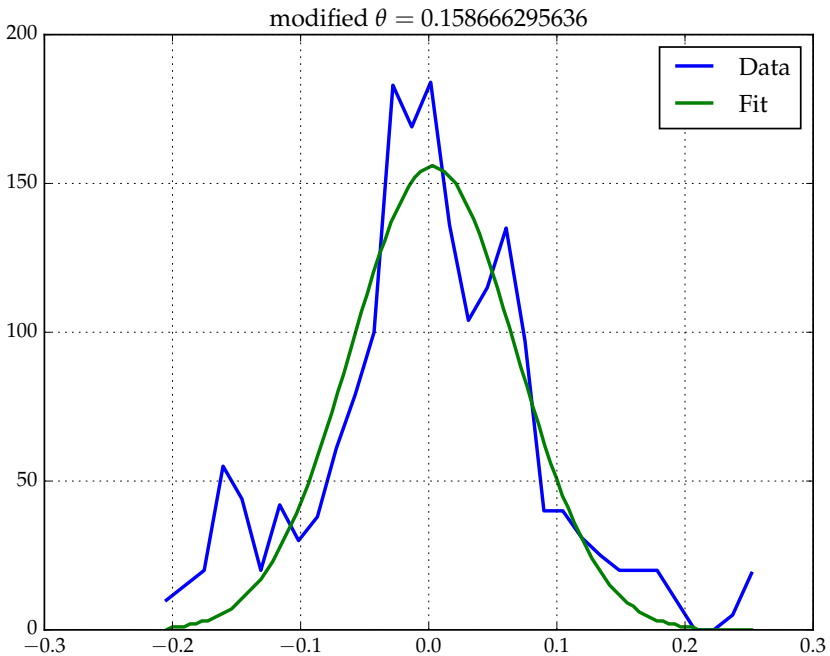
1000
800
600
400
200
0
−0.2
−0.1
0.0
0.1
0.2
0.3


sidloi3 $\theta = 2.44346095279$
Data
Fit
800
700
600
500
400
300
200
100
0
−0.25
−0.20
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15

modified


modified $\theta = 0.158666295636$
Data
Fit
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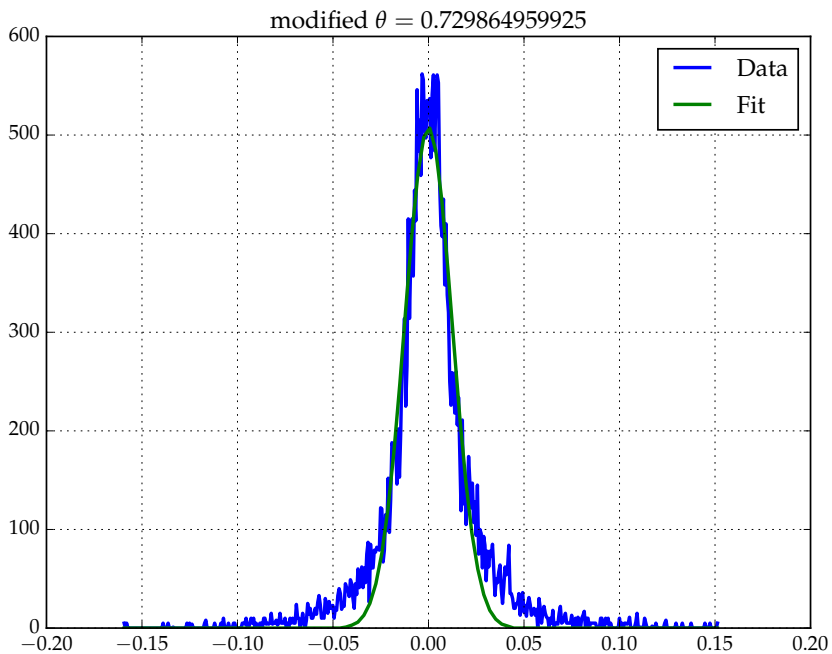
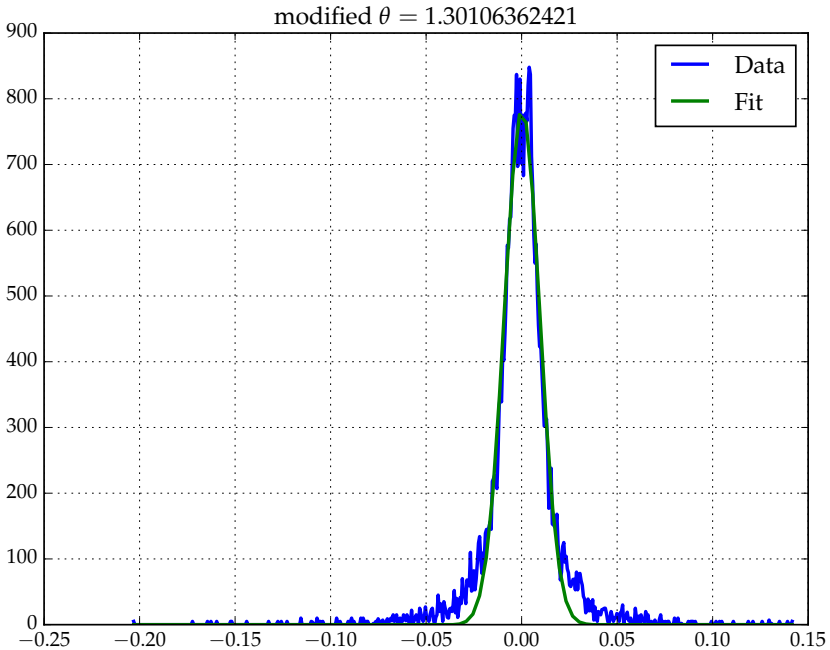
150
100
50
0
−0.3
−0.2
−0.1
0.0
0.1
0.2
0.3


modified $\theta = 0.729864959925$
Data
Fit
600
500
400
300
200
100
0
−0.20
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15
0.20

modified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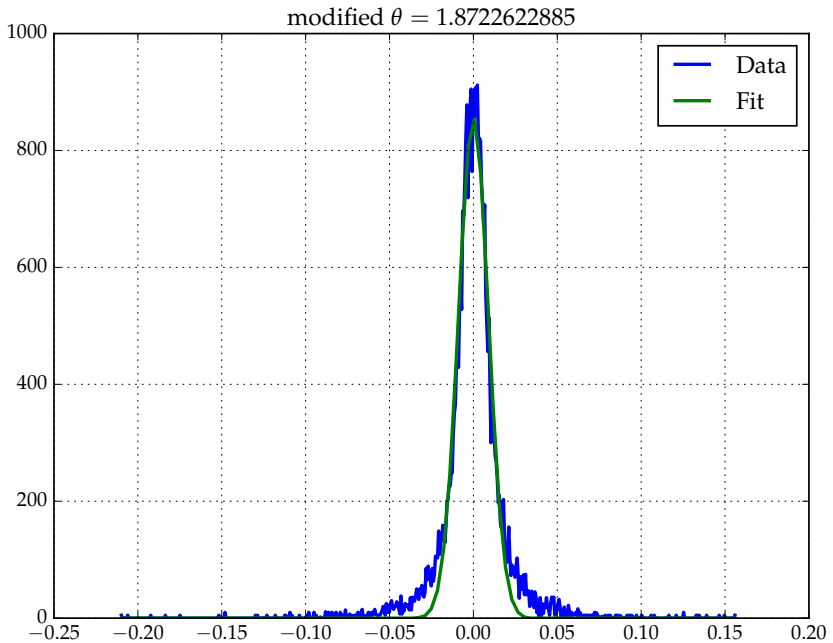
Data
Fit
900
800
700
600
500
400
300
200
100
0
−0.25
−0.20
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15


modified $\theta = 1.8722622885$
Data
Fit
1000
800
600
400
200
0
−0.25
−0.20
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15
0.20

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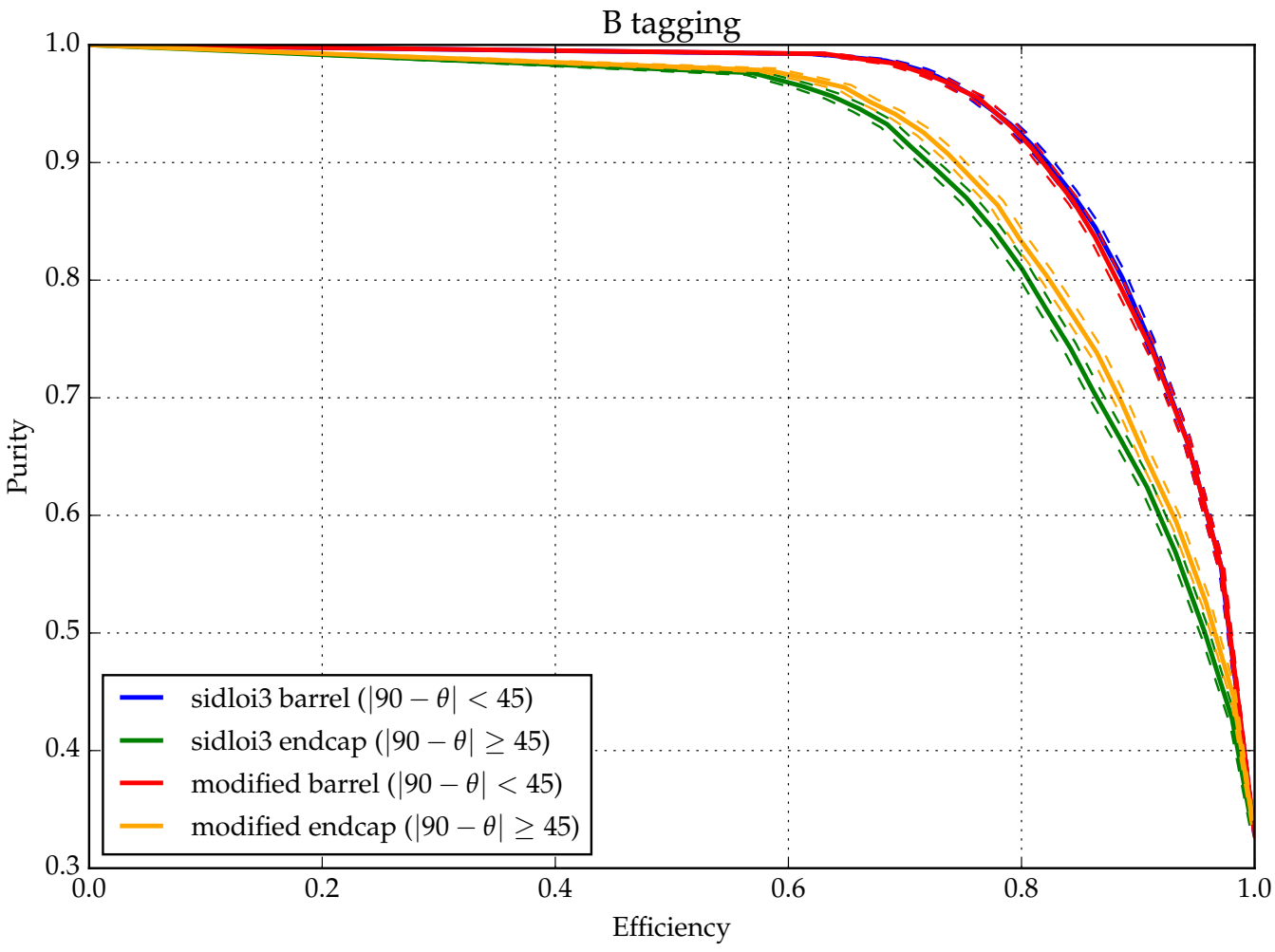
This is the full plot



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