Bhabha Tracking Efficiencies

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Motivation

- I would like to estimate the tracking efficiency on phase 2 data
- I use Bhabha events because if one track is reconstructed then the other particle should also produce a track

$$\epsilon = \frac{\text{Number of Bhabha events with exactly 2 tracks}}{\text{Number of Bhabha events with one or more tracks}}$$

- This idea comes from some plots presented by Sam in previous tracking and ECL meetings.

Getting Started

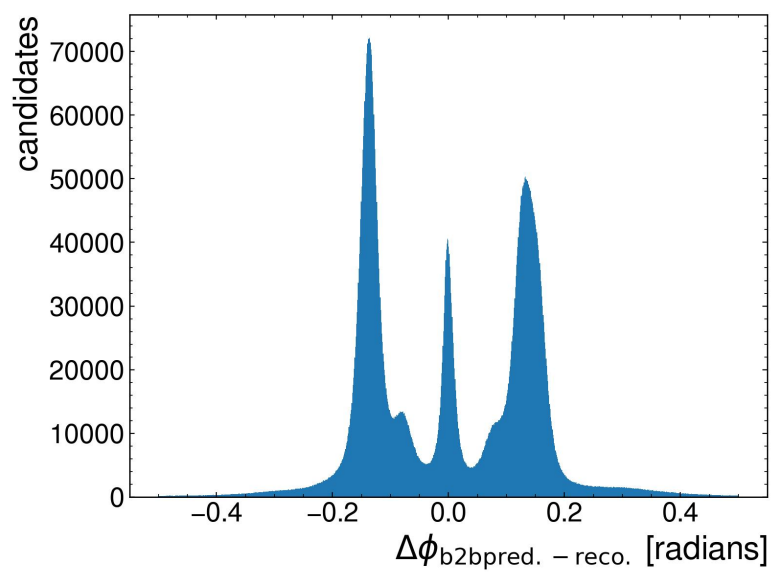
- Cuts Sam used:
  - gamma:probe '$(\mathrm{E} > 0.1)$'
  - gamma:tag '$(\mathrm{clusterE} > 3.0)$'
  - vpho:cand 'reconstructed from gamma:probe and gamma:tag'

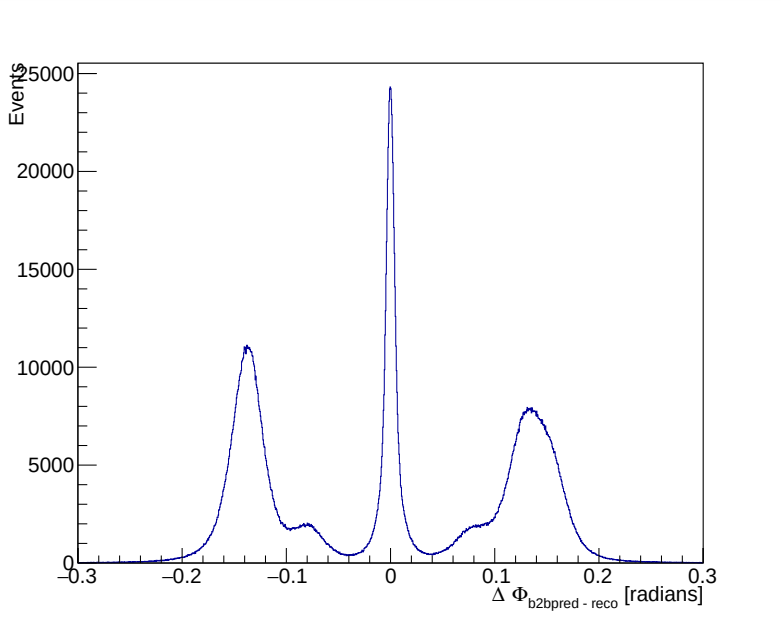
  - $0.296706 < \theta < 2.61799 \rightarrow$ It has to hit the ECL
  - $\mathrm{nCleanedTracks}[\mathrm{abs(dz)} < 2.0 \text{ and } \mathrm{abs(dr)} < 0.5 \text{ and } \mathrm{nCDCHits} > 0 \text{ and } \mathrm{pt} > 0.15] < 1 \rightarrow$ bad quality hits
  - $\mathrm{M(vpho)} > 8.0\,\mathrm{GeV} \rightarrow$ To cut away background (not from his email but surely he is using something like that)

- Cuts I use:
  - $\mathrm{M(vpho)} > 8.0\,\mathrm{GeV} \rightarrow$ For the vpho to have a mass of at least $8\,\mathrm{GeV}$, $\mathrm{gamma{:}tag}$ and $\mathrm{gamma{:}probe}$ must have at least an energy of more than $3\,\mathrm{GeV}$

Reproducing Plots

- The plots in the following slides are produced using prod6 (this is because as a starting point I tried to reproduce Sam's plots)
- Sam used all Prod6 data. I am only using the following: /hsm/belle2/bdata/Data/release-02-01-00/DB00000438 /prod00000006/e0003/4S/r02*/all/mdst.sub00/*.root
- Sam's plot is on the left.





Original idea

- Tread every hit in the ECL as a photon
- After reconstruction, check if there is a track associated with the cluster

```
fillParticleList('gamma:probe','clusterE > 0.0001 ',path=mypath)
fillParticleList('gamma:tag','clusterE > 0.0001',path=mypath)
reconstructDecay('vpho:cand -> gamma:probe gamma:tag',mass_cut,path=mypath)
```

- As a first check I ran over MC11 $\mathrm{ee} \to \mathrm{ee}$ samples with the same steering file
- Far too few vpho were reconstructed
- Explanation: The γ list is only filled by particles without a track
- So the reconstruction from two γ lists is exactly what we don't need

How to proceed

- If there is a cluster in the ECL, then we look if that cluster has a track associated. If it has than it is a electron/positron. If it has not then it is a gamma
- So the list we want is the electron list plus the gamma list

```
fillParticleList('gamma:probe','clusterE > 0.0001 ',path=mypath)
fillParticleList('e+:all','clusterE > 1', path=mypath)

reconstructDecay('vpho:elec0 -> e+:all','',path=mypath)
reconstructDecay('vpho:gamma0 -> gamma:probe','', path=mypath)

copyLists(outputListName='vpho:mypho_un',inputListNames=['vpho:elec0','vpho:gamma0'],path=mypath)
rankByHighest('vpho:mypho_un','daughter(0,clusterE)',path=mypath)
cutAndCopyList('vpho:mypho','vpho:mypho_un','',path=mypath)

reconstructDecay('vpho:bhabha -> vpho:mypho vpho:mypho',mass_cut,path=mypath)
```

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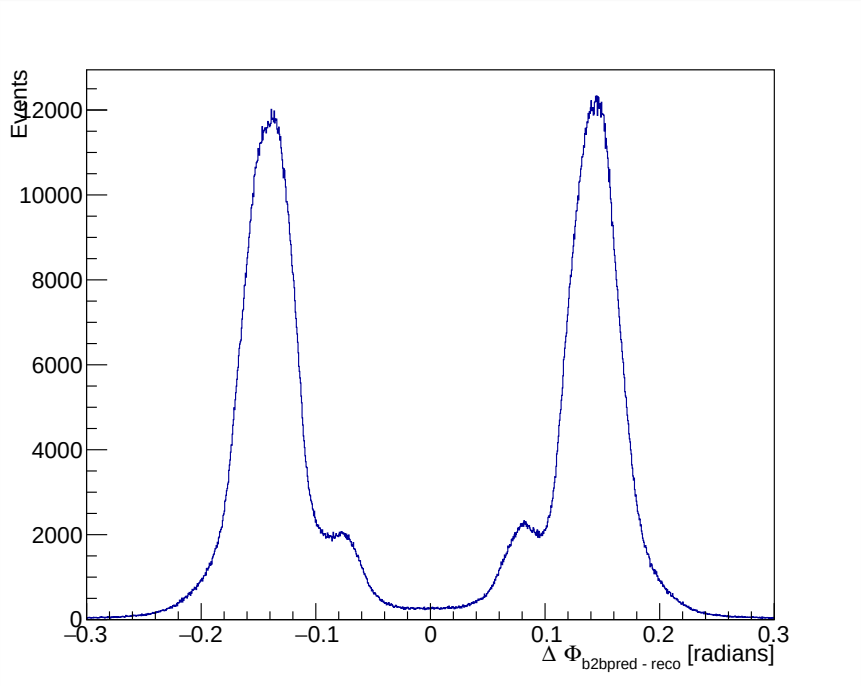
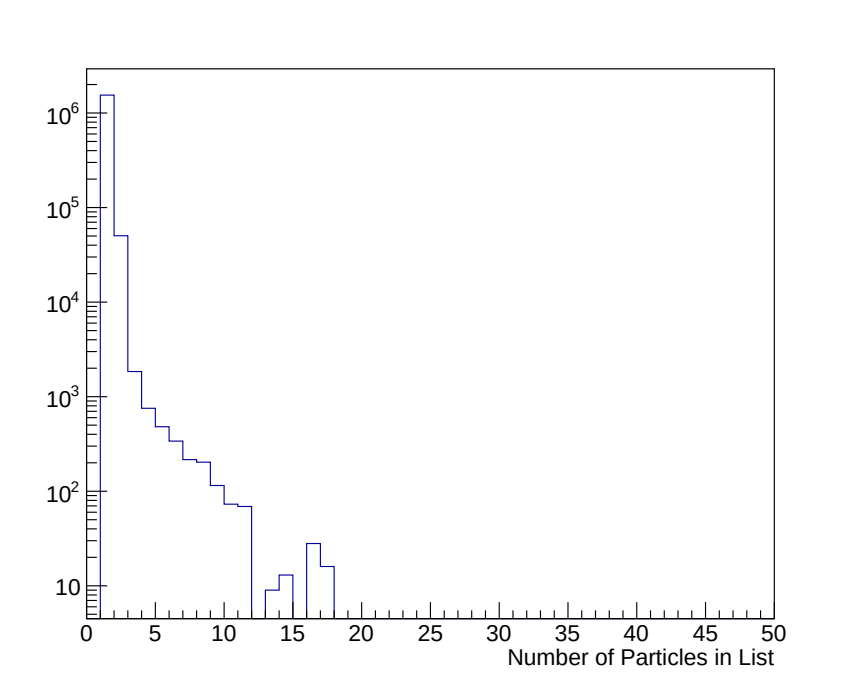
More problems

- Double peak structure has to be understood



More problems

- Double peak structure has to be understood
- Sometimes more than one vpho per event is reconstructed



Next steps

- Select best vpho
- Cut on $\Delta\Phi_{\text{b2bpred -reco}}$ peak and calculate a first efficiency