Bhabha Tracking Efficiencies

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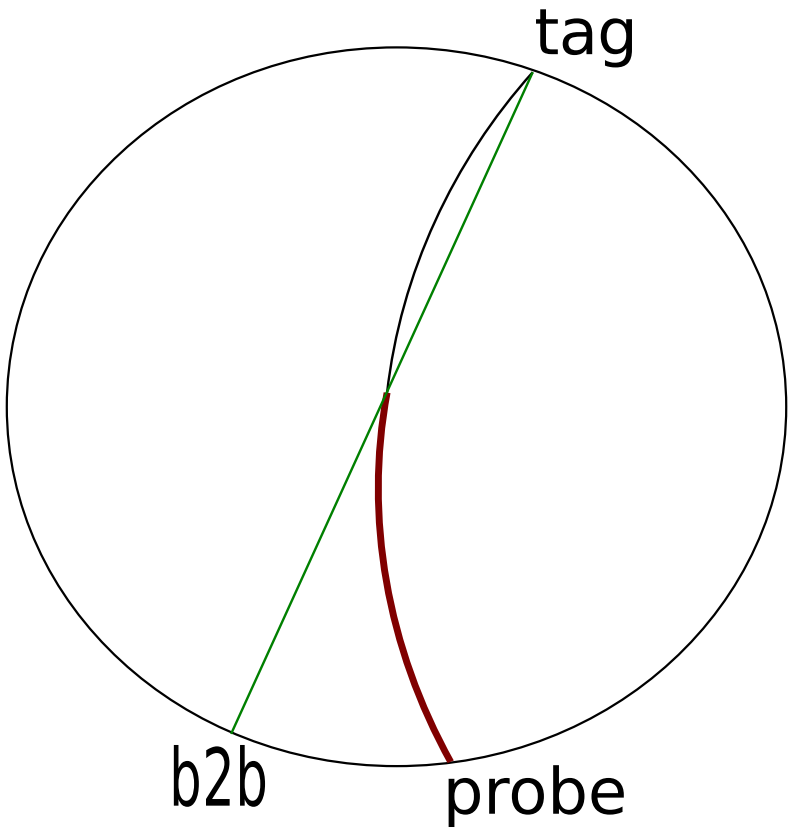
Motivation

- I am performing an analysis to estimate the tracking efficiency on phase 2 data
- The physics case I am considering is Bhabha events
  $e^+ + e^- \rightarrow e^+ + e^-$
- The definition of efficiency I am going to use is:

$$\epsilon = \frac{\text{Number of Bhabha events with exactly 2 tracks}}{\text{Number of Bhabha events with 1 or more tracks}}$$

- After selecting Bhabha events where at least one of the tracks was detected, one can look how many times the second one is found
- This idea comes from some plots presented by Sam Cunliffe in previous tracking and ECL meetings.

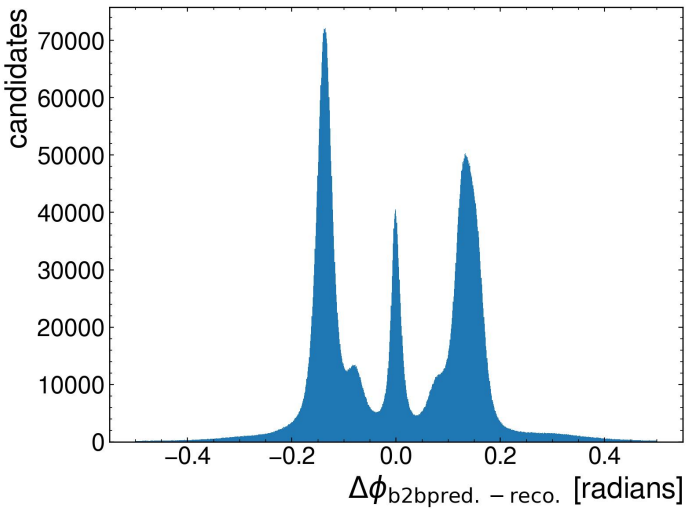
Motivation



- The two tracks have opposite curvature due to their charge

Motivation

Plot by Sam



vpho → gamma:probe+gamma:tag

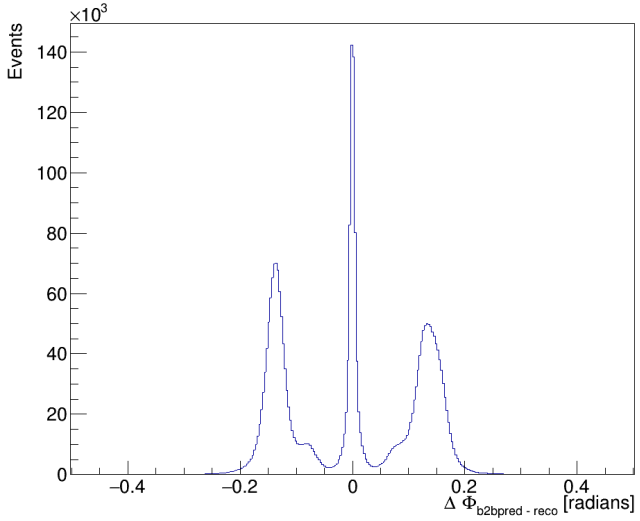
- gamma:probe '(E > 0.1)'
- gamma:tag '(clusterE > 3.0)'
- 0.296706 < θ < 2.61799
- nCleanedTracks[abs(dz) < 2.0 and abs(dr) < 0.5 and nCDCHits > 0 and pt > 0.15] < 1

A first attempt

- Fill a list of all the particles with an ECL Cluster associated (gamma)
- Reconstruct a Bhabha event from 2 of these objects
- Select a proper region in the $\Delta\Phi$ plot and check how many times a track was associated to a cluster

```
fillParticleList('gamma:probe','clusterE > 0.1 ',path=mypath)
fillParticleList('gamma:tag','clusterE > 3.0',path=mypath)
reconstructDecay('vpho:cand -> gamma:tag gamma:probe','M > 8.0',path=mypath)
```

Plot on data:



- Prod 6
- /hsm/belle2/bdata /Data/release-02-01-00 /DB00000438/prod00000006 /e0003/4S/r02*/all/mdst.sub00 /*.root

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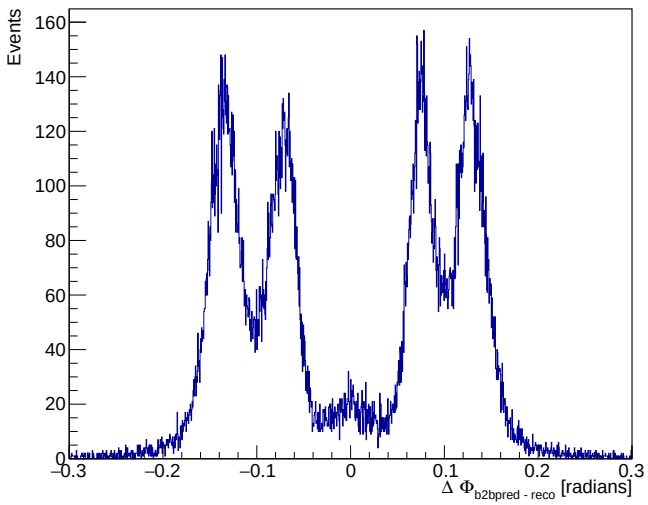
```

Plot on MC:



- MC11 $\mathrm{ee} \to \mathrm{ee}$
- very few $\mathrm{vpho{:}bhabha}$ reconstructed, no tracks associated to the daughters
- $\to$ in the framework the gamma list is filled with objects with an ECL cluster and NO track associated
- $\to$ wrong object to use for our purposes

Learning from experience

- To have a complete list of objects with an ECL cluster associated, one needs to "mix" two different lists, one of gammas and one of electrons

```
fillParticleList('gamma:all','E > 0.01 ',path=mypath)
fillParticleList('e+:all','clusterE > 0.01', path=mypath)

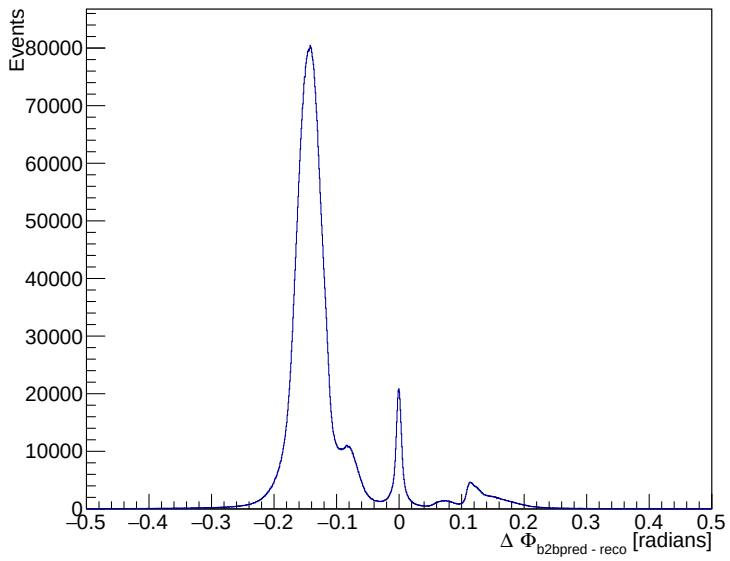
reconstructDecay('vpho:elec -> e+:all','',path=mypath)
reconstructDecay('vpho:gamma -> gamma:all','', path=mypath)

copyLists(outputListName='vpho:ECLobject_unranked',inputListNames=['vpho:elec','vpho:gamma'],path=mypath)
rankByHighest('vpho:ECLobject_unranked','daughter(0,clusterE)',path=mypath)
cutAndCopyList('vpho:ECLobject','vpho:ECLobject_unranked','',path=mypath)

reconstructDecay('vpho:bhabha -> vpho:ECLobject vpho:ECLobject','M > 8.0',path=mypath)
```

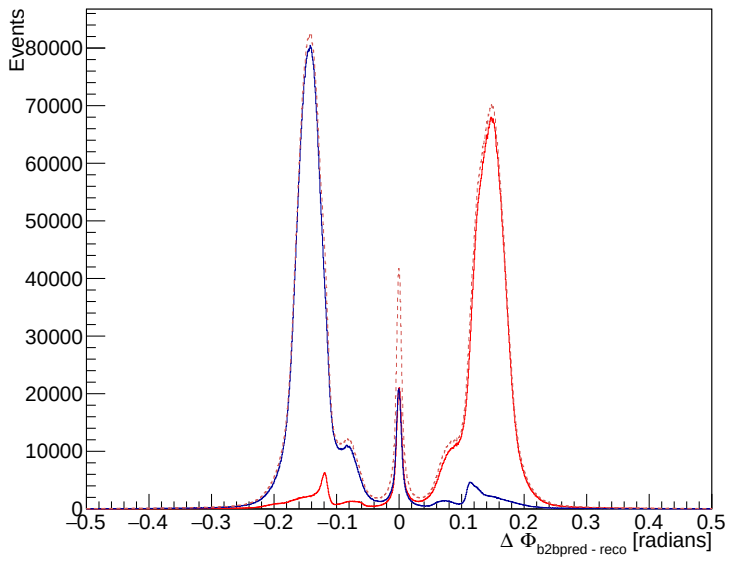
- The electron list does not require a ECL cluster$\rightarrow$ problem solved with the cut on clusterE
- The framework does not allow to mix lists of different types $\rightarrow$ problem solved with the "trick" of two intermediate virtual photons
- The ranking is a way for me to have the order of the daughters' under control
- The Bhabha candidates are finally reconstructed starting from 2 ECLobjects

$\Delta\Phi$ distribution, prod6



- The 3 peaks distribution is the result of considering each candidate as "tag" and as "probe"
- daughter_0_b2bClusterPhi - daughter_1_clusterPhi

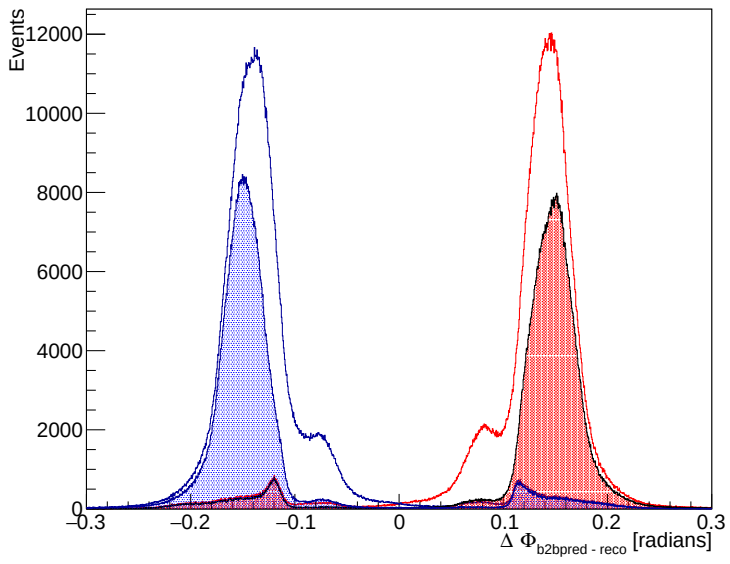
$\Delta\Phi$ distribution, prod6



- The 3 peaks distribution is the result of considering each candidate as "tag" and as "probe"
- daughter_0_b2bClusterPhi - daughter_1_clusterPhi
- daughter_1_b2bClusterPhi - daughter_0_clusterPhi
- Added both hists

- After adding the 2 hists I (of course) have double counted the events
- For my studies it would make more sense to concentrate on only one side to avoid double counting

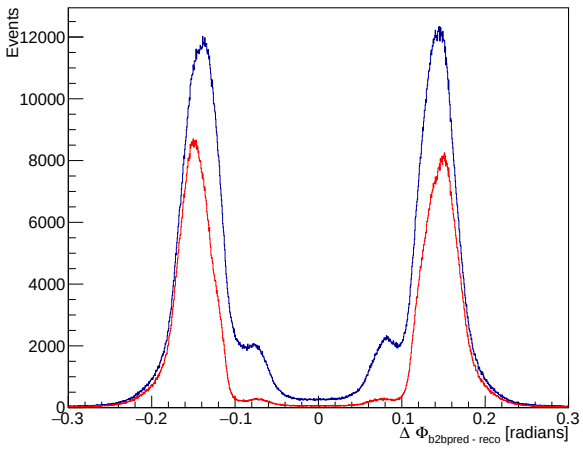
$\Delta\Phi$ distribution, MC11



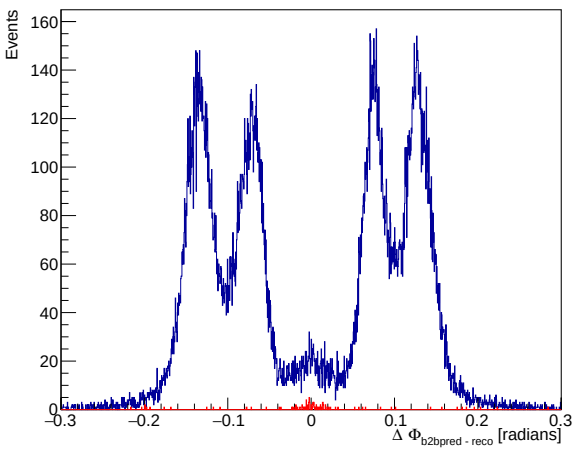
- The 3 peaks distribution is the result of considering each candidate as "tag" and as "probe"
- daughter_0_b2bClusterPhi - daughter_1_clusterPhi Reconstructed
- MCTruthMatched
- daughter_1_b2bClusterPhi - daughter_0_clusterPhi Reconstructed
- MCTruthMatched

$\Delta\Phi$ distribution, MC

all

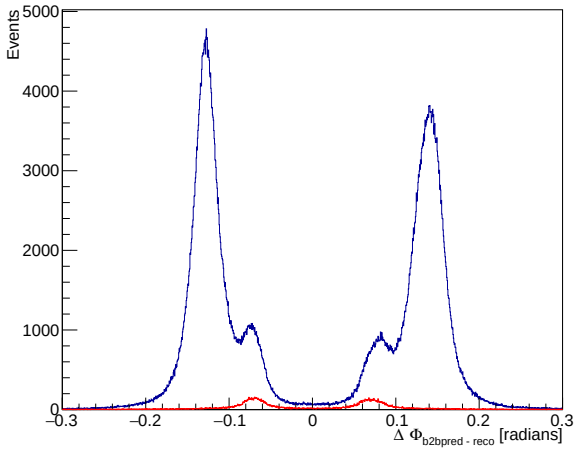


- MC11 $\mathrm{ee} \to \mathrm{ee}$ sample
- Reconstructed blue
- MCTruthMatched red



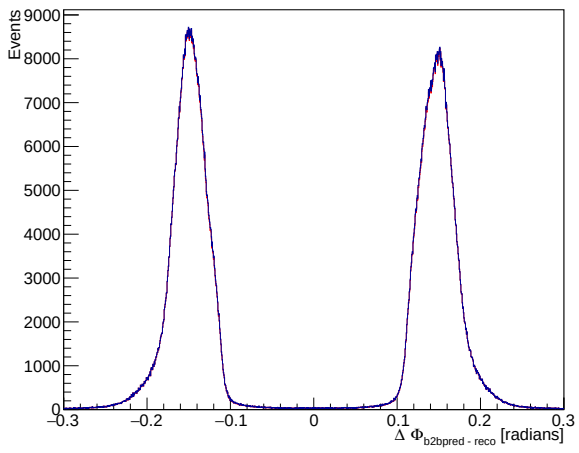
Two clusters;

No track



Two clusters;

One track



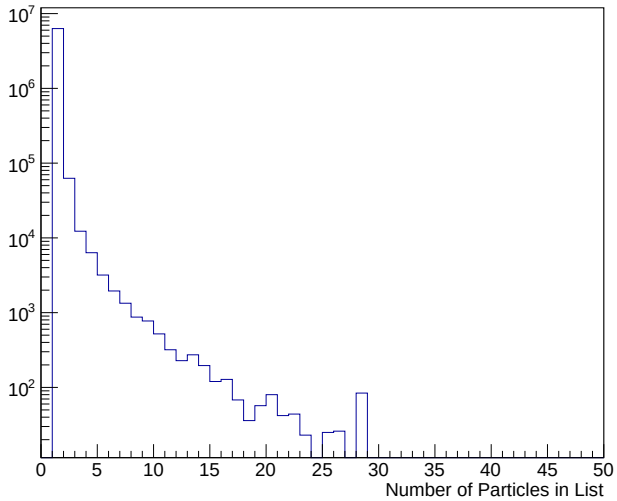
Two clusters;

Two tracks

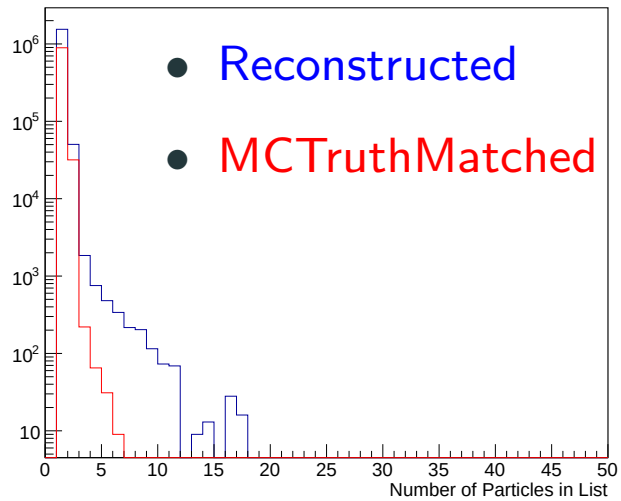
Multiple candidates

- For some events, there is more than one vpho reconstructed
- One needs to select only one vpho per event

Phase 2 Data



MC



Summary

- After a rough beginning and a lot of gained experience, I am now (hopefully) on the right track
- I hope to provide a first estimation shortly after Easter
- I still need to handle few things before it:
  - Select the best $\mathrm{vpho{:}bhabha}$ candidate
  - Define the signal region in the $\Delta\Phi$ plot based on MC