CPPNPP_timing

November 7, 2024

0.1 CPP/NPP timing assesment

This document looks at the timing of various detectors and relations in the CPP/NPP experiment. The main difference between this experiment and the standard GlueX running is that the target is located at $z = 1$cm and is a 5mm thick lead target.

We use here the plugin "timing" to analyze data from CPP/NPP. This plugin create several histograms that are looked at closer in this short document.

These histograms are:

DtimeM = new TH1D("DtimeM", "TrackVertexTime - BeamPhotonTime (TAGM);#Deltat [ns]", 1000, -50., 50.);

DtimeH = new TH1D("DtimeH", "TrackVertexTime - BeamPhotonTime (TAGH);#Deltat [ns]", 1000, -50., 50.);

DtimeHDC = new TH1D("DtimeHDC", "DOCA_{z}<30 TrackVertexTime - BeamPhotonTime (TAGH);#Deltat [ns]", 1000, -50., 50.);

DtimeHDC1 = new TH1D("DtimeHDC1", "DOCA_{z}>150 TrackVertexTime - BeamPhotonTime (TAGH);#Deltat [ns]", 1000, -50., 50.);

DtimeRF = new TH1D("DtimeRF", "TrackVertexTime - RFTime;#Deltat [ns]", 1000, -50., 50.);

DtimeRFChoice = new TH2D("DtimeRFChoice", "#PatNUM vs (TrackVertexTime - EventRFT);#Deltat [ns];Votes", 1000, -50., 50., 5, 0.5, 5.5);

DOCAZvsDtRF = new TH2D("DOCAZvsDtRF", "DOCA.z vs (TrackVertexTime - EventRFT);#Deltat [ns];DOCA z[cm]", 200, -10., 10., 240, -20., 220.);

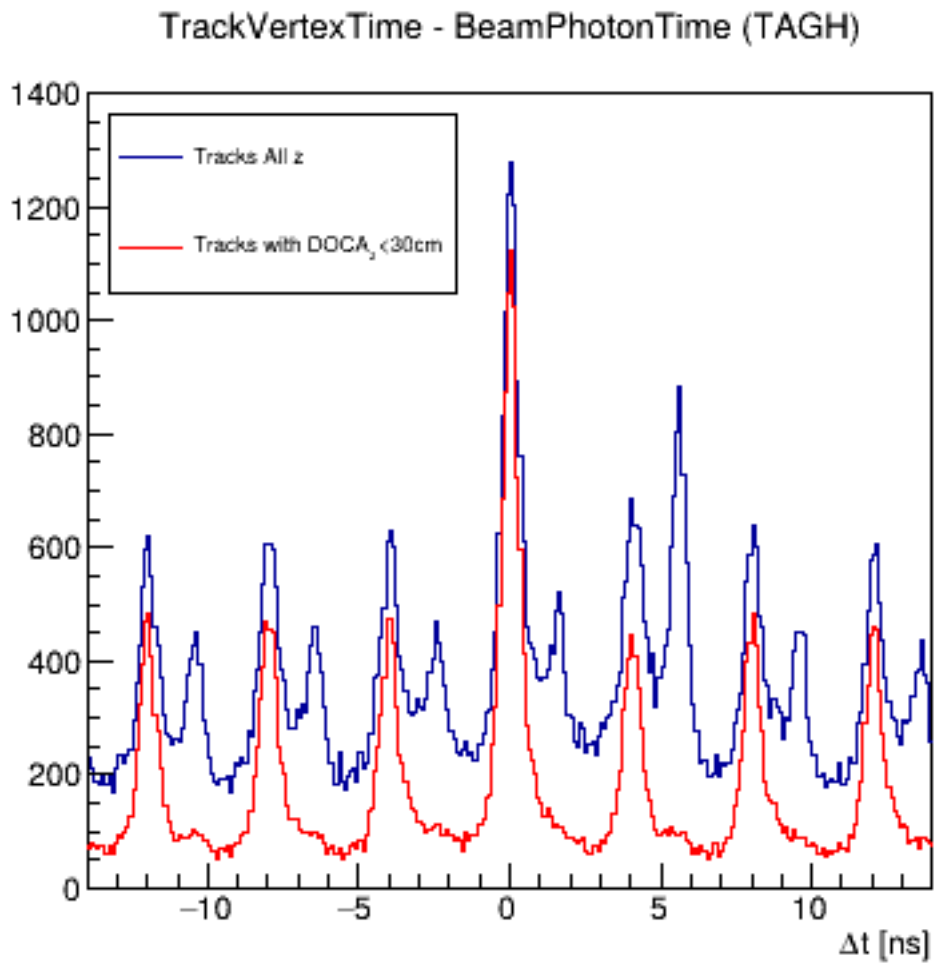
Here "DtimeH" is the track time at DOCA (distance of closest approach to the beam line) for "H" (hodoscope counters) minus the Beam Photon Time for all charged tracks that do have a match with a TOF point. Similarly "DtimeHDC" is the same but with a cut on the z position of DOCA to be smaller than 30cm. Below this will become more clear why this is important.

[1]:
```
import ROOT

loc = "/home/zihlmann/HallD/work/timing/"
rf = "hd_root_run101509.root"

RF = ROOT.TFile(loc+rf, "READ")
DtH = RF.Get("DtimeH")
```

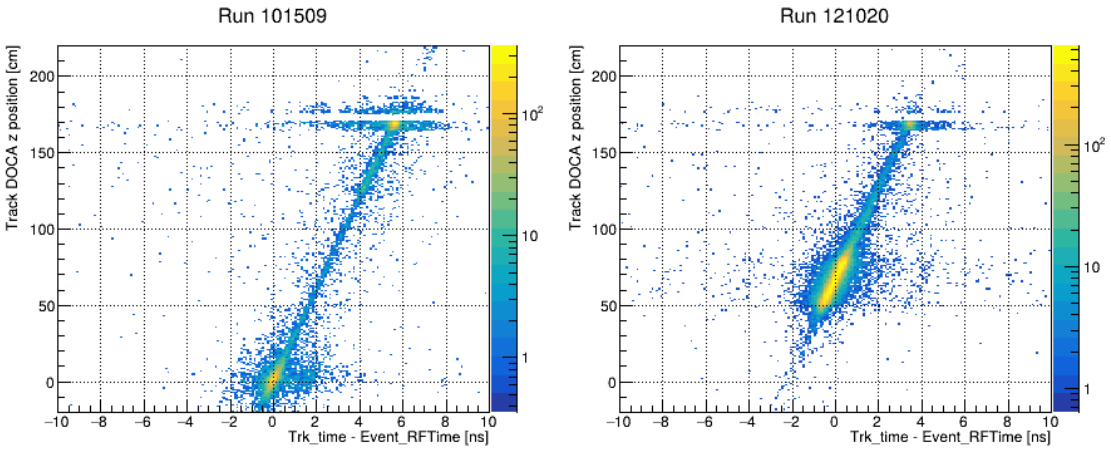
```
DtHcut = RF.Get("DtimeHDC")
DtHcut.SetLineColor(2)
DtH.SetStats(0)
DtHcut.SetStats(0)
C2 = ROOT.TCanvas("C2", "Picket Fence", 400, 400)
DtH.GetXaxis().SetTitle("#Deltat [ns]")
lg = ROOT.TLegend(0.12, 0.7, 0.45, 0.88)
lg.AddEntry(DtH,"Tracks All z", "l")
lg.AddEntry(DtHcut, "Tracks with DOCA_{z}<30cm", "l")
C2.cd()
DtH.GetXaxis().SetRangeUser(-14., 14.)
DtH.GetYaxis().SetRangeUser(0., 1400.)
DtH.Draw()
ROOT.C2.Update()
DtHcut.Draw("same")
lg.Draw()
ROOT.C2.Update()
```



To see this effect even better we look at the histogram where this time difference is ploted agains the DOCA z position of the track on the vertical axis. It is immediately evident that all the hits related to times at t=5.6ns and the correlated 4ns side peaks are related to tracks originatng close to the first FDC tracking chamber.

[2]:
```
VvsT = RF.Get("DOCAZvsDtRF")
VvsT.SetStats(0)
C3 = ROOT.TCanvas("C3", "2d timing vertex vs track time", 900, 400)
C3.Divide(2,1)
C3.cd(1)
VvsT.GetXaxis().SetTitle("Trk_time - Event_RFTime [ns]")
VvsT.GetYaxis().SetTitle("Track DOCA z position [cm]")
VvsT.SetTitle("Run 101509")
VvsT.Draw("colz")
ROOT.gPad.SetGrid()
ROOT.gPad.SetLogz()
C3.Update()
```

```
rfgluex = "hd_root_run121020.root"
RFgluex = ROOT.TFile(loc+rfgluex, "READ")
VvsTgluex = RFgluex.Get("DOCAZvsDtRF")
VvsTgluex.SetStats(0)
VvsTgluex.SetTitle("Run 121020")
VvsTgluex.GetXaxis().SetTitle("Trk_time - Event_RFTime [ns]")
VvsTgluex.GetYaxis().SetTitle("Track DOCA z position [cm]")
C3.cd(2)
VvsTgluex.Draw("colz")
ROOT.gPad.SetGrid()
ROOT.gPad.SetLogz()
C3.Update()
```



This demonstrates nicely that the timing depends on the "origin" of the track. The "origin" is represented by the z position of the track DOCA. Tracks originating from the actual CPP target (close to z=1cm) do have the expected timing difference close to zero, however all other track DOCA's are linearly dependend on the vertex location along the beam line. The indensity of hits after the target z=1 is low, however, it increases where the Helium Bag ends at about 120cm along the beam line corresponding to a flight time of about 4ns. The strong intensity close to 170cm is where the first FDC chamber is about to start. Close to z=0 at 1.5ns there is still some enhancement seen.

For comparison on the right is a plot from a GlueX run where the LH target center is at 65cm in z.

One question arises as to why is there a "gap" at about z=175cm. This means, there are no tracks originating from a z position close to 175cm, litteraly no tracks.

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