Hall C Analyzer (hcana)

HMS tracking in hcana

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Disclaimer

- I took help from these talks and report:
- Hall C 12 GeV Analyzer Update by Steve Wood
- Hall C 12 GeV Software Progress by

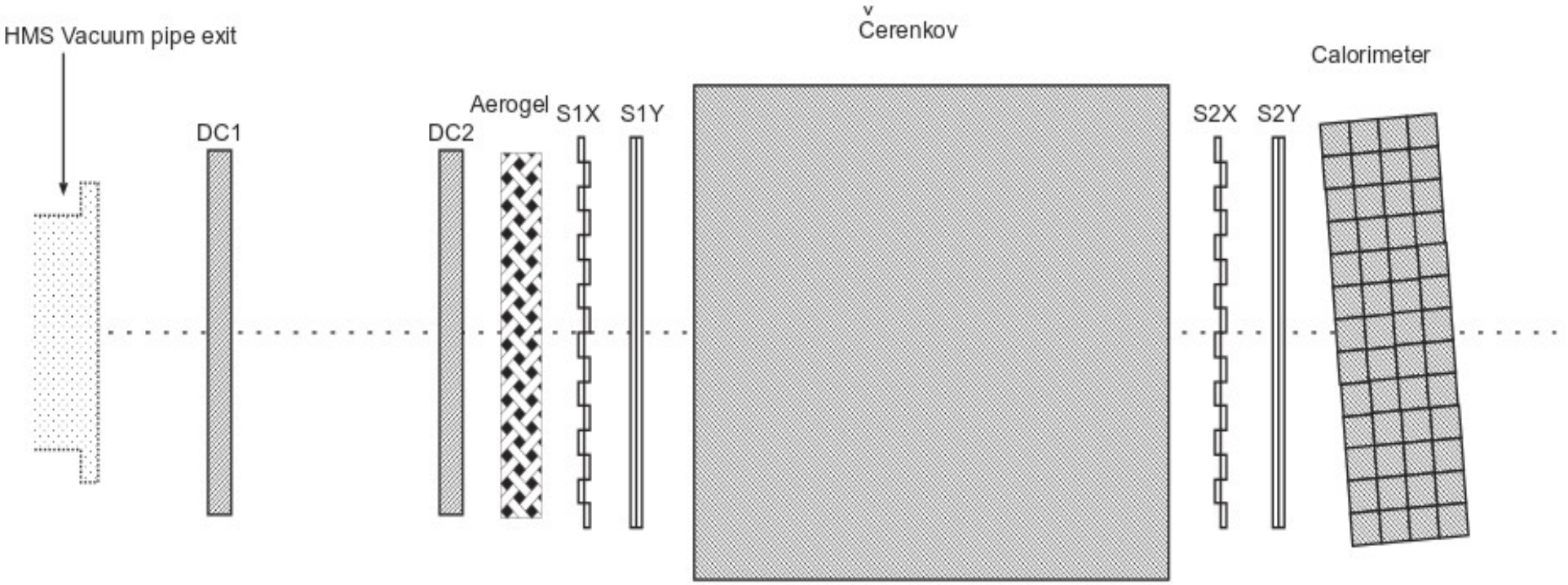
  Mark Jones
- HMS/SOS Tracking Code Enhancement

  T. Navasardyan , P. Bosted , M Jones

Outline:

- THcCherenkov
  - CoarseProcess: Pedestal subtracted ADC value and number of photo electrons
  - FineProcess: fCerFiredCounter (Track with engough Cherenkov NPEs)
- ThcHodoscope::FineProcess() determines following quantities using track info
  - Beta
  - Time at focal plane
  - fGoodScinHits(If we have hit only inside fiducial area and slope is not too large)
- THcHallCSpectrometer::TrackCalc() has three methods to decide Golden track. Flag of each method is in the PARAM file.
  - Golden track by least chi square / NDF value
  - Golden track by scin method
  - Golden track by prune method
- Explanation of large chi square differences
- Single fiducial tracking efficiency
- Work to do

Schematic of the HMS det ector package showing approximate detector locations along the central ray .The detectors are all located within the concrete-shield HMS detector hut.



Class Hierarchy (an example)

THaAnalysisObject

↓

THaDetectorBase

↓

THaDetector

↓

THaSpectrometerDetector

↓

THaNonTrackingDetector

↓

THcAerogel, THcCherenkov, THcHodoscope, THcShower

- h_trans_cer.f is written as THcCherenkov::CoarseProcess
- h_cer_eff.f is written as ThcCherenkov::FineProcess

hcana class hierarchy is given at:

https://hallcweb.jlab.org/hcanadoc/ClassHierarchy.html

THcCherenkov

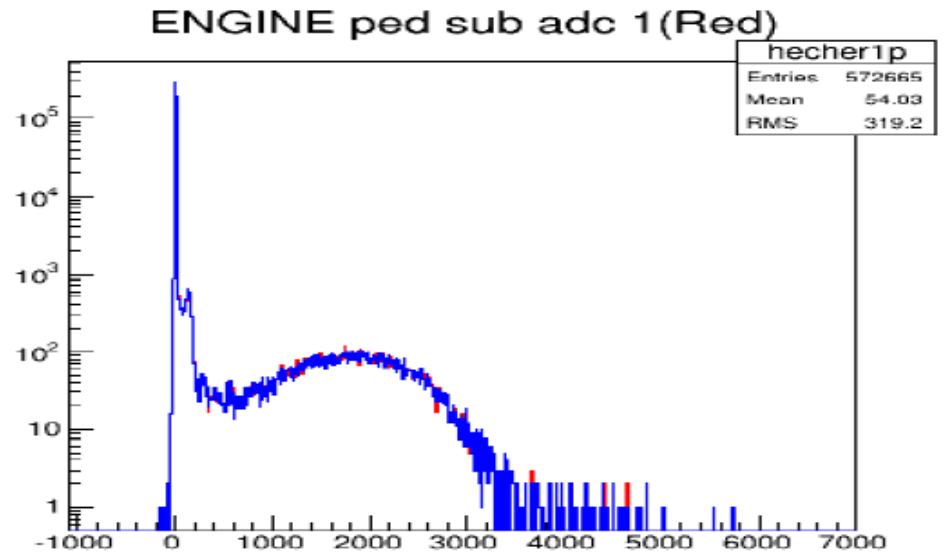
- Coarse process:
  - HMS Cherenkov detector has two PMTs. Loop over PMTs and number of PMTs can be set in PARAM file.
  - Pedestal subtracted ADC value (ADC_p)
  - NPE = Gain * ADC_p

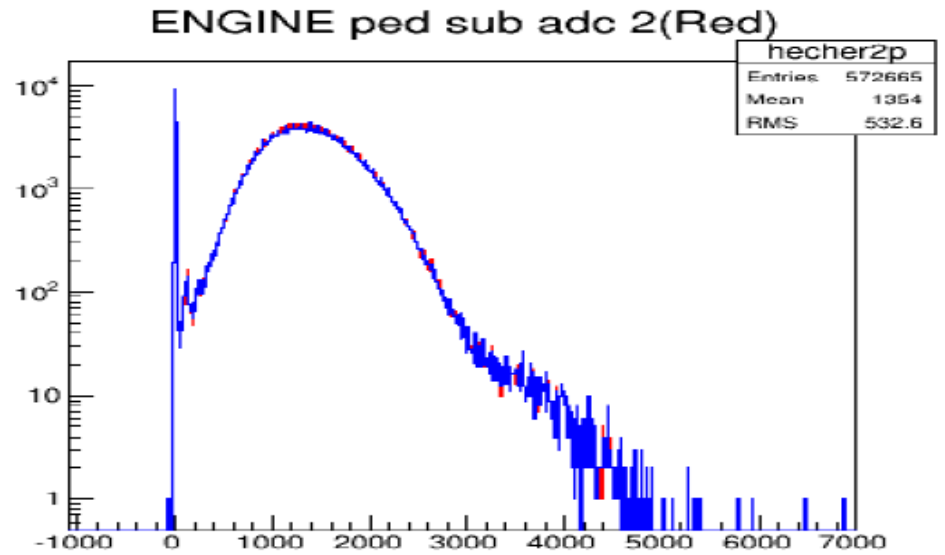
- Fine process:
  - Analyze cherenkov information for the "best track" (Golden track)
  - If track's chi-square / NDF is with in the range
  - If track's beta is with in the range
  - If track's energy is with in the range
  - If track is inside a region then increment the 'should have fired' counters (fCerTrackCounter)
  - If there are enough NPE then increment the 'did fire'

    counters (fCerFiredCounter)

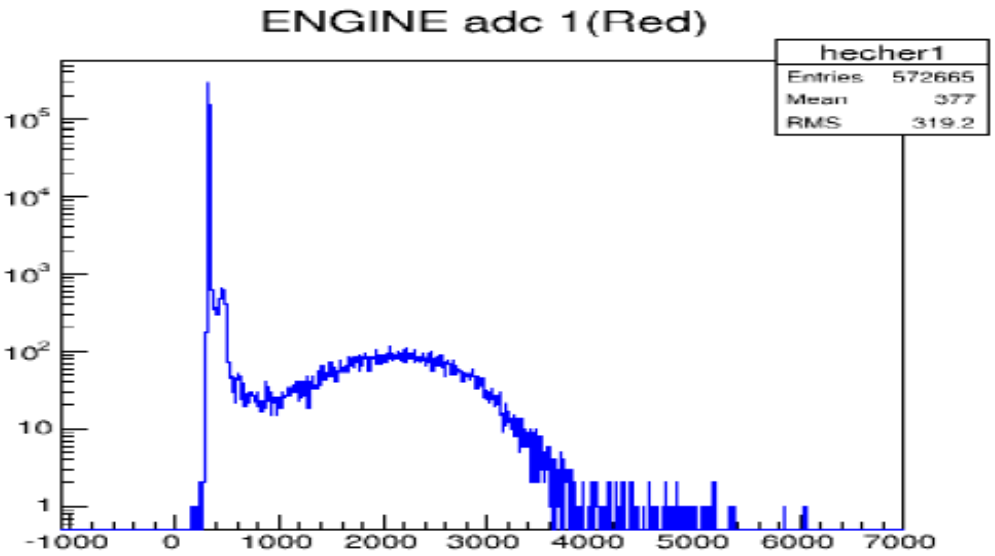
ThcCherenkov::CoarseProcess
Pedestal subtracted ADC values. ENGINE in red and hcana is in blue.
500,00 events of Run 52949 are analyzed.

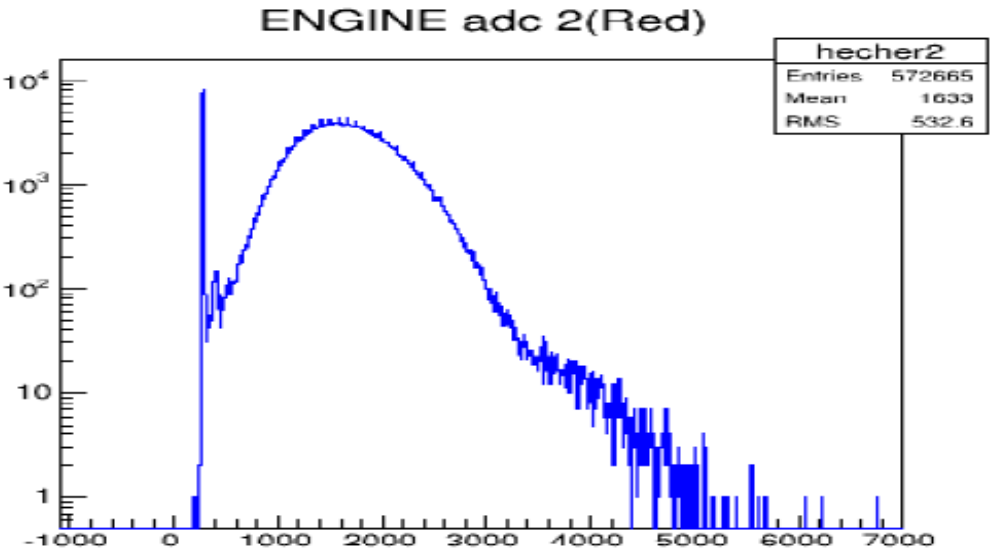
- pedestal value is Integer in ENGINE and real number in hcana





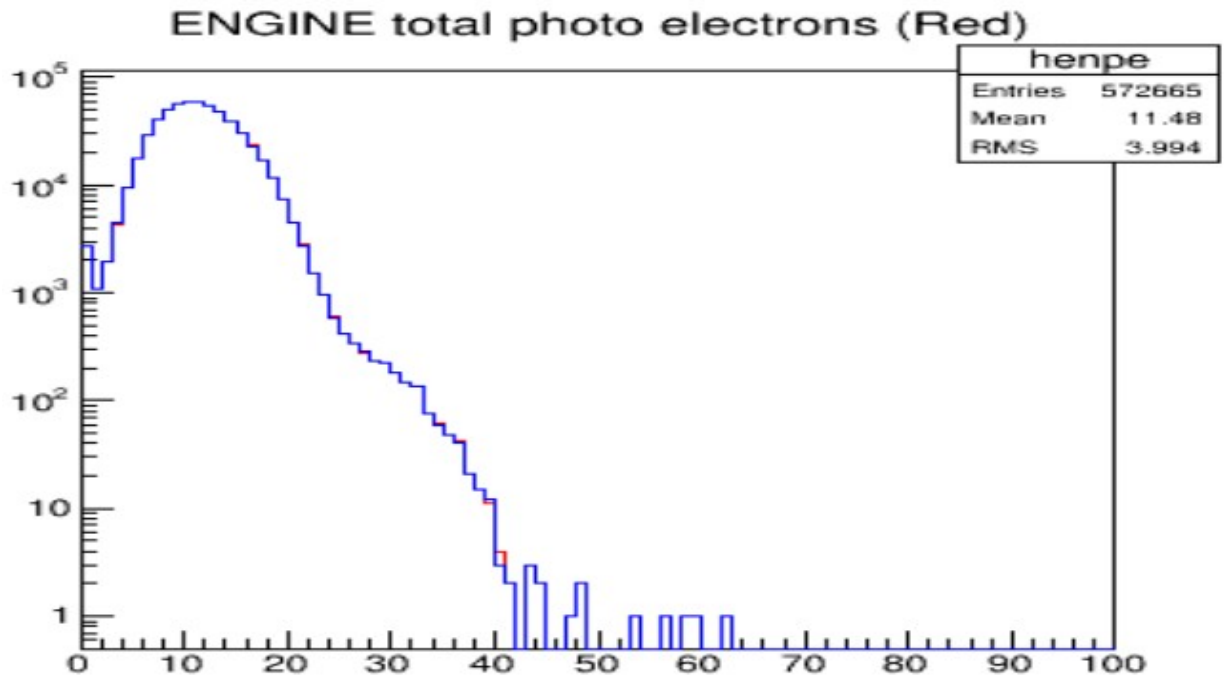
- pedestal value is real in ENGINE and hcana



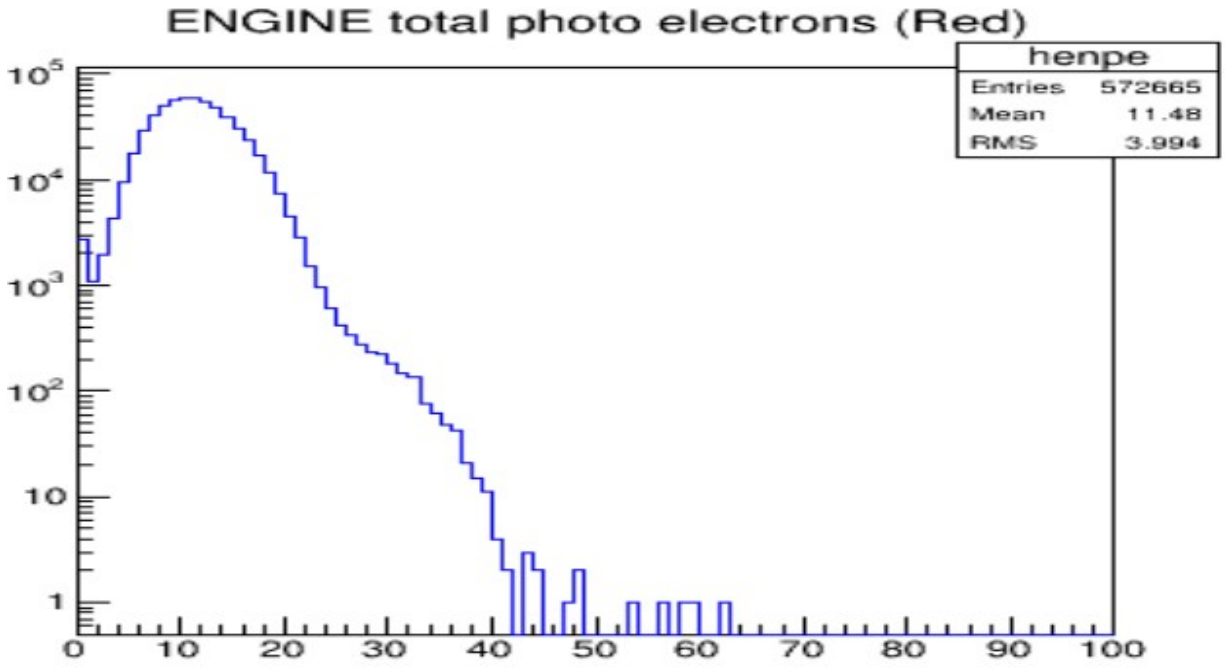


ThcCherenkov::CoarseProcess, NPE sum

- pedestal value is Integer in ENGINE and real number in hcana



- pedestal value is real in ENGINE and hcana

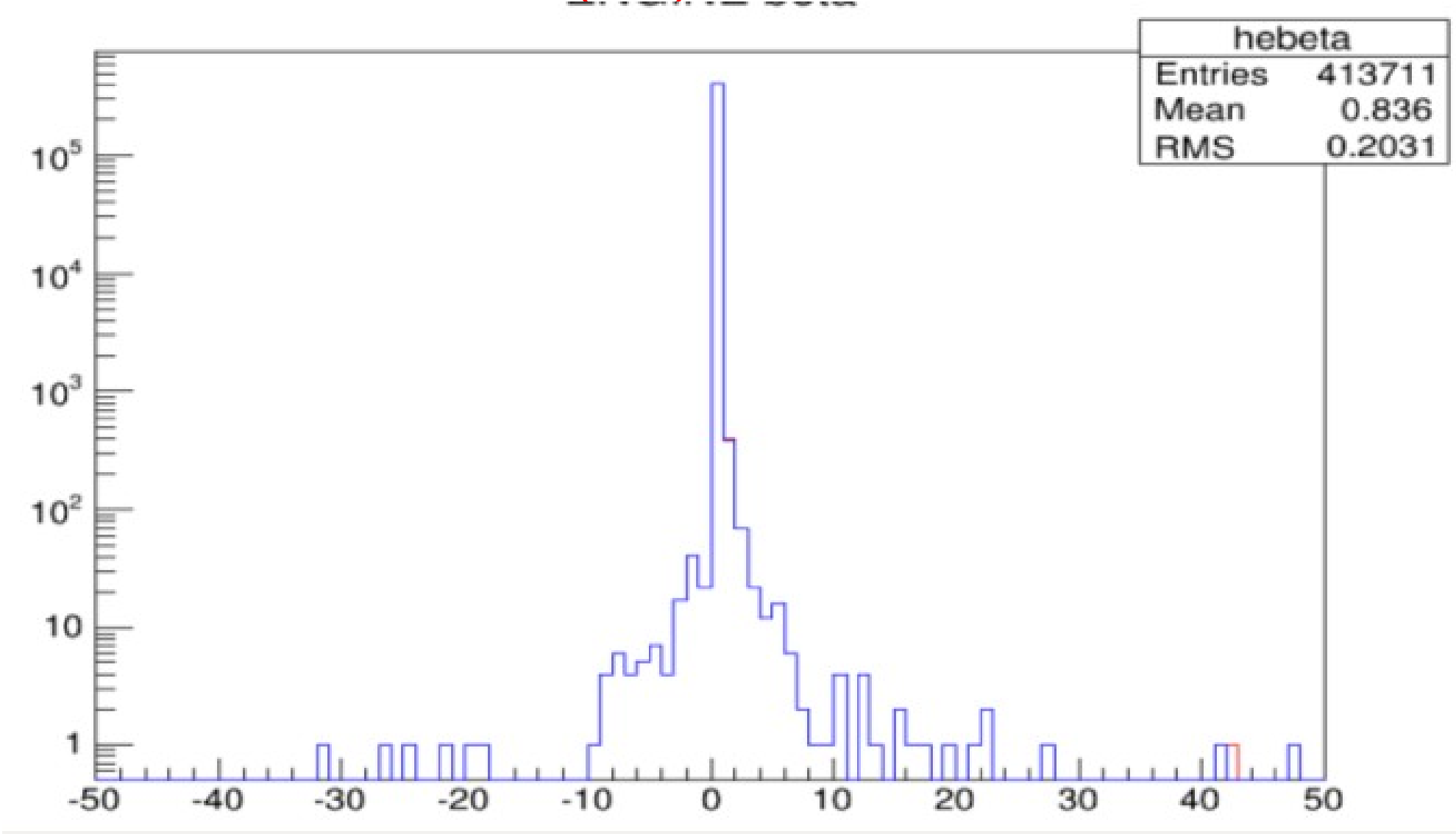


ThcCherenkov::FineProcess

- hcana 52941
- Event = 51000 region = 1 track counter = 5328 fired counter = 5322
- Event = 51000 region = 2 track counter = 4419 fired counter = 4417
- Event = 51000 region = 3 track counter = 12685 fired counter = 12675
-
-
- ENGINE 52941
- Event = 51000 region = 1 track counter = 6499 fired counter = 6491
- Event = 51000 region = 2 track counter = 3822 fired counter = 3820
- Event = 51000 region = 3 track counter = 13104 fired counter = 13092

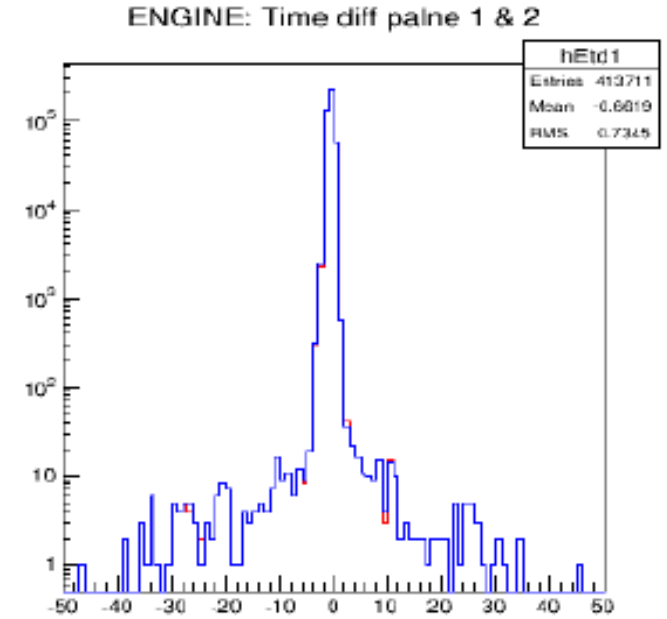
ThcHodoscope::FineProcess()Beta of a track

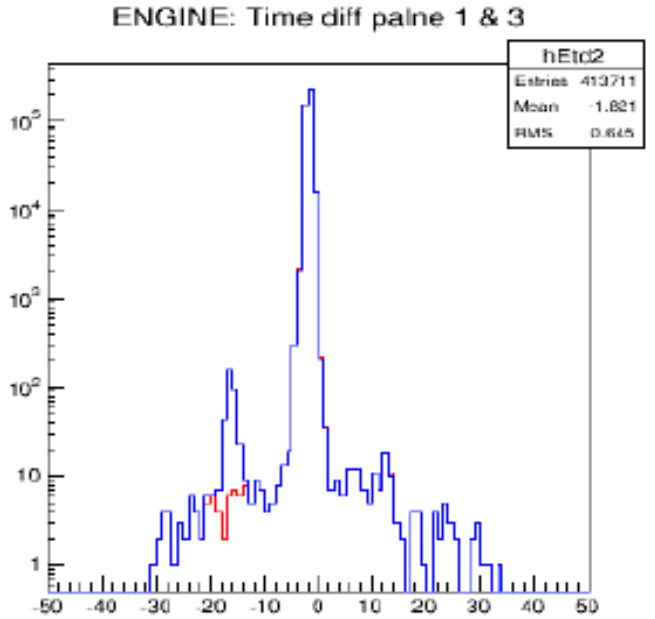
500,000 events of Run 52949 are analyzed.
Precision of value of beta is rounded to second decimal place.
In this figure the value of beta from hcana(Blue) is plotted over the value of beta from ENGINE(Red) .

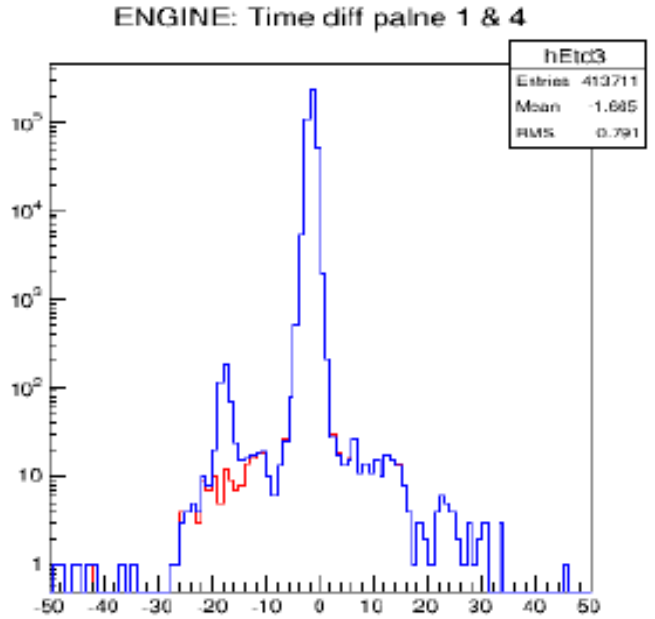


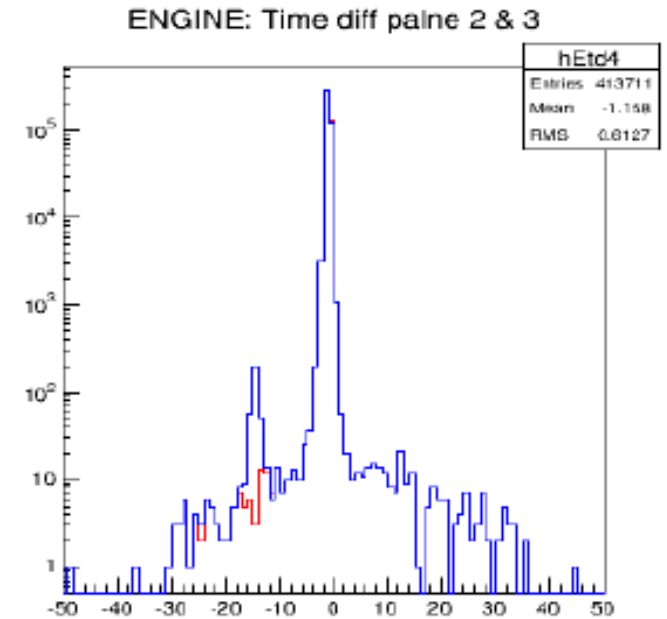
FpTimeDif Combination of difference of FP time for each of the four Hodoscope planes

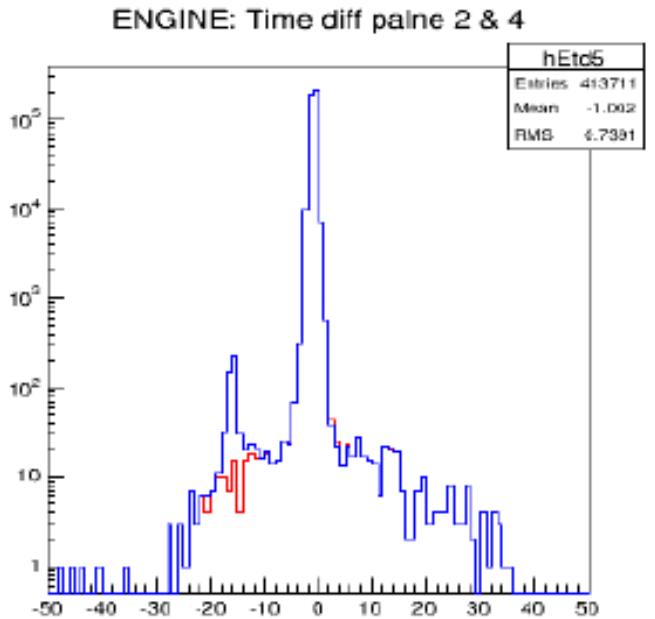
- ENGINE histograms are in blue and hcana histograms are in red. The reason of difference is that in ENGINE for some tracks the value of momentum is negative.

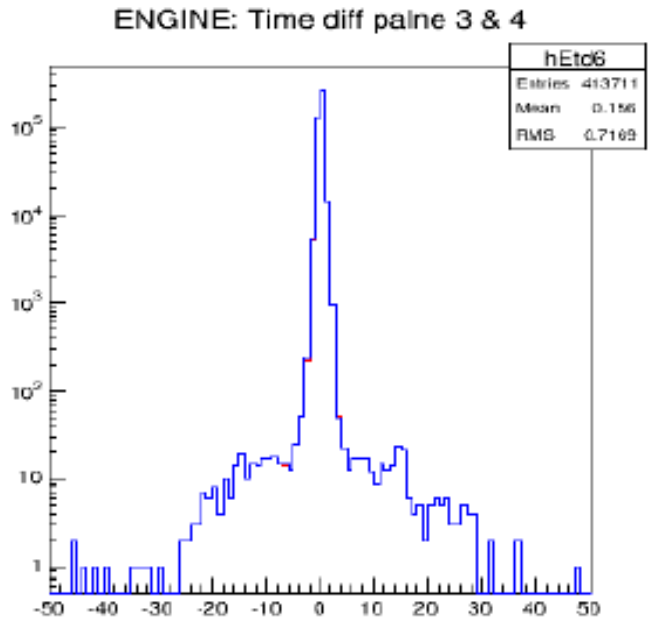




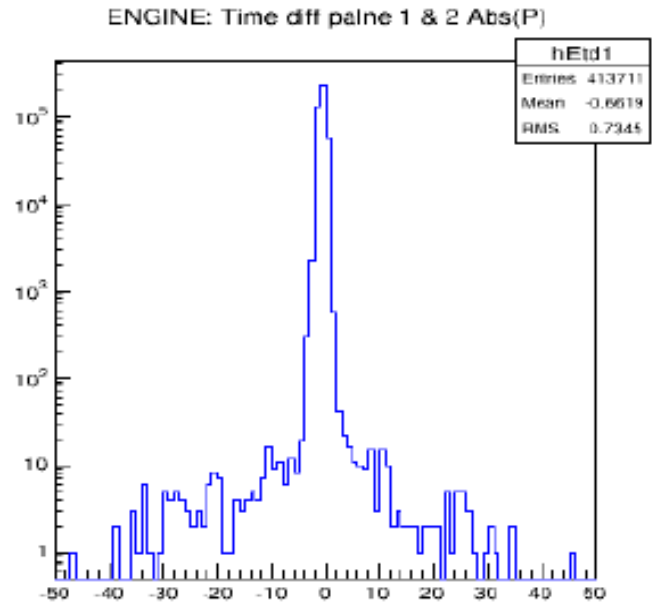


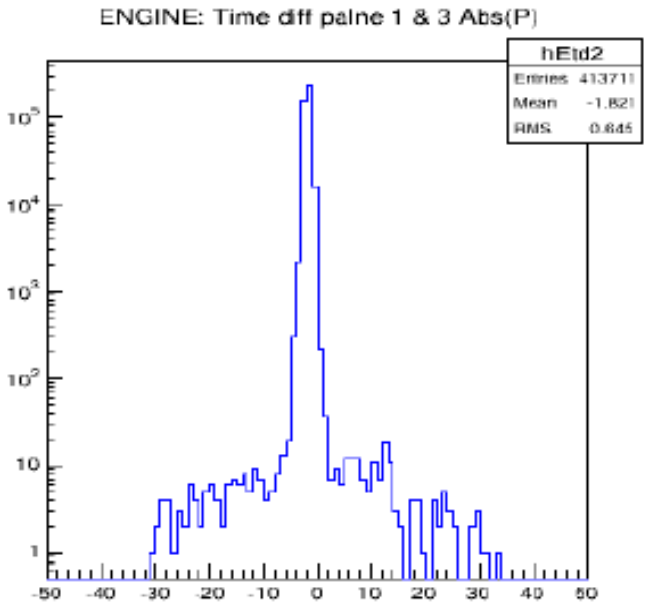


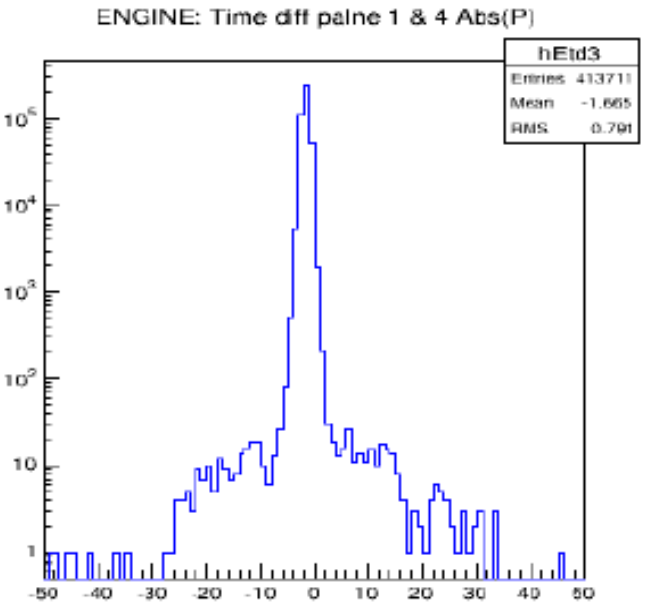


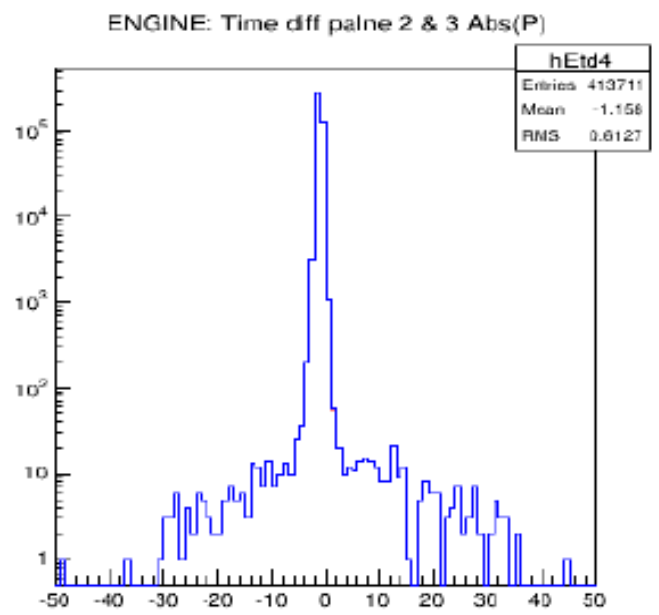


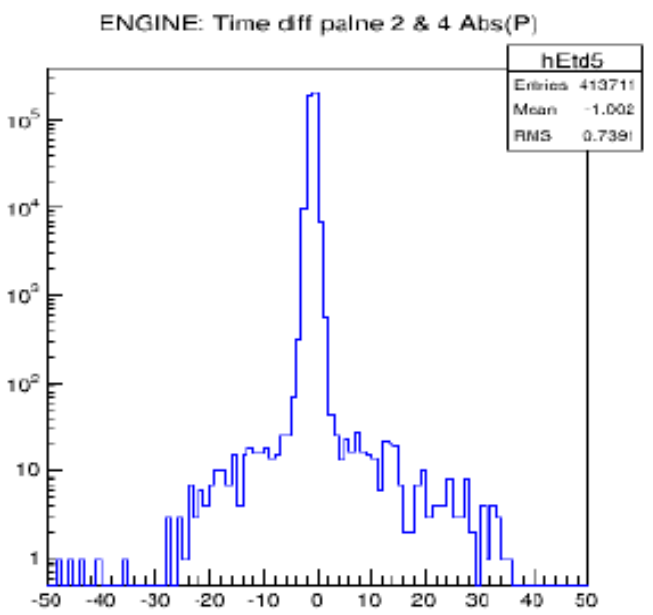
If we use absolute value of track momentum in h_tof.f then we have an agreement between ENGINE and hcana. Still two events are different.

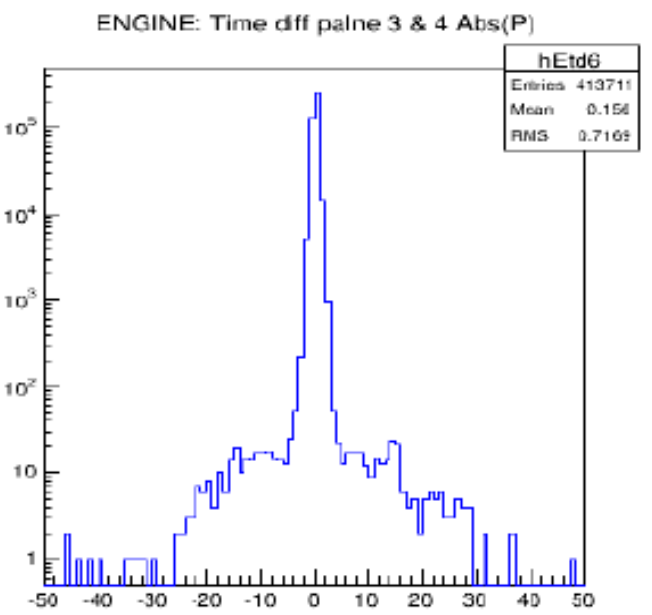












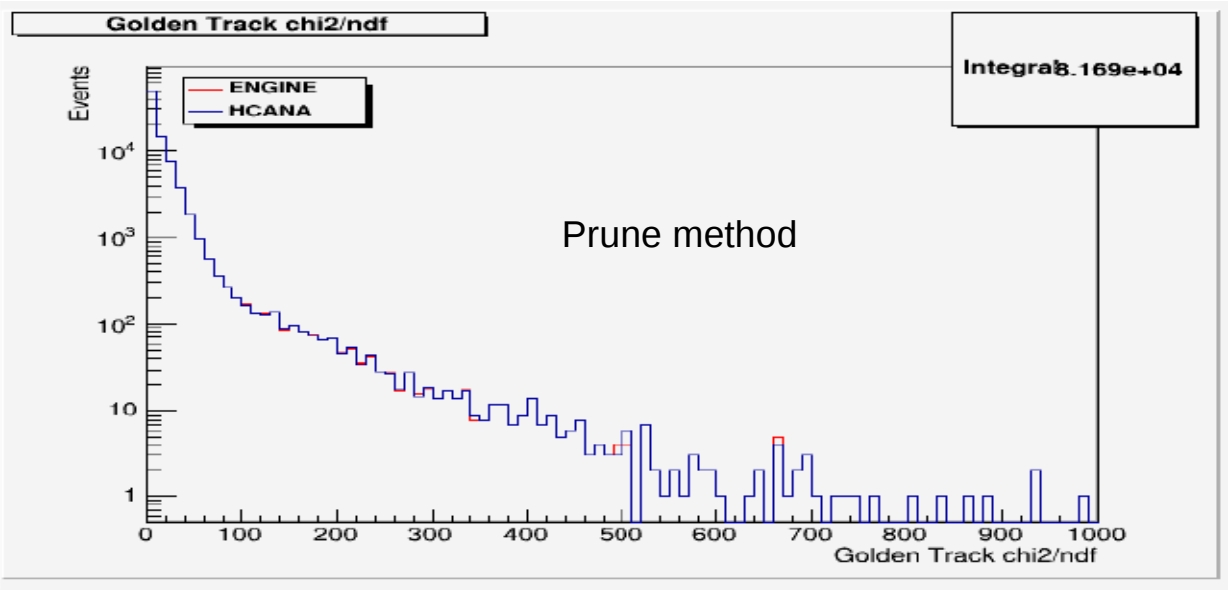
ThcHallCSpectrometer::TrackCalc()

It selects Golden track by three different methods

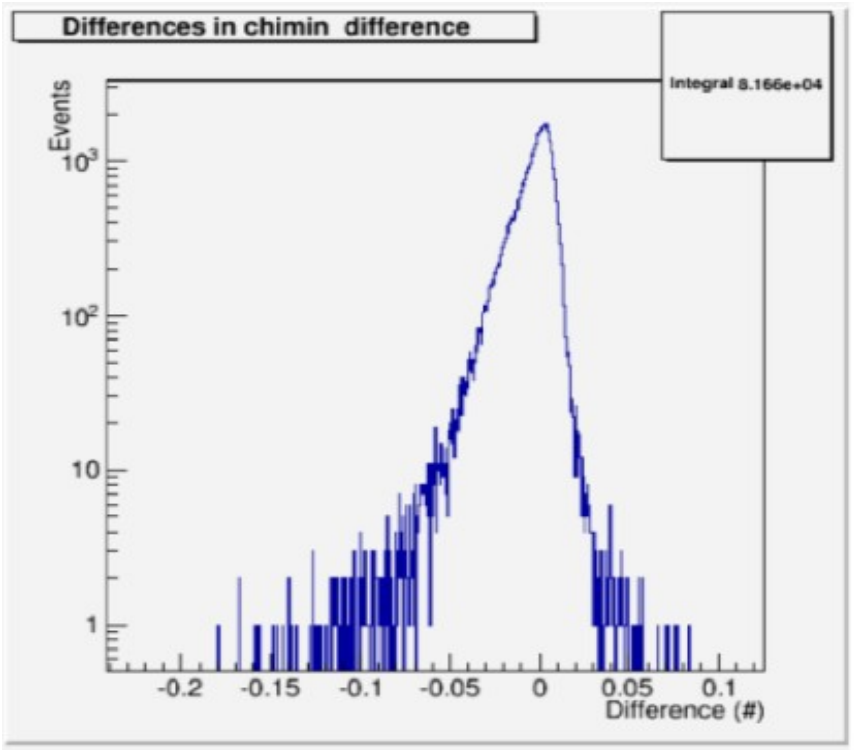
- Golden track by least value of chi square / NDF
- Golden track by scin method
  - Select the best track through the HMS by seeing which track is closest to S2y or if no S2y then use closest to S2x
  - If still have more than one tracks then select the track with smallest chi-square.
- Golden track by prune method
  - First loop over these quantities xp, yp, ytar, delta, shower energy, time of flight, beta, number of degrees of freedom of the track, chi-square, number of PMT hits on the track (within time cuts), the chi-square of the beta, the focal plane time relative to the nominal time, a hit in SY2 and a hit in SX2 to reject tracks which have greater value of any of these quantity
  - If still more than one tracks then select the track with smallest chi-square

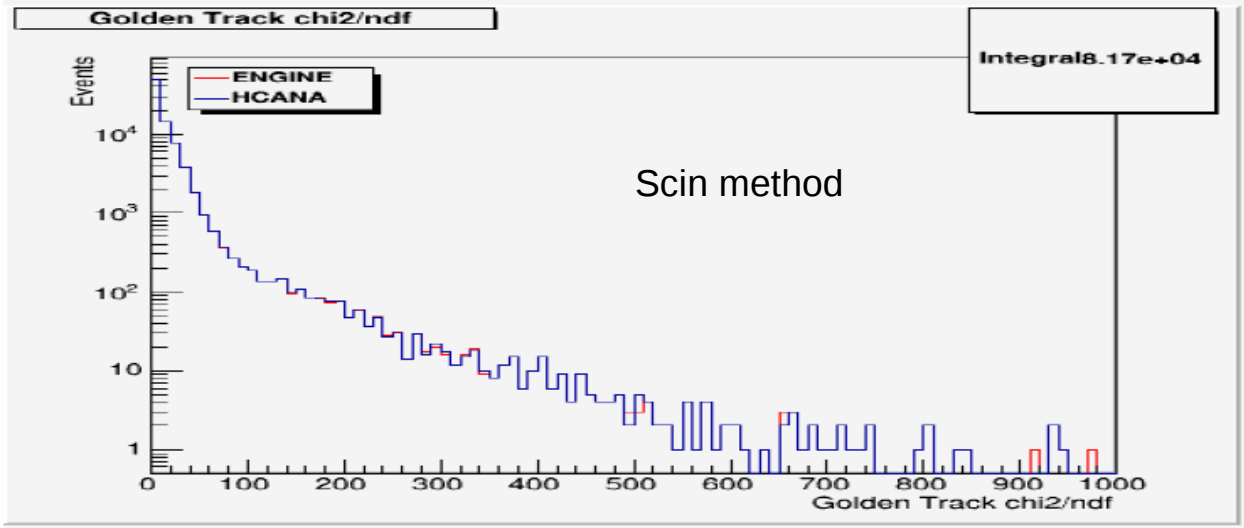
Golden Track using scin and prune method (Drift chambers)

- First 100,000 events of run 52949 are analyzed
- 25 Events for which the difference of chi square is more than 5 (scin method)
- 12 Events with different value of index of Golden track. (scin method)

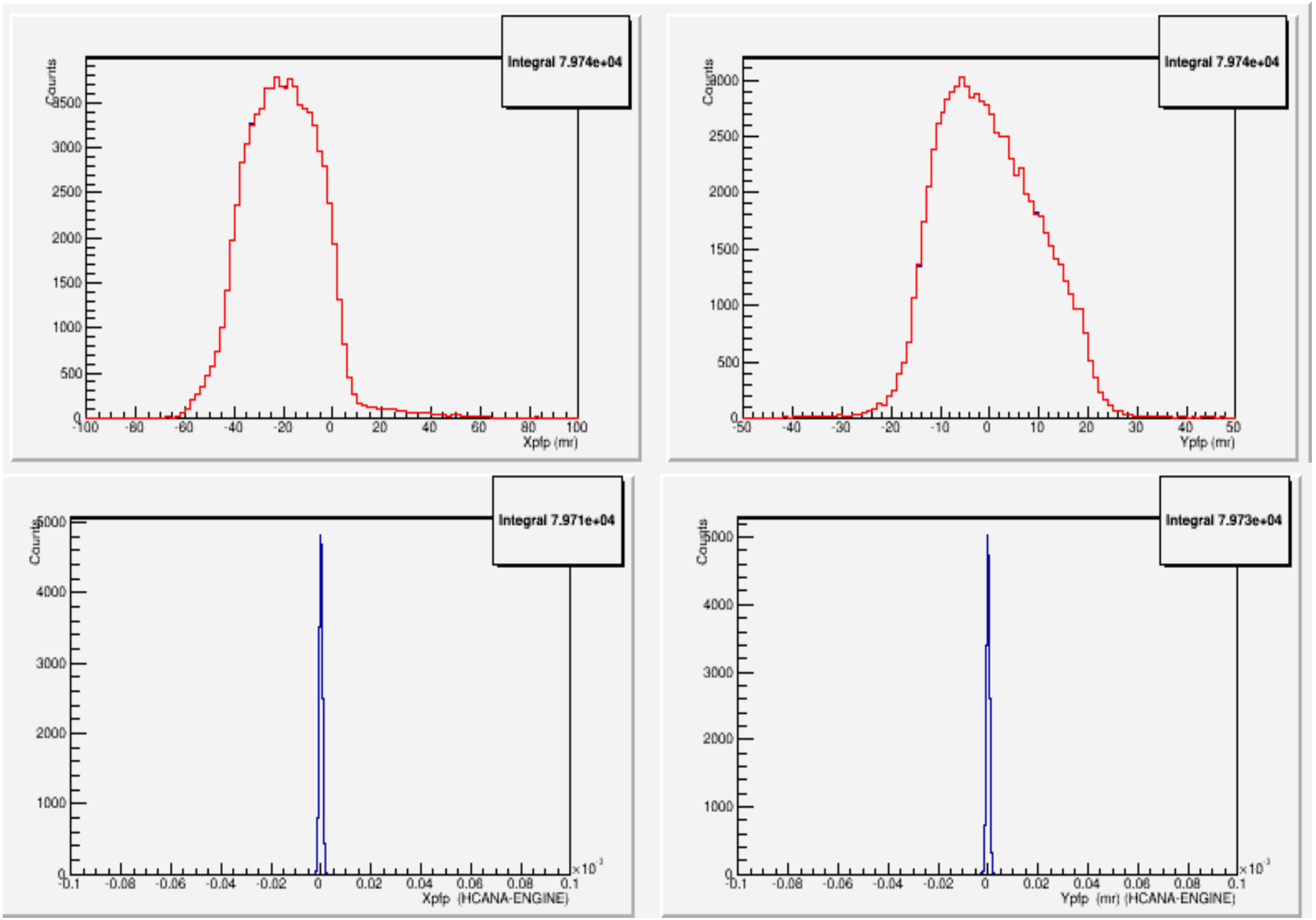


- **ENGINE(chi square / ndf) - hcana(chi square / ndf)**





Focal plane and angles. ENGINE in red and hcana in black



- This is taken from: https://hallcweb.jlab.org/wiki/images/4/41/Fp_ang_one.png

Difference of chi square
Run: 52949, Event: 3652
ENGINE chi square = 116, hcana chi square = 653

- This condition, **if (Tmath::Abs(xp_fit – xp_expect) < fStubMaxXPDiff)**

  in THcDriftChamber::LeftRight() changes the sign of “plusminus” between ENGINE and hcana

  ENGINE Abs(xp_fit-xp_expect) = 4.99978289E-02 fStubMaxXPDiff = 5.0000000E-02

  hcana Abs(xp_fit-xp_expect) = 0.0500072 fStubMaxXPDiff = 0.05

- Opposite sign of “plusminus” results in different value of “w_cor”

  w_cor = wire_center + plus_minus * drif

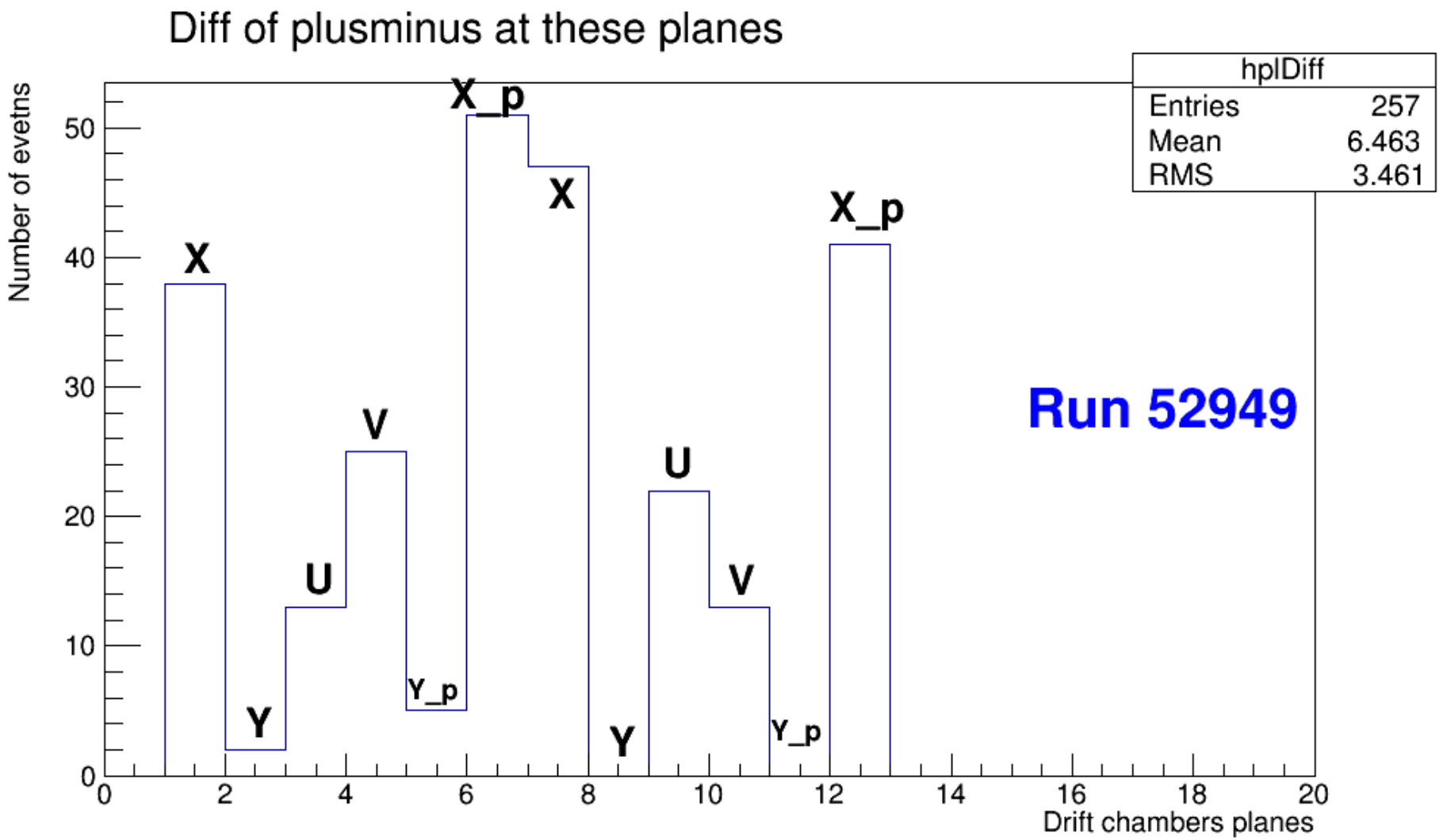
  ENGINE(h_left_right.h) hit = 9 wire_center = -17.385033 plus_minus = -1.0000000 drif = 0.44512597 w_cor = -17.830158

  hcana (THcDriftChamber::LeftRight()) hit = 9 wire_center = -17.385 plus_minus = 1 drif = 0.445238 w_cor = -16.9398

- Different values of “w_cor” results in large difference in chi square:

```
ENGINE: plane =  9   w_cor = -17.830158  chi2 =  34.923569
hcana:  plane =  9   w_cor = -16.9398    chi2 =  225.367
```

Difference of “plusminus” at these planes of drift chambers



Single Tracking Efficiency

- SING FID TRACK EFFIC = $\frac{hdid}{hscinshould} \pm \sqrt{\frac{hscinshould - hdid}{hscinshould + 0.0001}}$

- At the end of each event analysis “hscinshould” is incremented by one if:
  - We have hit only in our desired range of x and y but not outside of it
  - if the slope of track along x and y is not too high
  - if we have all the four planes of hodoscope are hit (for 4/4 trigger)
  - We have at least two photo electrons in Cherenkov detector
  - The ratio of energy deposit in calorimeter to the central momentum is more than .7
- “hdid” has same conditions mentioned above and if there is at least one track

Work to do

- Super SHMS code is also almost complete.
- For SHMS code we just need to change PARAM files for Drift Chambers, Hodoscope, Cherenkov and Aerogel detectors.
- Calculate the tracking efficiency using hcana
- Reproduce the tracking efficiency results of the report by Tanja Horn using hcana

Extra Slides

Code flow of hcana

(1) Loops through each apparatus calling Decode method

(i) THcDC::Decode

(a) Gets raw data form hitlist

(b) Loops thru chambers and calls fChambers[ic]->ProcessHits which fills THcDCHIT

(ii) THcHodoscope::Decode

(a) Gets raw data form hitlist

(b) Loops through each plane

(1) fPlanes[ip]->ProcessHits(fRawHitList,nexthit)

(2) all hits in plane: fPlanes[ip]->PulseHeightCorrection()

(3) Loops over fPlanes[ip]->GetNScinGoodHits to set fStartTime

(iii) THcShower::Decode

(a) Gets raw data form hitlist

(b) Loops through layers and calls fPlanes[ip]->ProcessHits(fRawHitList, nexthit)

Code flow of hcana

(2) THaSpectrometer::Reconstruct()

(i) Track() which calls THaSpectrometer::CoarseReconstruct()

(a) Calls THaSpectrometer::CoarseTrack

which Loops through tracking detectors and calls its CoarseTrack

THcDC::CoarseTrack find all tracks with focal plane quantities

(b) Loops through each apparatus calling CoarseProcess method

(1) THcHodoscope::CoarseProcess determines beta using track info

(2) THcShower::CoarseProcess fills THcShowerHit, THcShowerClusterList

and using track focal plane info to match tracks and clusters.

(ii) Loops through tracking detectors and calls its FineTrack

(iii) THcHallCSpectrometer::FindVertices

(a) Reconstruct target quantities and fill track momentum

(b) Loops thru nontracking detectors calling their FineProcess

(c) Calls ThcHallCSpectrometer::TrackCalc() which fills Golden track

(d) Calls CalcPID which combines PID info using ThaPIDinfo class.