## Notes about the neutron arm

Monday, October 22, 2007

- Neutron Detector Geometry
  - See documentation by Tim Ngo
  - Some modifications need to be made about Marker Bar location
  - Spreadsheet of values is available.
    - Location of Plumb Bob is taken as center location of neutron arm
      - Z is along the Beam Line
      - Yis horizontal, X is vertical.
- Neutron Detector Electronics
  - F1Fastbus for Neutron Detectors
    - F1 is a multihit TDC
  - $\circ$  1877 for Veto detectors and sums
  - **1881 for ADC**
  - 1850 for coincidence time info
  - Information about HV located in logbooks
  - HV info <u>http://hallaweb.jlab.org/experiment/E02-013/wiki/tiki-index.php?</u> page=BH+HV&highlight=HV
- Trigger
  - Coincidence time given by D.ctimeL1A
  - See great Wiki article D.ctimeL1A for full information -<u>http://hallaweb.jlab.org/experiment/E02-013/wiki/tiki-index.php?page=D.ctimeL1A</u>
  - Trigger formed of OR of L OR R Sums
  - http://hallaweb.jlab.org/experiment/E02-013/wiki/tiki-index.php?page=GenDocTrigger
- Database
  - THaScintPlane::ReadDatabase is the method
  - Sets up Detector Map (used in decoding) fDetMap
    - Loads in crate, slot, lo, hi, model, refindex for reference channels (first section)
    - Loads in crate, slot, lo, hi, model, refindex for left PMTs (second section)
    - Loads in crate, slot, lo, hi, model, refindex for left PMTs (third section)
    - Finds ADC detector map, loads in usual info (no refindex) for left then right
  - calib section
    - Goes through and reads lres and rres THaScintPMT(1,0,lres/rres)
    - Reads in info for THaScintBar
    - x, y, z, dx, dy, dz
      - General info from geometry
    - xw, yw, zw
    - c, att
    - Igain, Iped, Ires, Itoff, Iwalk, Ilowtdclim, Iuptdclim, Iwrapa
    - rgain, rped, rres, rtoff, rwalk, rlowtdclim, ruptdclim, rwrapa
  - $\circ \quad \text{Other may sections include:} \\$ 
    - left/right pedistals
    - left/right gain
    - Ieft/right toff
    - speed of light
    - attenuation
    - Ieft/right walkcor
    - Ieft/right walkexp
    - bar\_geom
  - Global Database infored in by THaNeutronDetector class
    - .global section
      - Contains plane name and description information

- Creates THaVetoPlane (planename, planedescr, this)
- Creates THaScintPlane (planename, planedescr, this)
- Decoding
  - NA decoding in THaScintPlane :: Decode
  - evdata.IsPhysicsTrigger is false means event isn't decoded
  - Gets reference channel GetNRefCh() for the ID (Integer)
  - ! Should only be 1 hit. GetNumHits(crate, slot, chan)
  - data is given by GetData(crate, slot, chan, 0)
  - Reference channel gets a TDC hit THaTdcHit(pmt, data)
  - Goes through all channels (between hi and lo detector)
  - For each channel, gets number of hits GetNumHits(crate, slot, chan)
  - Loops through hits
    - GetData(crate, slot, chan, hit) returns data
    - If (Adc) fills Adc array THaAdcHit (pmt, data)
    - If (Tdc) fills Tdc array THaTdcHit (pmt, data, timeoff)
      - □ Compares data reference time to wraparound (GetRawWrapAround)
      - For diff<-wrap/2 time off = ref time wrap \* resolution</p>
        - □ For diff>wrap/2 time off = ref time + wrap \* resolution
        - □ Else time off = ref time
        - □ Time returned in Tdc is Updated Time (real time and includes timeoff and toff)
    - ! Cut on Tdc, reference hit must exist for Tdc hit
    - ! Note all indexs are separate, Adc/Tdc cannot be compared (indexs)
  - Forms 'flat arrays'
    - Index is GetBarNum
    - rawA is GetRawAmpl()
    - pedcA is GetAmplPedCor
    - Eis GetAmpl
    - ! Only first Time is entered
    - Tis GetTime
- Read Out
  - <u>http://hallaweb.jlab.org/experiment/E02-013/wiki/tiki-index.php?</u>
    - page=Neutron+Detector+Analysis
  - http://hallaweb.jlab.org/experiment/E02-013/wiki/tiki-index.php?page=NA+software+variables
  - $\circ~$  As described, raw data information is in the form <code>lthit\_bar</code>
  - ? Comment in documentation, 'flat arrays' are depreciated
- CoarseProcess
  - In THaScintPlane Class
  - Sorts Hits by bar number, then value (earliest or highest amplitude first)
  - 2 Versions BuildCompleteBars + CombineHits or BuildAllBars
  - BuildCompleteBars:
    - Loops through Left Hits
    - If hit isn't within time range (pmt->GetRawLowLim() || pmt->GetRawUpLim() ) set 0
    - Do same for right time hit
    - If left hit exists and right hit exists, and left/right amplitude exists, hit is 'complete'
    - Times are time walk corrected (TimeWalkCorrection)
    - tdiff = .5 \* (rtime ltime)
    - tof = .5 \* (rtime + ltime)
    - yt = tdiff \* cn (cn is GetC())
    - Iamp/ramp is GetAmpl
    - amp = sqrt ( lamp\*ramp )
    - ya = log (lamp/ramp) \* .5 \* att (%GetAtt) + GetYPos()
    - THaScintHit (ptBat (%THaScintBar), 0, bat, yt + GetYPos(), tof, amp, tdiff)
  - CombineHits
    - Sorts by bar number

- Must have a hit
- THaMultiHit
- I Checks to see if GetHitEdep() > fThreshold
- Combines neighboring bars (within a plane) with hits
- FineProcess
  - In THaNeutron Detector Class
  - Loops through planes and hits
    - If GoodHit, then creates a THaScintHit from that hit (in fSingleHits)
    - GoodHit tests to make sure that GetHitYPos GetYPos < fHitLRMatch\*GetYWidth</li>
      This makes sure that the values for Left Right are reasonable
  - Creates Clusters
    - Sorts fSingleHits and indexs them
    - Hits are only used in one cluster
    - Creates THaMultiHit from first hit, and AddNeighbors (loops)
      - AddNeighbors is called recursively
      - To be added, must be within fClustTimeWindow
  - Sorts Clusters by Energy
  - Match Clusters to Veto MatchToVeto
    - Points from cluster back to target and looks for related hitsin Veto (2 veto bar window)
    - Checks THaScintHit->GetBarNum versus Veto Bar Number (by geometry)
  - Creates tracks BuildTracks
    - Defines position of hit, position of target, and vector between them
    - Creates track THaNDTrack
      - □ Theta is X/Z
      - Phi is Y/Z
    - ApparatusToLap to get Hall Coordinate Position of hit
    - Sets pathlength (na.tr.pathl variable)
    - Sets p vectors (only direction is correct) na.tr.pz / etc variables
    - ! Beta and Mom here are wrong (but not used?)
- Calibration
  - Veto Time Calibration
  - Neutron Time Calibration
    - Numerous Reports
- Analysis
  - sqrt(na.tr.pathl\*\*2+B.tr.vz\*\*2 -2\*na.tr.pathl\*B.tr.vz\*na.tr.pz/Norm)
    - Norm is the normalized momentum track vectors
  - BetaInv = (na.tr.time (same, and runs with, cluster time) (BB time RF time) +.05\*D.ctimeL1A[0] expected time) / pathlength \*.3
  - Momentum = .939/sqrt(Betalnv\*\*2 1)
    - Only for BetaInv>1
- Efficiency
  - Veto