Joint Hall A & C Data Analysis Workshop

• **Analysis Workshop** held June 25-26, 2018
• Great starting point for new users unfamiliar to the software
• **Git Repo** for interactive sessions covering wide range of topics

---

**Program**

**Monday, June 25, 2018**

**Morning Session**
(Chair: Mark Jones)

- **General**
  09:00  Welcome -- Ole Hansen
  09:05  Overview & Update on Hall A Analysis Software -- Ole Hansen
  09:30  Overview & Update of the Hall C Analyzer -- Eric Pooser

- **Hall A Analysis**
  10:00  Hall A optics optimization -- Tong Su
  10:30  Optics for mistuned spectrometers -- Eric Christy
  10:45  Coffee Break
  11:00  Beam energy determination -- Doug Higinbotham
  11:30  Using MySQL databases in analysis (*) -- Shujie Li
  12:00  Tritium replay on farm, analysis organization -- Tyler Hague
  12:30  Lunch (on your own)

- **Afternoon Session**
  (Chair: Ole Hansen)
  **Farm Use and Workflow Tools**
  13:30  Farm Use and Computing Resources Tips and Tricks -- Brad Sawatzky
  - Overview of JLab Computing Resources and Tools (*)
  - Common problems and how to avoid them
  - hcsweb: Quick and easy SWIFT job submission wrapper (*) -- John Matter
  - Question and Answer! (What are your problems, irritations, puzzles?)
  15:30  Coffee Break
  Using Python for Analysis Part I
  15:45  Hall A event visualization using Python -- Tyler Kutz
  16:00  Python Analysis Tutorial -- Eric Pooser
  17:00  Adjourn

**Tuesday, June 26, 2018**

**Morning Session**
(Chair: Eric Pooser)

- **Hall C Analysis**
  09:00  Effective Git use (*) -- Steve Wood
  10:00  Hall C Spectrometer Optics and Optimization -- Holly Szumila-Vance
  10:30  Coffee Break
  10:45  Cherenkov Analysis -- Abel Sun
  11:10  Calorimeter Analysis -- Vardan Tadevosyan
  11:30  Hodoscope Analysis -- Carlos Yero
  11:50  Drift Chamber Analysis -- Abishek Karki
  12:15  Lunch (on your own)

- **Afternoon Session**
  (Chair: Brad Sawatzky)
  **Intermediate-Level Analysis with ROOT**
  13:30  Linear analysis -- Mark Jones
  14:15  Updates & Introduction to Jupyter Notebooks (*) -- Ole Hansen
  14:30  Reading and processing trees (part 2) (*) -- Ole Hansen
  15:30  Coffee Break
  Using Python for Analysis Part II
  16:00  Python Analysis Tutorial continued (*) -- Eric Pooser
  17:00  Adjourn

---

Eric Pooser

01/28/2019

Hall C Winter Collaboration Meeting
Updates to HCANA: **b1ad79e & 66771fa**

- Per PMT timing cuts have been integrated into both calorimeter and aerogel detector classes
  - HMS Calorimeter (**THcShower**)  
    - `cal_pos(neg)_adcTimeWindowMin(Max)`
  - SHMS Calorimeter (**THcShowerArray**)  
    - `cal_arr_adcTimeWindowMin(Max)`
  - SHMS Pre-Shower (**THcShower**)  
    - `cal_pos(neg)_adcTimeWindowMin(Max)`
  - Aerogel (**THcAerogel**)  
    - `aero_adcPos(Neg)TimeWindowMin(Max)`
- Determines 'Good' FADC hit for each detector channel
  - One hit per event
• New hodoscope calibration procedure
• Utilizes FADC timing and pulse amplitude information to perform the time-walk calibration for each PMT
• Decouples calibration procedures into individual components

Updates to HCANA: a0d4684

Plots courtesy of Carlos Yero

Eric Pooser
• **THcRaster** has been updated to utilize the BPM information from EPICS

• Calculates the beam position and direction at the target as inferred from the BPMs

• Tree variables for the three BPMs and projection to the target in the EPICS coordinate system have been added

• The calculation of beam at the target utilizes A & C

• Raster variables are now in the EPICS coordinate system as it makes it easier to interpret the carbon hole runs
• **THcExtTarCor** now has tree variables that calculate **xsieve** and **ysieve** for the spectrometer

• Both **xsieve** and **ysieve** variables are also calculated for the golden track

• The calculations depend on the spectrometer i.e. the SHMS calculation includes a delta dependence when calculating sieve

• **THcHallCSpectromoter** now handles mispointing according to the input angle if the mispointing is not set by a parameter
  
  • The formula for mispointing comes from fits to surveys

• It is possible to set custom mispointings via (p)hmisspointing_x(y) in standard.kinematics
Updates to HCANA: 4a7af64 & 4d4418d

- Drift chamber classes updated to include a per wire sigma parameter
- `(p)h_using_sigma_per_wire` is optional and turned off by default
- When the per wire configuration is not being utilized then the sigma per plane parameters are utilized
- `THcTrigDet` and `THcCoinTime` updated to take in a `vector<string>` to identify which of the trigger detector TDC signals to use for the coincidence timing
- Names must be in order of SHMS ROC1, HMS ROC1, SHMS ROC2, HMS ROC2
  - `tcoin_trigNames = pTRIG1_ROC1 pTRIG4_ROC1 pTRIG1_ROC2 pTRIG4_ROC2`
- Raw TDC to time conversion factor is no longer hard coded in `THcCoinTime` and instead utilizes the `fTdcChanperNS` parameter
  - If more than one hit within window, the last hit is selected
  - If no hit is found in the window then the time is set to zero
Updates to HCANA: \texttt{24235e0}

- **\texttt{THcTrigDet}** modified to select good TDC hits within some time window
- Hit selection windows exist for all trigger apparatus variables
  - \texttt{(p)hVARX\_tdcTimeRaw}

Figs. showing plots with and without window cuts.

---

**PARAM/TRIG/t(p)hms.param**

---

Hall C Winter Collaboration Meeting

Eric Pooser

01/28/2019
• **THcHelcity** determines the beam helicity for each event

• By default it is assumed that there is a delayed reporting of 8 cycles and that quartets are used

• See [Steve’s talk @ 1400!](#)
• Large number of memory leaks have been corrected (Ole’s talk)
• Large memory leaks found in THcShower, THcShowerArray, and THcShowerHit
• On average these leaks caused a loss in memory of 420 bytes/event (840 MB / 2M events)
• Many more smaller memory leaks addressed in variety of classes
• Various access errors in THcHodoscope and THcHitList addressed as well
• Infinitely growing array found in THcHodoscope
• Once all fixes were implemented, a flat heap profile is observed
FADC Thresholds & Pedestal Golden Runs

- Thresholds for each FADC channel must be determined on a per channel basis (expert driven task)
- By default, all thresholds are set to 10 mV unless request is made
- When new thresholds are set, 'golden runs' for each spectrometer must be symbolically linked to a specific run of choice in the replay ROOTfiles directory
  - (s)hms_coin_replay_production_golden.root
- The 'golden' run utilized in the 50k online monitoring to monitor pedestal drifts of all FADC channels
- Critical path item in order to ensure quality of FADC data
Reference Time Selection

- Prior to any meaningful analysis being conducted, proper reference time selection cuts must be determined and incorporated into the replay.
  - Reference time selection is dependent on the first TDC/FADC hit in the window which is greater than the associated cut.
    - $X_{t(a)}dcrefcut$
  - If no hit is found, then the first hit relative to the beginning of the window will be selected.
- TDC cuts are required for both drift chambers and hodoscopes.
- ADC cuts are required for all detectors except for the drift chambers.
- Which reference time is being utilized for each detector is visible in the detector maps.

Simona’s Detailed Talk

Hall C Winter Collaboration Meeting

01/28/2019
Prior to interpreting any higher order physics related quantities, both TDC & ADC timing windows must be determined and configured into the replay.

TDC window limits for both the drift chambers and hodoscopes must be set appropriately:

- $X_{scin\_tdc\_min(max)}$
- $X_{dc\_tdc\_min(max)\_win}$

ADC window limits for each PMT in the stack must be set appropriately so that the analyzer can determine 'good' hits which are utilized in determining physics quantities:

- 'goodAdcTdcDiffTime' variables
- $t_{\text{pulse}} - t_{\text{ref}} - t_{\text{start}}$
- $X_{\text{adcTimeWindowMin(Max)}}$

Simona’s Detailed Talk
Detector Calibrations

- With all of the appropriate reference time selection cuts and timing cuts in place, detector calibrations are required.
- The hodoscope and Cherenkov detectors do not require new calibrations unless the HV settings have been modified.
- The calorimeter and drift chambers will most likely require a new calibration:
  - These calibrations are dependent on the kinematic settings.
- The calorimeter calibration is required for properly determining the trigger PID thresholds.

01/28/2019
Eric Pooser
Setting Trigger PID Thresholds

- Setting the hardware thresholds for the various trigger PID legs must be done prior to utilizing the PID triggers i.e. EL-REAL & EL-CLEAN
- Determining the thresholds can be done in a variety of ways
- The current 'online' method:
  - Take 3/4 runs in both spectrometers and check the electron efficiency and the pion rejection by placing cuts on the TDC PID legs
  - Take one run with low pi/e and one run with high pi/e
- An 'offline' method can also be done utilizing the FADC’s
Hall C Replay: Current Design

CONFIGURATION FILES
- RUN
- PARAM
- STD
- KINEM
- HMS
- SHMS
- GEN
- TRIG
- DBASE
- HMS
- DETEC
- TRIG
- PARAM
- SHMS
- CRATE
- MAPS
- DEF FILES

ANALYSIS FILES
- HMS
- SHMS
- DEFE FILES
- REPLAY SCRIPTS
- ROOT TREE
- DEF-FILE HISTOS
- ONLINE GUI

RESULTS
- MAPS
- SHMS
- CRATE
- HMS
- COIN

Eric Pooser
01/28/2019
Hall C Winter Collaboration Meeting
Current Workflow for Online Analysis

- Each run group maintains their own replay repository and workflow
  - Copy of the pre-existing `hallc-replay repository`
  - Copy of previous run groups replay
  - Custom replay set-up
- The replay repository lives on the cdaq cluster and is run on cdaql1
  - e.g. `/home/cdaq/hallc-online/hallc_replay_jpsi`
- It is highly recommended that changes in the repo be committed and pushed often (minimum once per day)
  - Every user is 'cdaq' and 'rm -rf *' will happen again!
- The shell command 'go_analysis' will put the user in the appropriate replay directory and setup the associated environment variables for the experiment currently on the floor
  - The analyzer is actively maintained in hallc-online/hcana
  - This too could be run group specific if there is a need
The current 50k replay and online monitoring is actively maintained by Hall-C staff.

The histograms that are displayed via the online GUI are critical to ensuring that the detectors and track reconstruction are functioning nominally.

The 50k replay infrastructure (analysis scripts & DEF-files) and online GUI is maintained in the hallc-replay repository.

- The current structure to the hallc-replay repo will likely change in the near future.

- Changes to the current 50k replay and/or online monitoring histograms are subject to the hallc-replay gate keepers.
  - Monitoring histograms are able to be added but not removed unless discussed.

- Online monitoring is posted to the web automagically.
  - Hall-C Live Page
• The online GUI is a useful tool that interacts nicely with the hallc-replay infrastructure

• Plots the histograms defined in the DEF-files that are filled via the analyzer on an event by event basis

• Executes macros that interact with the ROOT file data

• Can be utilized in the online scaler/full replays in order to display information of interest

'How-To' PDF
50k Replay Online Monitoring

- SHMS Hodoscope ADC Occ/Mult
- SHMS Hodoscope TDC Occ/Mult
- SHMS Hodoscope Pedestals
- SHMS Hodoscope Pedestal Monitoring
- SHMS Drift Chamber Wire Maps (all hits)
- SHMS Drift Chamber Wire Maps
- SHMS Drift Chamber Drift Distance
- SHMS Drift Chamber Drift Time
- SHMS Drift Chamber 1 Efficiency
- SHMS Drift Chamber 2 Efficiency
- SHMS Focal Plane
- SHMS Target Quantities
- SHMS Cherenkov Occ/Mult
- SHMS Cherenkov Pedestals
- SHMS Cherenkov Pedestal Monitoring
- SHMS Cherenkov NPE
- SHMS Calorimeter Occ/Mult
- SHMS Calorimeter Pedestals
- SHMS Pre-Shower Pedestal Monitoring
- SHMS Calorimeter Pedestal Monitoring
- SHMS Drift Chamber Reference Times
- SHMS Trigger Reference Times
- SHMS Fast Raster
- SHMS EPICS BPM
- SHMS Kinematics
- SHMS PID
- SHMS Trigger Pedestal Tracking

SHMS DC $X'_{fp}$ vs $Y'_{fp}$

01/28/2019

Eric Pooser

Hall C Winter Collaboration Meeting
50k Replay Online Monitoring

- HMS Hodoscope ADC Occ/Mult
- HMS Hodoscope TDC Occ/Mult
- HMS Hodoscope Pedestals
- HMS Hodoscope Pedestal Monitoring
- HMS Drift Chamber Wire Maps (all hits)
- HMS Drift Chamber Wire Maps
- HMS Drift Chamber Drift Distance
- HMS Drift Chamber Drift Time
- HMS Drift Chamber 1 Efficiency
- HMS Drift Chamber 2 Efficiency
- HMS Focal Plane
- HMS Target Quantities
- HMS Cherenkov Occu/Mult/Ped
- HMS Cherenkov Pedestal Monitoring
- HMS Cherenkov NPE
- HMS Calorimeter Occupancy
- HMS Calorimeter Multiplicity
- HMS Calorimeter Pedestals
- HMS Calorimeter Pedestal Monitoring
- HMS Drift Chamber Reference Times
- HMS Trigger Reference Times
- HMS Fast Raster
- HMS EPICS BPM
- HMS Kinematics
- HMS PID
- ROC3 Sync Check
- HMS Trigger Pedestal Tracking

Eric Pooser
01/28/2019
Hall C Winter Collaboration Meeting
Tools for Online Analysis

- Various tools that facilitate online operations live in the UTIL_OL repository
- Script to extract the angle camera photos for each run
- Script to monitor total accumulated charge in live time
- Script to parse relevant report file data to display to shift crew
- Shell scripts that handle the 50k replay utilized for detector checkout
  - 'run_(s)hms.sh'
  - 'run_coin_(s)hms.sh'
Once the 50k detector checkout analysis has concluded, further online analysis is entirely up to the run group.

Previous groups have conducted full replays of each run by analyzing both scaler replays (fast) and physics analyses (slow):

- Scaler replays for things like accumulated charge, dead time calculations, etc.
- Physics replays for 'bean counting' and kinematic checks (t vs. $\phi$)

Files corresponding to these analyses MUST live on the RAID disk under an experiment specific directory:

- e.g. /net/cdaq/cdaql1data/cdaq/jpsizzle/

Directories containing analysis files should symlink to common prefix which points to experiment specific location on the RAID disk:

- OUTPUT -> net/cdaq/cdaql1data/cdaq/jpsizzle/
- ROOTfiles -> OUTPUT/ROOTfiles/
- HISTOGRAMS -> OUTPUT/HISOGRAMS/
Individual users can/should create (and work in) their own workspace on cdaq11
e.g. `/home/cdaq/user`
  • Quick replays and sanity checks can be performed here
• All common file systems on the farm are mounted on the cdaq cluster
  • `/site, /apps, /mss, /cache, /work, /group, ...`
• Large files (CODA, ROOT, etc.) should not be written to `/home`
  • When shared file systems fill, many things break!
  • Analysis not critical to daily operations should be conducted on the farm
• Backups on the cdaq cluster are automagically conducted each day
• Everything on the cdaq files system (`/home`) are backed up daily at 2300 hrs
  • Identical copy of files system is made
  • No history is saved hence why subversion control via git is so important
• `/home/cdaq/hallc-online/` is backed up in its entirety with time stamps 12 hours out of phase with the file system backup
  • 7 days of history is saved however large files are omitted
Questions?
Backup Slides
Setting Trigger PID Thresholds

Eric Pooser
01/28/2019
Hall C Winter Collaboration Meeting
Setting Trigger PID Thresholds

- All trigger PID components reside in scalers, TDC’s, and FADC’s (where appropriate)
- One can study off-line the effects of imposing hardware discriminator threshold cuts via software cuts
- Consider an example for HMS:
  - E/P in calorimeter
  - Select pions via Cherenkov
  - Cut on PRHI TDC channel
  - Calculate ratio to determine appropriate threshold for pion suppression
Setting Trigger PID Thresholds

- Perform hardware threshold scan of PRHI leg

HMS PRHI PID (NPE SUM = 0.0)
Setting Trigger PID Thresholds

- Perform software threshold scan of PRHI leg

HMS PRHI PID (NPE SUM = 0.0)