

Minutes from the RG1a SIDIS-pi0 analysis of June 28, 2024
Notes by Casey Morean

Please remember to post your slides on the ELOG at <https://hallcweb.jlab.org/elogs/SIDIS+Pi0/>

Meeting Recording:

N/a

Passcode: N/a

Present: Peter Bosted, Alexandre Camsonne, Josh Crafts, Casey Morean, Avnish Singh

2-5 Minute Overview of Action Items:

Avnish:

- RVarDef bash script for NPSlib and hcana written and saved to his [analysis repository](#):
- Still TODO: Add wiki entry, add elog entry, present at RG1a or make it clear others can contribute on an as-needed basis. Discussed in detail below.

Josh:

- Similar results as Avnish on RVarDef.
- First version of the runlist is being made, communicated to RG1a.
- Will scan runsheets in the near future when he is in the counting house with some time. Will perform a bulk scan and junk runs have been labeled throughout the run.
- Spoke with Wassim on the waveform analysis for gain coefficients.
- Worked with Holly and Christine on the optics (Monday meetings)
 - Question from Peter on optics organization: Does each student still have their own kinematic? Will the Optics team still be in contact with Holly after her position change? Yes, and yes.
 - Still needs some clarification on the delta optimization.

Casey:

- Worked with Josh and Avnish on pion reconstruction - Did RVarDef first, set up analysis repositories and vscode.
- Working on mailing list ticket, awaiting group to be created.
 - Just approved while writing these minutes!
- Got step 1 of 2 done on angle encoder photos, working on step 2. ETA is about 2 weeks. Waiting on Mike for EPICS plots to perform full replay of the EPICS plots and angle encoder information.
- Presented hcana modulefiles at RG1a analysis meeting. TODO: Create a wiki entry on the topic. Elog already posted
- Requested Sanghwa to back up RCDB. Awaiting follow-up. Will upload new RCDB when Josh finishes runlist-v0.1.0

Peter:

- Updated his runlist to include target information, VTP trigger numbers, half-wave plate status, COIN time offset, NPS distance from target based on Mike's tables. Awaiting an updated list from Mike

- Went through all production runs and grouped them based on kinematic setting. Determine the Chi-sq of e-p coincidence rates. Elastics rates and labeled outliers, which amount to 1/10 runs. This was also done for electron singles rates.
 - Question: How should these be incorporated into the runlist?
 - Indeterminate categories. Add ELOG entries with chi-sq from this pass through the data and add a category to the indeterminate labeling. These runs aren't determined to be junk just yet - Need looked at more closely in the future.
 - potentially fixable runs.
- Peter Currently has a 'code' field, which is always the same now. The code field will specify the status of the run to reflect the type of state it is in. Junk, good, indeterminate, etc.

Updated actionable items from last week:

- ~~Avnish, Josh | Make a report of the RVarDef variables accessible to all users, document usage of RVarDef bash script.~~
- ~~Avnish, Josh | Reproduce the VTP trigger using the ADC information and gain coefficients used for a given run.~~
 No longer doing this, see below discussion. This costed Hao and Peter 2 months of work
- Casey | Add accompanying ROOT and / or PNG output for EPICS values on a run-by-run basis. These plots are to be viewed in a JSROOT server. The goal is to have these available for further evaluation if junk or problem runs are found.
- Casey | Complete the angle encoder script. Make the script two phases, where the first should save SHMS / HMS encoded data, and the second phase takes the encoded data and decodes it. (Second pass through phase two does not require a pass through all the data).
 First half of script complete, second part to be delivered in 2 weeks
- Casey | Run the replay pass to extract EPICS plots and angle images.
 Awaiting Mike's script, still working on second part of image script
- Josh | Update angle values in standard_coin.kinematics based on angle photos - See Casey task.
 Awaiting Casey's pass angle photos
- ~~Casey | Set up a SIDIS P10 mailing list~~
- ~~Josh | Present at next RG1a analysis meeting - Present what we know about current runs from a combination of the DVCS runlist sheet and Peter Bosted's makerunlist.f script~~
- ~~Casey | Present at the next RG1a (and record) proper use and loading of the analysis software.~~
 - Add a wiki entry on how to set up software.
- ~~Josh, Someone | Scan in all the NPS hand-written run sheets.~~
- ~~Casey | Ask Sanghwa to / how to save a copy of the current RCDB.~~
 - Awaiting response from Sanghwa.
- Casey | Update RCDB based on the runlist given by Josh. Add a version tag to this
 - Awaiting runlist and backup instructions from Sanghwa

No update at this meeting:

- Wassim? | Mapping of all the trigger level gain coefficients used in the trigger during the NPS run delineated by run number.
Josh talked with Wassim, awaiting response
 - Mike | Link the tutorial videos to the wiki and keep refer to the person to talk with to get passwords - or used common password
 - Mike | Create a report and version number for current epics script. Make the script available to Casey Morean for full pass through data.
 - Mike | Send table of epics information to Josh.
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Main Meeting Discussions

Peter:

Currently Peter has a runlist that has a code. We discussed such a code and an agreed upon kinematic listing. I suggested we don't use prime characters, and instead use a 'p' in its place for code compatibility. The current listing for kinematics does not include settings for non-production runs such as positrons, target studies, boiling studies, BCM scans, etc. I believe these should be added as separate kinematics.

- Peter will make an example naming scheme that captures the beam x, Q2, energy, and NPS distance (or similar) to uniquely label production kinematics instead of the existing 56 or so settings.
- Any time Josh updates the runlist kinematics, a mapping from old to new kinematics will be included. This will be similar to a changelog that will be updated for the runlist through time.
 - I suggest the versioning abide by major, minor, patch. The major version can align with the version used for the start of a pass. The minor can be the iteration and any small changes that don't break peoples' code can be a patch number. We will see how this goes, but it should be decided on the outset.

Peter currently looks at each PMT for a run and determines if the PMT was dead based on the PMT having no events. Josh has discussed making a table that includes all dead PMTs for each run throughout the run period. This will be for about 5000 runs, 1001 columns, so a big set of data.

- It would be nice if these can be listed in a simple python program with a matplotlib interface. A user of the program could enter a run and determine if the PMT was dead or not visually. They could then fast forward to the next run, next run, etc. to see the death of PMTs over time and over a given kinematic.

The discussion on dead PMTs brought up the high rate PMTs that we may want to mask in the analysis. At this time we will push this down the road. It may rely on a waveform analysis or some other in-depth study.

- Mask / remove high rate PMTs on a run by run basis and create a table. Study the effects these PMTs have on rate / efficiencies / etc. (Based on waveform analysis?)
- We will run SIMC for multiple fiducial efficiencies based on the dead PMTs. It may be simple enough to mask a given PMT for an entire kinematic instead of dealing with differences between runs in a given kinematic. Avnish and Peter will look at the fiducial efficiency and the effects removing a PMT will have.

- Awaiting work on simc_gfortran, see also discussion on simc_new.
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SIMC discussion:

Avnish has run SIMC using elastic input files and hydrogren_extra inputs for the XEM2 experiment. He is up to speed with the output root files names and normfac weighting in the outfiles. to do elastics comparisons he needs to determine where to place the empty p-arm detector such that protons that are generated fly into that detector's acceptance. Casey has a mathematica notebook to do this relativistic kinematics if desired.

Simc_new compiled for Avnish in RHEL7.9, but no events were generated after several minutes of running. Peter informed us we need to use the:

setenv SIMCIN and name of input file without .inp

Currently, Peter uses a simple modification of his 2021 parameterization for pi+/pi- form factors to obtain pi0 cross-sections. This parameterization is similar to that of Tanja from 2006 or 2009. The code in simc_new that is used for exclusive pions is physics_pions.f.

- Simc_new is not based on a close relative of simc_gfortran from gitub, but a close relative (what became the version on git) under the pT-sidis experiment. The directories to compare for code added to simc_new:
 - Simc_new: /group/nps/bosted/simc_new
 - pT-sidis simc (old): /group/c-sids/bosted/simc

Generally, for SIMC, we will need SIDIS as well as the exclusive pi-delta production tail. For now, pi0s do not have a very specific pi0 acceptance. The pions are generated wider than the nominal acceptance of the NPS model.

Every pi0 decays into two photons with the correct branching ratio (built into simc)

- These seem like good defaults, and we don't have a desire to update these at this time.

There was a discussion on the W=2 pion cross-section that comes in from radiative corrections, but I missed this.

pi0-Delta discussion:

There is a rich bit of physics in the pi0-delta channel the community is quite interested in. The pionLT group including Richard Trotta, Ali Usman, others are interested in the pi+Delta0 channel, pi- Delta++. Likely useful to discuss this with this group

- We have the pi0Delta0 and pi0Delta+ channel in our data.

Close to the production threshold in Regge model, 4 isospin states instead of 2 opens up larger set of possibilities for analysis.

- Access to more amplitudes, delta transition form factor (longitudinal part)
- Similar number of events as the exclusive pion, but rides on large background of events.

Peter used a Breit-Wigner shape for the delta with a realistic shape in the monte-carlo for the piDelta.

- Fun calculation of Clebsch-Gordan coefficients for delta relative to exclusive-pi0 (somewhere between 0.5 and 1)
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Pion Reconstruction

Avnish, Josh, and Casey met to start reconstructing pions. Casey suggested calculating events constructed by the VTP, but that took Peter and Wassim 2 months and they didn't make any progress on understanding those events.

Instead, construct π^0 and require the clusterE variable, and that there are just 2 clusters and energy above 1 GeV. Must be in time.

- All you need is: clusE, clusT, and x-y (block number).
- These are the 'fly' variables.

Peter then makes some more advanced cluster selections:

- Removes the ones where time is more than 3ns than the others and recalculates the time. Sharper time distr. Then eliminate nearby clusters.
- Sometimes can combine the clusters

Need improved calibrations to make π^0 peak come in at the proper mass.

- Can put an additional cut that sum of two energies must be large (exclusive).
- Even for the largest possible t, what is the momentum of π^0 , maybe 3GeV or something. Then only look at photons where energy is >2 GeV.

Ultimately have a cut on the minimum energy cluster. Hao has a cut at 1 GeV. Taking one high and low energy cluster, larger opening angle. A lot of background under π^0 mass peak.

Action items

- Peter | will add an analysis philosophy to the wiki broadly applicable to hall C analyses and the SIDIS- π^0 analysis specifically. Binning of data in x, Q^2 , ..., analysis phases, etc.
- Peter | Make a suggested naming scheme for kinematics to pass to the run group.
- Peter | Add an ELOG entry on the e- π^0 coincidence rates and chi-sq values / plots. List the outliers to be listed as indeterminate so Josh can categorize them as such in the runlist version.
- Peter | Link slides on 2021 parameterization, which uses π^+/π^- form factors to generate π^0 cross sections for simc_new.
- Josh | Add an entry for the runlist to the wiki. Tag specific entries in the ELOG that were used to inform the runlist. This could include Peter's ELOG entry on chi-sq for e- π^0 coincidence rates, etc.
- Josh | Make a dead PMT table. Add an ELOG and a wiki table
 - Potentially make a simple python script to go and visualize the dead PMTs for a given run.
- Josh | Deliver a runlist of BAD/Junk runs to peter based on run number, and reason. (Likely already delivered 7/5/2024)
- Josh | Create a sort of changelog between versions of the runlist. Prior to this, we need an entry relating the online running kinematics and the kinematics listed in the proposals. Some discussion on naming with primes and numbers could be included here as well.
- Give a first pass comparison of elastics on hydrogen and possibly deuterium for the NPS single-arm elastics runs. (using github version of simc_gfortran on AlmaLinux9).
- Avnish | Post an ELOG and wiki entry for RVarDef values. Explain that it is a list everyone can use and look up the actual variable definitions in the hcana or NPSlib code. As people find information on different variables they can add the details to the

RVarDef listing. Maybe link the specific variable to a specific wiki page? Present at the next RG1a meeting

- Casey / Peter | Discussion of charge based on Helicity scalers.

Awaiting Items

- Person TBD | Table listing all PMTs that have a high rate during the run. These could be masked for a given run or kinematic. We will start by having a table of dead PMTs first. This could be informed by some other analysis.
- Dave Gaskell, Avnish | Update github version of [simc_gfortran](#) to add NPS spectrometer (using Dave's generic detector? Move to other side of beamline). Include methods for pions, physics_pion.f (exclusive) and others for SIDIS (TBD).
- Analysis of piDelta events in the data. Discuss these events with people from the PionLT group