Report from the ACE: Some recommendations on analysis procedures for CLAS12 runs

Ken Hicks, Dave Ireland, Kyungseon Joo, Sebastian Kuhn, Silvia Niccolai, Eugene Pasyuk, Larry Weinstein

Reminder: ACE Goals

- ACE mandate:
  - Guide the development of analysis algorithms (after calibrations)
  - PID, momentum corrections, backgrounds, fiducial cuts, simulations, etc.
  - Higher level analysis: kinematic fitting, PWA (if applicable)
  - Standardize the algorithms and software

- ACE Deliverable:
  - A document (version 1.0) giving our DRAFT recommendations and text giving the rationale for these.
  - This is not a final version!! It is meant for discussion and feedback.

Collaboration Feedback

- We want to hear feedback from the collaboration
  - These recommendations need to be vetted
  - The analysis procedures (software tools) are collaboration-wide issues
  - We are working to test these procedures
- It will take time and iterations to get it right!
  - Today: just discussion of a few selected recommendations
  - Next meeting: revised draft of recommendations

Recommendation 1: General Procedures

- Calcom group provides the calibrations
  - Assume the calibration procedures are standardized (in the near future)
  - Try to minimize additional corrections that come later in the analysis chain
- Software group provides the framework for reconstruction
  - This is still under development but will soon be fully functional
  - Simulations output should be reconstructed in the same way as data
- Reconstruction -> HIPO file -> post-processing -> DST
  - The HIPO file contains event-based and track-based banks, information at the subdetectors level, and PID (Event Builder)
  - The HIPO file an also be converted in ROOT format, for the post-processing.
  - The document includes the EVENT.json file, feedback needed on what it should include
  - During post-processing one can apply refined particle ID, fiducial cuts, etc.

Recommendation 2: Analysis Notes

- An outline of a 2-stage analysis note review process:
  - Step 1: Run-group level analysis note (common to all analyses):
    - Documents the calibration procedures, beam properties, simulations setup, etc.
    - These would be reviewed **once** and then referred to by analysis of each final state
  - Step 2: Individual final-state analysis note
    - One checklist for cross sections, another for polarization measurements
  - Note: need to work with the analysis coordinator to outline the procedures common to all physics analyses for Run-group A.
    - The hope was that we could test this procedure using the KPP data, but since there was no beam information recorded for that run, only some of the checklist applies.

Recommendation 3: Tracking Philosophy

- Since the tracking code is still under development, it's premature to have working procedures for possible momentum corrections
- However, there are some lessons learned from CLAS:
  - It appears (but was not proven) that many of the momentum corrections used for CLAS stemmed from small misalignments of the DC's. Also, a Kalman filter was not used for CLAS tracking.
  - Hopefully there will be less need for momentum corrections at CLAS12. To ensure this:
    - Take data with all required field settings to allow determinations of detector positions.
    - Develop software that is flexible enough to minimize momentum corrections
    - Incorporate these calibrations directly into the next pass of "cooking".

Recommendation 4: Beam Information

- The beam info must be put into the data acquisition stream, for normalization purposes. This item should be high priority.
- The Faraday Cup (FC) needs to be calibrated, as the FC will see only 10% or less of the beam after the beam stopper.
- All calibrations need to be worked out in advance: how often to calibrate and procedures verified.
  - The SLM and BPM's should also be available in the data stream
  - Separate sets of scalers for run-gated and DAQ-not-busy.
- Polarized beam and polarized targets will require their own calibration procedures and info put into the data stream.

Recommendation 5: Radiative Correction

- Unfolding the effects of radiative corrections is not straightforward, and we don't want several methods being employed.
  - A suggested procedure is outlined in our document (version 1.0).
  - There was significant discussion within ACE about the correct way to do this.
  - We encourage feedback
- Recommend: have one procedure that all clas12 experiments follow, until it is shown to the collaboration that a better way to unfold radiative corrections is approved.
  - The ACE will likely to be the group responsible for vetting new procedures of this type.

Recommendation 6: Higher-level analysis

- Kinematic fitting: this should be used when possible.
  - Procedures have been developed, e.g. for g12, and can be adapted for clas12
- Multi-variate and Machine Learning tools:
  - These are available in ROOT (TMVA package) which is the best starting point.
  - Vetting these tools will take time—no previous use in CLAS.
- Dealing with background subtraction
  - Two common techniques: Q-factor method (M. Williams) and sPlots (ROOT)
- Blinded analysis, PWA, etc.
  - Use as appropriate, depending on the analysis (e.g., bump hunting).

Summary

- This is only the first step toward a future analysis plan
  - Version 1.0 is up for discussion. It will be revised as needed.
  - Some recommendations have been made, others will follow
  - Feedback from the collaboration is welcomed.
- Top priority recommendations:
  - Need to stabilize the analysis output: this is still not final
  - Need to get the beam information into the data stream and develop software for using this info to get cross sections and polarization observables.
- We encourage everyone to read our document (version 1.0) and give feedback.