DRAFT

Important Issues/Tasks for the MARATHON Data Analysis

April 2018

MARATHON's goal is the formulation of ratios of yields of scattered electrons for the 4 different gas targets (1H, 2H, 3H, 3He) normalized to the number of incident electrons and to the number of target nuclei and corrected for standard effects like dead-time, radiative energy losses, beam induced gas target changes, etc. The target length (same for all four gases), defined by spectrometer optics software means, cancels out in the ratios.

The online analysis has shown that the detectors have performed to the expectations and with high efficiencies. The present software gain equalizations for the Cherenkov counters look very treasonable, as the coefficients of the blocks of the calorimeters do. No abnormal tracking problems have been diagnosed. It is assumed that more studies will be done for the theses, but in the mean time all these are adequate for the PASS1 cross section ratio analysis.

Following is a preliminary list of important issues for the analysis of data and production of spectra of ratios of yields versus Bjorken x, in no particular order. It is to guide the discussion at the May 17, JLab/Bluejeans Meeting. At the end of the list are appended several suggestions by Zhihong for the preservation and organization of the data.

Offline Analysis Database

- Check all entries/input of the database used for the offline analysis of all runs. PASS1 analysis has been done with a revised/updated database.

- Table or plot all critical quantities of the database for each kinematics for visual inspection.
- Check and finalize the list of runs for the different targets for each kinematics. Identify runs with problems that need special attention/consideration.

Contamination of Events From Gas Targets

- Study the contamination of gas (3He, 3H, 2H, 1H) events by events from the Al end caps. This should be based on Zhihong's online algorithm/method.
- Determine the optimum z_target cut for each kinematics. (At the moment we have a generic +-10 cm cut.) As a byproduct, determine the HRS mispointings and compare with expectations.

"Boiling" Tests

- Analyze the March "boiling" tests and compare the results with results of the December tests (see reports by Sheren and Nathaly).
- Note that the December "boiling" data were taken with i) a different gradient setting of Q1 (as compared to the GMp/DVCS experiments) and ii) a few calorimeter blocks running with different high voltages (as compared to the GMp/DVCS experiments).
- The above 2 facts have essentially limited the statistics of the December data sample, allowing for their reanalysis with proper Left-HRS calorimeter coefficients and reverse matrix elements.

Detector Related Projects

- Make sure that the detector performance has been uniform/steady along the experiment.
- Set/fix Cherenkov ADC and calorimeter E/P cuts (currently set at Channel 1500 and 0.7 respectively).

Track Selection

- For PASS1 analysis we will use events with only one track. (In the case of events with multiple tracks, the current Analyzer code picks the track with the best chi-squared in space and time. This does not guarantee that the code picks the right track!)
- For PASS2 we will have to analyze all tracks. This will require some intelligent extra analysis/graphics to relate the multiple tracks with the ADC and TDC detector hits and keep the track that went through the detectors that fired.

Elimination of Bad Tracks

- Tracks that are unphysical must be eliminated. By unphysical is meant either that they exceed the expected position or angular focal plane limits or that they do not obey known optics correlation(s).
- Tracks that survive but seem to originate with unphysical scattering production quantities or from outside the physical target limits must be also eliminated.
- It is assumed that the mechanisms that produce the bad tracks are the same for all 4 gas targets and that the eliminations do not influence the cross section ratios.

Acceptance Cuts

- Every event that passes electron PID cuts is a good event unless proven otherwise! The latter can happen for events at the edge of the phase space of the spectrometer acceptance.
- Because of spectrometer optics uncertainties, we should not include in the final spectra for the cross section ratios the lowest and highest x bins (number TBD), which correspond to extreme values of in plane angle and relative momentum.

Beam Current Related Projects

- Complete analysis of the 2nd and 3rd Beam Current Monitor calibration data sets and compare results with those of the 1st set analyzed by Nathaly.
- Implement findings in the database to be created for PASS2.
- Conclude/integrate studies on the settling of the density with beam turn on and on a possible necessity of a beam trip cut.

Positron Subtraction

- Analyze positron runs of gas targets (3He, 3H, 2H at KINS 1, 3, 5, and 1H at KINS 1 and 3) and determine the associated e+/e- ratios.
- Produce a parametrization (exponential shape?) for positron contribution subtraction, applicable for all KINS (use guidance from Marco's study using an existing code).

Radiative Corrections

- All targets are a very small amount of gas radiator preceded by an upstream Al window and a Be window. Zhihong has shown that, as expected, radiative corrections for the four gas cross section spectra are about the same.
- A more precise calculation is needed to match the statistical precision of the data, using the POLRAD or an equivalent Mo-Tsai code.
- Coulomb correction is very small for the lightest nuclei, in general, but sizable for the 3He nucleus at high x, up to 0.5%, and should be included.
- Note that the calculations must be done for the actual gas densities with "boiling", not the nominal ones.

Bin Centering Correction

- Correction is in general sizable, especially in cases of rapid cross section variation. Should be studied, initially with a model.

Cross Section Model

- Must settle on a reliable 1H/2H DIS model applicable to the kinematic range of the experiment. Many in the core analysis group are familiar with the widely used Whitlow SLAC model, easy to be coded (even with EXCEL!).

PASS1 Data Quality Checks

- For first order diagnostic purposes all basic plots for scattering from the 4 gas targets must be inspected and evaluated for possible deficiencies.
- All existing outputs/pdfs must be updated by running the existing script [Hanjie, Tong] including the runs from the second phase of the experiment (after the transformer replacement).

Essential Plots/Tables Available Before PASS1 Analysis

- Dead time vs kinematics for all targets.
- Average current (when beam on) for all kinematics and targets.
- Plot of S0.S2 and S0.S2.CK scalers normalized to charge vs run for each kinematics for all targets.

Ultimate Check Before Getting Physics Results

- Compare MARATHON cross section ratio of proton to deuterium to SLAC cross section ratio from the fits of Whitlow et al. We must compare the model to the actual data (need to collect them in a table).

Zhihong’s Suggested List of PRE-OFFLINE-ANALYSIS Tasks

Following are tasks, exactly as suggested by Zhihong, that we should finish while our memories are still fresh! To be discussed and assign dedicated people to work on.

1) Clean up the run-info: We have setup multiple tools of recording and organizing the run-lists, including paper-tables, MySQL, wiki. We will end up using the MySQL (including the web-based one here) as the main source of the run-info. However, it is made automatically by collecting info from EPCIS (and hand input from shift-workers). We knows there are always errors. We should clean up the errors, by comparing with the info from wiki, and the paper-tables in the counting house.
2) Itemize all calibration runs into groups, like BCM, BPM, Target-Boiling, optics, etc.
3) Collect all survey results, including targets, spectrometer angles, beam-instruments, etc. Put them in a common place (Wiki is better for a place for permanent files and info)
4) Benchmark the data-base. We use github for version control of the data-base. While other experiments continue so as the data-base being changing, the data-base for MARATHON can be bench-marked (in the github language, we can "fork" or create a new branch for this experiment). Of cause, detector-related calibration can be continuously updated w/ other experiments.