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Kaon Filtering for CLAS Data

John McNabb

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I Introduction

The analysis of data from CLAS is a multi-step process. After the detectors for a given running period have been calibrated, the data is processed in the so called "pass-1 cooking." During the pass-1 cooking each event is reconstructed by the program a1c which finds particle tracks and computes momenta from the raw data. The results are then passed on to several data monitoring and filtering utilities. In CLAS software, a filter is a paramaterless function which returns an integer indicating whether an event should be kept by that filter(1) or not(0). There is a main filter program called g1_filter which controls several specific filters and outputs several files, one for each filter. These files may then be analysed seperately, allowing individuals interested in one reaction channel to work from smaller files than using the whole data set would require. There are several constraints on what the filter functions should do. Obviously, the filtered files should be as small as possible, however the filter should also not reject any events that might be used in the later analysis for which the filter was intended.

II Kaon Filtering

The first version of the kaon filter, FilterEventK.c, was a simple and straight forward filter. It used four banks: HEAD, TBID, TAGR, and RUNC. Each accepted event was required to have at least one particle with a TBID entry, a measured beta greater than 0, and a mass squared between 0.09 GeV and 0.49 GeV. This simple filter is quite adequate at handling low momentum particles. However, at a particle momentum in the lab above around 1.5 GeV, distinguishing kaons from pions becomes difficult due to the resolution of the time-of-flight measurements. This lead to a concern that kaons of sufficiently high momentum might be erroneously rejected. In addition, for events with multiple good tagger hits, only one tagger hit is used in the calculation of the beta and mass of each particle. The chosen tagger hit is determined by the timing coincidence with the Start Counter(after suitable corrections were made for the vertex location). The vertex location is also determined by the Tagger-Start

Counter coincidence from among the individual vertex locations in the TBTR bank. It is possible that there are events that contain real kaons for which the wrong tagger hit is chosen, which a more careful analysis might be able to recover. This filter was used for the g1a and g1b data sets.

The development of a new filter, FilterEventKtof.c, was meant to address these concerns. The new filter loops over all valid tagger hits to scan all possible event start times. A suitable vertex correction is made using the MVRT bank, which uses information from all charged particles to calculate the best estimate of the vertex location. The time-of-flight, beta and other relevent quantities are then recalculated for each particle using *all* the tagger hits. The measured time-of-flight, of the particle is then compared with the time of flight for a charged kaon (assuming that the measured momentum is correct), and if the difference is less than 1.0ns, the event is considered good and kept by the filter.

III Results

To compare the filters they were run on one file from the pass-0.4 cooking of run 20941. This run had an electron beam energy of 3.115 MeV, the highest beam energy used during the g1c running period. The original file contained 268056 events. The new Ktof filter found 13479 events and the the old K filter found 9685 events. Thus the file produced by the new Ktof filter is about 40% larger.

Below are several figures, each with four plots. For all the figures, the top left plot contains all events from the new Ktof filter, the top right plot contains all events from the old K filter, the lower left plot contains events that passed the Ktof filter, but failed the old K filter, and the lower right contains those events that passed the old K filter and did not pass the new Ktof filter. All the following figures have a similar layout. In Figure 1 are four plots of the time difference between the time-of-flight of a track as measured and for the expected time-of flight for a kaon vs the particle momentum in the lab. Note that the kaon peak is centered about -275ps away from zero. This is a result of a miscalibration of the "tag2tof" number which has since been fixed. For the purposes of this study only, the Ktof filter was shifted in time to accomodate this difference. Above a momentum of around 1.2 GeV, the pion peak can be seen rising into the picture. Figure 2 are the same plots, except only for particles that had a missing mass consistant with a Λ or Σ^0.

Figure 3 shows the missing mass computed for all particles in all events, assuming that the particles are kaons. It is clear that the new filter does not exclude any real kaons found by the old K filter. However, there is evidence in the shoulder of the bottom left missing mass plot around the mass of the Λ that some new kaons were found, although statistics are low.

Figure 4 is similar to Figure 3, except that only particles that have masses consistant with a kaon mass are plotted. Again one can see evidence in the bottom left plate for real kaons in the new filtered file that were not in the old.

There still exist three other kaon filters in addition to the two previously mentioned. The Kmiss filter looks for events with a proton and pi- that have an invariant mass consistant with a lambda hyperon, and have a missing mass close to that of a kaon. The KPE filter requires a kaon, a proton, and a photon energy greater then 0.85 GeV. The PKpKm filter requires a proton and a kaon, with a missing mass from these two consistant with another kaon. All these filters identify particles in a fashion similar to the old K filter and do not consider multiple tagger hits.

IV Conclusion

In conclusion, the new Ktof filter has been shown to include real kaon events that were rejected by the old K filter, while not excluding any kaon events that the old K filter found. The size of the file of the new Ktof filter is less than a 50% increase over the size of the old K filter. Therefore, the Ktof filter should replace the K filter in all future cooking passes.

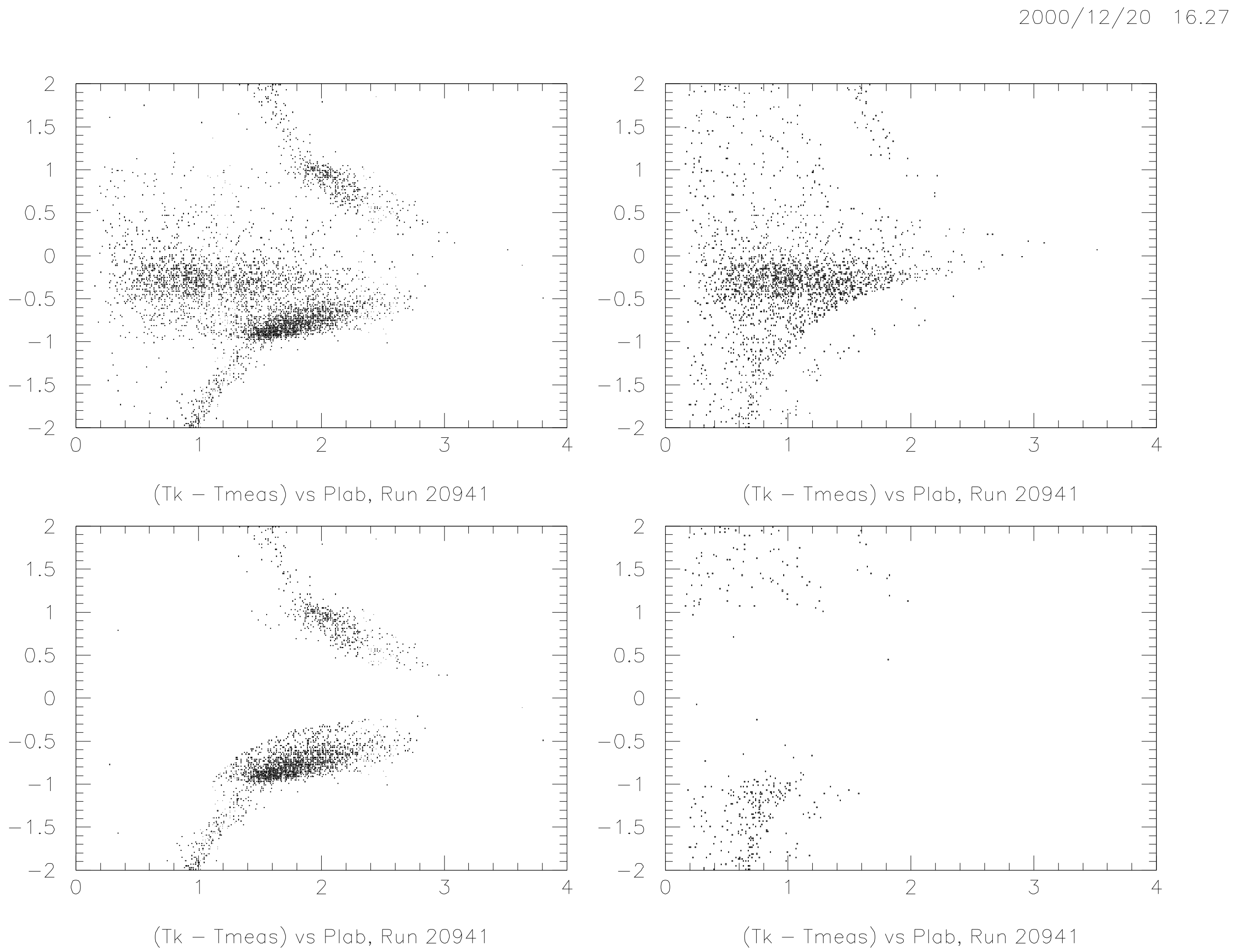

Figure 1: Time difference between measured particle ToF and hypothesized kaons of a given momentum vs lab momentum. The upper left and right panels show the Ktof and K filters respectively. The lower left panels show events that passed the Ktof filter and were rejected by the K filter. The lower right panel shows events that passed the K filter and were rejected by the Ktof filter.

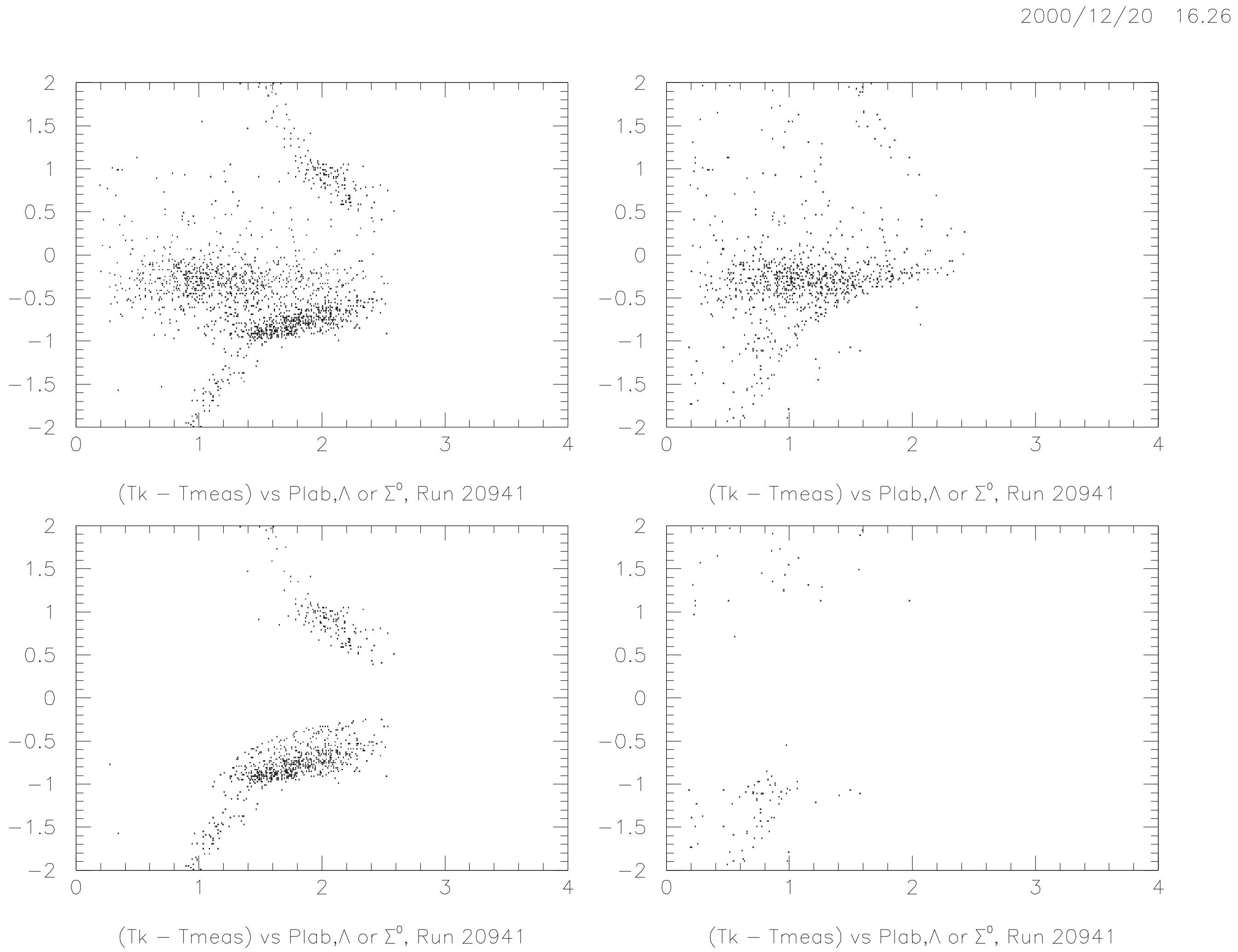

Figure 2: Time difference between measured particle ToF and hypothesized kaons of a given momentum vs lab momentum. Only particles where the missing mass is consistant with a Λ or Σ^0 were plotted. The upper left and right panels show the Ktof and K filters respectively. The lower left panels show events that passed the Ktof filter and were rejected by the K filter. The lower right panel shows events that passed the K filter and were rejected by the Ktof filter.

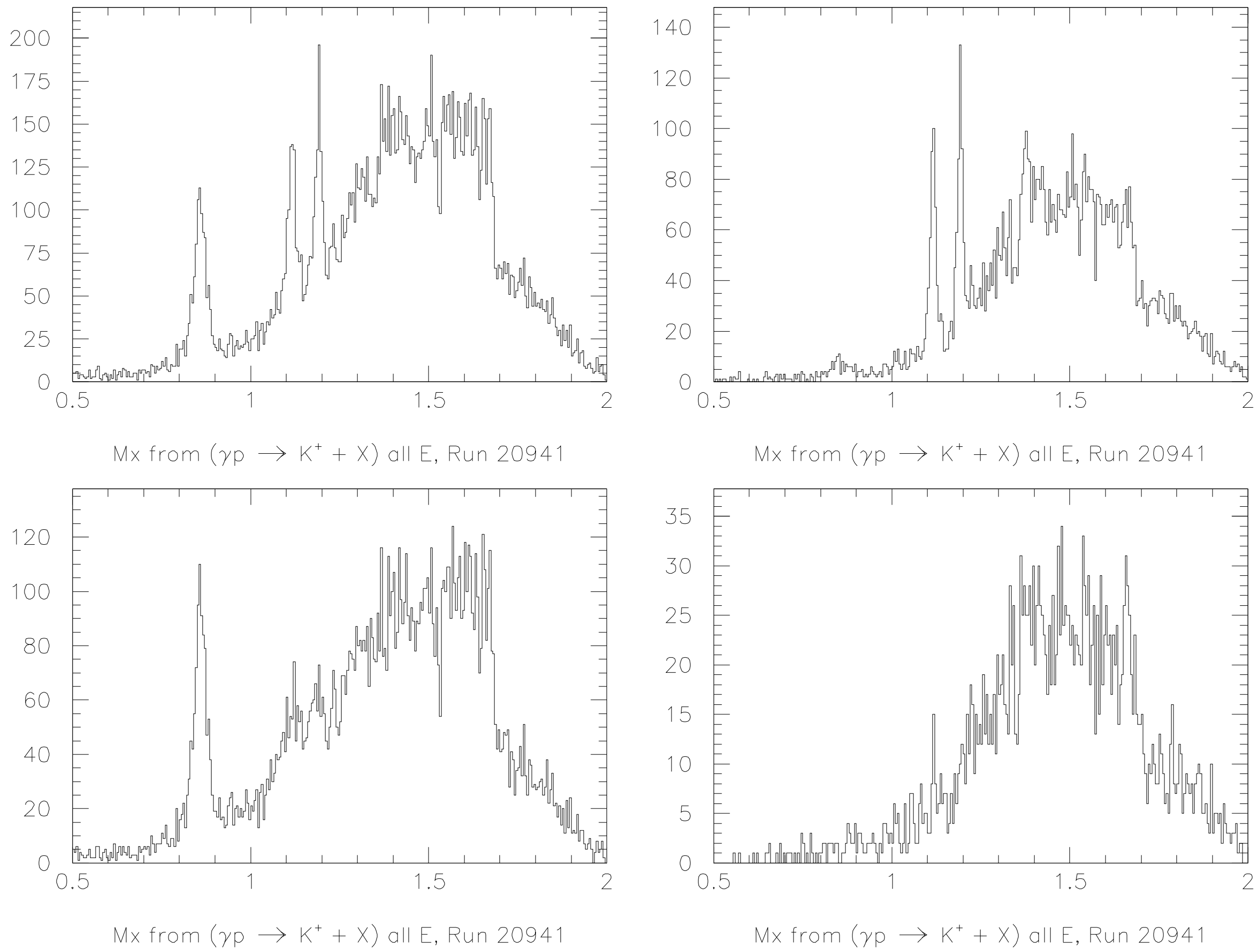

Figure 3: Missing Mass assuming Kaon. The upper left and right panels show the Ktof and K filters respectively. The lower left panels show events that passed the Ktof filter and were rejected by the K filter. The lower right panel shows events that passed the K filter and were rejected by the Ktof filter. Note the shoulder in the (Ktof and not K) panel on the lower left which shows that the new filter preserves some kaon events rejected by the old filter. The peak at around 0.9 GeV comes from misidentified pions.

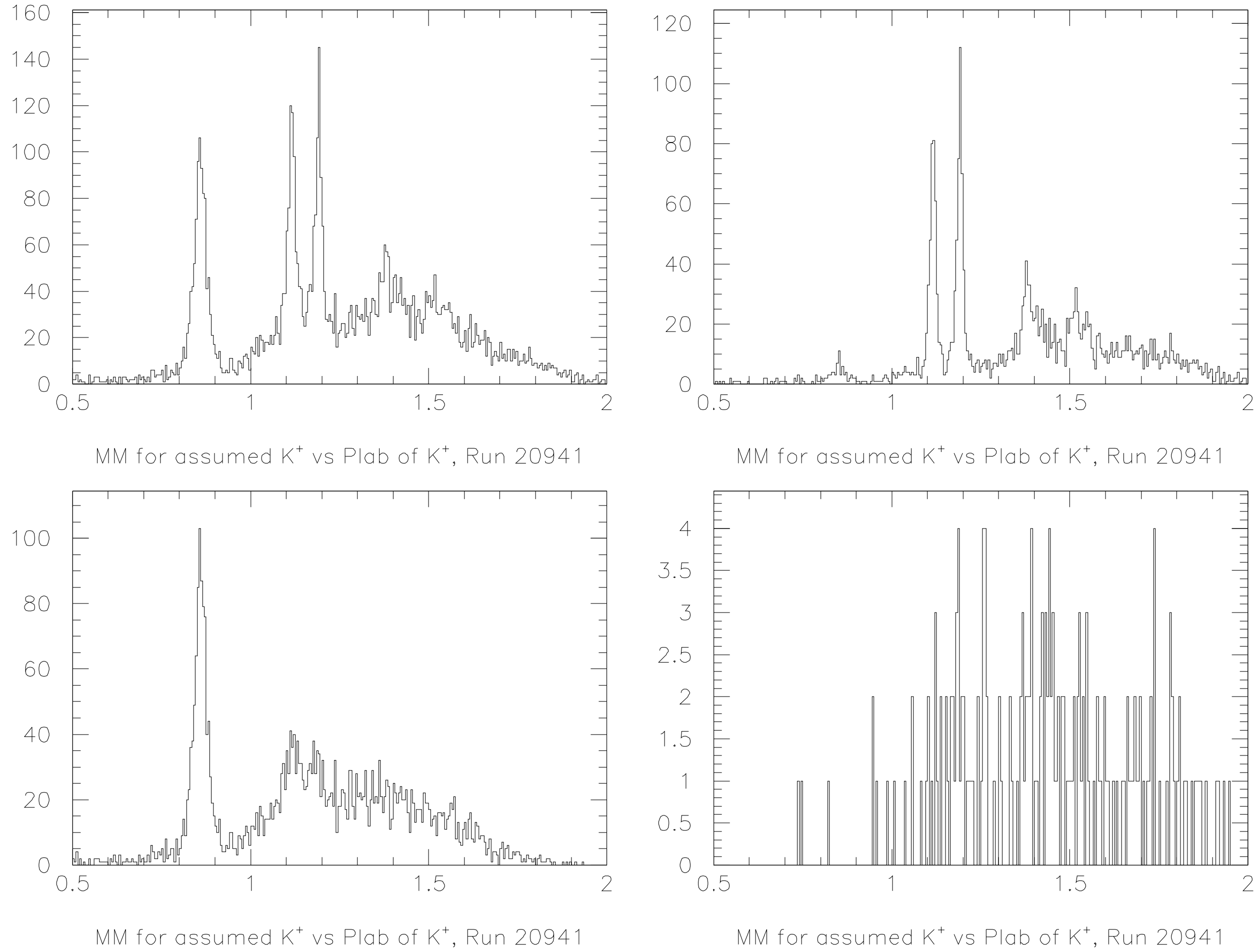

Figure 4: Missing Mass assuming Kaon for "good" kaons . The upper left and right panels show the Ktof and K filters respectively. The lower left panels show events that passed the Ktof filter and were rejected by the K filter. The lower right panel shows events that passed the K filter and were rejected by the Ktof filter. Note the peaks around 1.1 GeV in the (Ktof and not K) panel on the lower left which shows that the new filter preserves some kaon events rejected by the old filter.