Replies to pass-1 review comments

Charge #1: Is the quality of detector calibration and alignment adequate to achieve the performance specifications foreseen for CLAS12 or achievable at the current time, given the "state of the art" calibration, alignment and reconstruction algorithms?

No – While the current algorithms and methods used for calibration, alignment, and the reconstruction of data are adequate to achieve the CLAS12 performance specifications as has been demonstrated for RG-A and in most part for RG-B, the quality of RG-B calibrations of a few detector components, and some run ranges, must be improved before the start of the pass1. Moreover, the software release that will be used for RG-B pass1 is not the one used to obtain the results presented at the review.

Comments:

For the most part detector component calibrations are in reasonable shape. But recalibration of FTOF for a few runs, DC for RG-B, and FTcal at the beginning of the run period can improve the quality of data.
+ recommendation to calibrate one RGB for DC to improve residuals

Replies:

- FTOF calibration for the last set of runs showing S3 issues was redone – monitoring of that set of runs redone
- FT calibrations done
- New timelines ready: **https://clas12mon.jlab.org/rgb/pass0/v21.8.1/tlsummary/**
- DC experts informed – provided reply for committee (slide 3)
- Raffaella sent a message on May 10 to the review committee with the description of the changes in the new COATJAVA release (slide 2)
- Another change was afterwards added to correct EB beta calculation for CD neutrals, using electron vertex position (while before the vertex was set to (0,0,0)); this change has no impact on calibrations, as the pathlength used for calibrations is correct
- Modified implementation of CD veto to include CTOF, new release tagged (6c.5.7) and tested.
- New timelines are produced with latest release which includes all modifications described above

Raffaella's email about new COATJAVA release

Dear Review Committee,
I would like to correct something I said during the review on Friday concerning the software release RG-B has been using for calibration and the new software release that will be used for the data processing.

On Friday I mentioned that the new software release differs from the one used for calibration for an update to the CND path length calculation and the new CND-CTOF veto algorithm for the identification of neutrons in the central detector, which also involves using CTOF clusters instead of hits in the EB **Actually, the update to the CND path length calculation, which could potentially affect the calibrations, was already included in the release the run group has been using for their cooking so far.** Among the other updates included in the new release, the use of CTOF clusters vs. hits was tested showing no impact on the detector calibration.

The new software release is ready for final testing by the run group and a c-tag has been created for that purpose.
Best regards,
Raffaella

Mac's email about DC calibration quality for RGB

Hello Silvia;
There is nothing unusual or alarming about the attached timeline of DC residual means vs. run number. First, note the scale: the maximum extent of the vertical scale is +/- 100 microns. You can see oscillatory variations of about 20 microns taking place over the course of a few runs. This is due to atmospheric oscillations. This is a small effect which we are studying. But it is very small and will not make a significant change to the DC spatial accuracy.

You can also see a small, sudden jump of means at about run 6540 of about 40 microns. This is not understood, it is some kind of change to trigger timing is the best guess.

To summarize: these changes are small and will not be apparent in momentum or theta resolution variations run to run.

Second, and very important: the drift chambers show no evidence of a systematic drift in time of any calibration constants: they are time-reversal invariant. Calibrations could change with change of settings of course, but the last change of settings was done in Sept/Oct 2018.

So, it doesn't matter whether you calibrate BEFORE or AFTER a run. I will talk with Taya and we'll discuss whether any changes should be made to the CCDB.

Would you or Raffaella communicate this to the review committee? They (and everyone) needs to appreciate the fact that there is no evidence for any kind of systematic drift in calibration with time.
Thanks, Mac

Recommendations:

1) The identification of neutrons in CND and ECal and accurate reconstruction of its kinematics is important for key physics of RG-B experiments. As was shown, there is a significant shift in reconstructed beta for photons in both detectors, which ultimately will affect the quality of PID and momentum reconstruction of neutrons. Before pass 1 this issue must be resolved.

1) « Beta shift » for CND neutrals was thoroughly investigated:

- At the review it was observed on the beta vs edep plot done with CND_hit bank, and assuming vertex position at (0,0,0)
- It was then found (in DATA cooked with the OLD Coatjava) also for CTOF, and also using REC banks
- A bug was corrected in EB (calculation of beta for neutrals now uses electron vertex position)
- MC studies do not indicate significant discrepancies in reconstructed pathlength or time for neutrals
- Beta for photons in MC appears to be peaked slightly below one because beta is inversely proportional to the time of flight and the finite time resolution of CTOF and CND results in an asymmetric beta distribution that summed with background creates an apparent shift. Since CTOF resolution is better than CND, the effect appears to be smaller in CTOF. See next slides
- Part of the background at beta just below 1 comes from charged pion contamination (see next slides)
- Cooked RGK data at 7.5 GeV with COATJAVA 6c.5.7; extracted $ep \rightarrow e\pi^{+}n$ data to test reconstruction of neutrons; beta shift less than 2%. See next slides

2) Another important parameter for RG-B is the reliable identification of deuterons. As it has been shown, neutrons can be identified using time-of-flight in FD, but the beta vs. momentum distribution in CD does not show any hint of deuterons. A critical parameter for deuteron ID is the energy loss in the scintillator counters (CTOF and CND). Proper dE/dX information from these detectors must be presented in REC::XXX banks for users.

3) Since a new software release will be used for pass1, another pass0 with the new software must be performed, with full QA of high-level physics quantities.

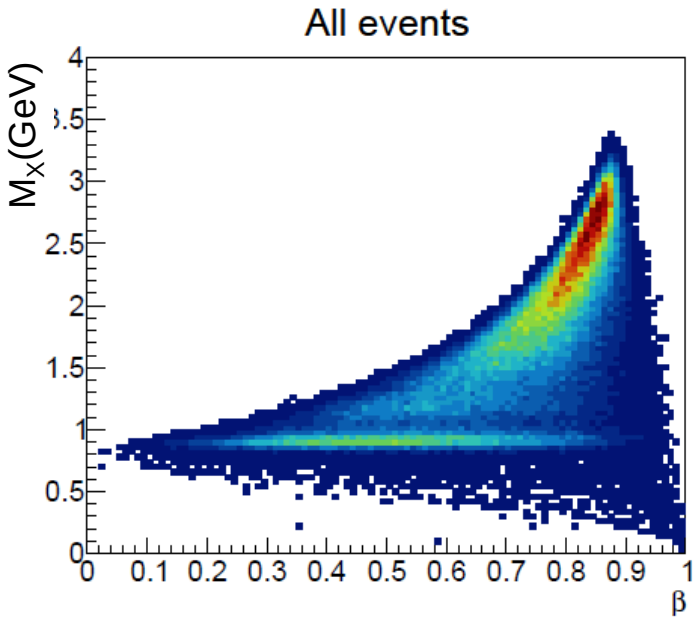
2) de/dx added to REC banks for CND

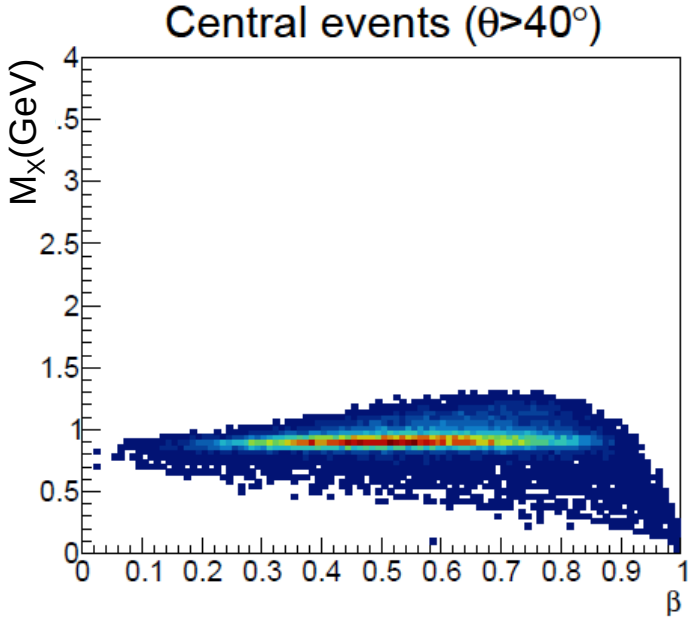
3) QA timelines on the new pass0: https://clas12mon.jlab.org/rgb/pass0/qa/spring/timeline/

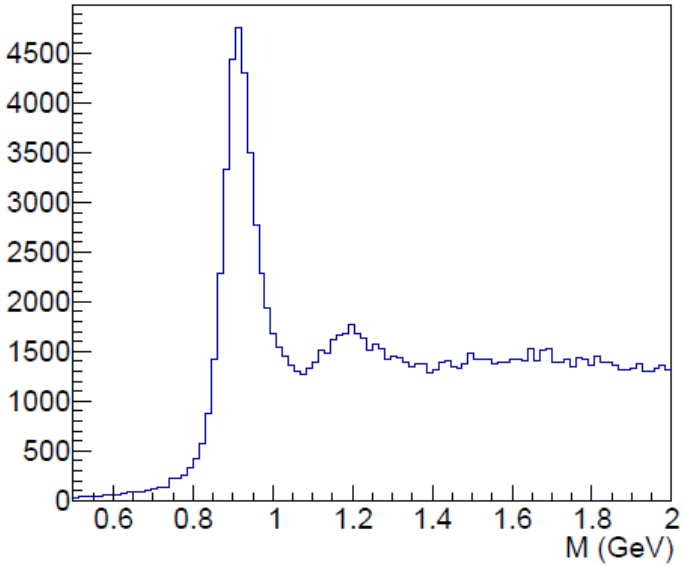
RG-K run 5832 (7.5 GeV), cooked with the latest COATJAVA

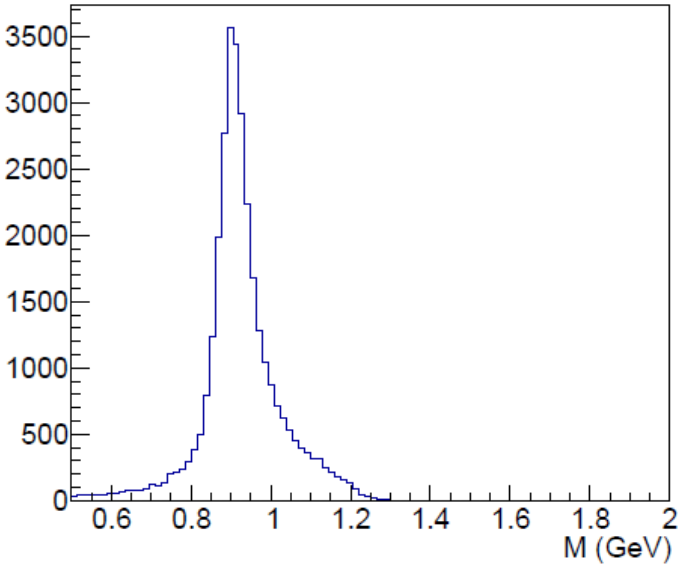
$ep \rightarrow e\pi^+X$

Requiring the missing particle to be in CD reduces most of the high-mass background

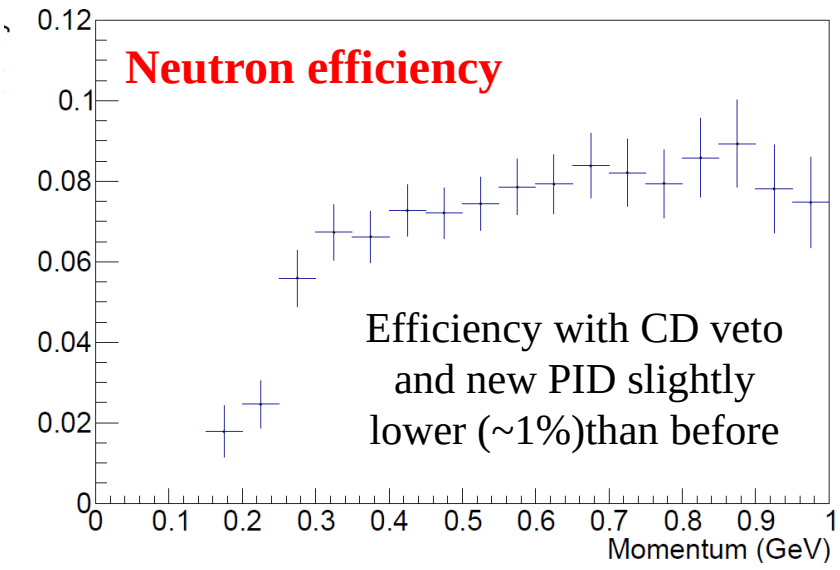


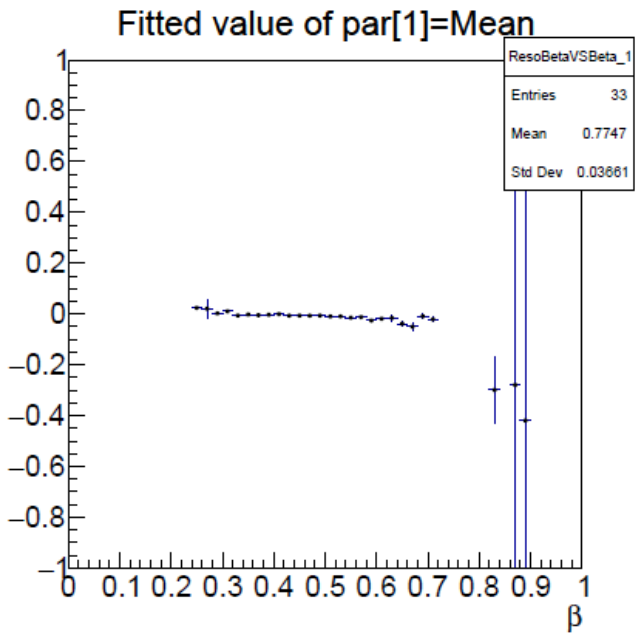


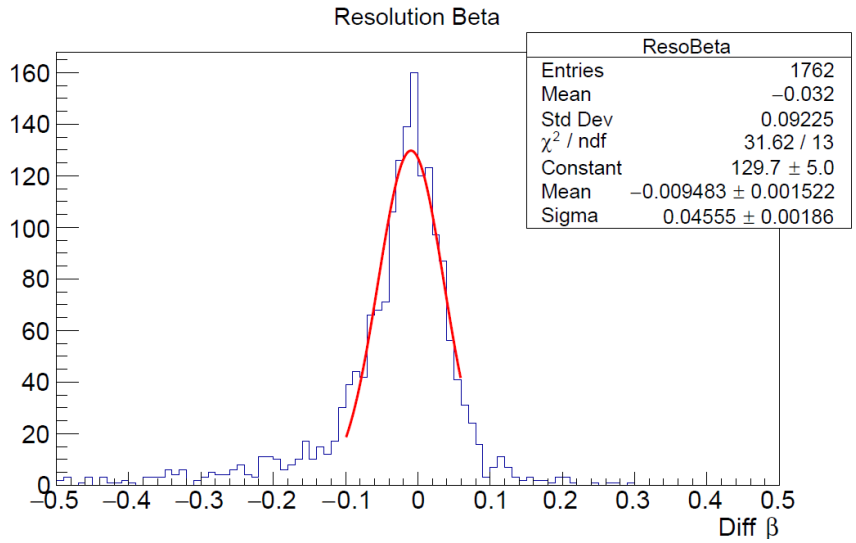


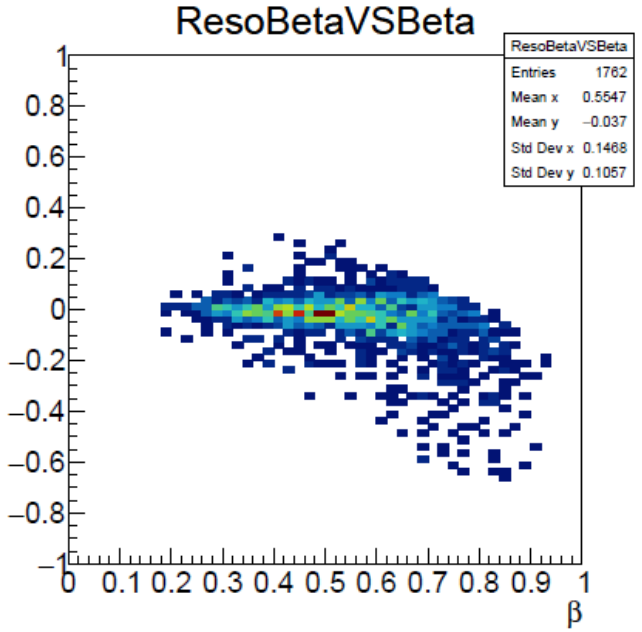


Missing neutron & detected neutron in CND (EB)





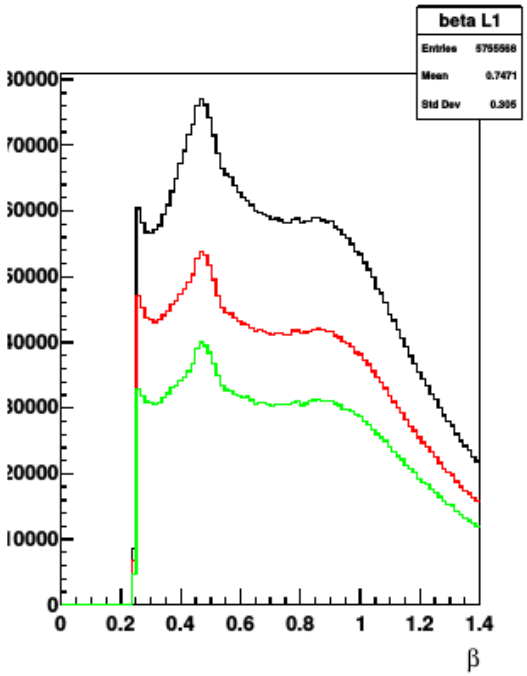


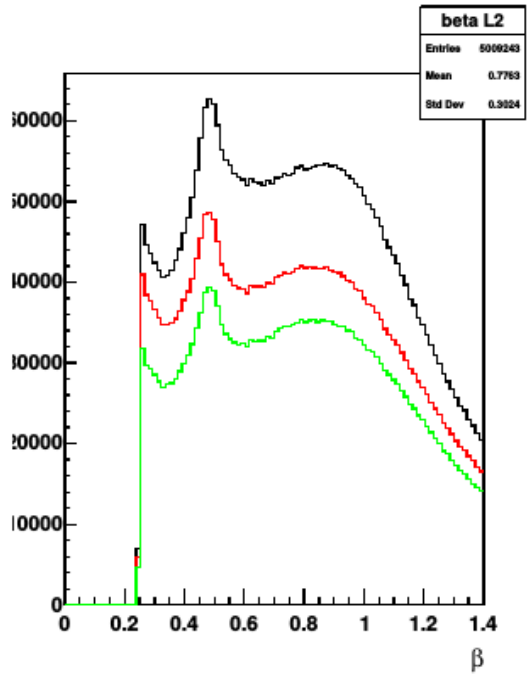


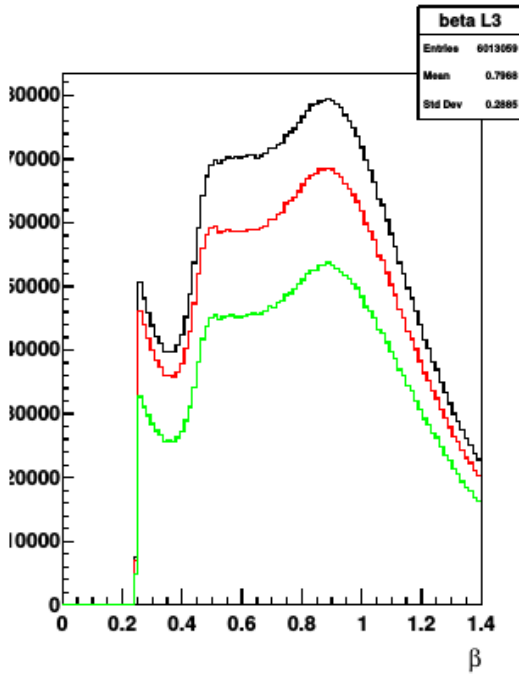
Neutron beta shifted only by ~0.01 (~2%)

RG-B run 6420, latest release

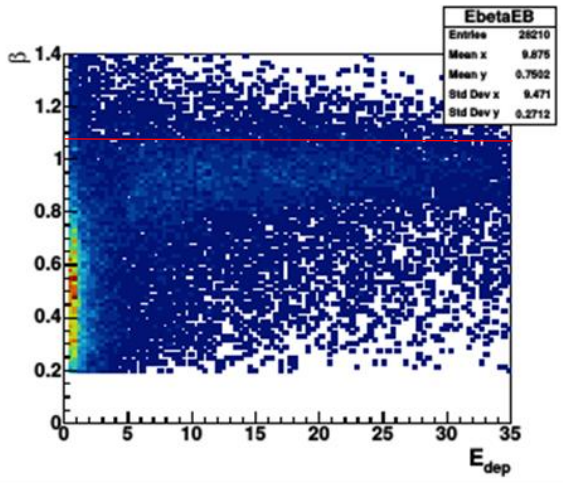
All data
After CD veto
CD veto + ϕ cuts on CVT holes

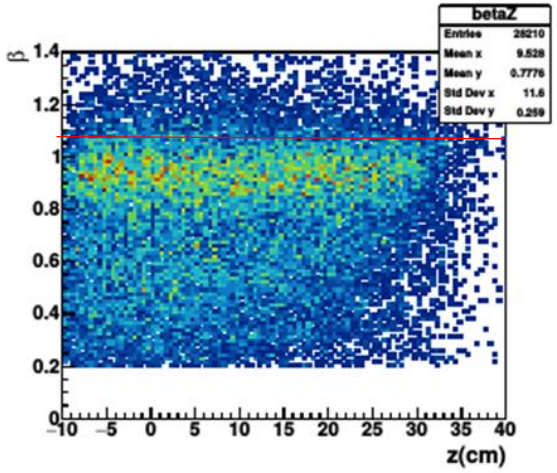


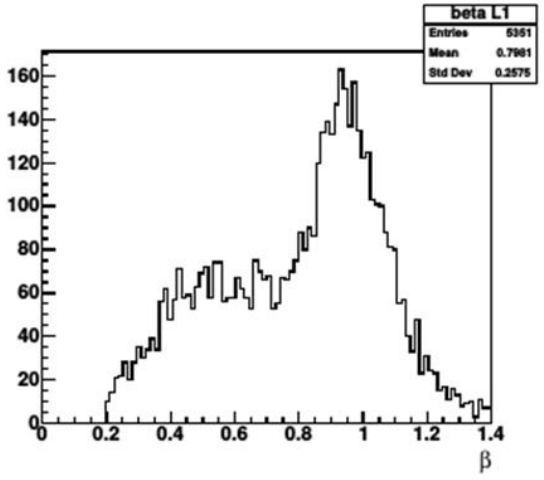




Monte-Carlo simulation: photons and neutrons in CD

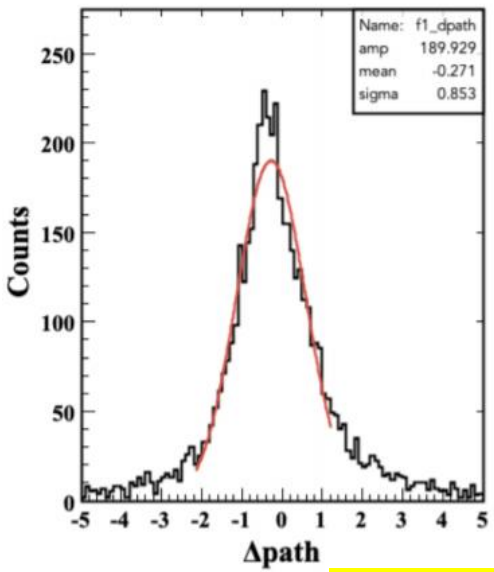


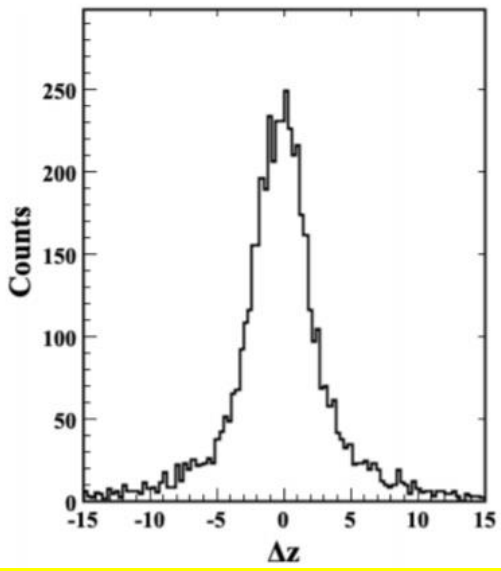


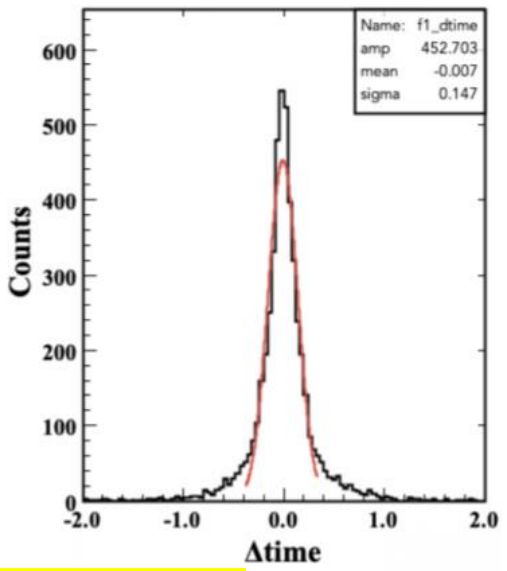


Check of reconstruction with simulated photons (from Raffaella)

CND

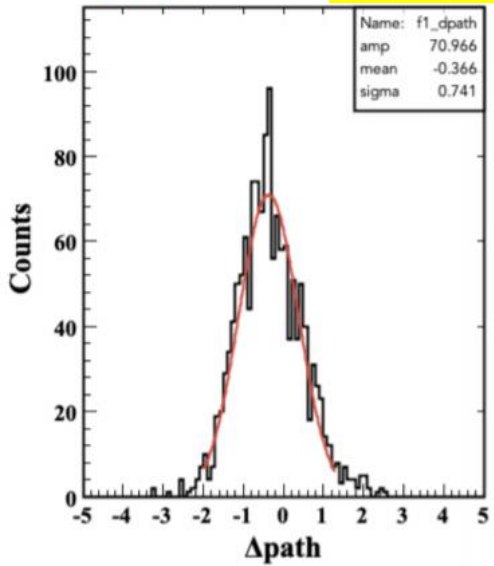


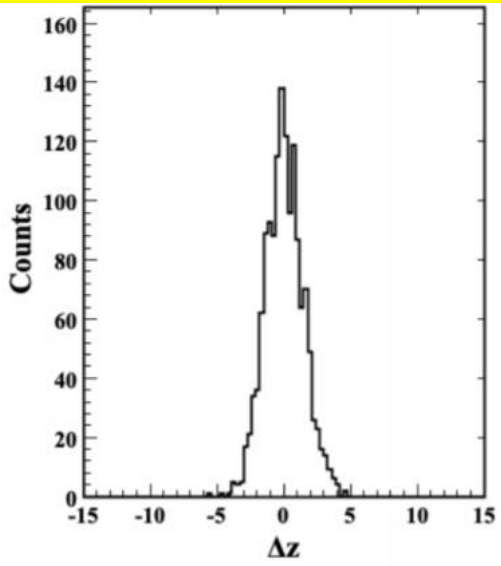


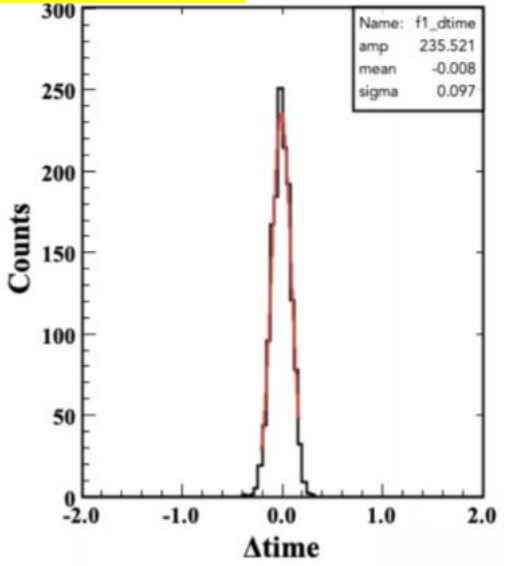


CTOF

~3mm shift in pathlength for CND and CTOF

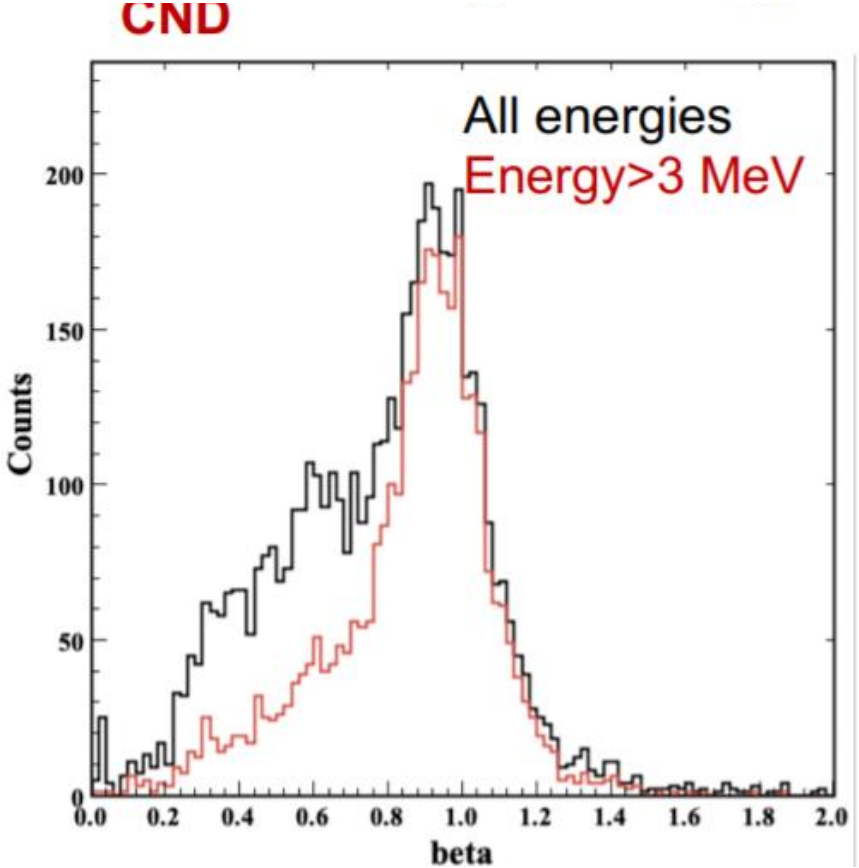


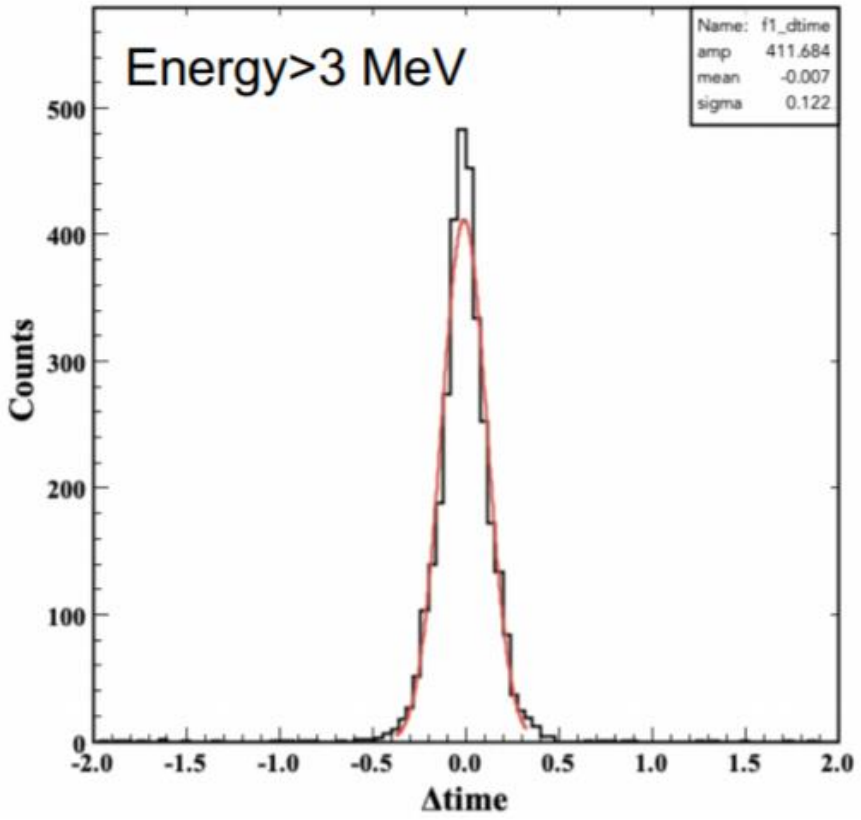




Check of reconstruction with simulated photons (from Raffaella)

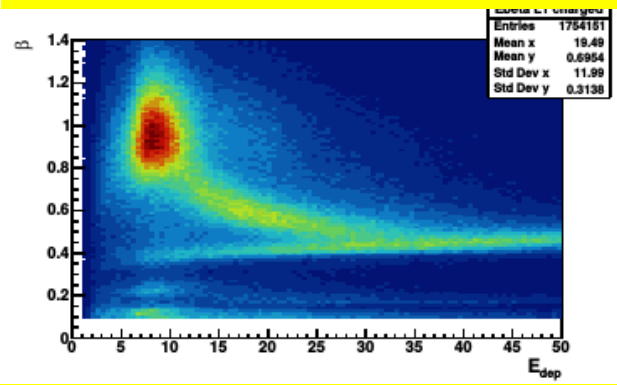
- The resulting beta distributions appear to be shifted from β=1 because of the small shift in the reconstructed pathlength but mostly because β is inversely proportional to the time and the finite time resolution results in an asymmetric β plot
- The effect can be reduced by applying an energy threshold on the cluster: higher energy corresponds to better time resolution

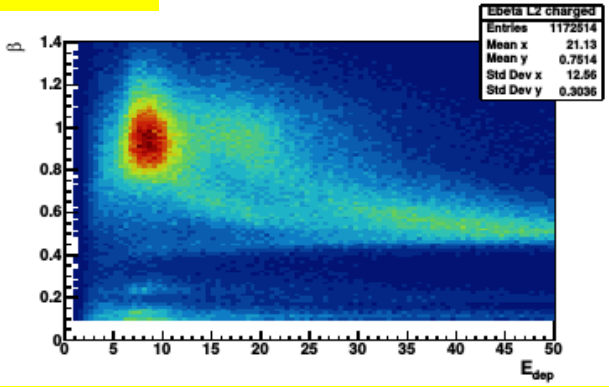


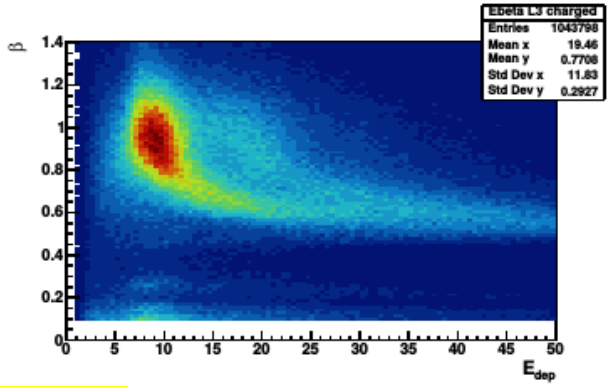


RG-B run 6420, latest release: positive charges in CND

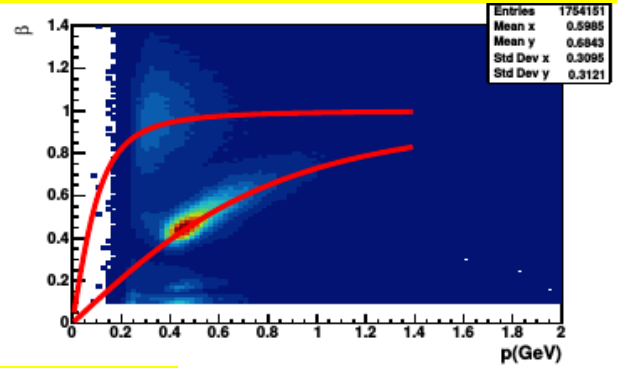
CND clusters matched with a **charged track**

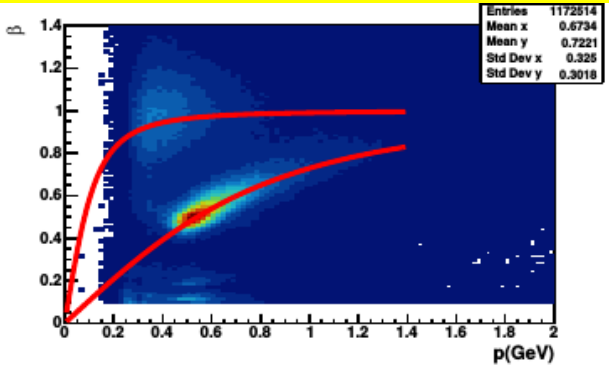


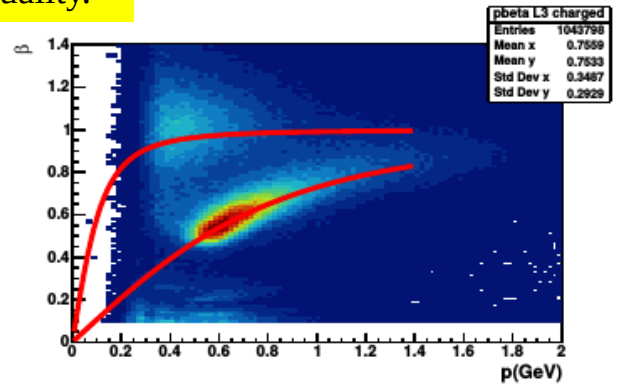




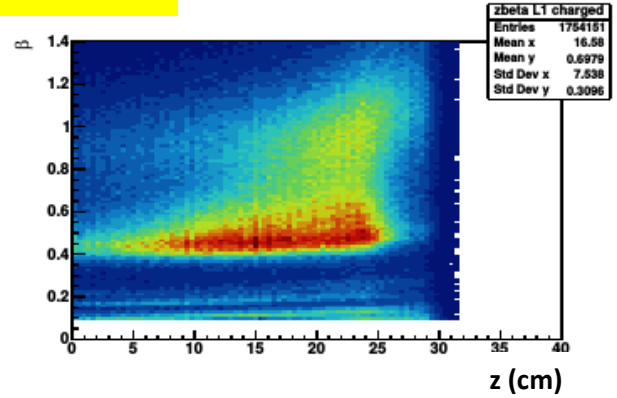
Beta vs p for positively charged tracks, beta computed from CND. Good calibration quality.

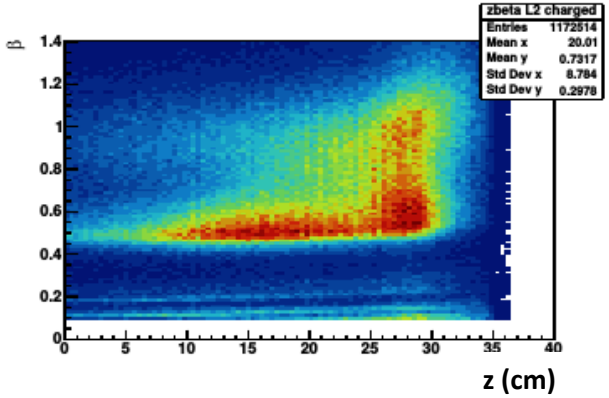


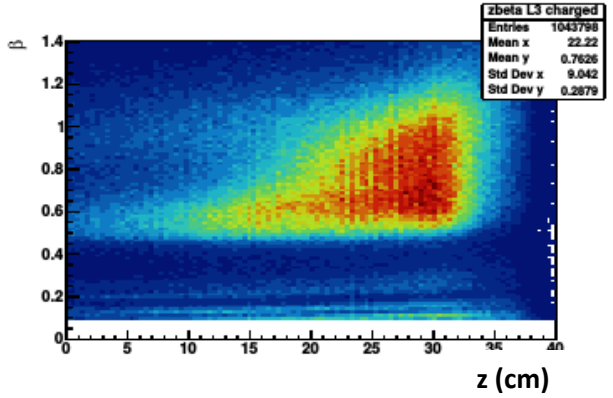




Beta vs z

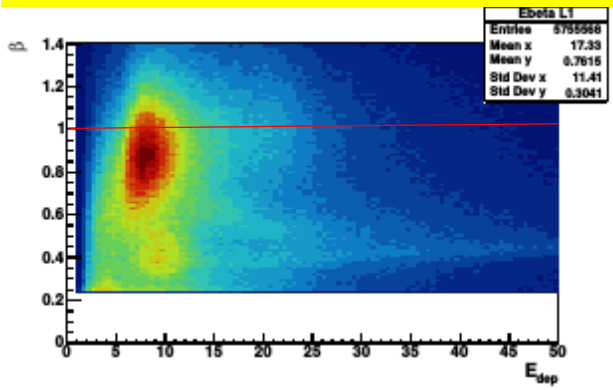


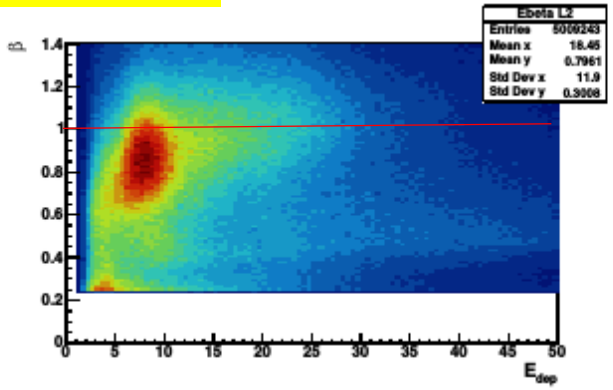


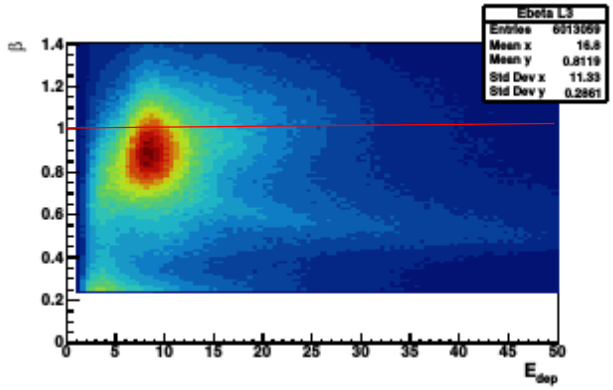


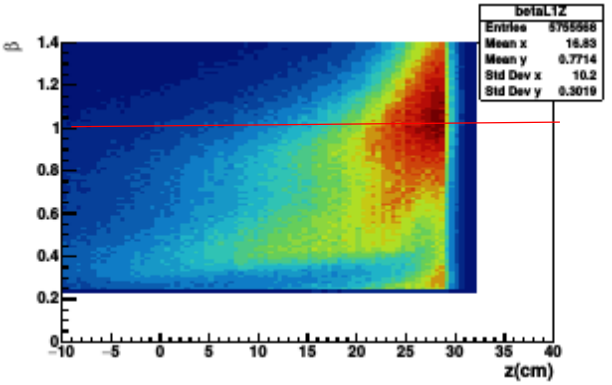
RG-B run 6420, latest release: neutral candidates

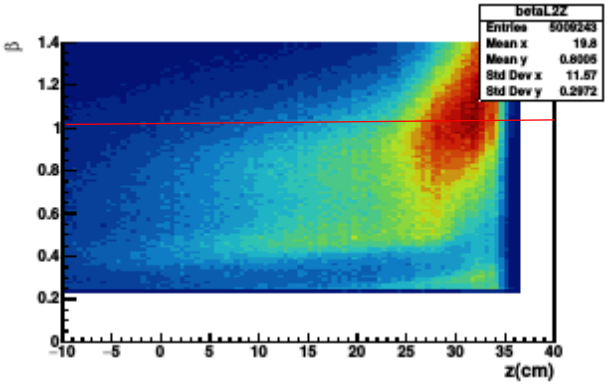
CND clusters **not matched** with a charged track

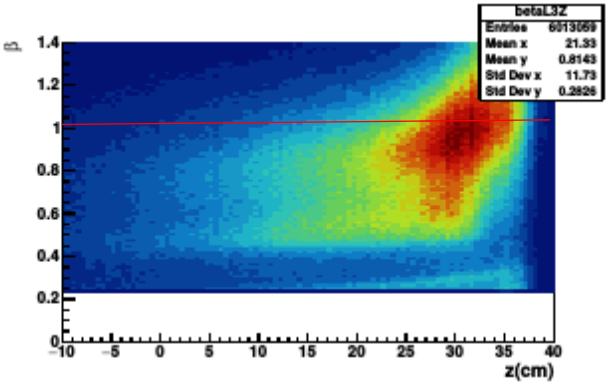




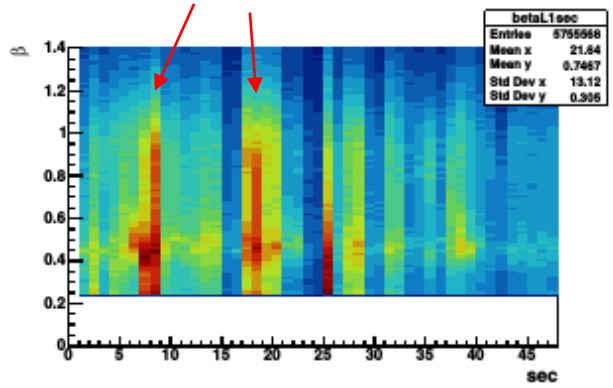


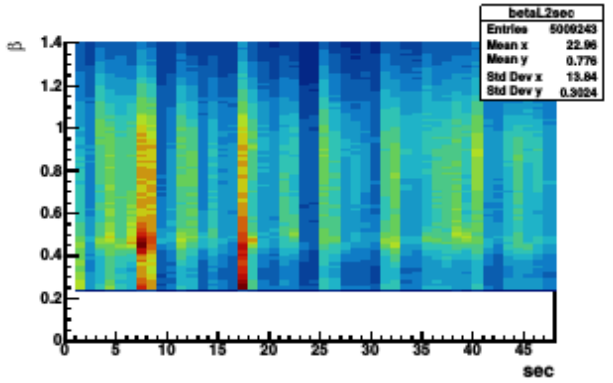


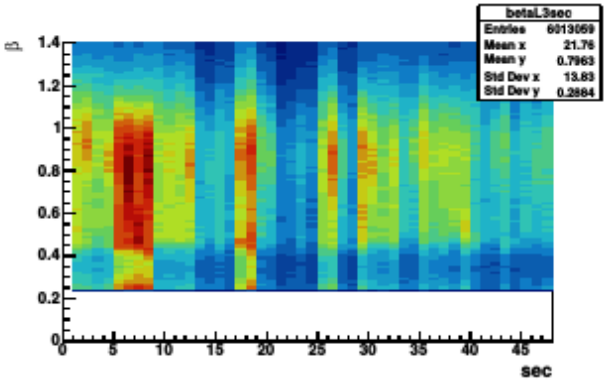




Dead zones of CVT – leakage from charged particles

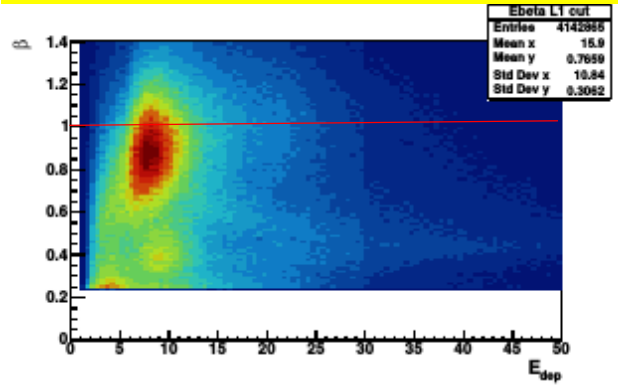


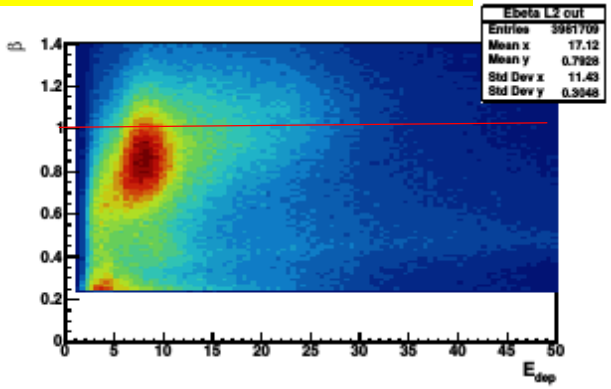


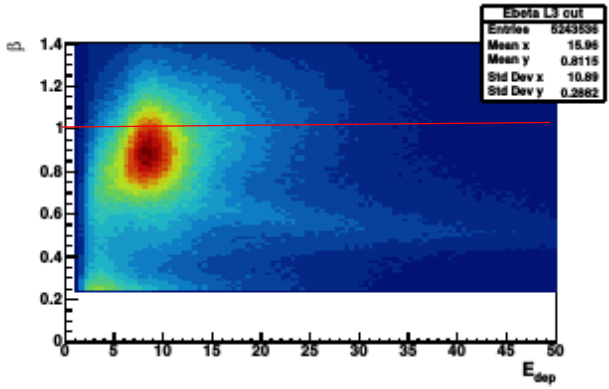


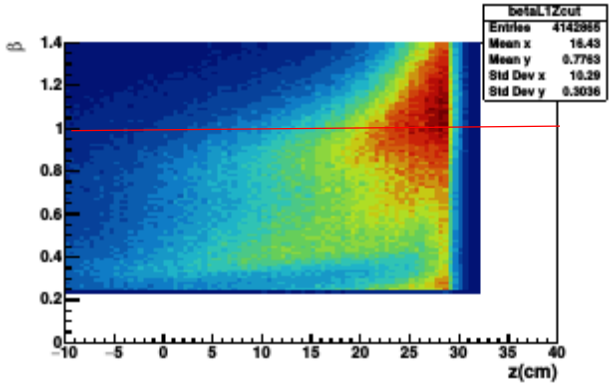
RG-B run 6420, latest release: neutral candidates

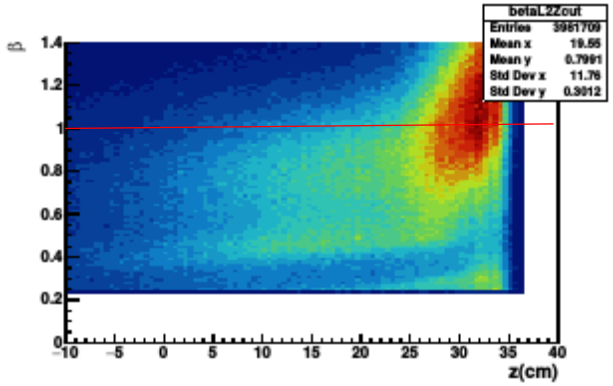
CND clusters **not matched** with a charged track, after **CD veto**

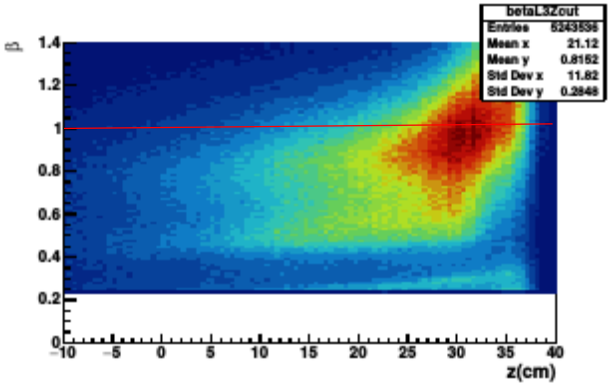




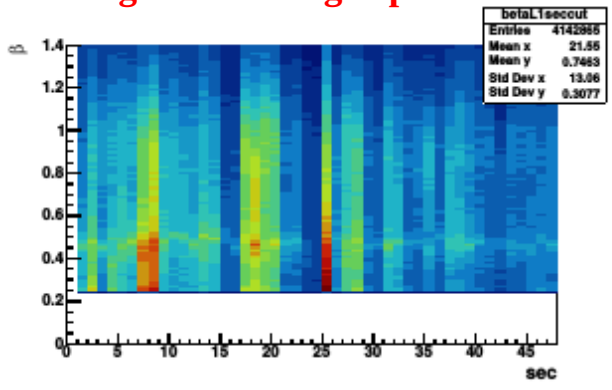


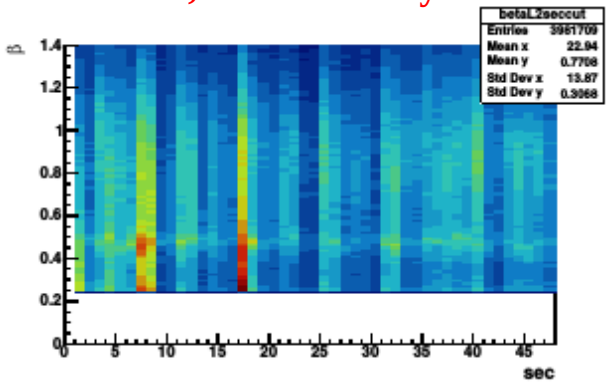


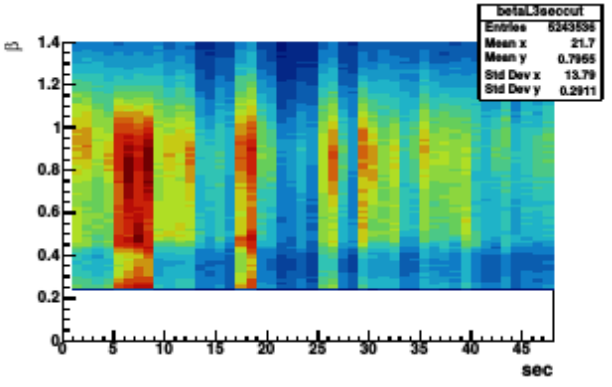




Leakage from charged particles decreases with veto, but is not fully removed

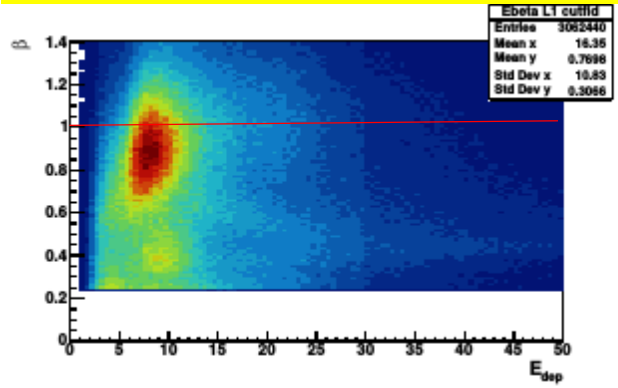


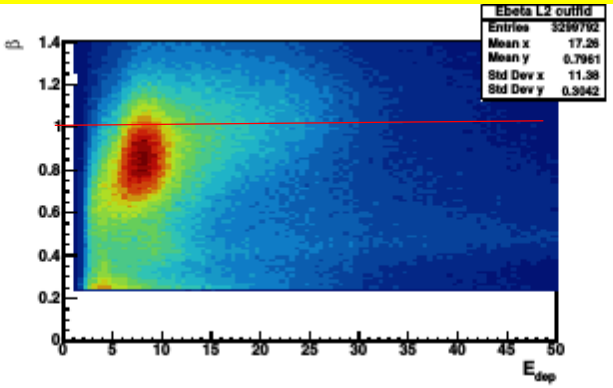


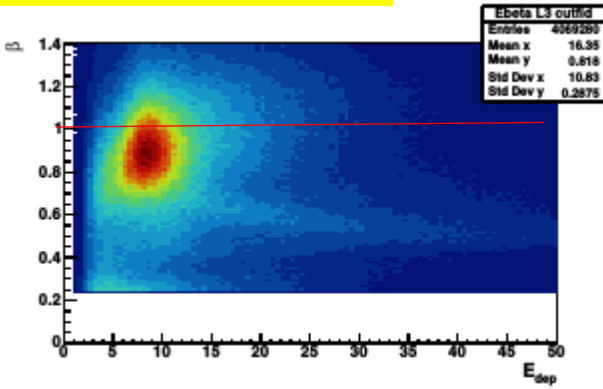


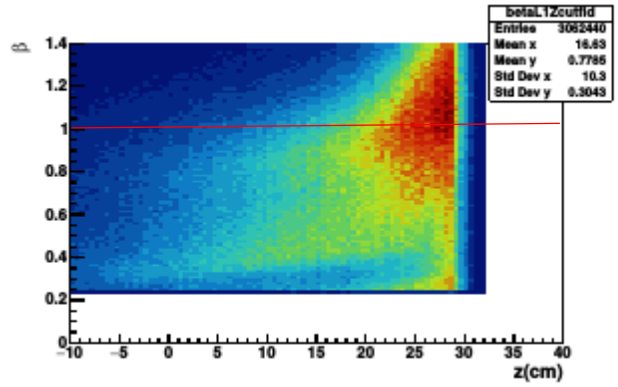
RG-B run 6420, latest release: neutral candidates

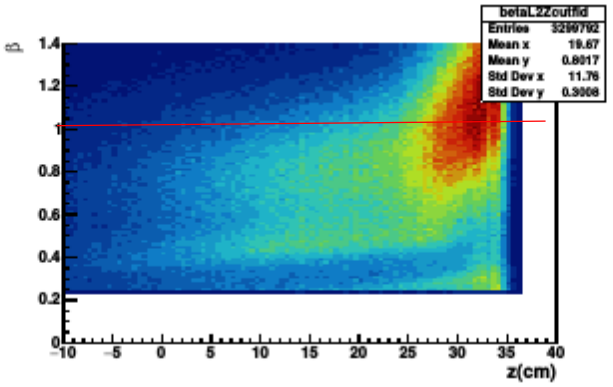
CND clusters **not matched** with a charged track, after **CD veto** and ϕ **cuts** to remove CVT holes

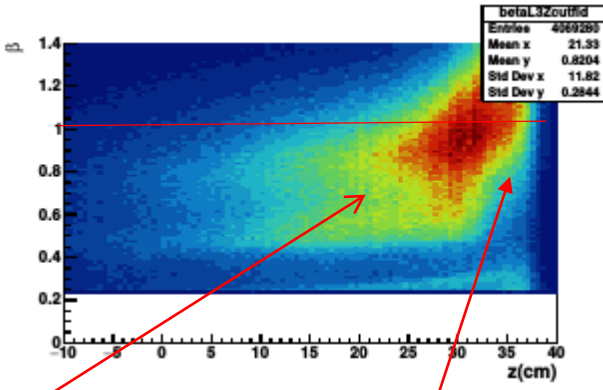












Still leftover contamination from charged particles, due to partial inefficiency of CVT even outside of dead zone. Mainly pions (see slide 10 for z distribution), as their edep is the one for MIPs (~6 MeV, for 3-cm-thick scintillators). Pion background « covers » the photon peak, contributing to the beta shift.
CD veto will need tuning, as was expectred. All necessary variables for the veto are kept in REC banks. Veto can be tuned and applied offline

Photons are the most forward-going (high z): beta centered at 1

Charge #3: *(a) Are analysis plans for the data set developed at adequate levels? (b) Is the list of planned skims defined and tested running analysis trains on preliminary data? (c) Are preliminary analysis results for the main reaction channels and observable available and consistent with expectations? (d) Is all ancillary information (helicity, Faraday Cup, …) available and understood?*

(a) Yes – The analysis plans for the leading candidates for the first publication of RG-B, nDVCS for example, are developed enough to proceed with analysis of a large data set.

(b) Yes – The skim list is in place. Four skims are defined that will compose ~20% of full DST output.

(c) Yes – The preliminary analysis results for many physics reactions are encouraging.

(d) No – Beam spin asymmetries have been shown, but not beam charge normalized yields, which are still in progress.

From QA timelines on latest pass-0 cooking (10 files/run)