Puzzling Cointime Behaviour

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Quarterly Analysis Meeting V

Introduction

- Analysis of KaonLT data for beam-spin asymmetry: high ϵ, E_{beam}=10.6 GeV, October 2018
- Coincidence data with e^- in HMS and hadron in SHMS
- Coincidence time distribution looks odd, with real events reconstructing to a bad coincidence time
- Related to TDC timing issue noted in November 2018

Yet more jitter tests -- found small issue w/ ref time, but nothing that impacts coin. times

Lognumber 3626796. Submitted by brads on Thu, 11/15/2018 - 18:11.

Logbooks:	HCLOG
Tags:	DAQ
References:	3625832 - More jitter tests -- nothing found on scope...

Took advantage of the accelerator down this afternoon to look at a few signals at the TDCs themselves.

I found that the reference signals at the TDCs in the counting house are inverted. These arrive as single-pair ECL at the TDC, and the ECL cables are all polarity swapped between the two ends, inverting the signal seen at the TDC. The upshot is that the TDCs are measuring the *trailing* edge of the ref times pulse, not the leading edge. The trailing edge can jitter depending on how well the upstream module is able to maintain the delta-T on its pulse width.

**** NOTE **** In practice, as seen in Fig 1, the jitter on the (effective) trailing edge seems to be very small (within the resolution of this scope). So, this issue should be corrected at a convenient time, but it does **not** appear to be particularly significant.

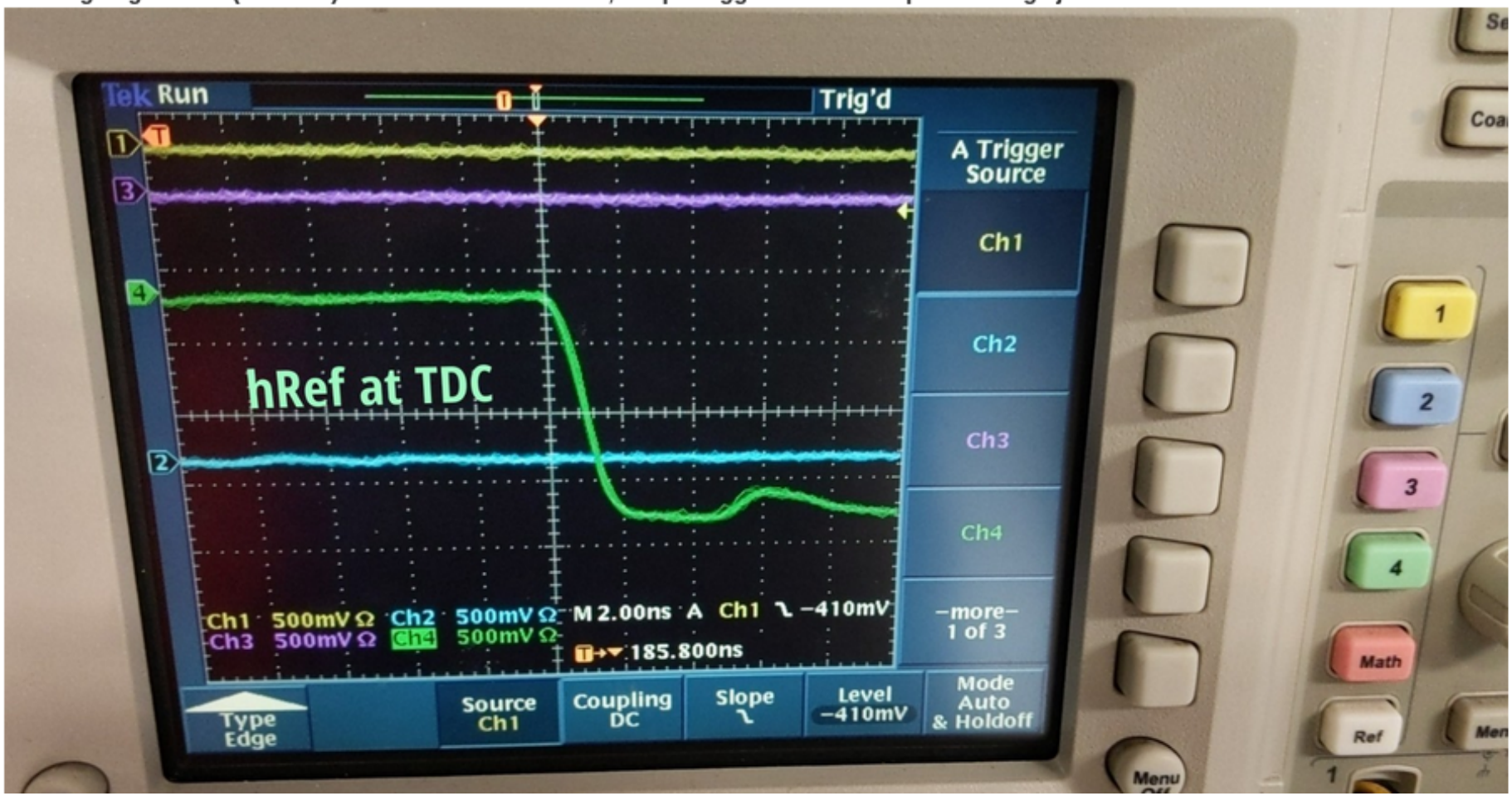
Other obersvations/comments:

- This may not affect the coin. time at all since the main components of the coincidence time are measured in a single TDC (so the ref time literally drops out of the difference). (*However*, it is not clear to me if any jitter on the ref time may creep back in through the plane-time corrections that are used in the final coincidence time though..)
- Any jitter on the trailing edge of the ref time can be measured by looking at the other copies of 'pretrigger 3/4' in the respective arm's "trigger TDC". The ref-time subtracted 3/4 pretriggers should be perfect deltas. The deviation is a measurement of the jitter between the 'real' 3/4 and the (inverted) ref-time trailing edge. That event-by-event difference measured in the one TDC could then be used to subtract off the ref-time jitter in all of the TDCs in that ROC.

Notes / comments on correcting this problem:

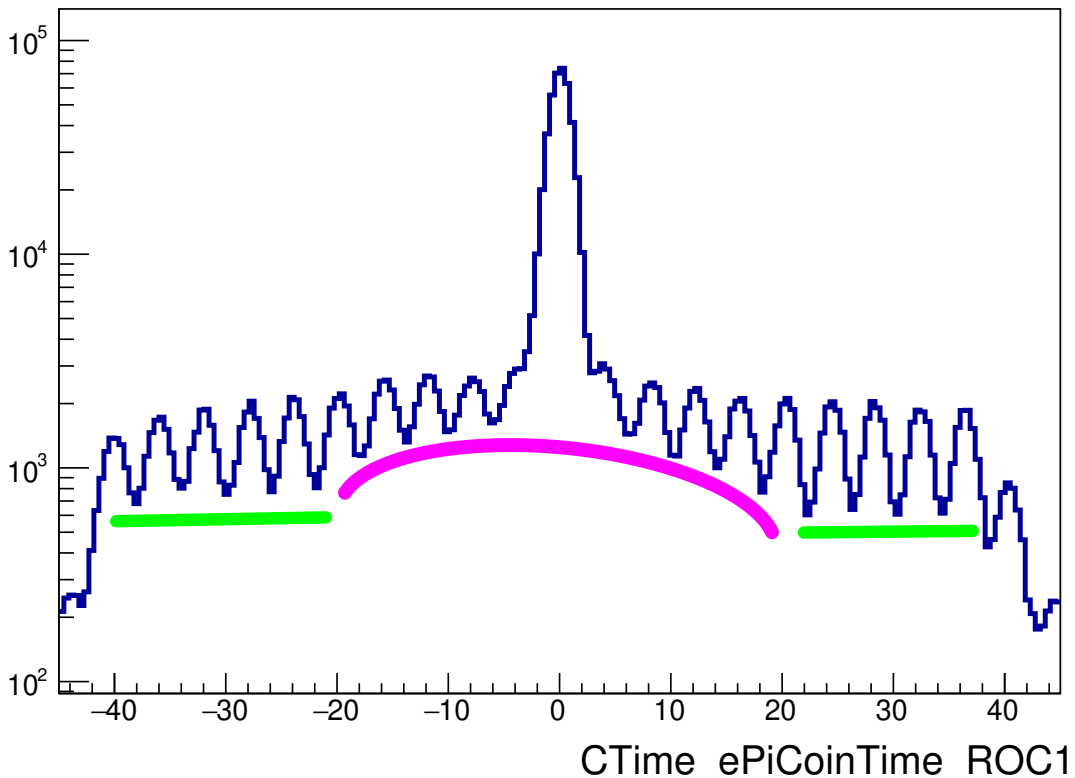
- The hardware change is trivial. Just flipping a few single-pair ECL cables and correcting the +/- labelling so this doesn't happen again.
- This will, however, result in the all TDC reference times shifting earlier by their width (20 ns). This will, in turn, shift all ref-time subtracted objects in TDCs the same -20ns as well. Note that the FADC reference times will **not** change (different signal path).
- So, we need to be careful that all of our 'hit selection' and physics timing cuts are still valid after this change. It should be possible to make an updated set of param files that shift all relevant cuts by the known 20ns and have them ready. This can be verified with EDTM, so we can make the change and verify the majority of these cuts without beam.

Leading edge of the (inverted) h3/4 ref time at the TDC; scope triggered of EDTM pulse -- negl. jitter



Discovery

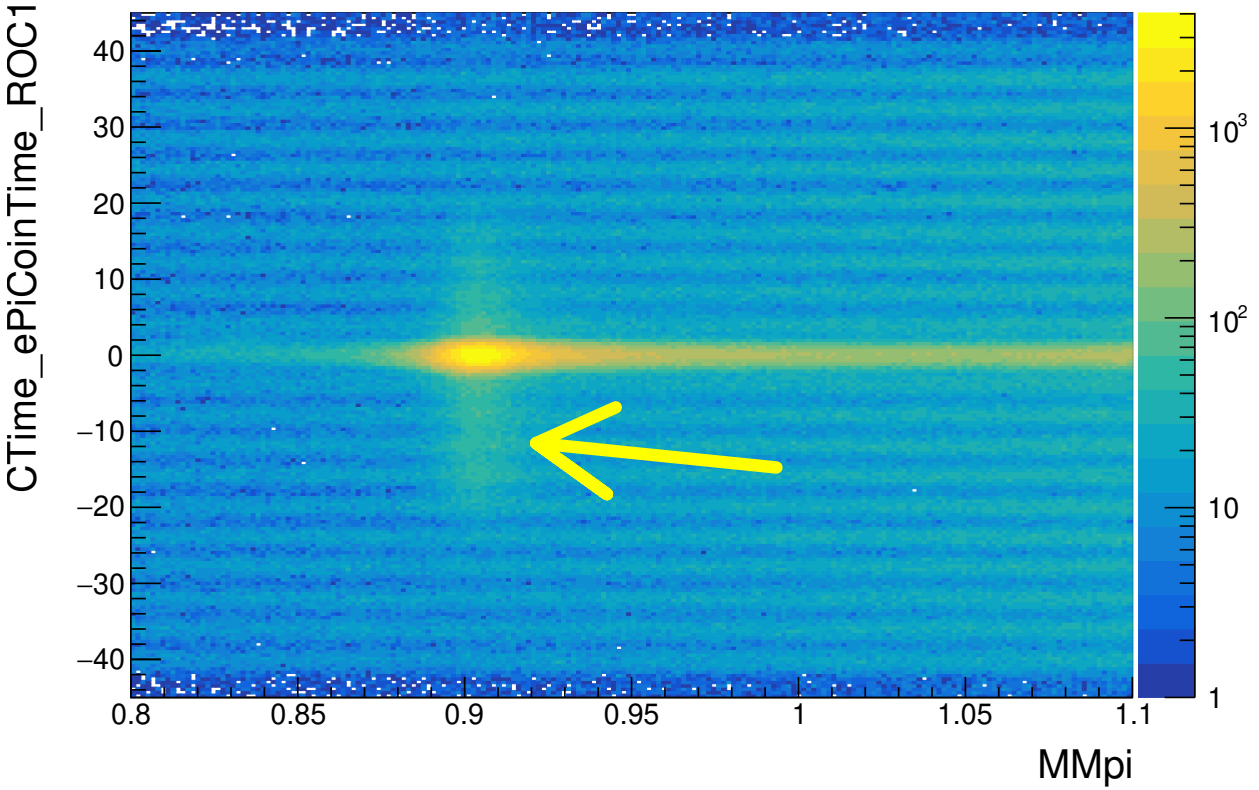
- Unexpected shape of coincidence time distribution: additional feature between ±20 ns



Q^2=2.115 GeV^2, W=2.95 GeV
SHMS center
Runs 4913–4947, Oct 2018
H_cal_etottracknorm>0.8
H_cer_npeSum>1.5
P_aero_npeSum>3
P_cal_etottracknorm>0.05
0.85<MMpi<1.0

Investigation: Missing Mass

- Missing mass is reconstructed to the neutron: real $p(e, e'\pi^+)n$ events



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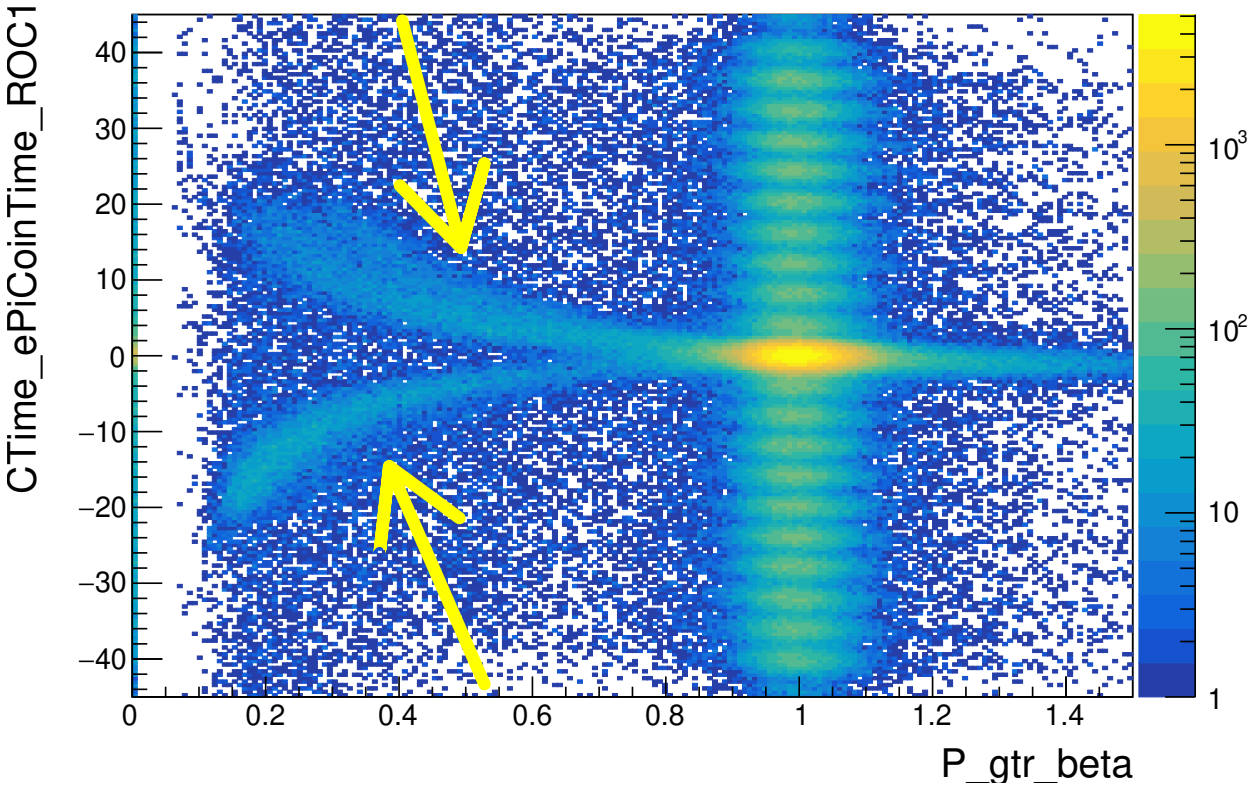
Investigation: SHMS Beta

- Events with bad coin time correspond to $\beta_{SHMS} < 0.8$



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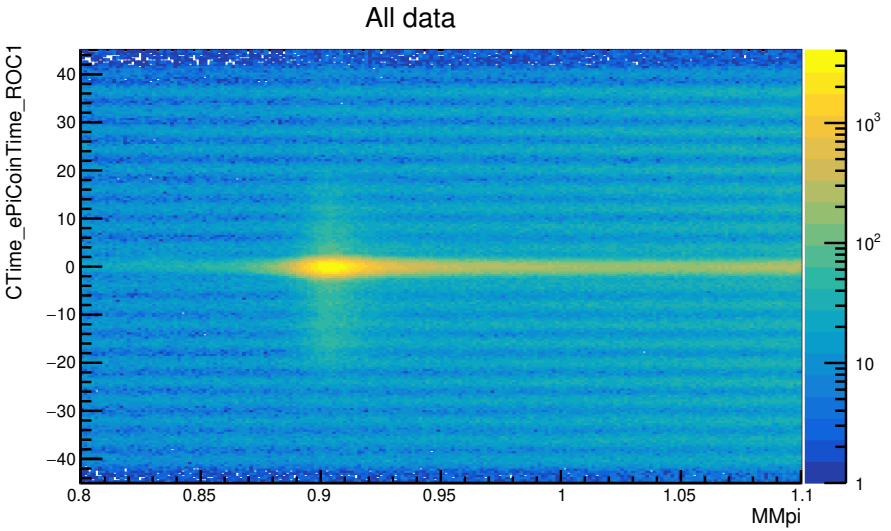
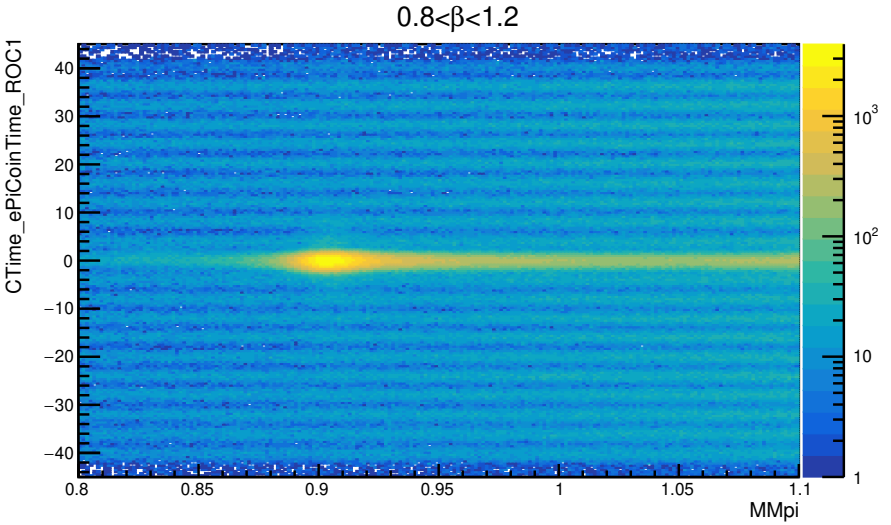
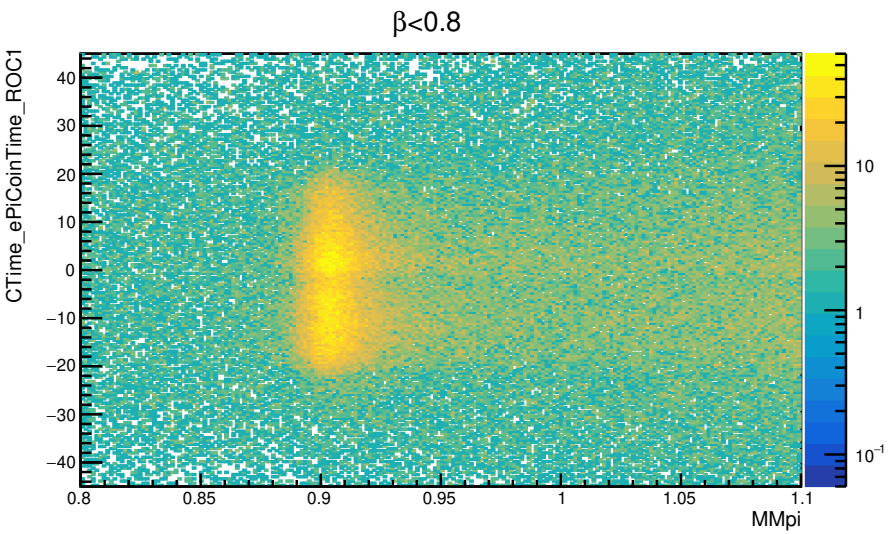
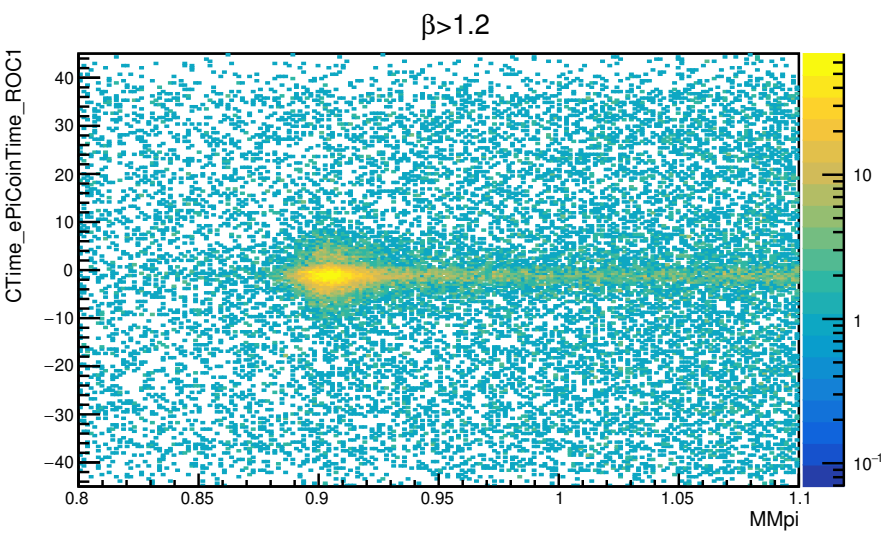
Investigation: Missing Mass and SHMS Beta





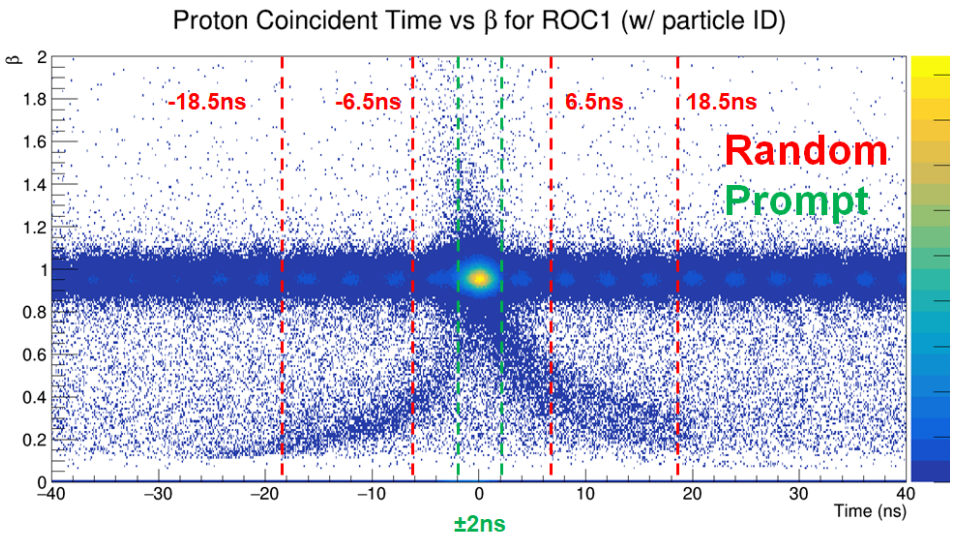




Other Reaction Channels

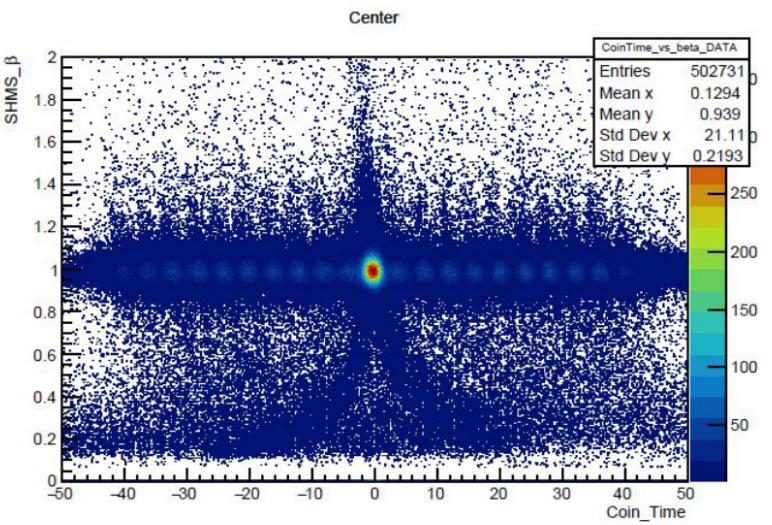
- Same effect seen regardless of what hadron is detected in the SHMS

$p(e, e'p)X$



plot by Stephen Kay

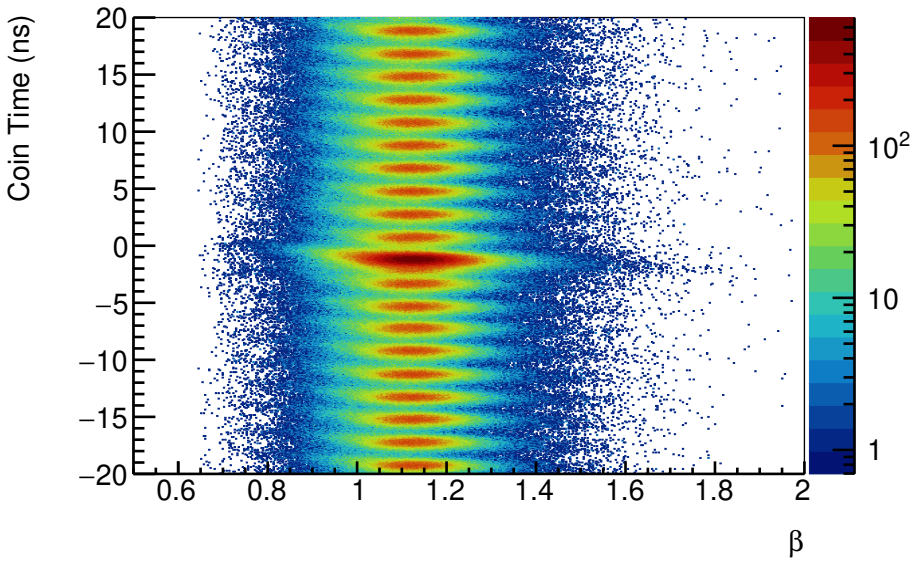
$p(e, e'K^+)\Lambda/\Sigma$

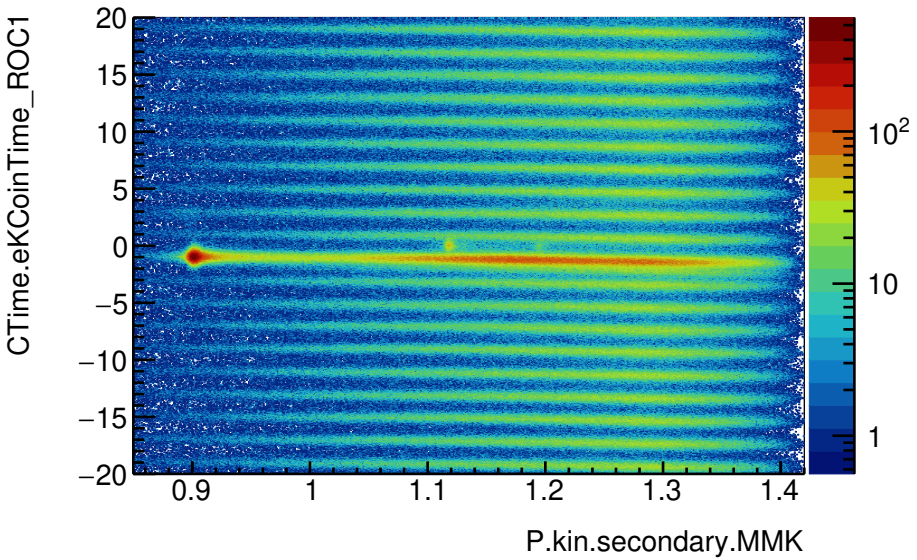


plot by Richard Trotta

Timeline

- TDC cables fixed on November 15, 2018
- For KaonLT, this affects only the E_{beam}=10.6 GeV run period (October 2018)
- Some SIDIS data will be affected
- For KaonLT E_{beam}=3.8 GeV (December 2018):

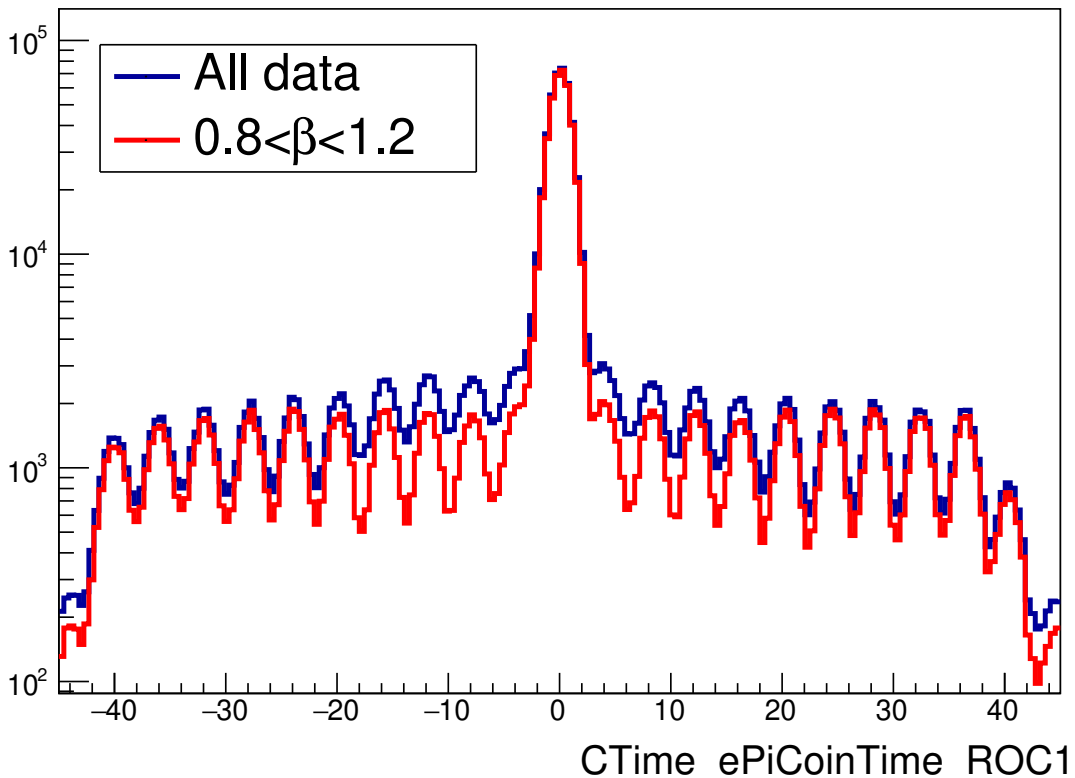




plots by Nacer Hamdi

Proceeding with Analysis

- Cut on β_{SHMS} before performing accidental subtraction
- Correct experimental yields for efficiency of this cut



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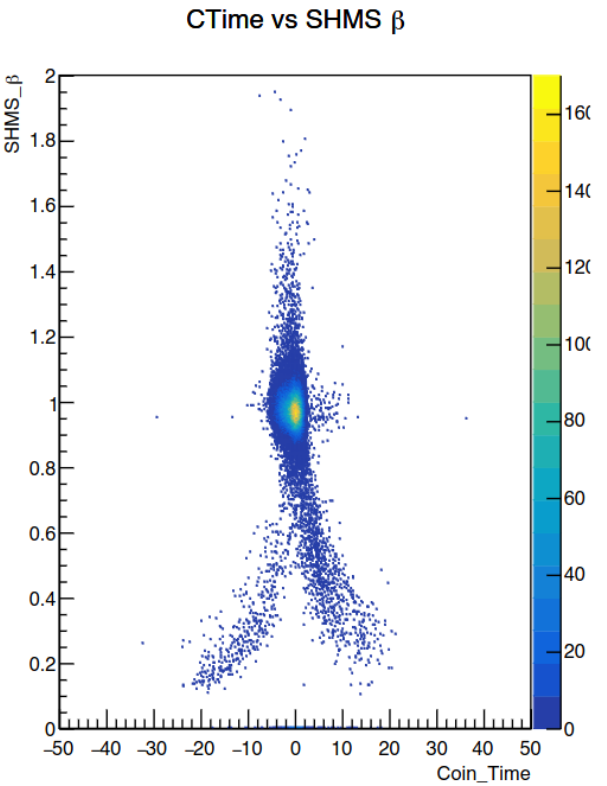
HeeP Coin Analysis

- Using H(e,e'p) data to determine the efficiency of the β cut
- Find clean event sample, then pick a reasonable cut for β to clean up coin time
- Calculate efficiency for each setting:

$$\frac{\text{Good events with } \beta \text{ cut}}{\text{All good events}}$$

- Exploring cut dependence of β cut to find efficiency that does not depend on PID
- Will eventually calculate run-by-run in report files for physics data



Summary

- Coincidence time spectrum affected by TDC cable issue
- Data from before November 2018 is affected
- Cut on SHMS beta needed to perform proper accidental subtraction
- Ongoing study: determining the efficiency of this cut from HeeP Coin data

> Questions, comments, suggestions welcome!