Can we measure the K^+ Lifetime in E949?

- recent KTeV results on K_L calls for examination of old measurements on all kaon properties
- Marciano /Kettell dialogue: might we be able to measure the K^+ lifetime?
  - current PDG lifetime ->12.384 ± 0.024 ns
    - +lots of decays to study
    - +can measure stop and decay in one identically instrumented system (target + CCDs)
    - - we ran at high rates, with high accidentals
    - - we didn't control/measure systematic effects

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- thought it was worthwhile to study our data
- check http://www.phy.bnl.gov/e949/analysis/klife for some email exchanges and further work

- **concept**: make measurement ‘solely’ in target, and use upstream beam system to study and limit problems from high rate

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- obvious conceptual problems with measurement ‘solely’ in target
  - data triggers use RS (except for KBEAM)
  - SWATHCCD code uses UTC analysis (and detector strobe or timing from RS)
- AND

  what sets our absolute timing calibration?

  (lets look at this question first)

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- timing for kaon and subsequent decay are measured in target system with 2ns TDCs and 500MHz CCD.
  - all beam gated, so at least naively independent of the rest of detector
- approximately 90% of timing information comes from CCDs
  - so, how well do we know calibration on CCD system? …and how can we be certain that calibration is unchanged from 2002?
  - defer this to TRIUMF experts, but maybe we can check in data

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- use the precisely known RF from AGS (93.141 MHz)
  - known to better than 1 part in 10^5
  - we saw this structure often in our beam counters
    - e.g. Kaon and Pion Cerenkov counters, which used the same CCD system clock as the target.

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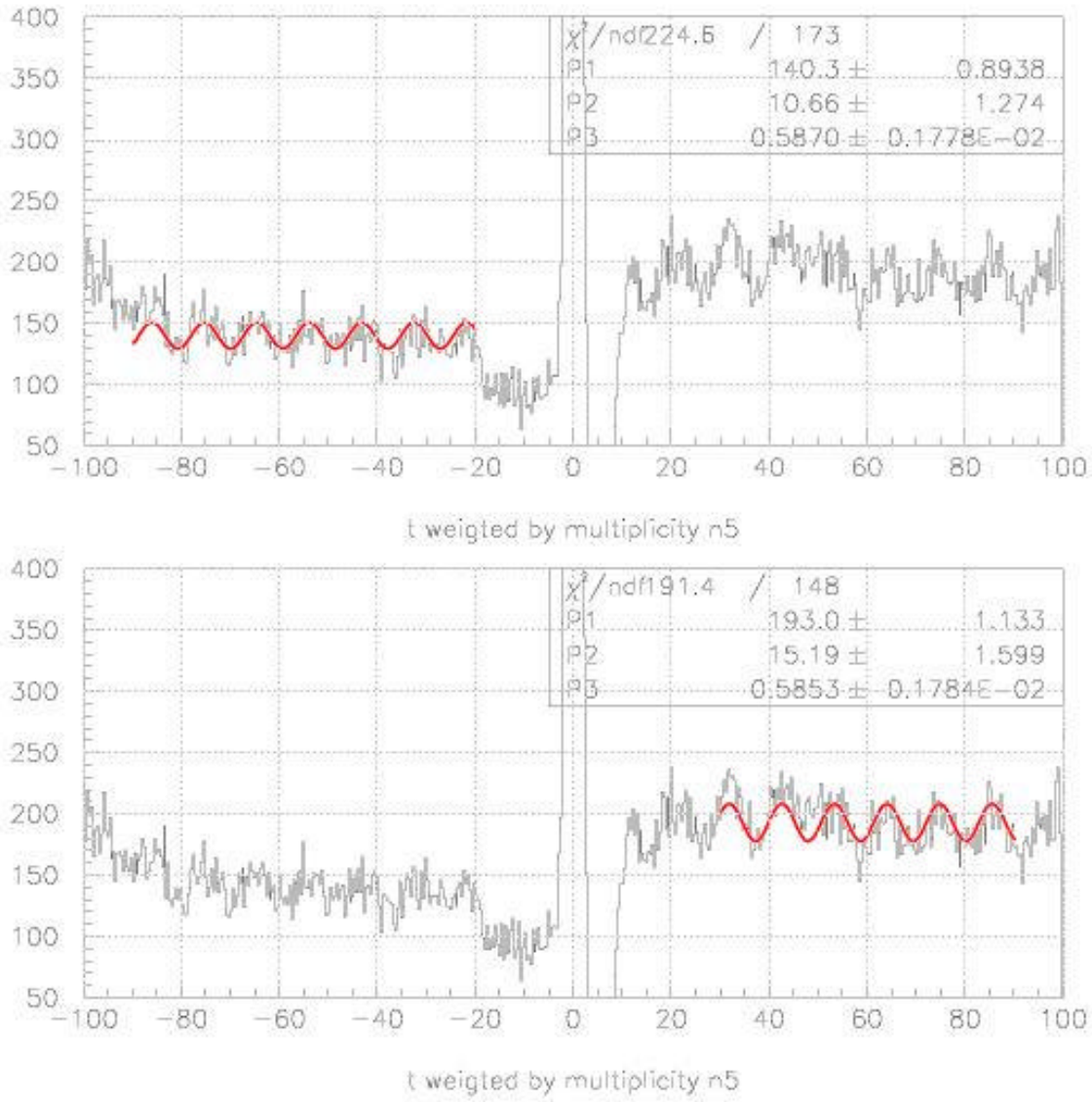
looking at CK (average times when multiplictiy was >5), get AGS frequency to ~1% (fit to cosine)



June 24, 2004

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- using AGS RF to check CCD clock looks quite promising
- a few problems sighted
  - time slew in CK CCD times seen
  - gains may or may not be balanced (or factor of up to 2 differences in individual tubes)
  - time shift noted for pulses after earlier pulse
- so, what about target analysis?

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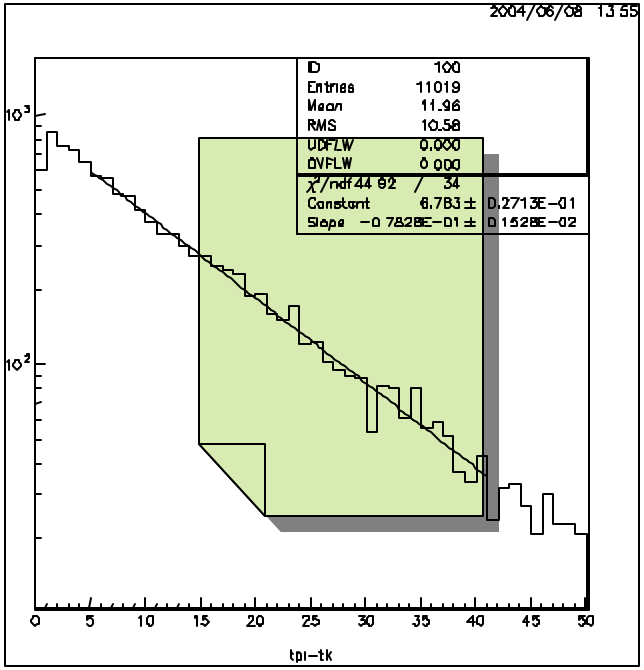
- **use simple target analysis (using SWATHCCD)**
  - ptot 195-250; itgqualt=0; abs(tk)<3; 0<tpi-tk<50; 40<ek<160
  - not bad for a first look (12.77 ± 0.24) ns with ~10k events, Km21 trigger



- **start studying systematics in target analysis**

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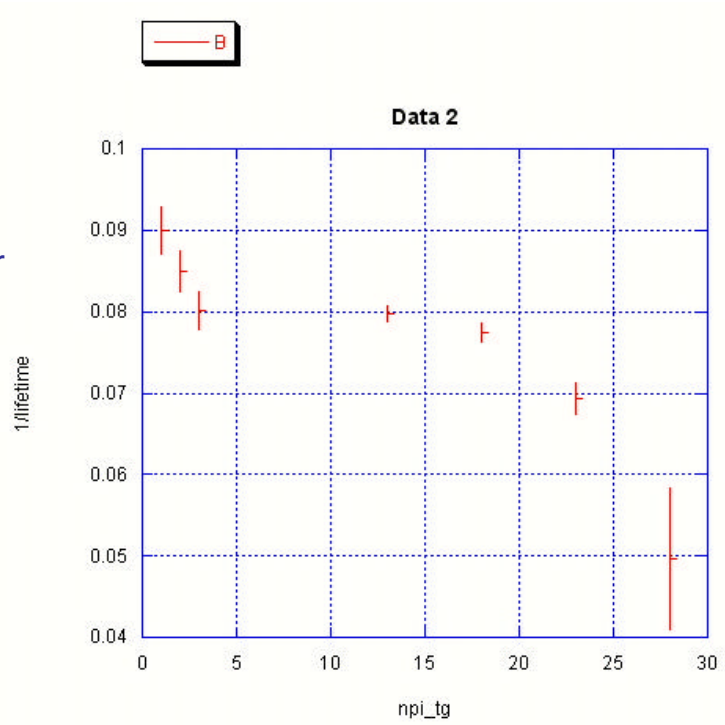
- problem(s) became apparent quickly
- systematic change in lifetime vs npi_tg traced to
  - 2nd pulse fitter in swathccd
  - ccd pulse finder uses 'reliability threshold' in ADC energy (typically ~0.7 MeV), and ADC energy decreases as a function of time after the beam-gated strobe (measured 6% effect on energy at 50ns)
- partial solution….turn off 2nd pulse fitting
- need to understand/measure the effect of adc gate
- what counts for lifetime determination is reconstruction **efficiency**, not npi_tg (efficiency may be effected for decays near target edge, but probably unchanged for decays originating closer to center).



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- what else have I looked at?
  - effect of 2-beam background, assuming we trigger and reconstruct 1st kaon decay
  - use toy Monte Carlo

Prob 2nd kaon	fit (1/lifetime)	ratio to input
.01	.08112 +- .00014	1.0034 +- .0017
.02	.08154 +- .00014	1.0086 +- .0017
.05	.08287 +- .00014	1.0251 +- .0017

- so, if we can limit 2k to < 0.5%, fit to lifetime probably OK at the 0.1% level

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- effect on detector rates by removing events with accidental CK or CPI activity within ± 100ns
  - checked BV activity (tpvbv)

no accidentals	**yes accidentals**
0.54 hits/event	1.41 hits/event
0.069 hits/event	0.293 hits/event (epvbv>5MeV)

- really need to study effect on T.2, and rest of RS

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- conclude-
  - no showstoppers yet
  - my gut says that it's crazy to try to extract precision measurement without attempt to control/measure systematics…..but I can't justify stopping work at this point
  - please give me your suggestions, remarks, and criticisms (but don't tell me the true CCD clock rate yet).