GLAST Large Area Telescope

What Time Is It?

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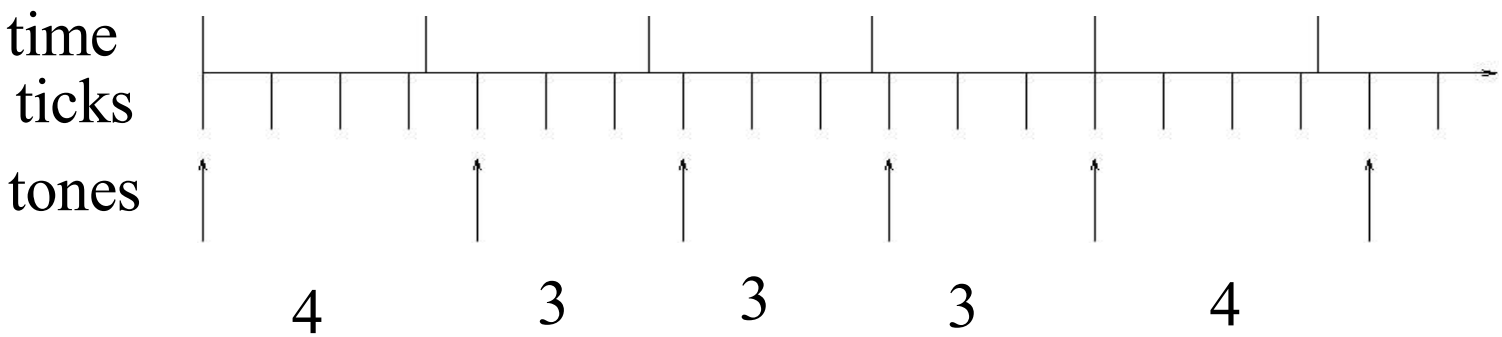
What we get

- LAT clock runs at 20MHz
  - or so
- GEM keeps track of the clock ticks
- Every second, on the second, the GPS receiver on the spacecraft sends the LAT an interrupt (Time Tone)
- The GEM makes a note of it
  - time and ticks
- So we get a list of times, and the corresponding elapsed ticks
-
- When we get an event, the GEM records the elapsed ticks at trigger time
-
- Interpolate event ticks into the list of ticks vs. time to get event time

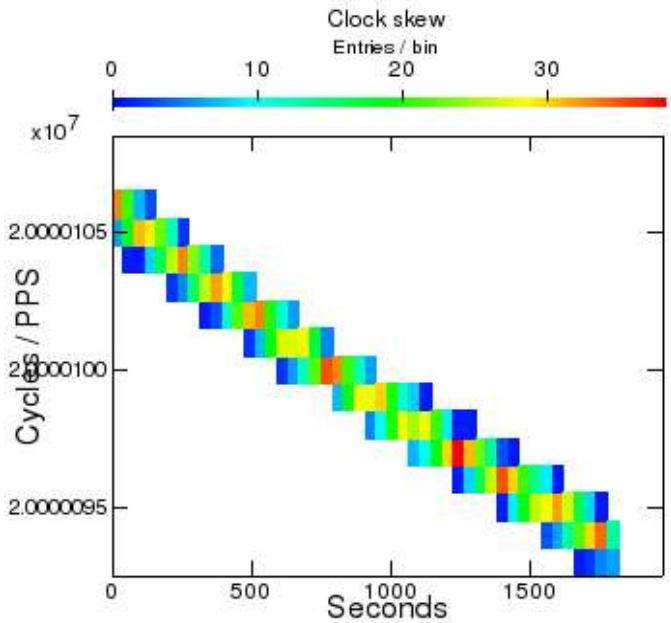
My Model

- We get a time tone every second
  - pretend GPS is perfect
- But we can't react to it until the next tick
- Time tones will not be an integer number of ticks apart
- But the GEM can only report integer separations
- Long term, elapsed ticks must add up to the right average value
- So we see dithering between 2 adjacent numbers



Reality

- We actually see dithering between 3 adjacent values
  - so there is some real scatter
  - but it's <~ 1 tick
- Also see long term drift in rate
- See my talk from 2006/06/30

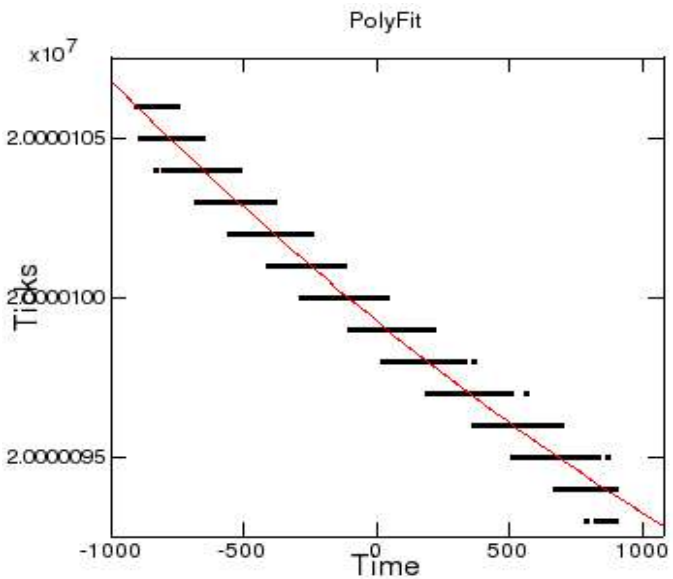


Simple Approach

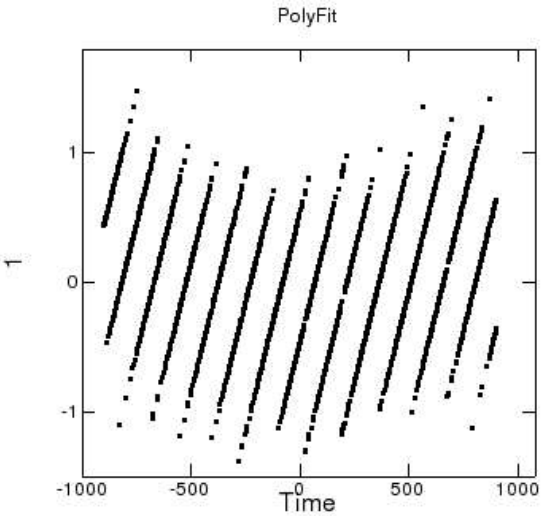
- Interpolate event time between time tones immediately before and after event
- $t_{event} = t_{prevTone} + (ticks_{event} - ticks_{prevTone}) / (ticks_{nextTone} - ticks_{prevTone})$
- This assumes no knowledge of when, within the reported ticks, the tones or event occurred
  - best estimate is that it happened in the middle
- We can never know, better than a tick, when the event was
- But we might be able to do better with the tones
- The error in the time assigned to an event by this method has a distribution with width = 3 ticks, σ = 0.5 ticks
  - it's the convolution of 3 1-tick-wide “box” distributions

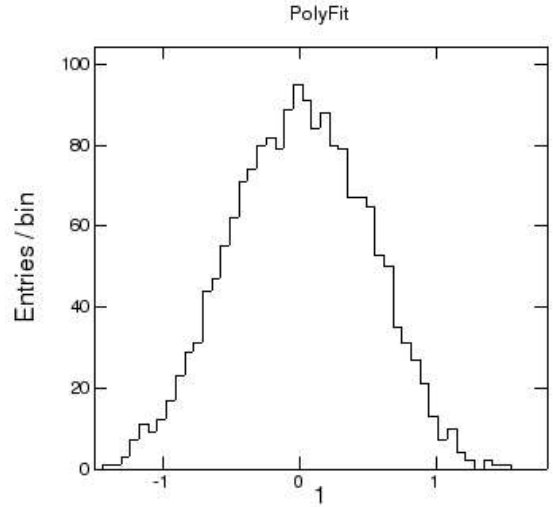
Try Fitting Rate vs. Time

- If we fit (elapsed ticks between tones) vs. time, we may be able to get better estimates of tick rate
- Try fitting polynomials
  - increase order until χ^2 stops decreasing
  - for run 077005067, this gave a 4th order polynomial

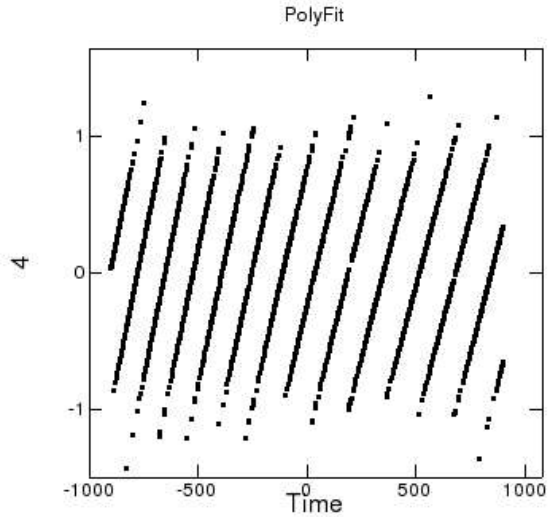


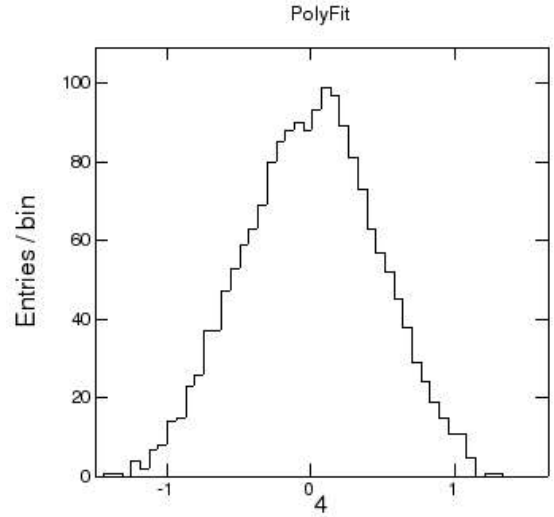
More Rate vs. Time





Residuals from linear fit
χ^2/dof = 2654/1799

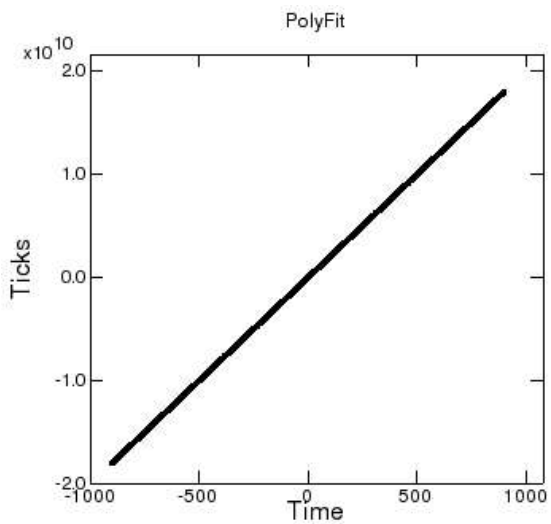


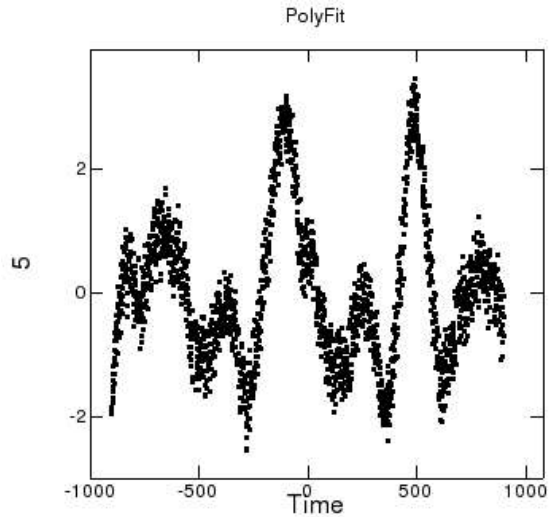


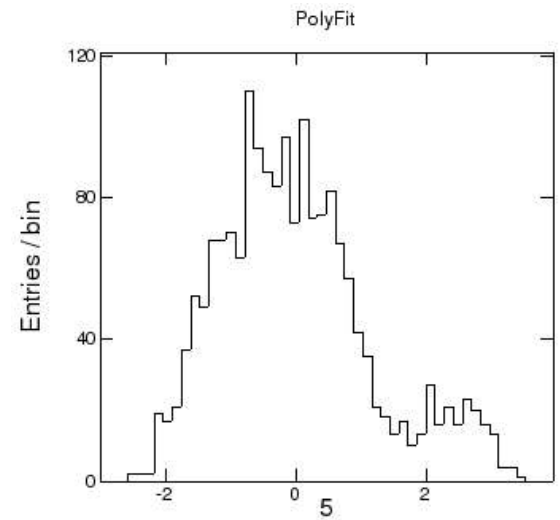
Residuals from 4th order fit
χ^2/dof = 2292/1796
Looks a lot like the expected width 2 triangle

Try Fitting Ticks vs. Time

- Maybe, if we fit ticks vs time instead of deltas vs time, we can fix the time of the tone to better than 1 tick
- If a 4th order poly fits deltas vs time, a 5th order fit should work for ticks vs time, right?







Residuals from 5th order fit

Or maybe not

Tentative conclusions

- It looks like we can make better-than-integer estimates of tick rate vs time
- It's not clear that we can do so for ticks vs time
- Not clear how useful sub-tick measurement of rates is if it's not accompanied by sub-tick measurement of time tone arrival
- Maybe a linear, single-frame interpolation is the best we can do
- But I'm not giving up yet