FDIRC Simulation Status

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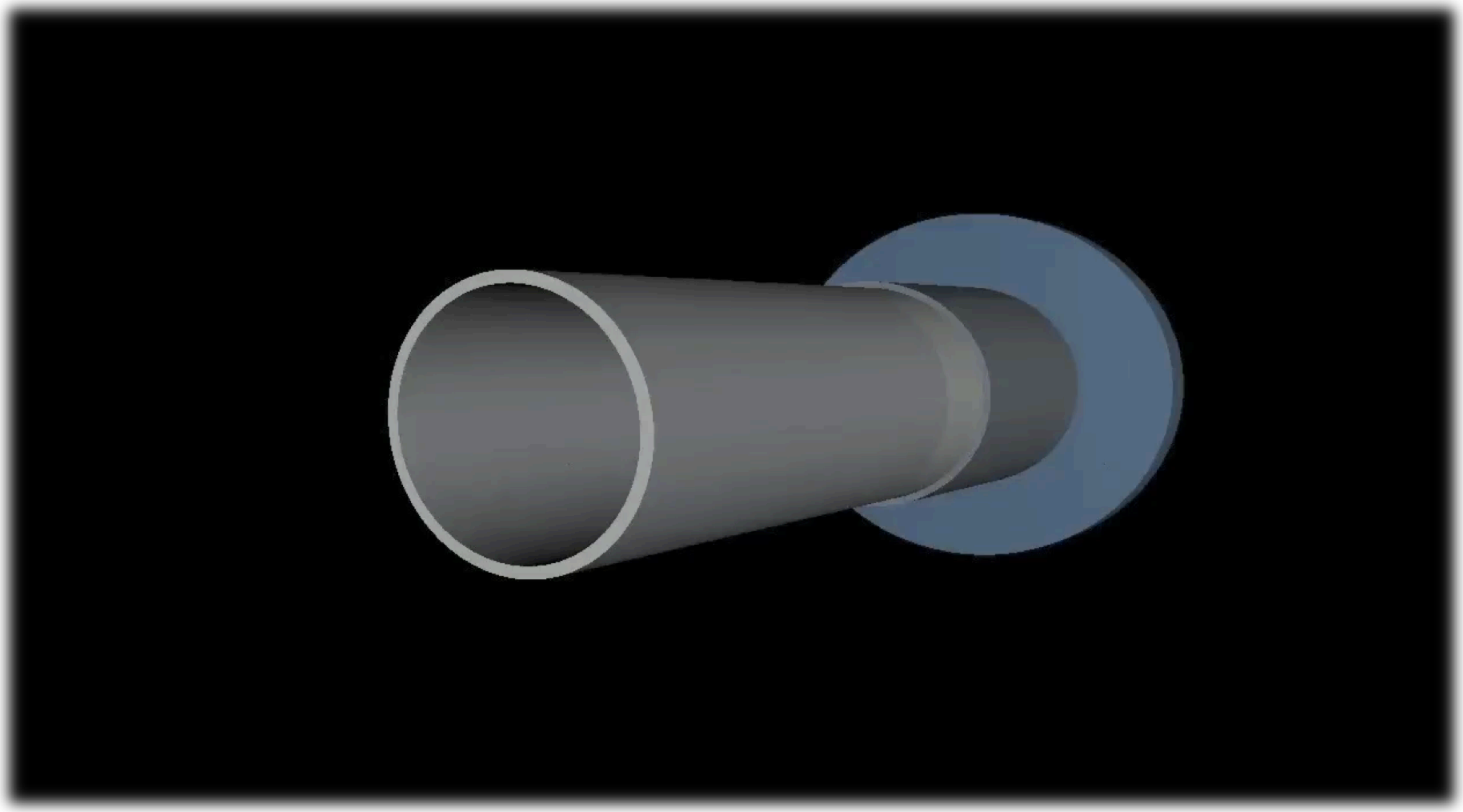
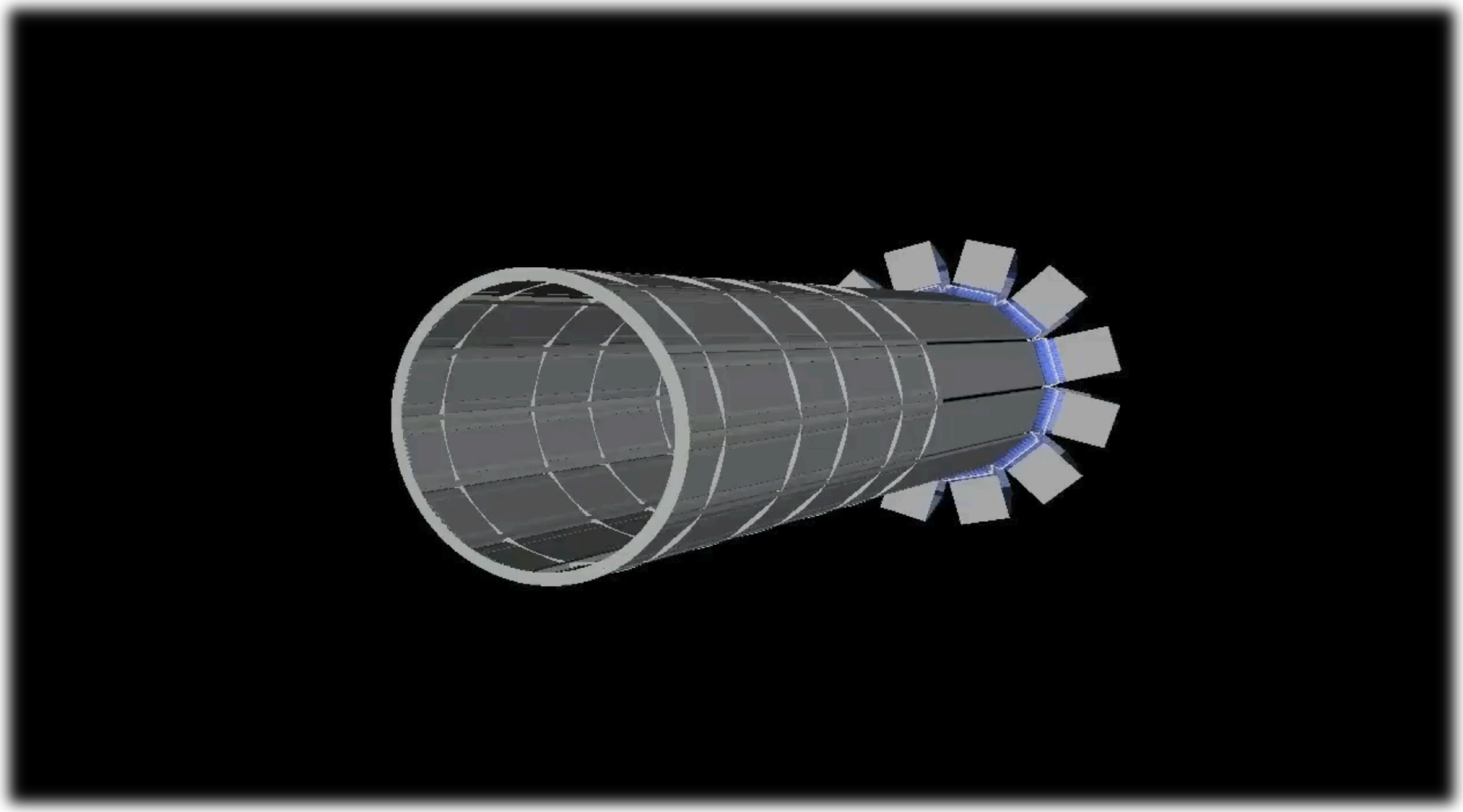
Outline

- FDIRC in FullSim (Bruno)
- Look at chromatic/time correction

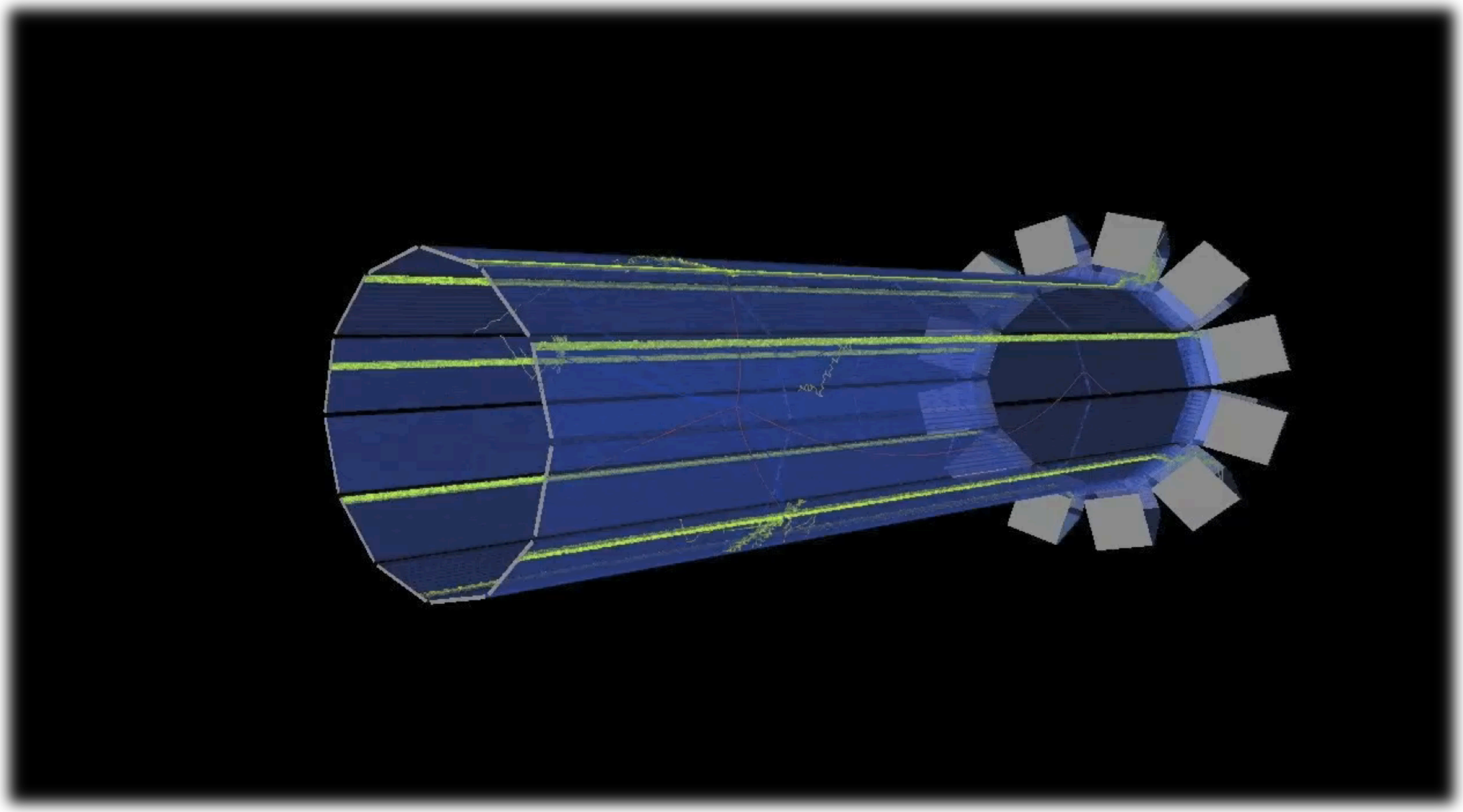
FDIRC in Bruno (all support)



No Outer Skins



An Event



Timing Correction First Look

- I wanted to start looking at what improvements could be gained by using timing to compensate for the chromatic dispersion that degrades the ring resolution.
- Recall:

$$\cos\theta_C = \frac{1}{n\beta} = \frac{1}{n_p(\lambda)\beta}$$

where n_p is the phase index and is a function of wavelength

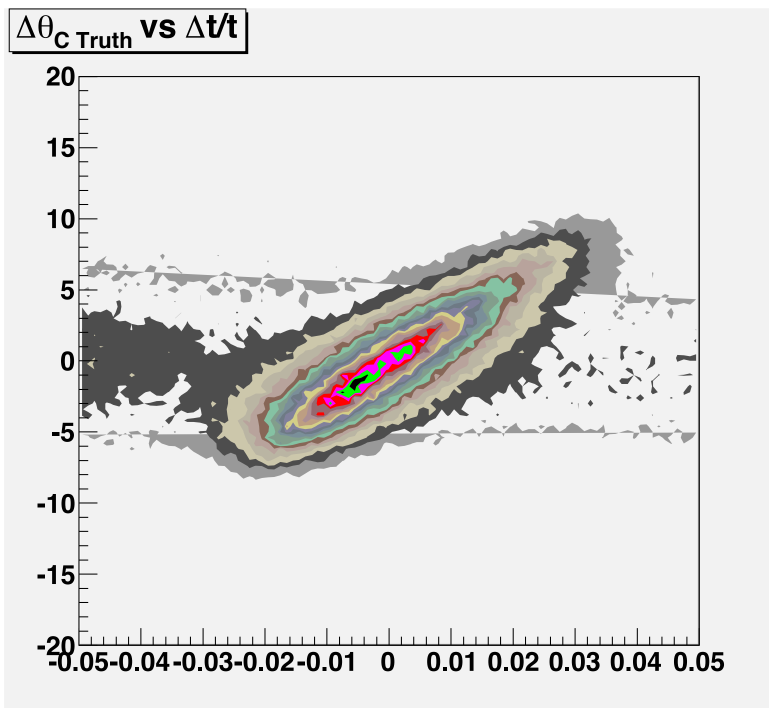
- Time of propagation depends on the group index, $n_g(\lambda)$
- Bottom line is that this introduces a correlation between the time of a photon's arrival and a shift in $\cos\theta_C$

Technique

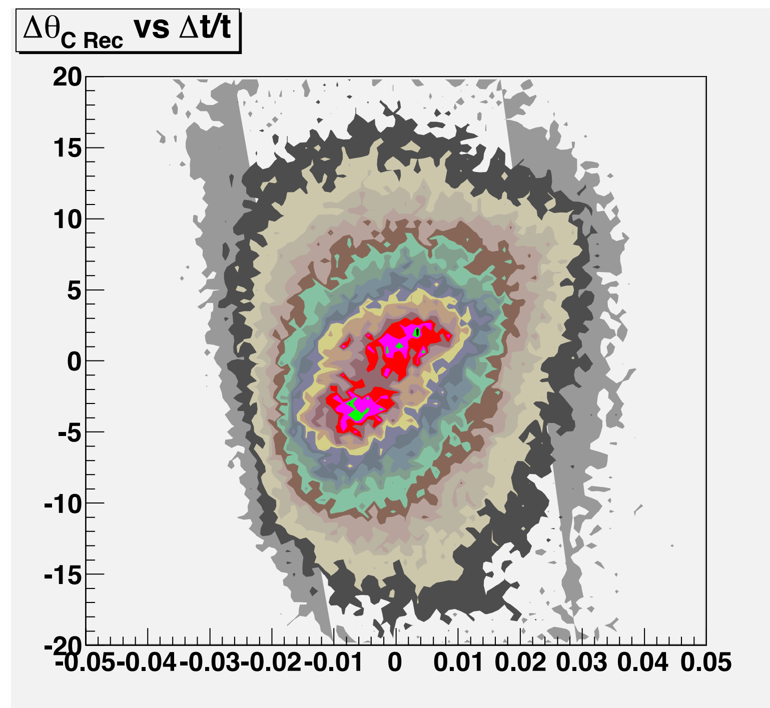
- The single photon library used to go from detector pixel to photon θ_x and θ_y was generated using monochromatic photons with $\lambda = 410$ nm
  - Near peak of PMT response
- Calculate θ_C and expected time assuming a 410 nm photon
- Expected time requires θ_x, θ_y and time from single photon library, z position from track, and which k_z ambiguity was used for this calculation (did it hit the forward mirror or not?)
- Use $(t - t_{410})/t_{410} = \{n_g(\lambda)/n_g(410) - 1\}$ to determine a correction factor to apply to $\cos\theta_C$ to get back to $\cos\theta_{C410}$

θ_C Resolution vs. $\Delta t/t$

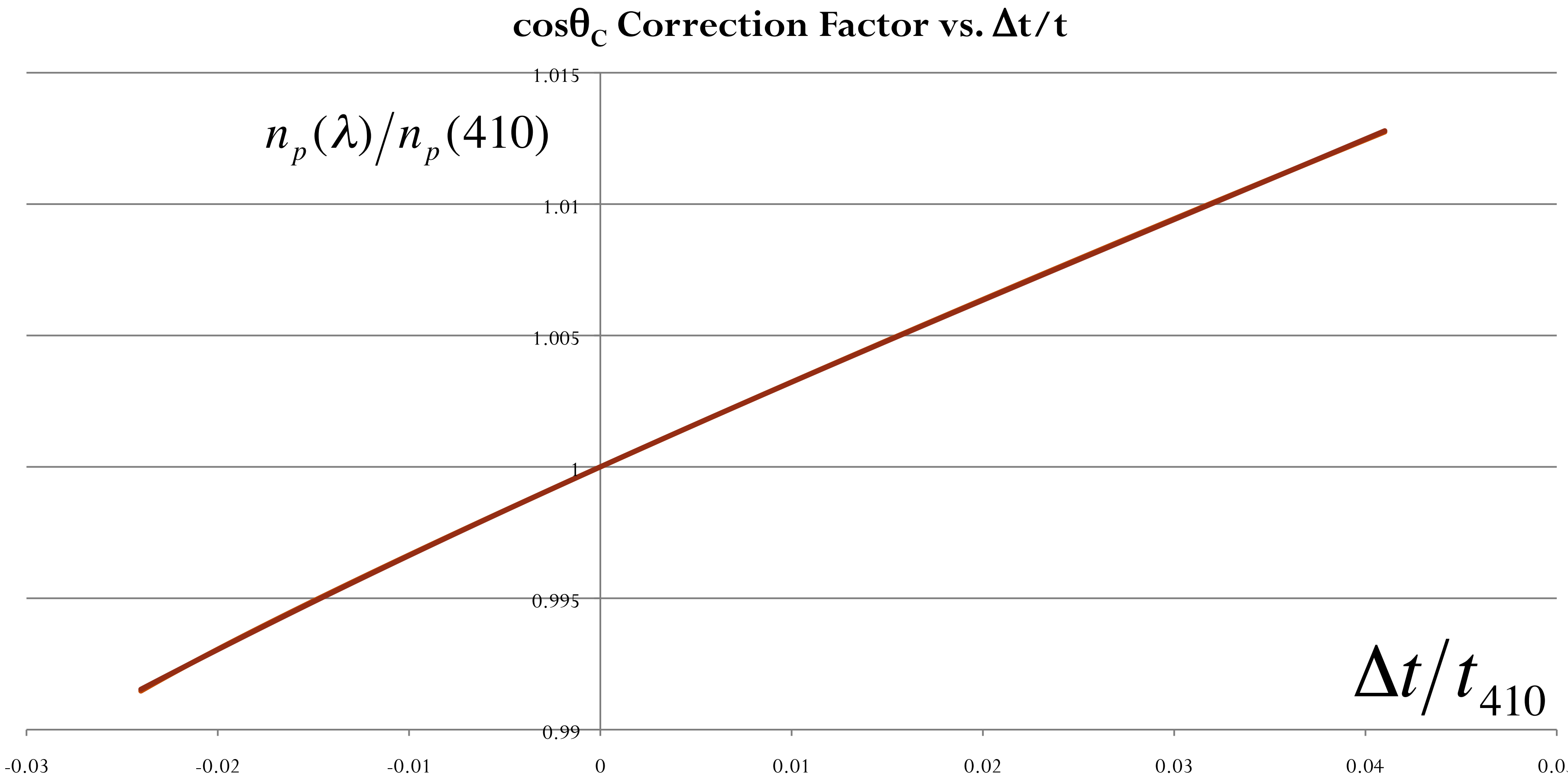
True θ_C - Nominal



Reco θ_C - Nominal



Spread comes from MS. This is a 4GeV π.



Multiplicative Factor to cosθ$_C$ vs. Δt/t

Correction is typically small, just a percent or so.

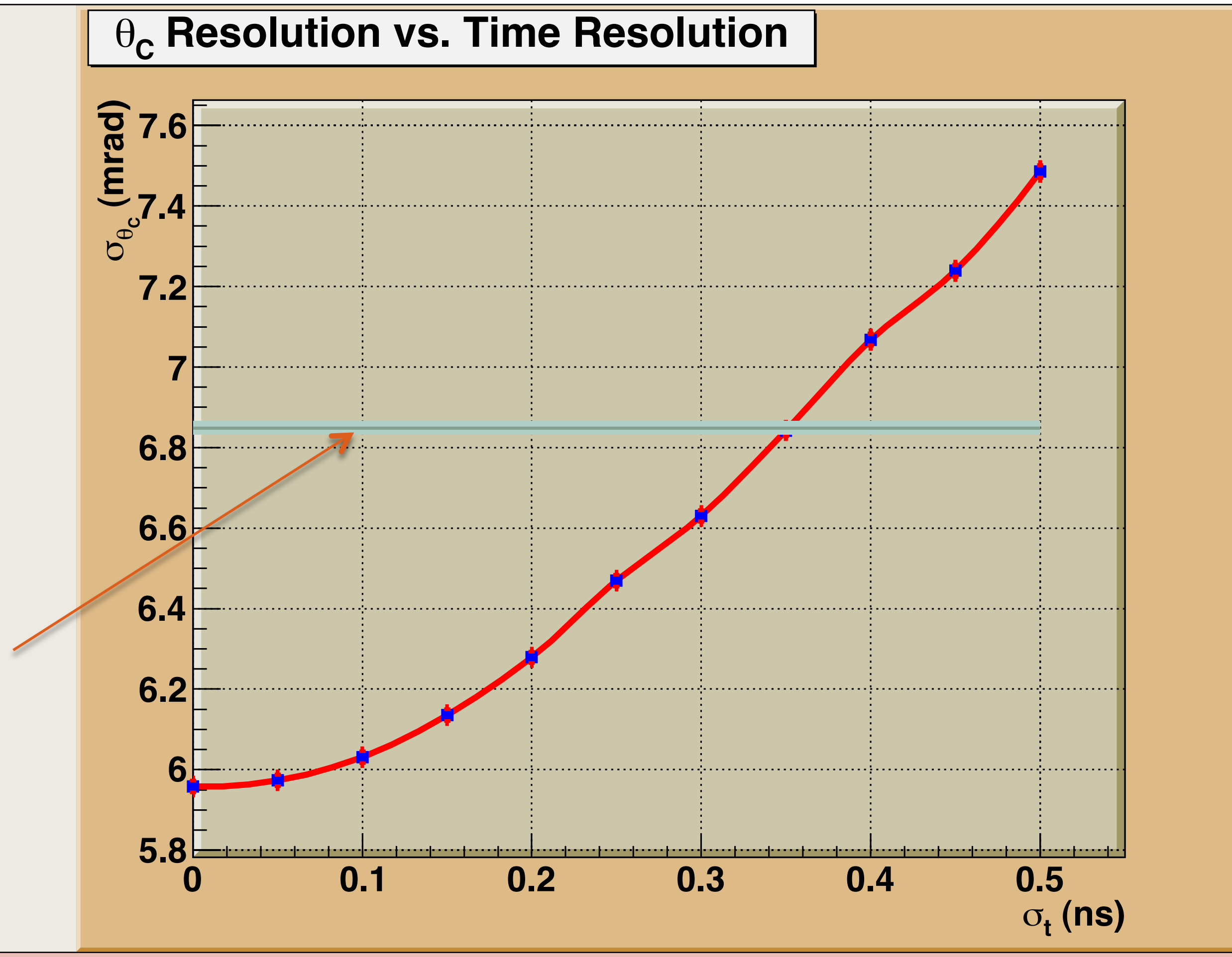
Time difference between photons typically less than 1ns ($\sigma \sim .7$ ns)

Use a 3rd order polynomial fit to the analytic function

Single Photon θ_C Resolution

3mm x 3mm pixels

Hamamatsu quotes transit time spread of 0.4ns (FWHM) for H8500 and H9500 which would mean sigma = 0.17ns

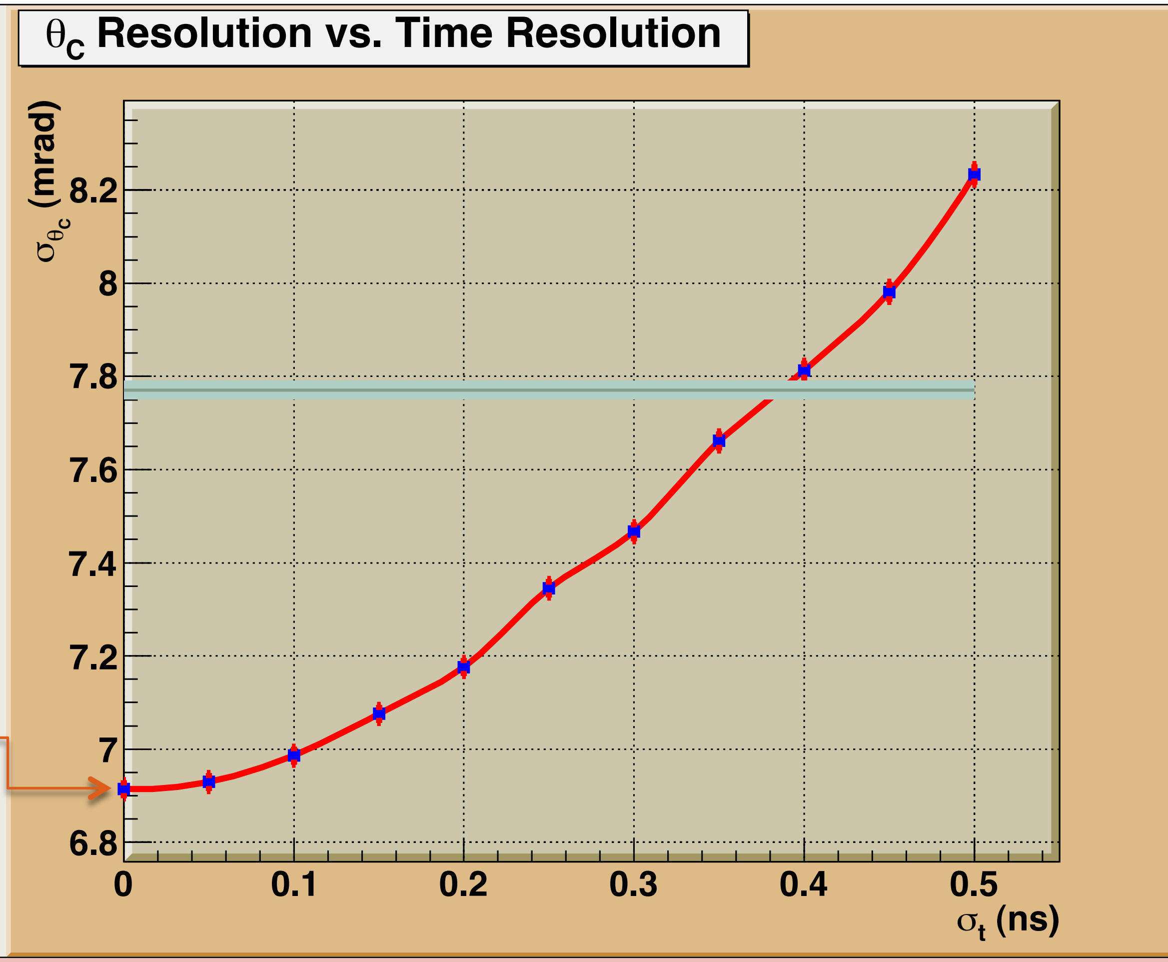


Resolution with NO time correction

Single Photon θ_C Resolution

12mm x 3mm pixels

Hamamatsu quotes transit time spread of 0.4ns (FWHM) for H8500 and H9500 which would mean sigma = 0.17ns



Almost as good here as 3mm pixel in y.

Single Photon θ_C Resolution

12mm x 6mm pixels

Conclusion

- Chromatic correction looks qualitatively consistent with FDIRC prototype results.
  - Could gain more than about 0.5 mrad in single photon resolution
    - Depends on *z* of track
  - Doesn't explicitly include resolution on track time, but that is common to all the hits
- One (unrelated) thing that concerns me:
  1. There is a significant difference in resolution between 3mm and 6mm pixel size in y => 3mm isn't small on scale of ring image.
  2. Ring images can be pretty flat in y (see next plot)
  3. Tubes have 1.5mm dead space around the edges => 3mm dead space between two tubes
  4. Could we have some dead zones were we lose many photons from a single track because of these cracks? Won't just be random loss, but could be very correlated.
     - Stagger the tubes?

4GeV π at 65° Boxes are 3mm x 3mm