Background Effect on Resolution

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Outline

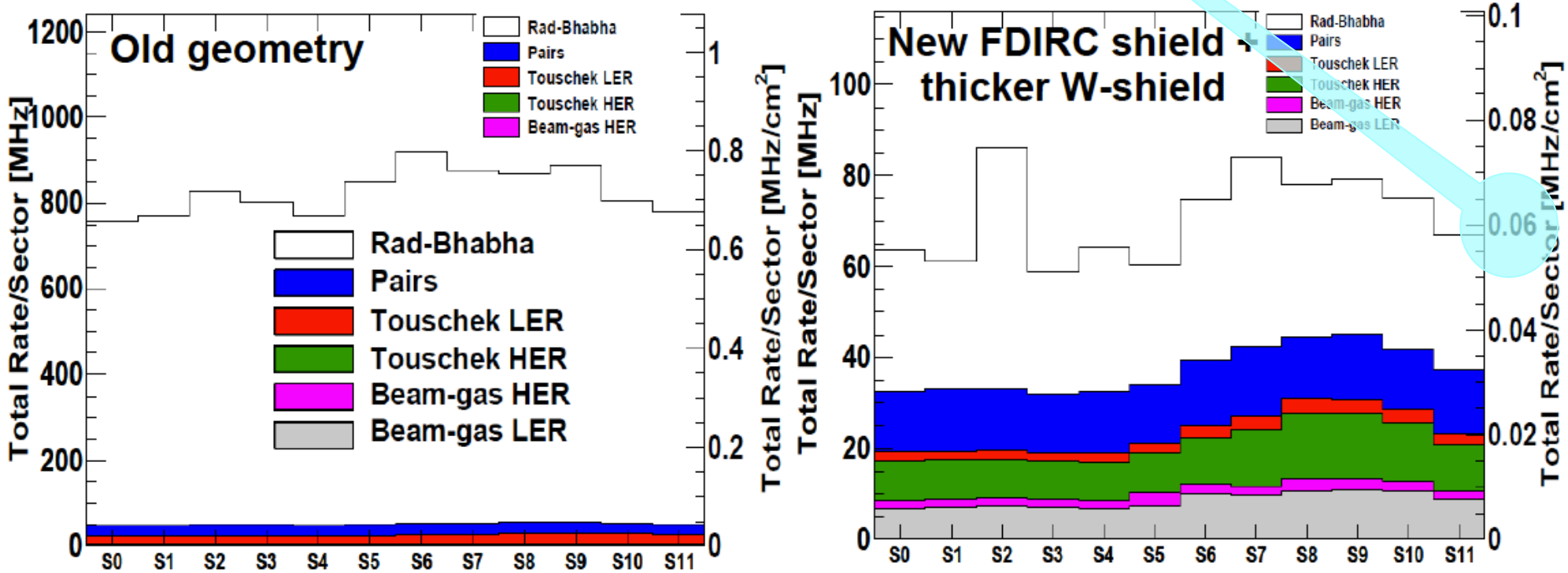
- Begin looking at possible effects of background on single-photon resolution in the FDIRC
- Background rates taken from Alejandro Perez's recent background studies
  - Includes Lead/Steel/Polyethylene shield
- Start with just uniform in Space and Time background

From Alejandro

Use 0.06 MHz/cm^2 as "Nominal" Background Rate

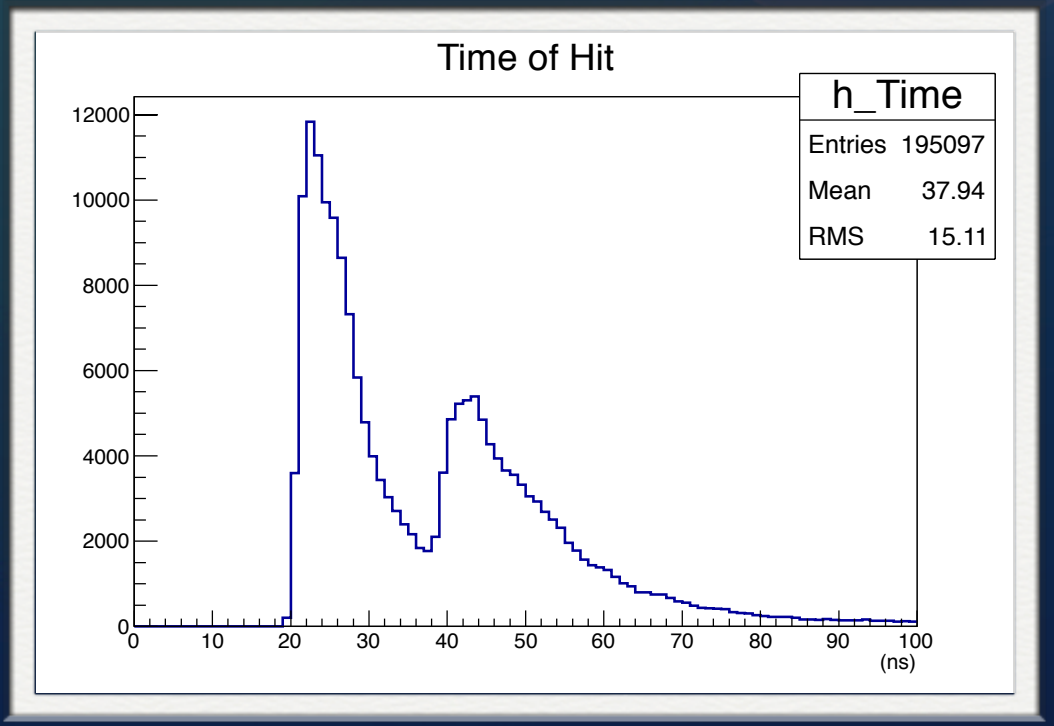
Look at 1x, 2x, 5x, 10x, 20x Nominal

Total bkg rates on FDIRC



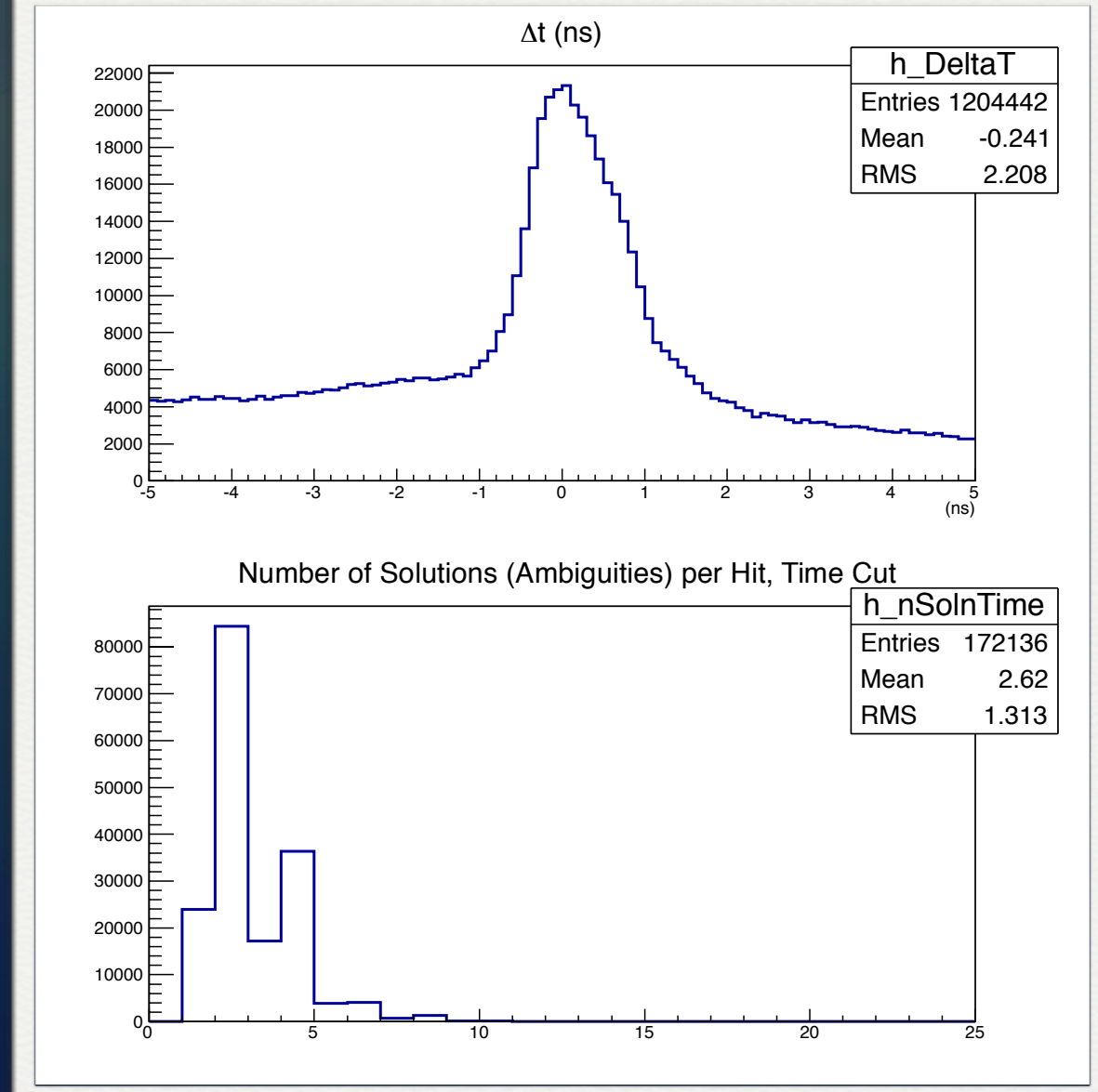
Simulation Parameters

- Background hits:
  - Randomly distributed over detector plane in Space
  - Uniformly random in Time from -25ns to 500ns
- Hits "Masked" if there is another hit <25ns earlier in the same pixel
- Simulated 10,000 cosmic tracks
- Used "Abs(Kx), Abs(Ky)" version of Photon Dictionary
- Full FDIRC (48 tubes in a sector)

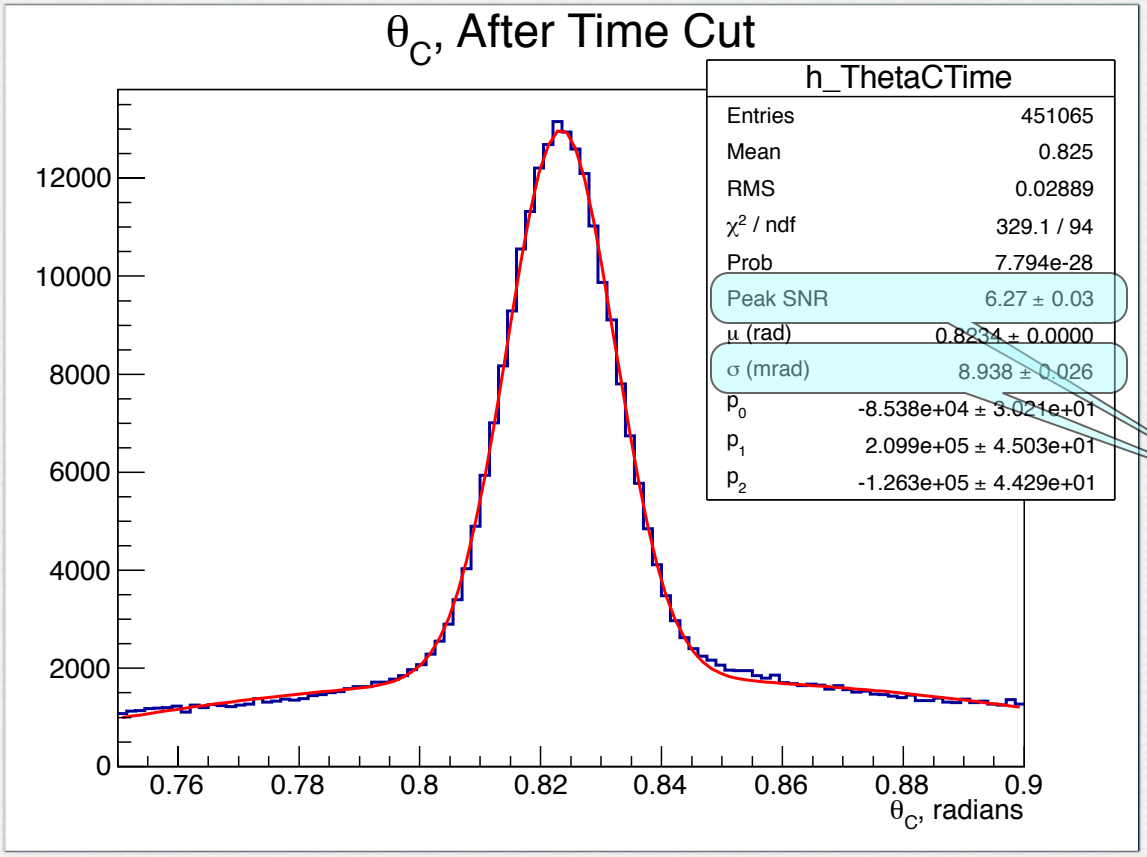


Hit Selection

- Only keep solutions from the hit if they are within -2 ns < Δt < 3ns
  - Δt is the difference between the hit time and the expected time given the solution from the dictionary
- After this cut, there are on average 2.6 solutions per hit

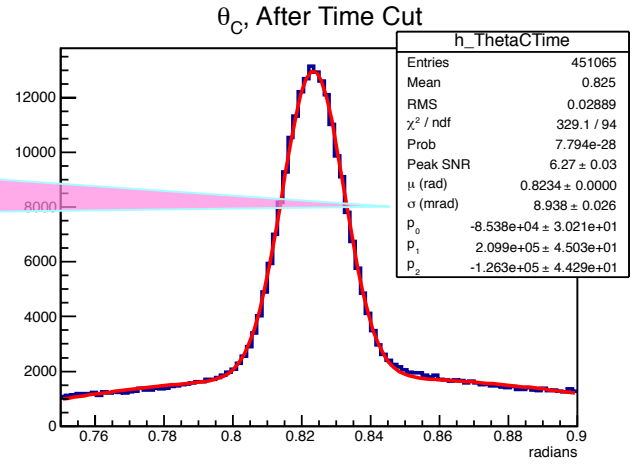


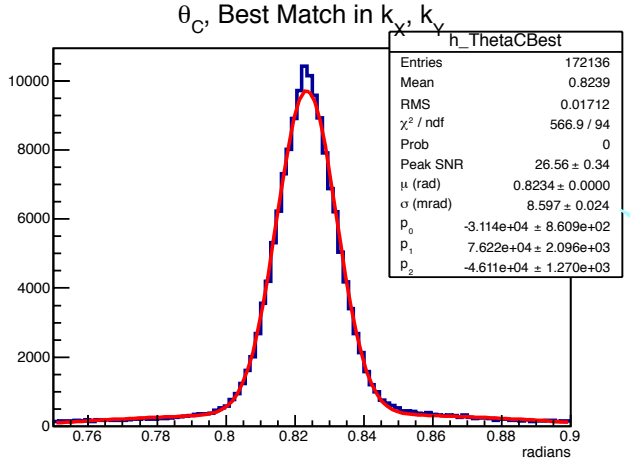
Single Photon Resolution



- No Background
- Fit to a Gaussian plus 2nd order polynomial
- Look at σ and Peak Signal-to-Noise Ratio
- Tails come from ambiguities

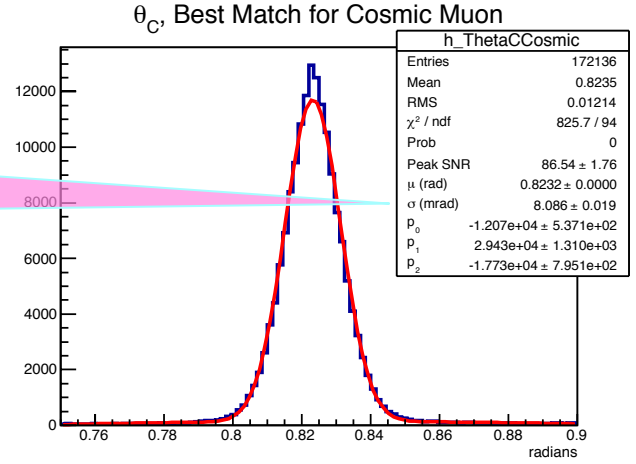
8.94 MRAD

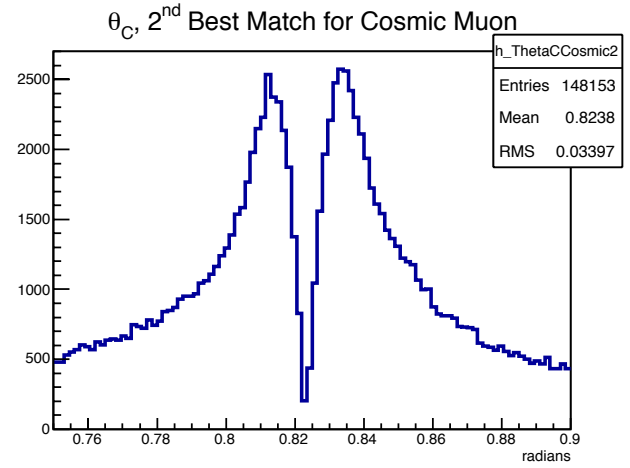




8.60 MRAD

8.09 MRAD





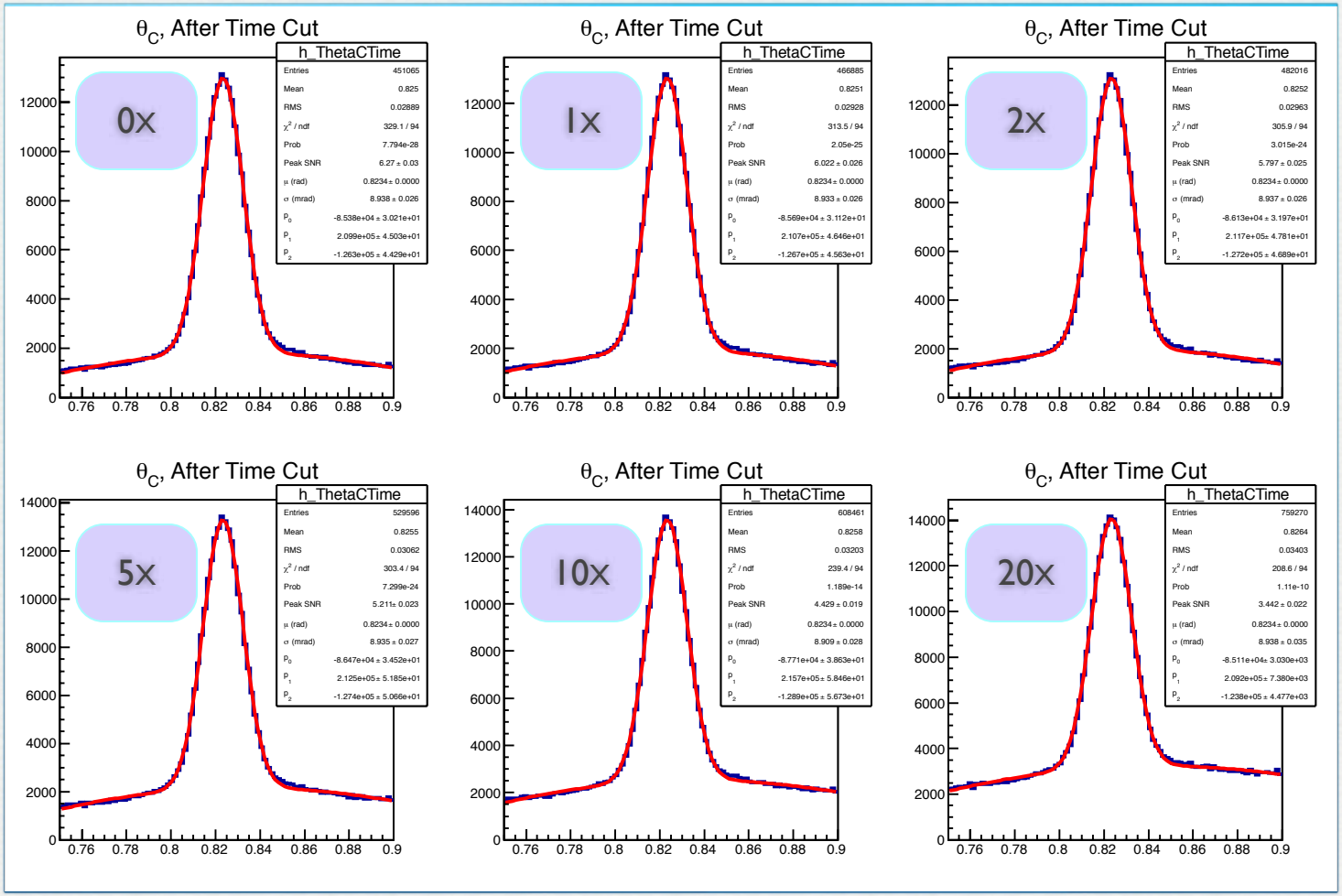
Effect of Ambiguities

Try to "Cheat" by picking solution with best match to true K_X and K_Y. Also, try o pick solution that is closest match to expected θ_C for a cosmic. This clearly biases the σ: 2nd best solution still peaks at expected value

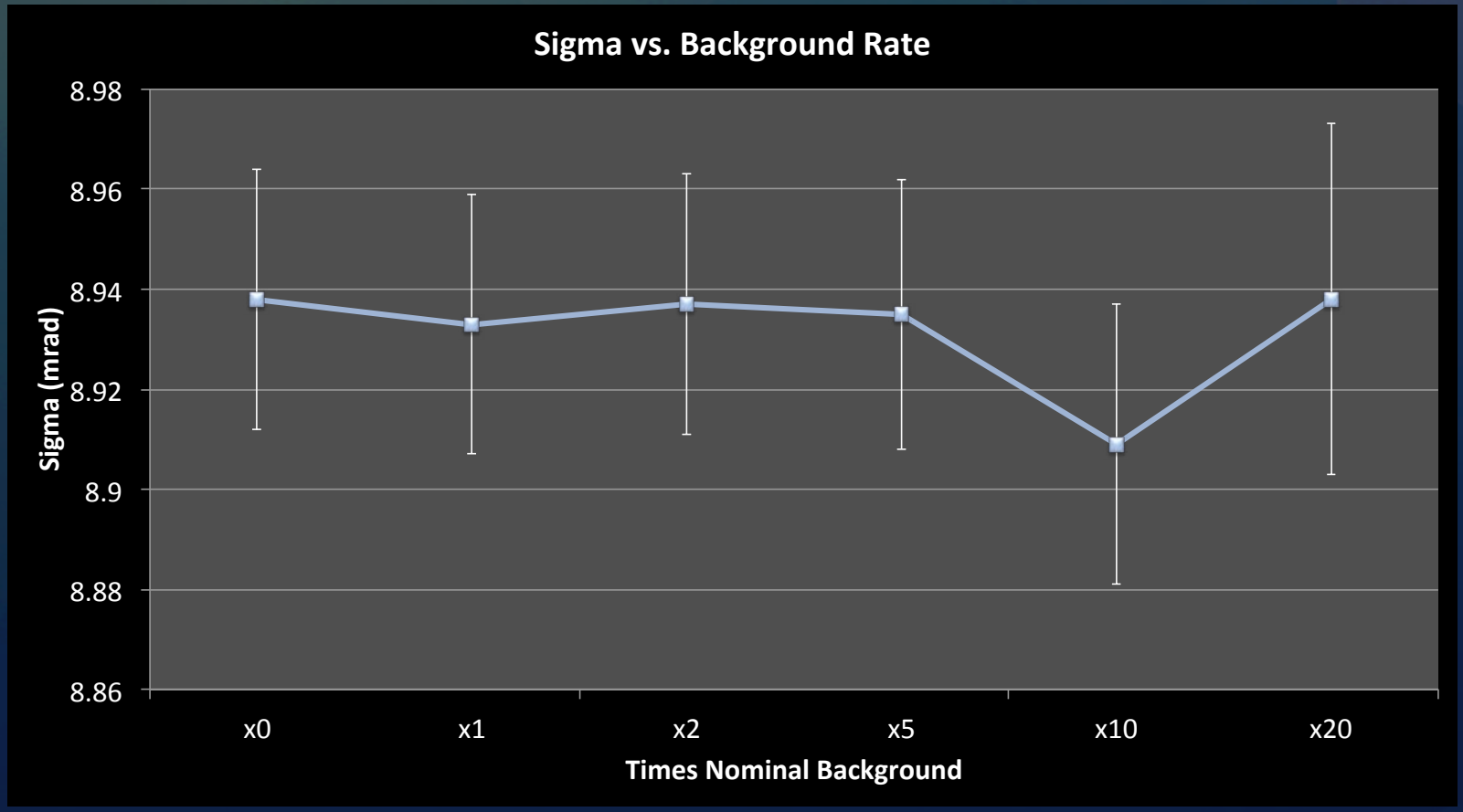
Line Shape vs. Background

No effect on sigma

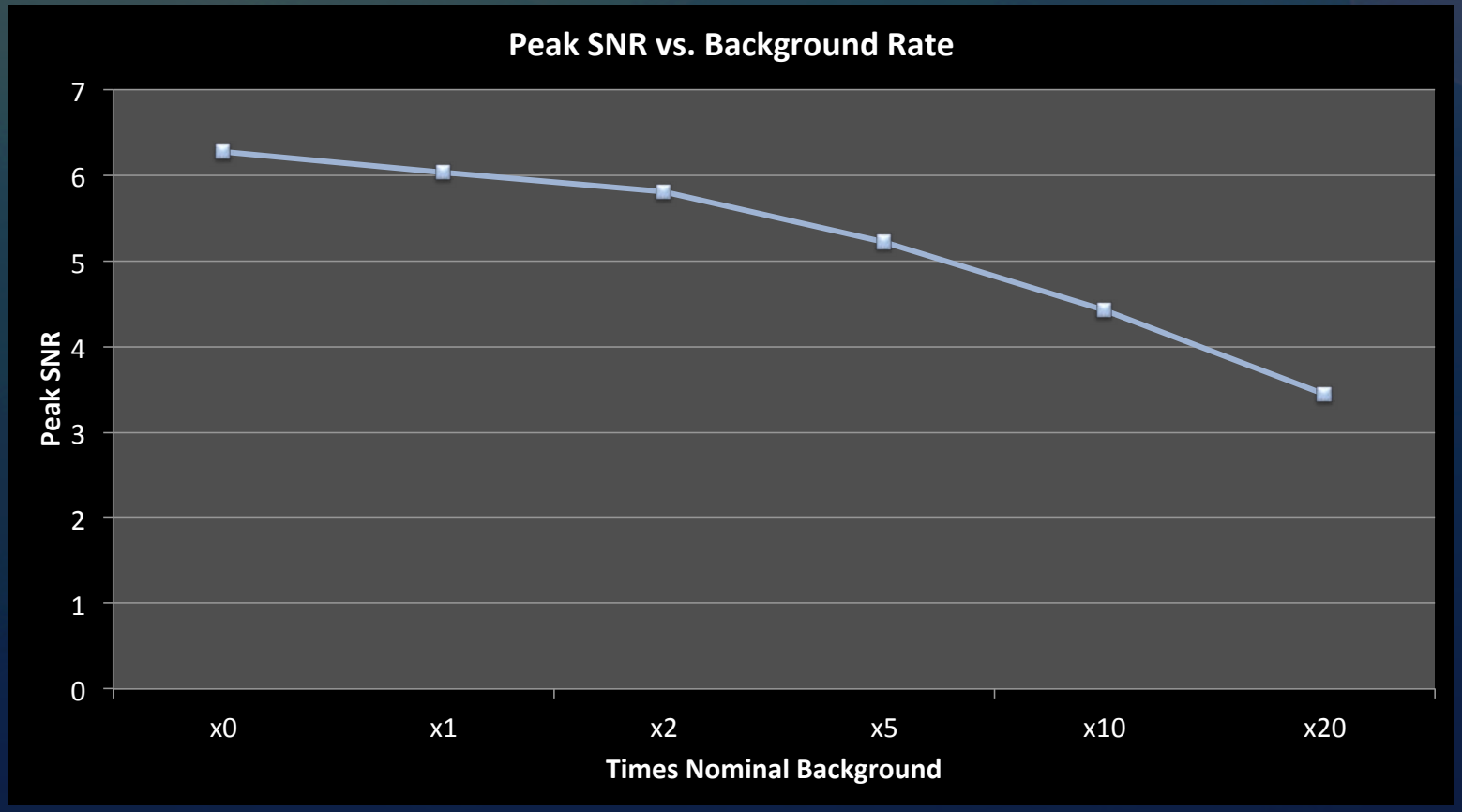
Begin to notice effect on SNR at 10x and 20x nominal rate



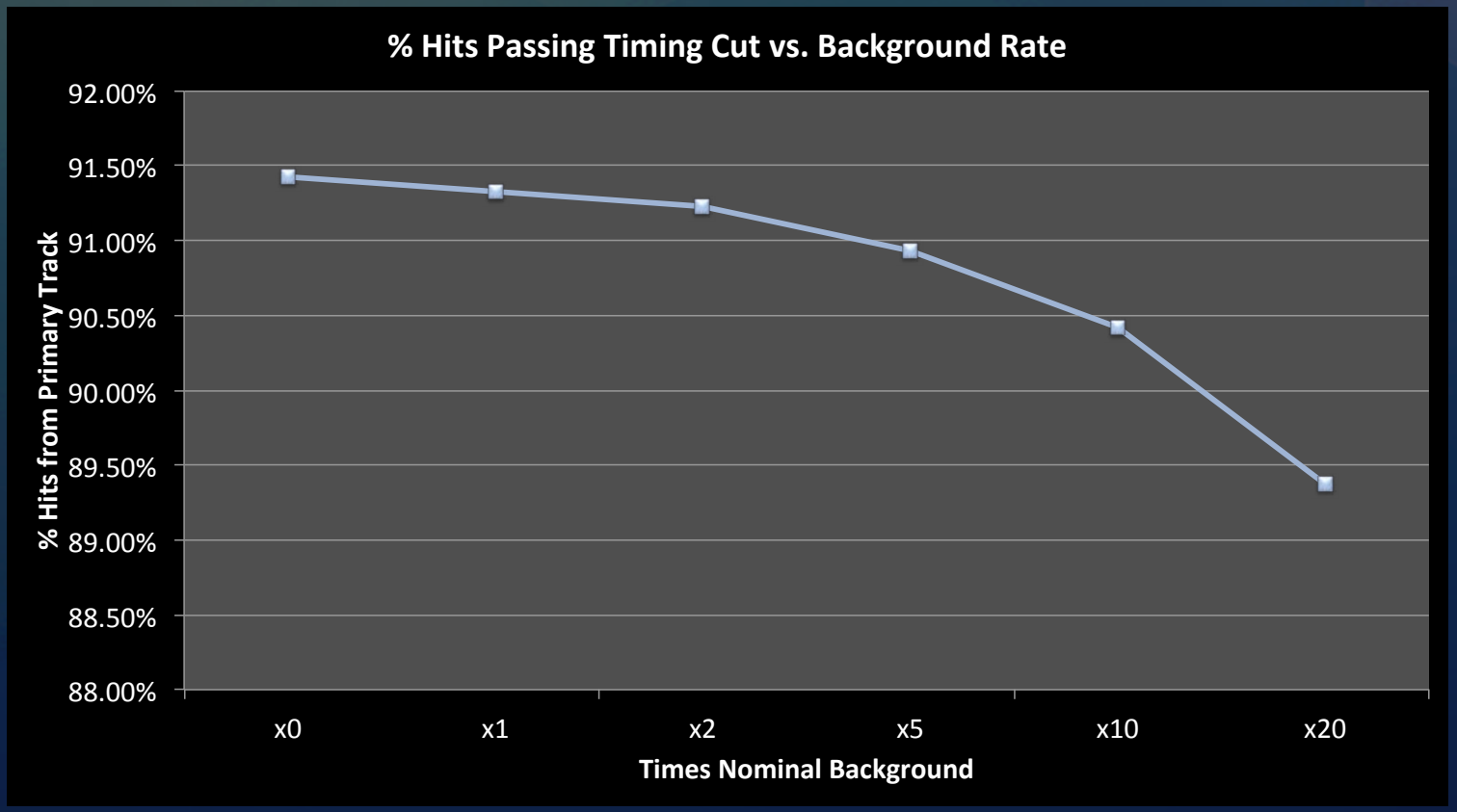
Sigma vs. Background Rate



Peak SNR vs. Background Rate



Hit Loss Due to Masking by Background Hits



Conclusion

- Single-photon resolution should be fairly insensitive to "salt and pepper" background.
  - Signal to Noise will be effected
  - Biggest effect would be loss of hits due to masking
    - Depends on modeling the electronics response correctly
- This is just single-photon resolution. More power should come from full track reconstruction
  - Should help S-N, and ambiguity resolution