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Photon Transport Monte Carlo

- Point response hypothesis
- Uniformity of response
- Summary

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Physical Pulse Model

- Point response hypothesis:
  - If we know the normalized response, $f(t;\vec{x})$ due to light produced at any point (x,y,z) then the response due to a track passing through the bar is:

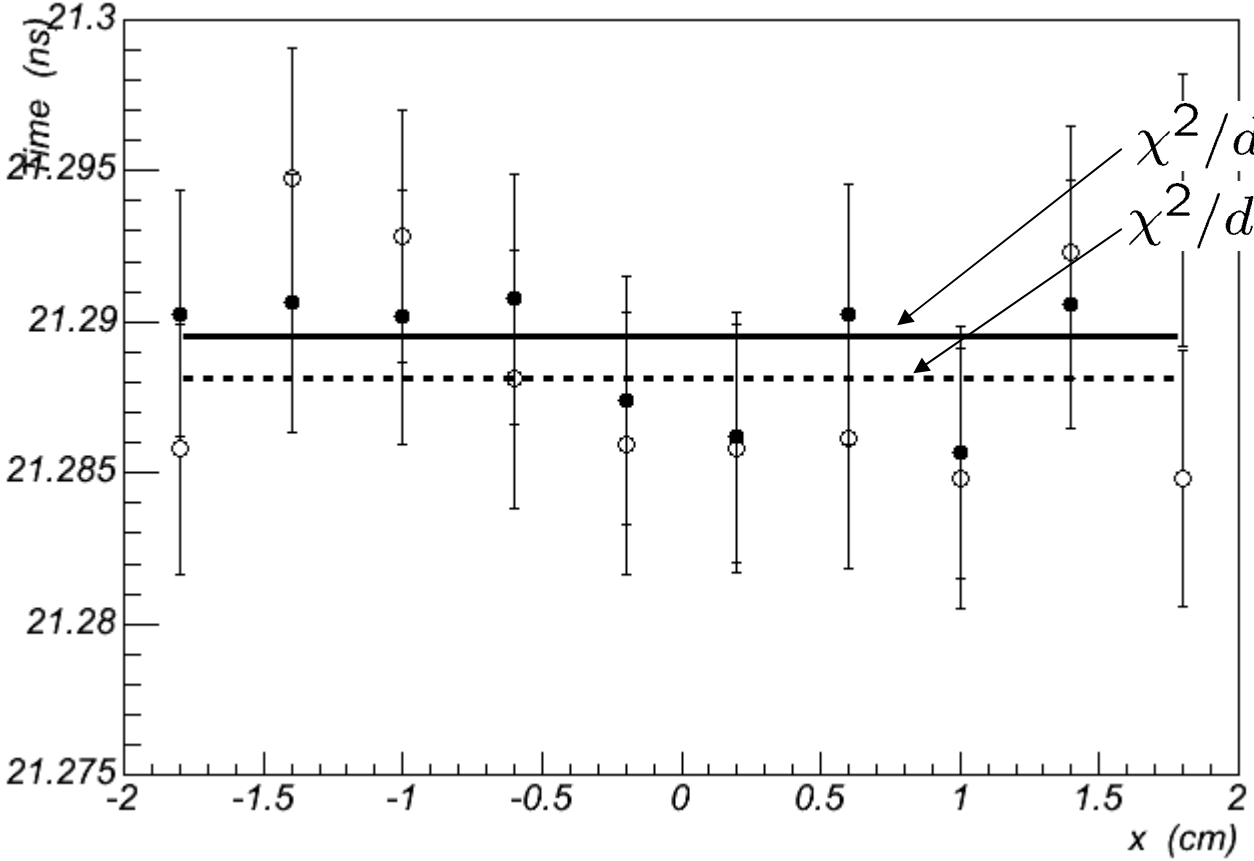
$$F(t) = \int \frac{dQ}{ds} f(t - s/\beta c; \vec{x}_0 + s\hat{u}) ds$$

  - Simplifying assumptions:
    - dQ/ds is a constant (turns out not to be true).
    - Normalized response independent of x,y.
    - This is what we need to check.

Check Uniformity Hypothesis

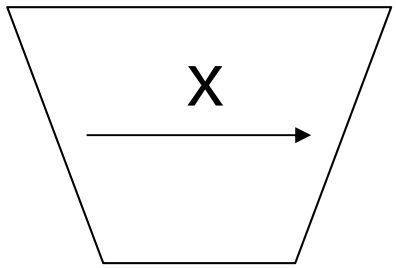
- Generate 10^5 scintillation photons at a single point (only ~500 get to the PMT)
- Determine average time at fixed threshold
- Compare points at different x,y in the bar but at constant z
- Are all the times the same?

Response Uniformity



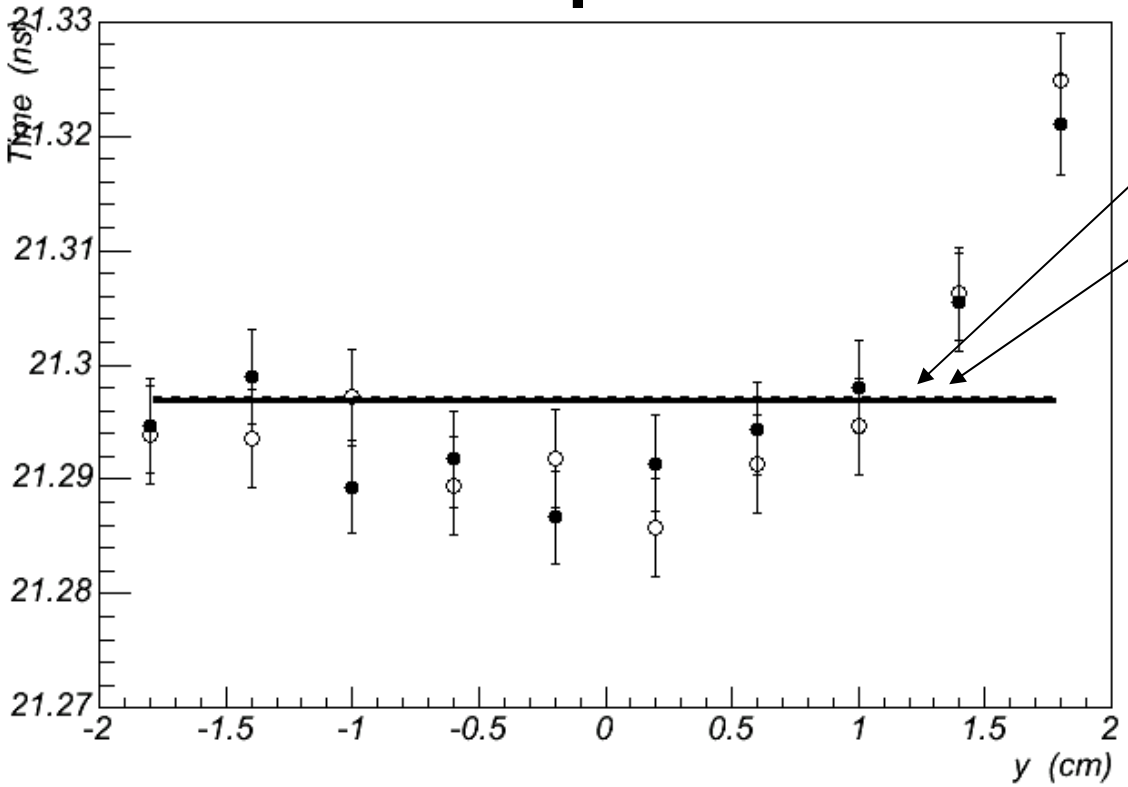
$\chi^2/dof = 2.9/9$ (east)

$\chi^2/dof = 6.9/9$ (west)



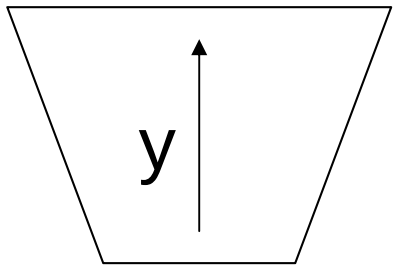
y=0, z=0

Response Uniformity



$\chi^2/dof = 48.7/9$ (east)

$\chi^2/dof = 63.9/9$ (west)



x=0, z=0

Response Uniformity

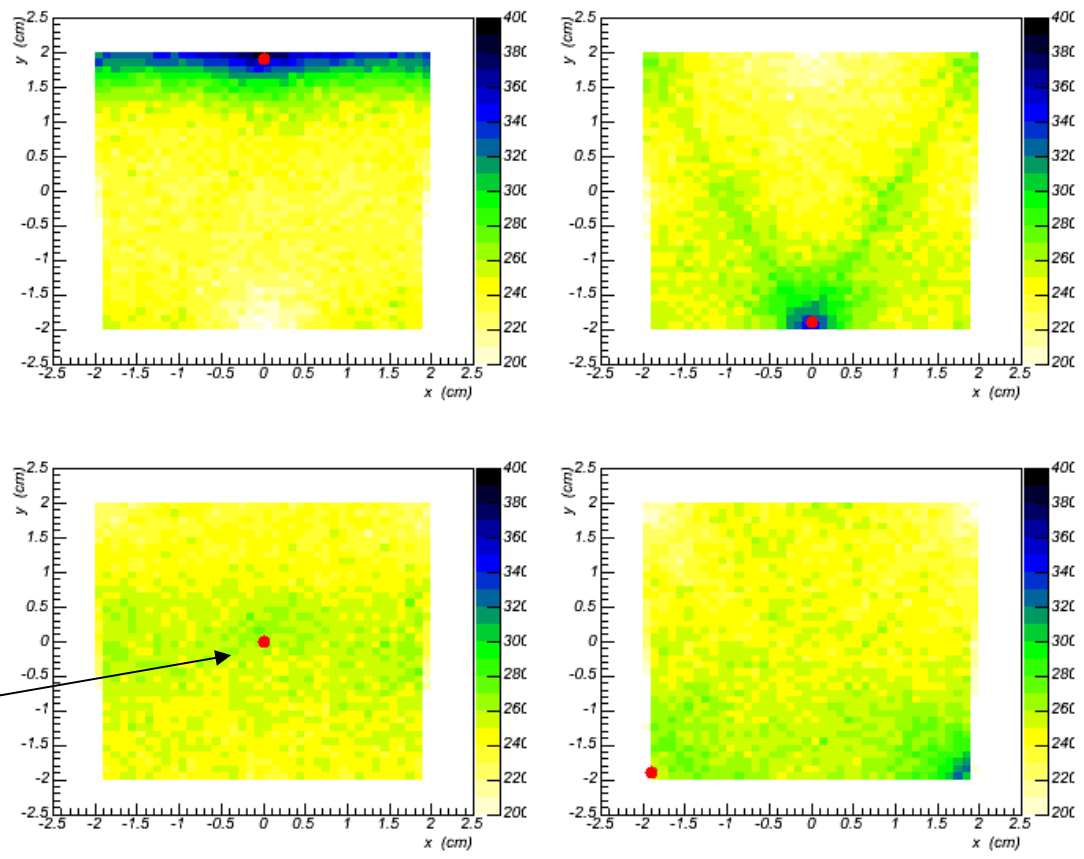
- Generate 10^8 photons at a fixed point in a bar of scintillator (no Winston cone).
- Where do they come out?
- Reflections off the sides create can produce complex patterns of light collection efficiency.
- Non-uniform light collection probably explains the observed biases.

Response Uniformity

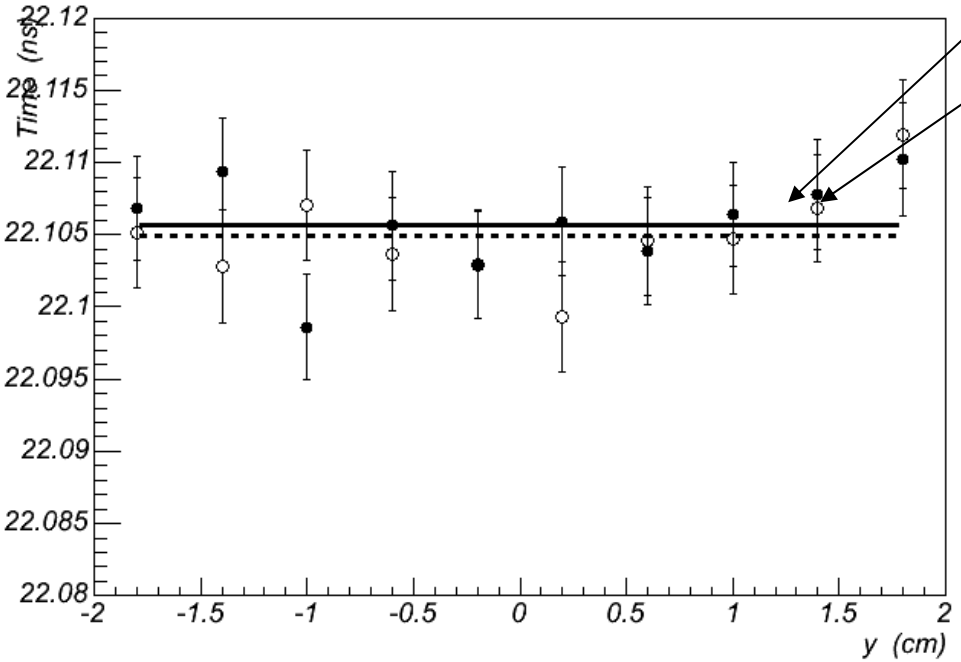
- Light collection is not uniform throughout the bar:

Coordinates of exit point at east end.

Photons generated here at z=0

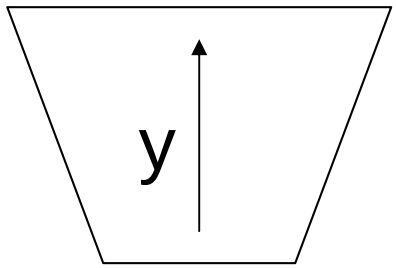


Response Uniformity (Constant Fraction)



$\chi^2/dof = 7.3/9$ (east)

$\chi^2/dof = 6.9/9$ (west)



x=0, z=0

Conclusions

- Point response hypothesis still under study.
- Significant biases simply from where the light is produced.
- The pulse shape seems to be the same.
- Can still be analyzed but needs a position dependent amplitude response.
- Fixed some bugs:
  - Default bar angle now 0.015 rad (was 0.06)
  - Speed improvement in root-finding algorithms
  - Updated to gcc 3.4.3, root 4.00/08.
  - Interfaced with SPICE simulations of front-end electronics