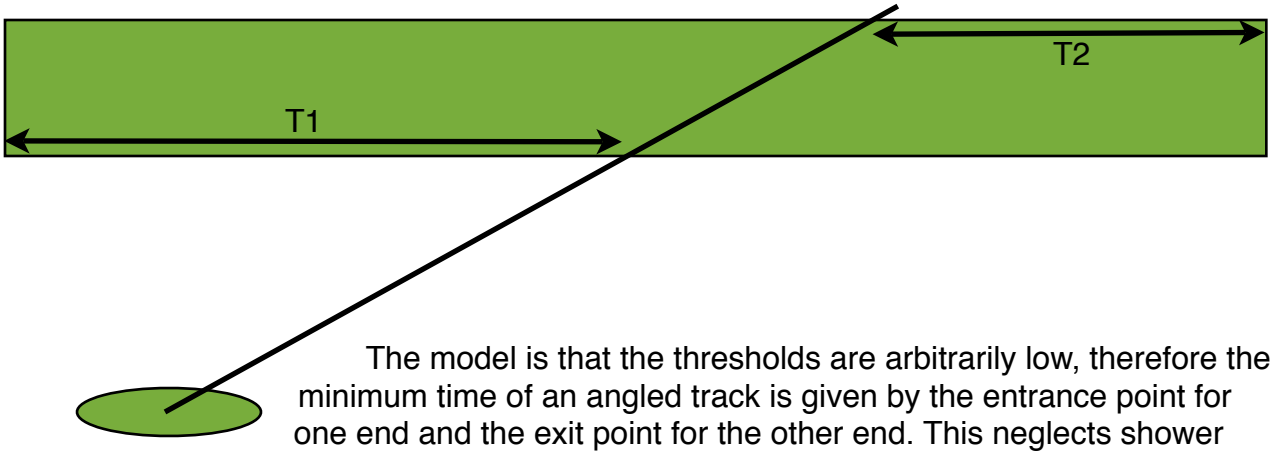
In the 7/15/2008 calorimeter meeting there was a discussion of possible variations of cell sizes for BCAL. I suggested that one impact might be time resolution due to the angled-track effect. Below I make an estimate of the order of magnitude of this effect.



The model is that the thresholds are arbitrarily low, therefore the minimum time of an angled track is given by the entrance point for one end and the exit point for the other end. This neglects shower fluctuations, rise times of scintillator, shower radius, geometrical dispersion in the fibers time walk corrections, etc. The mean time is (T1+T2)/2. The error in this mean time is given by simple geometry and it depends on the thickness of the cell: mean time is: (L-d/tan(theta))/2v, where L is the total length of the cell (taken as 390 cm), d is the cell height (1-3 cm), theta is the scattering angle, and v is the straight-line signal propagation velocity (taken as 19 cm/ns). I used the radial distance of the cell from the beamline as 75 cm to calculate the z coordinate.

Results shown in the plot below: full dispersion of about 240 ps for a 2 cm cell; probably equivalent to **RMS~ 80 ps** (if divide by square root of 12). If you can model the real effect accurately, may be able to make a correction and reduce it, but this is not a simple simulation and you have to know a priori what kind of particle you have. Averaging the response of several cells does not reduce this error.

This applies to photons; charged particles will be similar. *Neutrons will be different.* This matters if you have a lot of neutrons *from the target* to discriminate from photons; otherwise, the neutrons will only contribute to the random background.

Probability of neutron interaction across one cell is fairly uniform, therefore the interaction takes place anywhere along the path. If theta = 15 degrees and $v_{neutron} \sim c$, for a cell 2 cm in height, **RMS~70 ps**. In real life, neutrons interact very asymmetrically, so the geometric time dispersion will be larger. This time dispersion cannot be calibrated away, it is intrinsic. Averaging the response of several cells may reduce this error, depending on the thresholds used.

It is anticipated that the two classes of mean time errors discussed above are potentially relevant, since they are of a similar order of magnitude to the best that has been achieved in the test run for the time difference resolution at perpendicular incidence (see bottom figure, from GlueX-doc-840-v2, Zisis Papandreou).

W. Brooks, September 2008, comments on BCAL timing and geometric effects