

BCAL Timing

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- The current study was done using 3 datasets generated at $\theta=12^\circ$, 20° , and 90°
- Each data set contained 10k events
- $0 \leq E_\gamma \leq 2.0\text{GeV}$
- 5 different segmentation schemes, including “fine”
- Focus placed on uncertainty in time difference ($\Delta t/2$)
- No reconstruction code from *sim-recon* tree has been used. Analysis starts with individual shower steps generated by *hdgeant*

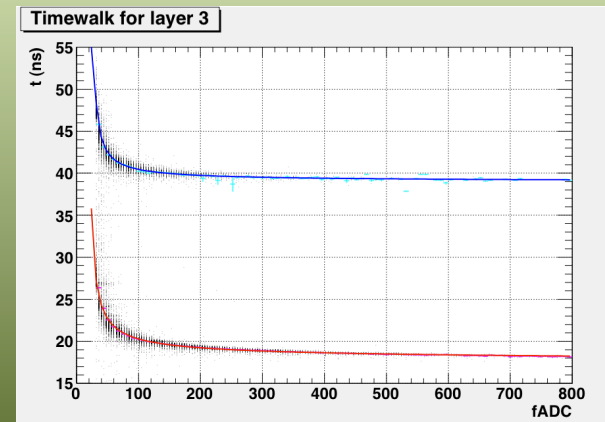
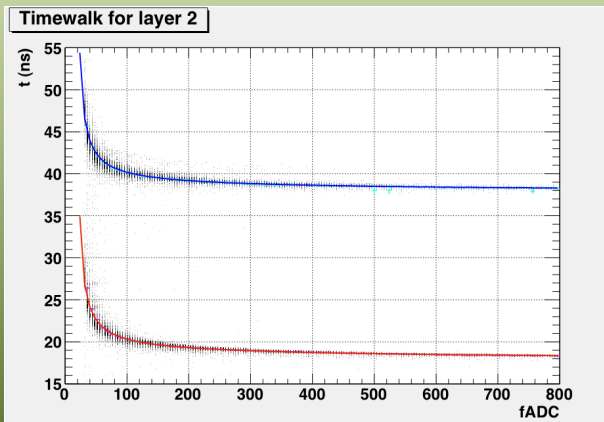
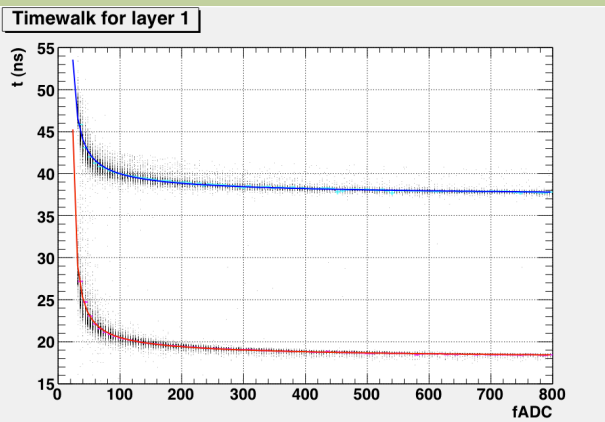
Timewalk Calibration

- Timewalk calibration done for each layer and each end independently.
- Time of each tube includes flight time and shift due to convolution of electronic pulse.
- The constant term in timewalk function removes all shifts/tof for 12° showers

Functional form of timewalk correction

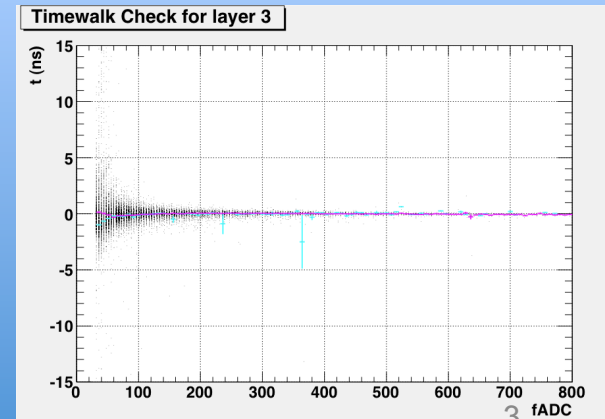
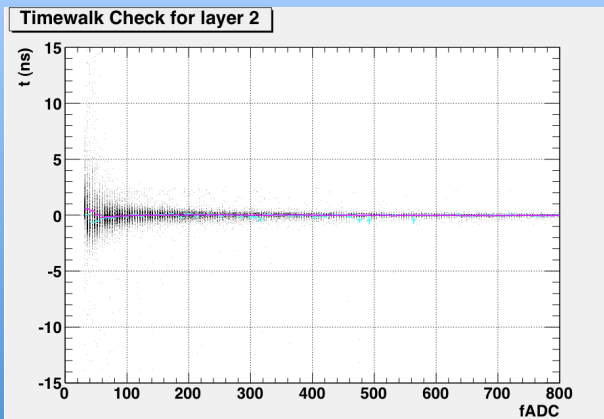
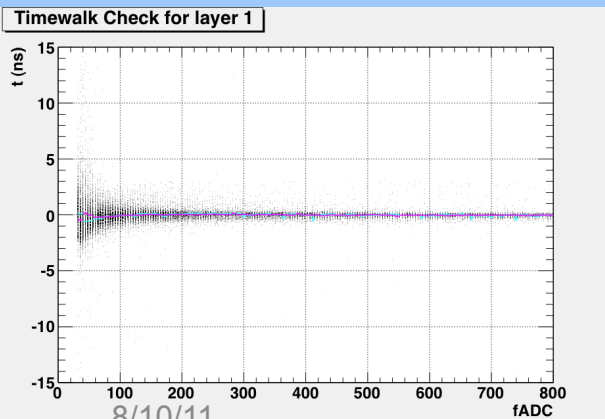
$$t = c_0 + \frac{c_1}{x^{c_2} + c_3}$$

Before Calibration



All plots for 12°, fine segmentation

After Calibration



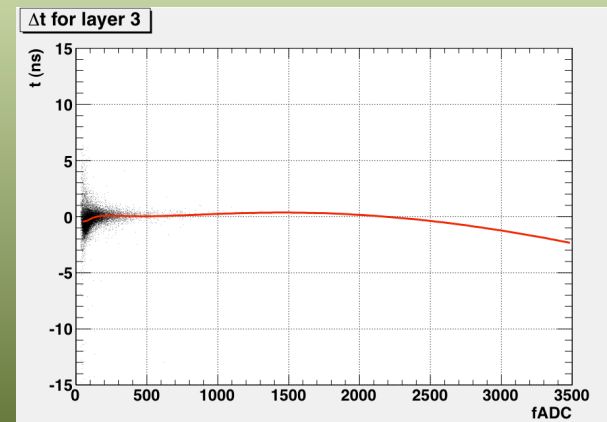
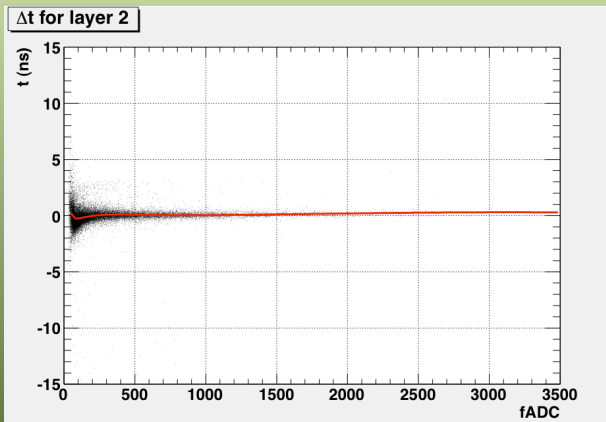
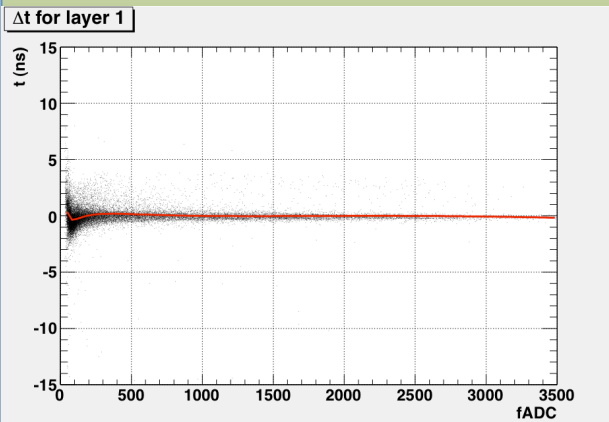
Calibration of time difference

- Calibration done for time difference of timewalk corrected values
- Layers calibrated independently
- Corrected Δt distributions broken up into bins of geometric mean having at least 300 hits.
- Gaussians fit and the σ s of each bin used to determine timing resolution function for each layer

Functional form of timing correction

$$\Delta t(x) = c_0 + x c_1 + x^2 c_2 + x^3 c_3 + x^4 c_4 + x^5 c_5 + x^6 c_6$$
$$x = \log \left(\sqrt{fADC_{up} \cdot fADC_{down}} \right)$$

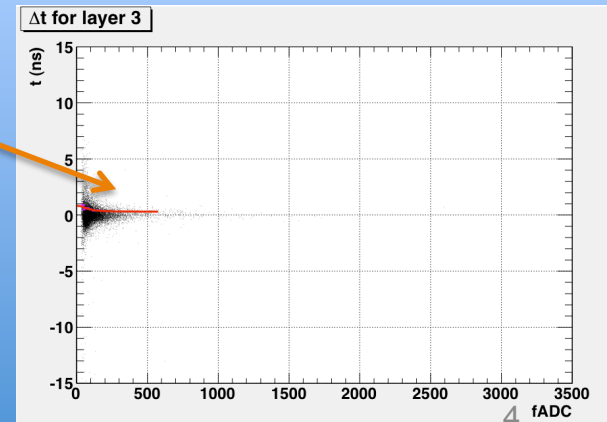
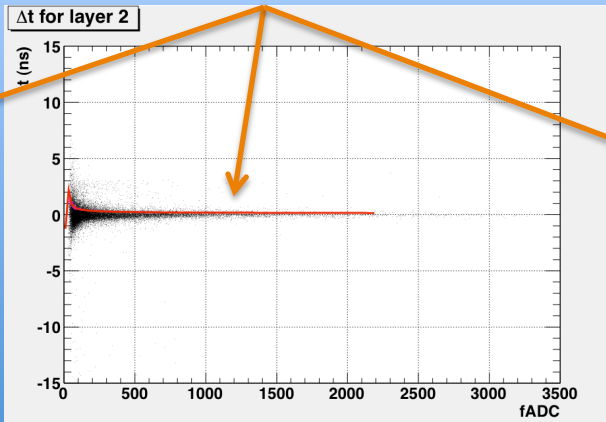
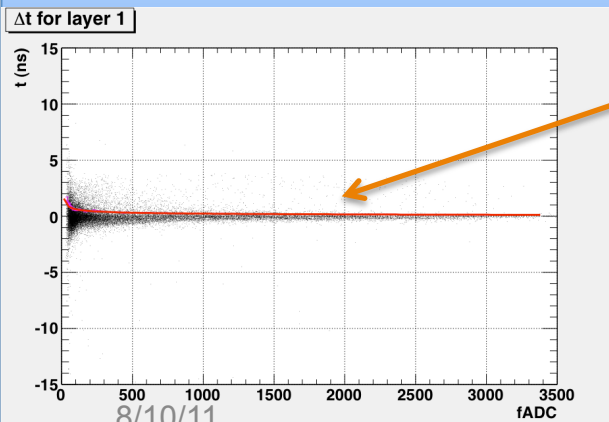
Before Calibration



All plots for 12°, fine segmentation

After Calibration

Resolution functions fit to σ 's of corrected Δt values



8/10/11

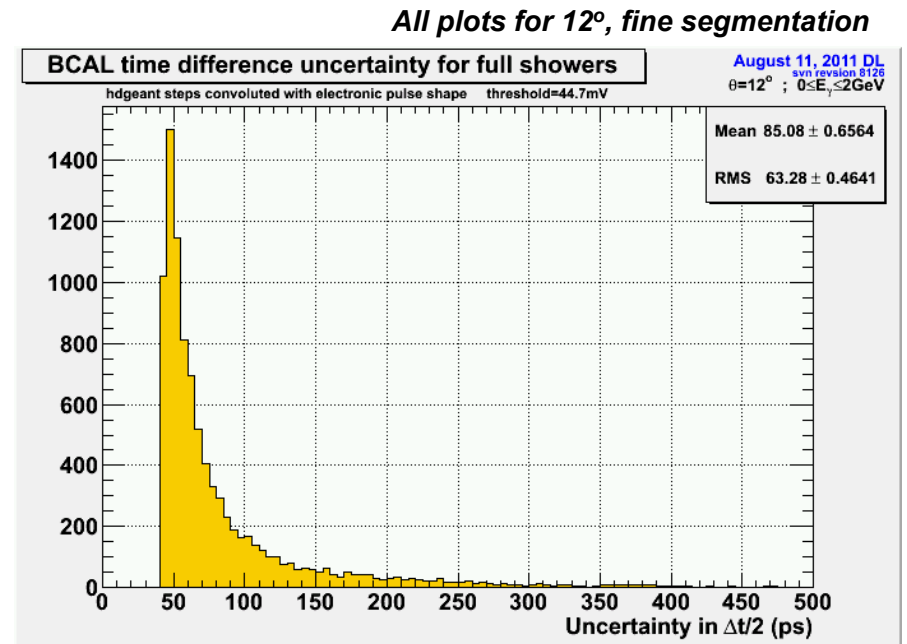
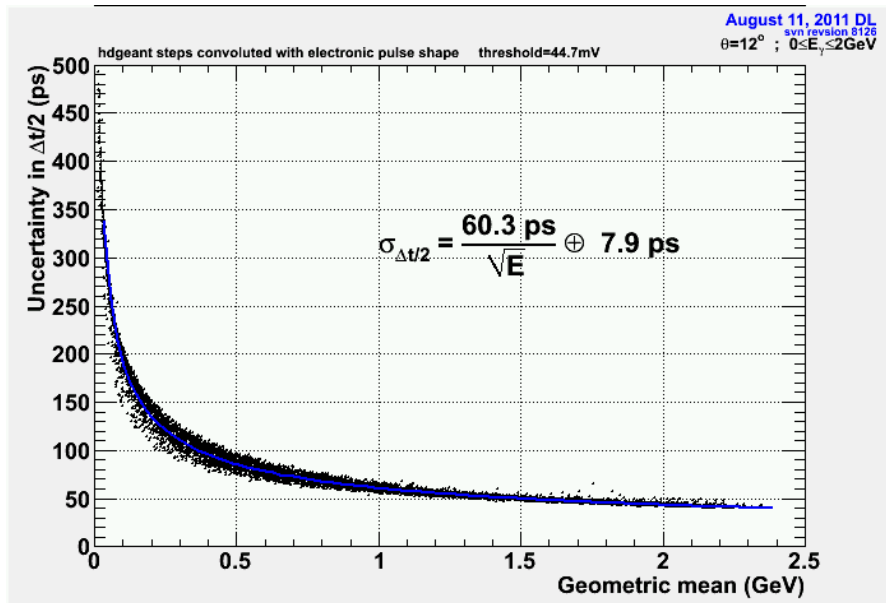
4

Uncertainty in $\Delta t/2$

- The Δt uncertainty functions for each layer were used to determine the total uncertainty for a shower for each event in the data set.
- The uncertainty is plotted below as a function of geometric mean (in units of GeV) on left and as a simple histogram on right.

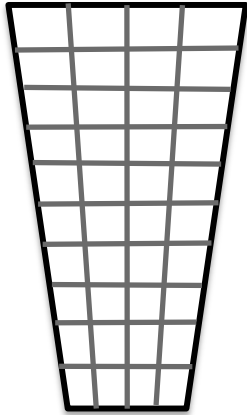
$$\sigma_{avg}^2 = \frac{\sum (w_i \sigma_i)^2}{(\sum w_i)^2}$$

$$w_i = \frac{1}{\sigma_i^2}$$

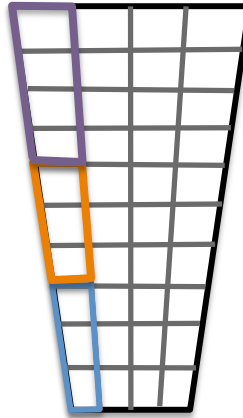


Segmentation configurations

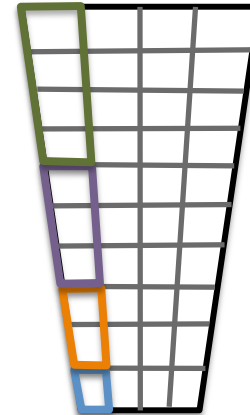
FINE



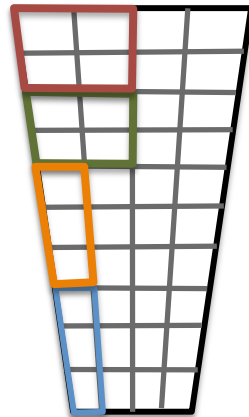
LAYERS334_SECTORS111



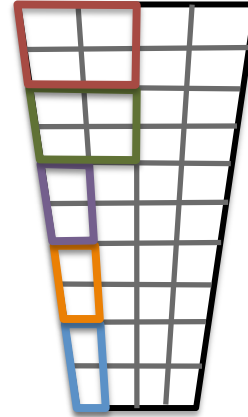
LAYERS1234_SECTORS1111



LAYERS3322_SECTORS1122

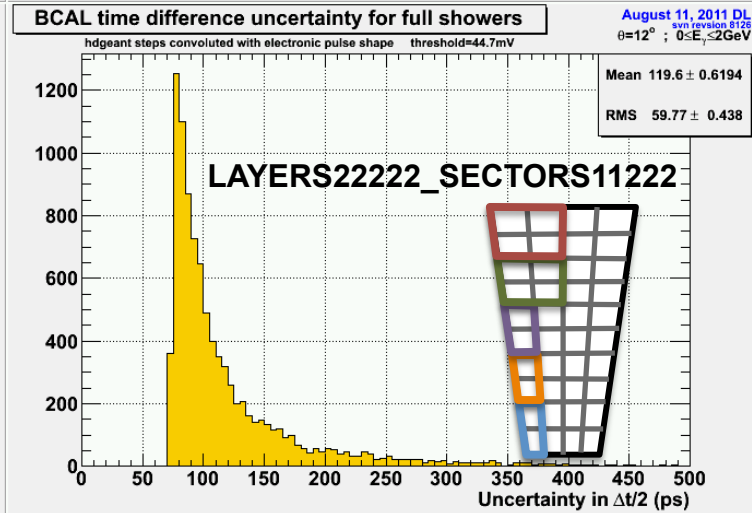
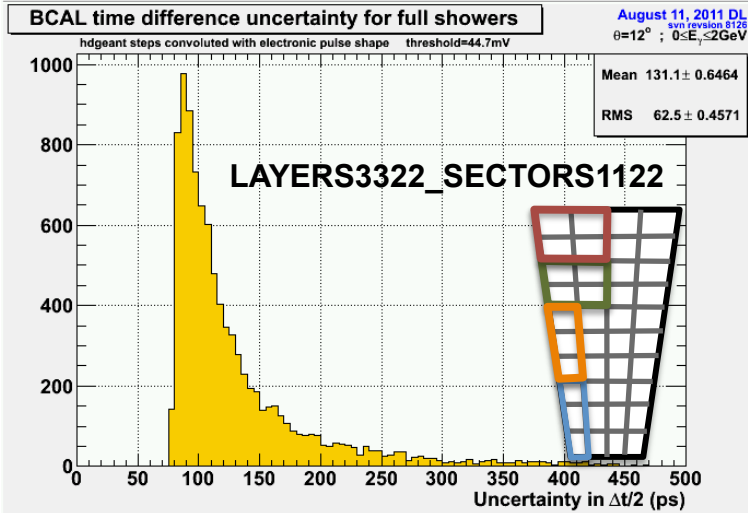
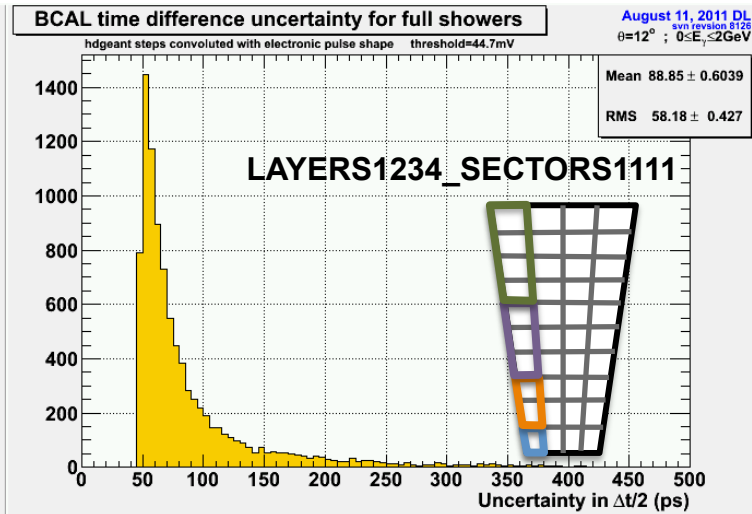
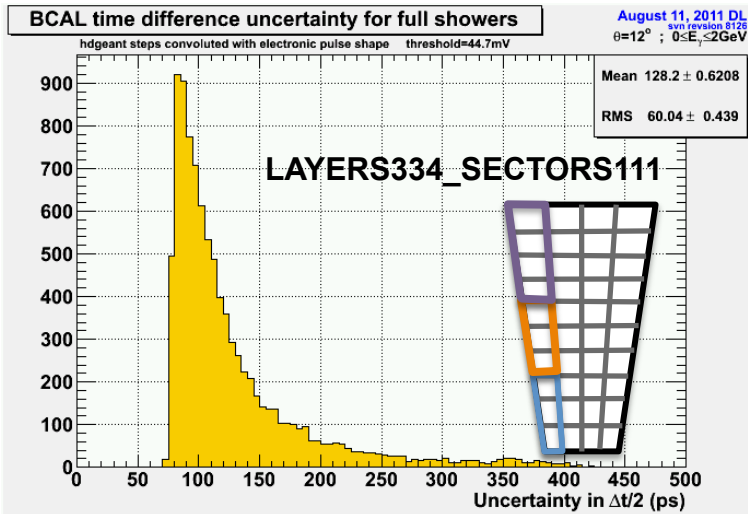


LAYERS22222_SECTORS11222



Additional segmentation Schemes

All plots for 12°, fine segmentation



Time difference resolution summary



All values in ps

Scheme	12°	20°	90°
Fine	85	53	27
LAYERS1234_SECTORS1111	89	63	31
LAYERS22222_SECTORS11222	120	86	
LAYERS3322_SECTORS1122	131	103	36
LAYERS334_SECTORS111	128	104	36

Summary and future

- It looks like the 1234 scheme may give very comparable timing resolution as the “fine” scheme
- Both the 1234 and “fine” schemes give significantly better timing resolution than the “course” schemes
- Still need to:
 - Look at time average resolutions
 - Implement any additional segmentation schemes we wish to consider
 - Write up GlueX-Note