

Analysis of Amplitude Information from 2006 BCAL Cosmics Runs

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Data Set

File	Trigger/Paddle Position (from the center)
/work/halld/bcal06/bcal_dst02458.root	+100 cm
/work/halld/bcal06/bcal_dst02459.root	+150 cm
/work/halld/bcal06/bcal_dst02475.root	- 50 cm
/work/halld/bcal06/bcal_dst02476.root	- 150 cm

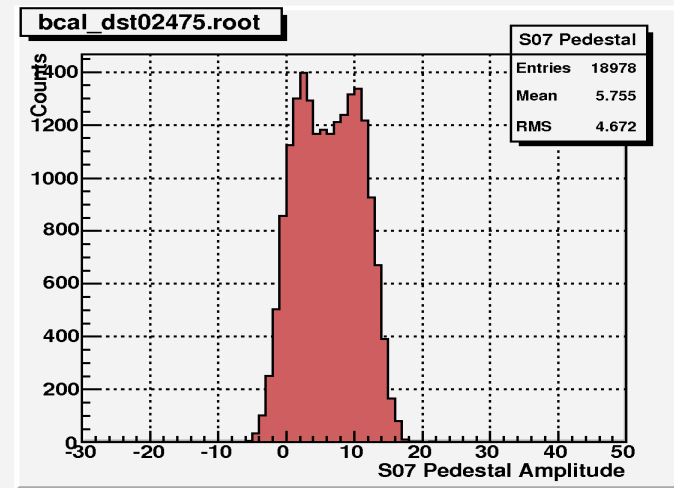
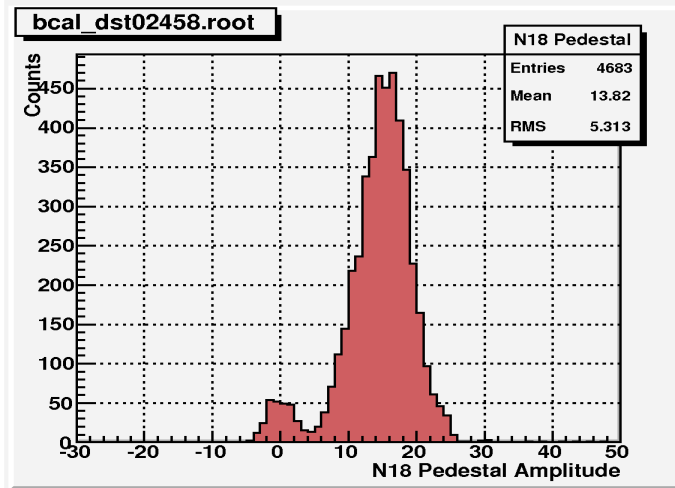
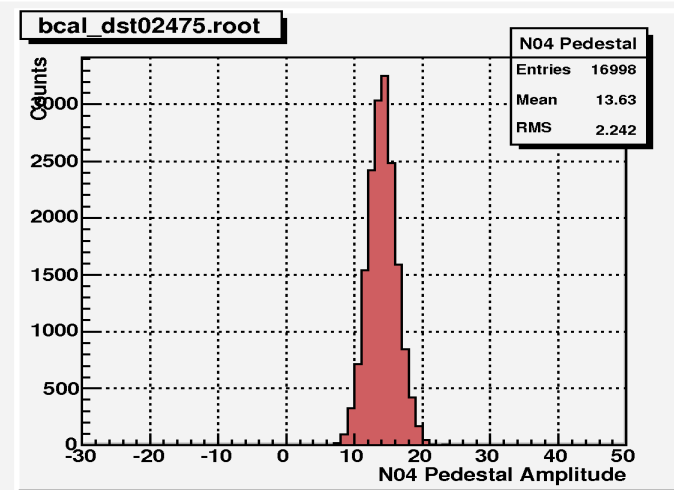
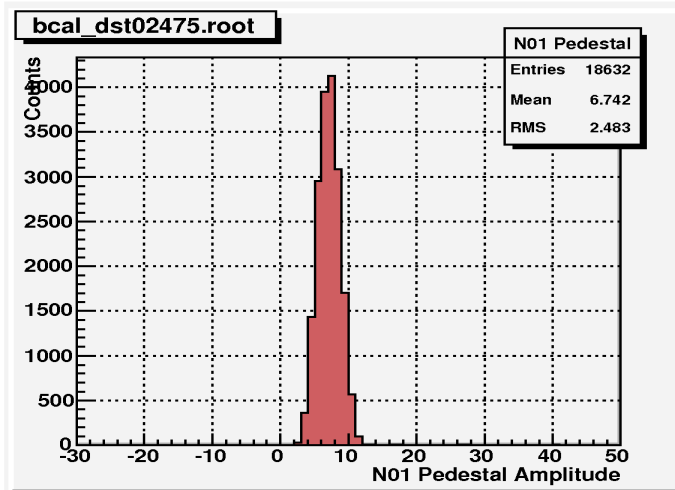
Selection of Pedestal Events

↓ Cosmic Ray Direction

	<10	?	<10		
	<10	<10	<10		
	<10	<10	<10		

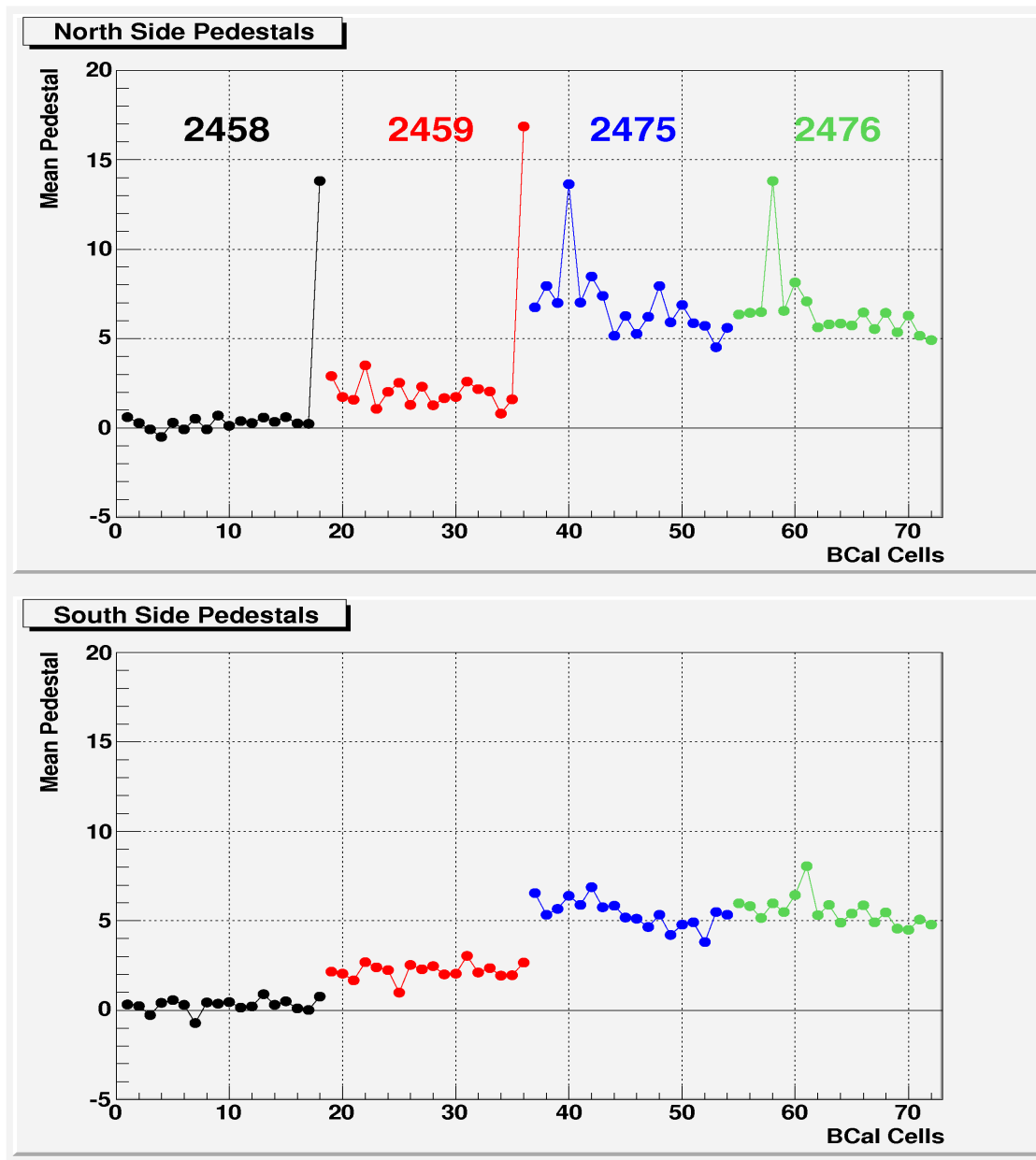
18 (6 x 3) segments

Typical and Abnormal Pedestal Spectra



Pedestals check & subtraction are needed

Mean Pedestal Values Summary



“Muon” Events Selection

↓ Cosmic Ray Direction

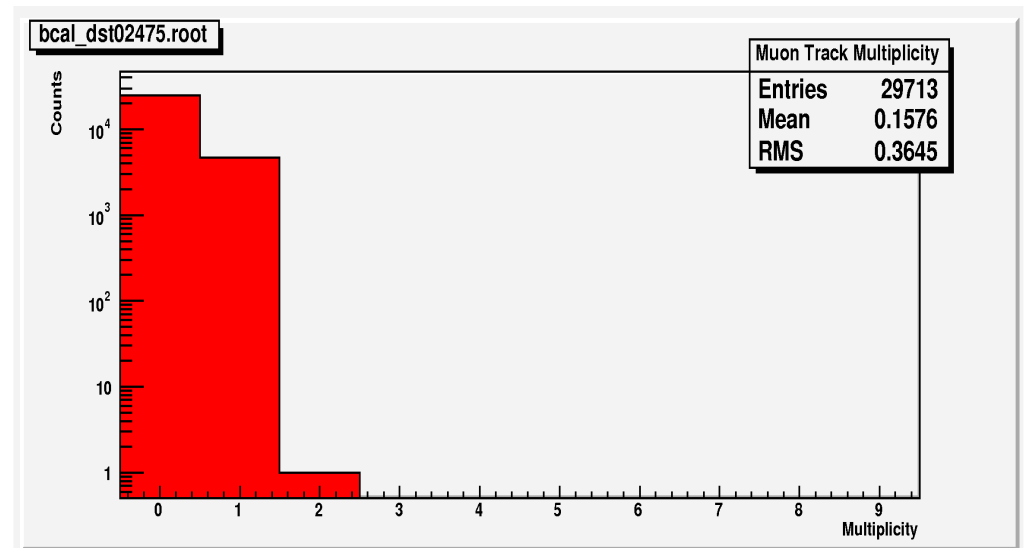
	<10	>70	<10		
	<10	?	<10		
	<10	>70	<10		

* Select MIPs

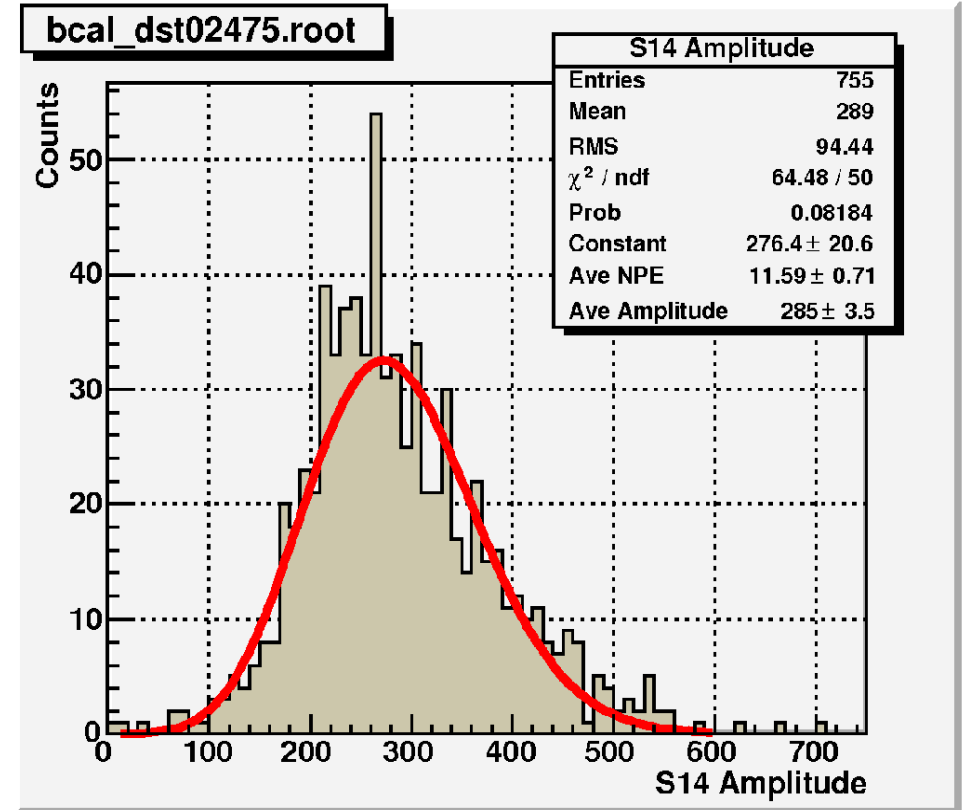
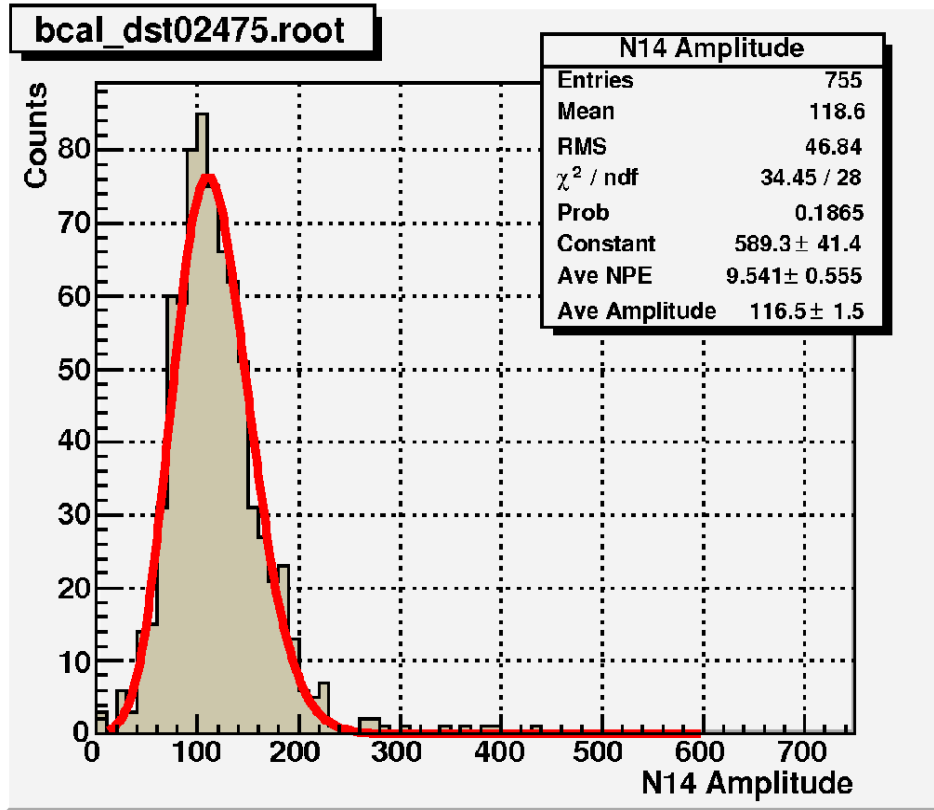
* Suppress showers

* Select vertical-oriented tracks

~ 15 – 20 %



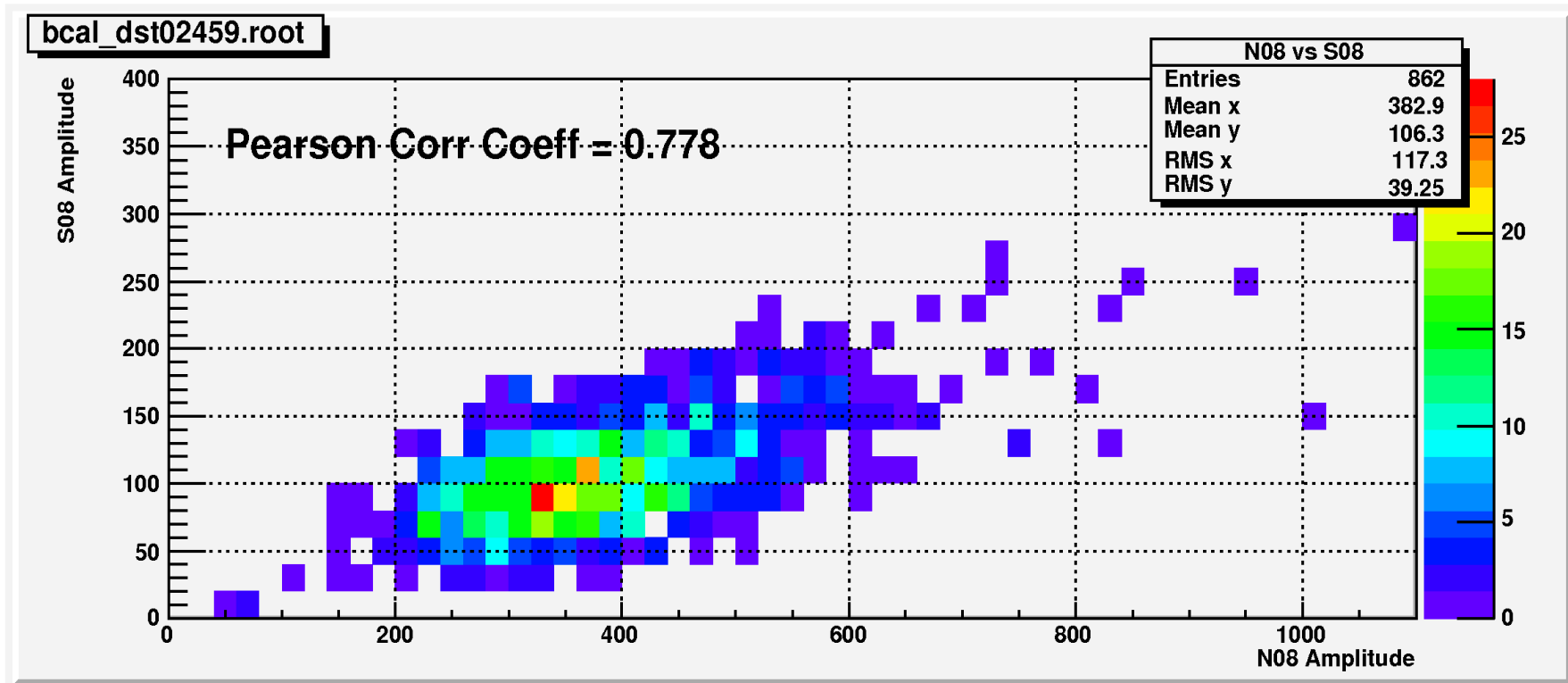
Amplitude Spectra



Poisson-type Fit:

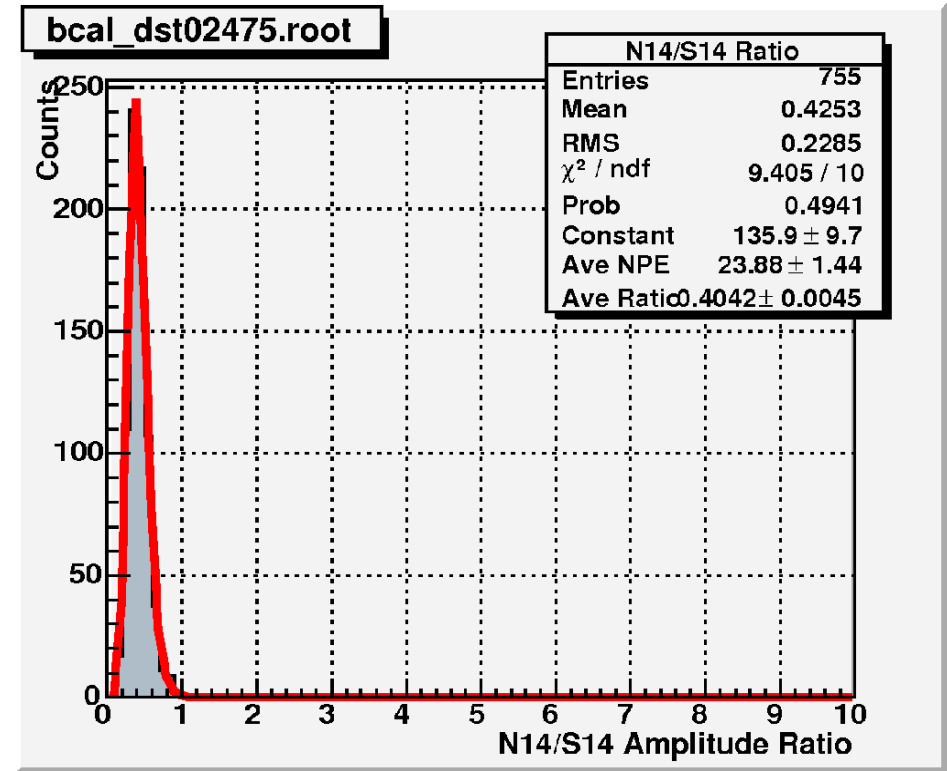
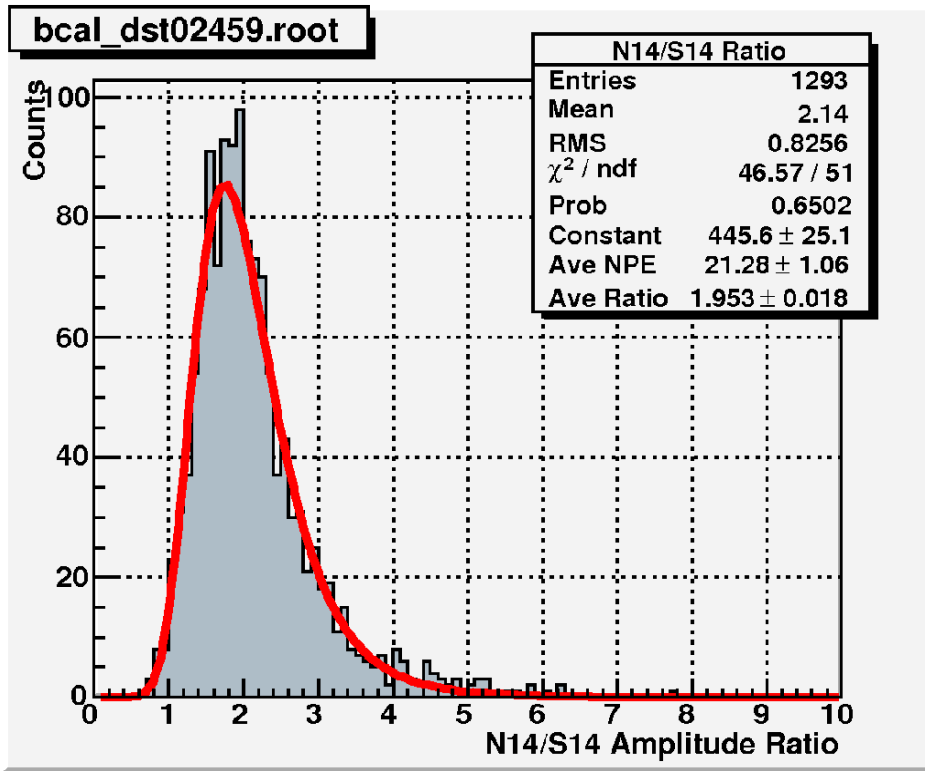
$$P(x, N) \sim e^{-N} N^x / \text{Gamma}(x+1)$$

$$\text{Pearson Correlation Coefficient} = \frac{\sum z_a z_b}{N}, \quad \text{where } z_x = \frac{X - \text{Mean}}{\text{RMS}}$$



i.e., not whole spectrum width is belong to the NPE fluctuations but a significant part of it originates from the variations in the deposited energy => **Ratio is needed**

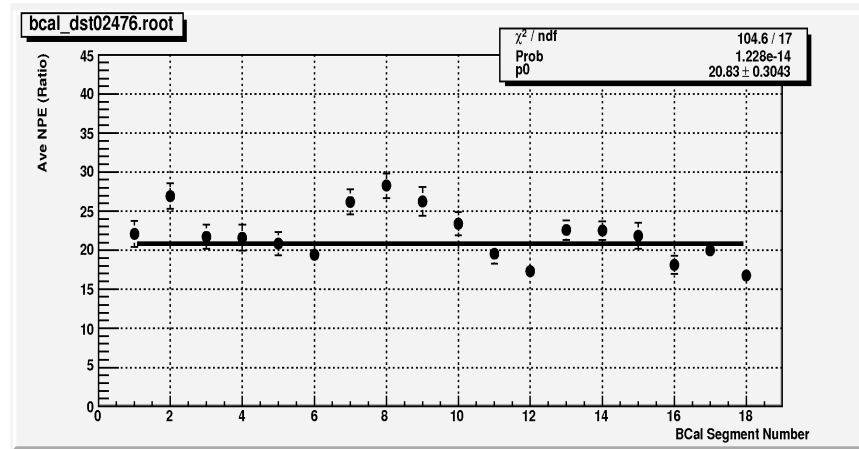
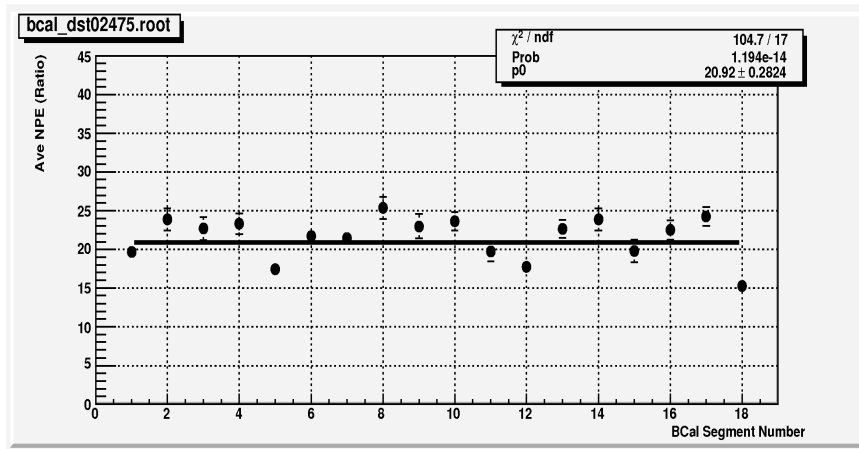
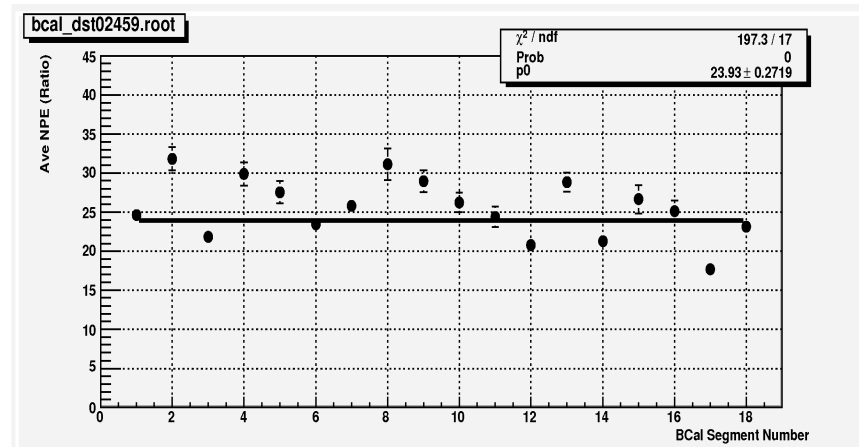
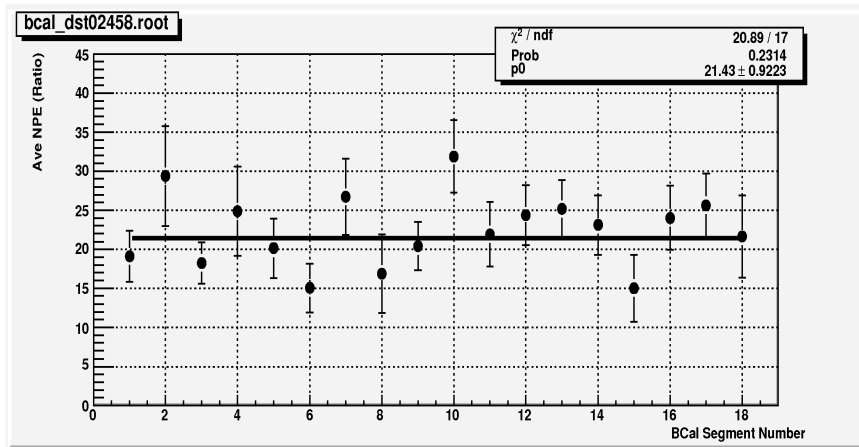
Ratio Spectra



Non-Poisson Fit:

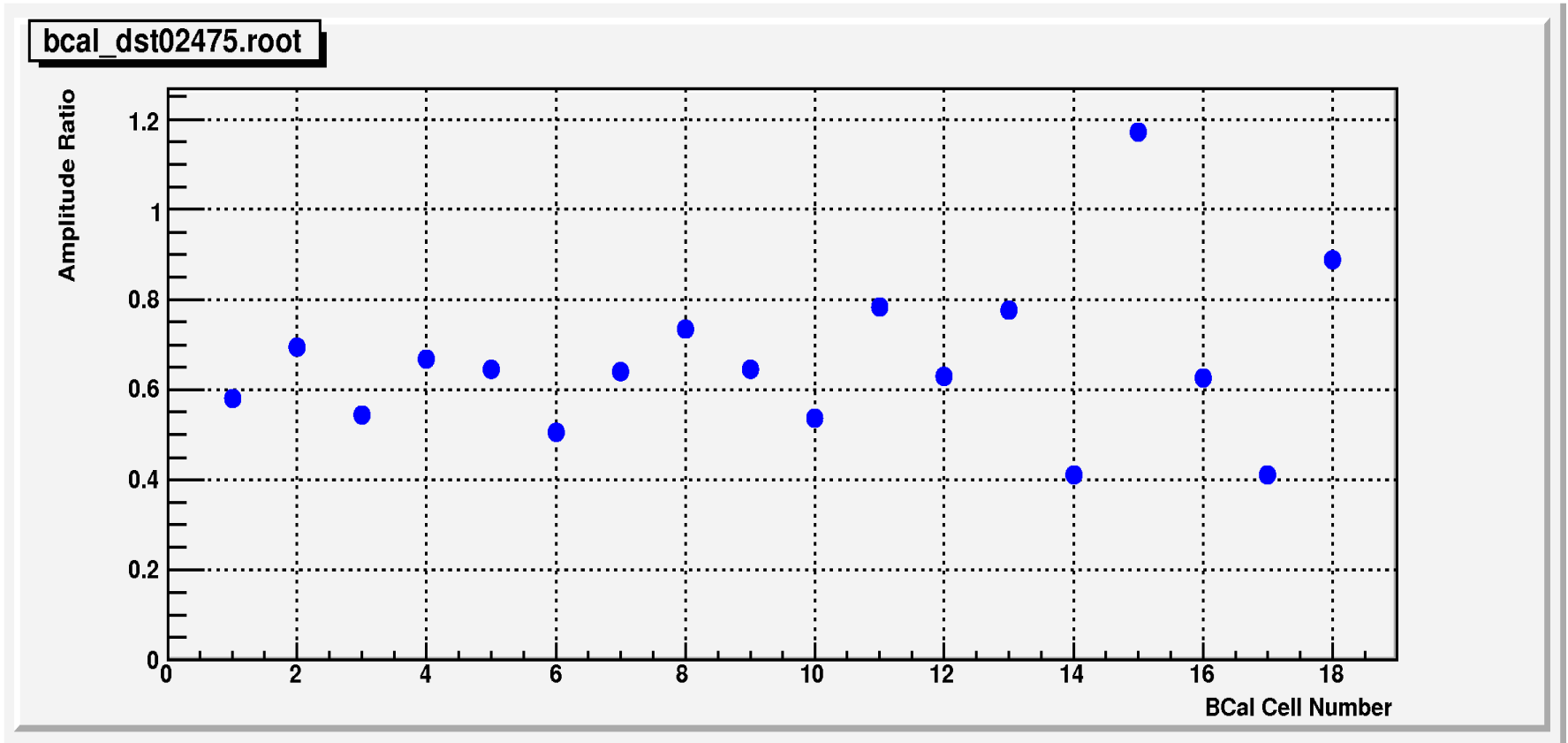
$$f(r) \sim \int P(x, N_{pe} \sqrt{R}) \frac{1}{r} P\left(\frac{x}{r}, N_{pe} / \sqrt{R}\right) \frac{x}{r} dx$$

Average Number of Photoelectrons



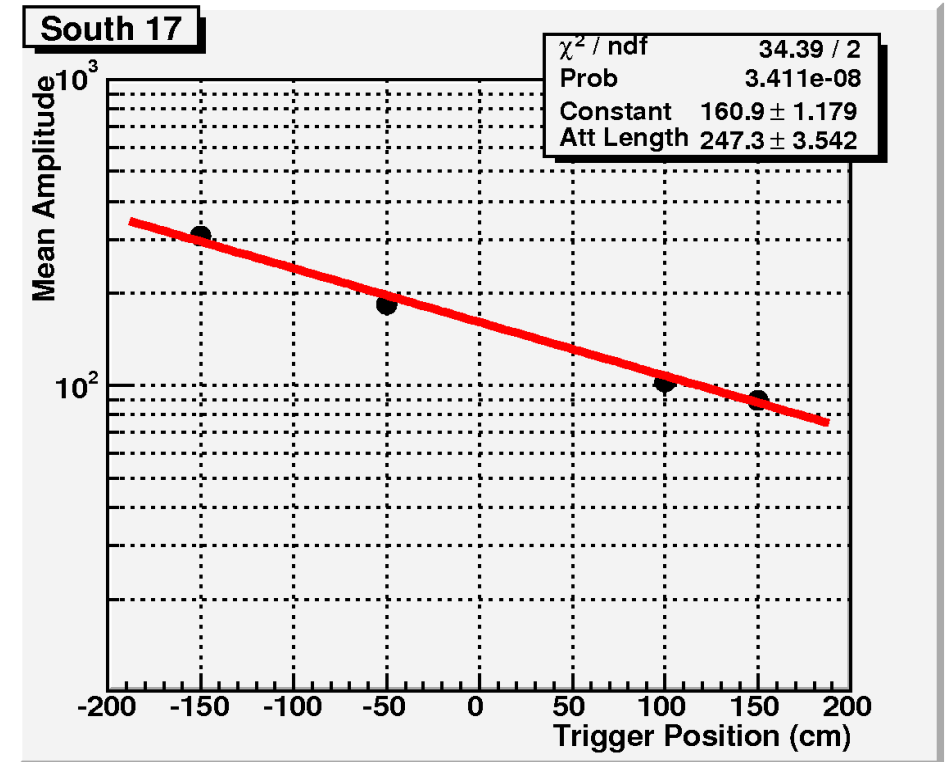
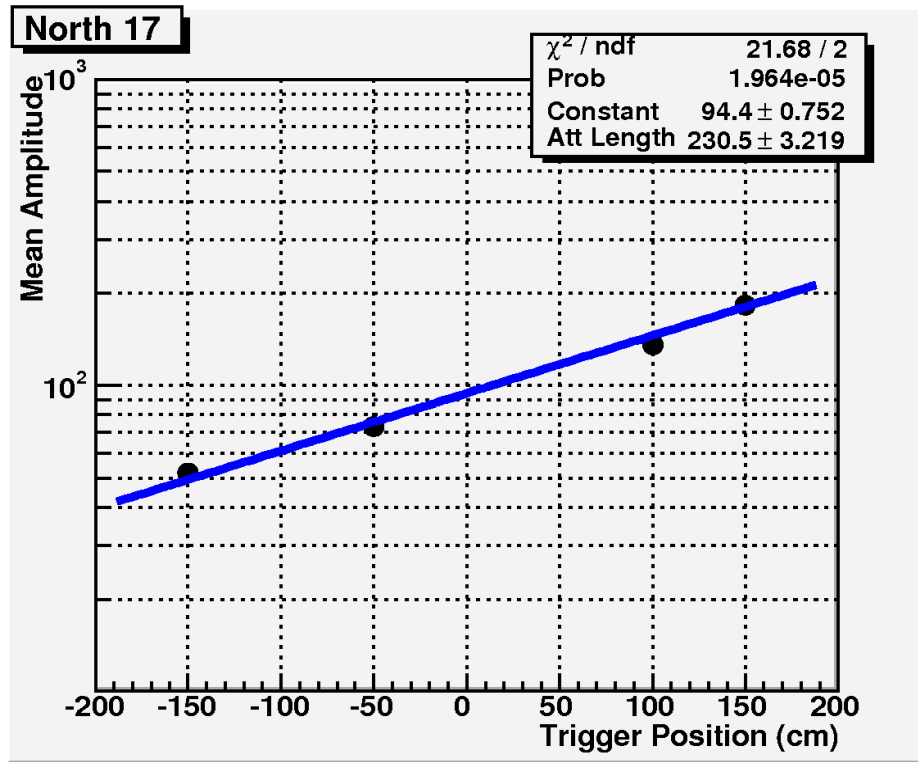
$$\text{Average } N_{pe} = 21.56 \pm 0.68$$

North-to-South Amplitude Ratios



Sector-by-sector extraction of the attenuation length is needed

Light Attenuation Length

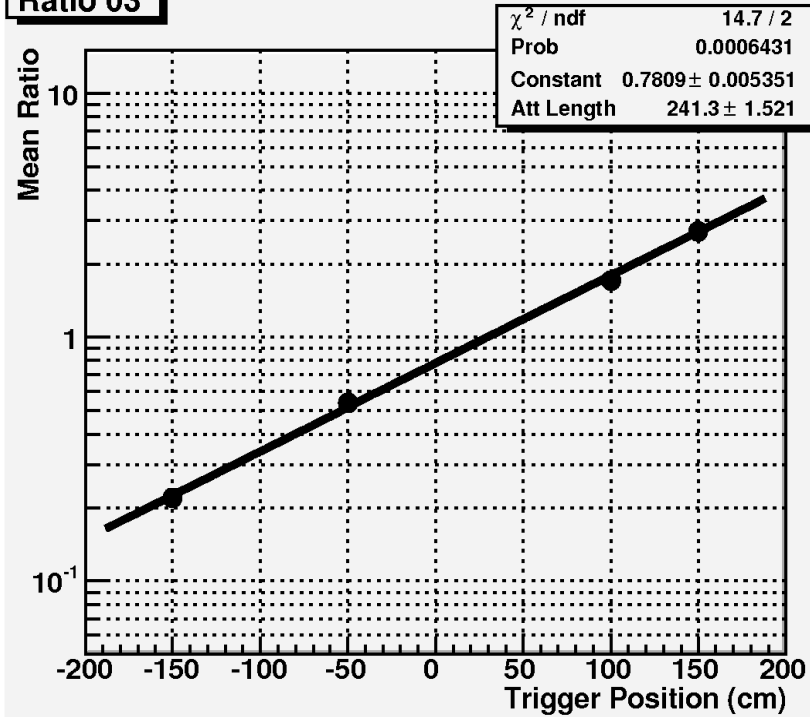


Run-by-run PMT gain variations are possible

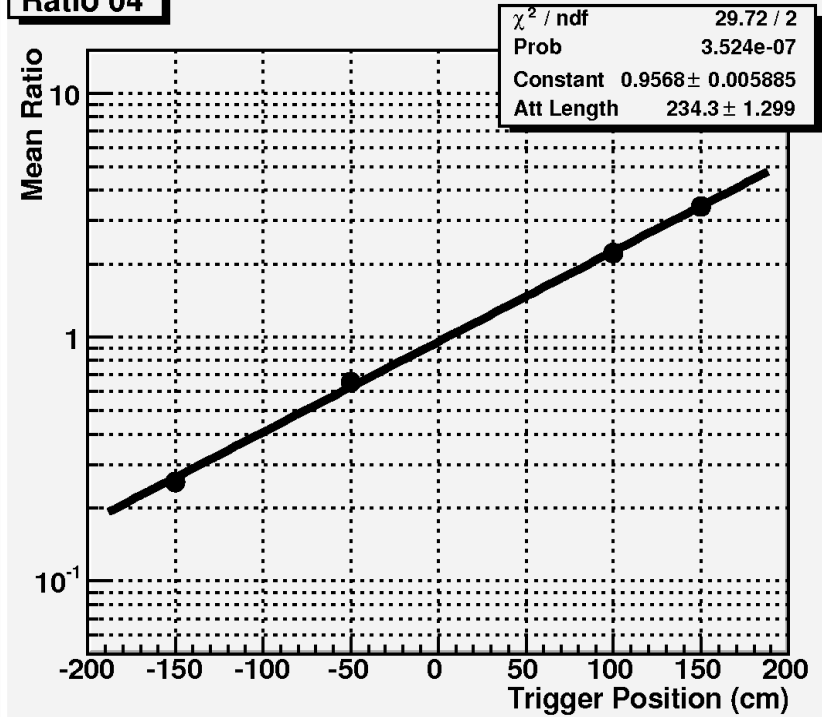
=> Ratio method might be more stable

Light Attenuation Length (Ratio Method)

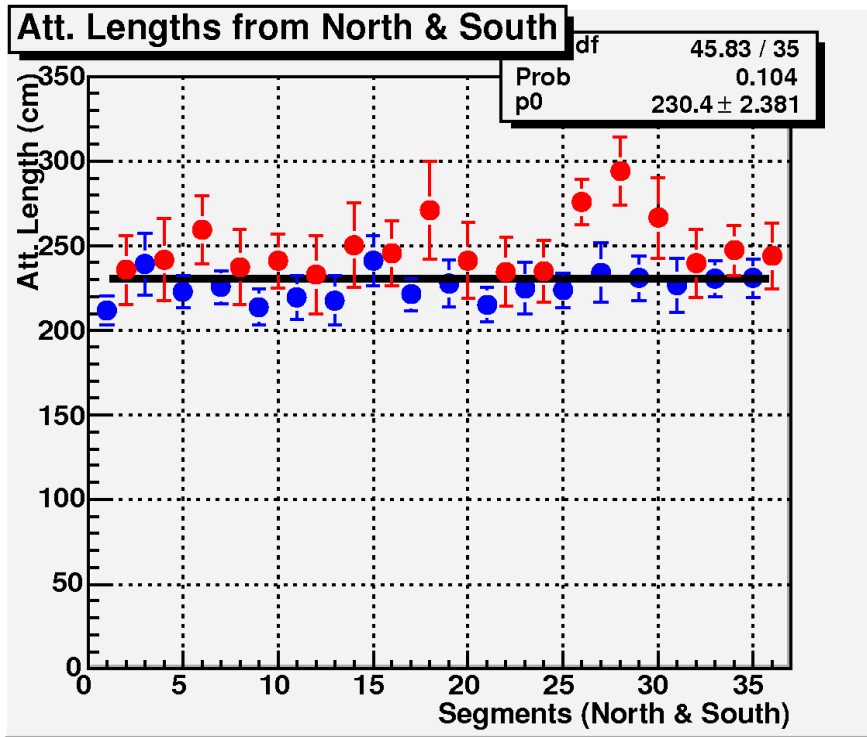
Ratio 03



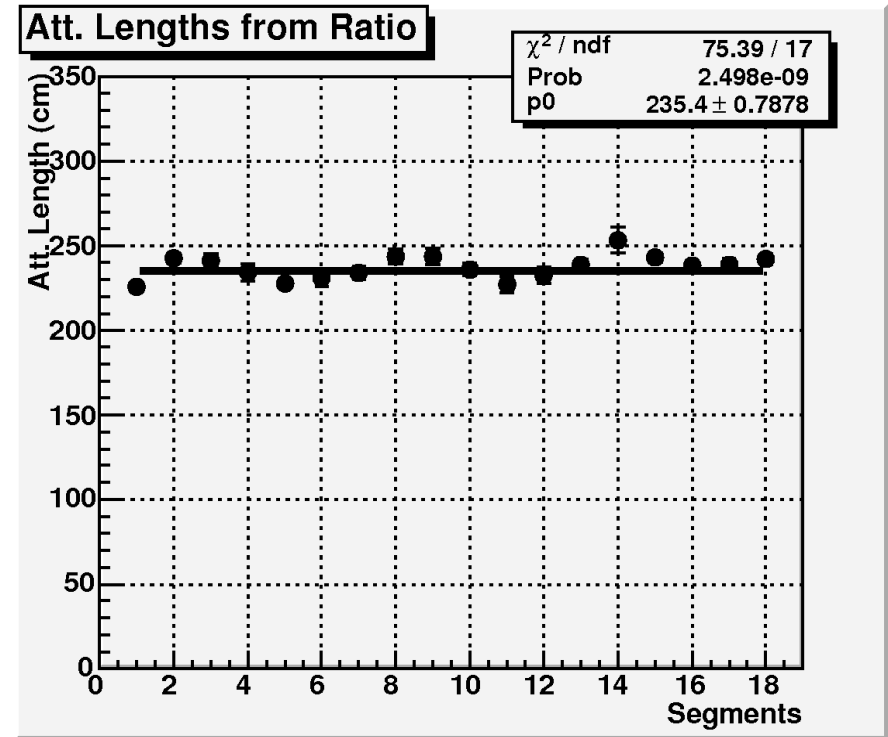
Ratio 04



Light Attenuation Length (Summary)



$230.4 \pm 2.8 \text{ cm}$



$235.4 \pm 1.7 \text{ cm}$

Conclusions:

- Pedestals check & subtraction are important
- Amplitude ratio spectra should be used for NPE extraction
- Averaged over all segments and all runs
 $\text{NPE} = 21.56 \pm 0.68$
- Mean light attenuation lengths from “one-side” technique (230.4 ± 2.8 cm) and from the “ratio” method (235.4 ± 1.7 cm) are in a good agreement