FIRST S.Valentine's Meeting 2013

ToF-Wall Activity Report

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Overview

TDC Calibration

TDC and trigger readings are related to physical quantities as follows:

$$TDC'_{t,b} = t_{add} - TDC_{t,b} = ToF_{Carbon} + \tau_{t,b} + \Delta_{t,b}$$

- TDC measurements were performed in common-stop mode: t_{add} takes into account the trigger correction

$$t_{add} = trg_{TW} - trg_{SC}$$

- $\tau_{t,b}$ is the time spent by the light pulse to propagate to the PMT in the slat
    - in sweepruns the hit position is known

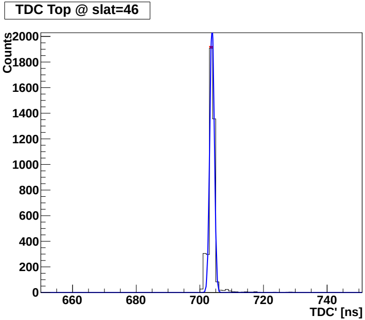
$$\tau_{t,b} = \frac{L}{2\, v_{light}}$$

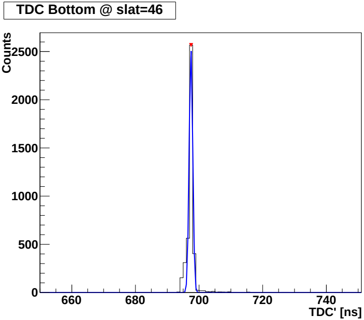
        - L is the slat length, v_{light} is the light speed in the slat
- ToF_{Carbon} is needed from MC simulation

TDC peak identification on slat 46

$$TDC'_{t,b} = ToF_{Carbon} + \tau_{t,b} + \Delta_{t,b}$$

- $\Delta_{t,b}$ can finally be determined after fitting the measured quantities



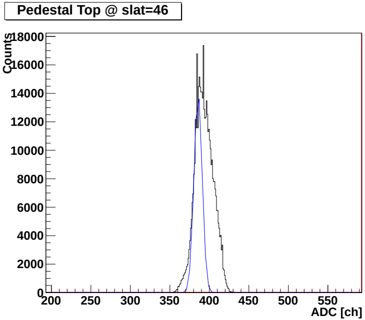


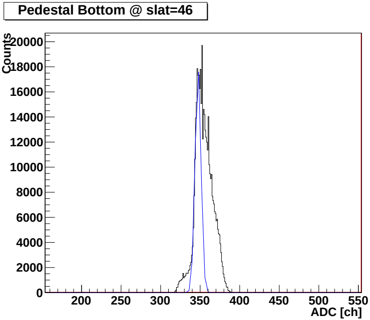
Pedestal Identification

Pedestal distributions must be identified to address ADC calibration

$$ADC'_{t,b} = ADC_{t,b} - PED_{t,b}$$

- $ADC_{t,b}$ are measured quantities
- gaussian fits of $PED_{t,b}$ distributions have been built in an asymmetric way on the left side
  - the left half-maximum has been taken as 0 energy



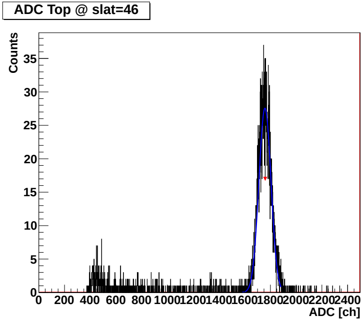


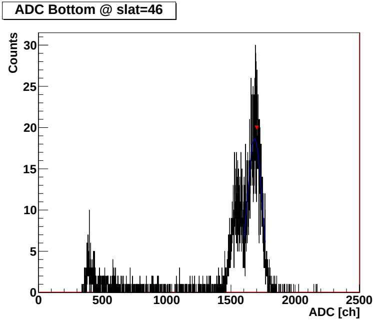
ADC Calibration

$ADC'_{t,b}$ are proportional to PMT inputs and thus to E_{loss}

$$ADC'_{t,b} = \epsilon_{t,b} E_{loss}\, e^{-\alpha[L/2 \mp Y]}$$

- $\epsilon_{t,b}$ are the PMT and electronic gains (to be found)
- E_{loss} is the energy released in the slat
- α is the absorption coefficient





Channel Status

Bad channel list - slats with 1 missing channel can be recovered

TDC top	TDC bottom	Pedestal top	Pedestal bottom	ADC top	ADC bottom
	1				1
9				9	
10				10	
	27				
				32	
					35
				36	
56				56	
				66	
76				76	
	82		82		82
	84				
		89		89	
93				93	
	101				
				102	
				104	
	113				
	133				
				139	
					142
				144	
	147				
					156
				162	
165	165			165	165
				187	

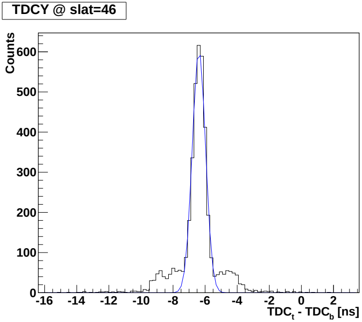
Legenda

lost channels
recoverable channels

Y Calibration via TDC

$$Y_{TDC} = \frac{v_{light}}{2}(TDC_b - TDC_t + \Delta_t - \Delta_b)$$

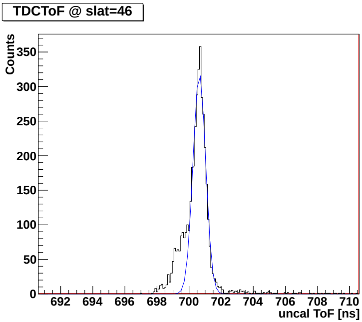
- in sweepruns the vertical hit coordinate is taken as 0
- $\Delta_t - \Delta_b$ can be calculated



ToF Calibration

$$ToF_{Carbon} = \frac{TDC_t + TDC_b - (\tau_t + \tau_b) - (\Delta_t + \Delta_b)}{2}$$

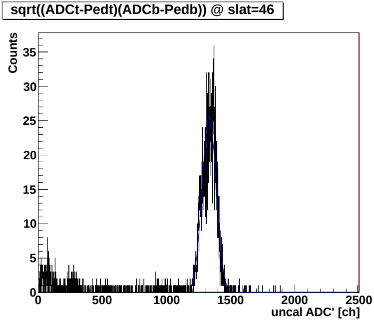
- the time spent by Carbon ions to travel from SC to TW (ToF_{Carbon}) can be provided by MC simulation
- $\Delta_t + \Delta_b$ can be calculated



E_{loss} Calibration

$$E_{loss} = \frac{\sqrt{ADC'_t \, ADC'_b}}{\sqrt{\epsilon_t \, \epsilon_b \, e^{-\alpha L}}}$$

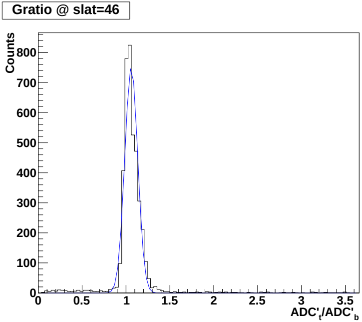
- in sweepruns E_{loss} is a function of the impinging angle, slat by slat, and can be reproduced by MC simulation (by now 116 MeV)
- the product $\epsilon_t \, \epsilon_b$ can be obtained by fitting



Y Calibration via ADC

$$Y_{ADC} = \frac{1}{2\alpha}\left(\log\frac{ADC'_t}{ADC'_b} + \log\frac{\epsilon_b}{\epsilon_t}\right)$$

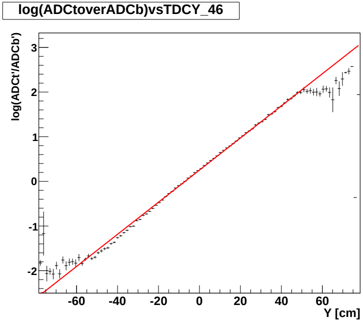
- in sweepruns the vertical hit coordinate is taken as 0
- the ratio ϵ_t/ϵ_b can be obtained by fitting

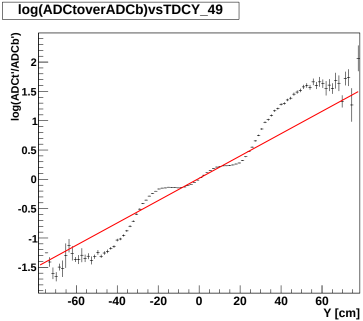


α and ϵ_b/ϵ_t Evaluation

$$\log \frac{ADC'_t}{ADC'_b} = 2\alpha Y_{TDC} - \log \frac{\epsilon_b}{\epsilon_t}$$

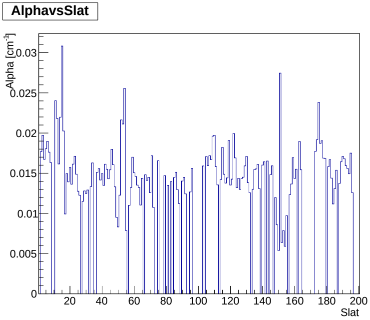
- slope (α) and intercept (ϵ_b/ϵ_t) can be determined
- Y_{TDC} and Y_{ADC} in production runs have been used for fitting

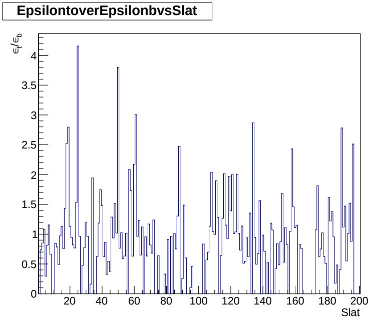




α and ϵ_b/ϵ_t Evaluation

- α and ϵ_b/ϵ_t are obtained slat by slat





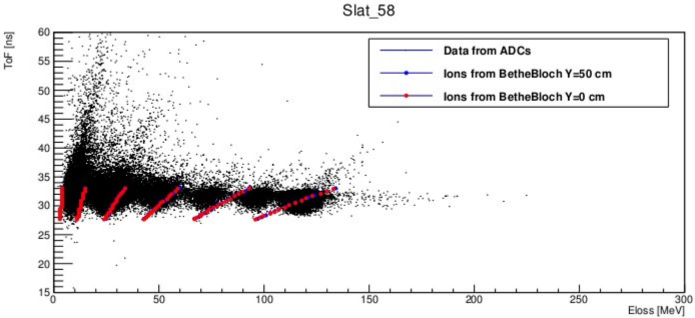
Benefits of Single Channel and Physical Quantity Calibrations

- calibration completion and self-check is possible
  - $\Delta_{t,b}$ and $\epsilon_{t,b}$ can be obtained from:
    - single channel calibration
    - physical quantity calibration
  - ϵ_t/ϵ_b can be fetched from Y_{TDC} and Y_{ADC} comparison
- hits with only 1 missing reading (over 4) can be recovered
  - hits with under-threshold signal on 1 TDC
    (mainly protons – 20% statistics)
  - slats with 1 failing channel

Z id and non-linearity problems

By comparing measured data and a expected values in *ToF* vs E_{loss} emerges the following:

- data distribution and theoretical curves disagree
- this can be attributed to non-linear effects in scintillation
- non-linearity can be corrected to ease Z id using the Bethe-Bloch model for fitting Z clouds



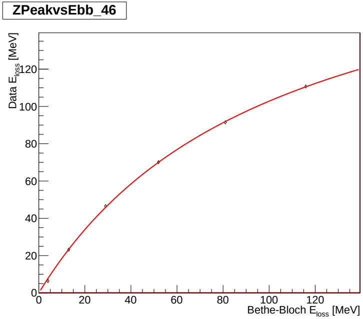
Non-linearity evaluation through Birks' model

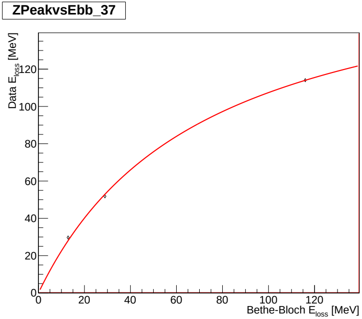
Scintillation pulses, L, are not linear with E_{loss}

- According to Birks' law:

$$\frac{dL}{dx} = L_0 \frac{dE/dx}{1 + k_b * dE/dx}$$

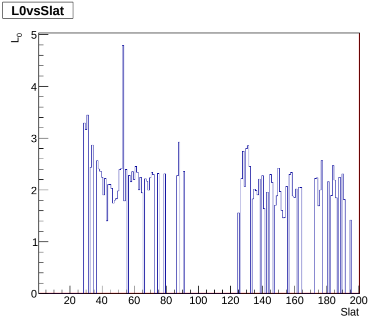
- dL/dx is derived from ADC measurements (Data E_{loss} from Z peak)
- dE/dx is given by the Bethe-Bloch formula (Bethe-Block E_{loss})





Non-linearity evaluation through Birks' model

- Birks' model parameters, L_0 and k_b, are found from fitting
  - more than 1 Z peak is needed
  - this condition is satisfied on a limited number of slats
  - some slats (< 32) are not reachable by primary fragments



Non-linearity evaluation through Birks' model

- once L_0 and k_b are known, a rescaling of the energy axis can be applied to overlap distributions with theoretical curves
- possibly their mean value can be applied to slats without fitting
- furthermore C peaks from sweepruns can be used in addition to those from data, to compensate where information is lacking

THE END

Thanks for your attention