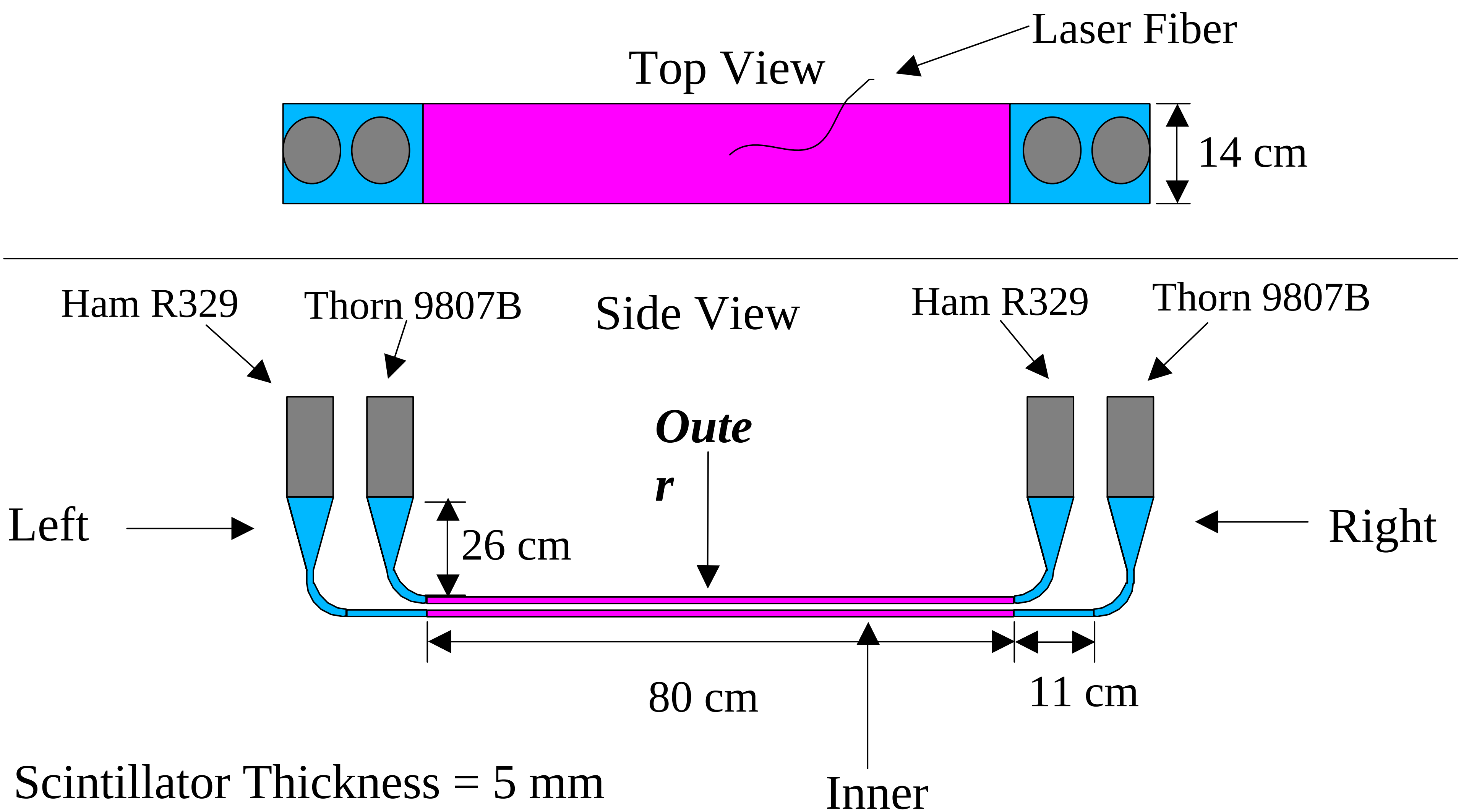
MuCap Gondola Tests

1. Laser Photoelectron Calibration.

2. Determining Position Along Z.

3. Long Time After Pulsing

Overview



Scintillator Thickness = 5 mm

Scintillator Separation ≈ 5mm

Laser to Calibrate $N_{\mathbf{p.e.}}$

Assume stable and consistent light pulse from laser.

Measured area from scintillator gives a mean of $\Leftarrow = f \, \mathrm{X} \, N_{p.e.}$

Where f is some unknown efficiency constant

It then follows the uncertainty in the area is given by $® = \dfrac{\Leftarrow}{\sqrt{(N_{p.e.})}}$

Thus: $N_{p.e.} = \left(\dfrac{\Leftarrow}{®}\right)^2$

This is a lower limit since σ is often due to more than just the uncertainty in N

Laser Process

1. Set laser to some arbitrary intensity.

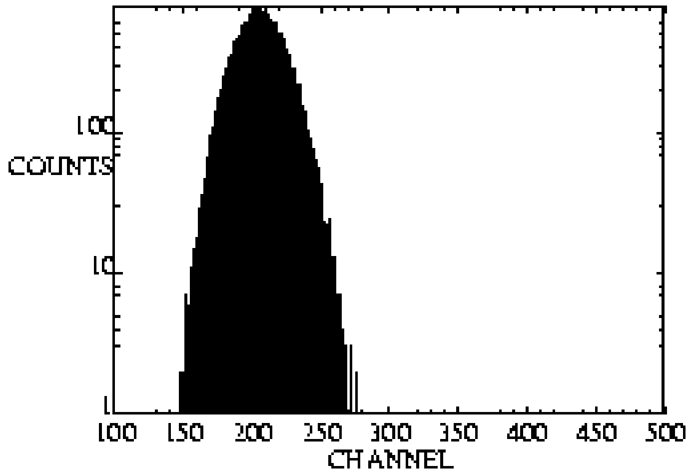
2. Use KMAX to get mean and FWHM.

3. Apply $N_{p.e.} = \left(\frac{\Leftarrow}{\circledR}\right)^2$

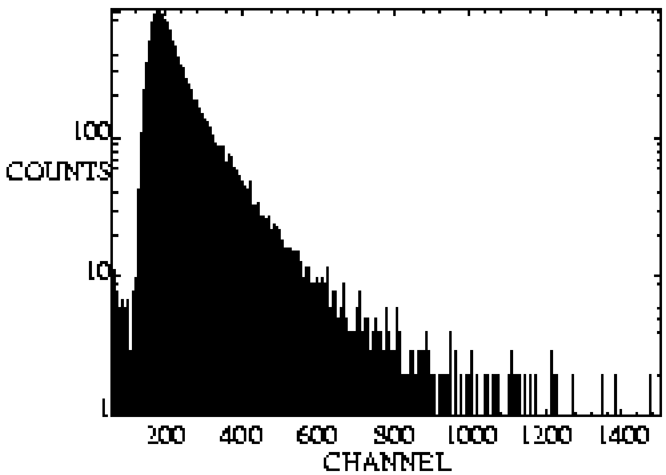
4. Repeat at new laser intensity.

5. Use slope of $N_{\mathbf{p.e.}}$ vs. μ at MIP average to get $N_{p.e.}$ per MIP.

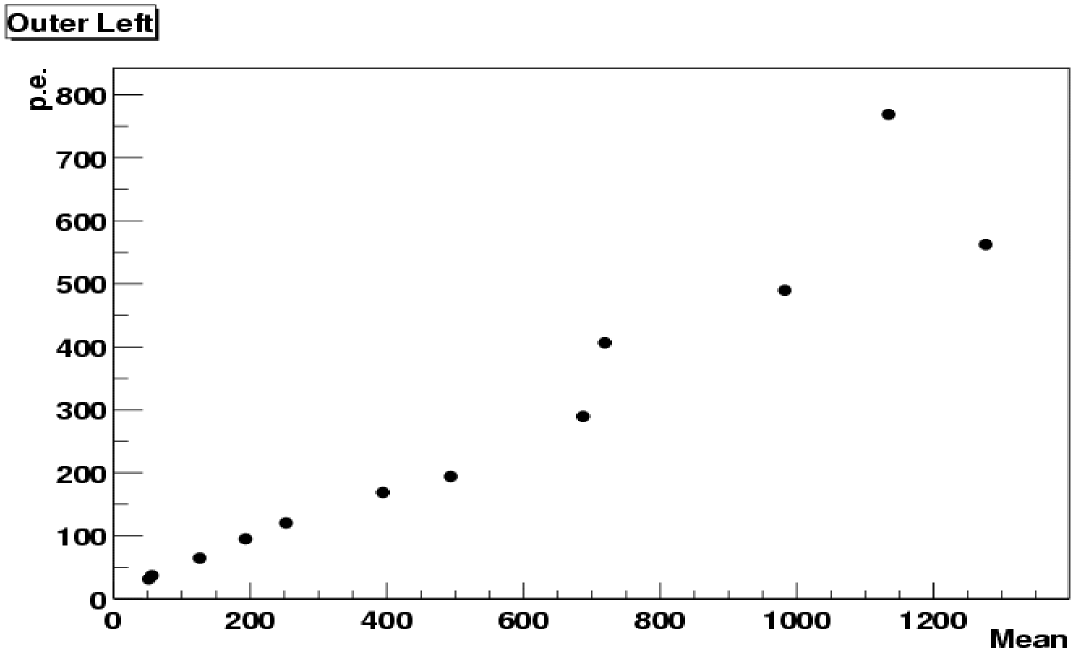
Example of Laser Data



OuterLeftADC Copy



OuterLeftADC Copy Copy



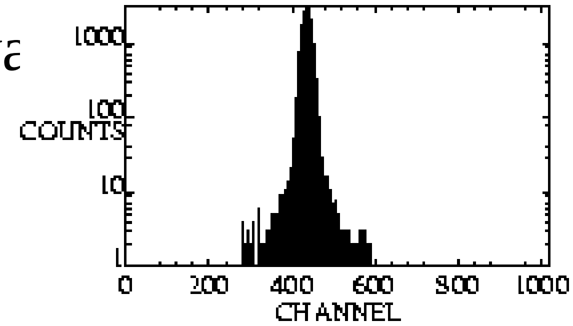
Laser Results

	Inner		Outer	
	Left	Right	Left	Right
$N_{p.e}$ per Channel	0.48	0.36	0.49	0.63
$N_{p.e}$ for MIP	74	61	80	102
Total $N_{p.e}$ for MIP	135		182	

Determine Position Along Z

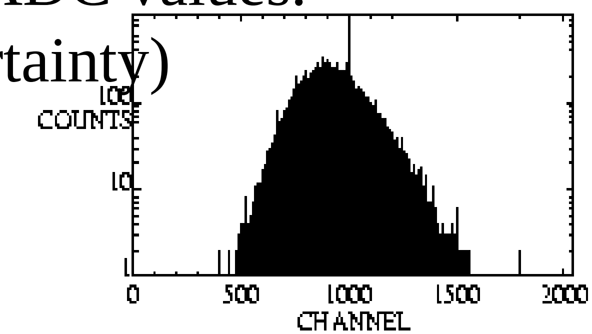
Two Methods

1. Δt between left and right TDC va



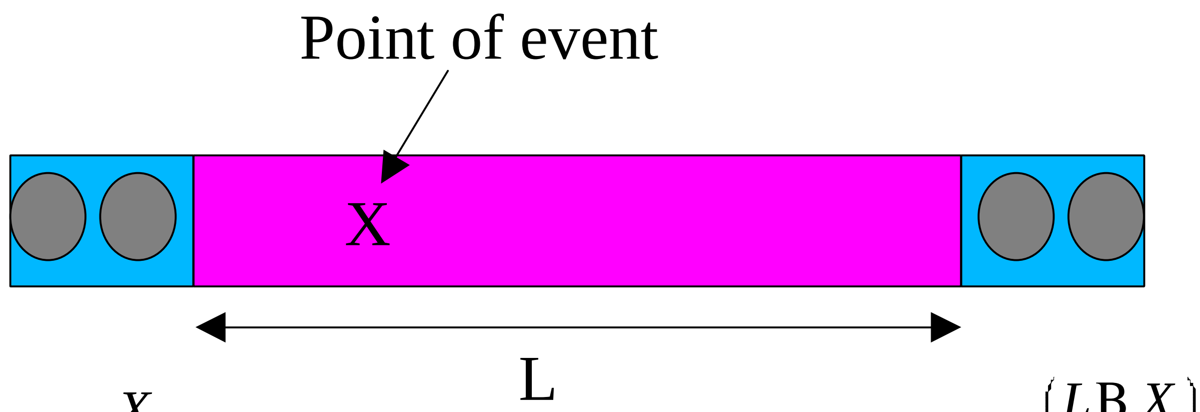
OuterTdcDiff Copy

2. Ratio of areas between left and right ADC values.
(Not useful due to large uncertainty)



OuterAdcRatio Copy

Using Δt



v = speed of propagation

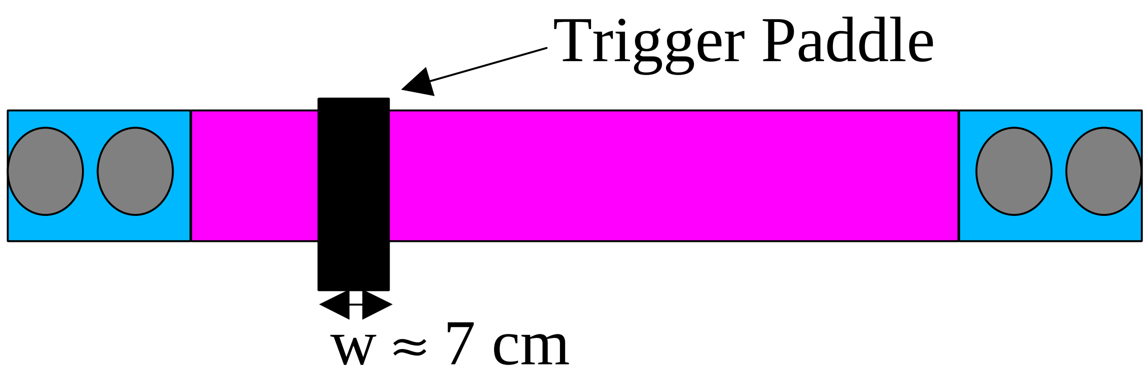
$$t_L = \frac{X}{v} \qquad t_R = \frac{(L - X)}{v}$$

$$\Delta t = t_L - t_R = \frac{2X}{v} - \frac{L}{v}$$

Since L and v are constant, the uncertainty in Δt becomes:

$$\sigma_{(\Delta t)} = \frac{2}{v}\sigma_X$$

Using Δt

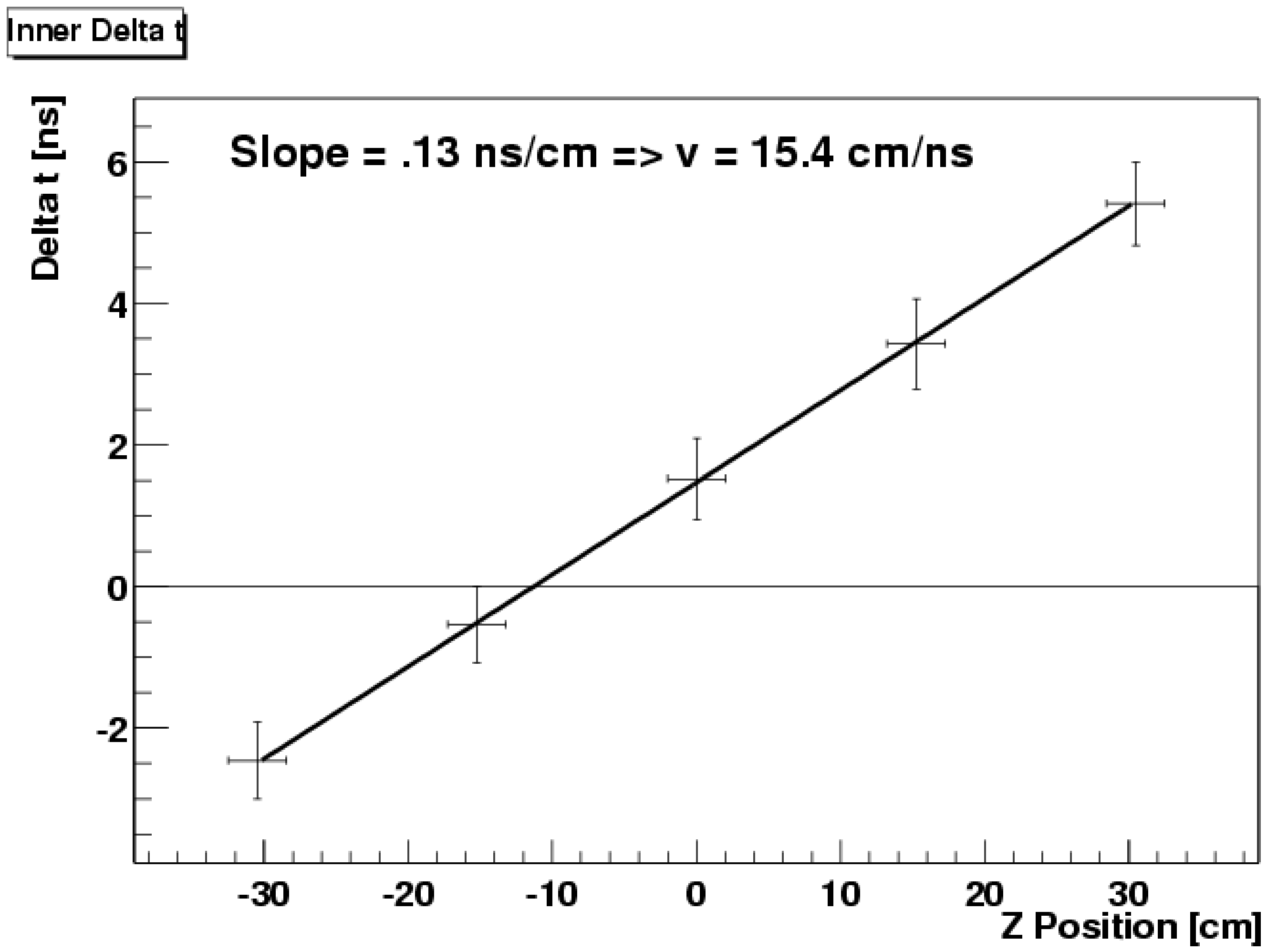


The uncertainty in position of paddle is given by $\circledR_{paddle} = \frac{1}{\sqrt{(12)}} w \, Z \, 2.02\, cm$
assuming a square paddle.

The the measured uncertainty is approximately give by $\circledR_X = \sqrt{(\circledR^2_{paddle} \, A \, \circledR^2_{Tru}}$

Therefore $\circledR_{True} = \sqrt{(\circledR^2_X \, B \, \circledR^2_{paddle})} = \sqrt{(\frac{v^2}{4} \circledR^2_{(\cap t)} \, B \, \circledR^2_{paddle})}$

Determine v from Δt vs. Position



σ_{True} for each position

With 7 cm Paddle

Position	Inner	Outer
- 30.5 cm	3.67 cm	3.17 cm
- 15.25 cm	3.67 cm	3.21 cm
0 cm	3.54 cm	2.98 cm
15.25 cm	4.36 cm	3.59 cm
30.5 cm	4.04 cm	3.48 cm
average	3.86 cm	3.29 cm

With 1cm Overlap @ center

	Inner	Outer
	3.5 cm	3.5 cm

langfristiges nachher pulsieren