

High Precision Time-of-Flight for the CMS Phase II Upgrade Test Stand Analysis



Adi Bornheim
September 2013
Caltech



Introduction

- **All plots have been inverted to be positive and x-axis have been scaled to be in ns.**

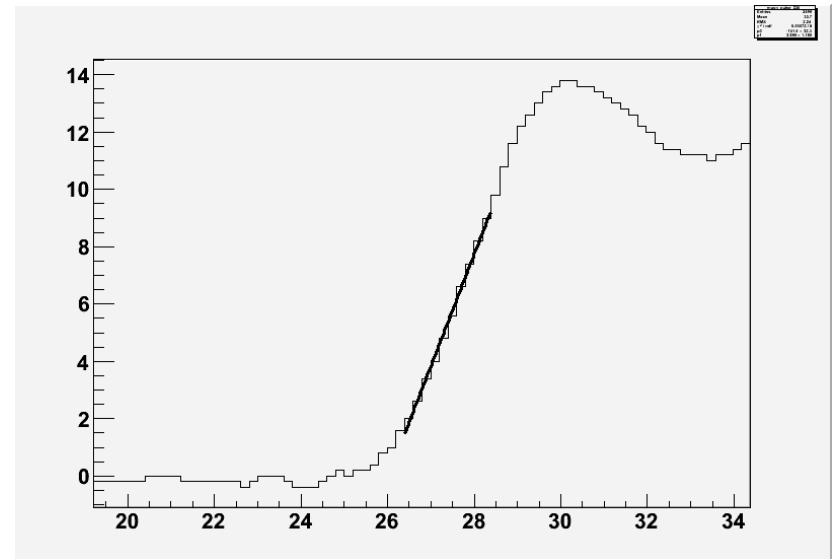
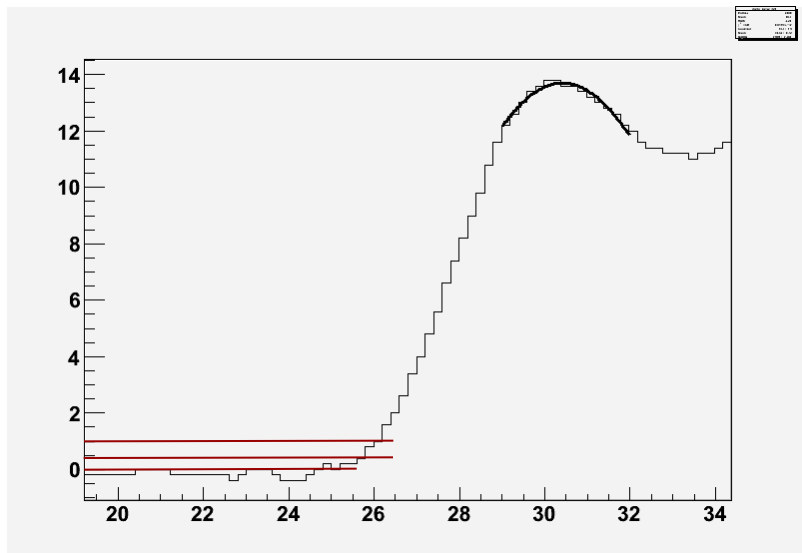


Chapter One

First data taking with a single side readout 10 cm LYSO crystal.



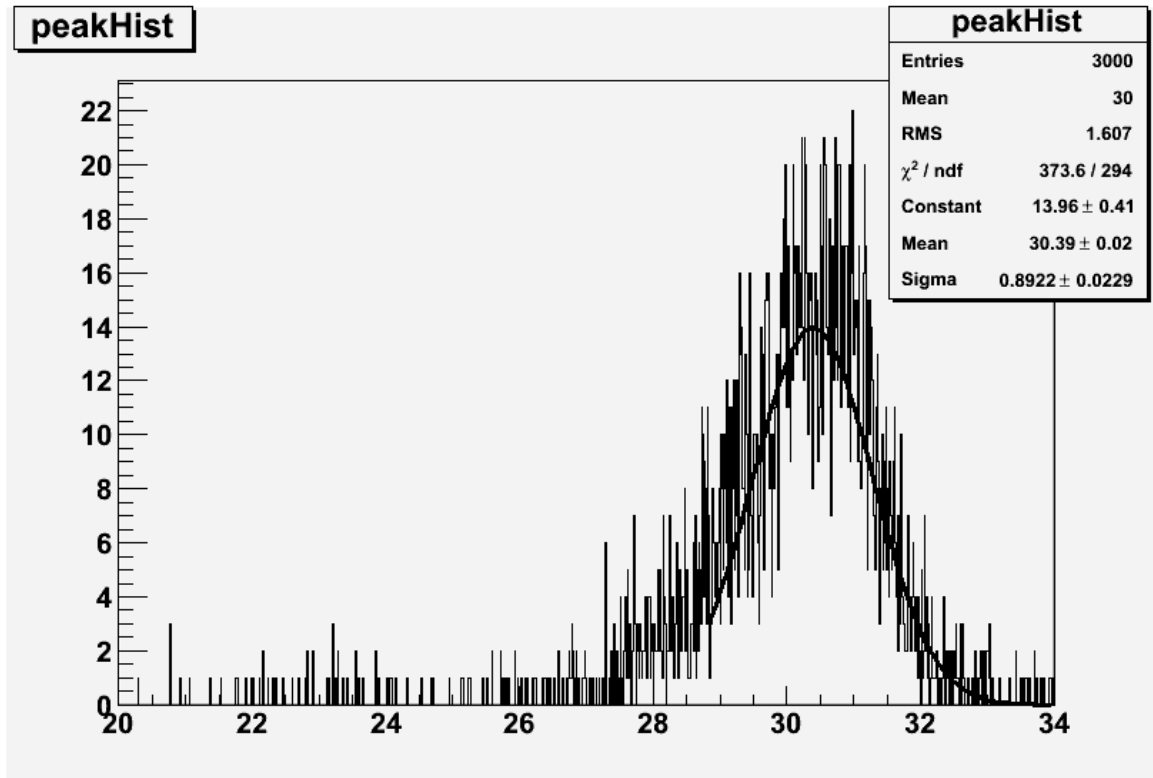
Peak Fit and Rise Time Fit



- Fit a gaus around the first peak of the pusle shape.
- Fit a 1st order polynomial to the rising edge.

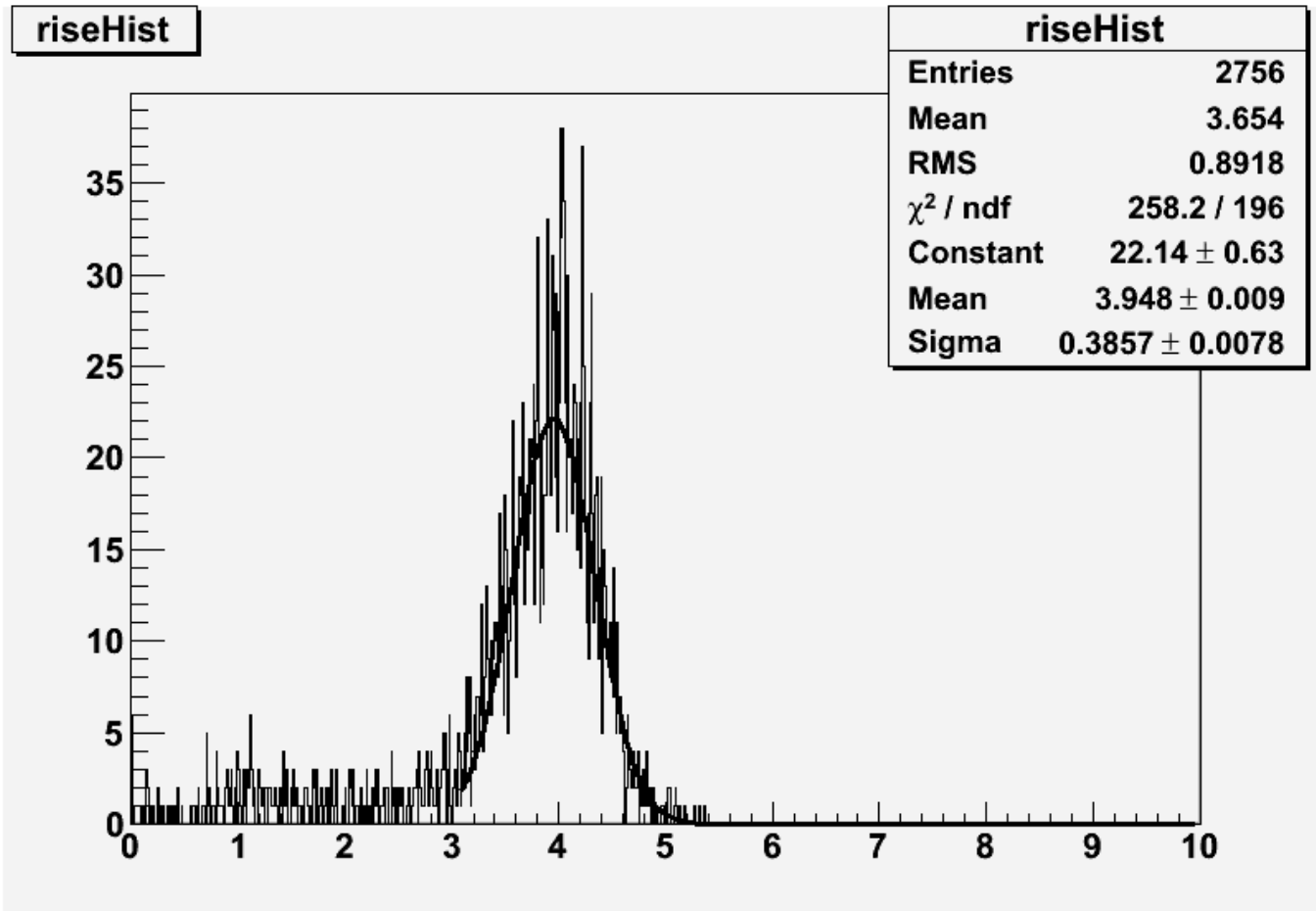


Peak Timing Jitter



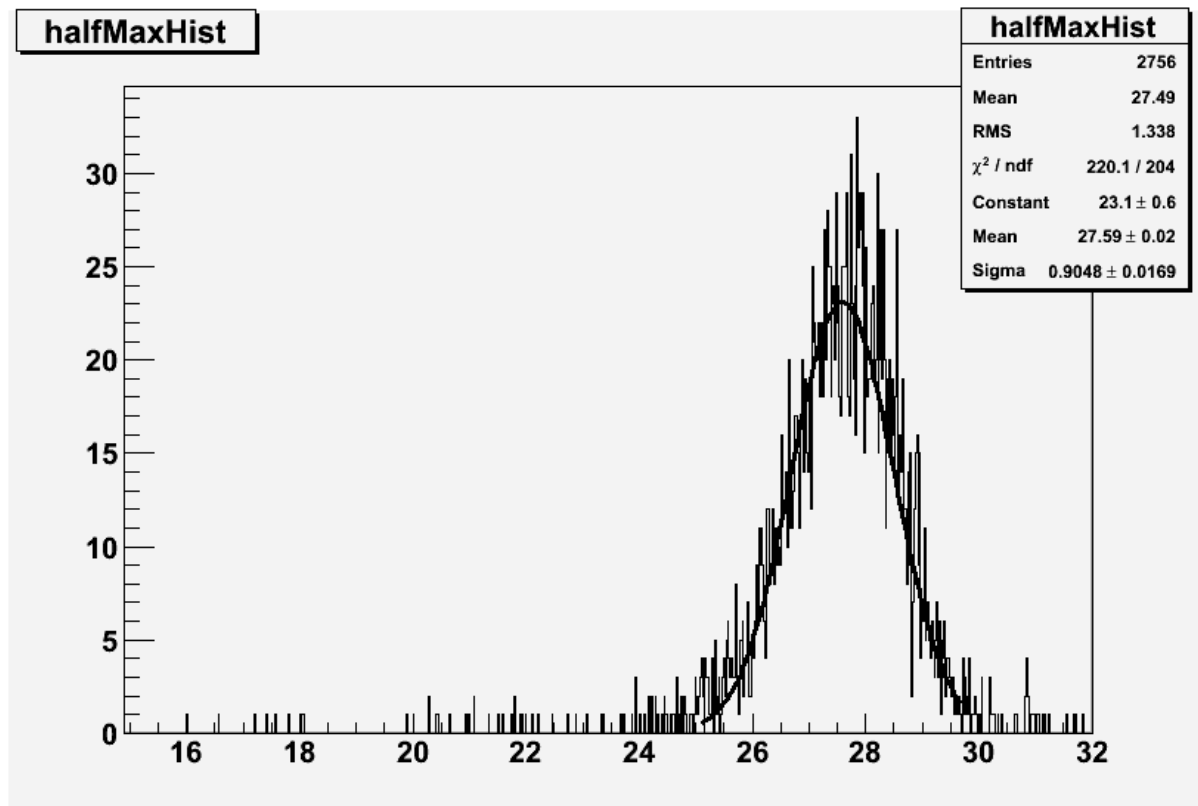


Rise Time Fit



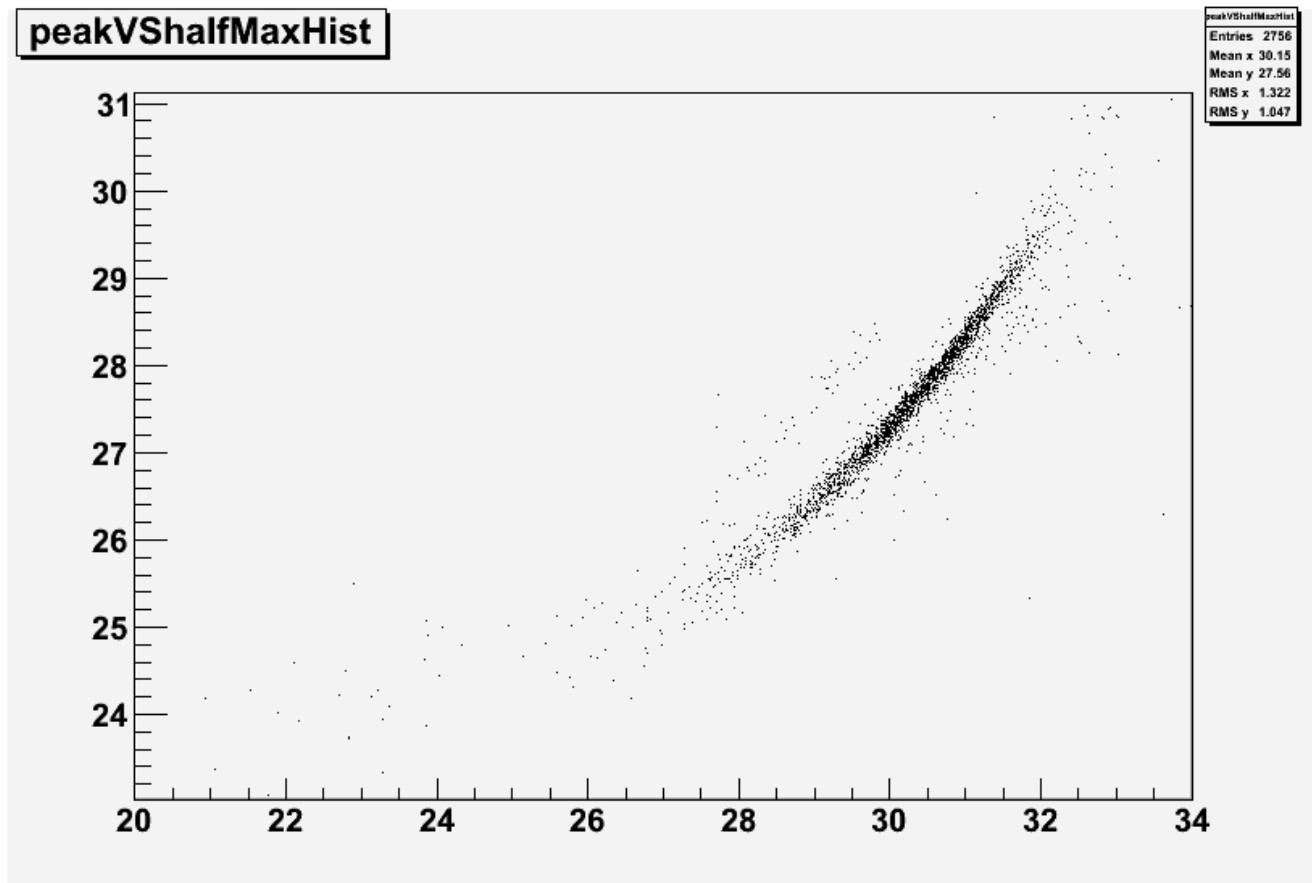


Half Max Time





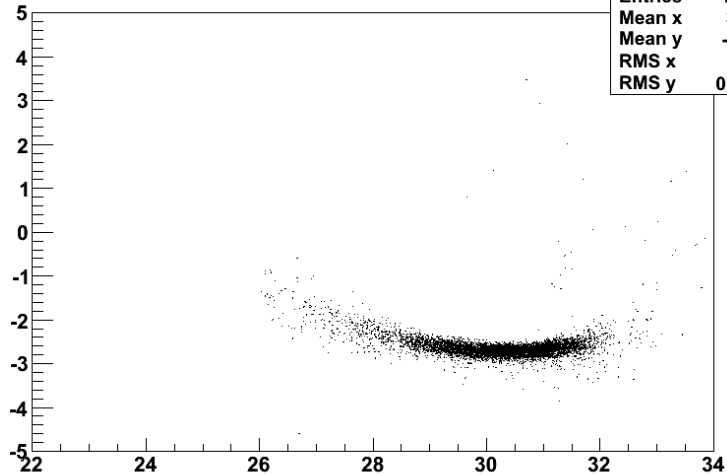
Peak vs Half Max Time





Correcting DeltaT

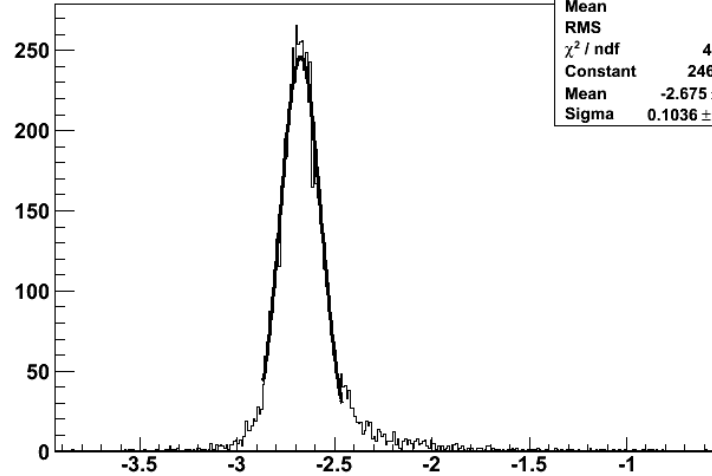
peakVSDeltahalfMaxHist



peakVSDeltahalfMaxHist

| | |
|---------|--------|
| Entries | 14314 |
| Mean x | 30.26 |
| Mean y | -2.631 |
| RMS x | 1.003 |
| RMS y | 0.2822 |

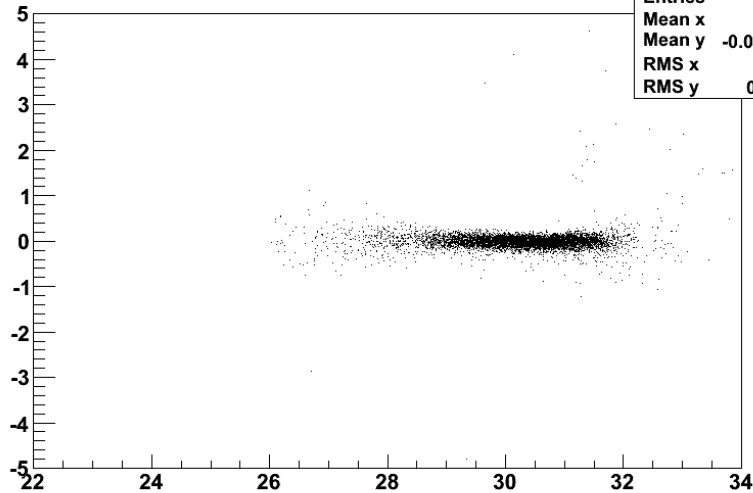
DeltahalfMaxHist



DeltahalfMaxHist

| | |
|-----------------------|-----------------|
| Entries | 7157 |
| Mean | -2.641 |
| RMS | 0.2 |
| χ^2 / ndf | 43.5 / 38 |
| Constant | 246.1 ± 4.2 |
| Mean | -2.675 ± 0.002 |
| Sigma | 0.1036 ± 0.0015 |

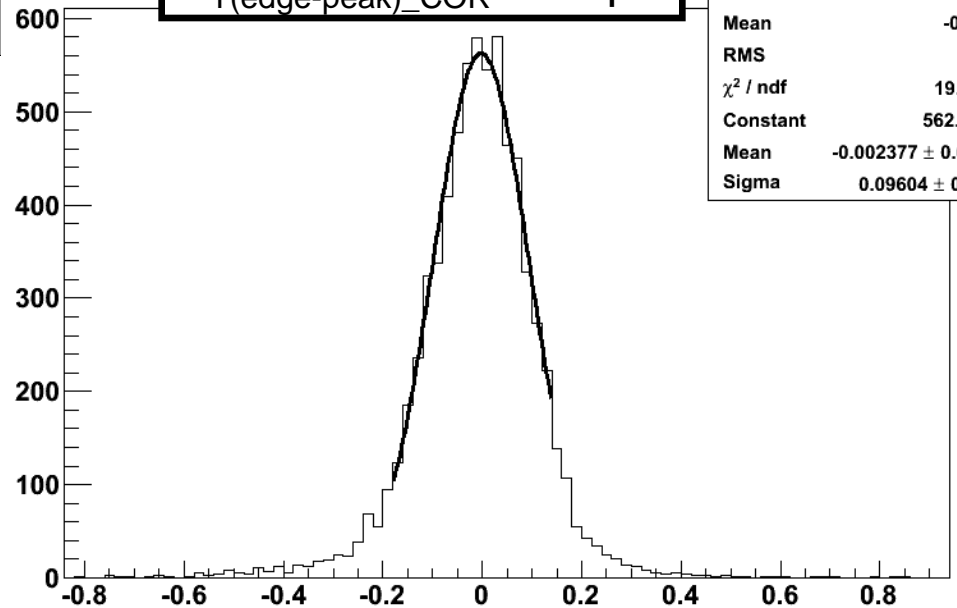
peakVSDeltahalfMaxCORHist



| | |
|---------|-----------|
| Entries | 7157 |
| Mean x | 30.26 |
| Mean y | -0.004851 |
| RMS x | 1.003 |
| RMS y | 0.2068 |

DeltahalfMaxCORHist

$\Delta_{T(\text{edge-peak})_COR} = 96 \text{ ps}$



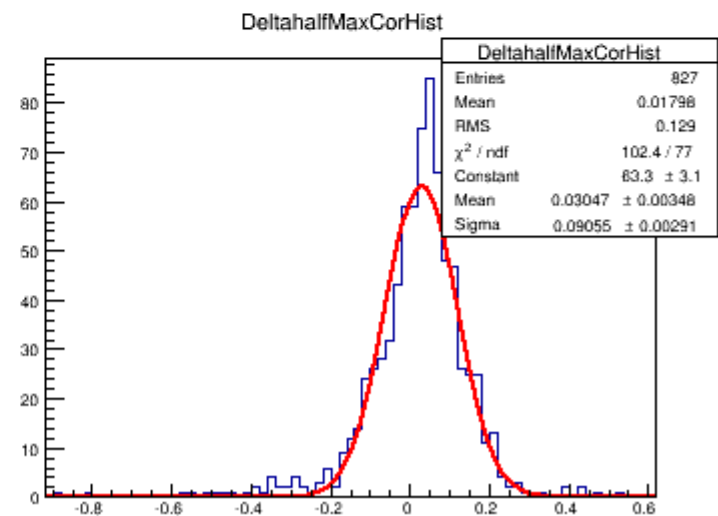
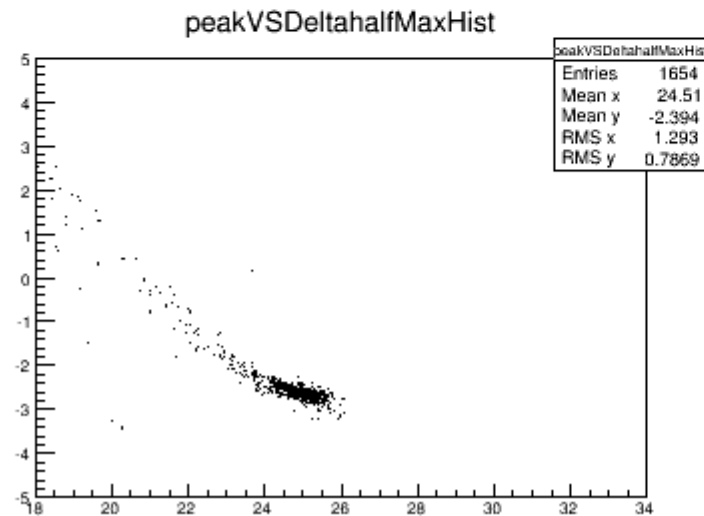
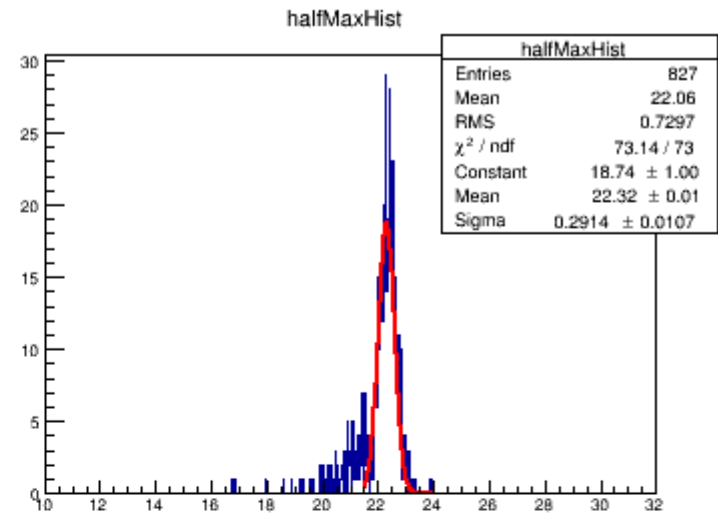
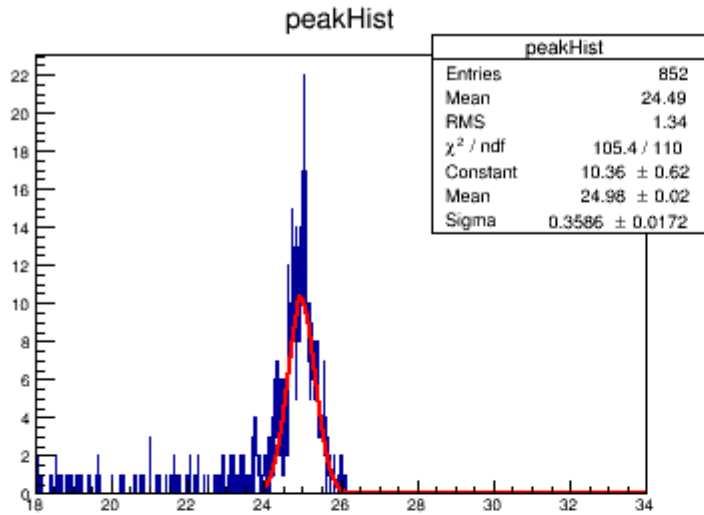
DeltahalfMaxCORHist

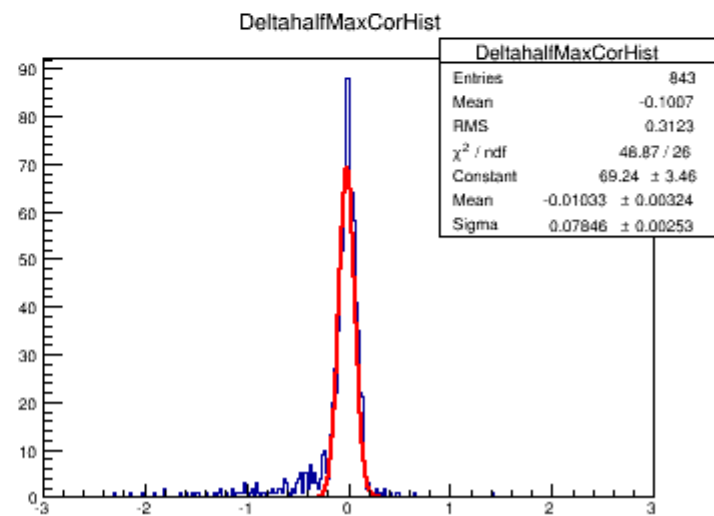
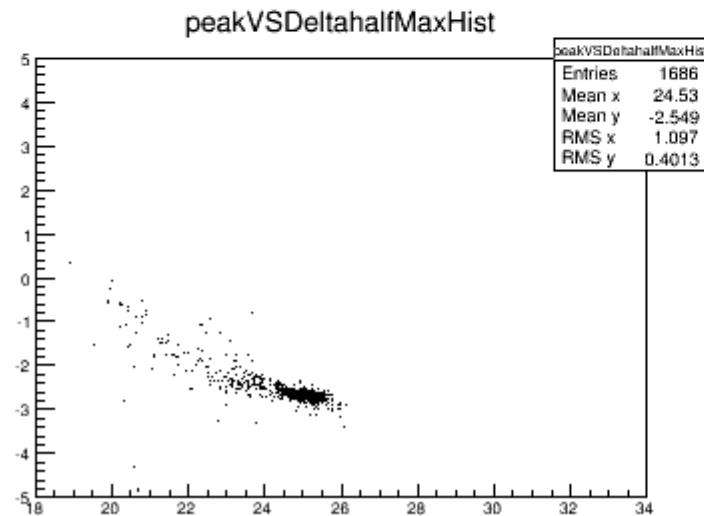
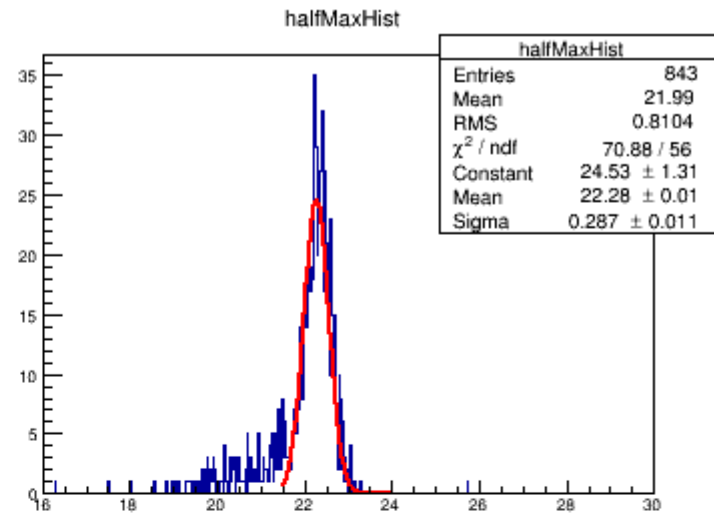
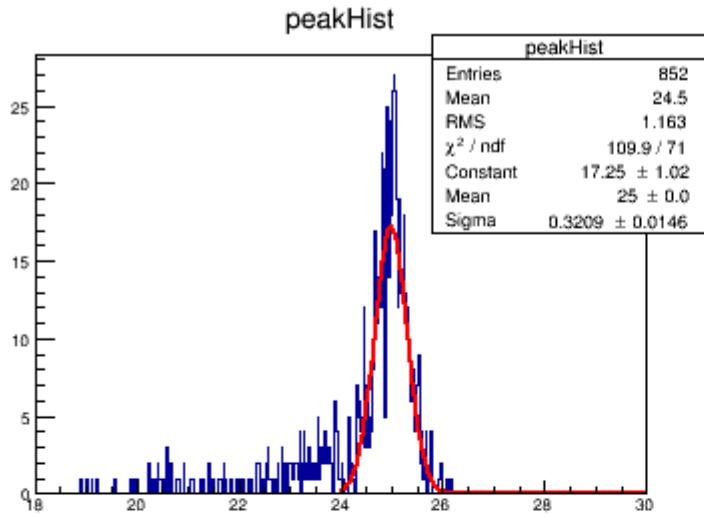
| | |
|-----------------------|----------------------|
| Entries | 7157 |
| Mean | -0.01074 |
| RMS | 0.1253 |
| χ^2 / ndf | 19.57 / 13 |
| Constant | 562.5 ± 9.7 |
| Mean | -0.002377 ± 0.001612 |
| Sigma | 0.09604 ± 0.00180 |

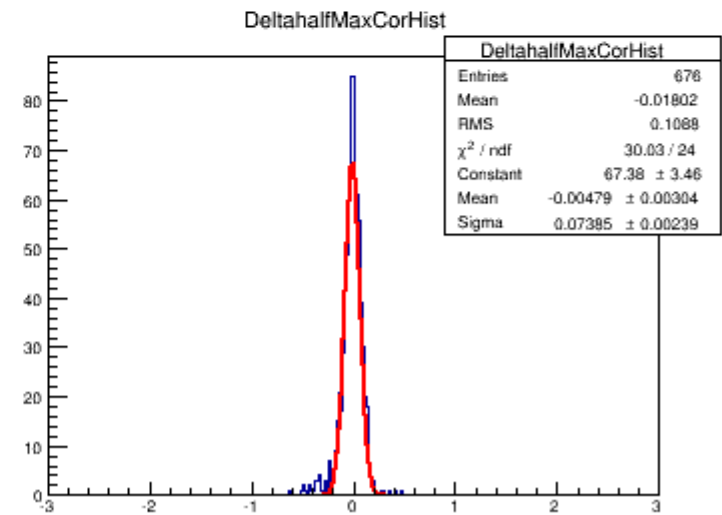
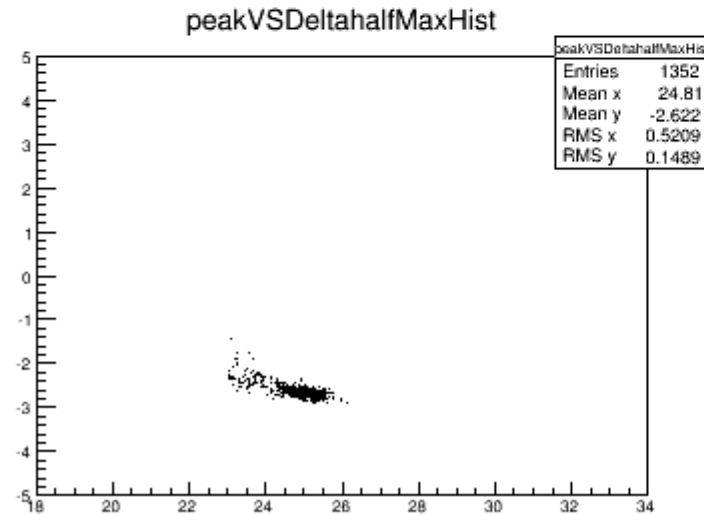
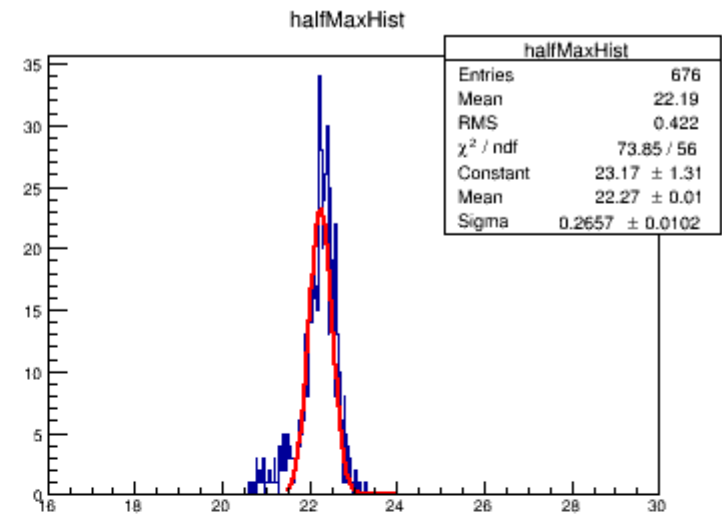
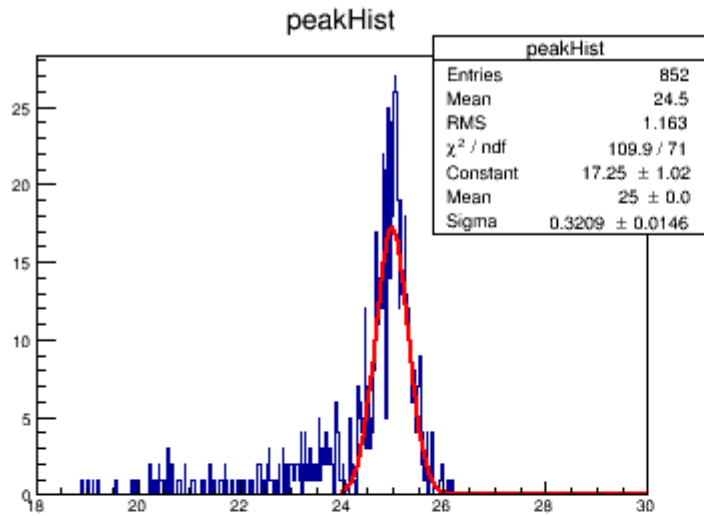


Chapter Two

Second data taking with a single side readout 1.7 cm LYSO crystal.

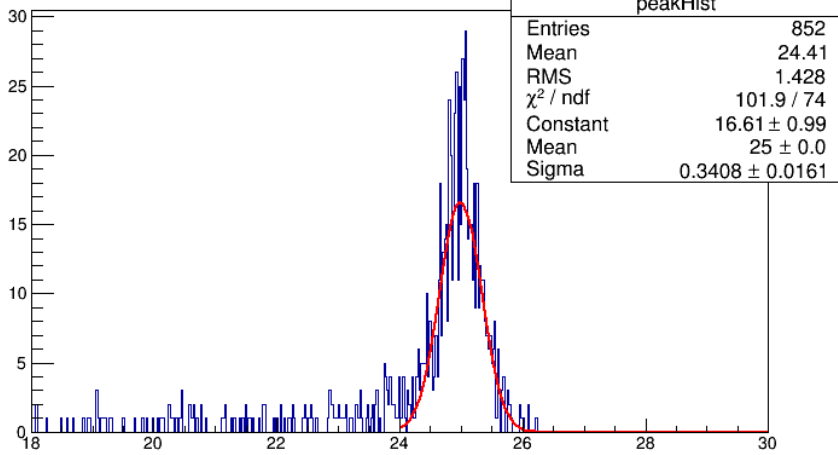




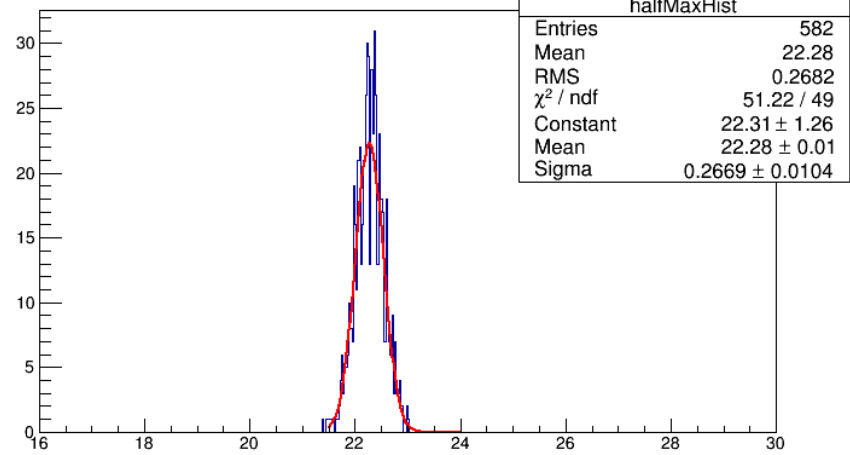




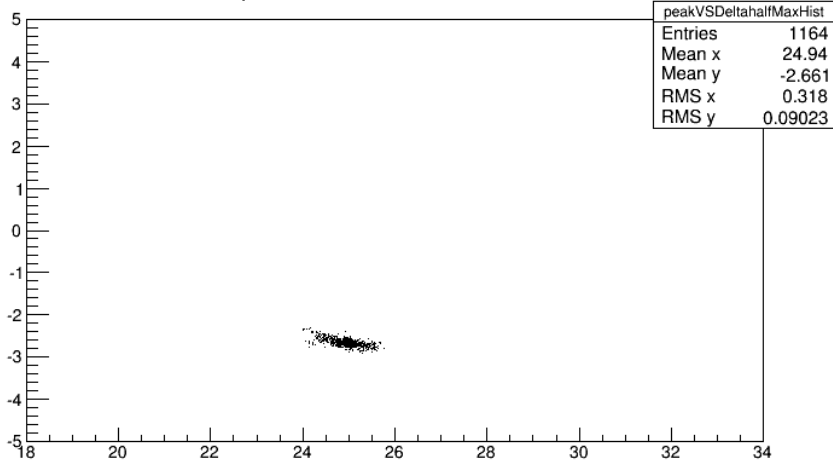
peakHist



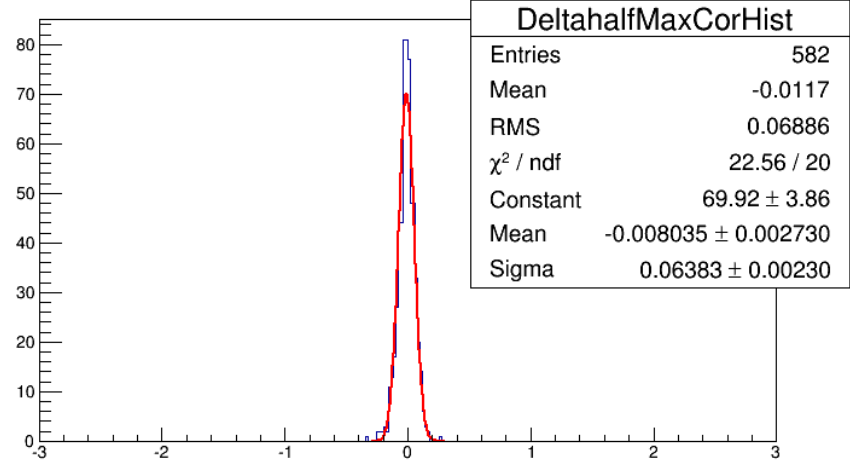
halfMaxHist



peakVSDeltahalfMaxHist



DeltahalfMaxCorHist

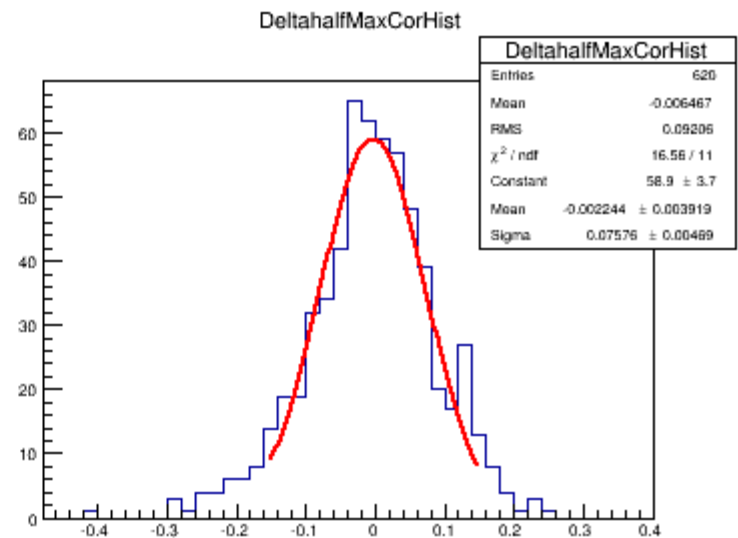
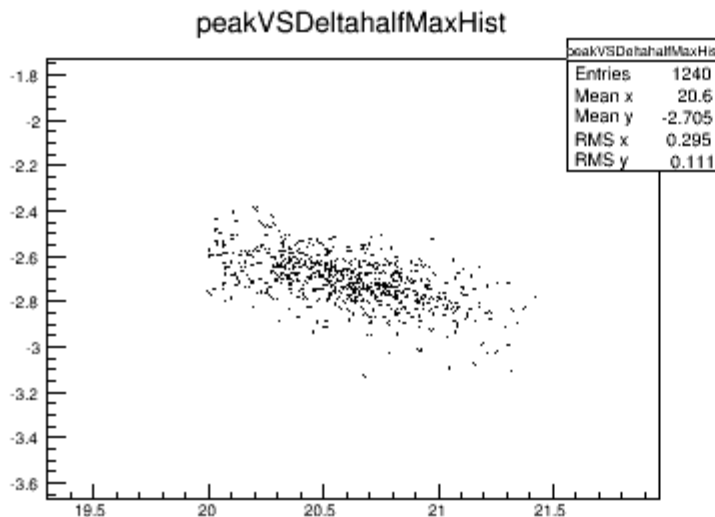
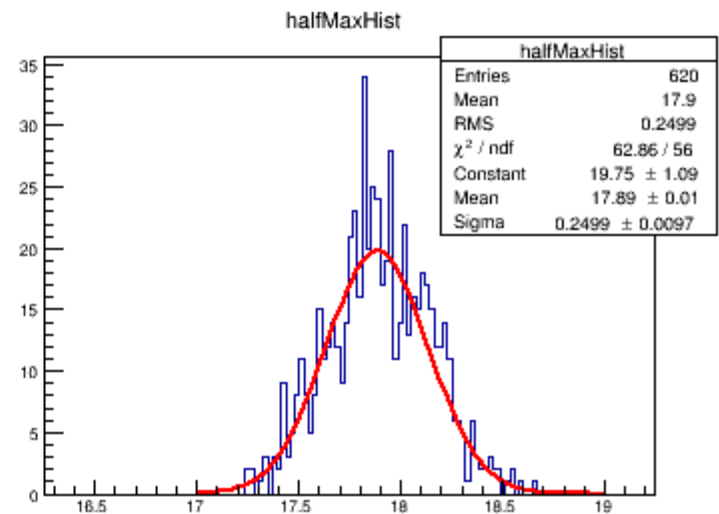
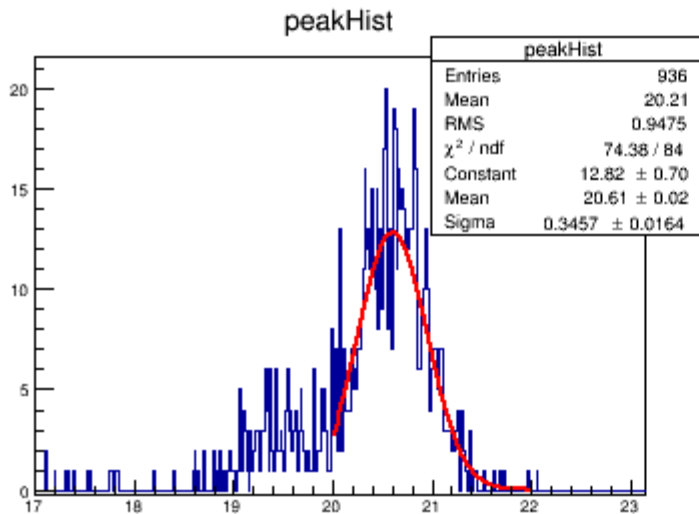


Peak fit : -1.0 to 1.5
Slope fit : -2.0 to -1.5



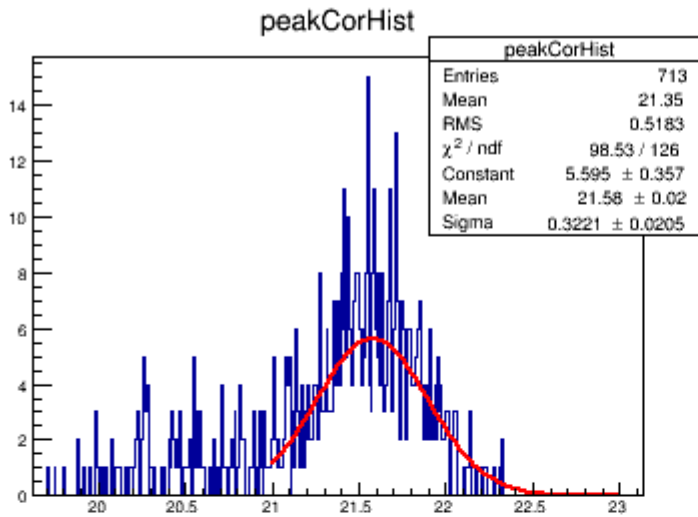
Chapter Three

**Third data taking with a single side readout 1.7 cm LYSO crystal
with a new faster scope.**

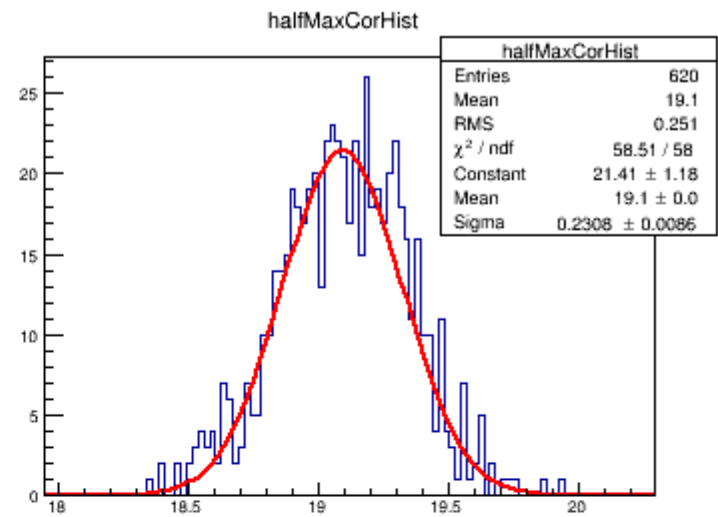


$$\text{DeltaTCor} = \text{DeltaT} - 1.784 + 0.2176 * \text{peak};$$

Caltech Test Stand



$$\text{peakCor} = \text{peak} + 1.097 * \text{amp};$$



$$\text{halfMaxCor} = \text{halfMax} + 3.95 * \text{slopeFit};$$