

Status of TWR Calibration and Reconstruction

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TWR Workshop / AMANDA meeting @ Madison

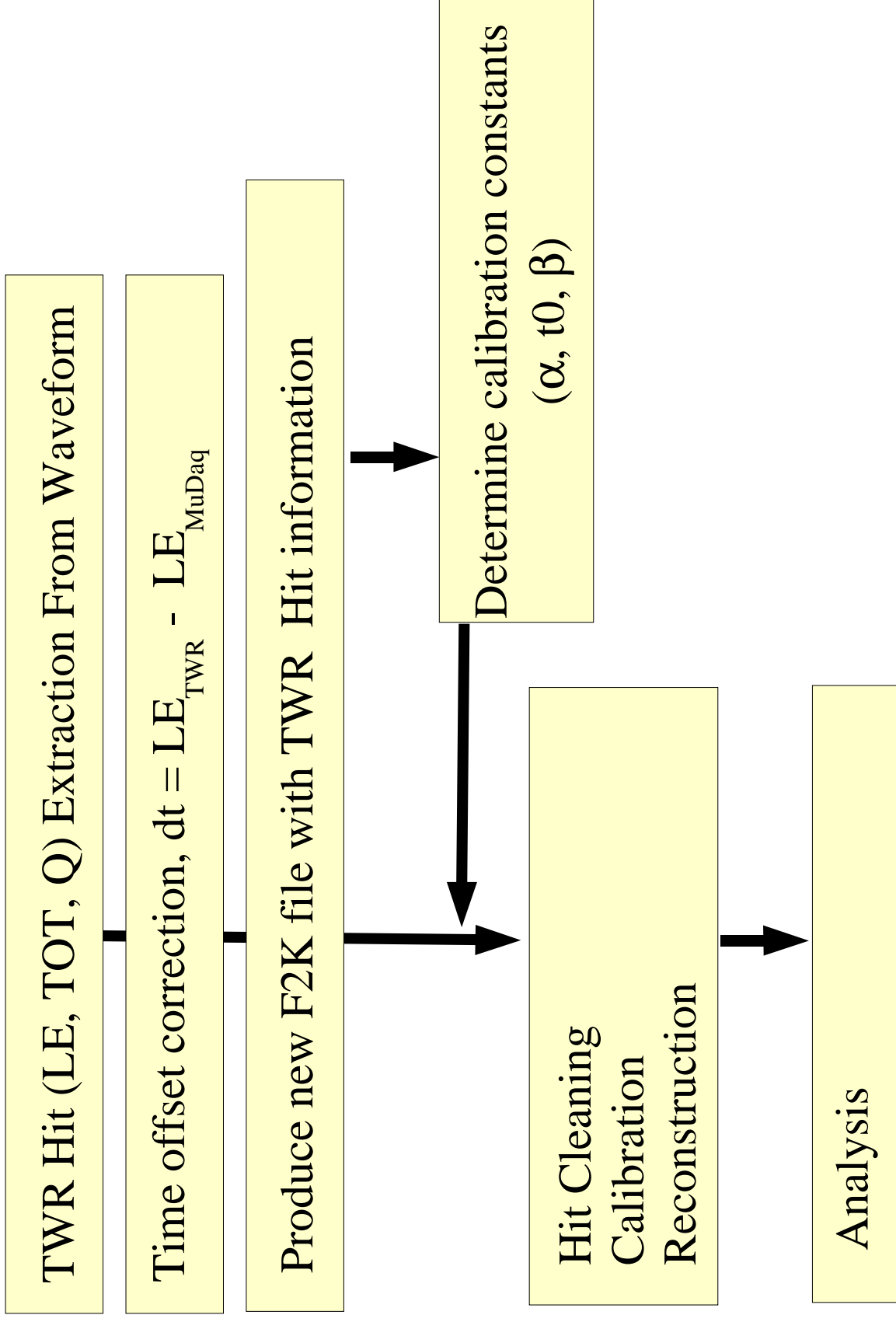
June 24-30, 2003

1. TWR hit production
2. Calibration
3. Reconstruction
4. Comparison TWR-MuDaq

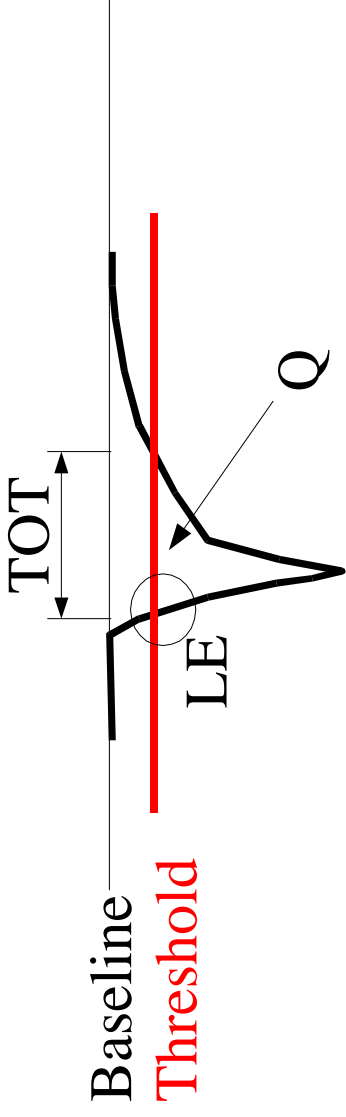
Work Overview

Sample :

- High Multiplicity Data with Scaled M24
- R7052-7133
- (Just After Fixing bug in Merger)

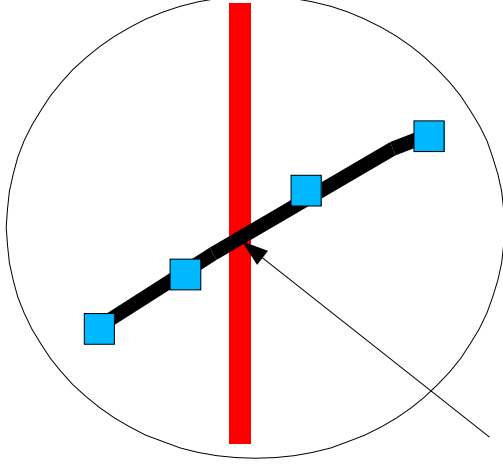


TWR Hit (LE, TOT, Q) Extraction From Waveform



Baseline : Use measured value for each OM

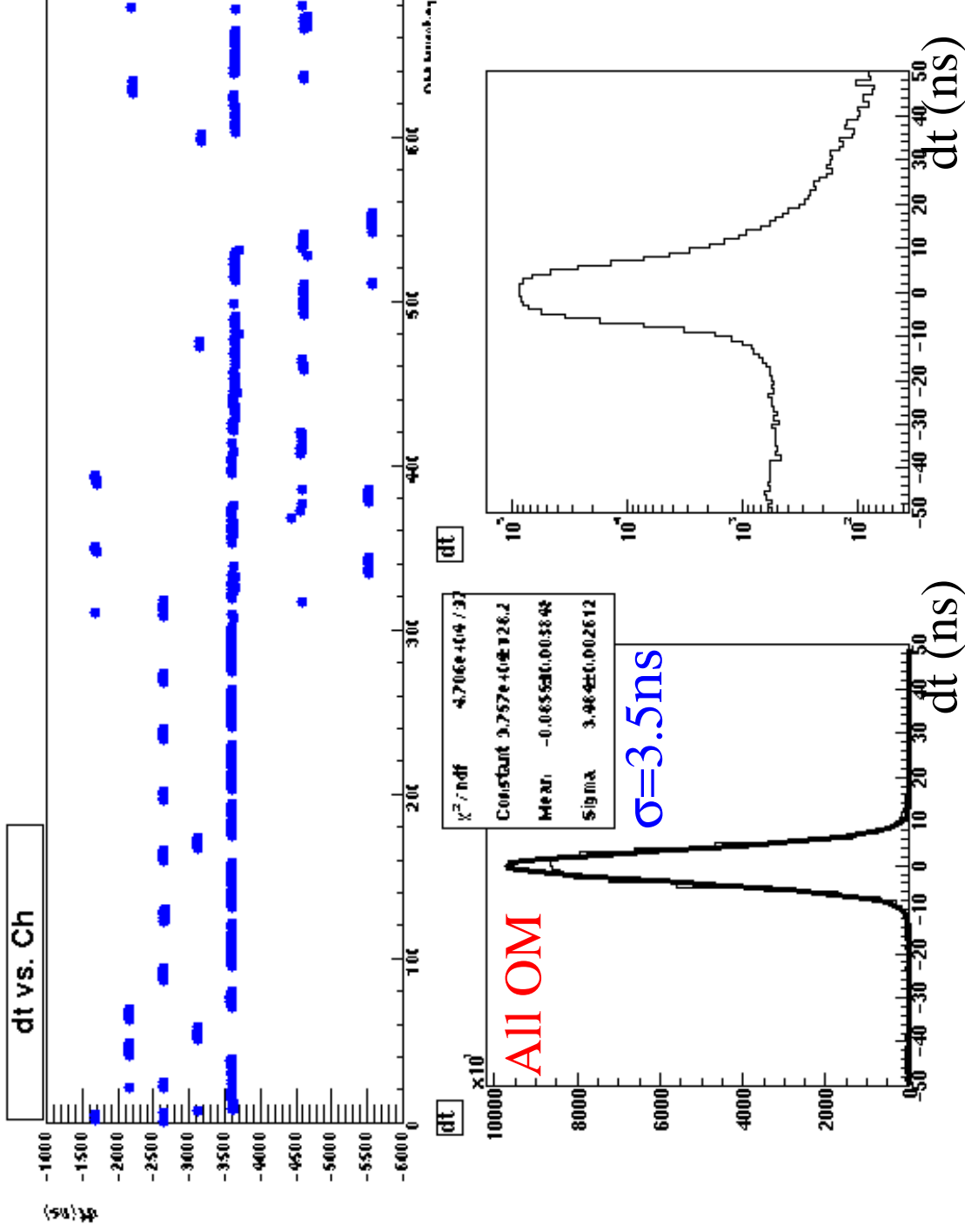
Threshold : Same as MuDaq



Fine LE is determined by interpolating between two digits near threshold

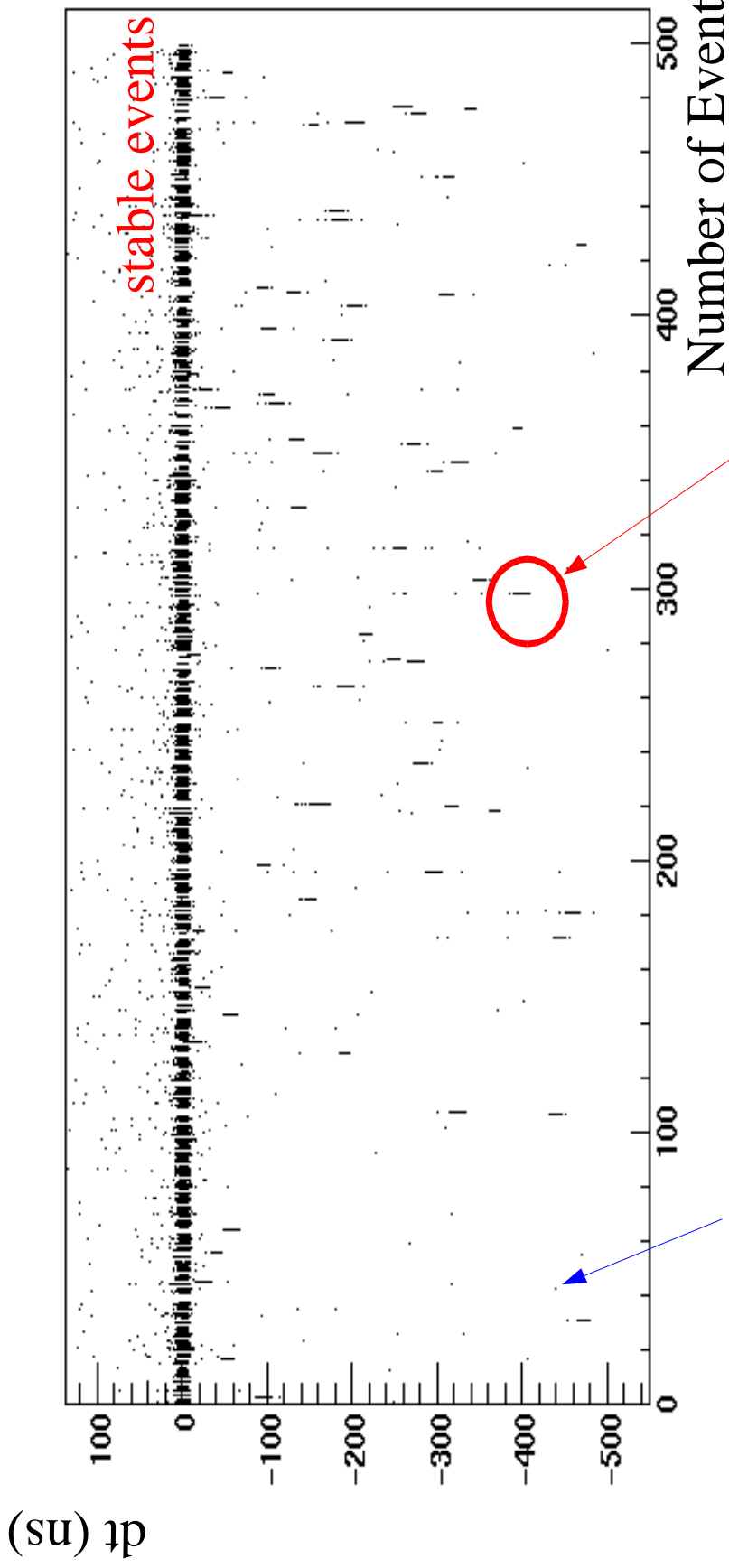
Time Offset Correction

Time Offsets between TWR and MuDaq for each OM are measured by fitting the $dt = LE_{\text{TWR}} - LE_{\text{MuDaq}}$ distributions.



Time Offset Stability-1

- Unstable Offset ($dt = LE_{\text{TWR}} - LE_{\text{MuDaq}}$) is observed.
- About 10% of Event offset is fluctuated by a few hundred ns.
- It may not affect to reconstruction itself.

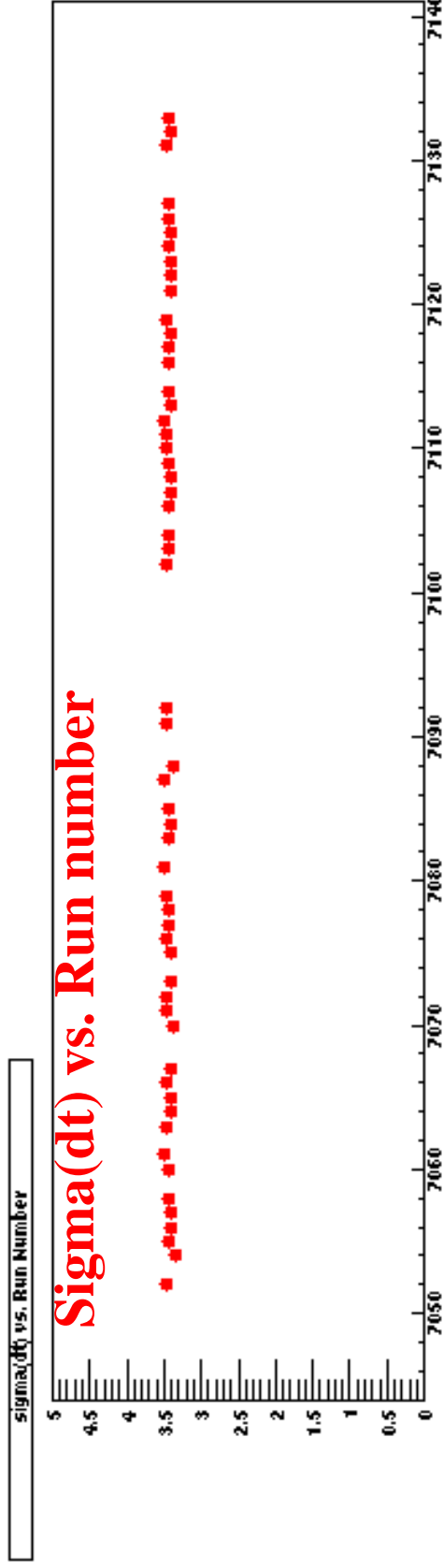
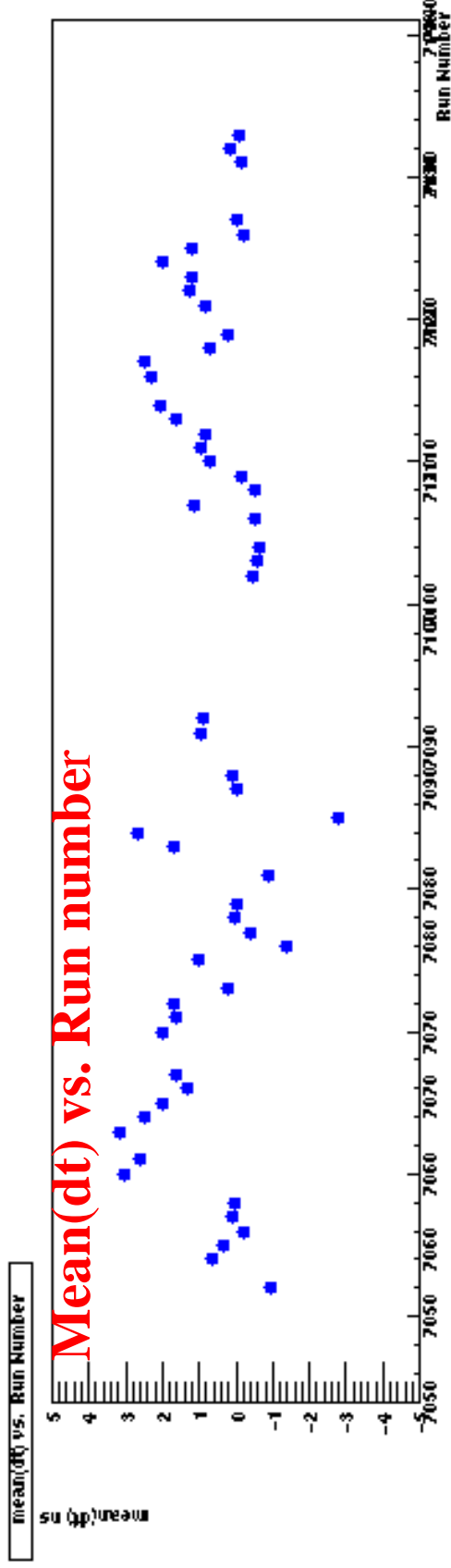


A dot represents dt of an OM

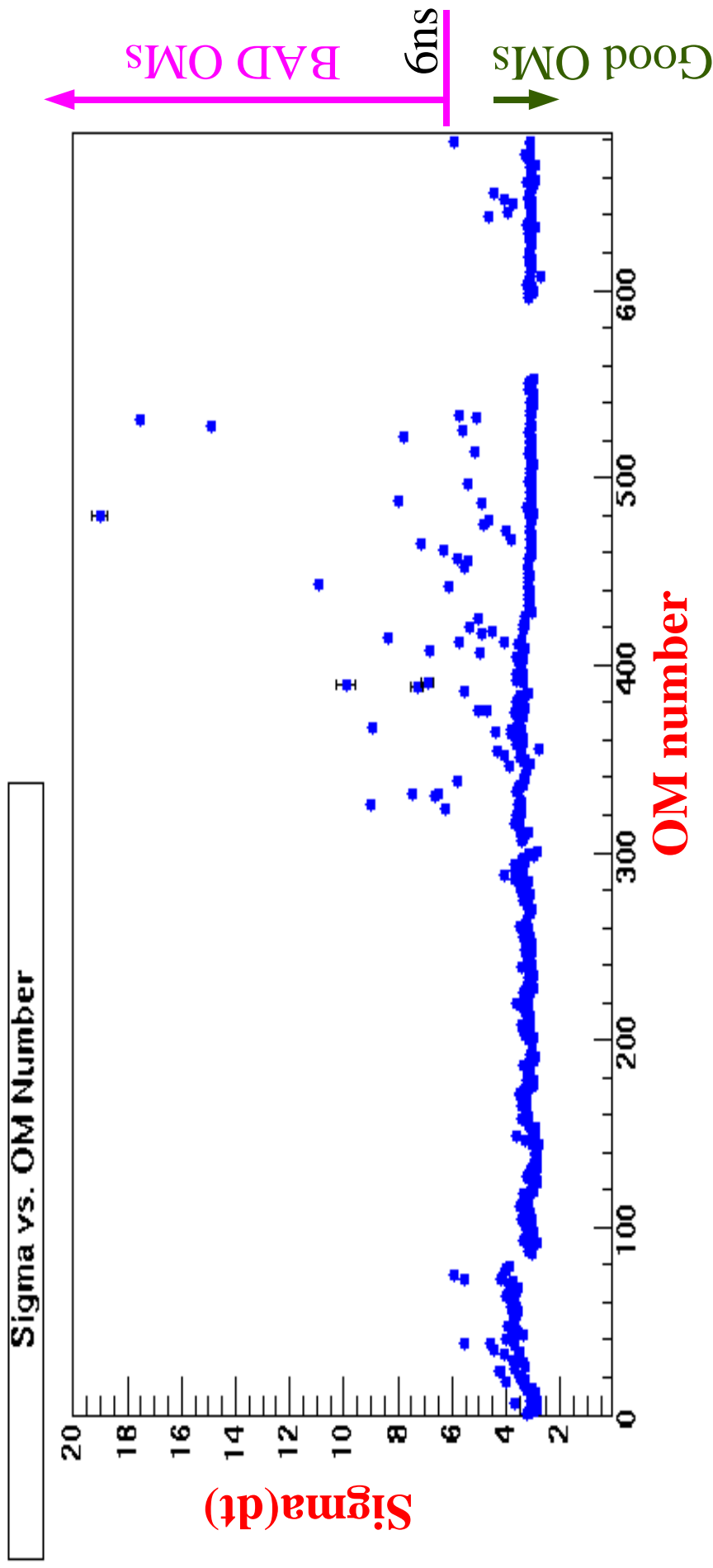
All OMs in the event is shifted

Time Offset Stability-2

- Run Dependence of dt.
- mean dt drifts about within ± 3 ns
- sigma is very stable



Good OMs / Bad OMs



BAD OMs:

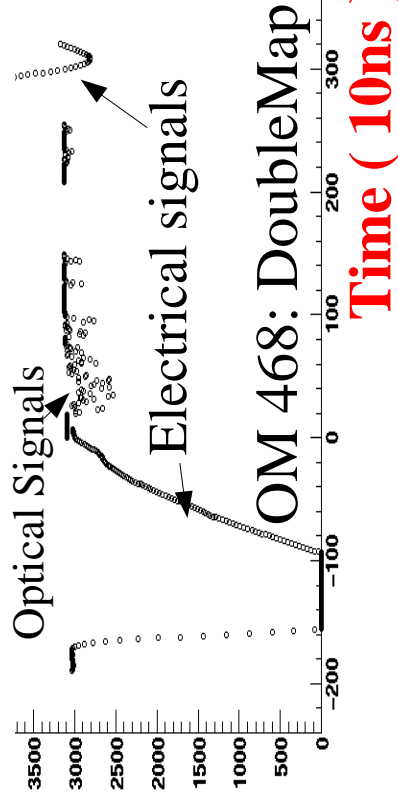
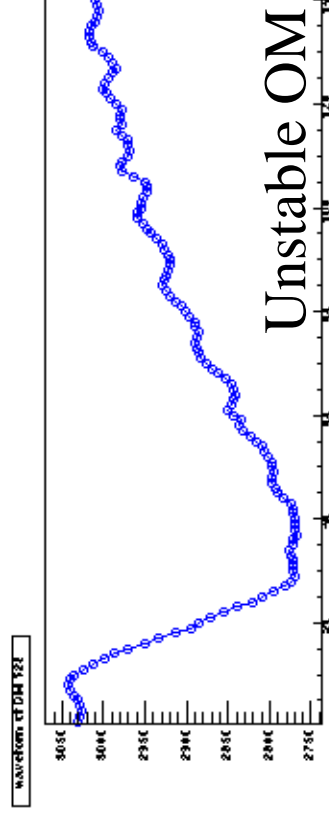
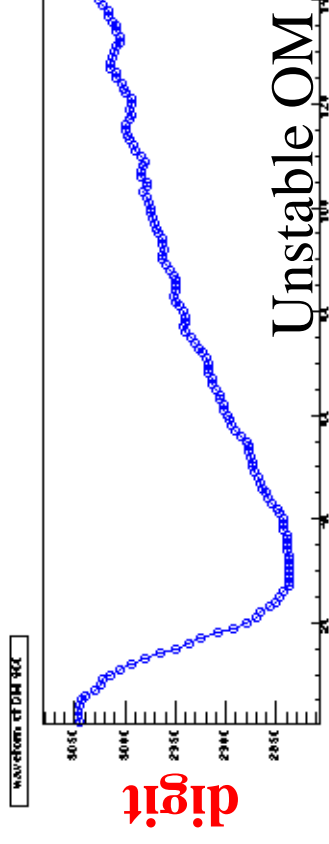
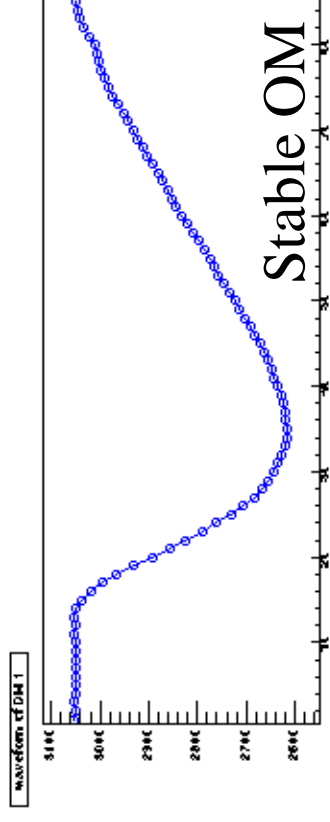
324 326 330 331 332 368 389 390 391

409 415 442 444 463 465 480 489 522

528 531

What happen in BAD OMs?

OM	σ	reason
76	6.760	Unstable
324	6.450	A little Unstable
326	8.790	
330	6.730	
331	6.770	
332	7.450	
339	6.320	Unstable
368	8.150	Mis mapping
389	10.10	
390	16.540	-> Already Known in MuDaq
391	6.590	-> Already Known in MuDaq
409	6.710	-> Already Known in MuDaq
415	8.440	
442	6.530	Unstable
444	11.22	Unstable
463	6.440	Unstable
465	7.870	Unstable
468	4.170	Double mapping
480	20.92	Unstable
489	8.220	Unstable
522	8.090	Unstable
528	16.28	Unstable
531	16.98	Unstable
533	6.260	Unstable
680	6.340	Unstable



New F2K with TWR Hit Information

- Produce New F2K file with TWR hit information.
- Use same event time as MuDaq

Original F2K File

```
TBEGIN 2003 115 78608
EM 116 7052 2003 115 78609.938718000 0
HT 2 427 1 0 22190 531 2
HT 4 562 2 0 22390 608 2
HT 5 63 3 0 22729 435 2
HT 6 98 4 0 22813 473 2
.....
WF 2.00 148.0 88 20832 1 New Hit Info. From WaveForm
WF 4.00 108 0 .....
.....
```

Keep

Remove

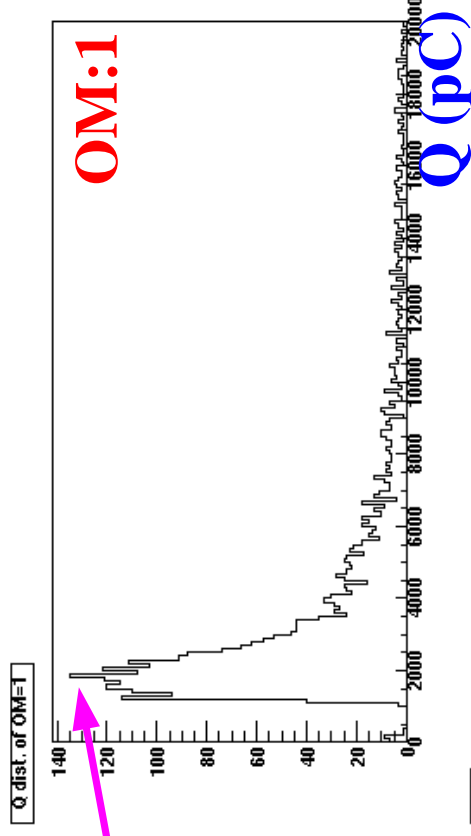
New F2K File

```
TBEGIN 2003 115 78608
EM 116 7052 2003 115 78609.938718000 0
HT 2 TWR.. HIT.. INFO
HT 4 TWR.. HIT.. INFO
HT 5 TWR.. HIT.. INFO
```

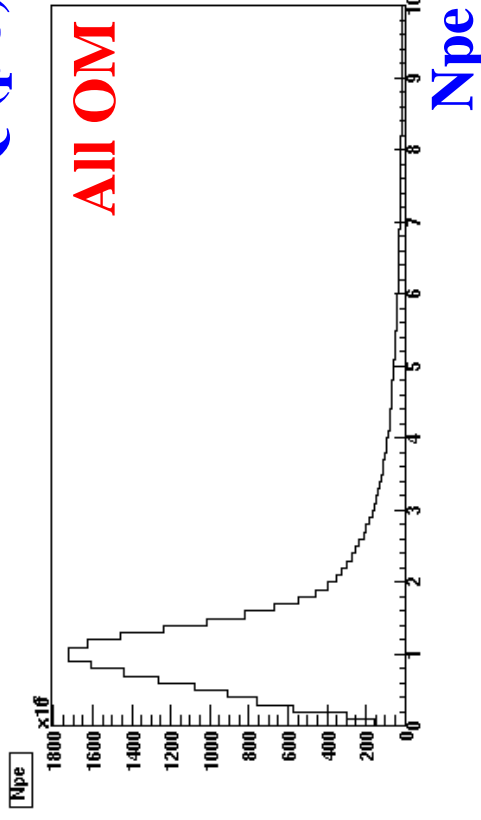
From WaveForm

Calibration 1 : Convertint Q to Npe

- $N_{pe} = \beta \times Q$
- $1/\beta$ is determined by the 1pe peak in the Q distribution.
- 1 pe peak is obtained by “Maximum bin” instead of fitting



$1/\beta = \text{Maximum bin}$



Calibration 2 : Time Walk (Slewing) Correction

- Accurate time can be obtained by correcting the time walk

$$T = LE_{TWR} - a / \sqrt{Q}$$

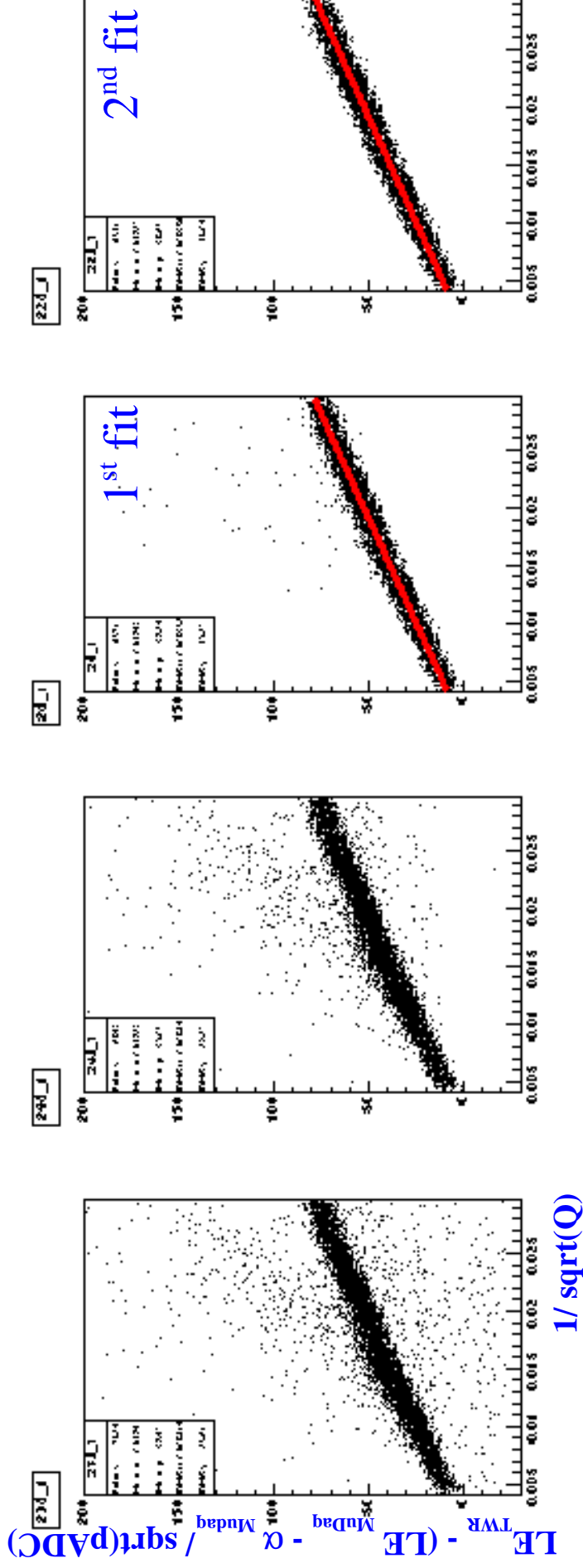
- Here, the α can be determined by fitting the distribution

$$LE_{TWR} - (LE_{MuDaq} - a_{MuDaq} / \sqrt{(pADC)}) \text{ vs. } 1 / \sqrt{Q}$$

- **Reference Time.**
- **If YAG data exists, It's not necessary**
- **Currently alpha measurement is not 100% independent from MuDaq.**
- **Need YAG data**

Details : TWC fit

$$LE_{TWR} - (LE_{MuDaq} - a_{MuDaq} / \sqrt{pADC}) \text{ . vs. } 1/\sqrt{Q}$$

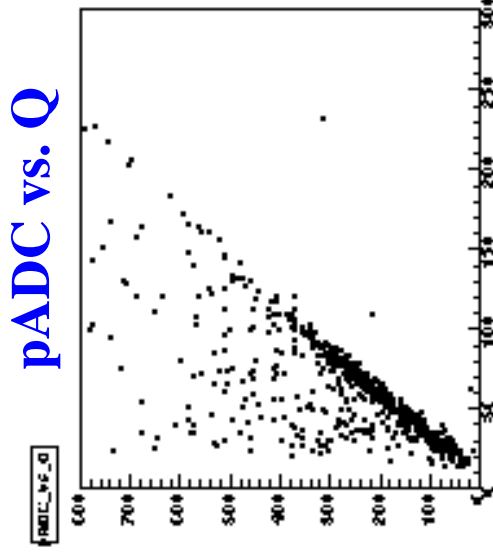


Event Offset Cut
 $|\langle dt \rangle| < 1.5 \text{ ns}$

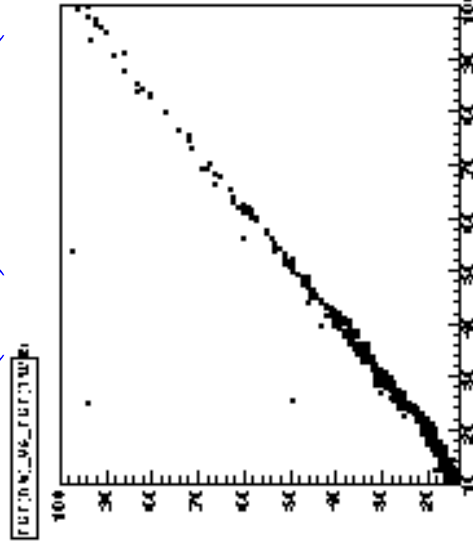
pADC/Q Cut

Remove
 Isolated Points

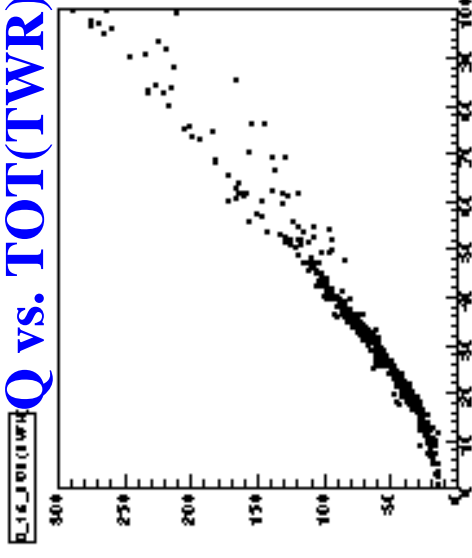
Removing Wrong pADC vias : pADC/Q cut



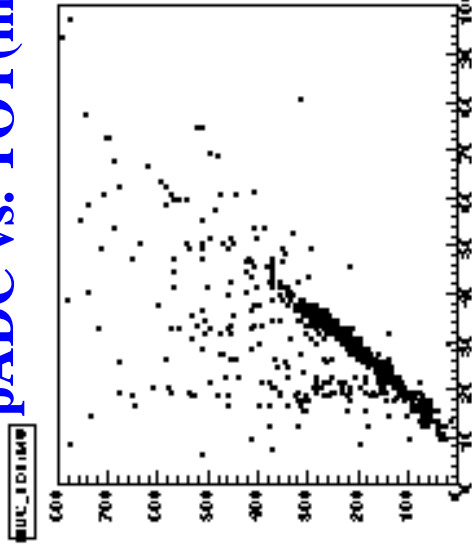
TOT(mu) vs. TOT(TWR)



Q vs. TOT(TWR)



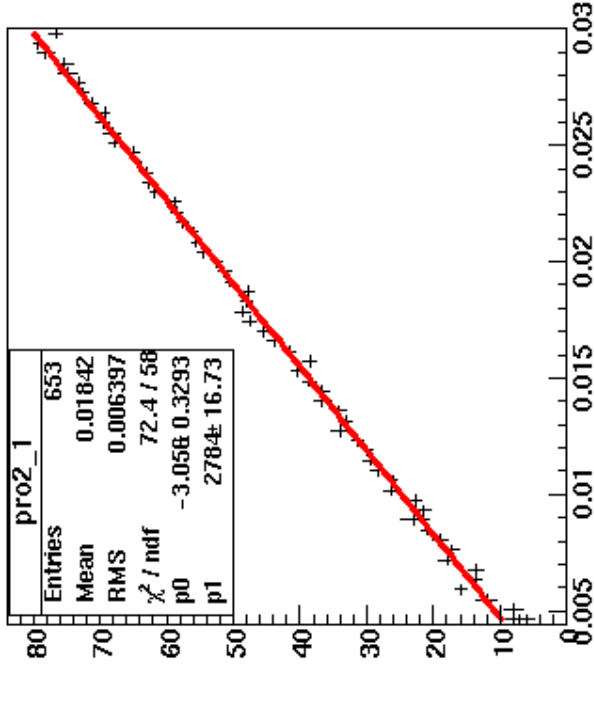
pADC vs. TOT(mu)



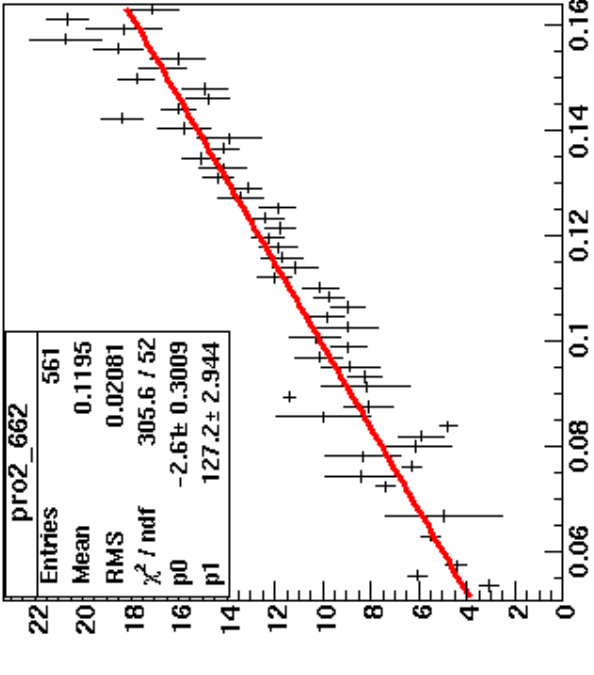
OMI 600 (Optical)

Detail : Fit Examples

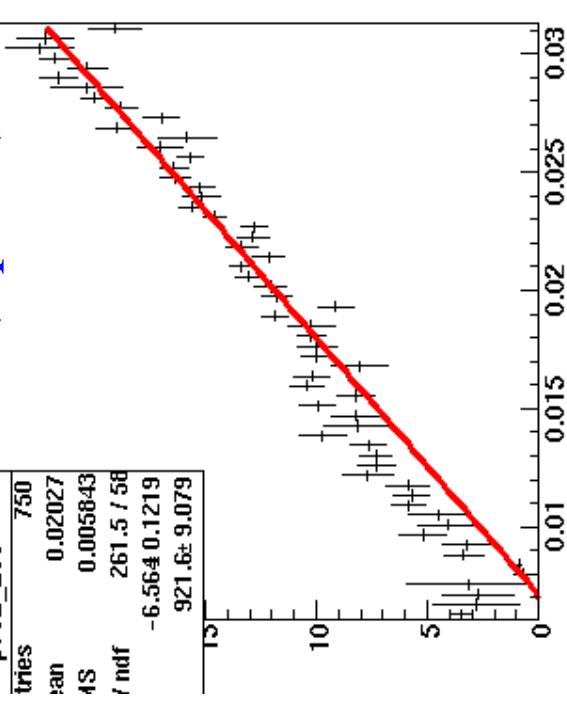
pro2_1 OM 1 (Electrical)



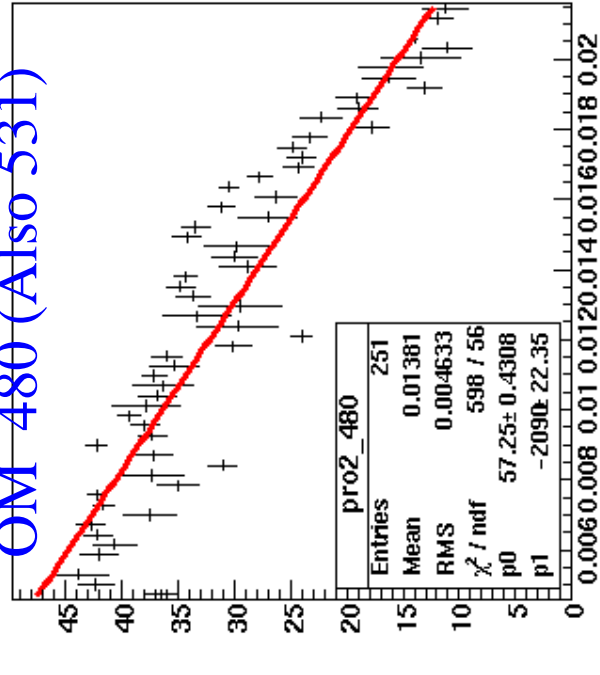
pro2_662 OM 662 (Optical)



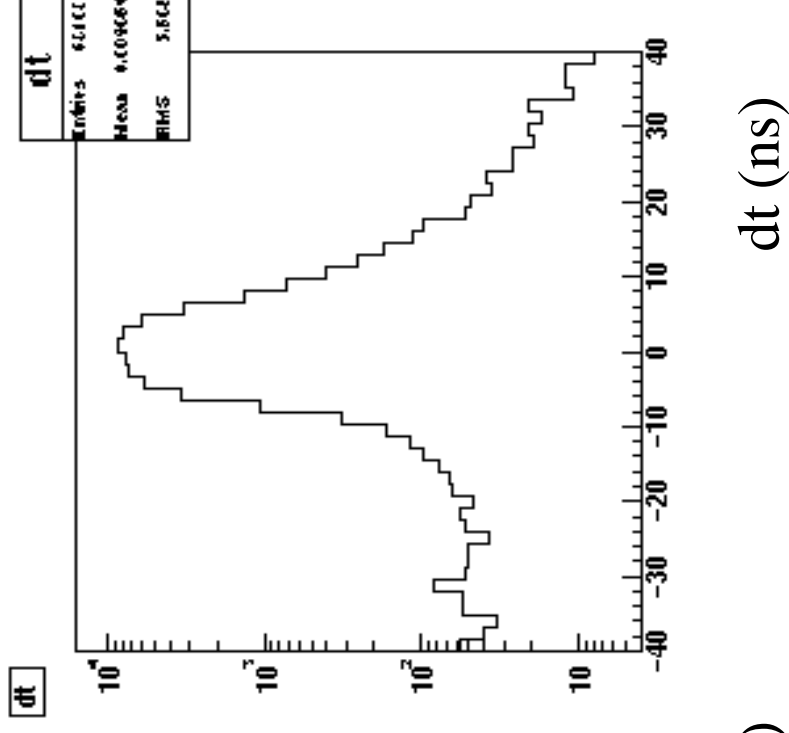
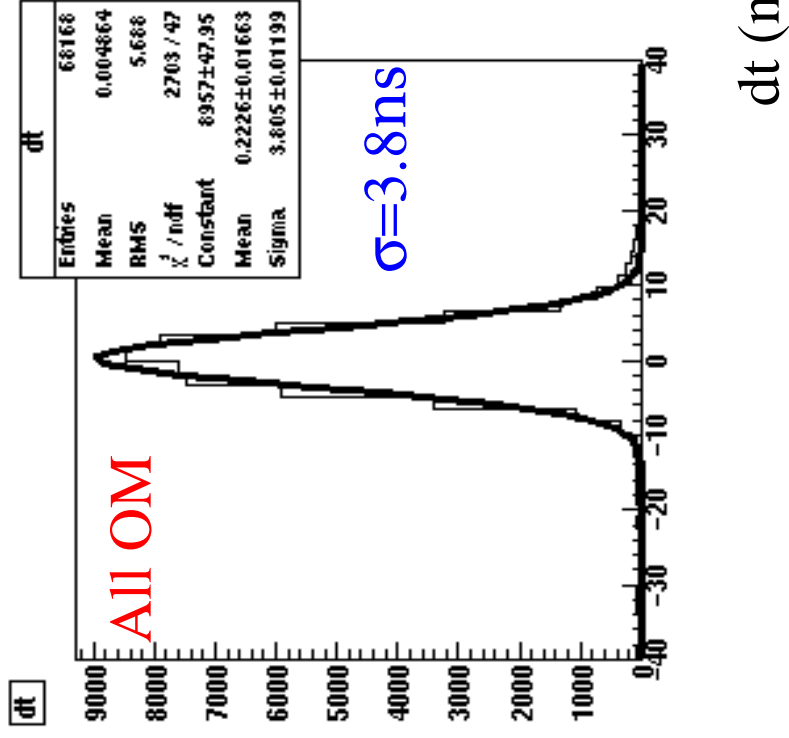
pro2_200 OM 200 (Optical)



pro2_480 OM 480 (Also 531)



dt distribution after Calibration



Hit Cleaning And Reconstruction

- ◆ Base on the standard L1 reconstruction script. (minbias reconstruction)

- BAD OM Cleaning :
 - Same as MuDaq (166) &
 - Not Connected Channels (5) : 27, 60,61,117,474
 - Mismaps(3) : 368, 396, 468
 - Negative α (3) : 164, 480, 531
- TOT Cleaning : Standard
- Multiplicity Cut : $M > 15$
- RshortAmp : Standard
 - $22875 - 2000 < \text{Trigger Time} < 22875 + 8000$
- Calibration (pC -> npe, LE -> $1/\sqrt{Q}$ correction)
- Time Window Cut : Standard (-2000 : 4500)
- Npe Cut : Standard $0.1 < N_{pe} < 1000$
- 1st Fit : Standard
- Isolate Cut : Standard Radius=100:Timewin=500:Num=1
- 2nd Fit : Standard

Comparison of Fit Result

- Present Analysis Scheme

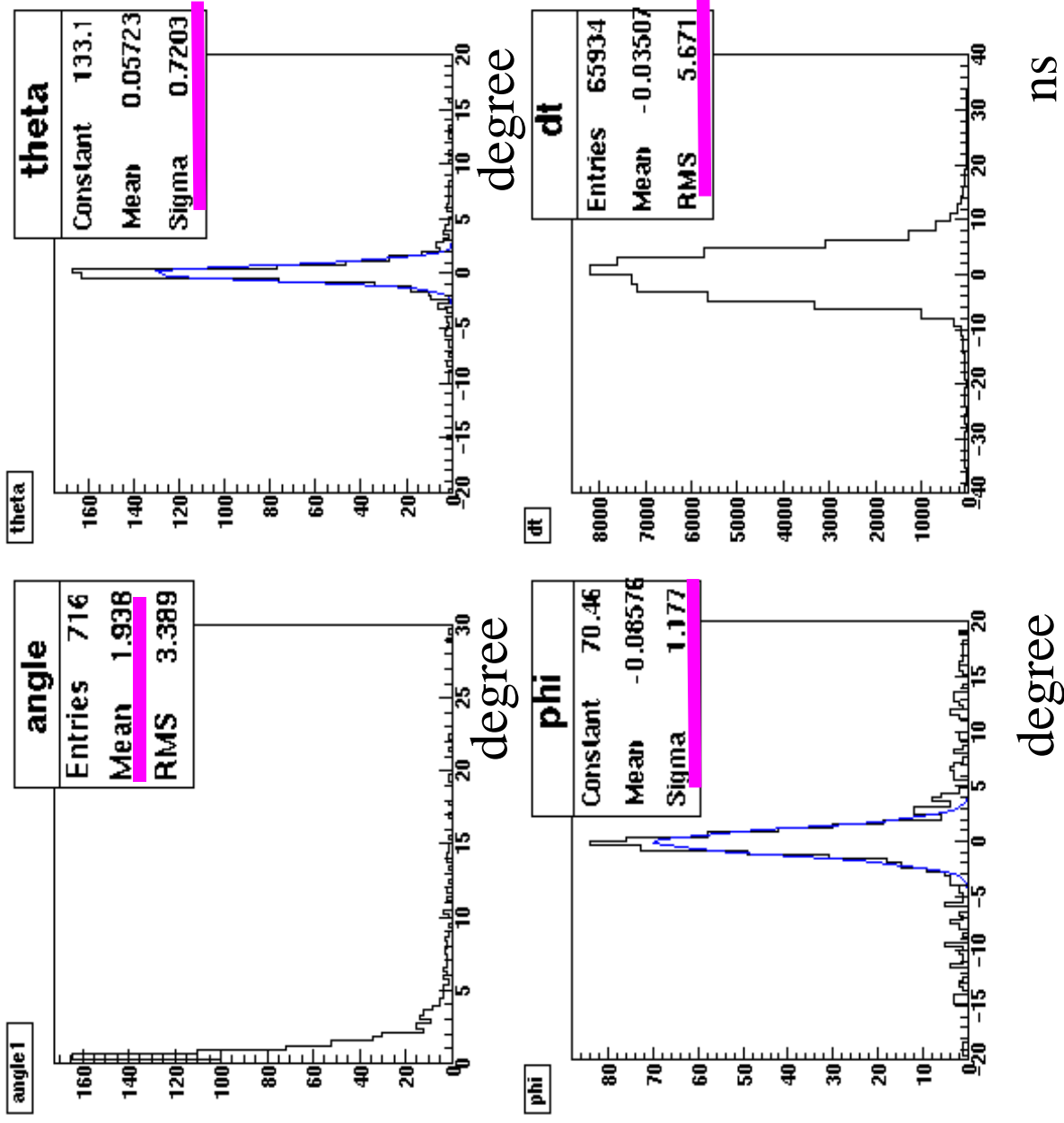
F2K (MuDaq) F2K (TWR)



Event Sync.

Comparison

- NewScheme in Sieglinde
???



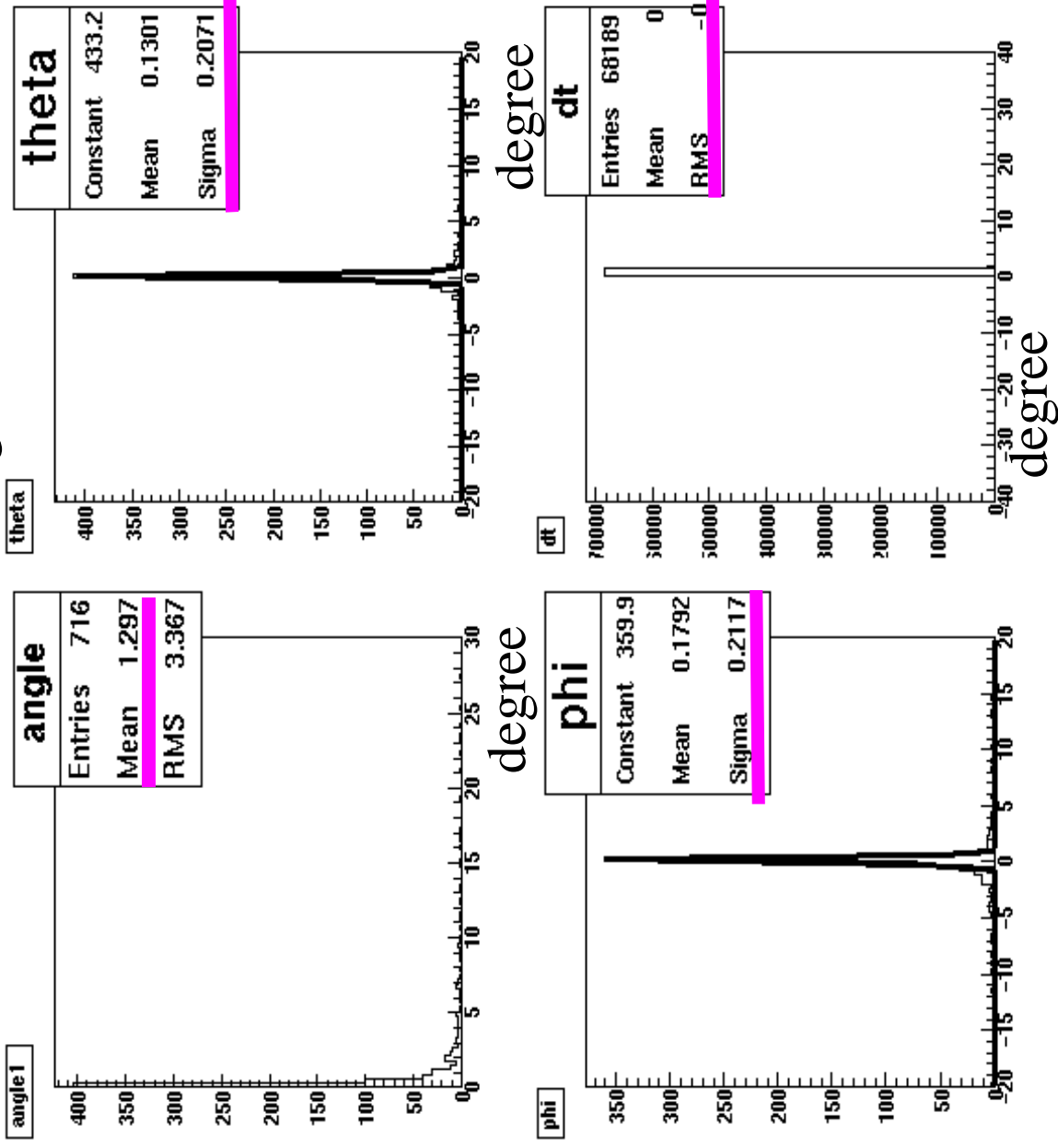
ns

degree

Interpretation of Fit Result

Error Source 1) : Fitting Error

➔ Evaluation : Performing the fit twice with same file

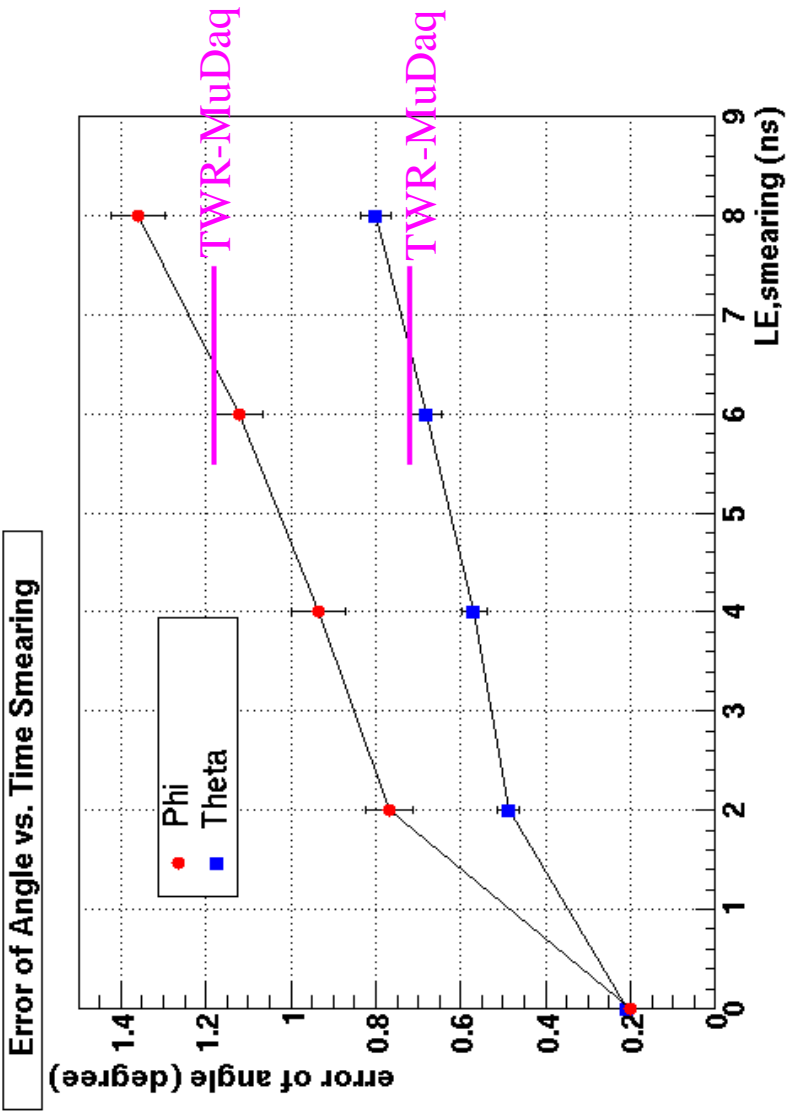
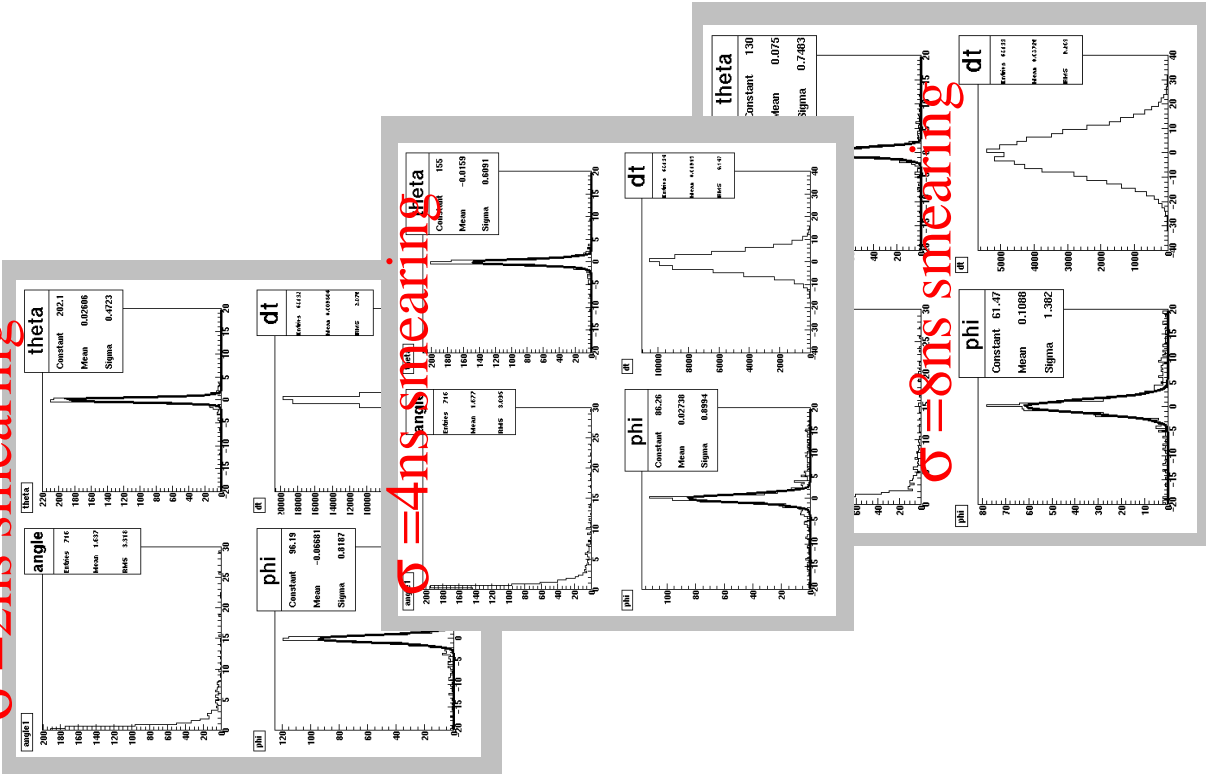


Interpretation of Fit Result

Error Source 2) : Error of dt

→ Evaluation : t smearing study

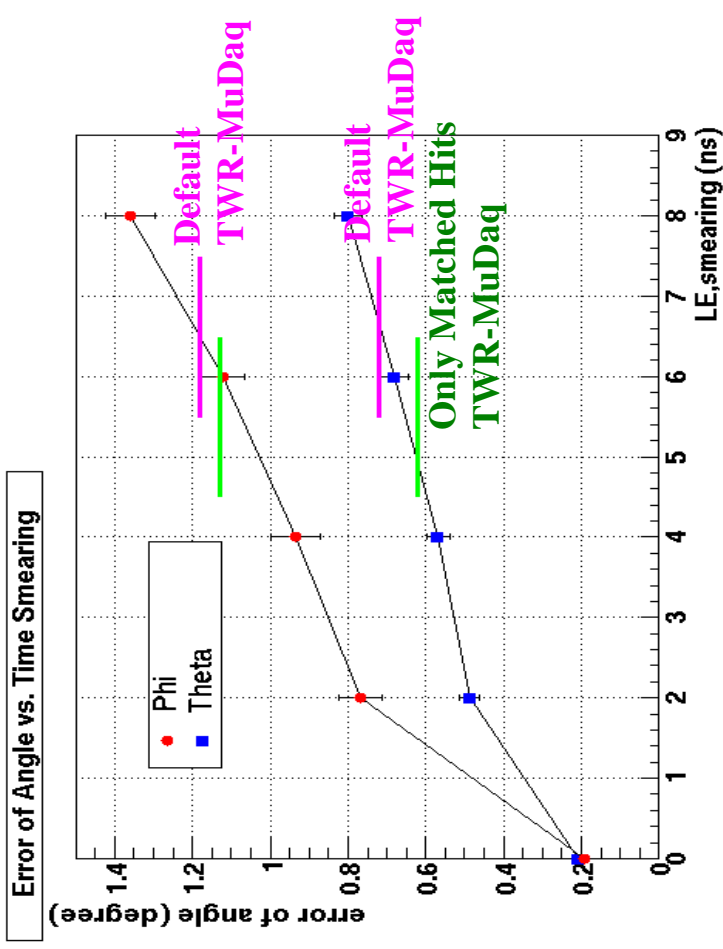
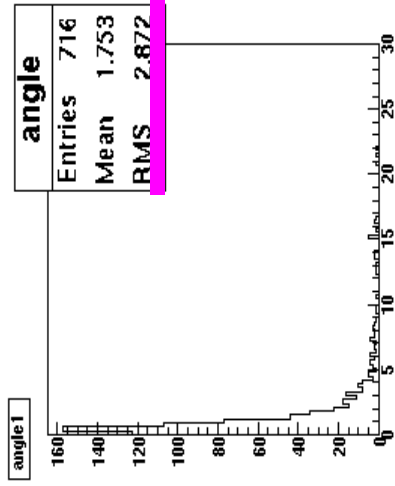
$\sigma = 2\text{ns}$ smearing



Interpretation of Fit Result

Error Source 3) : Different number of Hits in

➔ Evaluation : Use Hits if both of hits MuDaq/TWR exist.



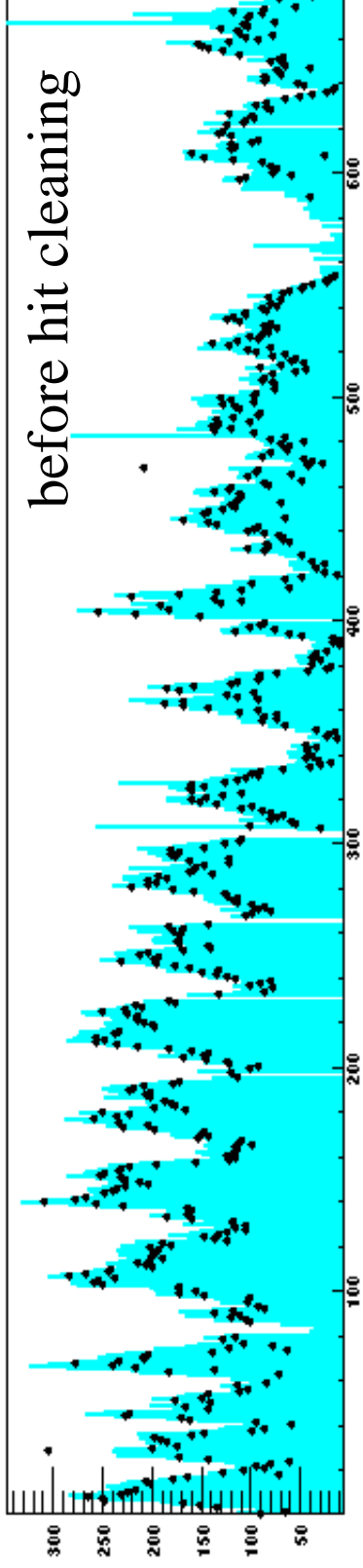
Number of Hits

Nhit vs. OM

● TWR

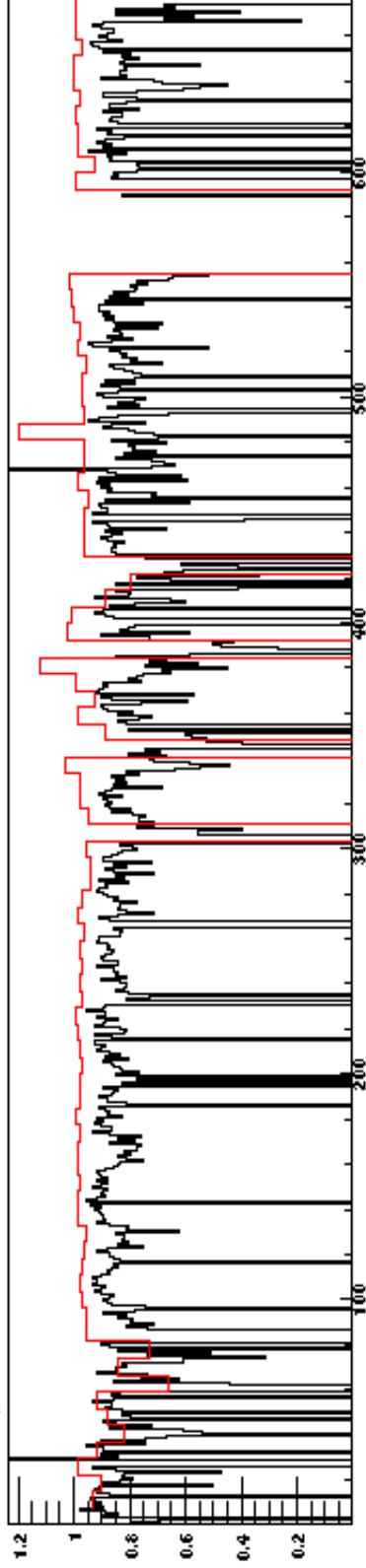
■ MuDaq

nch_1



Nhit(TWR)/Nhit(MuDaq) vs. OM

nch_2



- **Smaller Size of Time Window**
MuDaq = 32 μ s : TWR = 10 μ s
- ◆ **Higher Threshold (Feature extraction)**
MuDaq = 100-140 mV : TWR = 185 mV (Electrical)
(But smaller thresh. in Optical)

— Before Hit Cleaning

— After Hit Cleaning

Conclusion

- ★ TWR Calibration and reconstruction have been done in a test stage
- Leading edge time agreement is within 4 ns. (after TWC)
- (24 bad OMs are worse than 6 ns)
- Fluctuation and oscillation of the dt has been observed.
- MuDaq- dependent Time Work Calibration
- > Need YAG data for the precise calibration.

★ Reconstruction Results

- Space Angle : $\langle d(\text{angle}) \rangle = 1.94$ degree.
- $\theta : \sigma(\theta) = 0.72$ degree.
- $\phi : \sigma(\phi) = 1.18$ degree.
- These errors are interpreted by the fitting error, the error, the difference of Nhits and so on.

★ Plan

- Study of Angle Resolution
- MC and SPACE-AMANDA Data