

EH1 (AD 1&2, IWS, OWS) PMT Jul. 30 – Aug. 20 RollingGain Calibration Summary

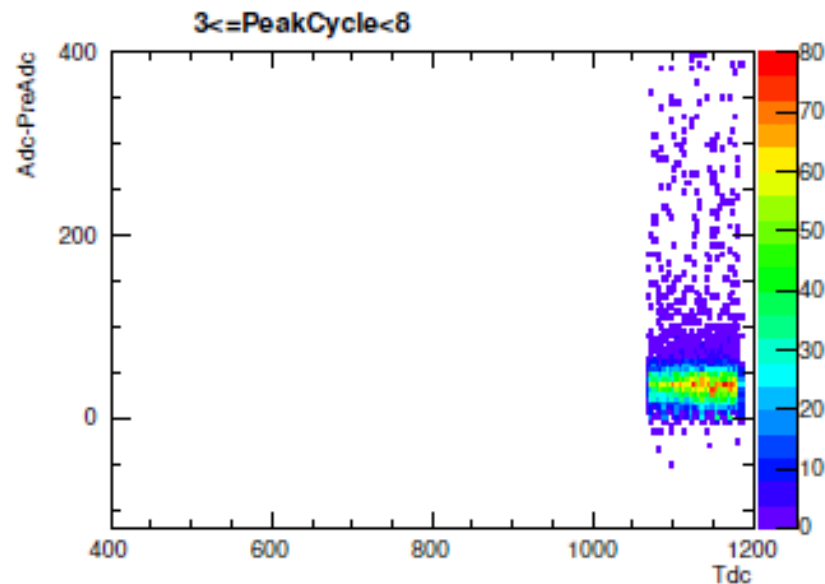
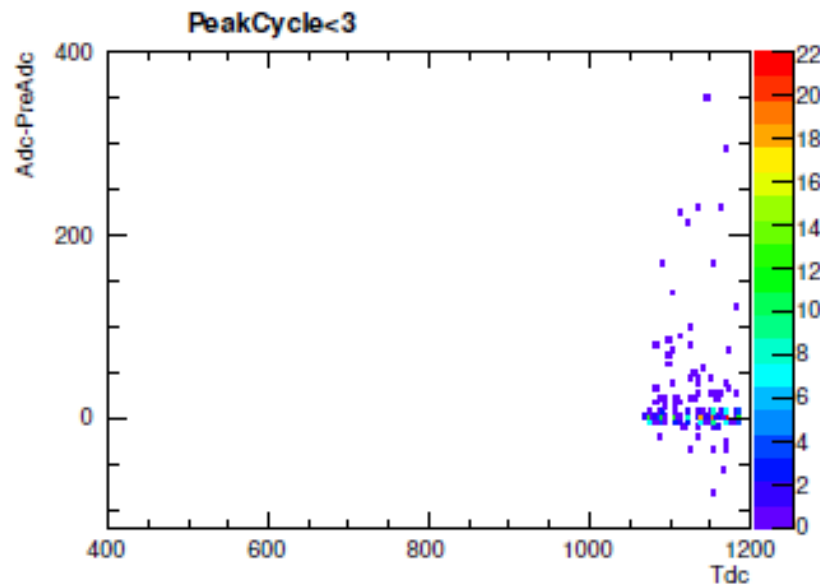
Zhe Wang (BNL) and Qing He (Princeton)

Aug. 22, 2011

Several import aspects:

1. Peak cycle selection
2. Robustness improvement
3. Precision improvement
4. Gain drift – Coherent
5. Tdc hit rate - Coherent
6. Comparison with LED
7. Individual gain-running PMTs

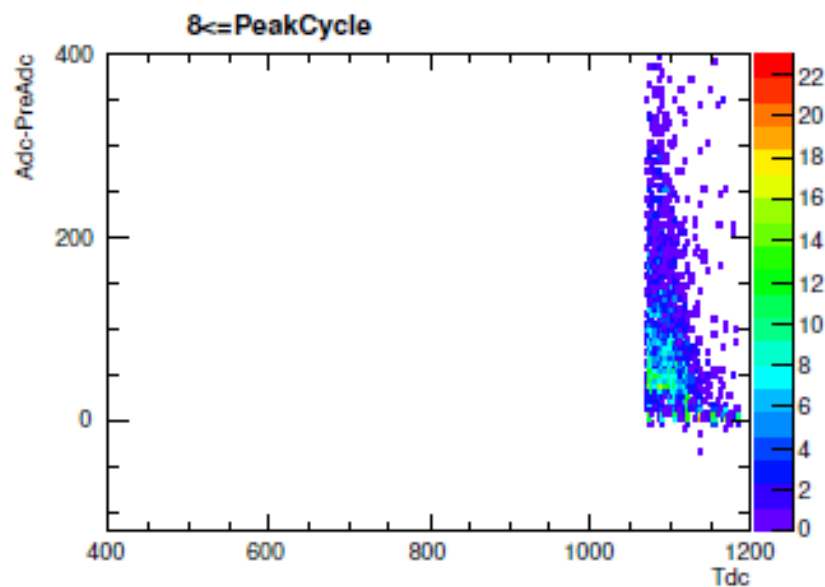
Peak cycle selection



No dark noise
component can be
identified by PeakCycle.
Doc6819

Addition to dark noise
selection: [3,8]

Other cuts: Doc6714

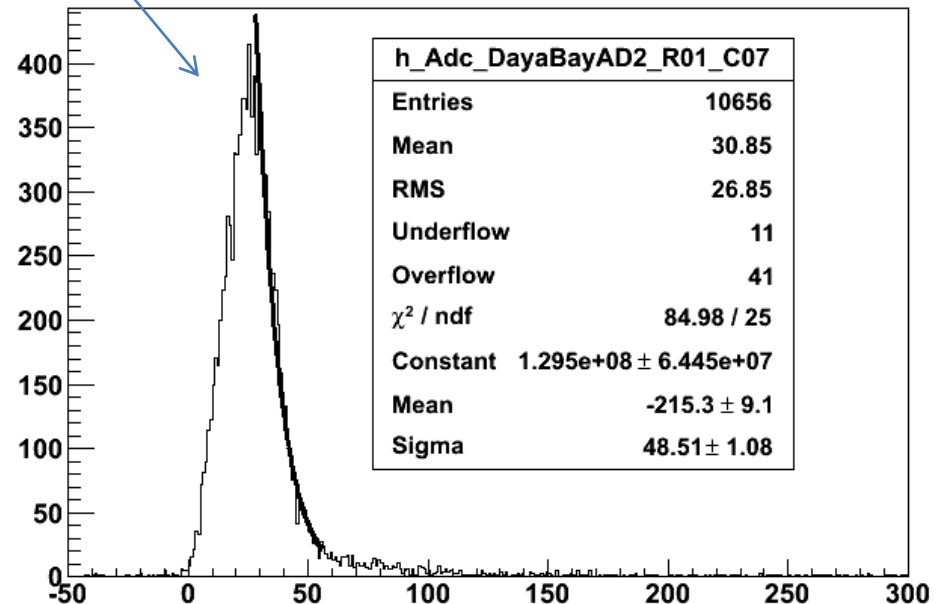


Robustness and Precision

Very strict fitting result requirement:

1. Root fit ok
2. $\chi^2/\text{ndf} < 10$
3. $6 < \text{Gain} < 80$ &&
4. Lower bound $< \text{Gain} < \text{upper bound}$
5. $\text{Gain Err} < 10$
6. $\text{Gain Sigma} < \text{Gain}$
7. $\text{sigma} > 1$ && $\text{sigma} < 40$

If a fit result can pass all of them, it is a failure.



Fitting period control:

1. Accumulation Time > threshold (1 hour currently)
2. Average Statistic > threshold (4000 entries currently)

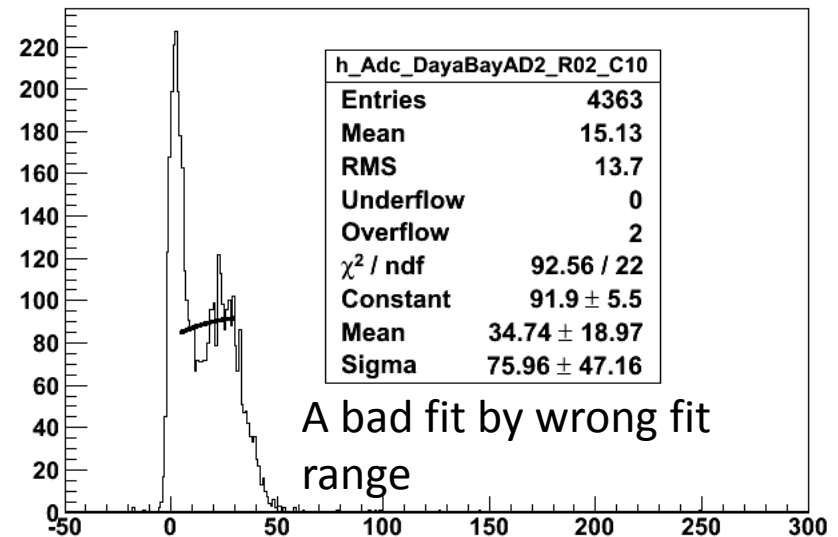
==>

- This gives about 2.5 hour per fit
- The statistical error for Gain is less than 1%
 $\sigma/\sqrt{4000}/\text{Gain} = (10/\sqrt{4000})/25$

Multi trials and gauss bailout:

1. Peak Cycle removed half of 40MHz or 80MHz Noise (Doc6819)
2. Full model fit first
 - 2.1 Fitting range auto adjustment
 - 2.2 Lower bound: $[0.3\text{Mean}, 0.5\text{Mean}]$, 9 trials
3. If full model fails, try gauss fit.
 - 3.1 Fitting range is also adjustable.
 - 3.2 Lower bound: $[0.3\text{Mean}, 0.5\text{Mean}]$, 9 trials

==> No failure out of a million fits
unless a really bad distribution

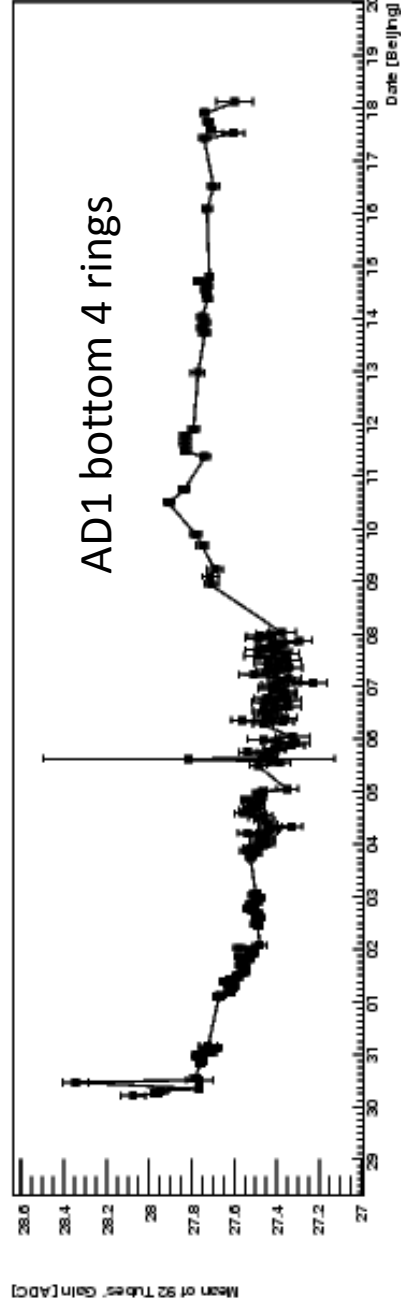


Gain drift - coherent

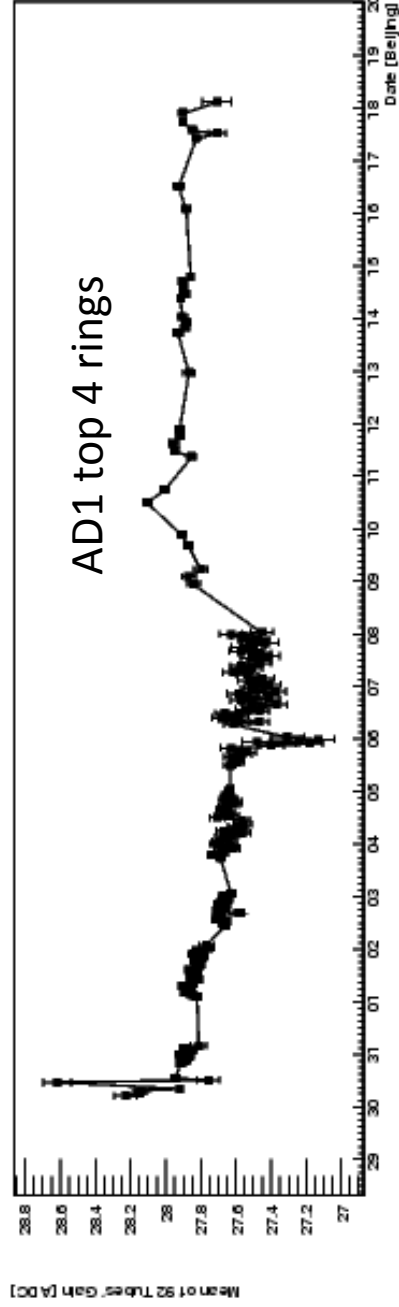
- Next page, the average gain of four group PMTs from Jul. 29 – Aug. 18 will be shown.
- You will see some coherent behaviors over all of them. These trends also be found in each ring, each board, even in one channel as long as statistical error is small.

8/22/2011

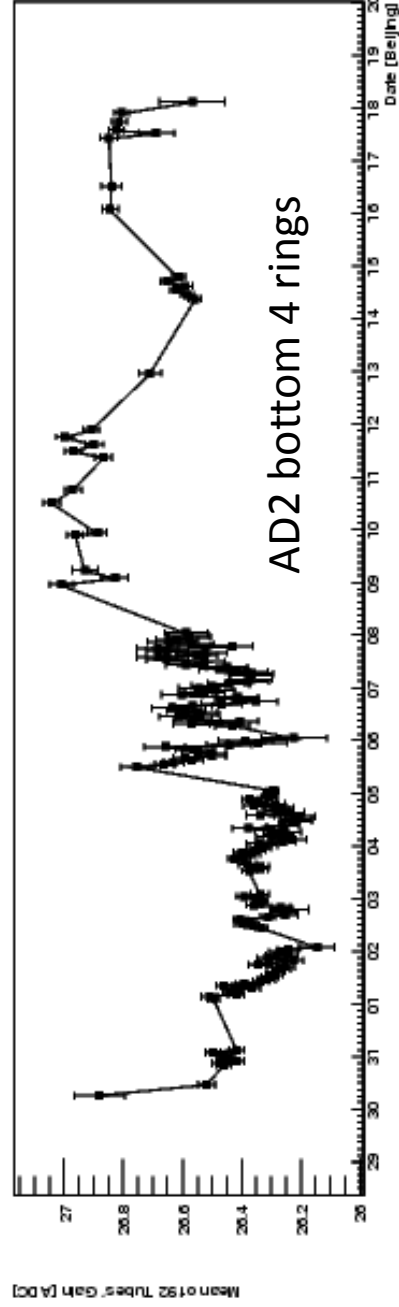
Graph



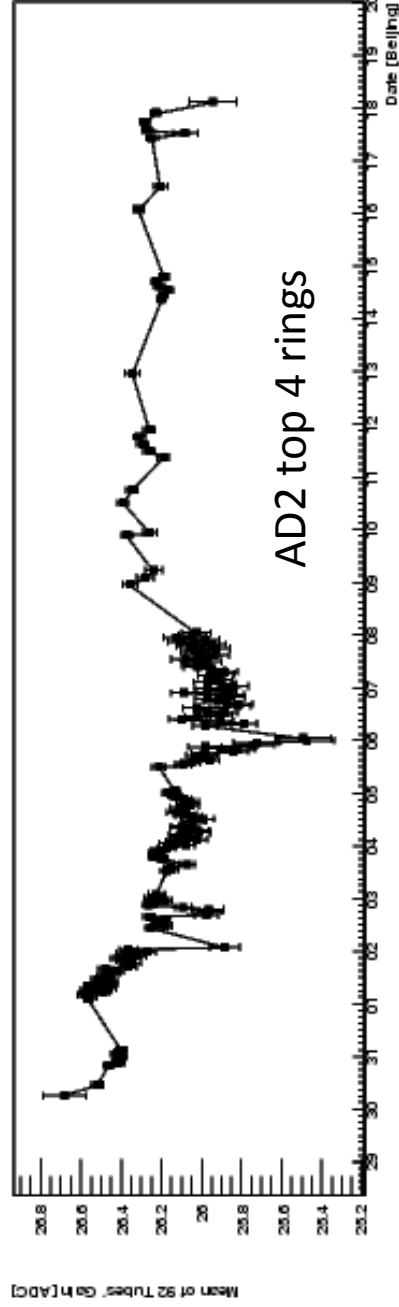
Graph



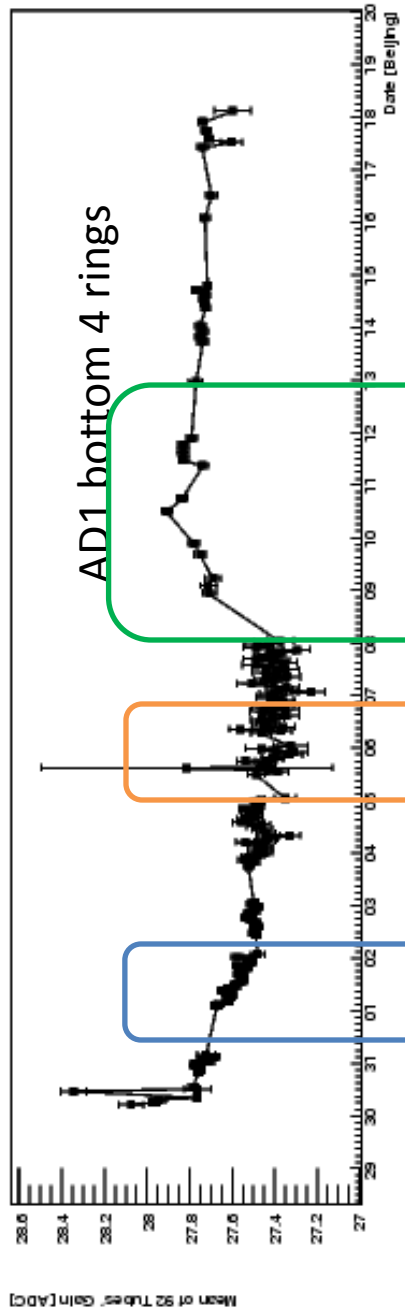
Graph



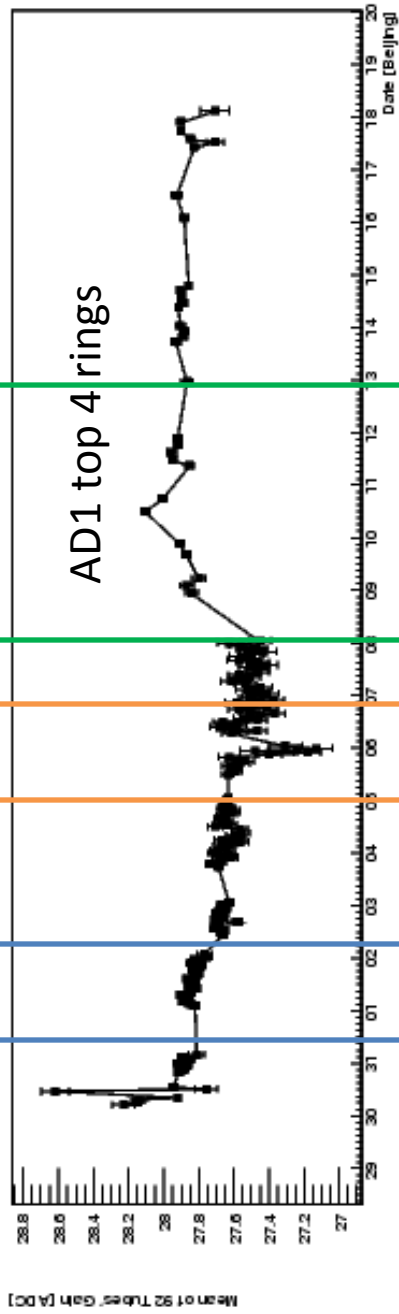
Graph



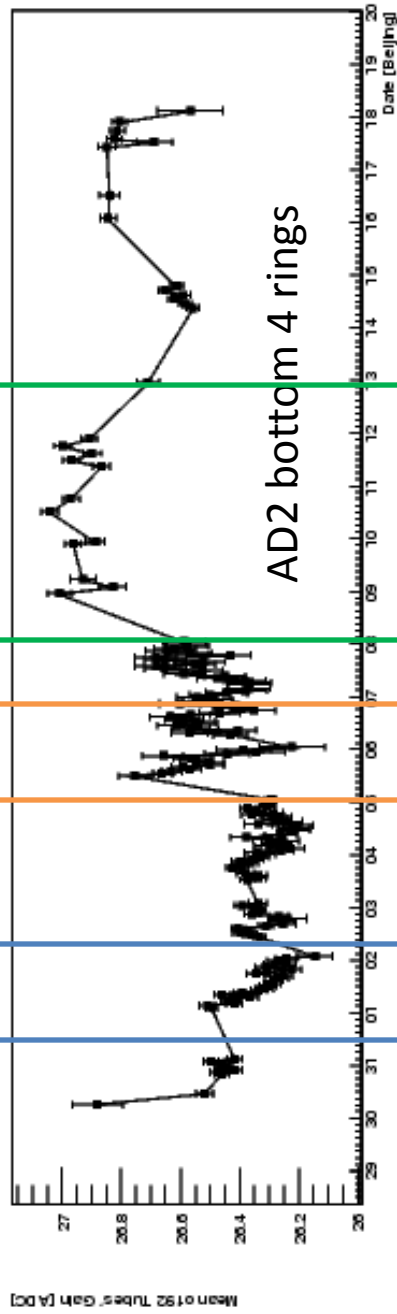
Graph



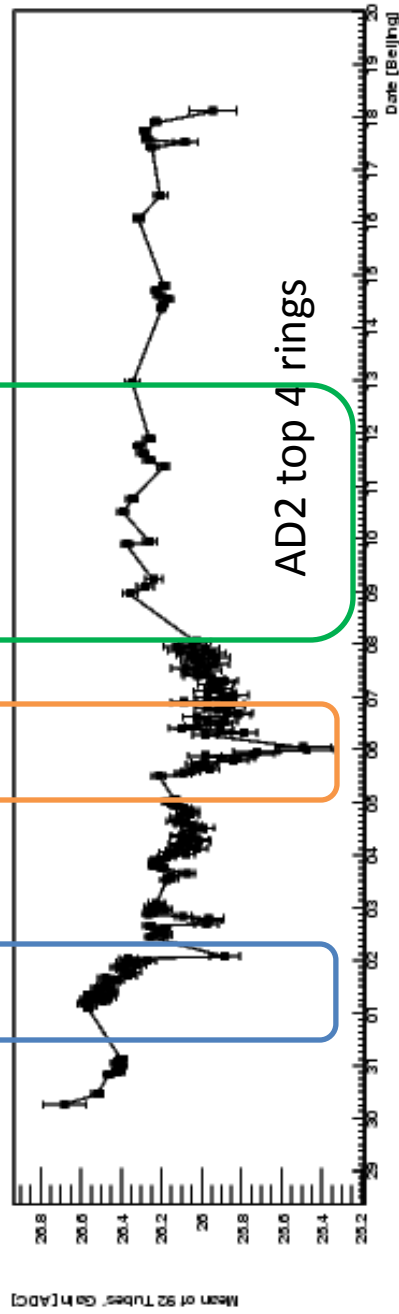
Graph



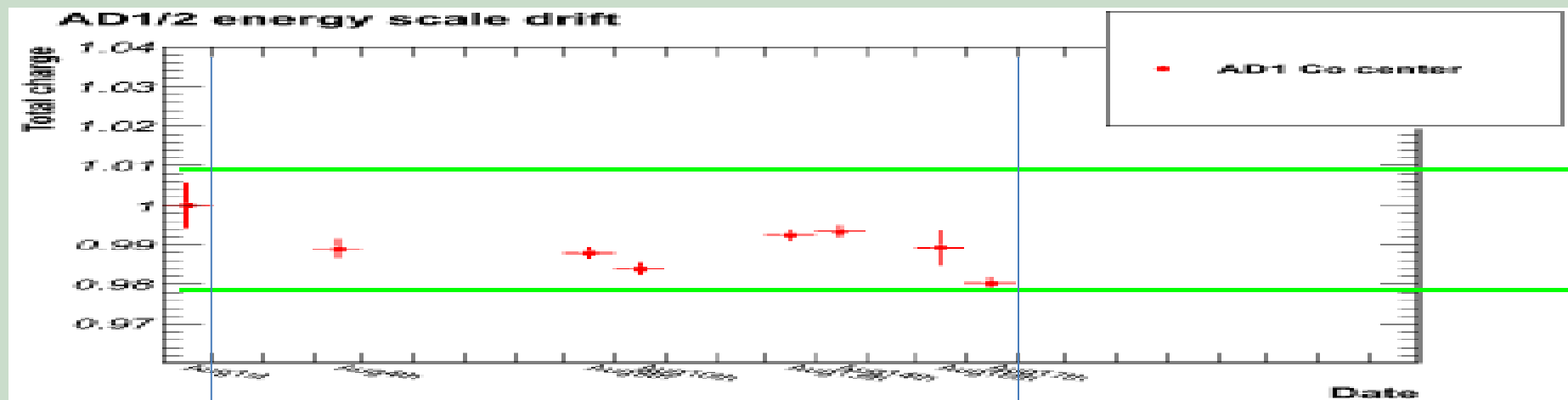
Graph



Graph

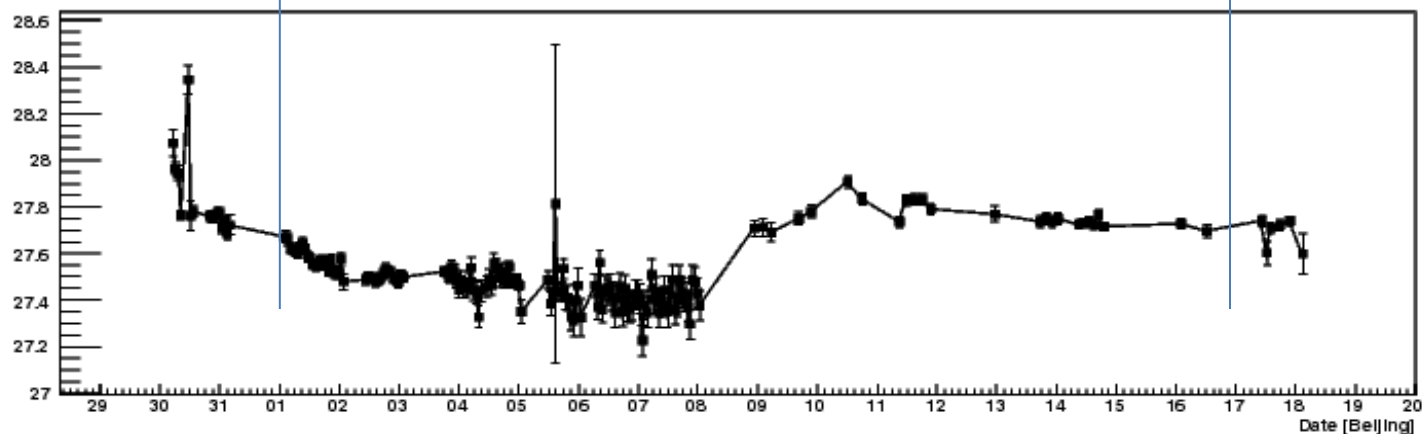


Detector center



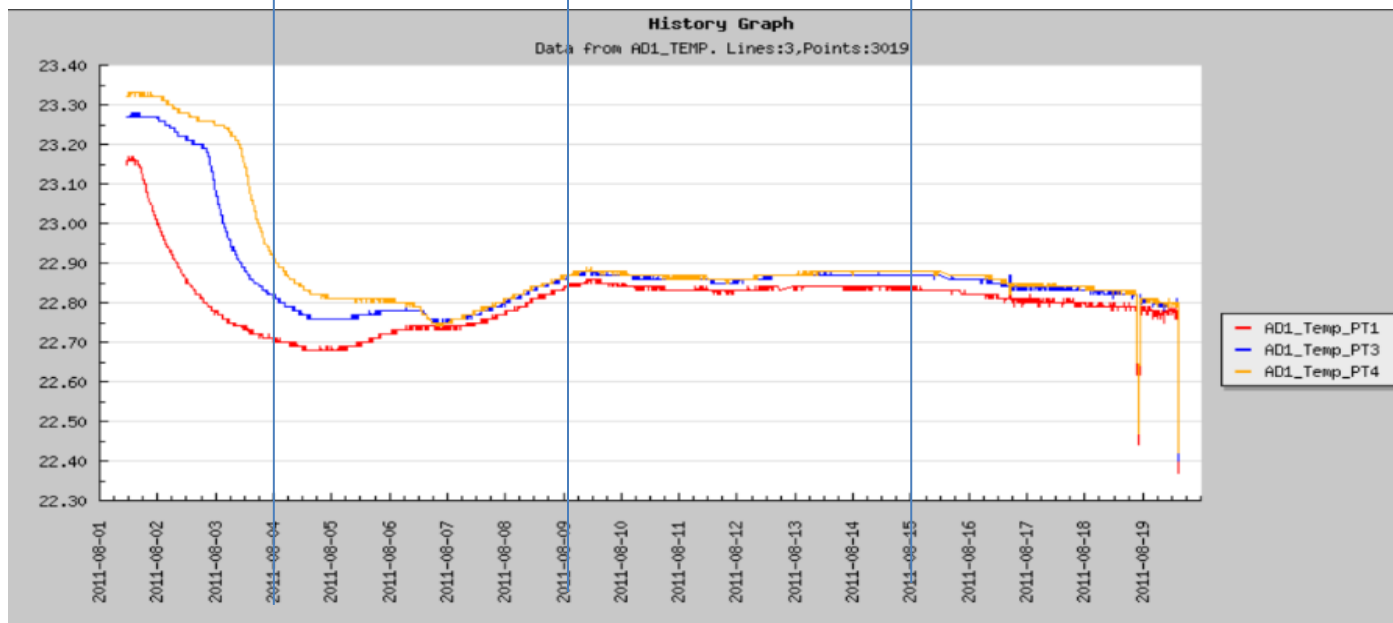
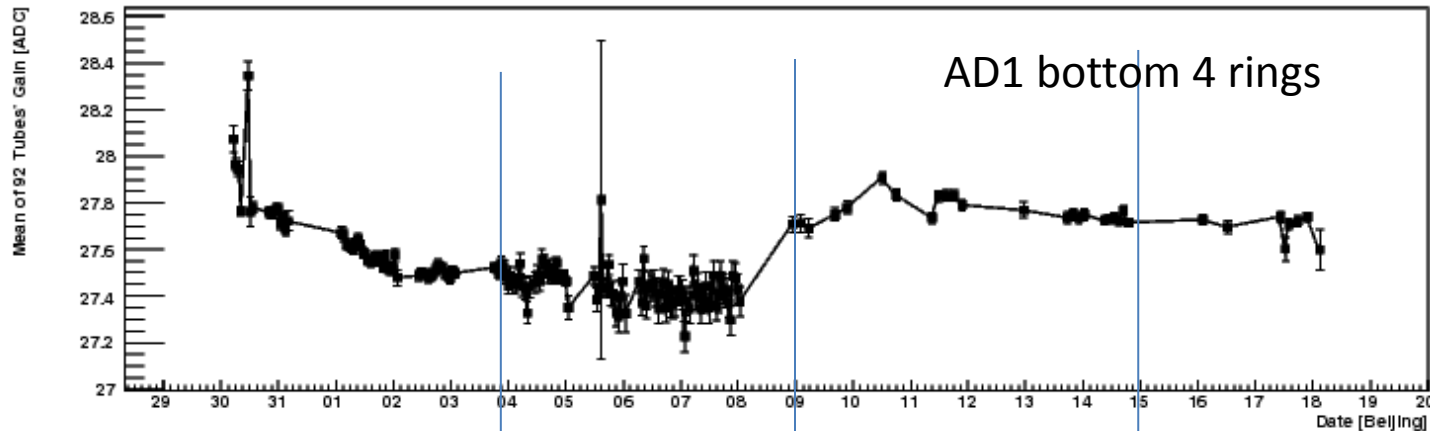
In Aug 4th, 9th, 10th, PMT gains are not
Even in this case, out detector is stable w

Compare with one slide from Zeyuan Doc6830, page 13



AD1 Gain drift and AD1 temperature:

Graph

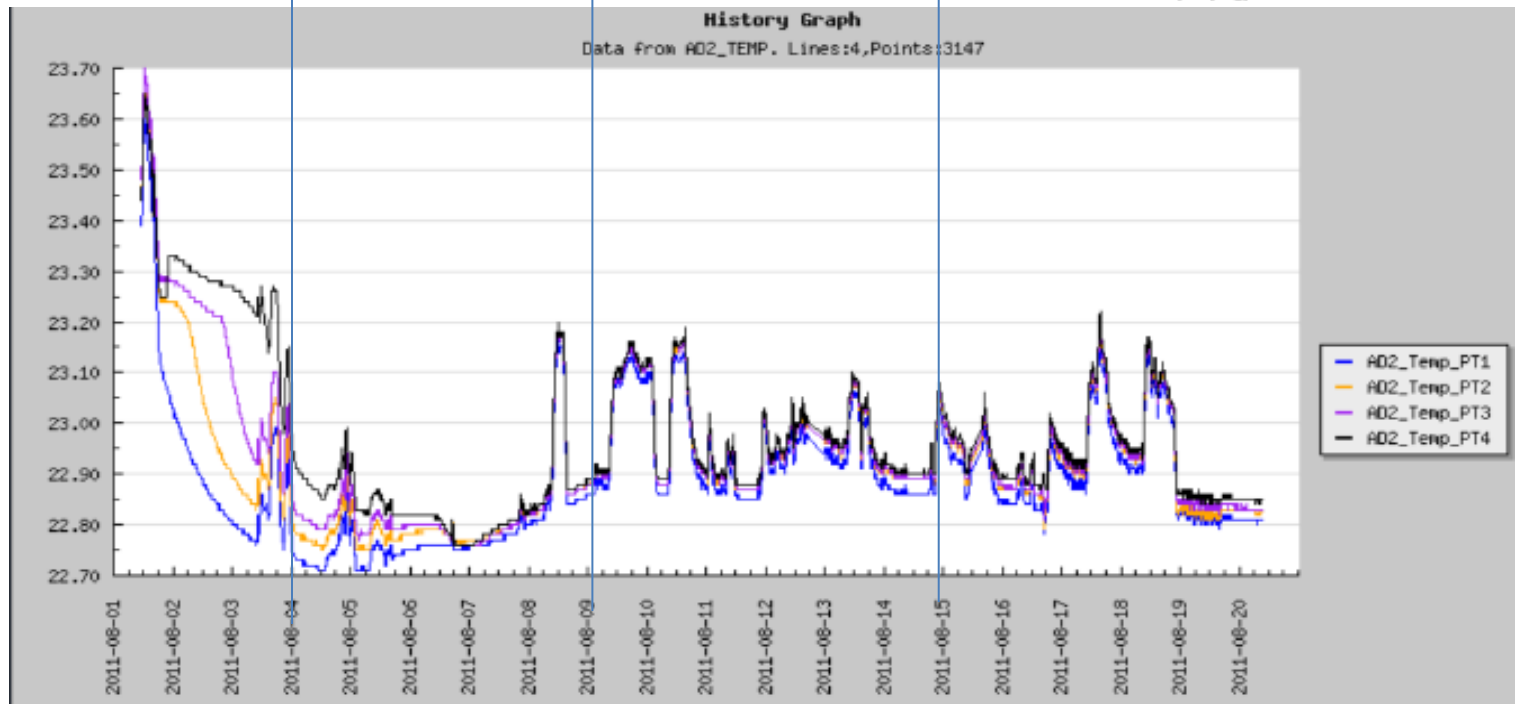
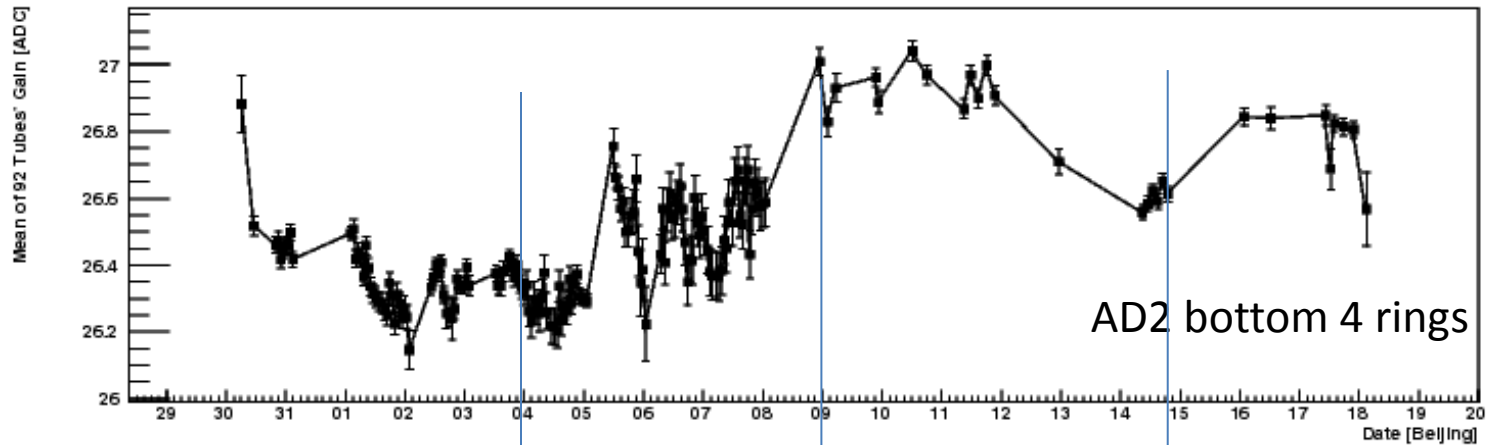


They are manually aligned together to guide the eyes.

It is about 0.1°C -- > 0.1 ADC increase -- $> 0.4\%$ in Gain (If ambient temperature is the dominant factor)

How about AD2?

Graph



- The maximum variation within one day could be $0.6\text{ADC}/26\text{ADC} = 2.3\%$
(AD2, Aug 5 – 6)
- The overall variation is about $1\text{ADC}/26\text{ADC} = 4\%$
- Ambient temperature has some coherent trend.
- Besides ambient temperature, there must be other factors for the short scale variance (<1day).
(HV, FEE, etc.)

Tdc hit rate - Coherent

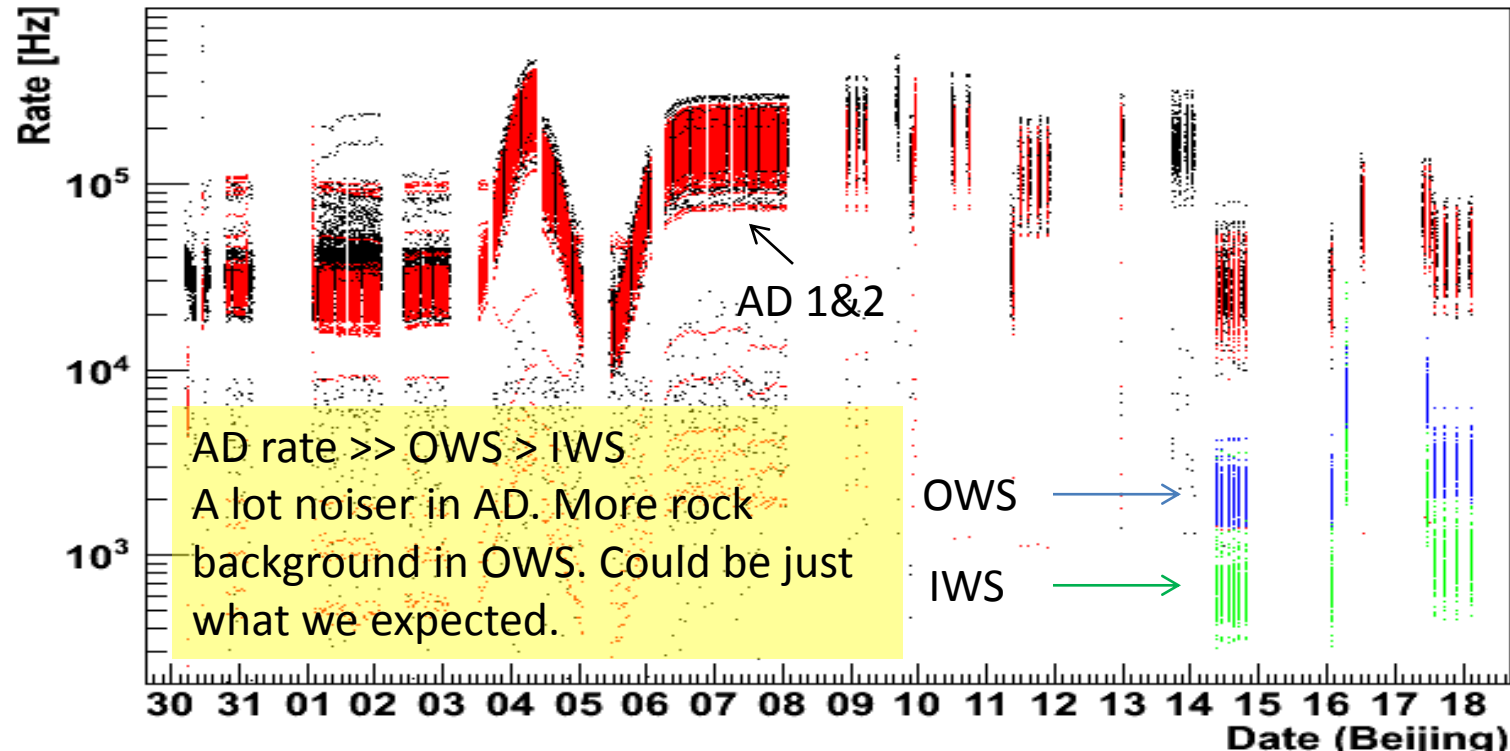
I used to call it dark rate. But just call it Tdc hit rate now

The value calculated is TDC hit rate in TDC window [1070, 1200] with 40MHz noise removed.

Include: Dark rate, Events below trigger threshold, Electronic noise (w/o 40MHz noise) and Ringing.

TDC Hit Rate History

Study in progress ...



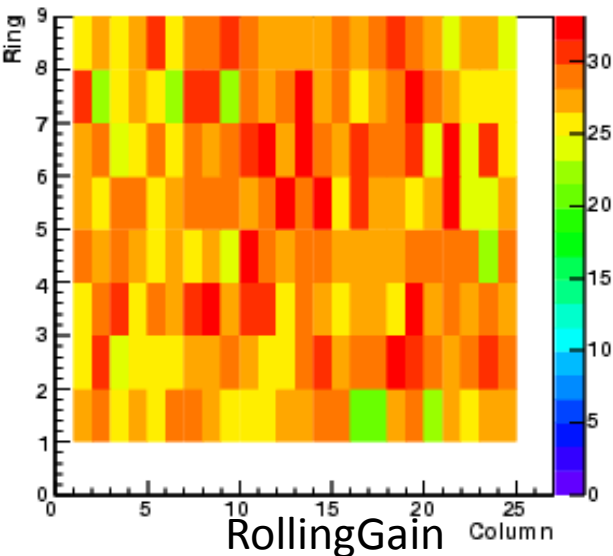
BTW, PMT gain isn't sensitive to this TDC rate at all.

Comparison with LED calibration result

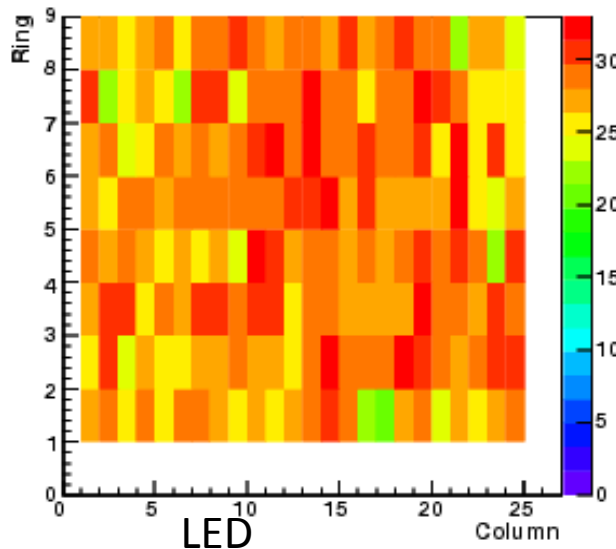
Aug 17

1. LED runs
 - AD1 run 12493 (10:27 am 3 minutes)
 - AD2 run 12515 (11:03 am 3 minutes)
2. RollingGain processed these runs:
(Need a hour to get enough statistic)
 - From: Run 12492 (10:18 am)
 - To: Run 12577 (4:31 pm)Taken the sample from the first hour
3. RollingGain output characteristic:
 - Average statistic (1500 entries)
 - Gain error: about 0.4ADC
 - (I guess LED calibration result is around the same range)
4. All the fits used the full model (fit ranges, some initial parameters may not be the same)

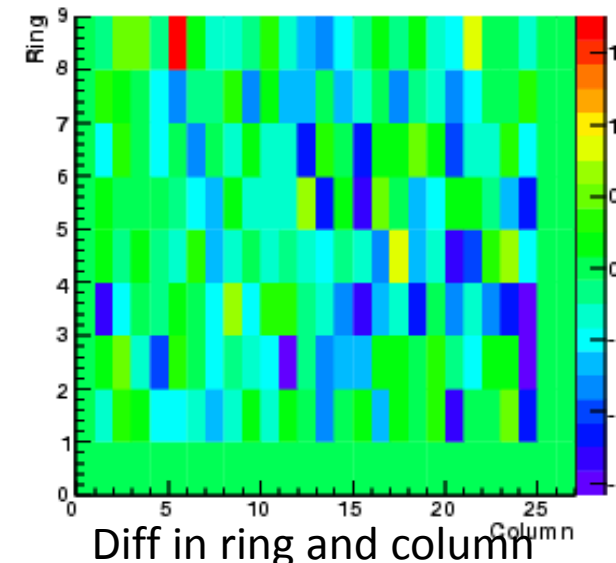
Ring:Column {(Spe)*(Ring>0&&Detector==1)}



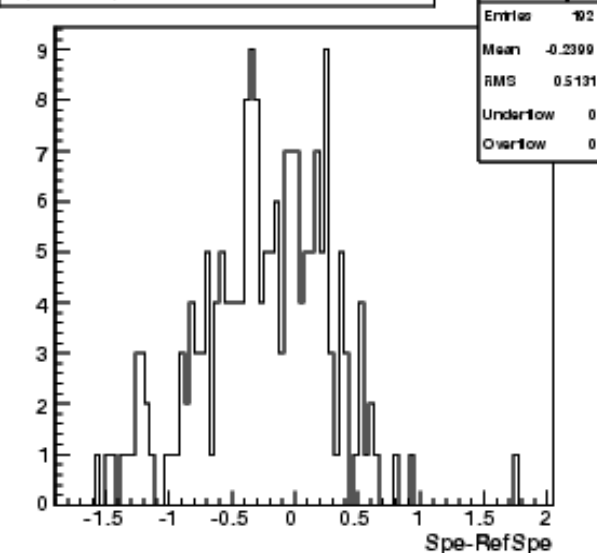
Ring:Column {(RefSpe)*(Ring>0&&Detector==1)}



Ring:Column {(Spe-RefSpe)*(Ring>0&&Detector==1)}



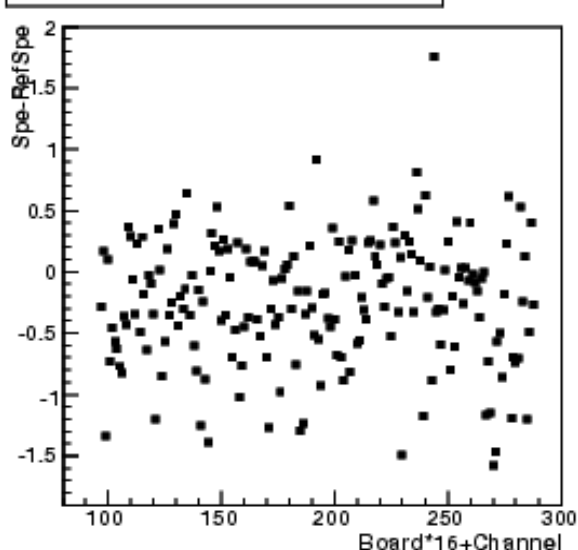
Spe-RefSpe {(Ring>0&&Detector==1)}



RG - LED, Mean: -0.23

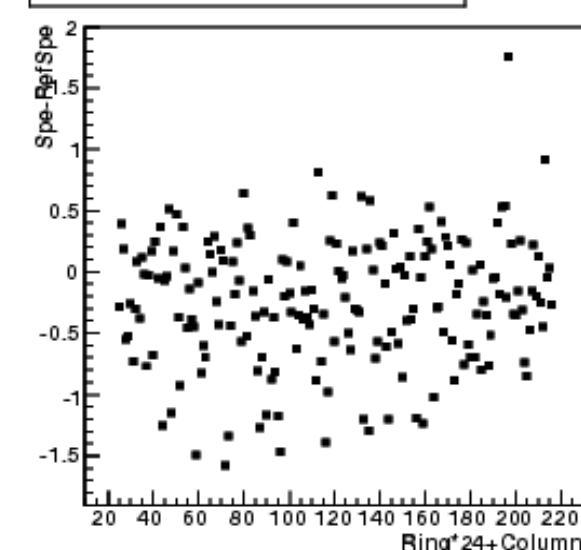
8/22/2011

Spe-RefSpe:Board*16+Channel {(Ring>0&&Detector==1)}



Diff in B*16+C

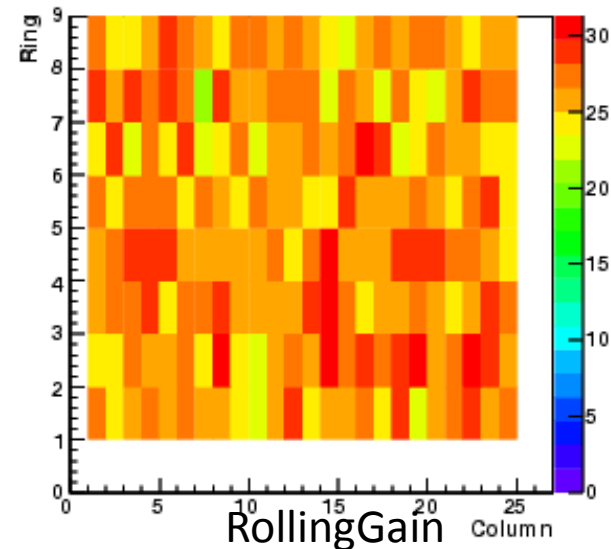
Spe-RefSpe:Ring*24+Column {(Ring>0&&Detector==1)}



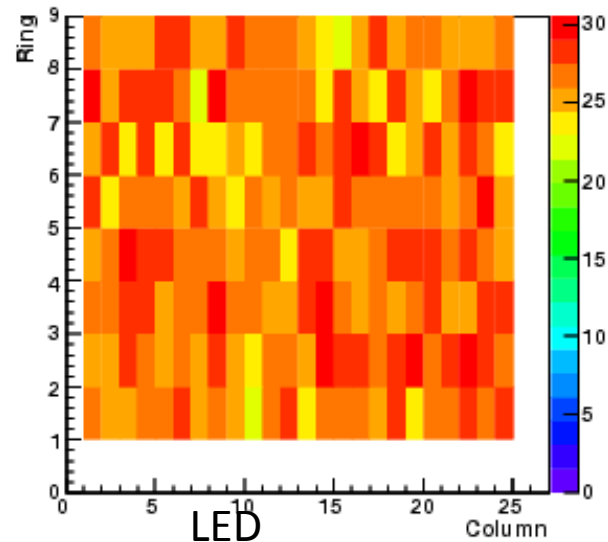
Diff in R*16+C

comp-AD2-DarkNoise-LED_Aug17

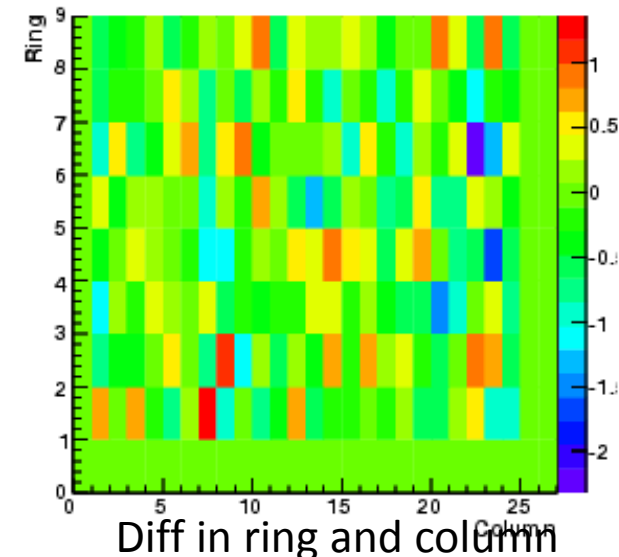
Ring:Column {(Spe)*(Ring>0&&Detector==2)}



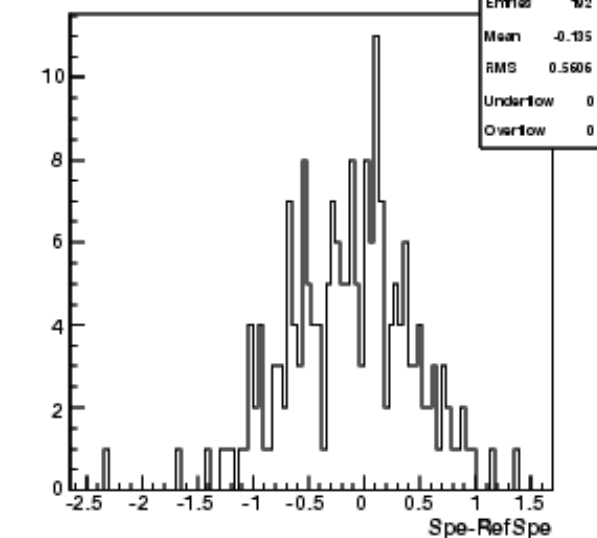
Ring:Column {(RefSpe)*(Ring>0&&Detector==2)}



Ring:Column {(Spe-RefSpe)*(Ring>0&&Detector==2)}



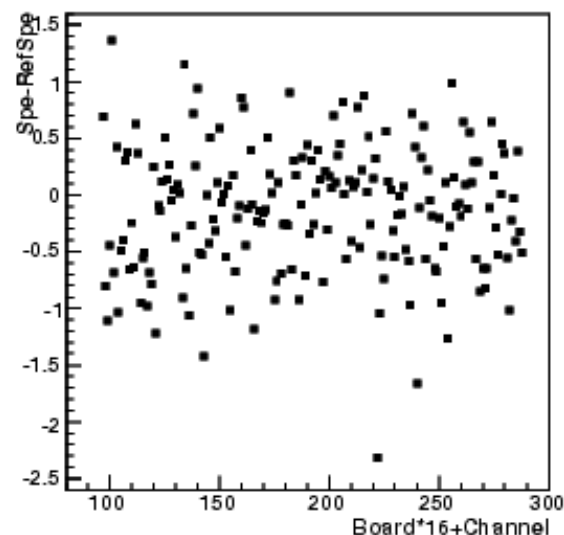
Spe-RefSpe {(Ring>0&&Detector==2)}



RG - LED, Mean: -0.14

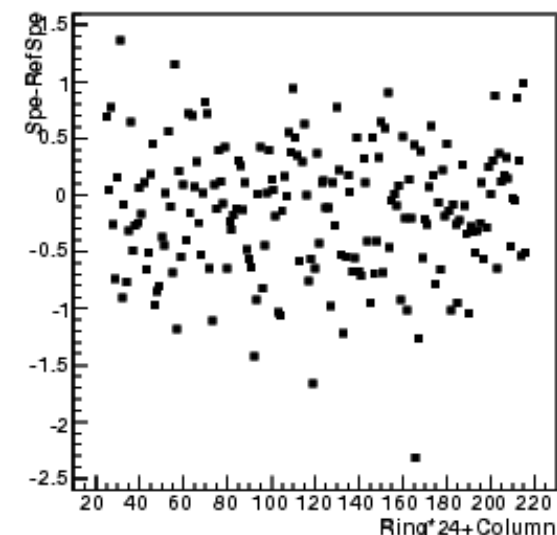
8/22/2011

Spe-RefSpe:Board*16+Channel {(Ring>0&&Detector==2)}



Diff in B*16+C

Spe-RefSpe:Ring*24+Column {(Ring>0&&Detector==2)}

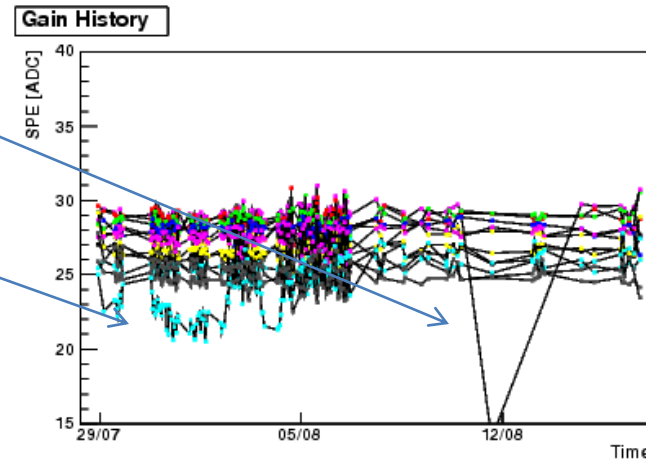


Diff in R*16+C

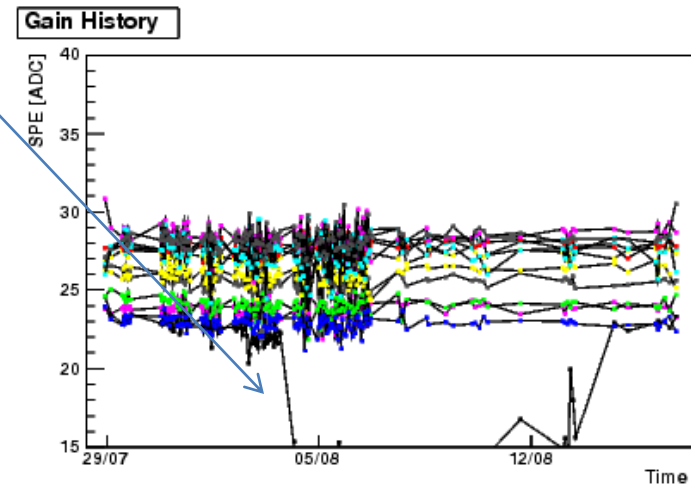
Please check the other reference document

1. AD2_R04_C14
(page 24, pink)
2. AD2_R04_C23
(page 23, cyan)
3. AD2_R07_C17
(page 30, black)
4. AD2_R08_C09
(page 31, black)

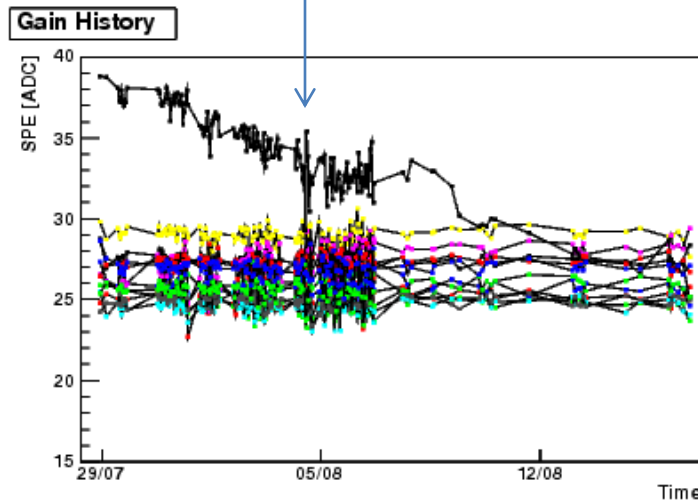
AD2_Ring_4_Column_13-24 P.24



AD2_Ring_7_Column_13-24 P.30



AD2_Ring_8_Column_1-12 P.31



Summary

1. A lot of studies had been carried out for RG. Improved hit selection, robustness and precision.
2. Coherent gain drift
3. Coherent Tdc hit rate drift
4. Consistent with LED calib result
5. Part of the result was committed to DB.
6. Further development is under discussion.