Tracker Parameters Trending Monitor

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All the work is done by T. Kawamoto, a graduate student of Hiroshima University under a mentor by H. Tajima and TKR team.

Purpose of the Monitoring

- To make it sure that TOT calibration has been correctly done, and there has been no significant increase of bad strips during the LAT integration which lasted almost a year!
- To establish the way to monitor the TKR performance before and after the environmental test at NRL.

Parameters to be monitored

- TOT Calibration parameters trend
  - Threshold DAC trend.
    - TkrThresholdCal.py
  - Circuit amplifier gain trend (charge amp + shaping amp)
    - TkrNoizeAndGain.py
  - TOT fitting parameters trend .
    - TkrTotGain.py

  - Show monitoring result of Tower1

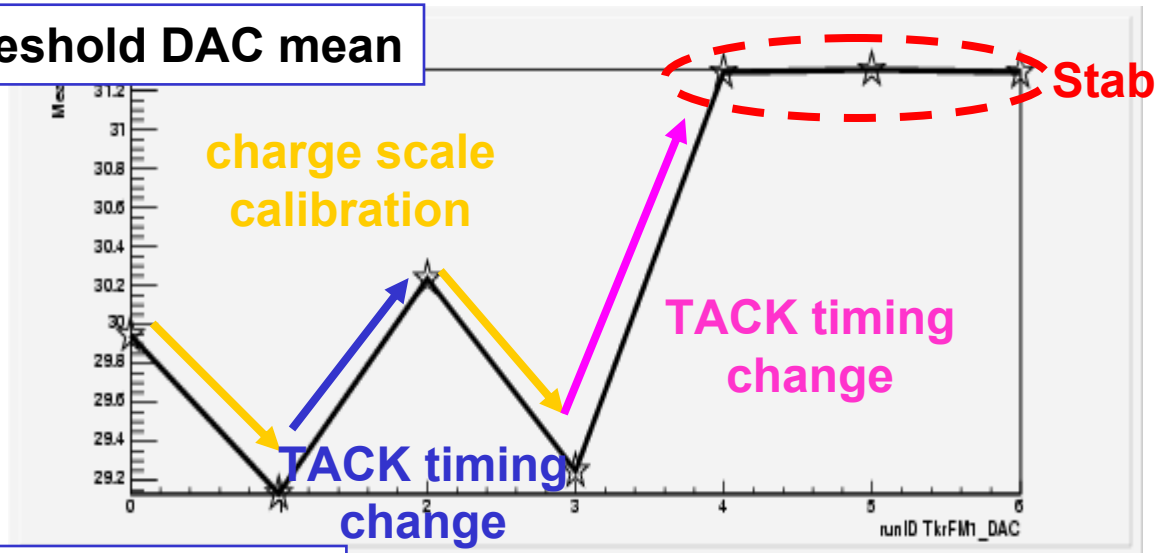
- Bad strip trend
  - Dead,Hot strips from online calibration test.
  - Disconnected strips from muon hit distribution.

Threshold DAC Monitor

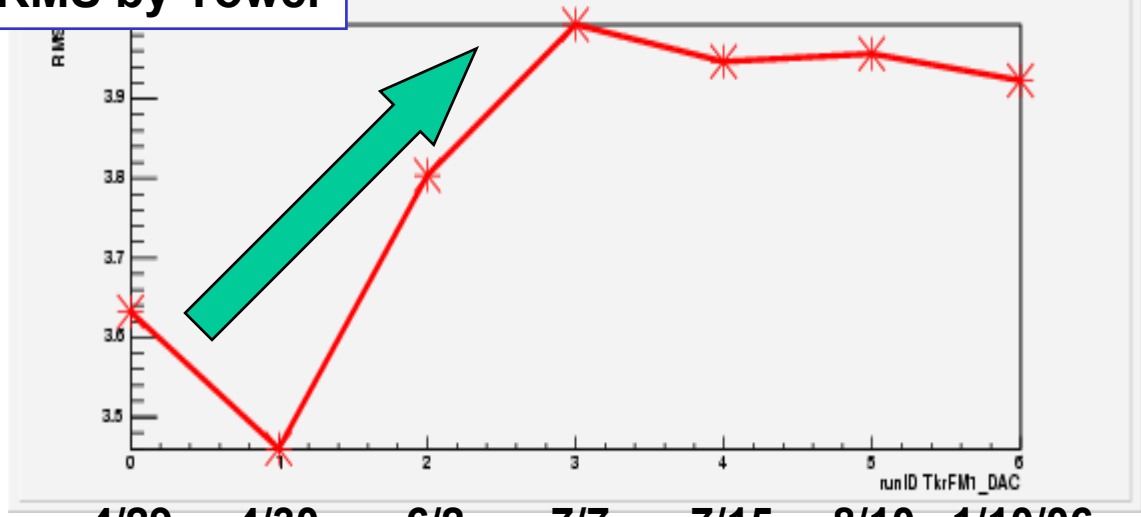
0: arrival at SLAC
1: charge scale calibration
2: Flight TEM installed
3: charge scale test
4: 6 tower test
5: 8 tower test
6: 16 tower test

•RMS increases even though we applied charge scale calibration. This turned out not due to the TKR problem, but bugs in the test script. (Feedback of the Monitoring)

Threshold DAC mean



RMS by Tower



4/29 4/30 6/2 7/7 7/15 8/10 1/10/06

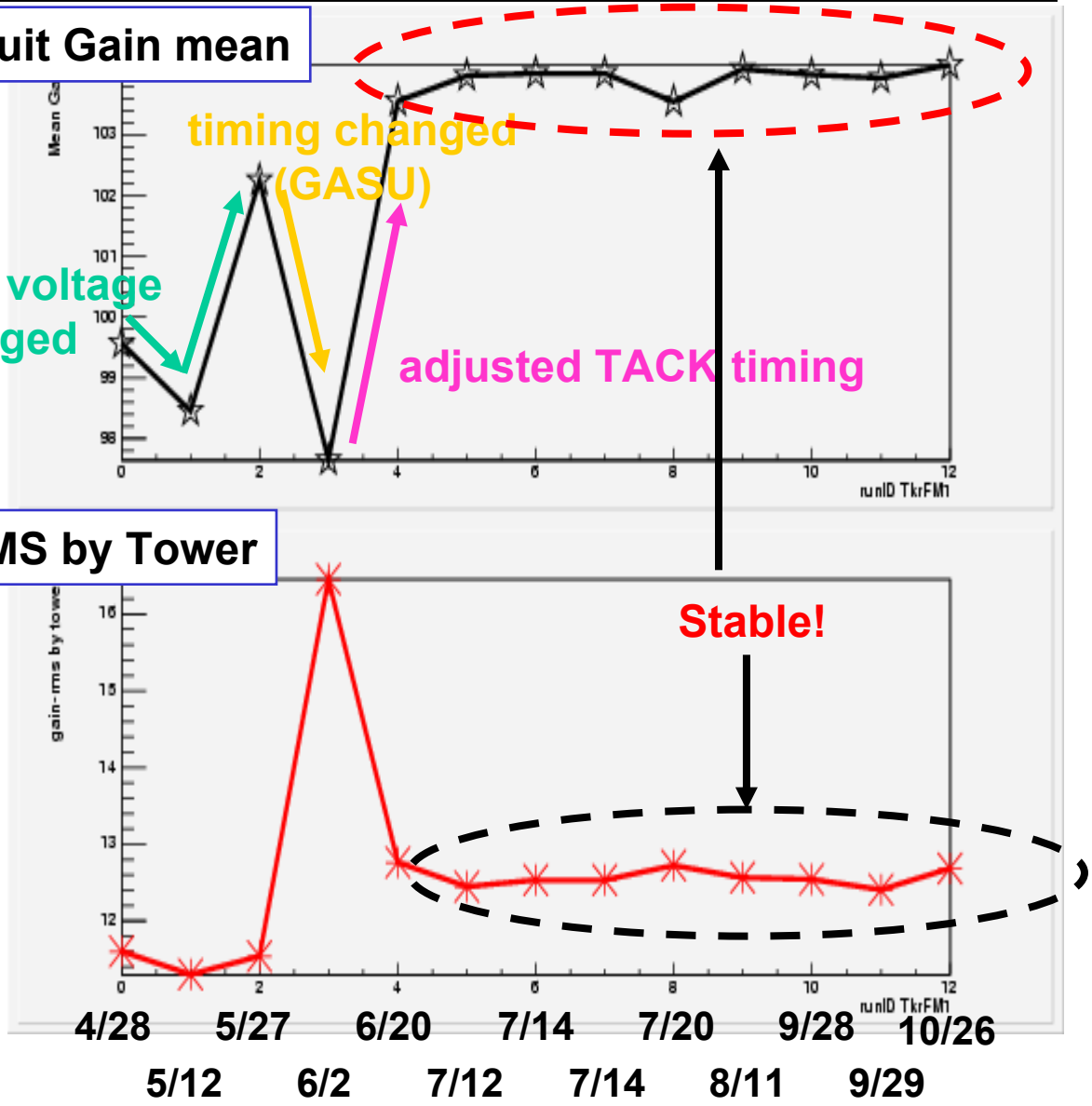
Circuit Gain Monitor

Circuit Gain:

$$\frac{\text{Output Voltage}}{\text{Injected Charge}}$$

0: arrival at SLAC
2: install in Grid
4: adjust TACK timing
5-8: 6 tower test
9: 8 tower test
10,11: 10 tower test
12: 16 tower test

After adjusting TACK timing, gain has been stable throughout 6, 8, 10 and 16 tower test.



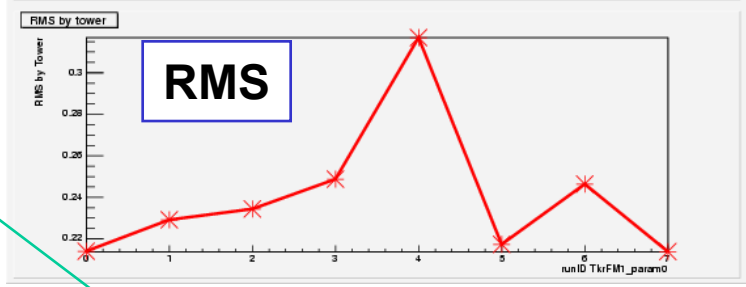
TOT Fitting Params Monitor

Charge (fC) = p0 + p1*TOT + p2*TOT^2

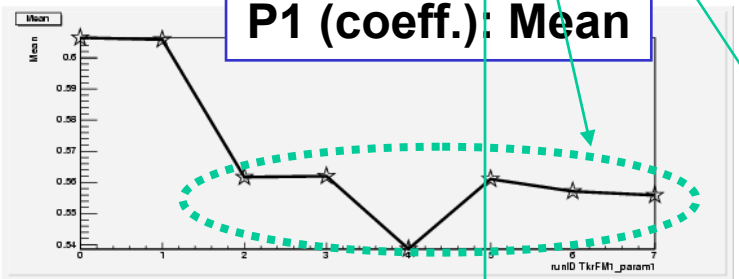
- Parameters have been **stable** in the latter part of the test.

P0 (offset): Mean

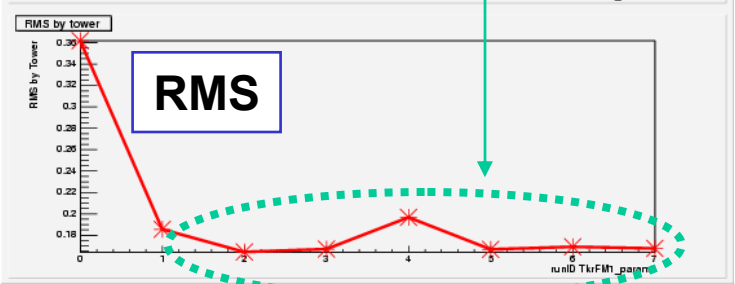
RMS



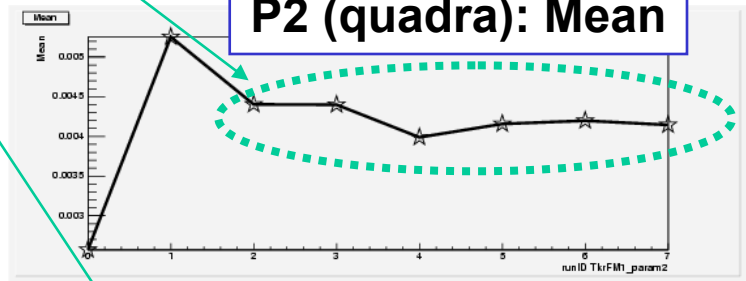
P1 (coeff.): Mean



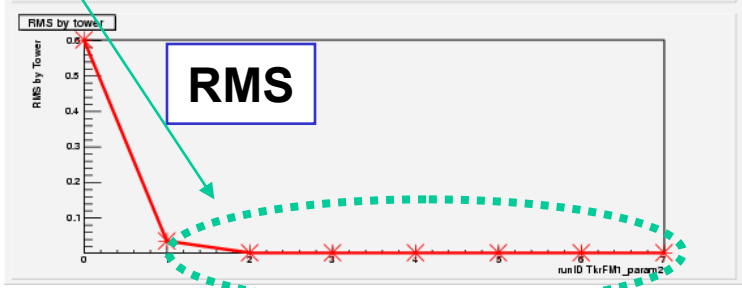
RMS



P2 (quadra): Mean



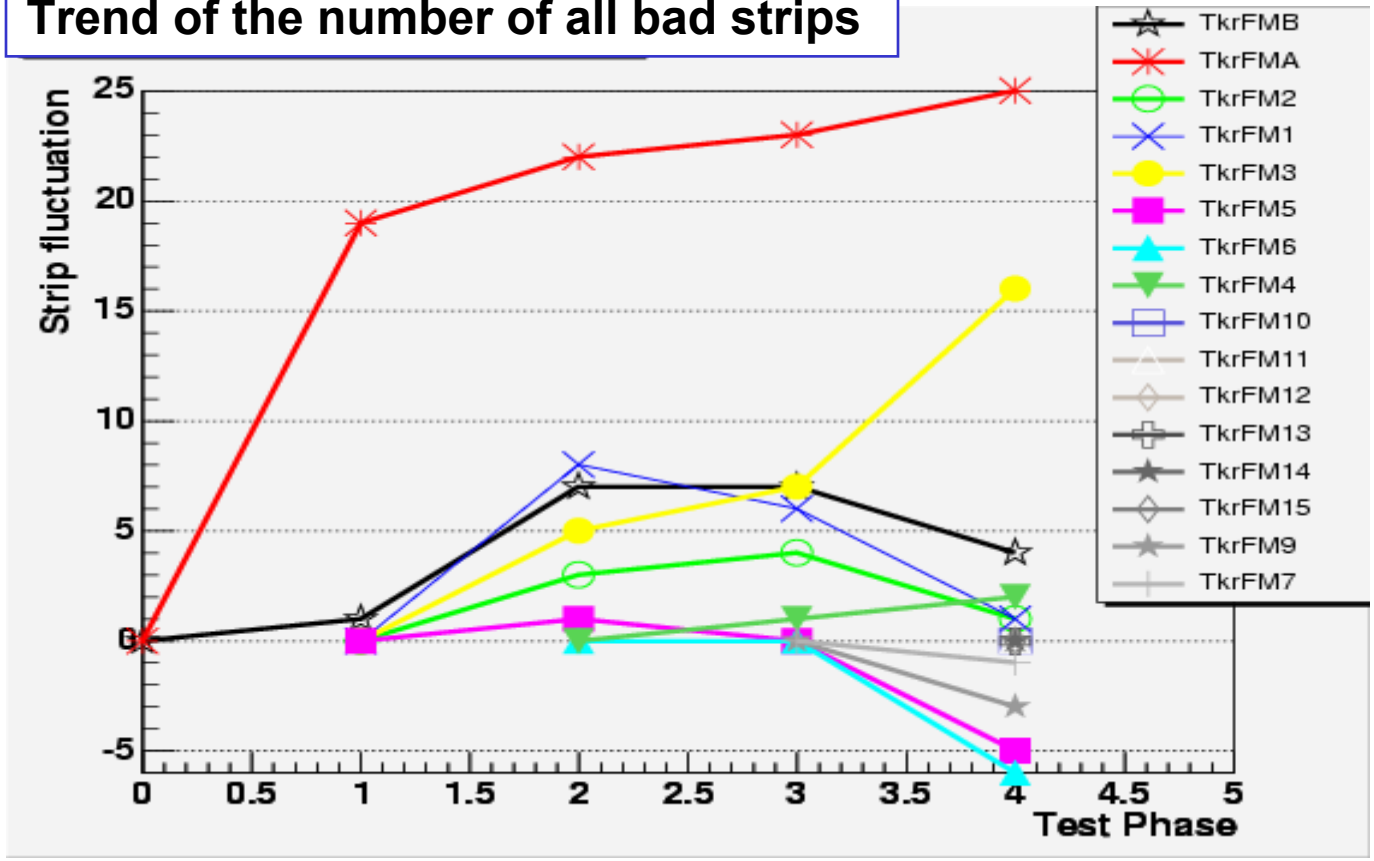
RMS



Bad Strip Monitor

Bad Strip: Dead + Hot + Disconnected

Trend of the number of all bad strips

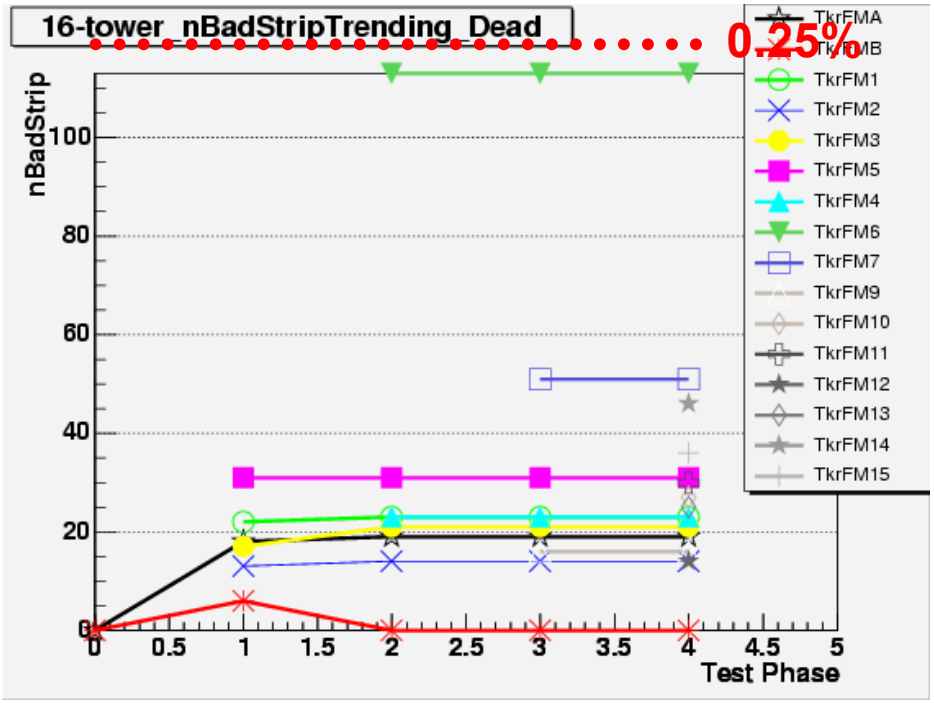


0: 2 tower test
1: 4 tower test
2: 6 tower test
3: 10 tower test
4: 16 tower test

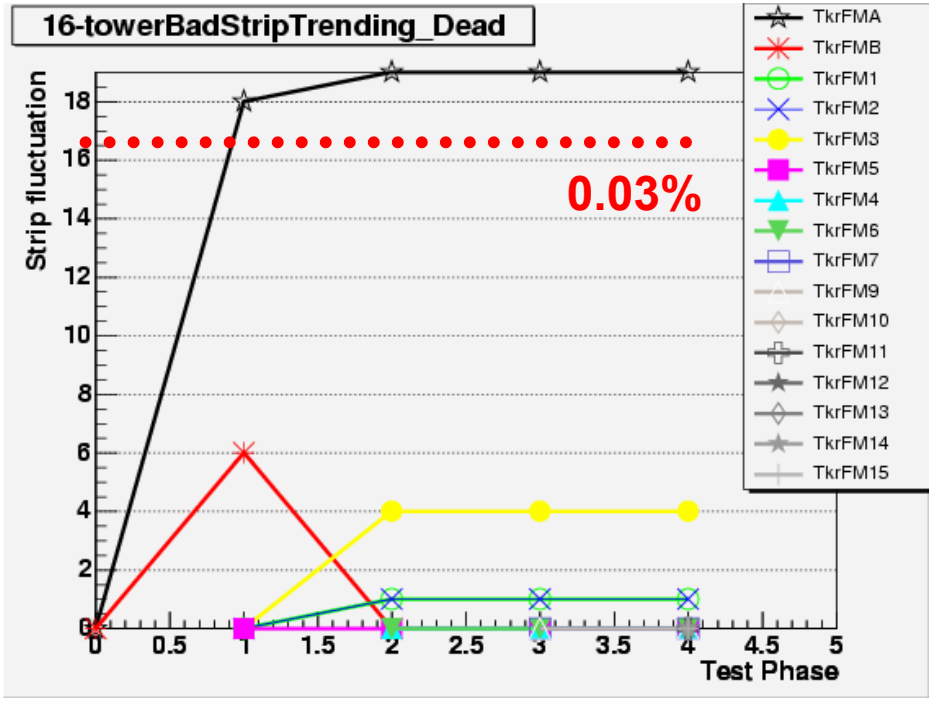
- **Maximum increase of all bad strips is 25, less than 0.05% of strips in tower.**

Dead Strip Monitor

The number of dead strips



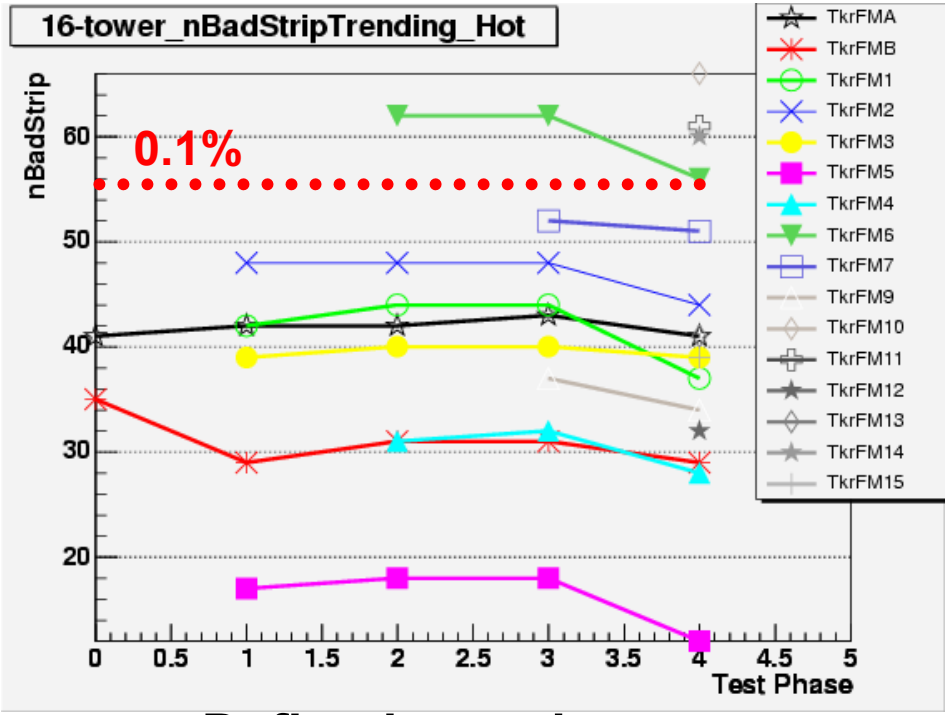
Fluctuation of # of dead strips



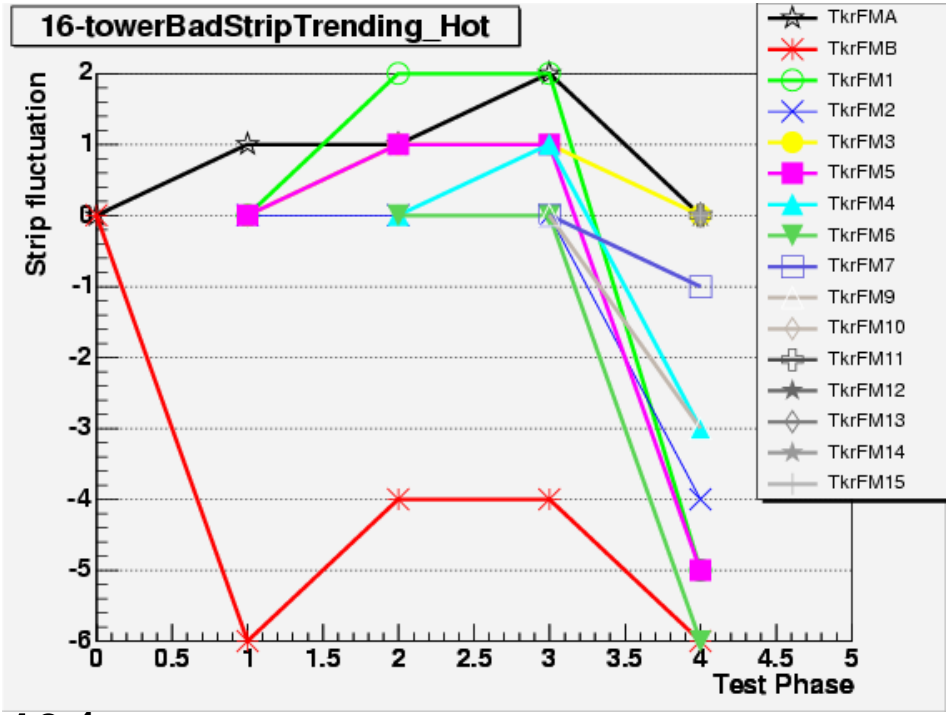
- **Less than 0.25% for all 16 towers.**
- **The maximum increase of dead strip is 19 strips, only ~0.03% of strips in a tower -> no degradation of read-out electronics.**

Hot Strip Monitor

The number of hot strips



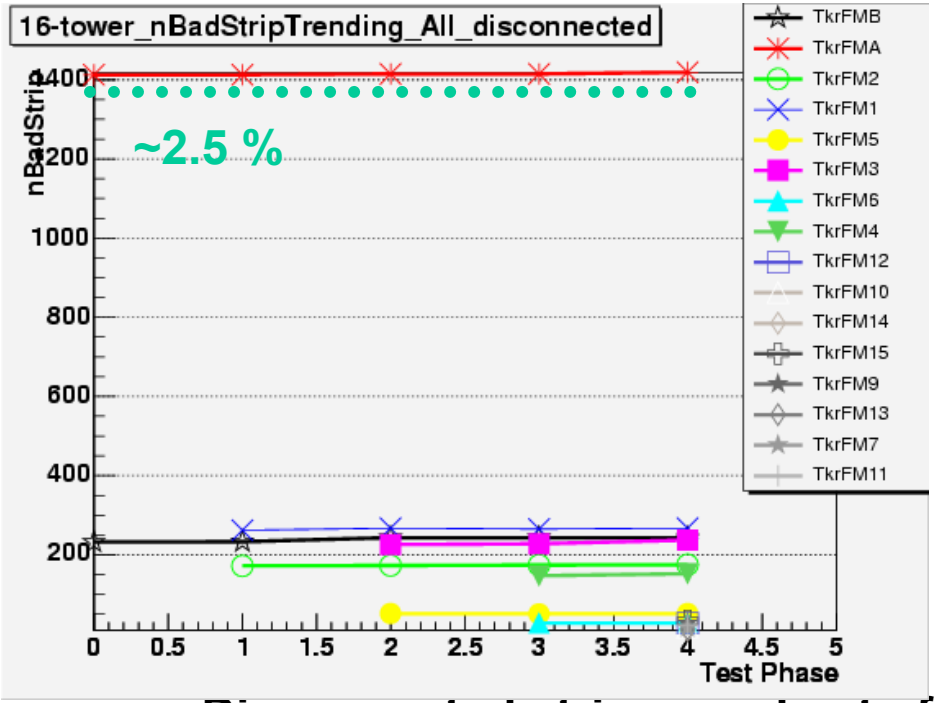
Fluctuation of # of hot strips



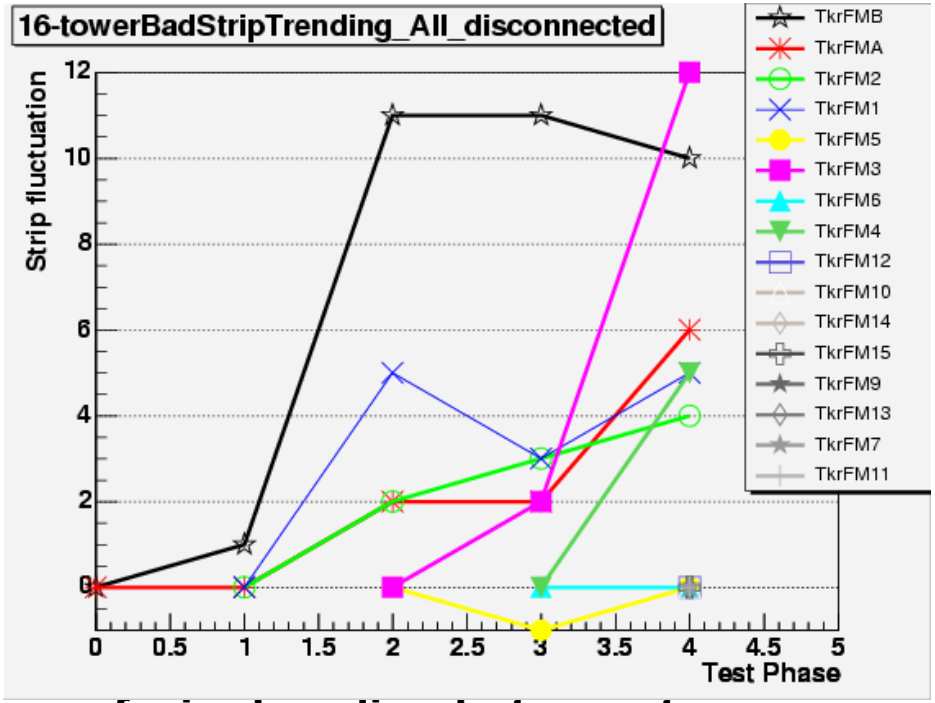
- Defined as noise occupancy > 10^{-4}
- # of Hot strips of each tower is only ~0.1% or less of strips in a tower.
- The number decreased in most of towers (see next)

Disconnected Strip Monitor

The number of disconnected strips



Fluctuation of # of disconnected strips



- Disconnected strips are due to failure of wire bonding between two SSDs or SSDs and pitch adapter.
- ~1400(~2.5%) hot strips found at FMA.
  - Due to initial encapsulation process.
  - Process improved and the number of disconnected strips decreased down to ~200, less than 0.4% of strips in a tower
- Fluctuation well understood: most of "new" disconnected strips were originally classified as hot strips.

Conclusion

•TOT calibration parameters have been monitored and found to be stable.
•Some unstable parameters were found not due to the hardware problem, but due to minor bugs in test script. Trending monitor gave back feedback to TKR test procedure.

• Bad strips have been also monitored. The number of bad strip is less than 3% (TkrFMA) and less than 0.4% for all others.
•The fluctuation of bad strips is well understood.

In summary, TKR is in good condition, and TKR team established the way to monitor the performance of towers.

TM would like to thank to H. Tajima, M. Sugizaki and All TKR team members for their devoted help to Takuya Kawamoto. He obtained a master degree of physics through this trending monitor work.