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)
Note: The diagram represents time series data of Circuit Gain Monitor.

- **Mean**: Shows the average circuit gain across different test dates.
- **RMS by Tower**: Illustrates the root mean square (RMS) variation in gain per tower.
- **Dates**:
  - 4/28
  - 5/12
  - 5/27
  - 6/2
  - 6/20
  - 7/12
  - 7/14
  - 7/20
  - 8/11
  - 9/28
  - 9/29

The diagram highlights:
- **Supplied Voltage Changed**
- **Timing Changed**
- **Adjusted TACK Timing**

- **Circuit Gain**: Output Voltage and Injected Charge.

- **After adjusting TACK timing**, the gain has been **stable** throughout 6, 8, 10, and 16 tower test periods. **Stable!**

**Dates of Interest**:
- **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
Charge (fC) = p0 + p1*TOT + p2*TOT²

- Parameters have been stable in the latter part of the test.
Bad Strip: Dead + Hot + Disconnected

Maximum increase of all bad strips is 25, less than 0.05% of strips in tower.
Dead Strip Monitor

The number 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 $\sim 0.1\%$ or less of strips in a tower.
- The number decreased in most of towers (see next)
Disconnected Strip Monitor

The number of disconnected strips

- 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.

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