Module Production and Testing in the U.S.

Last month we had a two day workshop on production and testing at the two U.S. sites.

Wim Beaumont participated by VRVS in the multi-rod session.

<u>All aspects</u> of production – from hybrid reception to rod shipping – were reviewed with the idea of making the procedures as common as possible, identifying potential problems, and trading knowledge bases from the two sites.

The workshop allowed a fruitful pairing of counterparts from FNAL and UCSB.

Elements of the production and testing processes that received particular attention included

- **A problem noted by UCSB with their conductive epoxy connections.**
- **Wire bond encapsulation.**
- **An issue that has arisen with the module noise cuts in the ARCS tests.**
- **The status of the multi-rod systems.**

Module Production Summary

Both FNAL and UCSB resumed module production late last year using qualified components but distinguishing between version 4 and version 5 hybrids (pairing version 4 with STM sensors and version 5 with HPK sensors).

- **We have not been able to use the full set of version 4 hybrids due to a mismatch with hybrid type and STM (>=lot4) sensor type for the components on hand.**

127 modules have been constructed at FNAL

- **108 HPK**
  - **84 L34, 24 L56**
- **19 STM**
  - **12 L12(p), 7 L34**

65 modules have been constructed at UCSB

- **26 HPK**
  - **24 L34, 2 L56**
- **33 R5S (TEC)**
- **6 R5N (TEC)**

Version 3 ⇔ sub-type 17
Version 4 ⇔ sub-type 18
Version 5 ⇔ sub-type 19

Module Production Summary

At FNAL

- **HPK**
  - **1 (marginal) Gantry placement failure, 2 handling accidents**
- **STM**
  - **1 >2% bad channels (*positive* noise)**

At UCSB

- **HPK**
  - **1 IV failure**
- **STM**
  - **1 CMN, 1 handling accident**
  - **3 modules used for irradiation studies**

Otherwise all modules are grade A per the testing specifications. No common mode noise was observed in any of the 134 HPK modules.

Steps have been taken to prevent, or at least limit, future handling accidents.

ARCS Noise Issue

We resumed production at FNAL starting with HPK sensors and noticed that the average noise was lower than what we had seen in the past, especially for 4-APV modules.

- **Low noise is good but this leads to a practical problem as a significant fraction of the modules fail the ARCS low noise absolute cut.**
  - **We do not upload XML files for 'failing' modules and this in turn becomes a problem for the module and rod LT comparisons.**

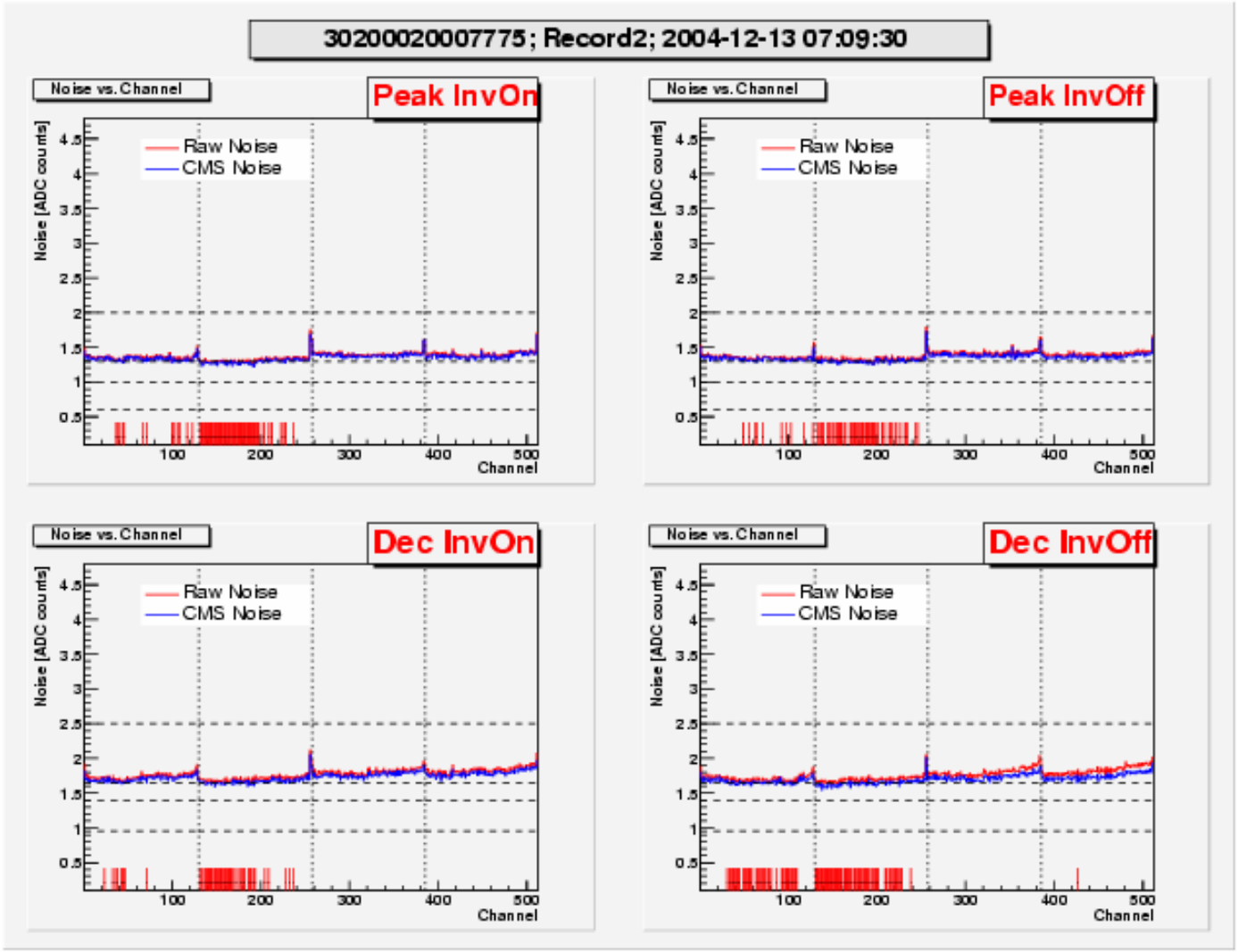
At first we suspected the difference was due to change from STM to HPK sensors, but subsequent production with STM sensors also showed lower noise.

- **We have also ruled out the upgrade from ARCS version 7.0 to 7.2 as a source of the difference as well as any hardware changes.**
  - **Previously produced modules have unchanged noise performance.**

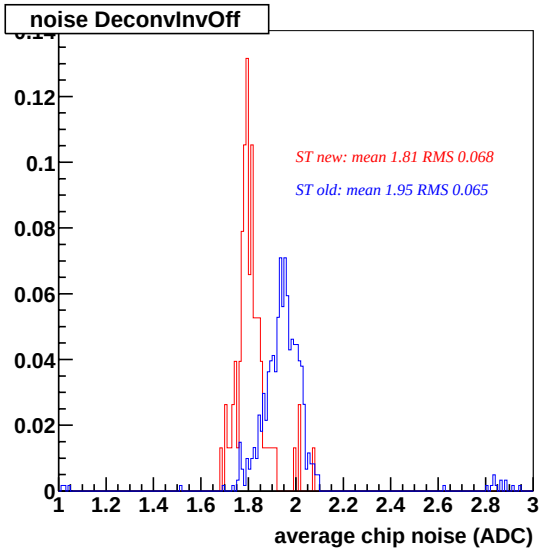
Given the evidence that the change is coming from the hybrids and may even be batch related, we feel that the best solution would be to switch form absolute to relative cuts.

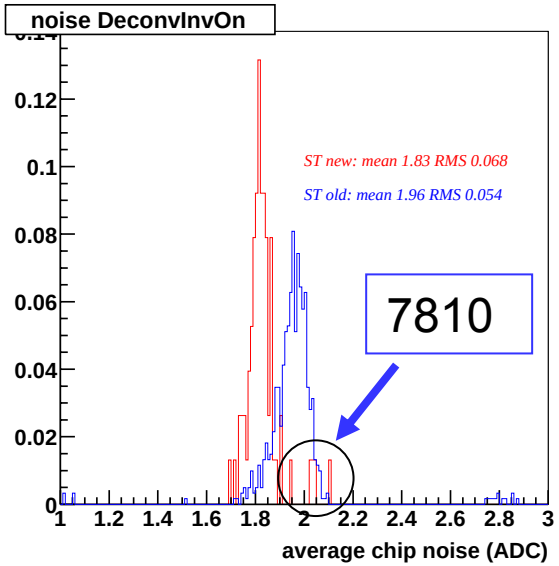
- **An additional check could be made that the average noise is not too high.**

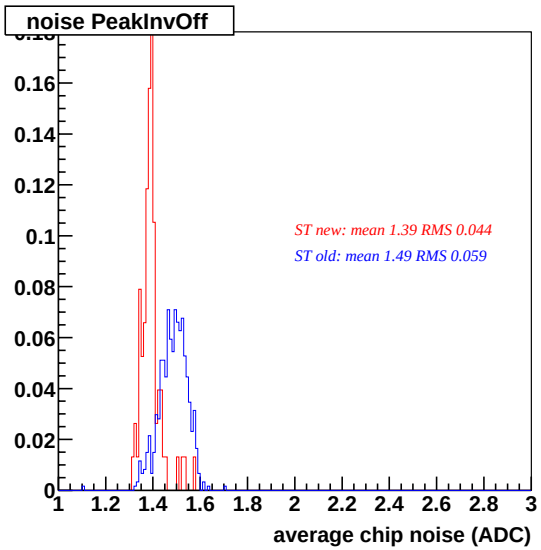
ARCS Noise

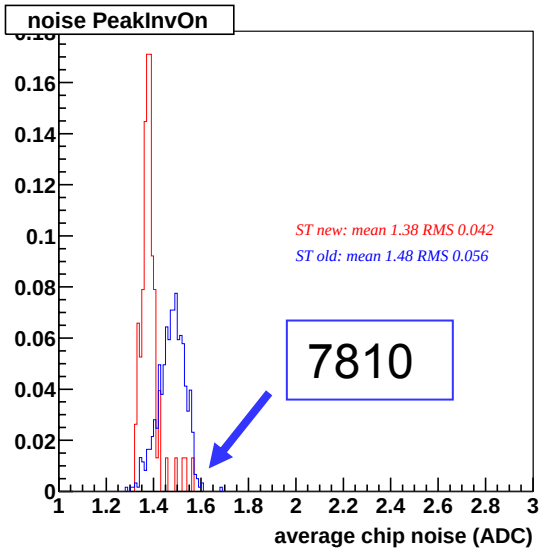

30200020007775; Record2; 2004-12-13 07:09:30
Noise vs. Channel
Peak InvOn
Raw Noise
CMS Noise
Noise [ADC counts]
Channel
Noise vs. Channel
Peak InvOff
Raw Noise
CMS Noise
Noise [ADC counts]
Channel
Noise vs. Channel
Dec InvOn
Raw Noise
CMS Noise
Noise [ADC counts]
Channel
Noise vs. Channel
Dec InvOff
Raw Noise
CMS Noise
Noise [ADC counts]
Channel

TOB2: STM(v4) vs STM(v3)

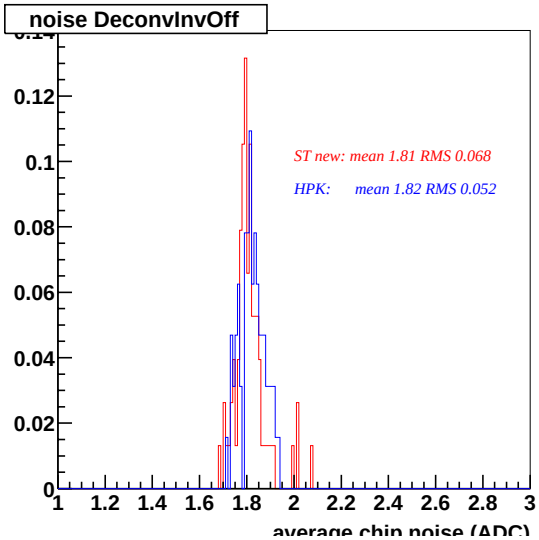


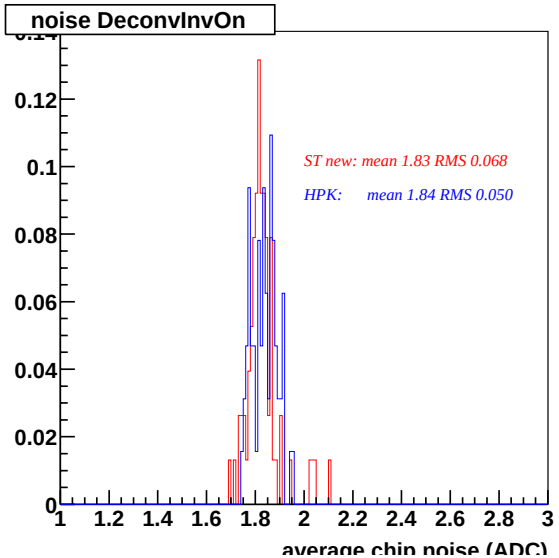


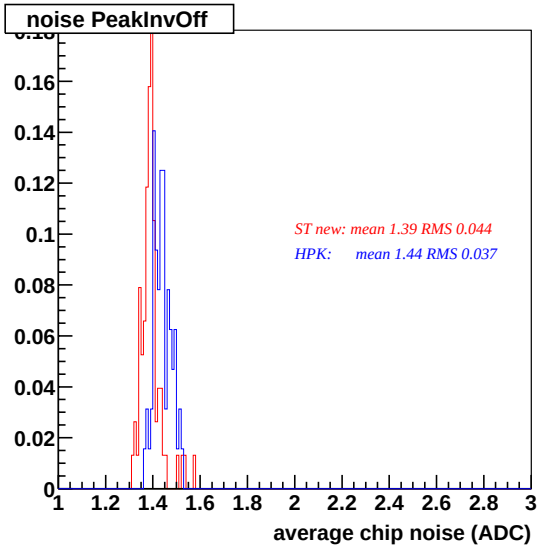


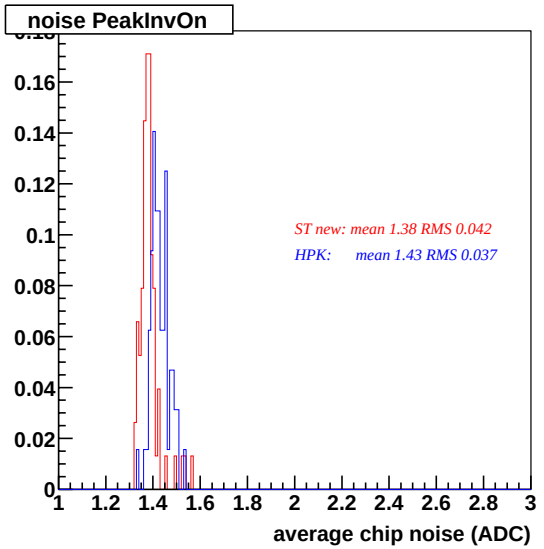


TOB2: HPK(v5) vs STM (v4)

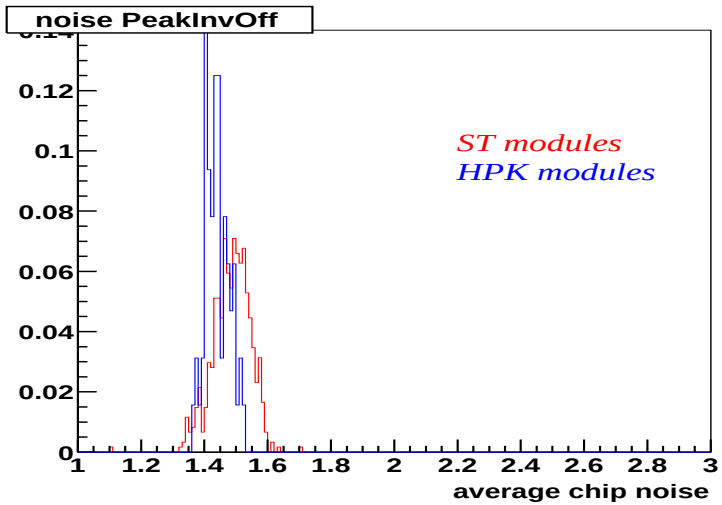


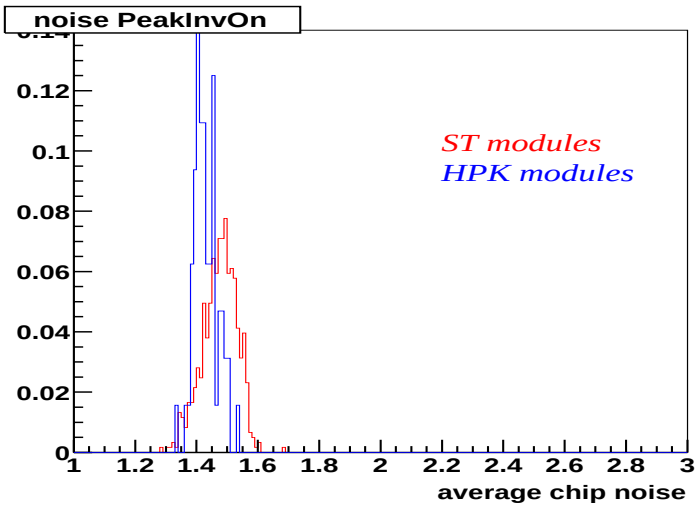


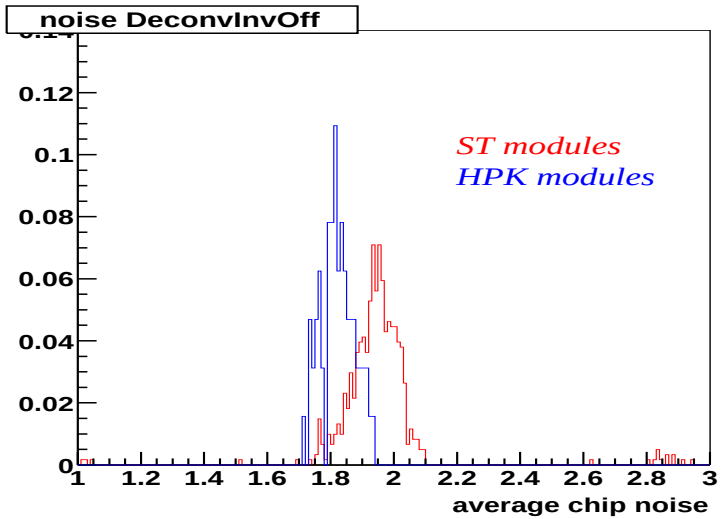


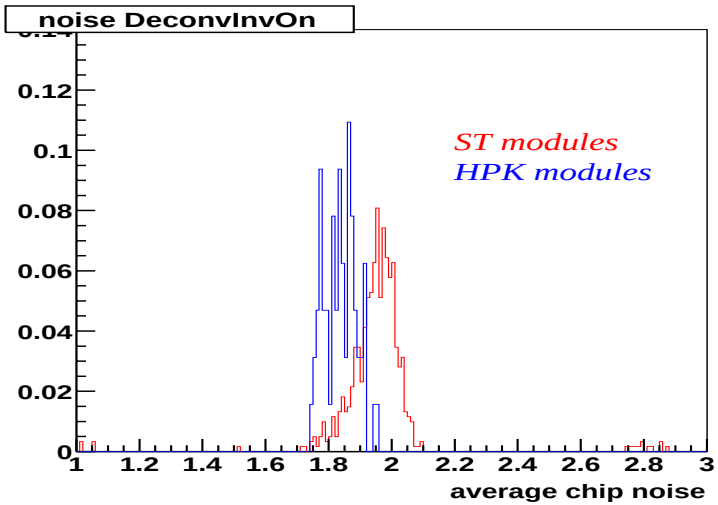


TOB2: HPK(v5) vs STM(v3)

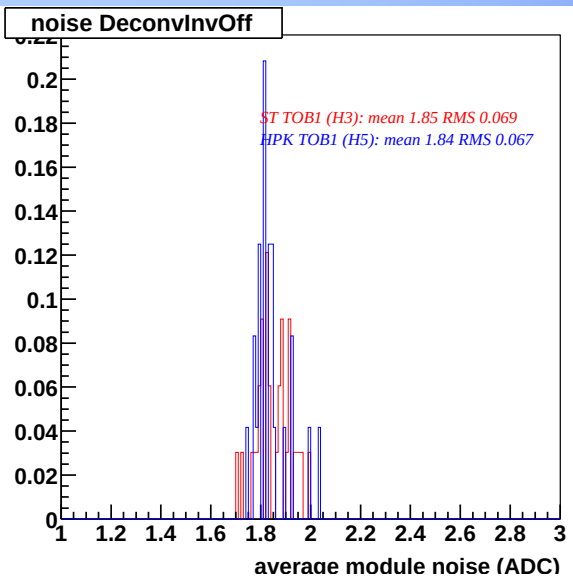


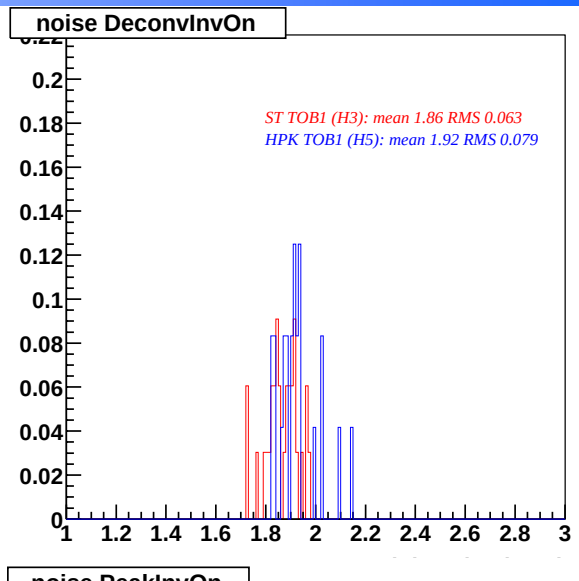


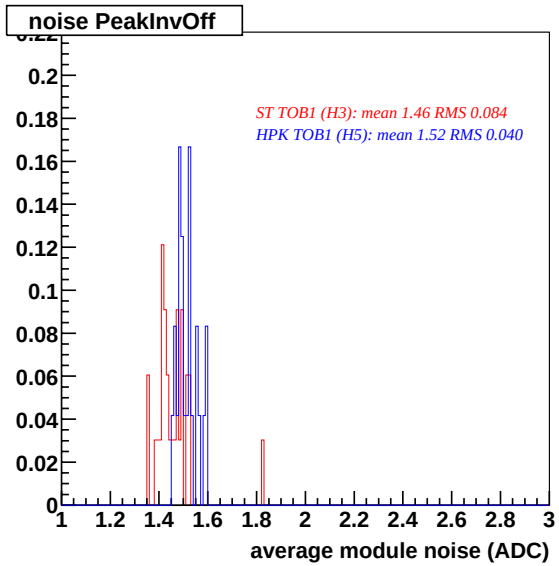


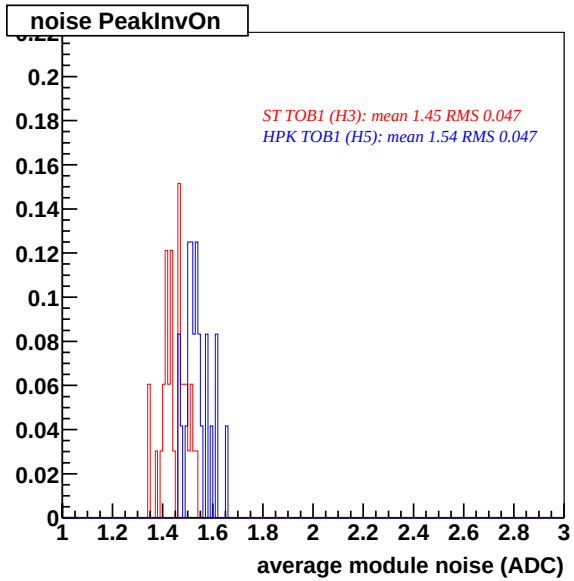


TOB1: HPK(v5) vs STM(v3)









Module LT Systems

As of last month both LT systems have reached their full and final forms. The last steps included

- **The backplane modification at FNAL.**
- **Upgrading from CCU6 to CCU25 boards at UCSB.**

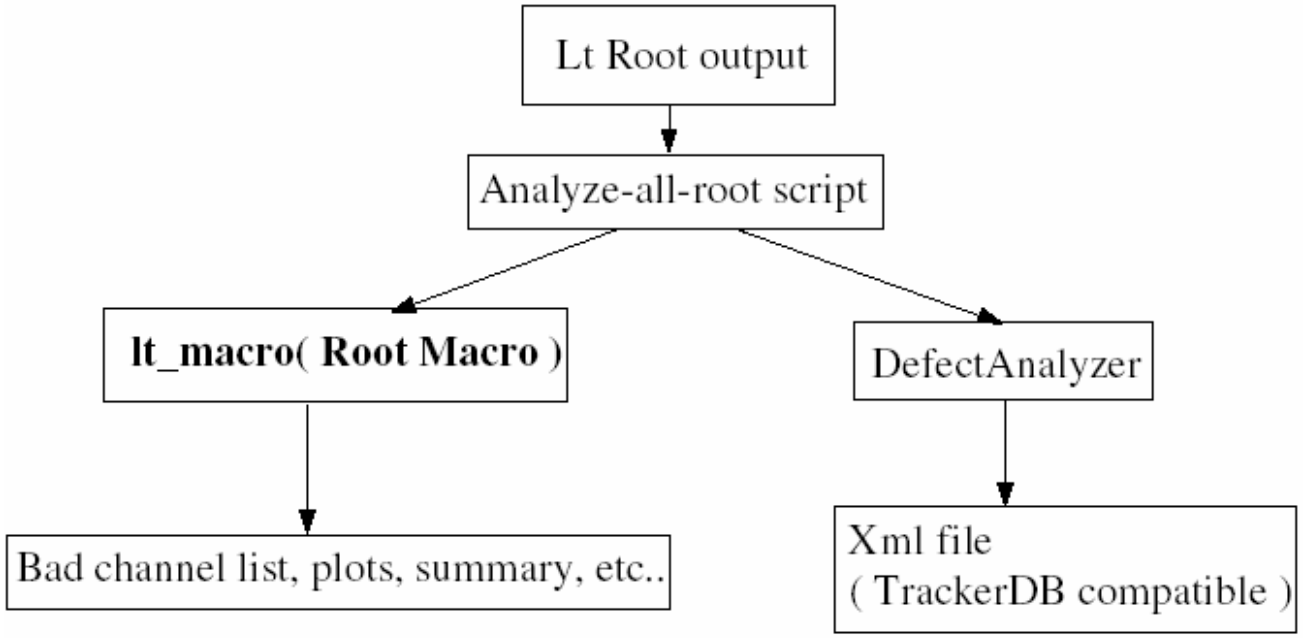
Following the backplane work at FNAL, we ran a scenario with 10 modules and the results were flawless – no I2C errors, no missing records, and no HV problems.

The standard LT scenario runs for 12 hours.

- **This limits us to 20 modules per day per site for full testing.**

Module LT Defect Analysis

LT data analysis flow

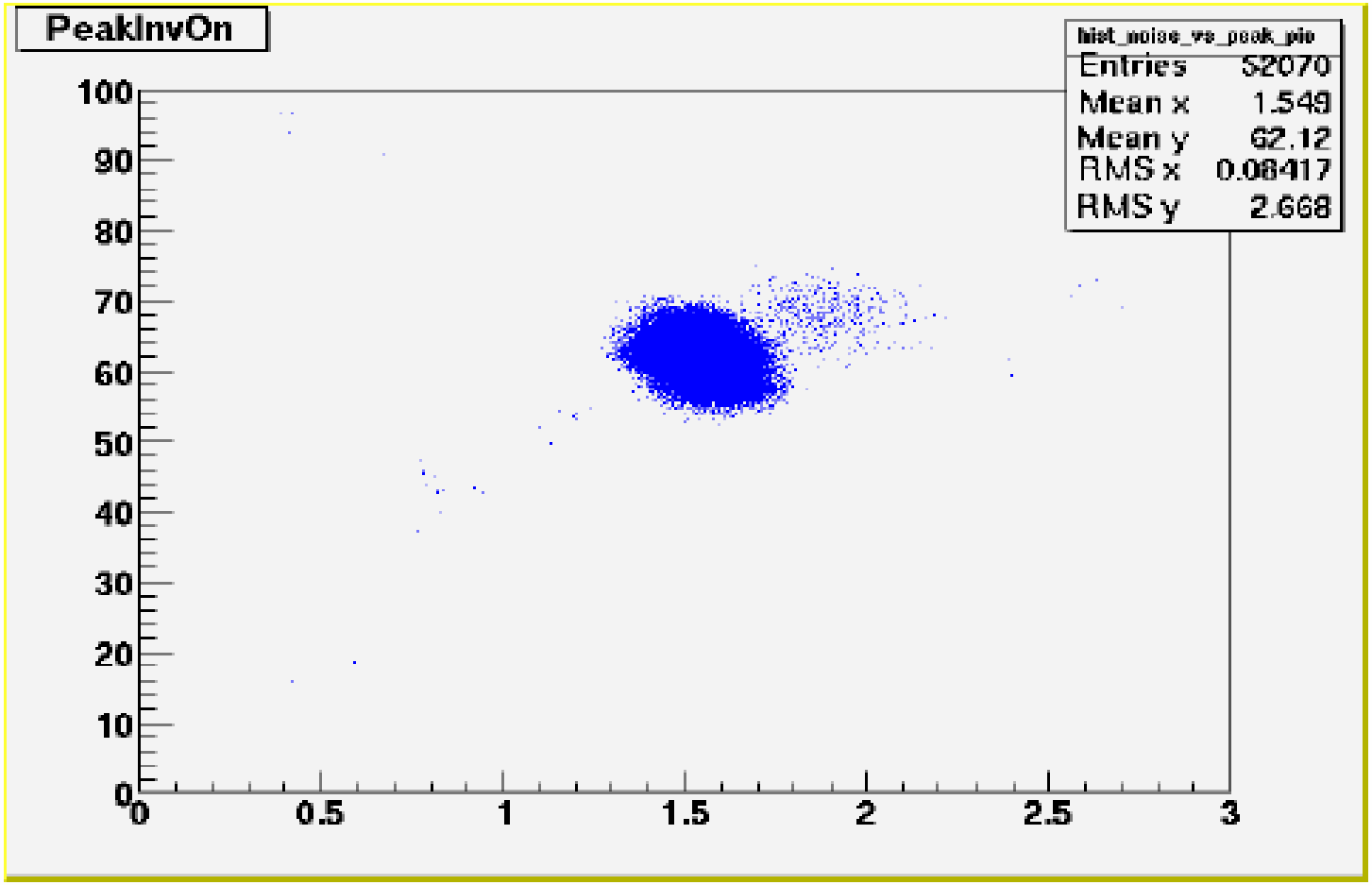


Following modules records had "string literal too long" and caused ERROR:ORA-01704:

7702 7703 7705
7706 7707 7721

Some work is necessary to consistently generate legal XML files.

Module LT Defect Analysis



FNAL LT Defect Analysis

Modules 30200020007702 – 7809.

List of bad channels:

7706 - 177 tso
7721 - 90-98 sht
7722 - 58 oso, 332 tso
7723 - 468 oso
7724 - 397 oso
7725 - 272 oso
7731 - 512 oso
7738 - 371 tso
7746 - 189 tso
7755 - 510 tso
7760 - 1 oso
7761 - 20,21 sht, 22 oso
7764 - 98 tso
7772 - 82 tso
7773 - 372 oso
7777 - 367 tso
7783 - 402 tso
7784 - 291 oso, 441 tso
7785 - 492 oso
7793 - 31,32,33 sht
7801 - 24 tso
7804 - 236 tso
7807 - 151 tso

29 bad channels out of 108 modules with overall
84 x 512 + 24 x 768 = 61440 channels.

There is one case – one channel – where the ARCS found a oso but the LT did not.

FNAL LT Performance

Modules 302000200007702 – 7809.

During testing several problems occurred:

- I2C errors
- Missing records
- HV crate trip

List of bad runs for modules 30200020007702-7809:

7704 – missing pkinvoff records in all tests
7718 – i2c errors in cold record
7750 – i2c errors in all tests
7754 – i2c errors in cold and last records
7775 – missing last record
7793 – missing first record
7794 – i2c errors in last record
7797 – lost HV bias during first IV Run

Prior to backplane modification!

Missing records – suspecting a software bug, contacted Wim Beaumont.
I2C Errors – related to coldbox backplane problems (loose connections), expecting to be fixed after backplane modification,
HV problems – HV channels are tripping if fail to establish set value within few seconds

Single-Rod Systems

The single-rod system at FNAL was recently modified to allow chilled water cooling of the test box.

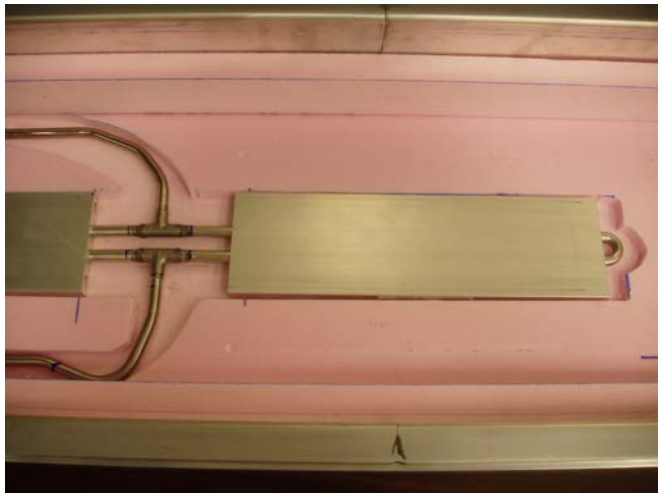
- **May be important for double-sided rods or cases where a rod is powered for longer than the usual 15 minutes.**
- **UCSB is looking into a similar modification for their test box.**

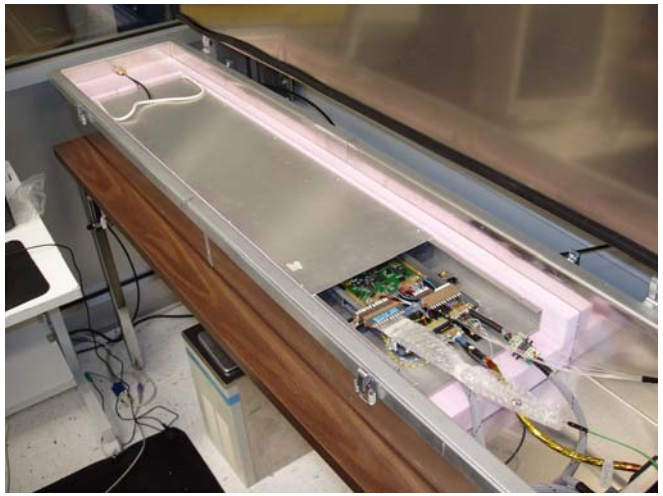
<u>The single-rod systems have been relatively stable at both sites for many months now</u>.

- **We have run into some problems in trying to upgrade to LT_struct v23 at FNAL.**

Single rod testing is intended as a quick screening for the multi-rod systems.

- **No defect analysis**
- **No XML files**





Multi-Rod Systems

Quick summary (more detail in TOB meeting):

Both systems are now being tested at their full capacity

- **8 SS4 rods or 6 SS6 rods** Both sites have assembled ~20 rods

Spurious interlock trips have been eliminated

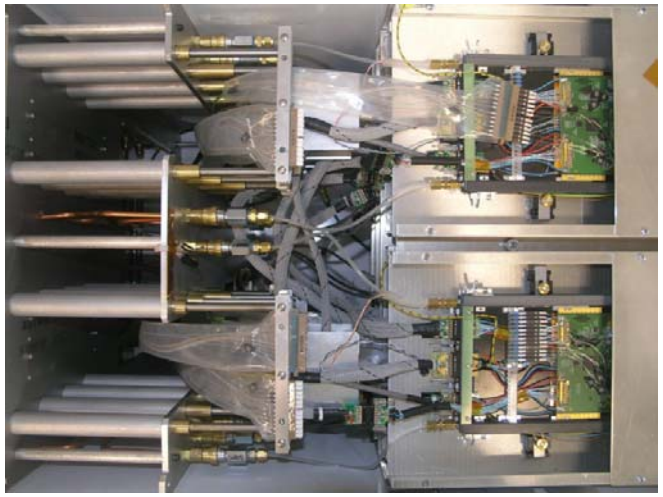
Wim Beaumont has access to both systems and as recently released LTStruct v23

- **Several bug fixes**
- **Allows for scenario recovery**
- **Overall system stability dramatically improved**
  - **Hundreds of consecutive Pedestal and dozens of TimeTune and OptoScan runs for 8 SS4 rods without errors at FNAL.**
  - **8 rods put through ~ 30 thermal cycles at UCSB**

Still observe some hardware access errors from the FEC device driver, I2C errors, empty FIFO errors, FED device loop errors, and occasional DAQ hanging and crashes.

- **Debugging in progress**

Multi-Rod Systems



Other multi-rod updates

- Scenario progress and log files are now remotely monitored through a web interface
- Strain relief for fiber optic bundles has been improved
- Grounding schemes are now identical at the two sites
- Electronic logs used to report progress on testing and debugging
  - http://cmsdb.fnal.gov:8080/mrt/