US Module Testing Update

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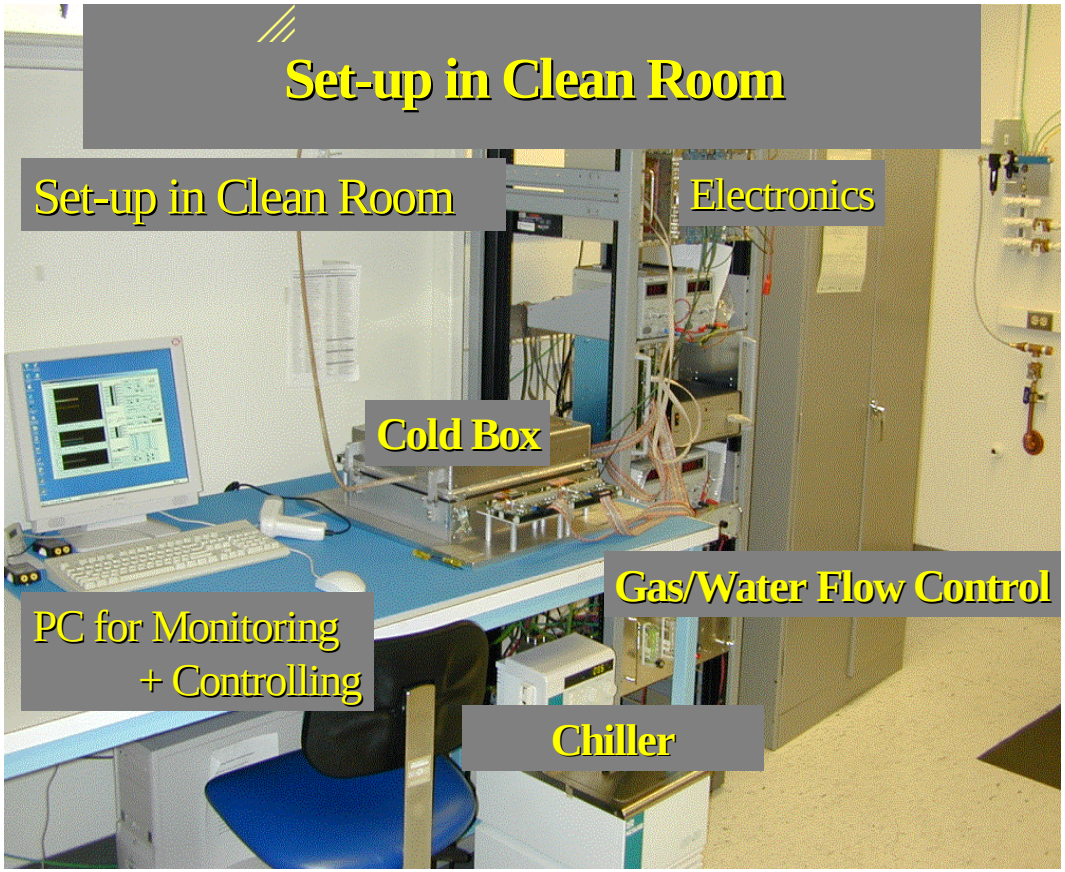
(On behalf of the US testing group)

Update of Readiness

Description of Production

New Studies of CMN Modules

Hybrid Wire Bonding/Thermal Cycler

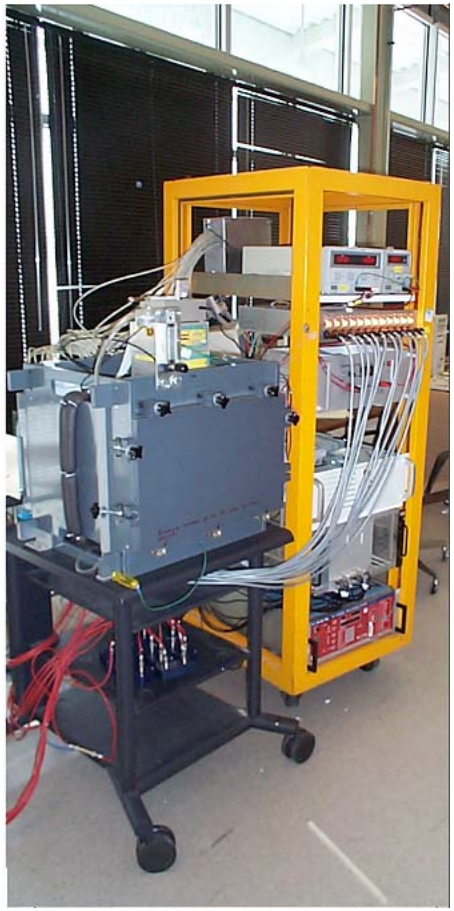


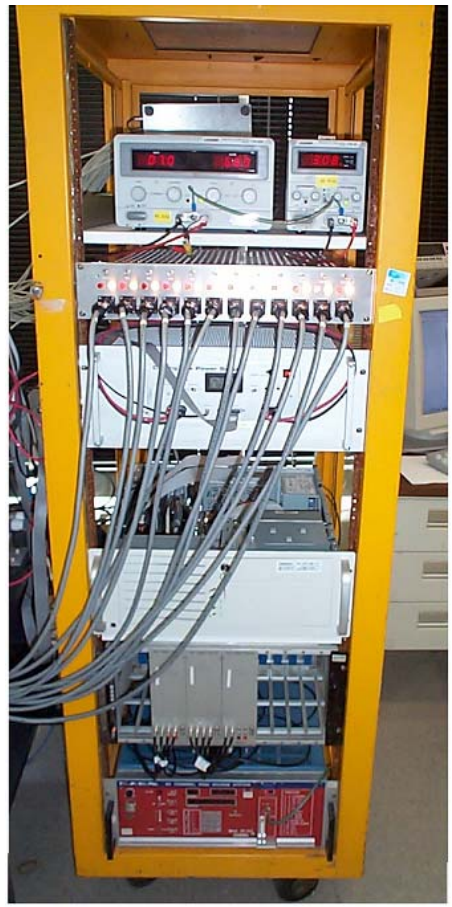
- 80 hybrids bonded and thermal cycled
  - 4 PLL failures at -20 C
  - 2 APV failures
  - Opens
    - 2 hybrids with 1 open
    - 3 hybrids with 2 opens
    - 1 hybrid with 3 opens
    - 1 hybrid with 4 opens
    - Opens due to AL pulling off PA
- UCSB thermal cycler fully commissioned
- FNAL thermal cycler built and being shipped
- Beginning to assemble test stand for Mexico City

Soon will have capability of ~80 hybrid thermal cycles per day

FNAL Vienna Box

- Fully Operational
  - Installed F-MUX, TPO, NIM2LVDS, electrometers
  - Calibrated electometers readout
- Ready to thermo-cycle 10 modules at one time, ready to run 10-14 hours scenario with 3 thermal cycles, PedRun, CalRun, IVRun.
  - Multiple people are trained to operate Lt stand (2 grad. students, 2 technicians)





UCSB 150 Module Production

- Goals
  - To establish new peak production capacity (15 modules/day)
    - Determine if testing capabilities sufficient
  - Build as many modules as possible using new ST sensors as agreed upon in December
    - Use sensor grading scheme to find out if subclass of perfect sensors exists
- Results
  - Easily met testing capacity needs
  - Extremely low rate of introduced failures seen
  - CMN modules occurred at same rates as previous builds using re-probed sensors
    - Did not appear to depend on production period or sensor grading

New UCSB Production

- Expected peak production rate of 15 modules/day maintained over a two week period (150 modules)
  - Modules used sensor grading scheme by Vienna (A+,A,B)
- Complete set of module tests made
  - ARCS quick test
  - Module thermal cycle (Vienna Box)
    - 1 thermal cycle for each module (~7 hours)
  - After thermal cycle LED tests
- From this exercise, it is clear that we will be able to test the 15 module/day peak rate

UCSB Module Quality/Grading

- 117 modules tested so far
- Failure rates/sources (excluding CMN modules)
  - 0.39% Bad channels on average
    - 0.26% Known bad sensor channels
    - 0.13% Unmarked bad sensor channels
    - 0.004% open hybrid-APV bonds
    - 0.001% module bonding
    - 0.002% testing errors
  - Less than **0.01%** bad channels introduced during assembly/bonding/testing
- Module Grading
  - 103 Grade A
  - 5 Grade B
    - All due to sensor faults
  - 7 Grade A/F
    - 6 CMN modules
      - 1 after thermal cycle
    - 1 module fails to operate at -20 C
      - Tested in 3 different Vienna box slots
  - 2 Grade C/F
    - 12 mid-sensor opens in aluminum strips (lithographic errors)
    - 1 CMN module

UCSB Thermal Cycling Results

- 101 modules thermal cycled
  - One module does not function at -20 C
    - Tested in 3 different cold box slots
    - Hybrid bonded and thermal-cycled at UCSB without seeing this effect
  - One module developed CMN
    - Prior to thermal cycling, the channel had 10 ADC noise
    - Now consistently has CMN
  - One module have a single APV channel burn-out
  - Multiple noisy channels (2-5 ADC) appeared and disappeared after cycling

CMN modules and sensor grading

Sensor Grade	2001-2			2002-3			2003		
	NUMBER	CMN	%	NUMBER	CMN	%	NUMBER	CMN	%
GRADE A+	29	1	3.4%	4	1	25.0%	12	0	0.0%
GRADE A	38	2	5.3%	11	1	9.1%	16	1	6.3%
GRADE B	0	0	0.0%	6	1	16.6%	1	0	0.0%

- Sensors graded using Vienna rules
  - All sensors were re-probed prior to assembly
  - Worst sensor grading out of two measurements used
- Sensors sub-divided into three time periods
  - 2001-2
    - Prior to Week 39, 2002 (Pre-production)
  - 2002-3
    - Week 39, 2002-Week 12, 2003 (Production improvements being implemented)
  - 2003
    - Week 13, 2003-now (Final Production)
- 7 Common mode modules found (6% of production)
  - Same rate as seen previously with re-probed sensors
  - 1 after thermal cycling
- No statistically significant difference rate in CMN modules for the different sensor grading

FNAL module testing summary

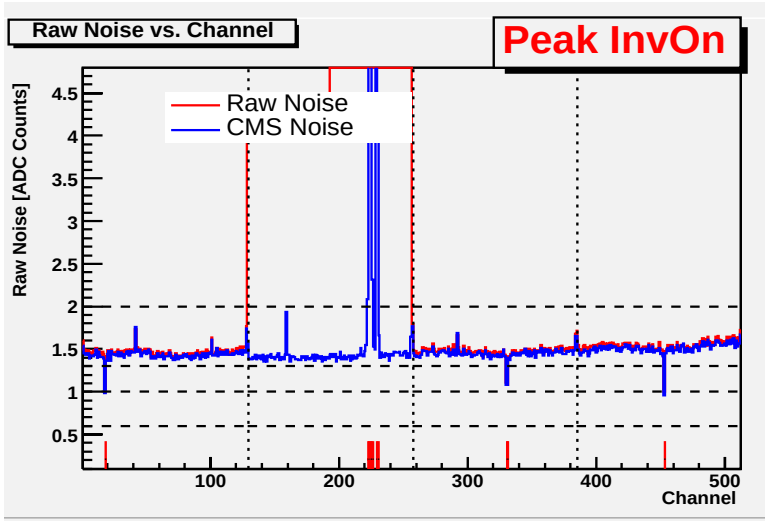
- 7 modules are produced in December-January
- Sensors were selected to have current below 1.5 μm

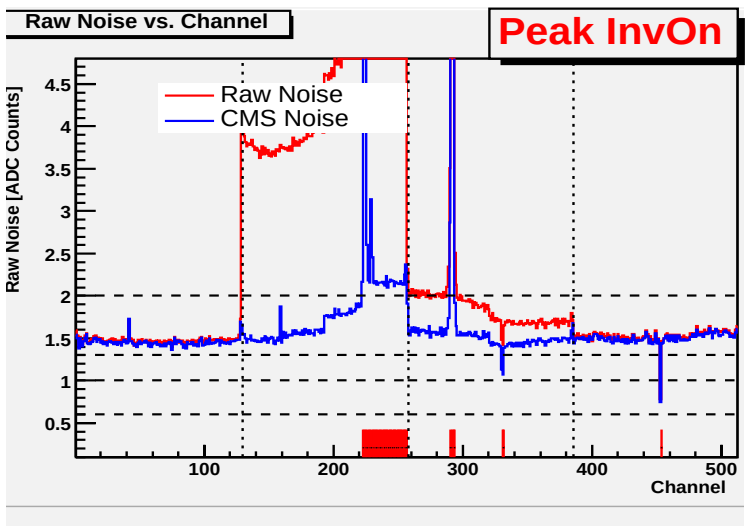
	Module	709	710	711	712	713	714	715
sensors	**# of bad channels**	**5 (72,74,82, 511,512)**	**0**	**1 (333)**	**1 (232 - Istrip)**	**2 (143) (201 – Istrip)**	**1 (202)**	**1 (281 - Istrip)**
Module Information	**Current (μA)**	**4.0**	**4.0**	**3.6**	**3.6**	**3.5**	**3.2**	**3.5**
	# of bad channels	**5 (72,74,82, 511,512)**	**0**	**1 (333)**	**0**	**2 (143, 486)**	**1 (202)**	**0**
Grade		**A**	**A**	**A**	**A**	**A**	**A**	**A**
After Long term		**ok**	**ok**	**278 (noisy)**	**ok**	**ok**	**ok**	**ok**
Additional information				PH (#512) repaired	PH (#512) repaired	**Metallization problem** **Pinhole #486 pulled**		

FNAL Retesting of CMN Modules

- 5 CMN modules still at FNAL studied further
  - Standardization of CMN module measurements
    - Turn-on point, determination of bad sensors, etc.
  - Serves as a measure of the stability of CMN modules
- Results
  - 2 of the 5 modules had degraded even further
    - Addition pinhole and additional CMN chip found
  - Turn-on of CMN effects occur near depletion voltage

Module Time Degradation- Module 689

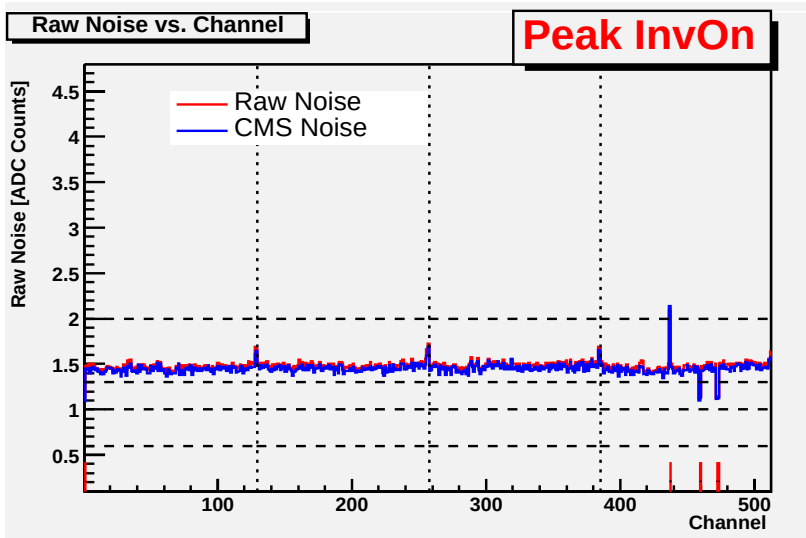


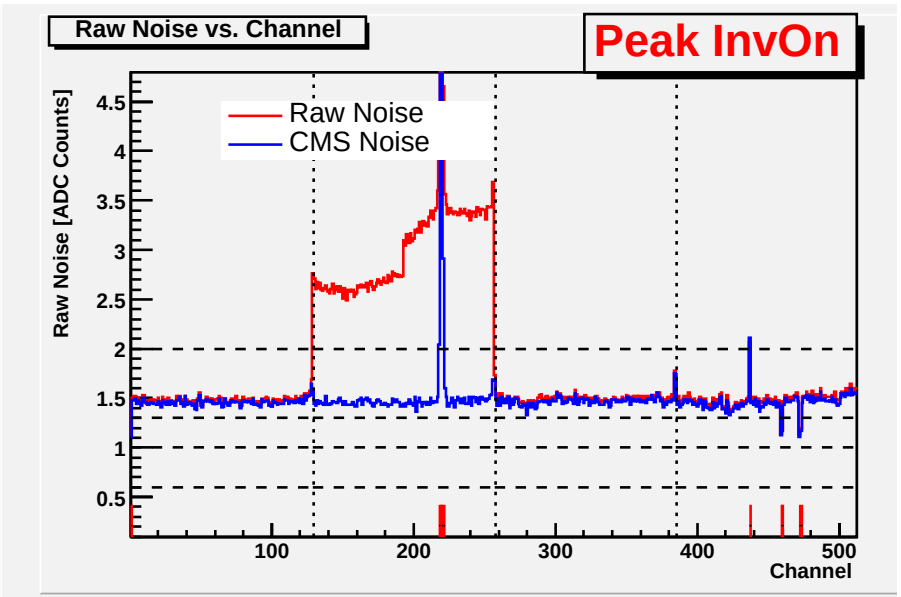


- After 3 months on shelf, module retested
- Second chip now has a high noise channel which causes common mode noise
  - Channel previously only had a slightly higher noise

Module Time Degradation-705

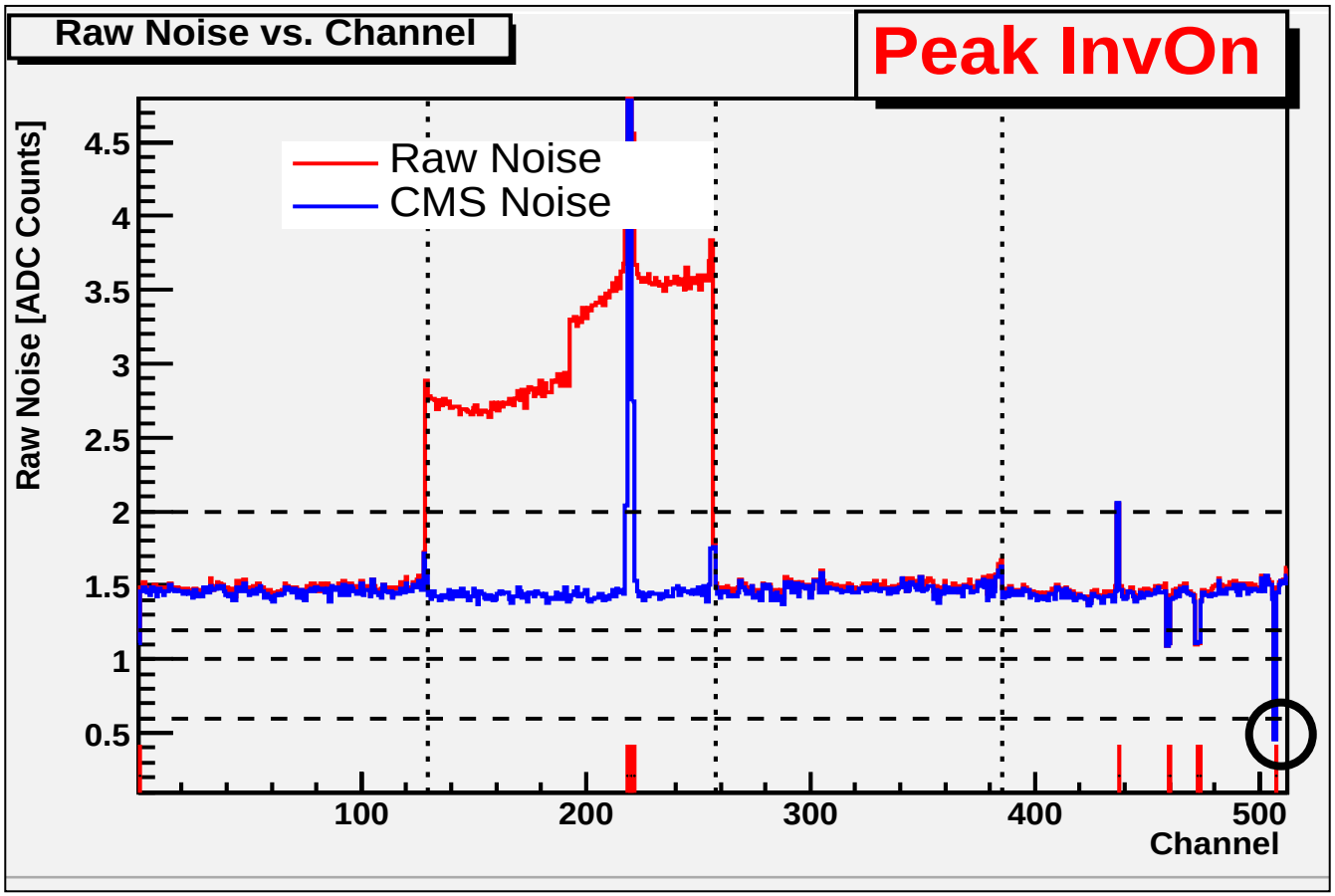
•After assembly module was tested (09/08) on ARCS at 400 V and graded “B” (6 faulty channels). No problems observed.





•After LT, one chip shows CMN

Module Time Degradation-705 II



After sitting on shelf for more than 3 months, module re-tested. A new pinhole is found

Conclusions

- The last few months has been a period of extreme growth in the US
  - Rod burn-in stands under commissioning at both FNAL and UCSB (see P. Tipton's talk)
  - Both sites have commissioned Vienna cold boxes with all 10 slots operational
- At UCSB, ability to test at peak production rate of 15/day demonstrated for 2 week period
  - Modules have excellent quality BUT CMN modules are still being produced at the ~5% rate!!!!
    - Same as rate seen before in modules using good re-probed sensors
- At FNAL, 2 of the 5 CMN modules still available are showing an increasing number of problems
  - More CMN chips and pinholes
  - CMN turn-on occurs near depletion voltage
    - Same as UCSB