



US Module Testing

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On behalf of the US TOB testing group

6/3/03



Electronics Testing Group

- Fermilab (FNAL)
 - S. Tkaczyk +2 technicians
- University of California, Riverside (UCR)
 - Gail Hanson, Patrick Gartung, Gabriella Pasztor
- University of California, Santa Barbara (UCSB)
 - A. Affolder, S. Burke, C. Campagnari, D. Hale, J. Incandela, S. Levy, S. Stromberg +2 Undergraduate Students
- University of Illinois, Chicago (UIC)
 - E. Chabalina, C. Gerber + 1 Graduate Student
- University of Kansas (KU)
 - A. Bean, L. Christofek, D. Coppage
- University of Rochester (UR)
 - R. Eusebi, A. Hocker, P. Tipton + 1 Graduate Student



Current Status

- We currently have 35 M800 hybrids.
 - All have been tested and ready for module production.
 - We found 2 broken bonds in first visual inspection, and then a 3 broken bond in second visual inspection.
- 18 prototype modules constructed at Fermilab
 - Used in rod prototypes and beam tests
 - All of extremely good quality
- 8 production modules constructed each at UCSB and Fermilab.
 - All are fully characterized and working well, damage to wire bonds occurred in shipping.
 - <0.5% bad strips introduced in production at both sites
- Upgraded to ARCS 6.0.



Fermilab Clean Room



- We are only testing now in the clean room. We have 10 m x 7 m, Hybrid storage is in a dry box.



UCSB Testing Clean Rooms

- Clean room adjacent to production area 29 m² recently completed

- Move into clean room went smoothly
- All stands fully functional



- >100 m² clean room dedicated solely to TOB rod assembly/testing

- Removed gantry, wirebonder, OGP from space and into new clean room
 - Space available for rod assembly/testing
 - Simplifies transportation/storage of rods



Long-term Module Storage



- We have three cabinets at FNAL and one cabinet at UCSB for module storage
 - Each cabinet holds 300 modules and has compressed air flowing through box
 - Shelves made by KSU machine shop.



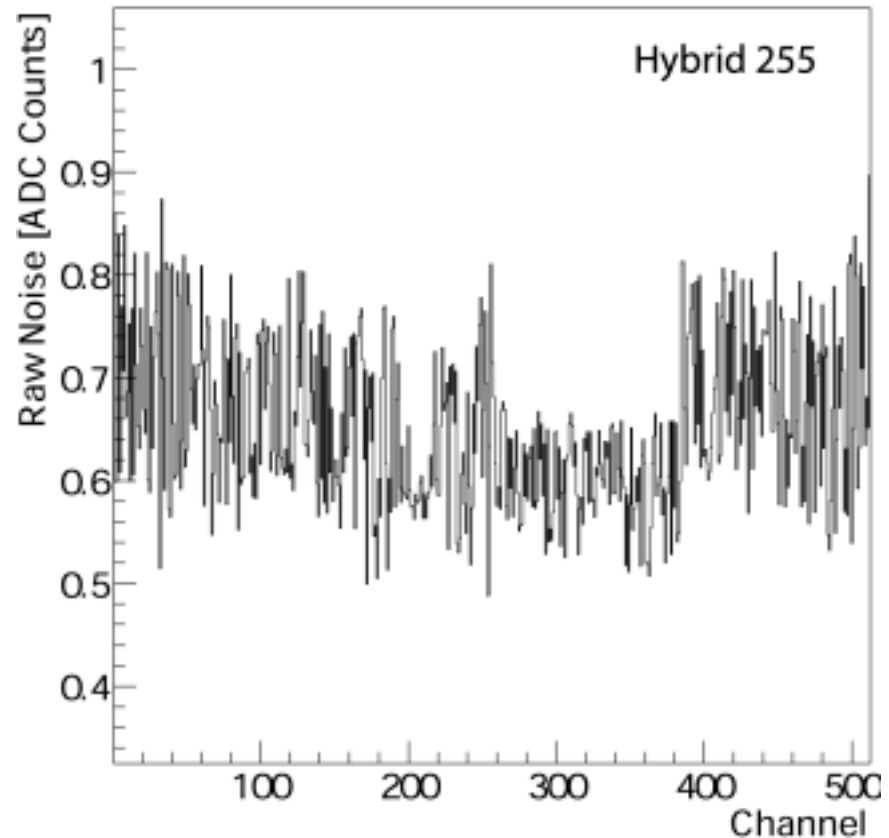
ARC Hybrid Test Results

- 4 (11) hybrids have had APV bonded to pitch adapters at UCSB (FNAL)

- 2 opens developed in 7680 channels
 - Final pitch adaptors will be more uniform → even better bonding performance

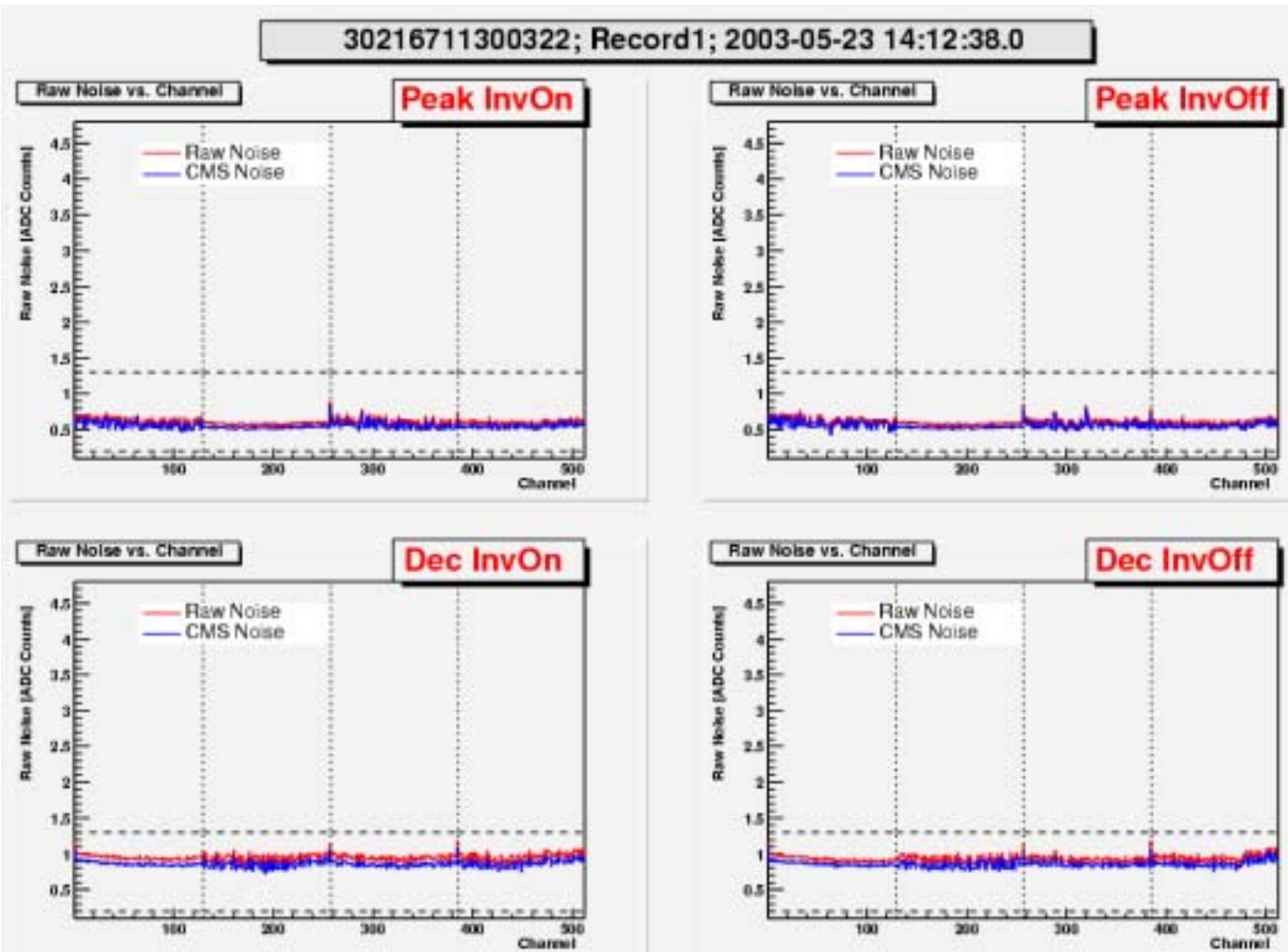
- Hybrid clamshells enable testing without large pickup effects at chip edges

- Same requirements can be made for hybrids with or w/o PA bonded





Hybrid Testing Results



- No wings in the data because the system is properly grounded!
- We are using the absolute value cuts suggested by Tony Affolder and Stephen Levy:
min = 0.2 ADC
max = 1.3 ADC
- All hybrids have passed, no bad or noisy channels.



Hybrid Thermal Cycler

• Hybrid pitch adaptor pulsing/thermal cycling test

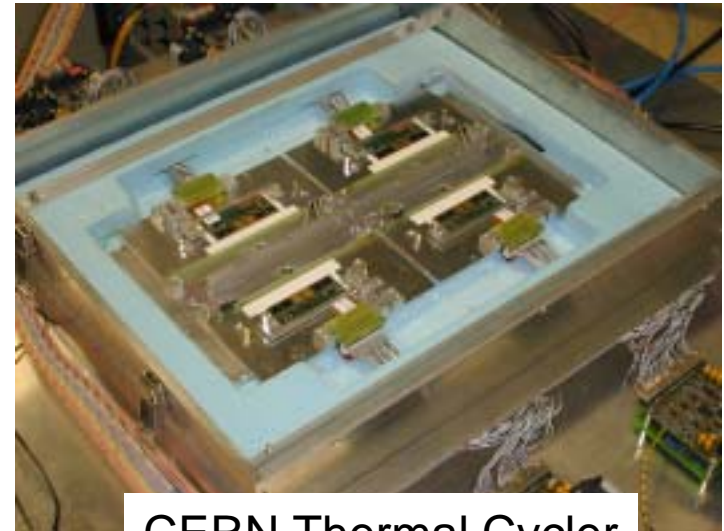
- Acts as short-term burn-in (20 minutes)
 - Hybrids (and components) tested for several minutes prior to arrival

• Very custom set-up

- Sam Burke (UCSB) has begun design work for electrical system
 - Baseline provided by CERN
- Dave Hale (UCSB) has begun mechanical design
- Software for data acquisition and interlocks provided by CERN

• System should be operational in time for need (late summer)

- Test/bonding performed by CERN for M800 hybrids



CERN Thermal Cycler

If failure rate determined to be low after first 200-300 hybrids, will only sample test hybrids



Module Testing Results

30200020000665; Record1; 2003-05-14 09:48:54.0

Because system is grounded properly, we can see the individual features clearly.

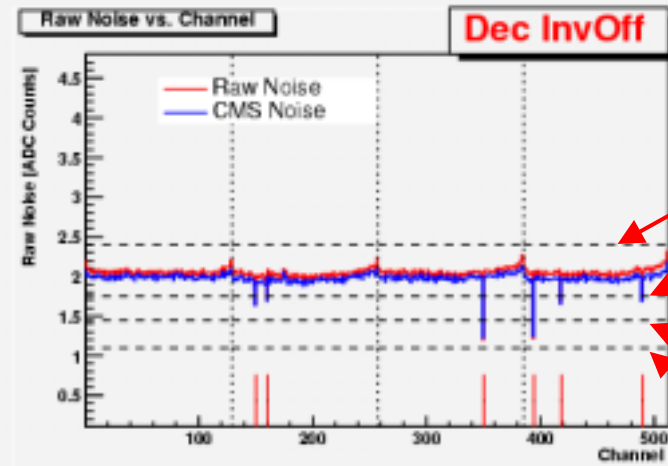
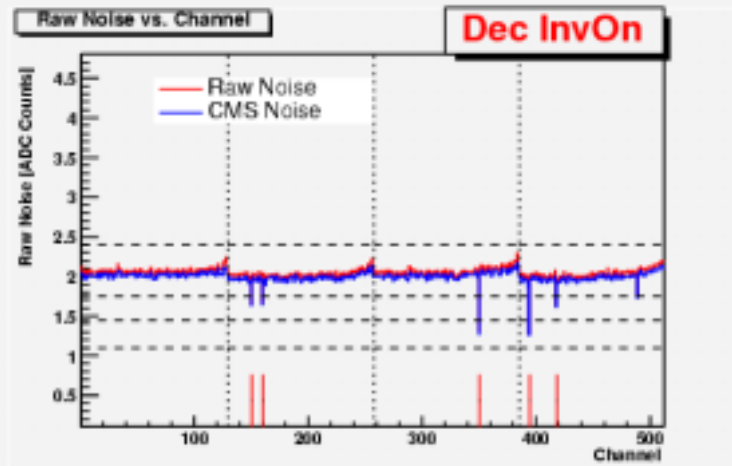
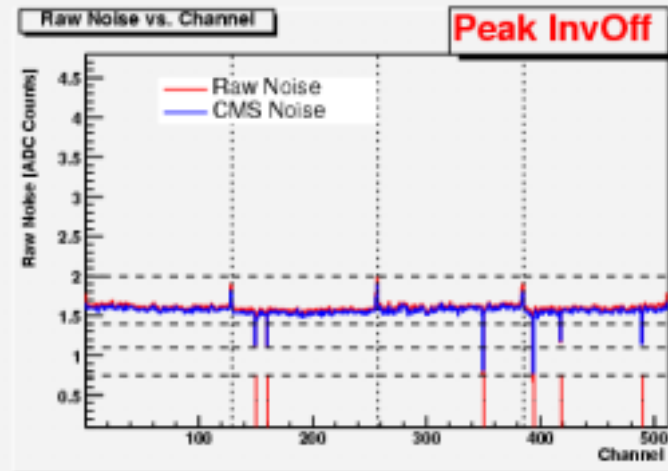
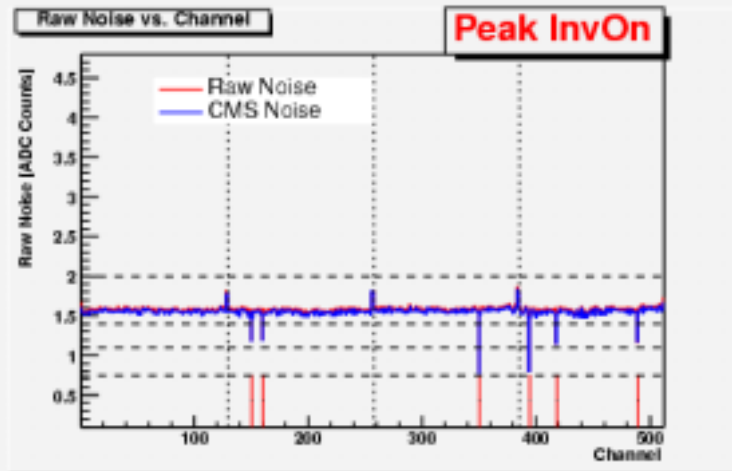
← Flagged channels

Noisy channel

Sensor-sensor open

Sensor-PA open

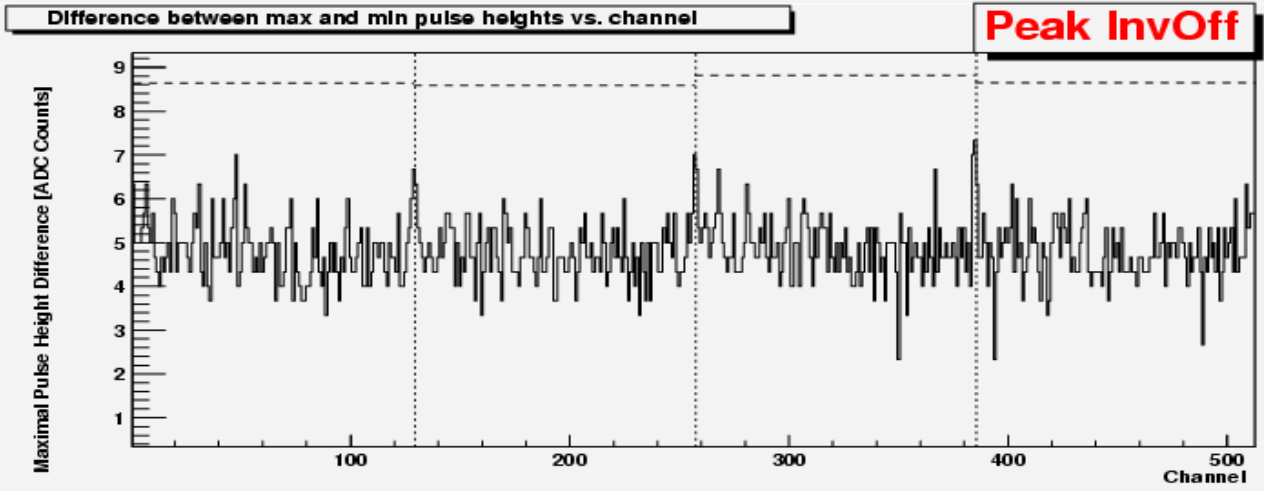
Pinhole



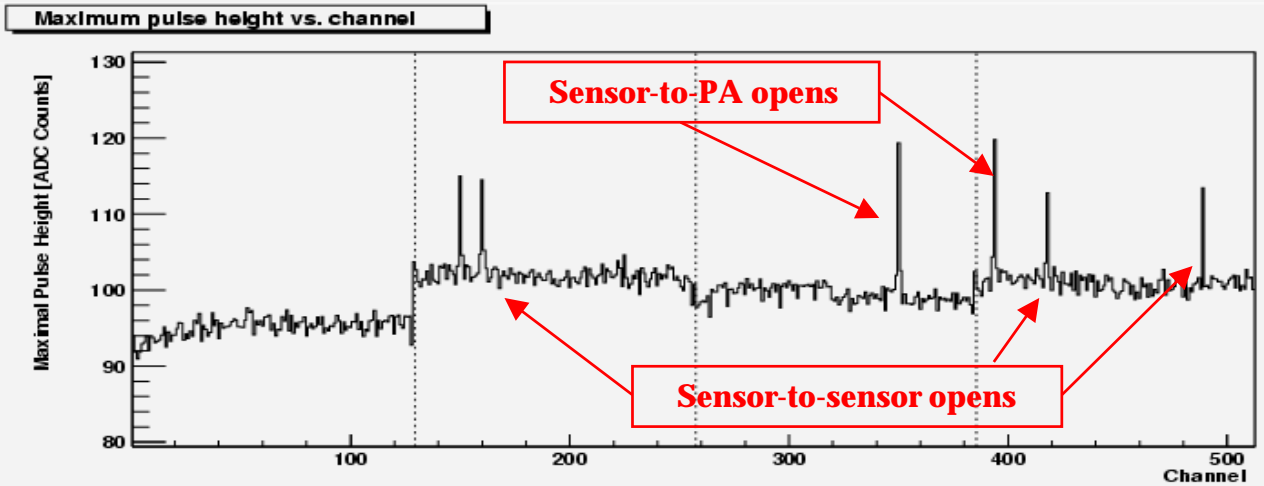


Pinhole Test

30200020000665; Record 1; 2003-05-14 09:48:54.0



We can see the individual features from the pinhole test. They correspond exactly to the lower noise channels on the previous transparency.

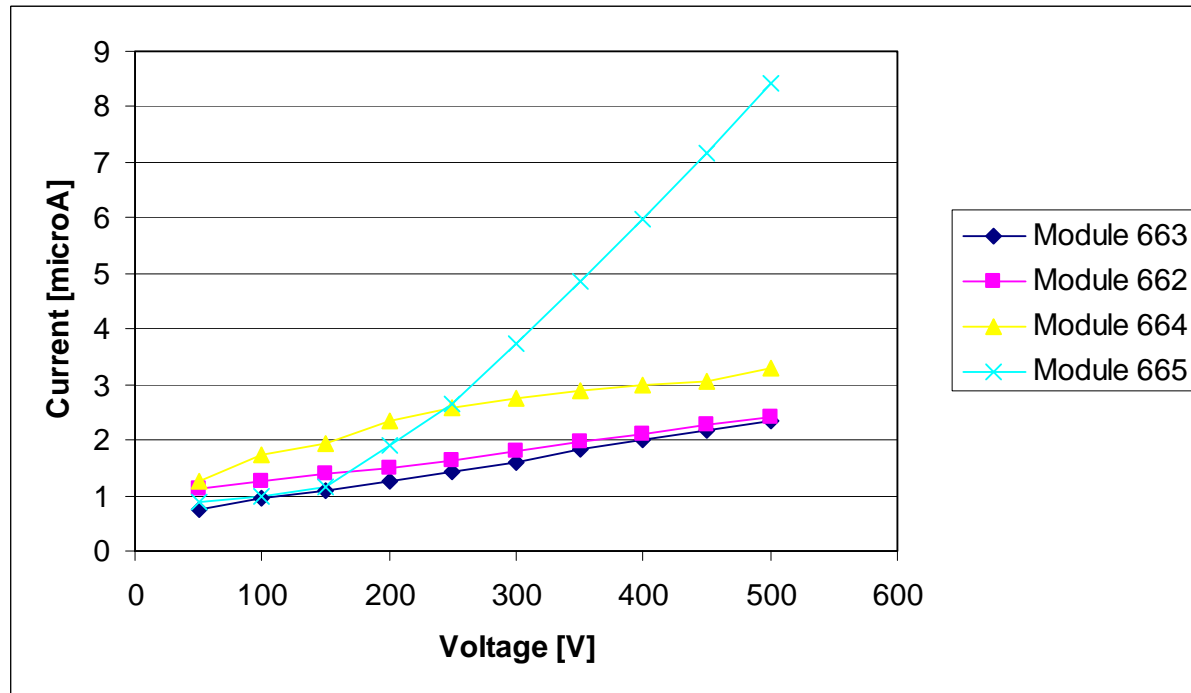


Sensor-Sensor open:
150, 160, 418, 489

Sensor-PA open:
352, 396



Initial I V Curves from Modules



We are performing the IV tests (manually) up to a voltage of 500V in 50V intervals. We have observed no break down which would come from damage to the guard rings. (See Frank Hartman's talk.)



Fermilab Module Testing Summary

module	Pulled bonds based on sensor information	Other defects on sensor (I, Poly, Cac)	Additional defects found in testing
659	140, 146, 426		175 – not bonded
660	49,78,471	204,212,119,375,387 not seen in testing	261 – not bonded
661	64,65,197,231	450,231,136	226,406 – noisy channels
662	139,241,403,383	377,378	377-378 are identified as shorted channels
663	207,330,331,179,438	205,379,256,207	481-484 – group of noisy channels

Summary : (Elizaveta Shabalina)

- 2 channels are not bonded due to dirty bonding pads on PA.
- **No pinholes introduced!**
- Noisy channels (module 663) are under investigation.



UCSB Module Testing Summary

- Few bad channels introduced in production
 - <0.5% of channels
- 4 modules have a total of 7 channels with noise that increases with bias voltage
 - 3 modules have a total of 5 channels that have visible lithographic errors
 - 1 module has two channels next to unbonded pinhole
- Last 4 modules have no bad channels introduced

Ladder	Sensor Bad Channels	Bonding Bad Channels	Testing Bad Channels	Total % Bad Channels
876	1.5+2	3	1	1.4%
865	1.5	0	5.5	1.4%
866	1.5	0	9.5	2.1%
867	4.5	0	1.5	1.2%
877	0 (1??)	0	0	0.0%
878	0 (2??)	0	0	0.0%
879	0	0	0	0.0%
880	2(+2??)	0	0	0.3%



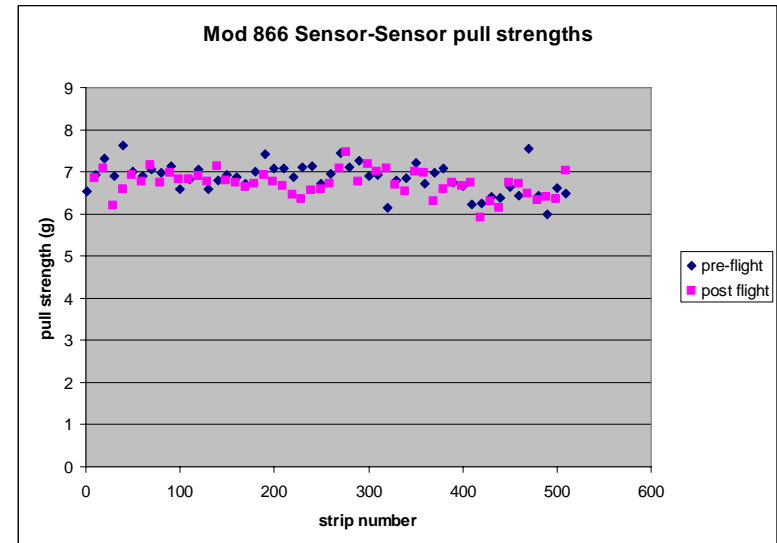
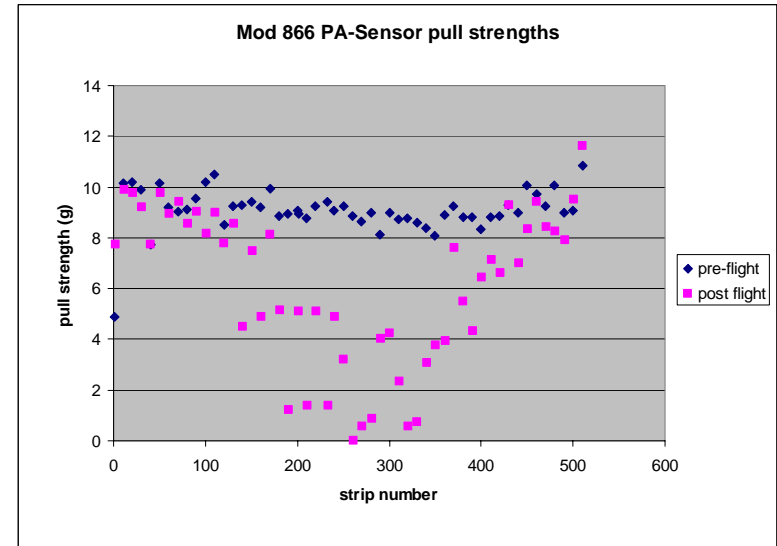
Module Burn-in Status

- Both Vienna cold boxes fully functional
 - One will be shipped to FNAL shortly
 - Still waiting for one Torino interlock box
- CAEN A1303 fully integrated with Daq_Cms_Like software
 - See http://hep.ucsb.edu/people/gartung/A1303_mod/a1303.htm for details.
- UCSB recently upgraded to Lt v1.0, Fermilab currently upgrading from Lt v0.81
- Both Vienna cold boxes thermal cycled under software control
- Thermal cycled 8 production modules with no failures
 - 4 with 4 thermal cycles (20C to -15C) over 16 hours (overnight)
 - 4 with 16 thermal cycles (20C to -15C) over 64 hours (over weekend)
- Single module readout working properly, multi module readout being tested with Lt v1.00
 - Only one active readout (only one hybrid to utri adapter)



Module damage during shipment

- 6 modules shipped to CERN for test beam
 - 2 hand carried on flight
 - 2 shipped DHL in heavy box
 - 2 shipped DHL in light box
- All show failure of wire bonds between PA and sensor for central 100-200 channels
- Recently hand carried a module between UCSB-BNL and back (~7000 km)
- Pull tested every 10th bond before/after flights
 - No bond breakage, but characteristic bond weakening seen between PA-sensor
 - Assume such weakening occurred in all prior shipments of prototypes
- US group actively working with CERN to address this problem





Summary & Conclusions

- We have tested a total of 47 hybrids.
- We have constructed and tested 16 modules. All were fully tested and characterized. Six modules were shipped to CERN for the test beam. The wire bonds were damaged in shipping.
 - 8 modules thermal cycled with no failures induced
- We have paused module production while a new assembly plate is surveyed for the gantry and wirebond failures due to shipping understood.
 - Group actively working to understand these failures
- We are set up to thermal cycle our modules in Vienna cold box

We can't ramp up to full production without more hybrid-to-utri adaptors (can only read out one channel currently)