

TIB Module Production

Overview

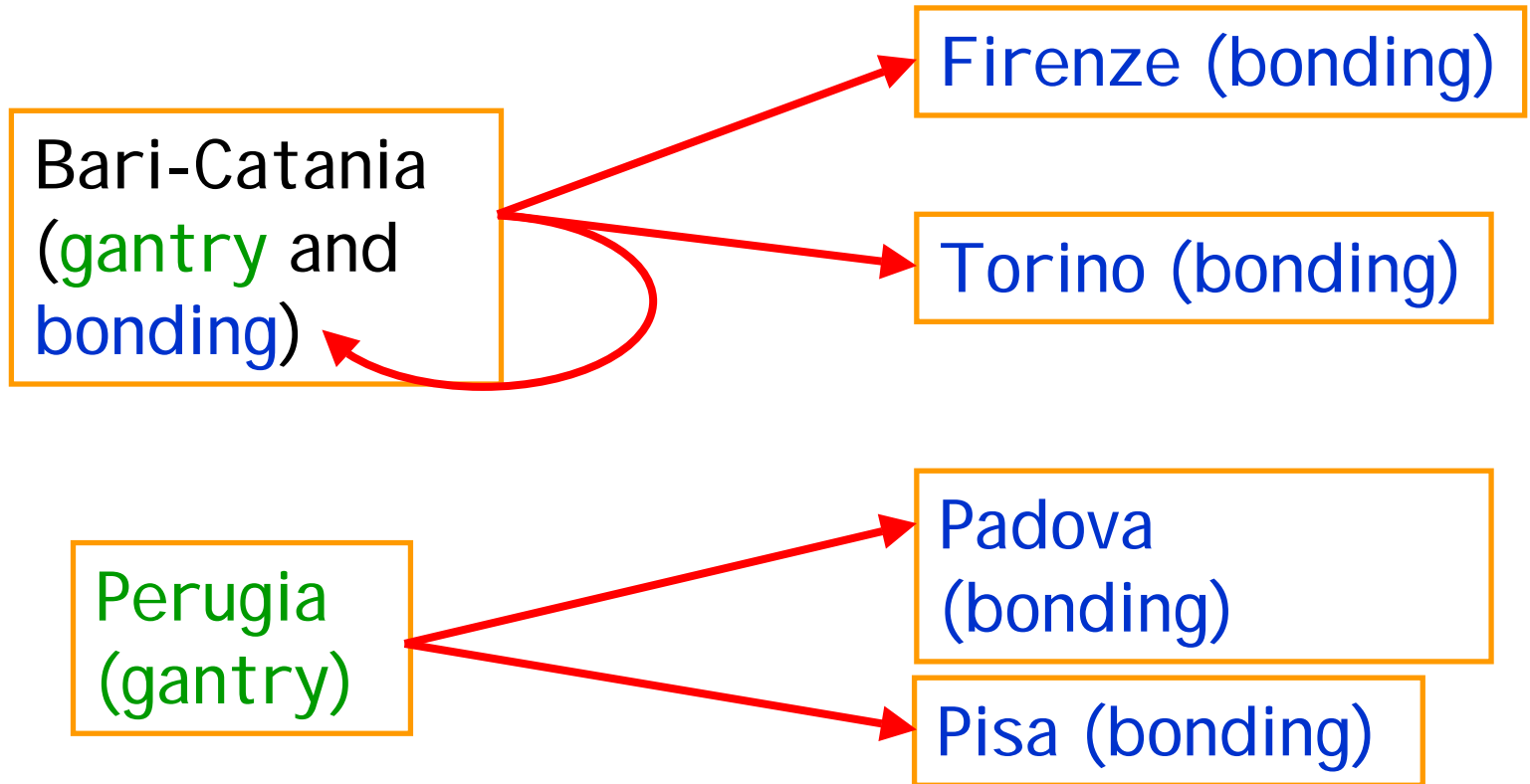
- Production Flow
- Gantry Centres
- Bond Centres
- Production Rates
- Quality Checks and Data Analysis
- Possible Problems
- Final Results and Comments

Introduction

- Having all necessary components in hand to build modules, TIB could finally start production of modules
- The first goal was to produce 100 modules fully tested by the end of September
- The guideline: start and go in production with no stops. Work day by day without interruption to verify our capabilities
- Try to follow all procedures and prescriptions
- Situation updated on September 15

TI B Production Centres

- 6 centres participated in this production with the following distribution scheme:



Overall Testing Scheme

- All labs, for testing at gantry and bonding sites, are using ARCS 6.2.1 which performs **FAST** and **DEEP** tests
- As decided in the Task Force meeting in Torino, the **FULL TEST** consists of (@400 V bias):
 - Pedestals and noise in all the 4 modes
 - Pulse shape in all the 4 modes
 - Pipeline test in peak inv on
 - Pinhole test in peak inv off
(only for bonded modules)

After each production action at least a FAST test has always been done: a FULL one will be required from now on for future reference

Gantry: Bari and Perugia



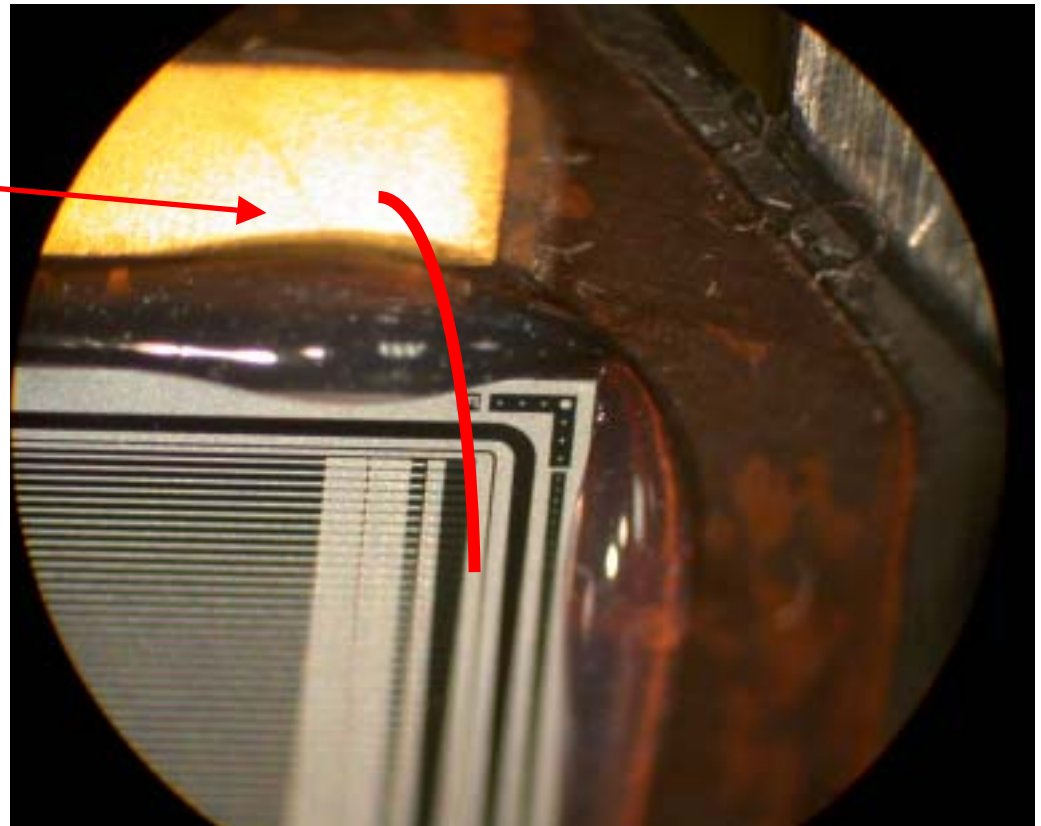
64
modules
assembled
in total

- 48 hybrids received at each site
- 56 modules assembled at almost flat rate of 4 per day
- In Perugia max rate test: 8 in one day. All production done in 8 working days out of 9
- In Bari: 1 technical stop for gantry repair (4 days), they are now ready to do maximum rate test. Before stop 23 modules in 6 working days

Results from Gantry

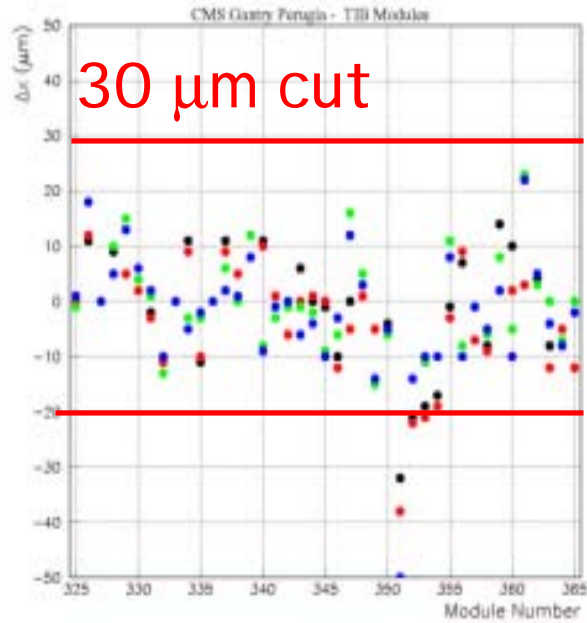
- Excellent yield, no bad modules, all grade A
- Some problems with glue: too fluid, not easy uniform dispensing, correct quantity etc.

GND reference
Bonding Pad to
Guard Ring

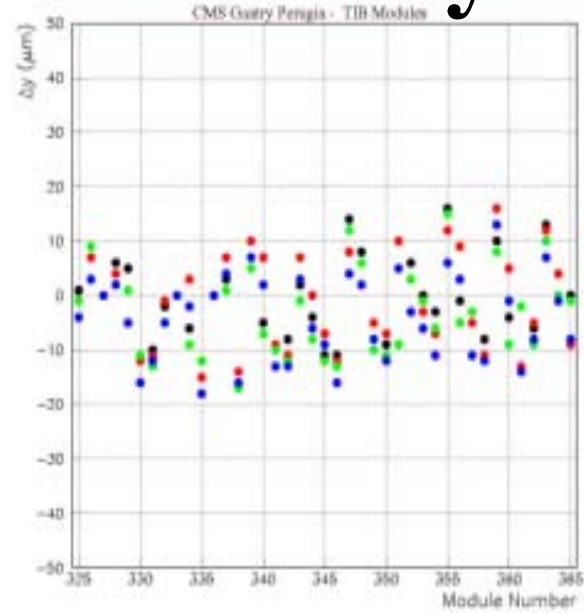


Picture by A. Kaminsky, PD

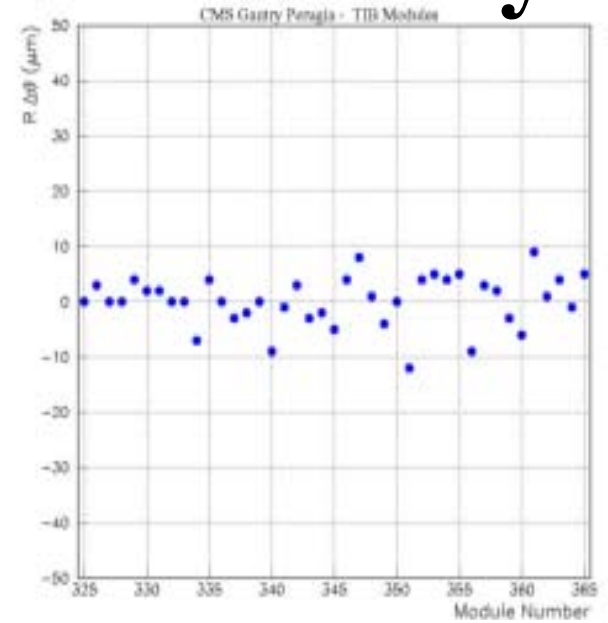
8 Modules Survey on PG Gantry



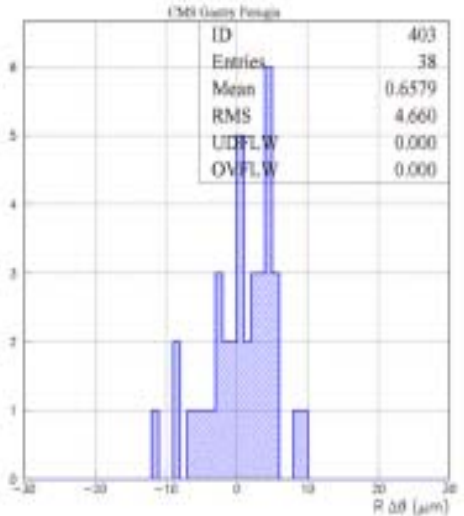
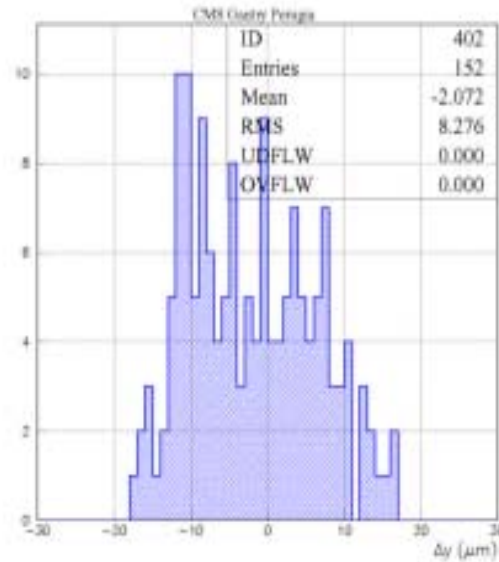
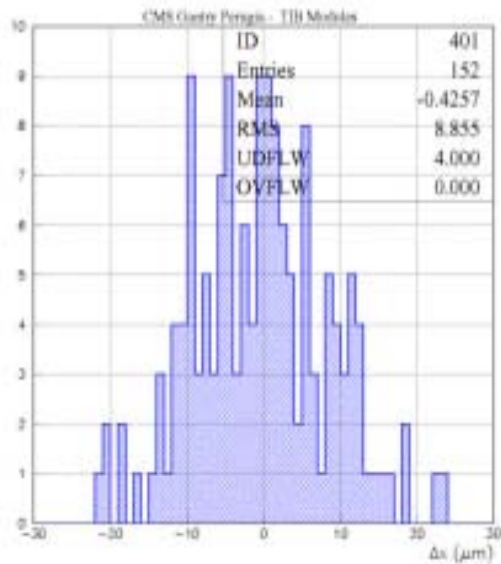
DeltaX



DeltaY



R DeltaTheta



Module Deliveries to Bonding Centres

- Delivery status from Perugia:
 - 16 modules to Pisa
 - 8 to Padova
 - 12 to Pisa (to be delivered)
- Delivery status from Bari:
 - 8 to Firenze
 - 8 to Torino
 - 12 in Bari
- No **major** problems during shipping by **commercial express carrier**, but **some action required** on: screws and nuts, foam in transport box, fixation of kapton cables



Optical Inspection Station

Optical Inspection is
a fundamental step,
do not overlook

The first and last operation
are always here !

Bonding Centres

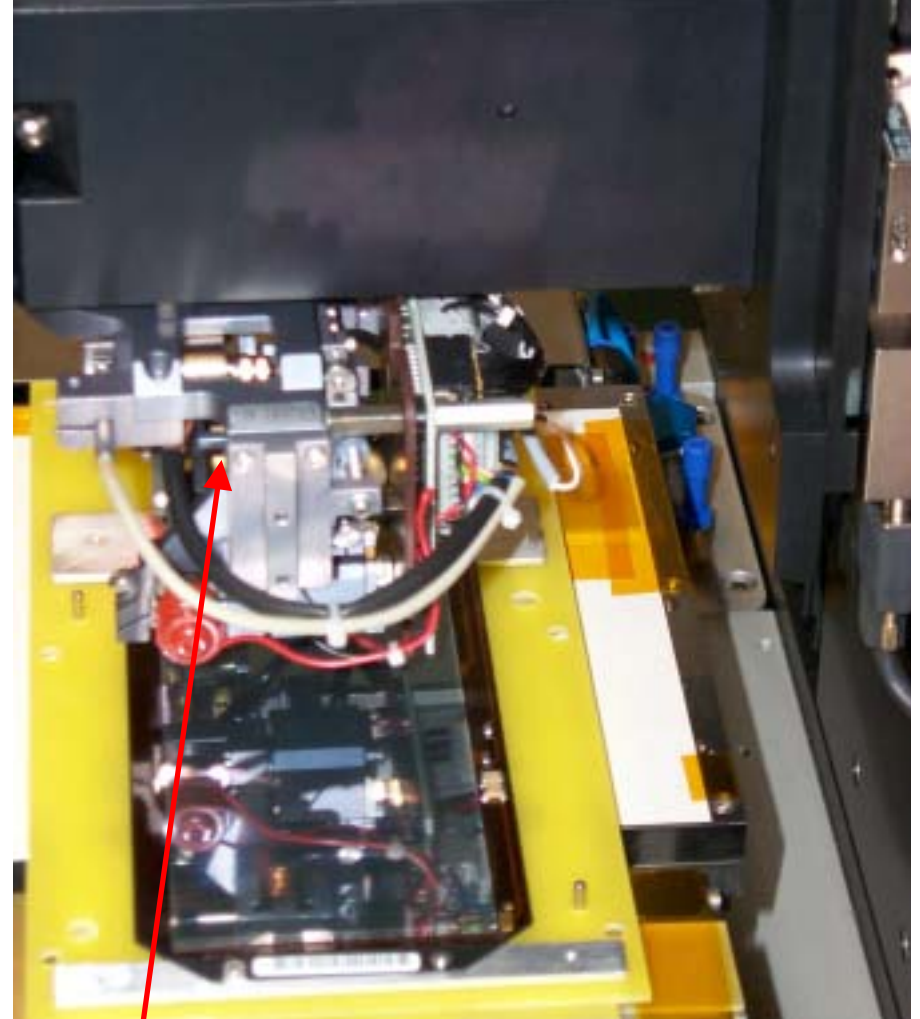
- TIB sites followed bonding procedures, including pull tests:
 - they pulled bonds on PA test pads AND between PA and sensor
- Results are quite satisfactory: ~ 8-10 g
- Data are already in PROD DB, and can be retrieved, for example, with S. Costa web interface

Summary of recent TIB&TOB prod

	#bonded	Problems or lack of	Rework	New defects by Bonding	Pull Tests on PA TAs	Pull Tests on 50 th PA-Sen	rate	
BARI (old PA)	7	Yes: varying par w/ PA, edges	0-10 (avg=3.3) per Mod	No	~ 8 g			
(new PA)	5	No: same par for all Pas	0 in 4 Mod 2 in 1 Mod for pad cleanliness	No			3	
FIRENZE (new PA)	8	No	On 2 Mod: 2 bias ring-capacitor		8 -10 g No diff w/ area	~ 9 g Uniform across det	3	
PISA (new PA)	13/16	No further details on bonding. Data not in DB yet The 3 not-yet-bonded modules had mechanical or IV problems						?
TORINO (new PA)	8	No	No	No	4 x 3 areas 10.0 ± 0.8g	9.7 ± 1.3	3	
FNAL (old PA)	Report on last 17		<u>See next slide</u>	No		~8 ± 1 by eye <u>See plot</u>	3	
UCSB (old PA)	54	10: at edges of PA or for pad cleanliness	<< 10	2 missing (besides those to be skipped)	to find par (vary w/ single RMT PA)	NOTE: 45m to find par vs. 15m <u>tot</u> for bonding!	7	

Database

- Gantry and bonding centres are fully operational with data insertion on the Production DB
 - All the actions and shipping of the new modules have been correctly registered
- Test results still have some problems with the production of the correct XML output
 - Should be solved soon
- Many uploads have been done on the test DB for electrical test and can be downloaded using different clients applications



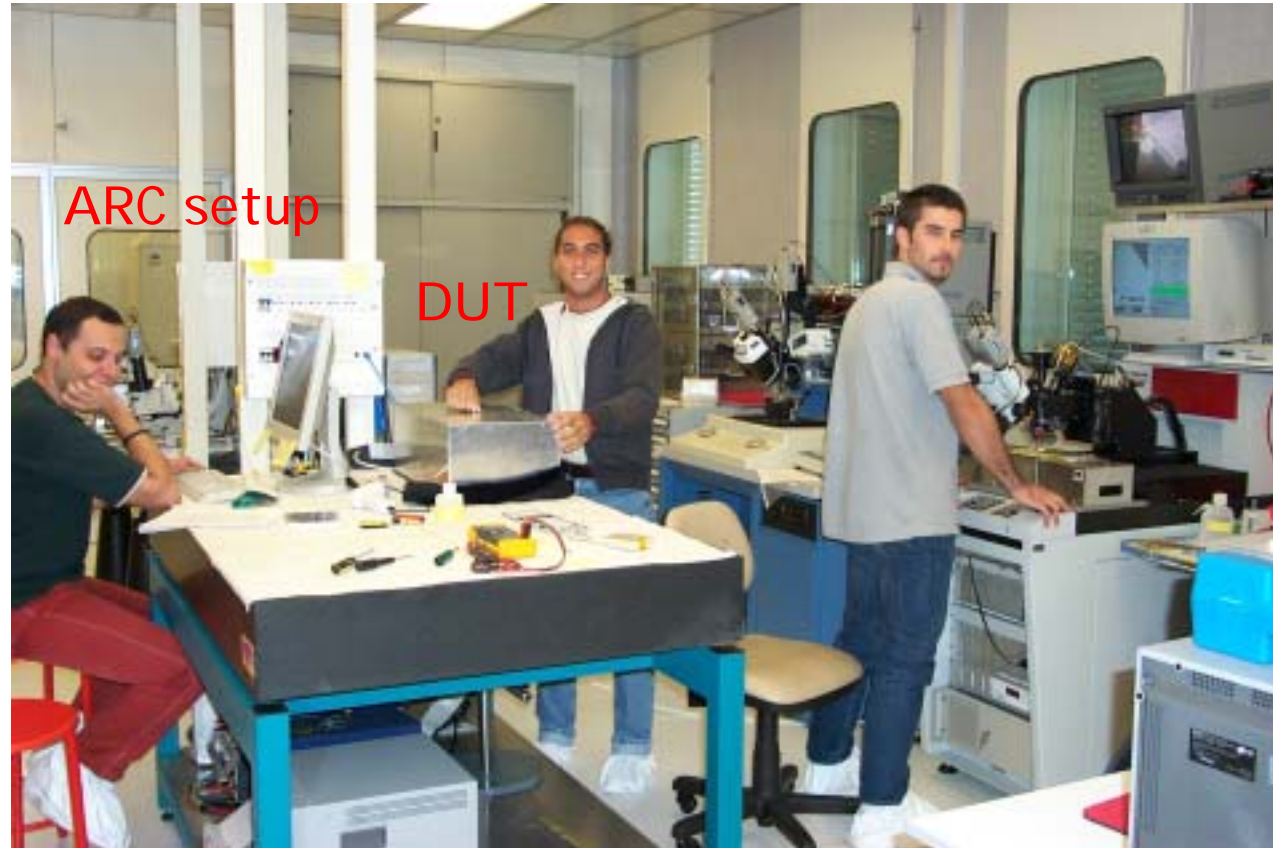
Bonding heads at work...

The Test Sequence

- The production procedure sequence requires, for QA:

Delvotec 6400

- Full test
- HV bonding
- I V curve
- Full test
- PA to sensor bonding
- Full test
- I V curve

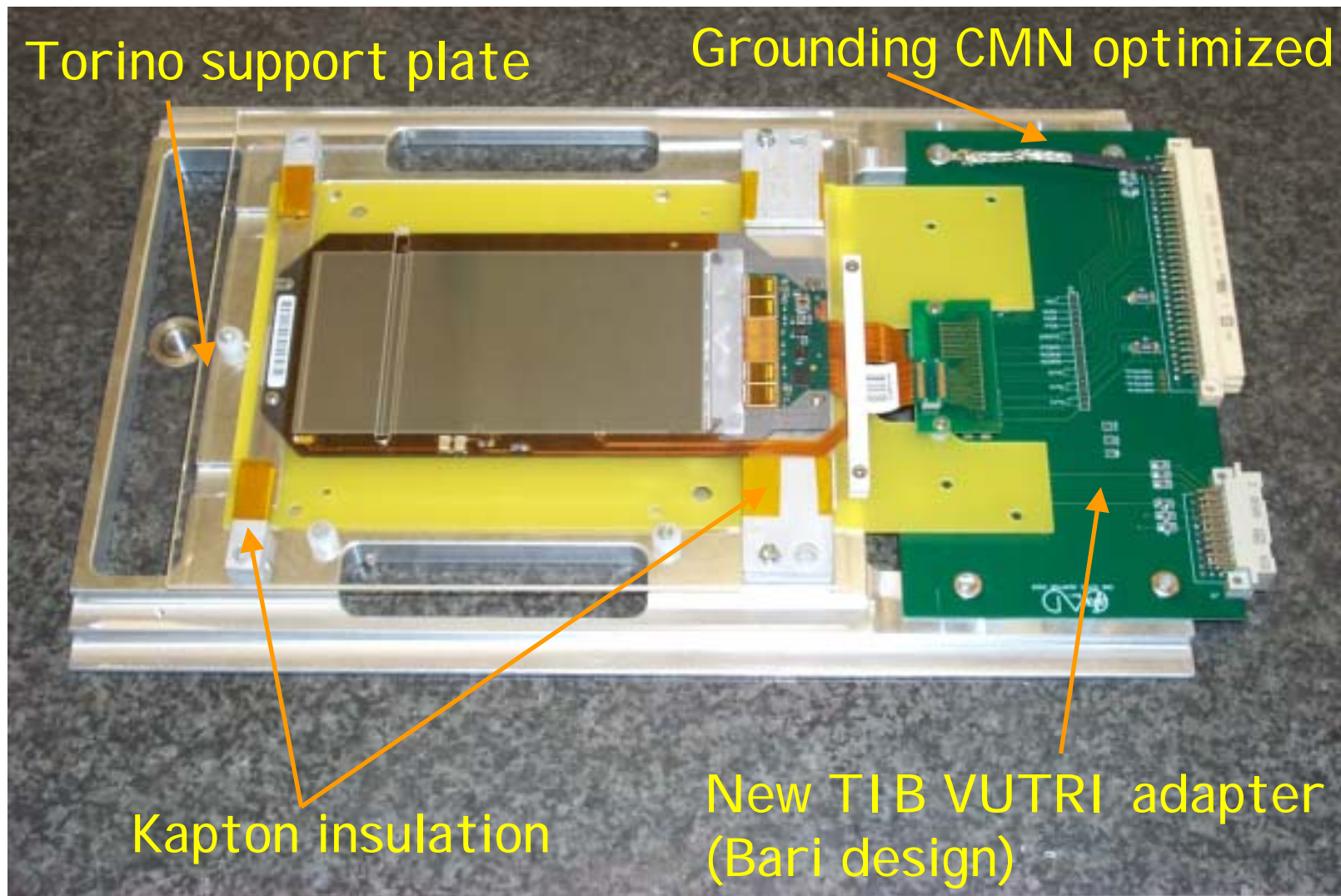


Firenze clean room and (part of) production & test staff

New TI B Modules



New Module Detailed View



Rates

- Rate of modules fully bonded and tested:

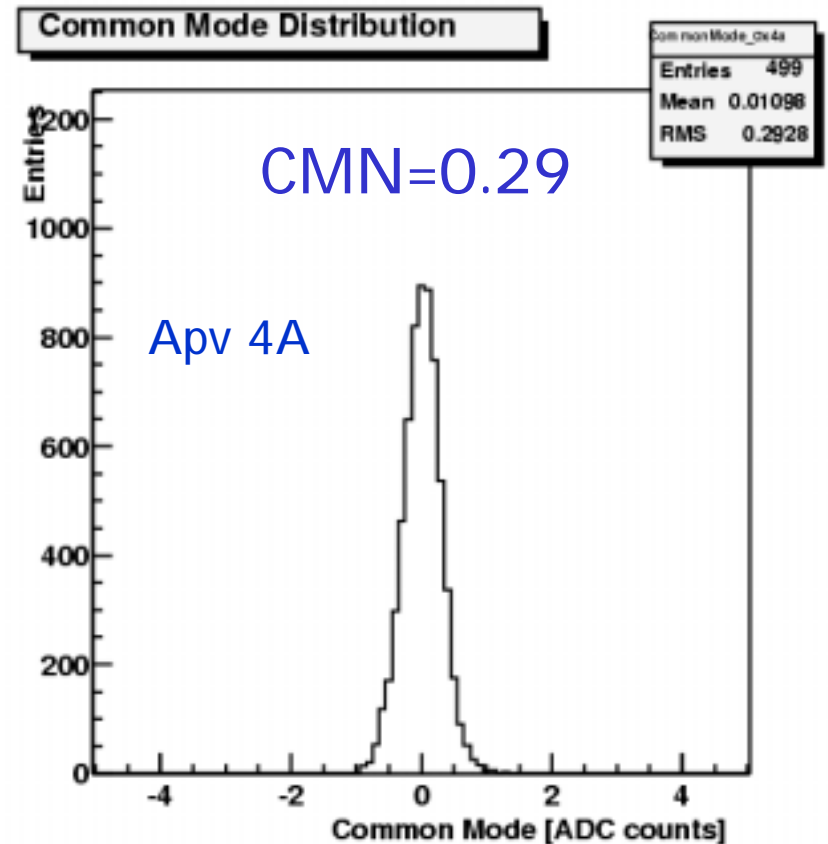
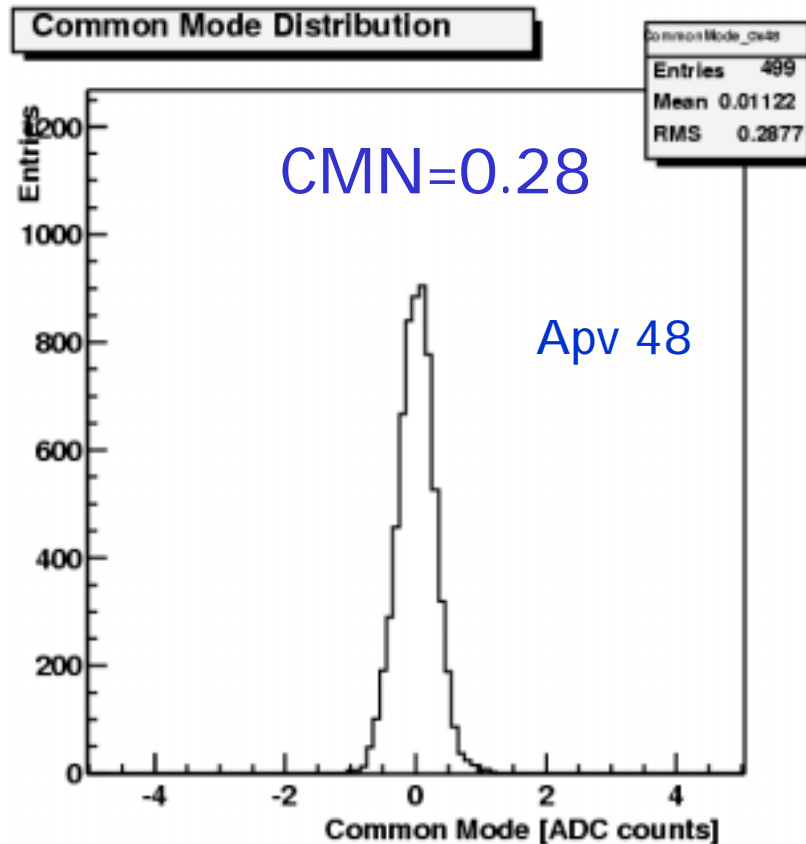
Total	Rate/day
- Bari 6 in 4 days	1.5
- Firenze 8 in 3 days	2.5
- Pisa 16 in 5 days	3
- Torino 8 in 4 days	2

- 38 modules in total
- 3/38 modules have severe problems on kapton cable and connector, and **FAIL** tests
- 3 modules (Bari, Firenze, Torino) have shown electrical problems on cable. They are now working but...
- Total of 35 (or 32 ?) **grade A** modules passing all tests

CMN Performances

All the TIB centres now meet very well the CMN requirements ($\text{CMN} < 0.4$ in peak inv off)

Mod 032



Analysis Summary

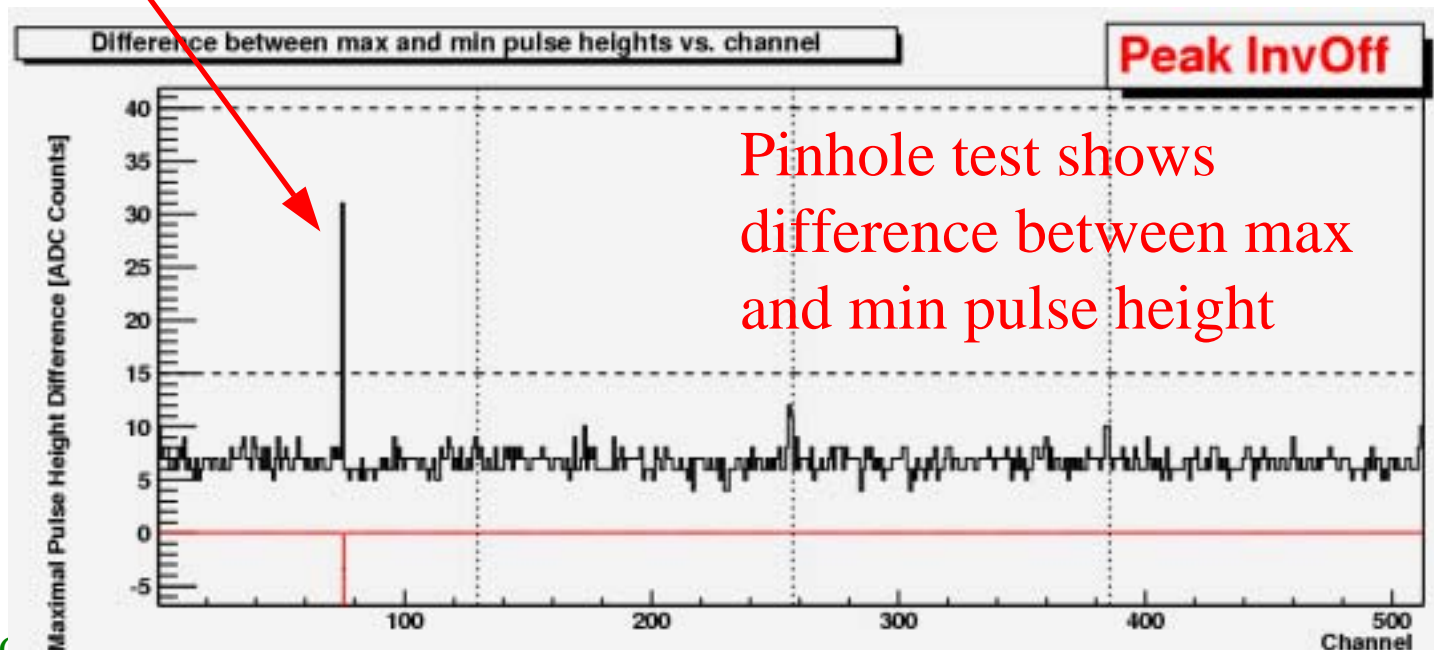
- 31 modules deeply analyzed until today (15872 strips)
- Total bad strips found by official macros: 42 (= 0.26%)
- If we do not take into account the edges and mid APV channels, we obtain a total of 6 bad strips (< 0.04%)
- All but one are marked as NOISY

The One Strip

(see J.R.R. Tolkien)

Only 1 module seems to have a “real” problem: 050 (bonded in Pisa) has a strip flagged as a **pinhole** by official macros

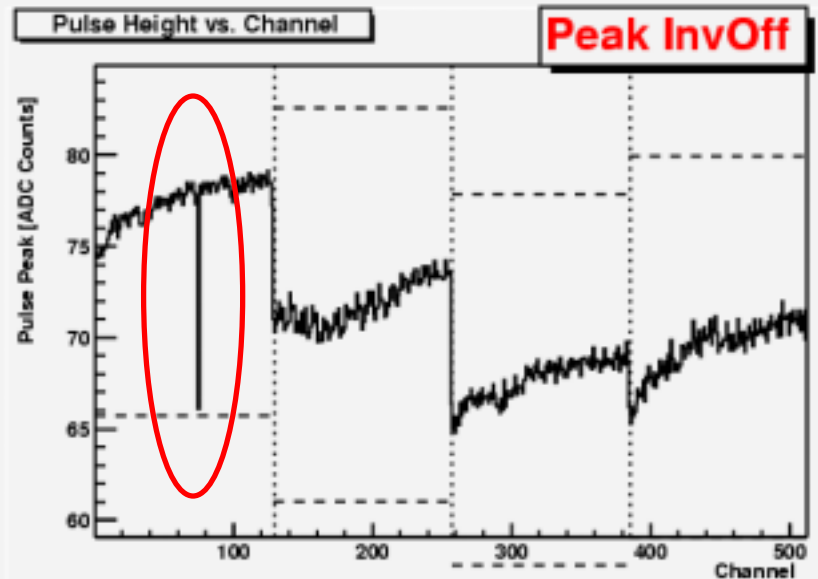
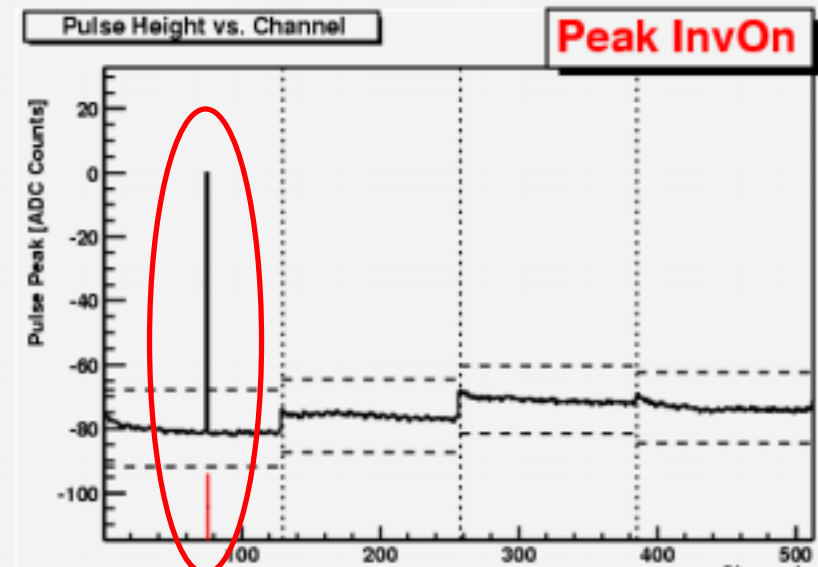
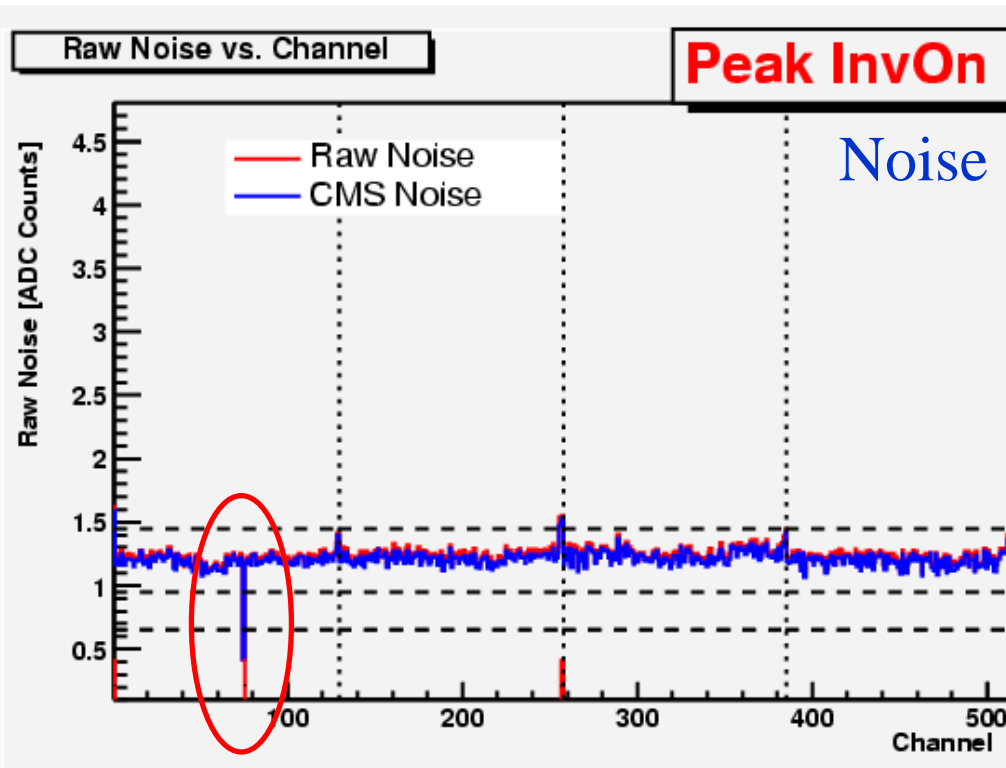
Chan#	Peak Off	Peak On	Dec Off	Dec On
75		PHL-		PHL-



The One Strip

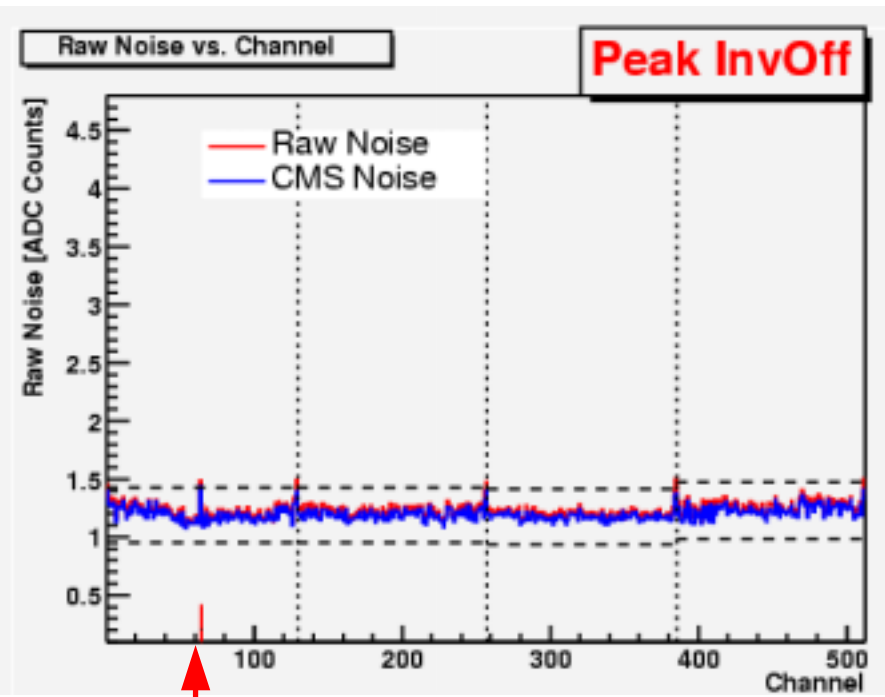
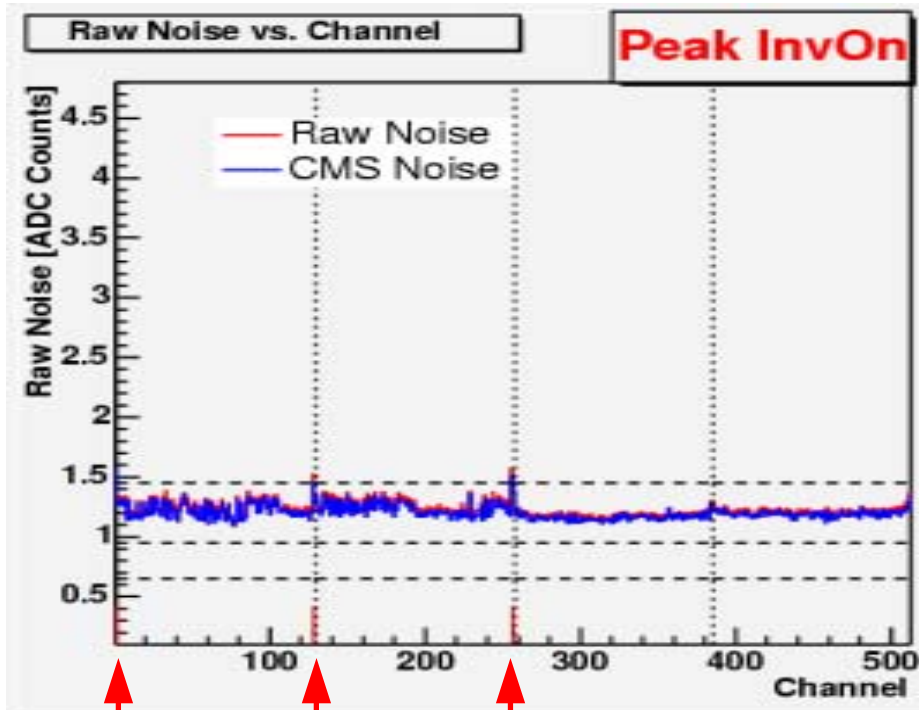
Pulse shape

This is confirmed also
by **noise and pulse
shape** tests results



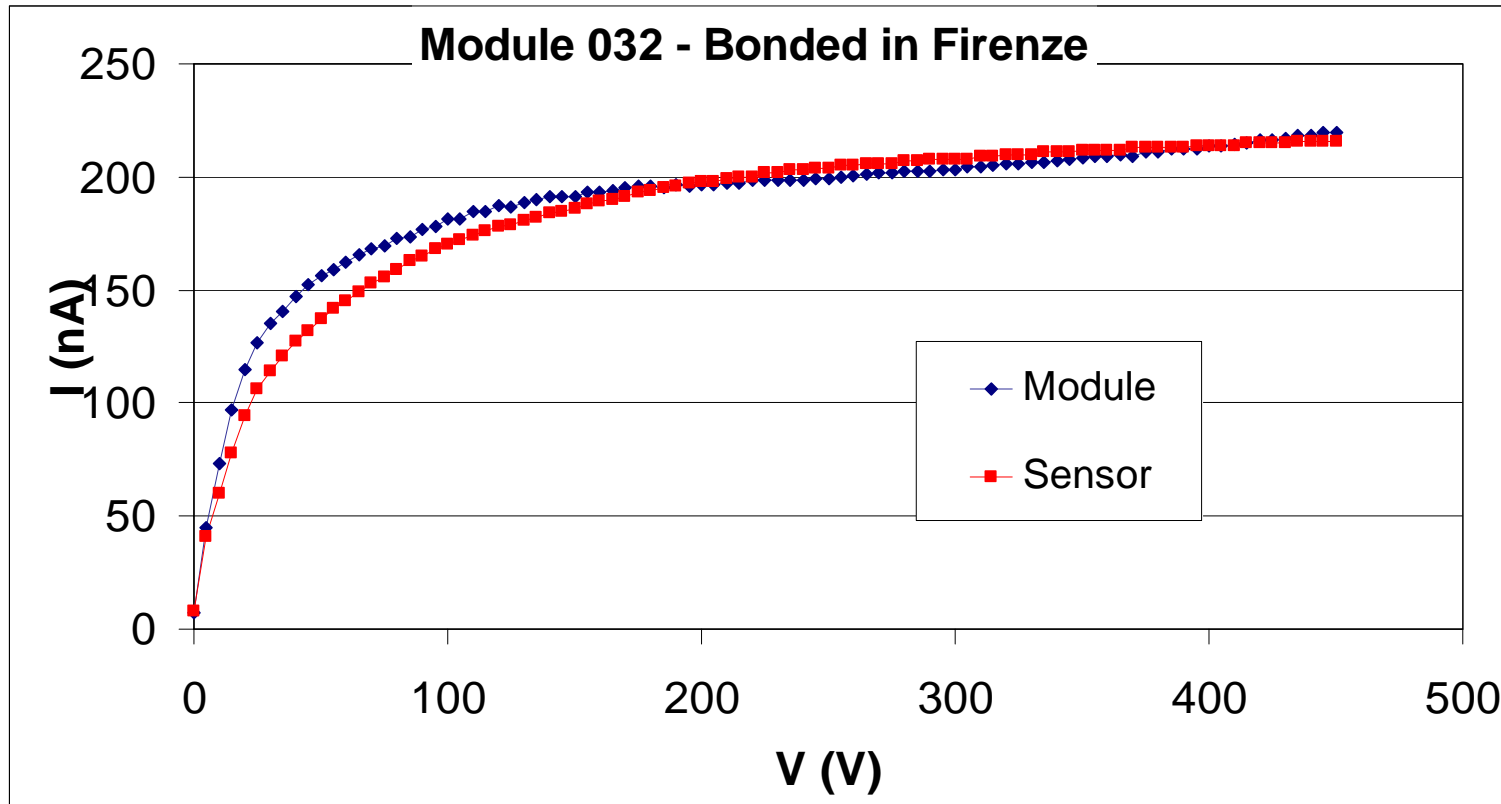
Edges and mid APV channels

- A lot of channels at the edges and in the middle of each chip (1 64 65 128) are marked as bad **only in the noise test**
- We do not like to consider these strips as really bad
- Moreover the noise is so small that they will have **MINIMAL or NO** impact in detector performance



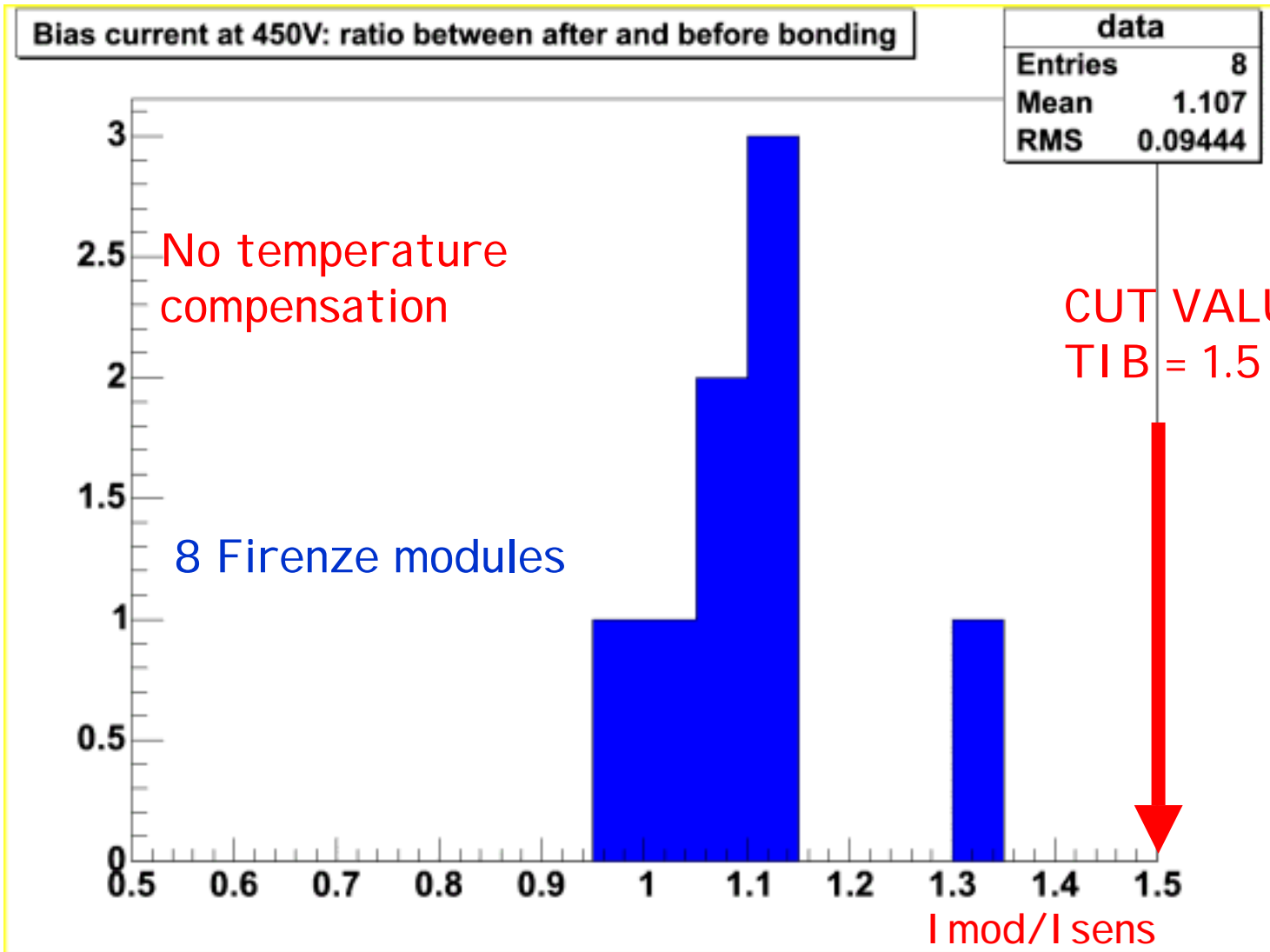
Module I V Characteristics

- First I V curve is done immediately after bonding HV bias and GND return
- It is compared to sensor data in DB

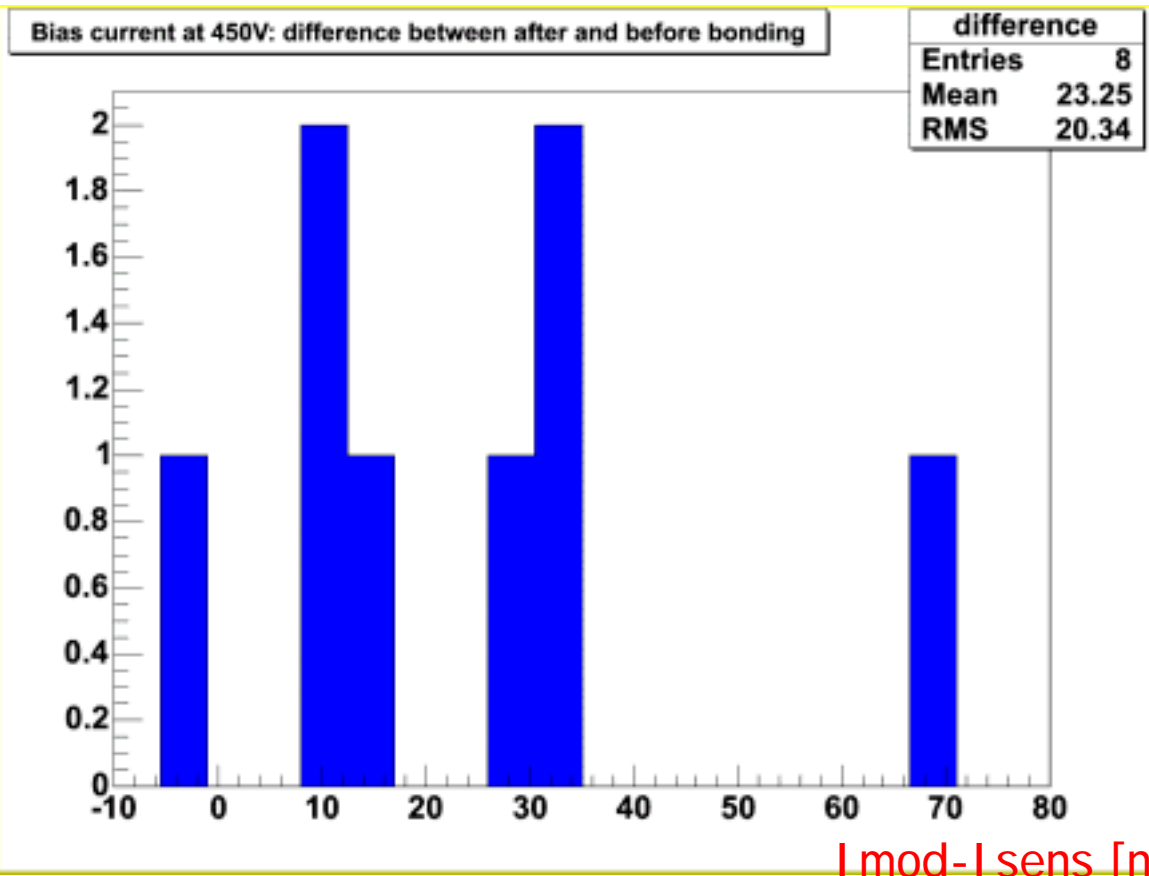


$I_{\text{module}}/I_{\text{sensor}} @ 450 \text{ V}$

I-V Distributions on a sub-sample



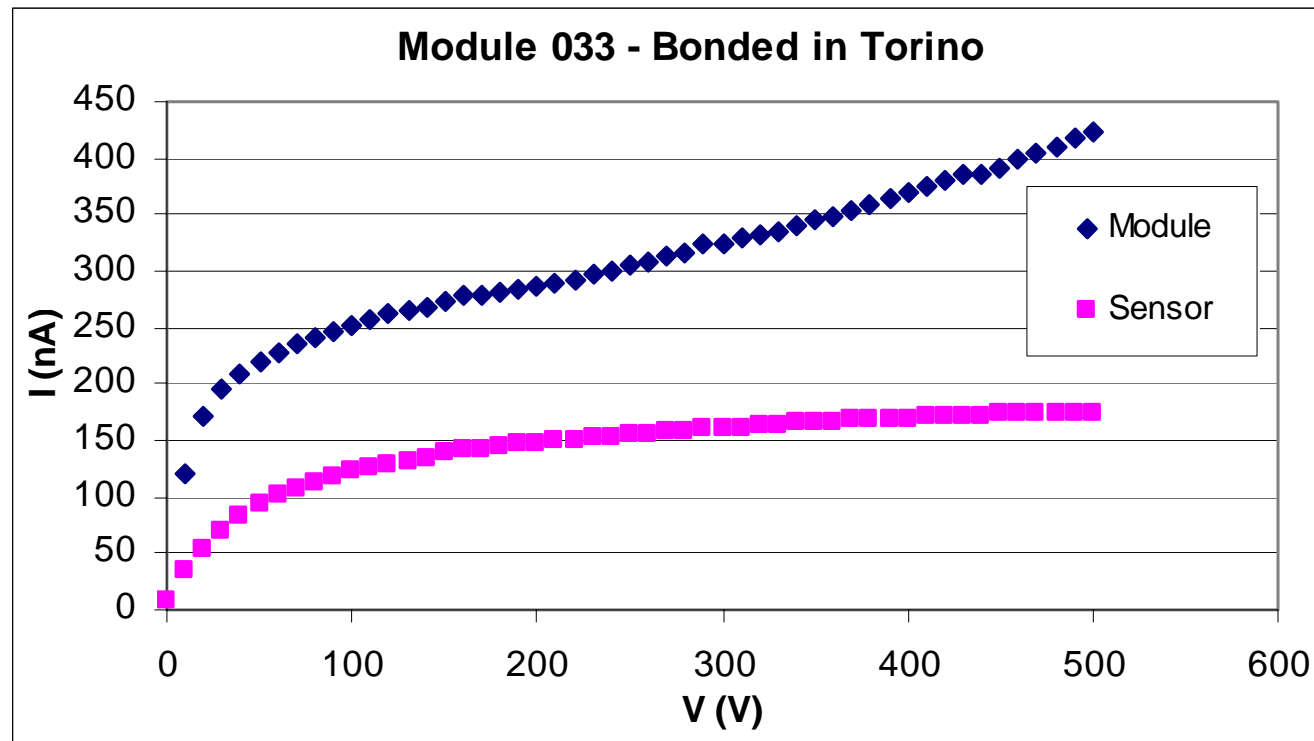
The Plot shows Current Differences Distributions on a sub-sample. Scale is nanoAmpere !



Mod #	I_{mod} nA	I_{sens} nA
24	237	209
25	243	211
26	226	216
27	241	233
28	196	200
30	281	214
31	248	217
32	219	205

More on I -V

- One module has a current of 420 nA @ 450 V
 - From the sensor db should be 182 nA
- Continue on investigating, but do not discard

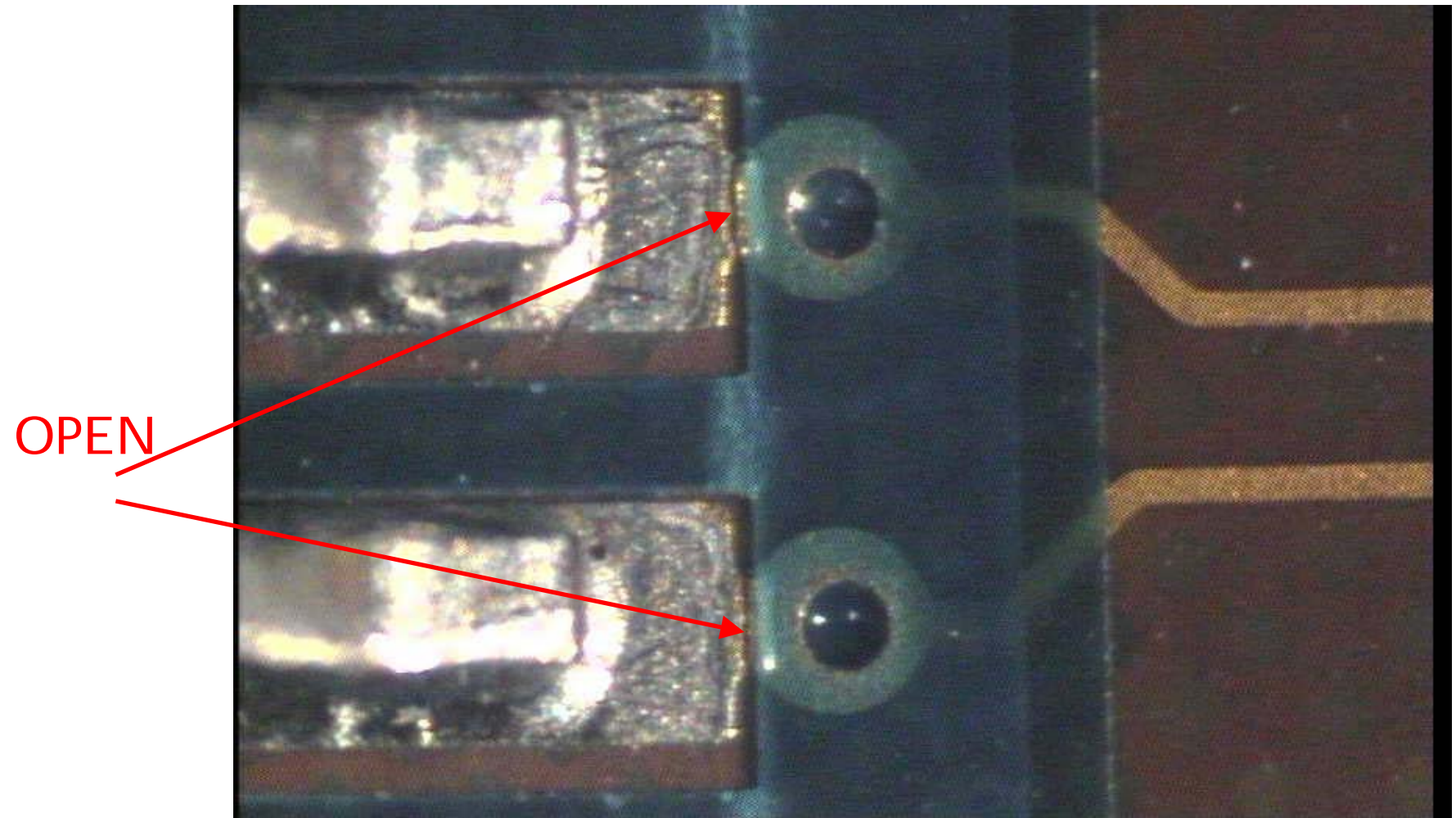


Module Anomalies

- A few hybrids or modules showed problems during testing in both gantry and bonding centres
 - 3 in Pisa
 - 1 in Florence (recovered)
 - 1 in Bari (recovered)
 - 1 Torino (recovered)
- 3 of them have been recovered, but what about reliability ?
- They all showed electrical discontinuities on: signal lines, digital lines, connector contacts.
- The effect was loss of chip control or loss of analog output
- IT IS EXTREMELY DIFFICULT TO TRACE BACK TO THE ORIGIN OF ANOMALIES: behaviour is not exactly reproducible

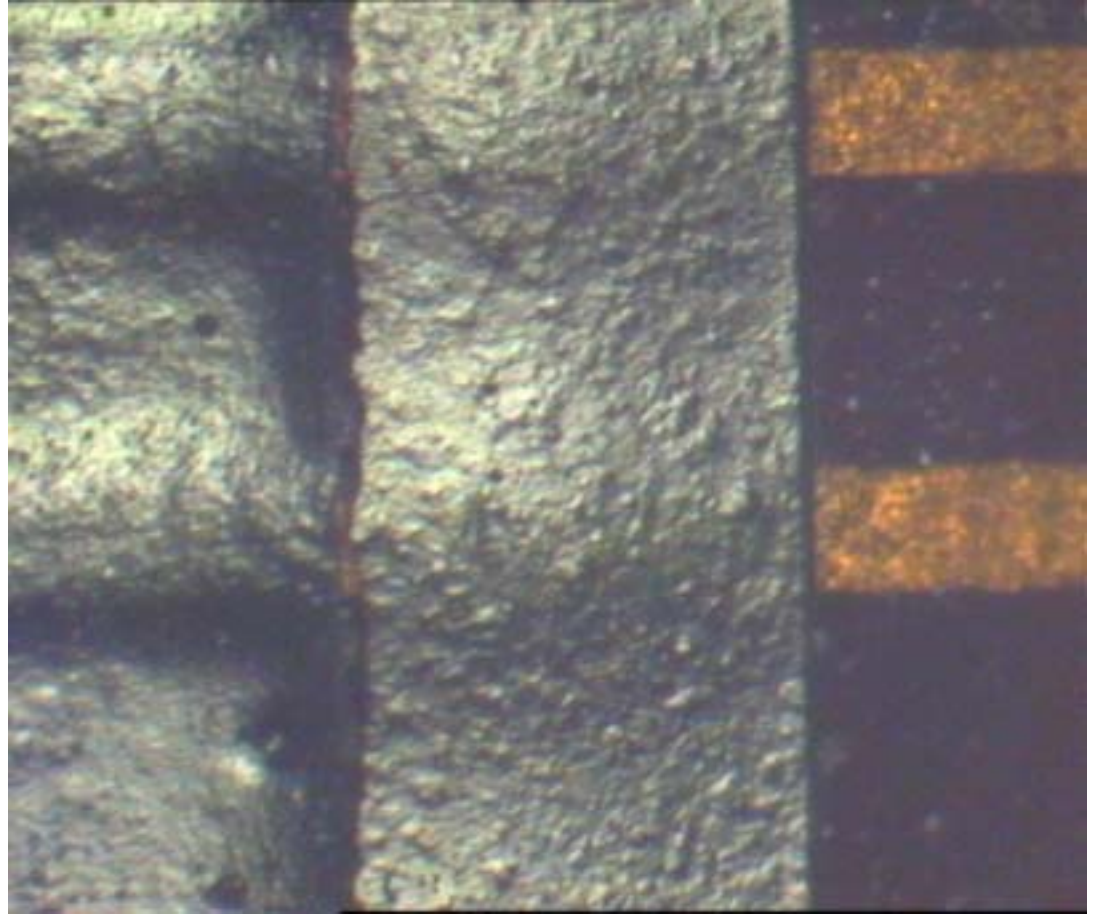
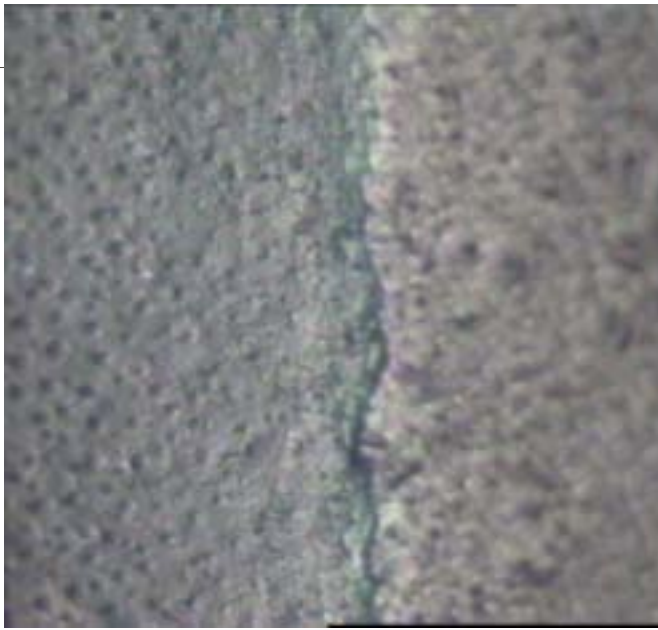
Hybrid Investigations in Bari

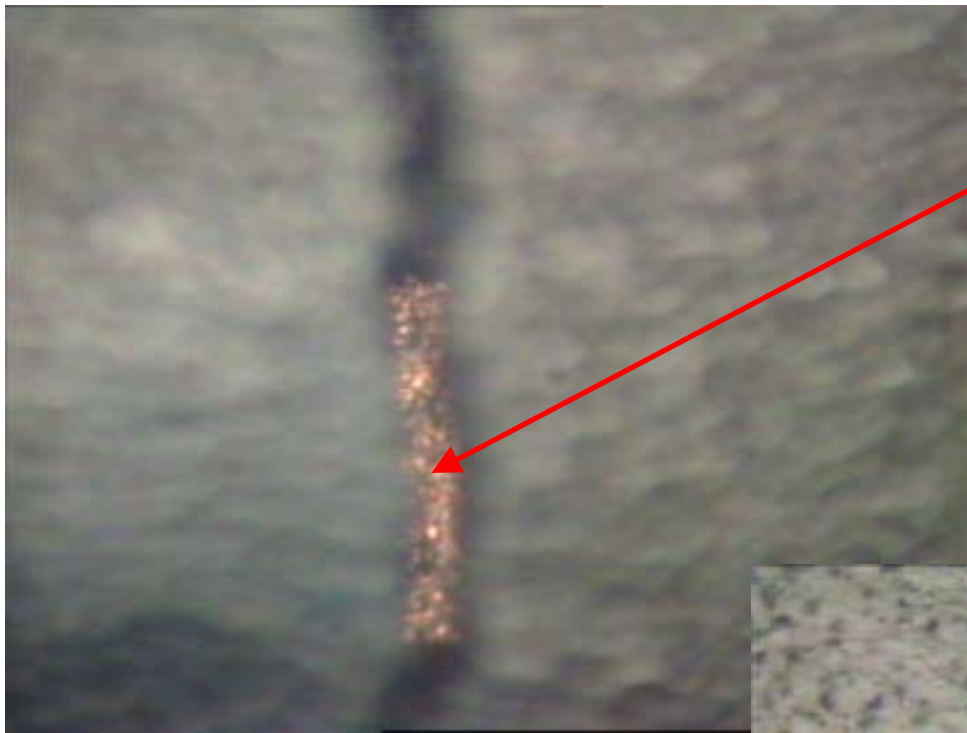
- In Bari 1 module lost I²C control: failure found on kapton/samtec connector traces. REPAIRED



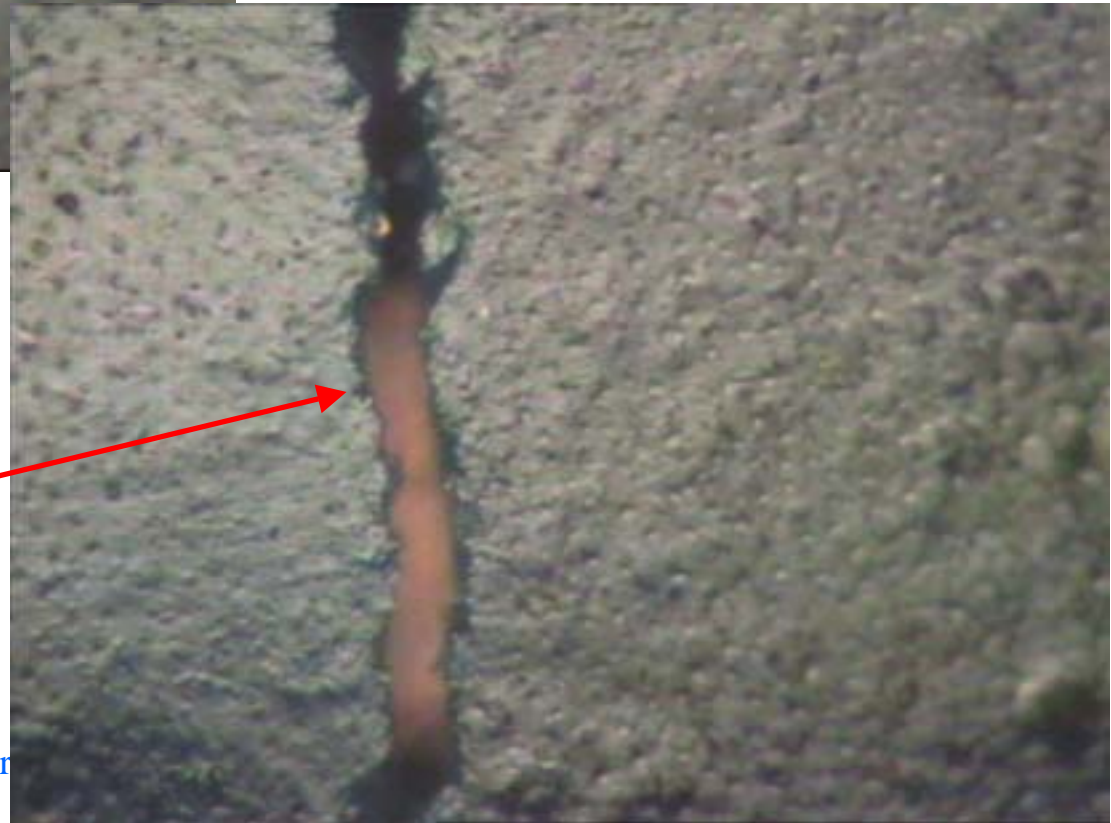
Hybrid Investigations in Firenze

- In Firenze a module which had already passed tests before and after HV bonding, failed last test after sensor bonding.
- The kapton cable had never been disconnected before failure
- No evident reason: carefully studied for electrical contact, broken traces or so.
- A high magnification microscope showed tiny cracks (5 to 20 micron wide) on 6 kapton cables out of 8. They could not be directly correlated with failures, but they appear as weak points.





Focus on gold trace

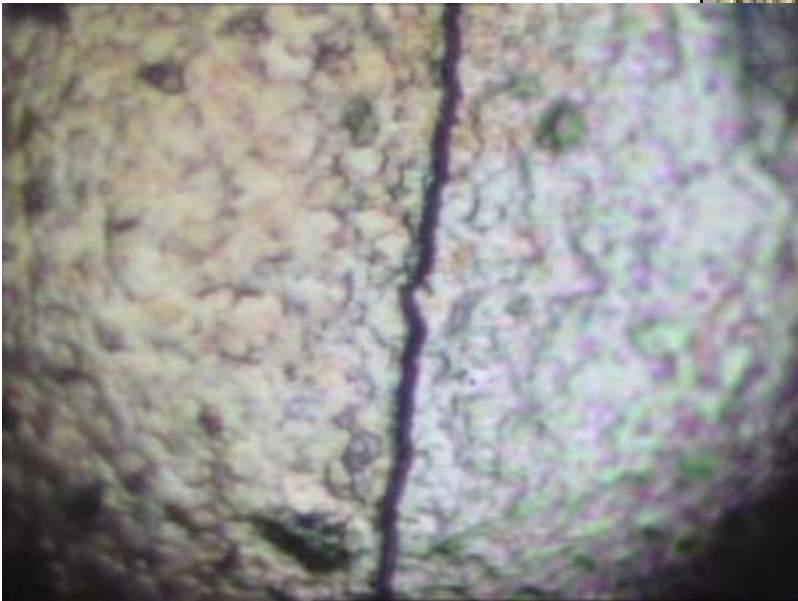
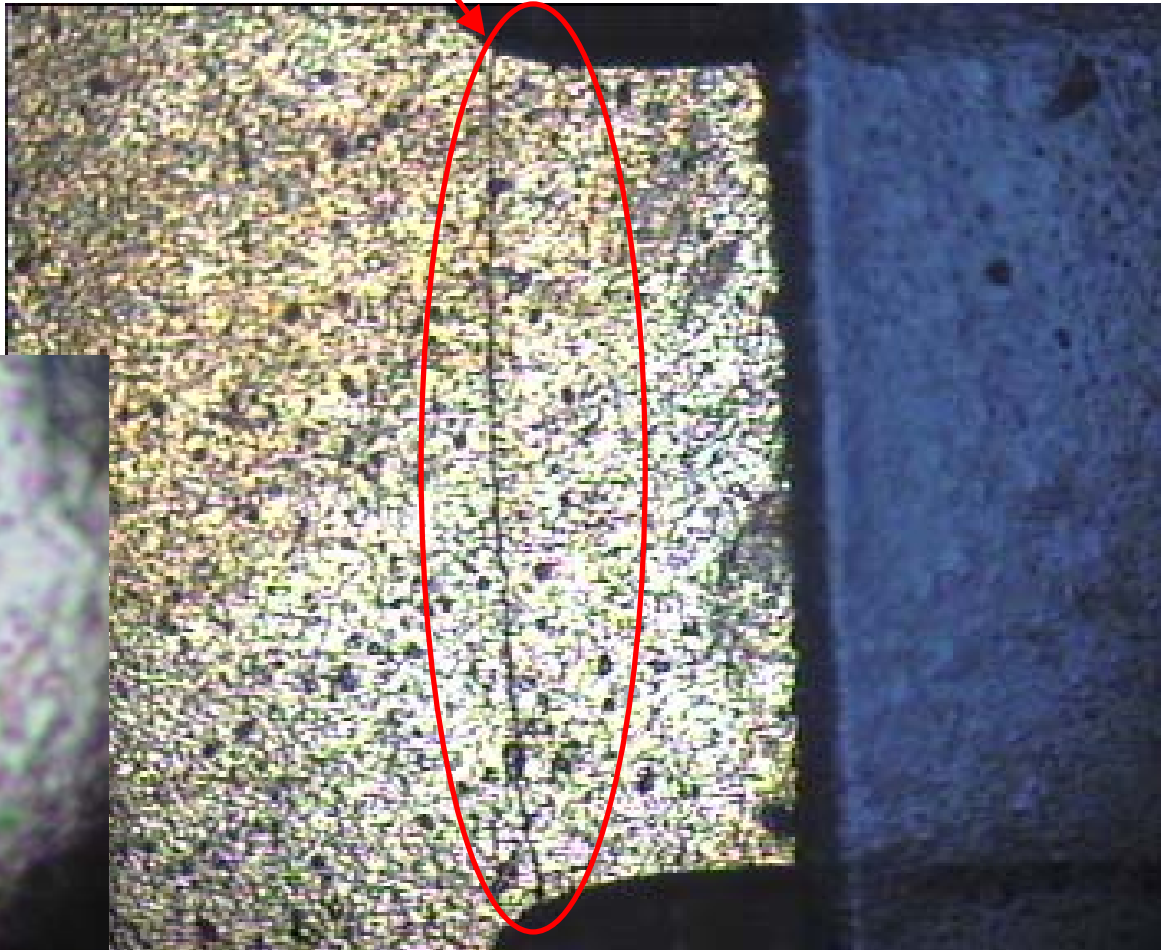


Focus on top layer



A tiny crack near NAI S soldering pad (different position on kapton cable w.r.t. previous pictures)

Cracks like this one could give intermittent problems as seen in TIB (and TOB) cables

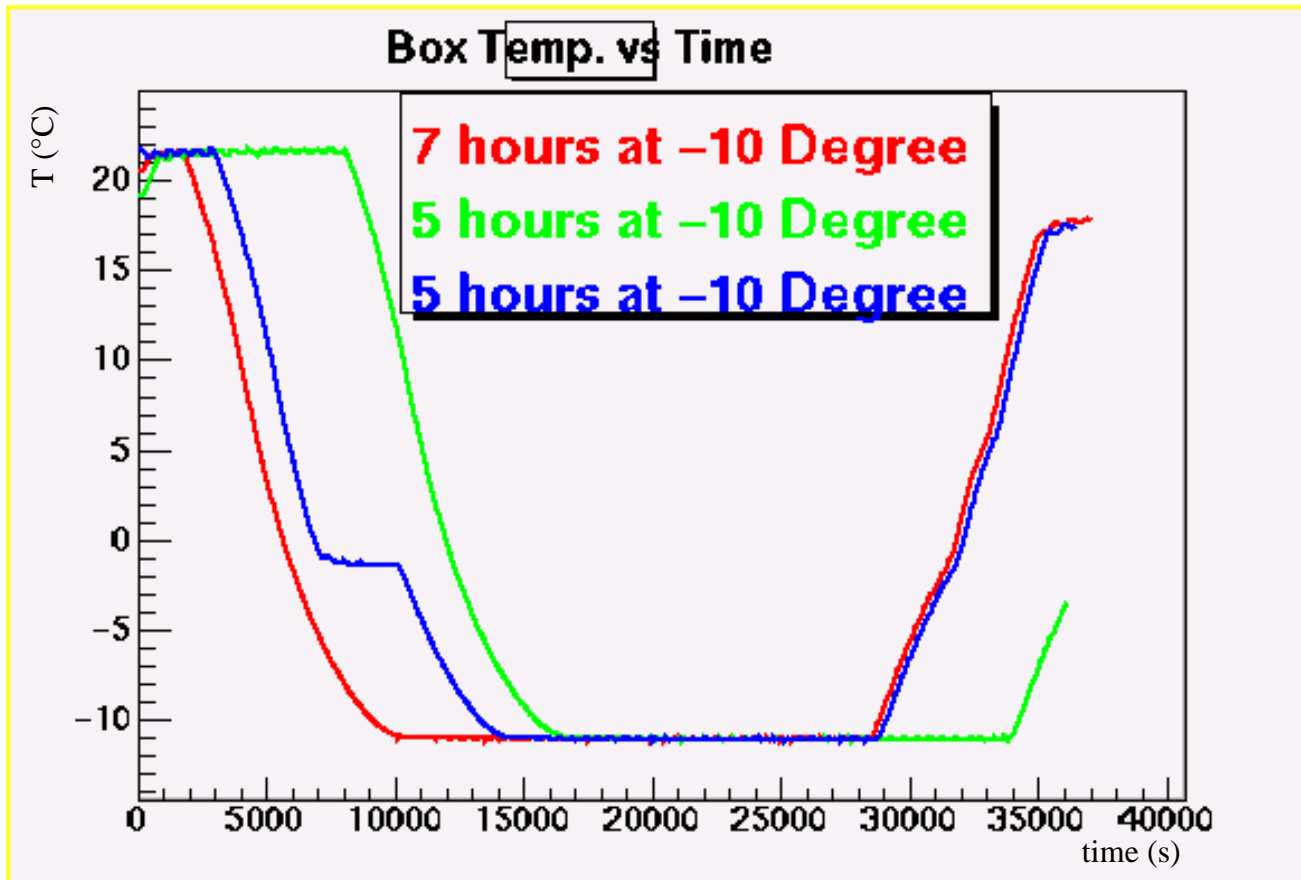


Preliminary Results on Tests at Low Temperature

- The “rush” production of TIB modules did not include compulsory cold passive tests or Long Term tests
- Some labs had the opportunity to give a first glance to this kind of measurements
- Pisa:
 - All 13 modules passively cooled down to $-15\text{ }^{\circ}\text{C}$
 - 1 module thermally cycled in Vienna box with LT readout for **17 hours**
- Firenze: ARC readout during cycles
 - module 032 at $-22\text{ }^{\circ}\text{C}$ for **18 hours**
 - module 026 at $-11\text{ }^{\circ}\text{C}$ for **70 hours**

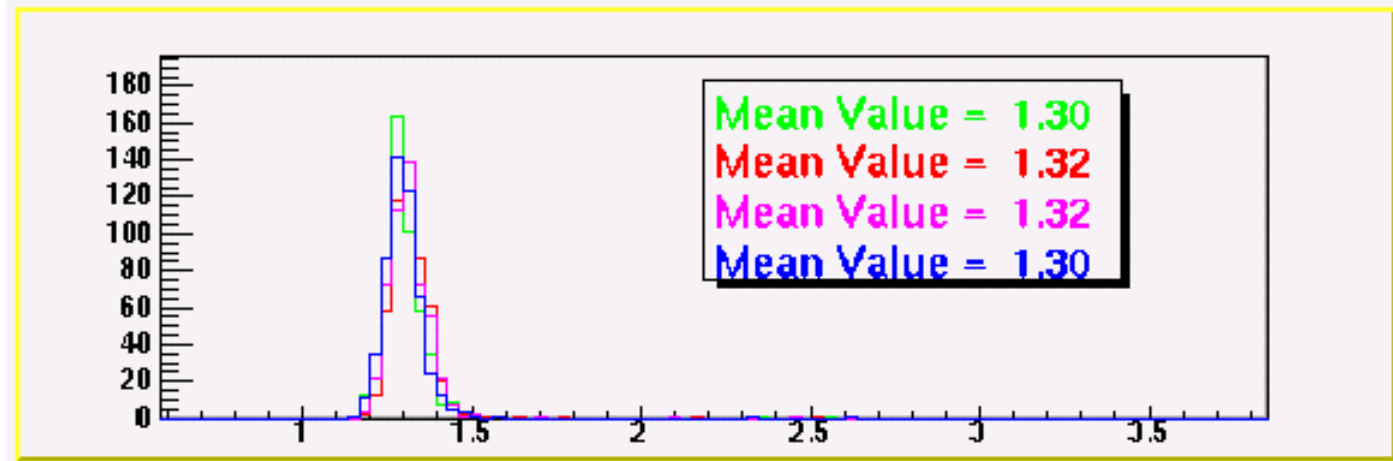
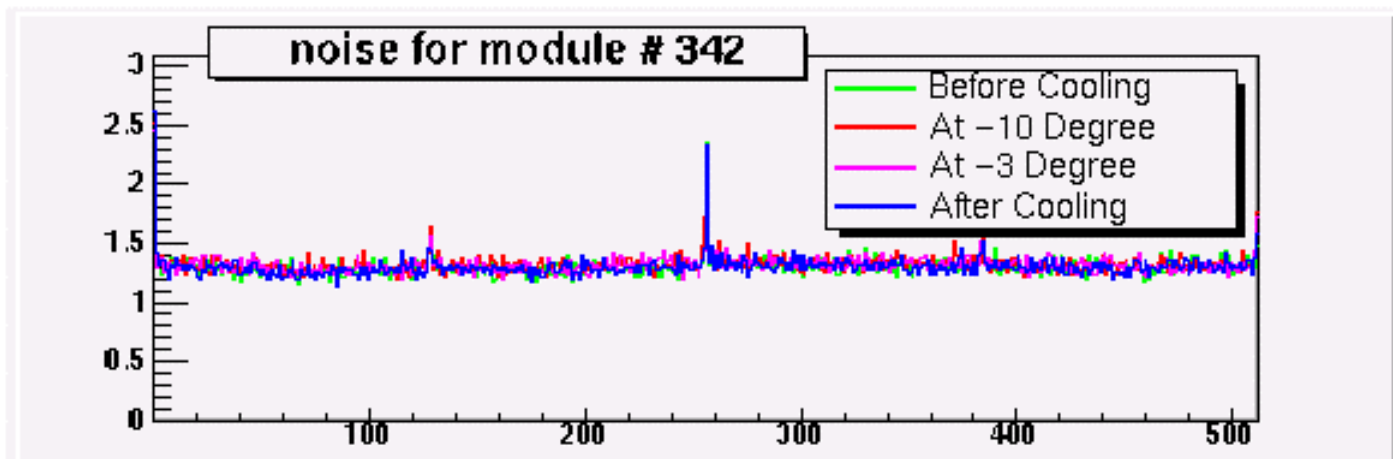
Long Term Test in Pisa

One module was tested with 3 thermal cycles for 17 hours with LT software



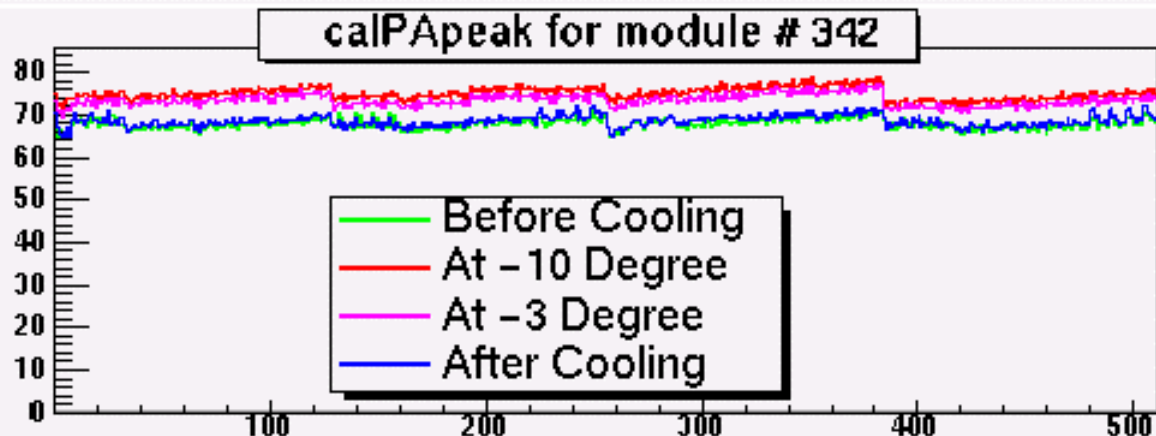
Long Term Test in Pisa

Noise during the cooling cycles

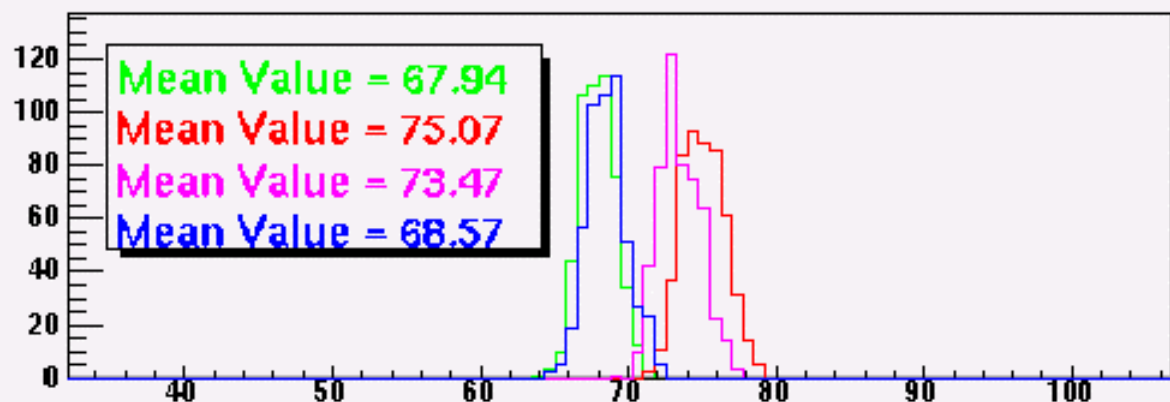


Long Term Test in Pisa

Calibration during the cooling cycles



No failures
after cold tests
both in Pisa and
Firenze



Very preliminary
results, need to
adopt standard
parameters of
the test, like T,
time, number of
cycle

Conclusions on T1 B "Rush" Production

- Gantry:
 - 64 modules produced in one go in September
 - Peak rate of 8 modules per day reached in Perugia
 - 4 modules per day per centre can be easily guaranteed
- Bonding and testing:
 - 36 modules bonded and tested, 2 failed before bonding
 - Between 2 and 3 modules per day per centre
- The whole procedure is in place and working
 - Defects and failures are identified with a high level of precision
- Module quality:
 - A few problems with Kapton cables, 2 modules rejected
 - 42 bad strip over almost 16000 studied
 - Only one real defect !