

Module Test and Xcalibration with the CMS like system

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IEKP, Karlsruhe*

1. Xcalibration

check readiness of production centers and reproducibility of the test data
with one TEC R6 module *N 30200020000644*

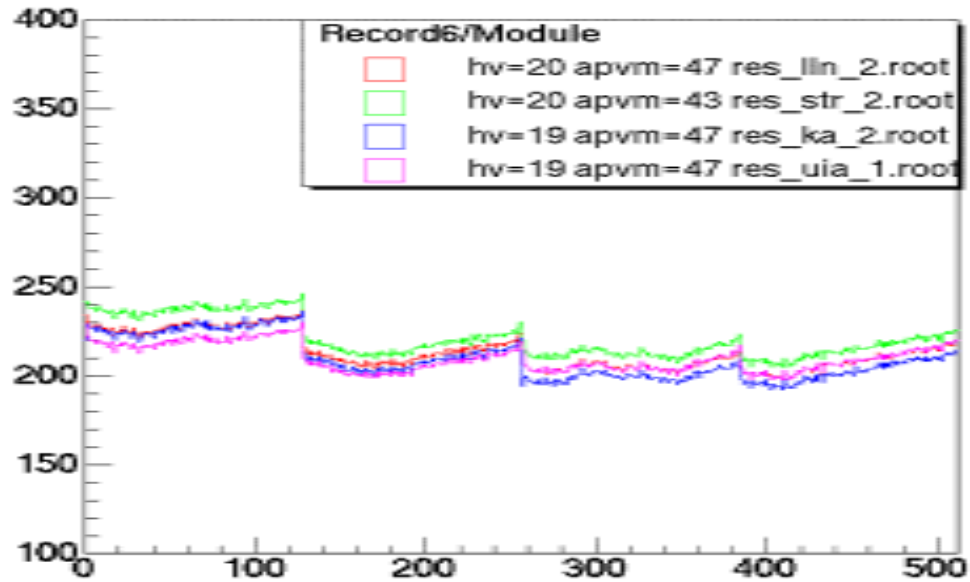
- CMSlike setup: *PC with FED,FEC,TSC,CIO + UTRI (box,LV and Hv are not specified)*
- Software: *Lt_081, 100*
- Testing scenario: *xcalibration.lt (PedRun,CalRun,CalprofRun,LatRun at different apvmode and HV=0 and 20V, IVRun(200V))*
- Settings: *default*

Setup	Comments
1. Antwerp	Vienna box, cooled down tom -5C
2. Karlsruhe	single module setup, no temperature control
3. LLN	LLN cold box
4. Strasbourg	single module setup, no HV control

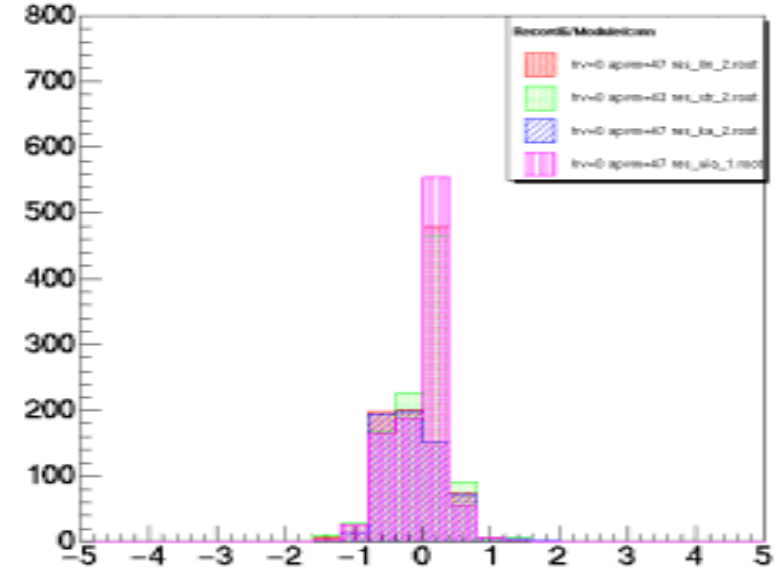
Xcalibration: Results I

All CMS like setups produce similar results for the Noise, Calibration, Leak .

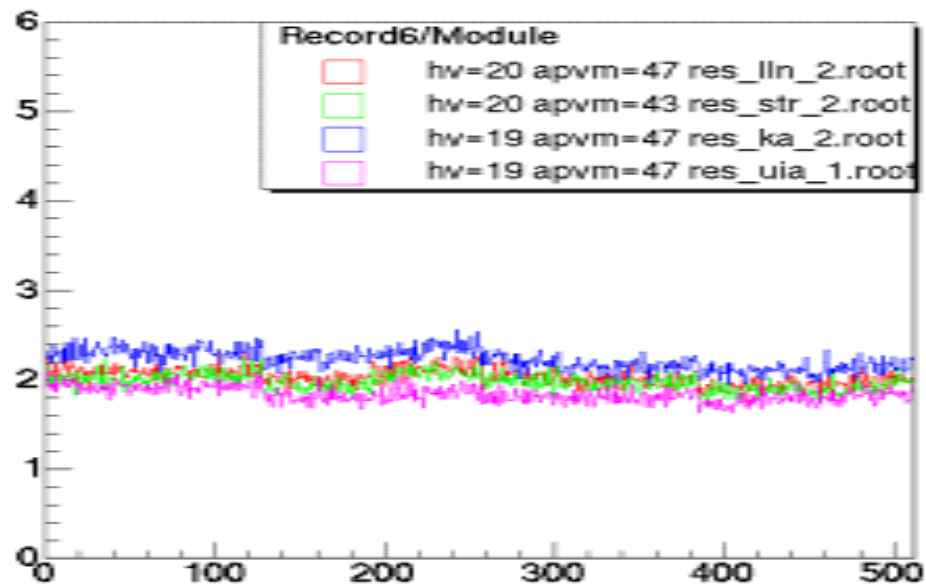
THpedestal



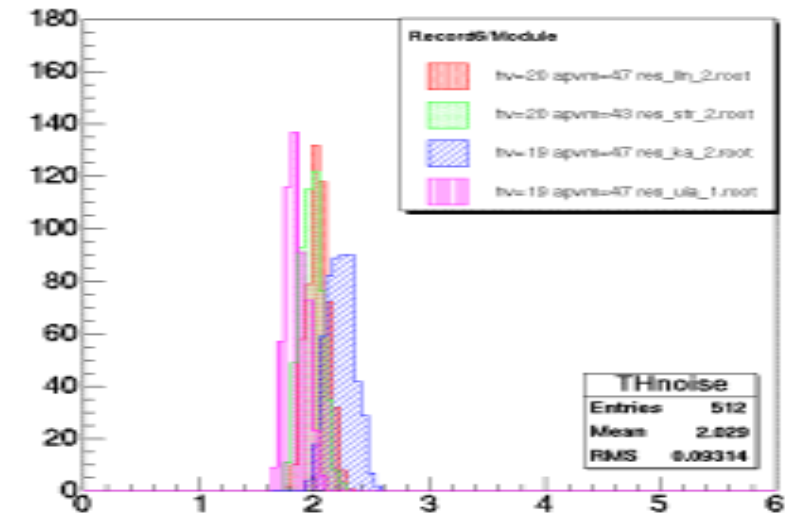
THcmn_0



THnoise



THnoise



Xcalibration: Results II

Common mode noise: <1ADC (invON HV=20V) for all setups

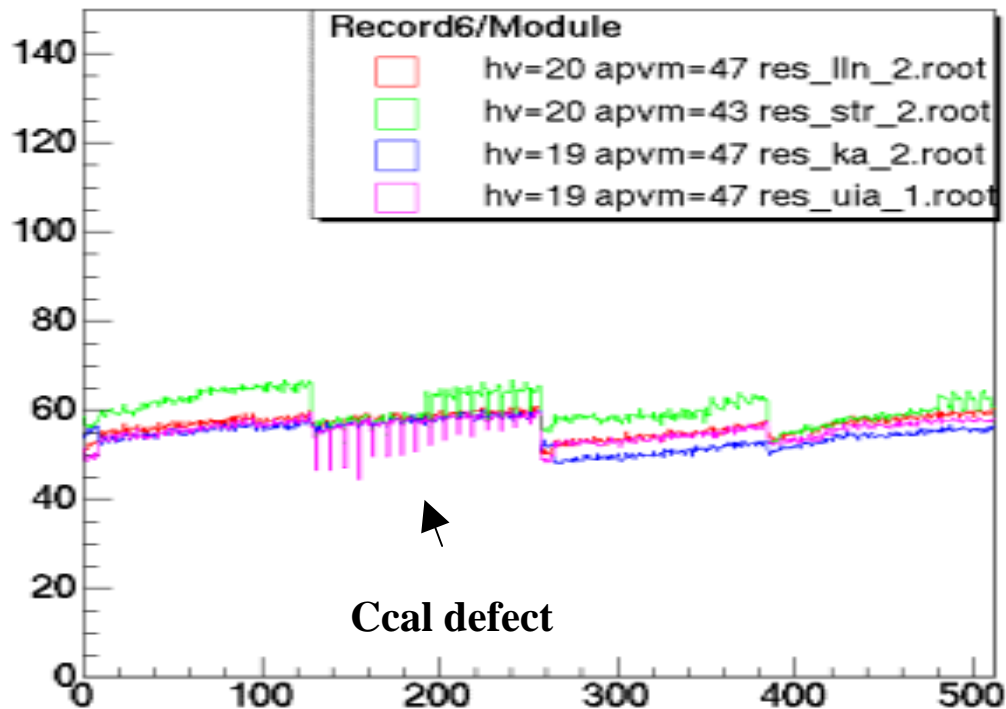
Raw noise: within 15% HV(0-20V)

Noise: within 15% for different apvmodes and HV

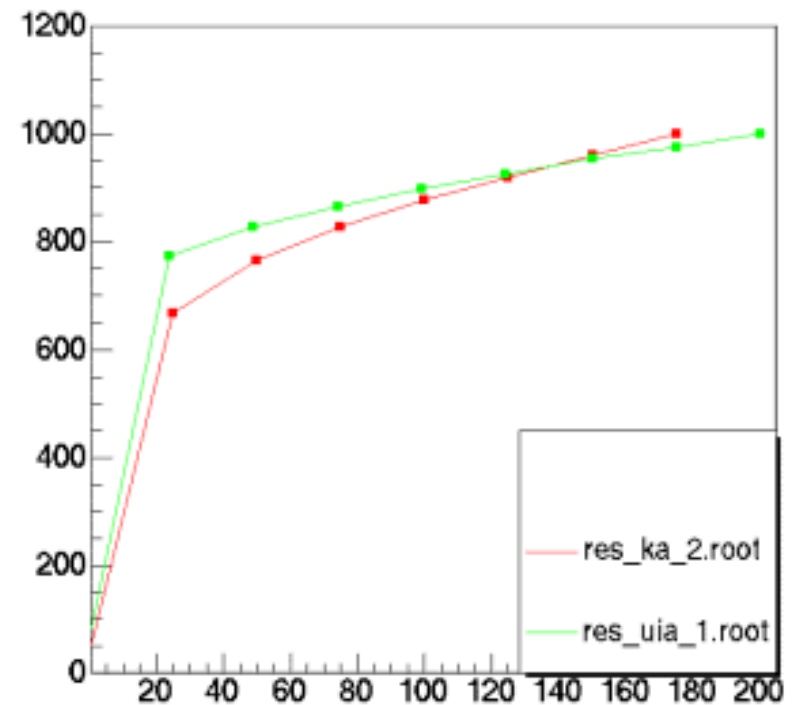
Calibration amplitude: within 20% for different modes

Ileak : within 10% (up to 200V)

THcalPApeak



IV



Xcalibration: Results III

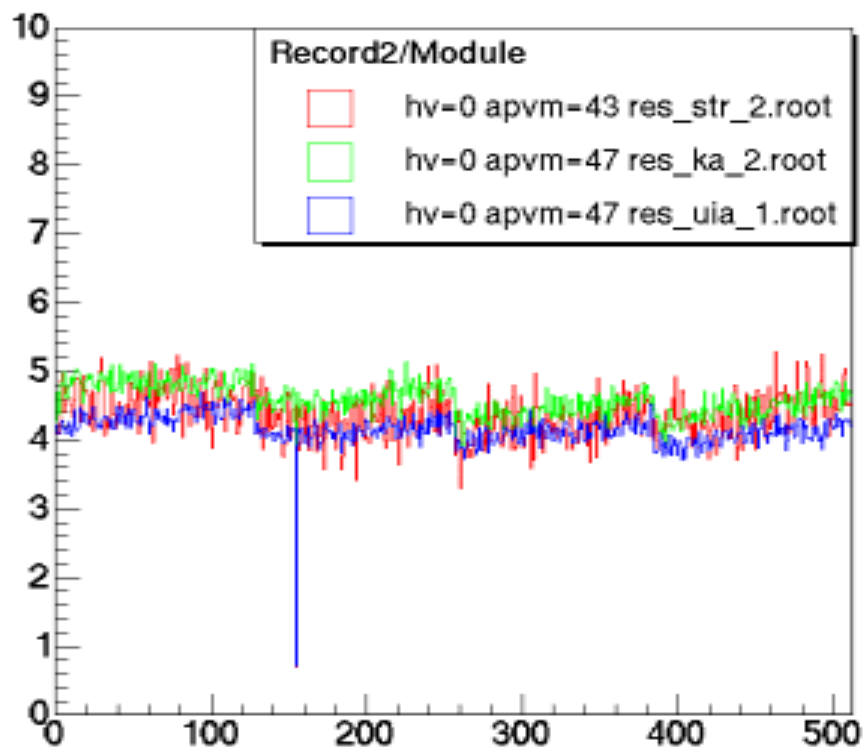
Bad channels:

no bad channels found except...

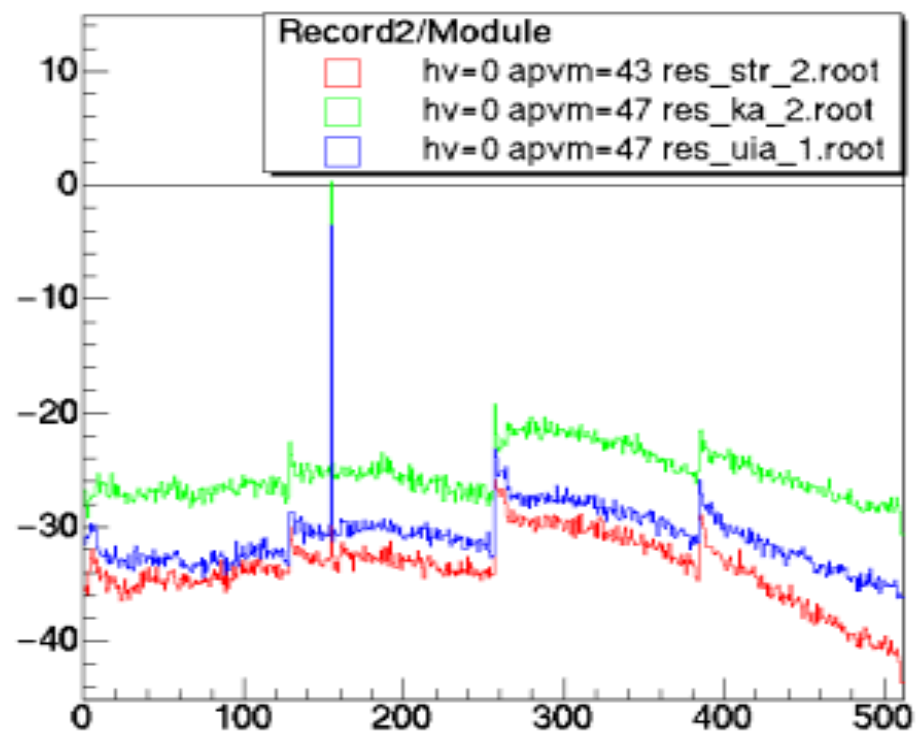
one (154) at inverter ON and HV=0 later associated with a pinhole found in Karlsruhe, Strasbourg, Antwerp

(LLN didn't run at HV=0 due to HV problem)

THrawnnoise



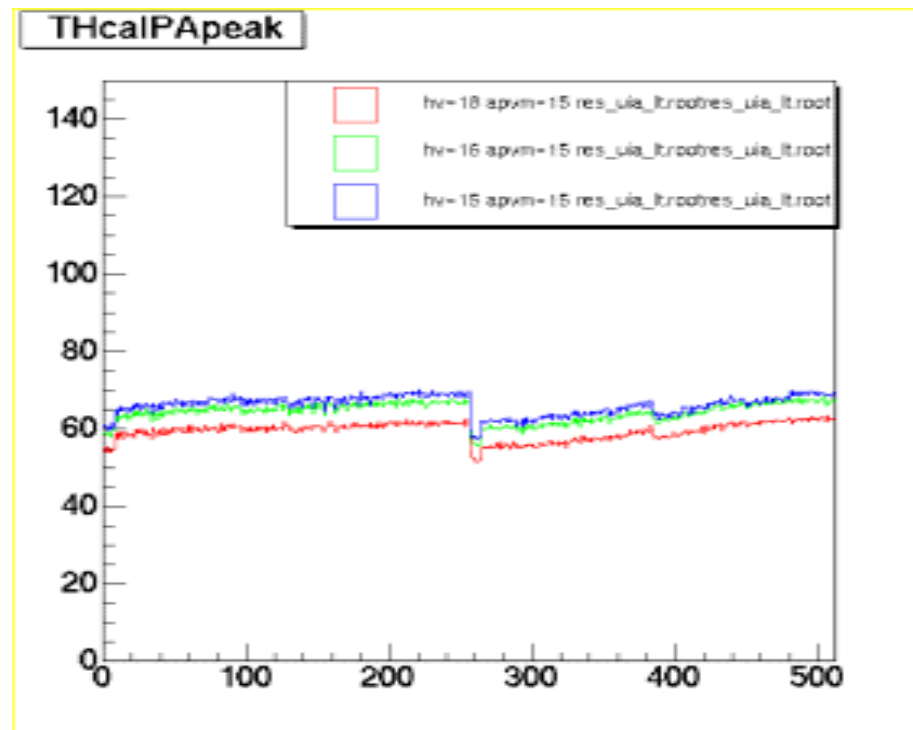
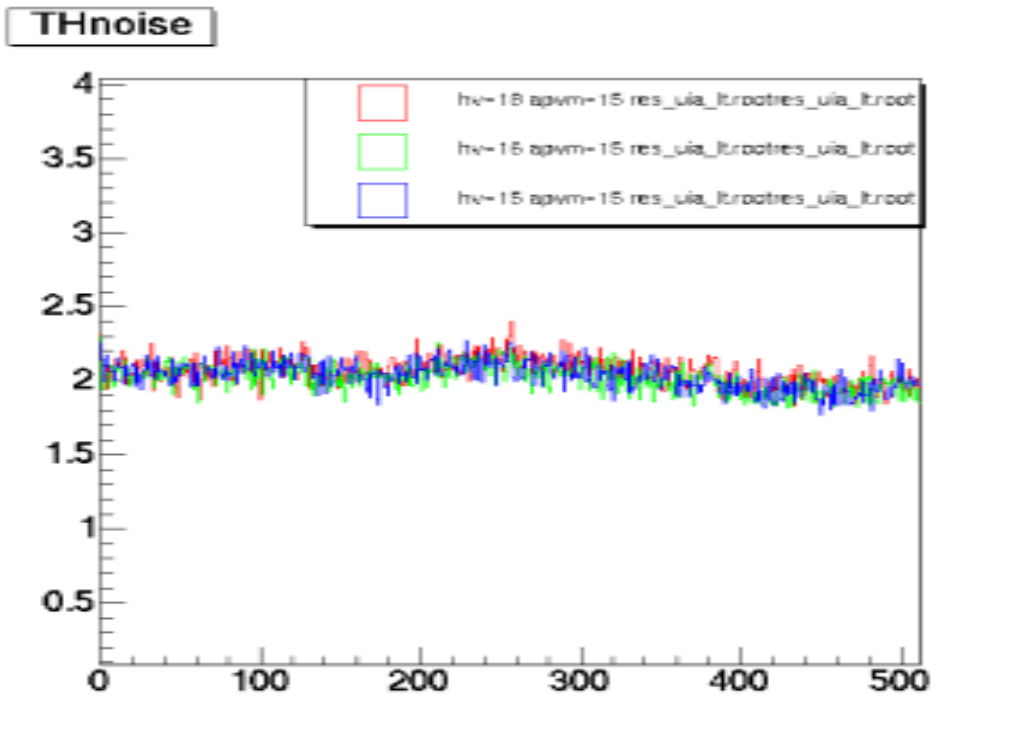
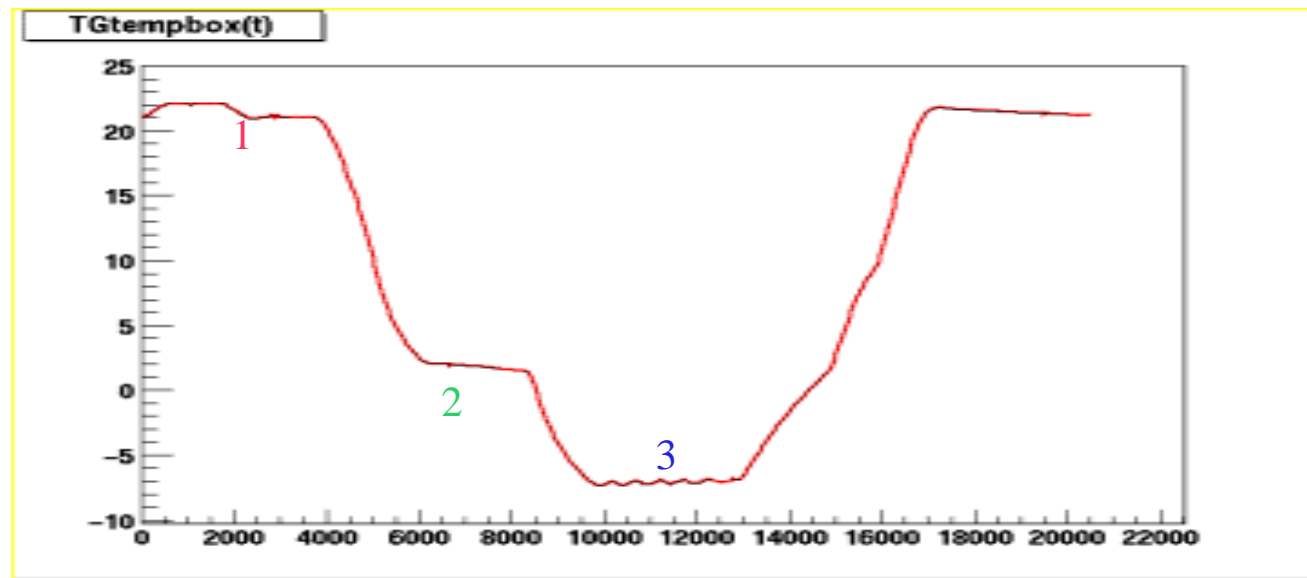
THcala



Xcalibration: Results IV

Operation in cold.
(in Antwerp Vienna box)
20C, 0C, -5C
Noise: same
Acal : within 10%

no significant changes

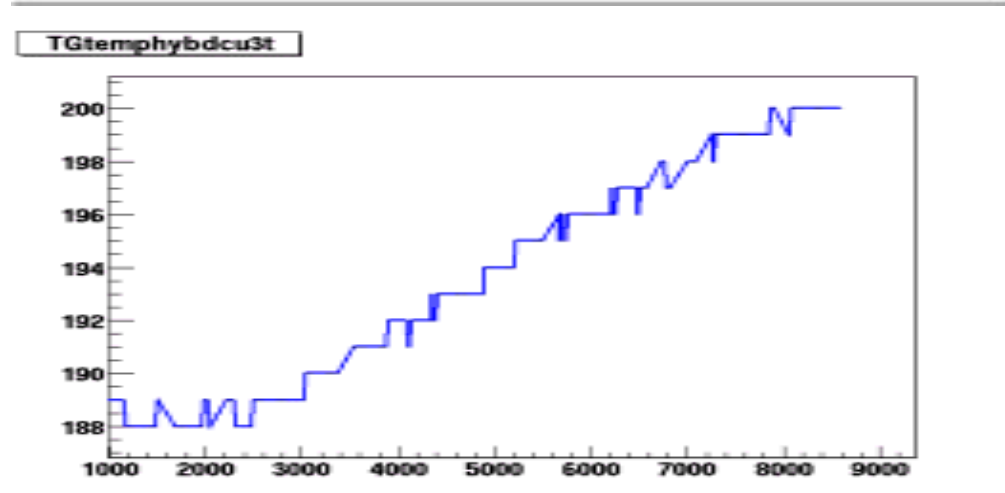
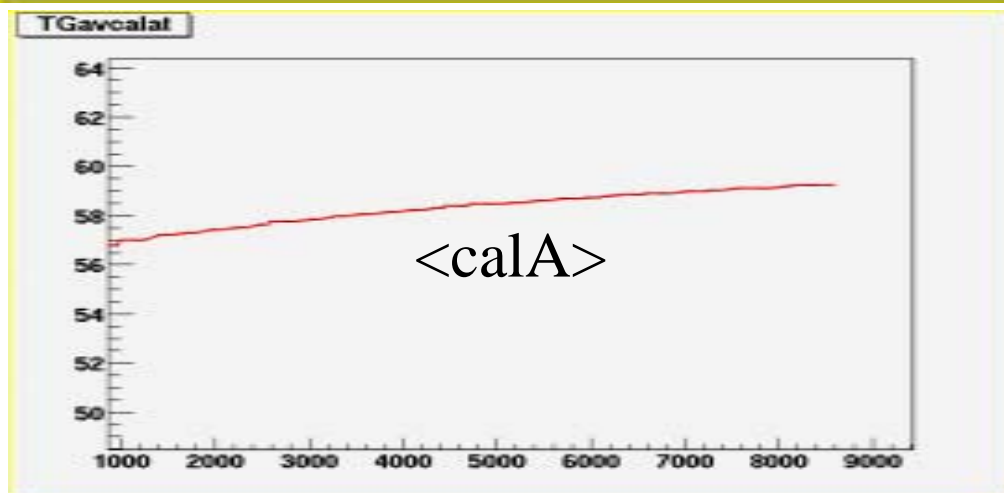
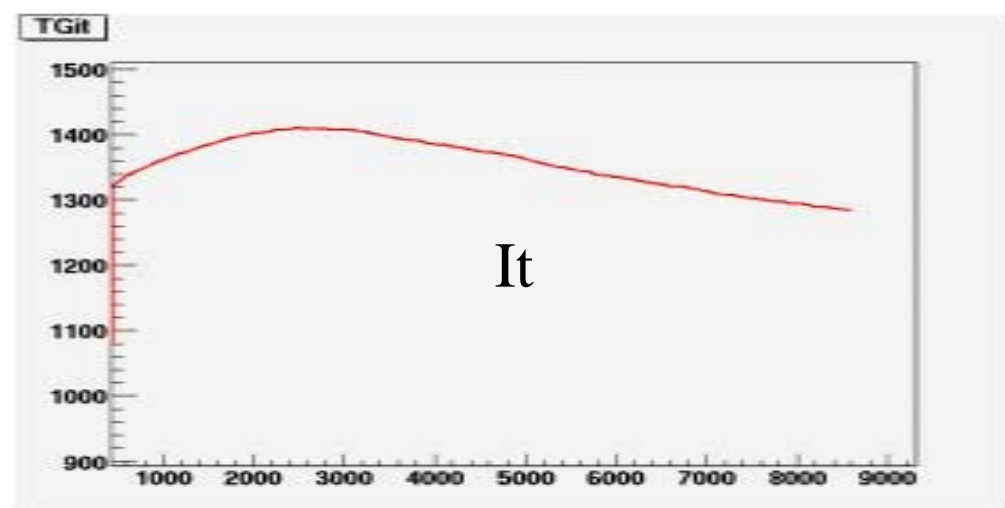
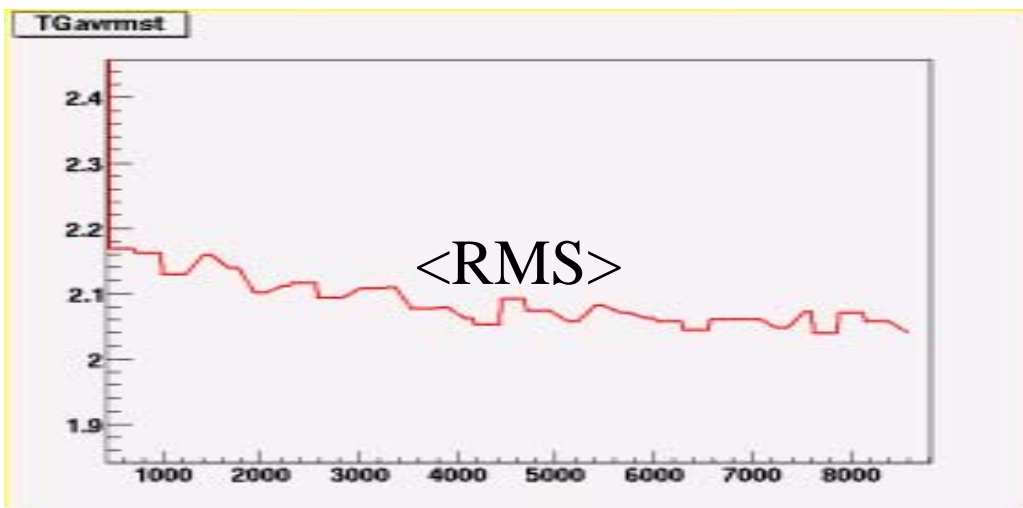


Xcalibration: Results V

Stability:

2.5 hours at Troom after switch ON (no temp.control)

< 10% drift of average noise and calA

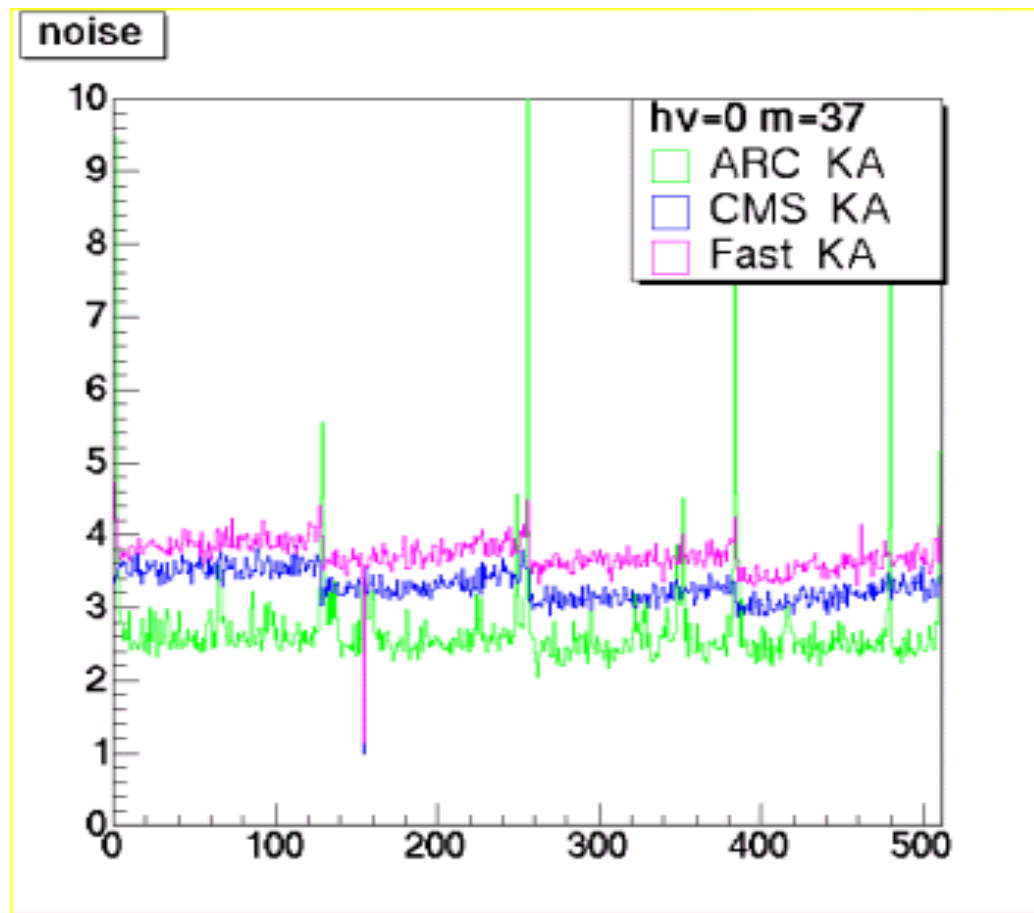
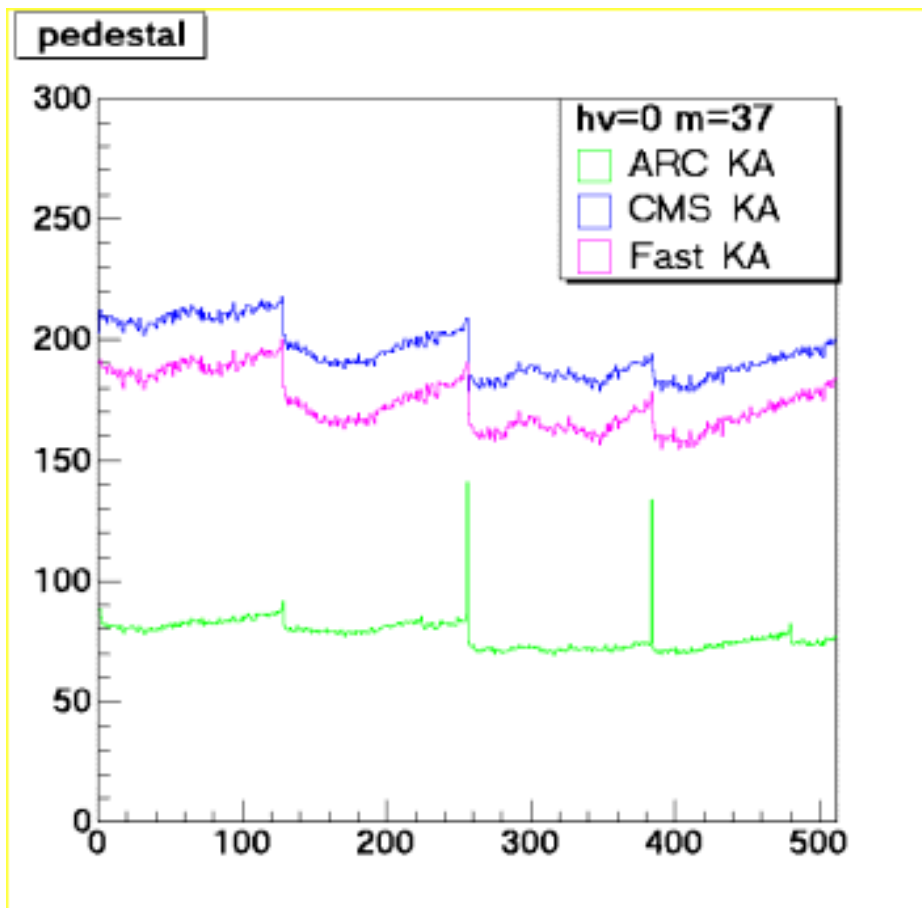


Other setups(not CMSlike):

Karlsruhe

-Fast(after bonding) setup. *Similar to CMS like with a bit more noise*

-ARC: *big edge effect, unstable (under investigation)*

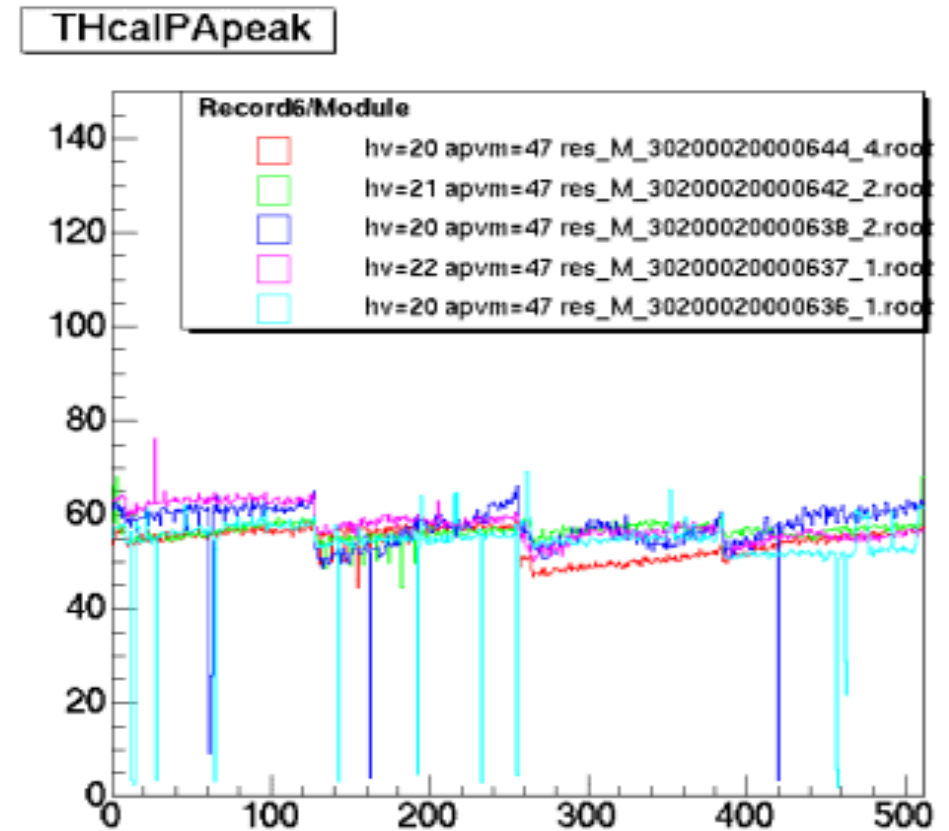
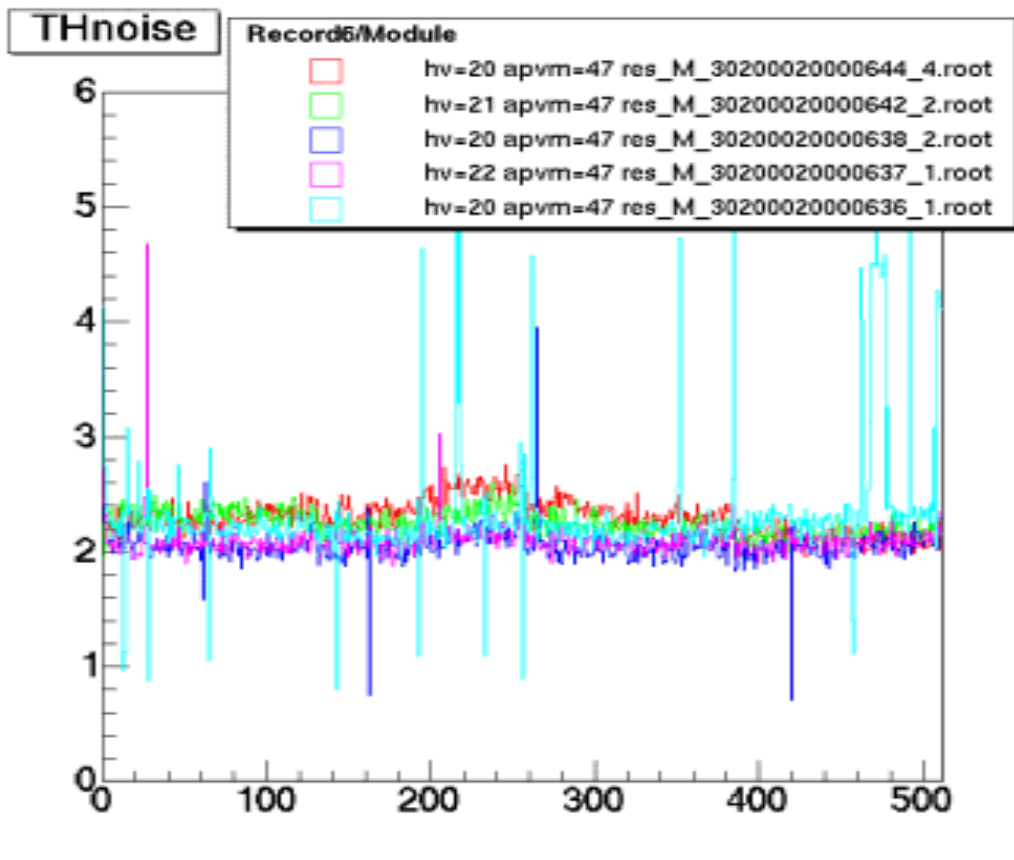
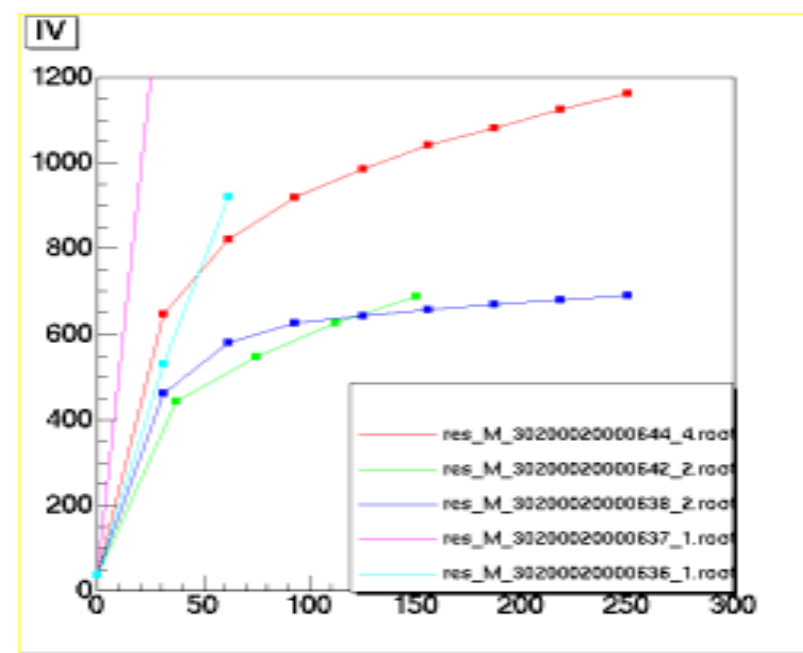


2. Module Tests

5 more modules R6 preserie have been tested in Karlsruhe (636,637,638,642,644) and 2 R5 with the xcalibration scenario .

No problem during running

Used to define selection criteria and algorithms



Analysis and definition of defects

Defects classification:

1. component defect: APV,(PLL,MUX,DCU),Sensors

APV: abnormal behaviour (noise,pedestal), apverrorbit, pipeaddress MUX: gain DCU:response

Sensor: Ileak

2. bad channel. Abnormal behavior.

- absolute cut $X1 < X < X2$

-relative cut $|X - avX| > Thr * rmsX$; $X = \text{noise, calA, etc}$ due to;

bonding(open,short,connected),pitch

adapter

sensor (pattern defect, pinhole,bulk Ileak)

Important to have same distribution of X for different setups before comparing data!

How to calculate X?

How to select Threshold and Cuts?

At which settings to operate (apv, voltages,etc)?

How to combine results of different tests?.....

Tests available

Basic tests: PedRun , CalRun(CalProfRun) , IVRun , Pinholetest(LightRun), ConnectivityRun, LatRun

Complimentary : BPlaneRun, LedRun,

Analysis and definition of defects II

Component defects.

Example.

Ring 5 modules 630(stereo) 627(normal)

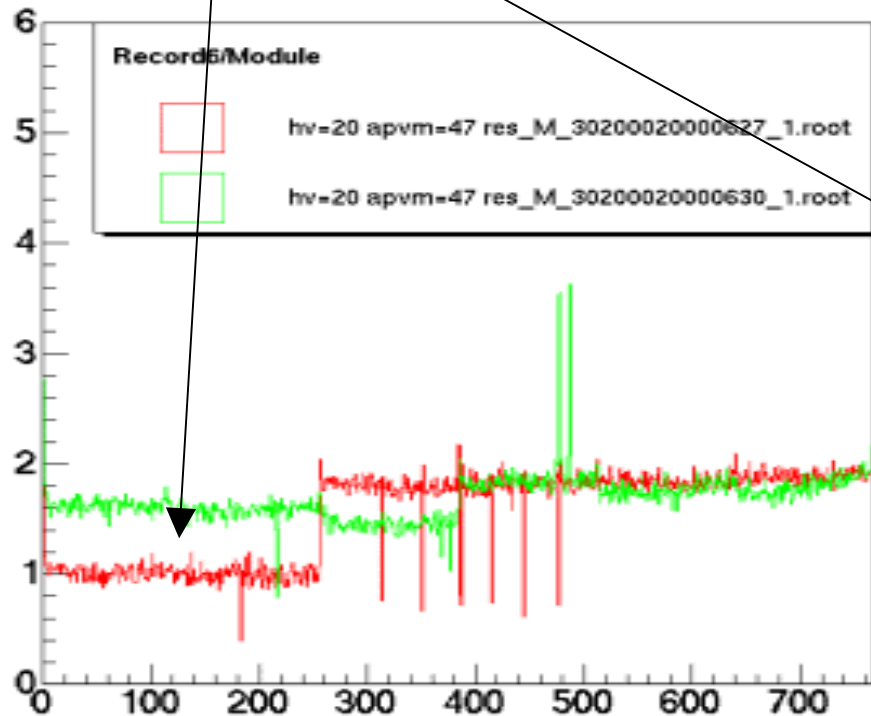
Low gain for the first 2 chips in 627 and 3th chip in 630

Use an average noise, calA ,etc per APV chip as for the bad channels.

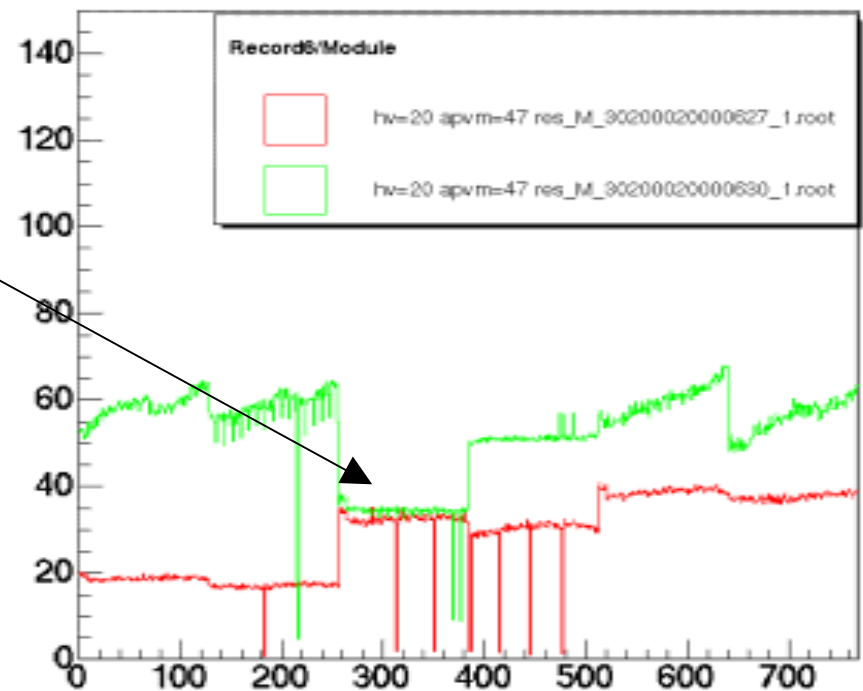
Step 0. Tag abnormal components

Tag this APV's as abnormal

THnoise

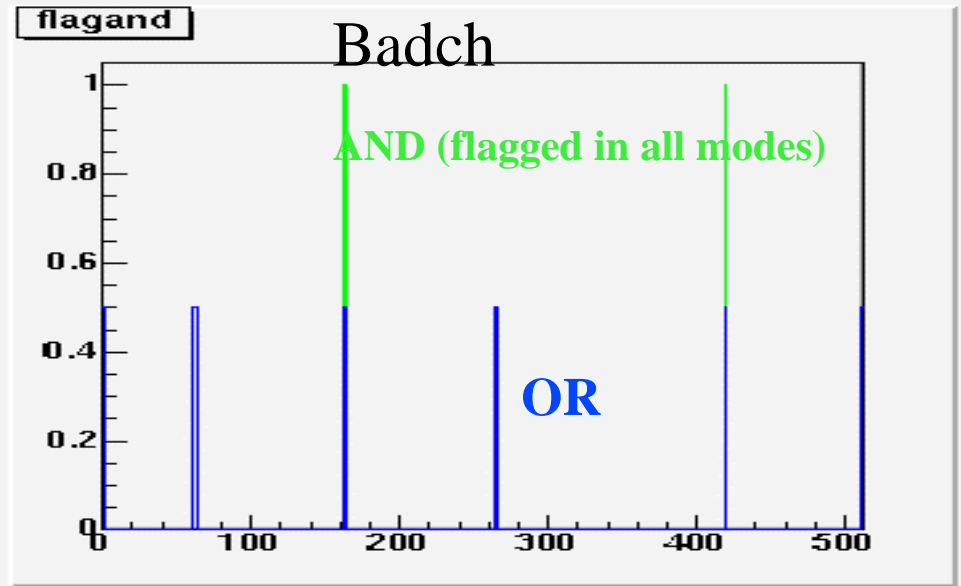
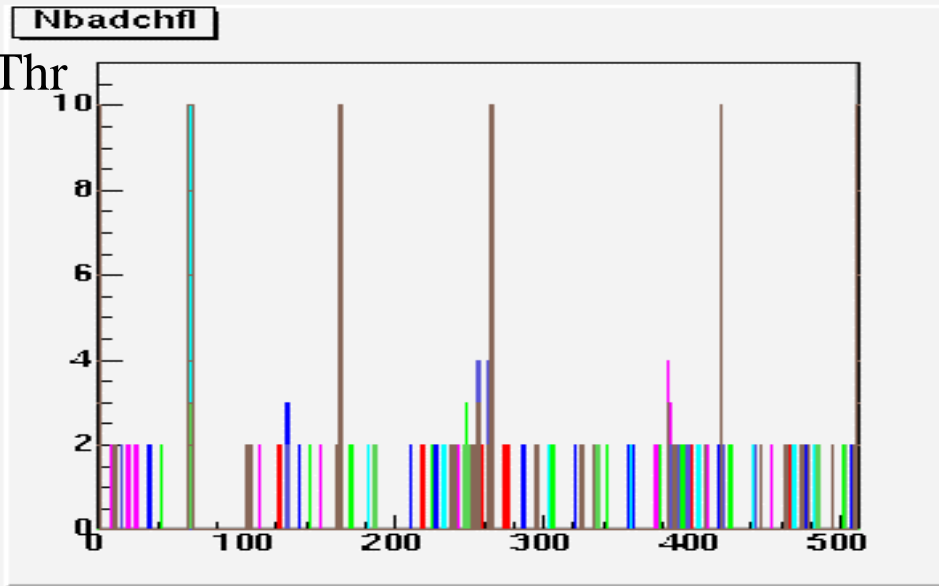
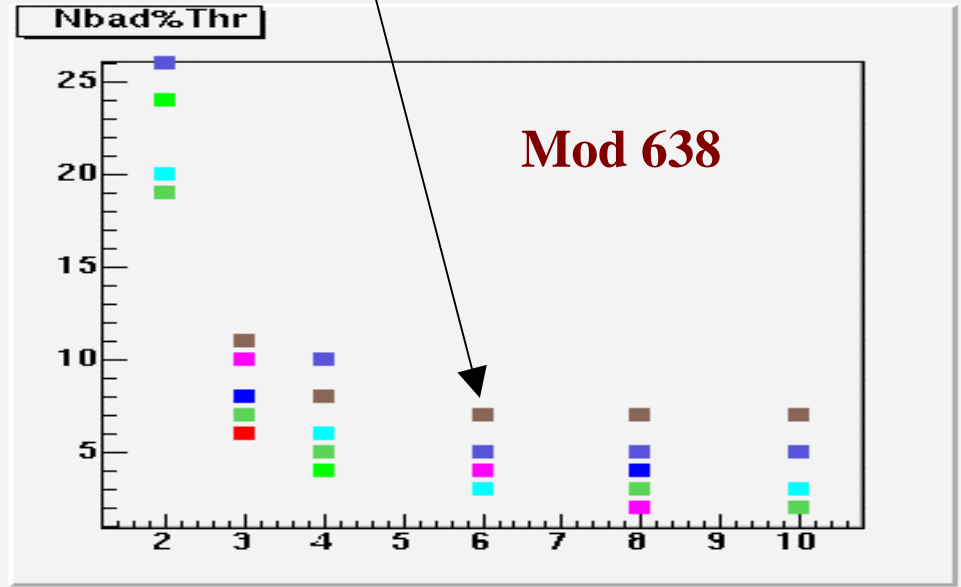
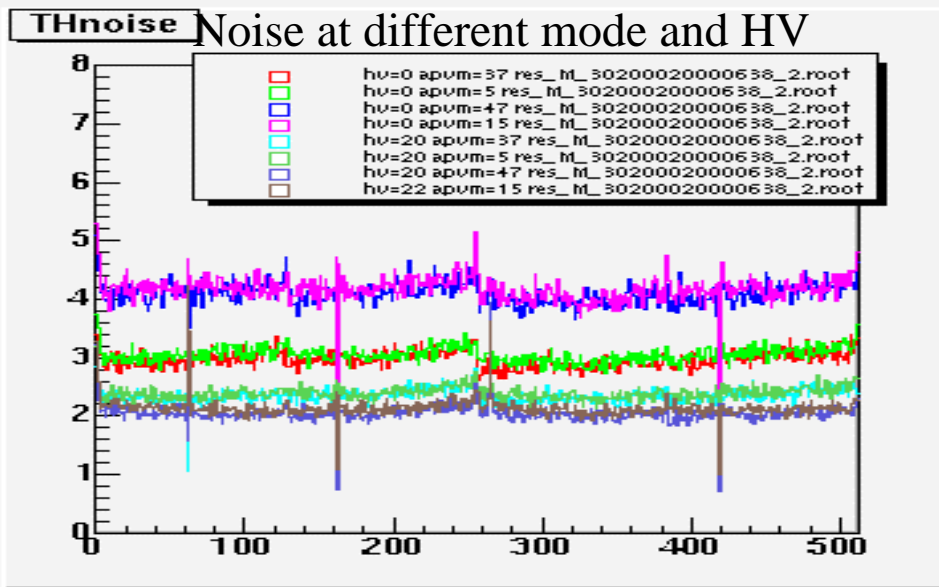


THcalPApeak



Analysis and definition of defects III

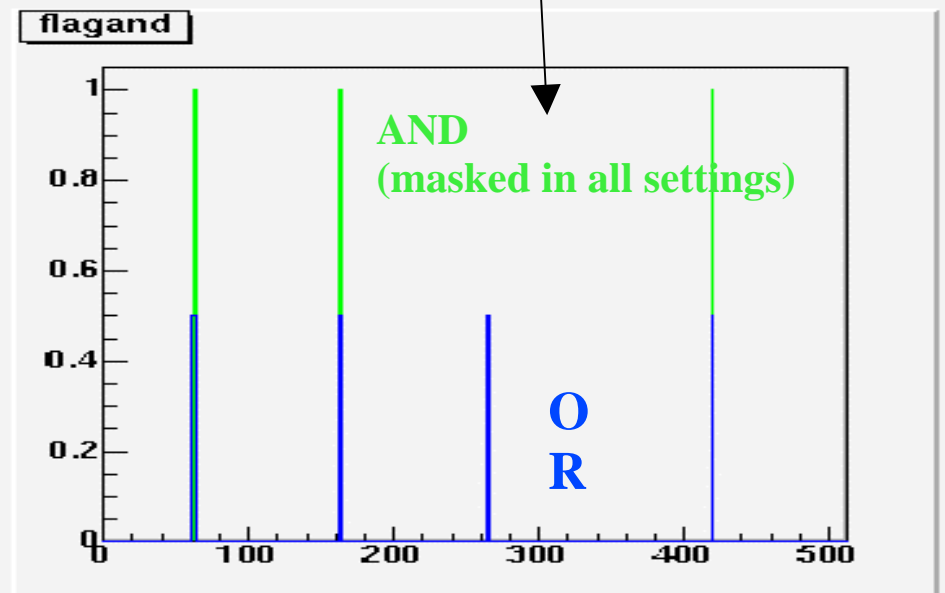
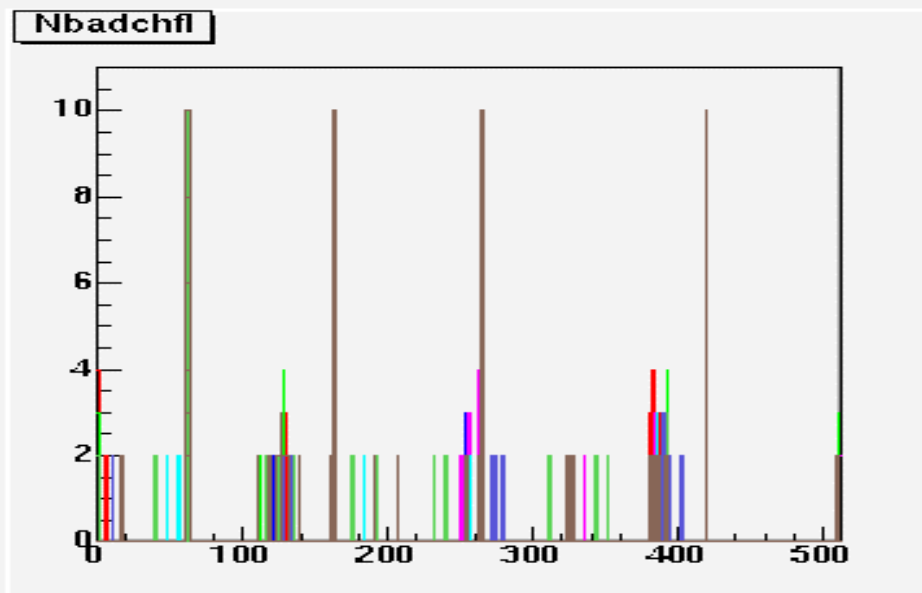
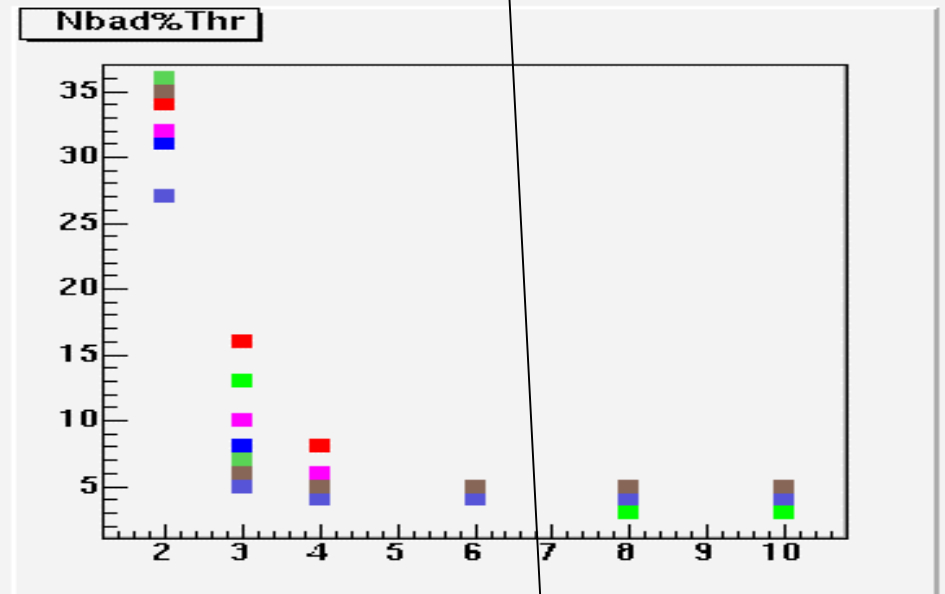
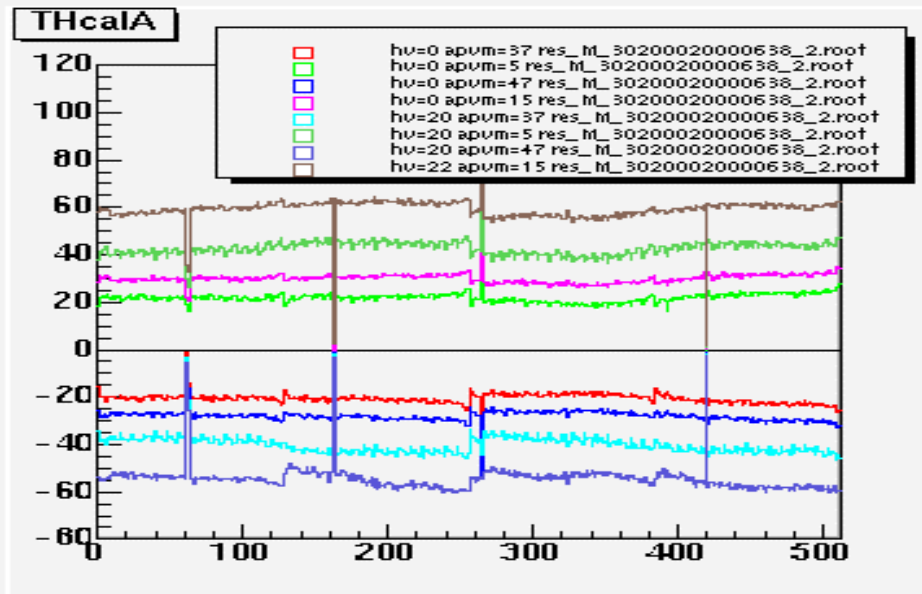
Step 1 Select threshold for the relative cut of this parameter (f.ex. Noise) for this type of modules (once)



Analysis and definition of defects IV

Same for the calibration signal. Define threshold.

Step 2. OR all bad channel flagged at various mode and HV for each test.

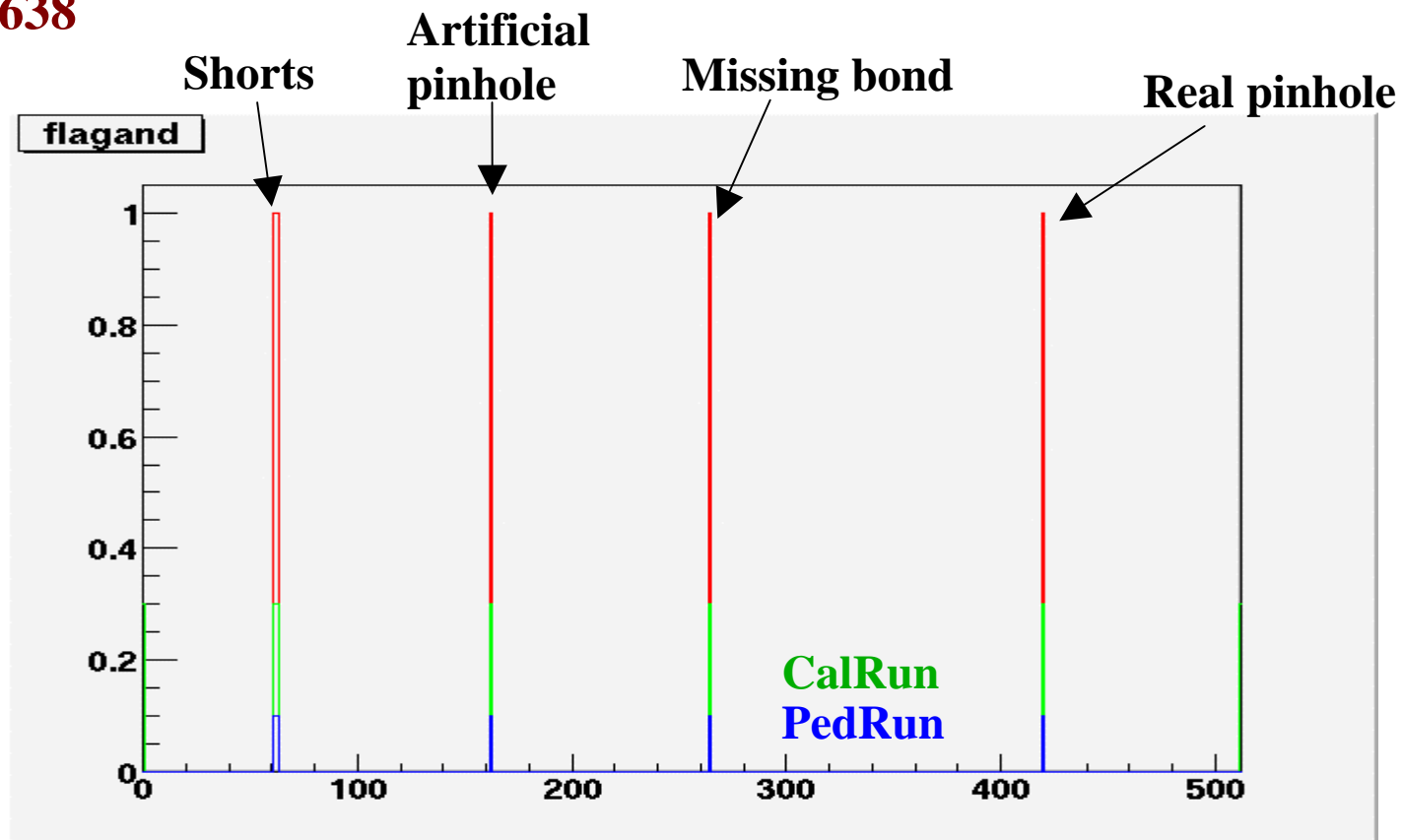


Analysis and definition of defects V

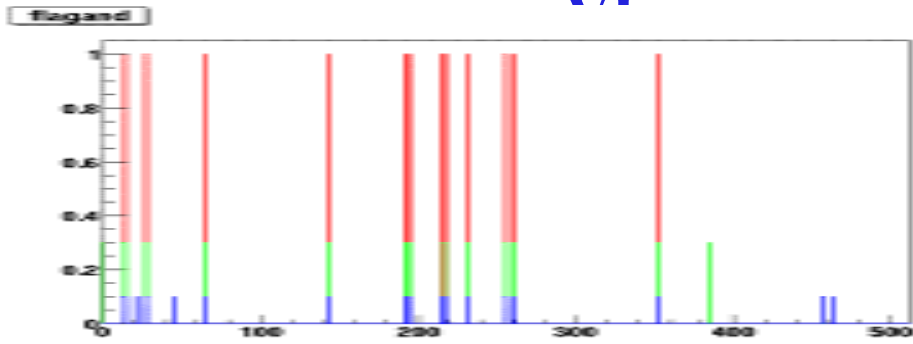
Step 3. AND results from different tests (PedRun and CalRun) for the confirmation.

Simple defects; open, shorts can be tagged with the PedRun and CalRun on

Mod 638

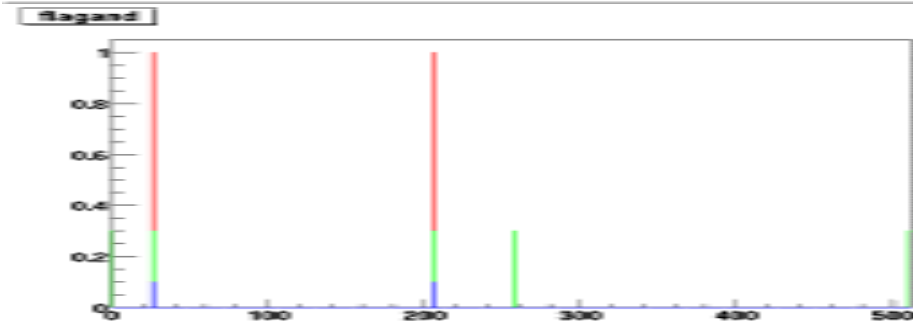


Analysis and definition of defects

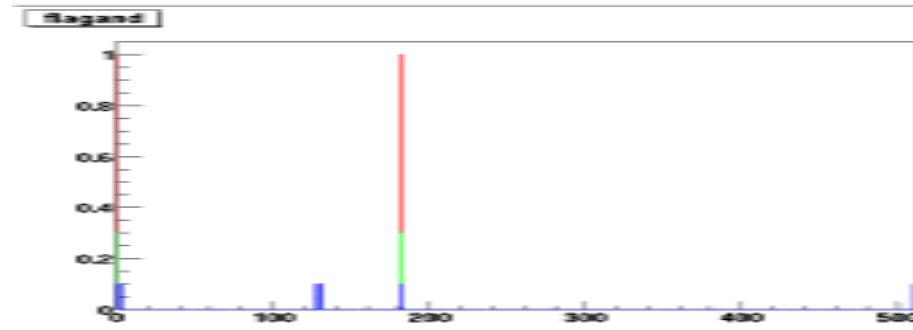


Other modules:

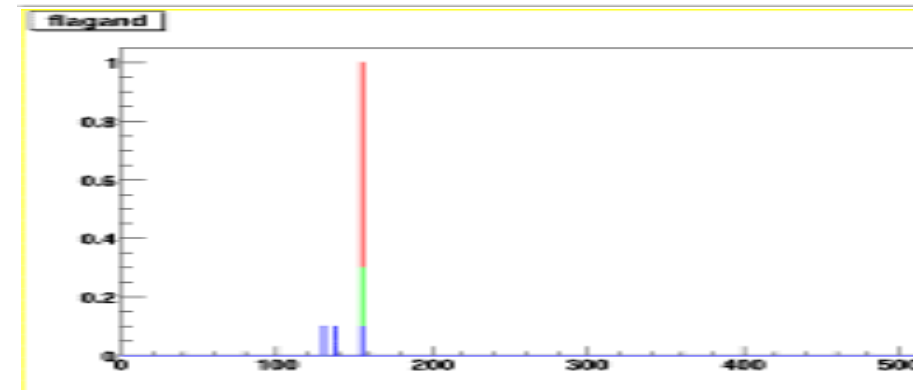
636: 15 opens (damaged bonds to PA)



637: 26-short, 205-open



642: 183,512 -pinholes



644: 154 -pinhole

Pinholes hunting

- High leakage pinhole is seen from the noise and calibration
- Low leakage pinhole can show up by saturating of the APV ch.

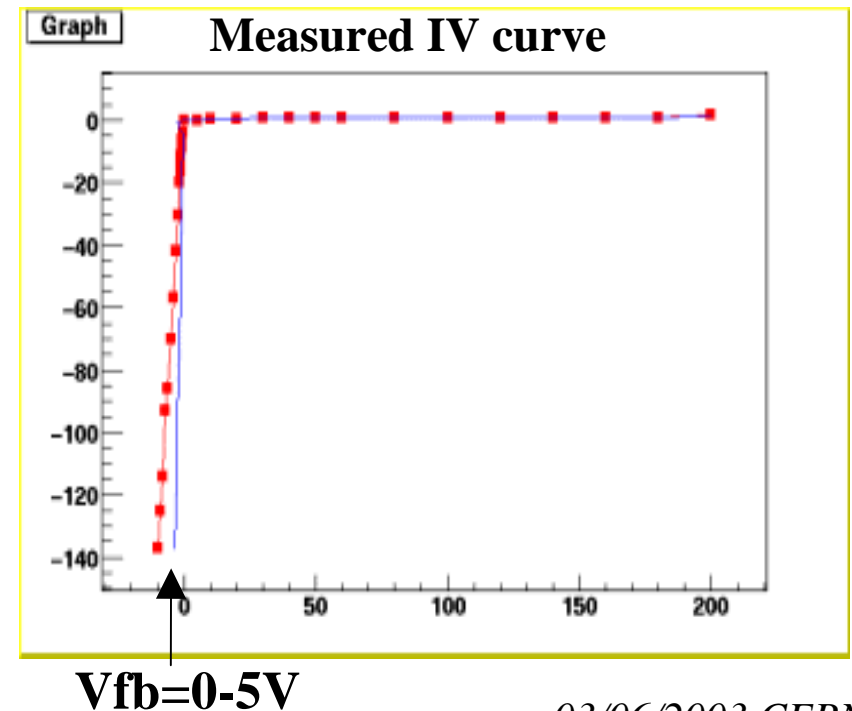
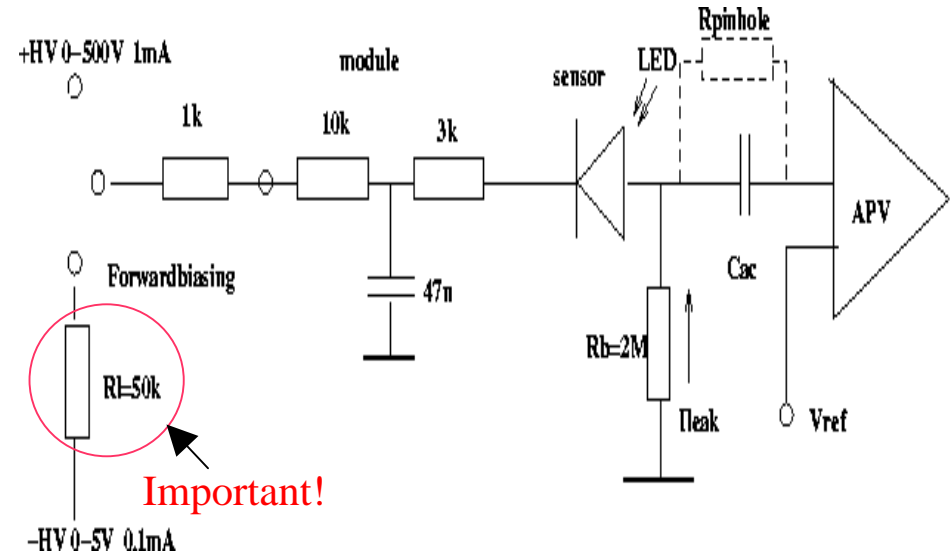
In case of pinhole an input current produces dV offsets on $R_b = 2M$ which saturates APV.

Sources of currents:

- 1) APV itself (HV=0 seen in mod644 and not with HV, when I_{leak} compensates APV current)
- 2) Sensor I_{leak} by irradiation or light .
- 3) Forward biasing.

Advantages:

- Safe. Does not produce the huge charge near implant(as with Led) Current $< 60\mu A$. Can't burn module with $R_{protection} \sim 50K$.
- Can be used for petals/rods, longterm and cold
- Simple: One need $5V \times 0.1mA$ power supply and a switch.

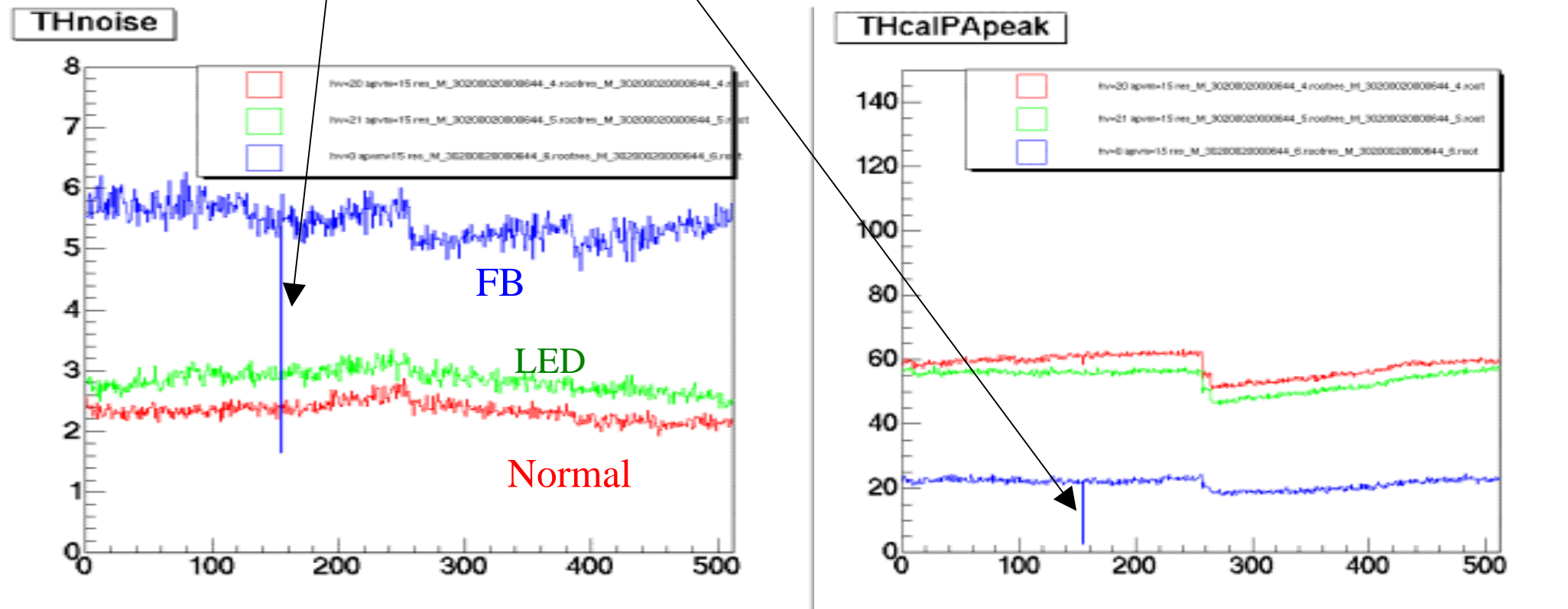


Forward Biasing I

Have tried forward biasing ($V_{fb}=-5V$, $I=60\mu A$) and Led illumination ($150\mu A$) for 7 preserie modules.

Low current pinhole is not seen with the Led($HV=20$) and clearly seen with the FB

Mod 644

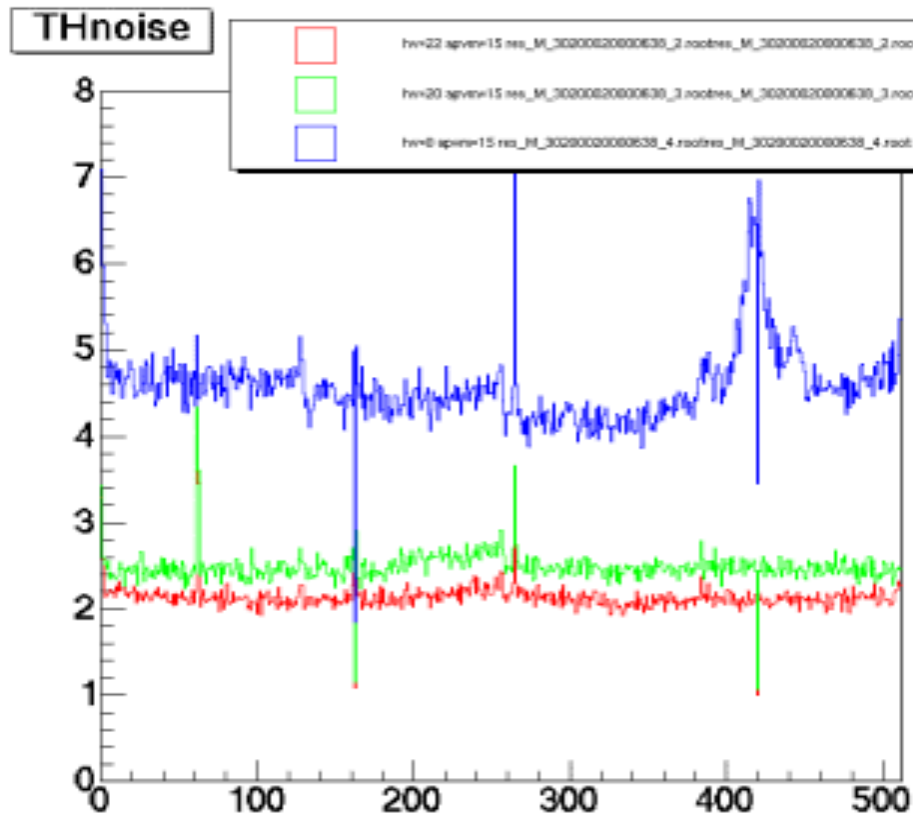


Forward Biasing II

Analysis

Step 4. The FB (LED) bad channels are OR with the badch from other tests (Ped and CalRun)

Another example: **Mod 638**

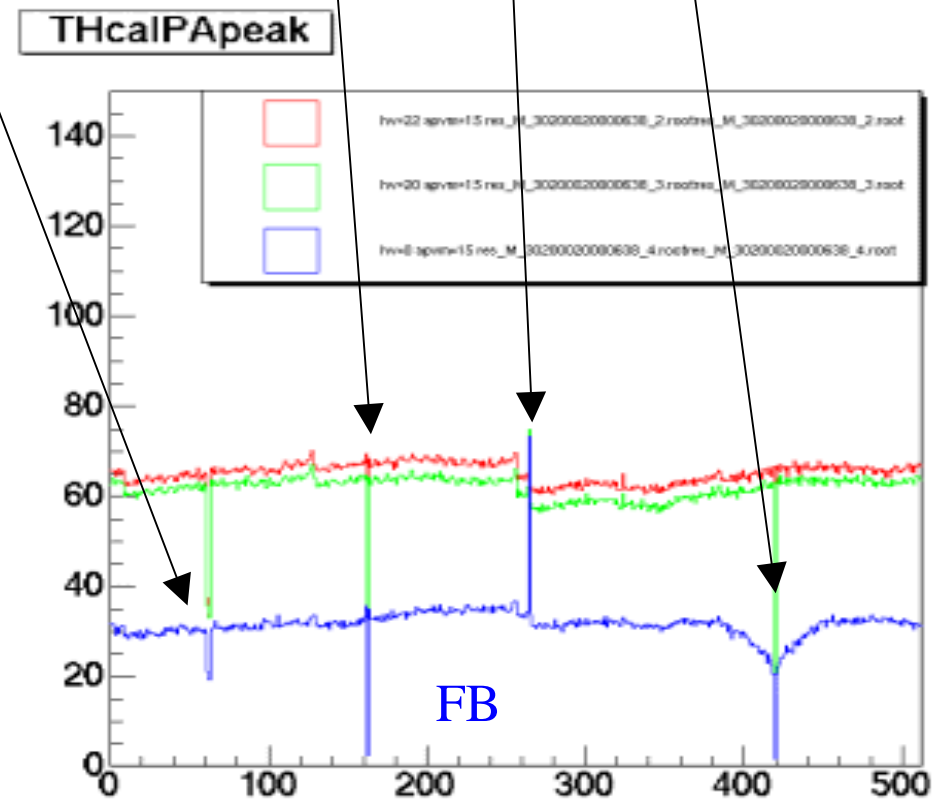


Shorts

Real real pinhole(has to unbonded)

Artificial pinhole

Open



Summary

- 1. CMSlike system (hardware and software) worked well for the Xcalibration and ready for production. More Xcalibrations is needed to check slow control parts(Temp,Hum,HV) and operation in cold.**
- 2. Algorithms to define defects out of different tests are proposed and will be implemented.**
Bad channels are in OR for each test(pedestal,calibration) at different conditions (operation at HV=0 is important) . AND flags for different tests. Pinhole test(FB or LED) is in OR with the obtained mask.
- 3. Forward biasing is an effective tool for pinhole findings.**
Can be used in longterm tests and later with petals/rods.