Testing of n-ABCD2 metalized chips on the Barrel Kapton hybrid/module

Y. Unno, et al.

KEK

Abstract

The n-strip readout ABCD2 chips which were thinned and metalized in the backside were stuffed on the kapton hybrids developed for the SCT Barrel module. A 6 chips hybrid was connected to 6cm strips and then 12 cm strips daisy-chaining two square barrel detectors. All channels with 6 cm strips were stable for the maximum range of FE bias current, 285 μA, with the nominal FE shaper current at 18 μA. Channels with 12 cm strips developed instability for the number of strips more than 40. The instability were suppressed for the full range of FE bias current up to 285 μA by setting the FE shaper current at 10 μA in the setup. A fully stuffed module, 12 chips and 4 detectors, was fabricated and performance was mapped out for the combination of FE bias and shaper currents. Instability was observed in the region of FE shaper current being >8 μA and FE bias current >147 μA. With the FE shaper current being below 8 μA the chips worked for the full range of FE bias currents up to 285 μA. However, the chips were still unstable for the thresholds below about 50 mV.

Introduction

Feb SCT week-- reported

- KEK has tested several n-ABCD2-metalized chips to 6cm strips
- Reported successful operation of the chips in the full range of FE bias current
- Then, in summary, presented

"Next plans"

June SCT week -- reports on

(1) 6 chips with 12 cm strips, two detectors being daisy-chained

(2) 12 chips with 12 cm strips, being a full barrel module

Next plans

(as of Feb. SCT week, √ as of June SCT week)

- **√Stuff the hybrid with more chips, e.g., 6 chips**

- **√Bond (most of) channels to (single) detector**

  - 6 cm in this configuration

  ~~**- 12 cm requires "ganging" and not practical for this**~~

  ~~**- 12 cm "ganging" is possible by using the "irradiation pitch adaptor", but only 4 chips per hybrid**~~

  - 12 cm: 2 detectors in series

- **√If the single detector operation is successful,...**

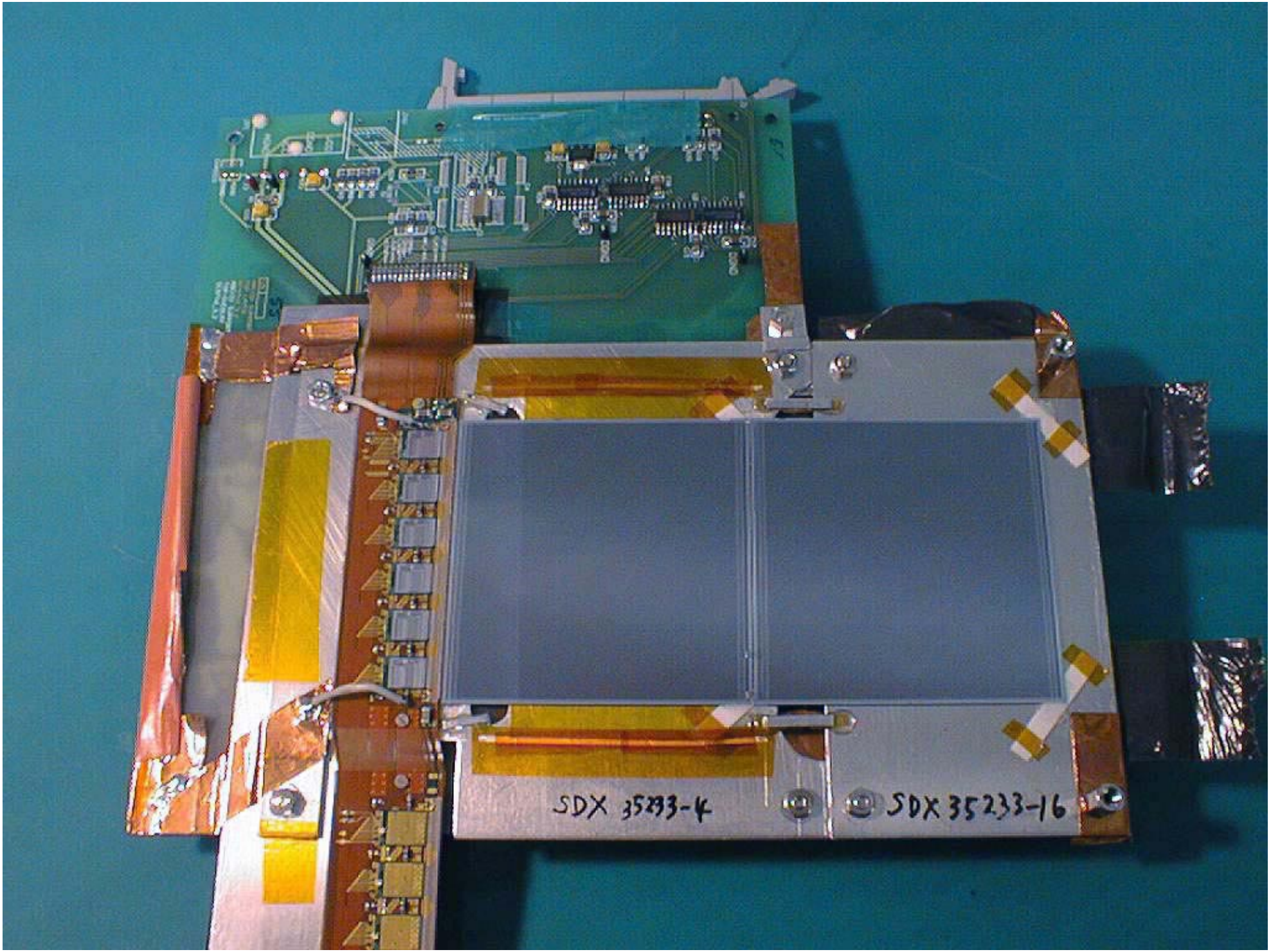
  - A few more chips (which we have so far) on the other side, and

- **√Build a double-side Barrel module**

  - If the operation is successful, which is a BIG question mark, then...

- **Start building the "back-metalized" p-ABCD module as soon as possible**

  - There might be a surprise in the p-chips...


SDX 35293-4
SDX 35233-16

End-tap half module - 6 chips with 2 detectors

-Barrel Kapton hybrid being populated with 6n-ABCD2-metalized chips

- Analog and Digital grounds were connected on the hybrid

-Carbon-carbon bridge being glued on the hybrid with electrically conductive glue where the chips were, i.e., “conductive bridge”

-The hybrid and the detectors were placed on an Aluminium support plate

-The hybrid bridge was electrically connected to the Aluminium plate

-Several attempts were tried to improve the instability situation, e.g., addition of there-inforcing electrical wire connections as seen in the photo, which did not help to improve the situation, though

6 cm strips

-AllchipswerestablefortheFEbiascurrentsupto285μA,withthe FE shaper current at 18 μA

- 50% median charge, noise charge, in the unit of mV

- At 212 μA,..., 285 μA,

90 mV threshold ~ <1 fC

Noise charge:

~ 0.17 fC (~1100 e) at 212 μA

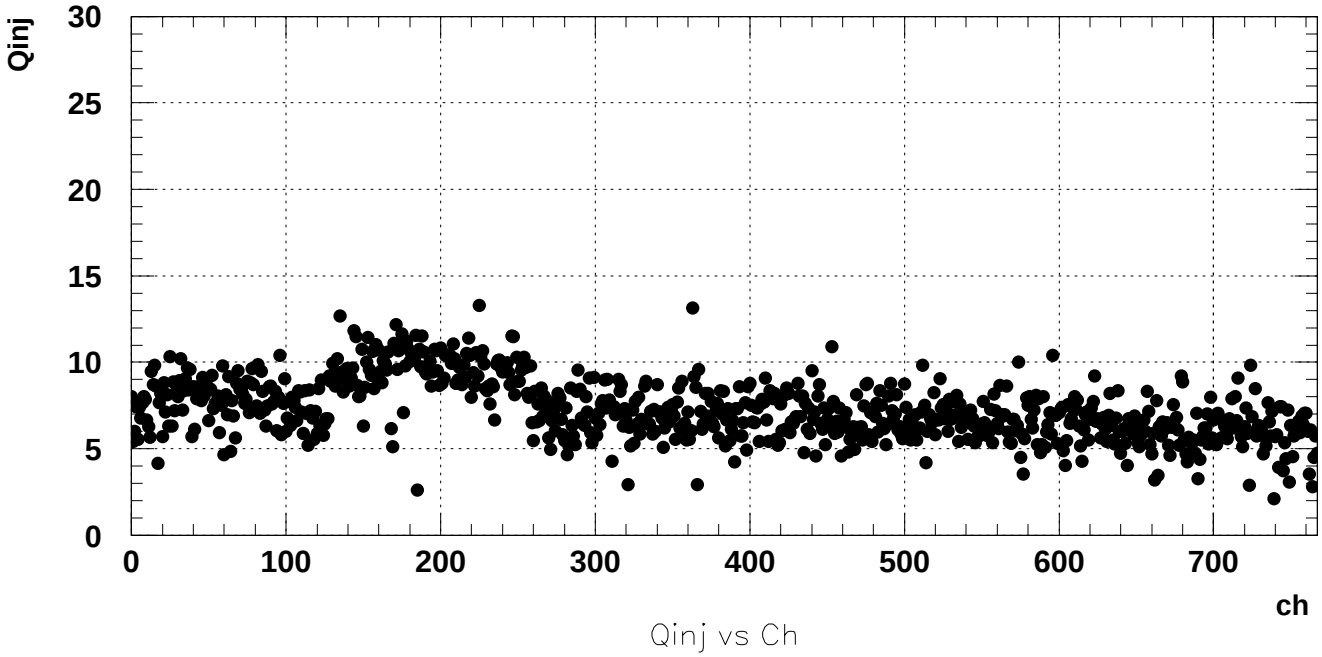
~ 0.15 fC (~ 950 e) at 285 μA

- Dead strips ~ 10

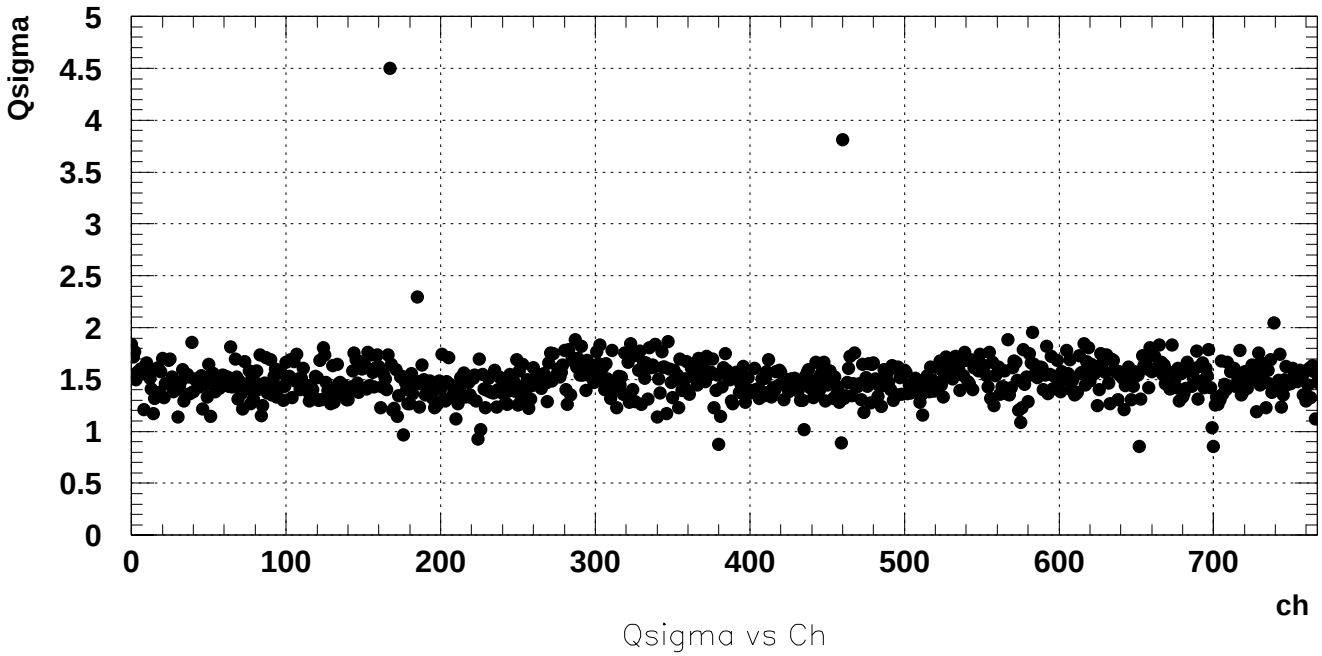
matched with the dead strips of the n-on-n detectors

No systematic study, though

qins18b285t090.dat2f



Qinj vs Ch



Qsigma vs Ch

Two chips-alternative 12 cm strips

(1) Alternative channels to form 12 cm strips

- First 2 chips, “alternative” 64 channels were 12 cm

-12cm-stripchannelsofthefirst2chipswereunstable,withastrange channels pattern, i.e., the chip-edge channels were as stable as expectedbuttheinstabilityincreasedtowardthecentre-channelsof the chip

- Other 6cm-strip chips were stable

(2)Disablingthefirst2chips,andincreasingthe12cm-strip channels step-by-step

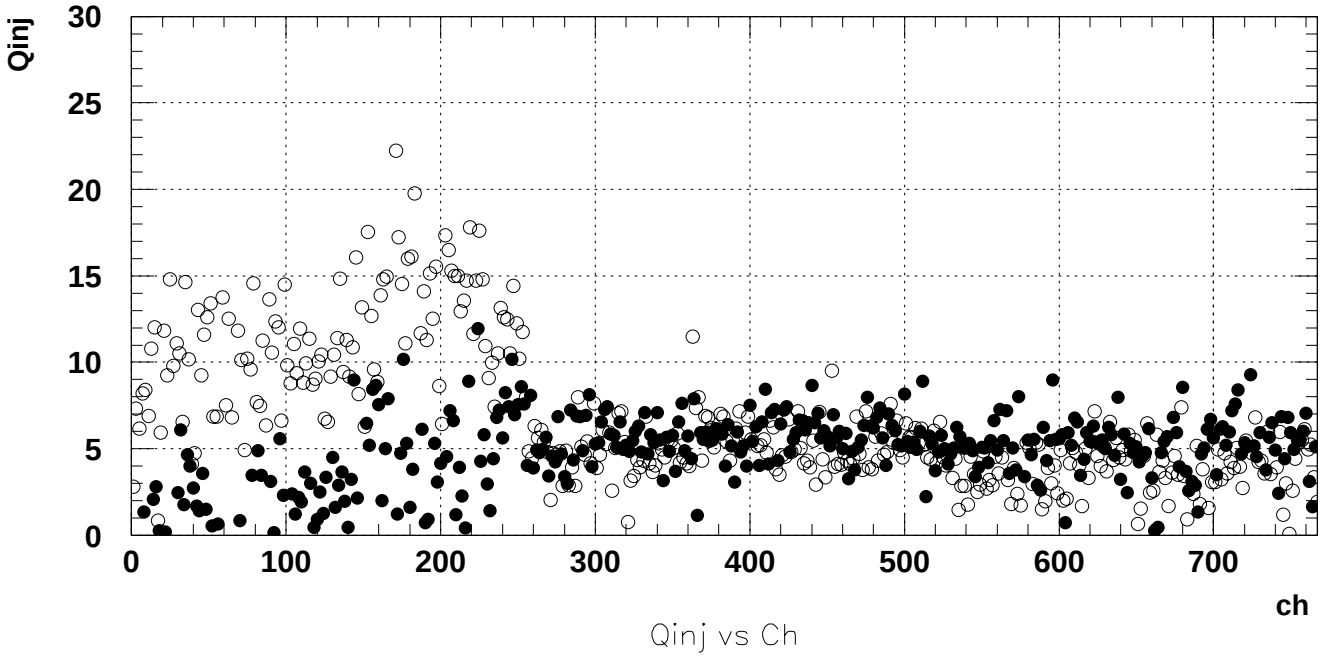
-Thelastchip,E5,stepof5,10,15,20stripsfromtwoedges,(x10,x20, x30, x40)

- At x40, although the noise charge figures were still reasonable, “noisescan”showed“instability”intheoccupancyplotasafunction of the thresholds, “double-peak”

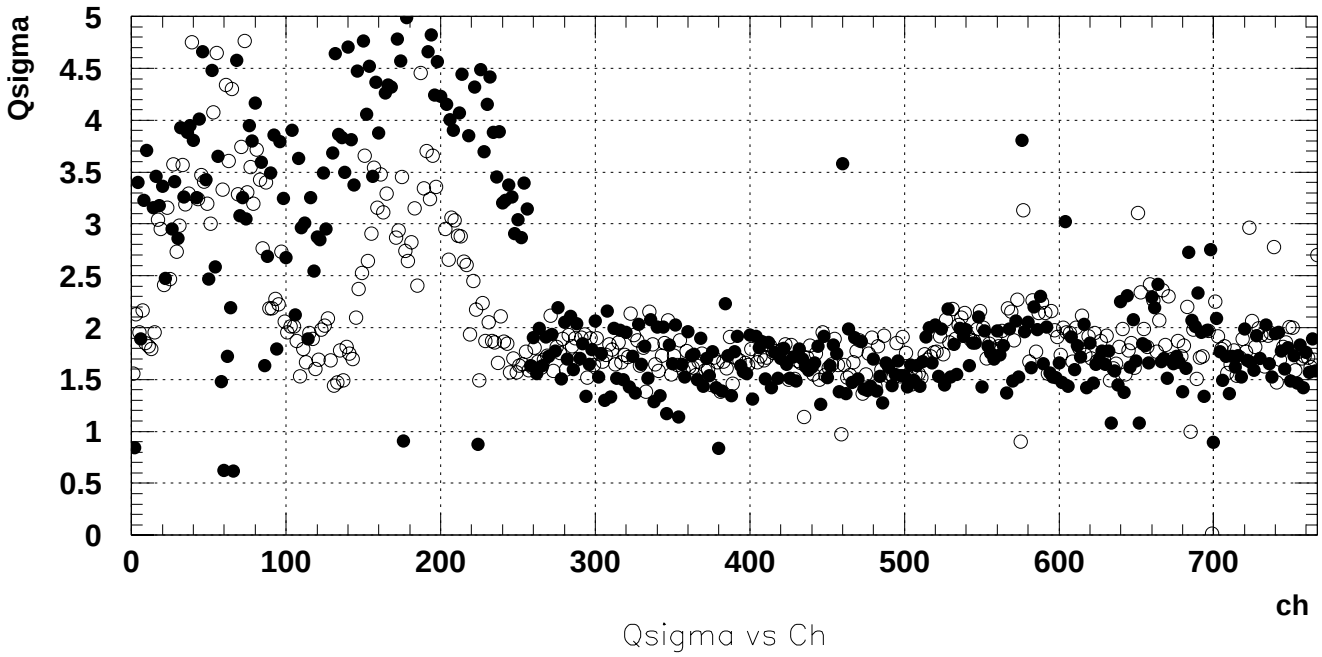
- The above is at the FE shaper current at 18 μA. Reduction of the shapercurrentto10μA,suppressedtheinstability,andthechipswere stable over the full range of FE bias current, up to 285 μA

- The first 2 chips, which showed instability before, were quiet

qins18b248t090.dat2f

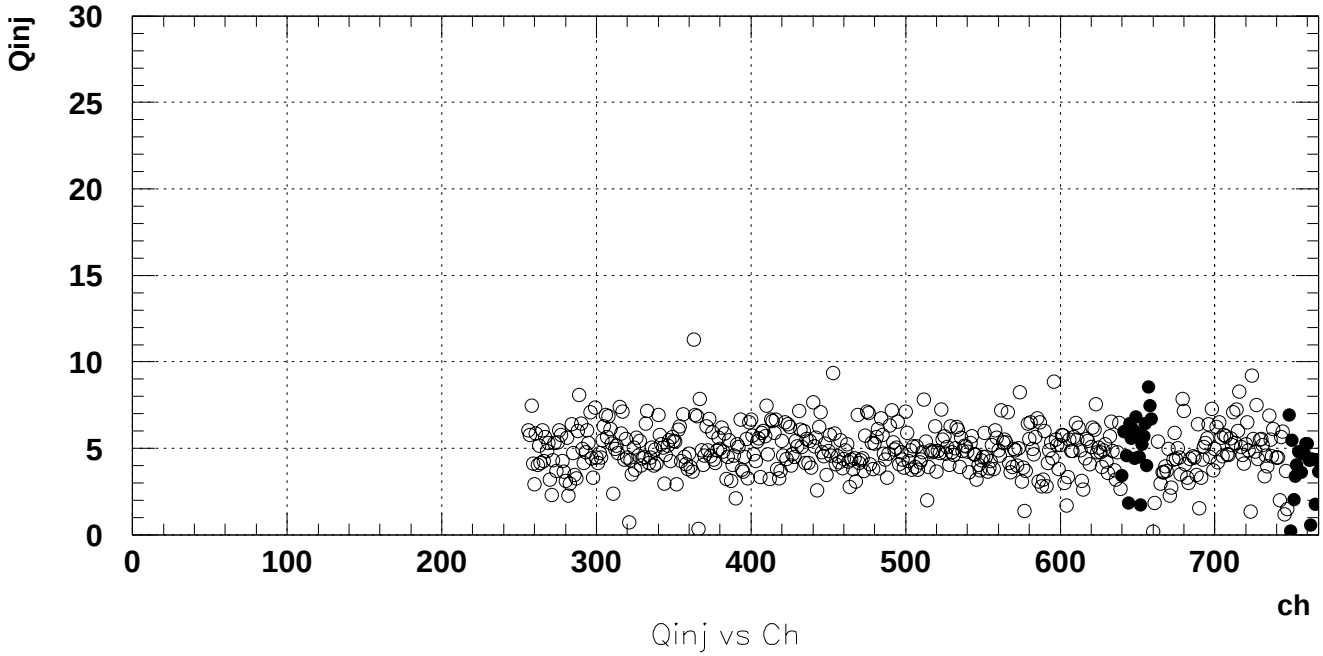


Qinj vs Ch

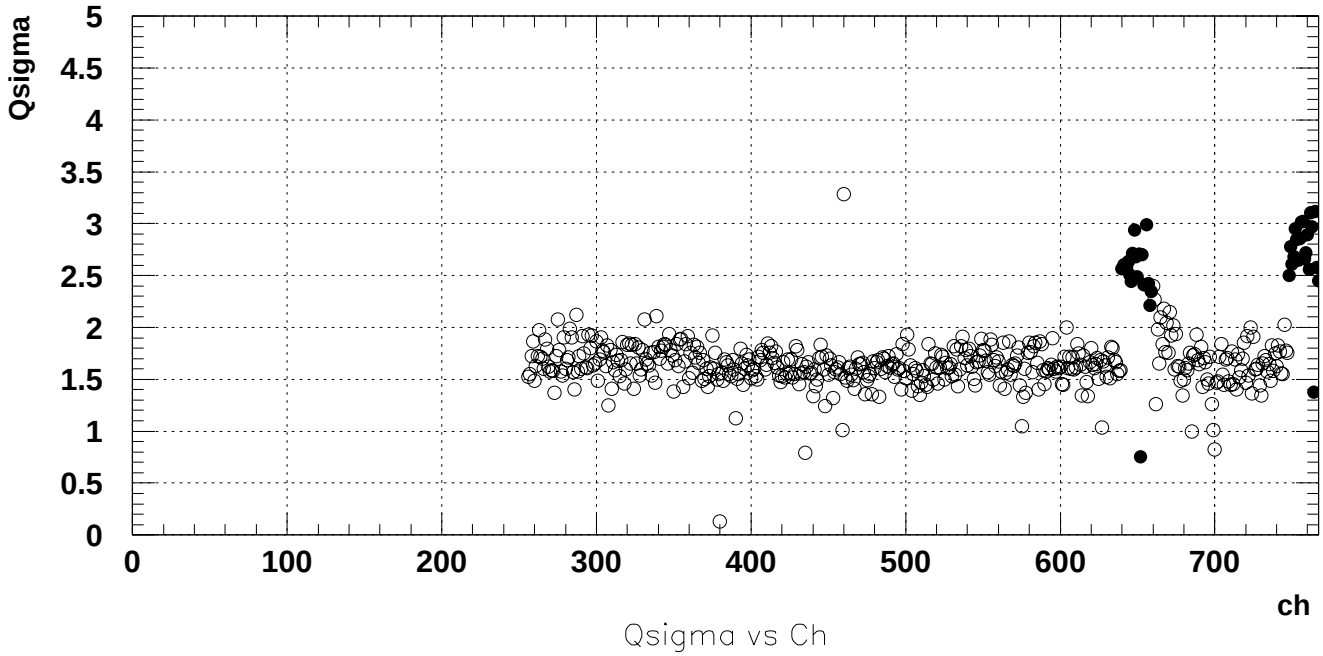


Qsigma vs Ch

qins18b248t070x40.dat2f



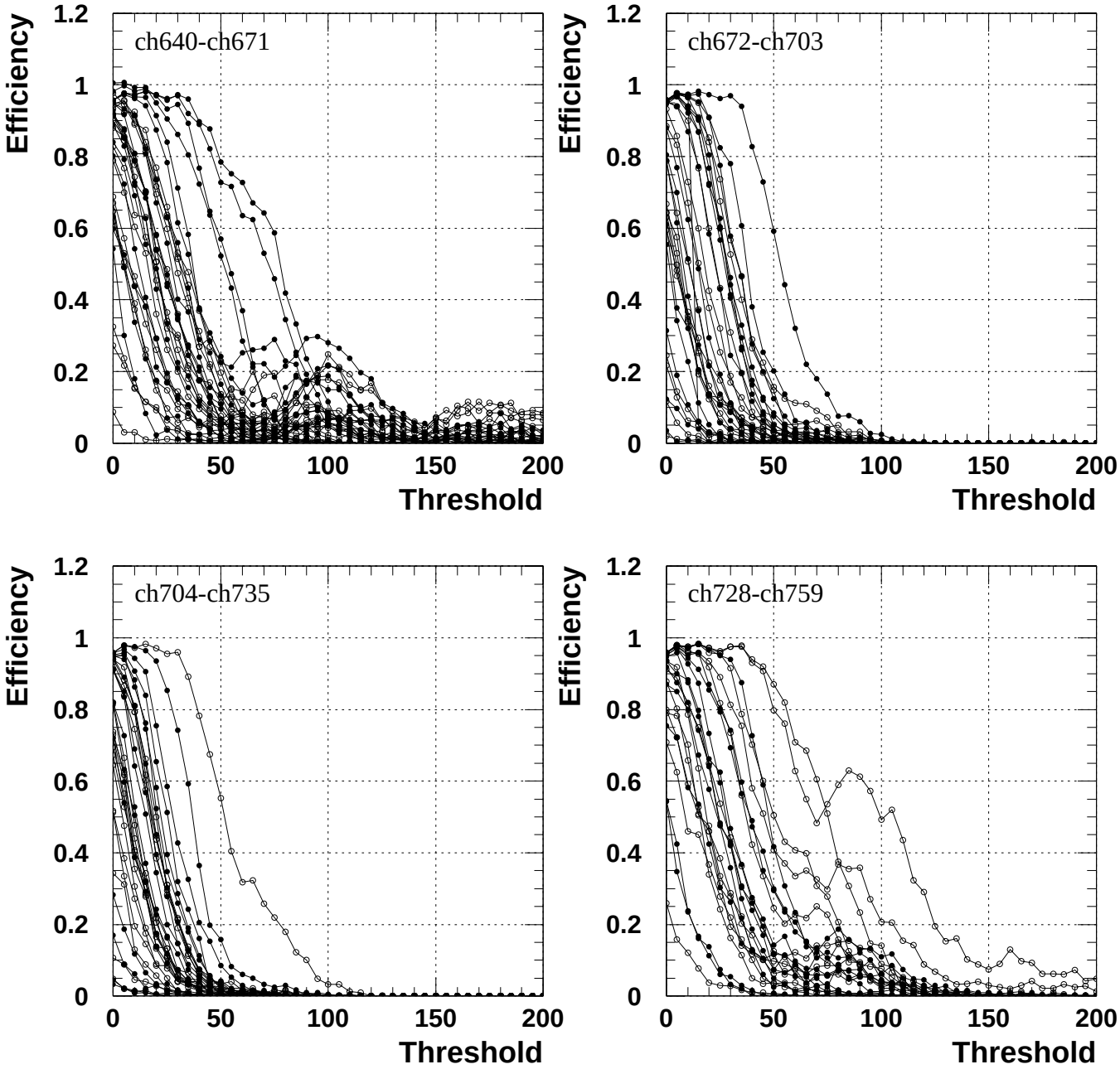
Qinj vs Ch



Qsigma vs Ch

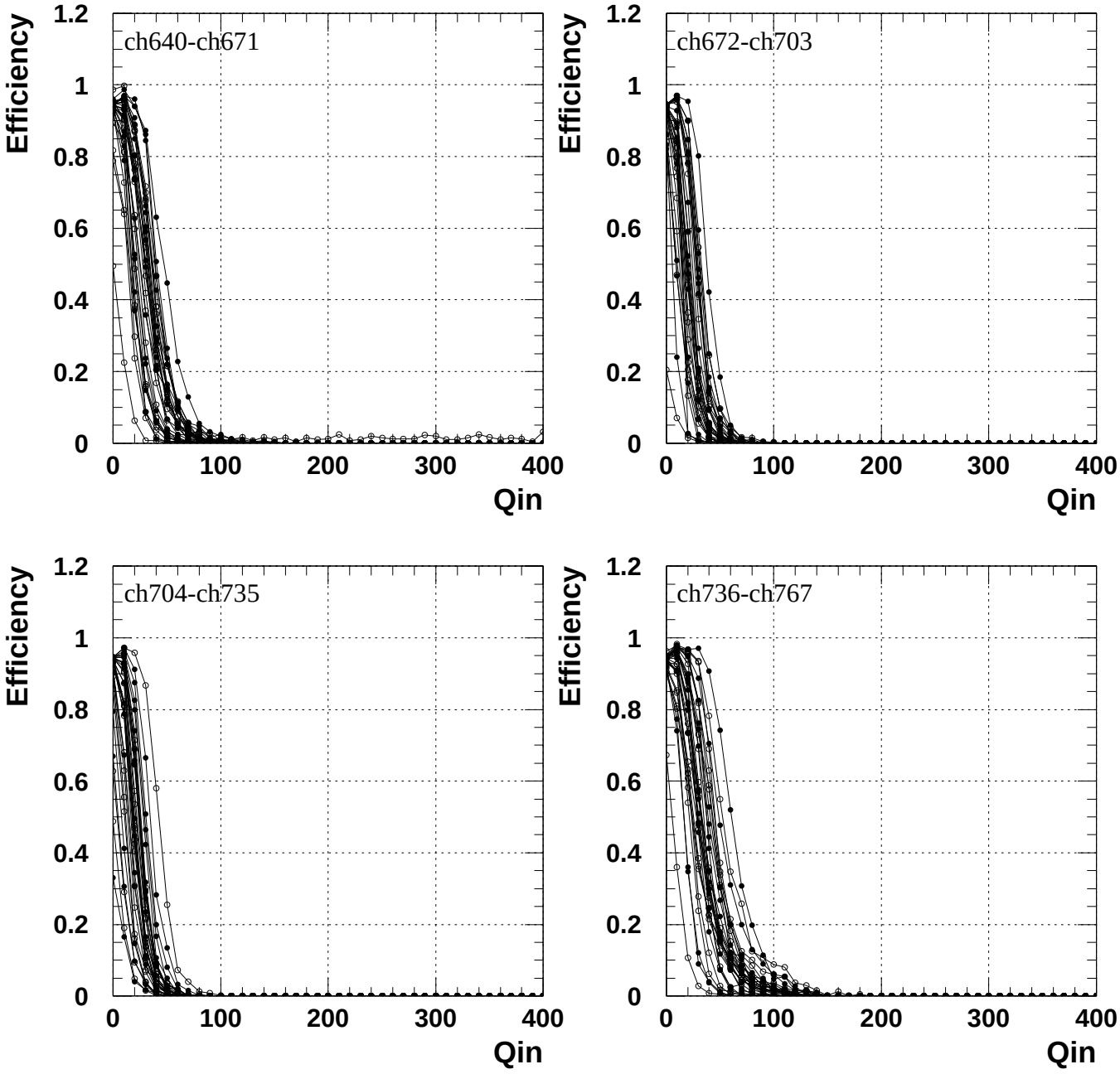
99/04/02 11.22

noises18b248t200x40.dat2

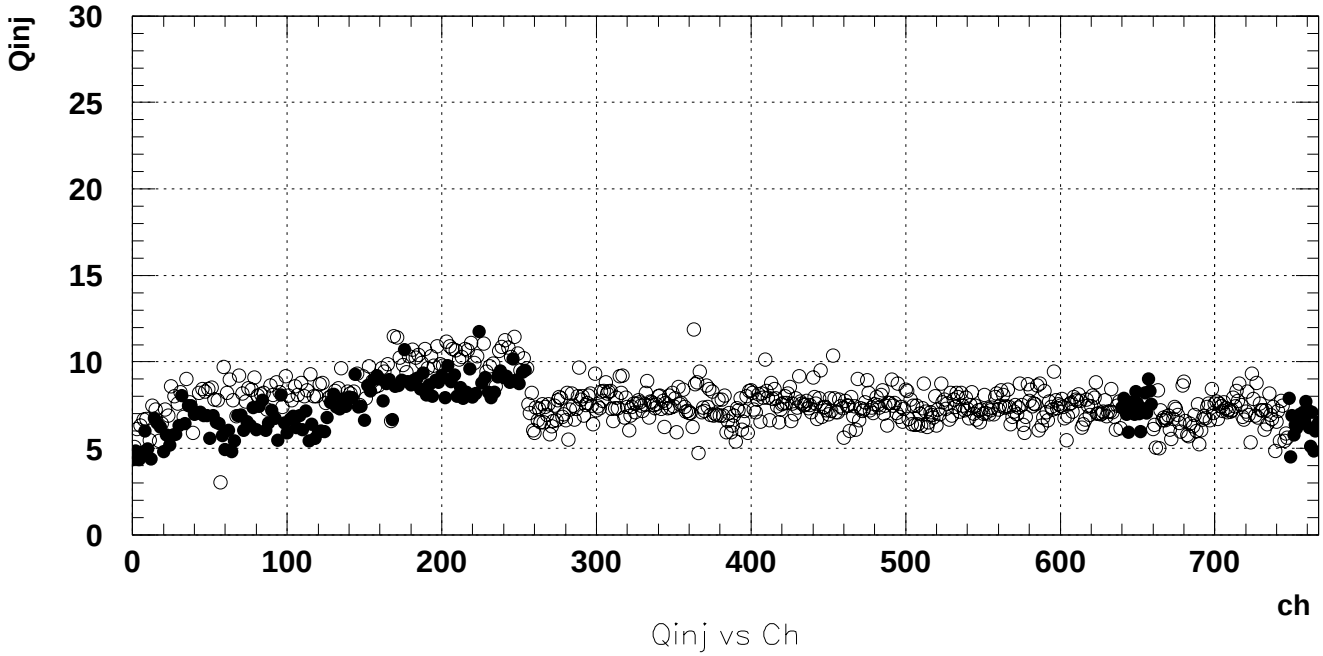


99/04/07 18.03

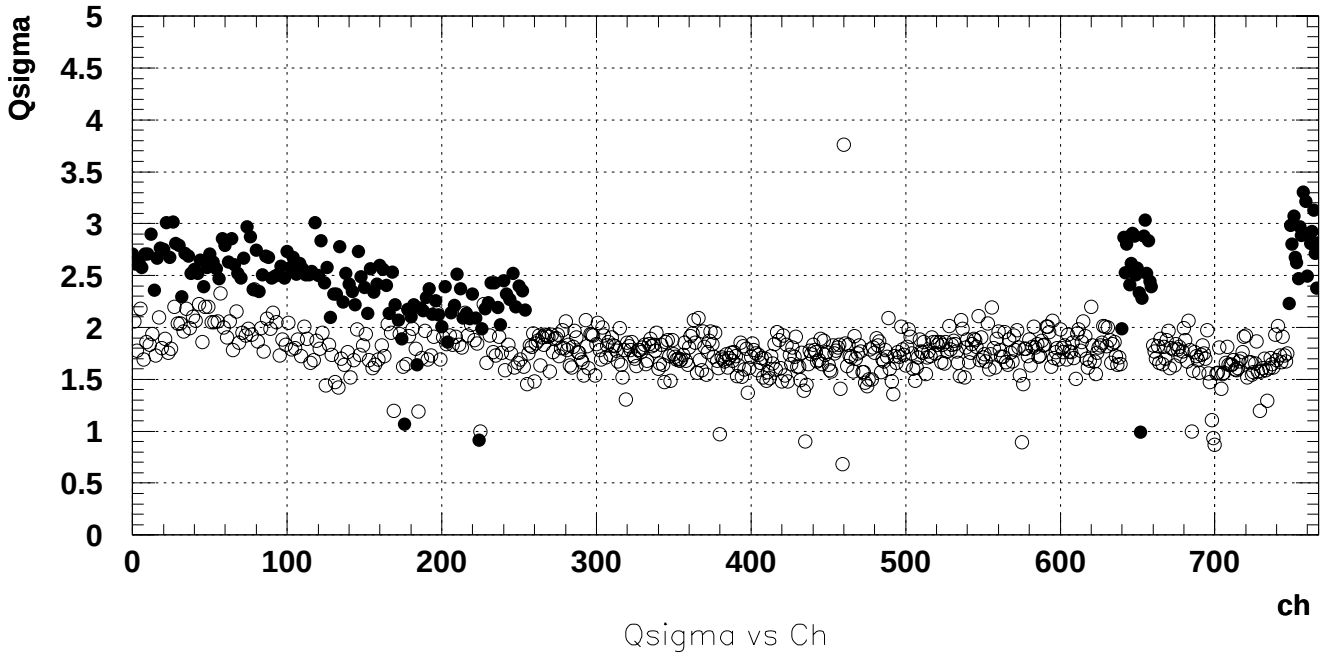
noises10b248t400x40m0s1on.dat2



qins10b248t100x40m0s1on.dat2f

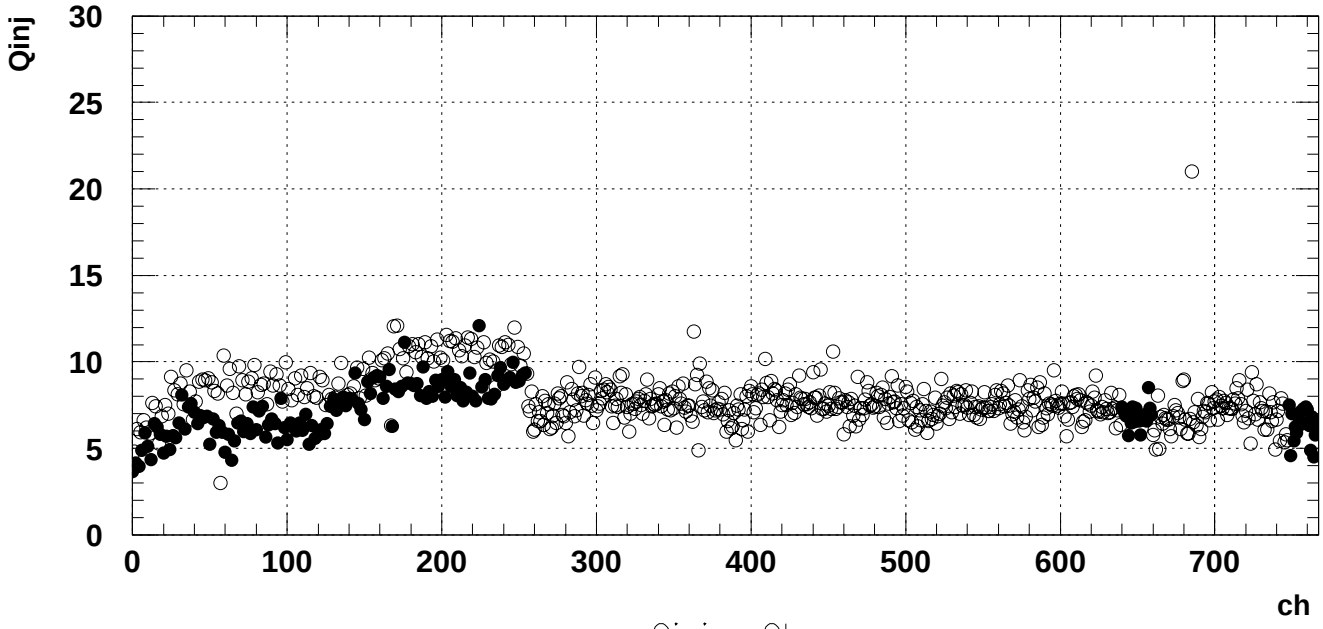


Qinj vs Ch

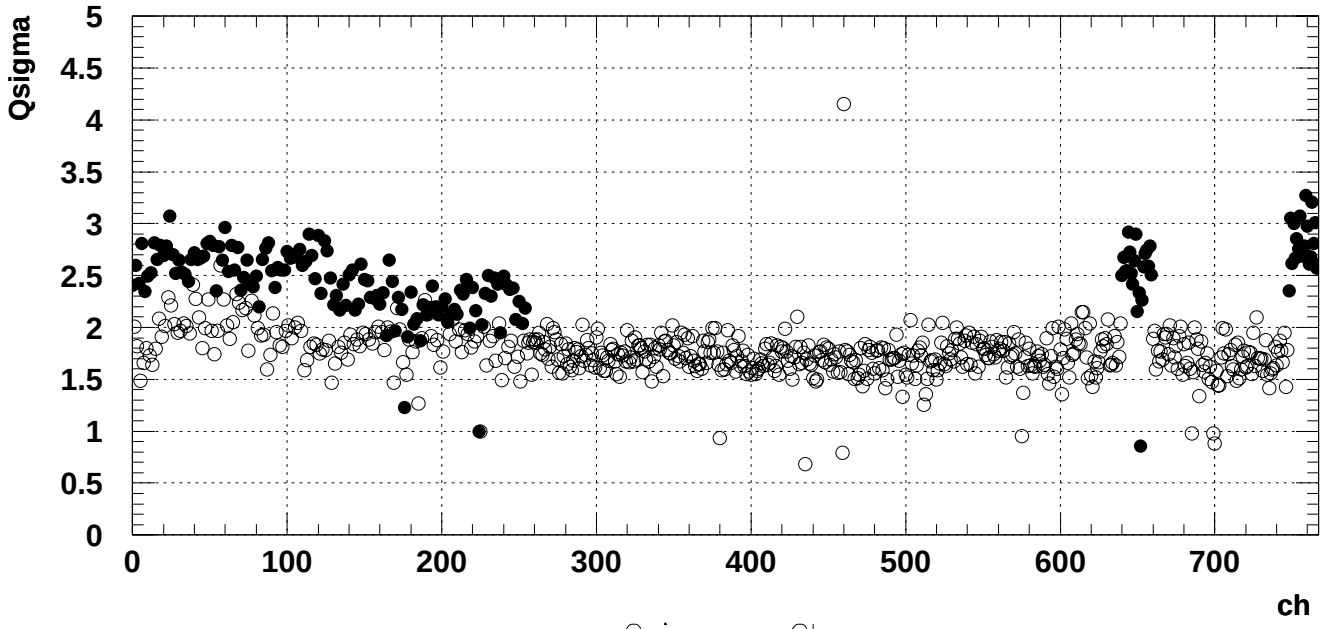


Qsigma vs Ch

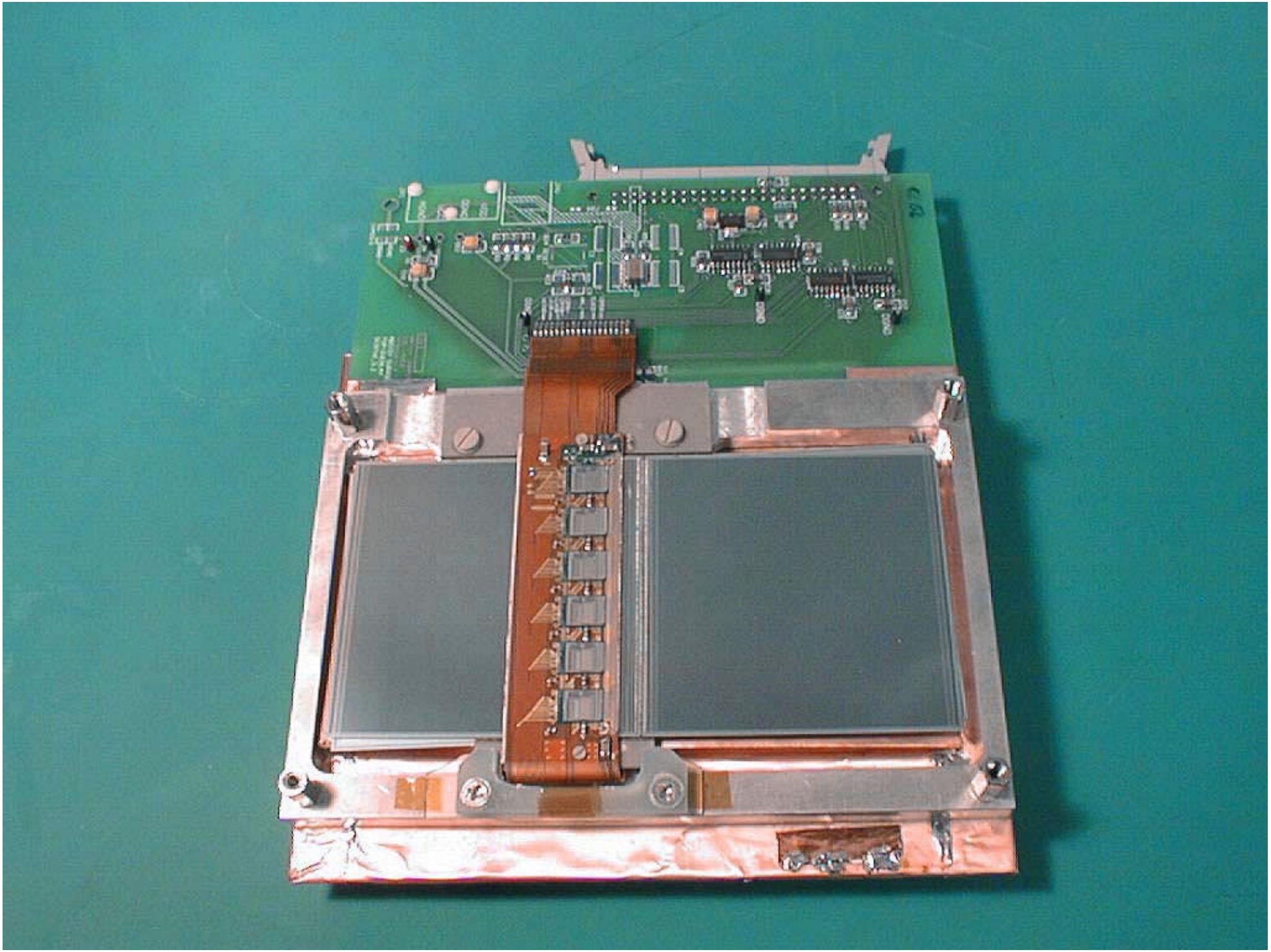
qins10b285t100x40m0s1on.dat2f



Qinj vs Ch



Qsigma vs Ch



Full module - 12 chips and 4 detectors

- Encouraged with the result of the "End-tap half module", a Barrel "centre-tapped" full module was fabricated and tested

- A fully populated 12 chips Kapton hybrid

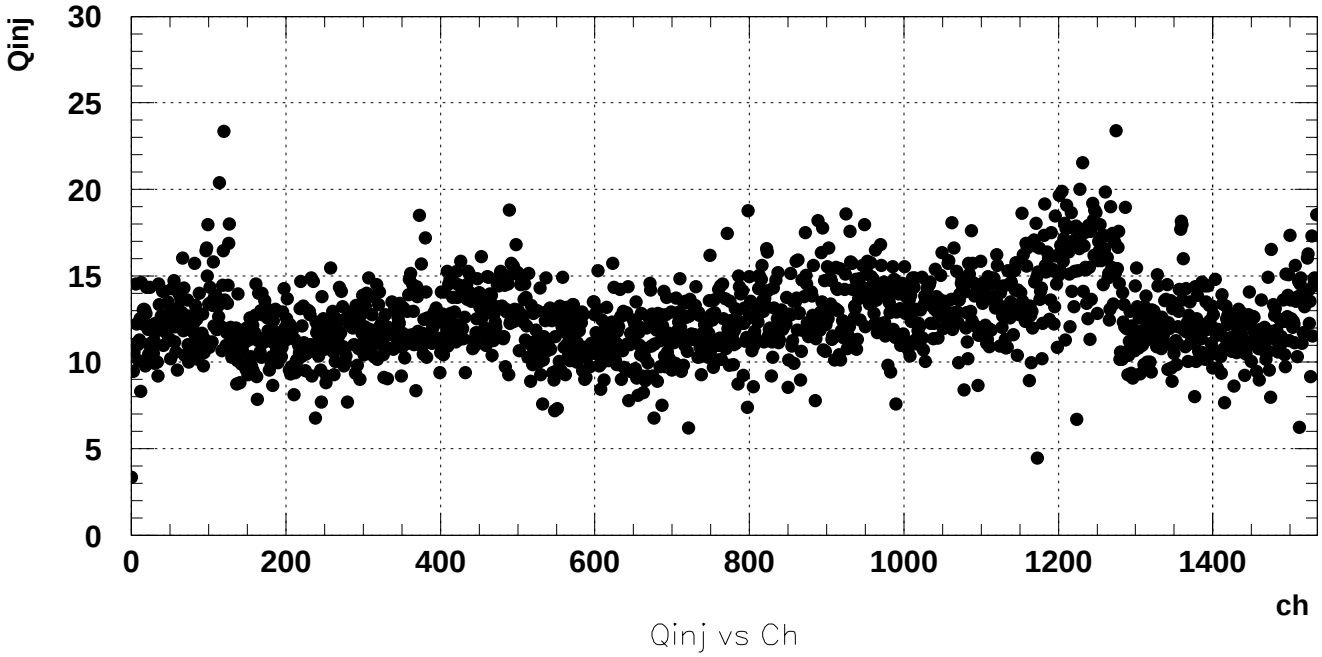
- Analog and Digital grounds were connected on the hybrid

- Carbon-carbon bridge, conductively connected to the chip ground, i.e., "conductive bridge"

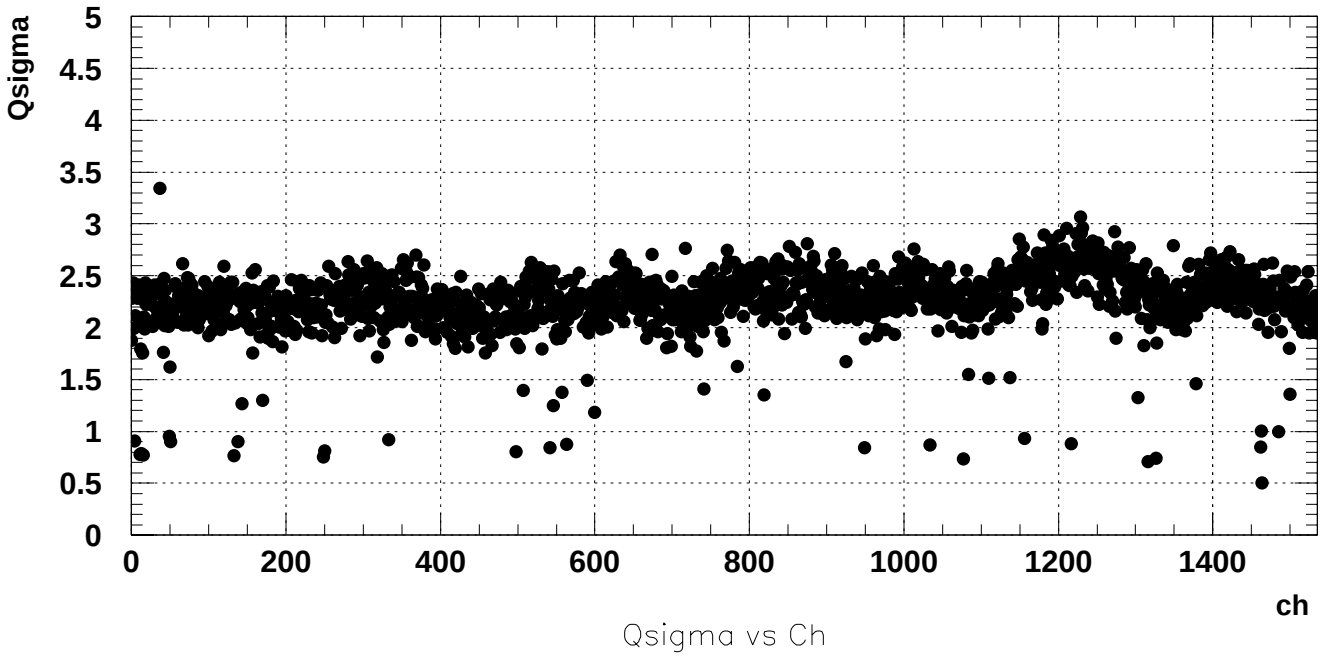
- Polyimide-coated TPG baseboard, being used to conduct the high voltage from the hybrid to the backplane of the detectors

- Hybrid-bridge and the baseboard was insulted with AlN facings

qins18b138t090.dat2f

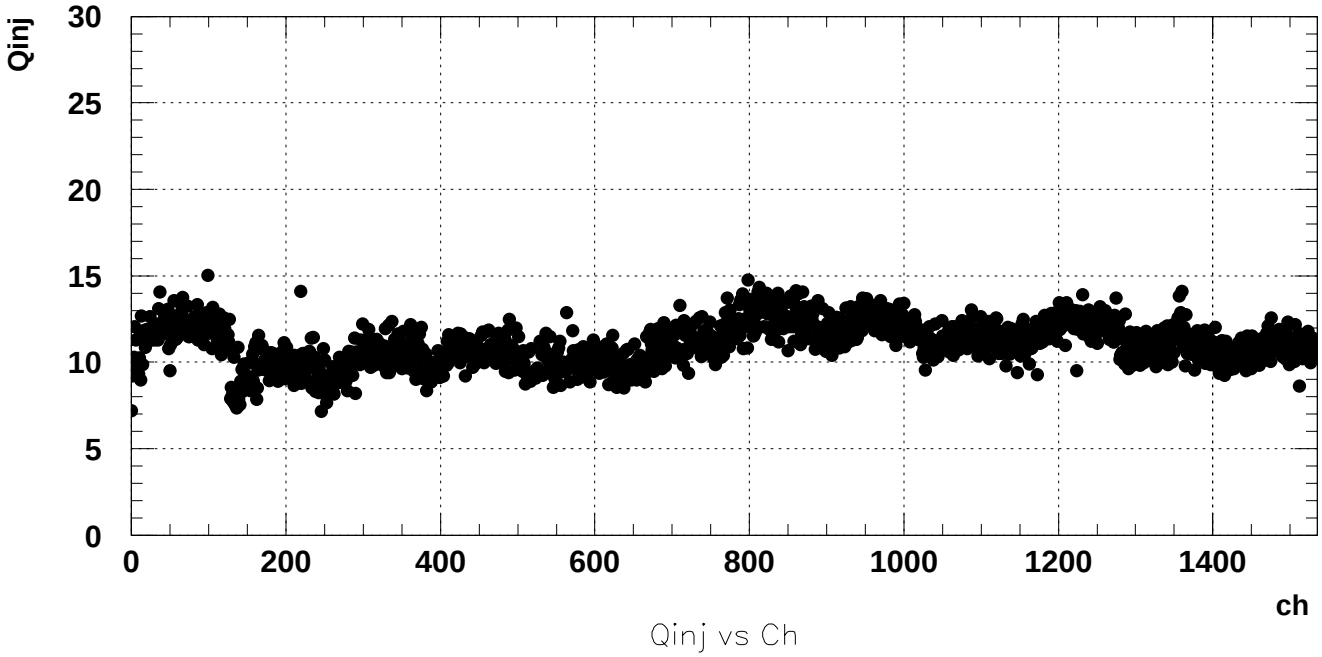


Qinj vs Ch

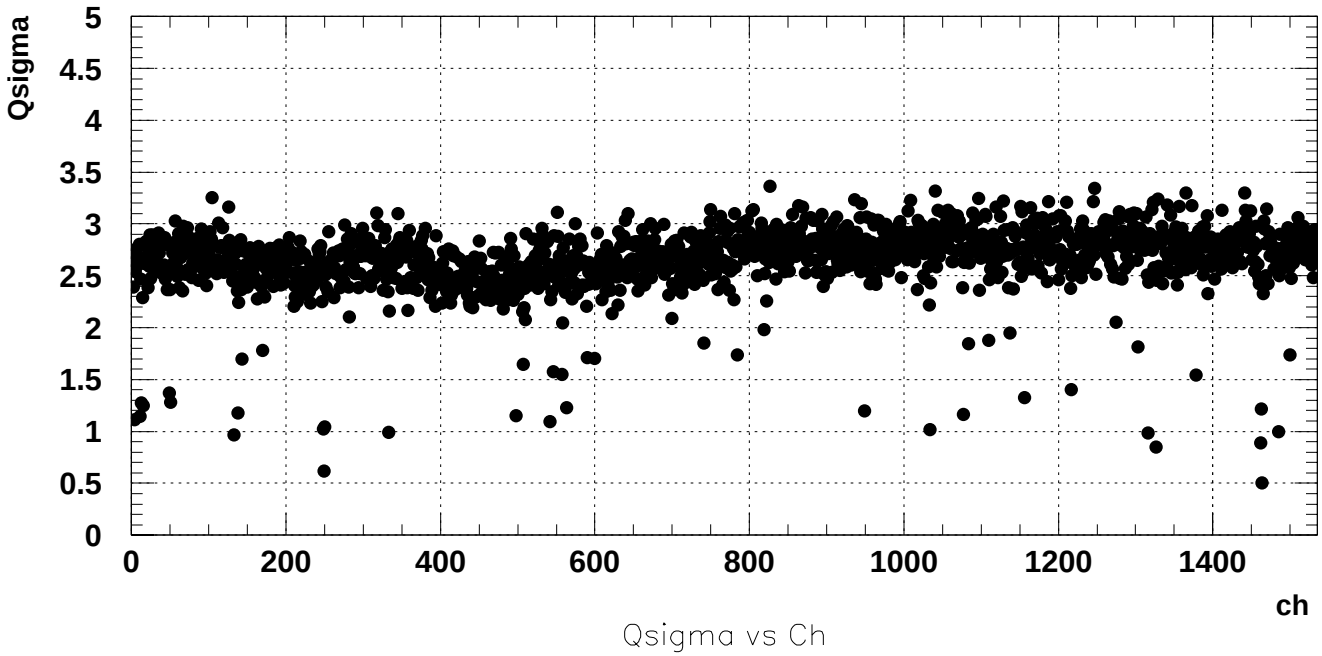


Qsigma vs Ch

qins05b285t090.dat2f



Qinj vs Ch



Qsigma vs Ch

Results

(1) Scanning the operationable range

-FE bias and shaper currents were scanned in order to investigate the operationable region in the parameter space

-The noise charges showed the full chips were stable where the gain is low, i.e., either "low FE bias and high shaper currents" or "high FE bias and low shaper currents"

- Examples of the charge injection scan

- Low bias and high shaper currents:

  Lower noise, 0.23~0.25 fC (1450 ~ 1560 e)

  Larger spread in channel uniformity

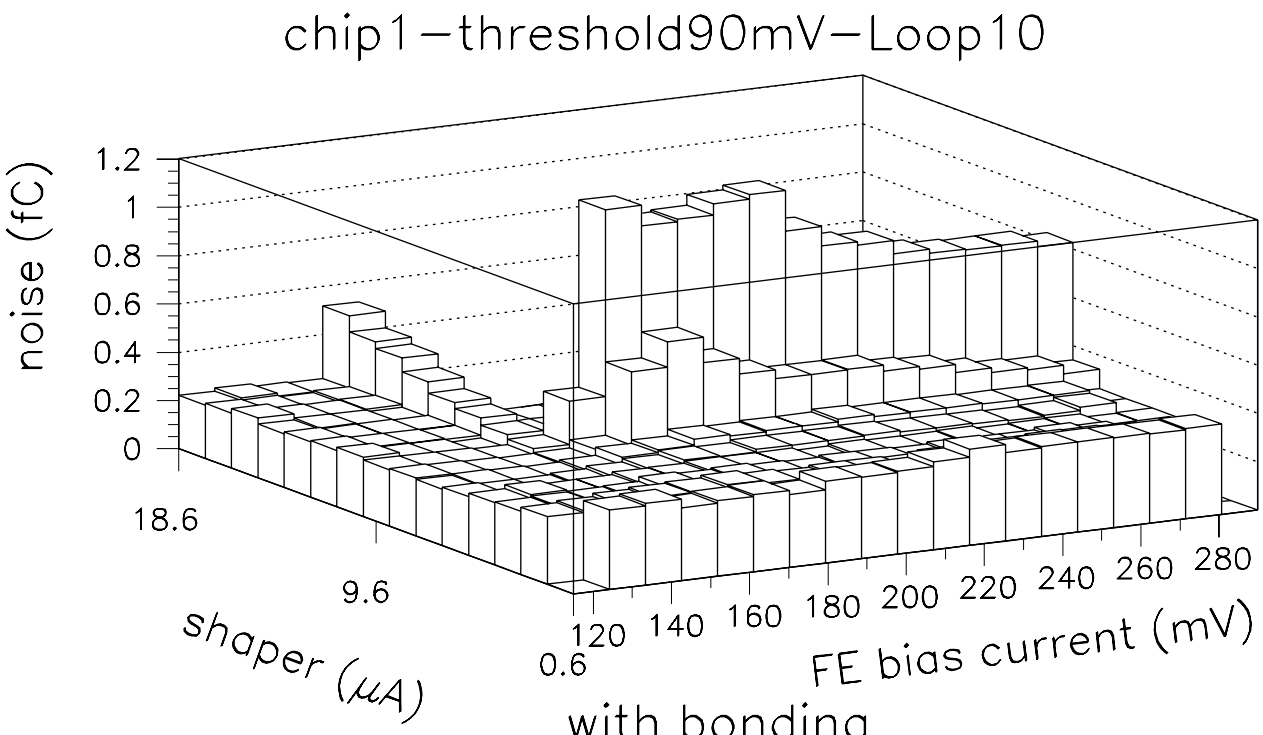
- High bias and low shaper currents:

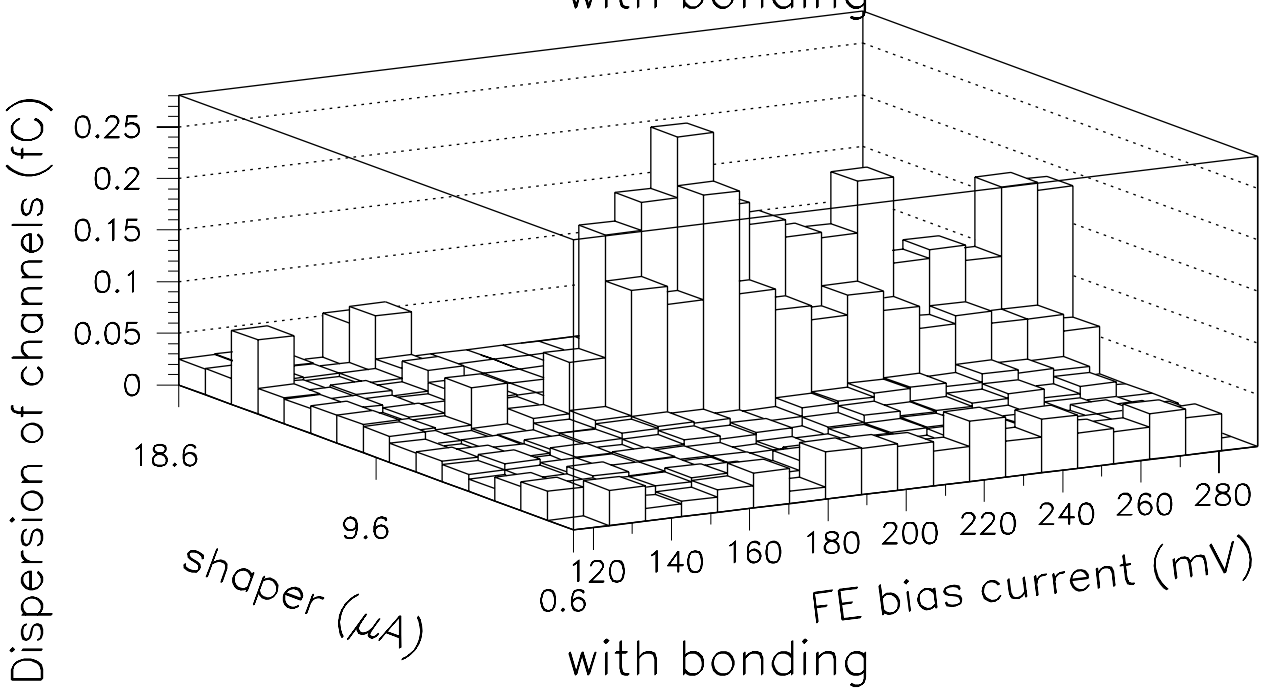
  Larger noise, ~ 0.28 fC (~ 1750 e)

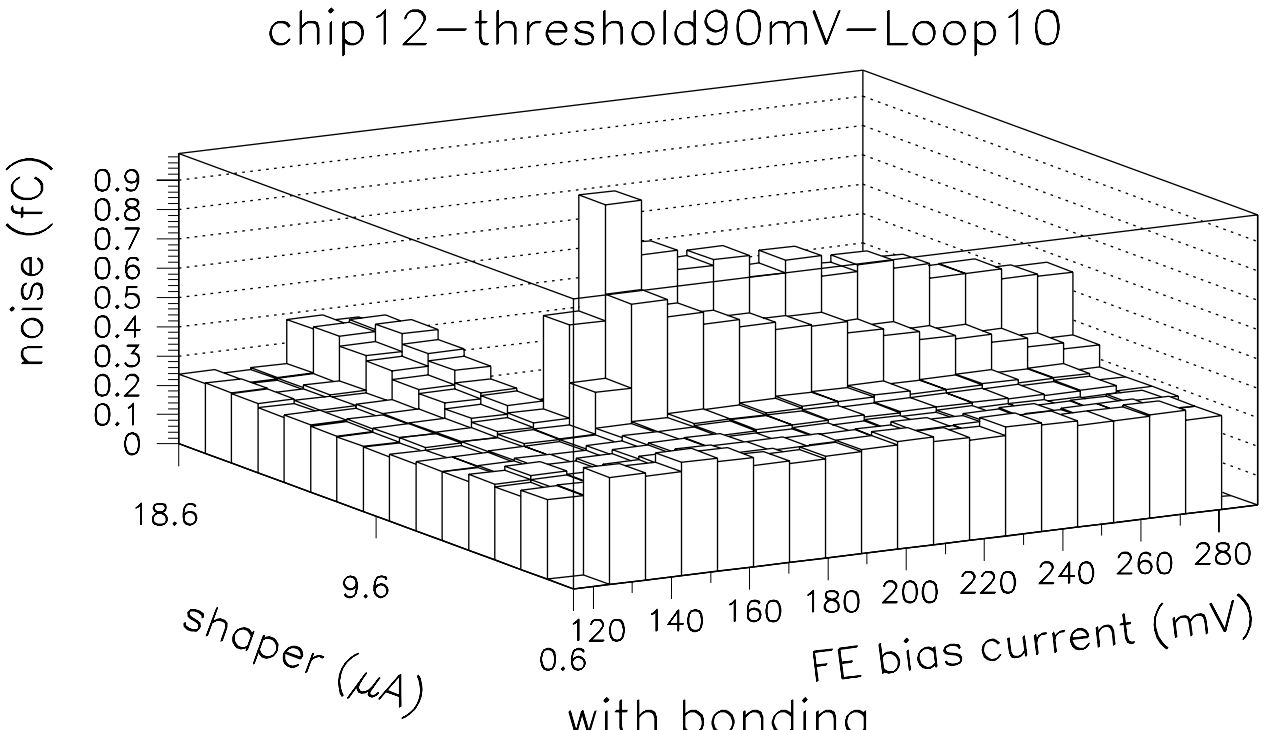
  Smaller spread in uniformity

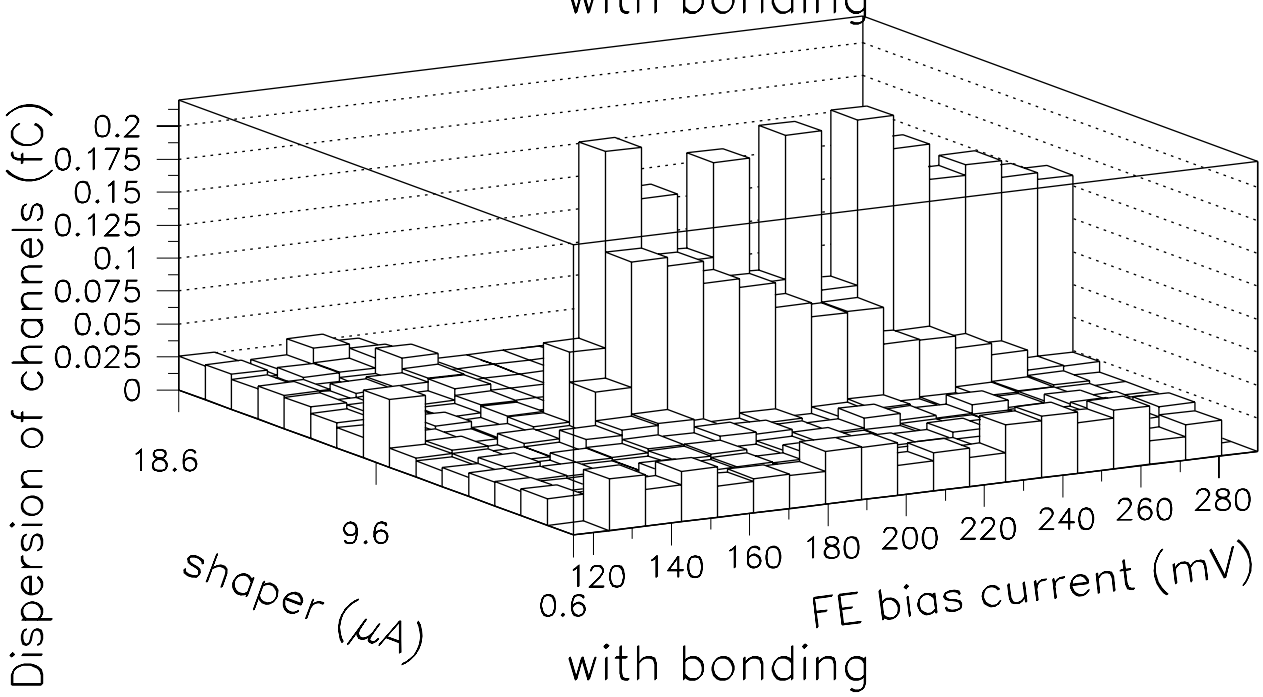
- Gain was smaller, 70 ~ 80 mV/fC

- Still "unstable" in the thresholds <50 mV

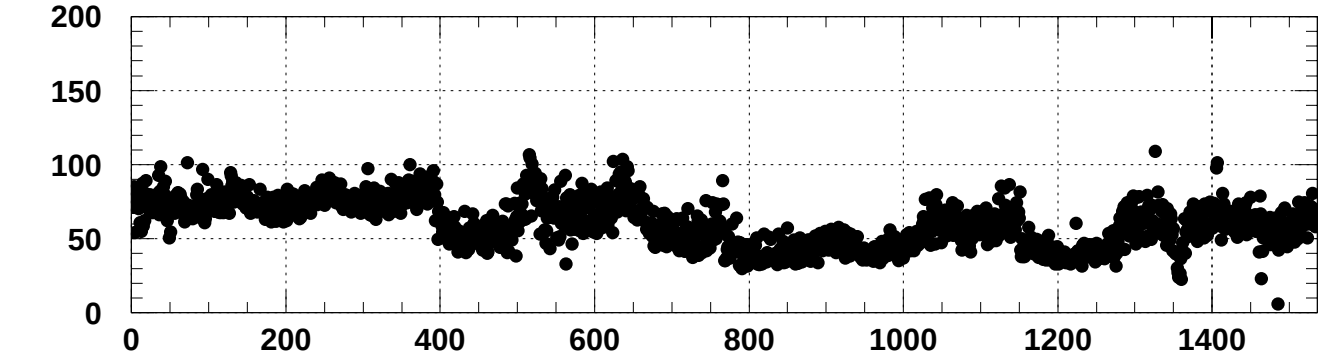

chip1−threshold90mV−Loop10
noise (fC)
1.2
1
0.8
0.6
0.4
0.2
0
18.6
9.6
0.6
shaper (μA)
120 140 160 180 200 220 240 260 280
FE bias current (mV)
with bonding


Dispersion of channels (fC)
0.25
0.2
0.15
0.1
0.05
0
18.6
9.6
0.6
shaper (μA)
120 140 160 180 200 220 240 260 280
FE bias current (mV)
with bonding

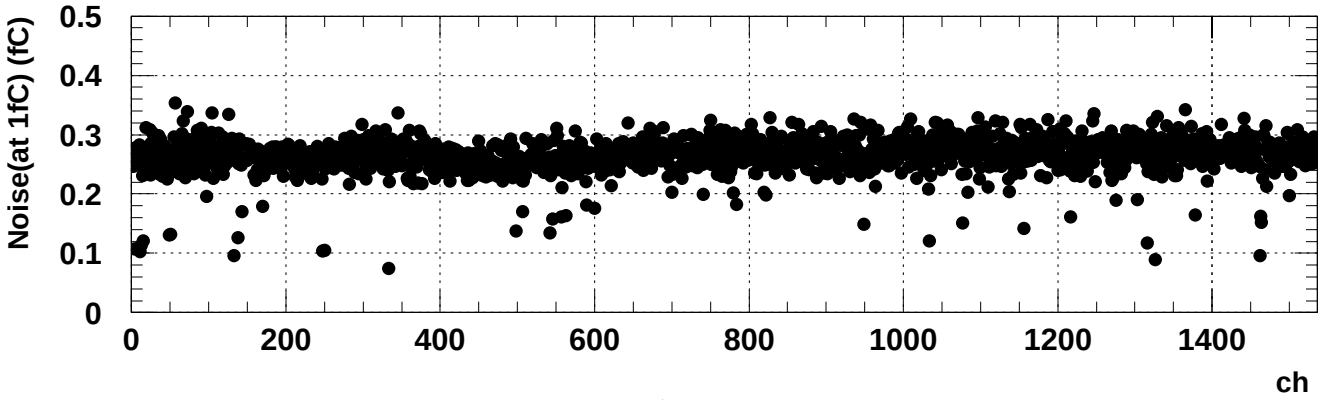

chip12−threshold90mV−Loop10
noise (fC)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
18.6
9.6
0.6
shaper (μA)
120 140 160 180 200 220 240 260 280
FE bias current (mV)
with bonding


Dispersion of channels (fC)
0.2
0.175
0.15
0.125
0.1
0.075
0.05
0.025
0
18.6
9.6
0.6
shaper (μA)
120 140 160 180 200 220 240 260 280
FE bias current (mV)
with bonding

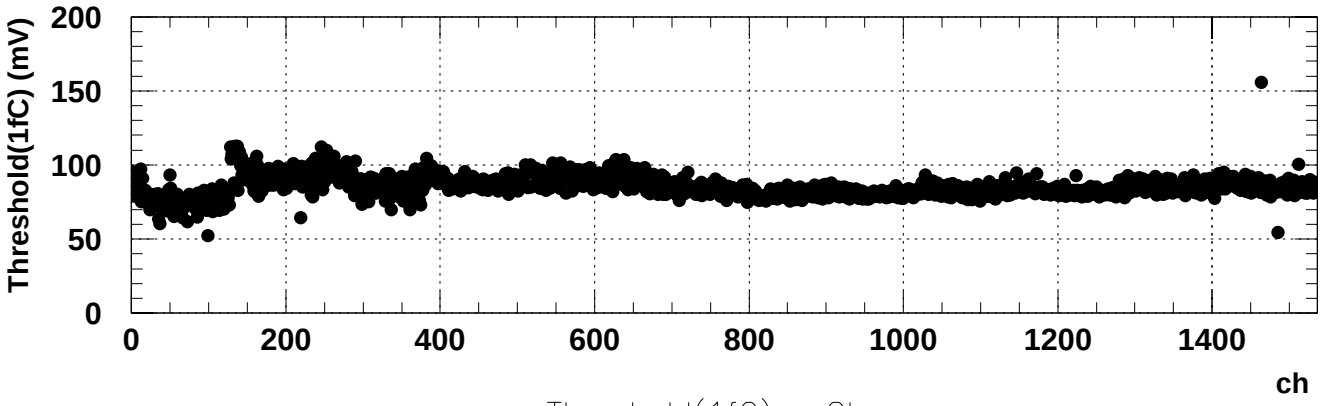
qins5b285.1fc



Gain(mV/fc) vs Chan



Noise vs Chan



Threshold(1fC) vs Chan

Summary

(1) Half and full modules were fabricated with n-ABCD2-metalized chips

(2) On the Barrel Kapton hybrid, the chips were stable in the full range of FE bias current with the shaper current at the nominal value of 18 μA for the 6 cm strips

(3) More than 40 strips being connected to 12 cm-strips, the chips started to show "instability"

(4) Lowering the gain by reducing the FE shaper current improved the instability

(5) The full module was operationable in the low gain regime, either with high FE bias and low shaper current or with low FE bias and high shaper currents

(6) The noise performance was better in the low FE bias current, but the channel uniformity was better in the high FE bias current