Electrical Module based on the ABCD Kapton Hybrid

T. Kohriki, Y. Unno, T. Kondo, S. Terada

Physics, KEK

and other SCT collaborators

Abstract

An ATLAS SCT electrical module has been successfully built with the ABCD chips and the ABCD Kapton hybrid. The 12 chips hybrid was assembled first and tested, then, the hybrid was assembled into the detector-baseboard unit, using the prototype assembly jigs of KEK. This particular module used the Carbon-carbon material for the hybrid bridge.

Introduction

- **An “Electrical module” in the Japanese cluster for the goal of the module programme by Sep. 98**
- **Fully loaded hybrid and with four detectors**
- **The demonstration module with the ABCD Kapton hybrid**
- **Investigation of a low-mass, high-thermal conductivity, and (near-) zero CTE solution for the hybrid bridge, with a carbon-fibre material (Carbon-carbon)**
- **Fabrication:**

  - Single detector module with a 6 chips hybrid

  - Full “Electrical module” with a 12 chips hybrid

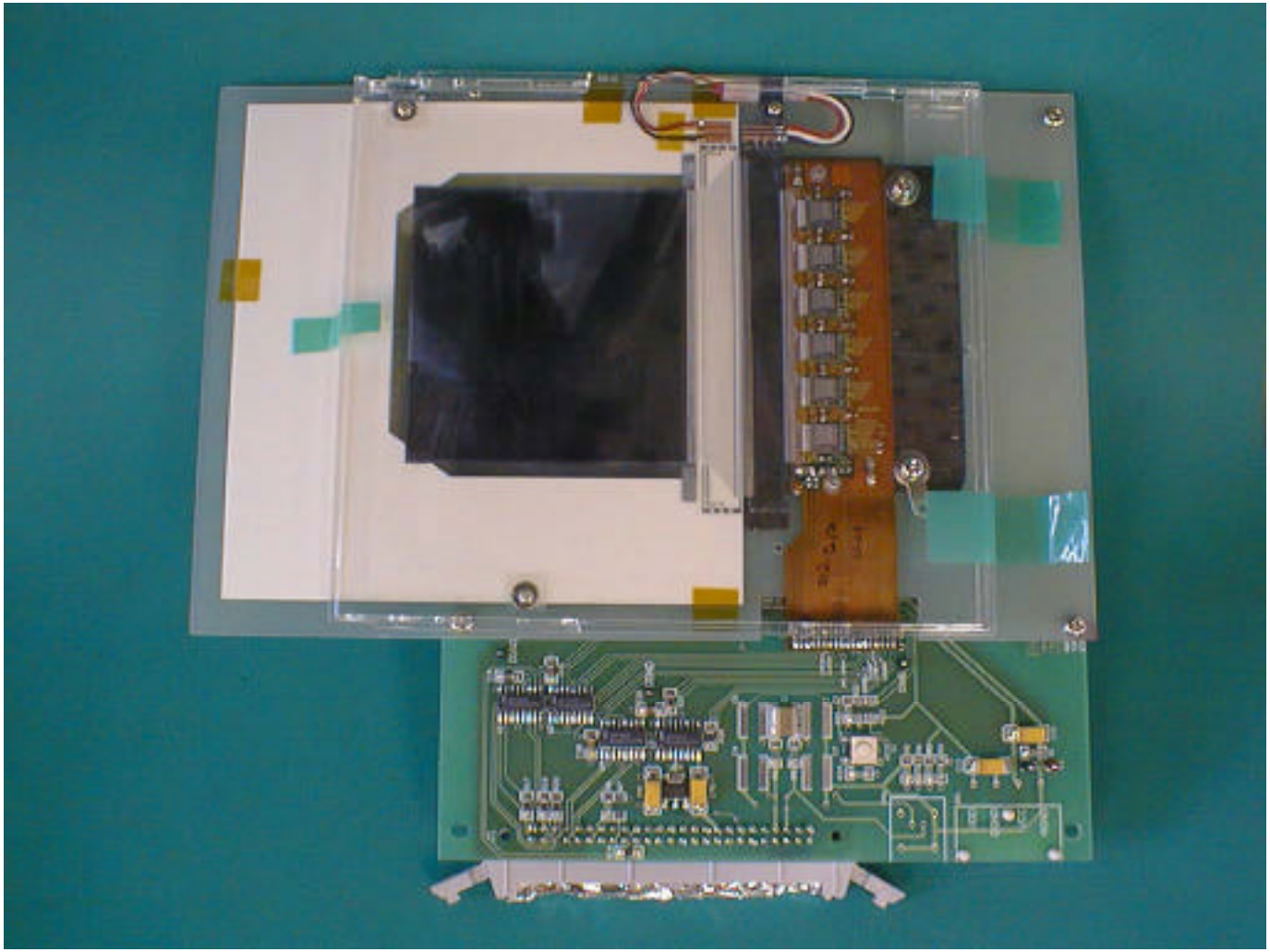
A 6 chips hybrid module

- **The 6 chips hybrid was the first ABCD Kapton hybrid assembled, chip-by-chip, in order to investigate the effect involved in adding more chips**

- **The analysis of the chip-by-chip step will be presented in the ASIC's and hybrid session**

- **Recycle the ABCD chip/hybrid for testing, e.g., for measuring the irradiated detectors**

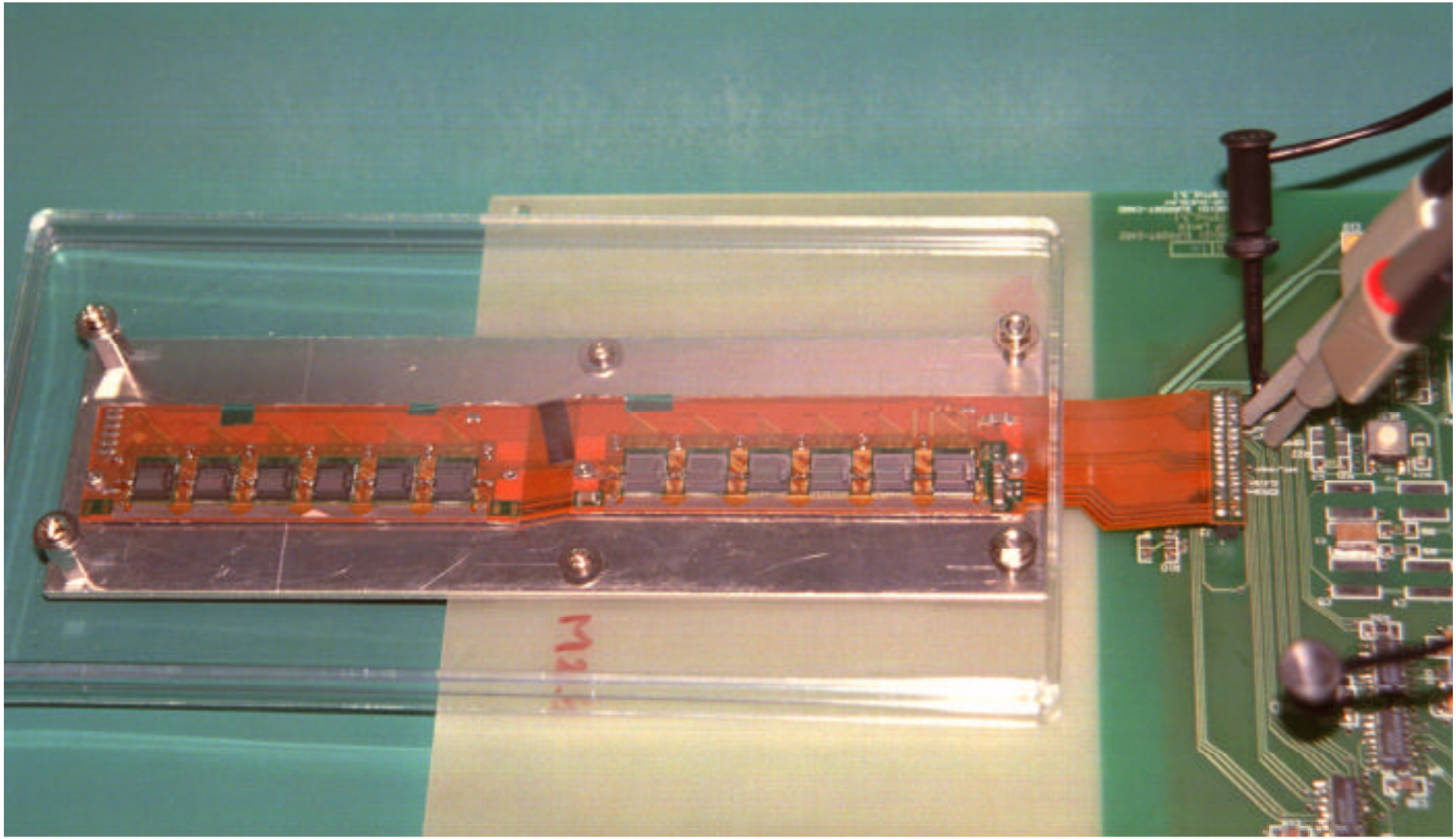
- **The 6 chips hybrid was glued on the Carbon-carbon plate, together with a glass fan-in and a glass pitch adaptor, and connected to a single-detector on the ceramic board being used for the irradiation**



12 chips “Electrical Module”

Hybrid

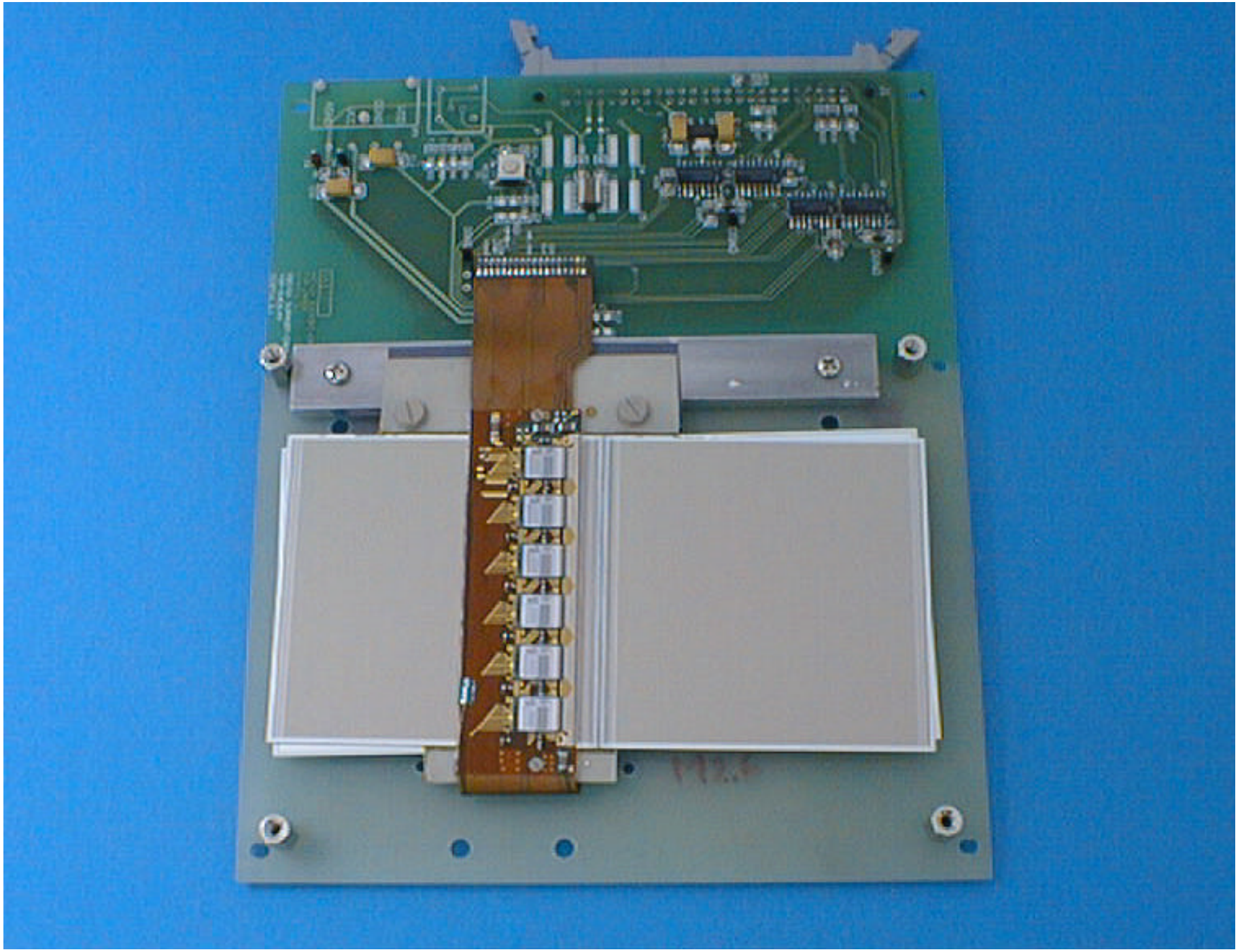
- **A new hybrid assembly with 12 chips (n-ABCD)**
- **Carbon-carbon bridges were glued on the hybrid prior to the components stuffing (Glue: BN filler loaded Araldite 2011(?)), and glass fan-in’s, too**
- **12 chips stuffing. The first 6 chips were “Good” quality, Q ~ 2, but the last 6 chips were “Poor”, Q $\leq$ 1**
- **The hybrid was measured with the charge injection of the internal calibration DAC, before mounting on the detector-baseboard unit**



12 chips “Electrical Module” (cont’d)

Detector-baseboard assembly

- **Baseboard: TPG, coated with epoxy (for practical reason)**
- **Facings: AluminumNitride (for practical reason), 150 μm thick**
- **Detectors: n-on-n ATLAS97 novel p-stop detectors**
- **Assembling with the prototype assembly jigs of KEK**
- **Glue: Araldite 2011 + BN filler, glue pattern on the drawing (from RAL)**

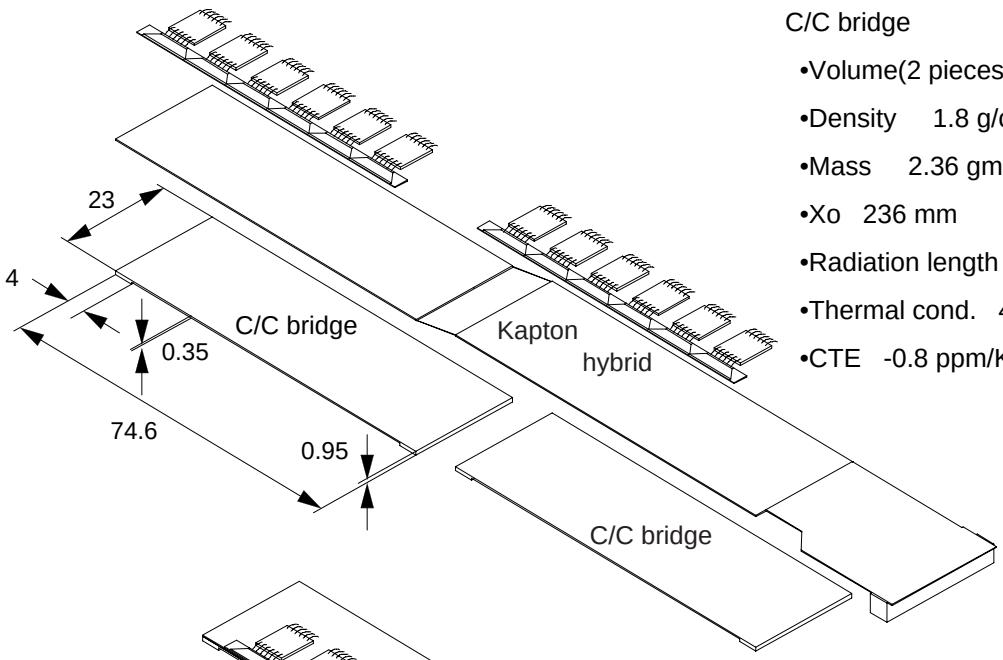


12 chips “Electrical Module” (cont’d)

Hybrid assembling on the detector:

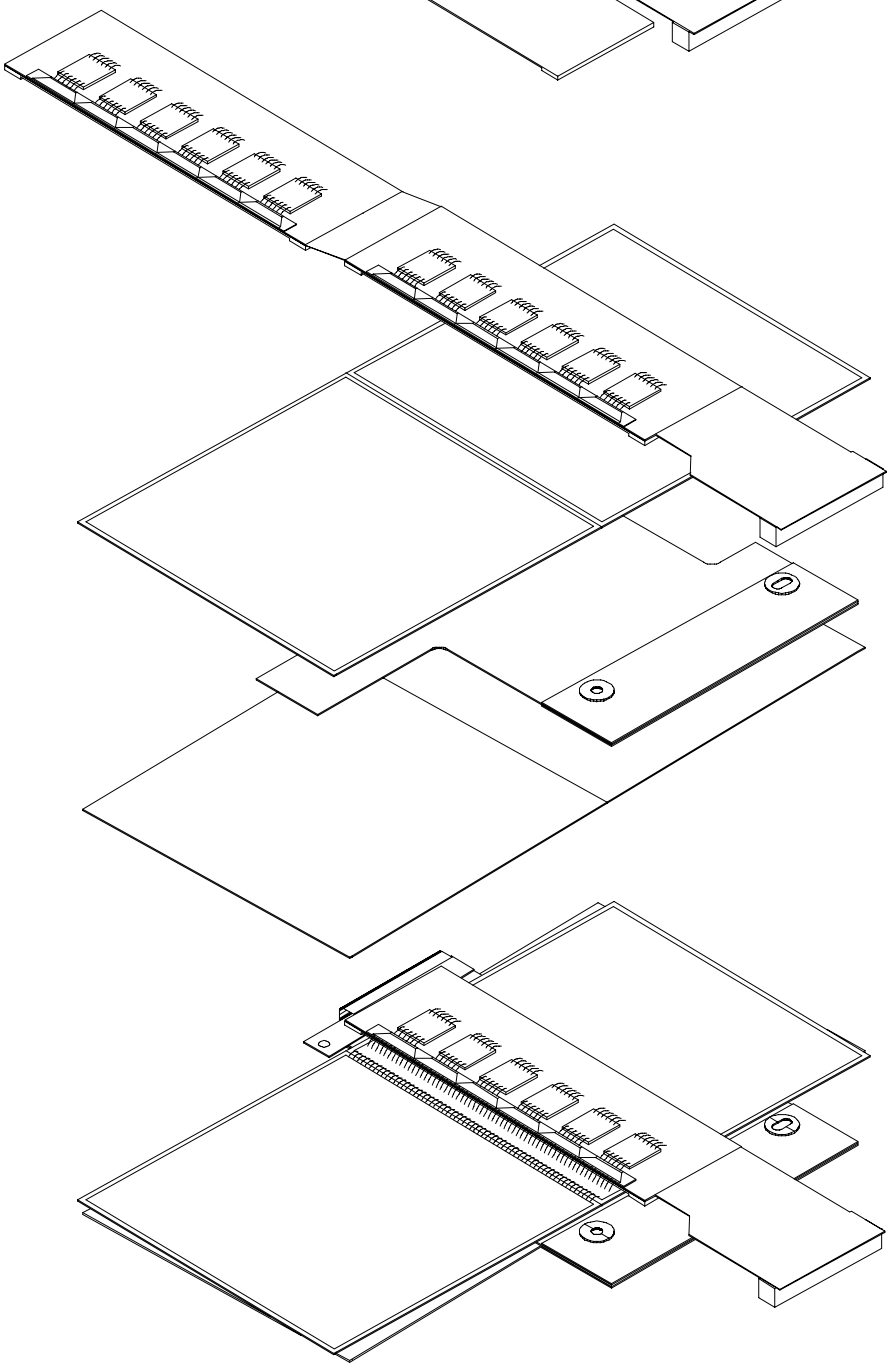
- **PEEK screws locate the hybrid and keep the hybrid while gluing (Araldite2011+BN)**
- **Wire-bondings between the chip~fan-in, fan-in~detector, detector~detector, on both sides**
- **Special arrangement of the wire-bonding for testing purpose, 4 unbonded IC channels per 32 channels**

Module9808ABCDn/carbon

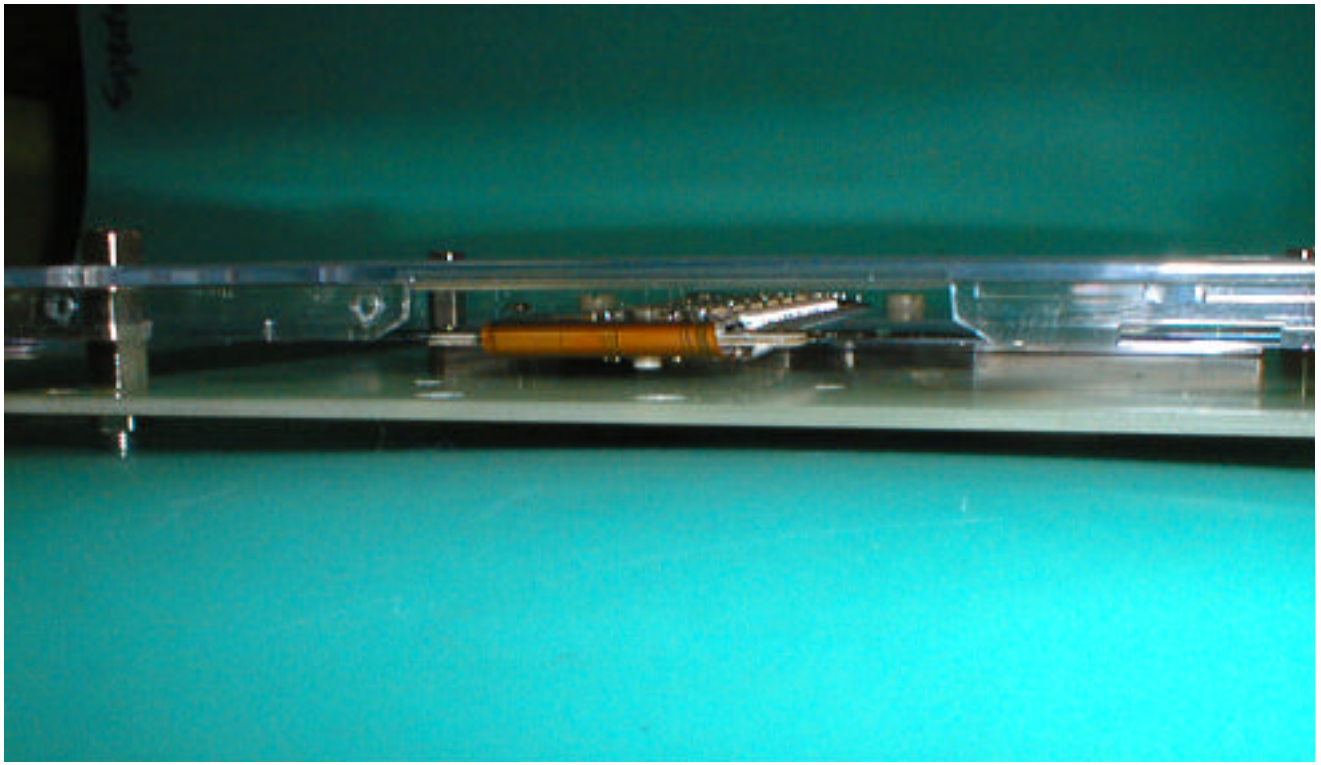


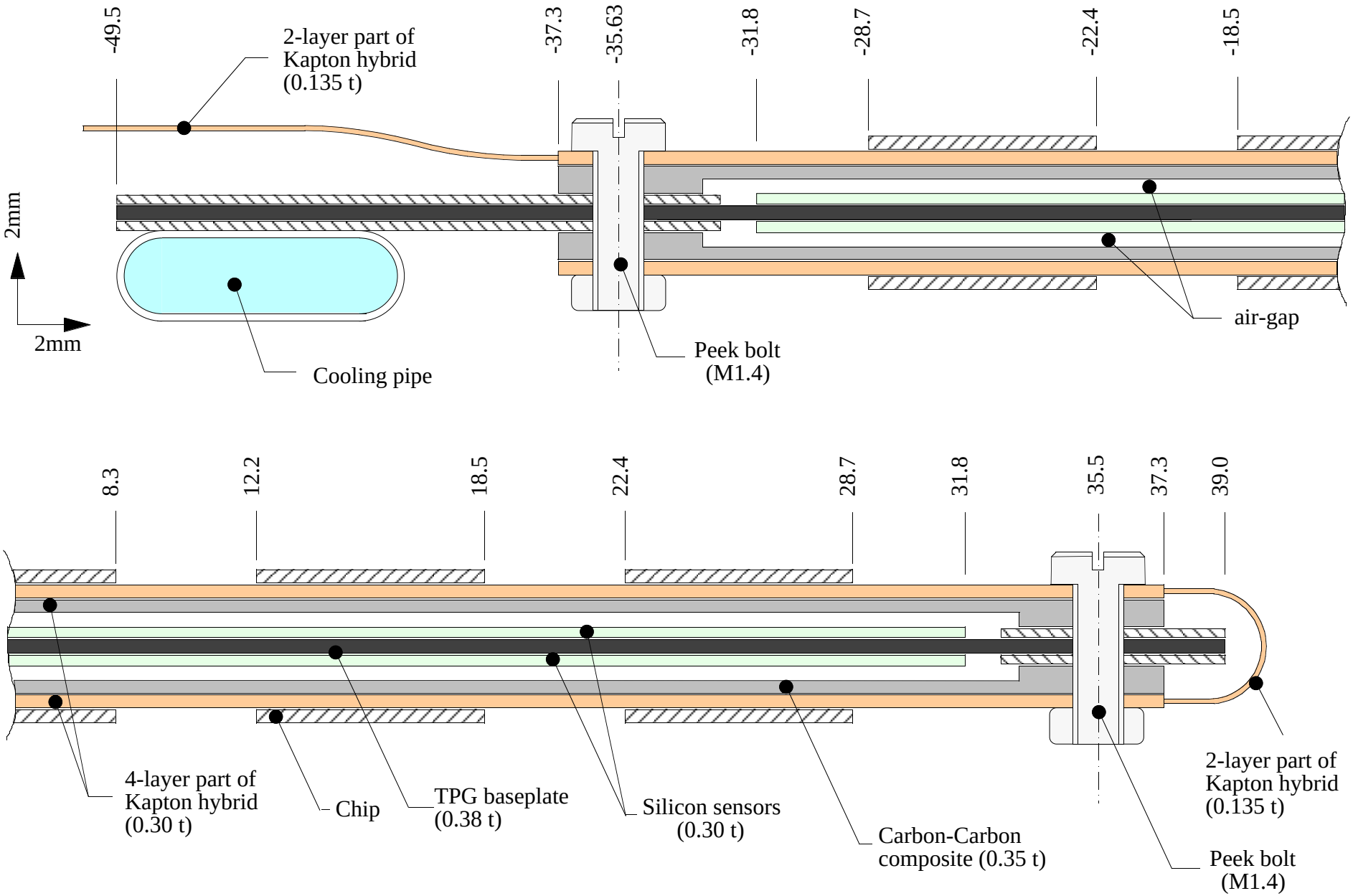
C/C bridge

- •Volume(2 pieces) 1311.46 mm^3
- •Density 1.8 g/cm^3
- •Mass 2.36 gm
- •Xo 236 mm
- •Radiation length 0.068%(over detector area)
- •Thermal cond. 400 W/m/K(XY),25 W/m/K(Z)
- •CTE -0.8 ppm/K(XY),10 ppm/K(Z)



980902KEK





Cross Section of ATLAS Barrel SCT module with Kapton hybrid

98.9.4 T. Kondo/T. Kohriki

Testing

Detector leakage currents pre- and post-assembly:

- **Pre-assembly: The leakage current was measured at the detector production site, i.e., at Hamamatsu,**

- **Post-assembly: The leakage current was measured by biasing the detectors through the bias connections on the cable connector**

- **Leakage currents [μA]**

		Post-		Laser-cut	
Bias [V]	Pre-	H-OFF	ON	H-OFF	ON
0	0	0	10	0	0
50	--	0.7	14	0.8	0.7
100	0.9	1.0	8	1.1	1.0
150	--	1.4	25	1.4	1.3
200	7.6	6.5	42	2.6	2.6

- H-OFF: Hybrid power OFF

- Laser-cut: cutting the traces on the Fan-ins of the "short" strips

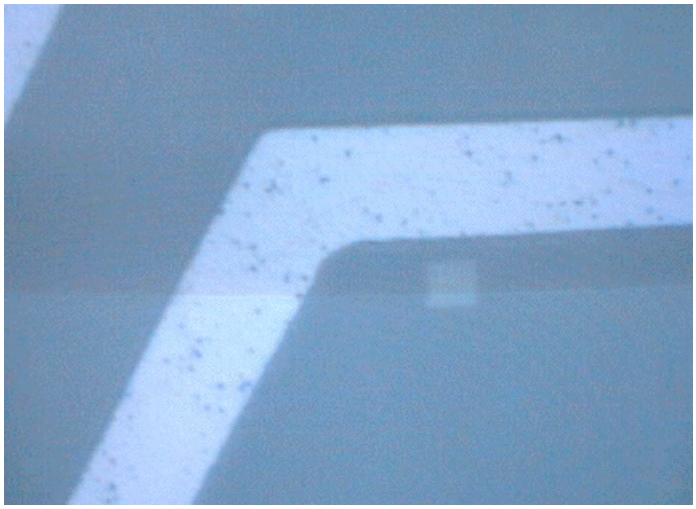
- "Short" strips = AC coupling shorted, i.e., punch-throughed

Pre- and Post- Assembly

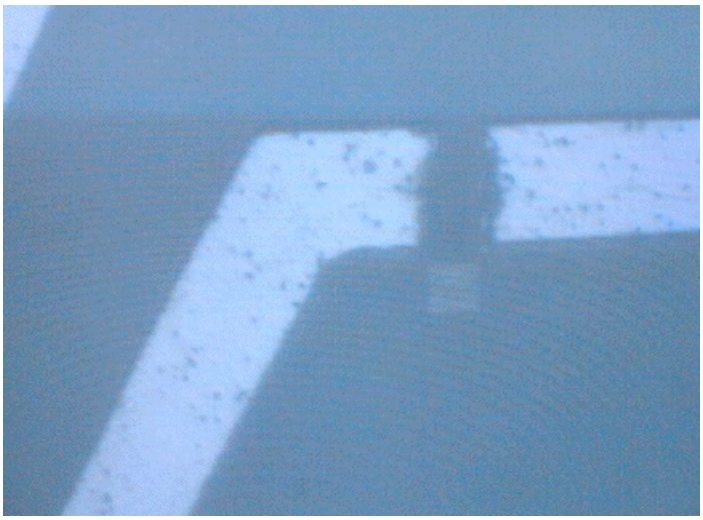
- **All detector strips were bonded to Fan-ins and to the IC channels**
- **Powering ON the hybrid drew strange and an order larger currents**
- **Disconnecting the known “short” strips by cutting the Al traces on the Fan-in solved the problem**
- **No visible increase of the leakage current after the assembly**

Laser-cutting

- **Al trace before cutting**



- **Al trace after cutting**



Testing (cont'd)

Charge injection testing:

- **Internal DAC**
- **Charge injection scan for Gain, offset, and noise evaluation**
- **Bias: 0V, 200 V, and seen the clear difference of noise**
- **Qualitatively, there was very little increase of noise in the "unbonded" channels, e.g., see ch 256-383 (chip2)**
- **The data is being analysed for quantitative evaluation**

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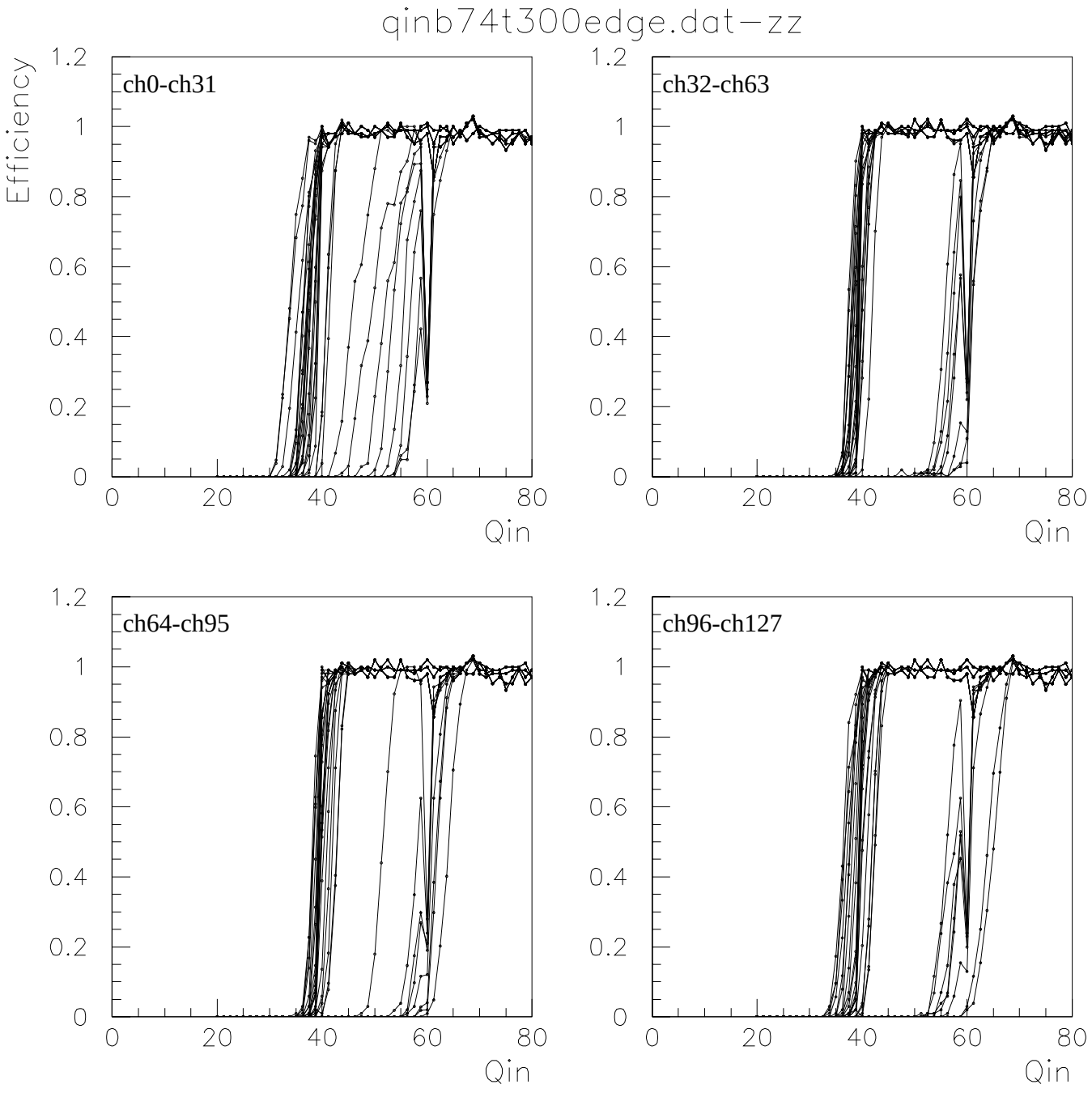
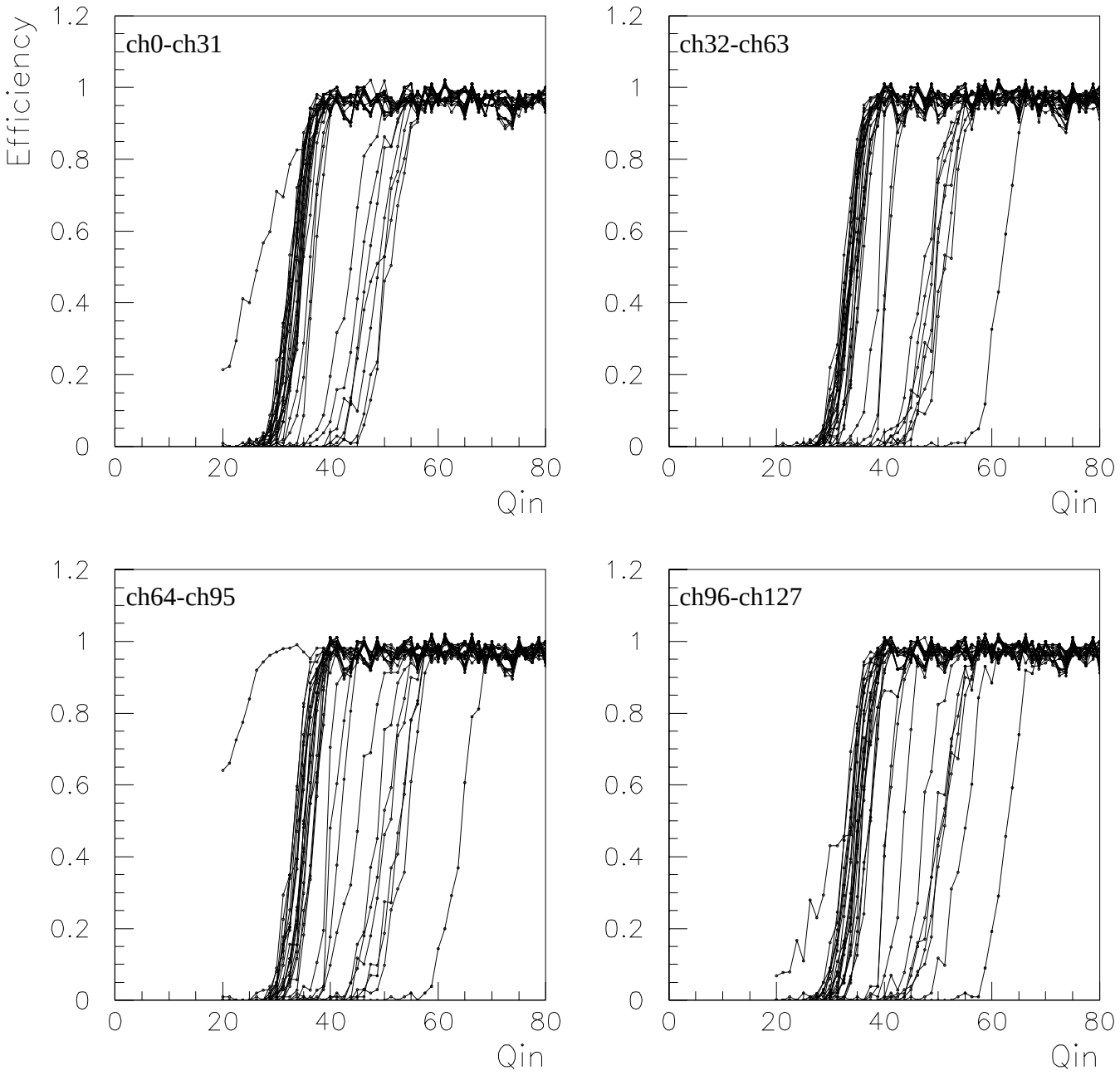

qinb74t300edge.dat−zz
Efficiency
ch0-ch31
ch32-ch63
ch64-ch95
ch96-ch127
Qin
0
0.2
0.4
0.6
0.8
1
1.2
0
20
40
60
80

Khybrid3/fullmodule/Bias200V/qinb74t300edge.dat—zz



Material in Module (Barrel)

Preliminary!!

1. TDR		1.226%Xo
Silicon detectors		0.641
FEE chips		0.035
Electronics parts		0.026
Baseboard (incl. glues)	BeO+TPG	0.185
Hybrid (incl. Fan-ins)	BeO+Au	0.314
Connector		0.025

2. All TPG baseboard		1.175%Xo
Silicon detectors		0.641
FEE chips		0.035
Electronics parts		0.026
Baseboard (incl. glues)	TPG	0.134
Hybrid (incl. Fan-ins)	BeO(28 mm W)+Au	0.314
Connector		0.025

3. Be + Cu/Kapton hybrid		1.038%Xo
Silicon detectors		0.641
FEE chips		0.035
Electronics parts		0.026
Baseboard (incl. glues)	TPG	0.134
Hybrid (incl. Fan-ins)	Be(23 mm W) + Cu/Kapton	0.177
Connector		0.025

4. Carbon-Carbon + Cu/Kapton hybrid 1.044%Xo

Silicon detectors		0.641
FEE chips		0.035
Electronics parts		0.026
Baseboard (incl. glues)	TPG	0.134
Hybrid (incl. Fan-ins)	CC(23 mm W) + Cu/Kapton	0.183
Connector		0.025

- **Point radiation length passing two hybrids**

- Silicon + TPG		0.84 %Xo
- BeO + Au		0.90 %Xo
	Total	1.74 %Xo

- Silicon + TPG		0.84 %Xo
- Be +Cu/Kapton		0.68 %Xo
	Total	1.52 %Xo

- Silicon + TPG		0.84 %Xo
- CC +Cu/Kapton		0.69 %Xo
	Total	1.53 %Xo

Summary

- **Modules with the ABCD Kapton hybrid have been successfully fabricated**
- **Full, 12 chips, 4 detector, “Electrical Module” has been assembled**
- **No visible increase of the leakage current was observed, after cutting the input traces of the “short” strips to the amplifier**
- **Charge injection testing is underway and looks promising...**
- **Next,**
- **Laser scan, in preparation**