Thermal and Thermo-distortion measurement of the Barrel module with Irradiated Detectors

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(for ESPI system)

- 3 x 10^{14} protons/cm^2 (nominal) irradiated detector for the proper thermal behaviour (of the detector)

- Geometry based on the drawing "..070.." series

  - Adhesive pattern according to the "..070-04-A"

  - Adhesive: Araldite 2011 + BoronNitride powder

  - BeO facing for the cooling and far-side "ears"

- Be bridge + Kapton hybrid (with heater chips) to simulate a low-mass solution

- Two types of measurements

  1) Thermal runaway

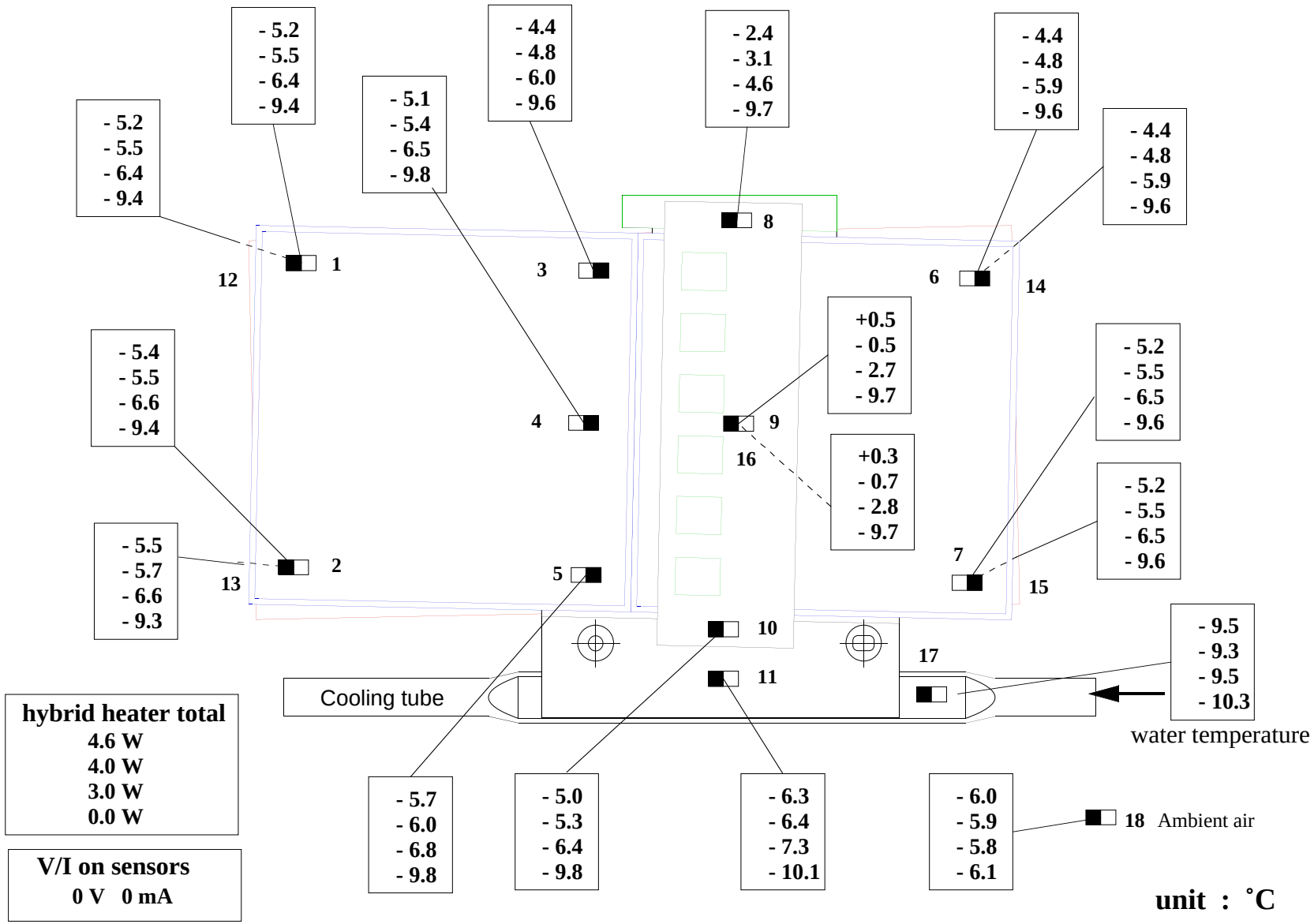
  2) Thermo-distortion

- Preliminary results, as the measurements were done very recently

Thermal runaway measurement (done at KEK)

- Oval cooling pipe
- Direct contact to the cooling “facing” (with thermal grease)
- Simple water cooling:
  - Water temperatures of -10, -2, and +0.8 °C
- Heat generation
  - Hybrid power: 0, ..., 4.6 W (total in pair)
  - Bias voltages: 0, 100, 200, 300, ... V

KEK thermal module with irradiated silicon sensors (3 x 1014 protons/cm**2)**



Temperature Profile with no voltage on silicon sensors

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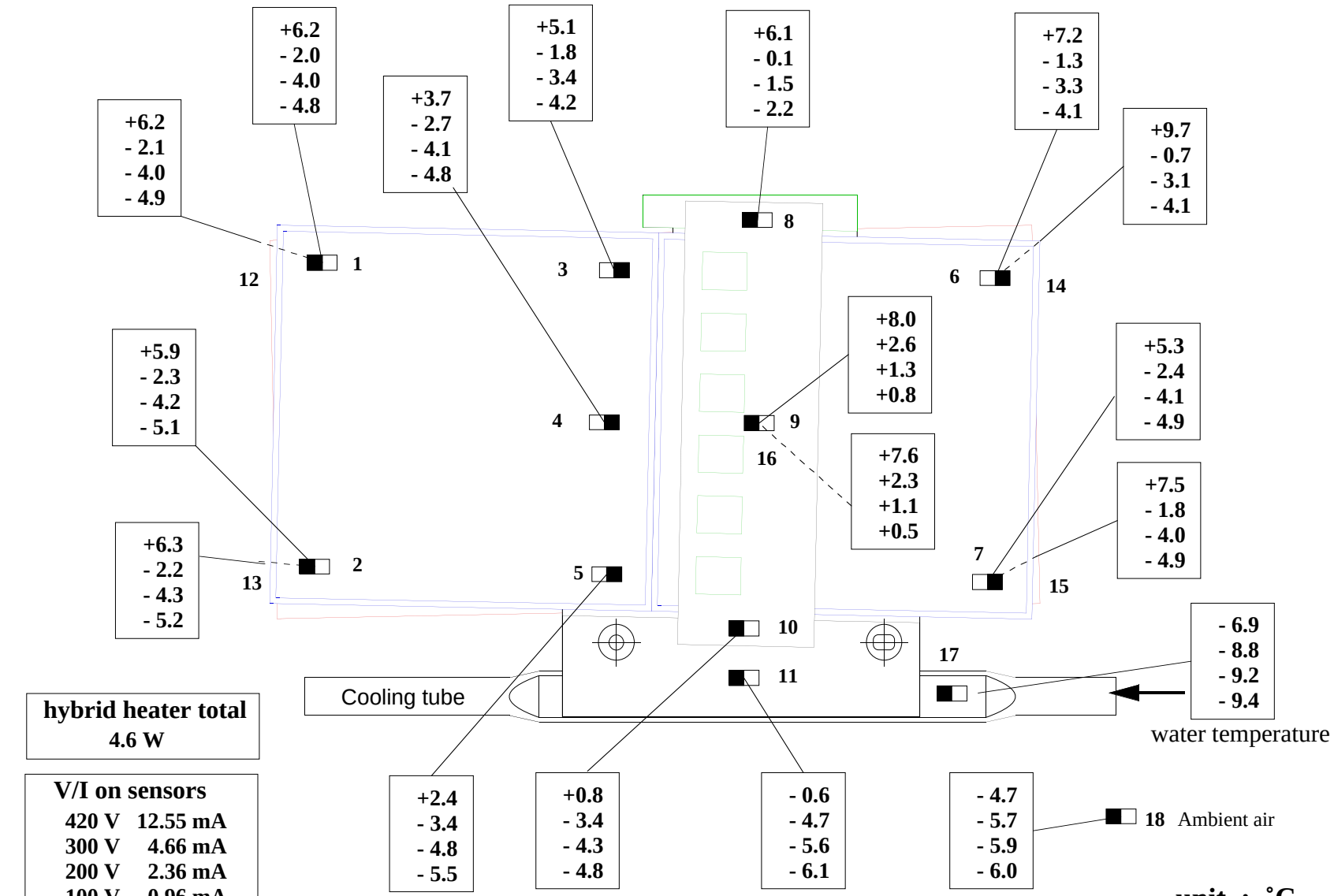
KEK thermal module with irradiated silicon sensors (3 x 10**14 protons/cm**2)



hybrid heater total
4.6 W

V/I on sensors

420 V	12.55 mA
300 V	4.66 mA
200 V	2.36 mA
100 V	0.96 mA

runaway voltage = 430 V

Temperature Profile with power on silicon sensors

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Thermal runaway results (Preliminary)

- Temperature difference between the coolant to the Silicon “far-corner” with full hybrid power is $\Delta T \sim 4\ ^{\circ}C$

- With the cooling temperature at -10 °C, which is 5 °C higher than the expected cooling temperature, Silicon “far-corner” runs away at around 420 V

- Comparison with the thermal FEA is being underway

Thermo-distortion measurement

- Measurement was done last week, May 26 to 30, using the Oxford ESPI system
- Cooling was done via “PG block”: (Round) Al tube - PG block - Module
- Analysis is being underway, results are VERY preliminary
- Interests:

  - Distortion (of the detectors) along the thermal runaway, specially the geometrical effect of the TPG core (extension in the one-side of detectors)

  - Distortion along the cool down

  - Distortion with powers (hybrids, detectors) ON

- Measurements at ROOM (+20 °C) and COLD (-15 °C)

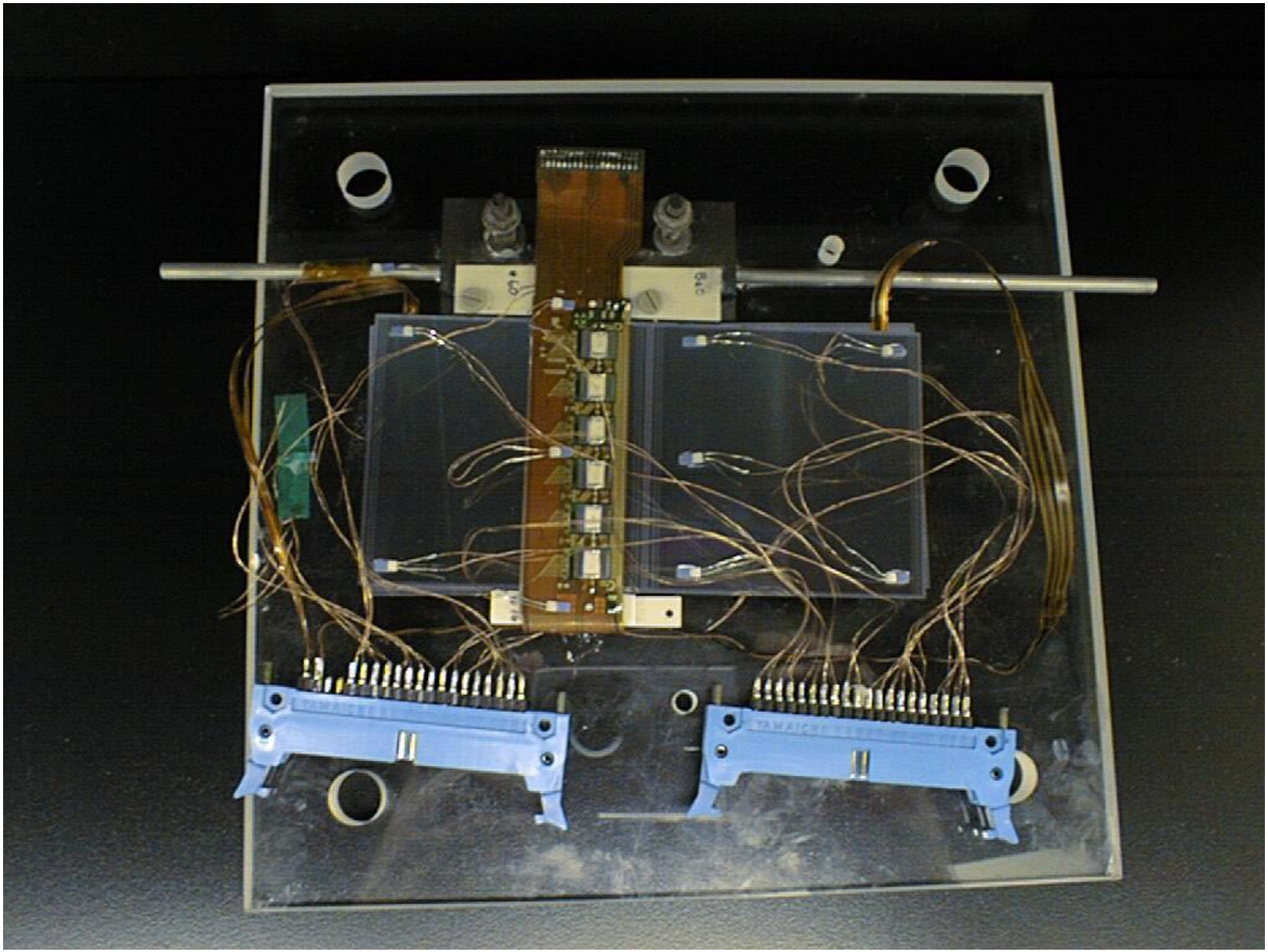


Image examples

- Bias voltage between 0 V and 300 V (at COLD, hybrid OFF)

  ~25 fringes (from edge-to-edge) (~ 6 micron)

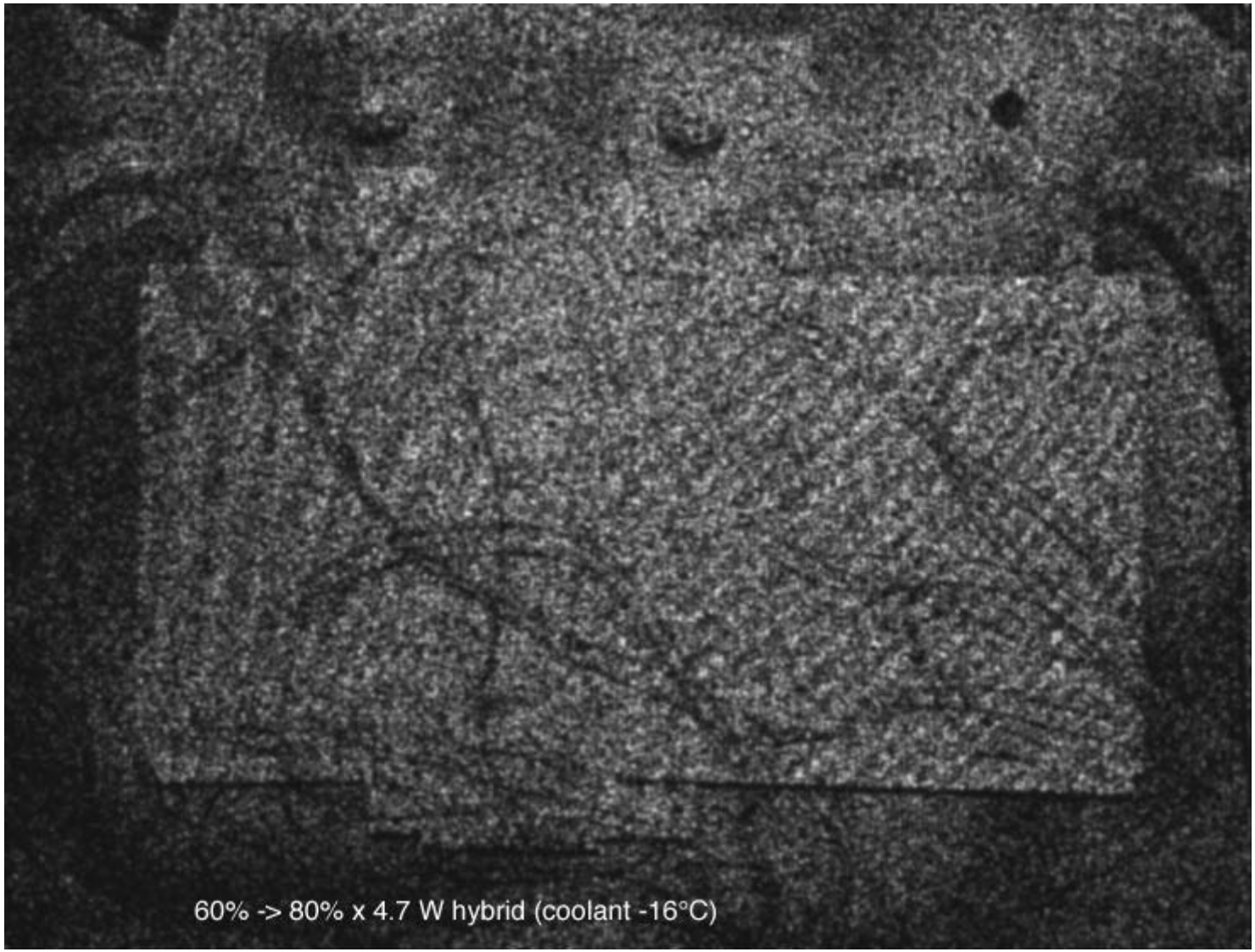
  No apparent “edge” of the TPG core

- After the cycle of “0 power” - “Full power (350 V, 4.6 W) - “0 power” (cycle time ~ 15 min.)

  ~ 2 fringes (~ 0.5 micron), would be less if left longer

- Hybrid powers between 60% and 80% of the full power (Bias 0 V, ROOM), i.e., $\Delta P = 1/5\ P\_full$

  ~36 fringes(?) (9 microns)


60% -> 80% x 4.7 W hybrid (coolant -16°C)

“Twist” distortion ?

- Both ends (steps) of the hybrids are glued on the baseboard (via BeO facing)
- The CTE mismatch (Be: 12.4 ppm/K, TPG: ~ -1 ppm/K) may have generated the distortion (twist) due to the 40 mrad rotation-offset
- To be confirmed with the BeO bridge module (UK) (BeO: 8.7 ppm/K)

- Solutions/proposals

For the Be bridge, to go for a design with

- Glue the cooling-side end (step),
- Fixation with screw & nut (as done in the distortion study in the TDR) to allow to slide

There are other options which can be pursued...

Preliminary results

- Detector power does not give serious distortion, nor the effect of the core (shape)

- CTE mismatch of the hybrid bridge and the baseboard may have generated the “twist” in the module, which gives 45~50 micron out-of-plane motion in the “far-corners” of the silicons