Development of a QC method for assembly of heat conductive material on new ATLAS pixel sensor module

Year-End Presentation
2019/12/23(Mon)

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introduction

- LHC will be upgraded to HL-LHC

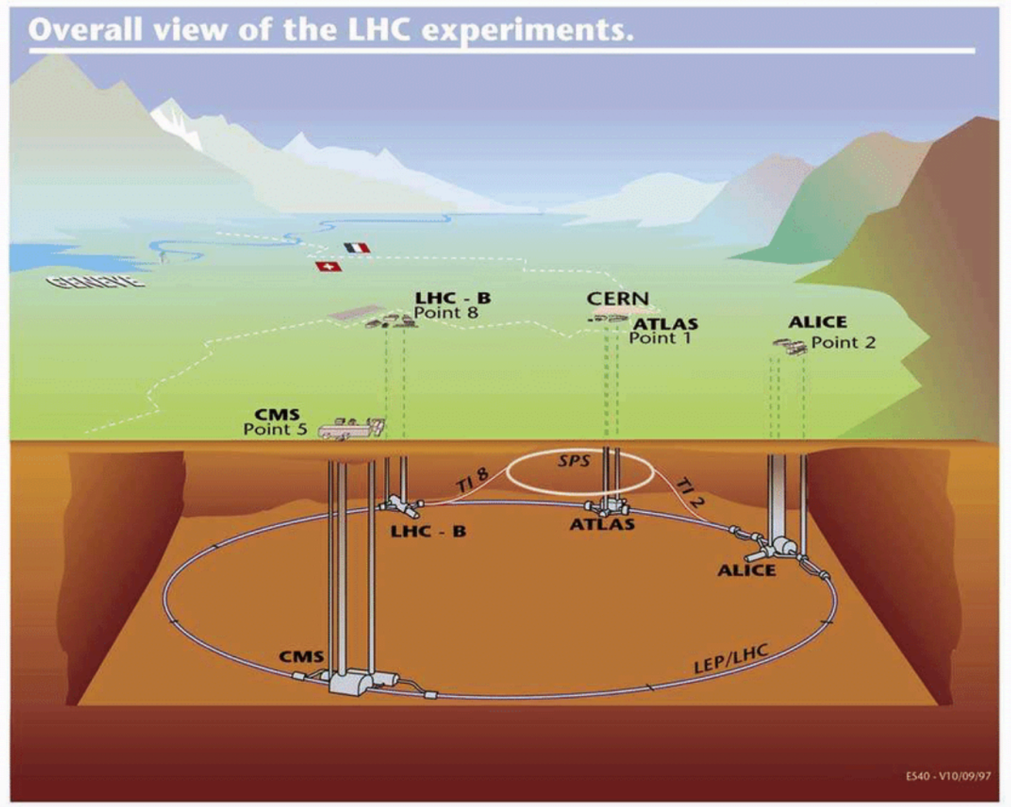
- **L**arge **H**adron **C**ollider
  - proton - proton collision in $\sqrt{s}$ = 13 TeV.
  - Luminosity ~ $10^{34}cm^{-2}s^{-1}$
  - Integrated luminosity ~ 200 fb^{-1} (until 2018, run2)

- **H**igh **L**uminosity **LHC**
  - Luminosity

    5~10 times of LHC

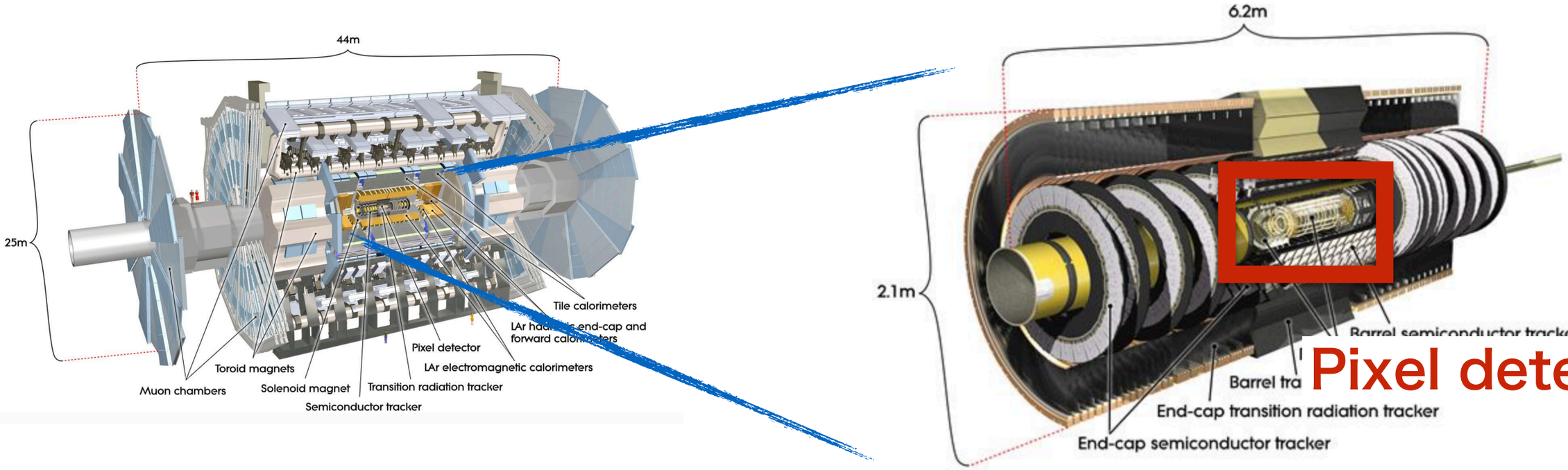
    (250 fb^{-1} per year)
  - Integrated luminosity

    3000 fb^{-1} 12 year after upgraded



introduction

- ATLAS inner pixel detector will be upgraded for HL-LHC



For HL-LHC, we will upgrade the pixel detector.

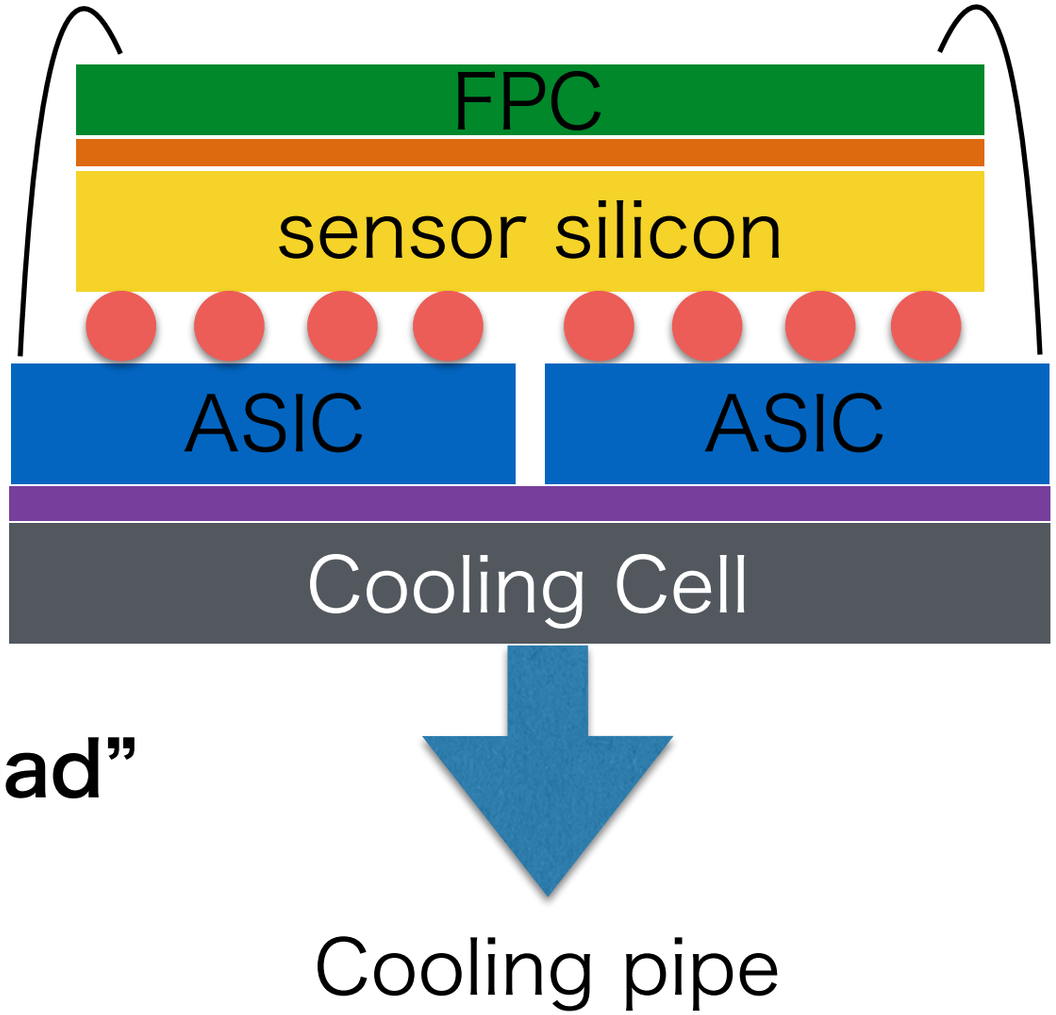
To upgrade, we have to do

- mass production
- QA/QC (**Q**uality **A**ssurance/**Q**uality **C**ontrol)

introduction

- in production of new pixel sensor module
  - Cooling Cell (carbon) will be loaded
    - Because front-end ASIC generate heat (10~20W).
    - Connected to Cooling pipe

- with bad glueing,
  we can not cool the sensor enough.



→ we must detect those **“thermal bad”** module.

introduction

- how to detect “thermal bad”
  - candidate methods
    - leakage current
    - surface temperature gradient

- by comparing health module and intentional bad module, we can know the behaviour of thermal bad.

- Now I am evaluating the sensitivity of these methods

introduction

- procedure
  - prepare temperature monitor system

  - **Now going on** measuring the leakage current and surface temperature with health FE-I4 module

- same measurement with intentional bad thermal conduction
  - exam)
    - use module which is intentionally failed to glue,
    - bad contact between Cell and cooling pipe

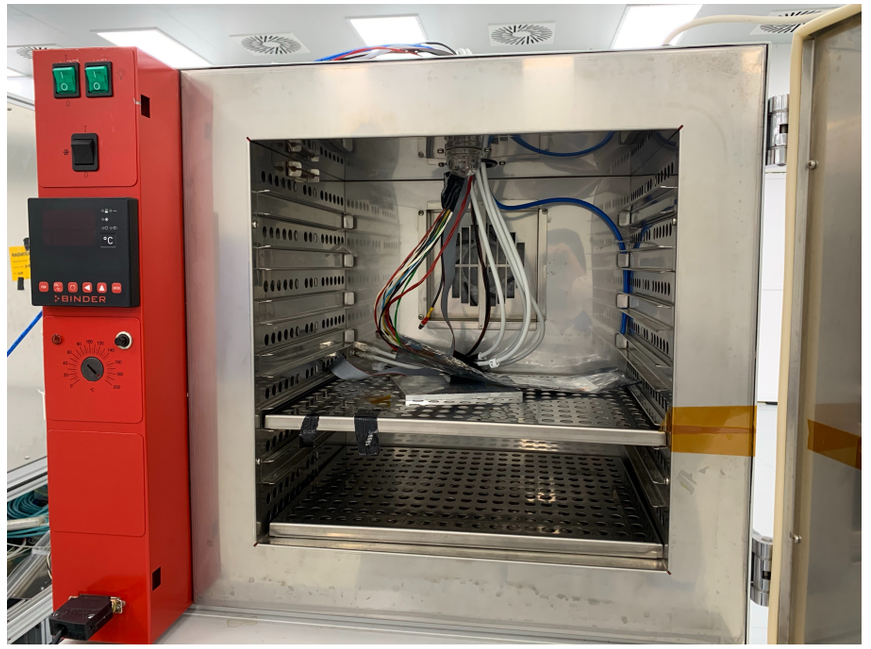
Temperature monitor system

- Temperature monitor
  - measure the NTC resistance
    - NTC means thermistor which has negative temperature coefficient
  - calibrate by using Steinhart-Hart equation $\frac{1}{T} = A + B\ln R + C(\ln R)^3$

    A,B,C is coefficient,

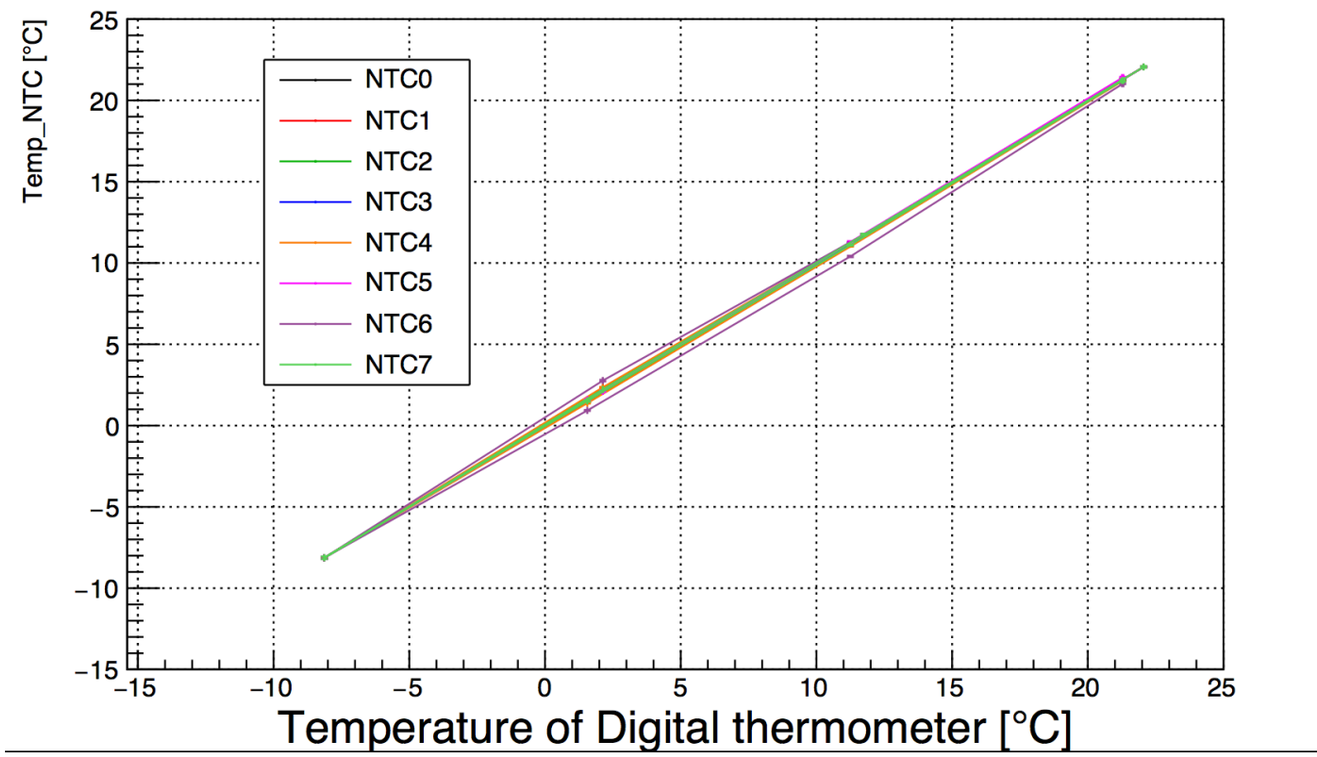
    T is temperature,

    R is NTC resistance



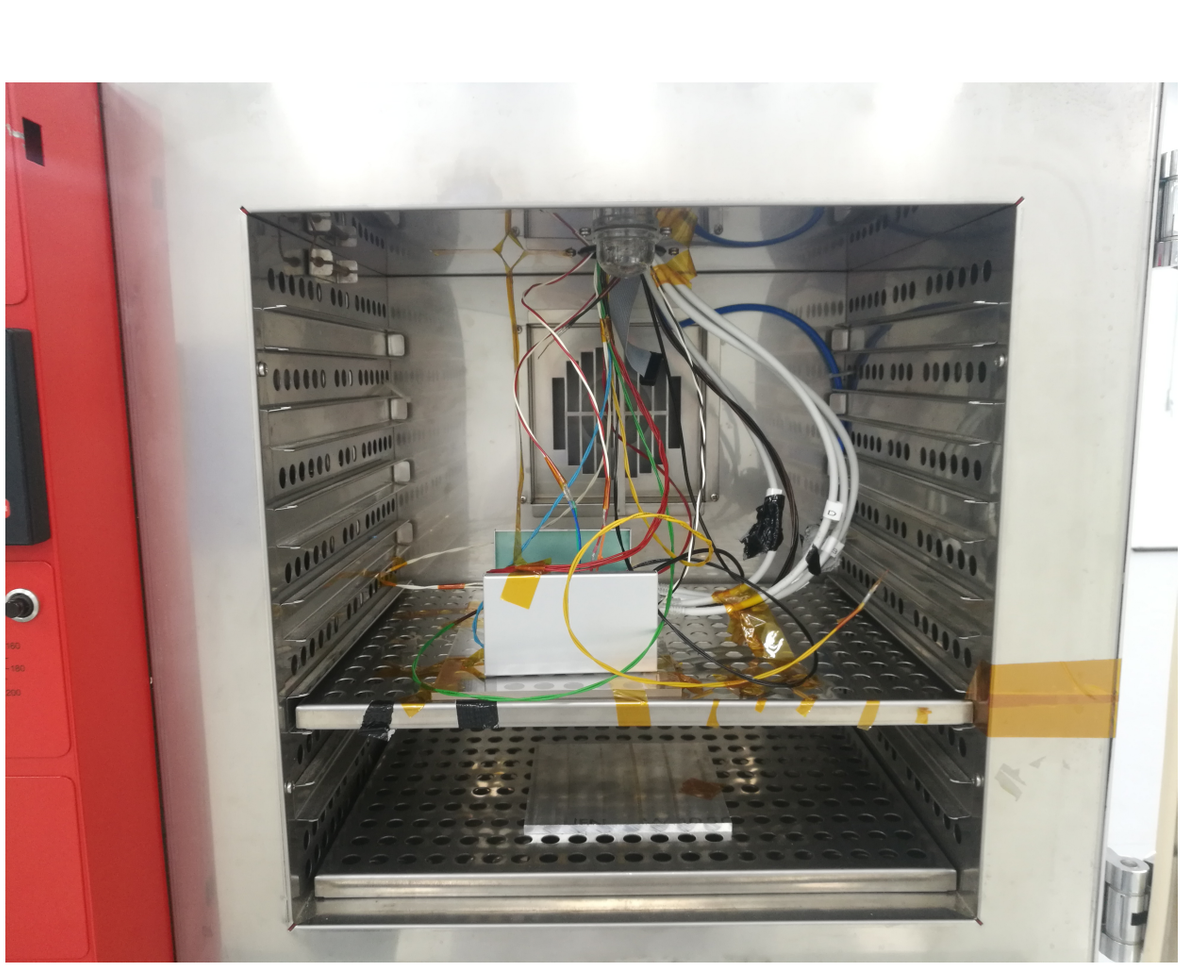
In calibration, I put 8 NTCs and digital thermometer into the climate chamber.

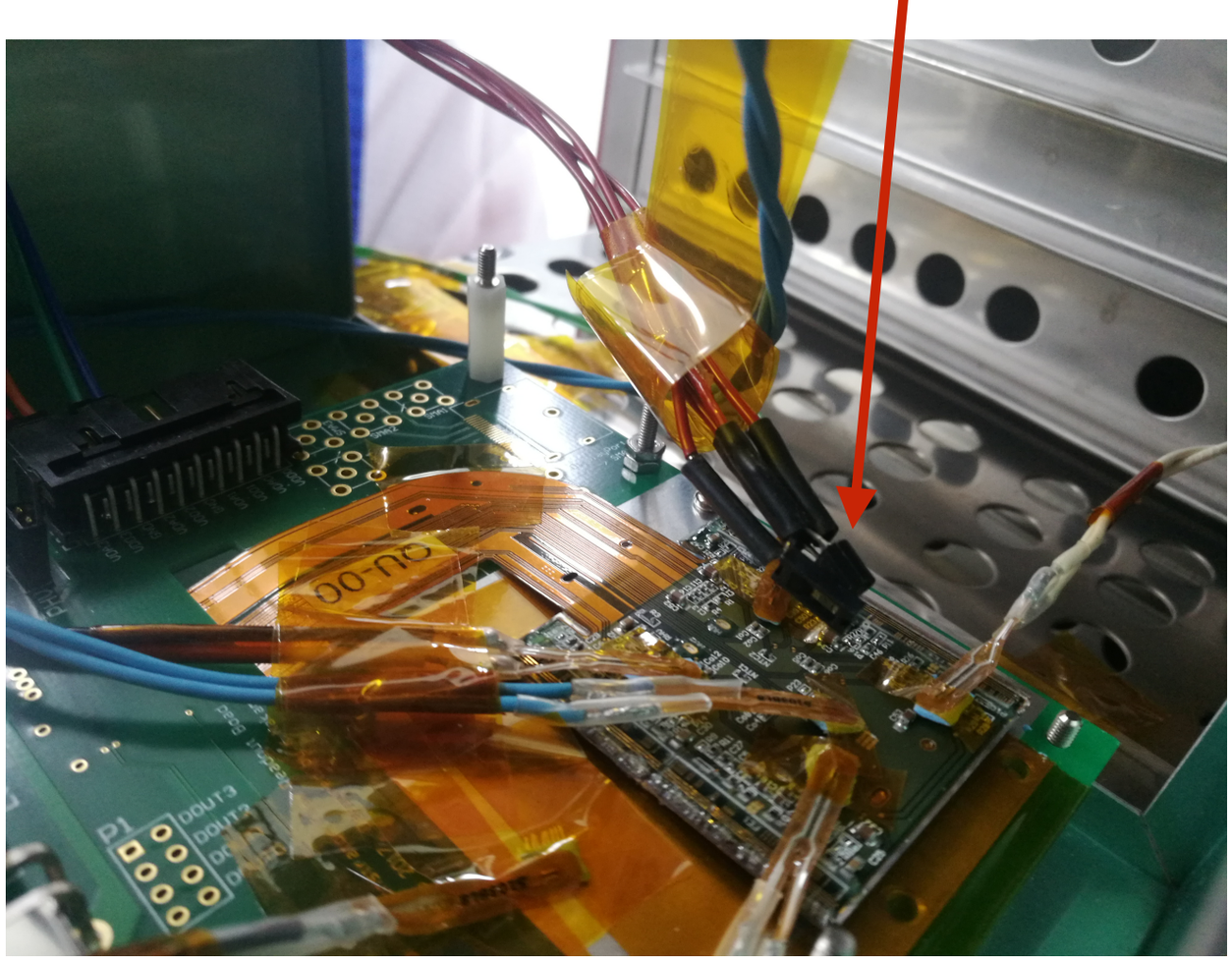
calibration looks good.
(NTC6&7 is not important)



measuring setup

- setup to measure the leakage current & surface temperature
  - attach NTCs on surface of sensor module with thermal paste.
  - read the resistance of module NTCs with multimeter.
    (2 NTCs already implemented on module flex)
  - with cables connected (HV, LV, LAN)



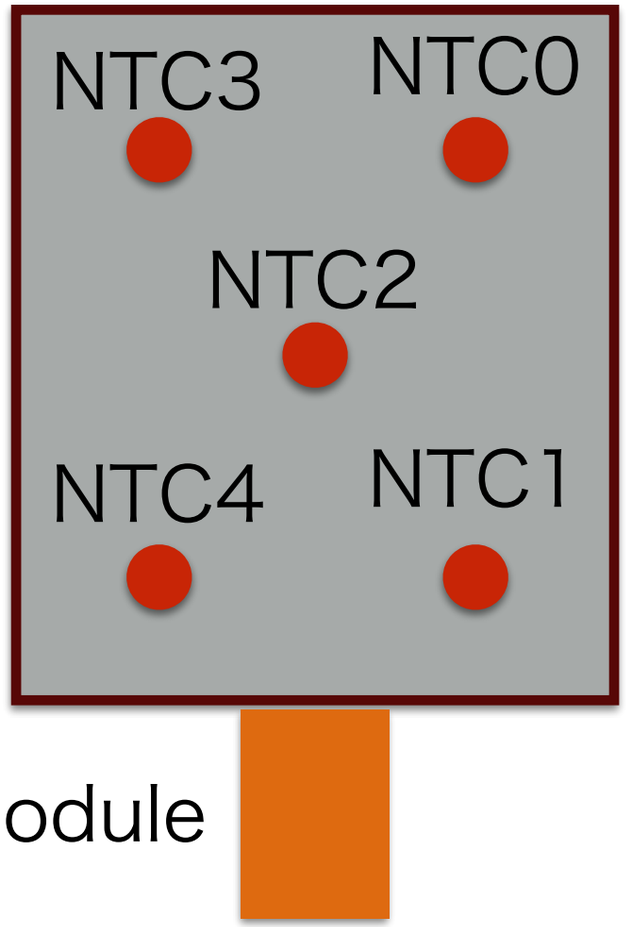


measuring setup

- setup to measure the leakage current & surface temperature

  - purpose :
    - to know behaviour of below values at several temperature
      - leakage current
      - surface temperature

  - To do so,
    - I measure these values
      changing climate chamber temperature
      w/ and w/o ASIC working.

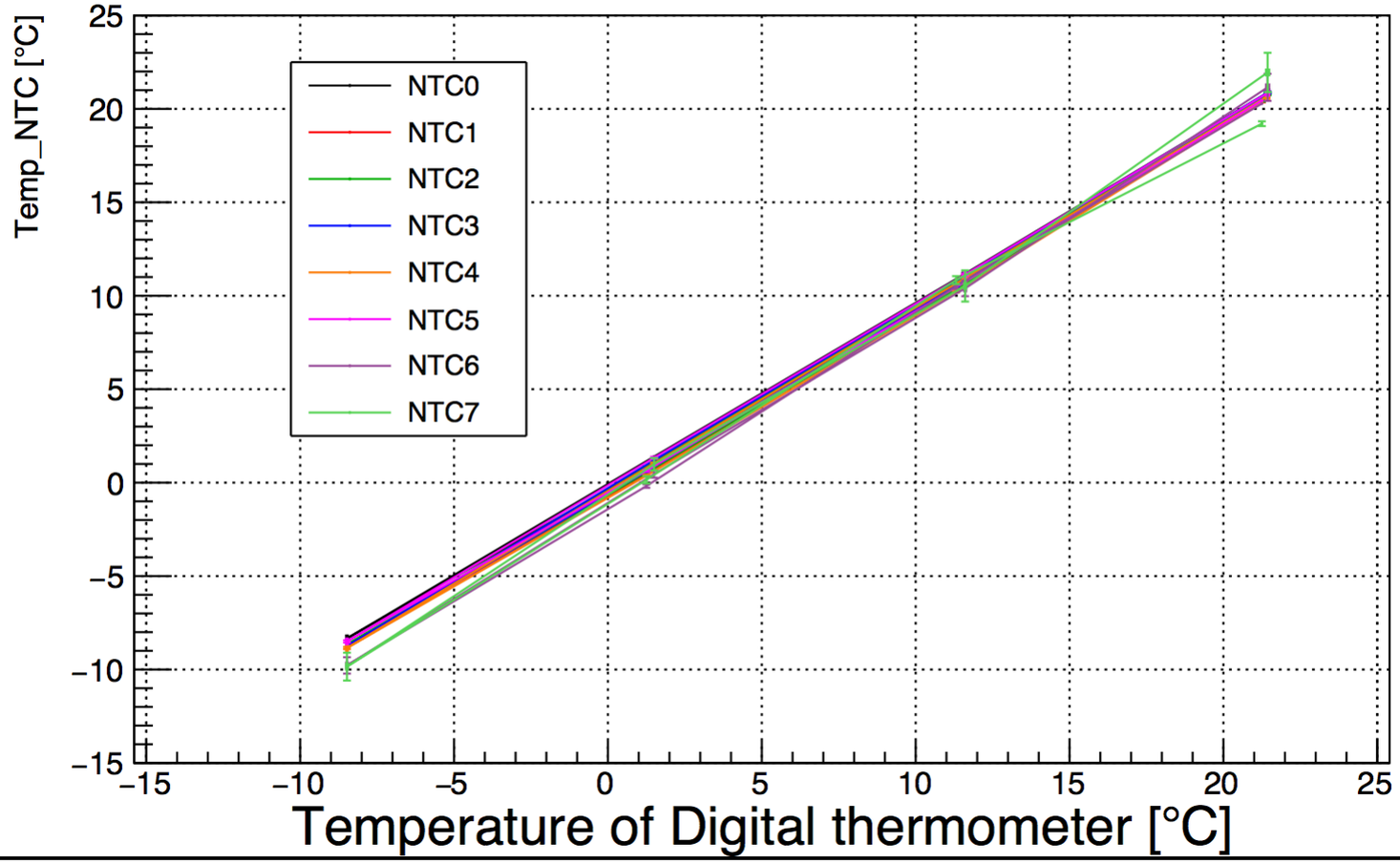


measuring setup

- setup to measure the leakage current & surface temperature
  - To confirm temperature readout,
    check NTC temperature without ASIC operation

it means all NTC measure the temperature of same silicon plate

- NTC 0~4 is on module surface.
- NTC5 is on readout PCB board
- NTC 6,7 is on air.



NTC0~4 is almost same temperature

It looks good to measure surface temperature

measurement

- Now going on measuring leakage current & surface temperature

Summary

- I am working on development the method how to detect “thermal bad”
  - I am trying two candidate way
  - leakage current & surface temperature gradient

- I prepared
  Temperature monitor system & measurement setup

- I am going on measuring leakage current & surface temperature

Prospects

- I will continue to measure the leakage current and surface temperature with health module

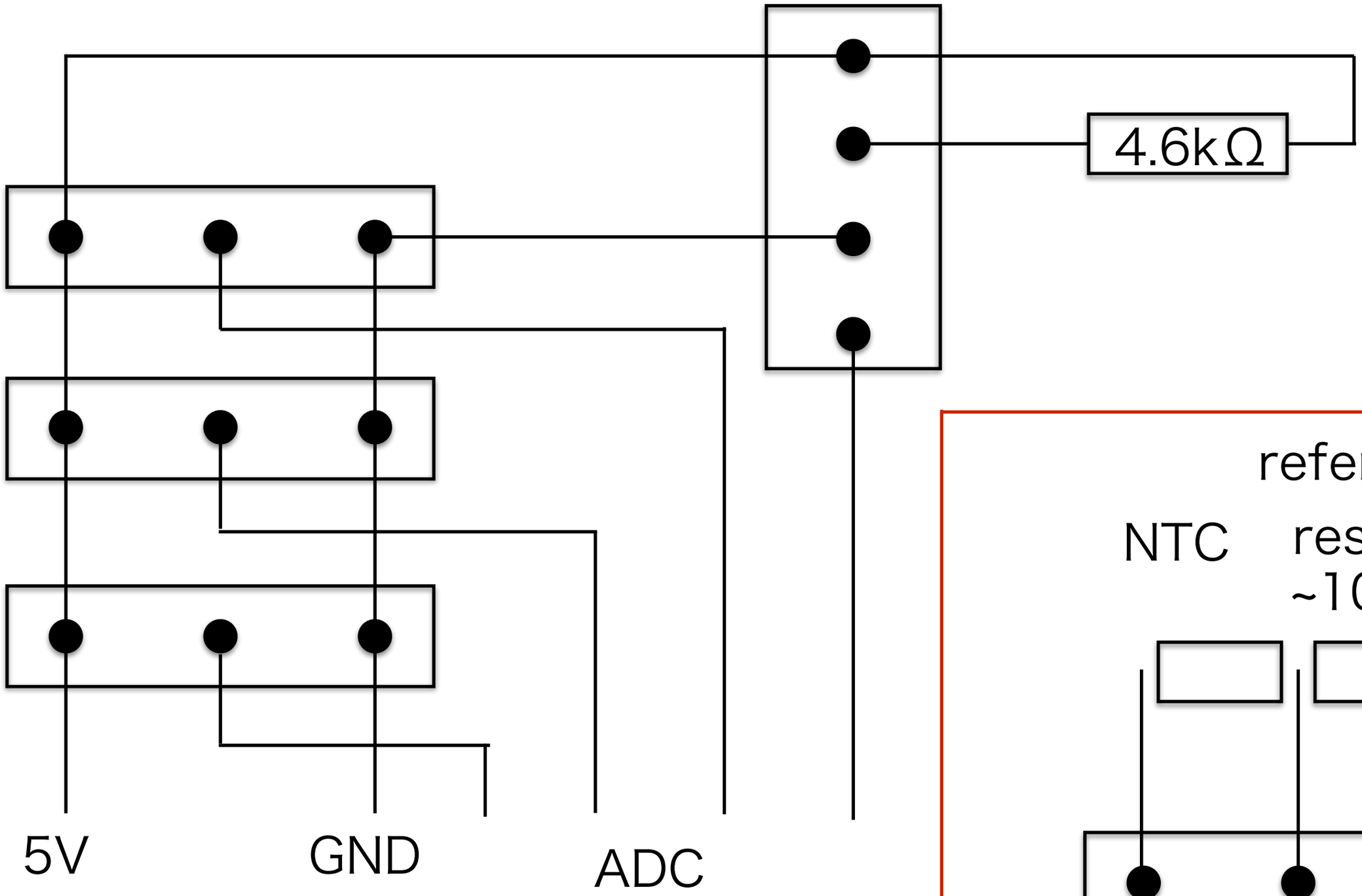
- same measurement with intentional bad thermal conduction
  - exam)
    - use module which is intentionally failed to glue,
    - make bad thermal contact between Cell and cooling pipe

Back up

monitor system

- circuit

(for humidity)



reference

NTC resister ~10kΩ