

**LHC-ATLAS アップグレードにおける
Micromegas 検出器量産に向けた
品質評価方法の開発**

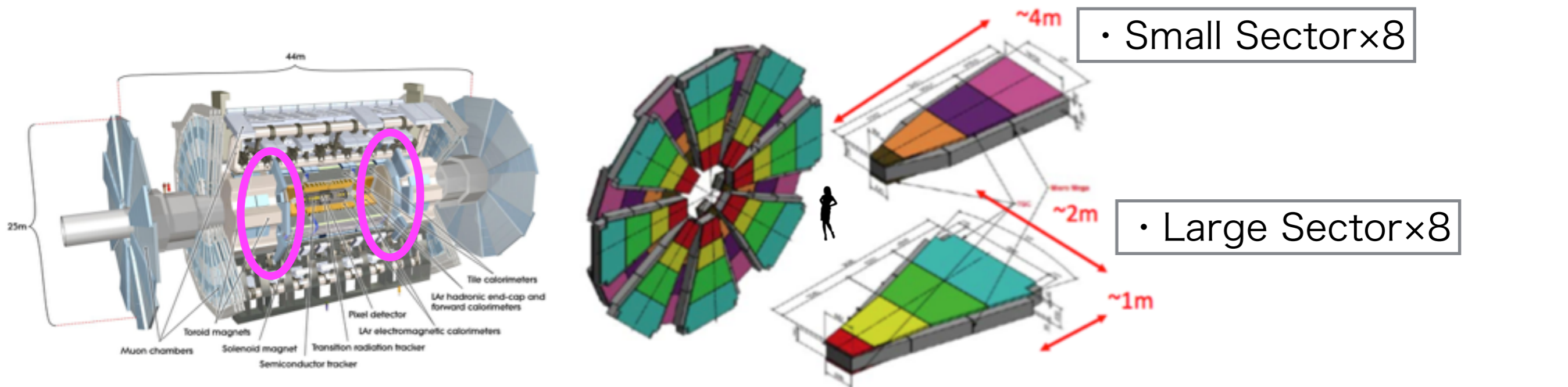
Masahiro Yamatani

The University of Tokyo, ICEPP

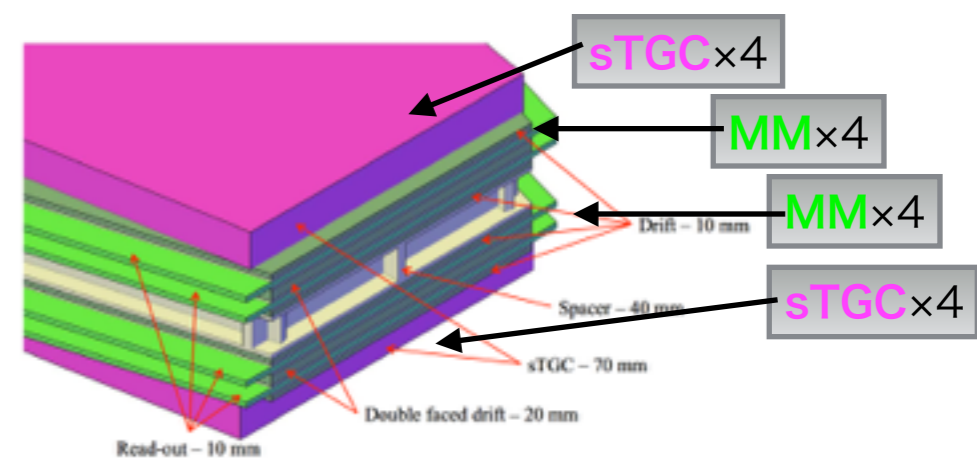
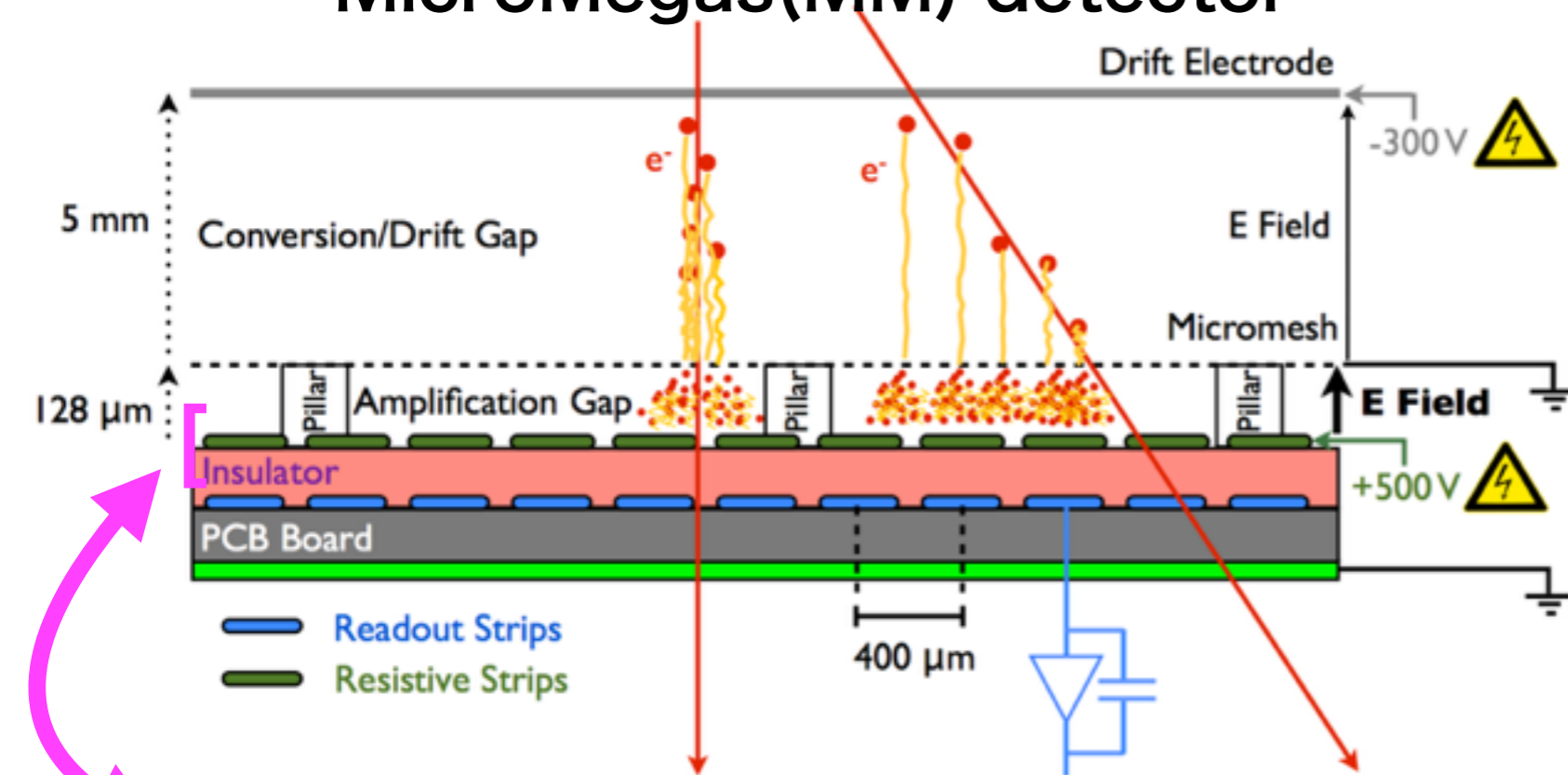
21st ICEPP symposium

9 Feb 2015

Our contributions to ATLAS phase1 upgrade



MicroMegas(MM) detector



Resistive Strips

- Perform as anode.
- Spark-protected.

● Japan group provides **Resistive Strips foils.**

Resistive (Strip) foils

Example of Resistive foil

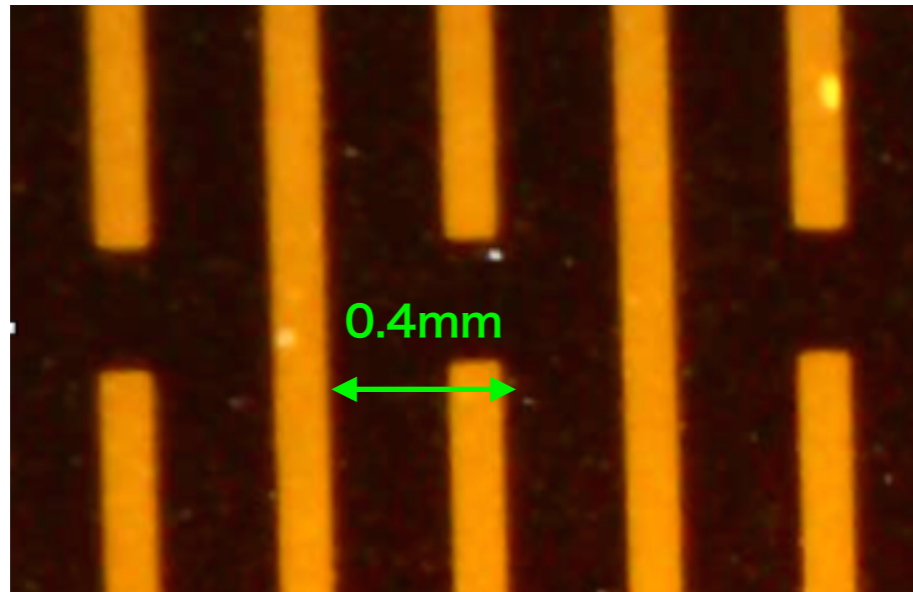


Resistive Strips

- Perform as anode
- **Fine strips (~400 μm pitch)**
- Spark-protected
- **High resistivity (~20M Ω /strip cm)**

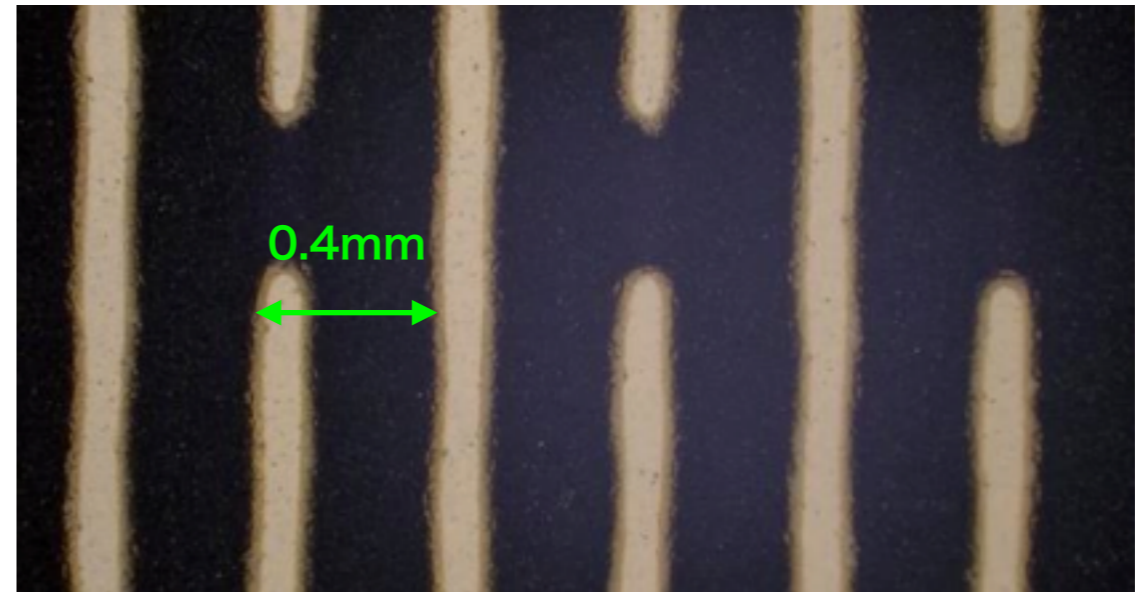
There are two types of resistive foils.

Sputter type



- Fine structure (~10 μm) can be formed.
- High uniformity.
- Takes time to make. • Expensive.

Screen Print type

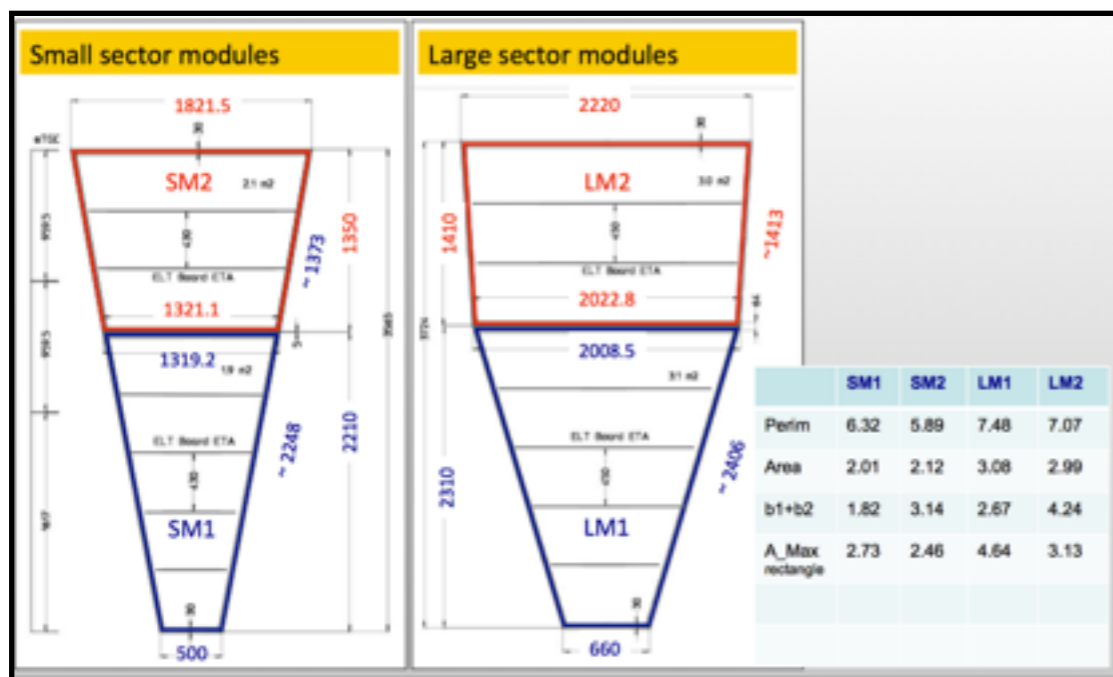


- Fine structure (~10 μm) is difficult.
- Low uniformity.
- Cheap and fast.

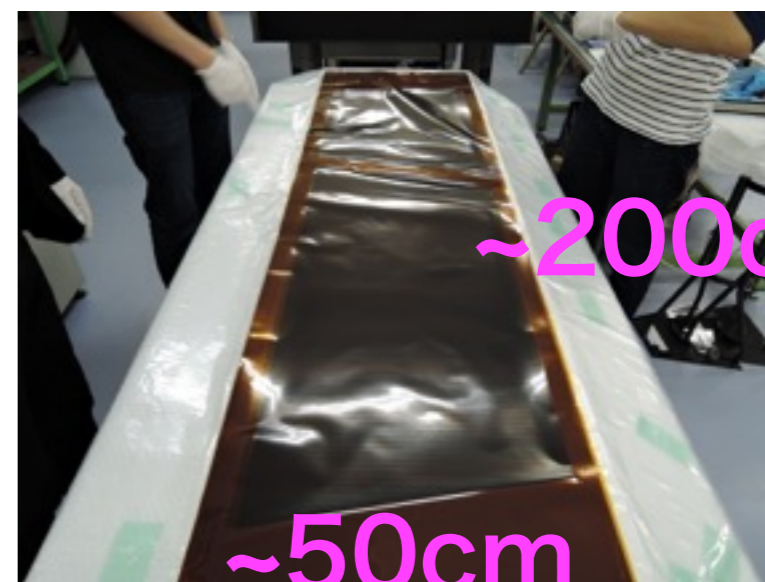
**Decide final design based on the results of
prototype MicroMegas detector**

MicroMegas detector mass production (2015 Summer~)

- Mass production will start this summer.



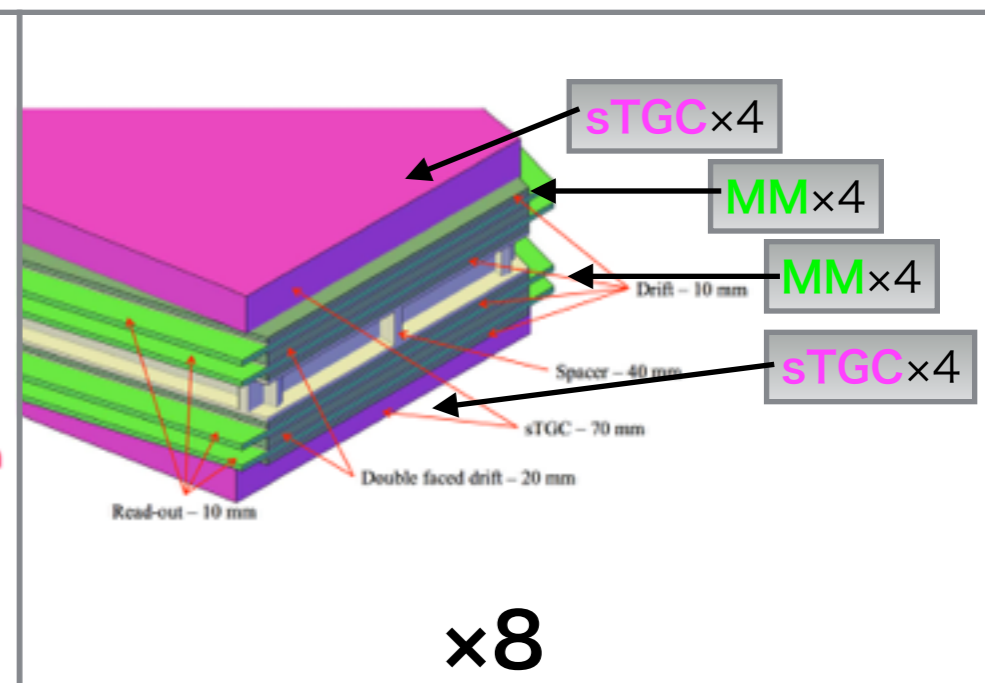
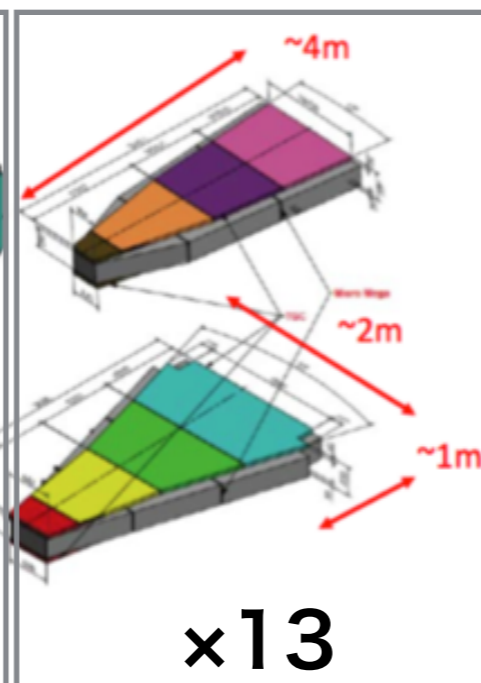
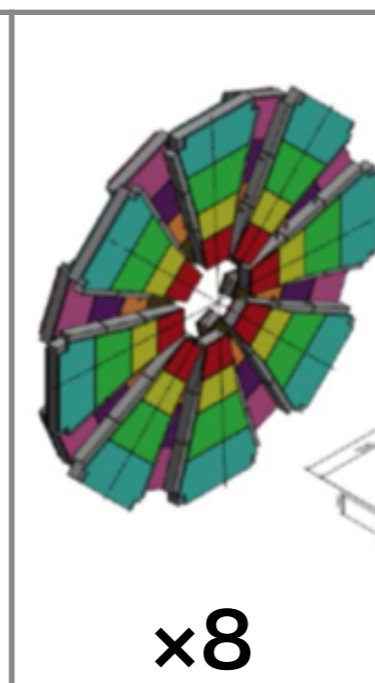
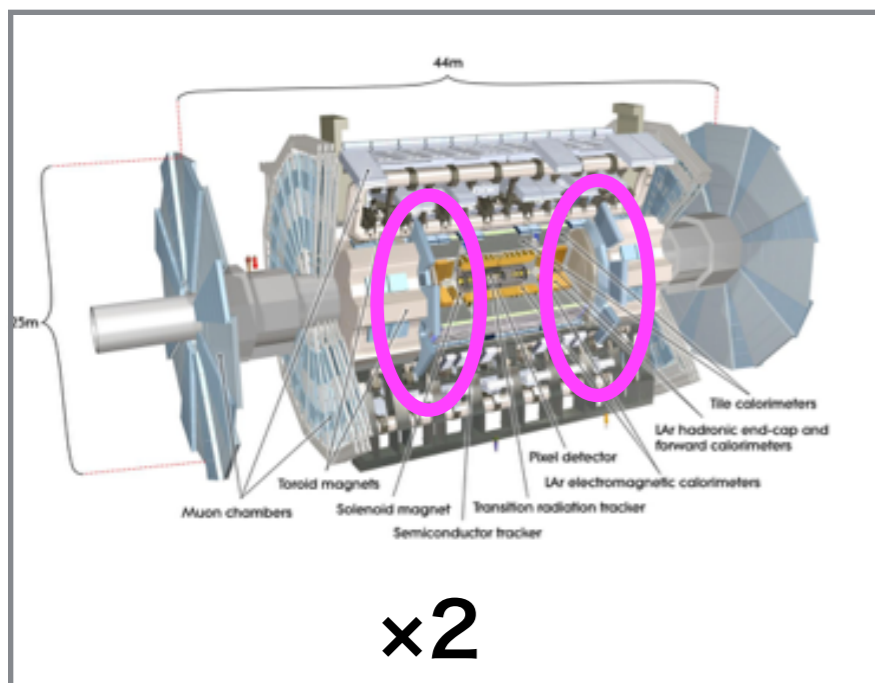
13 types of foils



~200cm

~50cm

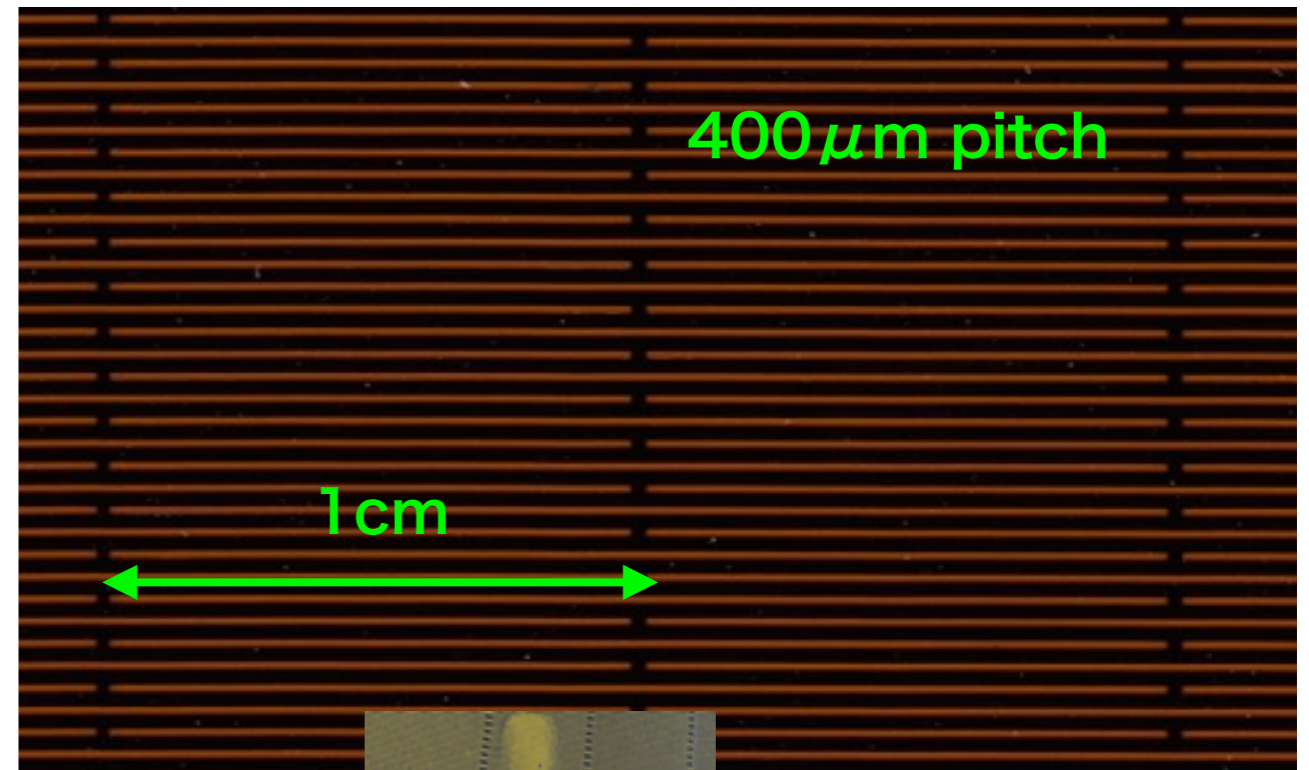
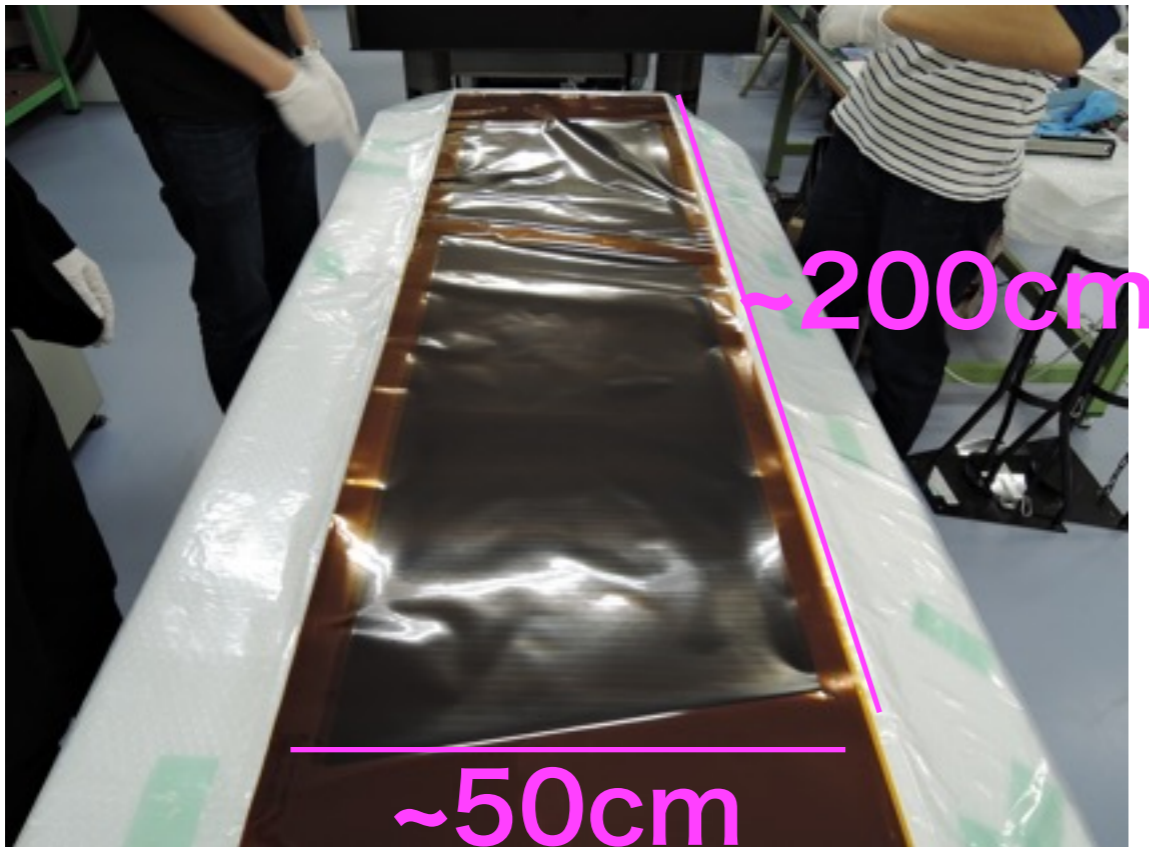
Typical size of resistive foil.



4 → 1664 foils are needed!

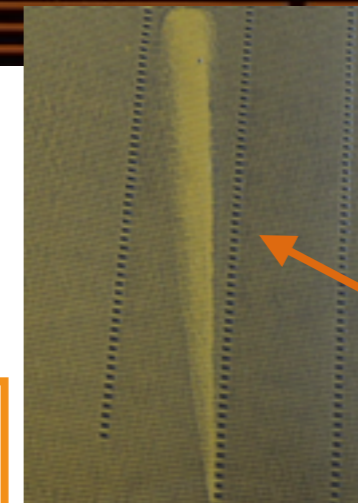
Quality assurance

Assure the quality of resistive foil produced in Japan.



What to look?

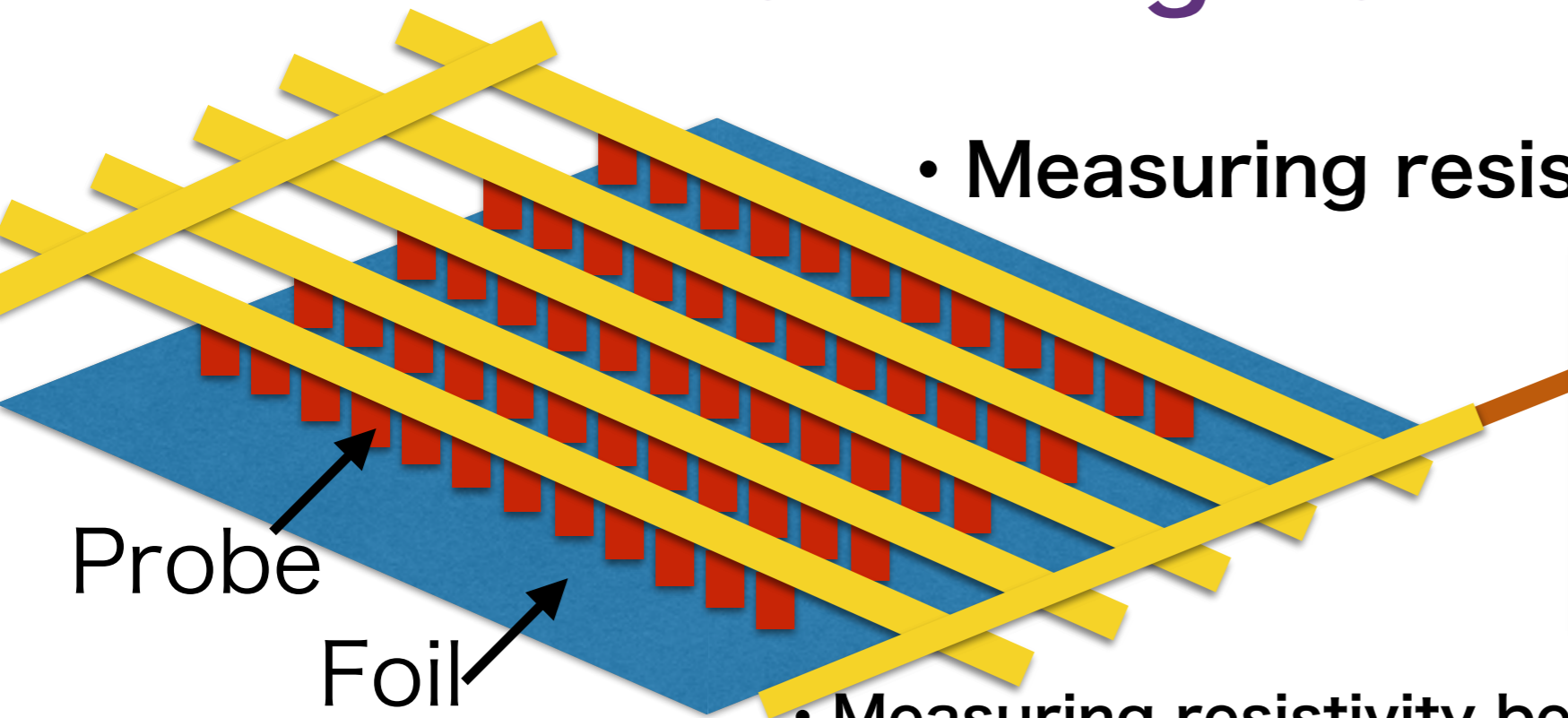
- ① Resistivity ~ 20MΩ per 1cm strip
- ② Strip pattern ~ no defect



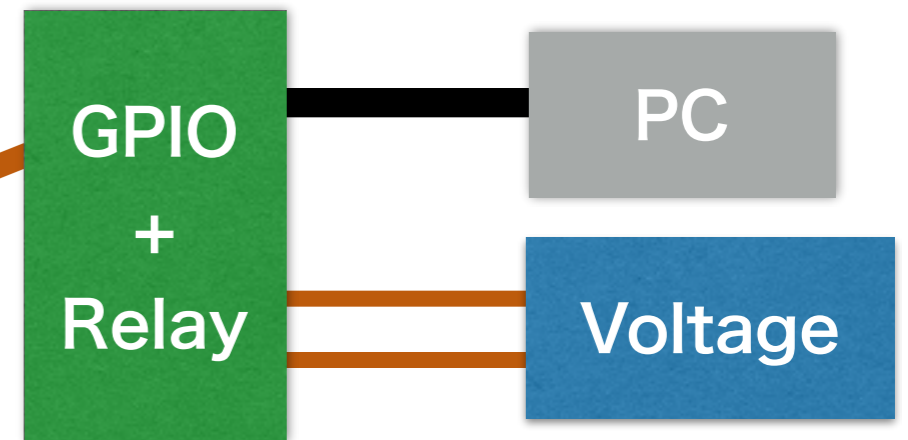
Examples of defect.

→...We are developing the methods to check them

Measuring Resistivity

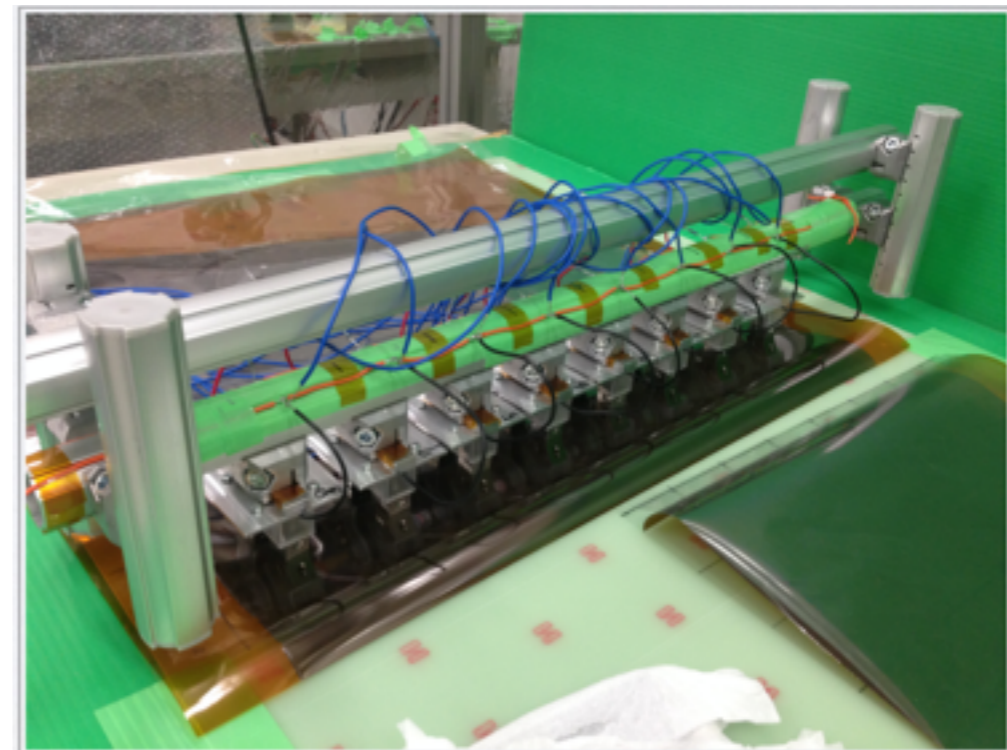
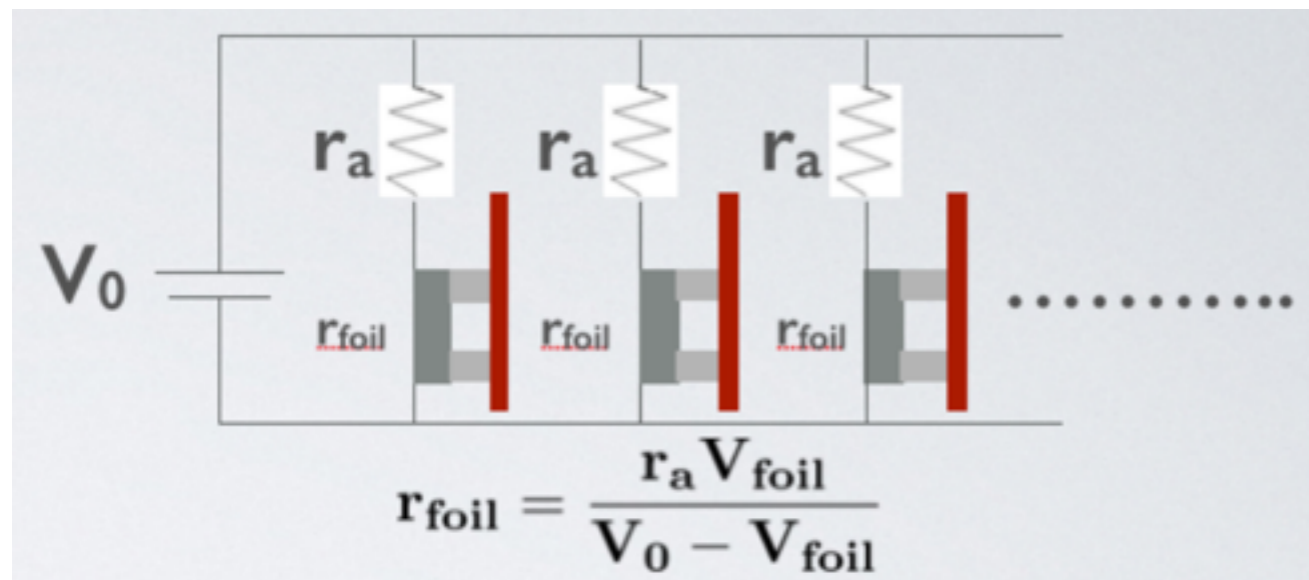


- Measuring resistivity two-dimensionally



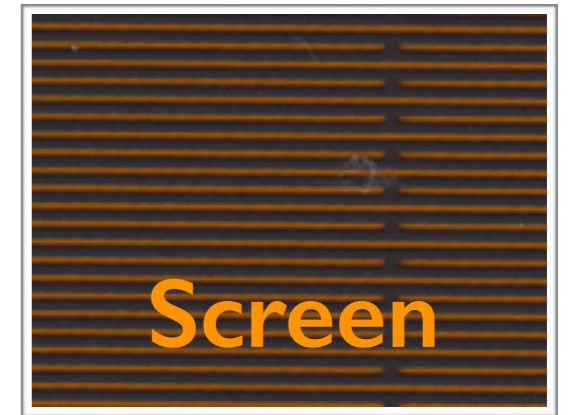
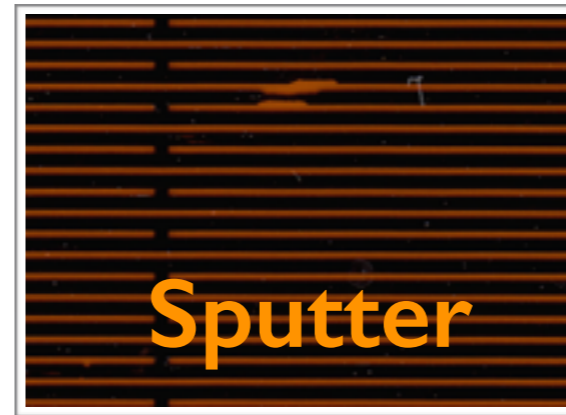
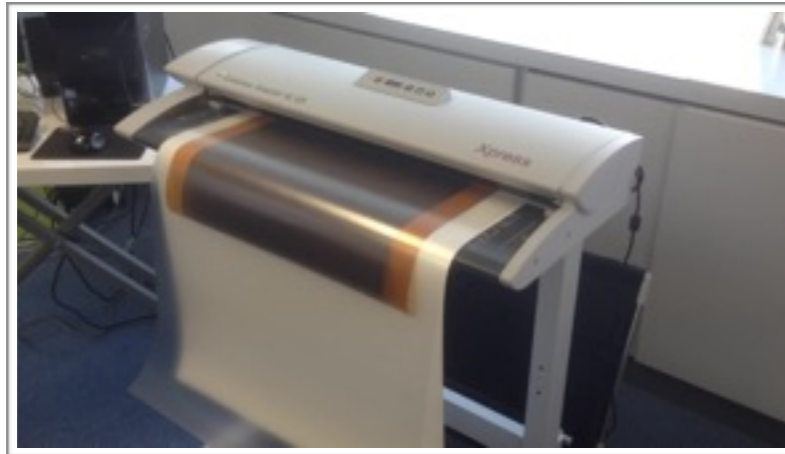
- Measuring resistivity between arbitrary two probes

1st generation(not two dimensionally)



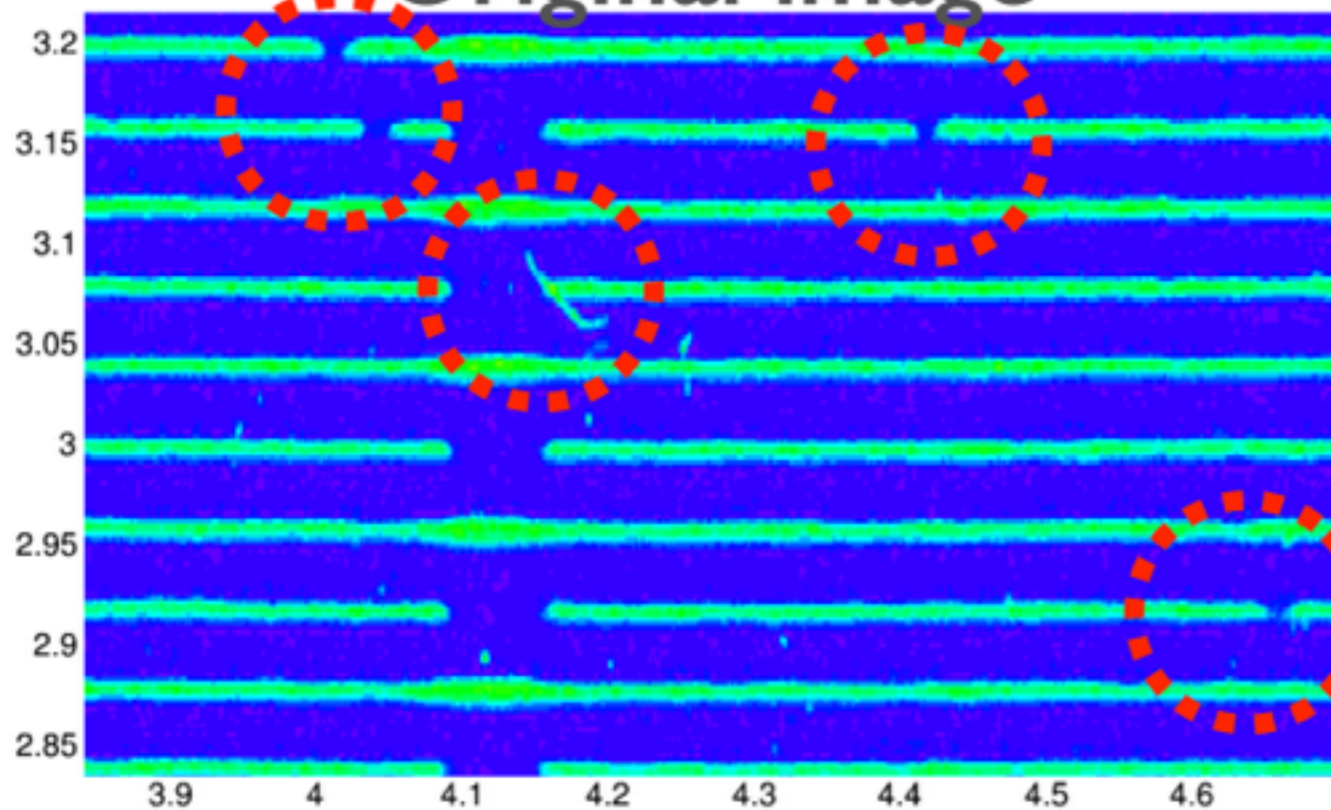
Strip Pattern check

- Scan Resistive foil and analyze it by ROOT(using TASImage)

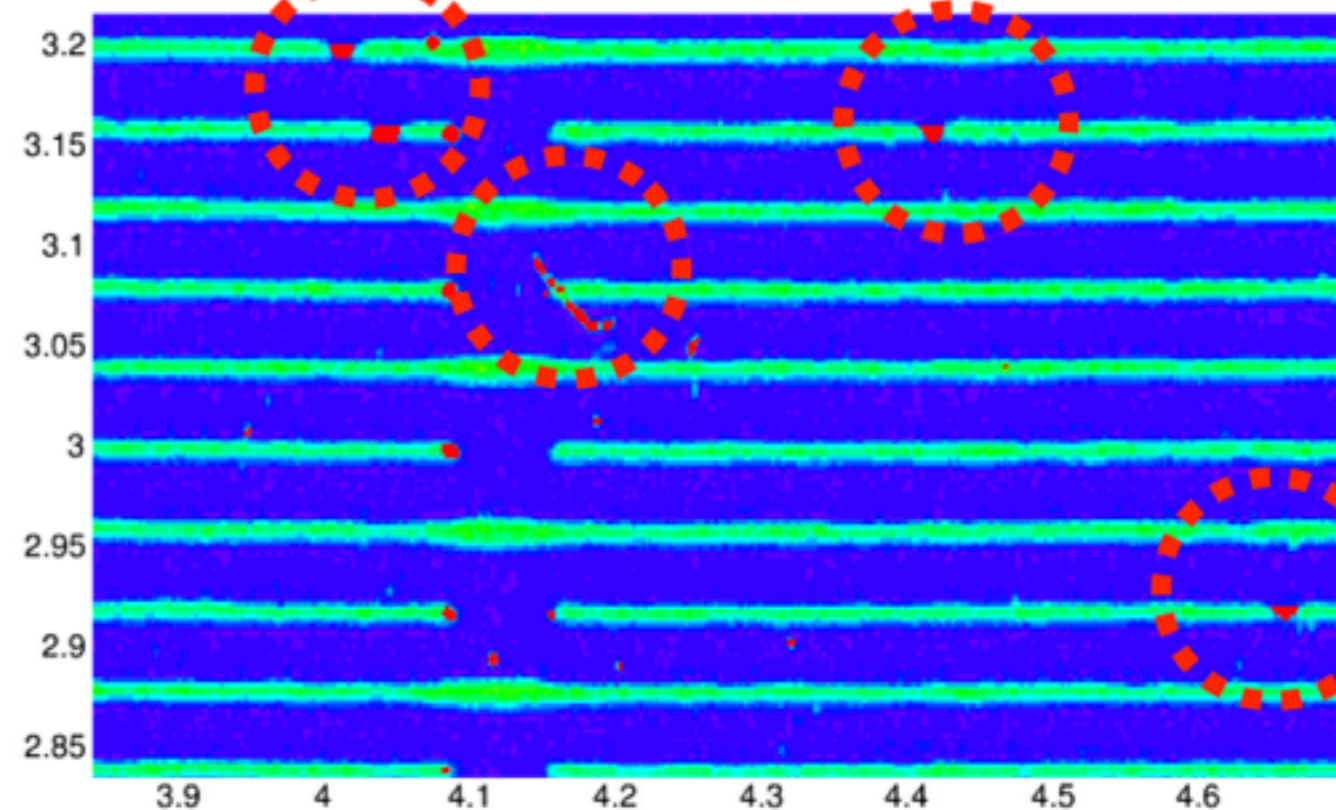


Results of error detection

Original image

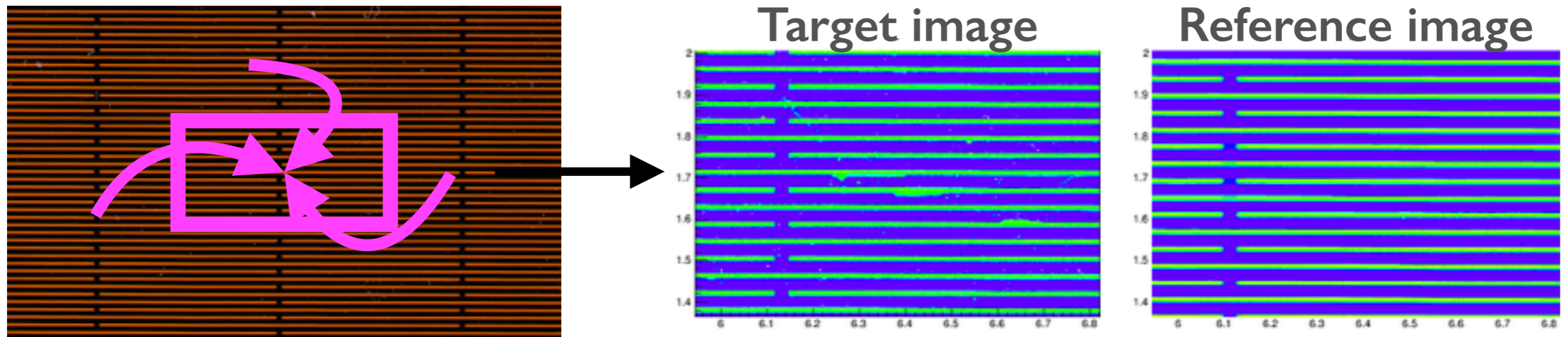


Result of error detection

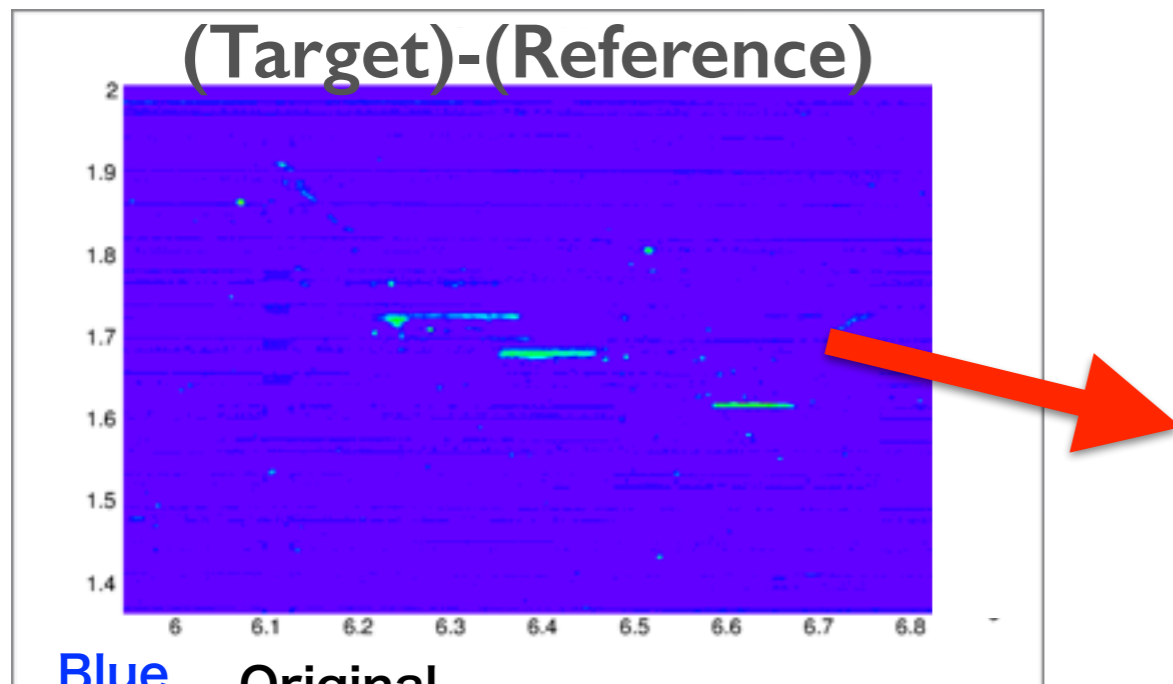


Error detection algorithm

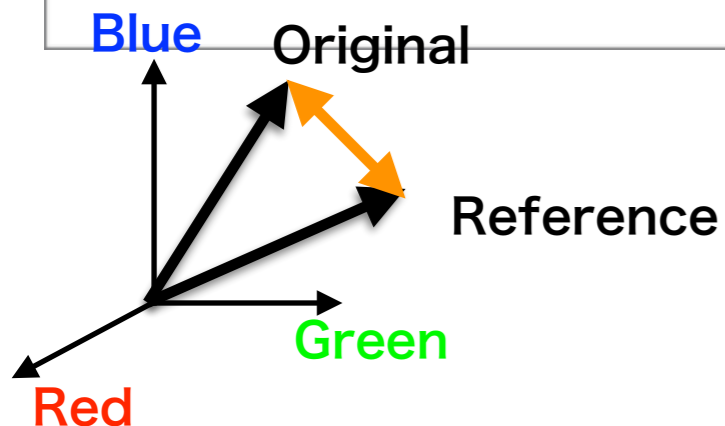
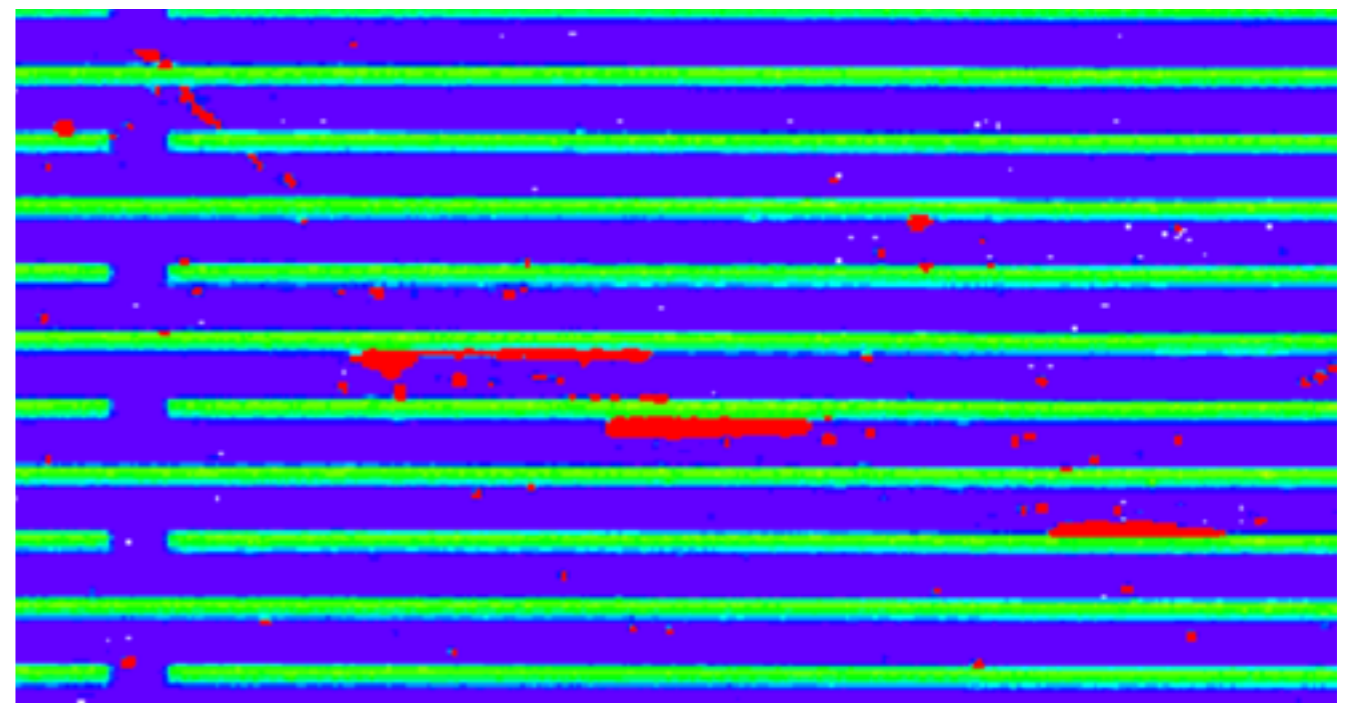
① Generate Reference image based on images around it.



② Take difference between Reference image and Target image.

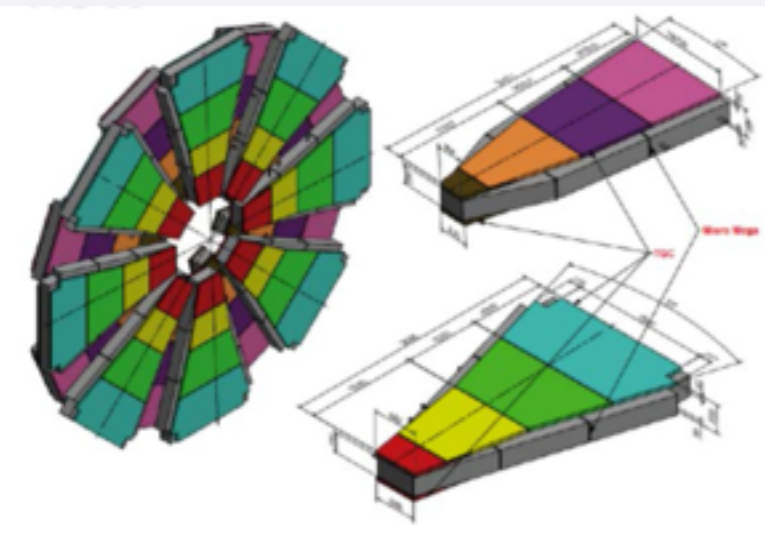
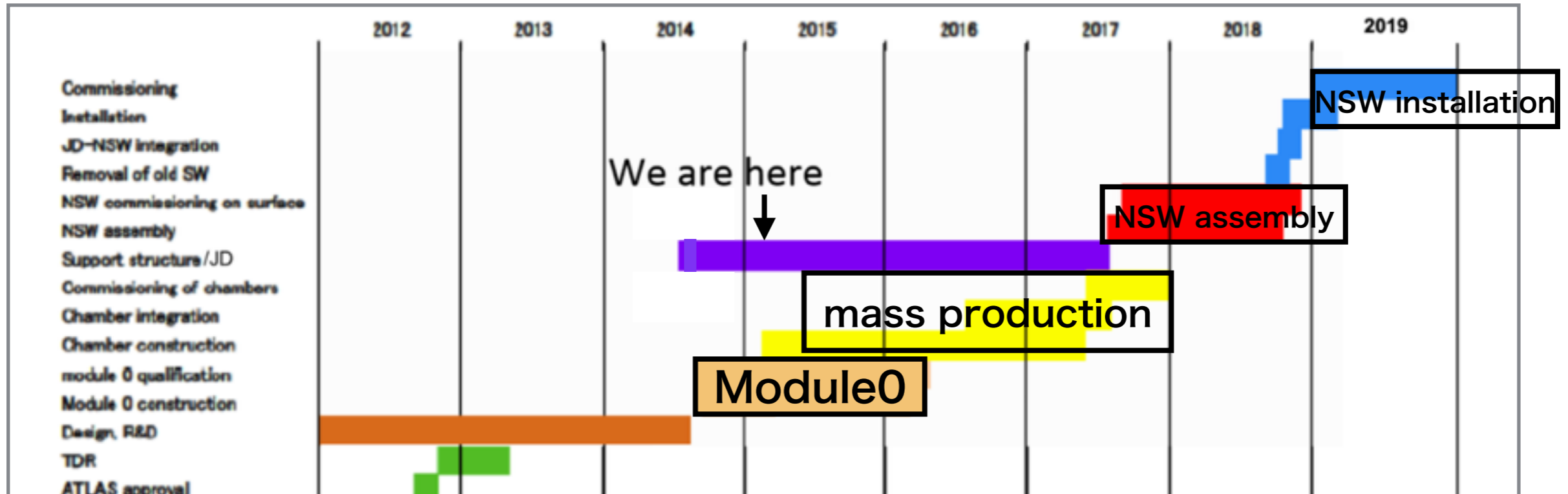


③ Set threshold for error detection.



Prototype-model MicroMegas detector.

→MicroMegas group make prototype-model MicroMegas detector called **Module-0** before mass production.



→Small Sector×1

→Large Sector×1



Module-0

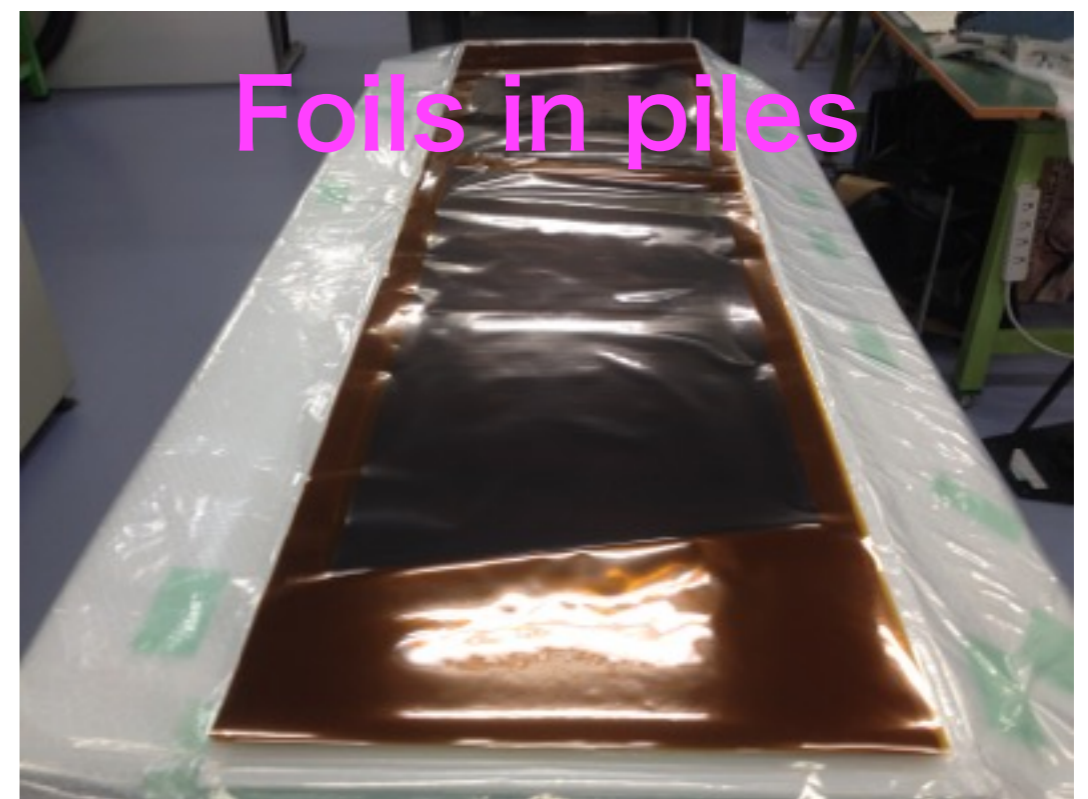
○ **Module-0 construction has already started.**

→ **Japan group provides Resistive foil.**

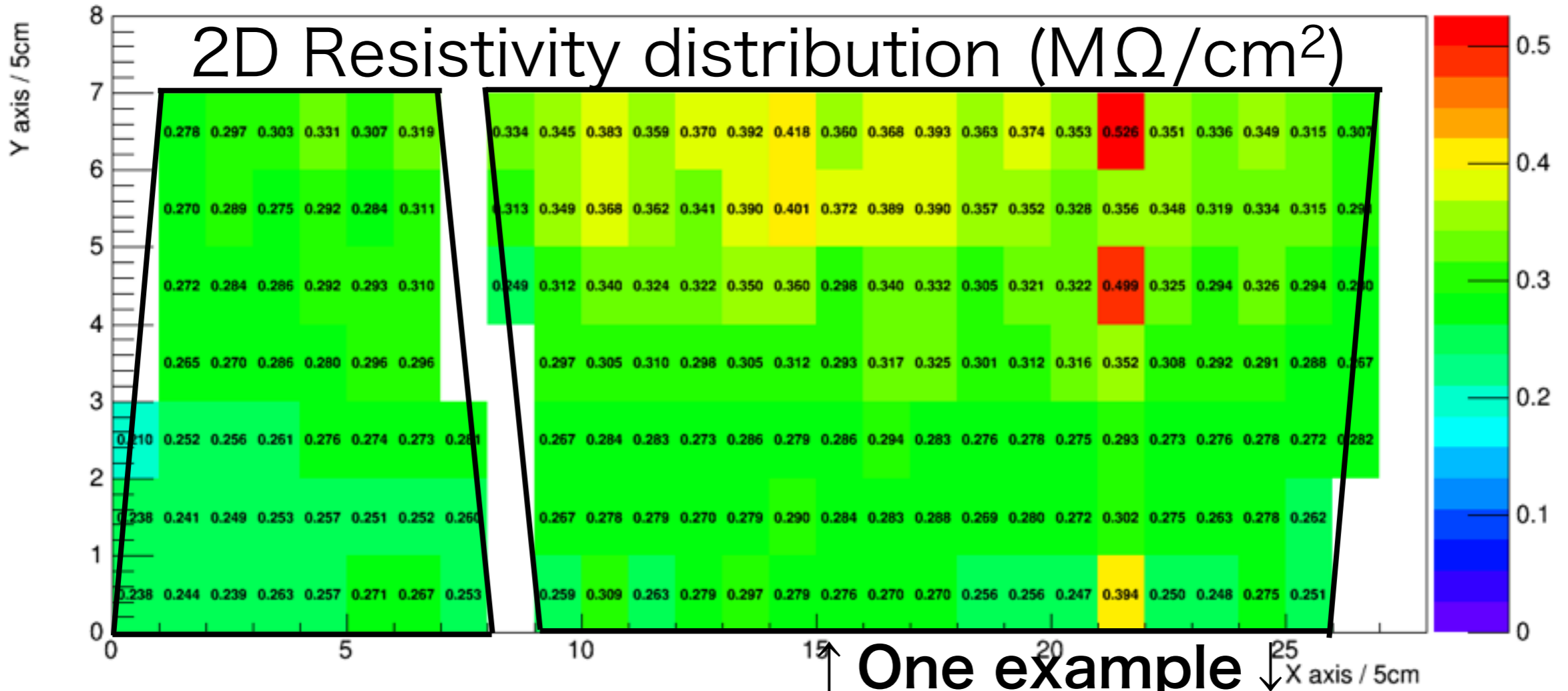
Tests of our method in Module-0 production

First 36 foils for Module-0 arrived at KEK (3 Feb)

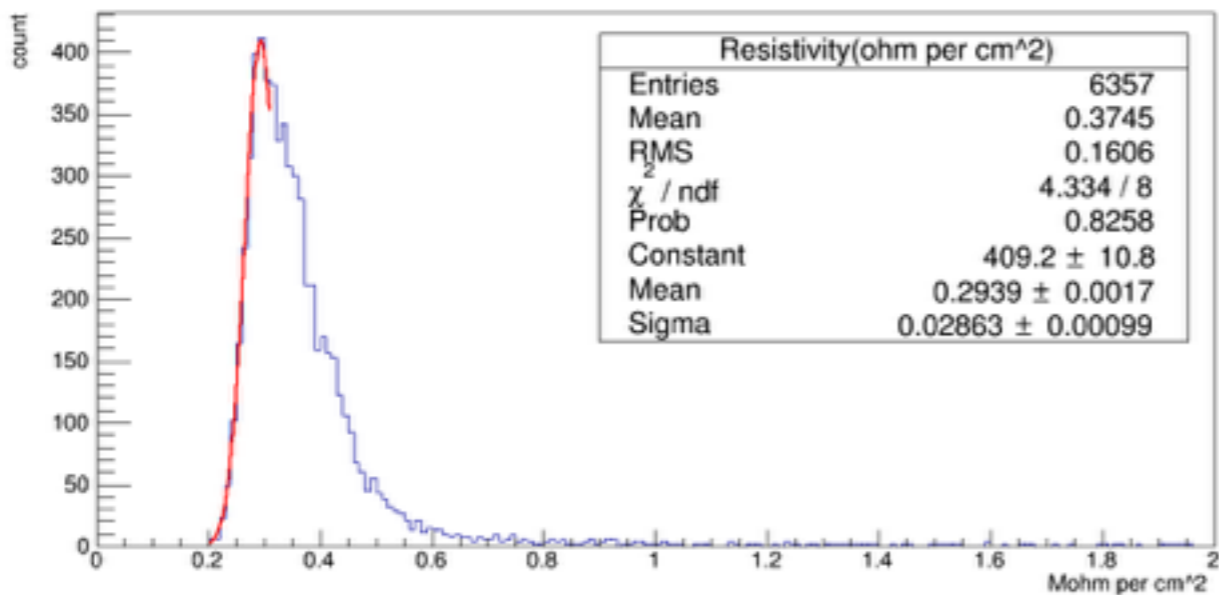
→ We measured foil's resistivity using our method.



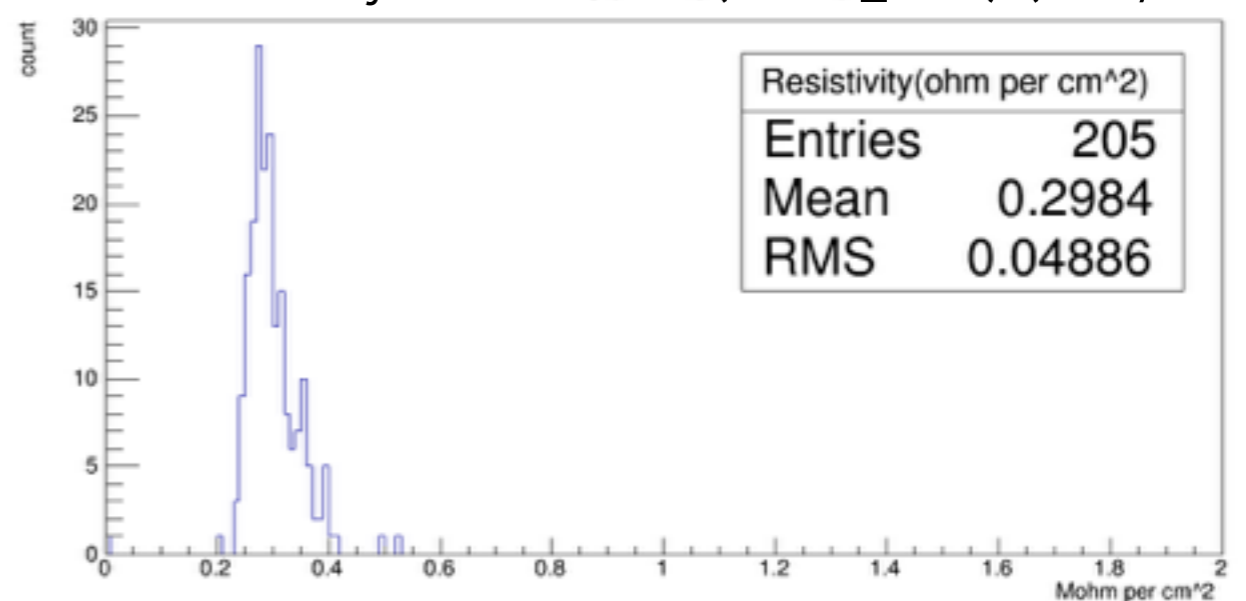
Part of measurement results



1D Resistivity distribution (all data) ($M\Omega/cm^2$)



1D Resistivity distribution (SE15_001) ($M\Omega/cm^2$)



$$R_{\text{mean}} = 7.012 \pm 1.341 \text{ (M}\Omega\text{/1cm strip)}$$

Summary

- Japan MicroMegas group provide Resistive foil.
- We are developing the method to check the quality of Resistive foils.
- Tests of the method using Module-0 foils are going on now.

Future Plan

- We establish the quality check methods using the results of Module-0 test as reference.

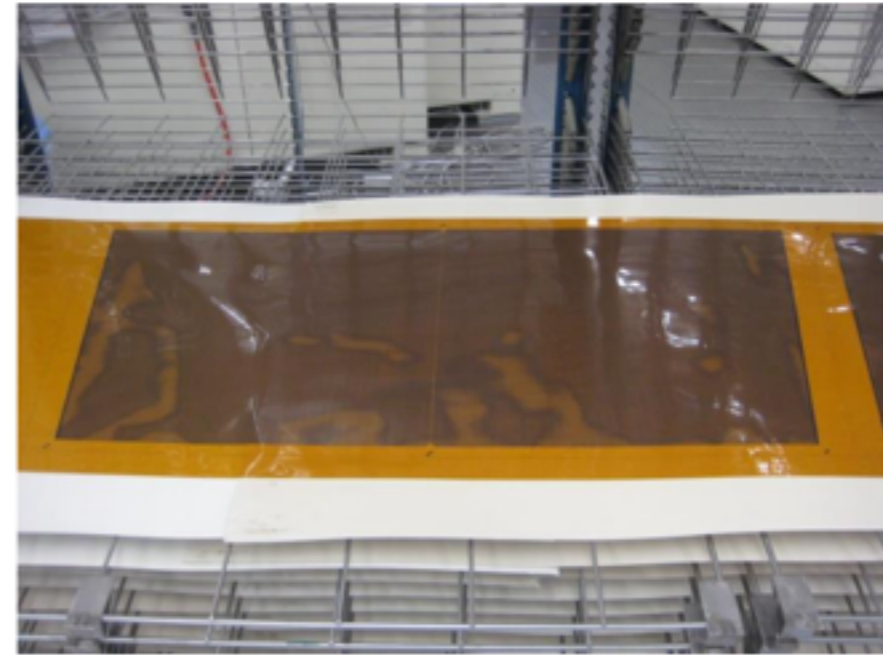
Back up

Printing procedure (Matsuda Screen)

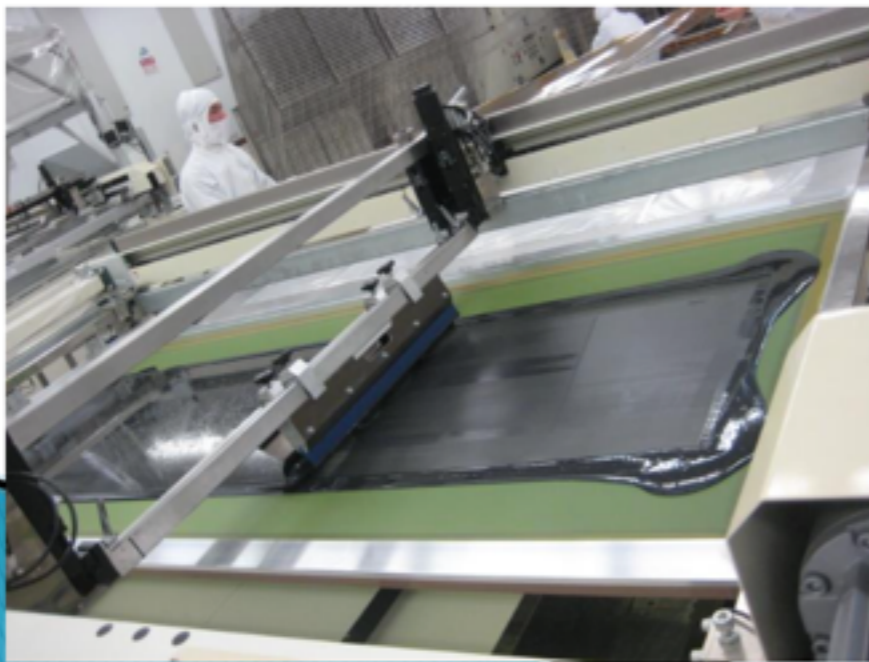
Resistive paste is put on



Printing is done



Squeegee is controlled automatically



Drying with 170 degree, 2H.

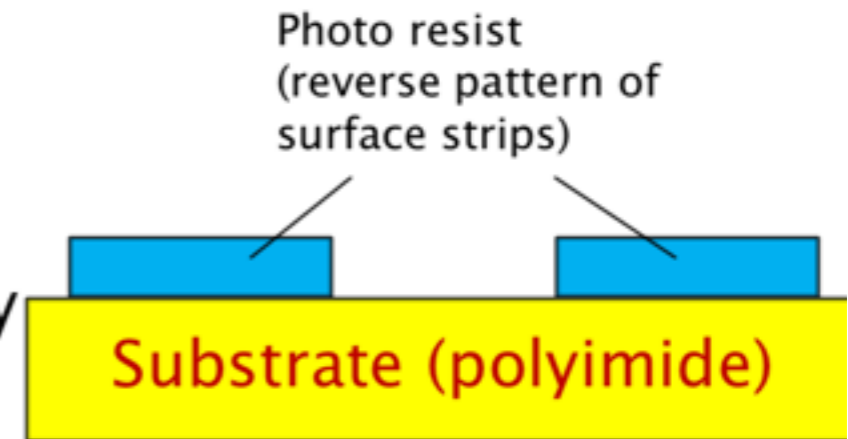


A. Ochi, ATLAS MM weekly 2015/01/27

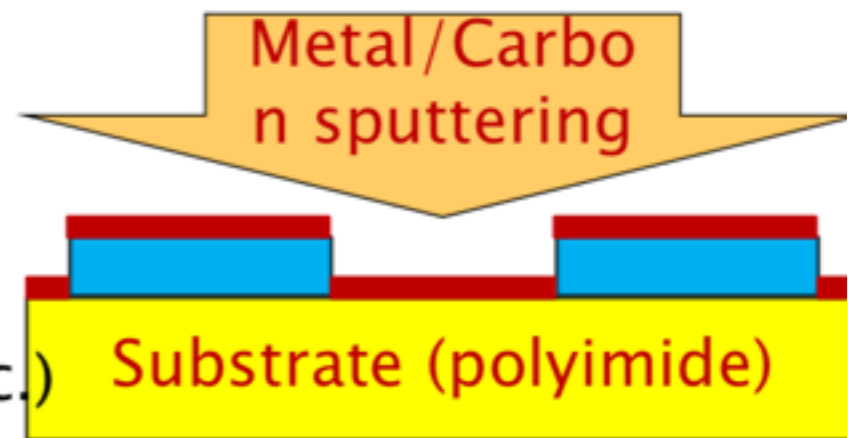
Liftoff process using sputtering

- ▶ Very fine structure (a few tens micro meter) can be formed using photo resist. (same as PCB)
- ▶ Surface resistivity can be controlled by sputtering material and their thickness

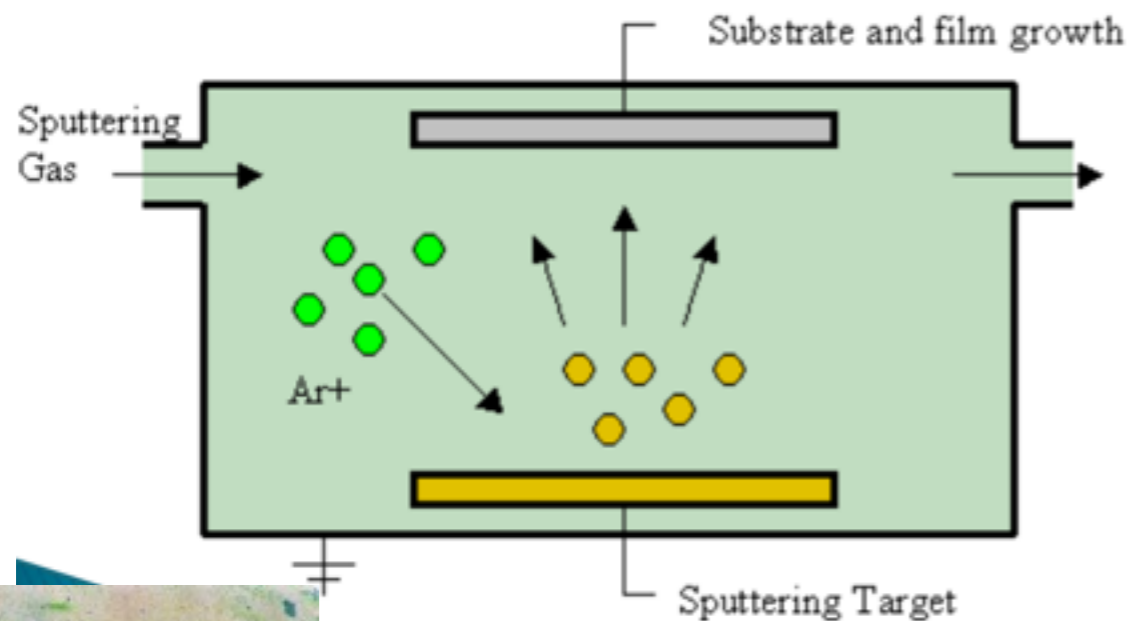
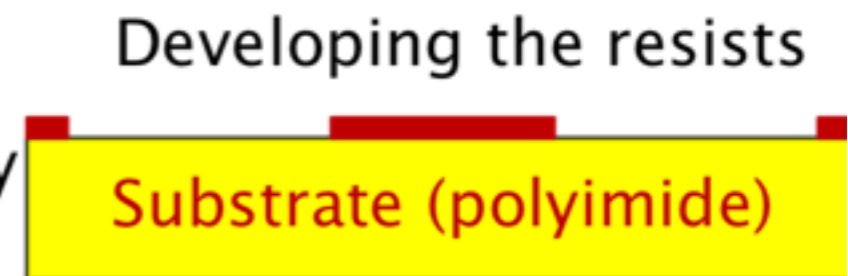
@PCB company (Laytech inc.)



@Sputtering company (Be-Sputter inc.)

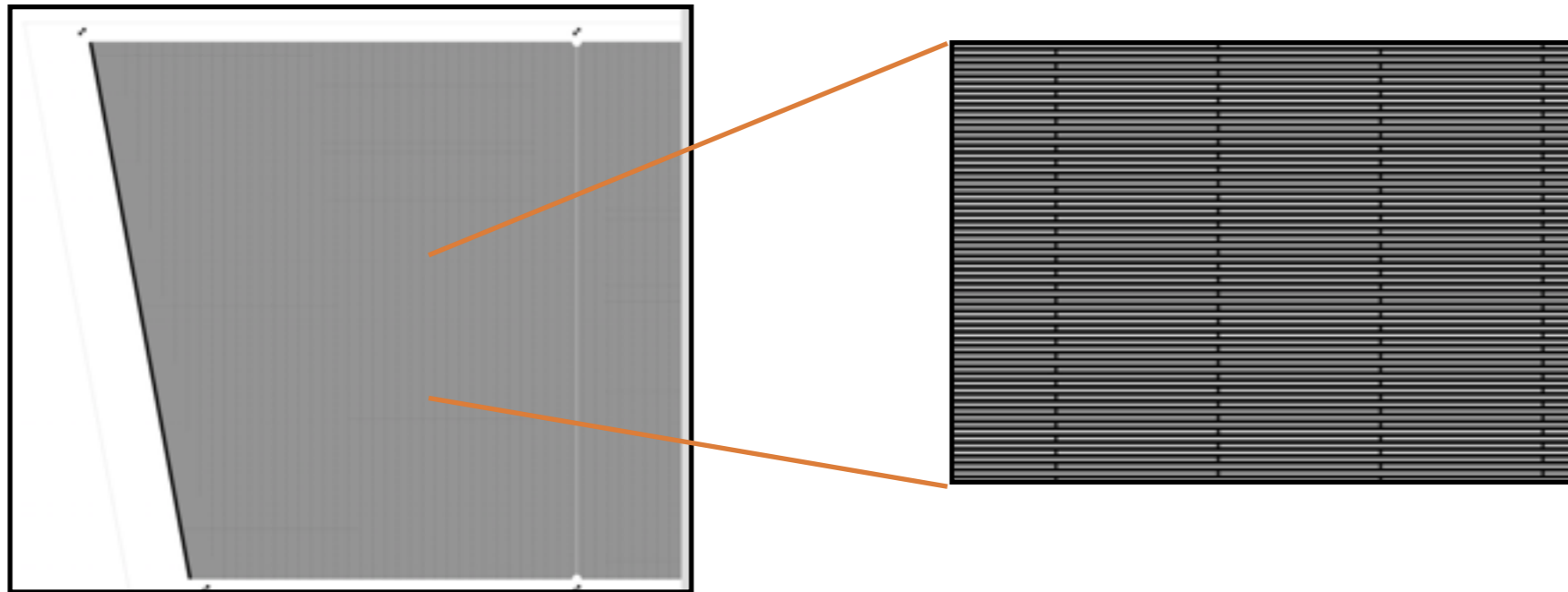


@PCB company (Laytech inc.)

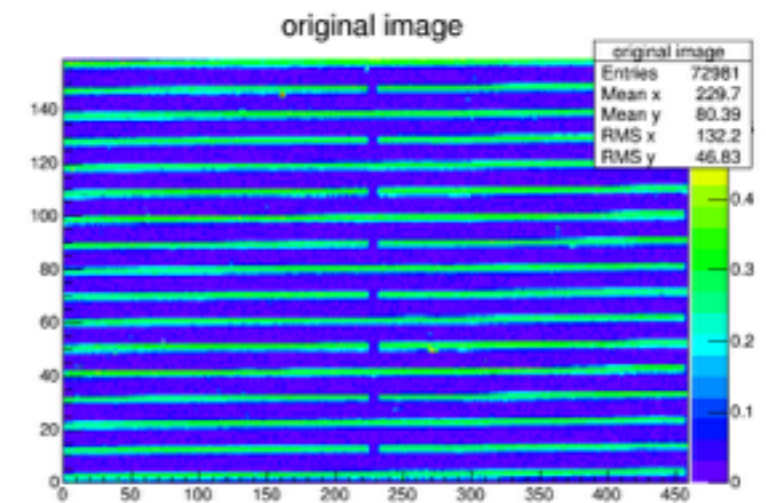
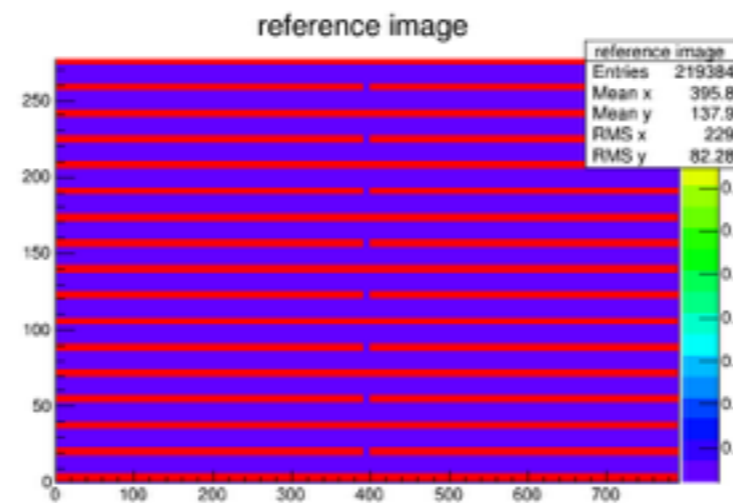
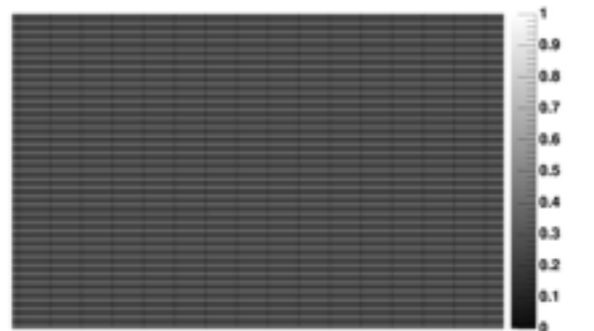


Other methods for optical analysis

○ Compare with reference.

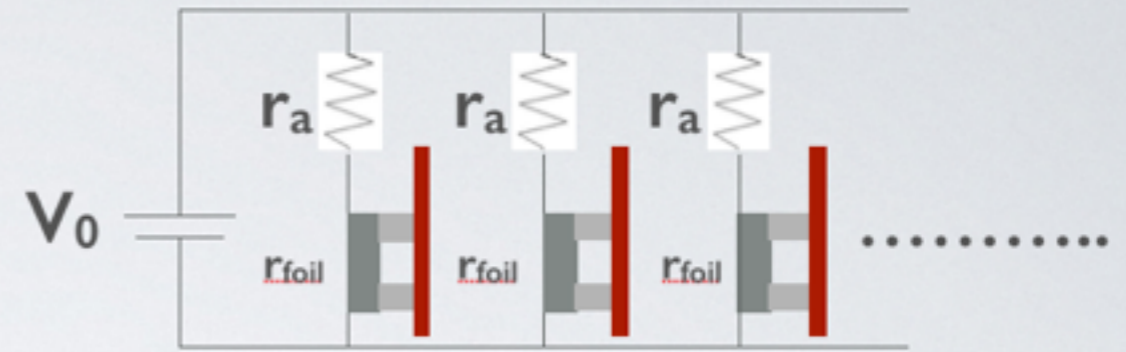
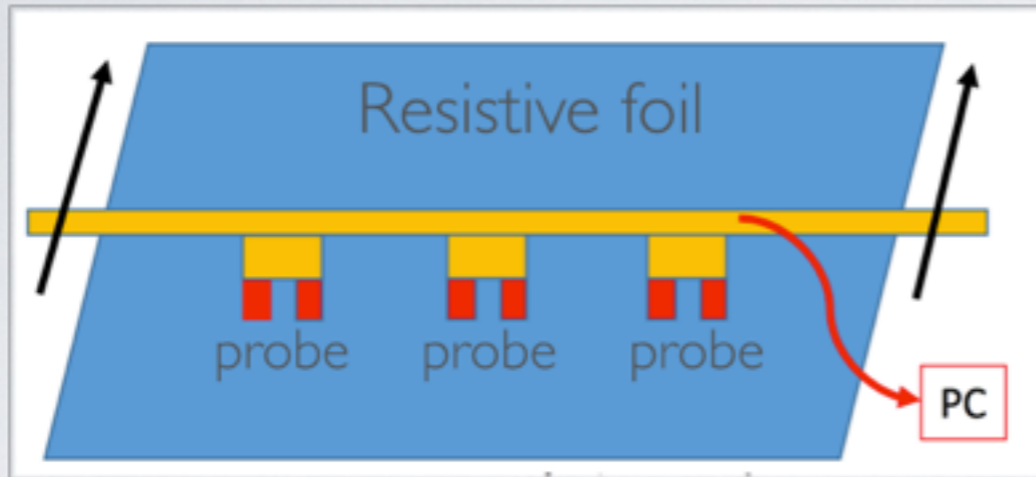


↑BMP ↓ TH2DHistogram



Resistivity

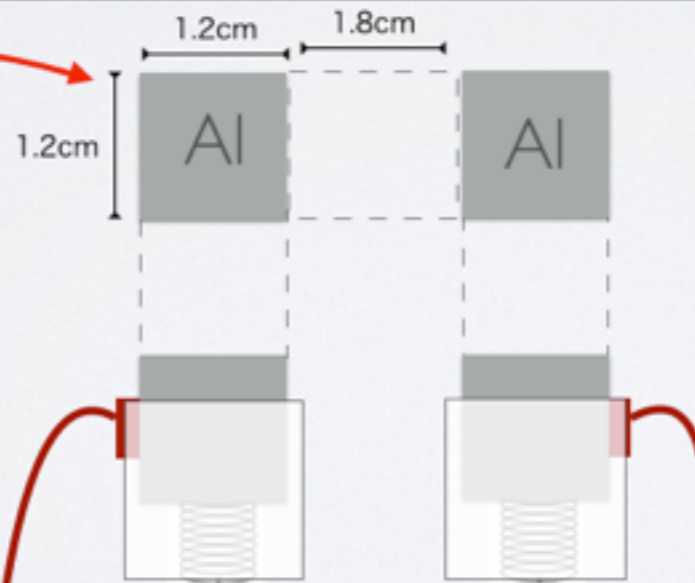
- How to measure Resistivity → using voltage dividing.



$$r_{\text{foil}} = \frac{r_a V_{\text{foil}}}{V_0 - V_{\text{foil}}}$$



Probe(No 1~8)



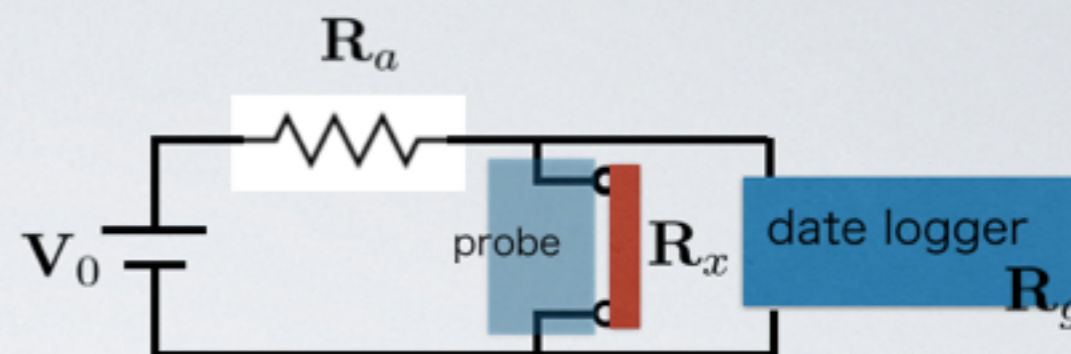
• Springs for appropriate pressure



Measurement method using voltage dividing

Combined resistance of data logger and foil is

$$r = \frac{R_x R_g}{R_x + R_g}$$

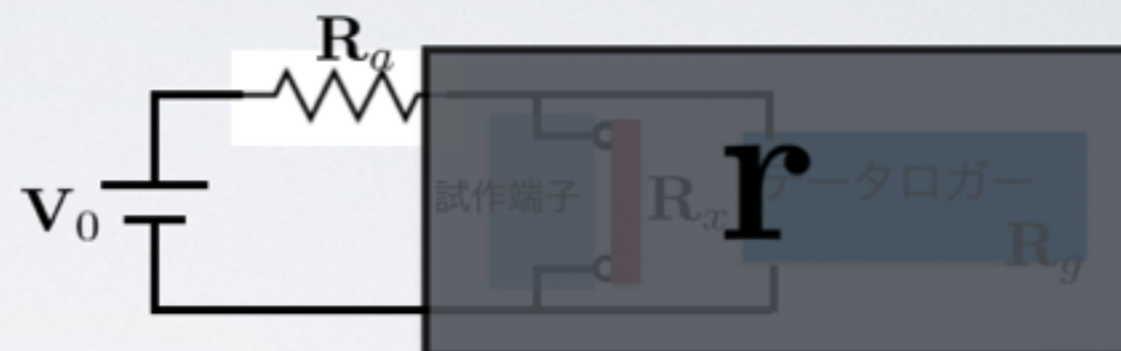


Voltage applied to the combined resistance is

$$V_f = \frac{r}{r + R_a} V_0$$

$$\rightarrow r = \frac{V_f}{V_0 - V_f} R_a$$

$$\rightarrow \frac{R_x R_g}{R_x + R_g} = \frac{V_f}{V_0 - V_f} R_a$$



Resistivity of data logger

$$R_g = 1.06 [\text{M}\Omega]$$

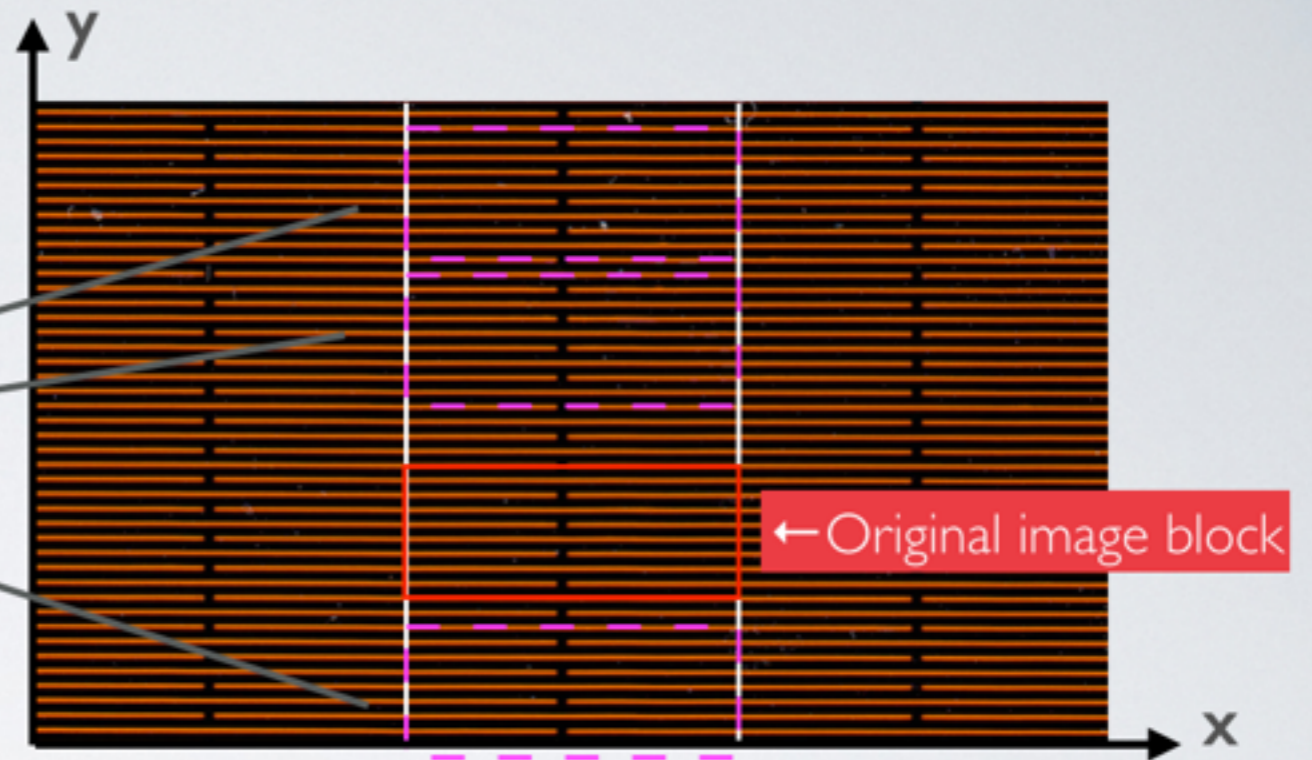
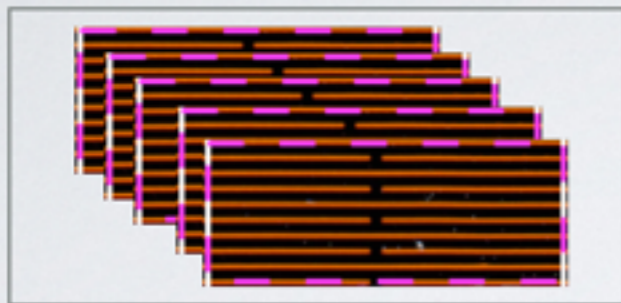
$$\ast R = 0.56 \text{M}\Omega$$

$$R_x = \frac{R_a R_g V_f}{R_g (V_0 - V_f) - V_f R_a}$$

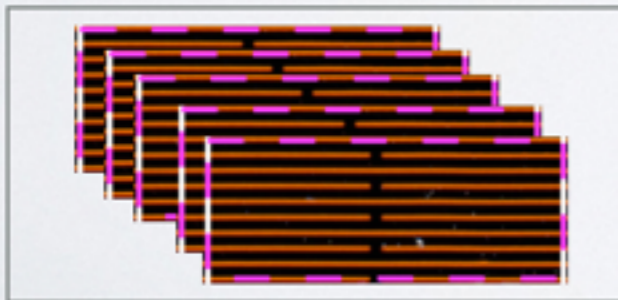
$$R_g = \frac{R_a R_x V_f}{R_x (V_0 - V_f) - V_f R_a}$$

The method to generate expected image

- ① Scan along y direction and collect image blocks which seems to have same patterns as the original image block



- ② Take the average of these image blocks (per pixel)



- ③ Expected image!



very simple!

Error detection(ESL Screen Print, using same algorithm)

180um

200um

220um

