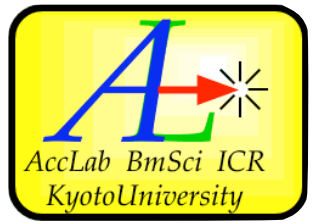




ACCELERATOR LABORATORY
ADVANCED RESEARCH CENTER FOR BEAM SCIENCE
INSTITUTE FOR CHEMICAL RESEARCH
KYOTO UNIVERSITY

# Plans for inspection, diagnostics — Eddy Current Inspection, and T-Mapping —

Y. Iwashita and H. Hayano

# Eddy Current Surface Inspection

Prepared by Mr. Hiroshima (Theta-Technology)

# Eddy Current Test for Nb Plate

2008.04.18

K.Nakano Hokuto Electronics

T.Hiroshima Theta-Technology

1. Test Sample:

(a)Nb plate (t 2.8 x 40 x 100 mm) with drilled holes as shown in Table 1.

(b) Nb plate with artifitial Ta contamination as shown in Photo.1

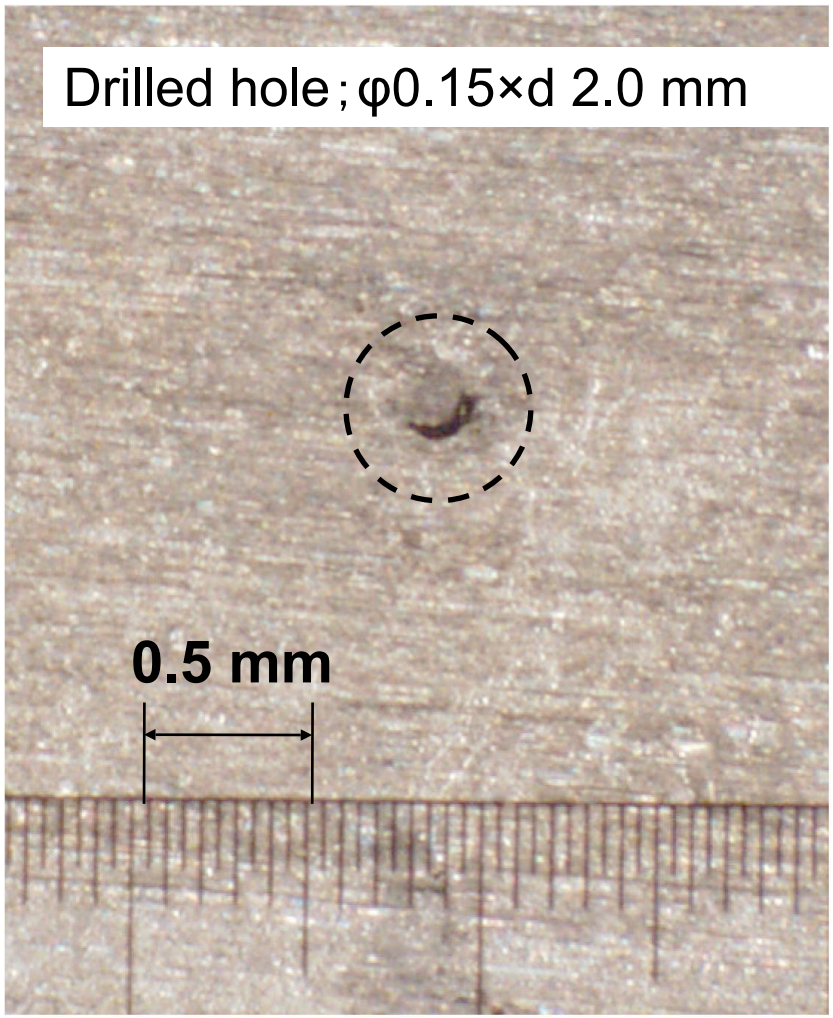
2. Probe used on ECT (Eddy Current Test)
Flux sensing type probe
Exciting coil :Cubic type 5 × 5 mm
Detection coil : Thin film planer type
φ5.0 × t 0.1 mm、100T

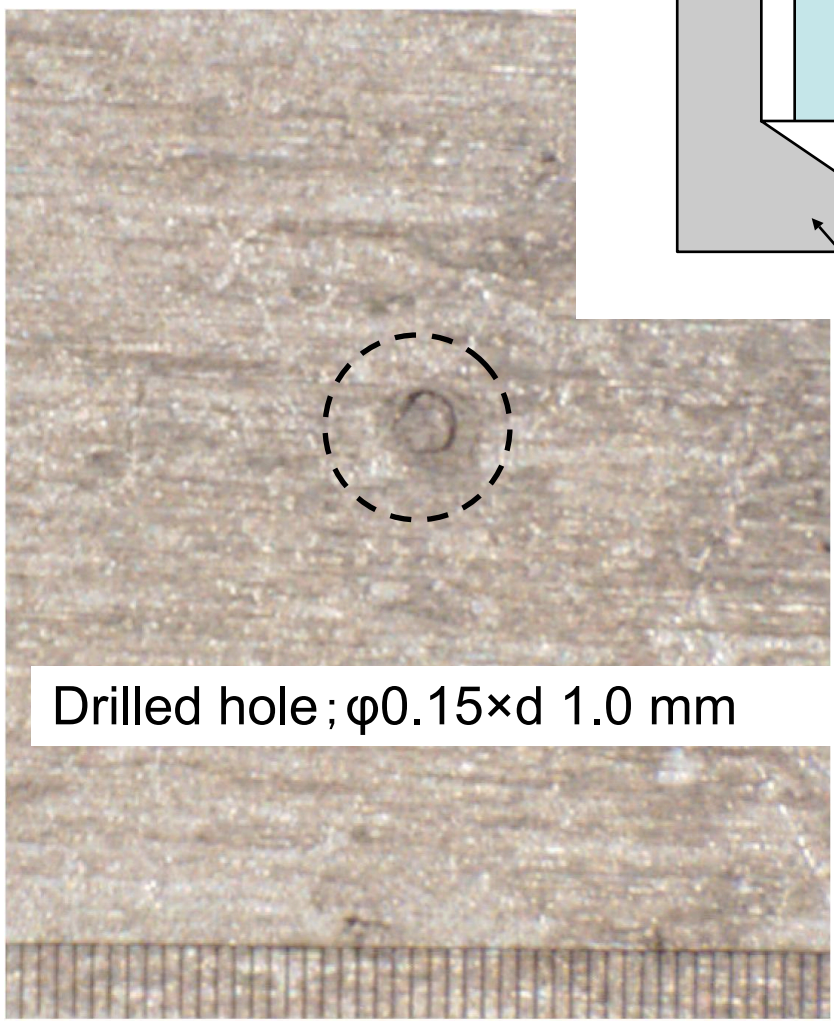
3. Testing System
Testing system is shown in Fig. 1 and is constructed by an eddy current tester that is specially designed by Hokuto Electronics, X-Y Scanner, digital volt meters and PC.
Figure 2 shows testing system .

Table 1 Dimension of holes

| Plate No. | Diameter | Depth |
|---|---|---|
| 1 | 0.08<br>0.10<br>0.15<br>0.20<br>0.25 | 0.6 |
| 2 | 0.15 | 0.1<br>0.2<br>0.6<br>1.0<br>2.0 |

# Artificial Ta Contamination



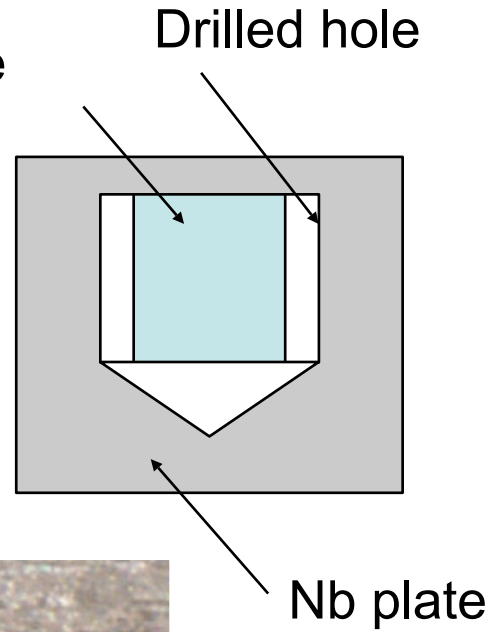




Photo. 1 Artificial Ta contamination

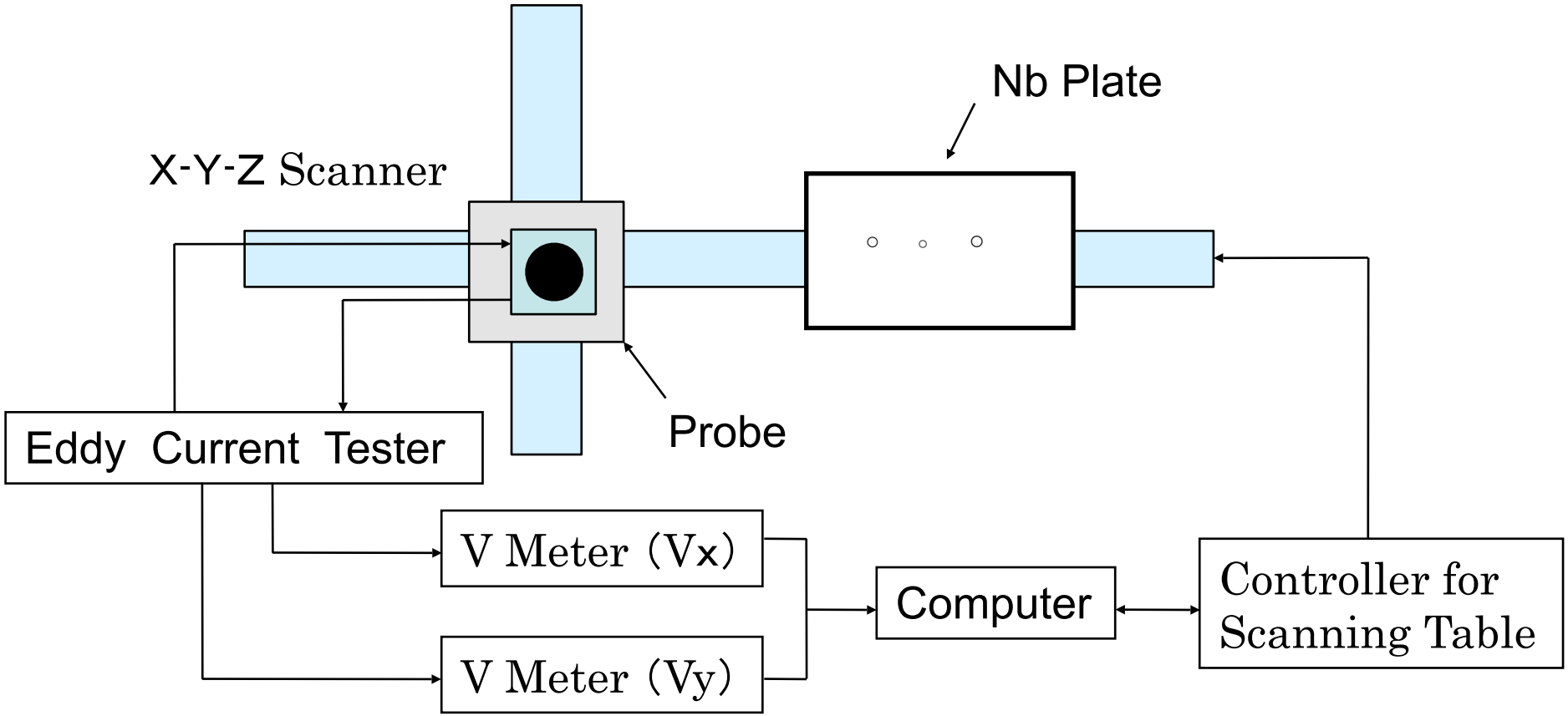
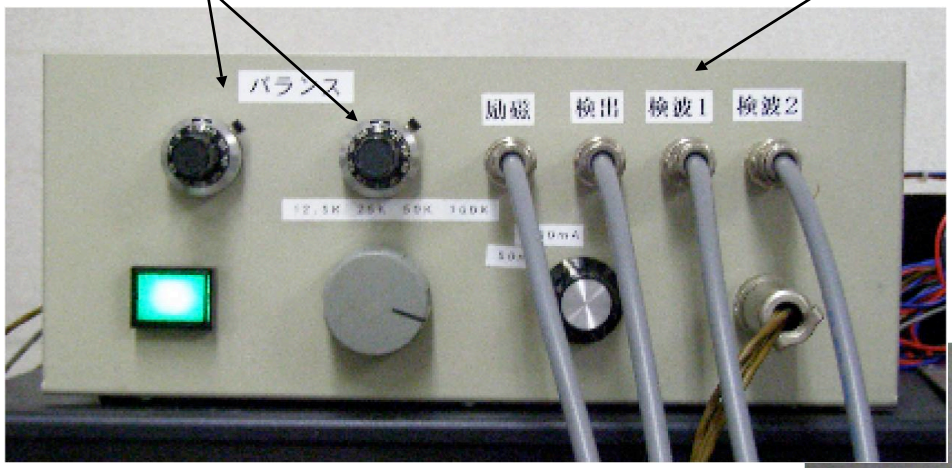



Fig. 2 Testing system for Nb Plate

Null adjuster

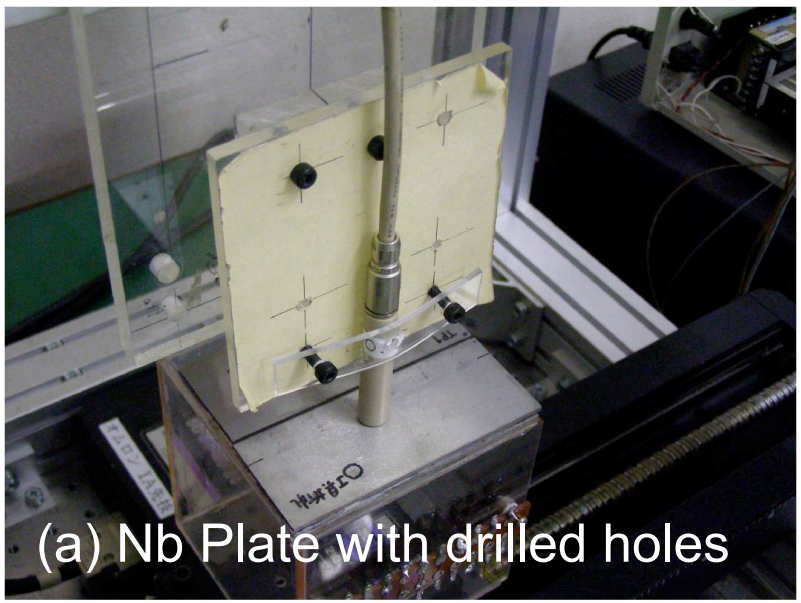
Monitoring terminals




- Exciting wave
- Detecting signal
- Demodulate signal（X,Y）

Photo. 3 Eddy Current Tester

ET Probe


(a) Nb Plate with drilled holes

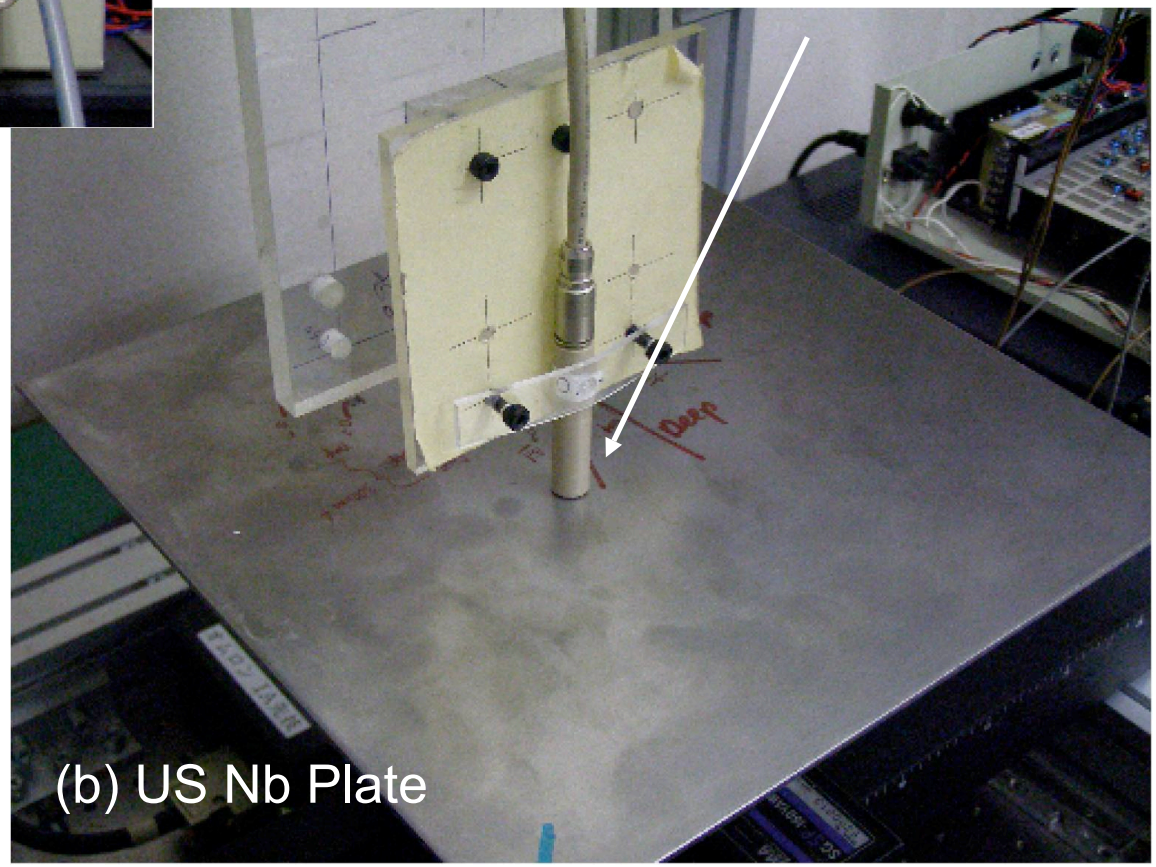
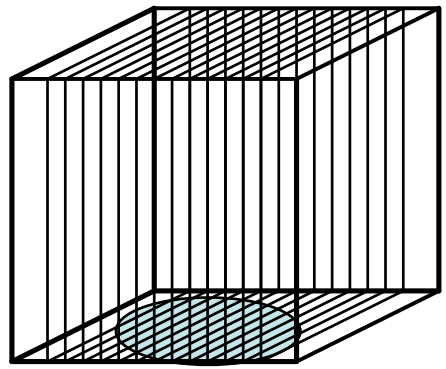

(b) US Nb Plate

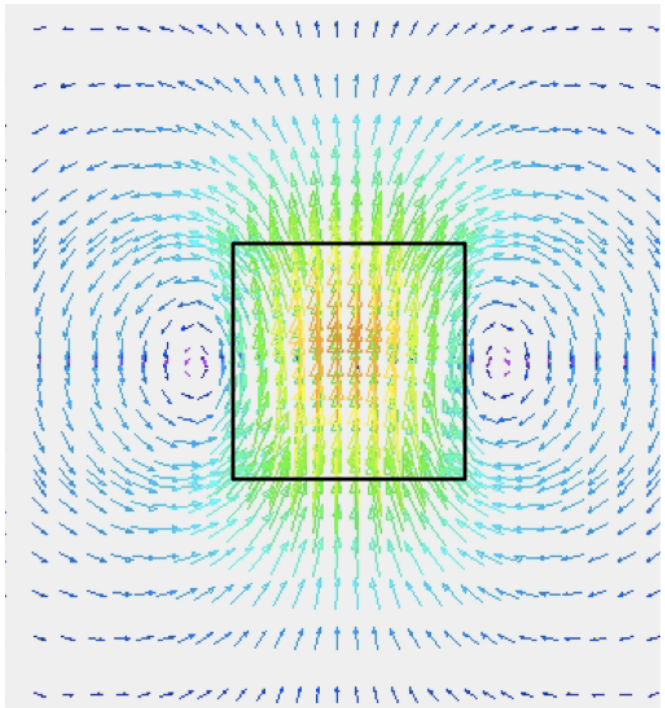
Photo. 2 Eddy Current Testing of Nb Plate

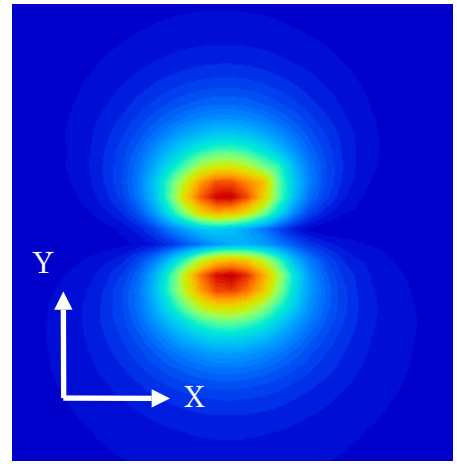
# Eddy Current Probe used for inspection of Nb plate

Cubic exciting oil

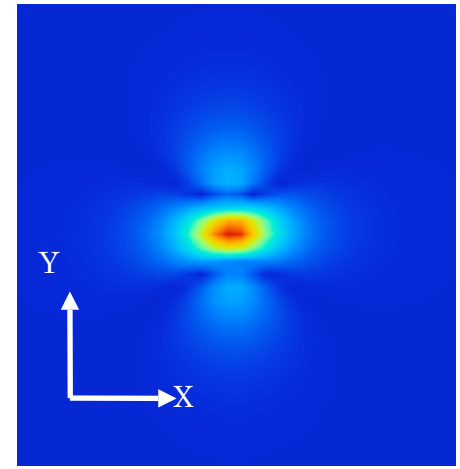


Thin film planer coil






(a) Vertical Component



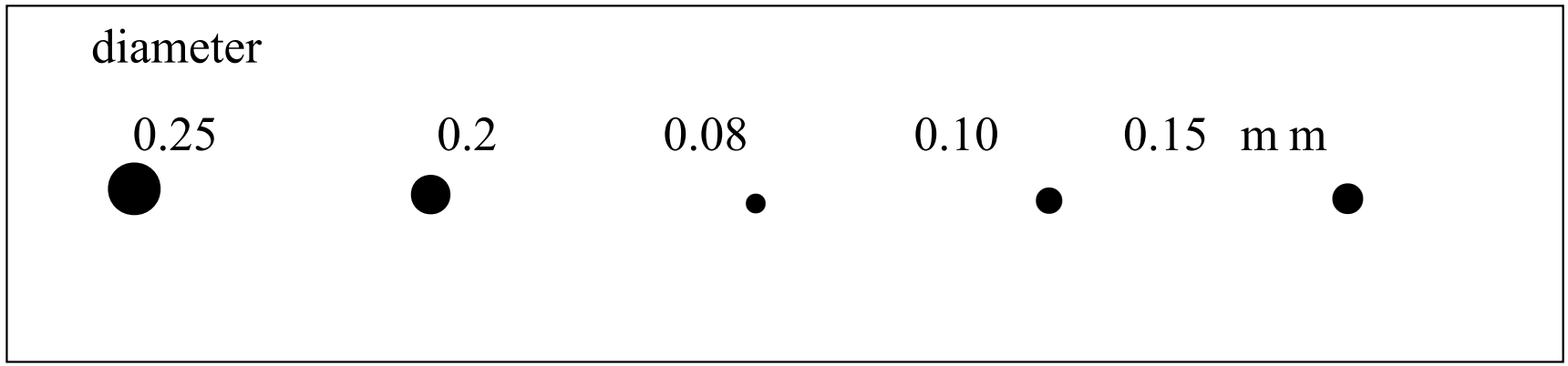

(b) Horizontal Component

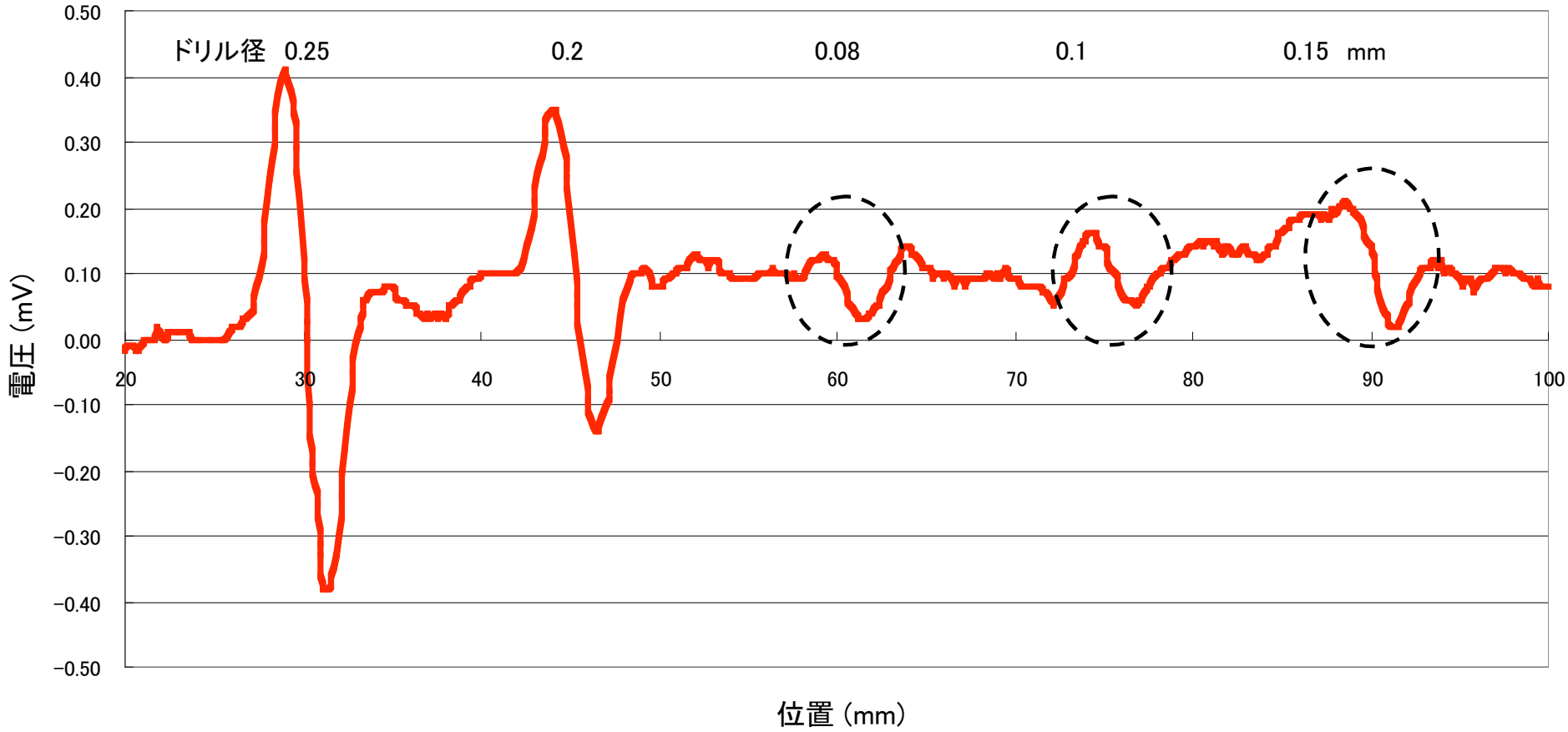
Profile of Exciting Magnetic Field (freq.:25 kHz)

Circular eddy current is observed in edge of exciting coil and eddy current is flowed straightly in central portion.

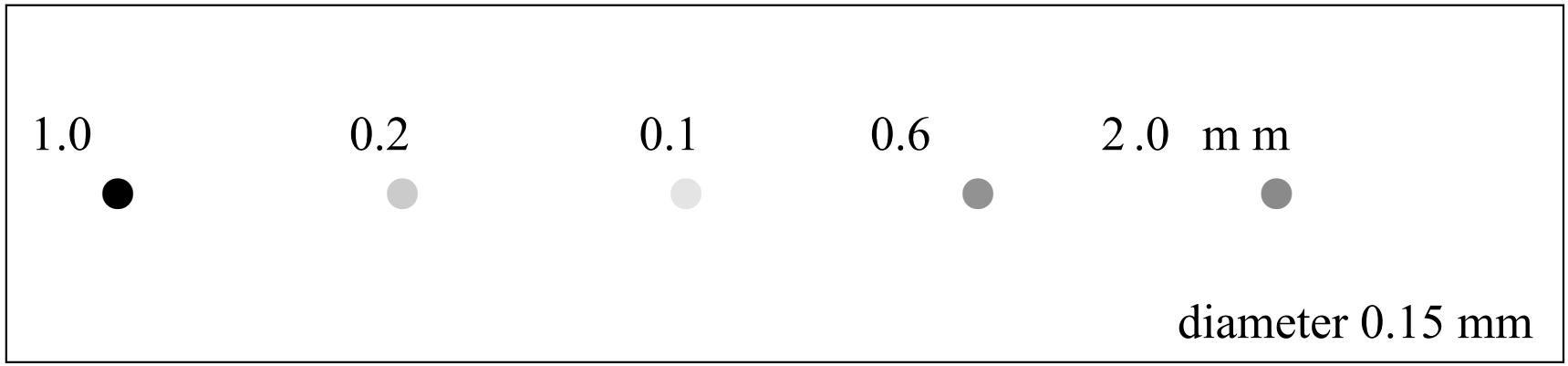
FEM simulation result

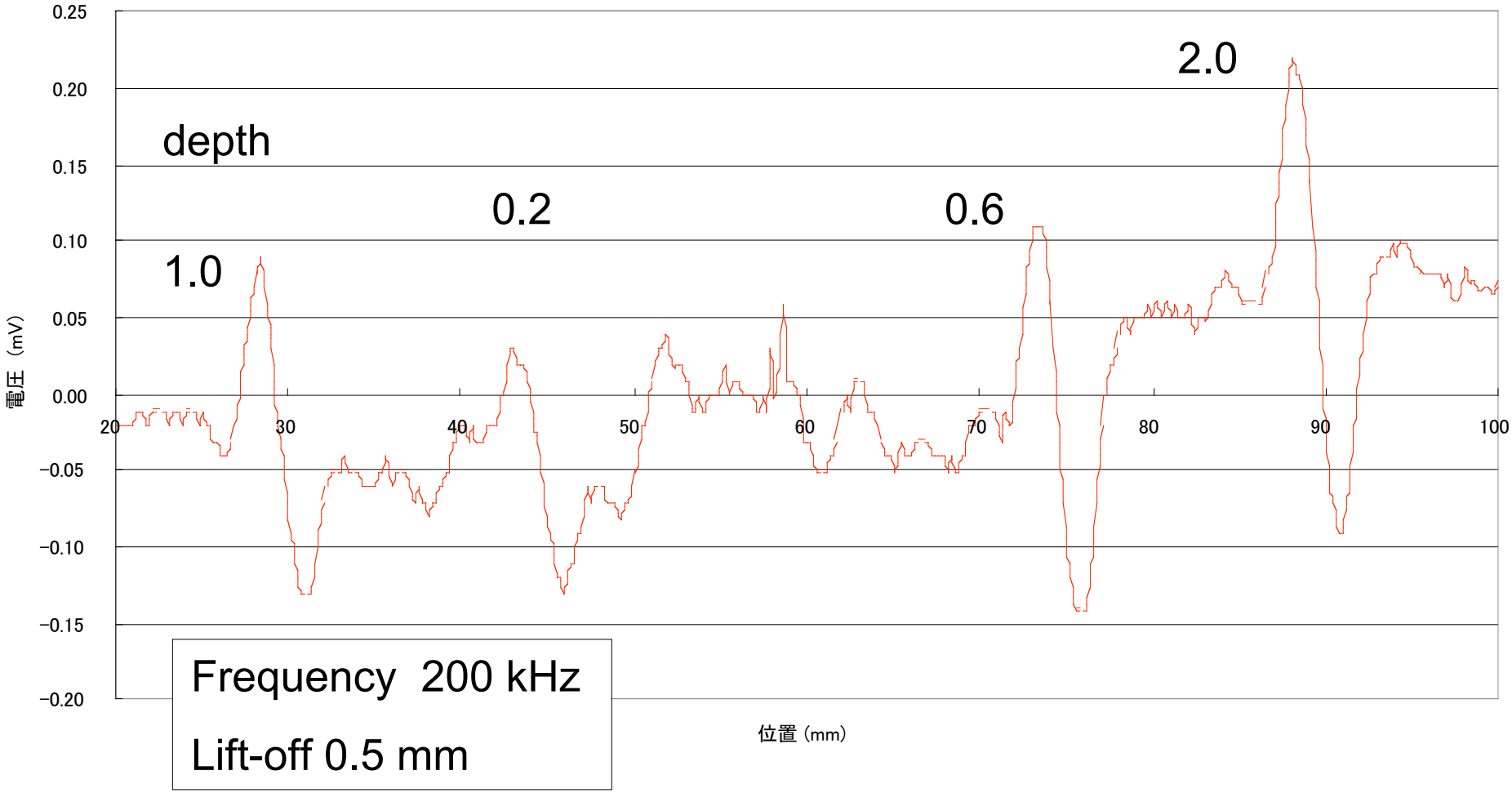
# Test Result 1 plate No.1



# Test Result 2 plate No.2



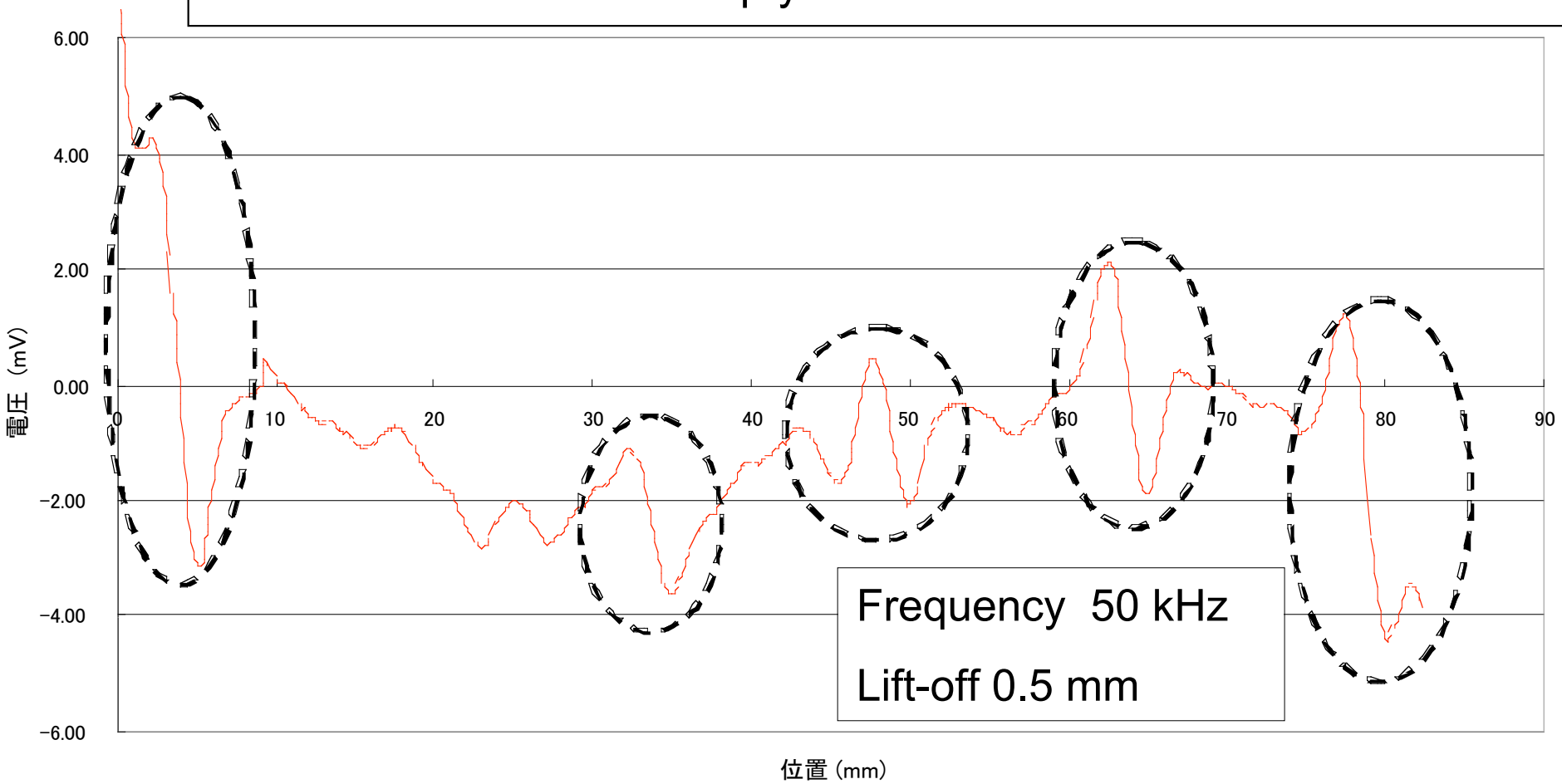



# Test Result 3 plate No.3

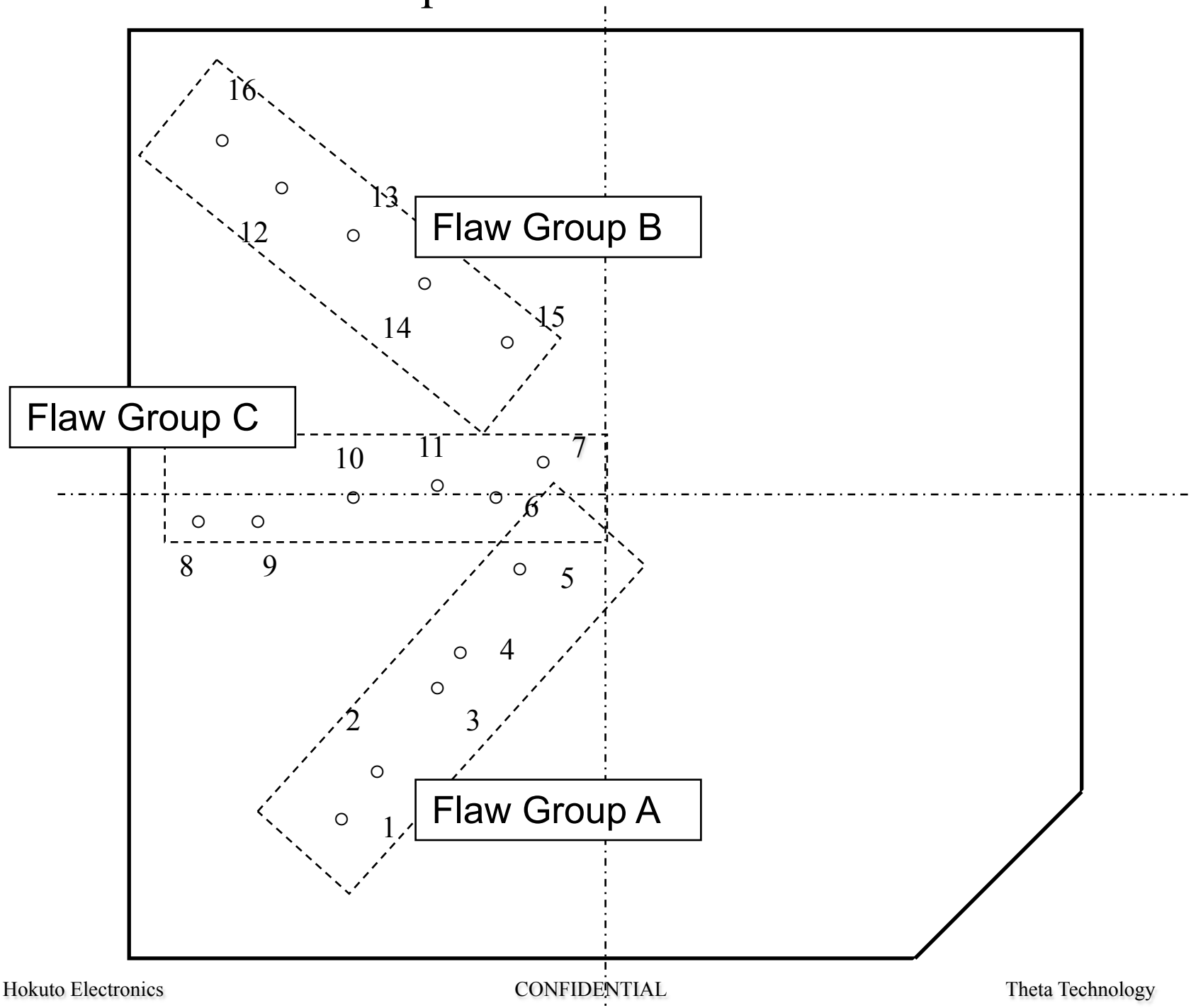
Ta contamination

$\phi$ 0.15 × 2.0 d : 0.1 d : 0.3 $\phi$ 0.15 × 0.6 $\phi$ 0.15 × 1.0

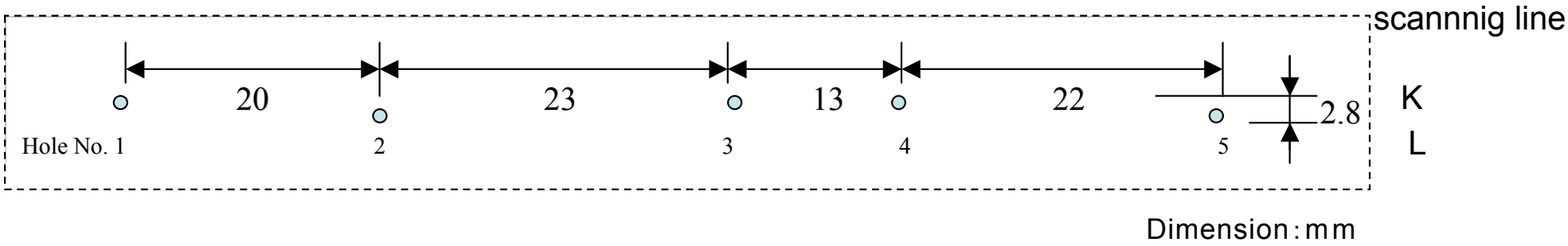
Φ0.15 mm empty holes



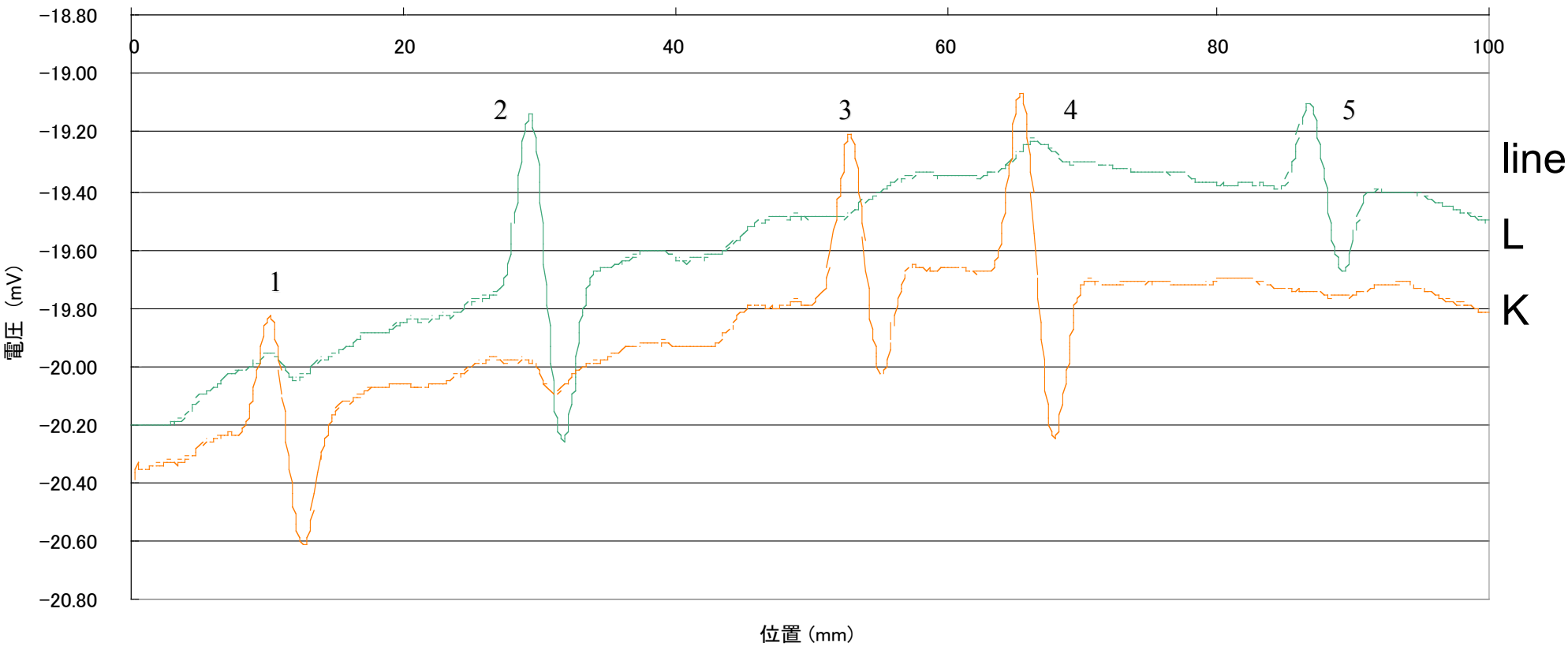
# Drilled holes of US Nb plate



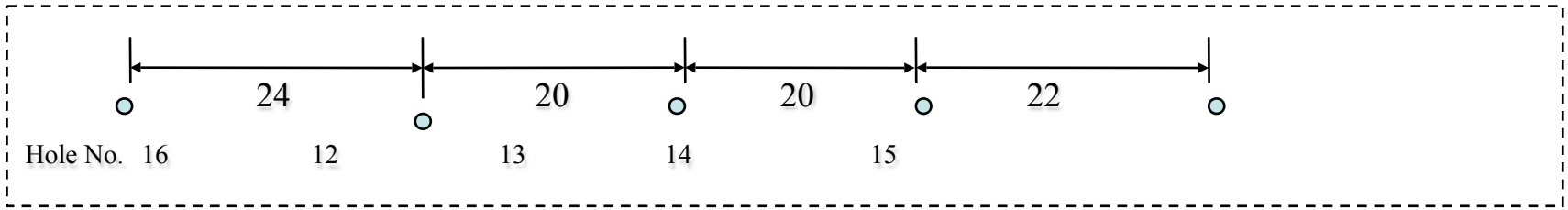
# Test result of flaw group A（ hole 1 ～ 5）

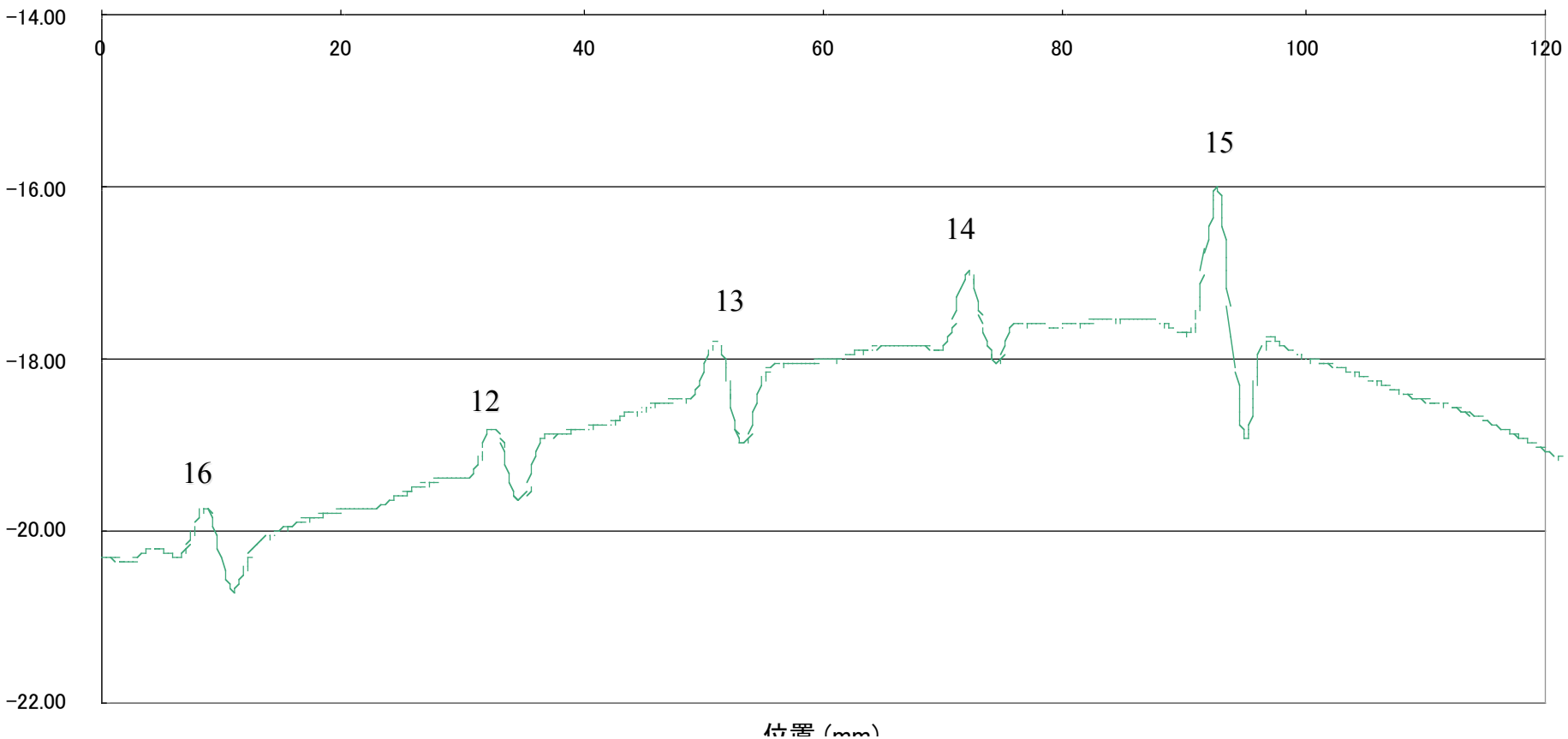



Dimension：mm

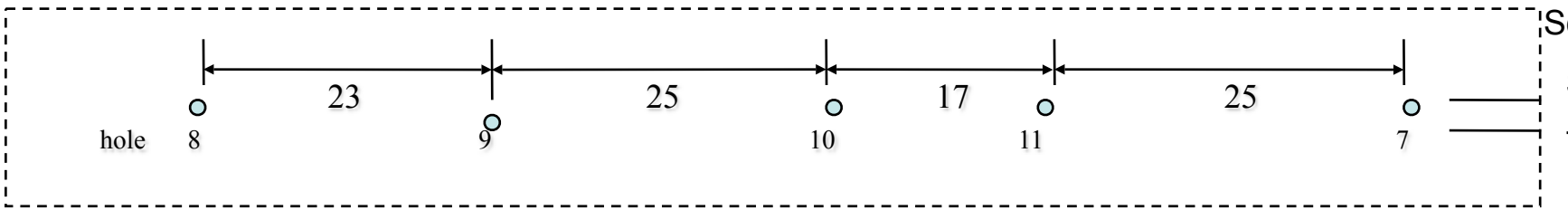


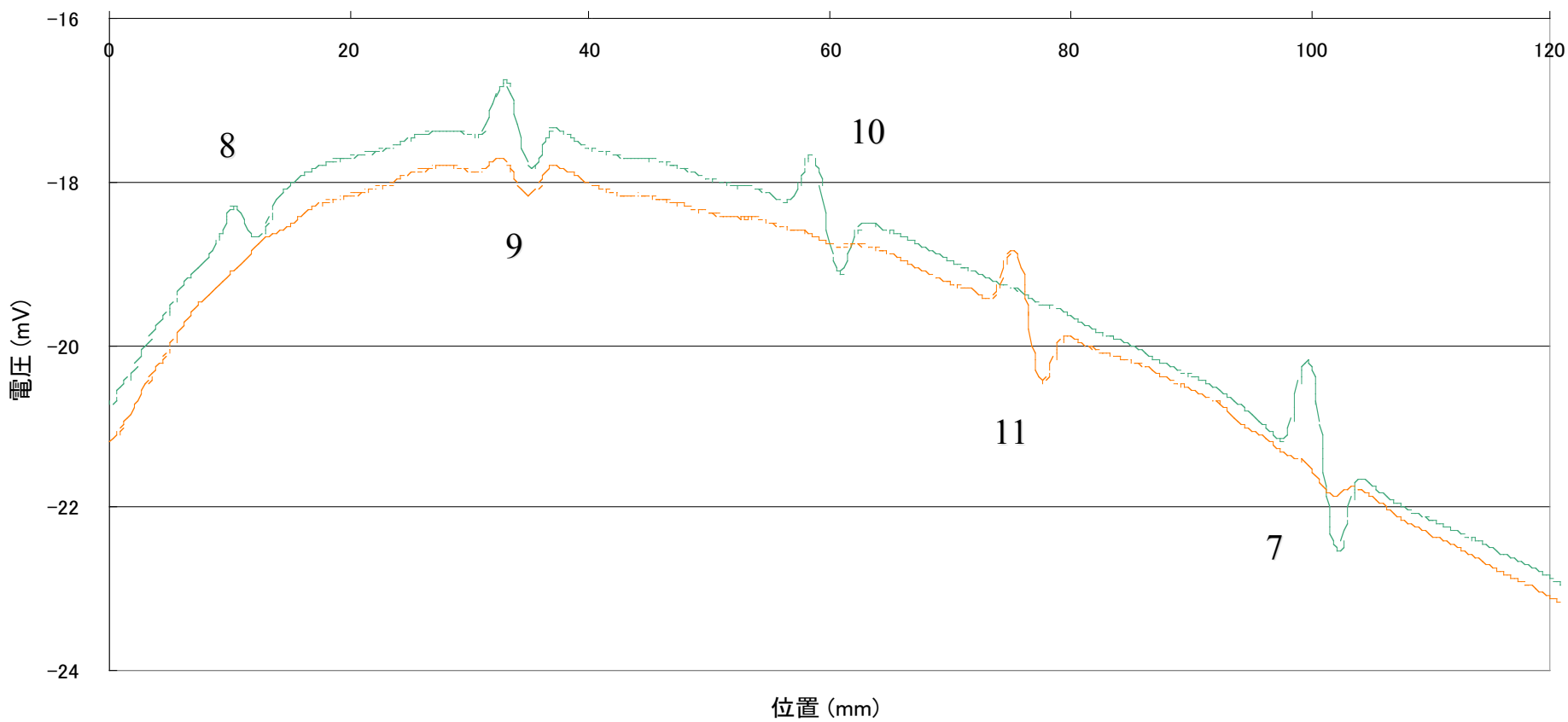
# Testing result 2　　Flaw group B（hole 12 ～ 16）



# Testing result 3 Flaw group C（hole 7、8 ～ 11）



# Conclusion

1. Drilled hole can be detected clearly by eddy current testing. Artificial Ta contamination can be also detected in spite of small conductivity difference between Nb and Ta.

2. Eddy current probe which has cubic exciting coils and thin film planer detecting coil can detect drilled hole of 0.15 mm in diameter and 0.6 mm in depth.

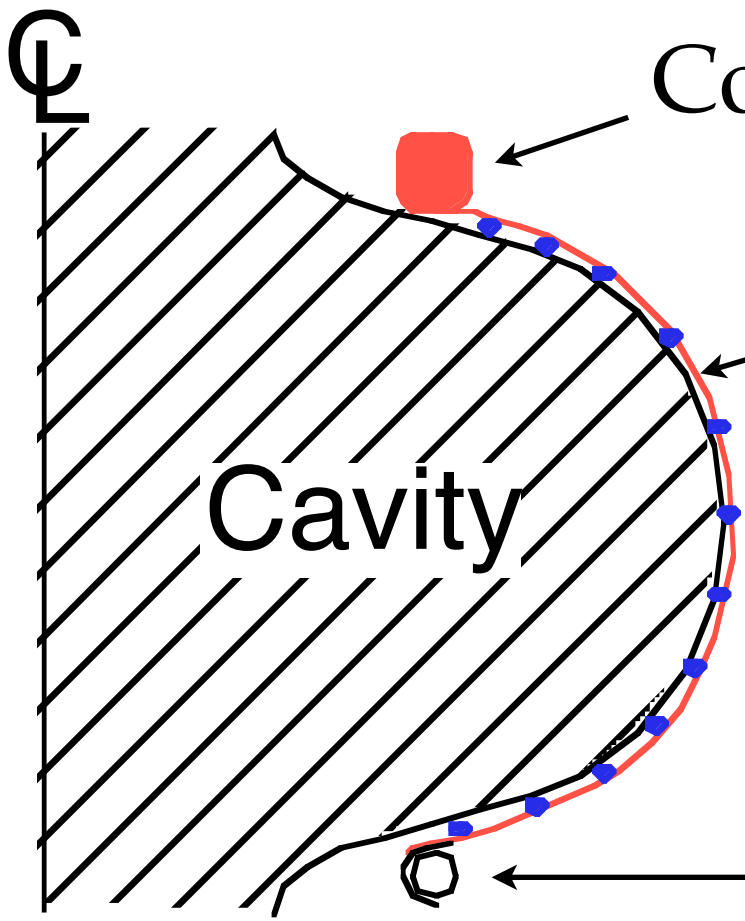
3. Higher detectability will be achieved by using more smaller detecting coil such as 1.5 mm in diameter.

4. Background signal caused by camber of plate will be decreased by differential signal conditioning.

# T-mapping

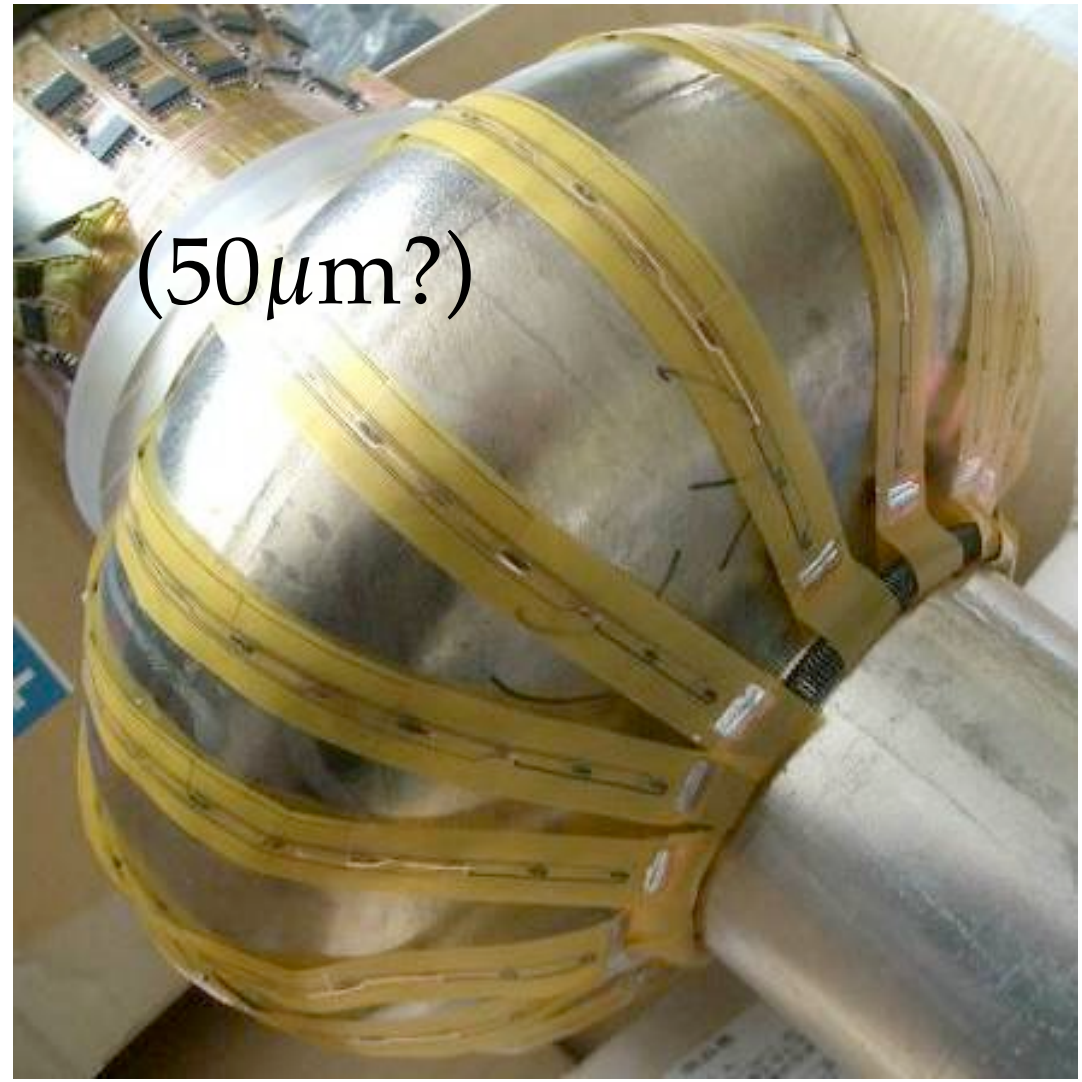
— Towards easy installation
and less cabling —

# Easy Installation —basic concept —




$$V_F = \eta \cdot \frac{kT}{q} \ln\left(\frac{I_F}{I_s} - 1\right)$$

# Easy Installation




as of 2008.4.18

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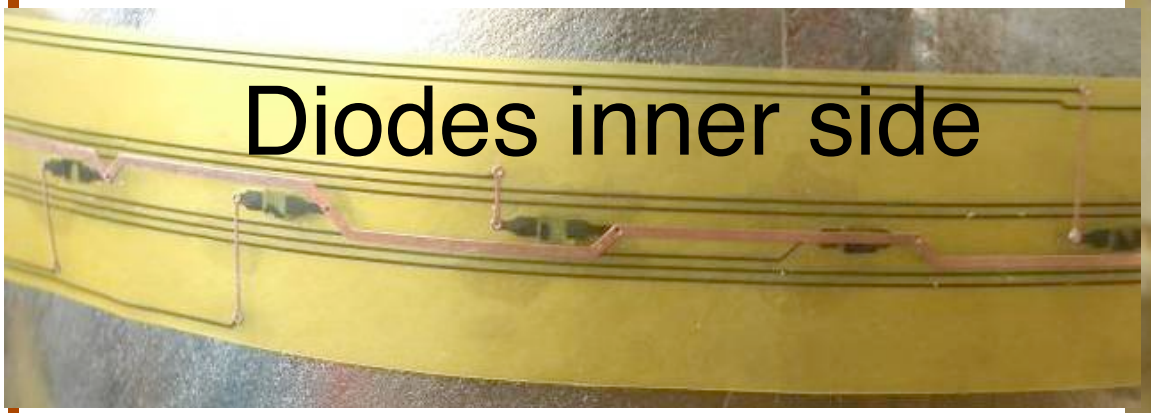
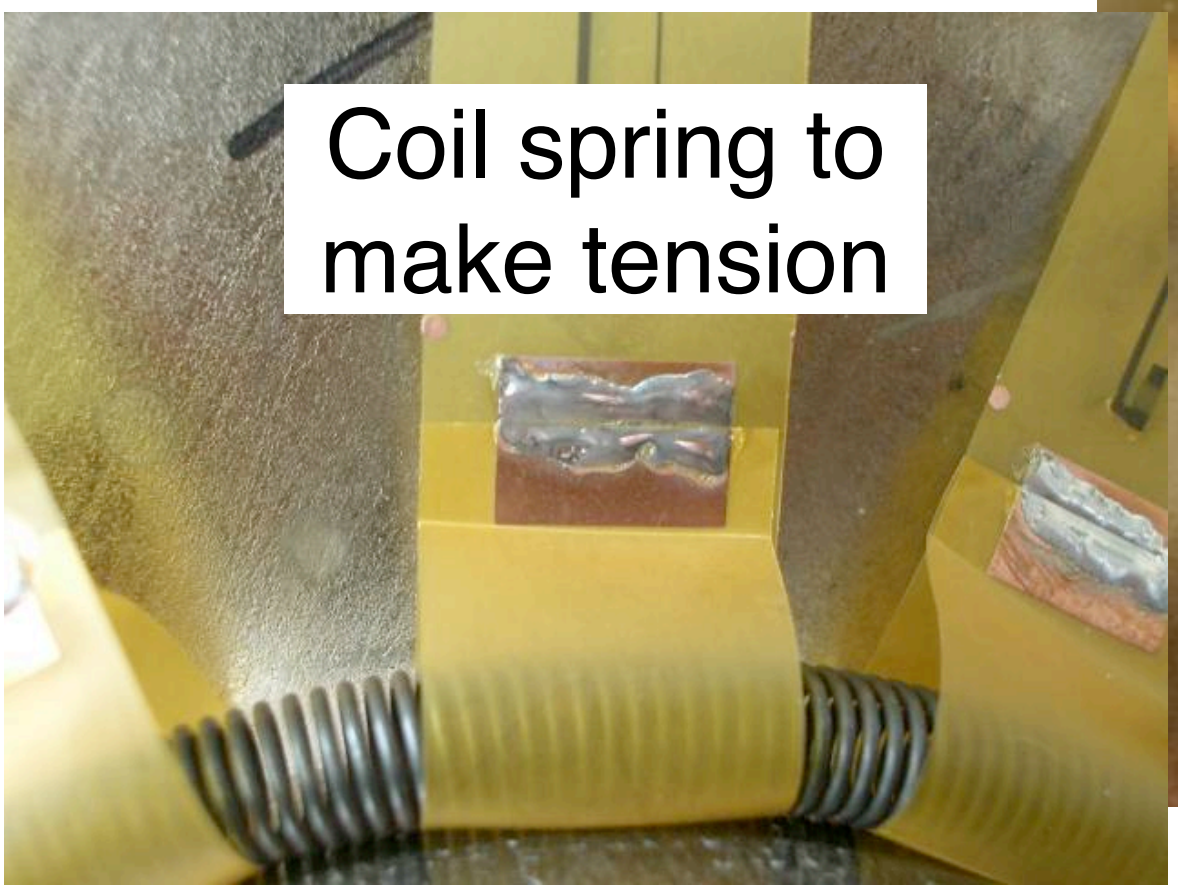
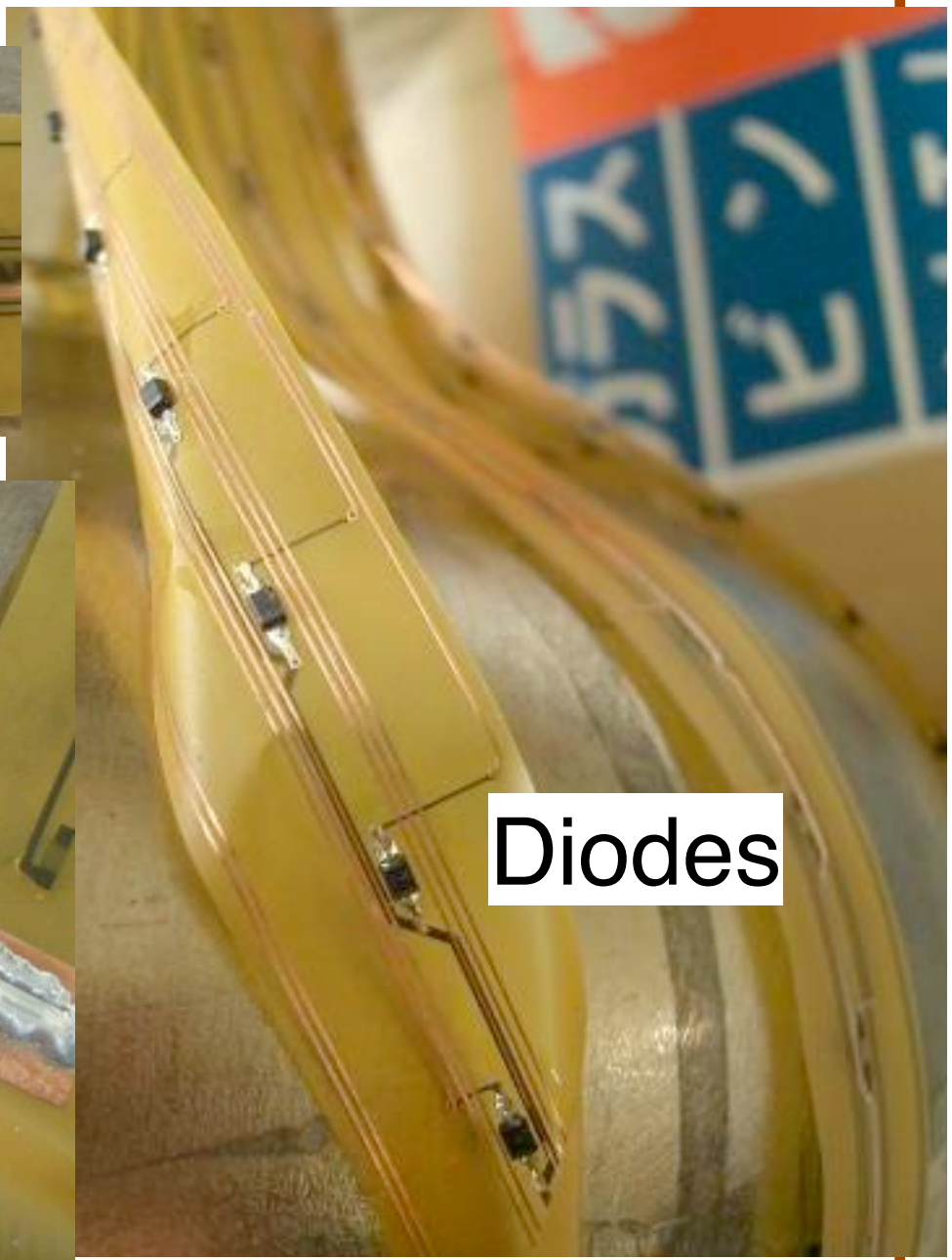
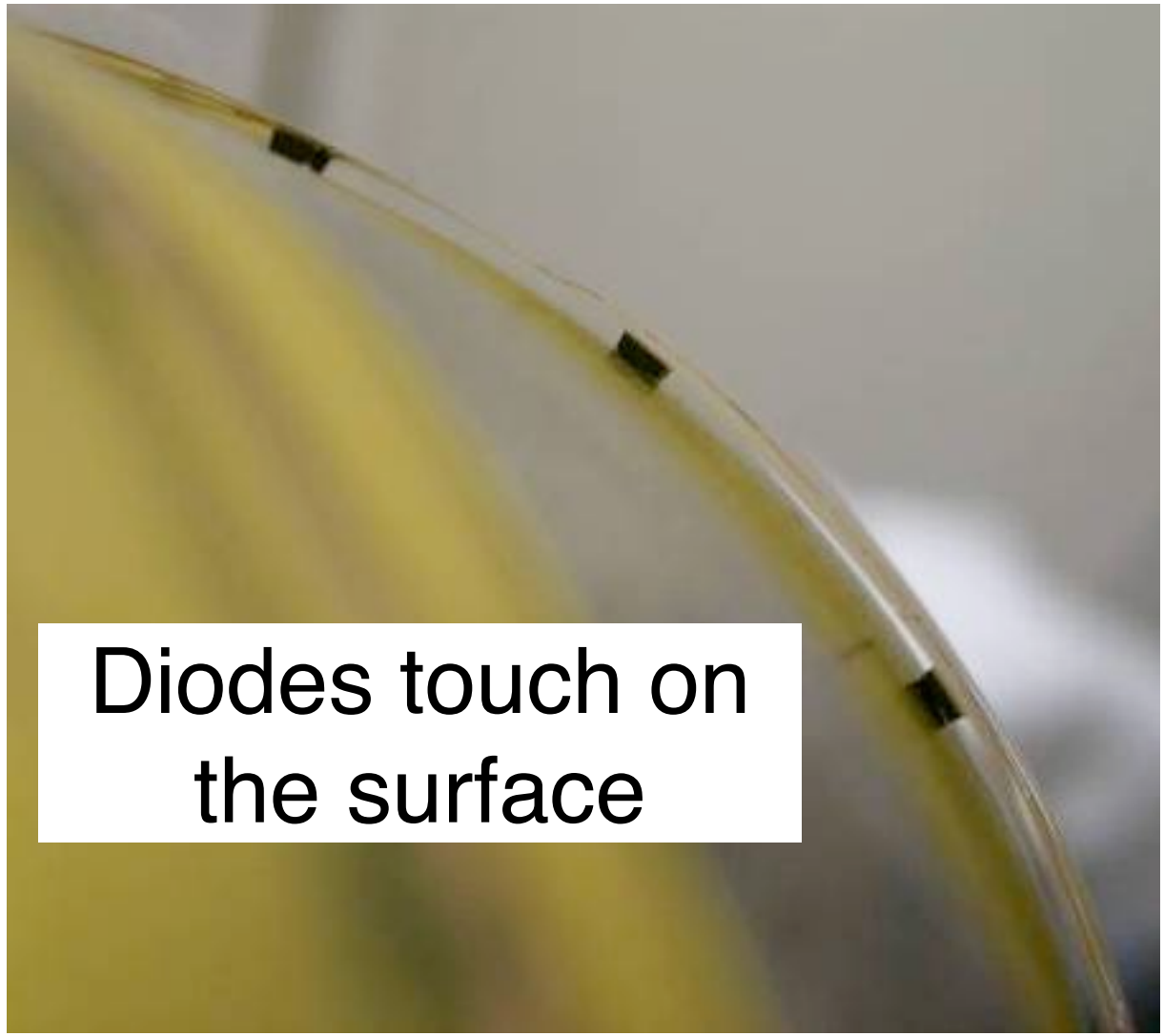

Diodes inner side

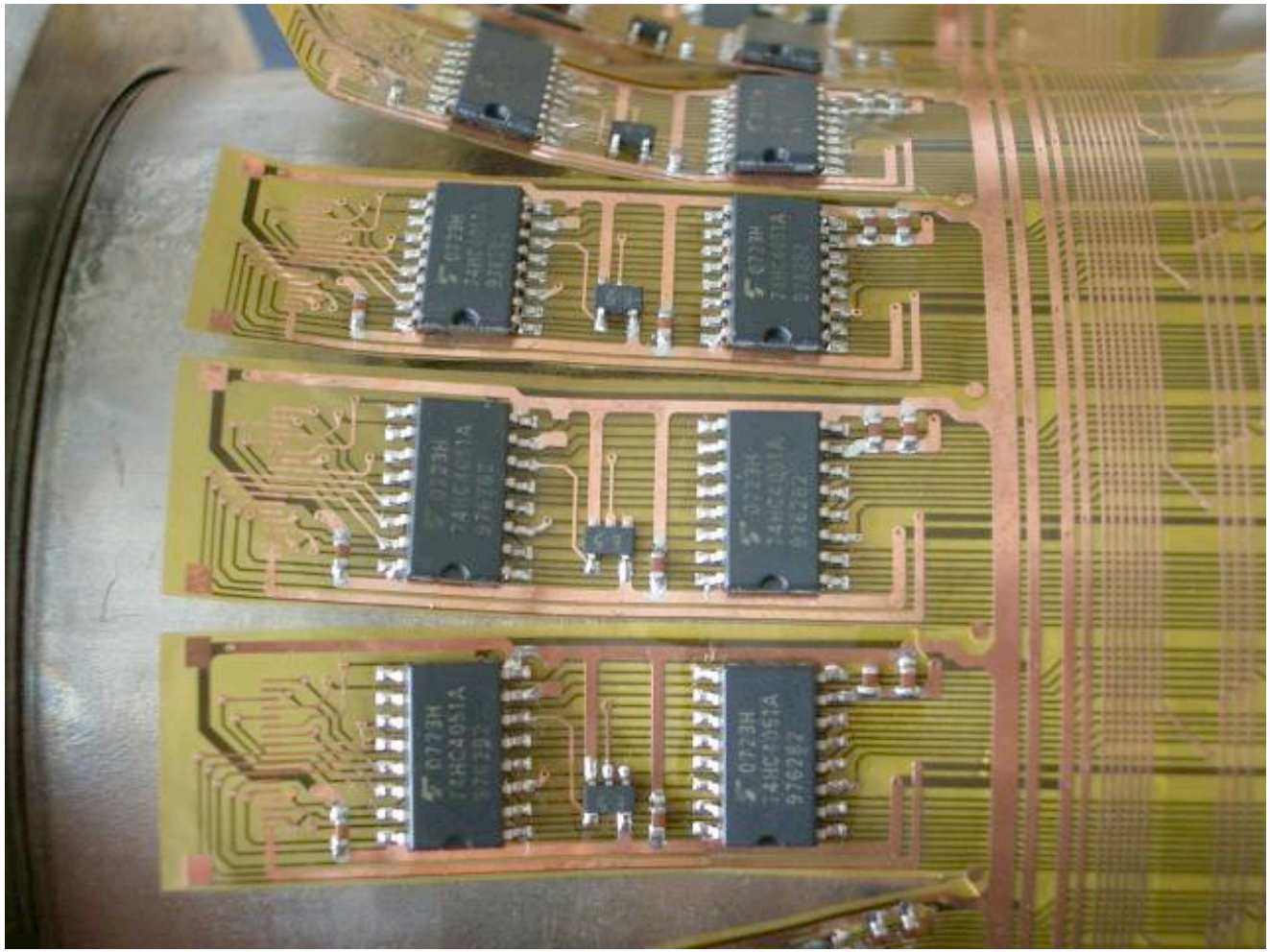

Coil spring to
make tension

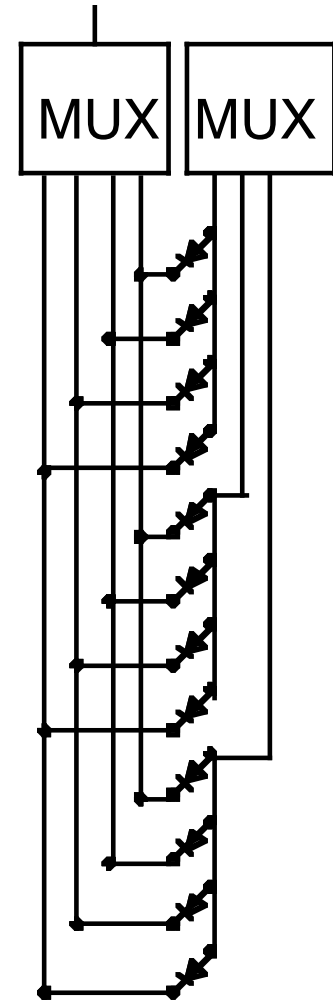

Diodes



Diodes touch on the surface

# Sensor lines are multiplexed by analog MUX (HC4051)



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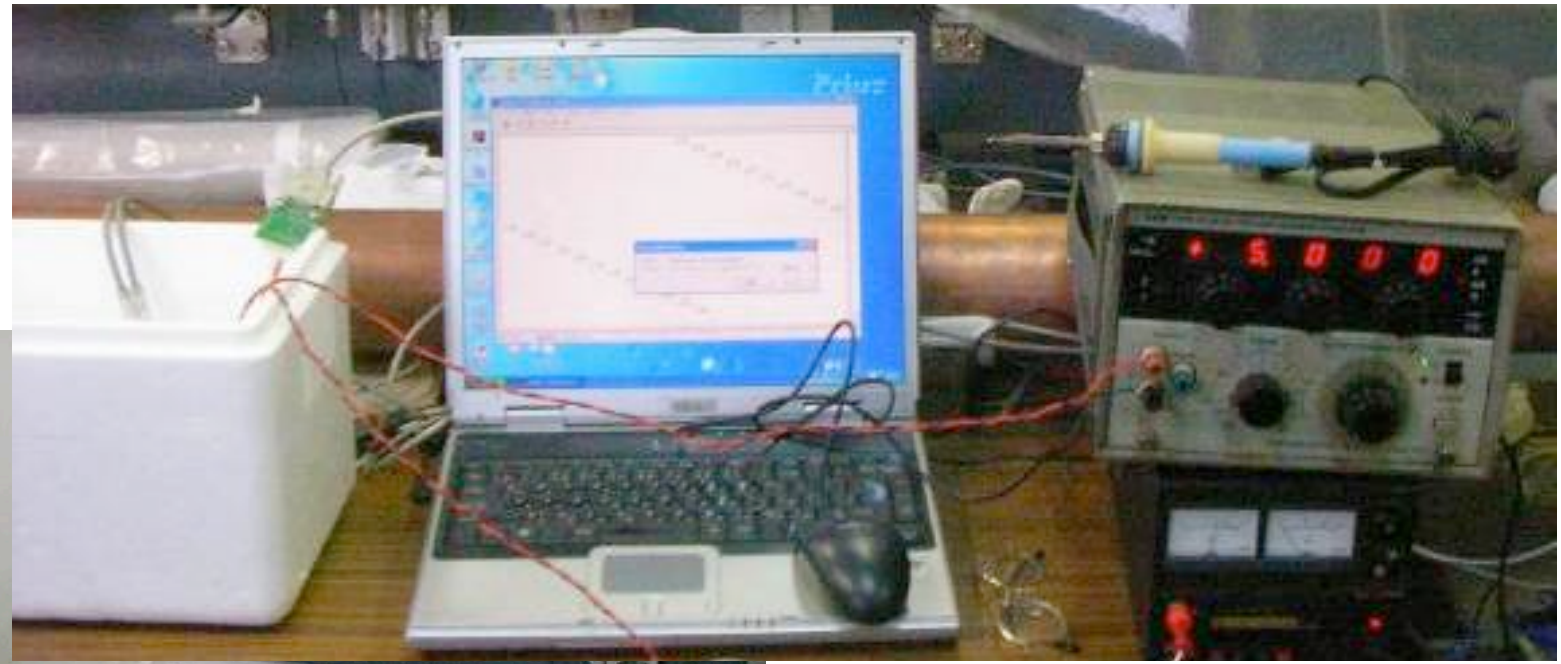
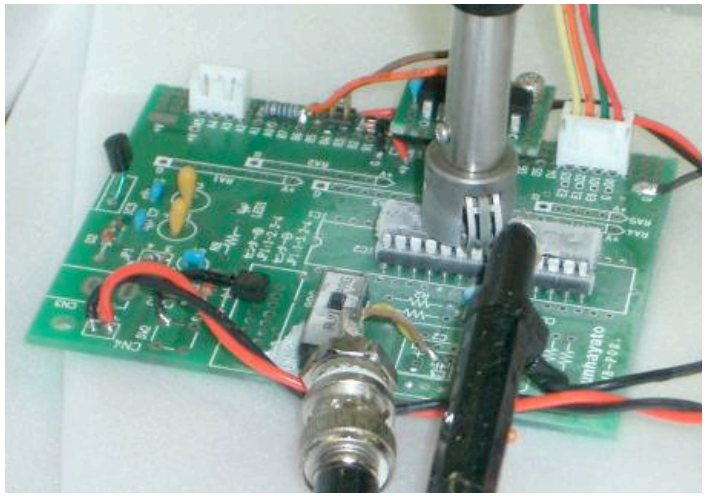
# Low Temp. Operation Test (LqN2)



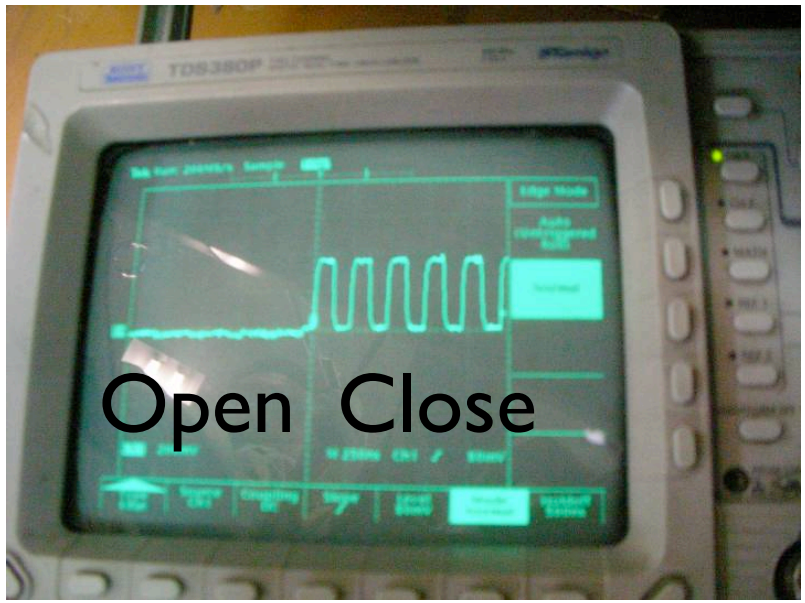
# Low Temp. Operation Test (77K)



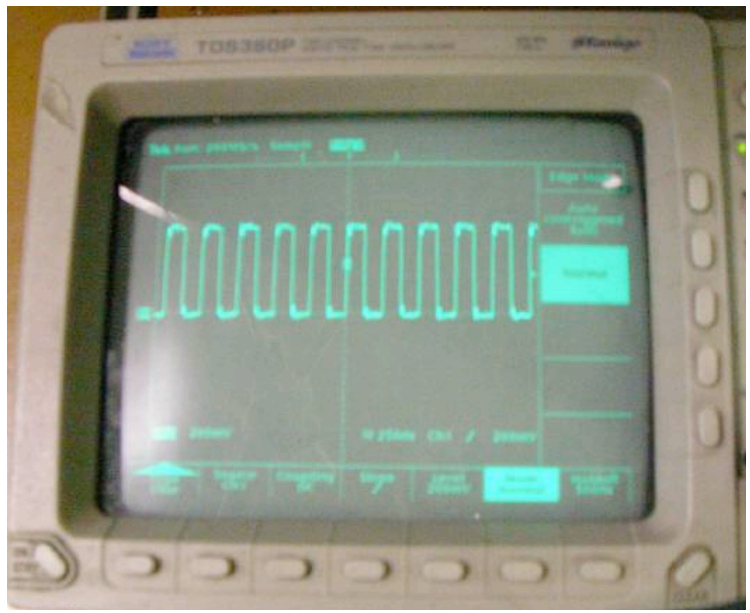
## PIC16F87x

- This board stops at -60°C
- TC74HC4066AP worked
- 74HC14P worked

HC4066




HC14



# Summary

I. Installation of the Multi-strip PCB seems OK.
(need to fix the size)

II. The flexible PCB did not loose flexibility at 77K.

III. Analog MUX worked at 77K. — Need 2K test.

IV. Combines sensor lines with A-MUX:
8bit address lines combine up to 256 sensors.
2 signal lines from each cell.
= 8 + 2 x 9 + 2 (power for IC's) = 28 lines

V. Serial ADC may work — Need check.

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