

# การรับข้อมูลดิจิทัลและประมวลผลเป็นภาพ (Image Processing)

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ศูนย์เทคโนโลยีอิเล็กทรอนิกส์และคอมพิวเตอร์แห่งชาติ (NECTEC)



THAI  
SYNCHROTRON  
NATIONAL LAB



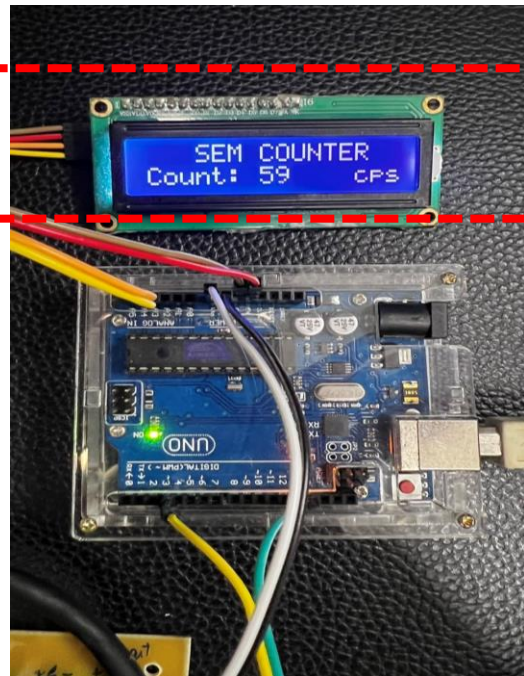
NECTEC  
a member of NSTDA

# Last Year's Activity Recap: Single-Point Measurements

## Detection



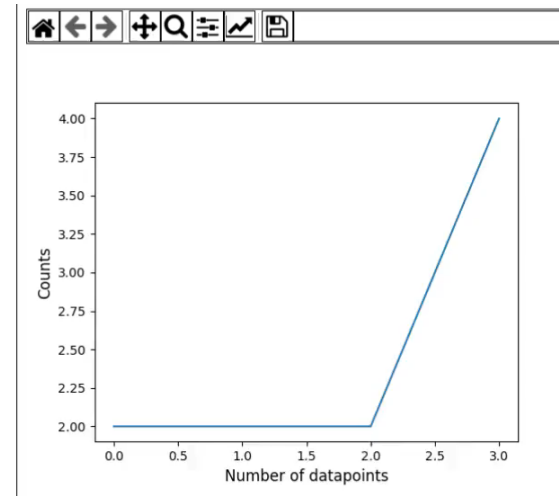
Count readings from microcontroller



## Visualization



### Acquisition



Chosen pixel coordinates:

0

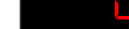
(row)

0

(column)

Stop Acquisition

Reset Data



Source off

## Processing

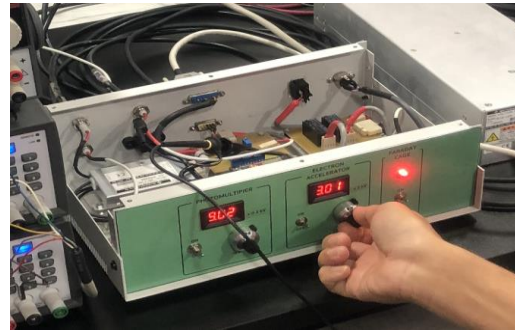
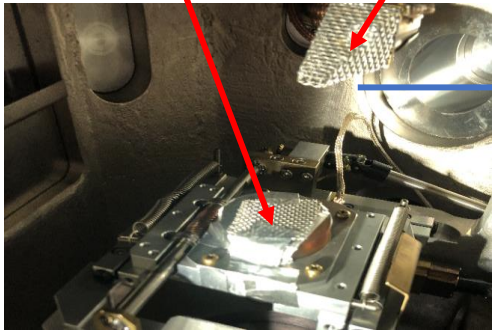
Source	Count	Mean	Stdev
Sr-90 (low dose)	15	37	10.43
Sr-90 (high dose)	15	42	9.92
Cs-137 (low dose)	15	55	7.56

# This Year's Objective: 2D Imaging

Metallic mesh sample



Faraday cage



Detection Components

NodeMCU ESP32 for Acquiring Count Signals



Receiving

Computer with Python Program



Sending

Motorized Translational Stage (For Moving Sample)



(Imitates scanning coil behaviors)

Arduino Nano for Controlling Translational Stage



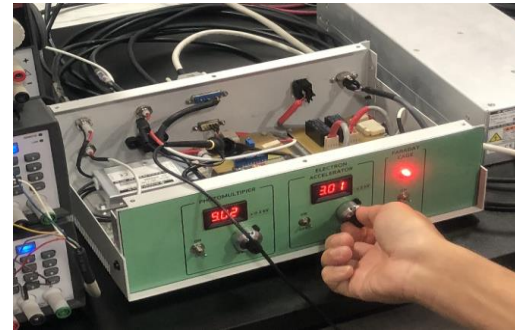
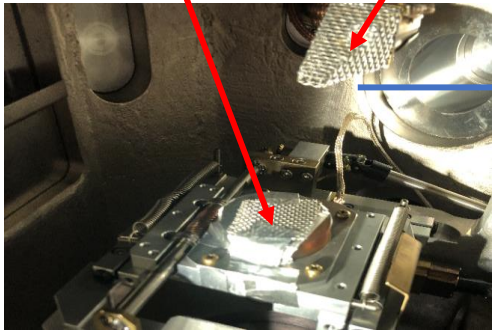
----- Synchronized commands

# First Visit to NARIT @ Chiang Mai

Metallic mesh sample



Faraday cage



Detection Components

Arduino Nano for Acquiring Count Signals



Receiving

Computer with Python Program



Sending ready signal

Human-Controlled Translational Stage (For Moving Sample)



(Imitates scanning coil behaviors)

----- Synchronized commands



# First Visit to NARIT @ Chiang Mai

- Human-controlled translational stage



Keep Exit New Options Normal Page Break Preview Custom View

Sheet View Workbook Views

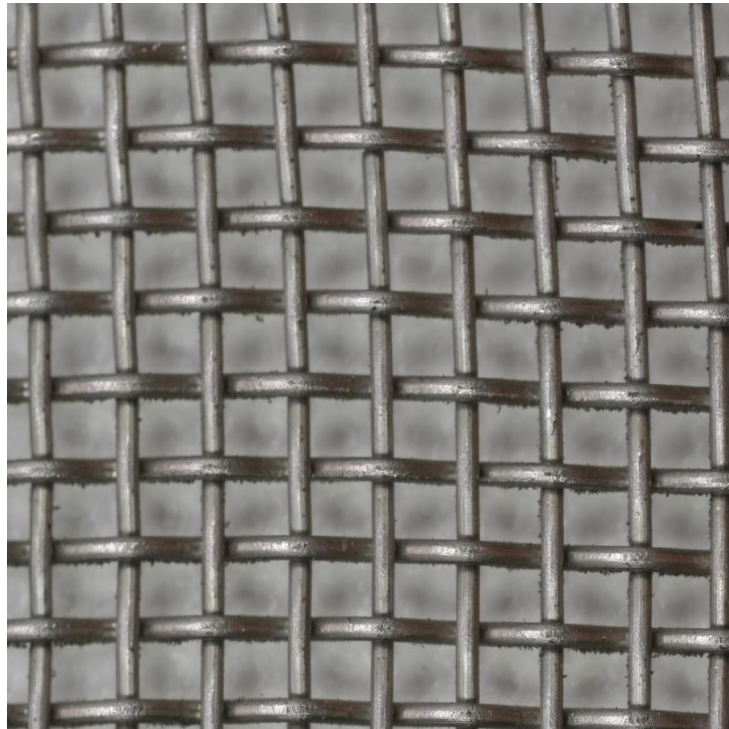
G12

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5				
2	20.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	20.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	21.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	21.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	22.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	22.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	23.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	23.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	24.0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	24.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	25.0	1	1	1	1	1																		
13	25.5																							
14	26.0																							
15	26.5																							
16	27.0																							
17	27.5																							
18	28.0																							
19	28.5																							
20	29.0																							
21	29.5																							
22																								
23																								
24																								

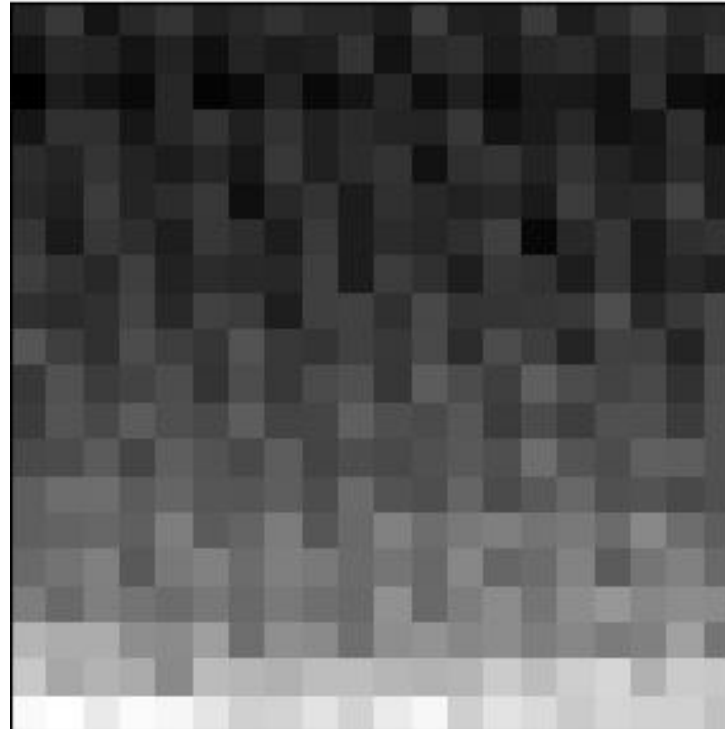
Scratchpad showing data collection progress for 20 x 20 pixel image

# First Visit to NARIT @ Chiang Mai

**Actual Image**  
(10 x 10 mm<sup>2</sup>)



**Corresponding SEM Image**  
(20 x 20 pixels,  $\approx$  1% noise)



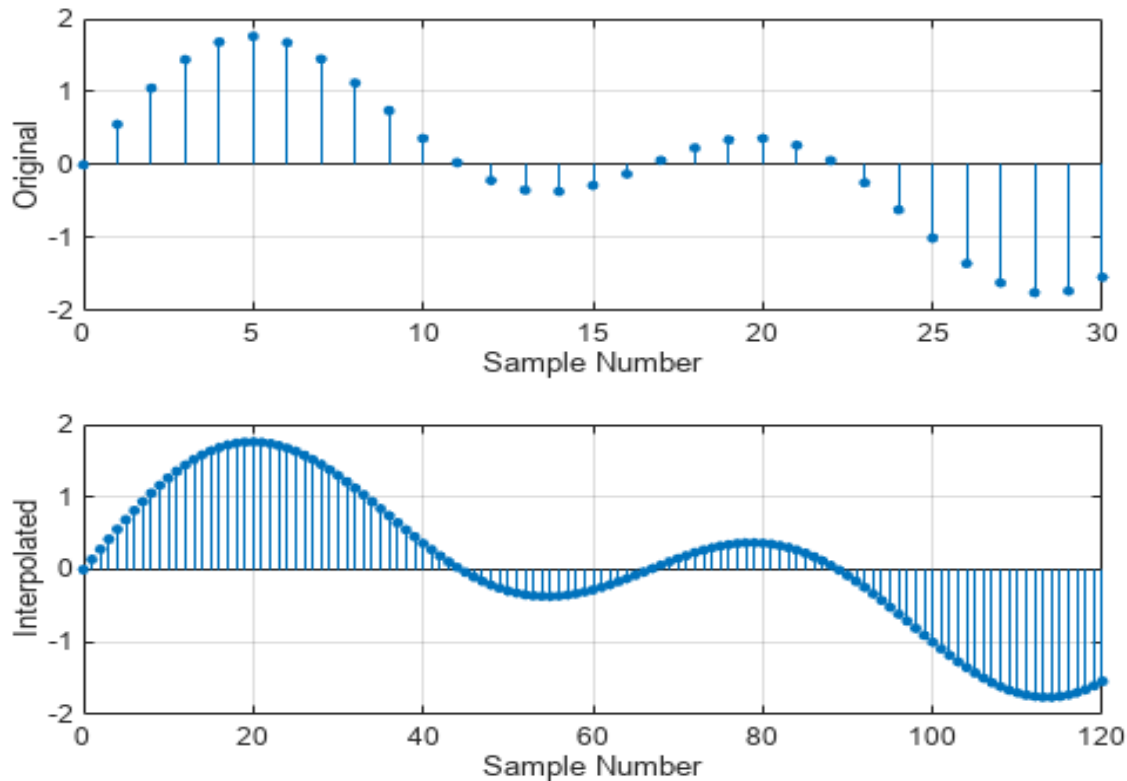
- 20 x 20 pixels
- 0.5-mm step size
- 25 scans/pixels

**Problem:** Too large pixel size -> loss of small details.

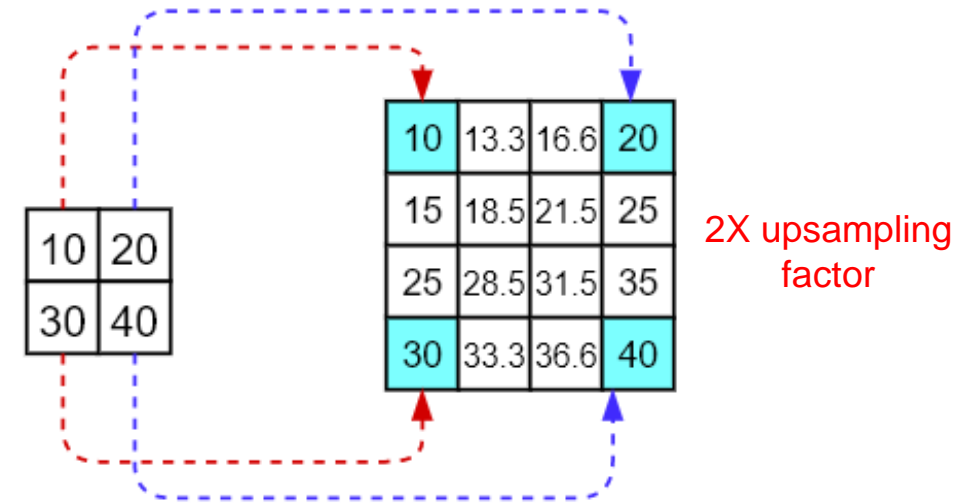
# Interpolation

- Estimates unknown data points from the known ones

## 1D Interpolation [1]



## 2D Interpolation [2]



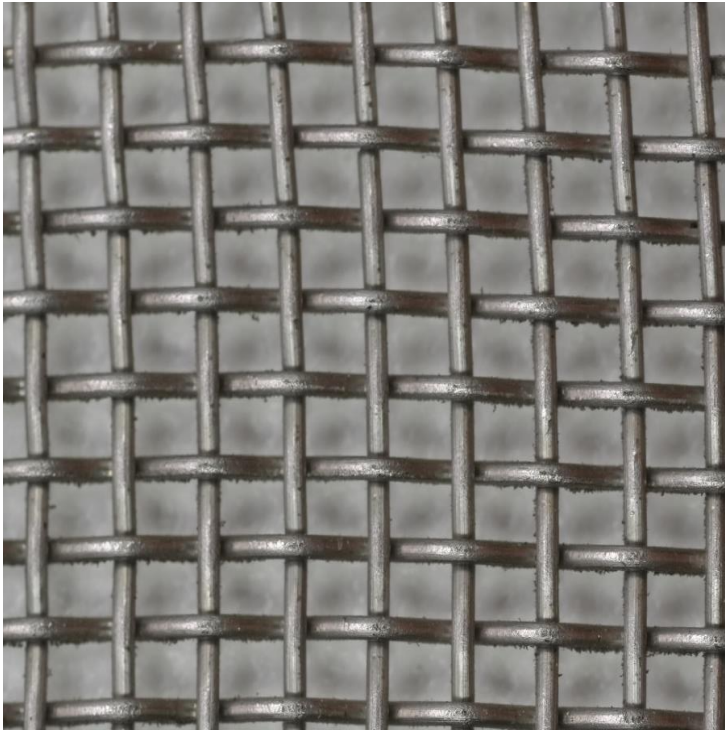
**Interpolation increases (upsamples) the number of pixels.**

[1] [Interpolation — increase sample rate by integer factor - MATLAB interp \(mathworks.com\)](#)  
[2] DOI:[10.3390/app10103658](#)

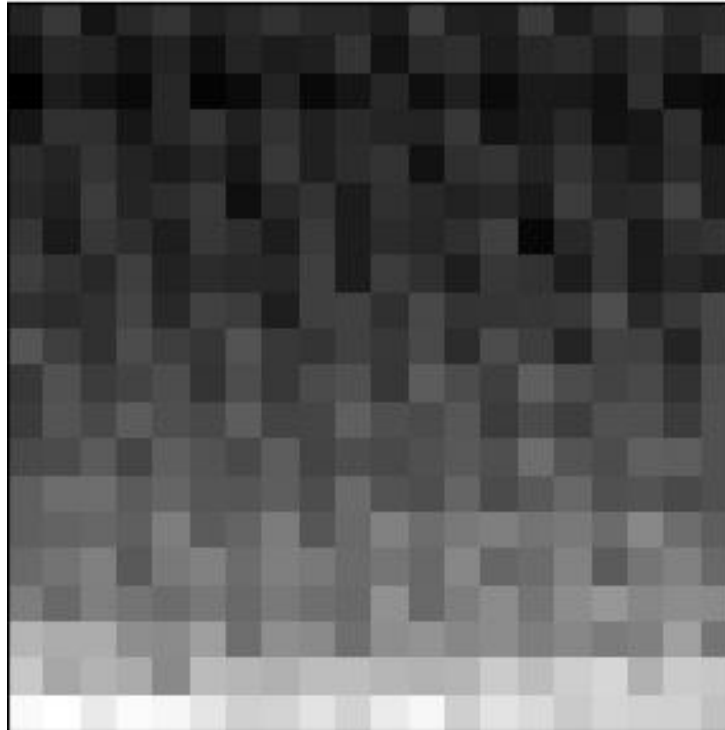


# First Visit to NARIT @ Chiang Mai

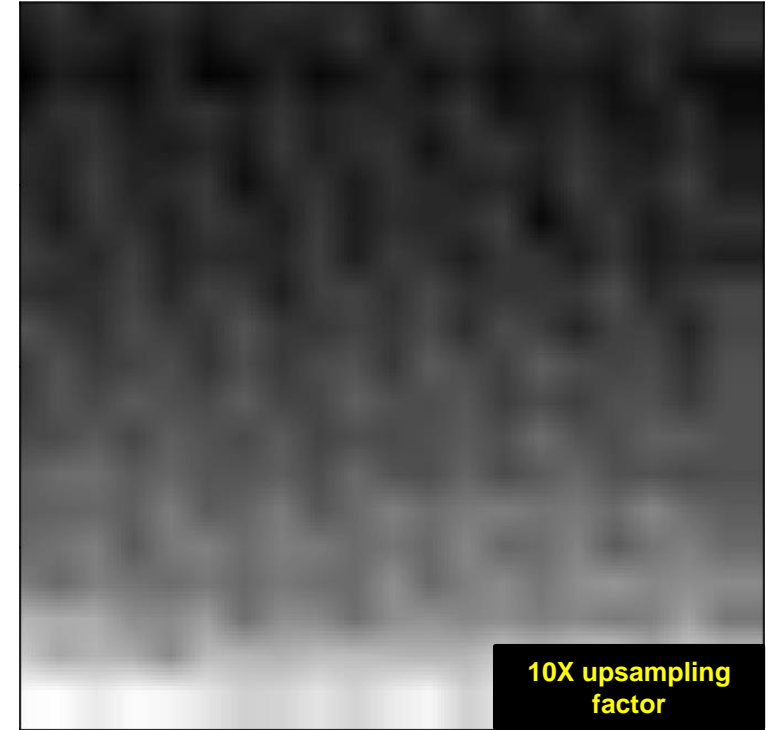
**Actual Image**  
(10 x 10 mm<sup>2</sup>)



**Before Interpolation**  
(20 x 20 pixels, 1% noise)



**After Interpolation**  
(200 x 200 pixels)



**More noticeable  
pattern details.**

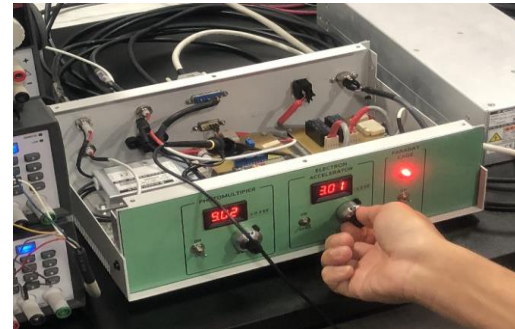
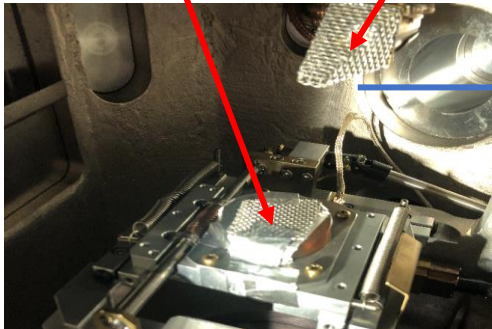


# Second Visit to NARIT @ Chiang Mai

Metallic mesh sample



Faraday cage



Detection Components

Arduino Nano for Acquiring Count Signals



Receiving

Computer with Python Program



Sending

Motorized Translational Stage (For Moving Sample)

Arduino Nano for Controlling Translational Stage

Plus smaller and more stable e-beam emission.



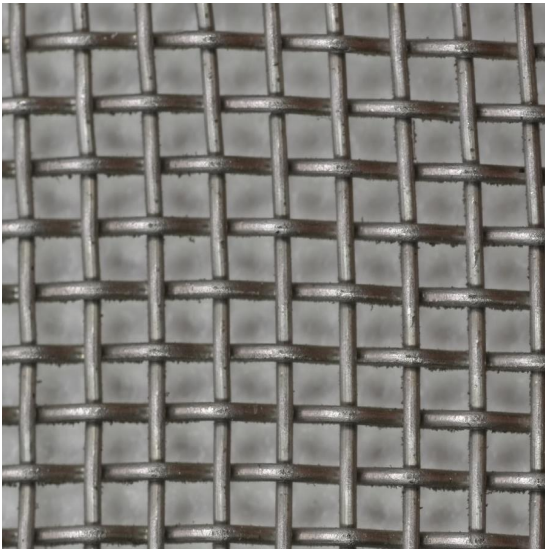
(Imitates scanning coil behaviors)



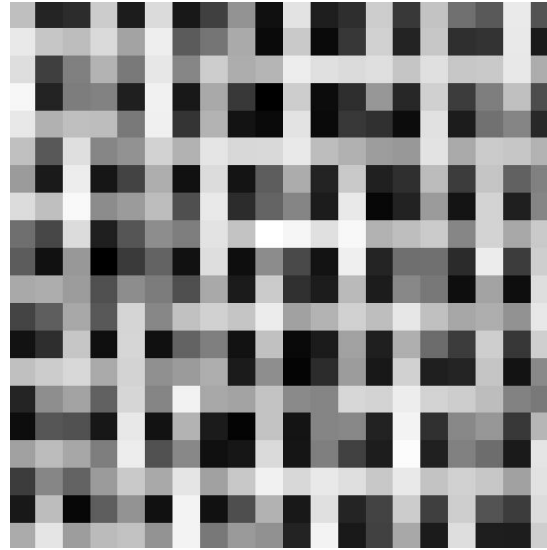
----- Synchronized commands

# Second Visit to NARIT @ Chiang Mai

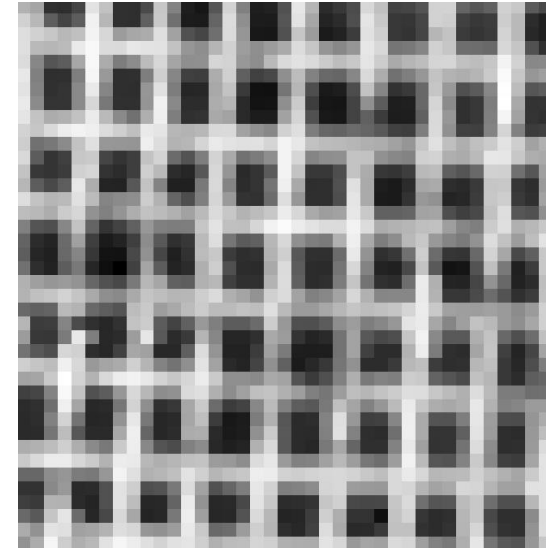
**Actual Image**  
(10 x 10 mm<sup>2</sup>)



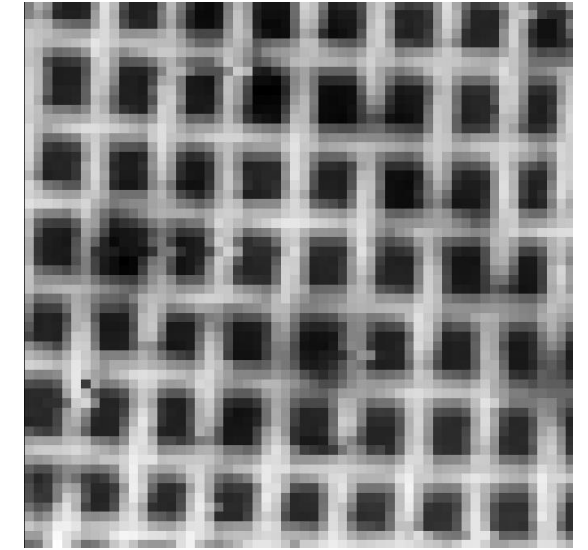
**SEM Images**  
(no upsampling)



- 20 x 20 pixels
- 500- $\mu$ m step size



- 40 x 40 pixels
- 250- $\mu$ m step size

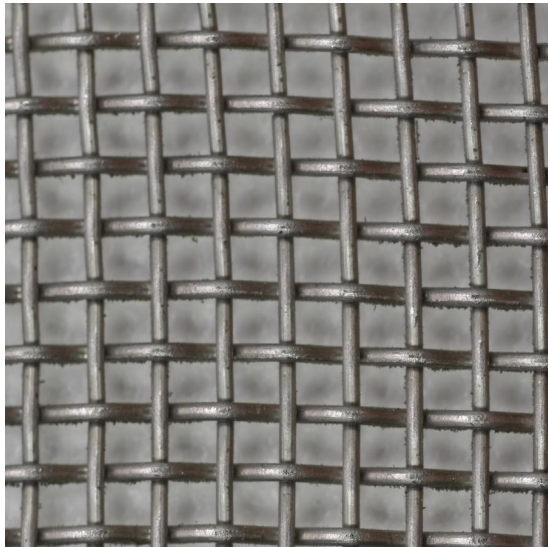


- 58 x 58 pixels
- 175- $\mu$ m step size

# Second Visit to NARIT @ Chiang Mai

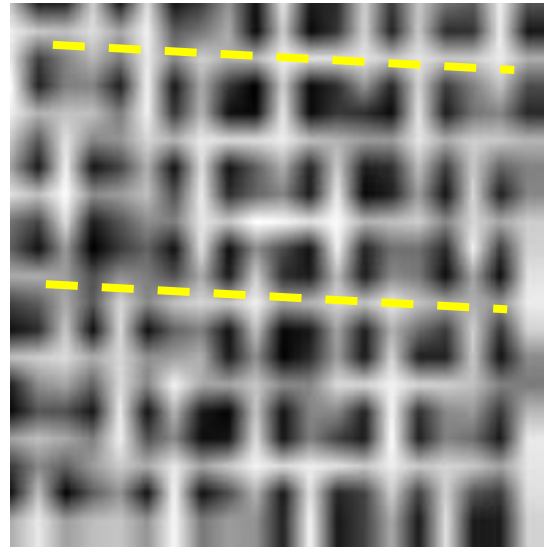
## Actual Image

(10 x 10 mm<sup>2</sup>)

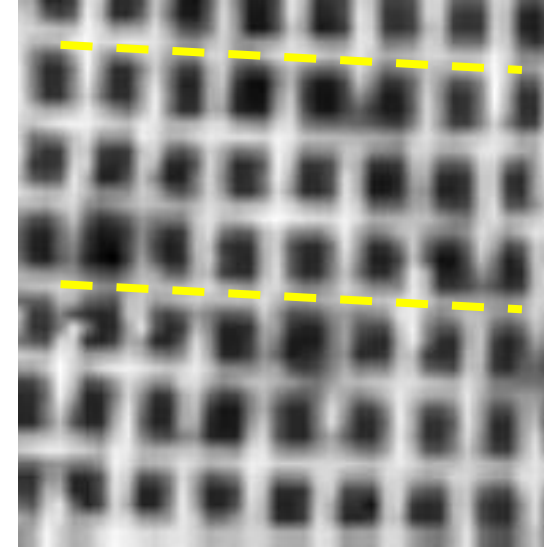


## SEM Images

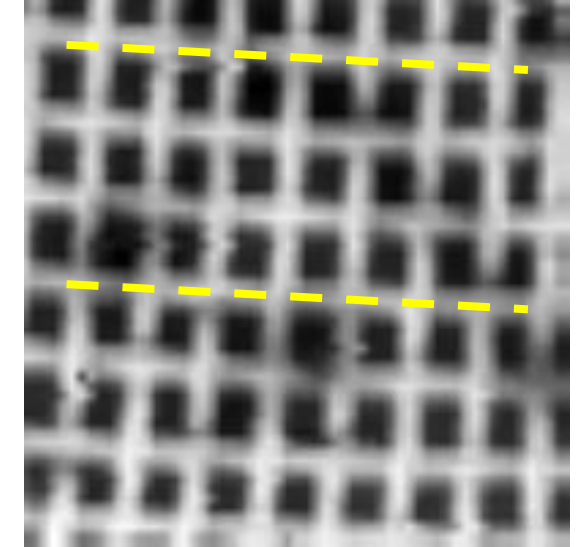
(Upsampled to 200 x 200 pixels, < 1% noise)



- 20 x 20 pixels
- 500-µm step size



- 40 x 40 pixels
- 250-µm step size



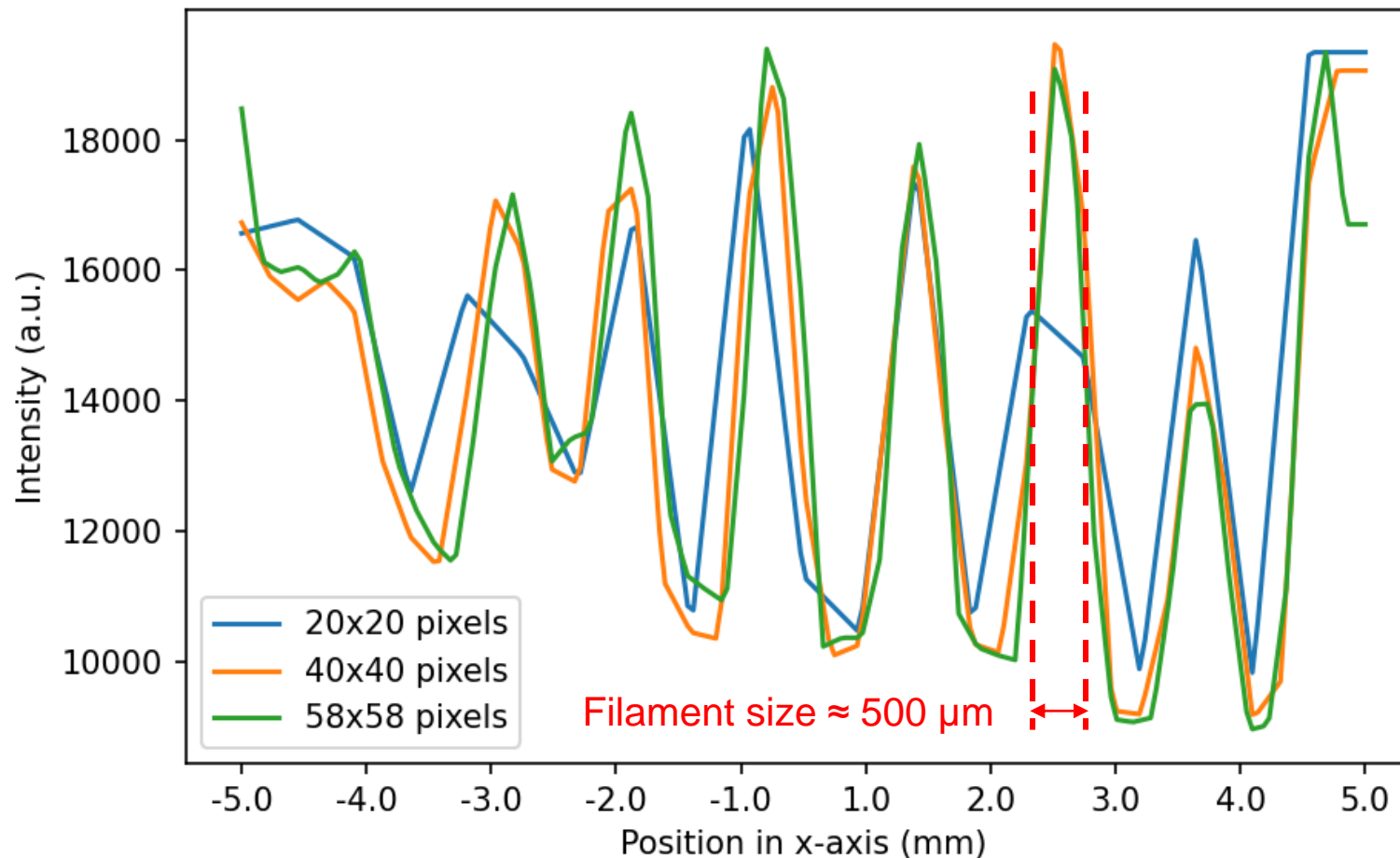
- 58 x 58 pixels
- 175-µm step size

- Using smaller step size enhances details of small features

- Note: Glitches in SEM images might be caused by stepper motors' movements

# Second Visit to NARIT @ Chiang Mai

- Horizontal cross-sections through the middle of upsampled images





# Conclusions and Future Work

## Conclusions

- The SEM team has successfully acquired the first 2D image of metallic mesh samples.
- Improved beam quality (smaller beam size & more stable emission) and image upsampling technique help improve the image quality.

## Future works

- Apply more signal processing technique to enhance image resolution (e.g. super-resolution imaging).
- Design user-friendly GUI interface for image acquisition and processing.

# Conclusions and Future Work

The screenshot shows the SEM Image Acquisition V2.0 software interface, which is a Qt Designer window. The window has two tabs: "Acquire Image" (selected) and "View Saved Image". The main area is a large black rectangle representing the image acquisition area. To the right of this area are two panels of controls:

- Acquisition Parameters:** This panel includes four spin boxes: "Num X pixels" (set to 100), "Num Y pixels" (set to 100), "Step size (um)" (set to 50), and "Num acq/pixel" (set to 1).
- Image Processing:** This panel includes an "Upsampling factor" spin box (set to 3), two radio buttons for "Average" (selected) and "Standard dev.", a "Brightness" slider, a "Contrast" slider, and a "Reset" button.

At the bottom of the window is the "Main Controller" section, which contains a "Choose port:" dropdown menu and a prominent green "Start Acquisition" button. Red dashed boxes and arrows highlight these three main sections: Acquisition Parameters, Image Processing, and Main Controller.

# THANK YOU

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