

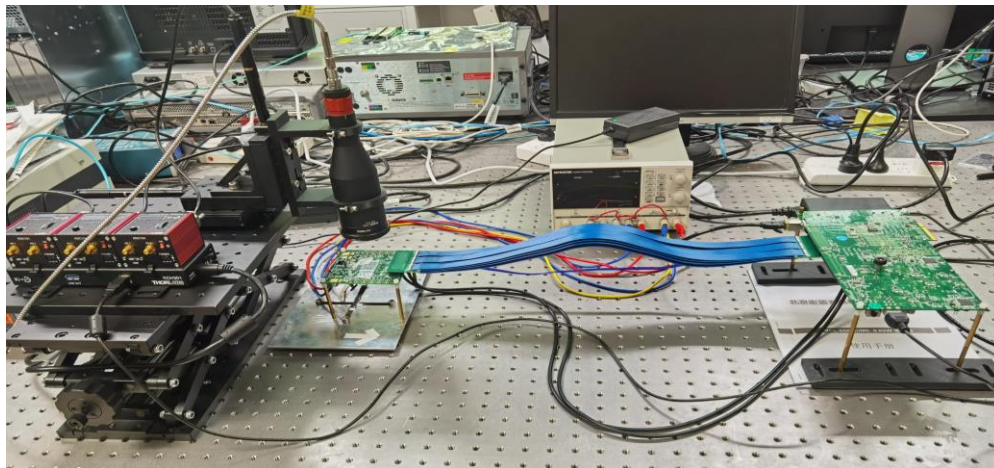
Laser Test on TaichuPix

Wei Wang

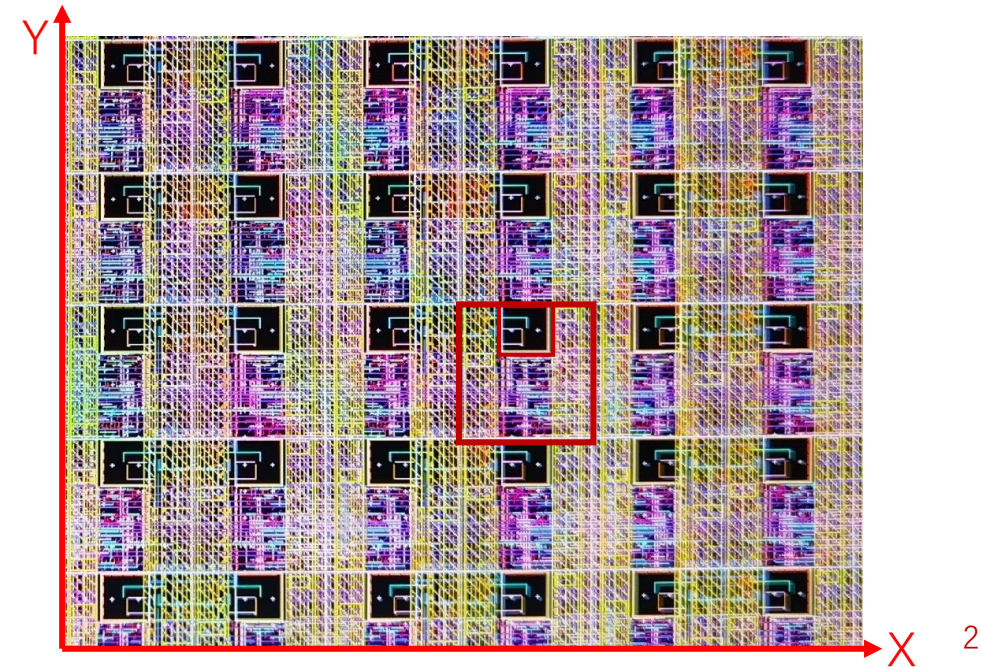
IHEP

Testing system

- 3-D linear translation stage
 - XY-plane for testing, Z-axis for focusing
 - Min repeatable step 0.2 μ m
- Optical system
 - Laser diode with 658nm wavelength
 - Expected min spot size \sim 1.13 μ m

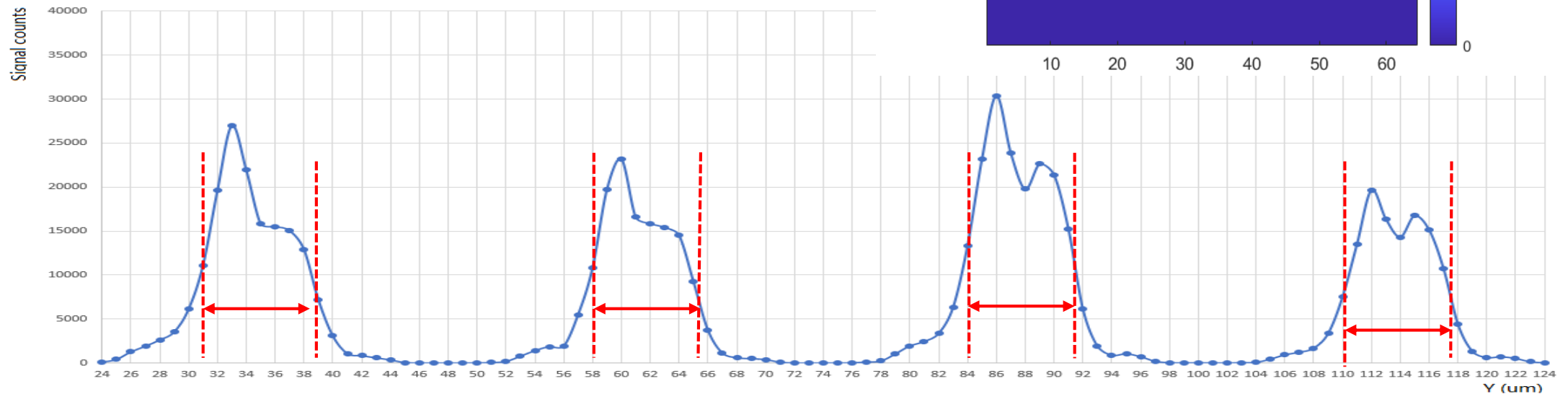


- TaichuPix test area
 - Pixel size 25x25 μ m
 - Aluminum mask with 8.4x8.4 μ m window
 - 64x64 pixels active area



System validation

- ◆ X,Y-axis scan with step of 1 μm
- ◆ Single pixel response
(laser spot $< 8\mu\text{m}$)
- ◆ Observed $\sim 8\mu\text{m}$ mask window
 - ◆ Correspond to the design



Resolution measurement

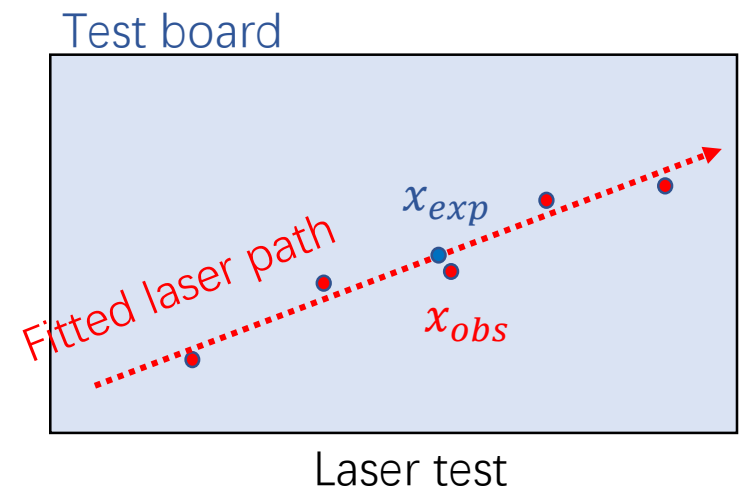
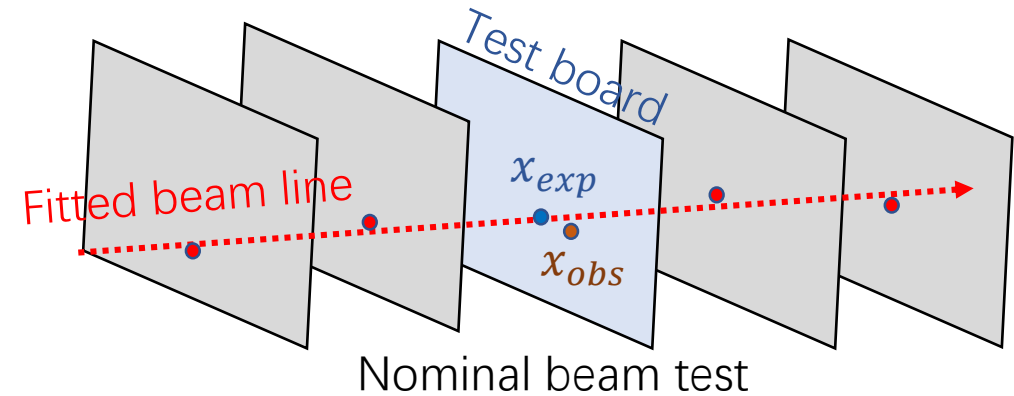
- ◆ Theoretical single pixel resolution

$$\sigma_{theory} = \frac{25(\mu m)}{\sqrt{12}} = 7.22(\mu m)$$

- ◆ Experimental resolution

$$\sigma_{experiment} = \sigma(\delta(x_{observed} - x_{expected}))$$

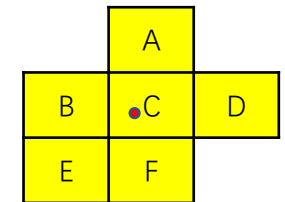
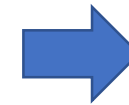
- One dimension laser scan on the test board with fixed step
- Take the linear fit of the observed X,Y position as the expected laser position



Resolution measurement

- ◆ Reconstruction algorithm
 - ◆ Find the pixel with maximum readout value as the **seed**
 - ◆ Search for **fired pixels** within **5x5 pixels around the seed**
 - ◆ Take the geometry center of fired pixels as the reconstructed position

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	12	0	0	0
0	0	23	86	9	0	0
0	0	2	14	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0



$$x = \frac{1}{n} \sum_i x_i$$

$$y = \frac{1}{n} \sum_i y_i$$

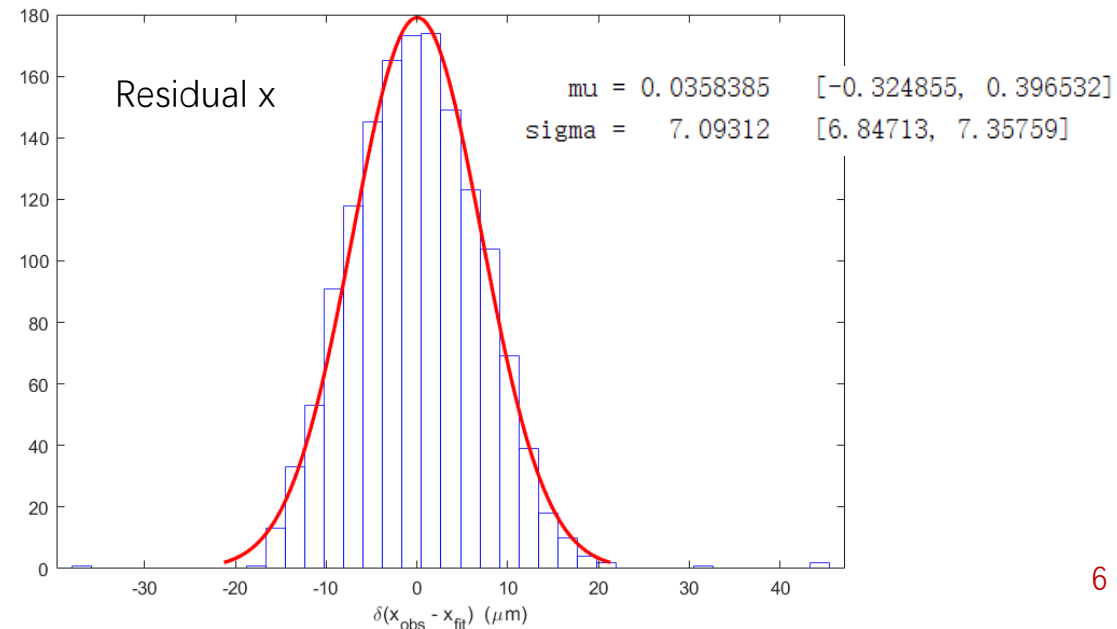
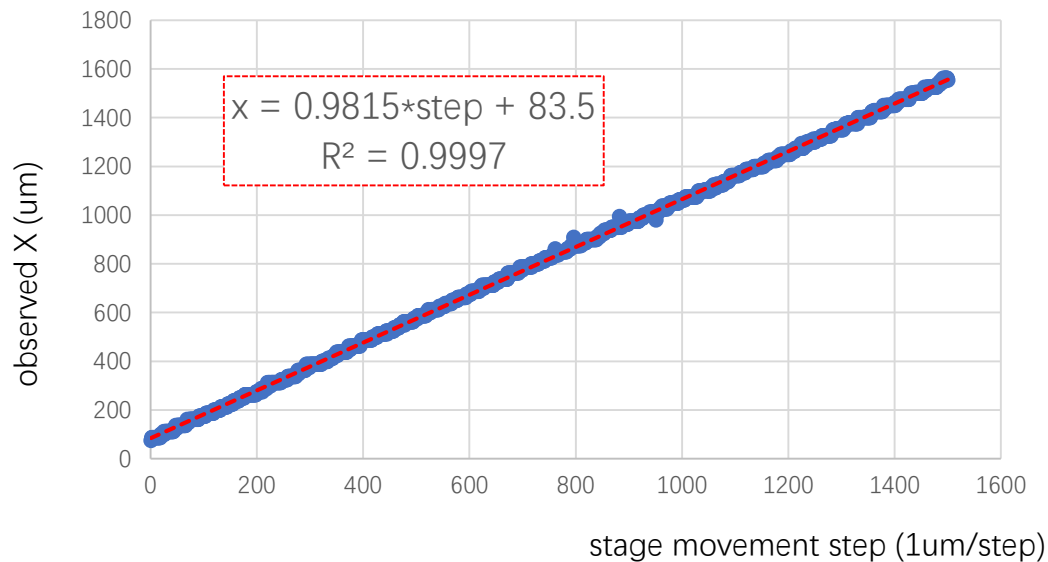
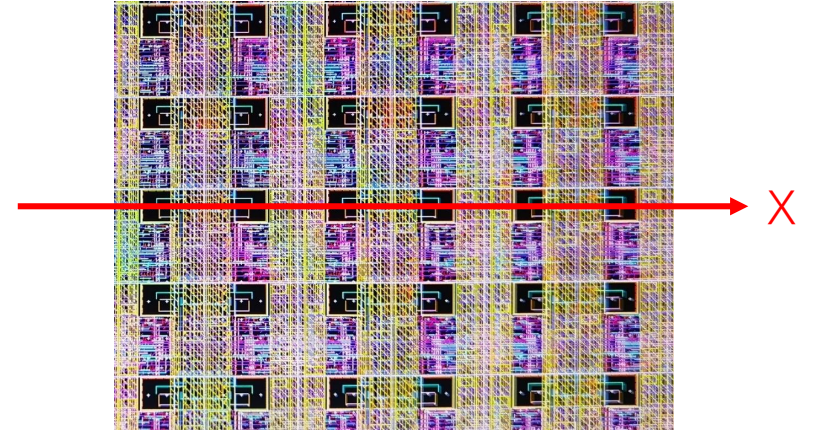
$$i = A \sim F, n = 6$$

Note:

Data = #fired event in one readout period \propto laser pulse frequency and intensity
In real application, data=1 for one particle hit.

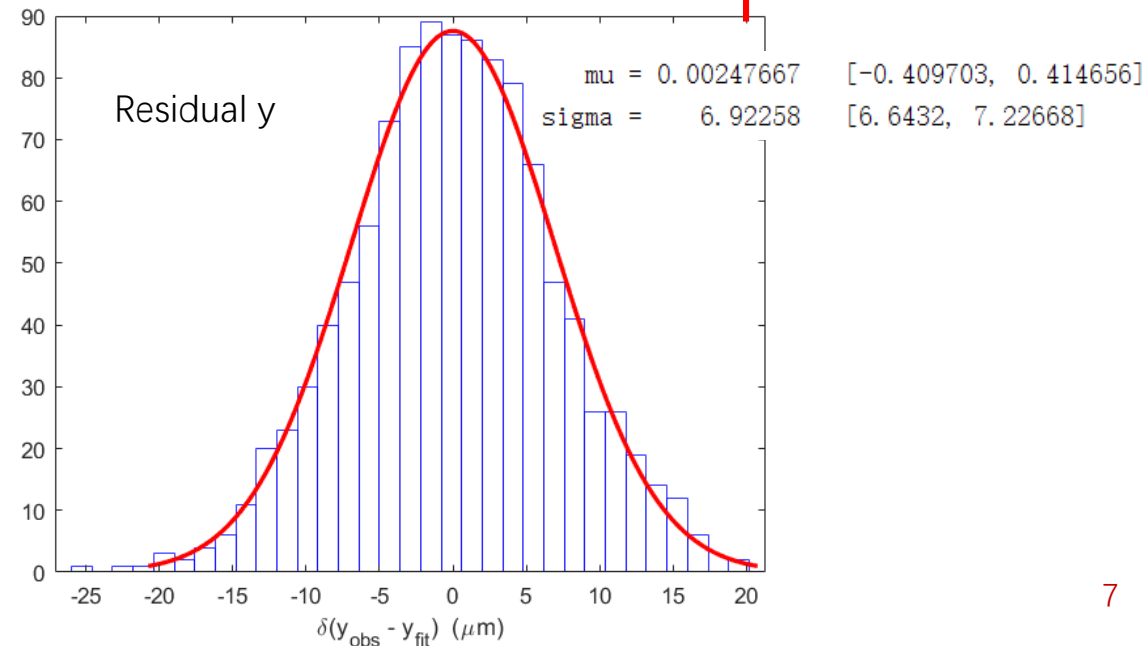
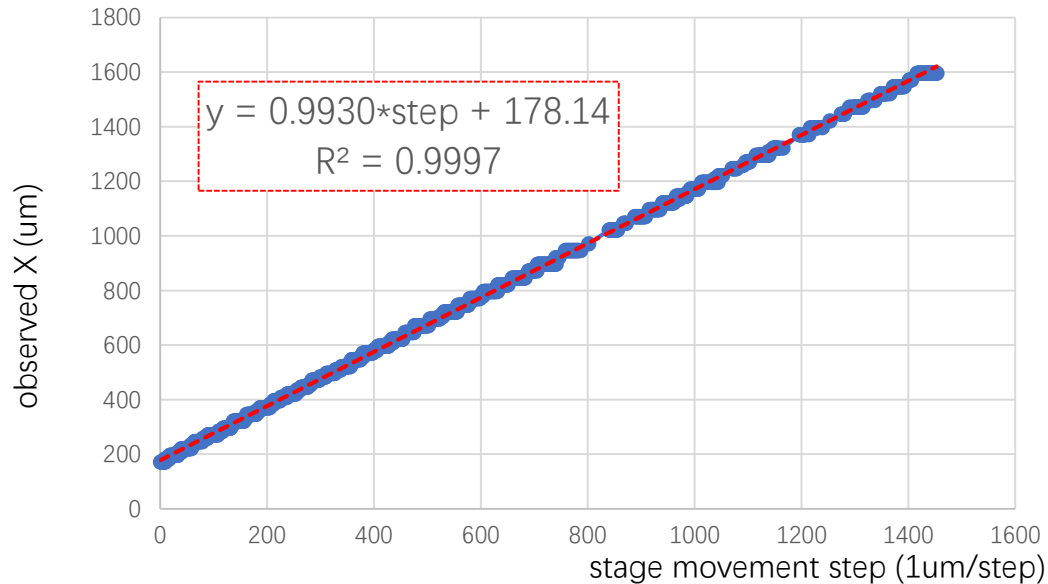
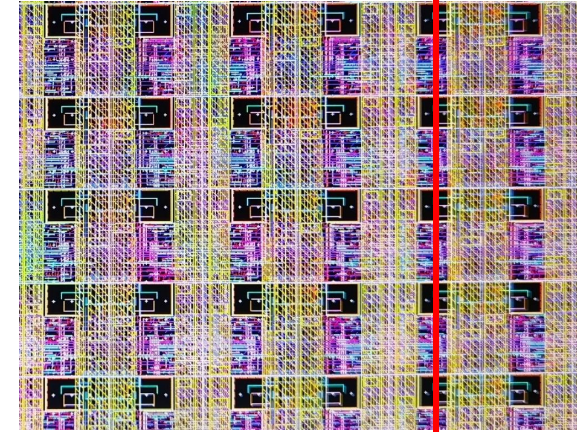
X-axis resolution (1~2 pixel response)

- X-axis scan with 1 μ m/step
- 1~2 pixel fired in each step
- Observed $\sigma_x = 7.09\mu m$
(1488 points)



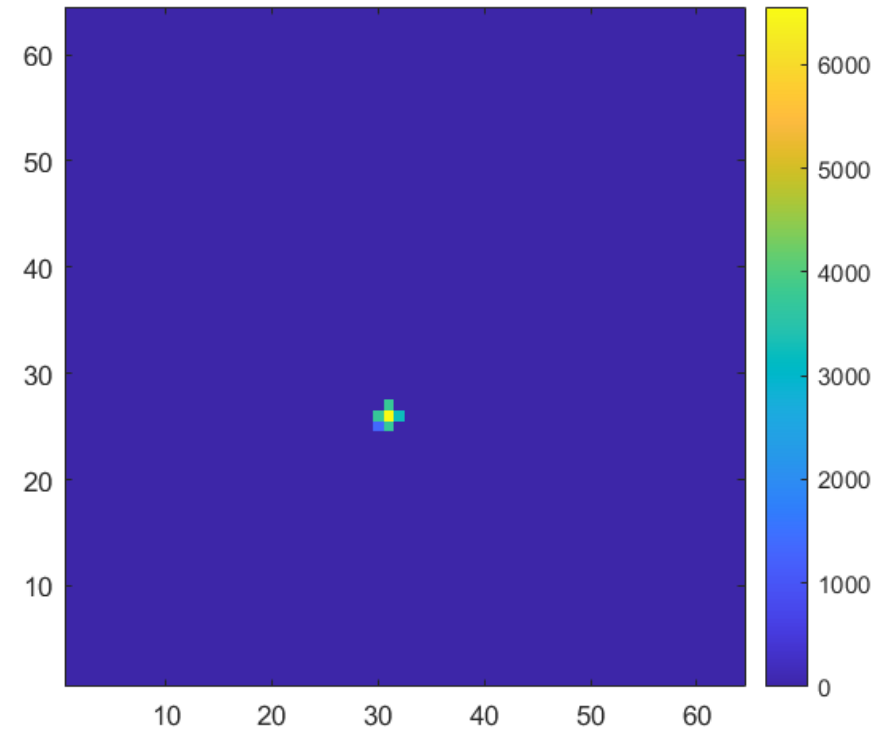
Y-axis resolution (1~2 pixel response)

- Y-axis scan with 1 $\mu\text{m}/\text{step}$
- 1~2 pixel fired in each step
- Observed $\sigma_y = 6.92\mu\text{m}$
(1086 points)



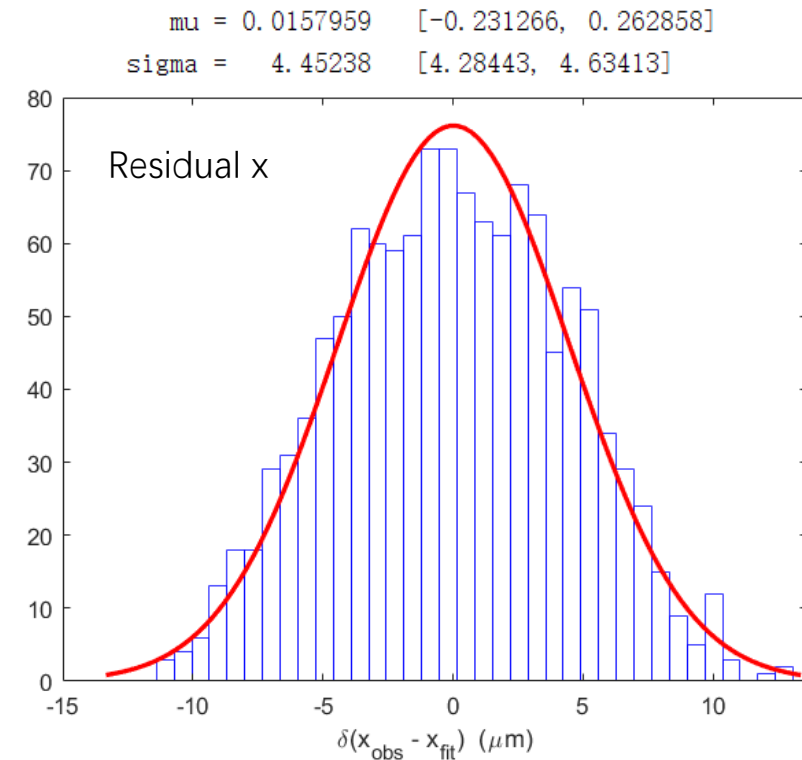
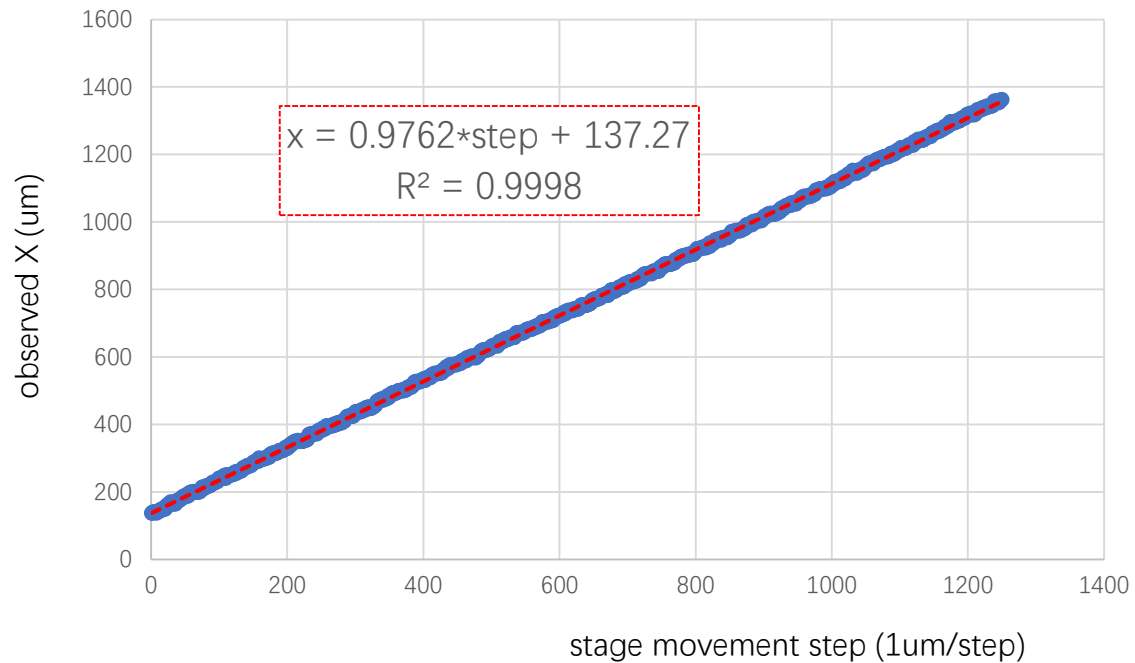
Multi-pixel response

- ◆ In real application, multiple pixels could be fired
 - ◆ Pixel threshold, Incident angle, etc.
- ◆ 3x3-pixel response is tested to emulate real hit clusters in CEPC
 - ◆ Pixel threshold, laser intensity, focusing



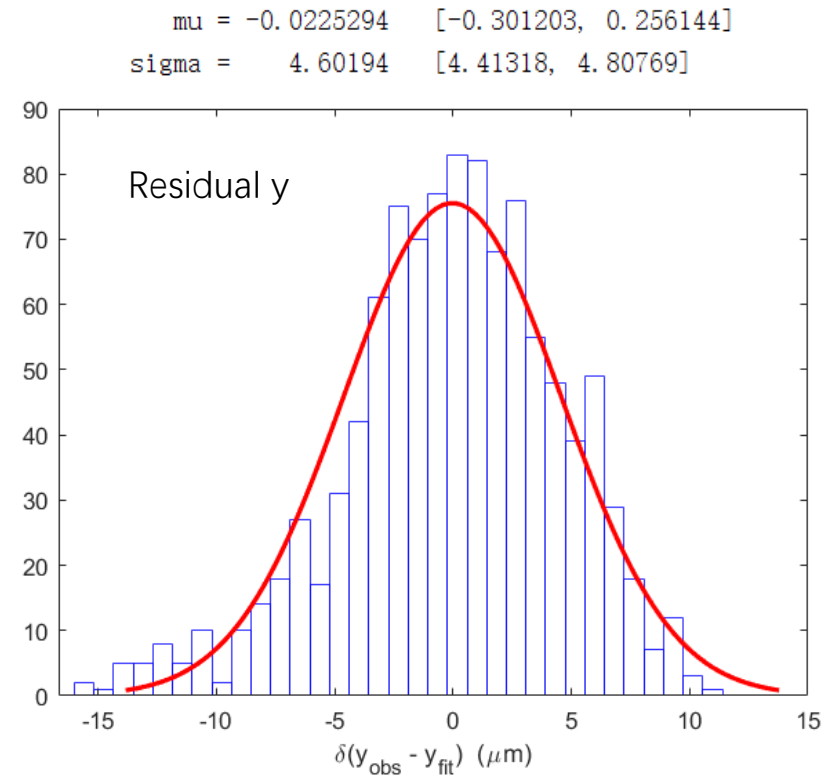
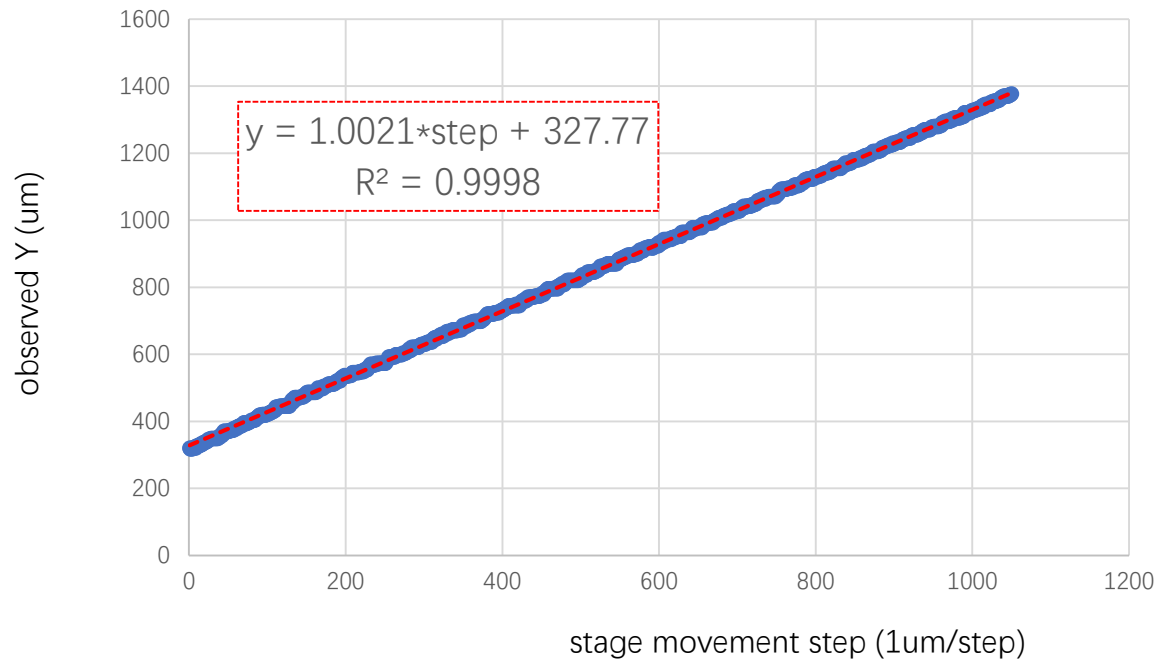
X-axis resolution (3x3-pixel)

- ◆ X-axis scan with 1 $\mu\text{m}/\text{step}$, $\sim 3 \times 3$ pixels fired in each step
- ◆ Observed $\sigma_x = 4.45\mu\text{m}$
(1250 points)



Y-axis resolution (3x3-pixel)

- ◆ Y-axis scan with 1 μ m/step, \sim 3x3 pixels fired in each step
- ◆ Observed $\sigma_y = 4.60\mu m$
(1050 points)



Summary

- ◆ Laser test system for TaichuPix has been set up
- ◆ Preliminary result of TaichuPix resolution (MOST2 target 3~5um)
 - ◆ 1~2 pixel response: ~7um
 - ◆ 3x3-pixel response: ~4.5um
 - ◆ Symmetry in X and Y directions
- ◆ Next step
 - ◆ Test with various cluster size (1~10 pixels)
 - ◆ Study in different pixel array
 - ◆ Laser linear scan with random directions
 - ◆ More statistics

◆ Back-up