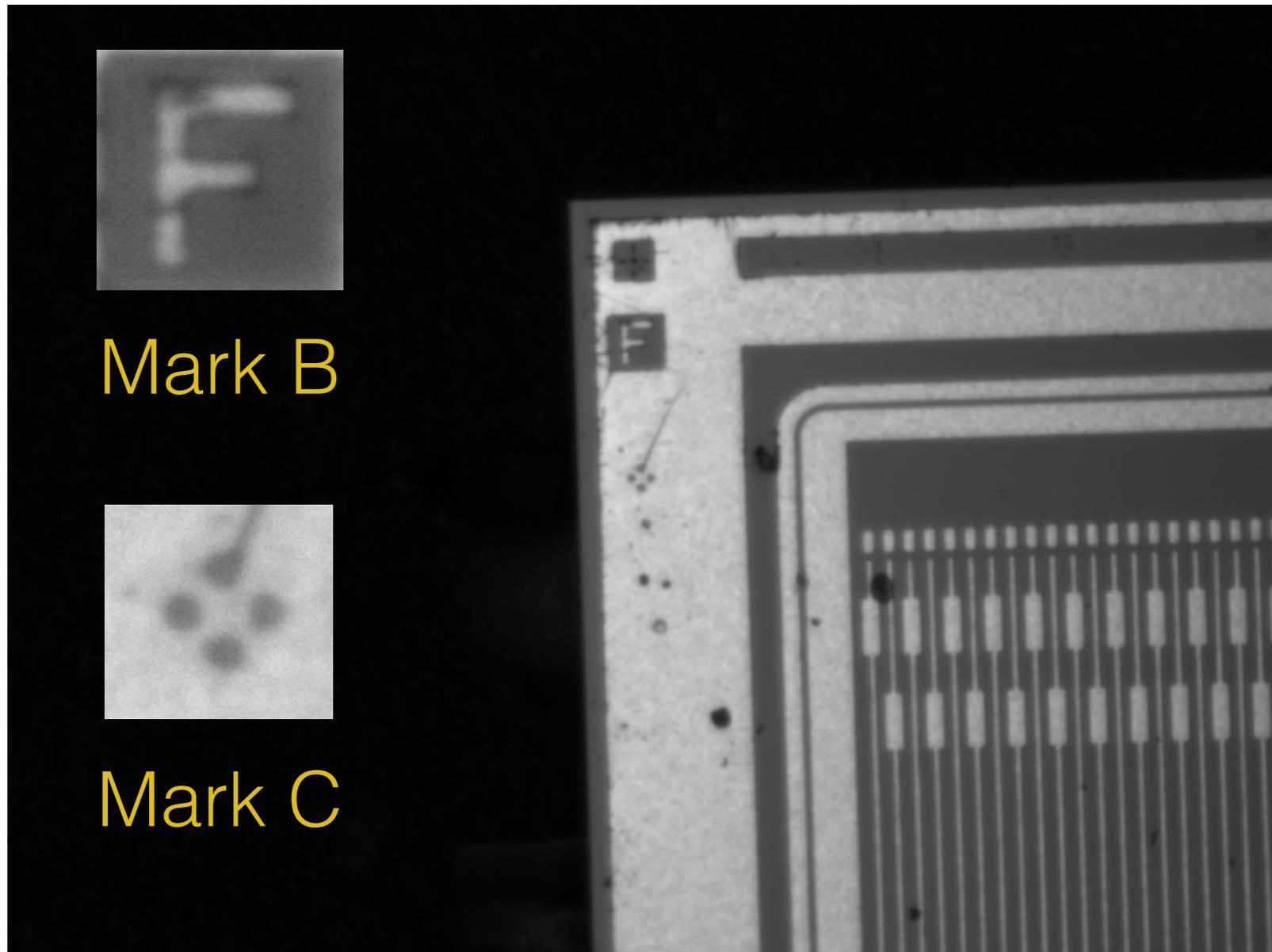
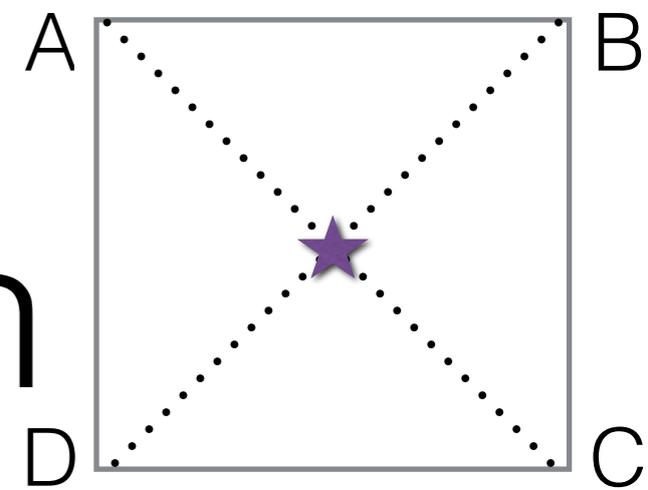
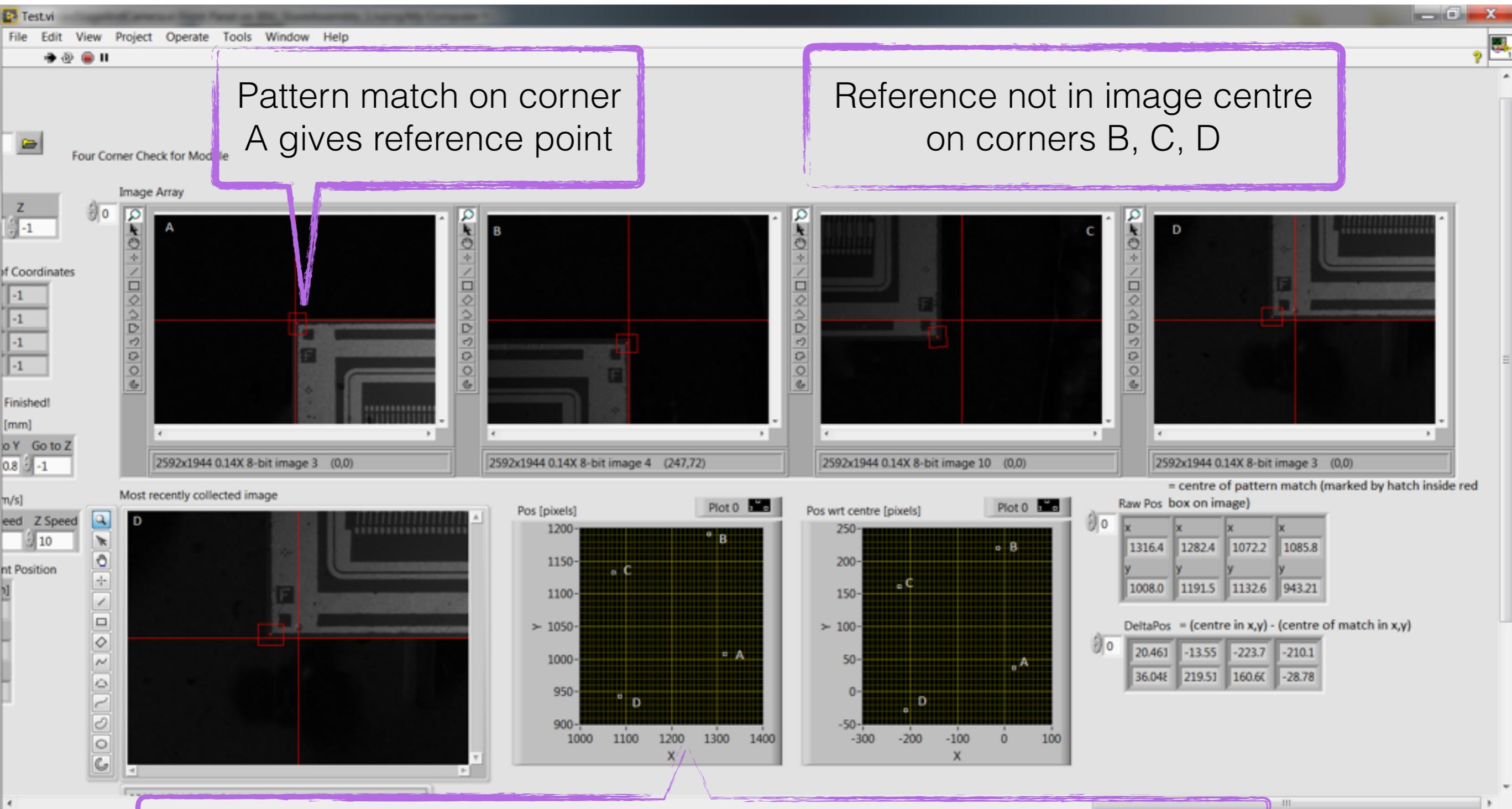


Module position



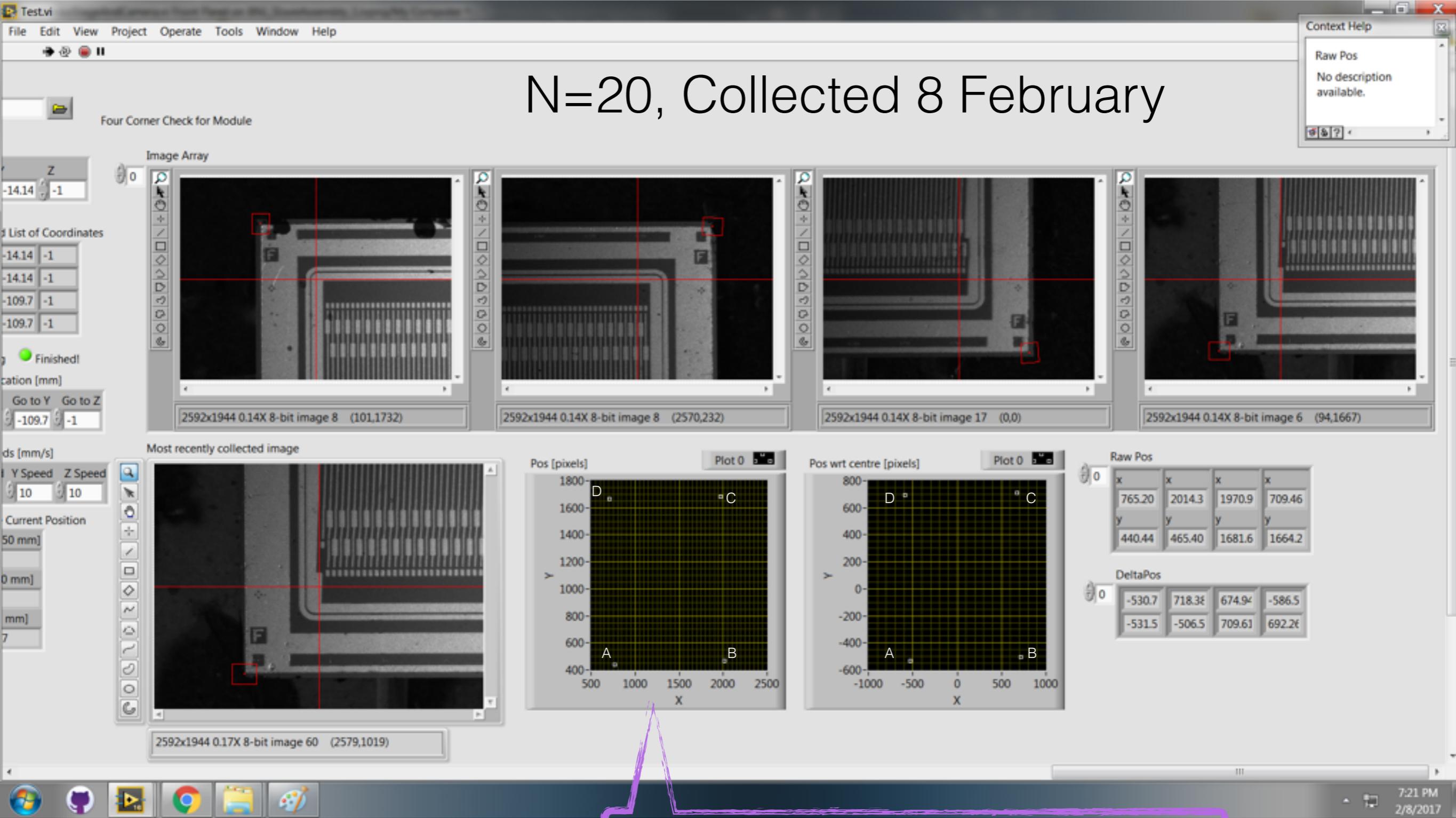
- Centre camera field on module corner A
- Predict B, C, D XYZ stage positions using module size
- Measure location of fiducial mark in each image to find
 - Centre of module
 - Angle of module rotation wrt stage

“Is my module aligned wrt the stage?”



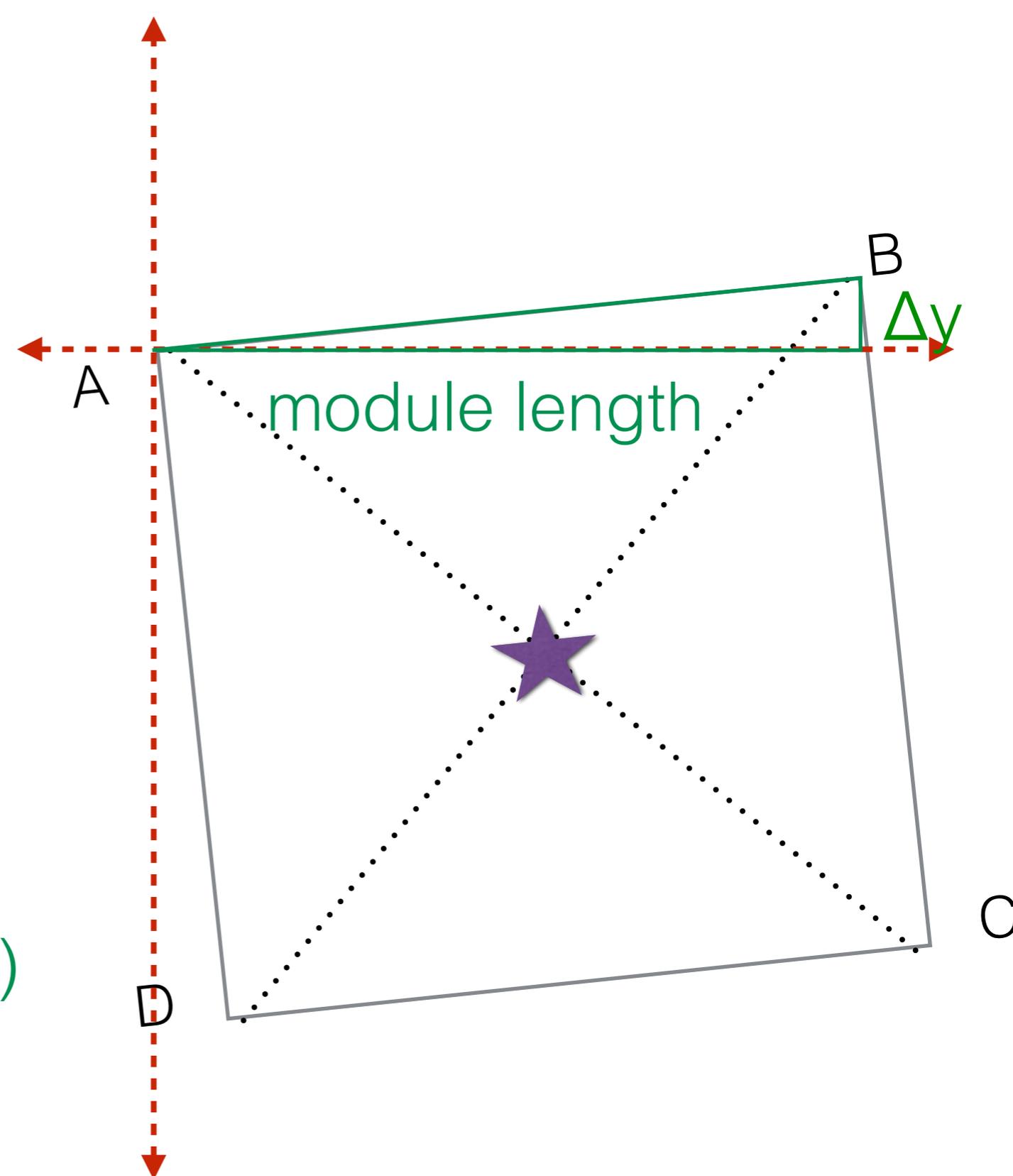
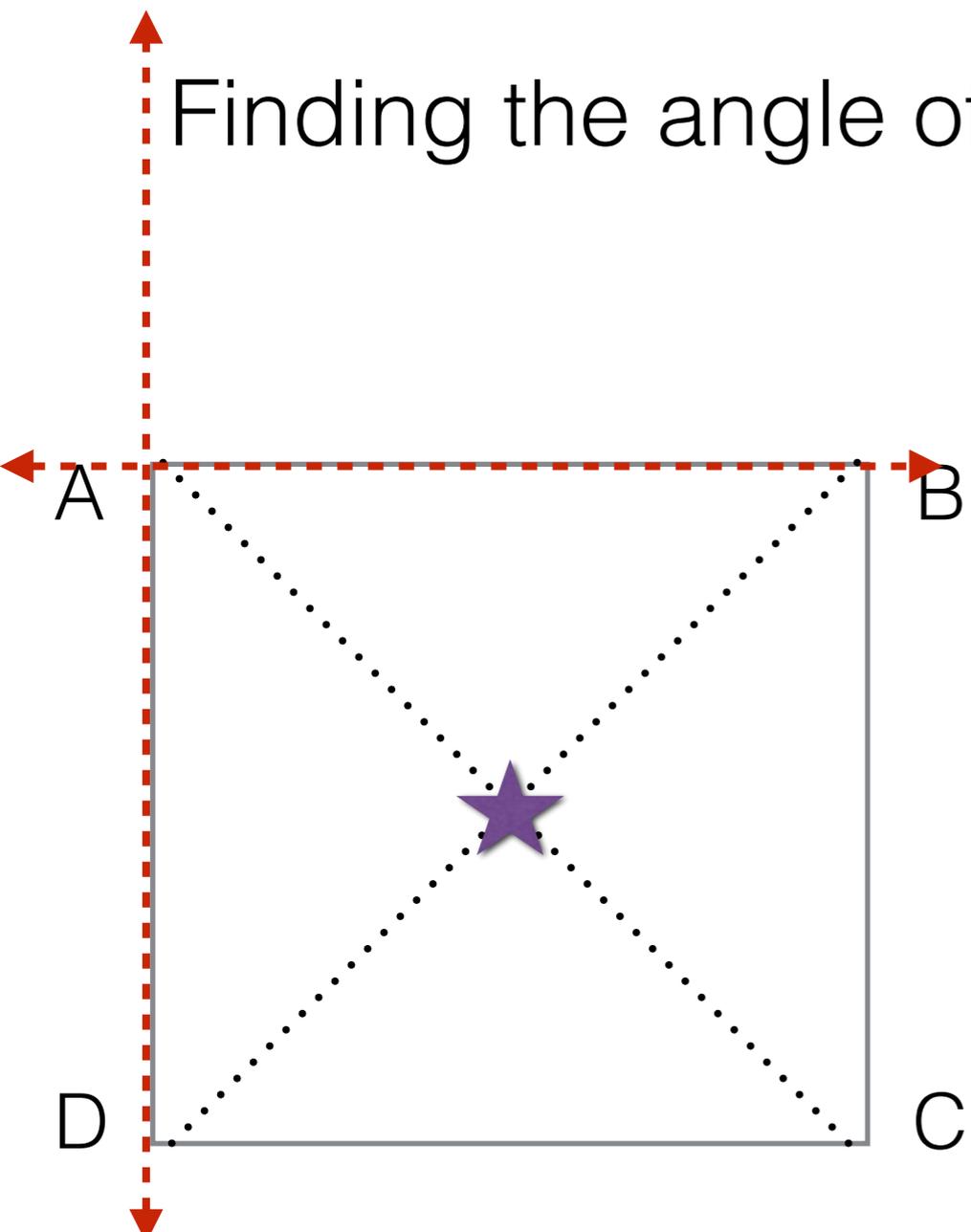
Improved module-stage alignment

N=20, Collected 8 February



Scatterplot of all pattern match coordinates shows a ~rectangle

Finding the angle of module rotation

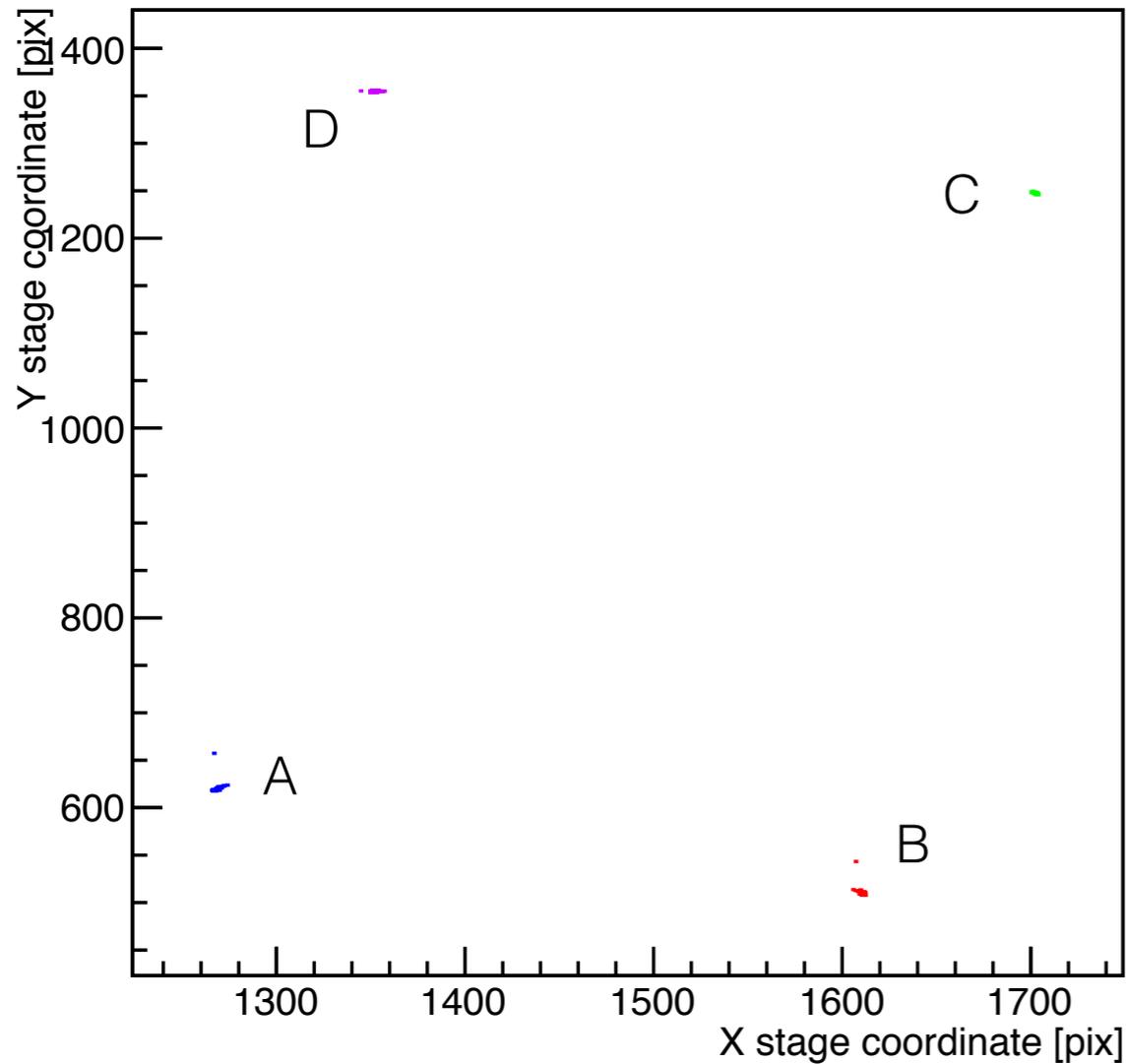


$$\theta = \arctan(\Delta y / \text{module length})$$

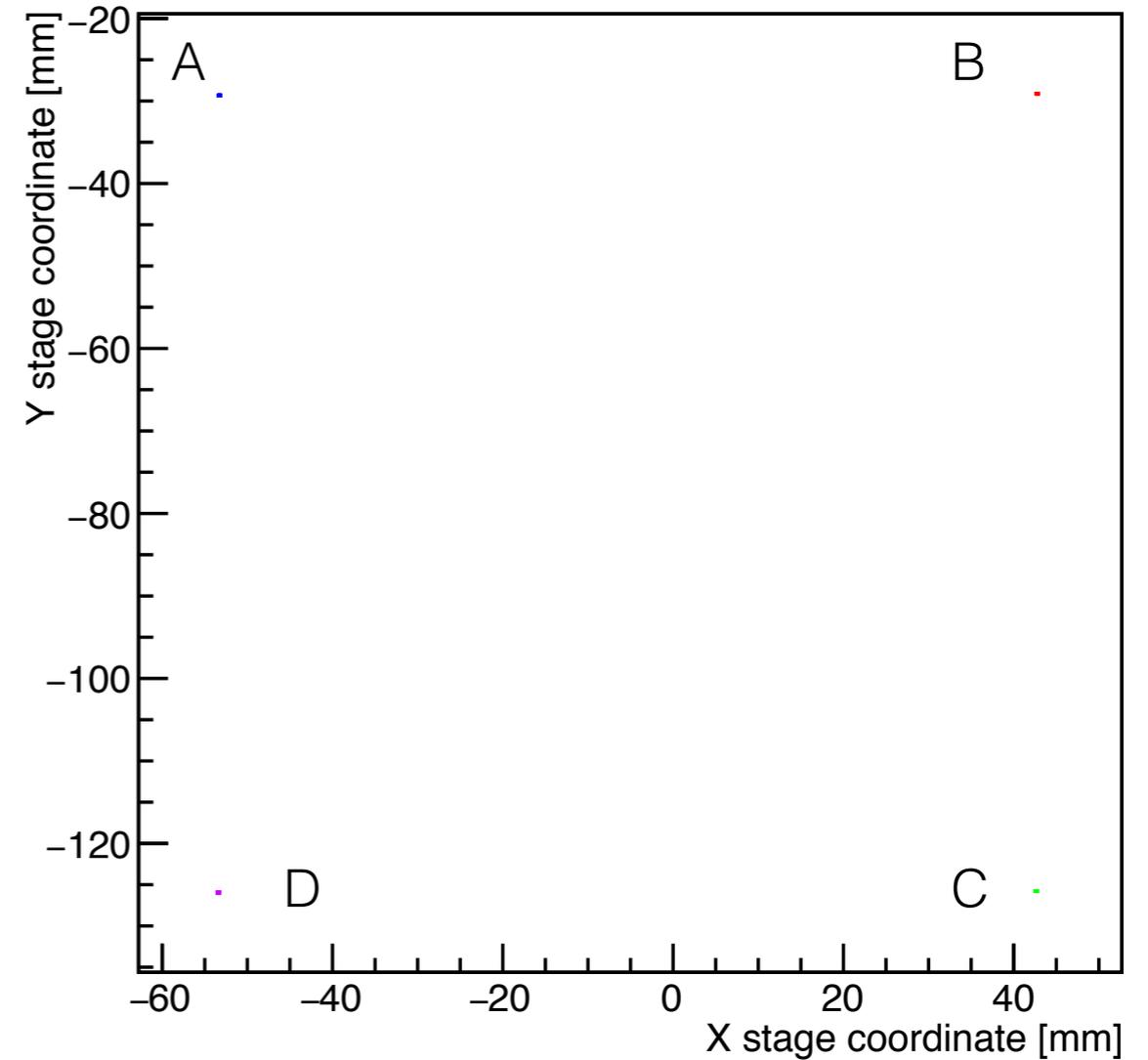
N=100 dataset, collected 6 February 2017

- Module positioned with post-it notes

Collected Module, F (N100)



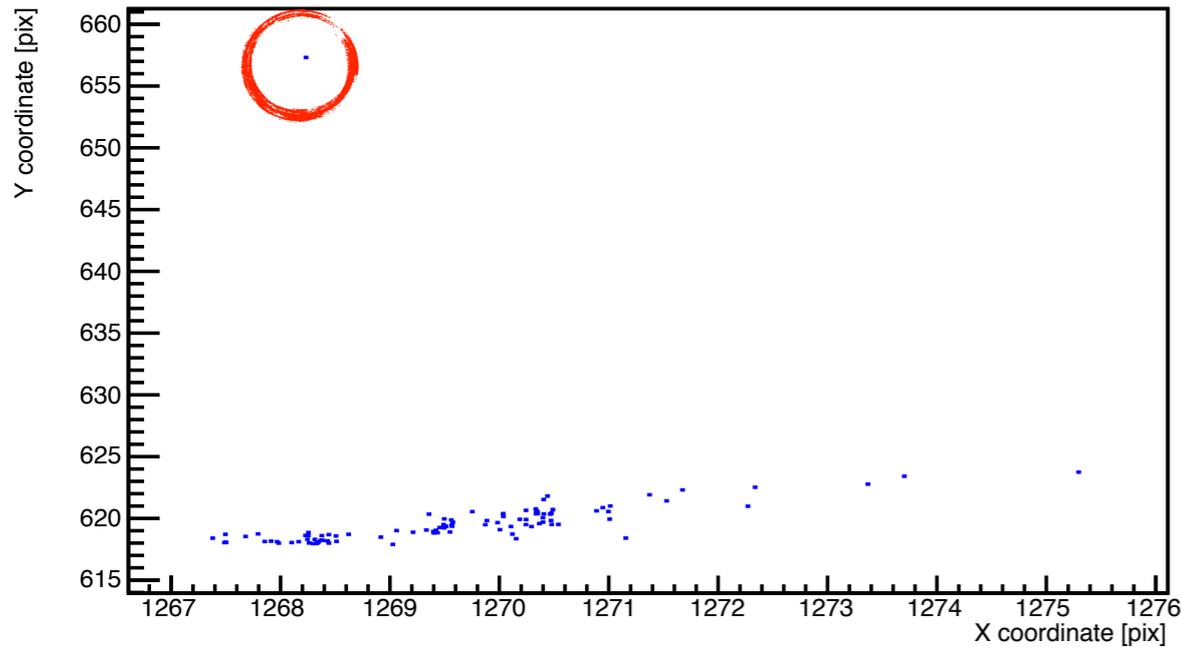
Collected Module, F (N100)



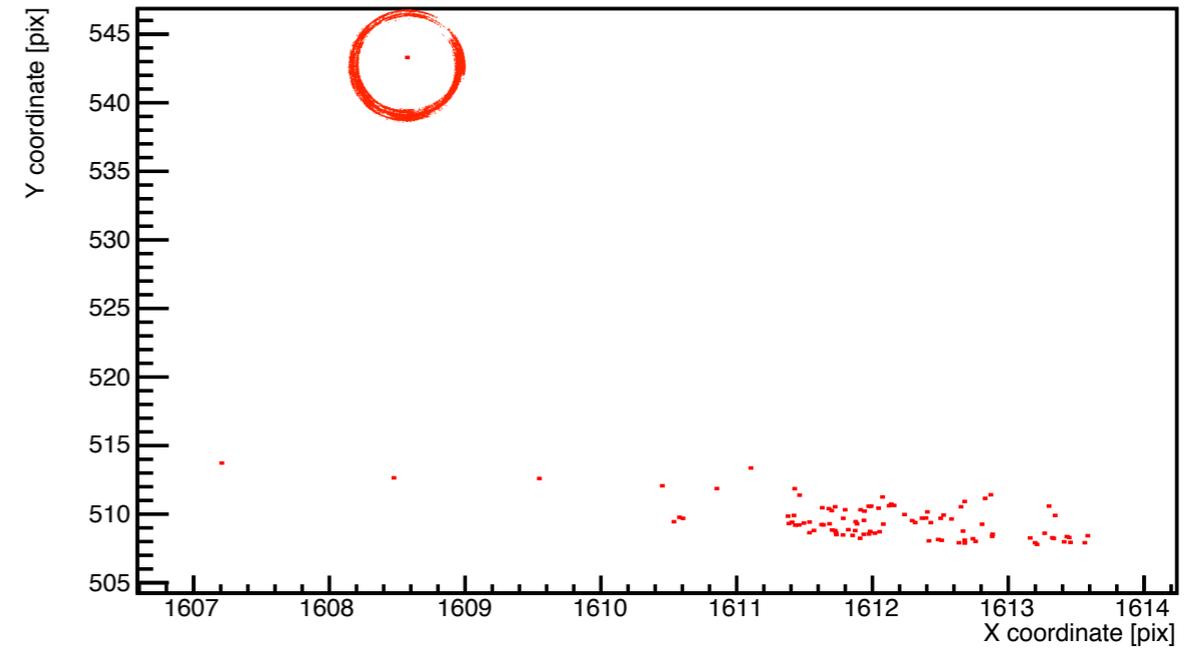
$\text{res}(F) = 0.792 \times 3.18 \text{ um}$
 $\text{res}(\text{Four Dots}) = 0.912 \times 2.94 \text{ um}$
 $\text{angle} = 0.107 \text{ degrees}$

N=100 dataset, collected 6 February 2017: Matching “F”

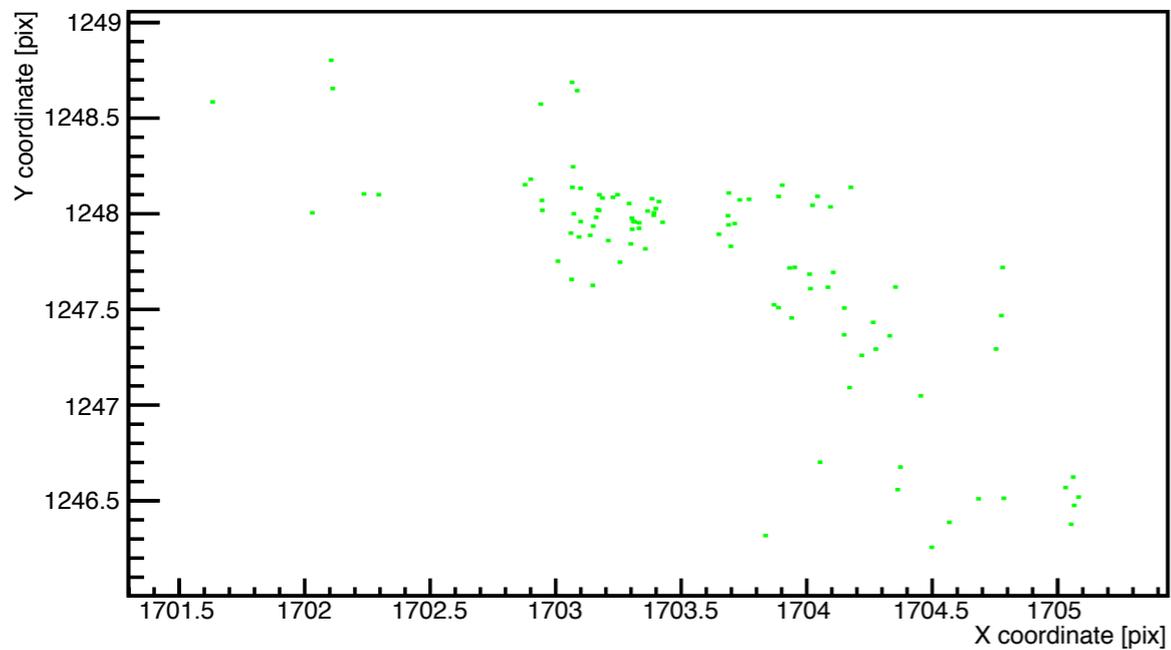
Corner A



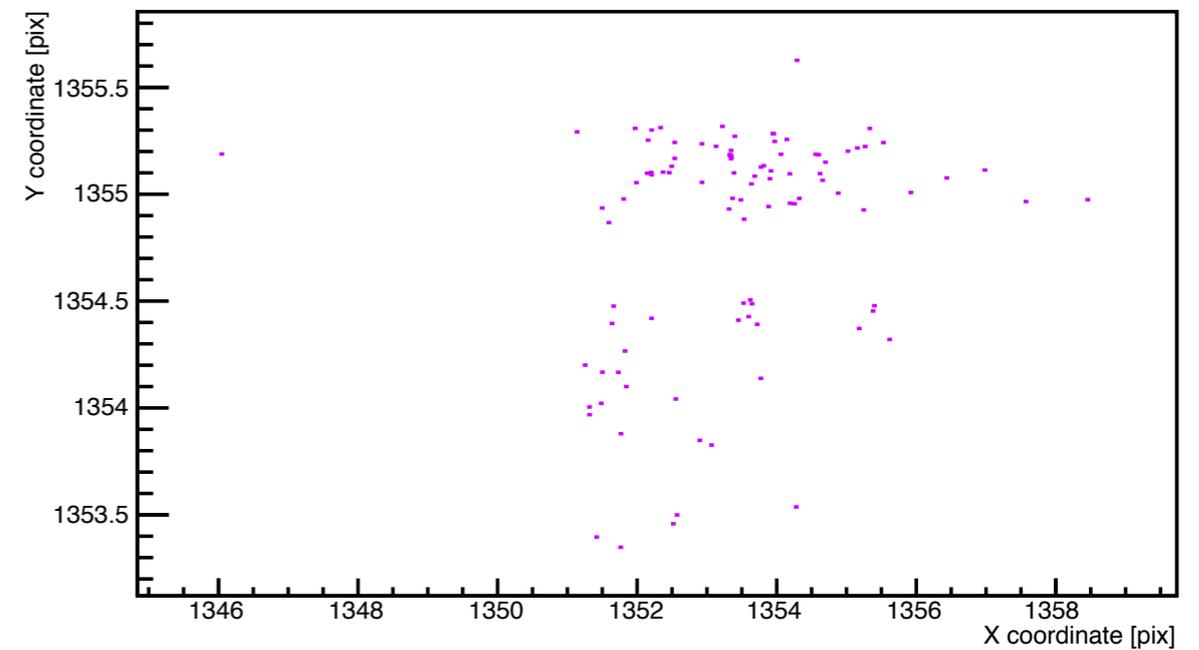
Corner B



Corner C

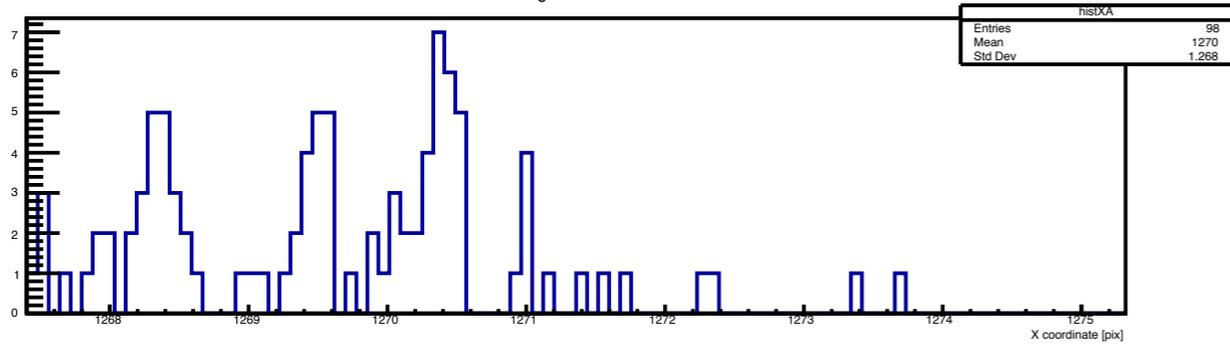


Corner D

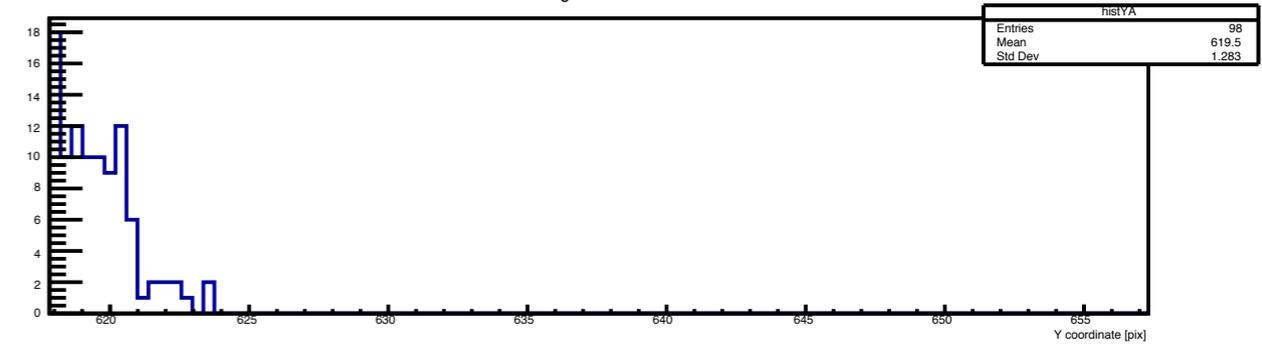


N=100 dataset, collected 6 February 2017: Matching "F"

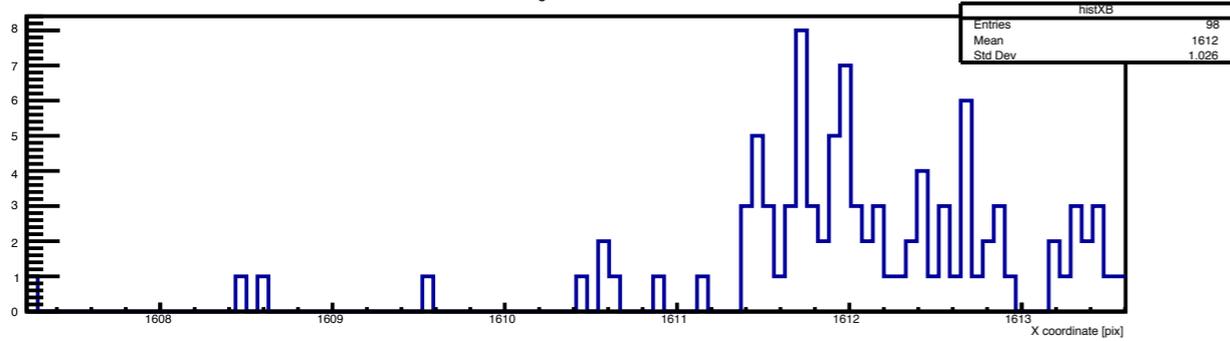
X histogram of corner A



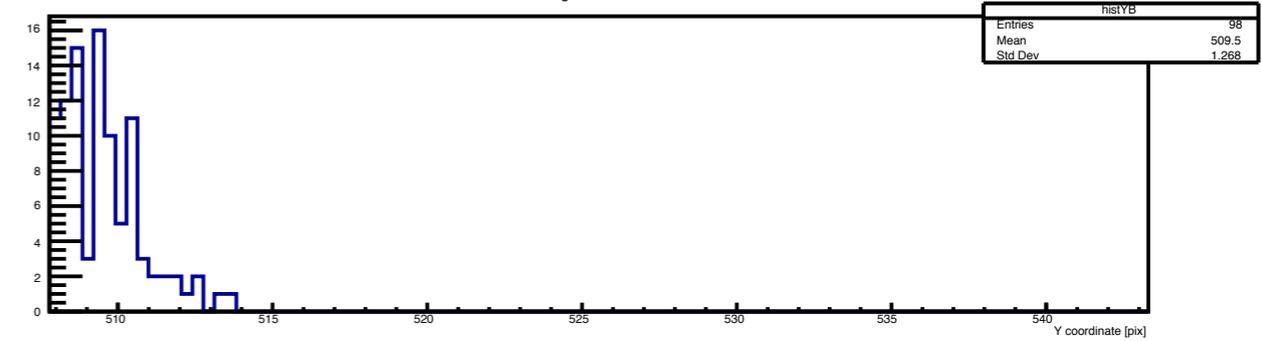
Y histogram of corner A



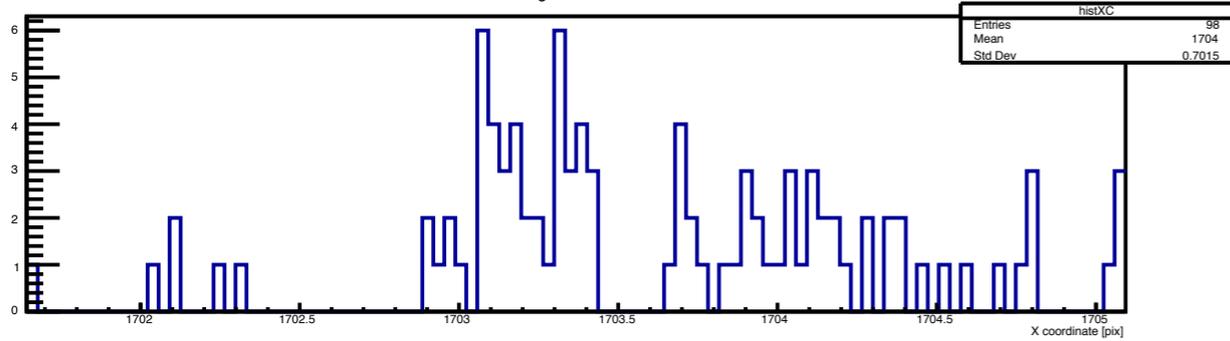
X histogram of corner B



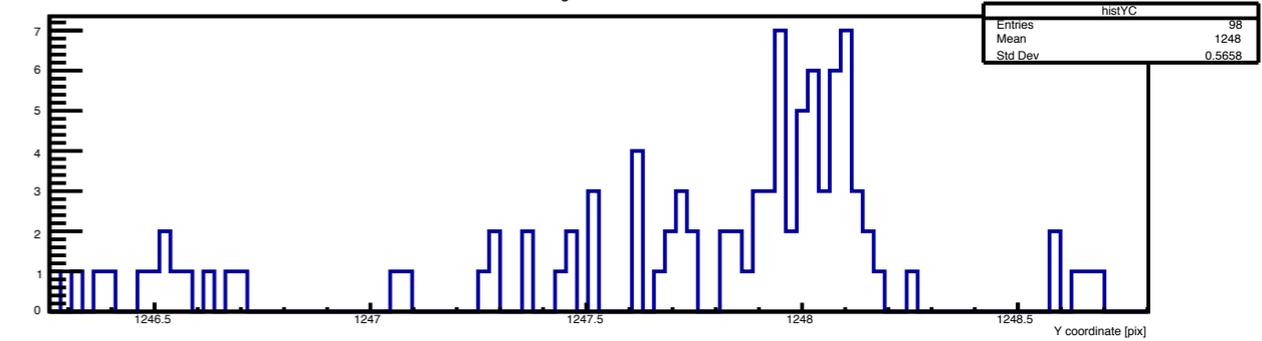
Y histogram of corner B



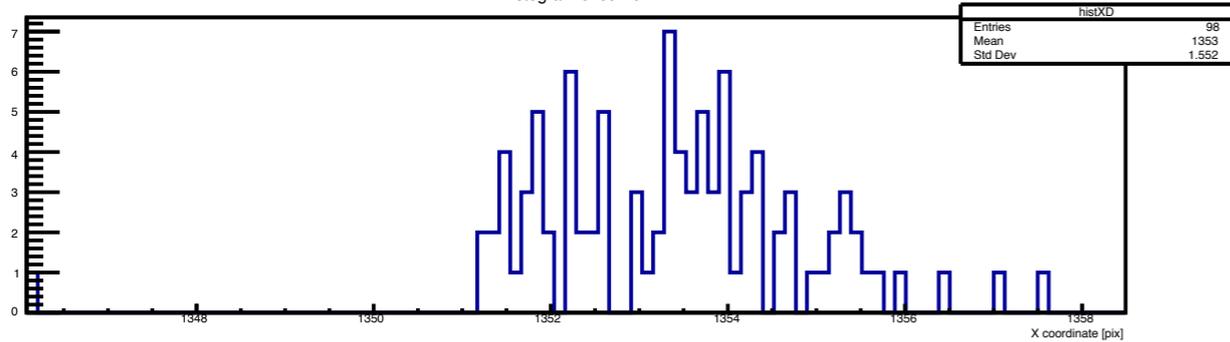
X histogram of corner C



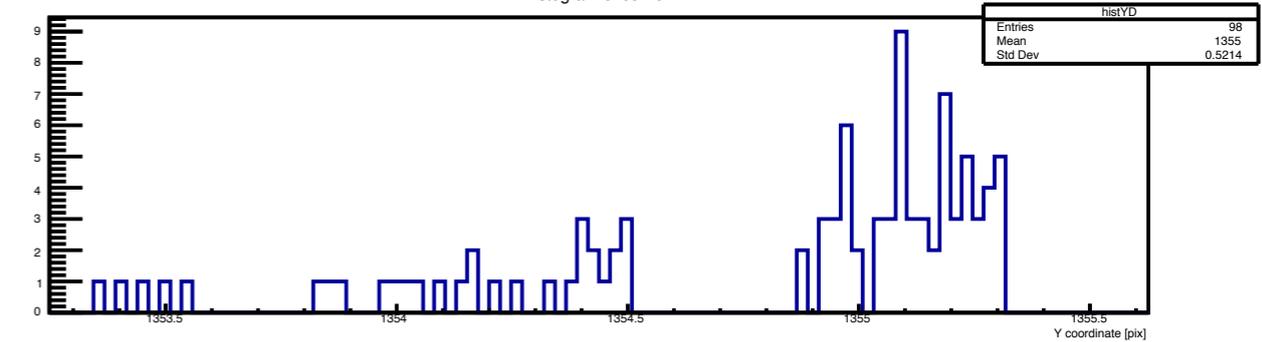
Y histogram of corner C



X histogram of corner D



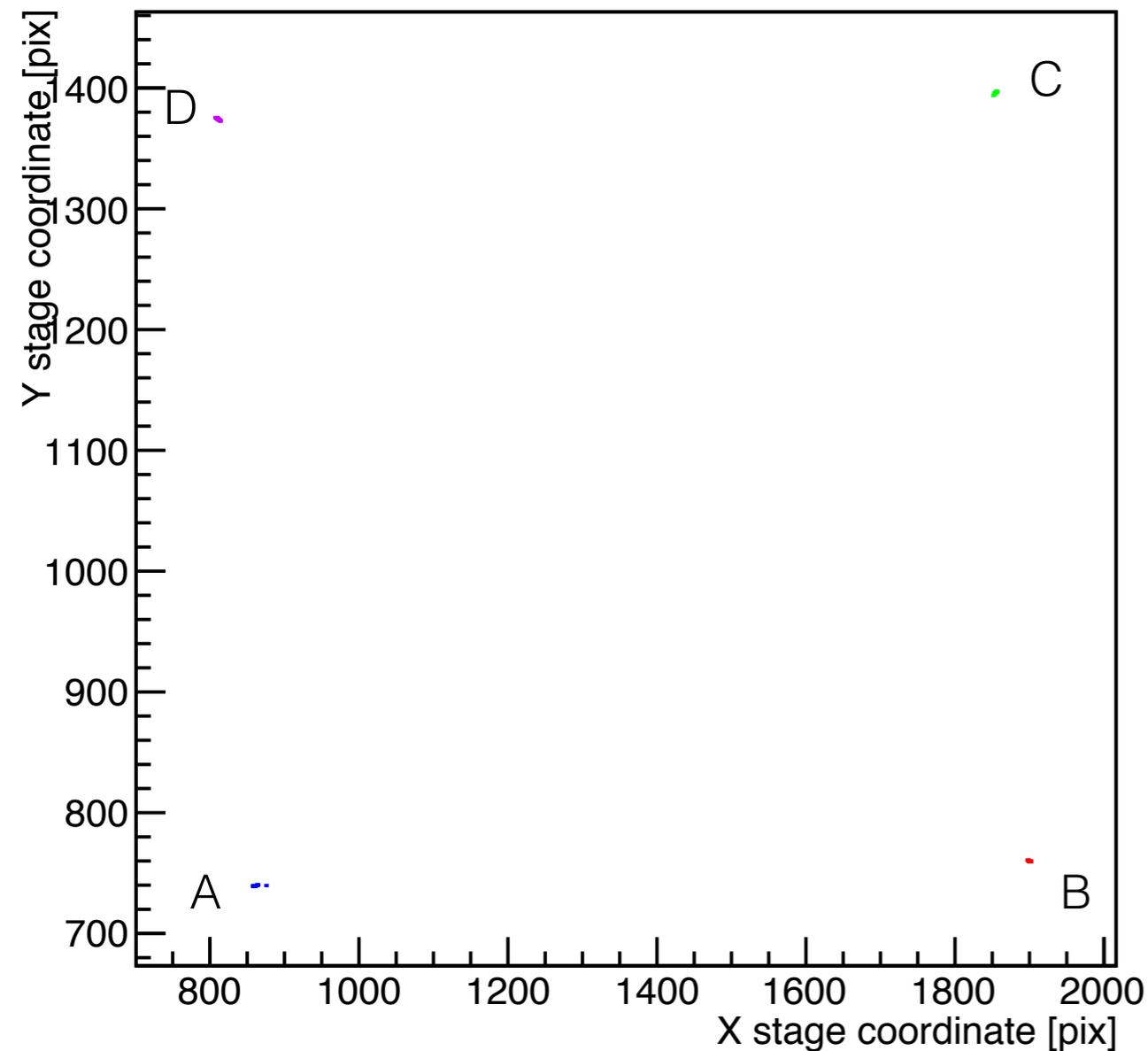
Y histogram of corner D



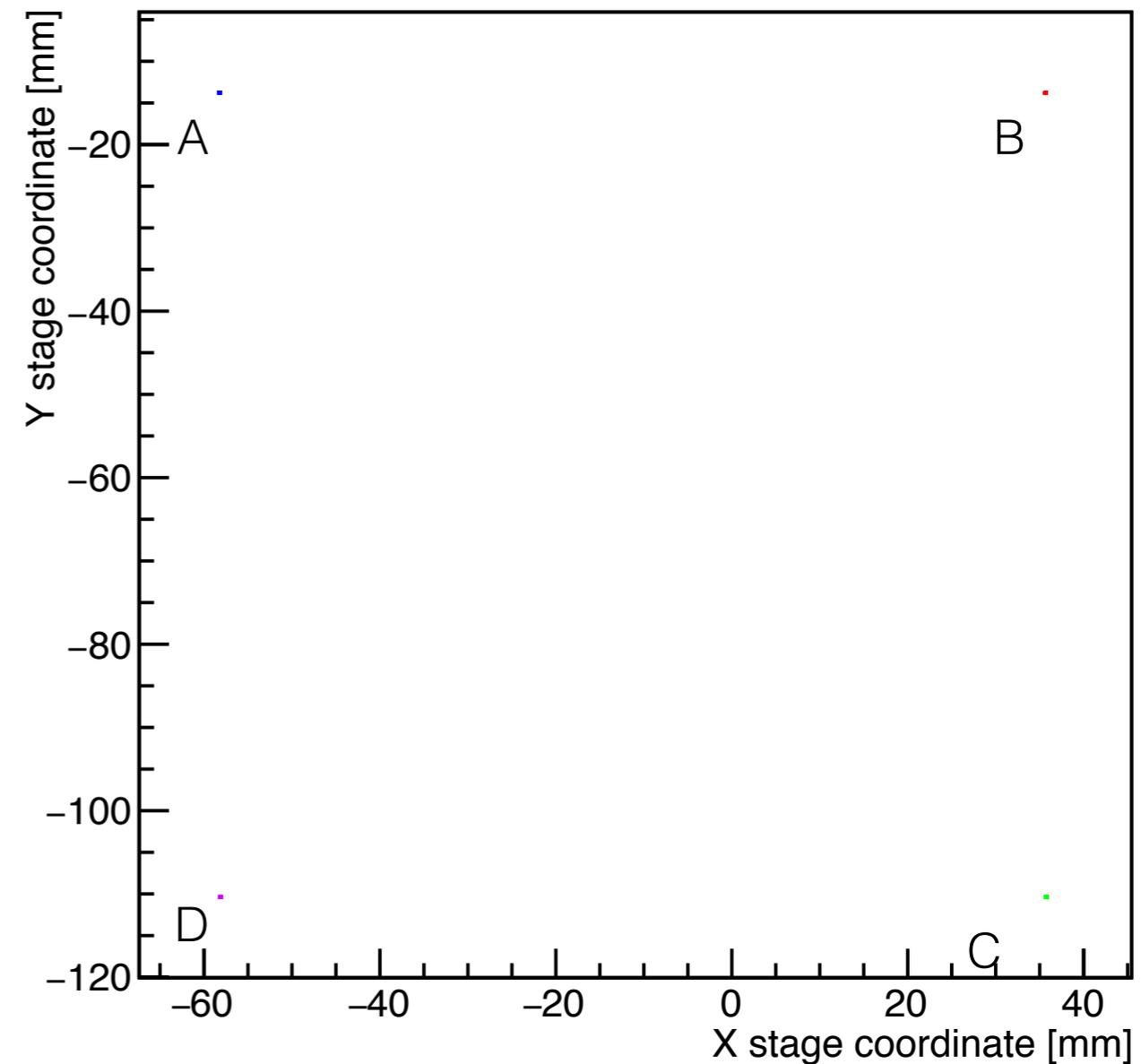
N=20 dataset, collected 8 February 2017

- Module positioned against precision set square

Collected Module, F (N20_02-08)



Collected Module, F (N20_02-08)



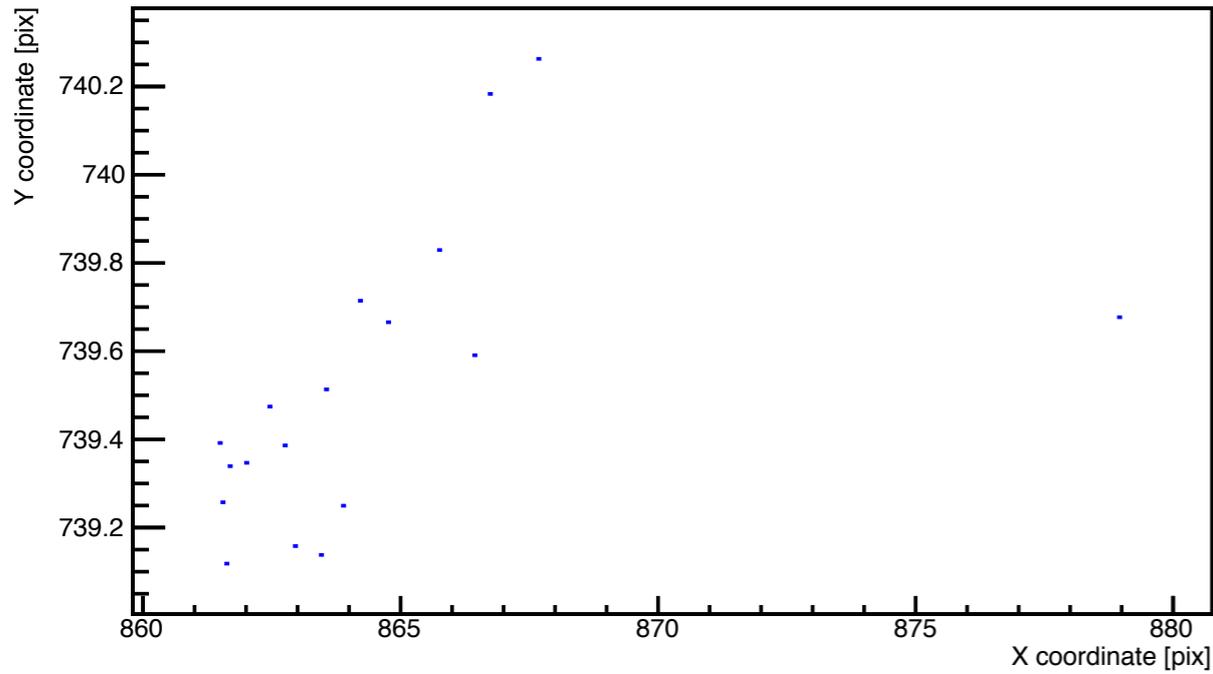
$$\text{res}(F) = 1.38 \times 0.79 \text{ um}$$

$$\text{res}(\text{Four Dots}) = 2.29 \times 1.93 \text{ um}$$

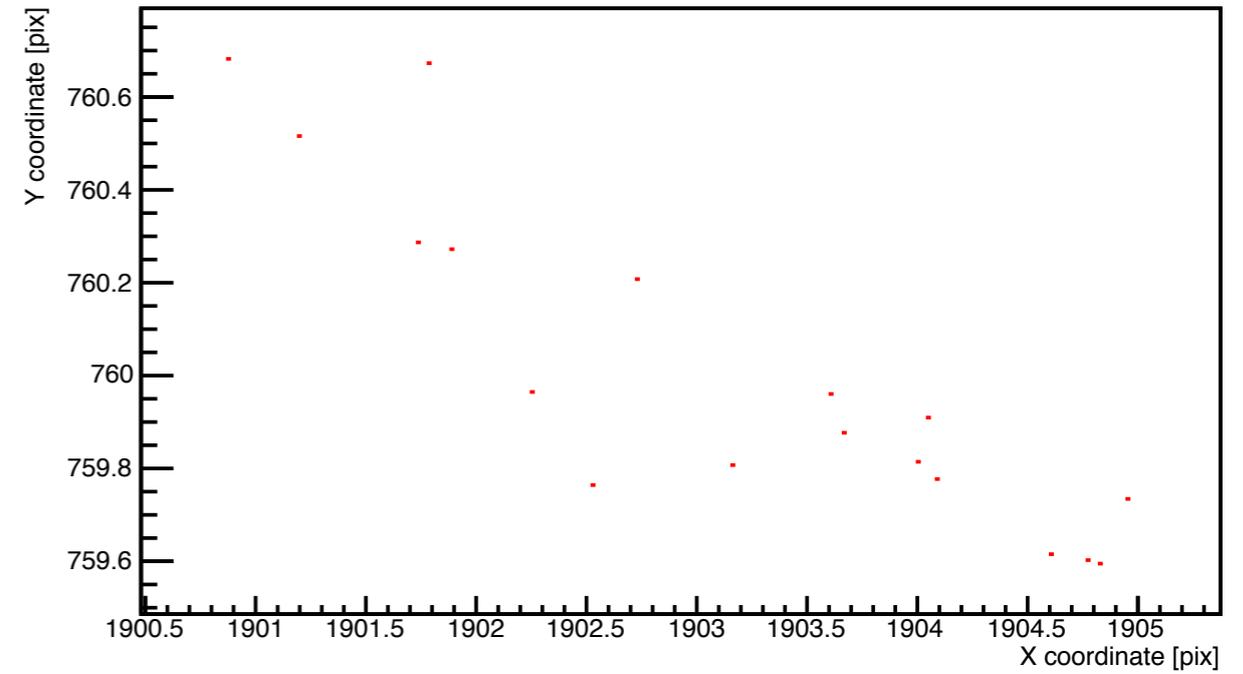
$$\text{angle} = 0.0195 \text{ degrees}$$

N=20 dataset, collected 8 February 2017: matching "F"

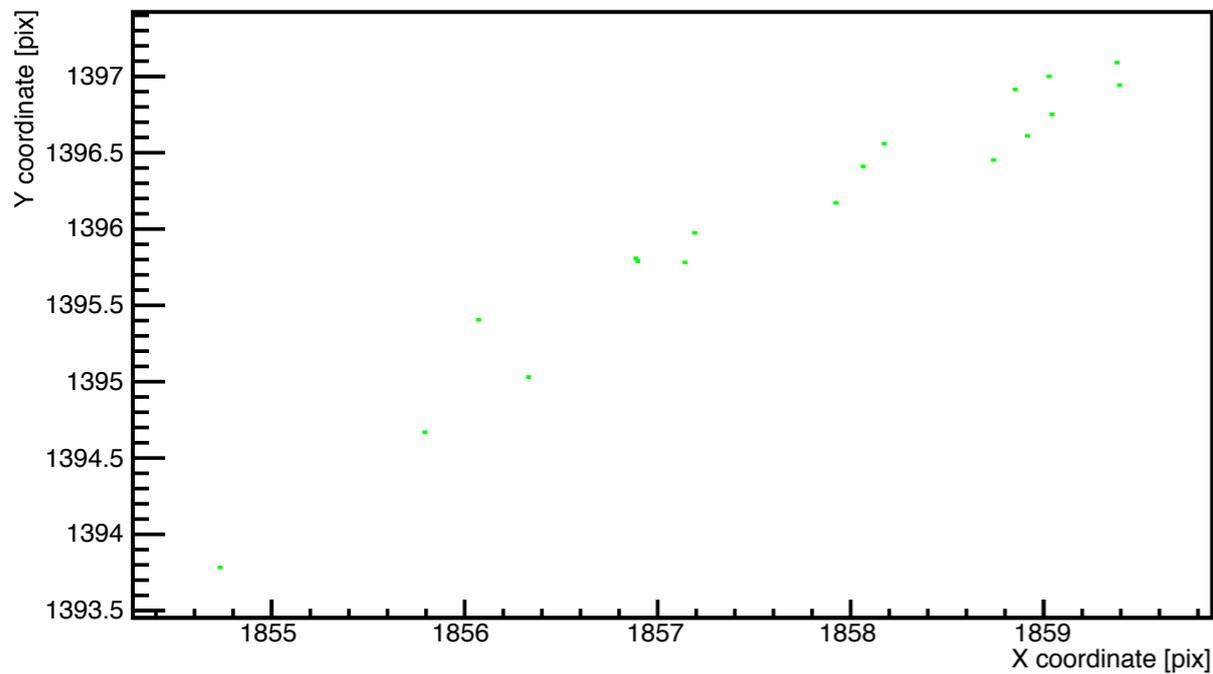
Corner A



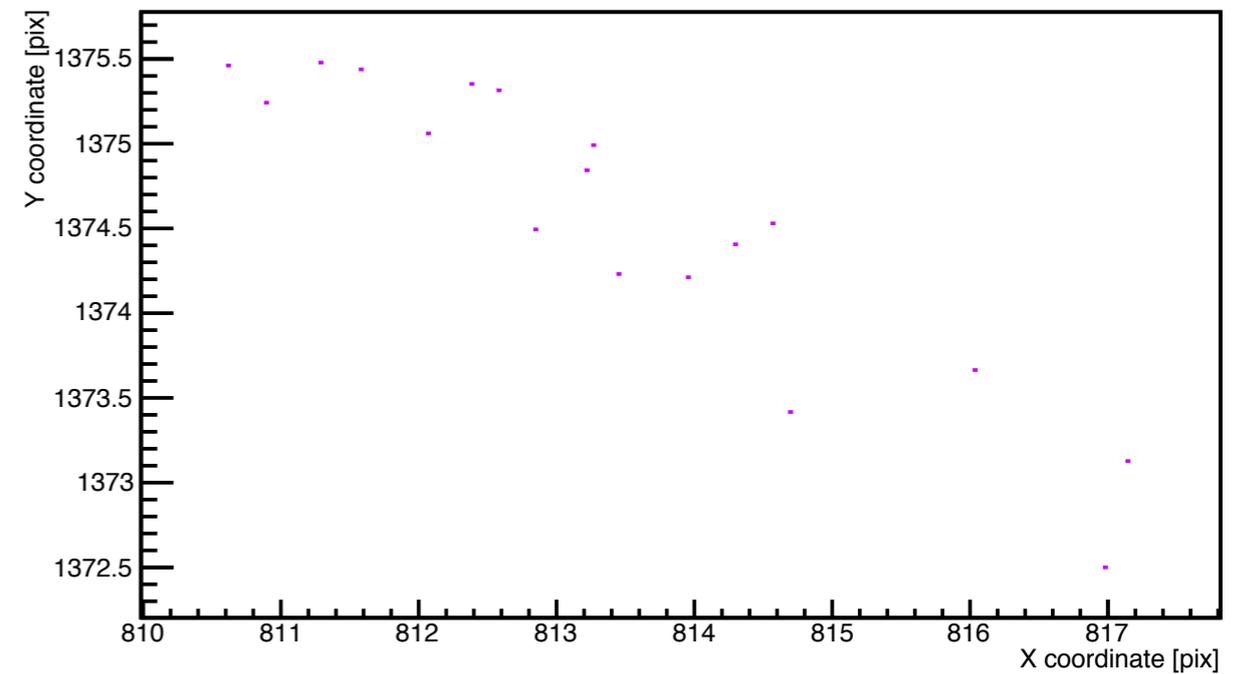
Corner B



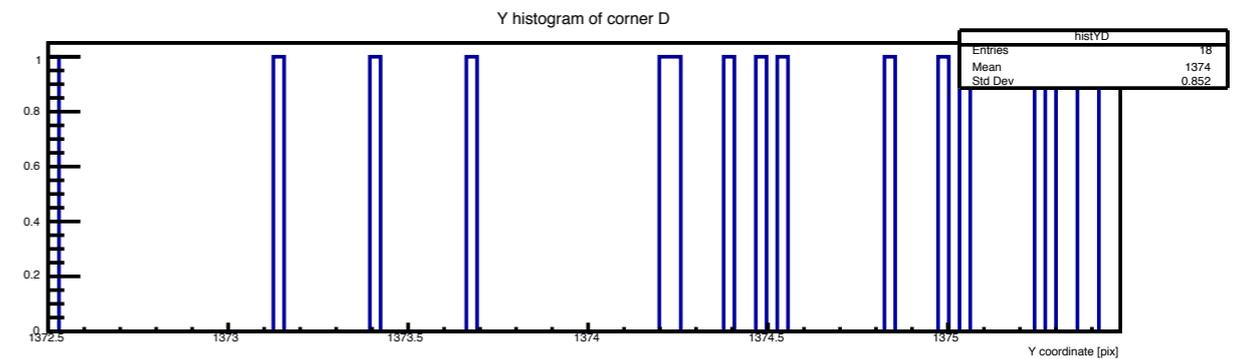
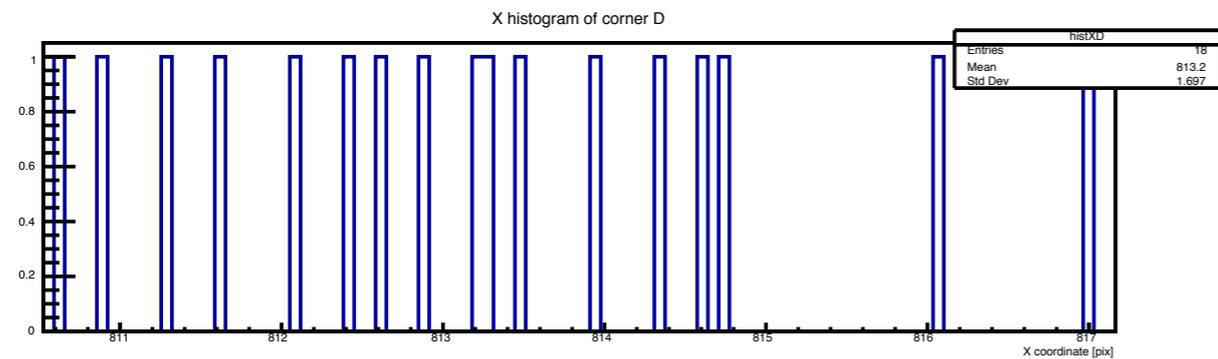
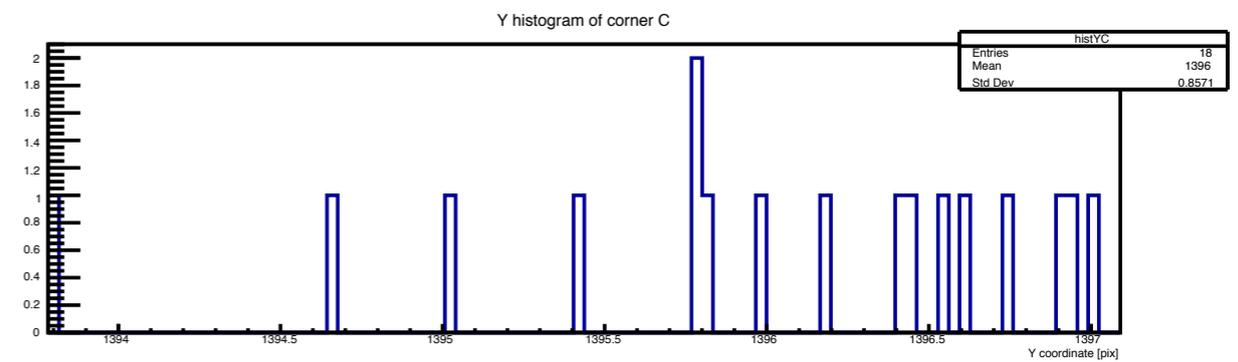
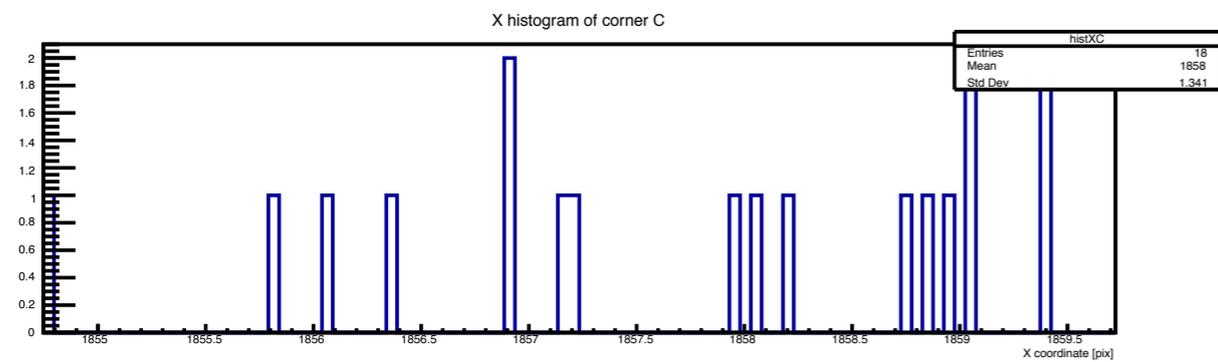
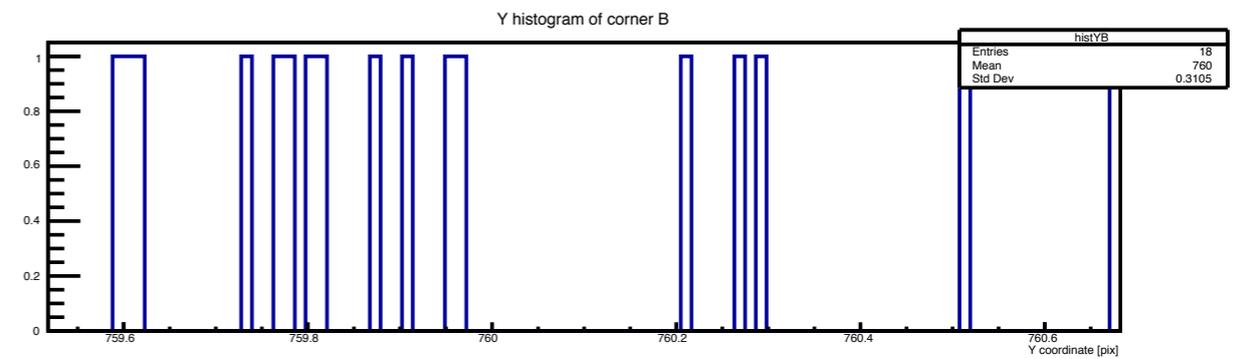
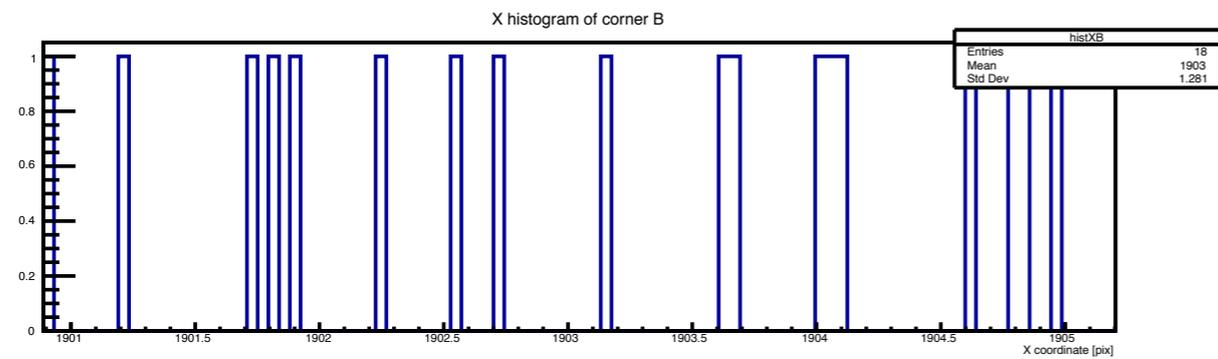
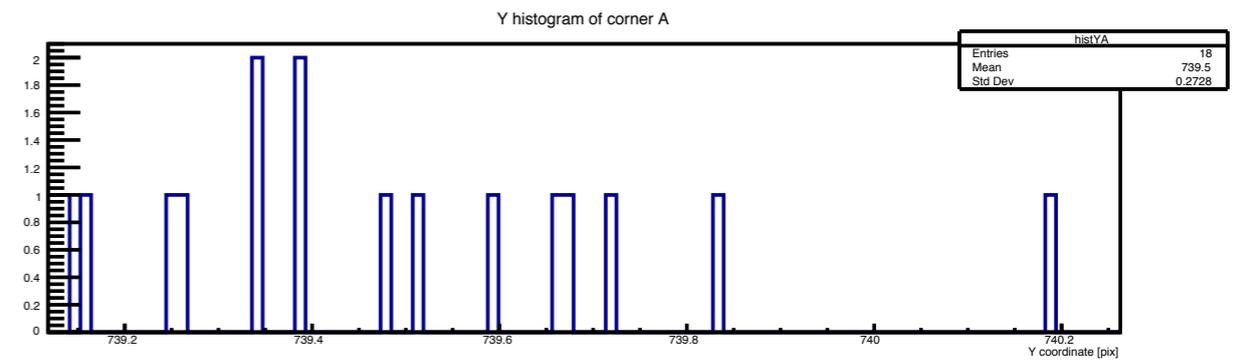
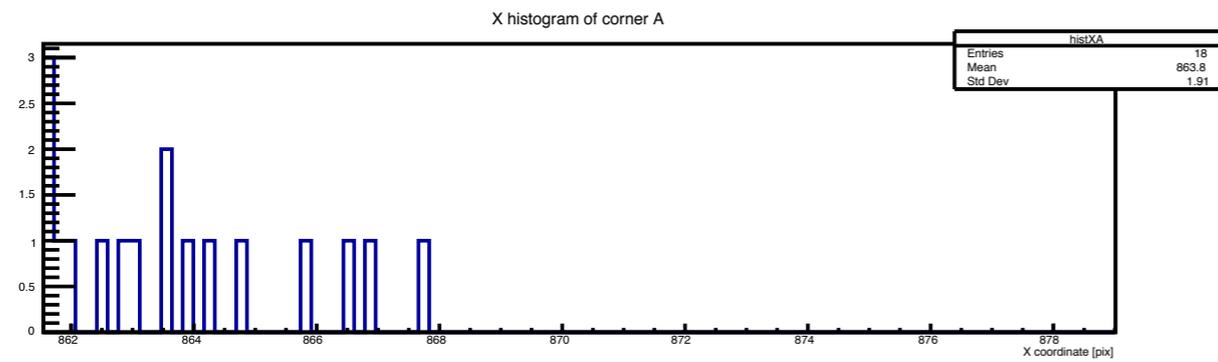
Corner C



Corner D



N=20 dataset, collected 8 February 2017: Matching "F"



Notes

- Template quality matters
 - “F” template larger than four dots template
- Point distributions/histograms not Gaussian
 - Should move to fits... unlikely that a Gaussian fit is appropriate