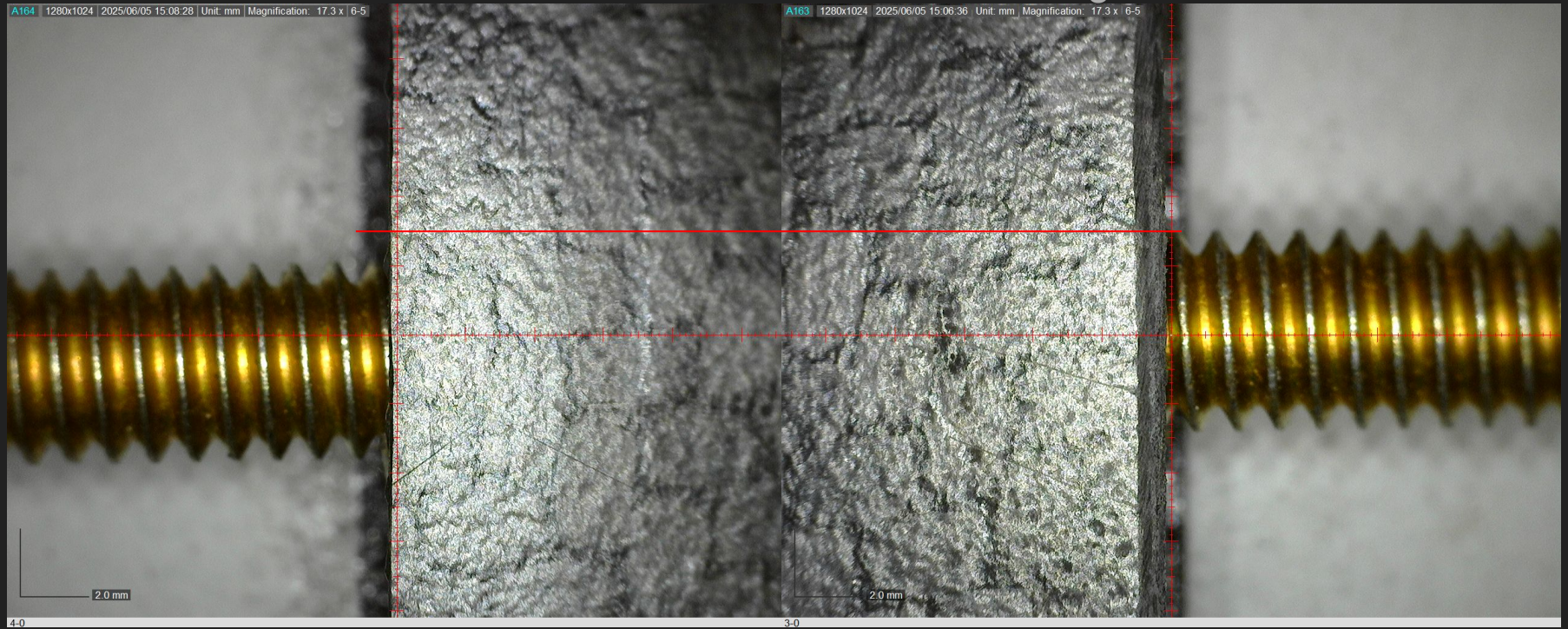
Demonstration of measuring φ*R distribution with camera parallel to -r

Ring 4, Hole 0/120

Ring 3, Hole 0/120

Crosshair aligned to this rod



Analysis

The crosshair was zeroed so that the upper 3mm mark aligned with the top of ring 3 rod 0/120

Difference in position measured as the height above the center line minus 3mm

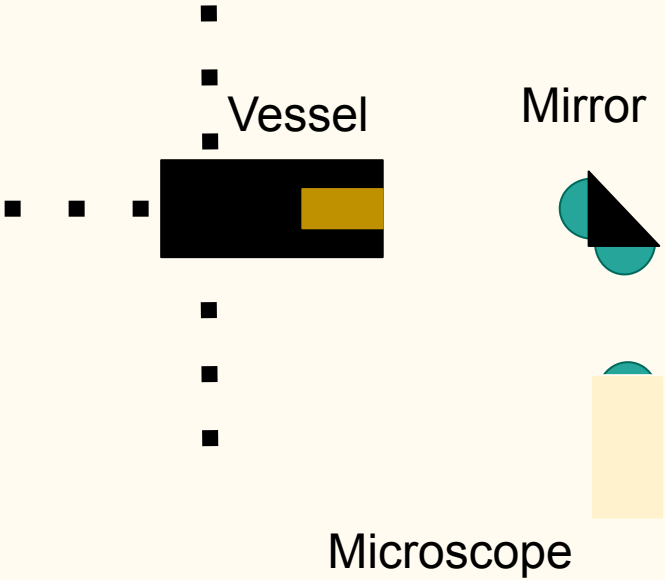
	0/120	15	30	45	60	75	90	105
Ring 4	-0.9mm	-0.4mm	-0.2mm	-0.1mm	0mm	-0.2mm	-0.2mm	-0.7mm
Ring 3	0mm	0mm	0.2mm	0.4mm	0.4mm	0.3mm	0.3mm	0.1mm
3-4	0.9 mm	0.4 mm	0.4 mm	0.5 mm	0.4 mm	0.5 mm	0.5 mm	0.8 mm

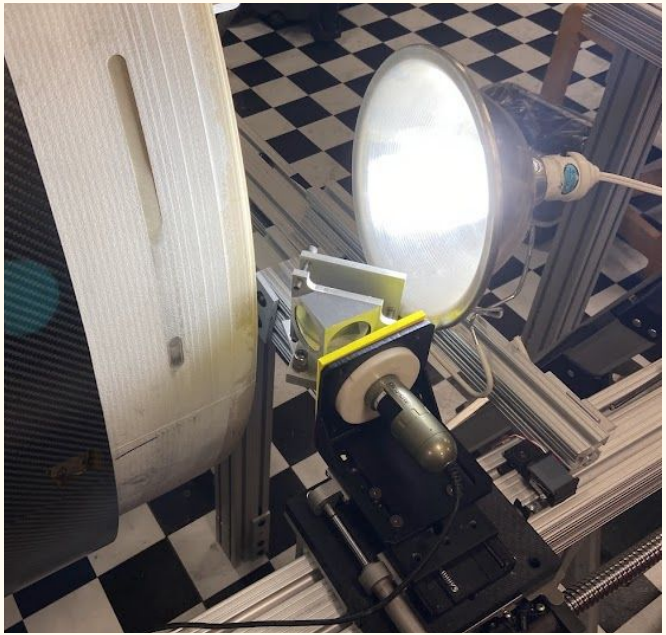
Around ring 3, the mean displacement relative to ring 3 hole 0 is 0.21 mm and the standard deviation is 0.15 mm

Around ring 4, the mean displacement relative to ring 3 hole 0 is -0.34 mm and the standard deviation is 0.29 mm

The difference between means is 0.55 mm

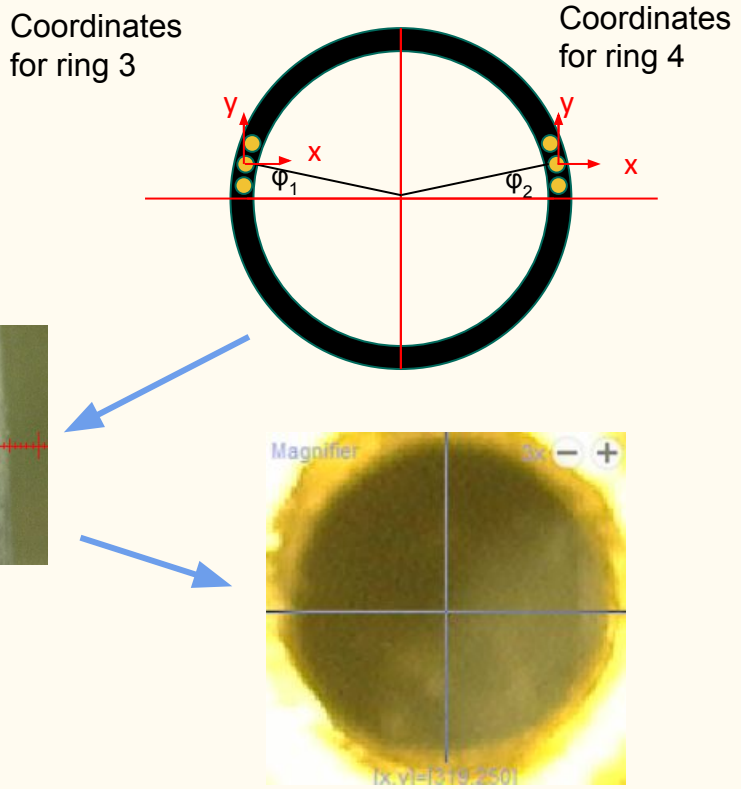
Set up





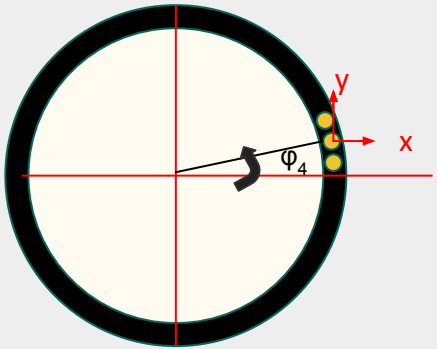
Measurement

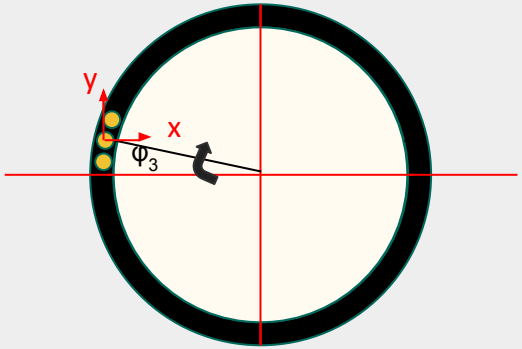
- Calibrate the microscope
- Center the microscope on one hole to avoid parallax
- Use a digital zoom and crosshair to estimate the x and y pixel value at the center of the hole.
- Rotate the mandrel by 1/120 of a revolution and find the central pixel value for the next hole
- repeated the process for all holes.
- Find the conversion from pixel to mm



Coordinate Systems Looking Parallel to +/- ẑ

Coordinates for ring 4
Hole numbers go counter-clockwise





Coordinates for ring 3
Hole numbers go clockwise

Converting from local (x,y) to (R,φ)

All (x',y') measured at a fixed φ_n for each ring

$x_n = R_n * \cos(\varphi_n)$

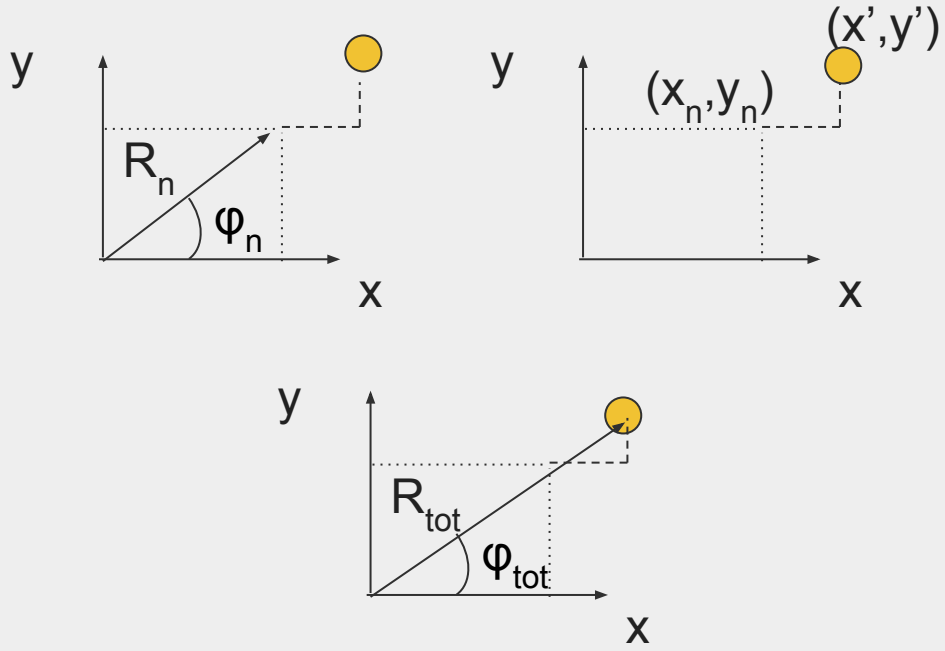
$y_n = R_n * \sin(\varphi_n)$

$X_{tot} = x_n + x'$

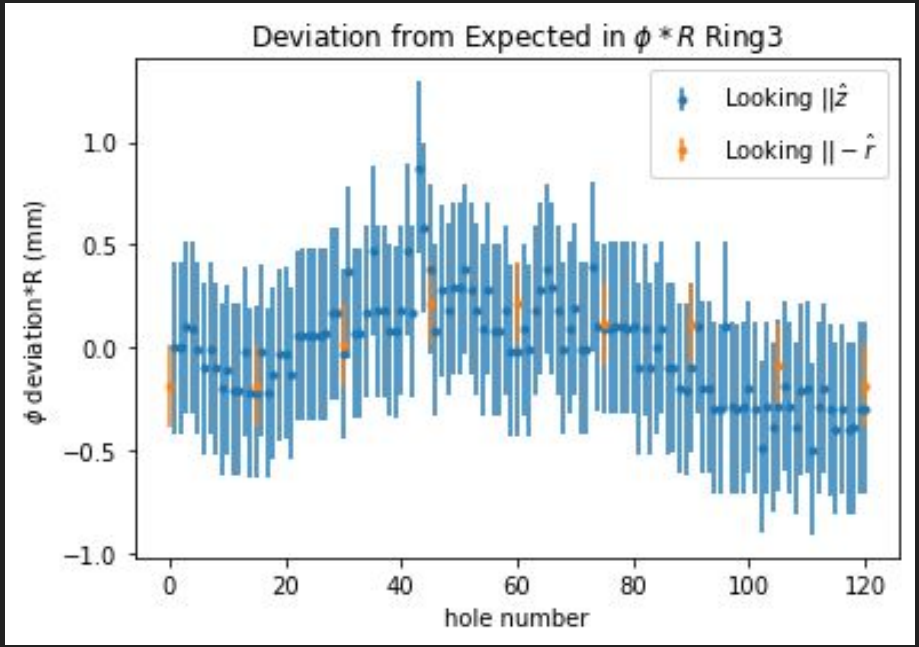
$y_{tot} = y_n + y'$

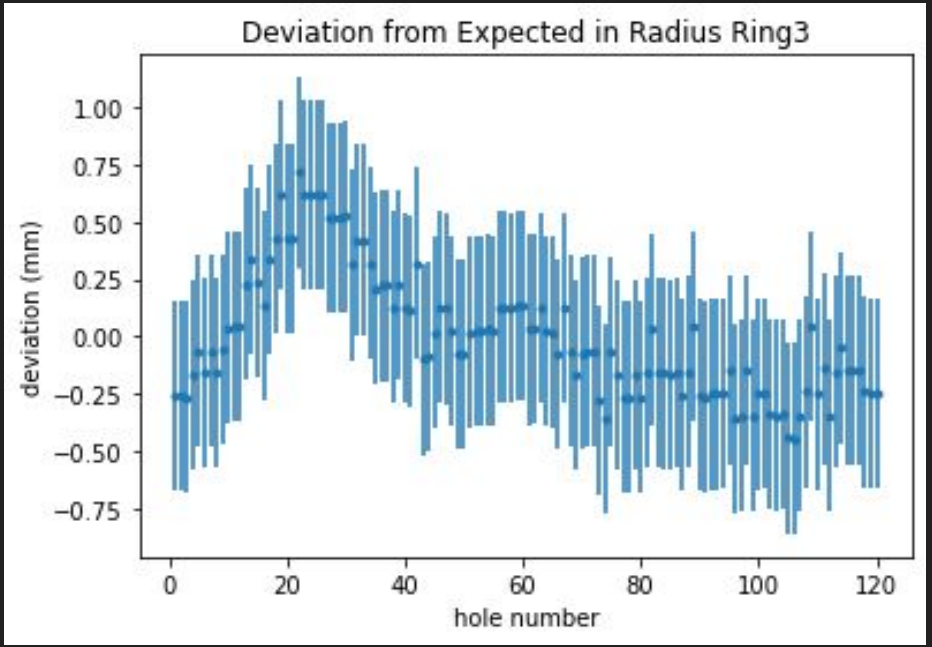
$R_{tot} = \sqrt{x_{tot}^2 + y_{tot}^2}$

$\varphi_{tot} = \tan^{-1}(y_{tot}/x_{tot})$

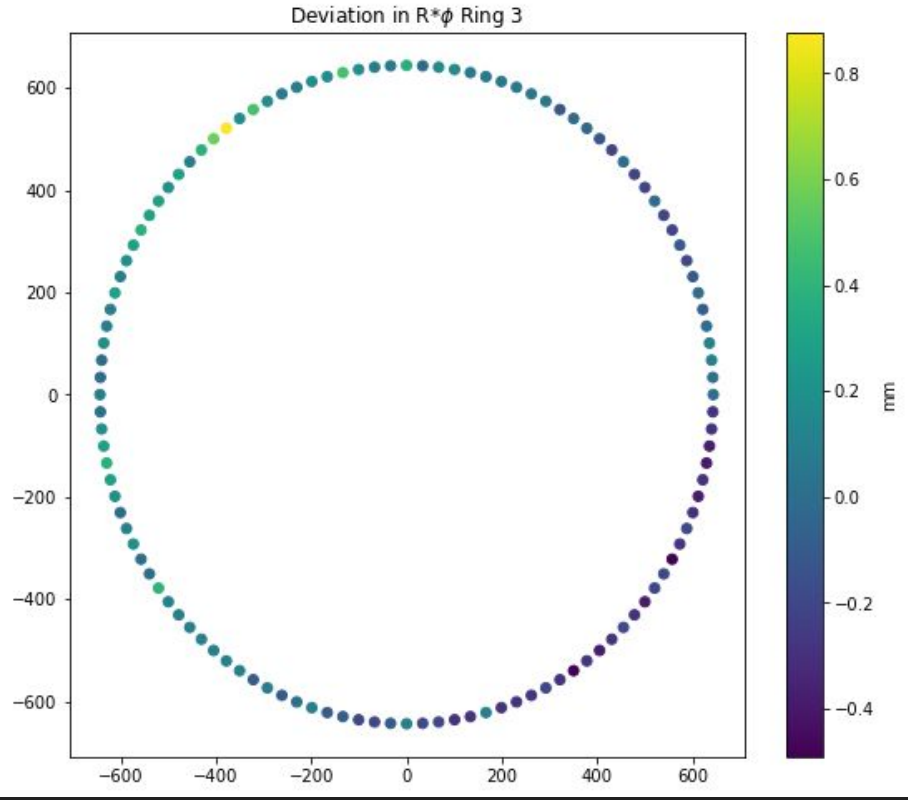


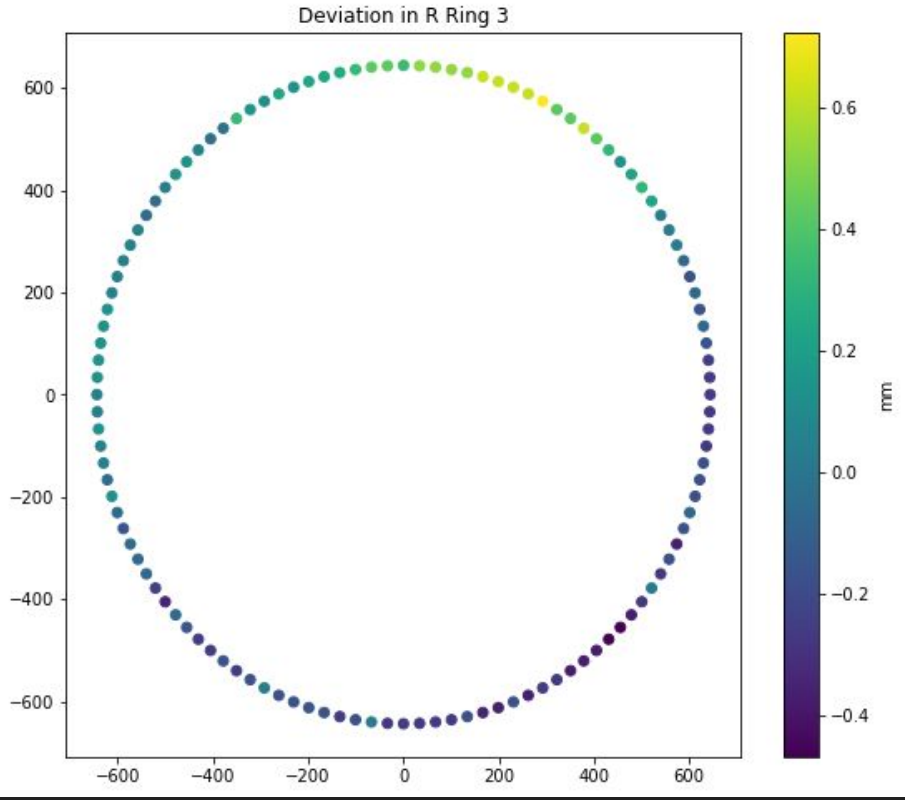
Results


Deviation from Expected in $\phi * R$ Ring3
Looking $||\hat{z}$
Looking $|| -\hat{r}$
ϕ deviation*R (mm)
1.0
0.5
0.0
−0.5
−1.0
0
20
40
60
80
100
120
hole number

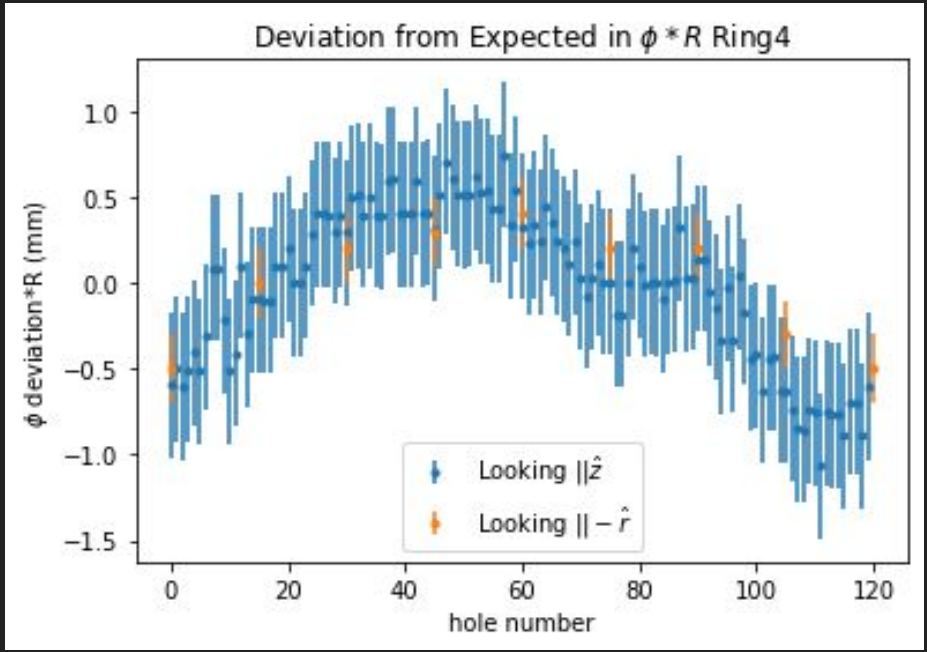

Deviation from Expected in Radius Ring3
deviation (mm)
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
0
20
40
60
80
100
120
hole number

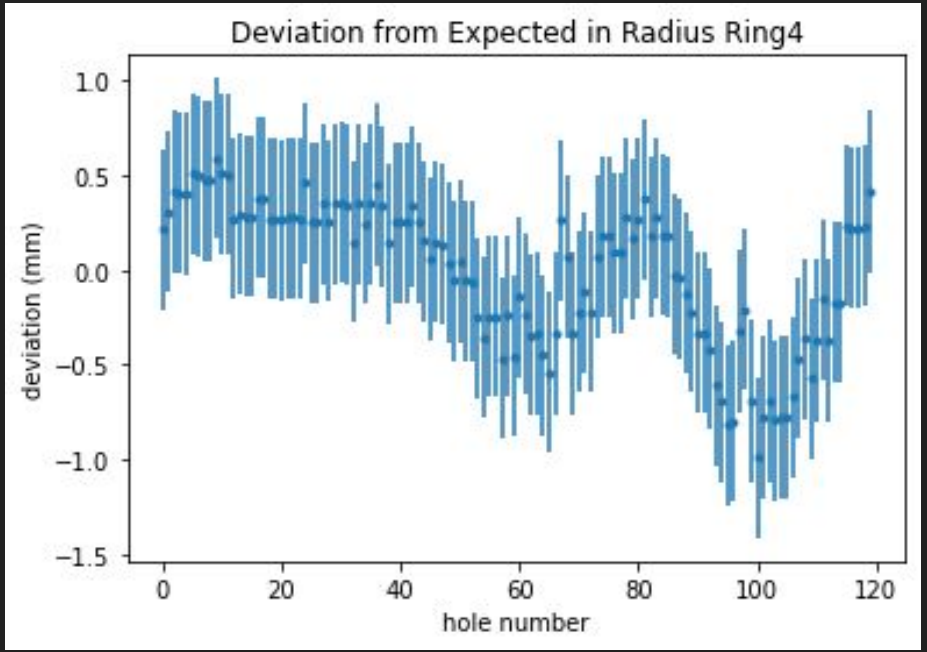
Deviations for each hole Ring 3





Results


Deviation from Expected in $\phi * R$ Ring4
ϕ deviation*R (mm)
hole number
Looking $||\hat{z}$
Looking $||-\hat{r}$


Deviation from Expected in Radius Ring4
deviation (mm)
hole number

Deviations for each hole Ring 4