

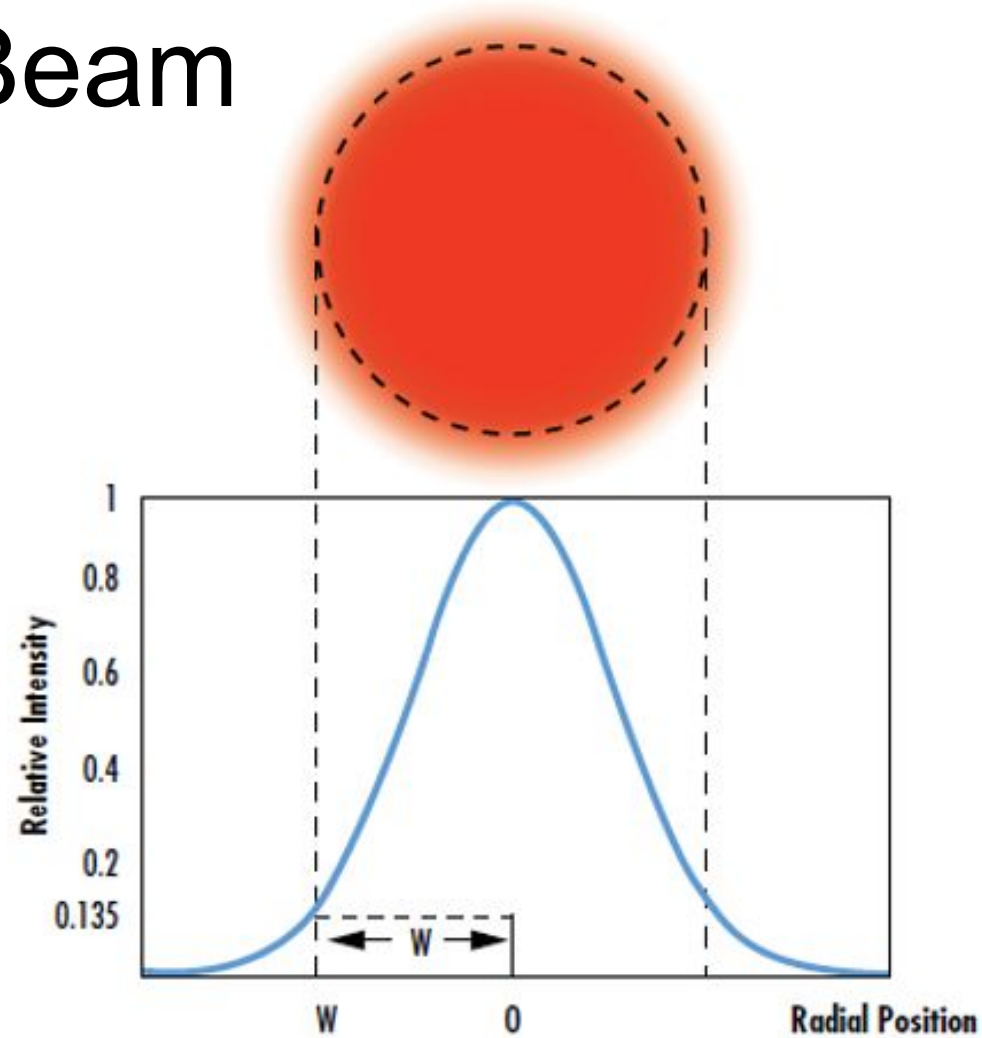


# The Quantification of the Overlap of two Gaussian Laser Beams

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Second supervisor: Dr. Mick Mulder

# Gaussian Beam

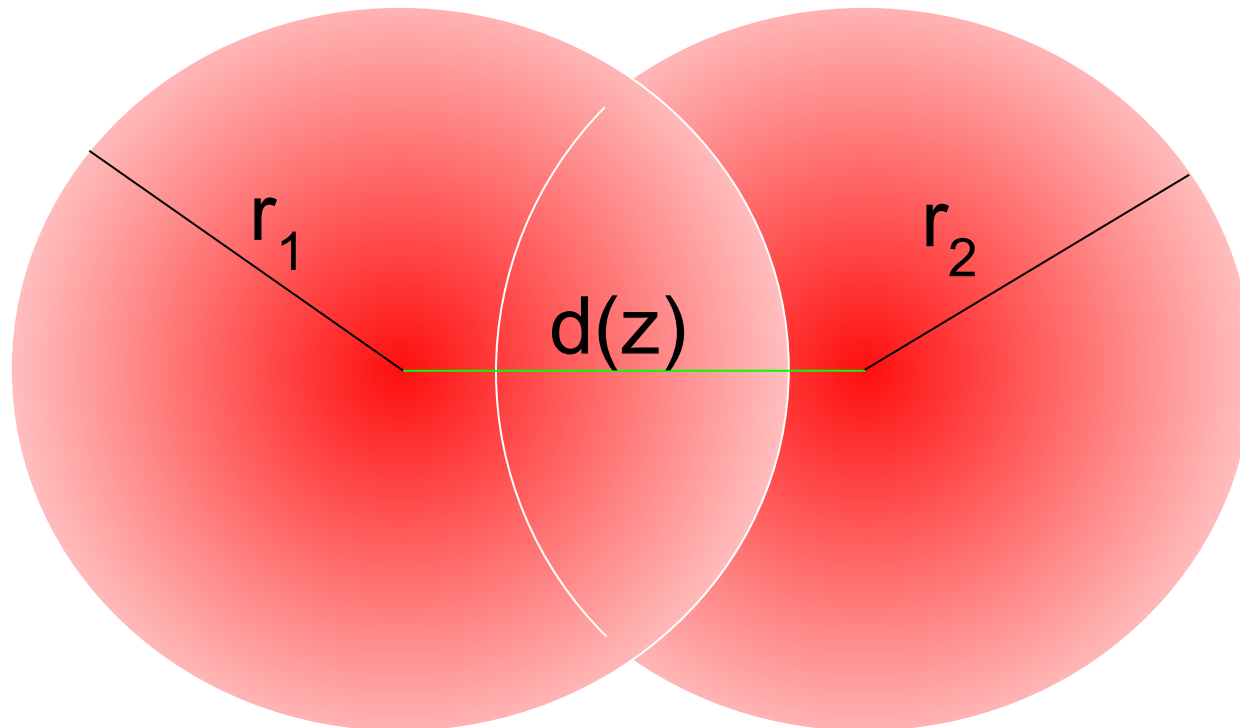


Edmund Optics, "Gaussian Beam Propagation"

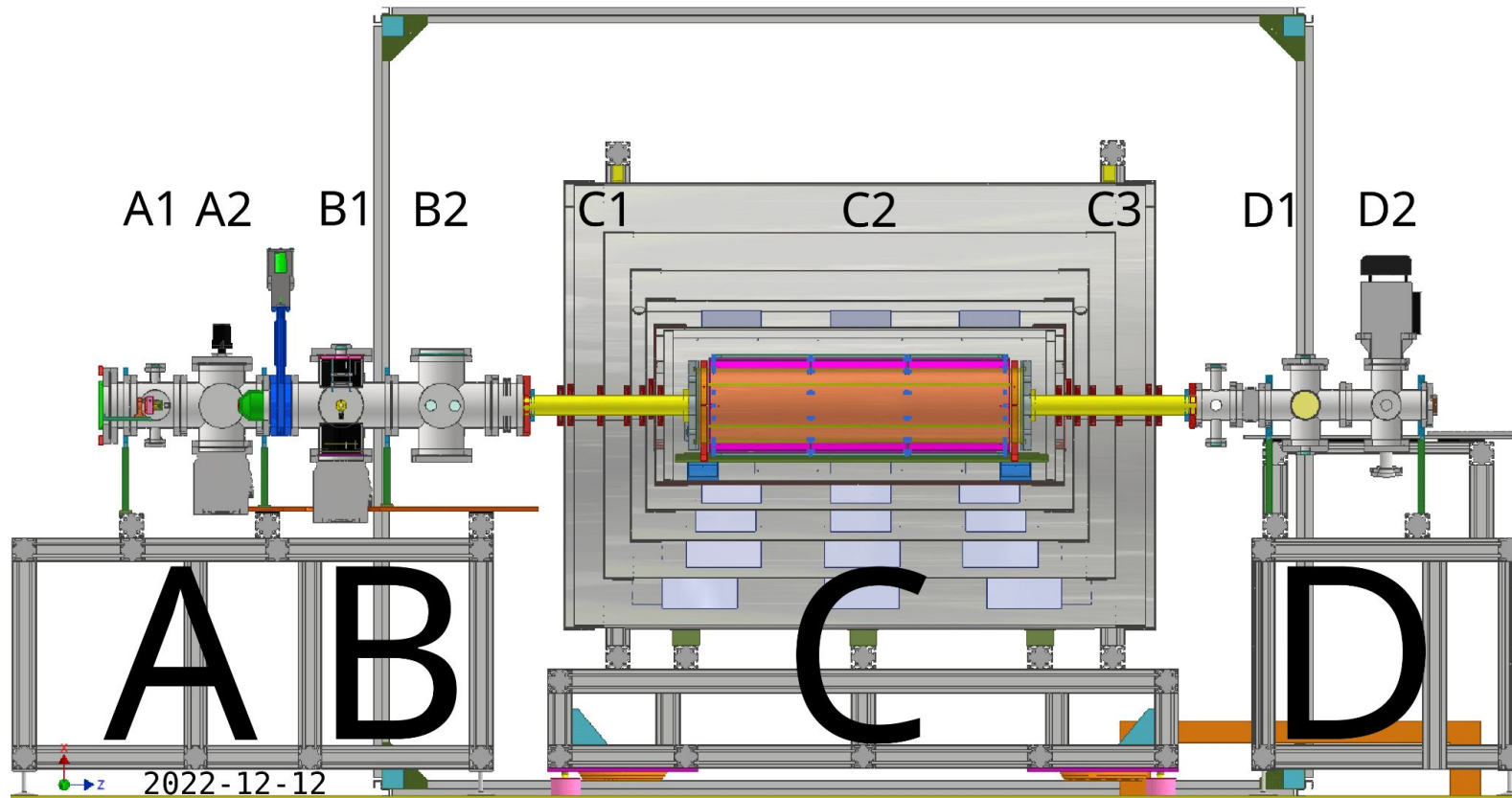


# Beam overlap

$$\text{Overlap: } \beta = \frac{d(z)}{r_1 + r_2}$$

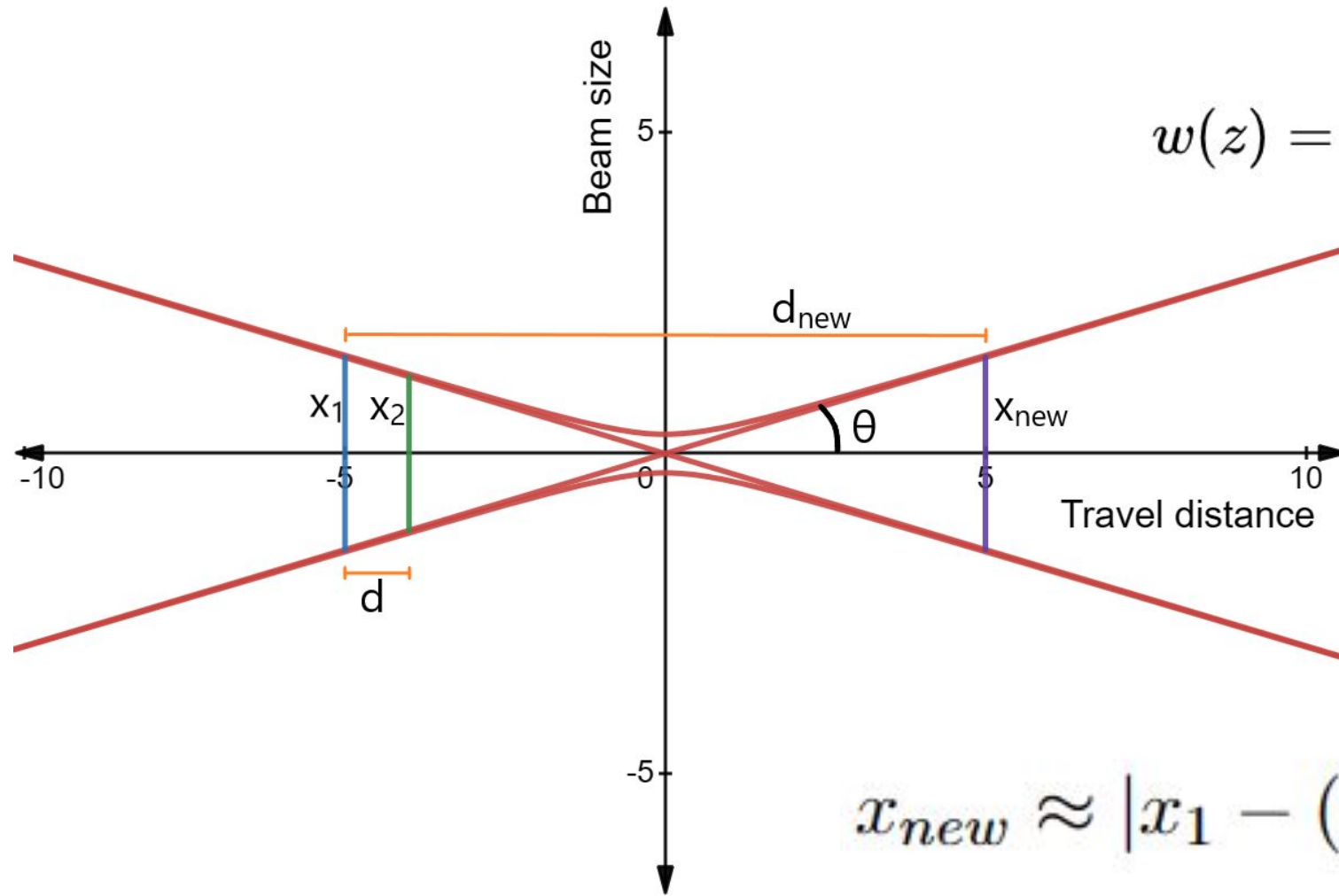


# eEDM Experimental Setup





# Gaussian Beam Propagation



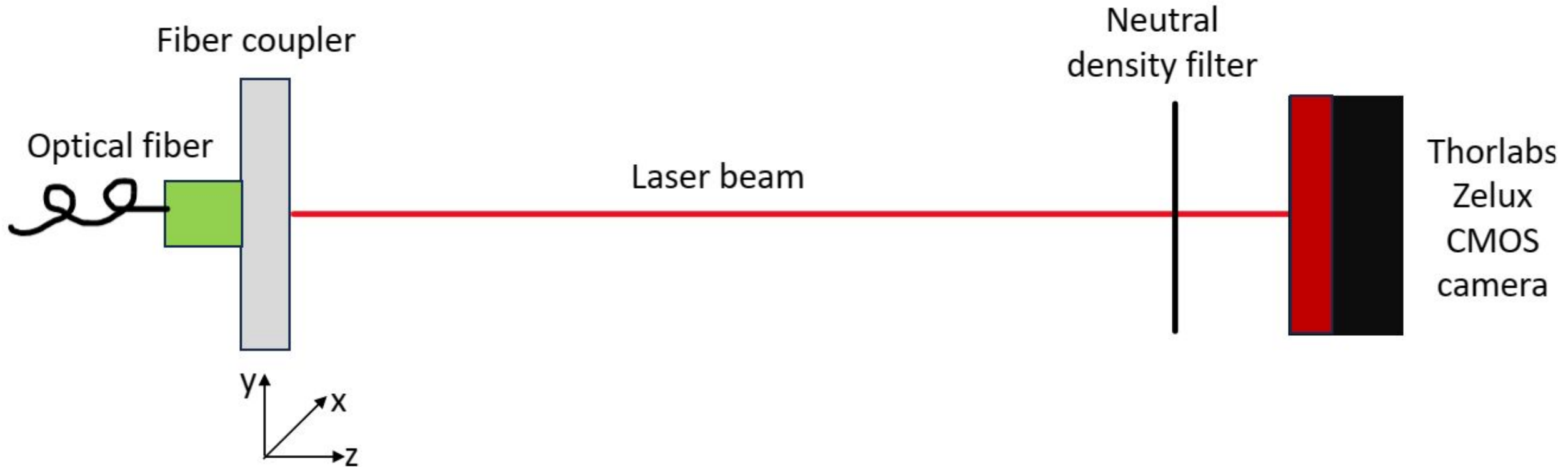
$$w(z) = w_0 \sqrt{1 + \left(\frac{z}{z_R}\right)^2}$$

$$z_R = \frac{\pi w_0^2 n}{\lambda}$$

$$x_{new} \approx \left| x_1 - (x_1 - x_2) \frac{d_{new}}{d} \right|$$

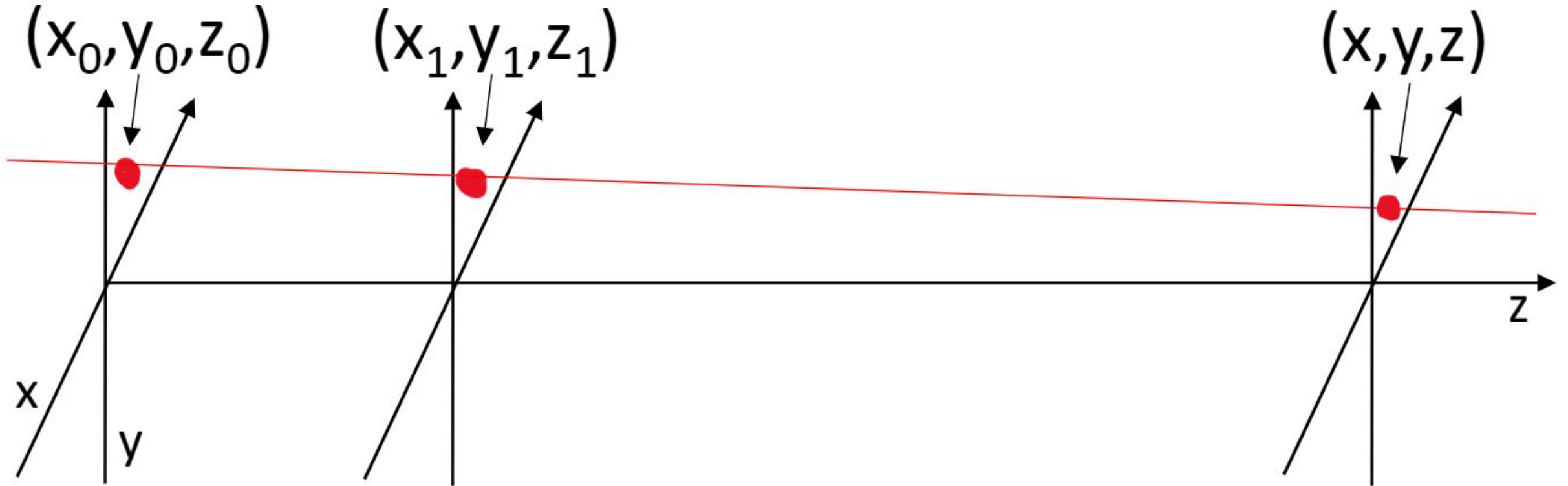


# Basic Setup





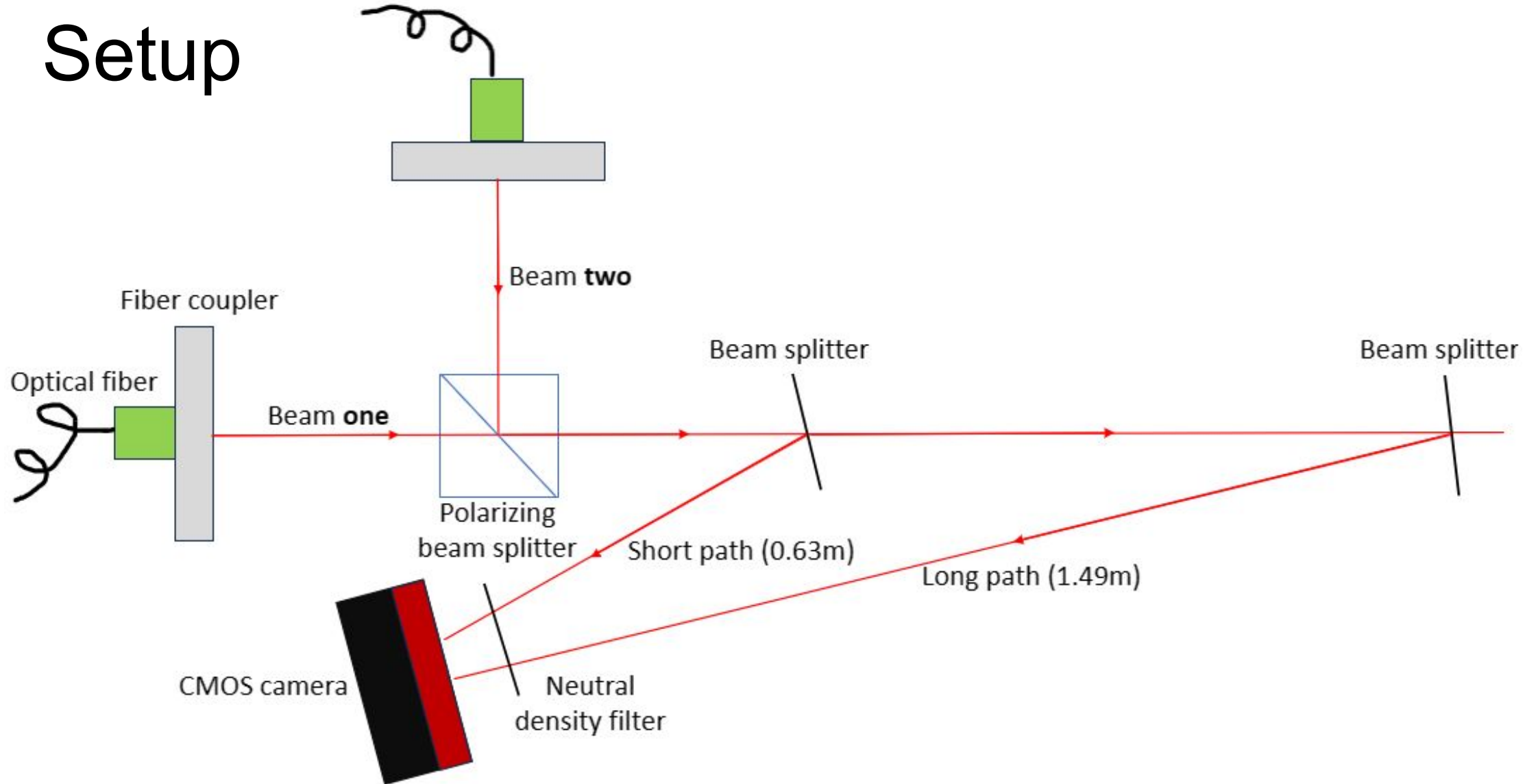
# Tracing the center of the beam



$$x = \left( \frac{x_1 - x_0}{z_1 - z_0} \right) z + x_0$$

$$y = \left( \frac{y_1 - y_0}{z_1 - z_0} \right) z + y_0$$

# Setup







# CMOS camera



Sensor size 1440x1080 pixels  
Pixel size: 3.45  $\mu\text{m}$

Thorlabs, "Compact Scientific Digital Cameras User Guide CS165  
Zelux® CMOS Scientific Cameras".

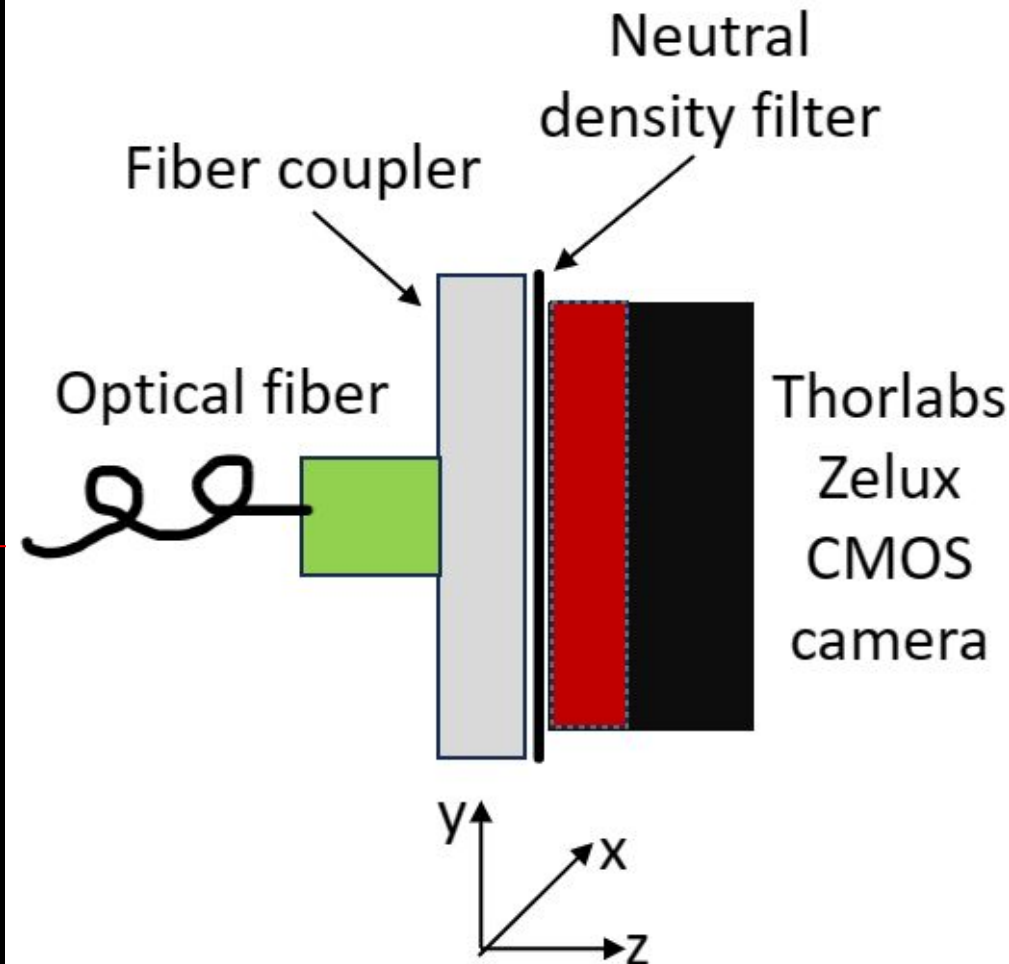
# Obtained Images and derived width and position of the centers of the beams



# Beam one close to the fiber coupler

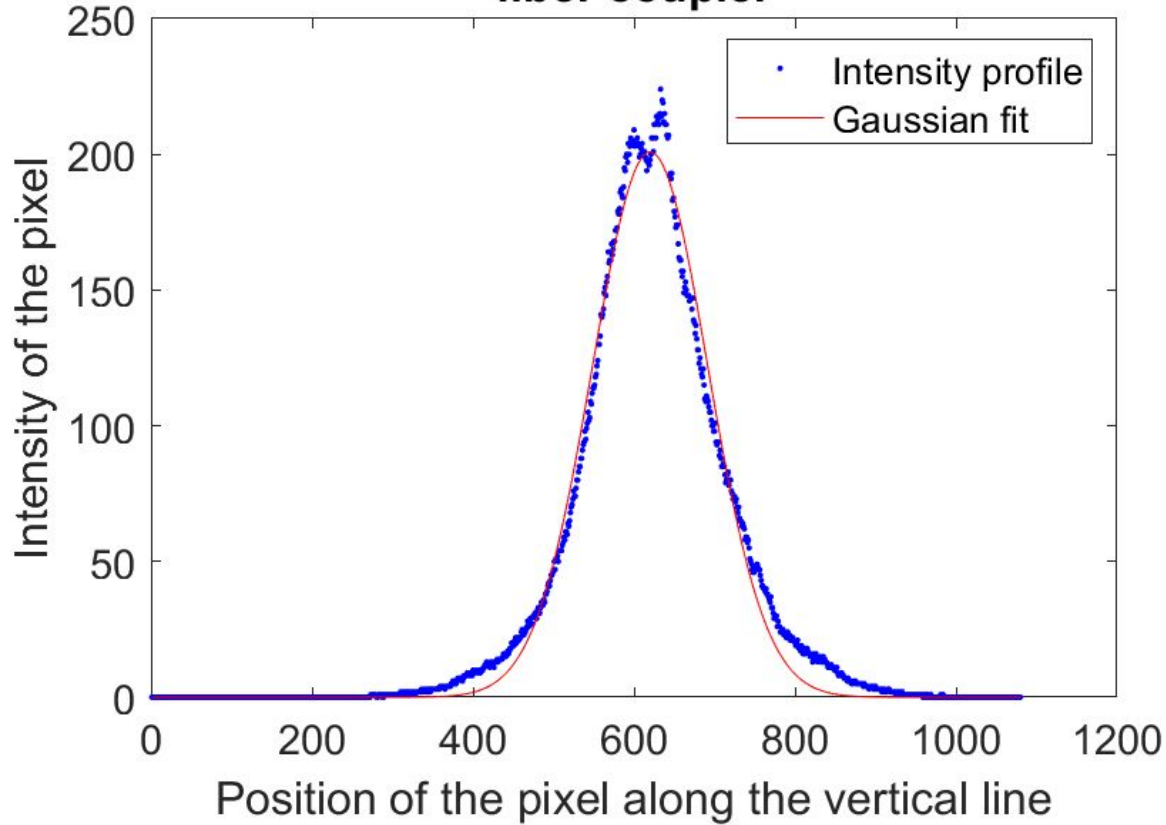


Taken on 16 June 2023

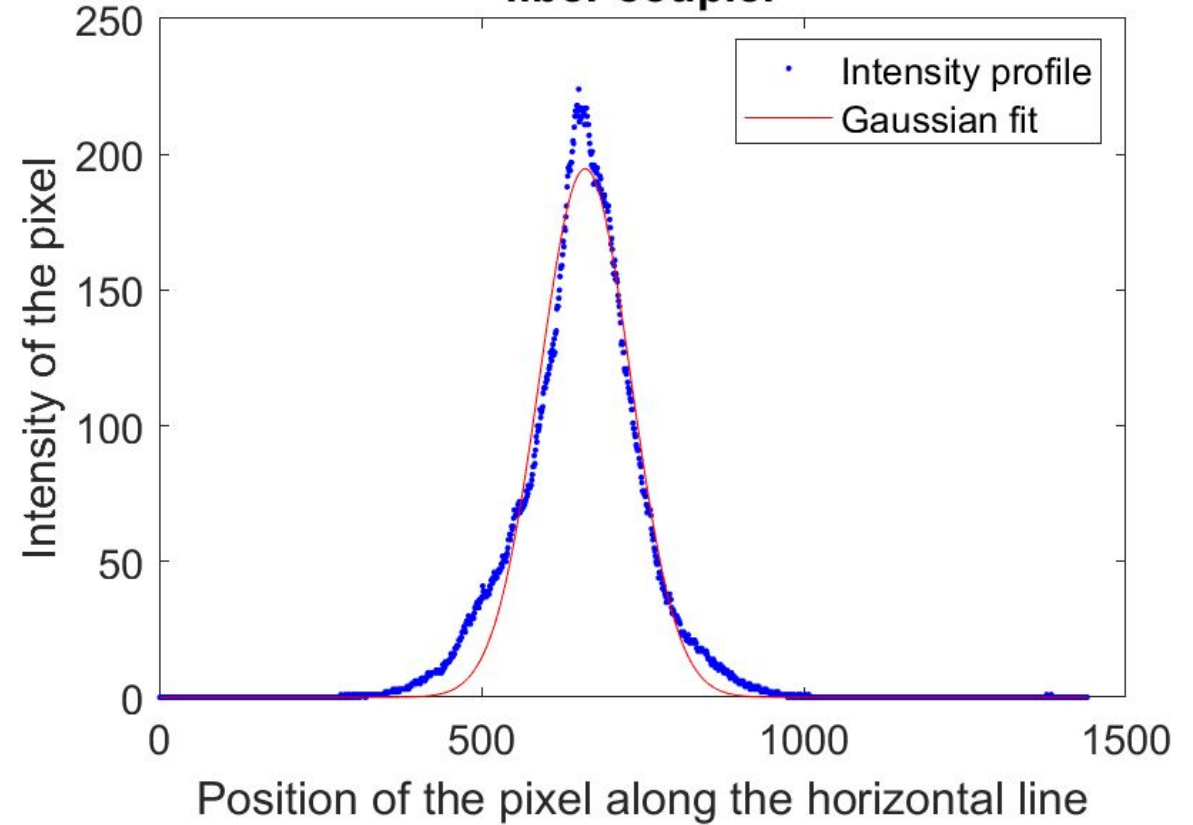




**Vertical profile of beam one close to the fiber coupler**



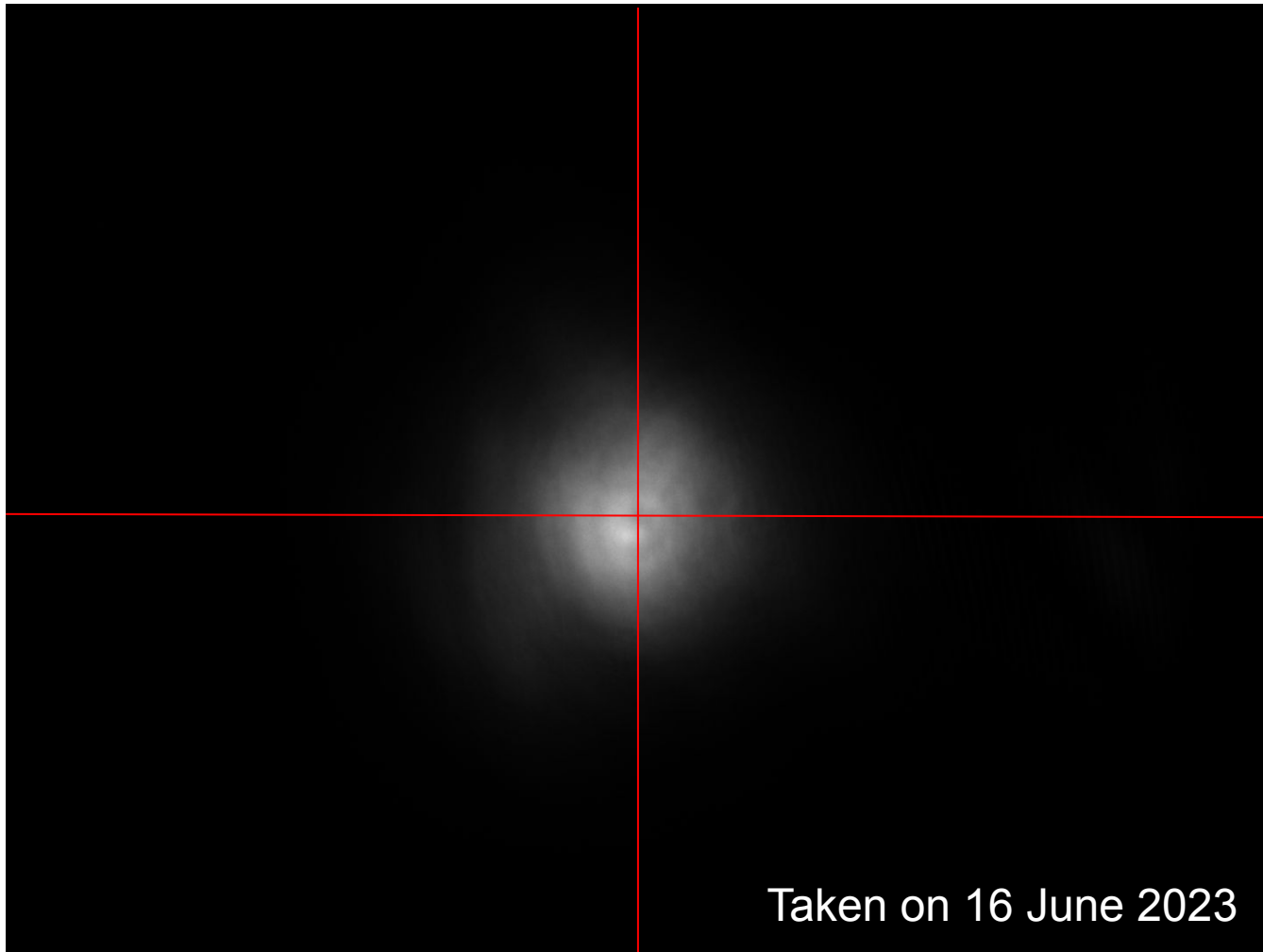
**Horizontal profile of beam one close to the fiber coupler**



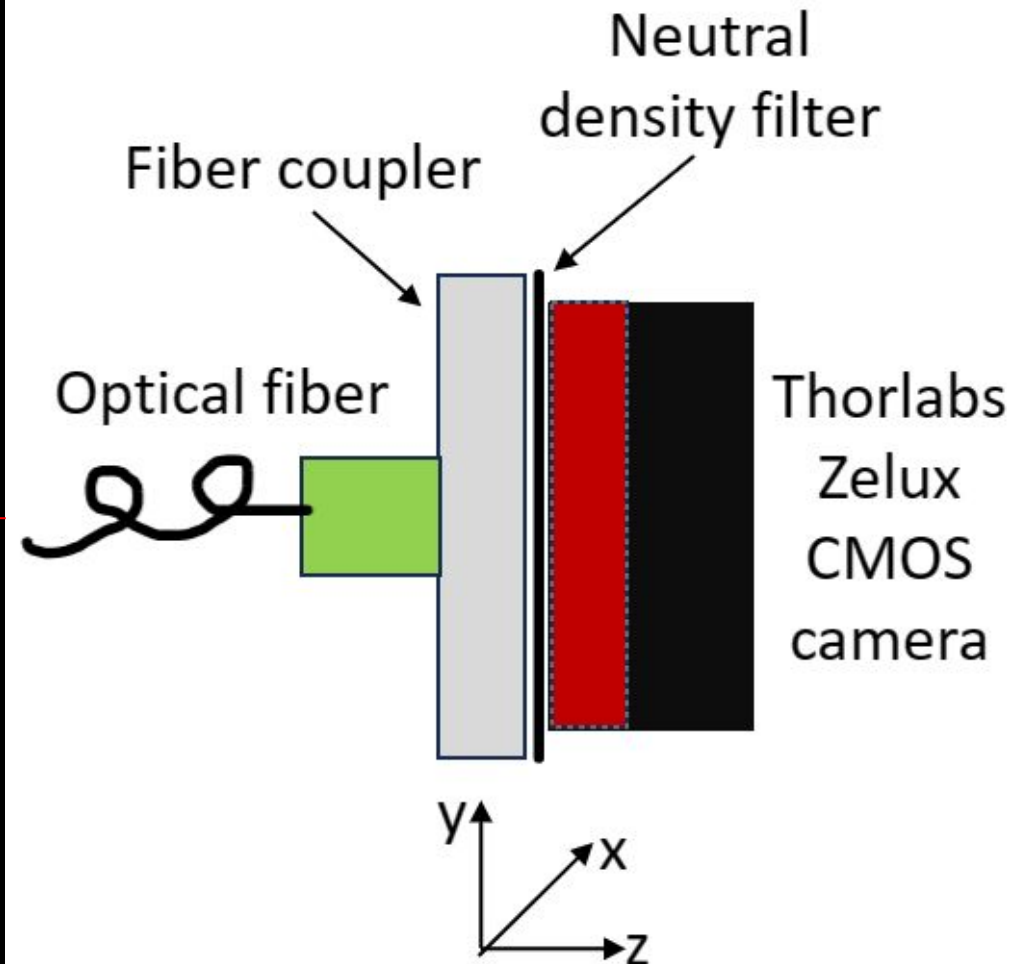
Mean width	Vertical maximum	Horizontal maximum
$0.99 \pm 0.05$ mm	$620 \pm 1$ pixels	$661 \pm 1$ pixels



# Beam **two** close to the fiber coupler

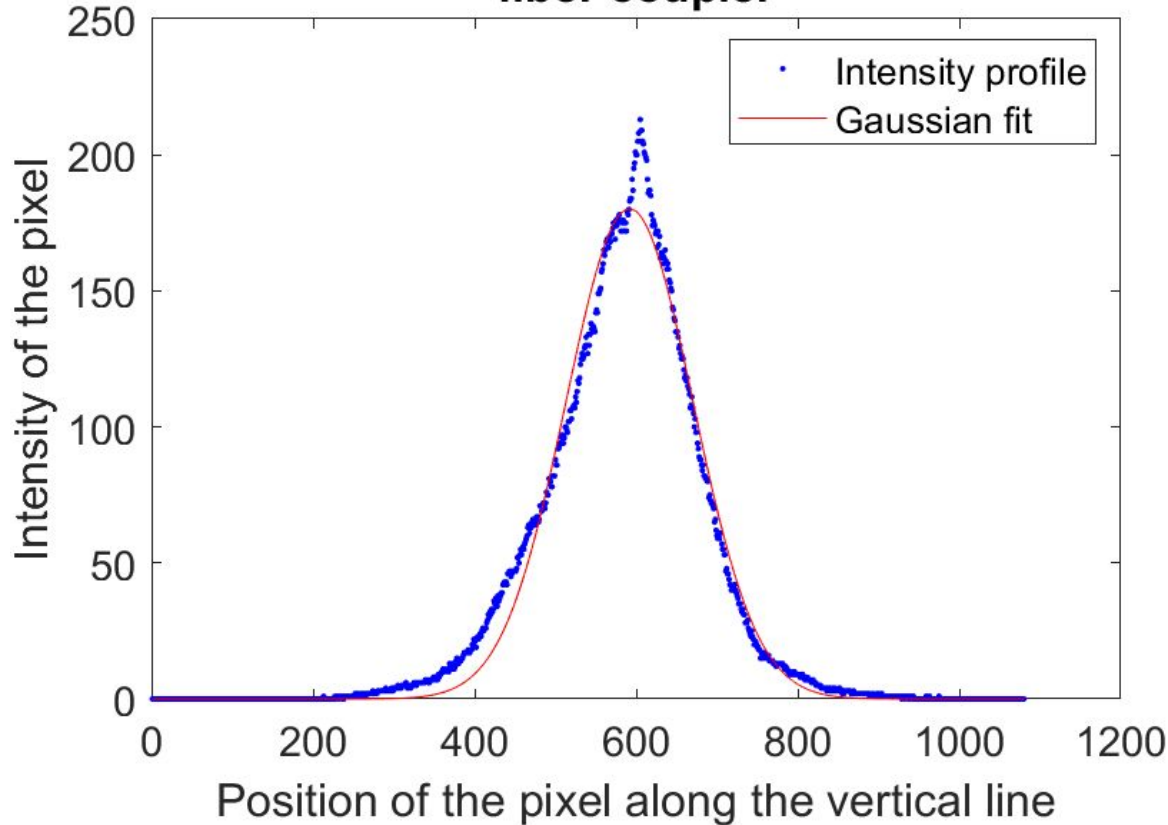


Taken on 16 June 2023

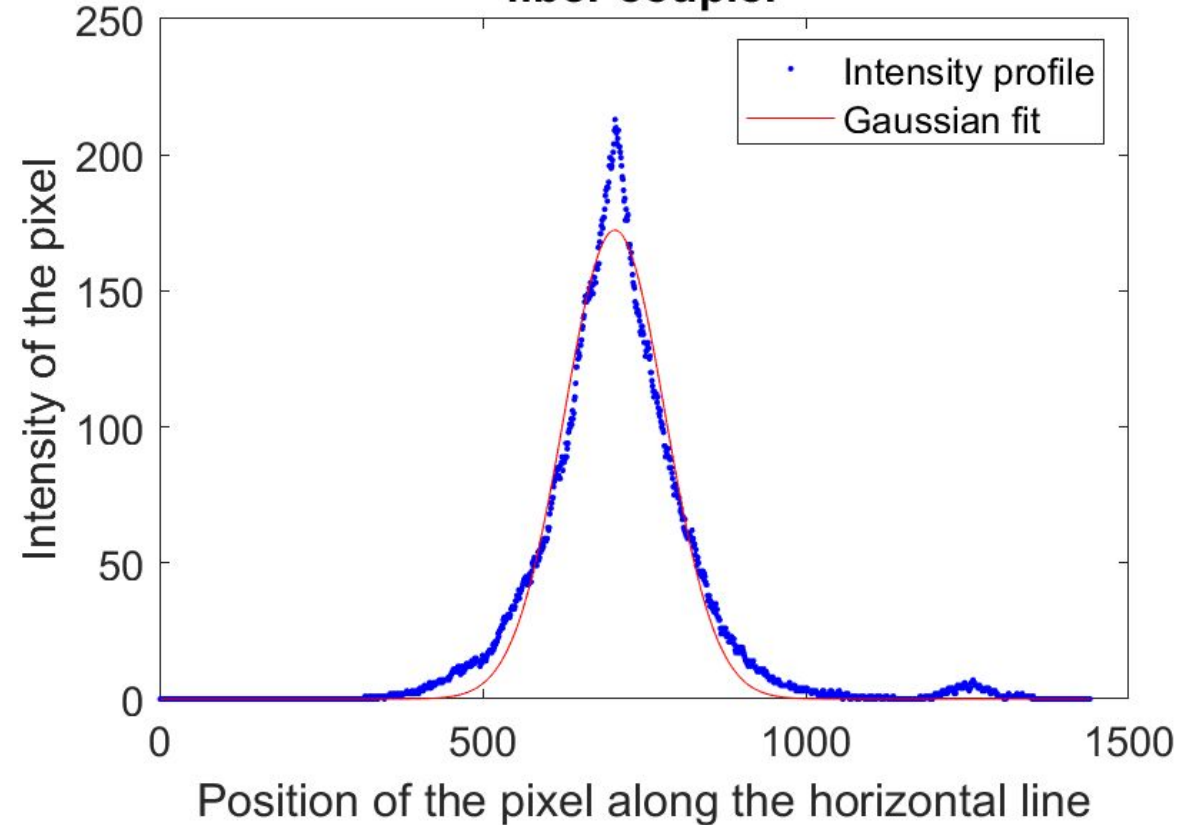




**Vertical profile of beam two close to the fiber coupler**

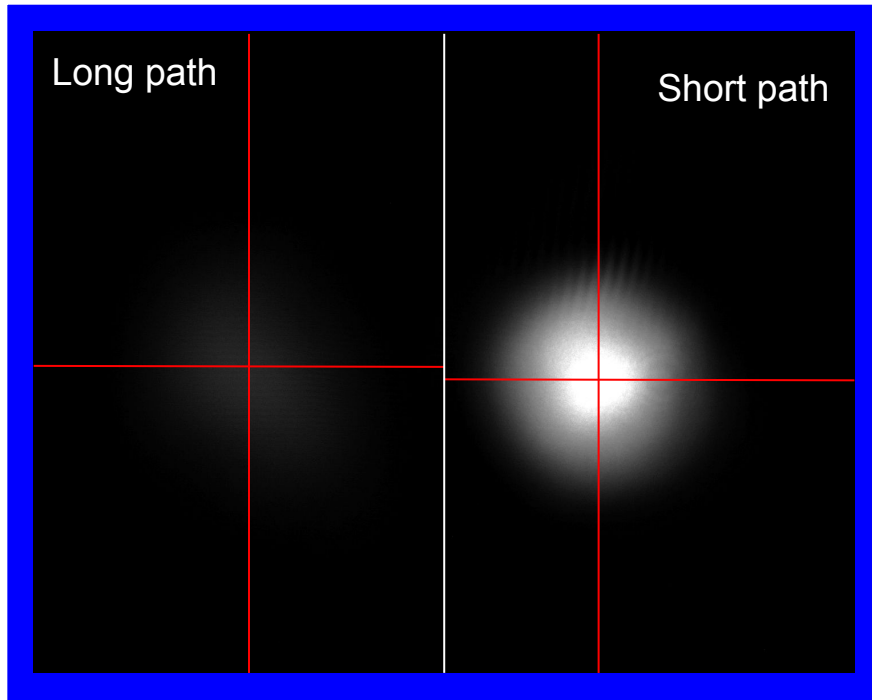


**Horizontal profile of beam two close to the fiber coupler**

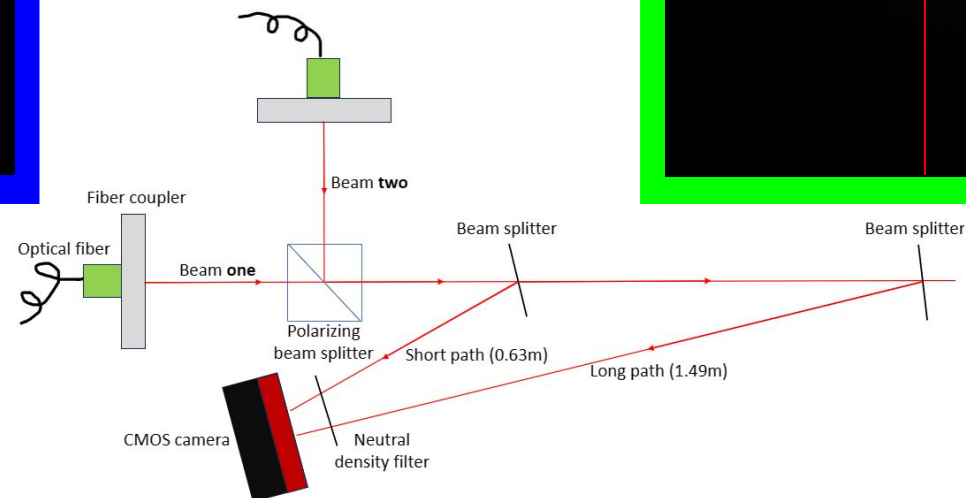
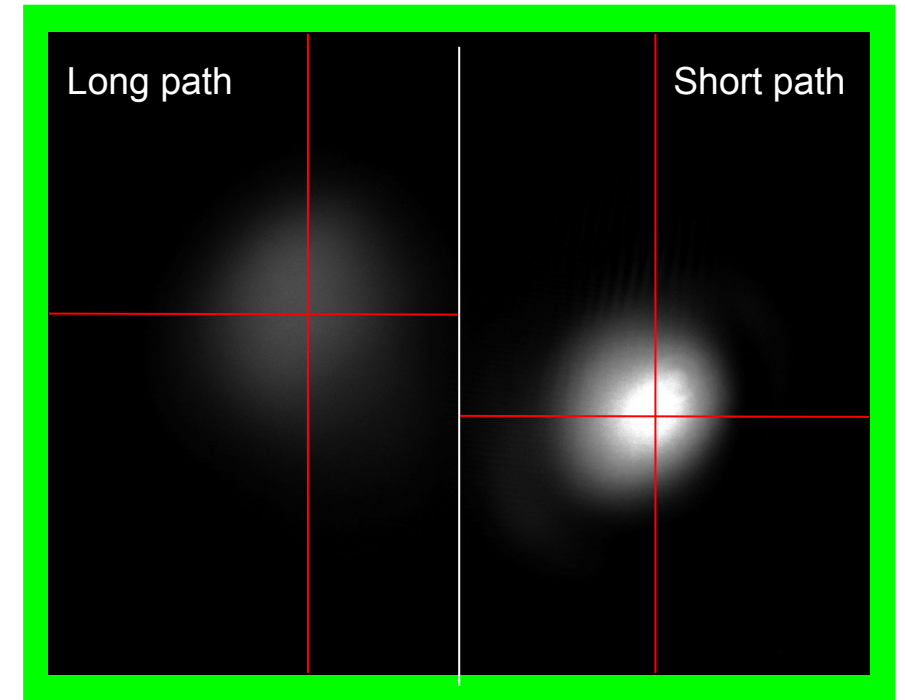


Mean width	Vertical maximum	Horizontal maximum
$1.08 \pm 0.06$ mm	$592 \pm 1$ pixels	$704 \pm 1$ pixels

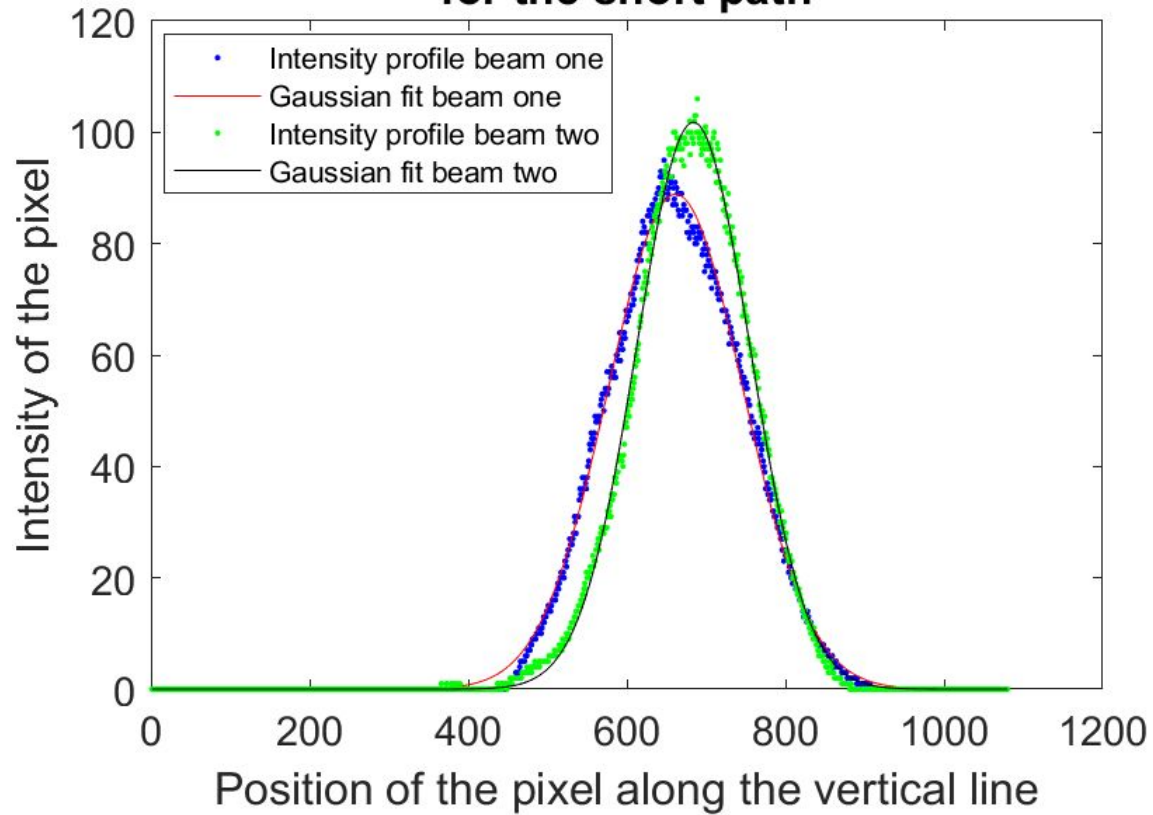
# Short and long path of beam **one** and **two**



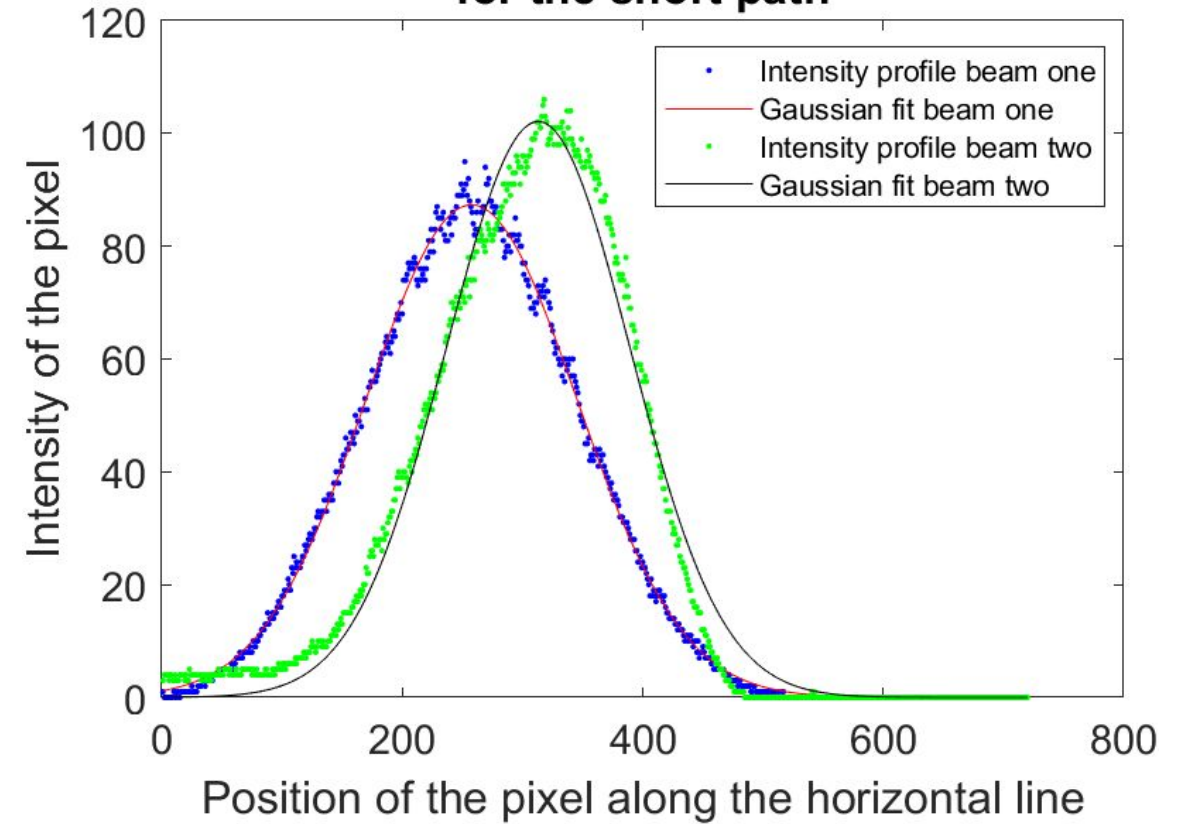
Taken on 9 June 2023



### Vertical profile of beam one and two for the short path



### Horizontal profile of beam one and two for the short path



Mean width beam **one**

Mean width beam **two**

Distance between centers

Overlap

$1.19 \pm 0.01$  mm

$1.02 \pm 0.03$  mm

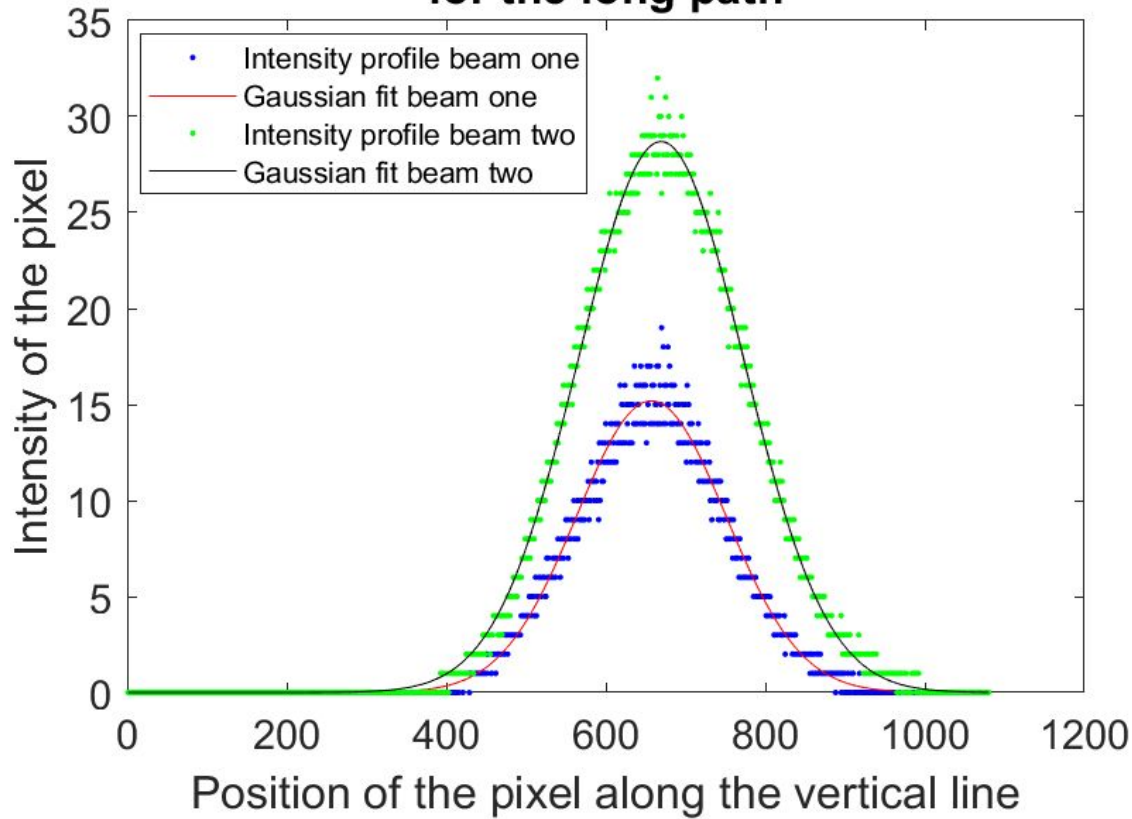
$0.21 \pm 0.01$  mm

$0.19 \pm 0.01$

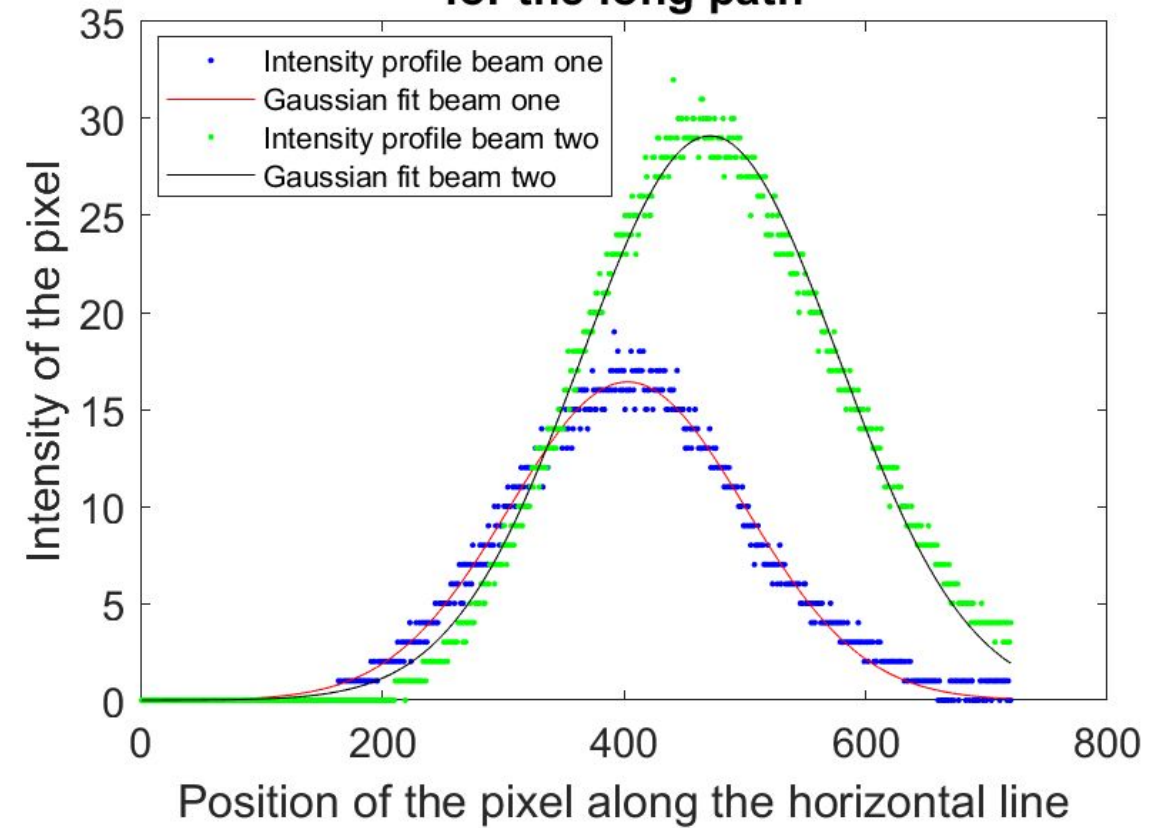




### Vertical profile of beam one and two for the long path



### Horizontal profile of beam one and two for the long path



Mean width beam **one**

Mean width beam **two**

Distance between centers

Overlap

$1.3 \pm 0.1$  mm

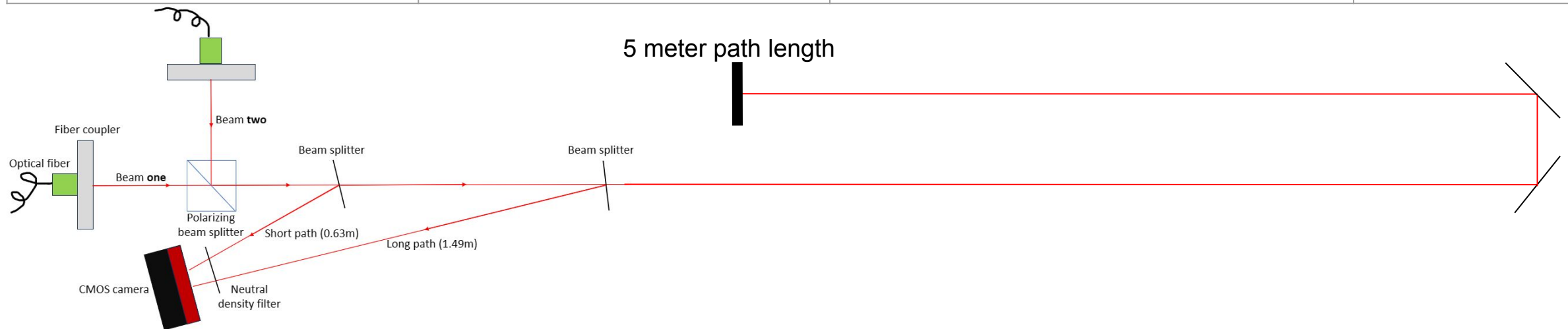
$1.4 \pm 0.1$  mm

$0.24 \pm 0.01$  mm

$0.17 \pm 0.01$

# Size, distance between the centers and overlap of the two beams at **five meters** from the fiber coupler

Width beam one	Width beam two	Distance between centers	Overlap
$2.6 \pm 0.7$ mm	$3.2 \pm 0.7$ mm	$0.47 \pm 0.08$ mm	$0.17 \pm 0.04$





# Conclusion

- › Quantification of the overlap of two Gaussian Laser Beams
- › Overlap can now be improved
- › Magnification of beams not taken into account yet



university of  
 groningen

Thank you for your attention