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Monomode fibre

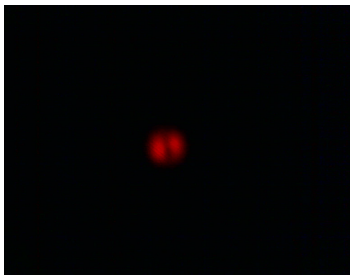
5. Summary of tasks of the experimental work

4.2. Monomode optical fiber injection and mode profiles (40 min)

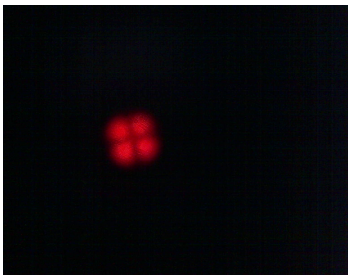
Present at least **three images** with intensity distributions that present different mode profiles similar to the ones shown in the examples above (Figure 16). Play with different adjustments to get the highest contrast of the images and prevent saturation. Show **two images** for different polarization states, when the polarizer is rotated by 90°. (Rotate the polarizer – do not rotate the lens cap or the laser!). Interpret your result.

Picture1– Mode profile

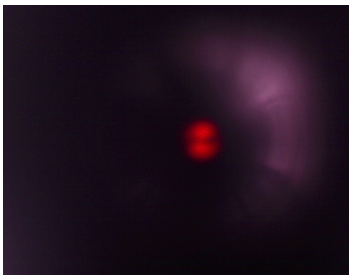
Picture2– Mode profile



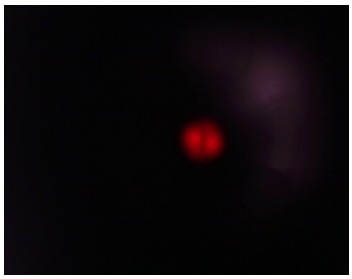
Picture3– Mode profile



Picture3– Polarized 0deg



Picture3– Polarized 90deg

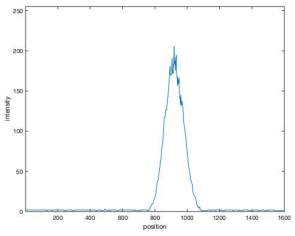
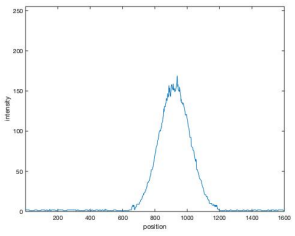
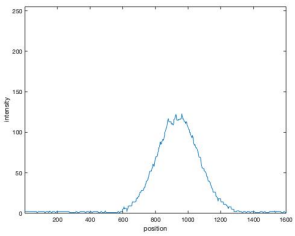


Discussion (compare and interpret):
We can obtain different modes by distancing the source from the fiber, thus changing the incident angle. Those modes generate different geometries at the fiber's exit.

In particular, Picture 3 is a combination of Picture 4 and Picture 5, it has two very distinct polarizations.

4.3 Measurement of the numerical aperture (30 min)

Present **three example photos** for different positions of the spot after the fibre exit. Show **line plots** of the intensity profile for these images. Make a table with full width at the bottom values for a minimum of 5 measurements. Calculate the numerical aperture value for the monomode fibre. Make an error calculation. Interpret your result.

Picture1– Position 0mm	Picture2– Position 2mm	Picture3– Position 4mm
		
Picture1– Line plot 1	Picture1– Line plot 3	Picture1– Line plot 3
		

Measurement number	1	2	3	4	5	6	7
Distance mm	0	1	2	3	4	5	6
Spot diameter pxl (bottom of curve)	288	381	484	551	613	720	801
Spot diameter in mm (1px=2.835um)	0.82	1.08	1.37	1.56	1.74	2.04	2.27
Angle (deg) (half, not full) = arctan(diameter/2/distance)		28.37	18.93	14.59	12.26	11.54	10.72
NA = sin(angle) (n=1)		0.48	0.32	0.25	0.21	0.2	0.19

Average numerical aperture of the fibre NA= 0.275

Error estimation $\Delta NA = \Delta(\sin\theta)$ = standard deviation $\sin(\theta)$

$\Delta NA = 0.1$

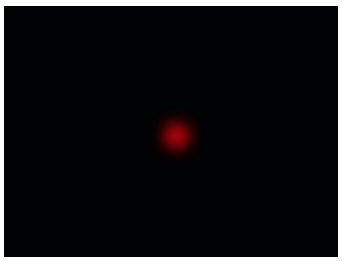
Comparison with value of datasheet. Interpret your result (a few sentences)
We find a value different from that of the datasheet which is at NA=0.10 to 0.14.

We explain that difference by the slight imprecision on the real source distance and mostly by the way the spot diameter was measured. We really took the very bottom of the line plot for our spot size measurements so maybe by taking it at half width or something more tolerant we'll get within that range of values.

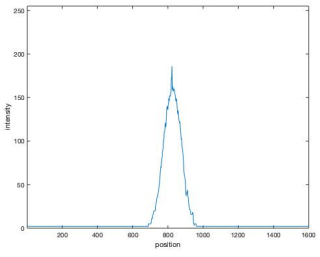
4.4. Coupling for different numerical apertures (30 min)

Show the **two images and line plots**. Evaluate which coupling is more efficient (for High NA or low NA) by comparing the data taken at the same exposure conditions. Give a short explanation of the result.

Picture1– z23mm_3



Picture1– Line plot



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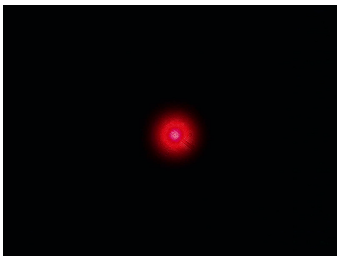
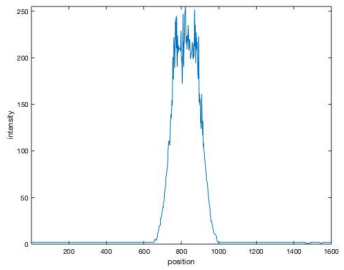
Picture 2– z60mm_3	Picture 2 Line plot
	

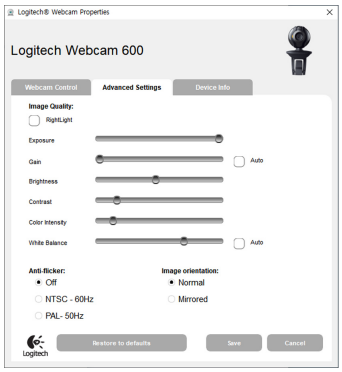
Position	1	2
Distance lens cap fibre entrance	23mm	60mm
Numerical aperture NA	0.02 (275px diameter)	0.008 (340px diameter)

Explanation of your result (a few sentences)
As we put our source further from the fiber, the NA decreases and the light entering the fiber is much more concentrated, we have fewer losses by dispersion and in the end a better, greater and more luminous, spot size.

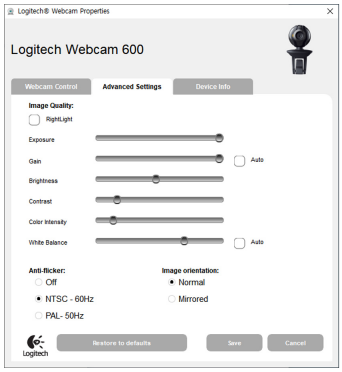
4.5. Monomode fibre coupling for different sources 20 min

Show sample images for light spots on the camera for each source (**3 images**). Give the exposure conditions for each source (screenshot of the settings window, ALT PRTSC). Why is it so difficult to couple light from LED and halogen source? Give a short explanation.

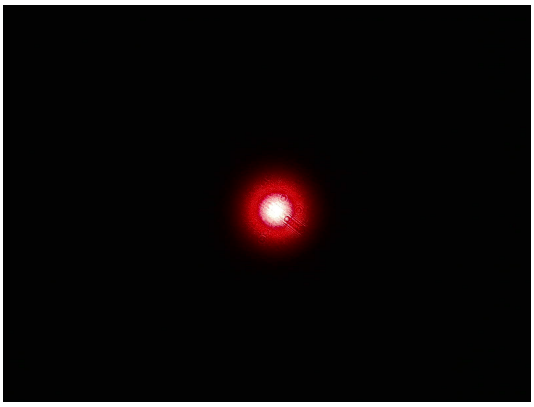
Picture 1 – Halogen

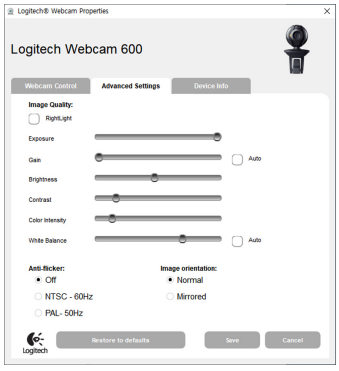


Picture 2 – LED



Picture 3 – Laser





Comments and explanations:
The laser, compared to the other two, has a very concentrated light beam which make it very easy to concentrate into the fiber whilst the other two disperse a lot and we must compensate through other means (e.g. as shown in Picture 2: high gain for the LED)

We can't distinguish the wire of the halogen because it got lost in the fiber's mode propagation.

Personal feedback:

Was the amount of work adequate? Yes

What is difficult to understand? ±

What did you like about it? Got to know more about this very effective and commonly used communication medium.

How can we do better? It's pretty good already