What is light?

This is a question that scientists have struggled with for centuries. Light has no mass but it is obvious that it exists. It can travel from place to place at incredible speeds but how does it move? If you were to magnify a ray of light what would you see?

Following many years of investigation, we have got to the point where we have a good understanding of the nature of light. This knowledge has unlocked the potential for light to be used for many exciting new applications. Scientists at the University of Oxford are amongst those developing new ways of using light which could be used to produce driverless cars, super-computers and powerful telescopes.

Light investigations

Isaac Newton studied how light obeyed strict rules such as the law of reflection. Light bounces off a mirror at the same angle that it hit it - much like a pool ball hitting a cushion. He concluded that therefore, light must consist of particles - like lots of tiny balls.

In 1801 Thomas Young carried out his now famous 'double slit experiment'. His observations of interference patterns showed that light was behaving like a wave.

So how does light behave - as a stream of particles or as a wave?...

...or could it be both?

Your task

We now know that light, like all EM radiation, behaves like packets of energy called quanta or photons.

A version of Young’s experiment can be set up where single photons are sent through the double slits.

1. On the next pages, fill in the boxes to write your prediction, method, results and conclusion.
2. Complete your conclusion by using the information on the final page to write a scientific explanation for your results.
**Equipment**

Laser (fires one photon at a time)  |  Double slit  |  Detector (photodiode)

**Prediction**
Photons are fired at the double slit one at a time. Use the blank bar chart axis to show what pattern you would expect to see on the detector after one second.

<table>
<thead>
<tr>
<th>Photons counted</th>
<th>Position (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>3.8 4.2 4.4 4.6 4.8 5 5.2 5.4 5.6 5.8 6 6.2 6.4 6.6 6.8</td>
</tr>
<tr>
<td>80</td>
<td>4.4 4.6 4.8 5 5.2 5.4 5.6 5.8 6 6.2 6.4 6.6 6.8</td>
</tr>
<tr>
<td>60</td>
<td>4.6 4.8 5 5.2 5.4 5.6 5.8 6 6.2 6.4 6.6 6.8</td>
</tr>
<tr>
<td>40</td>
<td>4.8 5 5.2 5.4 5.6 5.8 6 6.2 6.4 6.6 6.8</td>
</tr>
<tr>
<td>20</td>
<td>5 5.2 5.4 5.6 5.8 6 6.2 6.4 6.6 6.8</td>
</tr>
<tr>
<td>0</td>
<td>5.2 5.4 5.6 5.8 6 6.2 6.4 6.6 6.8</td>
</tr>
</tbody>
</table>

http://www.oxfordsparks.ox.ac.uk/run-for-your-light
Results 1

The data after one second is shown below.

Is this consistent with your prediction?
Suggest an explanation for the results.

http://www.oxfordsparks.ox.ac.uk/run-for-your-light
Results 2

The data after 5 minutes is shown below. A pattern has arisen.

The conclusion from this experiment is that photons sometimes display wave-like properties. Explain how the data shows this.

Hint: Look at the interference pattern on page 1.

http://www.oxfordsparks.ox.ac.uk/run-for-your-light