You can read a short essay on the puzzle of this duality by John Archibald Wheeler.

There's clearly a difference between the measurements we ought to make if light is only a photon, or if light can be both a photon and a wave. The crucial measurements will depend on how long we wait before observing. Suppose we make measurements every several minutes.

If we had two detectors, we would expect to see one photon in each detector half the time. But, of course, we only have one detector. Q: If we sent 200 photons into the device, making the measurement every several minutes, what would we expect to read from the detector?

If light is a wave, the photon would go through both of the arms and interfere when it reaches the detectors. If light is a particle, the photon would go through one arm or the other, and we would see either zero or one photon in the detector.

When Hellmuth and his colleagues ran the experiment, they discovered that small temperature variations in the fibers caused the detected intensity to vary slowly, on timescales of a minute or two. That meant that the form of the interference drifted during the experiment.

Q: If we sent 200 photons into the device, what would we expect to read from the two detectors?

A slight change in path length to one arm of the interferometer would be expected to cause constructive interference in Detector 1, and destructive interference in Detector 2. Choose one of these pairs of values for the two detectors for each time interval:

- Detector 1: 0.90, Detector 2: 0.10
- Detector 1: 0.30, Detector 2: 0.70
- Detector 1: 0.15, Detector 2: 0.85
- Detector 1: 0.05, Detector 2: 0.95
- Detector 1: 0.70, Detector 2: 0.30
- Detector 1: 0.50, Detector 2: 0.50

Now, let's consider what happens if light is composed of discrete pieces: photons. We have a couple of photodetectors at the end of the interferometer. If light is a photon, and we close the upper arm, we expect to see no photons in the lower detector. In the other arm, bounce

Suppose we set the Pockels cell so that it only allows horizontally polarized light to pass through it. This effectively "closes" the upper arm of the interferometer, because any photon passing through the cell will immediately be blocked by the fixed polarizer in the lower arm of the interferometer. For every odd-numbered pulse (1, 3, 5, 7, etc.), leave the Pockels cell set to "open", so that light can (and must) go through both arms of the interferometer and interfere with itself in the detectors.

For every even-numbered pulse (2, 4, 6, 8, etc.), close the upper arm of the interferometer: set the Pockels cell so that it only allows vertically polarized light to pass through it. This effectively "closes" the upper arm of the interferometer, because any photon passing through the cell will immediately be blocked by the fixed polarizer in the lower arm of the interferometer. For every odd-numbered pulse (1, 3, 5, 7, etc.), leave the Pockels cell set to "open", so that light can (and must) go through both arms of the interferometer and interfere with itself in the detectors.

The blue rectangles in the diagram above represent mirrors. The solid blue ones are ordinary mirrors which reflect 100% of the light. The dashed blue ones are half-silvered mirrors which reflect half of the light and transmit half.