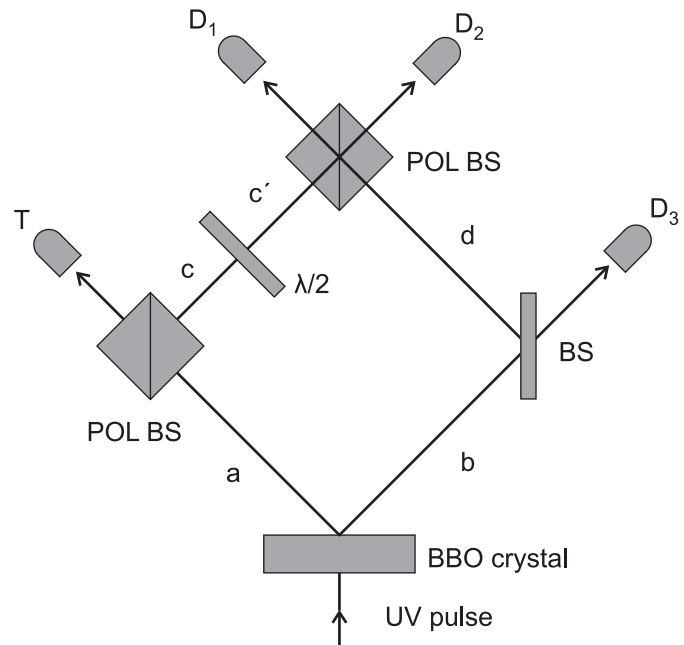**8.** The figure schematically shows an experimental setup for the creation and detection of GHZ states at the photo-detectors D_1, D_2 and D_3. Briefly describe the action of the BBO crystal, the polarizing beam splitters (POL BS), the beam splitter (BS), the $\lambda/2$ plate and the photo-detectors used in this setup. [10]

Consider the (rare) situation where two polarization entangled pairs of photons in state $|\Psi\rangle = (|HV\rangle + |VH\rangle)/\sqrt{2}$ are simultaneously present after the BBO crystal. By following this state through the experimental setup and working out the relevant components of the state in each of its parts show that a click in all four detectors signifies a GHZ state of the form $|\text{GHZ}\rangle = (|VVH\rangle + |HHV\rangle)/\sqrt{2}$. [10]

Given that two pairs of entangled photons are simultaneously created after the BBO crystal what is the probability of a GHZ state being detected with perfect photo-detectors? Thus estimate the rate of GHZ state creation for a repetition rate of $1\,\text{MHz}$ of the UV pulse and down-conversion probability of 0.1%. [5]