Advanced Topics in Computer and Brain Sciences

Final Presentation

Submitted by:
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Beam ~~me~~ my image up, Scotty

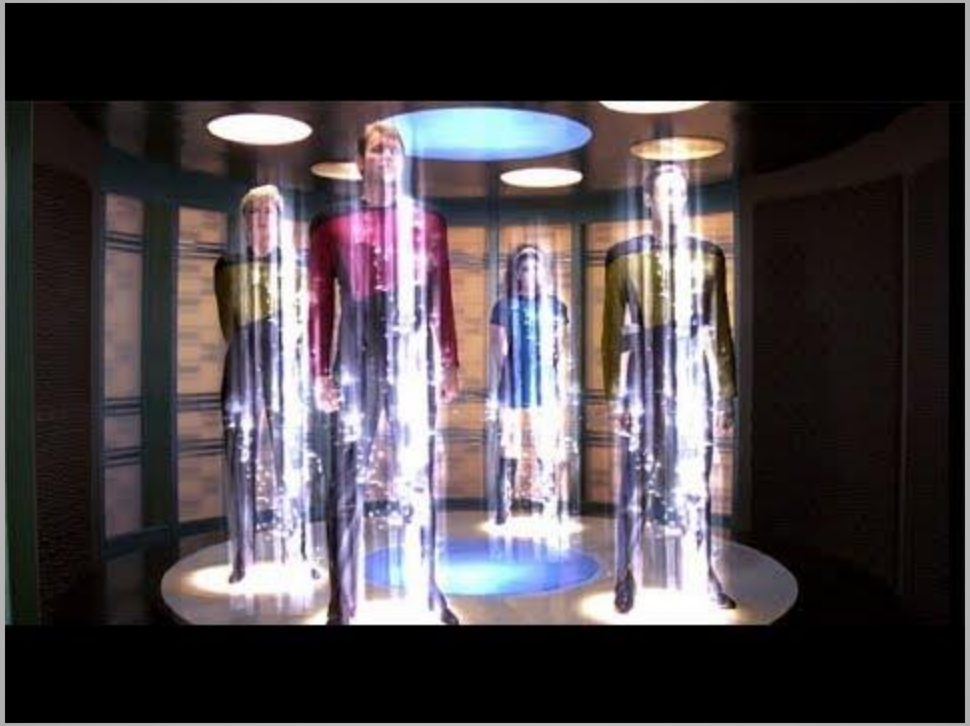
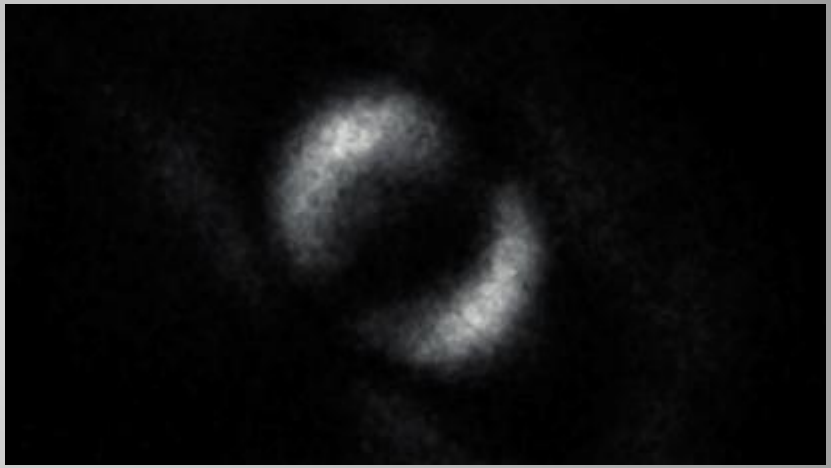


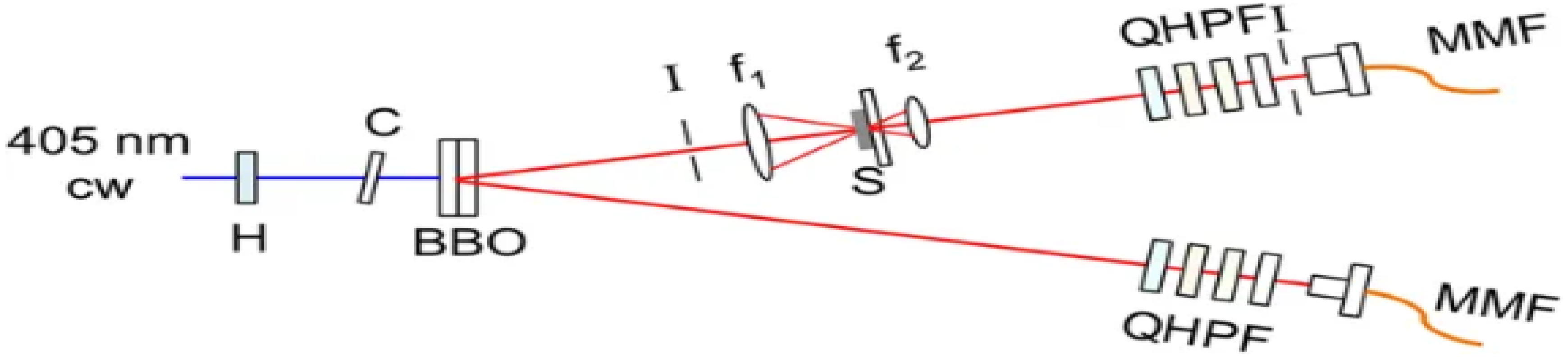
Image Teleporting

Background



First image of Einstein's 'spooky' particle entanglement
https://www.bbc.com/news/uk-scotland-glasgow-west-48971538

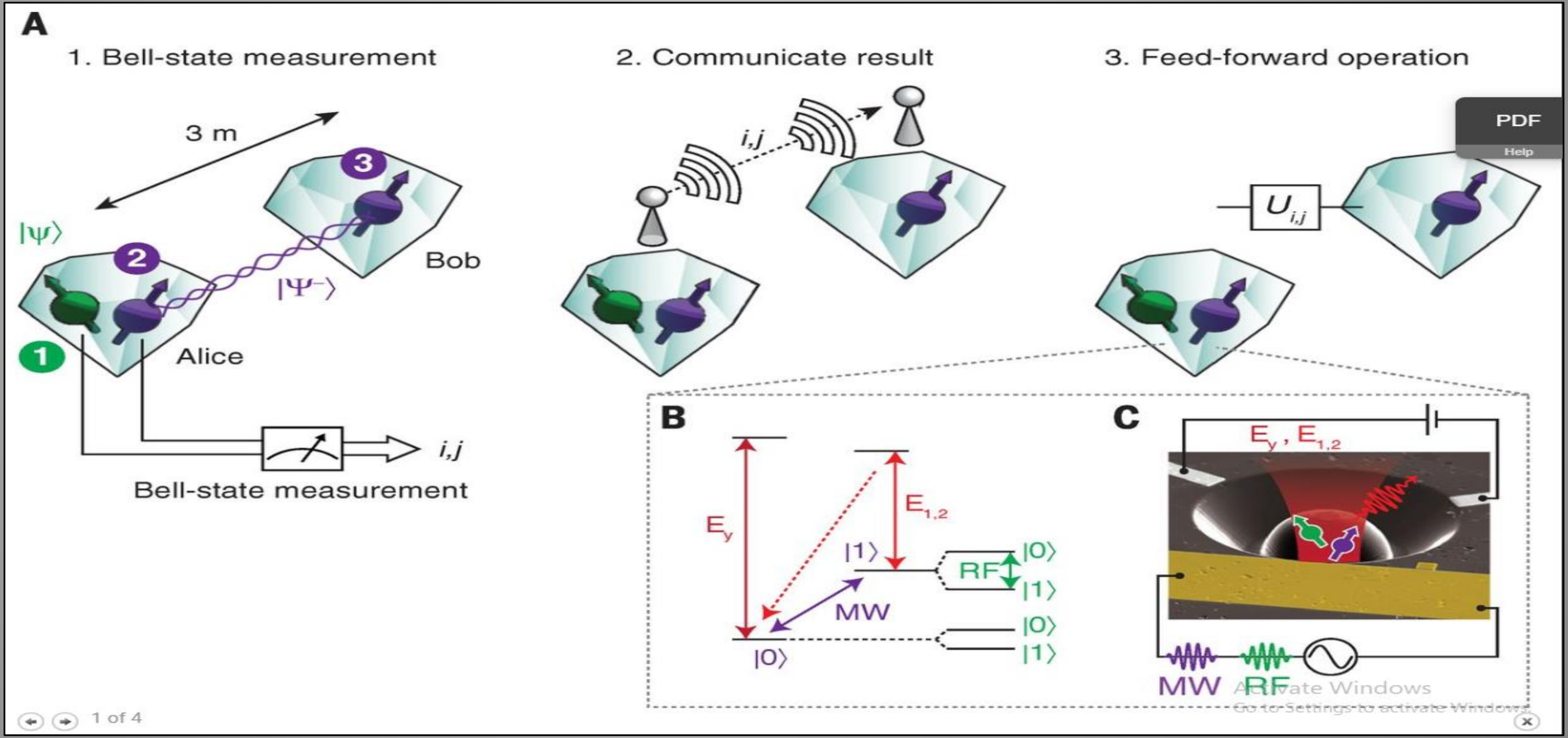
Photon Entanglement Through Brain Tissue



Apparatus used 401 nm linearly polarized light.
State preparation optics included Half-wave plate (H), pre-compensating crystal (C) and pair of BBO crystals. Sample transmission optics included iris (I), lenses with focal lengths f_1 and f_2, and the sample (S). State projection optics included quarter-wave plates (Q), Glan-Thompson polarizers (P) and band-pass filters (F). Photon collection optics included small and large area collimators and multimode fibers (MMF).

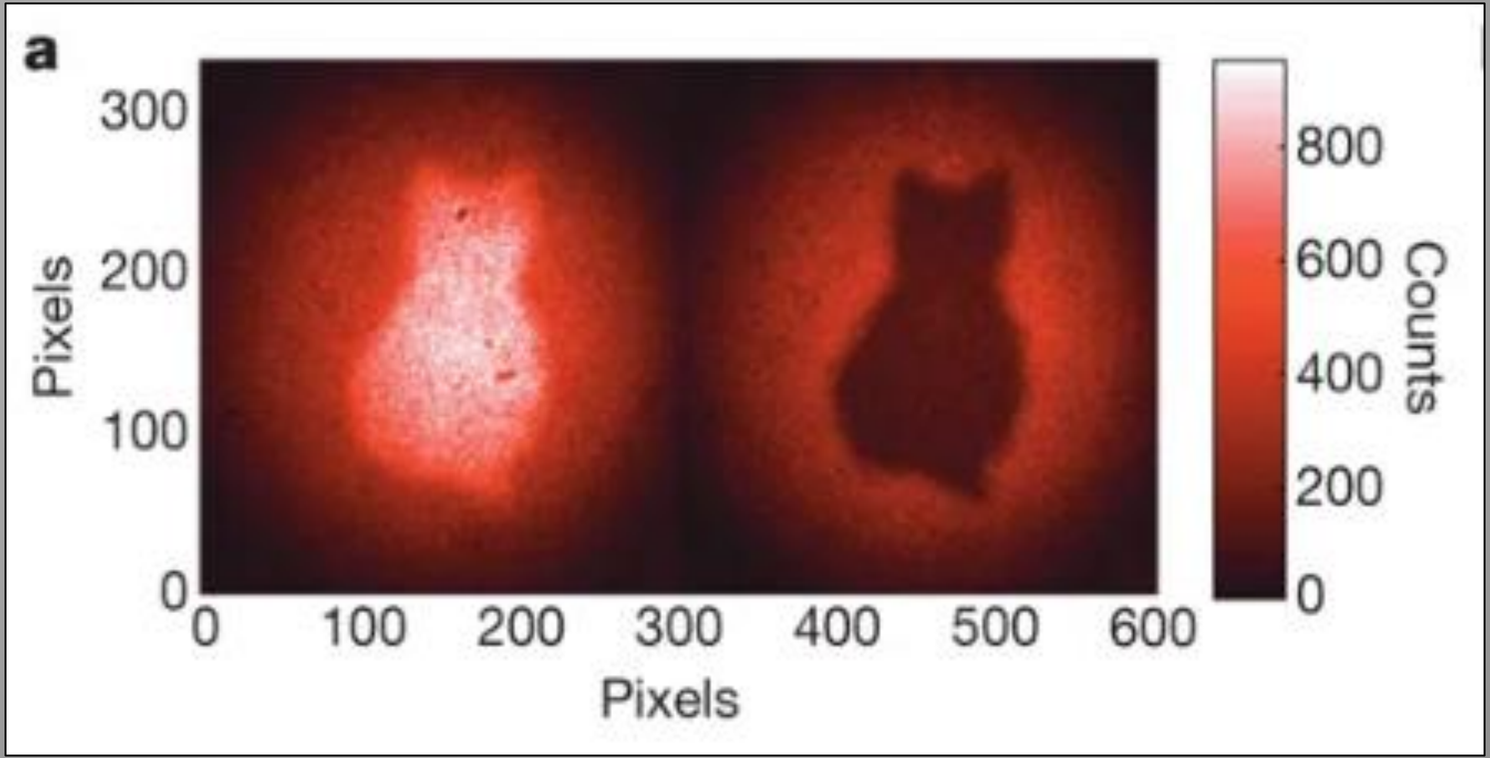
https://www.nature.com/articles/srep37714

Unconditional quantum teleportation between distant solid-state quantum bits



https://science.sciencemag.org/content/345/6196/532

Quantum Entanglement Camera Images Object With Photons That Never Come Near It



https://spectrum.ieee.org/tech-talk/semiconductors/devices/quantum-entanglement-camera

Image Information Transfer is limited by speed of light – as the process was done by beams of light

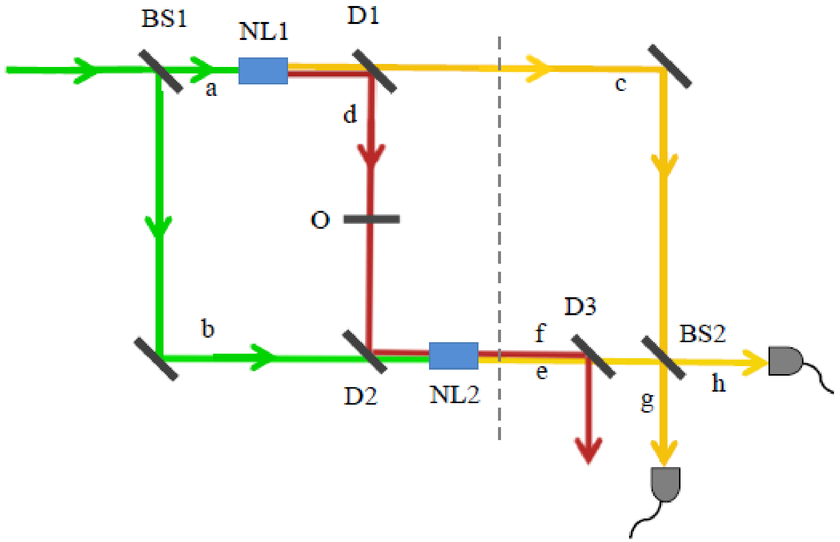


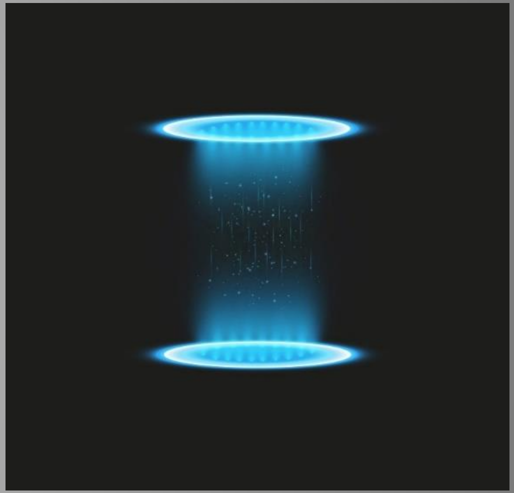
Figure 1. Schematic of the experiment. Laser light (green) splits at beam splitter BS1. Beam *a* pumps nonlinear crystal NL1 where collinear down-conversion may produce a pair of photons of different wavelength called signal (yellow) and idler (red). The idler, bearing amplitude and phase information from object O, reflects at dichroic mirror D2 to align with pump mode b, which illuminates nonlinear crystal NL2, whose own collinear idler aligns with the NL1 idler to make the down-conversion source unknowable, as the two signals combine at beam splitter BS2. Consequently, signal interference at BS2 reveals idler transmission properties of object O.

https://www.nature.com/articles/nature13586

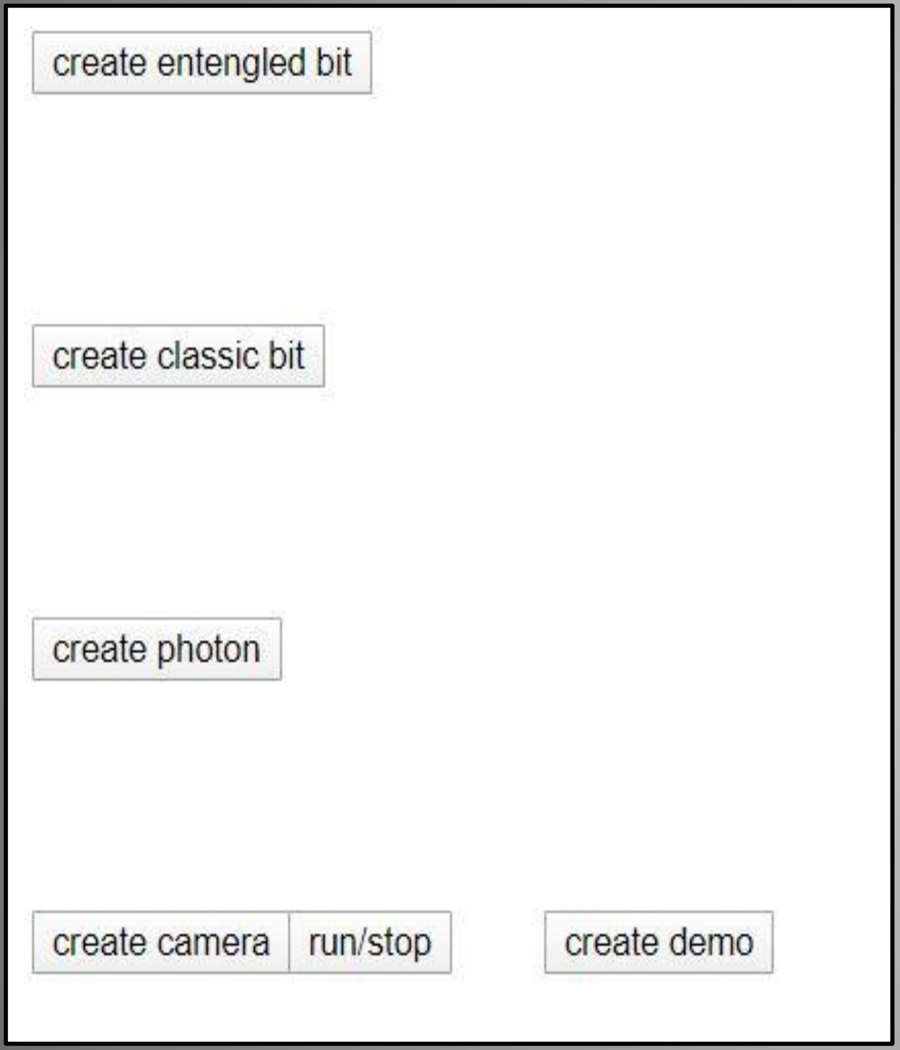
Image Teleporting Simulator

Simulator purpose:

Simulates **Quantum Entanglement mechanism** that can be manually, **build and run**, a pre-determined simulation to show **Image Teleporting**



Simulator Controls



Create entangled bit: create a bit that cab be entangled,
press 0 to give it a zero value or any other key for value 1.
Once you have two entangled bits, you can click and drag them close to each other and they will become entangled

Create classic bit: works like the entangled one.

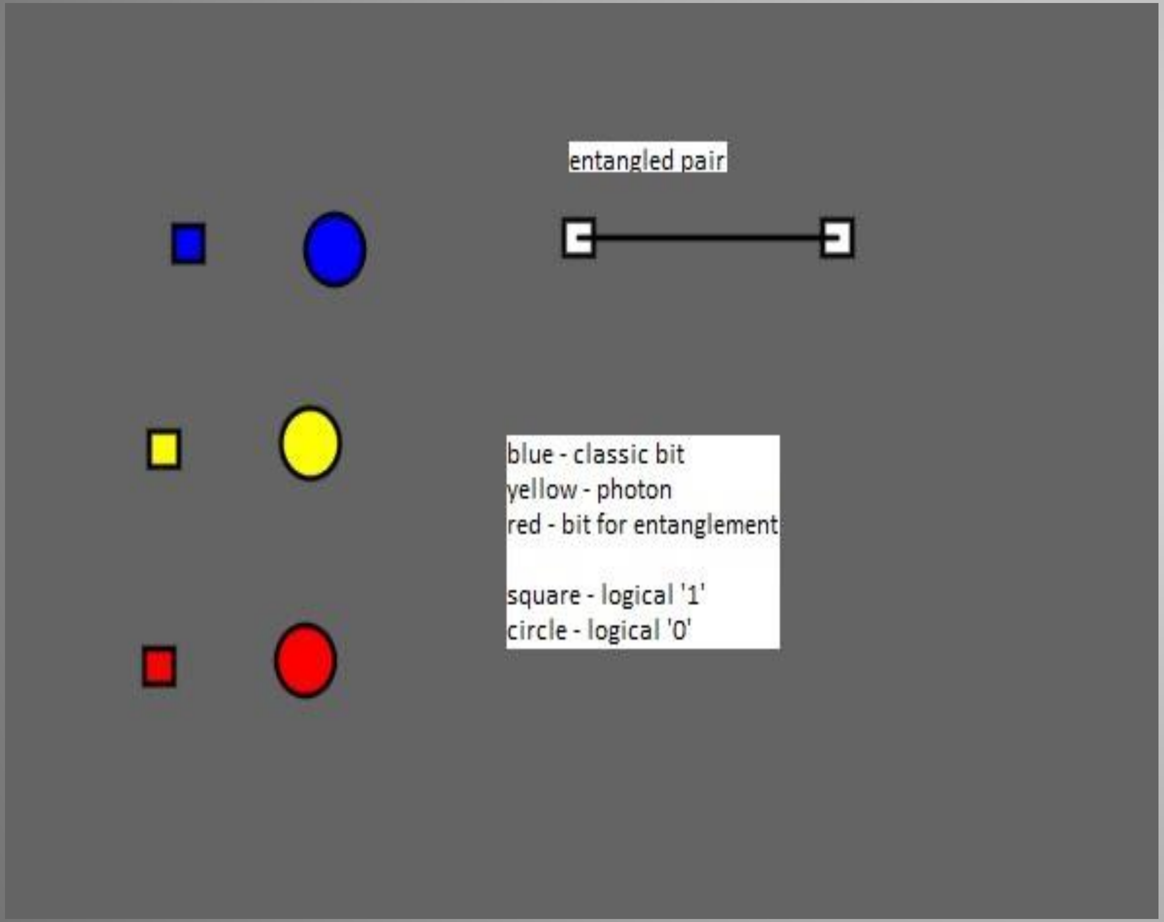
Create photon: like the classic bit it will begin to move toward the closest entangled bit it can find and than the simulation will begin the teleportation process.

Create camera: make a simulation of a 5X5 photo being taken where each entangled bit refer to a pixel in the camera,
after the photons being absorbed on one side and teleported to the other side,
a picture will appear based on the values of those photons.

Run/stop: stop/run the simulation

Create demo: makes 4 triplets of entangled pair and a photon to show all 4 different states of photons.

Legend



blue bits - are the classical bits that we will use to transfer Alice quantum state.

yellow - are the photons whose state we wish to teleport,

red - are the particles to be entangled and be sent to Alice and Bob.

white - entangled particles .

<u>line connecting</u> the entangled particles is the classic channel upon which we will teleport the classical bits of information.

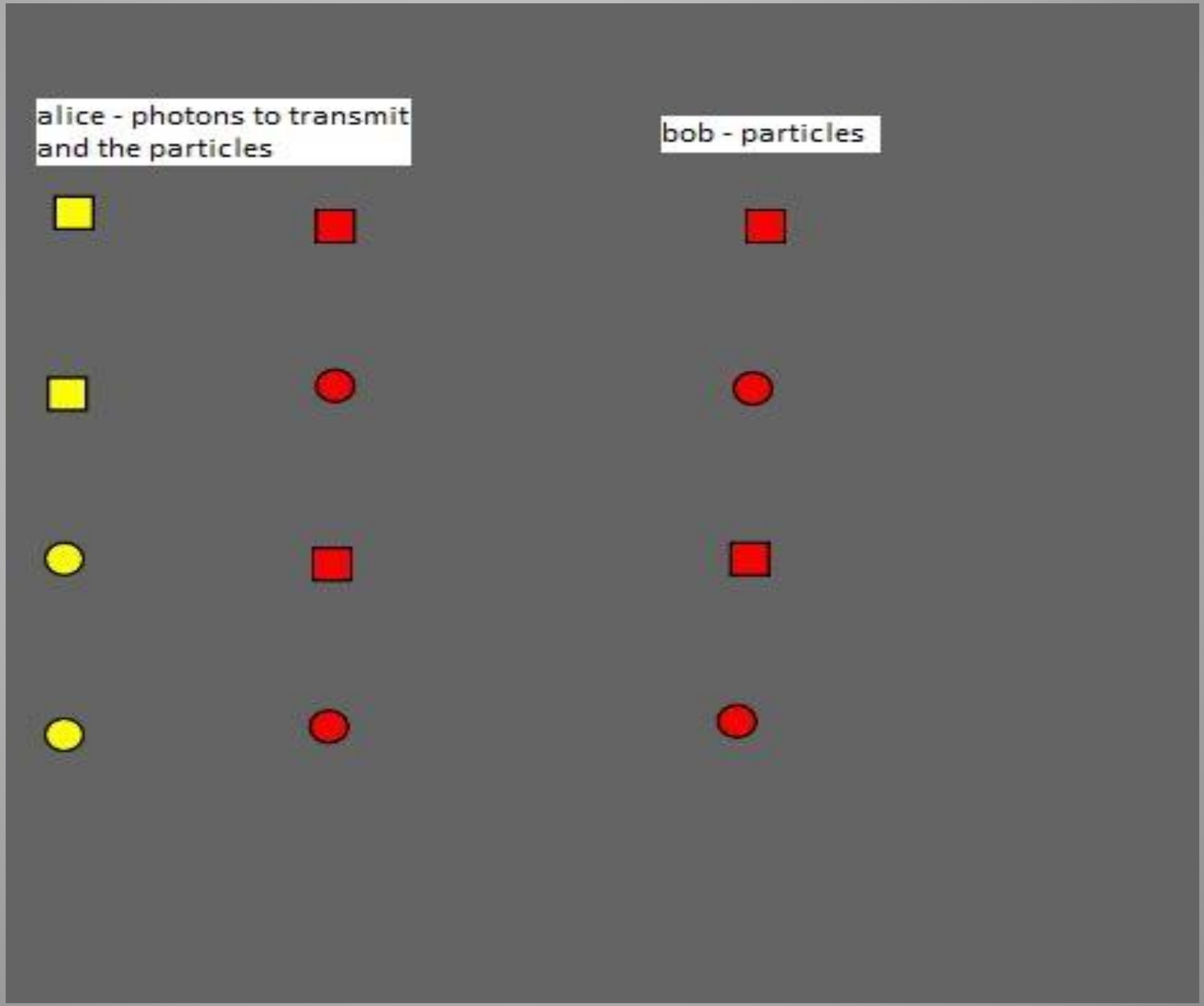
Teleporting Process - four different states

$$|\Phi^+\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |0\rangle_B + |1\rangle_A \otimes |1\rangle_B) \quad (1)$$

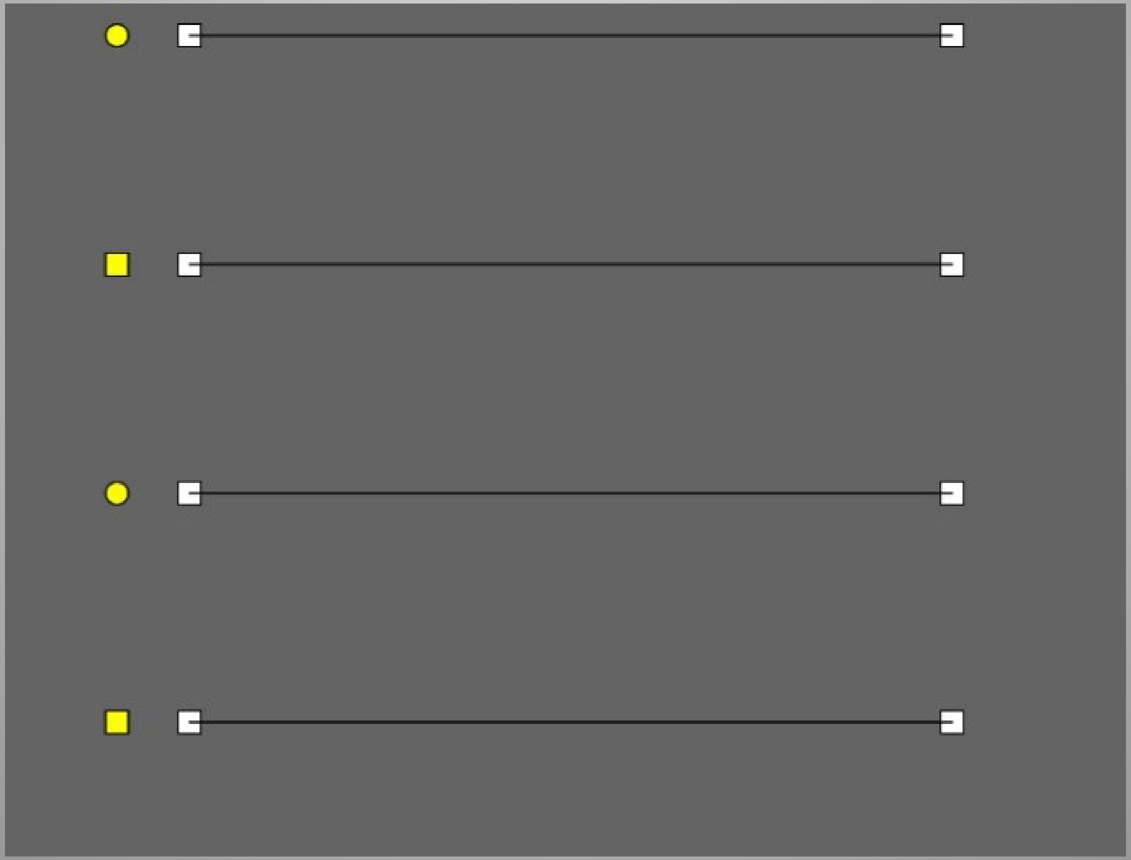
$$|\Phi^-\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |0\rangle_B - |1\rangle_A \otimes |1\rangle_B) \quad (2)$$

$$|\Psi^+\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |1\rangle_B + |1\rangle_A \otimes |0\rangle_B) \quad (3)$$

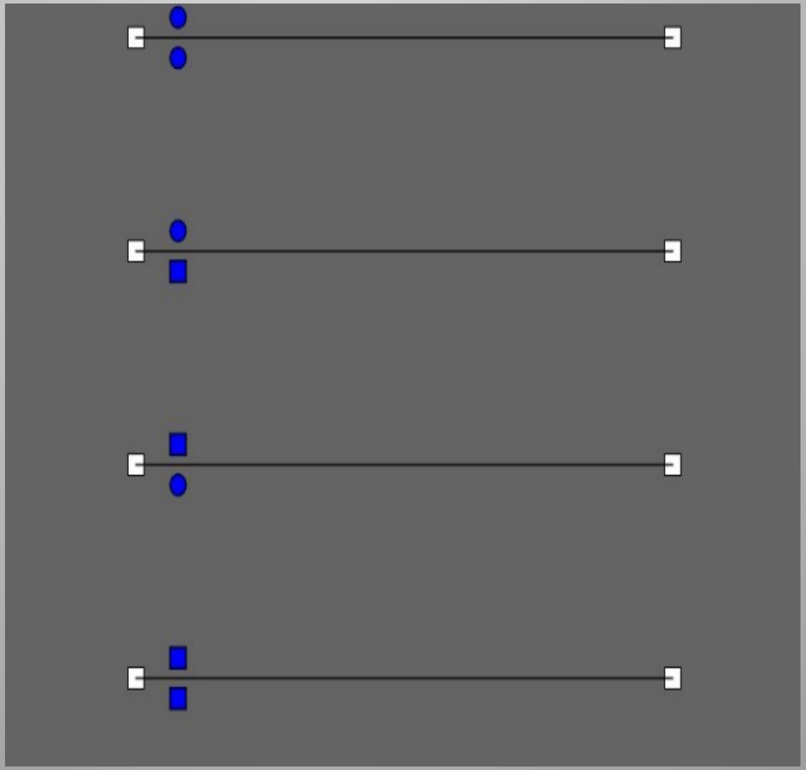
$$|\Psi^-\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |1\rangle_B - |1\rangle_A \otimes |0\rangle_B). \quad (4)$$



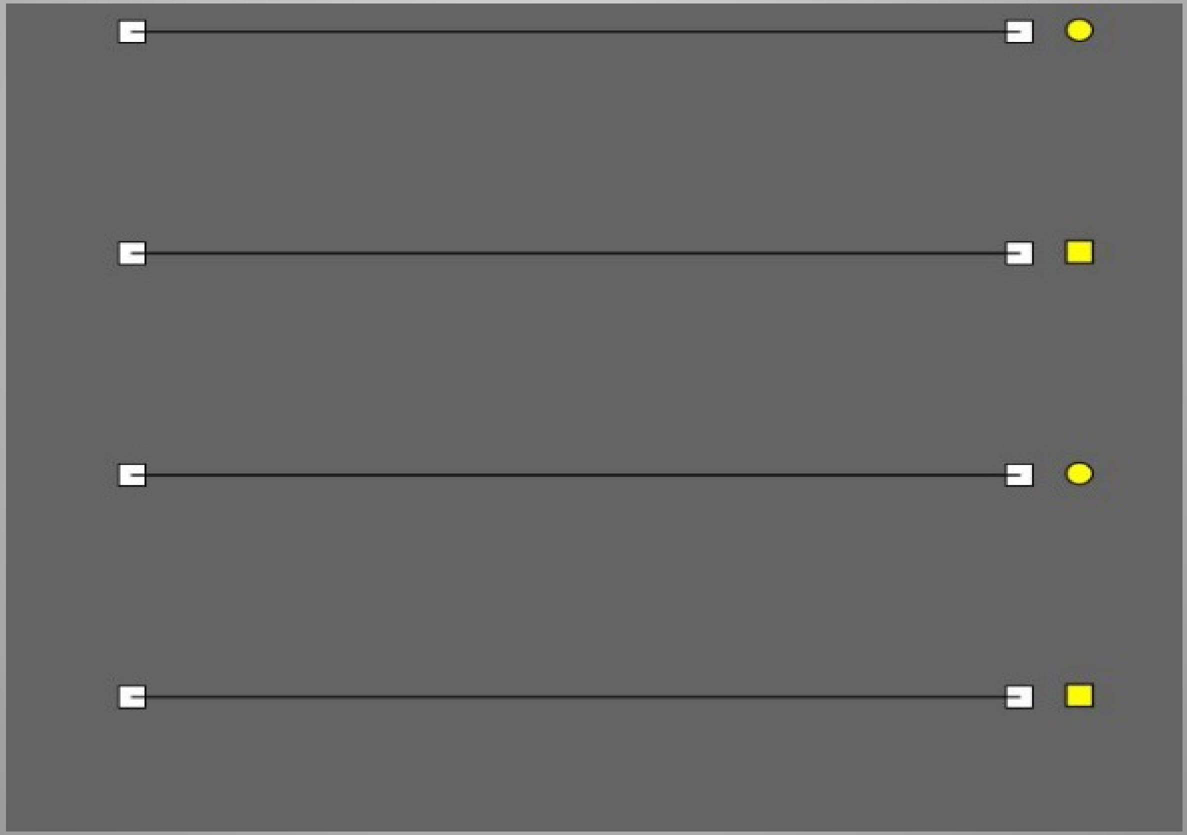
Teleporting Process - entangled particles with unknown value, and the photons to be teleported



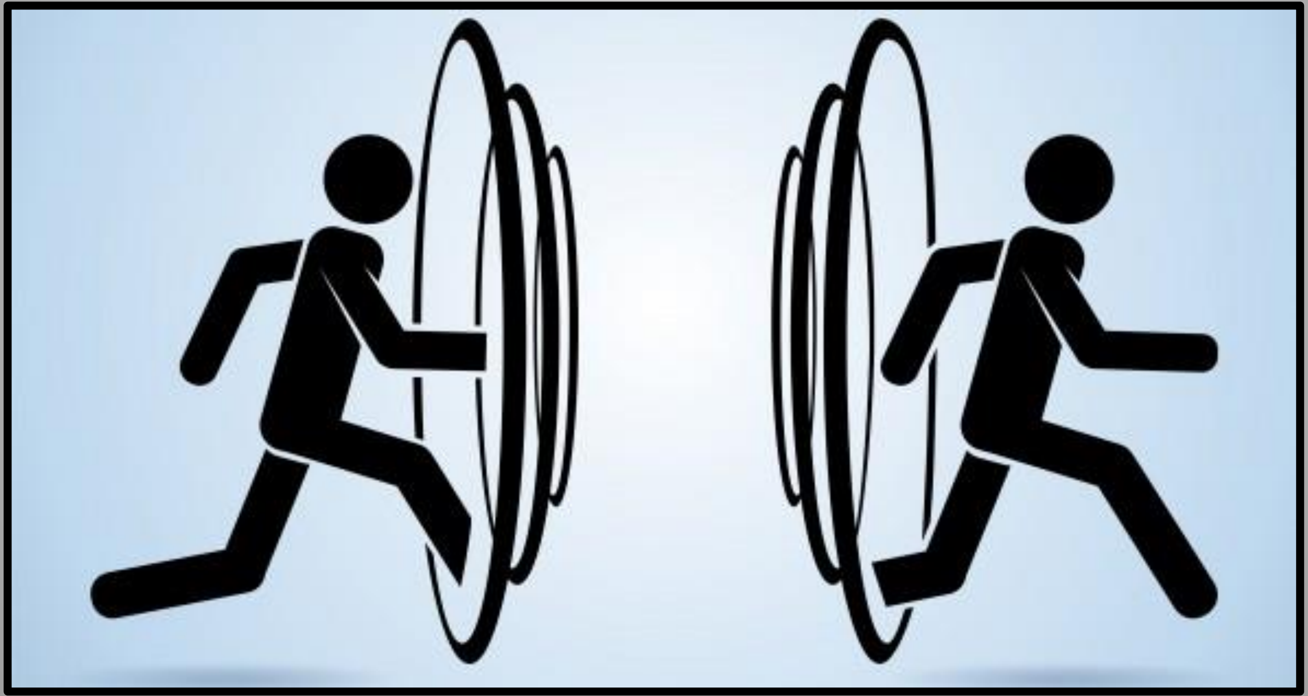
Teleporting Process - after measurement there are 4 different classical bit variation, which then start to transmit to Bob



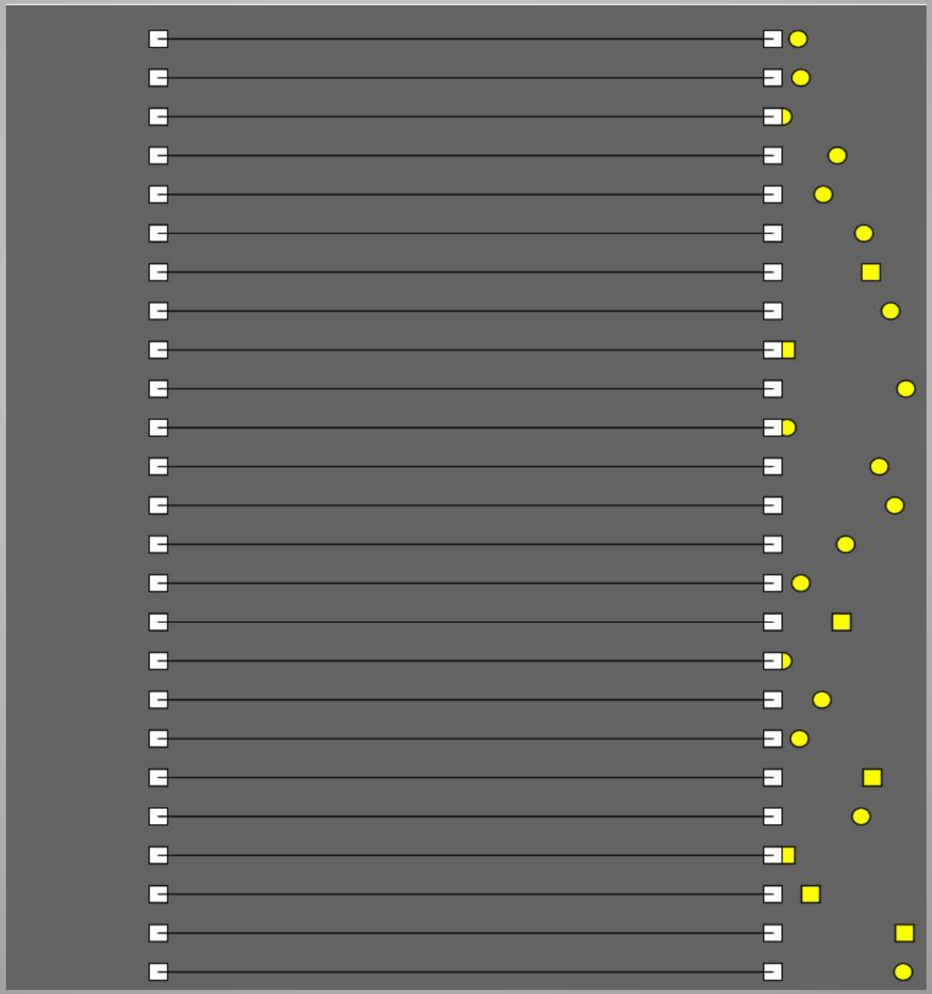
Teleporting process - the states of the photons were correctly teleported after receiving the classical bits



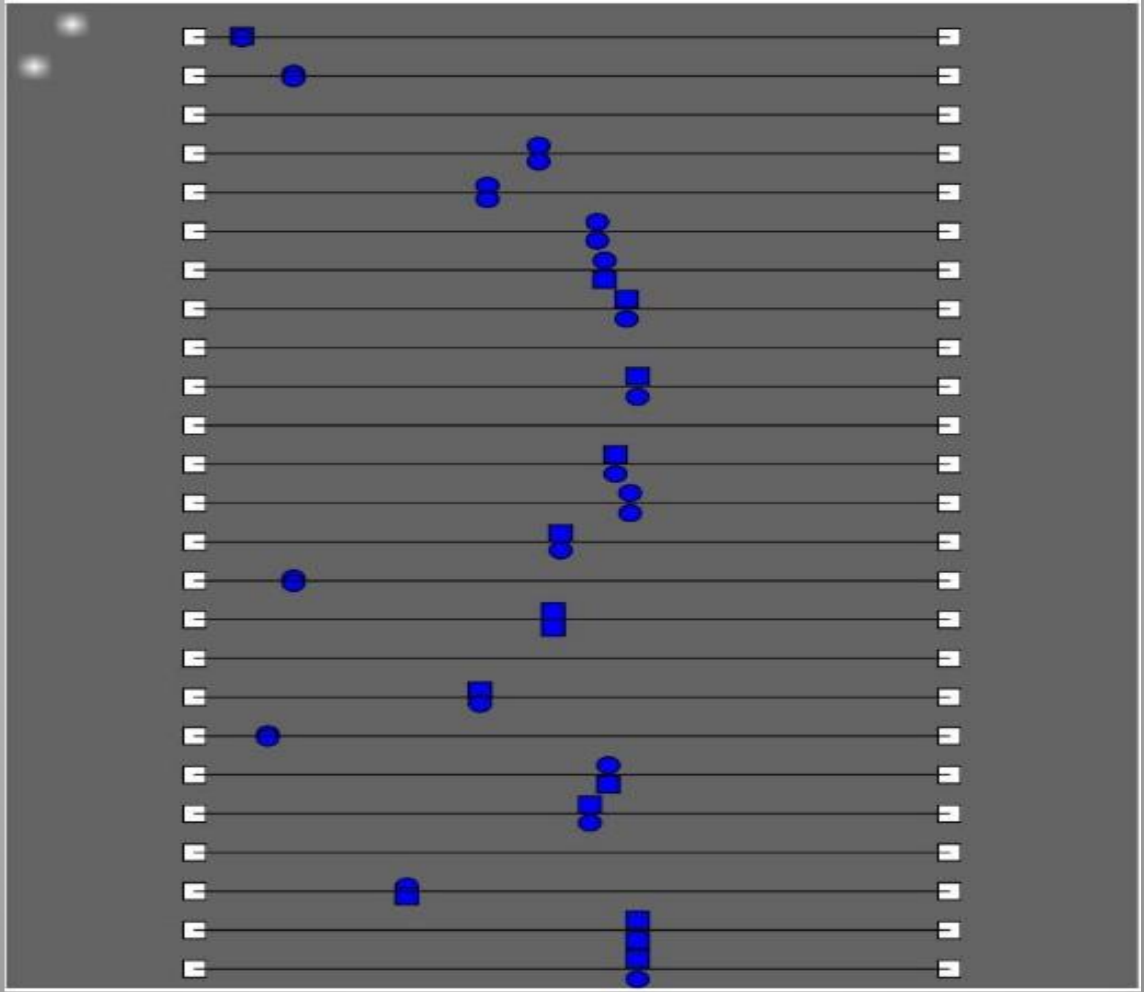
Imaging teleporting simulation



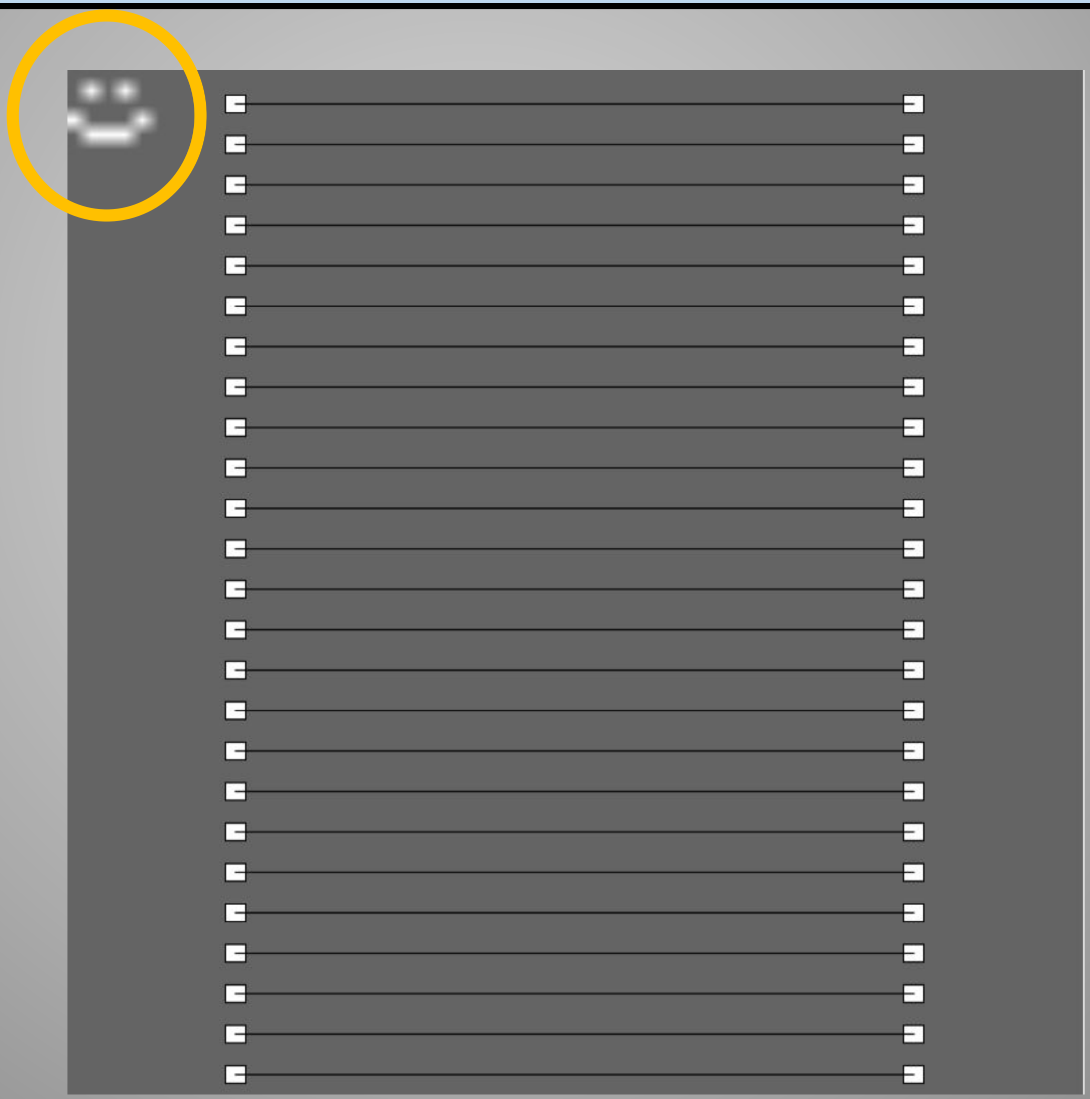
Simulation Initial state sending the image as a vector



Simulator Process - the image is being built, still some classical bits on the way



Simulator final - the image has reached Bob and has been reconstructed



Suggestions for Applications

- In case of illness, tumor, accident or disability of the optic nerve, then we can transfer the images, as described, from the eyes to the **Visual cortex** in the brain.
- We can transfer entangled imaging data to both side of the brain as the image arrived to one side.

Thank You