BFIII Workshop
Single-Photon Experiments and the Quantum Eraser
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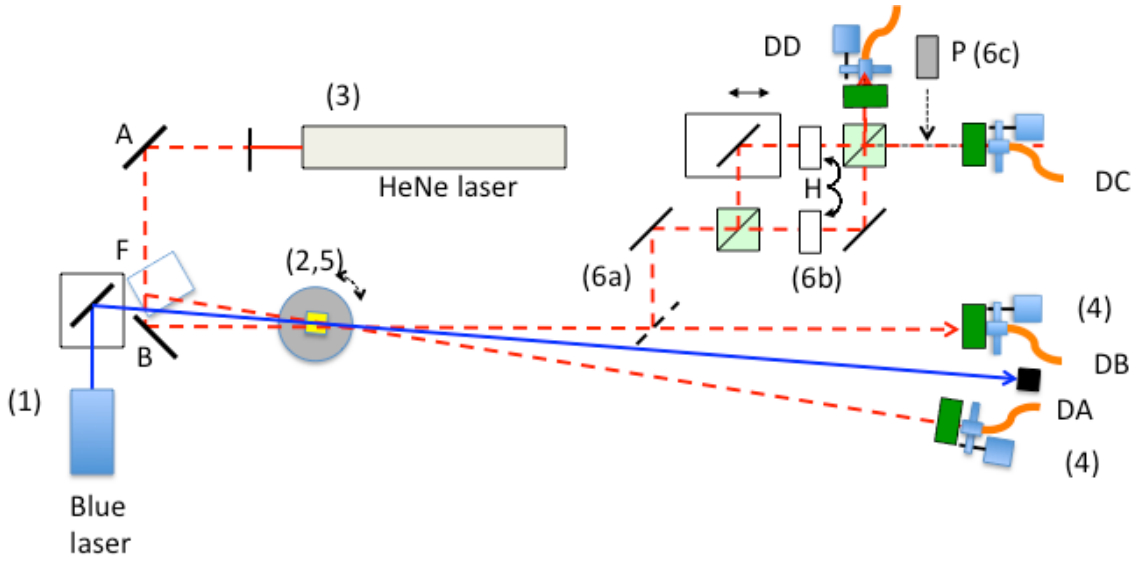
The purpose of this workshop is to get participants familiar with single photon experiments. The activities will involve some demonstrations and also some hands-on activities for getting a feel for the alignments involved.

Our activities will be based on the setup shown in the figure. We can break down the parts as follows:



1. It all starts with a "blue" 405-nm laser. It is steered toward a crystal.
2. This crystal creates photon pairs from input photons, through a the process of spontaneous parametric down-conversion. The photon pairs have a wavelength of 810 nm. There are too few of them to see them on a card.
3. A HeNe laser is used to mimic the path of the down-converted photons. For the purpose of aligning the fiber collimators that collect the down-converted photons.
4. Hands-on activity I (two participants):
    a. Align the iris of the collimator so that the beam is centered on the iris. This is a critical step.
    b. Screw the filter on the collimator and adjust collimator mount's tilt so that beam is reflected straight back. Once done, check that beam is still centered on the iris. If not repeat.

c. Put fiber and look for light coming out of the other end. Adjust the tilt of the collimator so that beam is as narrow as possible and as bright as possible.
d. Connect collimator to fiber connected to detectors DA or DB

5. Now we are ready to look for down-conversions.
   Hands-on Activity II (1 participant):
   a. Maximize coincidences by:
      i. Tilting the crystal,
      ii. Tilting the collimators (both axes),
      iii. If necessary, translating (slightly!) one of the collimators along the track. The coincidences should be more than accidental coincidences: Nacc= $N_A N_B$ T where T = 50ns
      (rule of thumb if N_A=N_B=10k -> Nacc= 5).
6. W now flip the flipper mirror and reroute one of the photons to a Mach-Zehnder interferometer. We can see interference with the He-Ne laser. We will go ahead and start taking interference data and recreate the quantum eraser:
   a. When the paths of the interferometer are indistinguishable we see interference fringes on detector C and the oppositely-phased fringes on detector D. Note that there are very few triple coincidences. This is because the photon interferes with itself but collapses whole at only one detector.
   b. Hands-on activity: Rotate one of the half-wave plates by 45 degrees. This rotates the polarization of the light going through it by 90 degrees. The paths are now distinguishable by polarization and so there is no interference.
   c. Hands-on activity: Place the polarizer with transmission axis at 45 degrees in front of detector C. This projects the two polarization components along the diagonal erasing the path information. Thus, interference reappears.