

University of Ljubljana
Faculty of Mathematics and Physics

Adrian Udovičič

Alignment of Sagnac Interferometer

PhD Study

prof. dr. Rainer Kaltenbaek

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Abstract

Key words:

1 Introduction

In this part I will try to explain the methodology I used while aligning the Sagnac Interferometer for our entanglement distribution setup. The alignment has been confirmed to be quite well over a distance of 14 m, bouncing the beam from one end of our optical table to another a few times and then finally observing it on a camera. Care was taken into making sure the beam stays as flat as possible using an iris.

1.1 Preparation

After the initial alignment mentioned by [1] up to step 6, in order to see interference fringes one must pre-align the interferometer. This is done by first removing the half-wave plate (HWP) from the inside of the interferometer, or setting it to 0° .

Next, it is important to place two irises, one just after the output of the main PBS, and the second one as far away from that one as room on the table will allow. The reason for this is error propagation. It is much easier to see if the beams are misaligned over a larger distance.

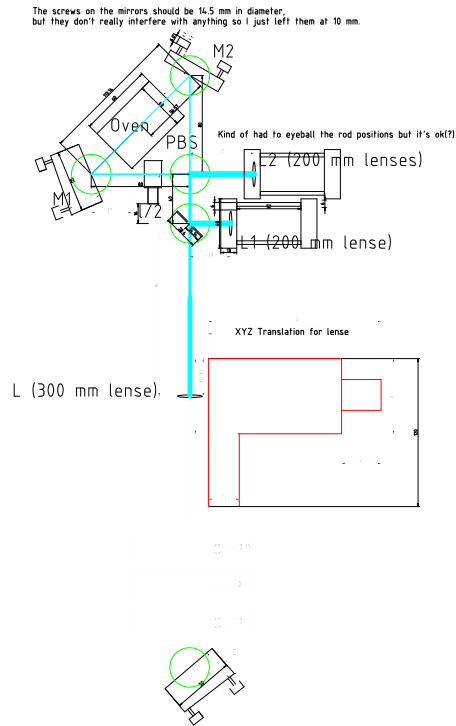
Prepare a camera with its lens removed and make sure you can connect and see an image on your computer.

Place the camera on the table next to the iris closest to the PBS, make sure the iris is fully open (and the camera pointing the right direction ;)), and observe what happens when you change the beams' polarization using a HWP, going from H, to D, to V, and back. If the Sagnac Interferometer (SI) is badly misaligned, you should be able to see two beams, spatially separated, when rotating the HWP. You may repeat this step for the second iris if you so wish.

1.2 The fun part

Start with the farthest iris and set the polarization of the pump to either H or V. Here you have to choose which mirrors will be your H mirrors, and which will be your V mirrors. This is crucial for this to be a time efficient endeavor. It is an arbitrary choice, but one that needs to be made and respected throughout the entirety of the alignment process. Choose them in an intuitive way for you. Based on 1.2, we choose the H mirrors to be C, and M2, and the V mirrors to be M0, and M1.

[H]



Once you have chosen which mirror (or coupler) you will use for alignment of a specific branch you can start the alignment. The alignment is done in multiple steps for each branch. First, with the webcam, check again the positions of the H and V beams. You want them to be superimposed when you go to D. Lets say you start with H. The beam should go through the interferometer on the image 1.2 from $C \rightarrow M0 \rightarrow M2 \rightarrow M1$ and continue straight to the top lens for instance. The order of the last two mirrors will be switched for the other polarization. You place the webcam at the farthest iris and rotate the knobs on your H mirrors/coupler such that it moves through the center of the closed iris. You want to move the farthest mirror (coupler) M0 (C) as little as possible as this will make the largest impact on the beampath. Once you're sure the beam is going through the (almost) fully closed iris' center you move to the other branch. Place the camera to the closer iris to the PBS. Change polarization on HWP1 to V. Do the same thing as described above until the beam passes through the center of the (almost) fully closed iris. Next comes the important bit. Stay on V and move to the other iris. Now you will only move the horizontal knob in the V branch of the interferometer. This way you are changing the angle at which the beam passes through the 1st iris, while making sure it passes through the 2nd iris. Repeat the above step to get the beam through the closed iris. Then do the same thing on the H branch at the farther away iris. Repeat all of these steps until you see the two beams overlapping as much as possible. You will use this same method later as well when optimizing the interference.

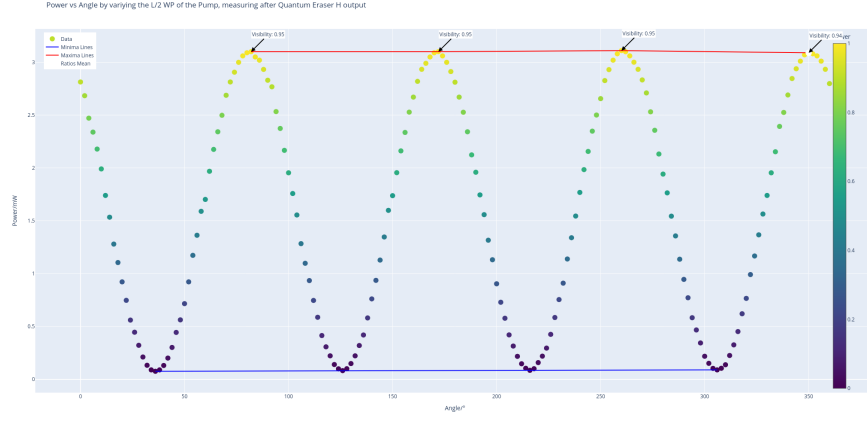


Figure 1.1: Plotting the power of the transmitted beam after a quantum eraser. In image 1.2 we have a part of the quantum eraser setup. At the output of the PBS we have another HWP and PBS through which we measure the interference.

References

- [1] R. D. Hamel, “Realization of novel entangled photon sources using periodically poled materials.”

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