# Poisson's Spot: Single Photon Interaction

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## Introduction

This project represents an investigation of the Poisson's Spot using single photon interaction at Central Washington University. Poisson's Spot is a consequence of electromagnetic wave interference. The phenomenon occurs when light is obstructed by a circular object resulting in the diffraction of waves leading to a localized bright spot centered in the produced shadow.

Classically this phenomenon is resolved with the wave model of light; however, photon interference should exhibit the same effect.

To investigate this, a novel method was introduced to evaluate the Poisson spot under the constraints of single photon interaction. A 474 nm laser was passed through a BBO crystal which resulted in down conversion of the light via spontaneous parametric down conversion. This was done to ensure single photon interactions. Two photon detectors were then inserted in the path of the photons, one path containing a circular obstruction.

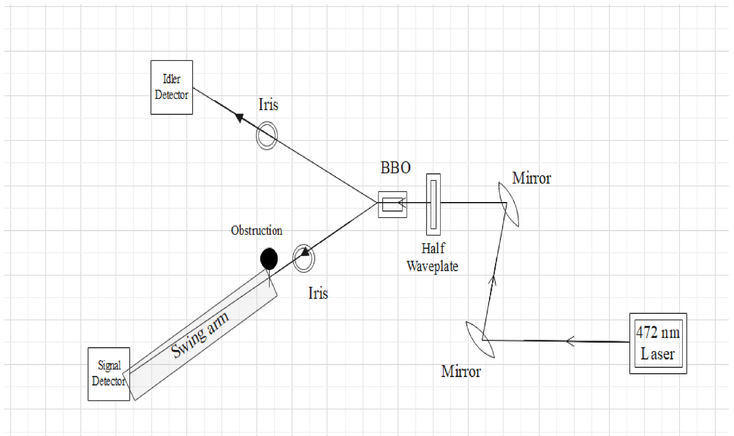
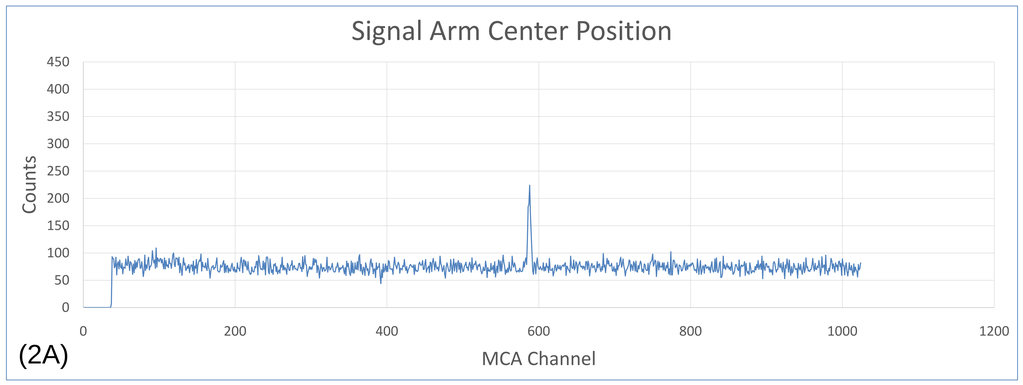



Figure 1. This schematic depicts the experimental apparatus. Light from a 474 nm laser was directed through a half-waveplate into a BBO crystal. In the crystal 474 nm photons from the beam are down converted via spontaneous parametric down conversion into two coincident photon rays. The photons propagate down separate paths. The idler arm was set up to detect one photon and the signal arm was set up to be obstructed by a circular object and detect the other photon.

## Methods

Coincident photons via spontaneous parametric down conversion through BBO crystal
Stainless steel ball-bearing glued to glass slide to produce obstruction
Iterative scanning of down converted photons in signal arm
Time correlated coincident photon data via Time Amplitude Converter (TAC) and multi-Channel Analyzer (MCA)
Delay cable in signal arm produces identifiable peak in MCA spectrum for coincident photon detections
Graphed data representing coincident rates scanned across shadow of obstruction



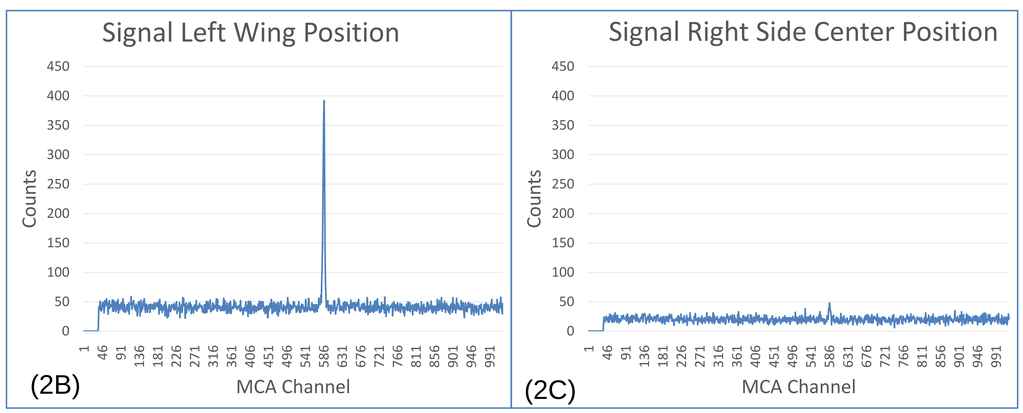




Figure 2. The graphs show counts as a function of delay time; the obvious peaks in figures 2A and 2B and the barely resolvable peak in figure 3C correspond with the position in the spectrum associated with coincident photon detections.
Figure 2A. This data represents a spectrum obtained with the signal arm positioned to detect photons in the center of the shadow of the obstruction.
Figure 2B. This data represents a spectrum obtained with the signal arm positioned to detect photons just outside of the shadow of the obstruction on the far-left side
Figure 2C. This data represents a spectrum obtained with the signal arm positioned to detect photons slightly off center from the obstruction's shadow

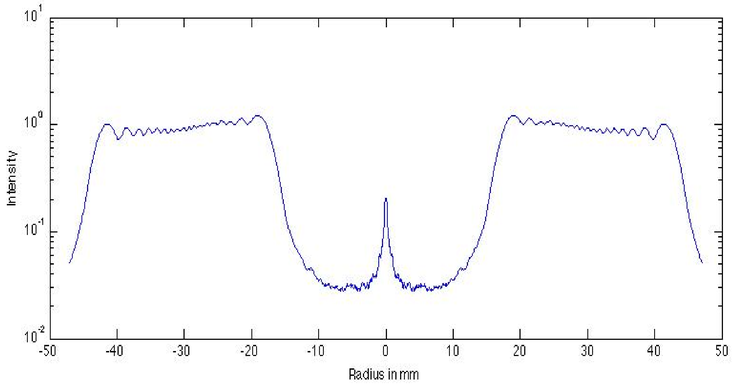



Figure 3. This is Matlab generated luminosity intensity vs position graph of the Poisson Spot. There are high peaks outside the shadow representing unobstructed light. The central peak is the Poisson Spot sandwiched by low rates from the obstruction.[1]

## Results

- Data gathered from scanning shadow of obstruction is as shown in figure 3.
- The coincidence spectra gathered, and shown in figure 3, show a peak outside of the shadow, a drop in rates off-center in the shadow followed by a peak at the center of the shadow. This behavior is in accordance with the form of the classical phenomenon.

## Conclusion

The results of this experiment suggest a Poisson Spot constituted by single photon interactions. The preliminary data is in accordance with that of a classical Poisson spot elucidated through a wave interpretation of electromagnetic radiation. Though further data collection is necessary to establish that the Poisson spot has genuinely been observed using this novel method, observed aspects of the system presented in this poster is consistent with the corresponding classical phenomenon.

## References

1) Vanderbei,R. & Gott, J. (2011, May 6). Poisson's Spot ( AKA Spot of Arago). Retrieved from https://vanderbei.princeton.edu/images/Questar/PoissonSpot.html
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