Cosmic Ray Telescope

Background:

Muons are the most abundant cosmic ray particles at the Earth's surface. This is because they are not very reactive and lose energy very gradually. In this exercise, you will be required to demonstrate that the flux of muons changes as the position of a scintillator changes. You will rotate the apparatus through 90°, measuring muon incidences at no fewer than four independent points.

The apparatus before you has two scintillator paddles situated vertically one above the other. The photomultiplier tubes are already attached. You can only rotate through a full 90° by turning the apparatus one way.

Procedure:

The apparatus is arranged so that at 90°, the wide sides of the scintillator paddles are horizontal. As you rotate to ~0°, the wide sides will become increasingly vertical. As this happens, you should see a decrease in the number of muon incidences.

1. Begin with the paddles at 90° (the paddles should be horizontal).
2. Attach a PMT base to the PMT's on each paddle.
3. Attach the power supply to the PMTs, and the PMT outputs to the amplifier inputs.
4. Connect the amplifier output to the oscilloscope. Adjust power supply to no more than +800V.
5. Check now for a signal from each paddle. Make a sketch.
6. Connect the second amplifier outputs to the multipurpose coincidence inputs.
7. Connect the coincidence outputs to counter-timer inputs. Connect the other positive incidence output to the external trigger on the oscilloscope.
8. Set the scope to use the signal from the counter to trigger signals one and two.
9. Set the counter to begin a count with an incidence on one input and end with an incidence on the other.

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10. Allow this to run for 30 to 45 minutes. This will help later on. Record the incidence count.
11. Rotate the apparatus to a new position. Try to be independent of your previous position, but don't rotate too far because you need four measurements. Be sure to measure the angle the supporting rod makes to the horizontal.
12. Repeat steps 8-10 until you have four independent measurements. It is important to allow the apparatus to run for the same amount of time for each measurement, otherwise the number of incidences may not correspond correctly to the appropriate relationship.

Results:

As you record incidences, you should notice a decrease in the total number for the same amount of running time. This relationship should correspond to $\sin^2\_$ with _ being the angle of the apparatus to the horizontal. At your final measurement, approximate with 1-5 degrees, rather than using 0, as $\sin^2 0$ is 0, a trivial result.

In your write up, please show this relationship in a table with all four measurements. Show your calculation of error, and provide a graph of the relationship including appropriate error bars (error bars are relatively easy to do in Excel). Note any irregularities, and state what might be the cause.