Polarizer simulation method.

The local simulation of the polarizer define two results:

- The output taken by the photon (e or o is used)
- A coefficient proportional to the time taken for the polarizer crossing.

This is done in 2 steps:

- 1: Calculation of an amplitude value depending on the hidden variables of the photon and the angle of the polarizer.
- 2: A test with two threshold values equal to PI/4 and PI/2.

Step 1:

Calculation of the amplitude for the threshold test.

The photon is modelled using 3 variables noted **p, q, r**

With:

p : Angle of polarization.
q and r : Two other angles, whose origin is not established.

The value of these three variables are defined by the source during emission with random values between [0..PI] (and uniform distribution).

The amplitude value, noted **S**, is defined as follows:

By setting:

d = p - a_pol

(p: photon polarization)
(a_pol: angle of the polarizer)

Note: If the d value is negative, the polarizer having a periodic PI period operation, the d + PI positive value is used.

S is then defined by the sum:

S = d/2 + q/6 + r/12

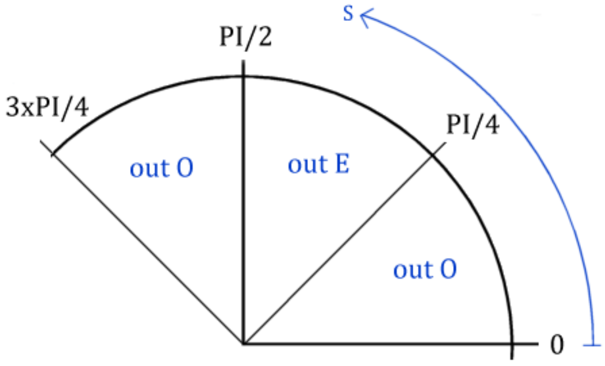
The amplitude of this value varies between 0 and 3*PI/4, of which 2/3 depends on the difference in polarization angle of the photon / polarizer angle.

Step 2:

Determination of the output.

It is done with a test comparing the value S with two thresholds values PI/4 and PI/2

If S between PI/4 and PI/2, the output is e, otherwise it is o.



Coded in C language, this produces the following code:

```
#define OUT_O 0                 // value used to code o out
#define OUT_E 1                 // value used to code e out

int out;
float d, S;

d = pho.p - a_pol;              // a_pol is polarizer angle
if (d < 0)
  d = d + PI;                   // use positive modulus PI value

S = d/2 + pho.q/6 + pho.r/12;

if ((S >= PI/4) && (S < PI/2))
  out = OUT_E;                  // S in PI/4..PI/2 range
else
  out = OUT_O;
```

Note: pho.p, pho.q, pho.r represent the variables p, q, r associated with the photon.

Calculation of the polarizer crossing time.

When it leaves the polarizer, the polarization of the photon is adjusted to the e or o output.

A transit time coefficient can be defined by calculating the variation in polarization occurred between its input and output from the polarizer.
The crossing time is then proportional to this repolarization value.
This repolarization can reach a maximum of PI / 2.

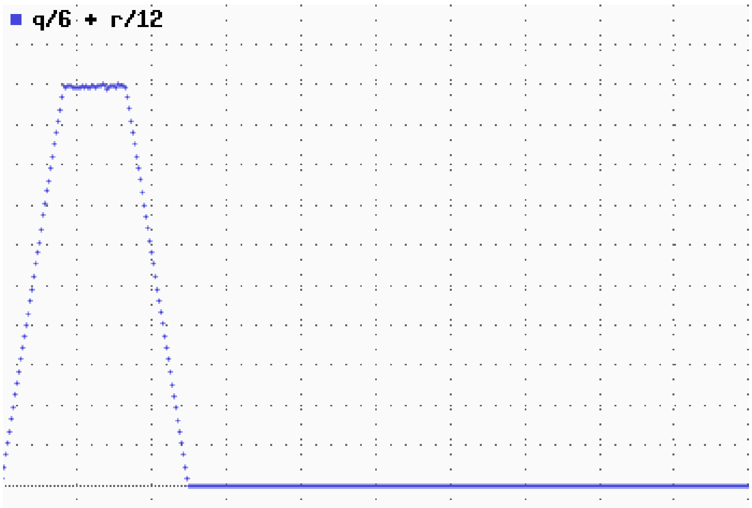
Note: Using a sigmoid-like shaped transmit time function with an inflection point in PI/4, allow to produce $\sin^2/\cos^2$ correlations if the size of the pairing window is not enlarged. ('st1 delay' parameter in the EPR simulation program).

Interpretation:

It is difficult to know if this local model is only computational, or can represent something existing.
In the second case, it would be necessary to relate the quantities p, q, r to elements of an existing local theory.

We can notice that the output is determined to 2/3 by the difference in polarization.
The variables q and r allow for the last third to modulate the switching direction.

This can represent a form of jitter whose distribution graph is as follows:



X axis : 0..PI

As the photon move in a 3 dimensional space, the q/6 + r/12 sum is maybe related to physical magnitudes depending on the direction of the movement.

Note: Use of this algorithm is made on the following web page, describing methods for drawing circles.

http://pierrel5.free.fr/physique/circle/circles.htm (see "Method using randomness and correlations", co_cos() function.)

The code uses a stripped-down version of the algorithm, which makes it more readable than one used into the EPR simulation program.
It also uses the value 1 instead of PI, but that doesn't change the operation.

We can notice in this code that the time coefficients used to cross the polarizer (variables ra and rb) allow, with the help of a test, to determine in advance if the results o / e are correlated.
We can also notice, when there are two possible choices for the output o (S < PI/4, or S > PI/2), the output o taken is that corresponding to a minimum of repolarization, thus seeming to apply the principle of least action.

Conclusion:

The main objective of this simulation is to show that a local method can still explain the last EPR experiments carried out and that it is still not mandatory to invoke non-locality to explain the results.

Regarding the 'old' experiments using continuous sources and moving window pairing, local simulation also makes it possible to obtain a stable violation of the Eberhard (or CH) inequality with intensities greater than that obtained in these experiments.

Regarding the more recent experiments using fixed windows and pulsed sources, these ones obtained inequality violation intensities with a low amplitude very close to 0.

The simulation, using the positivity test tool, shows that very low amplitudes are very dependent on stochastic variations.
An experiment would then have to be repeated a large number of times (10 to 20 times), using a large number of samples to validate the stability of a result.
It also shows, by simulating QM, that higher amplitudes would have to be obtained if the non-locality applied.

The simulation also makes it possible to show that with a local model, a stable violation can be obtained if the multiple detections (accidental) are counted as uu. (No detection on Alice and Bob).
The reason is that if the multiple detections are not produced by randomness at detector level, but result from multiple emissions of pairs by the source, counting the measurement as uu indirectly allows to undercount the situations producing uu measurements, corresponding to specific conditions that do not generate correlations, by replacing them with a detection of the second emitted pair, without this being detectable. This ultimately generates a counting error for the result of the inequality.
It is therefore necessary, when counting, to take into account all the multiple detections, and to count each detection as a single measurement.

However this last point is not described in the results of experiments, seeming to be secondary.
It is however an essential point, because even with a low rate of incorrectly counted measurements (2%), a stable violation of inequalities can also be produced with a local system and pairing with fixed windows.