The Sunshine Line

I take advantage of every way possible to watch signs of the progression of winter so that I know it is coming to an end. For example I celebrate the arrival of certain days like December 1 which is the start of meteorological winter that runs from December 1 to February 28 (29) instead of astronomical winter from December 21 to March 21, because the sooner it starts, the sooner it will end. I also note December 7 which is the day of the earliest sunset at 40 degrees north latitude. After that the evening light lasts a bit longer each and every day. December 21, the day of the least amount of daylight is another landmark along the way through the dreaded period of winter. After that, the amount increases slowly each day. Then there is January 3 which is the day of the latest sunrise. After that…..well, you get the picture.

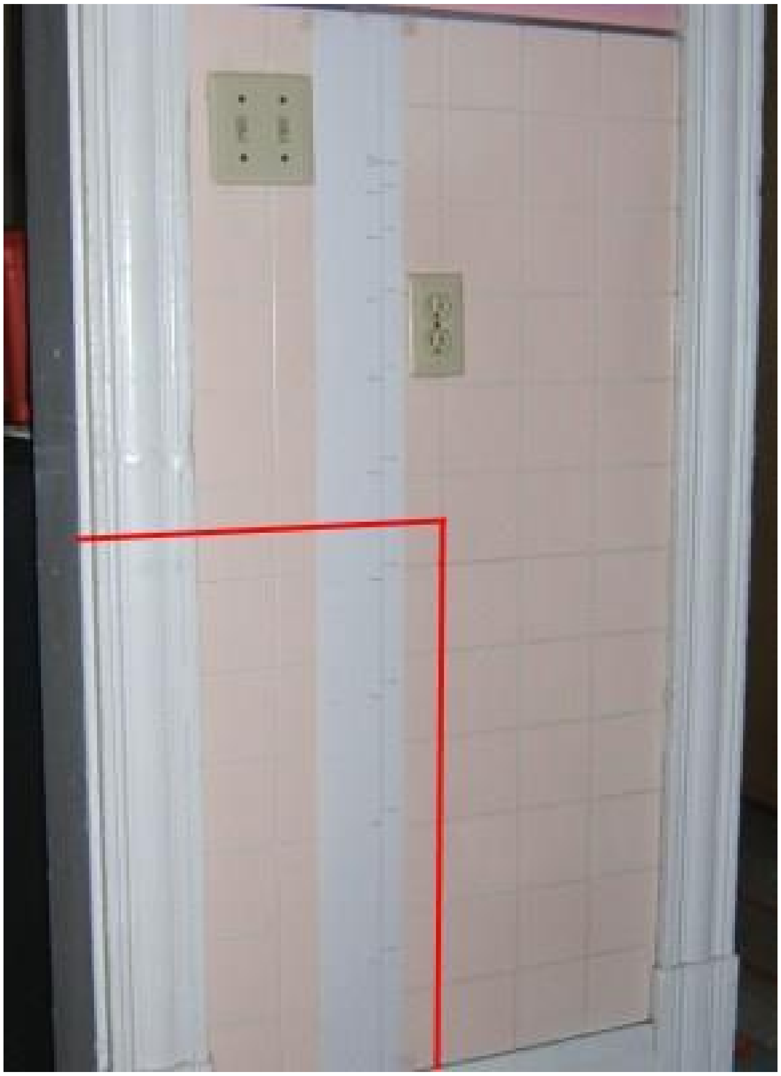
Of course all the things above are related to the motion of the Earth around the Sun. One way to directly observe that is to note the Sun's elevation each day at a certain time. A convenient way of doing that is to watch where sunshine coming through a window falls on an opposite wall. My kitchen is situated just right to take advantage of that as shown and explained here.

That is a crude panorama of my kitchen. The sunlight comes in the window at the right and falls on the vertical strip of paper at the left. The spot where the sunlight falls marks the progression of the winter days. The spot moves up the paper until December 21, and then down the paper till it is too low to strike the wall sometime in mid-February.

At first I used just the top edge of the window blind as a reference, but that was not exact enough for me as the line was indistinct, especially on days with thin clouds, haze, fog, etc., and I installed a piece of cardboard on the window with a ¼" hole in it as a pinhole projector to throw a circular (elliptical actually) spot of light on the paper. The hole and spot are shown here.

The extreme contrast between the sunlit area and the non-lit area made it hard to get a good picture of the spot, but you can see what I mean. The metal strip is indicated because it enters into the computations below.

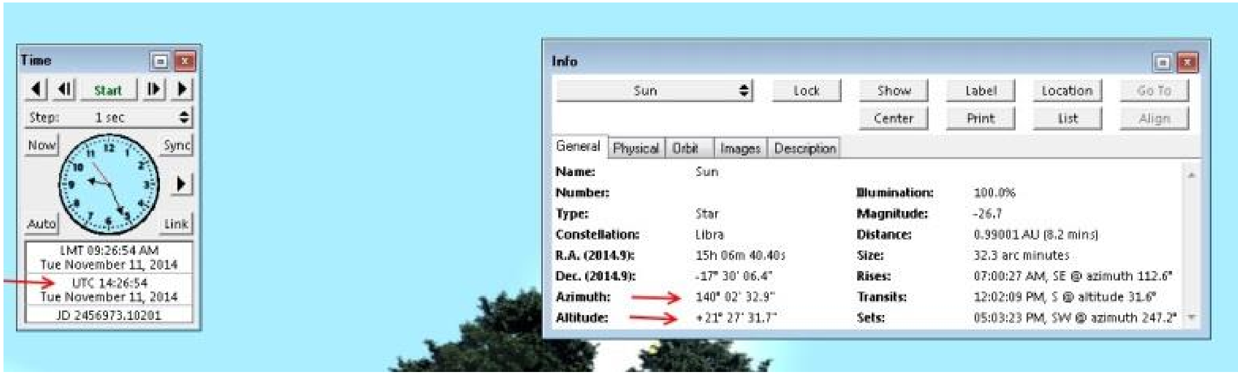
Now some trigonometry makes it easy to predict just where that spot should be each day. First of all, look at this picture:



Notice the red line which represents the sunshine line from the top and side of the window. When the side is on that particular 'grout line' in the wall tile is when the center of the spot (not shown here) is marked on the strip of paper.

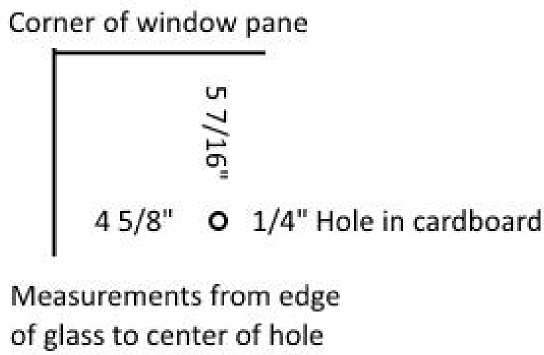
Here we go with the trigonometry now. First of all it is possible to determine the time of day that the side strikes the 'grout line'. Simply time it one day, and determine the Sun's azimuth at that time. No matter the day, when the azimuth is at that figure is when the side will be on the grout line. Here the time of day varies from 1442.5 UTC on October 22 to a time of 1420.8 UTC on December 1, then back up to 1511.7Z on February 19. The exact time varies according to the analemma and the equation of time. I'm not going into that here.

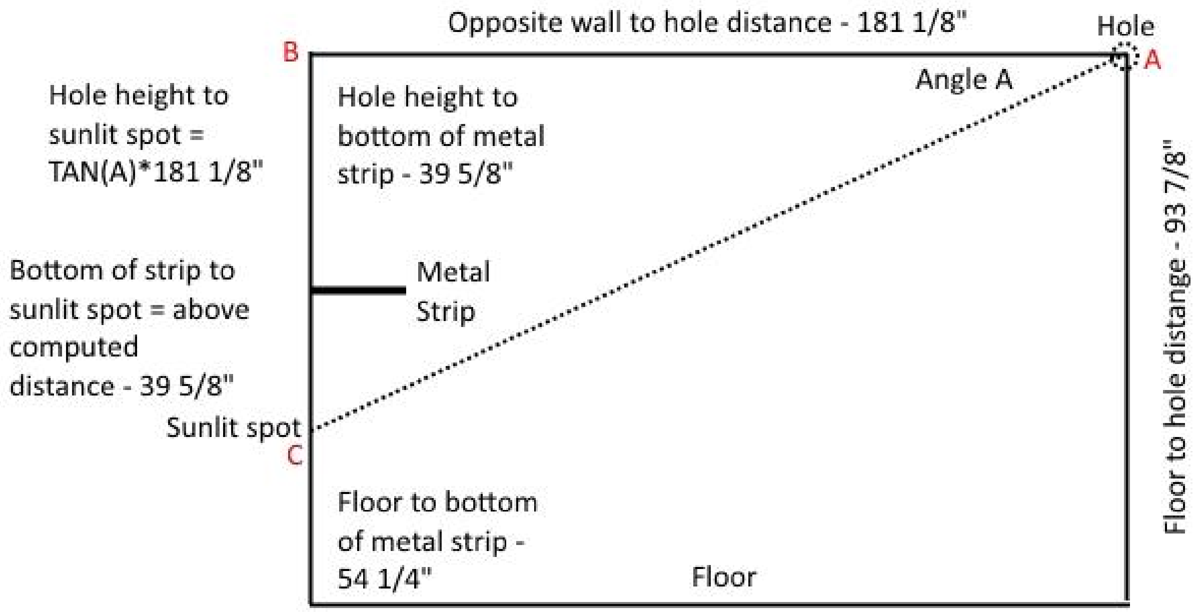
The azimuth so determined turns out to be 140 degrees, 2 minutes, 35 seconds (within +/- several seconds of arc). Now using a program that shows the Sun's azimuth and altitude for any date and time such as Voyager, the Sun's altitude can be determined by setting the date and time to that which gives the required azimuth. Here's a screen shot showing the date of November 11.



Note I've set the time to when the azimuth is 140 02 32.9 in the right window. Then the time turns out to be 14:26:54, at which time the altitude of the sun is 21 27 31.7

That provides us with all the info we need to determine just where on that strip of paper the spot of light from the window strikes.





First of all here is some info. The right side of the diagram represents the wall with the window. The left side is the wall with the strip of paper. The top is a level line from the hole at the window to the wall opposite.

Above that, the small diagram merely gives the location of the hole on the window pane for reference in case it needs to be reinstalled for some reason.

We know the angle A which is the Sun's elevation. We know one side AB of the triangle is 181.125" from measuring the kitchen. Now we need to compute the other side BC of the triangle. From elementary trigonometry, when an angle and adjacent side of a right triangle are known, the opposite side is determined from the equation TANGENT(A)*181.125 in our case here. With the angle A being 21 27 31.7 or 21.46 degrees, the 'side' turns out to be 71.20". Now the metal strip comes into play. We subtract 39.625" from 71.20" giving us 31.575" which is the distance from the bottom of the metal strip to the center of the spot of light, or where it should be on November 11, the date for which the computations were made.

Now it’s a matter of computing distances for every 5 days, marking the predicted spots on the paper, and checking their accuracy on the clear mornings. A clear morning is not all that common here, but there will be enough of them to get a good idea of how the system works.

An actual measurement on November 28 showed 14.9” vs. a predicted 15.6”. Not bad, and closer than what I had set up previously using the top of the window before changing to the hole/spot. Still it will be interesting to see how that error tracks as more data is input. If it is a constant 0.7”, it’s probably an error in measuring the room somewhere. If it varies, perhaps it’s an error in my trigonometry.