NNTP-Posting-Date: Fri, 24 Mar 2017 01:21:58 -0500 From: Jeff Liebermann je...@cruzio.com Newsgroups: rec.bicycles.tech Subject: How to easily measure lumens Date: Thu, 23 Mar 2017 23:22:03 -0700 Message-ID: 1s99dc17adi362vfoefkpk752q2tui3dtg@4ax.com X-Newsreader: Forte Agent 5.00/32.1171 MIME-Version: 1.0 How to easily measure lumens without an integrating sphere. The correct way to measure total light output from a bicycle headlight or flashlight is with an integrating sphere: https://www.google.com/search?q=integrating+sphere&tbm=isch https://www.youtube.com/watch?v=mvyptpA-BmY These are not cheap, although they can be home built. There are also other ways to do it (lumen tube): http://s1074.photobucket.com/user/mrsdnf/media/stuff/IMG 3226.jpg.html https://www.youtube.com/watch?v=xOE1ykJ5WAU My method is far from accurate, but good enough for estimating and comparing the light output of flashlights and bicycle headlights. To make it work, you'll need a tape measure and a lux meter. I'm using this one: http://www.ebay.com/itm/381903904643 It's main advantages are that it does auto ranging, has a max hold feature, and is cheap. First, the math: 1 lux = 1 lumen per square meter. That means if I project a circular spot on the wall, with an area of 1 square meter, the indicated brightness in lux equals the approximate lumens output, which can be read directly from the lux meter. Notice that it is NOT important to know the beam width or the distance between the light source and the wall. How big is a 1 square meter spot? Area = Pi \* radius^2 For Area = 1 square meter the radius of the spot is: r = sqrt(1/Pi) = 0.564 meters The diameter of the spot is 1.12 meters (44 inches). Find a darkened room with a suitable wall, and put two pieced of masking tape on the wall separated by 1.12 meters (44 inches). Notice that the wall does not need to be flat or painted white. Half way between the two markers, hang the lux meter. To measure, turn on the lux meter and punch the max hold button. This will display and hold the highest reading. Start well back from the wall, turn on the flashlight, and slowly move towards the wall until the edge of the light spot lands on top of the two markers. Turn off the light and read the meter. The meter reading in lux will be equal to the lumens output of the flashlight or bicycle headlight. I bought various flashlights on eBay and tested them at maximum brightness with new batteries. This one claims 5000 lumens but delivers 200 lumens. http://www.ebay.com/itm/322447023467

This one claims 300 lumens but delivers 97 lumens.

http://www.ebay.com/itm/391639378962
This one claims 6000 lumens, but delivers 212 lumens.
http://www.ebay.com/itm/201457081072

There are plenty of problems with this method. Putting the lux meter at the center of the circle causes the meter to favor lights with hot spots in the middle. A properly designed bicycle light or flashlight should have an even and equal brightness distribution across the spot on the wall, but this is rarely the case. I'm working on a more accurate way to measure and calculate the average light output. Probably, it will be measuring the light in the center and along the edge, and taking an average or estimating the total based on a gaussian light distribution. Or maybe not putting the lux meter in the center of the circle. That's for later.

Another error is the color temperature of the light. LED's come in a variety of color temperatures. The lux meter has a different sensitivity at each of these colors where the sensitivity curve follows the sensitivity of the human eye. https://image.slidesharecdn.com/ivanperrepresentationfor24-141008071626- conversion-gate02/95/pls-2014-is-measuring-led-illuminance-with-a-lux-meter-accurate-19-638.jpg Comparing lights with different color temperatures will be a problem.

There is also a problem in dealing with the 1 square meter area when the spot is not a perfect circle, but rather an ellipse as in many bicycle headlights. Area = Pi \* major\_axis\_radius \* minor\_axis\_radius This can be easily measured, but will be different for each headlight with an elliptical beam pattern and will therefore be a bit more complicated to measure.

I also do not yet have a calibration illuminance standard. Therefore, I don't know how accurate this method might be until after I get or build one.

Good luck, have fun, enjoy, and please post some test results for various bicycle headlights.