

Measuring Test Mass Scattering

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Outline

- What I've completed thus far:

 - Calibration of Nikon D7100

- What I'm currently working on:

 - Photon absorption of camera sensor

- What else I'm going to try to accomplish:

 - Analyzing pictures coming from the test masses themselves

 - Calibration of Nikon D810

What I've completed thus far: Camera Calibration

- Want to measure the energy scattering off the test masses
 - Source of noise
 - Scattered photons = fewer photons in the beam path
- Pixel “counts” → energy (or power)
 - Continue work of CJ, 2016 SURF student

Camera Calibration

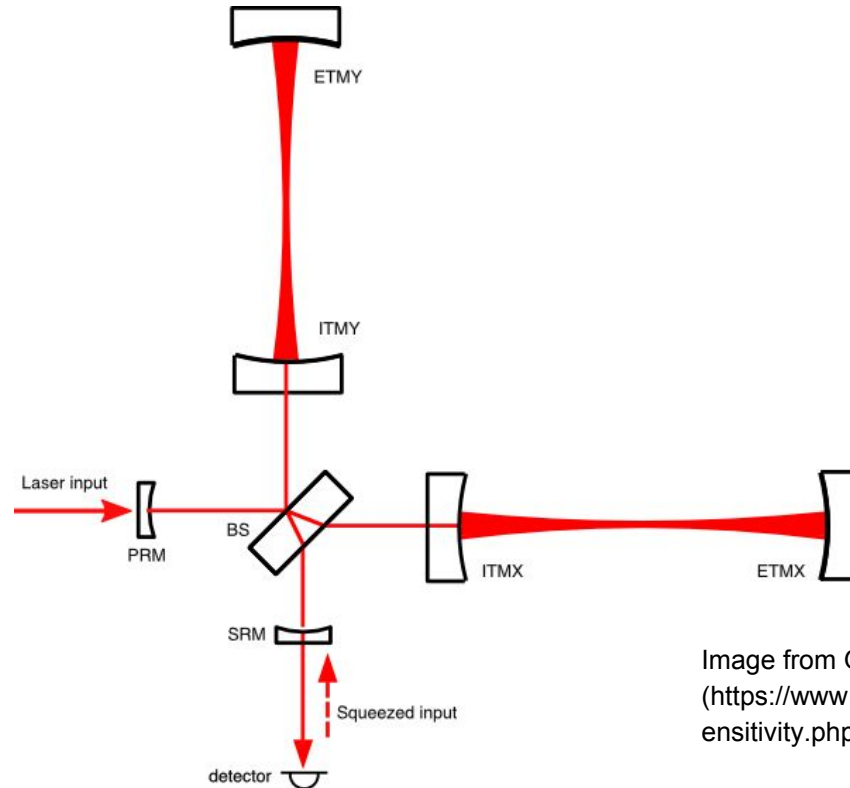
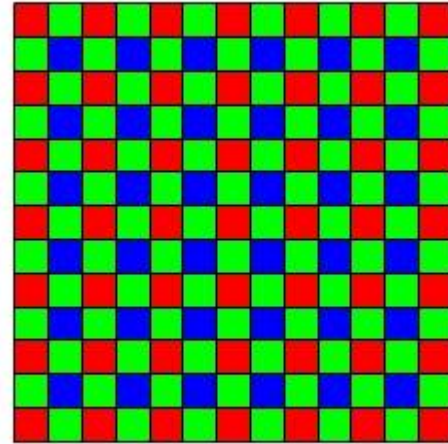


Image from GWoptics.com,
(https://www.gwoptics.org/finesse/examples/aligo_sensitivity.php.)

Camera Sensors

- Camera sensors are composed of millions of pixels
- Counts ~ Photons absorbed
 - Each of the pixels are made of 4 individual subpixels (usually R, B, G, G)
- Bayer filter
- Found calibration for each



Bayer filter

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Image from HowStuffWorks:
(<http://s.hswstatic.com/gif/digital-camera-bayer.jpg>)

Demosaicing and Other Image Adjustments

-Challenge: cameras are designed to take good looking pictures

-Demosaicing, compression, auto white balance, etc. alter the relevant data

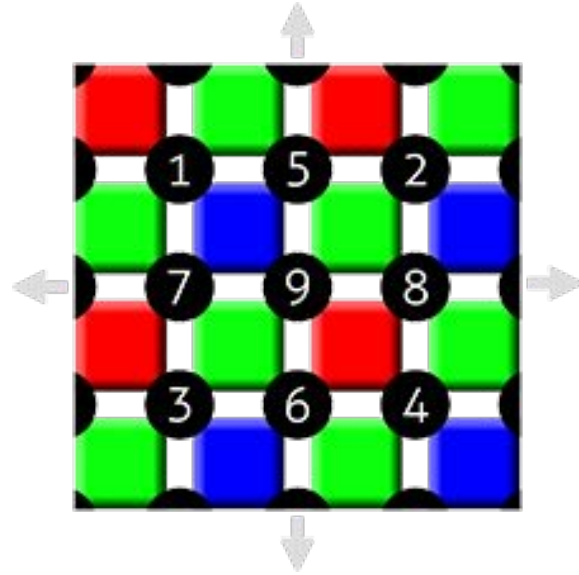
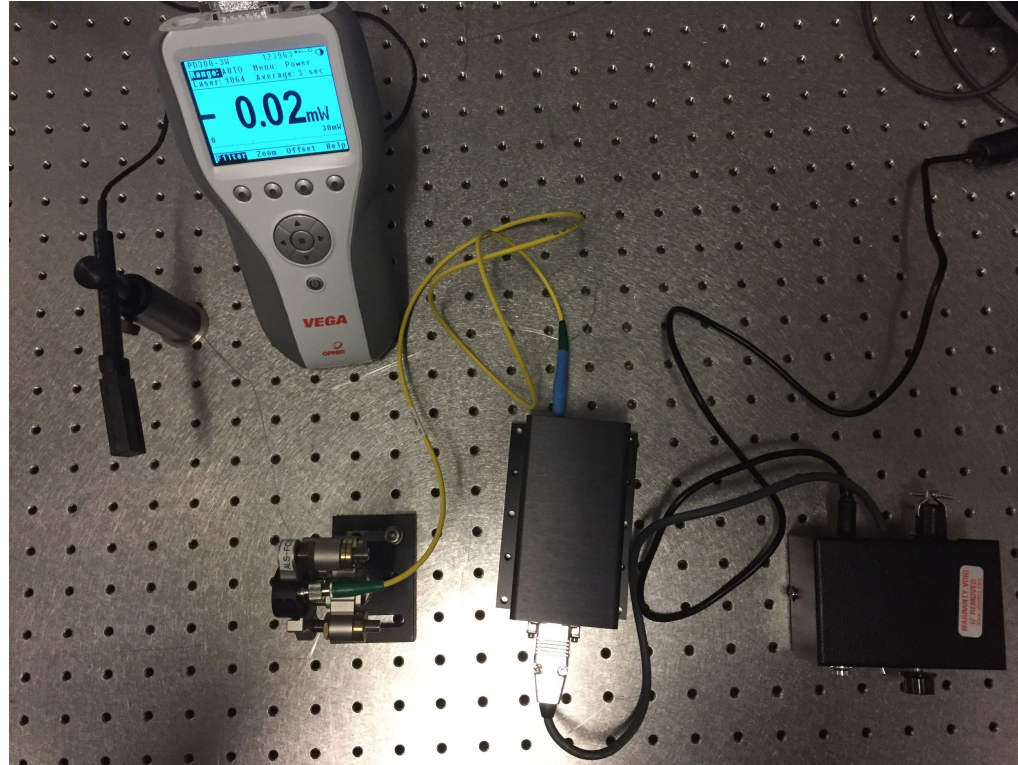
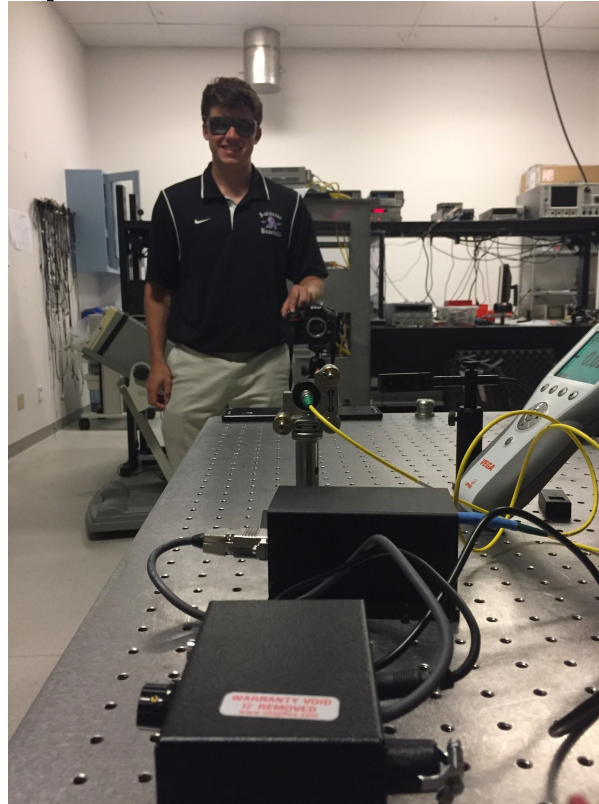


Image from Cambridge in Color:
<http://www.cambridgeincolour.com/tutorials/camera-sensors.htm>

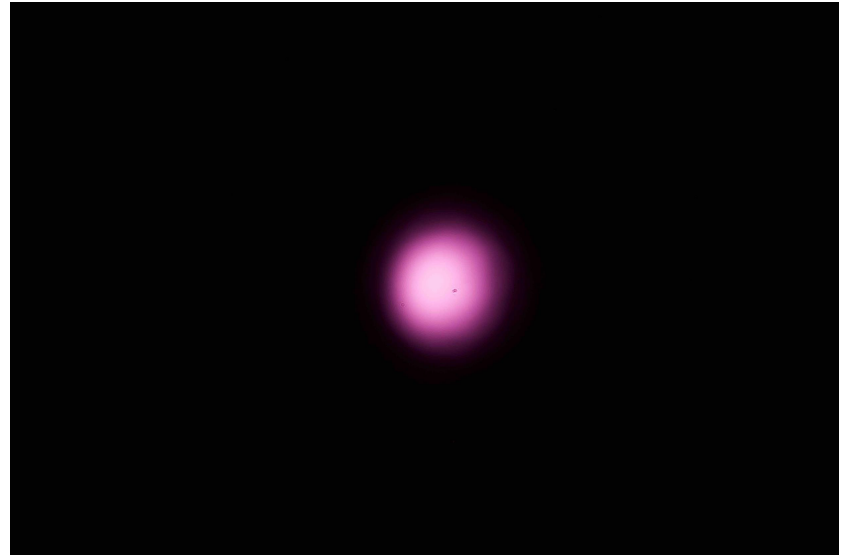
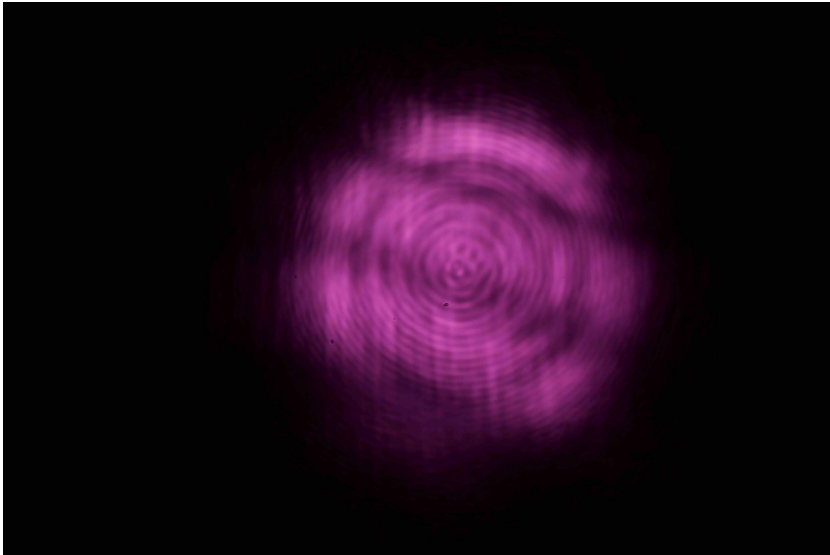
Experimental Setup



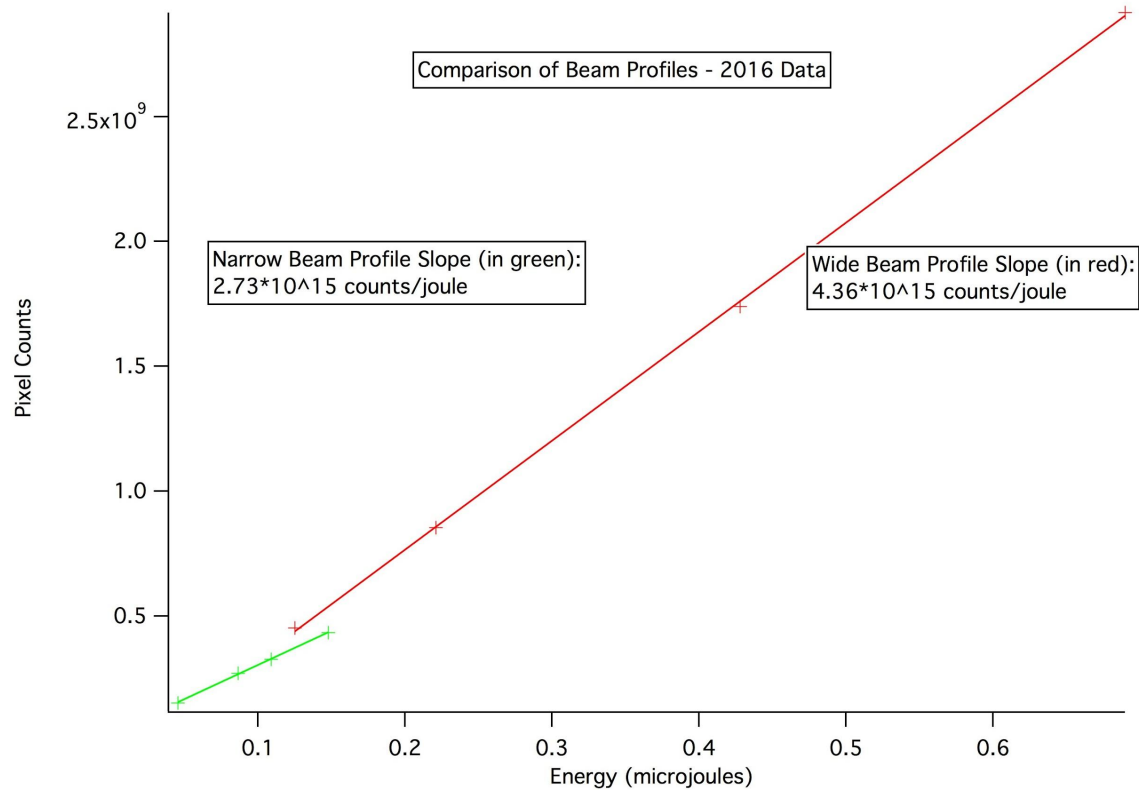
Experimental Setup



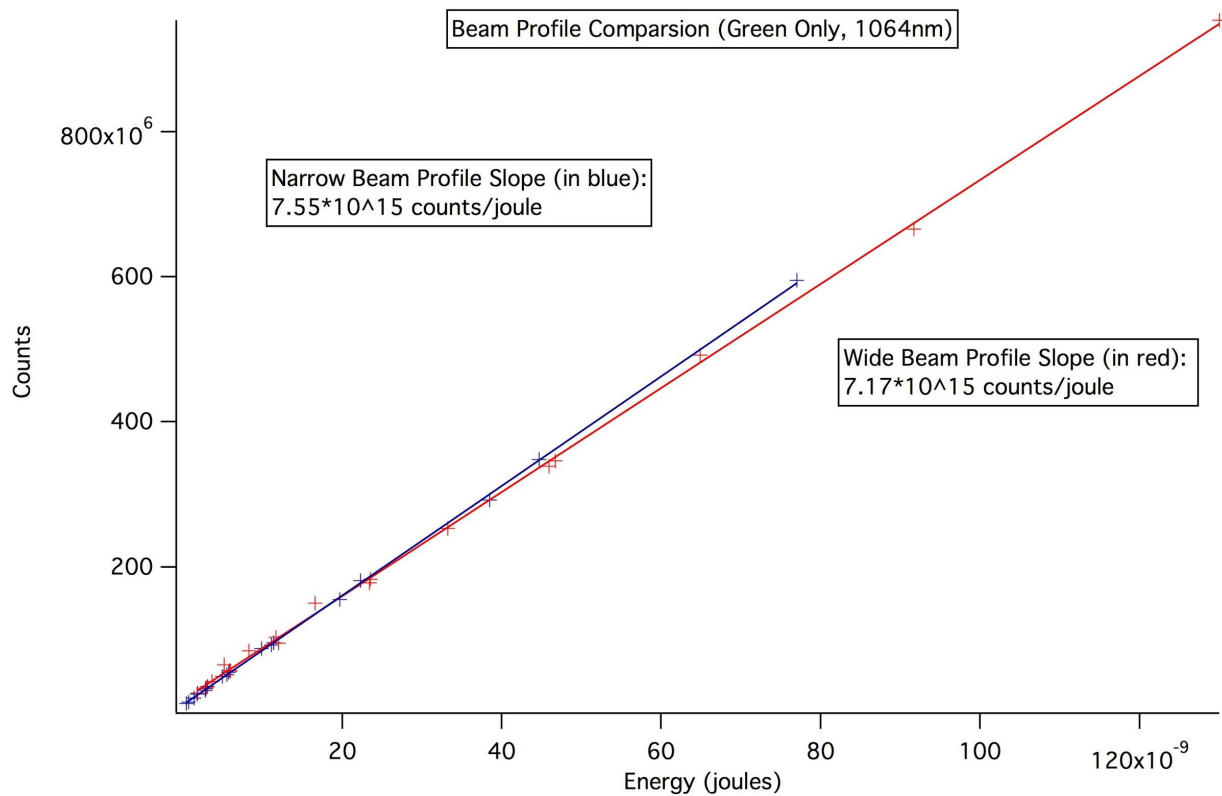
Beam Profile Investigation



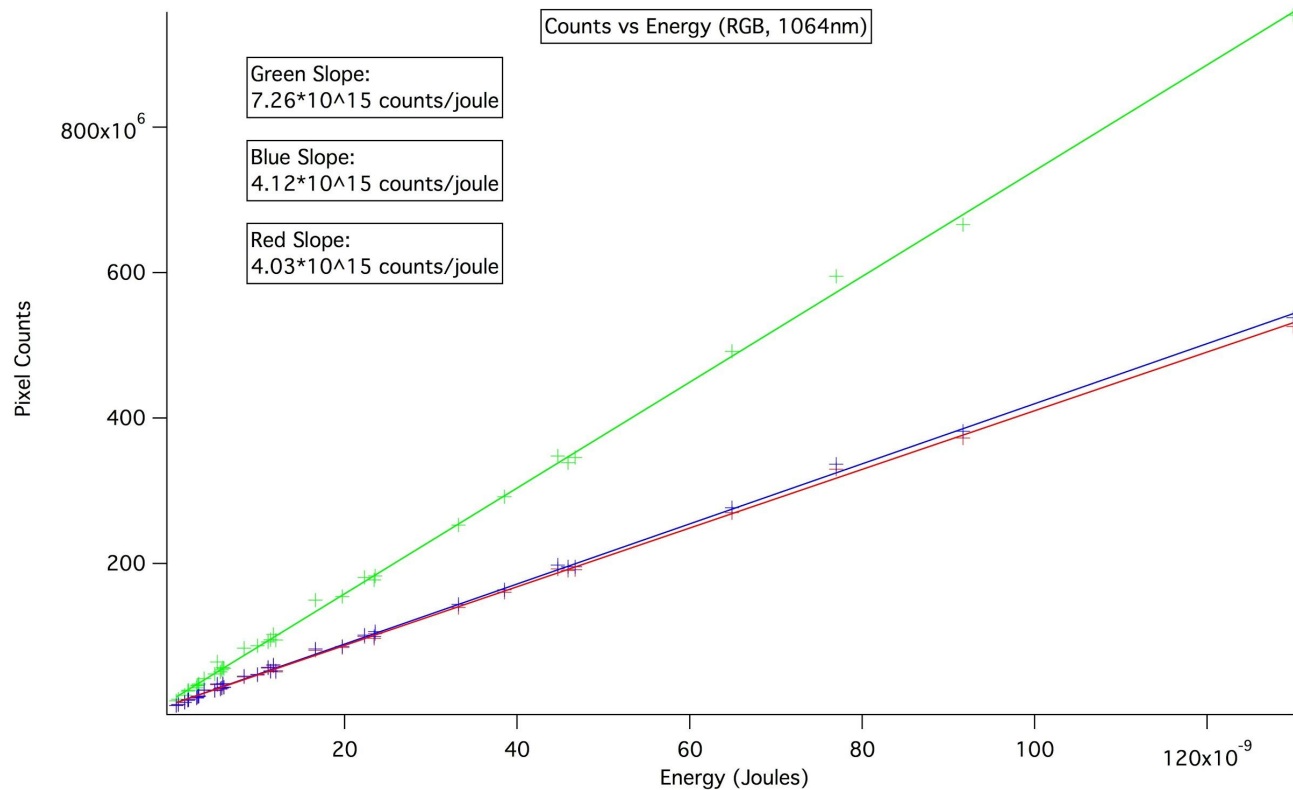
Beam Profile Investigation



Beam Profile Investigation



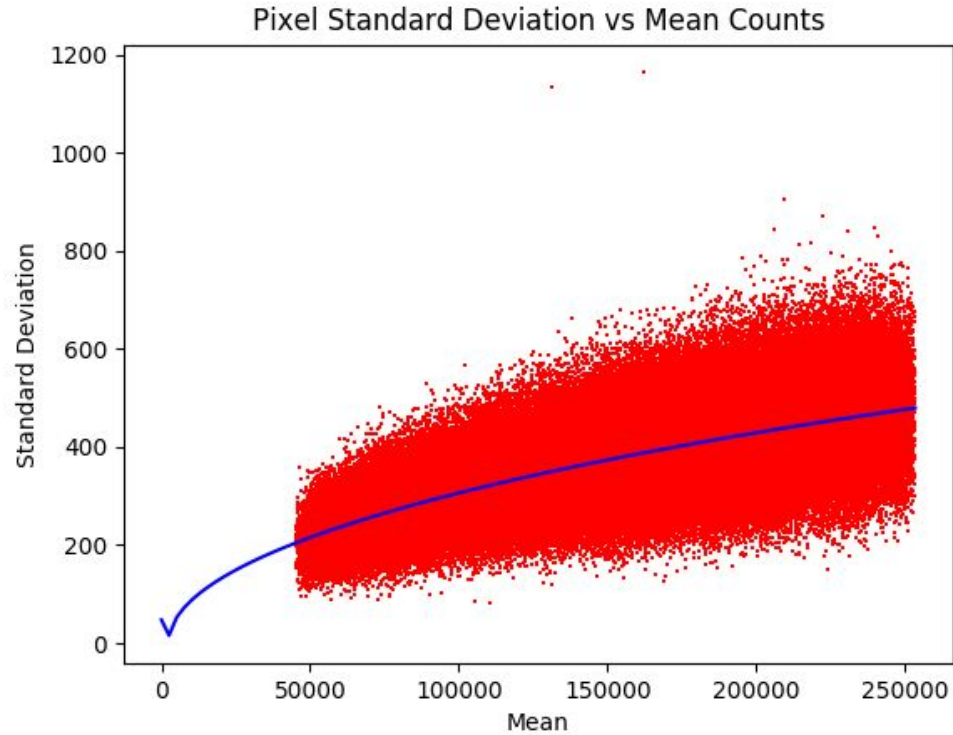
Calibration Results, 1064 nm



What I'm currently working on: Photon Absorption

- Better estimate of the error in the scattering measurements
- Simple case: Find standard deviation of a pixel -> find number of photons incident on that pixel (Nphotons)
 - Shot Noise
 - Standard Deviation = $\text{Sqrt}(N\text{photons})$

Photon Absorption



Future Plans

- Complete photon absorption measurements

 - Large datasets, laser light source presented challenges

- Second DSLR Calibration

- Use results of camera calibration and absorption projects to analyze images of the test mass scattering