Illumination Field Uniformity for the Measurement of Quantum Efficiencies of SNAP's Infrared Detectors

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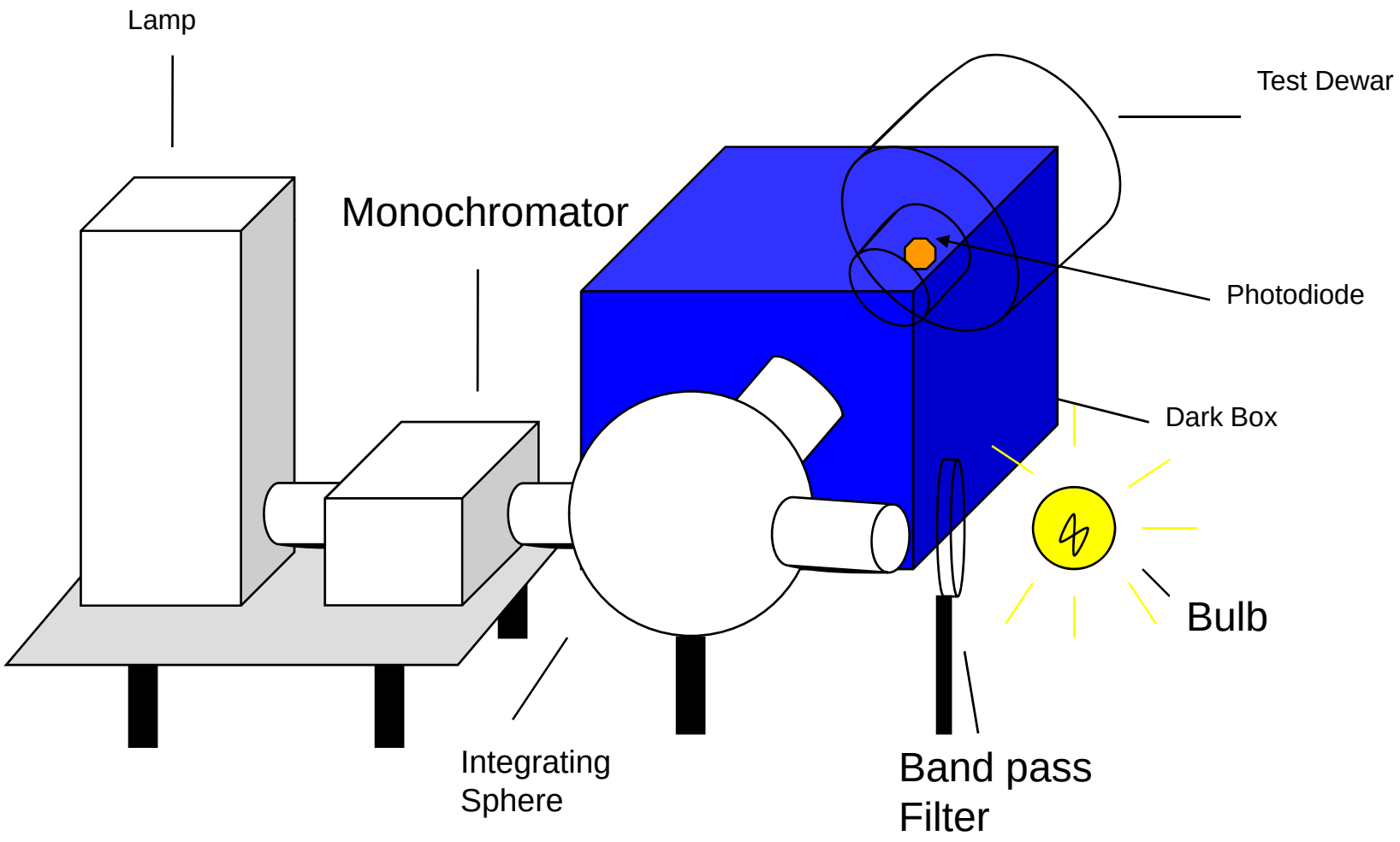
About SNAP

- SuperNova Accelertion Probe
- The expansion of the universe is accelerating.
- SNAP will observe type Ia supernovae and use them to determine the expansion history of the universe.
- It will also use gravitational lensing to measure distances and growth of structure.
- Different models of Dark energy have been proposed and SNAP will help to discern which amongst them is correct.

Quantum Efficiency (QE)

- The ultimate goal is to calibrate SNAP.
- To that end it is necessary to measure the quantum efficiency in each pixel in the detector array to better than 1% accuracy and precision.
- QE = photons detected / photons emitted

Experimental Setup



Previous Measurements

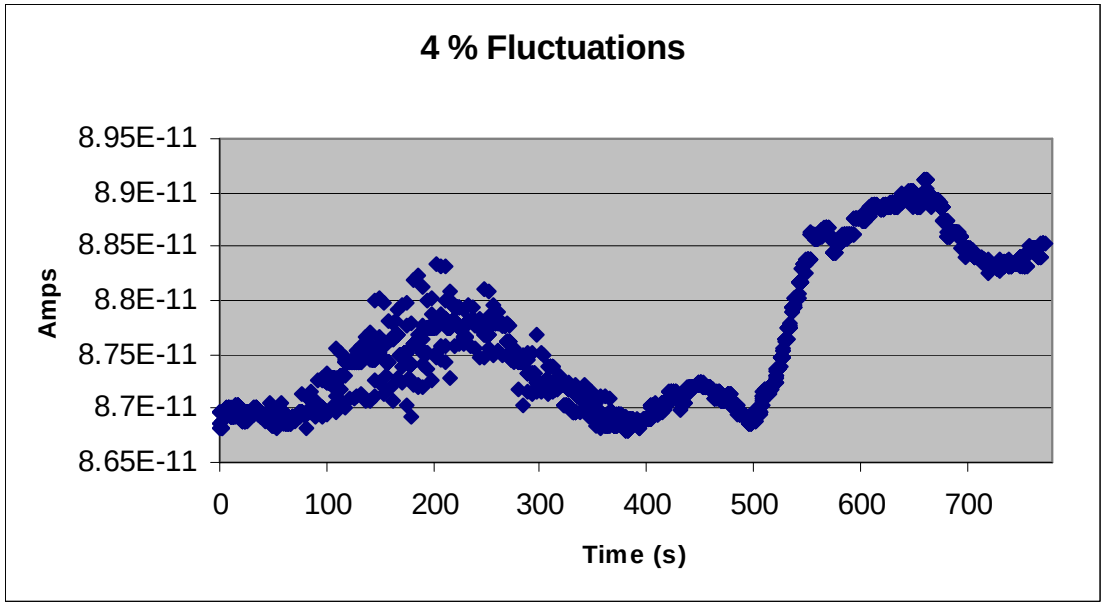
- Good to 5%.
- Sources of error included light leaks, reflections and poor coating. The diode used was also sensitive to thermal variations.
- QE measurements are taken in the cold (~80 K) to simulate spaceflight conditions.

Measurement Technique

- Ideal to produce a flatfield, but difficult.
- It is also possible to correct for variations in the field once they have been measured.
- However, the final setup will change and an understanding of the sources of reflections gives us confidence that we are not introducing systematic errors in the QE measurements.

Measurement Problems

- Cable was long and unshielded.
- The presence of the window.
- Light source's intensity was fluctuating over time.

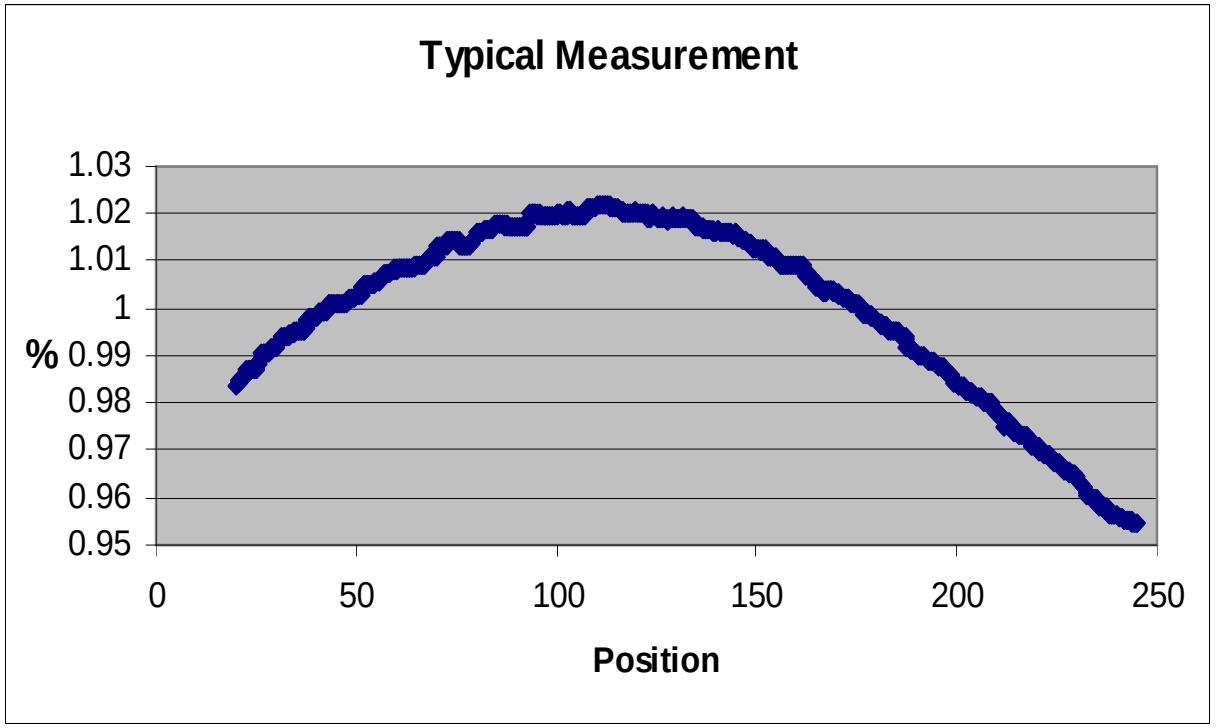


Dealing with Fluctuations

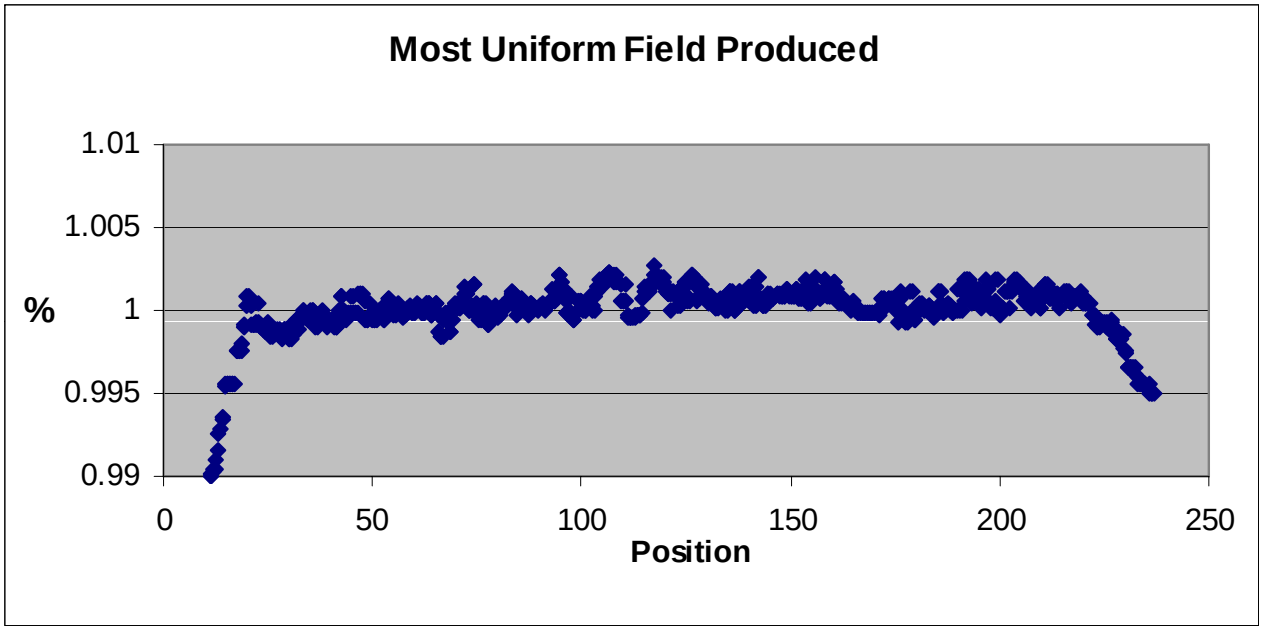
- Attempted to install a “feedback mechanism” to regulate the lamp’s behavior.
- It consisted of a photodiode and some electronics that connected directly to the lamp’s power supply.
- However, the input readings needed to be within a certain range and so a different setup is being constructed.
- Currently still waiting for some parts that were ordered about a month ago.

Typical Illumination Pattern

- Initially 7 % variation



Eventually…

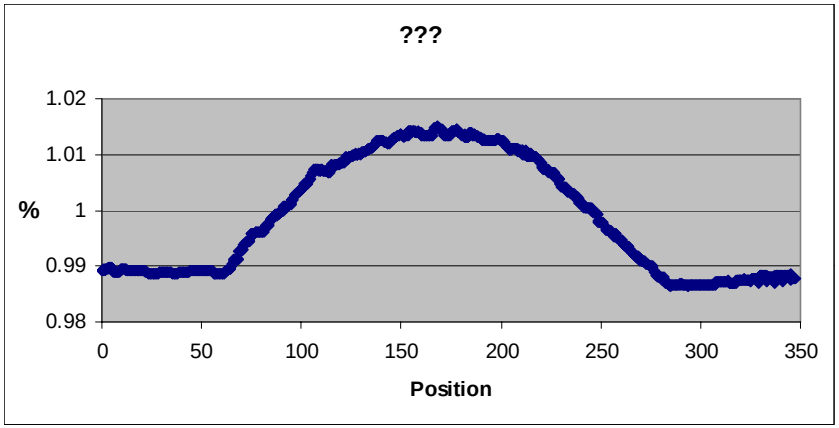


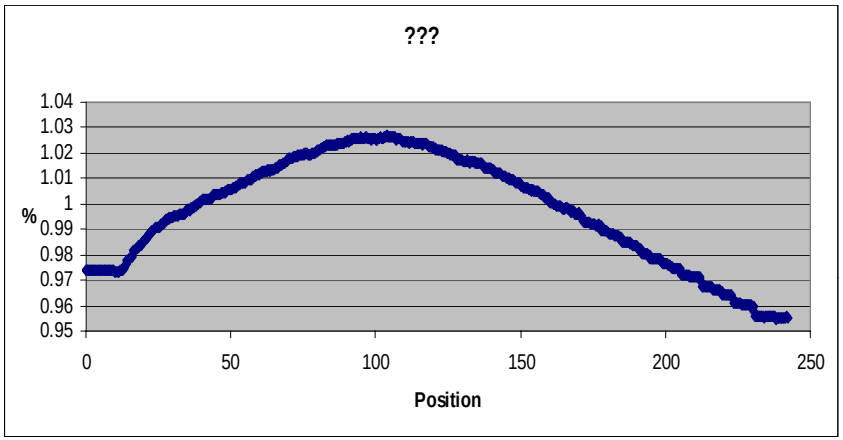
- Though this was not easily accomplished…

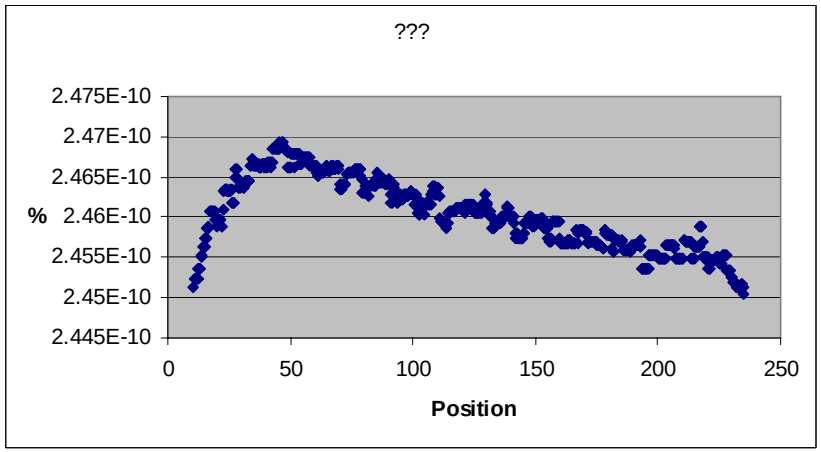
One of the most important things I learned this summer…keep careful track of all your experiments

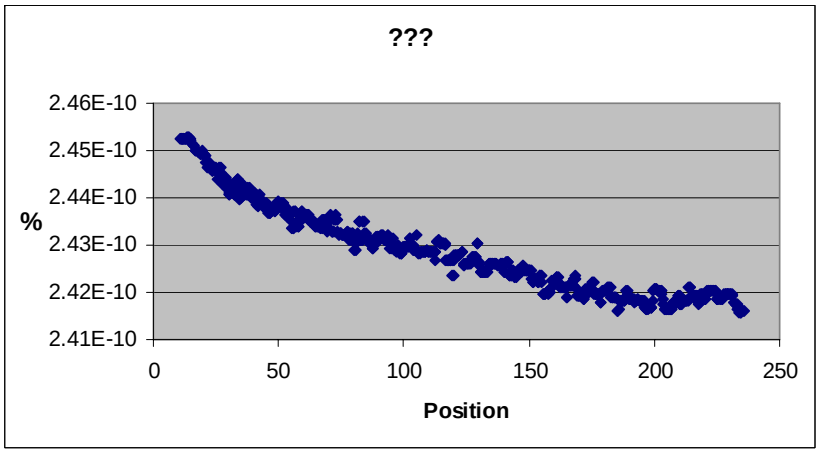
- List of things I tried:
  - A different felt for baffling:
    - All around optical path and inside of the dewar.
  - Diffuser
    - Before and after integrating sphere.
  - Baffling screens at side of dewar
  - Nothing at all
  - Rings
    - Different combinations to cut glance angle reflections.

Lost track of these…





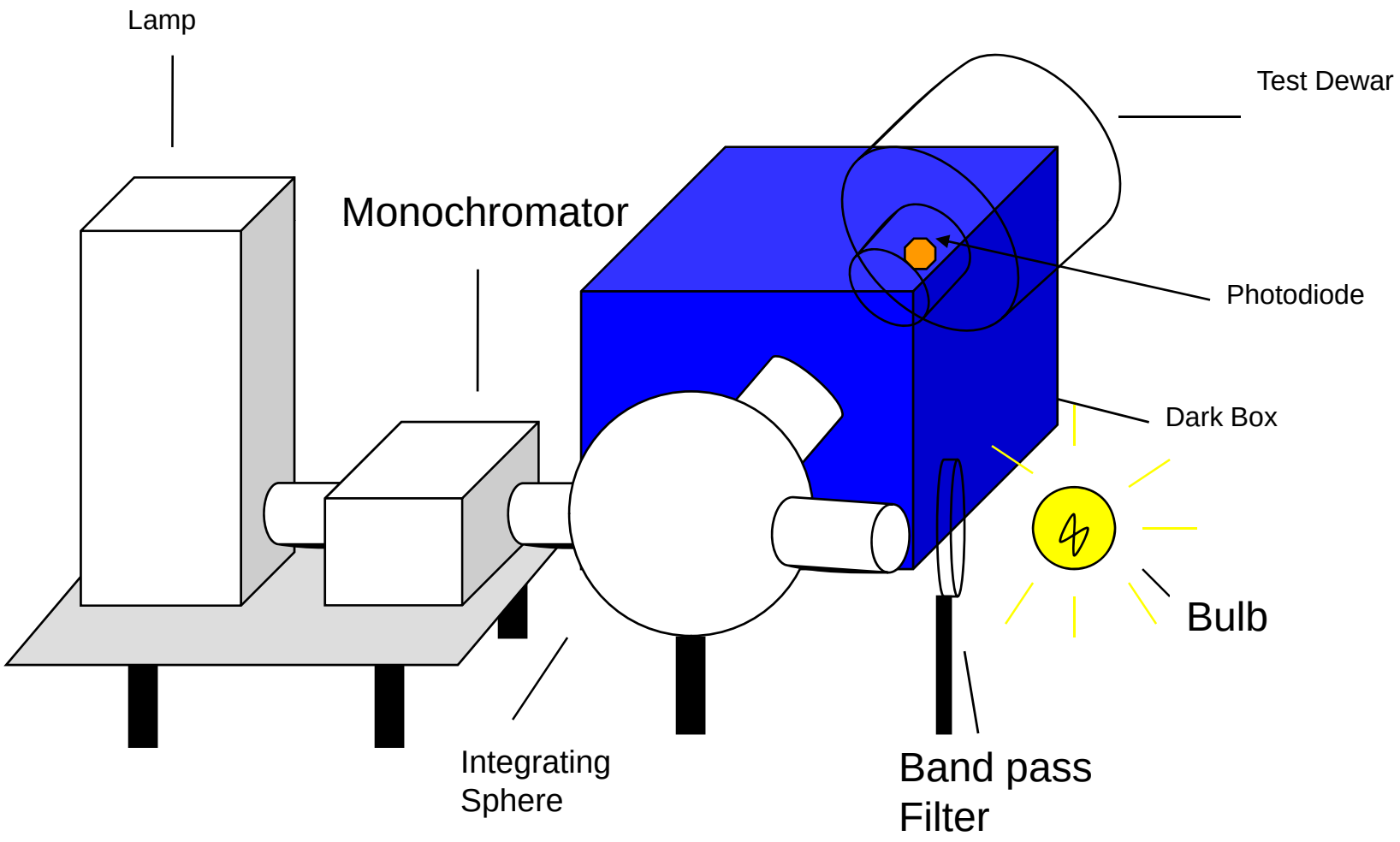




Black is not in the black in the Infrared

- Since my early efforts at baffling reflected light were not very successful, I decided to take a look for myself with an infrared viewer.
- What I found was that the black felt we were using, though dark to the naked eye, was fairly reflective in the infrared.
- We recoated all inside surfaces with the new felt.
- It didn’t work due to glance angle reflections.

Experimental Setup



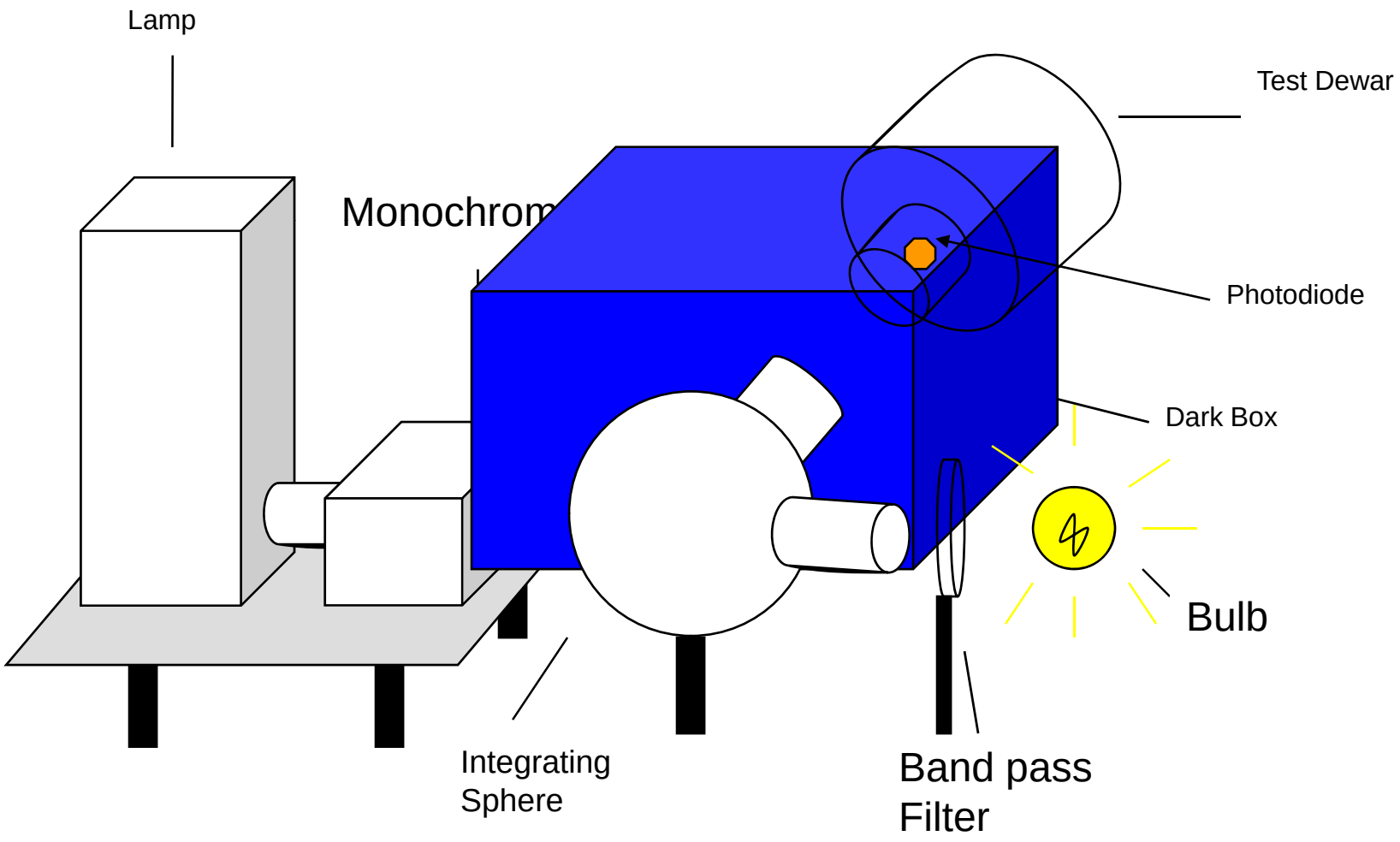
The diffuser

- Due to a consistent asymmetry in the measurements I was led to believe that the integrating sphere itself was not producing a uniform field.
- I attributed this malfunction to the way the sphere was being illuminated.
- Thus I placed a roughened piece of plexiglass at the sphere’s input.
- This didn’t work either.

Asymmetrical box – asymmetrical measurement?

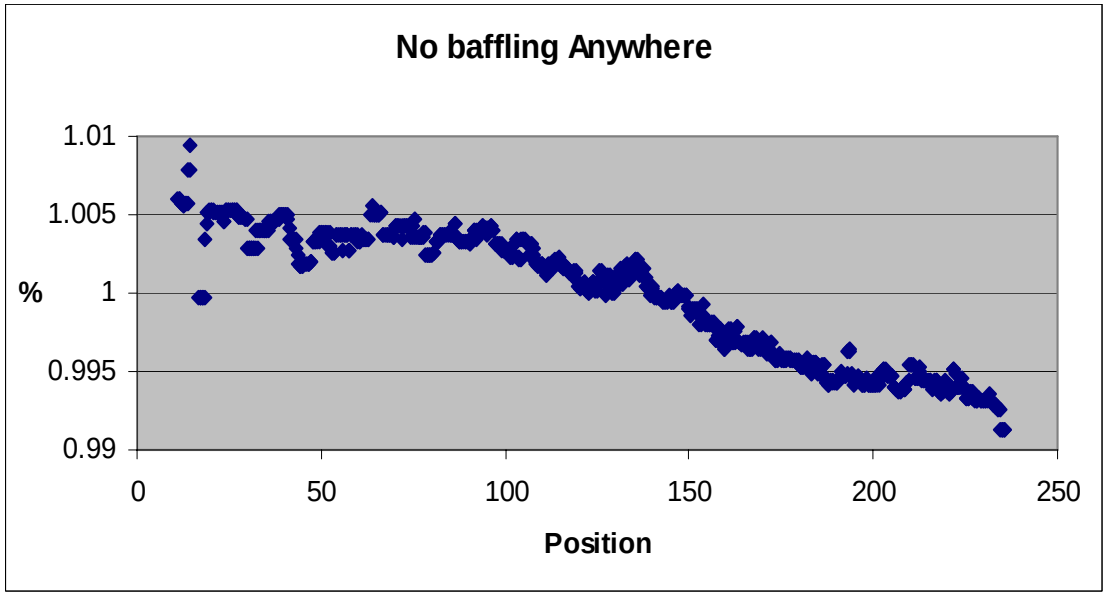
- At some point I believed the asymmetry might have been the result of the fact that the window leading to the dewar was closer to one wall of the box than the other.
- I investigated by placing baffles on the sides of the box.
- This investigations proved fruitless.

Experimental Setup



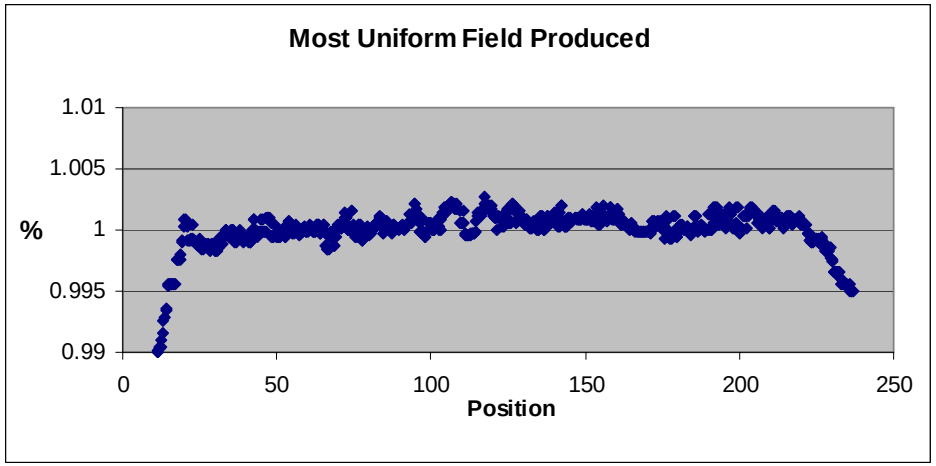
Maybe reflections aren’t so bad

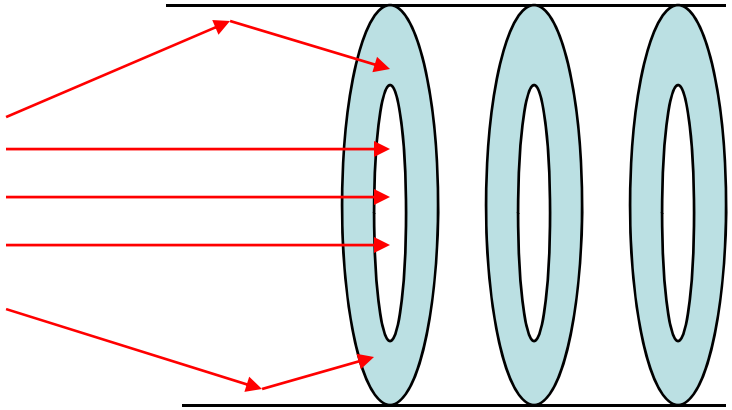
- At a curious whim I decided to look to see what the pattern looked like without any baffling on any surface.
- To my surprise the measurements were fairly uniform.
- Scattered light was actually smoothing the pattern.



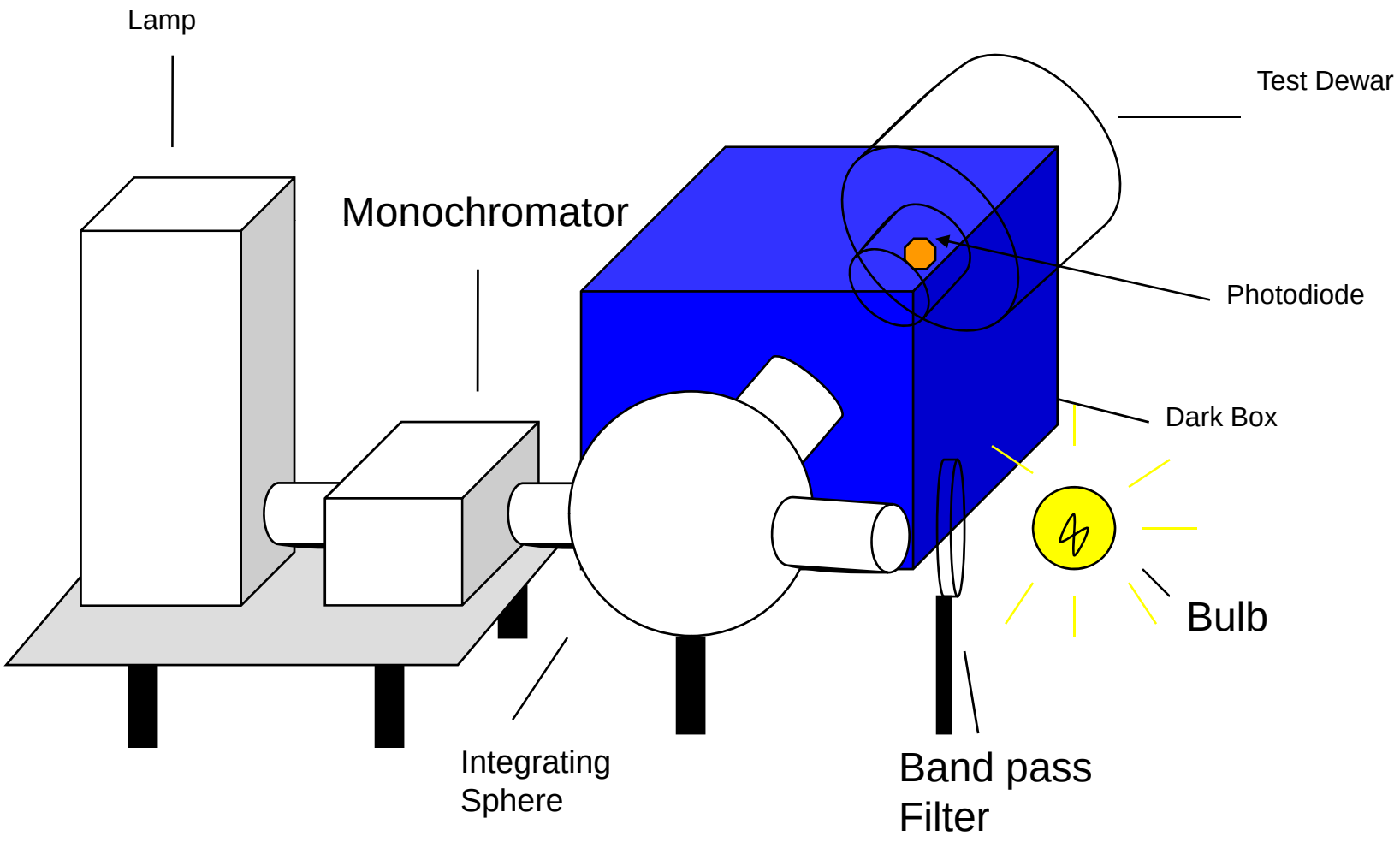
Success at last

- I decided to try and cut glance angle reflections all throughout the light path channel using a series of rings.





Experimental Setup



What’s ahead

- The field is a little too small.
- Dewar window problem.
- Accounting for the whole detector inside of the dewar.

Acknowledgements

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