Characterization and Modification of a Grating Spectrometer for Time-Resolved Spectroscopy

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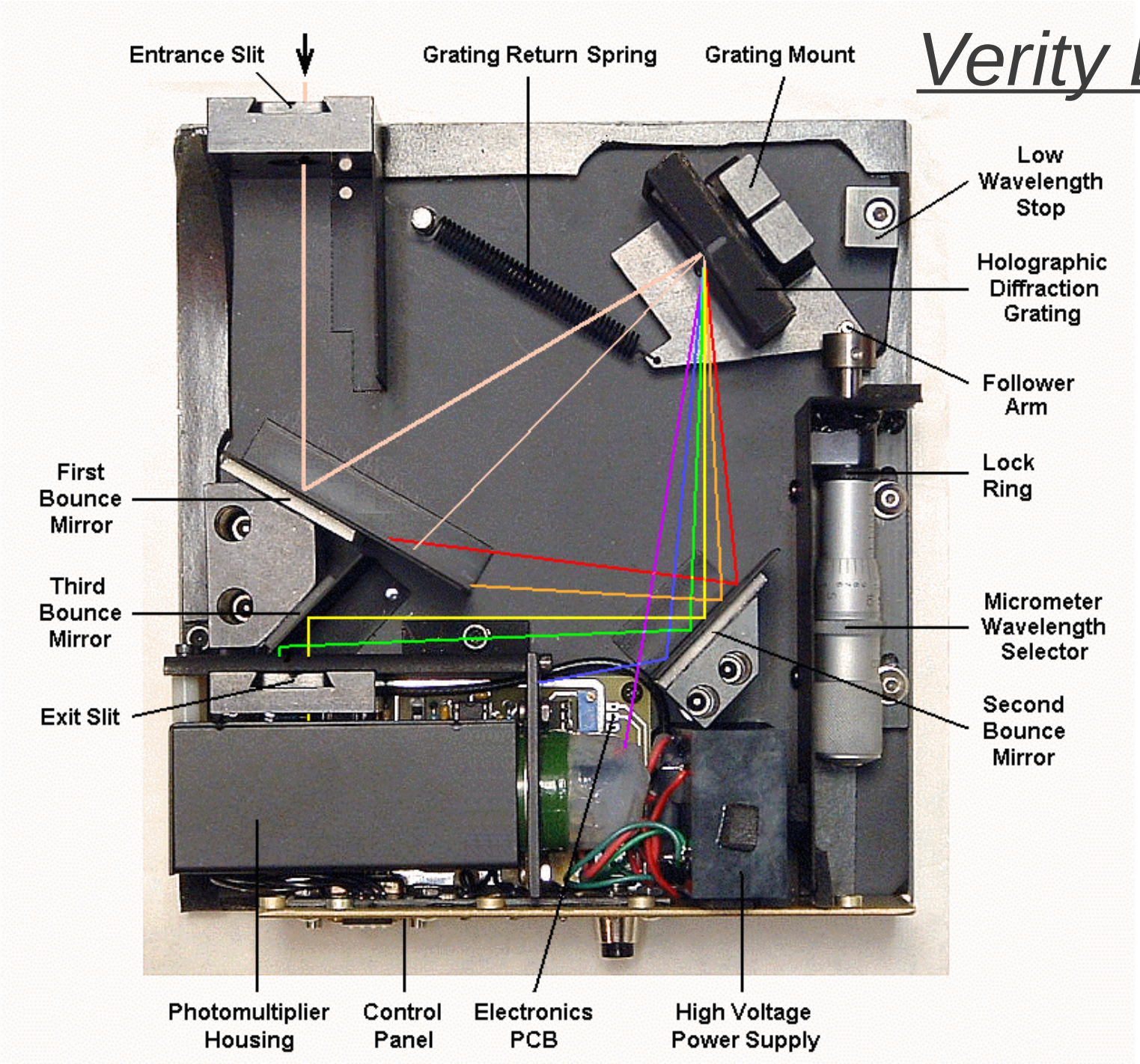
Overview

- Goal: To make a spectrometer with time-resolved capabilities available to the beamline
  - Users at Sector 7 combine lasers and X-rays
  - Analysis of X-ray luminescence via time-resolved spectroscopy can be an important resource
- Modifying an existing monochromator allows for a relatively cost-effective precision instrument.

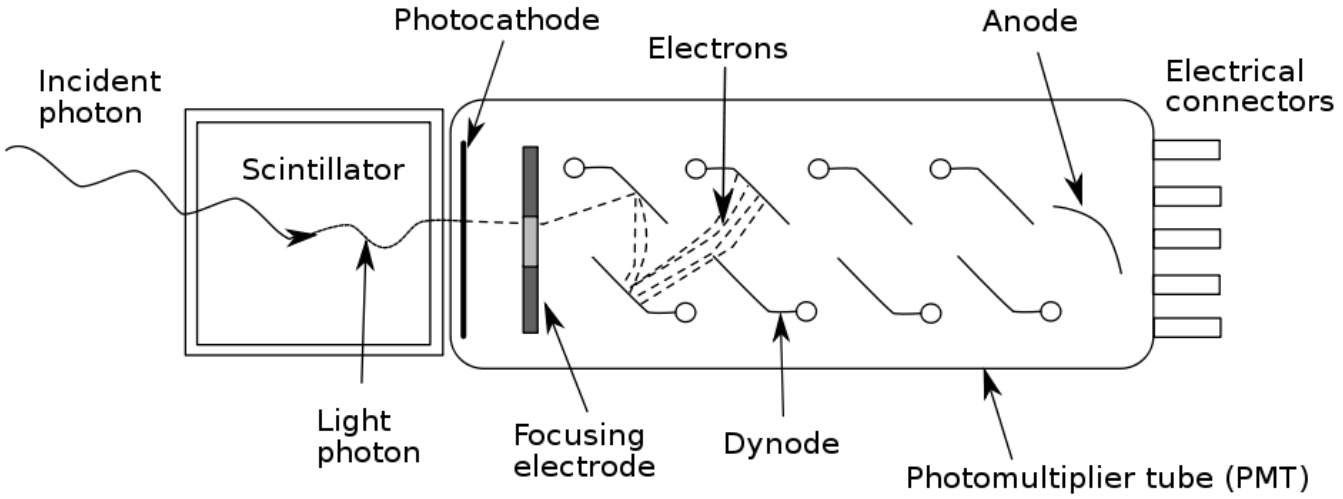
Verity EP200Msd



- Resolution inversely proportional to slit size
- Holographic grating

Image courtesy of Sam's Laser FAQ

Photomultiplier Tube (PMT)



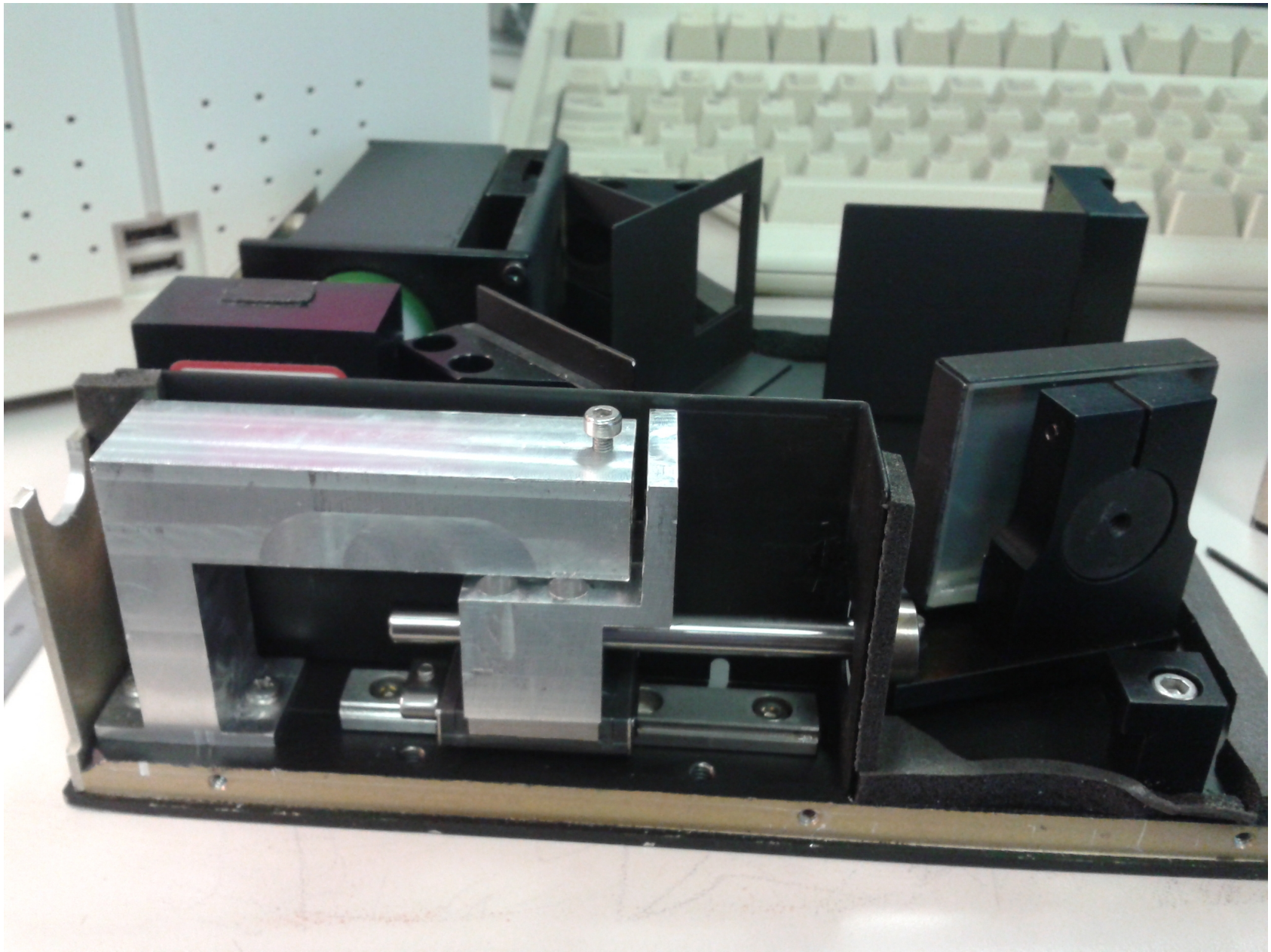
- The Hamamatsu R928 PMT used has high quantum efficiency, optimized in visible range
- Possesses single-photon sensitivity, necessary for time-resolved spectroscopy

Modifications

- Two versions of Verity monochromator:
  - EP200Mmd (motor-driven)
  - EP200Msd (manual)
- Micrometer removed from EP200Msd model
- Replaced with linear actuator for automated scanning functionality

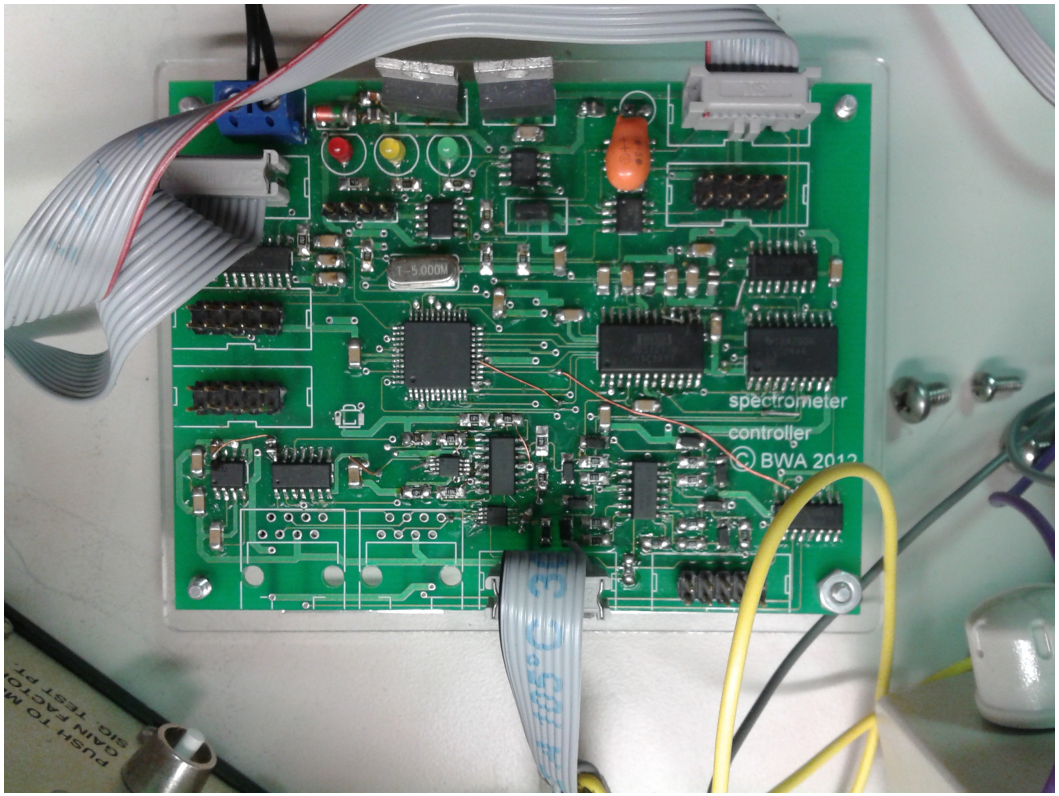
Images courtesy of Verity Instruments, Inc. and 40-30 Sourcing

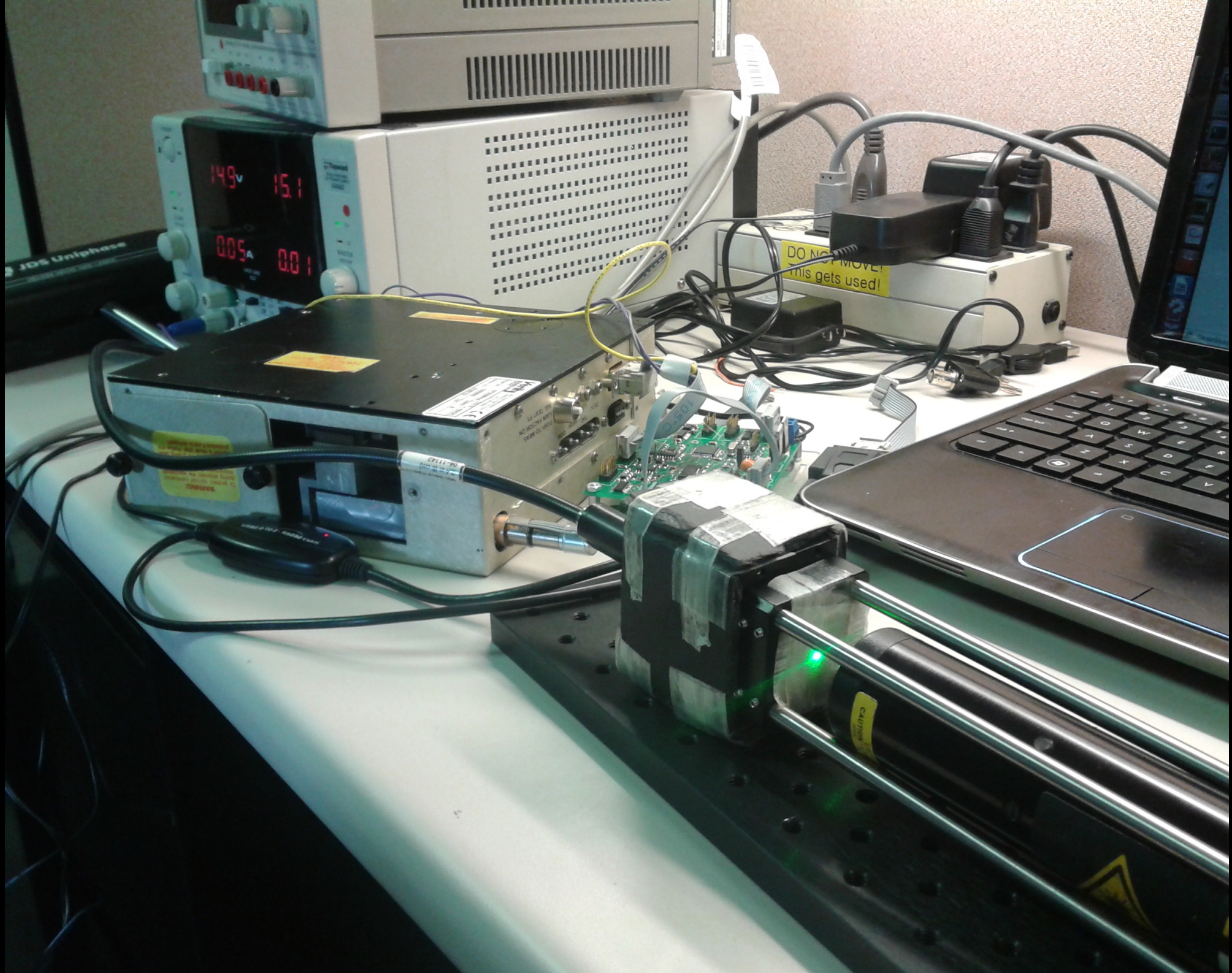
Modifications



Spectrometer Controller

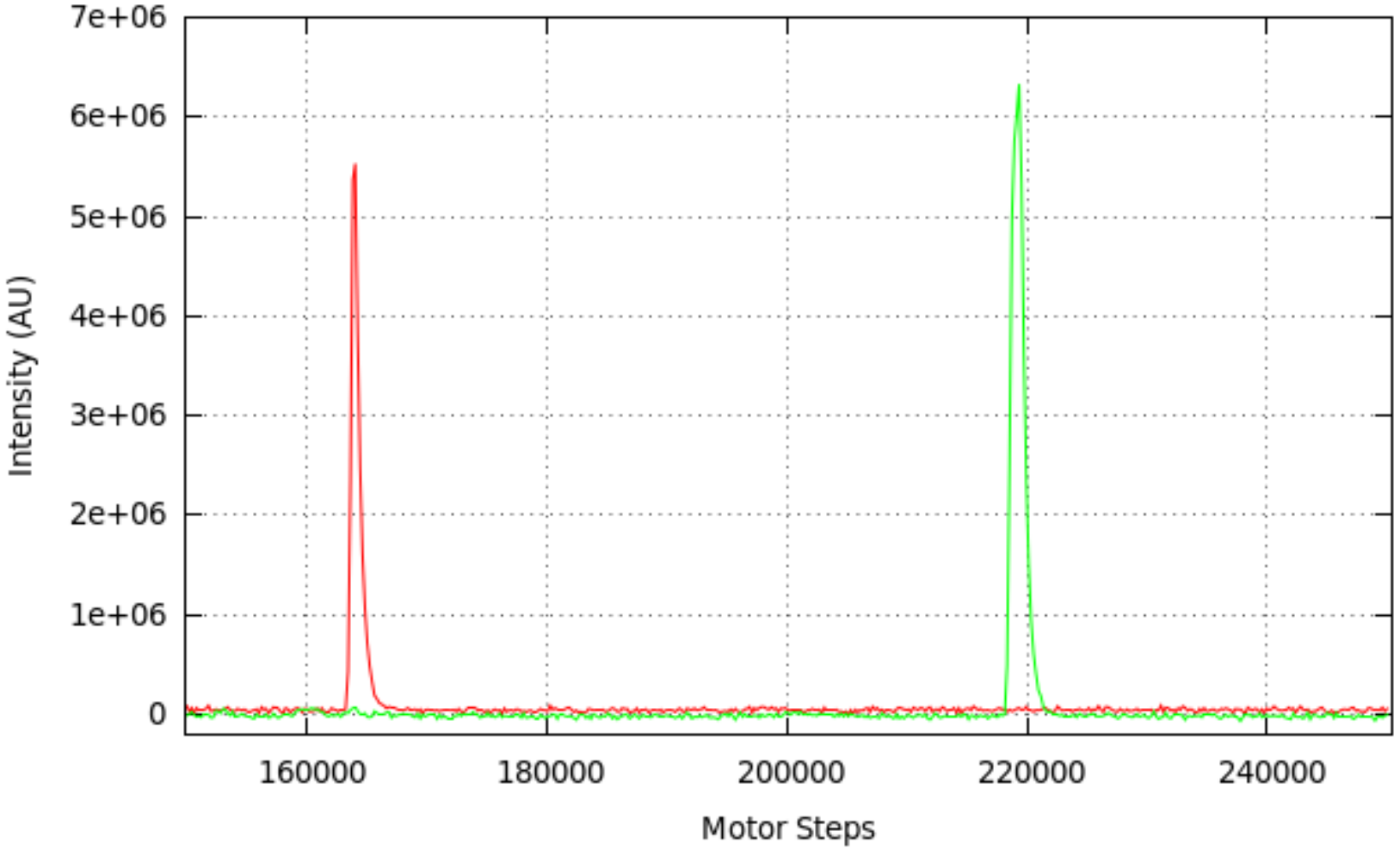
- Dedicated controller drives actuator, contains DA and AD converters.
- Operations managed by octa-core Propeller chip



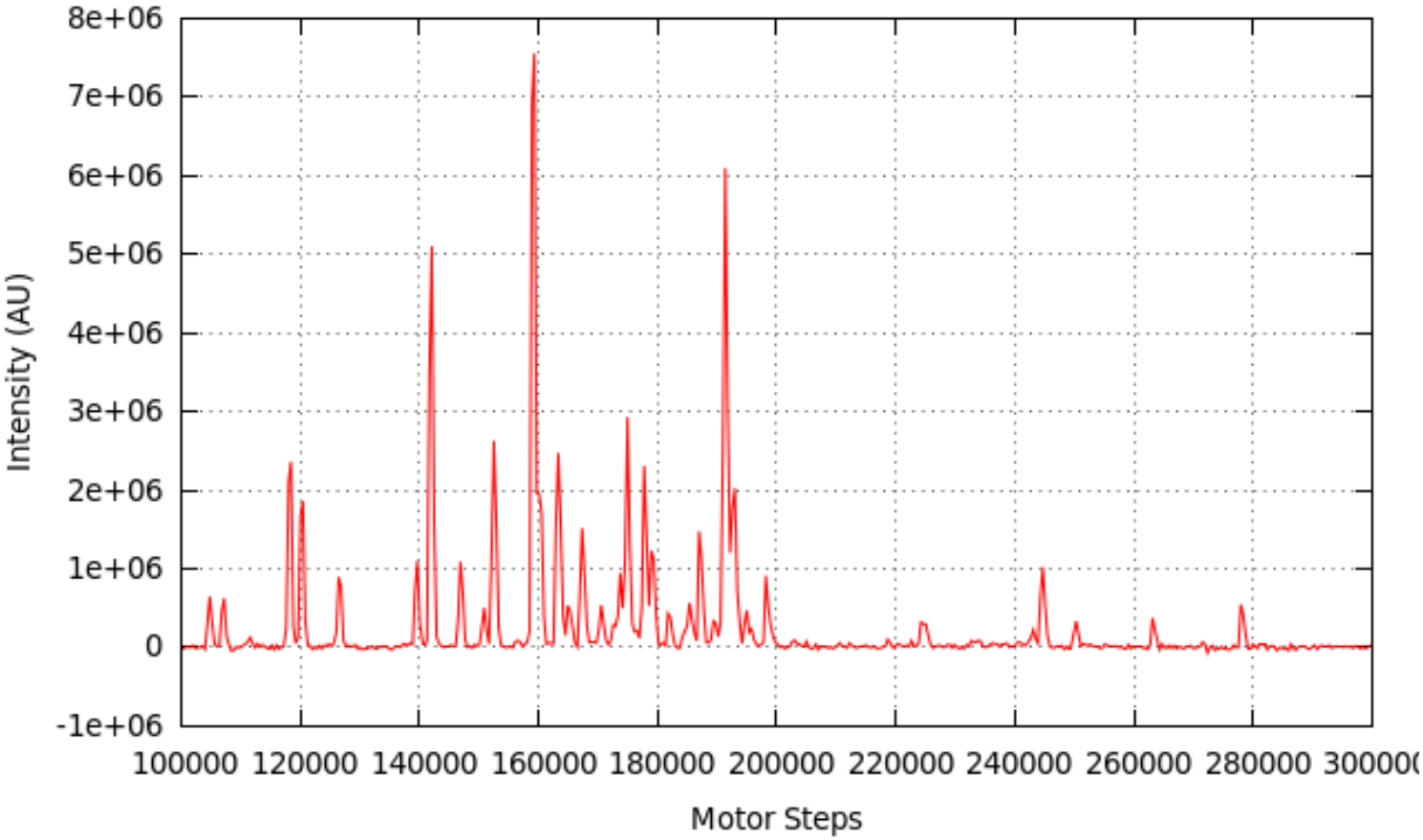

JDS Uniphase
14.9V
15.1
0.05A
0.01
This gets used!

Calibration

- Red (633 nm) and green (543.5 nm) helium-neon (HeNe) lasers

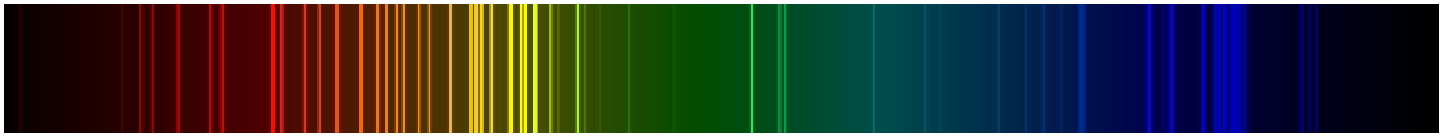


Calibration



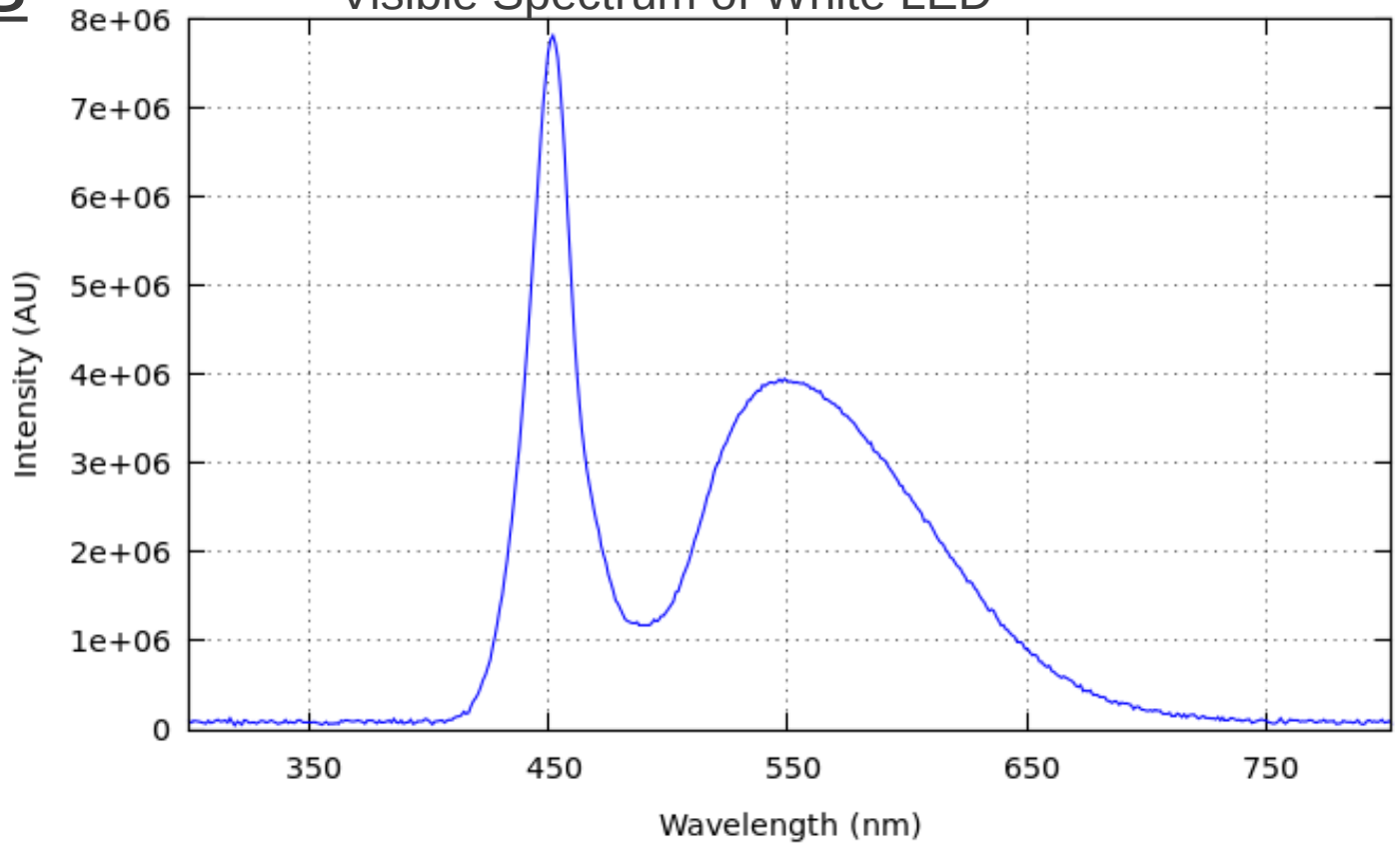
Helium:

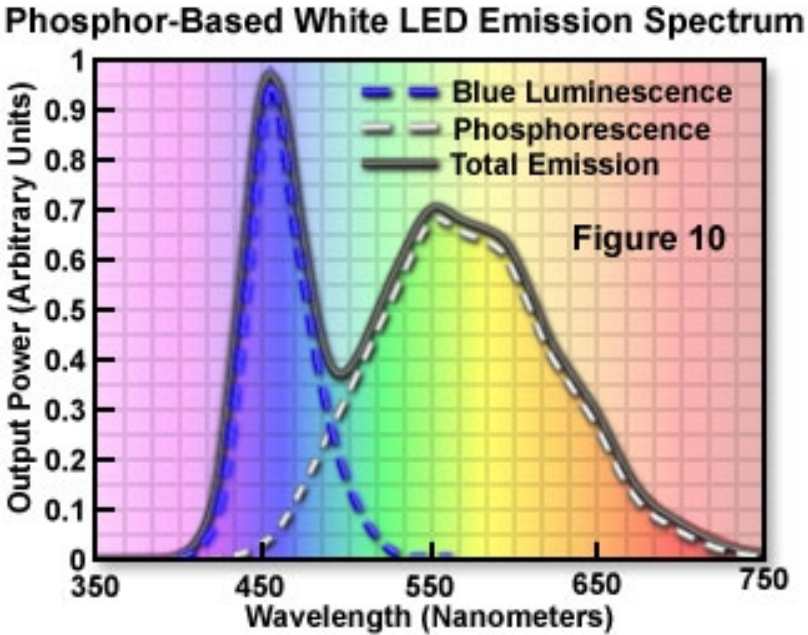
Neon:



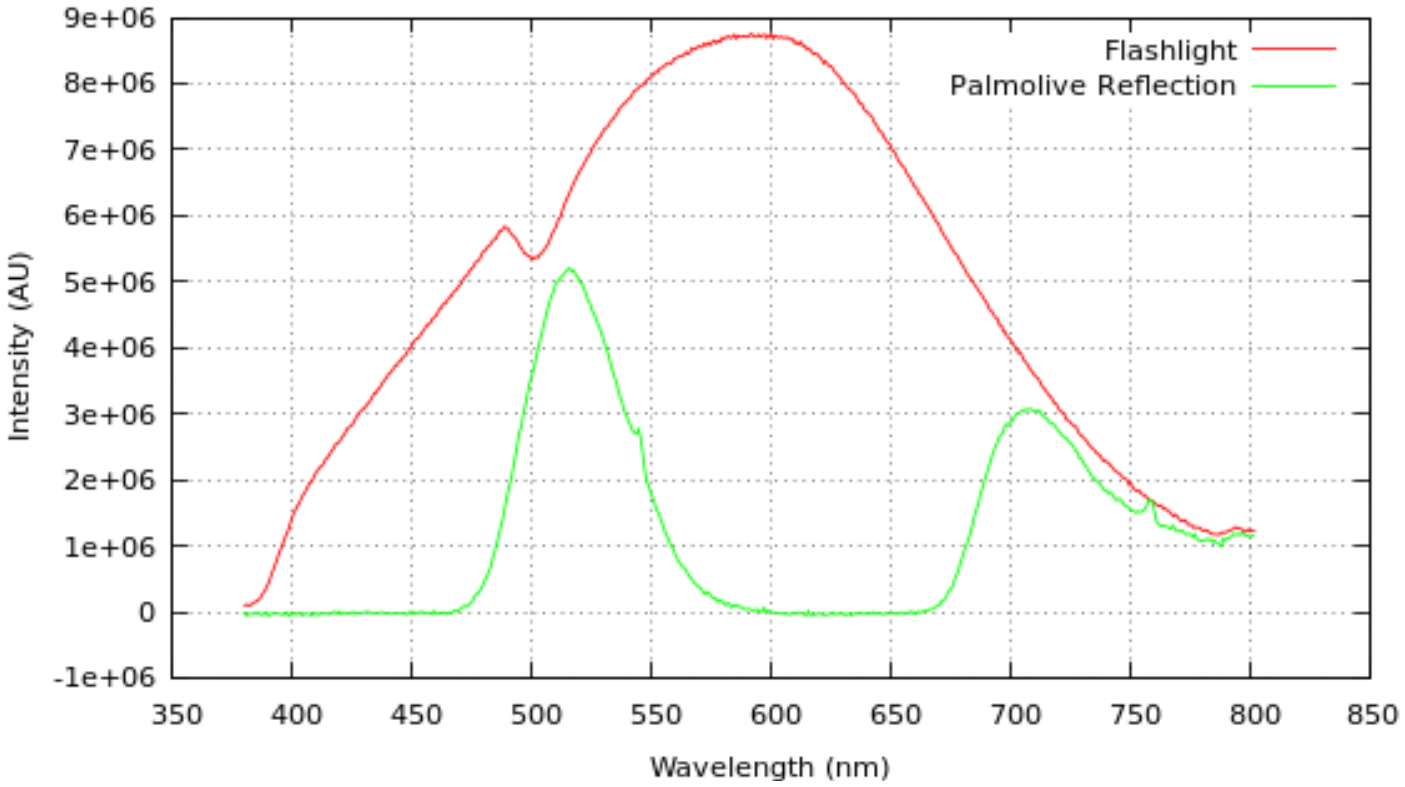
Images courtesy of the Astronomical Data Center

Samples





Images courtesy of Olympus America Inc. and AndroidAuthority.com



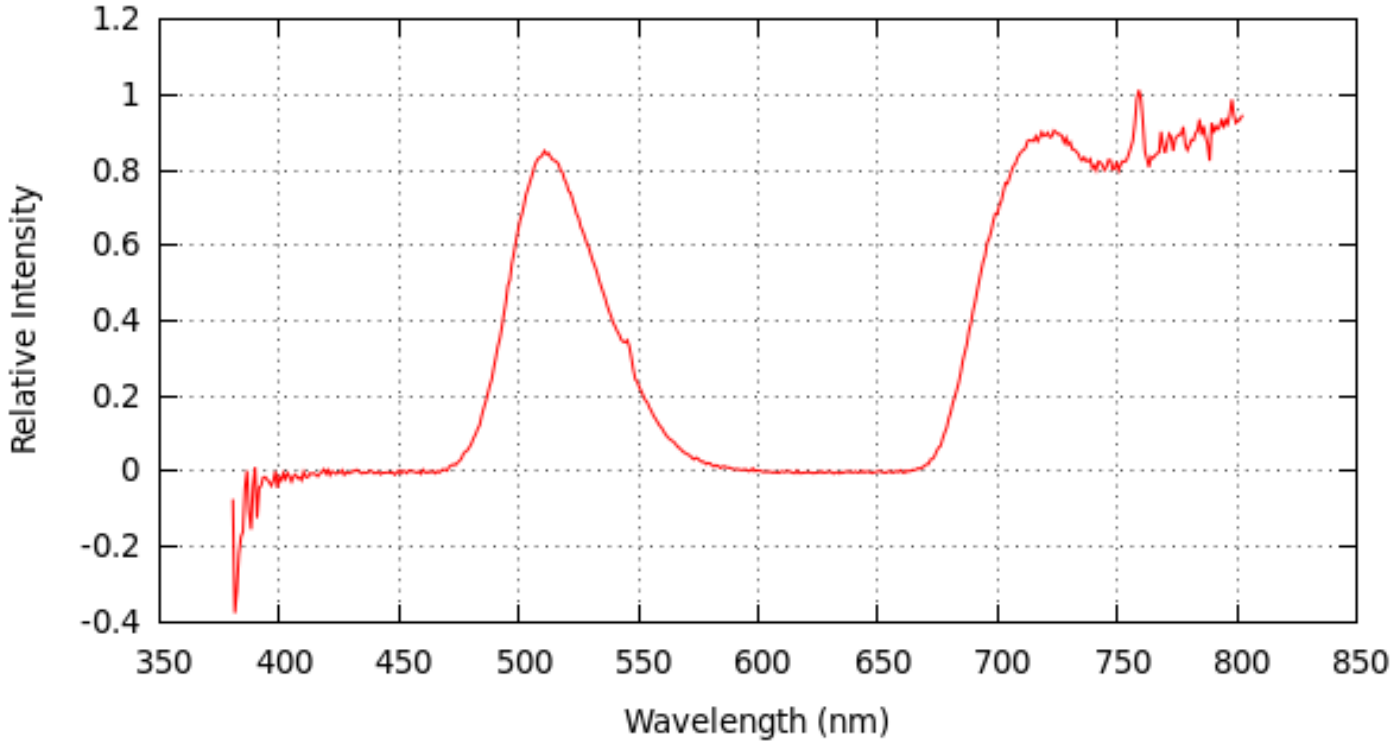
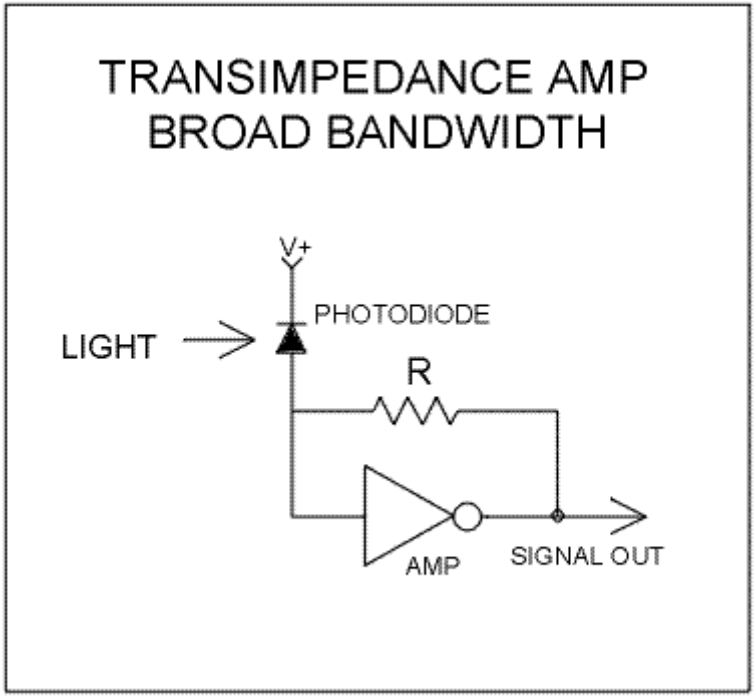


Image courtesy of Colgate-Palmolive and emedco

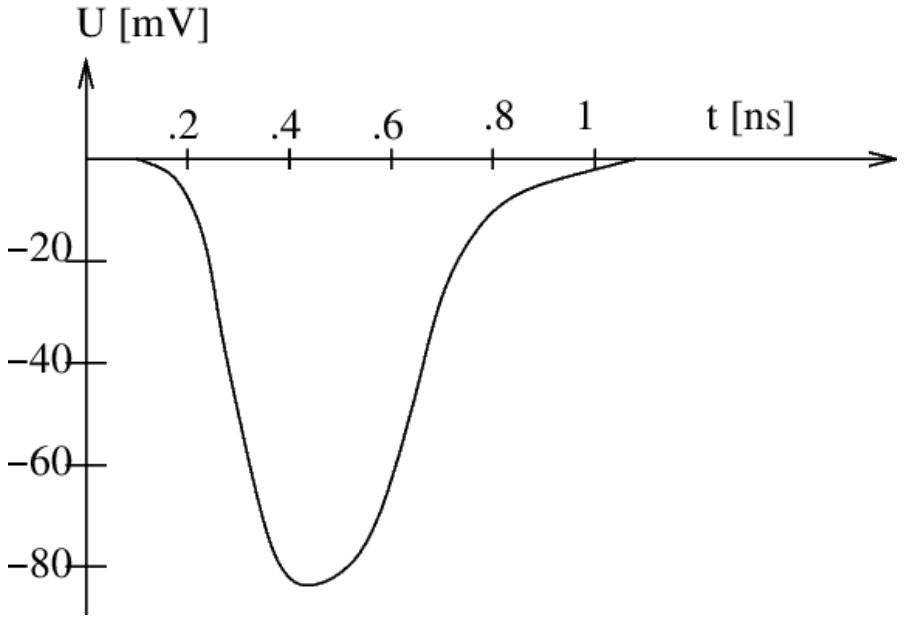
Plans for the Future

- Achieve time-resolved functionality
  - Send PMT output to transimpedance amplifier to convert current to voltage



Plans for the Future

- Obtain ~100mV pulses on the order of a few ns



- Implement on beamline for users to obtain spectra quickly and effectively

Summary

- A manual monochromator has been modified with the feature of automated scanning
- Modification has been proven successful by subsequent calibration and characterization
- The capability of obtaining time-resolved spectra is currently being developed