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.
Resolution inversely proportional to slit size

Holographic grating

Image courtesy of Sam's Laser FAQ
The Hamamatsu R928 PMT used has high quantum efficiency, optimized in visible range. It 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
Modifications
Spectrometer Controller

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

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

Helium:

Neon:

Images courtesy of the Astronomical Data Center
Visible Spectrum of White LED

Phosphor-Based White LED Emission Spectrum

Images courtesy of Olympus America Inc. and AndroidAuthority.com
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