Lecture #2
Data Acquisition: About DAQ
Hardware and LabView

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PHYS 4580, 6280, and 7280
Last week

• Exercise to introduce students to:
  – LabVIEW (Measurement/control)
  – Igor Pro (Analysis/Presentation)
  – Optical measurement experimental Set-up.

• Time constant of Thermopile Detector
Response time of the thermopile (at one wavelength)

Lamp

CM110 monochromator

1” focal length

Collimated beam

2” focal length

Chopper

Thermopile

USB communication

1000 X amplifier

NI USB 6009 DAQ “board”
The “Set-Up”

Light Source

Tungsten – halogen bulb

Monochromator

Detector, Sample or Device (perhaps with I/V measurement)

A lens or two

focal length, f

Samples – semiconductor layers, transparent conductive layers, PV devices

Detectors – calibrated thermopile, photodiode
A thermopile is an electronic device that converts thermal energy into electrical energy. It is composed of several thermocouples connected usually in series or, less commonly, in parallel.

Thermopiles do not respond to absolute temperature, but generate an output voltage proportional to a local temperature difference or temperature gradient.

Thermopiles are often used to provide a voltage output in response to temperature as part of a temperature measuring device, such as the infrared thermometers widely used by medical professionals to measure body temperature. They are also used widely in heat flux sensors. The output of a thermopile is usually in the range of tens or hundreds of millivolts.

After Wikipedia and Dexter Research
Our Sun, and other Blackbody light sources, emit more than one wavelength of light.
Wavelength Dependent Response of PV Materials and Devices

Quantum Efficiency, aka Spectral Response

Schematic cross section of a typical Cu(InGa)Se$_2$ solar cell

From “Cu(InGa)Se$_2$ Solar Cells”, by Shafarman and Stolt and PVEducation.org
Spectral Products, CM110 1/8\textsuperscript{th} meter monochromator

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Czerny-Turner, dual-grating turrets</td>
</tr>
<tr>
<td>Focal Length</td>
<td>110mm</td>
</tr>
<tr>
<td>f/#</td>
<td>3.9</td>
</tr>
<tr>
<td>Beam Path</td>
<td>Straight through standard, right angle provided on request.</td>
</tr>
<tr>
<td>Wavelength Drive</td>
<td>Worm and wheel with microprocessor control and anti-backlash gearing. Bi-directional. Usable in positive or negative grating orders.</td>
</tr>
<tr>
<td>Wavelength Precision</td>
<td>0.2nm</td>
</tr>
<tr>
<td>Wavelength Accuracy</td>
<td>± 0.6nm</td>
</tr>
<tr>
<td>Slewing Speed</td>
<td>&gt;100nm/second</td>
</tr>
<tr>
<td>Stray Light</td>
<td>&lt;10\textsuperscript{-5}</td>
</tr>
<tr>
<td>Slits</td>
<td>Standard Set includes: 0.125mm, 0.15mm, 0.30mm, 0.6mm, 1.2mm and 2.4mm x 4.0mm. For other sizes, consult SP.</td>
</tr>
<tr>
<td>Max Resolution</td>
<td>&lt;1nm w/1200G/mm grating and standard slits</td>
</tr>
<tr>
<td>Gratings</td>
<td>One to two gratings. (30 x 30mm) must be purchased. See Appendix A for options</td>
</tr>
<tr>
<td>Software</td>
<td>Demonstration control program and LabView driver included.</td>
</tr>
<tr>
<td>Power</td>
<td>UL listed 110/220V power pack</td>
</tr>
<tr>
<td>Interface</td>
<td>RS232 standard</td>
</tr>
<tr>
<td>Warranty</td>
<td>One year</td>
</tr>
</tbody>
</table>
| Options                | ● Hand-held control module with function keys and display for local control  
                          ● IEEE-488 interface    
                          ● Interface cables     
                          ● Gold optics           |

Serial commands sent from computer to CM110 via USB.
Czerny-Turner Monochromator

The diagram shows the layout of a Czerny-Turner Monochromator, which is a device used in spectroscopy to separate different wavelengths of light. The focal length, $f$, is indicated on the diagram.
LabVIEW Training and References

http://www.ni.com/academic/students/learn/

Reference Textbook:


Analog to Digital Conversion (a through resource):