
Introduction to Lighting Systems and Controls

Course No. ENRG 54

Outline

A. Introduction to fundamentals of lighting

- Lighting terminology
- Physics and principles of lighting
- Units of measurement
- Vision and colors
- Ambient, directional and task lighting
- Over- and under-illuminance

B. Lighting systems

- Components
- Types of lamps
- Ballasts
- Lamp comparison matrix
- Types of lighting luminaires and intensities
- Energy efficiency measures (EEMs)

C. Lighting controls

- Basic concepts of effectiveness of lighting control
- Types and appropriate applications of lighting controls
- Lighting control equations
- Energy efficiency measures (EEMs)

D. Additional EEMs

- De-lamping
- Scotopic lighting
- Task and ambient light levels
- Circadian rhythms

E. Lighting measurements

- Tools
- Data loggers and applications

F. Lighting calculations

- Equation and method of calculating lumens (zonal cavity formula)
- Equation and method of calculating energy savings
- Method of calculating skylight energy savings

G. Lighting standards, codes and regulations

- Underwriters' Laboratory (UL)
- Uniform Building Code (UBC)
- Americans with Disabilities Act (ADA)
- Title 24 applications

H. O&M measures to assure optimal performance

E. Lighting measurements

1. Tools

2. Data loggers and applications

1. Tools

- Flicker checker
- Illuminance meter
- Luminance meter
- Spectrophotometer
- Goniophotometer
- Circuit tracer

Flicker checker – check types of ballast

- Spin to check the type of ballast
- Magnetic -- see patterns spinning in opposing directions
- Electronic – continuous circles
- Why: **secondary frequency**
- Multiple light sources could affect the result
- Alternative tool: discriminator
 - green: electronic
 - red: magnetic



Illuminance meter

- For “incident” light level readings (fcd or lux)
- 1 fcd = 10 lux
- Normally need to average several spots



Konicaminolta.com

Luminance meter

- For reading reflected or transmitted “brightness” (in cd/m^2)
- Specifies the brightness of a luminous surface and/or a light source
- reading materials:

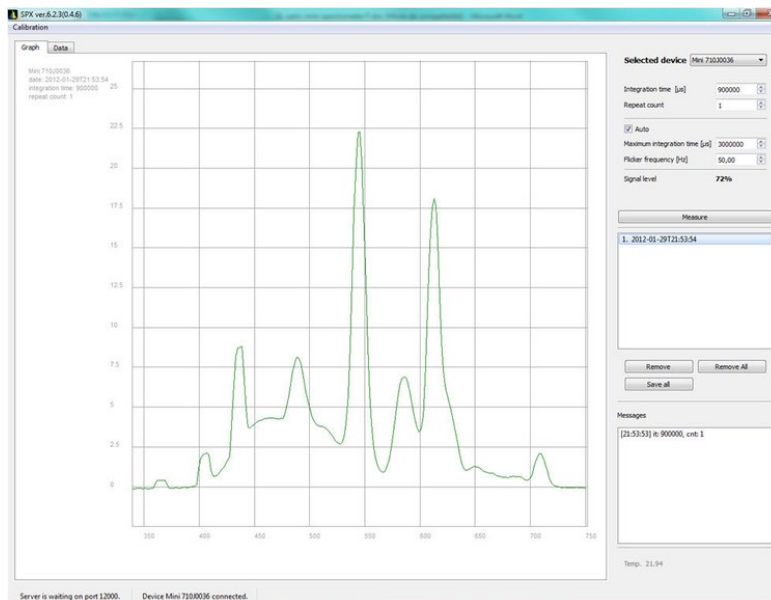
<http://www.konicaminolta.com/instruments/products/light/luminance-meter/ls100-ls110/index.html>



Konicaminolta.com

Spectrophotometer

- Measures light intensity as a function of the light source wavelength
- Measures spectral reflectance of objects
- Reading materials: <http://senze-instruments.com/gl-optic-mini-spectrometer--.html>



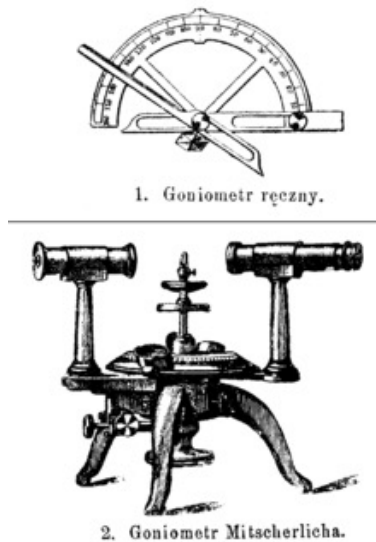
Mini-spectrometer



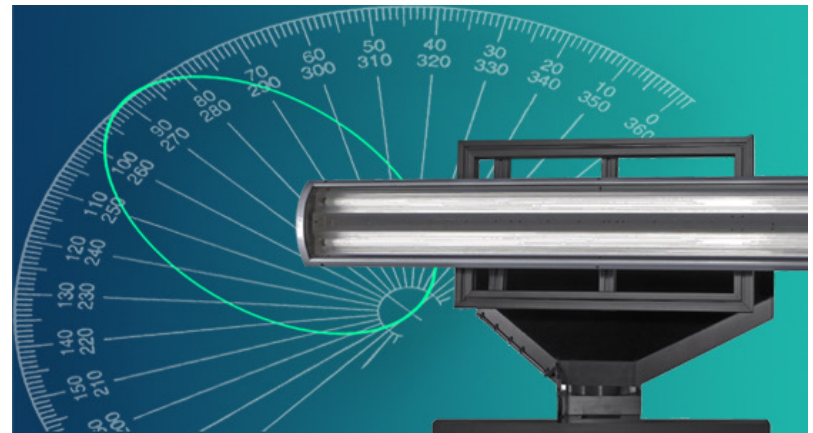
Goniphotometer

- Measure the light emitted from luminaires and lamps at different angles
- reading materials: http://wiki.answers.com/Q/What_is_the_principle_of_goniophotometer ;

<http://www.pro-lite.uk.com/File/goniophotometers.php>



Wikipedia.com



Circuit tracer

- Used to find wiring indoors and outdoors
- Consists of a probe, transmitter and receiver
- Performs tests w/o having to interrupt power



http://www.licensedelectrician.com/Store/Circuit_Tracers.htm

D. Lighting measurements

1. Tools

2. Data loggers and applications

2. Data loggers and applications

- Occupancy

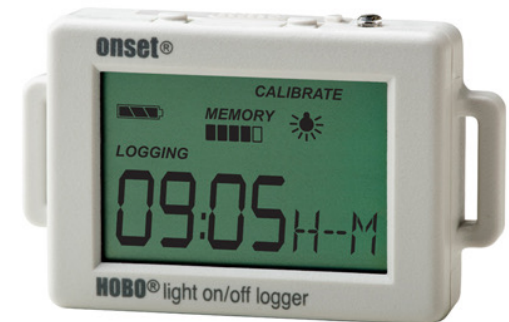
-Used to determine energy saving potential by recording when a space is occupied/vacant, and when lighting is on/off



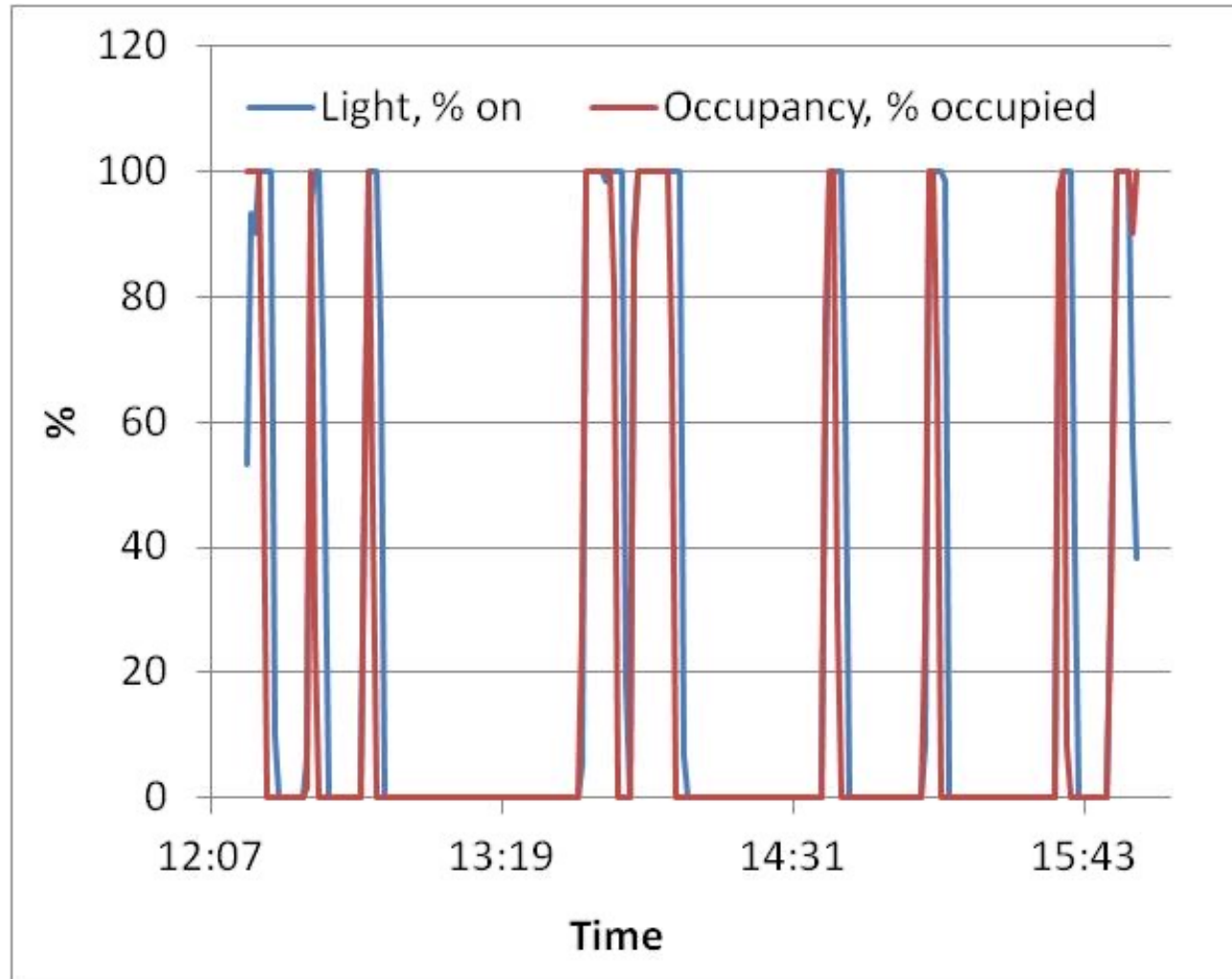
<http://www.onsetcomp.com>

- Hours of use
- Multiple channels

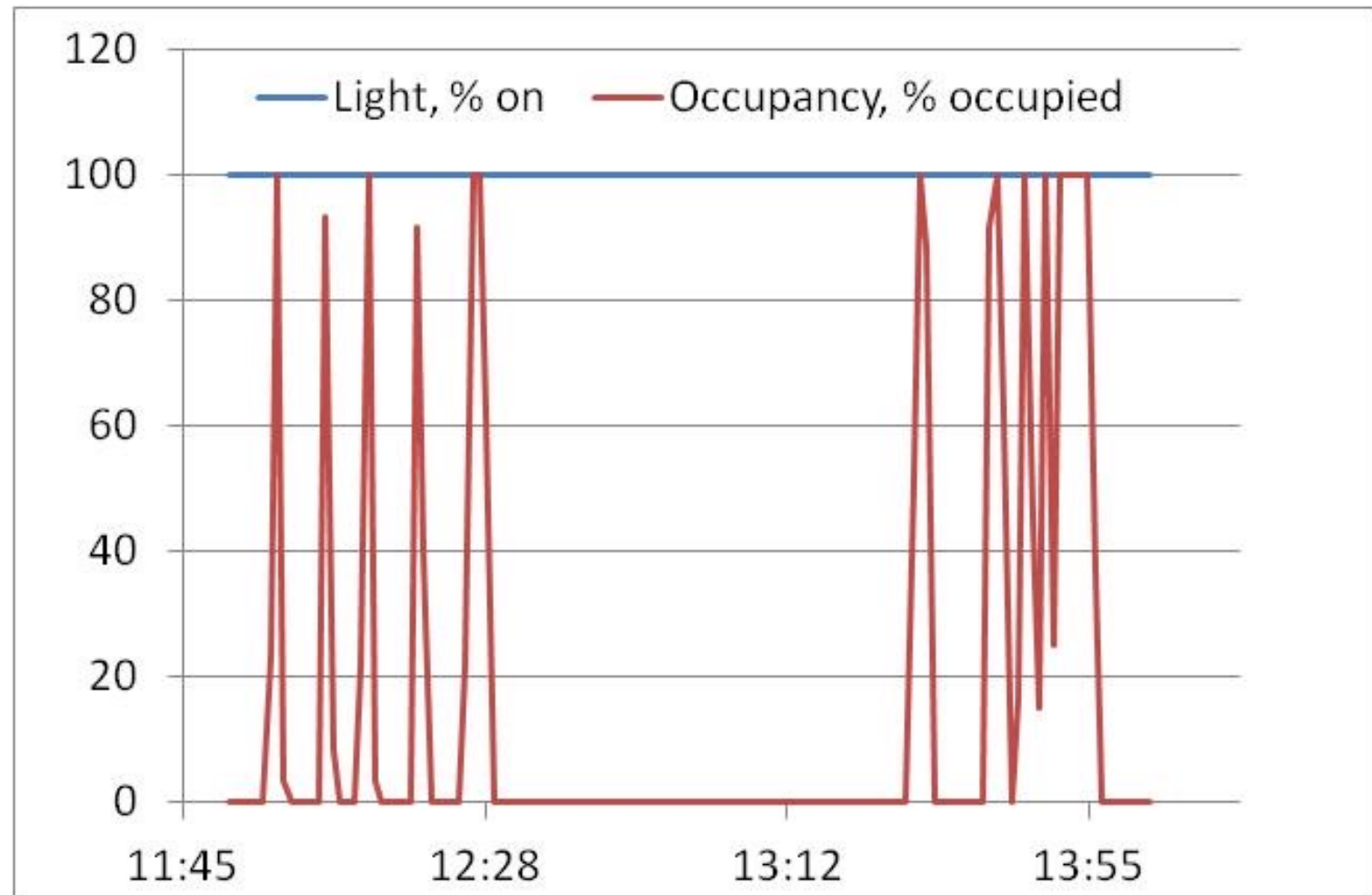
pay attention where to install



Occupancy



Occupancy



Laboratory project 1

Learn how to use selected tools covered in this chapter



Homework 3

1. Design data logger experiment – determine what you want to test
2. Decide the right type of logger and proper place to install
3. Install data logger
4. Load data logger data onto computer
5. Plot figure by Excel
6. Find potential problem
7. Come up a solution
8. Write a report

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Building Automation Systems Instructor Workshops

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