

# Multisensor-Humidity and Light Applications

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# Device Purposes

## Maintaining Humidity

Detects undesirable humidity and adjusts accordingly

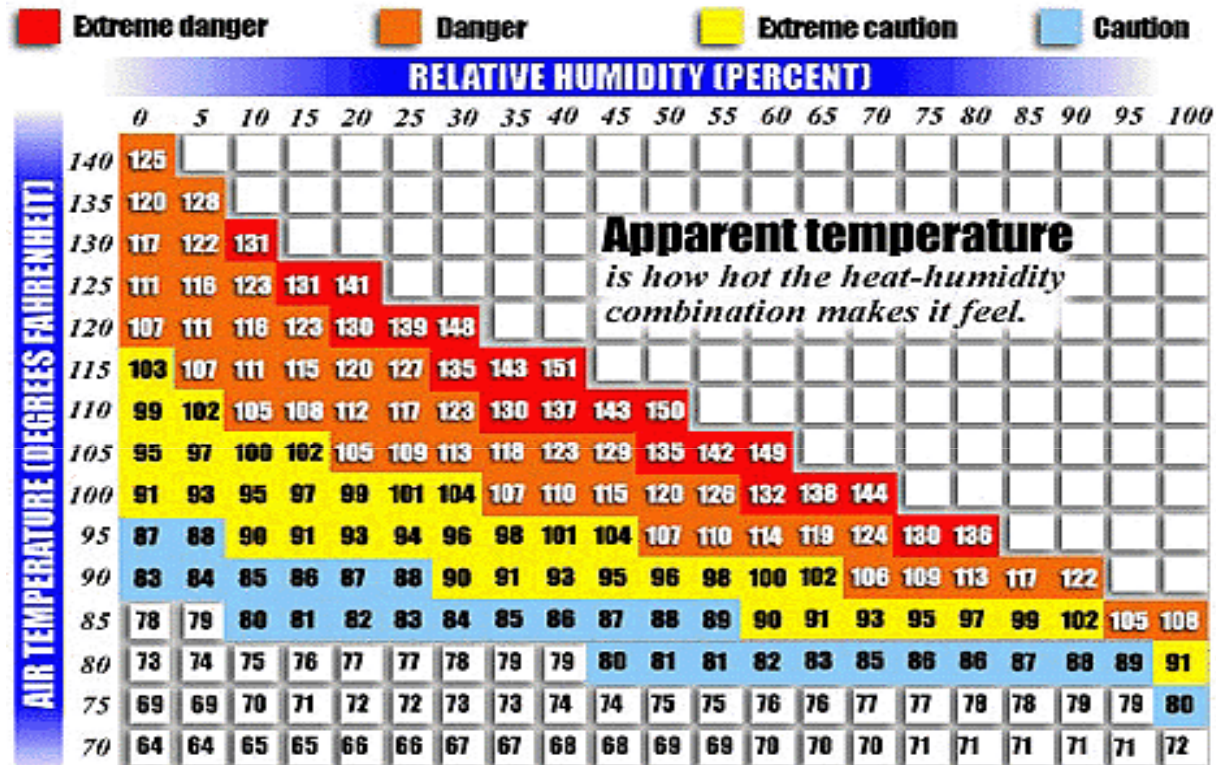
- Too high (+70%)
- Too low (-30%)

## Detecting Light

# Humidity Issues

- Humidity for comfort: 30-60% relative humidity. 50% and below to control dust mites. For people that suffer from allergies and asthma, relative humidity must be between 45 and 55%.
- Low humidity (under 30%) can lead to discomfort such as dry skin and excessive thirst. Dehydration depletes water needed for sweating and thickens the blood, requiring more work to pump blood.
- High humidity and high heat stresses the cardiovascular system.

# Apparent temperature



High humidity makes heat more dangerous because it slows the evaporation of perspiration – the body's natural cooler.

<http://www.usatoday.com/weather/wheat3.htm>

# High Humidity High Heat

- When heat and humidity combine to slow evaporation of sweat from the body, outdoor exercise becomes dangerous even for those in good shape.
  - Heat cramps, muscle cramps—imbalance of body salts
  - Fainting—quick drop in blood pressure if not used to exercising in heat
  - Heat exhaustion—losing fluid and salt leads to dizziness and weakness.
  - Heat stroke—body temp can rise to 105 degrees +
    - Lethargy, confusion, unconsciousness
    - Fatal

# Dangers to Elderly and Infants

- The *American Heart Association* warns seniors to limit activity when the temperature is above 70 degrees with humidity above 70%.
- 70 degrees is common indoor temperature and exercising indoors will be risky health-wise if humidity is not controlled.
- Extreme humidity generally is uncomfortable and may cause respiratory complications

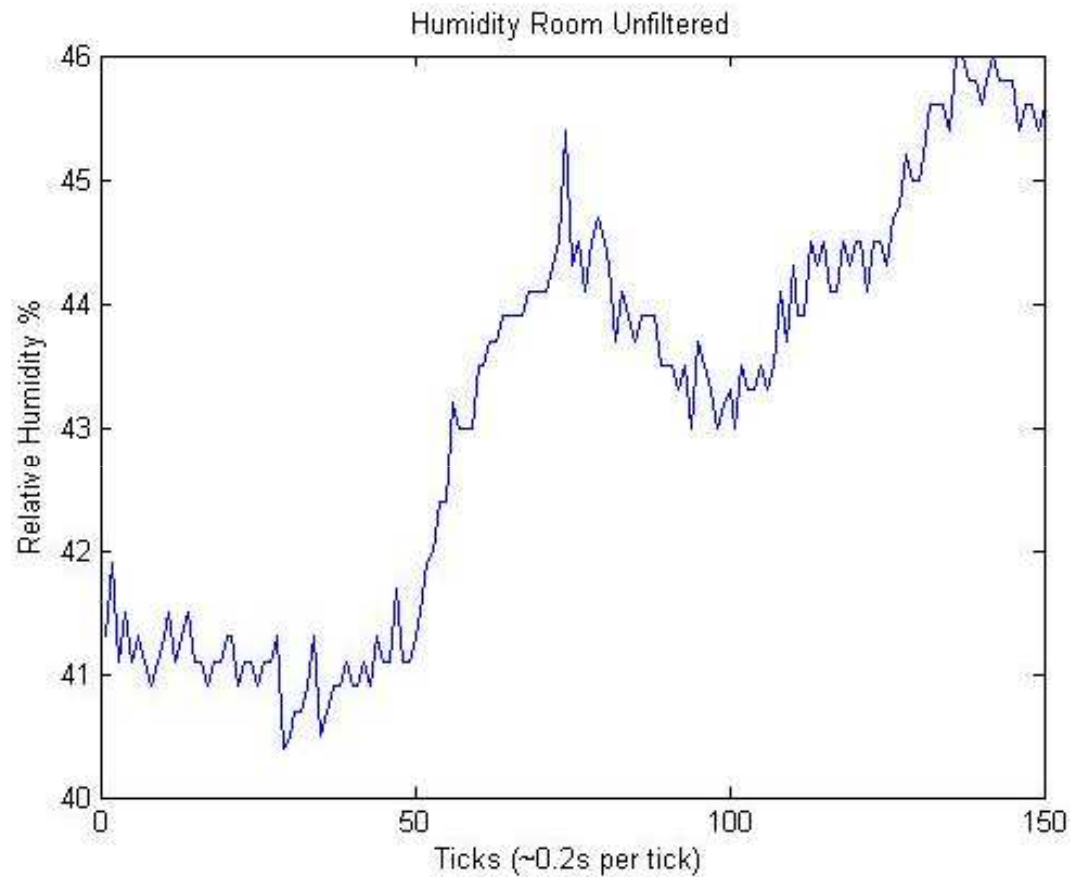
# Humidity Effect on Electronics

- Low humidity (dry):
  - Static electricity buildup
    - Leads to discharges, which can shut down a computer or destroy memory and information
    - Dielectric breakdown leading to material destruction
  - Makes materials brittle
- High humidity
  - Increases conductivity of permeable insulators
  - Condensation causes permanent damage (when moving from cold to warm humid place) shorts circuits

# Principle

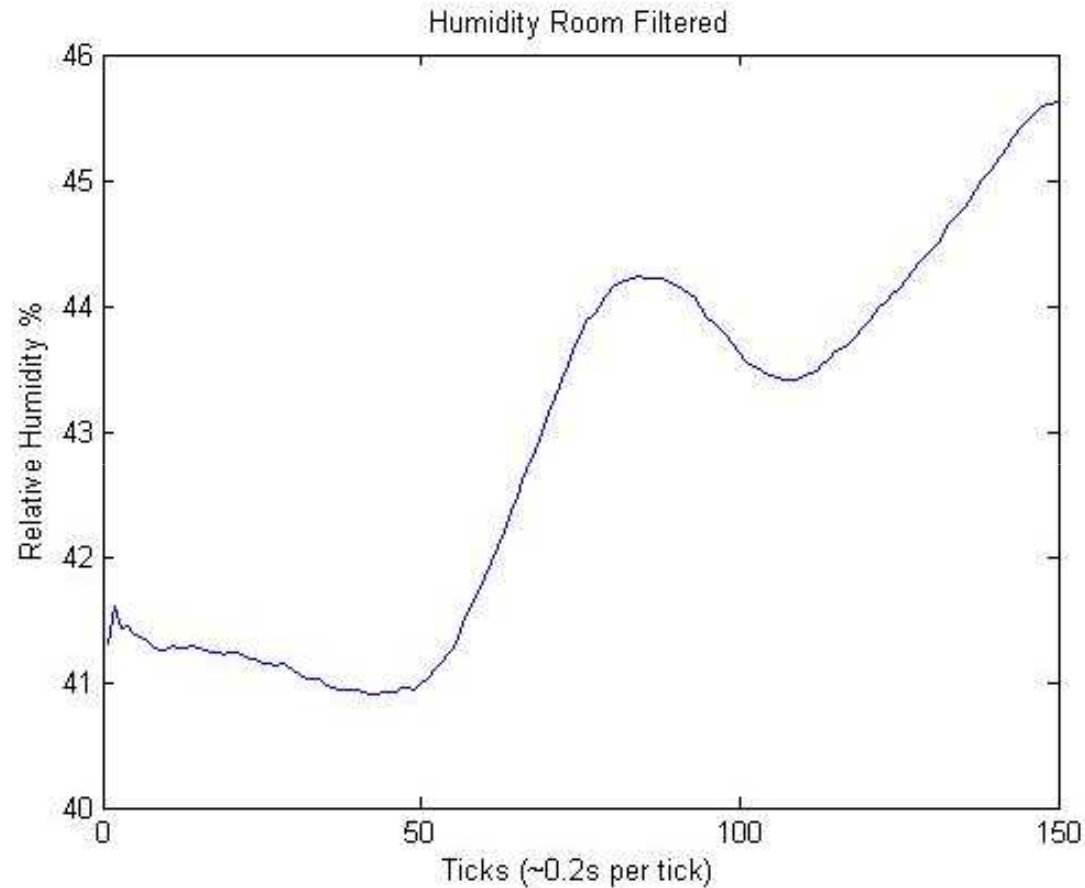
- Stores relative humidity values and uses a moving average to remove high frequency noise.
- After a relative humidity 60% for a certain length of time, turn on a dehumidifier (ac, heater, etc) until humidity reaches desired amount.

# Initial Humidity Test



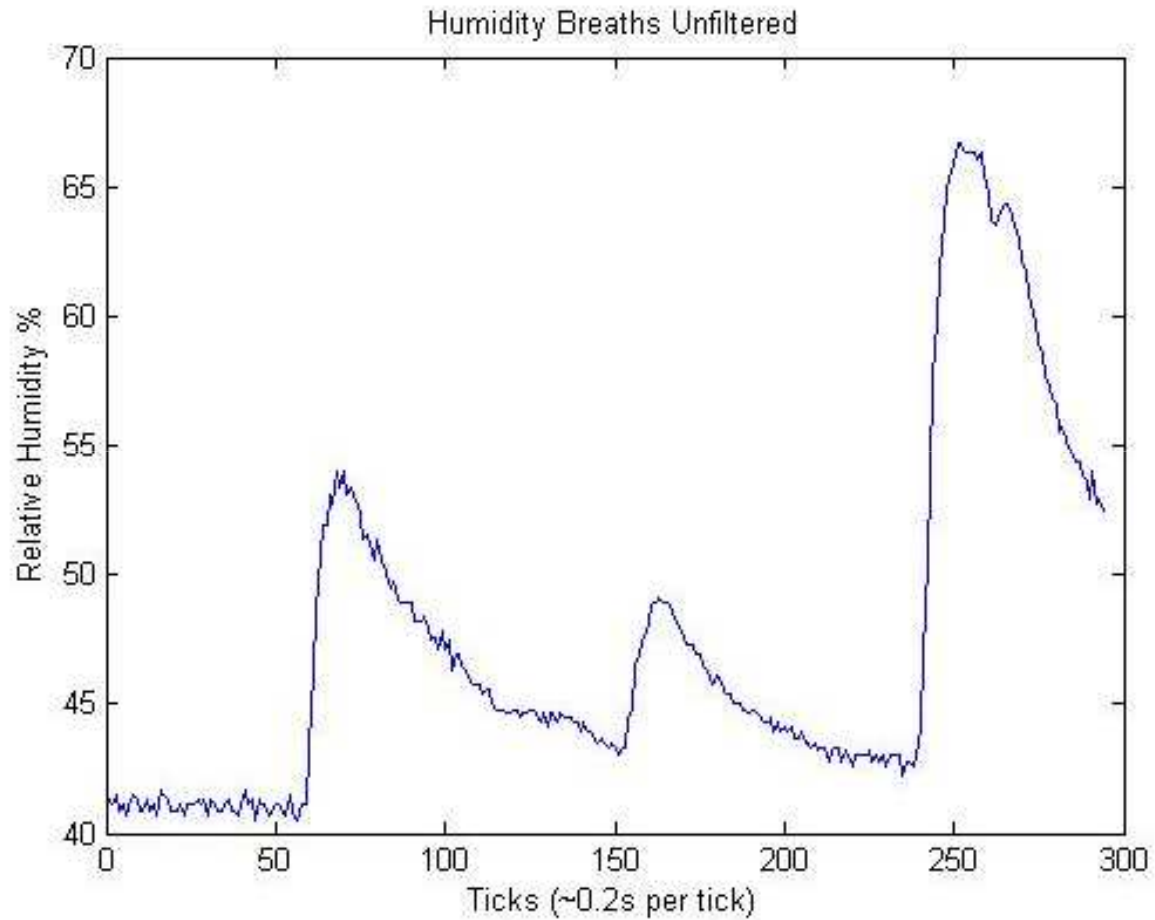
Lifted sensor from rest on the table to in the air and held it vertically.

# Initial Humidity Test- Filtered



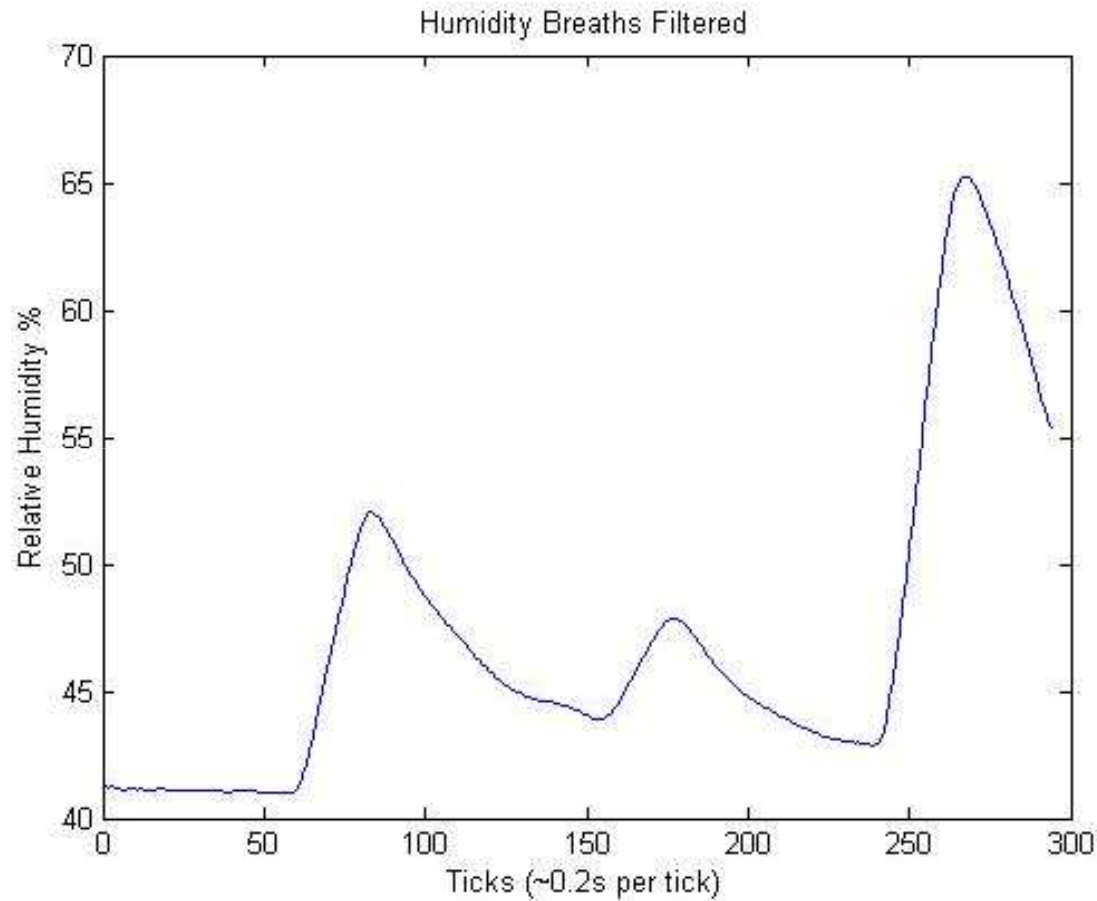
- Filtered results smoother. Humidity changes unknown.

# Breath Humidity



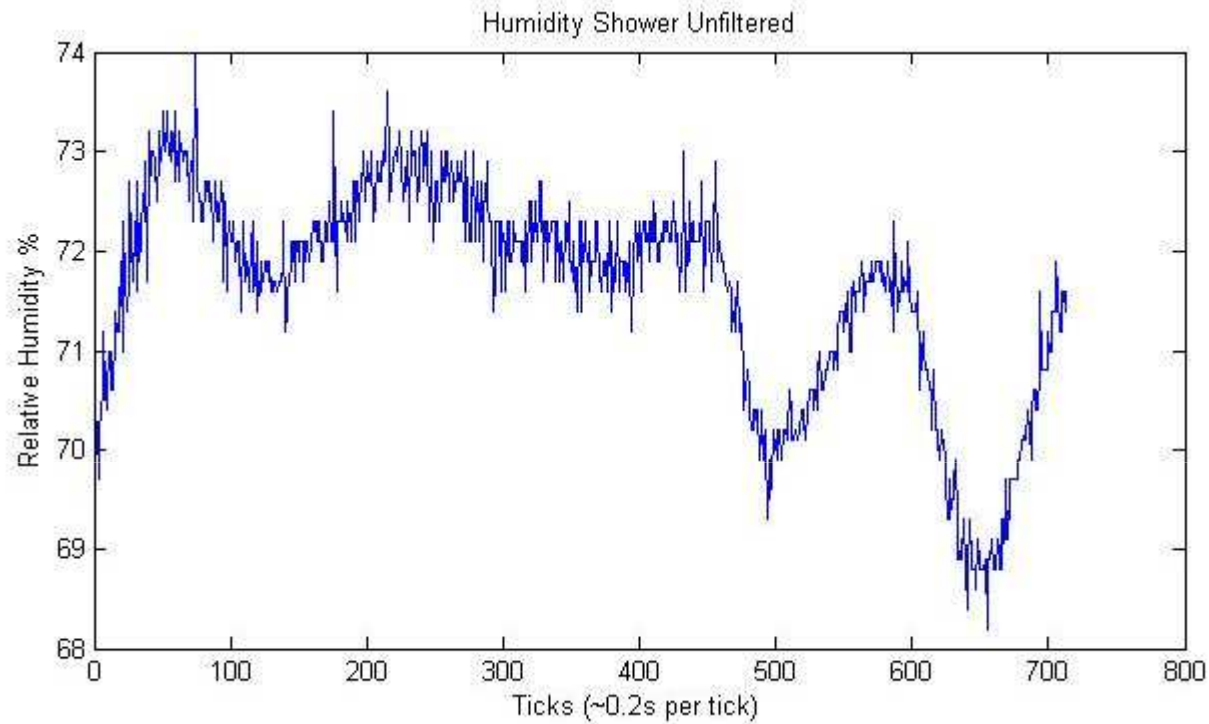
Small warm breath, then far cool breath, then close warm breath

# Breath Humidity Filtered



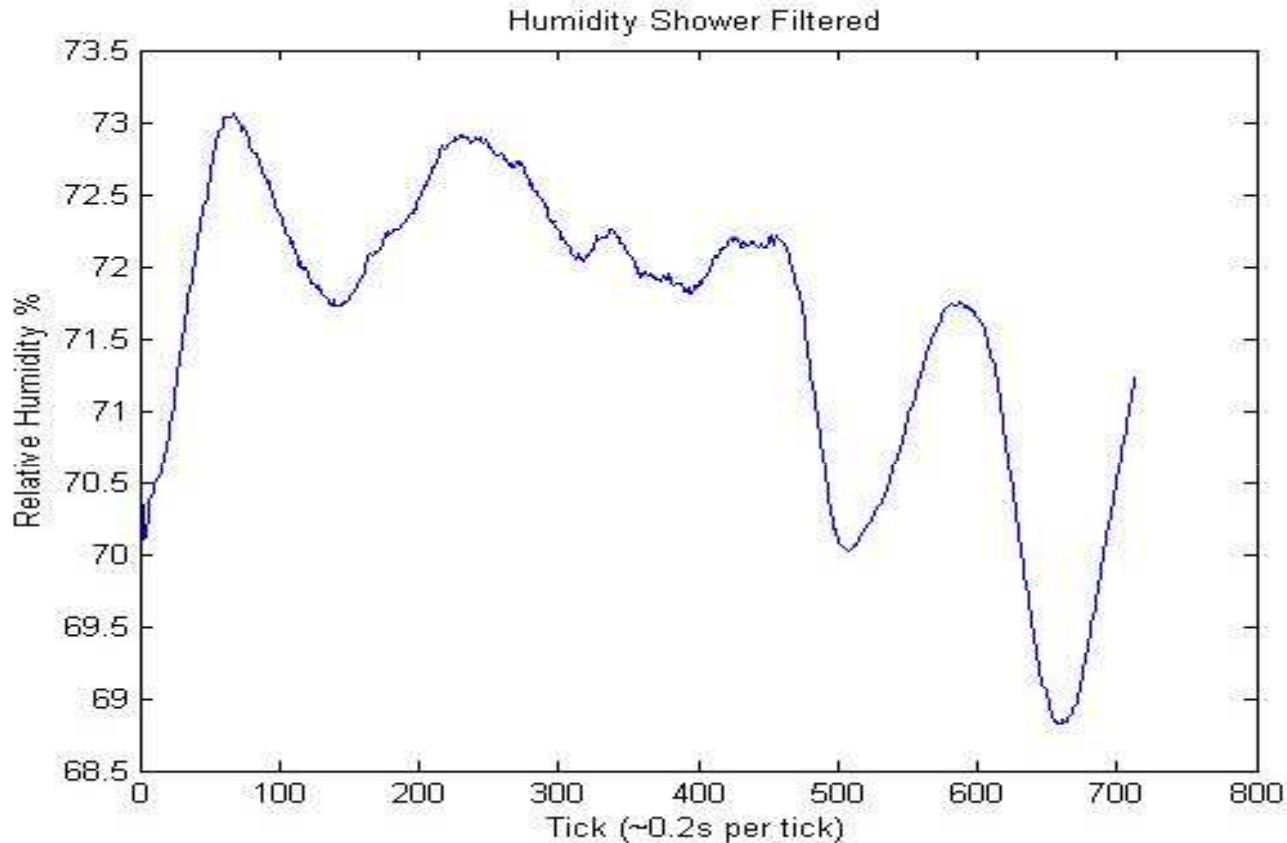
Smoothed out high frequency noise with a 20-point moving average filter.

# Shower Humidity



Results of humidity several minutes into the shower. Normal room at around 40%.

# Shower Humidity Filtered



- Planned on 10 mins of data but only logs 2.5mins. Humidity high as expected midway.

# Shower Humidity Waiting

- error

# Light Sensor Application

Detects sunrises

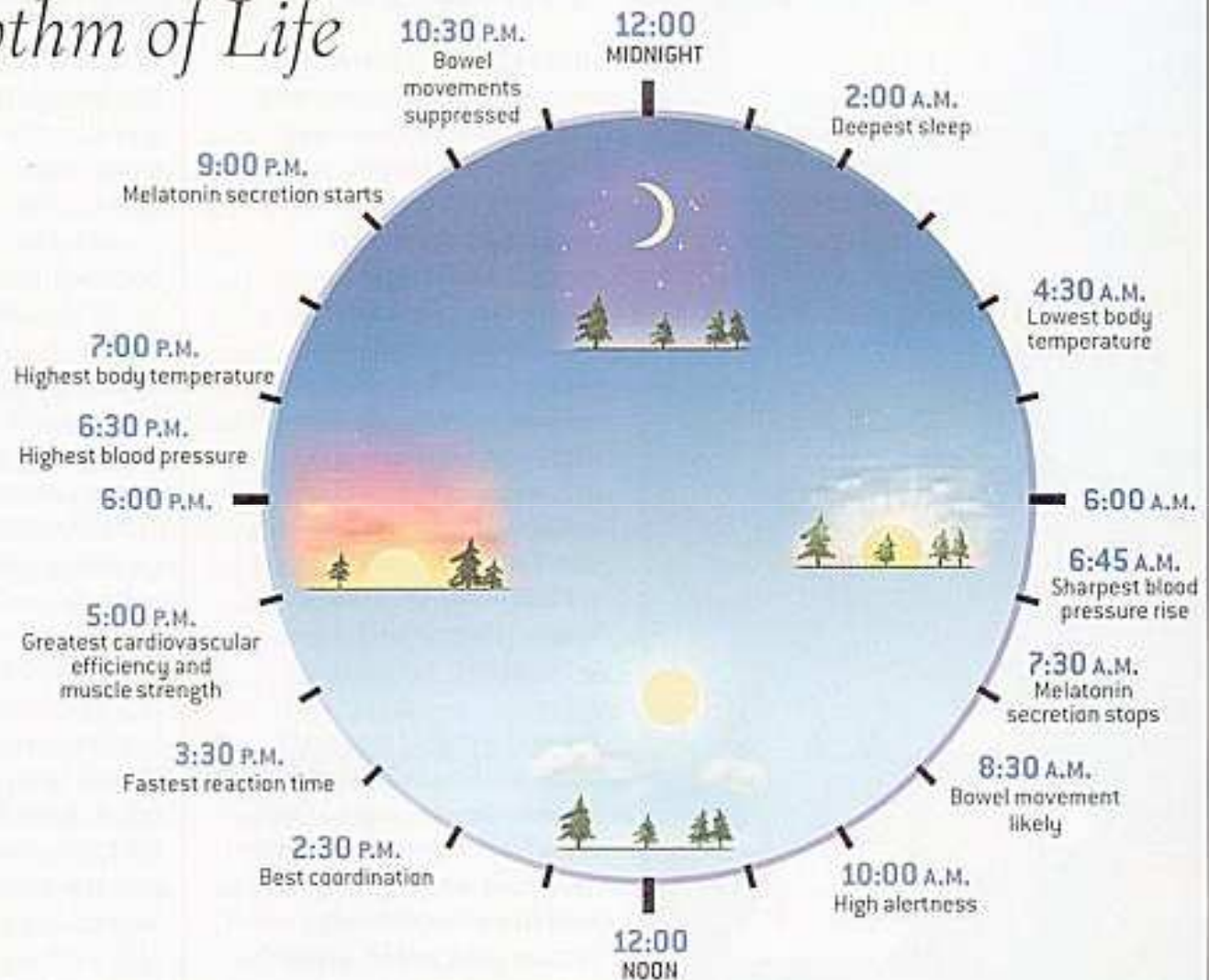
- Checks for steady rises in illuminance
- Flags if illuminance has been above a certain level for a while
- Set off an alarm to wake up the consumer to calibrate an accurate circadian rhythm.



## CYCLIC EVENTS

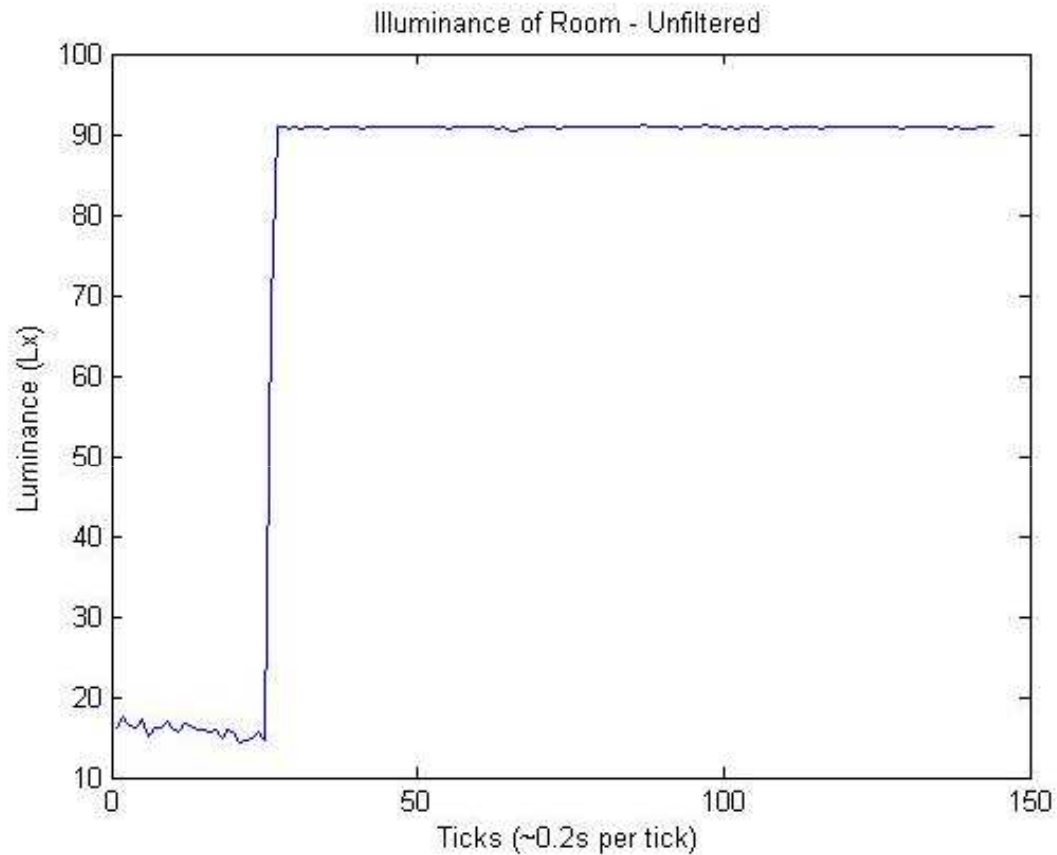
# The Rhythm of Life

THE CIRCADIAN CLOCK affects the daily rhythms of many physiological processes. The diagram at the right depicts the circadian patterns typical of someone who rises early in the morning, eats lunch around noon and sleeps at night. Although circadian rhythms tend to be synchronized with cycles of light and dark, other factors—such as ambient temperature, meal times, stress and exercise—can influence the timing as well. —K.W.



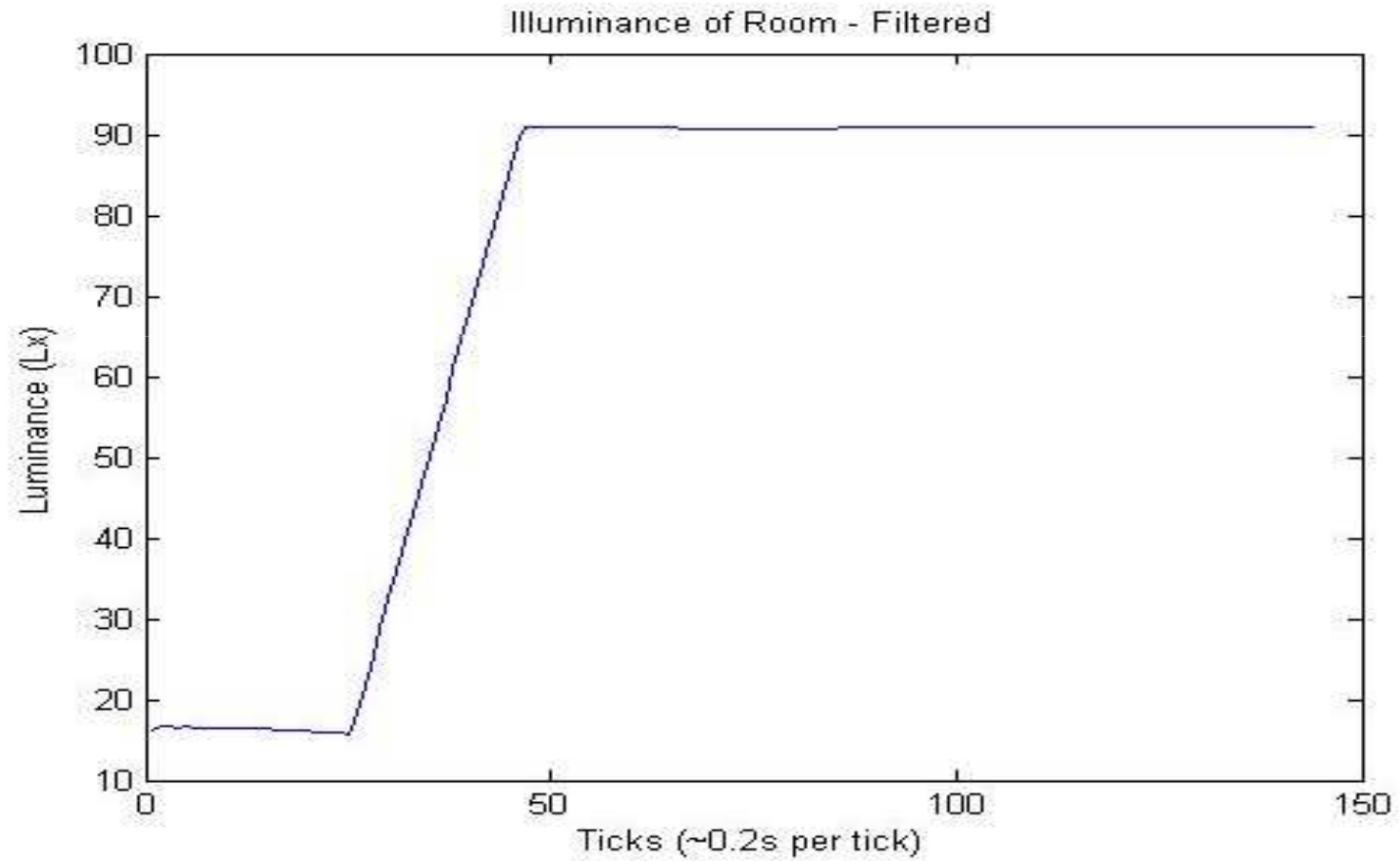
SOURCE: *The Body Clock Guide to Better Health*, by Michael Smolensky and Lynne Lomberg, Henry Holt, 2000

# Light Data

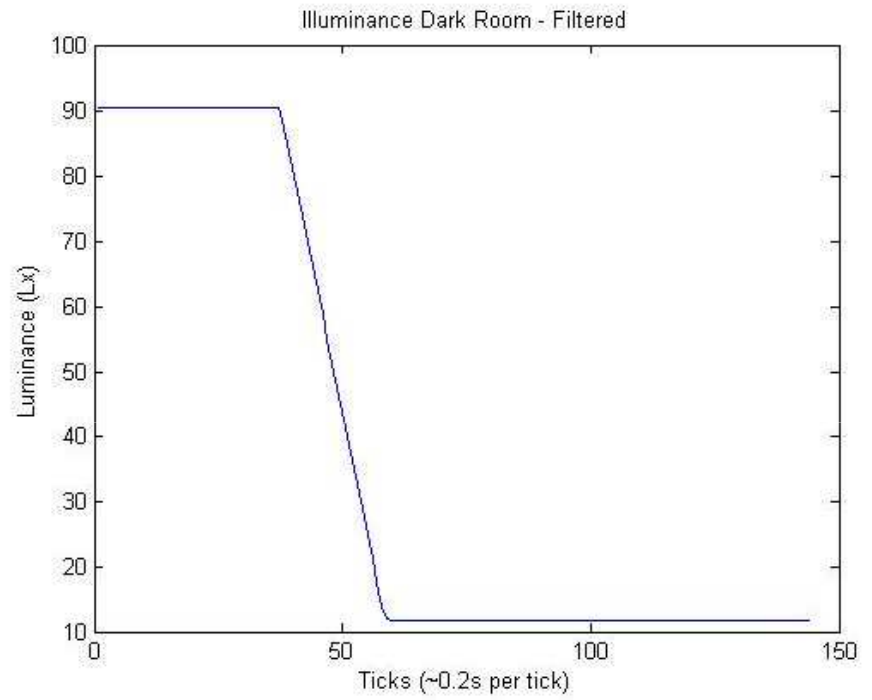
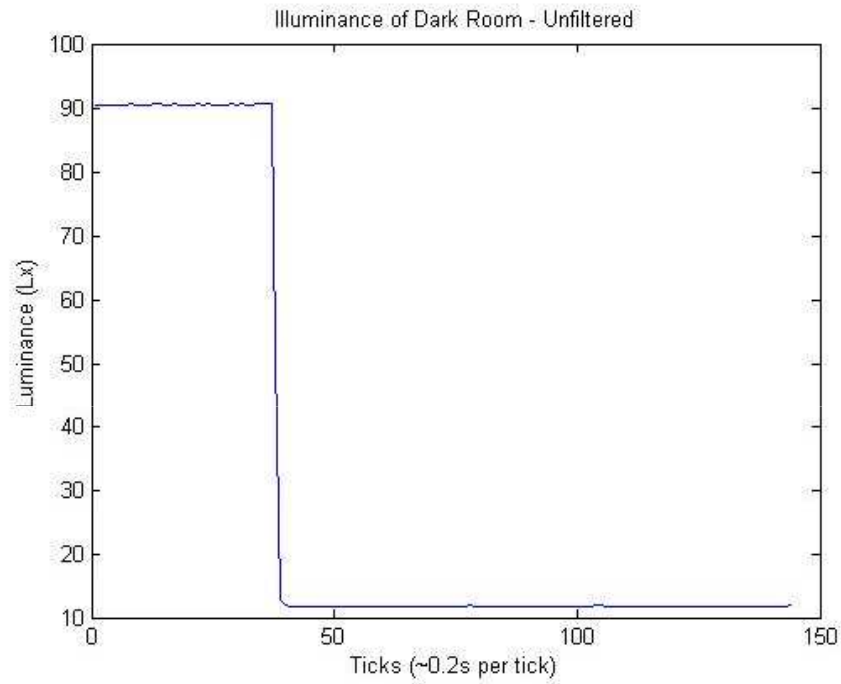


- Little information, filter unnecessary

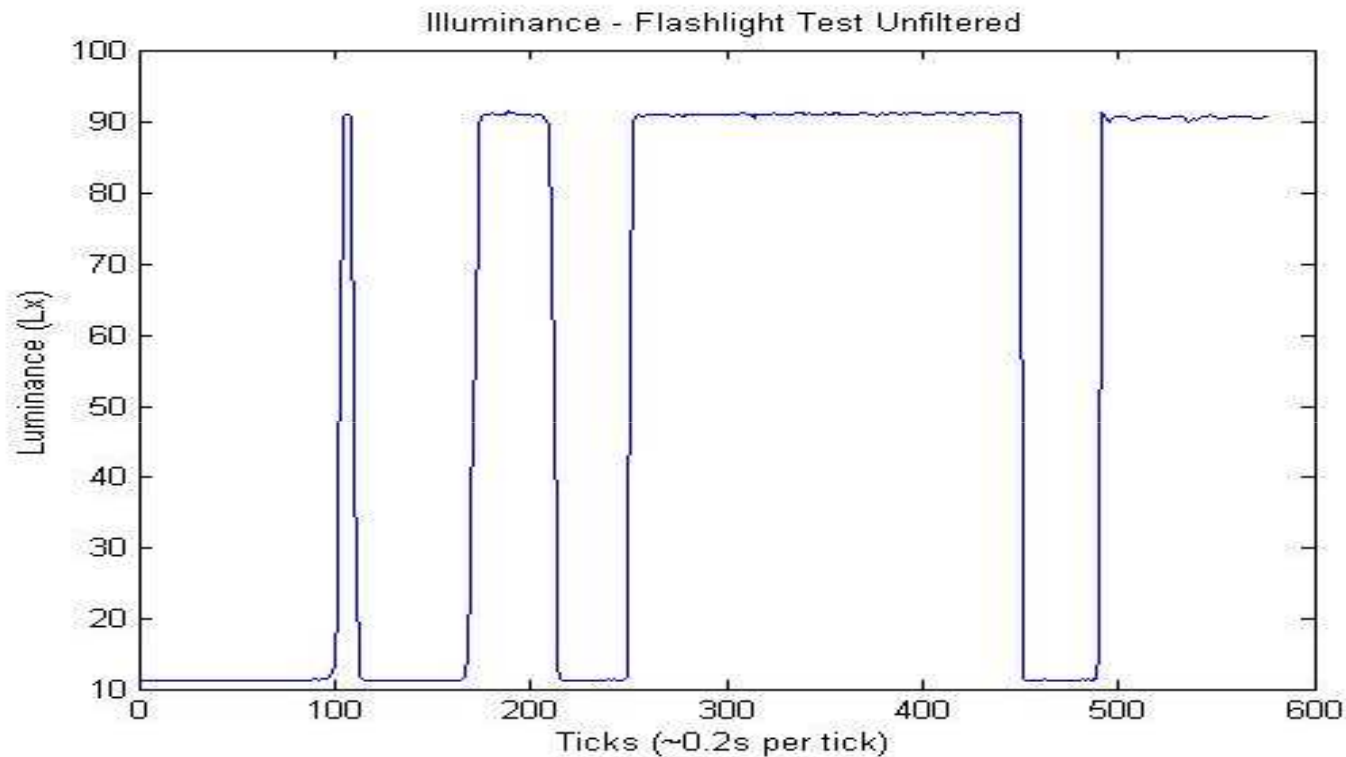
# Filtered Room Illuminance



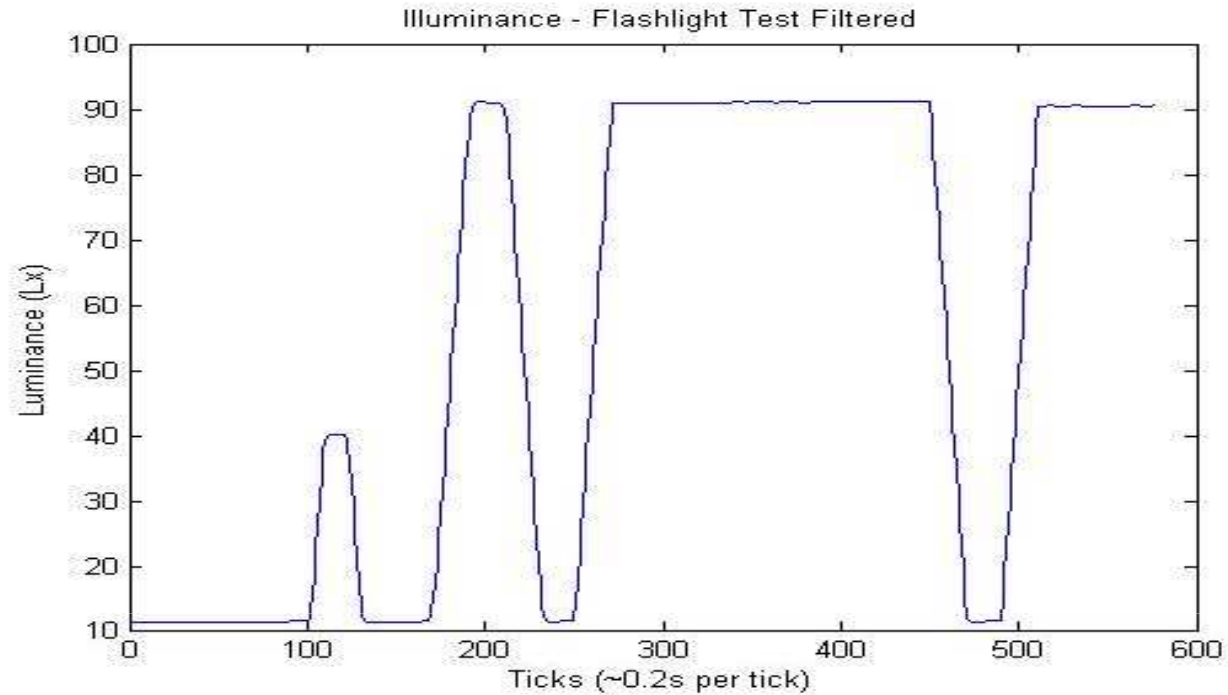
# Dark Room Illuminance



# Flashlight Test



Initially, swept flashlight around to make sure no noise got through. Then spiked all the way up to make sure sunrise didn't trigger quickly. Then reset and did a sunrise test and worked reset and tried again, worked.



Enter the COM port number to which the module is connected (ex: 3): 4

Enter time (minutes) over which to retrieve data: 2

bright! occurred at tick 112.000000

dark! occurred at tick 122.000000

bright! occurred at tick 179.000000

dark! occurred at tick 225.000000

bright! occurred at tick 258.000000

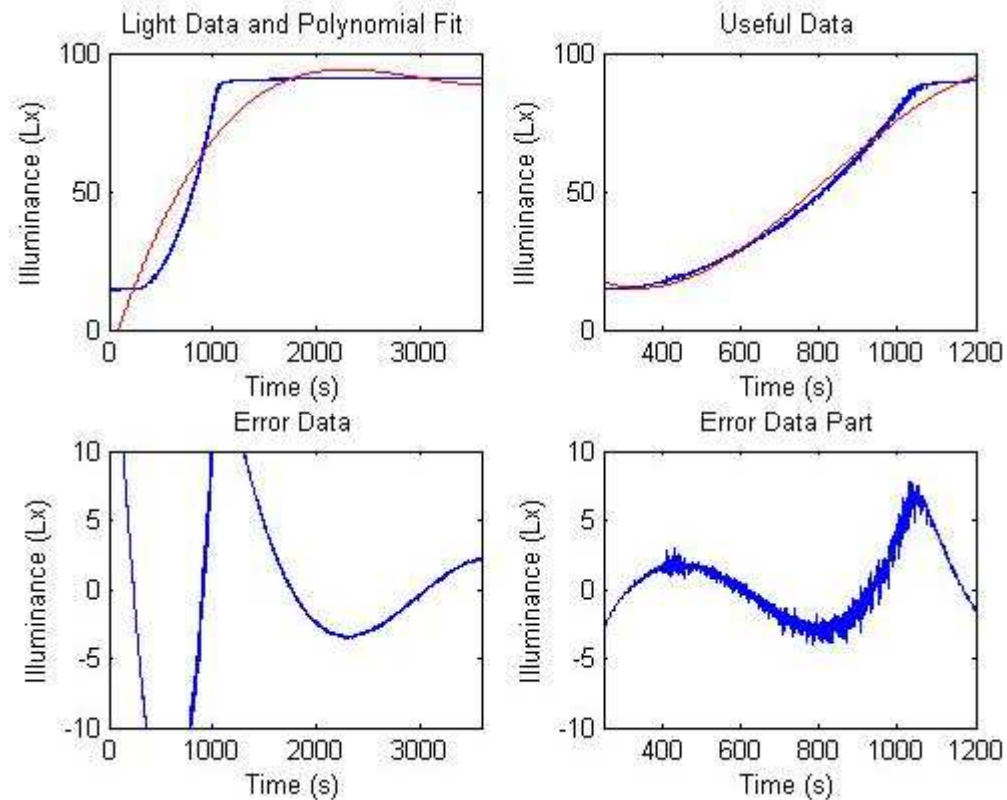
SUNROSE! occurred at tick 315.000000

dark! occurred at tick 464.000000

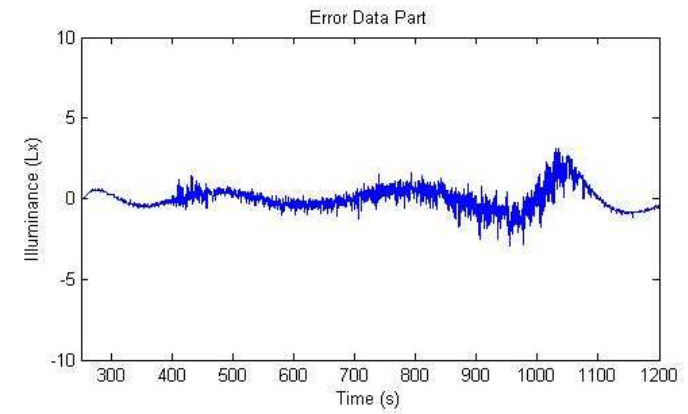
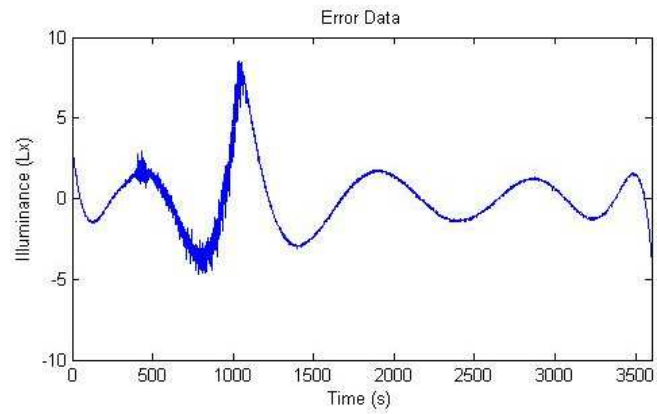
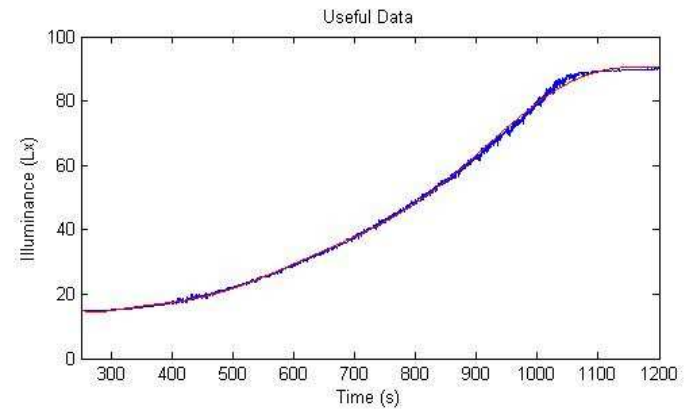
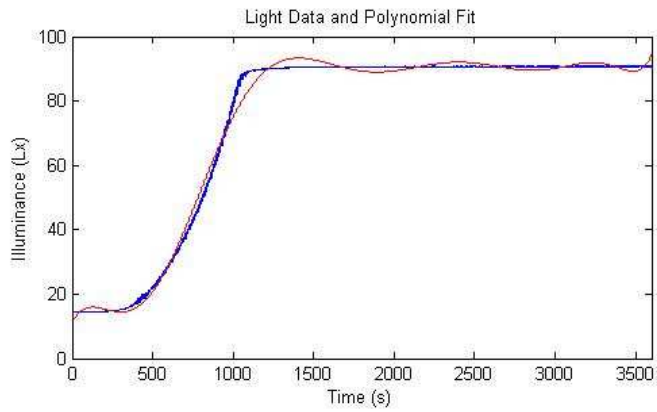
bright! occurred at tick 498.000000

SUNROSE! occurred at tick 555.000000

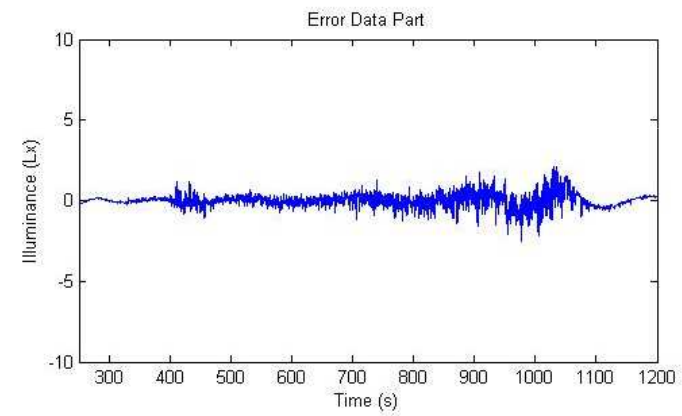
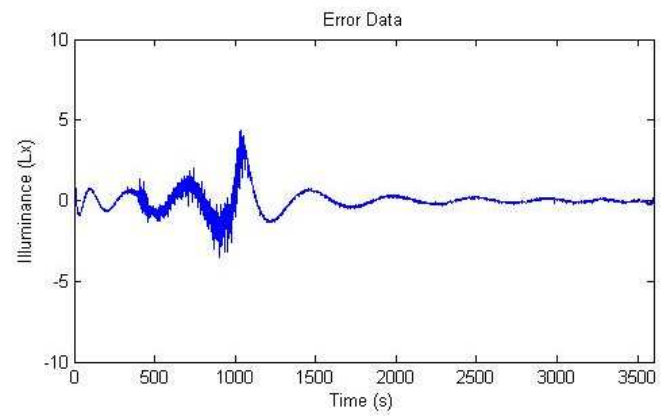
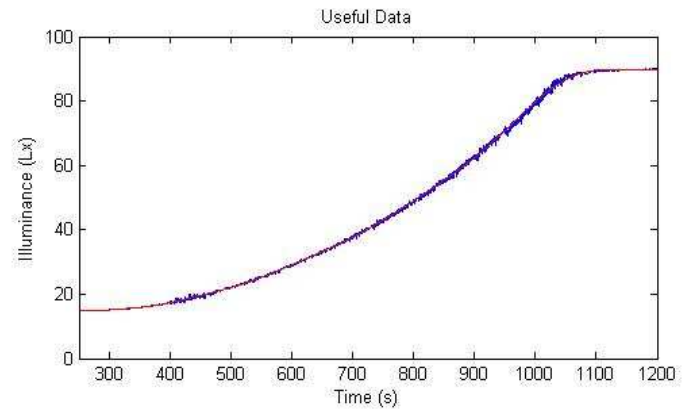
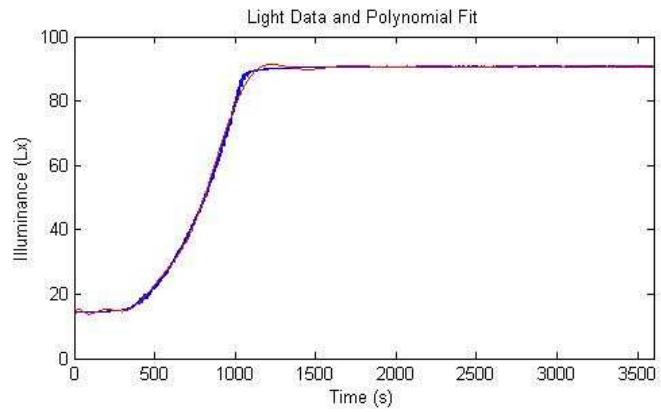
# Sunrise Tests-Standard day



Polynomial fit of  $n=3$  and its errors with data extraction

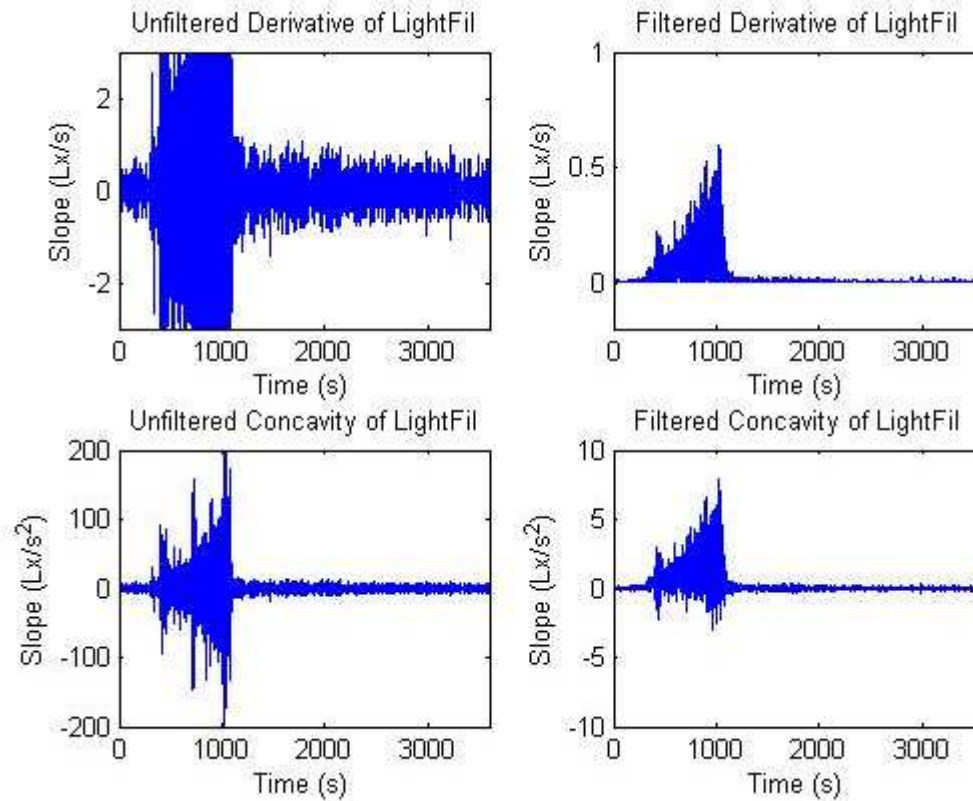


N=10



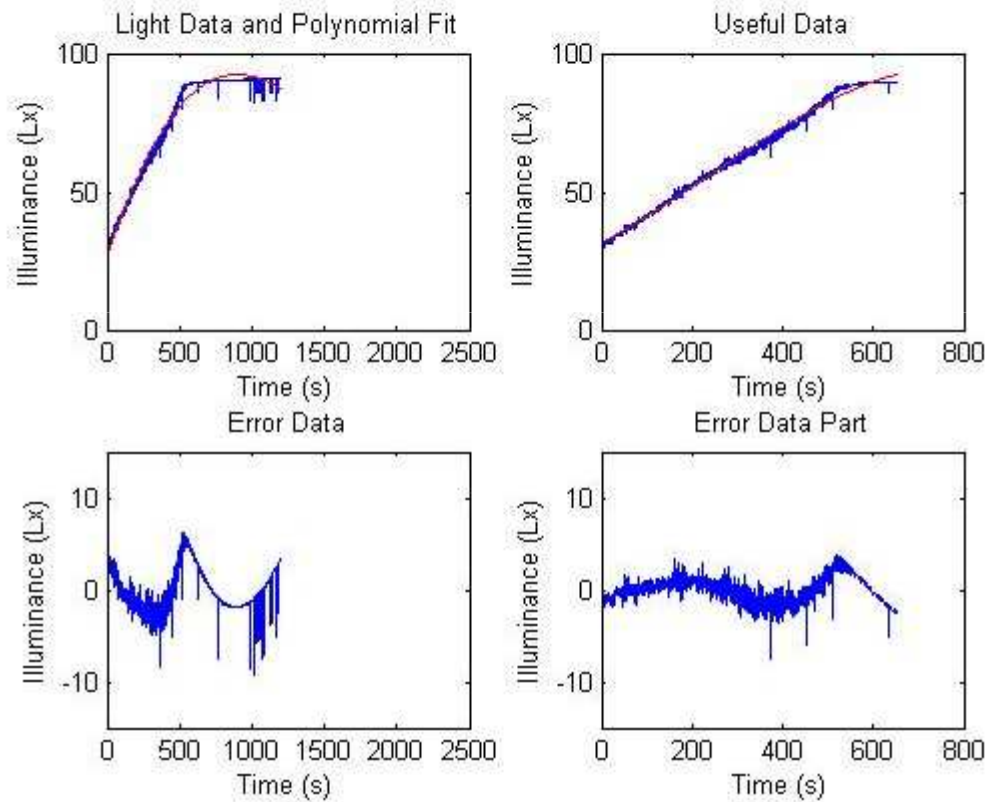
N=20

# Calculus Analysis

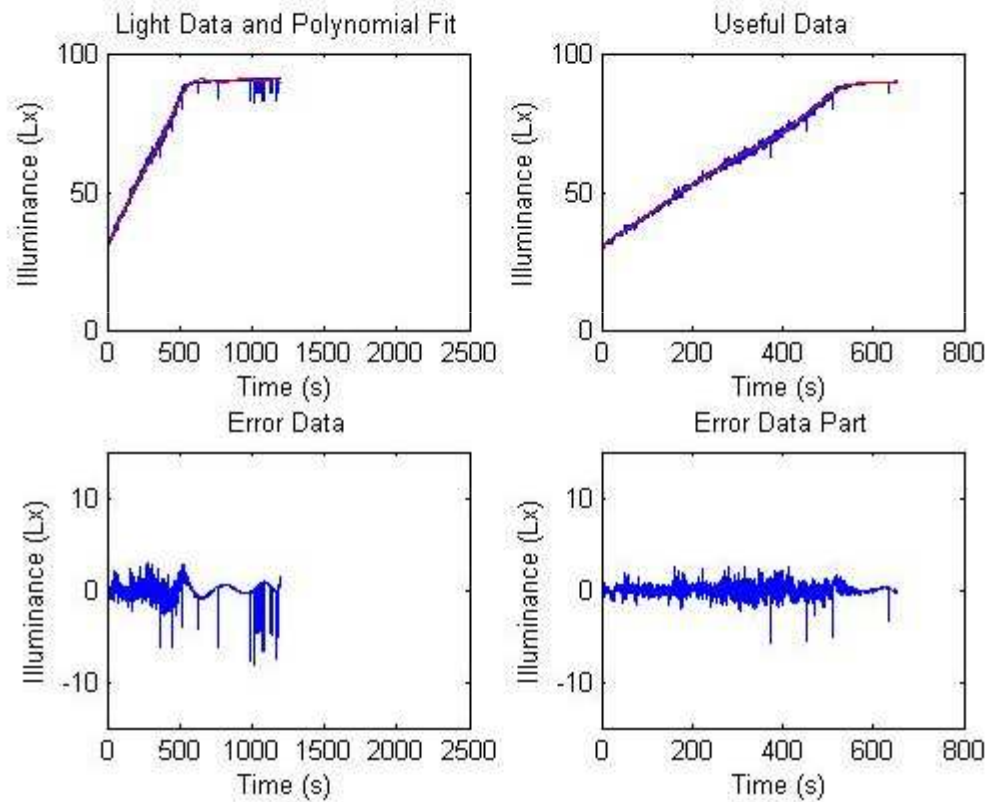


Signature easily detected with filtered derivative and filtered concavity

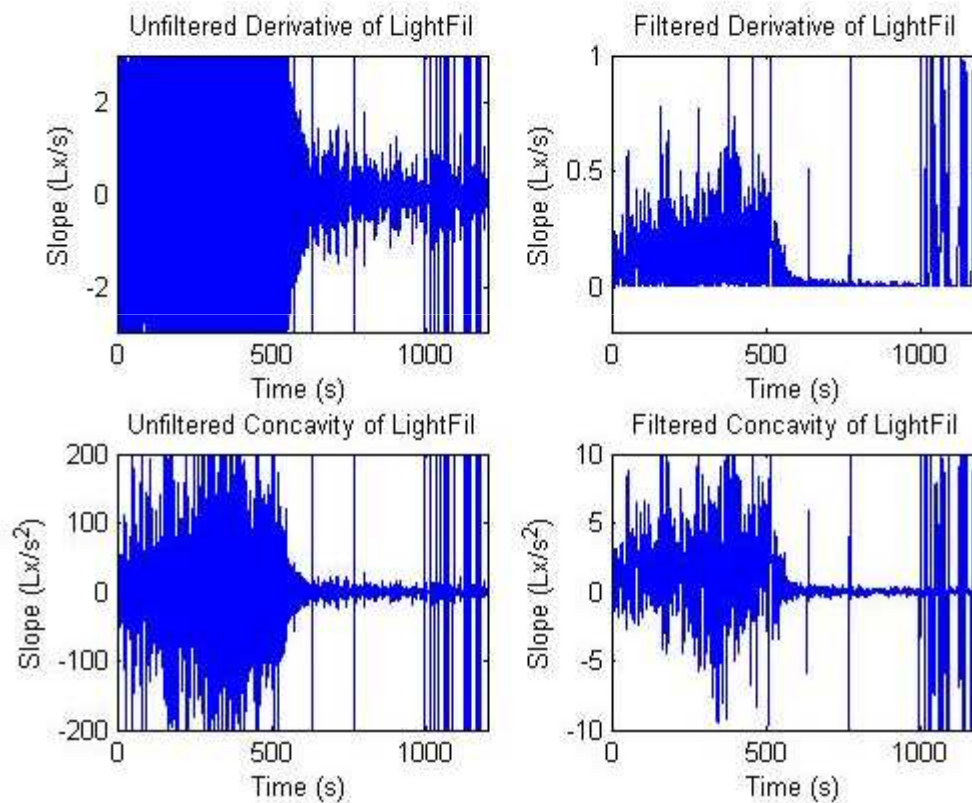
# Rainy day N=3



# Rainy Day N=10

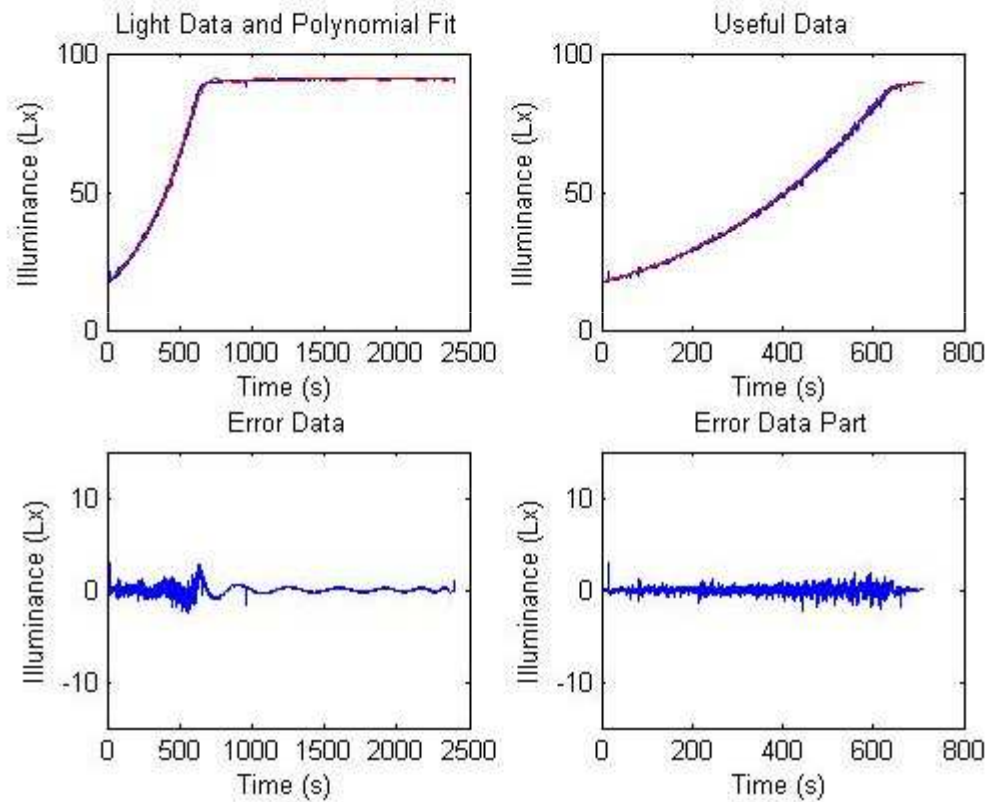


# Rainy Day Analysis

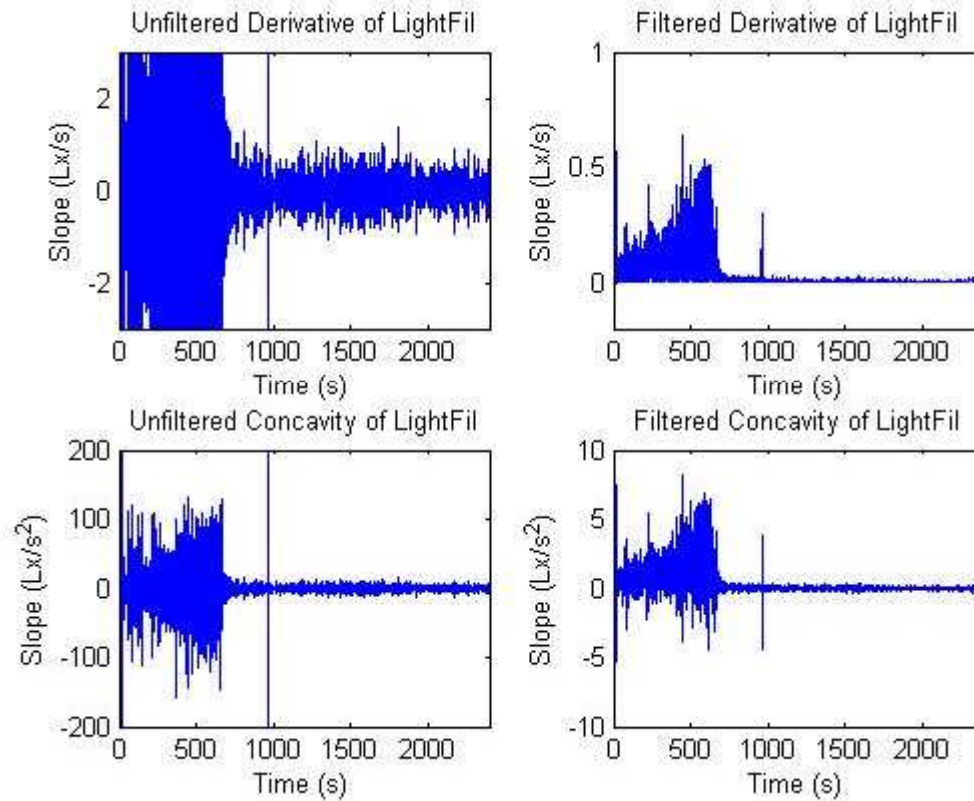


Rain presents much more noise

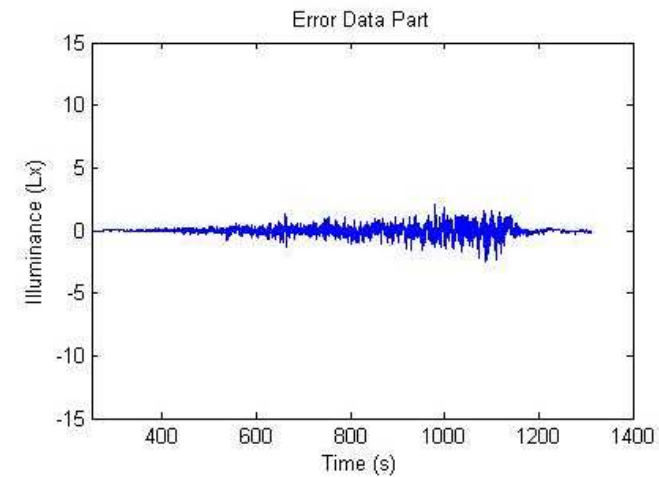
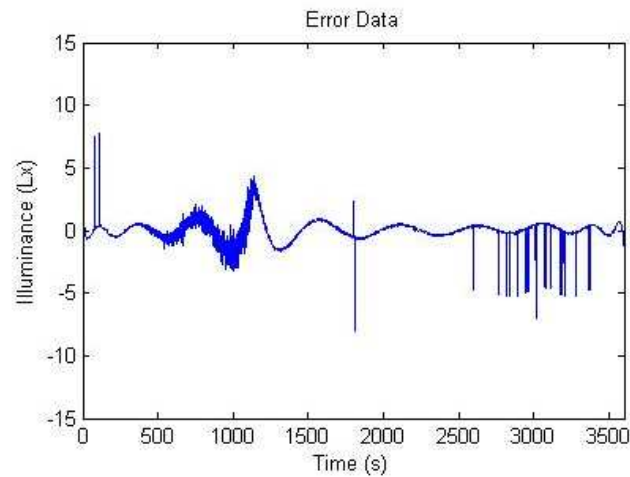
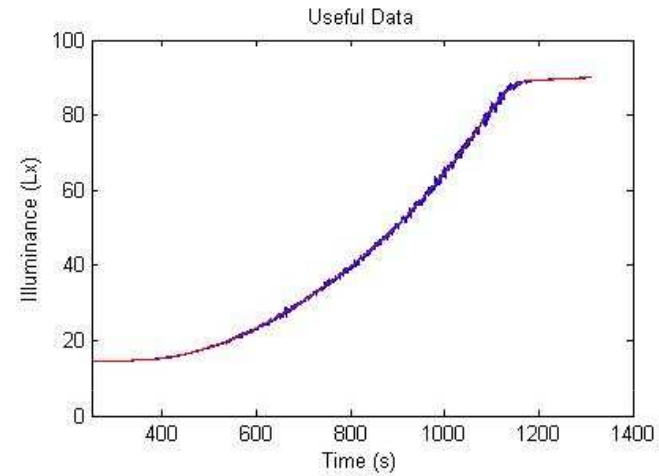
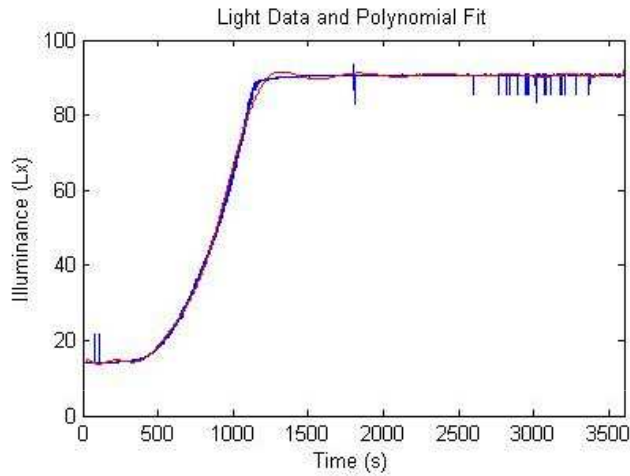
# Sunrise, late start



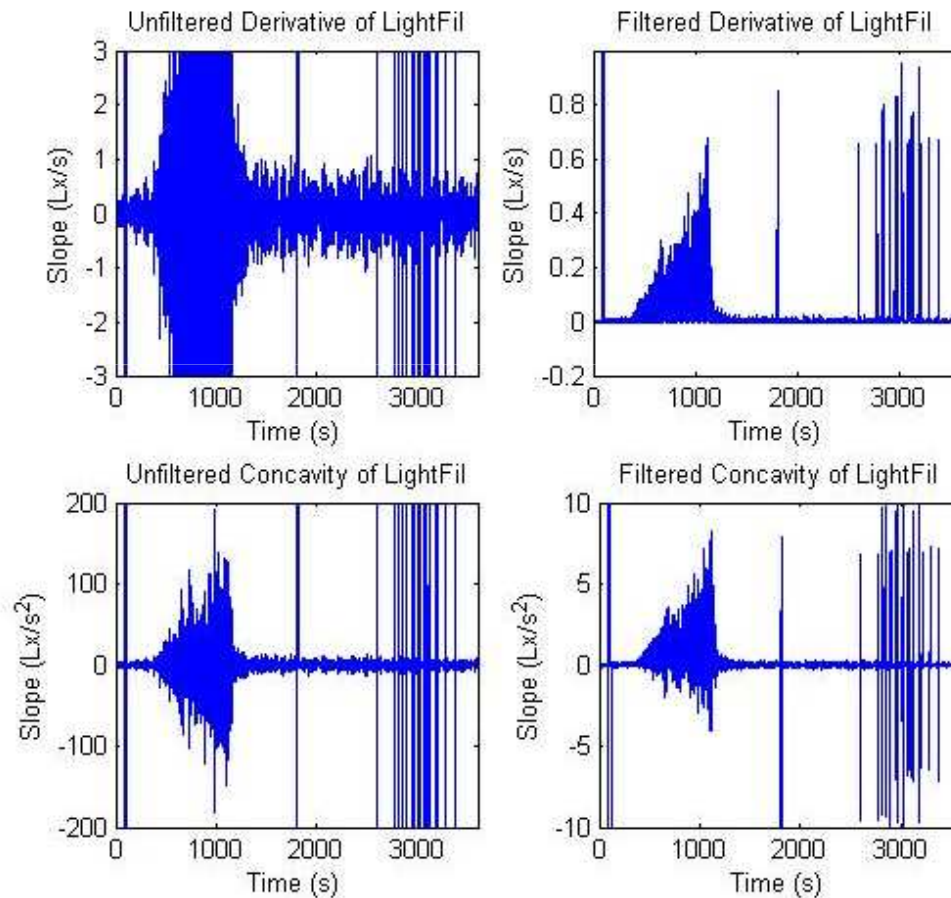
# Sunrise- Late Start Analysis



# Beautiful Day N=20



# Beautiful Day Analysis



Signatures are very clear, and the manually inserted noise did not correspond to a sunrise signature. Effective protocol for sunrise detection.

# Questions?