Ecological Applications of Sensor Networks

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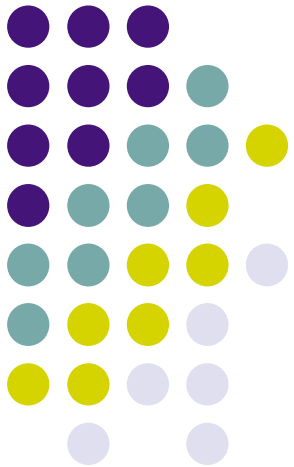
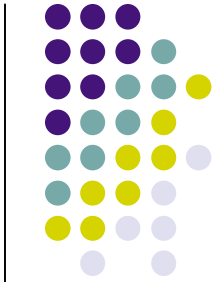


Presentation Outline



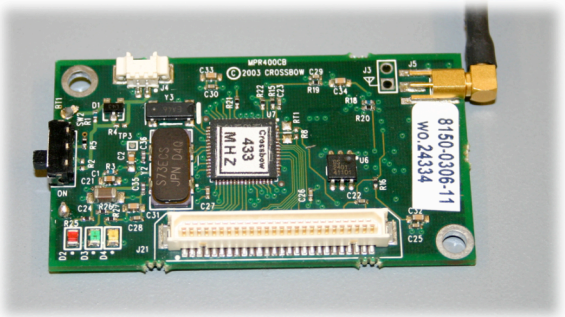
- Motes
- MATLAB Analysis
- Photosynthesis Models
- Project Future
- Questions

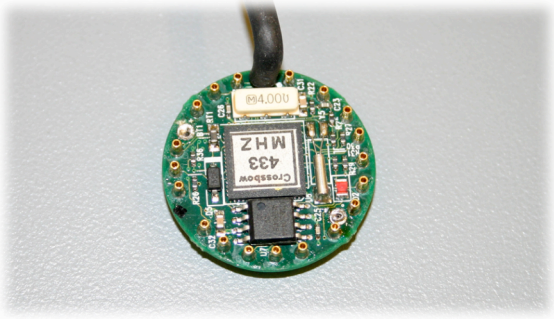
Project Goals

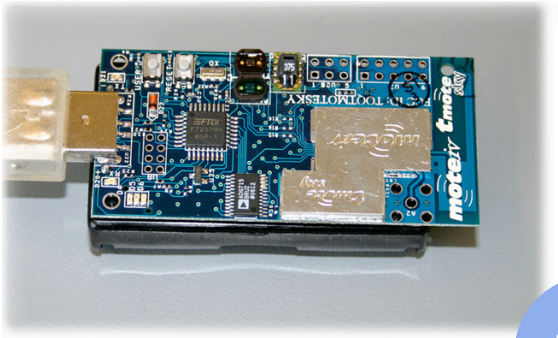
- Use wireless sensor networks (WSN) to monitor ecological phenomena
- Motes to MATLAB interface
- Model carbon uptake during photosynthesis
- Compare results with conventional methods

What is a Mote?

- Wireless
- Sensors
- High data resolution
- Power efficient
- Cheap

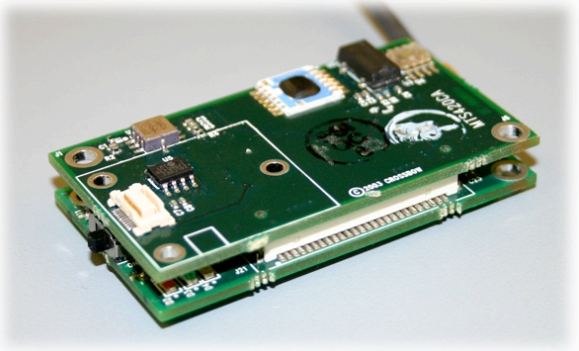






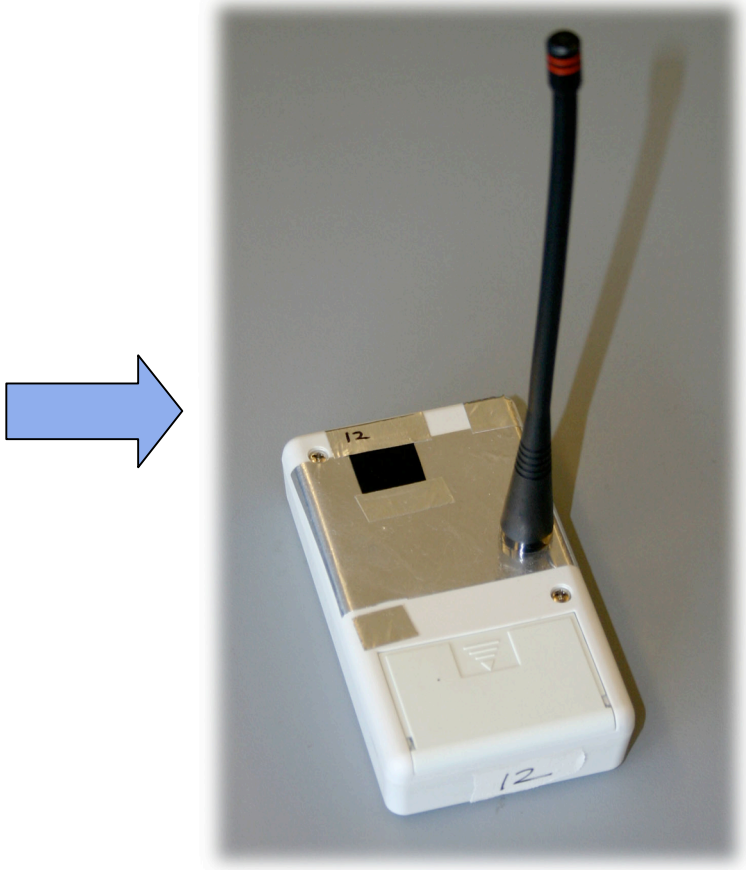
Mote Assembly

Mica2 Mote



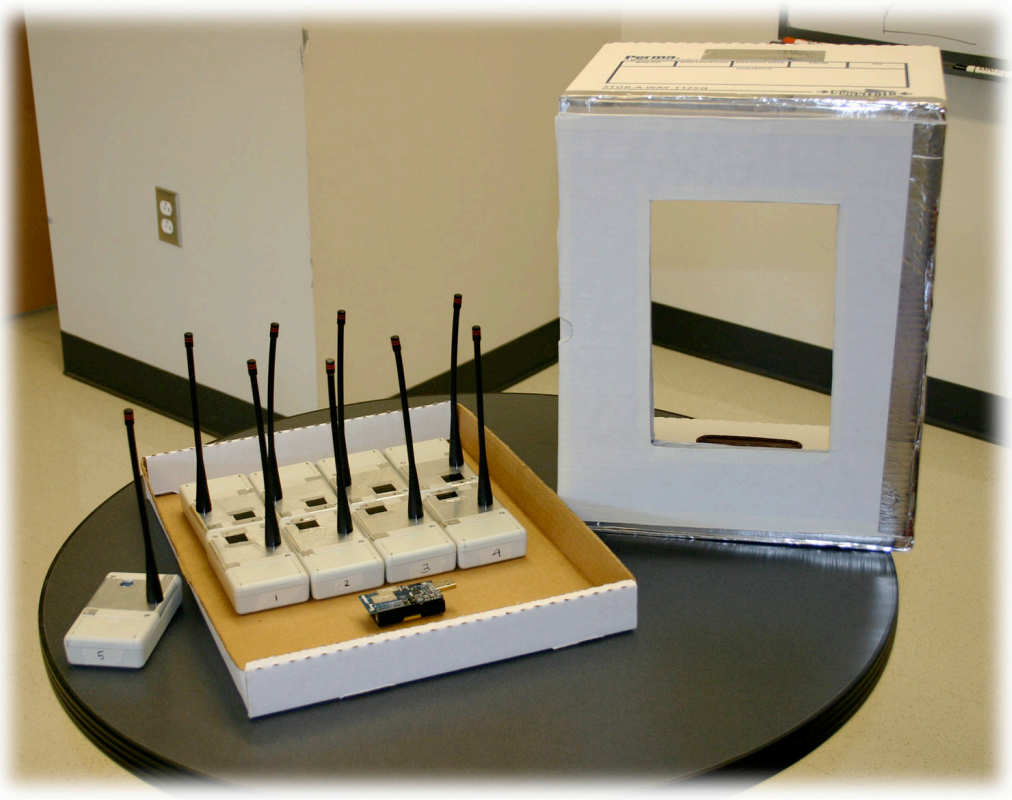
Antenna

AA Batteries

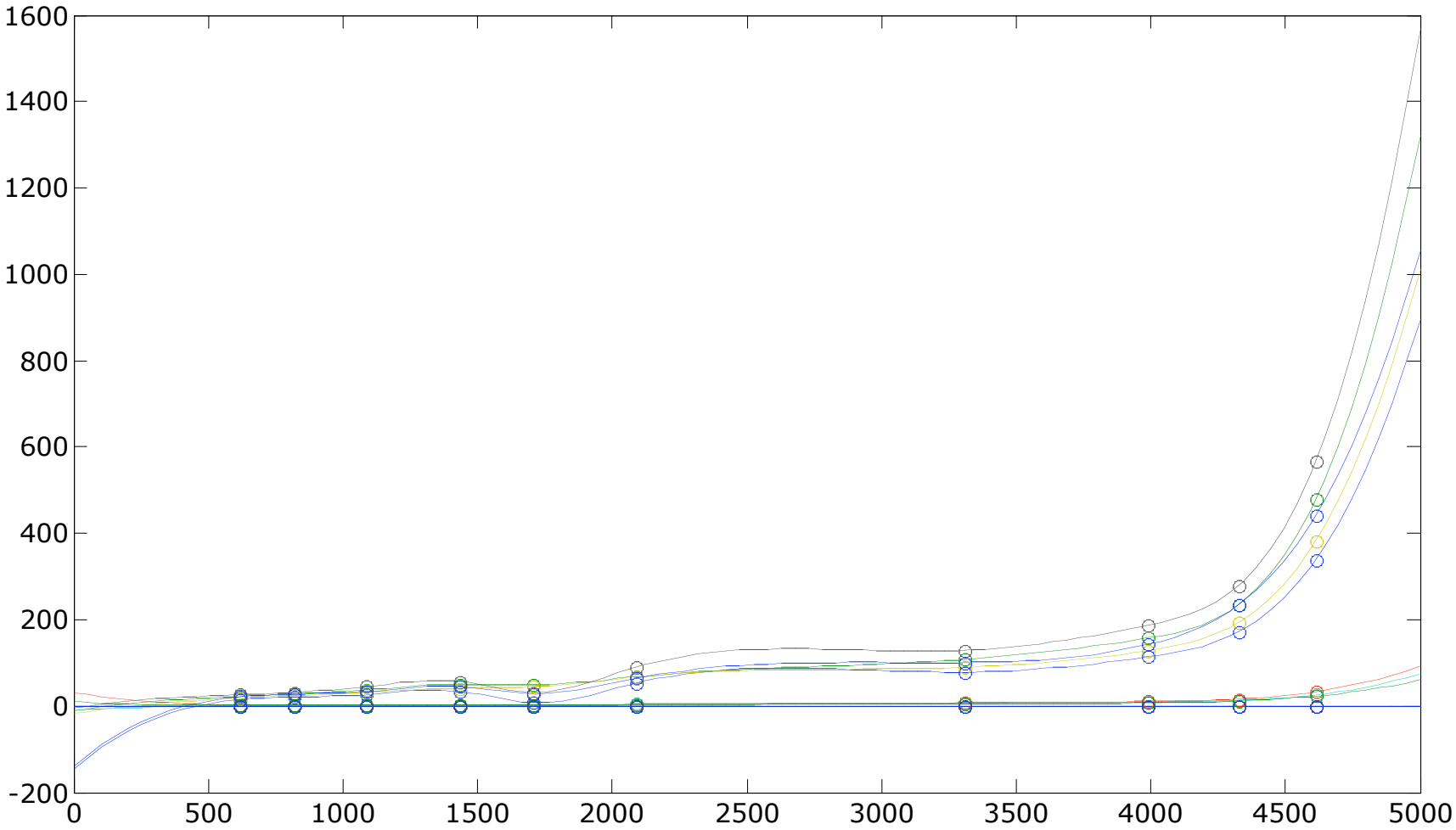


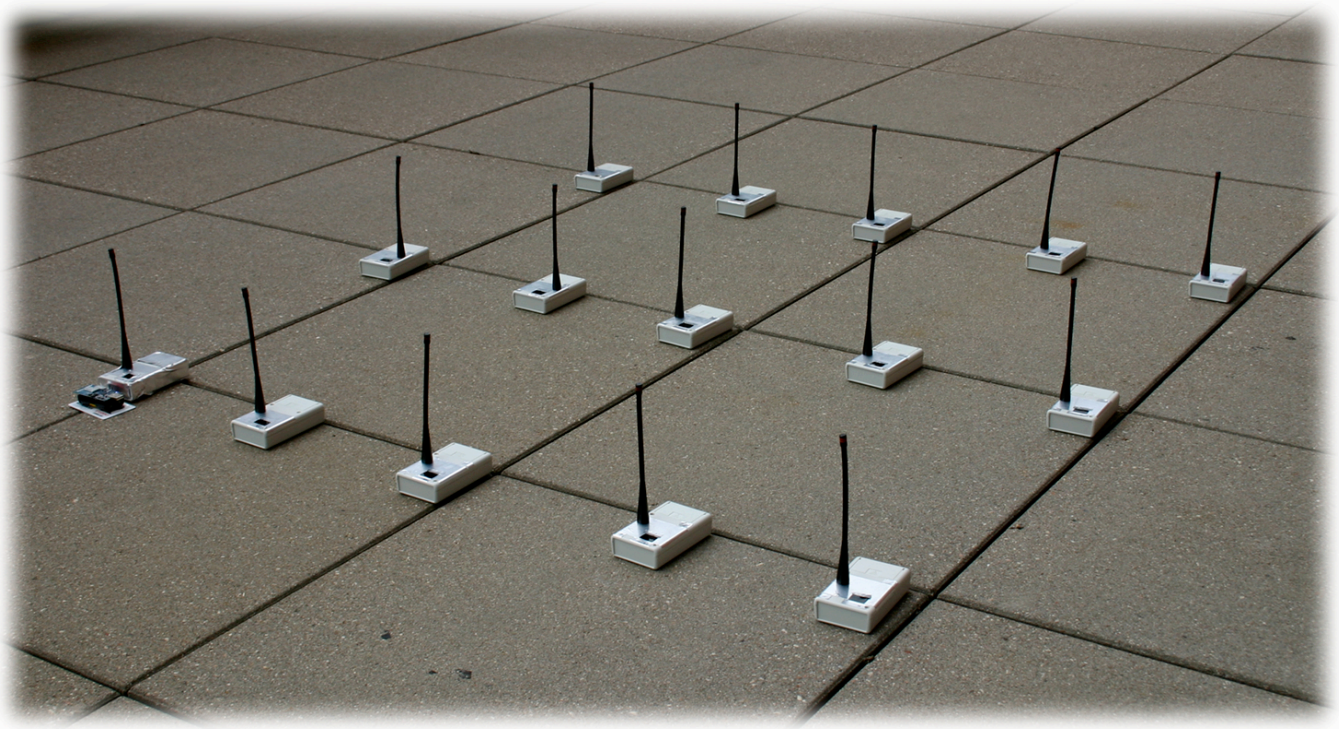
Mote Calibration

- Not factory calibrated
- Paper diffusing light box

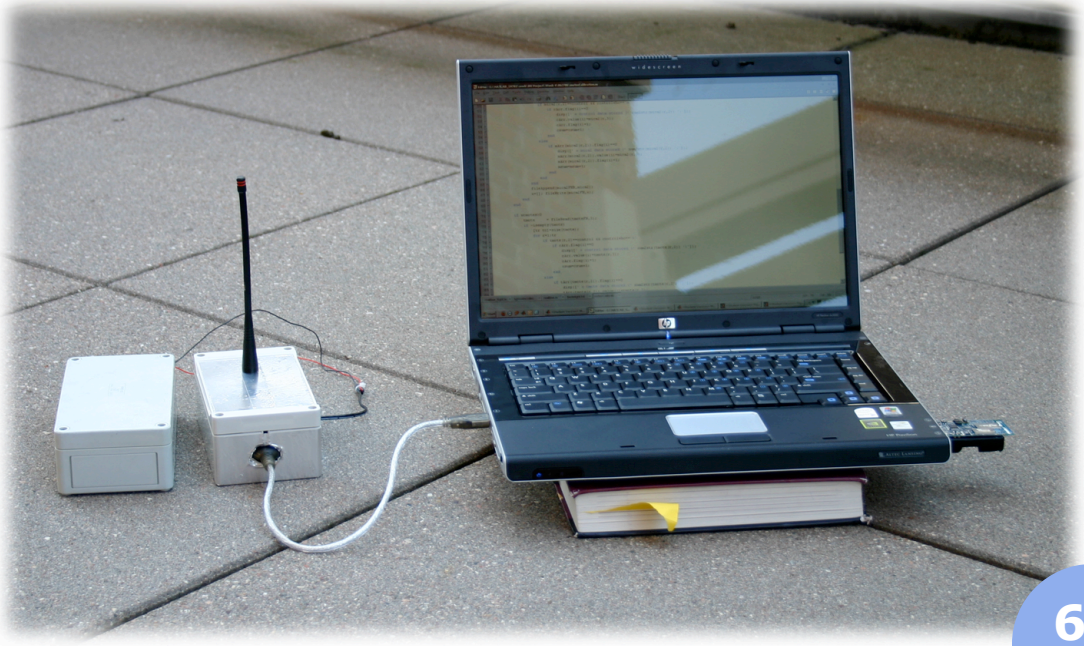


Calibration Curves

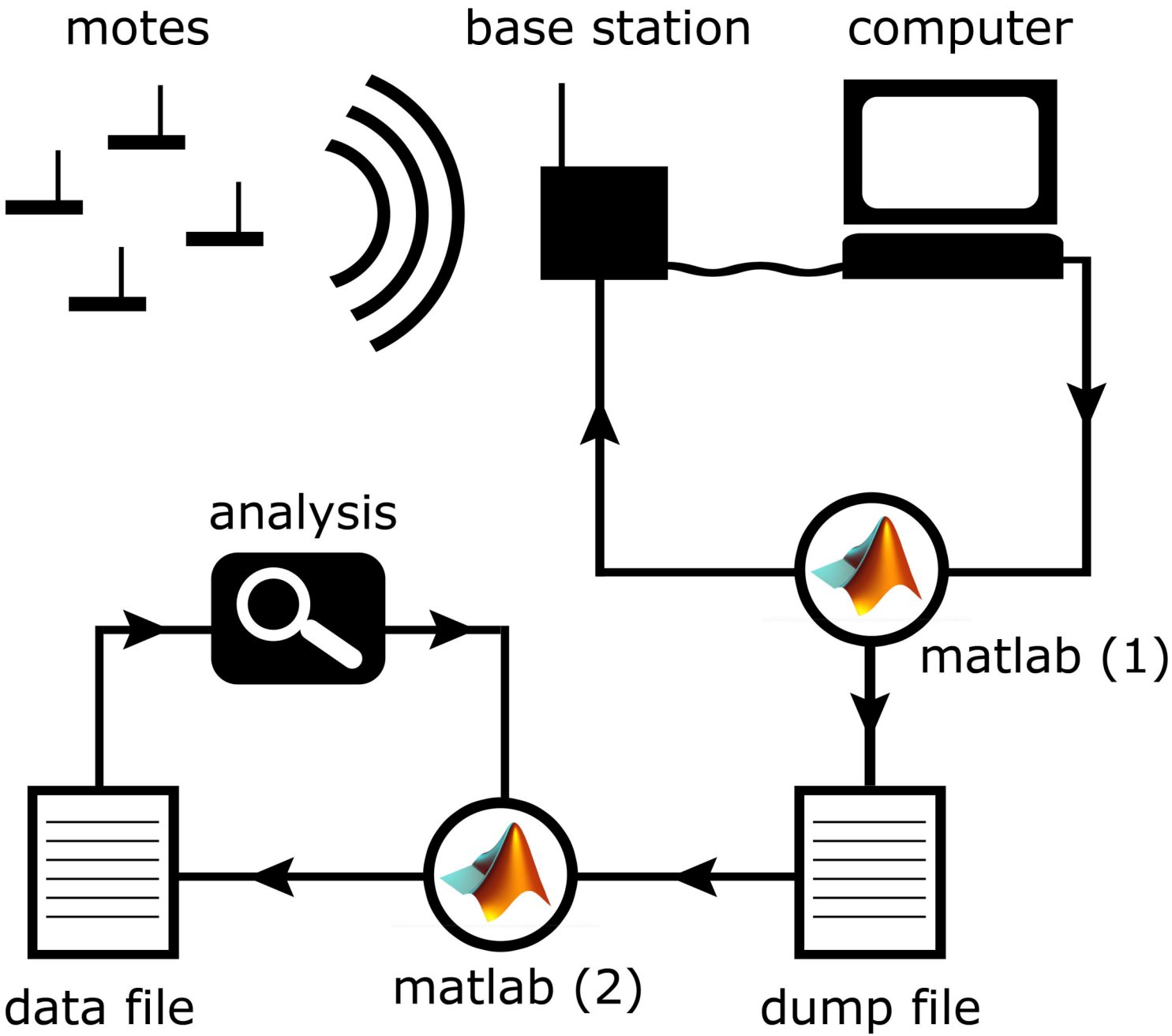




Mote grid

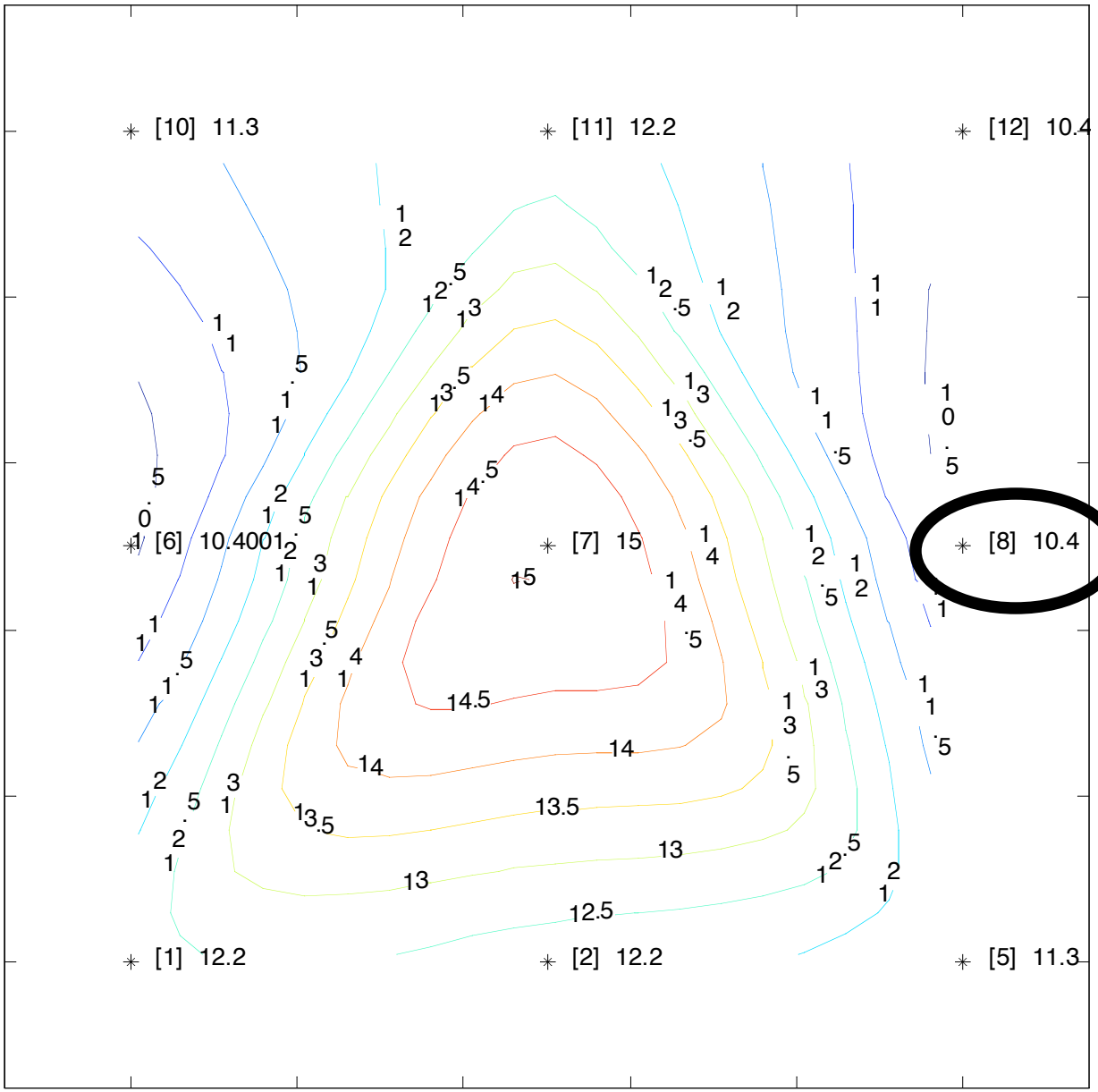


Base station and Matlab


motes
base station
computer
analysis
matlab (1)
data file
matlab (2)
dump file

Real-Time Analysis

- Data arrives at random times
  - Universal time
  - Temporal interpolation
- Motes located discretely
  - 3D spatial interpolation
- Motes die
  - Smarter dynamic algorithm



9 motes evenly spaced

Mote Position [id] lux

Photosynthesis

- Converts sunlight energy to chemical energy.
- Plant consumes CO2
- Intentions
  - Collect WSN data relevant to photosynthesis
  - Calculate photosynthetic activity over WSN area

Photosynthesis Models

- Simple model
  - f(L) = CO2
  - Can use averaged data
- Dynamic model
  - f(L, t, T) = CO2
  - Cannot use averaged data

L = light Intensity
t = time response
T = temperature

Model Data

- Conventional Satellite Methods
  - Resolution usually 1 sq. km
    - Dynamic equations → flawed results
- Wireless Sensor Networks
  - Almost unlimited data resolution
    - Dynamic equations → better results

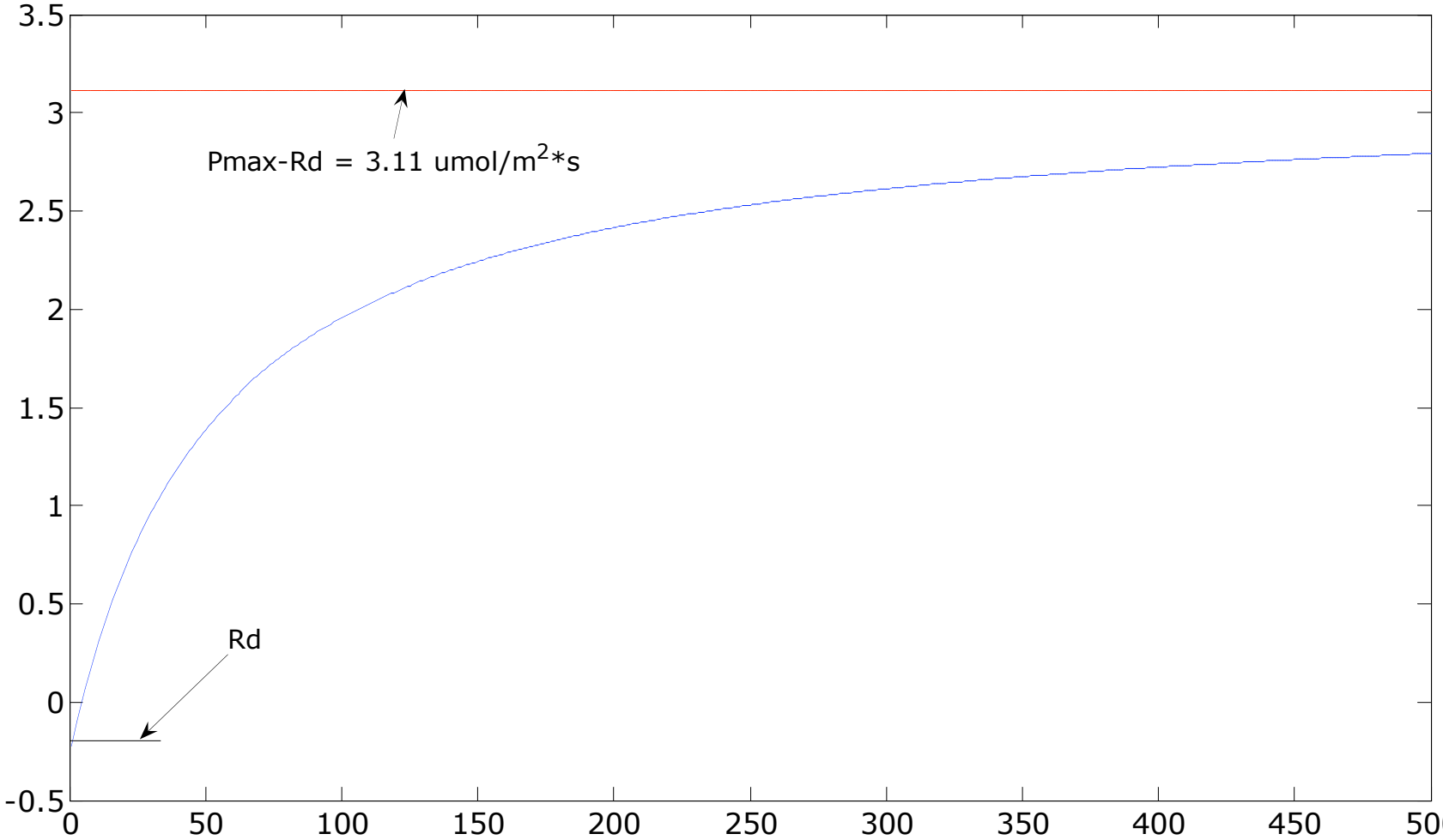
Simple Model

P	CO2 consumption (net)
P_{max}	max CO2 consumption
a	quantum yield
h	light intensity
R_d	dark respiration rate

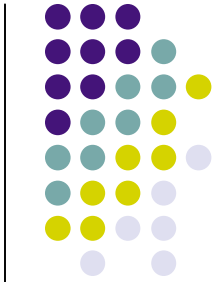
$$P(h) = \frac{ahP_{\max}}{ah + P_{\max}} - R_d$$

Equations found in
'Estimates of net photosynthetic parameters…', Sullivan, Bolstad, Vose, February 1, 1995

Photosynthetic Curve

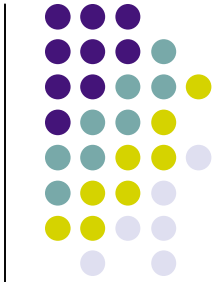


Project Future

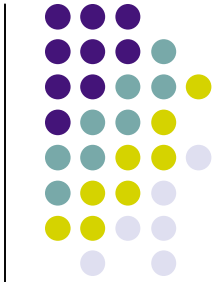


- Find dynamic model
- Finish MATLAB applications package
- Build low power LINUX base station
- Field tests
- Compare results with conventional methods

Review



- Motes are cheap and effective tools for collecting data over an area
- MATLAB interface is useful
- Complex photosynthesis models work better with WSN



Questions?