NIMS

Networked Info-Mechanical Systems

Overview

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NIMS Workshop Outline

NIMS

- Overview
- Sample Deployments
- Sample Datasets
- Tutorial
  - Deployment
  - Calibration
  - Controlling the NIMS node
  - Sampling
  - Data merging
- Questions and Answers
- NIMS demonstration

Networked Infomechanical Systems (NIMS) Approach

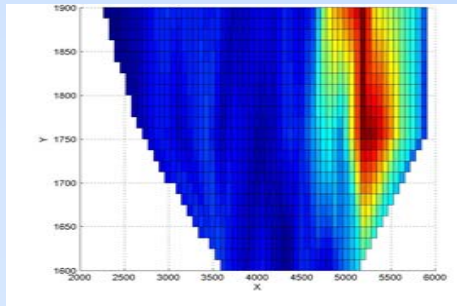
NIMS

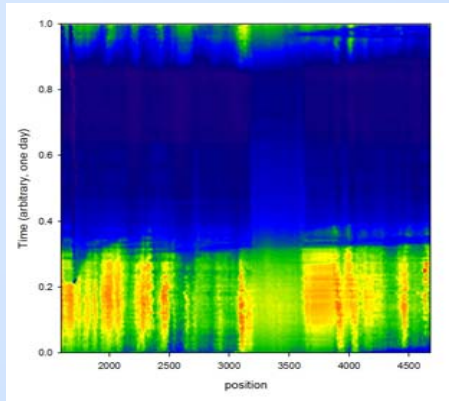
- Require ***active*** architecture with:
  - autonomous *physical configuration*
  - fixed and actuated sensors
- Require adaptation
  - In-field
- Require actuation attributes:
  - Transport large instruments
  - 3D volume access
  - Extensive
  - Reliable
  - Low environmental impact
- Networked Infomechanical Systems (NIMS)
  - *One deployment – many sample locations*

Actuated Observation: Driven by *Sampling* Requirements

NIMS

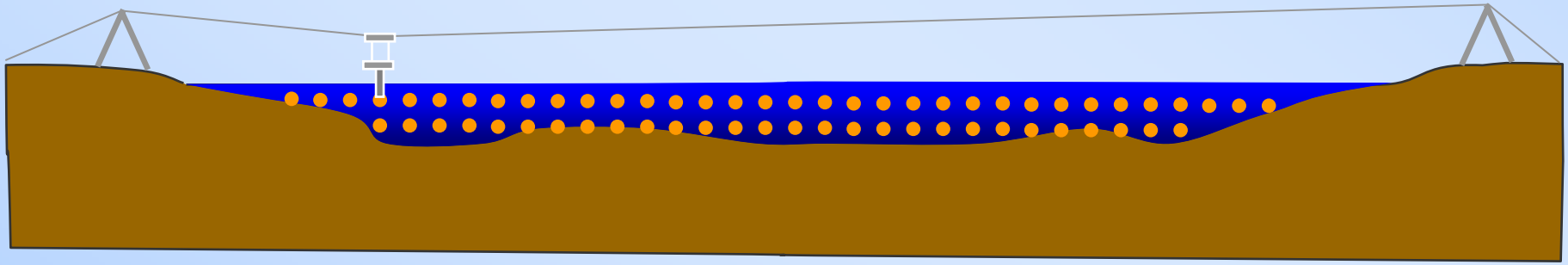
- Current Systems and Observations
  - Field NIMS
    - Solar radiation
  - River NIMS
    - Aquatic contaminants
  - NIMS Thermal Mapper
    - Plant physiology
  - NIMS Laser Mapper
    - Ecosystem structure
- Common Application Characteristics
  - Field variables display high spatial frequency over large area
  - Oversampling not practical
  - *Actuated* and *fixed* sensing required





NIMS RD Deployment

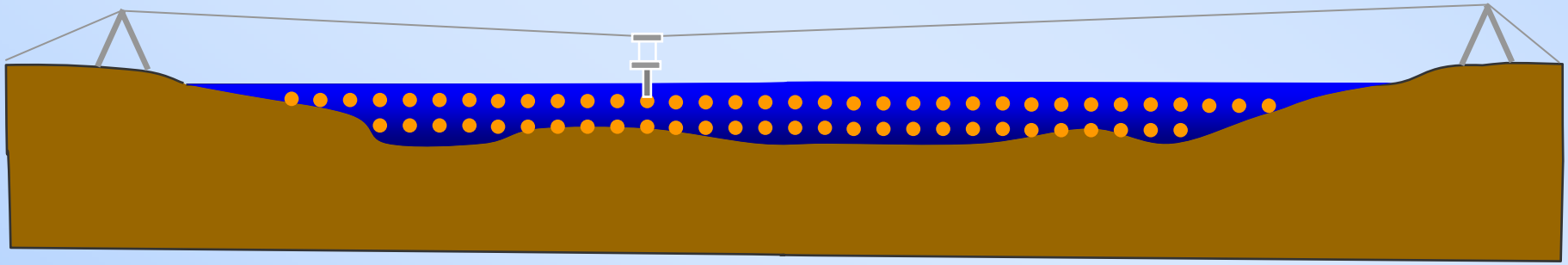
NIMS



Courtesy of CENS

NIMS RD Deployment

NIMS



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NIMS RD Deployment

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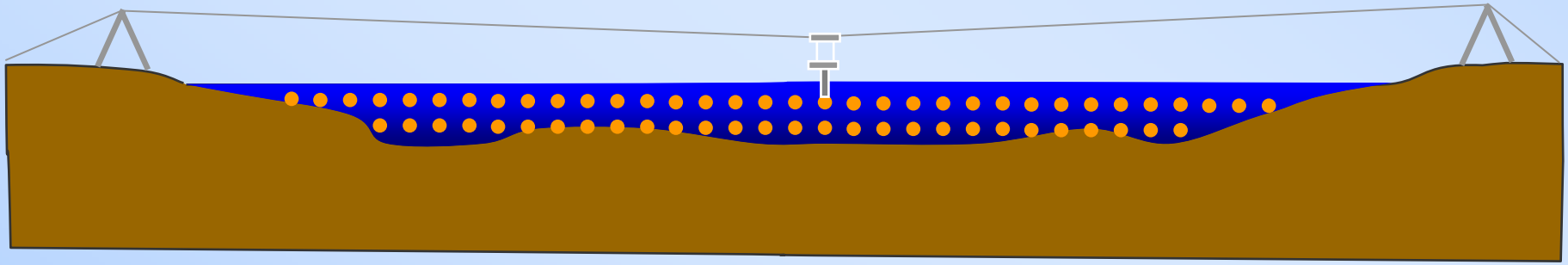

Courtesy of CENS

NIMS RD Deployment

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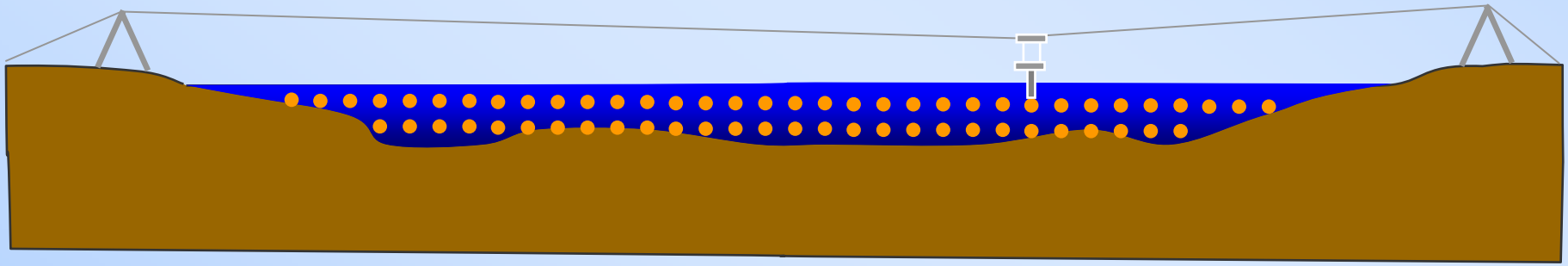
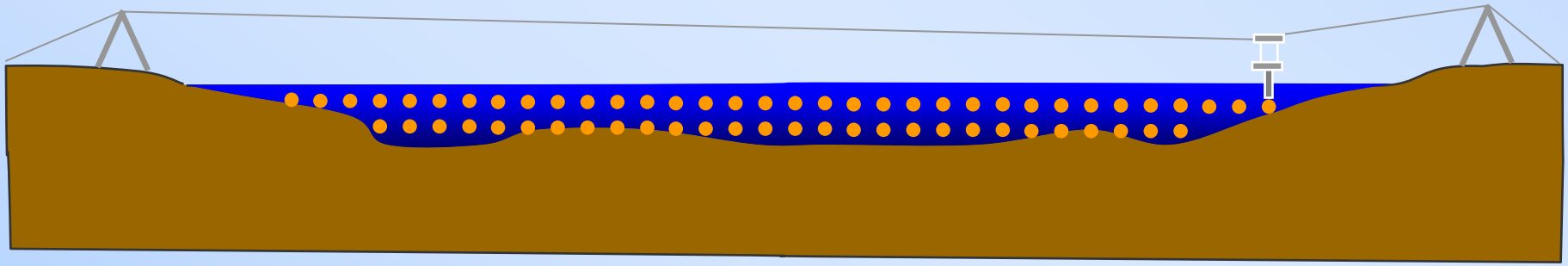


Courtesy of CENS

NIMS RD Deployment

NIMS

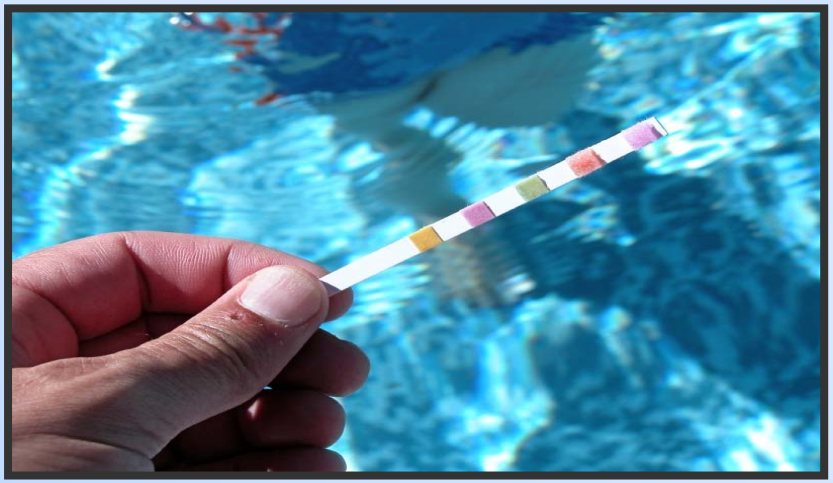


Courtesy of CENS

Comparison with Prior Methods

NIMS

Manual



NIMS

- High resolution profile of flow and contaminants
- *Direct* high resolution measurements of contaminant mass flow
- *Track* input/output of contaminant sources
- **1000x improvement in sampling capacity!**

NIMS RD: San Joaquin River System

UC Merced: Jason Fisher, Sandra Villa-Millazar, Robert Foster, Chris Butler, Tom Harmon
UCLA: Robert Gilbert, Eric Graham, Yeung Lam, Michael Stealey, and Eric Yuen

Courtesy of CENS

Courtesy of CENS

Merced–San Joaquin River Confluence

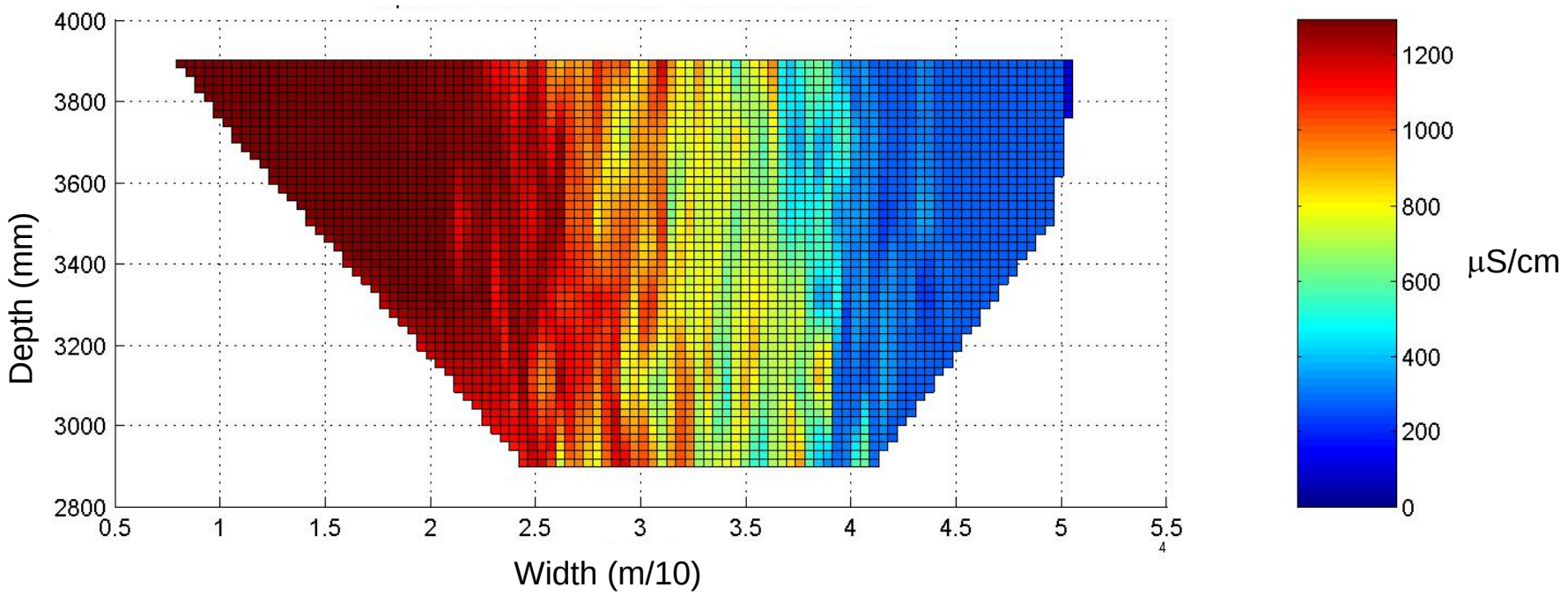
- **River monitoring management**
  - Spatially resolved for total mass flow
- **Contamination**
  - Public health and agricultural land loss
- **Status**
  - Currently undersampled

Courtesy of CENS


Sensor Node
Nitrate
Ammonium
Conductivity
pH
Temperature
Depth
Attitude
(pitch/roll/yaw)
Compass Heading
3 Axis Velocity

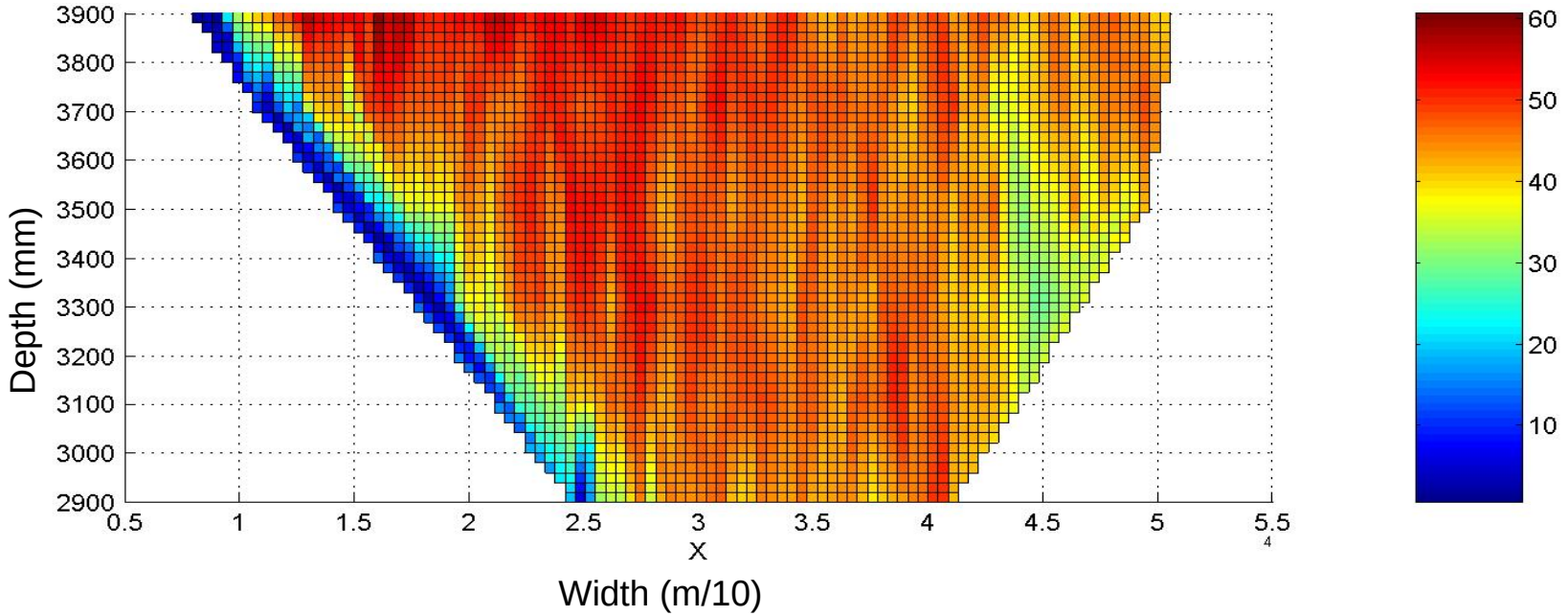
Conductivity (Salt Concentration)

NIMS



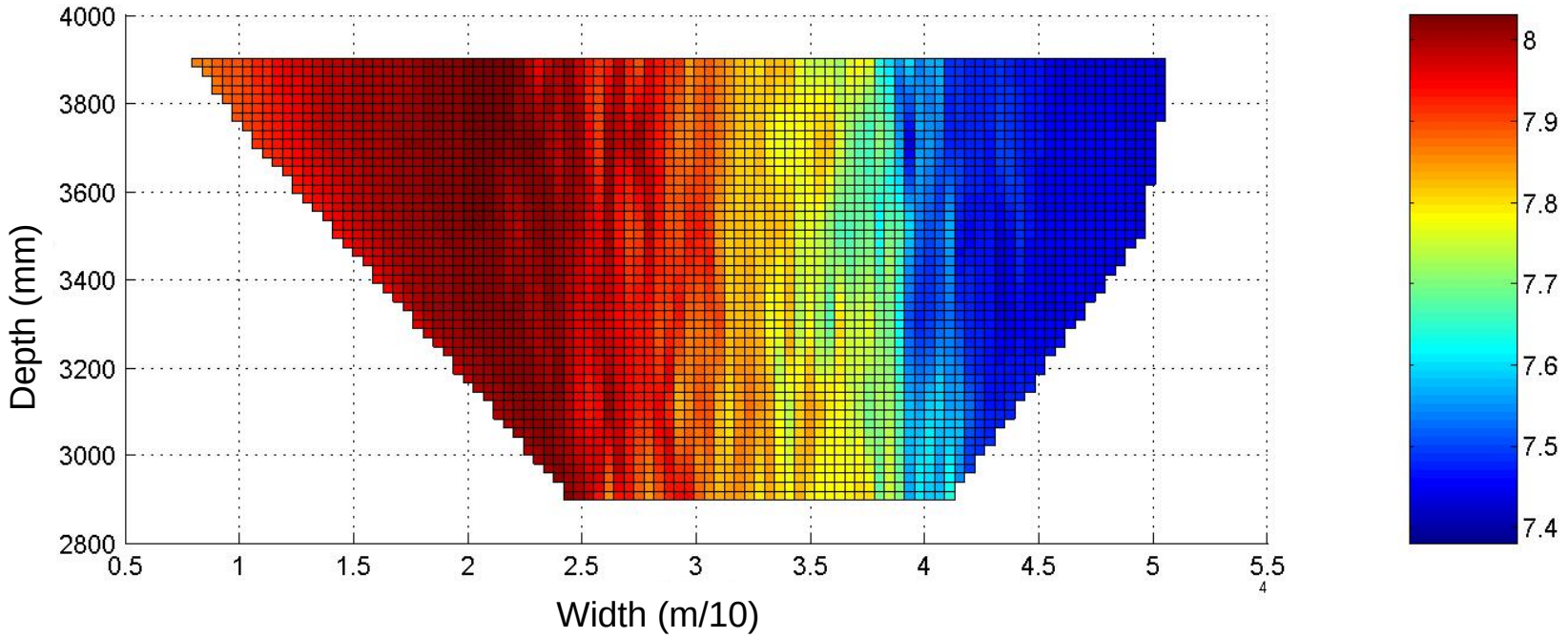
Water Velocity Magnitude

NIMS



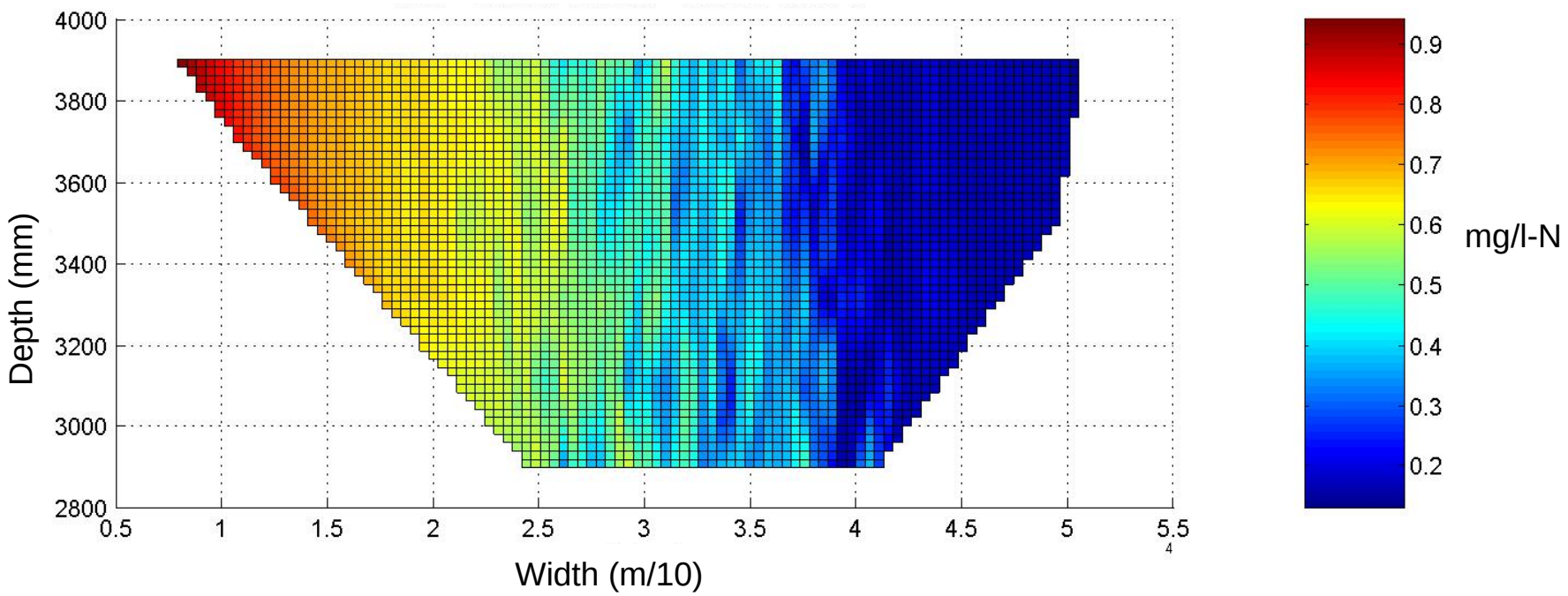
pH

NIMS


Depth (mm)
4000
3800
3600
3400
3200
3000
2800
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
4
Width (m/10)
8
7.9
7.8
7.7
7.6
7.5
7.4

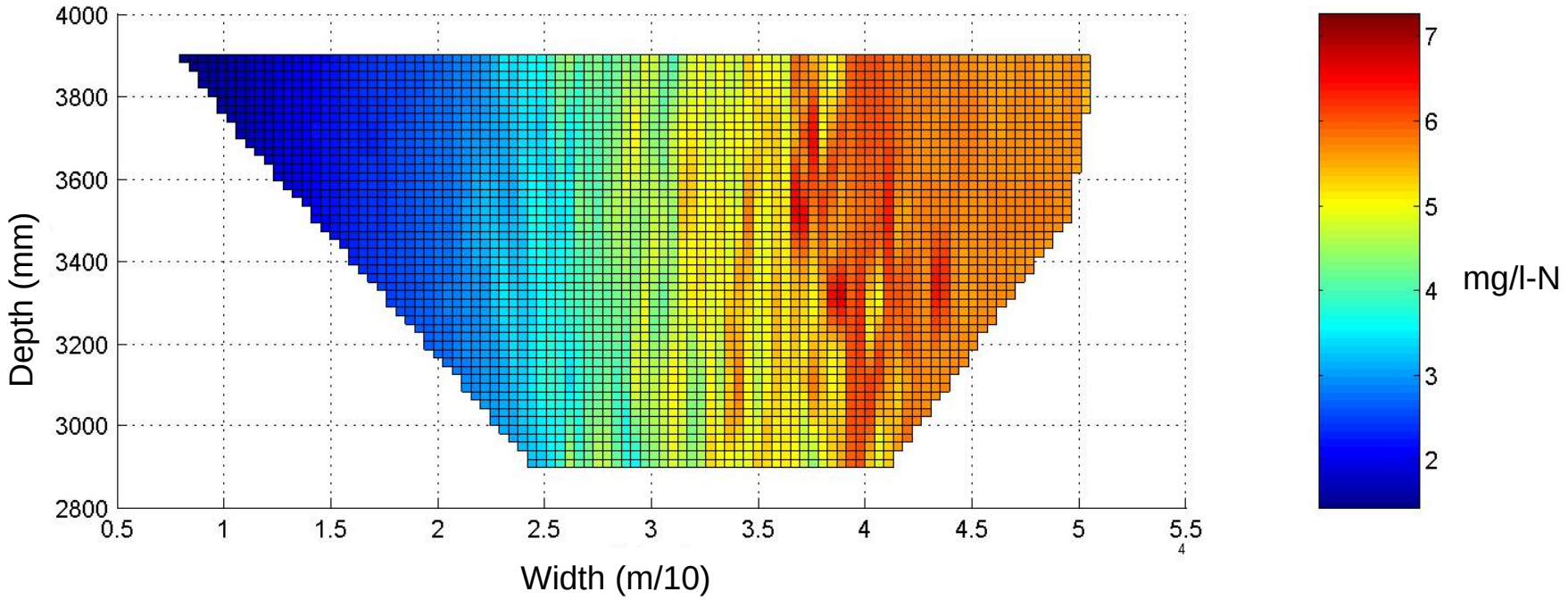
Ammonium

NIMS



Nitrate

NIMS



NIMS Profiling of Lake Biomass Distribution

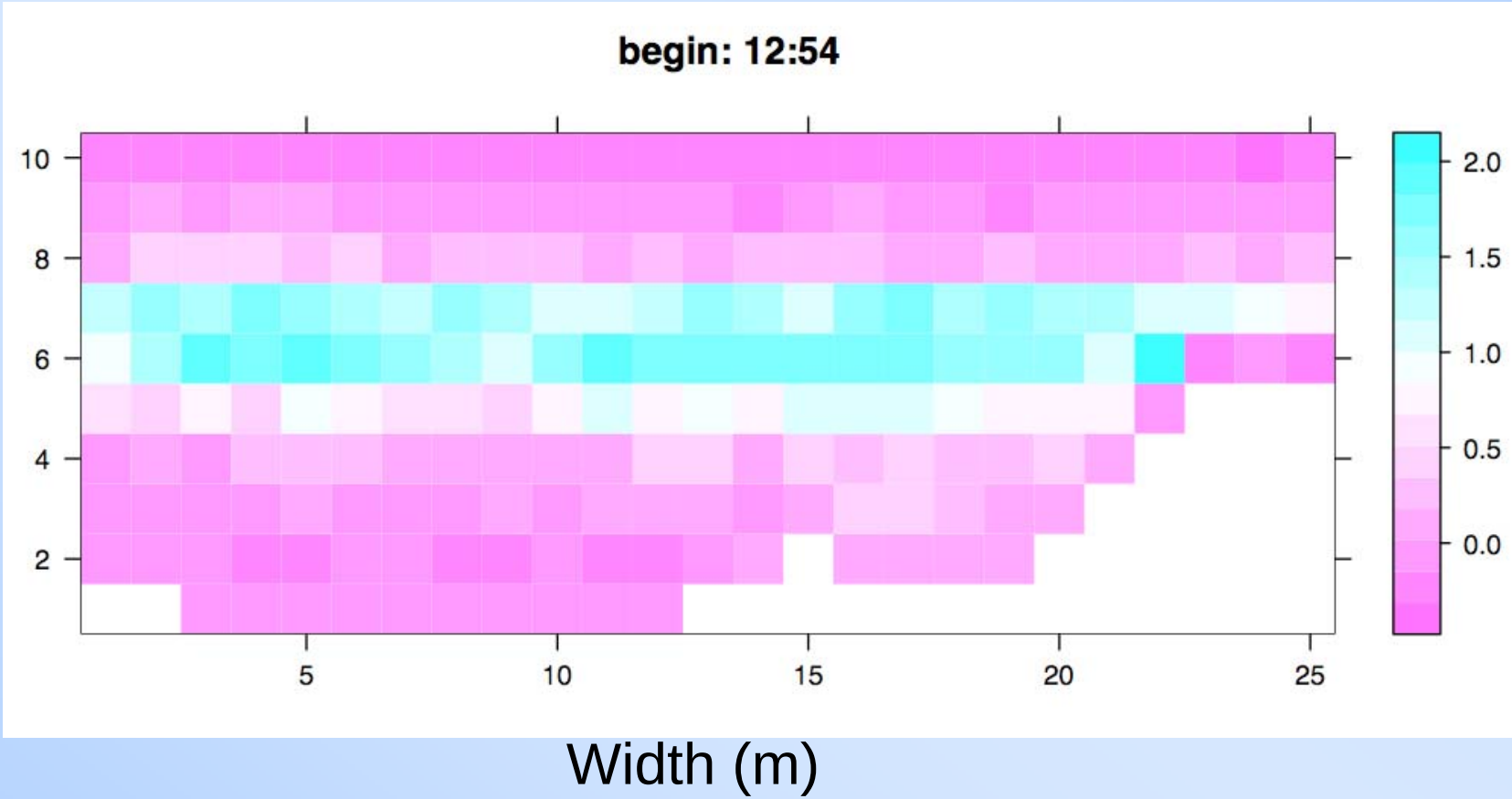
USC Robotics Lab
NAMOS Sensor Nodes

UCLA
NIMS Rapidly Deployable

Courtesy of CENS

NIMS Profiling of Lake Biomass Distribution

NIMS



NIMS Profiling of Lake Biomass Distribution

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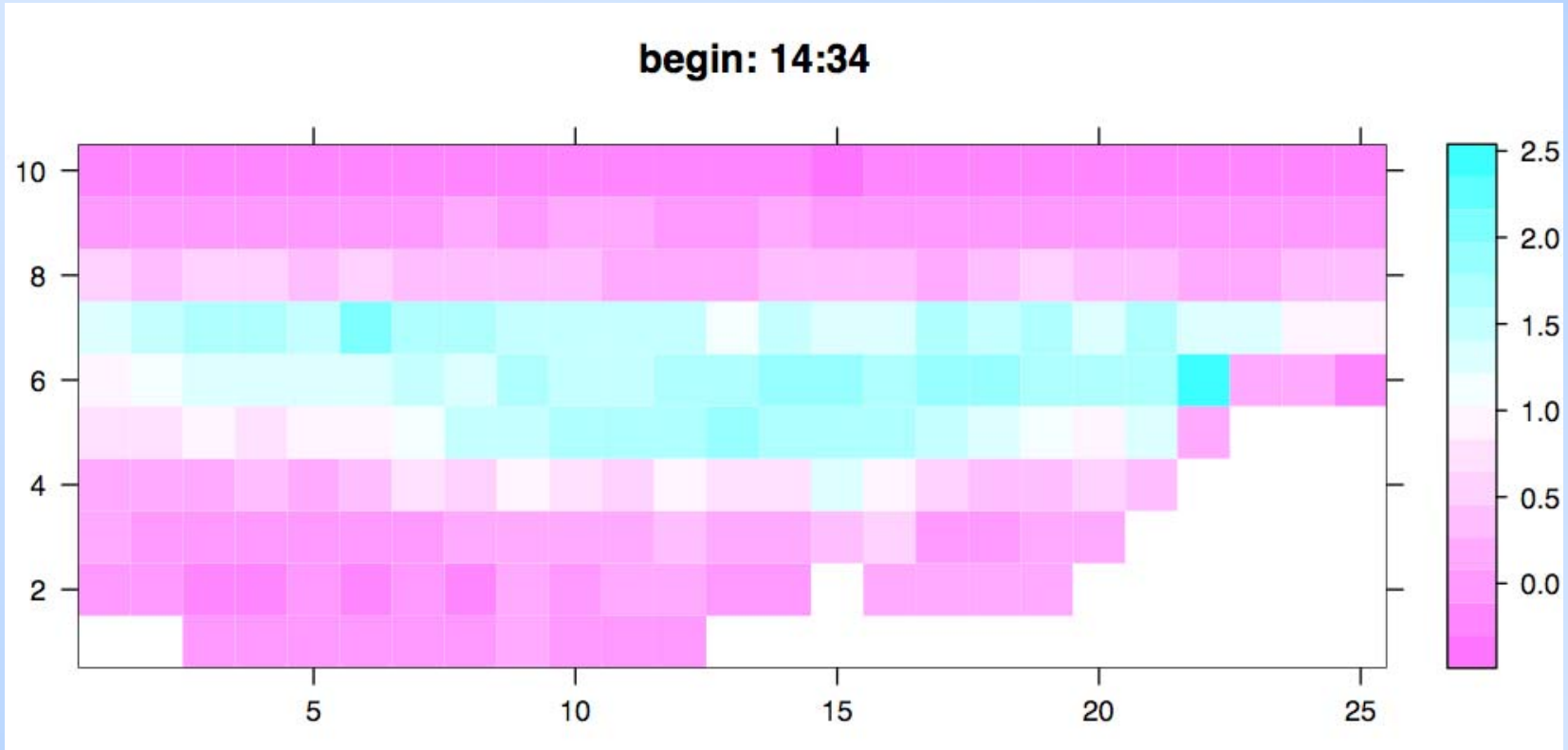

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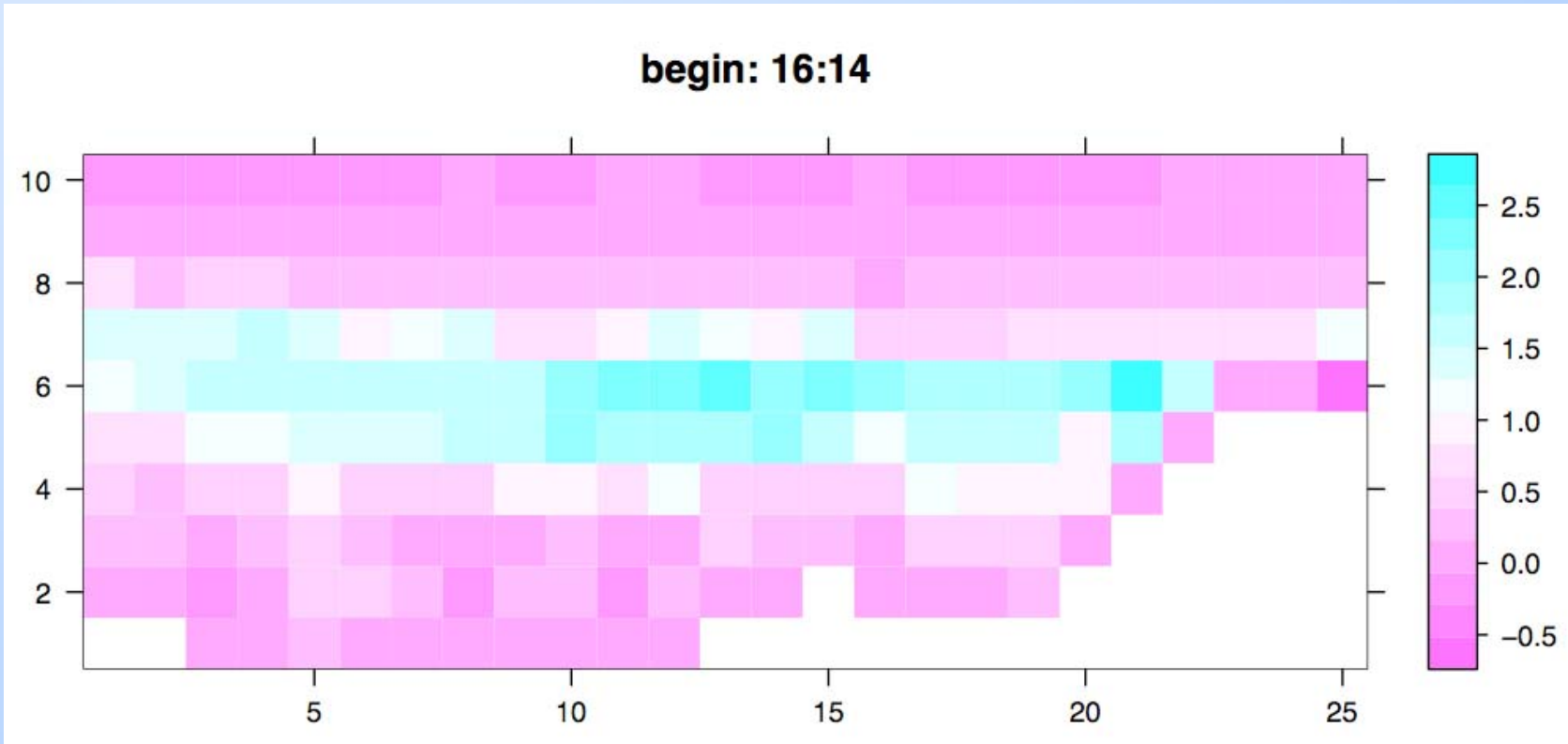

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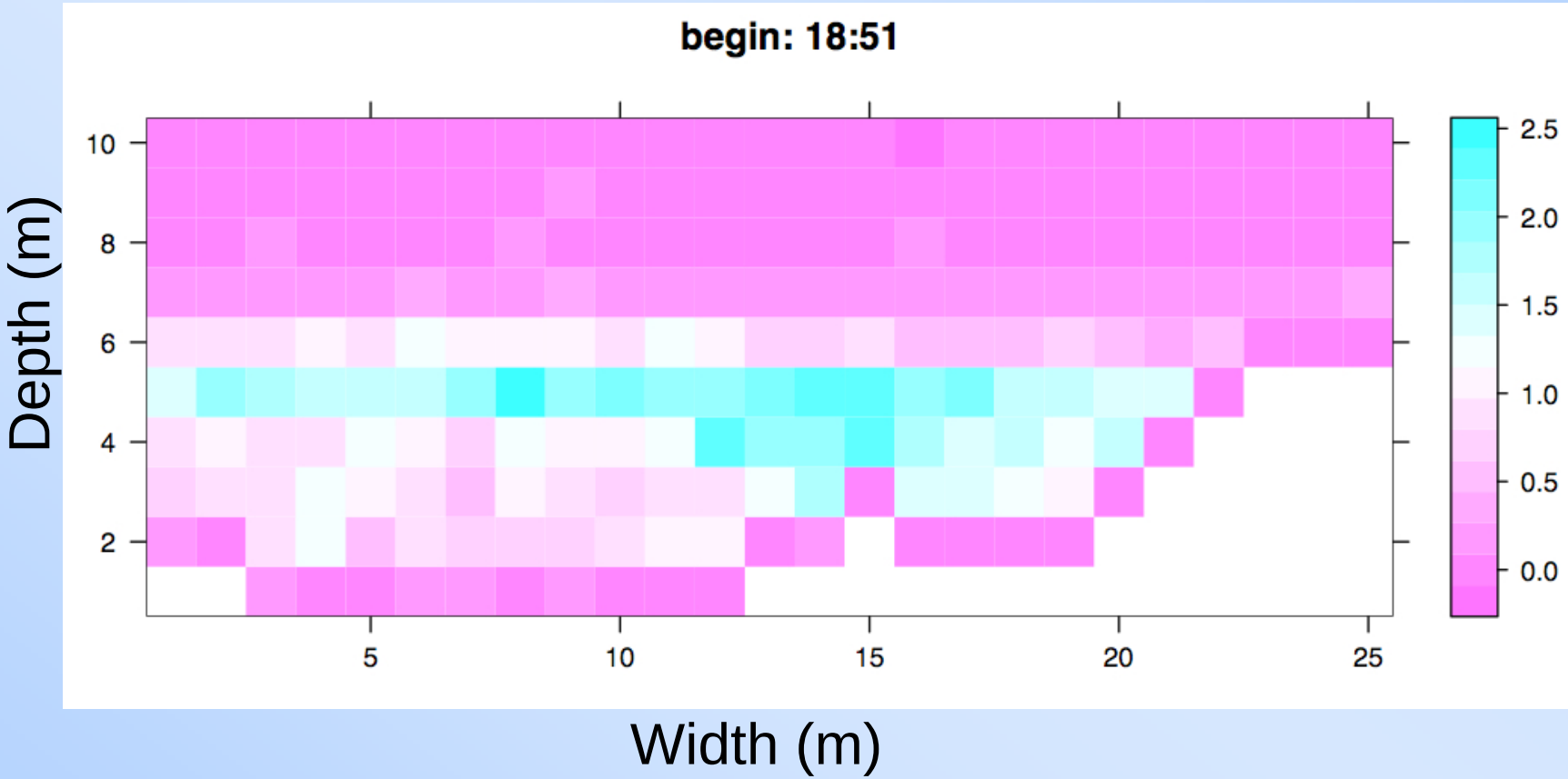

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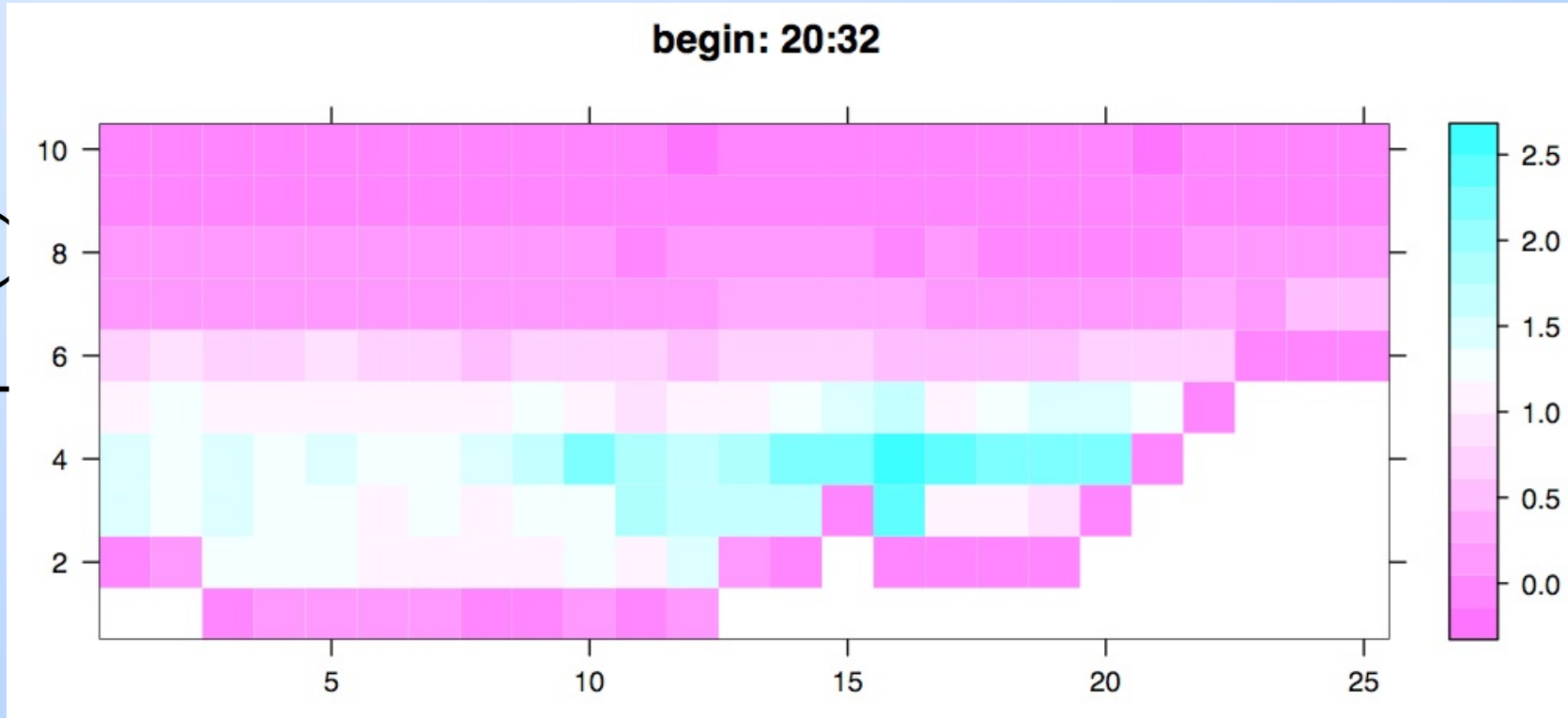

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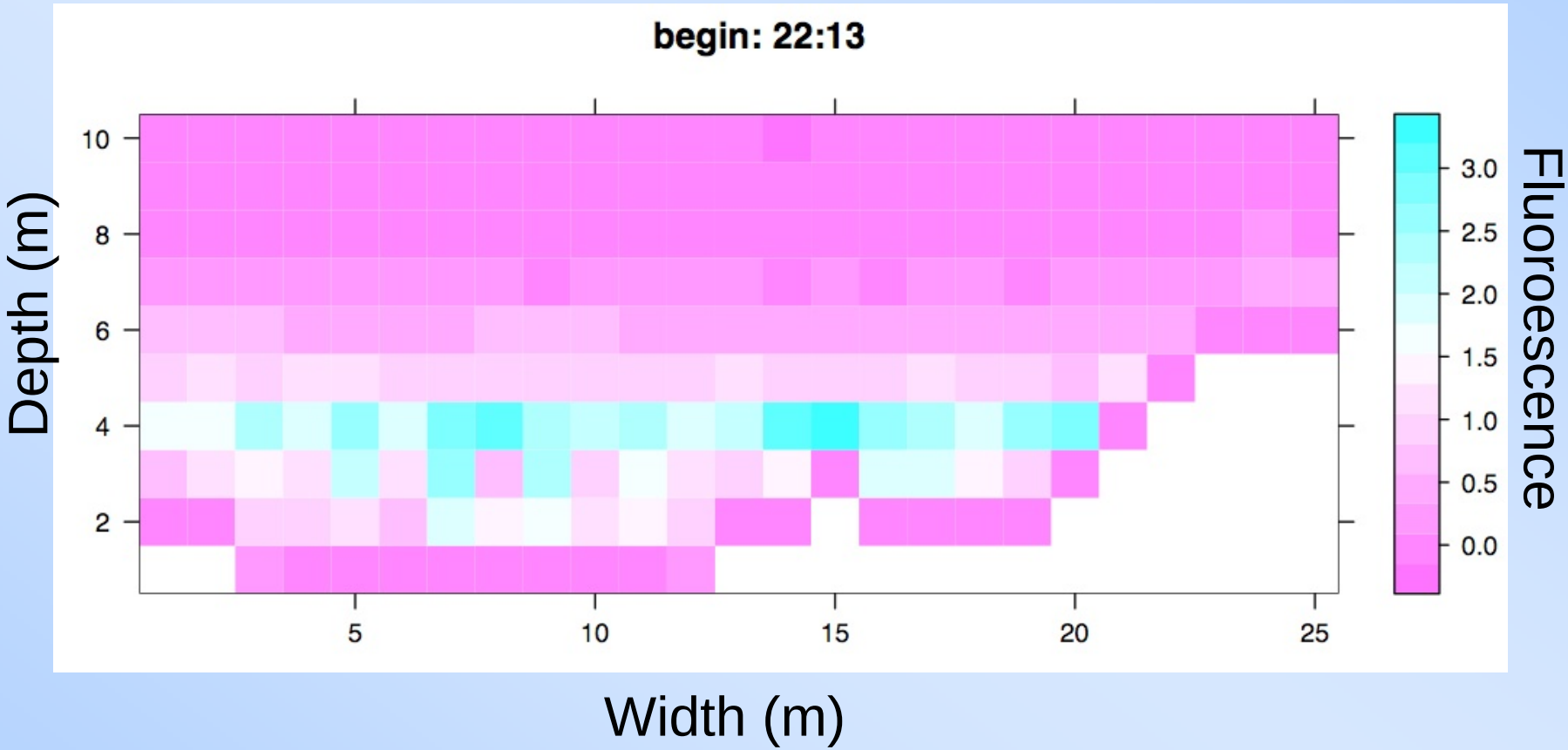

NIMS Profiling of Lake Biomass Distribution

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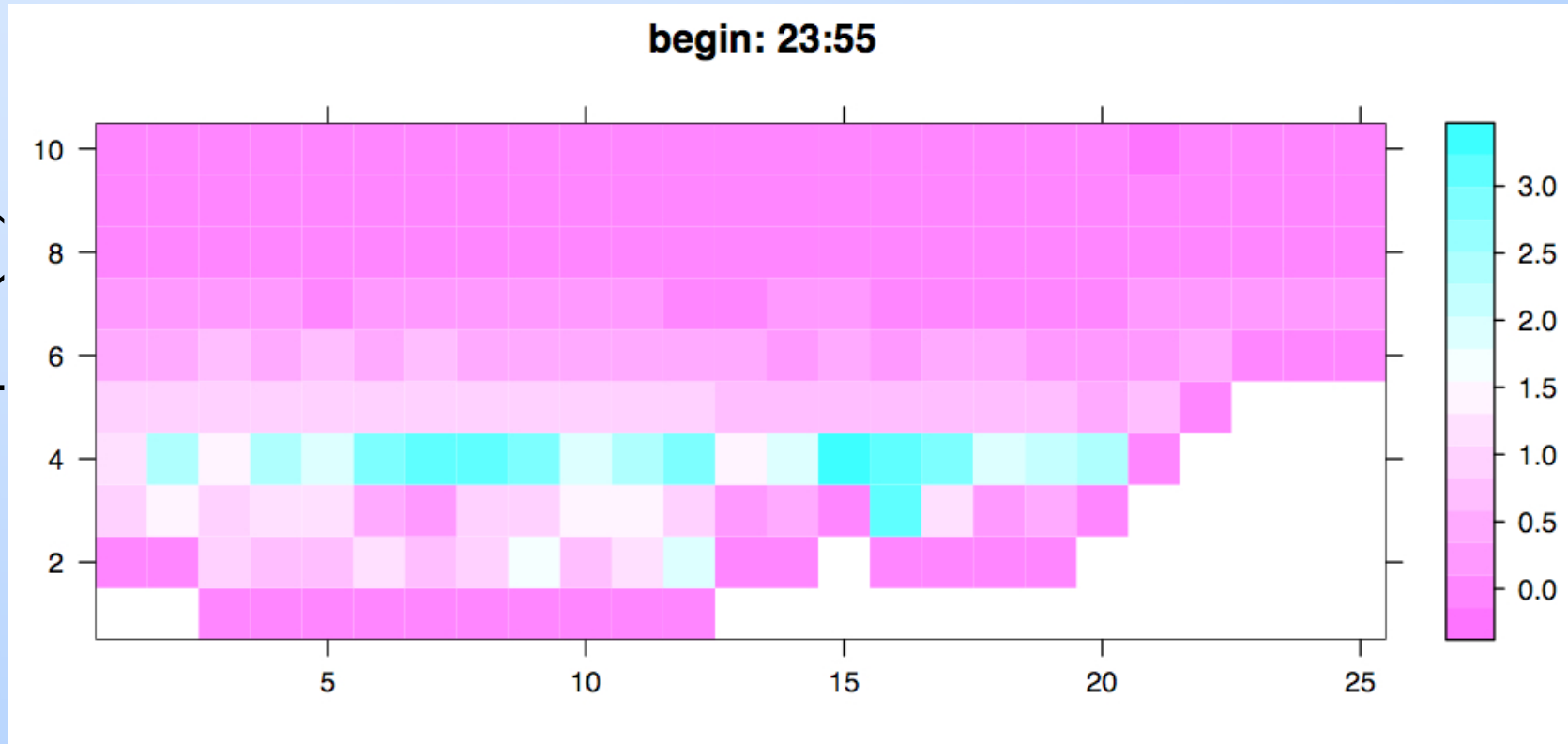

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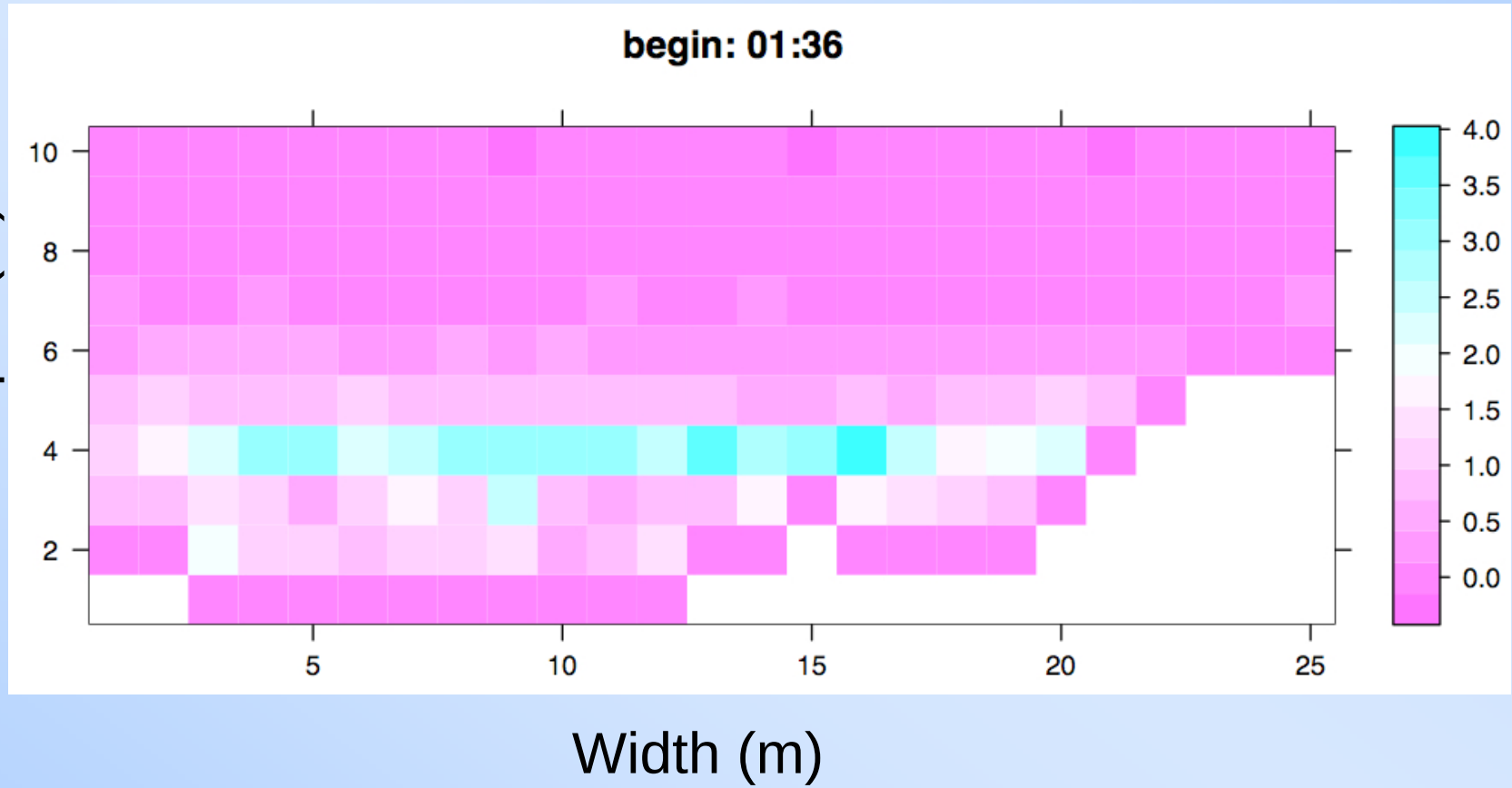


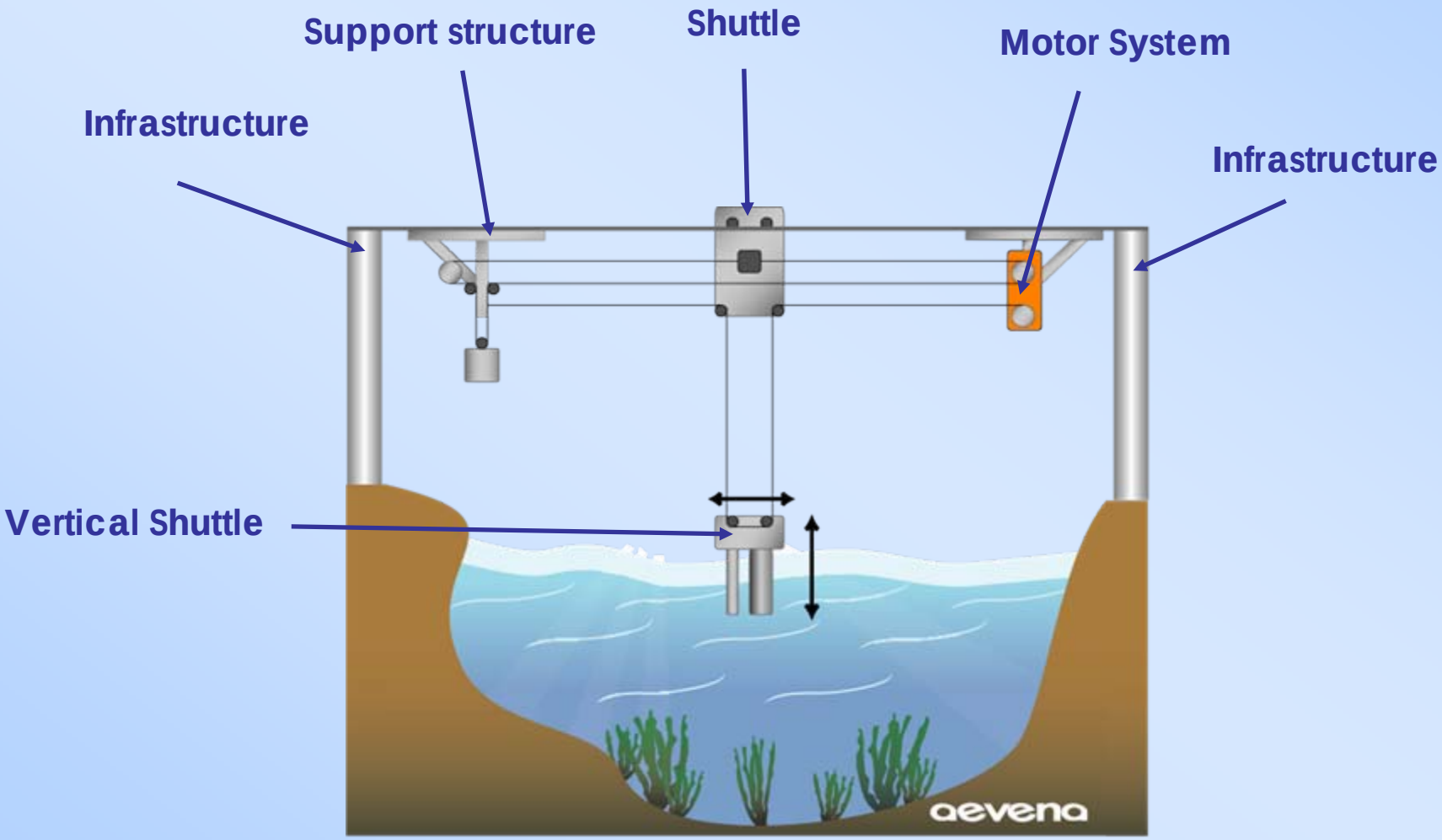
NIMS

Networked Info-Mechanical Systems

Tutorial

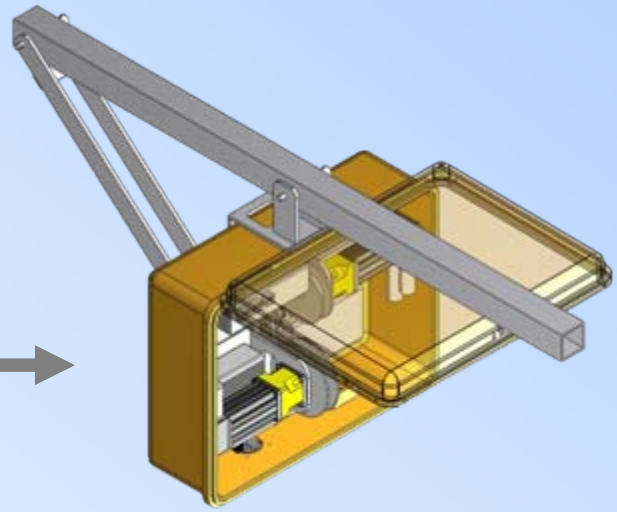
NIMS RD Mechanical Parts

NIMS



NIMS RD System Components

NIMS



Serial Interface
or
Wireless Interface

NIMS RD Software Suite

- Calibration
- Control
- Data Processing

NIMS RD

- Infrastructure
- Motor System
- Shuttle

NIMS RD Usage Steps

NIMS

1	2	3	4
			
Deploy NIMS System	Calibration Define Boundaries	Move/Sample	Merge Data

Deploy NIMS RD System

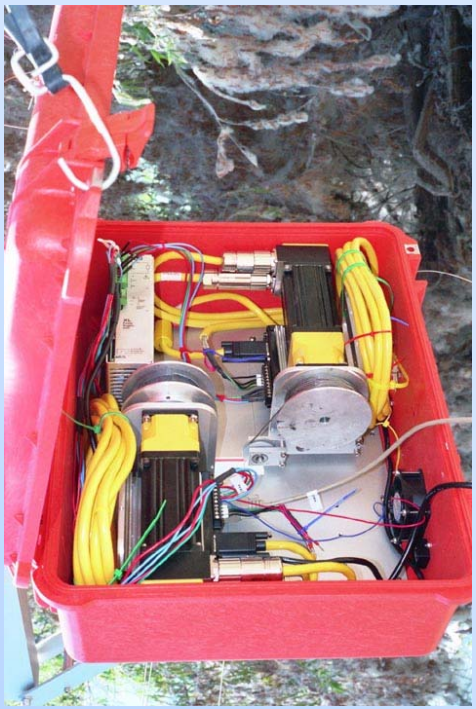
Install Infrastructure + Cable

Existing infrastructure

Rapidly deployable infrastructure

Deploy NIMS RD System

Install Motor System



Motor system

Motor system

Deploy NIMS RD System

NIMS

Install Motor System

Existing infrastructure

Rapidly deployable infrastructure

Deploy NIMS RD System

NIMS

Install Shuttle system

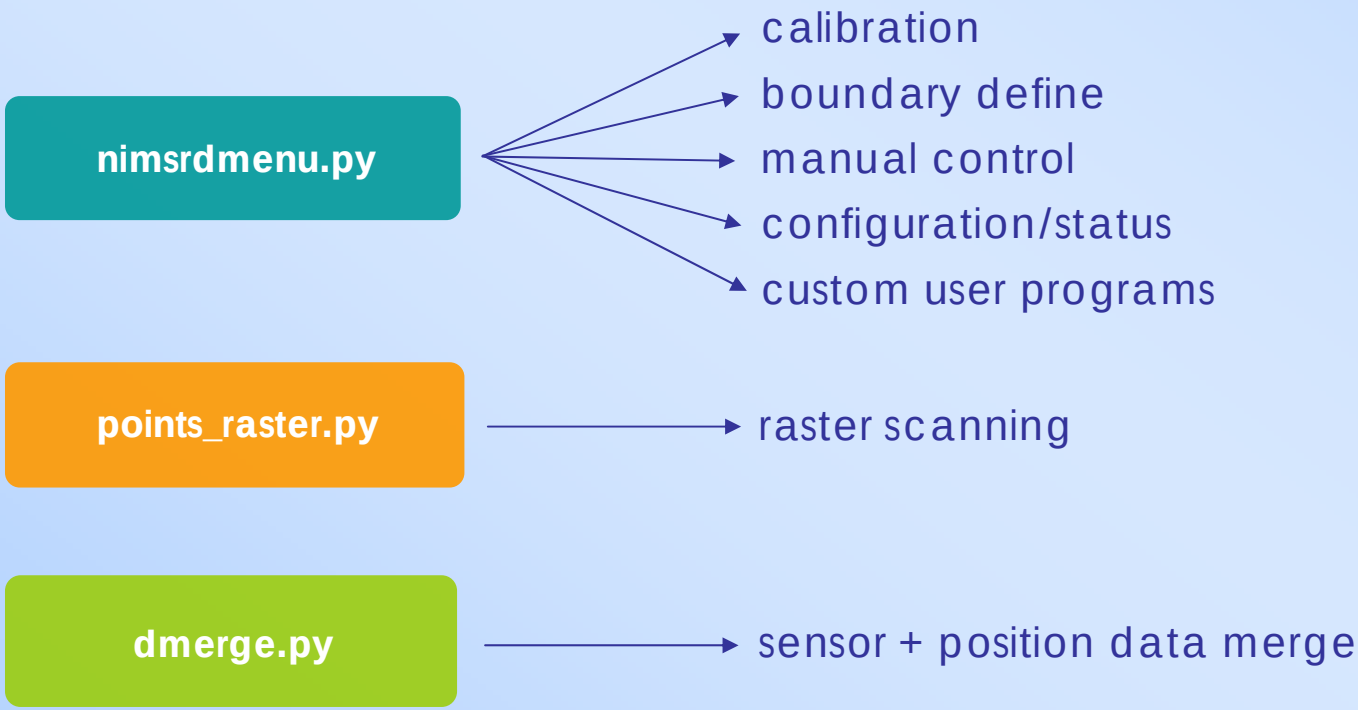
Shuttle installation

Instrument installation

NIMS RD Software Suite

NIMS

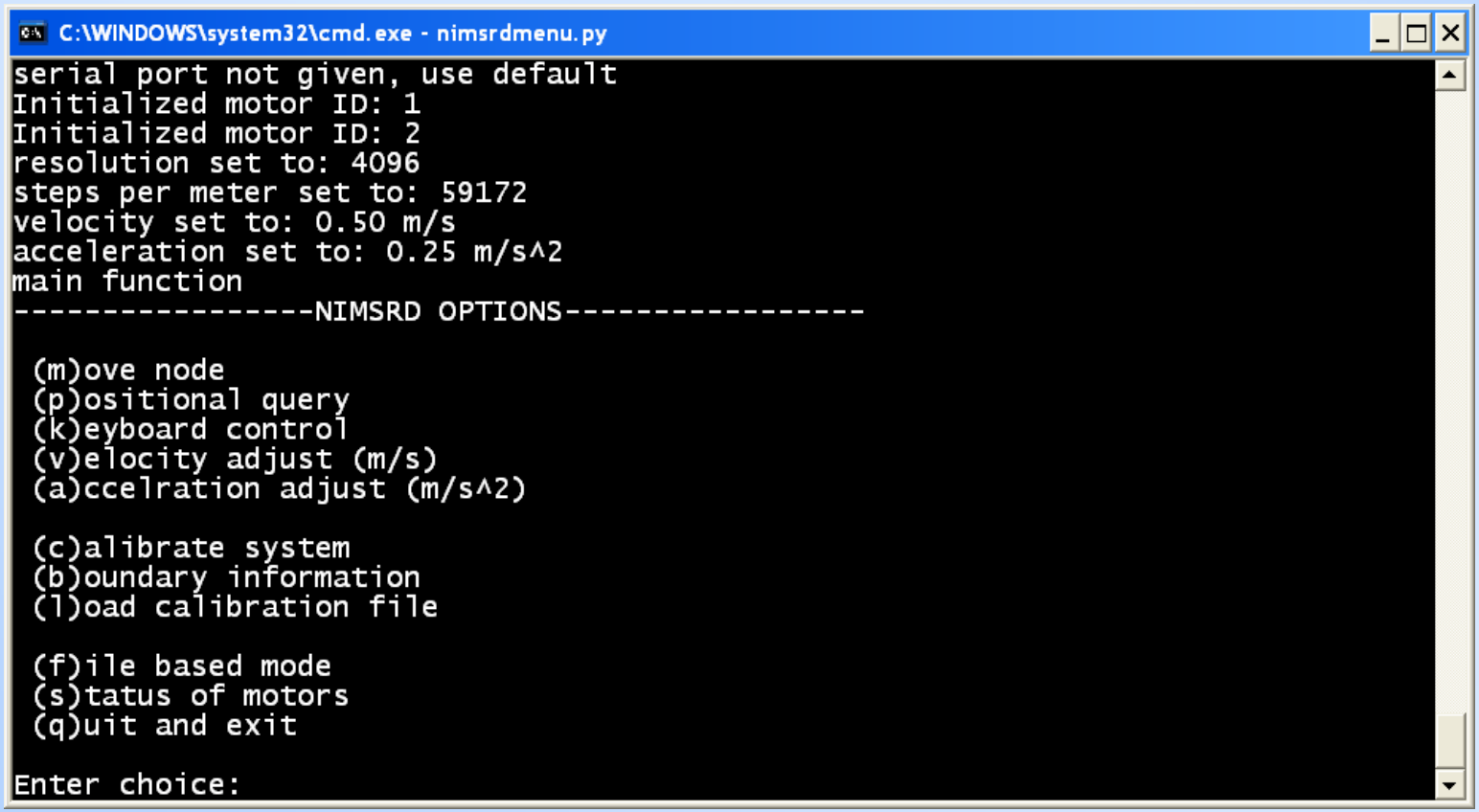
- Written in cross-platform language Python
- Windows and Linux compatible
- Main software programs



nimsrdmenu.py

NIMS

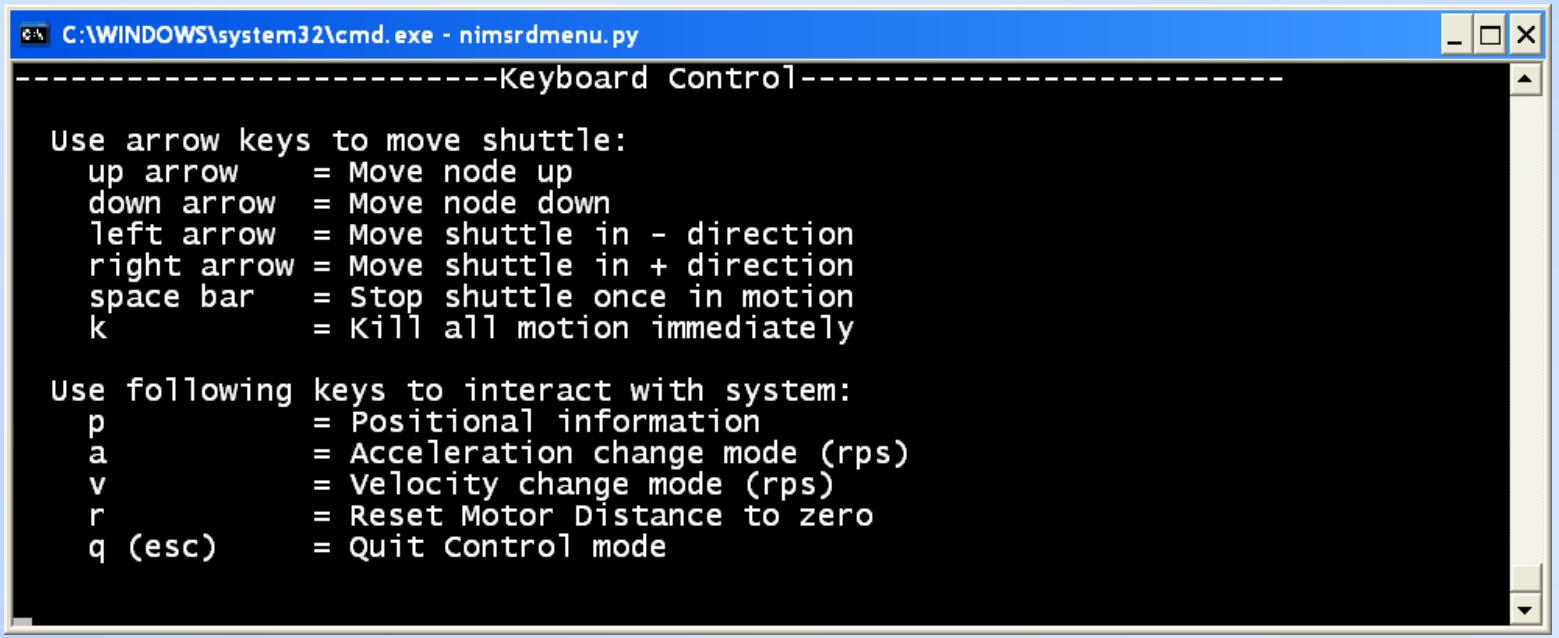
Main Menu



nimsrdmenu.py

NIMS

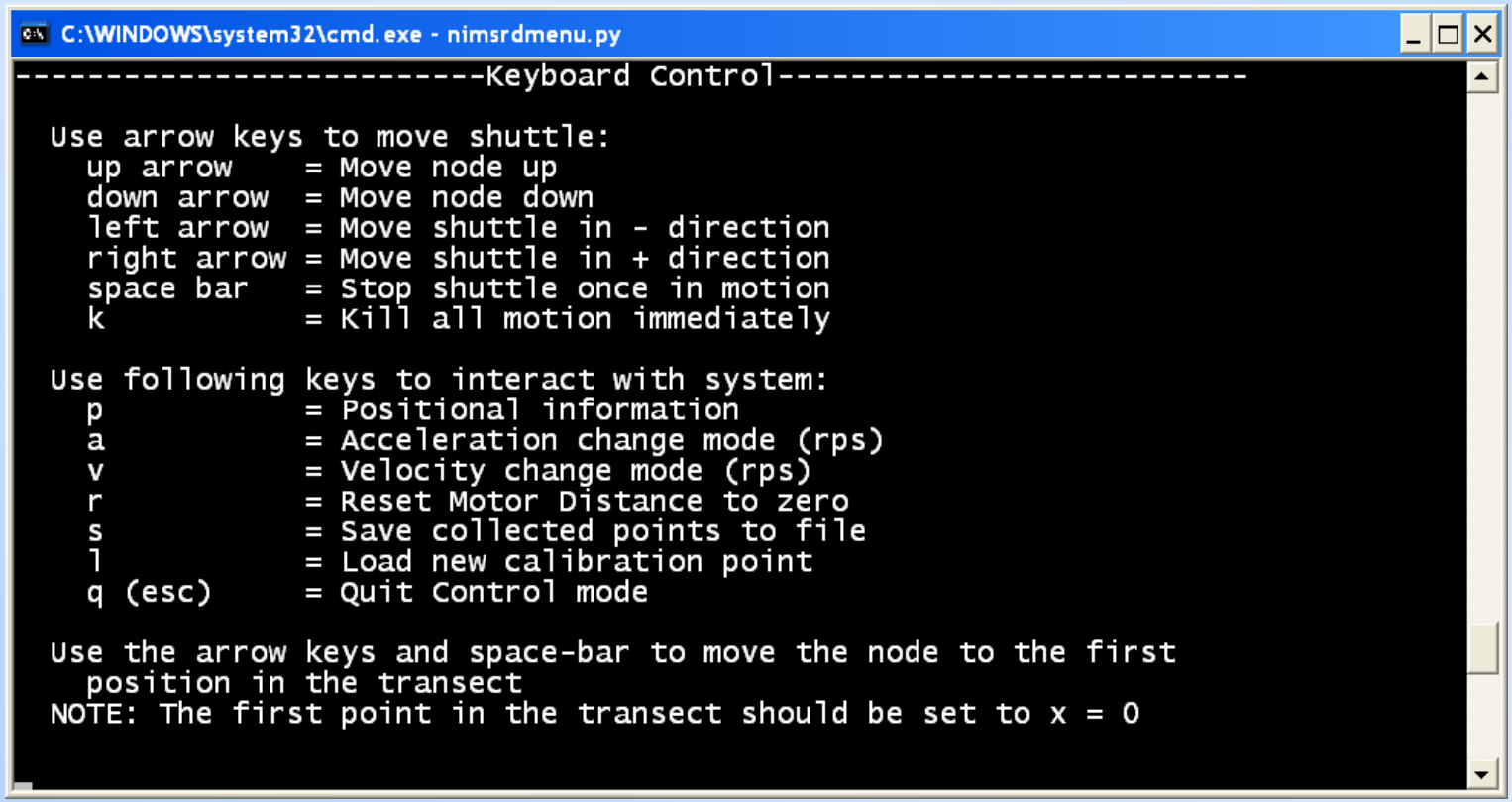
Move Node



nimsrdmenu.py - Calibration

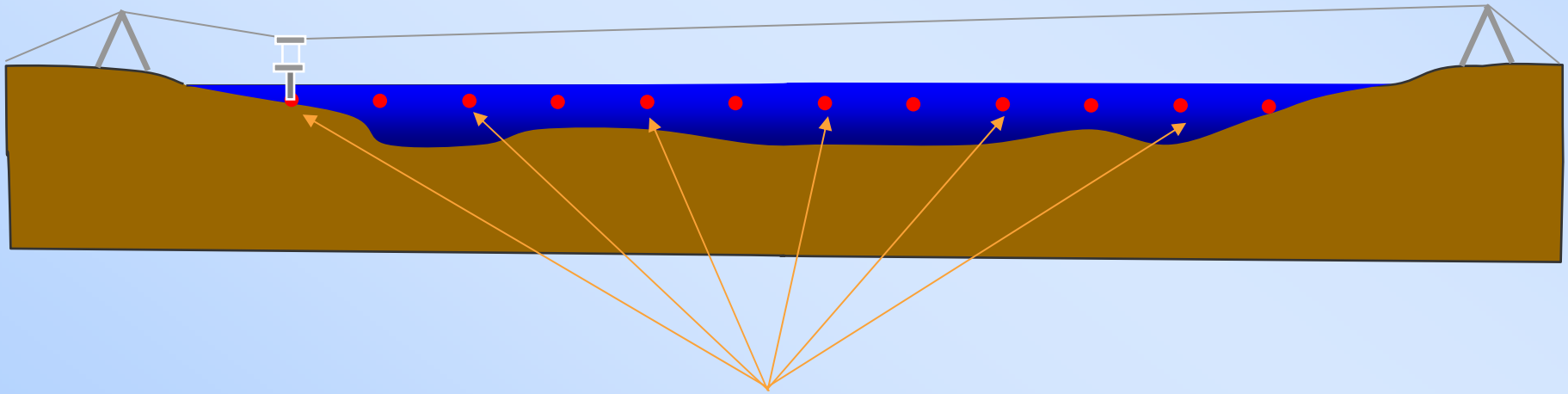
NIMS

Calibration (new calibration)



nimsrdmenu.py - Calibration

NIMS

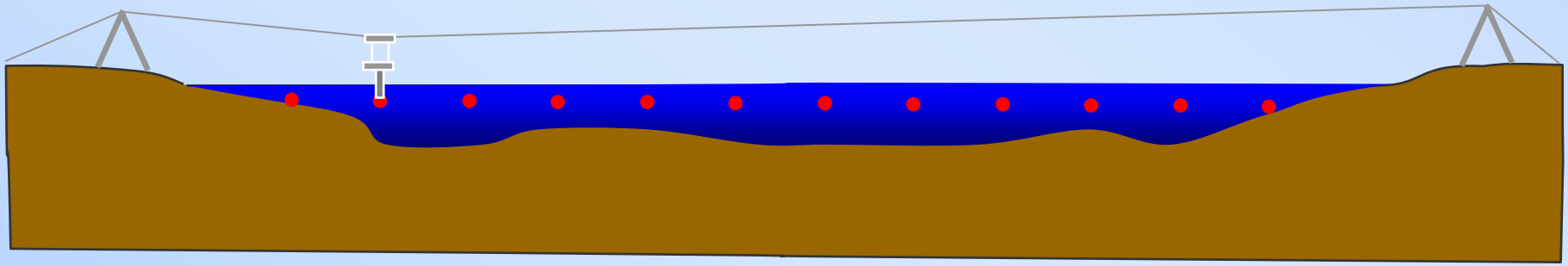


Calibration points

Courtesy of CENS

nimsrdmenu.py - Calibration

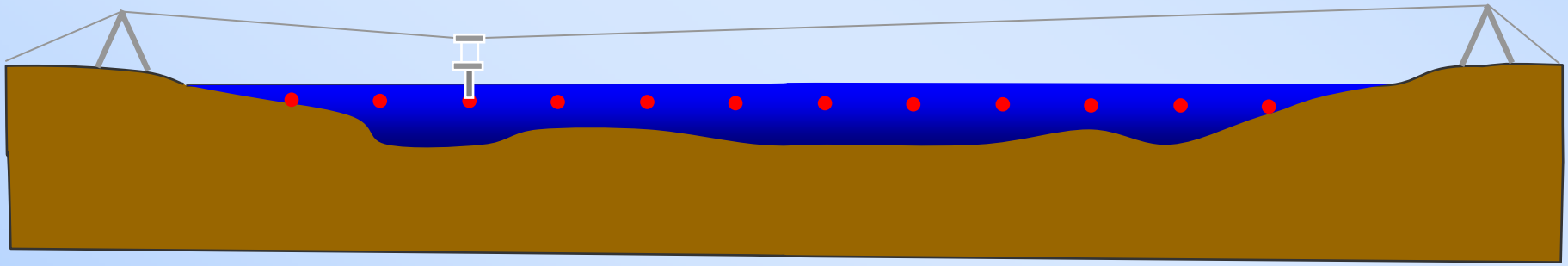
NIMS



Courtesy of CENS

nimsrdmenu.py - Calibration

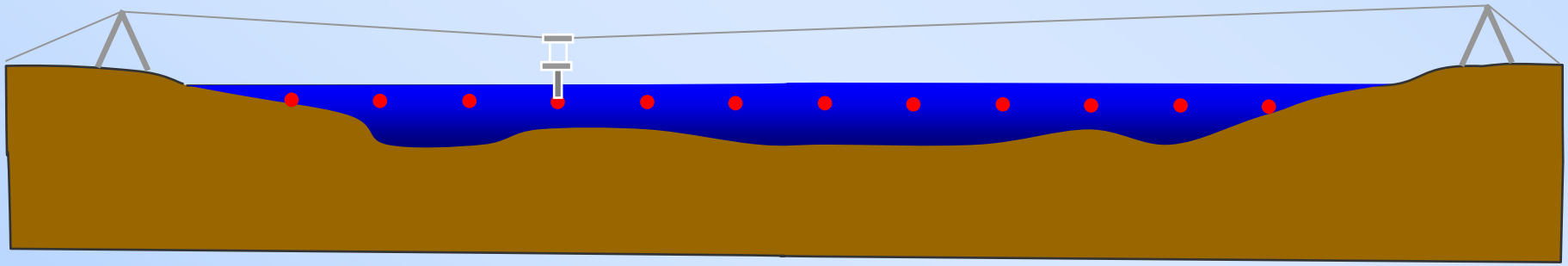
NIMS



Courtesy of CENS

nimsrdmenu.py - Calibration

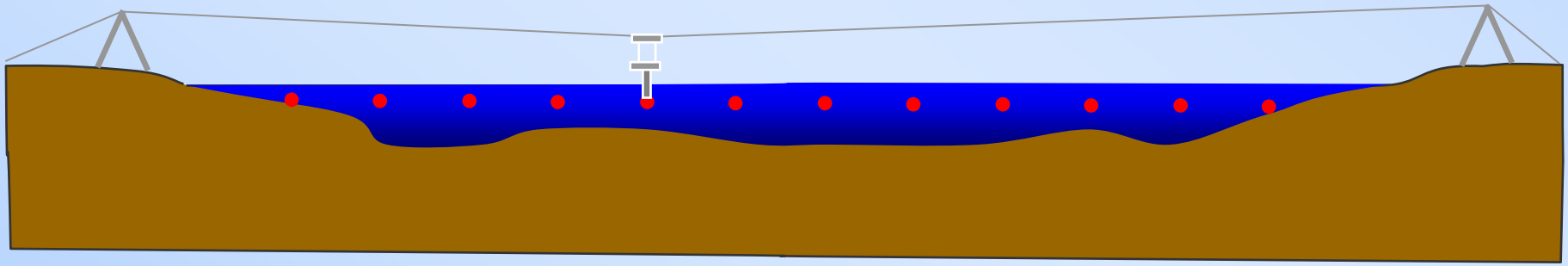
NIMS



Courtesy of CENS

nimsrdmenu.py - Calibration

NIMS



Courtesy of CENS

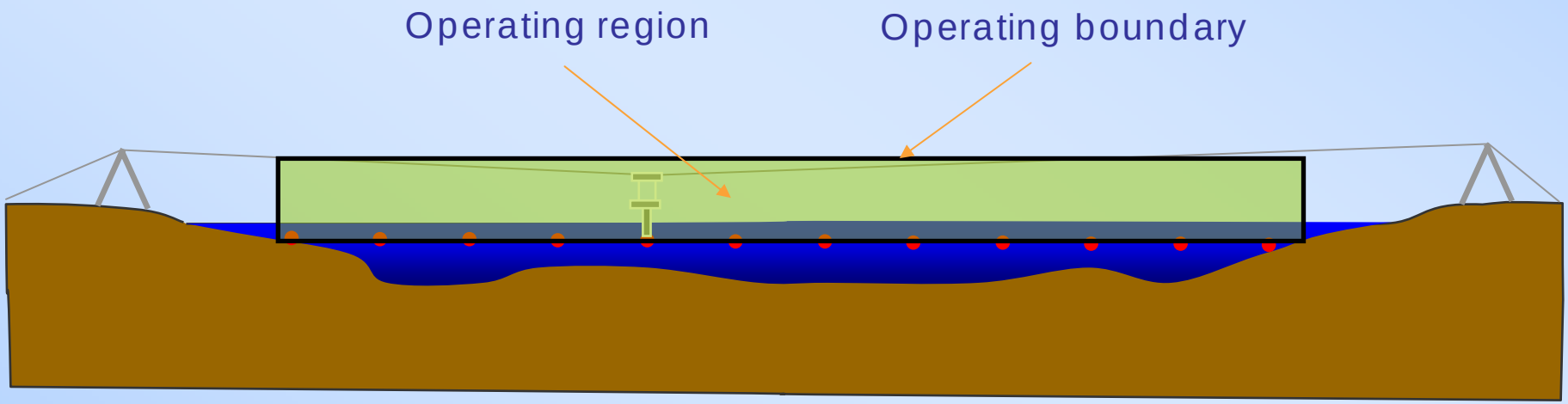
nimsrdmenu.py - Calibration

NIMS

Calibration

1. Manually move the starting position to the origin
2. Press ‘l’ key in the calibration menu to start
3. Enter the measured position
4. Move to the next location
5. Repeat steps 3 and 4 until the end of the transect is reached
6. Press ‘s’ to save the configuration file

nimsrdmenu.py - Boundaries



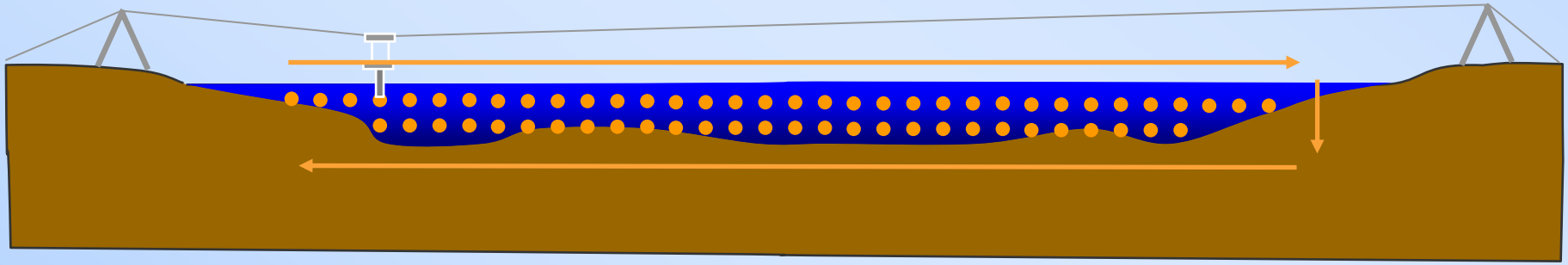
Courtesy of CENS

nimsrdmenu.py - Boundaries

Boundary Menu

```
-----------------BOUNDS OPTIONS-----------------
(p)rint current boundary points
(e)nable boundary checking
(d)isable boundary checking
(c)lear boundary points
(s)et boundary points
```

points_raster.py



Courtesy of CENS

points_raster.py

NIMS

How to Do a Raster Scan

1. Create ‘points.txt’
2. Open up a terminal for the ‘nimsrdmenu.py’ program
3. Run ‘points_raster.py’
4. File is outputted to ‘[year]-[month]-[day].txt’

points_raster.py

NIMS

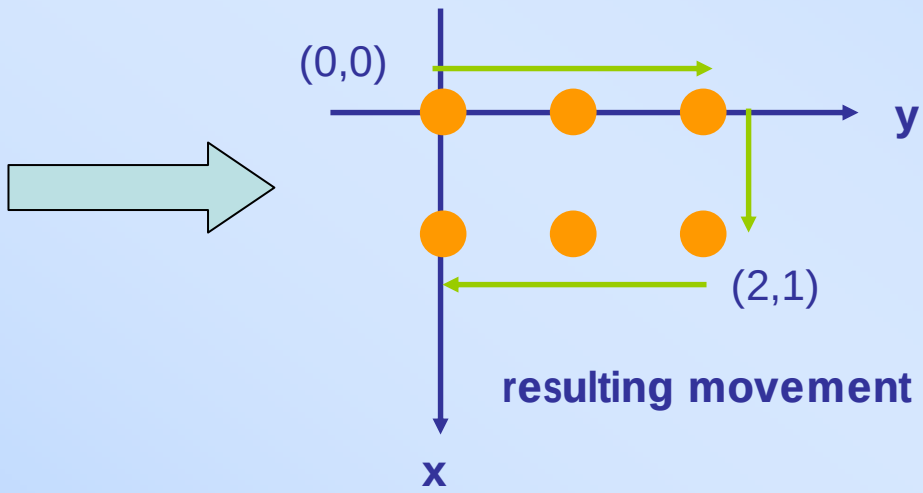
How to do a Raster Scan

```
<x> <y> <dwell>
• (There are spaces between each of the three elements in the line)
• <x>: NIMSRD x-position in meters
• <y>: NIMSRD y-position in meters
• <dwell>: amount of time to spend at that particular ,
• position in seconds
```

‘points.txt’ file format

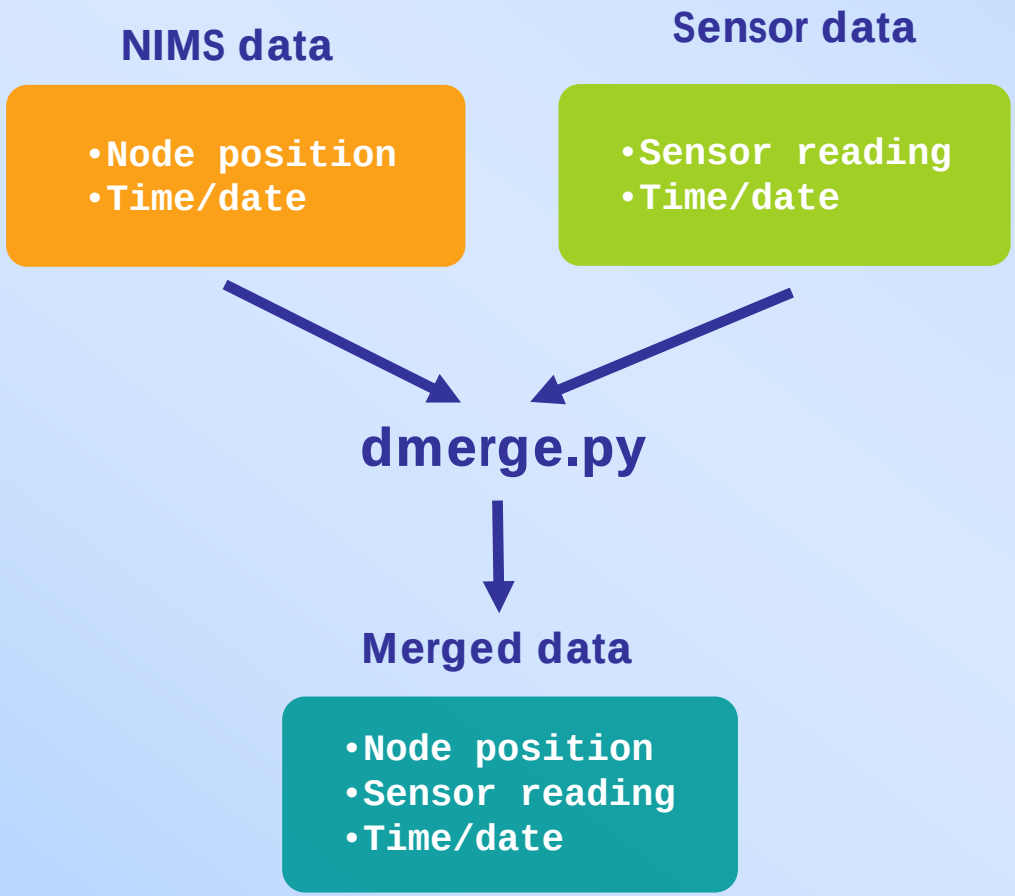
```
0 0 5
1 0 5
2 0 5
2 1 5
1 1 5
0 1 5
```

‘points.txt’ sample file



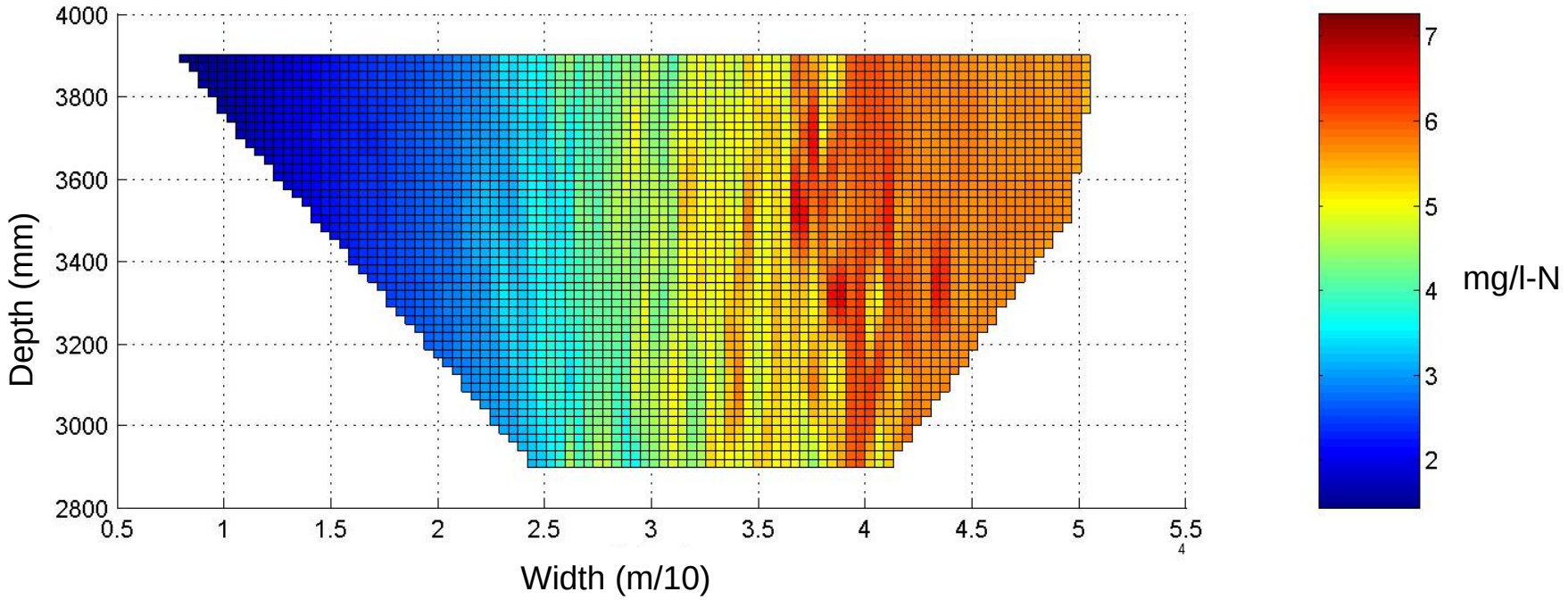
dmerge.py – Merging Data

Merging NIMS Positional Data with Sensor Data



Sample Merged Data Plot

NIMS



Future Developments

NIMS

- Simplify the deployment process
- Embedded computer for autonomous mode
- Self-calibration
- Size and weight reduction
- Integration with wireless data acquisition

Demonstration