This is the first session of the MicroLAB training course and is intended to get the new user oriented before moving on to practical hands-on training.

Later sessions include software operation, programming MicroLAB, running analyses, downloading and processing data, servicing and plenty of opportunity for questions and answers.

Introduction

- Overview of MicroLAB system
- Demonstrate operation of MicroLAB
- Introduction of group and backgrounds

This session of the training course will provide an overview of the MicroLAB system and its various sub systems.

We will also briefly demonstrate the operation of MicroLAB.

Agenda

- General anatomy
- Analysis
- Electronic configuration
- Chemical engine
- Detector design
- Commands
- Scripts

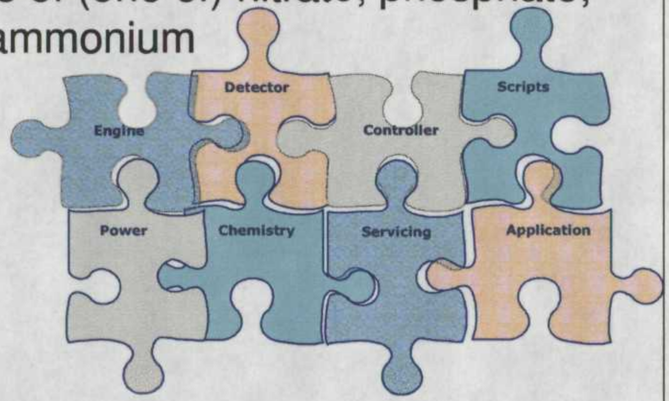
This session of the MicroLAB training course will provides outlines for each module:

1. General anatomy
2. Analysis
3. Electronic configuration
4. Chemical engine
5. Detector design
6. Commands
7. Scripts

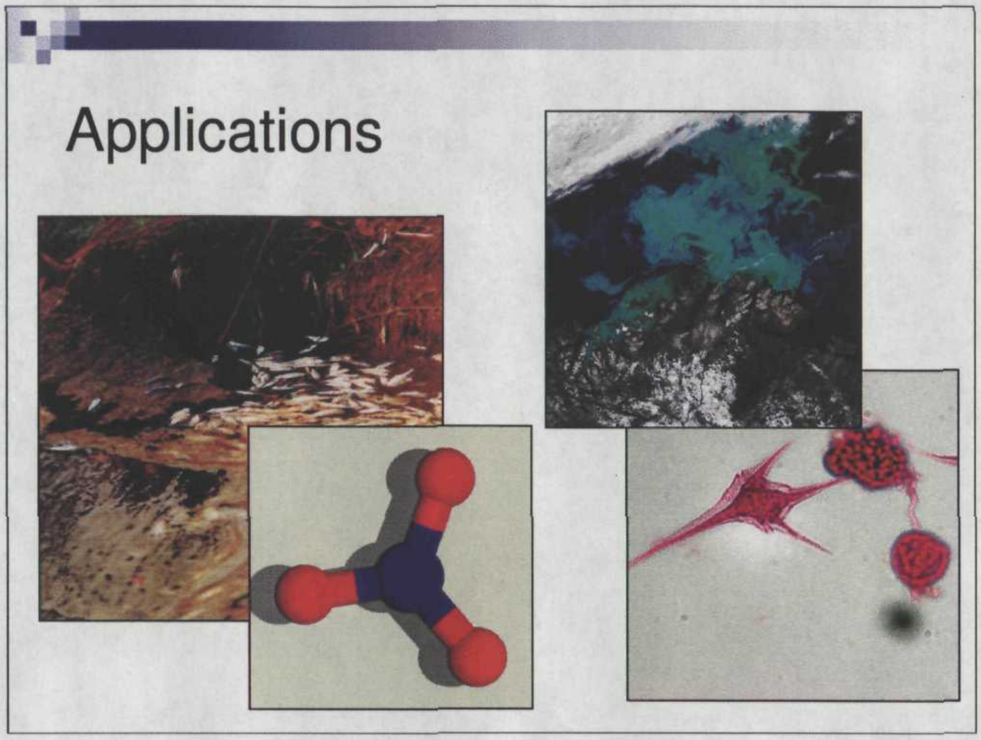
Further detailed information is available in the MicroLAB manual.

What is MicroLAB?

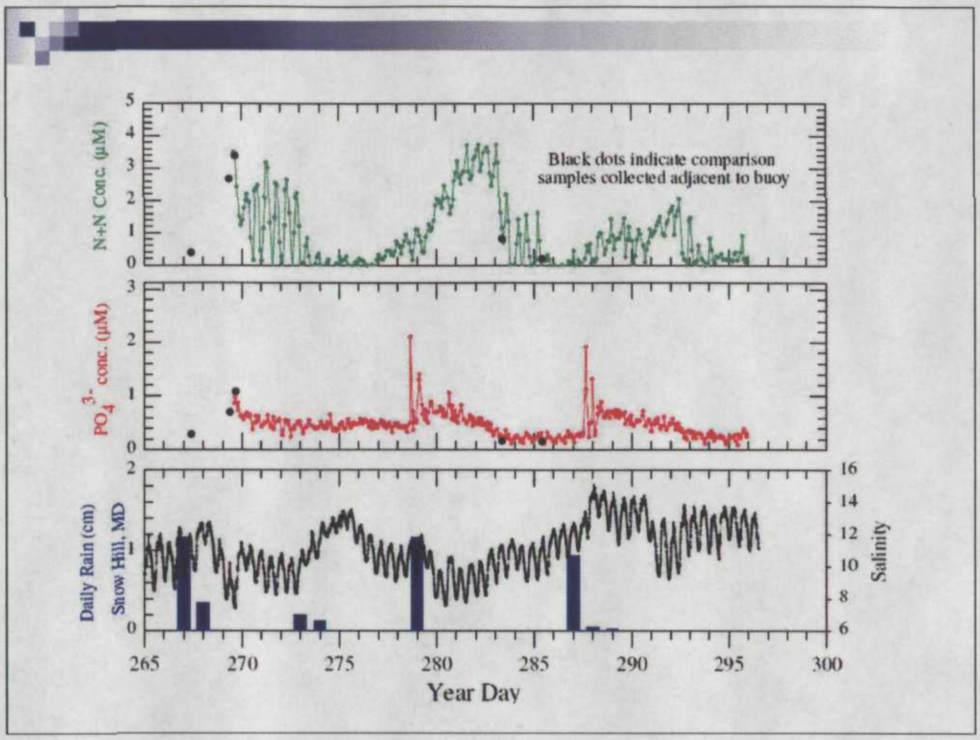
- MicroLAB is a wet chemistry analyzer for the analysis of (one of) nitrate, phosphate, silicate or ammonium



MicroLAB is an system for the automated (robotic) measurement of nutrient concentrations. It comprises a number of sub-systems. These all fit together with the application to provide data that cannot be obtained by conventional sampling methods. This introductory section explains how the MicroLAB sub-systems fit together.



Application areas include, environmental research, TMDL assessment, HAB studies, statutory monitoring, euthrophication and nutrification determinations, early warning systems, capture of important episodic events, agricultural run-off measurements and many more.



First of all some data to focus our minds on the objective of deploying MicroLAB.

It is important to emphasize the capabilities that MicroLAB offers and the crucial insight that high frequency nutrient data provides. Please review the figure above.

The green trace is NO3+NO2 and the red trace is PO4. The blue columns in the lower chart are daily rainfall. The nutrient signals reveal increases in nutrient concentrations following rain events, as well as a tidal component. What is most surprising is the high-frequency (minutes scale) several-fold increases in reactive phosphorus coincident with the rain events.

These nutrient pulses were attributed to runoff from a heavily agricultural watershed.

Note that conventional sampling, with samples collected every few days, missed all of the pulses in phosphorus (particularly as they occurred in stormy periods) and many of the longer-lived increases in nitrogen.

Chemistry

- Colorimetry or fluorimetry (NH4)
- Measure beam attenuation
- EPA / NEMI standard methods
- Automated discrete analysis
- Frequent self-calibration

MicroLAB uses standard and time-honored wet chemistry which is the benchmark for environmental water quality measurements.

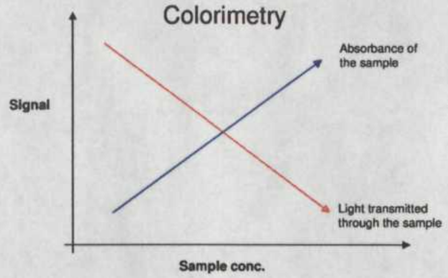
For NO3, PO4 and SiO4 colorimetric methods are used. For NH4 a fluorimetric method is used.

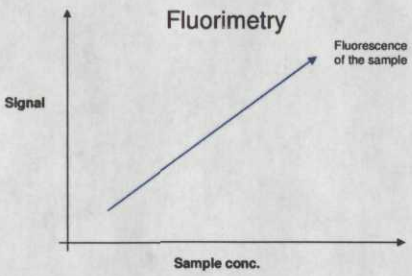
The chemistry employed is compliant with and directly comparable to the EPA standards methods.

However, MicroLAB is not and segmented flow or flow-injection analyzer in a can. MicroLAB performs automated discrete analysis on a sample by sample basis. In other words MicroLAB collects a sample of approximately 1 ml, reacts it, and then measures the intensity of the reaction from the whole sample.

As well as analyzing environmental samples, MicroLAB frequently runs self-calibration standards for quality assurance purposes. This standard is carried "on-board" during each deployment.

Measurement Methods





Colorimetry is used to measure NO3/NO2, PO4 and SiO4. The attenuation of a beam of light is recorded. The light passing through the sample decreases with increasing concentration. This is shown by the red line. Absorbance increases linearly (to a point) with concentration as shown by the blue line. This is in accordance with the Beer-Lambert Law.

Fluorimetry is used to measure NH4. The fluorescence of the dye when excited by a beam of light is recorded. The light fluoresced (emitted) by the sample increases linearly with increasing concentration. This is shown by the blue line.

Further information relating to colorimetry can be found at the following links:

http://en.wikipedia.org/wiki/Colorimeter
http://en.wikipedia.org/wiki/Beer-Lambert_law
http://en.wikipedia.org/wiki/Absorbance

Further information relating to fluorimetric can be found at the following links:

http://en.wikipedia.org/wiki/Fluorescence
http://en.wikipedia.org/wiki/Fluorescence_spectroscopy

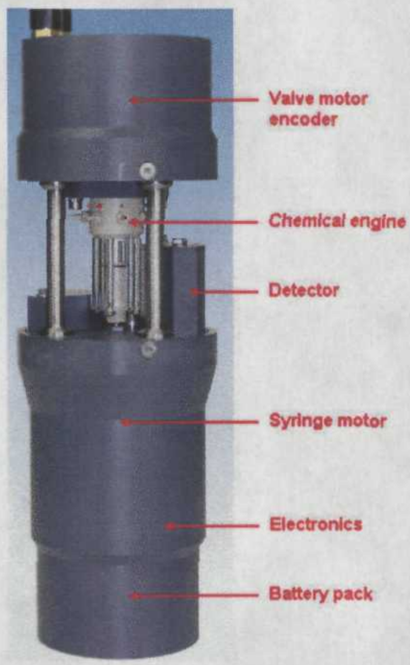
Anatomy

To use MicroLAB effectively you must familiarise yourself with the basic anatomy of the system and some technical issues. If you are not familiar with electronic instrumentation you may find some concepts challenging at first. However, you will soon become comfortable with these aspects.

The main component parts and modules are shown in the photograph. The reagent housing has been removed to allow the analyzer to be seen.

MicroLAB pressure cases contain the battery back. Any other nominal 12 volt DC supply can be used as an external supply.

Analyzer



MicroLAB's main components are indicated in this photograph.

The valve motor and gearbox drive the valve rotor and position the valve at each port. The integrated precision shaft encoder ensures accurate positioning of the valve.

The valve and syringe form MicroLAB's chemical engine providing the ability to sample, add reagents, mix and inject the resulting dye into the detector.

The detector measures the intensity of the colored or fluorescent dye.

Samples are collected, mixed and reagents added by moving the syringe in and out. The syringe is driven by a linear stepper motor.

The datalogger and controller are integrated into the lower housing.

The optional internal battery pack is installed in the bottom of the lower housing. This is a primary pack (i.e. it is not rechargeable). MicroLAB may be powered by an external 12 volt DC (nom.) power source (e.g. car battery).

Reagent bags

Reagent, standards and waste bags are installed in the lower section of the guard around the outside of the lower housing of the analyzer. The picture shows the view looking in from the top of the lower guard section. Each bag has a specific position in the carousel. Each reagent bag connects to a specific port on the valve.

Analysis

- Take water sample
- Read blank (and record)
- Reduce (NO3 only)
- Add reagents
- Develop (heated for PO4 and NH4)
- Read reaction (and record)
- Flush
- Preserve cadmium (NO3 only)

Take water sample

MicroLAB obtains an external water sample or a calibration standard from the on-board standard

Read blank (and record)

The sample/standard is pumped into the detector and the light through (or fluorescence of) the sample is read and recorded.

Reduce (NO3 only)

For nitrate (only) the sample is then reduced to nitrite (NO2) in the cadmium column.

Add reagents

Reagents are added to the sample in the syringe to create a colored or fluorescent dye.

Develop (heated for PO4 and NH4)

The dye is then developed. In the case of PO4 and NH4 the development is heated.

Read reaction (and record)

The light through the reacted dye is then read and recorded.

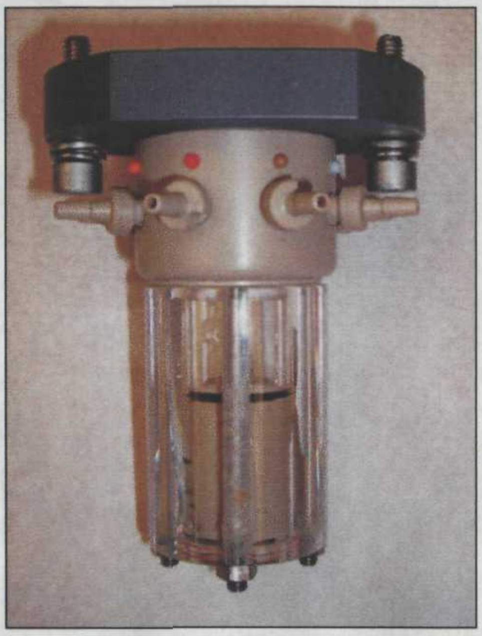
Flush

The detector and syringe are flushed

Preserve cadmium (NO3 only)

For nitrate the cadmium column is preserved with an on-board reagent

Syringe/Valve

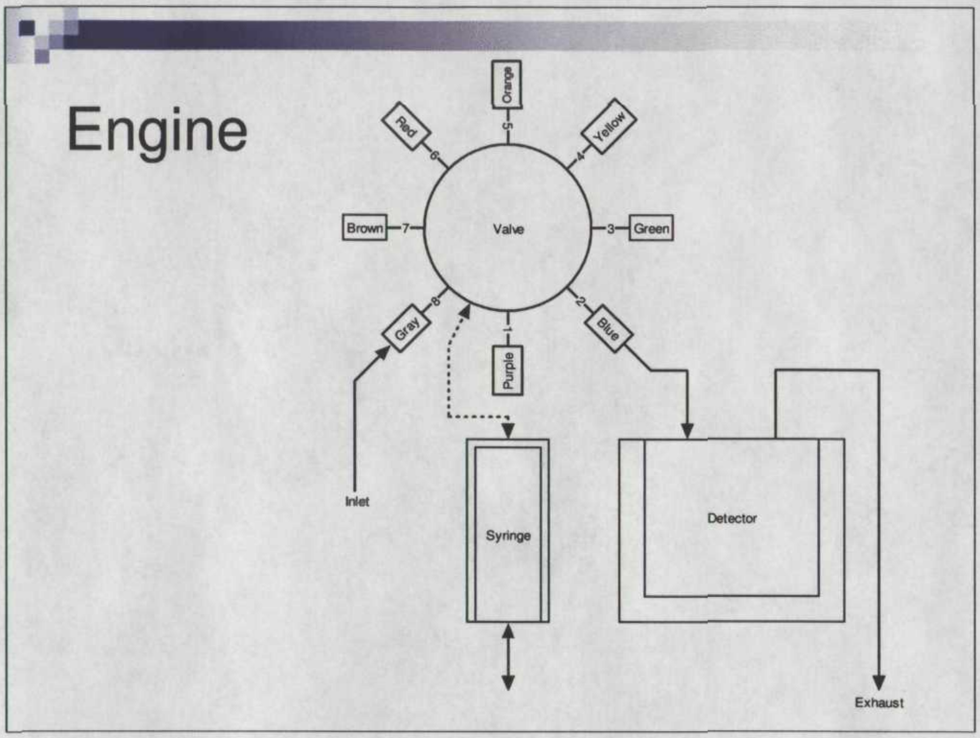


Samples are taken and reacted by manipulating them in MicroLAB's syringe and valve. For example to collect a sample the valve is (normally) positioned at the gray port. This connects the gray port with the syringe chamber. The syringe can then be retracted to draw a sample into the chamber.

Reagents can be added to the sample by turning the valve to a port connected to one of the reagent bags. The syringe is then retracted to precisely dose the sample with reagent. A further reagent may be added in a similar manner.

One the sample is reacted or during reaction the dye is injected into the detector. This is done by turning the valve to the detector port and inserting the syringe.

The valve and syringe are entirely user serviceable.



MicroLAB's hydraulic system has three major components and comprises a multi-port valve (normally with 8 ports), a syringe and a detector as shown in the block diagram below.

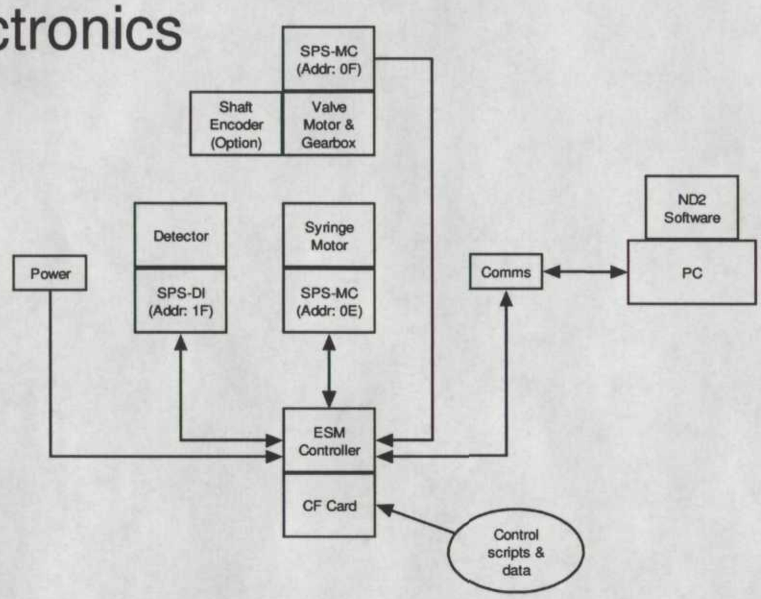
Each valve port can be uniquely selected by the valve motor controller and when the valve is "at" a particular port the valve nozzle is connected to the syringe chamber. For example if the valve is at the gray port, retracting the plunger will draw fluid into the syringe via that port. If the valve is then positioned at the blue port, inserting the plunger will inject the fluid into the detector. The gray port is normally designated the inlet and the blue port is connected to the detector. The other port connections are dependent on the chemistry regime used.

The valve is usually moved "to" a port. That is, you will either manually or programmatically move the valve to the gray or yellow (etc.) port. Unless you specify otherwise the valve SPS controller will select the shortest distance (to save time and power). Moving from the purple to the gray port is said to be moving 1 port clockwise. Then moving back to the blue port is 2 ports counter/anti-clockwise.

The valve has an alignment point that is near, but not exactly at, the gray port. This is an arbitrary reference point that provides the valve drive system with an absolute reference. The distance to the purple port is then calibrated and this is known as the valve offset. <u>Aligning the valve only moves it to the valve reference point. It must then be moved to a port before fluid can be draw into or expelled from the syringe.</u>

The syringe can be inserted or retracted a number of "steps". These are individual stepper motor steps and the full travel is approximately 4500 steps. This equates to approximately 3 ml volume in the syringe. More accurately: 1443 syringe steps = 1.0 ml volume

Electronics

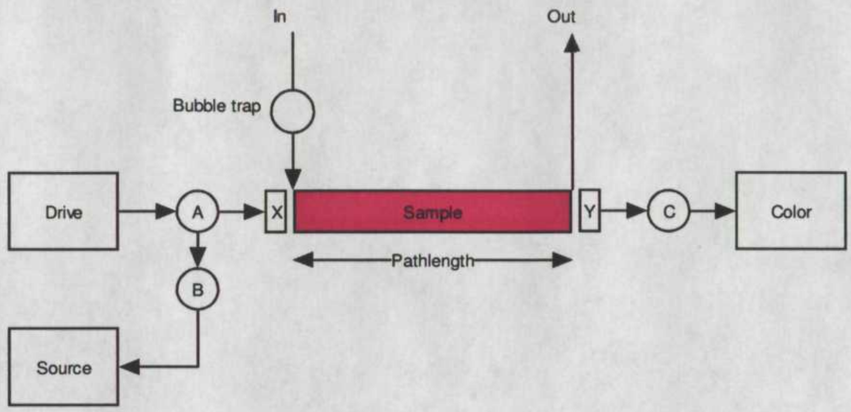


The user communicates with MicroLAB via an RS232 link. This is a common serial communication connection and protocol found on most desktop PCs and many laptop computers. It may be necessary to install an RS232 "card" in your computer to provide a suitable COM port. If you have any queries please do not hesitate to ask.

MicroLAB contains a number of electronic sub-systems, these include the ESM controller unit, the motor drivers and the detector interface. The motor drivers and detector interfaces are individual intelligent devices that are controlled by the ESM.

Each motor and detector module has its own microprocessor built-in and is configured as a peripheral to the main controller. The peripherals are located on a "bus" and this bus arrangement is called the Serial Peripheral System (SPS). Accordingly the motors and detectors are called SPS devices and each has an individual two-character address.

Detector



The colorimeter design is shown in a block diagram below and in its most simple form consists of a capillary tube with an LED light source at one end and a photodiode detector at the other. The sample is injected into the pathlength between the light source (A) and the beam measurement detector (C). The intensity of the light source is monitored with a further detector (B).

The light from (A) passes through a broadband interference filter (X) selected at the peak spectral response of the chemical method to be used. The beam then travels through the sample and when it emerges from the capillary it passes through a narrow-band interference filter (Y) also selected at the peak spectral response of the dye. Finally the light is incident on (C) the beam detector.

The light intensity is set accurately by the LED drive and a feedback mechanism that uses photodiode (B) to monitor the light launched into the sample. The light launched into the sample is know as the "source" value and the light out is called the "color" measurement. The beam intensity is normally set algorithmically using feedback or can be set directly using the digitally adjustable LED current.

The inlet has a bubble trap that is designed to prevent bubbles from building-up in the capillary. It is important that the inlet to the colorimeter is connected to the valve. Reverse connection will cause measurement noise. The inlet tube is indicated by a dot on the detector cover.

Detectors with various pathlengths and wavelengths are available as standard and determine the analytical method and sensitivity. In accordance with the Beer-Lambert law shorter pathlengths have greater range and longer pathlengths have greater sensitivity.

Custom pathlength and wavelength detectors are available to special order.

Devices & Controls

- Valve motor / gearbox
  - Rotate (clockwise & counter-clockwise), align valve
- Syringe Motor
  - Insert and retract plunger
- Detector
  - Set-light intensity, measure beam, heat, hold temperature.
- Analog instrument
  - Temperature probe, chlorophyll fluorometer, etc.

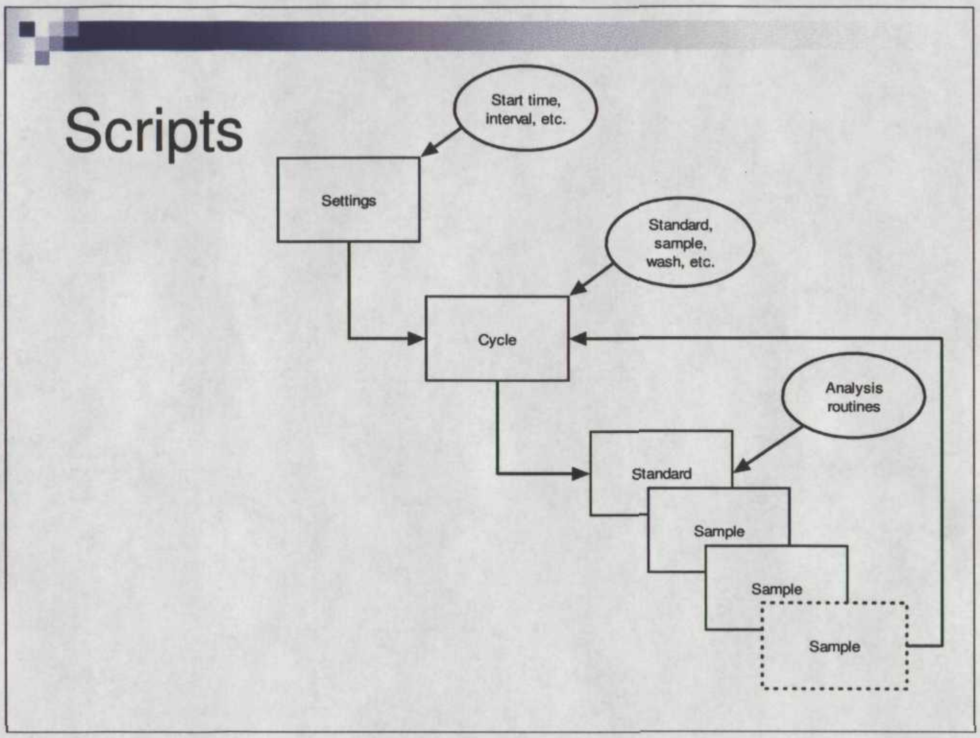
MicroLAB provides a flexible approach to configuration and control of the motors and detectors via the integrated scripting language and NutrientDATA 2 .

It is important to understand that MicroLAB operates by controlling the SPS and external devices and these are shown in the table below:

Device	**Controls**
Valve motor / gearbox	Rotate (clockwise & counter-clockwise), align valve
Syringe Motor	Insert and retract plunger
Detector	Set-light intensity, measure beam, heat, hold temperature.
Analog instrument	Temperature probe, chlorophyll fluorometer, etc.

To take a blank measurement MicroLAB would follow the command sequence below:

1. Align valve
2. Move valve to inlet
3. Retract plunger
4. Move valve to detector
5. Insert plunger
6. Set light
7. Measure beam



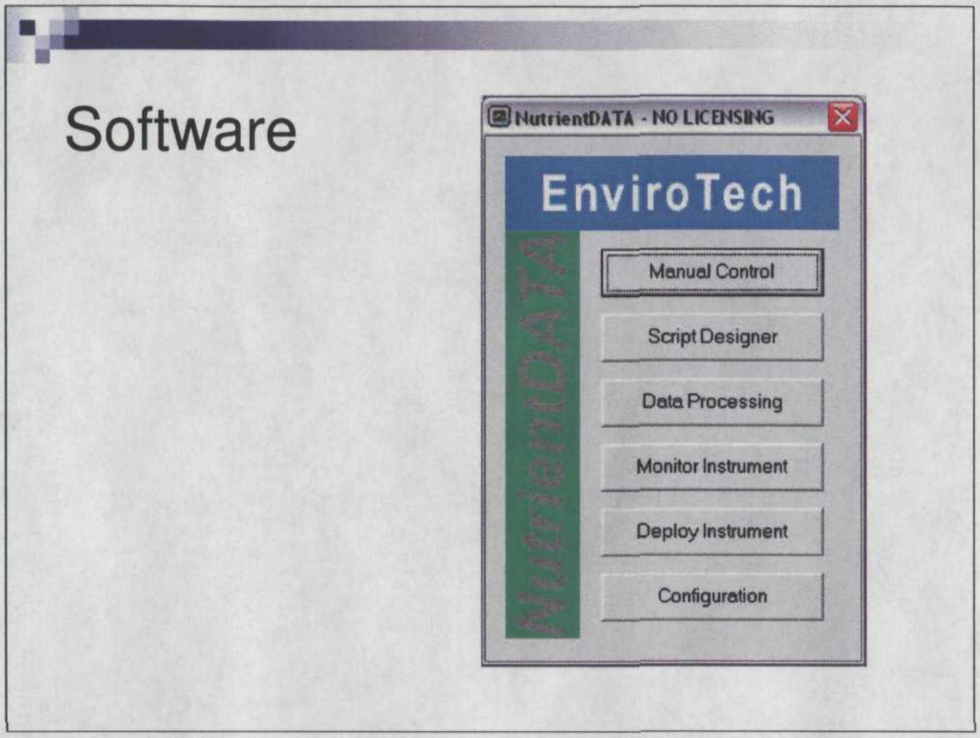
MicroLAB performs chemical routines by following scripts that are uploaded into memory. Your MicroLAB will be factory configured. Default or specially designed scripts (if requested) will be provided on your CD or via email.

Normally you will simply run the default chemistry routines. However, if you wish to change the chemical routines you are able to design and upload your own scripts using the NutrientDATA 2 Script Designer.

The analysis scripts, such as the sample and standard are a sequence of commands that operate the valve, syringe and detector and ultimately perform the analysis routine.

The analysis cycle script defines the sequence of sample, standard and other analysis scripts.

The settings determine the master controls such as sample interval, deployment duration and detector light intensity.



NutrientDATA 2 is an EnviroTech LLC software product that provides an easy to use interface to MicroLAB. Features include: Manual controls, instrument configuration, deployment programming, analysis routine set-up, bench testing, data download, data processing & calibration

The NutrientDATA Control Panel is displayed after the splash screen and provides the following options:

Manual Control
Manual control of instrument functions (insert plunger, move valve, etc.)

Script Designer
Edit, upload and run scripts for automatic analysis

Data Processing
Download and process recorded data

Monitor Instrument
Check serial output from MicroLAB

Deploy Instrument
Start MicroLAB auto-sampling routine

Configuration
Configure communications, time & date and software licenses

Demonstration (if-self training postpone until the next session)

1. Click on each Control Panel button to view the individual dialogs
2. Work through the Manual Control exercise in the manual section 16.1 / p.117
3. Open the script file and read through a few lines of the Sample(S) script

Deployment Frames

A stainless steel deployment frames are available from EnviroTech LLC.

In-line deployment frame

The frame is made from heavy gauge material with a tie bar designed to take a through load or be attached to a mooring line. The deployment frame includes clamps for MicroLAB.

Bottom deployment frame

For shallow water applications or bottom deployments a pyramidic deployment frame is available. This is made from heavy gauge stainless steel with anchor points for additional ballast, ground lines and marker floats.

Summary & Questions

- Overview of MicroLAB and component parts
- Next: Practical MicroLAB session
- Practice makes perfect
- Please provide feedback on training

This ends the first section of the training.

Please remember to allow sufficient time to practice with your MicroLAB before your first deployment. You should perform one mock deployment, even on the bench-top, at the very least.

Classroom Training

For class-room on-site training there we be a break shortly and then we will proceed onto hands-on practical training.

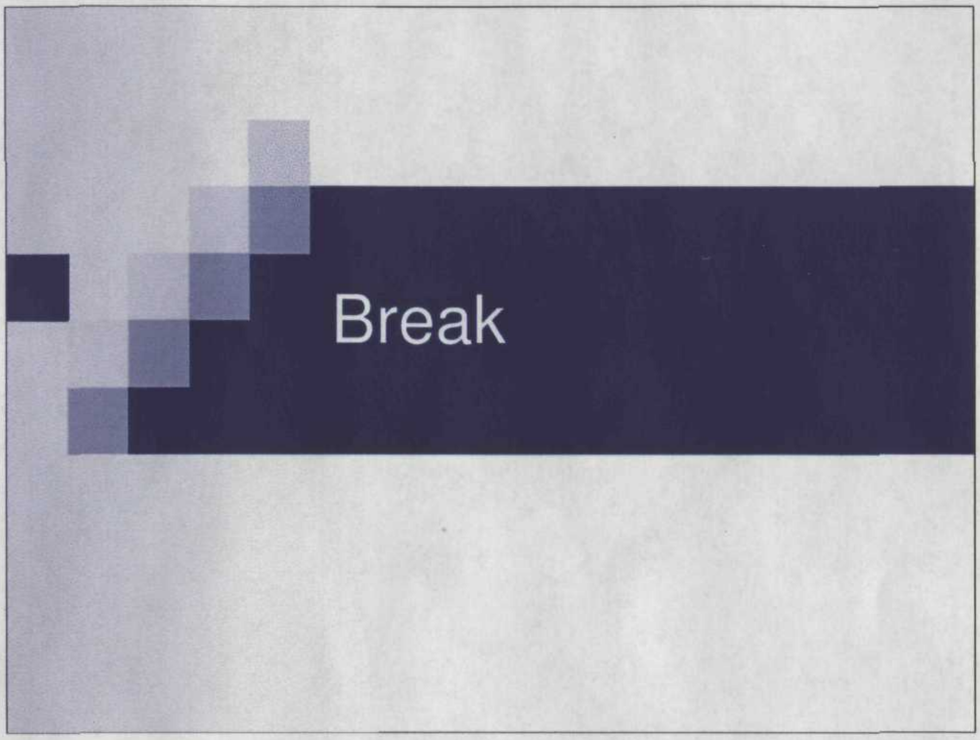
Self-Training

For self-training we recommend that you now work through the MicroLAB Quick Start Guide.

More Information

- Comprehensive manual
- Website resources
  - Manuals, articles, software, help desk
- Help Desk
  - envirotechinstruments.com/help.htm
  - help@envirotechinstruments.com

Further information and help is always available. Please do not hesitate to use the Help Desk or contact us directly.



Coffee anyone?!