

BPC[®] Blue Handbook

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BPC® Blue Instrument Overview

The perfect tool for determining the biodegradability of materials

A fully automated, analytical platform designed to easily, accurately and efficiently measure the gas flow and volume *generated or consumed* during fermentation or biological respiration processes.

Its user-friendly software makes the online monitoring and control of the experiments possible through any smartphone, tablet, or computer anywhere and at any time.

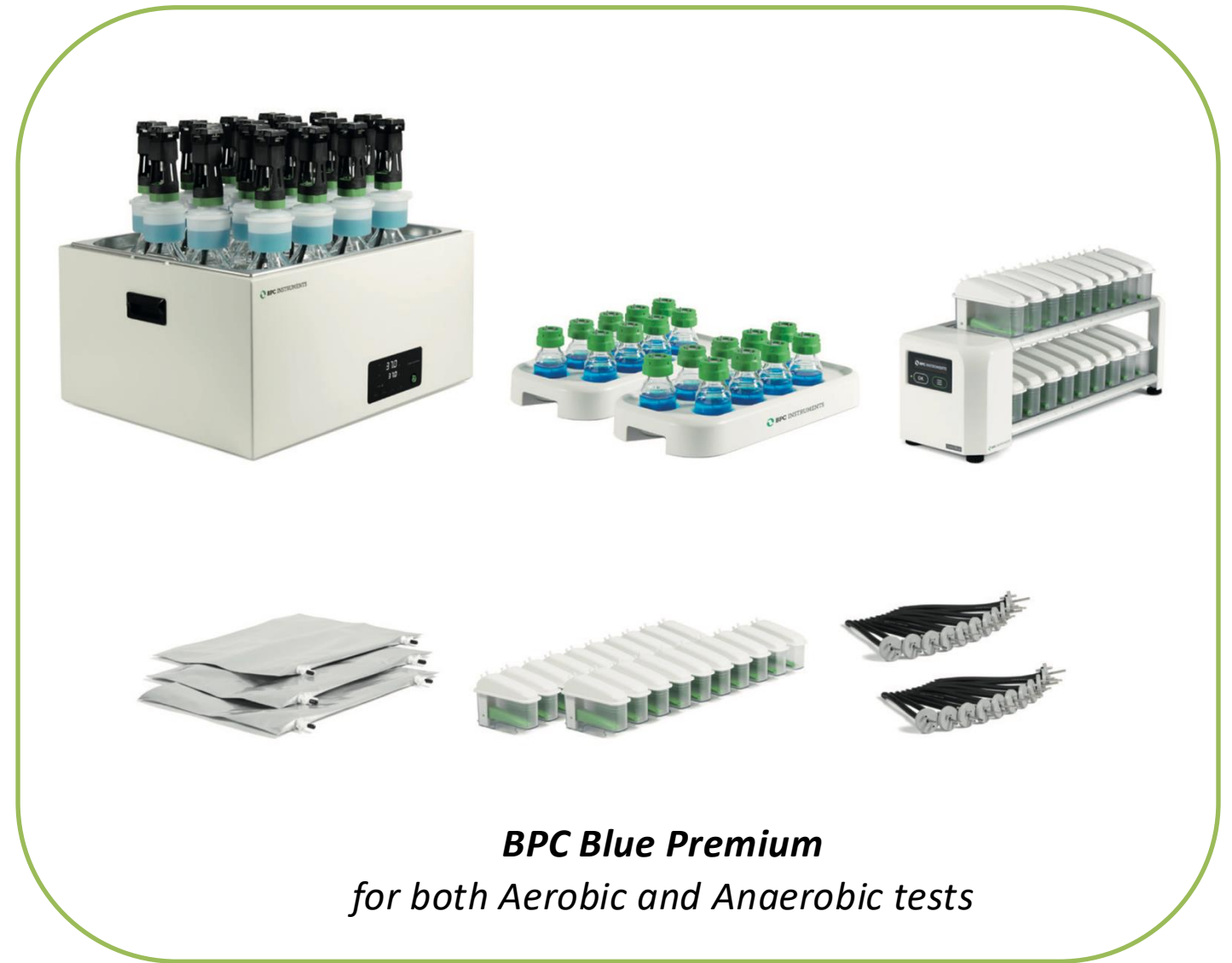
It provides real-time kinetic information and the level of biodegradation of polymers under aerobic or anaerobic conditions. This evaluation can be performed considering different environments following specific procedures in accordance with various international standard methods.



BPC Blue Premium

18 independently operating reactors each connected to 18 Flow Cell Units for simultaneous gas volume detection, suitable for both Aerobic and Anaerobic biodegradability tests

BPC® Blue Instrument Configurations



Each configuration of BPC Blue is available in two versions:

- **Standard** 18-channel version
- **Light** 9-channel version

Biodegradability Norms and Standards

Determine the biodegradability of a material according to a large number of standards:

Anaerobic biodegradability

- ISO 14853 – ultimate anaerobic biodegradation of plastic materials in an aqueous system
- ISO 13975 – ultimate anaerobic biodegradation of plastic materials in controlled slurry digestion systems
- ISO 15985 – ultimate anaerobic biodegradation and disintegration under high-solids anaerobic digestion conditions
- ISO 11734 – ultimate anaerobic biodegradability of organic compounds in digested sludge
- ASTM D5511 – anaerobic biodegradation of plastic materials under high-solids anaerobic digestion
- ASTM D5210 – anaerobic biodegradation of plastic materials in the presence of municipal sewage sludge
- ASTM D5526 – anaerobic biodegradation of plastic materials under accelerated landfill conditions
- OECD 311 – anaerobic biodegradability of organic compounds in digested sludge

Aerobic biodegradability

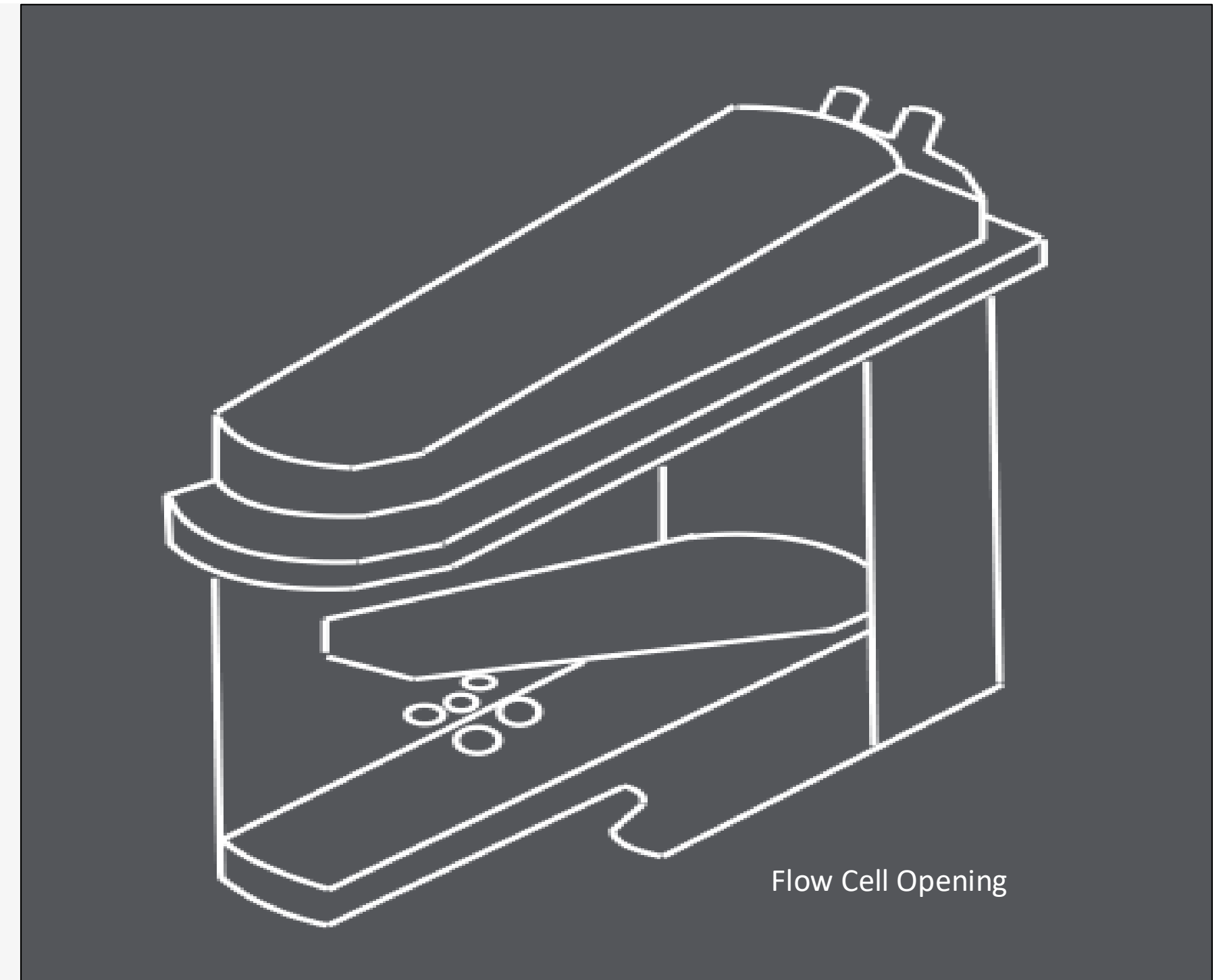
- ISO 14851 – ultimate aerobic biodegradation of plastic materials in an aqueous system
- ISO 17556 – ultimate aerobic biodegradation of plastic materials in soil
- ISO 18830 – aerobic biodegradation of non-floating plastic materials in a seawater/sandy sediment interface
- ISO 23977-2 – aerobic biodegradation of plastic materials exposed to seawater (part 2)
- OECD 301 – ready biodegradability of chemical materials in aerobic aqueous medium

Detection Unit: Working Principle

Gas is collected under a flow cell in a chamber filled with water. While the flow cell is in its horizontal sitting position, a magnet located at its end is in contact with a sensor below it.

Once a certain gas volume (i.e., 2 or 9 mL depending on the measurement resolution) has been collected in the Flow Cell Unit (FCU) chamber, the force of buoyancy leads the flow cell to open and release the entrapped gas.

The system counts each flow cell opening while registering the environmental temperature and pressure. This information is then used to calculate and normalise the gas flow rate and volume to standard conditions (i.e., 1 atm, 0 °C, and zero moisture content).

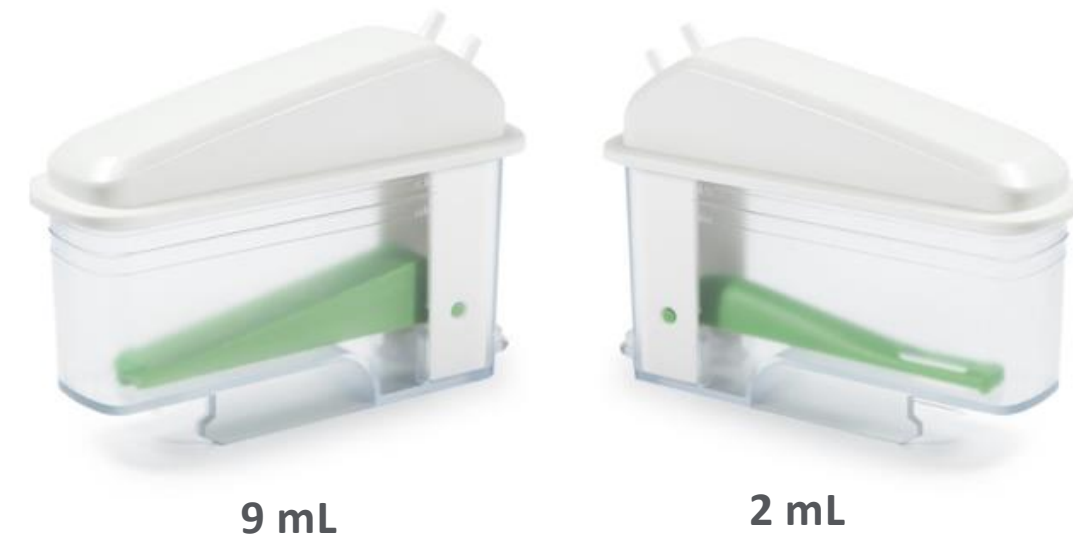


Flow Cell Unit

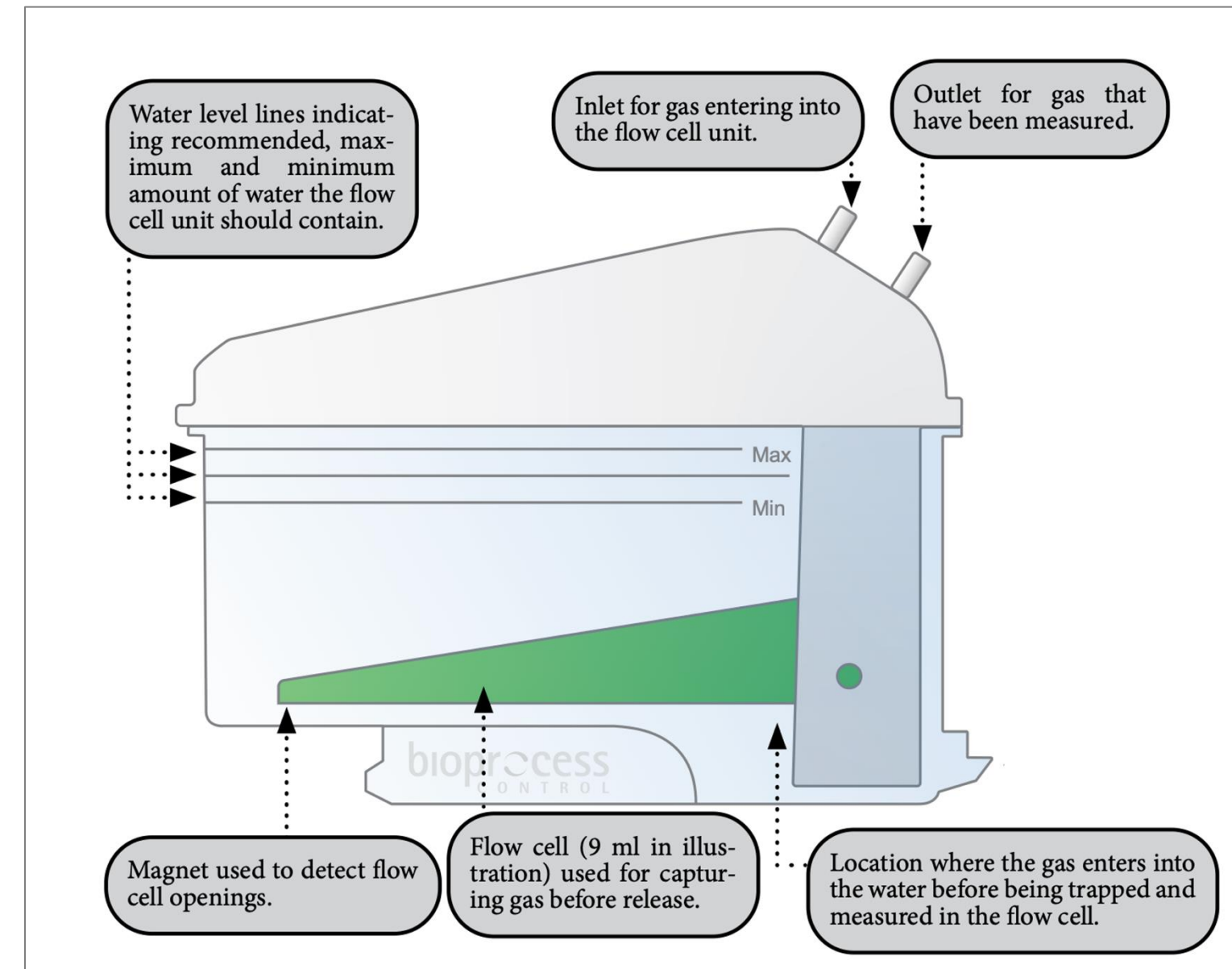
- Flow Cell Units (FCUs) are available in different measurement resolutions, 9 and 2 mL, for low and ultra-low gas measurements.
- FCUs can be easily removed from the detection unit, replaced and placed back.



Standard BPC Core Blue detection unit (18 channels)



Flow Cell Units are filled with a low amount of water and provide a closed system. This way, they can detect even the gases with high solubilities in water (e.g., biogas, CO₂)



BPC[®] Blue Anaerobic System

BPC® Blue Anaerobic Biodegradability – How Does It Work?

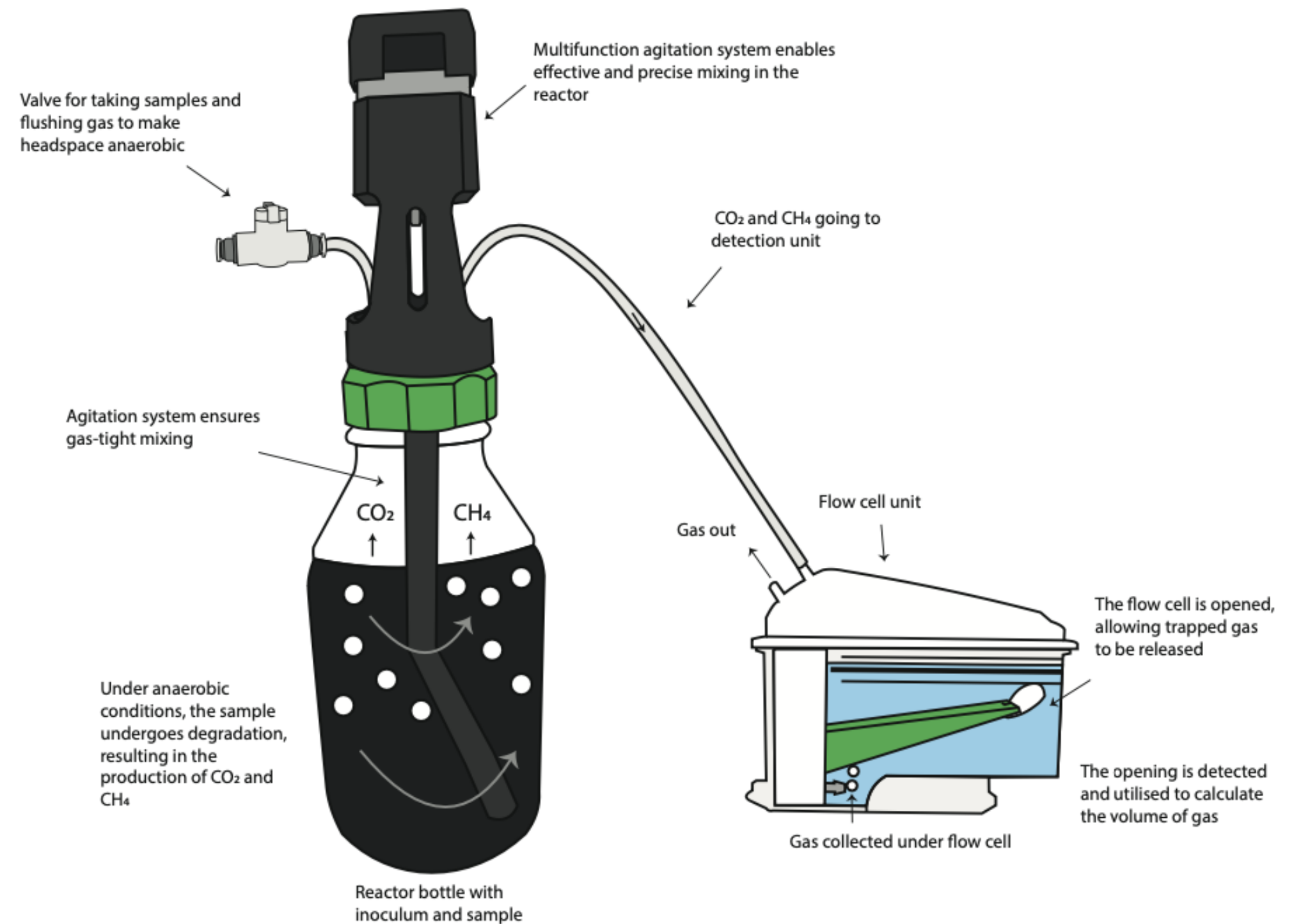
The system operates on a mechanism based on biogas ($\text{CH}_4 + \text{CO}_2$) measurements.

Under anaerobic conditions, biodegradable materials are converted into methane (CH_4), carbon dioxide (CO_2), water (H_2O) and biomass.

The CH_4 and CO_2 produced in the bioreactor go to the detection unit, into the flow cell unit where the volume of produced gas is measured.

The recorded volumes can be adjusted in the software to account for variations in temperature, atmospheric pressure and water vapor.

The biodegradation rate and kinetics of the process can be visualised in the software.



BPC® Blue Anaerobic Configuration

UNIT A: INCUBATION UNIT

This is where the biodegradation process takes place. The provided 18 (1 L) or 9 (2 L) bioreactors are to be filled with your inoculum and sample and placed into the thermostatic water bath. Our thermostatic water bath allows temperature control up to 60 °C. It is provided with a lid to minimize water loss and ensure stable temperature control.

Each reactor is equipped with a brushless DC motor that ensures well-mixed content. A motor controller provides the power via motor cables, where all the motors receive the same information.

UNIT B: BPC CORE (DETECTION) UNIT

This is where the biogas ($\text{CH}_4 + \text{CO}_2$) is recorded and processed. This unit consists of 18 or 9 flow cell units (FCUs) for simultaneous gas volume detection from 18 or 9 independently operating reactors. The produced gas enters the flow cell unit where it is being measured. Data is stored directly on the core unit and can be accessed through a computer or internet connection.

Unit A



Default version (18 reactors)

Unit B



Light version (9 reactors)



Technical Specifications

Incubation unit:

Thermostatic water bath with either 18 x 1000 mL, or 9 x 2000 mL (Light) reactors. Temperature control up to 60°C with a precision of 0.2 °C.

Gas detection unit:

BPC Blue Core unit with 18 or 9 flow cell units (FCUs). Build in sensors: temperature, pressure, hall, accelerometer. It features an OLED screen that can display the IP address of the instrument, version of the software, current environmental parameters (temperature and pressure), and if the instrument is horizontally levelled.

Measurement resolution:

2 mL or 9 mL

Operation mode:

Batch anaerobic test

Agitation system:

18 or 9 brushless DC motor-driven stirrers (up to 200 rpm). Multifunctional mechanical agitation with adjustable interval, speed and rotation directions.

Software:

Pre-installed Aurora software. Accessed with web browser, no installation or internet connection necessary*

Data storage:

Locally.

* connection required for remote access

Delivery Check

BPC Blue Anaerobic Standard

Unit A – Sample incubation unit

1 Thermostatic water bath & 1 base tray
 1 Thermostatic water bath lid for 18 reactors (1 L)
 18 Glass reactors (1 L)
 18 Brushless DC motors
 15 Brushless DC motor cables 250 mm
 3 Brushless DC motor cables 500 mm
 1 Brushless DC motor cable 1500 mm
 1 Motor controller signal cable
 18 Axis couplings for brushless DC motors
 18 Stirrers GL 45 (1 L) standard
 1 Brushless DC motor power splitter
 1 Motor controller unit (MCU)
 1 MCU power adapter
 18 Push-in valves 6 mm

Unit B – BPC Core Unit

1 BPC Core
 18 Flow cell units (FCUs)
 36 Check valves
 1 Plastic syringe
 1 Main unit power adapter
 1 Ethernet cable

Other components

1 Festo tubing 50 m
 1 Funnel
 18 Tubing stoppers
 36 Push-in connectors 6 mm
 12 Soft binders 7/180 mm
 36 Multi-coloured marker clamps
 1 Bottle/tube opening tool
 FCU volume sheet

BPC Blue Anaerobic Light

Unit A – Sample incubation unit

1 Thermostatic water bath & 1 base tray
 1 Thermostatic water bath lid for 9 reactors (2 L)
 9 Glass reactors (2 L)
 9 Brushless DC motors
 6 Brushless DC motor cables 250 mm
 3 Brushless DC motor cables 500 mm
 1 Brushless DC motor cable 1500 mm
 1 Motor controller signal cable
 9 Axis couplings for brushless DC motors
 9 Stirrers GL 45 (2 L) standard
 1 Brushless DC motor power splitter
 1 Motor controller unit (MCU)
 1 MCU power adapter
 9 Push-in valves 6 mm

Unit B – BPC Core Unit

1 BPC Core
 9 Flow cell units (FCUs)
 18 Check valves
 1 Plastic syringe
 1 Main unit power adapter
 1 Ethernet cable

Other components

1 Festo tubing 50 m
 1 Funnel
 9 Tubing stoppers
 18 Push-in connectors 6 mm
 6 Soft binders 7/180 mm
 18 Multi-coloured marker clamps
 1 Bottle/tube opening tool
 FCU volume sheet

Setting Up The Instrument

Step 1: Unpack and place the thermostatic water bath and detection unit on a flat, level surface.



Thermostatic water bath for temperature control of the process

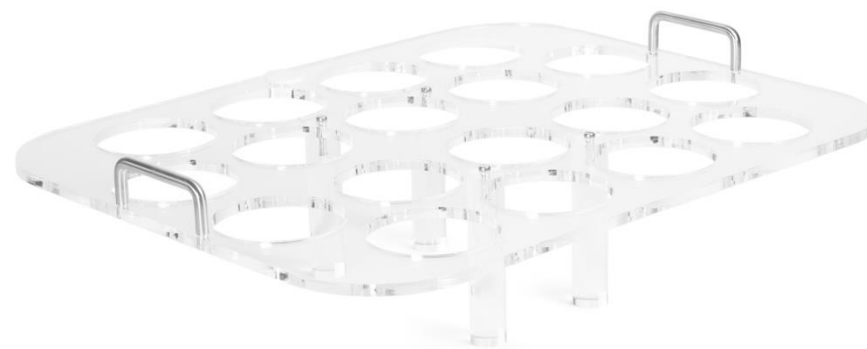


Detection unit

Step 2: Remove the blue plastic protection on the thermostatic water bath lid, mount the legs and handles and place the tray on the bottom and the lid on top of the thermostatic water bath.



Thermostatic water bath tray (place on bottom)



Thermostatic water bath lid for 18 bottles

Step 3: Add your sample and inoculum in the bioreactors. A funnel is provided to aid with the addition of samples in the bioreactor.

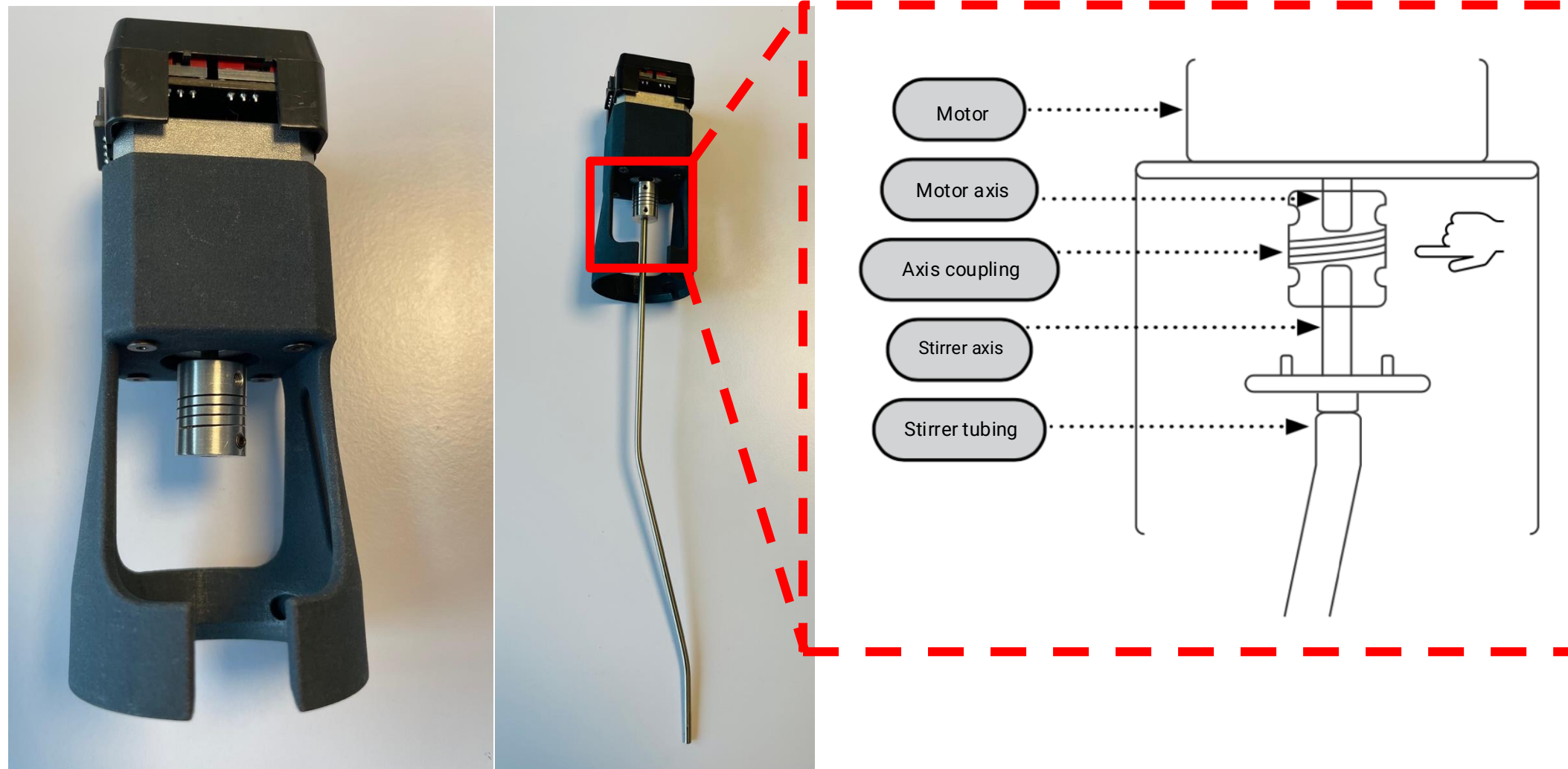
Note: Ensure the mixture of substrate and inoculum is well-mixed before closing the reactor.

Step 4: Assemble the bioreactors as shown below.



Setting Up The Instrument

Step 5: Assemble the DC motorized stirrer



Note: The motor axis and the stirrer axis should meet in the middle of the axis coupling (WITHOUT TOUCHING). If the stirrer axis puts tension on the stirrer tubing, it might, over time, drill a hole through the bottom of the stirrer and compromise the air seal of the setup. **Approximately 5 – 7 mm between the two metal shafts within the axis coupling is ideal.**

Step 6: Add the motor to the reactor by placing it on the top, with the metal rod going into the bioreactor and fitting into the stirrer.

Step 7: Add a piece of tubing to the push-in valve and attach it to one of the 2 ports on the lid. A tubing stopper could be also used instead of the push-in valve. The other port is the gas outlet.



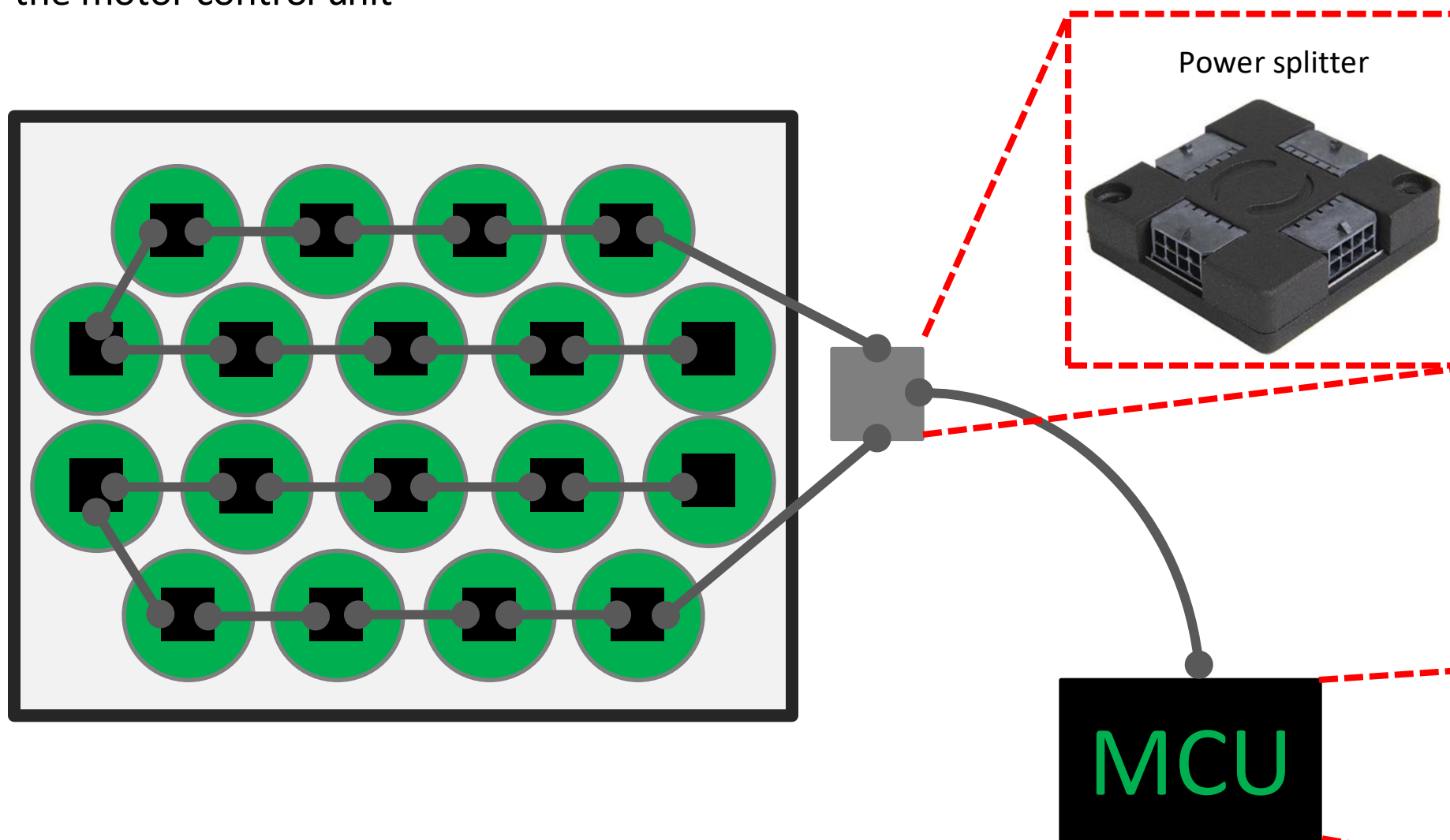
Step 8: Place the bioreactors inside the thermostatic water bath. Fill the water bath with distilled water until it reaches the lid.



NOTE: Check the water level in the water bath periodically.

Setting Up The Instrument

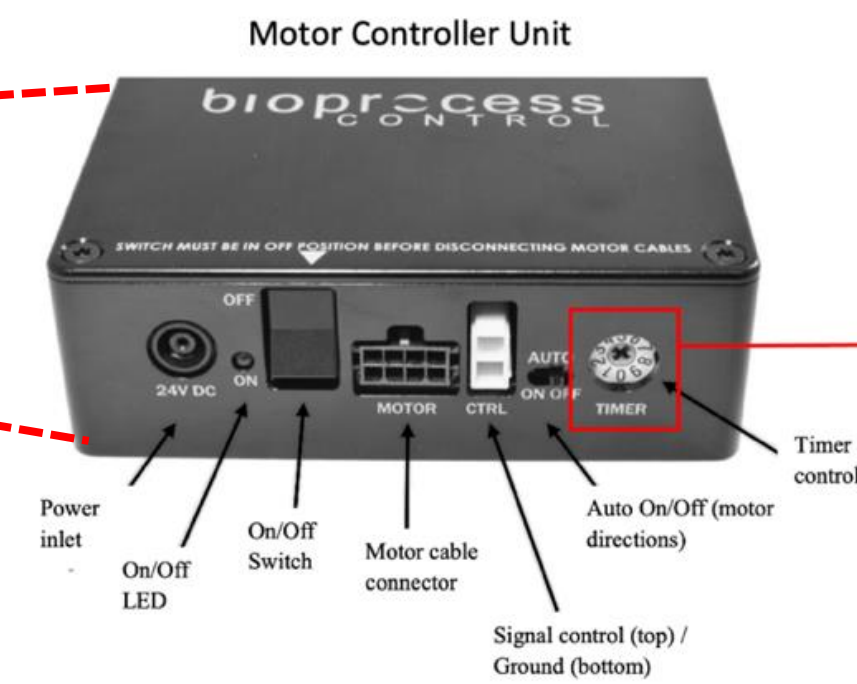
Step 9: Connect motors to each other (via brushless DC motor cables) and the motor control unit



Setting up the agitation system

- Connect the short motor cables (250 mm) in series – leaving one port free on the first and last motors in the chain. **See the image for a motor cable management guid**
- Connect one longer motor cable (500 mm) to the first motor and one longer cable to the last motor in the chain, and connect them to the motor power splitter
- Use the 1500 mm motor cable to connect the motor power splitter to the motor control unit (MCU)
- Connect the signal cable from the motor controller to the detection unit
- The MCU should also be connected to a power supply

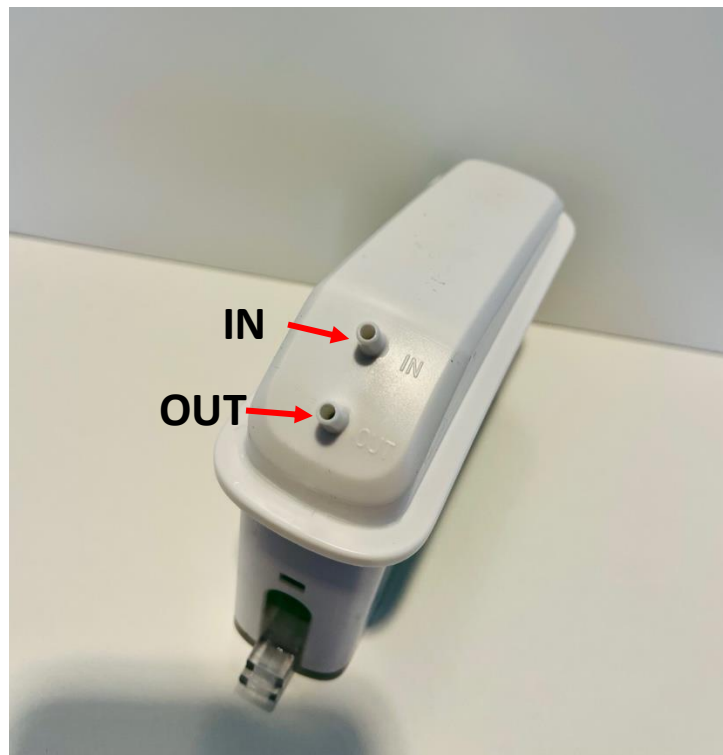
NOTE: Make sure that the power adapter for the motor controller is disconnected from the power supply when inserting or removing the motor cables.



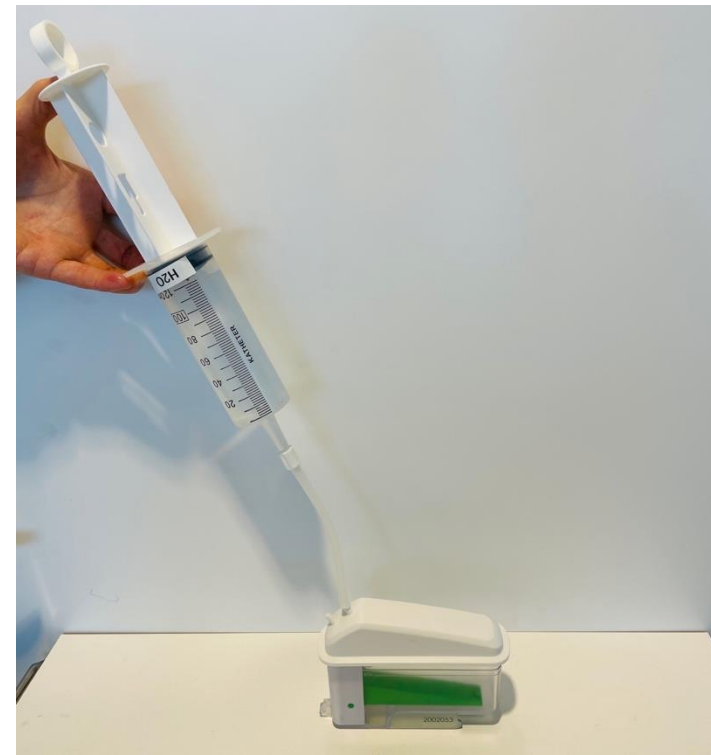
Timer position	Time (s)
0	5
1	15
2	30
3	45
4	60
5	120
6	300
7	600
8	1800
9	3600

Setting Up The Instrument

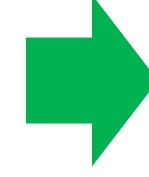
Step 10: Fill the flow cell units (FCUs) with distilled water.



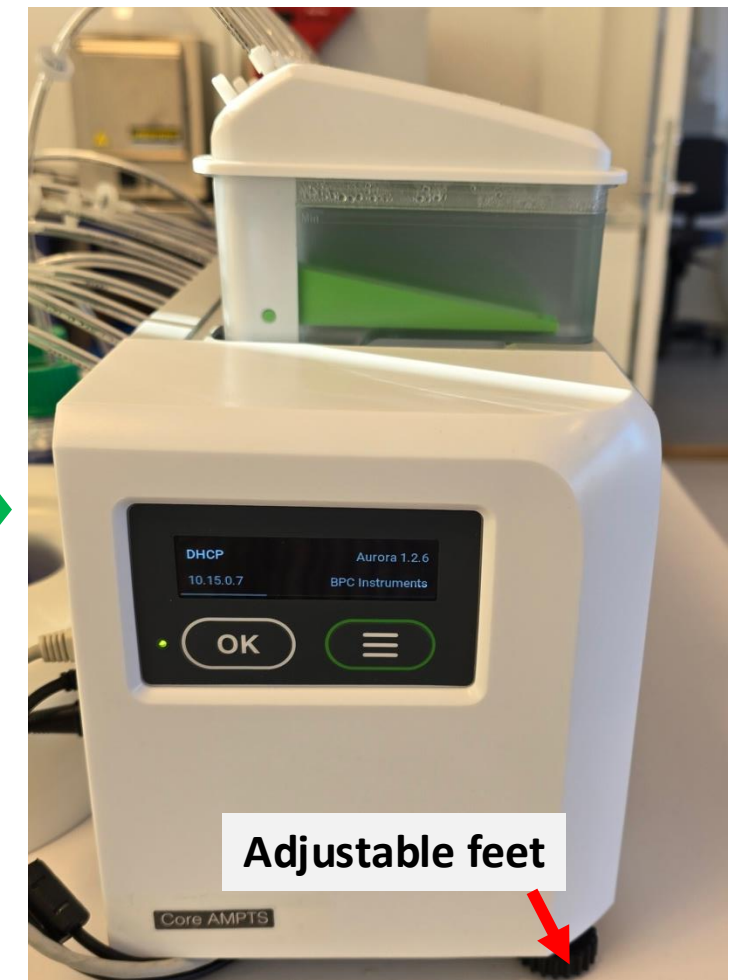
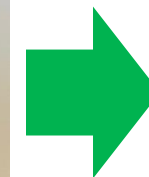
Each individual FCU has an inlet and an outlet for the gas.



Use the syringe to add water *via* the inlet of the FCU.



The water should be added until the recommended level is reached.



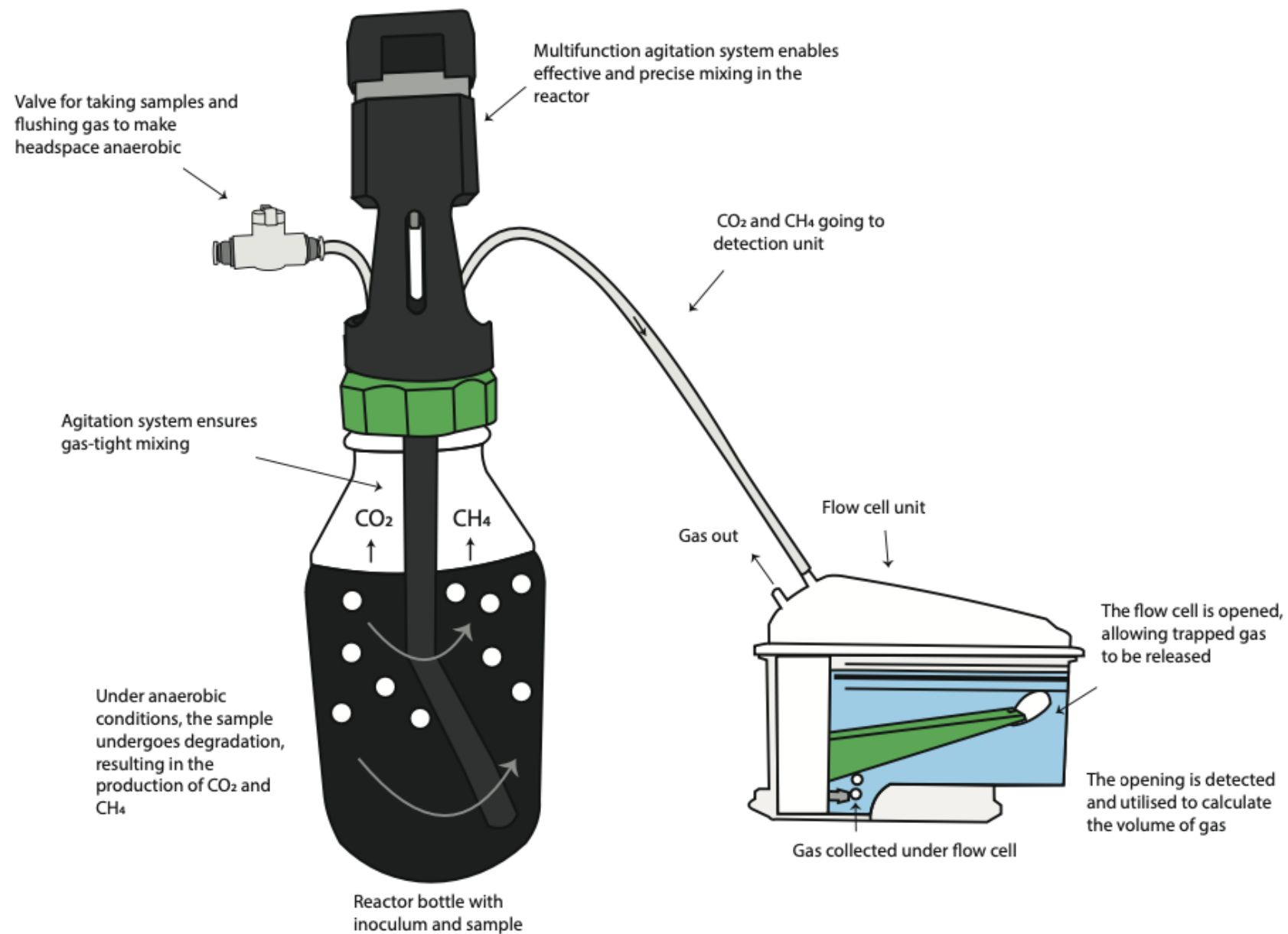
Make sure that each FCU is level on the core unit and seated correctly.

Check the FCU indicator or our **built-in levelling tool**.

Use the **adjustable feet** to level the detection unit.

Setting Up The Instrument

Step 11: Attach tubing between the reactor and detection unit.



TIP: Cut 36 (BPC Blue Anaerobic) or 18 (BPC Blue Anaerobic Light) pieces of Festo tubing sufficient in length to connect the gas outlet of each reactor to the corresponding FCU. In order to simplify this procedure, use push-in connectors (two per channel) provided with the instrument. To avoid water flowing back from Unit B to Unit A, check valves can be inserted close to the inlet of each FCU in order to the target substance flow in one direction only.



Use the softer binder to group tubing of channels that are related to each other. In order to easily identify each channel, add the multi-coloured marker clamps (two per channel) provided in different colors. Mark each channel by writing the proper description using a ballpoint pen, water-based pen, marker, etc.



Setting Up The Instrument

Step 12: Flush the system with nitrogen gas (or similar) - **optional**

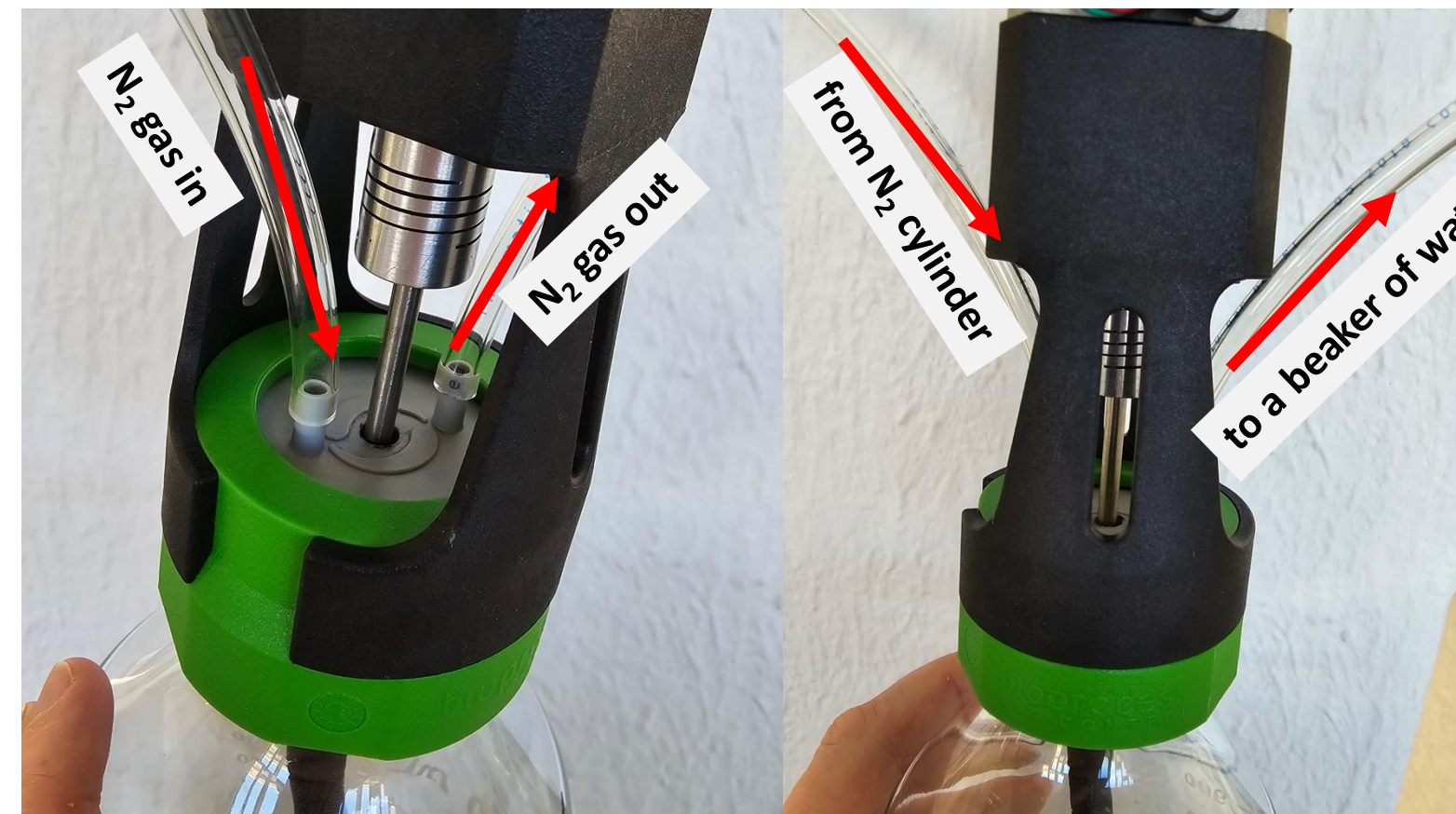
Flushing to create anaerobic environment:

To create an anaerobic environment, the reactors can be flushed with nitrogen gas (or another suitable anaerobic gas).



Set-up a nitrogen (or other gas) cylinder with tubing. Use a flow meter or beaker of water to check there is a reasonable nitrogen flow (not too strong)

NOTE: If you want to flush the reactors to create the anaerobic environment, disconnect the tubing from the BPC Core Unit beforehand to eliminate the risk of damaging the external check valves (if used) by the high-pressure gas flow.



- Taking reactors one by one:
- Disconnect tubing from the detection unit and place this tubing in a beaker of water. This allows us to monitor the flow of gas through the reactor.
 - Attach the nitrogen supply *via* the second port.
 - Flush the system for approximately 1-2 minutes. Keep this flushing time consistent for every reactor.
 - Reattach the tubing to the detection unit quickly and repeat for the next reactor.

Top Tip: For flushing it is helpful to have two people, one to flush the system and one to attach and reattach tubing quickly.

Connecting The Instrument

Step 13: Connect the detection unit.

- Connect to the power supply
- Connect to the internet connection/ethernet port (for remote connection) or directly to your computer *via* the ethernet cable
- Check instrument **green light** is on
- Connect to the motor control unit (MCU) when necessary



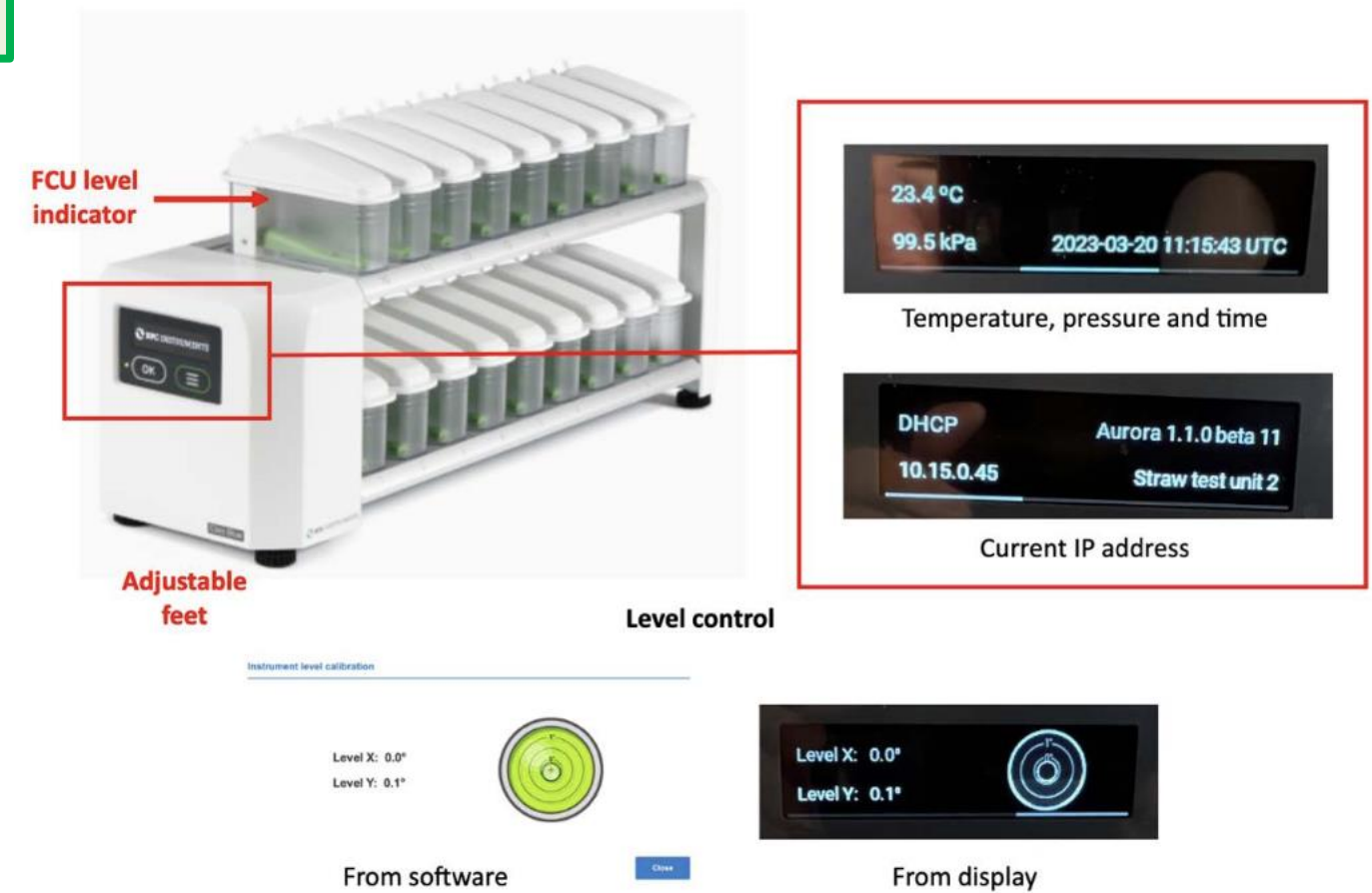
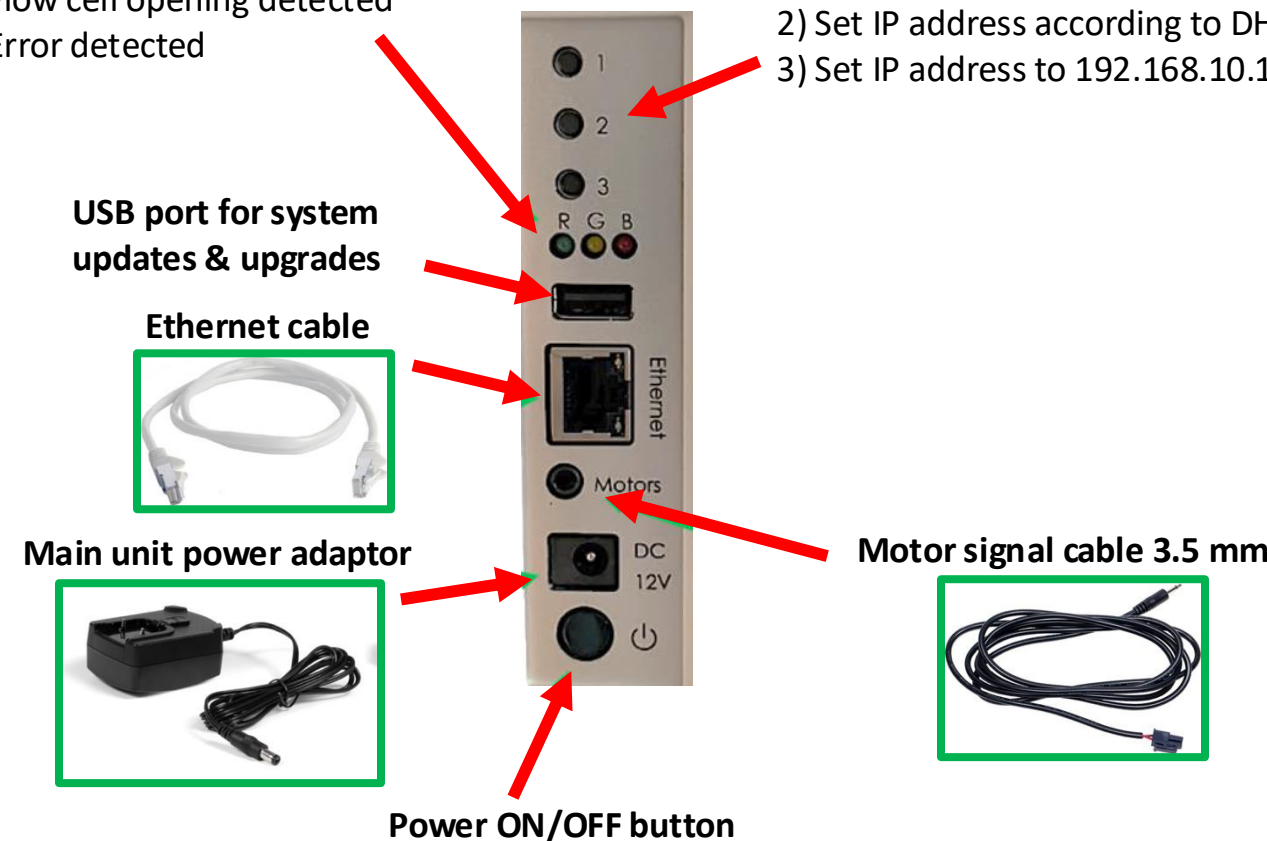
Connected instrument

Instrument status lights:

- Instrument has booted properly
- Flow cell opening detected
- Error detected

Functions:

- 1) Reset password
- 2) Set IP address according to DHCP server
- 3) Set IP address to 192.168.10.11



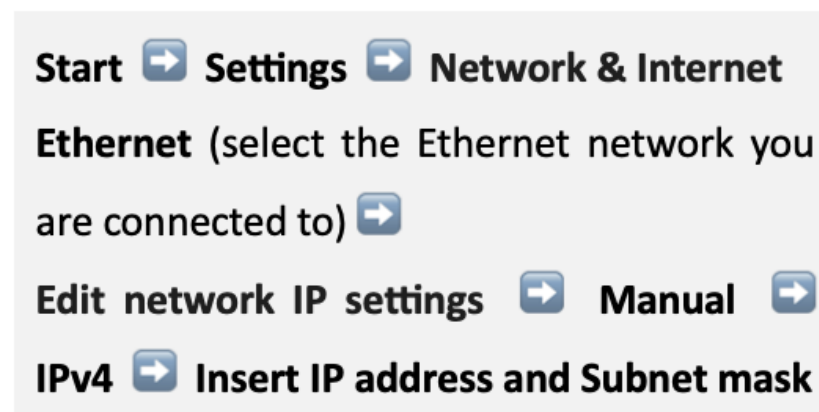
The BPC Core Unit is equipped with an OLED screen that provides information regarding the status of the instrument (environmental conditions, time, current IP address used by the instrument and alignment indicator). This can be accessed through two physical buttons located below the screen.

Connecting The Instrument

Step 14: Access the software

a. Connecting directly to computer:

- Ensure the ethernet cable is plugged into your computer directly



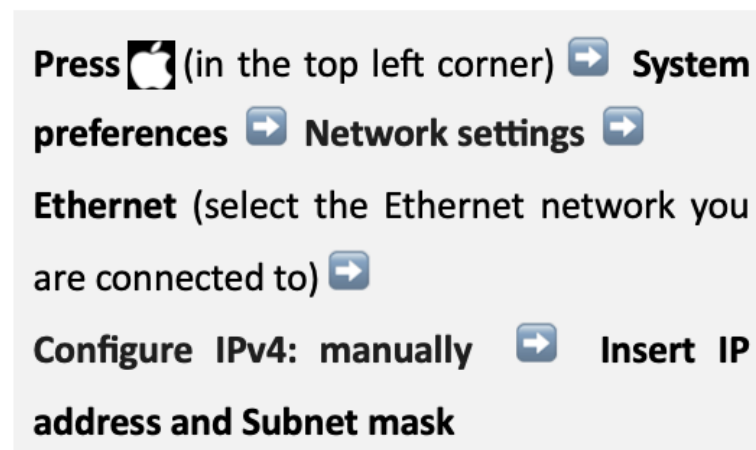
IP address:

Subnet mask:

Default gateway:



Windows 11



Configure IPv4:

IP address:

Subnet mask:

Router:

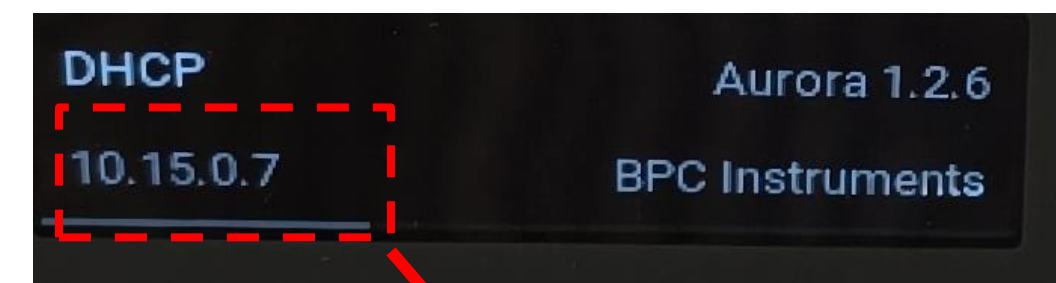


Mac OS 12.x

- Open a browser (Google Chrome recommended) and type in the default IP address **192.168.10.11**
- Log-in to the software (default password **bpc**)

b. Connecting remotely:

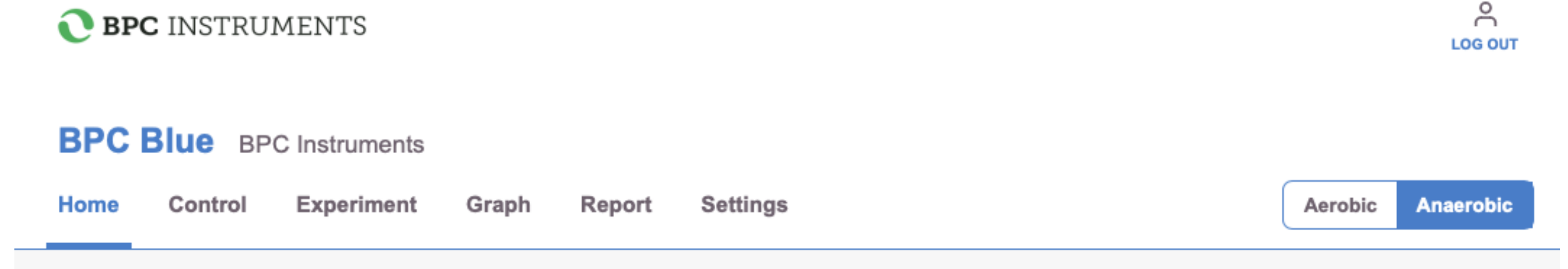
- Ensure the ethernet cable is plugged into the network
- Open a browser (Google Chrome recommended) and type in the IP address of your instrument - if you are unsure this can be found via the instrument OLED screen
- Log-in to the software (default password **bpc**)



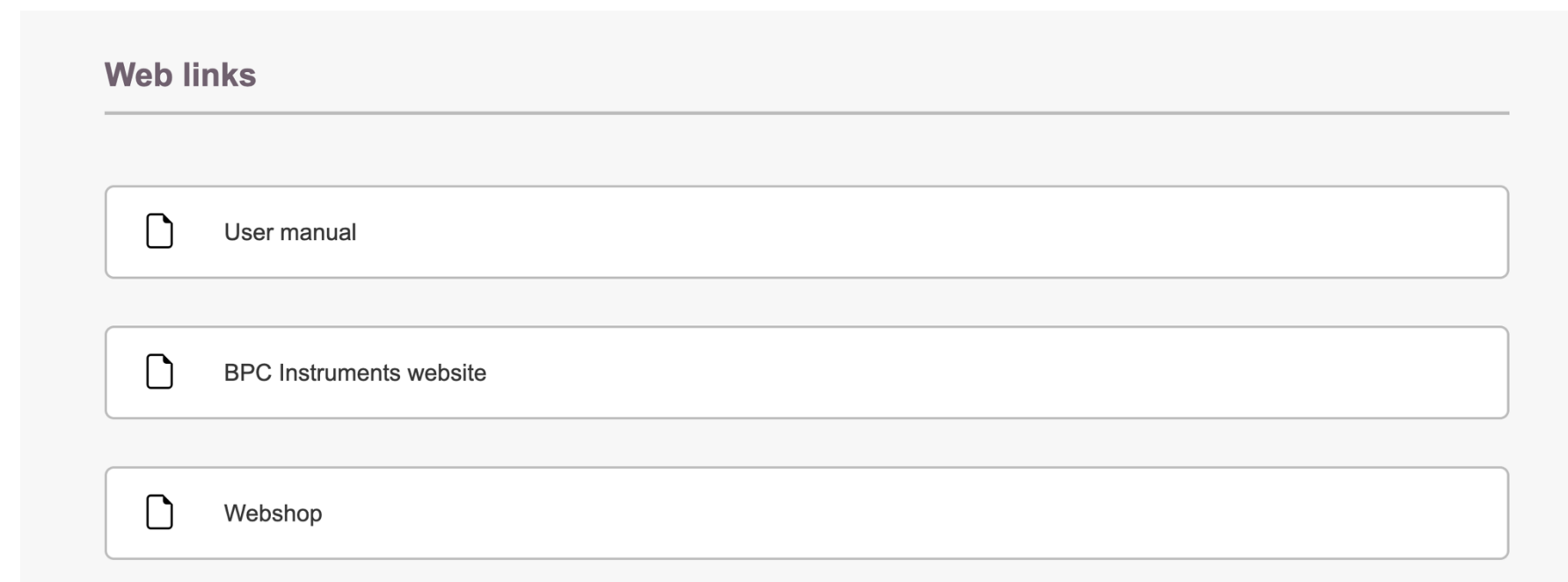
Instrument IP address

Software - Home

When you open the software via a browser, you will first be asked to login. Default password for our instruments is **bpc**



On the home page you will find the navigation menu and a “Log out” button (above) as well as links to our website and user manual (below). Here is also where you can choose between aerobic and anaerobic mode.



Software - Control

BPC Blue BPC Instruments

Home **Control** Experiment Graph Report Settings

Aerobic **Anaerobic**

Lines

Line	Name	Cell volume [ml]	Control	Status	Started [UTC]	Duration
1	Line 1	9.07	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
2	Line 2	9.09	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
3	Line 3	9.10	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
4	Line 4	9.07	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
5	Line 5	9.07	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
6	Line 6	9.13	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
7	Line 7	9.12	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
8	Line 8	9.16	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
9	Line 9	9.12	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
10	Line 10	9.00	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
11	Line 11	9.14	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m
12	Line 12	8.97	<input type="checkbox"/>	Running	2024-03-13 13:05	12d 18h 19m

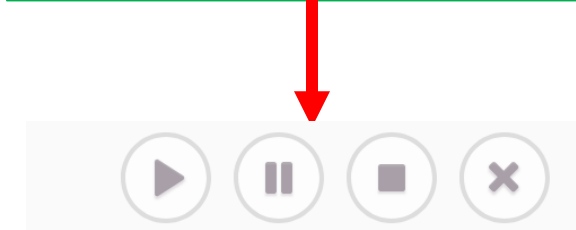
On the “Control” page you can:

- Allocate names and colours to each channel
- Enter FCU calibration values
- Control line recording and start/stop/pause recording
- View instrument status and experiment duration
- Control motor agitation system

FCU calibration values

Start/stop/pause lines (bottom of table)

Agitation controls



Line number & colour

Sample name

Status and duration

Agitation Motor power

Phases Single Double

Speed [%]

	Speed [%]	Time [min]
Phase 1	<input type="text" value="30"/>	<input type="text" value="10"/>
Phase 2	<input type="text" value="10"/>	<input type="text" value="10"/>

Software - Experiment

BPC Blue BPC Instruments

Home Control **Experiment** Graph Report Settings

Aerobic Anaerobic

Samples

Add sample

Samples	Name	Total solids [%]	TOC [g C/g]	Delete
1	1g Cellulose	95.0	0.000	

Blank 1

Line	Name	Amount of inoculum [g]	Amount of sample [g]	Delete
4	1g Cellulose 1	100.0	1.0	
5	1g Cellulose 2	100.0	1.0	
6	1g Cellulose 3	100.0	1.0	

Add lines

Blanks

Add blank

Blank	Name	Delete
1	Blank (raw soil)	

Line	Name	Amount of inoculum [g]	Delete
1	Blank (raw soil) 1	100.0	
2	Blank (raw soil) 2	100.0	
3	Blank (raw soil) 3	100.0	

Add lines

On the “**Experiment**” page you can:

- Enter relevant parameters such as total solids (%), amount of inoculum and sample
- Insert TOC (Total Organic Carbon) in order to generate biodegradation rate graph
- Group samples and blanks according to replicates
- Allocate a blank to each sample

Add and group samples

Input parameters

Allocate a corresponding blank

Add and group blanks

Software – Graph / Lines

The screenshot shows the BPC Blue software interface. At the top, there are navigation tabs: Home, Control, Experiment, Graph (selected), Report, and Settings. On the right, there are buttons for 'Aerobic' and 'Anaerobic'. Below the navigation, there are three main sections: 'Lines', 'Groups', and 'Biodegradation'. The 'Lines' section contains a grid of 18 numbered buttons (1-18) and a 'Select/Deselect all' checkbox. Below this, there are two dropdown menus for 'Output unit' (set to 'Normalized volume [Nm]') and 'Rate unit' (set to 'Nm/day'). At the bottom, there is a graph titled 'Accumulated gas volume [Nm]' showing multiple colored lines representing different experimental runs over time.

On the “**Graph/Lines**” page you can:

- View real-time data in a graph form
- Change view settings such as normalisation function and gas flow units
- Select which lines you wish to view

Line selector

Units

Normalisation function

This block contains two separate graphs. The top graph is titled 'Accumulated gas volume [Nm]' and shows a line graph with multiple colored lines representing the total gas volume produced over time (0d to 60d). The y-axis ranges from 0 to 800. The bottom graph is titled 'Gas flow rate [Nm/day]' and shows a line graph with multiple colored lines representing the daily gas flow rate over time (0d to 60d). The y-axis ranges from 0 to 120. Both graphs include standard chart controls like zoom and pan.

Two viewable graphs

Accumulated gas volume

Gas flow rate

Software – Graph / Groups

On the “**Graph/Groups**” page you can:

- View real-time data in a graph form as average for each group of triplicates
- Change view settings such as normalisation function and gas flow units
- Select which groups you wish to view

Group selector

Units

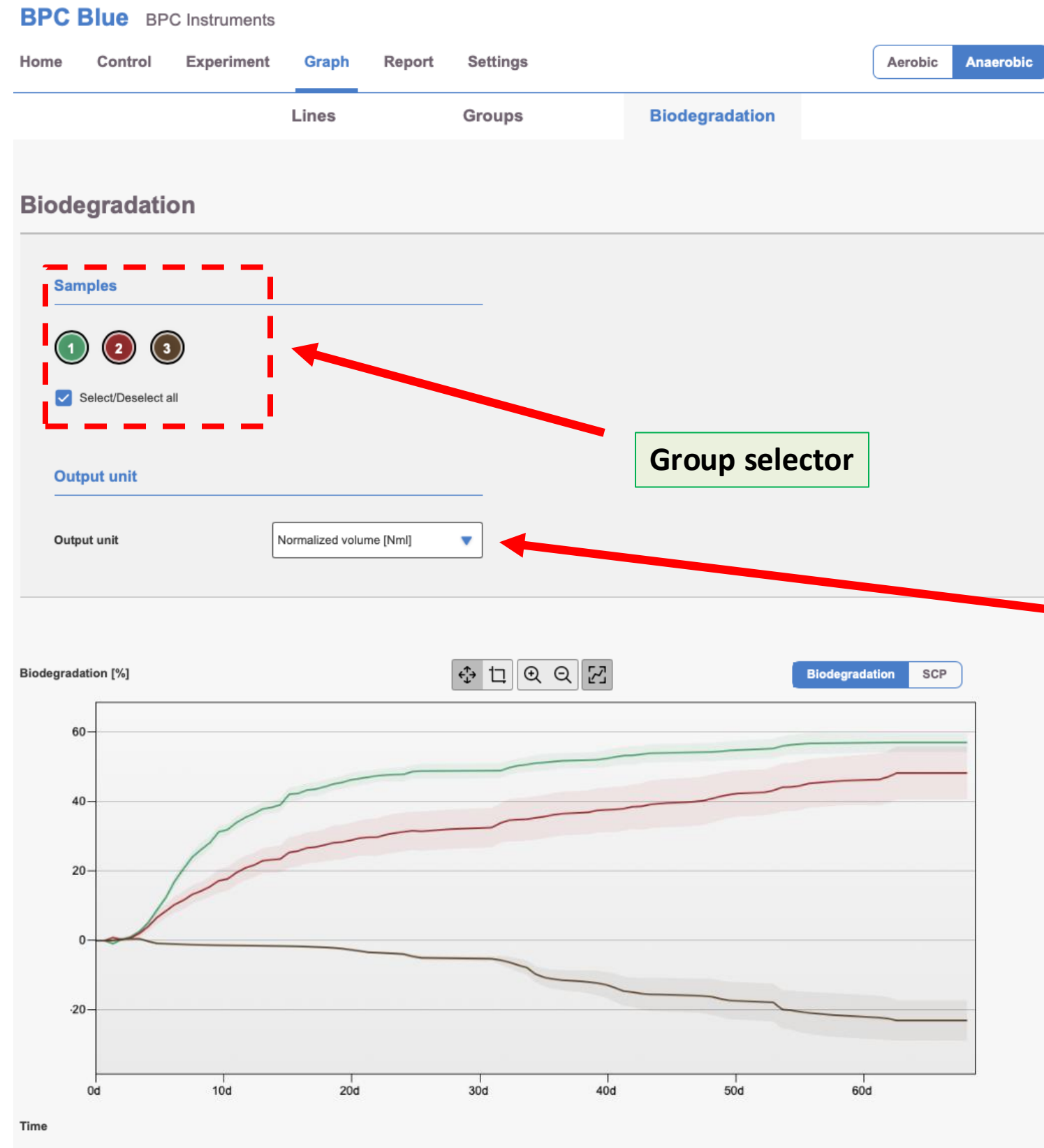
Normalisation function

Two viewable graphs

Average accumulated gas volume

Average gas flow rate

Software – Graph / Biodegradability



On the “**Graph/ Biodegradability**” page you can:

- View real-time biodegradation rate data in a graph form
- Change view settings such as normalisation function and gas flow units
- Select which groups you wish to view

Group selector

Normalisation function

Software - Report

BPC Blue BPC Instruments

Home Control Experiment Graph **Report** Settings

Aerobic Anaerobic

Lines

Groups

Download report

Line	Name	Status	Started [UTC]	Duration	Include	Raw data
1	Line 1	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
2	Line 2	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
3	Line 3	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
4	Line 4	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
5	Line 5	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
6	Line 6	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
7	Line 7	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
8	Line 8	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
9	Line 9	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
10	Line 10	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
11	Line 11	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV
12	Line 12	Running	2024-03-13 13:05	12d 18h 26m	<input checked="" type="checkbox"/>	CSV

On the “Report” page you can:

- Download individual or total reports of data
- Download both raw and normalised data
- Select which file format, units and gas normalisation the data should include

Download raw data

Download full report

Settings for reports

Report settings

Output unit: Normalized volume [Nm^l]

Gas flow unit: Nm^l/h

Interpolation interval: Day

Report file format: Microsoft Excel (XLSX)

Download reports

Software - Settings

BPC Blue BPC Instruments

Home Control Experiment Graph Report **Settings**

Aerobic Anaerobic

System information

System information

Software version	Aurora 1.2.6
Hardware version	1083-5.3.1-210-r4
Serial number	1100-3100-1100-1047

Software licenses

Copyright BPC Instruments AB

Show open source licenses

Calibration settings

Time settings

Instrument	26/03/2024, 08:30:04
Web browser	26/03/2024, 08:30:11

Synchronize now

Instrument level calibration

Instrument level calibration

Reset accelerometer

Show level

On the “**Settings**” page you can:

- Check system information and software licenses
- Calibrate time, date, instrument level, temperature and pressure
- Change instrument name and password
- Reset to factory/default settings
- Adjust network settings
- View system warning (error) log

System warning log

System ok, no warnings

Clear log

Warning! Do not change time/date settings while the system is running

Before starting the experiment

Simulate openings

Testing the detection unit and software:

- Before starting the experiment, simulate a flow cell opening by manually removing each FCU and put it back in numerical order from 1 to 18 (repeat this procedure three times).
- Follow the corresponding result of each opening on the plots on the graph page of the software to make sure that both the detection system and data acquisition system function properly.

After the experiment is finished

Finishing steps once the experiment is finished:

- Generate and download a report on the report menu of the software.
- Turn off the thermostatic water bath and the motors, including the motor controller.
- Next, unplug the power adapters (for the Motor Controller and the Gas Volume Measuring Device) from the power source.
- Disconnect the tubing and remove the lids from the reactors. Removing these components after experiments can often pose a challenge due to their tight fit, specially the tubing to the different connectors. BPC Blue Configurations are equipped with a bottle/tube opening tool to easily remove lids and tubing without the risk of damaging them and the connectors.



Bottle / tube opening tool

What else can BPC Instruments offer you?

Online Training

BPC Instruments can provide online trainings to all our new customers. Our expert team is ready to help you start your first experiment and ensure the instrument is working correctly.

Continuous Support

Most of our team members are scientists and engineers who are experts in their field. We are always ready to answer your questions and happy to assist!

Compare Results with Laboratories Worldwide

Real-time temperature and pressure compensations minimise the impact of possible variation in measurement conditions. Thus, you can compare your data with different laboratories around the world easily.

Scientific References

You can rely on our products just as many of our customers from academic institutions, universities and key industrial players worldwide. Check our selection of more than 1000 scientific references available on our website.