

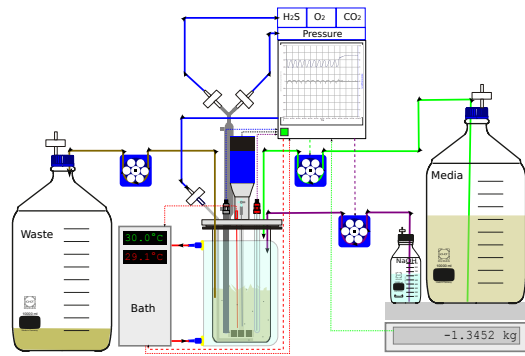
# 1<sup>st</sup> QTB PBR Hack'a'thing

Soldering for and by beginners.

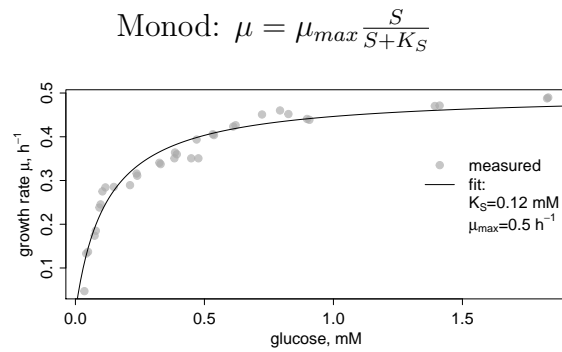
March 2–4, 2016

## Contents

<b>1</b>	<b>PBR Hack'a'thing Projects</b>	<b>2</b>
1.1	Gas Flux: Gas'o'meter . . . . .	2
1.2	Liquid Flux: Continuous Culture & Turbidostat . . . . .	3
1.3	Light Flux: Spectrometer . . . . .	3
1.4	Heat Flux: Water Bath Thermostat . . . . .	4
1.5	The Kaiten Eppi: Automated Sampling Device . . . . .	4
1.6	Single Cell Biology: Microfluidic Device . . . . .	4
1.7	The Server . . . . .	5
<b>2</b>	<b>Program</b>	<b>6</b>
2.1	Day 1 <12:00 : Building Bioreactors . . . . .	6
2.2	Day 1 >13:00 : Hack'a'thing I . . . . .	6
2.3	Day 2 : Hack'a'thing II . . . . .	6
2.4	Day 3 : Hack'a'thing III . . . . .	6
<b>3</b>	<b>Outlook: 2<sup>nd</sup> QTB PBR Hack'a'thing</b>	<b>7</b>
3.1	<i>Growth Dynamics</i> : Photobioreactors in Research . . . . .	7
3.2	<i>Single Cell Dynamics</i> : Microfluidic Devices . . . . .	7
3.3	<i>Omics</i> : Sterile and Automated Sampling Devices . . . . .	7



(a) Dougie's Reactor



(b) Snoep *et al.* 2009

Figure 1: Bioreactors

# 1 PBR Hack'a'thing Projects

## 1.1 Gas Flux: Gas'o'meter

**Project:** Extend existing setup, co2meter's O2 and CO2 sensors with Sainsmart's Arduino Mega+Touch screen; see directory `offgas/arduino` in <https://git.hhu.de/machne/PSIControl> for Arduino code

1. **code** sensor calibration routines via touch-screen (use PSI gas mixing system)
2. **build** water trap, tubing path from reactor, and casing for sensors and Arduino;  
**build** improved gassing system (glas blowers!) to allow lower flow
3. **build** & **code** interface to Aalborg XFM digital mass flow meter: connect the Aalborg's RS 485 interface to Arduino hardware serial Tx3/Rx3, and Ground
4. **build** & **code** valve control to measure several reactors; connect via Arduino software serial connections; perhaps attach to PSI Multicultivator

### Materials:

- Existing setup: **available**
- Aalborg XFM, with RS 485 interface: **available**
- Valve system for gas tubing, controllable *via* serial interface: **obtain**

## 1.2 Liquid Flux: Continuous Culture & Turbidostat

**Project:** build a module consisting of media and waste bottles, a reactor vessel, peristaltic pump(s), and a balance; pump and balance are controlled *via* serial interfaces from an Arduino+Touchscreen and/or Raspberry Pi. The flow rate is controlled *via* pump and recorded *via* the balance, dilution rate (depends on culture volume) is recorded or can be set.

1. **build** a simple reactor vessel (Schott bottles) with liquid media flow, from media bottles through reactor vessel and out to waste bottle; connect *via* tubing and pumps, record *via* balance
2. **build**: add gassing system of project 1.1
3. **build** & **code**: combine with 1.3 to make turbidostatic control

### Materials:

- Media bottles, screw caps with inlet/outlet openings, and tubing: **available** & **obtain**!
- Balance (e.g. Mettler Toledo PBK785-3XS/f): **obtain**
- Peristaltic pumps: ordered?
- Arduino: **obtain**

## 1.3 Light Flux: Spectrometer

**Project:** Simple spectrometric measuring tool based on AvaSpec-Mini2048L-U25

1. Basic: Connect to Raspberry Pi, using drivers provides by Avantes; **code** simple interface with display and/or recording functions
2. Advanced: use LED for absorbance, reflectance, or fluorescence measurements; **build** light paths and perhaps a reactor probe for online recording

### Materials:

- AVASPEC-MINI2048L-V25, Minispectrometer: **available**
- Fiber optic cables, VIS/NIR: 1 m, 200  $\mu\text{m}$  VIS/NIR and 1m, 600  $\mu\text{m}$ : **available**
- Raspberry Pi Version 1: **obtain**
- LED system: use PSI LEDs or **obtain**

- Reactor probe: **build** together with fine mechanics or glas blowers

## 1.4 Heat Flux: Water Bath Thermostat

**Project:** build a water bath for growth vessels, control T, read-out energy required for maintaining constant T and estimate the amount of heat withdrawn or administered

1.

### Materials:

- Jacketed reactor vessel: **build** or **obtain**
- Julabo water bath, e.g. F25-ME
- Arduino and/or Raspberry Pi

## 1.5 The Kaiten Eppi: Automated Sampling Device

**Projects:** build sterile and automated sampling device; using a controllable syringe pump, sampling into the Kaiten Eppi (automated: pump sample into tubes, potentially pre-filled with chemicals, vortex, and transport them into liquid N<sub>2</sub> or other storage containers)

### Materials:

- Sterile sampling device by HHU glas blowers: **available**
- Syringe pump: **obtain**
- Kaiten Eppi: **build**
- Sainsmart Arduino Mega & Touchscreen: **obtain**

## 1.6 Single Cell Biology: Microfluidic Device

**Project:** Basic microfluidics and live-cell imaging device; scratch growth chambers and liquid flow channels into microscope slide; attach 2–3 pumps; and control *via* arduino/screen

### Materials:

- Ilka's lab microscope: **available**
- Microscopy slides: **available**
- 2–3 peristaltic pumps for microfluidics: **obtain**
- Sainsmart's Arduino Mega + Touchscreen: **obtain**

## 1.7 The Server

**Project:** a master software running on a (detachable) linux desktop that synchronizes and speaks via a comon interface to all Arduino and Raspberry Pi modules; the modules themselves can interpret get, set and act impulses (use arguments only when absolutely necessary)

### Materials:

- `setTime(time_t t)`: sets the current master time to all modules
- `get(..., time_t t)`: get all values, currently available (with a time stamp), or from a previous time  $t$
- `act(..., time_t t)`: act (switch on and off), now or at future time  $t$

## 2 Program

### 2.1 Day 1 <12:00 : Building Bioreactors

Talks, 30-60 min:

- Rob's DIY Reactor - The Beginnings: The Captor - Arduino-controlled mini PBR
- Dougie's DIY Reactor - 20 yrs Later
- Avantes - Spectrometry: Spectrometry applications, incl. NIR for metabolite measurements and OD; software interface to Avantes spectrometers
- CellDeg - Optimizing Photosynthetic Growth: Introduction to CellDeg's 2.5 k Euro algal growth setup (overnight 30 g/L cyano biomass)

### 2.2 Day 1 >13:00 : Hack'a'thing I

- Introduction to the Gas'o'meter: connecting sensors with Arduino, making an autonomous measurement device via Sainsmart's Touch Screen
- Introduction to Rob's reactor: complete setup for photosynthetic growth
- Self-organizing into teams: lab hardware (tubing etc.), control hardware (soldering etc.), software and/or by projects (1.1–1.6)

### 2.3 Day 2 : Hack'a'thing II

- Hardware I: soldering, tubing
- Software I: probe/sensor/pump  $\Leftrightarrow$  arduino/raspi interfaces
- Visit HHU's fine mechanics and glas blower work-shops, place orders for stuff missing for above goals

### 2.4 Day 3 : Hack'a'thing III

- Hardware II: Integrate projects 1.1,1.3&1.2 into a simple DIY reactor and/or with PSI FMT150 or Multicultivator
- Software II: arduino/raspi  $\Leftrightarrow$  master/server interface  
Standard data formats and interfaces
- Brain storming: relation of data and models and beer

### **3 Outlook: 2<sup>nd</sup> QTB PBR Hack'a'thing**

#### **3.1 Growth Dynamics: Photobioreactors in Research**

Talks, 30-60 min:

Nir Keren, Hellingwerf, Jan Cervený, Dougie Murray, something microfluidics?

#### **3.2 Single Cell Dynamics: Microfluidic Devices**

Integrate project 1.6 with the simple microscope in Ilka's lab, or a more advanced system (CAi?)

#### **3.3 Omics: Sterile and Automated Sampling Devices**

Proper sampling for high-throughput data (mass spectrometry, sequencing) acquisition