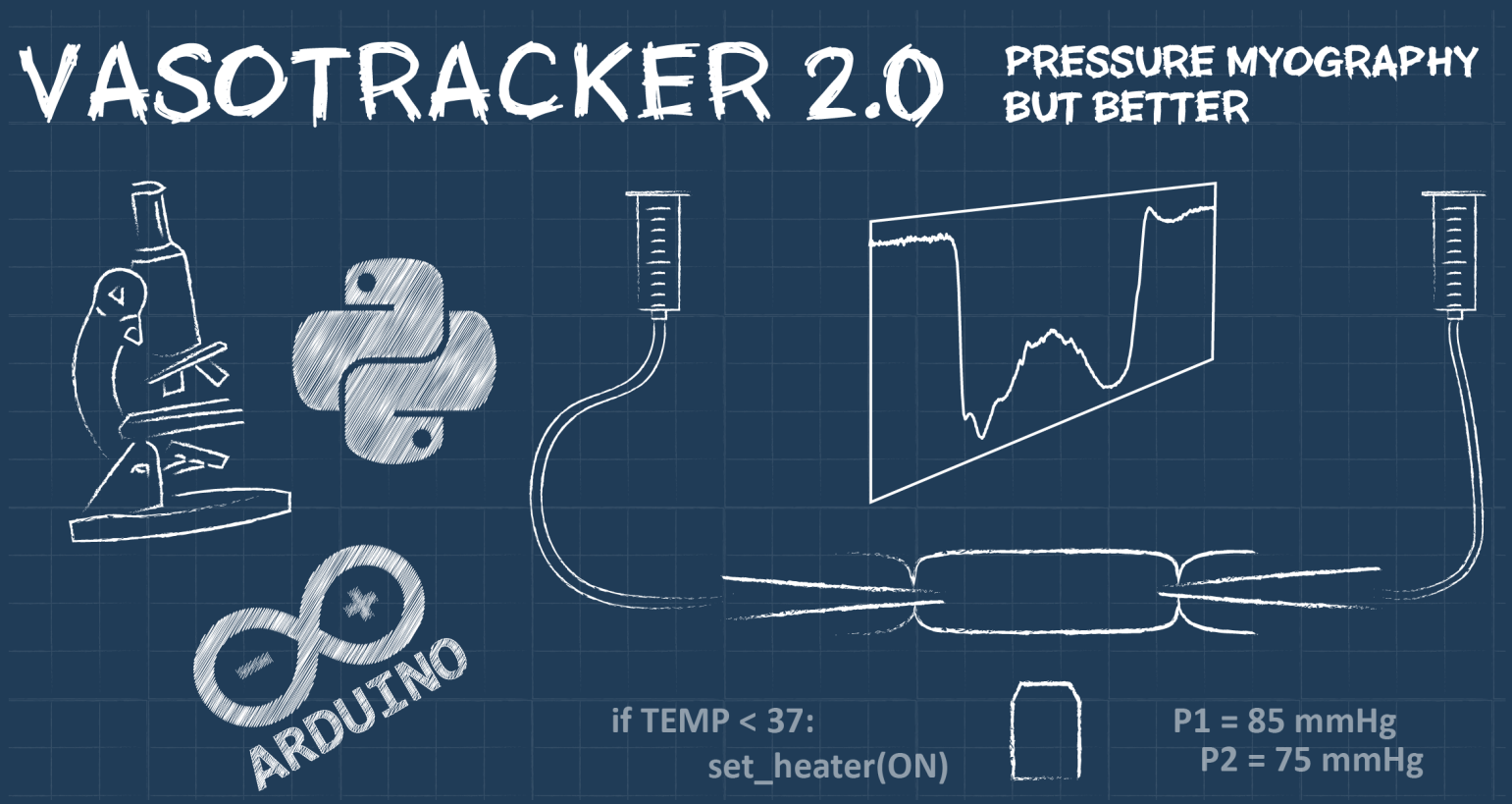
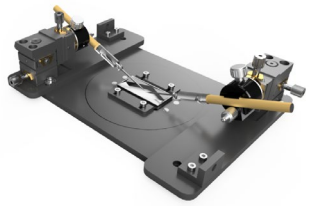


VasoTracker System Guide

2024



Developed by Calum Wilson & Matthew Lee at the University of Strathclyde

Email vasotracker@gmail.com if you need help.

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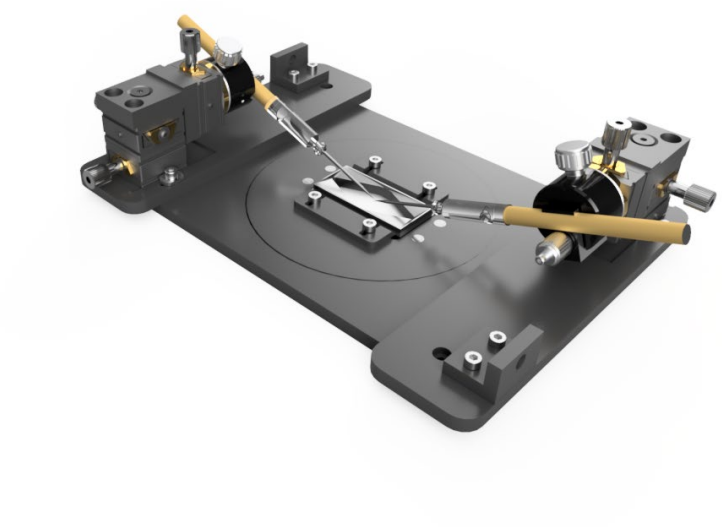
Overview



Affordable, Open-Source Pressure Myography

VasoTracker 2.0 is a cost-effective, open-source system designed to measure and track the diameter of isolated, pressurized blood vessels. This accessible alternative to commercial pressure myograph systems costs approximately **£13,500**, roughly **25% of the cost** of commercial options.

Whether you're new to vascular research or seeking to optimize your lab's setup, VasoTracker 2.0 provides a modular and customizable solution. This guide provides an overview of core and additional components, alongside recommendations, to help you create a complete pressure myography system.

Core VasoTracker Components

Approximate build cost: £3320

- **Bath Chamber (~£2,500)**
  - https://vasotracker.com/pressure-myograph/
- **Temperature & Pressure Monitor (~£320)**
  - https://vasotracker.com/temperature-pressure-sensor/
- **VasoMoto Pressure Control System (~£500)**
  - https://vasotracker.com/vasomoto/
- **VasoTracker Software (free)**
  - https://vasotracker.com/software/

Additional Components for a Complete System (approximate cost for new components: £10,150)

To fully set up a VasoTracker-based pressure myography system, the following are also required. Approximate cost for new compponents: £10,150.

- **Microscope** (inverted preferred, ~£5000)
- **Camera** (compatible with microscope, ~£400)
- **Laptop Computer** (for data capture and analysis, ~£500)
- **Temperature control system** (~£4250**)**

For more information on building your own VasoTracker system, visit https://vasotracker.com/.

Citing VasoTracker

For citation details, please visit: https://vasotracker.com/publications/

Recommended Microscopes

The VasoTracker pressure myography chamber offers flexibility for researchers, being compatible with both inverted and upright microscopes. We suggest an **inverted trinocular microscope** with a camera port for optimal use.

Inexpensive Microscope Options:

Most microscopes will work, and many researchers will be able to find a suitable microscope lying around in their department. A good source of inexpensive second-hand microscopes is eBay (**we have purchased Olympus CK40 and CKX41 microscopes for less than £1000 each**).

New Microscope Recommendations:

At Strathclyde, we like Nikon microscopes, so here are two models that fit different budgets:

1. **Nikon Ts2R (Price ~ £8,000)**

- **Requirements:**
  - Camera port & c-mount adapter
  - Objectives (4x, 10x, 20x, 40x).
- **Benefits:**
  - This microscope has a very nice mechanical stage.
  - Nice optics.
  - Can be configured in any way you want (fluorescence options)

https://www.microscope.healthcare.nikon.com/products/inverted-microscopes/eclipse-ts2r

2. **Nikon Ts2 (Price ~ £4,000)**

- **Requirements:**
  - Camera port & c-mount adapter
  - Objectives (4x, 10x, 20x, 40x).
- **Benefits:**
  - Cheap
  - Nice optics
- **Drawbacks:**
  - The stage! We remove it, and just sit the myograph on directly on the microscope. This is a pain if you want fine control of where the artery is.

https://www.microscope.healthcare.nikon.com/products/inverted-microscopes/eclipse-ts2

Recommended Cameras

The VasoTracker pressure myography software is powered by Python 3 and μManager 2.0. This combination facilitates lots of different camera compatibility.

Inexpensive Camera Options:

Most microscopes will work, and many researchers will be able to find a suitable microscope lying around in their department. A good source of inexpensive second-hand microscopes is eBay (**we have purchased Olympus CK40 and CKX41 microscopes for less than £1000 each**).

New Camera Recommendations:

We have fully tested and use the following cameras:

1. **Thorlabs CS165MU/M (Price ~ £400)**

- **Requirements:**
  - Camera (~£380)
  - C-mount adapter (~£18)

Camera: https://www.thorlabs.com/thorproduct.cfm?partnumber=CS165MU/M
C-mount adapter: https://www.thorlabs.com/thorproduct.cfm?partnumber=SM1A10

2. **Basler Ace 2 (a2A1920-160um)**

- **Requirements:**
  - Camera (~£380)
  - USB 3.0 Cable (~£6)

Camera: https://www.baslerweb.com/en/shop/a2a1920-160umbas
USB 3.0 Cable: https://www.amazon.co.uk/dp/B0CQCNTLZM/

3. **The Imaging Source (DMK 42AUC03, Monochrome)**

- **Requirements:**
  - Camera (~£200)
  - USB 3.0 Cable (~£6)

Camera: https://www.theimagingsource.com/en-us/product/industrial/2u/dmk42auc03/
USB 3.0 Cable: https://www.amazon.co.uk/dp/B0CQCNTLZM/

Recommended Computers

For optimal performance when running the VasoTracker system, we recommend a desktop or laptop with the following specifications:

Recommended Desktop Specifications

- **Operating System:** Windows 10 or newer
- **Memory (RAM):** 16 GB minimum
- **Storage:** SSD (Solid State Drive) for efficient data handling
- **Processor:** Intel i5 or higher for robust performance

An HP desktop with these specifications generally costs around **£700**. Desktop setups can be particularly advantageous in lab environments, offering reliable integration with peripherals and long-term stability for intensive data processing.

Example desktop computer:

HP Pro Mini 400 G9 Business Desktop - Core™ i5

- **Link:** https://www.hp.com/gb-en/shop/product.aspx?id=997S0ET&opt=ABU&sel=DTP
- **Cost:** £710

Recommended Laptop Specifications

- **Operating System:** Windows 10 or newer
- **Memory (RAM):** 16 GB minimum for smooth data processing and analysis
- **Storage:** SSD (Solid State Drive) to ensure faster boot times and efficient data handling
- **Processor:** Intel i5 or higher for adequate processing power

A HP laptop with these specifications typically costs around **£1000+**. We really do recommend a desktop option though.

Example laptop computer:

HP EliteBook 840 G11 14” Business Laptop – Core™ Ultra 7

- **Link:** https://www.hp.com/gb-en/shop/product.aspx?id=8A4U3EA&opt=ABU&sel=NTB&_gl=1
- **Cost:** £1320

Temperature Control Options

Temperature Monitoring

The **VasoTracker Temperature & Pressure Monitor** provides real-time temperature monitoring within the bath chamber. A sensor placed in the bath chamber connects to VasoTracker 2.0 software, offering continuous temperature data for precise control. The device can be built for ~£320.

Full build details here: https://vasotracker.com/temperature-pressure-sensor/

Temperature Control

To regulate temperature, VasoTracker 2.0 relies on external temperature control systems. Here are some recommended setups with estimated costs as of October 2024:

1. **Hotplate Stirrer & Peristaltic Pump (~**£3500**):**
    - Hotplate Stirrer (~£500)
    - 2-channel Masterflex Ismatec Reglo Peristaltic Pump (~£3000)

2. **Heated Circulator & Peristaltic Pump (~**£4250)
    - Optima T100 Heated Circulating Bath (~£1000)
    - Radnoti Heating Coil (1.5 mL) (~£250)
    - 2-channel Masterflex Ismatec Reglo Peristaltic Pump (~£3000)

3. **Inline Solution Heater & Peristaltic Pump (~£5500)**
    - Warner SH-27B inline solution heater & TC-324C Controller (~£2500)
    - 2-channel Masterflex Ismatec Reglo Peristaltic Pump (~£3000)
    -

Solution Control

To maintain a constant solution volume in the bath, it is recommended to use **a 2-channel peristaltic pump**.

Adjusting the Bath Volume:

- The VasoTracker 2.0 chamber offers two bath configurations:
    - **Low-volume chamber:** 2 mL capacity
    - **Higher-volume chamber:** 3.5 mL capacity
- Adjust bath volume by raising or lowering the perfusion plumbing.

Tip: Using larger tubing on the outflow side helps prevent overflow if both channels of the peristaltic pump are set to the same speed.

Pressure Control Options

Pressure Monitoring

The **VasoTracker Temperature & Pressure Monitor** provides real-time pressure monitoring via two inline pressure transducers connected to the VasoTracker bath chamber. The device continuously streams pressure data to the VasoTracker software. The device can be built for ~£320.

Full build details here: https://vasotracker.com/temperature-pressure-sensor/

Pressure Regulation Options

VasoTracker 2.0 supports two main types of pressure regulation systems (estimated costs as of October 2024):

Hydrostatic Gravity Columns (for experiments requiring flow through the blood vessel lumen)

1. **Gravity-driven perfusion system (cost ~£400):**
    - **Setup:** 50 ml syringes mounted on magnetic holders connected to each side of the pressure myograph.
    - **Operation:**
        - Maintain constant pressure without flow by setting syringes at equal height.
        - Adjust pressure by raising or lowering the syringe height.
        - Introduce flow without changing pressure by moving syringes up/down in opposite directions.
    - **Monitoring:** Pressure can be observed using the **VasoTracker Pressure Monitor.**

Pressure Servo Controllers (for no-flow experiments, e.g. assessing myogenic tone)

1. **VasoMoto Open-source Pressure Servo Controller (cost ~£200):**
    - **Features:** Integrates directly with VasoTracker via USB, allowing VasoTracker software to control it (does not require the VasoTracker Pressure Monitor).
    - **Full build details here:** https://vasotracker.com/vasomoto/

2. **Commercial Pressure Servo Controller Systems (e.g., Living Systems LS-PS-200. ~£4000):**
    - VasoTracker software can control the LS-PS-200 via the following peripherals (full instructions can be found in the VasoTracker software manual):
        - National Instruments DAQ Board (e.g. USB-6001, ~£275).
        - A BNC cable (e.g. Amphenol 115101-35-M1.00, ~£25)
        - A BNC breakout cable (e.g. Pomona 4969, ~£15)

www.vasotracker.com