



**Slides available online:
bit.ly/osmend1**

Open Science Hardware in the Biomedical Field

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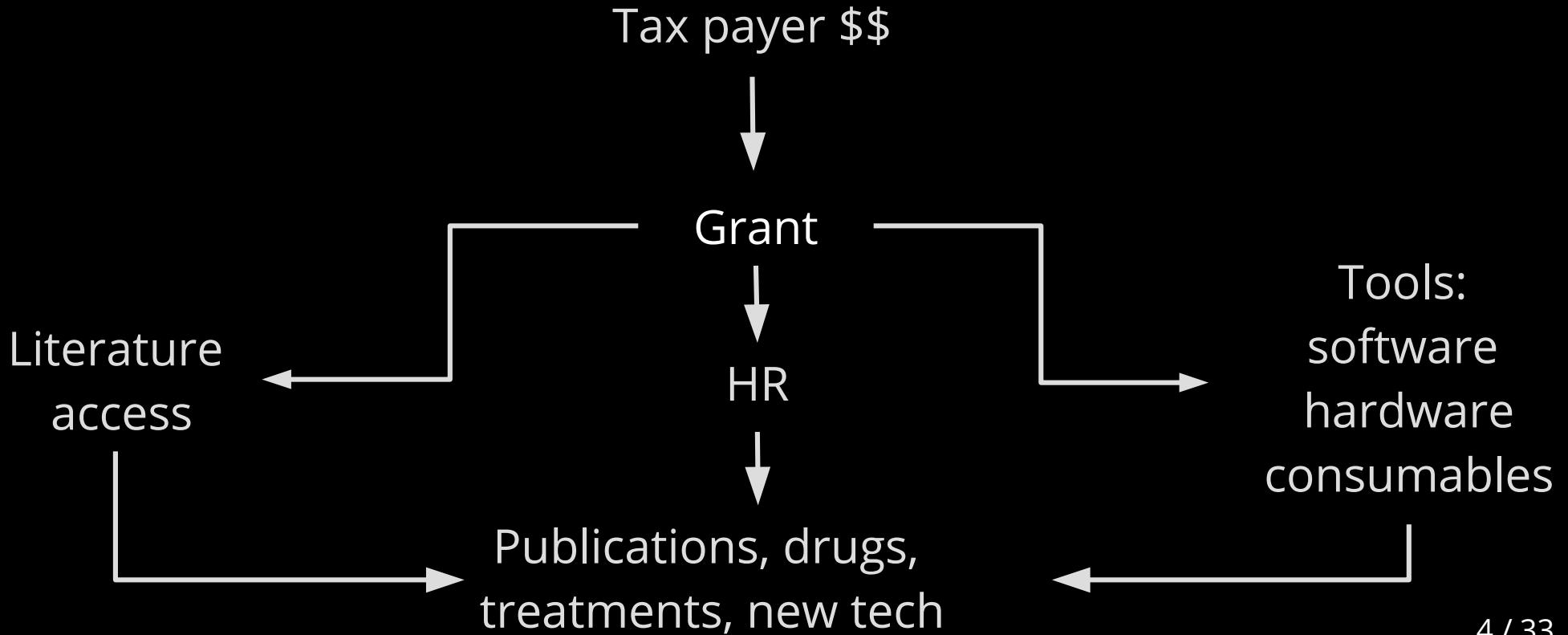


Brief Intro (open source related projects)

- 2013/1 → openeuroscience.com started
 - Open source projects related to Neuroscience
- 2013/2 → Open source adviser @ Trendinafrica.org
 - Organization of open labware workshops
 - development of open source tools
- 2015 → Editor of PLoS channel: Open source toolkit
 - Collection open source projects for science
 - Send your projects!



Public hospitals, Research centers, Universities



Public hospitals, Research centers, Universities

Publications, drugs, treatments, new tech



Patent, copyright



Technology transfer



Distribution/production Oligopoly



High Costs

Case study: Stethoscope



3M Littmann

3M Littmann Master Cardiology 27"
(Black Edition) Stethoscope

ITEM #: LITT-MCR-2

★★★★★ 45 Reviews | Write a Review

Our Price: **\$229.98**

Quantity	1	2
Unit Price	\$229.98	\$227.49

① Color: *Black Edition*
\$229.98

② Add Personalization (Optional):

Head Personalization Style:
No Head Personalization

Head Personalization [Limit 3 Characters] (\$14.98) :

Tube Personalization (All Caps) [Limit 19 Characters] (\$14.98) :

Case study: Stethoscope



Tarek Loubani

30 cents in printed plastic and materials

One of the equipments in Glia project

<https://github.com/GliaX>

Case study: Stethoscope



Tarek Loubani

Preliminary data shows the performance is better than Littmann stethoscopes!



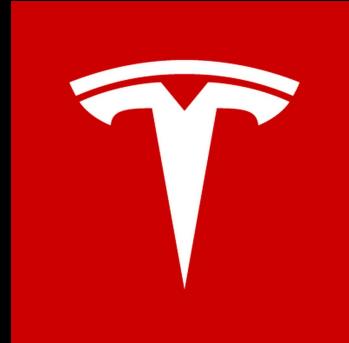
30 cents in printed plastic and materials

One of the equipments in Glia project

<https://github.com/GliaX>

Open Source / Open Access

- Culture/philosophy “started” in the ~60s
 - Mainly computer software/drivers
- all blueprints are shared
 - Information is free (LIBRE)



Open Source Hardware / Free Hardware

- No intellectual property or patents (or at least permissive)
 - Existing companies sell service, leads to fairer prices & access
- Hardware
 - Also around for some years
 - Gained power with:
 - Price drop in electronics
 - DIY manufacturing tools (3D printers, laser cutters, etc)
 - Online repositories

Case study: PCR machines

ThermoFisher
SCIENTIFIC

Q

Order Support | Sign In ▾

Quick Order 0

SimpliAmp™ Thermal Cycler



Katalognummer: A24811

Applied Biosystems™ Verwandte Anwendungen [PCR](#)

	Katalognummer	Packungsgröße	Listenpreis (EUR)	Menge
★	A24811	1 instrument	4.990,00	<input type="text"/>

[Mein Preis & Verfügbarkeit >](#) Zum Warenkorb hinzufügen

Benötigen Sie ein Webangebot? [>](#)

Case study: PCR machines



The image shows a wooden OpenPCR machine. It has a black top plate with a central screw and a handle. The main body is made of light-colored wood with black hardware. The words "OpenPCR" are printed on the front panel. To the left, a portion of a white and blue ThermoFisher SimpliAmp machine is visible.

ThermoFis SCIENTIF

SimpliAmp

OpenPCR

Quick Order 0

Preis (EUR)	Menge
<input type="text"/>	<input type="text"/>

m Warenkorb hinzufügen

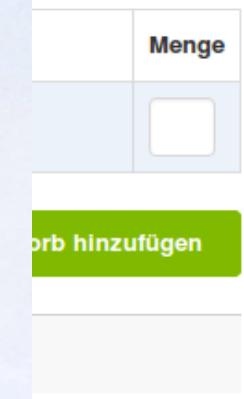
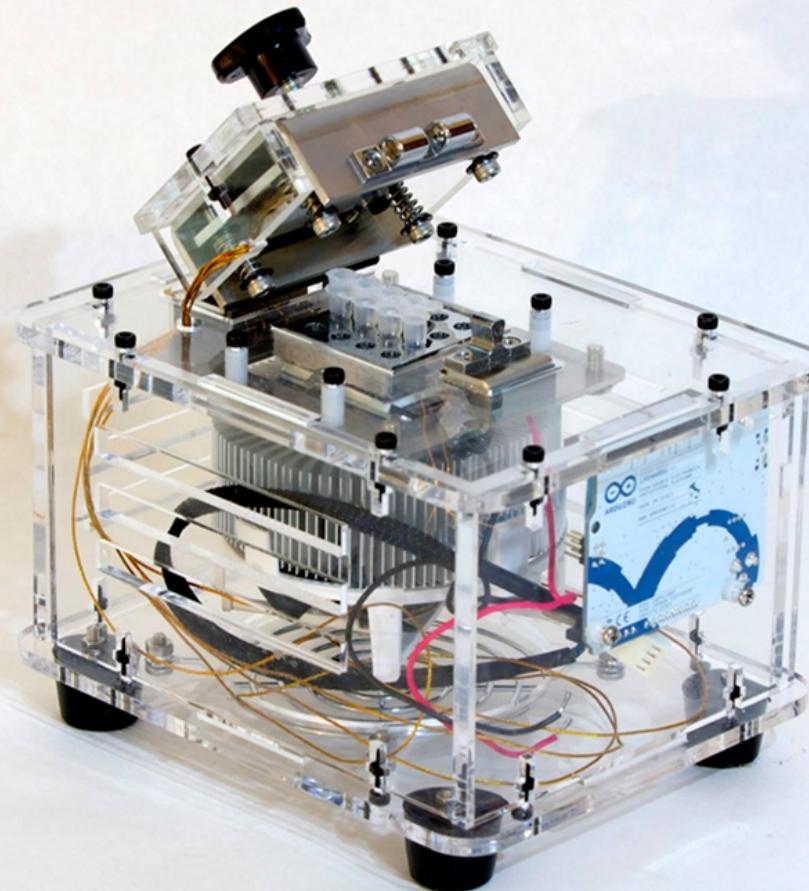
Buy for 650US\$ or build it yourself

Case study: PCR machines



Shingo Hisakawa

Thermo
SCIENCE
SimpliA



Case study: 3D printing machines



Build it for 65US\$

A screenshot of a web-based shopping cart interface. At the top right, there is a red button labeled "Check Order" and a red shopping cart icon with the number "0". Below this, there is a table with two columns: "Produkt" and "Menge". A green button labeled "Warenkorb hinzufügen" is located at the bottom left of the table area. The rest of the page is mostly blank white space.

The use of open source hardware

- Open source hardware → defined by OSHWA:
 - Hardware needs to be released with documentation
 - Software for the hardware must be open (or easy to make open)
 - Redistribution agnostic (derivation, businesses, hobbyists, etc)
 - Attribution
 - No discrimination (persons and endeavor)

“Why my doctor prescribed me OS Hardware”



Hugo Silva

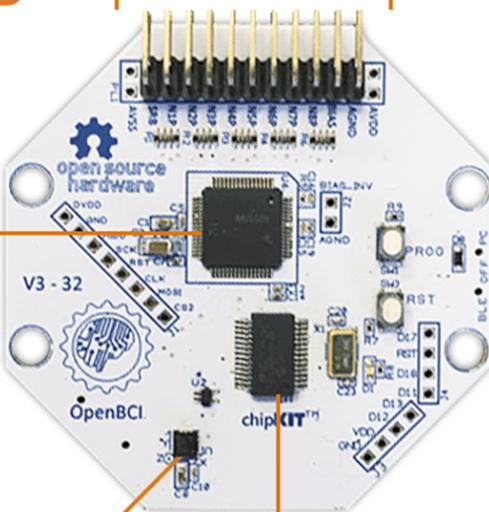


Open BCI

OPENBCI CYTON BOARD

HIGH POWERED ANALOG FRONT-END

- Texas Instruments ADS1299 -
- high gain, low noise ADC -
- 24 bit channel resolution -
- up to 16 kHz sampling rate -

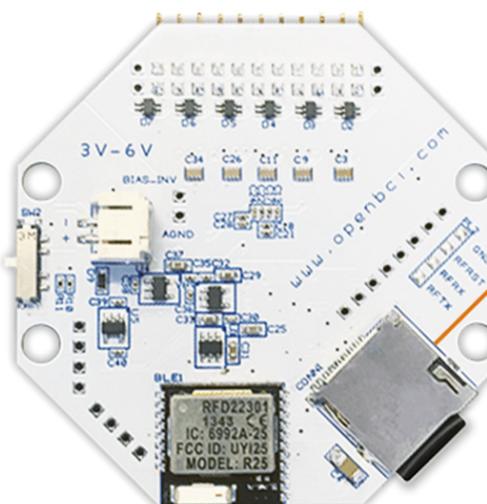


ACCELEROMETER

- ST LIS3DH -
- 3-axes accelerometer -
- 16 bit data output -

8 BIOPOTENTIAL INPUT CHANNELS

- brain (EEG), muscle (EMG), & heart (ECG)
- ground w/ inverted common mode noise



PROGRAMMABLE

- PIC32 uC (Microchip)
- Arduino-compatible
- 5 GPIO pins

LOCAL SD STORAGE

- maximum data rates
- improved portability

WIRELESS COMMUNICATION

- RFDigital RFD22301
- Bluetooth Low Energy (BLE)
- high data rate radio via USB
- Arduino compatible

Open BCI

System Control Panel ▾ OPENBCI Shop Issues Help

Stop Data Stream Notch 60Hz BP Filt 5-50 Hz Layout

Time Series ▾ Vert Scale Window

50 uV 5 sec Auto

50 uV
100 uV
200 uV
400 uV
1000 uV
10000 uV

0.07 uVrms

2.45 uVrms

5.11 uVrms

3.64 uVrms

8.64 uVrms

8.51 uVrms

16.7 uVrms

14.4 uVrms

Time (s)

Data stream started.

FFT Plot ▾ Max Freq Max uV Log/Lin Smooth Filters?

60 Hz 100 uV Log 0.9 Unfilt.

Amplitude (uV)

Frequency (Hz)

Head Plot ▾ Intensity Polarity Contours Smooth

2x + ON 0.9

The screenshot shows the OpenBCI software interface. At the top, there's a navigation bar with tabs for System Control Panel, OPENBCI, Shop, Issues, and Help. Below the navigation bar are three buttons: Stop Data Stream, Notch 60Hz, and BP Filt 5-50 Hz, followed by a Layout button. The main area has three panels: 'Time Series' on the left, 'FFT Plot' in the center, and 'Head Plot' on the right. The 'Time Series' panel displays eight colored traces (1-8) representing EEG signals over time, with vertical scales ranging from 50 to 10000 uV and a horizontal scale of 5 seconds. The 'FFT Plot' panel shows the power spectrum of the signals from 0 to 60 Hz, with amplitude on a logarithmic scale from 0.1 to 100 uV. The 'Head Plot' panel shows a circular electrode map with numbered electrodes (1-8) and a central 'R' marker, with settings for intensity, polarity, contours, and smoothness. A status bar at the bottom says 'Data stream started.'

HIGH POWERED ANAL FRONT-END

Texas Instruments ADS1299
high gain, low noise AD
24 bit channel resolution
up to 16 kHz sampling rate

ACCELEROMETER

ST LIS344DL
3-axes accelerometer
16 bit data output

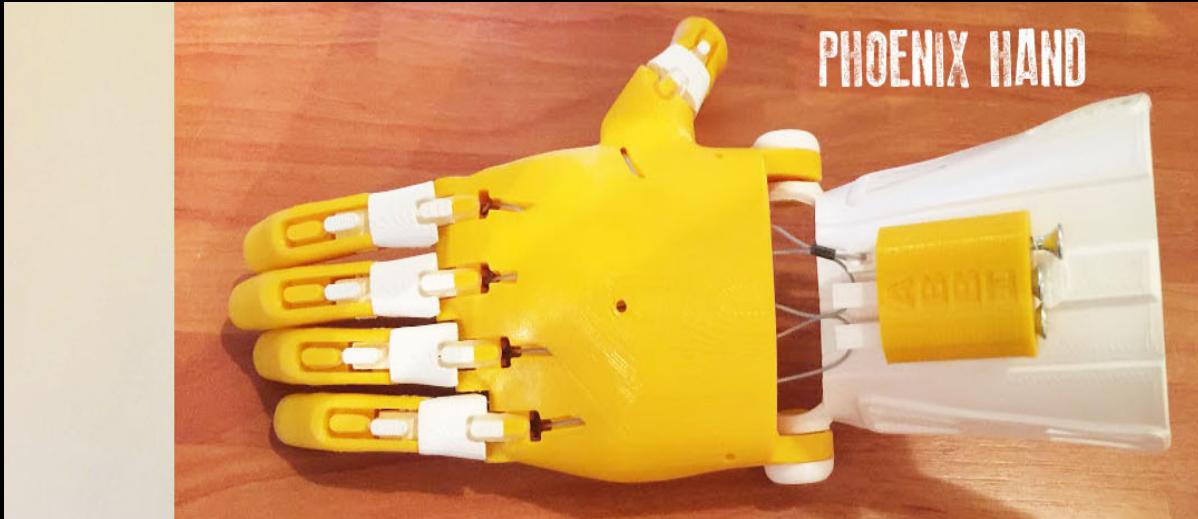
LOCAL SD STORAGE

- maximum data rates
- improved portability

COMMUNICATION

RFID22301
Low Energy (BLE)
Wireless radio via USB
Bluetooth compatible

Enabling the Future



Printed parts
Customizable
3-15€ in materials

Case study: OS Hardware as a teaching tool



“Open Labware” Schools
2015 – Durban
2015 – Addis Ababa
2017 – Ibadan
2018 – April Cape Town



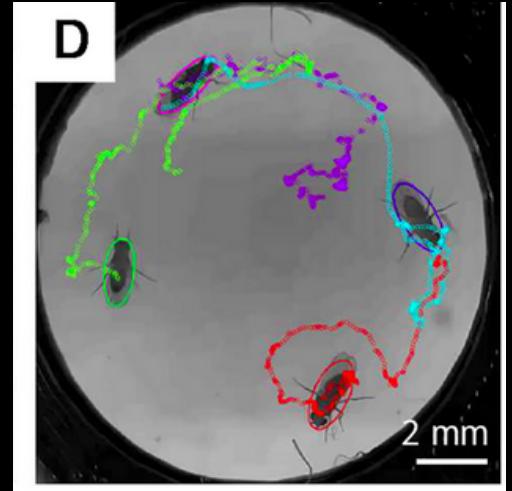
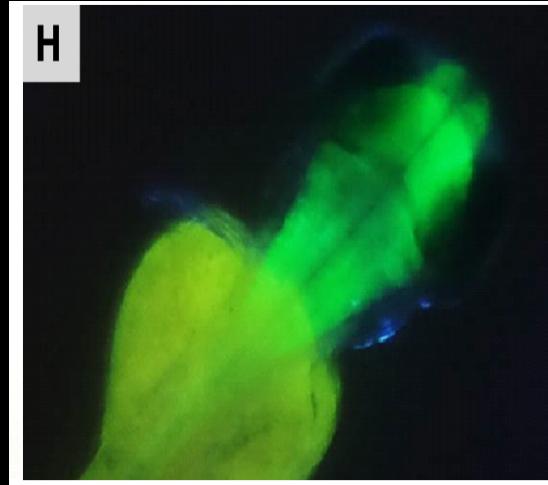
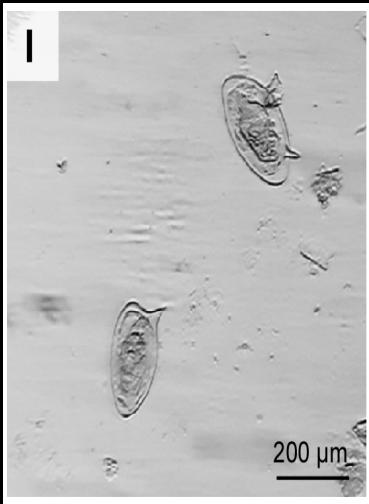
In the Menu:
“Sharing how to build fishing rods”
AKA
Share basic electronics and 3D printing knowledge

Case study: OS Hardware as a teaching tool



Dr. Odunayo Azeez video

FlyPi: Affordable modular lab



OpenNeuroscience

FlyPi: Affordable modular lab



PLOS | BIOLOGY

COMMUNITY PAGE

The €100 lab: A 3D-printable open-source platform for fluorescence microscopy, optogenetics, and accurate temperature control during behaviour of zebrafish, *Drosophila*, and *Caenorhabditis elegans*

Andre Maia Chagas^{1,2,3,4*}, Lucia L. Prieto-Godino^{3,5}, Aristides B. Arrenberg^{1,6}, Tom Baden^{1,3,4,7*}

¹ Werner Reichardt Centre for Integrative Neuroscience, University of Tübingen, Tübingen, Germany, ² Graduate school for Neural and Behavioural Neuroscience, University of Tübingen, Tübingen, Germany, ³ TReND in Africa gUG, Bonn, Germany, ⁴ Institute of Ophthalmic Research, University of Tübingen, Tübingen, Germany, ⁵ Center of Integrative Genomics, University of Lausanne, Lausanne, Switzerland, ⁶ Institute of Neurobiology, University of Tübingen, Tübingen, Germany, ⁷ School of Life Sciences, University of Sussex, Brighton, United Kingdom

* andremaia.chagas@gmail.com (AMC); t.baden@sussex.ac.uk (TB)

Check for updates

OPEN ACCESS



Paper published, then what?

- Once papers are published development “stops”
- Researchers don’t have time/interest to mass produce
- What happens to all these tested/benchmarked/peer-reviewed designs?
 - Can we improve access by doing the boring jobs?

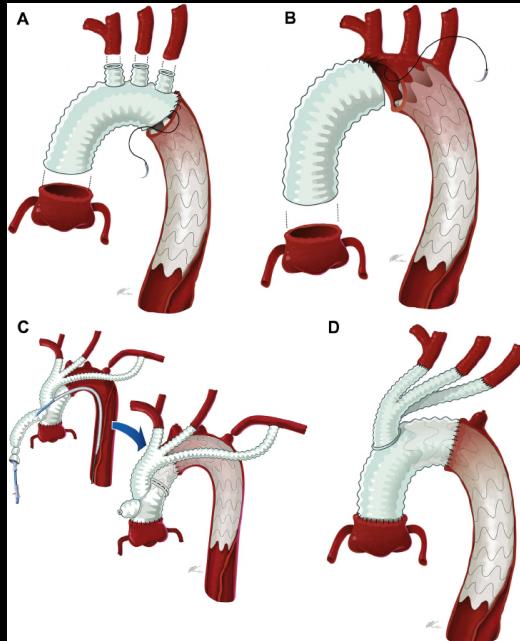
Paper published, then what?

- Looking for early adopters!
 - www.prometheus-science.com/flypi



Prometheus Science

Treatments - Next step?!



Open Stent

HEALTH

THESE BIOHACKERS ARE CREATING OPEN-SOURCE INSULIN

TO MAKE THE DRUG AFFORDABLE FOR MILLIONS OF DIABETICS WORLDWIDE

By Alexandra Ossola Posted November 18, 2015

Open Insulin

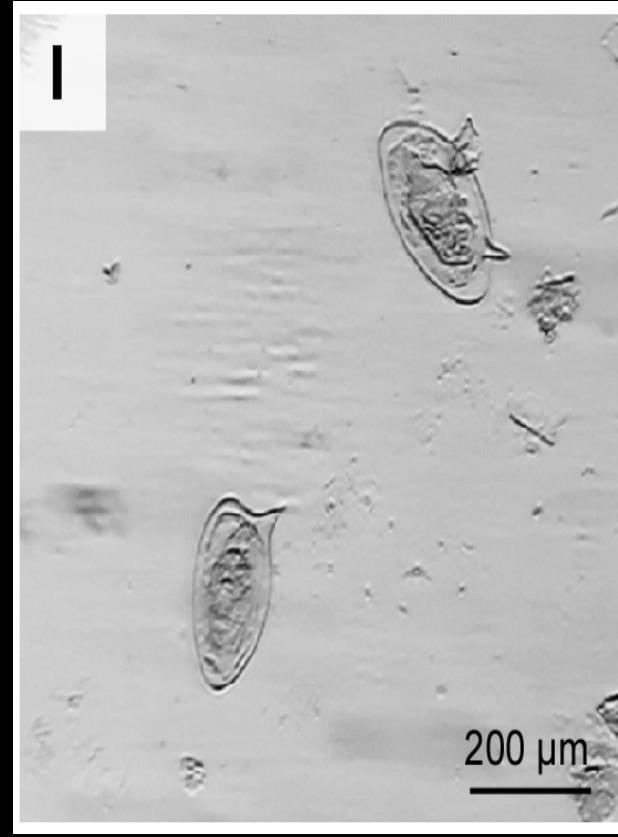
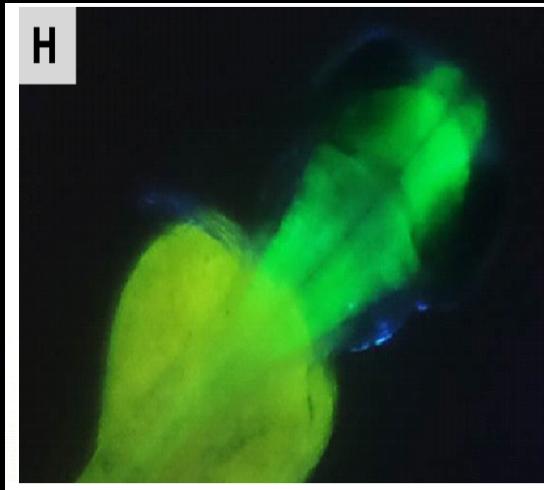
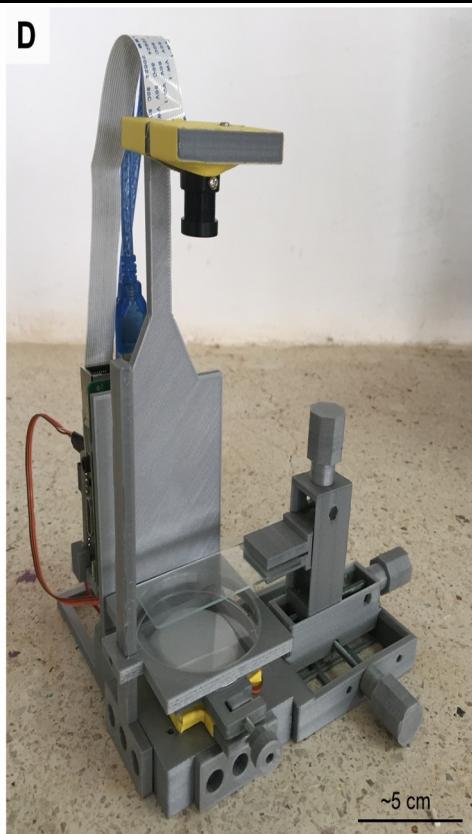
Repositories and online communities

- GOSH (<http://openhardware.science/>)
- PLOS Channel (<https://channels.plos.org/open-source-toolkit>)
- Open Neuroscience (openeuroscience.com)
- Open Plant Science (<http://openplant.science/>)
- Hackaday.io (hackaday.io)
- CTA – UFGRS (<http://cta.if.ufrgs.br/capa/>)
- Instructables (instructables.com)
- Journal of open Hardware (<https://openhardware.metajnl.com/>)
- HardwareX (<https://www.journals.elsevier.com/hardwarex>)
- Appropedia (http://www.appropedia.org/Welcome_to_Appropedia)
- Hackteria (hackteria.org)

Thank you for your attention!

- Questions?
 - Slides available online:
 - bit.ly/osmend1
 - Contact: andre@prometheus-science.com

Microscopes



communities

- Wevolver
- GOSH
- Hackaday.io
-

Open and profitable

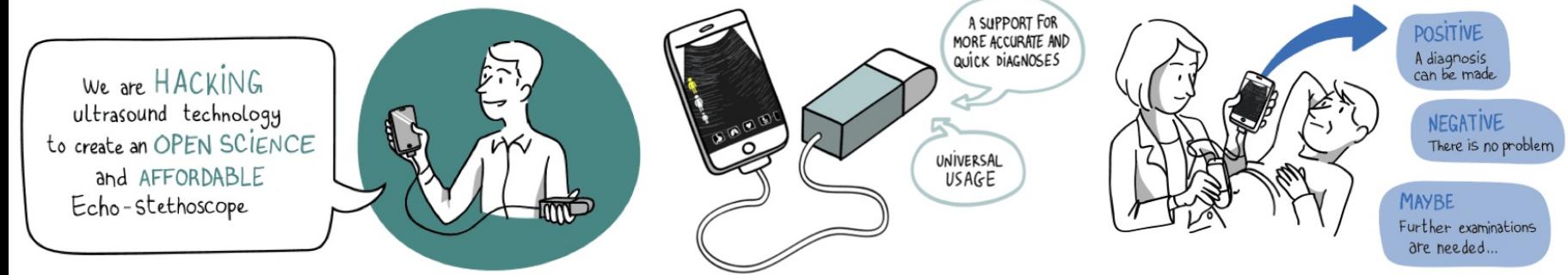
- Company examples

Hurdles of the biomedical field and why open is better

- Certifications, legal requirements, etc

echOpen project

DESIGNING AN OPEN SOURCE AND LOW-COST ECHO-STETHOSCOPE



Right here in your backyard!