

- <http://bit.ly/ROCKFOSH>

Bringing Science to the 21st century: Open Source tools for better research

The Rockefeller University
Andre Maia Chagas
02/22/2019

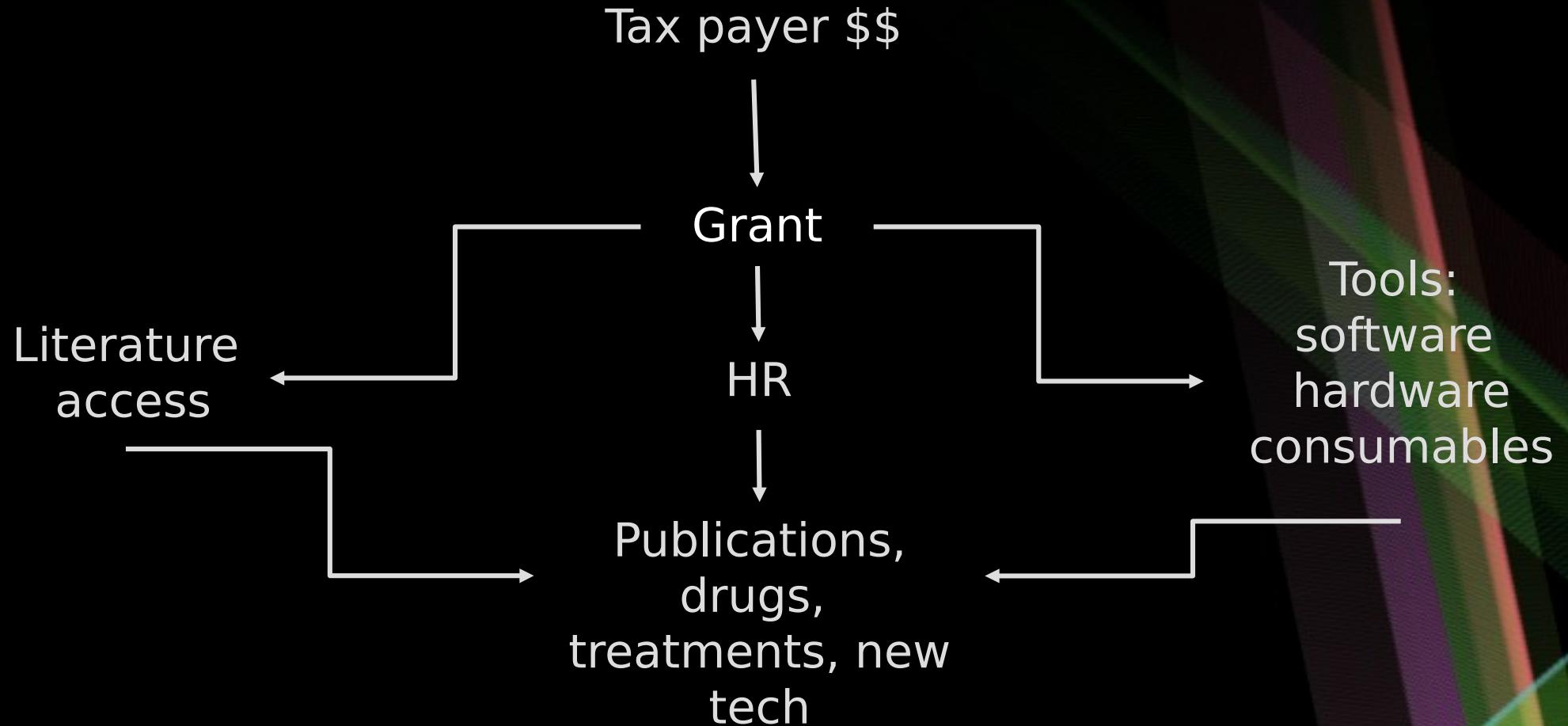
Who am I?

- Biology / Neurosciences
- Advocating Open Science:
 - Open Neuroscience (<http://bit.ly/OpenNeuro>)
 - Trend In Africa (<http://bit.ly/TIAfrica>)
 - Plos Channel: Open Source toolkit (<http://bit.ly/2yrVDnw>)
 - Mozilla & FreiesWissen Fellow
 - Mapping scientific equipment demand (<http://bit.ly/BFOSH>)
- Building tools @ BadenLab (<http://bit.ly/2TU7THW>)
 - visual stimulators
 - behavioural setups
 - customizing off-the-shelf equipment

Summary

- Science funding
- Scientific equipment: time for an overhaul
- 30 seconds to master open source
- Open Science Hardware
- Communities and interesting links
- Questions

How we are funded



How we are funded

Publications, drugs, treatments,
new tech



Patent, copyright



Technology transfer



Distribution/production Oligopoly



High Costs

Scientific equipment: time for an overhaul

Microscopes:

- ~17th century
- Scientific grade ~5000€
- Fluorescence +~5000€
- No patents
- Hard to repair
- Hard to customize
- Designed for european/US markets



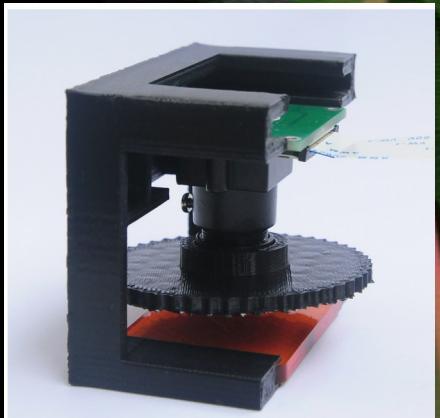
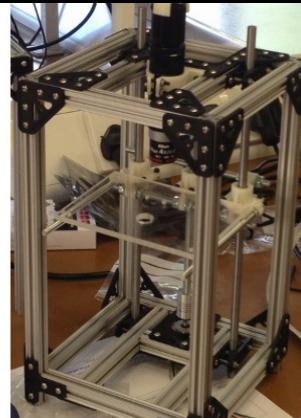
By Chad Anderson, CC BY-SA 2.0,
<https://commons.wikimedia.org/w/index.php?curid=45625745>



By Zephyris at the English language Wikipedia, CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=13320450>

Scientific equipment: time for an overhaul

- Open Source Microscopes:
 - Different capabilities
 - Published in peer reviewed journals
 - Much more affordable
 - Portable, battery driven, easy to customize



Scientific equipment: time for an overhaul



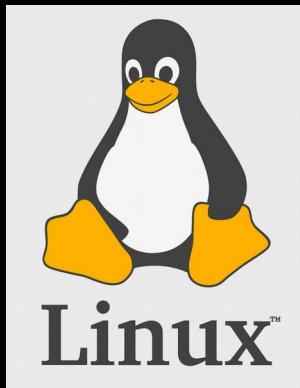
<http://bit.ly/flypios>

30 seconds to master Open Source

- Everything (code, hardware design, protocols, cake recipes) created is shared freely via licenses (GNU, Creative Commons, OSHWA, and many other), using any means at hand (Internet, usb sticks, recipe notebook)
- We've always done it. Now we just have a fancy name for it and metrics so that all projects follow a certain standard.

30 seconds to master Open Source

- Powers your smartphones, data centers, computers in airplanes, supercomputers.



<https://www.zdnet.com/article/its-an-open-source-world-78-percent-of-companies-run-open-source-software/>

Rodent behavioural setup

- Regular (proprietary)
- 2 PCs (2 x 250€)
- Acquisition card (610€)
- Windows (130€)
- MATLAB (2000€)*
- Microsoft office (100€)
- Total: 3340€
- Open source
- 01 Raspberry Pi (31€)
- Arduino (10€)
- Linux (0€)
- Python (0€)
- LibreOffice (0€)
- Total: 41€

Open Design 3D-Printable Adjustable Micropipette that Meets the ISO Standard for Accuracy

Martin D. Brennan , Fahad F. Bokhari  and David T. Eddington * 

Department of Bioengineering, University of Illinois at Chicago, Chicago, IL 60607, USA



ORIGINAL RESEARCH ARTICLE

Front. Neural Circuits, 06 December 2013 | <https://doi.org/10.3389/fncir.2013.00184>

Delivery of continuously-varying stimuli using channelrhodopsin-2

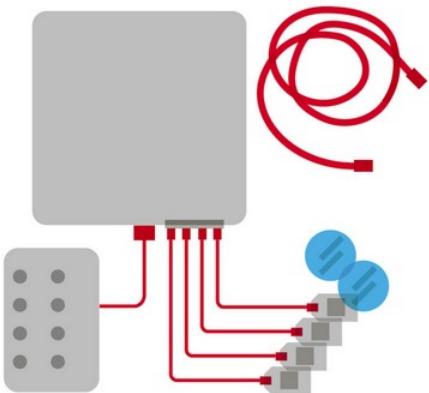
Tatjana Tchumatchenko^{1*†},Jonathan P. Newman^{2*†},Ming-fai Fong^{2,3} andSteve M. Potter²

	Plexon LD-1	Plexon PlexBright ¹	Thorlabs DC4100	Cyclops (Current FB)	Cyclops (Optical FB)
Speed					
10-90% rise time ² (μs)	49	76	?	< 0.1	0.53
90-10% fall time ² (μs)	39	89	?	< 0.1	0.46
Dead time, worst case ² (μs)	140	160	?	1.0	1.0
Small signal -3dB bandwidth ⁴ (kHz)	10.5	?	100 ^{3,5}	> 2500	> 2500
OS compatibility	N/A	Windows	Windows	Windows, Linux, Mac	
Cost	\$700.00	\$5300.00	\$3059.0 ⁷	~\$160.00 ⁸	~\$200.00 ^{8,9}



Flexible and affordable multichannel electrophysiology.

The Open Ephys acquisition board is part of a complete platform for conducting multichannel electrophysiology experiments. And it's entirely open-source. This means you can build it at low cost and modify it to enable new types of experiments.



Industry-standard data quality

Powered by industry standard [Intan](#) chips. Stream 256 channels via USB 2.0 or 512 channels via USB 3.0.

Standard interfaces

Use your system with a wide array of headstages, adapters & breakout-boards designed by you and other labs and know that things fit together seamlessly.

Designed by users

The acquisition board was designed to be flexible and productive in practical use.

User-friendly, modular software

The acquisition board works automatically with the [Open Ephys GUI](#), which allows you to visualize and analyze your data in real time with a growing collection of plug-ins.



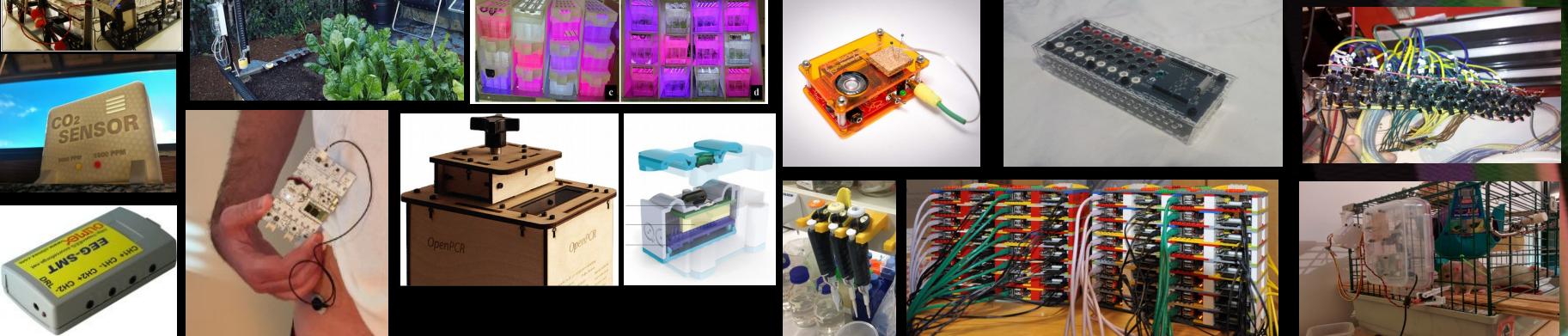
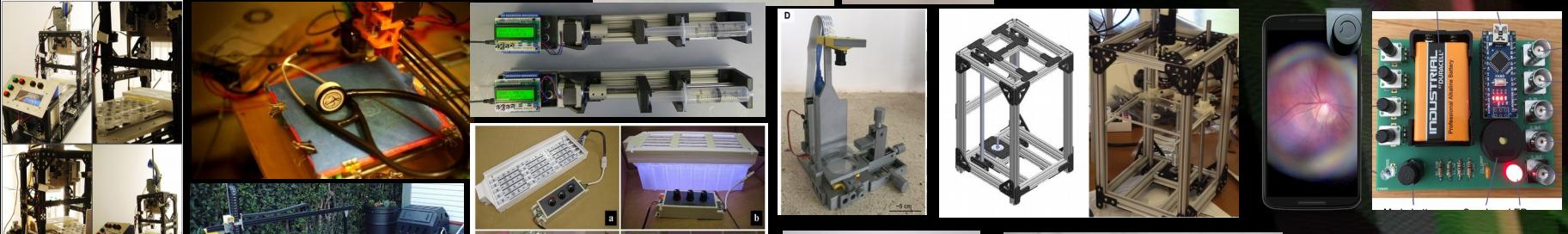
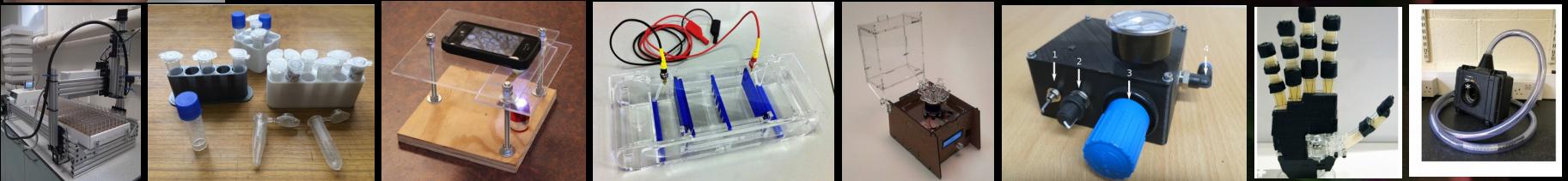
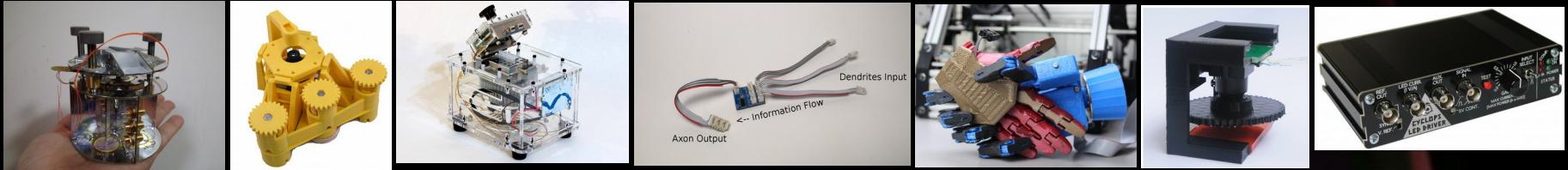
open ephys

Starter Kit

€5,400.00

The Starter Kit includes all of the items required to immediately start working with the Open Ephys Acquisition Board.

It comes with two 32-channel headstages (with accelerometer incorporated) and the necessary cables to connect them. It also includes a headstage adapter, in case you want to use both headstages in the same electrode interface board (EIB). Two I/O boards allow the acquisition board to be connected with auxiliary analog and digital inputs.



Companies & non-profits developing OS Hardware



WaterScope

Prometheus Science



NEURO TINKER



OPENBCI



OPENROV



Kithub

UIORodeo

Smart Lab Technology

Sanworks

QCM

OPEN

quartz crystal microbalance



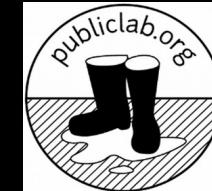
Sam and Tom
industriy's



SAFECAST



flyPAD
fruit flies going hi-tech



OS Hardware: Living in the “Cambrian explosion”

- Wikipedia >70 projects (only commercial level/big projects)
- In these slides at least another 36
- Many, MANY more in repositories online
- OS tools to create hardware are getting better and easier
- Software
- Fast prototyping
- Lower price for manufacturing
- Internet infrastructure
- Sharing videos, tutorials, documentation
- Some companies applying OS business models are >5 years old.

OS in research and education

- “Traditional systems:
 - Expensive (fluoresc. Scope >5000€)
 - One supplier commitment
 - Hard to fix/customize/upgrade
 - One per lab/classroom
 - Costly calibrations
 - Bugs hard to spot
 - Fixed, one size (has to) fit all
- OS systems
 - Affordable (fluoresc. Scope <250€)
 - Buy parts from anywhere
 - Know your tools from inside out
 - Many per lab/classroom
 - Calibrate before every experiment
 - Bugs are easier to spot
 - Adaptable to local realities

Build following demand



- Projects normally start with a local need:
 - one lab, in one department, inside one institution...
- What if we could map the needs researchers have?
 - And build OS Hardware based on that demand?
 - Online survey <http://bit.ly/BFOSH> Please share!
 - Landing page: <https://fosh-following-demand.github.io/en/home>
 - Repos: <https://github.com/FOSH-following-demand>

Contributions and suggestions are welcome!!

PLOS Open Source toolkit

 PLOS JOURNALS ▾



Open Source Toolkit

A global forum for open source hardware and software research and applications

About the Editors

Curated collection of papers:

- Open Source Software
- Open Source Hardware

GOSH community



- Make open source hardware the norm for science by 2025

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)
- Open Behaviour (<http://openbehavior.com/>)

- Thank you!
- <http://bit.ly/ROCKFOSH>