

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

# Bringing Science to the 21<sup>st</sup> century: Open Source tools for better research

Open Science MOOC –  
Open Research Software and Open Source  
Andre Maia Chagas  
18/02/2019

# Who am I?

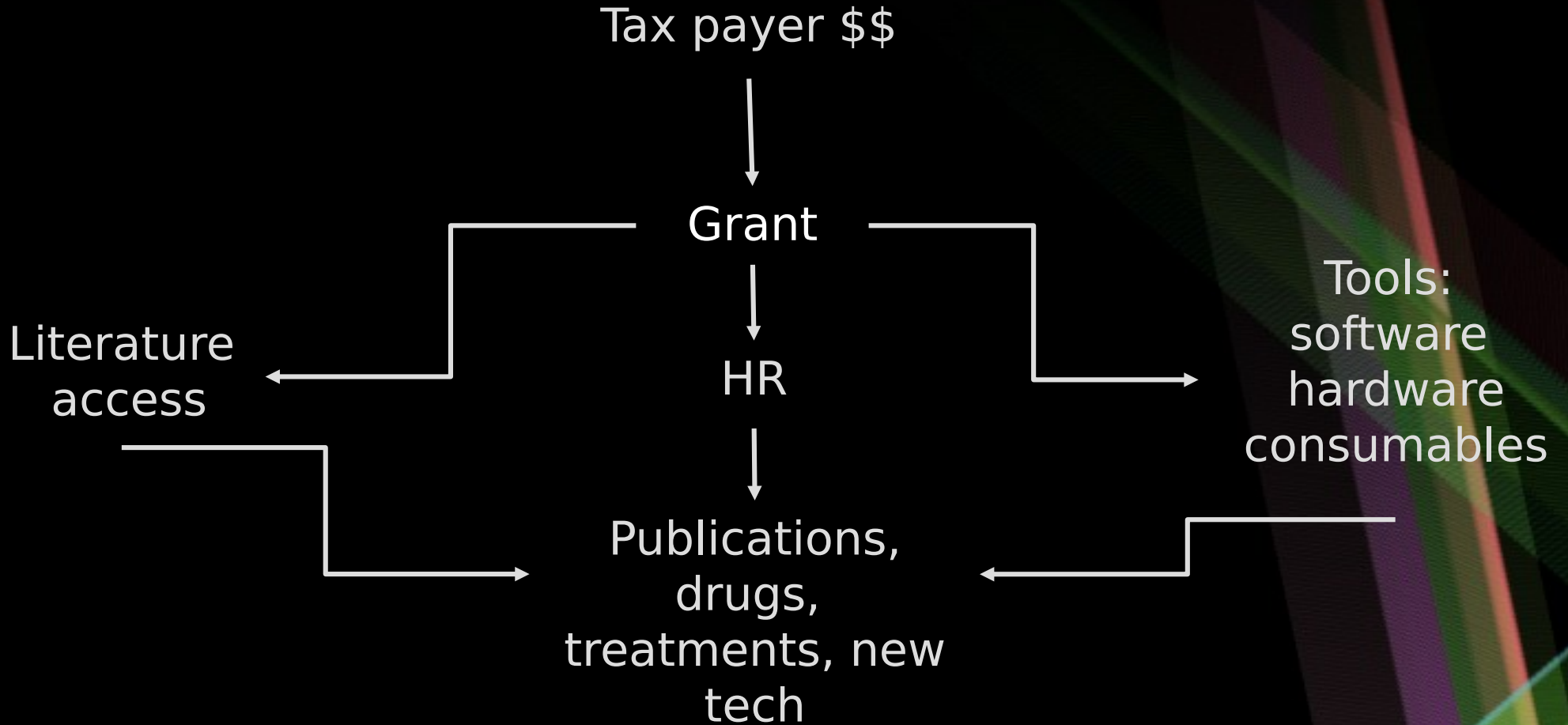
- Advocating Open Science:
  - Open Neuroscience (<http://bit.ly/OpenNeuro>)
  - Trend In Africa (<http://bit.ly/TIAfrica>)
  - Plos Channel: Open Source toolkit (<http://bit.ly/2yrVDnw>)
  - Mozilla & FreiesWissen Fellow
    - Mapping scientific equipment demand (<http://bit.ly/BFOSH>)
- Building tools @ BadenLab (<http://bit.ly/2TU7THW>)
  - visual stimulators
  - behavioural setups
  - customizing off-the-shelf equipment
- Prometheus Science
  - Open Source hardware as service for scientists and educators
    - With Karen Haink

# Summary

- Science funding
- Software: Is it doing what you expect?
- 30 seconds to master open source
- Open Science Software
- Questions I
- Scientific equipment: time for an overhaul
- Open Science Hardware
- Communities and interesting links
- Questions II



# How we are funded



# How we are funded

Publications, drugs, treatments,  
new tech



Patent, copyright



Technology transfer



Distribution/production Oligopoly



High Costs

# Software: Is it doing what you expect?

Comment

Open Access

## Gene name errors are widespread in the scientific literature

Mark Ziemann, Yotam Eren and Assam El-Osta

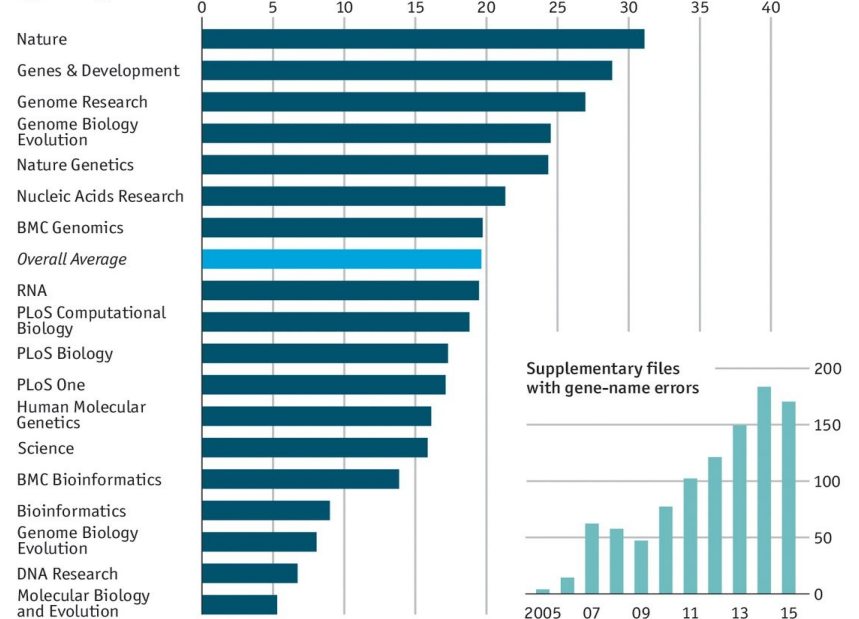
*Genome Biology* 2016 17:177

<https://doi.org/10.1186/s13059-016-1044-7> | © The Author(s). 2016

Published: 23 August 2016

### #VALUE! error

Genomics papers with spreadsheet errors in supplementary files, 2005-15, %  
By publishing journal



Source: "Gene name errors are now widespread in the scientific literature", Ziemann, Eren and El-Osta, 2016

# Software: Is it doing what you expect?

Automatic conversion of gene symbols to dates and floating-point numbers is a problematic feature of Excel software. The description of this problem and workarounds were first highlighted over a decade ago [1]—nevertheless, we find that these errors continue to pervade supplementary files in the scientific literature. To date, there is no way to permanently deactivate automatic conversion to dates in MS Excel and other spreadsheet software such as LibreOffice Calc or Apache OpenOffice Calc. We note, however, that the spreadsheet program Google Sheets did not convert any gene names to dates or numbers when typed or pasted; notably, when these sheets were later reopened with Excel, LibreOffice Calc or OpenOffice Calc, gene symbols such as *SEPT1* and *MARCH1* were protected from date conversion.

# Software: Is it doing what you expect?

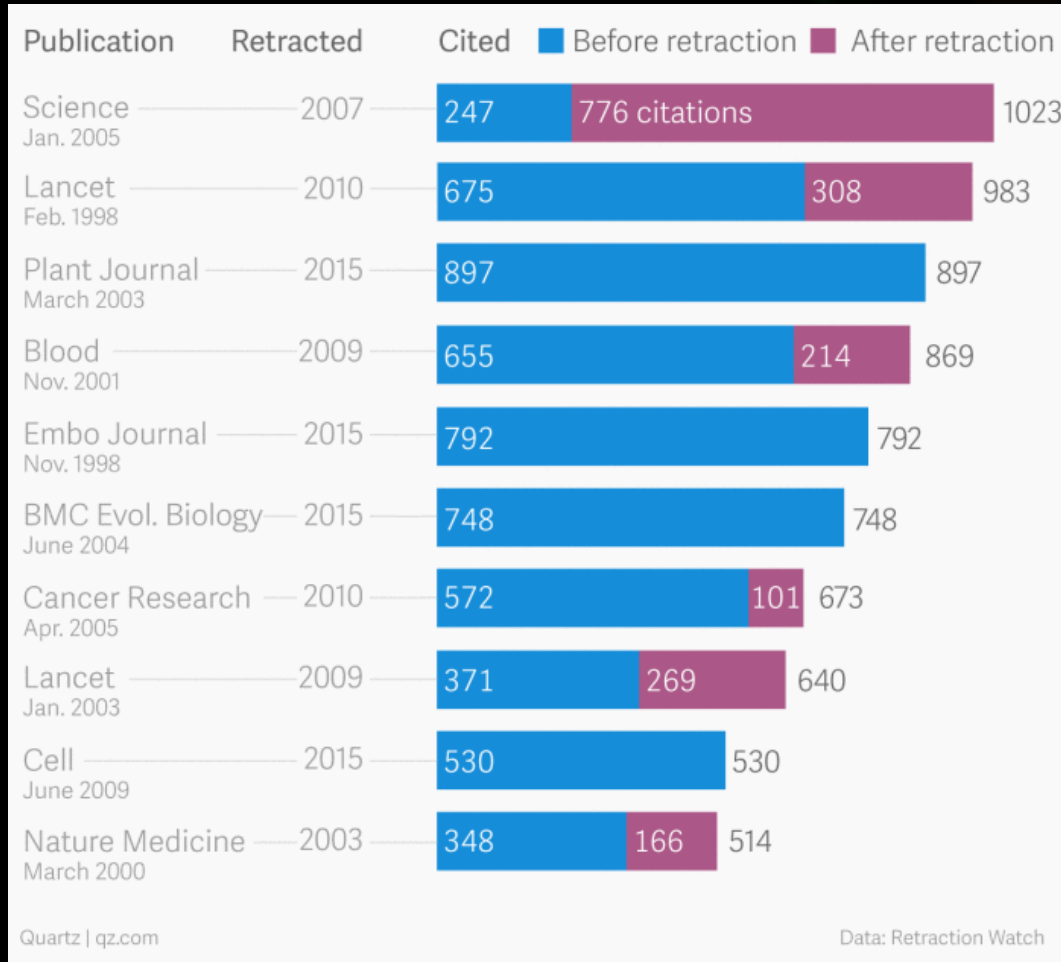
## Retraction: Hires et al, Whisker Dynamics Underlying Tactile Exploration

At the request of the authors, *The Journal of Neuroscience* is retracting “Whisker Dynamics Underlying Tactile Exploration” by S. Andrew Hires, Alexander L. Efron, and Karel Svoboda, which appeared on pages 9576–9591 of the June 5, 2013 issue. The authors report, “After publication we discovered that higher-order eigenmodes were incorrectly summed when calculating the time-dependence of whisker shape during touch with a rigid object. Correction of this error revealed that our boundary conditions were inappropriate for the whisker-object interactions treated in our paper. Modification of these boundary conditions will alter the results presented in Figures 6–11. We therefore wish to withdraw the article. A corrected treatment will be published in the future. We apologize for any confusion caused by this error.”

Analysis were done in house using “X”



# Software: Is it doing what you expect?

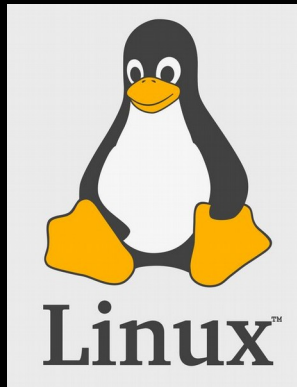


# 30 seconds to master Open Source

- 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.





# Open Science Software

- Jupyter notebook demo



“Given enough eyeballs any problem becomes trivial”

# Open Source Software



Turn a Git repo into a collection of interactive notebooks

Have a repository full of Jupyter notebooks? With Binder, open those notebooks in an executable environment, making your code immediately reproducible by anyone, anywhere.



Project Jupyter exists to develop open-source software, open-standards, and services for interactive computing across dozens of programming languages.

OpenSesame

EEGLAB

neo



GraphicsMagick

ACQ4

Psychtoolbox-3

TensorFlow™

Jupyter



eLabFTW

NeuroDebian

PsychoPy  
Psychology software in Python

PyMVPA

BROCCOLI

µManager

ImageJ  
Image Processing and Analysis in Java

GNU Octave

ALLEN BRAIN ATLAS  
DATA PORTAL



Bonsai

BrainBrowser  
v2.5.2

BRIAN

JASP

SPM

GNU PSPP

iPipet

nipy.org



neural  
ensemble  
.org



BioJS Blog

neurosynth

SpikeGadgets  
Software



OpenWorm  
Building the first digital life form. Open source.

BIO-TRACKING



FreeSurfer

pySPACE

KinectoTherapy

# Open Science Software

- Where to start?
  - Many tutorials online
  - Reach out to developers – They will be super happy!
  - Open Science MOOC
  - Openscapes – mentorship program to empower scientists with open data science tools! (<https://www.openscapes.org/>)

# Questions I

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

# Scientific equipment: is open better?





# Scientific equipment: is open better?



## Lead times:

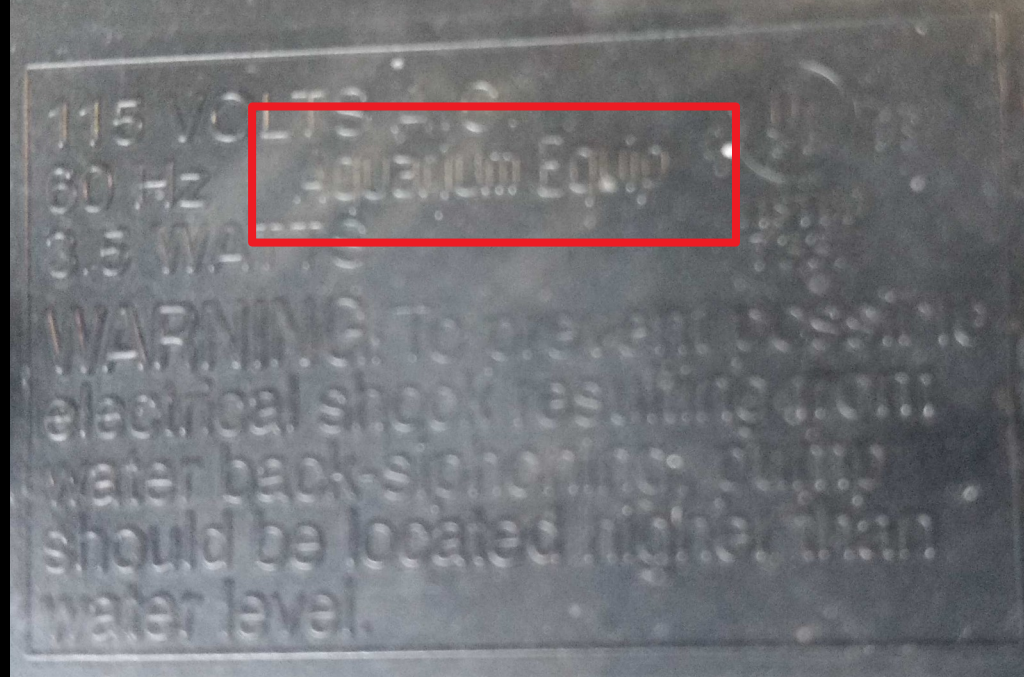
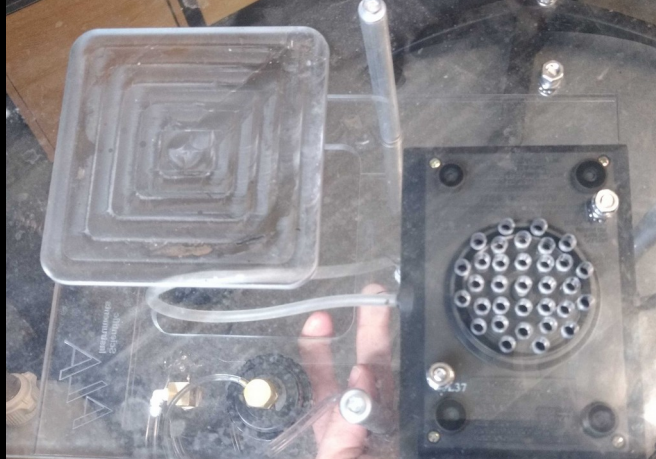
Typical dispatch time for the following systems are:

- Electrophysiology = 8 – 10 weeks
- Multiphoton = 16 -18 weeks
- LASU = 16 -18 weeks
- Hyperscope = 16 -18 weeks
- FLIM = 22 – 24 weeks

Item	Code	Description	Qty	Unit Price	Value
	<b>DEL</b>	<b>Delivery Charge</b>	<b>1.00</b>	<b>£39.00</b>	<b>£39.00</b>
		Postage and packaging			
	<b>ALAVWK</b>	<b>Vacuum Waste Kit</b>	<b>1.00</b>	<b>£710.44</b>	<b>£710.44</b>
		Vacuum Waste Kit - for use with Level Lock LL-2			

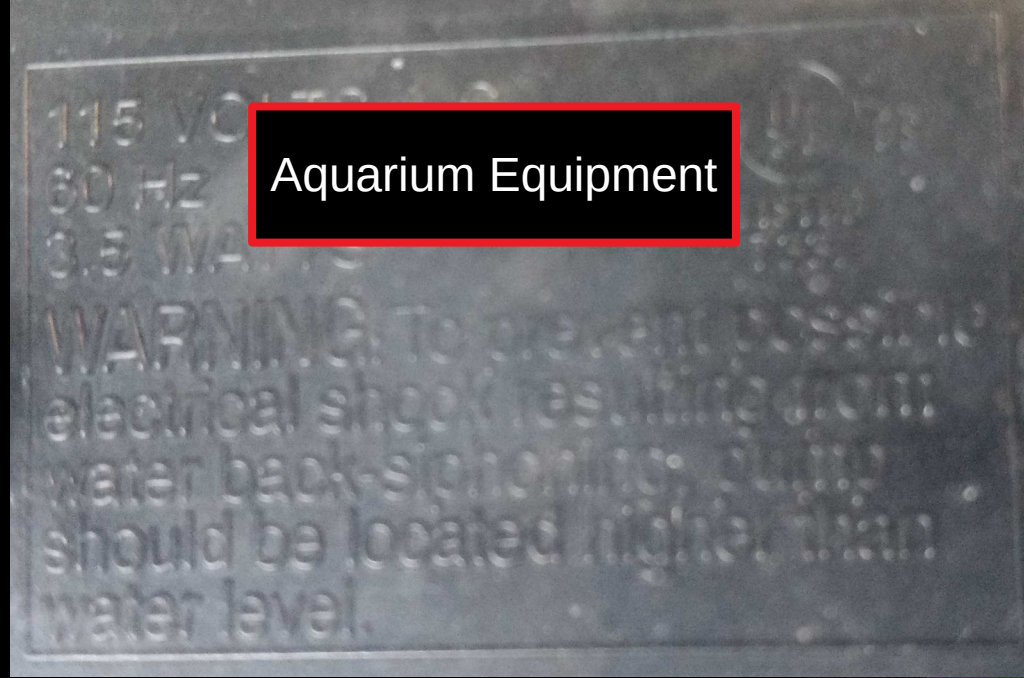
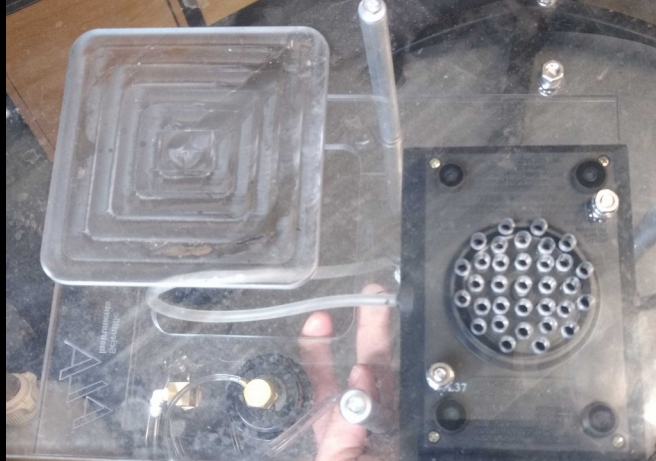
Item Total GBP 749.44  
**Grand Total GBP 749.44**

# Scientific equipment: is open better?





# Scientific equipment: is open better?



# Scientific equipment: is open better?

**BUY 1, GET 1 AT 5% OFF** (add 2 to basket) [See all eligible items](#) ▶

Free postage



## Double Outlet Airpump /Aquarium Oxygen Air Pump Fish Tank Quiet Silent Single

Condition: **New**

Colors:

Sizes:

Quantity:

9 available

[3 sold](#)

**£7.99**

**Buy it now**

[Add to basket](#)

**30-day returns**

Free postage

Posts from United Kingdom

Postage: **Free** Economy Delivery | [See details](#)

Item location: Leeds, United Kingdom

Posts to: United Kingdom [See exclusions](#)

Delivery: Estimated by **Wed. 17 Apr.** 📍

Payments: Processed by PayPal

Get more time to pay. [See payment information](#)

Returns: 30 days refund, buyer pays return postage | [See details](#)

Mouse over image to zoom



# Scientific equipment: time for an overhaul

## Microscopes:

- ~17<sup>th</sup> century

- “Scientific grade” ~5000€
  - Fluorescence + ~5000€

- No patents

- crucial piece for research and diagnostics



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

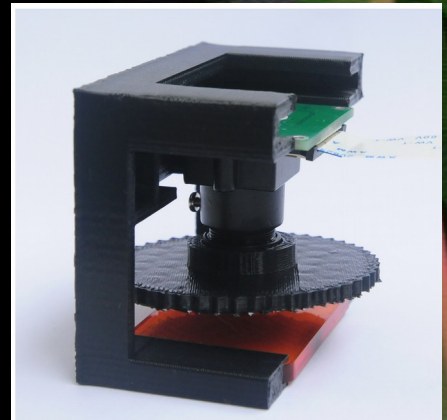
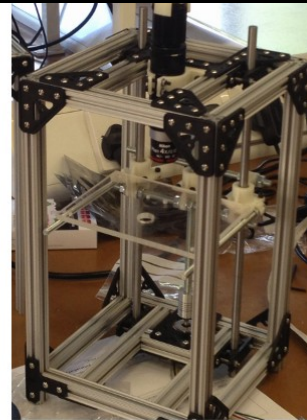


By Zephyris at the English language  
Wikipedia, CC BY-SA 3.0,  
<https://commons.wikimedia.org/w/index.php?curid=13320450>



# 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



# 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

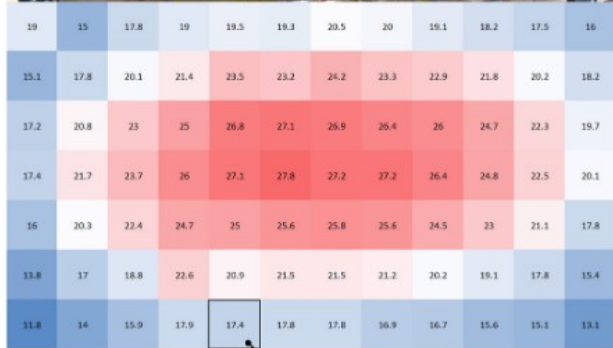






# Application of 3D printing to prototype and develop novel plant tissue culture systems

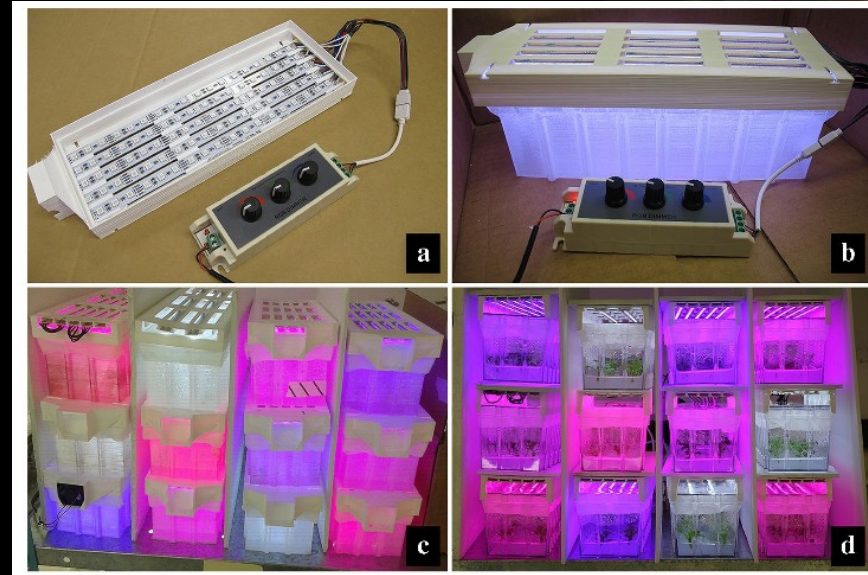
Mukund R. Shukla, Amritpal S. Singh, Kevin Piunno, Praveen K. Saxena and A. Maxwell P. Jones\*



$11 \mu\text{mol m}^{-2} \text{s}^{-1}$

$10\text{cm}^2$

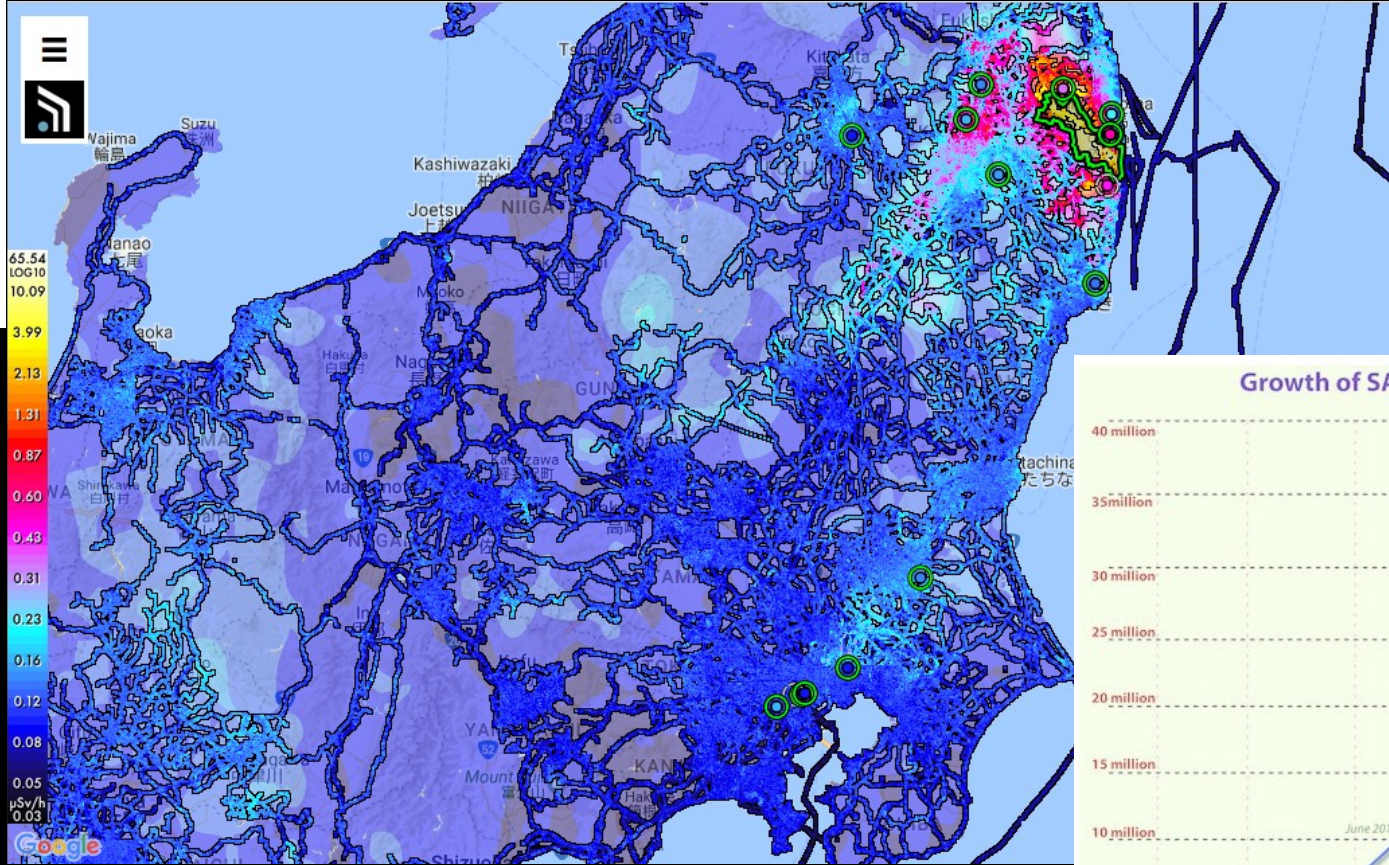
$30 \mu\text{mol m}^{-2} \text{s}^{-1}$



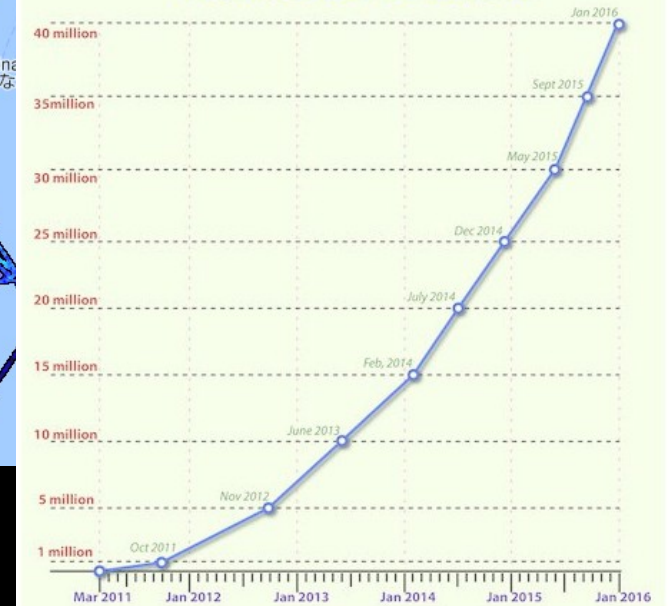
Build your own  
bGeigie Nano



KIT AVAILABLE NOW

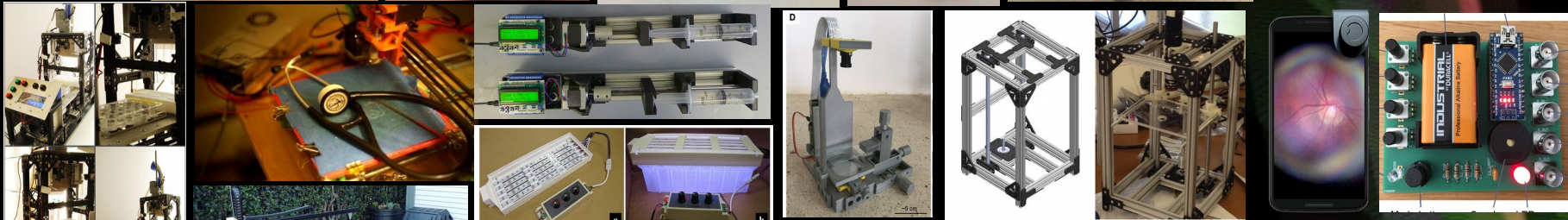
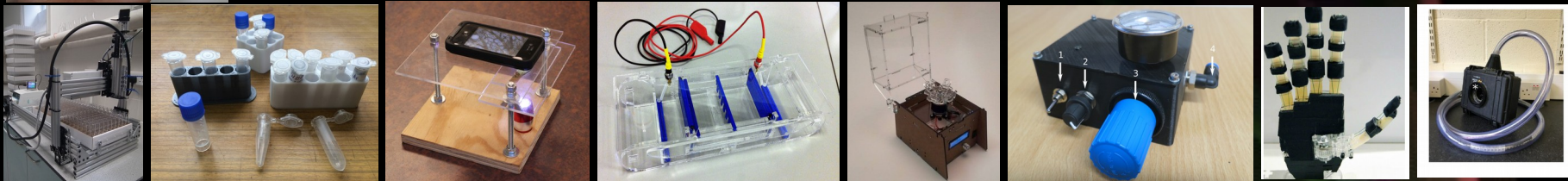
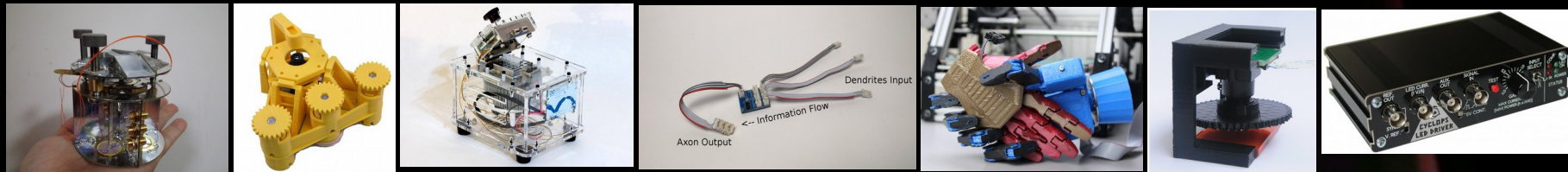


Growth of SAFecast dataset



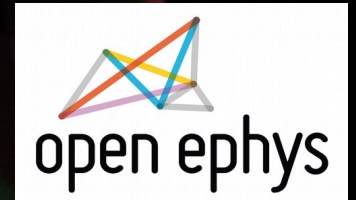
Safecast.org







# Companies & non-profits developing OS Hardware



Sam and Tom industries



# 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.

# Open Source 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!!



# 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 ([openneuroscience.com](http://openneuroscience.com))
- Open Plant Science (<http://openplant.science/>)
- Hackaday.io ([hackaday.io](http://hackaday.io))
- CTA - UFRGS (<http://cta.if.ufrgs.br/capa/>)
- Instructables ([instructables.com](http://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](http://www.appropedia.org/Welcome_to_Appropedia))
- Hackteria ([hackteria.org](http://hackteria.org))
- Open Behaviour (<http://openbehavior.com/>)

# Questions II

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

Thank you for your attention!