BioImaging North America

OME

4D Nucleome

QUAREP-LiMi

RRID

CORE MARKETPLACE

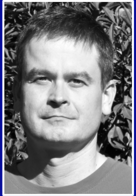
ABRF

Imaging-PHD: Persistent Identification and Citable Hardware Description of Microscope Configurations

Caterina Strambio-De-Castillia


Anita Bandrowsky


James Chambers


David Grunwald


Nate Herzog


Josh Moore


Judith Lacoste


Adrian Zai

UMass Chan MEDICAL SCHOOL

2023-09-13-15
FAIR Facilities and Instruments

NIH National Institutes of Health

Chan Zuckerberg Initiative

Outline

1. Why the persistent identification and citable description of microscopes is important
2. The importance of leveraging community work to engage microscope users, custodians and manufacturers
3. What we are planning to do
4. How we are planning to do it

Quality, Rigor and Reproducibility

- Pharmaceutical Companies know the impact of low quality data and lack of rigor.
- In this 2011 paper, they show only 18% of Phase II clinical trails are successful.
- One major reason is insufficient validity of targets.
- Billions of research dollars wasted every year.
- Slows development of new life saving treatments.

Believe it or not: how much can we rely on published data on potential drug targets?

Florian Prinz, Thomas Schlange & Khusru Asadullah

Nature Reviews Drug Discovery **10**, 712 (2011) | Cite this article

112k Accesses | **1137** Citations | **964** Altmetric | Metrics

A recent report by Arrowsmith noted that the success rates for new development projects in Phase II trials have fallen from 28% to 18% in recent years, with insufficient efficacy being the most frequent reason for failure (Phase II failures: 2008–2010. *Nature Rev. Drug Discov.* **10**, 328–329 (2011))[1]. This indicates the limitations of the predictivity of disease models and also that the validity of the targets being investigated is frequently questionable, which is a crucial issue to address if success rates in clinical trials are to be improved.

https://www.nature.com/articles/nrd3439-c1

Quality, Rigor and Reproducibility

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- In this 2011
- One major
- Billions of r
- Slows deve

eLife

Reproducibility in Cancer Biology: Challenges for assessing replicability in preclinical cancer biology

Timothy M Errington, Alexandria Denis, Nicole Perfito, Elizabeth Iorns, Brian A Nosek
Center for Open Science, United States; Science Exchange, United States; University of Virginia, United States

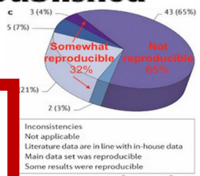
Feature Article · Dec 7, 2021

Center for Open Science, United States; Science Exchange, United States; University of Virginia, United States

Cite as: eLife 2021;10:e67995 DOI: 10.7554/eLife.67995

published

Florian Prinz, Thomas Schlange & Khusru Asadullah



...pment projects in
...efficacy being the
Drug Discov. **10**,
...se models and also
...le, which is a crucial

FA...

eLife

Replication Study: Biomechanical remodeling of the microenvironment by stromal caveolin-1 favors tumor invasion and metastasis

Mee Rie Sheen, Jennifer L Fields, Brian Northan, Judith Lacoste, Lay-Hong Ang, Steven Fiering, Reproducibility Project: Cancer Biology
Department of Microbiology and Immunology, United States; MIA Cellavie Inc, Canada; Harvard Medical School, United States

Replication Study · Dec 17, 2019
Cite as: eLife 2019;8:e45120 DOI: 10.7554/eLife.45120

Quality, Rigor and Reproducibility

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eLife

Reproducibility in Cancer Biology: Challenges for assessing replicability in preclinical cancer biology

"Differences in imaging instruments is another source of variability that could affect the outcomes between studies. The implementation of standardization procedures for equipment performance (e.g. International Organization for Standardization/Draft International Standard for confocal microscopes currently under development [ISO/DIS 21073]) could provide metrics to compare one istrument to another, facilitating reproducibility."

...and metastasis

...le, which is a crucial

Mee Rie Sheen, Jennifer L Fields, Brian Northan, Judith Lacoste, Lay-Hong Ang, Steven Fiering, Reproducibility Project: Cancer Biology

Department of Microbiology and Immunology, United States; MIA Cellavie Inc, Canada; Harvard Medical School, United States

Replication Study • Dec 17, 2019

Cite as: eLife 2019;8:e45120 DOI: 10.7554/eLife.45120

https://elifesciences.org/articles/55133

SCIENCE FORUM

Imaging methods are vastly underreported in biomedical research

Abstract A variety of microscopy techniques are used by researchers in the life and biomedical sciences. As these techniques become more powerful and more complex, it is vital that scientific articles containing images obtained with advanced microscopes include full details about how each image was obtained. To explore the reporting of such details we examined 240 original research articles published in eight journals. We found that the quality of reporting was poor, with some articles containing no information about how images were obtained, and many articles lacking important basic details. Efforts by researchers, funding agencies, journals, equipment manufacturers and staff at shared imaging facilities are required to improve the reporting of experiments that rely on microscopy techniques.

GUILLERMO MARQUÉS*, THOMAS PENGO AND MARK A SANDERS

Methods for imaging experiments are described briefly, if at all

Few articles contain the information required to replicate the imaging experiments

Image processing and analysis are rarely described in detail

Journal (articles with imaging/total articles, percentage)	Imaging figures (%)	Imaging methods (%)	Pass methods quality (%)
Developmental Biology (29/30, 99%)	79	4.2	3.4
Development (28/28, 100%)	75	7.0	14.3
Developmental Cell (32/32, 100%)	69	4.8	9.4
J Cell Biology (29/30, 97%)	72	10.1	37.9
Nature Immunology (18/29, 62%)	22	5.5	11.1
J Immunology (17/31, 55%)	21	2.3	5.9
J Neuroscience (18/30, 60%)	37	7.8	7.1
Biophysical Journal (14/30, 47%)	28	10.2	50.0
Total developmental biology (89/90, 99%)	74	5.2	9.0
Total immunolgy (35/60, 58%)	21	4.6	8.6
Total (185/240)	52	6.7	16.7(*)

eLife FEATURE ARTICLE

https://elifesciences.org/articles/55133

SCIENCE FORUM

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Abstract A variety of microscopy techniques are used by researchers in the life and biomedical sciences. As these techniques become mo… articles containing images obtained with a… image was obtained. To explore the repo… articles published in eight journals. We fo… articles containing no information about… important basic details. Efforts by research… and staff at shared imaging facilities are re… on microscopy techniques.

GUILLERMO MARQUÉS*, THOMAS

Methods for imaging experiments are described briefly, if at all

Few articles contain the information required to replicate the imaging experiments

…sis are rarely

Authors need to improve their understanding of the imaging techniques they use in their research, and reviewers and editors need to insist that enough information is given to evaluate and replicate experimental imaging data.

Mandatory deposit of original image files (including accurate metadata; ***Linkert et al., 2010***) in a repository would be a step in the right direction.

Journal (articles with imag…			…s methods quality (%)
Developmental Biology (29/…			
Development (28/28…			
Developmental Cell			
J Cell Biology (29/30			
Nature Immunology			
J Immunology (17/31			
J Neuroscience (18/3…			
Biophysical Journal (…			
Total developmental biology (89/90, 99%)	74	3.2	9.0
Total immunolgy (35/60, 58%)	21	4.6	8.6
Total (185/240)	52	6.7	16.7[(*)]

Sharing Value - Accelerates Science

International Neuroimaging Data-sharing Initiative

- Increased the **scale of scientific studies** conducted by data contributors
- Recruits **scientists from outside the consortium**
- Recruit scientists from a **broader range of disciplines**
- **Dispel myth** that scientific findings using shared data cannot be published in high-impact journals
- **913 publications, 20,297 citations**

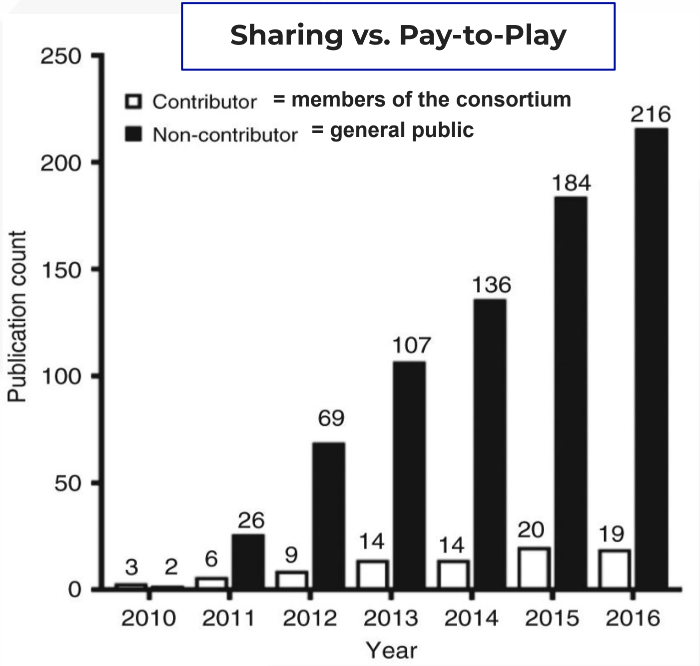
- 50 countries across 6 continents
- 81% Peer Reviewed Journals
- Data published in mathematics, computer science, physics, and engineering journals

Article | Open Access | Published: 19 July 2018

Assessment of the impact of shared brain imaging data on the scientific literature

Michael P. Milham, R. Cameron Craddock, Jake J. Son, Michael Fleischmann, Jon Clucas, Helen Xu, Bonhwang Koo, Anirudh Krishnakumar, Bharat B. Biswal, F. Xavier Castellanos, Stan Colcombe, Adriana Di Martino, Xi-Nian Zuo & Arno Klein

Nature Communications **9**, Article number: 2818 (2018) | Cite this article



https://www.nature.com/articles/s41467-018-04976-1

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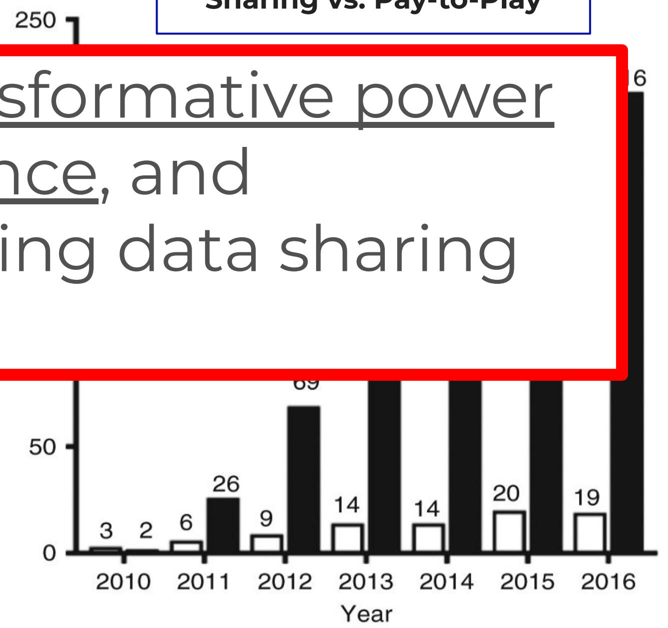
Sharing vs. Pay-to-Play



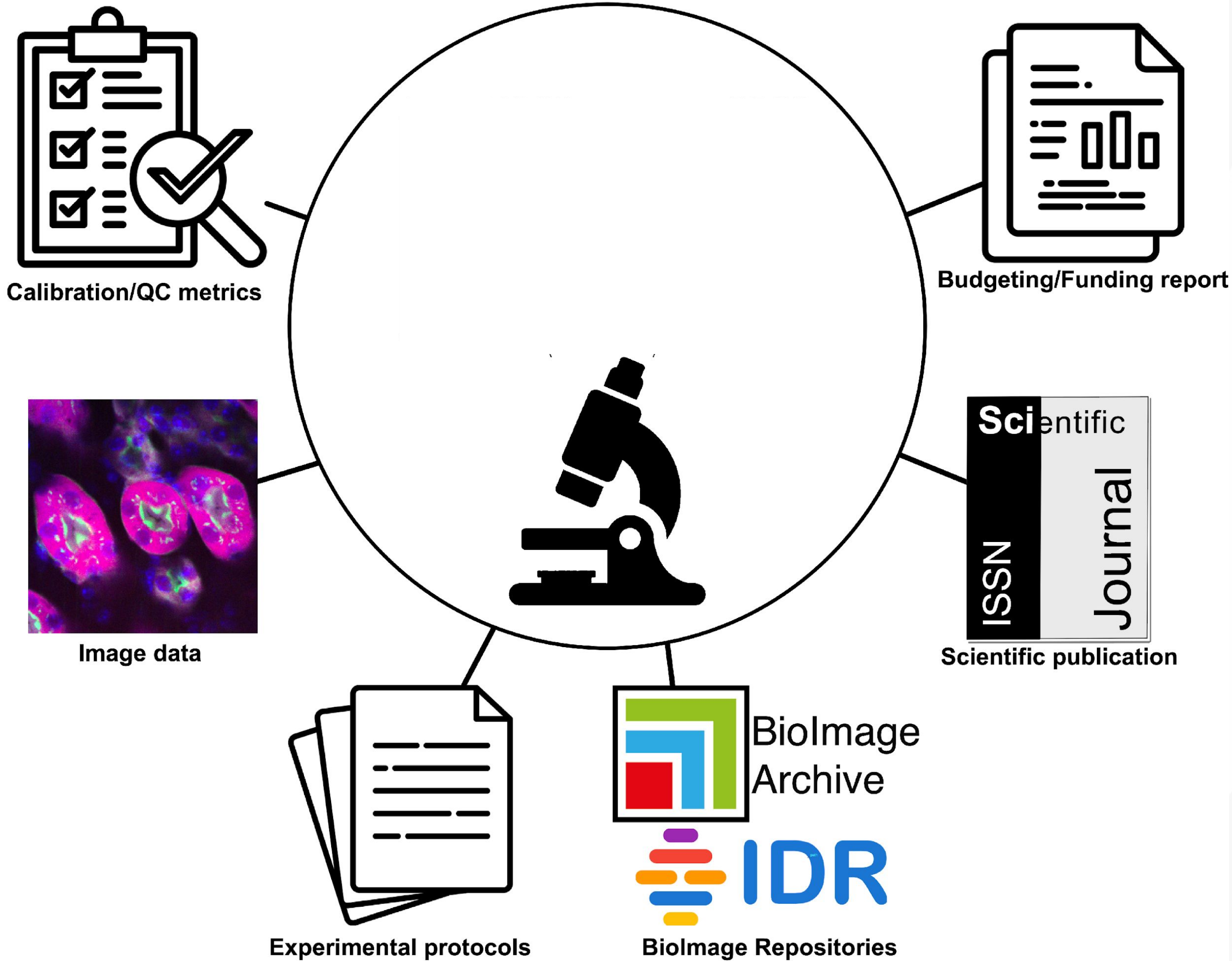
"These findings [...], suggest the transformative power of data sharing for accelerating science, and underscore the need for implementing data sharing universally."

Di Martino, Xi-Nian Zuo & Arno Klein

Nature Communications **9**, Article number: 2818 (2018) | Cite this article

https://www.nature.com/articles/s41467-018-04976-1

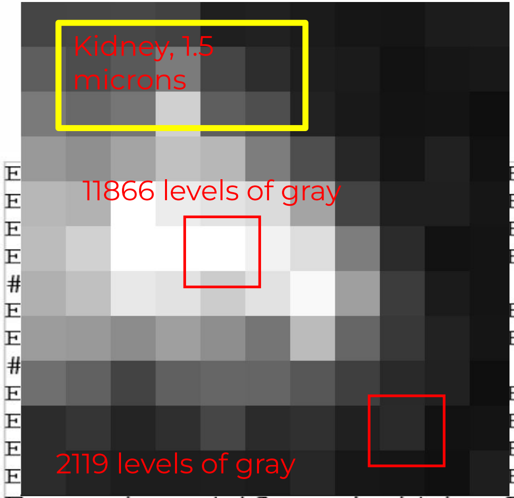
Imaging - Persistent Hardware Descriptors (PHD) project

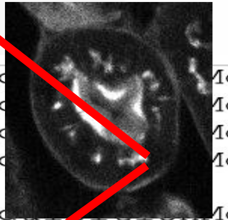


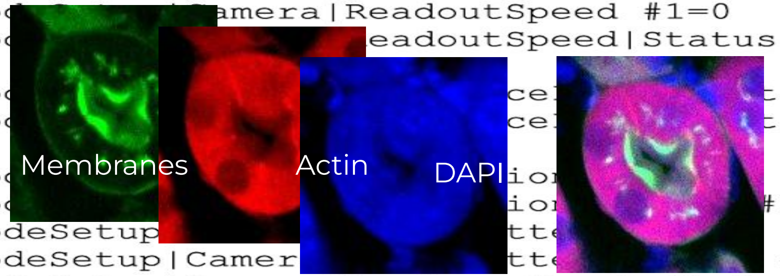
WHY there is a need for the Persistent Identification and Citable Description of Microscopes Hardware

1. Educate users on the technical characteristics of instruments
2. Helping users select microscopes that meet their experimental needs
3. Link microscopes with QC metrics
4. Link microscopes with the image data they produce
5. Report microscope hardware configuration in scientific manuscripts
6. Empower core-facility by tracking instrument utilization in manuscripts /proposals /financial reports

Image Data







- Multi-dimensional (XYZCT)
- TB to PB
- VISUALIZATION is mandatory
- METADATA is essential
- COMPUTING POWER and SPEED necessary for:
  - 3D VISUALIZATION
  - PROCESSING and ANALYSIS

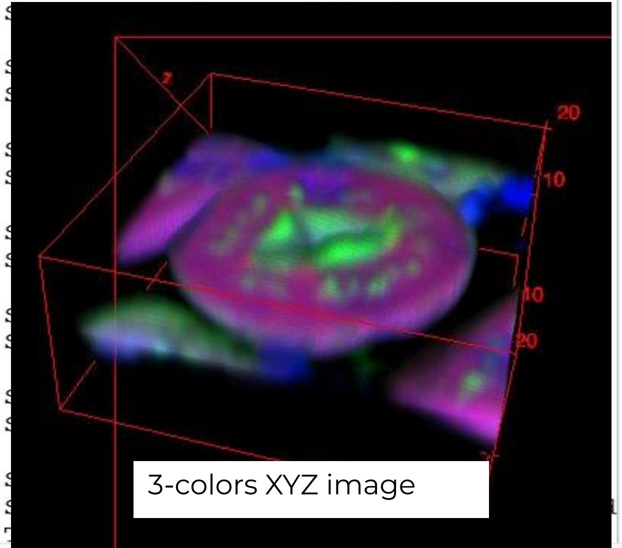
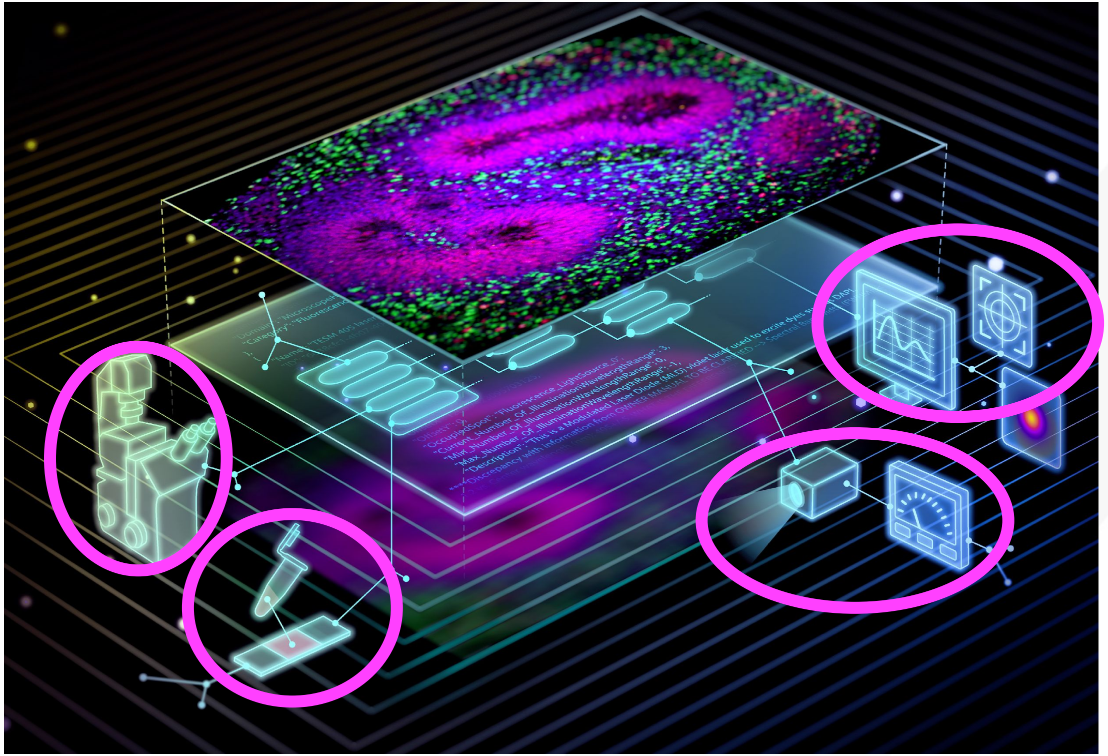


Image Metadata

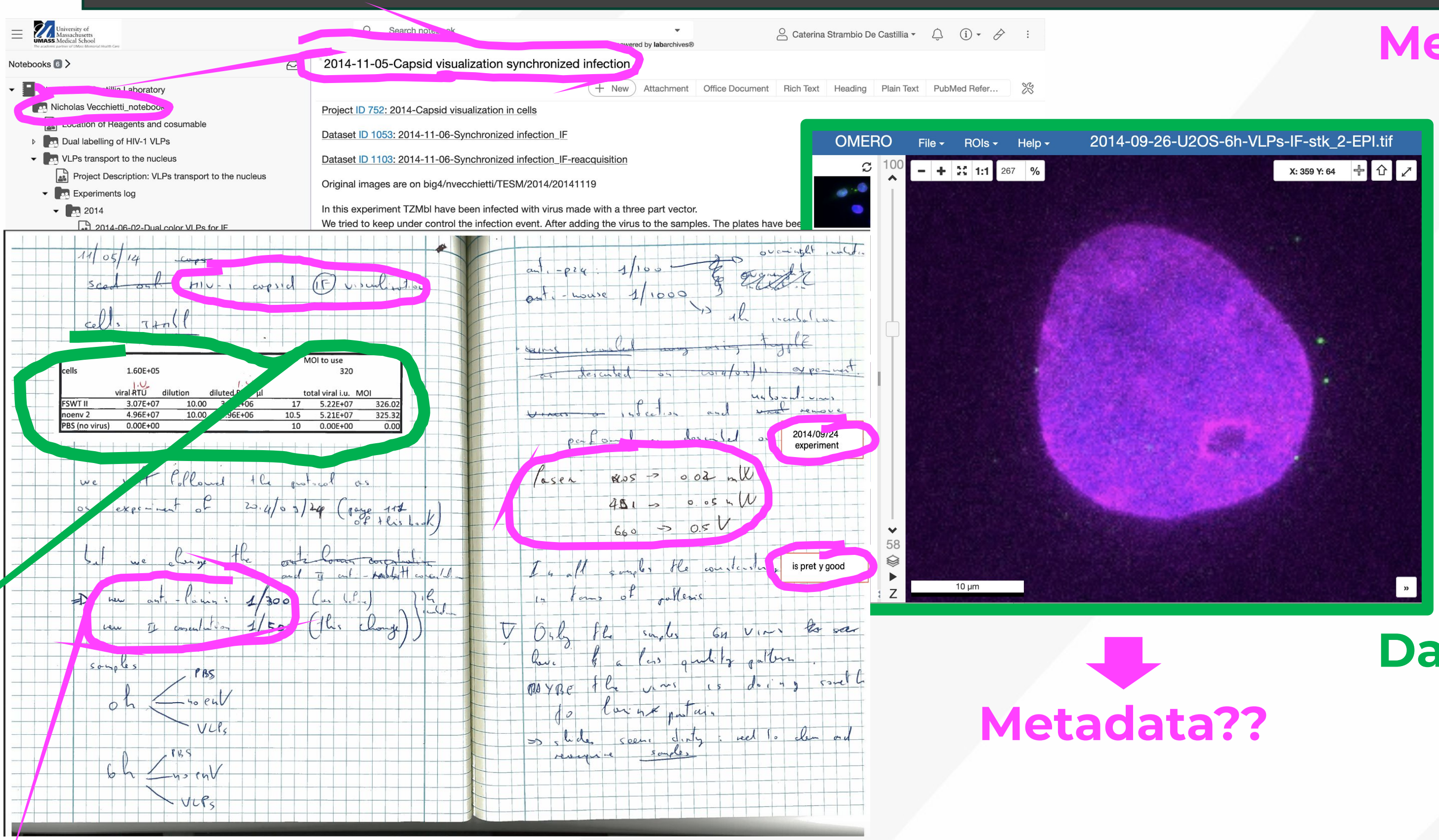


© Thao Do (Allen Institute, Seattle, WA, USA)
Nature Methods FOCUS issue on Reporting and Reproducibility in Microscopy:
https://www.nature.com/collections/djiciihhjh

All information that is needed to interpret, evaluate the quality reproduce and share microscopy images

- Sample preparation
- Image Acquisition
  - Hardware configuration
  - Acquisition setting
  - Quality Control
- Image data processing and analysis

Data and metadata from a lab notebook to publication methods



Metadata??

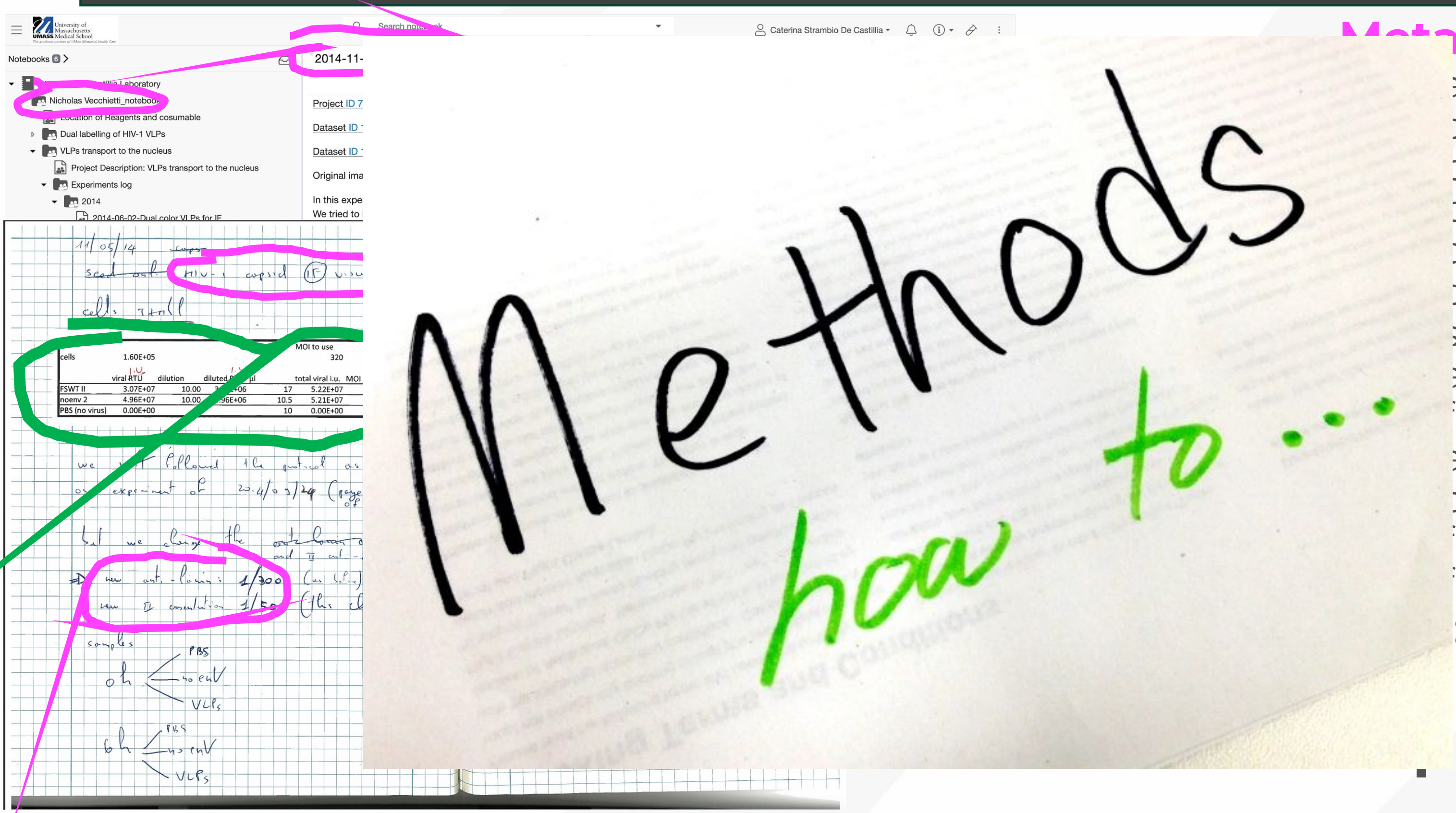
Metadata:

- author name
- date
- page number
- project name
- description
- comment
- sample name
- antibody name
- fluorophore
- acquisition conditions
- file name
- file location

Data:

- cell counts
- quality scores
- gel image

Data and metadata from a lab notebook to… publication methods



Metadata:

- author name
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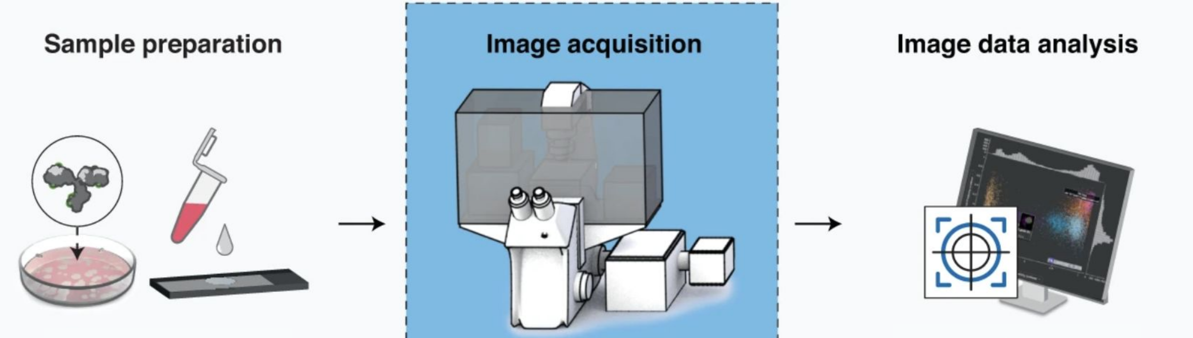
- project name
- description
- comment
- sample name
- antibody name
- fluorophore
- acquisition conditions
- file name
- file location

:

- cell counts
- quality scores
- gel image

The life-cycle of image data: from Sample Preparation to Image Acquisition, Analysis and Publication



Experimental and Sample Metadata → **Microscopy Metadata** → **Analysis and Visualization Metadata**

This has to be organized and managed!

https://www.nature.com/collections/djiciihhjh

WHAT

Metadata content

German BioImaging
Gesellschaft für Mikroskopie und Bildanalyse

Digital Research Alliance of Canada

CBI BIC
Canada BioImaging
BioImagerie du Canada

4D Nucleome

BioImaging North America

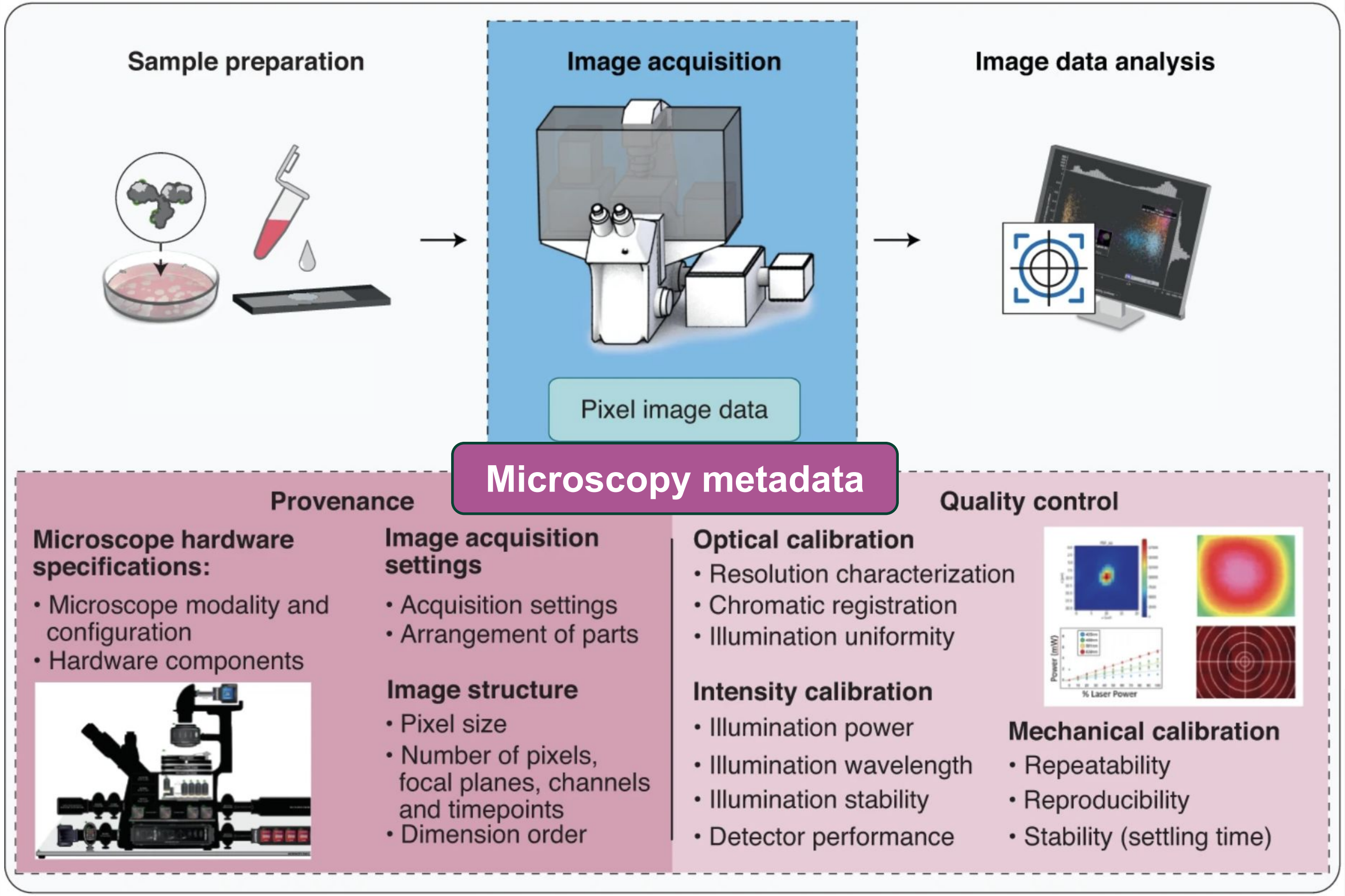
I3D:bio

UMASS MEDICAL SCHOOL

QUAREP-LiMi

OME

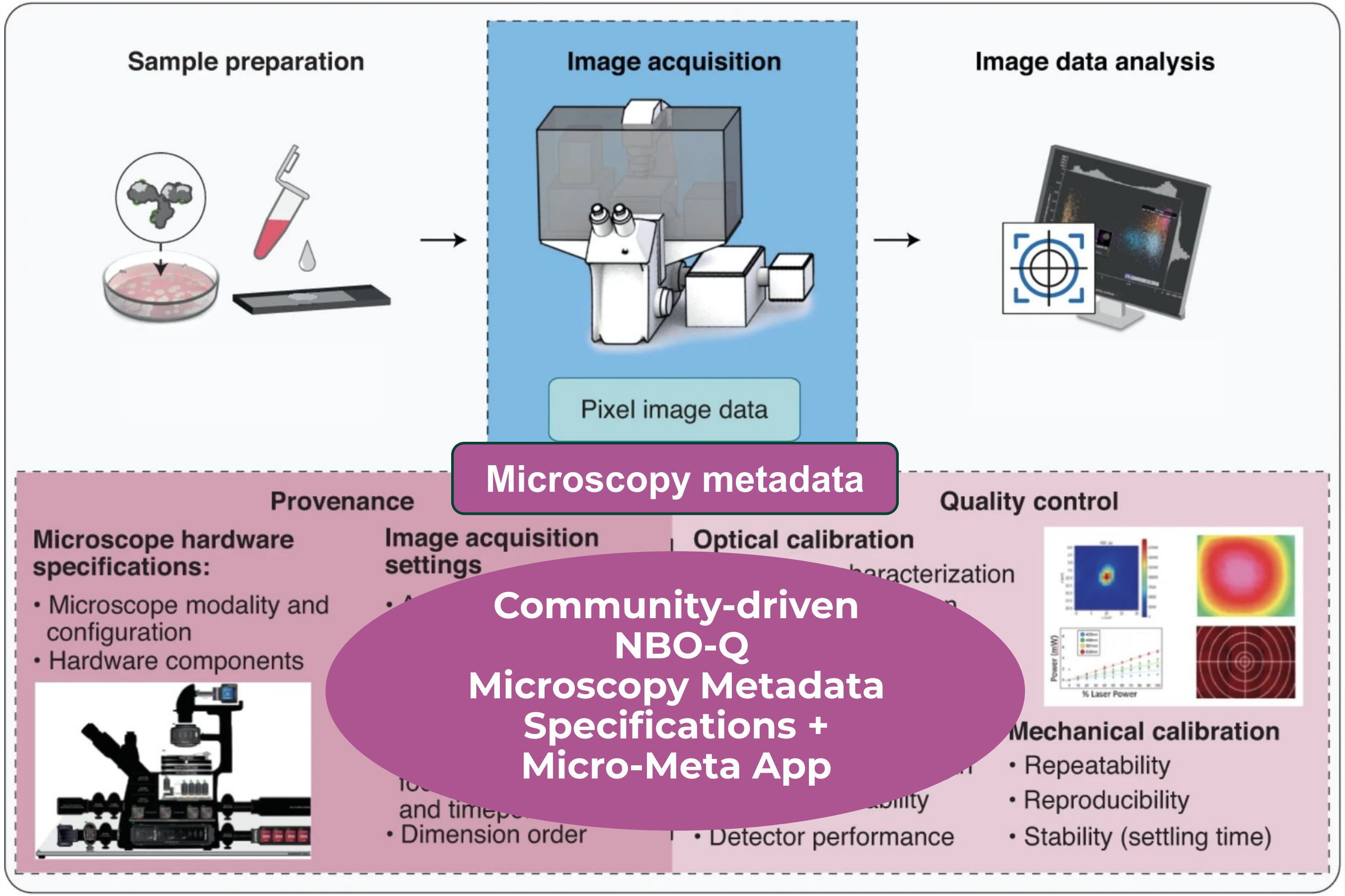
Experiment metadata can be captured in user-friendly ways...



WHAT

Metadata content

Experiment metadata can be captured in user-friendly ways...



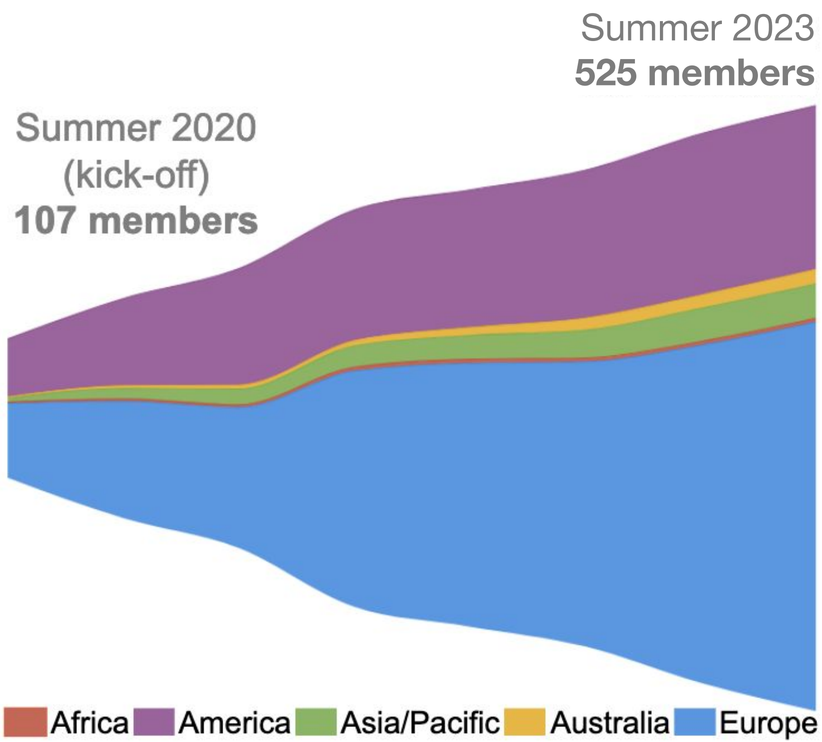
WHAT

Metadata content

Global partnerships are essential to find shared consensus that empower all community members

QUAREP-LiMi: gathering industry and academia to promote quality, reproducibility and sharing-value

Membership growth



Membership composition

Building momentum: Nature Methods FOCUS issue and Nature Methods Editorials

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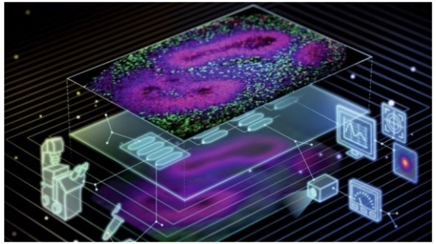
nature > nature methods > focus

Focus | 03 December 2021

Reporting and reproducibility in microscopy

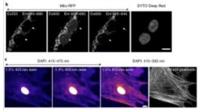
This Focus issue features a series of papers offering guidelines and tools for improving the tracking and reporting of microscopy metadata with an emphasis on reproducibility and data re-use.



Best practices and tools for reporting reproducible fluorescence microscopy methods

Comprehensive guidelines and resources to enable accurate reporting for the most common fluorescence light microscopy modalities are reported with the goal of improving microscopy reporting, rigor and reproducibility.

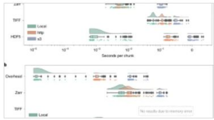
Paula Montero Llopis, Rebecca A. Senft ... Michelle S. Itano



OME-NGFF: a next-generation file format for expanding bioimaging data-access strategies

OME's next-generation file format (OME-NGFF) provides a cloud-native complement to OME-TIFF and HDF5 for storing and accessing bioimaging data at scale and works toward the goal of findable, accessible, interoperable and reusable bioimaging data.

Josh Moore, Chris Allan ... Jason R. Swedlow



A global view of standards for open image data formats and repositories

Imaging technologies are used throughout the life and biomedical sciences to understand mechanisms in biology and diagnosis and therapy in animal and human medicine. We present criteria for globally applicable guidelines for open image data tools and resources for the rapidly developing fields of biological and biomedical imaging.

Jason R. Swedlow, Pasi Kankaanpää ... Shuichi Onami

QUAREP-LiMi: a community endeavor to advance quality assessment and reproducibility in light microscopy

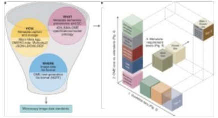
The community-driven initiative Quality Assessment and Reproducibility for Instruments & Images in Light Microscopy (QUAREP-LiMi) wants to improve reproducibility for light microscopy image data through quality control (QC) management of instruments and images. It aims for a common set of QC guidelines for hardware calibration and image acquisition, management and analysis.

Ulrike Boehm, Glyn Nelson ... Roland Nitschke

Towards community-driven metadata standards for light microscopy: tiered specifications extending the OME model

Rigorous record-keeping and quality control are required to ensure the quality, reproducibility and value of imaging data. The 4DN Initiative and BINA here propose light Microscopy Metadata Specifications that extend the OME Data Model, scale with experimental intent and complexity, and make it possible for scientists to create comprehensive records of imaging experiments.

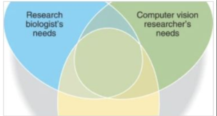
Mathias Hammer, Maximiliaan Huisman ... Caterina Strambio-De-Castillia



REMBI: Recommended Metadata for Biological Images—enabling reuse of microscopy data in biology

Bioimaging data have significant potential for reuse, but unlocking this potential requires systematic archiving of data and metadata in public databases. We propose draft metadata guidelines to begin addressing the needs of diverse communities within light and electron microscopy. We hope this publication and the proposed Recommended Metadata for Biological Images (REMBI) will stimulate discussions about their implementation and future extension.

Ugis Sarkans, Wah Chiu ... Alvis Brazma



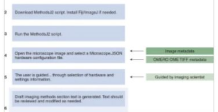
Micro-Meta App: an interactive tool for collecting microscopy metadata based on community specifications

Micro-Meta App is an intuitive, highly interoperable, open-source software tool designed to facilitate the extraction and collection of relevant microscopy metadata as specified by recent community guidelines.

Alessandro Rigano, Shannon Ehmsen ... Caterina Strambio-De-Castillia

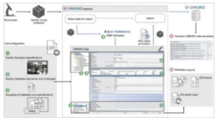
MethodsJ2: a software tool to capture metadata and generate comprehensive microscopy methods text

Joel Ryan, Thomas Pengo ... Claire M. Brown

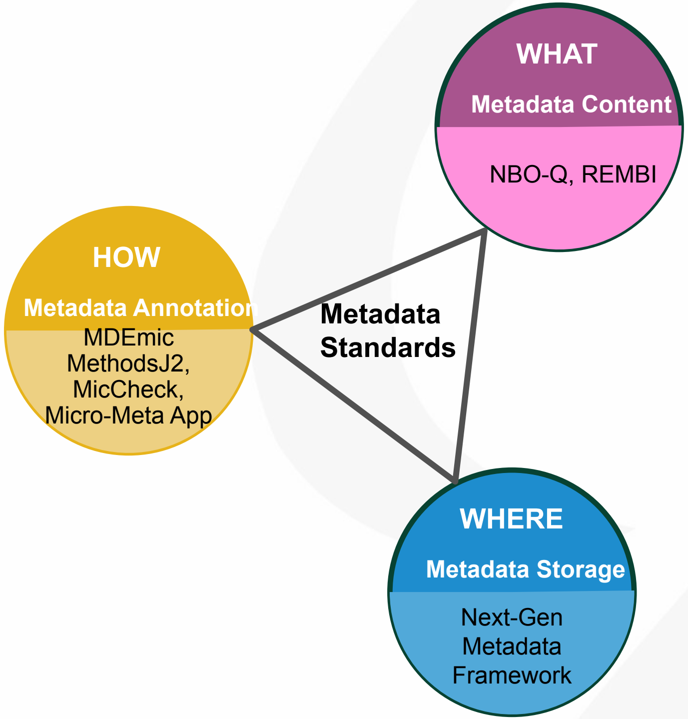


MDEmic: a metadata annotation tool to facilitate management of FAIR image data in the bioimaging community

Susanne Kunis, Sebastian Hänsch ... Stefanie Weidtkamp-Peters



QUAREP WG7: The different aspects of Metadata



Community-driven microscopy metadata standards requires:

1. community-driven specifications for ***WHAT*** information should be captured in microscopy metadata (pink bubble);

1. Shared rules for ***HOW*** metadata capture and storage should be implemented in practice

1. Next-generation file format (NGFF) and Next-Generation Metadata Framework ***WHERE*** image data and metadata should be contained for exchange

QUAREP Partnership with manufacturers to develop community camera glossary and metadata model

The making of microscope camera standards

Cameras are a crucial part of microscopes and are also built into many kinds of instruments. To make their output comparable takes standards.

Vivien Marx

The academics and company scientists in the group Quality Assessment and Reproducibility for Instruments & Images in Light Microscopy (QUAREP-LiMi) are developing standards for microscopy camera output.

As in other areas of standards development, working with companies is crucial; "after all they are the expert of the hardware they are producing," says Caterina Strambio-de-Castillia, a researcher at the University of Massachusetts Medical School's Program in Molecular Medicine and a Chan Zuckerberg Imaging Scientist, who spearheads this effort within QUAREP-LiMi. A separate story in this issue of *Nature Methods* about emerging standards in microscopy can be found in this issue.

Part of the work in developing standards for cameras in microscopy and imaging is about creating common definitions as a public resource. "The QUAREP-ers are moving on all that quite well," says Jason Swedlow of the University of Dundee, who

Cameras are a crucial part of microscopes and imaging systems. Agreeing on standards to provide defined descriptions for aspects such as gain or readout speed is tricky. Credit: W. Bulgar/Science Photo Library

technology feature

Check for updates

Imaging standards to ease reproducibility and the everyday

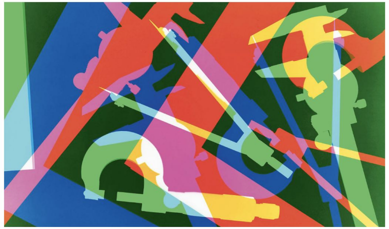
Imaging and microscopy technology advances in leaps and bounds. To address accumulated pain points, academics and companies are making headway on standards.

Vivien Marx

With a view to transparency and reproducibility in microscopy, scientists are hammering out standards to address, for instance, the surprises of fluctuating illumination power, the jungle of file formats, the mysteries of missing metadata and the diversity of camera outputs. A second story in this issue of *Nature Methods* focused on camera standards can be found here.

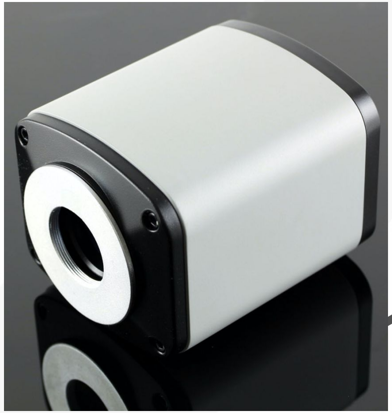
"We need standards," says Roland Nitschke of the University of Freiburg. Developing standards in imaging is a noble deed that can make some eyes glaze over even beyond the glaze arising from long hours at the microscope. Those who feel they lack the time to pitch in on standards might be glad to hear that some not-so-distant developments stand to help microscopy users pull out their hair a bit less. Here's a peek at how some emerging standards could address real-world pain points.

Standards development is not a task for



Emerging standards in microscopy are being set up to address many pain points in the field. Credit: TEK Image/Science Photo Library

- **January – August 2022**: 10+ focused feedback sessions to build consensus
- **Completed first parsing of camera hardware specifications and image acquisition settings!**
- **Due Summer 2023:** Revision of **4DN-BINA-OME-QUAREP** Camera Metadata model + Terms definitions



Camera
- Manufacturer: *Xyz*
- Catalog Nr: *0000*
- Mount: *C-mount*
- FrameRate: *20 fps*
- ReadOutRate: *30 MHz*

EVIDENT OLYMPUS

ZEISS

Leica MICROSYSTEMS

Nikon

pco.

Scientifica

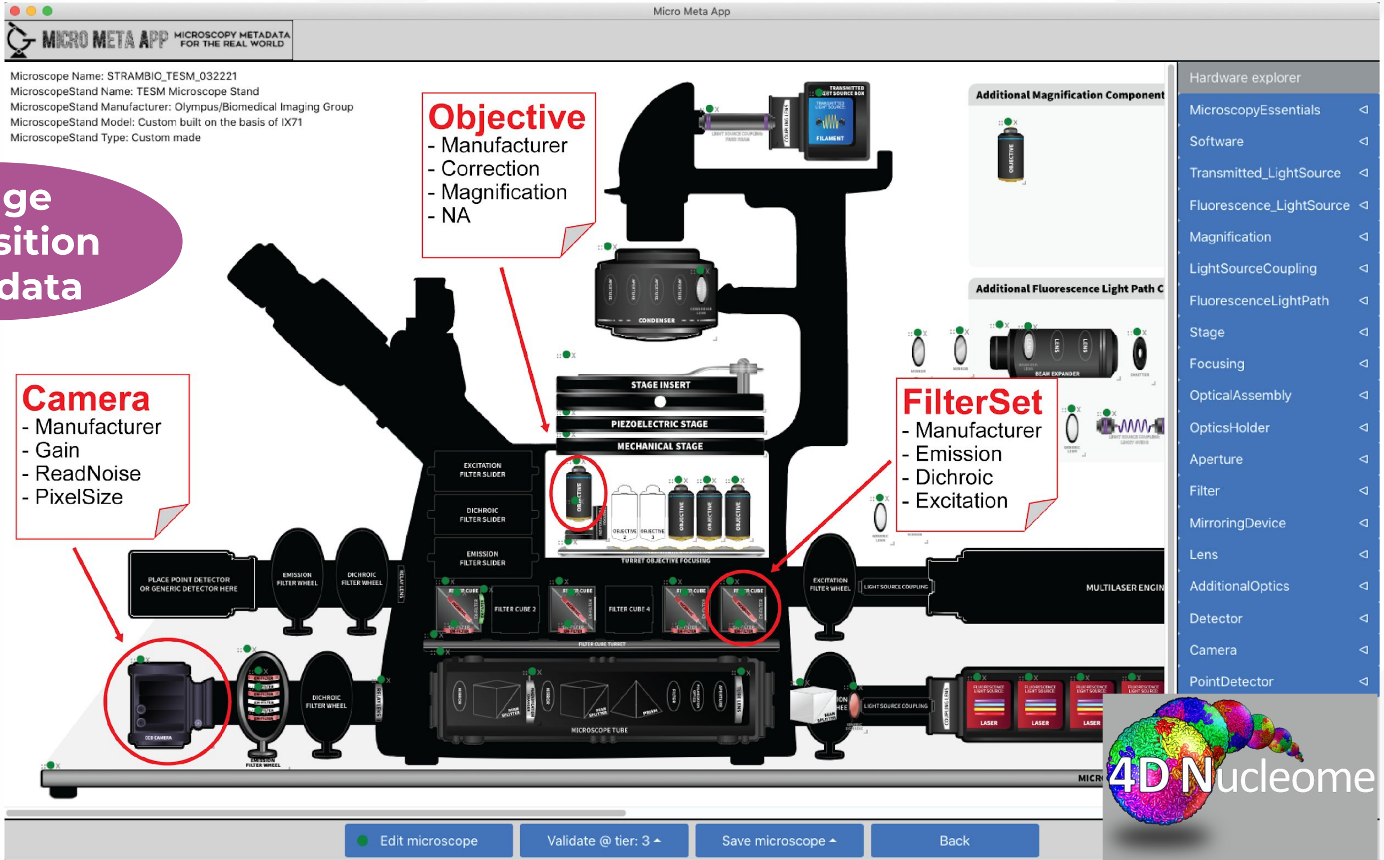
OXFORD INSTRUMENTS ANDOR

TELEDYNE PHOTOMETRICS

HAMAMATSU PHOTON IS OUR BUSINESS

Micro-Meta App: an example of a metadata annotation tool to collect microscopy metadata based on community specifications for hardware, settings and QC

Image Acquisition Metadata



QUAREP-LiMi

BioImaging North America

4D Nucleome

OME

Core Marketplace + RRID: supporting the persistent identification of core-facilities

CORE MARKETPLACE

SEARCH HELP POSTINGS

USEDit UNIVERSAL SCIENTIFIC EQUIPMENT DISCOVERY TOOL

ABRF

VBRN Vermont Biomedical Research Network

An IDeA Network of Biomedical Research Excellence (INBRE)

SEARCH | ADD/EDIT MY FACILITY

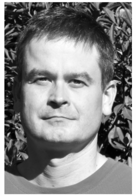
SEARCH THE COREMARKETPLACE

Find Plasmids

Find Cells

Find Organisms

The team and the community



David Grunwald
Physics, Photonics

James Chambers
Core Manager

Judith Lacoste
Quality-Control

Josh Moore
OME, GerBI –
Next Gen Metadata

German BioImaging
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ABRF

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OME

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CBI BIC
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SciCrunch, RRID

RRID

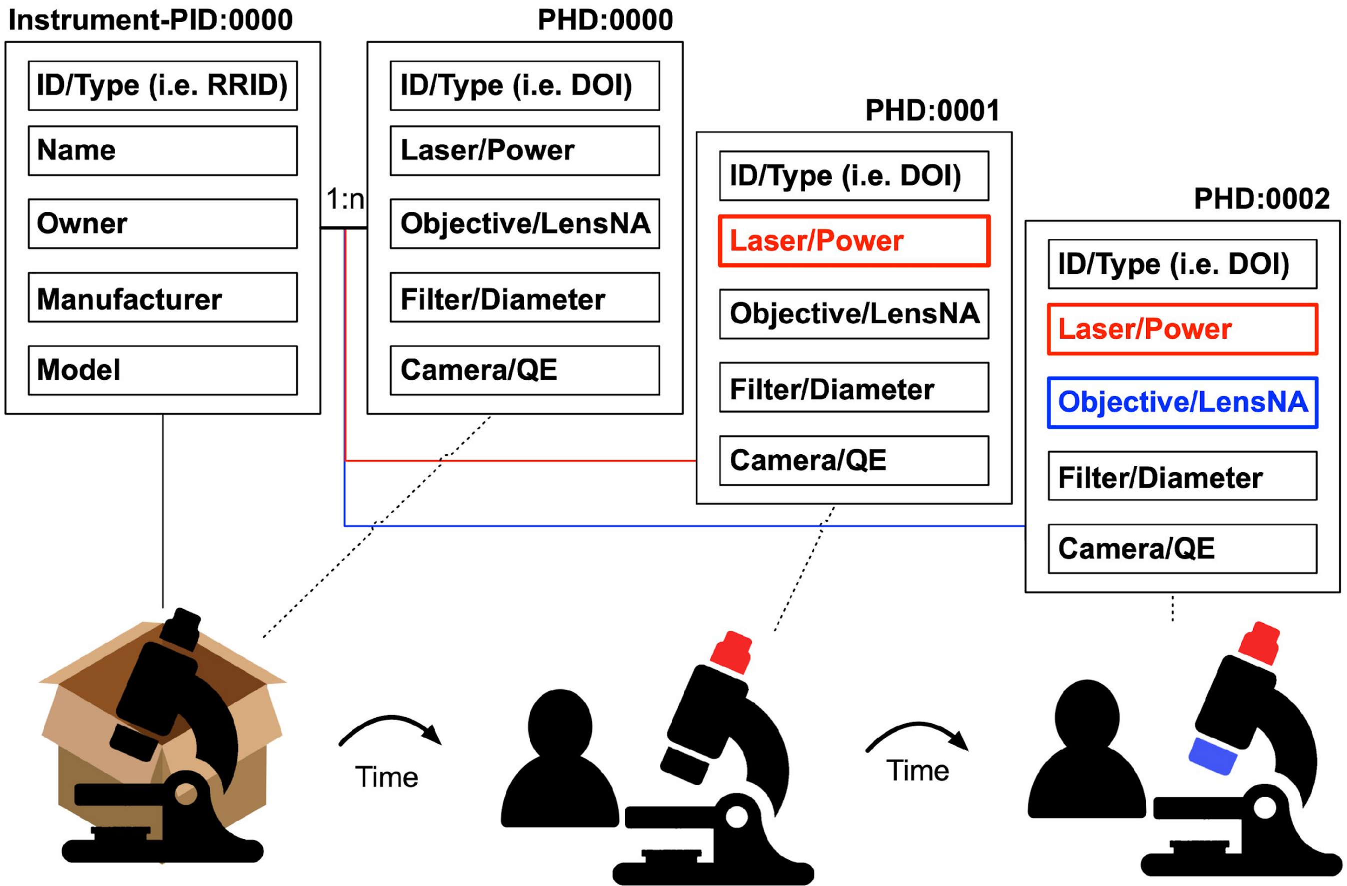
Nate Herzog
CoreMarketplace

CORE MARKETPLACE

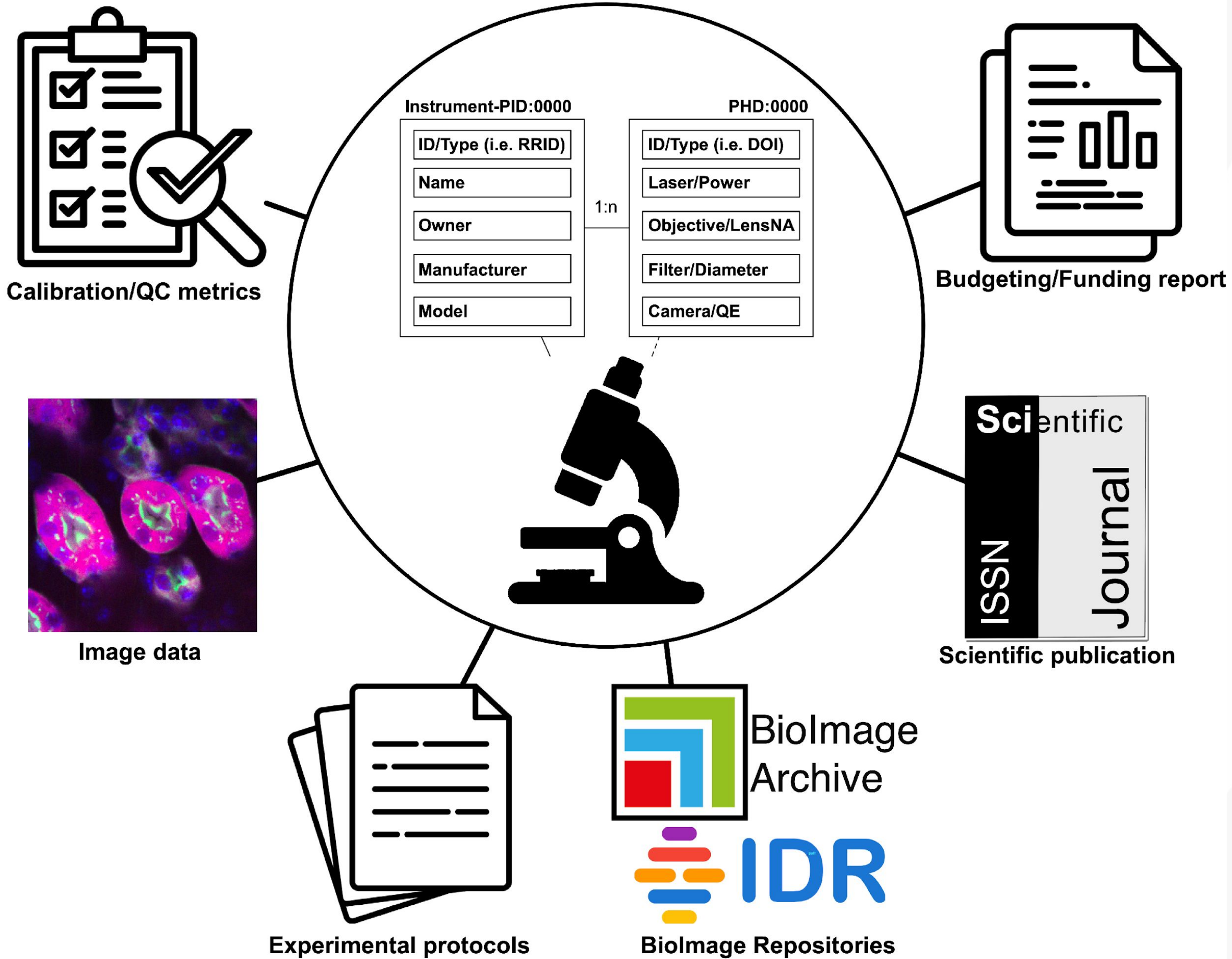
Imaging - Persistent Hardware Descriptors (PHD) project

Full description of the technical configuration

Identifying metadata

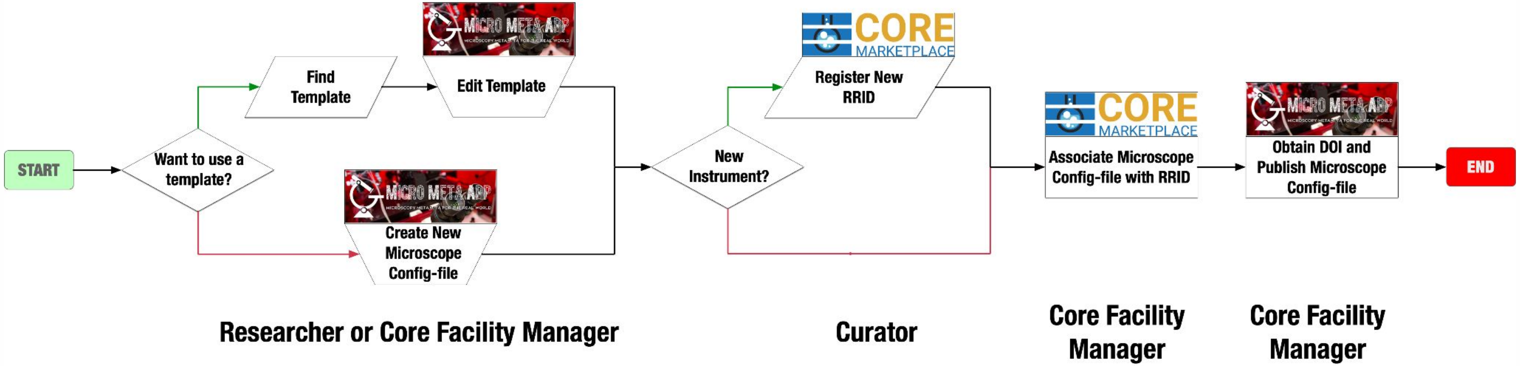


Imaging - Persistent Hardware Descriptors (PHD) project

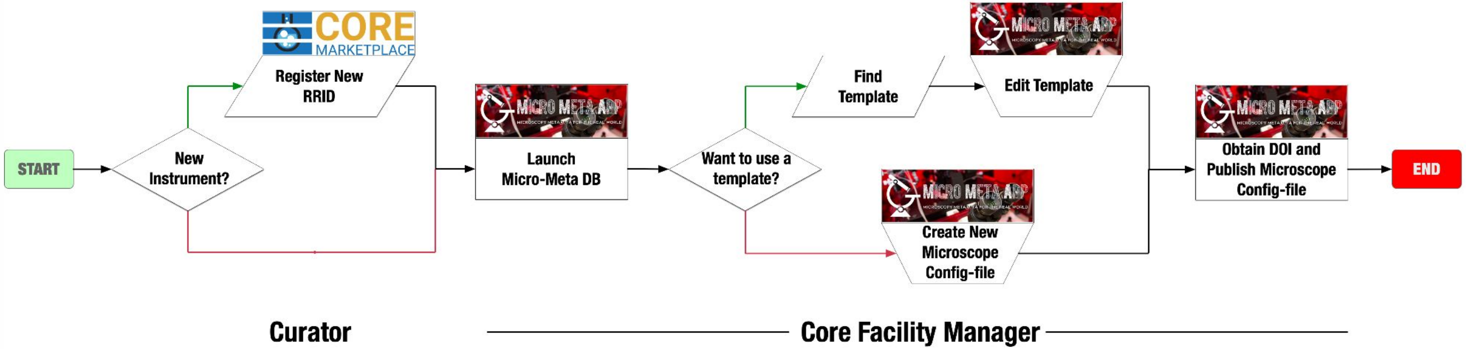


RRID/Core Marketplace + Micro-Meta DB

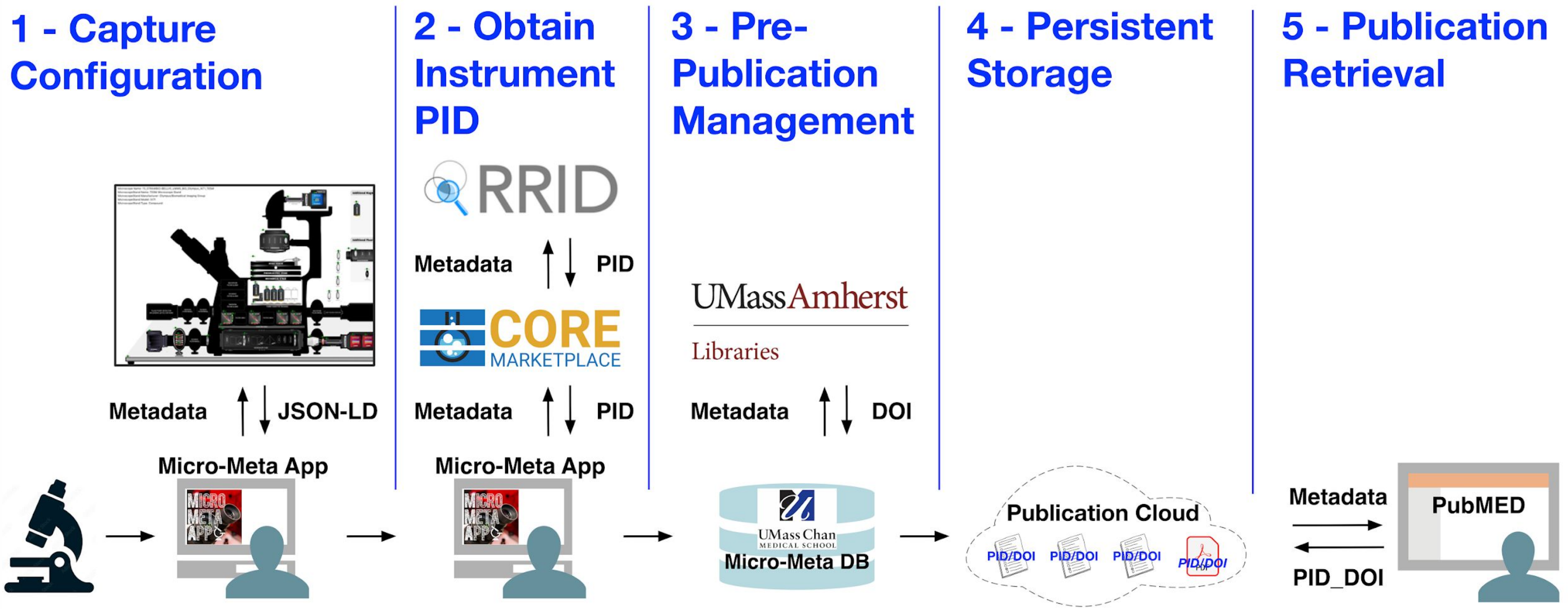
User Story: I am a researcher using a Microscope available at a core-facility, and I want to report the Microscope configuration correctly to be able to publish it and fulfill NIH DMP requirements.



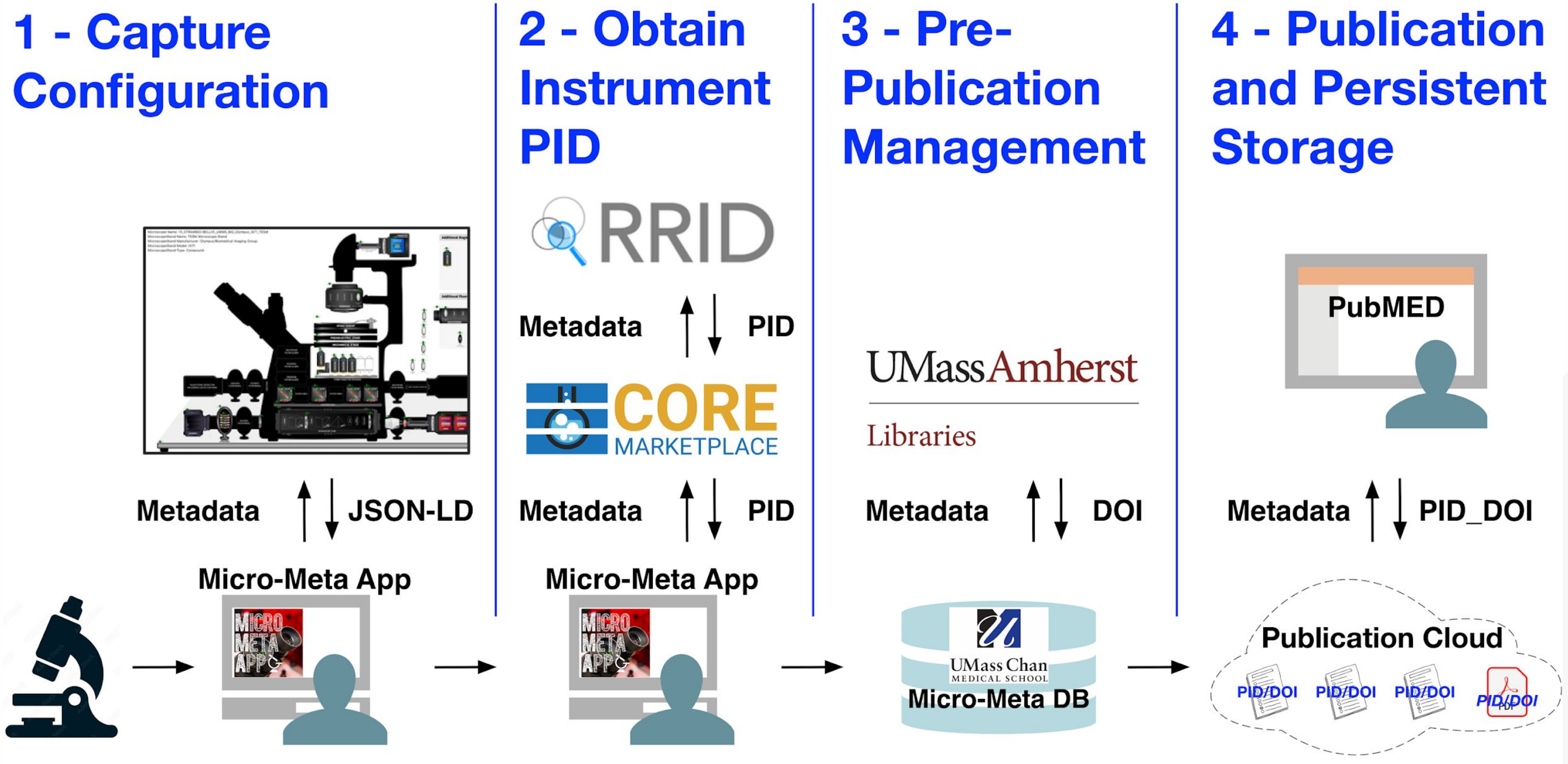
User Story: I am a facility manager and I have registered my core facility with CoreMarketplace. As a facility manager I want to use CoreMarketplace and Micro-Meta DB to keep track of the configuration, hardware specifications and performance metrics of my microscopes so that users can learn about them, identify the appropriate instrument for their experiments, and properly document their experiments to ensure reproducibility and sharing value



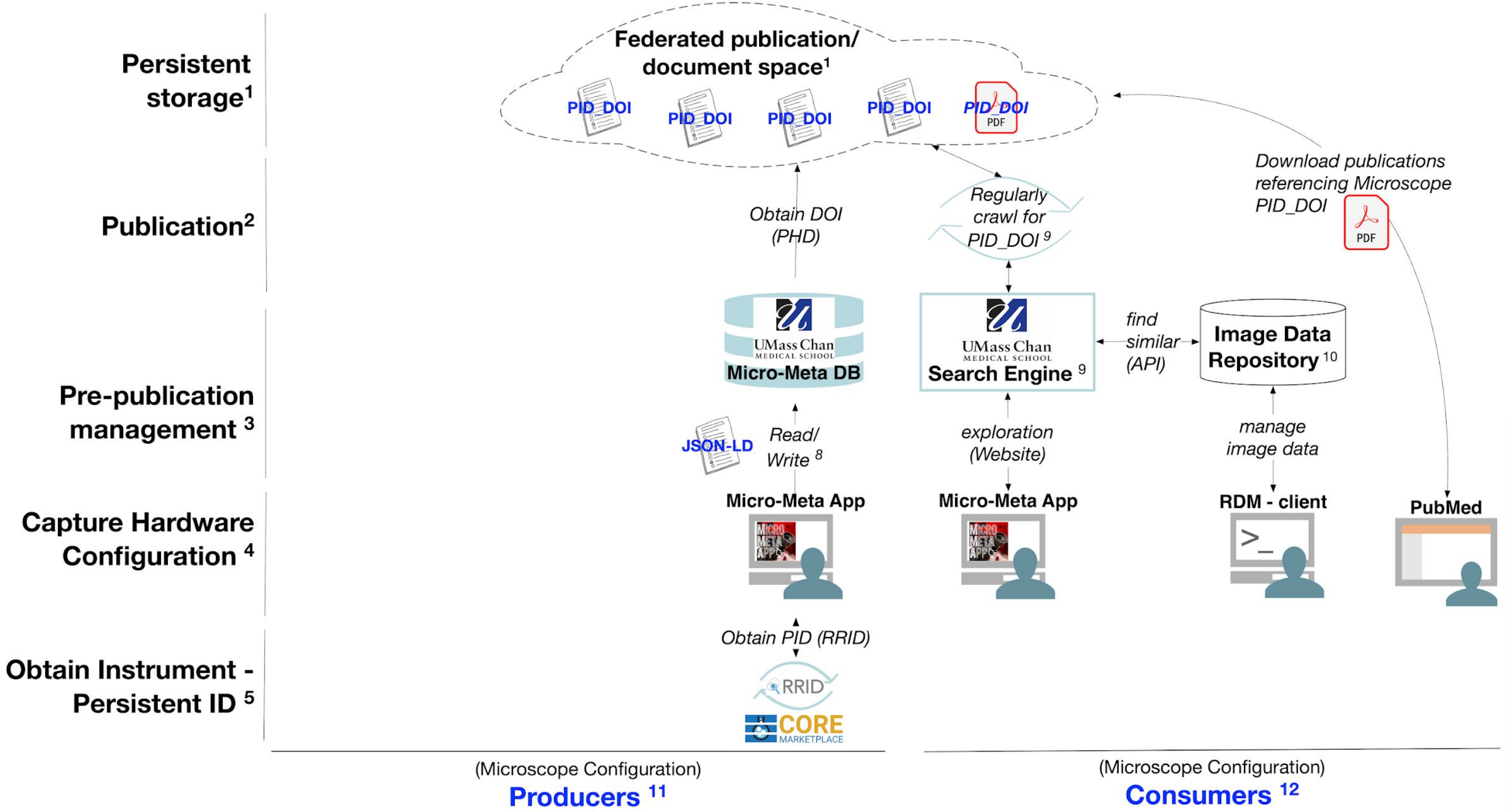
The plan: PHD – persistent hardware descriptors based on RRID and stored in Micro-Meta DB



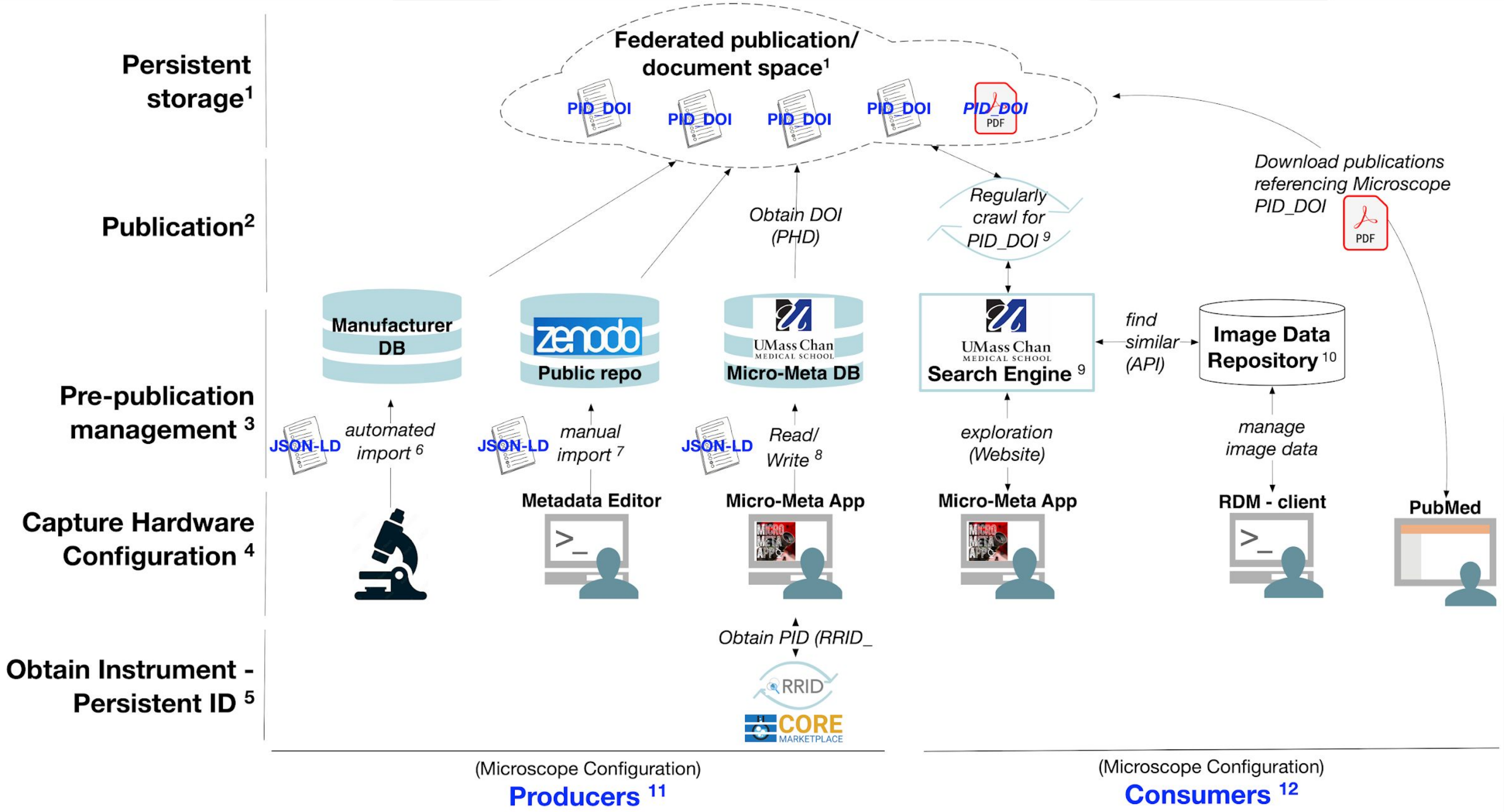
The plan: PHD – persistent hardware descriptors based on RRID and stored in Micro-Meta DB



The structure: PHD – persistent hardware descriptors based on RRID and stored in Micro-Meta DB



The structure: PHD – persistent hardware descriptors based on RRID and stored in Micro-Meta DB

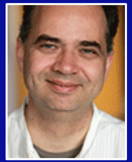


Questions & Answers

THANK YOU!

UMass Med + Canada Bioimaging


Judith Lacoste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BINA+QUAREP-LiMi

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- Britta Schroth-Diez, Max Plank, Dresden
- Damir Sudar, Uni Oregon, QIS
- Caroline Miller
- Nikki Bilay + Vanessa Orr, BINA
- BINA Quality Control and Data Management WG
- QUAREP-LiMi WG7 – Metadata

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4DN Community

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Imaging Scientists Community

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- Jason Swedlow, OME
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- Will Moore, OME
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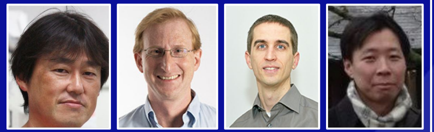

NIH National Institutes of Health

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Tanenbaum Open Science Institute (TOSI)

Chan Zuckerberg Initiative