

# Micro-Meta App: an interactive software to facilitate the collection of OME-compliant microscopy metadata based on community-driven specifications

Alex Rigano, Shannon Ehmsen, Serkan Utku Ozturk, Alexander Balashov, Burak Alver, David Grunwald and Caterina Strambio De Castillia



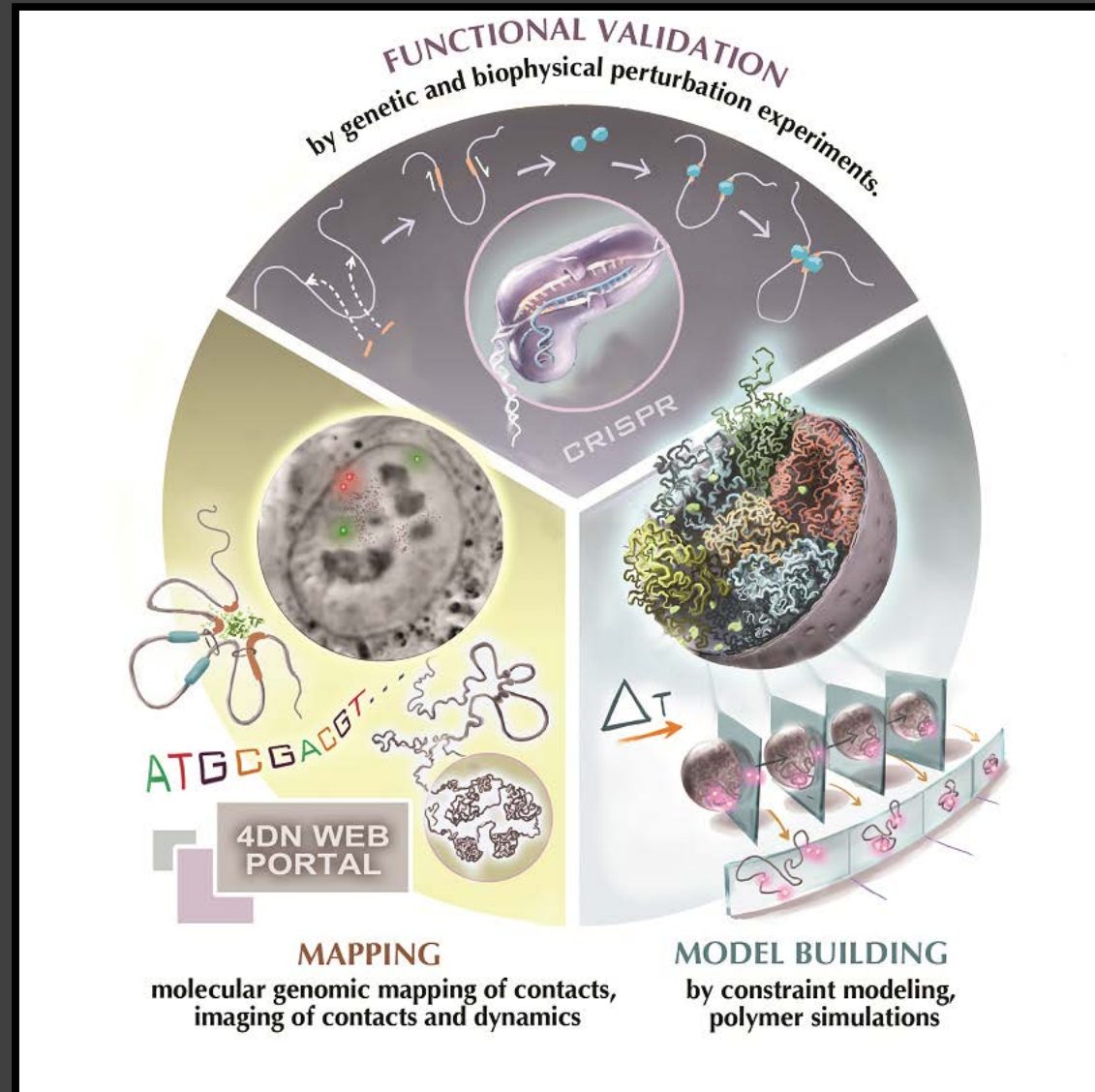
2021-1-5 – Virtual UK Bioimaging



# NIH 4D Nucleome Initiative

*Standards and Metrics for imaging datasets produced by the 4D Nucleome consortium*

- Community driven
- Shareable
- Adaptable
- Extensible
- Easy to use
  - *Minimum Information principle*
  - *Requirements that scale with experimental requirements and complexity*
  - *Maximize automation in metadata collection*
  - *Promote community consensus*

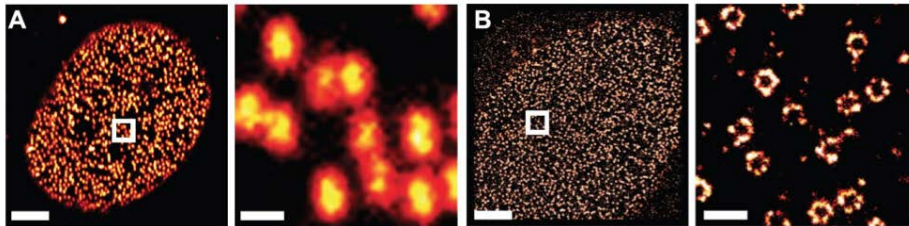
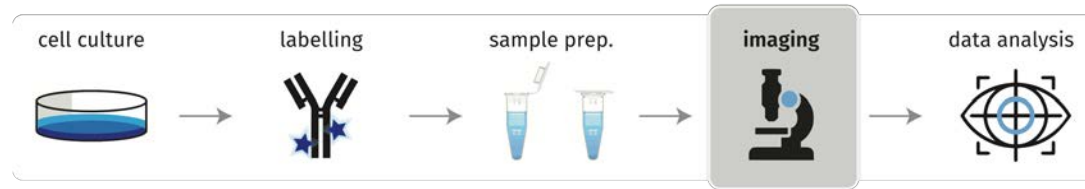


4DN IWG Members: David Grunwald , Joan Polit-Ritland, Rob Singer, , Burak Alver, Rob Coleman, Warren Zipfel

<https://www.4dnucleome.org>

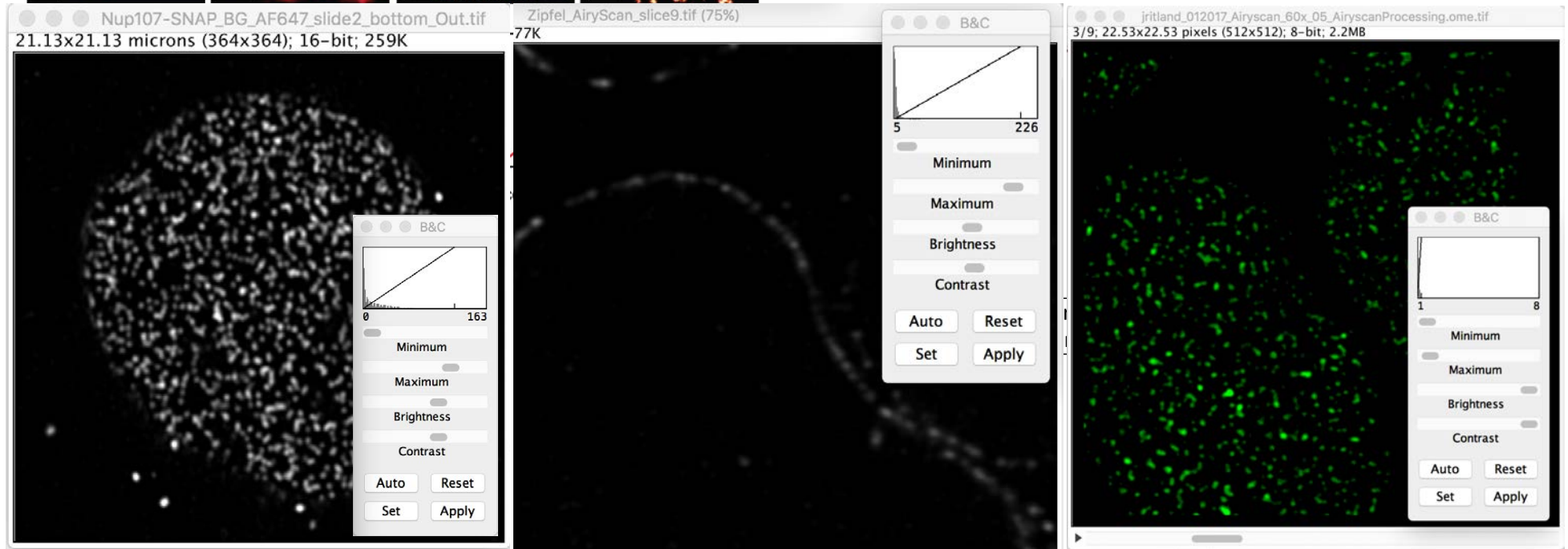


# Can images be compared and shared across different labs and imaging results reproduced?



Thevathasan, J.V., Kahnwald, M., Cieřliński, K. *et al.* Nuclear pores as versatile reference standards for quantitative superresolution microscopy. *Nat Methods* **16**, 1045–1053 (2019).

<https://doi.org/10.1038/s41592-019-0574-9>







# The lack of reproducibility is universal

NATURE | NEWS FEATURE

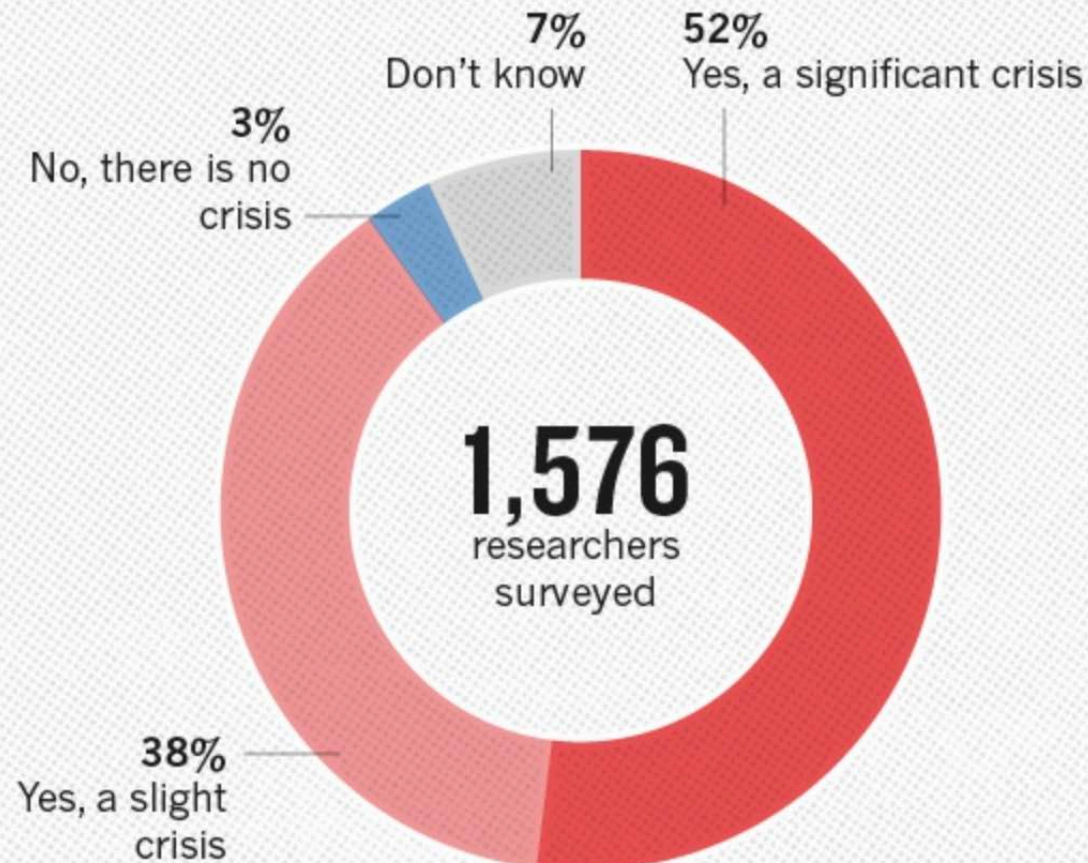
## 1,500 scientists lift the lid on reproducibility

Survey sheds light on the 'crisis' rocking research.

**Monya Baker**

25 May 2016 | Corrected: 28 July 2016

### IS THERE A REPRODUCIBILITY CRISIS?



## 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 PENG0 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 immunology (35/60, 58%)	21	4.6	8.6
Total (185/240)	52	6.7	16.7 <sup>(*)</sup>

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. Unfortunately, many articles published in the life and biomedical sciences do not contain this information. This is a problem because the information is important for basic research and for the development of new imaging techniques. We have surveyed the methods used by authors and staff at several major life and biomedical journals on microscopy methods.

GUILLERMO

*Methods for imaging experiments are described briefly, if at all*

*Few articles contain the information required to replicate the imaging experiments*

*Analysis 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 imaging methods quality (%))

Developmental Biology (29/30)

Development (28/28, 100%)

Developmental Cell (29/30)

J Cell Biology (29/30)

Nature Immunology (29/30)

J Immunology (17/31)

J Neuroscience (18/30)

Biophysical Journal (18/30)

Total developmental biology (89/90, 99%)

Total immunology (35/60, 58%)

Total (185/240)

75

7.0

14.2

74

5.2

9.0

21

4.6

8.6

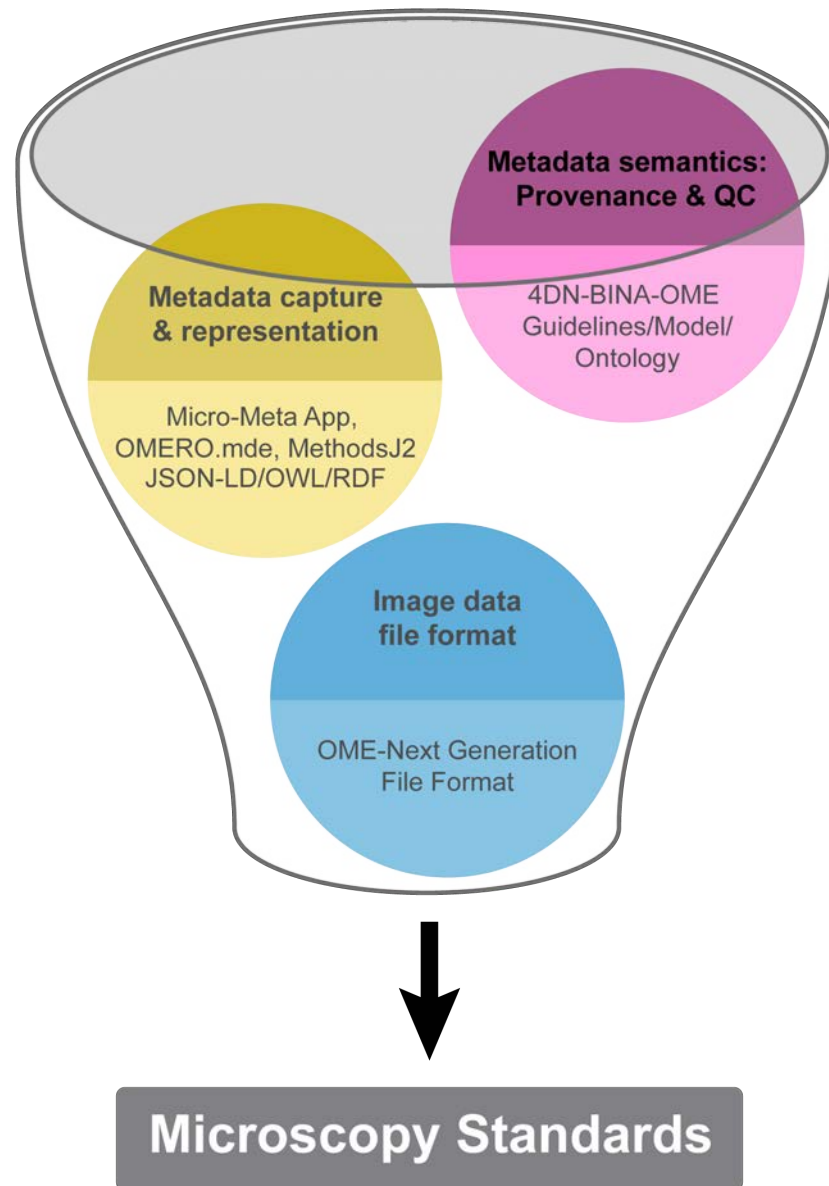
52

6.7

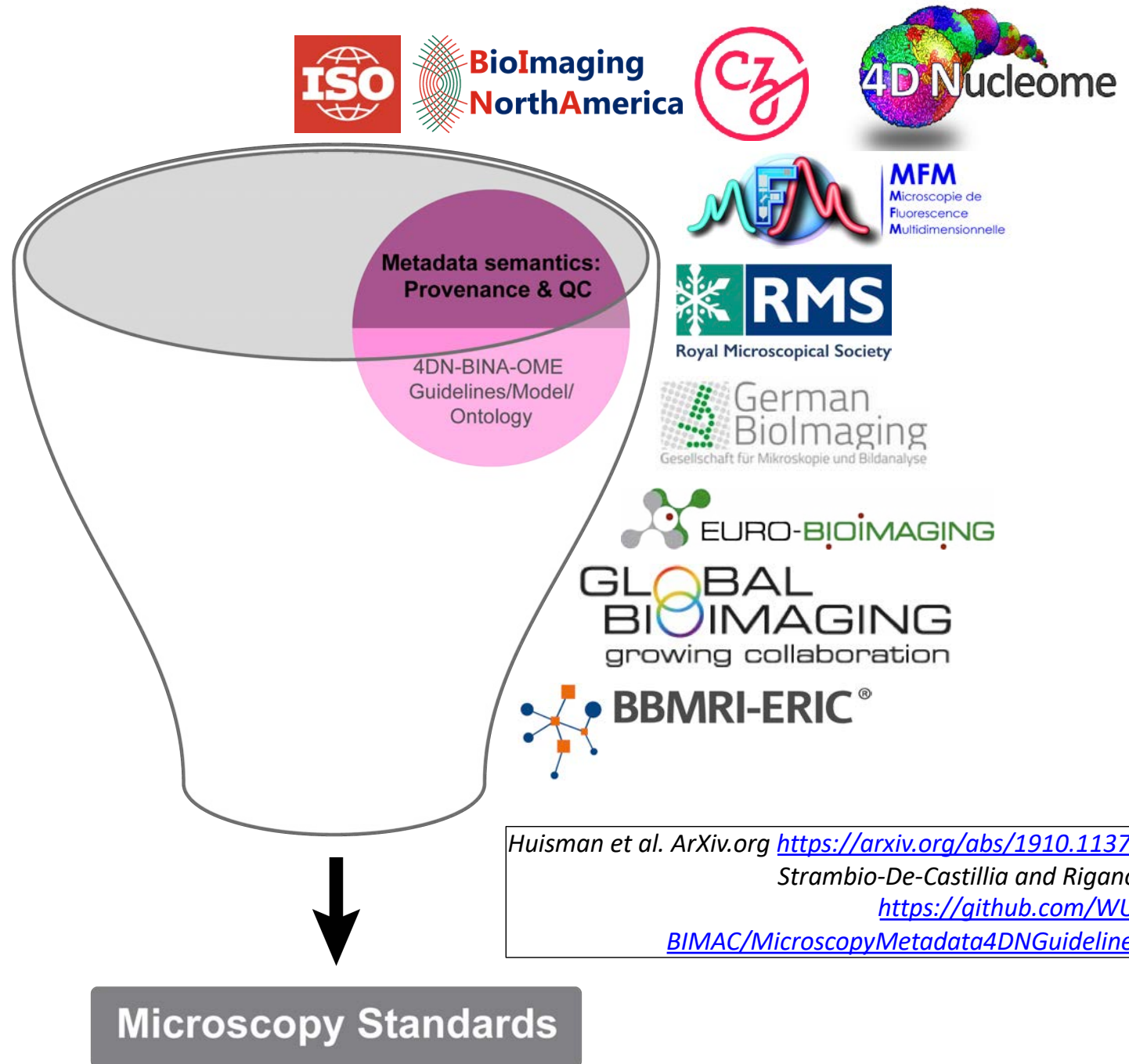
16.7<sup>(\*)</sup>



# What do we mean by Microscopy Standards?



# What do we mean by Microscopy Standards?

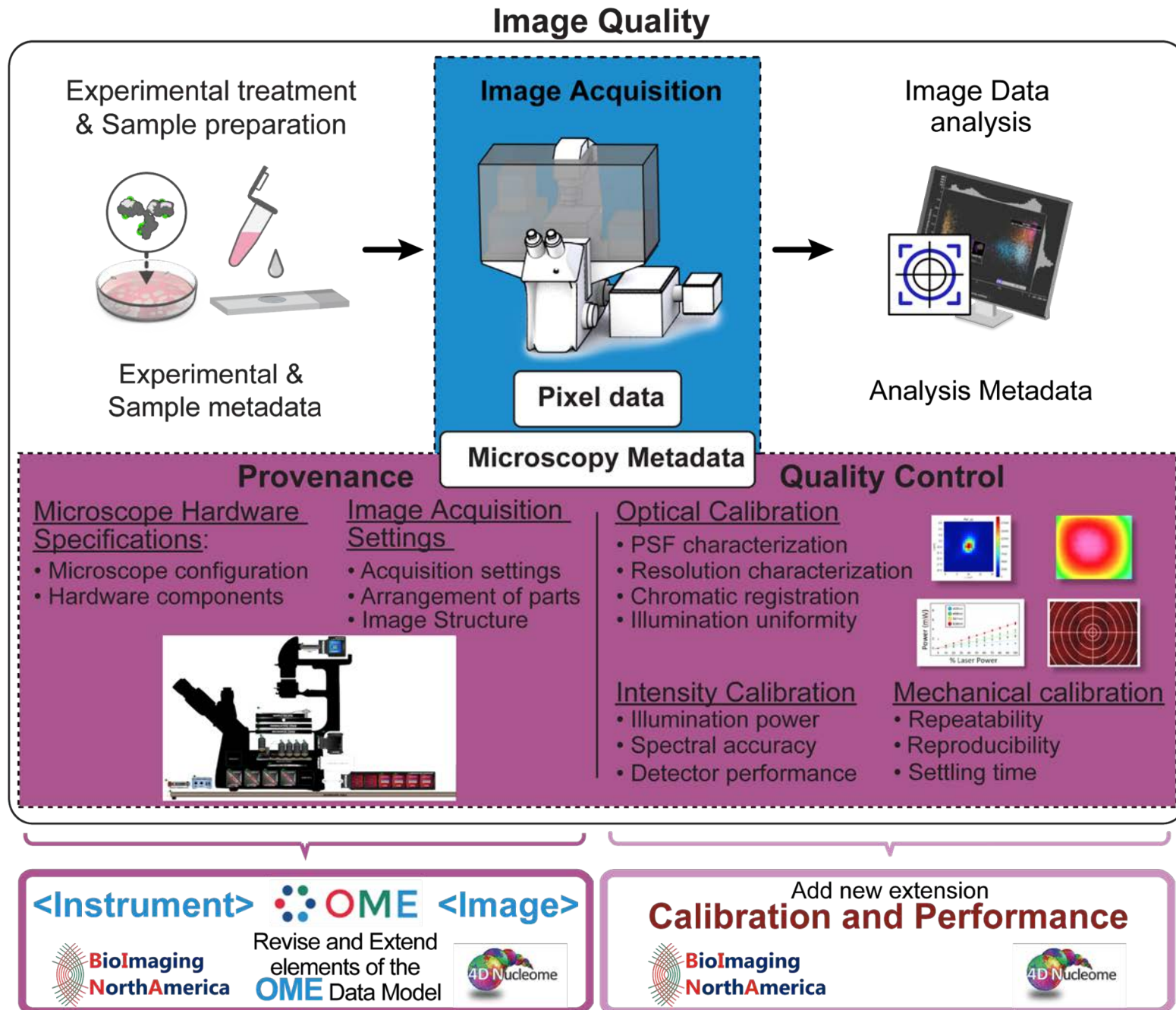


ISO 23494: Biotechnology – Provenance  
Information Model for Biological  
Specimen and Data  
<https://www.iso.org/standard/80715.html>

Huisman et al. ArXiv.org <https://arxiv.org/abs/1910.11370>  
Strambio-De-Castillia and Rigano,  
<https://github.com/WU-BIMAC/MicroscopyMetadata4DNGuidelines>

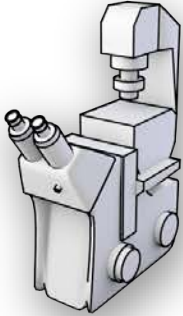
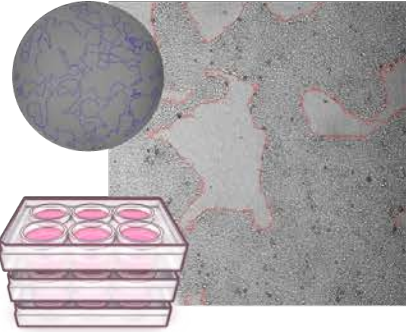
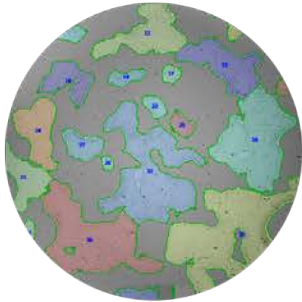
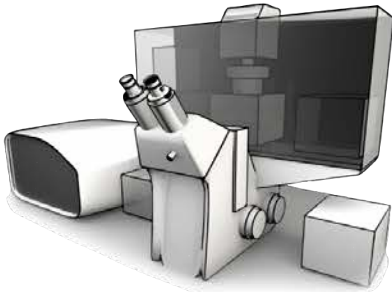
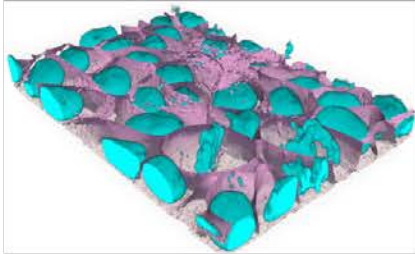
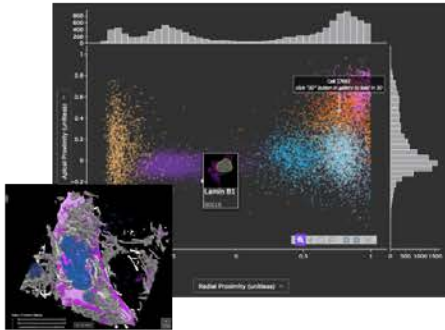
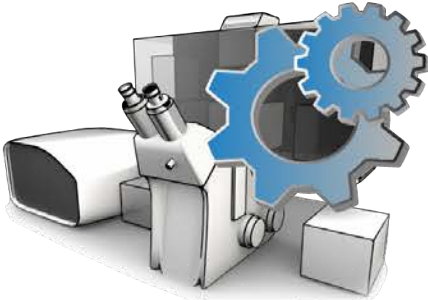
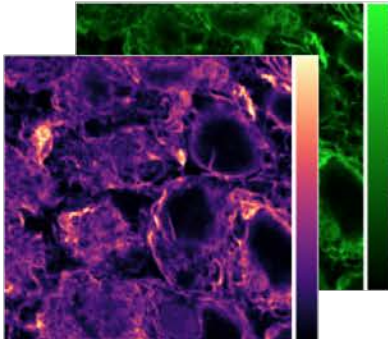
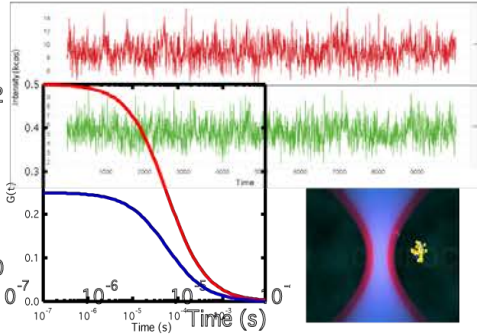


# Metadata is essential for reproducibility and to compare and share data



# Scaling reporting guidelines with experimental complexity, and image analysis needs facilitates sharing and reproducibility

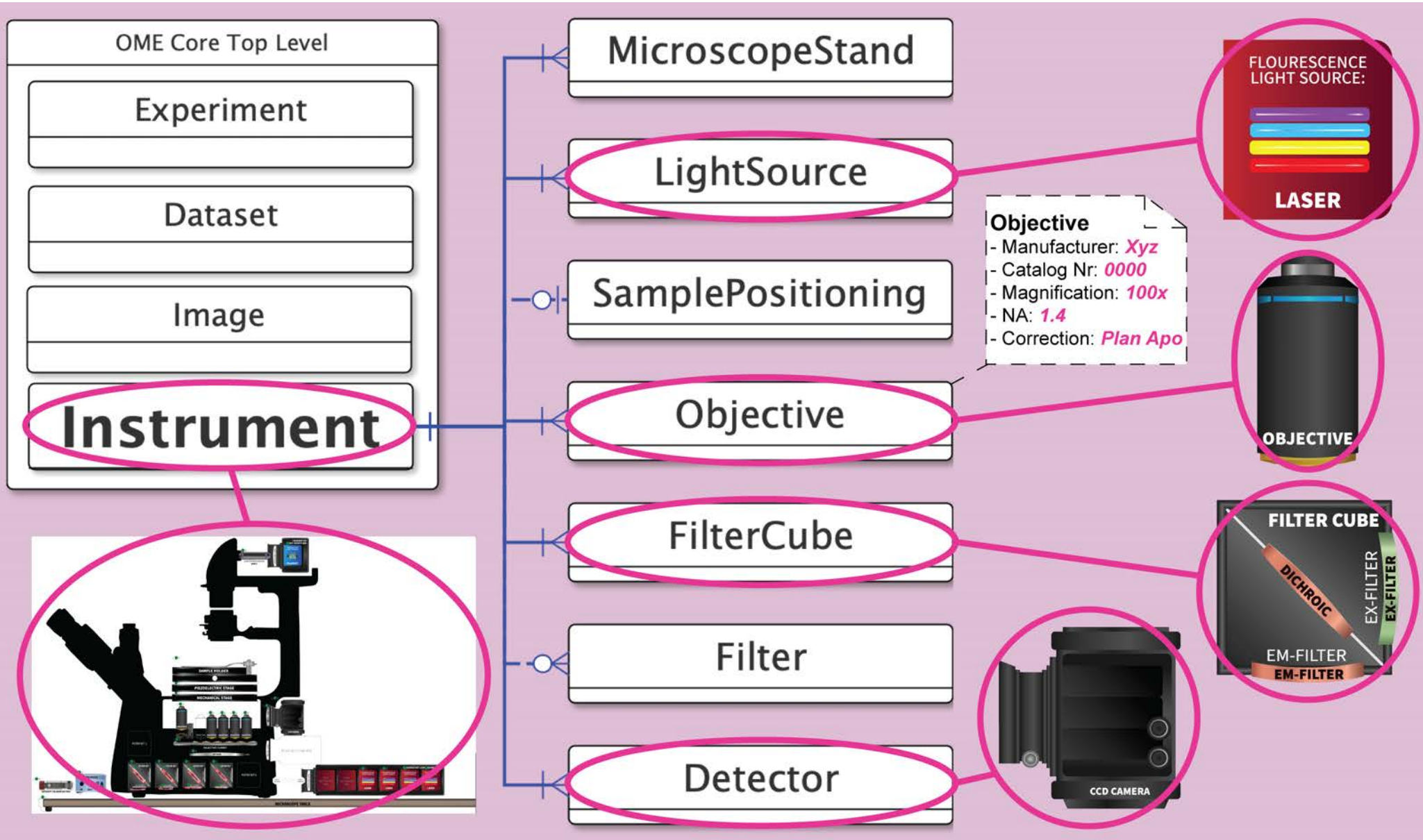
Metadata semantics:  
Provenance & QC

	Microscope and Modality	Experiment and Images	Results and Analysis
<b>Tier 1</b> Minimum Information/ Materials & Methods			
<b>Tier 2</b> Advanced Quantification and/or Live cell imaging			
<b>Tier 3</b> Manufacturing/ Technical development/ Full documentation	 Custom system		



# Metadata model: a schematic representation of reality that can be utilized to organize data

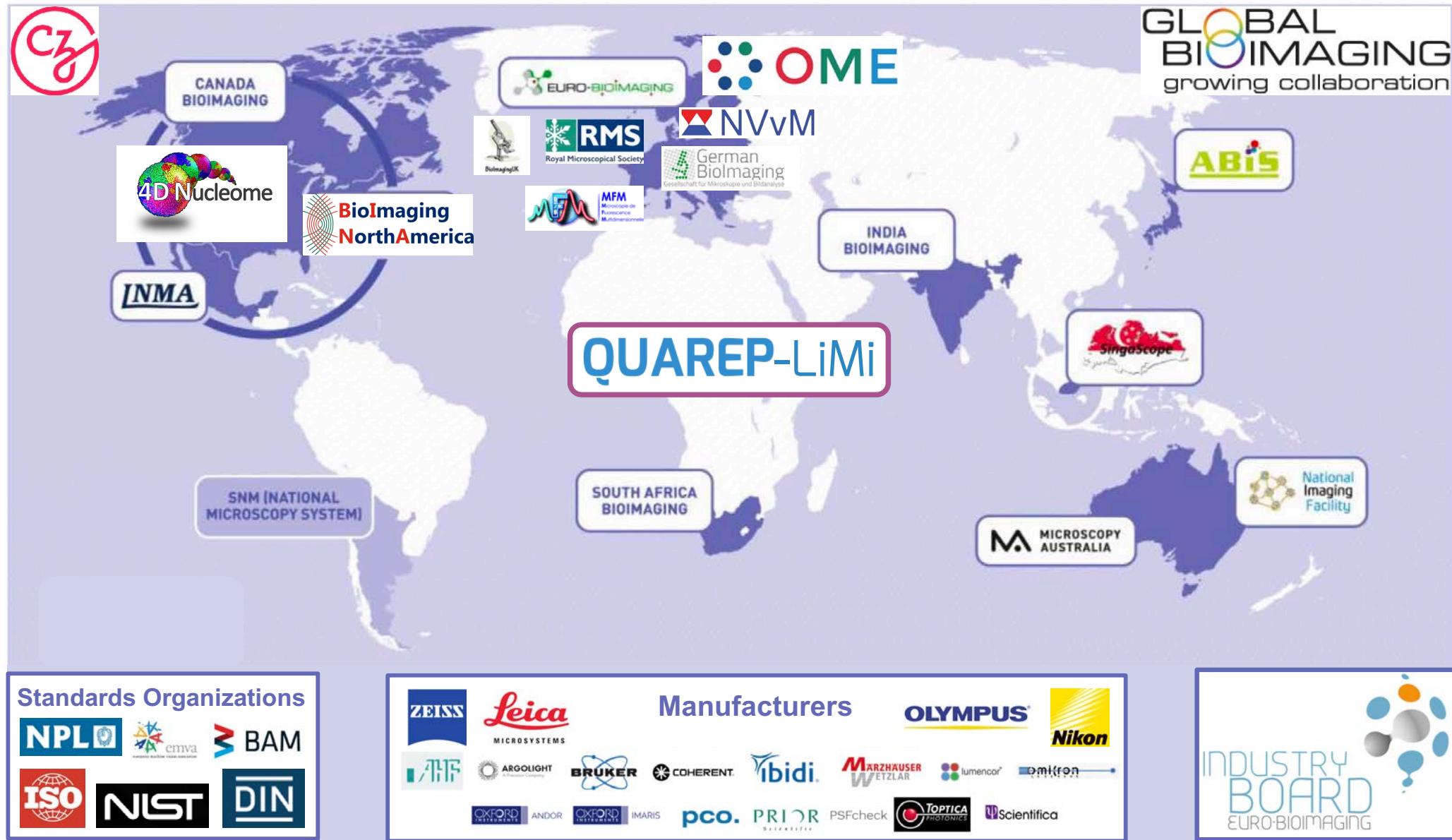
Metadata semantics:  
Provenance &  
QC





# From 4DN recommendations towards community-driven 4DN-BINA-OME global Microscopy Metadata standards

Metadata  
semantics:  
Provenance &  
QC

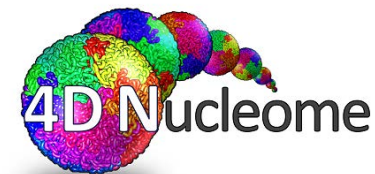


# ... BUT METADATA REQUIREMENTS ARE NOT ENOUGH...

Metadata  
capture &  
representation

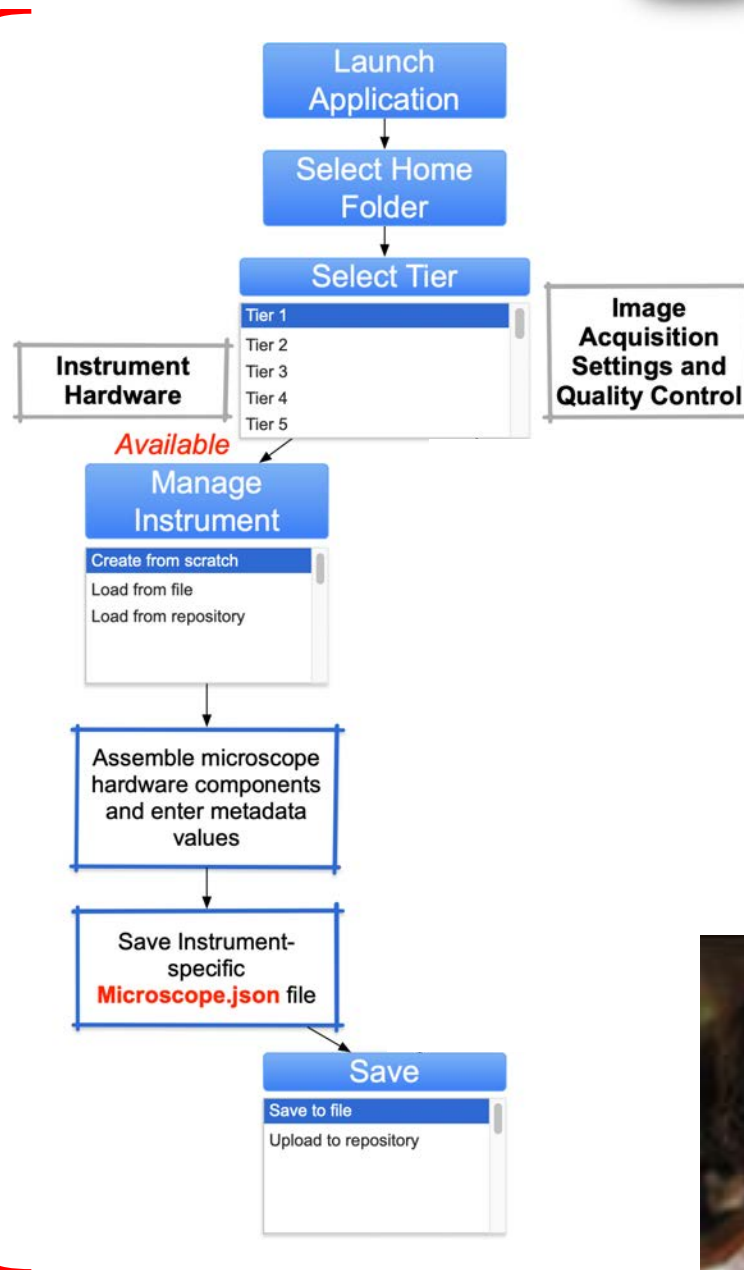


# Two user-interaction workflows: 1 Manage Hardware



## Three implementations

- 4DN Portal (Javascript React)
- Standalone (Javascript Electron)
- OMERO.web plug-in

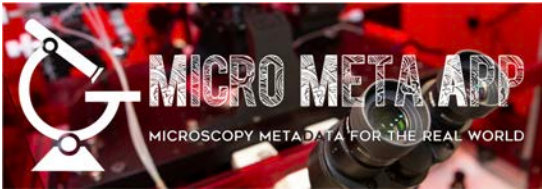
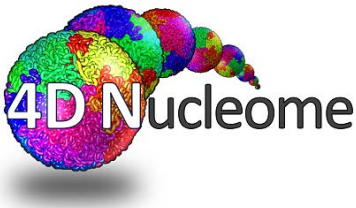


Alex Rigano



Metadata capture & representation

# Micro-Meta App is integrated in the DCIC portal where it facilitates sharing and reproducibility of 4DN imaging datasets



Genomic binding dynamics of PBAF are regulated via select chromatin states  
Charles A. Kenworthy, Vincent Wong, et al., bioRxiv 2017

Assay Description >

Experiment Set Properties

Experiment Set Type Replicate	Organism H. sapiens	Biosource Type immortalized cell line	Biosource U2OS
Experiment Type(s) SPT	Modification Type Stable Transfection	Treatment Type Chemical	Assay Details Target: PBIR1 protein
Sample Image	Imaging Paths ch00	PBIR1 protein targeted by JF549-labeled Halo Tag	

Sample SPT frame - T1/2000

Viewing Options

Max Intensity  
Auto Channel  
Quality: Normal  
Zoom (%)  
333  
Line Plot  
Rendering Details  
Chromatic: Off  
Grayscale  
Rendering Settings  
Copy Paste  
Interpolate  
Current Image  
Z: 1/1 T: 798/2000  
Scale bar  
Image Information  
Image Link  
ROI Count: 9

4DN Data Portal

Data Tools Resources Experiment Sets Search

Draft Create Edit View JSON

June 2nd, 2020 at 11:27am

MicroMeta Attribution Details

4DN MicroMeta

Save Clone Manage

MICRO META APP MICROSCOPY METADATA FOR THE REAL WORLD

Name: Single Molecule Tracker - Coleman Lab - v03  
Manufacturer: Nikon  
Model: Ti-U

Additional Magnification Components

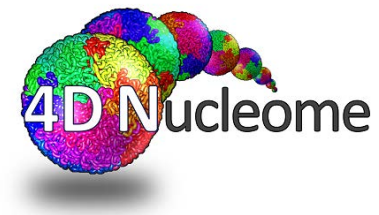
Additional Light Path Components

- AdditionalOptics
- Calibration
- Camera
- Detector
- Fluorescence\_LightSource
- Focusing
- LightPath
- LightSourceCoupling
- Magnification
- MicroscopyBasics
- Mirror
- Stage
- Transmitted\_LightSource

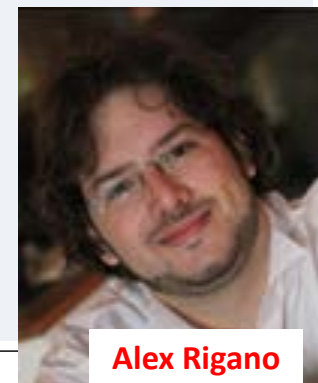
Edit microscope Validate @ tier: 2 Save microscope Back

Metadata  
capture &  
representation

# Micro-Meta App is integrated in the DCIC portal where it facilitates sharing and reproducibility of 4DN imaging datasets



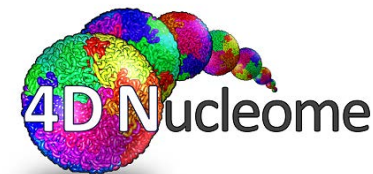
A screenshot of the OMERO web client interface. The browser address bar shows "omero.umassmed.edu:4080/webclient/userdata/?experimenter=102". The OMERO navigation bar includes links for Data, History, Help, Figure, Tag Search, Any Value, Micro-Meta, and Admin. The left sidebar shows a tree view with "Alex Rigano" and "Microscopes". The main panel displays the "Micro-Meta App" for "Alex Rigano". The right sidebar shows project details for "Project ID: 1751", "Owner: Alex Rigano", and lists attachments: "MICROSCOPE template\_1 (13.32 KB)", "Single Molecule Tracker\_7\_2019-12-02 (11.66 KB)", and "TESM\_MMA\_el\_120119 (37.09 KB)".



Alex Rigano

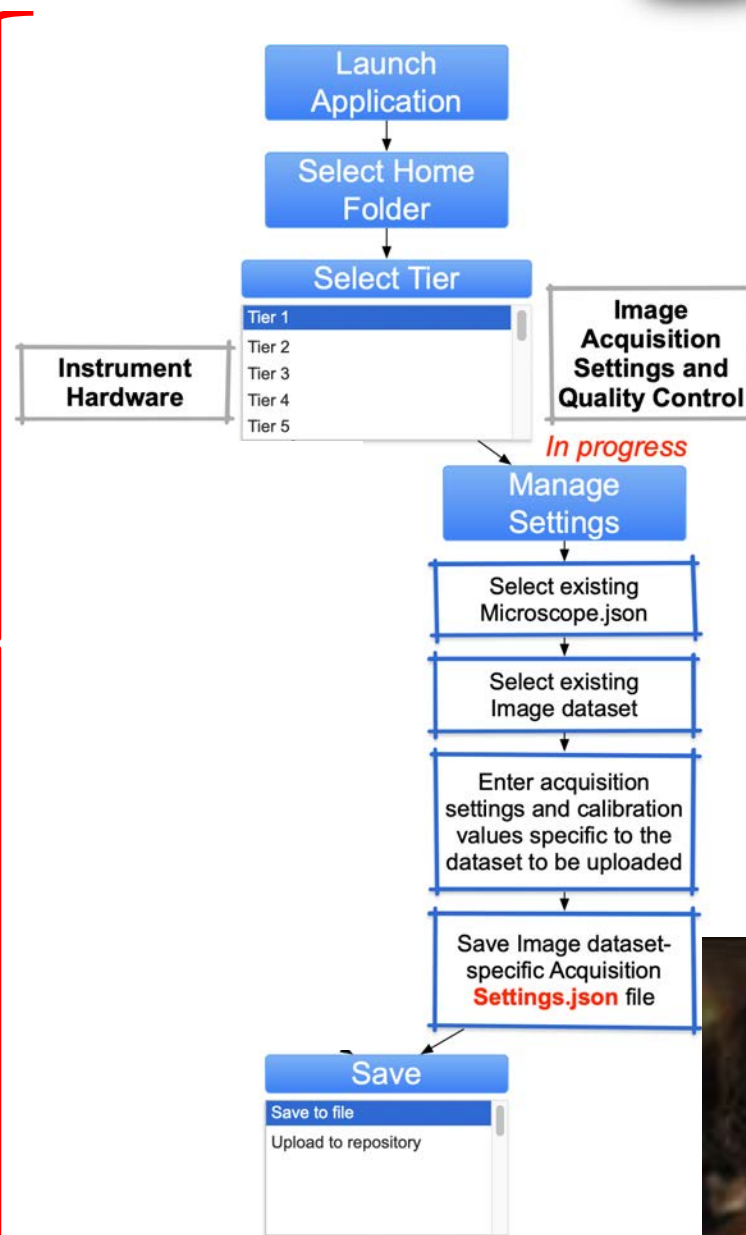
Metadata  
capture &  
representation

# Two user-interaction workflows: 2 Manage Settings



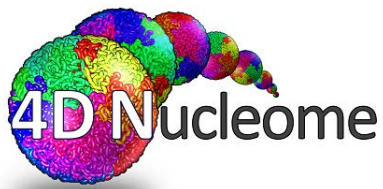
## Three implementations

- 4DN Portal (Javascript React)
- Standalone (Javascript Electron)
- OMERO.web plug-in



Alex Rigano





# Manage Image Acquisition Settings: edit Channel configuration

Metadata  
capture &  
representation



Microscopy Metadata For The Real World

- Edit Experiment
- Edit ImagingEnvironment
- Edit TIRFSettings
- Edit ObjectiveSettings
- Edit Plane
- Edit Channel**
- Edit DetectorCalibration
- Edit OpticalCalibration

Edit Image

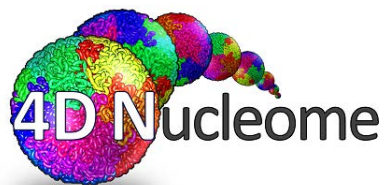
Validate @ tier: 1 ▼

Export setting ▼

Back

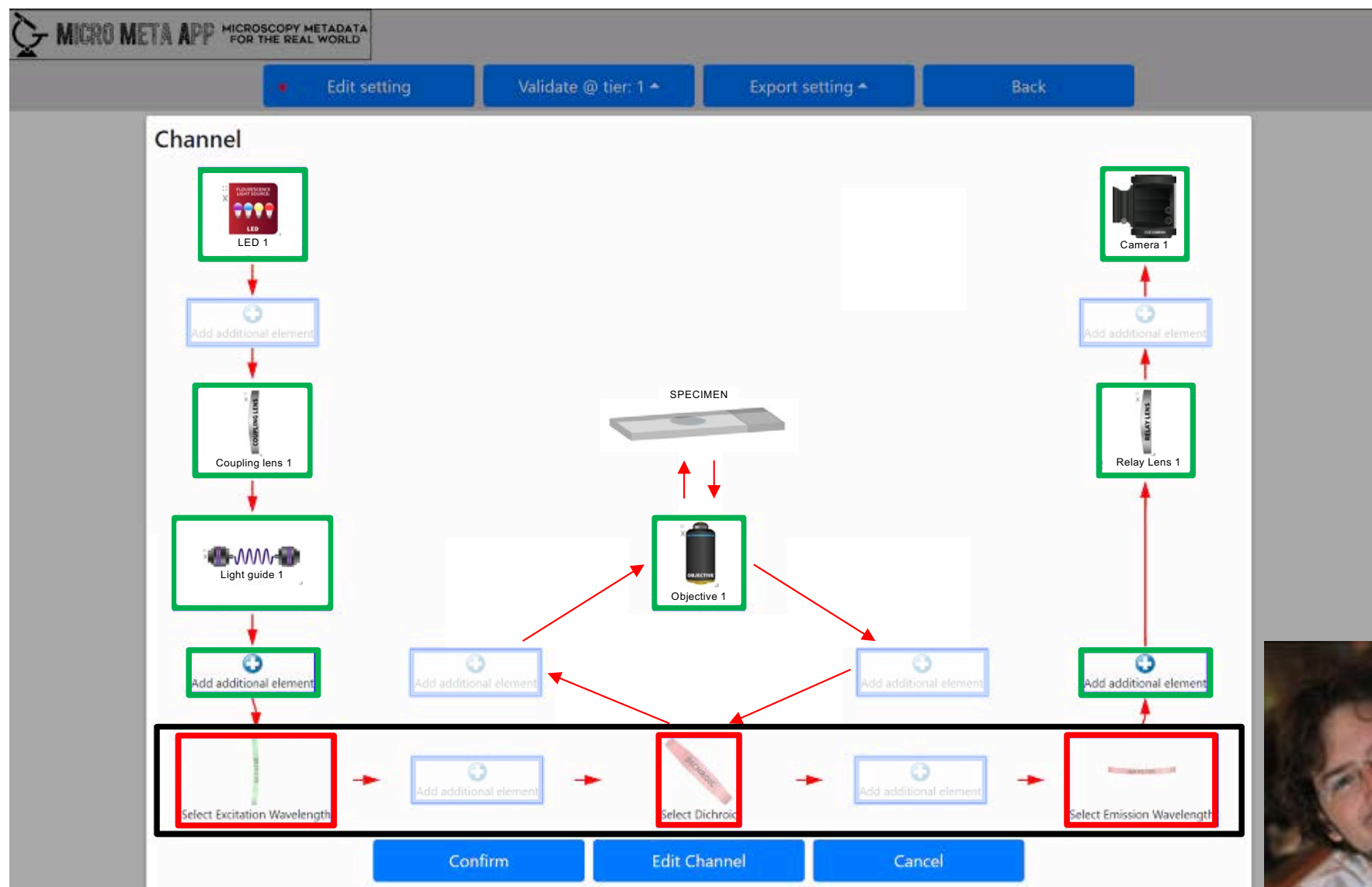


Alex Rigano

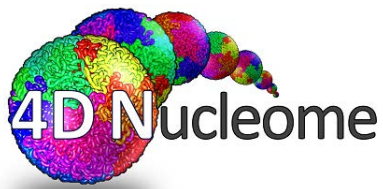


# Manage Image Acquisition Settings: configure the Channel light path

Metadata  
capture &  
representation



Alex Rigano



# Manage Image Acquisition Settings: select hardware components to add to the Channel light path

Metadata  
capture &  
representation

**MICRO META APP** MICROSCOPY METADATA FOR THE REAL WORLD

Edit setting Validate @ tier: 1 Export setting Back

### StandardDichroic

If you modify the number of band-pass, the information not saved are going to be lost!

**StandardDichroic**

**General** ManufacturerSpecMirrorDichroicTransmittanceRange\_0TransmittanceRange\_1

**General**  
General information about the element

Name  
A user defined name for this component.

Cube3 Dich

ID  
A unique identifier for this component.

ae035d21-0c75-414c-9a07-855700b0f1ee

Description  
This is a simple multi-line comment or annotation describing this component.

This is a dual pass dichroic used for Green, and Red emission.

Tier  
The tier level of this component.

2

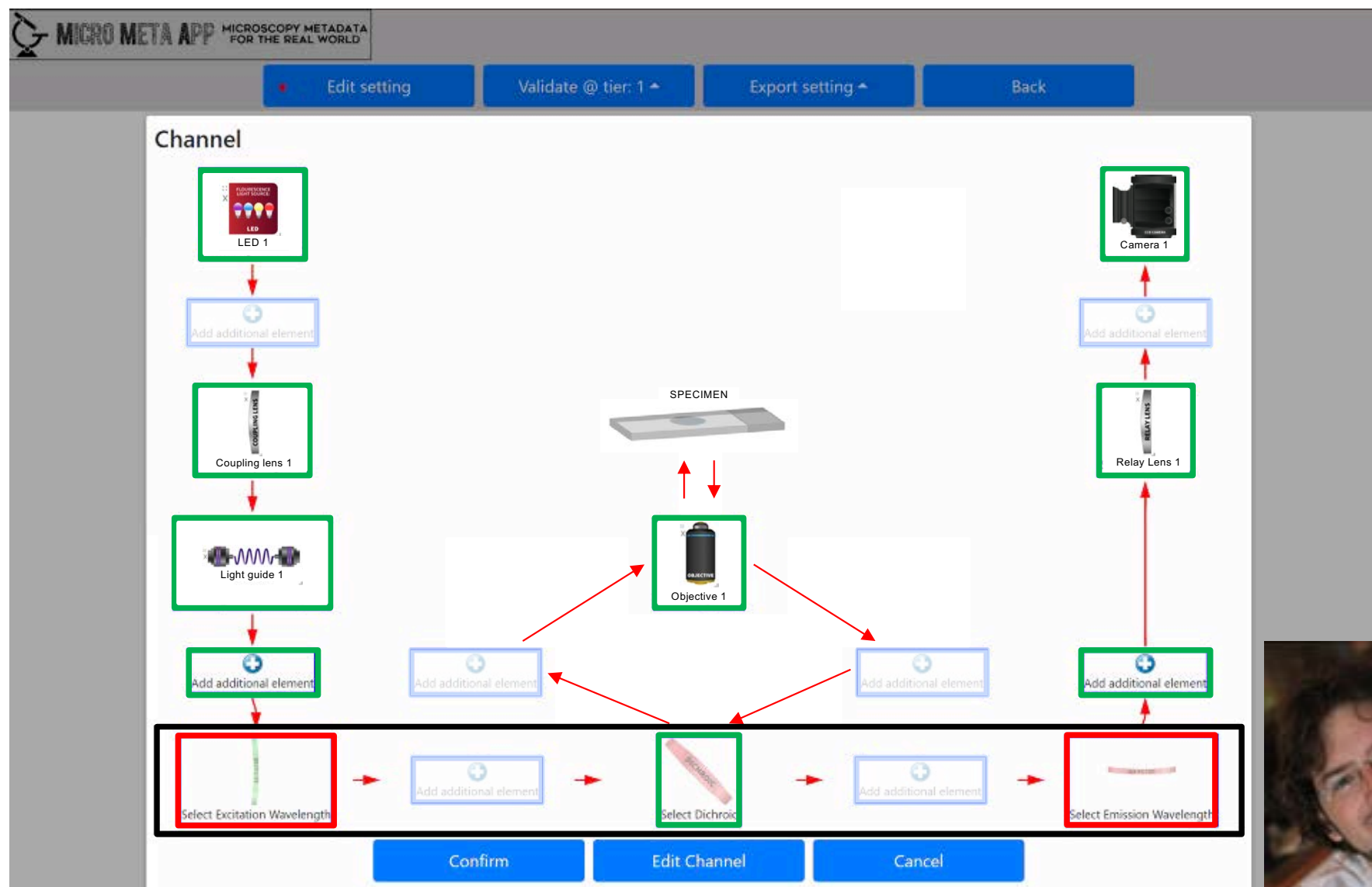
Confirm Cancel





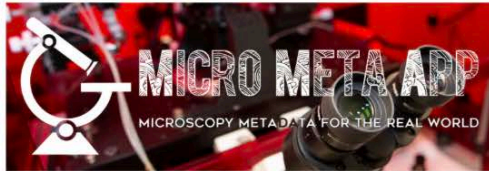
# Manage Image Acquisition Settings: configure the Channel light path

Metadata  
capture &  
representation



Alex Rigano

## Micro Meta App



Microscopy Metadata for the real world!

[View the Project on GitHub](#)  
WU-BIMAC/MicroMetaApp.github.io

This project is maintained by [WU-BIMAC](#)

Hosted on GitHub Pages — Theme by [orderedlist](#)

*Micro Meta App* is an open, easy to use, and powerful software platform to capture and manage Microscopy metadata on the basis of the [4DN-BINA extension](#) of the [OME data model](#).

## The current version is v0.29.0-a1!!

This is an *alpha* release and the source code is available as follows:

- Javascript [React](#) implementation is [available here](#)
- Javascript [Electron-wrapped](#) implementation is [available here](#)
- Prototype [OMERO](#) plugin is [available here](#)

If you want to use it and help us testing it please contact:  
[caterina.strambio@umassmed.edu](mailto:caterina.strambio@umassmed.edu).

This version introduces major improvements in Micro-Meta App user experience.

### Highlights include:

- Icons snap in place ([link](#))
- Several bug fixes ([link](#))

Find the full documentation [here](#)

## Micro-Meta App beta v1.0.0-b1 is coming soon!

Towards the first beta version!!

MicroMetaApp  
latest

Search docs

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Step-by-step instructions

Launching Micro-Meta App

A - Launching the standalone version of Micro-Meta App.

B - Launching the Micro-Meta App from the 4DN Data Portal

C - Launching the Micro-Meta App OMERO.web plugin

Using Micro-Meta App

Support Read the Docs!

Please help keep us sustainable by allowing our Ethical Ads in your ad blocker or go ad-free by subscribing.

Thank you! ❤️

## B - Launching the Micro-Meta App from the 4DN Data Portal

Instructions on how to use the Micro-Meta App in the context of the [4D Nucleome Data Portal](#) are coming up soon.

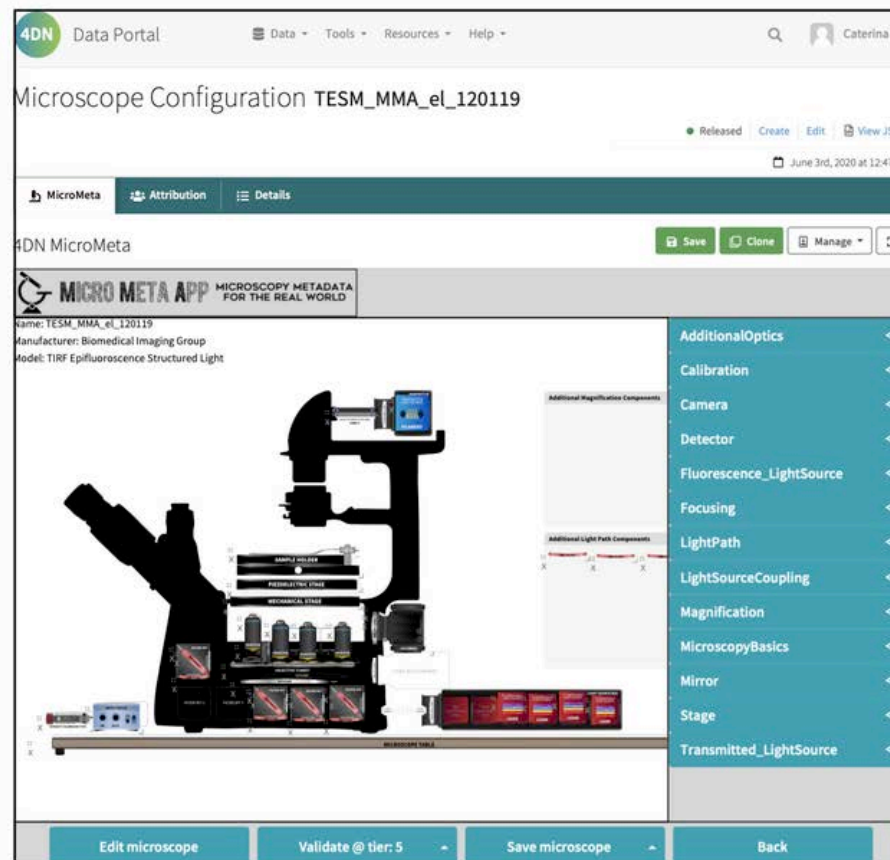


Figure 2: Micro-Meta App can be used in the context of the 4D Nucleome Data Portal.



# THANK YOU!

Strambio De Castillia  
lab:

- **Alex Rigano**



UMMS - Bio-Imaging Group

- Karl Bellve'
- **Kevin Fogarty**

BINA

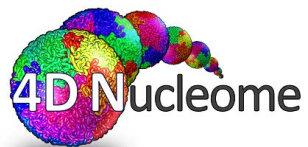
- **Alison North, The Rockefeller U.**
- **Claire Brown, McGill**
- **BINA Quality Control and Data Management WG Members**



(Ulrike Boehm, James Chambers, Nathalie Gaudreault, Alison North, Arturo Pimentel, Damir Sudar, Peter Bajcsy, Claire Brown, Alex Corbett, Orestis Faklaris, Judith Lacoste, Alex Laude, Glyn Nelson, Roland Nitschke)

ISO Provenance Standard

- **Peter Holub, BBMRI-ERIC**
- **Rudolf Wittner, BBMRI-ERIC**
- Heimo Müller, BBMRI-ERIC



Chan  
Zuckerberg  
Initiative 

 **BioImaging  
NorthAmerica**

 University of  
Massachusetts  
Medical School  
[umassmed.edu](http://umassmed.edu)

Grunwald lab – UMMS-RTI

- **David Grunwald**
- **Mathias Hammer**
- **Max Huisman**
- Farzin Farzam



4DN Community

- **4DN IWG: Bob Singer, Rob Coleman** (Albert Einstein), **Joan Politz-Ritland** (Hutch), **Warren Zipfel** (Cornell U.), **Anders Sejr-Hansen** (MIT),
- **DCIC: Peter Park, Burak Alver, Koray Kirli, Alexander Balashov, Serkan Utku Ozturk, Shannon Ehmsen** (HMS)



CZI

- **Jennifer Waters, CZI, HMS**
- **George Campbell, HMS**
- **Michelle Itano, CZI, UNC**



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- **Josh More, OME**
- **Norio Kobayashi, RIKEN**
- **Shuichi Onami, RIKEN**
- **Jay Copeland, HMS**

