

The Open Microscopy Environment:

12th Annual Users Meeting

University of Dundee, Scotland

Jason Swedlow

The OME Consortium

#ome2017



Centre for Gene Regulation & Expression
Div of Computational Biology
School of Life Sciences, University of Dundee
Dundee, Scotland, UK



Seattle, WA, USA
Dundee, UK

Talk Outline

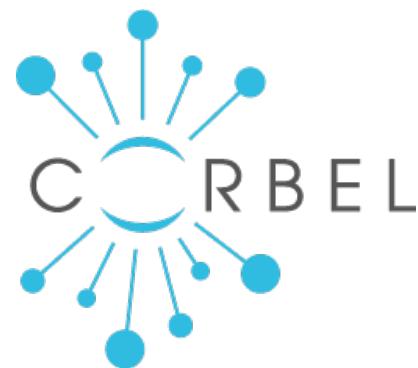
- Thank you!
- This Meeting...
- The Problem
- Our Progress
 - High Level Survey
 - See the Workshops
- Funding...
- Future Priorities...

Thank you!!!



Wilma Woudenberg June Matthew

Thank you!!!



Dundee OME Team



Jason
Swedlow



Sebastien
Besson



Jean-Marie
Burel



Mark
Carroll



Helen
Flynn



David
Gault



Kenny
Gillen



Roger
Leigh



Simone
Leo



Simon
Li



Dominik
Lindner



June
Matthew



Josh
Moore



Will
Moore



Balaji
Ramalingam



Gabriella
Rustici



Aleksandra
Tarkowska



Petr
Walczysko



Harald
Waxenegger



Eleanor
Williams



Wilma
Woudenberg

The OME Consortium



Paul
French



Gaudenz
Danuser



Ilan
Davis



Gianluigi
Zanetti



Peter
Sorger



Spencer
Shorte



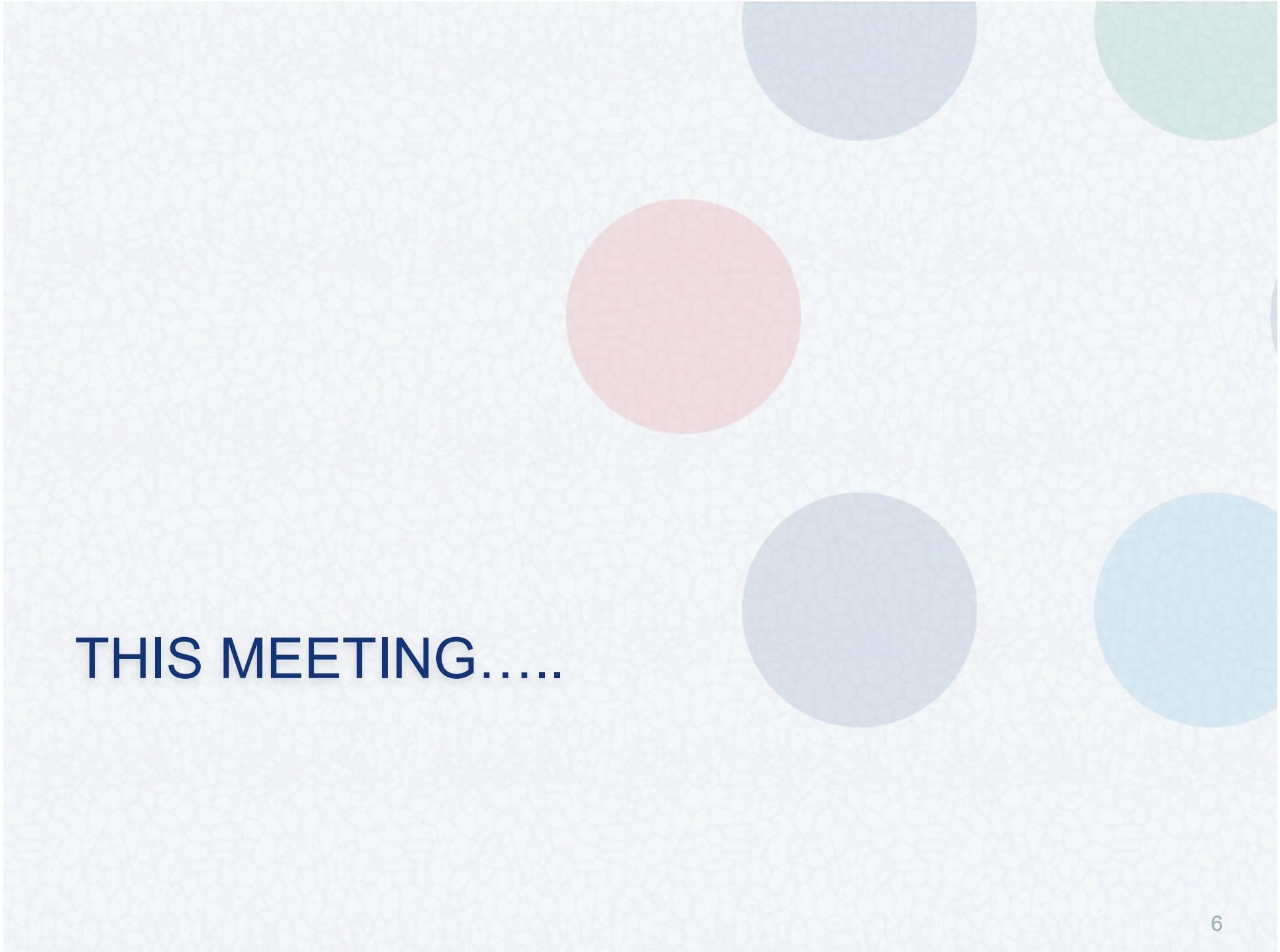
Alvis
Brazma



Rafael
Carazo-Salas



Edoard
Bertrand



THIS MEETING.....

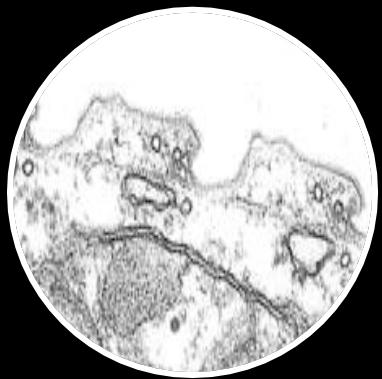
Meeting Purpose

12th Annual User's Mtg

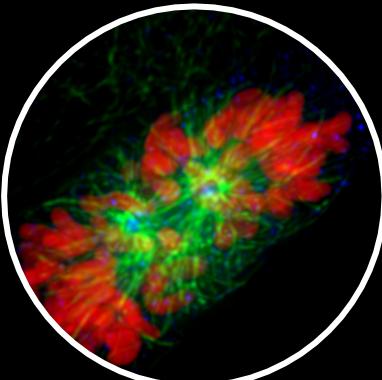
- Attendees
 - OME Consortium
 - Invited Speakers
 - Broad cross-section of users
- *Day 1:* Presentations
 - Lightning Talks
 - Project Overview
 - Invited Speakers
- *Day 2:* Workshops & Demos
- *Day 3:* Talking, Planning, Coding
- Progress Report
- Future development priorities & planning

THE PROBLEM

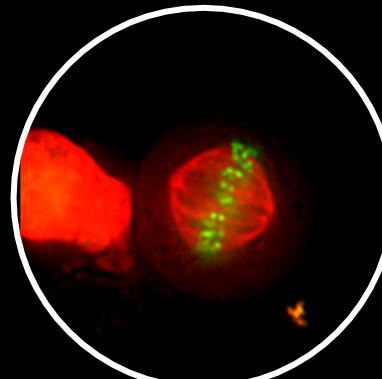
The Image Problem... is Ubiquitous



Organelles



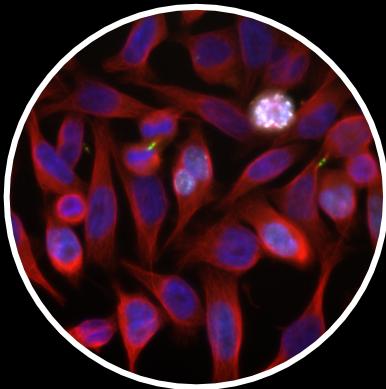
Cells



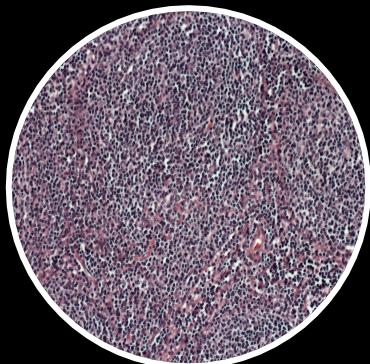
Dynamics



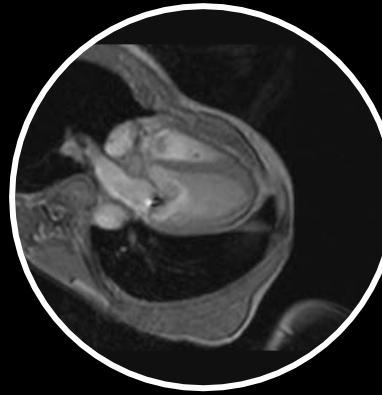
Physiology



Lead Discovery
Target Validation



Pathology



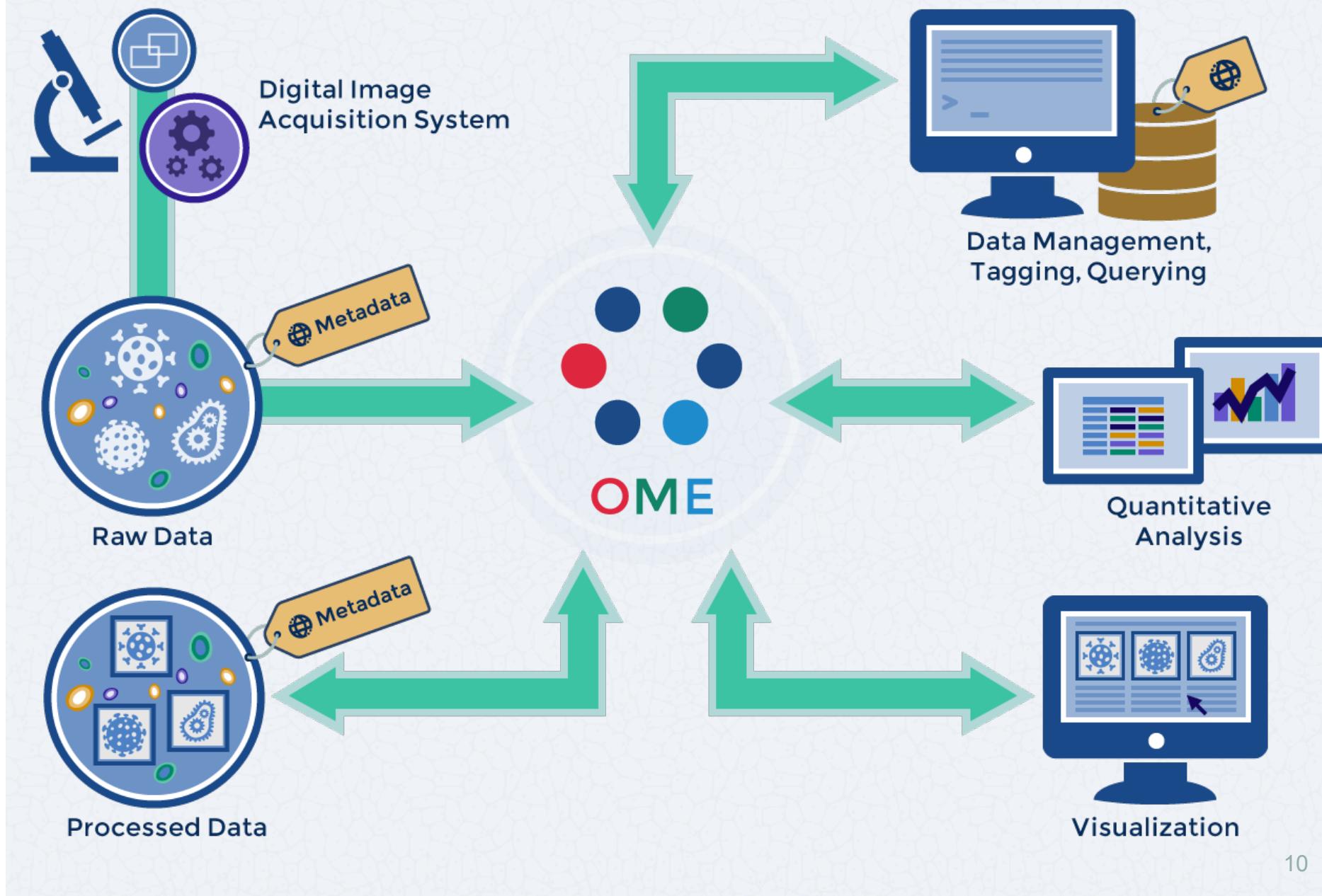
In Vivo

A pretty picture?

A measurement?

A resource?

...Towards Image Informatics



What We Do



OME-TIFF

The logo for OME FILES consists of a stylized "F" shape made of three horizontal bars in red, green, and blue, followed by the text "OME FILES" in a bold, sans-serif font. The "O" is red, "M" is green, and "E" is blue.

The logo for BIO-FORMATS features a stylized diamond shape composed of red, green, and blue segments, followed by the text "BIO-FORMATS" in a bold, sans-serif font. The "B" is red, "I" is green, and "O" is blue.

The logo for OMERO features a cluster of six colored dots in red, green, blue, and white, followed by the text "OMERO" in a bold, sans-serif font. The "O" is red, "M" is green, and "E" is blue.

The logo for IDR features a series of horizontal bars in purple, orange, blue, and yellow, followed by the text "IDR" in a bold, sans-serif font.

OME File Formats

OME-XML ~ OME Data Model

OME-TIFF – TIFF file with OME-XML in the header

OME Files – C++-based reference implementation of OME Data Model

Bio-Formats – Java-based PFF reader & reference implementation



Sebastien
Besson



Roger
Leigh



David
Gault



Melissa
Linkert

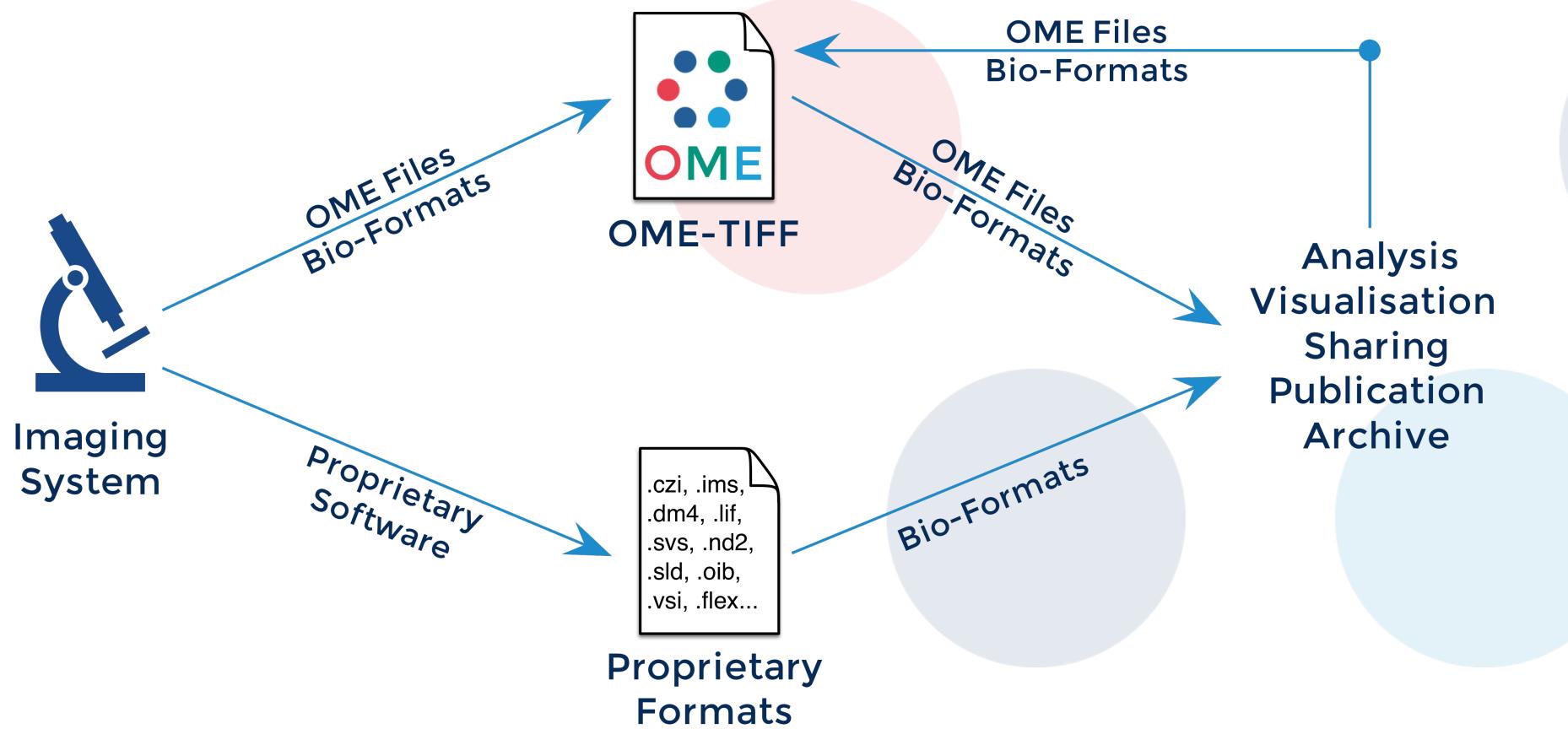


Simone
Leo



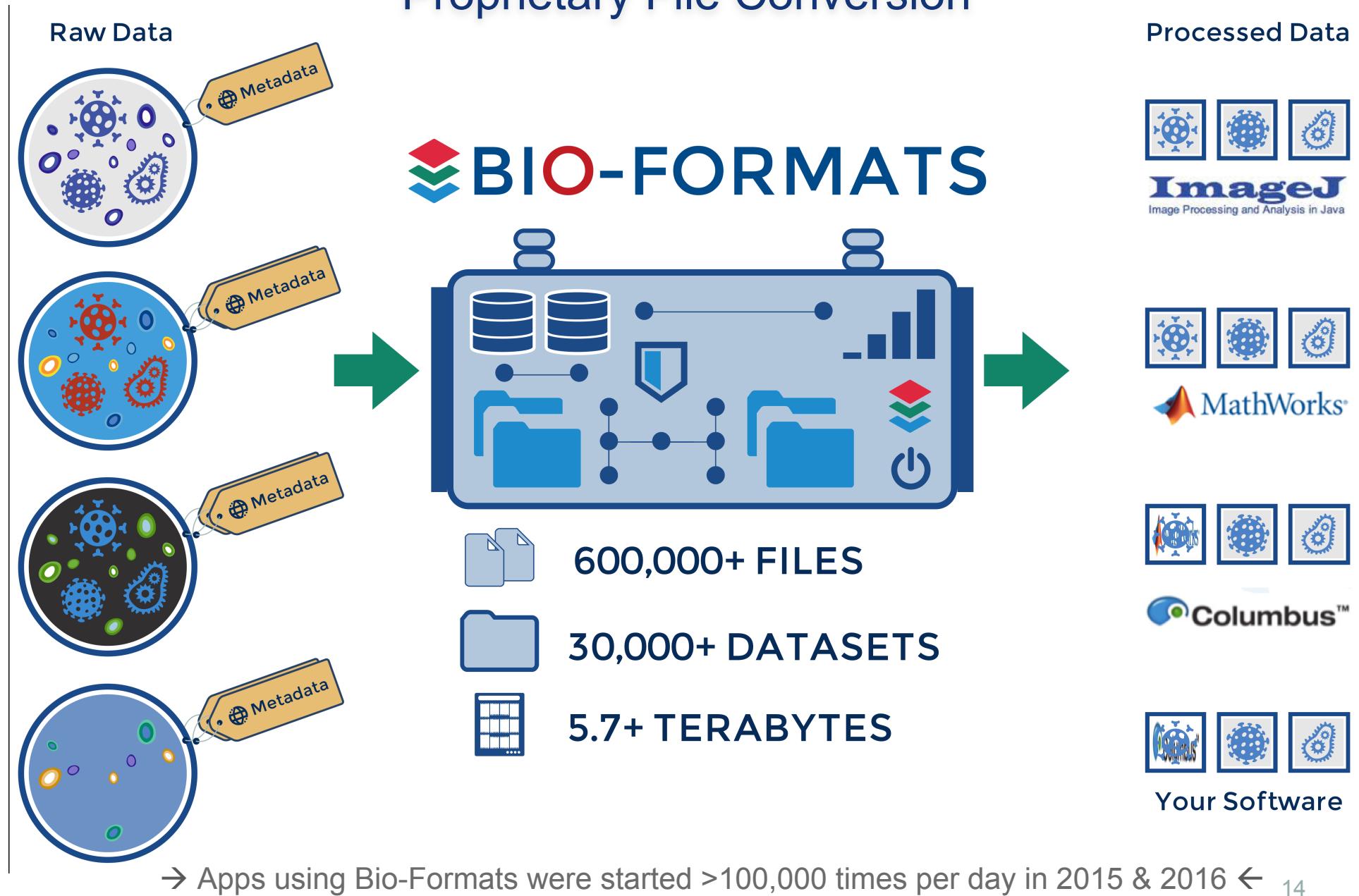
Balaji
Ramalingam

OME File Formats

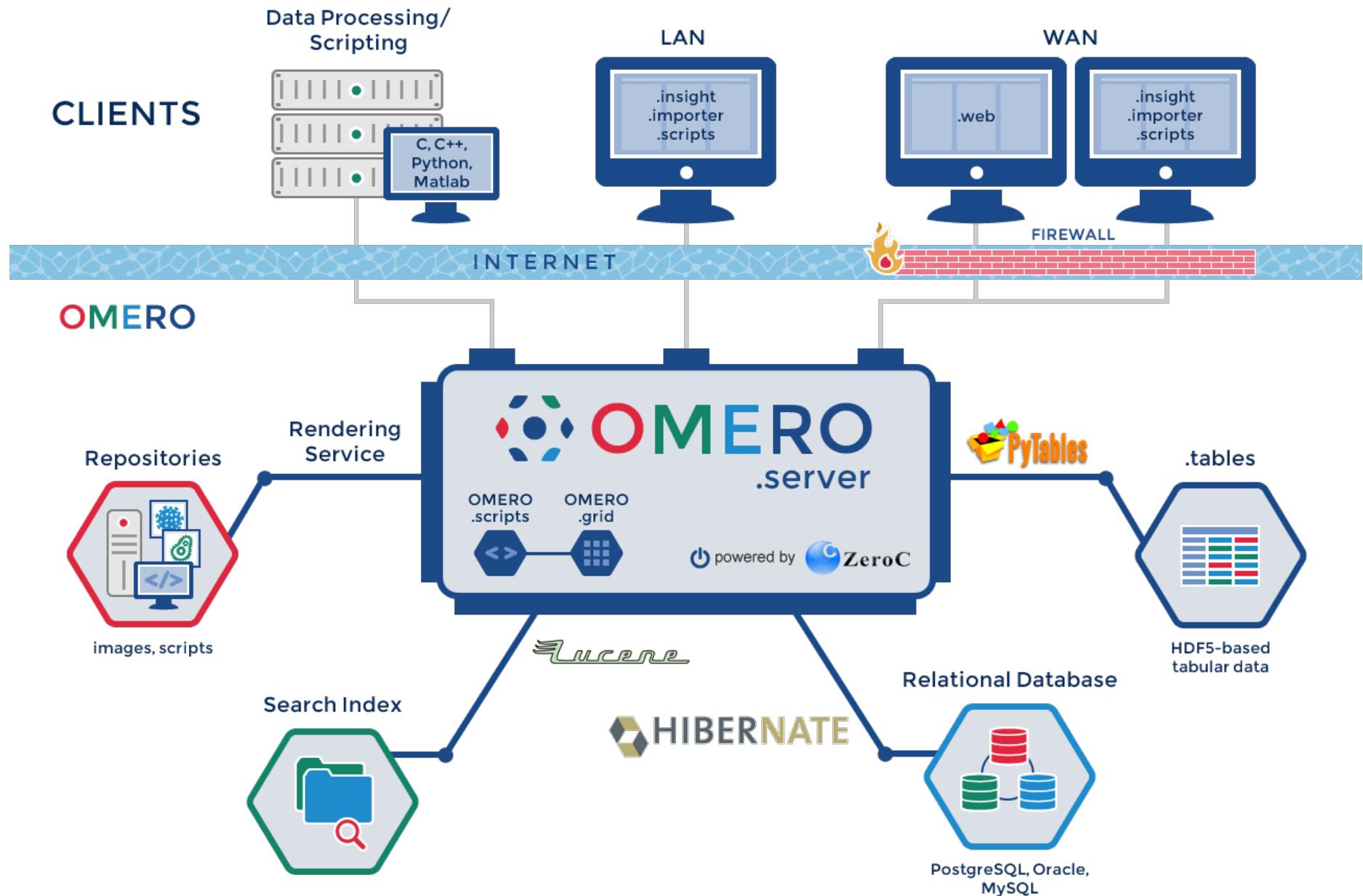


BIO-FORMATS:

Proprietary File Conversion

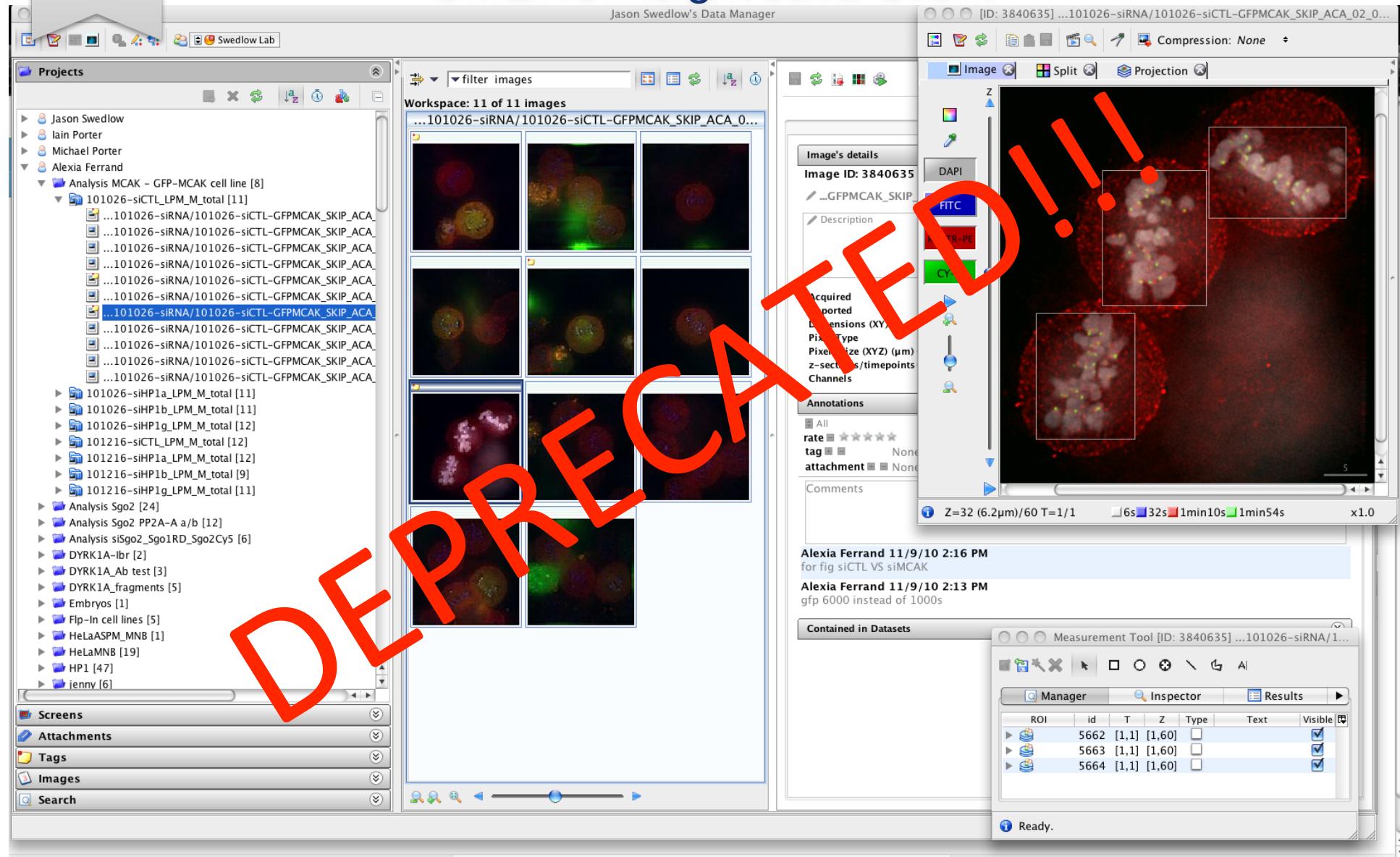


The OMERO Platform





OMERO & BIO-FORMATS: OMERO.insight Java Client





OMERO & BIO-FORMATS: OMERO.web Client

OMERO Data History

Swedlow Lab Alexia Ferrand

Explore Tags Public

Alexia Ferrand

- Analysis MCAK - GFP-MCAK cell line 8
 - 101026-siCTL_LPM_M_total 11
 - ...MCAK_SKIP ACA_02_01_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_02_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_03_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_04_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_05_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_06_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_07_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_08_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_09_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_11_R3D_D3D.dv
 - ...MCAK_SKIP ACA_02_12_R3D_D3D.dv
 - 101026-siHP1a_LPM_M_total 11
 - 101026-siHP1b_LPM_M_total 11
 - 101026-siHP1g_LPM_M_total 12
 - 101216-siCTL_LPM_M_total 12
 - 101216-siHP1a_LPM_M_total 12
 - 101216-siHP1b_LPM_M_total 9
 - 101216-siHP1g_LPM_M_total 11
 - Analysis MCAK_CENPAcells 4
 - Analysis MCAK_KyotoWT 4
 - Analysis Sgo2 24
 - Analysis Sgo2_PP2A-A a/b 12
 - Analysis siSgo2_Sgo1RD_Sgo2Cy5 6
 - Analysis_siAll_KyotoWT 2

Thumbnails

General Acquisition Preview

Z:/aferrand/HP1/101026-siRNA/101026-siCTL-GFPMCAK_SKIP ACA_02_07_R3D_D3D.dv

IMAGE ID: 3840635

Launch full viewer

Owner: Alexia Ferrand
Acquisition Date: 2010-10-26 13:55:25
Imported Date: 2010-10-26 14:06:41
Dimensions (XY): 512 x 512
Pixels Type: uint16
Pixels Size (XYZ) (μ m): 0.1001 x 0.1001 x 0.2000
Z-sections/Timepoints: 60 x 1
Channels: DAPI, FITC, RD-TR-PE, CY-5
Show unset fields

RATING
No ratings

TAGS

ATTACHMENTS

OTHERS:

COMMENT: Alexia Ferrand at 2010-11-09 14:16:33
for fig siCTL VS siMCAK

Viewing Options

Normal Max Intensity Split Channel

Quality Normal Zoom (%) 50

Line Plot

Rendering Details

Channels - Edit DAPI FITC RD-TR-PE CY-5 Color

Current Image Z: 32/60 | T: 1/1

Image Information Image Link

ROI Count: 3 Show ROIs | Hide

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Z-sections Timepoints



OMERO & BIO-FORMATS: OMERO.web Client

OMERO Data History

Swedlow Lab Alexia Ferrand

Explore Tags Public

Alexia Ferrand

Analysis MCAK - GFP-MCAK cell line 8

101026-siCTL_LPM_M_total 11

...MCAK_SKIP ACA_02_01_R3D_D3D.dv
...MCAK_SKIP ACA_02_02_R3D_D3D.dv
...MCAK_SKIP ACA_02_03_R3D_D3D.dv
...MCAK_SKIP ACA_02_04_R3D_D3D.dv
...MCAK_SKIP ACA_02_05_R3D_D3D.dv
...MCAK_SKIP ACA_02_06_R3D_D3D.dv

Viewing Options

Normal Max Intensity Split Channel Quality

Z:/aferrand/HP1/101026-siRNA/101026-siCTL-GFPMCAK_SKIP_AC...
https://nightshade.openmicroscopy.org/webclient/img_detail/3840635/#

IMAGE ID: 3840635

Launch full viewer

Owner: Alexia Ferrand
Acquisition Date: 2010-10-26 13:55:25
Imported Date: 2010-10-26 14:06:41
Dimensions (XY): 512 x 512
Pixels Type: uint16
Pixels Size (XYZ) (μ m): 0.1001 x 0.1001 x 0.2000

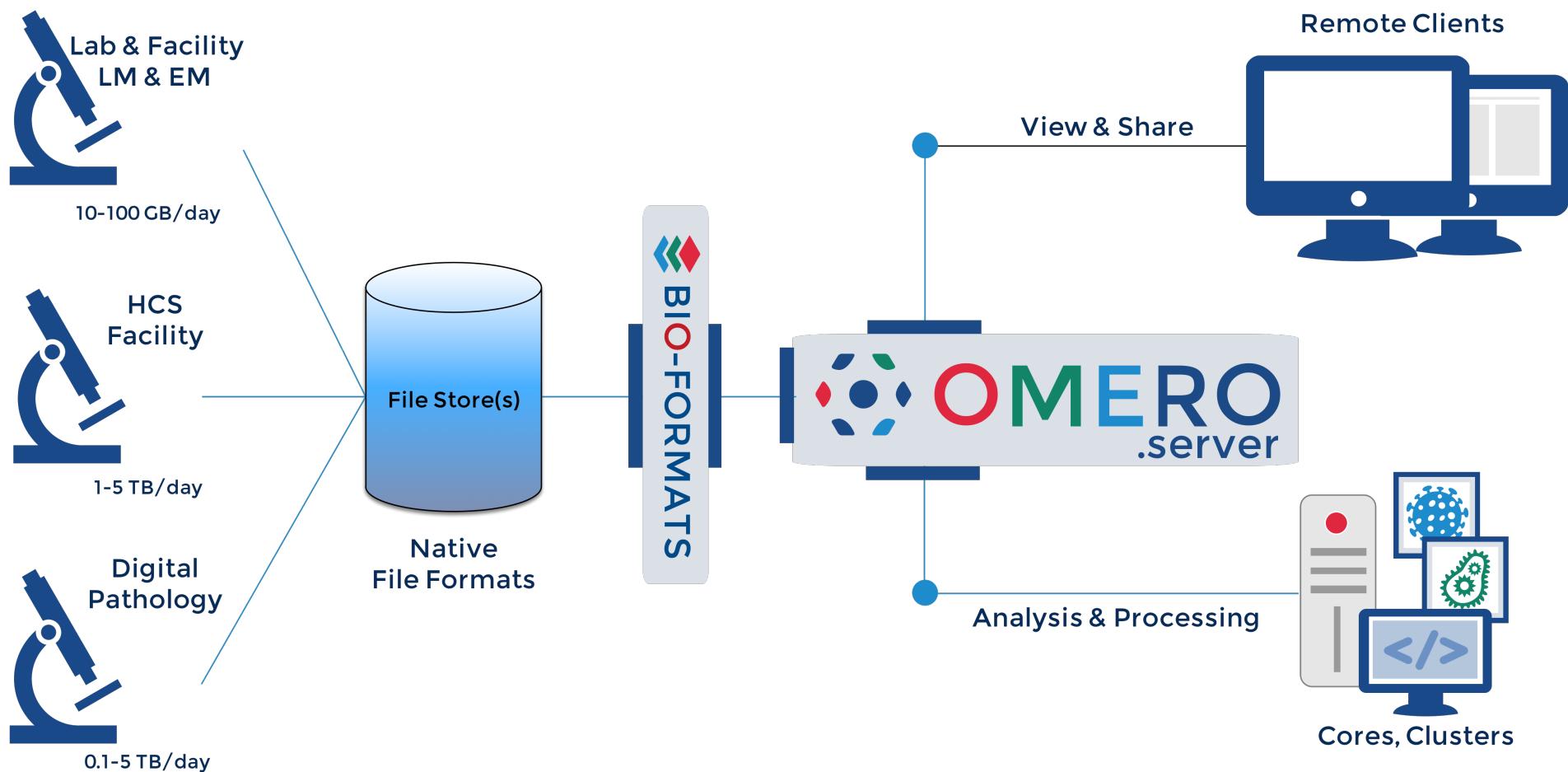
TR-PE, CY-5

101216-siHP1a_LP
101216-siHP1b_LP
101216-siHP1g_LP

Analysis MCAK_CENP/
Analysis MCAK_KyotoV/
Analysis Sgo2_24/
Analysis Sgo2_PP2A-A/
Analysis siSgo2_Sgo1F/
Analysis_siAll_KyotoW/

irrand at 2010-11-09 14:16:33
CTL VS siMCAK

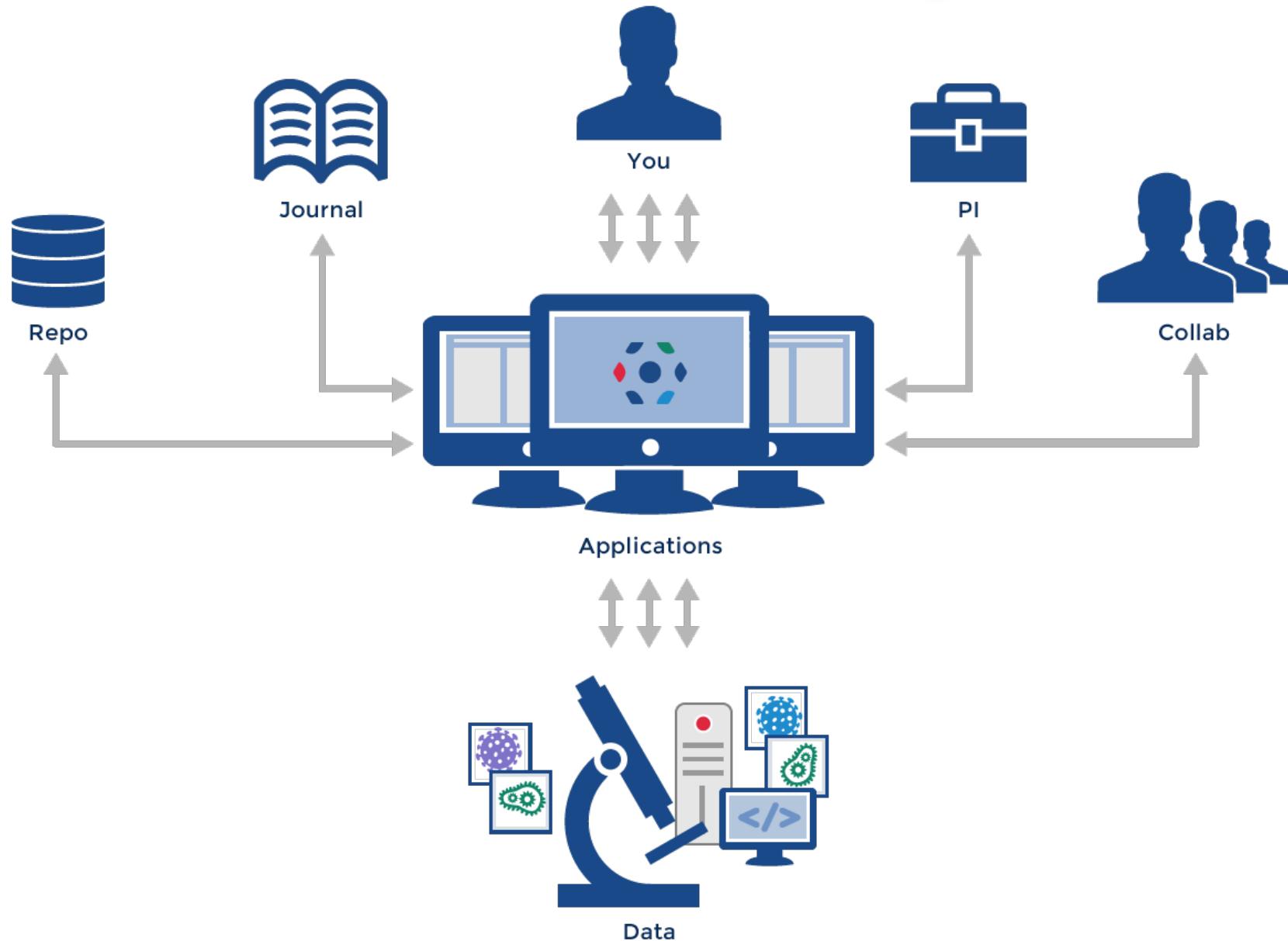
OMERO & Bio-Formats: Interfaces for Image Data Access



The Standard Paradigm



The “Scientific Data” Paradigm

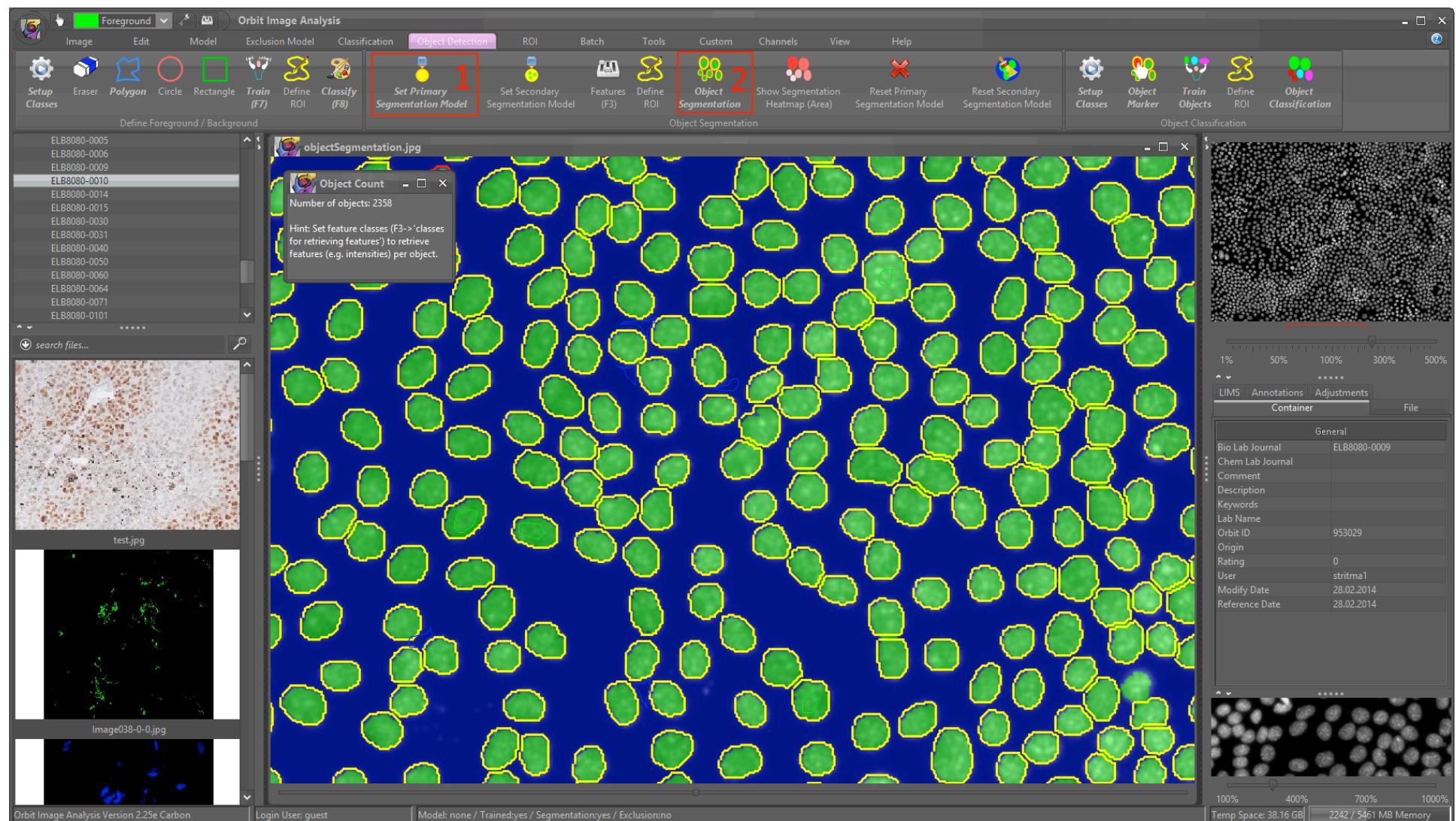


Gray et al, 2005, *Scientific Data Management in the Coming Decade*, Microsoft Research



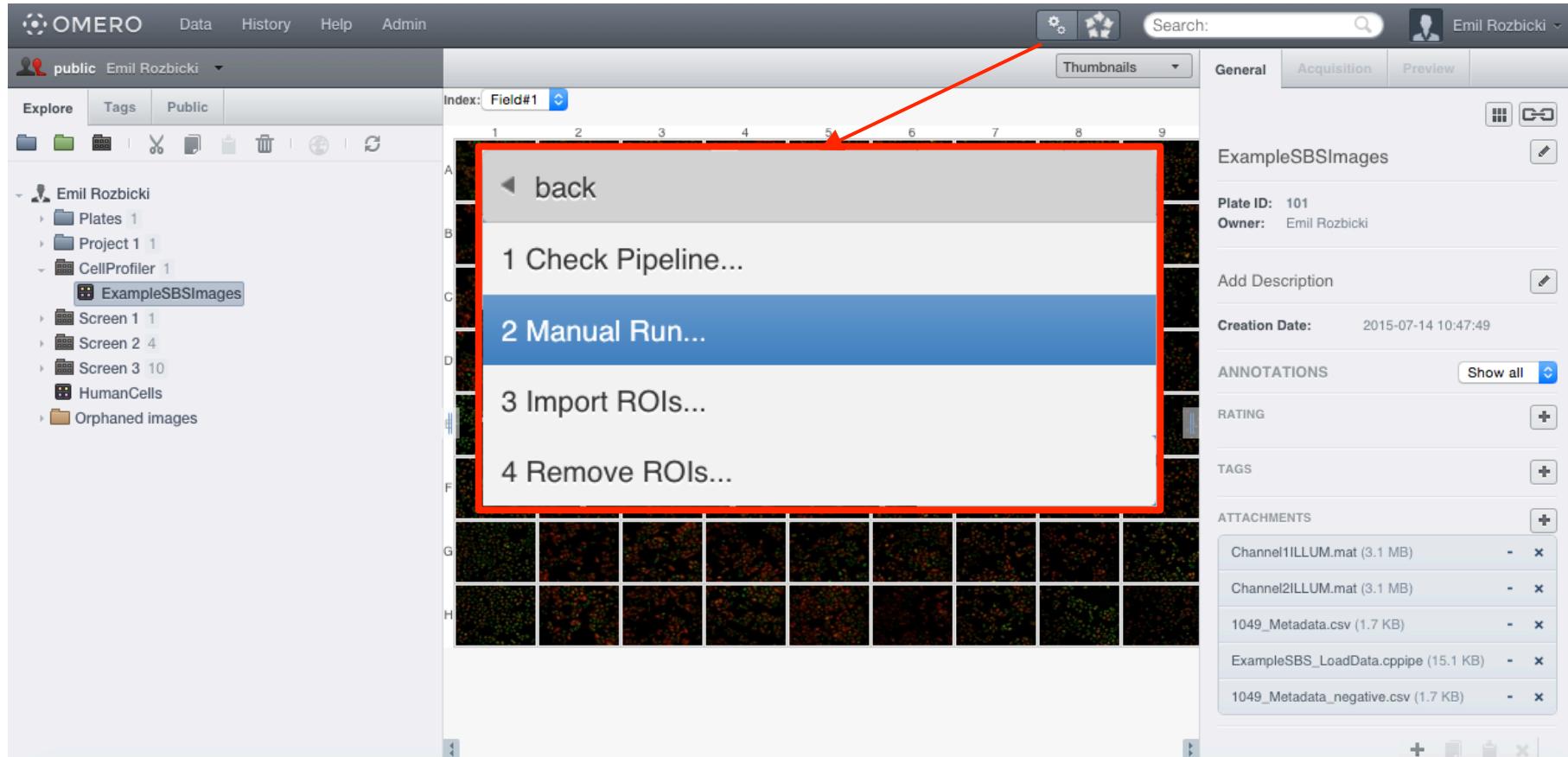
INTEGRATING ANALYSIS...

Orbit.bio

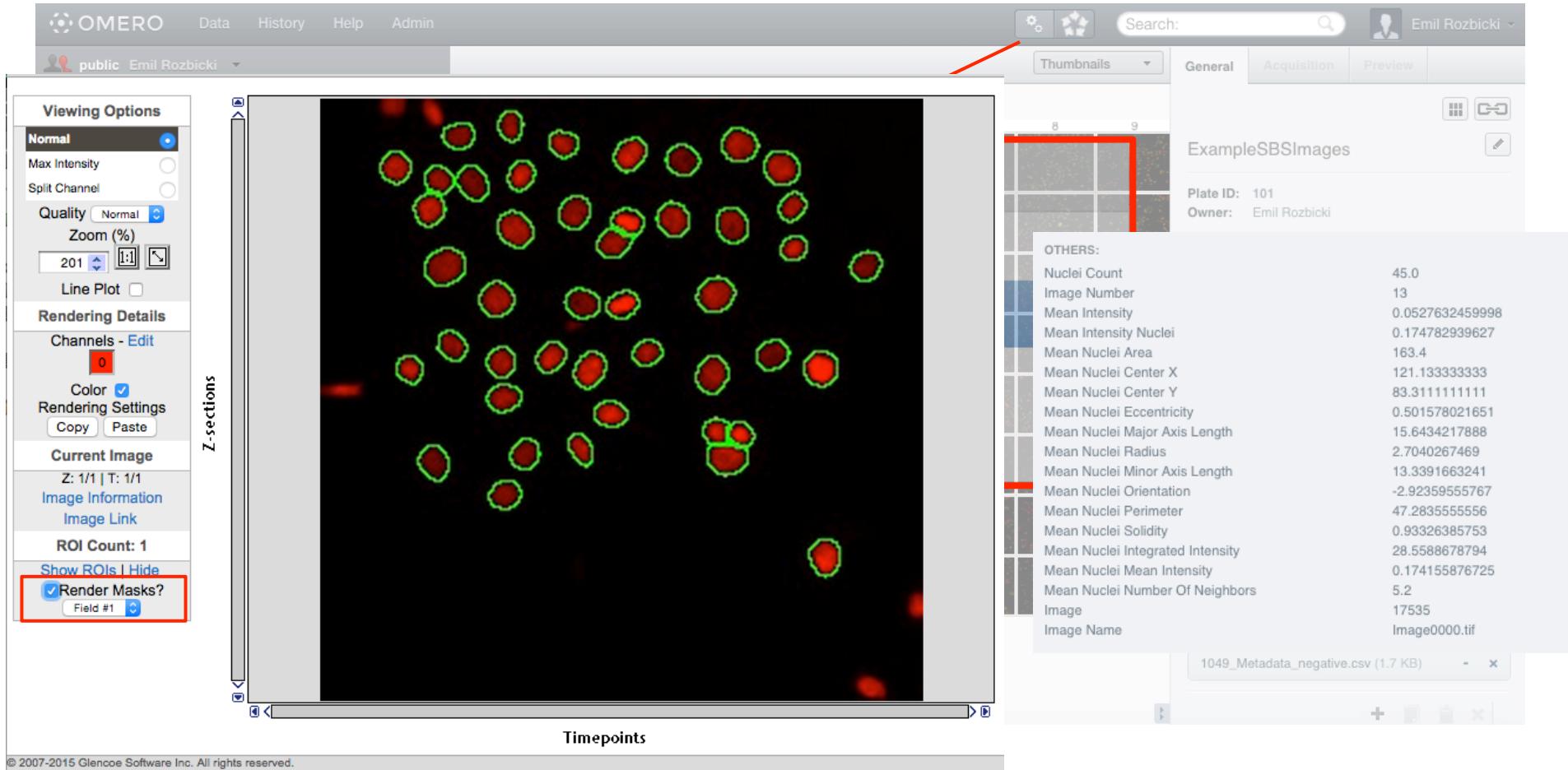


Manuel Stritt, Actelion Pharmaceuticals; <http://orbit.bio>

OMERO & CellProfiler



OMERO & CellProfiler



Chris Allan & Emil Rozbicki, Glencoe Software

Examples of Analysis Integration

FLIMfit– fluorescence lifetime fitting (Matlab)

ImageJ/Fiji, Icy– Pluggable, desktop Image processing tools (Java)

Orbit– Feature-based segmentation, tracking (Java)

WND-CHRM-- weighted nearest neighbor machine learning (Python)

ThunderSTORM and PALMSiever– Localisation SRM (ImageJ, Matlab)

OMERO2CV– LSFM Multi-View Reconstruction (C++, OpenCV, ITK)

uTrack– Globally optimised object tracking (Matlab)

CellProfiler– HCS segmentation and features (Python)

Jupyter– web-based image processing w/ NumPy, OpenCV, ITK (IPNB)

mTools– Otsu, basic segmentation (Matlab)

OMERO.figure– web app (JSON)

Columbus Acapella®-- commercial Big Data processing...



DATA SHARING, PROVENANCE, INTEGRATION...

Security Model

PERMISSIONS	 Read	 Annotate	 Write	 Privacy
 Private	✓	✓	✓	 You
 Group-Read	✓	✗	✗	
 Group-Annotate	✓	✓	✗	 Your Group
 Group-Write	✓	✓	✓	
 Public-Read	✓	✗	✗	
 Public-Annotate	✓	✓	✗	 Anyone
 Public-Write	✓	✓	✓	



OMERO & BIO-FORMATS: Pathology Instruction

The screenshot shows the OMERO web client interface for pathology instruction. The left sidebar displays a tree view of image collections, including 'Anatomy' (with subfolders like 'BS21007 Introductory Anatomy' and 'BS21007 Practical 3 Epith CT Muscle'), 'Histology' (with subfolders like 'BS31002 Practical 1' through 'BS31002 Practical 8'), and 'Orphaned images'. The main area shows a grid of thumbnail images representing different tissue sections. A specific image, '14_Tendon.svs', is selected and highlighted with a blue border. To the right of the thumbnails, a detailed view of the tendon section is displayed in a separate window. This window includes a 'Viewing Options' panel with settings for 'Quality' (Normal), 'Rendering Details' (Channels: 0, 1, 2, Color checked), and 'Current Image' (Z: 1/1 | T: 1/1). The main viewing area shows a histological image of tendon fibers, with a scale bar of 25.00% and a 'Timepoints' slider at the bottom.

OMERO Data History Jason Swedlow

Virtual Microscope Anatomy

Explore Tags Public

Filter Images

14_Tendon.svs

IMAGE ID: 46

Full viewer

Owner: Anatomy
Acquisition Date: 2011-08-26 20:08:22
Imported Date: 2013-07-30 14:23:16
Dimensions (XY): 42257 x 43037
Pixels Type: uint8
Pixels Size (XYZ) (µm): 0.0000 x 0.0000
Z-sections/Timepoints: 1 x 1
Channels: 0, 1, 2

14_Tendon.svs - Google Chrome
https://learning.openmicroscopy.org/dundee/webclient/img_detail/46/

Viewing Options
Quality Normal
Rendering Details
Channels - Edit
0 1 2
Color
Current Image
Z: 1/1 | T: 1/1
Image Information
Image Link
ROI Count: 0

Z-sections

Timepoints

Scale: 25.00%

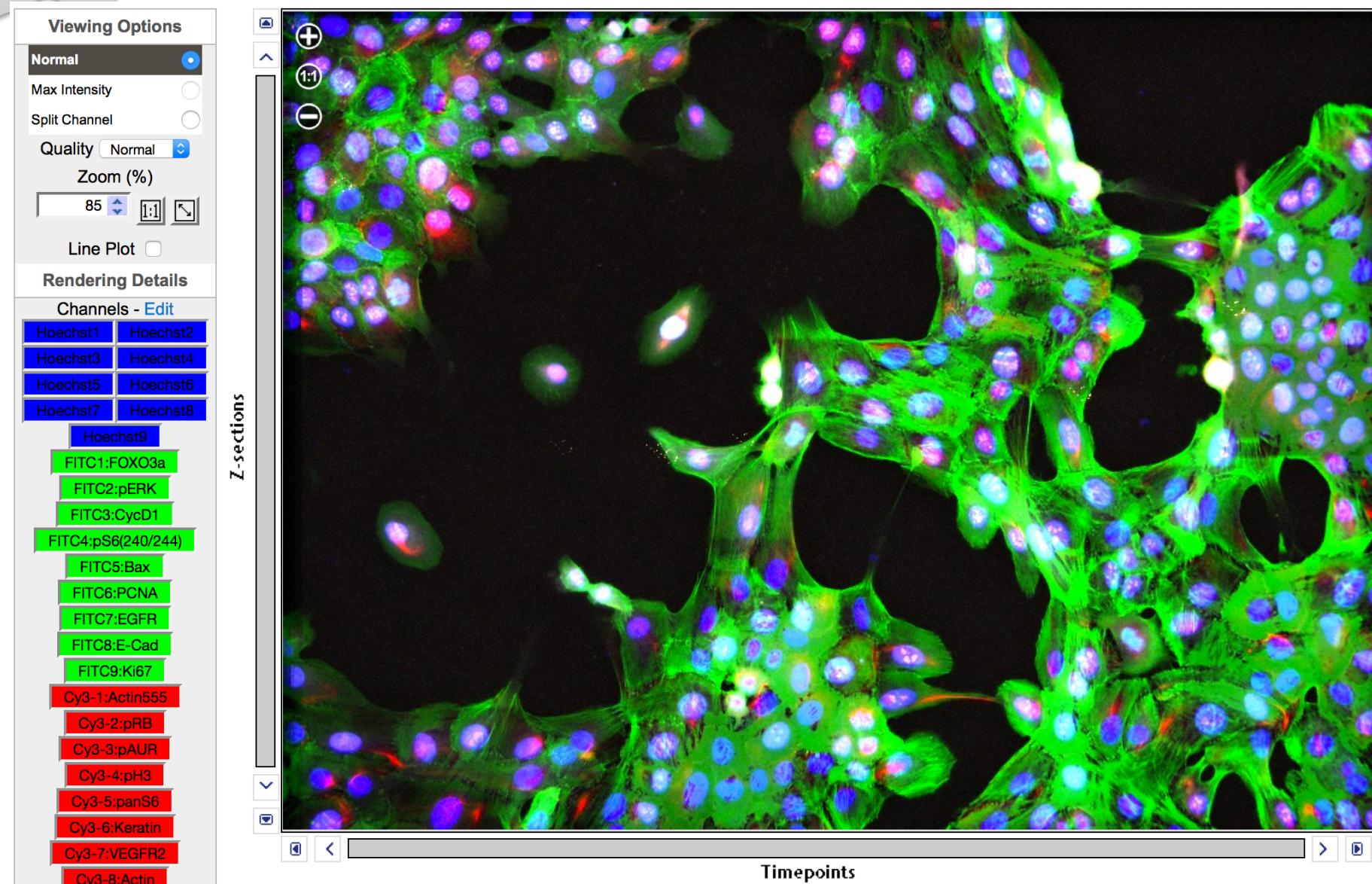
© 2007-2011 Glencoe Software Inc. All rights reserved.

<https://learning.openmicroscopy.org/dundee/webclient/userdata/?experimenter=5#>

Paul Felts, Dundee; learning.openmicroscopy.org; u:course, pw:omero



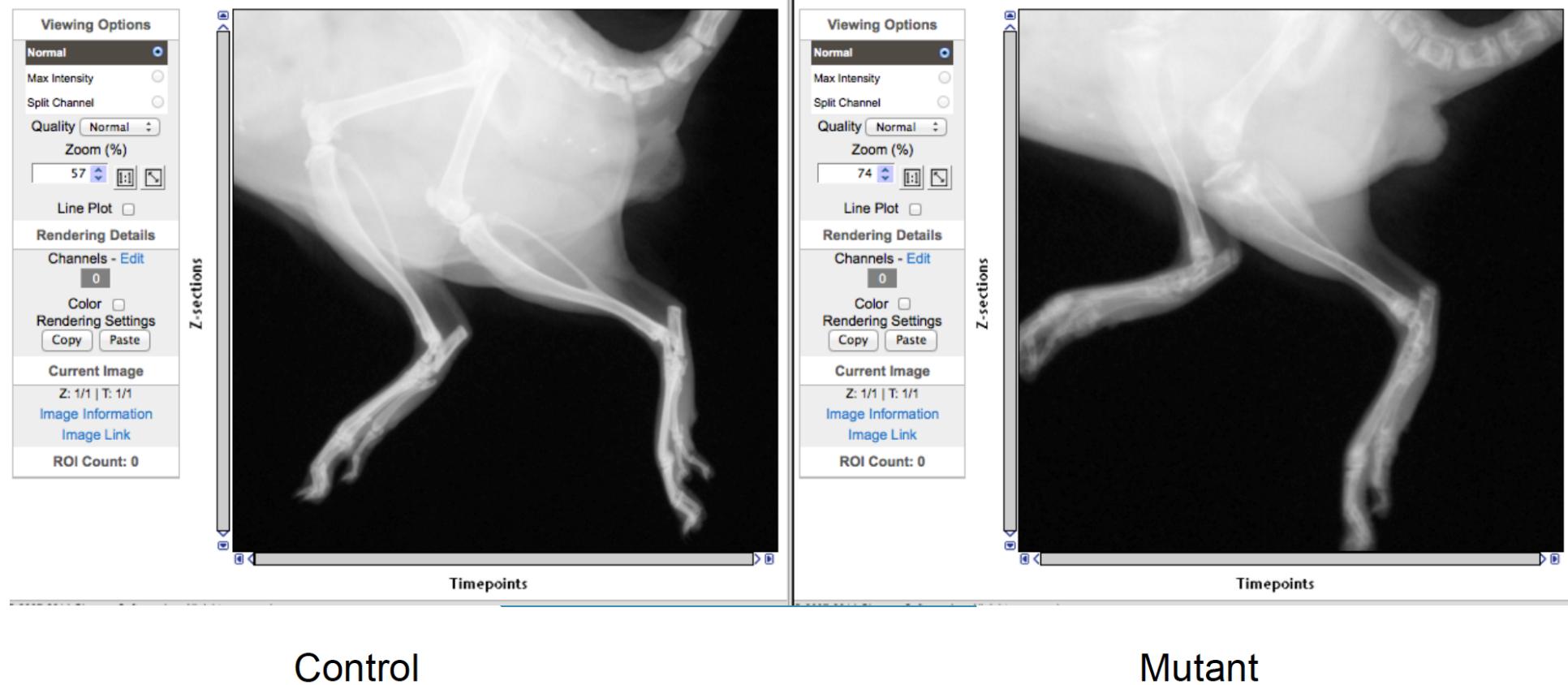
OMERO & BIO-FORMATS: HMS LINCS Database: 27 Channel Cyclic IF



Jia-Ren Lin, Zoltan Maliga, & Peter Sorger, Harvard Med School



OMERO & BIO-FORMATS: KOMP2/IMPC



www.mousephenotype.org





EMPIAR/EMDataBank / PDBe

Protein Data Bank in Europe
Bringing Structure to Biology

Share **Feedback**

EMD-2363 › Volume slicer

Electron tomogram through a Gemmata obscuriglobus cell

Sample name: Gemmata obscuriglobus cell
Method: Tomography
Resolution: N/A

Quick links

- EMD-2363 overview
- Function and Biology
- Experiments and Validation
- View
- Downloads
- Volume viewer
- Volume slicer**
- Visual analysis



OMERO @ Liverpool

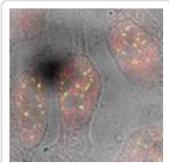
OMERO.gallery

Logged in as: Public User

Liverpool CCI OMERO Gallery

You can browse projects below

See Lab Public



- Projects: 2
- Datasets: 25
- Images: 785

[Explore »](#)

PostAcquisition



- Projects: 0
- Datasets: 2
- Images: 5

[Explore »](#)

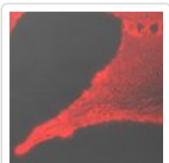
Levy Lab Public



- Projects: 2
- Datasets: 31
- Images: 791

[Explore »](#)

Fernig Lab Public



- Projects: 2
- Datasets: 11
- Images: 444

[Explore »](#)

David Mason, Liverpool



SSBD @ Riken

SSBD Database

[» Japanese](#)

Browse through categories:

[Home](#) [Resources](#) [Manuals](#) [Publications](#) [News](#) [Software](#)

[Data Search](#)

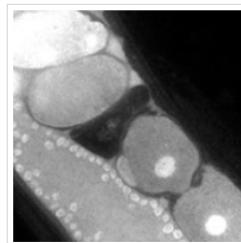
[Image Search](#)

Introduction of SSBD

Systems Science of Biological Dynamics (SSBD) database provides a rich set of open resources for analyzing quantitative data and microscopy images of biological objects, such as single-molecule, cell, gene expression nuclei, etc. Quantitative biological data and microscopy image are collected from a variety of species, sources and methods. These include data obtained from both experiment and computational simulation.

Samples

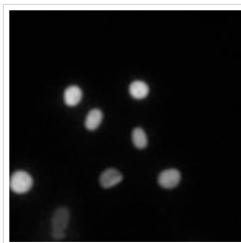
Microscopy images



Calcium response and shape changes in oocyte of *C. elegans*

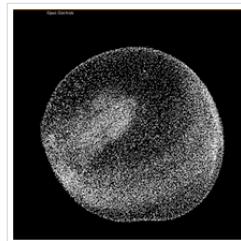


Nuclear division dynamics in *C. elegans* wild-type embryo

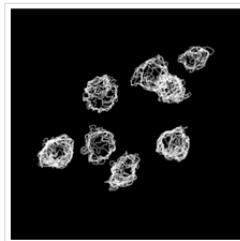


ERK activity in rat kidney epithelial (NRK-52E) cells

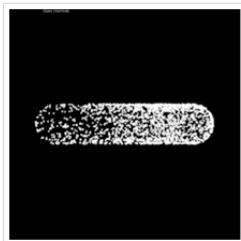
Quantitative data



Nuclear division dynamics in *D. rerio* wild-type embryo



Nuclear division dynamics in *C. elegans* wild-type embryo



Single molecule dynamics in *E. coli* wild-type

News and Events

May. 20. 2017: SSBD API notice

SSBD REST API full service is now available.

Mar. 1. 2017: SSBD API notice

SSBD REST API coordsXYZ is currently unavailable due to recent system maintenance. The service will resume shortly. Please check back later.

[Older news ...](#)

Information

OMERO: Images can be viewed on [OMERO.web](#). If you have problem viewing the images on the website, please click on the drop-down arrow on the right of 'public data' on the bar above the data tree, select 'Public' group and 'public data' to view the images (click [here](#) for more details).

OMERO session ID: None

Introducing SSBD Database



Introducing the

SSBD Database

Systems Science of Biological Dynamics

Links

[NBDC RDF Portal](#) [RIKEN Meta Database](#) [WDDD](#)

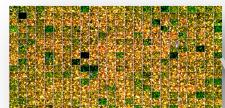
[OME](#) [Ensembl](#) [WormBase](#)



The IDR

IDR 0006

Gene Product
Targeting HCS



Genetic HCS



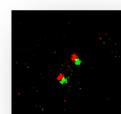
Geographic HCS



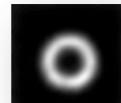
Chemical HCS



Histopathology



3D-SIM



Super-resolution

The IDR web client interface displays a 5D image viewer. On the left, a sidebar lists studies and their experiments. The main area shows a grid of thumbnails representing 5D images. To the right, a detailed panel provides experimental metadata, biomolecular annotations, and analysis results.

Experimental metadata:

- Image ID: 3230268
- Well ID: 1315357
- Owner: Demo User
- Well Details:
 - Acquisition Date: 2010-09-01
 - Import Date: 2010-09-01
 - Dimensions (XY): 1080 x 1080
 - Pixels Type: uint16
 - Pixel Size (XYZ) (μm): 0.66 x 0.66 x -
 - Sections/Timelapses: 1 x 1
 - Channels: Hoechst, ERSyo, ERSyoBleed, PhGolgi, Mito
 - ROI Count: 0
- Attributes
- Gene
- ORF
- ORF supplementary

Biomolecular annotations:

- 331 ORFs
- Gene Identifier
- Gene Symbol
- ORF Identifier
- ORF Sequence
- ORF Comments

Analysis results:

- Tables
- INFO:
 - Plate: 5965
 - Well: 1315357
 - Well Number: 247
 - Characteristics: Homo sapiens [Organism]
 - Term Source 1: NCBTaxon
 - Term Source 2: EFO
 - Term Source 1: U2OS [Cell Line]
 - Term Source 2: EFO_0002869
 - Accession: ccsbBroad304_05835
 - ORF Identifier: ccsbBroad304_05835

Thumbnail Labels:

- Index
- Field 1
- 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
- A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P

Thumbnail (of 5D Images)



Cross-data
browsing



Cloud
analysis

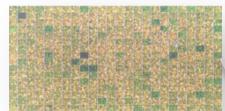


Download
(local analysis)

The IDR

IDR 0006

Gene Product
Targeting HCS



Genetic HCS



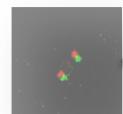
Geographic HCS



Chemical HCS



Histopatho



3D-SIM



Super-resolution

Integrated studies

Index Field 1

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

41757 [Well K7, Field 1]

Image ID: 3230268 Well ID: 1315357 Owner: Demo User

Well Details

Acquisition Date: 2013-08-20 Import Date: 2013-08-20 Dimensions (XY): 1080 x 1080 Pixels Type: uint16 Pixels Size (XYZ) (μm): 0.66 x 0.66 x - Z: 1 sections/Timelapses: 1 Channels: Hoechst, ERSyo, ERSyoBleed, PhGolg, Mitc ROI Count: 0

Attributes

Gene: 331 Added by: Demo User Gene Identifier: Gene Symbol: ORF: 0 Added by: Demo User ORF Identifier: ORF supplementary

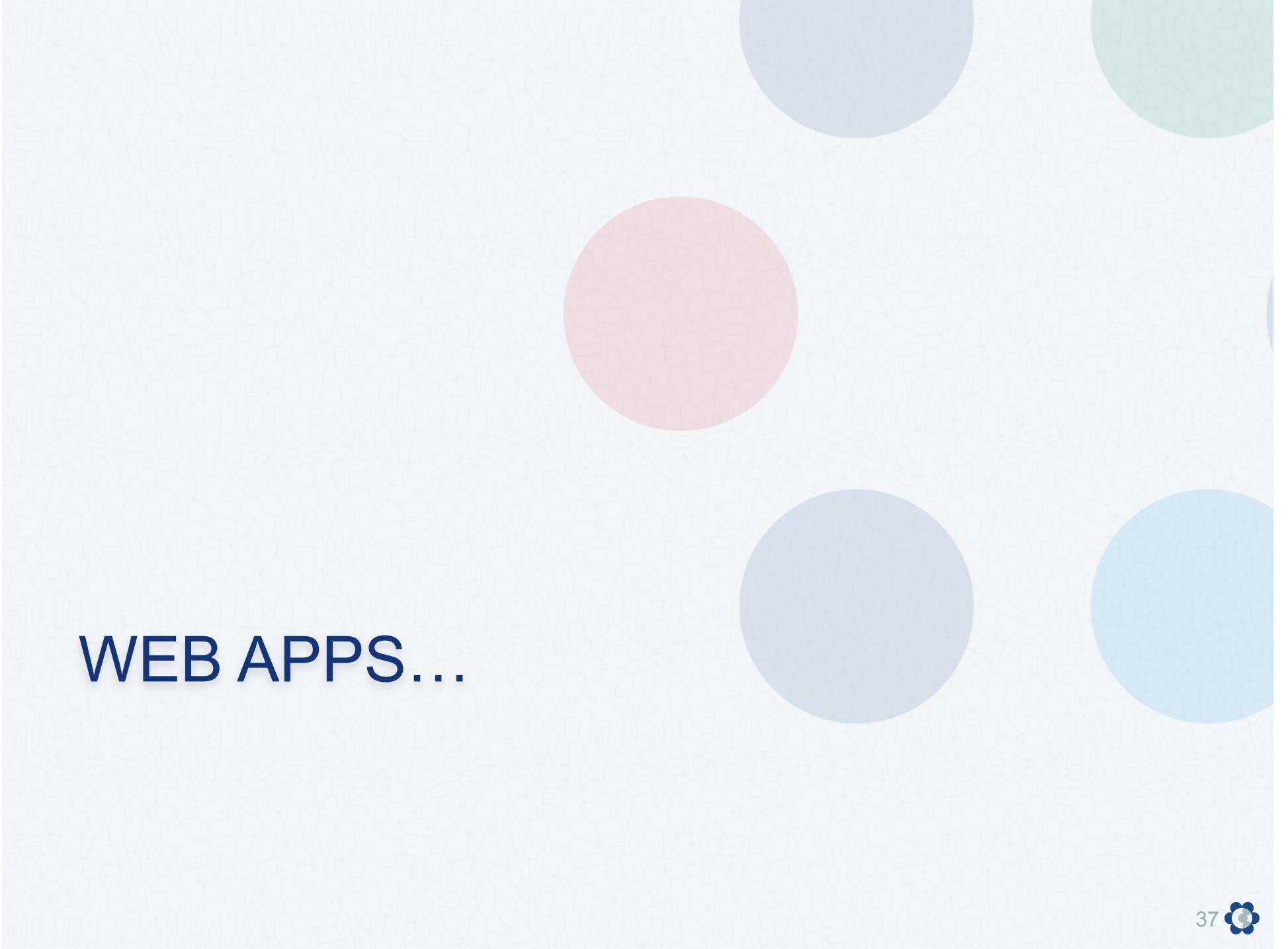
Added by: Demo User ORF Sequence: ORF Comments: GOTCTAT seqcdffcad304_05836Open Reading Frame at 66, 1557

Experimental
metadata

Biomolecular
annotations

Analysis
results

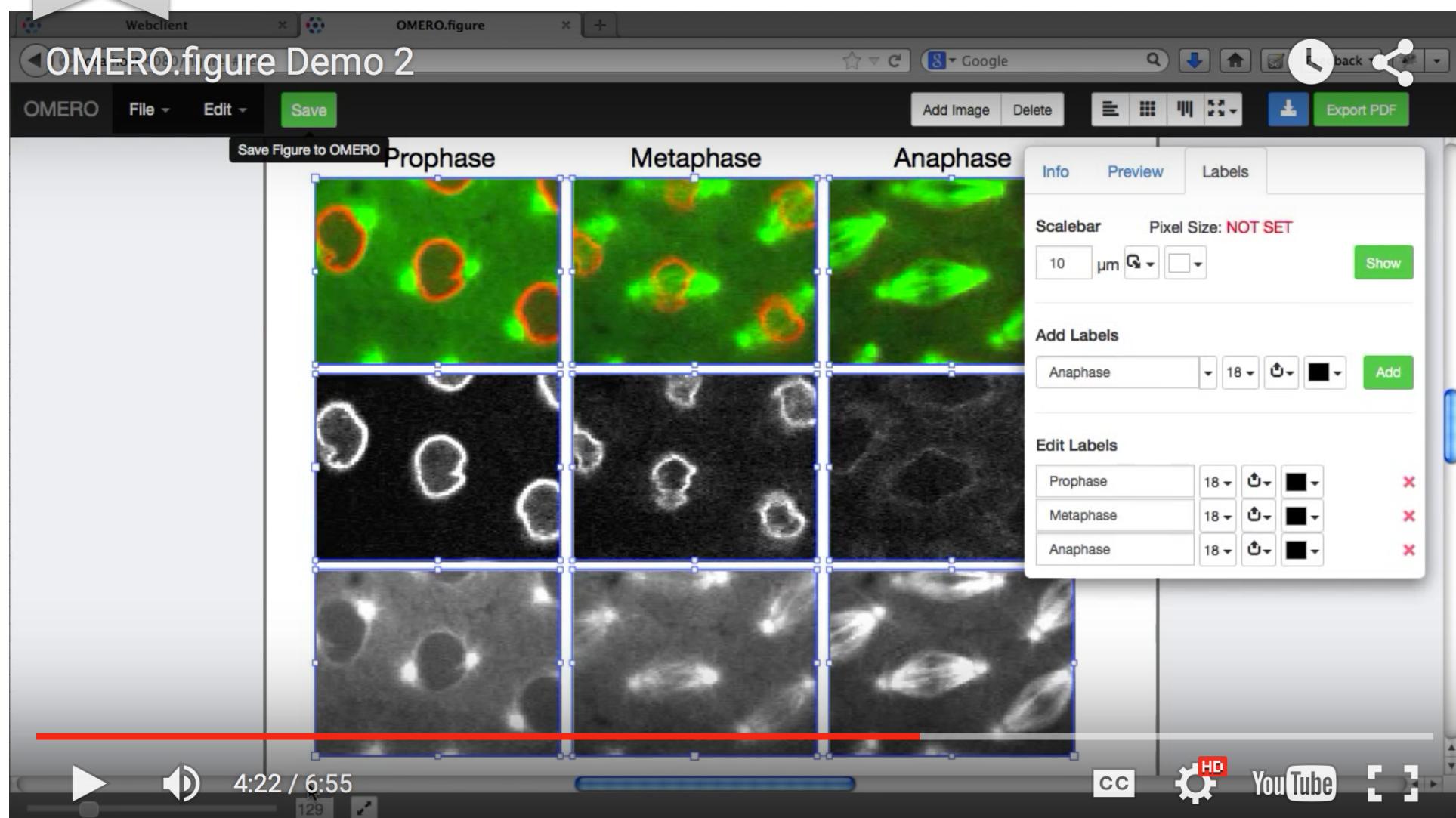




WEB APPS...



OMERO.figure



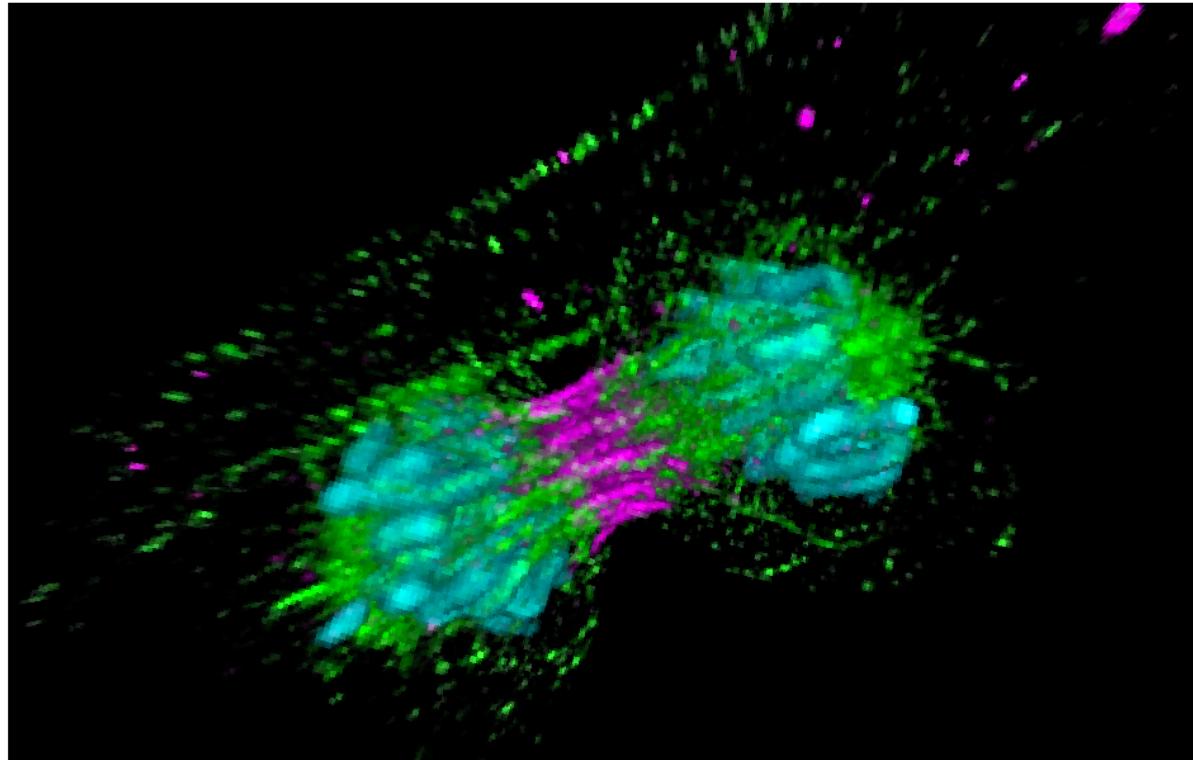


FPBiolImage

First Person Bioimage

jason/PTRE/P-TRE_10_R3D_D3D.dv

Press M for a full list of controls



Images generated in OMERO.



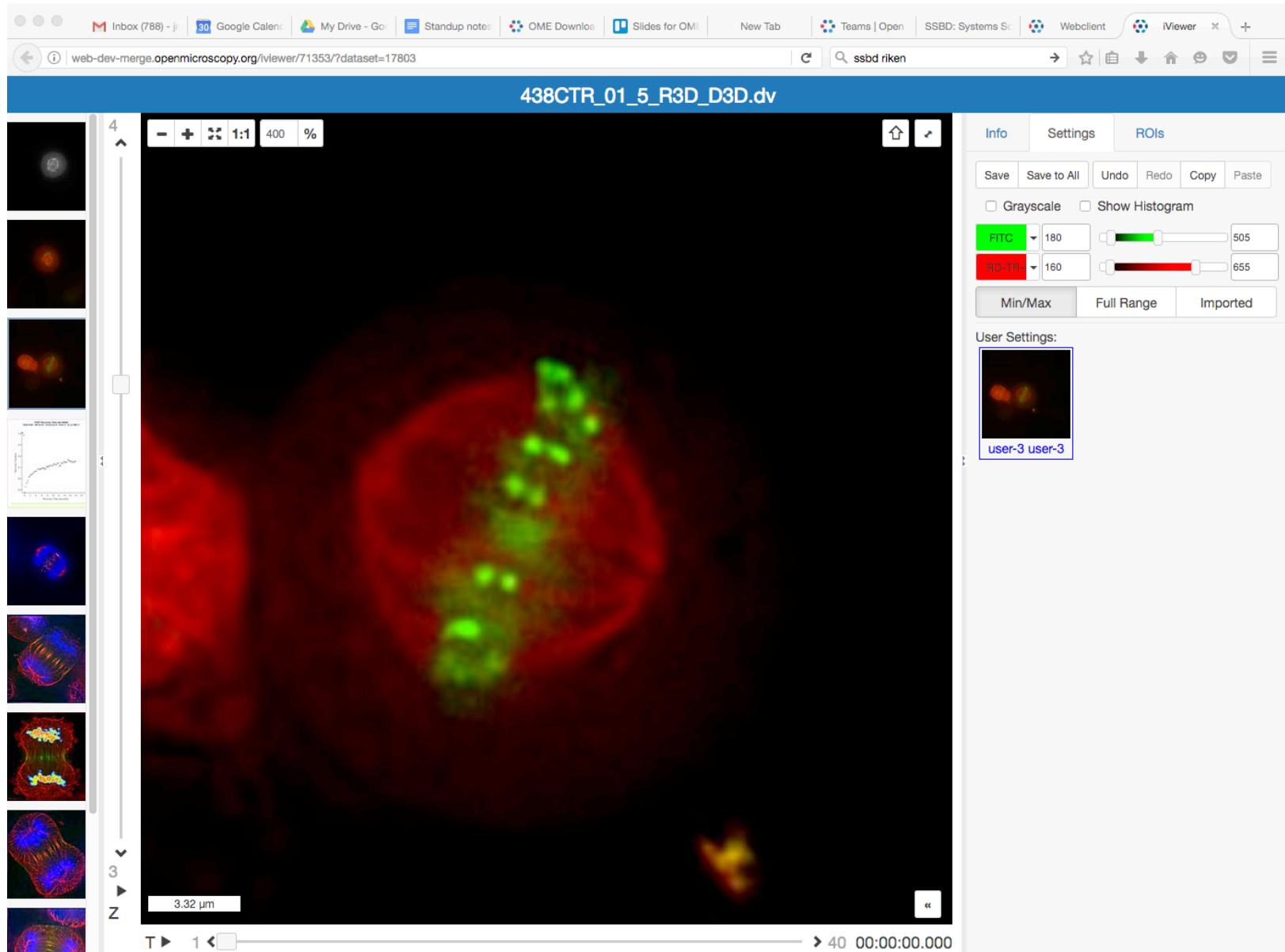
© Marcus Fantham

See the paper in [Nature Photonics](#)



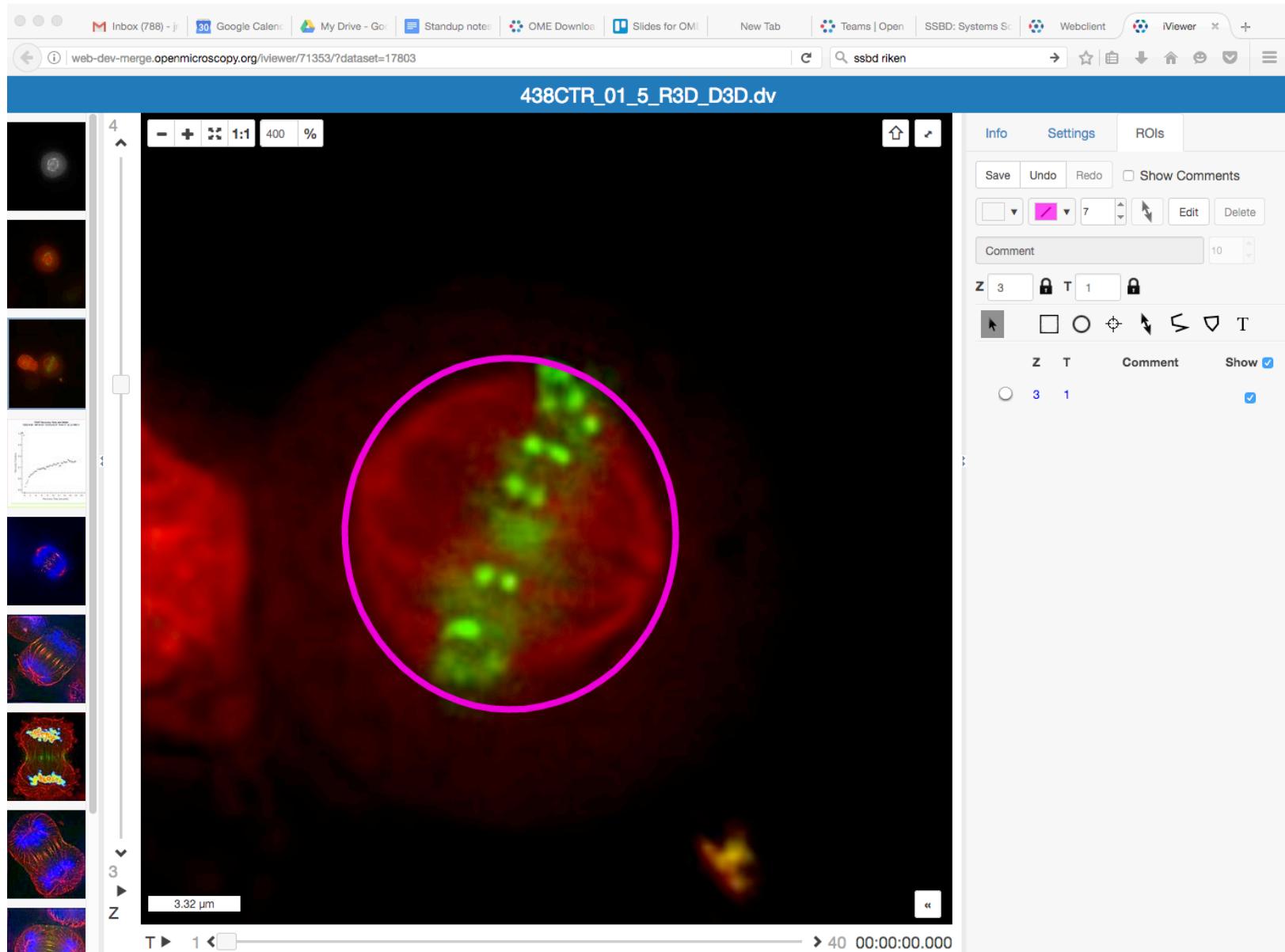


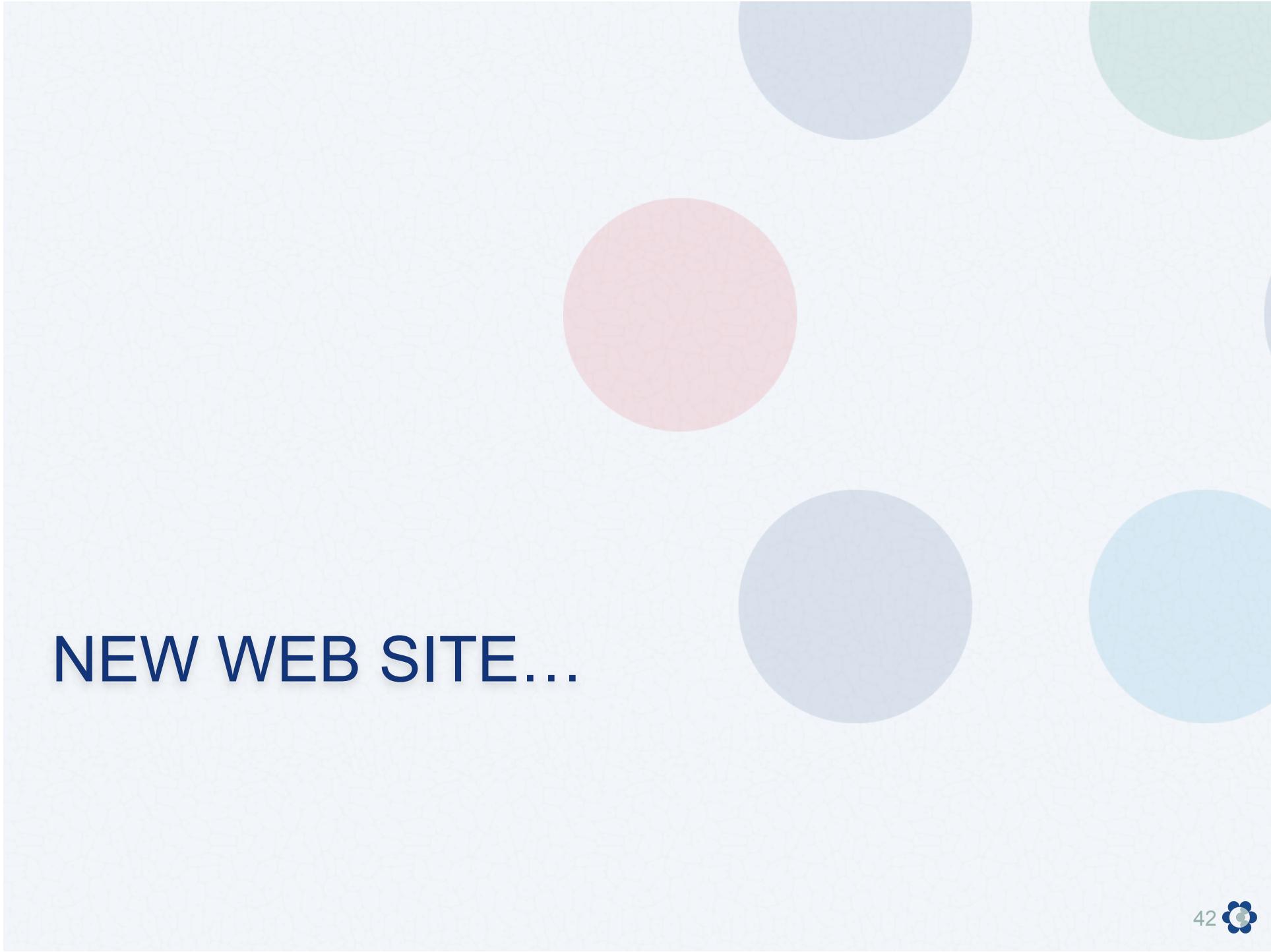
OMERO.iviewer





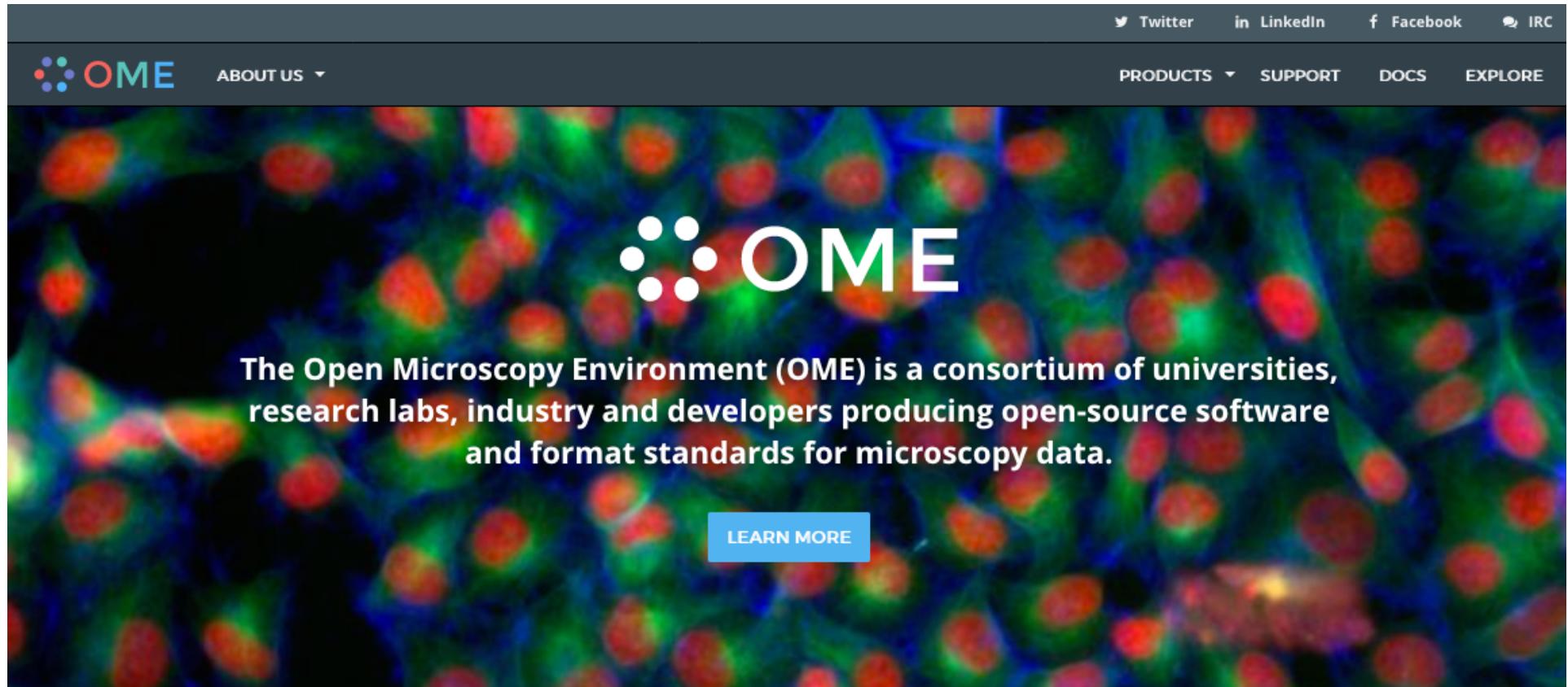
OMERO.iviewer





NEW WEB SITE...

Coming soon....



<https://openmicroscopy.github.io/www.openmicroscopy.org/>

FUNDING

OME Grant Funding

- BBSRC IDR (2015 - 2106)
- Horizon 2020 (2016 – 2018)
 - MULTIMOT
 - Euro-BioImaging PPII
 - CORBEL
 - Global BioImaging
- BBSRC BBR Extended Metadata (2014 - 2017)
- Wellcome Biomedical Resource Bio-Formats Updates 2017 - 2019

BIO-FORMATS:

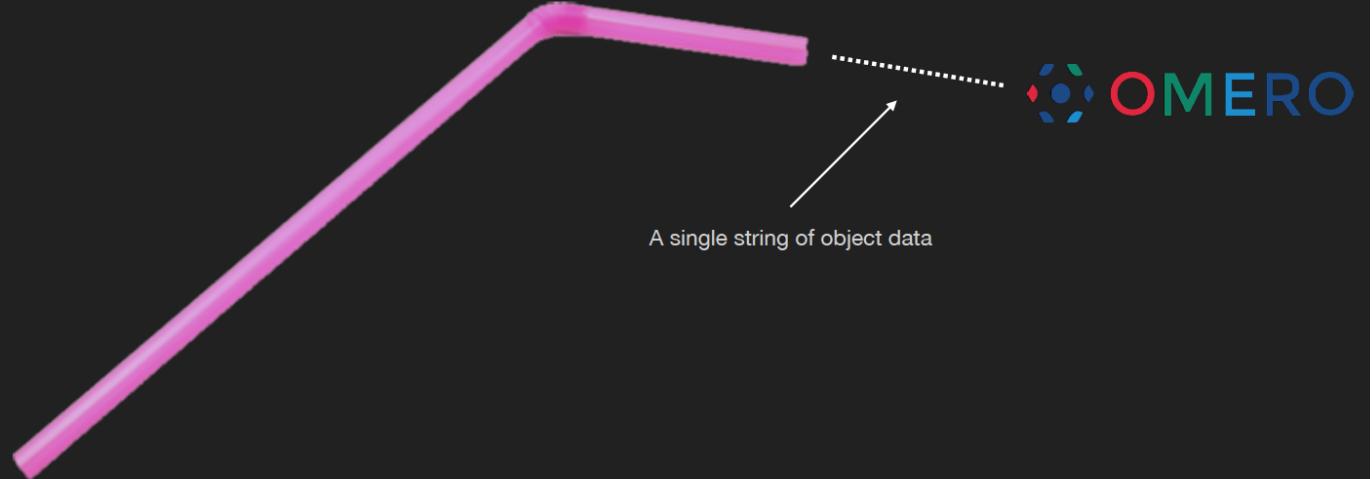
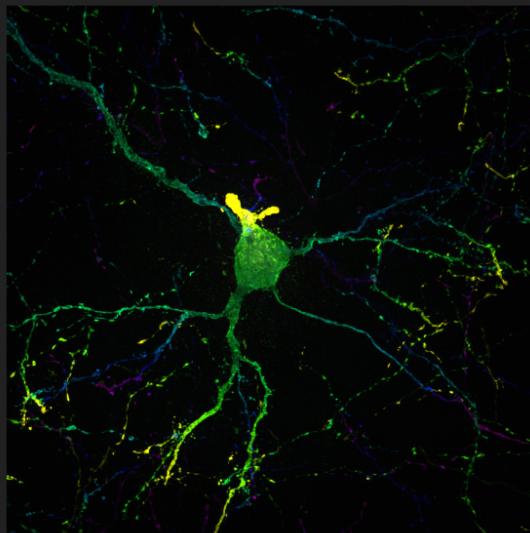
Opportunities for Academic/Commercial Collaborations

- 3i: Building and maintaining a SlideBook file format reader
- PerkinElmer: Commission Glencoe to provide open source Harmony HCS format reader
- ZEISS: Commission Glencoe to build open source JPEG-XR decoder
- Olympus Europe: Commission Glencoe to build open source OIR reader

→ See *blog.openmicroscopy.org* for more info

OME2016: Luke Hammond/QBI

The Blitz Gateway



* Blitz is also non scalable

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OME2017: Thank you BD2K!!!

- OHSU & HMS BD2K award for OMERO Scaling Updates
 - Read-Only OMERO
 - Session Portability

What About Brexit?!?!?!

- OME mostly UK-funded
 - Wellcome Trust, BBSRC – ~£10M since 2011
- Funding Infrastructure is Hard
 - Harder when £€\$ are tight, uncertain times
- Future Opportunities
 - National/Trans-national Research Infrastructures
 - BiolImagingUK, France BiolImaging, German BiolImaging, Japan BiolImaging, NCI...
 - Partnerships with research labs, institutions, projects
 - UK, USA, Europe, Japan
 - Academic, Industrial, Commercial



2017/2018 PRIORITIES?

Some words to think about...

- New Modalities (MS, Raman, X-ray, etc.)
- Multi-modal/Correlative
- Federation:
 - SSO
 - Distributed Data
- Import/Export
- Ontologies
- OMERO Gateway
- Apps
- Microservices
- Notebooks
- Client Architecture
- Archiving
- ...

Thank you!



Jason
Swedlow



Sebastien
Besson



Jean-Marie
Burel



Mark
Carroll



Helen
Flynn



David
Gault



Kenny
Gillen



Roger
Leigh



Simone
Leo



Simon
Li



Dominik
Lindner



June
Matthew



Josh
Moore



Will
Moore



Balaji
Ramalingam



Gabriella
Rustici



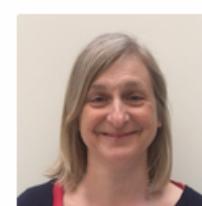
Aleksandra
Tarkowska



Petr
Walczysko



Harald
Waxenegger



Eleanor
Williams



Wilma
Woudenberg

