OME ⟷ ImageJ2

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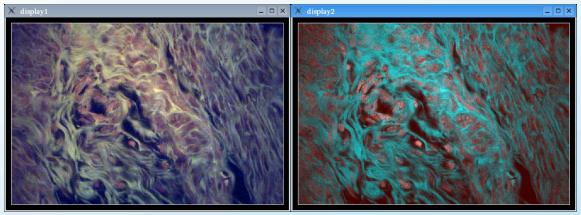
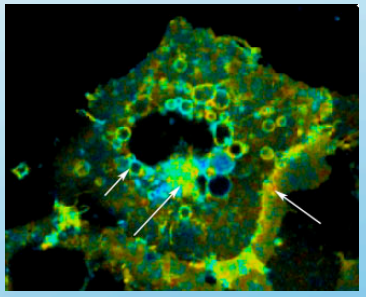
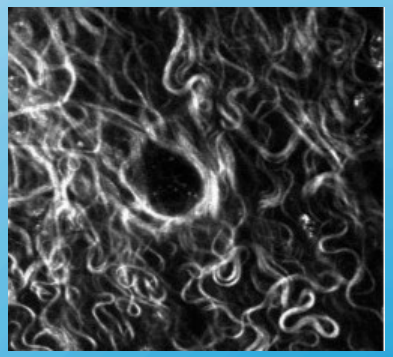
- New optical instrumentation to facilitate studies of the dynamics of living specimens.
- Better software for capture and visualization of dynamic, 3-D biological events
- Been OME Development partner since 2003
- Image Informatics for multidimensional data
  - spatial and temporal
  - spectral and lifetime dimensions
  - polarization

Mission of LOCI

Our data:







Fluorescence,
Spectra, Lifetime
(λ,τ)

Time-Lapse
(t)

Dynamics

Chemistry

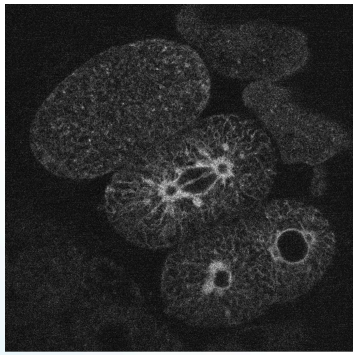
Optical Microscopy

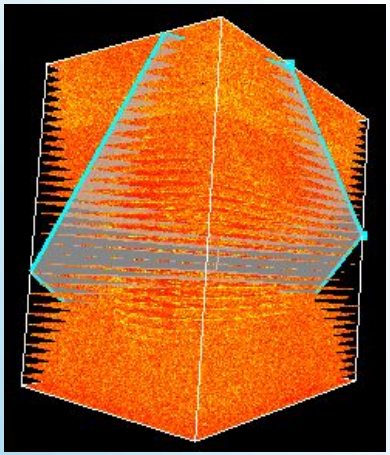
Physics

Structure

Phase, Polarization,
Scatter, Harmonics
(ϕ, θ,…)

Space
(x, y, z)





Supporting Technologies

Hardware
Acquisition software
Analysis and Visualization
Data Management

LOCI

Curtis Rueden
Lead ImageJ2

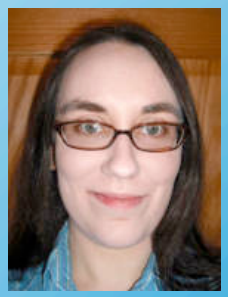
Barry Dezonia
ImageJ2
Developer

Mark Hiner
SCIFIO Developer

Johannes Schindelin
Lead FIJI, ImageJ2
and OME developer

Jimmy Fong
Lifetime Analysis
Researcher

Kristin Briney
OME XML Metadata
Graduate Programmer



Melissa Linkert
Lead Bio-Formats
(Glencoe Programmer
in residence)

Aivar Grislis
ImageJ2
Developer

OME

LOCI

LOCI OME Informatics Group- 2012

Overview of our OME efforts:

- Specific OMERO linked applications
  - BK Cho in Murphy lab on Omero.searcher
  - Forward Project for data dissemination

- Originated OME-TIFF in 2004
  - Now fully integrated into OMER0
  - Used by many open and commercial tools
  - Our current focus on robust tools to read and write OME-TIFF

- Originated Bio-Formats in 2005
  - partnership with OME and Glencoe
  - Over 120 formats
  - Over 30,000 installations
  - Recent focus on native bindings

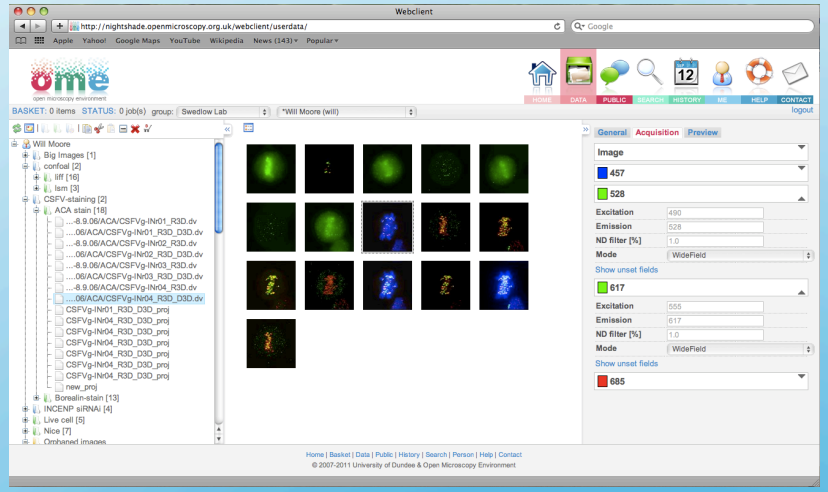
- XML Schema Improvements for Acquisition and Analysis
  - Our WiscScan software and now MicroManager
  - Plans to extend to others that want richer “OME-TIFF”

- Interoperability between OME and other tools (FarSight, CellProfiler, FIJI, ImageJ

- ImageJ 2.0 (ImageJDev.org)

Bio-Formats: the tool for interoperability

BIO-FORMATS



CellProfiler™
cell image analysis software

GLENCOE SOFTWARE

icy

ImageJ
Image Processing and Analysis in Java

JCB Data Viewer

vtk

itk

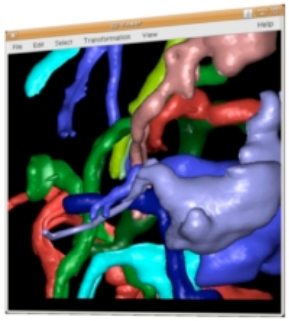
Open Source Toolkit Development

FARSight

OME

BIO-FORMATS

Interoperability



Fiji Is Just ImageJ

ImageJ

Image Processing and Analysis in Java

CellProfiler™

cell image analysis software

µManager

THE OPEN SOURCE MICROSCOPY SOFTWARE

Why ImageJ2?

- Support the next generation of image data
- Interoperate and collaborate with other projects
- Broaden the ImageJ community
- Reuse each others' work wherever practical
- Provide a central online resource for ImageJ
  - Program downloads, a plugin repository, developer resources and more

Universität Konstanz

OME

Max Planck Institute of Molecular Cell Biology and Genetics Dresden

MARINE BIOLOGICAL LABORATORY · WOODS HOLE · 1888

HHMI janelia farm research campus

BROAD INSTITUTE

And anyone who wants to contribute!

LOCI

Who Develops ImageJ2?

NATIONAL INSTITUTES OF HEALTH

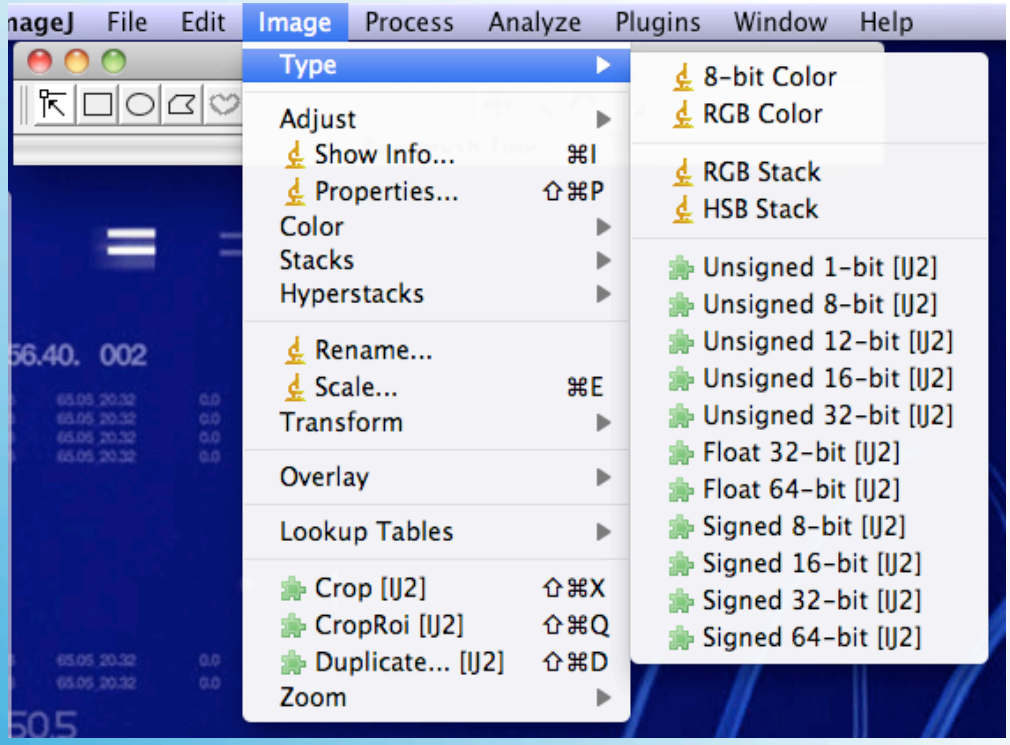
- Preserve backwards compatibility
- Maintain good performance
- Support N-dimensional imaging
- Use common input and output for data
- Minimize complexity
- Employ open source software dev. practices

Guiding Principles

- Supports most ImageJ1 plugins and macros
- Many new pixel types
- Multidimensional data beyond 5D
- Import and export of many file formats
- Improved region of interest (ROI) tools
- Truly headless
- Automatic updates
- Easily install additional plugins (e.g., Fiji >350 plugins!)
- 175 new/reimplemented core ImageJ2 plugins so far

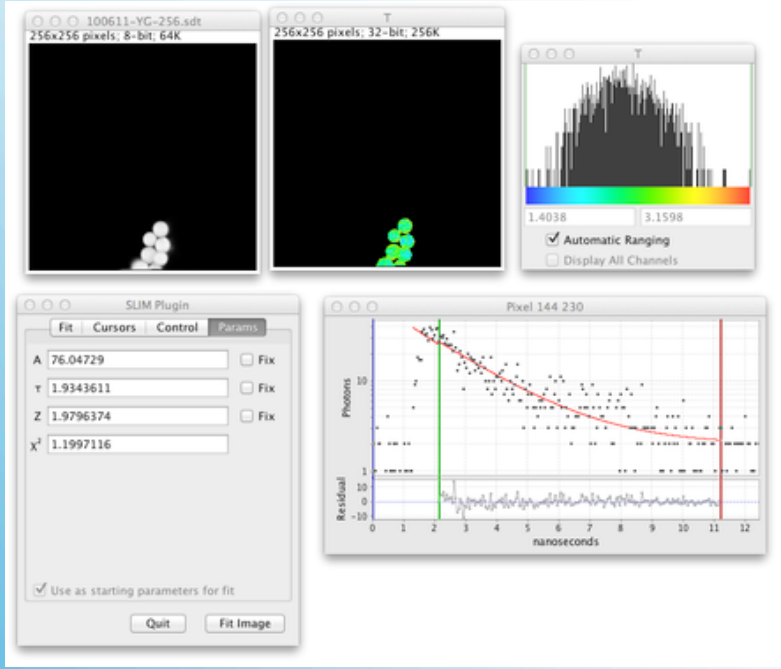
ImageJ 2.0.0-beta2

- Based on ImgLib2 library
- Any data source (files, URLs, DBs...)
- N-dimensional images
- Unlimited pixel types
- Write algorithms once



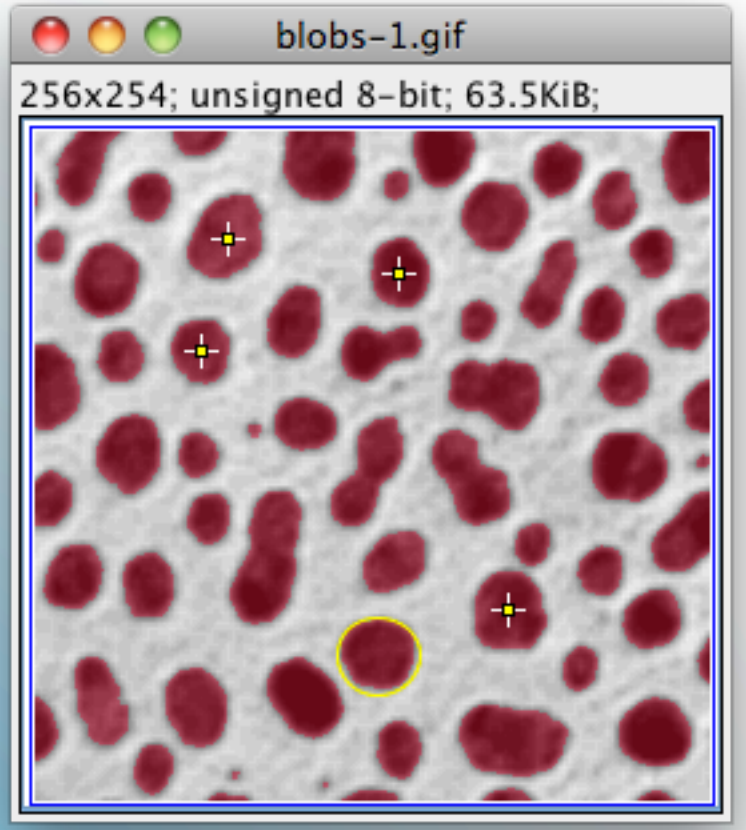
Data Model

- The user interface provides views of the data
- Show multiple datasets in one window
- Or multiple windows showing the same dataset
- Composite any # of channels
- Fully pluggable



Displays and Visualization

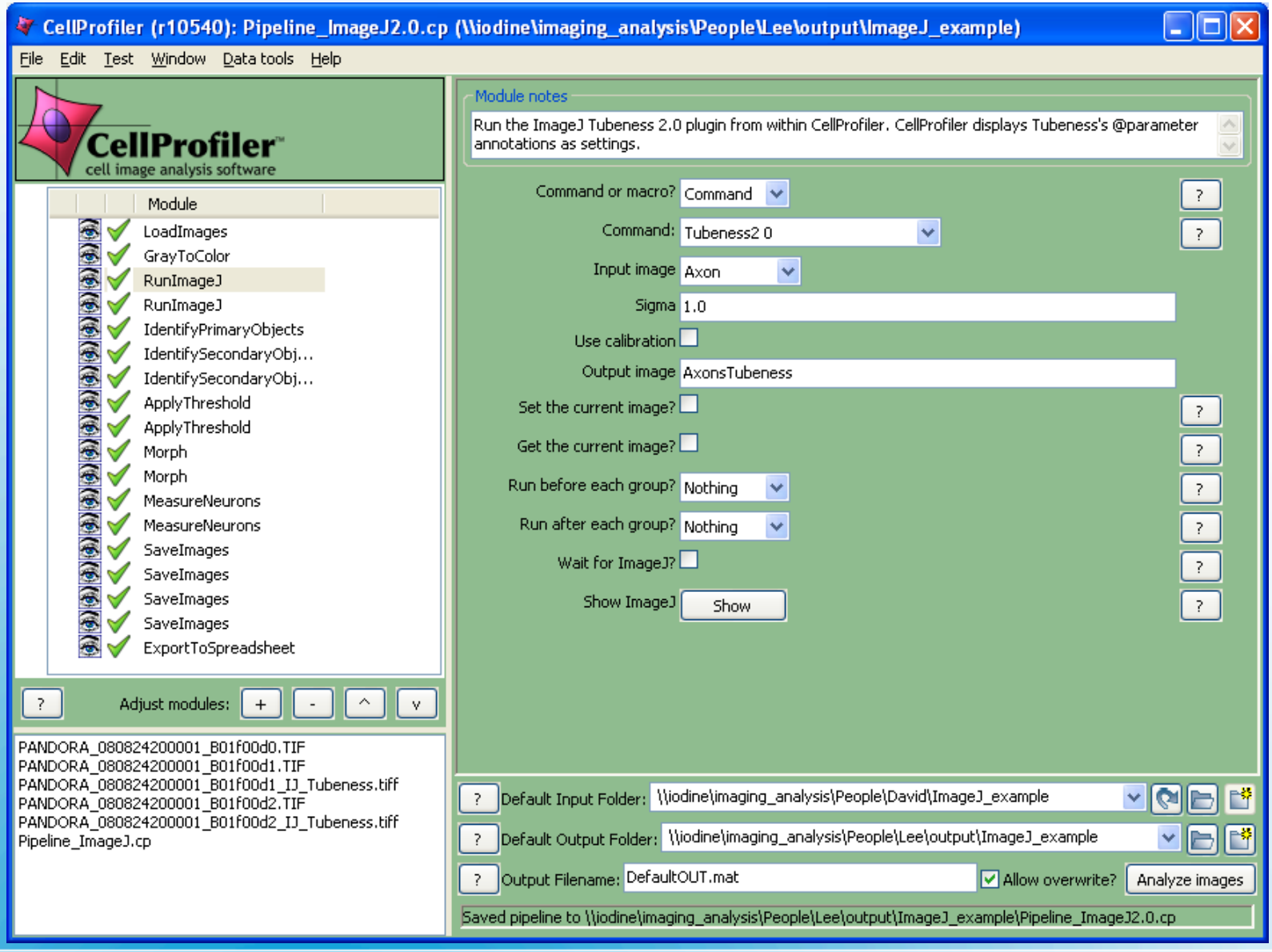
- ROIs are functions that identify samples upon which to operate
- Overlays are visuals superimposed over a dataset, often (but not always) linked to ROIs



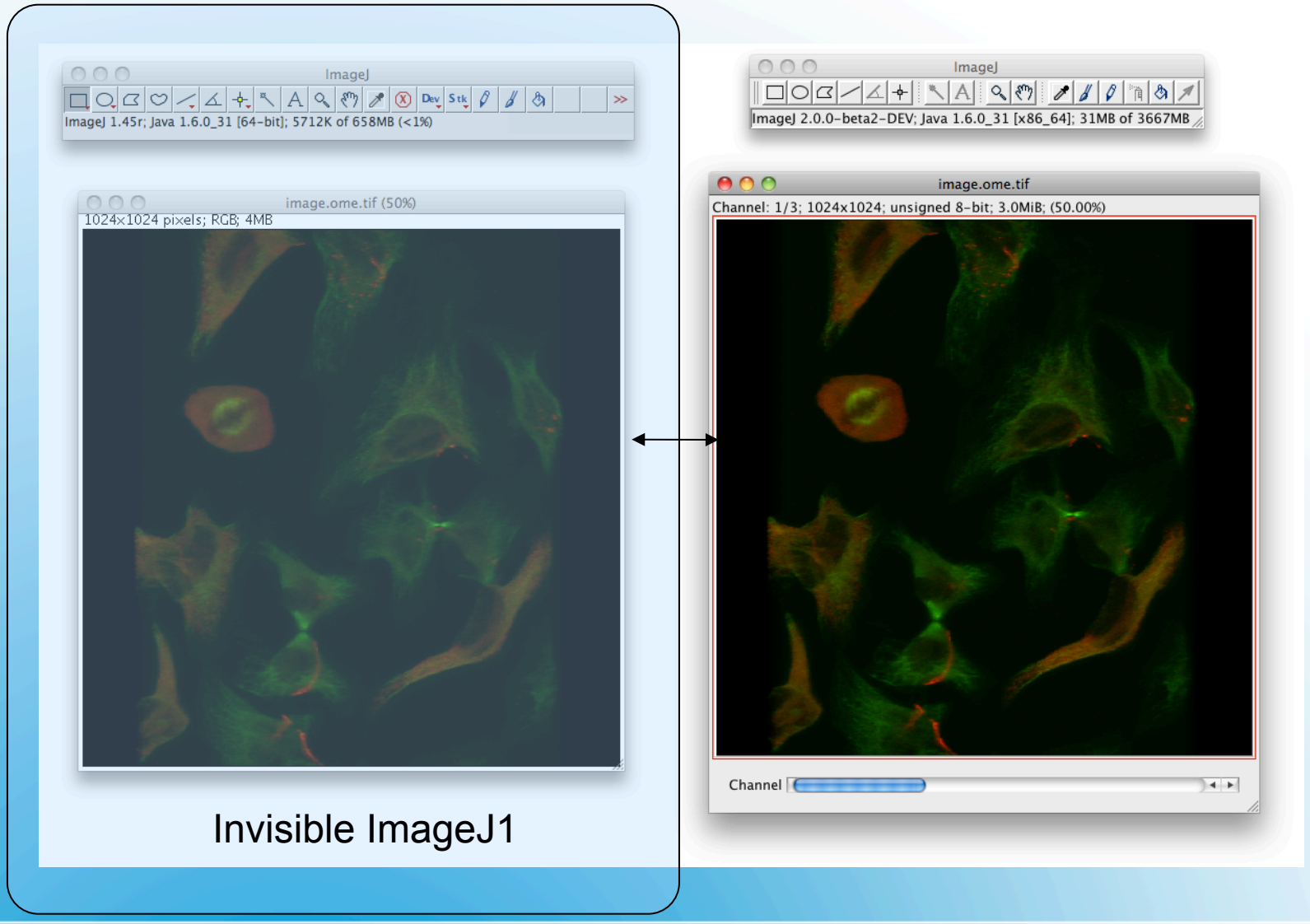
Regions of Interest

User Interface

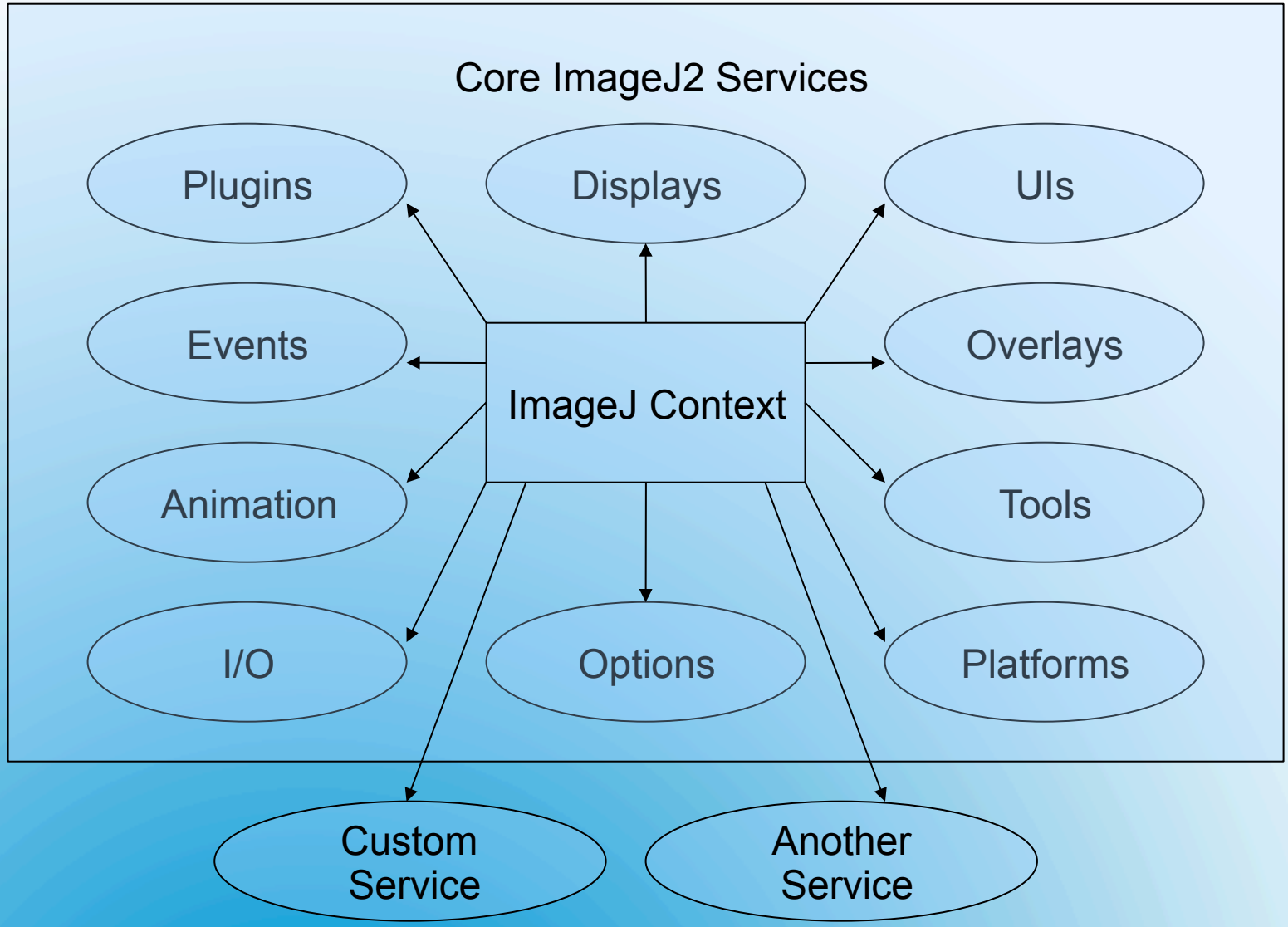
- Provides widgets for several UI styles:
  - Swing
  - “Pure” AWT
  - Eclipse SWT
  - Apache Pivot
- Custom UIs possible
- Can run headless
- Use ImageJ2 as a library to execute plugins



Interoperability

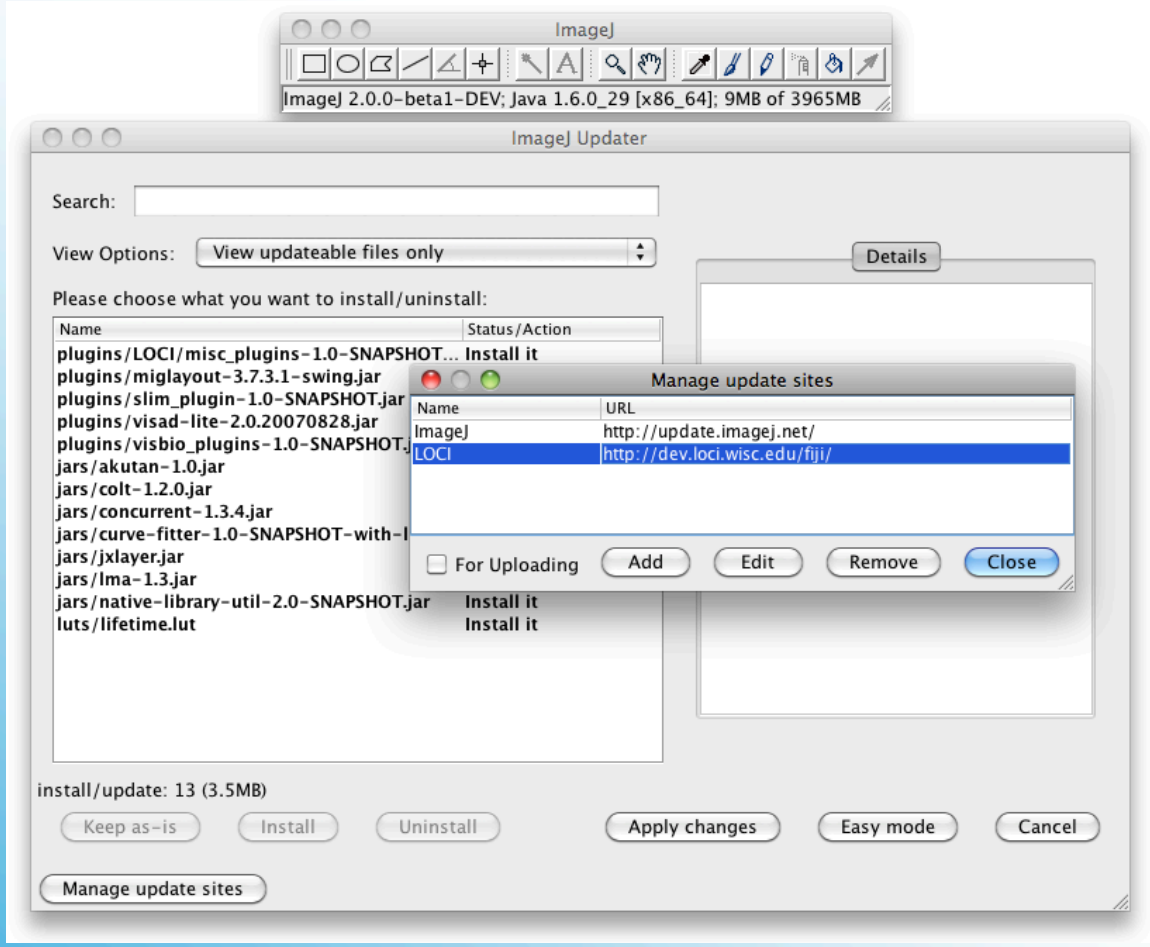


Compatibility



Service Architecture

- Keeps ImageJ2 plugins up-to-date
- Installs new plugins
- Anyone can create an update site and upload their own plugins to it
- Compatible with existing Fiji update sites (including fiji.sc)

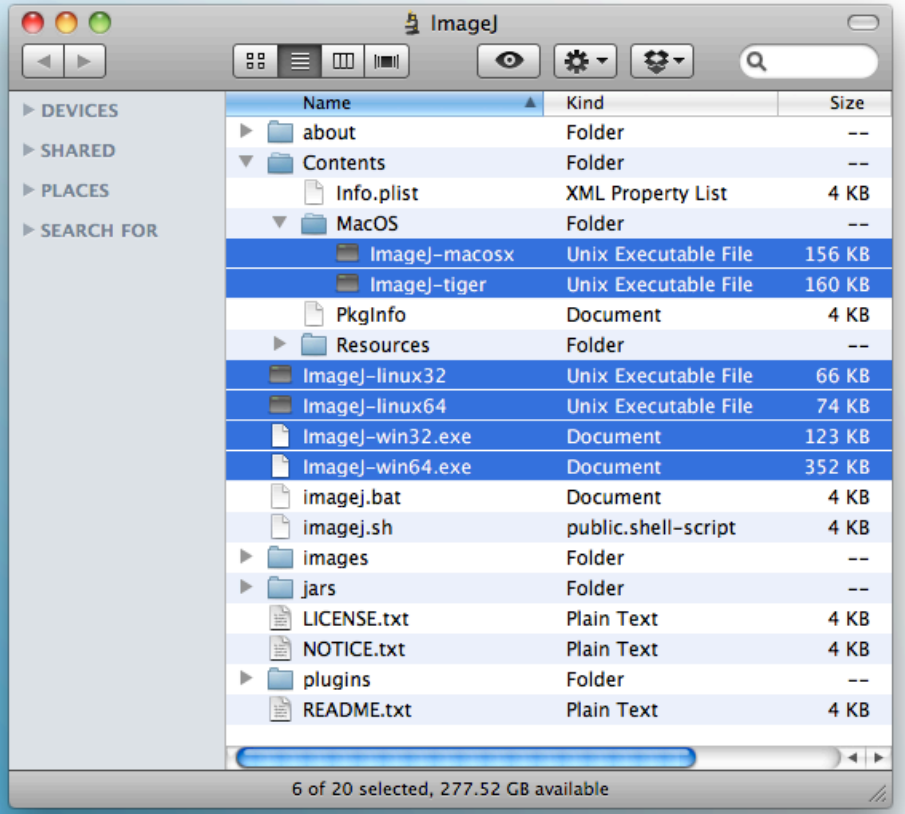


ImageJ Updater

- Uses SCIFIO (SCientific Image Format Input & Output) library for reading and writing data
- New formats can be added as SCIFIO plugins

Data I/O

- Many options for launching ImageJ2
- Run scripts in batch mode
- Multiple platforms
- Run headless



Launcher

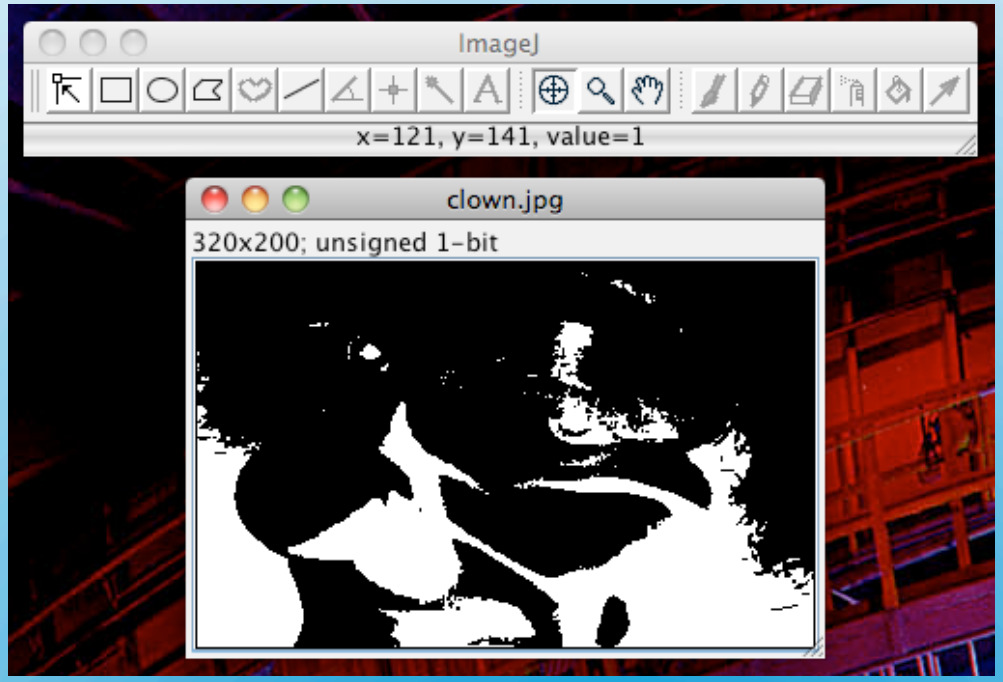
- Release one beta per month
- Big green button
- Easier development
- Better integration with native code
- Website: central plugins listing
- Application-driven development

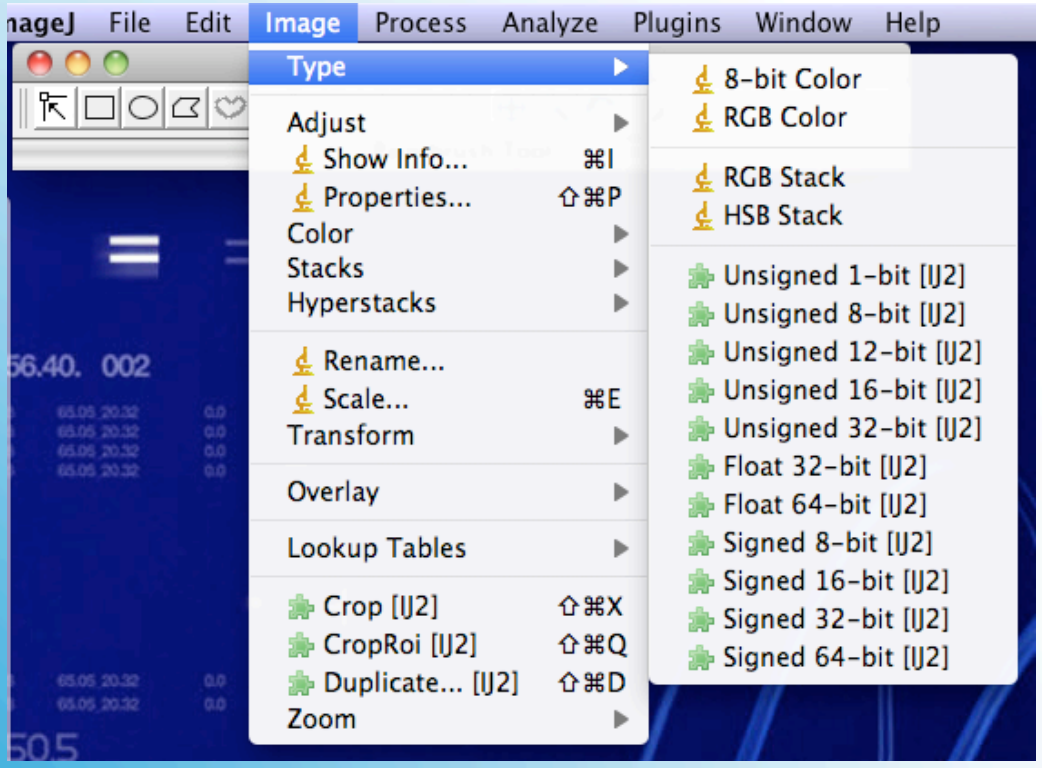
Future Directions

ImageJ2

What can ImageJ2 already do?
(as of June 2012)

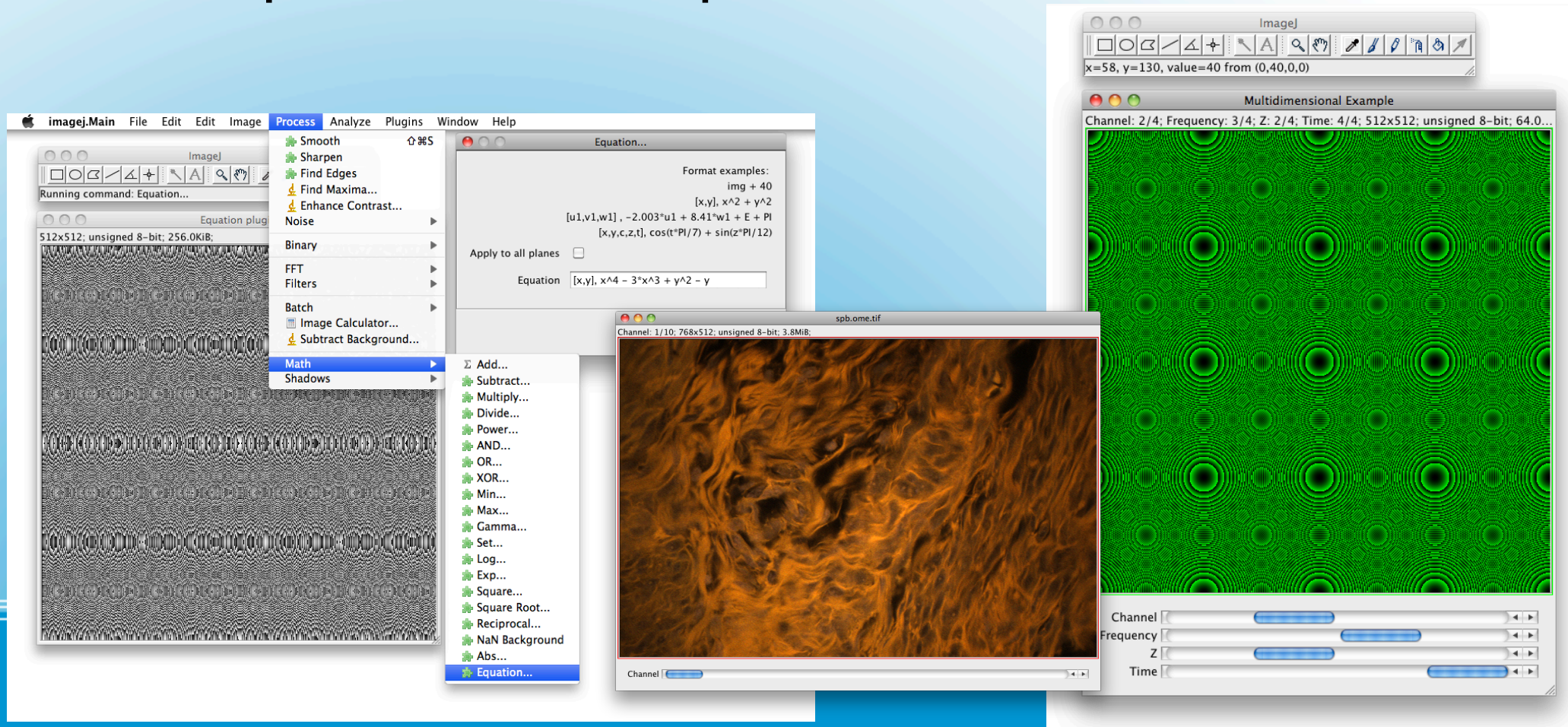
- Driven by powerful ImgLib2 processing library
- Support for many new data types





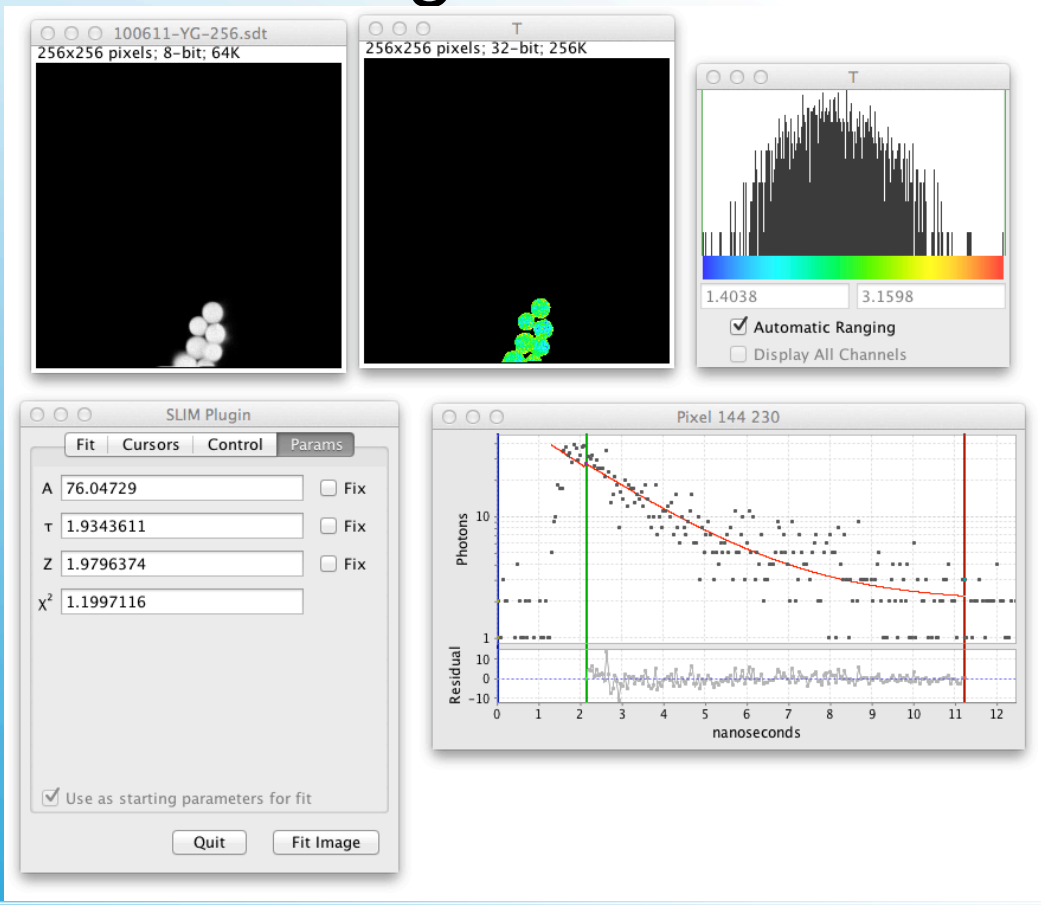
ImageJ2: Data Model

- Support for more than five dimensions
- Composite more than seven channels
- Improved math equation editor



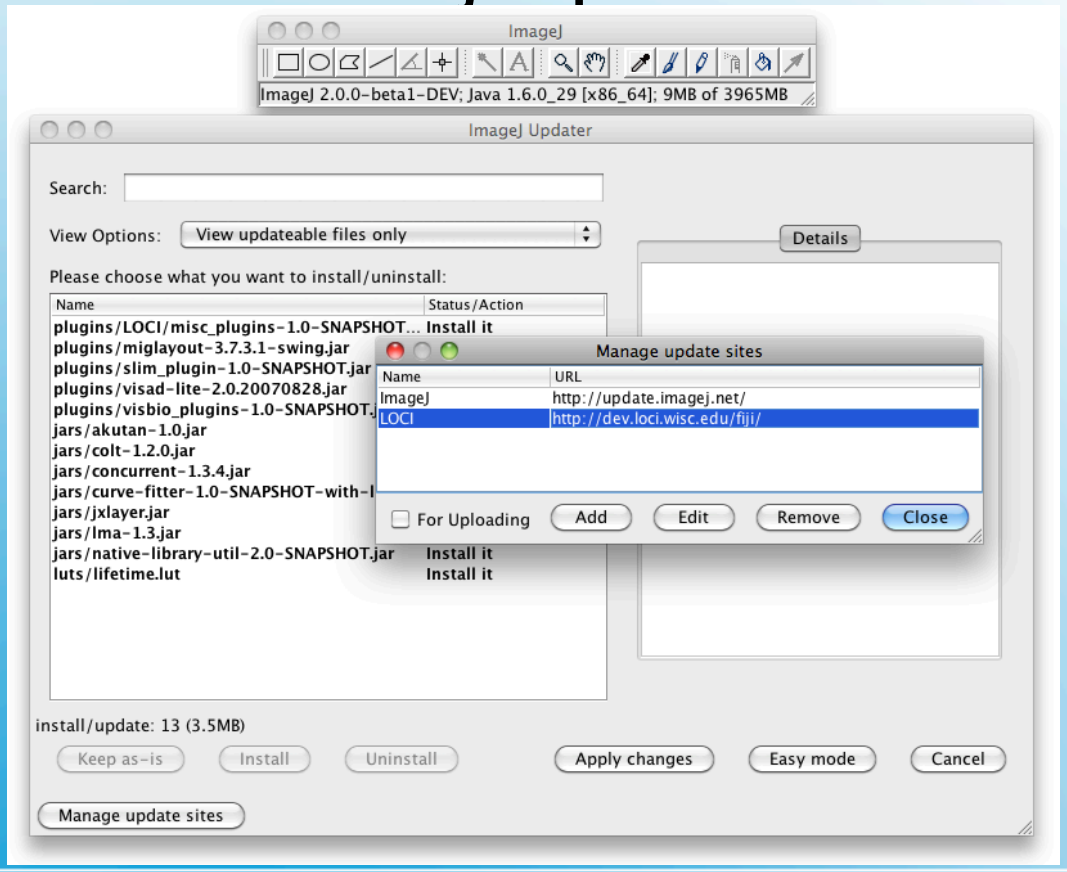
ImageJ2: N-Dimensional

- SLIM Plugin for visualizing and analyzing combined spectral lifetime image data
- Works with data in time domain
- Available from LOCI update site



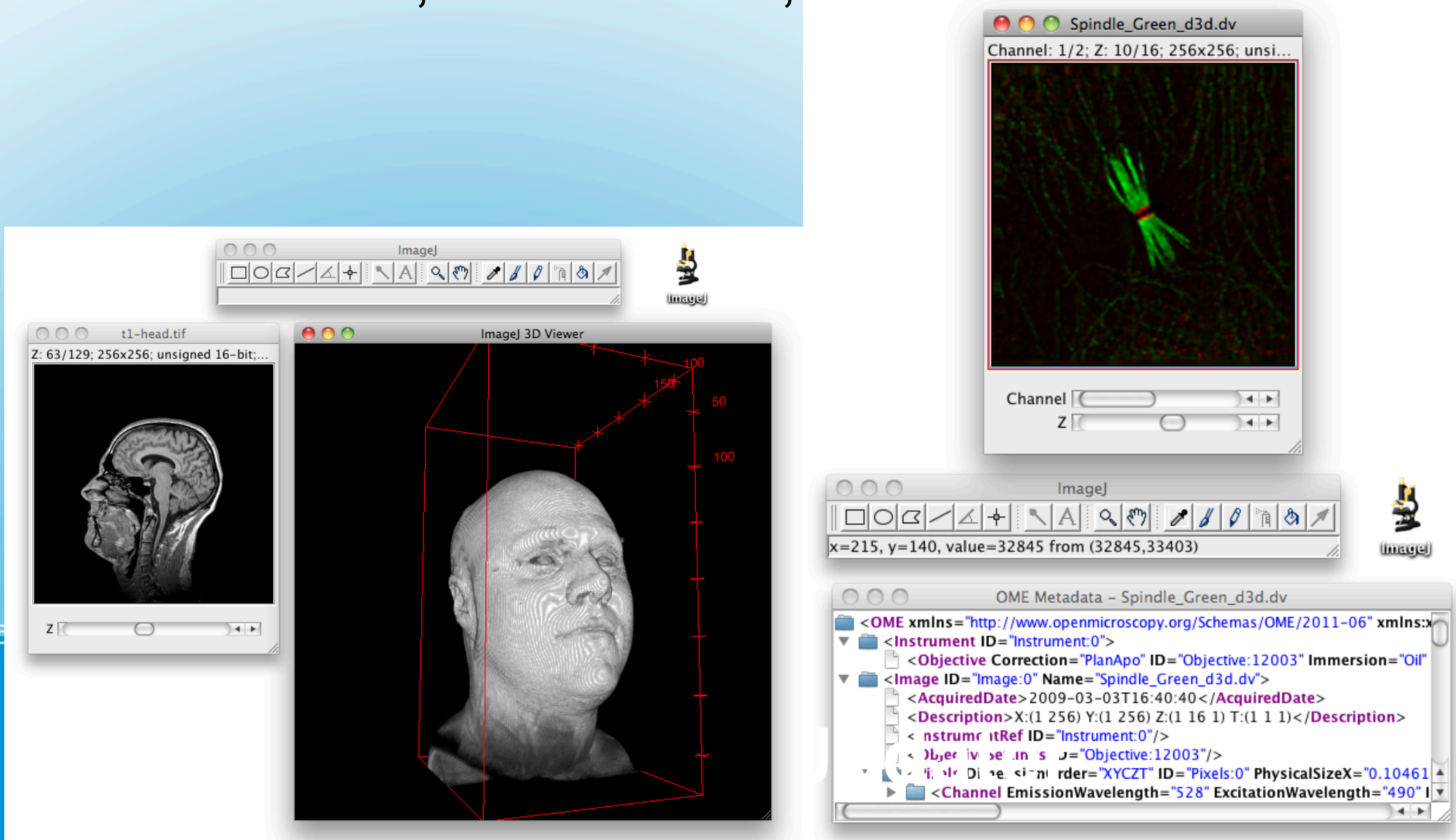
ImageJ2: Spectral Lifetime Analysis

- Central mechanism for installing new plugins
- Compatible with Fiji update sites

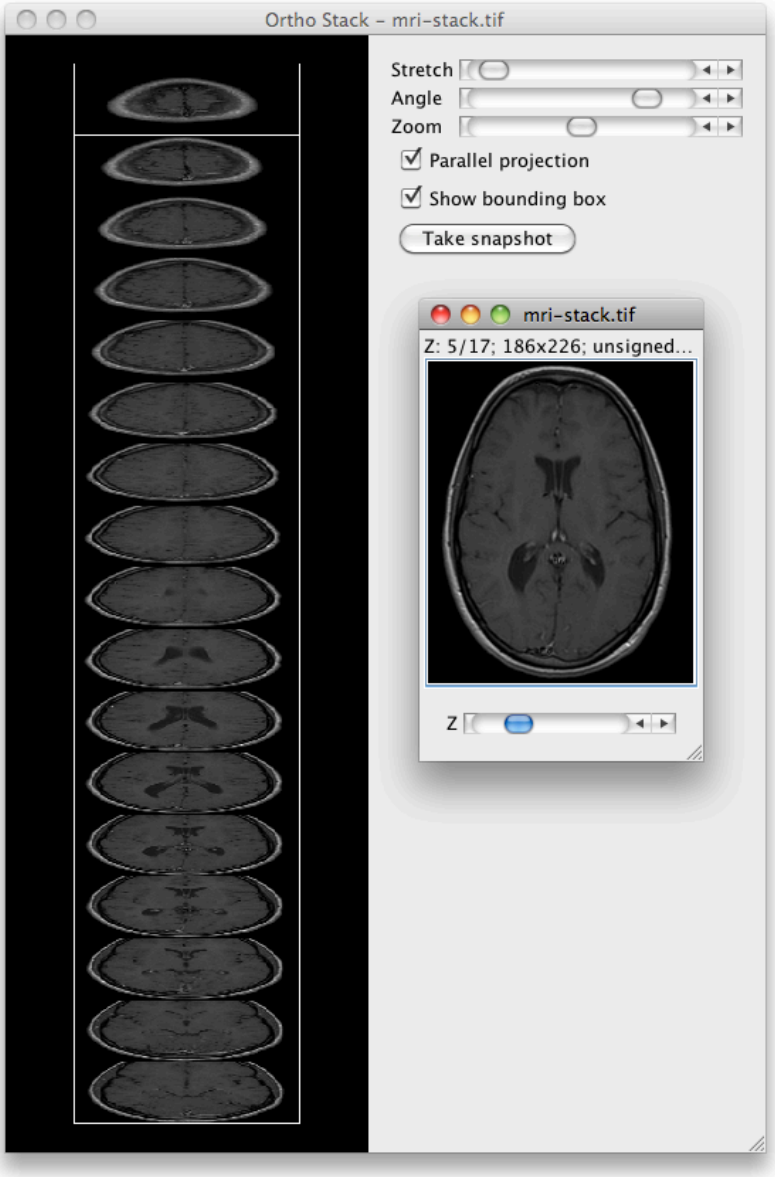


ImageJ2: Updater

- Install and use Fiji plugins
- 3D Viewer, Bio-Formats, more

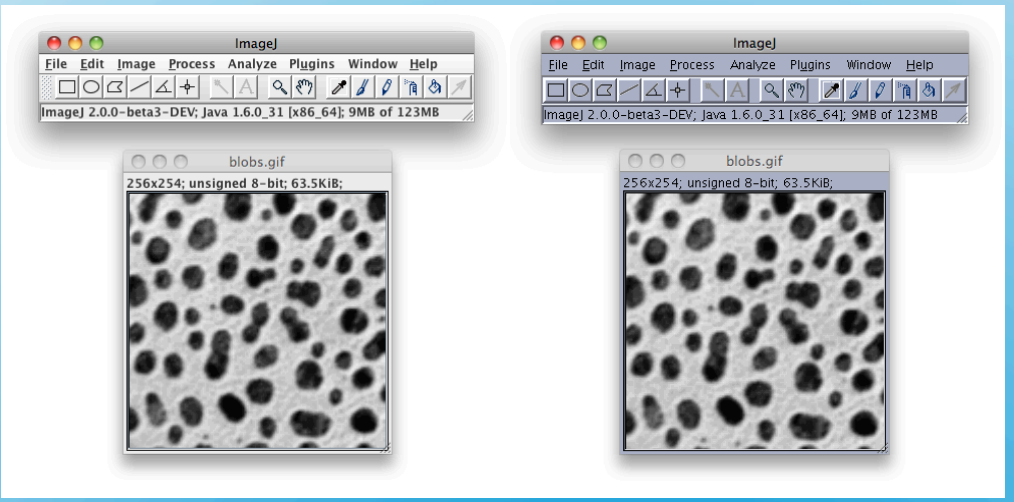


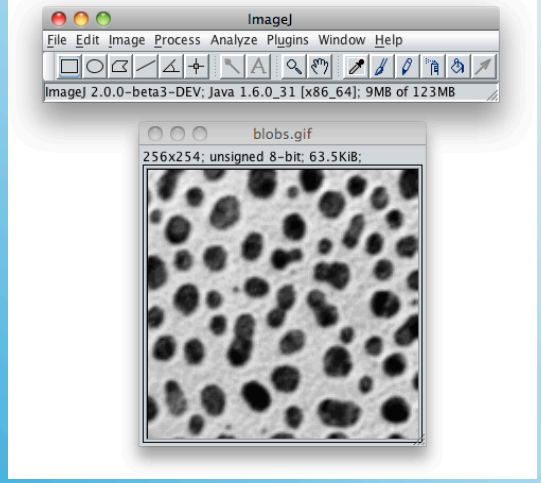
- Can work with third party update sites too
- On right, VisBio Ortho Stack plugin from LOCI update site

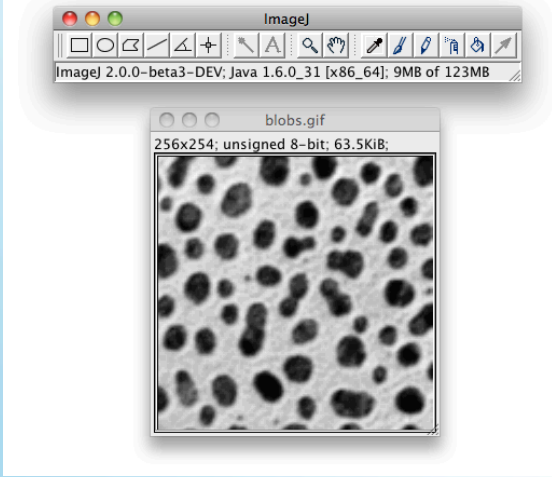


ImageJ2: Updater

- Multiple user interfaces possible
  - Swing, AWT, Apache Pivot, Eclipse SWT…
- Support for Swing Look & Feels
  - Metal, Motif, Nimbus, Aqua, Windows, GTK, etc.

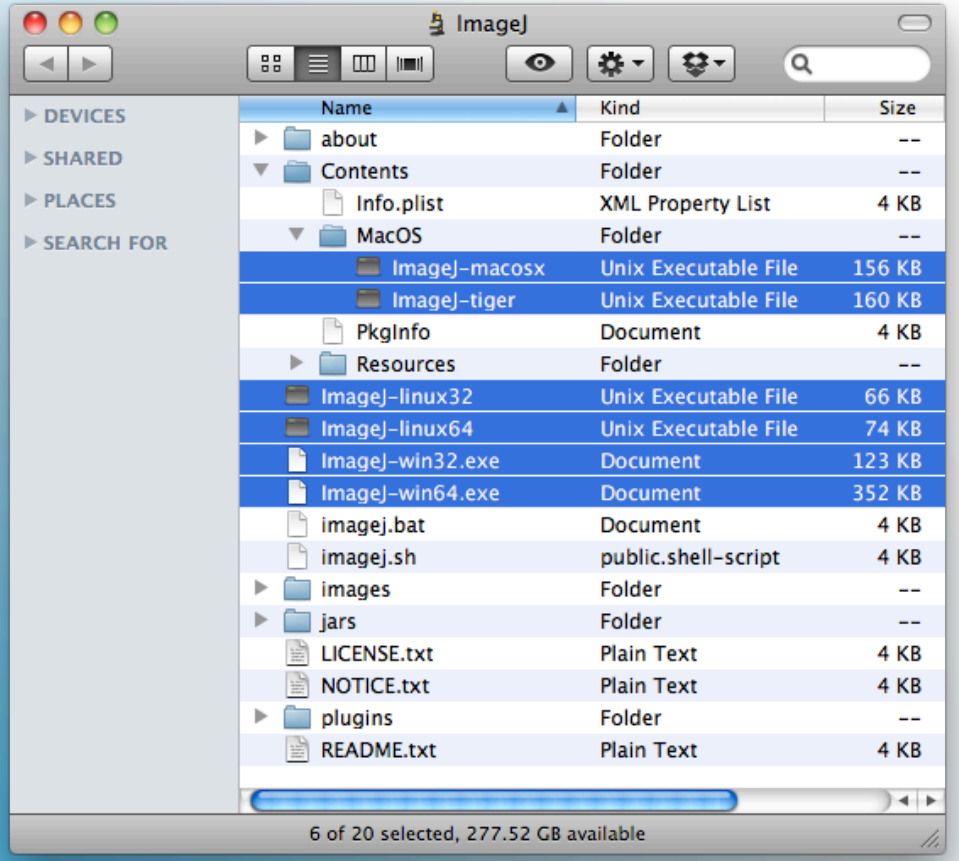






ImageJ2: Customizable UIs

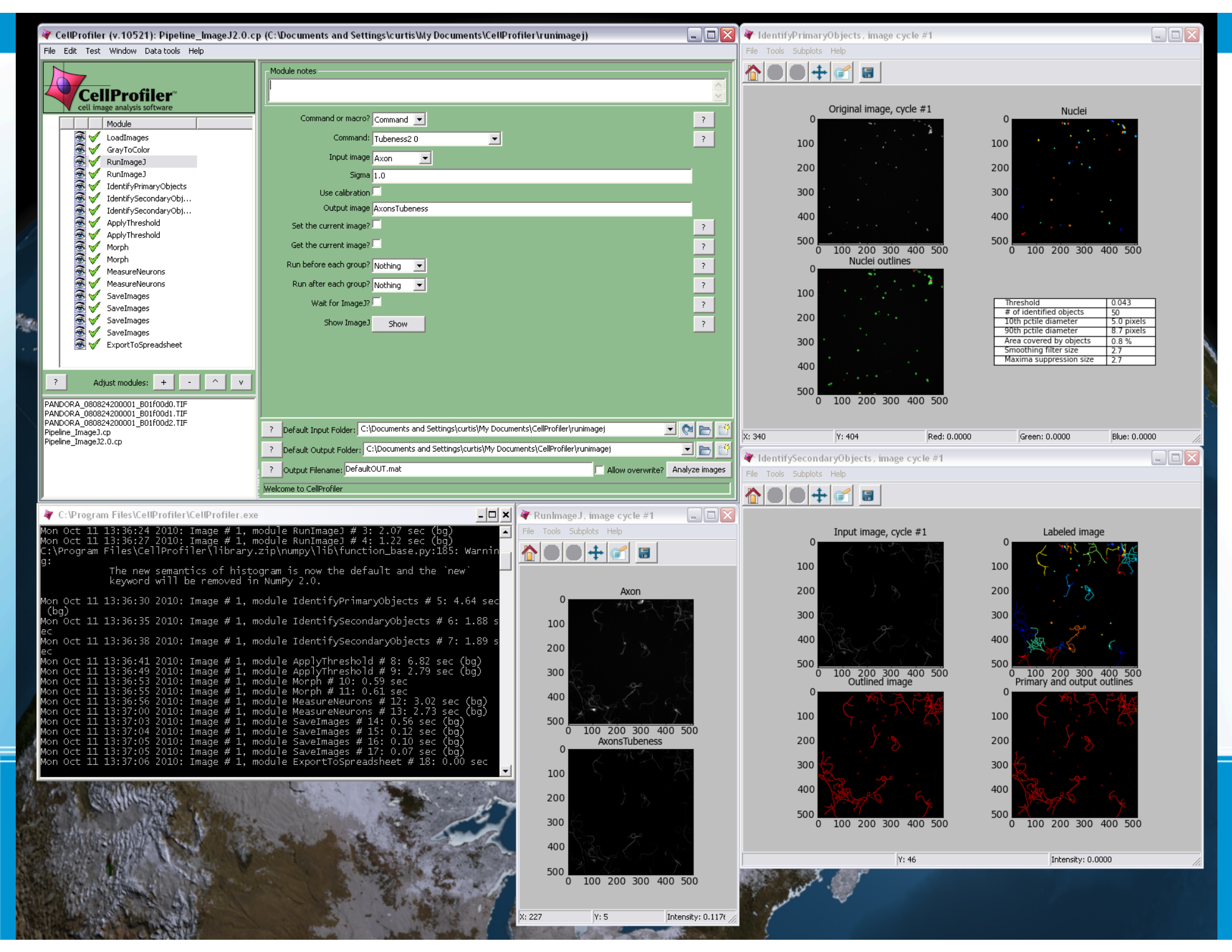
- New launcher with many more features
- Based on Fiji's launcher
- Single, multi-platform distribution of ImageJ



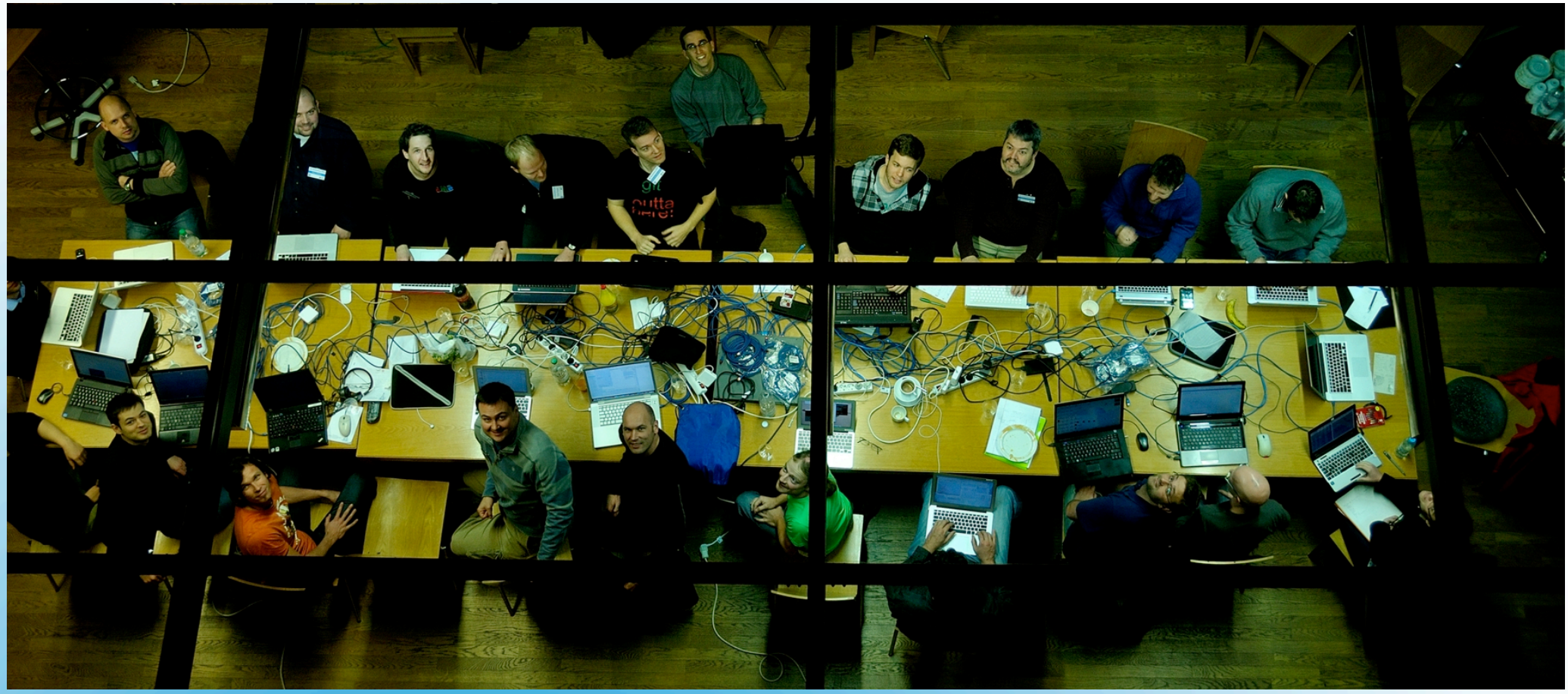
ImageJ2: Launcher

- Separate data model from user interface
- Plugin framework works completely ***headless***
- Enables integration with other tools:
  - CellProfiler (see next slide)
  - KNIME Image Processing
  - OMERO servers and clients

ImageJ2: Interoperability


CellProfiler (v.10521): Pipeline_ImageJ2.0.cp (C:\Documents and Settings\curtis\My Documents\CellProfiler\runimagej)
File Edit Test Window Data tools Help
CellProfiler
cell image analysis software
Module
LoadImages
GrayToColor
RunImageJ
RunImageJ
IdentifyPrimaryObjects
IdentifySecondaryObj...
IdentifySecondaryObj...
ApplyThreshold
ApplyThreshold
Morph
Morph
MeasureNeurons
MeasureNeurons
SaveImages
SaveImages
SaveImages
SaveImages
ExportToSpreadsheet
Adjust modules:
PANDORA_080824200001_B01f00d0.TIF
PANDORA_080824200001_B01f00d1.TIF
PANDORA_080824200001_B01f00d2.TIF
Pipeline_ImageJ.cp
Pipeline_ImageJ2.0.cp
Module notes
Command or macro? Command
Command: Tubeness2 0
Input image Axon
Sigma 1.0
Use calibration
Output image AxonsTubeness
Set the current image?
Get the current image?
Run before each group? Nothing
Run after each group? Nothing
Wait for ImageJ?
Show ImageJ Show
Default Input Folder: C:\Documents and Settings\curtis\My Documents\CellProfiler\runimagej
Default Output Folder: C:\Documents and Settings\curtis\My Documents\CellProfiler\runimagej
Output Filename: DefaultOUT.mat
Allow overwrite?
Analyze images
Welcome to CellProfiler
IdentifyPrimaryObjects, image cycle #1
File Tools Subplots Help
Original image, cycle #1
Nuclei
Nuclei outlines
Threshold 0.043
# of identified objects 50
10th pctile diameter 5.0 pixels
90th pctile diameter 8.7 pixels
Area covered by objects 0.8 %
Smoothing filter size 2.7
Maxima suppression size 2.7
X: 340 Y: 404 Red: 0.0000 Green: 0.0000 Blue: 0.0000
IdentifySecondaryObjects, image cycle #1
File Tools Subplots Help
Input image, cycle #1
Labeled image
Outlined image
Primary and output outlines
Y: 46 Intensity: 0.0000
C:\Program Files\CellProfiler\CellProfiler.exe
Mon Oct 11 13:36:24 2010: Image # 1, module RunImageJ # 3: 2.07 sec (bg)
Mon Oct 11 13:36:27 2010: Image # 1, module RunImageJ # 4: 1.22 sec (bg)
C:\Program Files\CellProfiler\library.zip\numpy\lib\function_base.py:185: Warning:
The new semantics of histogram is now the default and the `new` keyword will be removed in NumPy 2.0.
Mon Oct 11 13:36:30 2010: Image # 1, module IdentifyPrimaryObjects # 5: 4.64 sec (bg)
Mon Oct 11 13:36:35 2010: Image # 1, module IdentifySecondaryObjects # 6: 1.88 sec
Mon Oct 11 13:36:38 2010: Image # 1, module IdentifySecondaryObjects # 7: 1.89 sec
Mon Oct 11 13:36:41 2010: Image # 1, module ApplyThreshold # 8: 6.82 sec (bg)
Mon Oct 11 13:36:49 2010: Image # 1, module ApplyThreshold # 9: 2.79 sec (bg)
Mon Oct 11 13:36:53 2010: Image # 1, module Morph # 10: 0.59 sec
Mon Oct 11 13:36:55 2010: Image # 1, module Morph # 11: 0.61 sec
Mon Oct 11 13:36:56 2010: Image # 1, module MeasureNeurons # 12: 3.02 sec (bg)
Mon Oct 11 13:37:00 2010: Image # 1, module MeasureNeurons # 13: 2.73 sec (bg)
Mon Oct 11 13:37:03 2010: Image # 1, module SaveImages # 14: 0.56 sec (bg)
Mon Oct 11 13:37:04 2010: Image # 1, module SaveImages # 15: 0.12 sec (bg)
Mon Oct 11 13:37:05 2010: Image # 1, module SaveImages # 16: 0.10 sec (bg)
Mon Oct 11 13:37:05 2010: Image # 1, module SaveImages # 17: 0.07 sec (bg)
Mon Oct 11 13:37:06 2010: Image # 1, module ExportToSpreadsheet # 18: 0.00 sec
RunImageJ, image cycle #1
File Tools Subplots Help
Axon
AxonsTubeness
X: 227 Y: 5 Intensity: 0.117

- SCientific Image Format Input & Output
- SCIFIO is simply the core of Bio-Formats
- Isolates core from PFFs and OME data model
- Convert other scientific imaging data models
- Provided under Simplified BSD License
- Bundled with ImageJ2, ITK, VisAD…
- Bio-Formats becomes a “SCIFIO plugin”
- Core Project of OME
- Recently funded by NSF



ImageJ2, FIJI OME Hackathons

Acknowledgements

- Principal Investigators
  - Kevin Eliceiri (LOCI), Rudolf Oldenbourg (MBL), Anne Carpenter (Broad), Jason Swedlow (Dundee) Pavel Tomancak (Dresden), Bob Murphy (Carnegie Mellon), Badri Roysam (U. Houston).
- Developers
  - Curtis Rueden, Grant Harris, Barry DeZonia, Aivar Grislis, Mark Hiner, Johannes Schindelin (ImageJ2)
  - Lee Kamentsky, Adam Fraser (CellProfiler), Melissa Linkert (Bio-Formats)
- Collaborators
  - Wayne Rasband (ImageJ)
  - Albert Cardona (Fiji)
  - Stephan Preibisch, Stephan Saalfeld (ImgLib, Fiji)
  - Mark Longair, Jean-Yves Tinevez (Fiji)
  - OMERO development team (OME)
  - Glencoe
  - Michael Bethold and KNIME team

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NIH ImageJ2 Grant
NSF SCIFIO Grant
Wellcome Trust Open Microscopy Environment Grant

Image Informatics Postdoctoral Position @LOCI

Announcement:

Computational Postdoctoral Position at the Laboratory for Optical and Computational Instrumentation (loci.wisc.edu).

- **Position integrates quantitative imaging, image informatics in systems biology study.**
- **The project will leverage and add to many of the open source toolkits in use and development at LOCI including the Open Microscopy Environment, and FIJI ImageJ projects.**

Please email Kevin Eliceiri eliceiri@wisc.edu if interested.

LOCI
Laboratory for Optical and Computational Instrumentation

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