

Center for Bioimaging Informatics

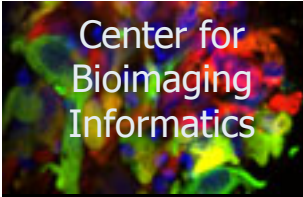
www.bioimage.ucsb.edu

Supported by NSF ITR #0331697



UCSB Bioimaging and OME

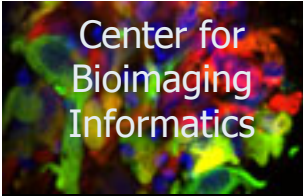
April 20 2006



- Manjunath (UCSB) & Murphy(CMU)
- 5 Years bioimaging effort
- 2 1/2 years in
- Biology + Image Processing + Catabases

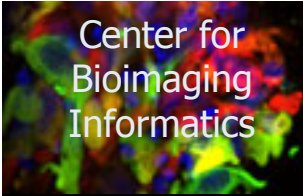


- Diverse users
 - UCSB Neurosciences institute
 - Retinal detachment : Fischer et al
 - Microtubule dynamics : Feinstein and Wilson
 - CMU Murphy Lab
 - Flybase
 - *Univ. of Utah Marc Lab* (internal development)
- Dataset challenges
 - Multiple types and collection techniques
 - Complex images (5D) and metadata
 - Acquisition and management of large sets
 - Security and Sharing of experimental data



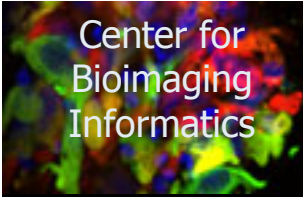
Motivation

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 - Security and Sharing of experimental data
- Analysis creates knowledge
 - Image analysis
 - Querying
 - Mining



Challenges

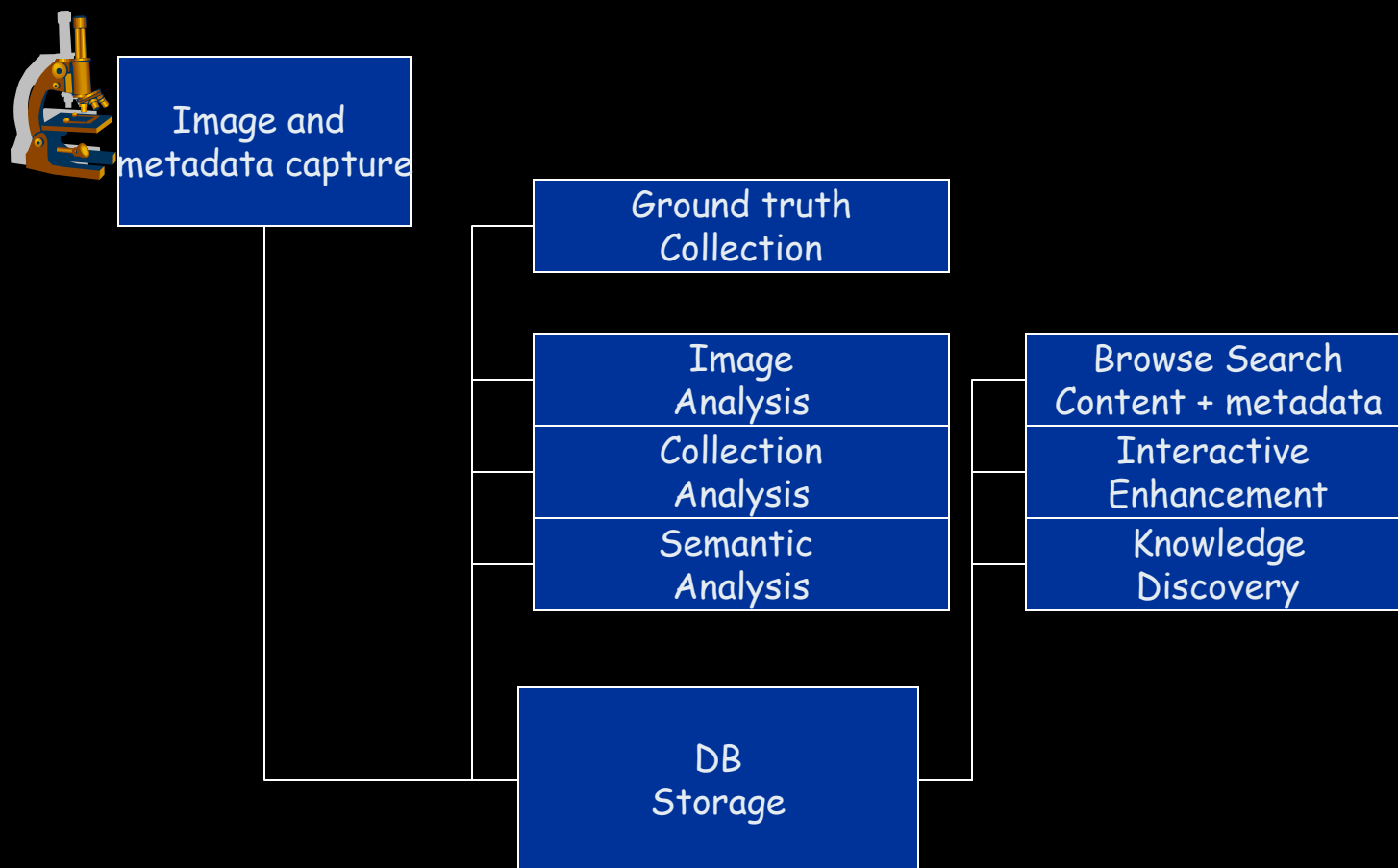
- Experimental metadata capture
- Dataset management
 - Personal collections
 - Multiple organizations
 - Privacy and security
- Analysis design
- Analysis integration

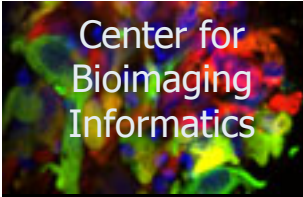


UCSB/CMU Timeline

- Kickoff Sep 2003
- Staffing Sep 2004
- 1st Prototype delivered Jan 2005
 - (mysql, php, collections)
 - 2nd prototype design begins
- Illya visits Feb 2005
- Internal Review Mar 2005
- Internal move to OME Oct 2005
- Review and BISQUE demo Mar 2006

System diagram





- Current dataset collection
- BISQUE functionality
 - Data management
 - Ground truth acquisition
 - Analysis
- Architecture

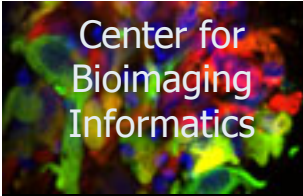


Current collections

- UCSB Retinal Objects (confocal, EM)
- UCSB Microtubule Objects(light, AFM)

Type	Current	Backlog	Rate/y	Expected 4Yrs	2D Images
Retinal EM	500	22000	500	23,000	23K
Retinal confocal P	3000	600	2400	10,000	10K
Retinal confocal Z	600	14000	12000	10,000	50K
Microtubule light	3000	2500	2500	13,000	400K
Microtubule AFM	0	500	1200	5000	30K
Flybase	0	125K	0	125K	125K

- Analysis feature sets can be several times raw data
- Total estimated size in TBs and growingn for 1 Lab
- Complexity and analysis are the main issues



Data management capabilities

- Digital notebook
 - Capture experimental/image parameters
 - Direct import process
 - Reconfigurable (confocal, 4 x microtubule, etc)
- Web
 - Web access and browsing
 - Organize images and metadata
 - Data sharing environment
 - Search by metadata or content
 - Integrated analysis

Screenshots (Digital Notebook)

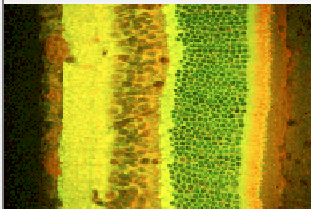
Image Name:

Path:

Refresh

Choose Directory

Name	Modified
☐ NCXSY01_equalize.TIF	2004-02-12 12:04:06
☐ NCXSY01_normalize.TIF	2004-02-12 11:25:04
☐ NCXSY02_equalize.TIF	2004-02-12 12:02:30
☐ NCXSY02_normalize.TIF	2004-02-12 11:23:36
☐ NCXSY04_equalize.TIF	2004-02-12 12:02:30
☐ NCXSY04_normalize.TIF	2004-02-12 11:23:36
☒ NCXSY05_equalize.TIF	2004-02-12 12:04:08
☐ NCXSY05_normalize.TIF	2004-02-12 11:25:06
☐ NCXSY06_equalize.TIF	2004-02-12 12:02:24
☐ NCXSY06_normalize.TIF	2004-02-12 11:23:30
☐ NCXSY07_equalize.TIF	2004-02-12 12:02:24
☐ NCXSY07_normalize.TIF	2004-02-12 11:23:30
☐ NCXSY14_equalize.TIF	2004-02-12 12:03:40
☐ NCXSY14_normalize.TIF	2004-02-12 11:24:38
☐ NCXSY50_equalize.TIF	2004-02-12 12:04:16
☐ NCXSY50_normalize.TIF	2004-02-12 11:25:12
☐ NCXSY51_equalize.TIF	2004-02-12 12:03:34
☐ NCXSY51_normalize.TIF	2004-02-12 11:24:34
☐ NCXSY53_equalize.TIF	2004-02-12 12:02:08
☐ NCXSY53_normalize.TIF	2004-02-12 11:23:14
☐ NCXSY54_equalize.TIF	2004-02-12 12:02:10



[Internal Metadata]

[Document Name]

D:\ITR\Cat\redgreen\section\normal\NCXSY05_equalize.TIF

[Software]

ImageMagick 5.4.9 09/01/02 Q16

http://www.imagemagick.org

[Date Time]

11-24-1992

[Artist]

1992 ACCUSOFT INC, ALL RIGHTS RESERVED

Save

Batch Save

Upload

Print Preview

Species ☐

cat

Animal ID ☐

018AAD

Experimental Condition ☐

3days

Imaging date ☐

2/24/06

Image Source ID ☐

Image ID ☐

File Name ☐

NCXSY05_equalize.TIF

View ☐

cross section

Location ☐

Magnification ☐

Antibody Channel 1 (red) ☐

rcd_opsin

Cell Type Antibody Channel 1 (red) ☐

rcd

Antibody Channel 2 (green) ☐

Glial Fibrillary Acid Protein

Cell Type Antibody Channel 2 (green) ☐

muller

Antibody Channel 3 (blue) ☐

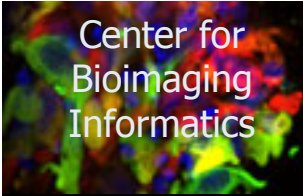
Cell Type Antibody Channel 3 (blue) ☐

notes ☐

Check All

Clear All

Clear Form



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Screenshots (browsing)

UCSB Center for BioImage Informatics - Mozilla Firefox

http://bioimage.ucsb.edu/

University of California, Santa Barbara

Center for BioImage Informatics

Select: [Create](#) | [Search](#) | [Options](#) | [Help](#) | [Mode: Dual](#)

Search: [Project](#) | [Dataset](#) | [Image](#) | [Retina Image](#) | [Microtubule Image](#)

Dataset Search Close

owner	group	name
All	All	description
kris.kivilekval	OME	
swaroop	6193_searchat	
august	6193_downloa	

Search: in left | right pane results as XML

Dataset: Retina multichannel (294 images)

Group: OME
Owner: kris.kivilekval

Description: These images were imported using the OME command-line tool on Mon Mar 6 19:43:02 2006. This description was auto-generated. Use the -D command-line parameter to specify your own descriptions during image import.

Transferring data from bioimage.ucsb.edu...

Screenshots (search)

UCSB Center for BioImage Informatics - Mozilla Firefox

http://bioimage.ucsb.edu/beqas/#

University of California, Santa Barbara

You are now logged in as kris.kvilekval.

Center for BioImage Informatics

Select: [Create](#) | [Search](#) | [Options](#) | [Help](#) | [Modes: single](#)

Search: [Project](#) | [Dataset](#) | [Image](#) | [Retina Image](#) | [Microtubule Image](#)

Searching: RedCy2:rod_opsin

441 Result(s), Page 1 of 37

Image: D5-29
Retinal Condition: 3days+28days(r)
View: section
Red Cell: microglia
Green Cell: rod
Blue Cell: muller
Red: rod_opsin
Green: isolectinB4
Blue: GFAP
Species:
Animal Id: Q8D5
Location: REST
Magnification: 0.206239
Tissue:
CD Number: 113
Notes: 206 DSP29.TIF 3days+28days(r) section rod_opsin isolectinB4 GFAP 0.2062388 3 microglia rod muller 1-21-03 113 Q8D5 REST RetinalImage

Image: 28D-41
Retinal Condition: 28days
View: section
Red Cell: microglia
Green Cell: rod
Blue Cell: muller
Red: rod_opsin
Green: isolectinB4
Blue: GFAP
Species:
Animal Id: 765
Location: REIT
Magnification: 0.309358
Tissue:
CD Number: 116
Notes: 64 28DP41.TIF 28days section rod_opsin isolectinB4 GFAP 0.309358 3 microglia rod muller 3-11-03

Searching: GreenCy2:vimentin

64 Result(s), Page 1 of 6

Image: 41VR-5
Retinal Condition: 7days(1+6days_O2)
View: section
Red Cell: muller
Green Cell: redgreen
Blue Cell:
Red: red_green_cone_opsin
Green: vimentin
Blue:
Species:
Animal Id: 141
Location: REST
Magnification: 0.220148
Tissue:
CD Number: 77
Notes: 496 41VRP5.TIF 7days(1+6days_O2) section red_green_cone_opsin vimentin none 0.2201479 2 muller redgreen 9-27-01 77 141 REST RetinalImage

Image: 41VR-3
Retinal Condition: 7days(1+6days_O2)
View: section
Red Cell: muller
Green Cell: redgreen
Blue Cell:
Red: red_green_cone_opsin
Green: vimentin
Blue:
Species:
Animal Id: 141
Location: REST
Magnification: 0.236659
Tissue:
CD Number: 77
Notes: 522 41VRP3.TIF 7days(1+6days_O2) section red_green_cone_opsin vimentin none 0.236660 2 muller

Transferring data from bioimage.ucsb.edu...

Screenshots (search)

UCSB Center for Bioimaging Informatics - Mozilla Firefox

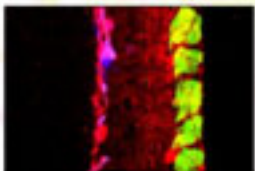
File Edit View Go Bookmarks Tools Help

http://bioimaging.ucsb.edu/bsq/

ITR Bioimage Retina OME ITR Database

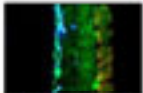
(Included in dataset[s]: Mon Mar 6 19:36:04 2006 Import Dataset , Retina multichannel)

581 Result(s), Page 1 of 49
 << 1 2 3 4 5 6 7 8 9 10 >>

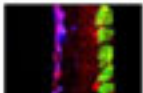


ID: 1
 Group: OME
 Owner: kris kvilekval
 Size X,Y,Z,T,C: (768, 512, 1, 1, 3)
 Original Files: NCCNP1_normalize.TIF
 [image] [download]
 NCCNP1_equalize.TIF
 [image] [download]
 NCCNP1.TIF
 [image] [download]

Other Pixels



Tag: zseries
 X,Y,Z,T,C: (768, 512, 7, 1, 3)



Tag: normalize
 X,Y,Z,T,C: (770, 513, 1, 1, 3)



Tag: equalize
 X,Y,Z,T,C: (770, 513, 1, 1, 3)

Retinal Image Meta Data

Retinal Condition: normal
 View: section
 Red Cell: horizontal
 Green Cell: ganglion
 Blue Cell: amacrine
 Red: calretinin
 Green: neurofilament
 Blue: calbindin
 Species:
 Animal Id: 097b
 Location: LEST
 Magnification: 0.228656
 Tissue:
 CD Number: 133
 Notes: 852 NCCNP1.TIF normal section
 calretinin neurofilament calbindin 0.2286561
 3 horizontal ganglion amacrine 7-21-03 133
 097b LEST RetinalImage



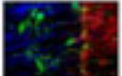


Image: D5-29
 Retinal Condition: 3days+28days(r)
 View: section
 Red Cell: microglia
 Green Cell: rod
 Blue Cell: muller
 Red: rod_opsin
 Green: isolectinB4
 Blue: Glial Fibrillary Acid Protein
 Species:
 Animal Id: Q8D5
 Location: REST
 Magnification: 0.206239
 Tissue:
 CD Number: 113
 Notes: 206 D5P29.TIF 3days+28days(r) section rod_opsin
 isolectinB4 GFAP 0.2062388 3 microglia rod muller 1-21-03
 113 Q8D5 REST RetinalImage

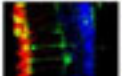


Image: 28D-41
 Retinal Condition: 28days
 View: section
 Red Cell: microglia
 Green Cell: rod
 Blue Cell: muller
 Red: rod_opsin
 Green: isolectinB4
 Blue: Glial Fibrillary Acid Protein
 Species:
 Animal Id: 765
 Location: REIT
 Magnification: 0.309358
 Tissue:
 CD Number: 116
 Notes: 64 28DP41.TIF 28days section rod_opsin
 isolectinB4 GFAP 0.3093582 3 microglia rod muller 2-11-03
 116 765 REIT RetinalImage

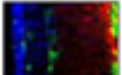


Image: 7DMI-2
 Retinal Condition: 7days
 View: section
 Red Cell: microglia
 Green Cell: rod
 Blue Cell: muller
 Red: rod_opsin

Transferring data from bioimaging.ucsb.edu...

Screenshots (search similar)

UCSB Center for Bioimaging Informatics - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://bioimaging.ucsb.edu/bioimaging/index.html

CTR Storage Retina CME CTR Database

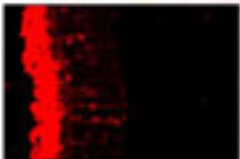
RetinalImage Search Close

Retinal Condition	Red Cell	Red Cy3	Species	Location	Magnification
Any	Any	rod_opsin	Any		
View	Green Cell	Green Cy2	Image Num	Notes	Tissue
Any	Any	Any			
	Blue Cell	Blue Cy5	Animal Id	CD Number	
	Any	Any			

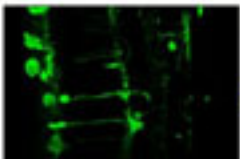
Search: in left | right pane results as XML

Image: 28D-41

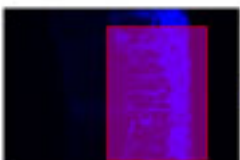




find similar



find similar



find similar

ID: 3
Group: CME
Owner: kris kirkwood

Transferring data from bioimaging.ucsb.edu...

Screenshots (search similar)

UCSB Center for Bioimaging Informatics - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://bioim.eos.ucsb.edu/faq/index.html

ITR Biomage Retina OME ITR Database

OME

UCSB Center for Bioimaging Informatics

Welcome

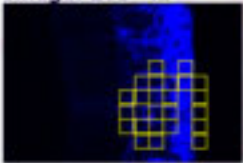
Any Any Any

Blue Cell Blue Cy5 Animal Id CD Number

Any Any

Search: in left | right pane results as XML

Image: 28D-41

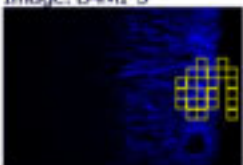


ID: 3
Group: OME
Owner: kris kivelov
Retinal Condition: 28days
View: section
Red Cell: microglia
Green Cell: rod
Blue Cell: muller
Red: rod_opsin
Green: isolectinB4
Blue: GFAP

Number of results searched: 3

[Render Rectangles](#)

Image: D-4M1-3



ID: 161
Group: OME
Owner: kris kivelov

http://bioim.eos.ucsb.edu/faq/index.html

Windows taskbar: 11:27 AM, C:\Documents and Settings\..., C:\Documents and Settings\..., Microsoft PowerPoint..., UCSB Center for Bioimaging Informatics, Bioanalyzer v. 6.1.1, 11:59 AM

Screenshots (personal collection)

UCSB Center for BioImage Informatics - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://bioimage.ucsb.edu/que/

CTR BioImage Retina CME ITR Database

University of California, Santa Barbara You are now logged in as: kris.kvilekval

Center for BioImage Informatics

Select: [Create](#) | [Search](#) | [Options](#) | [Help](#) Mode: [single](#)

Search: [Project](#) | [Dataset](#) | [Image](#) | [Retina Image](#) | [Microtubule Image](#)

Edit Image, ID=2



You are not the owner of this image, editing will be prohibited

Name:

Description:

Permissions: ☐ Private
Search enabled for: ☐ All ☐ Group
Download enabled for: ☐ All ☐ Group

[Submit](#) | [Cancel](#)

Searching: GreenCy2-vimentin

64 Result(s), Page 1 of 6
<< 1 2 3 4 5 >>

Image: 41VR-5
Retinal Condition: 7days(1+6days_O2)
View: section
Red Cell: muller
Green Cell: redgreen
Blue Cell:
Red: red_green_cone_opsin
Green: vimentin
Blue:
Species:
Animal Id: 141
Location: REST
Magnification: 0.220148
Tissue:
CD Number: 77
Notes: 496 41VRP5.TIF 7days(1+6days_O2) section
red_green_cone_opsin vimentin none 0.2201479 2 muller
redgreen 9-27-01 77 141 REST RetinalImage

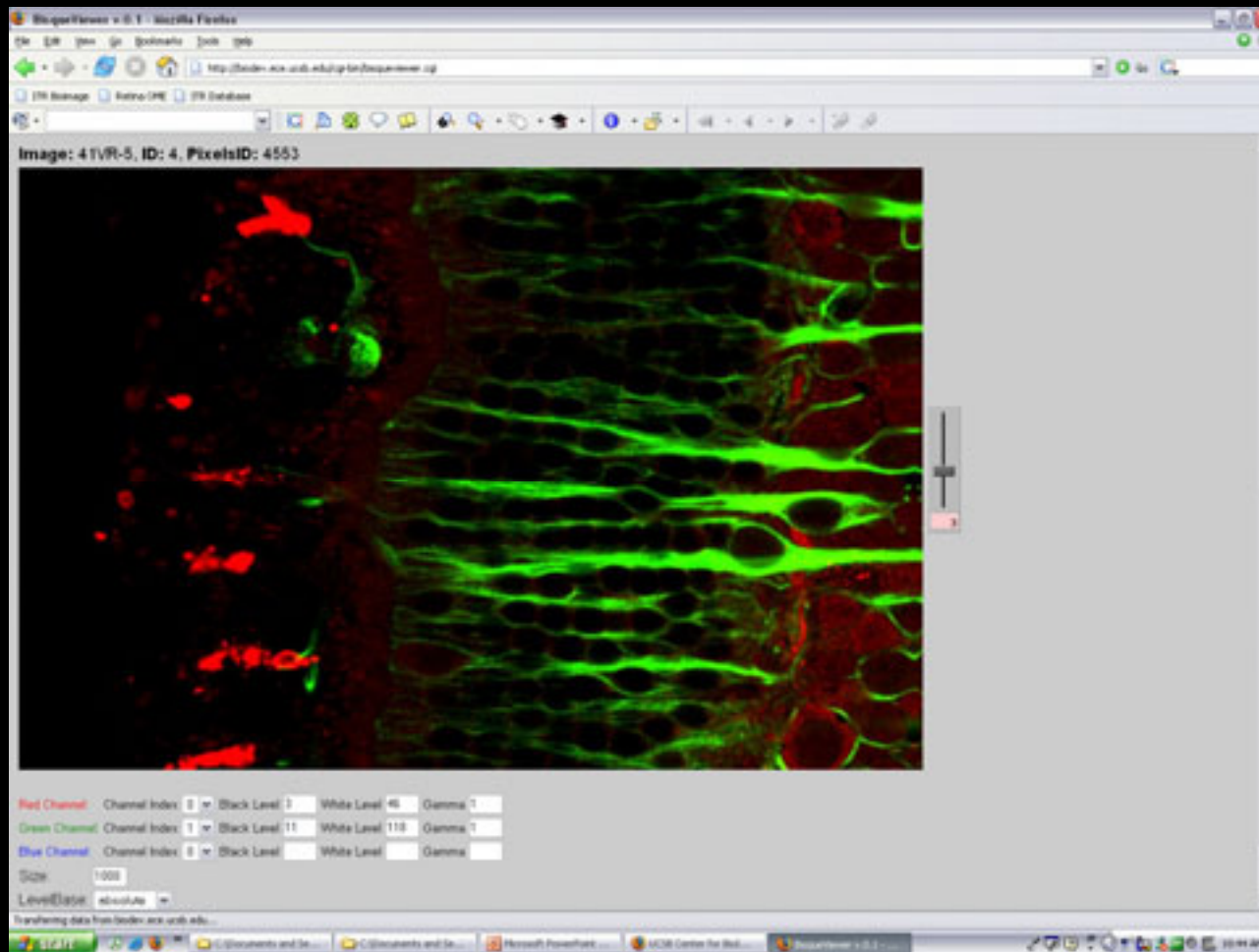
Image: 41VR-3
Retinal Condition: 7days(1+6days_O2)
View: section
Red Cell: muller
Green Cell: redgreen
Blue Cell:
Red: red_green_cone_opsin
Green: vimentin
Blue:
Species:
Animal Id: 141
Location: REST
Magnification: 0.236659
Tissue:
CD Number: 77
Notes: 522 41VRP3.TIF 7days(1+6days_O2) section
red_green_cone_opsin vimentin none 0.236659 2 muller
redgreen 9-27-01 77 141 REST RetinalImage

Transferring data from bioimage.ucsb.edu...

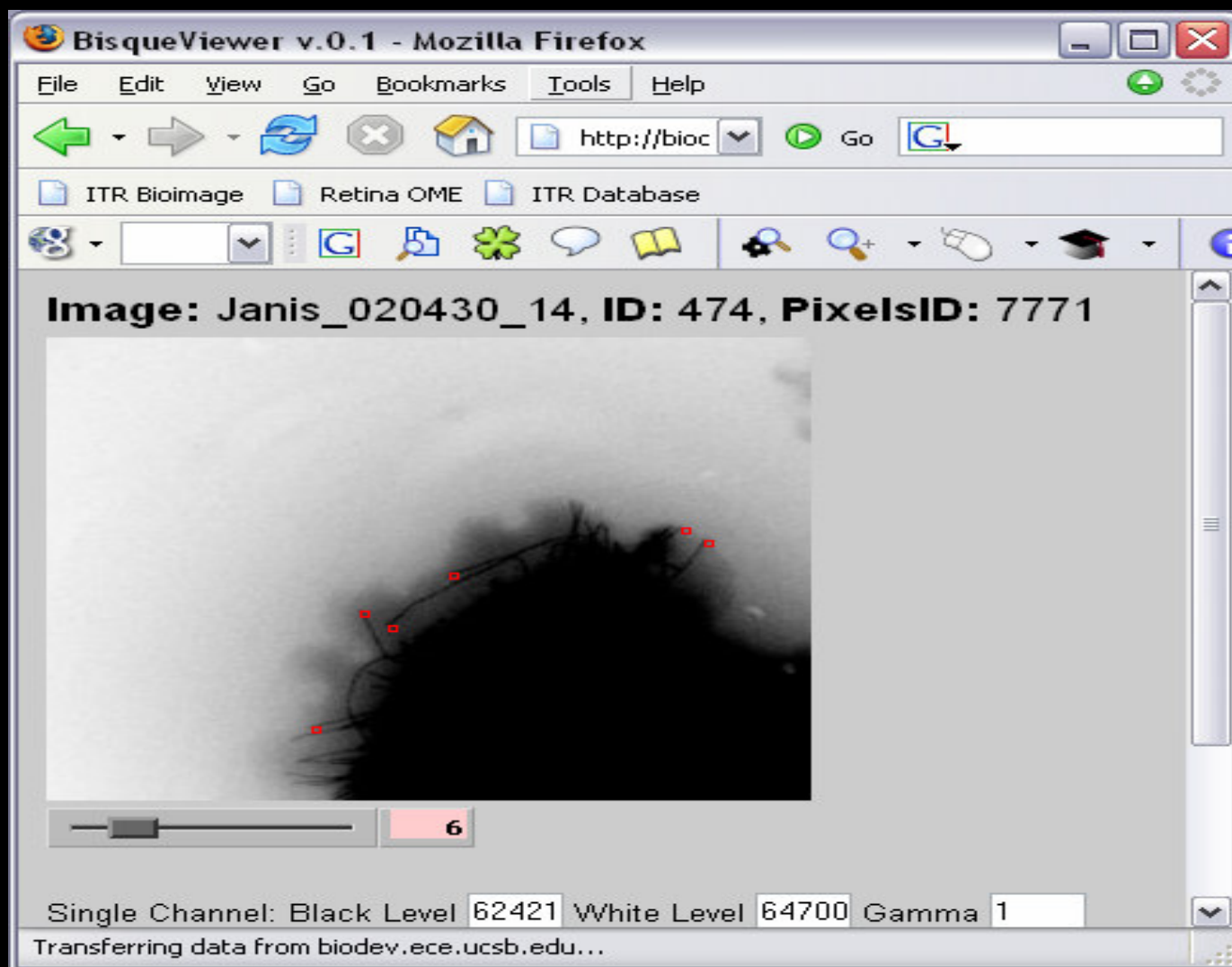
START C:\Documents and Se... C:\Documents and Se... Microsoft PowerPoint UCSB Center for Bio...

18:42 AM

Screenshots (5D Viewer)



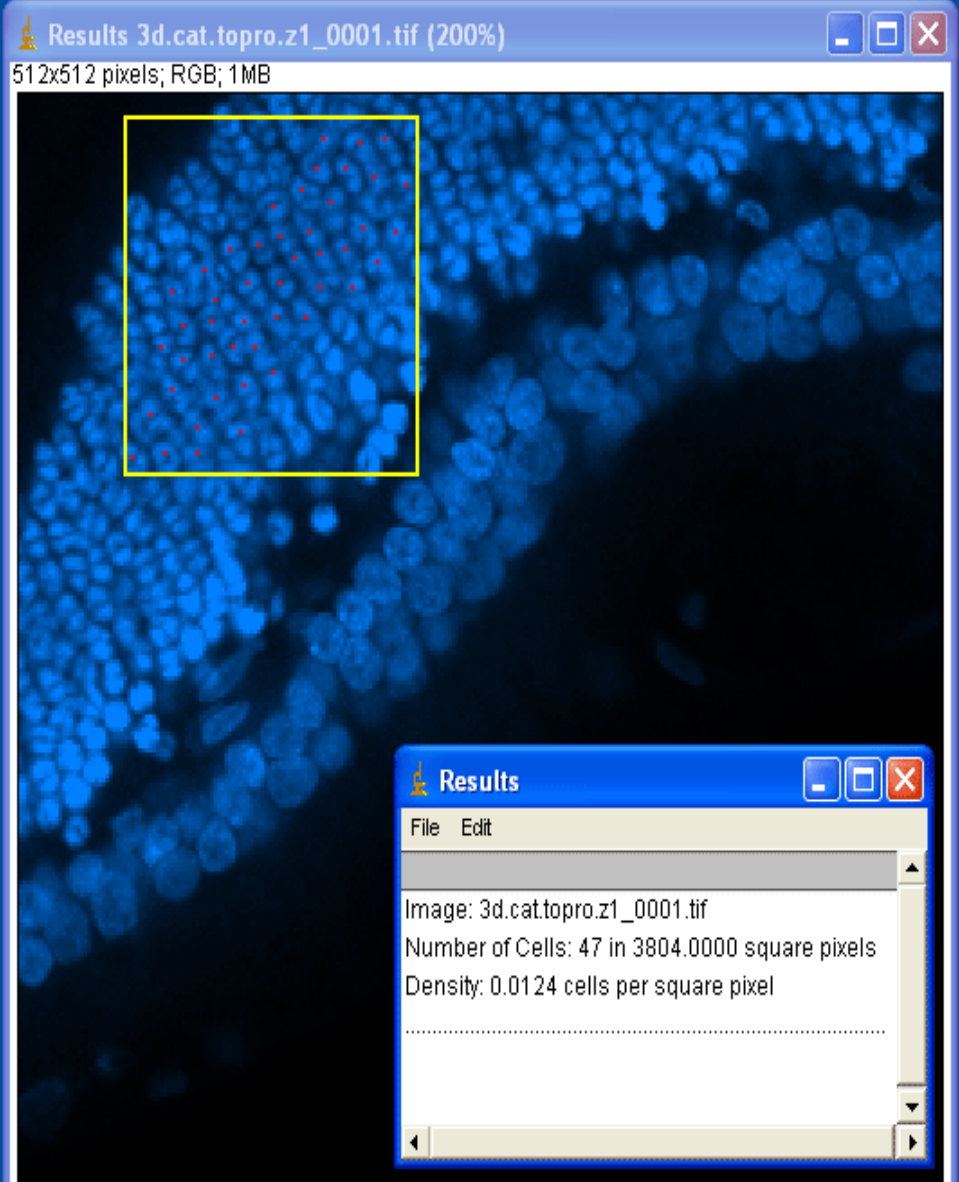
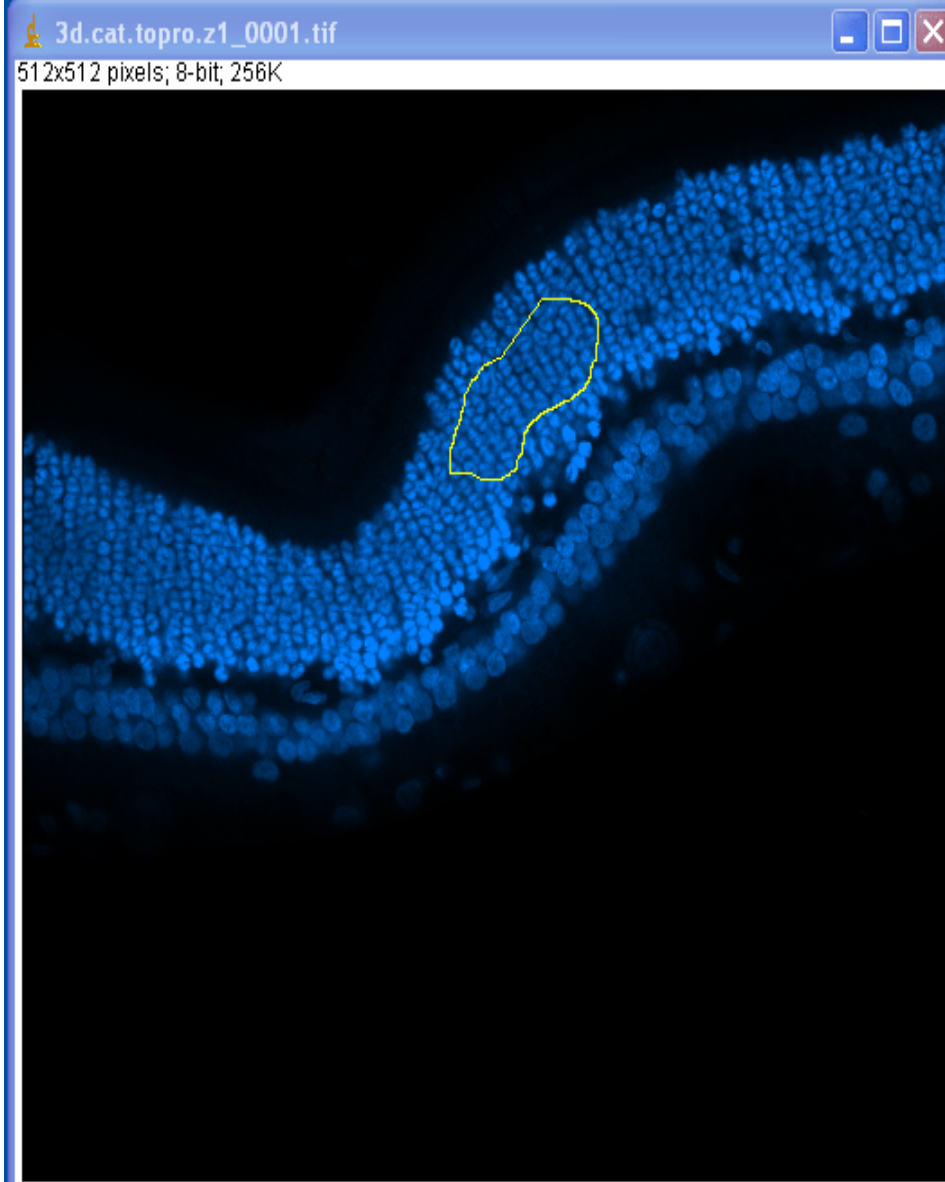
Screenshot (5D with tracks)



- Integrated image analysis
 - Advanced image processing
 - Cell counter (ImageJ)
 - Quantify microtubule dynamics
 - Track identification
- Integration in progress
 - *Segmentation and classification*
 - *Microtubule tracker*
 - *Modeling microtubule dynamics*
 - *Modeling uncertain data*
 - *Relevance feedback improving search*

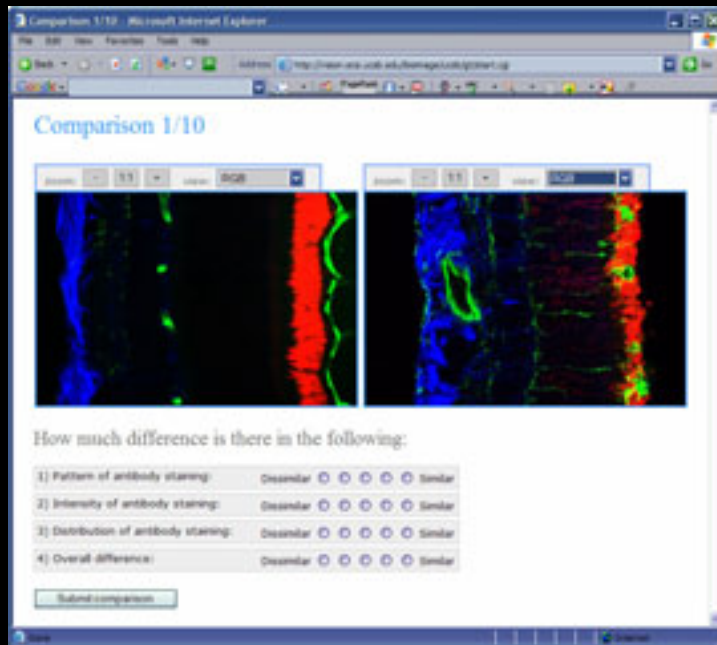


Screenshots (Image Analysis)

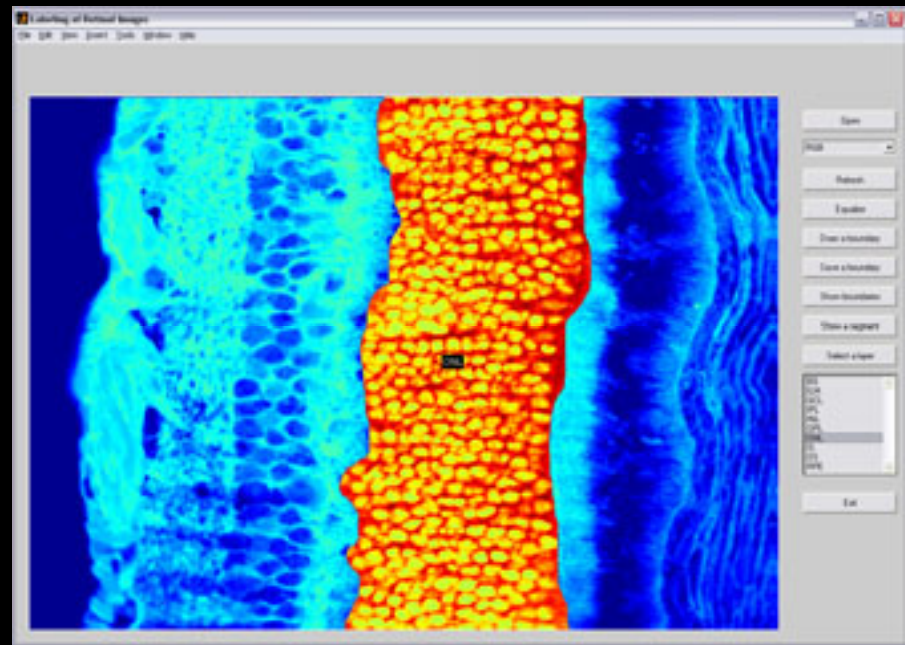


Ground truth acquisition tools

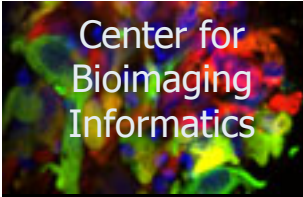
Image processing and infrastructure teams are developing universal “ground truth” collection tools able to retrieve data from data-base and feed user defined information back to the database. The main communication vehicle is XML interchange format.



+

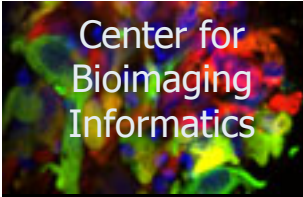


At the current stage stand alone tools are being developed and tested that later on will be grouped in the universal application able to communicate directly to the data-base.



System description overview

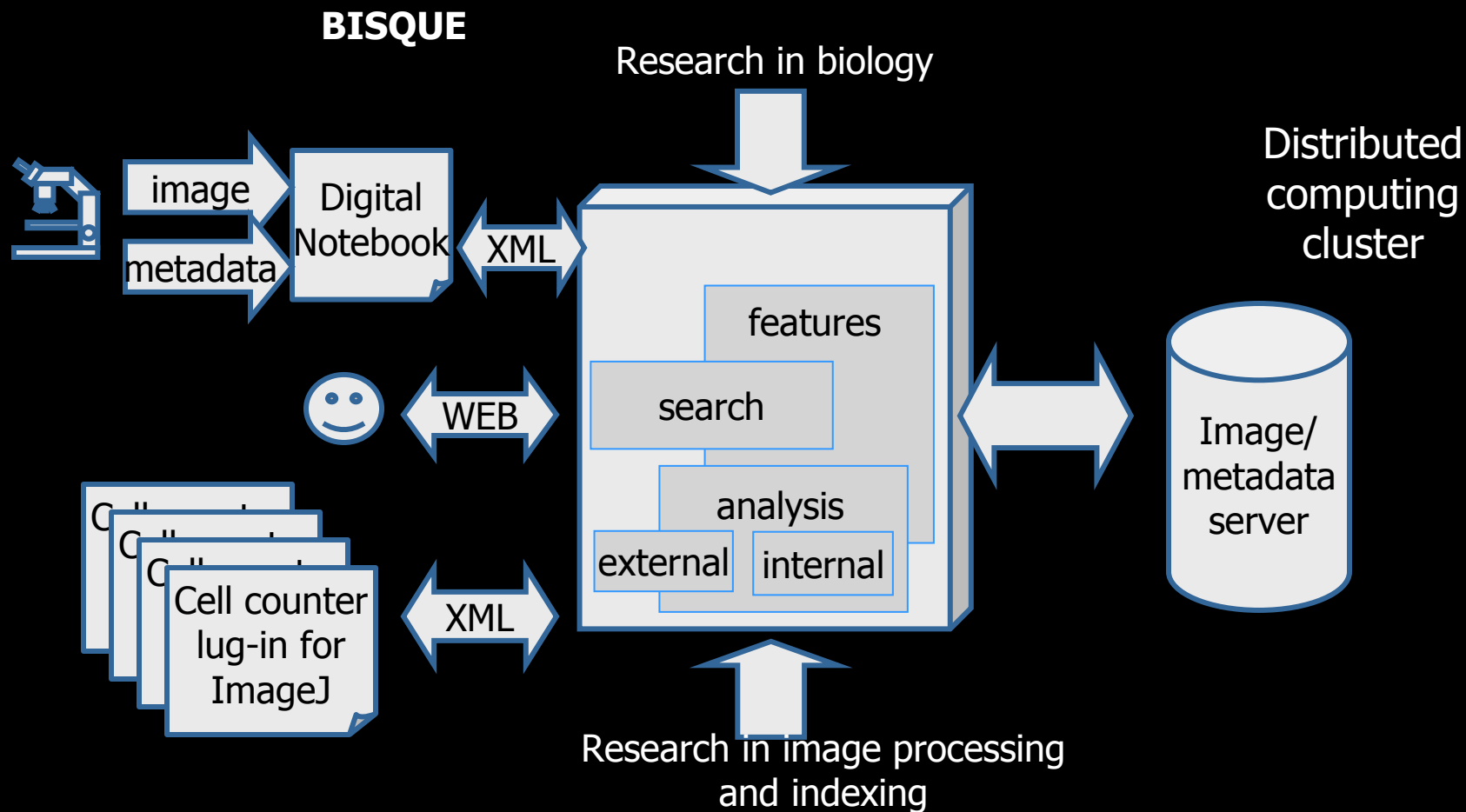
- Current dataset collection
- Current functionality
 - Data management
 - Ground truth acquisition
 - Analysis
- **Architecture**



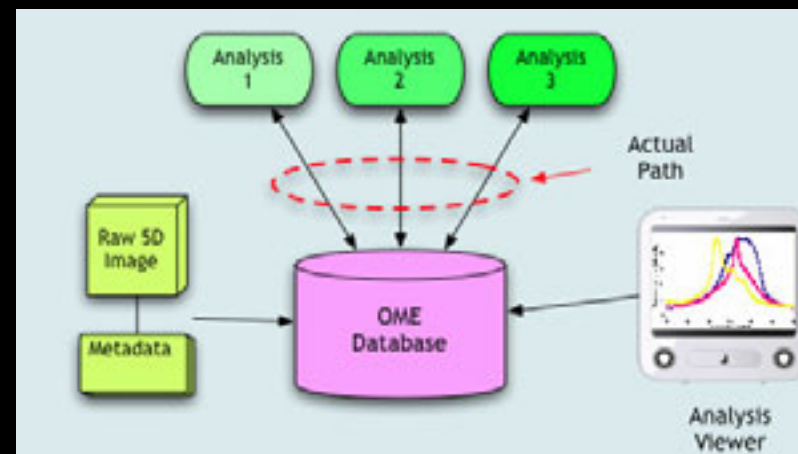
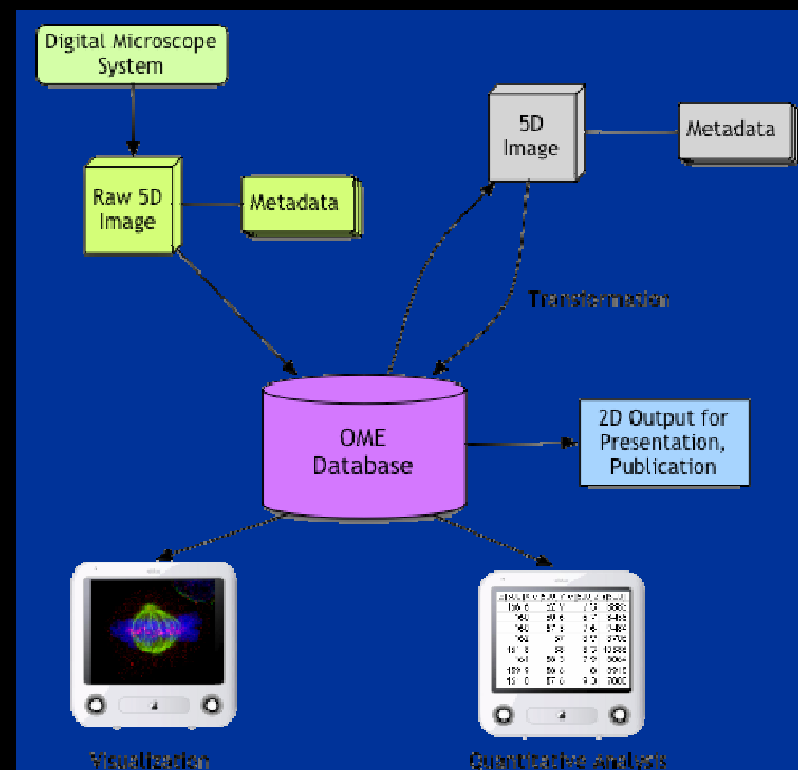
- Hardware
 - 16 node Cluster
 - dual Intel Xeon 3GHZ
 - Gigabit network switch
 - 2 TB Storage
- Software
 - Linux
 - OME (Apache, Postgresql)
 - Bisque

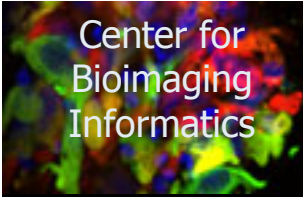
Bisque Architecture

Bio-Image Semantic Query User Environment



- Open Microscopy Environment
 - “OME is an open source software project to develop a database-driven system for the quantitative analysis of biological images. OME is a collaborative effort among academic labs and a number of commercial entities”.
- Provides base for image/metadata storage and analysis integration
- [Boston: Sorger Lab](#)
- [Baltimore: Goldberg Lab](#)
- [Dundee: Swedlow Lab](#)
- [Madison: LOCI](#)

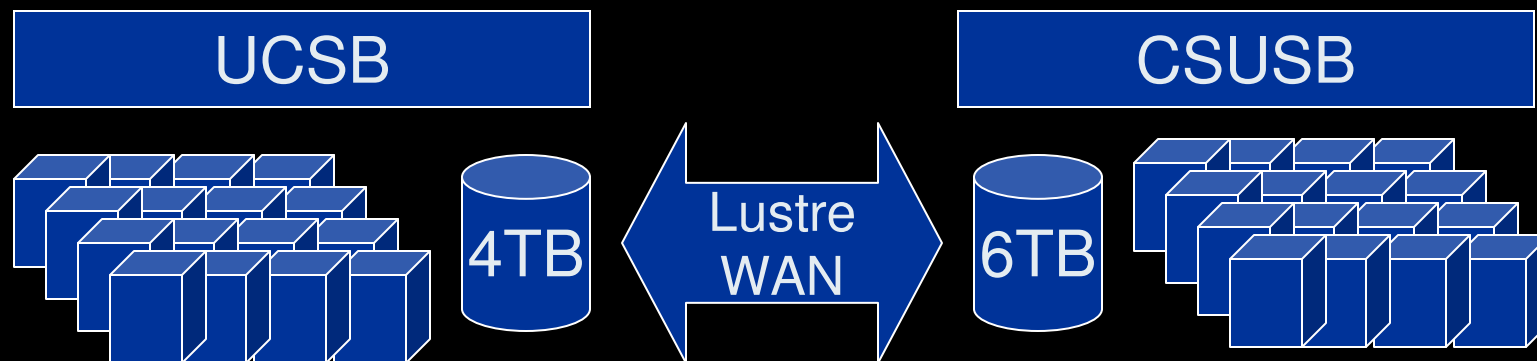




Bisque extensions

- Ongoing extensions with OME
 - Content based search
 - Analysis integration with OME
 - Segmentation
 - Cell Counting
 - Etc.
 - Front end dataset and analysis support
 - Schema additions for image types and analysis
 - Uncertainty modeling and queries

- Scalable Distributed System for collaboration
- Cluster for analysis
- Distributed storage
 - Lustre filesystem
 - Shared Postgres metadata
 - Local image servers
- Bisque/OME over file system





Conclusion

- Built 1st generation w/ >4000 images
 - Integrated several *useful* analyses
 - Being used internally
 - External Interest
- Immediate future
 - Continued development
 - analysis integration
 - Dataset integration
 - Local user feedback
 - Expand user base
 - Remote deployments
 - Integration with other projects
 - Flybase : Integration of schema/datasets in progress
 - BIRN :Mediation framework: when available

- Please visit:
 - <http://bioimage.ucsb.edu/bisque>
 - User: guest/bioimage
- Team:
 - H. Alagud, A. Black, D. Fedorov, S. Jagadish, S. Jagannath, R. Kumar, T. Kuo, W. Smith