Core Facilities Annual Report FY2016

Dr. Charles Delwiche and Amy Beaven (assisted by Maureen Johnson)

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Executive Summary

The Imaging Core's (IC) two confocal laser scanning microscopes, the Leica SP5X and the Zeiss LSM710, saw a combined average use of 50.3 hours per week in FY16, which is a 17.2% increase over FY15. Between FY09 and FY14, the Zeiss consistently saw more use than the Leica, but in FY15, the Leica was used more than the Zeiss (1206.25 hours vs. 963.5 hours, respectively). That trend continued in FY16; 1602 hours vs. 1021 hours, respectively. The increased use is due in part to the installation of the Leica's new HyD detector and time-gating technology in FY14.

In FY15, consumable and service contract expenses for all facility microscopes exceeded the total income collected via charge-backs by $10,802.20. However, in FY16, the facility's income exceeded expenses by $3,484.12. This increase in revenue is primarily due to changes in the terms of a startup agreement between CBMG and an incoming professor: in FY15, the professor received free time on the Leica SP5X, but starting in FY16, the professor paid half the normal rate. The microscope with the largest disparity in income versus expenses was the DeltaVision; expenses exceeded chargeback income by $9,699.50. However, in April 2016, Dr. Charles Delwiche purchased four new objective lenses for the DeltaVision (10x, 20x, 40x dry LWD, 40x oil) and loaned them to the IC. The microscope has already gained new users due to these lenses.

From FY05 through the end of FY16, 644 individual researchers were trained to independently operate the DeltaVision and confocal microscopes, including students taking the 2-credit course, BSCI427/CBMG688W, Principles of Microscopy. Use of the facilities microscopes has resulted in at least 129 publications (see Appendix 2: Publications). The director of the IC has also continued assisting other departments with their imaging needs by providing training on non-IC microscopes, including the LSM700 system in the PLS building, and the Zeiss LSM710 system at Shady Grove.

The IC implemented a new variable rate system for the confocal microscopes and DeltaVision in FY13, where "peak" times (M-F, 8am-6pm, weekends/holidays) were charged at a slightly higher rate than the "off-peak times" (all other times). In FY16, ~17% of all microscope use occurred during off-peak hours (~25% for confocals alone). The director of the IC recommends we continue offering the variable rate system through FY17.

In December 2014, a PerkinElmer confocal spinning disk was installed in room B0118 of the Physical Sciences Complex (PSC) building. It is the first instrument in the new Imaging Incubator, and is managed by the director of the IC. Thus far, the PerkinElmer has seen limited use because the instrument did not function properly for approximately 6 months, and because the facility is still under construction.

During FY15 and FY16, several users inquired about the ability to take color images in the IC. To meet these user's needs, the director is working with Facilities Management to renovate the IC's former darkroom, to make way for an upright Nikon microscope with a motorized stage and color camera. This microscope is currently housed on the third floor of MICB.

A thorough investigation of microscope hourly rates at other institutions (Appendix 3) shows the IC's confocal, DeltaVision and widefield rates are below the average charged at similar institutions ($35/hr, $31/hr and $19/hr respectively). Although we expect to generate more revenue in FY17 (due to the expiration of the aforementioned startup agreement), we recommend keeping rates the same, because over the last two fiscal years, the facility's expenses exceeded income by a total of $7,318. Please see Table 14 for a complete list of all proposed rates.

Introduction

Established in the year 2000 by the Department of Cell Biology and Molecular Genetics, the Imaging Core (IC) was designed to enhance research and education at the University by providing students and faculty with access to sophisticated light microscopes and imaging instrumentation whose purchase and maintenance costs far exceed the budgets of individual investigators. Serving as the primary resource for advanced light microscopy in the Biological Sciences at the University of Maryland, the IC carries the mission of providing state of the art light microscopy instrumentation, training users in basic and advanced light microscopy techniques and introducing the latest technology and innovations in light microscopy.

Located in room 0107 Microbiology Building, the IC facility includes 9 rooms, five of which are dedicated microscope space, office space for the Director, and a wet-bench lab space with fume hood. When first established, the IC contained a single confocal microscope and a deconvolution microscope. Over the years, demand for time on the instruments increased dramatically, necessitating the purchase of a second confocal in 2008. At present, the IC contains 2 state-of-the-art confocal microscopes (a Zeiss LSM710 and Leica SP5X), a DeltaVision deconvolution/TIRF microscope (installed in March FY14), a Zeiss AxioObserver fluorescence microscope (available for use in February FY14), and a Zeiss AxioPhot brightfield microscope. In December 2014, a PerkinElmer spinning disk confocal microscope was purchased and installed in the Physical Sciences Complex. This microscope will be part of the new Satellite Core, and is currently managed by the director of the IC.

The Director of the IC, Amy Beaven, oversees the routine operation of the laboratory and is available during normal business hours to provide training on all equipment, guidance on experimental design, assistance with image analysis and technician-assisted microscope operation. Since taking over the IC operation in November 2005, Ms. Beaven has trained over 644 researchers from at least ten different departments in six colleges and three different campuses of the University of Maryland.

The IC is used by a diverse group of investigators, including undergraduates, graduate students, post-docs, technicians and faculty. Students enrolled in the annual 2-credit class CBMG688W/BSCI427, Principles of Microscopy, gain hands-on experience in the operation of the IC's brightfield, DeltaVision and Leica SP5X confocal microscopes. This course has trained an average of fifteen students each year for the past ten years.

In the past, funding for the IC came from a combination of user fees and support from the University of Maryland. In an effort to become self-sustaining, trends in facility income, expenses and instrument usage were analyzed over time (the details of which are published in IC's FY10-15 Annual Reports). The analysis showed that a gradual increase in hourly instrument rates were necessary in order for the facility to become financially independent. As such, user fees were incrementally increased over several years in the hopes that the IC would be able to cover all maintenance and service contract costs through user fees alone. It should be noted that current instrument fees are priced competitively and still below the average rates charged at similar institutions with equivalent instrumentation (see Appendix 3).

Facility Mission

The mission of the Imaging Core (IC), located in 0107 Microbiology Building, is to enhance research and education within the College by:

1. Providing access to state-of-the-art light microscopy and imaging instrumentation.
2. Offering detailed training opportunities and support in basic and advanced light microscopy techniques.
3. Keeping researchers up to date with the latest technology and innovations in light microscopy.

Organizational Structure and Governance

- Director of the Facility: Amy Beaven
- Faculty supervisor: Dr. Charles Delwiche, Professor
- Advisory Committee: Dr. Charles Delwiche, Professor (CBMG) Dr. Jose Feijo, Professor (CBMG), Dr. Iqbal Hamza, Professor (ANSC), Dr. Wolfang Losert, Professor (PHYS), and Dr. Stephen Wolniak, Professor (CBMG).

Personnel

The Director of the Facility, Amy Beaven, is the only full-time staff member within the facility. She was hired in 2005 to manage the Imaging and Genomics Core facilities and was promoted to Director in 2010. Ms. Beaven received her Master's degree in Biology in 1999 and has over 14 years intensive experience in confocal imaging techniques. She is available during the hours of 8am-4:30pm to provide guidance in experimental design, training on all equipment, technician-assisted confocal operation and assistance with image analysis.

History of the Facility

Amy Beaven was hired to manage the Imaging Core Facility in November 2005. She took over for the previous director of the facility, Dr. Robert Brown, who had left the University several months previously. At this time, the facility contained both Imaging and Genomics-related equipment. Instrumentation included a Zeiss LSM 510 confocal microscope (0107E), a DeltaVision deconvolution microscope (0107F), an Olympus fluorescence microscope (0107), a Bio-Rad FX Pro Plus Imager, a Konica film processor (0107A), an ABI 3730xl DNA sequencer (0107H), two ABI 3100 DNA Sequencers (0107H) and an ABI 7700 Sequence Detector Real-Time PCR machine (0107H).

- **Table 1: Current Imaging Core Equipment**

Equipment	Location	Purchase Date	In-College Rate History (Academic Year)
Zeiss LSM 710 Confocal Microscope	0107E MICB	October 2009	2009/2010: $15.00/hr 2010/2011: $18.60/hr 2011/2012: $22.00/hr 2012/2013: $26.00/hr Peak; $23.00/hr Off-Peak 2013/2014: $26.00/hr Peak; $23.00/hr Off-Peak 2014/2015: $28.00/hr Peak; $24.00/hr Off-Peak 2015/2016: $32.00/hr Peak; $22.00/hr Off-Peak
Leica SP5X Confocal Microscope	0107H MICB	December 2008	2008/2009: $15.00/hr 2009/2010: $15.75/hr 2010/2011: $18.60/hr 2011/2012: $22.00/hr 2012/2013: $26.00/hr Peak; $23.00/hr Off-Peak 2013/2014: $26.00/hr Peak; $23.00/hr Off-Peak 2014/2015: $28.00/hr Peak; $24.00/hr Off-Peak 2015/2016: $32.00/hr Peak; $22.00/hr Off-Peak
Deltavision Deconvolution/TIRF Microscope	0107F MICB	March 2014	2013/2014: $10/hr 2014/2015: $10/hr thru 3/2015 2014/2015: $28.00/hr Peak; $24.00/hr Off-Peak 2015/2016: $28.00/hr Peak; $24.00/hr Off-Peak
Zeiss AxioObserver Fluorescence	0107K	February 2014	2012/2013: $5/hr 2013/2014: $5/hr
Axiophot Fluorescence Microscope	Main lab	CoolSnap, Elements: July 2007	$2.00/hr since installation
PerkinElmer confocal spinning disk	B0118 PSC	December 2014	2014/2015: $28.00/hr Peak; $24.00/hr Off-Peak

Outreach Activities During FY16

1. FY16: throughout the year, the Director of the IC provided training and support for the PerkinElmer confocal spinning disk system in the Imaging Incubator, B0118 Physical Sciences Complex. This includes: train new users on the system, troubleshoot equipment problems, perform billing, implement the KeyWatcher security system, and work with FM and DES to plan construction modifications to rooms B0107 and B0112.
2. FY16: throughout the year, the Director provided training for the Zeiss LSM700 confocal system in IBBR/BioE/PLS. In addition, worked with DES and the manager of the facility to define a BSL-2 protocol, modeled after the IC's new protocol.
3. FY16: throughout the year, provided support for the Genomics Core.
4. 2015 Fall Semester: the Director trained members of the class CBMG688W/BSCI427, Principles of Microscopy, to use the Axiophot microscope, the DeltaVision deconvolution microscope, and the Leica SP5X confocal microscope.
5. 2015 Fall Semester: the Director assisted members of BSCI415 with the acquisition of confocal images.
6. November 2015-February 2016: worked with DES to develop/approve BSL-2 protocol for IC. Protocol was implemented in February 2016.
7. October 16-20, 2015: Hosted Olympus confocal demonstration for Sougata Roy lab.
8. January 12, 2016: Hosted/organized Zeiss Technology Day, which was attended by almost 60 people. Topics included: Axioscan, Large-Scale Imaging, Advances in Confocal Microscopy, 3D Ultrastructure and Correlation for Life Sciences.
9. 2016 Spring Semester: the Director showed two current Calvert High school students how to operate the confocal microscope, and provided an overview of Core Facility management.

Summary of Facility Usage

In FY16, use of the Zeiss LSM710 averaged 19.5 hours/week and Leica SP5X use averaged 30.7 hours/week. The combined average usage of 50.3 hours/week is a 17.2 % increase from FY15.

Between FY09 and FY14, the Zeiss consistently saw more use than the Leica, but in FY15, the Leica was used more than the Zeiss (1206.25 hours vs. 963.5 hours, respectively). That trend continued in FY16; 1602 hrs. vs. 1021 hours, respectively. The DeltaVision saw a modest decrease in use — 154 hours in FY15, versus 198 hours in FY16.

In FY15, consumable and service contract expenses for all facility microscopes exceeded the total income collected via charge-backs by -$10,802.20. However, in FY16, the facility's income exceeded expenses by $3,484.12. The increase in revenue is primarily due to changes in the terms of a startup agreement between CBMG and an incoming professor: in FY15, the professor received free time on the Leica SP5X, but starting in FY16, the professor paid half the normal rate.

Although we expect to generate more revenue in FY17 (due to the expiration of the aforementioned startup agreement), we recommend keeping rates the same, because over the last two fiscal years, the facility's expenses exceeded income by a total of $7,318. Please see Table 14 for a complete list of all proposed rates.

Table 2: FY16 Income and Expenses

Instrument/ Source Income	Service contract cost	Consumable Cost	Total Expenses	Income	Income - Expenses
Zeiss LSM 710	$19,755.00	$608	$20,363.00	$32,847.25	$12,484.25
Leica SP5 X	$37,743	$609	$38,352.00	$35,865.00	$-(2,487.00)
DeltaVision	$16,200	$323	$16,523.00	$6,823.50	$-(9,699.50)
Zeiss Observer	$0.00	$152.94	$152.94	$1,086.25	$933.31
Axiophot	$0.00	$152.94	$152.94	$6	$-(146.94)
LSM700 training	$0.00	$0.00	$-	$900	$900.00
CBMG688W	$0.00	$0.00	$-	$1,500	$1,500.00
Total	$73,698.00	$1,846	$75,543.88	$79,028.00	$3,484.12

Table 3: Combined LSM 710, SP5 X, DeltaVision, and Observer Microscope Data by Fiscal Year:

Fiscal Year	Income from User Fees	Total # Hours Used	Total hours used for UMCP courses	Total # Training Sessions
2009	$5,090.75	345.78	0.00	39
2010	$30,732.93	2086.19	70.96	87
2011	$57,738.83	3087.55	55.50	68
2012	$49.777.56	2265.25	62.751	49
2013	$55,810.80	2180.00	90.75	61
2014	$57,061.30	2114.30	71.25	63
2015	$60,175.25	2699.75	69.5	63
2016	$76,622.00	3090.00	75.5	62
Total	**$398,515.77**	**17,869.07**	**496.21**	**492**

Table 4: Leica SP5X Summary Data:

Fiscal Year	Income from User Fees	Total # Hours Used	Total hours used for UMCP courses	Total # Training Sessions
2009	$5,090.75	345.78	0	39
2010	$18,362.80	1282.517	70.96	43
2011	$24,290.48	1325.3	55.5	35
2012	$21,882.08	1021.25	62.75	29
2013	$21,922.00	932.25	90.75	35
2014	$25,160.55	886.3	71.25	34
2015	$25,576.25	1206.25	38.75	27
2016	$35,865.00	1602.00	36.00	17
Total	**$178,149.91**	**8,601.65**	**425.96**	**259**

Table 5: Zeiss LSM710 Summary Data:

Fiscal Year	Income from User Fees	Total # Hours Used	Total hours used for UMCP courses	Total # Training Sessions
2010	$12,370.13	803.675	0	44
2011	$33,448.35	1762.25	0	33
2012	$27,895.48	1244.00	0	20
2013	$33,888.80	1247.75	0	26
2014	$31,470.75	1173.75	1.5	17
2015	$27,654.50	963.5	6.5	22
2016	$32,847.25	1021.0	7	20
Total	**$199,575.26**	**8,215.68**	**15**	**182**

Table 6: DeltaVision Summary Data:

Fiscal Year	Income from User Fees	Total # Hours Used	Total hours used for UMCP courses	Total # Training Sessions
2014	$317.50	31.75	0.0	12
2015	$6472.00	375.5	24.25	13
2016	$6,823.50	269.5	32.5	20
Total	**$13,295.50**	**676.75**	**56.75**	**45**

Table 7: AxioObserver Fluorescence Microscope Data

Fiscal Year	Income from User Fees	Total # Hours Used	Total hours used for UMCP courses	Total # Training Sessions
2014	$112.50	22.5	0	0
2015	$790.00	154.5	0	1
2016	$1,086.25	198.0	0	5
Total	**$1,988.75**	**375.0**	**0**	**6**

During FY16, 46 different laboratories from 9 different departments (AGNR, BioENGR, Biology, CBMG, Chem/Biochem, ENGR, ENT, Psychology, Physics) and 3 off-campus laboratories (USGS, Henry Jackson Foundation, and Howard University) made use of the facility's confocal microscopes. CBMG accounted for 45% of the total microscope use (Figure 3). Departments within CMNS accounted for 71.2% of use (Figure 4).

Figure 1: Top Microscope Users by Department FY16

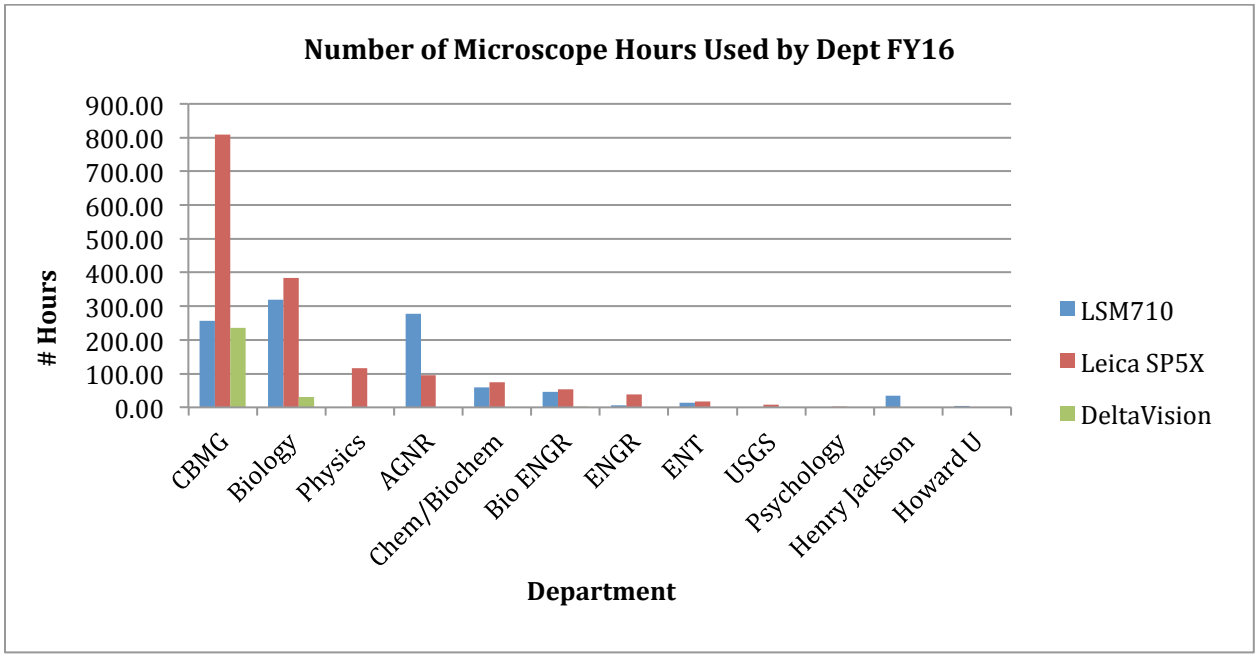


Figure 2: Top Microscope Users FY16

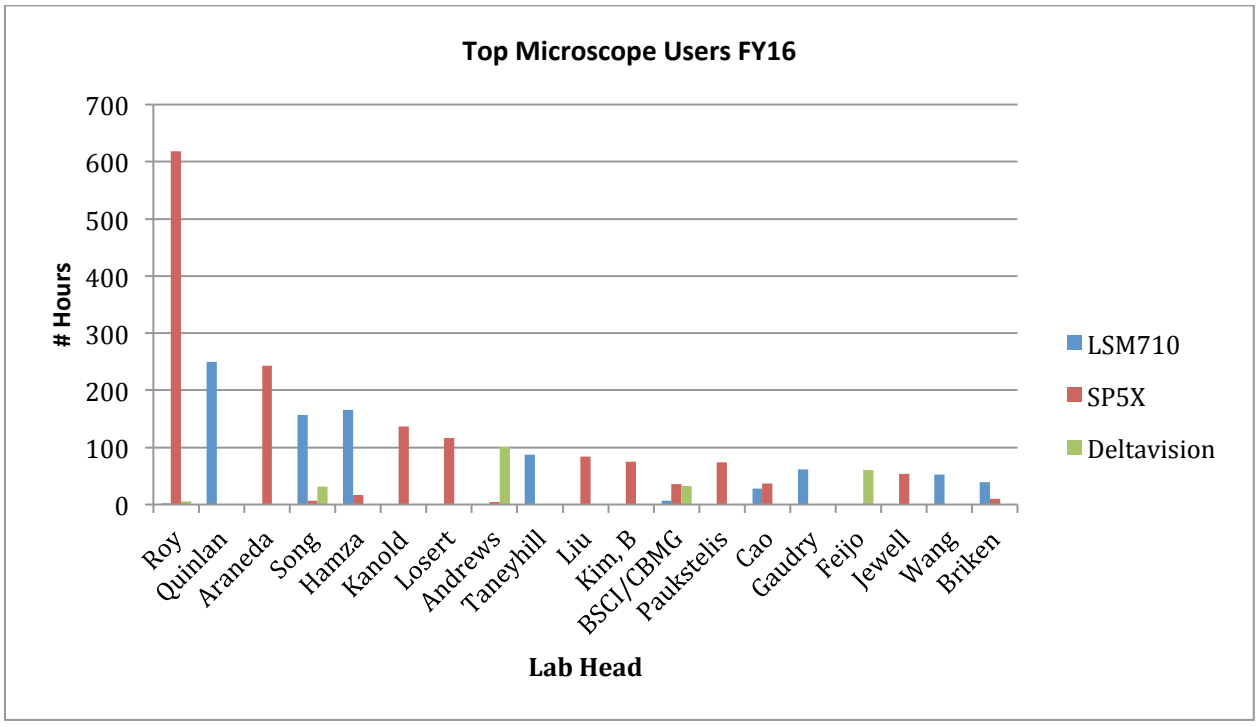


Figure 3: CBMG versus non-CBMG Use of Microscopes FY16

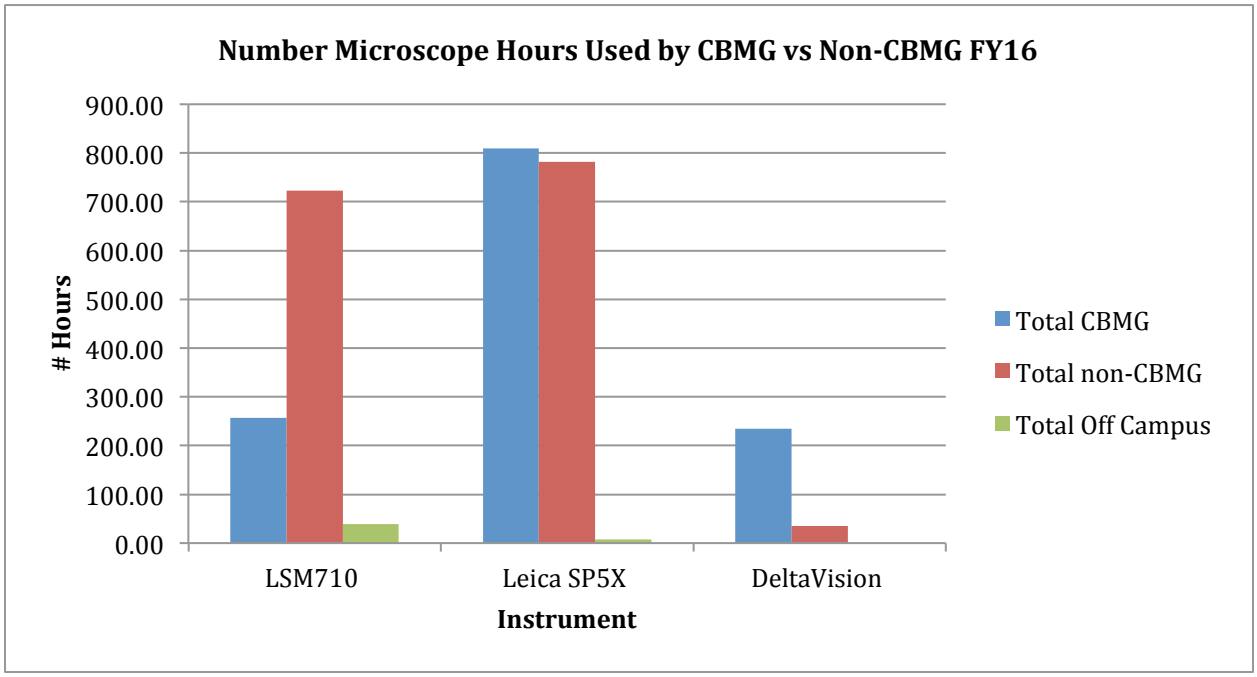
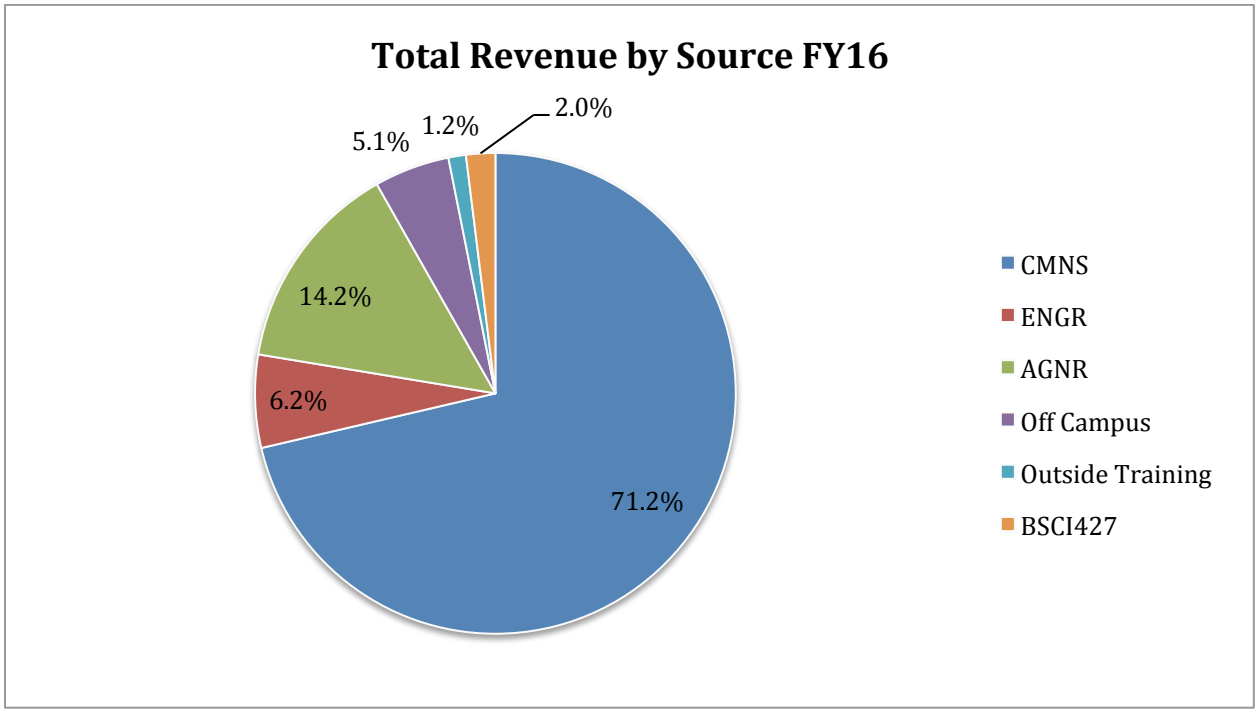


Figure 4: Total Revenue by Source FY16



Operating Cost Analysis

At the end of FY16, the Imaging Core account held a balance of $100,925.47.

Table 8: Total Imaging Core Facility Income and Expenses from FY09-FY16

Year	Total Income (including subsidies)	Total Imaging Core Expenses	Net Balance
FY2009	$5,090.75	$6,113.25	$-(1,022.50)
FY2010	$68,232.80	$29,563.70	$38,669.10
FY2011	$95,238.48	$55,524.75	$39,713.73
FY2012	$87,277.66	$76,562.12	$10,715.54
FY2013	$55,810.80	$59,672.67	$-(3,861.87)
FY2014	$57,184.03	$59,876.48	$-(2,692.45)
FY2015	$63,153.25	$73,955.45	$-(10,802.20)
FY2016	$79,028.00	$75,543.88	$3,484.12
Total	**$398,515.77**	**$436,812.30**	**$74,203.47**

Table 9: Cost Breakdown: Leica SP5X

Year	Service Contract Cost	Expenses	Income	Income (subsidies)	Income - Expenses
FY2009	0	$6,113.25	$5,090.75	0	$-(1,022.55)
FY2010	$26,000.00	$2,375.80	$18,362.80	$37,500.00	$27,487.00
FY2011	$36,075.00	$488.25	$24,290.00	$37,500.00	$25,226.75
FY2012	$52,296.00	$2,055.56	$21,882.08	$37,500.00	$5,030.52
FY2013	$37,091.50	$1,886.66	$21,922.00	0	$(-17,057.16)
FY2014	$37,091.50	$359.92	$25,160.55	0	$-(12,290,87)
FY2015	$37,743.00	$51.49	$25,576.25	0	$-(12,218.24)
FY2016	$37,743.00	$609.00	$35,865.00	0	$-(2,487.00)
Total	**$264,040.00**	**$14,595.93**	**$178,149.91**	**$112,500.00**	**$12,013.98**

Table 10: Cost Breakdown: LSM 710

Year	Service Contract Cost	Expenses	Income	Income (subsidies)	Income - Expenses
FY2009	0	0	0	0	0
FY2010	0	$1,187.90	$12,370.00	0	$11,182.10
FY2011	$17,730.00	$1,231.50	$33,448.00	0	$14,486.50
FY2012	$19,260.00	$2,950.56	$27,895.58	0	$5,685.02
FY2013	$19,260.00	$1433.51	$33,888.80	0	$13,195.29
FY2014	$19,260.00	$359.92	$31,470.75	0	$12,210.75
FY2015	$19,755.00	$51.49	$27,654.50	0	$7,848.01
FY2016	$19,755.00	$608.00	$32,847.25	0	$12,484.25
Total	**$115,020.00**	**$7,822.88**	**$199,574.88**	**0**	**$77,091.92**

Table 11: Cost Breakdown: DeltaVision

Year	Service Contract Cost	Expenses	Income	Income (subsidies)	Income - Expenses
FY2014	$0.0	$739.22	$370.50	0	$-(421.72)
FY2015	$16,200.00	$51.49	$6134.50	0	$-(10,096.99)
FY2016	$16,200.00	$323.00	$6,823.50	0	$-(9,699.50)
Total	**$32,400.00**	**$1,113.71**	**$13,295.50**	**0**	**$-(20,218.21)**

Projected Cost Analysis:

If rates, service contract costs and instrument usage remain unchanged, the Imaging Core will increase by $10,099.00. However, we expect one of the top microscope users (Dr. Sougata Roy) to use less time on the instruments in FY17, because he is now paying full price to use the facility's instruments, and because he recently purchased a confocal spinning disk system for his laboratory.

Table 12: FY17 Projected Income and Expenses if rates remain unchanged

Microscope	Projected Expenses (consumables & service contracts)	Projected Income	Income-Expenses
LSM710	$20,787	$32,830	$12,043
SP5X	$39,032	$46,410	$7,378
DeltaVision	$17,232	$6,823	$-(10,409)
Other	$0	$1,086	$1,086
Total	**$77,051**	**$87,150**	**$10,099**

Proposed Rate Schedule:

A thorough examination of confocal microscope rates at other institutions (Appendix 3) shows that the facility's microscopes are priced below average. The average rate (data updated August 2016) for similar confocal microscopes at >30 institutions was $35/hour, and the average rate for a DeltaVision system was $31/hr.

Although the account balance at the end of June 2016 was $100,925.47, the facility must renew the Zeiss LSM710 service contract in September ($19,962.00) and the Leica SP5X two-year agreement and December (~$75,486.00).

Because the facility lost $7,318 over the last two years, and because we expect one of the top microscope users (Dr. Sougata Roy) to use less microscope time, we recommend keeping the current rates the same for FY17. Please see Tables 13-14 for a list of current and future rates.

Table 13: Current Imaging Core Rates

Instrument	Users within CMNS	Training fee within CMNS	On-campus users not affiliated with the College	Users not affiliated with the campus
Zeiss LSM710	Peak: $32/hr Off-Peak: $22/hr	$150/person	$40/hr	$80/hr
Leica SP5 X	Peak: $32/hr Off-Peak: $22/hr	$150/person	$40/hr	$80/hr
DeltaVision Deconvolution	Peak: $28/hr Off-Peak: $22/hr	$150/person	$40/hr	$80/hr
PerkinElmer spinning disk	Peak: $32/hr Off-Peak: $22/hr	$150/person	$40/hr	$80/hr
Axiophot Fluorescence	$2.00/hr	$2/hr	$2.00/hr	$5.00/hr
Zeiss AxioObserver	$5.00/hr	$25/person	$8.00/hr	$20.00/hr

Table 14: Proposed Imaging Core Rates

Instrument	Users within CMNS	Training fee within CMNS	On-campus users not affiliated with the College	Users not affiliated with the campus
Zeiss LSM710	Peak: $32/hr Off-Peak: $22/hr	$150/person	$40/hr	$80/hr
Leica SP5 X	Peak: $32/hr Off-Peak: $22/hr	$150/person	$40/hr	$80/hr
DeltaVision Deconvolution	Peak: $28/hr Off-Peak: $22/hr	$150/person	$40/hr	$80/hr
PerkinElmer spinning disk	Peak: $32/hr Off-Peak: $22/hr	$150/person	$40/hr	$80/hr
Axiophot Fluorescence	$2.00/hr	$2.00/hr	$2.00/hr	$5.00/hr
Zeiss AxioObserver	$5.00/hr	$25/person	$8.00/hr	$20.00/hr

Appendix 1: Summary of changes in instrumentation since November 2005

- 8/2006: A Mini Med 90 Film Processor (cost: $3,588.00) replaced the old Konica processor. The department paid $2,500.00 of the total cost and each of the following PIs contributed $109: Jonathan Dinman, Jeffrey DeStefano, Kenneth Frauwirth, David Mosser, Anne Simon, Wenxia Song, Richard Stewart and Elizabeth Gantt.
- 10/2006: Dr. Steve Wolniak (Interim Chair of CBMG) procured a Zeiss Axiophot fluorescence microscope for the facility following Dr. Ron Weiner's retirement. A CoolSnap EZ monochrome camera, computer workstation and Nikon Elements software (total cost: $13,400.00) were purchased in 2007 for the microscope using CBMG funds.
- 4/2007: The 7700 Sequencer Detector was replaced with a Roche LightCycler 480 Real-Time PCR machine, which was purchased through CBMG using the Bioscience Research Building capital equipment funds (and is housed in BRB; see below).
- 8/2007: Due to a drop in usage, the 3100 North DNA sequencer was taken out of operation.
- 12/2008: The instruments in 0107H MICB (two ABI 3100 DNA sequencers, the ABI 3730xl DNA Sequencer and the Roche LightCycler 480 Real-Time PCR machines) were moved to the new Genomics Core, room 2229 Bioscience Research Building.
- 12/2008: The Leica SP5 X confocal microscope was installed in room 0107H MICB. This microscope was obtained by Drs. Ian Mather and. Steve Wolniak via an NSF MRI grant.
- 10/2009: The LSM510 confocal microscope was dismantled to make way for the new Zeiss LS change M710. The LSM710 was purchased using college funds, authorized by Dean Allewell.
- 1/2009: Genomics Core Equipment: Bio-Rad CFX 96 Real-time PCR machine was purchased and placed in room 2229 BRB.
- 4/2010: Genomics Core Equipment: Due to a drop in usage, the 3100 "West" DNA sequencer was taken out of operation.
- 7/2011: Genomics Core Equipment: July 2011: Both the 3100 "West" and 3100 "North" DNA sequencers were sold through Terrapin Trader.
- 11/2011: A Thermo Scientific Midi 40 CO2 incubator was purchased using IC funds ($3,194.00).
- 2/2014: a Zeiss AxioObserver widefield fluorescence microscope was relocated from room 3207 Bioscience Research Building. The microscope was installed in room 0107K and upgraded with a new computer, new software (Zen 2012) and a new power supply, using a combination of departmental and IC funds.
- 3/2014: A DeltaVision Deconvolution/TIRF microscope was installed in room 0107F MICB. The microscope was purchased with departmental and college funds.
- 4/2014: Financial responsibility for the DNA sequencer was transferred to the Biology Dept.
- 8/2014: The Leica SP5 X was upgraded with a new HyD detector and time-gating technology.
- 10/2014: The Zeiss LSM 710 computer was replaced (free upgrade due to computer issues with the old operating system) with a Windows 7 computer and the software was upgraded to the latest version of Zen.
- 12/2014: A PerkinElmer spinning disk confocal microscope was installed in the Satellite Core, room B0118 Physical Sciences Complex.
- 1/2015: As a result of increased instruments and Imaging Core responsibilities, management of the Genomics Core was transferred from Amy Beaven to Dr. Yan Wang.
- 7/24/15: The Mini Med 90 Film Processor was taken out of service. It was decontaminated by DES (Cleveland Taylor) and sent to Terrapin Trader.
- 2/2016: IC implemented new BSL-2 protocol, to allow imaging of approved BSL-2 samples.
- 4/2016: Dr. Charles Delwiche purchased 4 new objective lenses for the DeltaVision and loaned them to the IC: 10x 0.4 NA, 20x 0.75NA, 40x 0.6NA LWD and 40x 1.3NA oil lens

Appendix 2: Publications that entailed the use of the Zeiss LSM 510:

1. Bish, S. E., W. Song, and D.C. Stein. 2008. Quantification of bacterial invasion into host cells using a beta-lactamase reporter strain: Neisseria gonorrhoeae invasion into cervical epithelial cells requires bacterial viability. Microbes Infect. 10:1182-1191.
2. Sikes, J. M. & Bely, A. E. Radical modification of the A-P axis and the evolution of asexual reproduction in Convolutriloba acoels. Evolution and Development 10, 619-631 (2008).
3. The MHC class II-associated invariant chain interacts with the neonatal Fc gamma receptor and modulates its trafficking to endosomal/lysosomal compartments. Ye L, Liu X, Rout SN, Li Z, Yan Y, Lu L, Kamala T, Nanda NK, Song W, Samal SK, Zhu X. J Immunol. 2008 Aug 15;181(4):2572-85
4. Activation of the JAK/STAT-1 signaling pathway by IFN-gamma can down-regulate functional expression of the MHC class I-related neonatal Fc receptor for IgG. Liu X, Ye L, Bai Y, Mojidi H, Simister NE, Zhu X. J Immunol. 2008 Jul 1;181(1):449-63.
5. Identification and characterization of an alternatively spliced variant of the MHC class I-related porcine neonatal Fc receptor for IgG.
6. Ye L, Tuo W, Liu X, Simister NE, Zhu X. Dev Comp Immunol. 2008;32(8):966-79. NF-kappaB signaling regulates functional expression of the MHC class I-related neonatal Fc receptor for IgG via intronic binding sequences. Liu X, Ye L, Christianson GJ, Yang JQ, Roopenian DC, Zhu X. J Immunol. 2007 Sep 1;179(5):2999-3011
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14. Cheng, P. C., B. K. Brown, W. Song, and S. K. Pierce. 2001. Translocation of the B cell antigen receptor into lipid rafts reveals a novel step in signaling. J. Immunol. 166 (6):3693-701.
15. Song, W. 2001. Signaling, actin dynamics and endocytosis. Acta Biophysica Sinica. 17 (1):10-18.
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30. Berry D.L. and Baehrecke E.H. (2007) Growth arrest and autophagy are required for programmed salivary gland cell degradation in Drosophila. Cell 131, 1137-1148.
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Publications that entailed the use of the DeltaVision (to date):

1. Renberg R., Yuan X., Samuel T., Miguel D., Hamza I., Andrews N., Flannery A. (2015) The heme transport capacity of LHR1 determines the extent of virulence in Leishmania amazonensis. PlosOne.
2. Bai, X., Zhang, Y., Huang, L., Wang, J., Li, W., Niu, L., ... Liu, C. (2016). The early activation of memory B cells from Wiskott-Aldrich syndrome patients is suppressed by CD19 down regulation. *Blood*. doi:10.1182/blood-2016-03-703579

Other accomplishments that entailed the use of the Leica SP5 X:

1. Eduardo E. Zattara: Winner of 2016 American Microscopical Society Ralph and Mildred Buchsbaum Prize for Excellence in Photomicrography Color division https://www.researchgate.net/publication/296699445_Winner_of_the_2016_American_Microscopical_Society_Ralph_and_Mildred_Buchsbaum_Prize_for_Excellence_in_Photomicrography_Color_division?ev=prf_pub
2. Venuti, L. S.; Swierzbinski, M.E., & Herberholz, J. (2014, November). *Investigation of fast autoinhibition in the lateral giant circuit of crayfish.* Poster session presented at the meeting of the Society for Neuroscience, Washington D.C.

Appendix 3: Example Confocal Rates at Other Institutions

Table 15: Example Confocal Rates (updated August 2016)

Facility	Instrument	Type	Hourly rate
Berkeley Biological Imaging Facility	Zeiss LSM 710	Confocal	$35
Berkeley Biological Imaging Facility	Zeiss LSM 510	Confocal	$29
Cornell University Life Sciences Imaging Core	Zeiss LSM 710	Confocal	$35
Cornell University Life Sciences Imaging Core	Leica SP2	Confocal	$20
University of Virginia School of Medicine	Zeiss LSM 510	Confocal	$34
University of Virginia School of Medicine	Zeiss LSM 510	Confocal	$38
University of Virginia School of Medicine	Zeiss LSM 510	Confocal	$54
Northwestern University Biological Imaging	Leica SP5	Confocal	$38
Northwestern University Biological Imaging	Zeiss LSM 510	Confocal	$37
Arizona State Imaging Facility	Leica SP5	Confocal	$40
Duke University Light Microscopy Core	Leica SP5	Confocal	$27
Duke University Light Microscopy Core	Zeiss LSM 780	Confocal	$27
Ohio State University	Olympus FV 1000	Confocal	$30
Michigan State U Center Advanced Microscopy	Zeiss LSM 510	Confocal	$25
Michigan State U Center Advanced Microscopy	Olympus FV 1000	Confocal	$25
University of Washington Keck Facility	Zeiss LSM 510	Confocal	$44
University of Washington Keck Facility	Leica SP8	Confocal	$44
Oklahoma State University	Leica SP2	Confocal	$30
University of Connecticut	Leica SP8	Confocal	$15
UVA Keck Center	Zeiss LSM 510	Confocal	$35
UVA Keck Center	Leica SP5X	Confocal	$35
Oregon State University	Zeiss LSM 780	Confocal	$20
Oregon State University	Zeiss LSM 780	Confocal	$21
Yale School of Medicine	Zeiss LSM 510	Confocal	$50
Yale School of Medicine	Leica SP5	Confocal	$50
Texas A&M	Olympus FV 1000	Confocal	$42
University of Maryland School of Medicine	Zeiss LSM 510	Confocal	$40
Colorado State University	Zeiss LSM 510	Confocal	$40
Boise State University	Zeiss LSM 510	Confocal	$41.15
Rockefeller University	Leica SP8	Confocal	$52
Notre Dame	Nikon A1	Confocal	$27
Washington University in St. Louis	Nikon A1	Confocal	$32
Washington University in St. Louis	Leica SP2	Confocal	$32
Perlman School of Medicine	Leica STED	Confocal	$85
University of California, Davis	Olympus FV 1000	Confocal	$35
UC Santa Cruz	Leica SP5	Confocal	$25
Indiana University	Leica SP5	Confocal	$18.25
U of Arizona, Env Health Sciences	Leica SP2	Confocal	$32
Oregon Health and Science University	Zeiss LSM 780	Confocal	$40
Oregon Health and Science University	Olympus FV 1000	Confocal	$33
U of Georgia Biomedical Microscopy Core	Zeiss LSM 710	Confocal	$35
University of Illinois at Chicago	Zeiss LSM 510	Confocal	$30
University of Illinois at Chicago	Zeiss LSM 710	Confocal	$41
UC San Diego	Olympus FV 1000	Confocal	$36
UC San Diego	Zeiss LSM 510	Confocal	$36
Baylor College of Medicine	Nikon A1	Confocal	$28
University of Michigan Medical School	Leica SP5X	Confocal	$30
Virginia Commonwealth University	Zeiss LSM 710	Confocal	$20
University of Chicago Comp Cancer Center	Leica SP2	Confocal	$32
University of Colorado, Boulder	Zeiss LSM 510	Confocal	$35
MIT Koch Institute	Nikon A1	Confocal	$36
Average			**$35**

Table 16: Example DeltaVision Rates (updated August 2016)

Facility	**Instrument**	**Type**	**Hourly rate**
Berkeley Biological Imaging Facility	DeltaVision	DeltaVision	$28
Northwestern University Biological Imaging	DeltaVision	DeltaVision	$35
Duke University Light Microscopy Core	DeltaVision Elite	DeltaVision	$14
Rockefeller University	DeltaVision	DeltaVision	$39
Notre Dame	DeltaVision	DeltaVision	$19
Washington University in St. Louis	DeltaVision	DeltaVision	$32
Perlman School of Medicine	DeltaVision	DeltaVision	$70
University of California, Davis	DeltaVision	DeltaVision	$35
Indiana University	DeltaVision	DeltaVision	$18.25
U of Arizona, Env Health Sciences	DeltaVision	DeltaVision	$25
Oregon Health and Science University	DeltaVision	DeltaVision	$28
U of Georgia Biomedical Microscopy Core	DeltaVision	DeltaVision	$30
University of Arizona Microscopy Alliance	DeltaVision	DeltaVision	$35
University of Arizona Microscopy Alliance	DeltaVision	DeltaVision	$25
UC San Diego	DeltaVision	DeltaVision	$28
Baylor College of Medicine	DeltaVision	DeltaVision	$28
University of Michigan Medical School	DeltaVision	DeltaVision	$41
MIT Koch Institute	DeltaVision	DeltaVision	$36
Average			**$31**

Table 17: Example Spinning Disk Rates (updated August 2016)

Facility	**Instrument**	**Type**	**Hourly rate**
Cornell University Life Sciences Imaging Core	Andor Spinning Disk	Spinning disk	$30
Northwestern University Biological Imaging	Leica Spinning Disk	Spinning disk	$37
Duke University Light Microscopy Core	Andor Spinning Disk	Spinning disk	$18.40
University of Connecticut	Andor Spinning Disk	Spinning disk	$15
Rockefeller University	PE Spinning Disk	Spinning disk	$39
Notre Dame	Andor Spinning Disk	Spinning disk	$17
Perlman School of Medicine	Olympus Spinning Disk	Spinning disk	$80
UC San Diego	Perkin Elmer Spinning Disk	Spinning disk	$36
University of Colorado, Boulder	Nikon spinning disk	Spinning disk	$45
MIT Koch Institute	Nikon spinning disk	Spinning disk	$36
Average			$35

Table 18: Example Widefield Fluorescence Microscope Rates (updated August 2016)

Facility	**Instrument**	**Type**	**Hourly rate**
Cornell University Life Sciences Imaging Core	Olympus Widefield	Widefield	$15
University of Washington Keck Facility	Widefield	Widefield	$28
UVA Keck Center	Widefield	Widefield	$15
Average			**$19**

Appendix 4: A Six Month Analysis of Scheduled (Predicted) Versus Used (Actual) Time

An analysis comparing time scheduled versus actual time used on the facility's major microscopes shows users reserved 100 more hours than they actually used over a period of six months. This resulted in an estimated $5,139 in lost revenue in FY16 due to the unused time.

Instrument	**Actual Hours**	**Scheduled hours**	**Schedule-Actual**	**Actual Revenue**	**Predicted Revenue**	**Predicted-Actual**
Zeiss LSM710	1007.25	1032	24.75	$30,769.5	$31,354	$128
Leica SP5 X	1319	1373.5	54.5	$38,430.5	$40,242	$1,811.5
DeltaVision Deconvolution	74	96.5	22	$2,072	$2,702	$630
Total	**2400.25**	**2502**	**101.25**	**$71,272**	**$74,298**	**$2,569.5**