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Micro/Nano Technology Center

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Micro/Nano Technology Center

Innovation Through Miniaturization
louisville.edu/micronano

Modeling & Layout

Mask Generation
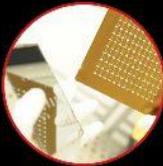
Lithography

Thermal Processing

Thin Film Deposition

Wet/Dry Etching

Characterization/
Packaging

MICRO/NANO TECHNOLOGY CENTER
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Louisville, KY 40292
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2013
Annual Report

March 6, 2014

University of Louisville Micro/Nano Technology Center
Annual Report
FY2013

Dr. Kevin Walsh, Director
Dr. Shamus McNamara, Associate Director
Dr. Julia Aebersold, Manager
Wendy S. Metcalf, Administrative Associate
Don Yeager, Technical Staff and Facilities Coordinator
Dr. Xiaojin Wang, Senior Process Engineer
Curtis McKenna, Research Engineer Scientist and Outreach Coordinator
Dr. Evgeniya Moiseeva, Post Doc Scholar
Mary Watson, Administrative Assistant

INTRODUCTION

The University of Louisville Micro/Nano Technology Center (MNTC) is a university-recognized recharge service center established in 2004. The MNTC consists of a \$30M 10,000 ft^2 cleanroom facility for the fabrication of novel materials and devices, a 1,000 ft^2 packaging and characterization lab and a 300 ft^2 design, layout and simulation lab. This diverse multi-user core facility is utilized for research, teaching and to extend microfabrication services to internal and external clients in Kentucky and throughout the nation. This document serves as its official annual report for the fiscal year ending June 30, 2013. Below are the summarized financial and operational activities for the UofL MNTC during that period.

FINANCIAL SUMMARY

The MNTC ended FY13 with a surplus of \$19,626 (Table 1) compared to a deficit of \$16,498 in FY12. Details of the financial year are listed below.

Table 1 presents the itemized breakout of expenditures and income for the MNTC for FYE 6/30/13. Expenditures for FY13 were \$213,664 with revenues of \$233,289 resulting in a $\underline{\text{\$19,626 surplus}}$. The largest expenditures consumed by the cleanroom were liquid nitrogen (\$53K), laboratory supplies (\$49K) and equipment maintenance (\$31K). The university continues to charge an administrative fee of 10% of expenses which came to \$16K for FY13.

Not captured in the MNTC Balance Sheet from Table 1 is the "*staff subsidy*" or funds the UofL MNTC receives through the Speed School of Engineering (SSE) to support staff salaries. CAR funding (continuing annual resources or "hard money") is provided by the SSE for an administrative position (Wendy Metcalf), three technical support positions (Don Yeager , Mike Martin, and Curt McKenna) and a managerial position (Julia Aebersold). In total, the 5 staff positions totals approximately \$261k of salary support and fringe benefits (Table 2). Table 3 details unsubsidized salary and fringe benefits (\$20,444) which are supported directly by MNTC revenues. All of this technical and administrative support is vital for the safe operation and financial success of the MNTC because, unlike most other multi-user core facilities, the UofL MNTC operates all of its ~\$20M of capital equipment without any annual maintenance contracts. Instead, we rely on our trained technical staff to maintain tools and operations, ensure personal safety, provide ongoing training to all cleanroom clients and perform processing services for a majority of the MNTC's external clients. Although the number of staff in the UofL MNTC is relatively low compared to other comparably-sized cleanroom facilities (for example, the University of Michigan cleanroom has a staff of over 20), we remain confident in our ability to deliver both safe operations and a high-quality research experience for our many users.

Revenue for the MNTC generated by quarter for FY13 is shown in Figure 1, with a summary of internal and external income for the fiscal year in Figure 2. A breakdown of total revenue (\$233,289) shows that 71% or \$166,073 came from internal clients and 29% or \$67,217 from external clients. A list of internal faculty along with their department affiliation and revenue contribution appears in Table 4 and Figure 3. For FY13, the MNTC had an impressive 21 faculty from 7 departments use the facility. Figure 4 presents a breakdown of internal revenue by department, showing the largest percentage was generated by ECE faculty at 39%. A list of our 25 external clients for FY13 appears in Table 5, combining for \$67,217 of external revenue (Figure 5). Table 6 presents a comprehensive list of all 69 MNTC internal users for FY13 which consisted

of 21 faculty, 45 students/post-docs/engineers, and 3 teaching assistants (TAs). In total, an impressive 94 clients accessed the UofL MNTC in FY13. This number excludes the approximate 25 students enrolled in the 3 Microfab/MEMS classes which also utilized the cleanroom for teaching.

Figure 6 presents a nice comparison of MNTC internal and external income for the last 10 years (from FY04 to FY13). In FY10 and FY11 MNTC revenues began to decline for the first time in part due to the difficulties of internal faculty winning federal grants as the government reduced spending. In FY12, the MNTC hired a new manager, Dr. Julia Aebersold, with the goal of increasing external business and re-engaging internal users. Consequently, revenues have increased steadily since that operational change. External revenue is up a dramatic 222% ($46,374) since FY11, and internal revenue is up 23% ($30,748). Figure 7 details MNTC operational expenses during that same time period, illustrating our overall revenue-neutral operation for the last 10 years.

Figure 8 presents accumulative income from FY04 to FY13 for internal clients ($1,334.007). The top 6 faculty clients of the MNTC are Dr. Walsh of ECE ($342k), Dr. Keynton of BE ($100k), Dr. Cohn of ECE ($99k), Dr. Harnett of ECE ($89k), Dr. Alphenaar of ECE ($86k), and Dr. McNamara ($79k). Figure 9 presents total internal income ($1,334,090) by department since FY04. The dominant department continues to be ECE at $755,487 (57%), followed by BE (12%), ME (12%), Physics (8%), and Chemical Engineering (3%).

Figure 10 shows the number of departments, faculty, students, post docs and researchers who have annually used the cleanroom since FY06. In the spring of 2012 a new fee structure was implemented that charged clients per process along with an access fee to cover costs of gowning. As a result, the number of FY13 users decreased slightly - 57 students/post-docs/researcher to 45, 22 faculty users to 21, 9 departments to 7 for FY13. While this trend was concerning, access data in FY14 indicates a reversal of this trend due to acceptance and approval of the new fee structure. With a more objective and concrete fee structure, we were also able to list our rates on the web, which has helped business.

Figure 11 shows total grant revenue awarded to the University of Louisville that directly used the MNTC core facility since 2001. This amount is an impressive $59M with 33% originating from the Department of Defense and 23% from the University of Kentucky Research Foundation (i.e. KY NSF EPSCoR Program which is managed by UK). This produces an impressive 10 year average of approximately $6M/yr of income, which correlates to over 1/3 of SSE's overall research funding. A significant portion of this funding would not have been possible without the unique resources of the MNTC and its cleanroom facility. Table 7 highlights the tremendous leveraging ability of the MNTC core facility. In FY13, user fees of $125,277 were generated from 31 grants totaling $13.9M, resulting in a multiplication factor to the University of 111 to 1 for the MNTC core facility!

In conclusion, on behalf of the entire MNTC personnel, we wish to thank all the individuals who have supported and continue to support the micro/nano initiative at the University of Louisville.

EXPENDITURES

SALARIES AND BENEFITS (S&B)

Student	858.00
Temp	18,069.94
Health Insurance	133.76
FICA	1,382.36
	20,444.06

SUPPLIES AND EXPENSES (S&E)

Out -Of-State Air	331.80
Out -Of-State Hotel	808.76
Out -Of-State Misc.	437.84
Employee Recruitment	1,994.20
Laboratory	49,815.75
Chemicals	12,900.06
Compressed Gas (cylinders)	367.87
Liquid Nitrogen	53,870.45
Demurrage	2,005.22
Office Supplies	648.35
Instructional & Training	90.08
Software	431.74
Stockroom	150.19
Meeting	436.41
Maintenance Supplies	6,294.87
Computer	854.97
Criminal Background Checks	40.10
Freight	571.16
Overnight and Grant Mailings	1,999.47
Postal Service	196.75
IT-iTech Xpress	38.00
IT-Printing Svcs	658.00
IT-Copy Finishing Svcs	96.00
IT-Color Copies	90.00
IT-Long Distance & Grnt Appr.	100.02
IT-Cellphone Charges	809.09
IT-Pre Print Design	40.00
Physical Plant Services	2,300.67
IT-Network Base Infrastructure	1,932.00
IT-Install -Network Base Infra	75.00
Equipment Maint	31,205.50
IT Internal Print/Copy Usage	33.90
Computer Maint	99.95
Registration	695.00
Dues & Memberships	69.60
Parking	3.50
Promotional Activities	3,713.04
Business Meals	34.00
Publicity & Promotion	250.00
Prizes & Awards	75.55
UL Administrative Fee	16,654.71
TOTAL EXPENDITURES	213,663.63

INCOME

USER FEES

External	$67,216.48
Internal	$166,072.85
	$233,289.33
Surplus	**$19,625.70**

Table 1. The MNTC balance sheet for FY13.

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Julia W. Aebersold		01530			75,000.00
Michael D. Martin	GB100477	IB111308	E1239	E0372	53,001.00
Curtis P. McKenna		CS120662A	E1259		43,282.32
Wendy S. Metcalf		1026823	E1259	E0372	37,411.00
Donald H. Yeager		01530			53,136.96
TOTAL					**261,831.28**

Table 2. Salary subsidy from SSE for FY13.

Payroll Detail For:	S0083 FY13		
	Salary	Fringe	Total
Grothaus, Caitlin (Temp)	9,323.67	786.30	10,109.97
Moiseeva, Evgeniya (Temp)	3,849.62	307.62	4,157.24
Ratnayake, Dilan (Temp)	858.00	15.35	873.35
Watson, Mary (Temp)	4,896.65	406.85	5,303.50
TOTAL	**18,927.94**	**1,516.12**	**20,444.06**

Table 3. Salary expenses supported by the MNTC for FY12.
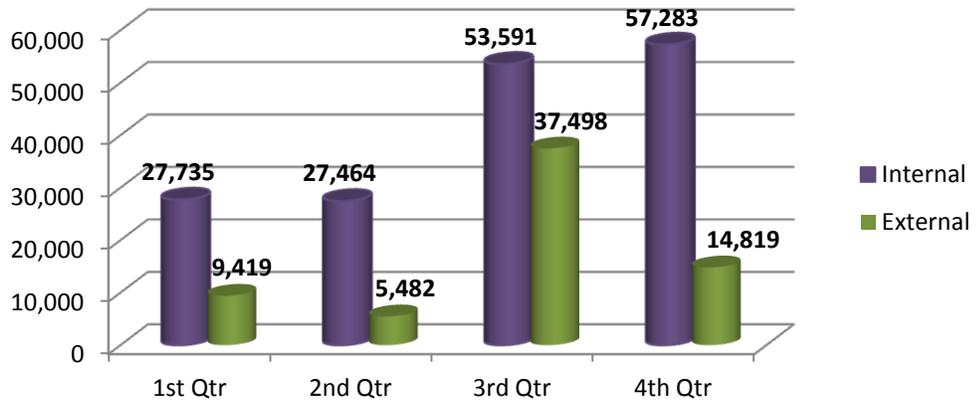
Total Amount of Internal Revenue = $166,073
Total Amount of External Revenue = $67,217
Total Amount of Revenue = $233,289

Figure 1.   Internal and external revenue generated each quarter for FY13.
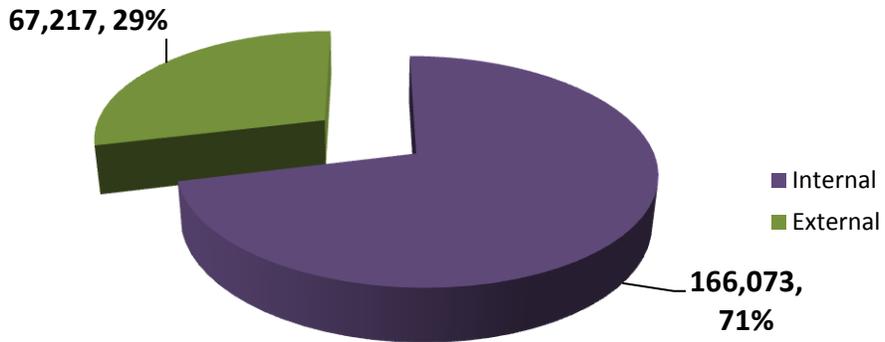
Total Amount of Revenue = $233,289

Figure 2. Total internal and external revenue generated in FY13.

1	Alphenaar	ECE	$1,200
2	Baldwin	CHEMISTRY	$50
3	Berfield	ME	$7,759
4	Burns	CHEMISTRY	$636
5	Bio-Engineering	BE	$3,000
6	Cardio. Innov. Inst (Drs. Boyd, Hoying & Keller)	MED	$4,467
7	Cohn	ECE	$550
8	ECE	ECE	$12,219
9	Fan	CHEMISTRY	$2,471
10	Foreman	ECE	$100
11	Fu	CHEM ENG	$9,784
12	Harnett	ECE	$19,965
13	Keynton	BE	$3,785
14	McCoy	CHEM ENG	$58
15	McNamara	ECE	$3,033
16	Naber	ECE	$80.00
17	Panchapakesan	ME	$14,614
18	Sethu	BE	$7,910
19	Walsh	ECE	$58,676
20	Williams	ME	$13,346
21	Zamborini	CHEM	$2,371
	TOTAL		$166,073

Table 4.   Internal faculty clients for FY13.
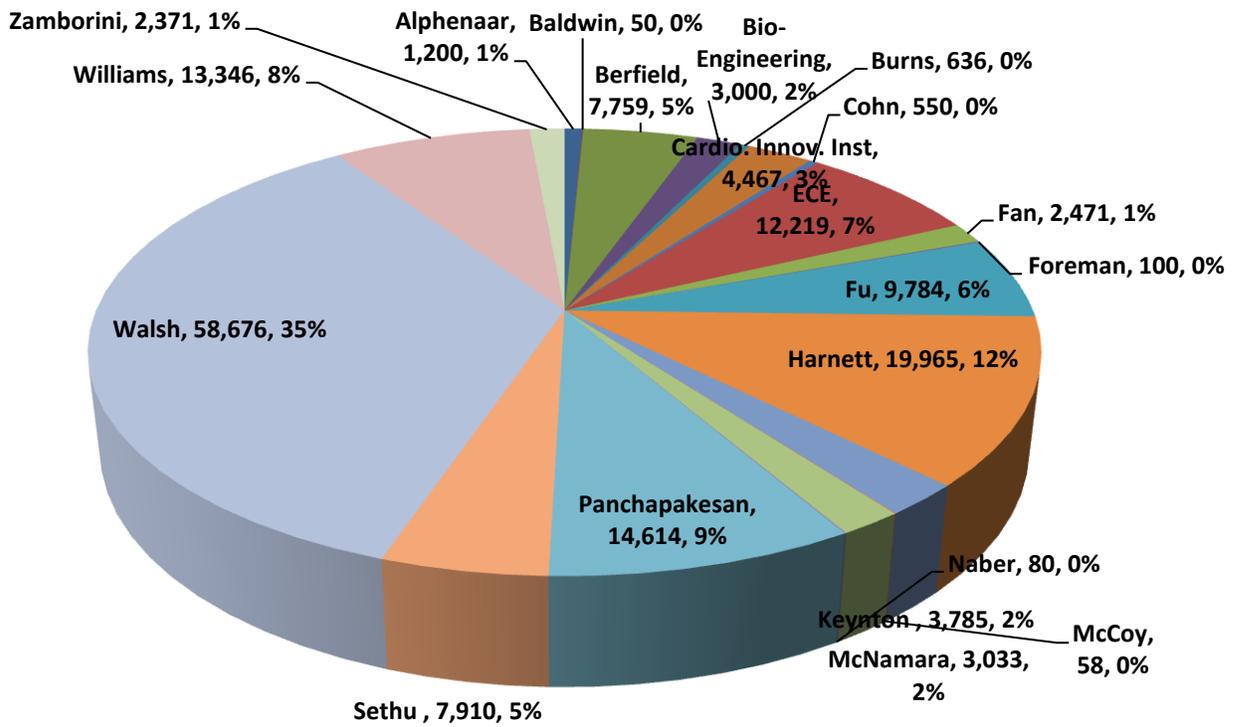
Figure 3. Internal clients by amount and percentage for FY13.
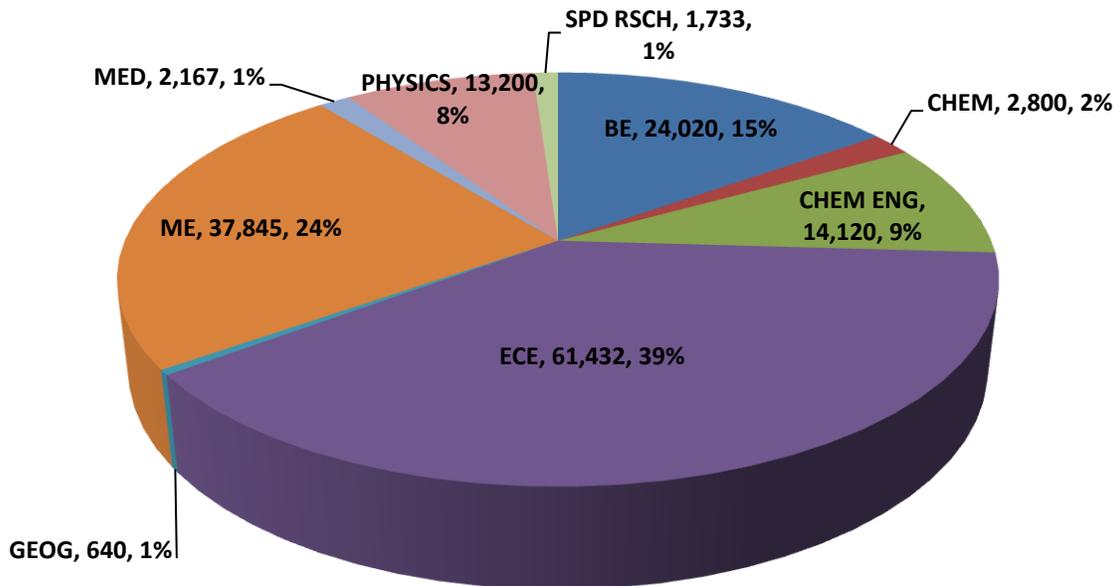
Total Amount of Internal Revenue = $166,073

Figure 4. Internal revenue from departments by amount and percentage for FY13.

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1. AC-Forensics, Inc.	566.00
2. Advanced Semiconductor	188.00
3. ALCAVIS HDC	210.00
4. Aslan, Mustafa	6,721.60
5. Birck Nanotechnology Center	362.00
6. Brockman-Hastings LLC	4,211.00
7. Ducommun	1,723.03
8. Hastings	138.52
9. Honeywell, Inc.	7,706.00
10. Lenox Laser	402.00
11. Matt Dieruf	250.00
12. Moxtek	19,123.50
13. Nauganeedles, LLC	9,456.00
14. Promerus, LLC	2,031.69
15. PureLight Labs, LLC	3,064.00
16. QuSwami, Inc.	4,409.16
17. Science Exchange	128.00
18. The MicroWerks, LLC	2,255.00
19. UK-Boyd	137.74
20. UK-Li	292.94
21. UK-May	453.72
22. UK-Shin	479.58
23. UK-Trinkle	774.07
24. University of Minnesota, NFC	877.75
25. Western Kentucky University	1,255.18

Total Amount of External Revenue = $67,217

Table 5.   External clients for FY13.
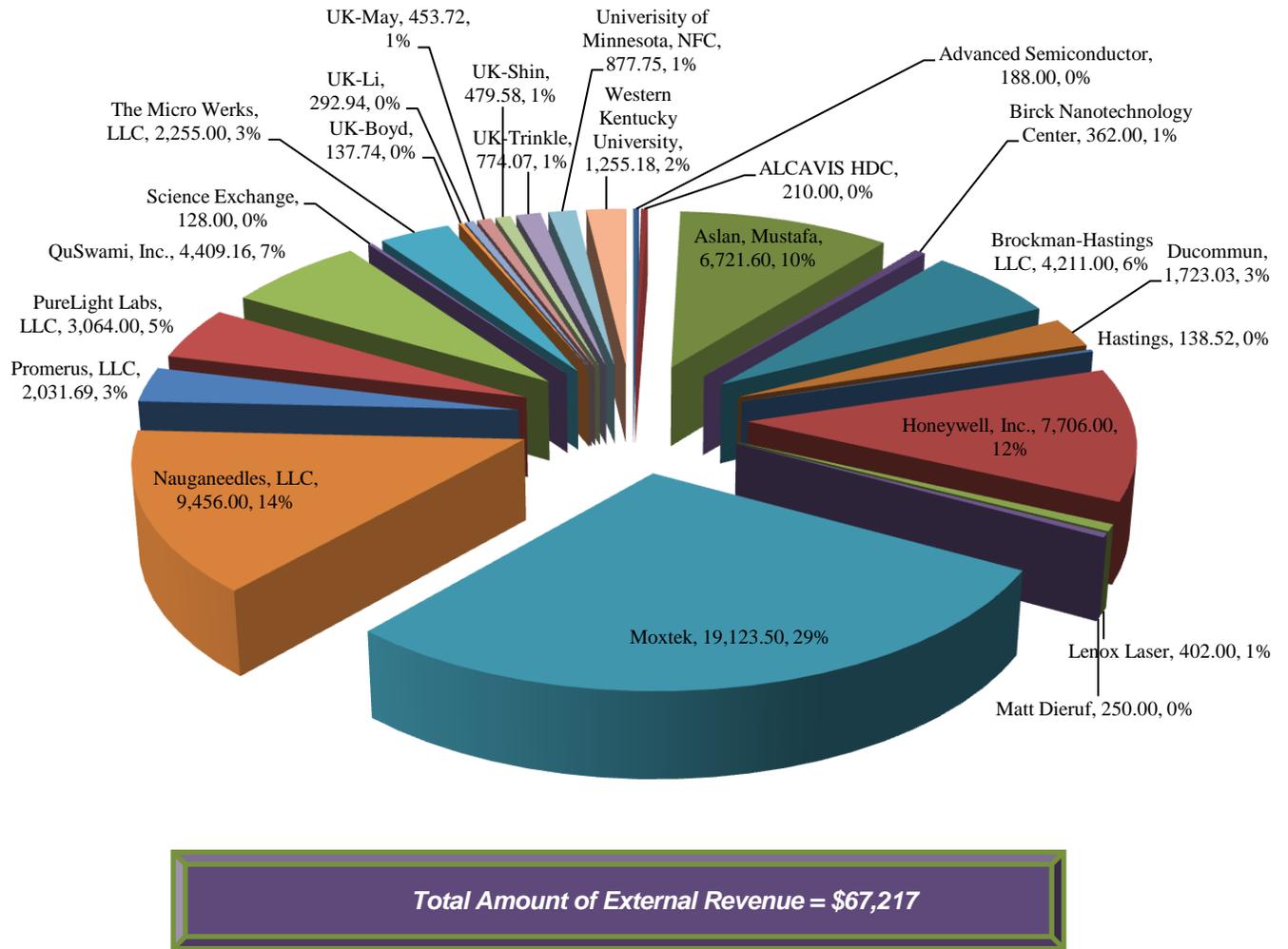
Figure 5. External clients by amount and percentage in FY13.

Faculty Advisors	Department	Students/Post Docs/Researchers	
Dr. Bruce Alphennar	ECE	Abeyweera	Buddika K
Dr. Richard Baldwin	CHEM	Beharic	Jasmin
Dr. Thomas Berfield	ME	Benken	Alex
Dr. Chris Burns	CHEM	Boden	Seth
Bioengineering	BE	Burkhead	Thomas
*Cardiovascular Innovation Institute	School of Med	Chen	Jubin
* Dr. Nolan Boyd	School of Med	Crain	Mark
* Dr. James B. Hoying	School of Med	Cuba Garcia	Vasili
* Dr. Brad Keller	School of Med	Estrada	Rosendo
Dr. Robert Cohn	ECE	Faiz	Abderrazzak
Electrical & Computer Engineering	ECE	Faul	Andre
ECE 544	ECE	Heacox	Kurtis
Dr.Theresa Fan	CHEM	Hopkins	K.
Dr. Chris Foreman	ECE	Khosravi	Farhad
Dr. Xiaoan Fu	CHEM ENG	King	Benjamin C.
Dr. Cindy Harnett	ECE	Li	Mingxiao
Dr. Robert Keynton	BE	Lin	Ji-Tzuoh (George)
Rodica McCoy	CHEM ENG	Long	Juexuan
Dr. Shamus McNamara	ECE	Loomis	Robert J.
Dr. John Naber	ECE	Lucas	Thomas
Dr. Balaji Panchapakesan	ME	Marei	Mohamed
Dr. Palaniappan Sethu	BE	Martin	Michael D.
Dr. Kevin M. Walsh	ECE	Miller	Kane J.
Dr. Stuart Williams	ME	Moiseeva	Evgeniya V.
Dr. Francis Zamborini	CHEM	Nguyen	Dung M.
		Ogunwale	Mumiye A,
		Osborne	Christopner
		Pantibandla	Phani Kumar
		Parichehreh	Vahidreza
		Phelps	Isaac J
		Porter	Daniel
		Ratnayake	Dilan
		Rinehart	Sean M
		Senousy	Yehya
		Smith	Daniel
		Smith	Scott
		Snatchko	Bryan R
		Sun	Xinghua
		Trada	Hiren V.
		Velasco	Vanessa
		Wolf	Rob
		Wolsiefer	Amanda I
		Xu	Peng
		Yuan	Hanwen
		Zhu	Li

Table 6. A summary all internal users for FY13.

Total Internal Income = $1,334,090
Total External Income = $373,054
Total Income = $1,707,144
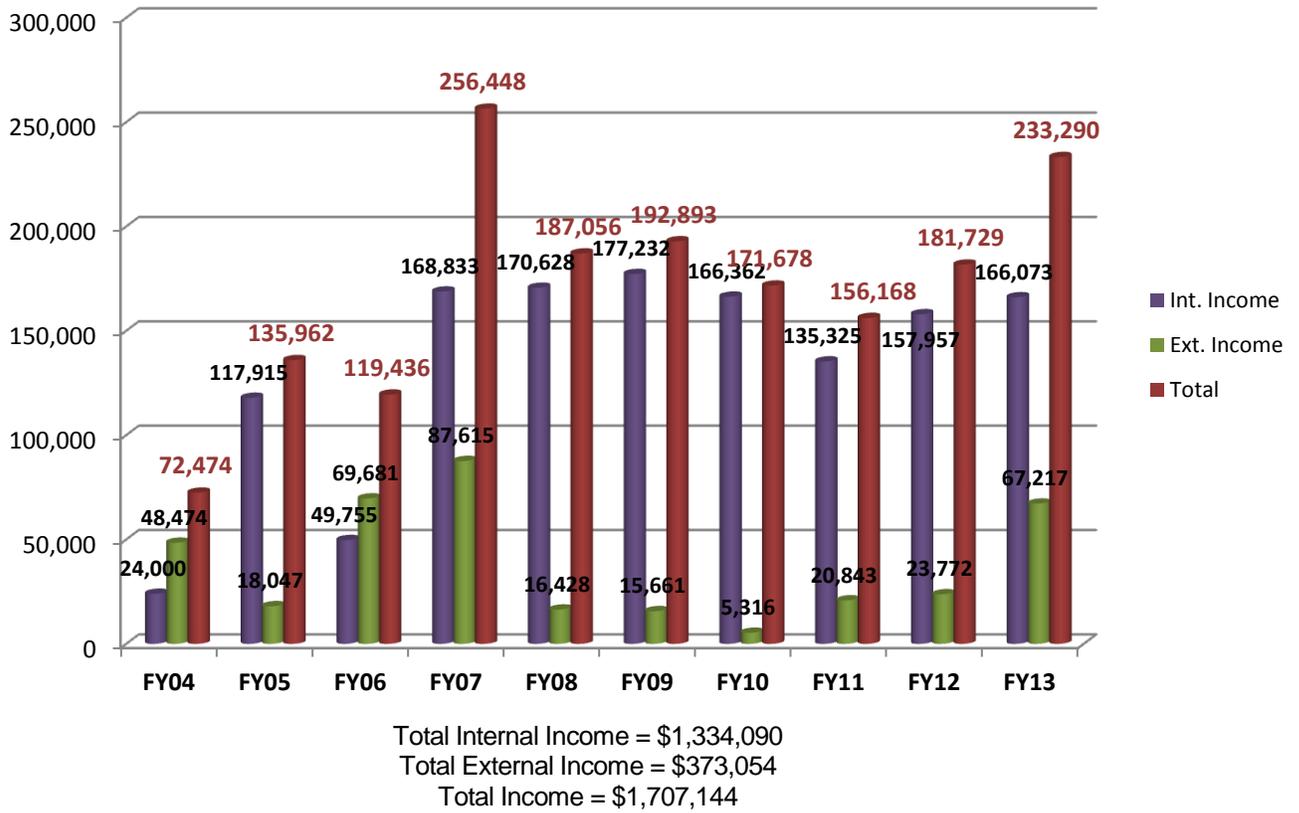
Figure 6. Annual comparison of internal and external income from FY04 through FY13.

Total Other Expenses = $1,321,214
Total Salary = $367,917
Total Expenses = $1,689,131
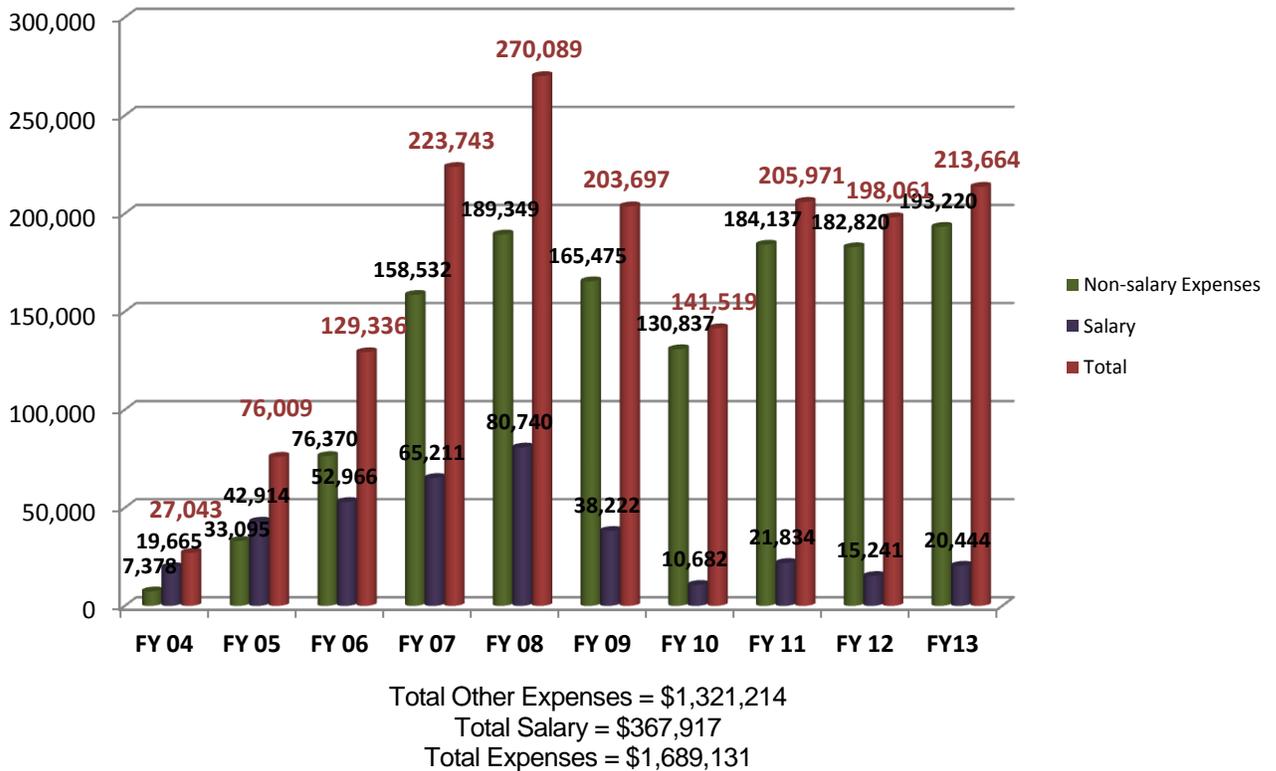
Figure 7. Annual comparison of operational and salary expenses for FY04 through FY13.

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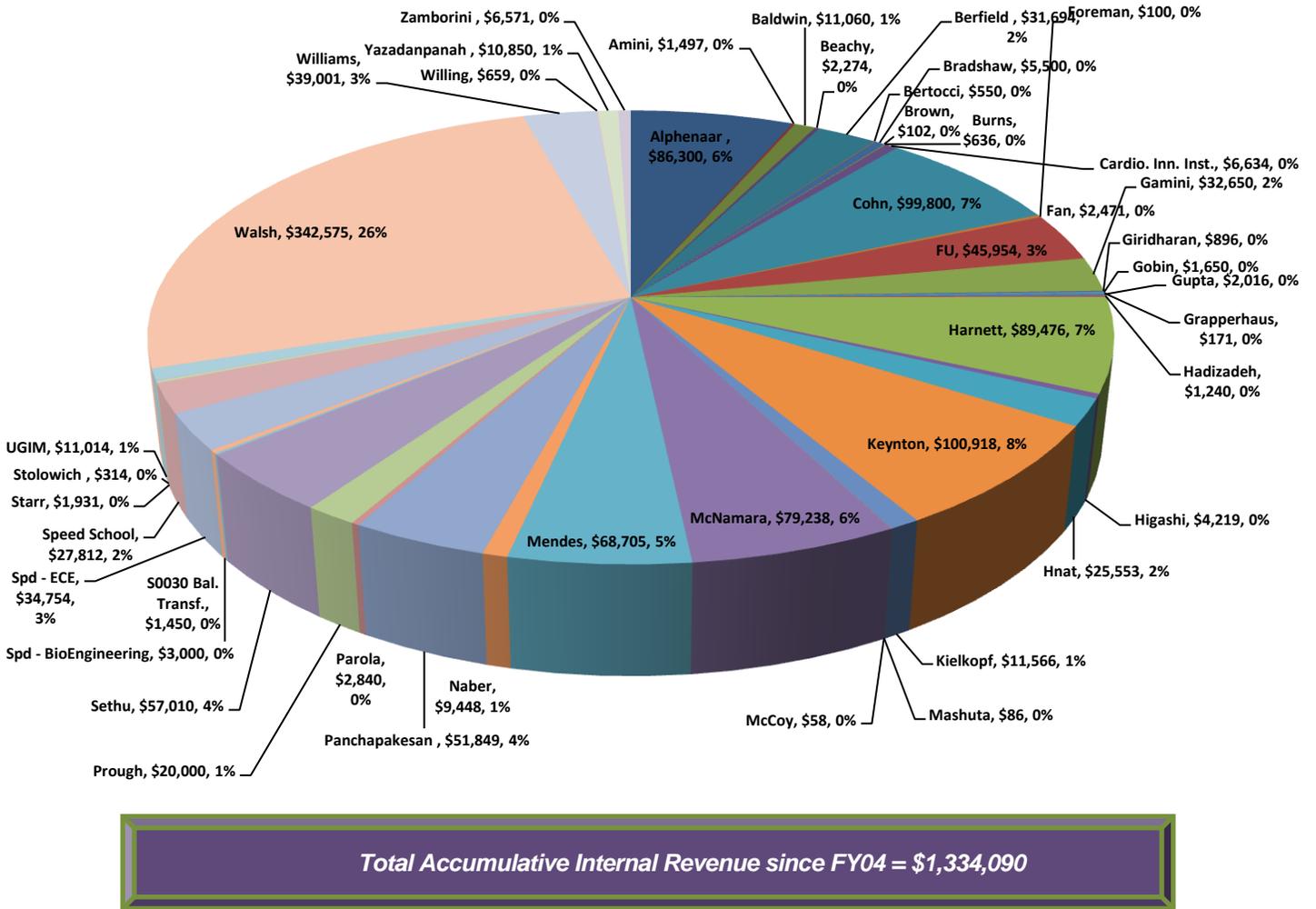
Figure 8. Cumulative income for internal clients from FY04 through FY13.

Total Accumulative Internal Revenue since FY04 = $1,334,090

STEAM INST., $2,840, 0%
PHARM, $2,016, 0%
SPD RESEARCH, $1,931, 0%
SPD SCHOOL, $27,812, 2%
UGIM, $11,014, 1%
BIOCHEM, $20,000, 1%
SCH OF PUB HLTH, $2,274, 0%
MED, $6,634, 0%
GEOGRAPHY, $1,240, 0%
EDUC., $102, 0%
MECH ENG., $154,147, 12%
PHYSICS, $112,921, 8%
BE, $163,474, 12%
CHEM ENG., $46,671, 3%
CHEM, $25,527, 2%
ECE, $755,487, 57%
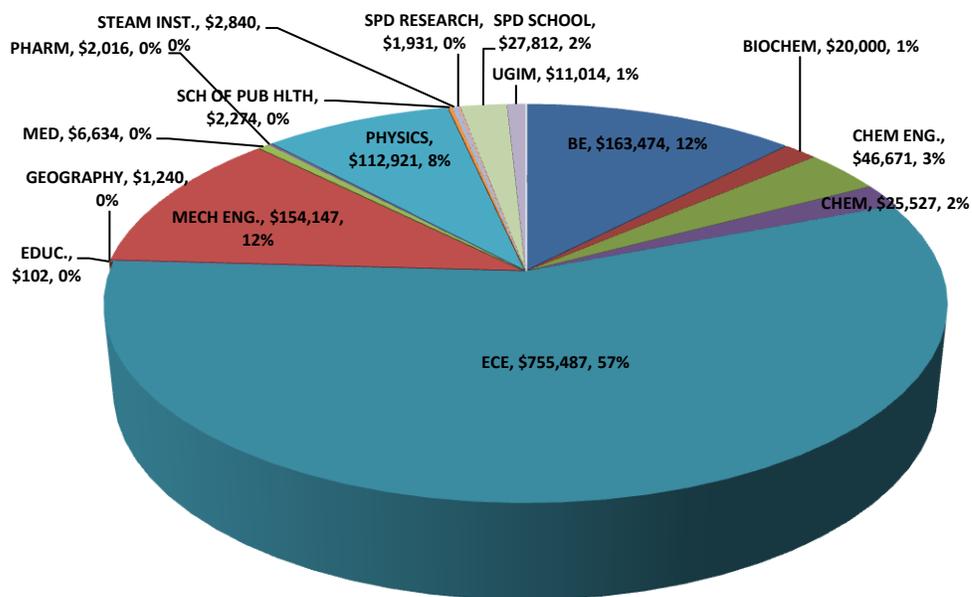
Total Accumulative Internal Revenue since FY04 = $1,334,090

Figure 9. Cumulative internal income by department from FY04 through FY13.
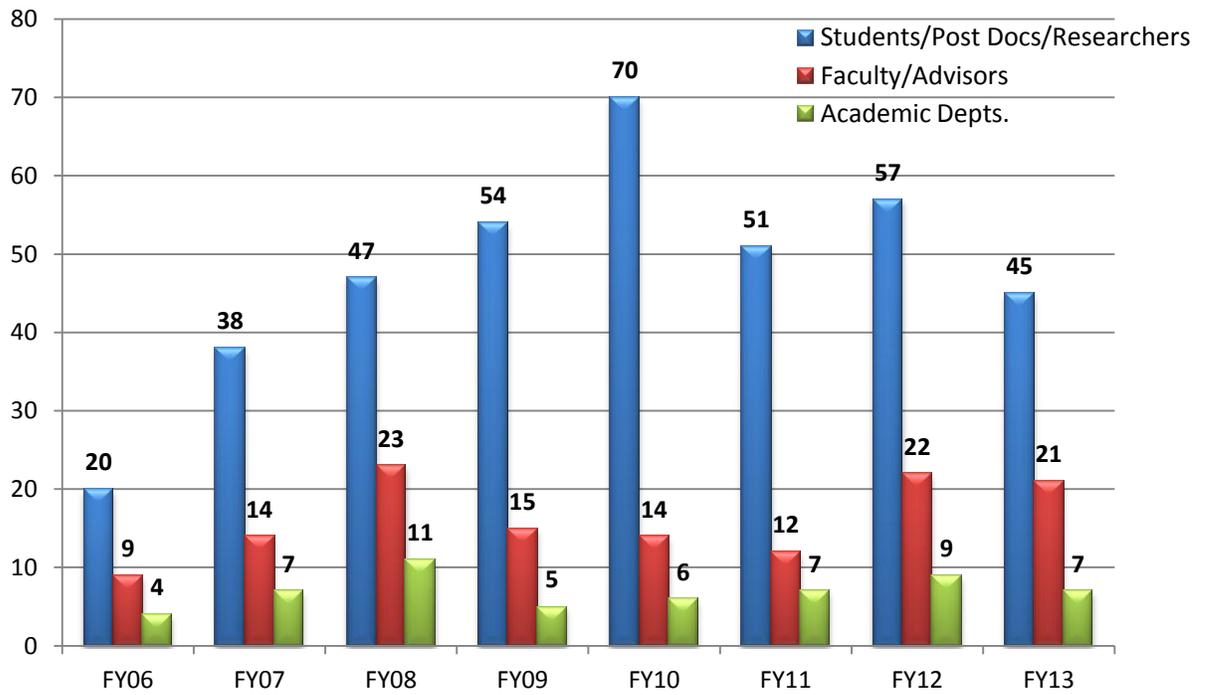
	Students/Post Docs/Researchers	Faculty/Advisors	Academic Depts.
FY 06	20	9	4
FY 07	38	14	7
FY 08	47	23	11
FY 09	54	15	5
FY 10	70	14	6
FY 11	51	12	7
FY 12	57	22	9
FY 13	45	21	7

Figure 10. Cleanroom access from FY06 through FY13.

University of Akron, $169,311, 0%

University of Arizona, $169,538, 0%

Universal Technology Corporation, $18,025, 0%

S.W.R.I., $193,253, 0%

Startups, $678,252, 1%

Oregon State University, $226,529, 0%

Purdue University/NIH, $62,000, 0%

NIH, $2,233,638, 4%

National Inst. For Hometown Sec., $1,610,350, 3%

NASA, $2,208,792, 4%

LECO Corporation, $71,939, 0%

National Heart Association, $77,000, 0%

KyEPSCor, $602,180, 1%

Ky Science & Technology Corp., $180,000, 0%

Ky Science & Engineering Foundation, $609,961, 1%

Ky Council on Postsecondary Ed., $842,592, 1%

Honda Research Institute United States, $532,240, 1%

Federal Contractor 1, $1,362,467, 2%

EPA, $1,341,200, 2%

DOJ, $500,000, 1%

DOE, $1,780,802, 3%

DOD, $19,537,226, 33%

University of Kentucky Res. Fdn., $13,455,747, 23%

NSF, $7,542,707, 13%

Western Ky University, $21,000, 0%

Wallace H. Coulter Foundation, $118,600, 0%

US Air Force Research Laboratory, $499,905, 1%

American Chemical Society, $200,000, 0%

Bill & Melinda Gates Foundation, $484,000, 1%

Department of Health & Human Services, $1,672,062, 3%

Total Grant Dollars: $59,001,317

Figure 11.   Accumulative grant funding utilizing the MNTC from October 2001 through FY13.

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|	Speedtype	Funding Source	Grant Agency	Fac.	PI	Dept	Title	Start Date	End Date	Total Grant Dollar Amount	Total Amt. to Service Center
Alphenaar	GB090532	Grant	NSF	Alphenaar	Alphenaar	ECE	Enhancement of Exciton Dissociation in Organic Solar Cell	9/1/2009	8/31/2013	339,048.00	1,100.00
Alphenaar	GB120197	Grant	Kentucky Science & Technology Cor	Alphenaar	Alphenaar	ECE	Commercialization of the Ambi-Harv Energy Harvesting Mod	10/1/2011	9/30/2012	75,000.00	100.00
Berfield	GB110924	Grant	NSF	Berfield	Berfield	ME	Micro-Patterning Through Mechanics and Cracking of Drying	9/1/2011	8/31/2014	250,000.00	7,759.00
Burns	GB100490	Grant	American Chemical Society	Burns	Burns	Chemistry	Periodic MesoporousSilicas as Supports for Late Metal	8/1/2010	8/31/2013	100,000.00	456.00
Cohn	GB080292	Grant	National Inst. For Hometown Sec.	Cohn	Cohn	ECE	Optical Alarm for Defense of Critical Infrastructure	4/3/2009	6/30/2013	1,610,350.00	550.00
Fan	GB130027B1	Grant	Ky Council on Postsecondary ED	Fan	Miller	MED	KLCRP FY13 and FY14 Funding-Early Detection	10/1/2012	6/30/2014	842,592.47	2,471.00
Fu	GB111304B	Grant	Bill & Melinda Gates Foundation	Fu	Graham	Microbiology	Disposable sampling plate andf breath test to patients	10/13/2011	12/31/2013	48,400.00	8,419.00
Harnett	GB090786	Grant	Kentucky Science & Engineering Fdn.	Harnett	Harnett	ECE	Computer Aided Optimal Design of a MicroFluidic Coulter	7/1/2009	9/30/2012	99,943.00	4,306.00
Harnett	GB101062	Grant	Oregon State University	Harnett	Harnett	ECE	Characterizing the Phytoplankton Component of Oceanic Pa	9/1/2010	7/31/2013	226,529.00	835.00
Harnett	GB110782	Grant	Kentucky Science & Engineering Fdn.	Harnett	Harnett	ECE	Emerging Ideas: Light-Powered Hybrid Microactuators for	7/1/2011	9/30/2014	90,000.00	4,048.00
Harnett	GB120654	Grant	University of KY Res Fdn	Gobin	Gobin	BE	Engineering Platforms for Exploring Cellular (Federal)	9/1/2008	8/31/2013	712,473.00	1,036.00
Harnett	GB120654A	Grant	University of KY Res Fdn	Harnett	Gobin	BE	Engineering Platforms for Exploring Cellular (State)	9/3/2011	8/31/2013	196,062.00	2,014.00
Hoying	GB101087	Grant	University of Arizona	Hoying	Hoying	CII	Theoretical and Experimental Investigations of Architect	8/1/2010	7/31/2012	169,538.00	3,162.00
Keynton	GB101259	Grant	NASA	Keynton	Keynton	BE	Diagnosing & Mitigating Human Exposure to Radiation	9/1/2010	8/31/2012	2,000,000.00	435.00
McNamara	GB110376	Grant	NIH	Panchapakesan	Panchapakesan	ME	Nanotube Antibody for Profiling Circulating Disease	8/9/2011	7/31/2014	422,722.00	1,450.00
McNamara	GB111027	Grant	NSF	McNamara	McNamara	ECE	Nano-Porous Thermoelectric Based Knudsen Gas P	9/1/2011	8/31/2014	289,249.00	165.00
McNamara	GB120654A	Grant	University of KY Res Fdn	McNamara	Gobin	BE	Engineering Plateforms for Exploring Cellular (State)	9/3/2011	8/31/2013	196,062.00	2,868.00
Panchapakesan	GB110376	Grant	NIH	Panchapakesan	Panchapakesan	ME	Nanotube Antibody for Profiling Circulating Disease	8/9/2011	7/31/2014	422,722.00	3,070.00
Panchapakesan	GB120456	Grant	NSF	Panchapakesan	Panchapakesan	ME	GOAL 1: High Aspect Ration Nano-Needle Integrated Standin	6/1/2012	5/31/2015	353,004.00	510.00
Panchapakesan	GB121045	Grant	NSF	Panchapakesan	Panchapakesan	ME	Scalable Nanomanufacturing of nano-carbon based composite	9/1/2012	8/31/2016	353,054.00	230.00
Sethu	GB111336	Grant	University of Akron	Sethu	Sethu	BE	A Novel, In vitro Platform for Correlating and Quantifying	5/1/2012	4/30/2015	169,311.00	895.00
Sethu	GB120654A	Grant	University of KY Res Fdn	Sethu	Gobin	BE	Engineering Plateforms for Exploring Cellular (State)	9/3/2011	8/31/2013	196,062.00	7,910.00
Sunkara	GB120700	Grant	University of KY Res Fdn	McCoy	Sunkara	Chem Eng	DOE EPSCoR Renewal: Nanoscale Materials and Architecture	7/15/2011	7/14/2014	1,128,000.00	58.00
Walsh	GB120662A	Grant	University of KY Res Fdn	Walsh	Walsh	ECE	(STATE) KY nanoNet: A Statewide Integrative Micro/Nano	9/1/2011	12/31/2013	125,475.00	125.00
Walsh	IB111308	Contract	Federal Contractor 1	Walsh	Walsh	ECE	MEMS Sensor Research	1/9/2012	3/11/2014	1,362,467.00	55,380.50
Walsh	IB130440	Contract	Universal Technology Corporation	Walsh	Walsh	ECE	Photonic Heterodyne Detector	11/16/2012	8/15/2013	18,025.00	3,737.00
Williams	GB110798	Grant	Kentucky Science & Engineering Fdn.	Williams	Williams	ME	Dielectrophoretic Nanoneedles for Trapping and Character	7/1/2011	6/30/2013	80,000.00	3,105.00
Zamborini	GB090171	Grant	National Science Fdn	Zamborini	Zamborini	Chem	Electrochemical Oxidation and Sensing/Molecular Electron	7/1/2009	2/28/2013	330,000.00	1,021.00
Zamborini	GB110497	Grant	American Chemical Society	Zamborini	Zamborini	Chemistry	Electrochemically Controlled Alkene Binding Affinity Of	8/1/2011	8/31/2014	100,000.00	1,349.00
Zhang	GB081337	Grant	NIH	Zhang	Zhang	Chemistry	Mass Informatics for Two Dimensional Gas Chromatography	5/1/2009	4/30/2014	1,388,194.00	228.00
Zhang	IB120773	Contract	LECO Corporation	Zhang	Zhang	Chemistry	Development of Peak Alignment Methods for High-Resolution	4/1/2012	3/31/2013	71,939.00	370.50
										13,962,281.47	125,277.00

Table 7. U of L sponsored research utilizing the MNTC in FY13.