

**UofL Micro/Nano Technology Center
Annual Report
FY2012**

Dr. Kevin Walsh, Director
Dr. Shamus McNamara, Associate Director
Dr. Julia Aebersold, Cleanroom Manager
Wendy S. Metcalf, Administrative Associate
Don Yeager, Technical Staff and Facilities Coordinator
Michael Martin, Technical Staff
Curtis McKenna, Technical Staff and Outreach Coordinator
Caitlin Grothaus, 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 sq. ft. cleanroom facility for the fabrication of novel materials and devices, a 1,000 sq. ft. packaging and characterization lab, and a 300 sq. ft. modeling and simulation Lab. This diverse multi-user core facility is utilized for both research and teaching. This document serves as its official annual report for the fiscal year ending June 30, 2012. Below is summarized the financial and operational activities for the center during that period.

FINANCIAL SUMMARY

The MNTC ended FY12 with a deficit of \$16,498 compared to a deficit of \$49,803 in FY11. Details of our financial year follow.

Table 1 presents the overall financial status of the MNTC for FYE 6/30/12. Expenditures for 2012 were \$198,227 and revenues were \$181,729, resulting in a \$16,498 deficit for the fiscal year. Unsubsidized salaries for 2012 were \$14,671 and Fringe Benefits were \$569 for a total of \$15,241 (Table 2), a significant decrease from FY11 (\$21,834). Our largest expenditures were liquid nitrogen (\$43K), laboratory supplies (\$23K), and chemicals (\$29K). The university increased the administrative fee on expenses to 10% (\$16K).

Revenue for the MNTC by quarter is shown in Figure 1 and a summary is displayed in Figure 2. Of our total revenue of \$181K, 87% or \$157K came from internal users. A list of internal faculty users along with their department affiliation and revenue contribution appears in Table 3 and Figure 3. Figure 4 breaks down our internal revenue by department, showing that 39% was generated by ECE faculty. A list of external users appears in Table 4 and external revenue (\$23K) is displayed in Figure 5. Table 5 presents a comprehensive list of all MNTC internal clients in FY12.

Comparisons of FY04 through FY12 are presented next. As shown in Figure 6, total income increased in FY12 by \$22K from the previous year, and external income increased \$3K from the previous year. Figure 7 shows that expenses in FY12 decreased by \$8K from the previous year.

Figure 8 presents Total Income from Internal Users (\$1,106,007) since FY04. The top 5 faculty users of the MNTC are Dr. Walsh of ECE (\$283K), Dr. Cohn of ECE (\$99K), Dr. Keynton of BE (\$97K), Dr. Alphenaar of ECE (\$85), and Dr. McNamara of ECE (\$76K).

Figure 9 presents Total Internal Income (\$1.16M) by Department since FY04. The dominant department continues to be ECE at \$659K or 56%, followed by BE at 13%, Physics at 10%, ME at 10%, and Chem Engineering at 3%.

Figure 10 shows the number of departments, faculty, students, post docs and researchers who have annually used the cleanroom since FY06. The number of students/researchers/post docs who utilize the facility increased slightly from 51 to 57 in FY12. The number of faculty users increased from 12 to 22 and departments increased slightly from the previous year.

Figure 11 shows the total Grant Revenue that has come into the University of Louisville as a result of grants which have used the cleanroom since 2001. This amount is a staggering \$51.3M with 38% coming from DOD and 15% from NSF. A significant portion of this funding would not have been possible without the unique resources of our micro/nano cleanroom facility.

Finally, Table 6 shows the leveraging ability of the MNTC. Sponsored research into the University which utilized the MNTC in FY12 was an amazing \$6,911,059. Of that outstanding amount, \$84,954 (1.23%) was used for cleanroom user fees.

Not captured in the MNTC Balance Sheet shown in Table 1 is the “*staff subsidy*” which the cleanroom receives through the Speed School of Engineering. The Speed School provides CAR funding (continuing annual resources or hard money) for an administrative position (Wendy Metcalf), three technical support position (Don Yeager , Mike Martin and Curt McKenna), and a managerial position (Julia Aebersold). In total, our staff of 5 positions comes to approximately \$253K of support (including fringe benefits). Such human resource support is vital for the continued success of the MNTC. The MNTC operates all of its ~\$20M of capital equipment without any annual maintenance contracts. We therefore rely on our experienced technical staff to keep our sophisticated equipment operational, ensure personnel safety, and provide ongoing training to our nearly 100 total cleanroom users. Although these staff numbers are a bit on the low side when compared to other university cleanrooms of our size (10,000 sq. ft.), we are confident in our ability to deliver a safe and quality product to our user base with a staff of this size.

OPERATIONAL SUMMARY

The last fiscal year of the MNTC cleanroom saw major changes in operations and personnel. In February of the 2012 fiscal year, a new cleanroom manager was hired after a national search (Dr. Julia Aebersold). A review of the facility was performed and below is a listing of items implemented since the beginning of February.

New Rate Structure

After a review of MNTC operations and consultation with our new Dean of Engineering, it was determined that we should modify our existing rate structure so that it is more consistent with other comparable facilities. The new rate structure was modeled from other academic cleanrooms where charges were based upon objective usage data including access, materials and supply usage, and equipment usage as opposed to our previous subjective 3-tier usage system. The new rate structure was designed in FY12 and scheduled for implementation in Sept of FY13. Appendix 1 provides details about the new charging structure.

Equipment Installations

A grant from the Kentucky Experimental Program to Stimulate Competitive Research (KY EPSCoR) allowed the purchase a Trion Gas Metal Etching System. This dry etch tool expands the capabilities of the cleanroom to include chlorine-based etch recipes to dry etch a multitude of films including chrome (for photomasks), gallium nitride, platinum, polysilicon, titanium, tantalum, tungsten, etc. An updated scrubber and booster fan was added to the Oxford Plasma Enhanced Chemical Vapor Deposition (PECVD) system to improve safety. This system will prevent the accidental / catastrophic release of toxic gases going to the PECVD into the atmosphere. Adding these safeguards enables P and N doping processes at the PECVD, which can be directly applied for the development of solar cells and other green technologies.

Faculty Advisory Board (FAB)

A faculty advisory board (FAB) was developed to establish a dialogue between the MNTC staff and faculty users to communicate events and discuss issues in the cleanroom. Outcomes from the FAB meetings included reprogramming the bioMEMS bay for PDMS processing. As a result, the MNTC staff has become proficient in PDMS soft lithographic techniques, which has generated additional revenue from internal and external clients.

Visual Changes & Outreach

A variety of visual changes and outreach activities occurred in FY12 to inform the general public about the existence of the cleanroom and its capabilities. The MNTC website was updated so one can easily locate equipment capabilities and rates. Standard operating procedures (SOPs) were updated. The MNTC also established a presence on the Science Exchange website to offer its microfabrication capabilities to other academic and business entities. The lobby of the Shumaker Research Building was revamped with visual aids to better promote the cleanroom and its activities. This included new banners, displays, signs and changing the content on the lobby monitor. Plans for the upcoming year are to continue many of the above efforts and to develop a new video focused upon the capabilities of the cleanroom which should help generate interest from non-traditional cleanroom users.

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

Table 1. Financial Status of the MNTC Service Center FYE 6/30/12

Micro/NanoTechnology Cleanroom Balance Sheet

EXPENDITURES

SALARIES AND BENEFITS (S&B)

Student	10,059.83
Temp	4,611.55
Health Insurance	67.50
FICA	501.96
	15,240.84

SUPPLIES AND EXPENSES (S&E)

Out -Of-State Air	469.00
Laboratory	23,476.21
Chemicals	29,764.88
Compressed Gas (cylinders)	3,009.31
Liquid Nitrogen	43,933.75
Demurrage	2,477.29
Office Supplies	1,231.66
Non-Library Books & Binding	285.89
Software	101.92
Stockroom	374.12
Meeting	461.32
Maintenance Supplies	9,413.73
Computer	1,391.99
Equipment	15,996.26
Overnight and Grant Mailings	899.87
Postal Service	71.62
Photo Duplicating/Reprints	287.84
IT-iTech Xpress	517.50
IT-Printing Svcs	1,343.04
IT-Copy Finishing Svcs	165.50
IT-Voice Network Monthly	282.00
IT-Color Copies	170.00
IT-Cellphone Charges	576.81
IT-Data Network Monthly	750.00
IT-Pre Print Design	187.50
Physical Plant Services	325.39
IT-Voice Mail Svcs	36.00
IT-uConnect Data Monthly	300.00
IT-uConnect Voice Monthly	564.00
Equipment Maint	7,605.35
IT Internal Print/Copy Usage	453.92
Software Maint	1,144.00
Insurance TGM Satellite repair	16,371.14
Prizes & Awards	83.98
Insurance Recoveries	(17,955.00)
Transfers	20,367.00
UL Administrative Fee	16,051.58

TOTAL EXPENDITURES

198,227.21

INCOME

USER FEE

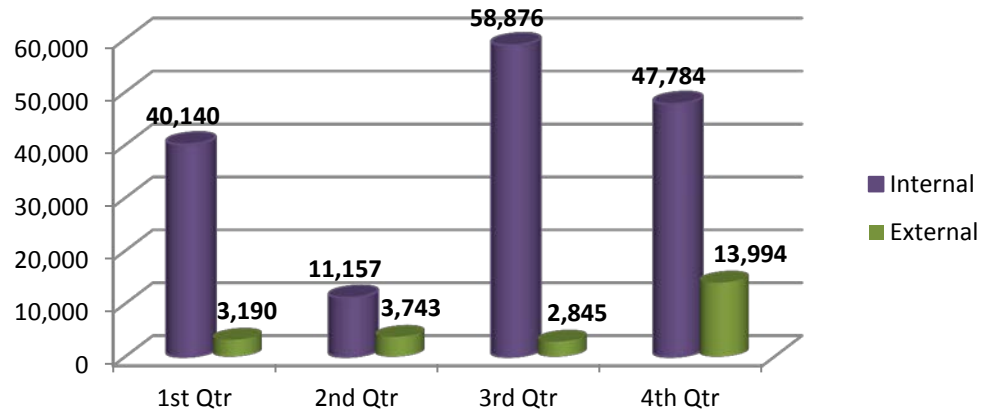
External	(23,771.63)
Internal	(157,957.32)
	(181,728.95)

Deficit **-16,498.26**

Table 2 . Salaries for FY12

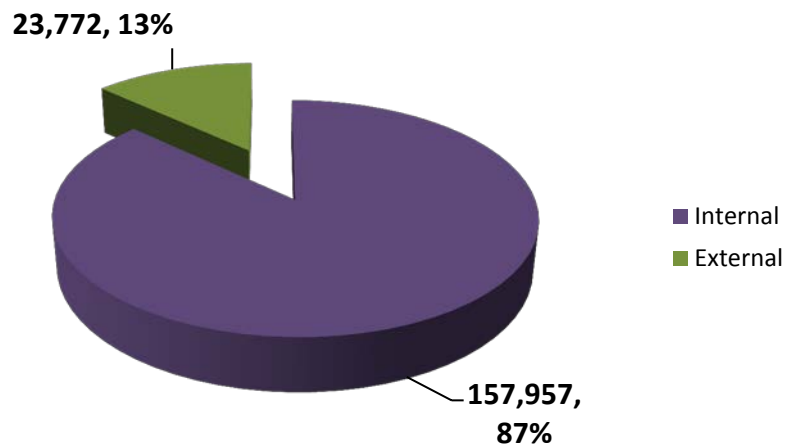
Payroll Detail For:	S0083 FY 12		
	Salary	Fringe	Total
Grothaus, Caitlin (Part-time)	11,624.88	320.21	11,945.09
Russell, Zachary (Co-Op)	3,046.50	249.25	3,295.75
TOTAL	14,671.38	569.46	15,240.84

Figure 1. Internal and External Revenue Generated by Quarter for FY12



Total Amount of Internal Revenue = \$157,957.32
Total Amount of External Revenue = \$23,771.63
Total Amount of Revenue = \$181,728.95

Figure 2. Total Internal and External Revenue Generated in FY12



Total Amount of Revenue = \$181,729

Table 3. Internal Faculty Users in FY12

Baldwin	CHEMISTRY	\$600
Berfield	ME	\$8,505
Bertocci	ME	\$550
Cardio. Innov. Inst (Drs. Boyd & Hoying)	MED	\$2,167
Cohn	ECE	\$5,150
ECE	ECE	10,195
Fu	CHEM ENG	\$14,120
Gobin	BE	\$1,650
Hadizadeh	GEOGRAPHY	\$640
Harnett	ECE	\$14,823
Keynton	BE	\$15,220
McNamara	ECE	\$3,420
Mendes	PHYSICS	\$13,200
Naber	ECE	180.00
Panchapakesan	ME	\$11,385
Sethu	BE	\$7,150
Starr	SPD	\$1,733
Walsh	ECE	27,664
Williams	ME	\$17,405
Zamborini	CHEM	\$2,200
TOTAL		\$157,957

Figure 3. Internal Users in FY12

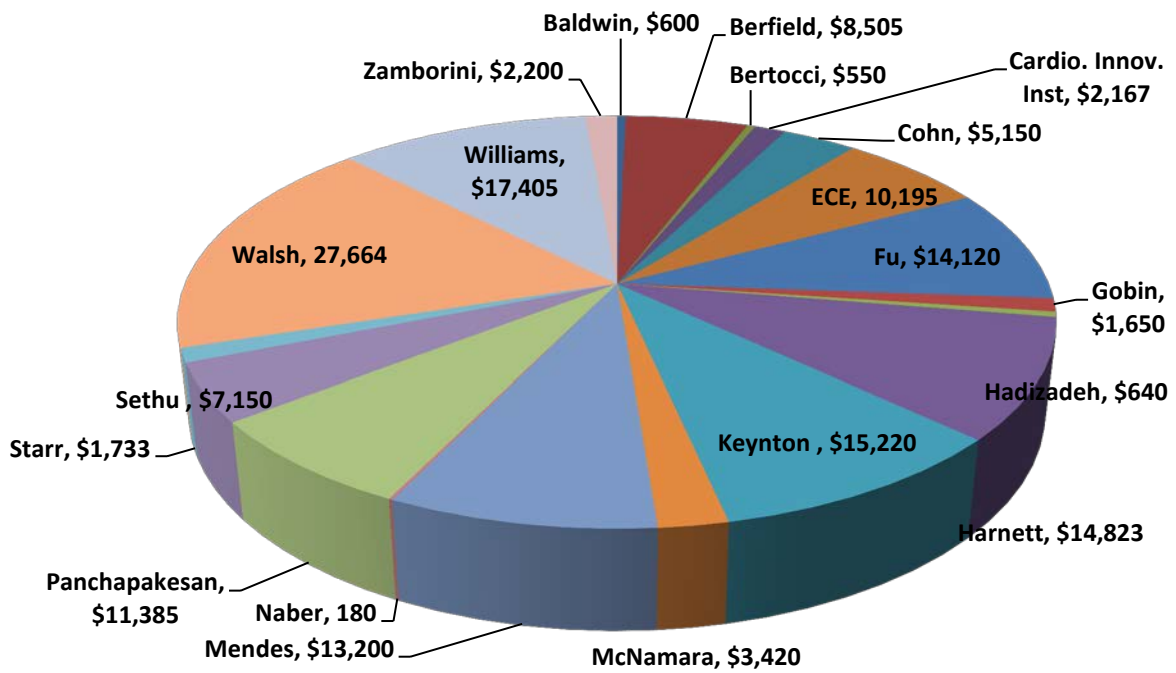
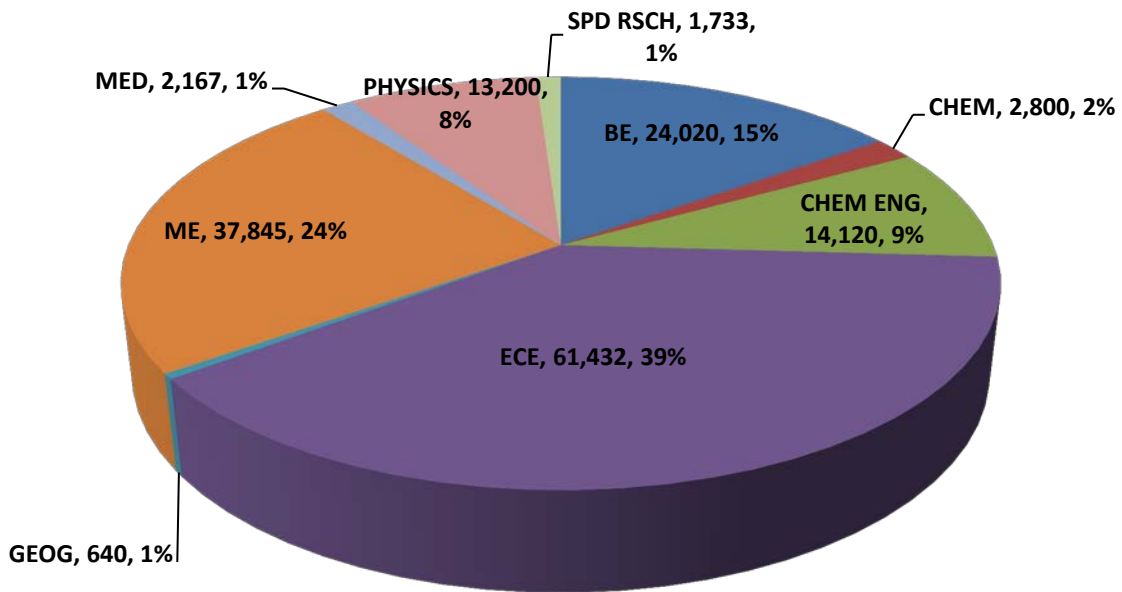


Figure 4. Internal Revenue by Departments in FY12



Total Amount of Internal Revenue = \$157,957

Table 4. External Users in FY12

AC Forensics	\$2,715
Company #1	\$1,038
Aslan, Mustafa	\$344
Clemson University	\$762
Honeywell	\$4,250
JFN Designs, Inc.	\$1,500
Lytzamed Santo Olivo	\$1,100
Nauganeedles	\$644
NOMAD	\$410
Company #2	\$1,313
The Micro Werks, LLC	\$6,536
Ultra Trace Detection	\$250
Univ. of Kentucky-May	\$521
Univ. of Kentucky -Trinkle	\$233
Univ. of Minnesota	\$924
Western Ky University	\$1,231
TOTAL	\$23,772

Figure 5. External Users in FY12

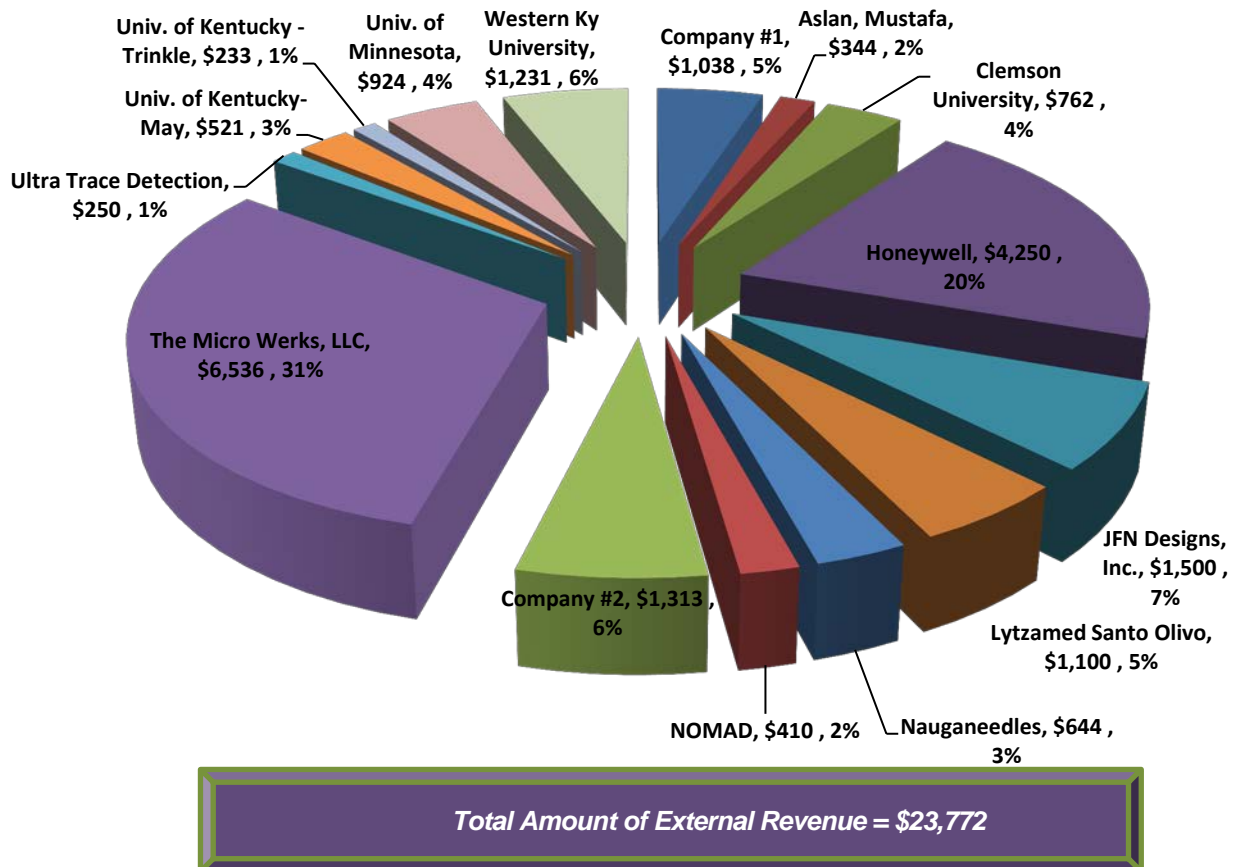
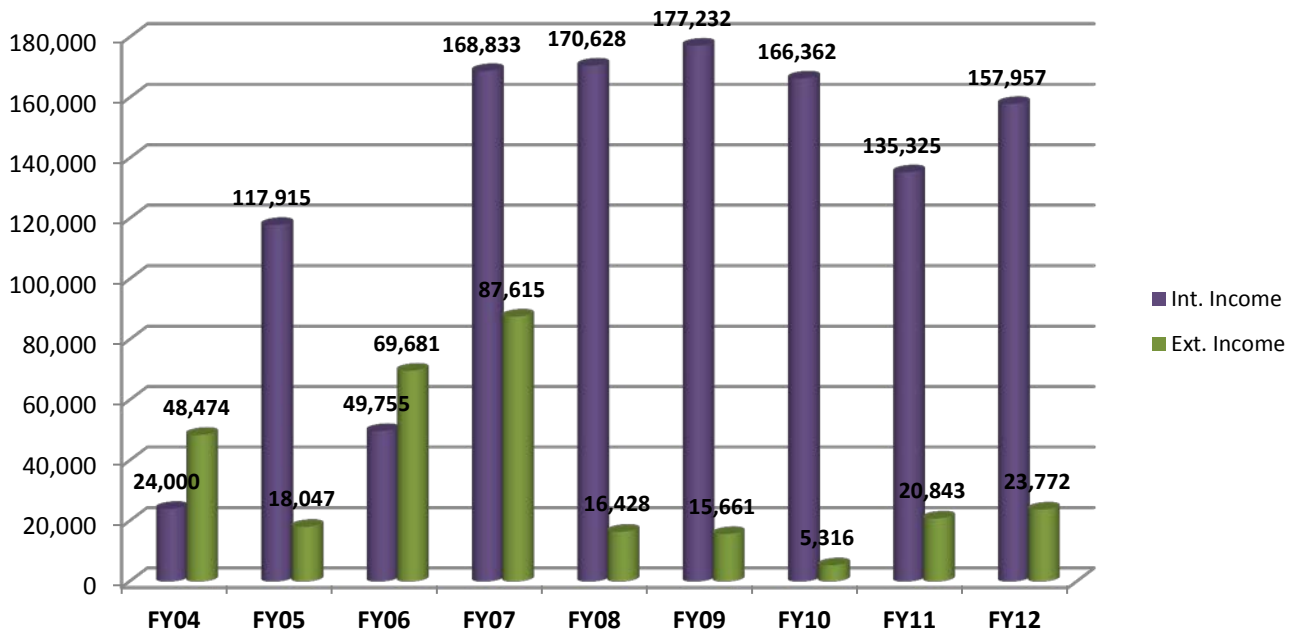


Table 5. FY 12 Internal Cleanroom Clients

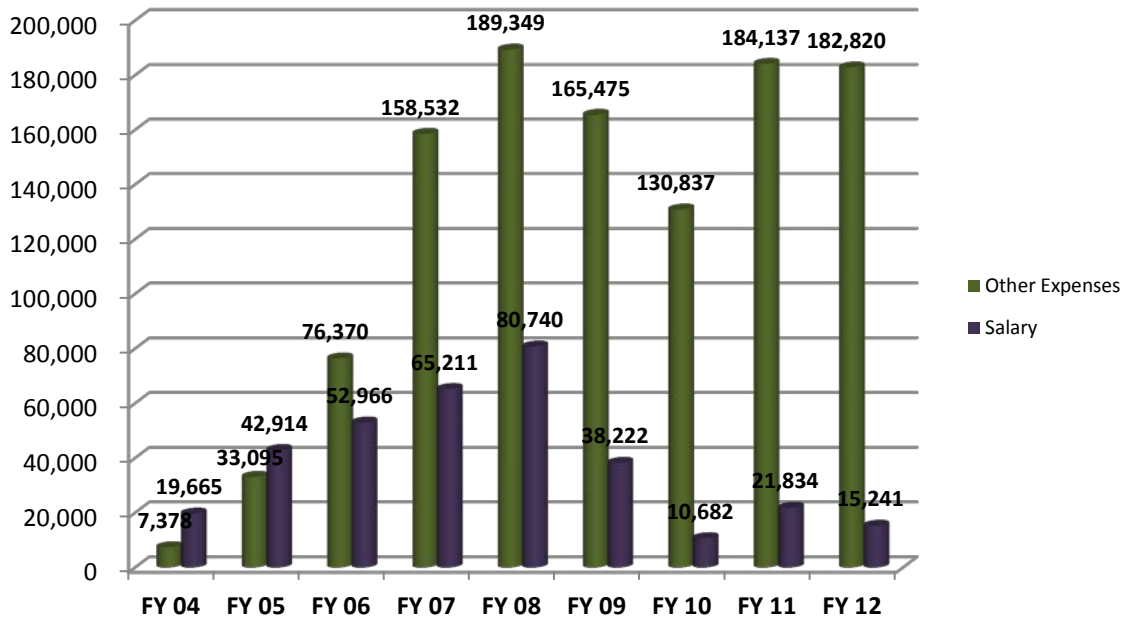
Faculty Advisors	Department	Students/Post Docs/Researchers	
Dr. Bruce Alphennar	ECE	Aebersold	Julia W.
Dr. Richard Baldwin	CHEM	Akhtar	Seyed Meysam
Dr. Thomas Berfield	ME	Arva	Sreenath
Dr. Gina Bertocci	ME	Bishop	Justin
Dr. Roger Bradshaw	ME	Burkhead	Thomas
*Cardiovascular Innovation Institute	School of Med	Cambron	Scott
* Dr. Nolan Boyd	School of Med	Chaparala	Yugandhar
* Dr. James B. Hoying	School of Med	Chen	Jubin
Dr. Robert Cohn	ECE	Cheong Ng	Nitzia
ECE Class	ECE	Crain	Mark M
Dr. Xiaon Fu	CHEM ENG	Dong	Huihang Dong
Dr. Andrea Gobin	BE	Duff	J. Dominick
Dr. Jafar Hadizadeh	GEOG	Estrada	Rosendo
Dr. Cindy Harnett	ECE	Faiz	Abderrazzak
Dr. Robert Keynton	BE	Ferreira	Ryan
Dr. Shamus McNamara	ECE	Gerfen	Kurt
Dr. Sergio Mendes	PHYSICS	Han	Xue
Dr. John Naber	ECE	Heacox	Kurtis
Dr. Balaji Panchapakesan	ME	Hennessey	Christopher
Dr. Palaniappan Sethu	BE	Hewaparakrama	Kapila
Dr. Thomas Starr	SPD-RSCH ADMIN	Hoveyda	Marashi Seyedey
Dr. Kevin M. Walsh	ECE	King	Benjamin C.
Dr. Stuart Williams	ME	Li	Mingxiao
Dr. Francis Zamborini	CHEM	Lin	Ji-Tzuoh (George)
		Loomis	Robert J.
		Lucas	Thomas
		Lynch	Joseph
		Marei	Mohamed
		Martin	Michael D.
		Miller	Kane J.
		Moiseeva	Evgenia V.
		Mostafa	Eslam A.
		Nguyen	Dung M.
		Onkst	Tyler J.
		Osborne	Christopner
		Parichehreh	Vahidreza
		Patel	Dhruvinkumar
		Pharas	Kunal
		Porter	Daniel
		Ratnayake	Dilan
		Santa	Lytzamed
		Schnitzer	Matthew
		Senousy	Yehya
		Sethu	Palaniappan
		Smith	Scott
		Staebler	Bryon
		Trada	Hiren V.
		Velasco	Vanessa
		Wang	Ni
		Webster	Nathan
		Wiederkehr	Rodrigo Sergio
		Wolsiefer	Amanda I
		Wood	Nicholas R.
		Work	Andrew H.
		Xu	Peng
		Yuan	Hanwen
		Zhu	Li

Figure 6. Comparison of Income for FY04 Through FY12



Total Internal Income = \$1,168,007
Total External Income = \$305,837
Total Income = \$1,473,844

Figure 7. Comparison of Expenses for FY04 Through FY12



Total Other Expenses = \$1,127,994
Total Salary = \$347,473
Total Expenses = \$1,475,468

Figure 8. Cumulative Income for Internal Users since FY 2004

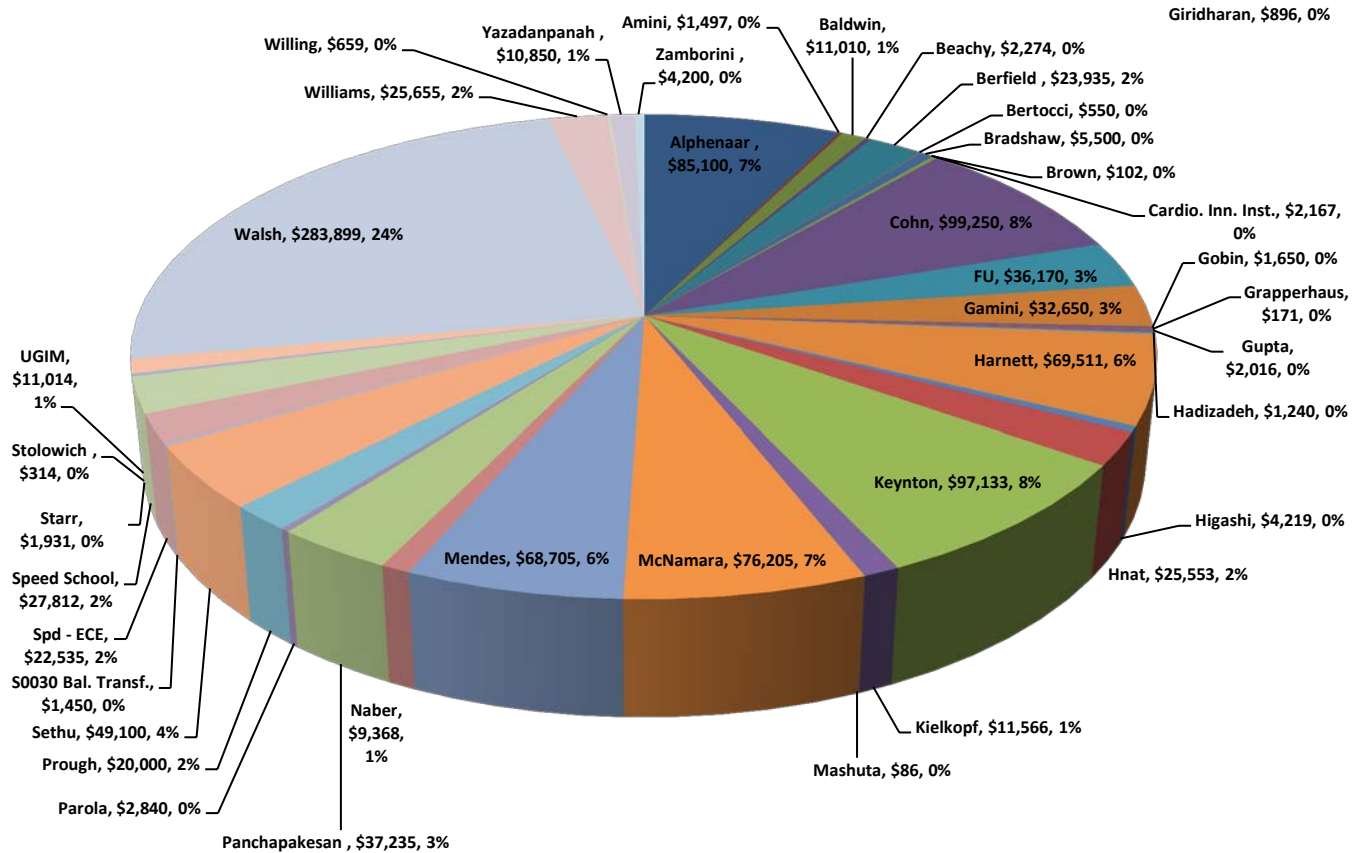
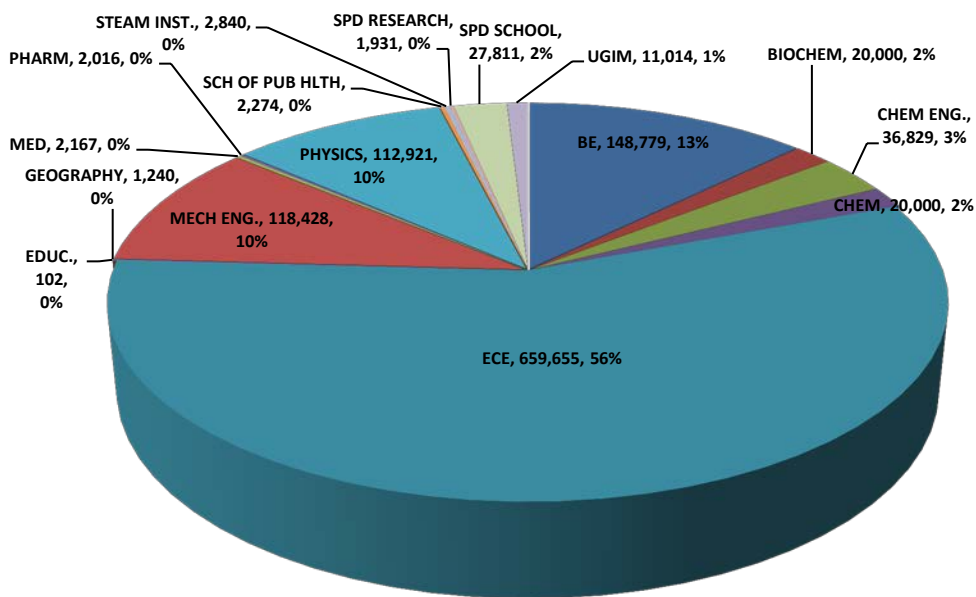
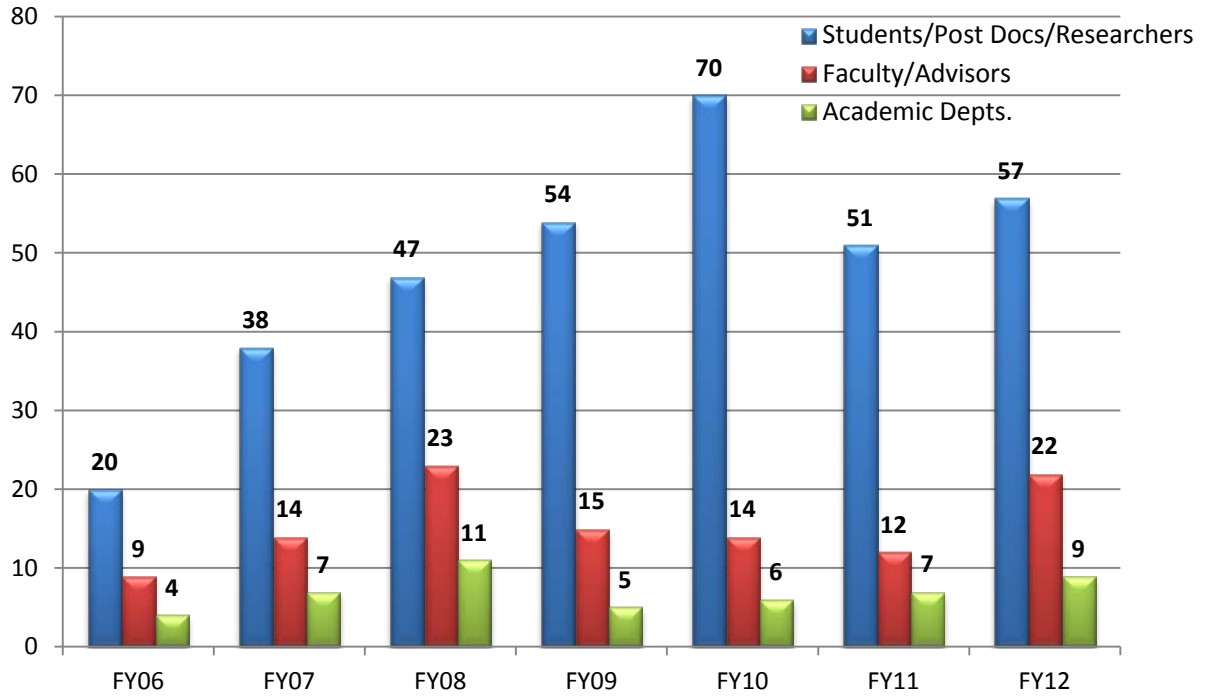


Figure 9. Cumulative Internal Income by Department since FY2004



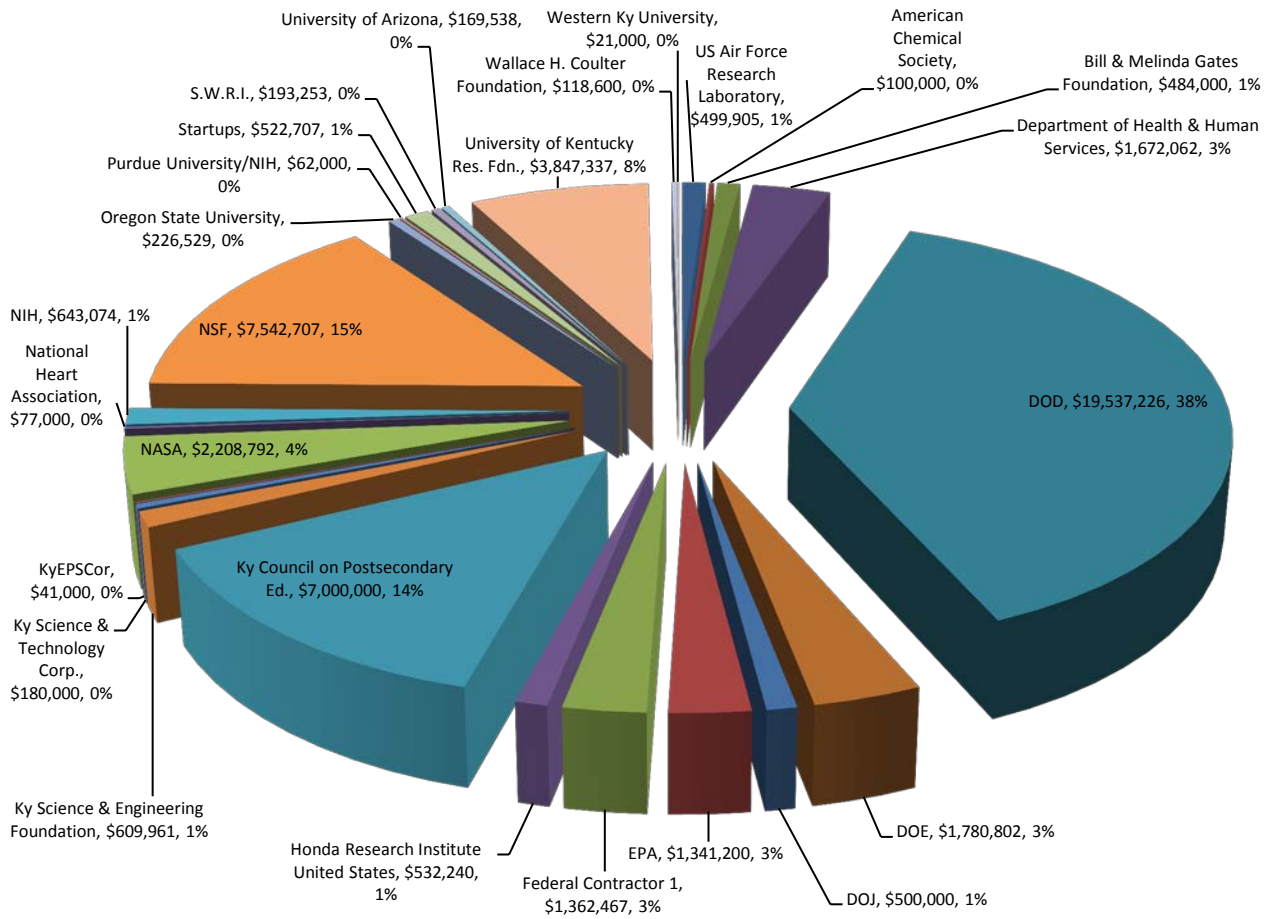
Total Accumulative Internal Revenue since FY04 = \$1,168,007

Figure 10. Cleanroom Access since FY06



	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

Figure 11. Total Grant Dollars that have used the Cleanroom since October 2001



Total Grant Dollars - \$51,273,401

Table 6. UofL Sponsored Research Which Used the MNTC in FY12

Faculty	Funding Type	Funding Source	PI	Dept	Title	Start Date	End Date	Total Grant Dollar Amount	Total Amt. to Service Center in FY12
Hadizadeh	Grant	NSF	Hadizadeh	A&S Geog.	Microstructural Analysis of Gouge From the San Andreas	5/1/2006	4/30/2012	489,423.00	640.00
Harnett	Grant	University of KY Res Fdn	Gobin	BE	Building Ky's New Economy with EPSCoR Engineering	9/1/2008	8/31/2013	2,180,337.00	4,400.00
Keynton	Grant	University of KY Res Fdn	Gobin	BE	Building Ky's New Economy with EPSCoR Engineering	6/1/2008	8/31/2013	602,180.00	3,300.00
McNamara	Grant	University of KY Res Fdn	Gobin	BE	Building Ky's New Economy with EPSCoR Engineering	9/1/2008	8/31/2013	2,180,337.00	550.00
Mendes	Grant	University of KY Res Fdn	Gobin	BE	Building Ky's New Economy with EPSCoR Engineering	9/1/2008	8/31/2013	2,180,337.00	6,600.00
Sethu	Grant	University of KY Res Fdn	Gobin	BE	Building Ky's New Economy with EPSCoR Engineering	9/1/2008	8/31/2013	2,137,417.00	2,200.00
Harnett	Contract	KY EPSCoR	Gobin	BE	State EPSCoR Transforming Ky's Ne Economy	6/1/2008	8/31/2013	602,180.00	1,100.00
McNamara	Contract	KY EPSCoR	Gobin	BE	State EPSCoR Transforming Ky's Ne Economy	6/1/2008	8/31/2013	602,180.00	550.00
Mendes	Contract	KY EPSCoR	Gobin	BE	State EPSCoR Transforming Ky's Ne Economy	6/1/2008	8/31/2013	602,180.00	550.00
Zamborini	Grant	National Science Fdn	Zamborini	Chem	Electrochemical Oxidation and Sensing/Molecular Electron	7/1/2009	2/28/2013	330,000.00	1,100.00
Williams	Grant	National Science Fdn	Zamborini	Chem	Electrochemical Oxidation and Sensing/Molecular Electron	7/1/2009	2/28/2013	330,001.00	550.00
Panchapakesan	Grant	NSF	Panchapakesan	ME	Carbon Nanotube Based Photomechanical Actuators	6/1/2008	5/31/2012	302,172.00	2,750.00
Panchapakesan	Grant	NSF	Panchapakesan	ME	REU Supplement for NSF Career: Carbon Nanotube Base PH	6/1/2008	5/31/2012	5,998.00	650.00
Mendes	Grant	Kentucky Science & Engineering Fdn.	Mendes	Physics	Plasmonic Enhancement of Optical Fiber Interfaces	7/1/2009	12/31/2011	80,018.00	1,100.00
Harnett	Grant	Kentucky Science & Engineering Fdn.	Harnett	ECE	Computer Aided Optimal Design of a Microfluidic Coulter	7/1/2009	9/30/2012	99,943.00	1,416.00
Zamborini	Grant	Kentucky Science & Engineering Fdn.	Zamborini	Chem	The Reactivity of Pure and Alloy Organic-Modified Metal	7/1/2009	6/30/2012	80,000.00	550.00
Panchapakesan	Grant	Ky Science & Eng. Fdn	Sethu	BE	Microfluidic Cell Arrays for High-Throughput Cell Culture	7/1/2009	6/30/2011	100,000.00	1,650.00
Sethu	Grant	Ky Science & Eng. Fdn	Sethu	BE	Microfluidic Cell Arrays for High-Throughput Cell Culture	7/1/2009	6/30/2011	100,000.00	550.00
Bertocci	Grant	U.S. Department of Justice	Bertocci	ME	Development of Scientific and Objective Methods for Detect	10/1/2009	6/30/2012	500,000.00	550.00
Walsh	Grant	Air Force Rsch Lab	Walsh	ECE	MEMS TPSS Project	9/1/2010	9/1/2011	499,905.00	3,850.00
Harnett	Grant	Oregon State University	Harnett	ECE	Characterizing the Phytoplankton Component of Oceanic Pa	9/1/2010	7/31/2013	226,529.00	2,985.80
Hoying	Grant	University of Arizona	Hoying	CII	Theoretical and Experimental Investigations of Architect	8/1/2010	7/31/2012	169,538.00	1,801.06
Keynton	Grant	NASA	Keynton	BE	Diagnosing & Mitigating Human Exposure to Radiation	9/1/2010	8/31/2012	2,000,000.00	8,180.00
Williams	Grant	Nauganeedles, LLC	Cohn	ECE	Batch Fabrication of High Aspect ration Metallic AFM Prob	2/1/2011	1/31/2013	150,000.00	1,350.00
Panchapakesan	Grant	NIH	Panchapakesan	ME	Nanotube Antibody for Profiling Circulating Disease	8/9/2011	7/31/2014	422,722.00	1,300.00
Boyd	Grant	National Heart Association	Boyd	Cardio	Microvascular Repair using Adipose-Derived Stromal Vascu	7/1/2011	6/30/2012	77,000.00	183.00
Harnett	Grant	Kentucky Science & Engineering Fdn.	Harnett	ECE	Emerging Ideas: Light-Powered Hybrid Microactuators for	7/1/2011	9/30/2014	90,000.00	825.50
Williams	Grant	Kentucky Science & Engineering Fdn.	Williams	ME	Dielectrophoretic Nanoneedles for Trapping and Character	7/1/2011	6/30/2013	80,000.00	625.00
Cohn	Grant	Kentucky Science & Engineering Fdn.	Williams	ME	Dielectrophoretic Nanoneedles for Trapping and Character	7/1/2011	6/30/2013	80,000.00	200.00
Fu	Grant	Bill & Melinda Gates Foundation	Graham	Microbiology	Disposable sampling plate andf breath test to patients	10/13/2011	12/31/2013	48,400.00	4,070.00
Sethu	Grant	University of KY Res Fdn	Gobin	BE	Engineering Platforms for Exploring Cellular (Federal)	9/1/2008	8/31/2013	712,473.00	3,550.00
Gobin	Grant	University of KY Res Fdn	Gobin	BE	Engineering Platforms for Exploring Cellular (Federal)	9/1/2008	8/31/2013	712,473.00	1,650.00
Harnett	Grant	University of KY Res Fdn	Gobin	BE	Engineering Platforms for Exploring Cellular (State)	9/1/2011	8/31/2013	196,060.00	4,100.00
Mendes	Grant	University of KY Res Fdn	Gobin	BE	Engineering Platforms for Exploring Cellular (State)	9/2/2011	8/31/2013	196,061.00	4,400.00
McNamara	Grant	University of KY Res Fdn	Gobin	BE	Engineering Platforms for Exploring Cellular (State)	9/3/2011	8/31/2013	196,062.00	2,320.00
Sethu	Grant	University of KY Res Fdn	Gobin	BE	Engineering Platforms for Exploring Cellular (State)	9/3/2011	8/31/2013	196,062.00	1,650.00
Cohn	Contract	Nauganeedles, LLC	Cohn	ECE	Batch Fabrication of High Aspect ration Metallic AFM Prob	2/1/2011	1/31/2013	150,000.00	3,850.00
Walsh	Contract	Federal Contractor 1	Walsh	ECE	MEMS Sensor Research	1/9/2012	3/11/2014	1,362,467.00	5,574.42
Starr	Contract	The Micro Werks, LLC	Starr	Spd-Rsch Ad	Fabrication of CASPAR Chips	8/1/2011	12/31/2011	5,545.00	1,732.91
								6,911,059.46	84,953.69

APPENDIX 1

MNTC Rate Structure (as of 9/13/2012)

Users of the MNTC will be charged a daily cleanroom access fee and an equipment processing fee appropriate for the process. All users will be charged including faculty.

**A) Daily Access Fee for the Cleanroom: Internal User: \$25/day
External User: \$34/day**

Access fees will be capped after 10 access events or a maximum of \$250/month for internal users or \$340/month for external users.

B) Equipment Usage Fee: Equipment and the processes associated with a particular tool are divided into 4 Groups, representative of costs associated with the tool and materials used for the process. Usage rates are defined below for internal and external users. A cap of \$1,000 per month will be implemented for equipment usage, access fees and training for internal users only. This cap does not include exceptional consumables (wafers or PDMS) or services performed by the MNTC staff (i.e. dicing and photomasks). Service Center rates are \$60/hour including either the internal or external equipment usage rate.

Equipment Group 0	Internal Rate	External Rate
Dektak Profilometer	\$0	\$0
Filmetrics	\$0	\$0
Optical Microscopes	\$0	\$0
Stereoscopes	\$0	\$0
Toho Thin Film Stress Measurement System	\$0	\$0
Solvent Wet Bench	\$0	\$0
Spin Rinse Dryers	\$0	\$0
Vacuum Ovens	\$0	\$0
Spinners	\$0	\$0
Developer Wet Bench (LF8-1A Solvent Develop Hood)	\$0	\$0
Developer Wet Bench (115X Base Develop Hood)	\$0	\$0
Spinner Benches (153X Hot Plate Spinner Combo)	\$0	\$0
Solvent Bench (301 Solvent MEMS in wet etch bay)	\$0	\$0

Equipment Group 1	Internal Rate	External Rate
RTP	\$30/sample	\$41/sample
Yes Polyimide Oven	\$30/batch	\$41/batch
Yes Image Reversal Oven	\$30/batch	\$41/batch
Intelligent Micro-Patterning System	\$30/sample	\$41/sample
March RIE	\$30/sample	\$41/sample
HF-8 Axic Barrel Asher	\$30/batch	\$41/batch
Reynolds Electroplating Bench	\$30/batch	\$41/batch
Zeiss Axioskop	\$30/sample	\$41/sample
QFI Thermal Imaging System	\$30/session	\$41/session
Ion Mill	\$30/sample	\$41/sample
Zygo Optical Laser Profilometer	\$30/sample	\$41/sample
Flip Chip Bonder	\$30/sample	\$41/sample

Equipment Group 2	Internal Rate	External Rate
Wire / Wedge Bonding	\$40/session	\$54/session
Dicing (performed by the user)	\$40/sample	\$54/sample
Tube Furnaces	\$40/batch	\$54/batch
Photolithography (Spin Photoresist, Soft Bake, Exposure, Develop, Hard Bake)	\$40/sample	\$54/sample
Parylene System	\$40/batch	\$54/batch
LF-8 2 RCA Clean Hood (RCA Cleaning)	\$40/batch	\$54/batch
305 Acid Hood (Nanostrip, Aluminum Etch, Chrome Etch, BOE)	\$40/batch	\$54/batch
307 Base Hood (KOH, TMAH)	\$40/batch	\$54/batch
308 EDP Etch Hood (Gold Etch, Copper Etch)	\$40/batch	\$54/batch

Equipment Group 3	Internal Rate	External Rate
Oxford PECVD /sample	\$50/sample	\$68/sample
Beneq ALD /sample	\$50/sample	\$68/sample
Lesker PVD 75 /sample	\$50/sample	\$68/sample
Technics Sputterer /sample	\$50/sample	\$68/sample
Denton Thermal Evaporator /sample	\$50/sample	\$68/sample
MVD /sample	\$50/sample	\$68/sample
Lesker E-beam /sample	\$50/sample	\$68/sample
DRIE /sample	\$50/sample	\$68/sample
Xactix XeF ₂ Isotropic Etching /sample	\$50/sample	\$68/sample
Raith 150 /sample	\$50/sample	\$68/sample
Suss Bonder /sample	\$50/sample	\$68/sample
Critical Point Dryer /sample	\$50/sample	\$68/sample

C) Additional Fees

Training: **Internal Users:** \$60/hour and will include the tool usage fee
External Users: \$82/hour and will include the tool usage fee

Dicing:** **Internal Users:** \$50/sample if performed by the MNTC staff
External Users: \$68/sample if performed by the MNTC staff

PDMS Pails:** **Internal Rate:** \$400/pail
External Rate: \$544/pail

Wafers**	Internal Rate	External Rate
Non-Oxidized SSP Wafer	\$15/wafer	\$20/wafer
Oxidized SSP Wafer	\$25/wafer	\$34/wafer
DSP Wafer	\$25/wafer	\$34/wafer
Oxidized DSP Wafer	\$35/wafer	\$48/wafer
Prime SSP Wafers	\$20/wafer	\$27/wafer

Photomasks, Greyscale Photomasks & E-beam Lithography**:	1 st hour flat rate	Rate after 1 st hour
Internal Rate (MNTC staff provided service)	\$100	\$40/hour
External Rate (MNTC staff provided service)	\$136	\$54/hour

**not included in the monthly cap