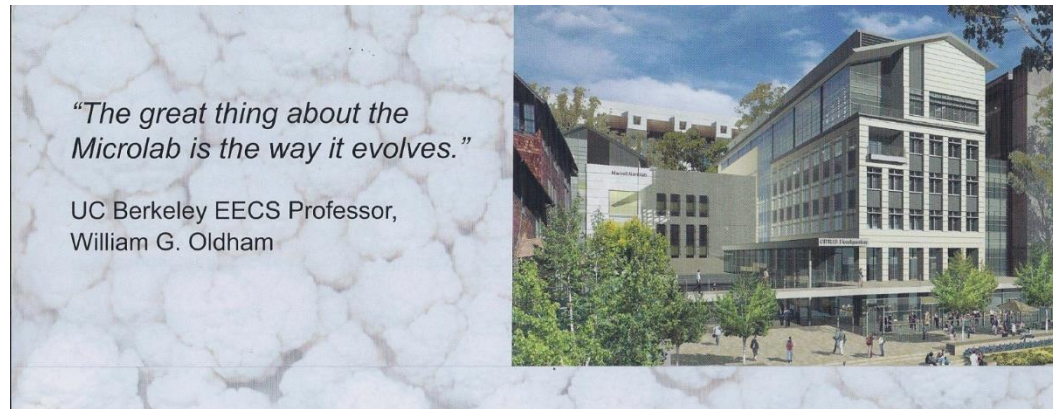




Marvell Nanofabrication Laboratory

2018 Principal Investigators Meeting



Professor Ming C. Wu

Faculty Director

Dr. Bill Flounders

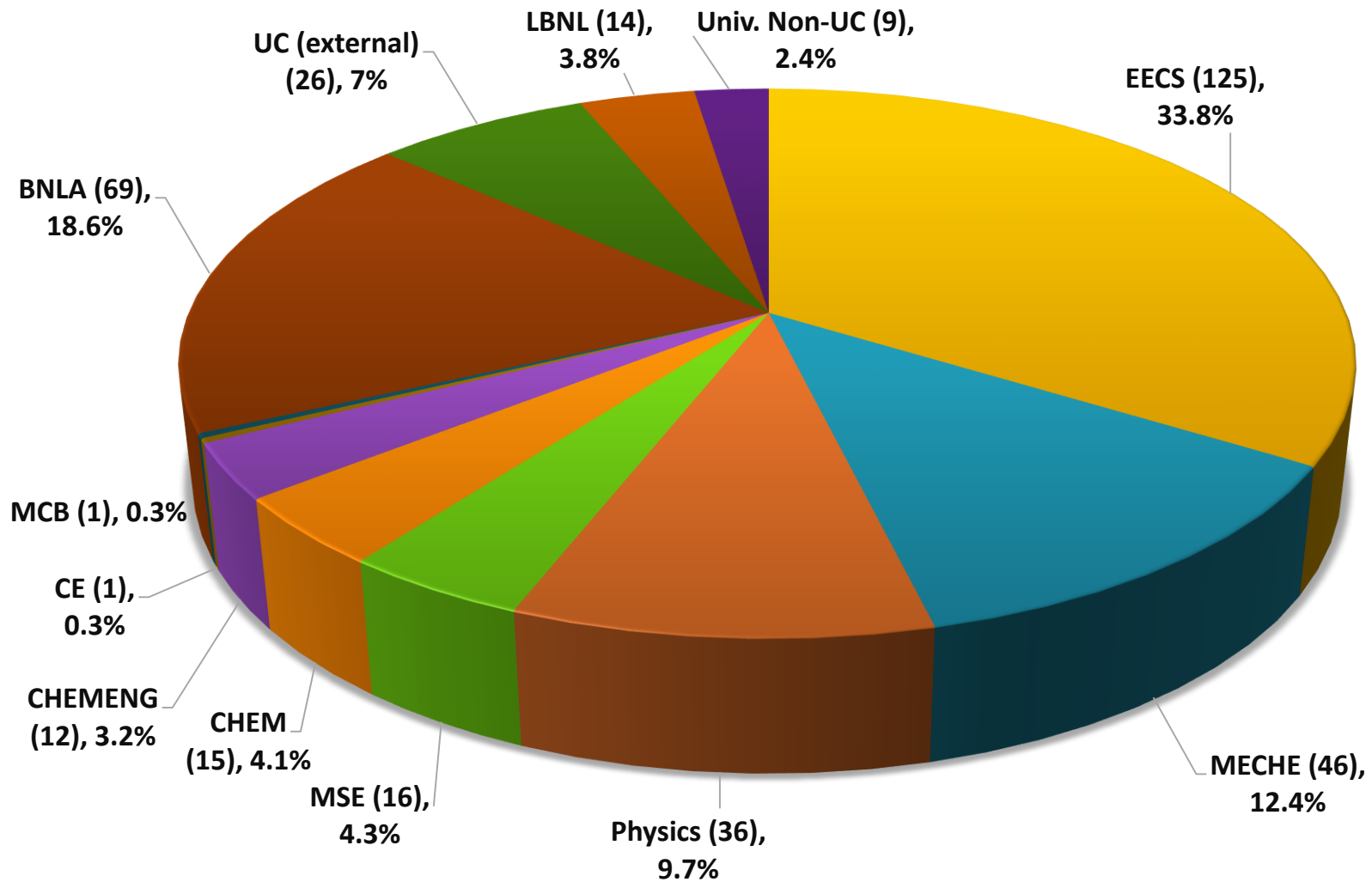
Executive Director



Agenda

- ❖ Membership Status, Internal / External Usage Trends
- ❖ Staffing Status
- ❖ NanoLab High School Intern Program (3 min video)
- ❖ New Equipment Qualification Categories
- ❖ New Equipment / Capabilities
- ❖ FY 18/19 Rates Overview
- ❖ Summary of Support from VCR's Office

Lab Members by Department FY 17 Total = 370



The NanoLab 2017

Analysis of the Top 20

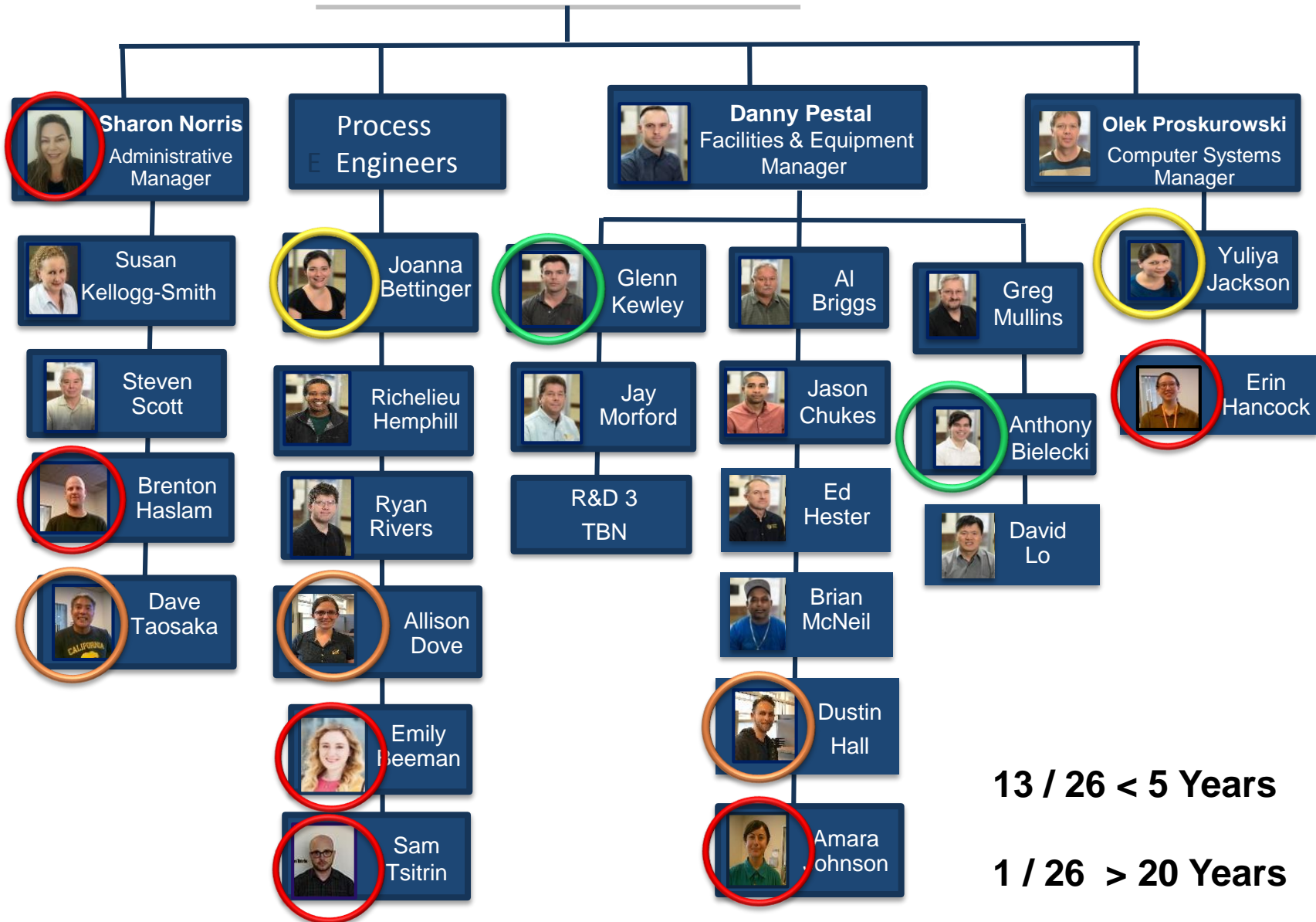
Top 20 by Dept			Financial		
		Δ		Δ	
EECS	10	-1	All Academic	\$2.09 M	-\$190 K
Mech Eng	2	-1	Top 20 Academic	\$1.81 M	-\$ 50 K
Chemistry	2	0	All BNLA	\$1.91 M	\$250 K
Physics	2	0			
MSE	2	1	Top 10 Academic	> \$72K each	
UC Davis EE	2	1	Top 10-20	> \$23K each	

Lab Members Historical Analysis

FY	2010	2011	2012	2013	2014	2015	2016	2017
Total	466	474	497	471	462	441	420	370
UCB	367	353	370	340	326	280	297	252*
Ext Acad	48	67	68	59	66	87	55	49
BNLA	51	54	59	72	70	74	68	69
EECS	122	132	138	126	139	135	142	125
Physics	42	36	45	39	35	31	38	36
MSE	21	27	31	23	21	23	17	16
Mech Eng	102	99	106	95	87	59	62	46
BioEng	12	10	7	8	4	4	4	1
Chem/ChE	65	47	42	49	30	28	34	27

* ~25 service accounts removed from member count

Staff Organizational Chart



- 1
- 2
- 3
- 4

13 / 26 < 5 Years

1 / 26 > 20 Years

NanoLab High School Intern Program for Young Women – Now Linked to Berkeley High School

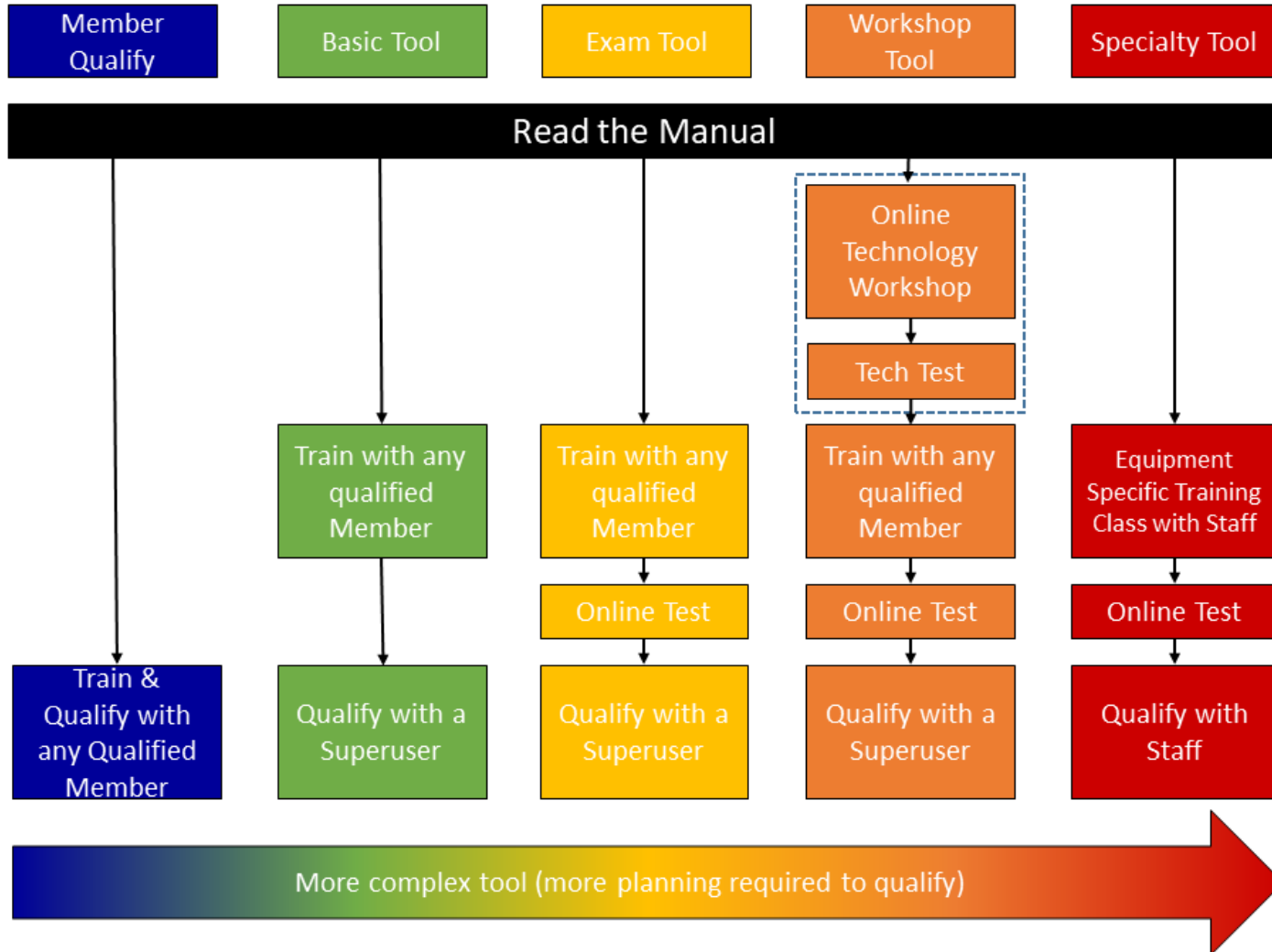
Overview Video (Just 3 minutes) available here:

<http://citris-uc.org/berkeley-high-suits-marvell-nanolab/>

Program on going since 2001.

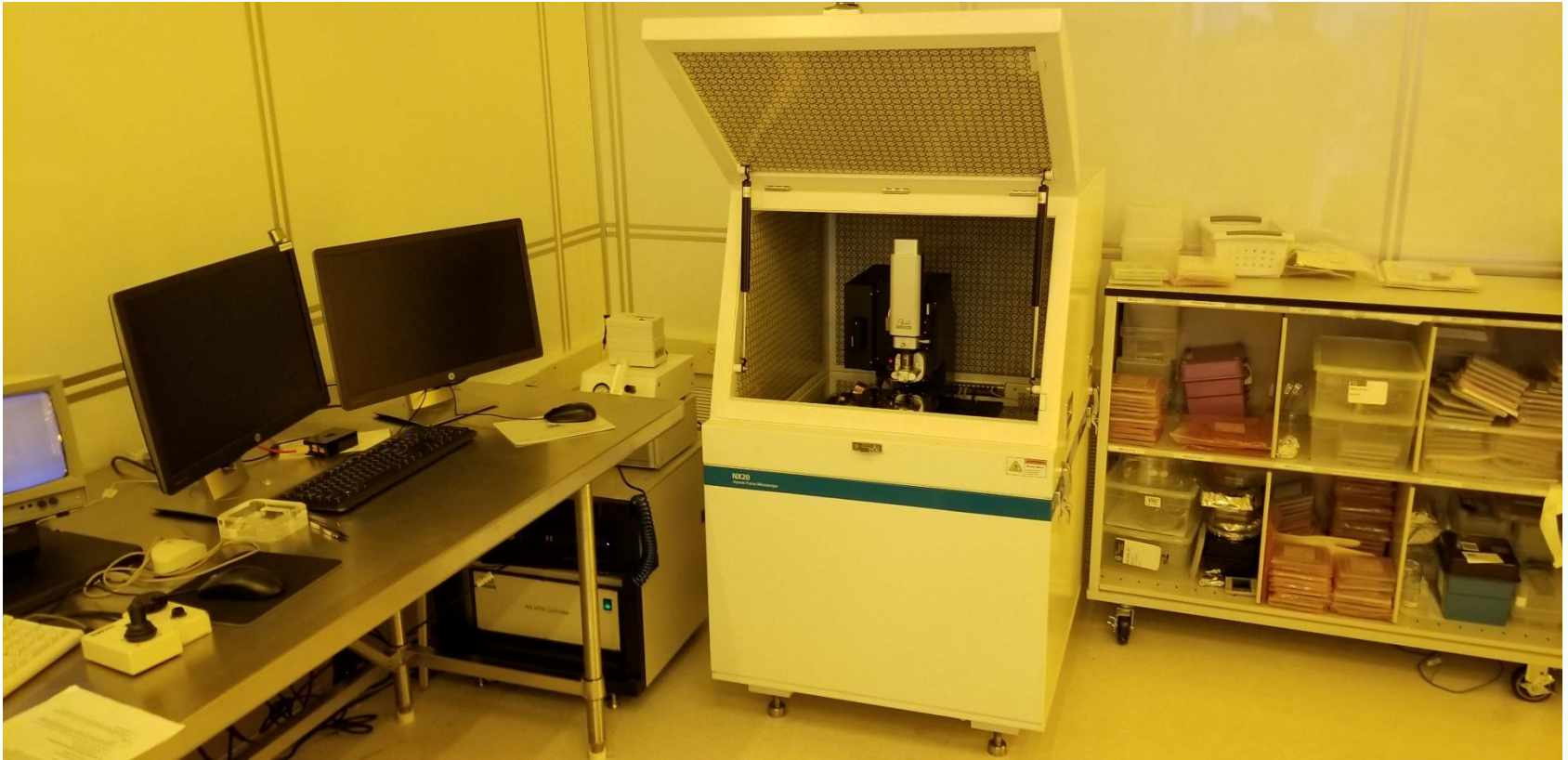
New Equipment Qualification Categories

46 simple metrology / 51 etch bond / 67 furnaces sinks / 13 PVD dual plasma / 11 SEM EBL AFM



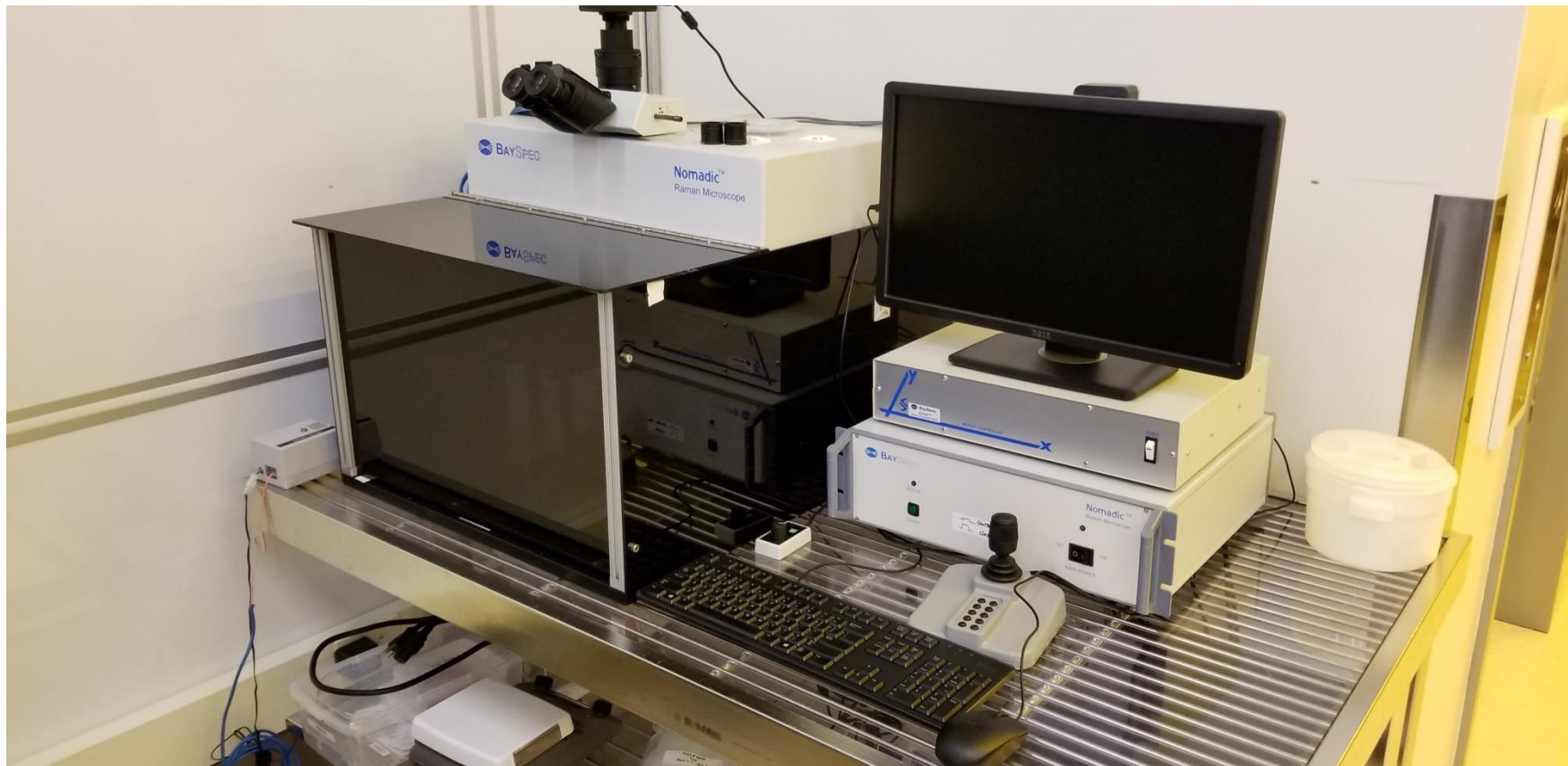
Park AFM In The NanoLab

Previous afm Microlab ~ 1988 - 1992



Initial training was completed by 51 lab members representing 22 faculty and 9 affiliate companies. Sustained use of the tool by 32 lab members representing 21 faculty and 6 affiliate companies.

New Raman Microscope



Tool owned by BNLA company. Approved for shared lab placement 2015
BNLA default \$40K. Demo tool purchase \$65 K; quote for new \$130K
Residual debt traded for tool title transfer to NanoLab.

New spectroscopic Ellipsometer



Former instrument from Prof Spanos 1998 UC Discovery grant
New equipment purchased with BNLA fees ~\$40K

New wet sink installed – metal etch. One side wafer / One side chip



Equipment Depreciation Fund: ~ \$50K

Another ebeam evaporator

Toshiba Donation May 2016. Released Sep 2017



Initial release May 2017, announced last year
Multiple rebuilds required.

NanoLab / Machine shop provided:

- Rebuilt pump package
- Rebuilt 6 pocket e-gun
- Ebay planetary rotation susceptor
- Spare QCM
- Custom 6" and 4" wafer holders

~ Spare parts, good shopping, gradual attention and ~\$35K yields:

New high performance box coat system for evaporation of oxides

Academic Recharge Rates

Fiscal Year	FY 2018	FY 2019	
Access Fee per month	\$89.00	\$84.90	- 5%
General Laboratory Rate	\$43.20/hr <i>Cap: \$1,400.00/month</i>	\$43.80 <i>Cap: \$1,400.00/month</i>	+ 1% ----
Special Equip Rate Tier 1 <i>wire bonder, HF vapor, polymer, metrology</i>	Tier 1: \$21.00/hr <i>Tier 1 cap: \$200.00 / month Rate over Tier 1 Cap: \$0/hr</i>	Tier 1: \$21.00/hr <i>Tier 1 cap: \$200.00 / month Rate over Tier 1 Cap: \$0/hr</i>	---- - 1% ----
Special Equip Rate Tier 2 <i>LPCVD, PECVD, DRIE, general purpose SEM</i>	Tier 2: \$43.80/hr <i>Tier 2 cap: \$1,400.00/month Rate over Tier 2 cap: \$5.70/hour</i>	Tier 2: \$43.80/hr <i>Tier 2 cap: \$1,400.00/month Rate over Tier 2 cap: \$5.70/hour</i>	0% ---- - 7%
Special Equip Rate Tier 3 <i>DUV, 50kV ebeam litho SEM, epi-SiGe</i>	Tier 3: \$60.00/hr <i>Tier 3 cap: \$1,500.00/month Rate over Tier 3 cap: \$19.20/hour</i>	Tier 3: \$ 61.80/hr <i>Tier 3 cap: \$1,500.00/month Rate over Tier 3 cap: \$19.00/hour</i>	+ 3% ---- - 1%
Special Equip Rate Tier 4 <i>130 kV ebeam litho</i>	Tier 4: \$101.40	Tier 4: \$84.00	- 17%
Staff Services	\$84.60	\$86.40	+ 2%

BNLA Recharge Rates

Fiscal Year	FY 2018	FY 2019		Academic
Access Fee per month	\$123.60	\$123.60	---	\$84.90
General Laboratory Rate	\$47.40/hr <i>Cap: \$2,450.00/month</i>	\$49.20/hr <i>Cap: \$2,450.00/month</i>	+ 3% ---	43.80 \$1,400
Special Equip Rate Tier 1 <i>wire bonder, HF vapor, polymer, metrology</i>	Tier 1: \$21.00/hr <i>Tier 1 cap: NA</i>	Tier 1: \$21.00/hr <i>Tier 1 cap: NA</i>	---- ----	\$21.00 \$200
Special Equip Rate Tier 2 <i>LPCVD, PECVD, DRIE, general purpose SEM</i>	Tier 2: \$52.20/hr <i>Tier 2 cap: NA</i>	Tier 2: \$54.00/hr <i>Tier 2 cap: NA</i>	+ 2% ----	\$43.80 \$1,400
Special Equip Rate Tier 3 <i>DUV, 50kV ebeam litho SEM, epi-SiGe</i>	Tier 3: \$84.60/hr <i>Tier 3 cap: NA</i>	Tier 3: \$85.20/hr <i>Tier 3 cap: NA</i>	+ 0.7% ----	\$61.80 \$1,500
Special Equip Rate Tier 4 <i>130 kV ebeam litho</i>	Tier 4: \$214.80	Tier 4: \$186.60	- 15%	\$84.00
Staff Services	\$84.60	\$86.40	+ 2%	\$86.40

BNLA Annual Membership Fees

FY 17/18		FY 18/19	
Lab Members Per Company	Annual Rates	Lab Members Per Company	Annual Rates
1	\$18,500	1	\$18,500
2	\$28,500	2	\$28,500
3	\$38,500	3	\$38,500
4	\$42,500	4	\$42,500
5	\$55,000	5	\$55,000
6*	\$65,000	6 *	\$65,000

**** Non-Core Access Program**

- 6th member = restricted access
- max 20hours/month 10am – 8pm
- unlimited non-core 8pm – 10am

VCR Investment in the NanoLab

➤ FY15 \$250K

- NanoLab obtains \$650K Gift In Kind as match for 2year VCR Investment
- Purchased 2chamber PECVD and 2chamber PVD for \$300K

➤ FY16 \$250K

- \$150K to new ebeam down payment
- \$100K to new aligned wafer bonder

➤ FY17 \$100K; NanoLab to Match. \$200K AFM selected

- \$100K to new AFM / \$100K BNLA

➤ FY18 \$100K; NanoLab to Match.

- Investment to support MaskLess Litho purchase
- Tool review underway – Heidelberg is most established; Microwriter, Kloe
- Tool selection to emphasize robust instrument to meet heavy use by widest range of NanoLab members.

Summary

- Academic Rates kept flat or decreased
 - Overall membership modest decrease
 - EECS, Physics, MSE Dept use steady
 - Mech Eng, Bio Eng, Chem Dept use decline

- Modest increases to BNLA
 - Non-core hour access program available, not used

- NanoLab continues to expand services and capabilities
 - Efforts to streamline training continue; process staff add
 - AFM up and in heavy demand
 - Negotiated financial solution yields new metrology
 - Foundation infrastructure maintained: sink and ellips replacement

- VCR investment in NanoLab to support MaskLess Litho purchase



The shared lab model is alive and well thanks to your support.

Chancellor Christ Tour June 16, 2017

The NanoLab responds to your issues and works to control your costs.



Thank you