The Berkeley Marvell NanoLab

The History

The Specifics

The Capabilities

The Present

The Advantages

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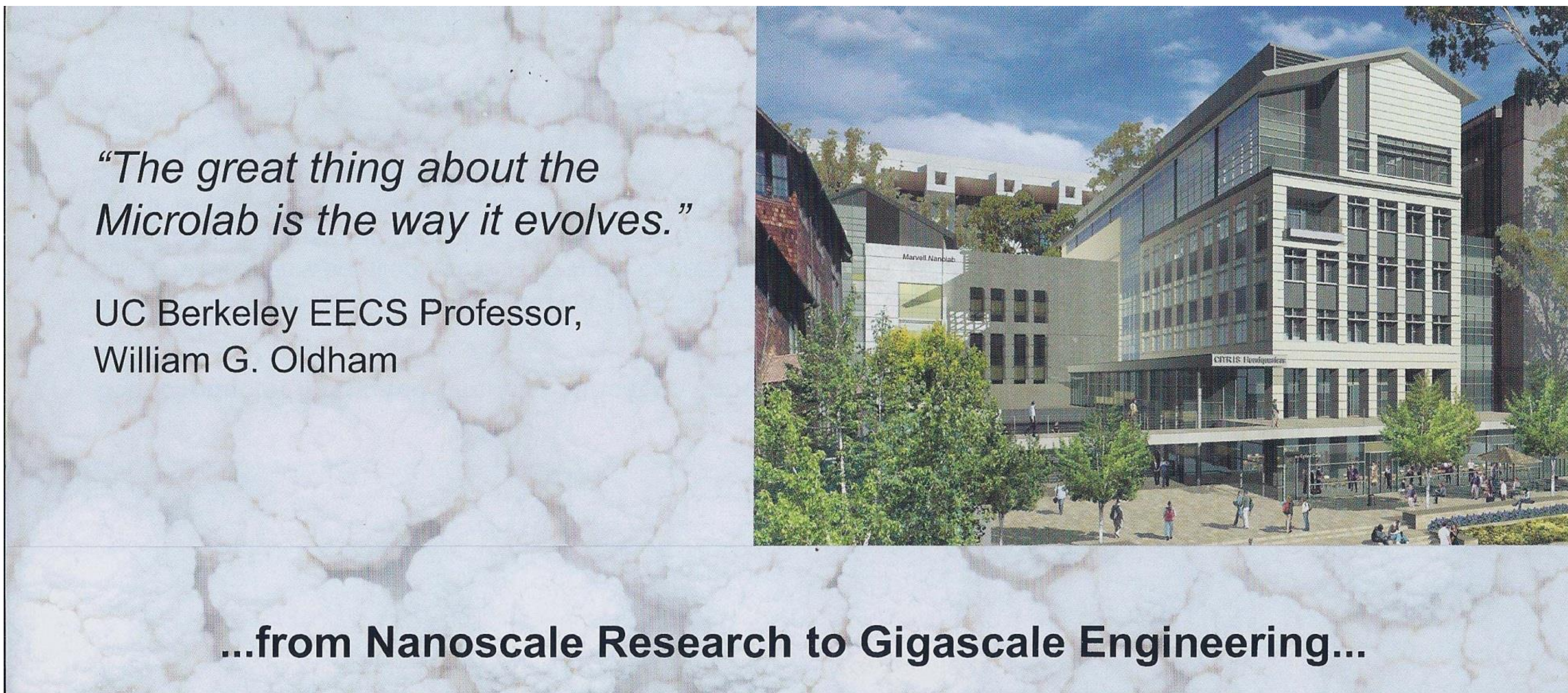
The History
An Evolving Laboratory



The History: Phase 1 Early ICs

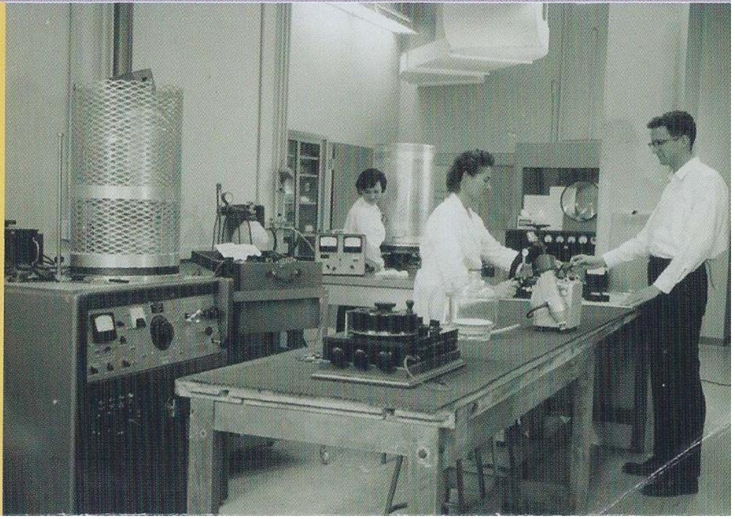
Faculty from EE share equipment to be able to conduct research in the new field of integrated circuits

THE EVOLUTION OF THE BERKELEY MICROLAB

Semiconductor Integrated Circuits Fabrication Laboratory, "The Old Lab" 1962 - 1982

In 1960, only months after some of the key patents on integrated circuit fabrication were filed, professors in the department of Electrical Engineering conceived plans for the country's first university IC lab. Working circuits, aligned by hand and fabricated on 3/4-inch-diameter silicon wafers emerged in 1962. As EECS Professor Emeritus David Hodges notes, *"It was pretty primitive in those days . . . but we got some working circuits . . . and we learned an awful lot!"*

Background: N-MOS op-amp. K. Burns/Prof. Paul Gray, 1976



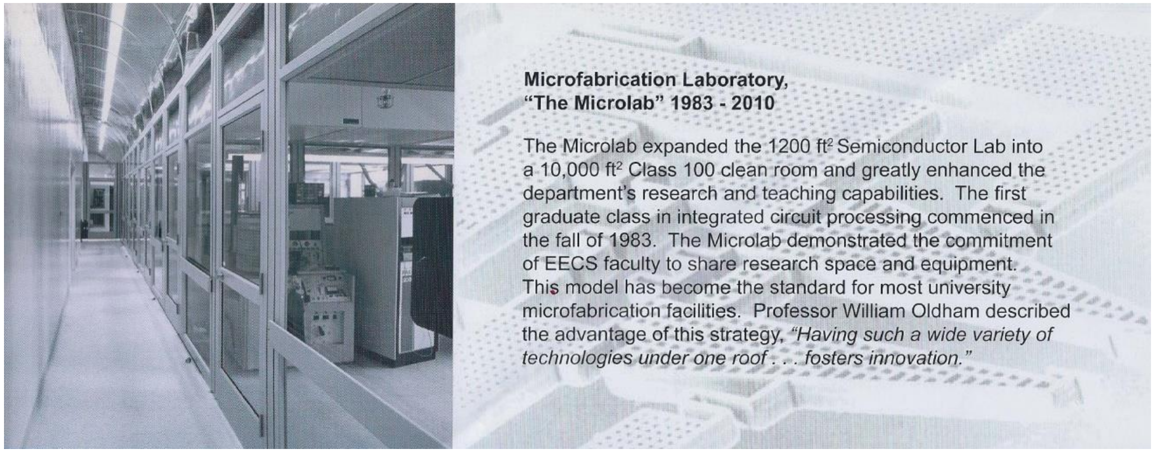
Fabricated some of the earliest fundamental microelectronic devices

high speed A/D converters, operational amplifiers

PABX line finder circuit (private automated branch exchange)
- the basis of integrated services digital networks

The History: Phase 2, EECS to COE
ICs to MEMS to new discrete devices

The shared equipment model is expanded, the faculty base grows, the recharge model is established, and external use is opened.

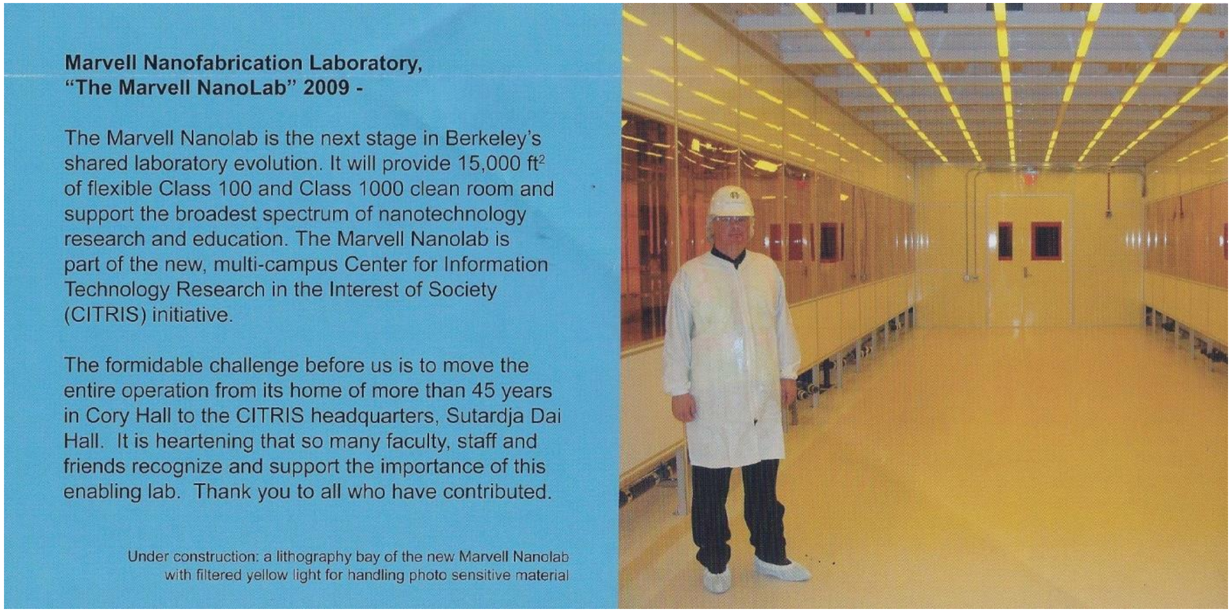


Home of the First NSF/Industry University Cooperative Research Center (IUCRC)
The Berkeley Sensor and Actuator Center BSAC
Fabricated some of the first MicroElecroMechanical Systems (MEMS)
- polysilicon based accelerometers, the basis of the airbag sensor,
- electrostatically actuated micromotors
- IC processed piezoelectric microphones

The world's smallest (Year 2000) gate length transistor (15nm)
One of the first finFET 3D transistors

The History: Phase 3, a cross campus facility Integrating Multiple Technologies

A larger purpose built cleanroom is built after critical mass achieved; commercial use growing to 50% of cost recovery, but 25% of use



World's smallest laser (2009) (Xiang Zhang, MechEng)
First demonstration of negative capacitance (Sayeef Salahuddin, EECS)
Development of nanomechanical transistor relays (Tsu-Jae King Liu, EECS)

The Specifics

- 15,000 ft^2 (1400 m^2) Class 100 Clean Room
- \$5M/year operating budget. 100% recharge recovery
  - >50% from industry access affiliate program
- 80 Academic PIs; ~350 researchers/year
  - ~24 companies ; 80 researchers/year
  - 50,000 total use hours/year

- Enabling >\$40M/year in research funds
- The NanoLab provides research capabilities for faculty system wide. An efficiently run shared facility with a low barrier to entry.
- Affiliate program supporting many local startups .

The Capabilities

- **Lithography**
  Contact aligners, i-line and 248nm stepper, backside capable, 130 kV e-beam to 7nm, 7 coat /develop tracks, UV hard bake

- **Deposition**
  ALD, PECVD, LPCVD: SiO2, Si3N4, poly-Si and SiGe, epi Si and Ge
  Unique: LACVD, SiC, AlN, diamond, Mo, Ru, 6 evap, 7 sputter

- **Etch**
  16 plasma systems including DRIE Si, ICP 3/5, ICP metal, XeF2, HF vapor, KOH, TMAH, Critical Point Drying

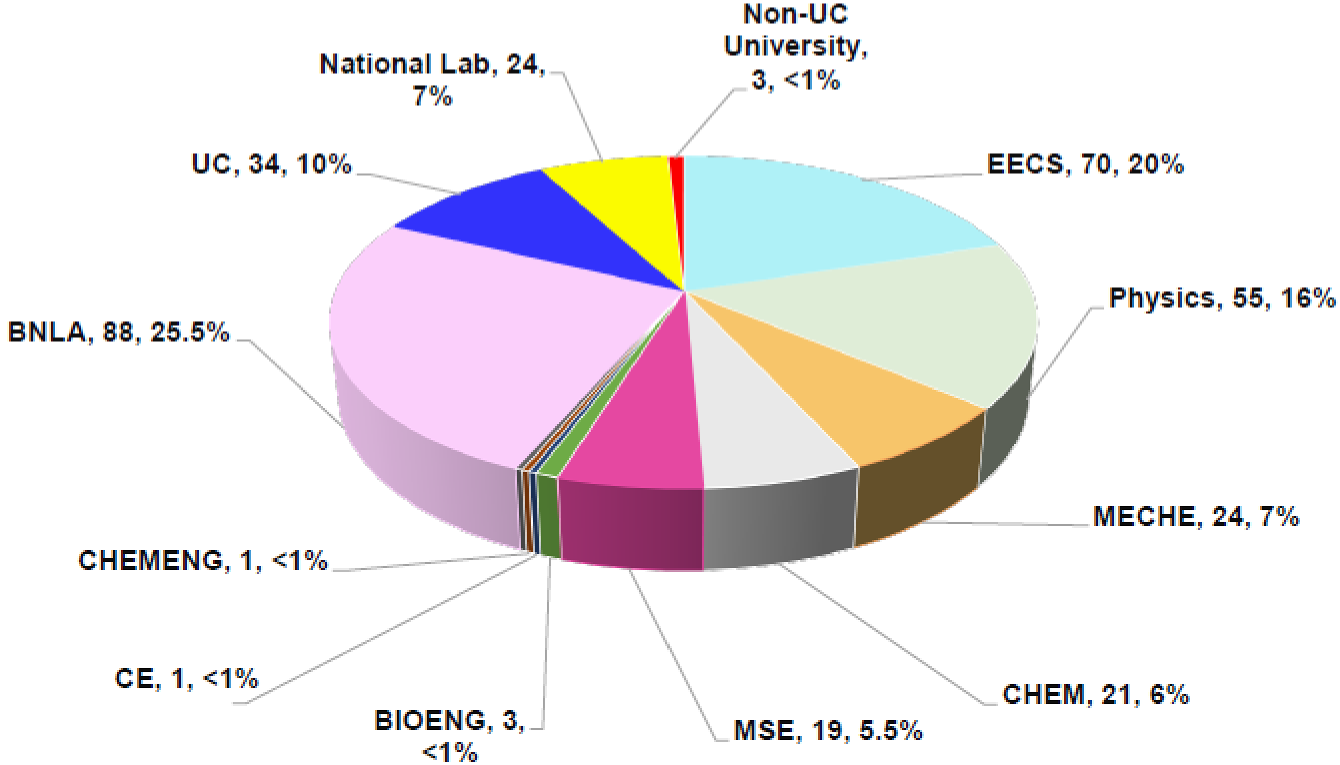
- **Planarize, Package**
  Si, SiO2, metal CMP; dicing, wafer bond, flip chip bond, die bond, Au and Al wire bond, parylene encapsulation

- **Metrology**
  SEM, AFM, XRD, EDX, reflectometer, contact + optical profilometer, interferometer, FTIR, spectroscopic ellipsometer, Raman scope

The Present

Membership is Strong and Stable

Labmembers by Department FY23



Fiscal Year	2018	2019	2020	2021	2022	2023
Total	382	376	342	304	329	343
UCB	257	241	217	191	189	194
Commercial	73 (19%)	84 (22%)	73 (21%)	72 (24%)	82 (25%)	88 (26%)
All Academic	309	292	269	232	247	255
External	125 (33%)	134 (36%)	125 (37%)	113 (37%)	140 (43%)	149 (43%)

CV-19

The Present

An active affiliate company program

CEITTA

AMFITZGERALD

A.M. Fitzgerald & Assoc., LLC

Adriatic Research Institute

ANYON TECHNOLOGIES

BW10 Inc.

Bandwidth 10,Inc.

IMAGIA

inSync Mirror

iota BIOSCIENCES powered by Astellas

Enertia Micro

Mekonos

hp

Nanoshift Consulting Group

LIMINA TECHNOLOGIES LLC

Nano Precision Medical

Nano Precision Medical, Inc.

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OMNITRON SENSORS

PsiQuantum

n·eye

2600 Tenth Street Suite 402
Berkeley, CA 94710

PrecisionNeuroscience

rigetti

Science

PIVOTAL SYSTEMS

Sonera

Serinus LABS

Texas Instruments

Jan 2023: 26 Members

The Present

Advantages for Academic Researchers

- More efficient use of valuable laboratory space and specialized research equipment
- Significant improvement in quality of support; researchers focus upon results not maintenance
- Maximum PI research flexibility integrating strategically selected, diverse cutting edge capabilities around a stable silicon baseline
- Wide diversity of research leads to enhanced research cross fertilization
- Earliest possible interaction with start up companies

The Present

Advantages for a VC funded startup

- **Cleanroom with wide range of process equipment is immediately available.**
- **5 photoresist systems characterized and maintained Immediate mask making capability**
- **No application and wait for city and county chemical handling permits**
- **Compare multiple technologies prior to equip purchase**
- **Well defined research expenses during prototype phase**
- **Facility access agreement only**
  - **Ensures separate IP and no revenue or equity sharing**

For any Lab related questions, please contact:

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or

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Thank You !