



## The Research Enterprise

*Ecosystem, Accountability & Opportunities*

*Steven Beckwith  
VP for Research & Graduate Studies*



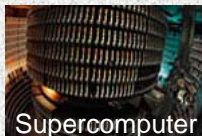
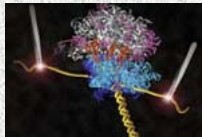
## Research and the University

Education, Research & Public Service

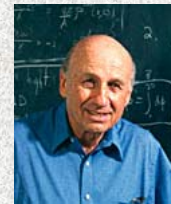
- Research distinguishes the University of California among California institutions of higher education
- The research opportunities are the most important factors in recruiting star faculty, postdocs & grad students to UC
- Research quality is one of the most important factors for top ratings in relative comparisons among universities



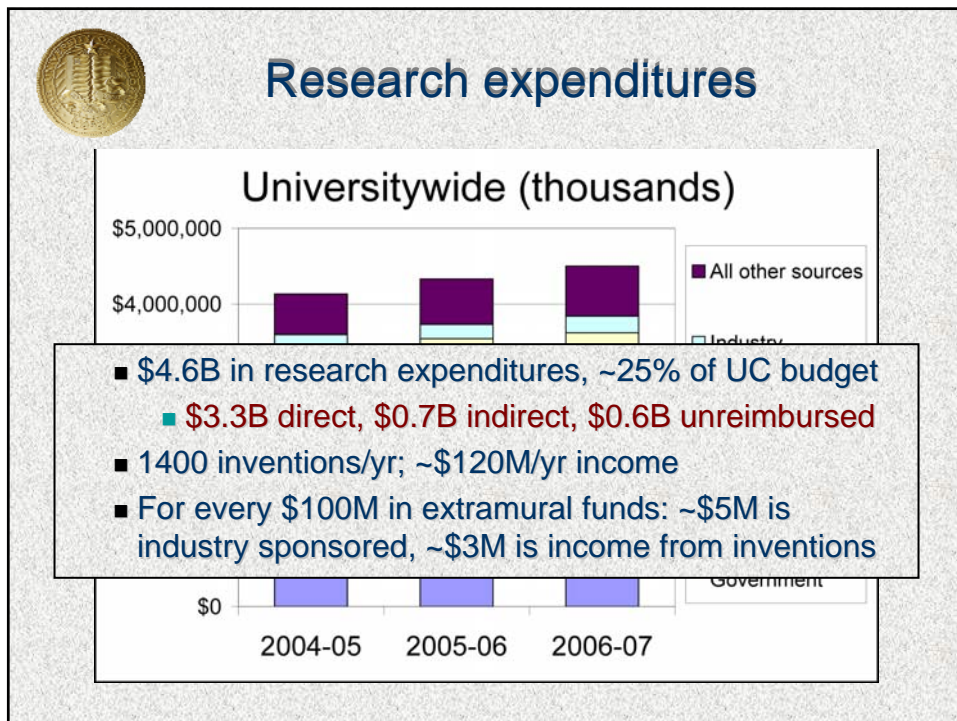
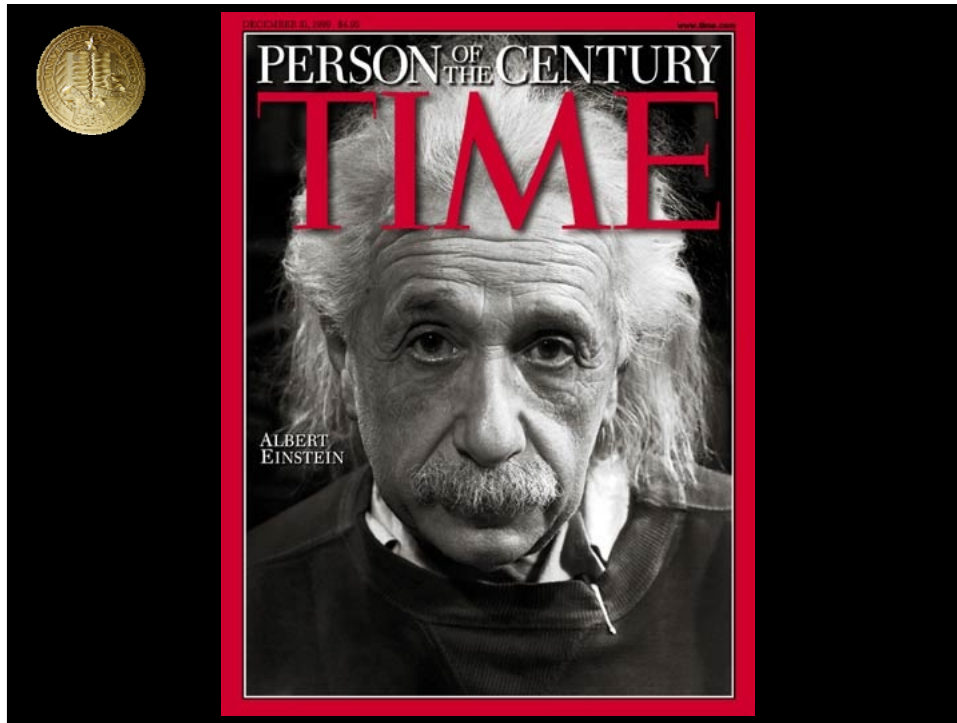
Students at Los Alamos NL



Supercomputer



UCSB Nobel Laureates  
David Gross & Walter Kohn





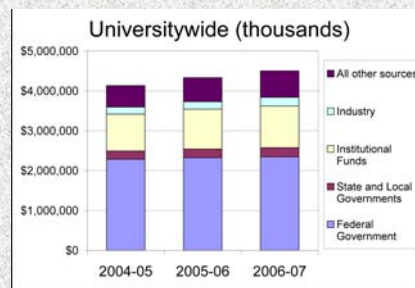
# Research Ecosystem

- Access to talent
  - Star faculty
  - Top students, talented postdocs (& staff)
  - Clusters of competence like research triangle, silicon valley, the “Mesa”, national labs & UC
- Access to resources
  - Major equipment & laboratories
  - Access to information: libraries & collections
  - Access to data: archives & databases,
- Opportunity in the marketplace of ideas
  - Peer review vs. periodic review



# Research Accountability: How do we measure success?

- Leading indicators
  - Research support \$
  - Graduate applications
- Medium lagging indicators
  - Publication rates
  - High-impact results
  - Citation indices
  - AAAS Humanities Indicators
- Long lagging indicators
  - Prizes, Awards, Societies
  - Rankings (NRC, UN&WR)



Recent Nobel Laureates at UC:  
2008 Roger Tsien UCSD

Success means new knowledge.  
*All leading measures of research productivity  
are only proxies for research success*



## NSF Rankings by R&D expenditures

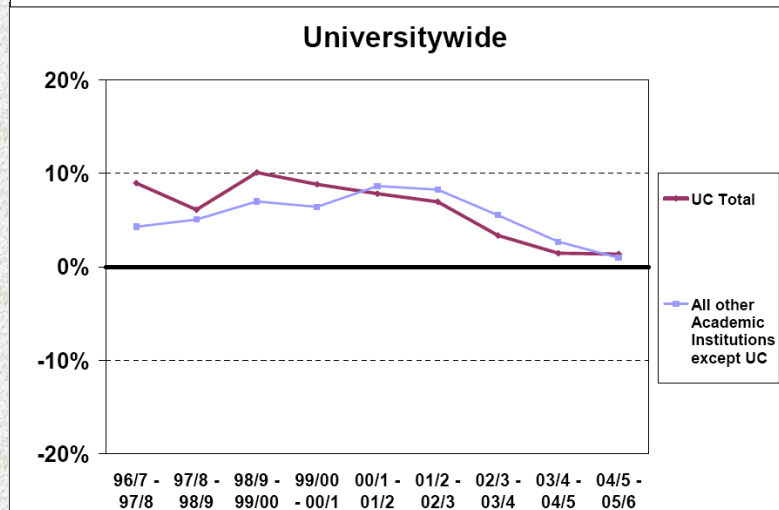
	2004-05	2005-06	2006-07
Berkeley	15	19	20
Davis *	17	16	16
Irvine *	58	57	58
Los Angeles *	4	3	4
Merced	329	295	270
Riverside	113	112	115
San Diego *	6	7	6
San Francisco*	5	5	2
Santa Barbara	97	98	89
Santa Cruz	123	121	117
<b>Sample (n)</b>	<b>630</b>	<b>640</b>	<b>672</b>

\*has a UC Medical Center



## Research Expense Comparison

Indicator 8.1  
Total Research and Development Expenditures, Annual Growth, 1996-97 to 2005-06







## Academic Ranking of World Universities 2007 IHE Shanghai Jiao Tong University

World Rank	Institution	Region	Regional Rank	Country	National Rank	Score on Alumni	Score on Award	Score on HiCi	Score on N&S	Score on SCI	Score on Size	Total Score
1	Harvard Univ	Americas	1	USA	1	100	100	100	100	100	73	100
2	Stanford Univ	Americas	2	USA	2	42	78.7	86.1	69.6	70.3	65.7	73.7
3	Univ California - Berkeley	Americas	3	USA	3	72.5	77.1	67.9	72.9	69.2	52.6	71.9
4	Univ Cambridge	Europe	1	UK	1	93.6	91.5	54	58.2	65.4	65.1	71.6
5	Massachusetts Inst Tech (MIT)	Americas	4	USA								70.0
6	California Inst Tech	Americas	5	USA								66.4
7	Columbia Univ	Americas	6	USA								63.2
8	Princeton Univ	Americas	7	USA								59.5
9	Univ Chicago	Americas	8	USA								58.4
10	Univ Oxford	Europe	2	UK								56.4
11	Yale Univ	Americas	9	USA								55.9
12	Cornell Univ	Americas	10	USA								54.3
13	Univ California - Los Angeles	Americas	11	USA								52.6
14	Univ California - San Diego	Americas	12	USA								50.4
15	Univ Pennsylvania	Americas	13	USA								49.0
16	Univ Washington - Seattle	Americas	14	USA								48.2
17	Univ Wisconsin - Madison	Americas	15	USA								48.0
18	Univ California - San Francisco	Americas	16	USA								46.8
19	Johns Hopkins Univ	Americas	17	USA								46.1
20	Tokyo Univ	Asia/Pac	1	Japan								45.9
21	Univ Michigan - Ann Arbor	Americas	18	USA								44.0
22	Kyoto Univ	Asia/Pac	2	Japan								43.1
23	Imperial Coll London	Europe	3	UK								43.0
23	Univ Toronto	Americas	19	Canada								43.0
25	Univ Coll London	Europe	4	UK								42.8
26	Univ Illinois - Urbana Champaign	Americas	20	USA	19	39	36.6	44.5	36.4	57.6	26.2	42.7
27	Swiss Fed Inst Tech - Zurich	Europe	5	Switzerland	1	37.7	36.3	35.5	39.9	38.4	50.5	39.9
28	Washington Univ - St. Louis	Americas	21	USA	20	23.5	26	39.2	43.2	53.4	39.3	39.7
29	Northwestern Univ	Americas	22	USA	21	20.4	18.9	46.9	34.2	57	36.9	38.2

**World (US Public) Rank**

3 (1) – UC Berkeley

13 (2) – UCLA\*

14 (3) – UC San Diego\*

18 (6) – UC San Francisco\*

35(10) – UC Santa Barbara

43(16) – UC Davis

44(17) – UC Irvine

(32) – UC Riverside

(33) – UC Santa Cruz



## Ranking Criteria (Shanghai)

Criteria	Indicator	Code	Weight
Quality of Education	Alumni of an institution winning Nobel Prizes and Fields Medals	Alumni	10%
Quality of Faculty	Staff of an institution winning Nobel Prizes and Fields Medals	Award	20%
	Highly cited researchers in 21 broad subject categories	HiCi	20%
Research Output	Articles published in Nature and Science*	N&S	20%
	Articles in Science Citation Index-expanded, Social Science Citation Index	SCI	20%
Size of Institution	Academic performance with respect to the size of an institution	Size	10%
<b>Total</b>			<b>100%</b>



## The Nobel Prize last decade

Columbia	6
UCSB	4
Stanford	4
MIT	4
UCSD	3
UCB	3
Caltech	3
Rockefeller	3
U. Colorado	3

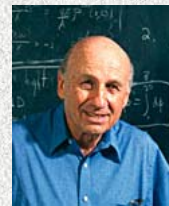
Institution at time of award, one per institution, 1999-2008

Prizes in sciences and economics:

Only four public institutions have three or more awards, UC Campuses account for 75% of these.



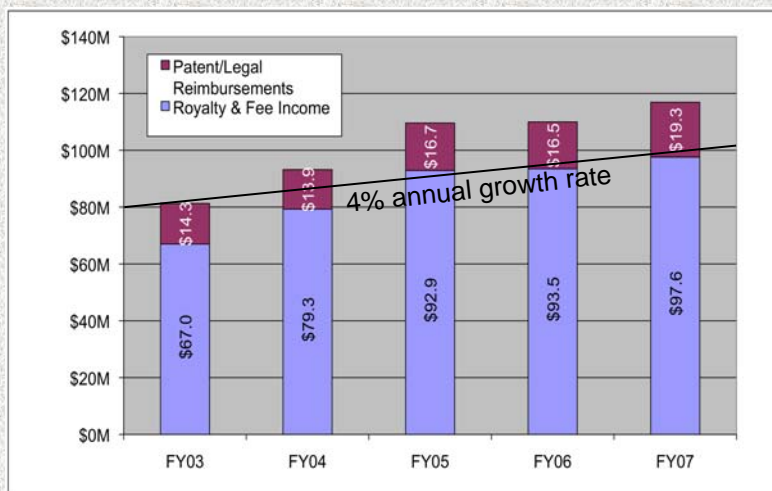
David Gross  
2004



Walter Kohn  
1998  
(not included)



## Total Income from Inventions





## Opportunities for UC Research

No single campus ranks #1 in research, but **collectively** the UC system is world dominant in research power and accomplishments

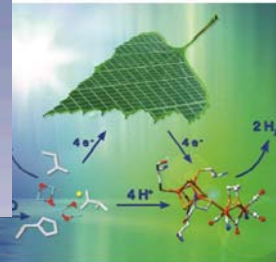
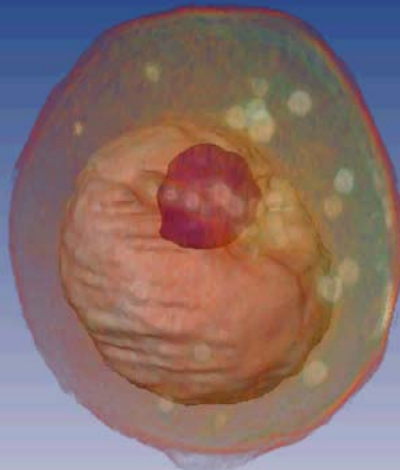
### Strategic opportunities

- Major research equipment: ALS, TMT
- Calif. Institutes for Science & Innovation
- Agricultural research & productivity
- State & national needs:
  - Climate change, energy, environment,
  - Transportation
  - Health-care: CA & global health
  - National defense & the "brain trust"



## 4<sup>th</sup>-G Advanced Light Source

Yeast cell 40 nm resolution; scale size: ~3  $\mu\text{m}$

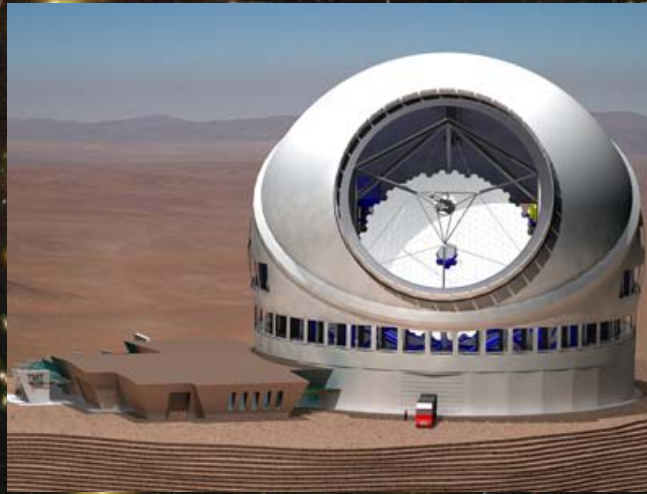


Carolyn Larabell, UCSF

<http://anatomy.ucsf.edu/larabellfaculty6.html>



## Thirty Meter Telescope



U N I V E R S I T Y O F C A L I F O R N I A

## Digital Humanities & Arts

- Texts, objects, maps recorded digitally
  - Allows search, analysis, & instruction tools
- New technologies provide creative new ways for research & learning in arts and humanities
- Demand for cyberinfrastructure can be greater in the humanities than in the sciences
  - Fine art has high information density
  - Connections to distant databases essential





# Science Incubators

The California Institutes for Science & Innovation



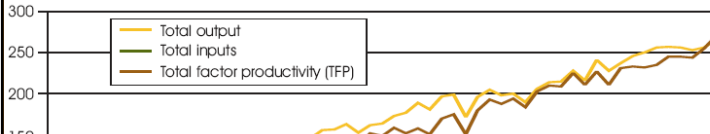
CALIFORNIA NANOSYSTEMS INSTITUTE



Figure 1

Changes in U.S. agricultural output, inputs, and total factor productivity<sup>1</sup> since 1948

Index: 1948=100



Gains in productivity have been a driving force for growth in U.S. agriculture. The effects of these changes over the second half of the 20th century were dramatic: between 1950 and 2000, the average amount of milk produced per cow increased from 5,314 pounds to 18,201 pounds per year, the average yield of corn rose from 39 bushels to 153 bushels per acre, and each farmer in 2000 produced on average 12 times as much farm output per hour worked as a farmer did in 1950. The development of new technology was a primary factor in these improvements.

Share of output growth due to:		
Growth in nonlabor inputs	11.8	54.1
Growth in labor hours	-34.2	23.7
		3.8
		3.4
		0.0

Source: Economic Research Service to isolate the effects of changes in technology and related factors from other changes in inputs on the growth of agricultural output.

Sources: Economic Research Service (agricultural statistics) and Jorgenson, et al., 2006 (statistics for all U.S. industries).

The development of new technology was a primary factor in these improvements.



## Long Range Planning Issues

- Competition for major research equipment:
  - ALS, TMT, ships, supercomputers, accelerators
  - Gump station, primate facilities, advanced laboratories
- Access to major industrial facilities
  - LBNL silicon foundry, UCO shops, aerospace industry
- Campus Research infrastructure
  - IT infrastructure, buildings & laboratories
- Competition from new foreign universities
  - Singapore, Korea, China, Abu Dhabi
- Policies: student support, tuition & tech transfer



## UC Challenges for Research

- With campuses, set & implement system-wide research priorities
  - **Create new & sunset old system-wide programs**
  - Advance major research priorities in the budget, among Regents, CA Legislature, federal government, and public: **Think BIG!**
- Enable UC as "Research arm of the state"
  - Create an efficient grant administration organization
  - Work with OP, legislature on state research initiatives
- Ensure research benefits return to taxpayers
  - Govern system-wide research & technology transfer policies to complement campus activity
  - Demonstrate the benefits of UC research to the public





## The National Laboratories

### ■ Lawrence Berkeley LBNL

- Budget \$600M/yr
- 4000 employees
- 1000 staff scientists
- 3400 guest scientists



Over 55 Nobel Laureates had significant collaborations at LBNL

### ■ Los Alamos LANL

- Budget \$2.2B
- 11,300 employees
- 1860 R&D staff



### ■ Lawrence Livermore LLNL

- Budget \$1.6B/yr
- 8000 employees
- 3500 R&D staff



## National Labs missions

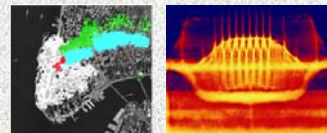
### ■ Lawrence Berkeley

- Basic research
- Energy and Environment
- Astrophysics, Cosmology and dark matter



### ■ Lawrence Livermore & Los Alamos- National Security

- Nuclear weapons
- Non-proliferation and counterterrorism
- Energy Security & Climate modeling



### ■ Labs provide national user facilities

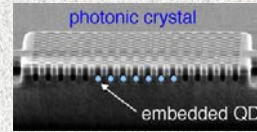
- Joint Genome Institute
- LBNL: advanced light source, molecular foundry, national energy research supercomputing center
- Los Alamos Neutron Science Center
- LLNL - National Ignition Facility (under development)





## National Labs Challenges

- Common challenges:
  - Declining U.S. support for science
  - Aging infrastructure
  - Absence of national nuclear arms policies
- LBNL is diversifying its mission to include energy and environment
  - Joint BioEnergy Institute
  - Energy Bioscience Institute with BP funding
- Los Alamos and Livermore Labs
  - Decline in core nuclear weapons program
  - Safety and reliability of nuclear weapons without nuclear testing
  - Expanded programs in nuclear non-proliferation, counter terrorism, energy security and climate modeling



Pit Manufacturing

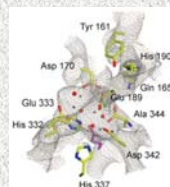


## The National Laboratories

- LBNL
  - Member of national lab system supported by the Department of Energy, Office of Science; managed by UC
- LANL LLC
  - Bechtel National, University of California, BWX Technologies, Washington Group International
- LLNL LLC:
  - Bechtel National, University of California, Babcock & Wilcox, Battelle, and Washington Group International



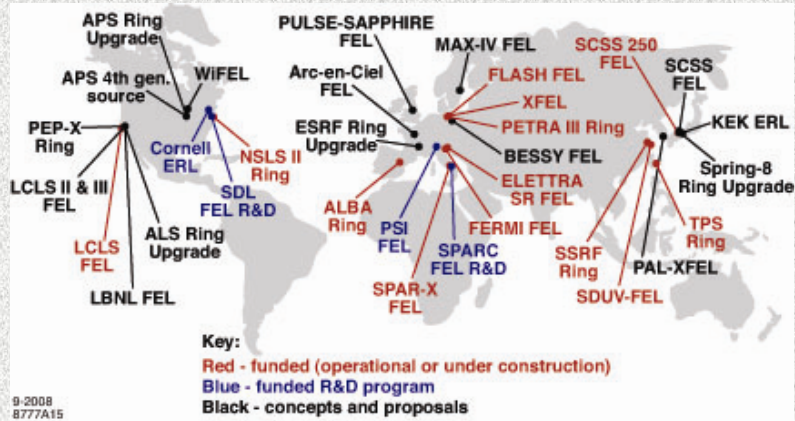
1950-1970s, Minuteman III







## International interest in new x-ray light sources is significant



## Vision for a future LBNL light source

