Emerging Trends

IEEE Spectrum Editorial Board

New York, NY

June 29, 2007

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

UCSD

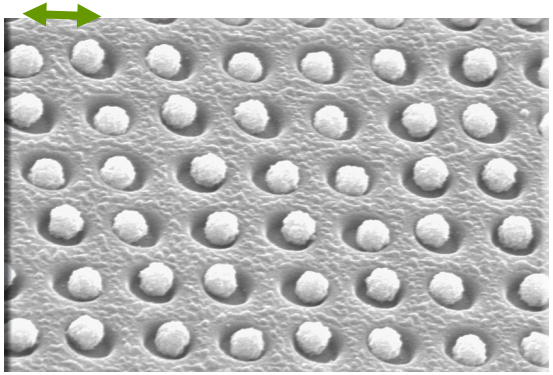
UCIrvine

Accelerator: The Perfect Storm-- Convergence of Engineering with Bio, Physics, & IT

1000x Magnification

MEMS

2 micron

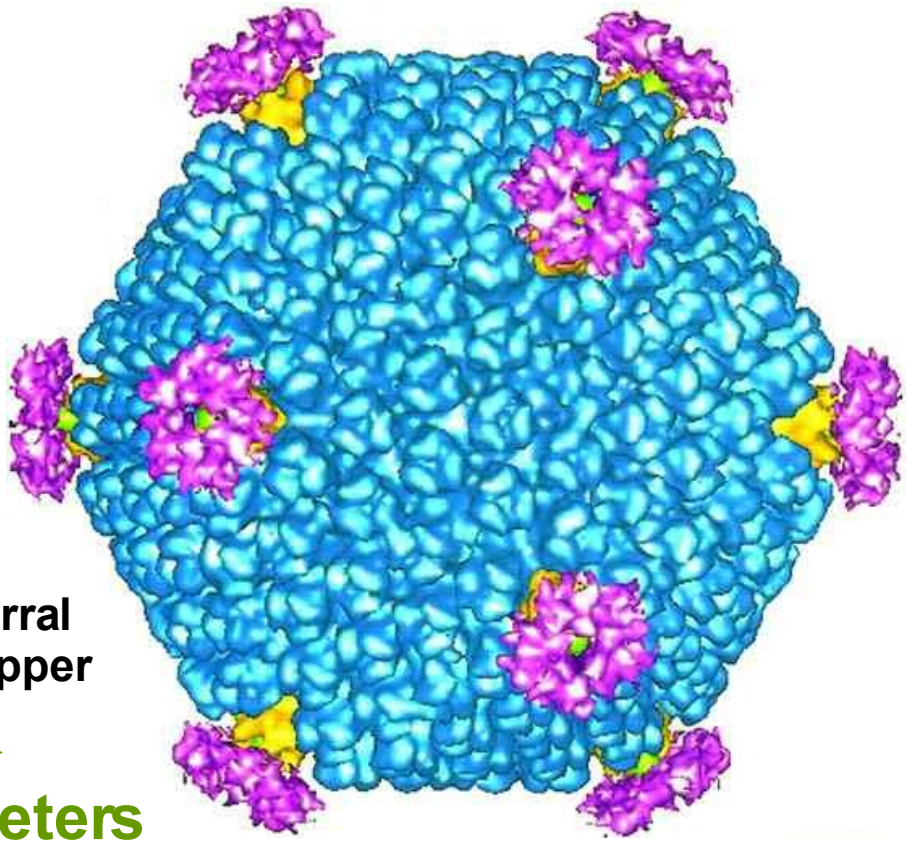


DNA-Conjugated Microbeads

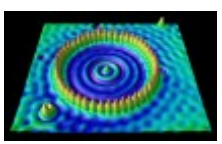


2 mm

400,000 x !



Human Adenovirus



IBM Quantum Corral
Iron Atoms on Copper

5 nanometers

400x Magnification

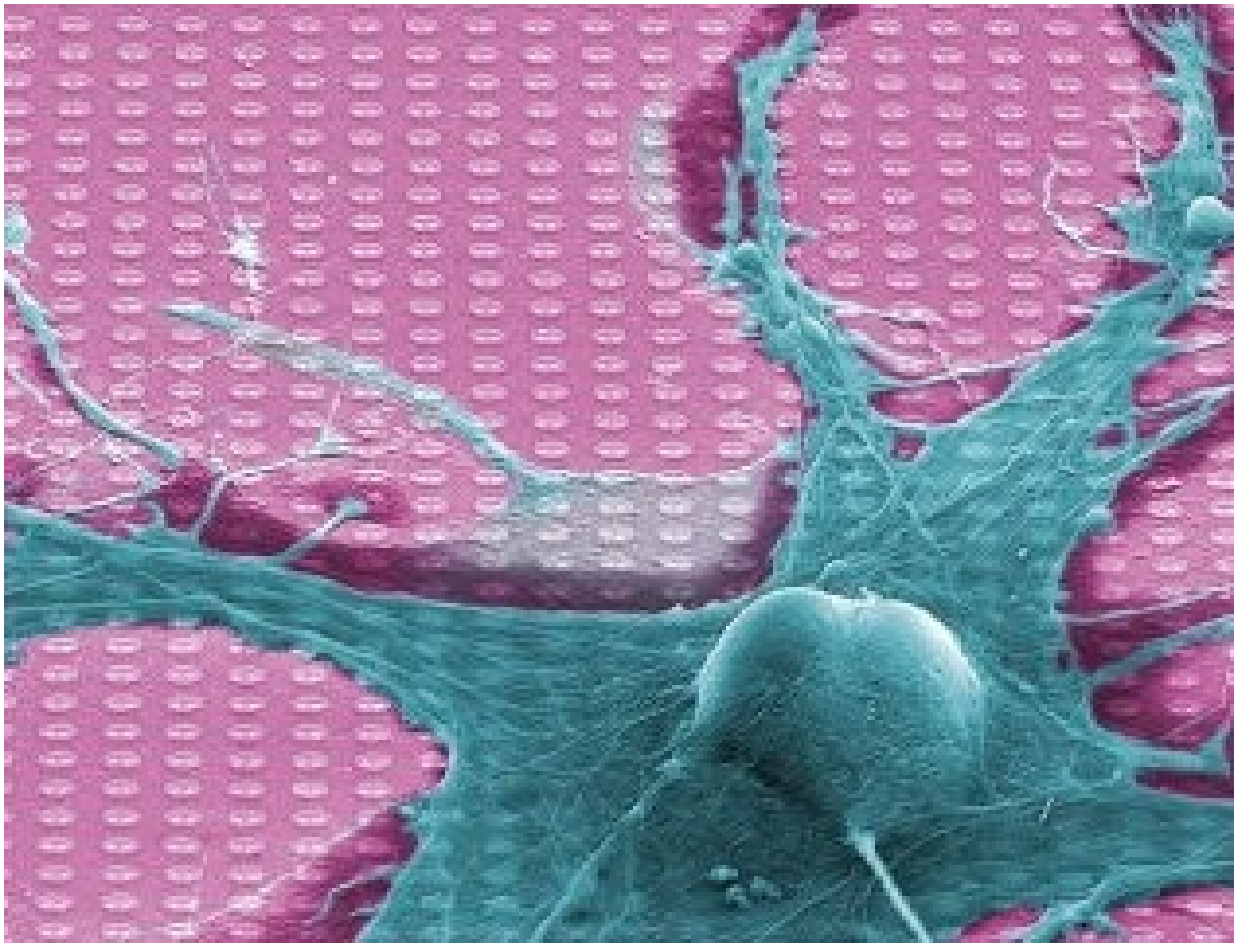
NANO

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Nanobioinfotechnology

it²

The Intersection of Solid State and Biological Information Systems



**Snail neuron grown on a CMOS chip with 128x128 Transistors.
The electrical activity of the neuron is recorded by the chip.
(Chip fabricated by Infineon Technologies)**

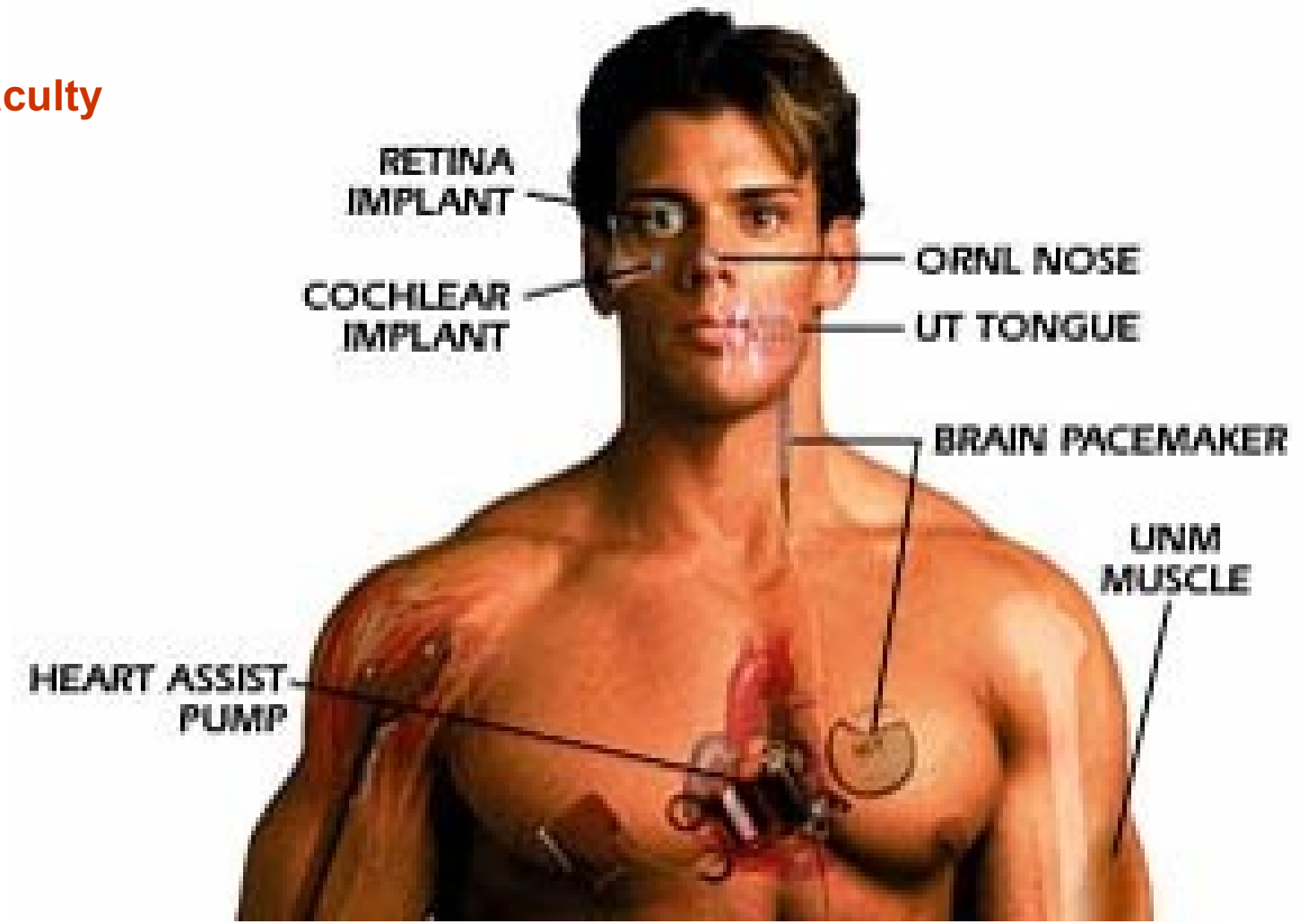
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www.biochem.mpg.de/en/research/rd/fromherz/publications/03eve/index.html

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Lifechips--Merging Two Major Industries: Microelectronic Chips & Life Sciences

65 UCI Faculty



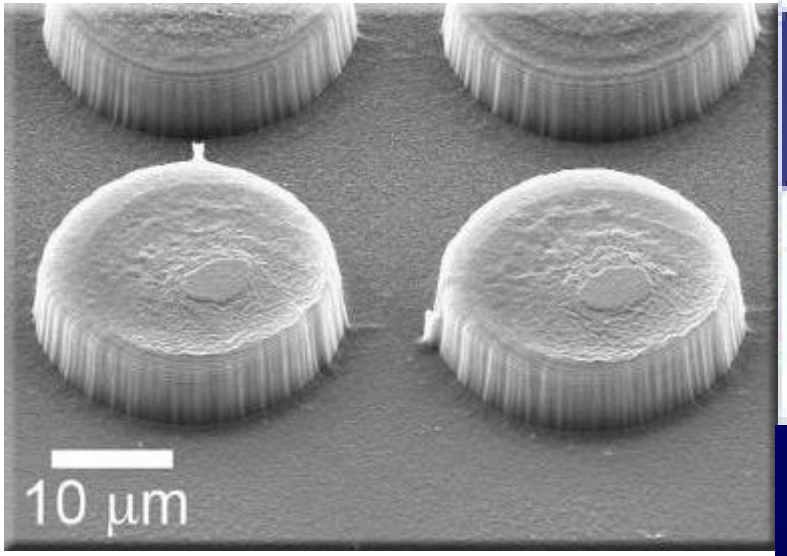
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lifechips
university of california, irvine
www.lifechips.org

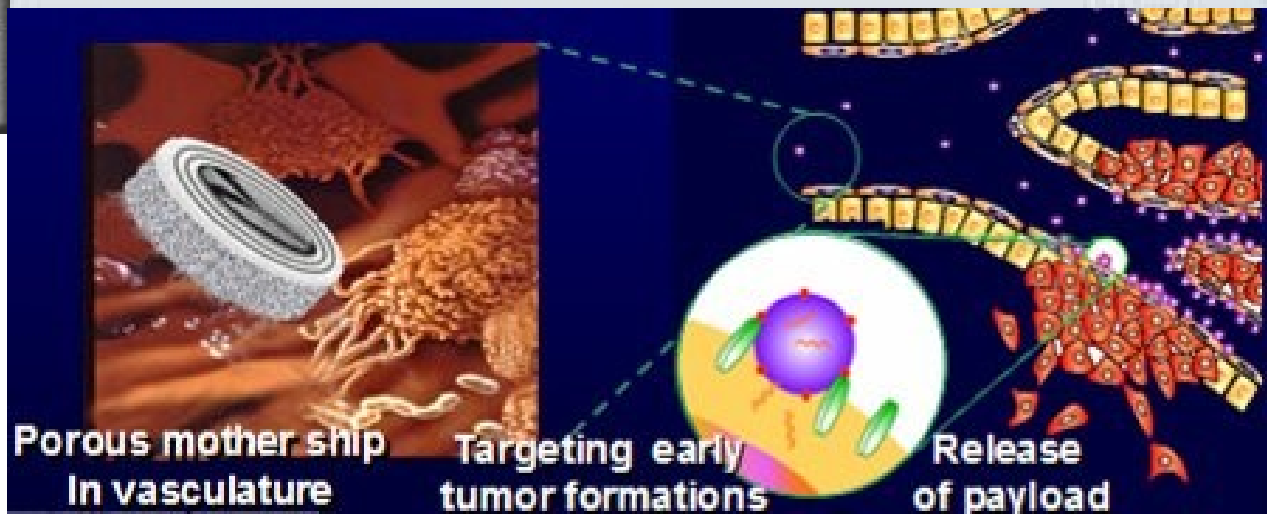
it²

Nano-Structured Porous Silicon Applied to Cancer Treatment

Nanodevices for In-vivo Detection & Treatment of Cancerous Tumors



Nanostructured “Mother Ships”
for Delivery of Cancer Therapeutics

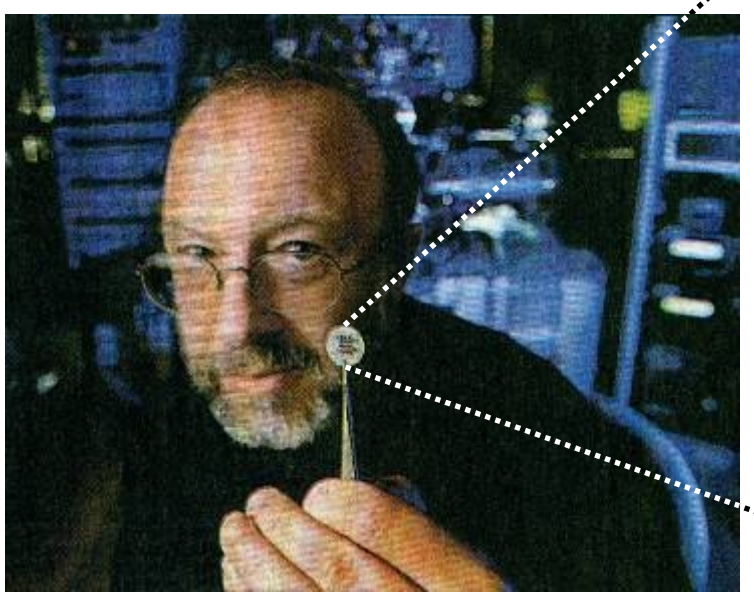


Michael J. Sailor Research Group
Chemistry and Biochemistry

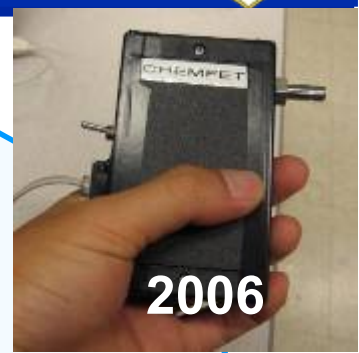
A World of Distributed Sensors Starts with Integrated Nanosensors

Developing Multiple Nanosensors on a Single Chip, Integrated with Local Processing and Wireless Communications

45 Faculty with Nano Projects at Calit2@UCSD



Ivan Schuller holding the first prototype in 2004



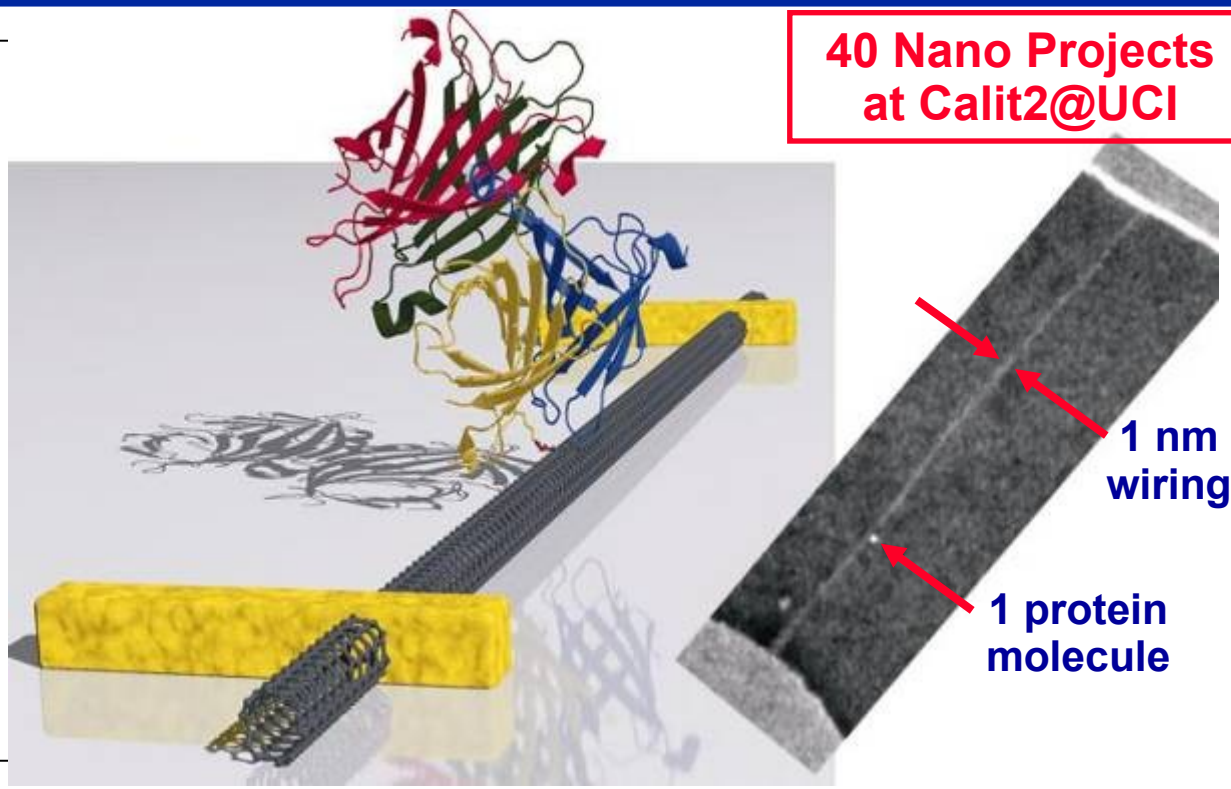
Technology Transfer:
RedX (Explosive Sensors), RheVision (Fauvation Optics)

I. K. Schuller, A. Kummel, M. Sailor, W. Trogler, Y-H Lo

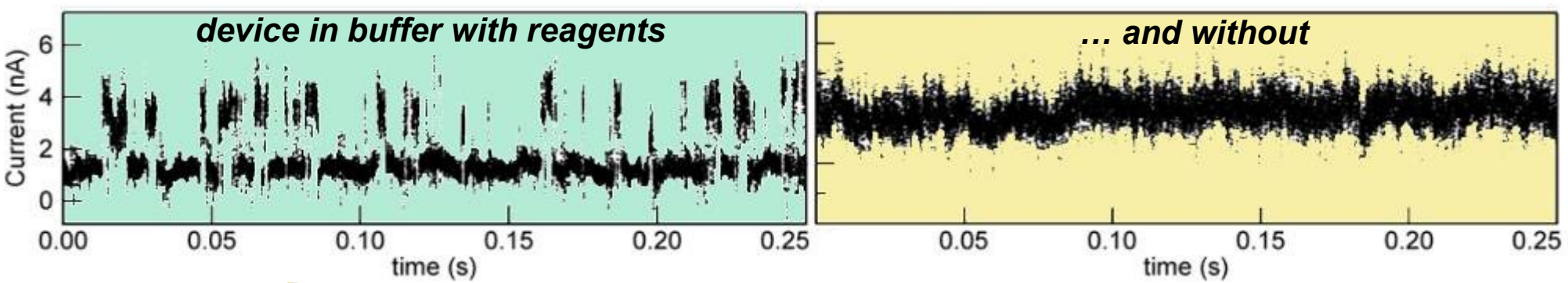
Real-Time Electronic Readout from Single Biomolecule Sensors

- Carbon Nanotube Circuits Provide Nanoscale Connectivity
- New Techniques Integrate Single-Molecule Attachments
- Dynamics and Interactions With the Environment Can be Directly Measured
- Electronic Readout Compatible With Hand-held, Low-power Devices

40 Nano Projects at Calit2@UCI



Schematic & SEM Image of Carbon Nanotube-based Device



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NSF

Source: Phil Collins & Greg Weiss, Calit2@UCI

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Building a Genome-Scale Model of E. Coli *in Silico*

JTB 2002

E. coli i2K

Genomics

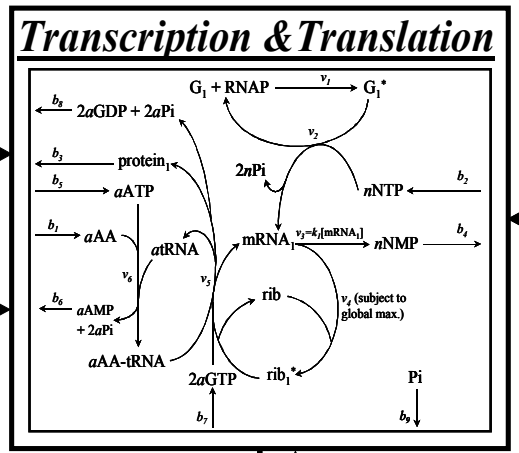
Transcriptomics

Proteomics

Metabolomics

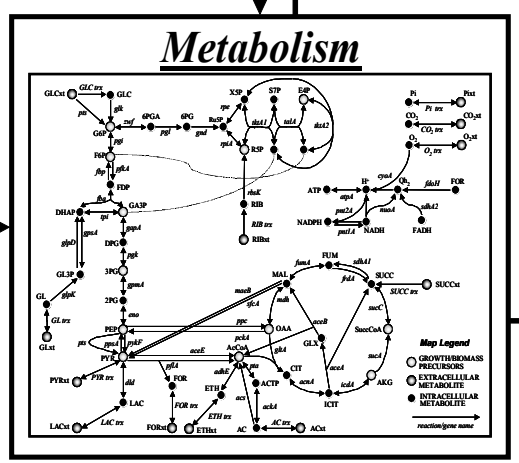
Interactomics

Environment



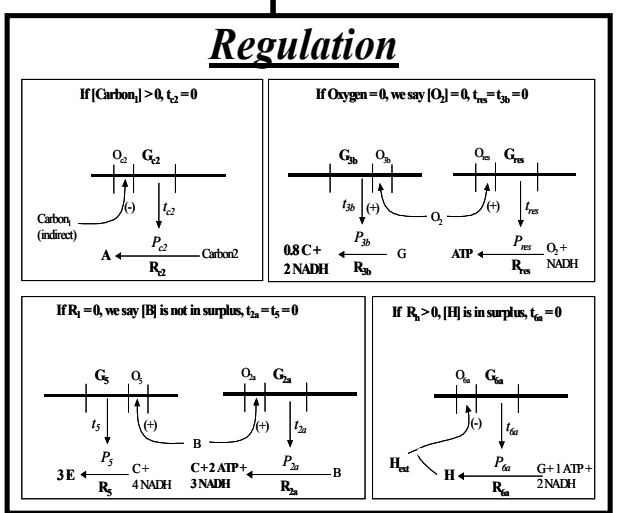
Proteins

Monomers & Energy



Regulatory Actions

JBC 2002



Input Signals

- **E. Coli**
  - **Has 4300 Genes**
  - **Model Has 2000!**

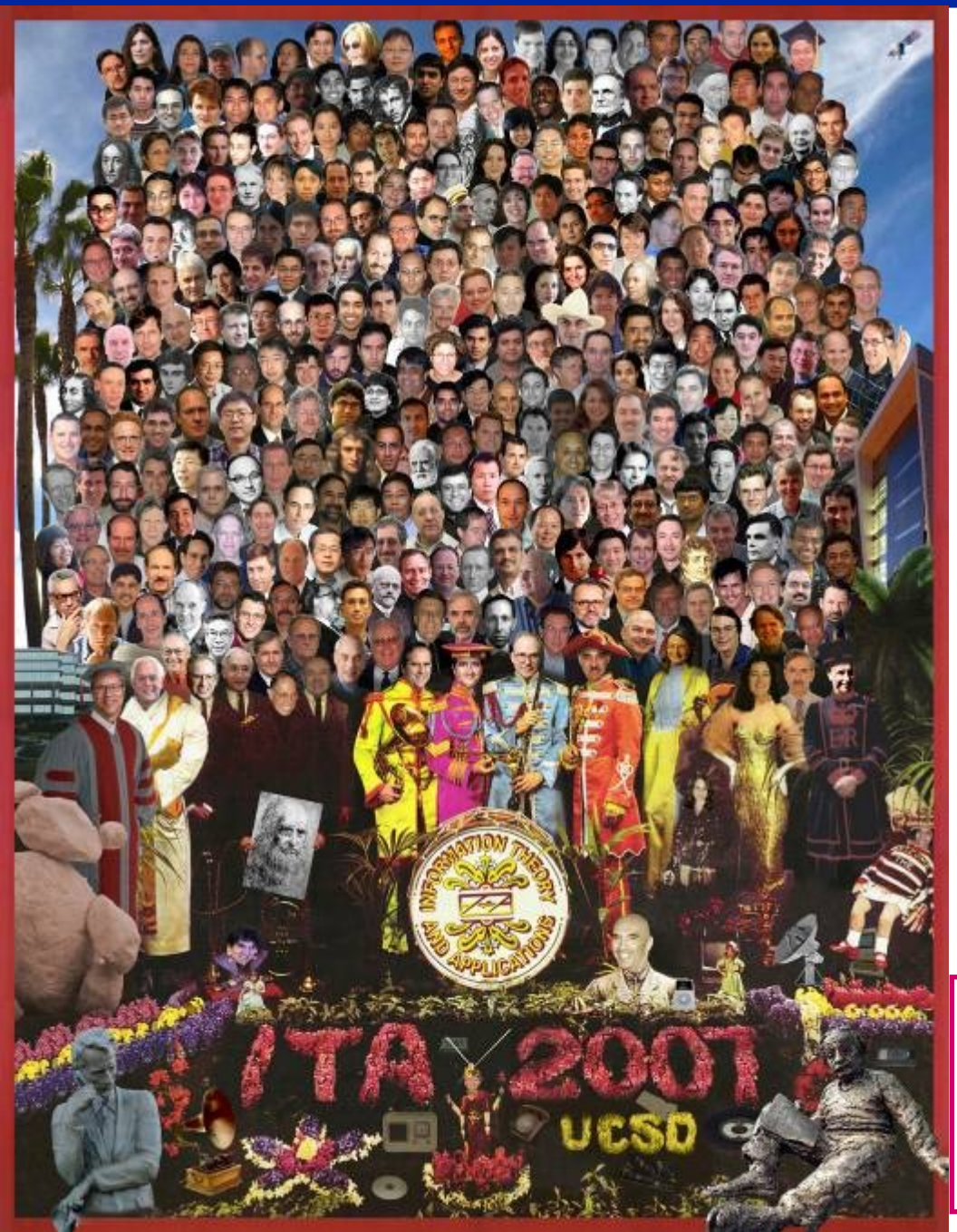
***in Silico* Organisms Now Available 2007:**

- Escherichia coli
- Haemophilus influenzae
- Helicobacter pylori
- Homo sapiens Build 1
- Human red blood cell
- Human cardiac mitochondria
- Methanosarcina barkeri
- Mouse Cardiomyocyte
- Mycobacterium tuberculosis
- Saccharomyces cerevisiae
- Staphylococcus aureus

Source: Bernhard Palsson
UCSD Genetic Circuits Research Group
http://gcrg.ucsd.edu

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Information Theorists Working with Bio, IT, and Nano Researchers Will Radically Transform Our View of Living Systems



"Through the strong loupe of information theory, we will be able to watch how such [living] beings do what nonliving systems cannot do: extract information from their surrounds, store it in a stable molecular form, and eventually parcel it out for their creative endeavors. ... So viewed, the information circle becomes the unit of life."
--Werner Loewenstein
The Touchstone of Life (1999)

Calit2's
Information Theory and Applications Center
http://ita.ucsd.edu

President Kalam of India Believes Nanobioinfotech is the Future for 600,000 Villages

- Interactive Knowledge System
- Convergence of Info- Nano - Bio
- Make the Bandwidth Available with No Limits
- PURA--Societal Grid With Electronic Connection of a Billion People

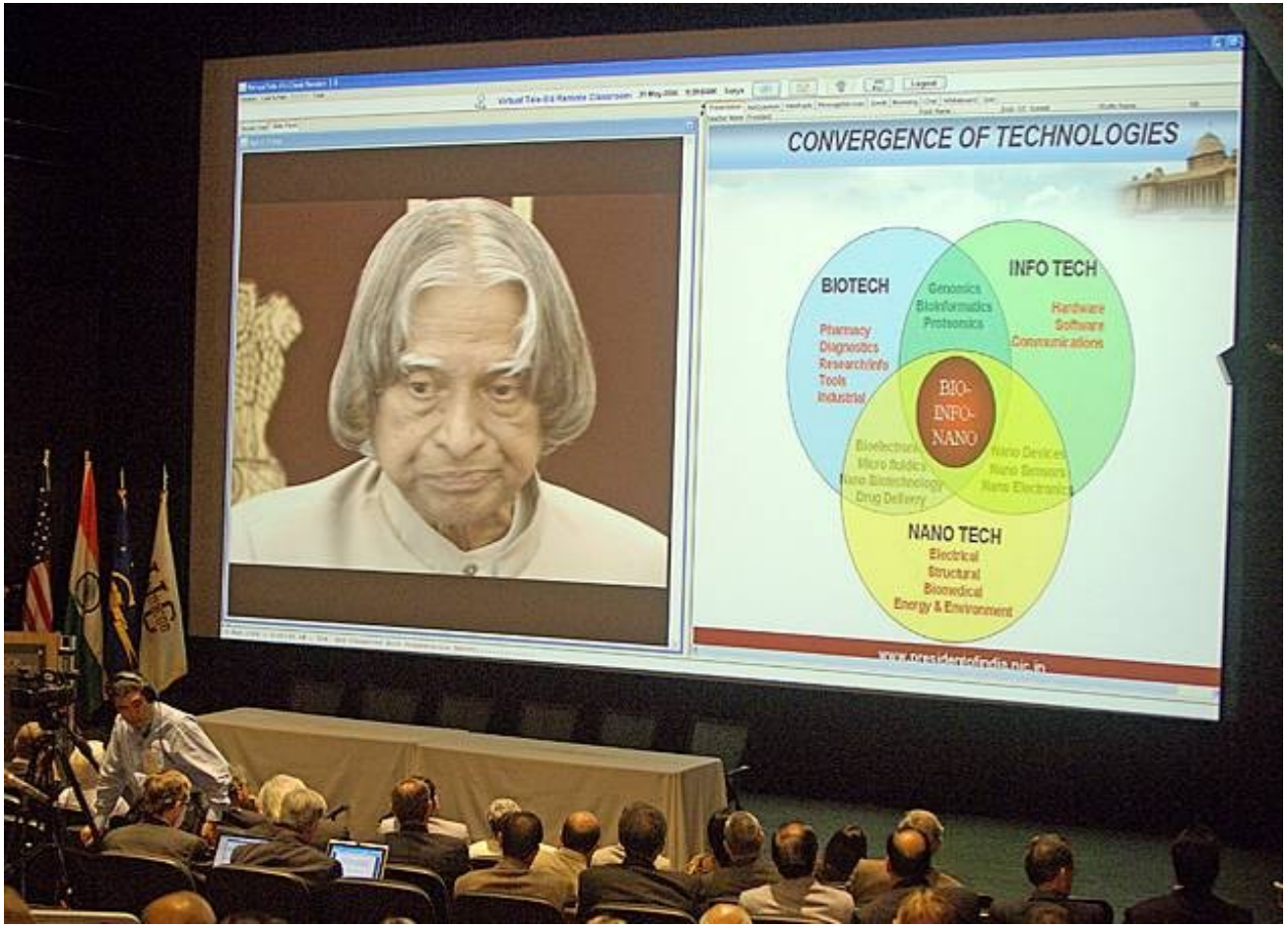


Photo: Alan Decker, UCSD

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The University Research World Is Connecting with Dedicated 10Gbps Light Paths

Maxine Brown, Tom DeFanti, Co-Chairs

iGrid 2005

THE GLOBAL LAMBDA INTEGRATED FACILITY

www.igrid2005.org

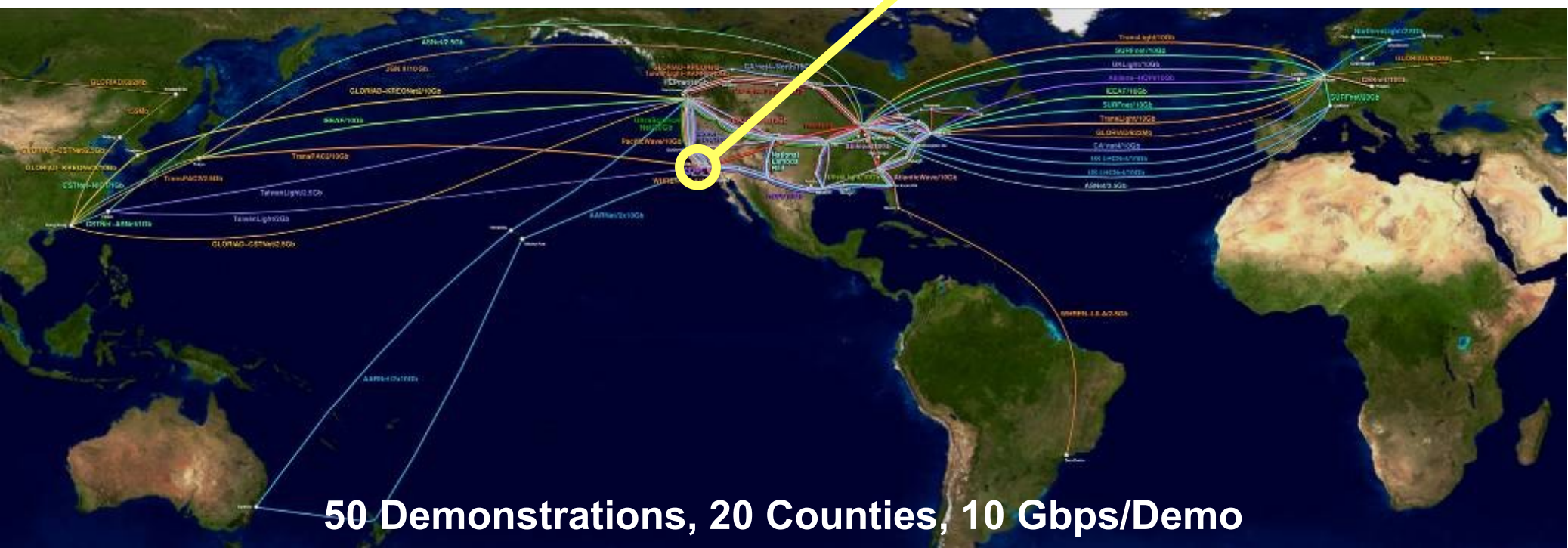


the UC Discovery Grant

September 26-30, 2005

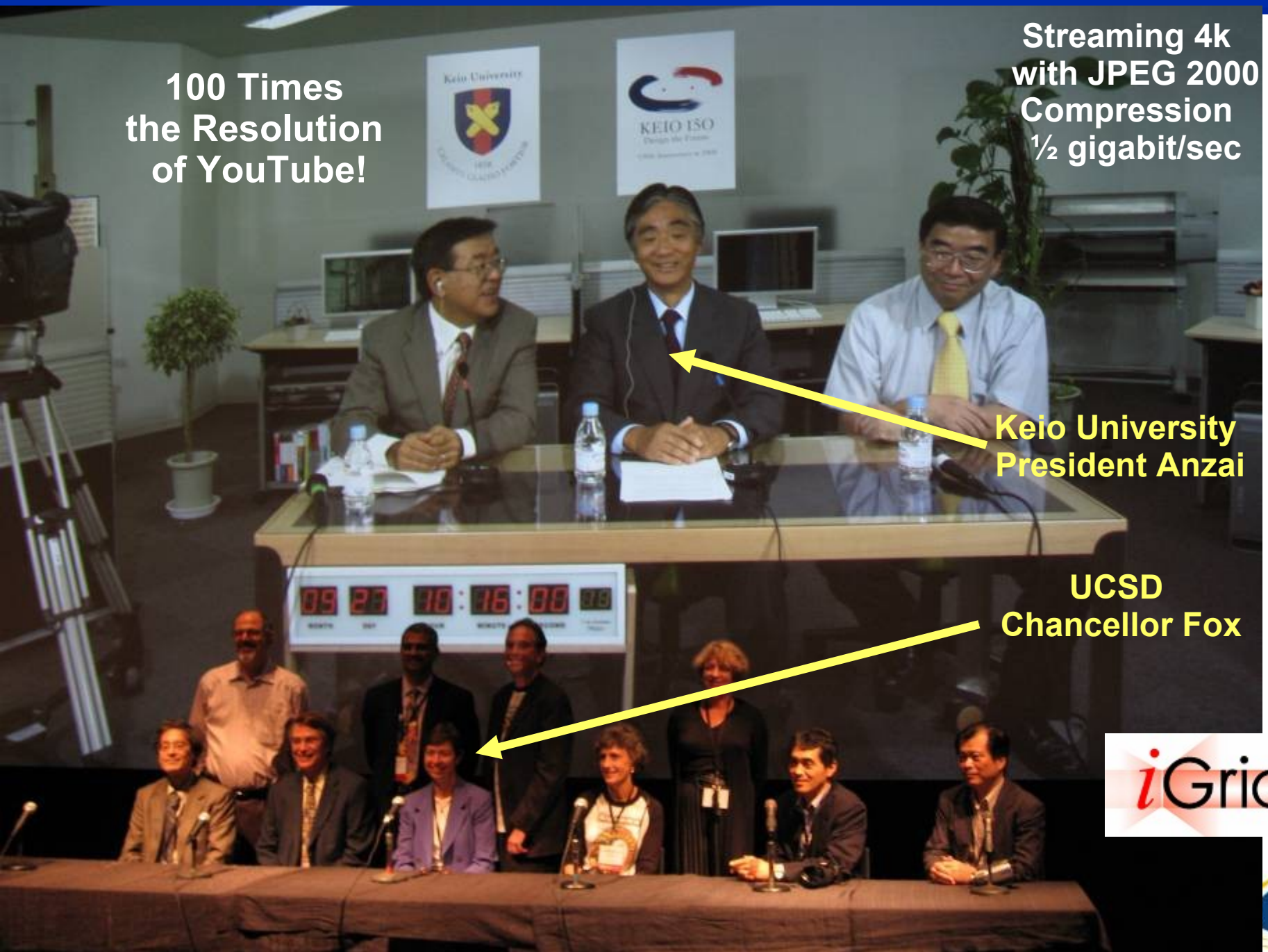
Calit2 @ University of California, San Diego

California Institute for Telecommunications and Information Technology



50 Demonstrations, 20 Counties, 10 Gbps/Demo

First Trans-Pacific Super High Definition Telepresence Meeting Using Digital Cinema 4k Streams



Talk by Laurin Herr

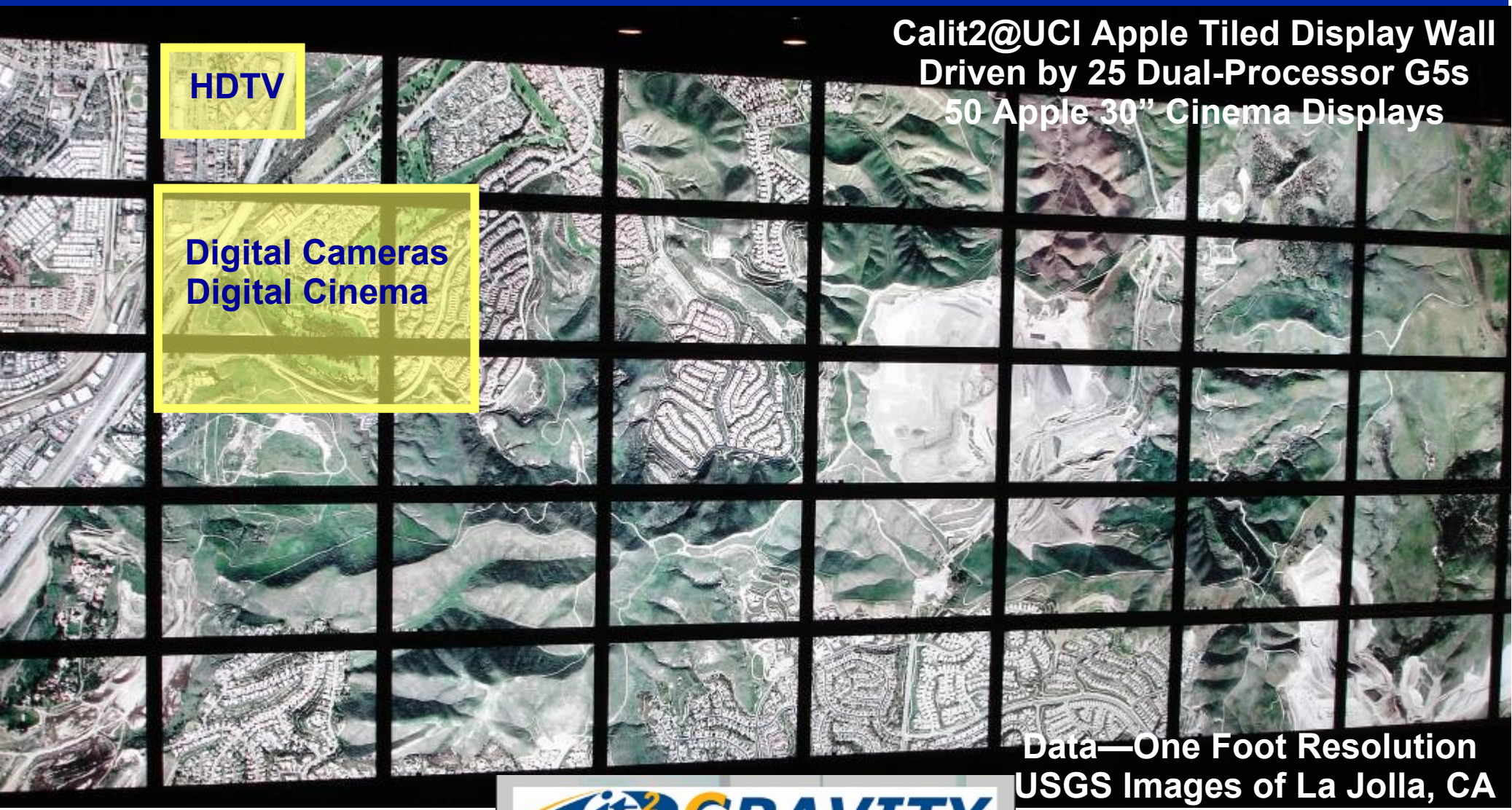
Lays Technical Basis for Global Digital Cinema

Sony
NTT
SGI

iGrid 2005

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Beyond 4k – From 8 Megapixels Towards a Billion Megapixels



it² Center of GRAVITY
Center of Graphics, Visualization and Imaging Technology

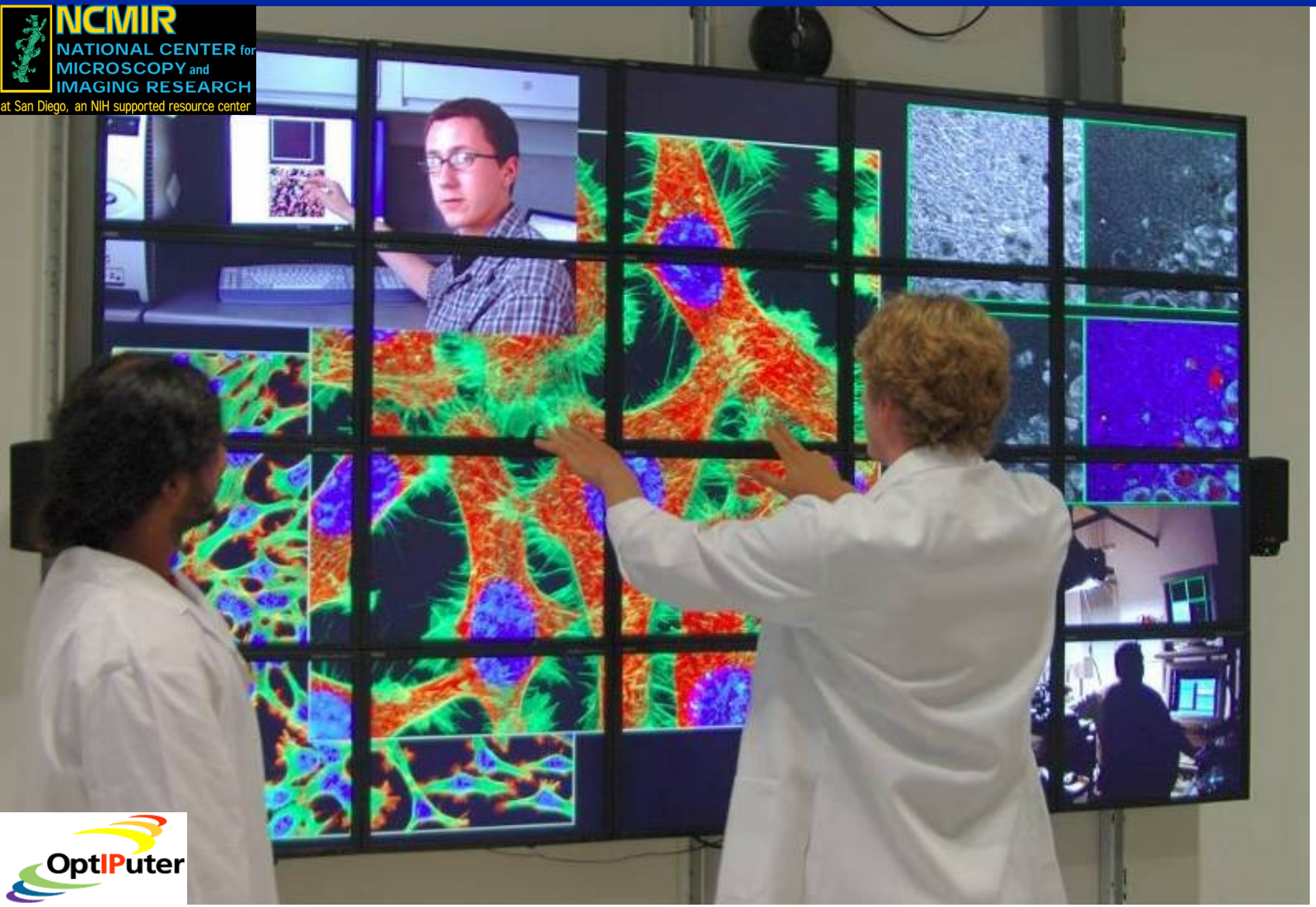
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Source: Falko Kuester, Calit2@UCI
NSF Infrastructure Grant

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The OptIPuter Project: Creating High Resolution Portals Over Dedicated Optical Channels to Global Science Data

NCMIR
NATIONAL CENTER for MICROSCOPY and IMAGING RESEARCH
at San Diego, an NIH supported resource center



Scalable Adaptive Graphics Environment (SAGE)

evl electronic visualization laboratory

NSF

$13.5M Over Five Years

Picture Source: Mark Ellisman, David Lee, Jason Leigh

OptIPuter

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Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
Univ. Partners: SDSC, USC, SDSU, NW, TA&M, UvA, SARA, KISTI, AIST
Industry: IBM, Sun, Telcordia, Chiaro, Calient, Glimmerglass, Lucent

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Broadband Depends on Where You Are









- **Mobile Broadband**
  - **0.1-0.5 Mbps**

100,000 Fold Range
All Here Today!

- **Home Broadband**
  - **1-5 Mbps**

"The future is already here,
it's just not evenly distributed"
William Gibson, Author of Neuromancer

- **University Dorm Room Broadband**
  - **10-100 Mbps**

- **Calit2 Global Broadband**
  - **1,000-10,000 Mbps**

Marine Genome Sequencing Project – Measuring the Genetic Diversity of Ocean Microbes

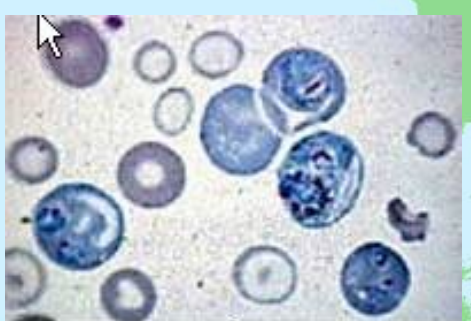


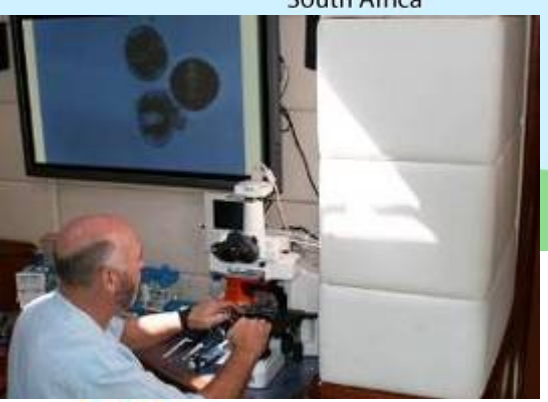
Each Sample ~2000 Microbial Species

Specify Ocean Data

Canada
United States
Mexico
Puerto Rico
Honduras
Costa Rica
Panama
Galapagos Islands
x 10 samples
French Polynesia
Vanuatu
Fiji
Tonga
Cook Islands
New Caledonia
x 17 samples
Australia
Cocos-Keeling Is.
Tanzania/ Zanzibar
x 7 samples
Seychelles
Madagascar
South Africa
x 8 samples

Analyzed
Sampled, but not Analyzed





Sorcerer II Data Will Double Number of Proteins in GenBank!

camera
Marine Microbial Ecology

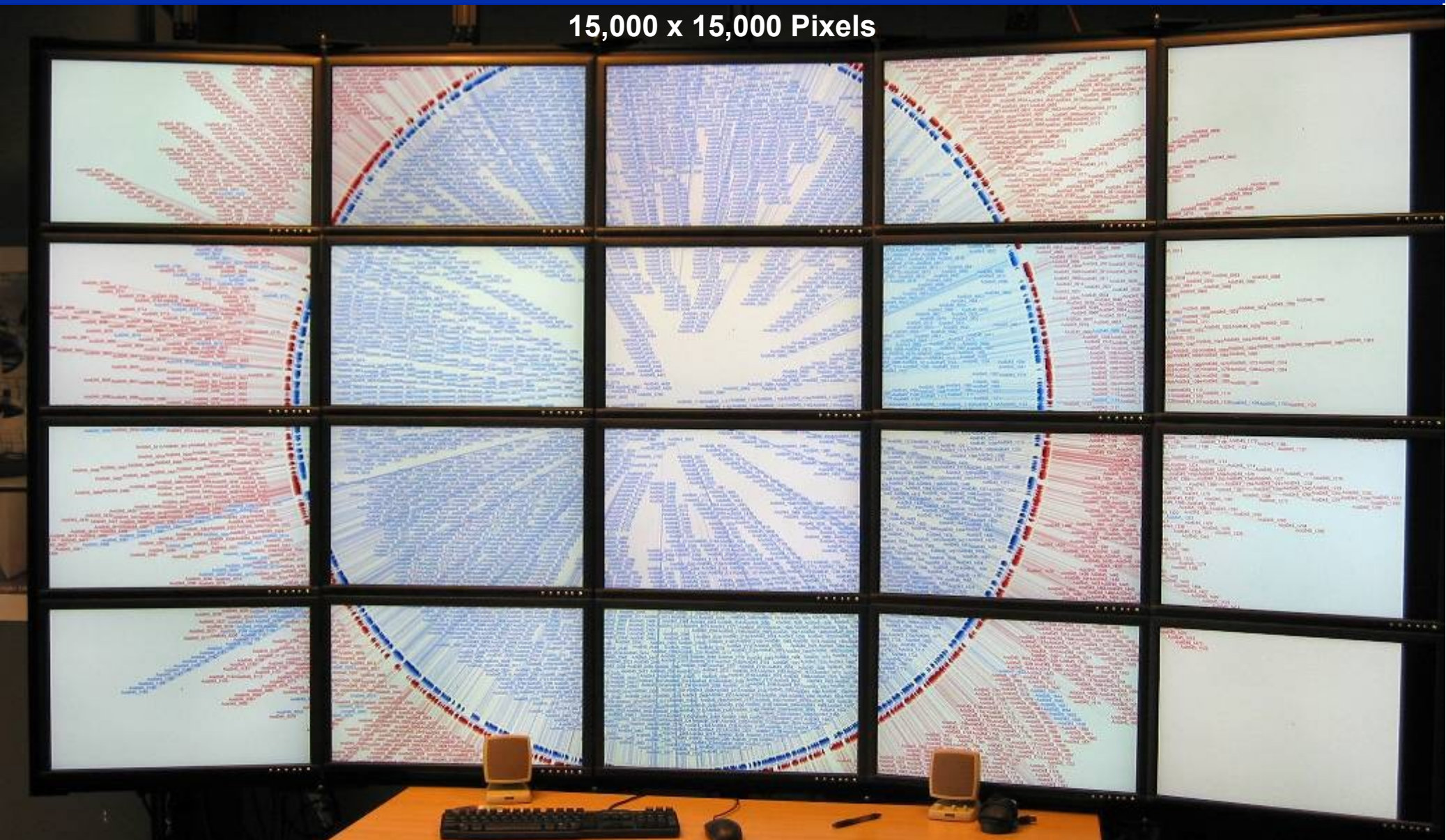
Marine Microbiology Initiative

Gordon and Betty MOORE FOUNDATION

J. Craig Venter INSTITUTE

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Use of OptIPortal to Interactively View Microbial Genome



UCSD
UCIrvine

Source: Raj Singh, UCSD

Acidobacteria bacterium Ellin345 (NCBI)
Soil Bacterium 5.6 Mb

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Use of OptIPortal to Interactively View Microbial Genome



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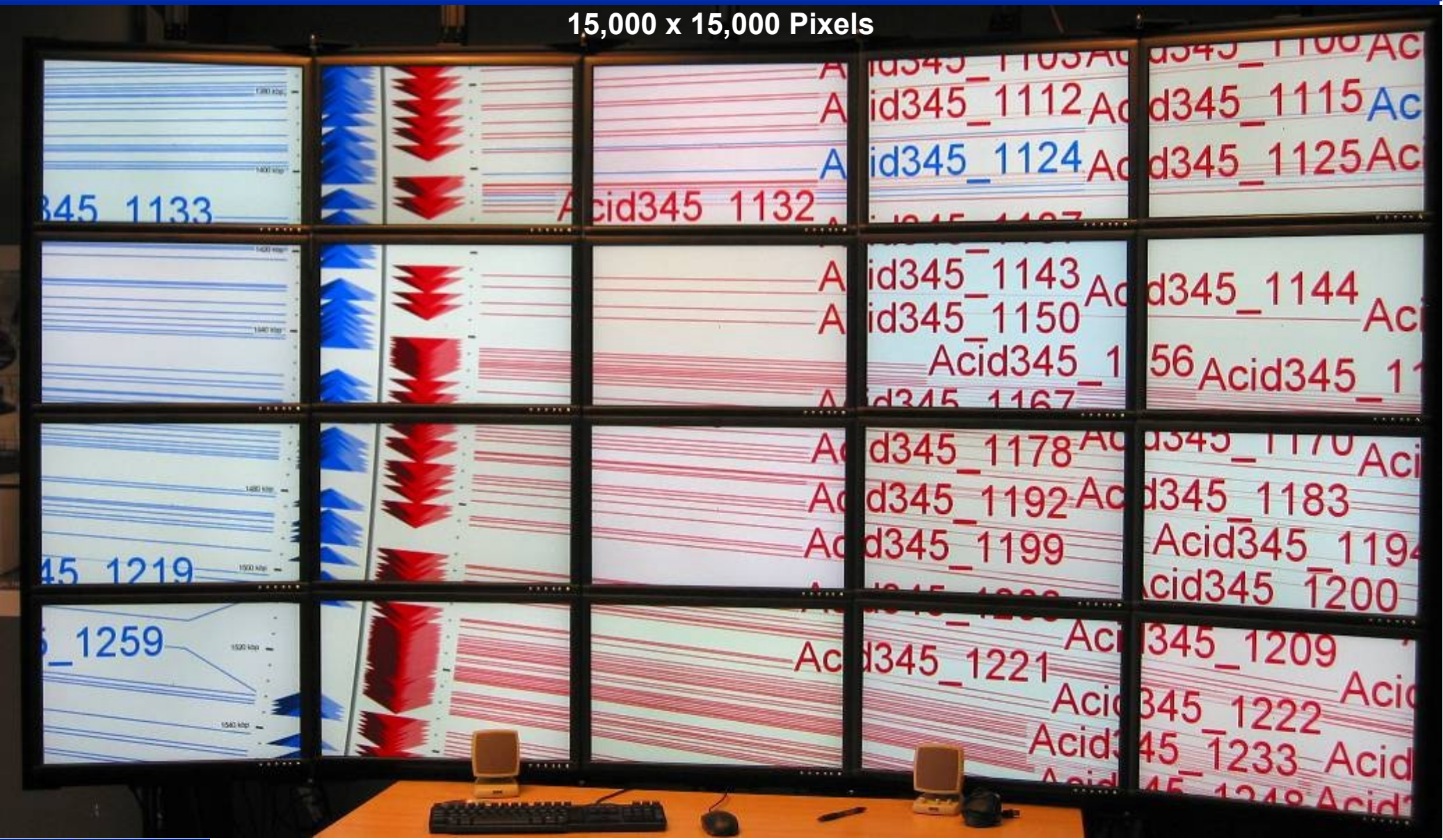
Source: Raj Singh, UCSD

Acidobacteria bacterium Ellin345 (NCBI)
Soil Bacterium 5.6 Mb

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Use of OptIPortal to Interactively View Microbial Genome

15,000 x 15,000 Pixels



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Source: Raj Singh, UCSD

Acidobacteria bacterium Ellin345 (NCBI)
Soil Bacterium 5.6 Mb

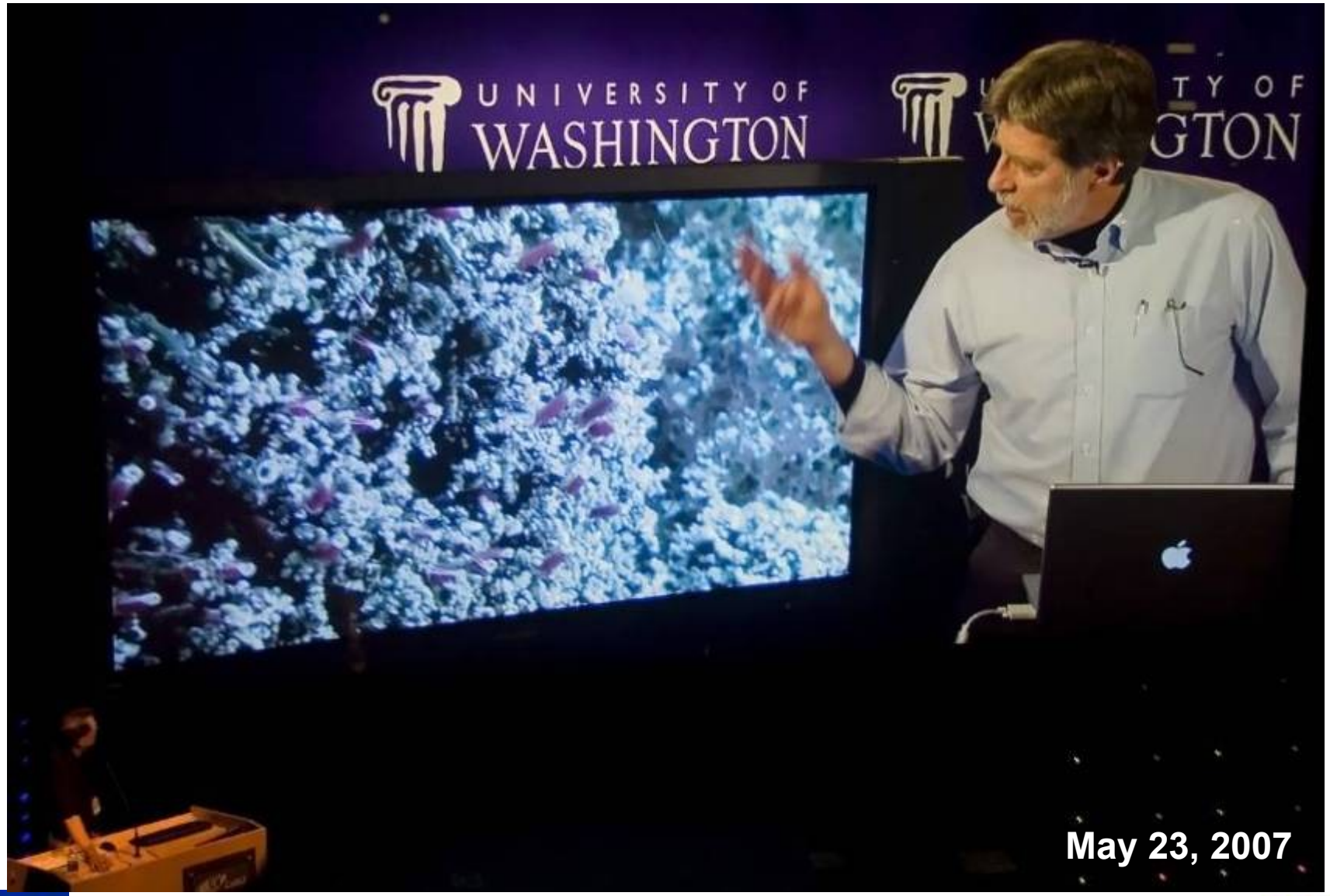
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An Emerging High Performance Collaboratory for Microbial Metagenomics



e-Science Collaboratory Without Walls Enabled by Uncompressed HD Telepresence

1500 Mbits/sec Calit2 to UW Research Channel Over NLR

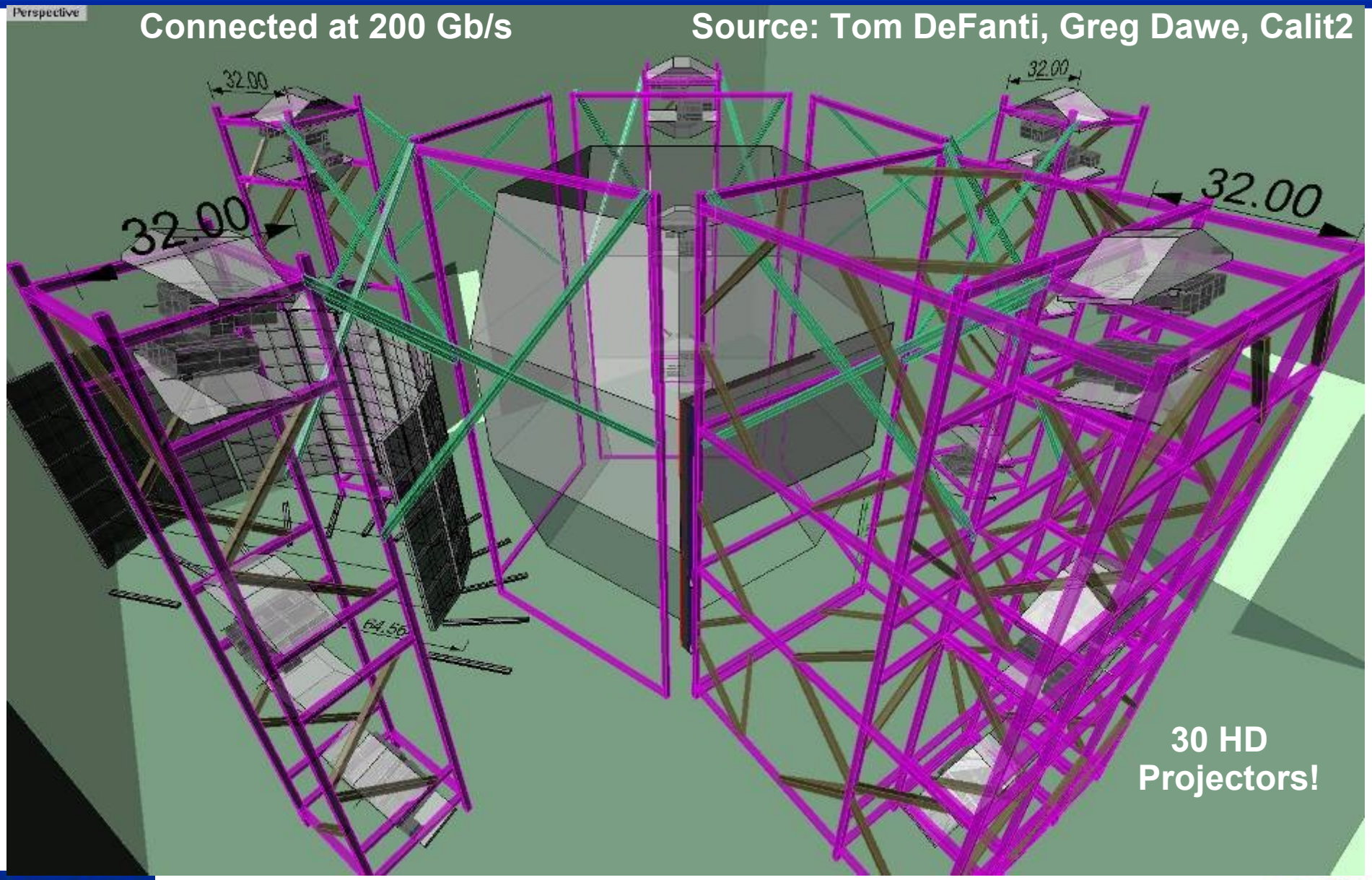


John Delaney, PI LOOKING, Neptune

Photo: Harry Ammons, SDSC

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3D OptIPortal Calit2 StarCAVE Telepresence "Holodeck"



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UCIrvine

60 GB Texture Memory,
Renders Images 3,200 Times the Speed of Single PC

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Can We Create a "My Space" for Science Researchers? Microbial Metagenomics as a Cyber Community

Over 1000 Registered Users From 45 Countries



USA	583
United Kingdom	46
Canada	35
France	35
Germany	32

camera
Marine Microbial Ecology

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