High Resolution Multimedia in a Ultra Bandwidth World

After Dinner Talk
IEEE ISM2005
Irvine, CA
December 13, 2005

Dr. Larry Smarr
Director, California Institute for Telecommunications and Information Technologies
Harry E. Gruber Professor,
Dept. of Computer Science and Engineering
Jacobs School of Engineering, UCSD

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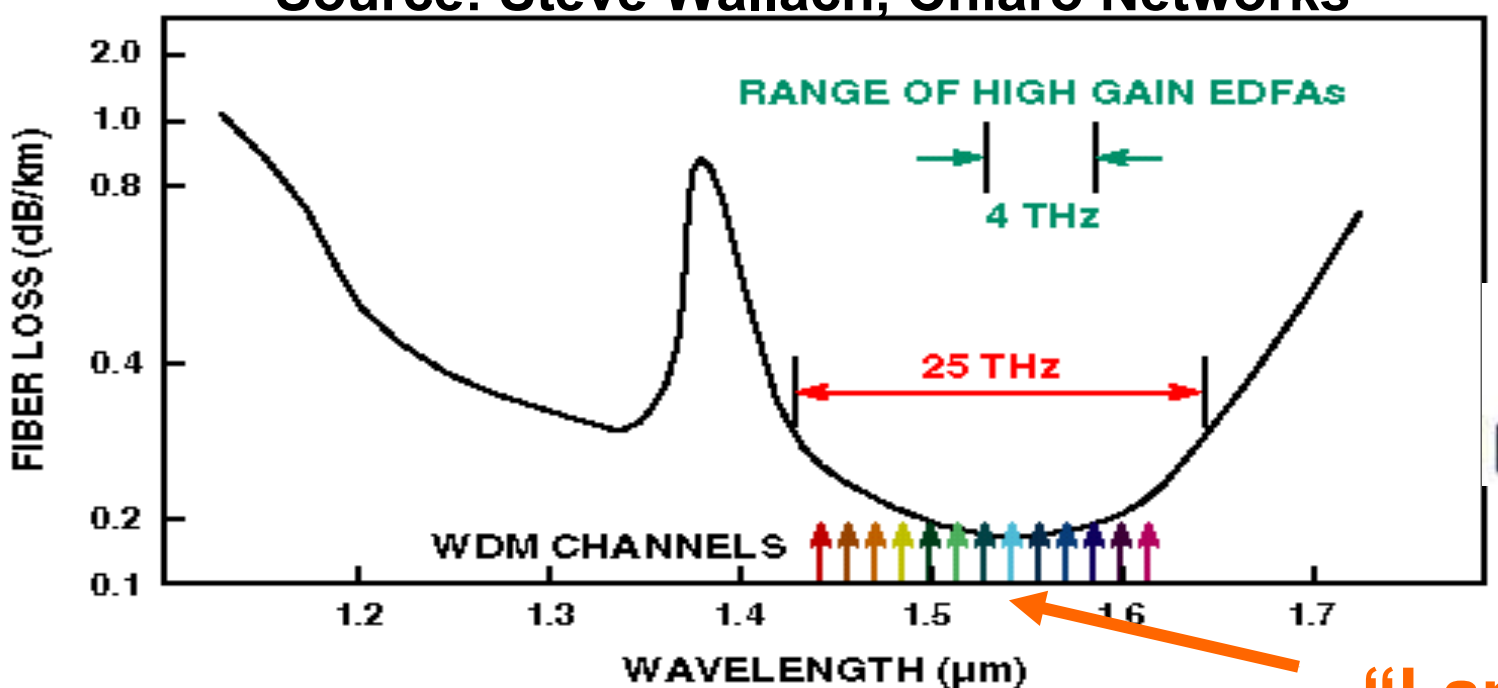
Dedicated Optical Channels Makes High Performance Cyberinfrastructure Possible

WAVELENGTH DIVISION MULTIPLEXING (WDM)

10 Gbps per User ~ 200x Shared Internet Throughput

- EXPLOITS
  - ENORMOUS BANDWIDTH OF SILICA FIBER
  - HIGH-GAIN WIDEBAND OPTICAL AMPLIFIERS

Source: Steve Wallach, Chiaro Networks



CHIARO

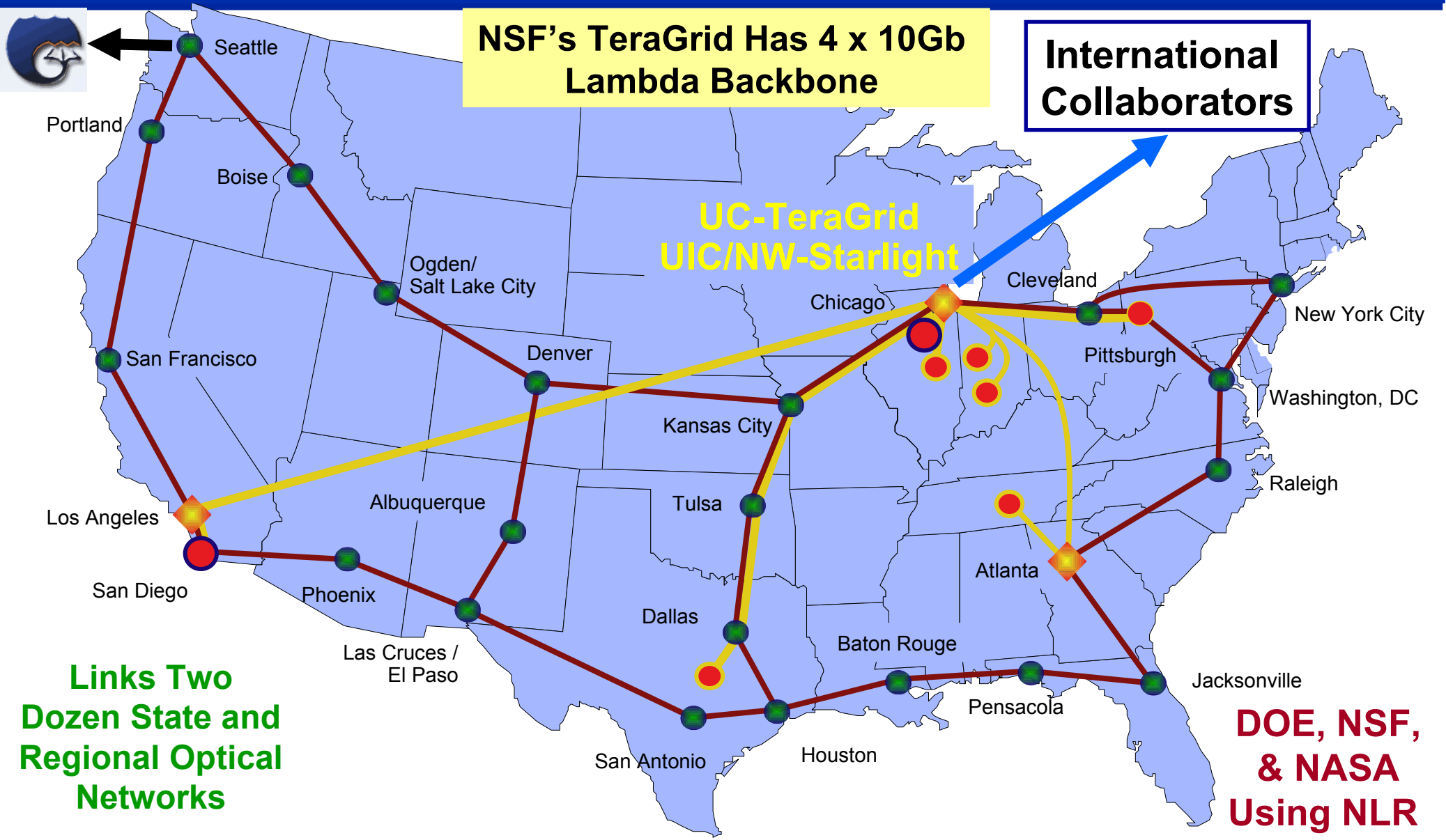
"Lambdas"

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Parallel Lambdas are Driving Optical Networking The Way Parallel Processors Drove 1990s Computing

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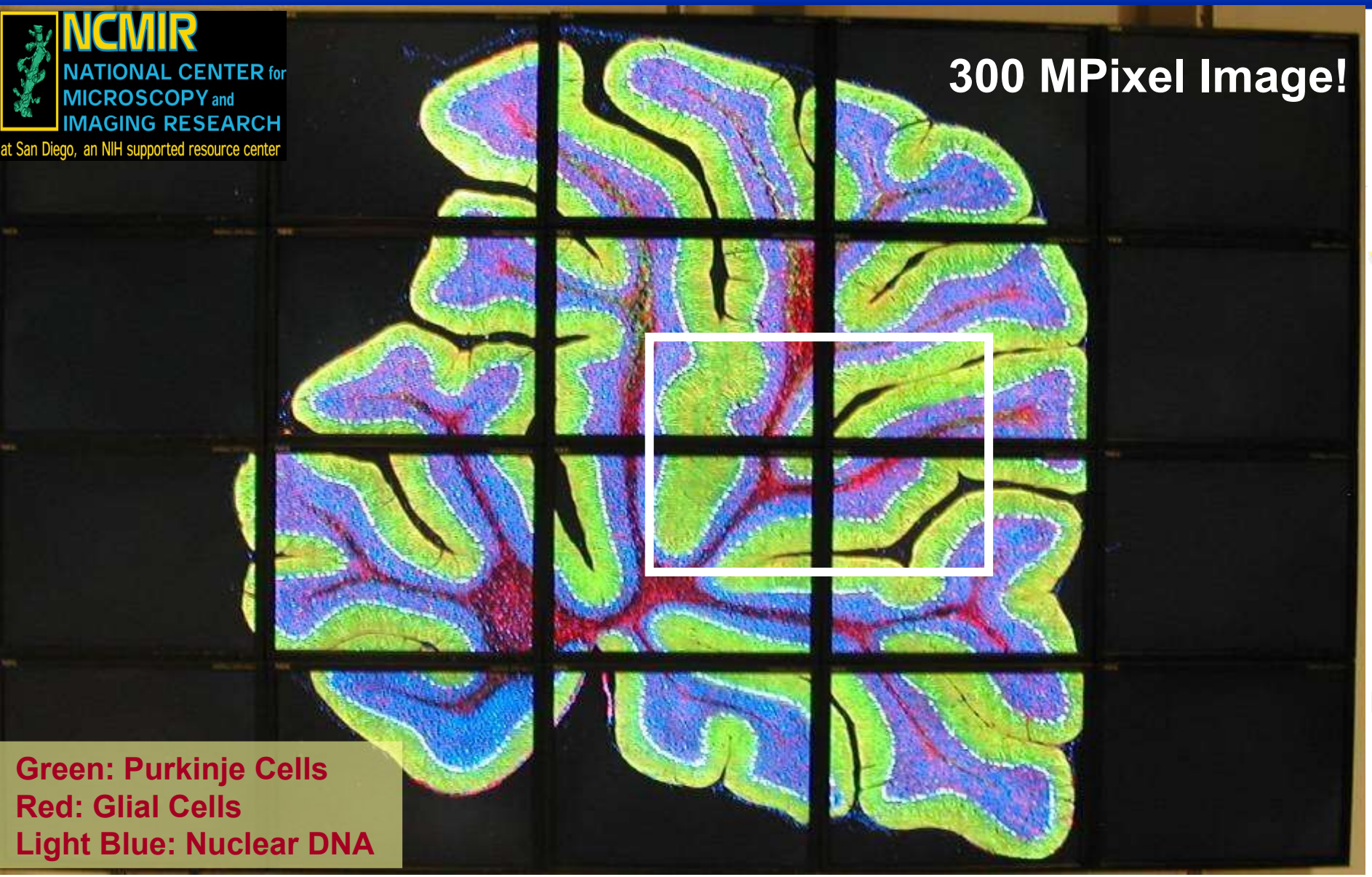
National Lambda Rail (NLR) and TeraGrid Provides Cyberinfrastructure Backbone for U.S. Researchers



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The OptIPuter -- From the Grid to the LambdaGrid: High Resolution Portals to Global Science Data

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



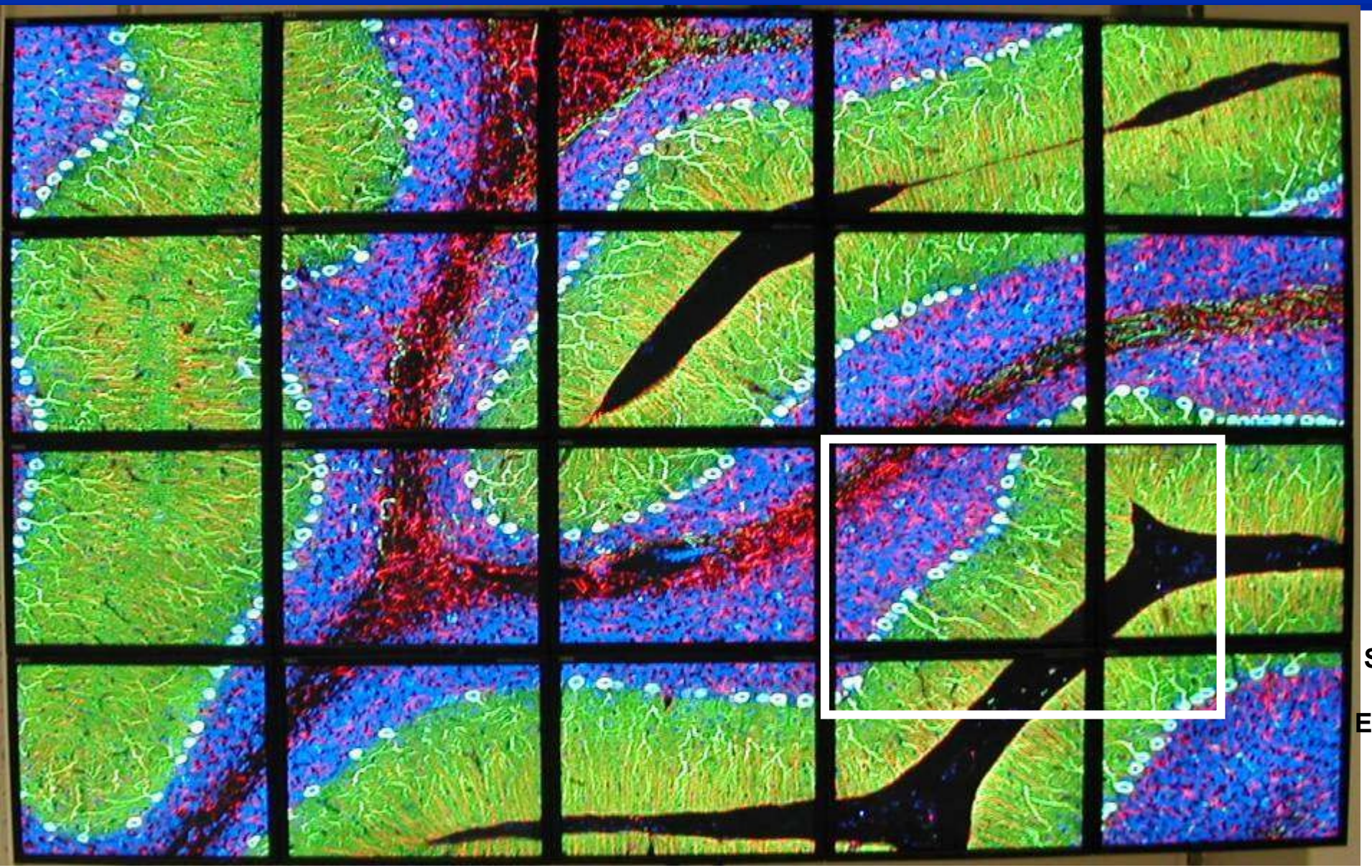
Green: Purkinje Cells
Red: Glial Cells
Light Blue: Nuclear DNA

Source: Mark Ellisman, David Lee, Jason Leigh

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Calit2 (UCSD, UCI) and UIC Lead Campuses—Larry Smarr PI
Partners: SDSC, USC, SDSU, NW, TA&M, UvA, SARA, KISTI, AIST

Scalable Displays Allow Both Global Content and Fine Detail



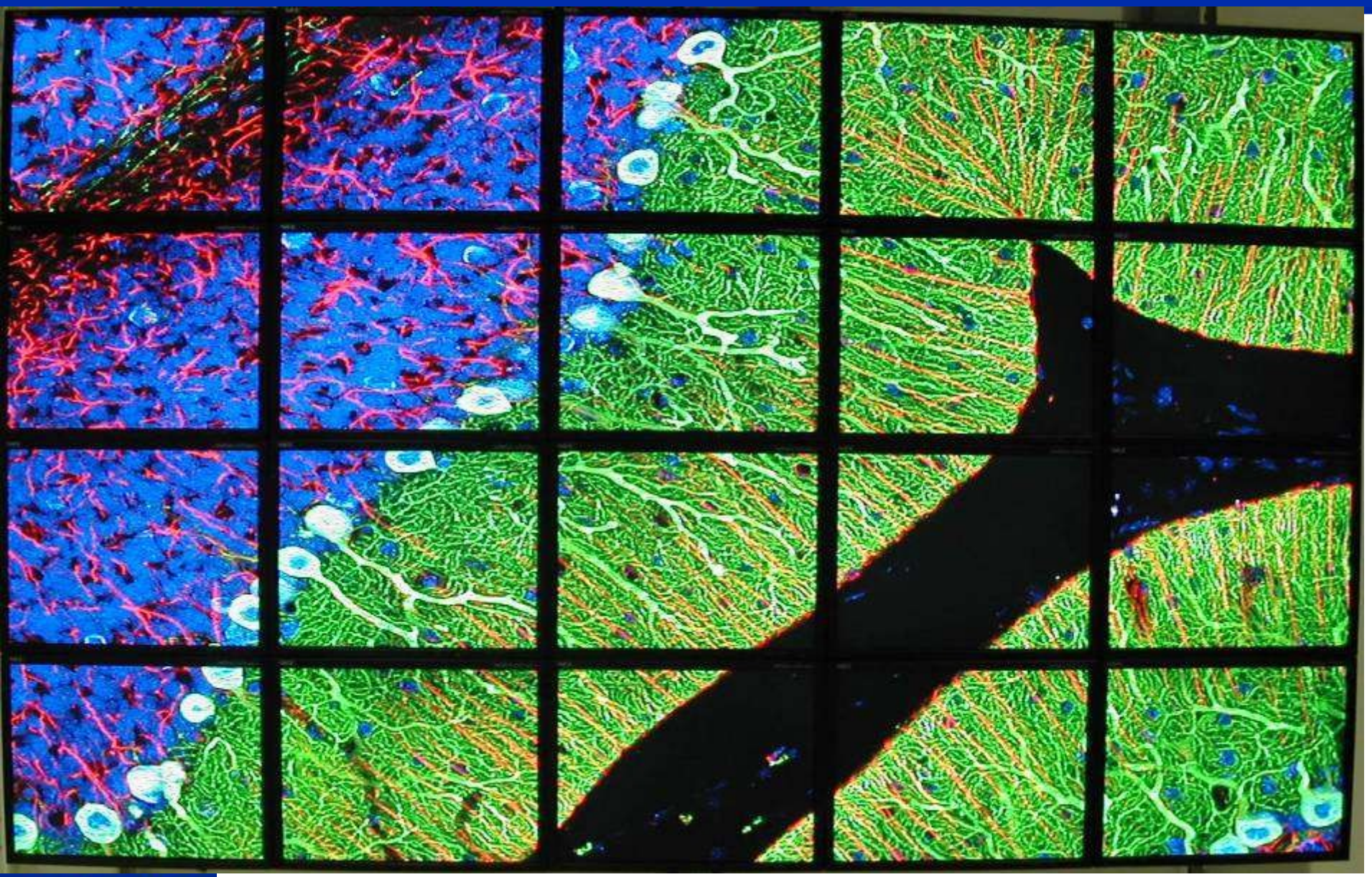
Source: Mark Ellisman, David Lee, Jason Leigh

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30 MPixel SunScreen Display Driven by a 20-node Sun Opteron Visualization Cluster

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Allows for Interactive Zooming from Cerebellum to Individual Neurons



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Source: Mark Ellisman, David Lee, Jason Leigh

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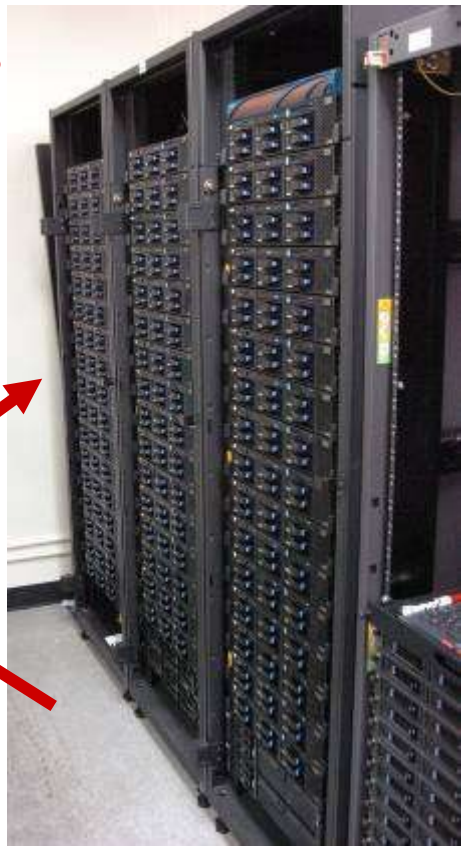
Campuses Must Provide Fiber Infrastructure to End-User Laboratories & Large Rotating Data Stores

SIO Ocean Supercomputer



UCSD Campus LambdaStore Architecture

IBM Storage Cluster



Streaming Microscope







2 Ten Gbps Campus Lambda Raceway







Global LambdaGrid

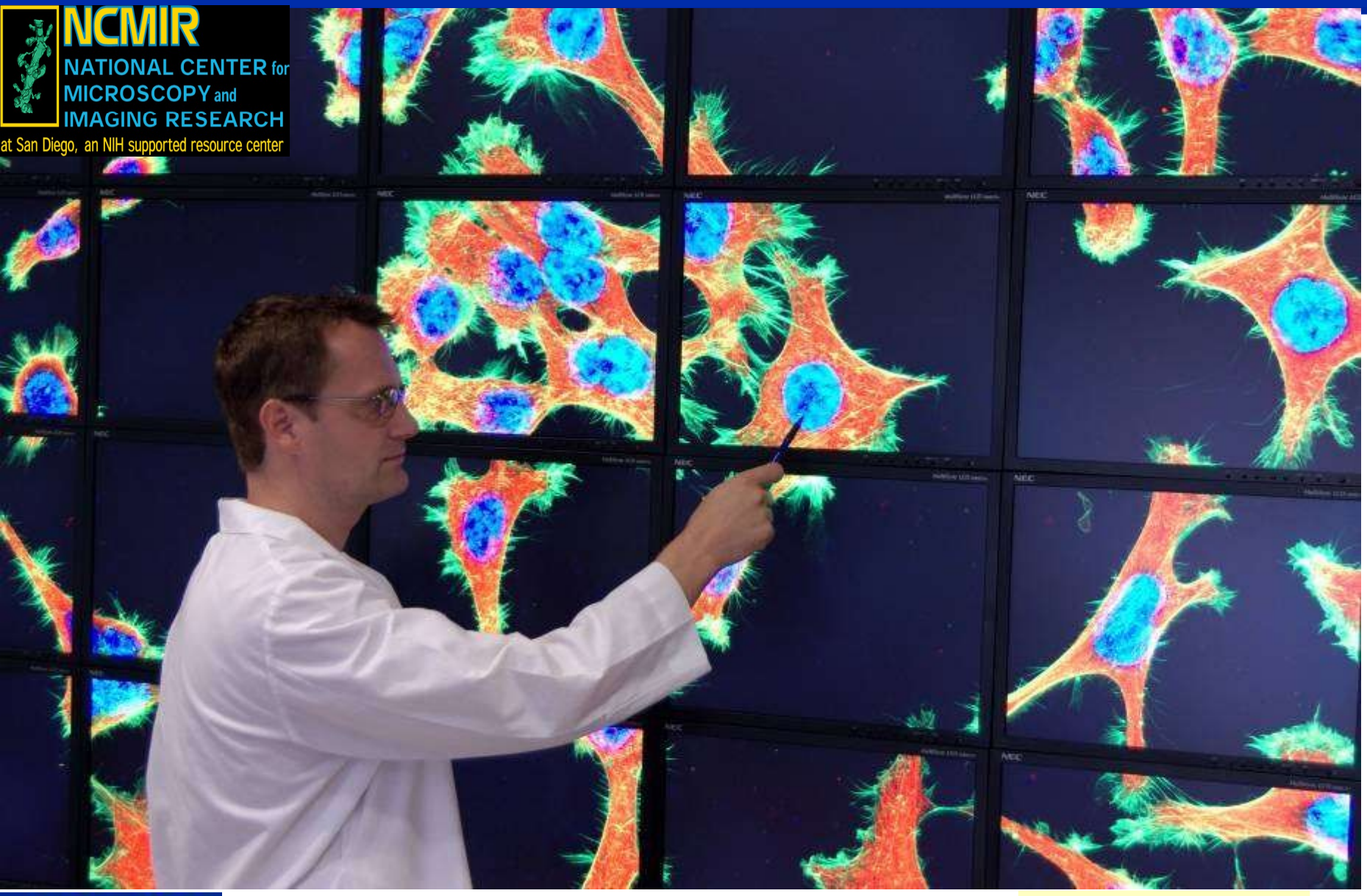
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Source: Phil Papadopoulos, SDSC, Calit2

it2

Realizing the Dream: High Resolution Portals to Global Science Data



Source: Mark Ellisman, David Lee, Jason Leigh, Tom Deerinck

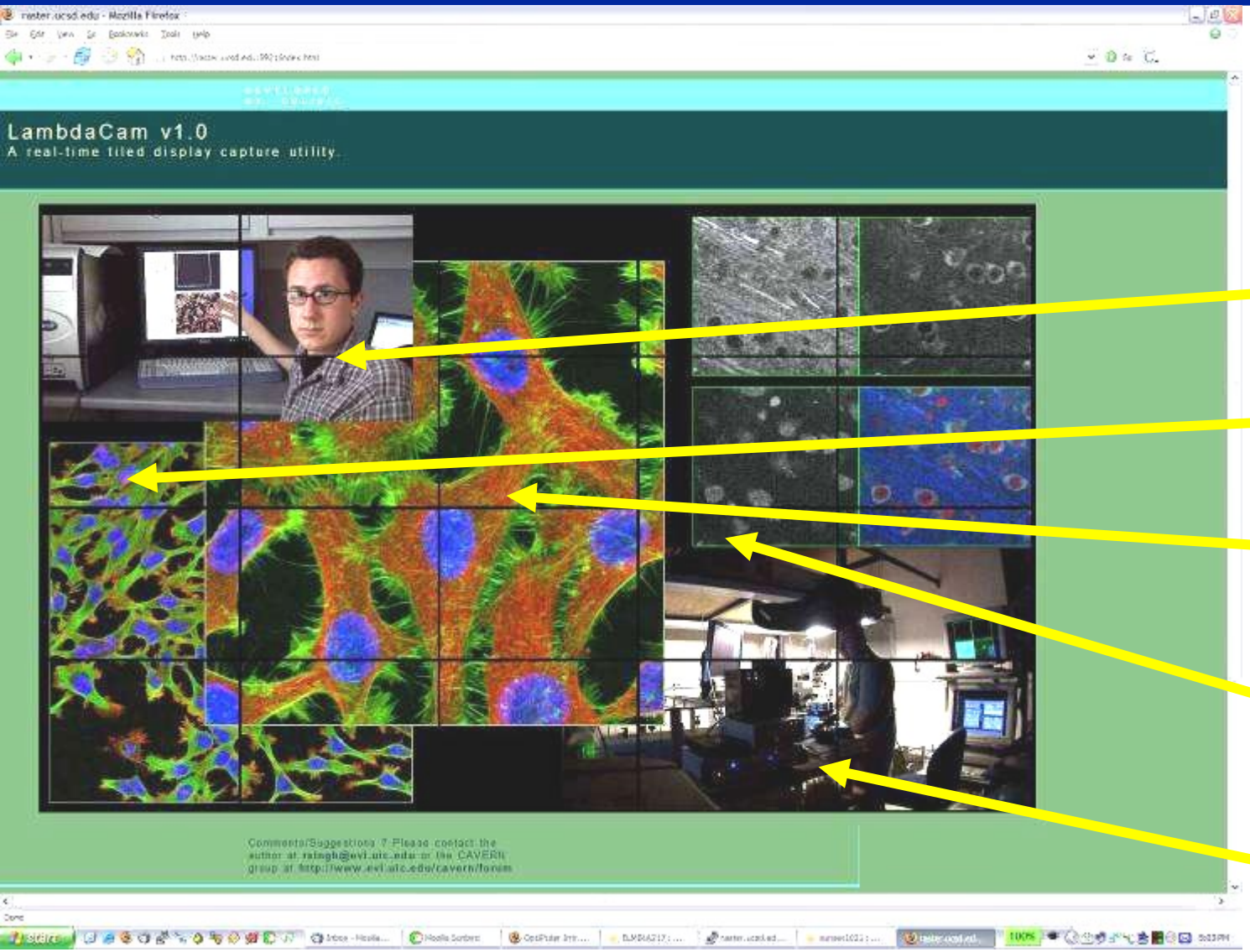
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650 Mpixel 2-Photon Microscopy Montage of HeLa Cultured Cancer Cells

Green: Actin
Red: Microtubles
Light Blue: DNA

it2

OptIPuter Scalable Adaptive Graphics Environment (SAGE) Allows Integration of HD Streams



SAGE Developed Under Jason Leigh, EVL

- HD Video from BIRN Trailer
- Macro View of Montage Data
- Micro View of Montage Data
- Live Streaming Video of the RTS-2000 Microscope
- HD Video from the RTS Microscope Room

LambdaCam Used to Capture the Tiled Display on a Web Browser

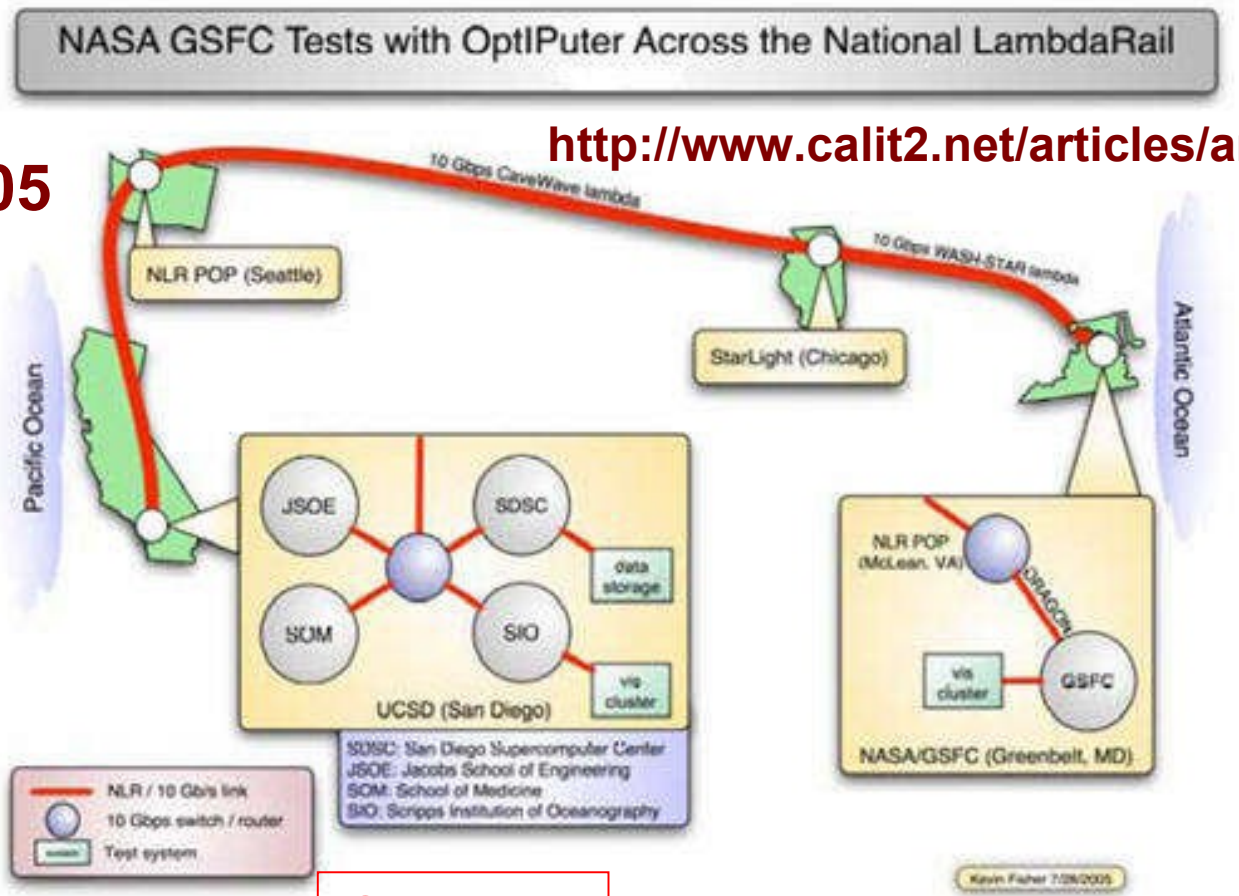
UCSD UCIrvine evl electronic visualization laboratory

Source: David Lee, NCMIR, UCSD

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

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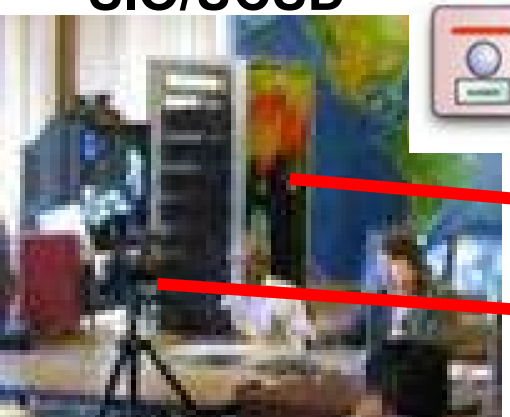
Combining Telepresence with Remote Interactive Analysis of Earth Sciences Data Over NLR



August 8, 2005

http://www.calit2.net/articles/article.php?id=660

SIO/UCSD



OptIPuter Visualized Data

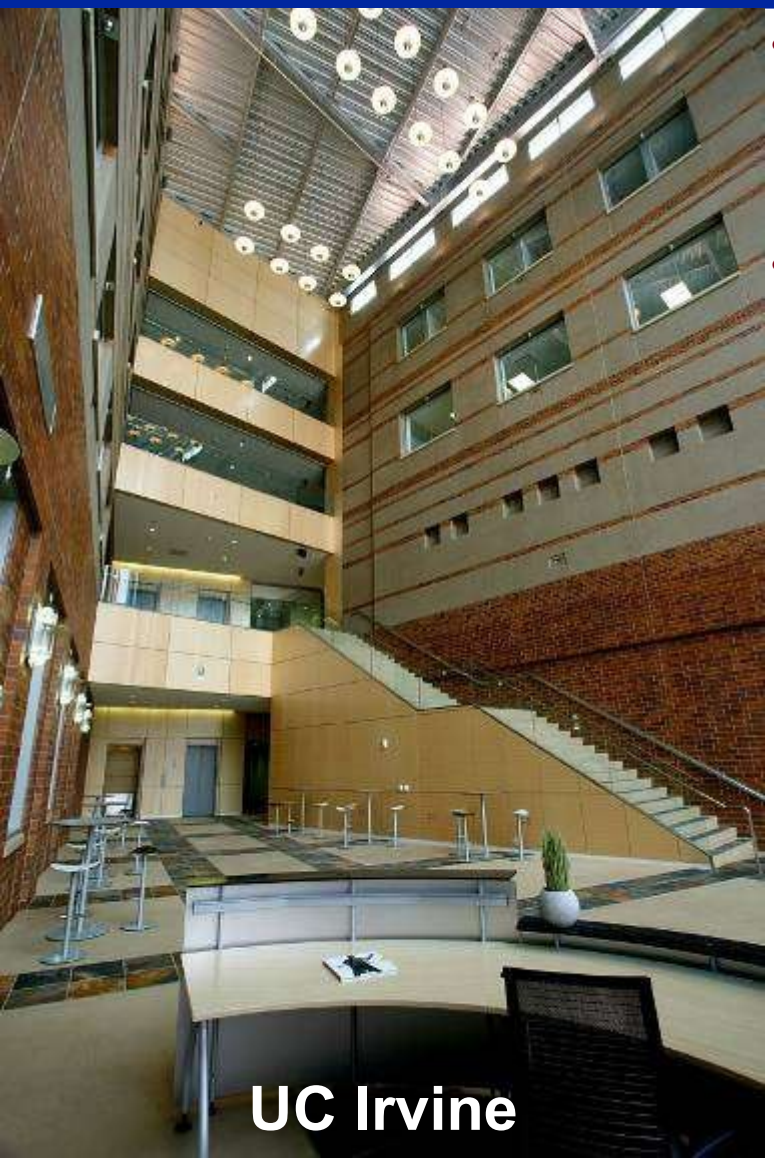
HDTV Over Lambda



NASA Goddard

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Two New Calit2 Buildings Will Provide Major New Laboratories to Their Campuses



- **New Laboratory Facilities**
  - Nanotech, BioMEMS, Chips, Radio, Photonics, Grid, Data, Applications
  - Virtual Reality, Digital Cinema, HDTV, Synthesis
- **Over 1000 Researchers in Two Buildings**
  - Linked via Dedicated Optical Networks
  - International Conferences and Testbeds

Richard C. Atkinson Hall Dedication Oct. 28, 2005



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www.calit2.net

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Toward an Interactive Gigapixel Display

- Scalable Adaptive Graphics Environment (SAGE) Controls:
- 100 Megapixels Display
  - 55-Panel
- 1/4 TeraFLOP
  - Driven by 30-Node Cluster of 64-bit Dual Opterons
- 1/3 Terabit/sec I/O
  - 30 x 10GE interfaces
  - Linked to OptIPuter
- 1/8 TB RAM
- 60 TB Disk

NSF LambdaVision MRI@UIC

Calit2 is Building a LambdaVision Wall in Each of the UCI & UCSD Buildings

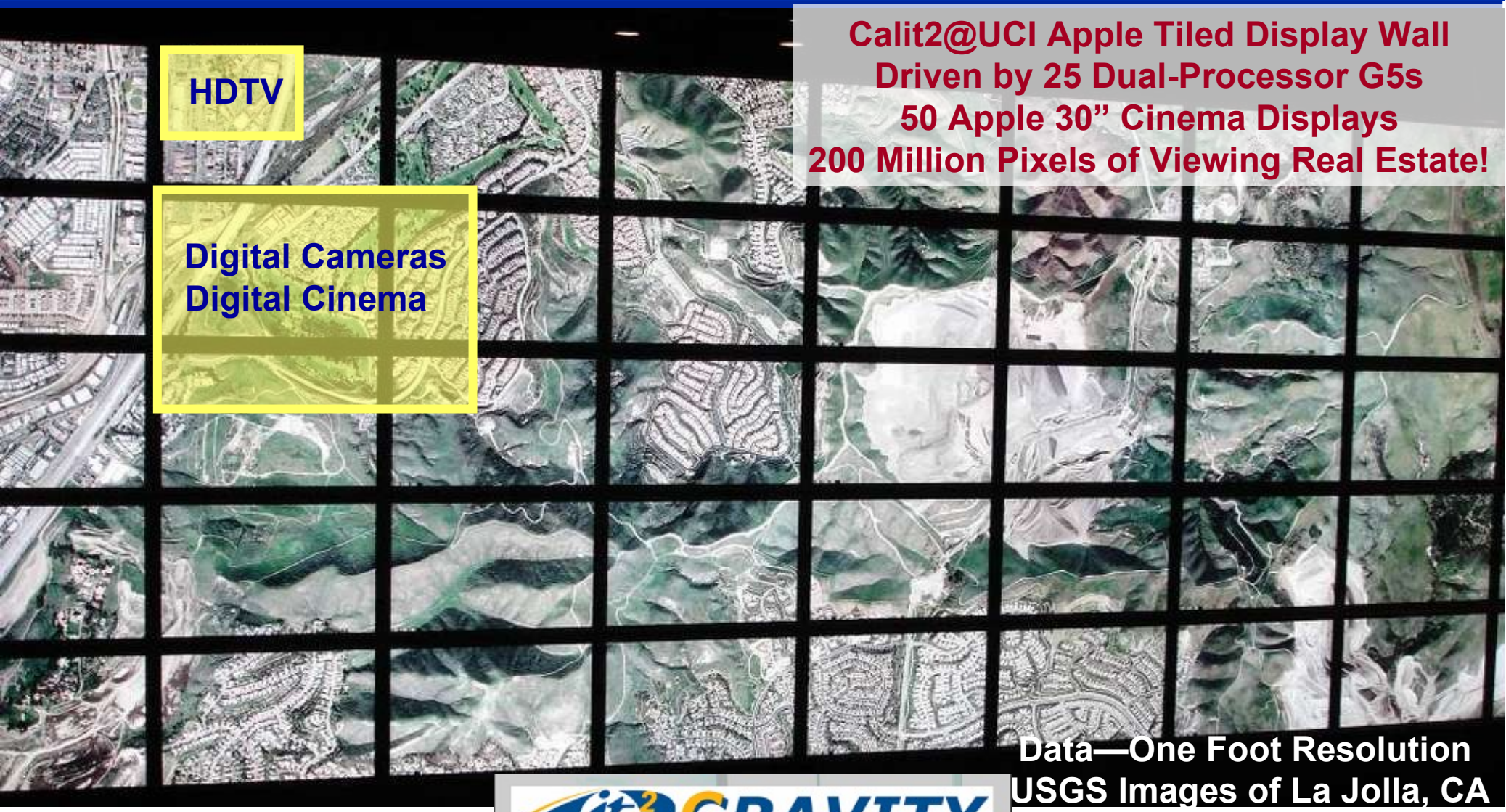


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Source: Jason Leigh, Tom DeFanti, EVL@UIC
OptIPuter Co-PIs

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Calit2 @ UCI Has the Largest Tiled Display Wall--HIPerWall



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Center of Graphics, Visualization and Imaging Technology

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Source: Falko Kuester, Calit2@UCI
NSF Infrastructure Grant

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Displaying Images from Electron Microscope



Zeiss Scanning Electron Microscope in Calit2@ UCI

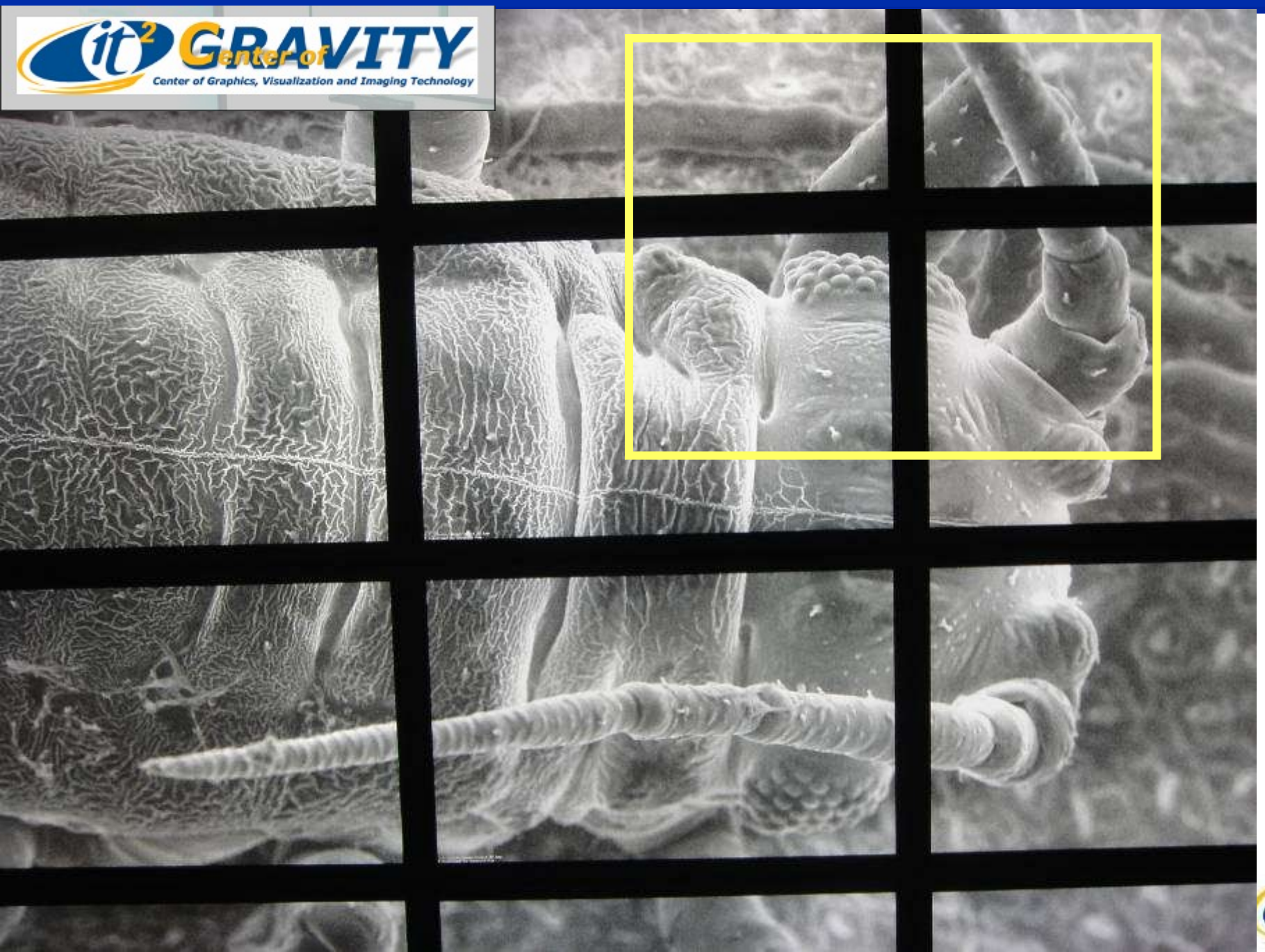


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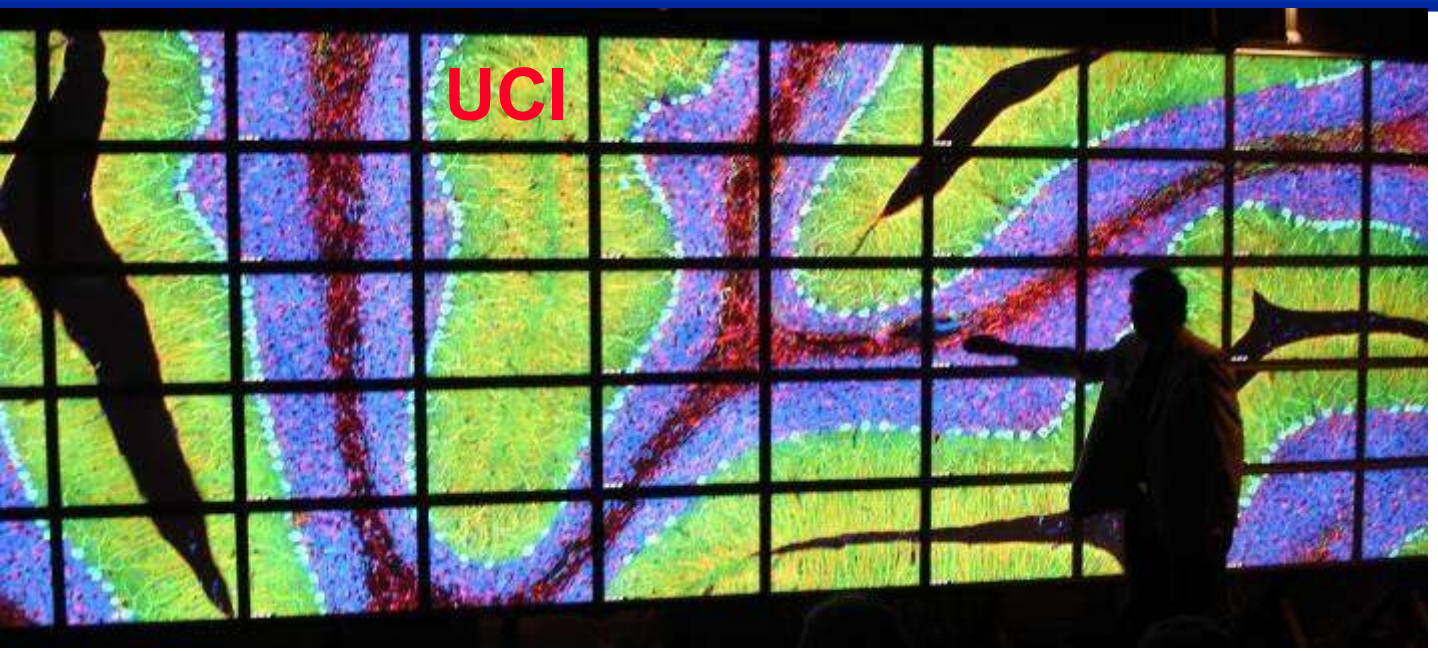
Zooming In


GRAVITY
Center of Graphics, Visualization and Imaging Technology

Bug Eye

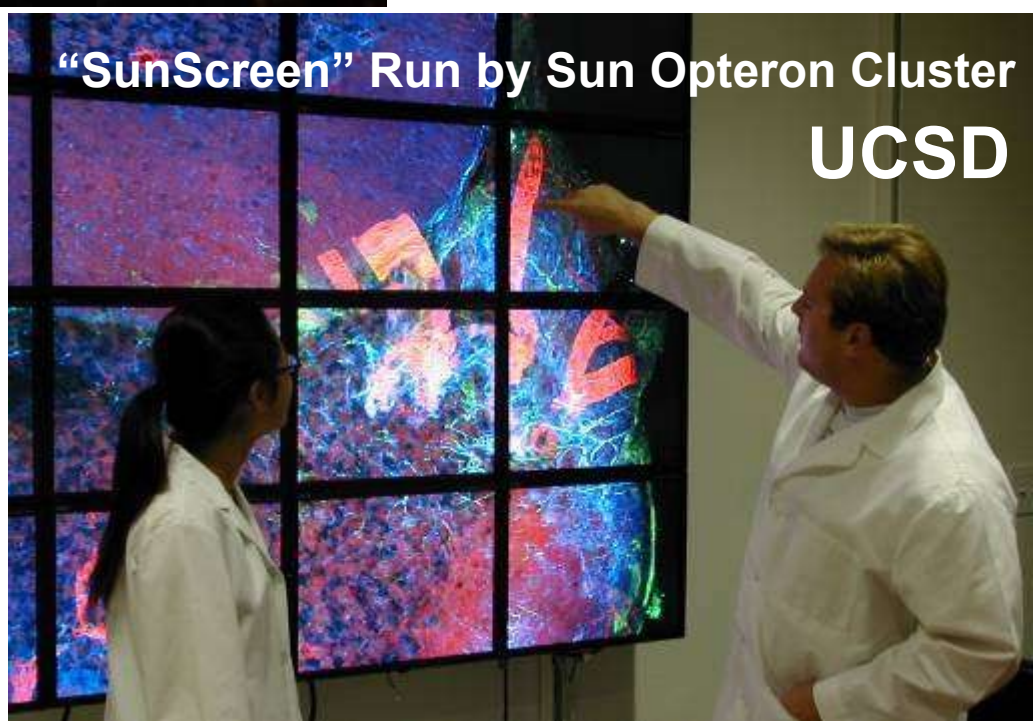


The OptIPuter Enabled Collaboratory: Remote Researchers Jointly Exploring Complex Data



OptIPuter

OptIPuter will Connect
Falko Kuester's
Calit2@UCI
200M-Pixel Wall and
the 30M-Pixel Display
at UCSD Ellisman's
BIRN Laboratories
With Shared Fast Deep Storage



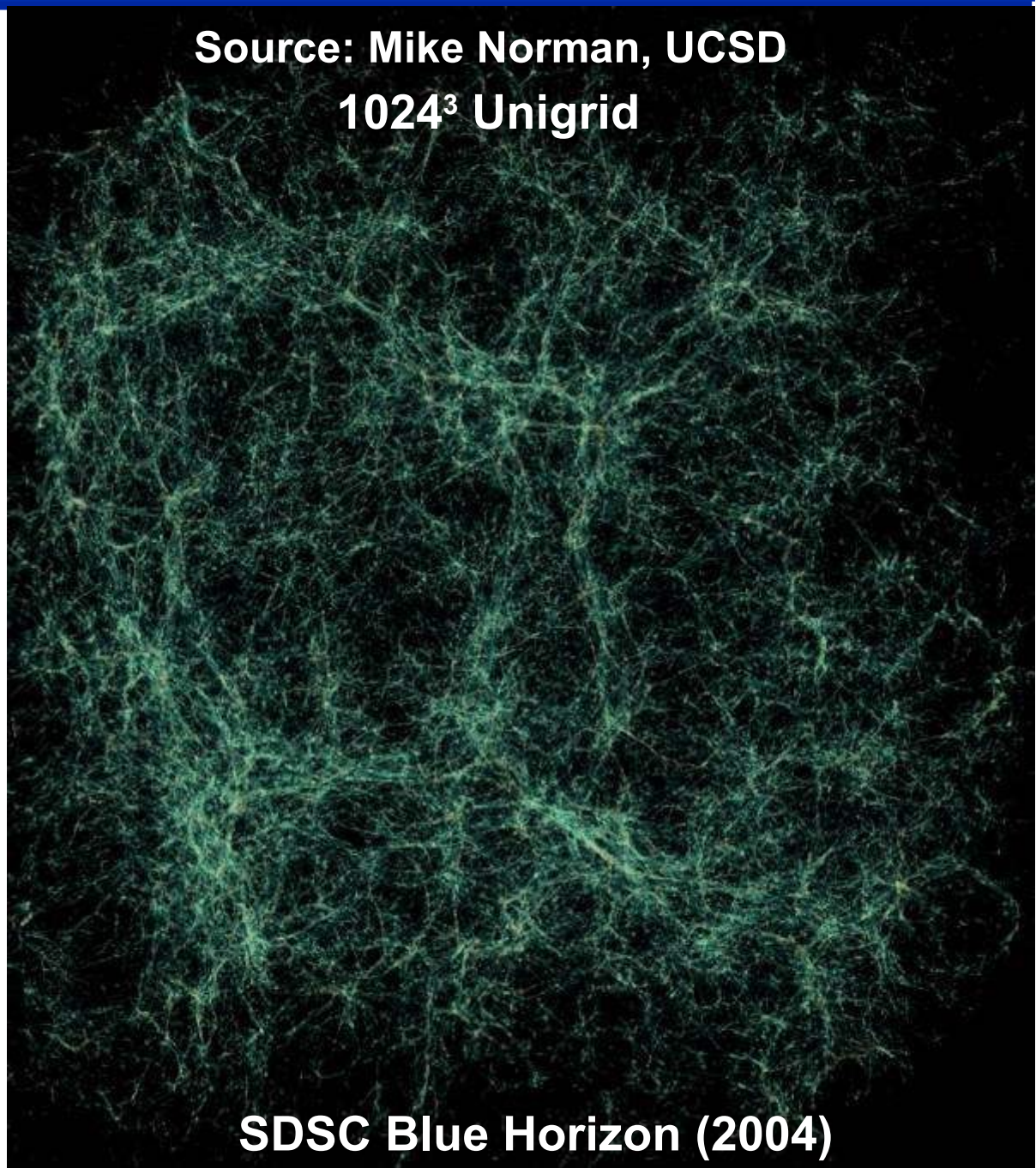
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To a LambdaGrid, a Supercomputer is Just Another High Performance Data Generator

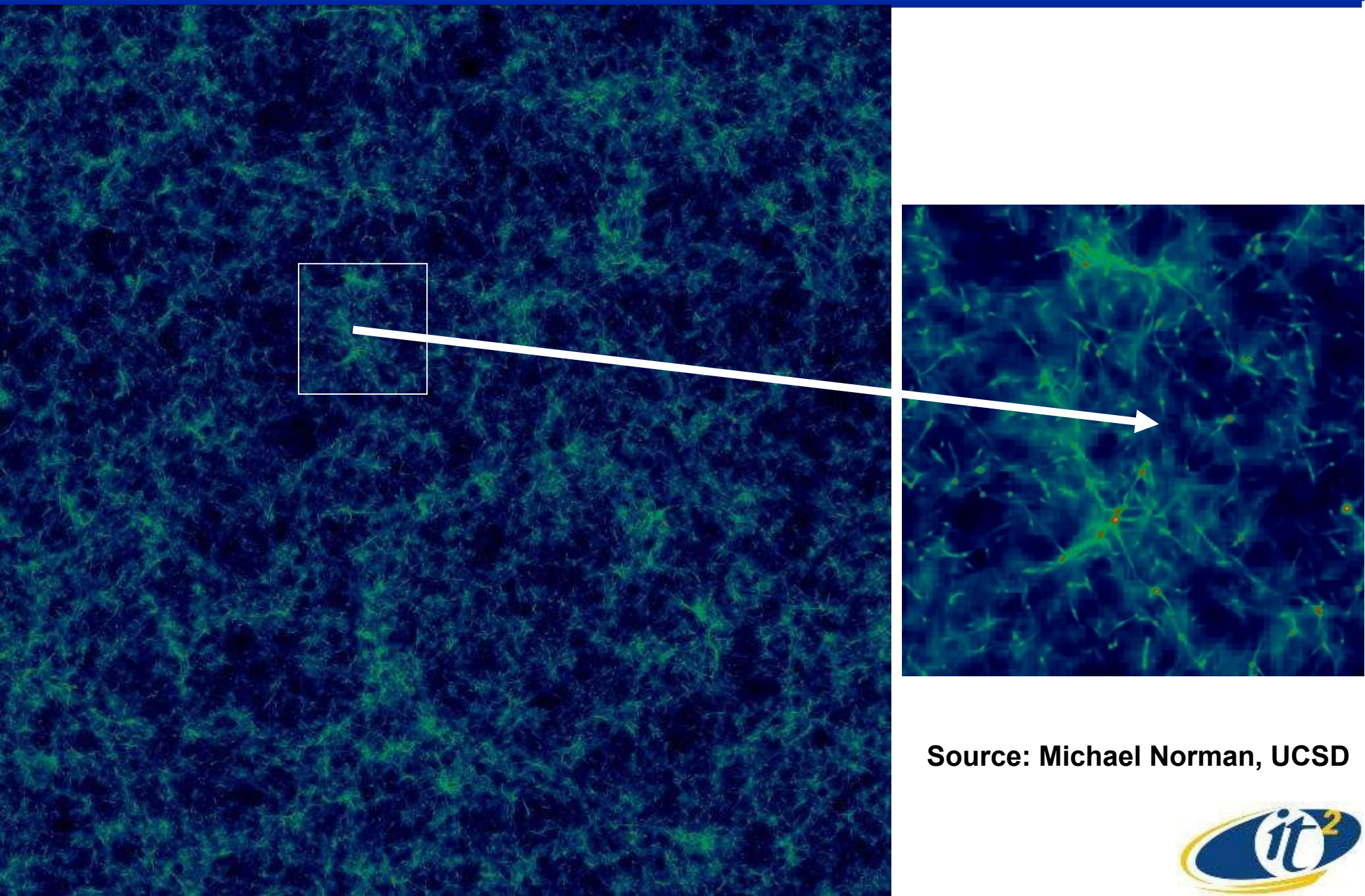
- 512^3 AMR or 1024^3 Unigrid
- 8-64 Times Mass Resolution
- Can Simulate First Galaxies
- One GigaZone Run:
  - Output ~10 TeraByte
  - "Snapshot" is 100 GB
  - Must Visually Analyze Remotely from End User Lab

"Cosmic Simulator" with a Billion Zone and Gigaparticle Resolution

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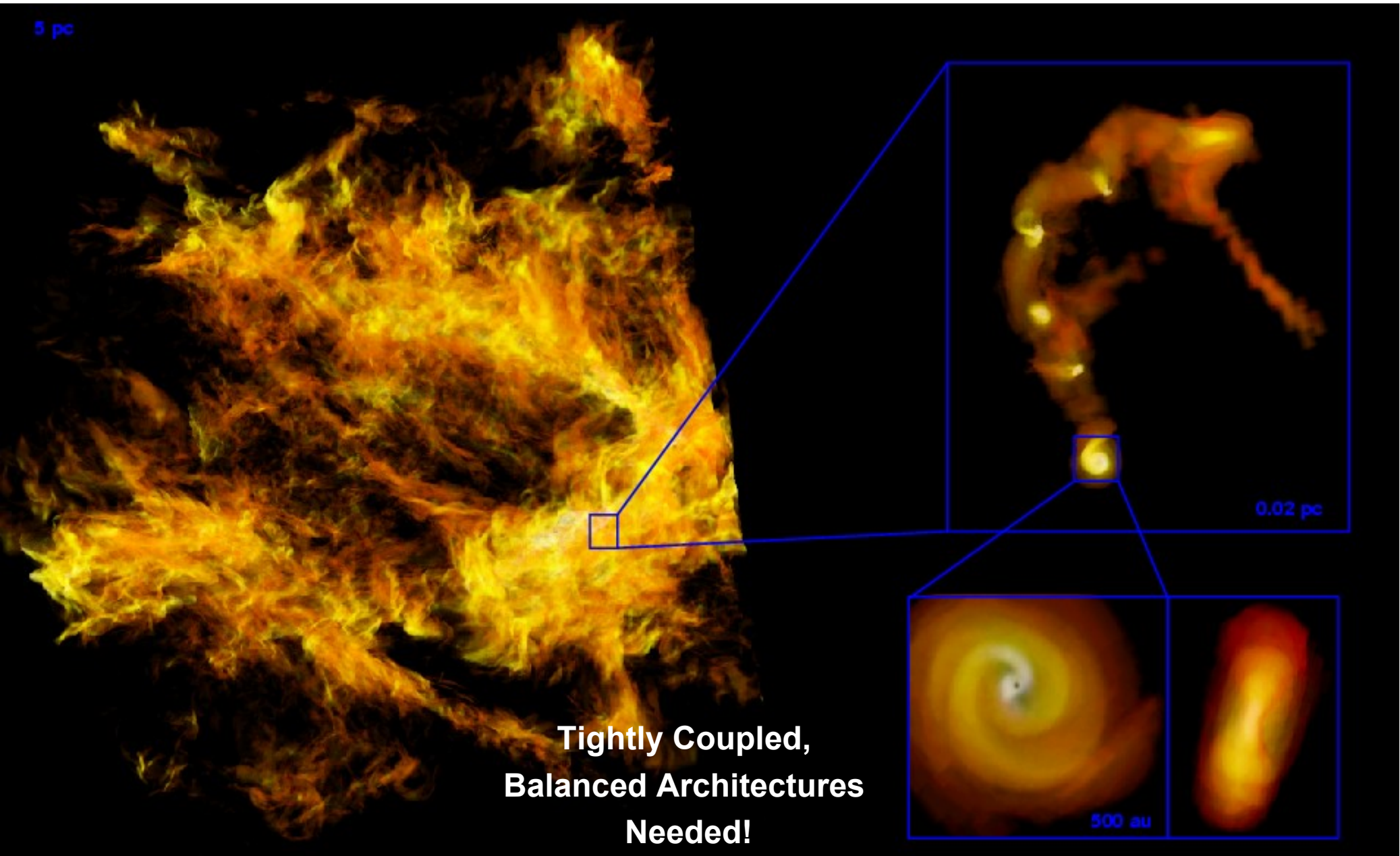
AMR Cosmological Simulations Generate 4kx4k Images and Needs Interactive Zooming Capability



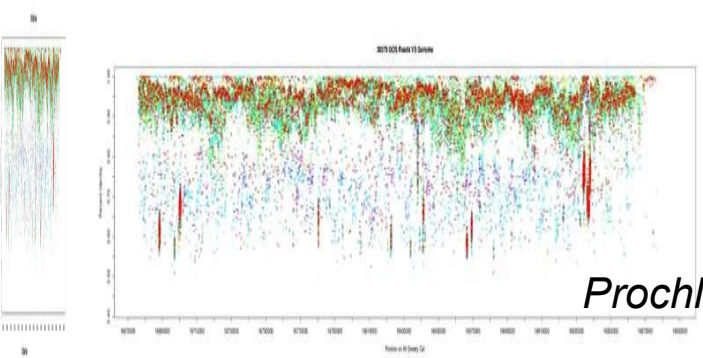
Source: Michael Norman, UCSD

AMR Simulation of Protostellar Disk Formation in Turbulent Molecular Clouds Dynamic Range=10^5

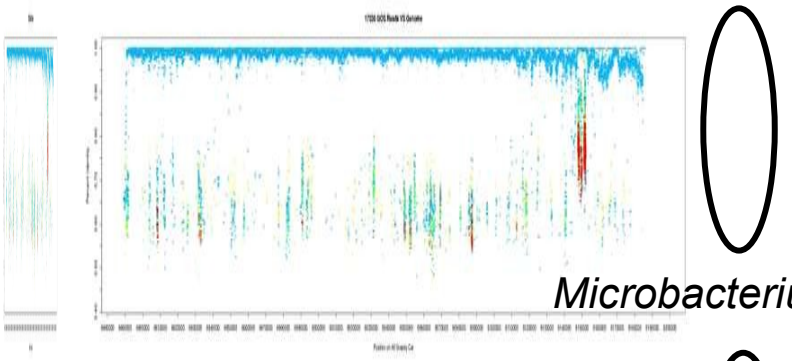
SDSC IBM Power4 DataStar



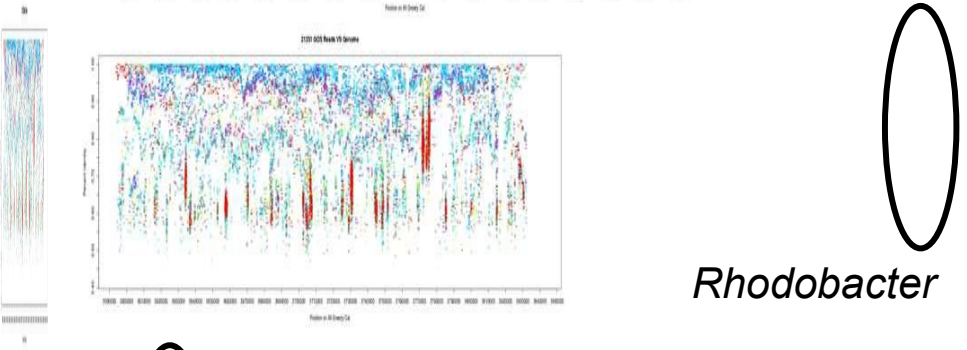
Metagenomics "Extreme Assembly" Requires Large Amount of Pixel Real Estate



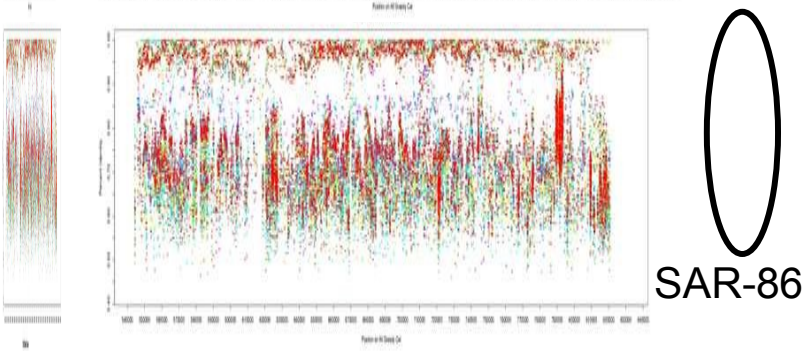
Prochlorococcus



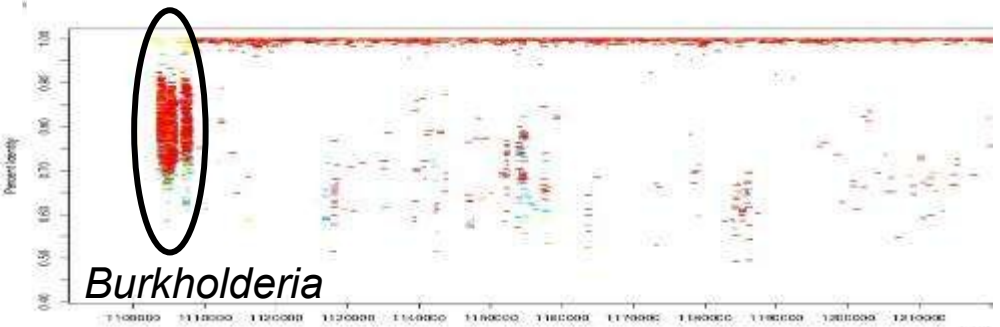
Microbacterium



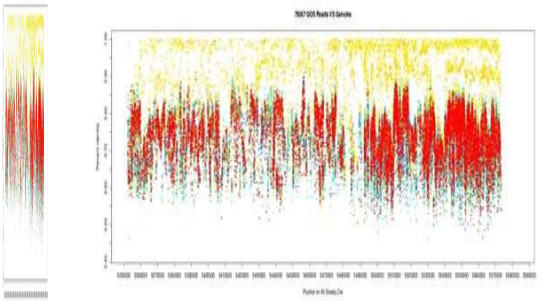
Rhodobacter



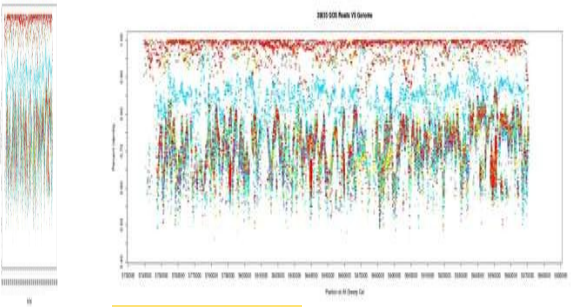
SAR-86



Burkholderia



unknown



unknown

Source: Karin Remington
J. Craig Venter Institute

High Resolution Aerial Photography Generates Images With 10,000 Times More Data than Landsat7

Landsat7 Imagery
100 Foot Resolution
Draped on elevation data





New USGS Aerial Imagery
At 1-Foot Resolution

~10x10 square miles of 350 US Cities
2.5 Billion Pixel Images Per City!

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Multi-Gigapixel Images are Available from Film Scanners Today



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The Gigapxl Project
http://gigapxl.org

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Large Image with Enormous Detail Require Interactive LambdaVision Systems



The OptIPuter Project Has Obtained Some of these Images for UCI HIPerWall

One Square Inch Shot From 100 Yards