Grids: How Universities Participate in Global Science

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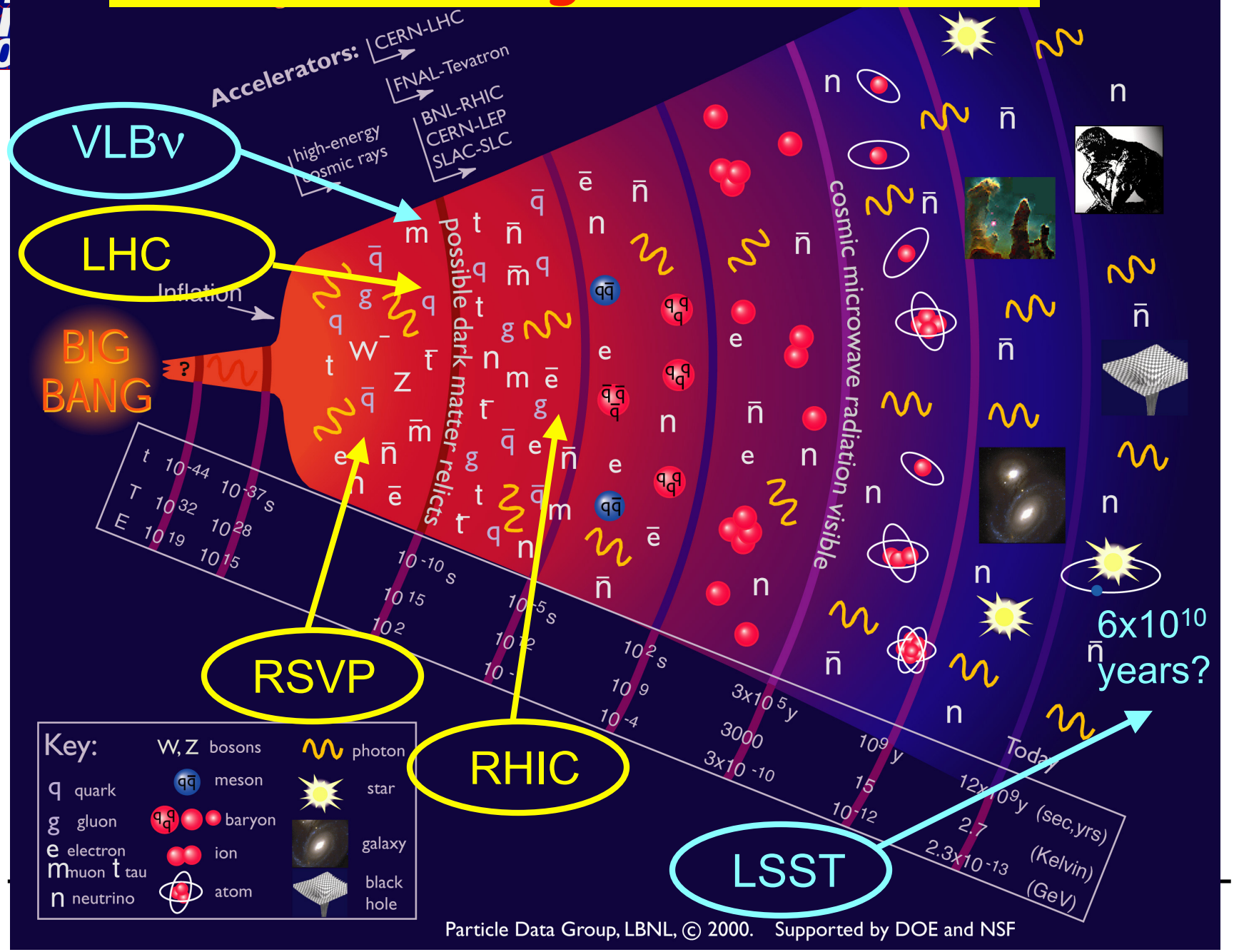
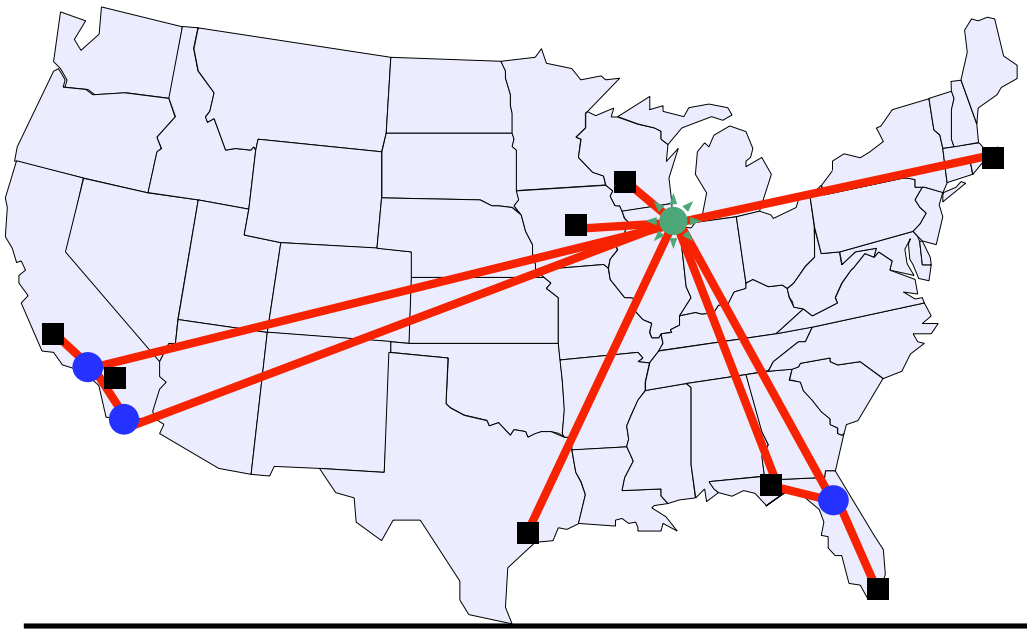
Understanding the Universe
Education / Outreach Discussion Meeting
Arlington, Virginia
April 8, 2004

Understanding the Universe



The Grid Concept

- Grid: Geographically distributed computing resources configured for coordinated use
  - Fabric: Physical resources & networks provide raw capability
  - Ownership: Resources *controlled* by owners and *shared* w/ others
  - Middleware: Software ties it all together: tools, services, etc.
- Goal: Transparent sharing of resources



US-CMS
"Virtual Organization"

Global Context of Data Grid Projects

Collaborating Grid infrastructure projects

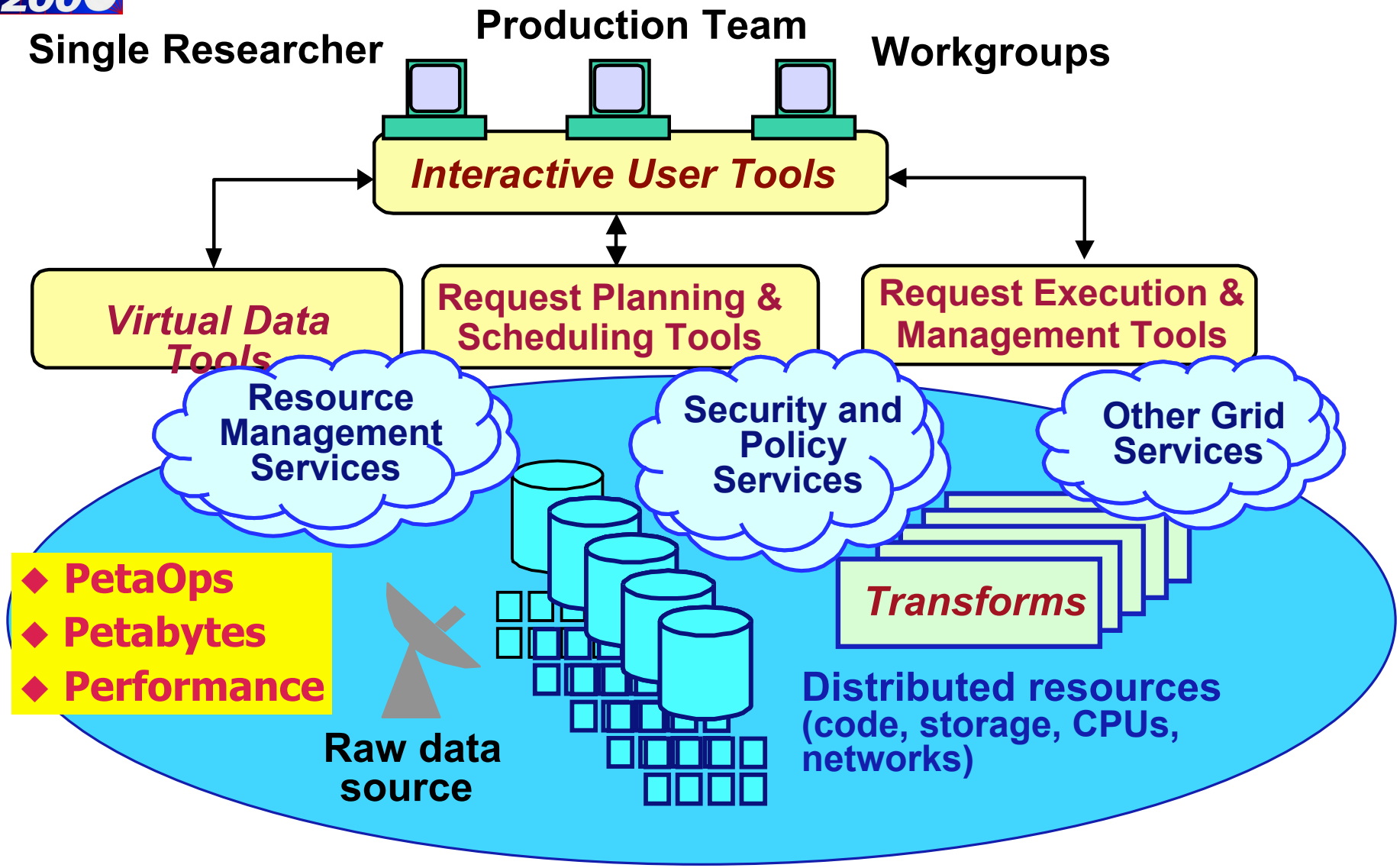
- U.S. Projects
  - GriPhyN (NSF)
  - iVDGL (NSF)
  - Particle Physics Data Grid (DOE)
  - PACIs and TeraGrid (NSF)
  - DOE Science Grid (DOE)
  - NEESgrid (NSF)
  - NSF Middleware Initiative (NSF)
- EU, Asia projects
  - European Data Grid (EU)
  - EDG-related national Projects
  - DataTAG (EU)
  - LHC Computing Grid (CERN)
  - EGEE (EU)
  - CrossGrid (EU)
  - GridLab (EU)
  - Japanese, Korea Projects

- **Two primary project clusters: US + EU**
- **Not exclusively HEP, but driven/led by HEP (with CS)**

U.S. "Trillium" Grid Projects

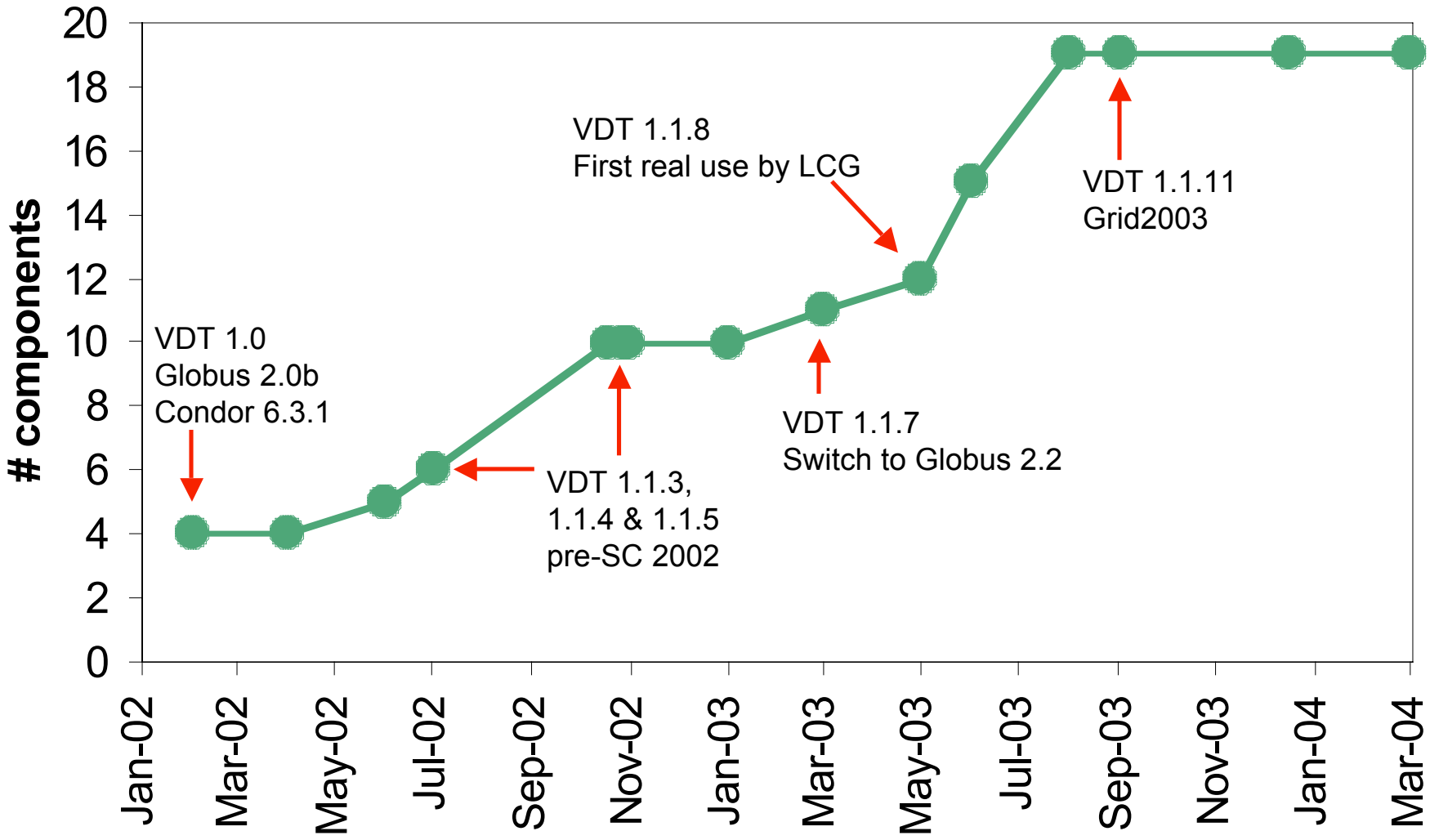
- Trillium = PPDG + GriPhyN + iVDGL
  - PPDG: $10M (DOE) (1999 – 2004+)
  - GriPhyN: $12M (NSF) (2000 – 2005)
  - iVDGL: $14M (NSF) (2001 – 2006)
- Basic composition (~150 people)
  - PPDG: 4 universities, 6 labs
  - GriPhyN: 12 universities, SDSC, 3 labs
  - iVDGL: 18 universities, SDSC, 4 labs, foreign partners
  - Expts: BaBar, D0, STAR, Jlab, CMS, ATLAS, LIGO, SDSS/NVO
- Complementarity of projects
  - GriPhyN: CS research, Virtual Data Toolkit (VDT) development
  - PPDG: "End to end" Grid, services, monitoring, analysis
  - iVDGL: Grid laboratory deployment using VDT
  - Experiments provide frontier challenges

Trillium: "PetaScale" Virtual-Data Grids

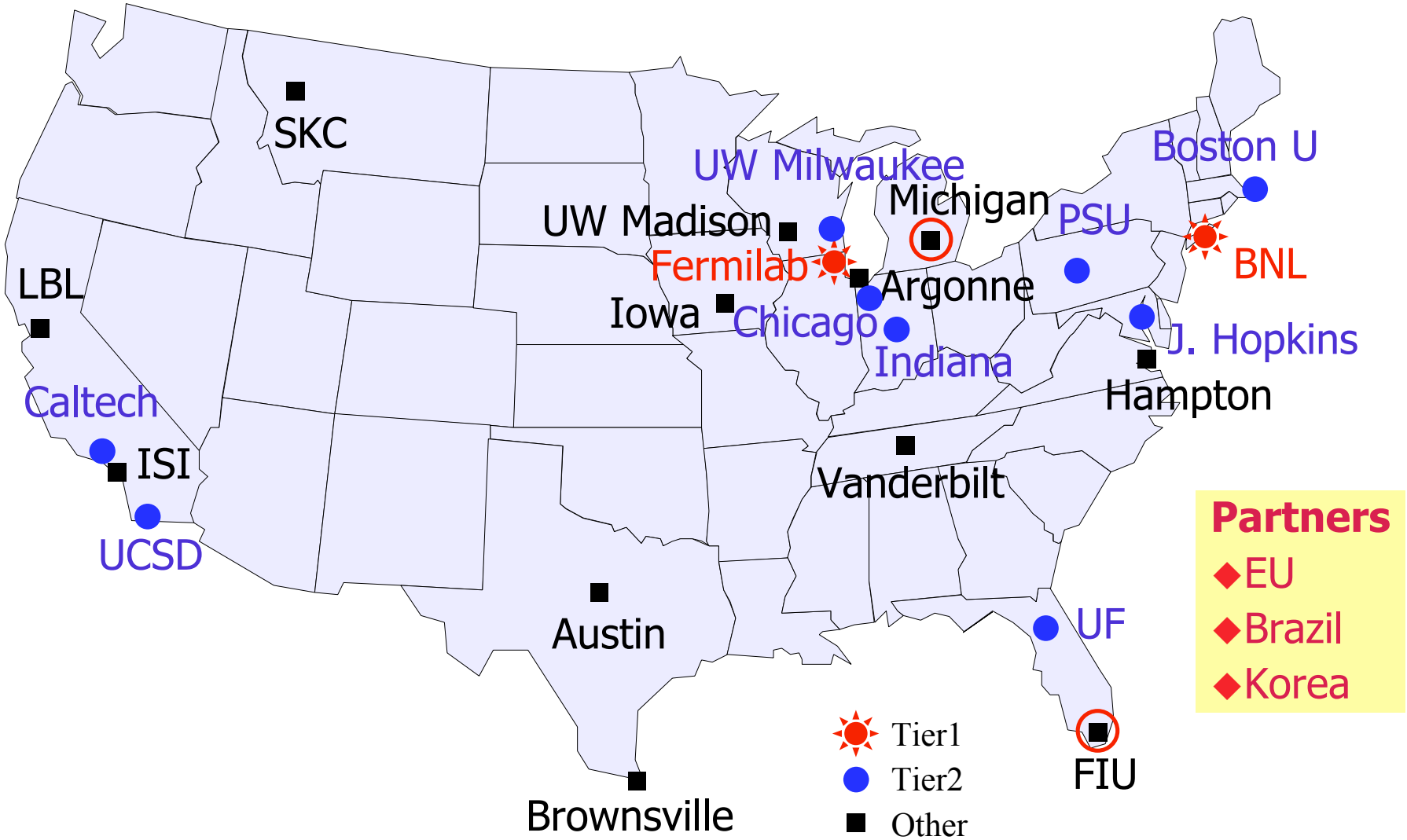


- PetaOps
- Petabytes
- Performance

GriPhyN: Virtual Data Toolkit

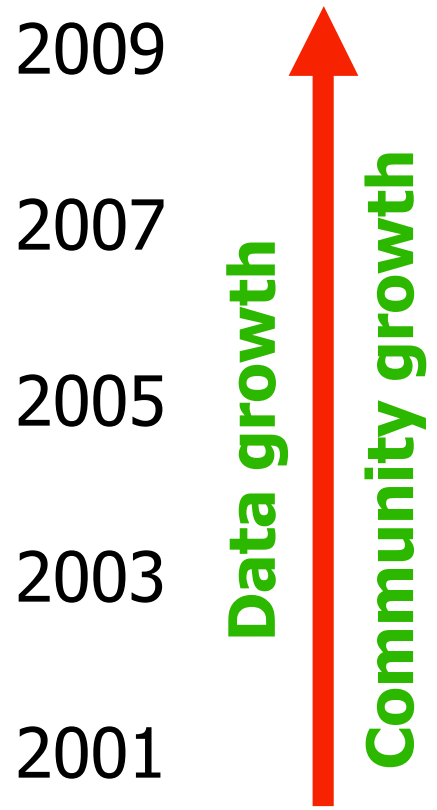


International Virtual Data Grid Laboratory



Trillium Science Drivers

- LHC experiments
  - 100s of Petabytes
- High Energy Physics experiments
  - ~1 Petabyte (1000 TB)
- LIGO (gravity wave search)
  - 100s of Terabytes
- Sloan Digital Sky Survey
  - 10s of Terabytes

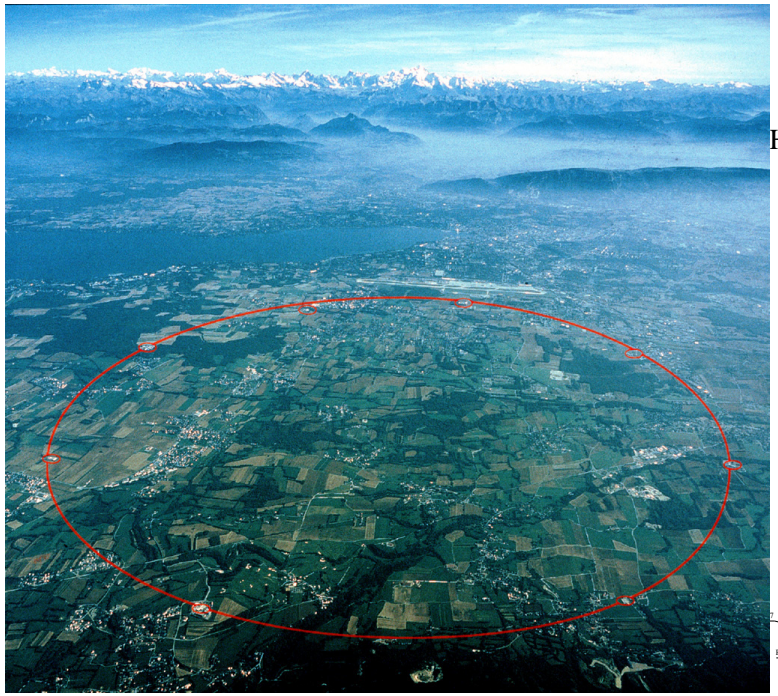


Future Grid resources

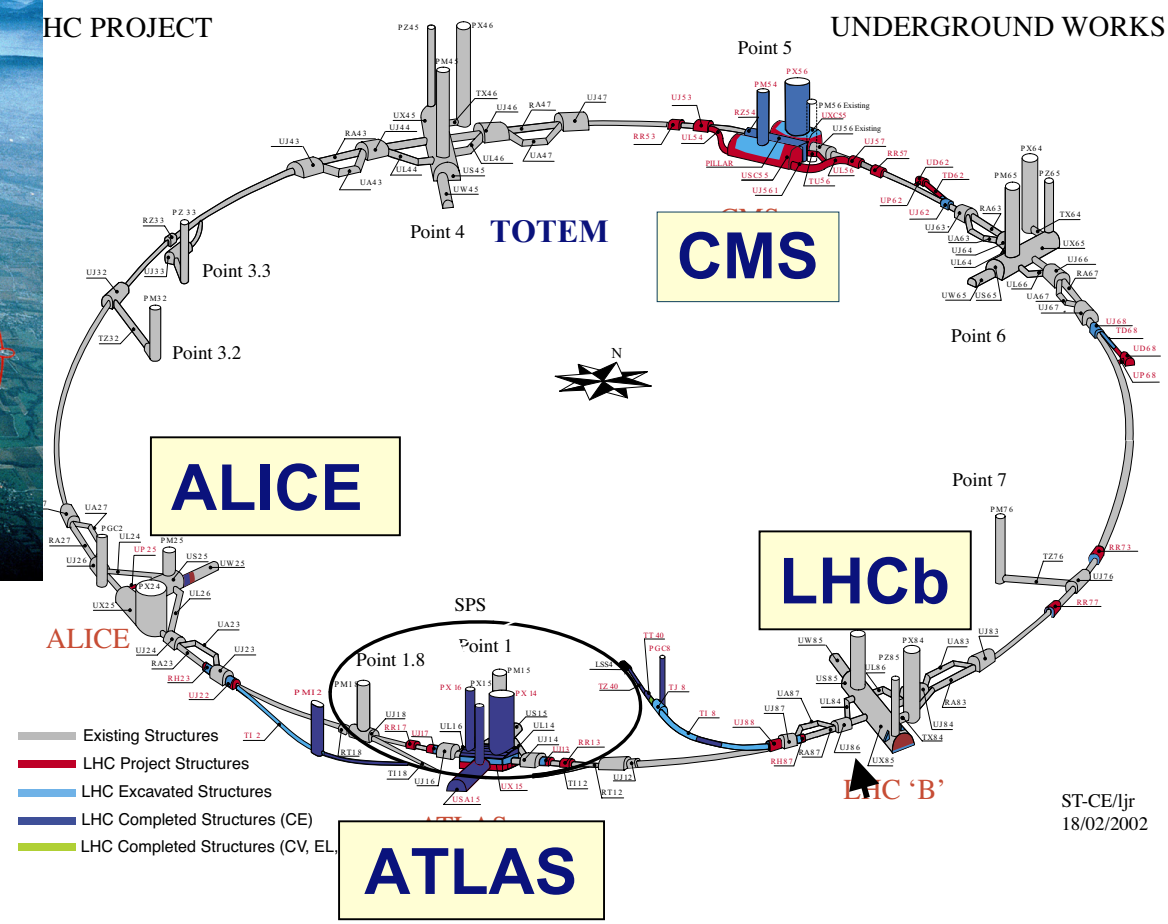
- **Massive CPU (PetaOps)**
- **Large distributed datasets (>100PB)**
- **Global communities (1000s)**

Data Grids and The Large Hadron Collider

Large Hadron Collider (LHC) @ CERN



✸ **27 km Tunnel in Switzerland & France**

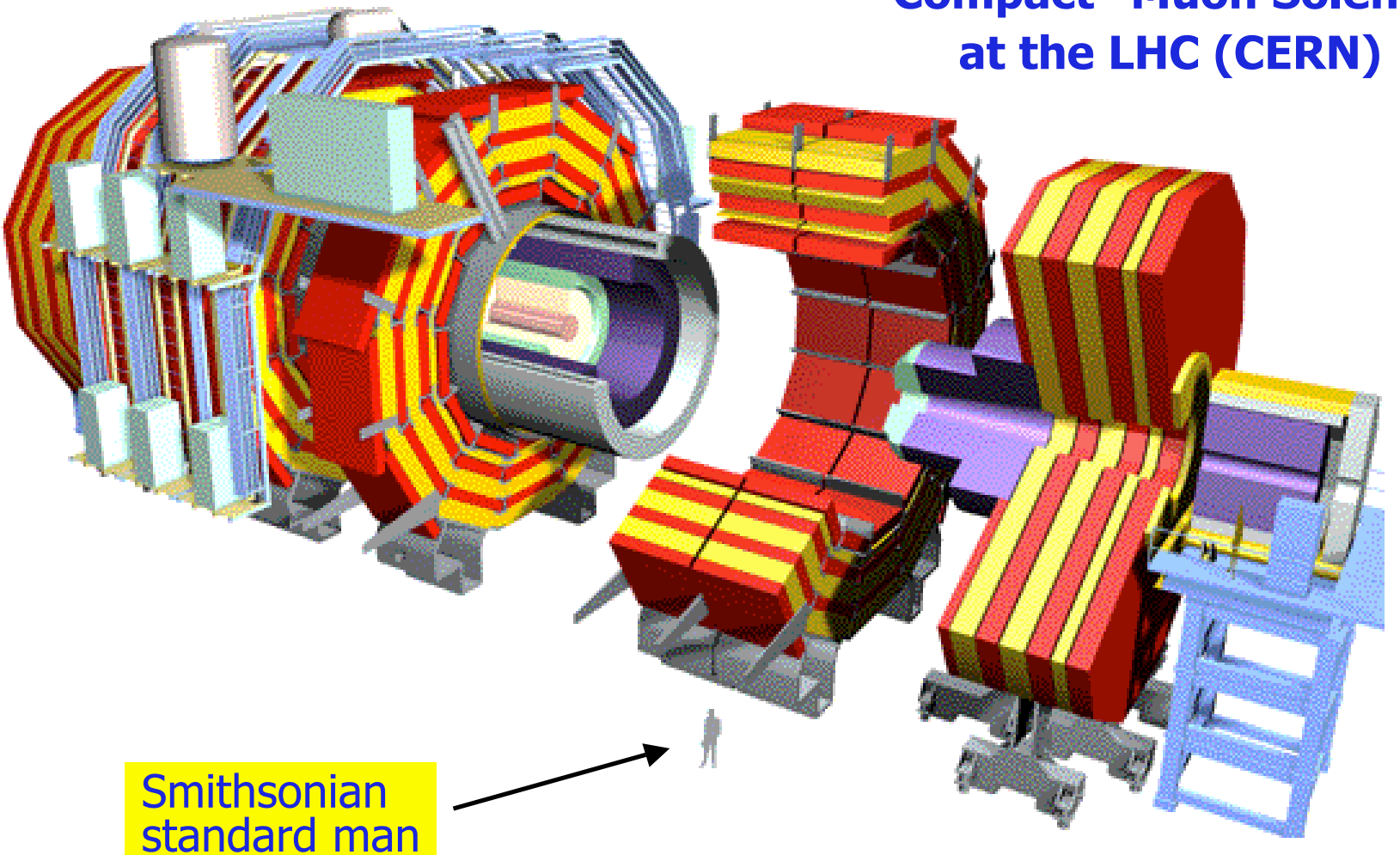


2007 – ?

- **Origin of Mass**
- **Supersymmetry**
- **New particles**

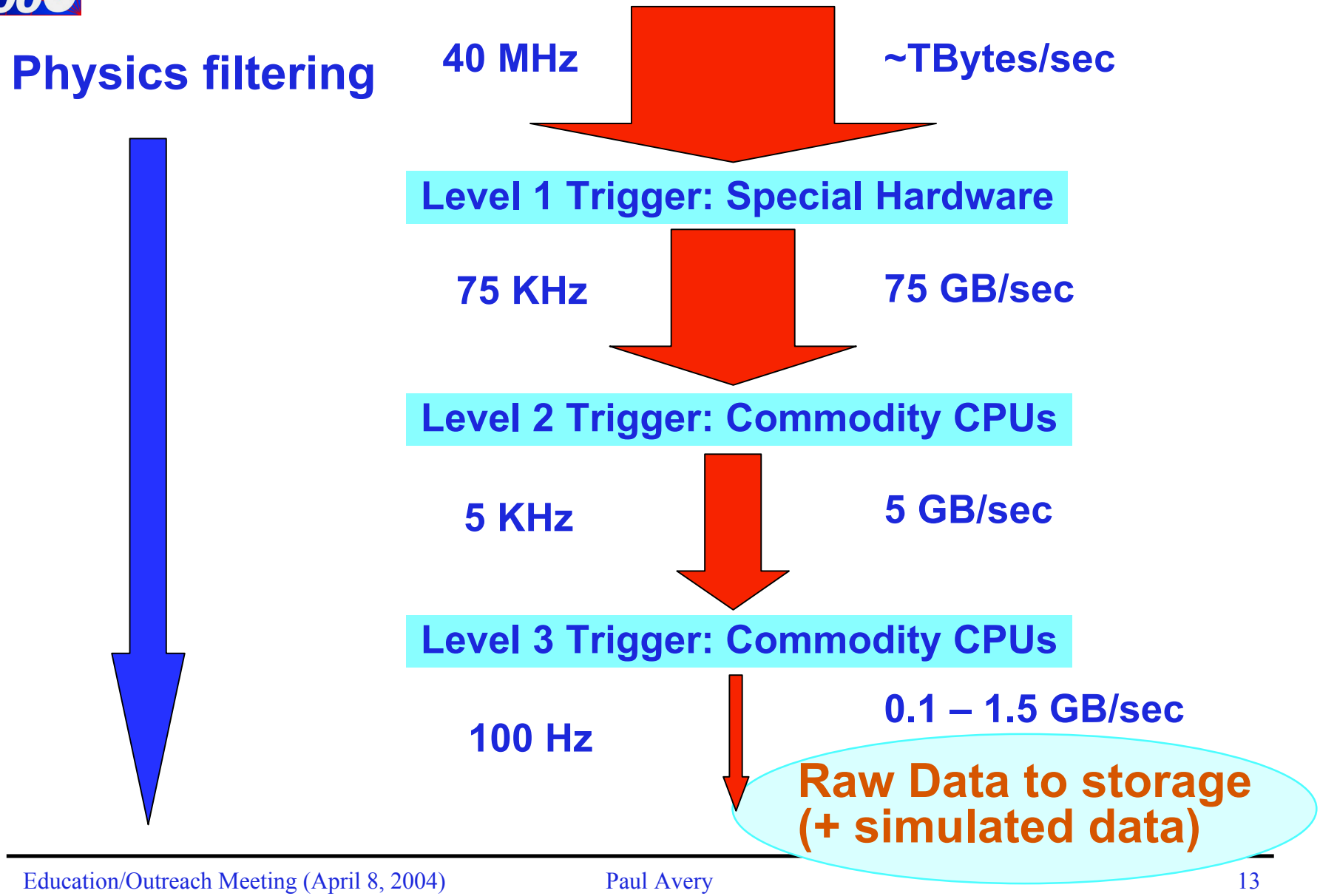
Example: CMS Experiment at LHC

"Compact" Muon Solenoid at the LHC (CERN)

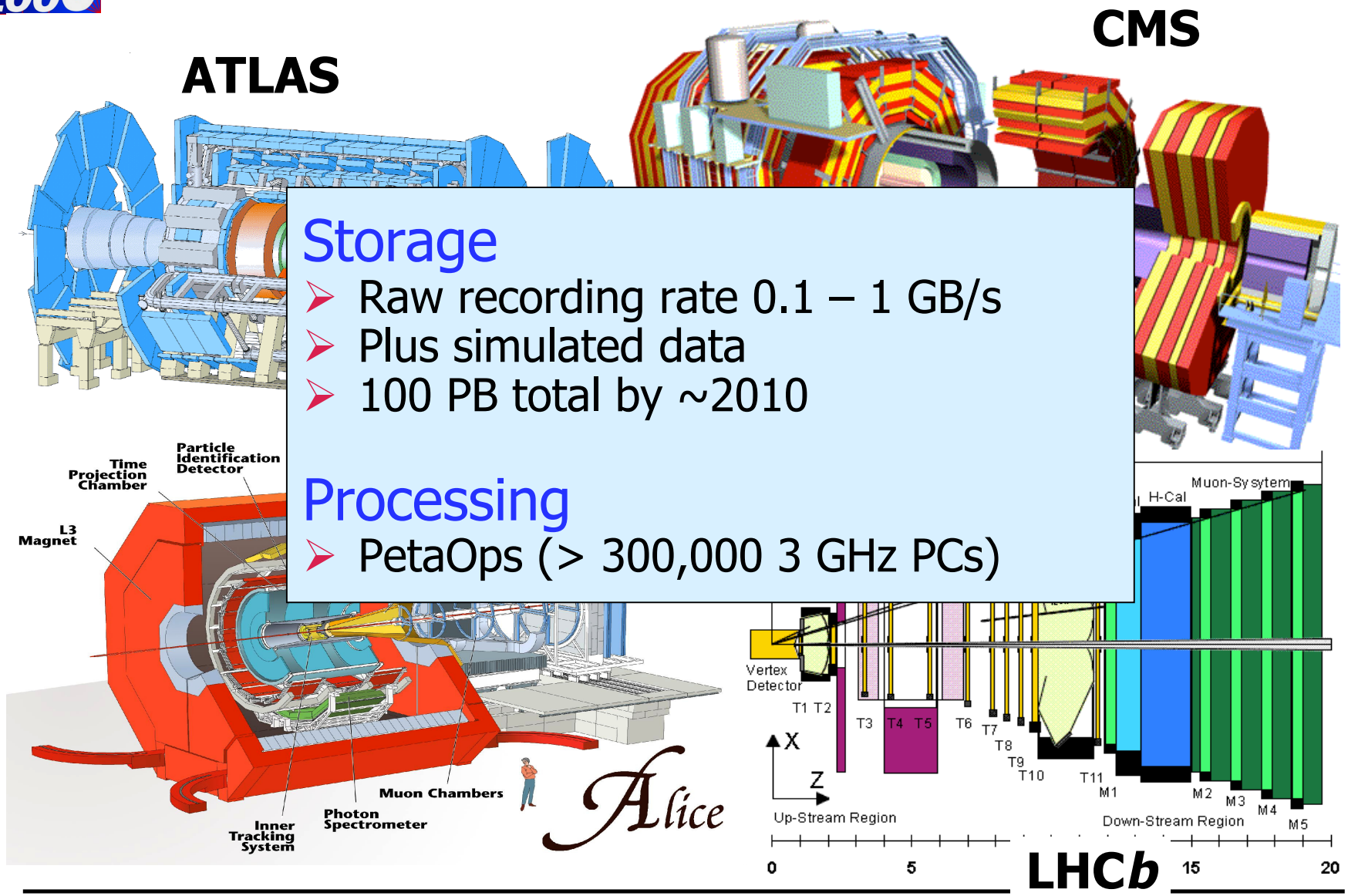


Smithsonian standard man

LHC Data Rates: Detector to Storage



LHC Data and CPU Requirements



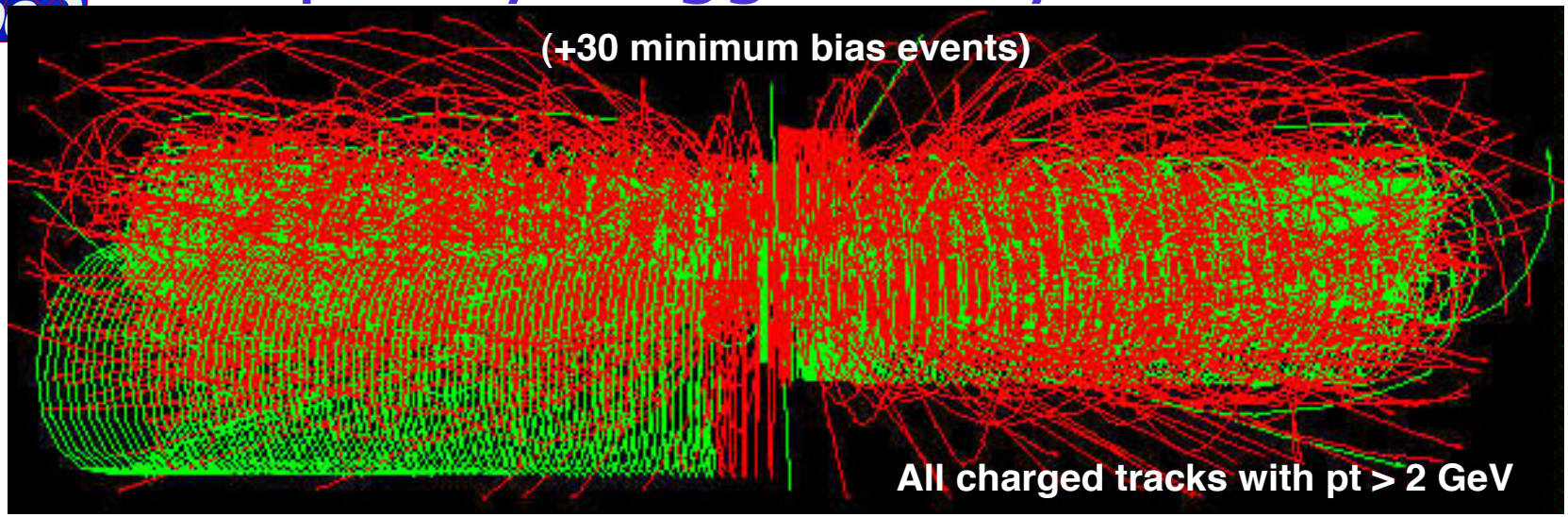
Storage

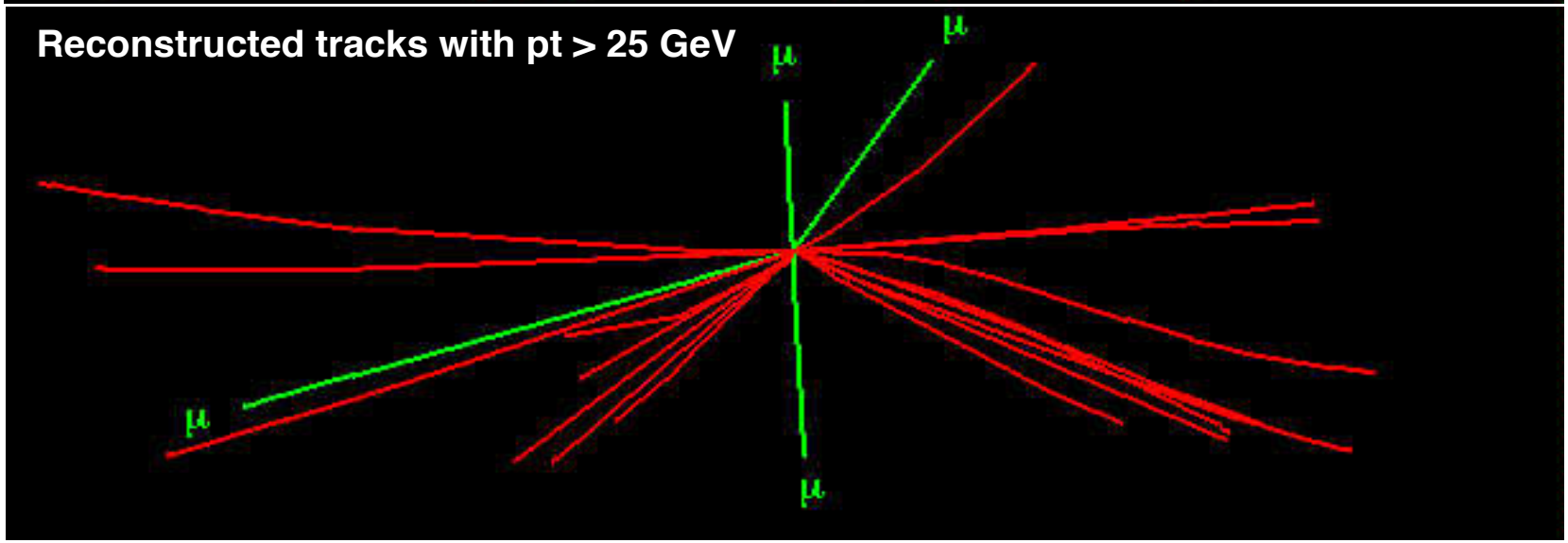
- Raw recording rate 0.1 – 1 GB/s
- Plus simulated data
- 100 PB total by ~2010

Processing

- PetaOps (> 300,000 3 GHz PCs)

Complexity: Higgs Decay into 4 muons

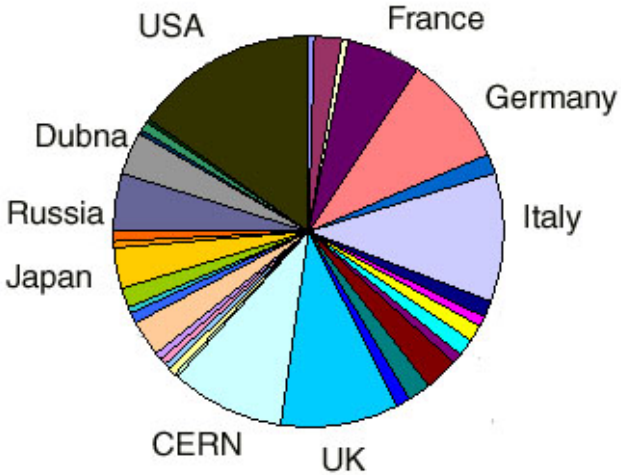




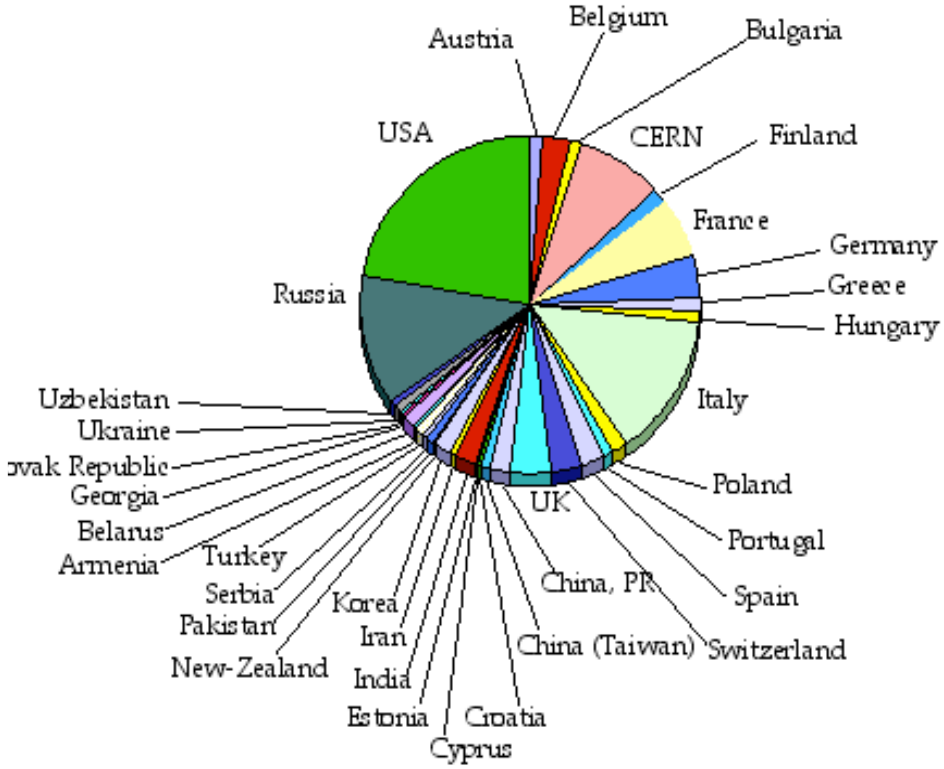
10^9 collisions/sec, selectivity: 1 in 10^{13}

LHC Global Collaborations

ATLAS



CMS



- **1000 – 4000 per experiment**
- **USA is 20 – 25% of total**

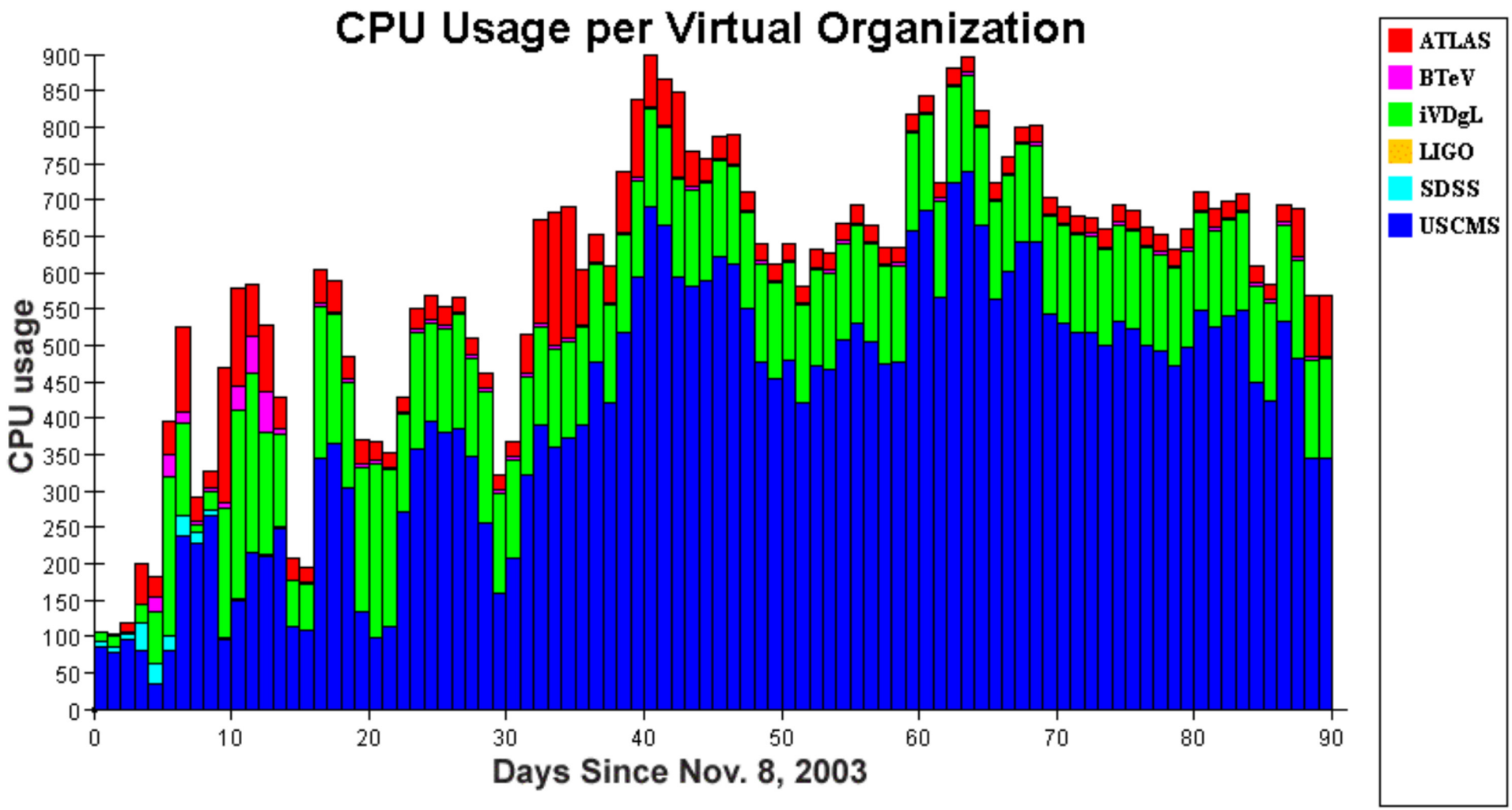
Universities and the Global LHC Data Grid Hierarchy

Grid2003: An Operational National Grid

- 28 sites: Universities + national labs (Fermilab, Brookhaven, Argonne, Berkeley)
- 2800 CPUs, 400–1300 jobs
- Running since October 2003
- HEP, LIGO, SDSS, Genomics

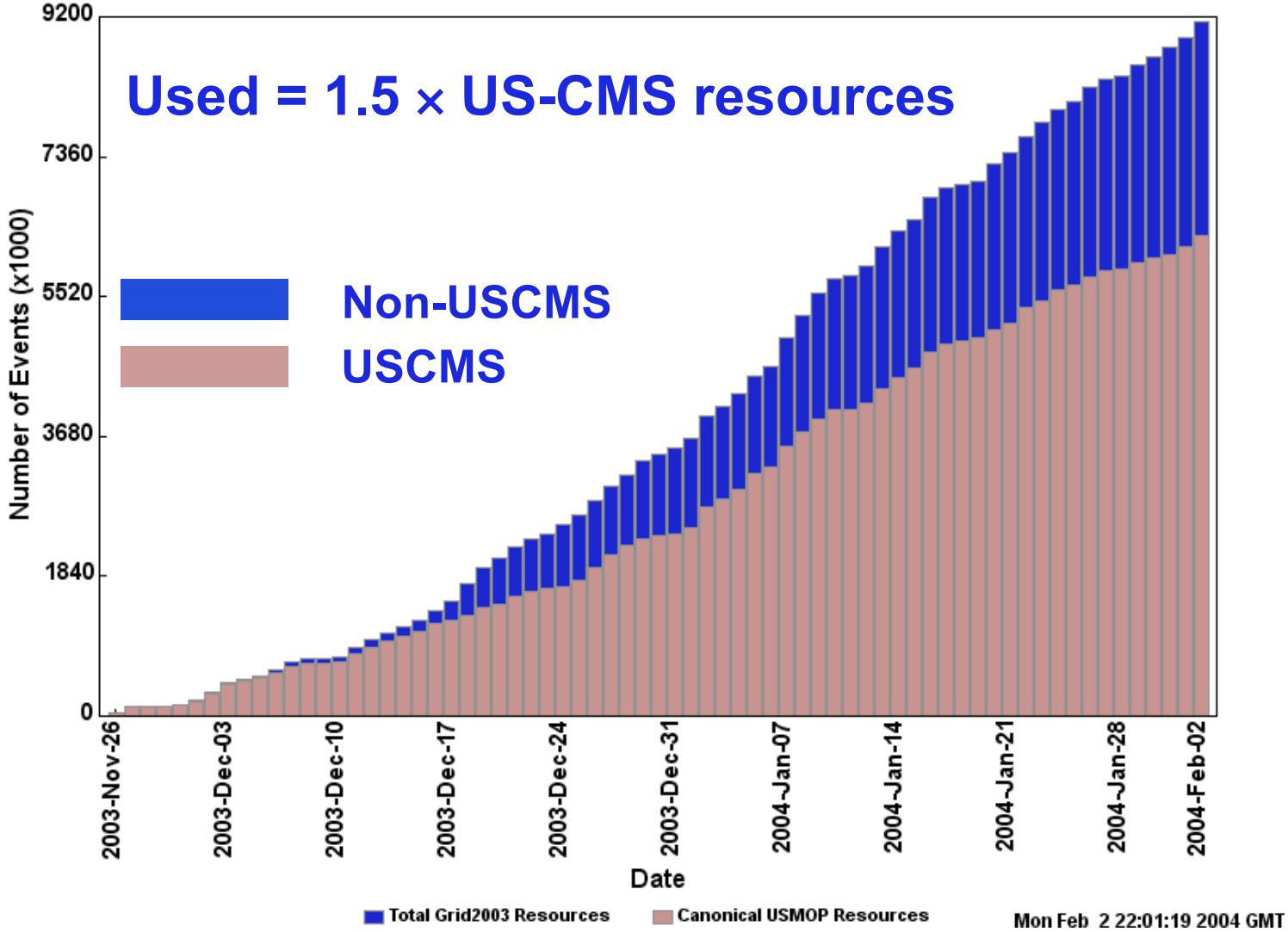
http://www.ivdgl.org/grid2003

Grid2003: Three Months Usage



Production Simulations on Grid2003

US-CMS Monte Carlo Simulation



Grid2003: A Necessary Step

- Learning how to operate a Grid
  - Add sites, recover from errors, provide info, update, test, etc.
  - Tools, services, procedures, documentation, organization
  - Security, account management, multiple organizations
- Coping with "large" scale
  - "Interesting" failure modes as scale increases
  - Dedicated operations team
- Developing strategies for future Grids
  - Delegation of responsibilities to conserve human resources
    - Project, Virtual Org., Grid service, site, application
  - Better services, documentation, packaging

- **Grid2003 experience critical for building "useful" Grids**
- **Frank discussion in "Grid2003 Project Lessons" doc**

Grid2003 Lessons (1)

- Need for financial investment
  - Grid projects: PPDG + GriPhyN + iVDGL: $35M
  - National labs: Fermilab, Brookhaven, Argonne, LBL
  - Other expts: LIGO, SDSS
- Critical role of collaboration
  - CS + 5 HEP + LIGO + SDSS + CS + biology
  - Makes possible large common effort
  - Collaboration sociology ~50% of issues
- Building "stuff": Prototypes ⇒ testbeds ⇒ production Grids
  - Build expertise, debug Grid software, develop Grid tools & services
- Need for "operations team"
  - Point of contact for problems, questions, outside inquiries
  - Resolution of problems by direct action, consultation w/ experts

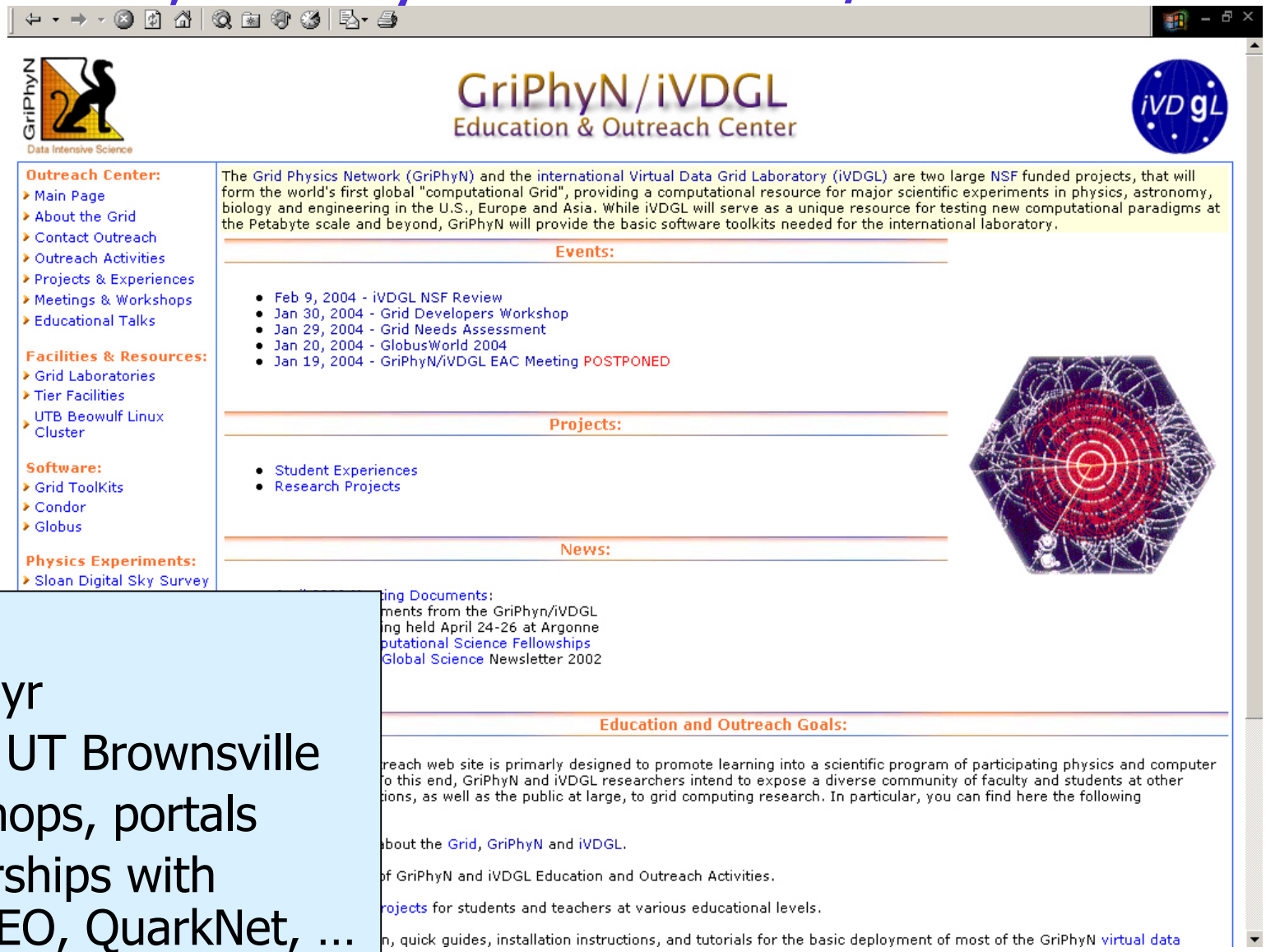
Grid2003 Lessons (2): Packaging

- VDT + Pacman: Installation and configuration
  - Simple installation, configuration of Grid tools + applications
  - Major advances over 14 VDT releases
- Why this is critical for us
  - Uniformity and validation across sites
  - Lowered barriers to participation ⇒ more sites!
  - Reduced FTE overhead & communication traffic
  - The next frontier: remote installation

U.S. Open Science Grid

- Goal: An integrated U.S. Grid infrastructure
  - Grid computing infrastructure to support US scientific efforts
  - CPU & storage resources from laboratories and universities
  - DOE and NSF partnership
- Getting there: OSG-1 (Grid3+), OSG-2, …
  - Series of releases ⇒ increasing functionality & scale
- Initial meetings
  - Sep. 17 @ NSF: Educators, scientists, etc.
  - Jan. 12 @ Fermilab: Public discussion, planning sessions
- Next steps
  - White paper to be expanded into roadmap
  - Presentation to funding agencies (June?)

iVDGL, GriPhyN Education / Outreach



Basics

- $200K/yr
- Led by UT Brownsville
- Workshops, portals
- Partnerships with CHEPREO, QuarkNet, …

CHEPREO: Center for High Energy Physics Research and Educational Outreach

Florida International University

- Physics Learning Center
- CMS Research
- iVDGL Grid Activities
- AMPATH network (S. America)

Funded September 2003
$4M initially (3 years)

CGWA : Center for Gravitational Wave Astronomy - Microsoft Internet Explorer

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GriPhyN

Data Intensive Science

CWGA

Center for Gravitational Wave Astronomy

iVDgL

25-30 students

GRID Summer Workshop
June 21-25 2004

Center for Gravitational Wave Astronomy
The University of Texas at Brownsville

Grid Physics Network (GriPhyn)

International Virtual Data Grid Laboratory (iVDGL)

The Center for Gravitational Wave Astronomy, a NASA University Research Center at the University of Texas at Brownsville, the Grid Physics Network (GriPhyn) and the International Virtual Data Grid Laboratory (iVDGL) will sponsor a one-week intensive summer workshop in Grid Computing and Scientific Data Analysis.

This school would be held on **South Padre Island**, located on the Gulf of Mexico, twenty miles from downtown Brownsville.

- General Information
- Curriculum
- Summer School Location

http://cgwa.phys.utb.edu/ My Computer

Grids and the Digital Divide
Rio de Janeiro, Feb. 16-20, 2004

HEPGRID AND DIGITAL DIVIDE WORKSHOP

ICFA SCIC

NEWS:

Bulletin: ONE TWO
WELCOME BULLETIN
General Information
Registration
Travel Information
Hotel Registration
Participant List
How to Get UERJ/Hotel
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Background

- World Summit on Information Society
- HEP Standing Committee on Inter-regional Connectivity (SCIC)

Themes

- Global collaborations, Grids and addressing the Digital Divide

Next meeting: 2005 (Korea?)

http://www.uerj.br/lishep2004