The National Science Foundation
One Particle Physicist's Experience

Randy Ruchti
Elementary Particle Physics Program
National Science Foundation

Topics

- A Fundamental Question
- Background
- Underlying Themes
- Program Scope
- Annual Activities
- Budget and Funding Information
- Partnerships and Broader Impacts
- Summary and Lessons

Fundamental Question

- What possesses an active experimental physicist to make a decision to work for a time at a funding agency?

Background

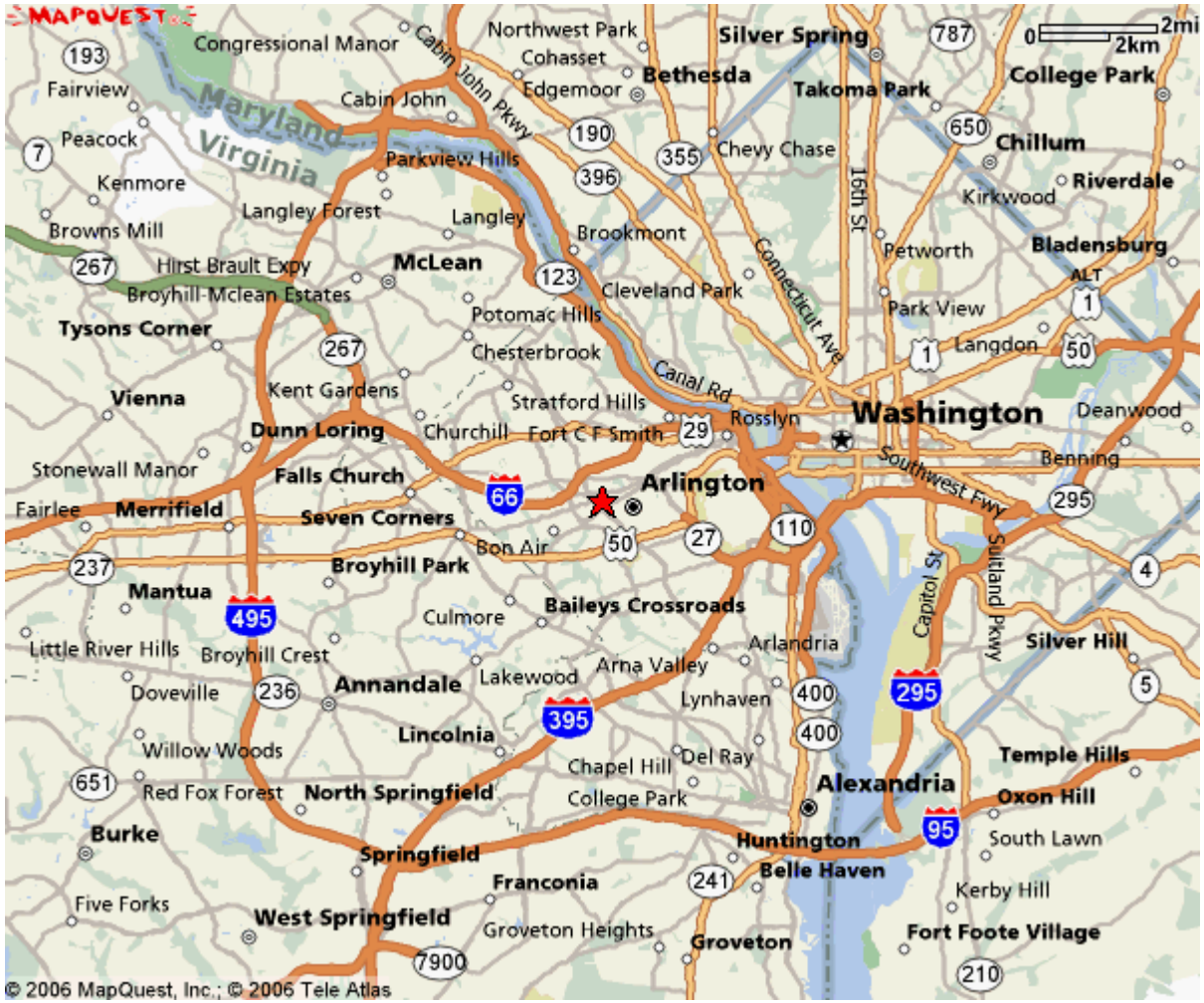
- Notre Dame is my home institution.
  - A major research university with many departments and colleges.
  - Access to colleagues in many different disciplines.
- I have been involved in many different types of projects:
  - Fixed Target Experiments
  - Detector Development (Active Targets, Scintillating Fiber Detectors for Tracking; Optical Decoding for Sampling Calorimetry, Generic Detector R&D)
  - Colliding Beam Experiments: DØ and CMS
  - Broader Impacts/Education: QuarkNet
  - Served as USCMS Education and Outreach Coordinator
  - Served on HEPAP, the High Energy Physics Advisory Panel
- Funding to support my research program and group has always been a constant struggle. Sources…
  - National Science Foundation
  - DOE
  - SBIR, STTR
  - TNLRC
  - Notre Dame
- And then I served on HEPAP…

NSF Established

- NSF Established in 1950.

The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" With an annual budget of about $5.5 billion, we are the funding source for approximately 20 percent of all federally supported basic research conducted by America's colleges and universities. In many fields such as mathematics, computer science and the social sciences, NSF is the major source of federal backing.

NSF Geographically



Organization Data

- NSF:
  - The National Science Board
    - Twenty-four members
    - Meets six times per year
  - The Director's Office
    - Director, Arden Bement
    - Deputy Director, Kathie Olsen
    - Directorates
      - Biological Sciences
      - Computer and Information Science and Engineering
      - Engineering
      - Geosciences
      - Mathematics and Physical Sciences
      - Social, Behavioral, and Economic Sciences
      - Education and Human Resources

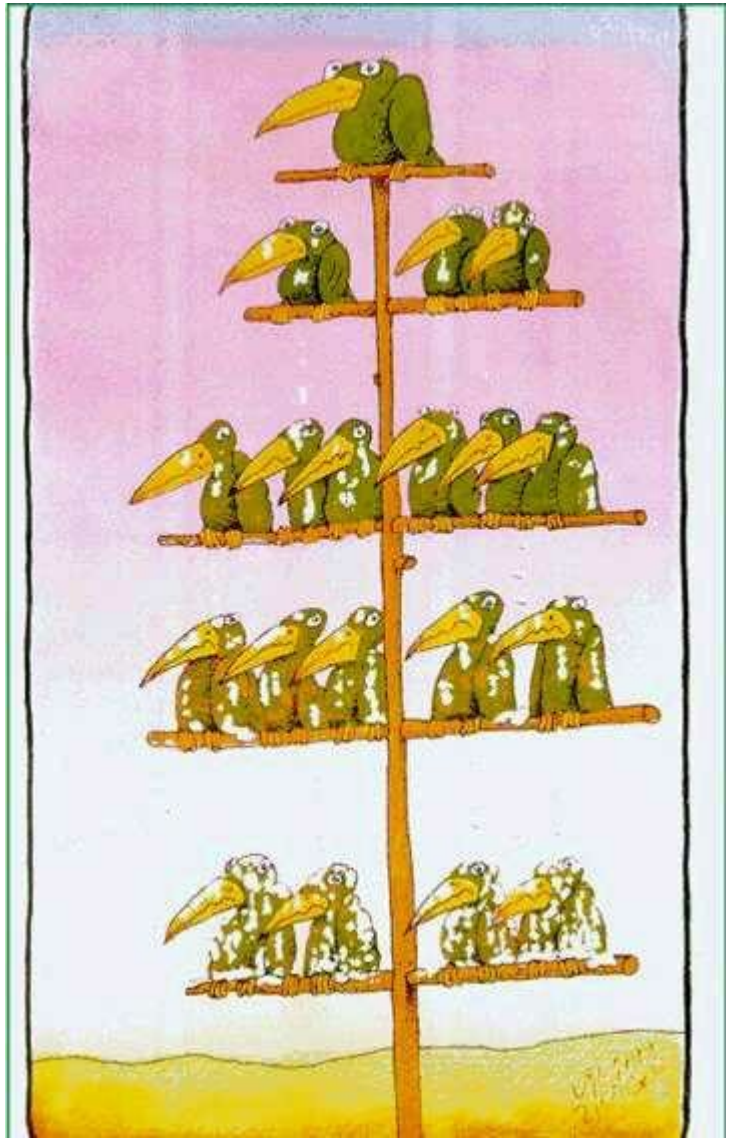
More Data

- Directors Office (continued)
  - Offices
    - Integrative Activities
    - International Science and Engineering
    - Legislative and Public Affairs
    - Polar Programs
    - ….
  - Staffing
    - 1200 Career Employees
    - 150 scientists on temporary duty
    - 200 contract workers

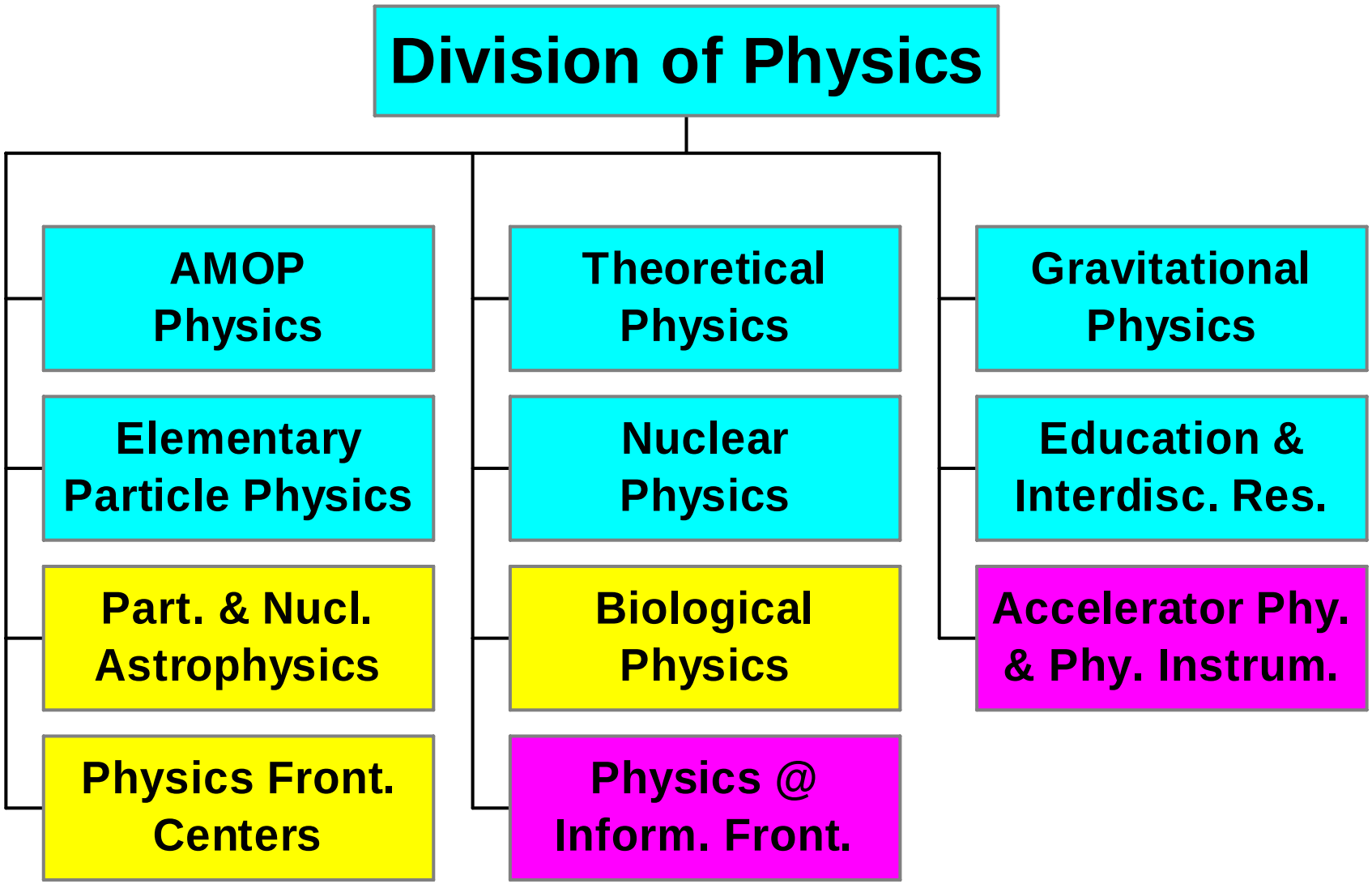
Whoa, Way More Data

- Mathematical and Physical Sciences
  - Astronomy
  - Chemistry
  - Materials Research
  - Mathematics
  - Physics
  - Multidisciplinary Activities

Management Simplified?



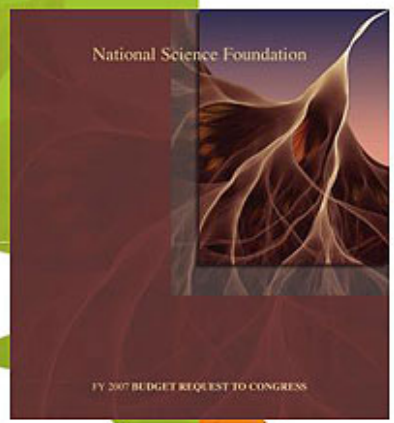
On Our Rung


Division of Physics
AMOP Physics
Elementary Particle Physics
Part. & Nucl. Astrophysics
Physics Front. Centers
Theoretical Physics
Nuclear Physics
Biological Physics
Physics @ Inform. Front.
Gravitational Physics
Education & Interdisc. Res.
Accelerator Phy. & Phy. Instrum.

President's American Competitiveness Initiative

2007 BUDGET REQUEST

Double the NSF budget over 10 years



NSF FY 2007

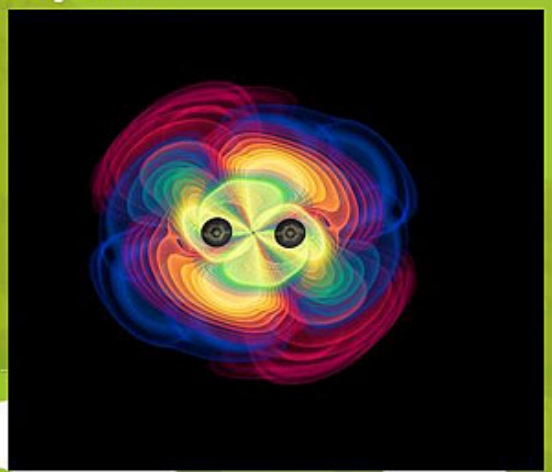
Budget by Account (millions)

2007 BUDGET REQUEST

Appropriations Account	FY 2007 Request	Change over FY 2006	
Research & Related Activities	$4,666	$334	7.7%
Education & Human Resources	$ 816	$ 20	2.5%
Major Research Equipment & Facilities Construction	$ 240	$ 50	26.0%
Salaries & Expenses	$ 282	$ 35	14.2%
National Science Board	$ 4	($.04)	(1.0%)
Inspector General	$ 12	$ .5	4.4%
TOTAL, NSF	$6,020	$439	7.9%

Elementary Particle Physics

2007 BUDGET REQUEST



Increase: $15 million

Bolstering K-12 Education

2007 BUDGET REQUEST

Graduate Teaching Fellowships in K-12 Education (GK-12)

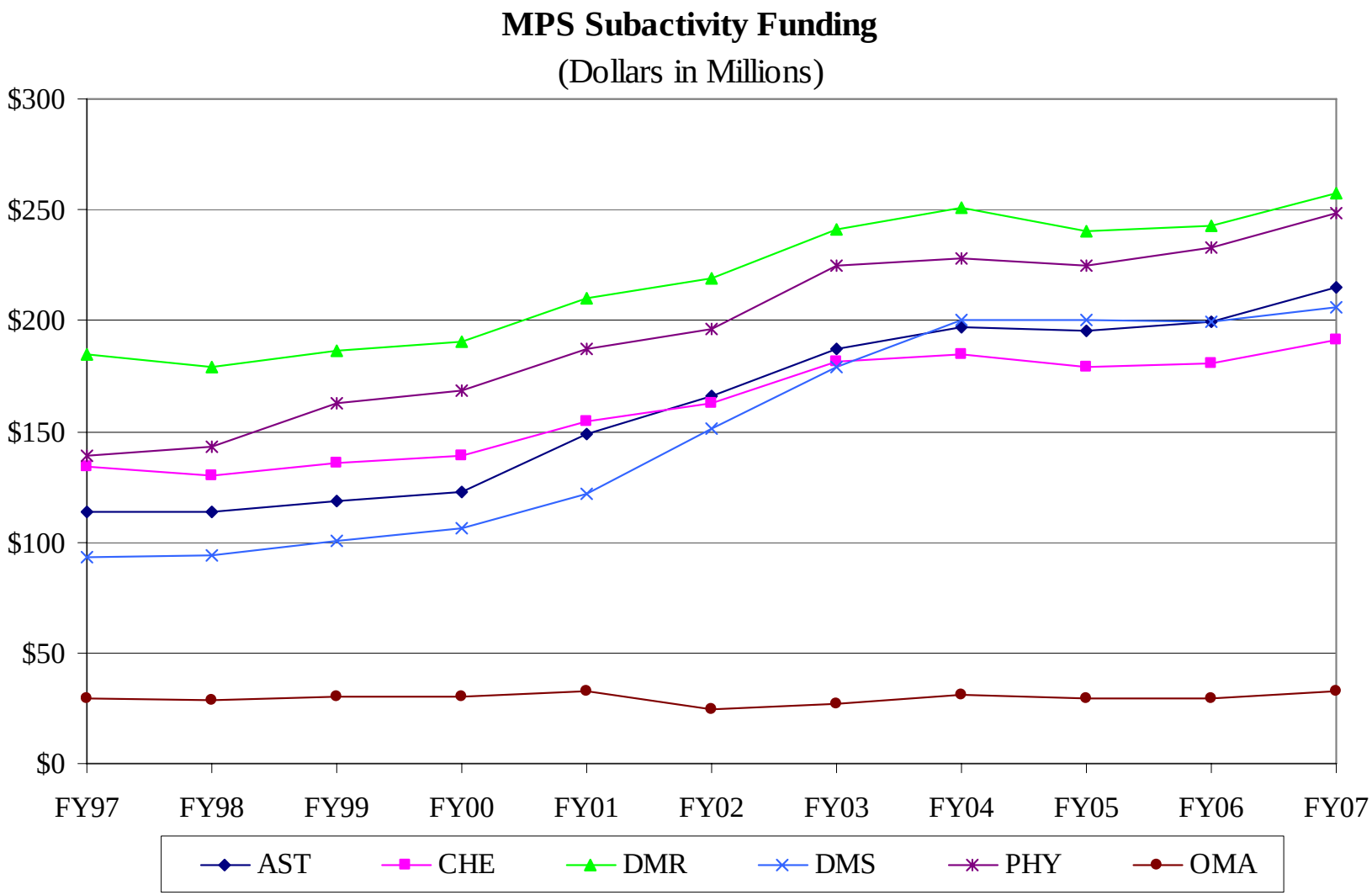
- 1000 Fellowships
- $56 million
- 10% increase

MPS by Division

(Dollars in Millions)

	FY 2004 Actuals	FY 2005 Actuals	Change from 04 to 05	FY 2006 Current Plan	Change from 05 to 06	FY 2007 Request	Change from 06 to 07
AST	196.63	195.11	-0.8%	199.65	2.3%	215.11	7.7%
CHE	185.12	179.26	-3.2%	180.78	0.8%	191.10	5.7%
DMR	250.65	240.09	-4.2%	242.91	1.2%	257.45	6.0%
DMS	200.35	200.24	-0.1%	199.30	-0.5%	205.74	3.2%
PHY	227.77	224.86	-1.3%	233.13	3.7%	248.50	6.6%
OMA	31.07	29.80	-4.1%	29.68	-0.4%	32.40	9.2%
Total, MPS	1,091.59	1,069.36	-2.0%	1085.45	1.5%	1150.30	6.0%
R&RA	4293.34	4234.82	-1.4%	4,331.48	2.3%	4,665.95	7.7%
NSF	5652.01	5480.78	-3.0%	5,581.17	1.8%	6,020.21	7.9%

10-Year Funding History



NSF FY07 Priorities

- From Michael Turner's Feb 6 Talk on the FY07 Budget Rollout. Points emphasized:
  - Advancing the Frontier (grant support)
  - Facility Stewardship, Instrumentation and CyberInfrastructure
  - Broadening Participation
  - Education and Workforce Development

Physics

- Physics Division Director, Joe Dehmer
- Experimental Particle Physics
  - Marv Goldberg
  - John Kotcher
  - Moishe Pripstein
  - Randy Ruchti
  - Jim Stone
  - Jim Whitmore
  - Kim Humphries, Staff Specialist
- Theoretical Particle Physics
  - Fred Cooper
  - Sara Huff, Staff Specialist

Underlying Themes

- Empowering University-Based Investigators
- Adding Value
  - Partnerships
    - Building Interdisciplinary Collaboration
  - Broadening Participation
    - Single Investigators
    - Non-traditional/Underrepresented participants
    - RUIs
  - Education and Outreach Activities

EPP Portfolio

- University Base Program
  - Accelerator based physics
  - Computational physics
- Cornell Storage Ring CESR
- LHC Construction and Operations (ATLAS, CMS)
- Accelerator and Detector R&D (APPI)
  - International Linear Collider related support
- Coordination with related groups (PNA,THY)
- DUSEL
- Partnerships

"Typical" NSF Fiscal Year for University Base Support

- September: Target date for proposals for next FY
  - September 27, 2006
- October: Proposals sent out for ad hoc review
- Fall: Visits by Project Leaders
- December: EPP and PNA Panel Reviews
- Winter: Site visits as needed
- January: Deadline, MRI Proposals
  - January 25, 2007 (Fourth Thursday of January)
- Winter/Spring: Declinations sent out
- Spring: Funding awards initiated
- Summer: Hold for final awards and supplements
- July: Deadline, Career Proposals for next FY
  - July 19, 2007 for MPS Proposals (Varies by Directorate)

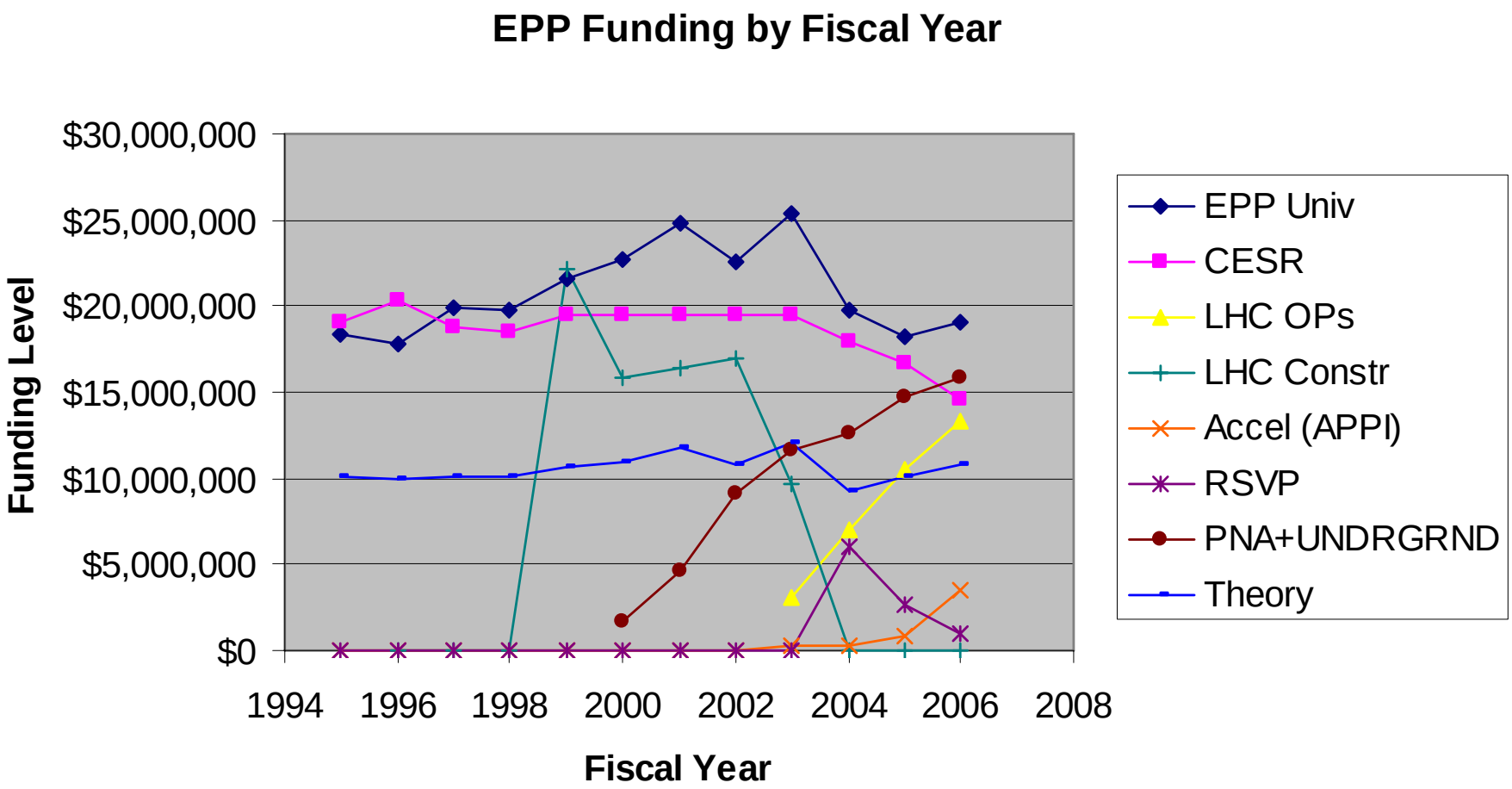
Program Guidance

- HEPAP
  - P5
  - NUSAG, DETF, CMB, DMSAG
  - AARD
  - UGPS
- Other External
  - EPP2010 and other Reports
  - Laboratory PACs and Resource Review Boards
  - MUFAC
  - FALC
  - Visits from Experimenters and Programs
  - Site Visits
- Internal
  - Committee of Visitors (3 year interval)

EPP Base Detail

EPP Base ($M)	2004	2005	2006
EPP Univ	$19.75	$18.19	$19.03
CESR	$18.00	$16.62	$14.62
LHC ops	$7.00	$10.51	$13.37
RSVP	$6.00	$2.65	$0.99
Accel (APPI)	$0.34	$0.78	$3.55
Subtotal	$51.09	$48.75	$51.56
PA	$10.21	$11.07	$11.33
NA	$1.86	$2.35	$3.25
Undergrnd	$0.62	$1.27	$1.28
Subtotal	$12.68	$14.69	$15.85
EPP Thy	8.70	9.11	9.83
Ast/Cs Thy	0.53	0.95	0.99
Subtotal	9.23	10.05	10.82
Total	$73.00	$73.50	$78.24

EPP Funding History

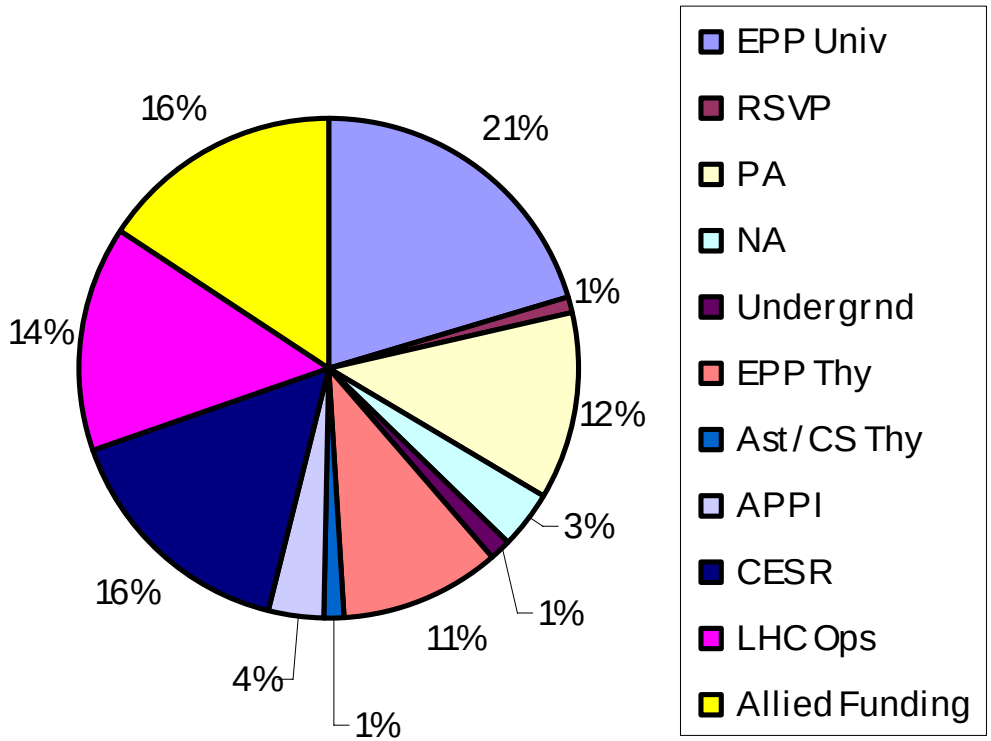


EPP Base and Allied Funding

	FY02	FY03	FY04	FY05	FY06
EPP Base					
Accel Based*	42.31	48.17	51.09	48.75	51.56
PNA+Underground	9.05	11.70	12.68	14.69	15.85
EPP+Astro/Cosmo Thy	10.84	12.07	9.23	10.05	10.82
Total Base	62.20	71.93	73.00	73.50	78.24
EPP Allied Funding					
MRI	3.20	1.70	0.00	0.75	1.66
PFC	4.00	4.00	5.02	5.56	5.77
OCI	6.00	6.30	6.50	5.65	3.63
PIF					2.45
OMA					0.54
ESIE	0.70	0.70	0.29	0.55	0.48
OISE					0.25
Total Allied	13.90	12.70	11.81	12.51	14.78
MREFC					
LHC construction	16.90	9.69			
IceCube	15.00	24.54	41.75	47.62	49.85

EPP Funding Distribution FY06

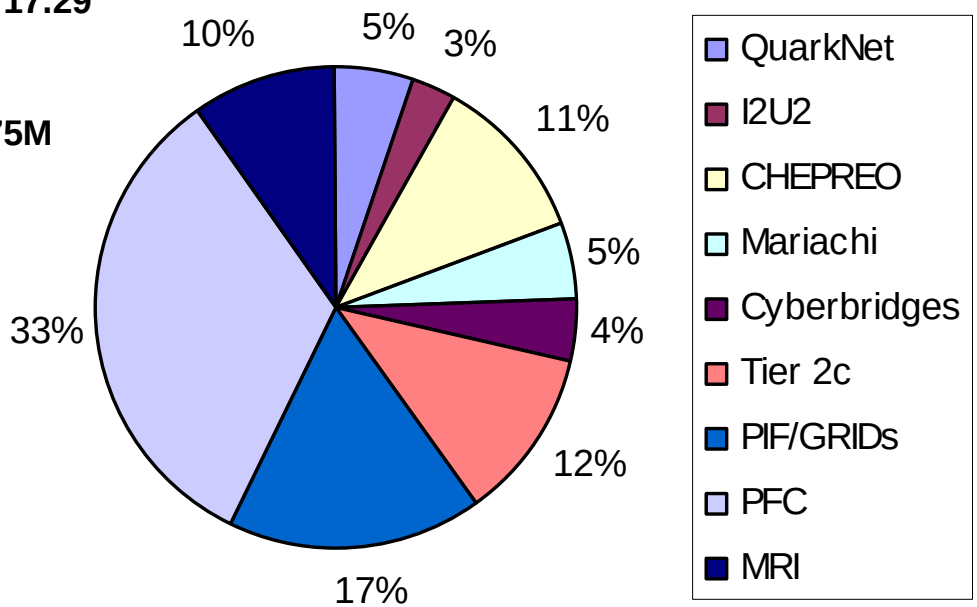
EPP Univ	**19.03**
RSVP	**0.99**
PA	**11.33**
NA	**3.25**
Undergrnd	**1.28**
EPP Thy	**9.83**
Ast/CS Thy	**0.99**
APPI	**3.55**
CESR	**14.62**
LHC Ops	**13.37**
Allied Funding	**14.78**
Total	**93.02**



FY06 Allied Funding

	EPP Base	Other	Sum
QuarkNet*	0.67	0.22	0.89
I2U2	0.00	0.54	0.54
CHEPREO	0.85	1.06	1.91
Mariachi	0.00	0.90	0.90
Cyberbridges	0.00	0.70	0.70
Tier 2c	0.99	1.00	1.99
PIF/GRIDs	0.00	2.93	2.93
PFC	0.00	5.77	5.77
MRI	0.00	1.66	1.66
Total	2.51	14.78	17.29

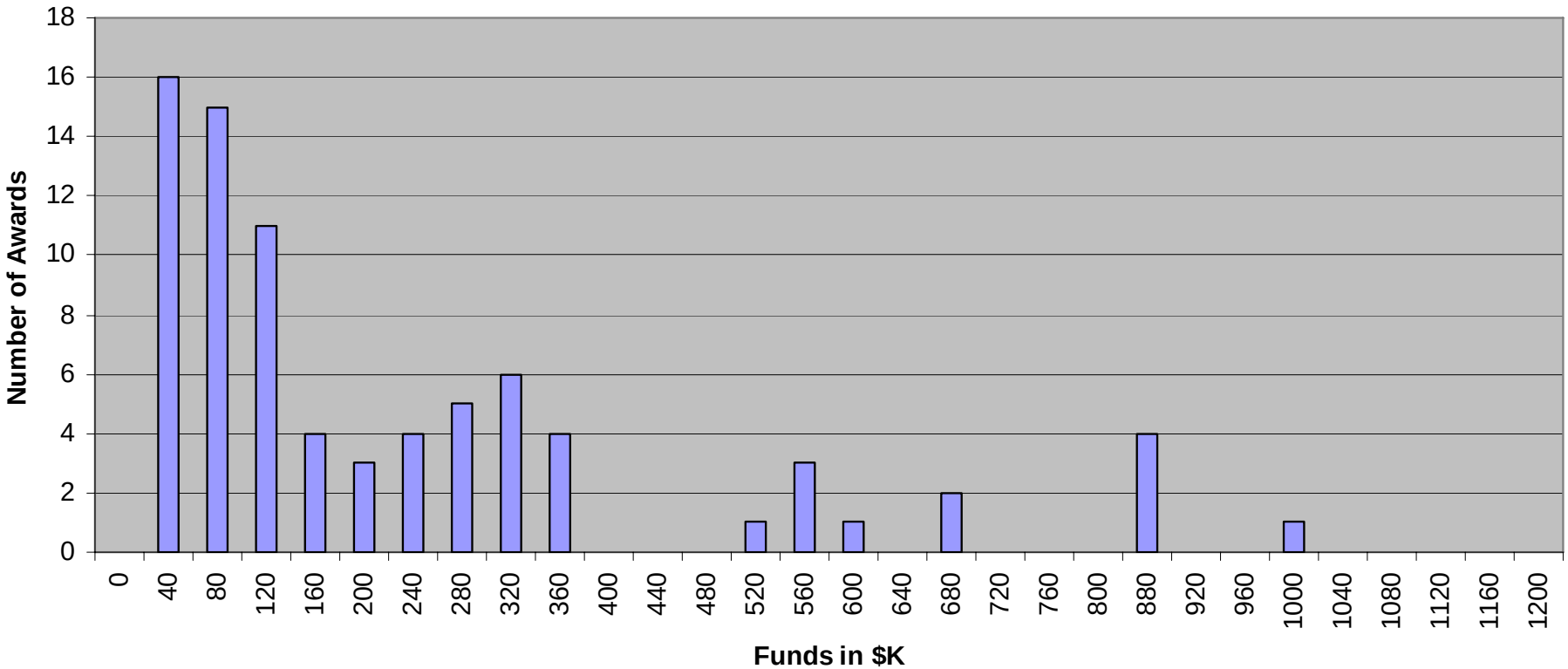
*** Does not include DOE/OHEP contribution of $0.75M**



Distribution of Accel-Based Univ Group FY05

Experiment	($k)
Tevatron	5,319
LHC	5,697
Neutrino	2,128
DESY/CERN	1,368
BNL/TJNAL	1,230
CLEO (not Cornell)	1,474
SLAC	504

FY06 Awards University Accelerator-Based Program



84 Total Awards. Average Award Size is $260k based 65 Awards.

Larger Awards (3) not displayed. Small Awards (16) are for conferences and workshops

Base-funded FTEs (FY05)

33 Universities
?? Theoretical Phys
(% change from FY2002)

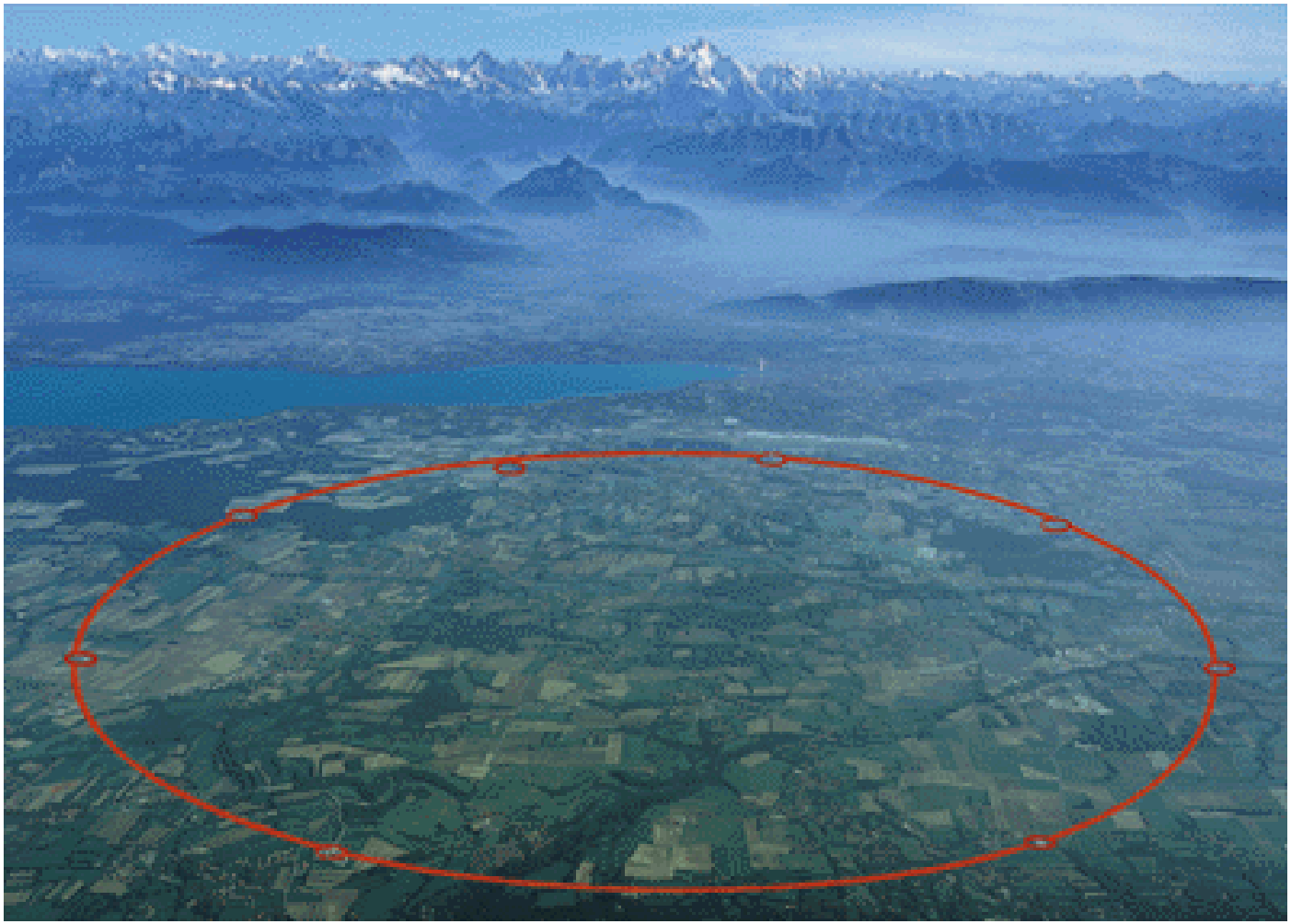
17 Accel-based Expts
18 Not-accel Expts

Program	# Faculty	# postdoc + research scientists	# grad students	**Total**
Theory (2003)	132	63	44	239
Experiment Accel based	94 (-4.1%)	79 (-1.3%)	99 (+4.2%)	272
Experiment Not-acceler	25 (+12.2%)	35 (+12.8%)	41 (-4.5%)	101
Total	251	177	184	612

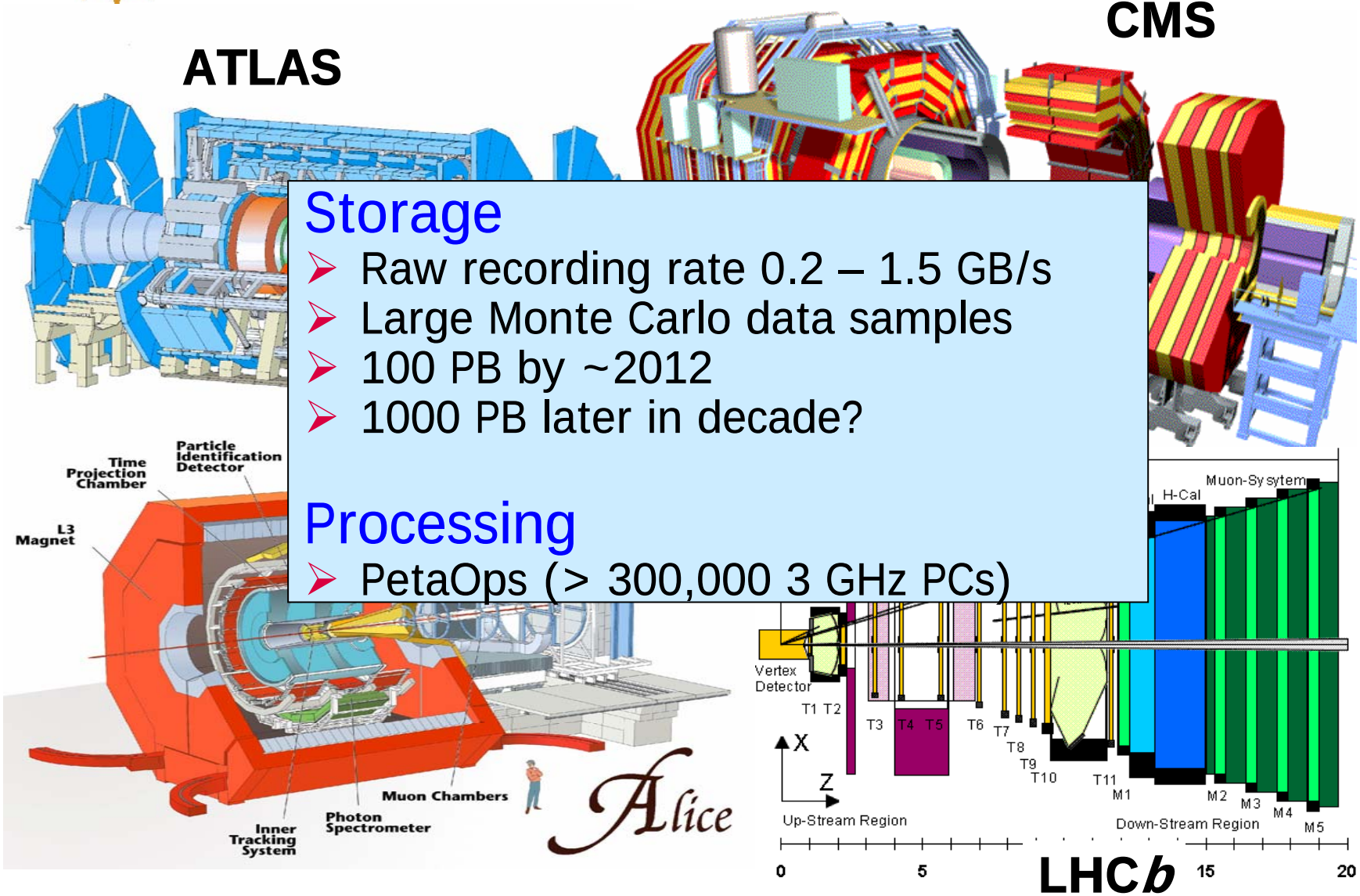
Partnerships

- Within NSF
  - Cyberinfrastructure
  - Education with research
    - Formal
    - Informal
  - Multidisciplinary Activities
  - International
- With DOE

Example LHC



LHC Data and CPU Requirements



Storage

- Raw recording rate 0.2 – 1.5 GB/s
- Large Monte Carlo data samples
- 100 PB by ~2012
- 1000 PB later in decade?

Processing

- PetaOps (> 300,000 3 GHz PCs)

LHC Global Data Grid (2007+)

- 5000 physicists, 60 countries
- 10s of Petabytes/yr by 2010
- CERN/Outside < 1/5
- CERN: T1 : T2 ~ 1:2:2

CMS Experiment

Online System

150 - 1500 MB/s

CERN Computer Center

10-40 Gb/s

Tier 0

Tier 1

Korea | UK | Russia | USA | • • •

>10 Gb/s

Tier 2

U Florida | Caltech | UCSD | • • •

Physics caches

2.5-10 Gb/s

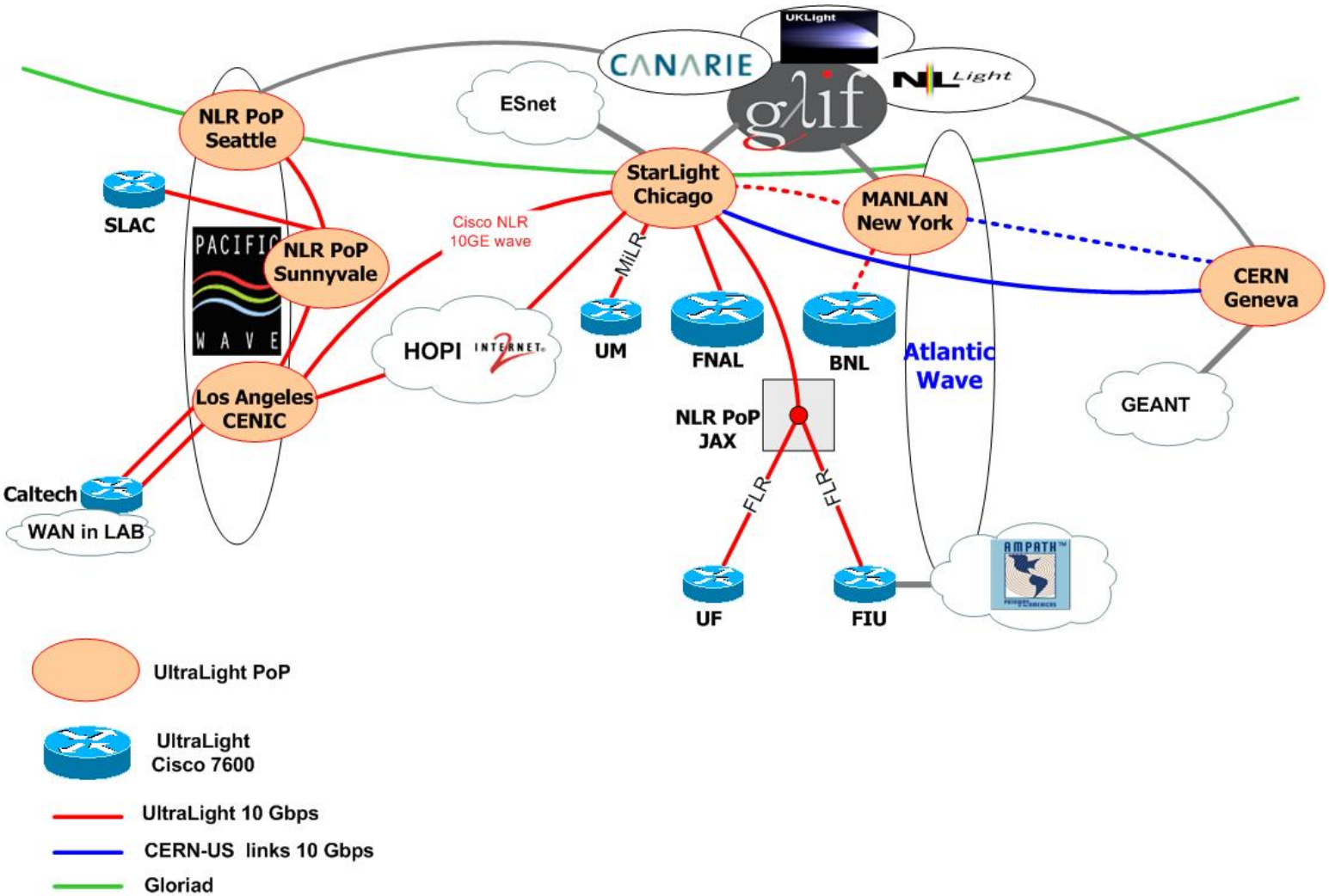
Tier 3

FIU | Iowa | Maryland | • • •

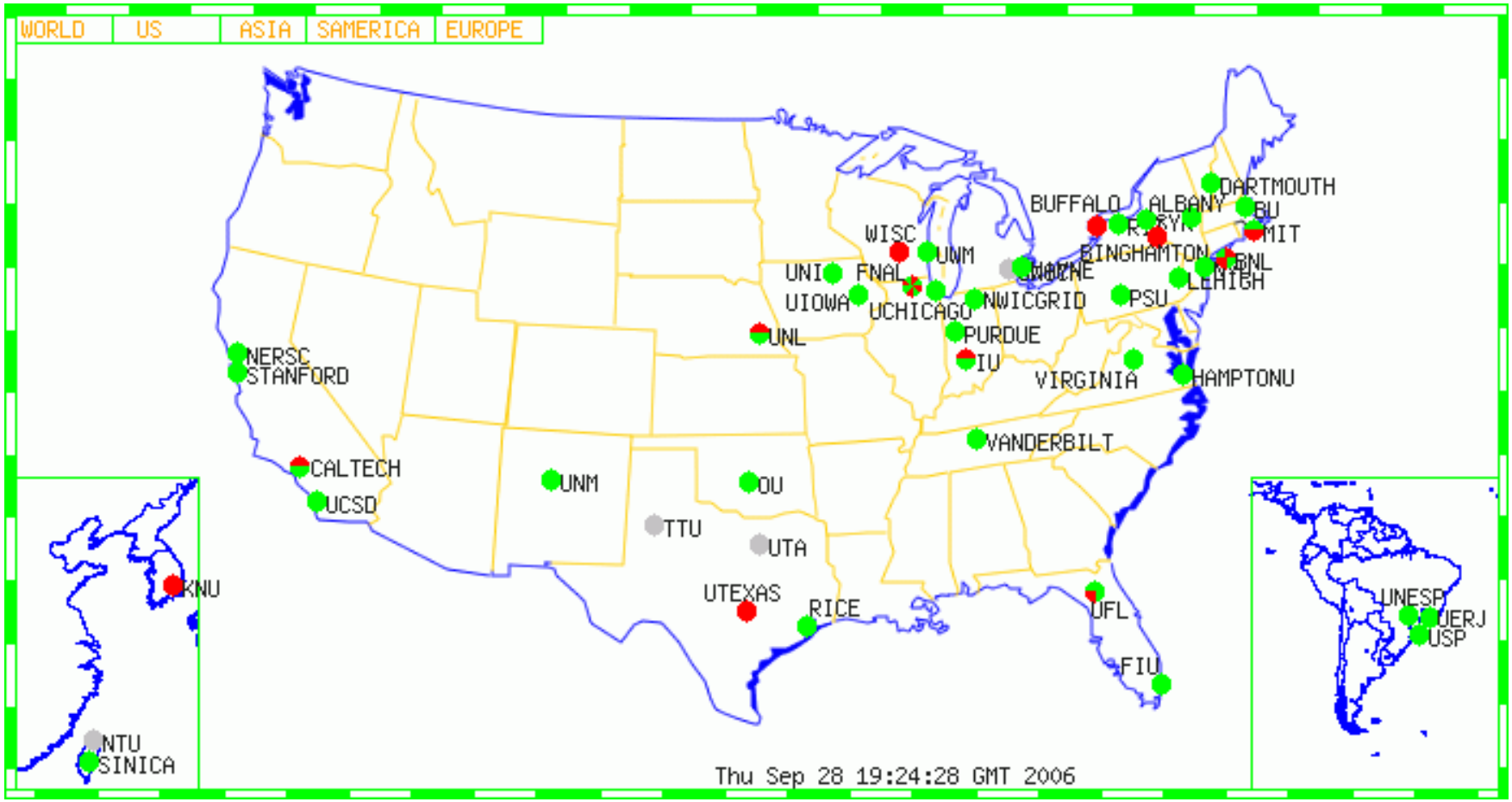
Tier 4

PCs

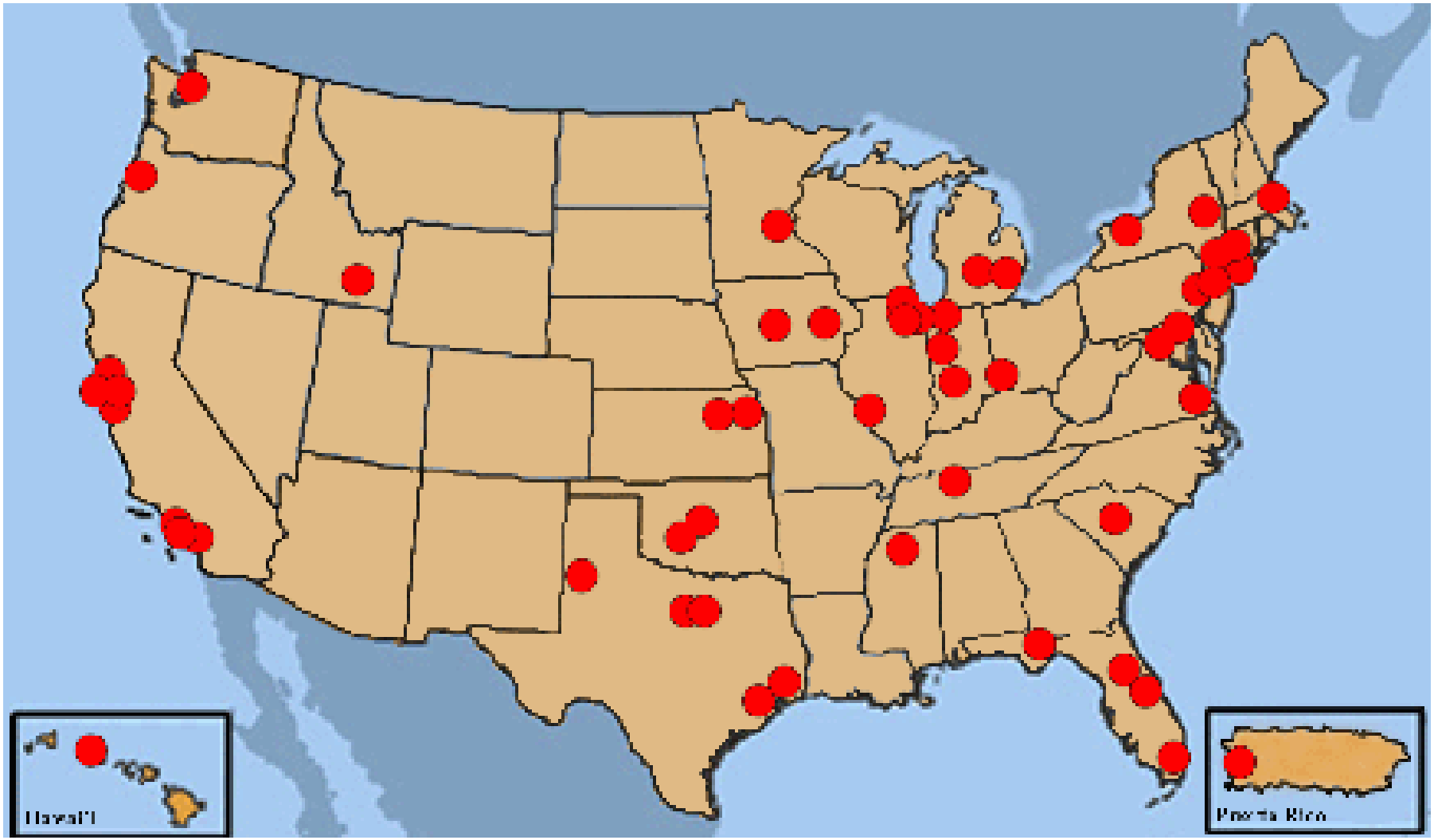
UltraLight


UKLight
CANARIE
ESnet
glif
NL Light
NLR PoP Seattle
SLAC
PACIFIC WAVE
NLR PoP Sunnyvale
Cisco NLR 10GE wave
StarLight Chicago
MANLAN New York
CERN Geneva
MiLR
HOPI INTERNET2
UM
FNAL
BNL
Atlantic Wave
GEANT
Los Angeles CENIC
NLR PoP JAX
FLR
FLR
Caltech
WAN in LAB
UF
FIU
AMPATH
UltraLight PoP
UltraLight Cisco 7600
UltraLight 10 Gbps
CERN-US links 10 Gbps
Gloriad

Open Science Grid



QuarkNet



Mariachi

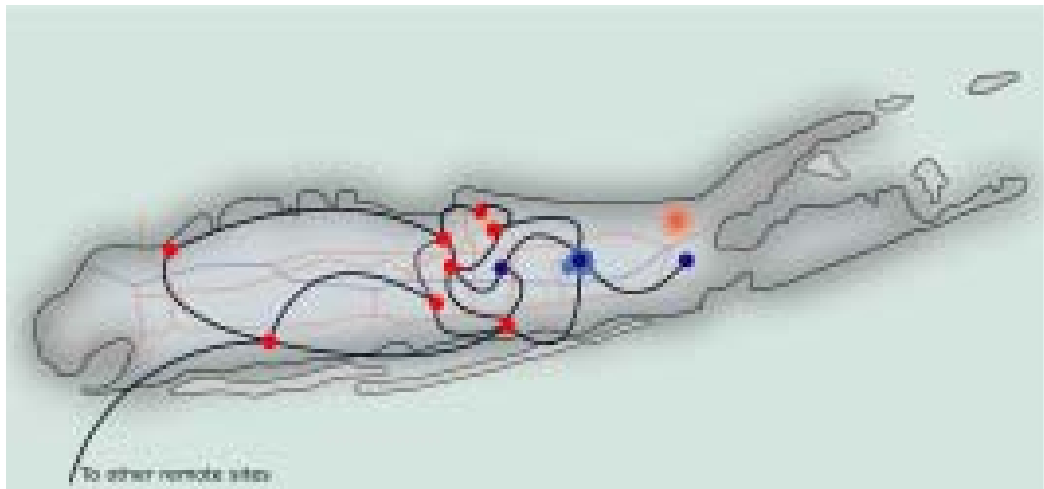
MARIACHI is a unique research experiment that seeks the detection of extreme energy cosmic rays (EECRs), with E $>10^{18}$ eV. It is an exciting project with many aspects:

Research: It investigates an unconventional way of detecting EECRs based upon a method successfully used to detect meteors entering the upper atmosphere. The method was developed by planetary astronomers *listening* to radio signals reflected off the ionization trail. MARIACHI seeks to *listen* to TV signals reflected off the ionization trail of an EECR. The unique experiment topology will also permit the study of meteors, exotic forms of lightning, and atmospheric science.

Computing and Technology: It uses radio detection stations, along with mini shower arrays hooked up to GPS clocks. Teachers and students build the arrays.It implements the Internet and the GRID as means of communication, data transfer, data processing, and for hosting a public educational outreach web site.

Outreach and Education: It is an open research project with the active participation of a wide audience working with physicists, including high school and college teachers and students. Teams representing high schools, community colleges and universities all collaborate in the experiment. The excitement of a real experiment motivates science and technology classrooms incorporating various high school physical science topics along with varied experiences in electronics, radio, optics, and others.

Extreme Energy Cosmic Rays are nuclei that have been accelerated to kinetic energies in excess of 10^{20} eV. Where do they come from? How are they produced? Are they survivors of the early universe? Are they remnants of supernovas? MARIACHI, a unique collaboration between scientists, physics teachers and students, is developing an innovative technique to detect and study them.



Summary

- We have a vested interest in University Groups.
- We take advice from the community seriously.
- Peer review is a cornerstone of our decision process.
- We aim to have a balanced portfolio
- We respond to proposals.

Lessons

- Scientific collaboration is required for successful experimentation in particle physics
  - This has been the situation for years.
  - Great science does not get done without support
- HEPAP taught me something
  - Active practitioners have to be involved on the funding agency side too, to make things work.
- NSF has taught me something
  - Collaboration is essential within the funding agencies.
  - There is challenging work to be done on all sides.

NSF Website

- http://www.nsf.gov/

Additional Slides

Programs of Interest

- MREFC: Major Research Equipment & Facilities Construction
- MRI: Major Research Instrumentation
- CI-TEAM: Cyberinfrastructure and Education
- PIF: Physics at the Information Frontier
- PIRE: Partnerships for International Research and Education
- SBIR: Small Business Innovation Research
- GOALI: Grant Opportunities for Academic Liaison with Industry
- GK12: Graduate Teaching Fellowships in K12 Education
- IPSE: Internships in Public Science Education
- DDDAS: Dynamically Data Driven Applications Systems

- See NSF website for opportunities
  - www.nsf.gov

  - Clearly Dictionary Needed to understand acronyms
  - More definitions at the end of the presentation

Acronyms - I

AP Physics	Advanced Placement Physics (for High School Students)
APPI	Accelerator Physics and Physics Instrumentation
AST	Astronomy Division
CHE	Chemistry Division
CHEPREO	Center for High Energy Physics Research and Education Outreach
CI-TEAM	CyberInfrastructure Training Education Advancement and Mentoring
COV	Committee of Visitors
CyberBridges	Grid Computing and Science Disciplines Interdisciplinary Research and Education
DDDAS	Dynamically Data Driven Applications Systems
DMR	Division of Materials Research
DMS	Division of Mathematical Sciences
DUSEL	Deep Underground Scientific Laboratory
EHR	Education and Human Resources Directorate
EPP	Elementary Particle Physics
ESIE	Elementary, Secondary and Informal Education
GK12	Graduate Teaching Fellows in K12 Education
GOALI	Grant Opportunities for Academic Liaison with Industry
I2U2	Interactions in Understanding the Universe (Research and Formal and Informal Education Program)
IPSE	Internships in Public Science Education
Mariachi	Mixed Apparatus for Radar Investigation of Cosmic-rays of High Ionization
MPS	Mathematical and Physical Sciences Directorate
MREFC	Major Reseach Equipment and Facilities Construction
MRI	Major Research Instrumentation

Acronyms - II

NA	Nuclear Astrophysics
OCI	Office of CyberInfrastructure
OISE	Office of International Science and Engineering
OMA	Office of Multidisciplinary Activites
OSG	Open Science Grid (Funded Jointly by DOE and NSF)
PA	Particle Astrophysics
PFC	Physics Frontier Centers
PHY	Physics Division
PhysTEC	Physics Teacher Education Coalition
PIF	Physics at the Information Frontier
PIRE	Partnerships for International Research and Education
PNA	Particle and Nuclear Astrophysics
QuarkNet	National Education and Outreach in Particle Physics (Funded Jointly by DOE and NSF)
R&RA	Research and Related Activities
RET	Research Experiences for Teachers
REU	Research Experiences for Undergraduates
SBE	Social, Behavioral and Economic Sciences Directorate
SBIR	Small Business Innovation Research
SGER	Small Grant for Exploratory Research
Tier 2c	Tier 2 Computing Center - DISUN (Data Intensive Science University Network)
Trillium	The trio of SCIDAC (DOE), GriPhyN (NSF/OCI), and iVDGL (NSF/PHY)
UltraLight	High Bandwidth Networking

Examples of Award Types

- Standard Grant: Variable time length. Funds given in one shot.
- Continuing Grant: Typically 3 years (can be 5 years). Funding set for initial year and out years unless specified otherwise.
- Cooperative Agreement: Required for large awards, particularly for Centers, Facilities, Projects.
- Supplement: Can be attached to any active award, up to 20% of total award commitment (at discretion of Program Officer).
- SGER: Small grant given for topical or high potential pay-off activity.

Other Awards

- MREFC: Major Research Equipment and Facilities Construction awards - for projects which exceed a minimum of ~$100M over the project life. Involves the NSB directly. Timing depends upon NSF priority and NSB schedule.
  - (examples: LHC, CLEO, IceCube)
- MRI: Major Research Instrumentation awards – for developing university scientific infrastructure. Proposal deadline is late January of a given year.
  - (examples: Aspects of the DØ Upgrade, MICE electronics development, MINERvA) Award maxima for two types of awards ($800k, $2M)

NSF Future Planning

- Mid-Scale Instrumentation
  - Now only in the planning phase
  - Intermediate between MRI and MREFC
  - 5 year time frame
  - Various possibilities
    - An experiment
    - Upgrades
    - Accelerator, Detector R&D, …
    - Equipment