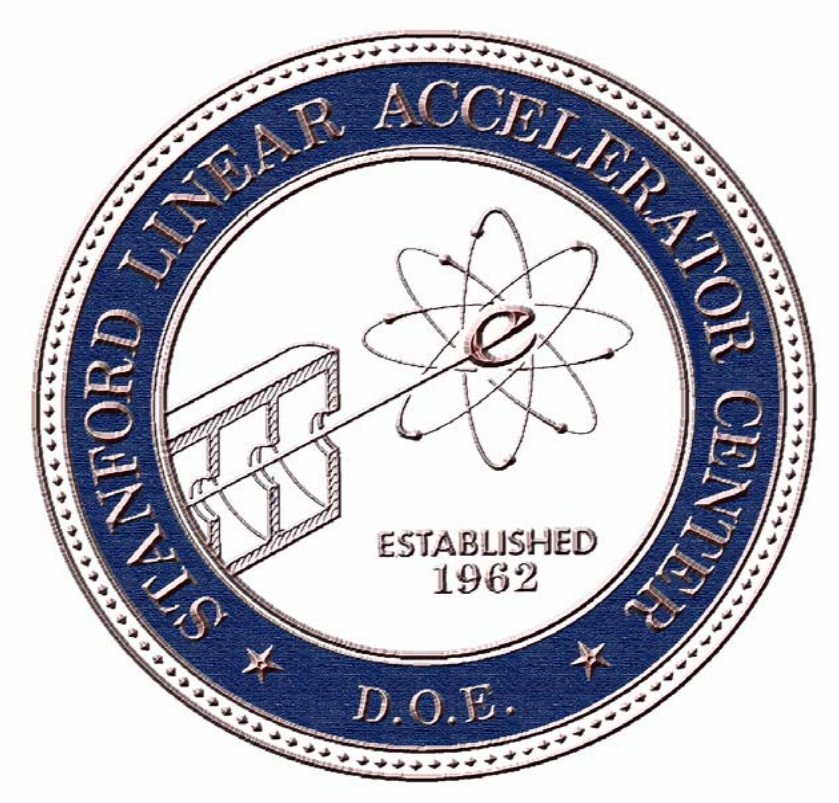
Director's Report



By Jonathan Dorfan, Director

DOE Annual HEP Program Review

April 9-11, 2003

Two Main Programs

- **High Energy Physics / Particle Astrophysics**

  Experiments, theory, accelerator development for studies of the ultimate structure of matter, the forces between the fundamental entities, the birth and evolution of the universe

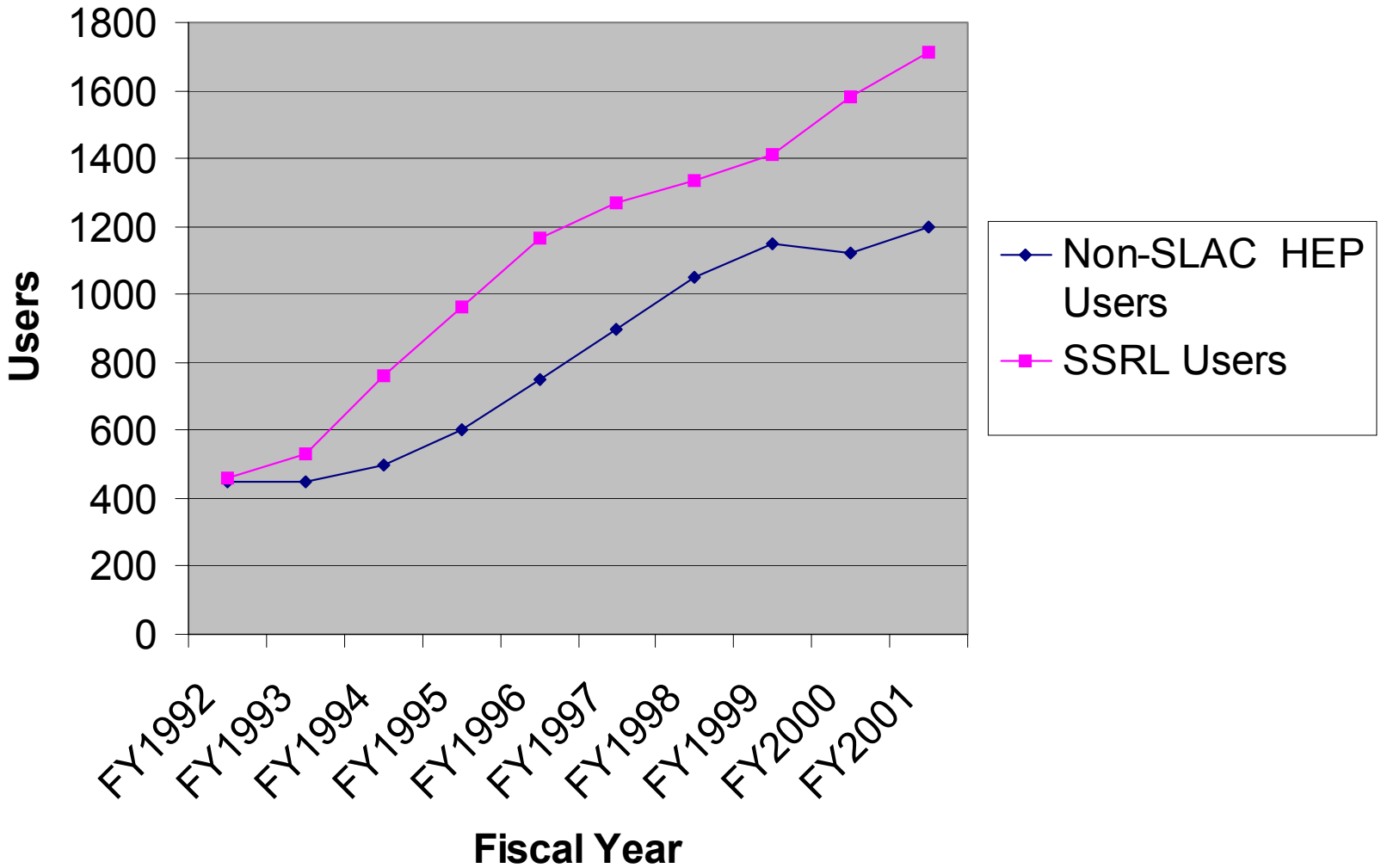
- **X-ray Science (SSRL)**

  The use of ultra high-intensity x-ray beams (ten million times the intensity of x-ray tubes) for studies in physics, biology, chemistry, medicine, and environmental sciences

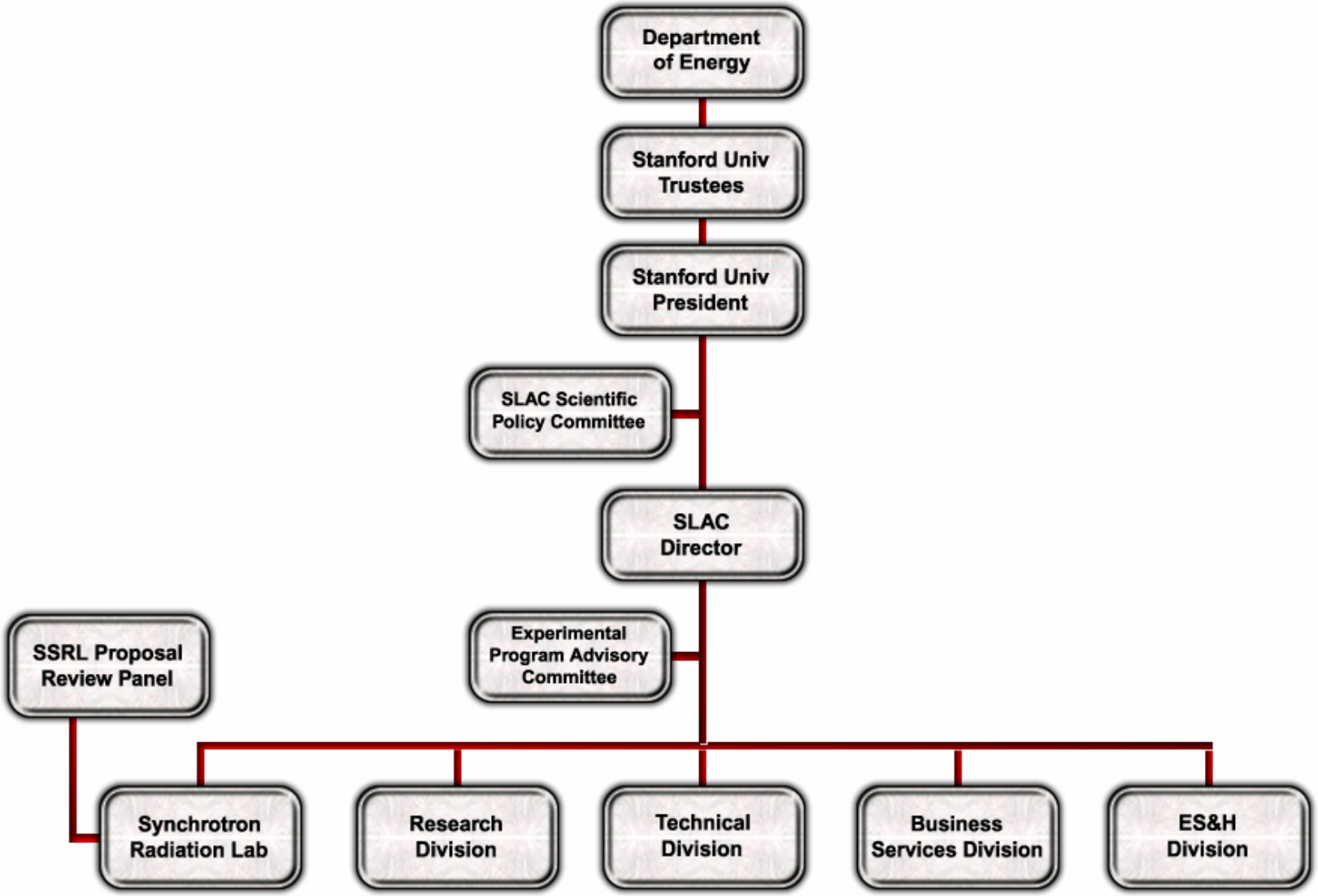
- **3000 scientists from about 20 nations use SLAC facilities to do their research**

- **Science Program at SLAC generates 800-900 publications / year**

Users for HEP and SSRL Continue to Grow



SLAC is managed as an M&O Contract between Stanford University and DOE

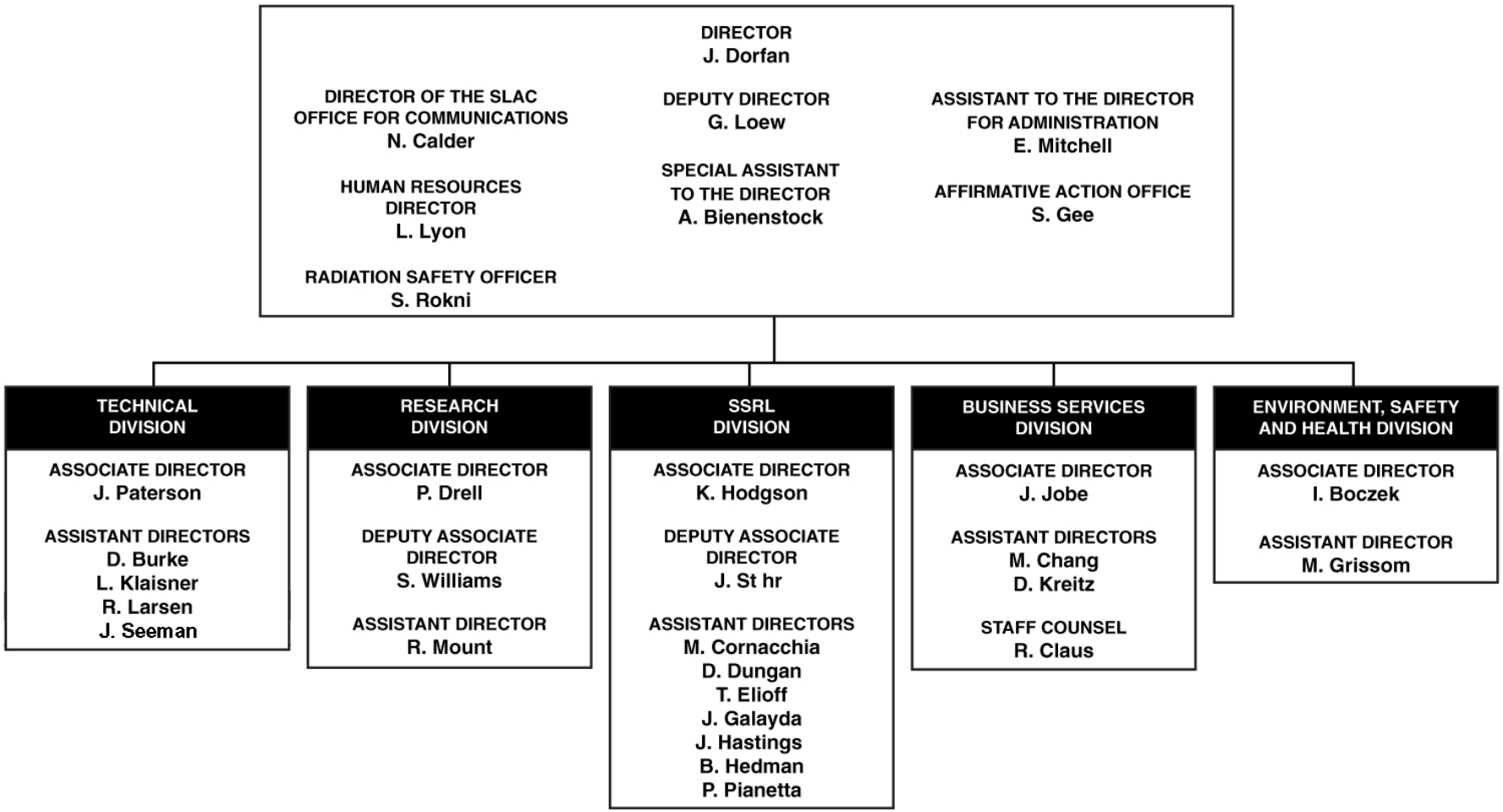


SLAC Experimental Program Advisory Committee

Phil Burrows	Oxford University
Allen Caldwell	MPI Munich
Tatsuya Nakada	CERN and PSI
Eckhard Elsen	DESY (Chair)
Emlyn Hughes	Caltech
Joseph Lykken	Fermi National Accelerator Laboratory
Shamit Kachru	Stanford University and SLAC
Rene Ong	UCLA
Chris Adolphsen	SLAC
David Rice	Cornell University
Aaron Roodman	SLAC
Elizabeth Simmons	Boston University

Stanford Linear Accelerator Center
Total Organization

Stanford Linear Accelerator Center Organization



SLAC — An Integral Part of Stanford University

- **SLAC benefits greatly from being an intimate and integral part of Stanford University**
- **SLAC is a School of Stanford with two faculties (departments). The HEP faculty comprises 30 active professors, the SSRL faculty comprises 17 active professors. HEP faculty includes joint appointments with the Physics Department**
- **SLAC celebrated its 40th birthday in October 2002. SLAC's history is one of cutting-edge technical innovation combined with outstanding scientific accomplishments. The close intimacy with a premier research University, Stanford, has been one of the key elements for this success**

"In preparing my remarks for today, I thought how difficult it is to think of Stanford without SLAC ….." This partnership has led to "collaboration in ways previously unimagined."

Stanford President John Hennesy speaking at SLAC's 40th Anniversary

SLAC
An Integral Part of Stanford University

- **The University augments and helps amplify the DOE's large investment at SLAC.**

  Two recent examples:

1) **Stanford has responded to our need for on-site housing by funding the $10.5M, 112 bed Guest House**

   - **Single-occupancy rooms $50/night. Double occupancy rooms $80/night**
   - **Availability of Guest House will save the user community about $2M/year**
   - **Occupancy in July 2003**

New Guest House is in Construction Phase

Entrance level from ring road

- **$50/night room rate**
- **Occupancy in July, 2003**

- **112 guest rooms**
- **Entry area includes lobby/registration area, small convenience shop, laundry, exercise room**

View from back of lodging

SLAC User Lodging
Construction Progress – 04/07/03

SLAC
An Integral Part of Stanford University

2) **Stanford has chosen to site the Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) on the SLAC site.**

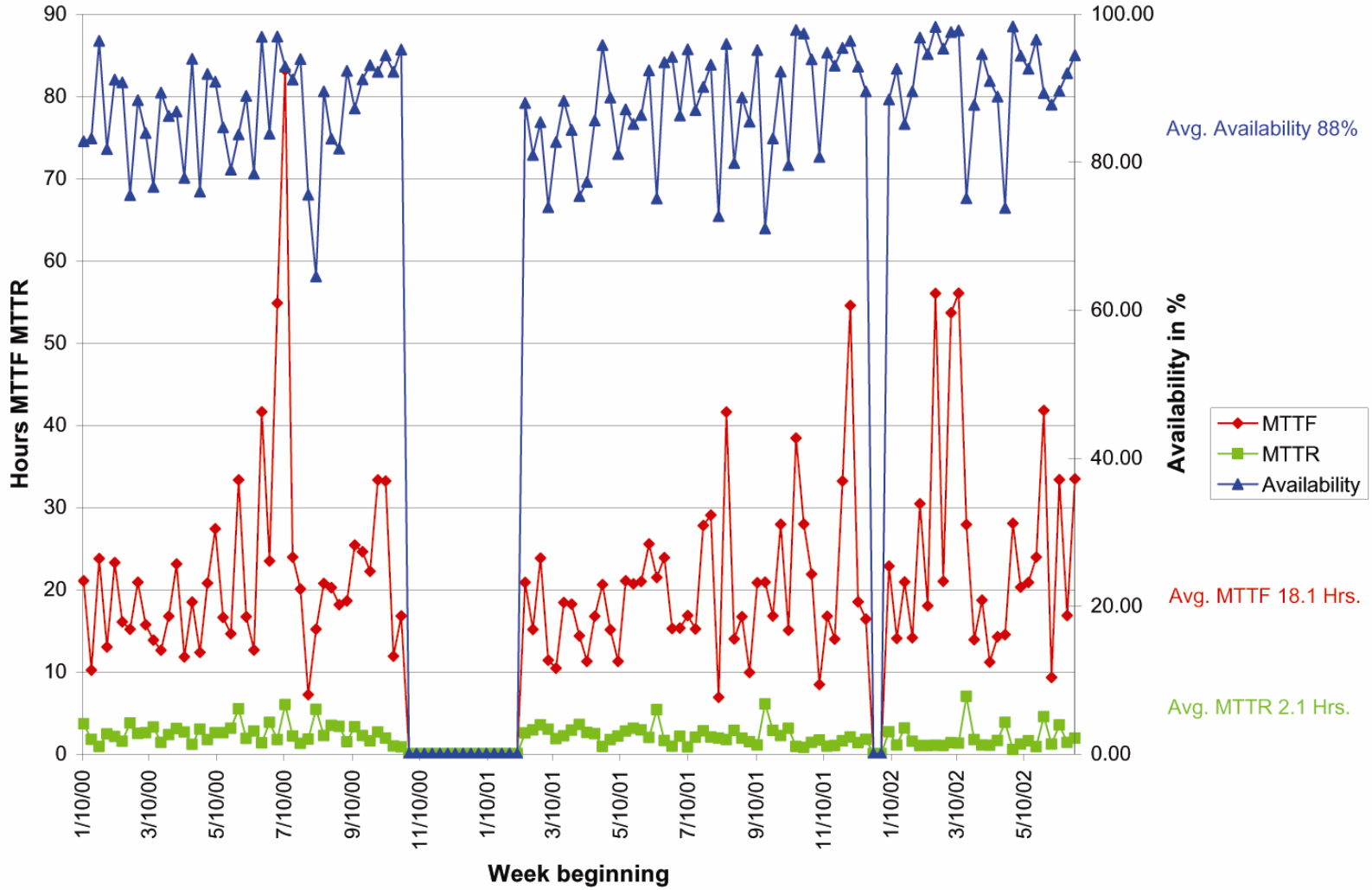
To establish the Institute, Stanford attracted two major gifts – one for the 25,000 sq ft Institute Building and another for a Endowed Chair for the Institute Director. Very substantial startup and sustaining funds have been provided by Stanford which have successfully attracted the "dream team" of Roger Blandford and Steven Kahn to direct the Institute

- **Without the extremely strong support of DOE and their willingness to make the appropriate facilitating administrative moves, we could not have realized this wonderful research opportunity**

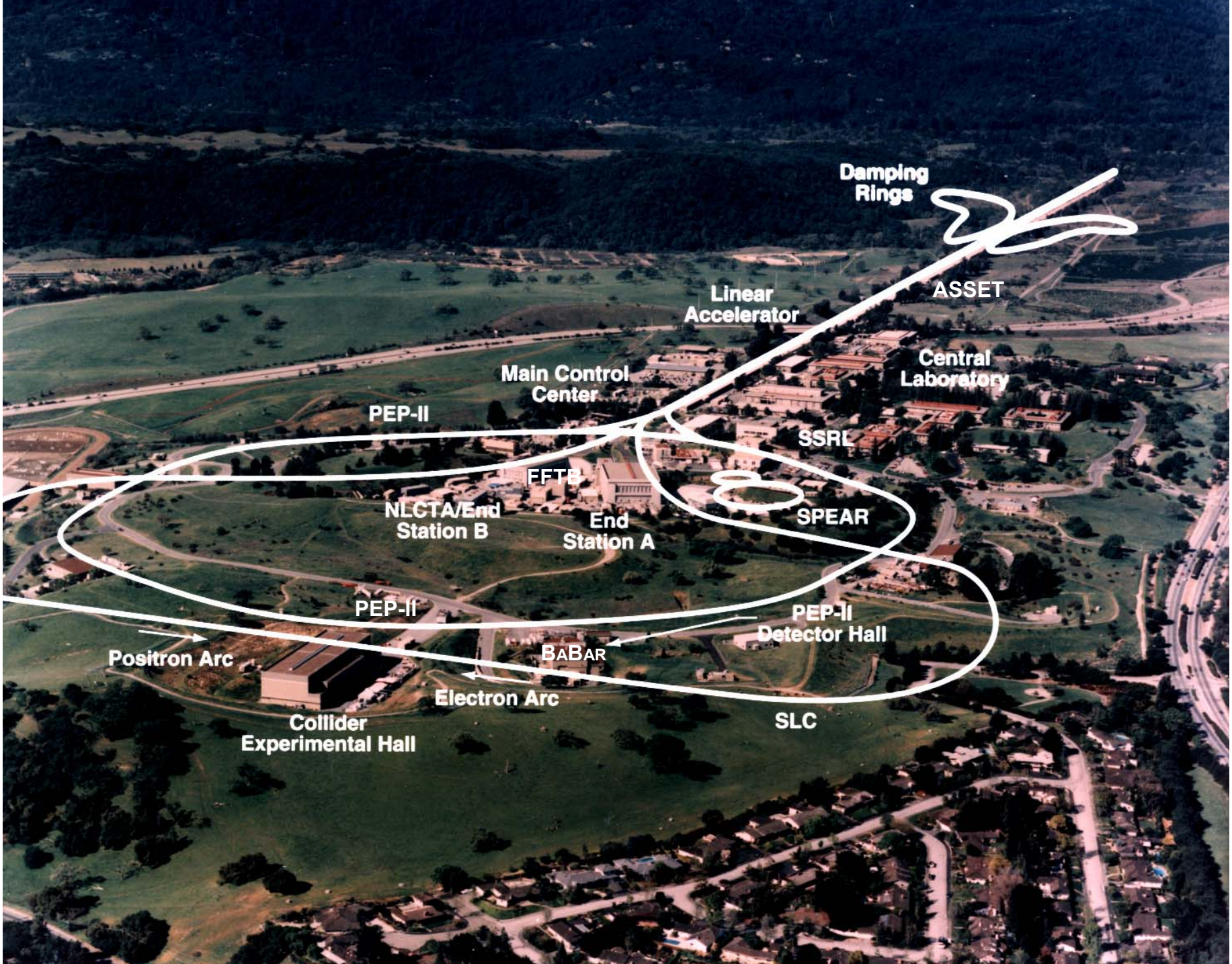
SLAC as an International Research Facility

- **Our primary function is constructing and operating large research facilities for our users. This requires**
  - a) **Highly specialized technical staff and extensive infrastructure to design, construct and maintain large accelerators and detectors**
  - b) **Extremely efficient operation of complex accelerators and detectors**
  - c) **Highly specialized, state of the art, computing systems (running 24/7/12) for the analysis and worldwide distribution of data**
- **The operating efficiency of SLAC's machines is exceptionally high — a tribute to the enormous skill and dedication of the Laboratory staff**

Weekly Mean Time to Failure, Mean Time to Repair, and Availability (HEP Systems)



Revised 10/07/02

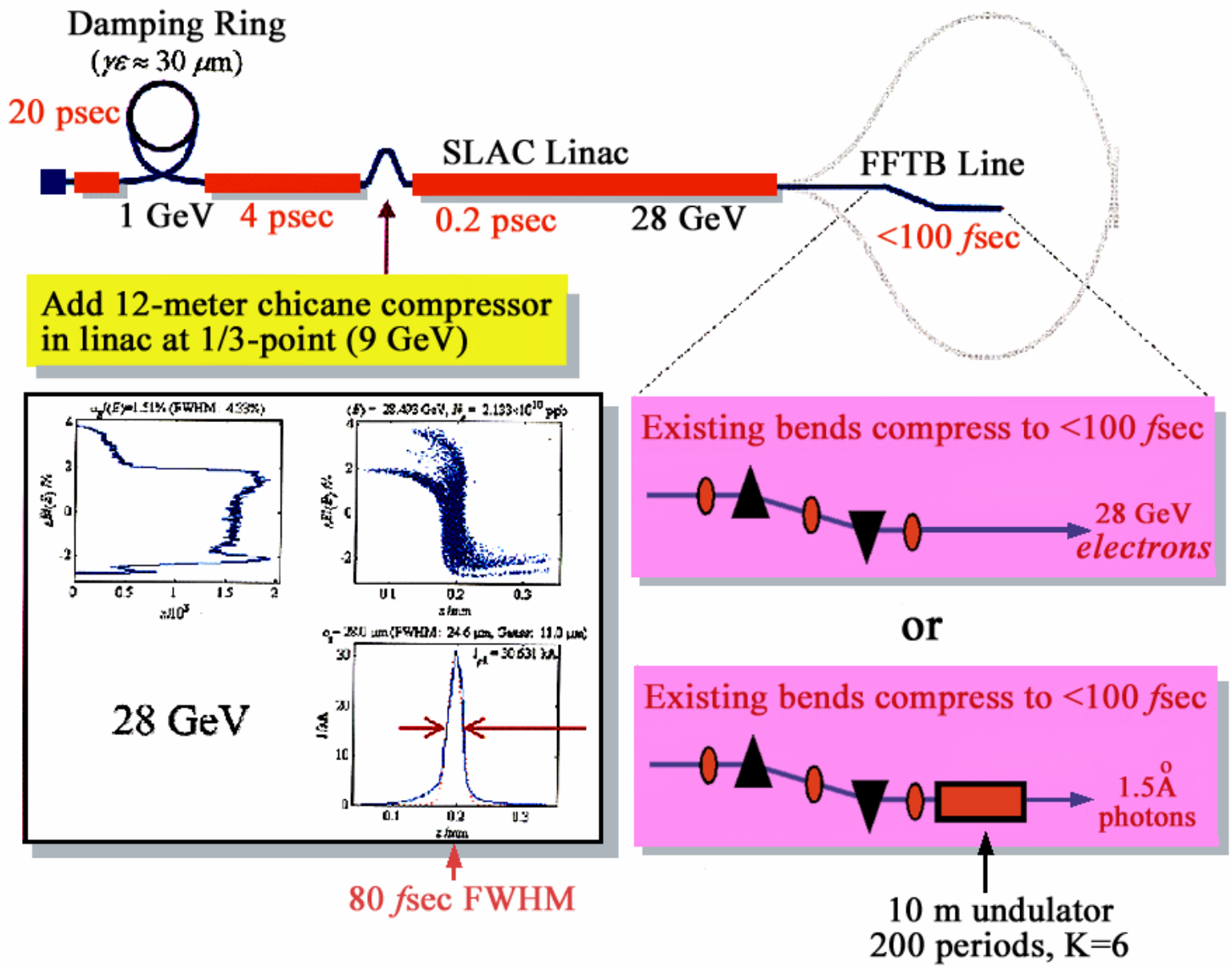

Damping Rings
ASSET
Linear Accelerator
Central Laboratory
Main Control Center
PEP-II
SSRL
FFTB
NLCTA/End Station B
End Station A
SPEAR
PEP-II
PEP-II Detector Hall
Positron Arc
BABAR
Electron Arc
SLC
Collider Experimental Hall

SLAC $e^{\pm}$, Photon Beams — Unique & in High Demand

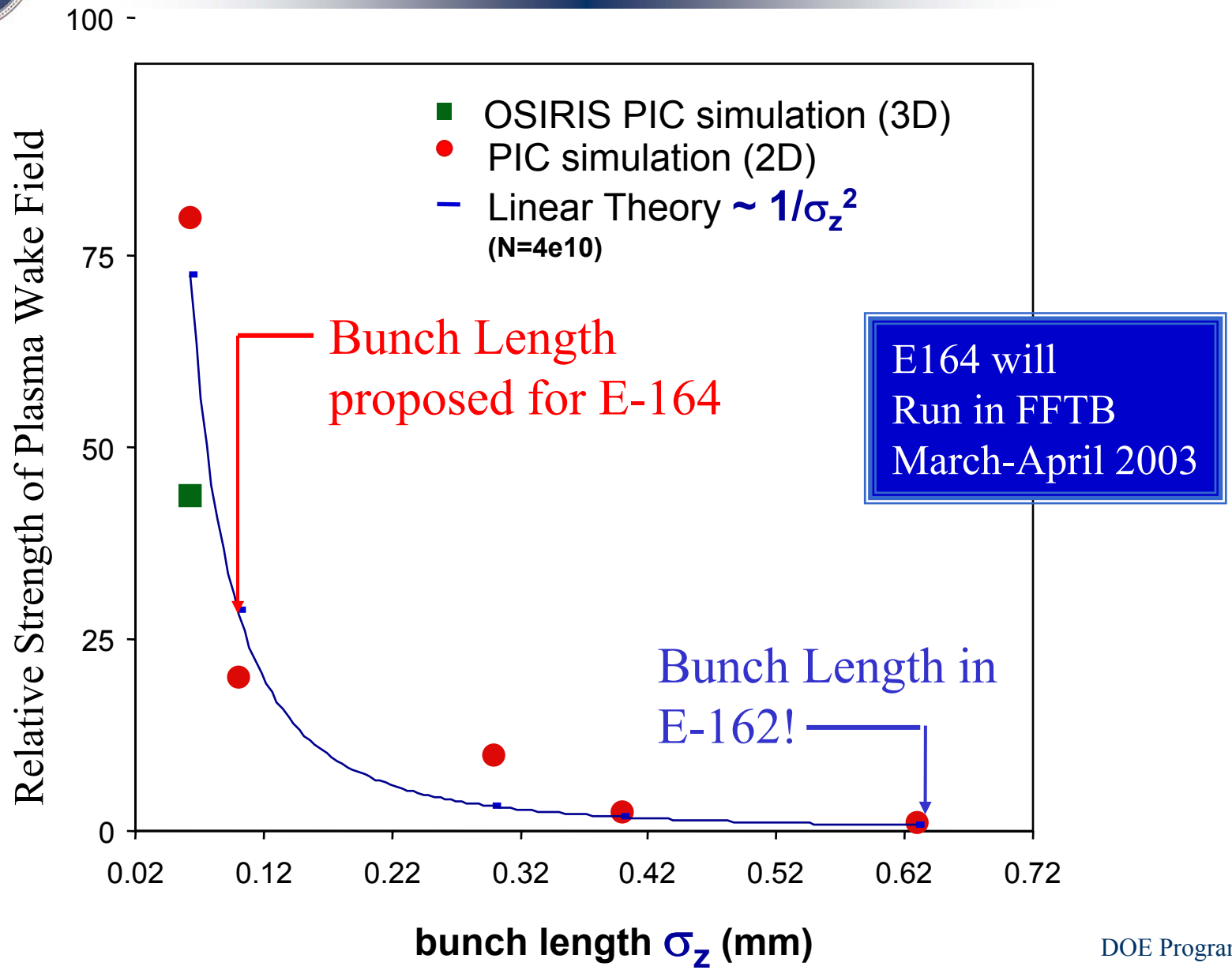
SLAC provides for the HEP research community particle beams that are unique in the world in many respects:

- **120 Hz of ultra-high energy (50 GeV), highly polarized (82%), very intense (6 x 10^{11}/bunch) electrons**
- **60 Hz of ultra-high energy (50 GeV), very intense (4 x 10^{10}/bunch) positrons**
- **Tunable, up to 45 GeV, circularly polarized photon beam (stalled for lack of funding)**
- **Operating one of the two highest performing e^+e^- colliding beam facilities ever built**
- **Capability for ultra-short electron pulse, < 100 *f*secs!**

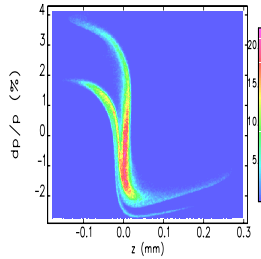
Sub-Picosecond Pulse Source

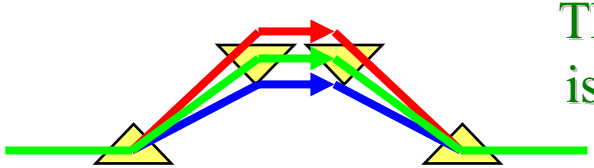


Do plasma wakes scale as $1/\sigma_z^2$?



Sub Picosecond Bunch Delivery





The new Sector 10 Linac Bunch Compressor Chicane is now delivering short pulses for FFTB experimenters

HIGHLIGHTS

- Measurement **of 70 μm (210 femtoseconds) rms bunch length at the end of the linac**
  - **Using the LOLA RF deflecting cavity to *streak* the beam**
- Bunch length optimization
  - **Fast scans of linac RF phase to find optimum for bunch compression**
  - **Observing energy loss due to wakefields as bunch becomes shorter**
- Additional FFTB magnets **commissioned to handle additional energy spread from short bunches**
- E164 Plasma Wakefield Acceleration **commissioning in progress**

SLAC Beam Parameters — Pre and Post SLC

SLAC LINAC FFTB BEAM BEFORE-AFTER SLC+SPPS SPECIFICATIONS J. Seeman, R. Erickson 14-Oct-02

Parameter	Units	Electrons Before SLC	Electrons After SLC	Electrons After SLC+SPPS	Positrons Before SLC	Positrons After SLC
Energy (E)	GeV	30	47	28	20	47
Particles per bunch (N)	x 10**8	10	400	400	0.33	390
Bunch length (sigz)	mm	3	0.5	0.025	4	0.5
Horizontal invariant emittance	m-rad	3.00E-04	4.00E-05	4.00E-05	2.00E-03	5.00E-05
Vertical invariant emittance	m-rad	3.00E-04	6.00E-06	6.00E-06	2.00E-03	3.00E-06
Absolute horizontal emittance at linac end	m-rad	5.11E-09	4.35E-10	7.30E-10	5.11E-08	5.44E-10
Absolute vertical emittance at linac end	m-rad	5.11E-09	6.52E-11	1.10E-10	5.11E-08	3.26E-11
Average x or y beta function at linac end	m	200	35	35	200	35
Average x beam size at full energy (sigx)	microns	1011	123	160	3197	138
Average y beam size at full energy (sig y)	microns	1011	48	62	3197	34
Energy Density=E*N/sigx/sigy/sigz	GeV/μ**2/mm	9.78E+03	6.38E+08	4.53E+09	1.61E+01	7.87E+08
Ratio of energy density after-to-before			65184	462692		48721729

In addition: Polarization was increased from 42% to 80%
Fill rate for PEP ring increased from 7 to 720 mamps/min

SLAC HEP Program

- **Main elements of the SLAC HEP Program**
  - ***B* Factory Colliding Beam Program**
  - **End Station A fixed Target Program**
    - E158 - Möller Scattering. Precision Measurement of $\sin^2\theta_w$ at low q^2
  - **Non Accelerator Physics**
    - USA, X-ray timing satellite exposure – in analysis
    - Gamma Ray Large Area Space Telescope (GLAST) – in construction
    - EX0 – R&D study for expt. to measure ν_e mass
  - **Theory**
  - **Accelerator R&D**
    - Linear Collider
    - Diverse, user-based program of advanced accelerator R&D experiments and theory

The SLAC HEP Program — Focused on the Central Issues of the Field

- Pattern of heavy flavor decays (*B* Factory)
- Electro-Weak Symmetry Breaking — Physics beyond the SM (Linear Collider)
- Precision Electro-Weak (E158)
- Neutrino mass (EXO)
- Dark Matter, Dark Energy, Gamma Ray Bursts, Evolution of Early Universe … (KIPAC, GLAST)
- Advanced Accelerator Techniques (FFTB, ORION)
- New Theoretical Frontiers

PEP-II and BABAR

- Run 2 concluded June 2002 with total integrated luminosity of 100 fb^{-1}
- 4 ½ month down time activities were completed on-time Nov. 15, 2002 at which time we commenced Run 3. Anticipate achieving our goal of total integrated luminosity of 150 fb^{-1} delivered by the end of FY2003
- BABAR is a highly successful collaboration. Continues to produce physics of exceptional quality at prodigious rate — in excess of 40 publications with lots more in the pipeline
- Continuous upgrade planned for *B* Factory with goal of integrating ~600 fb^{-1} by the end of 2006

End Station A — Still in High Demand

- **Doing science that cannot be done anywhere else**
  a) e^-e^- (Möller) scattering experiment (E158). Provides a unique opportunity to test the running of $\sin^2\theta_w$.
  First results were announced last week — remarkable achievement in precision

  b) Longitudinally polarized electrons scattering off a thin diamond target can provide circularly polarized photon beams of energy up to 45 GeV. Series of three experiments requiring moderate funding were approved for FY04-06. Current funding has prevented us from proceeding with this program

- **End Station A provides excellent science for ≈ 100 users who choose to push initiatives outside of the huge HEP collaborations. This diversity is important for the field, and we greatly regret having to forestall these options**

Particle Astrophysics — A New Area of Focus

- Scientific agendas of particle physics and particle astrophysics are highly overlapping
- Scientists at SLAC and its user community have a strong interest in particle astrophysics
  - Participation in USA experiment, now in analysis
  - GLAST, our first major activity as the host of a large international collaboration
  - Daunting challenges to the theory community to understand the physics of our early Universe and the relics that surround us
  - Strong interest from our accelerator theorists in cosmic acceleration mechanisms and phenomena
- Kavli Institute provides an exceptional opportunity for our user community to engage in this exciting frontier

GLAST

- **Important interagency initiative – combines the strengths of DOE and NASA. Provides "test-case" for even larger DOE/NASA involvement in the future**
- **GLAST has great discovery potential**
- **Instrument concept born at SLAC as outgrowth of HEP detector techniques. Construction is proceeding on schedule**
- **SLAC is the host and provides the core management for this 5-nation collaboration. The Laboratory will play a central role in all aspects of data analysis, much as we are now doing for BABAR**

HEP Theory at SLAC

- SLAC has an outstanding HEP theory group. The contributions are broad, encompassing the full gamut from highly formal to phenomenological

  The work of the theory group is enhanced by close cooperation with those in the Stanford Physics Department

  We anticipate additional vitality and enrichment associated with the implementation of the Kavli Institute

Advanced Accelerator R&D

Advanced Accelerator R&D - Developing the tools needed for the second half of this century

- Crucial for the future of accelerator-based science that we support advanced accelerator R&D. Accelerator-based science is by far the dominant activity of the DOE Office of Science
  - Push past the envelope of current methods
  - Advanced Accelerator R&D was accorded very high priority by the recent HEPAP Sub-Panel
- SLAC has a strong user-driven program of advanced accelerator R&D in the broad areas of plasma-based techniques, laser-driven acceleration, two-beam acceleration, high frequency/high gradient acceleration. Takes advantage of the unique beam parameters at SLAC
- The proposed ORION facility would concentrate and support the infrastructure for a more effective user-driven program. A request for incremental funding for ORION is under review by DOE and NSF

Linear Collider Development

- SLAC's push towards realizing a linear collider began in the 1980's with the construction of the SLC
- The success of the SLC — the world's only linear collider — spawned a worldwide linear collider R&D Program
  - This has resulted in the development of two feasible technologies which have achieved sufficient maturity to construct a TeV-scale machine
- All three regions – Europe, Asia and U.S. – have recently affirmed their very strong support for the construction of a 500 GeV electron positron linear collider as a necessary physics companion for the LHC
  - ECFA, ACFA & HEPAP have all endorsed the LC as an urgent need. All regions strongly urge that the project be fully international from the outset

Linear Collider

- SLAC and KEK, working very closely together, have carried the major burden of the X band (warm technology) development
  - Carried out as a truly international collaboration
- Full NLC Collaboration also includes FNAL, LBNL, LLNL, Canadian, British and Russian participants
- Resources are limited, but we at SLAC are beginning to work with the user community to build up the SLAC funds directed to LC detector R&D

Linear Collider — The NLC Collaboration

- **Progress on NLC R&D remains very impressive, albeit that it has been hampered by capped-funding**
- **The NLC and JLC collaborations have jointly endorsed a more conservative approach to delivering power to the X-band main linacs**

  The two designs are now fully overlapping — demonstration of this SLED-II based system is now a full collaboration of SLAC and KEK
- **The X-band technology remains the LC technology with the greatest energy reach**

Linear Collider — A Worldwide Priority

- **SLAC continues to play a central leadership role in the broad issues associated with realizing a fully international LC**
  - **Jonathan serves on the International LC Steering Committee**
  - **Jonathan (Chair) and Dave Burke serve on the US LC Steering Group. Many SLAC physicists serve in the USLSG sub-committees**
  - **Greg Loew has done an incredible job of chairing ICFA's Technical Review Committee, whose report is now available. The worldwide community owes Greg an enormous debt of gratitude. Many other SLAC physicists served on the TRC**
- **SLAC will be a major participant in the design, construction and operation of the machine and the detector wherever the linear collider is built. We will also be fully involved in exploiting the exciting science at the linear collider**


U.S. Steering Group
Asian Steering Group
European Steering Group
Govt. Agencies
Govt. Agencies
Govt. Agencies
International Steering / Oversight Group
Steers towards
International Organization / Laboratory Charged with Constructing LC
Global Goal ? 2005

Advanced Scientific Computing

- SLAC has historically played a leadership role in HEP computing
  - SLAC was the 1st web-site in the US
- We are currently providing cutting edge innovation and capabilities in two areas:

1) "Data Driven Computing"
   - Large scale data management
   - Driven by demands of BaBar
   - Developing data management and GRID technology that will be needed for LHC
2) "Application Specific Computing"
   - Next generation accelerator modeling tools
   - Large scale numerical simulations
   - Positioned to support other applications
     - Particle astrophysics
     - Bio-molecular simulations
     - ….

HEP Scientific Productivity at SLAC is High

- **Laboratory has been highly productive in the past 3 years:**
  - ***B* Factory successfully launched. Performance continues to be upgraded**
  - **Created a new area of focus for our users – particle astrophysics**
  - **Vibrant and highly relevant theory program**
  - **Much expanded user-based advanced accelerator program**
  - **Great progress on LC physics and accelerator R&D. Laboratory scientists continue to play a major role in developing an international LC**
  - **Laboratory is playing a leadership role internationally in both high throughput computing (BABAR handles ≈ 500 terabytes/year) and specialized application driven computing**
- **Maintaining this high level of productivity and taking advantage of the exciting opportunities for scientific growth are at odds with the recent and anticipated levels of funding**

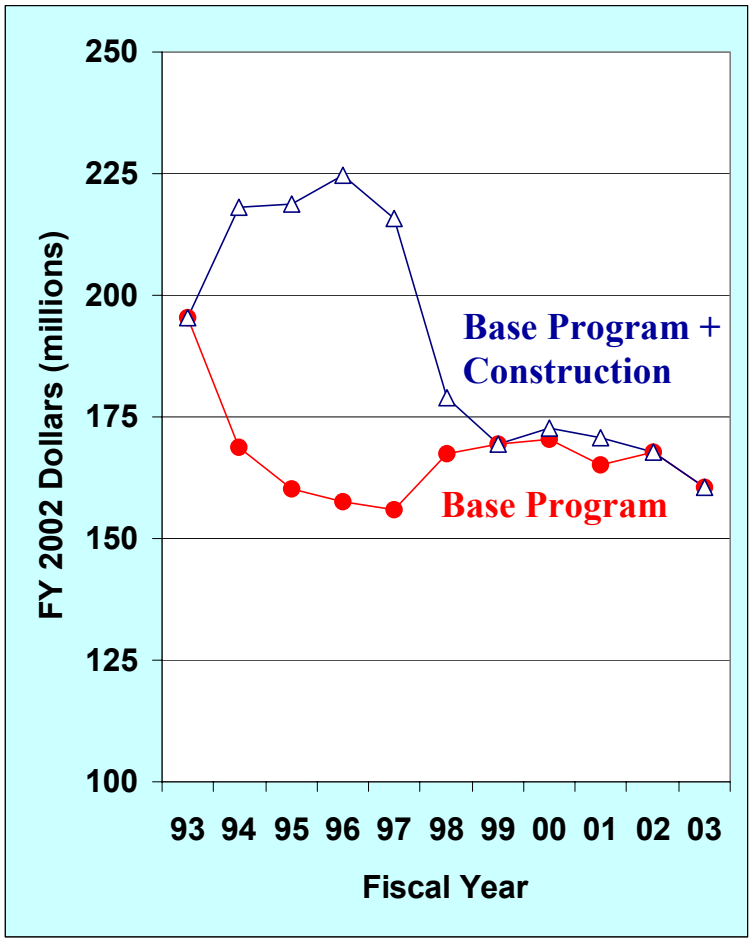
Major Concern — Level of U.S. HEP Funding

- **Laboratory is most appreciative of the high priority that we have received within the HEP program in the FY02, FY03 and FY04 budgets**

  However, given the extreme tightness of HEP total funding, the laboratory has had to accommodate to below inflation corrected budgets. This has caused major stress for the Laboratory

  - **We have been unable to sustain staffing levels commensurate with the workload. Our staff are stressed and spread very thin. This is affecting all the highest priority programs. We are having to share too many key people across multiple programs**
  - **Power costs have doubled since FY2002. Incremental costs for upgrading the *B* Factory facility are modest, but are nonetheless ~ $4M/year. Both these costs have had to be found within the flat-flat budgets**

SLAC HEP Funding
(FY2003 Dollars)



* For comparability over the years, the following two adjustments have been made:

1) Waste Management ($~2.7M per year) has been excluded in FY98 – FY03
2) Security ($~1.4M per year), directly funded from SC has been added in FY01 – FY03

FY	93	94	95	96	97	98	99	00	01	02	03
Base Prog. + Construction *	195.3	168.7	160.2	157.7	155.9	167.5	169.5	170.4	165.1	167.6	160.5
Base Program *	195.3	218.1	218.6	224.6	215.9	178.8	169.5	172.7	170.6	167.6	160.5

SLAC Electrical Power Costs
(Dollars in thousands)

	FY1999	FY2000	FY2001	FY2002	Est FY2003
Site Power	610	574	670	865	975
HEP Power	5,023	5,090	5,993	7,872	9,568
Total Power	**5,633**	**5,664**	**6,663**	**8,737**	**10,543**

FY03 – A Particularly Challenging Budget Year

- SLAC budget for FY2003 is $3.0M less in dollars than our FY2002 budget
- Dealing with this challenge has required a plan that
  - Makes cutbacks in all the program elements
  - Relies in addition on staff-related cost saving measures

HEP Program Cuts for FY03

- ***B*** **Factory running reduced from proposed 39 weeks to 34 weeks. In addition we are forced to reduce the spending on the *B* Factory machine upgrade by $3.5M**
- **Running time for E158 has been significantly cut back**
- **Construction of the photon beamline and experimental apparatus for the next 3 approved ESA experiments is completely halted. This almost certainly portends the cancellation of these experiments**
- **Funding for the NLC R&D is below expectations**
- **Funding for EXO R&D is significantly reduced**
- **All the M&S budgets supported by HEP have been squeezed very hard**
- **Routine upgrading of desk-top computers will be deferred for a year**

Staff-related Measures for FY03

- **Three staff-related measures have been implemented:**

1) Voluntary layoff program

This program is available to all staff. Forty employees took advantage of this program — many of them play key roles in the *B* Factory program

2) All HEP-funded staff will take vacation during FY03 equal to at least the vacation earned during FY03

3) All HEP-funded staff will take <u>leave without pay</u> this June 30, July 1, 2 and 3.

- **This represents a 1.5% reduction in take-home pay for the year**

Slac High Energy Physics Program
(Then Year Dollars in Millions)

	Actual FY02	Budget FY03
OPERATING	141.2	141.8
EQUIPMENT	15.6	14.0
AIP	7.1	3.0
GPP	4.2	4.2
Total SLAC HEP Budget	168.1	163.0
Funding	163.5	160.5
Carryforward	4.6	2.5
Total Funding	168.1	163.0

SLAC High Energy Physics Program
(Then Year Dollars in Millions)

		Actual FY02	Budget FY03
Labwide Base		3.0	3.9
ES&H		8.3	9.7
Waste Management	[1]	2.0	
GPP & Infrastructure	[1]	5.2	5.2
Tech Div Base	[2]	18.9	17.3
Research Div Base	[3]	18.2	19.5
B FACTORY		62.8	59.2
Machine		38.5	39.5
Detector		13.7	12.8
Detector Upgrade	[1]	0.6	0.2
Computing Hardware	[1]	3.0	3.7
AIP	[1]	7.0	3.0
NLC R&D	[1]	16.2	16.2
End Station A		5.2	3.8
Operations		5.1	3.8
AIP	[1]	0.1	
Particle Astrophysics		11.3	11.8
GLAST/LAT Instrument	[1]	8.1	8.8
GLAST Ops		2.3	2.1
Other		0.9	0.9
INDIRECTS not Included Above	[4]	17.0	16.4
Total SLAC HEP Budget/Request		168.1	163.0
Funding		163.5	160.5
Carryforward		4.6	2.5
Total Funding		168.1	163.0

1) Budget shown is the total HEP budget with indirect allocation

2) The Technical Division Base covers the operation and maintenance of the Injector Systems, the Damping Rings, the Positron Source, and the Linac; parasitic test beam to FFTB and ESA; accelerator experiments (Plasma Lens and Plasma Accelerator); beam tests for equipment associated with accelerator R&D; general accelerator physics and computation; and advanced accelerator R&D

3) The Research Division Base includes physics R&D (incl. BaBar) the theoretical physics group, Linear Collider physics studies, EXO, polarized photo-cathode source development, support of experimental facilities, general scientific computing support, Library (HEP journals and catalogue of HEP papers), user support, support of graduate students and post-docs, and the SLAC Summer Institute seminars and colloquia

4) Lab-wide Indirects: procurement, Common Site Support (site power and utilities, buildings and grounds, telecommunications and network operations, technical information services, etc.), and General and Administrative (human resources, budget and accounting, business information systems, legal, technology transfer, SU Indirects, etc.)

FY04 Will Continue to Challenge Us

- **We reiterate that we have been very favorably treated within the DOE FY04 budget, for which we are most thankful.**

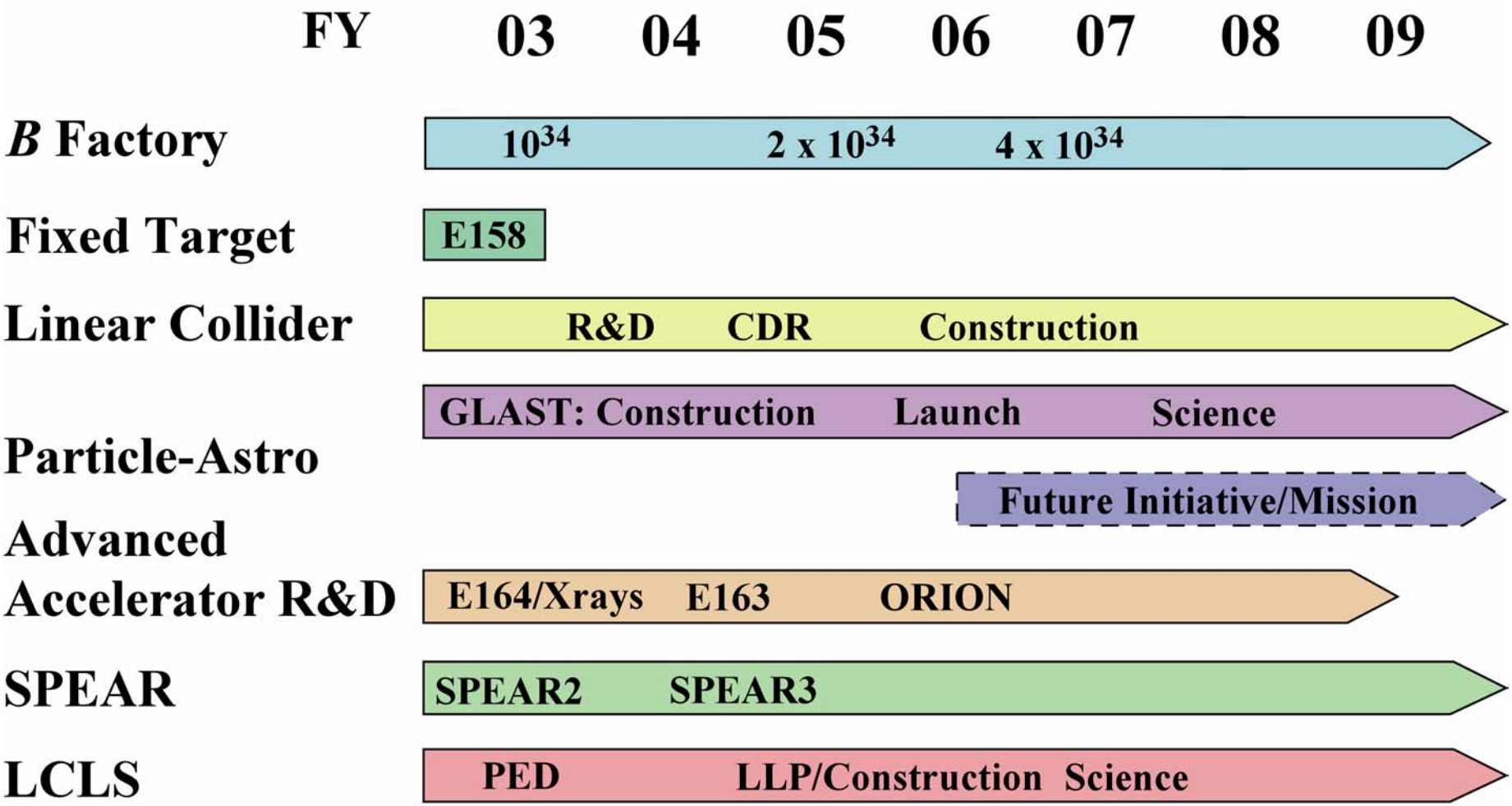
  We are hopeful that Congress will find a way to increase the FY04 Office of Science budget substantially, including for HEP

- **Nonetheless FY04 presents us with challenges:**
  - **Staff measures**
    - Need to preserve staff
    - Need to restore leave without pay ($2M)
    - Stanford benefits rate will go up ~ 3% ($4M)
  - **Committed to staying competitive in *B* Factory — requires that we find the resources to get back on the aggressive machine upgrade schedule**

ES&H Program

- The Laboratory has an extensive ES&H program, operating under the Integrated Safety Management System
- Safety is a line responsibility – nonetheless there are considerable resources available to the line managers within each of the Laboratory Divisions as well as highly specialized professionals within the ES&H Division
- Laboratory has received an "Outstanding" classification for ES&H from DOE 3 of the past 4 years

Future SLAC Program



Conclusions

- Scientific productivity has been very high in the past few years
- Scientific opportunities abound at SLAC
- Maintaining the competitiveness and full utilization of our HEP facilities is increasingly at odds with the funding level
- We continue to manage the fiscal tightness aggressively, but we are struggling now to avoid damage to our premier HEP programs like the *B* Factory

Conclusions
(continued)

- We recognize that these are very challenging fiscal times — and we greatly appreciate the high priority that the SLAC program has received within the HEP budget. We continue to work aggressively with the leaders in both the HEP Community and the DOE Office of Science Community at large to secure increased funding for the Office of Science

- We continue to be enormously motivated by our scientific agenda and we believe that SLAC remains a national asset worthy of increased investment