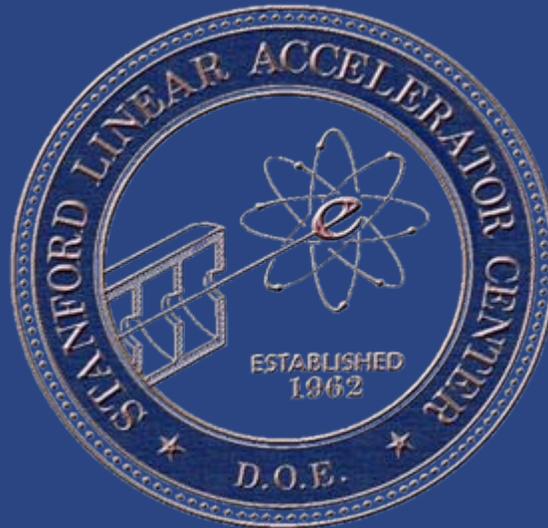


# SLAC Plans



**Jonathan Dorfan, Director**

**P5 Meeting, SLAC**

April 20, 2005

**SLAC**



Particle & Particle Astrophysics

# Outline of Talk

**My talk will address the two main topics of this P5 meeting  
as they pertain to SLAC, namely the  
B Factory Program and the National Roadmap**

## Outline

- 1. Context: Overview of the Laboratory**
- 2. B Factory Program**
- 3. SLAC and The Roadmap**



# SLAC Mission

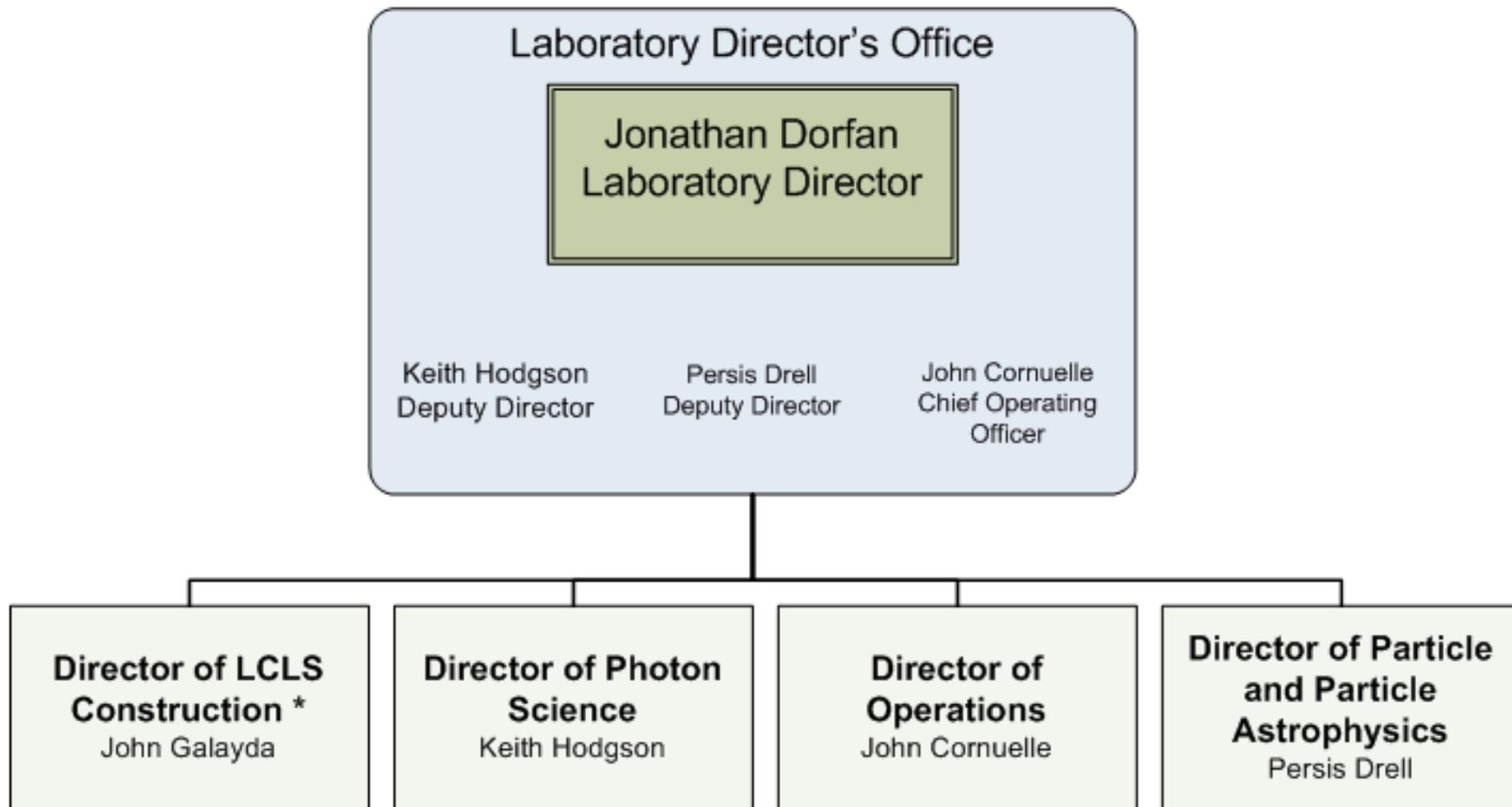
- **Photon Science Discoveries**
  - To make discoveries in photon science at the frontiers of the ultrasmall and ultrafast in a wide spectrum of physical and life sciences
- **Particle and Astroparticle Physics Discoveries**
  - To make discoveries in particle and astroparticle physics to redefine humanity's understanding of what the universe is made of and the forces control it
- **Operate Safely; Train the Best**
  - To operate a safe laboratory that employs and trains the best and brightest, helping to ensure the future economic strength and security of the nation



Particle & Particle Astrophysics

# Stanford Linear Accelerator Center

## Directorate Level Organization



\* Reports directly to the Laboratory Director



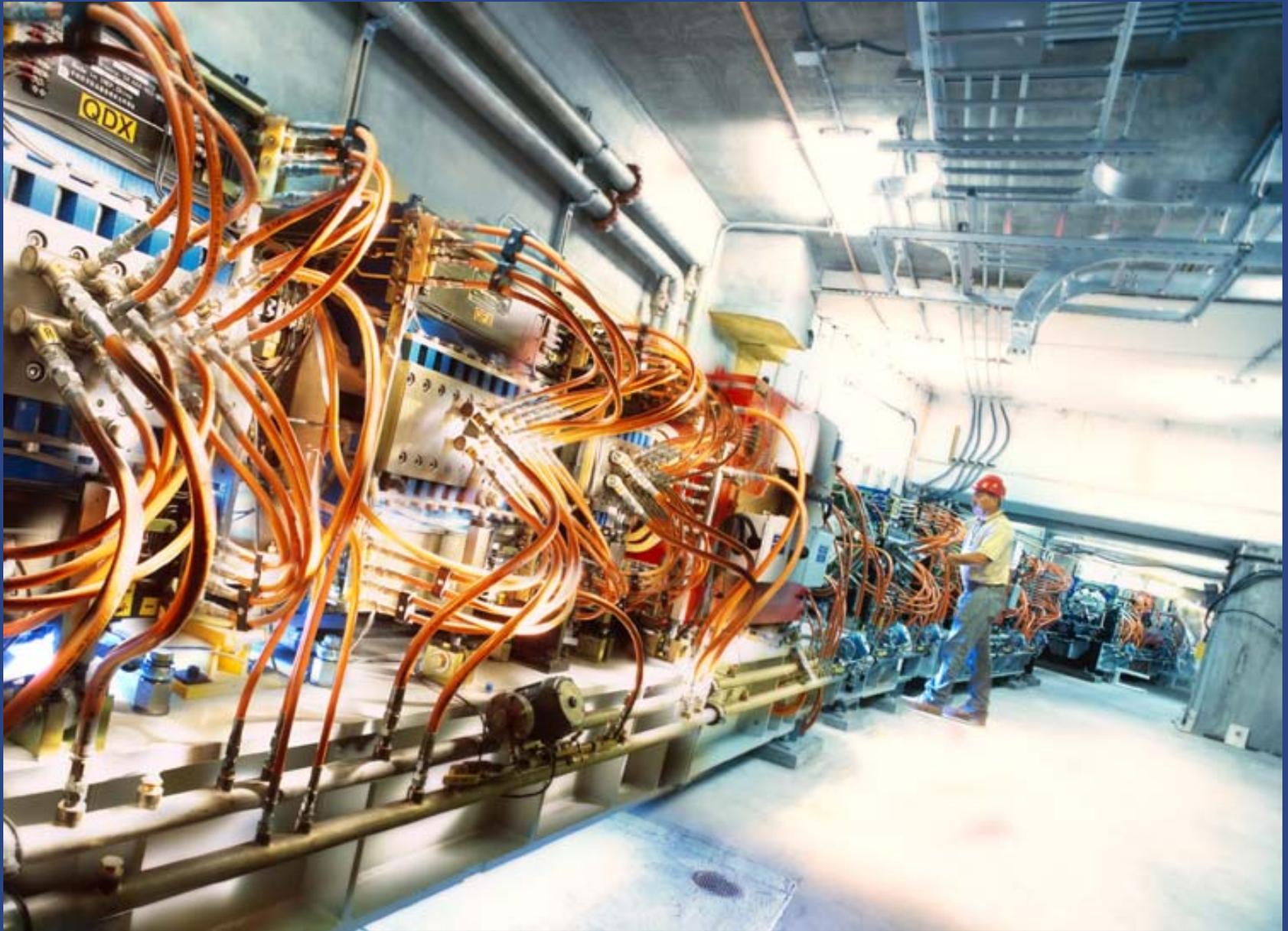
# Photon Science Program

**The use of ultra high-intensity x-ray beams for studies in physics, biology, chemistry, medicine, and environmental sciences**

**The recently upgraded SPEAR conventional synchrotron light source and the turn-on of Linac Coherent Light Source in 2009 provide a suite of instruments ideally suited for breakthrough science in the realm of the ultra-small and the ultra-fast**



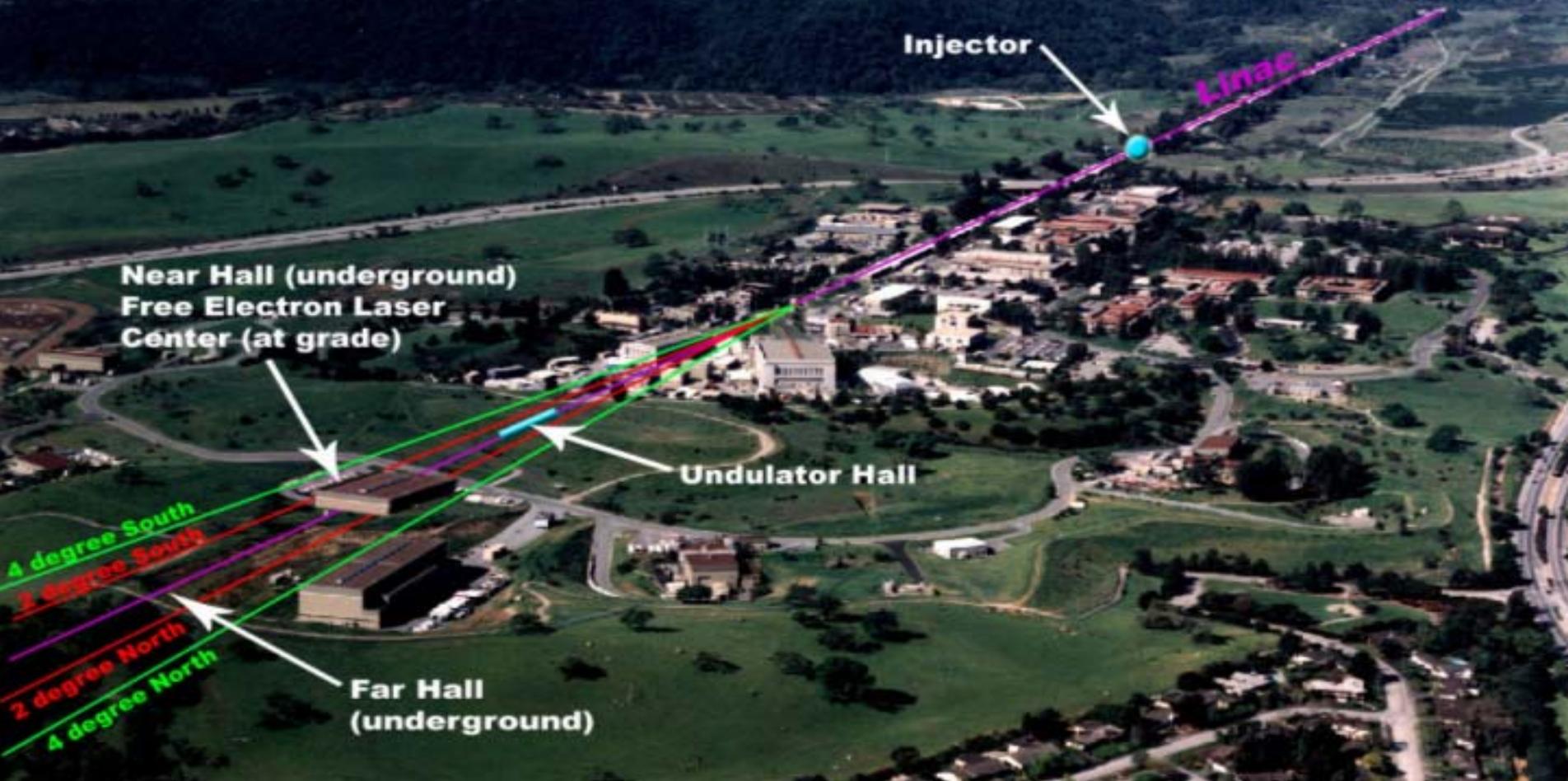
# *SPEAR3* – A brand New 3<sup>rd</sup> Generation Machine



# Linac Coherent Light Source

Turn-on in 2009: LCLS will be the World's First X-ray Laser

The Next Revolution in X-Ray Science



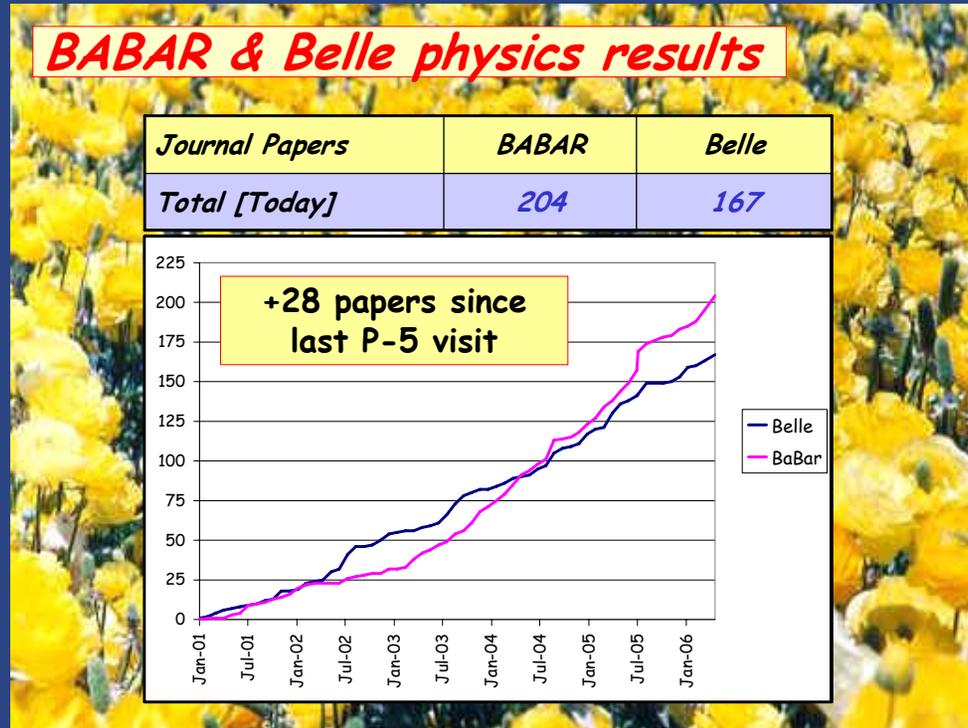
# B Factory Program: PEP-II and BABAR

- **The physics program at the SLAC B Factory remains absolutely compelling**
  - ↪ **The scientific program at  $1000 \text{ fb}^{-1}$  has enormous discovery potential and provides access to leading questions in heavy quark and heavy lepton physics that are uniquely achievable at an  $e^+e^-$  asymmetric B Factory**
- **Accordingly, the Laboratory's commitment to the B Factory Program has Never Been Stronger. We are fully committed to running PEP-II/BABAR through the end of FY2008, maximizing the integrated luminosity at every turn**
  - ↪ **Be assured, if we thought the physics program was no longer compelling or if we thought we were unable to perform at the level needed to deliver  $1000 \text{ fb}^{-1}$ , we ourselves would take steps to shut down operations**



# Great Physics Continues to Pour Forth

- SLAC B Factory continues to be a physics fountain
  - ↪ Babar maintains its furious pace of one, high-quality journal publication per week. In the short period since you were here last, they have produced 28 papers, including several “first-ever” measurements
  - ↪ By any metric, Babar’s productivity is outstanding; but it is especially impressive as measured by physics/fb<sup>-1</sup>



# Machine Upgrade Plans On Schedule

- Machine upgrade plans remain on schedule. Hardware will be installed this Summer that enable the as-promised peak luminosity of  $2 \times 10^{34} \text{ cm}^{-2} \text{ sec}^{-1}$
- PEP-II Machine Advisory Committee met January 18-20, 2006. They reviewed in great depth the upgrade plans for PEP-II and stated:

“With the announcement of a termination of the PEP-II HEP program no later than the end of FY2008, the PEP-II staff has reexamined major luminosity improvement projects and realigned priorities and plans appropriately. The staff has presented to this committee a sound plan to optimize productivity of the machine during this period, with a doubling of the luminosity to  $2 \times 10^{34} \text{ cm}^{-2} \text{ sec}^{-1}$ , reaching a total integrated luminosity of  $1000 \text{ fb}^{-1}$ ”
- Machine performance in the past three months was limited by an extremely subtle and difficult-to-isolate problem. You could find no better testament to the Laboratory staff’s complete dedication to the success of PEP-II than the ingenuity and agility that went into the diagnosis and repair of this problem, which is fixed



# We Seek P5's Strong Endorsement for Operations Through FY2008

- The 11-nation BABAR collaboration and their funding agencies share SLAC's strong commitment to operating the program through the end of FY2008 to be followed by at least 5 years of intensive data analysis
- FY2008 is very close at hand. P5's encouragement and support for operating this exceptional physics program through FY2008 is needed. Without your backing, maintaining the international support will be problematic, maintaining the high level of morale will become difficult and planning the Lab's program and resource utilization is challenging. But most of all, we put at risk achieving the full scientific potential of this great facility



1. Are there undiscovered principles of nature:  
New symmetries, new physical laws?
2. How can we solve the mystery of dark energy?
3. Are there extra dimensions of space?
4. Do all the forces become one?
5. Why are there so many kinds of particles?
6. What is dark matter?  
How can we make it in the laboratory?
7. What are neutrinos telling us?
8. How did the universe come to be?
9. What happened to the antimatter?

From "Quantum Universe"

**Evolved Thinker**



*We Live in Extraordinary times:*

- Major elements of the SM remain untested
- 95% of the Universe is Dark and mysterious

What connects the Luminous World to the Dark World??

# SLAC Program Is Focused on the Big Questions

1. Are there undiscovered principles of nature:  
New symmetries, new physical laws? (ILC, B Factory, LHC)
2. How can we solve the mystery of dark energy? (LSST, SNAP)
3. Are there extra dimensions of space? (ILC, LHC)
4. Do all the forces become one? (ILC, EXO, LHC)
5. Why are there so many kinds of particles? (B Factory)
6. What is dark matter?  
How can we make it in the laboratory? (ILC, GLAST, LSST, SNAP, LHC)
7. What are neutrinos telling us? (EXO)
8. How did the universe come to be? ( ILC, LHC, LSST, GLAST,SNAP)
9. What happened to the antimatter? (B Factory)

Broad-based attack on the leading questions  
in the field of particle physics



# The Program – Exploring the Energy Frontier Is Critical

- **The choices we have made for SLAC's future program are based solely on the physics imperatives. Thus our priorities are:**

## **1. The physics of the Energy Frontier**

- ↪ **We and our user community have been unwavering in our belief that the next major HEP facility must be the ILC. We recognize the risks associated with that choice, but feel that without such a physics tool as an adjunct to the LHC, one cannot expect to unravel the multitude of leading questions that confront us**
- ↪ **We have made application to join the Atlas experiment. The plan is that SLAC will be a Tier II site and an intellectual hub for the West-coast Atlas community**
- ↪ **We are participating in US LHC machine upgrade program, LARP**
- ↪ **We support a very strong advanced accelerator experimental and theoretical program, aimed at delivering new technologies that will take us to energies much above the ILC, LHC**



# Advanced Accelerator R&D

- **Developing the tools needed to explore the energy and luminosity frontier post LHC, ILC**
- **Crucial for the future of accelerator-based science that we support advanced accelerator R&D**
  - ↳ **Push past the envelope of current methods**
- **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 — there is nowhere else in the world that these experiments can be done**



# Cosmic Scale Experiments Are Essential Too

**2. As critical as the energy frontier is, complementary probes using non-accelerator based techniques will be needed to address the full suite of frontline questions. These involve using the cosmos as the laboratory. We believe that the two most essential unbuilt expts in this arena are SNAP and LSST. They are complimentary and BOTH are needed**

- ↪ **LBNL is the clear and highly competent leader of SNAP and we have an important, well defined support role**
- ↪ **SLAC is the leader of the DOE-based effort in the LSST R&D. LSST is by far the best-matched instrument for making the ground-based weak lensing measurements. The design is mature and there remain no major technical show stoppers. NSF-AST R&D funding is in place, and a path to obtain construction funding has been identified. Substantial private commitments are also in hand. What is needed now to make LSST a near-term reality is a commitment for \$100M to support the camera. It is hoped that P5 will see the extraordinary value of DOE stepping into this breach**



# Kavli Institute for Particle Astrophysics and Cosmology



**Founded 2003**

**Director: Roger Blandford**

**Deputy Director: Steve Kahn**

**~120 members**

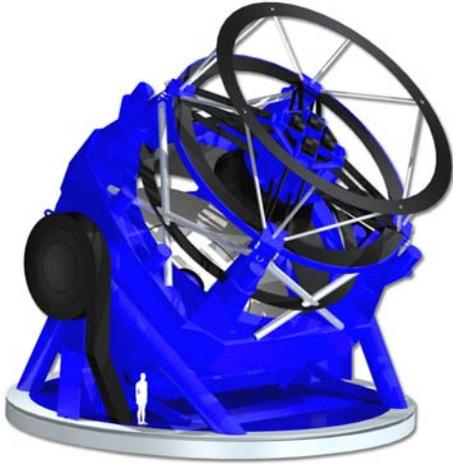
**Two new buildings, labs**

**Instrumentation, data analysis,  
particle astrophysics, relativity,  
computational astrophysics,  
observational cosmology,  
theoretical cosmology...**

**KIPAC is a major commitment by Stanford**

# KIPAC Projects

**LSST**  
First Light ~ 2013



**Dark Energy and Matter**

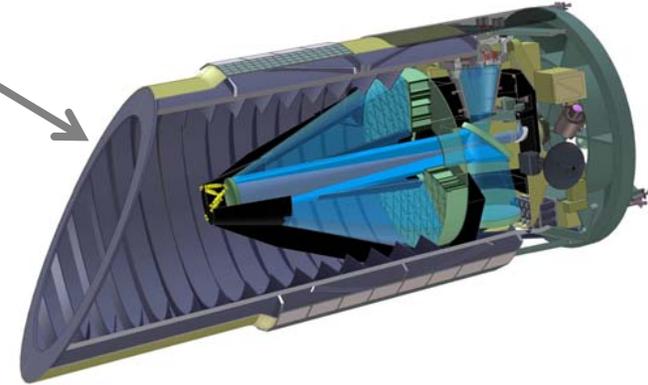


All Sky

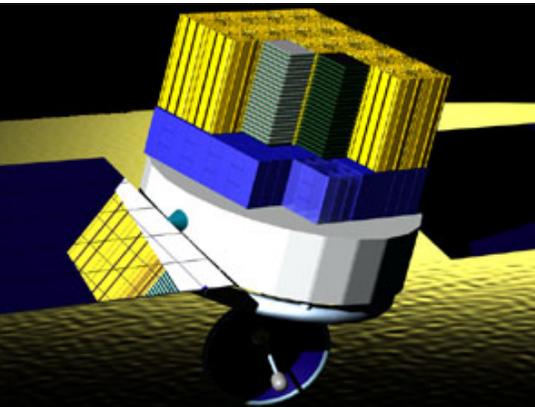


High  
Resolution

**SNAP**  
Launch ~ 2014



**GLAST**  
Launch 2007



The Real Thing!



All Sky

**Cosmic Accelerators  
and Black Holes**



# The Neutrino Sector

3. Two of the most pressing questions in neutrino physics are (a) what are the masses of the neutrinos and (b) are neutrinos their own anti-particles?

Observation of neutrinoless double-beta decay will settle (b) and allow one to extract the electron neutrino mass

Physicists at SLAC and the Stanford Physics Department are leading the development of a novel coincidence experiment, EXO, using Xenon as the parent nucleus.

The first phase – a 200kg prototype device to test the energy resolution of the proposed system (and capable of seeing neutrino double beta decay in a two year run) -- is in final construction and will move to the WIPP underground facility at the end of this calendar year

The next step will be a proposal for a several-ton device capable of reaching the 10 milli-electron volt mass range



# SLAC: The Core of the ILC

- **With its vast experience with linear colliders (SLC, NLC, ILC), it's extensive infrastructure and it's highly skilled staff, SLAC plays a critical role in all aspects of the International Linear Collider effort**
  - ↪ **No other laboratory contributes more to the ILC effort**
  - ↪ **Maintaining SLAC's pivotal role is essential to the ongoing success of the ILC.**
    - **Our concern: with the genuine need to expand the R&D effort nationally, insufficient funding will be available at SLAC to continue this critical role**
  - ↪ **SLAC remains an unswerving supporter of the global design approach (GDE)**
  - ↪ **SLAC maintains its position that it will be a major partner in ILC independent of its location -- it's the physics that we want to ensure**
- **SLAC staff are broadly involved in all elements of the GDE including the RDR process**



Particle & Particle Astrophysics

# SLAC and the GDE

## R&D Board Members

Chris Damerell  
Eckhard Elsen  
Terry Garvey  
Hitoshi Hayano  
Toshiyasu Higo  
Tom Himel (slac)  
Lutz Lilje  
Hasan Padamsee  
Marc Ross (slac)  
Andy Wolski  
Bill Willis, chairman

## CCB Members

C. Pagani  
G. Blair  
D. Schulte  
T. Markiewicz (slac)  
S. Mishra  
W. Funk  
K. Kubo  
M. Kuriki  
N. Toge



# SLAC and the GDE

## Design and Cost Board Members

Peter H. Garbincius

Wilhelm Bialowons

Jean-Pierre Delahaye

Atsushi Enomoto

Robert Kephart

Ewan Paterson (slac)

Nan Phinney (slac)

Tetsuo Shidara

Nobuhiro Terunuma



# RDR Matrix

- Matrix of Area Systems and Technical Systems to develop cost estimate  
(SLAC members in red)

	e- source	e+ source	Damping Rings	RTML	Main Linac	BDS
		Kiriki	Gao	ES Kim	Hayano	Yamamoto
			Guiducci		Lilje	Angal-Kalinin
	<b>Brachmann</b>	<b>Sheppard</b>	Wolski	<b>Tenenbaum</b>	<b>Adolphsen</b>	<b>Seryi</b>
	Logachev				Solyak	
<b>Technical Systems</b>						
Vacuum systems	Suetsugu	Michelato	Noonan			
Magnet systems	Sugahara		Thomkins			
Cryomodule	Ohuchi	Pagani	Carter			
Cavity Package	Saito	Proch	Mammosser			
RF Power	Fukuda		<b>Larsen</b>			
Instrumentation	Urakawa	Burrows	<b>Ross</b>			
Dumps and Collimators	Ban					
Accelerator Physics	Kubo	Schulte				
<b>Global Systems</b>						
Commissioning, Operations & Reliability	Teranuma	Elsen	<b>Himel</b>			
Control System	Michizono	Simrock	Carwardine			
Cryogenics	Hosoyama	Tavian	Peterson			
CF&S	Enomoto	Baldy	Kuchler			
Installation	Shidara	Bialwons	<b>Asiri</b>			



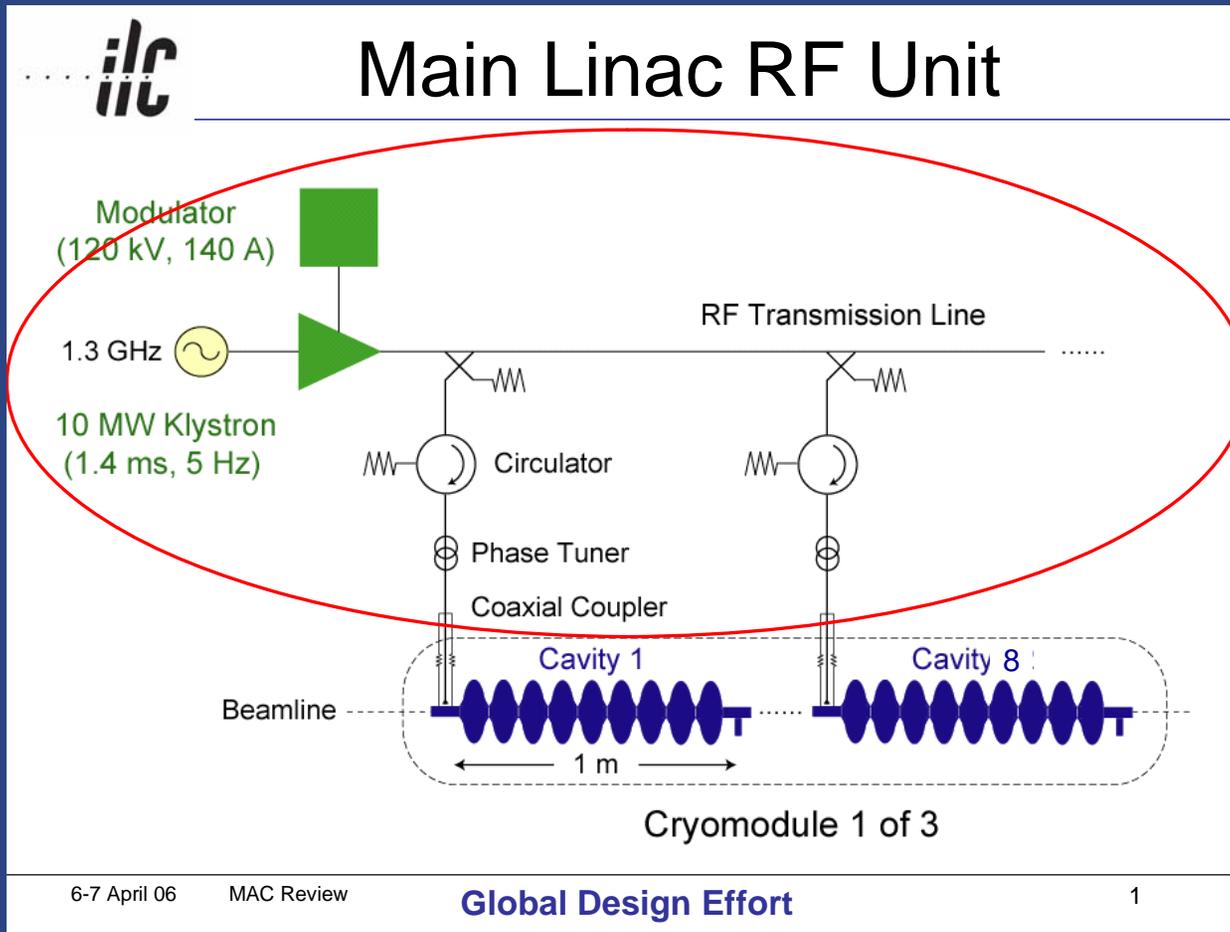
# ILC @ SLAC

- **Large and broad effort: 60 FTEs made up of about 80 people**
- **Four areas of major focus**
  - ↖ **Rf power sources (modulators, klystrons, rf distribution)**
  - ↖ **Particle sources (Polarized electron source and Positron source)**
  - ↖ **Beam delivery system and Machine-Detector Interface**
  - ↖ **Operational issues (highly available hardware, beam instrumentation, beam tuning techniques, and Machine Protection System)**
- **RF source work builds on core SLAC strength**
- **Particle sources and Beam Delivery System utilize experience from the SLC and R&D for the X-band linear collider**
  - ↖ **SLAC has led these efforts for the linear collider over the last decade**
- **Operational issues builds on knowledge from the SLC**
  - ↖ **Very experienced group from both SLC and the X-band R&D program**
- **Also significant amount of work ongoing on the civil eng. issues**



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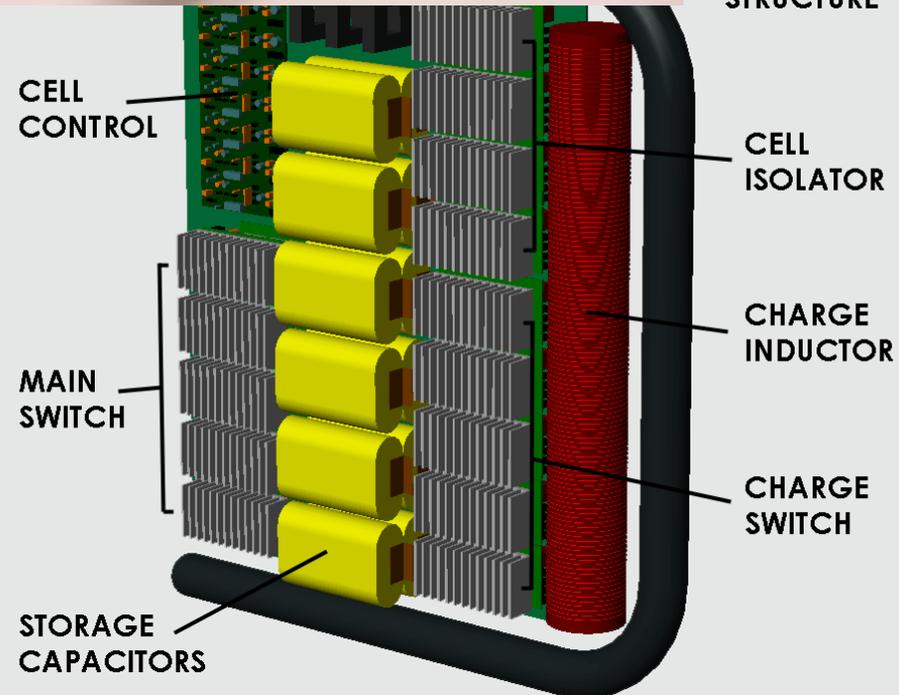
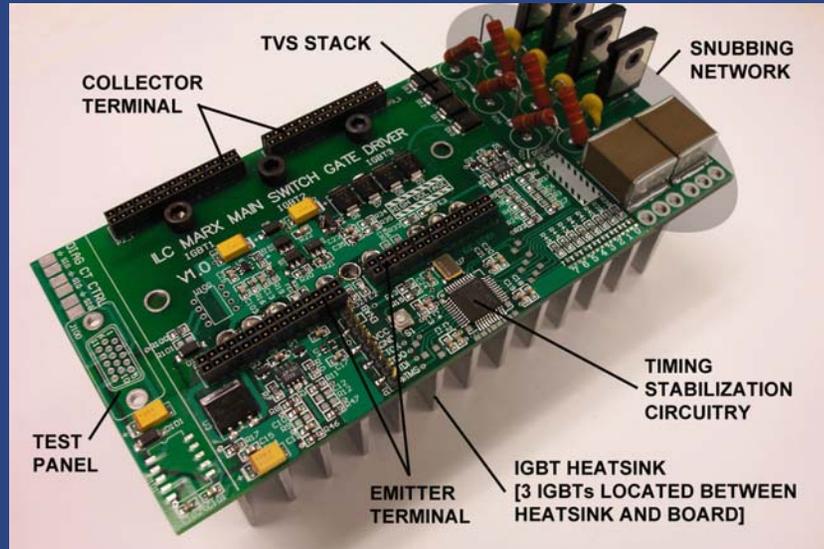
# One Example: The Main Linac RF System



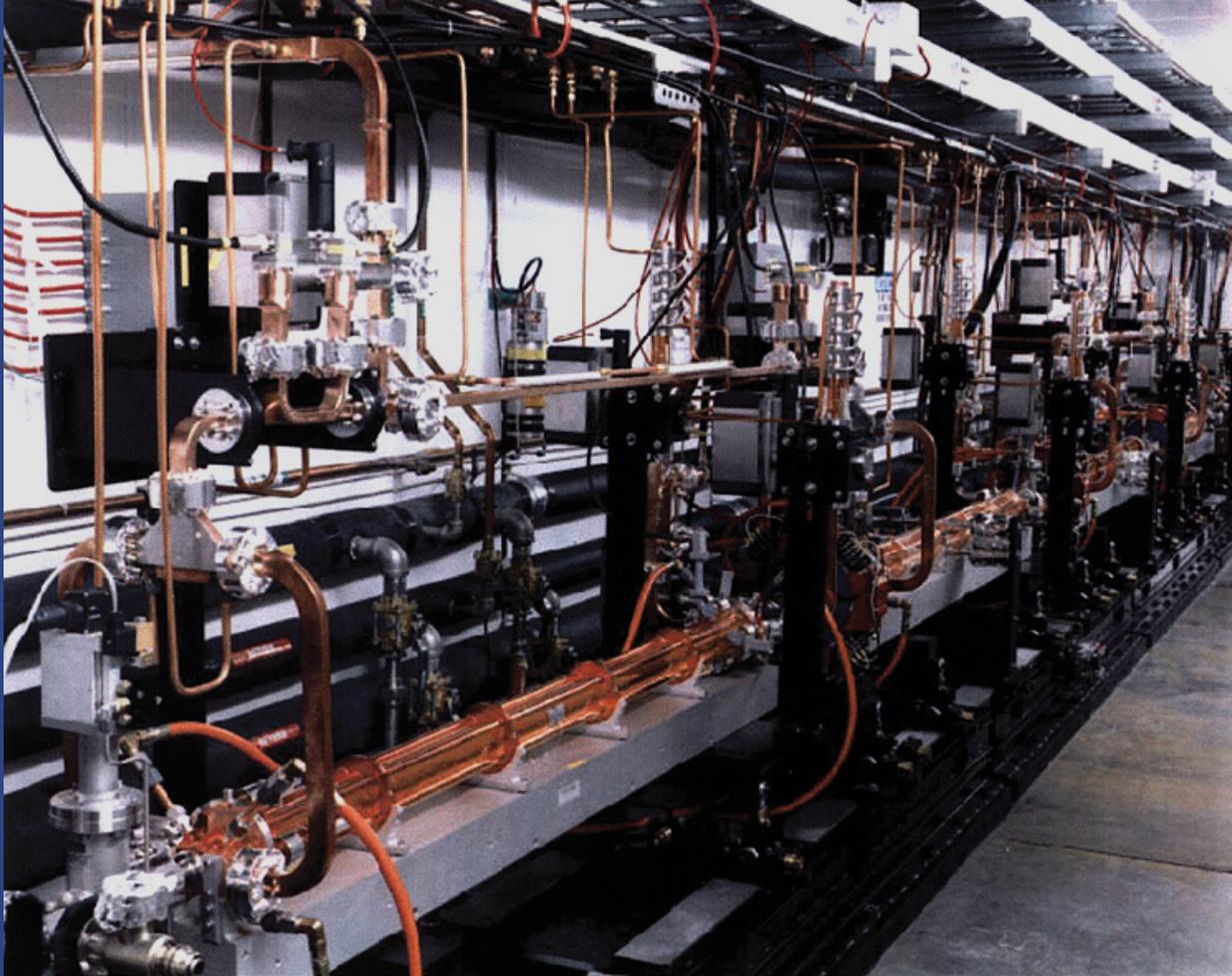
SLAC has the experience, the staff, and the infrastructure to provide a demonstration system from wall plug to the cold junction.

# SLAC Marx Generator Modulator

- Stack of 12 kV units
- Pros
  - ↪ Uses emerging technology
  - ↪ Modular design for longer MTBF and shorter MTTR
  - ↪ No oil; compact unit
  - ↪ No magnetic core
  - ↪ Finer waveform control



# Infrastructure: LC Test Accelerator at SLAC



**Fully operational  
accelerator for  
testing Linear  
Collider components  
and concepts**

**Currently doing  
intensive tests for  
ILC and  
high -gradient  
acceleration as well  
as laser acceleration  
advanced R&D**

**SLAC**



Particle & Particle Astrophysics

P5 Meeting  
4/20/06

# Unique Beams: Experiment at SLAC Demonstrates Positron Polarization

- E166 is an internationally based experiment that sought to demonstrate positron polarization. The experiment ran at the FFTB at SLAC. A helical undulator was used to produce the polarized positrons from a high energy electron beam

## Results:

- The Undulator produced photons at the expected intensity and showed predicted quadratic dependence on magnet current. Undulator is well understood
- Photon polarization was demonstrated and the observed asymmetry agreed well with that expected from the predicted undulator spectrum
- Polarized Positrons were produced, converted into photons and transmission asymmetry measured
- E166 has provided successful demonstration of feasibility of polarized positron production at ILC



# Summary

- **B Factory**: P5's encouragement and support for operating the SLAC B Factory program through FY2008 is needed. For-shortening this program precludes realizing the full scientific potential of this great facility and puts at risk major discoveries in the area of heavy quark and lepton physics
- **Roadmap**: The SLAC future program is driven by scientific opportunity, namely pursuing the big questions with a broad-based approach.
  - ↪ We are fully committed to the ILC
    - The energy frontier defines the future of our field
  - ↪ LSST and SNAP offer transformational opportunities for the field
    - We strongly encourage growth in the area of particle astrophysics



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