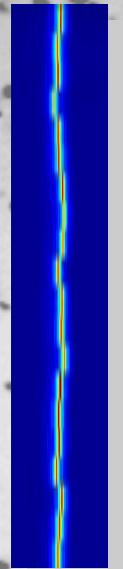
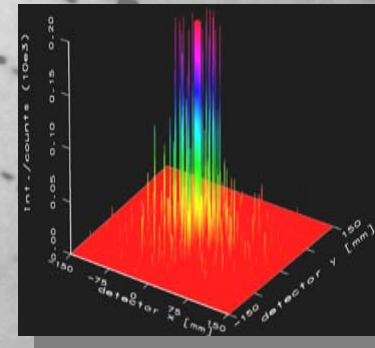
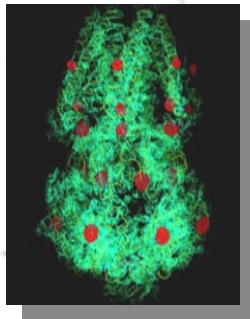
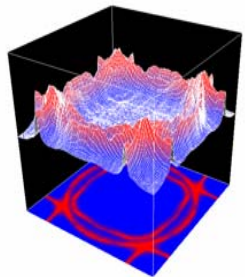


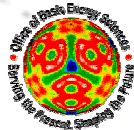
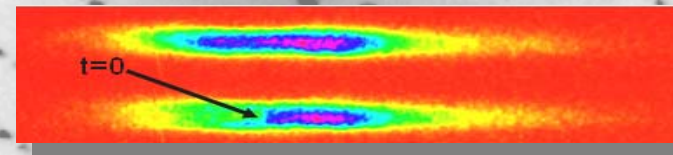
# LCLS Science Advisory Committee

February 13, 2006

## Welcome and Photon Science at SLAC – LCLS – SSRL – Science Initiatives



Keith O. Hodgson  
SLAC Deputy Director



Photon Science operations and research is funded primarily by the US Dept. of Energy Office of Science, Office of Basic Energy Sciences

# SLAC – A DOE National Laboratory and a School of Stanford University

Stanford Linear Accelerator Center - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.slac.stanford.edu/

Customize Links Free Hotmail Windows Marketplace Windows Media Windows

## SLAC

STANFORD LINEAR ACCELERATOR CENTER  
Operated by Stanford University for the U.S. Dept. of Energy

**Photon Science**  
LCLS | LUSI | SSRL | Ultrafast Center | more

**Particle & Particle Astrophysics**  
BaBar | GLAST | ILC | KIPAC | PEP-II | more

**Search**

SLAC WEB  PEOPLE

[Detailed Index](#)

[For Users](#)  
[For Staff](#)  
[For Students](#)  
[For Educators](#)  
[For Media and Press](#)

[About SLAC](#)  
[Safety](#)  
[Research Resources](#)  
[Visit SLAC](#)  
[Events](#)  
[Jobs](#)



**First Director Appointed for New Stanford Ultrafast Science Center**  
Phil Bucksbaum has joined the Stanford faculty to lead the Stanford Ultrafast Science Center, a partnership between Stanford and the U.S. Department of Energy. Bucksbaum will be a member of the Stanford Linear Accelerator Center (SLAC) Faculty and the Applied Physics Faculty in the School of Humanities and Sciences. [Read more...](#)

 Office of Science/  
U.S. D.O.E.

**News**

[New Deputy Directors Appointed at the Stanford Synchrotron Radiation Laboratory](#)

[DOE Distinguished Associate Award Presented to Arthur Bienenstock](#)

[Panofsky Prize Awarded for SLAC Breakthrough](#)

[Stöhr to Direct Synchrotron Radiation Lab](#)

[SSRL Users' Meeting \(10/15-10/19\)](#)

**News Sources**  
[SLAC Today](#) | [SSRL Headlines](#) | [symmetry](#) | [Interaction Point](#) | [Lightsources.org](#) | [Interactions.org](#) | [ILC NewsLine](#) | [SPIRES](#)

SLAC Celebrates [2005 World Year of Physics](#) with [Quantum Diaries](#)



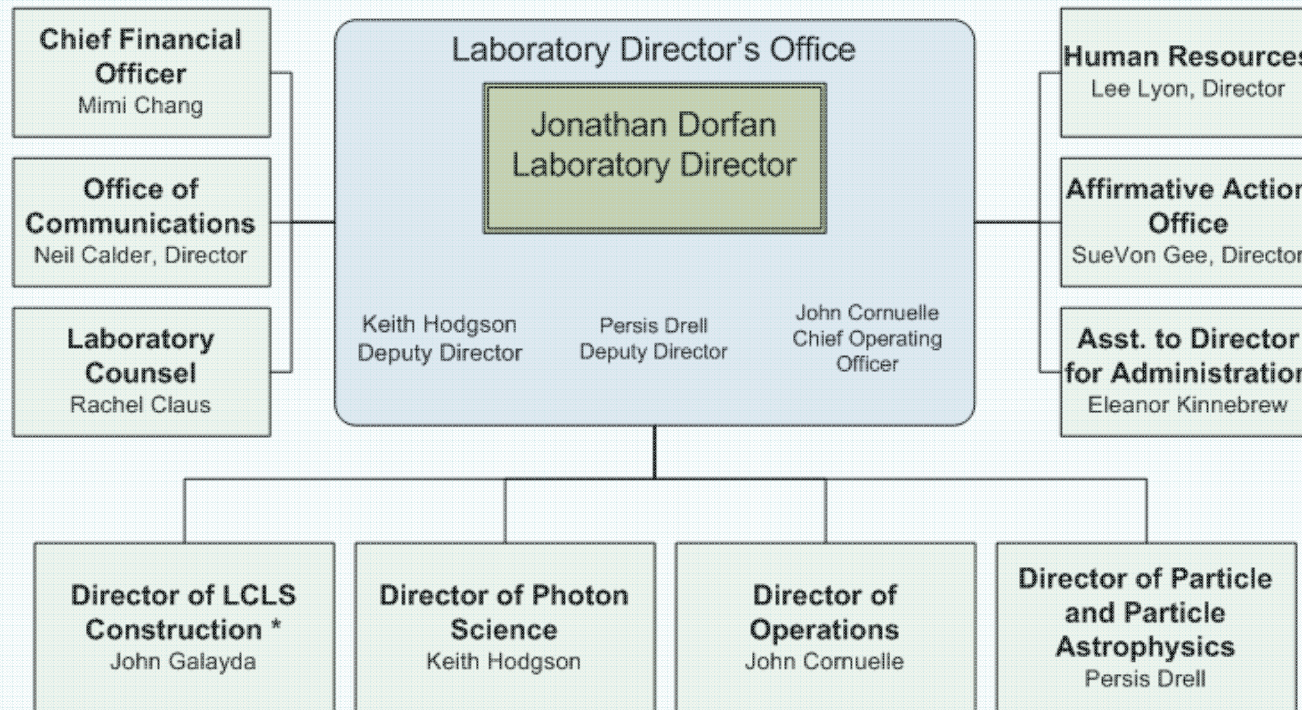
Stanford Linear Accelerator Center, Menlo Park, CA  
[Contact Us](#) | [Privacy Notice](#), [Security Notice and Terms of Use](#) | [Send us your comments on the new web site!](#)

Done

# SLAC – Senior Management and Organization

## Stanford Linear Accelerator Center

### Directorate Level Organization



\* Reports directly to the Laboratory Director

# SLAC PSD – The Photon Science Division



Photon Science : Stanford Linear Accelerator Center - Mozilla Firefox

http://home.slac.stanford.edu/photoscience.html

## SLAC

STANFORD LINEAR ACCELERATOR CENTER  
Operated by Stanford University for the U.S. Dept. of Energy

PHOTON SCIENCE  
[SSRL Users](#) | [Jobs](#) | [SSRL Science Highlights](#) | [Publications](#) | [Safety](#) | [Contact Us](#)

September 27, 2005  
 Stanford Professor Joachim Stöhr, an innovative x-ray scientist, will become the new director of the Stanford Synchrotron Radiation Laboratory (SSRL) on Oct. 1.  
 Deputy director of SSRL since 2000, Stöhr will be the fourth director in the pioneering laboratory's 32-year history.  
 "I'm looking forward to continuing to attract the best scientists to our outstanding facilities to produce basic and applied research with tremendous benefits for society," said Stöhr. [more...](#)

**LCLS**  
 The LCLS will be the world's first x-ray free electron laser when it becomes operational in 2009.

**SSRL**  
 SSRL is a National User Facility which provides synchrotron radiation for research in chemistry, biology, physics & materials science.

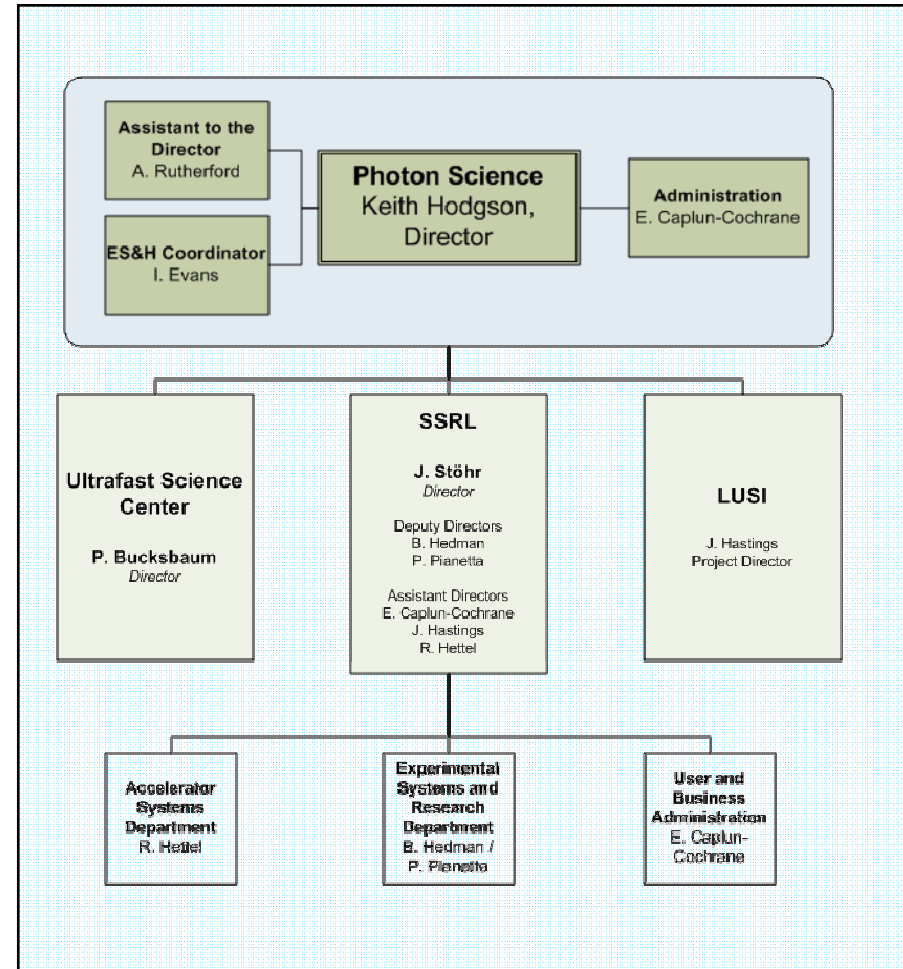
**Ultrafast Center**  
 The UFC will focus on ultrafast structural and electronic dynamics in atomic physics, chemistry, biology, & physics.

**LUSI**  
 LUSI will build instrumentation for LCLS science thrust areas.

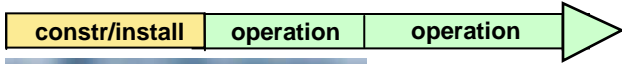
**Events**  
**32nd Annual SSRL Users' Meeting**  
 This year's Users' Meeting will feature sessions on x-ray absorption spectroscopy, structural genomics, ultrafast science and a sampling of materials research from other DOE labs. There will also be a young investigators session and a poster session, with awards for outstanding graduate student posters. Several workshops will be offered before and after the users' meeting, including small angle x-ray scattering and soft x-ray science at LCLS.

Stanford Linear Accelerator Center, Menlo Park, CA  
 Contact Us | Privacy Notice, Security Notice, and Terms of Use | Send us your comments on the new web site

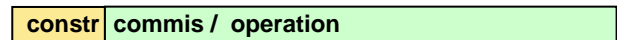
Last updated: Tue, 11 Oct 2005 23:10:29 GMT



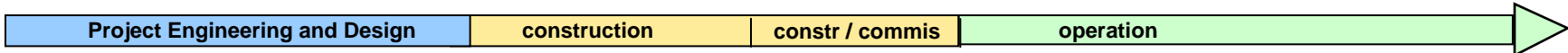
# SLAC PSD – Enabling Accelerators



- 3 GeV, low emittance intermediate energy x-ray light source (16 nm-rad), high current (500 mA) - providing enhanced photon beams (1-2 orders of magnitude more flux and brightness than SPEAR2)
- 7-month installation completed (on time and within budget) – commissioned very fast - user program resumed (March, 2004)
- Expansion capacity for new beam lines – 7 ID and 14 bend – first two ID lines already in design/construction – soft x-ray and hard x-ray (PX) undulators



- Pioneering experiment begun in 2003 using SLAC linac with added bunch compressor and undulator to produce 80 fsec x-ray pulses
- First direct experience with properties and applications of a high brightness, short pulse, linac-driven x-ray light source. Strong synergy between accelerator and photon science and valuable experience for LCLS science and technology
- SPPS decommissions beginning in April to enable LCLS construction



- World's first x-ray FEL - 1st year of civil construction - full funding in FY2006 budget enables significant step up in activity on project
- Is technically sufficiently mature and risks well understood to go into construction (CD3B) - strongly recommended by Lehman Review. First laser commissioning in FY2008 and project completion/operation (CD4) by mid FY2009
- Substantial headroom for future expansion of both performance and capacity to serve the Nation's needs through the next decade and beyond

- ***Operate Primarily General User Facilities (rather than PRT- or CAT-based)***  
Integrated approach to operations and management - including hardware, computer systems and control software – of all beam lines. In appropriate areas (e.g. structural biology) integrated programs funded from multiple sources is the model used. ES&H is centrally managed/coordinated in close cooperation with the SLAC ES&H Division.  
⇒ **the basis of the operational model planned for LCLS**
- ***Focus on High Level of User Service, Support and Satisfaction***  
Centralized Proposal Review System is very effective, transparent in process and responsive. Continually reflected in user surveys and reports.  
⇒ **essential for most efficient and rapid development of LCLS science program**
- ***Intellectual Leadership from SSRL Faculty and Close Ties with Stanford Campus***  
SSRL has a faculty of 20 members, of which 14 hold joint appointments with campus departments in 4 different schools. These faculty – in collaboration with scientists outside of SSRL – have contributed many innovations in synchrotron source development and synchrotron methodologies.  
⇒ **provide the foundation for LCLS science program and the future means to attract and retain outstanding faculty at SSRL to innovate and drive science enabled by LCLS**
- ***The Broader SLAC Environment***  
SLAC has world class programs and leadership in electron accelerators and accelerator physics. Scientific and technical expertise are central components of many aspects of developing linac-based light sources like LCLS and future evolution of SPEAR3.  
⇒ **key aspect of rapid progress to date, in first phase of LCLS and in future developments in source performance**

# SLAC PSD – The SSRL Division



- SSRL program begun in 1973, parasitic on the SPEAR high energy physics program - dedicated and funded by US DOE and a Division of SLAC since 1993. Pioneered many innovations in SR source technology and instrumentation.
- SSRL, a SLAC Division, operates a large general user program. Currently ~2000 users on more than 400 active proposals. More than 650 Ph.D. theses at over 100 institutions in the US and worldwide have used SSRL resources. More than 7000 publications have been reported utilizing SSRL resources since 1973.
- SSRL has research and user activities using the SPEAR3 storage ring that cover a wide range of basic and applied sciences - including new materials (magnetic, complex, polymers, biomedical), surfaces/interfaces and catalysis, environmental, nuclear stockpile stewardship, structural biology, imaging of nanostructured and bio-materials and studies of ultrafast phenomena.

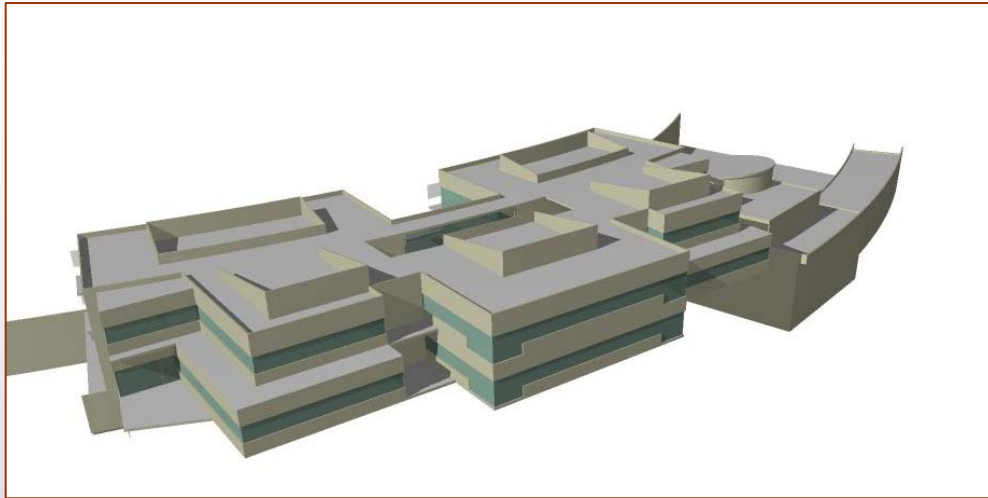


- **PULSE (Ultrafast Science Center)**
  - Currently five DOE-funded programs involving 8 faculty (goal is 12-14)
  - Stanford coinvestment (\$1M Keck and other) will help ensure that we lead world in developing this area (in addition to \$4.7M for 3 yrs from DOE)
- **XLAM (X-ray Laboratory for Advanced Materials)**
  - Core of 15 faculty - couples to initiatives at Stanford - ~\$2.2M in FY2005
  - Develops new techniques for studies in ultrafast and ultraslow time domains for correlated/complex systems
- **SEMSI (Stanford Environmental Molecular Sciences Institute)**
  - NSF-DOE institute involving 3 SSRL faculty focuses interdisciplinary research on most challenging environmental problems (\$7M over 5 years)
- **SBI (Structural Biology Initiative)**
  - Strongly engages other DOE and interagency support (BER and NIH) and private investment – core involves 6 faculty - ~\$72M over FY2005-2009
  - With developing LCLS-related capabilities – will be only laboratory in world with these capabilities in SMB
  - Major role in supporting R&D and users
  - Strongly couples to NIH PSI (structural genomics)

Investment outside of core DOE-BES opns over 5 yrs estimated to be >\$95M

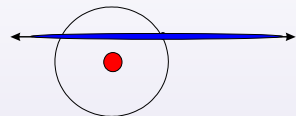


# PULSE - Ultrafast Science Center



- DOE award and center initiated 8/04
  - Phil Bucksbaum, Director (joint SSRL and Applied Physics Faculty)
- Initial focus of DOE funding is two main and one exploratory areas, 3<sup>rd</sup> party funding (Keck) for a 4<sup>th</sup> area
  - ⇒ AMO physics
  - ⇒ Materials sciences and magnetism
  - ⇒ Non-periodic and single molecule imaging
  - ⇒ Femtochemistry
- Faculty and research activities (up to six focus areas) will be ultimately housed in LCLS CLOC as well as possible space on campus – interim space in SSRL Bldgs. 130 and 137

# LCLS – the Initial Scientific Teams and Thrusts



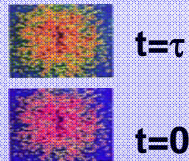
- AMO science

*team leader*

Lou Dimauro

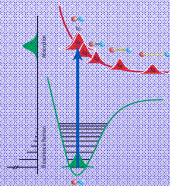
*co-team leader(s)*

Nora Berrah



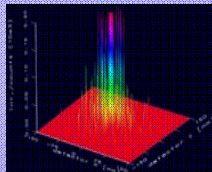
- Coherent scattering of nanoscale fluctuations

Brian Stephenson Karl Ludwig



- Diffraction studies of stimulated dynamics (pump-probe)

Kelly Gaffney David Reis  
Jörgen Larsson

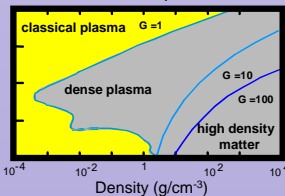


- Nano-particle and single molecule (non-periodic) imaging

Janos Hajdu Henry Chapman  
John Miao

## Experiments with LUSI Instruments

Aluminum plasma



- High energy density science

Dick Lee

Phil Heimann

# LCLS – an X-ray Free Electron Laser being Built at SLAC



## LCLS Science – the LUSI MIE Instrumentation Program

⇒ MIE managed by PSD to develop suite of 4 instruments for LCLS

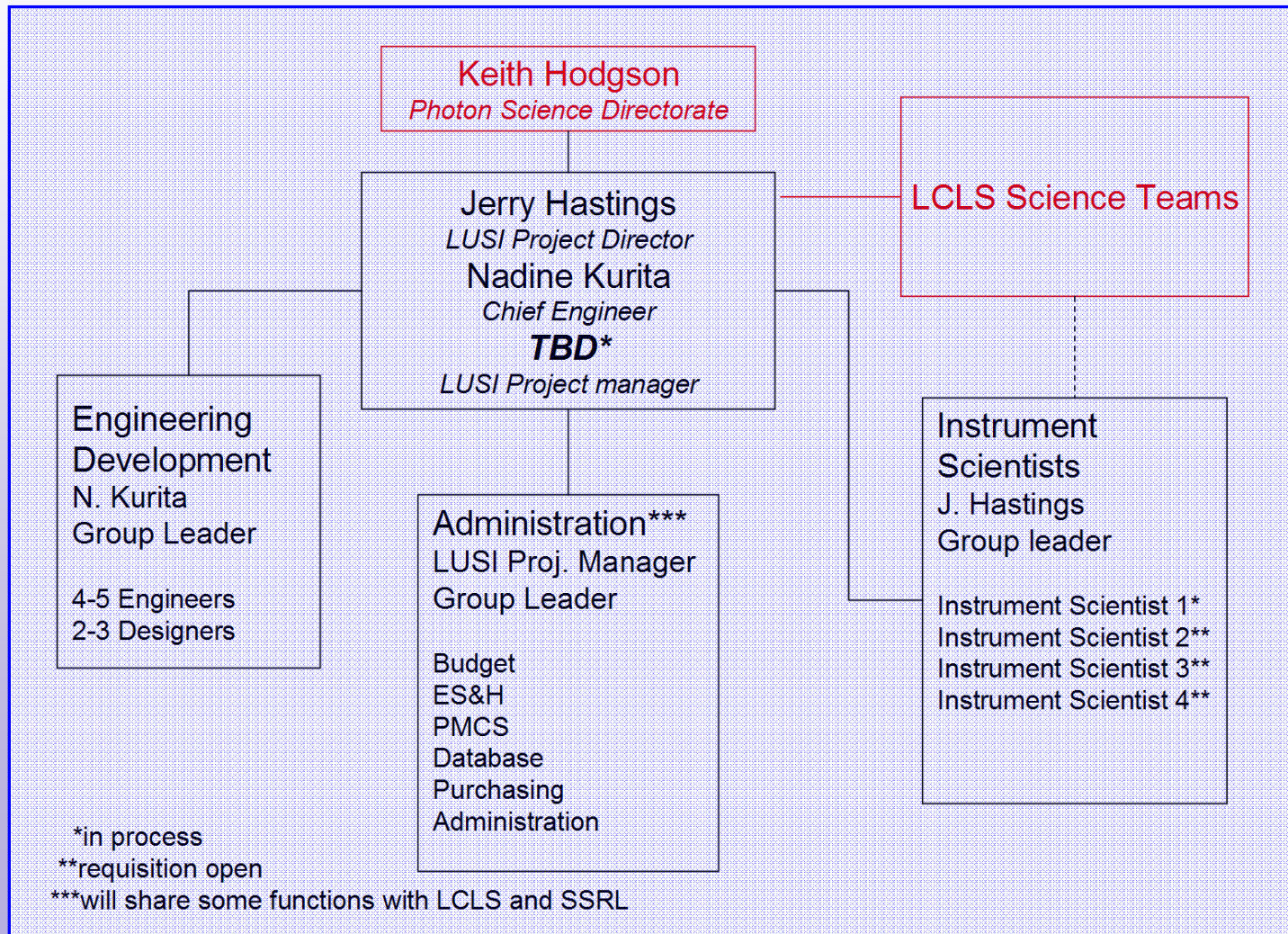
⇒ TPC of ~\$60M with start in FY2007 (\$10M)

⇒ Designs and builds 4 instruments on LCLS (one instrument – AMO - included in LCLS construction project)

⇒ Seeking support for 6<sup>th</sup> instrument (HEDS) from non-DOE SC sources

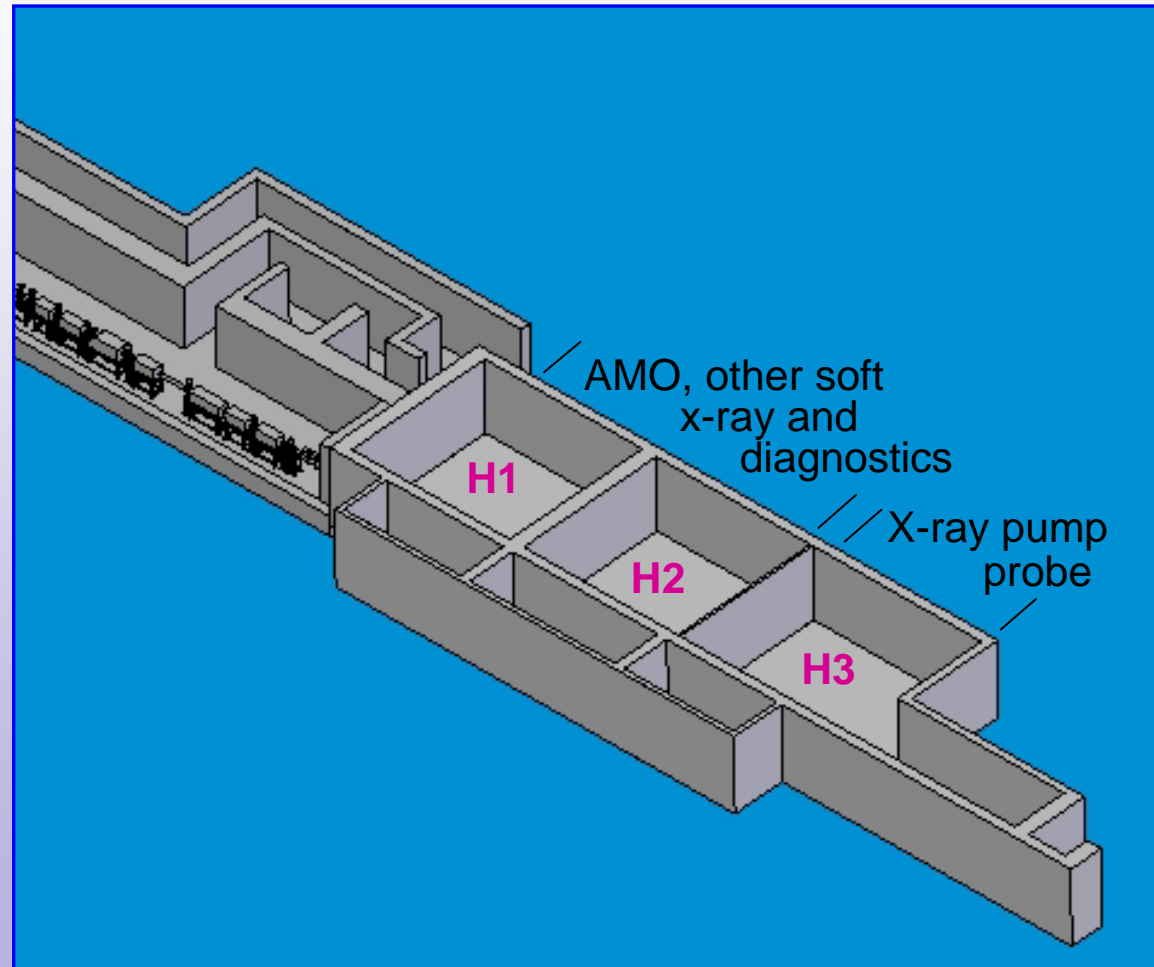
<http://www-ssrl.slac.stanford.edu/lcls/lusi/>

# LUSI MIE Instrumentation Program - Organization

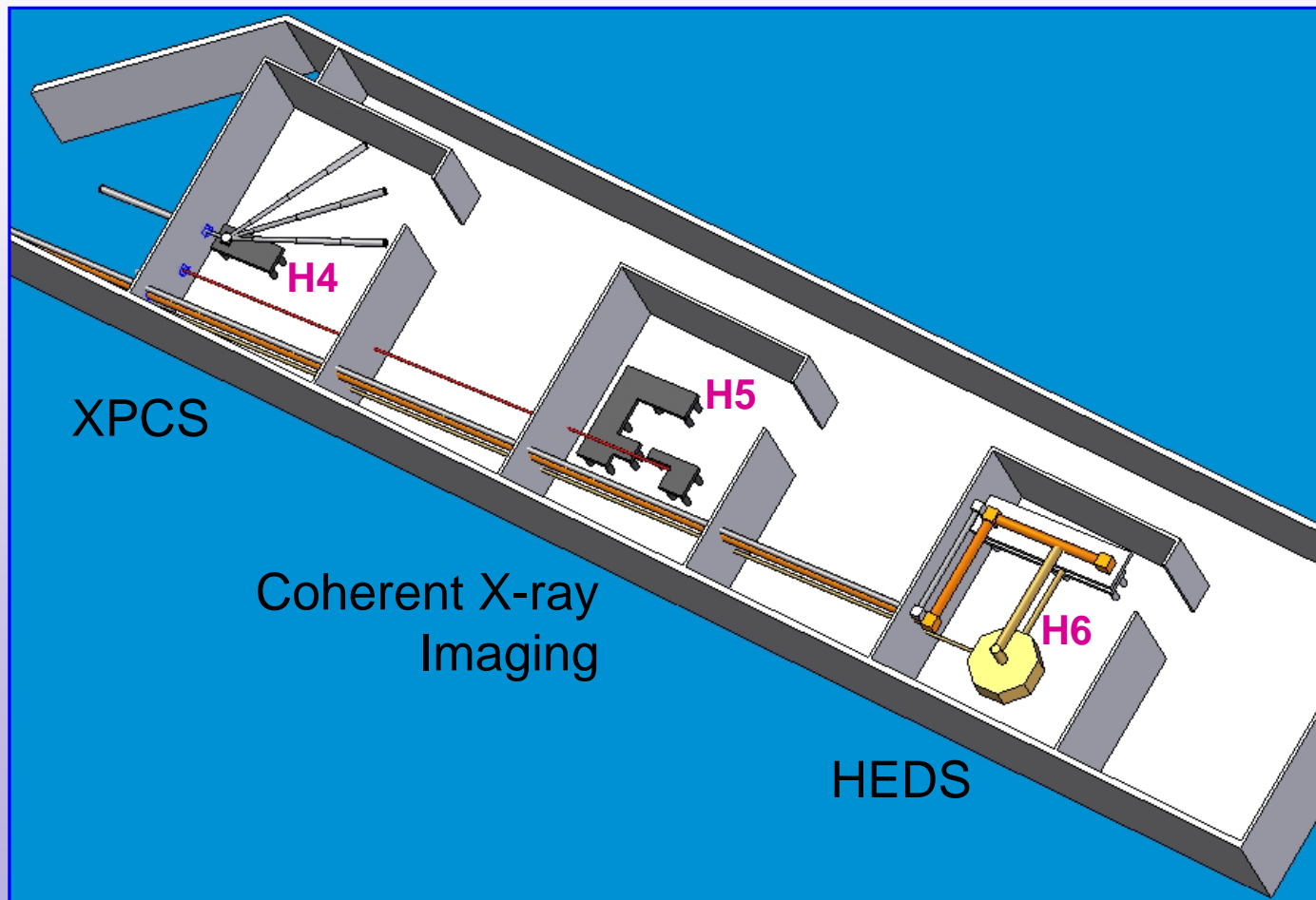


## Near Experimental Hall (NEH) and Hutches (H1,H2,H3)

- Soft x-ray pick-off mirror in the FEE will provide a soft x-ray beamline for H1 (and possibly H2), allowing efficient switching between experiments
- Mirror system at end of NEH will provide for x-ray beam deflection to 3 hutches in FEH



# Far Experimental Hall (FEH) and Hutches H4, H5, H6

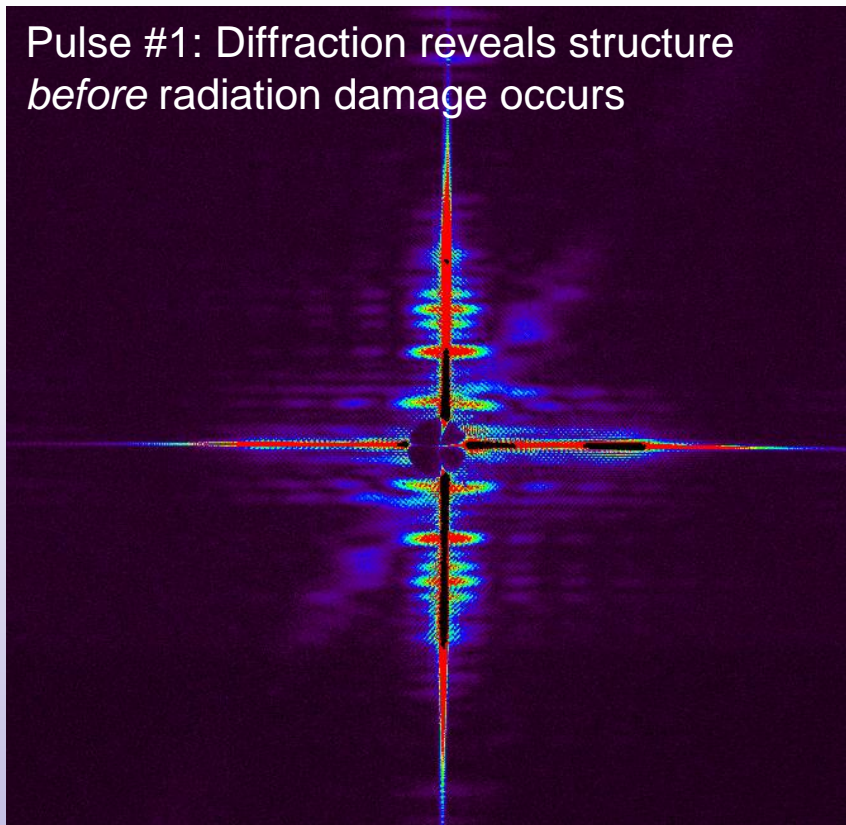


- ⇒ LCLS Lehman Review just completed - recommend strongly CD3B (beginning of civil construction) - John Galayda will elaborate
- ⇒ Full funding for LCLS construction in appropriated FY2006 budget
- ⇒ Full funding proposed in FY2007 for LCLS in President's budget
- ⇒ Funding to begin LUSI is proposed in FY2007 budget (with an accelerated profile)
- ⇒ Outlook for federal funding for physical sciences is very bright

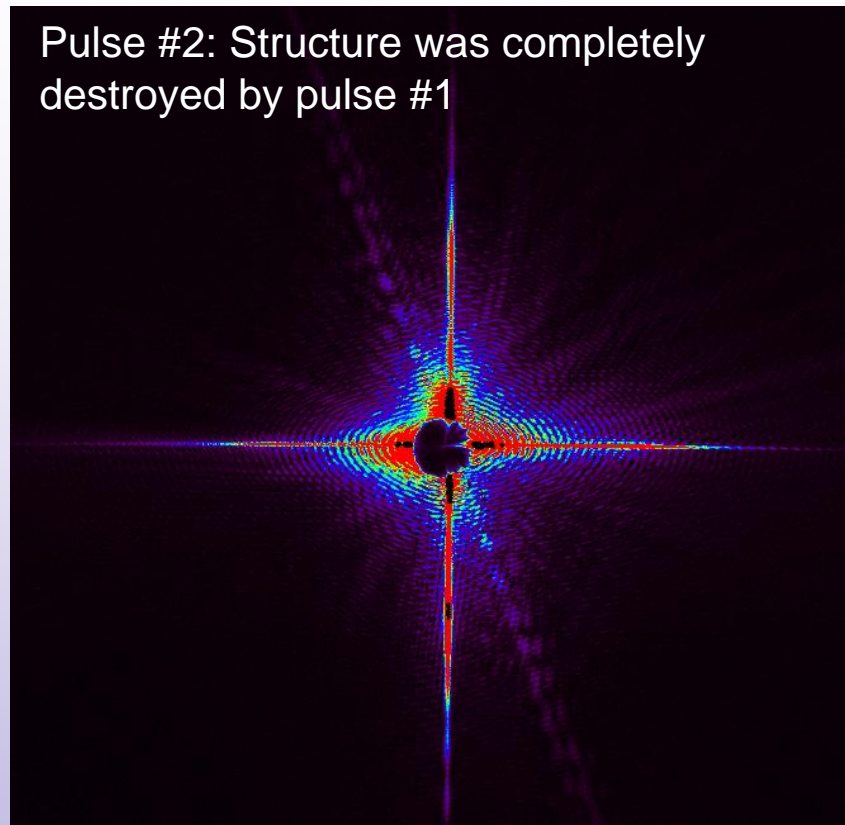
# Ultrafast Coherent Single Shot X-ray Diffraction

## – The First Demonstration at the VUV-FEL at DESY

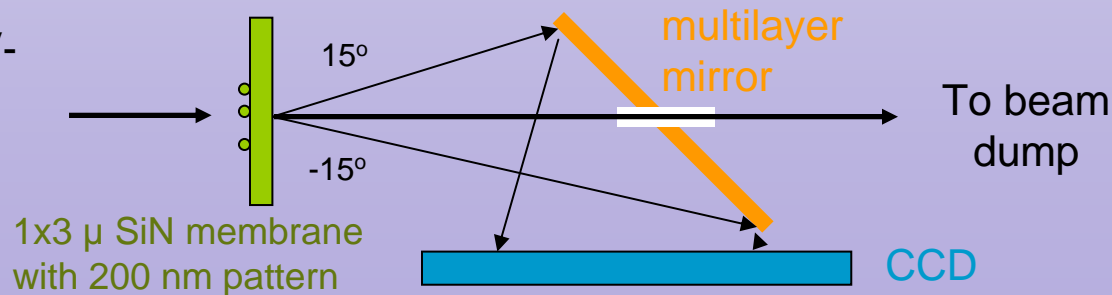
Pulse #1: Diffraction reveals structure *before* radiation damage occurs



Pulse #2: Structure was completely destroyed by pulse #1

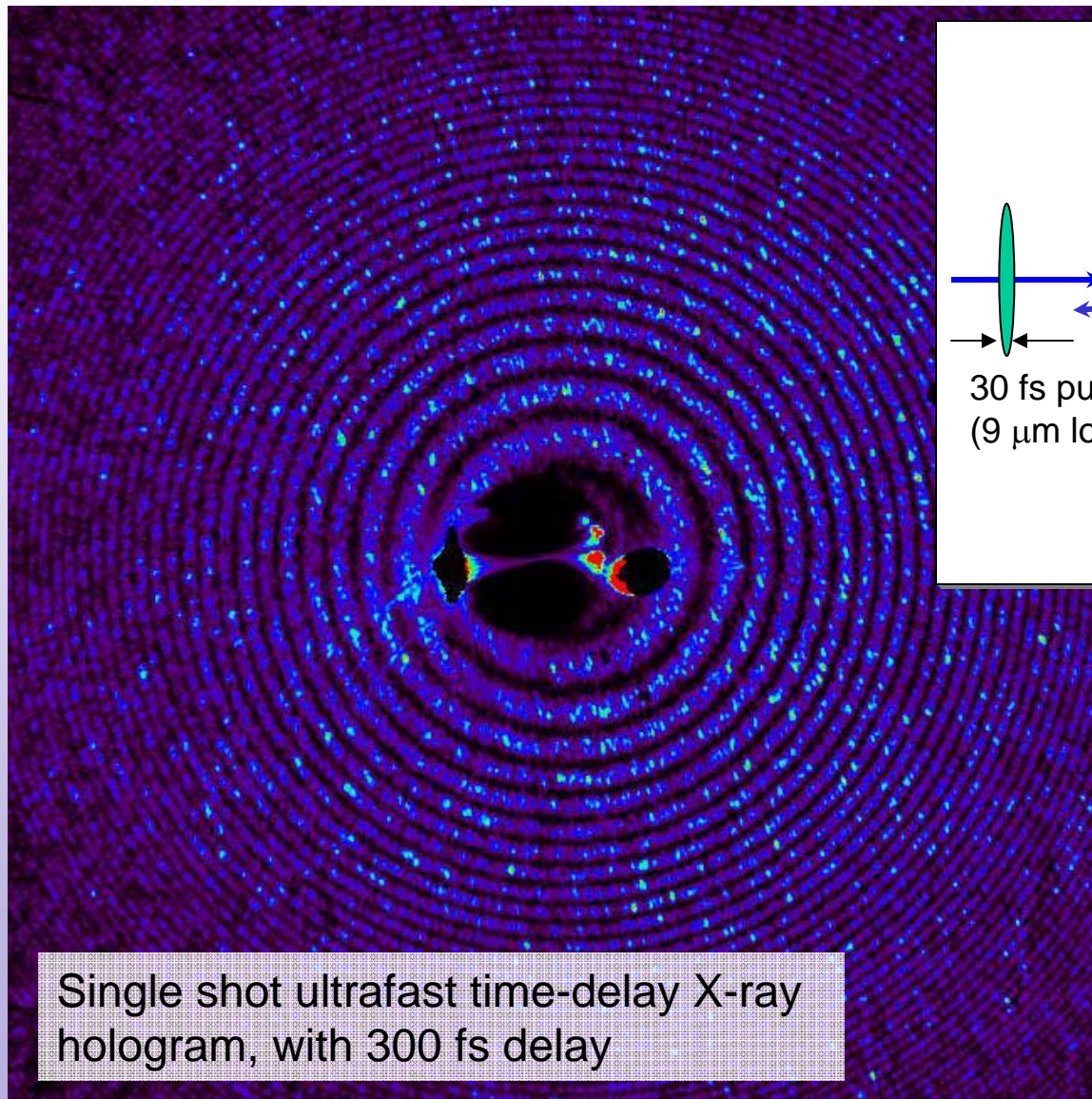


Incident VUV-FEL pulse:  
30 fs, 32 nm,  
 $3 \times 10^{13} \text{ W cm}^{-2}$

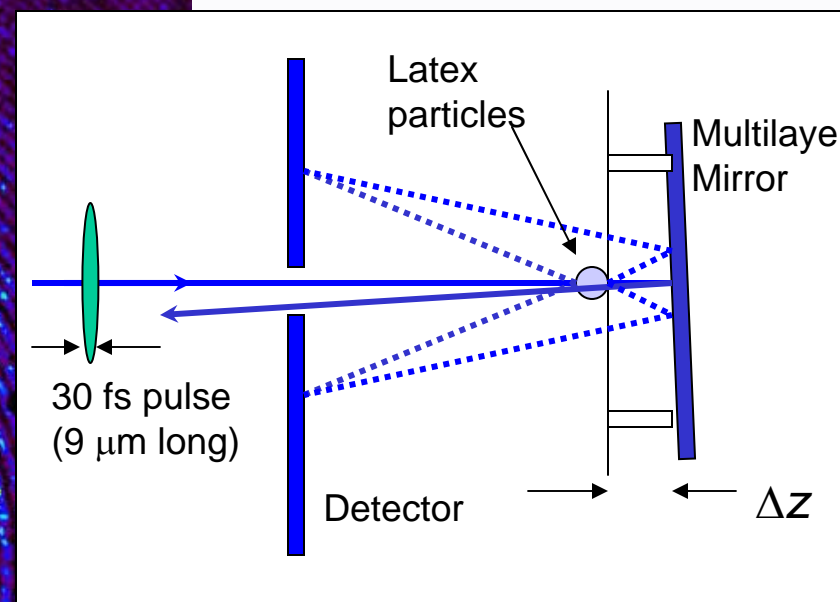




# VUV-FEL Pump-probe Experiments Measure the FEL-induced Explosion with 30 fs Time Resolution



Single shot ultrafast time-delay X-ray hologram, with 300 fs delay



- ..... Prompt diffraction
- ..... Delayed diffraction

$$\text{Time delay} = 2\Delta z/c$$

The pattern is the interference of the waves scattered from the unexploded particle (reference wave) and the same particle during explosion. Many particles generate speckle also.

For Additional Information

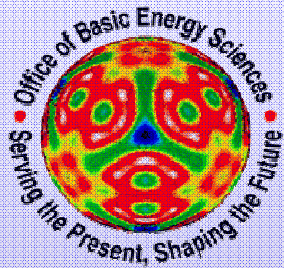


**SSRL**  
- <http://www-ssrl.slac.stanford.edu>

**SSRL news**  
- <http://www-ssrl.slac.stanford.edu/newsletters/headlines/headlines.html>

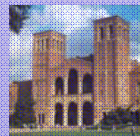
**LCLS**  
- <http://www-ssrl.slac.stanford.edu/lcls/>

**And This is All Possible Only with the Support of...**



**Photon Science operations at SLAC, the LCLS construction project, LUSI and PULSE are funded by the Department of Energy, Office of Science, Office of Basic Energy Sciences**

***LCLS Major Collaborating Institutions***



**UCLA**

***Foundation Support***



***For further information please contact:***



**KEITH O. HODGSON**

Howard H. and Jessie T. Watkins University Professor  
of SSRL and Chemistry

**SLAC Deputy Director  
Director of Photon Science Division**

Stanford Linear  
Accelerator Center  
2575 Sand Hill Road, SSRL MS69  
Menlo Park, CA 94025

Office (650) 926-3153  
FAX 9650) 926-4100

[Hodgson@SSRL.SLAC.STANFORD.EDU](mailto:Hodgson@SSRL.SLAC.STANFORD.EDU)