LCLS Control System Status

EPICS Collaboration Meeting

December 8-10, 2004

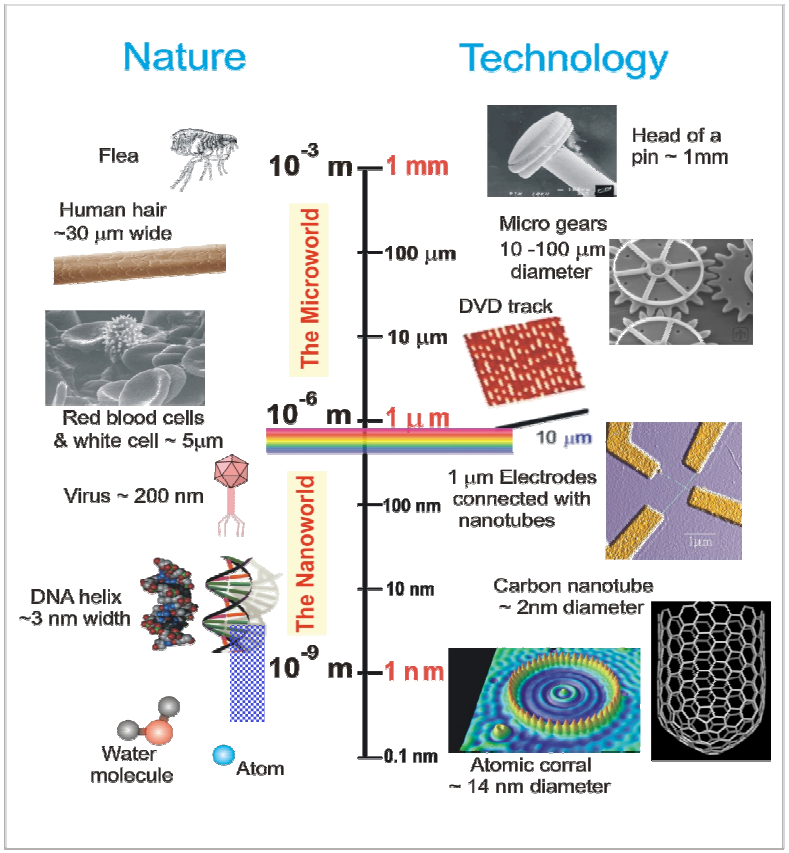
- **Outline**
  - Project Overview
  - Control System Goals
  - Resources
  - Design Slides for Global Systems
  - Tools/ Standards to adopt from the community for LCLS
  - Next 6 months
  - Conclusions

Bob Dalesio
dalesio@slac.stanford.edu

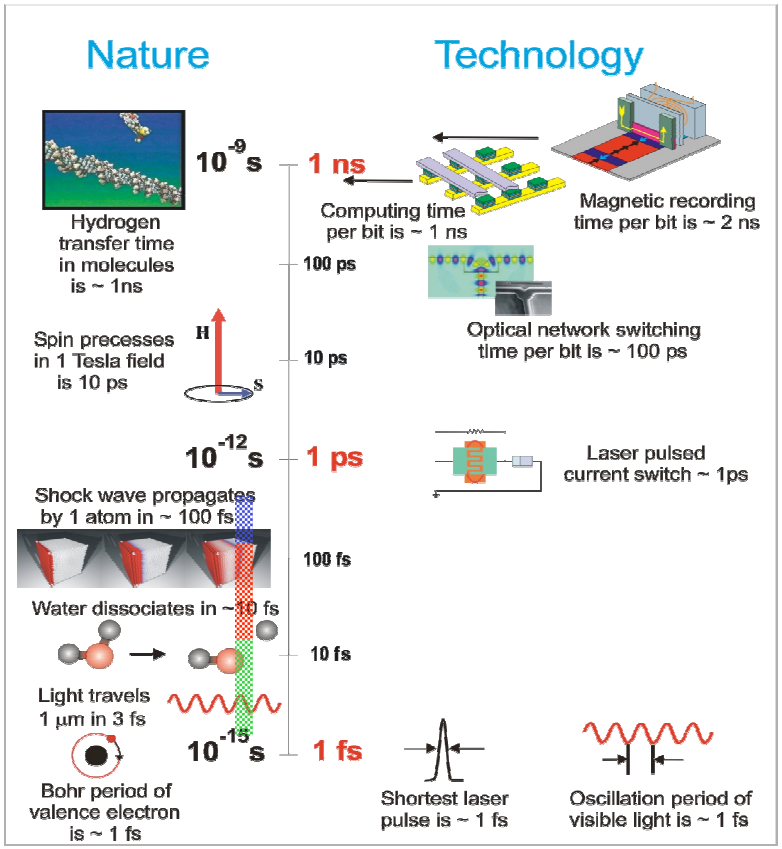
The World's First Hard X-ray Laser

X-FELs open the Ultra-Small and Ultra-Fast Worlds

Ultra-Small



Ultra-Fast



Bob Dalesio
dalesio@slac.stanford.edu

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dalesio@slac.stanford.edu

Capabilities

Spectral coverage: 0.15-1.5 nm

To 0.5 Å in 3rd harmonic

Peak Brightness: 10^{33}

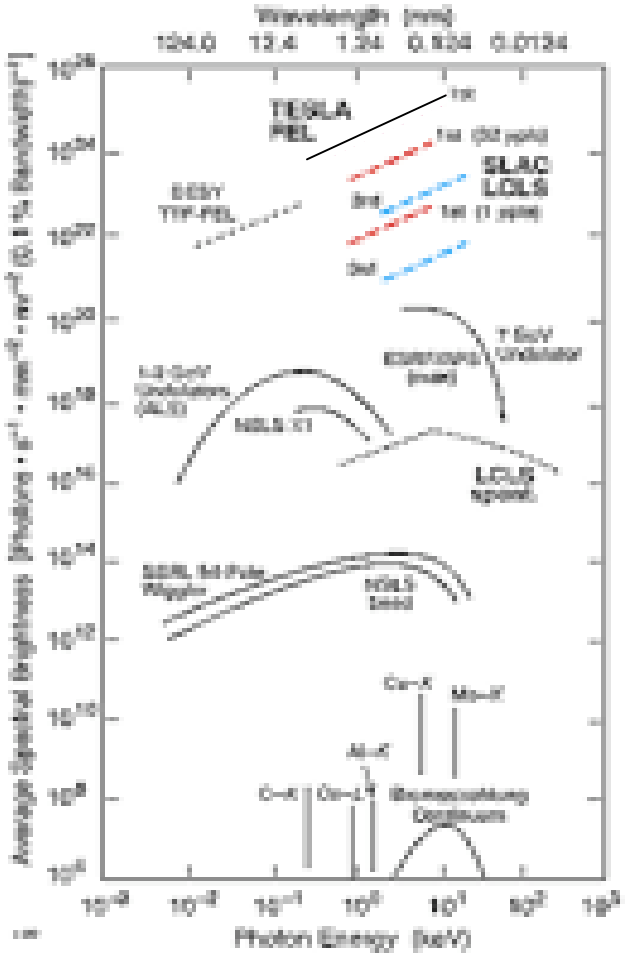
Photons/pulse: 10^{12}

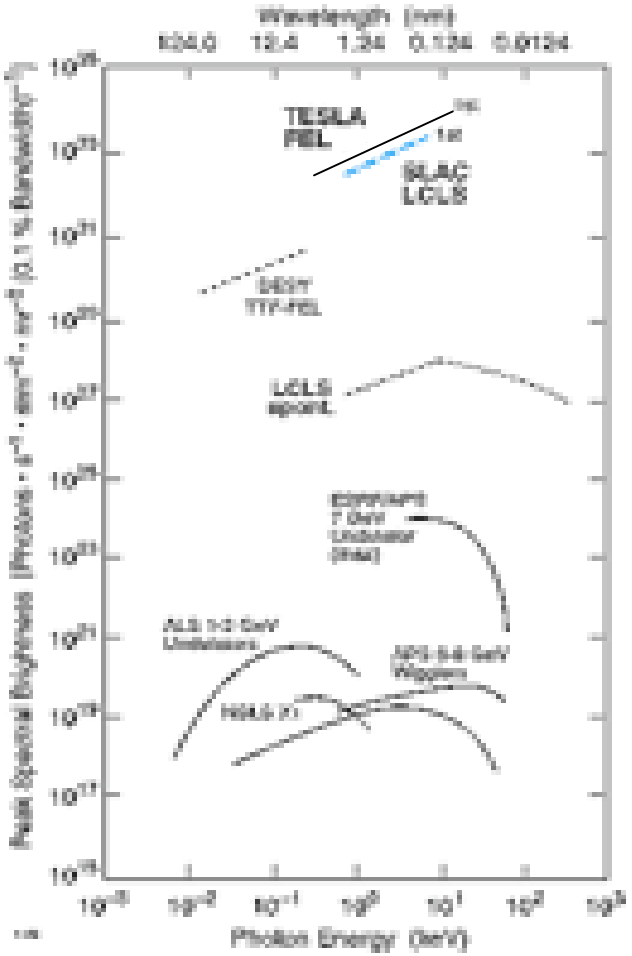
Average Brightness: 3×10^{22}

Pulse duration: <230 fs

Pulse repetition rate: 120 Hz

Upgrade – more bunches/pulse

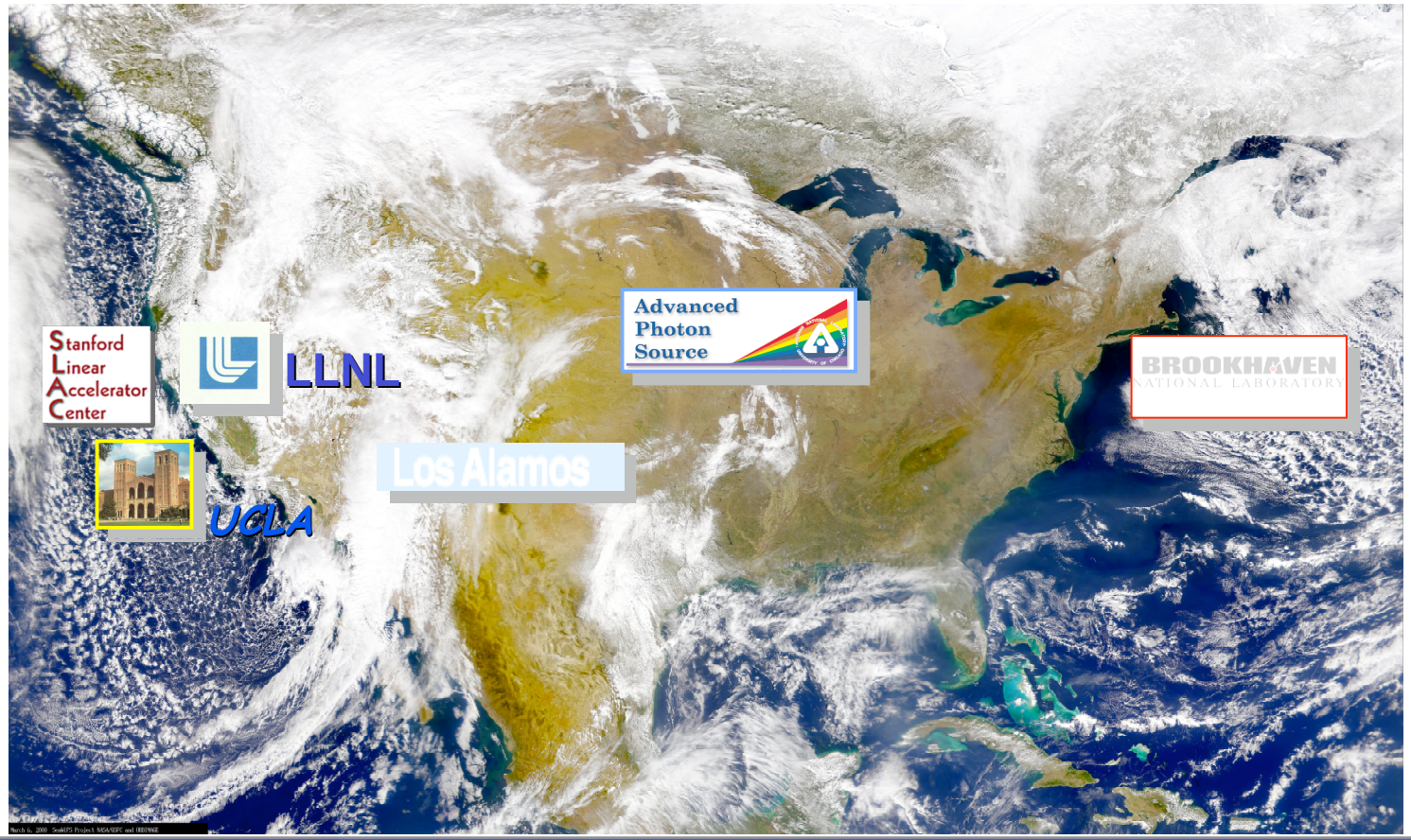




Bob Dalesio
dalesio@slac.stanford.edu

LCLS Construction Collaboration

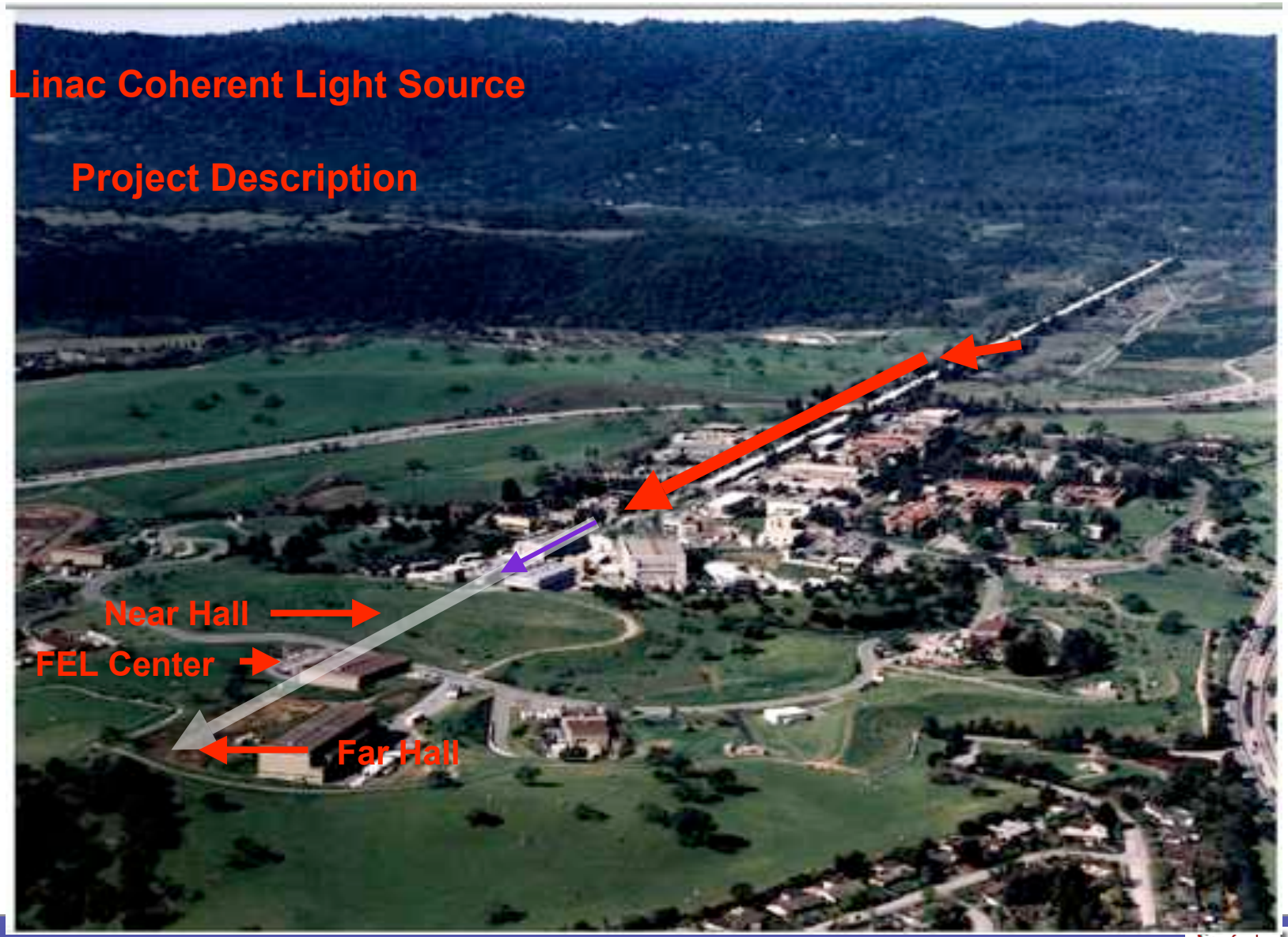
Project Management Responsibilities Delegated to Partner Labs



Bob Dalesio
dalesio@slac.stanford.edu

Linac Coherent Light Source

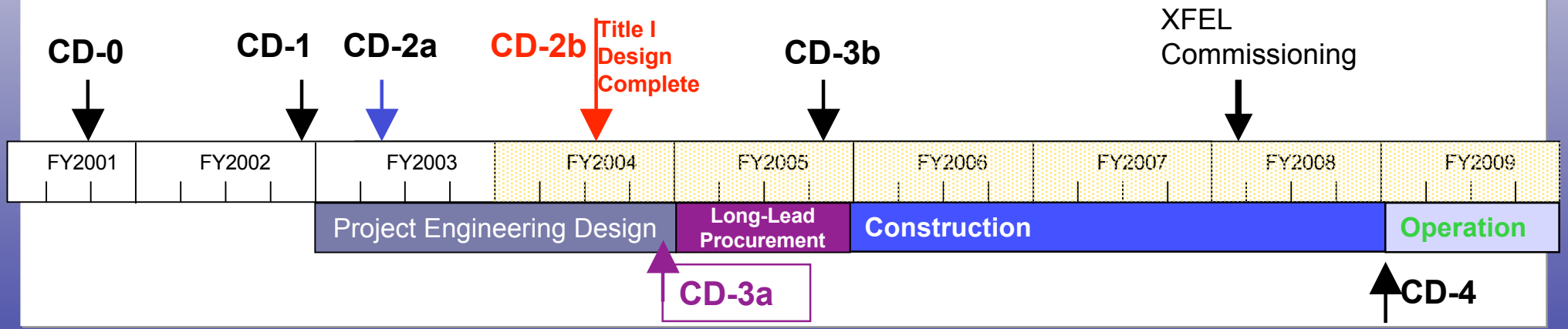
Project Description



Bob Dalesio
dalesio@slac.stanford.edu

LCLS - Estimated Cost, Schedule

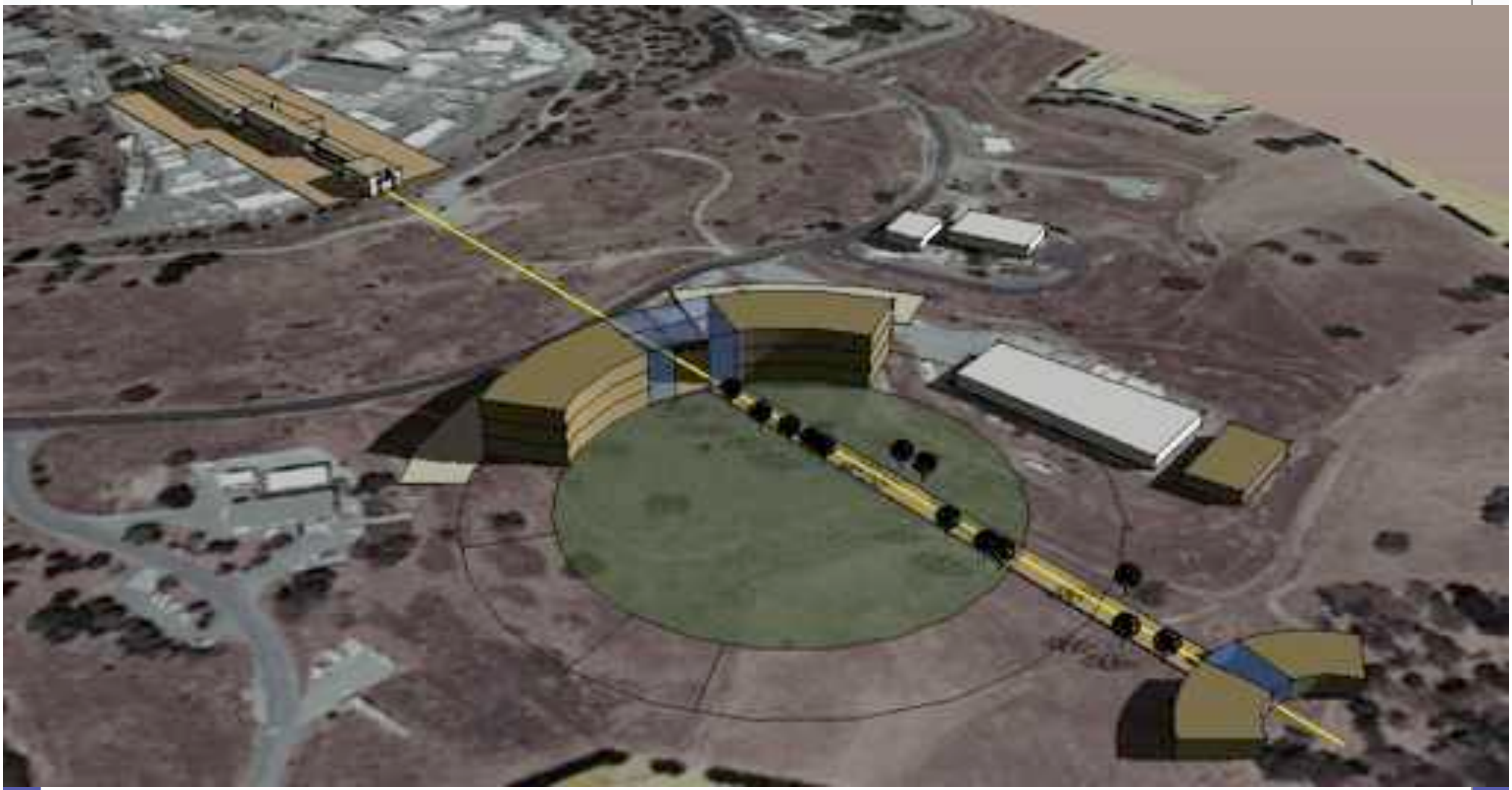
- *$273M Total Estimated Cost*
- *$315M Total Project Cost*
  - **FY2005** Long-lead purchases for injector, undulator
  - **FY2006** Construction begins
  - **FY2007** FEL Commissioning begins
  - ***September 2008*** Construction complete – operations begins



Bob Dalesio
dalesio@slac.stanford.edu

LCLS

Stanford Linear Accelerator Center
Stanford Synchrotron Radiation Laboratory



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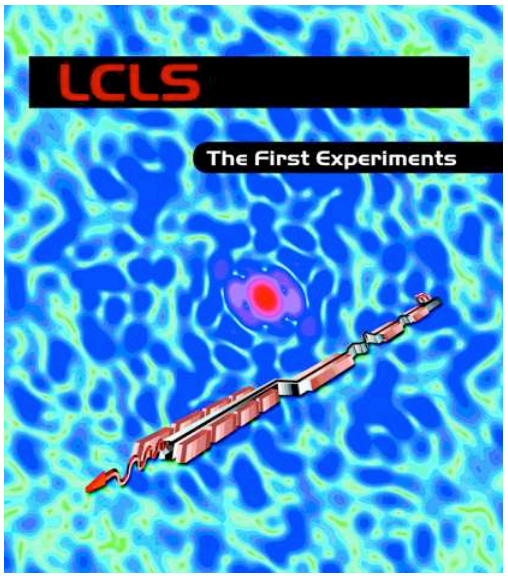
Bob Dalesio
dalesio@slac.stanford.edu

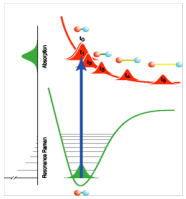
Stanford Linear Accelerator Center
SSRL

•SLAC-PUB-611

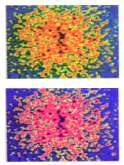


Program developed by international team of scientists working with accelerator and laser physics communities

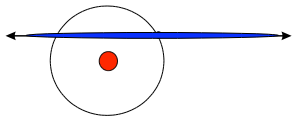
"the beginning.... not the end"



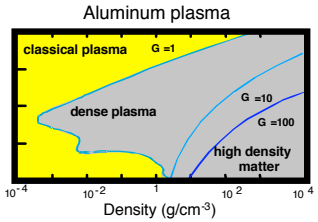
Femtochemistry



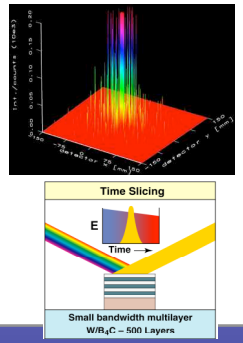
Nanoscale Dynamics in Condensed matter



Atomic Physics



Plasma and Warm Dense Matter



Structural Studies on Single Particles and Biomolecules

FEL Science/Technology

Bob Dalesio
dalesio@slac.stanford.edu

LCLS Control System Goals

- Provide a fully integrated control system to support the construction, test, installation, integration, operation and automation of the LCLS Accelerator
- Standardize all devices and components across all subsystems.
- Identify all data either by pulse id, beam pulse related time stamp, or 500 msec rough time stamp.
- Full integration with the SLC – timing, use of LCLS data in SLC high level applications, and use of SLC data in LCLS

Bob Dalesio
dalesio@slac.stanford.edu

Personnel – Resources FY 2005

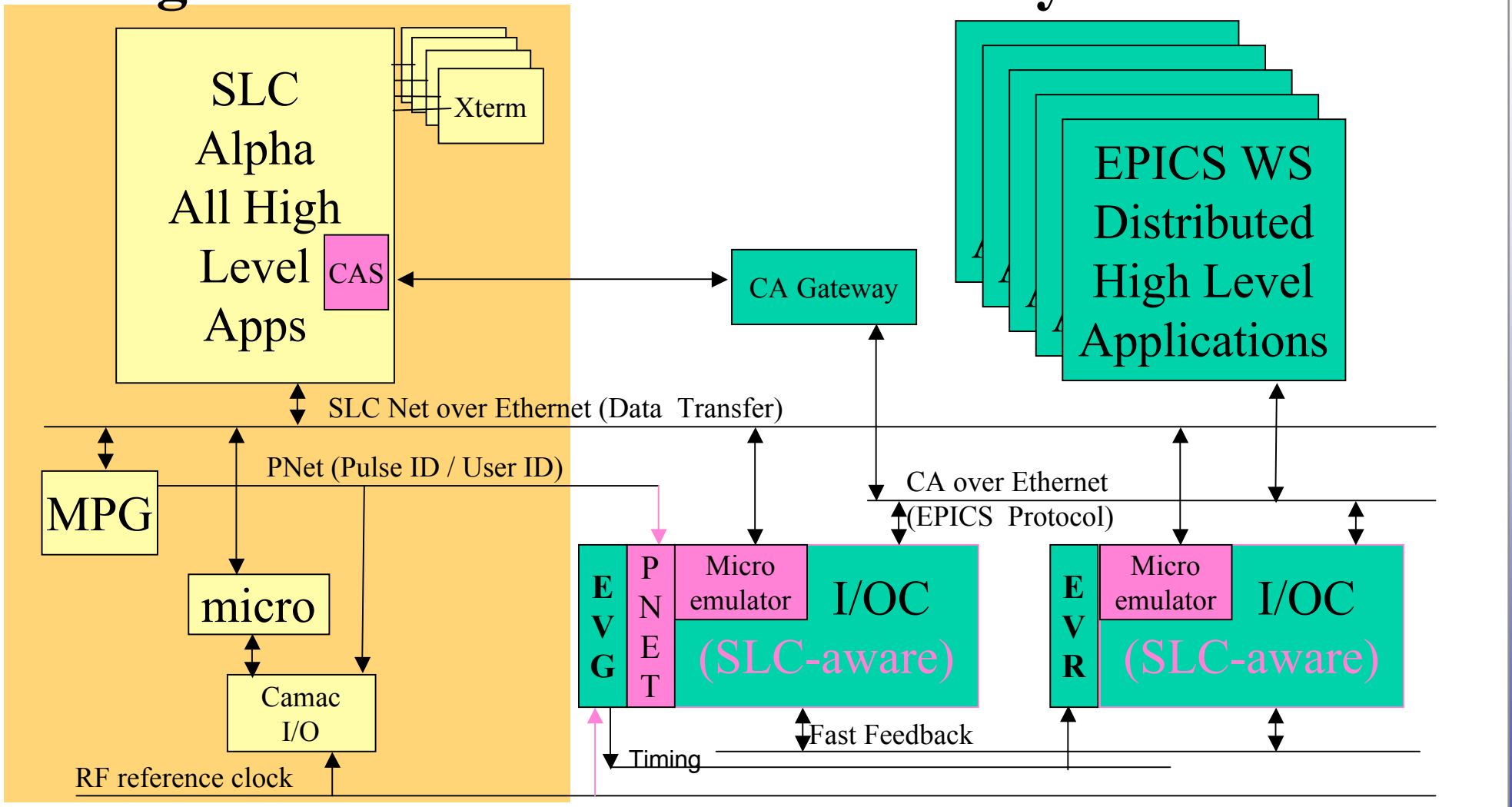
	Q1	Q2	Q3	Q4	06 Q1
Ctl. Elec. Engineer	0.75	4.35	735	7.35	7.35
Ctl. Sr. Elec. Tech.		1.11	3.35	3.35	3.35
Ctl. Elec Tech.		0.56	0.56	0.73	1.96
Pwr. Elec. Engineer		1.32	1.32	1.32	1.32
Pwr. Sr. Elec. Tech.		0.35	0.61	0.62	.62
Control Prog.	3.50	7.14	10.63	10.63	10.63

Continuing Resolution: take care of prototyping 1.75 in other WBS

Ramp up Over 6 months to full complement

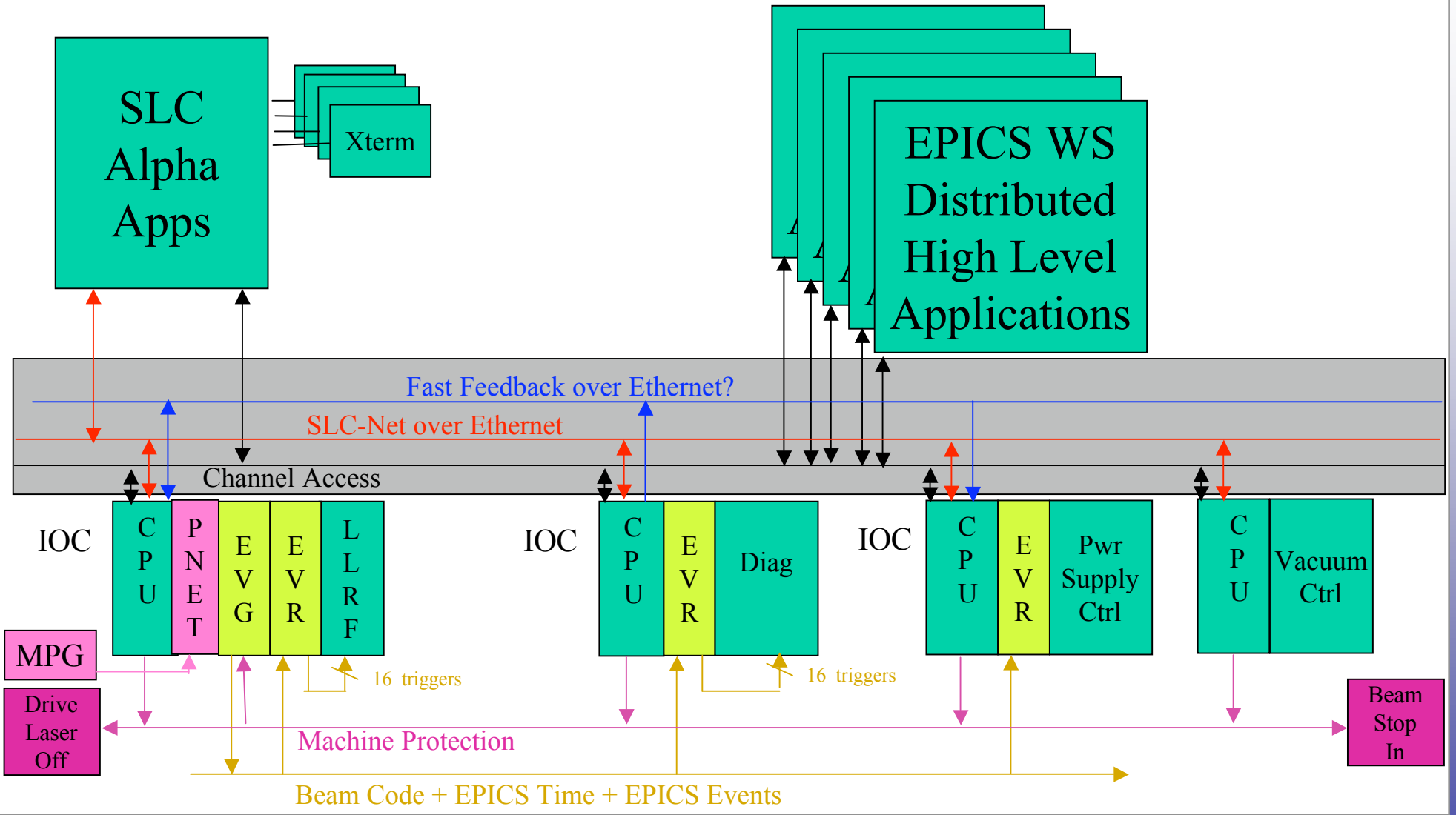
Bob Dalesio
dalesio@slac.stanford.edu

Integration with the SLC Control System



Bob Dalesio
dalesio@slac.stanford.edu

Global Communication Buses



Bob Dalesio
dalesio@slac.stanford.edu

Environment

EPICS Release	3.14.n
R/T OS	RTEMS
Workstation OS	LINUX
EPICS ADE (CVS)	Simple??
Compilers	GNU
Bug Report / Tracking	Artemis
Naming Standard	PEP II
Name Service	Name Server JLAB
Documentation	Web Area
Test stations	FFTB

Bob Dalesio
dalesio@slac.stanford.edu

Client Tools

Display Manager	EDM
Archiver	Channel Archiver
Alarm Handler	ALH
Message Logger	CMLog
Electronic Log Book	DESY, Babar, JLAB?
Stripchart	StripTool
Web based viewing	SPEAR, A-Beans, JoiMint,AIDA??
Image Analysis	Matlab format?
Save / Restore	?
RDB	SNS (leaning)
Gateway	3.14.6 Gateway

Bob Dalesio
dalesio@slac.stanford.edu

High Level Applications

- Matlab — Available for Physicists
- Python — Available for Physicists
- High Level Apps
  - SLC — Available in existing system
  - XAL — New direction
  - Matlab based — Growing group of users
- Top priorities to move into EPICS
  - Which ones make the SLC-aware IOC easier
  - Which are the most useful
  - Which are the easiest to pick off

Bob Dalesio
dalesio@slac.stanford.edu

Hardware Direction – Buy/Steal/Make

In-House	VME version of the PNET
Commercial	BPM - Echotek and Libera Electronics
Community	Timing System (Diamond/SLS/APS)
Community	Digital Power Supply Controller (SLS)
Commercial	LLRF - Digitizers
Commercial	Machine Protection System in PLC? 8msec
Commercial	Video – evaluate several options (30 Hz)
Commercial	Conventional Facilities through AB PLC
Community	Wire Scanners ??
Commercial	Fast feedback in shared memory?

Bob Dalesio
dalesio@slac.stanford.edu

Next 6 Months

- Complete SLC-aware IOC (30% Complete)
- Complete PNET Prototype (75% Complete)
- Complete BPM Prototype (5% Complete)
- Complete Timing Prototype (5% Complete)
- Complete Power Supply Prototype (30% Complete)
- Complete Video Prototype (10% Complete)
- Design Document for Machine Protection System – determine if there is something that we can evaluate
- Integrate Facility Controls, XRay Transport, Experimental Hall into the control system.

Bob Dalesio
dalesio@slac.stanford.edu

Conclusions

- We hope to base all of our hardware on developments from the community or those commercially available.
- Integration with the existing SLC system is a critical step to allow SLAC operators to use the existing tools while we are adopting and modifying replacements.
- We are using standard EPICS tools for core development and engineering interfaces.
- We are adopting all we can from the community and we will use our resources to extend them as we can.

Bob Dalesio
dalesio@slac.stanford.edu

LCLS Software Tasks – Development

- SLC-aware IOC
- Drivers for all new hardware
- Machine Protection / Mitigation
- Master pattern generator
- Fast Feedback Communication
- High Level Applications
  - Correlation Plots
  - Fast Feedback Loops
  - Emittance reconstruction from wire scans and profile monitors
  - Profile monitor image analysis for slice emittance with the transverse cavity
  - Beam Steering and online orbit modeling
  - Beam Steering “scans” to emittance reconstruction from wire scans and profile monitors

Bob Dalesio
dalesio@slac.stanford.edu

LCLS Software Tasks – Standardize/Acquire

- Data Archiving to support all phases of the project
- Operator Display Tools / Synoptic, Plots, Waveform, Image
- Alarm Management
- Electronic Log
- High Level Application Support: Matlab, XAL, Python
- Control System Configuration Tools
- Relational Database Management in all project aspects

Bob Dalesio
dalesio@slac.stanford.edu

LCLS Software Tasks – Control Programmer

- 1 RF Control
- 2 Diagnostics
  - 2.1 Toroids & Faraday Cups
  - 2.2 Beam Stops
  - 2.3 Profile Monitors & Video Devices
  - 2.4 Wire Scanners
  - 2.5 Bunch Length Monitors & E/O Diagnostics
  - 2.6 Beam Position Monitors
  - 2.7 Collimators
  - 2.8 All other stops
- 3 Gun Laser and Drive Control
- 4 Vacuum
- 5 Magnet Power Supply Control IOC and software
- 6 Beam Containment / Personnel Protection / Machine Protection

Bob Dalesio
dalesio@slac.stanford.edu

LCLS Hardware Tasks

- 1 Global
  - New timing boards – Master Pattern Generator and Event Receiver Boards
  - Machine Protection System
- RF Control – New LLRF Control
- 2 Diagnostics
  - 2.1 Toroids & Faraday Cups
  - 2.2 Beam Stops
  - 2.3 Profile Monitors & Video Devices
  - 2.4 Wire Scanners
  - 2.5 Bunch Length Monitors & E/O Diagnostics
  - 2.6 Beam Position Monitors
  - 2.7 Collimators
  - 2.8 All other stops
- 3 Gun Laser and Drive Control
- 4 Vacuum Standards
- 5 Magnet Power Supply Controllers
- 6 Beam Containment / Personnel Protection

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