Bean Line Controls and Interface to LCLS Facilities

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October 18, 2008

Thanks to Greg Hays and Chris O’Grady for presentations on lasers and data acquisition systems
Agenda

- Schedule
- Beam Line Control (slow systems)
- Space (end station)
- Vacuum
- Vacuum Chamber Compliance
- Beam Containment (BCS)
- Earthquake Bracing
- Facilities:
  - AC power requirements
  - Process (Cooling) Water
- User Interface Control Software

Data Acquisition (fast systems, Chris O’Grady)
Pump Laser (Greg Hays)
SXR Schedule

SXR has not been integrated into the LCLS schedule. These completion dates are the earliest possible dates and independent of the LCLS running schedule. Expected final installations are in December ’09.

<table>
<thead>
<tr>
<th>No.</th>
<th>Task Name</th>
<th>Finish Date</th>
<th>September/October/November</th>
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<td>Mono Engineering</td>
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<td>Target Completion SXR</td>
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SX R Controls:

The SXR beam line controls will be integrated into the LCLS controls protocols.

The devices will be LCLS supported, EPIC’s based.

- VME: ELMA 8 slot, Motorola MVME 6100 CPU (Slow cameras and sloe ADC)
- RS232: Digi 16 channel terminal server (motion & vacuum system controls)
- cPCI: (fast cameras…)
- ATCA: for detector interface boards (to be developed with individual experimental groups) and level 2 machines
Motion Controls

The supported motor type is the IMS SmartMotor Plus series:

- Wide range sizes available
- Controllers available without motors
- Will supply 48V to run motors
- Will supply terminal server ports (≥8)

Limit switches and hard stops on chamber positioning motors
Alignment & Fiducialization

Chambers should be fiducialized using SLAC standard tooling fixtures

- Use alignment team it locate system
- Minimize required range of travel and time to align

Eventually plan to have an alignment laser

- Might not be available for first users
- May not be useful if, not using a pump laser, or bringing it in through a new port.
SXO Layout

The first and second hutches NEH with AMO & SXR
End Station Space

- Beam is at ~1.4m above the floor
- Distance to back wall hutch ~3.0m*
- Distance to XTOD beam pipe ~1.3m
- Distance to laser table ~2.4m

*Configuration of the K-B Mirrors has not been finalized
Vacuum

The pressure at the x-ray optics need to be maintained at \(<5\times10^{-9}\) torr

- A differential pump is required between the end station and M3 mirror.
- Samples in the transmission chamber, just up stream of the grating tank, will have to UHV compatible.

Gauges: Cold cathode gauges are used throughout the LCLS for MPS. One will be required on all experimental chambers.
Vacuum (cont.)

Pumps: Ion pumps are in general going to be used throughout the SXR. This does not preclude other types with proper interlocks.

Valves: All valves in the beam path (manual or pneumatic) will have to be interlocked to the MPS system.
A concern has been raised as to contamination of the coaxial laser mirror and optical port. This section should be at <5x10^{-8} torr. Non-UHV systems will have to have their own differential pump or the coaxial mirror will have to be removed.
Vacuum Vessel Approval

All vacuum systems at SLAC have to be in compliance with all applicable codes and regulations (i.e. 10 CFR 851).

See Chapter 14 of the SLAC ES&H Manual for recommendations and requirements:


All vacuum chambers which do not meet all the criteria for inherently safe vacuum systems have to be submitted to HEEC for approval. (Including any system with a cross section >28 in². Essentially all sample chambers.)
Shielding & Beam Containment

Three major aspects to Shielding and BCS:

1) Shielding direct and scattered FEL radiation
2) Shielding radiation from plasma at FEL focus
3) Beam Containment FEL beam

All shielding will be under rigorous configuration control. This includes vacuum systems and any thing that can be moved into the beam (including samples). How configuration control will be maintained is under discussion.
Shielding Direct and Scattered FEL Radiation

Relatively easy to calculate and draft guidelines have been circulated.

• The thickness of standard vacuum chambers, and viewports exceeds their proposed guidelines. Bellows may require additional shielding for personnel to be in the hutch.
Shielding Radiation from Plasma at FEL Focus

RP has just started looking into this.

- The physics of these processes at soft x-ray energies is not clear.
- RP will make conservative assumptions until proven otherwise before personnel are allowed in the hutch with beam.
Beam Containment (BCS)

Beam Containment Systems are critical at SLAC.

- The FEL power is low, maximum of 2.1mJ/pulse
- The absorbed surface dose is high, particularly at low energies

Surface doses are close to or exceed the energy to take a material to melt temperature in a single pulse in the unfocused beam. (B$_4$C is used extensively as absorber)

With an ideally focused beam the doses are exceeded by a factor of $10^6$ to $10^7$

Multi-pulse damage has been demonstrated doses below the melt temperature.
Proposed BCS System

Initial work on a BCS concept is being worked out with RP:

- Numerous B4C collimators to define the beam
- Shielded air gaps to attenuate the soft x-rays
- Beam stop after end station

On the order of 4cm air is needed to attenuate the unfocused beam to level where steel can be used as the final shielding and on the order of 20cm air for focused beam.
Ray Trace Direct Beam at End Station

- B₄C Beam stop ≥1.5m from focus of beam
- Drift tube and bellows to chamber or other shielding
Reflected and Diffracted Beam

Before personnel with be allowed in hutch both reflected and diffracted beams will have to be addressed.

- Reflected beams looks manageable using common materials and air guards
- Diffracted beams should not be a burn through concern due to their narrow band pass. Multilayers made be a concern.

All cases will be rigorously evaluated
Operations

There will be three phases of hutch HPS implementation:

- **Phase 1**: No access hutches with beam, i.e. no access to Hutch 1 if beam is going to Hutch 2 (~ July – Dec ’09)
- **Phase 2**: No access to hutches with active experiments. Access to hutches with beam passing through. (~ Mar – June ’10)
- **Phase 3**: Access to hutches with soft x-ray experiments, Hutch 1 or Hutch 2.

SXR is working with Radiation Physics on defining and building in the necessary shielding and controls for access soon after SXR operations start.

Operations with samples in the transmission chamber for spectrograph mode will take longer to be approved.
Earthquake Bracing

All chambers will be anchored for seismic safety

• Need to know mass & center of mass of systems well ahead of time

Example: simple system approved and used at SSRL
Facilities

There will be AC Power near the end station
  • How much do we need?

There is limited process cooling water in the hutch.
  • Does anyone have requirements for this and is so how much?
User Interface Control Software

There has been very little development of software at the LCLS for interfacing the user with their experiments

• We need ideas on how it should be done.

• We need to get the attention of the LCLS management.