Summary of XTOD recommendations from the Lehman review on April 23-25, 2002

1) Increase R&D in the damage area as much in advance is possible before experiments take place. At the same time calculations of optical component performance must also be pursued.

Response-We have been unable to find an x-ray source capable of delivering the power loads expected at the LCLS. Instead, we have moved much of the instrumentation downstream by 20-250 m, and are diagnostic plans rely on materials that suffer a dose of < 10 % of that required to melt when placed in the beam. At the same time we have continued our development of simulation codes for testing component designs in the beam.

2) Increase communication with the undulator x-ray diagnostic group.

Response-Diagnostic issues have been discussed between the two groups in several meetings, the two most recent have been the Commissioning Diagnostics Workshop held in January 2004, and the Diagnostic R&D Planning Meeting, held in March.

3) Increase R&D to measure temporal resolution, achieve pulse timing, and measure pulse chirp.

Response-Considerable amounts of R&D funds were expended in FY03 in experimental effort to evaluate a scheme for measuring x-ray pulse length and synchronization with external lasers. The purpose of this experiment was to determine the sensitivity of the sensor to x-rays and the set up had limited capabilities to determine the sensor temporal resolution. The conclusion of this experiment was that the sensor had adequate sensitivity for the LCLS application, but that a considerable amount of funding is needed to implement a high-speed signal acquisition and recording system for the device before we can ascertain that the device has sufficient temporal resolution for our needs.

4) Evaluate the shielding requirements for the connected tubes and other elements.

Response- This is being addressed by Stan Mau group.

5) Assess contingencies based on individual component risk analysis.

Response-This was done project wide for CD2

6) Incorporate lessons learned from third generation light sources for developing optical component specifications and beam line component design.

Response-We have been and plan to continue surveying and consulting with experts from third generation light sources as we progress with component design.

Summary of XTOD recommendations from design review on March 26, 2004 (very preliminary recommendations spoken by the reviewers at the end of the meeting. Final report has not been submitted yet.)

1) Members of the New Technologies Engineering Division at LLNL , who will support the engineering effort, should become involved as soon as possible.

Response-Donn H. McMahon, New Technologies Engineering Division Group Leader at LLNL, will begin working on the project in June 2004.

2)Is fast valve protected from FEL beam? Linac should be interlocked to vacuum trip in beamline? Reliability (i.e. fast-valve false triggers, number of operation cycles)?

Is fixed aperture safe against mis-steer?

Normal-incidence components of moveable slits should be protected by fixed aperture so beam steering errors are not fatal. That probably means that 4.5mm is too large for fixed aperture. Silicon facings (or at least, entire slit jaw) should be easily replaced. Effect of mirror roughness (for hard xray operation) and optimal coating (for low-energy operation) should be explored. Coating stripe on jaw, allowing use with or without coating depending on energy by translating assembly?

Response-The effects of beam mis-steer are overestimated. If the electron beam is not traveling exactly down the undulator axis then the electrons will not produce a damaging FEL beam.

3)Gas attenuator is difficult piece. Deflecting-nozzle should be prototyped. What about mis-steering damage to deflecting nozzles? Plasma window exists; what are numbers for that (i.e. is gas-flow prohibitive cf open nozzle?). Rotating slots are mechanical, failure-prone, particularly if synchronization is lost (beam damage).

Solid attenuator: 'bleaching' issues? This is similar question to later comments regarding scintillator saturation. Choice of B4C is good.

Response-We plan to carefully examine the options for in the physics of the attenuators in FY04.

4)Scintillator camera:

Low-power version. Radiation damage to prism is concern (from high-E spontaneous rad.). Front-surface mirror is better, but introduces second surface to scintillator plate (reflections). Visible light can be brought outside vacuum via window.

Soft xray detectors are always difficult! Thin YAG may be less sensitive to spontaneous background than LSO? Should model them. Also, YAG is fast, with low afterglow.

Indirect imager. Not clear why this is needed. If scintillator can survive incident beam power, then it should be possible to attenuate visible light to reduce sensitivity. Not aware of any reports of scintillator saturation, but this beam is special. In any case, could use gas / solid attenuator to bring beam into range.

If high-E spontaneous is really a problem, then should make silicon mirror to bring out laser beam. It should work in the 0.1 degree range, like the slits proposed, but be a real high quality optic. Then, figure errors may still be unacceptable. Mirror itself will become a strong scatter source. Not clear what reflectivity will do under high-field conditions. Will effective Z be reduced by ionization (and hence critical angle)?

In both cases, it is destructive, and therefore only of use (at this location) during FEL commissioning. One portable version of the low-power device should be made.

Response-We plan to carefully place the components of the direct imager so as to minimize exposure. We also plan to do measurements with YAG crystals in November 2004. The indirect imager is an alternative to the direct imager/attenuator as a means of imaging the FEL footprint. An alternative is necessary since we don't know the scintillator damage threshold, and we don't know how well the attenuators will perform at these power levels. Finally a Beryllium mirror is far less likely to suffer damage in the high-power beam then silicon.

5)Windowless ion chamber:

Devil is in the details. May be OK. Suggest gas detector expert consultant. Many issues: space-charge, full charge collection/recombination at high local ionization levels, electron / ion ballistics and position-dependence of induced charge etc.

Response-none.

6) Spectral measurements for hard x-rays will be easier in far hall (bent-crystal spectrograph as tested at SPPS). SPPS instrument needs a better detector (silicon strip direct-detection device, integrating readout). Assuming a grating instrument is viable for soft x-rays, then near hall would be OK. 10^-4 is easy for hard x-ray, state-of-the-art for soft x-ray. Should consult soft x-ray instrument designer.

Response-Instruments placed in the far hall are more at risk for scheduling conflicts during construction and commissioning, and the effects of beam stability should it turn out to be worse than expected. Therefore the commissioning diagnostics will be located in the first hutch of the near hall, allowing work to continue downstream during commissioning.

8) Pulse length is still a challenge. SSRL interferometer experiments look encouraging, but probably a successful instrument will rely on a correlation technique (laser – xray, xray – xray). No true femtosecond detectors available.

Response-None

9) Commissioning plan:

Should be possible to calibrate and linearize total power meter beforehand. This seems to be simplest device capable of handling full laser power, and should have good dynamic range. It should therefore be the first instrument used to establish lasing, rather than imager. Not clear what it means 'saturate direct imager'. Saturate scintillator, CCD? Not sure scintillator will saturate. Visible light can be attenuated at will, so CCD is not an issue. Don't believe indirect imager is necessary, as discussed above.

Response-We plan to calibrate all instruments as much as possible. The imager is will give us a good picture of the spatial pattern although the total power meter will provide better quantitative information. Both detectors are needed at startup. Saturation during commissioning means that the x-ray levels are high enough to produce a full-scale output on the detector.

10) Kirkpatrick-Baez mirror focusing seems superior to refractive lens systems, both in focal spot size and efficiency. They should be the preferred solution. Mirror sizes are not prohibitive. Not clear what future of lens R&D is.

Response-The high z reflective systems are more at risk for damage than the Low Z. lenses. The lenses serve as an alternative focusing system for the warm dense matter experiments whose focusing requirements are modest.

Vacuum instrumentation:

14) Must be arranged so that vacuum gauges, valves and pump controllers are accessible by LCLS control system (EPICS).

Response-None.