LCLS Newsletter 10-APR-2000

Project Management *Lowell Klaisner, Max Cornacchia*

We need to keep the CDR on schedule to meet our and DOE's objective for funding the LCLS in FY 2003. The CDR is a self-consistent description of the machine that we will cost for submittal to DOE and congress. There will be areas of risk (i.e. areas where the R&D is not complete) and the contingency in the cost will be evaluated based on the perceived risk. We will need to defend the design, the cost, the risks and the contingency for those risks.

We told the TAC that we needed to make the major decisions on the configuration of the CDR machine by the beginning of June. They based the scheduling of the next TAC (May 19-20) to match that milestone. This means we need to decide on the injector (45 degrees to the Linac?), the undulator (FODO or Triplet), the footprint of the experimental hall, etc. by the TAC. This doesn't mean that these parameters can not be changed in the future but it does represent a major step in freezing the design for the CDR.

The CDR should describe a specific configuration. It should not go off into options that we will choose in the future. It can describe the history of how this configuration was chosen but only to the extent that it motivates the current design. The main emphasis is describing the configuration, the parameters, the analysis of the design, and the tolerances. Areas of risk can be identified with contingency plans.

The cost information will not be included in the bound CDR. It will be produced in a companion document. Our first task is to freeze the CDR design and describe that in text. Then we can cost the design and estimate the contingency.

<u>LCLS Conceptual Design Report Schedule</u>

CDR Outline and Responsibilities	November 19, 1999
Draft CDR layout	January 15, 2000
CDR layout plan	February 11, 2000 (TAC Meeting)
Initial Cost Estimate (including guesses)	May 1, 2000
Baseline Design Complete	June 1, 2000
Drafts of all sections Complete	October 1, 2000
Complete Cost Estimate	September 1, 2000
Contingency and Escalation Analysis Complete	November 1, 2000
Final Draft Complete	December 31, 2000
Go to press	March 1, 2001

LCLS General Seminar

The next LCLS seminar will take place on Monday, April 10 at 3:00 PM in LOS 2nd floor conference room. Ingolf Lindau will summarize the discussions and outcome of the recent LCLS Scientific Advisory Committee meeting.

FEL Physics Section Report *C. Pellegrini, H-D Nuhn*

P. Emma and H.-D. Nuhn visited Argonne National Laboratory on Wednesday and Thursday, April 5 and 6, 2000 to discuss tolerances for the FODO and Triplet focusing options with the Efim Gluskin, Nikolai Vinokurov and others. It became clear during the discussions that the Triplet focusing option introduces extremely tight tolerances that can not be met or need considerable R&D efforts to determine if they might me achievable.

Among the most critical tolerances is the internal alignment and long-term stability of the magnetic axes of the three Triplet quadrupoles relative to each other. A misalignment of the center quadrupole by less then a micro-meter will cause a micro-meter-size bump, that will be impossible to detect. The bump amplitude depends on the total alignment of the Triplet assembly and can cause the electron beam to be delayed by thousands of degrees of X-Ray phase with respect to the optical beam, thus making FEL gain unpredictable.

The undulator group agreed, therefore, not to consider the Triplet focusing option any further but instead to accept the FODO option with two slight modifications. (1) An increase in the length of the segment separations for every 2nd or 3rd separation to provide space for X-Ray beam diagnostics and (2) a slight increase in the length of the undulator sections to reduce the number of required sections as much as reasonably achievable.

Nikolai Vinokurov will work out a FODO design that will include these modifications. It seems possible to increase the lengths of the undulator segments from the presently 1.92 m to about 2.5-2.6 m, when the 15 GeV beta-function is increased from 18 m to 24 m. These modifications will only moderately reduce FEL gain but they will require more space for the undulator. This additional space requirement will need to be included in the on-going design of the utilization of the area after the undulator.

Photoinjector R&D News *J. Clendenin*

GTF Status

With the new convex mirrors and Schott rods installed, the laser is too tightly focused, even at 2.5 Hz. This is presumably due to the properties of the Schott glass. The ANL regenerative amplifier is currently at Positive Light to have Schott rods installed. Our plan is next to install even more strongly convex mirrors and/or to operate at 1.25 Hz.

Cathode Testing

The cathode testing apparatus is still at SLAC. It has been configured with a 6-way cross from LLNL rather than the original 5-way cross. The vacuum is still poor. The plan to initially clean with an IR laser has been nixed. The cleaning will be done at LLNL using a small spot UV laser.

It turns out the QE measurements reported from LLNL were made with the laser beam clipped. The QE now measured is several times 10^{-5}.

Undulator *Efim Gluskin/Liz Moog*

P. Emma and H.-D. Nuhn visited this week. After discussions of the tolerances involved in triplet and FODO designs, it was agreed to abandon the triplet design in favor of a FODO design. The tolerances for the first field integral through the triplet are very tight -- the 4 G-cm tolerance on the field integral becomes a half-micron tolerance on position of the central quadrupole. Although 4 G-cm can be measured, prototyping and testing (and the resulting delays) would be required to determine how to achieve the necessary mechanical stability.

Work is progressing on the FODO simulations in order to define the tolerances for the final alignment of the quadrupoles. The positions of the quads after the completion of beam-based alignment are being considered, with the resulting correlated displacements. P. Emma will send data files of displacements remaining after simulated beam-based alignment. In the mean time, a special case of strongly correlated errors has been considered. In this special case where errors are corrected within 2 undulator lengths, the alignment error tolerances are an order of magnitude less demanding than for uncorrelated alignment errors.

Work is also continuing on investigating different acceptable undulator lengths for the FODO design.

X-Ray Optics *Art Toor/Roman Tatchyn*

Optical Compression Task Force

A task force to examine methods to optically compress the 280-fs x-ray pulse to 50 fs or shorter has been convened by C. Pellegrini and A. Toor. At the second task force meeting on January 27, M. Cornacchia presented initial calculations by P. Emma that indicate an energy chirp of up to 4% can be imposed on the photon pulse. This is a preliminary finding, and if it turns out to be correct it is very good news, since it would allow most of the optical methods presently being considered to shorten an LCLS pulse to substantially less than 50 fs. Two separate pulse compression techniques based on the use of dispersive optics to introduce a path difference of ~ 200 fs between the beginning and end of the pulse have previously been suggested by C. Pellegrini and R. Bionta. Slicing of a chirped LCLS pulse using a single diffraction grating and a pinhole has been considered in earlier work by R. Tatchyn and more recently by R. Bionta. An alternative slicing technique based on reflection off a multilayer has also been proposed by R. Tatchyn. R. Tatchyn and R. Bionta will continue to refine the initial calculations for all four concepts and examine the effect of the optics for each concept on the FEL beam parameters.

Instrumentation Development for LCLS Diagnostics

R. Tatchyn has proposed a conceptual "multi-interferometer" approach capable of characterizing both the fine-scale temporal structure and total length of the lasing regions of an LCLS pulse on a single-shot basis. In principle, the method is applicable to pulses substantially shorter even than those generated by the LCLS. Calculations and studies of possible designs are in progress.

Absorption Cell Design

Dmitri Ryutov has completed preliminary calculations for a conceptual absorption cell design. A 25 cm length of xenon at about 75 Torr pressure will provide four orders of magnitude attenuation at 1.5 Å . With a 1 mm aperture the overall length of the cell could be kept to less than 1 m and provide negligible gas efflux with a combination of 100 l/s pumping of the inner chambers and a lower rate of ion pumping just outside of the exit and entrance apertures. Further designs and calculations associated with increasing the aperture size to ~1 cm and studies of potential molecular condensation problems are continuing. Possible adaptation of the basic design to serve as the beam stopper mask at the entrance to the X-ray optics experimental hall will also be explored.