Technical Advisory Committee (TAC)

Report 4: January 12-13, 2001 Meeting

TAC Committee Members:

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Introduction

The purpose of the Technical Advisory Committee (TAC) is to provide expert advice with regard to the R&D program of the Linac Coherent Light Source (LCLS). The report contains (A) general comments and sections on (B) the injector, (C) the accelerator and compressor, (D) the undulator, (E) x-ray optics, (F) FEL Physics, and (G) the VISA experiment.

A. General Comments

The collaboration as a whole is working well. Highlights at the meeting were the use of start-to-end simulations as a collaborative effort, wakefield research, undulator development, and the x-band compressor development.

Congratulations to the LEUTL team for the recent experimental results. We look forward to hearing more in the future.

B. Injector

The electron gun continues to be an area of LCLS that needs considerable work. We are delighted to see that a special task force has been assembled to provide the extra help needed. The task force can help is two important areas:

1. One area is solving the technical problems with the laser and cathodes.
   Problems in these areas have prevented the team from making significant progress in the experimental program.
2. It is important that the most powerful simulation tools available be used to simulate the gun beam dynamics. Most groups around the world have relied on combinations of PARMELA and semi-analytic computational tools to study the beam dynamics. In most laboratories, including the GTF there is considerable disagreement between the experimental data and the predictions of PARMELA and the semi-analytic tools. We note that PARMELA and the semi-analytic approach are in good agreement with each other. One should to ask the following questions:

(i) Are there some subtleties in the experimental setup that have prevented the beams from achieving the conditions used in the simulations?
(ii) Is there some fundamental physics of the beam dynamics near the cathode that is not well modeled by our codes?

We believe that it would be very instructive to analyze the beam dynamics in the first few cells of the gun/linac with a full 3-D electromagnetic code. It is particularly important to pay attention to the impact of non-uniform and asymmetric electron emission, as well as non-ideal rf fields, and non-ideal magnetic field in the focusing solenoid.

We note that wakefield effects are not being included in the current simulations of the injector linac. These should be added to the simulations immediately.

The plans for the development of the Ti:SAF laser for LCLS appear to be well conceived.

C. Accelerator and Compressor

The LCLS linac group is making great progress. Highlights include:

1. The new bunch compressor with x-band compensation,
2. tolerance studies and the low level RF review,
3. start-to-end simulations are being used extensively,
4. design optimization has produced more robust designs with less jitter sensitivity,
5. different scenarios of operation are under study and linac design is flexible,
6. and CSR modeling is using more realistic distributions.

D. Undulator

We are delighted with the work on the undulator. The mechanical design and fabrication progress is excellent. The new quadrupoles look excellent. The beam alignment plan is well conceived.

The vacuum chamber wakefields in the undulator are somewhat of a concern.

We await further results of simulation and the proposed experiment on GTF.

E. X-ray Optics

There are two major points:

1. The generic optics developments for focusing and damage issues should proceed with experiments and characterization.
2. The analogue of “start-to-end” simulations for the proposed experiments has begun for x-ray optics. These need to include all aspects of the source output and stability: for example, the shot-to-shot variation of the central wavelength. These complete designs will provide the focus for x-ray optics developments: monochromators, mirrors, and focusing elements.

F. FEL Physics

We suggest using simulations to develop a base of knowledge including all effects, like wakefields, but with 2 to 4 mm-mrad emittance. The FEL operation with large emittance is much like considering operation at longer wavelengths, like 15 angstroms. It may be essential during the early stages of LCLS development.

G. VISA Experiment

The VISA experiment was to clarify the importance of slice emittance in a high-gain FEL, SASE saturation, and explore the possibility of producing an energy-chirped electron bunch. The costs associated with VISA appear to have been about $500,000 last year.

The most important issues for LCLS relate to the generation, transport and manipulation of the electron beam while preserving beam quality. The injector development, emittance generation and preservation, and diagnostics along the transport path, including the undulator, are crucial. The formation of the SLAC taskforce to accelerate the work on the photo-injector gun is more important to LCLS than is the VISA experiment. While VISA remains an exciting FEL experiment, we do not anticipate it directly influencing the development path of LCLS.

Finally, we should be sensitive to students and post docs who are working on the VISA experiment.