LCLS Newsletter **JULY-2001**

Project Management *John Galayda*

Critical Decision 0 signed by James Decker.

On 13 June 2001 James Decker, Principal Deputy Director (and acting director) of the Office of Science, signed the LCLS "Critical Decision 0" document. This document identifies the "Linac Coherent Light Source (LCLS) project as a unique opportunity for a major advance in carrying out" the mission of the Office of Science.

The Office of Basic Energy Sciences has challenged the LCLS team to

* Fulfill requirements for Critical Decision 1 by January 2002
* Fulfill requirements for Critical Decision 2 by May 2002

A tremendous amount of work lies ahead; but DOE's proposal of these aggressive milestones is a significant sign of support for the LCLS.

An effort will be made to re-steer limited LCLS resources to expedite the production of a klystron modulator for the GTF. This new modulator will drive a 5045 klystron. This will enable the GTF to investigate gun performance at operating parameters more closely approximating those envisioned for LCLS operation.

Ian Evans has agreed to serve as Safety Officer for the LCLS. I look forward to working with Ian to maintain a safe working environment for the LCLS team.

An LCLS update report is on the agenda for the next BESAC meeting at the beginning of August.

Photoinjector R&D News *J. Clendenin*

The present Gun Test Facility (GTF) R&D team consists principally of John Schmerge, Steve Gierman, Paul Bolton, Brendan Murphy, Franz-Josef Decker, Rick Iverson, and Cecile Limborg. Other contributors are mentioned as appropriate in the text below by name.

During the month of June, the glass laser system has run fairly consistently with typically 3.6 mJ in the IR and 10(2.5)% conversion efficiency for 2(4) ps FWHM Gaussian pulses. Just recently, some small burn spots have become apparent on both rods, so the rods will have to be changed soon.

The parts for the second harmonic generation (SHG) “after burner” are due in soon. The design for the external amplifier has been established. These add-ons to the laser system should give us more than enough laser energy in the UV to produce 1 nC shaped-pulses using the present Cu cathode. The add-ons will be implemented during the GTF shutdown that begins in mid-August.

A considerable amount of additional emittance data has been taken for a 2-ps FWHM Gaussian pulse. It is consistent with the data reported earlier. This implies that the day-to-day variation that we now see in the uniformity of the spatial profile is probably not a limiting factor. Some of this and earlier data was included in Paul Emma's invited talk at PAC2001: "Issues and R&D Critical to the LCLS." Emittance measurements for a 4-ps FWHM Gaussian pulse are now underway.

The earlier PARMELA results for a 1-nC beam at the GTF presented by Mike Hernandez at PAC1997 have been reproduced. An emittance of about 1.1×10^{-6} m is predicted with the gun operating with 109 MV/m peak field. The PARMELA results for lower charge, corresponding to the present 2-ps and 4-ps pulses presently in used at the GTF, yield emittances slightly larger than the measured ones, but the simulations for these cases are not yet fully optimized.

Using a measured data set, a comparison has been made of the "online," "offline," and "fractional" emittance calculations. "Online" refers to the rather crude way our present control system can be set up to automatically select the pixels from an entire solenoid scan used for emittance analysis. "Offline" refers to a technique requiring human intervention in an attempt to account for all the detectible signal in CCD images. Generally, the offline emittances are 10-20% higher than the online. Alternatively, one can select the pixels by eliminating all that are less than some fraction of the projected peak value. For the same raw data, the lower the fractional cut, the higher the emittance. The comparison indicates that the online emittances correspond to about 2% fractional emittance, while the offline corresponds to <1%.

The GTF beam is low energy, about 30 MeV. There is a significance space-charge blow-up of the beam between the quadrupole and the screen used for emittance measurements. Solving the envelope equation for our case, it appears the real emittance is significantly lower (on the order of 20%) even for low charge (such as 100 pC), the effect getting stronger as the charge increases. In addition, since we never see spot sizes smaller than 100 μm, there is some suspicion, as reported last month (additional information can be found in A. Murokh et al., "Limitations on Measuring a Transverse Profile of Ultra-Dense Electron Beams with Scintillators," presented at PAC2001), that either the resolution of the profile monitor optical system and screen (YAG) is a limiting factor, or the beam image is blown-up by the YAG. The former is being checked using an Air Force high-resolution target. The latter will be checked by comparing YAG-based emittance measurements with those using a nearby OTR screen. None of the GTF emittance measurements to date have these corrections applied.

For temporal pulse shaping, it is very important that our Hadland sub-picosecond streak camera be useable. Presently the communication software controlling the focus mode is not working. The Hadland representative is promising to be at SLAC just after July 4th to work on this problem. The first measurements when the streak camera becomes functional are: (1) validation of stacker performance, and (2) calibration of laser pulsewidth scaling with compressor grating spacing.

Cathode QE profiles have been repeated. Variations of 10-30% are recorded. In addition data for a Fowler-Nordheim plot has been collected. The results are the same as earlier in the year. These measurements indicate there are no significant changes in the cathode since it was installed last year. This is a not-quite-perfectly-brazed single-crystal Cu cathode. The QE is good, but not better than some amorphous-Cu cathodes we have used in the past. The real improvements in performance are QE uniformity and low dark current. However, above 110 MV/m the dark current increases rapidly. This may be due to the weld rather than the Cu surface. We are considering testing a backplane (i.e., no weld) made from HIP Cu. Based on the work of the Nagoya group (C. Suzuki et al., "Fabrication of ultra-clean copper surface to minimize field emission dark currents," Nucl. Instrum. And Meth. A 462 (2001) 337), the performance of this material, properly prepared, may equal or even surpass that of single-crystal Cu.

A load-lock design for the GTF gun developed by Bob Kirby and Gerry Collet is still being evaluated. Such a device would greatly speed up cathode development as well as improve cathode performance in general.

The LCLS R&D funding for LANL for the coated Cs_2Te cathode test has been mostly pushed forward into FY02. The completion of the load-lock would facilitate the SLAC end of this test.

The moveable pepper-pot has entered the detailed design stage. Lynn Bentson is the mechanical engineer in charge. Manufacture is still anticipated for about August.

The modulator upgrade necessary to support a 5045 klystron for the GTF booster is still in a preliminary state. The two possibilities are conventional modulator, such as already exists for the SSRL injector linac, or an IGBT modulator. The former requires a considerable amount of SSRL and possibly also SLAC labor, while the latter is just money (although cheap) but is still in somewhat of an R&D state.

Most of the hardware for the new GTF control system is in hand. Implementation including associated software is planned for September.

A paper on the 120-Hz gun design was presented at PAC2001 (X.J. Wang et al., "High-Rep Rate Photocathode Injector for LCLS"). It is anticipated that there will be something like a mini-workshop at SLAC later this summer to review the design.

Dave Dowell has accepted a permanent position at SLAC. He will probably begin about October 1st. Dave will also be a Visiting Scientist at SLAC for 2-weeks beginning July 16th.

SPPS

There has been discussion about whether it is feasible to do any short pulse X-ray experiments and LCLS R&D in the next five or six years before the planned LCLS operation. One can imagine using the present SLAC beam and FFTB beamline in the next couple of years (before LCLS construction) and perhaps a replacement for the FFTB beamline in the LCLS era (both during LCLS construction and operation) to generate spontaneous radiation. This radiation is expected to have brightness of order 10^{25} photons/$mm^2 mr^2$(0.1%BW) and pulse lengths of less than 100 fs. The potential for such a source has generated significant excitement and possible scientific experiments are being planned. In addition, beam physics issues for LCLS can also be tested. A possible proposal for the short term, dubbed Short Pulse Photon Source or SPPS, was presented at the last SLAC Scientific Policy Committee (SPC) and was very well received. However there are significant questions about beamline capabilities, design, schedule and compatibility. A task force was set up to look at the technical aspects of both the SPPS and the new beamline and advise the SLAC director. Recommendations on how to proceed are expected around the end of July 2001.

VISA Report *Aaron Tremaine*

VISA, as collaborative experiment, is winding down, but the ATF plans to continue the experiment.

The issue being studied now is the CTR/peak current measurement at the undulator. Measurements after the 2nd linac section give around 70 A, but there is indication that the beam is compressed in the dispersion section before the undulator. Once the analysis is complete, we should have a complete set of beam parameters (current, emittance).

In addition to studying the fundamental radiation in which a gain length of 18.7 cm was measured, we have looked at the harmonics. A series of measurements on the harmonic radiation has been completed. A single shot spectrum has been captured in which the fundamental, 2nd and 3rd harmonics are seen. Also, harmonic energy vs. distance while in saturation has been measured. A gain length of 9.8 cm for the 2nd harmonic (422nm) and 6.0 cm for the 3rd (280nm) harmonic were measured. The spectral width and gain length decrease with harmonic mode, n, from that of the fundamental. The 2nd harmonic energy is comparable to the 3rd and about 1% of the fundamental.