BROOKHAVEN NATIONAL LABORATORY
NATIONAL SYNCHROTRON LIGHT SOURCE

MEMORANDUM

DATE: 14 December 2000

TO: Sam Krinsky, Richard Osgood, Peter Paul

CC: NSLS Management Group, FEL Project Team

FROM: William S. Graves, Richard Heese, Erik D. Johnson

SUBJECT: DUV-FEL Project Report; Period ended 13 December 2000

Work in Progress:

It has been some time since our last report, and there has been considerable activity both on the linac, and in preparation for connection of the linac to the NISUS undulator. Beam studies have been examining the performance of our photo-injector system, and working to achieve the high charge and emittance conditions required for successful implementation of the visible SASE FEL experiment. While this has largely been successful, it has not been without its interesting side trips including significant laser work, a cathode replacement, and some difficulty with the building cooling systems.

Early in November, the high charge work was proceeding reasonably well; beams around 0.3 nC and emittances of 4π mm-mrad or less were achieved. At one point during this work, the laser was focused down to a spot of 1 mm diameter while we were operating with a pulse energy of 190 μJ. This led to a breakdown on the cathode that created a pit on its surface (later determined to be about 120 μm in diameter and 10-15 μm deep). The pit created structure on the electron beam that made it difficult to continue the low charge emittance studies. During the studies, it had been noticed that our laser beam profile (in the UV) seemed to have significant structure on it, leading in some cases to intensity variations of 50% across the spot. This was felt to contribute to electron beam structure at both high and low charge. A spatial filter was quickly installed, which cleaned up the mode structure, but limited the laser energy at the cathode to about 30-50 μJ, making it difficult to perform high charge studies with good laser mode quality.

Because of these problems it was decided to spend some time on upgrading the laser power available at the cathode, and to use the enforced down time of the laser to replace the cathode. To upgrade the laser power, the second two-pass amplifier was brought into operation and the spatial filter rebuilt to work with the higher power. At present a total of 600 μJ of 266 nm light is available, and with the spatial filter in place, up to 140 μJ is available in a 'good mode'.

The cathode plate we removed in July was refinished, pre-baked, and installed. The tuner knobs were re-worked and dial indicators mounted so their position can be checked and reproducibly changed. The gun was then retuned and RF conditioned. Three sentences; about 2 weeks work!

Jim Rose put significant effort into retuning the gun with emphasis on increasing the field in the ½ cell relative to the full cell. This choice was based on modeling and comparison with data from our earlier

studies. At present the beam size exiting the gun has been reduced by about a factor of 2 and the solenoid can be operated at lower currents (down to 80 A) without scraping the beam on the mirrors. Other changes and improvements in the linac electronics have significantly reduced our interlock faults and dramatically improved the stability and reproducibility of the linac. The quantum efficiency of the cathode is lower than we ultimately require, but the laser power is adequate to allow the beam studies program to continue.

Just after the replacement work, our recommissioning was hampered by intermittent failures of the building chiller. Ultimately Plant Engineering tracked the problem down to a failing thermistor and process controller on the chiller. Once the problem was found and replacement parts obtained and installed the system has returned to uninterrupted operation.

We completed another round of fault studies for radiation safety with a larger range of charge than our previous measurements. The data are currently being examined to resolve some ambiguities; neutron dose rates are lower than we expected at the top of the shield wall, and lower than we measured earlier this year. Also there are some discrepancies in the levels measured by different instruments that need to be resolved. X-ray dose rates seem to fit our expectation values in the SAD.

Preparations for the connection of the linac to the undulator are also well under way. Plant Engineering placed the footing for the required external shield wall extension this week, and the additional block will be stacked over the next couple of weeks. Meetings have been held with the BNL and DOE safety professionals to establish the requirements and schedule for completing SAD and ASE revisions by the end of February.

Work is also under way to develop the alignment systems for NISUS. A mock-up test for a laser alignment system with feed-back has been discussed, and key components for testing are on order. A touch alignment system based on a rail is also being designed to determine the physical position of the corrector magnets on the undulator vacuum chamber.

Work Planned for Next Week(s):

The streak camera will arrive next week (12/18), so the laser will be used for testing for two days. We will then return to the beam studies program. After the holidays, we intend to run a beam studies program through January (at least) and continue operation of the linac in its present state as long as possible before breaking down for NISUS installation. The COUR experiment and Edge radiation measurements have been awaiting beam for some time. It is important to obtain some results before the configuration change-over. This is especially true for the Edge experiment, since the planned movement of the second dipole magnet in the dump line basically eliminates it from the machine.

Management:

Several factors loom large in planning the schedule for early next year. Running long enough to extract publishable results from the linac before changing configurations while meeting our commitment to produce FEL radiation (the main thrust of the project) is the key issue. Another factor influencing our schedule for the changeover will be the completion of components in the shops. This situation will need to be monitored closely to get the maximum productive output from the project.