NPS BPL AND FEL FACILITY UPDATE *

K.L. Ferguson†, C.W Bennett, W.B. Colson, J.R. Harris, J.W. Lewellen, S.P. Niles, B. Rusnak, R. Swent, Naval Postgraduate School, Monterey CA 93943 USA
T.I. Smith, Stanford University, Stanford CA 94305, USA

Abstract

The new experimental facilities for the Naval Postgraduate School Beam Physics Laboratory (NPS-BPL) are at the 95% completion level for exterior construction, and work has begun on the internal lab spaces. A general timeline for the commencement of first experiments is presented, along with an overview of the experimental path forward. The NPS-BPL is rated for considerably higher average powers (40 kW) than most university accelerator facilities, which presents unique challenges in both the physical and administrative realms. Design considerations, radiation approval processes and other lessons learned in a non-U.S. Department of Energy government facility are discussed.

PROGRAM GOALS

The Naval Postgraduate School is committed to the construction and operation of a free-electron laser and accelerator physics test bed, NPS-BPL. One of the primary missions of the NPS-BPL is student education. NPS grants Masters and Ph.D. degrees in a variety of disciplines, including physics, mechanical and electrical engineering. Accelerators by their nature require multidisciplinary efforts to construct, operate and characterize; thus, the NPS-BPL represents an opportunity for cross-disciplinary study and research. The NPS-BPL experimental program is intended to address technical challenges relevant to next-generation accelerator, light source and FEL design, and the study of topics of fundamental interest in accelerator physics. There is, naturally, substantial overlap, such as beam merger design, coherent synchrotron radiation effects, and beam halo formation. NPS-BPL will house the NPS FEL accelerator, control room, and associated facilities[1].

FACILITY

Location

The NPS-FEL laboratory is located in a research complex at the Monterey Pines golf course, a Navy-owned facility adjacent to the NPS main campus. The NPS-FEL laboratory building is one of several research buildings at Monterey Pines, including a jet-engine test laboratory, several wind tunnels, oceanographic laboratories, machine shops, and a flash X-ray facility.

* Work supported by the Office of Naval Research and the High Energy Laser Joint Technology Office.
† klfergu1@nps.edu

Figure 1: Vault exterior

Building

The building (Figures 1 and 2) is a two-part structure consisting of a vault for the accelerator and a lab for the control room, laser room, and other required spaces. The vault facility is new construction concrete with interior dimensions of 40 feet by 80 feet, with 3-foot thick walls and 2-foot thick ceiling for radiation shielding. The foundation is 6 feet wide to accommodate future wall extension if needed for additional radiation shielding. There is a 10x12 foot bay door at one end for large equipment access, and a personnel maze connecting to the lab/control side at the other end. The lab side of the building is also 40 feet by 80 feet with plans for a control room, workshop, laser room, and other technical space as required. A ribbon-cutting ceremony was held in December 2009 to mark beneficial occupancy of the building shell. Follow-on work includes installing a shielding door on the vault, outfitting the control room, and installing a cryogenic plant for superconducting radio-frequency (SRF) applications.

ACCELERATOR

The initial design configuration for the NPS FEL will be a traditional in-line arrangement without energy recovery[1]. Eventual upgrade to an energy recovery linear accelerator (ERL) is planned. Movement of the NPS SRF electron gun from initial testing offsite is expected to commence this fall, with follow-on testing in the vault and use of this as the baseline system to configure the control room and remote access to the vault.

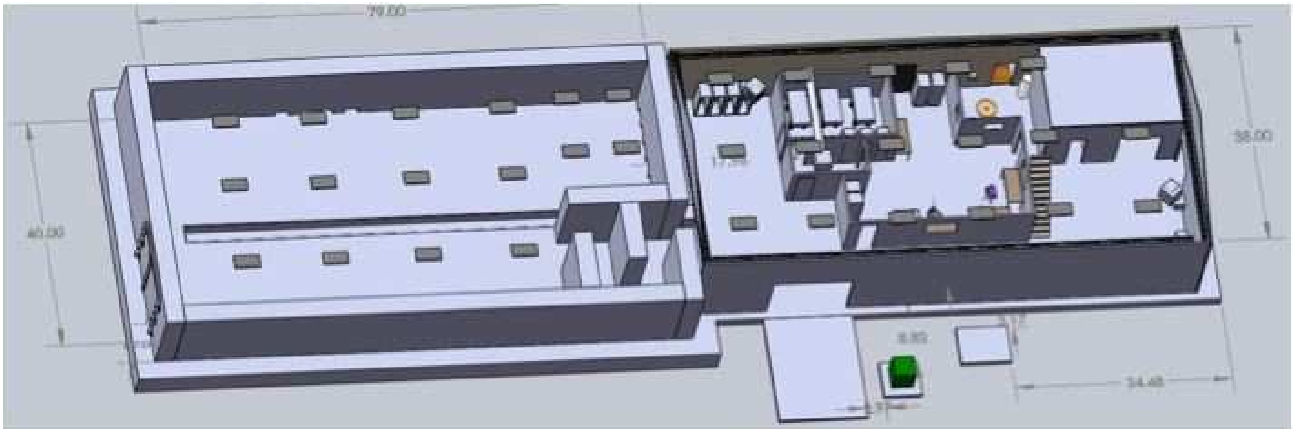

Figure 2: Design of NPS FEL building showing control room and vault space.

ONGOING EXPERIMENTS

In addition to the laboratory building construction, additional experiments have been ongoing both at NPS and offsite facilities. A superconducting RF electron gun was built and is undergoing testing at Niowave, Inc. in Lansing, Michigan. Further details of the SRF gun can be found in paper WEPB28 of these proceedings. Also the original thermionic electron gun from the Stanford SCA has been modified to a photoelectric gun for additional testing. Three dedicated cathode test stands have been designed and built to support specific research areas. The first is a dispenser cathode test stand to determine how much material enters the vacuum system from a dispenser cathode (Figure 3) in order to investigate suitability for an ultra high vacuum SRF gun or accelerator system. The second is a field emission cathode test stand (Figure 4) to investigate suitability of a diamond field emitter array (Figure5) as a cathode. The third is a photocathode test stand to continue laser/cathode studies (Figure 6). The design, construction, and initial experimentation with two of the stands served as Master's theses projects for recent NPS graduates[2][3]. All three test stands are standalone systems with integrated vacuum and diagnostics that do not require larger accelerator structures and can test multiple cathode technologies. They allow for design and evaluation for future FEL systems.

Figure 3: Dispenser Cathode example tested to determine level of material off-gassed into the vacuum

LESSONS LEARNED

Due to personnel turnover in the radiation safety program at NPS, FEL experimental work at NPS on the Stanford SCA gun was temporarily halted. This also affected the planned move of the NPS SRF gun to NPS for initial experiments. Backup plans were put in place to test the NPS gun at the manufacturing facility, as well as continue design work and experimental work on the dispenser cathode test stand until radiation permission is obtained. Having alternative research topics and hardware is very important when the average Master's student enrollment time is only two years at NPS. Lengthy delays in experimental systems can not be absorbed by the student schedule because of military requirements. The small size and portability of the three cathode test stands enables research to continue in smaller lab facilities while the larger building is completed. The final outfitting of the FEL lab has been delayed because of the radiation safety program issues so the original timeline goals have been modified to accommodate the delay. Having alternative experimental research plans proved to be valuable when the primary research areas were delayed due to external issues.

CONCLUSIONS

Construction is nearing completion on the Naval Postgraduate School free-electron laboratory, NPS-FEL. The laboratory will be capable of hosting the intended 40 MeV, 40 kW electron accelerator as well as other ongoing re-

Figure 4: Diamond Field Emitter Cathode test stand

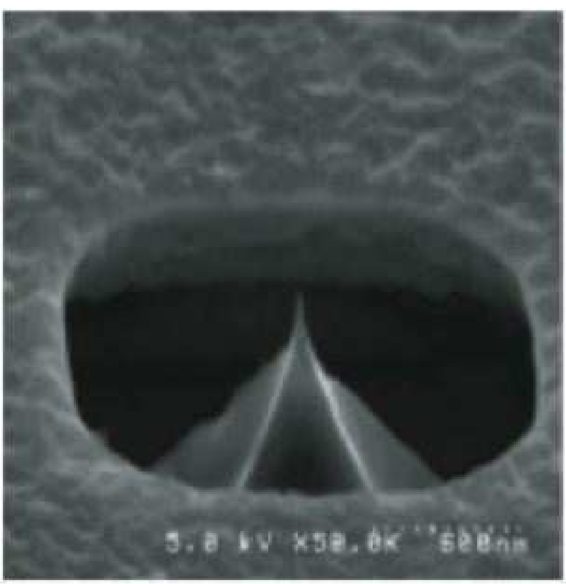

Figure 5: Single Diamond Field Emitter example

search programs in cathodes and beam transport. Research on multiple cathode systems is ongoing including photoelectric, thermionic, and field emitter systems. The NPS SRF gun will be moved into the new facility this fall to continue the NPS FEL construction and testing.

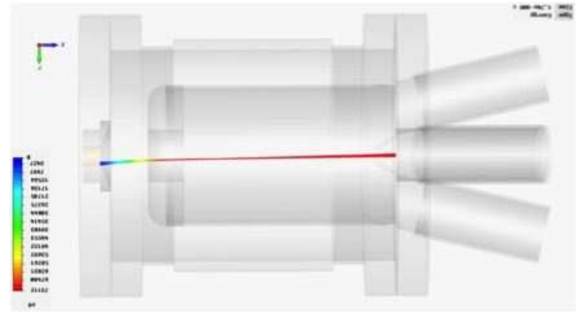

Figure 6: Photoelectric cathode test stand schematic

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