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COLORADO STATE UNIVERSITY (CSU) ACCELERATOR AND FEL FACILITY

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Abstract

The Colorado State University (CSU) Accelerator Facility will include a 6-MeV L-Band (1.3 GHz) electron linear accelerator (linac) with a free-electron laser (FEL) system capable of producing Terahertz (THz) radiation, a laser laboratory, a microwave test laboratory, and a magnetic test laboratory. The photocathode-driven linac will be used in conjunction with a hybrid undulator capable of producing THz radiation. Here, a summary of the systems used at the CSU Accelerator Facility is discussed. The building construction is completed and equipment move-in has begun. The first beam is expected to occur by mid 2015.

THE ADVANCED BEAM LABORATORY

The goal of the Advanced Beam Laboratory (ABL), Fig. 1, is to have a facility that houses both accelerator and laser technologies together. This will allow for the merging of the two technologies to perform novel science that could not be accomplished independently. In addition, the ABL will serve as a training facility in accelerator science for engineers and physicists from high-school up through to post-doctoral researchers.

Figure 1: ABL building.

CSU Accelerator Laboratory (CSUAL)

A major component of the CSUAL is a 6-MeV 1.3 GHz photocathode-based electron linac. Our L-band RF system is capable of producing 15-μs pulse durations at 10 Hz. Basic details are given in Table 1.

Table 1: Parameters of CSU Accelerator Laboratory

Laser Frequency	81.25 MHz
L-Band RF Gun Frequency	1.3 GHz
L-Band RF Gun Energy	6 MeV
L-Band Macropulse Length	15 μs
Repetition Rate	10 Hz

Electrons from a high QE cathode can be emitted at up to the 81.25 MHz rate. We expect to achieve up to a few nC per bunch The floor plan of the CSUAL with the shielding wall is given is Figure 2.

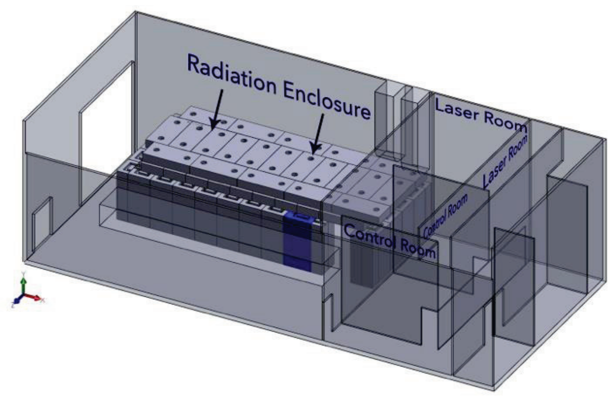

Figure 2: Floor plan of the CSUAL with shielding wall.

FEL AND UNDULATOR SYSTEMS

The CSU FEL, Fig. 3, will provide tunable radiation between 200 – 800 microns. The FEL will generate roughly 1 MW of peak THz power and a few mW of average power using 20 ps long bunches arriving at 81.25 MHz over 15 μs. Table 2 provides parameters of the undulator.

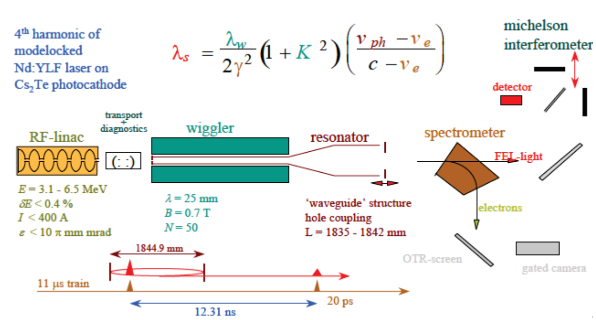

Figure 3: A schematic of the accelerator and FEL.

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Table 2: Parameters for Undulator

Type	Hybrid: NdFeB
K parameter	1 (at 8 mm gap)
Period	25 mm
Number of Periods	50

Drive Laser System

A Coherent Ti:S laser system will be used as the drive laser for the accelerator as well as facilitate other experiments. Its parameters are given in Table 3.

Table 3: Parameters for Accelerating Cavity

Micro Oscillator	
Avg. Power	> 300 mW
Rep. Rate	81.25 MHz
Pulse width	< 35 fs with ext. comp.
Legend Elite Duo Amplifier	
Avg. Power (at 800 nm)	> 10 W @ 1kHZ
Avg. Power (at 256 nm)	> 1 W @ 1kHZ
Pulse Duration	40 fs (FWHM)

Cathode Preparation Chamber

The cathode preparation chamber system will allow for the preparation and testing of a variety of novel photocathode materials. These can then be inserted directly into the injector for use.

Pulse Power Beam System

Figure 4 shows one of our existing klystrons, an L-band (1.3 GHz), 20 MW Thomson TV2022 type tube (left) and modulator system (right).

Figure 4: 1.3 GHz klystron and modulator system at CSU.

Control System

The existing control system (Fig. 5) for the CSU accelerator is based on NI LabVIEW and consists of SAIA PLCs for critical safety controls, a Microsoft Access database, a Beckhoff Soft PLC, an NI VXI chassis, a Beckhoff Lightbus system for fiber communications to PLCs, and associated control PC interface cards.

The major LabVIEW routines include PID-based cavity field control, cavity resonance monitoring, cavity conditioning routines, diagnostic monitoring, and an alarm-and-limit system.

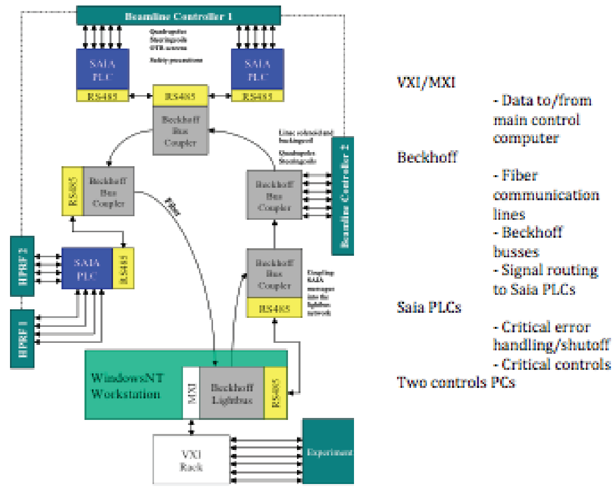

Figure 5: Control system diagram of CSU linac.

Linac

Figures 6 and 7 show schematics of the injector/linac as well as computed and measured field profiles and resonances.

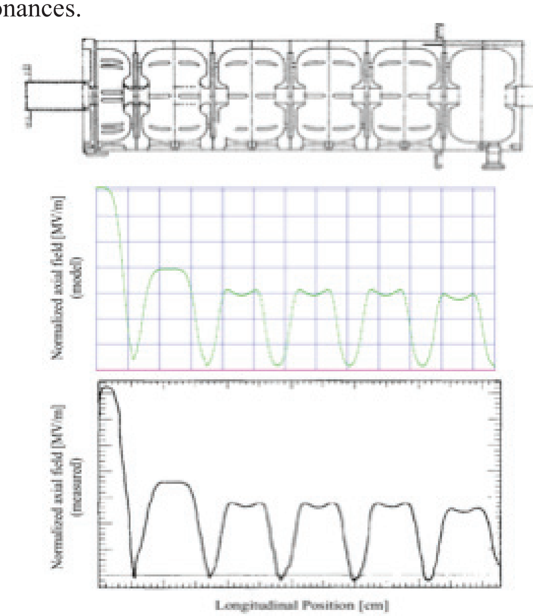

Figure 6: Field pattern of 5+1/2 cell LANL electron gun.

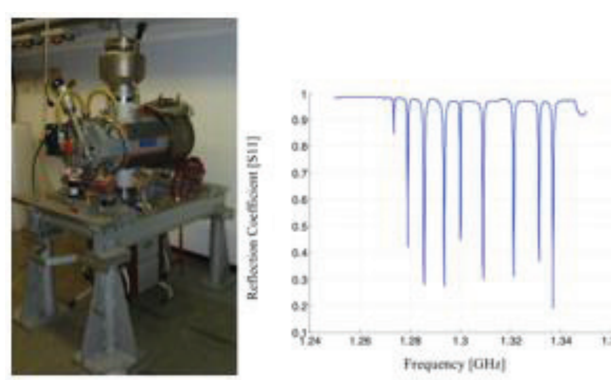

Figure 7: 5+1/2 cell LANL photocathode electron gun assembly and reflection coefficient results.

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LLRF Measurements

The master oscillator (MO) measurements have been done using the set up in Figure 8 and have shown to be adequate.

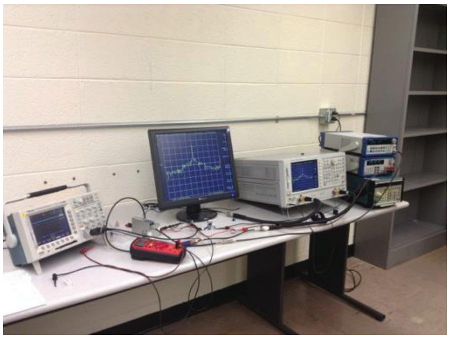

Figure 8: 1.3 GHz MO frequency measurement set up.

HPRF Transmission Component Measurements

We have measured all high-power passive RF components such as loads, directional couplers et cetera. An example measurement set up and results are shown in Figure 9.

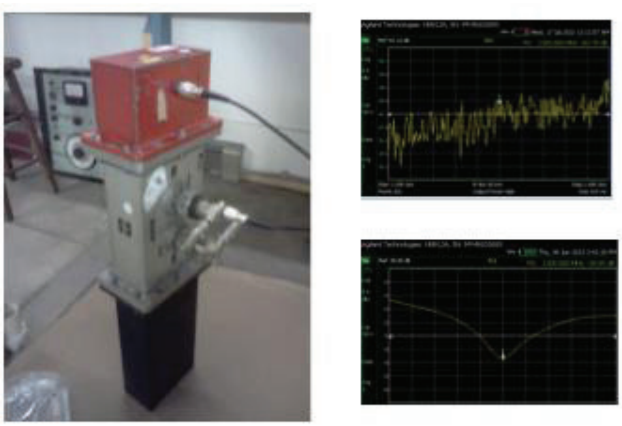

Figure 9: 1.3 HPRF directional coupler measurement set up and results at CSU.

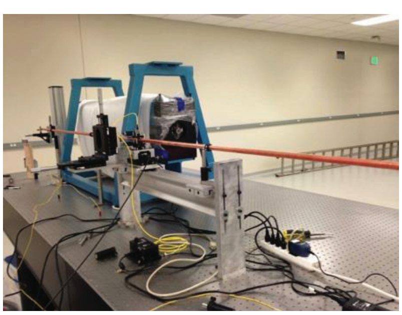

Figure 10: Pulsed-wire measurement set up.

Magnet Measurement Laboratory

A pulsed-wire measurement system (Fig. 10) has been constructed to measure the undulator magnet and preliminary measurements have been taken (Fig. 11). Once the undulator field is mapped, shims will be used for any needed corrections.

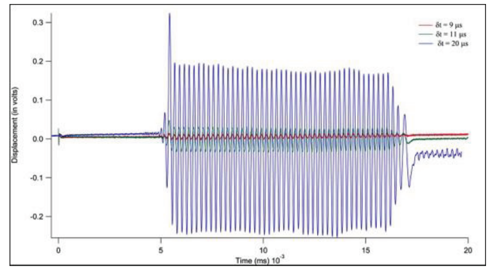

Figure 11: Pulsed-wire measurement results.

SUMMARY

The CSU accelerator system is coming together and once completed will provide high-brightness electron beam for a wide variety of experiments and research. Coupled with the adjacent high-power laser systems it should provide unique opportunities in the area of beam science and technology.

ACKNOWLEDGMENT

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