STATUS OF THE BNL ENERGY RECOVERY LINAC INSTRUMENTATION

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Abstract

The Energy Recovery Linac (ERL) project is currently under construction at the Brookhaven National Laboratory. Energy recovery operations are expected with high intensity beams that have current up to a few hundred milliamperes, while presenting the emittance of bunches with a charge of a few nC produced by a high current SRF gun. To successfully accomplish this task the machine will include beam diagnostics that will be used for accurate characterization of the beam phase space at the injection and reacceleration energies, transverse and longitudinal beam matching, orbit alignment, beam current measurement, and machine protection [1]. This paper describes the recent progress and present status of the systems that will be used to meet these goals. We expect first electron beams later this year.

Introduction

The diagnostics requirements have been described in several previously published papers [2,3]. There is a progression of ERL facility stages planned in order to move forward toward commissioning energy recovery operations. The diagnostic system configurations vary for each stage. The initial stage for beam testing includes the 2MeV SRF gun, a straight beam transport to an in-flight ILC, then to an isolated blanket CFW flange acting as a Faraday Cup. After gun testing with different cathodes we will extend the straight beam transport to include a pelletron pettine station. When the beam parameters are acceptable we will connect the transport to the injection SRF gun and deliver a beam to a low power dump after the 5-Cell SRF. The early commissioning stages are limited to 70W operation by the relatively small temporary beam dumps. The full complement of all of the ERL planed instrumentation subsystems, including devices in the energy recovery loop and high power beam dump, are shown in the figures to the right.

Beam Current Monitors

High precision DC current measurements will be made using a matched set of four Berkeley NCEA-111 DC current transducers (DCCT) and standard PC/T electronics.

There will be one of each installed in the injection and extraction transport beam lines. These DCCTs are configured in a dual mode [4] that will simultaneously monitor the beam by a low-noise Khovalev model 527 current sensor. The output level of the dual DCCT is full scale as a reference to the internal source to drive the dual DCCT output to zero. The output of the pair DCCT is then a differential current measurement.

The DCCT signal processing will be done using a National Instruments PXI-6124 8-slot chassis with a PXI-5121 4x16 I/O PCIE controller and a set of PXI-6439 432 AIN, 64-bit/digitizer for handling system tasks that include absolute and differential measurements. RMS (magnetic field, thermal, and gap compression) will be automatically removed by periodic scaling without beam. The anticipated sub-20% resolution may permit using this diagnostic as a second layer of the machine protection system [5] in the case the beam loss monitoring fail to detect beam losses.

Dipole Profile Monitor

A pair of specially designed YAG Dipole Profile Monitors will be provided, they will plunge into the beam path inside of the two injection 30 vertical dipole chambers as shown in the figures below. Proxie positioning will be provided by a stepper motor actuated plunging mechanism with a 4-inch stroke, containing a long YAG screen holder that extends into the dipole magnetic chamber through an auxiliary port to intercept the electron beam. The beam can be imaged at different places on the crystal including the edge depending on the plunge depth. This can be useful for semi-destructive beam halo monitoring. A specification and statement of work has been prepared, we hope to receive these devices from the vendor next year.

GigE Imaging Cameras

Images from the YAG and OTR screens are transported through a mirror labyrinth to a 5-motor lens and CCD camera in a local enclosed optics box. Communication cable length requirements and poor support for FireWire L394 cameras in the W55 and W58 Redfield Linacs warrants we currently use has prompted a migration to Gig camera technology for digital imaging tasks within our controls subsystems. The Manta G-21B from Allied Vision Technologies is the camera we plan to use for early operations. A software middleware layer is implemented using Arvax, an open-source glib/object based library which enables video acquisition from genicam based cameras, which makes the images available to various viewing and image processing applications. Users can control parameters such as image size, bit depth, resolution, exposure, gain, gamma, binning, triggering, etc. The images are used to characterize the beam and can be stored for later examination and calculation of projections, centroids, etc.

REFERENCES