CERN – EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CLIC – Note – 903

STUDY AND EXPERIMENTAL CHARACTERIZATION OF A NOVEL PHOTO INJECTOR FOR THE CLIC DRIVE BEAM

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Abstract

Abstract In this thesis, the transverse and longitudinal beam properties of the PHIN photoinjector are characterized. The ob jective of the research is to demonstrate the reliable and stable production of a 1.3 μs long bunch train, with 2.33 nC charge per bunch and 4.5 μC of total charge, by the PHIN photoinjector. The results of this thesis are the important steps towards the feasibility demonstration of a photoinjector as the Compact Linear Collider's drive beam source. The PHIN photoinjector has been conceptualized by a collaboration between "Laboratoire de l'Accélérateur Linéaire (LAL)", "Rutherford Appleton Laboratory (RAL)" and "Organisation Européenne pour la Recherche Nucléaire (CERN)". Within this collaboration, LAL and RAL have committed to the design and the construction of the RF gun and laser, respectively. The photocathode production as well as the overall coordination and commissioning were under the responsibility of CERN. The pro ject is in the framework of the second Joint Research Activity PHIN of the European CARE program. The photoinjector has been installed, in 2008, on a dedicated test-stand at CERN. During the commissioning of the PHIN photoinjector, the beam properties have been studied by rigorous systematic measurements and simulations. The maximum charge per bunch yield of the C s2 T e cathode has been found to be 4.4 nC , in agreement with the theoretical limit of 4.7 nC . The transverse normalized emittance, beam energy and energy spread have been measured both in a single shot and the time-resolved manner. The single shot measurements revealed useful information about the shot-to-shot stability of the beam properties, whereas the time-resolved measurements have reflected the stability along the bunch train. The multi-slit emittance measurement set-up, OTR profile monitors with gated CCD cameras and a segmented beam dump have been designed, implemented and utilized for the main measurements. The experimental characterization and the numerical studies clearly indicate the feasibility of a photoinjector within the specifications defined by the existing CLIC test facility. Further simulation and design studies have been conducted based on several modifications of the current PHIN RF gun design. In this successive model an RF gun with the specifications of the CLIC drive beam has been investigated and proposed as the preliminary design for the future CLIC drive beam injector studies. Keywords: Photoinjector, RF gun, CLIC drive beam source, space charge dominated electron beam, multi-slit emittance measurement.

Geneva, Switzerland
Date 02/08/2011