THE SYNCHRONIZATION SYSTEM BETWEEN RF WAVE AND THE LASER PULSE IN THE PHOTOINJECTOR

Shengguang Liu, Yonggui Li
Free Electron Laser Lab, IHEP, CAS, Beijing China 100080

Abstract:

The synchronization between RF wave and the laser pulse is one of the key questions in photoinjector, it effects the stability and reliability of injector. We design a sampling phase-locked electronic circuit which compare the phases of RF wave and the 28^{th} harmonic of laser pulse .It enhances the synchronization precision.

1 Introduction

The basic components of an RF photoinjector [1], illustrated in Fig. 1, consist of an RF gun with a photocathode, a laser and optical system producing the desired pulse structure, an RF source, and a timing and synchronization system.

The photocathode is made of material which has low work function. Mode-locked laser pulses illuminate the cathode, a great amount of electrons send out from the surface of cathode because of the photoemission effect .RF power input the gun at the most suitable moment and set up a strong electromagnetic field. The axial electronic field accelerate electrons to the exit of RF gun. The synchronization system is to choose a suitable timing relation between laser pulses and RF pulses and keep it.

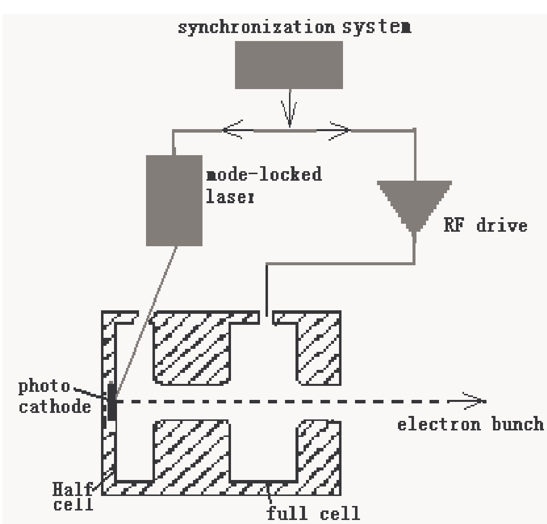

Fig. 1 Principal components of an RF photoinjector

2 The synchronization system

2.1 Procedure of the synchronization [2]

As show in Fig2, two signals send out of the microwave power. The big one be transmited to Klystron and amplified to 5MW, then pumping RF gun, it's phase can be adjusted by Phase shifter; The small one be amplified to a certain degree and into the phase detector as singal 1.

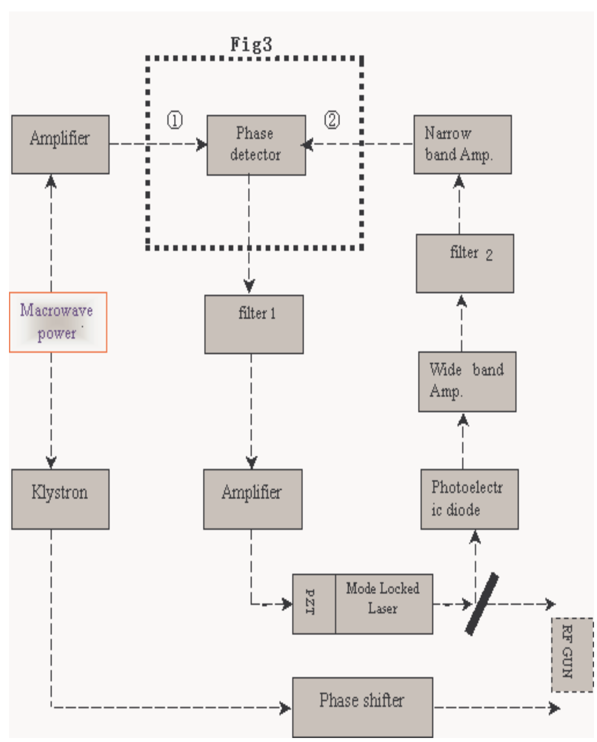

Fig. 2 The synchronization system

The mode-locked lasers send out short pulse laser. We stick the reflector of optical cavity on PZT. Laser be splitted into two light beams by light splitter, The big one incidents upon the cathode surface of RF gun as the driving laser, the small one be changed into electronic signal at first, then be amplified and through the special filter2, the filter2 can choose out the 28th harmonic of the laser pulse, it is the signal 2 into the detector. The detector gives off a voltage signal which depend on the phase relation between RF and laser pulse, the voltage signal works on PZT.

2.2 Principle of phase detector

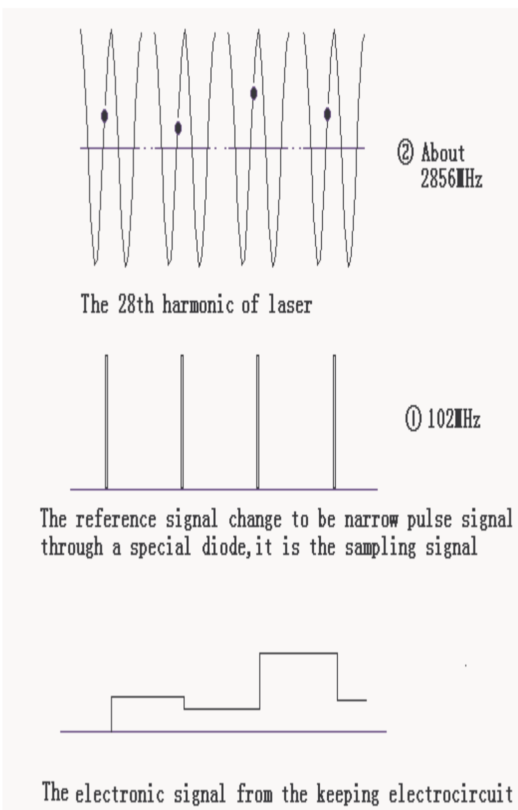

Fig. 3 The principle of phase detector

The interval of laser pulses T is 2L/c, L is the length of optical cavity .The reflector of optical cavity is sticked on PZT. The length of PZT vary with the change of error voltage signal V and the value of error electronic signal V depends on the time relation between microwave and laser pulse. Therefore the time relation between microwave and laser pulse changes, V changes, L changes, T changes, the time relation between microwave and laser pulse can be adjusted and keep stable. Illustrated in Fig. 3.

3 Simulation and the primary experiment result

3.1 In order to get the parameters of synchronization system, a simulation experiment was made with a VCO (voltage control oscillator) in the position of lasers in Fig2. The result show that the catching bandwidth is about 1MHZ.

3.2 Fig4 is the mode-locked laser pulses we got recently, the frequency is 87.25MHz.

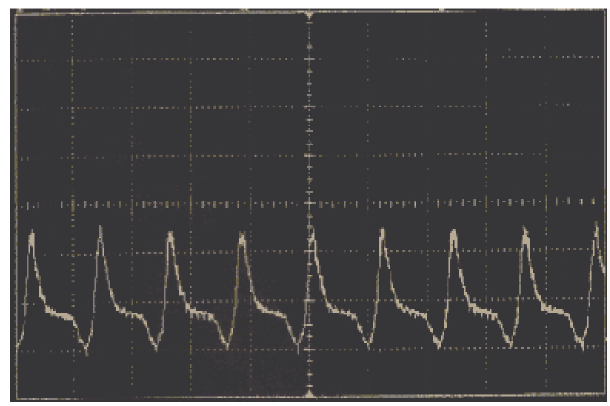

Fig. 4 Mode-locked laser pulses

References

[1] J. E. Clendenin, “RF PHOTOINJECTORS”, **Linac96**, Stanford 1996

[2] G.M.H.Knippels et al., “Sub-picosecond synchronization of a 10-fs-Ti: sapphire laser to FELIX.”