Study of beam dynamics of electron beam in a microtron for KAERI THz FEL

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Abstract

Microtron is the device that accelerates the electrons with circular orbit. Electrons in a microtron are accelerated by an alternating electric and a uniform magnetic field in a RF resonator. The electrons must have exactly same phase of acceleration electric field which is supplied from a magnetron to gain the certain energy at each passage through the RF resonator. Korea Atomic Energy Research Institute has operated microtron with thermionic cathode for the THz Free Electron Laser (FEL) generation and has a future plan of photocathode microtron for compact FEL. We will present the studying on the dynamics of electrons in a microtron with thermionic cathode and measure the current and the energy of each orbit in using PIC code.

Basic concept of Microtron

Circulation orbit

Transfer matrix at microtron

Phase stability

Criteria for longitudinal stability: \( -2 < T_R(RM) < 2 \)

For \( n = 1 \cdot 2 \pi \phi = 0 \)

At 2.8 GHz, \( r = 2 \) and \( l = 1, 8 \) 0.08 – 0.12 T & phase stable region \( -90^\circ \) to 122.5°

Properties of RF

Emission current

Loss of the resonator

Driver voltage

Electron acceleration voltage (center of resonator)

Dynamics of Electron beam

Properties of electron beam after 11th orbit

Average current of electron beam

Average voltage of electron beam

Average power of electron beam

Conclusion

Recently, high power femtosecond THz FEL is under development for pump-probe applications at KAERI, using photocathode. In thermionic emission, the several bunches of electrons with different radius are accelerated at the same time, while only one bunch with high peak current is accelerated in photocathode emission. Unlike to thermionic cathode, high peak current may degrade the beam quality due to RF instability.

To upgrade thermionic cathode to photocathode, We has simulated the microtron with photocathode code.