A.2 : Particle source part I (9, December, 2013) by Masao KURIKI

Answer the following questions.

Q.A2.1 According to several technical limitations, the size of the cathode active area is 6.0mm in radius. The laser is illuminated on the cathode with the same area and the intensity is flat. To extract the beam, 250kV bias voltage is applied between the cathode and anode with 100mm gap. To extract the required bunch charge (3.2nC), how much is the appropriate laser bunch length? Please assume that the extractable current density from the gun is limited by space charge effect.

Q.A2.2 How much energy spread ($\Delta E/E$) is expected if we inject directly the bunch to 1.3 GHz RF accelerator? Please assume that the bunch center is on crest and ignore beam-loading effect of the accelerator and space charge effect.

Q.A2.3 The energy spread of calculated in Q.A2.2. is likely to be larger than DR acceptance in energy (1.5% full width). We need bunching prior to the RF acceleration. As the bunching RF cavity, we employ a 650MHz RF cavity. The shunt impedance of the cavity is 2.0×10^6ohm and input RF power is 5.0 kW. What is the distance from the cavity to the first accelerator? Please assume only the linear term in the bunching.

Q.A2.4 How much bunch length is expected after the bunching? Please assume only the linear term. Laser wavelength for the beam generation is 700nm and the band gap of the GaAs crystal is 1.4 eV. The cathode temperature is 300 K.

Q.A2.5 By considering the next higher order on the energy modulation, the bunching performance is not good as expected obtained in Q.A2.4. How much extra bunch length is expected by this non-linearity?

Q.A2.6 By assuming the bunch length obtained in Q.A2.5, how much energy spread is expected at 5.0 GeV when we employ 2.6 GHz RF accelerator? Is this acceptable by DR (70mm z, 1.5% energy spread)?