

# INJECTOR FOR HIGH CHARGED ELECTRON BUNCHES

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## *Abstract*

We have designed an injector based on a 500 kV dc gun which can transport high charged electron bunches with the bunch charge of 1~2 nano-Coulomb(nC) maintaining an excellent beam quality. The resulting bunch can easily be manipulated to produce about 1 kA peak current after a magnetic bunching by about a factor of 2 to 3 which can be accomplished in the injector itself or in the main machine at a higher energy.

## NANO-COULOMB BUNCHES

Recently, we showed that a low emittance injector based on a photocathode dc gun can be designed with the help of the emittance compensation scheme [1,2]. Subsequently, we reported an injector design capable of producing an extremely low emittance and short bunch length beam for 80 pC electron bunches [3].

In this note we briefly report that we now have a high performing injector design for 1 to 2 nC electron bunches which could serve as the injector for an electron-ion collider project being proposed [4]. The design is again based on [2].

As in all our previous reports we assume that the bunch distribution at the cathode is Gaussian in both longitudinal and transverse directions. The rms bunch length of laser pulse is 20ps and the total beam bunch is initially 80 ps long. Beam parameters achieved at 10 MeV beam energy are:

<b>Bunch Charge</b>	<b>1 nC</b>	<b>2 nC</b>
$\epsilon_x(\text{mm-mrad})$	7.5	10
$\epsilon_z(\text{deg-keV})$	30	50
$\sigma_z(\text{ps})$	4	5

The injector performance is quite impressive as evidenced by the beam quality shown in the Table. However, we also should note that these values are at a location just before the injector chicane which could simply consist of three 20 degree bending magnets as in the Jefferson Lab IR-FEL. This chicane can be used for a further bunching by a factor of 2 to 3, if necessary.

An extensive study with Jlab version PARMELA during the design of the present IRFEL injector has shown that a well matched beam can be transported through the chicane without any noticeable further emittance degradation for an electron bunch with the charge up to 135 pC. As the bunch charge for which this injector is designed is an order of magnitude larger, the beam quality preservation in the bends is an important research topic for a further study. We are in the process of assessing effects to beam quality of the injection chicane for a bunch at  $\sim 1$  nC bunch charge level.

#### REFERENCES

- [1] B. Carsten, "New Photoelectric Injector Design for the Los Alamos National Laboratory XUV FEL Accelerator", Proceedings of the 10<sup>th</sup> International FEL Conf., Jerusalem (1988).
- [2] B. C. Yunn, "A New Low Emittance Injector for Future FEL Upgrades", Jlab Technote, Jlab-TN-01-009 (2001).
- [3] B. C. Yunn, "A Photocathode DC Gun Based High Brightness Injector", Jlab Technote Jlab-TN-01-021 (2001).
- [4] EPIC and/or EIC projects (2000).