LEETCHI: THE HIGH CURRENT ELECTRON SOURCE FOR THE CLIC DRIVE BEAM INJECTOR

Kévin Pepitone (kevin.pepitone@cern.ch), Steffen Doebert, CERN, Geneva, Switzerland
Baptiste Cadilhon, Bruno Cassany, Jacques Gardelle, CEA/CESTA, Bordeaux, France
Danish Nawaz, PAEC, Islamabad, Pakistan

Abstract

LEETCHI is a source which will produce 140 keV, 5 A, 140 µs electron beams at a repetition rate of 50 Hz. The shot to shot and flat top current stability of this drive beam injector for CLIC has to be better than 0.1 % and a geometrical rms-emittance of 14 mm.mrad is expected.

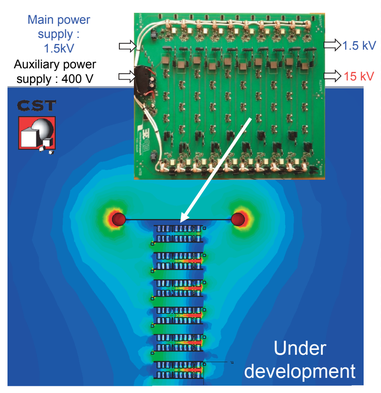
The development of a high voltage modulator, to achieve those requirements, is ongoing. A small test stand has been built which allows to diagnose and dump the beam produced by the thermionic cathode. The thermionic cathode is equipped with a grid which will allow us to control the current and eventually to have a feedback on the flattop shape. The beam dump, made of graphite, has been designed using two different codes, the Monte Carlo code GEANT4 to simulate the energy deposition and ANSYS used to simulate the thermal resistance of the graphite due to the long pulse duration. The geometry has been optimized with the ray tracing code EGUN and the 2D PIC-code MAGIC. All these simulations allowed us to optimize the geometry of the gun and to develop diagnostics which must survive to the heat deposition. Finally, the first electrical measurements of the beam will be presented.

Beam Parameters

Parameters	Values
Gun voltage	140 kV
Beam current	5 to 7 A
Pulse length	140 µs
Repetition rate	50 Hz
Emittance (rms)	< 20 mm.mrad
Shot to shot charge variation	0.1 %
Flat top charge variation	0.1 % after correction
Average power	4.9 kW

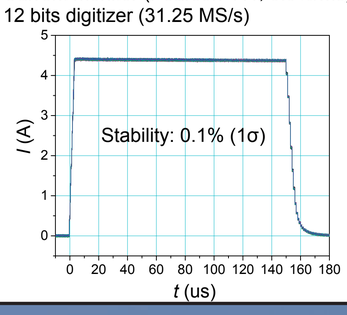
140 kV Solid State Marx Modulator

10 cards, 100 stages



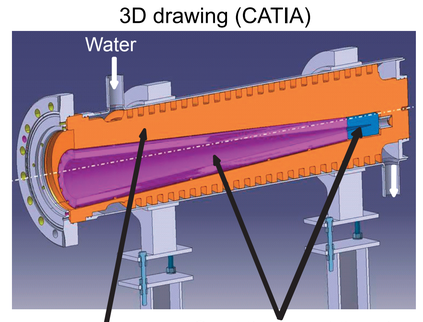
Tests with 10 stages (1 card)

Charging voltage = 800 V; 50 Hz
300 shots on 1800 Ω resistive load
Current monitor (Pearson 411, 0.9%/ms)
12 bits digitizer (31.25 MS/s)

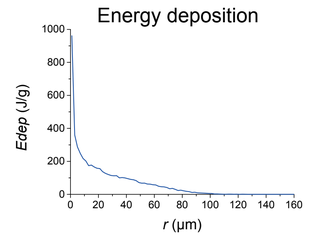


Beam Dump

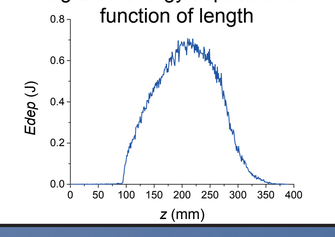
3D drawing (CATIA)



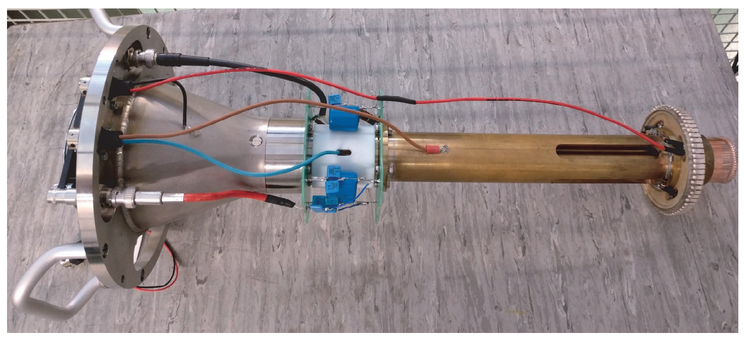
Energy deposition



Integrated energy deposition as a function of length

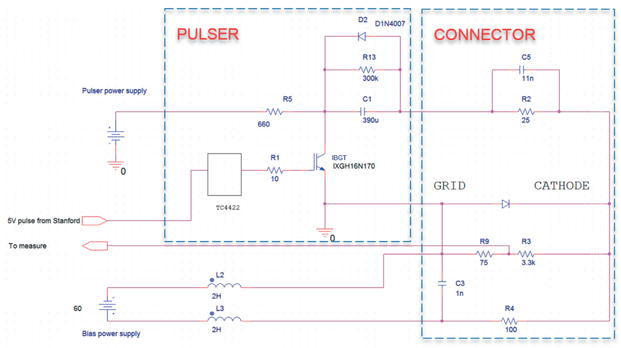


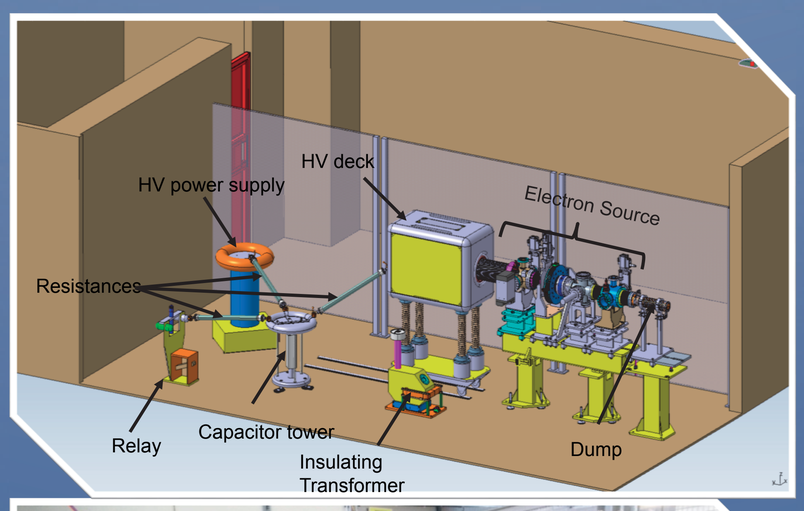
Cathode Connector



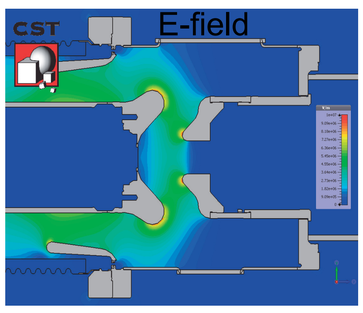
To connect 3 power supplies (Heater, Bias and Pulser) to the cathode, a connector has been developed.

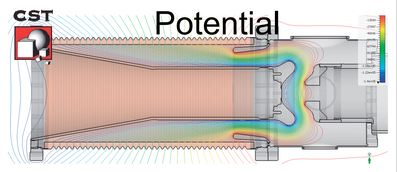
On this schematic, the “grid” of the cathode is the reference voltage. The Bias applies a positive DC voltage, blocking the electrons from the cathode, while the Pulser superposes a negative voltage to extract the pulsed electron beam. The amplitude and duration of the negative voltage defines the beam current and the duration.



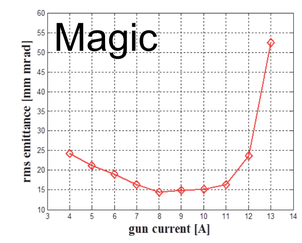


Simulations



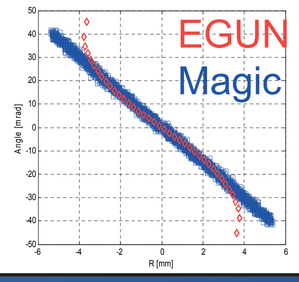


Maximum surface field 14 kV/cm



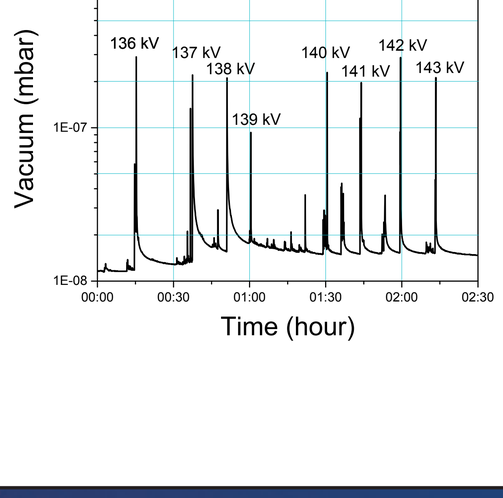
Current dependence of the emittance for the 8 mm cathode in the CTF3 gun

This simulations are for a 5 A beam from a 10 mm radius planar cathode, evaluated at the exit of the anode

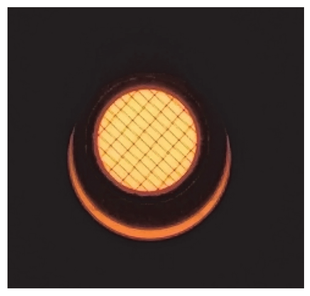


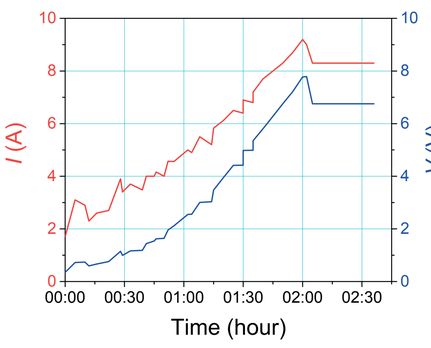
Experimental Results

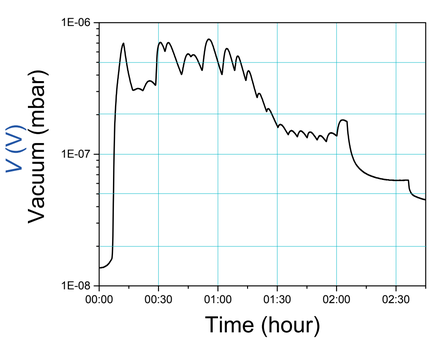
HV conditioning, variations of the vacuum as a function of the high voltage



Activation of the cathode (current and voltage) and variation of the vacuum during the activation

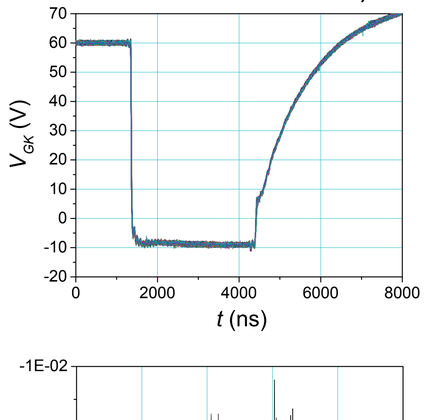


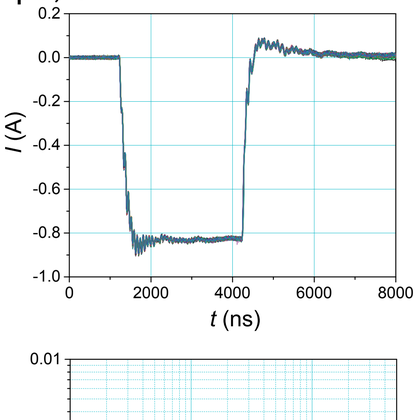


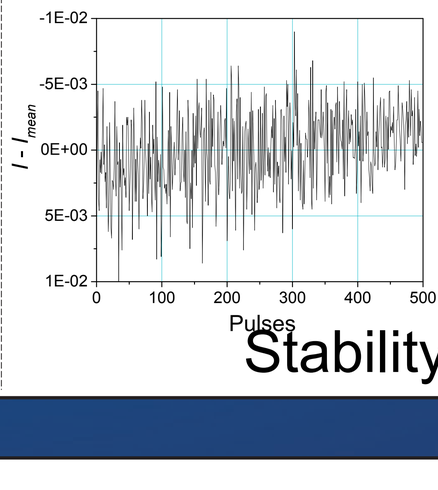


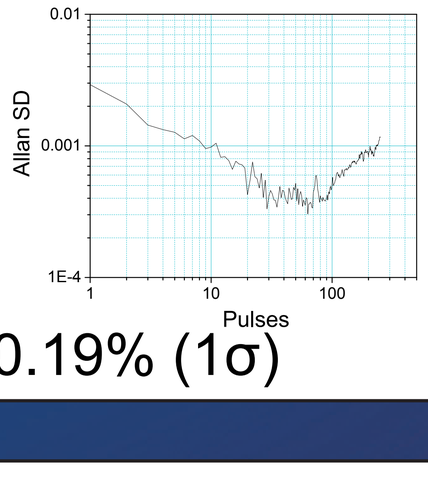
Preliminary Results (short pulses, low repetition rate, low current)

500 shots at 120 kV, 0.8 A, 3 µs, 0.2 Hz









Stability: 0.19% (1σ)

Conclusion

The CLIC drive beam electron source LEETCHI was put into operation successfully with short electron pulses. The first results are satisfying, the next step is to install the beam dump to increase the pulse length and the current. A silicon carbide target will be also installed to characterize the beam using OTR. According to the simulations performed with different codes, the emittance, for a 5 A beam, can be expected to be around 14mm.mrad. Due to the low energy electron, the angle between the target and the beam will be equal to 25 °. The modular mechanical design should be useable for a number of projects in need of a high current electron source because of its adaptability to a range of beam parameters.