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100keV DC GUN TEST STAND • LEG PROJECT

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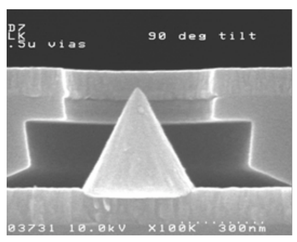
Introduction

In the scope of the Low Emittance Gun Project (LEG) a field emitter array (FEA) cathode is being considered as an electron source. In order to study the emission of electrons from such a cathode and to study space charge compensation techniques as well as to develop diagnostic procedures to characterize the beam resulting from such a setup it has been decided to build a 100keV gun test stand. Such a test stand gun has been modeled in 2D with the code MAFIA and an extensive parameter study has been conducted in order to optimize the design.

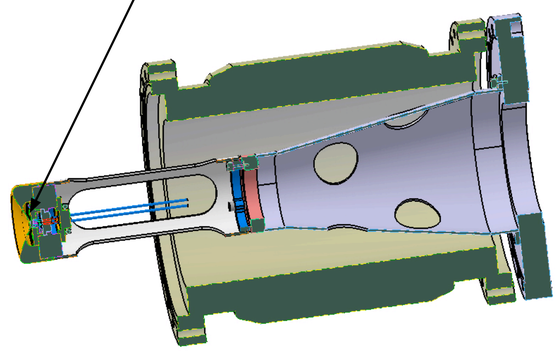
In this test stand, it is planned to compensate emittance blow-up due to space charge forces with a solenoid magnet. The solenoid magnet has recently been manufactured to our specifications at PSI. It is sealed off from the vacuum surroundings by a UHV-compatible water-cooled welded steel casing.

The test stand will contain various diagnostic equipment in order to characterize the 100keV electron beam. One of the most important parameters to be measured is the beam emittance which requires obstruction of a major part of the beam with different kinds of slit/pinhole arrays. The part of the beam passing the obstruction, the so-called 'beamlets', will hit a phosphor screen downstream. The light pattern produced in the phosphor will then be used to reconstruct the horizontal and vertical phase space of the electron beam.

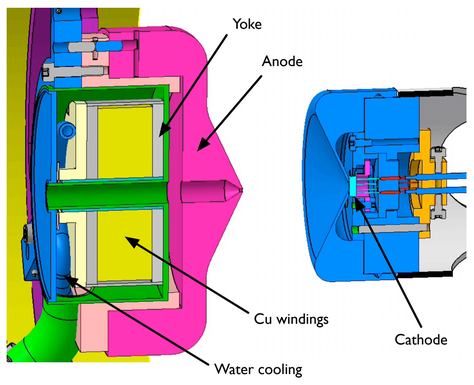
Field Emitter Array Cathode

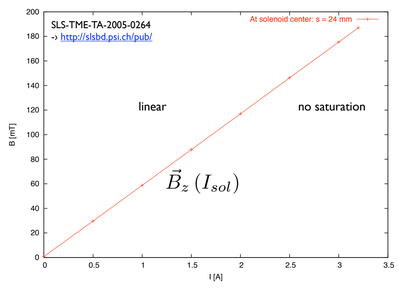


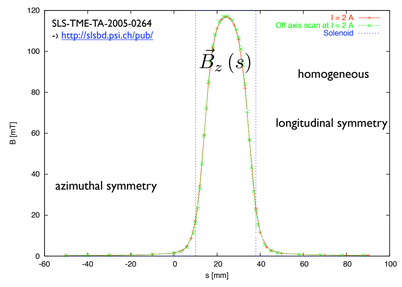
- Field emitter array (FEA) consists of thousands of gated molybdenum nano-tips
- FEA assembly is put on negative DC potential of 100kV
- Each FEA tip emits a beamlet when the gate layer is pulsed (>5ns, <320V)
- Beamlets can be focussed by an additional focussing layer
- Optimized diode geometry minimizes emittance at gun exit



In-Vacuum Solenoid Magnet

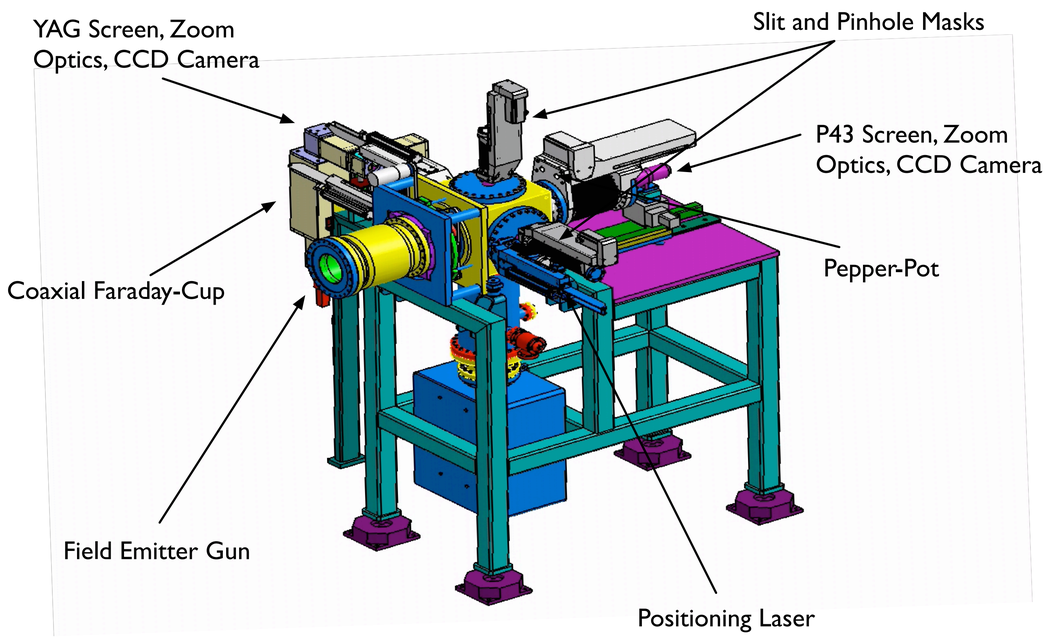




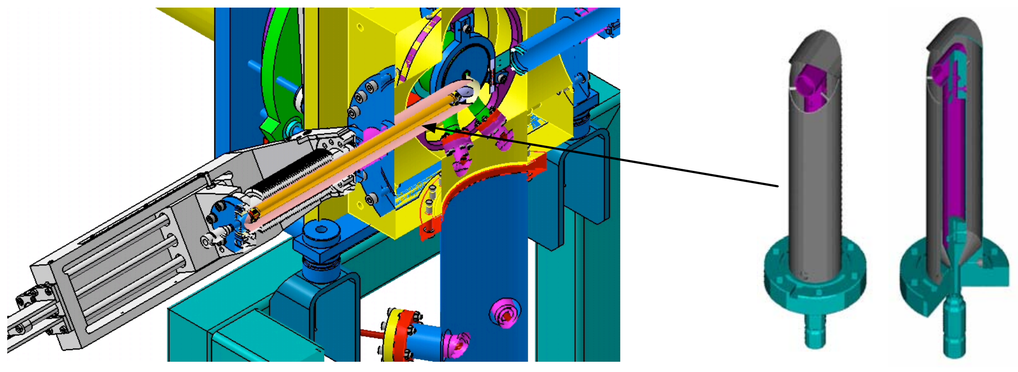


- DC solenoid right after gun anode provides focussing to emitted beam
- Solenoid is built in-vacuum and actively cooled through an in-vacuum cooling water circuit (~50W heat dissipation)
- 1000 copper windings deliver up to 200mT of magnetic field on beam axis
- Magnet iron yoke confines field outside of diode region
- Digital power supply control is integrated in EPICS

Diagnostics Overview

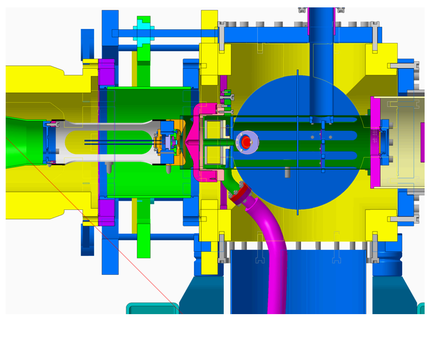


Movable Coaxial Faraday-Cup

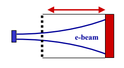


- The Faraday-Cup (FC) measures field emitted current and transient beam signals
- FC diameter is 20mm, the coaxial design provides high bandwdith (>4GHz)
- FC can be moved into beam directly behind the in-vacuum solenoid magnet through a pneumatic actuator
- Control is integrated in EPICS, readout through high bandwidth scope (2GHz, 20GS/s)
- Design is successfully used behind SLS LINAC electron gun (90keV)

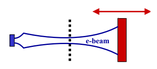
Slit and Pinhole Masks, Pepper-Pot



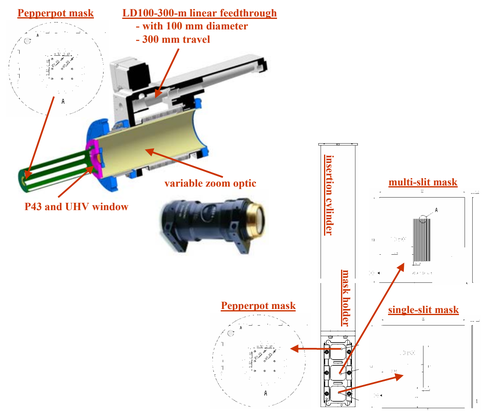
- Unfocussed Case
  Movable pepper-pot arrangement (300mm travel) with fixed distance (300mm) between pepper-pot and P43 screen



- Focussed Case
  Fixed slit/pinhole array insert with movable P43 screen (300mm travel)



- Laser eroded masks of 100µm tungsten substrate
- Slit/pinhole array inserted at solenoid focal point by motorized UHV feedthrough; slit position measured with linear encoder (0.5µm resolution)
- Pepper-pot arrangement with fixed distance to P43 screen to characterize unfocussed beam
- P43 (6-8µm, aluminized) screen at variable distance from mask for visualization of beamlets
- CCD camera and zoom optics (calibration scale on UHV quartz window) read out through EPICS



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