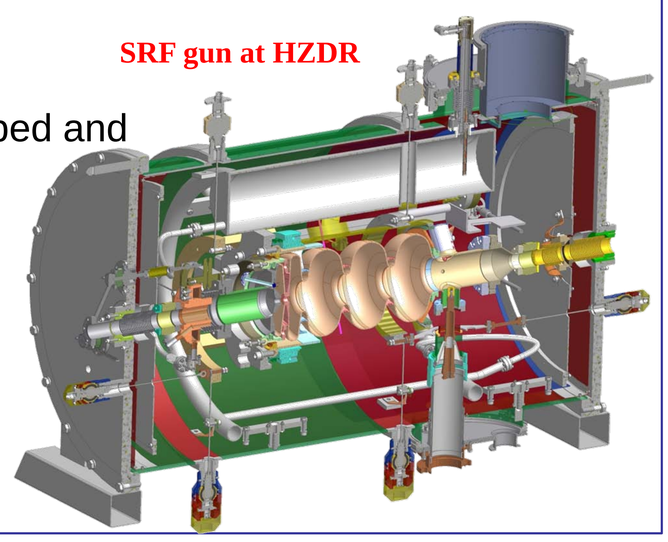
Emittance Measurement by Single Slit Scanning for the SRF Gun at HZDR

P. Lu, A. Arnold, P. Murcek, J. Teichert, H. Vennekate, R. Xiang

Background

SRF gun at HZDR

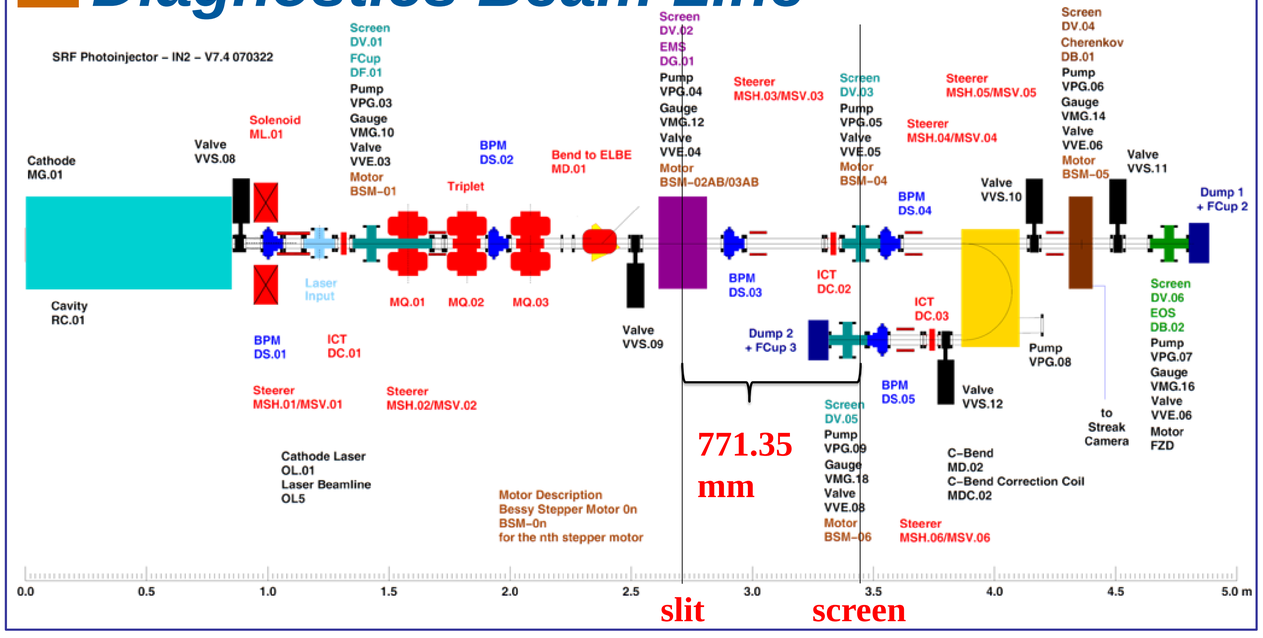


– a 3½-cell SRF gun was developed and commissioned at HZDR

– the SRF gun needs further optimization and refinement

– solenoid scanning emittance measurement performed, detailed phase space needed

Diagnostics Beam Line



Single-slit Scanning

Layout:

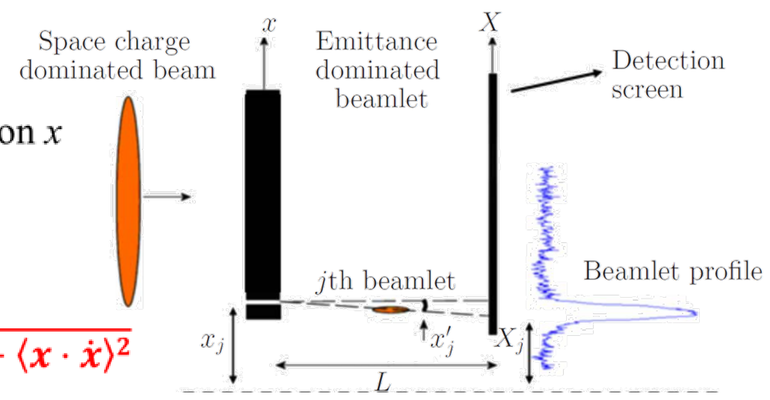
– tungsten slit board at section x

– YAG screen at section X

– camera shielded by lead

– $\varepsilon_{n,rms} = \beta\gamma\sqrt{\langle x^2\rangle\langle \dot{x}^2\rangle - \langle x\cdot\dot{x}\rangle^2}$

single slit sketch



Advantages:

– space charge influence weakened

– data overlap avoided

– high resolution of phase space

setup parameters

L	Slit width	Thick-ness	Pixels
771.35 mm	0.1 mm	1.5 mm	660×495

Mesurement steps:

– record beam parameters and scanning parameters in a “ ini file”

– record background data

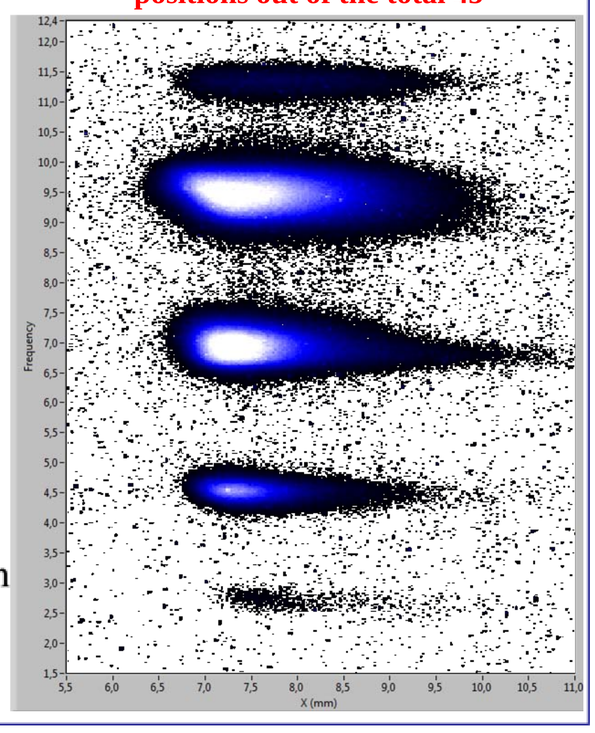
– scan the slit and record n images at each position

– eliminate the background and noises, fix errors known

– get the “beamlet profile” by integration

– calculate the rms emittance $\varepsilon_{n,rms}$

merged image from 5 slit positions out of the total 45



Preliminary Measurements

As a commissioning of the whole setup and software, we did 3 measurements of the SRF gun emittance with a change in the solenoid current, laser phase (compared to RF phase) and DC voltage on the cathode.The electron beam energy is 2.2 MeV. The bunch charge is about 0.05 pC. For the emittance values listed bellow, we will do further error analysis.

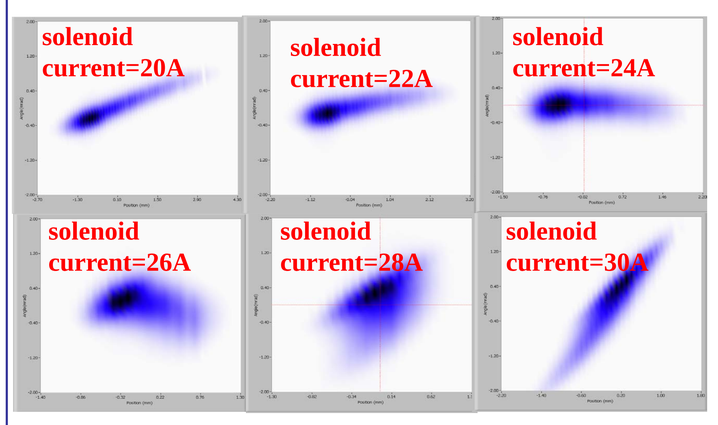
Emittance vs. Solenoid current:

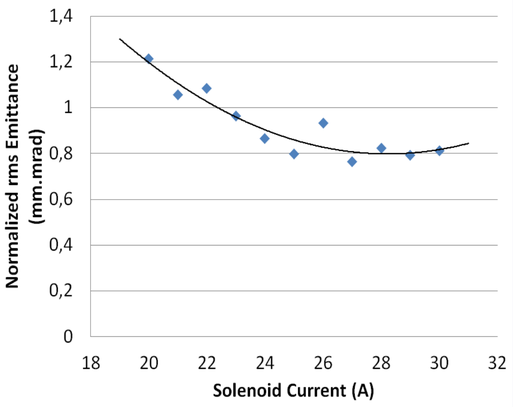
– solenoid current scanned: from 20 A to 30 A

– bunch charge: 0.05 pC

– laser phase: 30°.

– DC voltage: 5 kV.





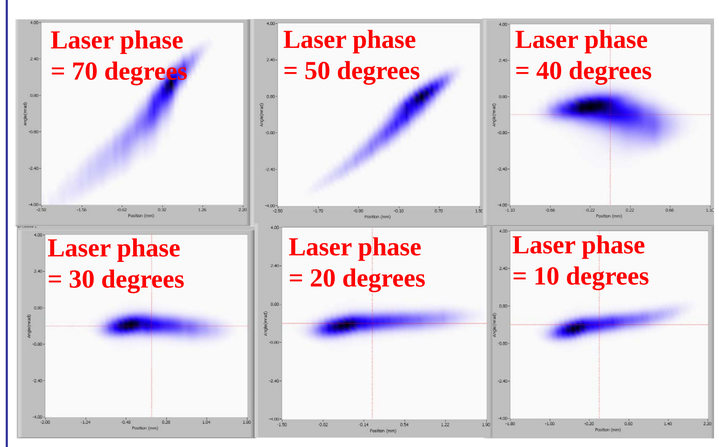
Emittance vs. Laser phase:

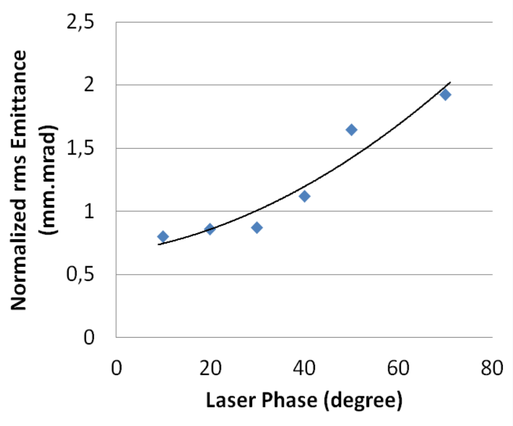
– laser phase scanned: from 10° to 70°

– bunch charge: from 0.042 pC to 0.052 pC.

– solenoid current: 25 A.

– DC voltage: 5 kV.





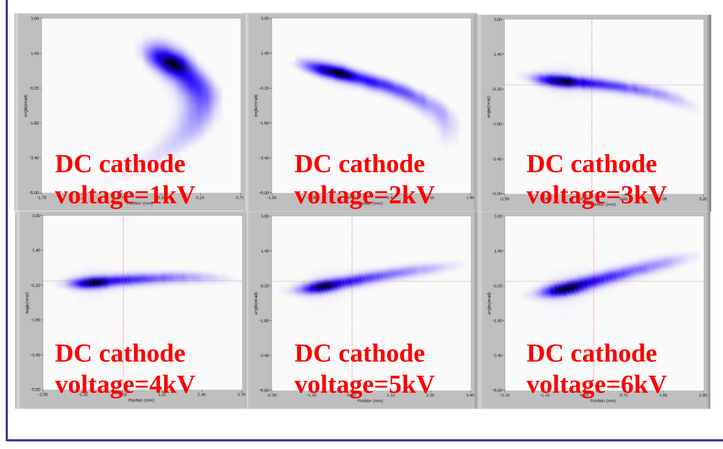
Emittance vs. DC voltage:

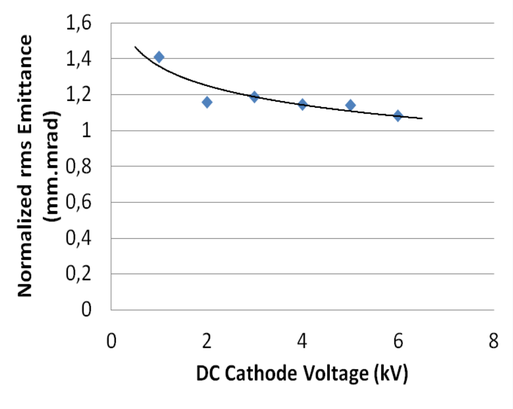
– DC Voltage scanned: from 1 kV to 6 kV

– bunch charge: from 0.046 pC to 0.053 pC

– solenoid current: 21 A.

– laser phase: 30°.





Work in Schedule

– optimization of the algorithm

– check with solenoid scanning method

– comparison with simulations

– analysis of errors

Acknowledgments

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M.Sc. P. Lu | Radiation Physics | ELBE | TU Dresden | p.lu@hzdr.de