

# Emittance optimization for various machine parameters at PITZ.

**PITZ 1.8 setup**

**Parameters for optimization**

**Optimization results for 1nC, 0.25, 0.1 nC, 0.02 nC and 2 nC bunch charges**

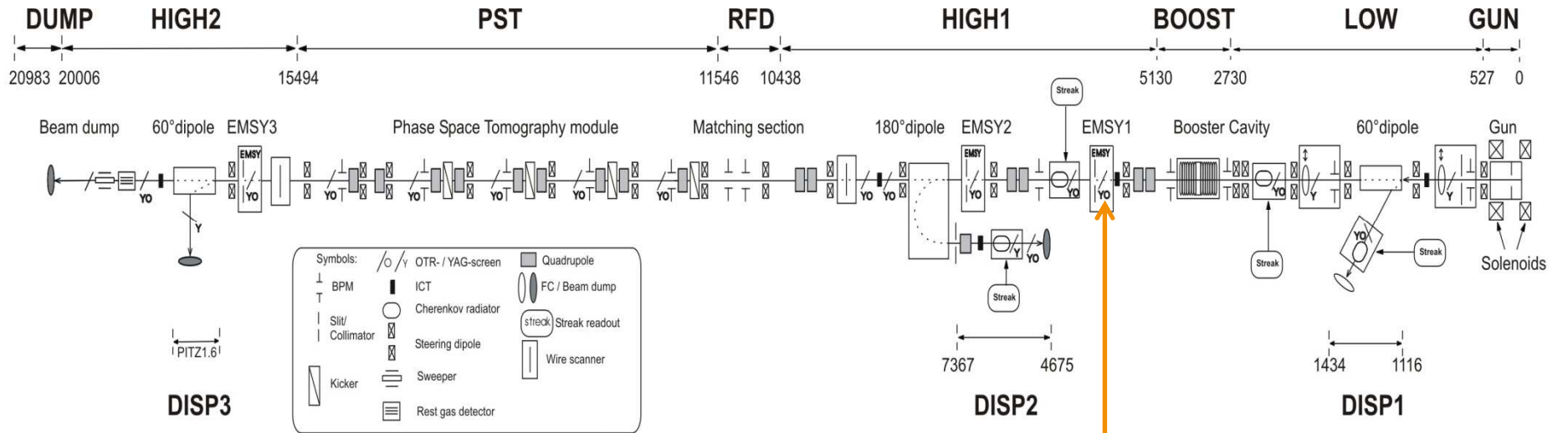
**Summary**

Grygorii Vashchenko  
DPG-Frühjahrstagung 2013  
Dresden, 04-08.03.2013

# PITZ setup.

**High energy part** ( up to ~25 MeV/c)

**Low energy part** ( up to ~6.7 MeV/c)

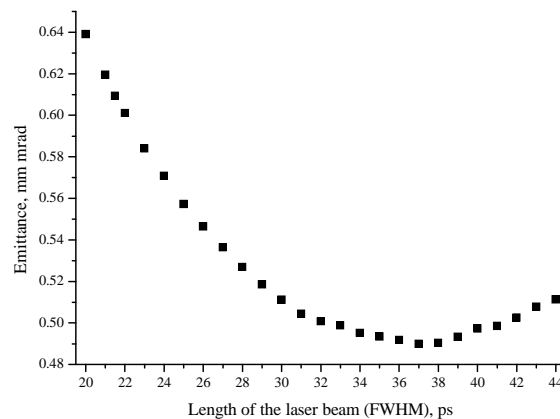
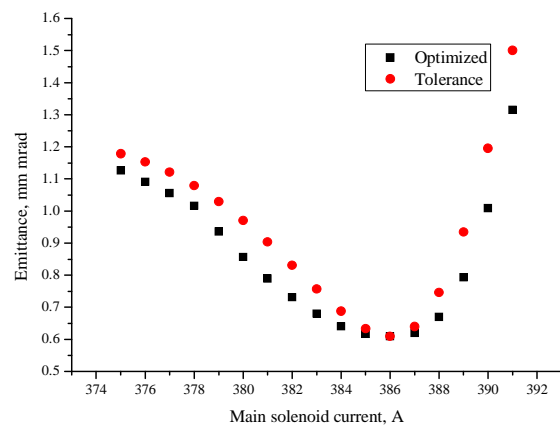
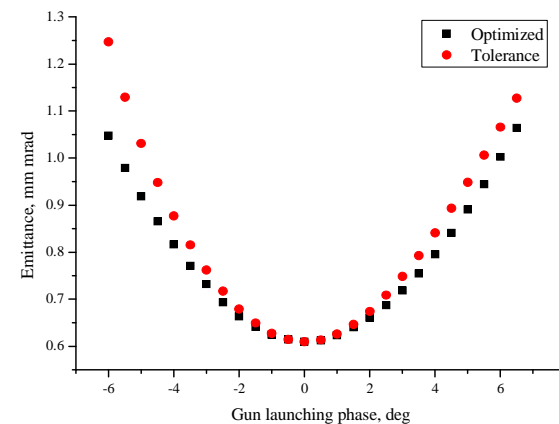
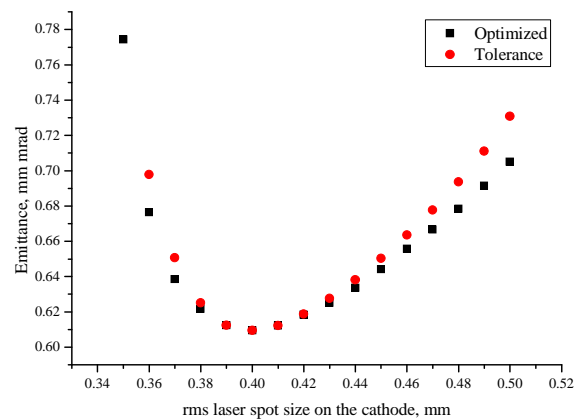
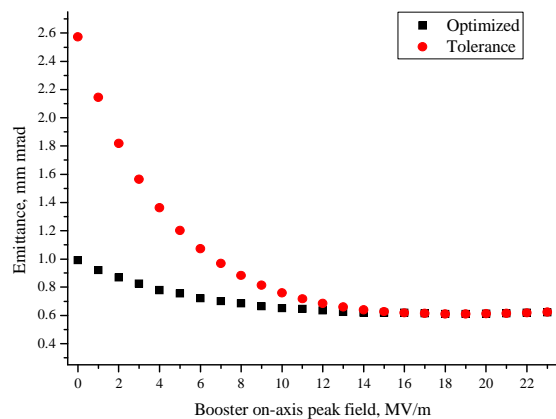


EMSY1 – optimization point –  
5.74 m downstream from the  
cathode

# Optimization parameters

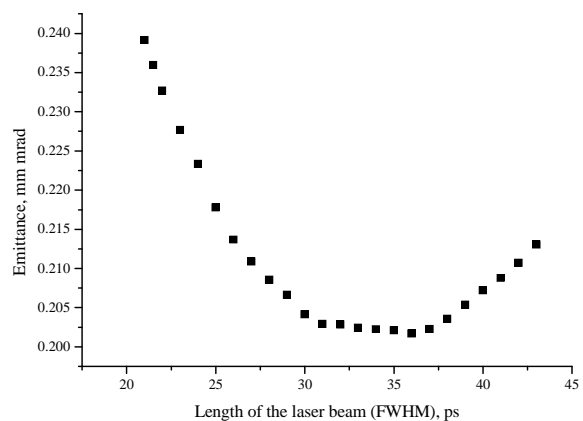
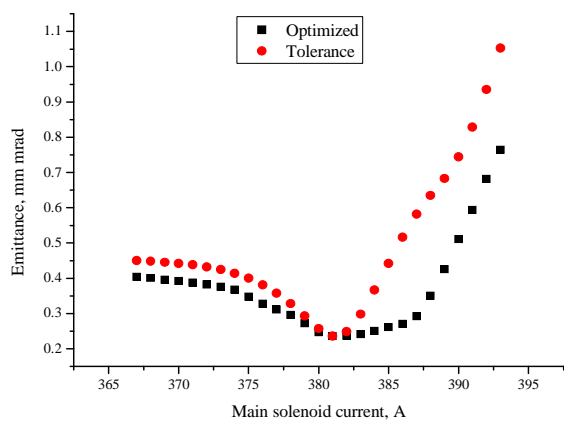
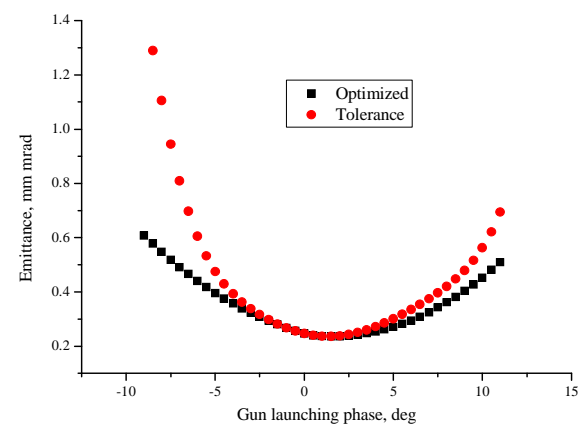
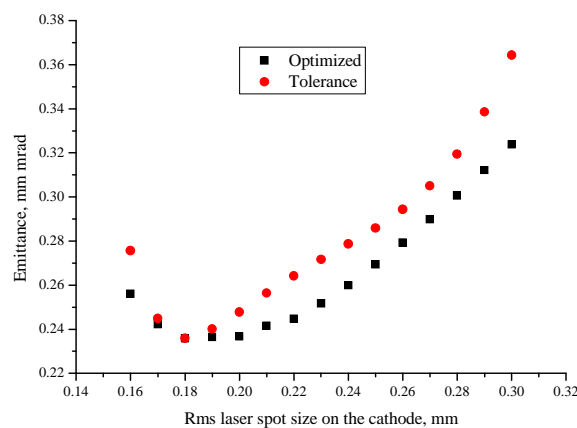
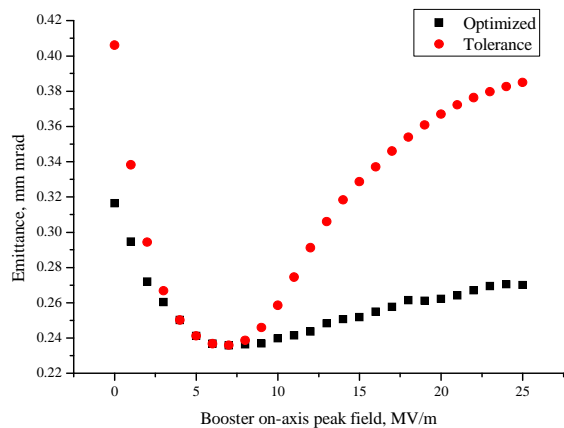
Parameter	Value	Value	Value	Value	Value	Unit
Bunch charge	1	0.25	0.1	0.02	2	nC
Flat top laser temporal profile, FWHM	[20;45]	[20;45]	[20;45]	[14;40]	[20;45]	ps
Flat top laser temporal profile, rt/ft	2	2	2	2	2	ps
Uniform laser transverse profile, rms	[0.35;0.6]	[0.15;0.3]	[0.09;0.21]	[0.035;0.11]	[0.55;0.71]	mm
Gun on-axis peak field	61	61	61	61	61	MV/m
Gun phase w.r.t. MMMG phase	[-8;8]	[-8;8]	[-8;8]	[-8;8]	[-8;8]	Deg
Main solenoid current	[370;400]	[360;400]	[360;400]	[360;400]	[360;400]	A
Booster on-axis peak field	[0;25]	[0;25]	[0;25]	[0;25]	[0;25]	MV/m
Booster phase w.r.t. MMMG phase	0	0	0	0	0	deg

# Emittance for 1nC bunch charge.



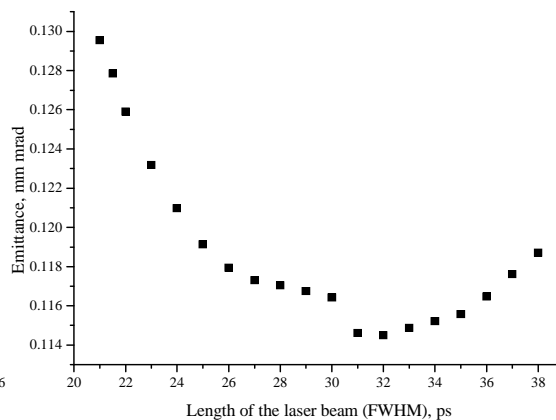
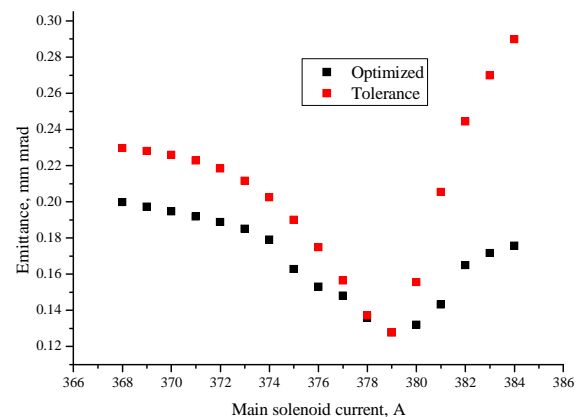
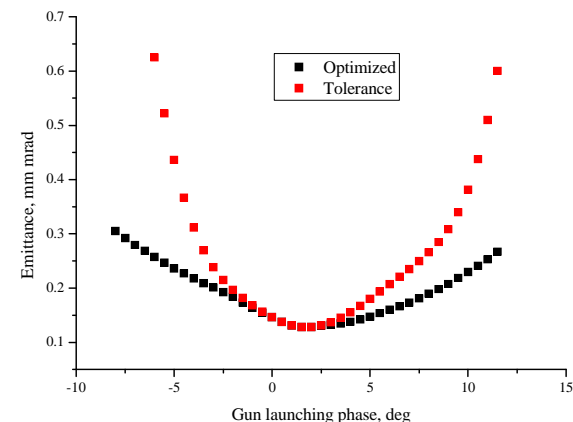
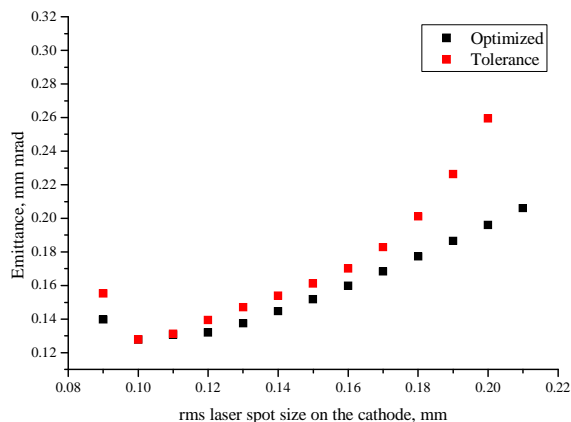
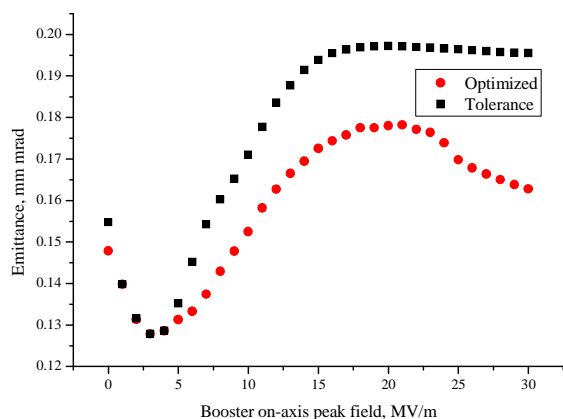
Parameter	Value
$\epsilon$ , mm mrad	0.61
$\sigma$ , mm	0.4
$I$ , A	386
$\varphi$ , deg	0
$E_b$ , MV/m	19

# Emittance for 250pC bunch charge.



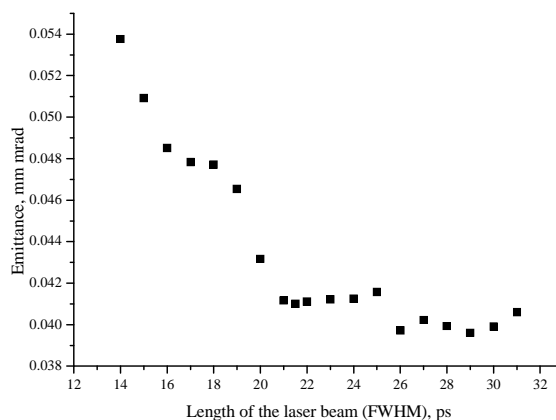
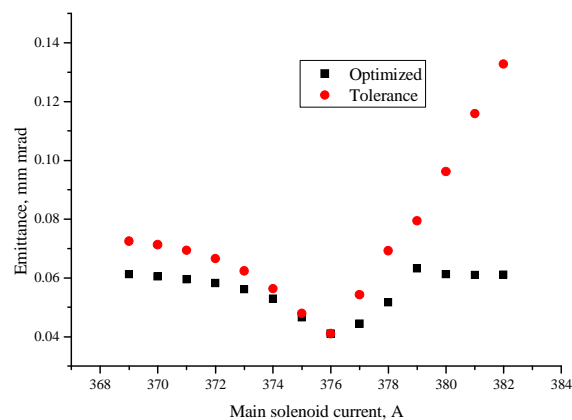
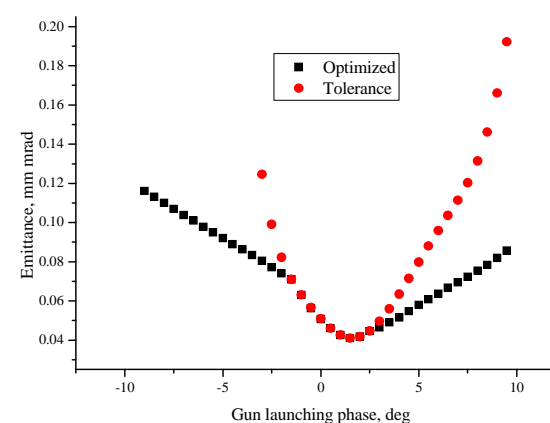
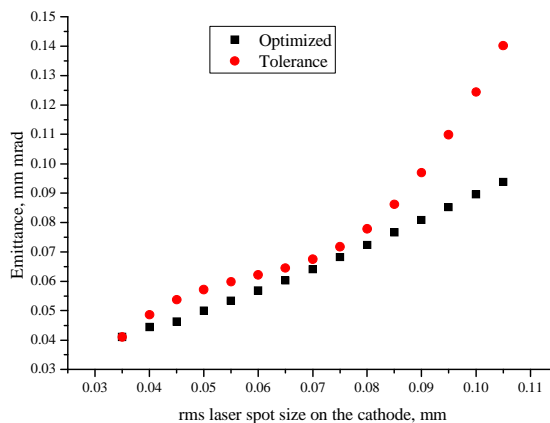
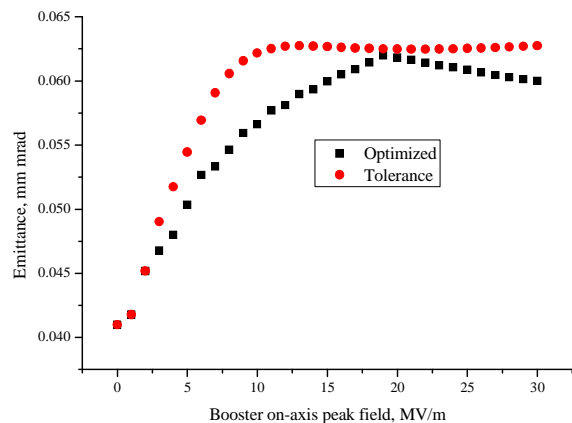
Parameter	Value
$\epsilon$ , mm mrad	0.24
$\sigma$ , mm	0.18
$I$ , A	381
$\varphi$ , deg	1.5
$E_b$ , MV/m	7

# Emittance for 100pC bunch charge.



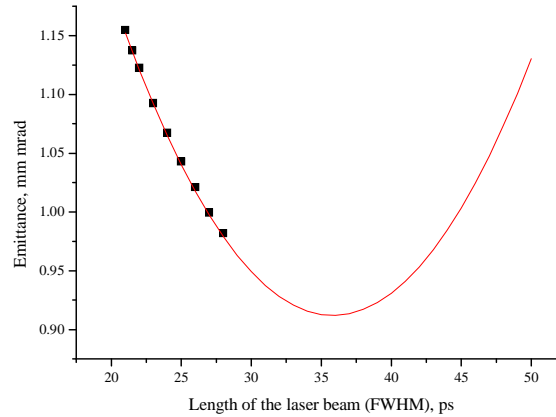
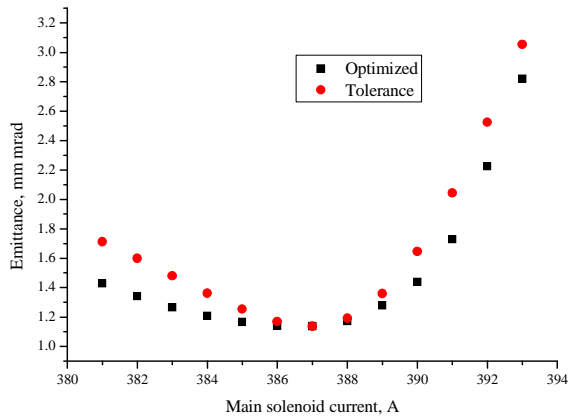
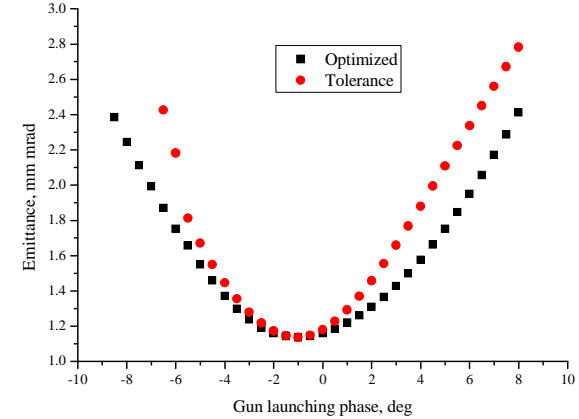
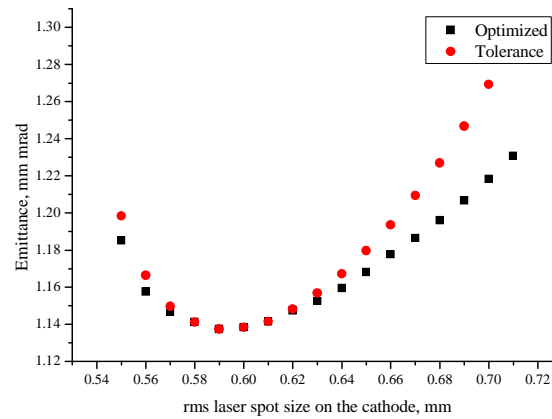
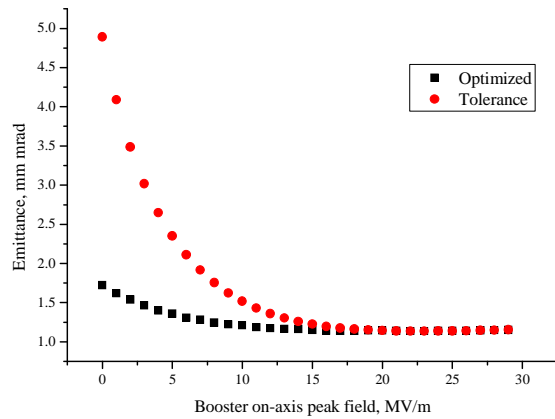
Parameter	Value
$\epsilon$ , mm mrad	0.13
$\sigma$ , mm	0.1
$I$ , A	379
$\varphi$ , deg	2
$E_b$ , MV/m	3

# Emittance for 20pC bunch charge.



Parameter	Value
$\epsilon$ , mm mrad	0.04
$\sigma$ , mm	0.035
$I$ , A	376
$\varphi$ , deg	1.5
$E_b$ , MV/m	0

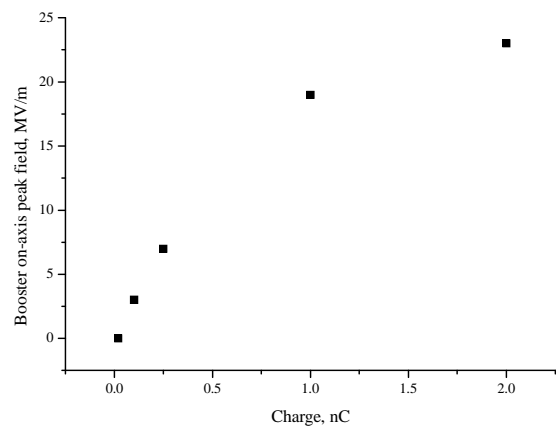
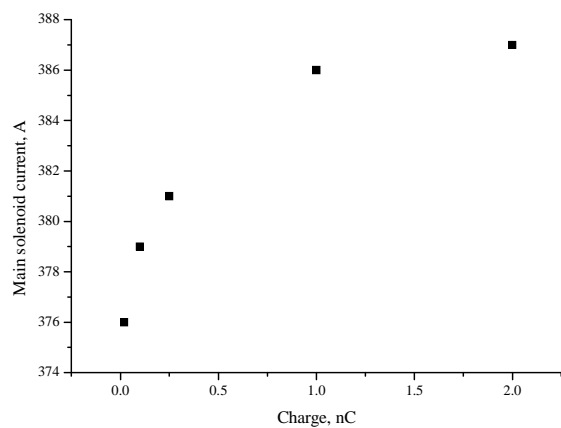
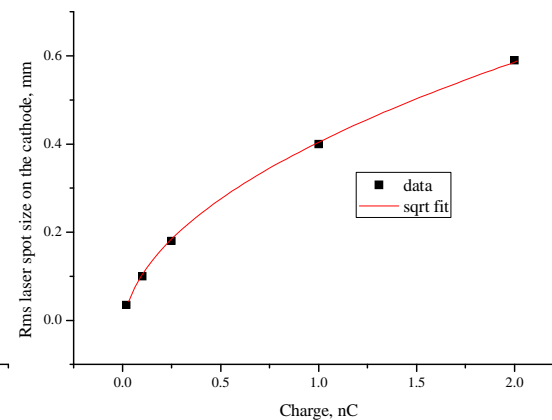
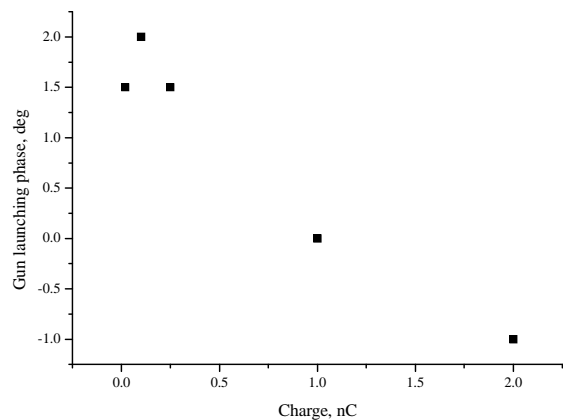
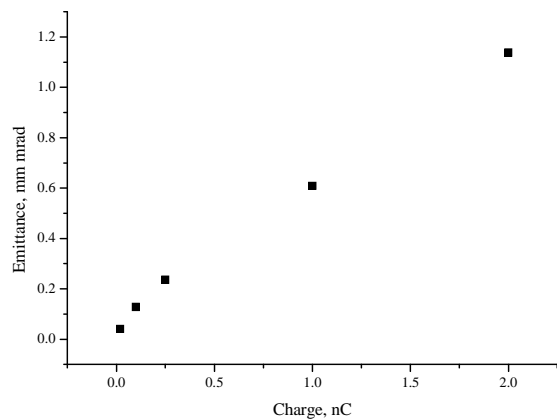
# Emittance for 2nC bunch charge.



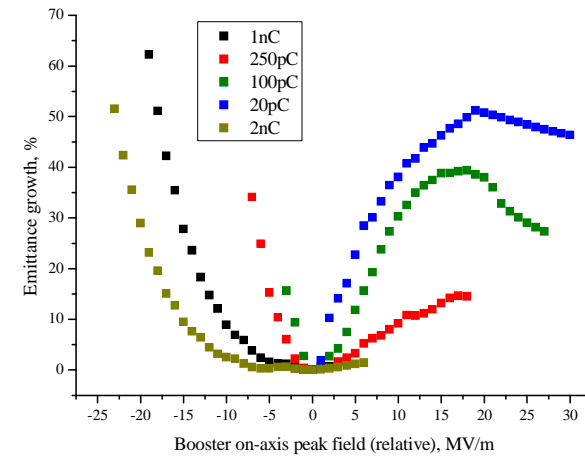
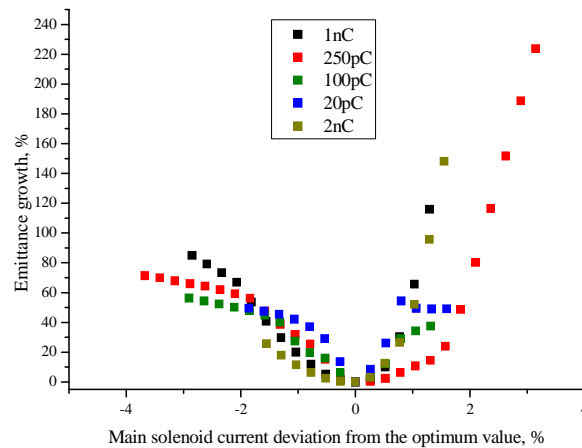
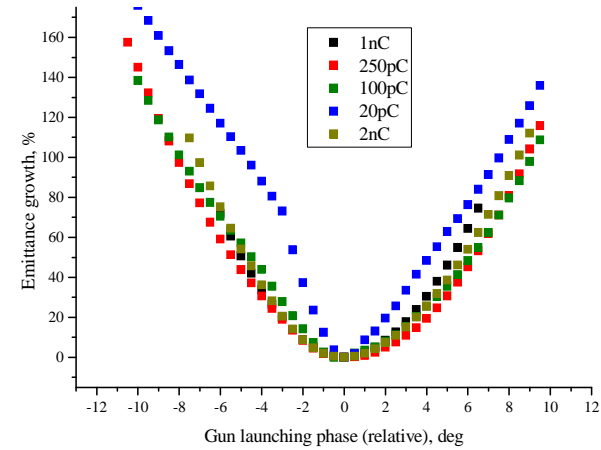
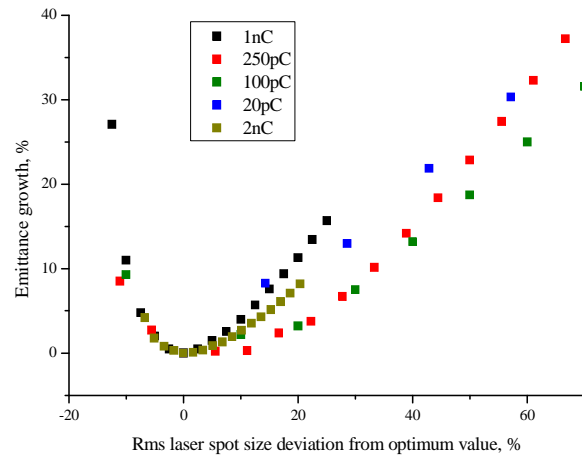
Parameter	Value
$\epsilon$ , mm mrad	1.14
$\sigma$ , mm	0.59
$I$ , A	387
$\varphi$ , deg	-1
$E_b$ , MV/m	23



# Emittance dependence on charge.



# Emittance dependencies on different parameters



# Systematic errors estimation

- Booster accelerating gradient:  $<5\%$  for  $\pm 1$  MV/m that corresponds to 800 KeV/c  $\Rightarrow$  Experimental precision:  $<100$  KeV/c  $\Rightarrow$  neglected.
- Rms laser spot size on the cathode:  $<5\%$  for  $\pm 0.1$  mm  $\Rightarrow$  Experimental precision  $<0.025$  mm  $\Rightarrow$  neglected.

Charge	Systematic error, %
2 nC	$<8\%$
1 nC	$<12\%$
250 pC	$<12\%$
100 pC	$<25\%$
20 pC	$<40\%$

# Summary

- Detailed simulations for **2nC**, **1nC**, **0.25nC**, **0.1nC** and **0.02nC** bunch charges are performed for a wide range of machine parameters.
- Possible systematic errors during experiments increase with a charge.
- Optimum emittance values at laser pulse length of 21.5 ps are presented in table.

Parameter	2nC	1nC	0.25nC	0.1nC	0.02nC	Unit
$\epsilon_n$	1.14	0.61	0.24	0.13	0.041	mm mrad
$\epsilon_{th}/\epsilon_n$	0.44	0.56	0.63	0.65	0.73	
$\langle \epsilon_{slice} \rangle$	1.04	0.57	0.22	0.12	0.037	mm mrad
$I_p$	80.3	43.1	11.8	4.9	1.0	A

# Thank You for attention.

