Photon flux and spectral characteristics of the Thomson source PlasmonX as function of the parameters of the electron beam, of the laser pulse, and of the electron-laser impact

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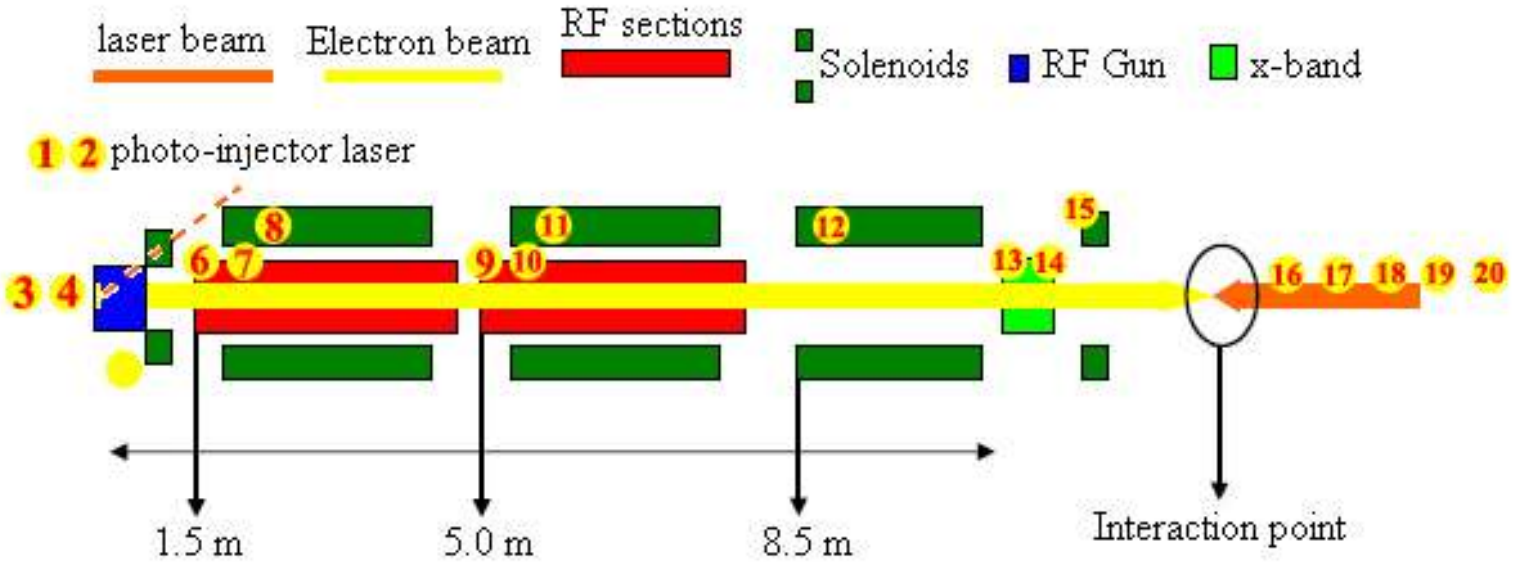
Beats and PlasmonX projects

SPARC beam line, simplified version

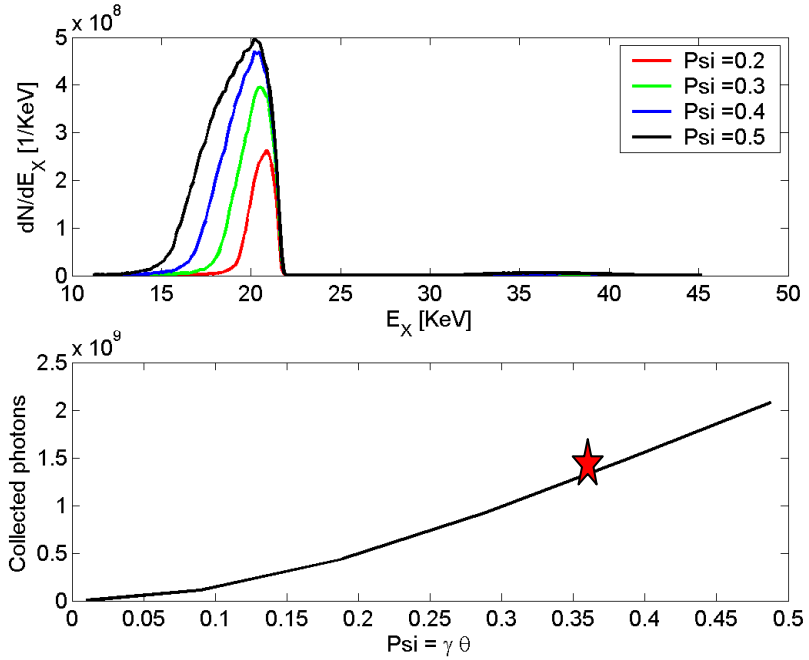


Reference case

Energy	Envelope r.m.s.	Emittance	Energy spread	Length r.m.s.	Charge
30.28 MeV	9.9 μm	0.8 mm mrad	$5\ 10^{-4}$	2 mm	1 nC

Wavelength	Waist	Energy	Time duration
0.8 μm	> 15 μm	5 J	4-15 ps

Peak frequency	Total photon number	FWHM bandwidth	r.m.s bandwidth	r.m.s divergence
$5.15\ 10^{18}$	$1.3\ 10^{9}$	9 %	2,75 %	1.32



Simulations made with TS²

Psi=0.36, θ=6 mrad

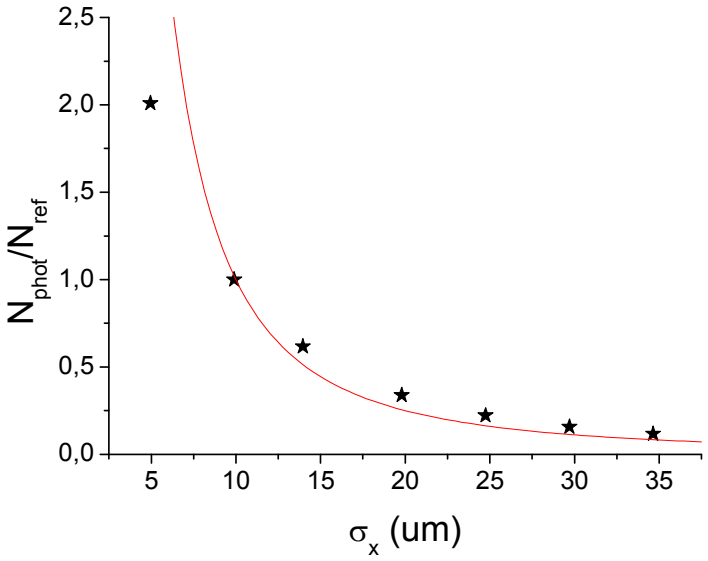
Parametric study:

Starting from the reference electron beam, we have varied the beam parameters singolarly, keeping fixed the other ones

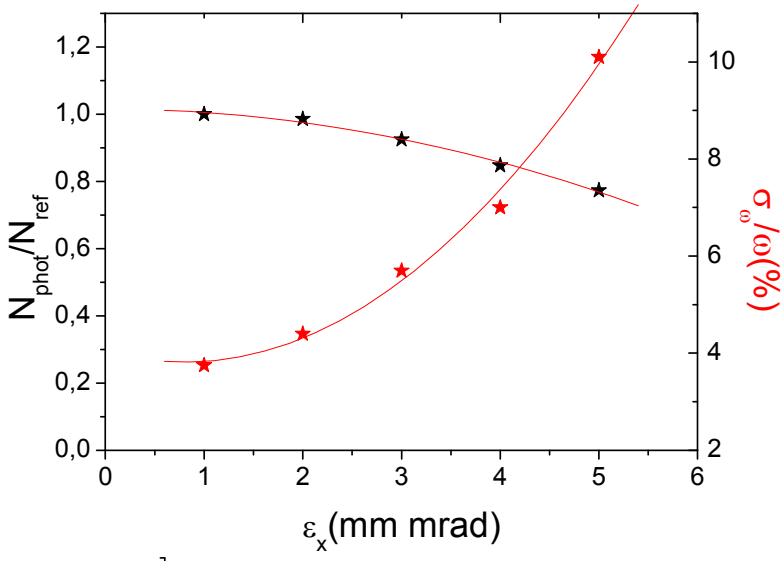
The simulations have been made with Pflux (only linear effects).

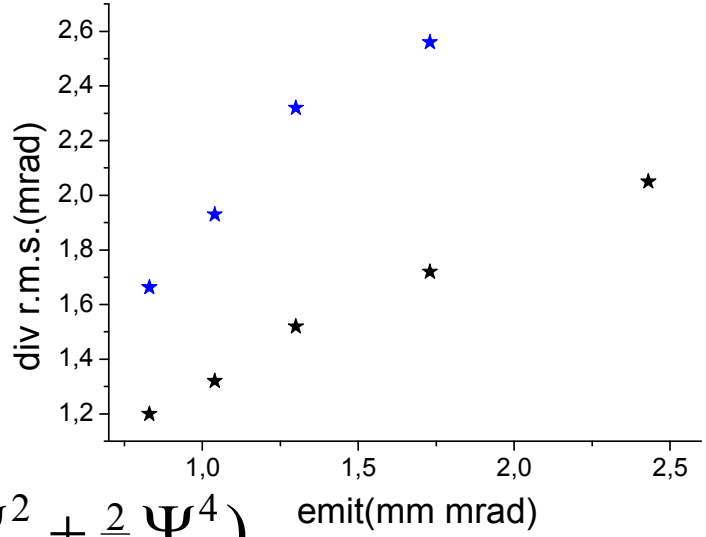
Charactersitics of the simulations:
15000 macroparticles
Laser pulse gaussian both transversally and longitudinally
Acceptance psi=0.36, θ=6 mrad
Diffraction effects taken into account.

Dependence on sigma_x



Dependence on emittance



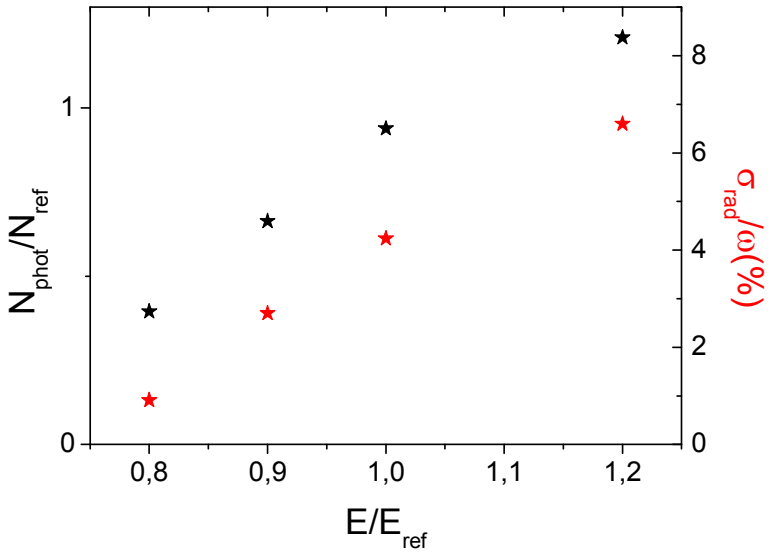


Overlap volume

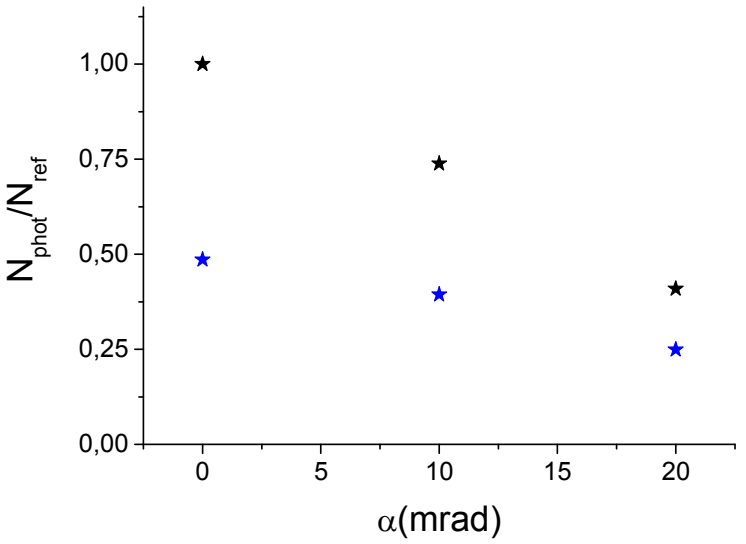
density

$$N(\Psi) \cong \pi\alpha\Im N_e \left(\frac{cT}{\lambda}\right) a_0^2 \Psi^2 \frac{\left(1+\Psi^2+\frac{2}{3}\Psi^4\right)}{\left(1+\Psi^2\right)^3}$$

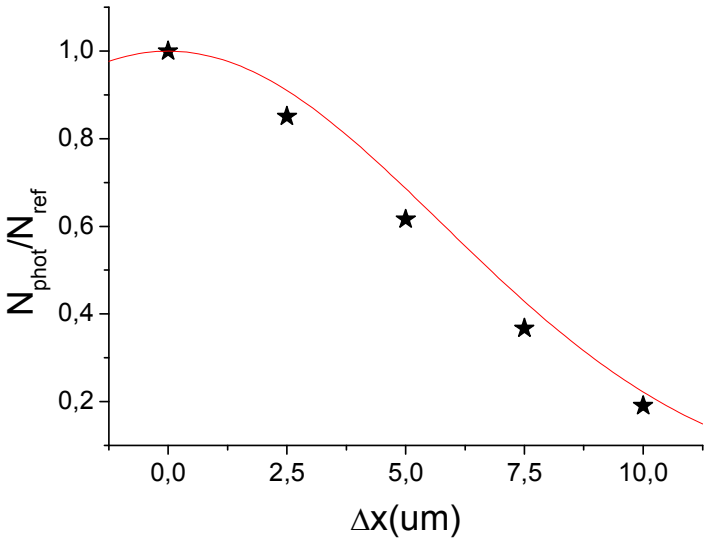
Dependence on energy



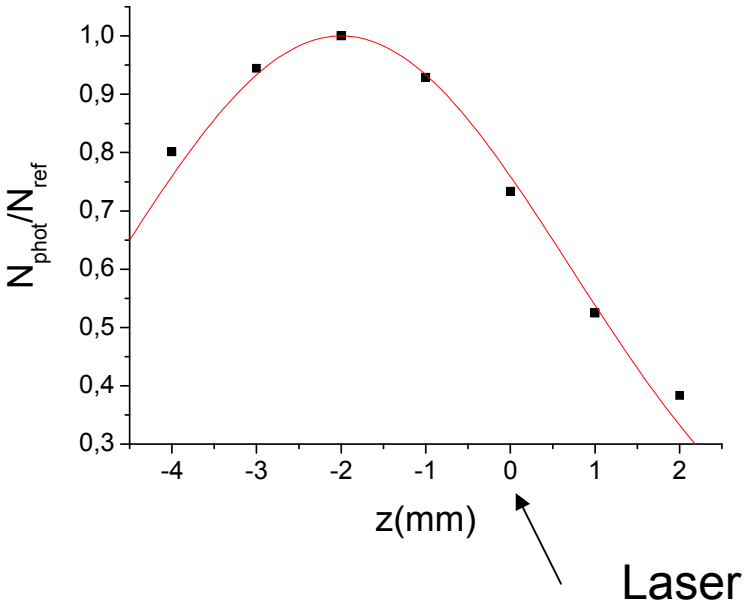
Dependence on scattering angle



Transverse jitters

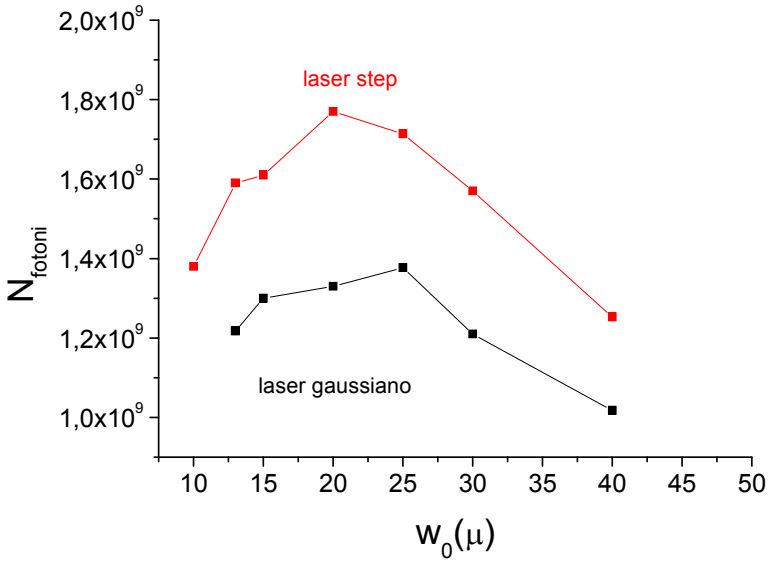


Temporal jitters



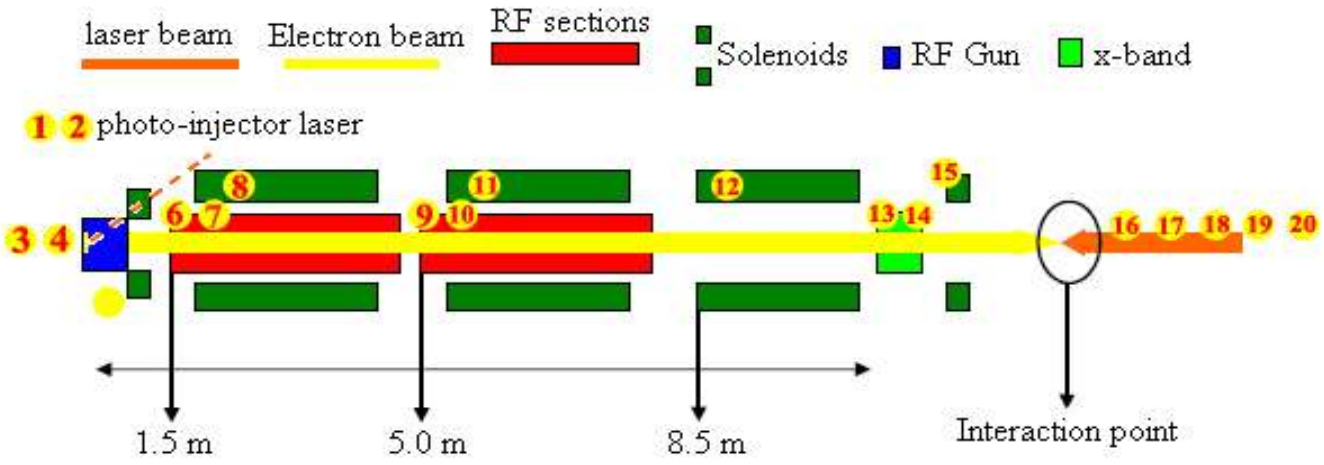
Laser focus

Dependence on laser waist (diffraction effects) for laser distribution gaussian and flat top.



Statistical study

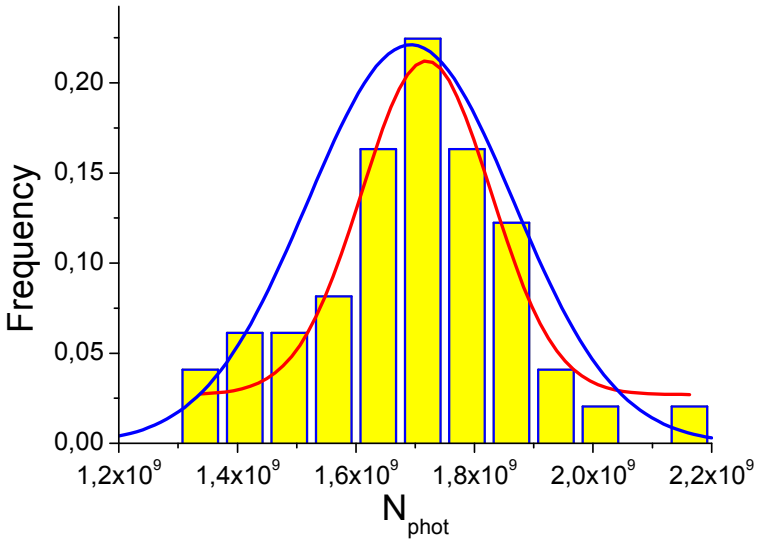
Each element of the statistical ensemble is a start to end from the cathode to the TS.
Simulation tools ASTRA+Pflux
Statistic made with 50 and 200 shot will be presented.
Lase pulse gaussian in both direction.
Simplified beam line
Only linear effects in the interaction
Laser diffraction neglected
Jitters coming from:

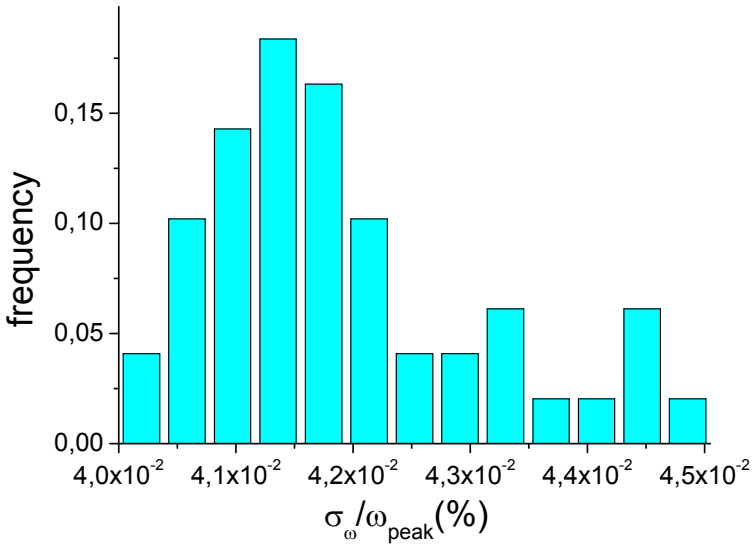


1	Bunch Charge [nC]	1.0	±0.05	±0.05
2	Bunch Length [ps]	30.0	±0.5	±0.5
3	Phase Gun [°]	0.0	±0.25	±0.5
4	Gun Gradient [MV/m]	120.0	±0.06	$\pm 10^{-3}$
5	Gun Solenoid [T]	0.2707	$\pm 5\ 10^{-5}$	$\pm 5\ 10^{-5}$
6	Phase I Struct. [°]	-30.0	±0.25	±0.5
7	I Struct. Gradient [MV/m]	13.4	±0.06	$\pm 10^{-3}$
8	I Struct. Solenoids [T]	0.1200	$\pm 5\ 10^{-5}$	$\pm 5\ 10^{-5}$
9	Phase II Struct. [°]	88.0	±0.25	±0.5
10	II Struct. Gradient [MV/m]	6.55	±0.06	$\pm 10^{-3}$
11	II Struct. Solenoids [T]	0.1145	$\pm 5\ 10^{-5}$	$\pm 5\ 10^{-5}$
12	III Struct. Solenoids [T]	0.1145	$\pm 5\ 10^{-5}$	$\pm 5\ 10^{-5}$
13	Phase X-band Struct. [°]	180.0	±0.25	±0.5
14	X-band Gradient [MV/m]	34.5	±0.06	$\pm 10^{-3}$
15	Focusing Solenoid [T]	2.8	$\pm 5\ 10^{-5}$	$\pm 5\ 10^{-5}$

16	Energy [J]	5	±0.05	±0.05
17	Spot Dimension [μm]	17	±1.5	±1.5
18	Spot Transv. Position	0	±2.5	±2.5
19	Interaction Angle [mrad]	0	±0.5	±0.5
20	Time duration [ps]	6	±0.5	±0.5

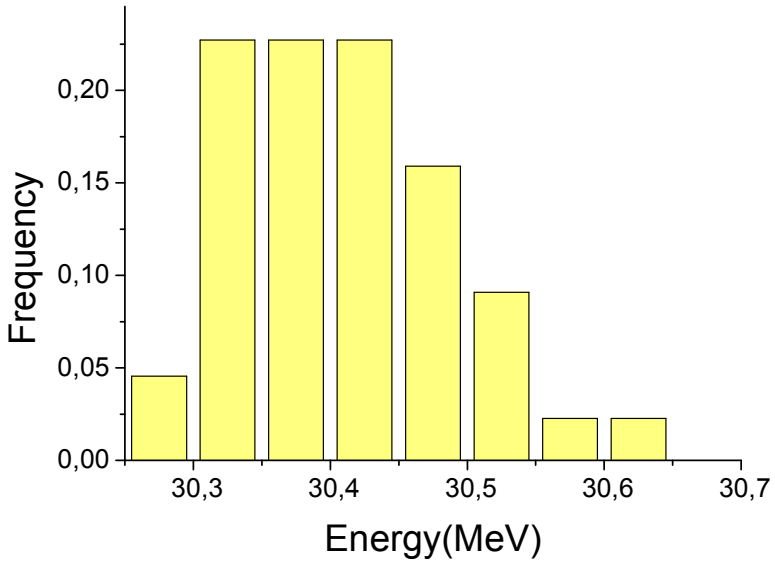
First case 50 shot

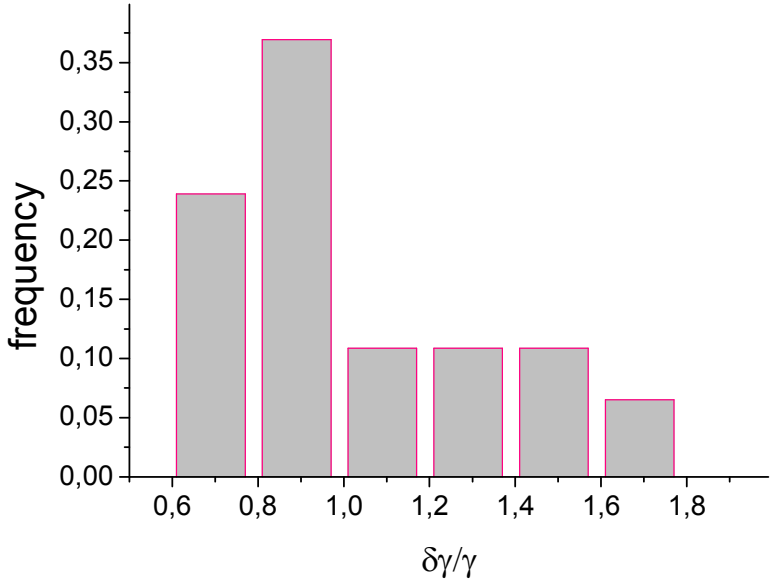


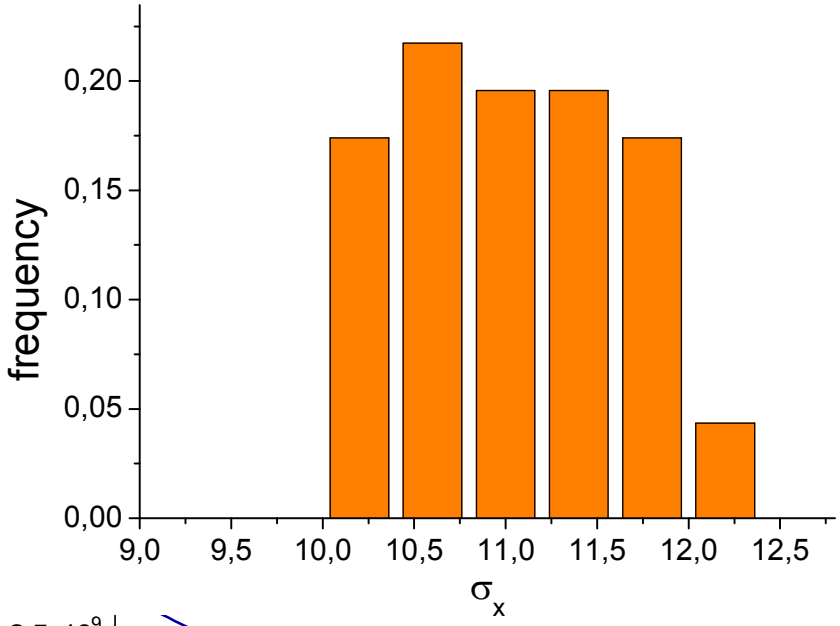


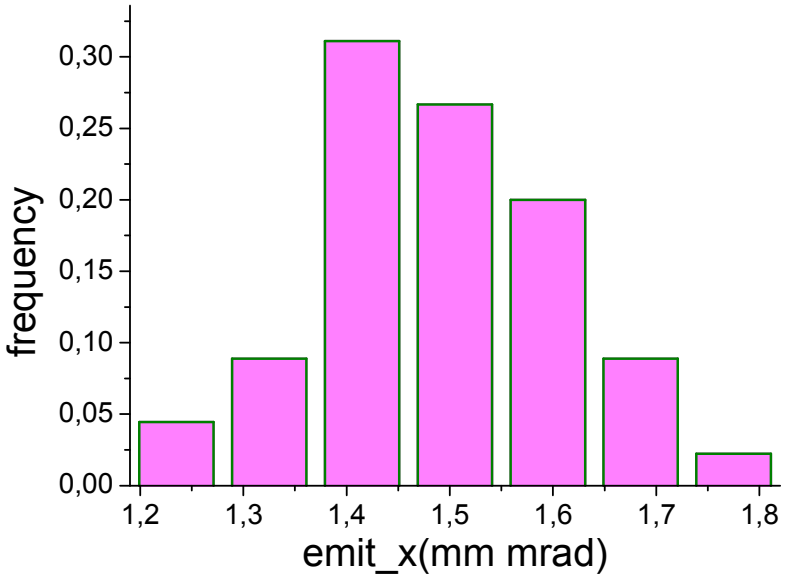
Photon number:
Most probable 1.71 10^9
Mean value 1.69 10^9
Standard deviation: 1.68 10^8
10 %
FWHM 3. 10^8
17.5%

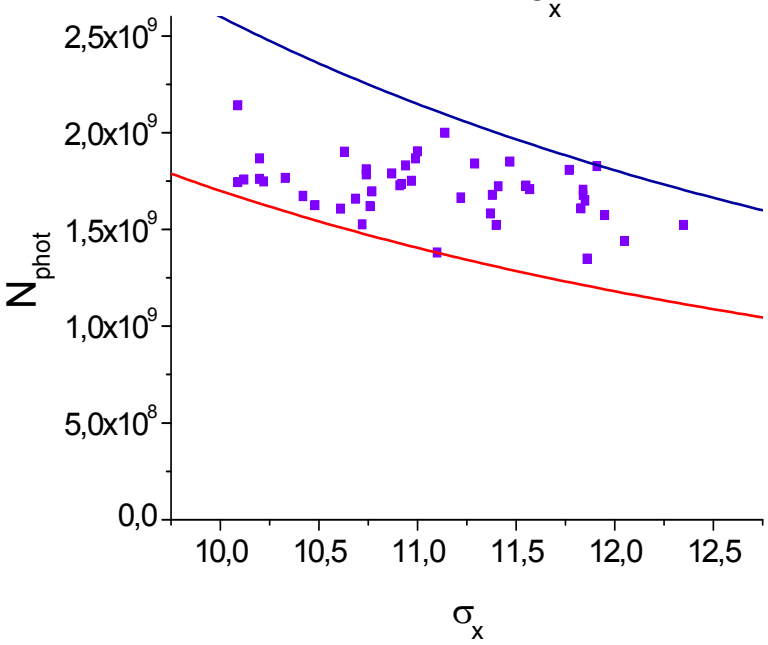
Banwidth:
Most probable number: 4.13 %
Mean value: 4.19%
Standard deviation: 1,33 10^{-3}
3,1%
FWHM 1.9 10^{-3}
4 %

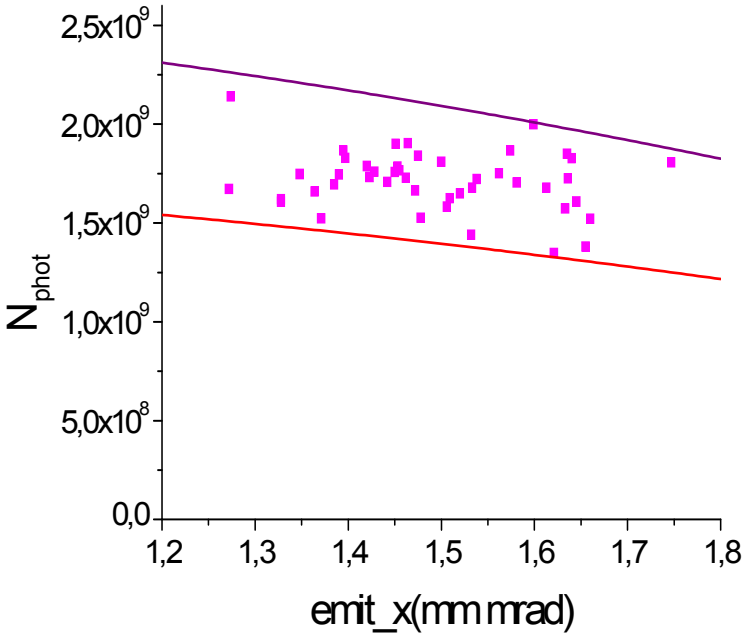

Frequency
0,00
0,05
0,10
0,15
0,20
30,3
30,4
30,5
30,6
30,7
Energy(MeV)


frequency
0,00
0,05
0,10
0,15
0,20
0,25
0,30
0,35
0,6
0,8
1,0
1,2
1,4
1,6
1,8
δγ/γ

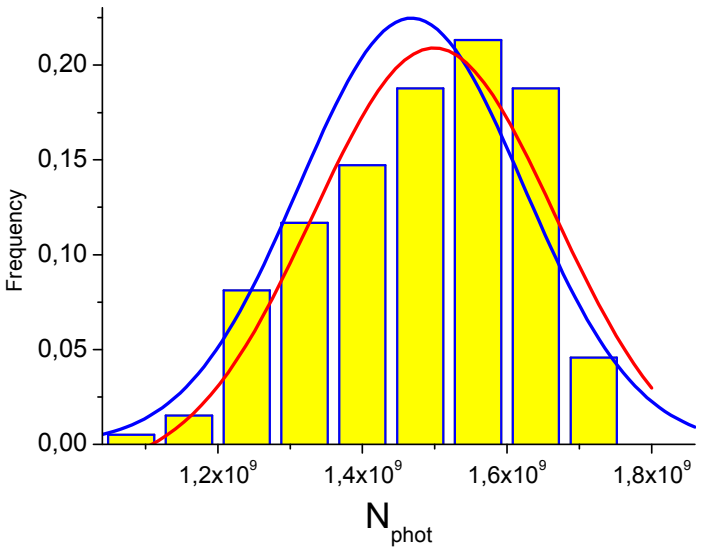

frequency
0,20
0,15
0,10
0,05
0,00
9,0
9,5
10,0
10,5
11,0
11,5
12,0
12,5
σx

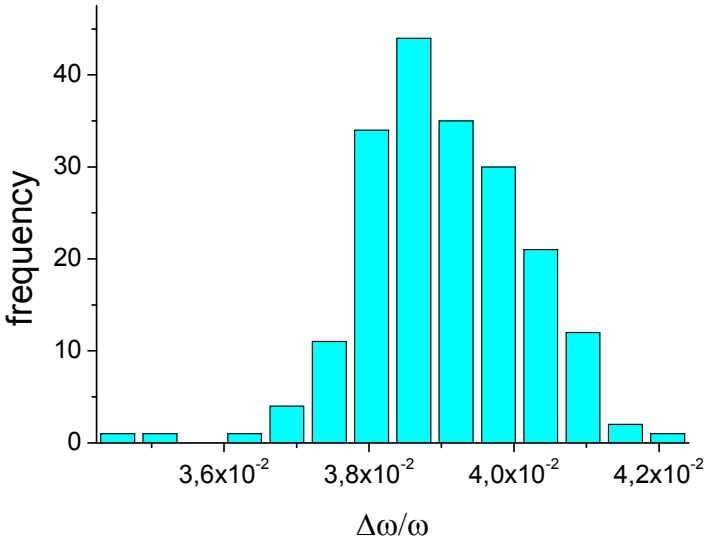

frequency
0,30
0,25
0,20
0,15
0,10
0,05
0,00
1,2
1,3
1,4
1,5
1,6
1,7
1,8
emit_x(mm mrad)


Nphot
2,5x10^9
2,0x10^9
1,5x10^9
1,0x10^9
5,0x10^8
0,0
10,0
10,5
11,0
11,5
12,0
12,5
σx


Nphot
2,5x10^9
2,0x10^9
1,5x10^9
1,0x10^9
5,0x10^8
0,0
1,2
1,3
1,4
1,5
1,6
1,7
1,8
emit_x(mm mrad)

Second case 200 shot





Photon number:
Most probable 1.56 10^9
Mean value 1.48 10^9
Standard deviation: 1.38 10^8
9.3 %
FWHM 4.8 10^8
30%

Banwidth:
Most probable number: 3,85 %
Mean value: 3,88 %
Standard deviation: 1,33 10^{-3}
3,1%
FWHM 2.3 10^{-3}
6 %