High Compression in XFEL

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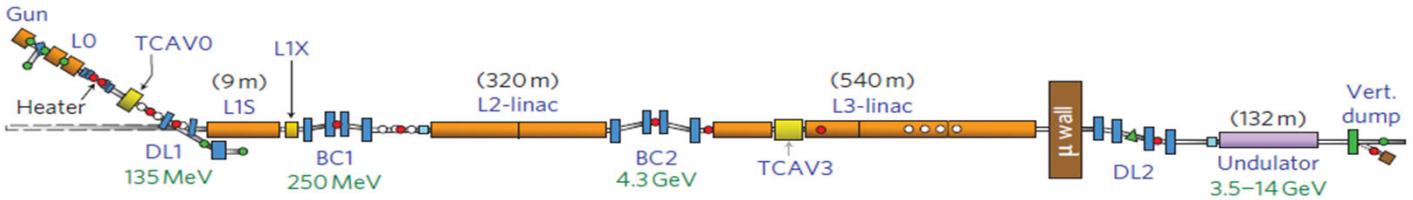
02.04.2012

DESY

SLAC-PUB-14234

FEMTOSECOND OPERATION OF THE LCLS FOR USER EXPERIMENTS*



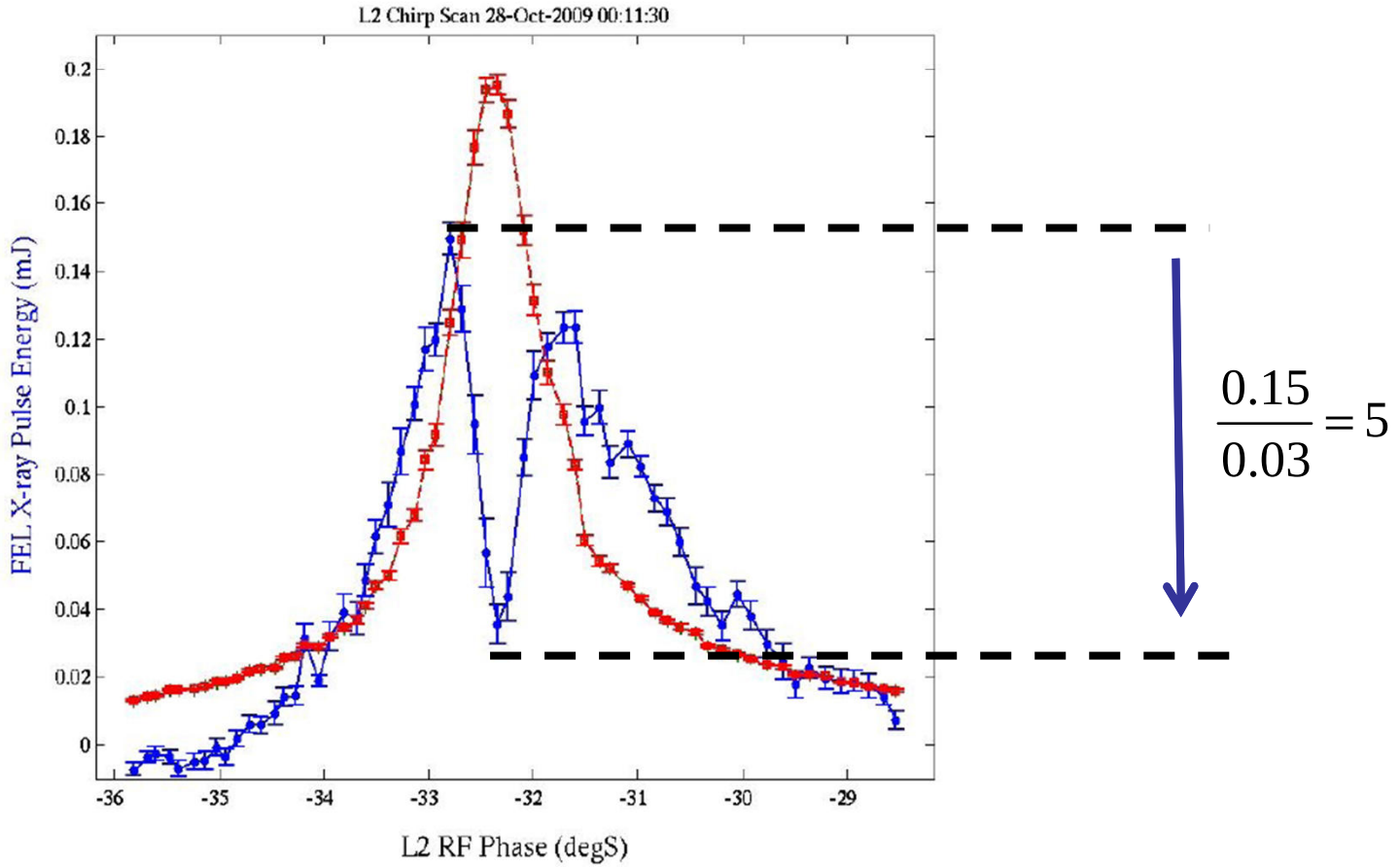
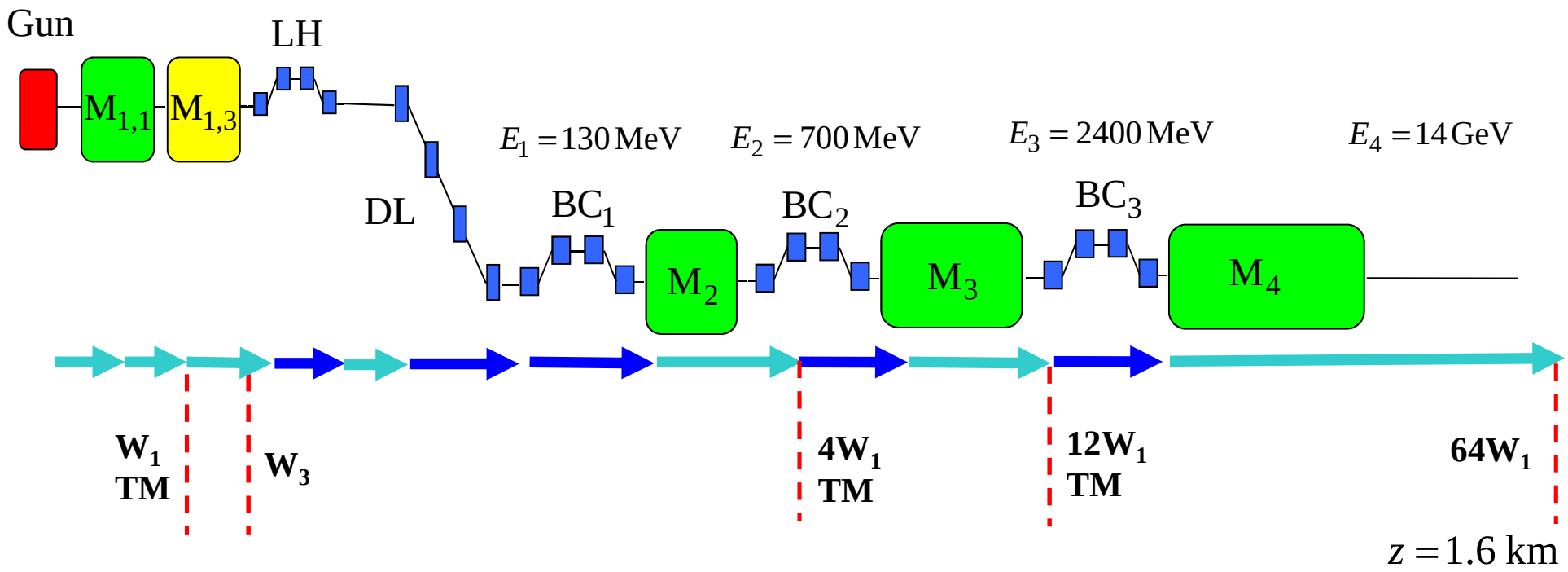


Figure 2: FEL power (blue) and Ipk(red) vs. compression

Beam dynamics simulations for the European XFEL

Full 3D simulation method (**200 CPU, ~10 hours**)



ASTRA (tracking with **3D space charge**, DESY, K. Flötmann)

CSRtrack (tracking through dipoles, DESY, M. Dohlus, T. Limberg)

W1 -TESLA cryomodule wake (TESLA Report 2003-19, DESY, 2003)

W3 - ACC39 wake (TESLA Report 2004-01, DESY, 2004)

TM - transverse matching to the design optics

Choosing of machine parameters

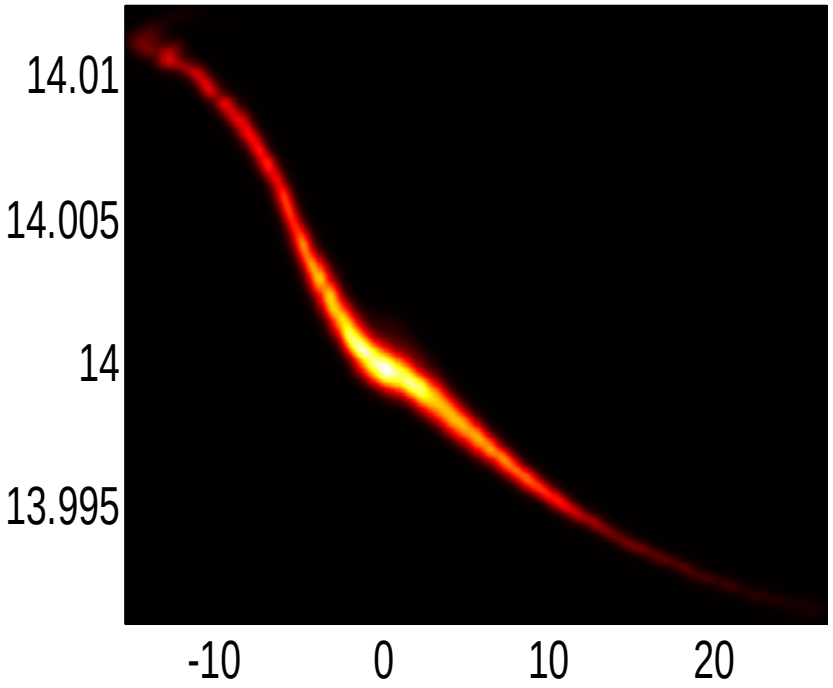
Macro-parameters

Momentum compaction factor in BC_1 $R_{56,1}$, [mm]	Compr. in BC_1 C_1	Momentum compaction factor in BC_2 $R_{56,2}$, [mm]	Compr. in BC_2 C_2	Momentum compaction factor in BC_3 $R_{56,3}$, [mm]	Total compr. C	First derivative Z', [m^{-1}]	Second derivative Z", [m^{-2}]
-78	3.5	-50	8	-20,…,-24	385	0	1000

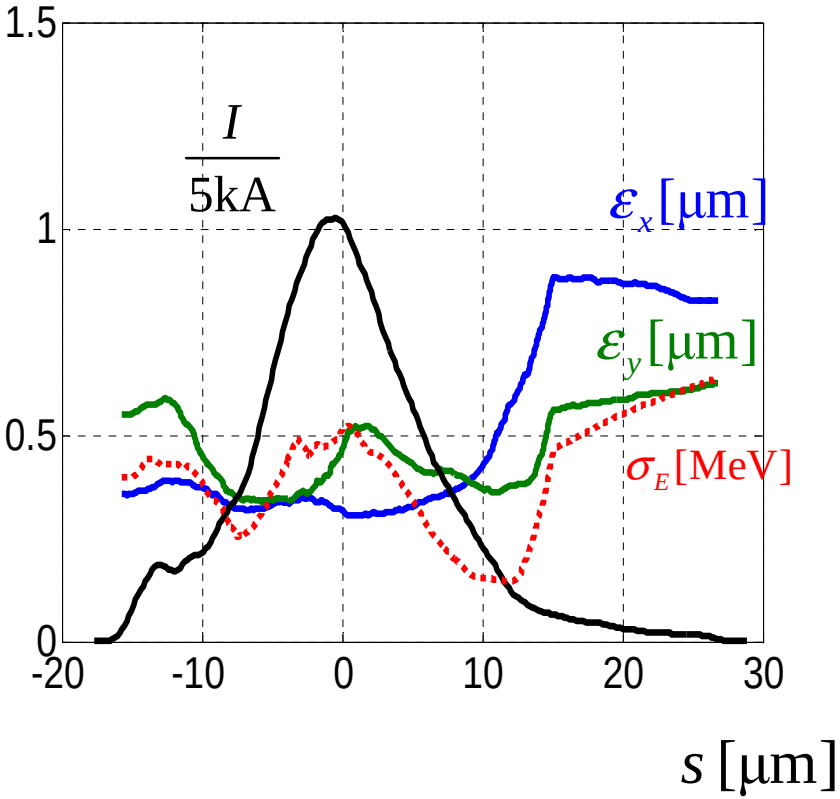
$E_1 = 130\,\mathrm{MeV}$ $E_2 = 700\,\mathrm{MeV}$ $E_3 = 2400\,\mathrm{MeV}$

$R_{56,3}$=-20mm

Phase space



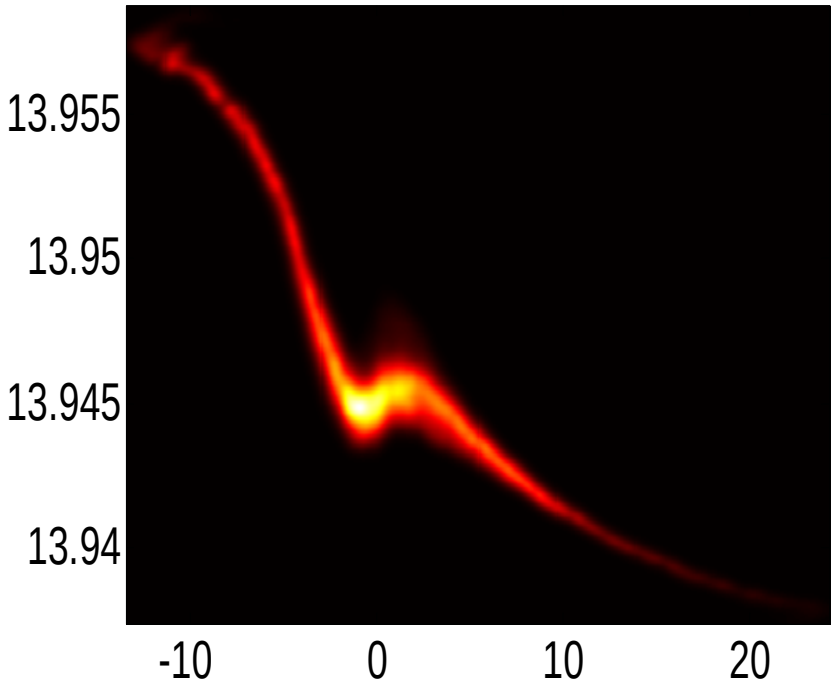
Current, emittance, energy spread



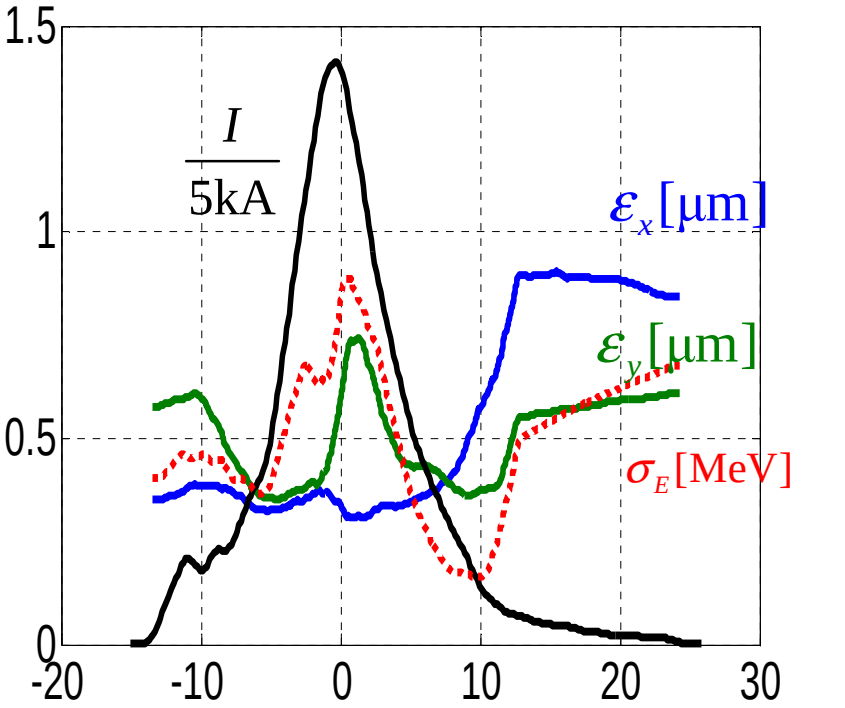
bunch head

$R_{56,3}$=-20.5mm

Phase space



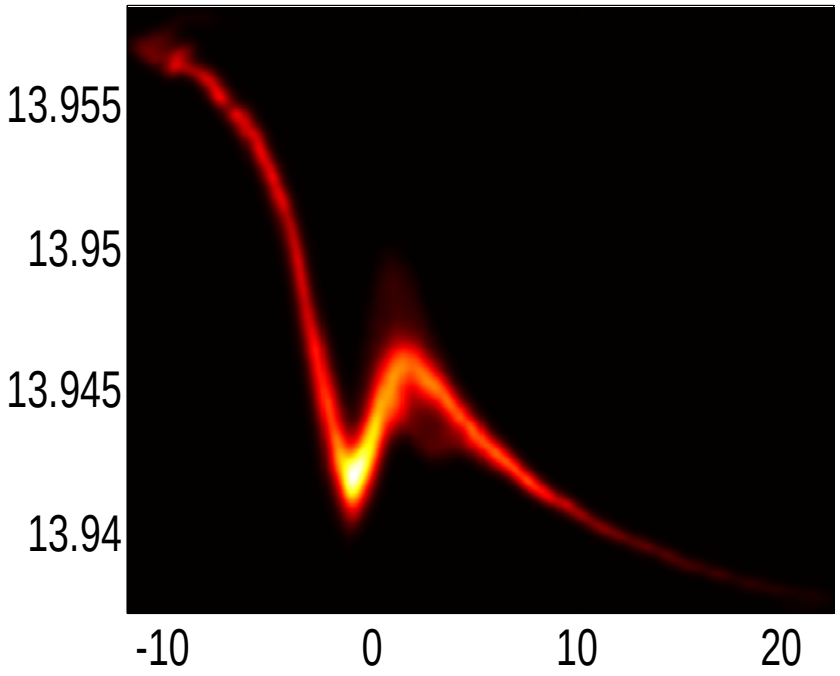
Current, emittance, energy spread



bunch head

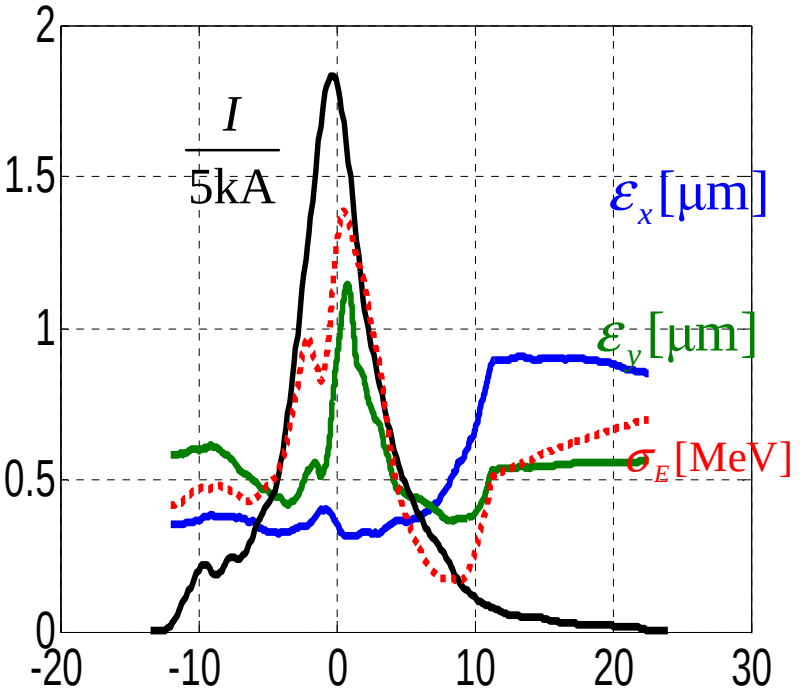
$R_{56,3}$ =-20.8mm

Phase space



s [μm]

Current, emittance, energy spread

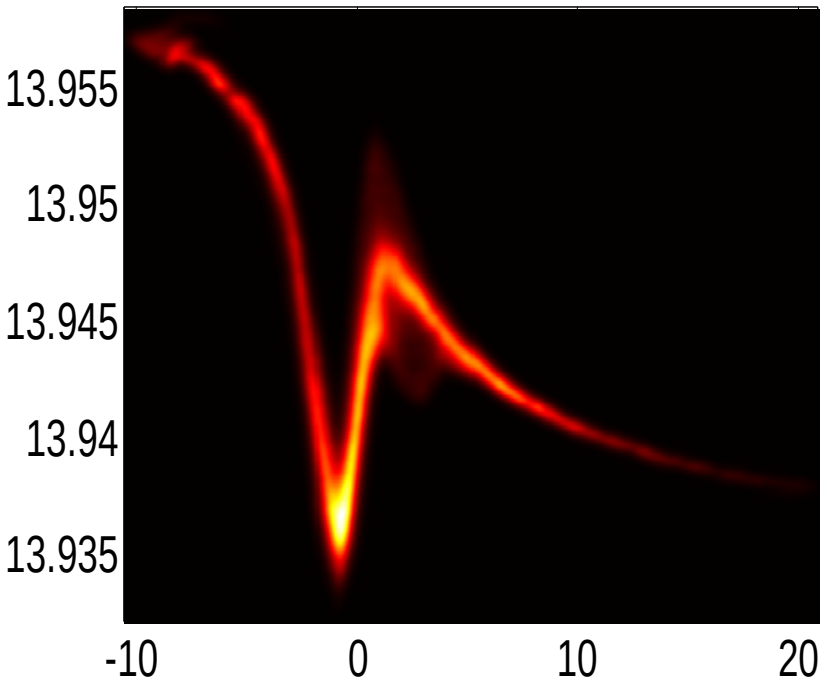


s [μm]

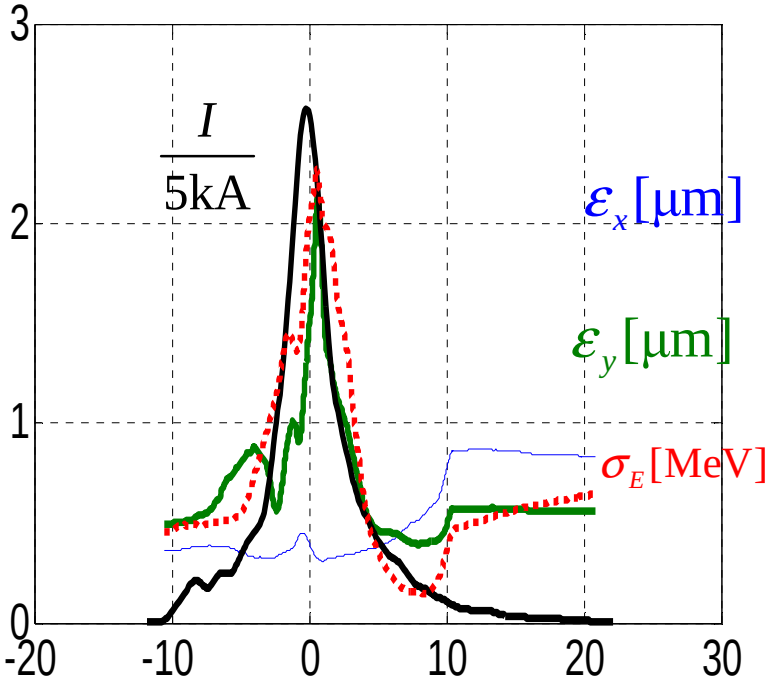
bunch head

$R_{56,3}$ =-21 mm

Phase space



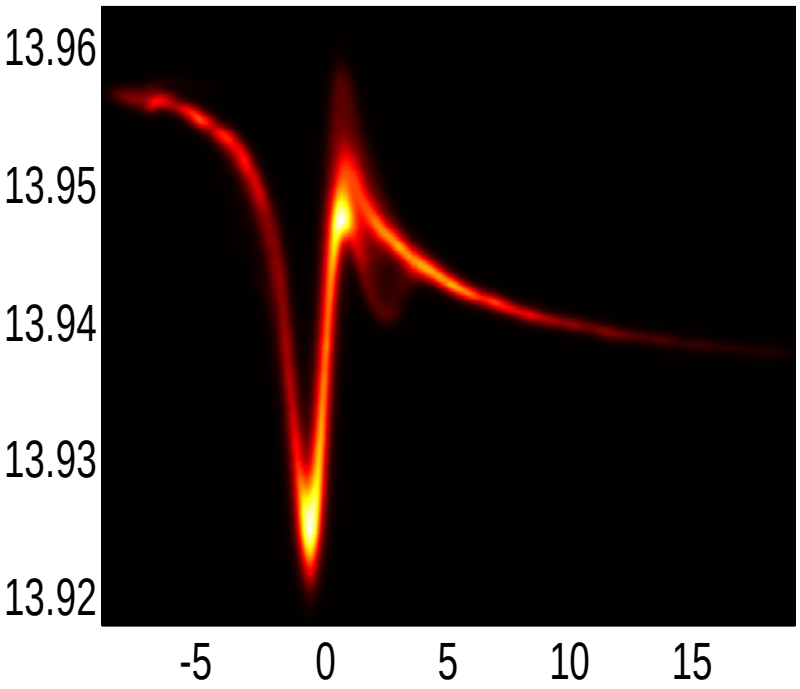
Current, emittance, energy spread



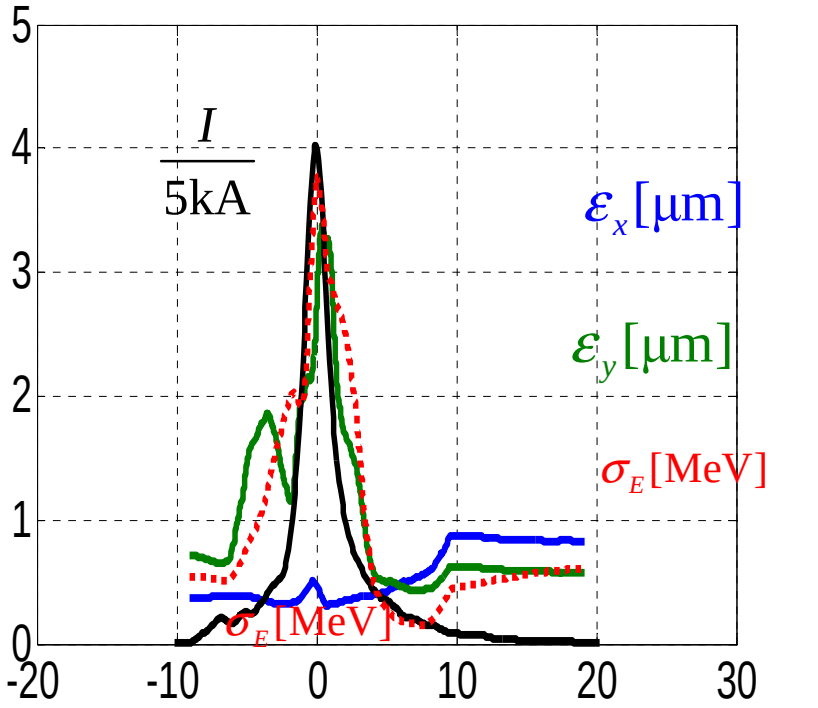
bunch head

$R_{56,3}$ =-21.3 mm

Phase space



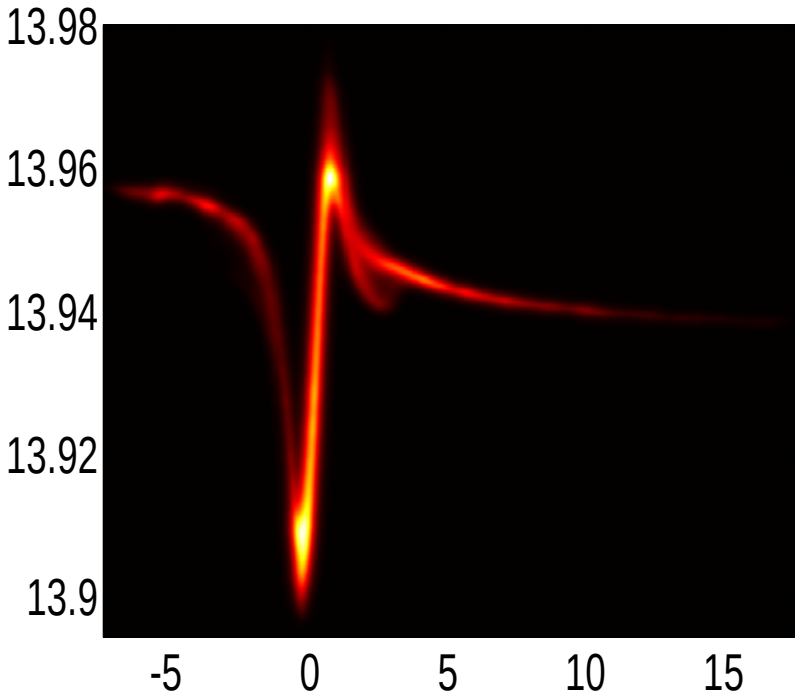
Current, emittance, energy spread



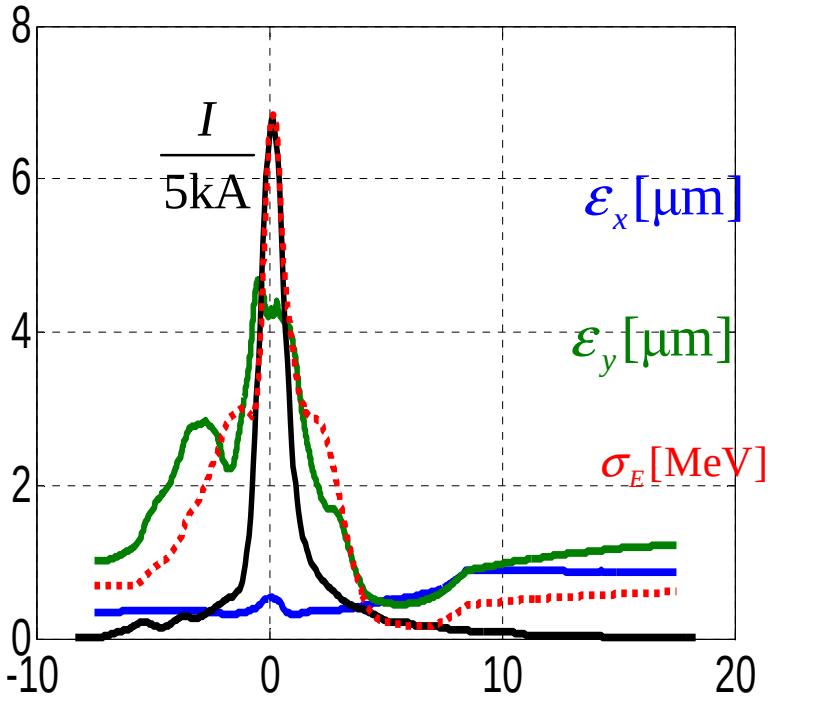
bunch head

$R_{56,3}$ =-21.6 mm

Phase space



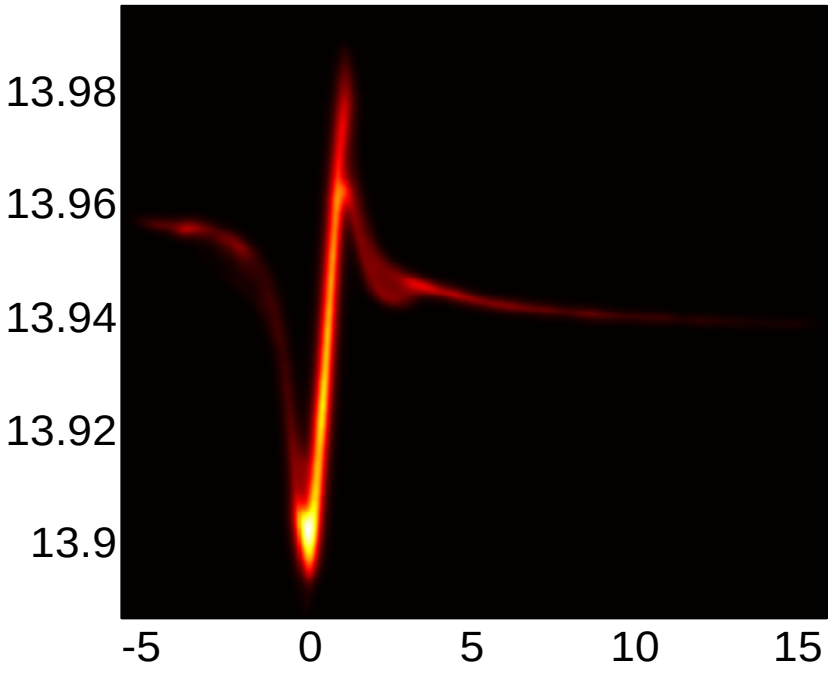
Current, emittance, energy spread



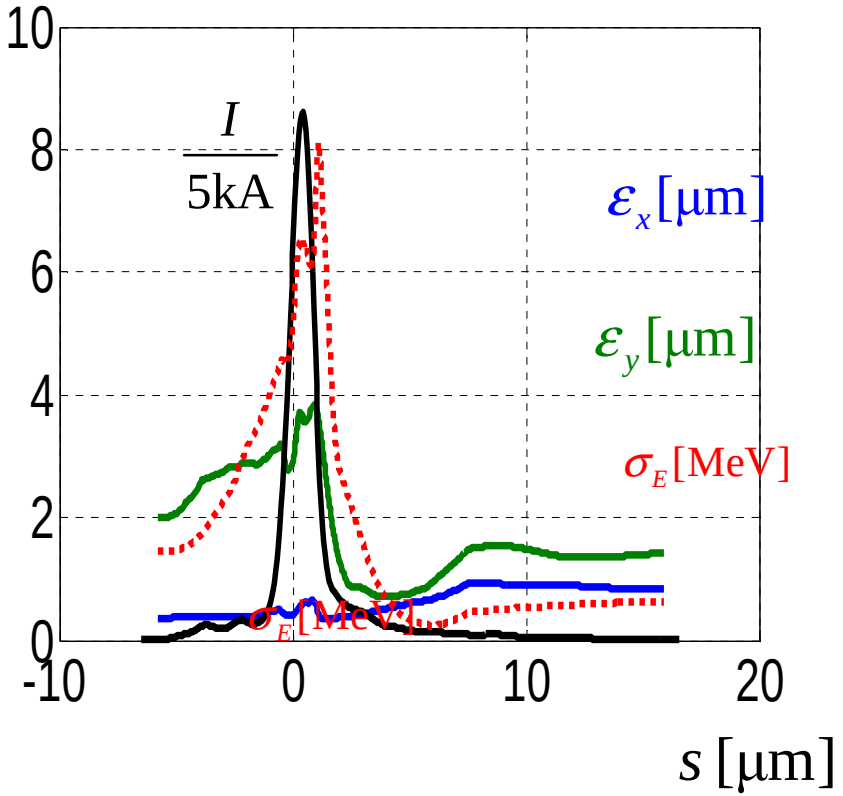
bunch head

$R_{56,3}$ =-21.9 mm

Phase space



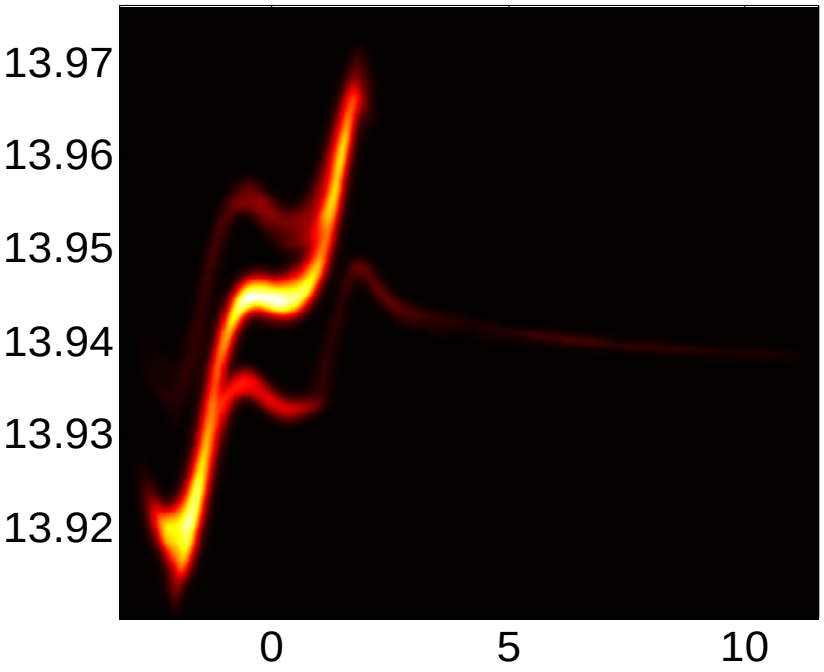
Current, emittance, energy spread



bunch head

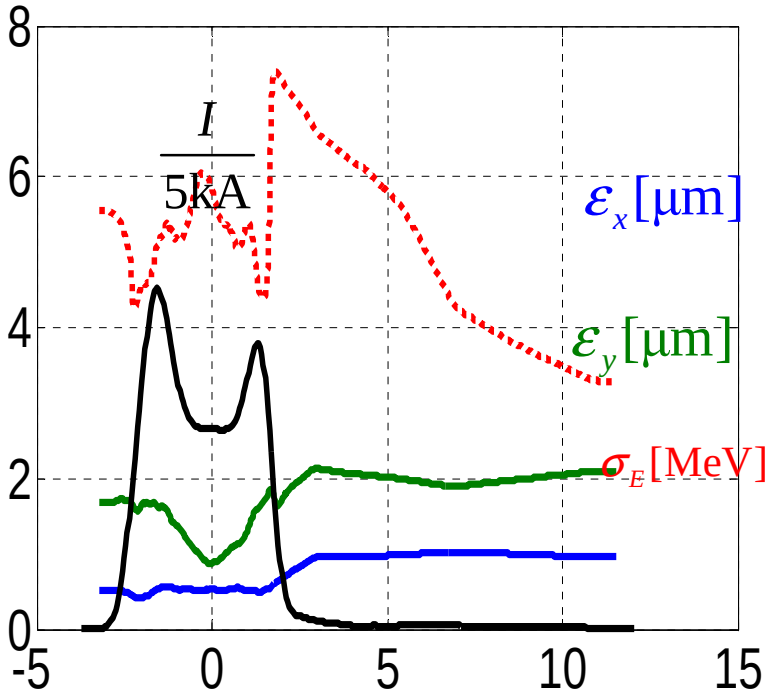
$R_{56,3}$ =-22.6 mm

Phase space



s [μm]

Current, emittance, energy spread

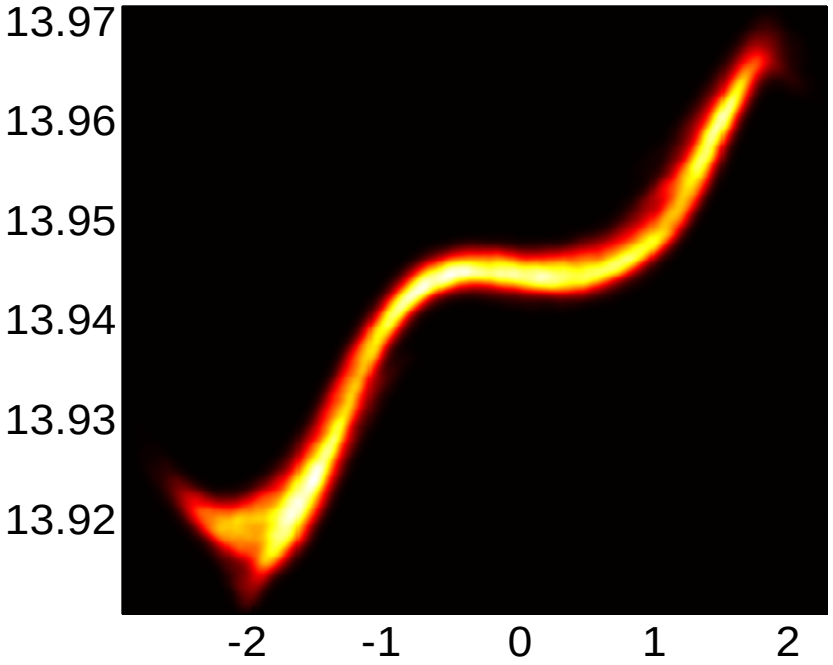


s [μm]

bunch head

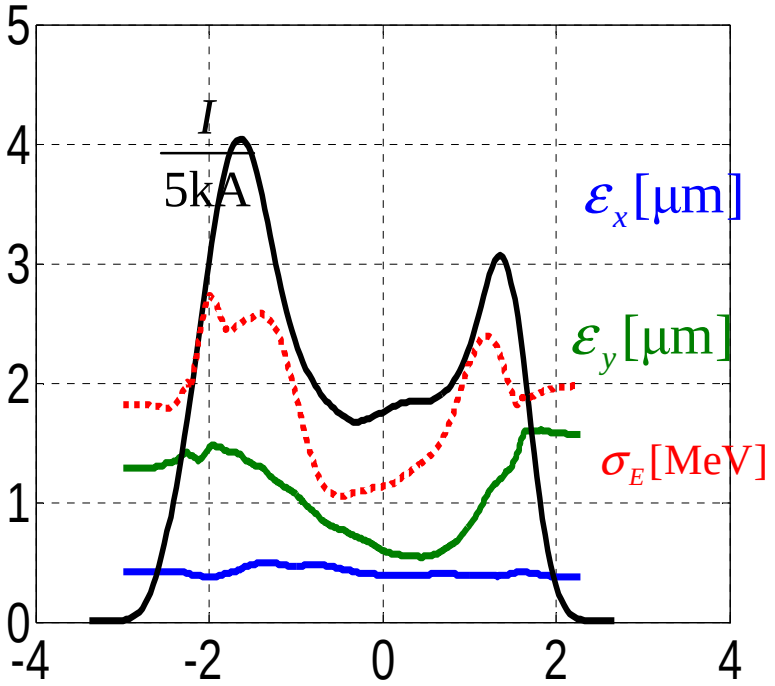
$R_{56,3}$ =-22.6 mm (70% of particles)

Phase space



s [μm]

Current, emittance, energy spread

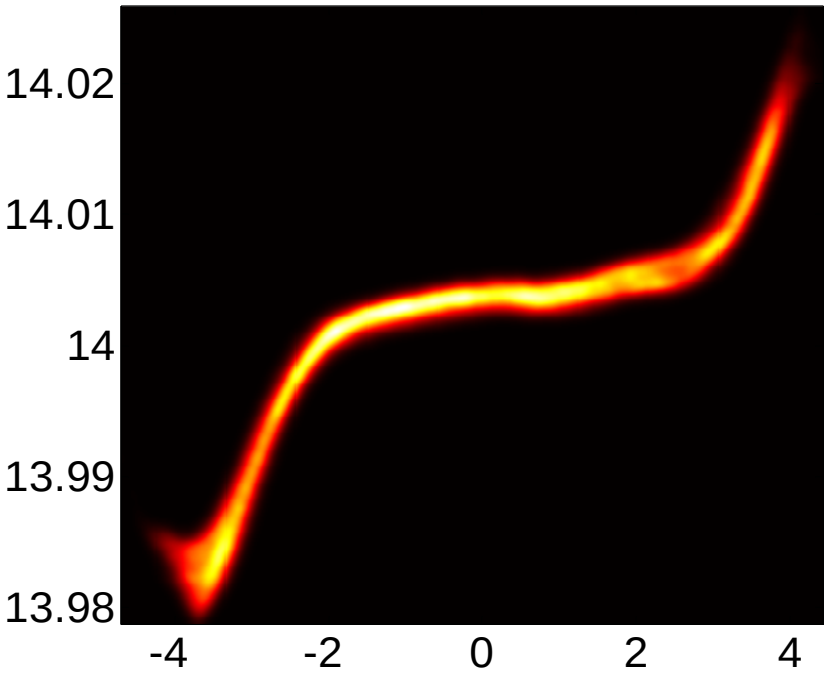


s [μm]

bunch head

$R_{56,3}$ =-23.2 mm (70% of particles)

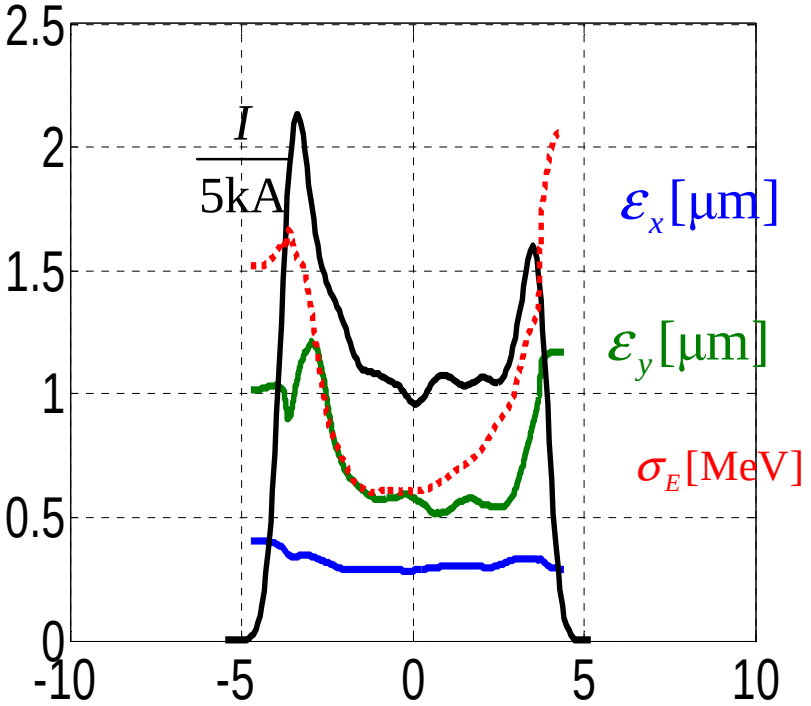
Phase space



s [μm]

bunch head

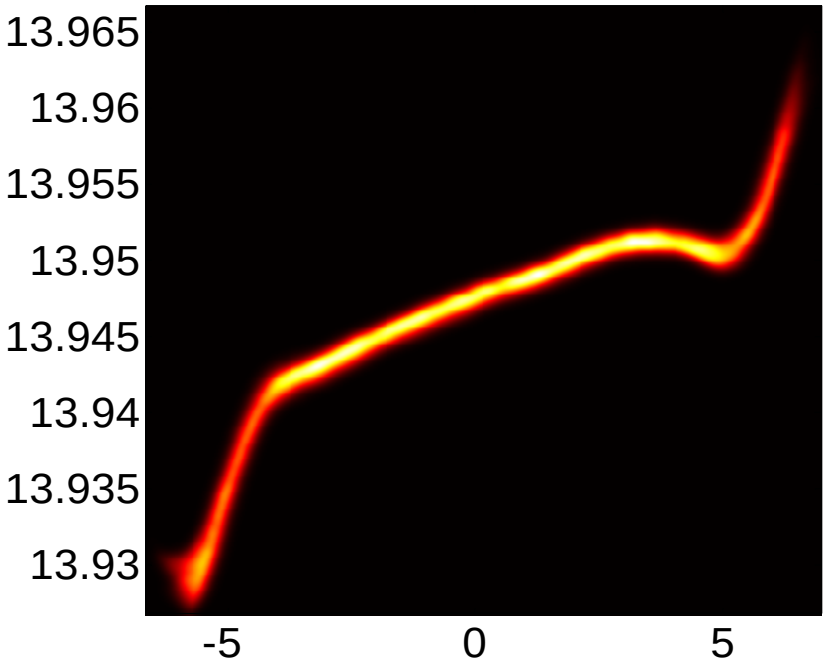
Current, emittance, energy spread



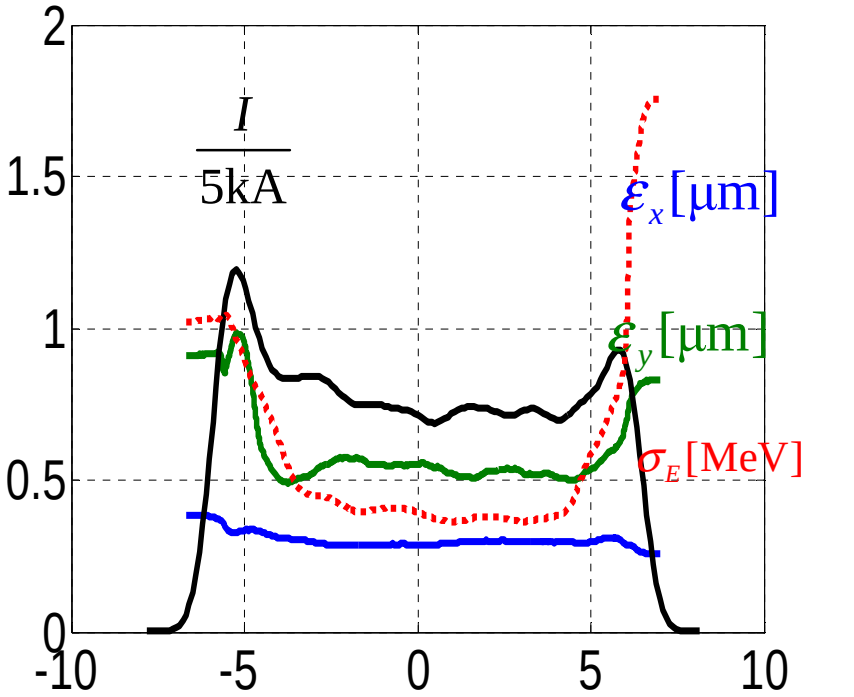
s [μm]

$R_{56,3}$ =-23.9 mm (70% of particles)

Phase space

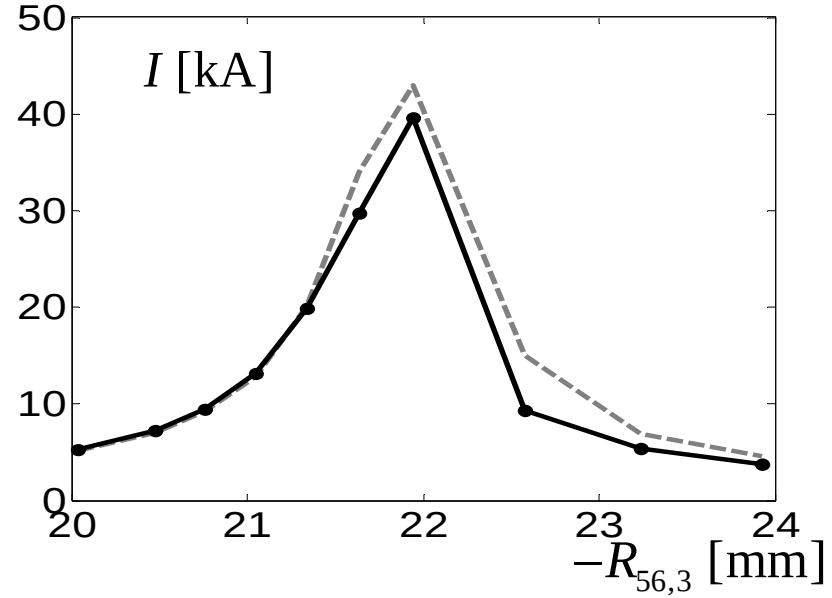


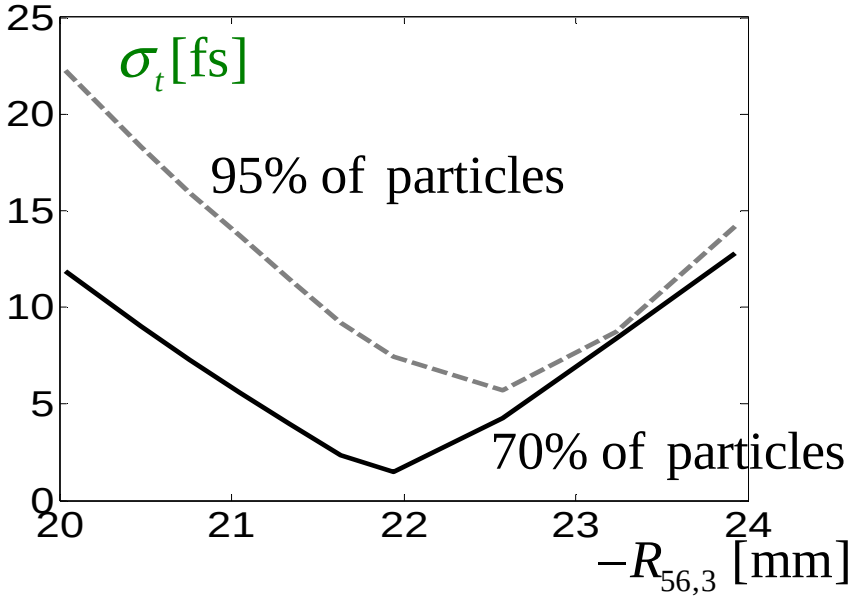
Current, emittance, energy spread

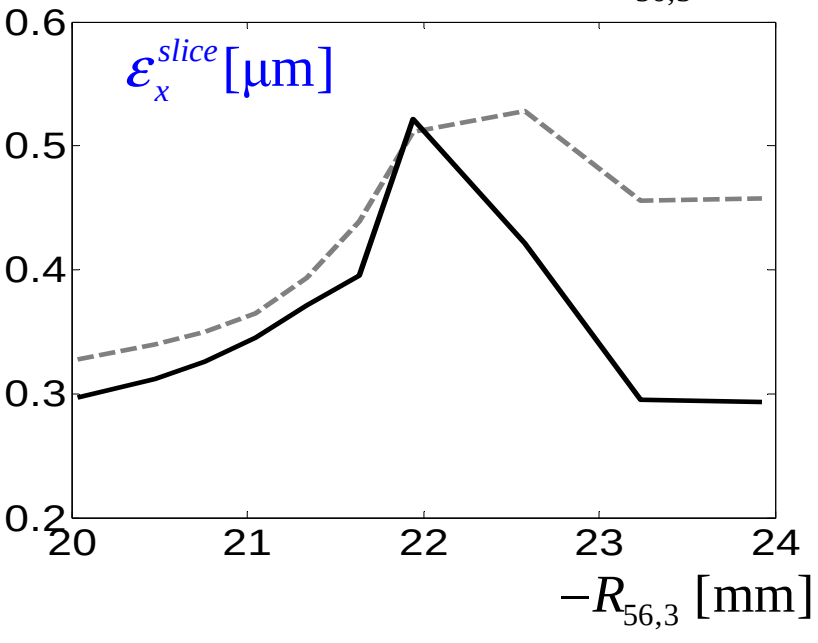


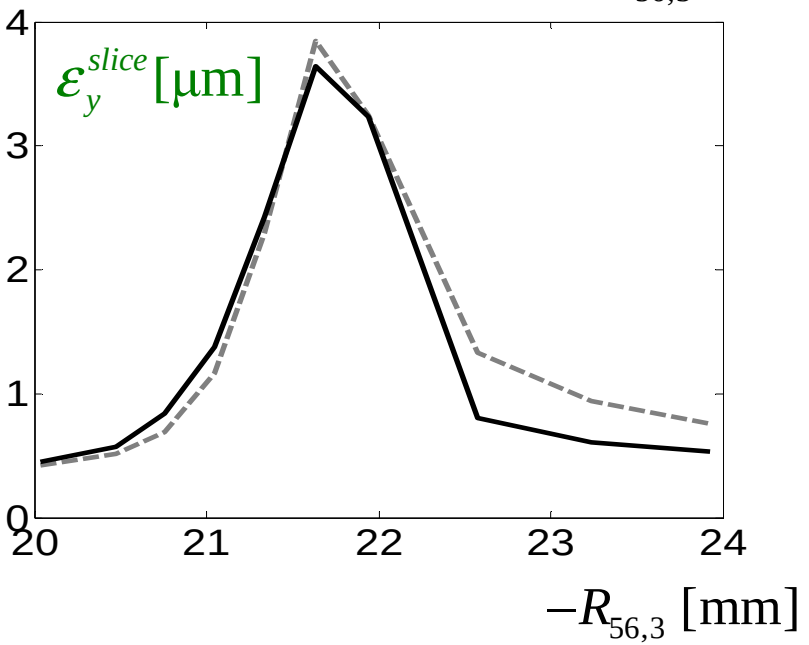
bunch head

Beam core parameters vs. R_{56}

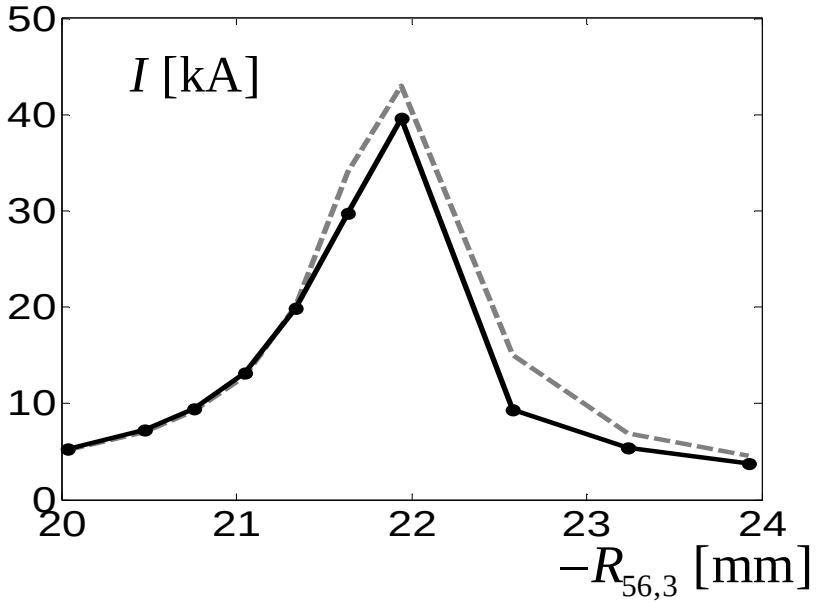


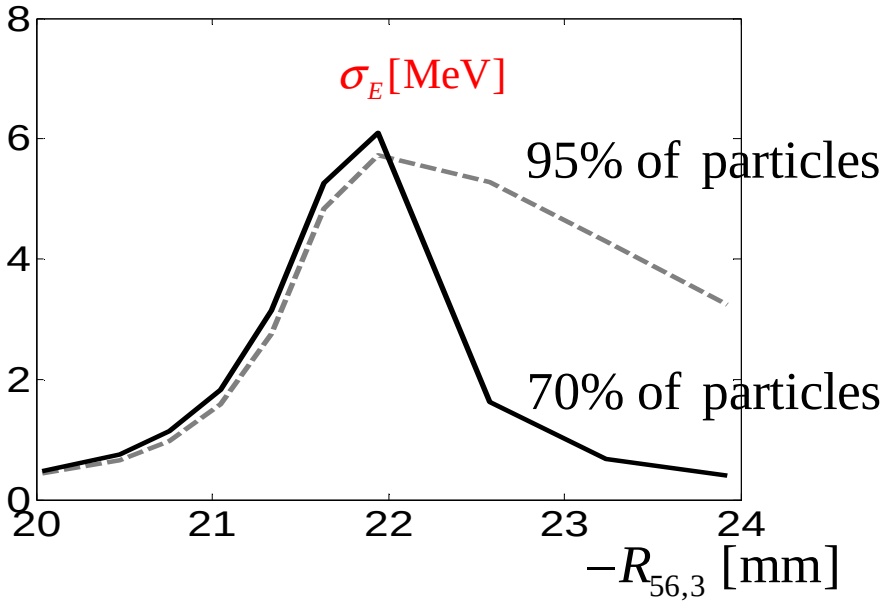


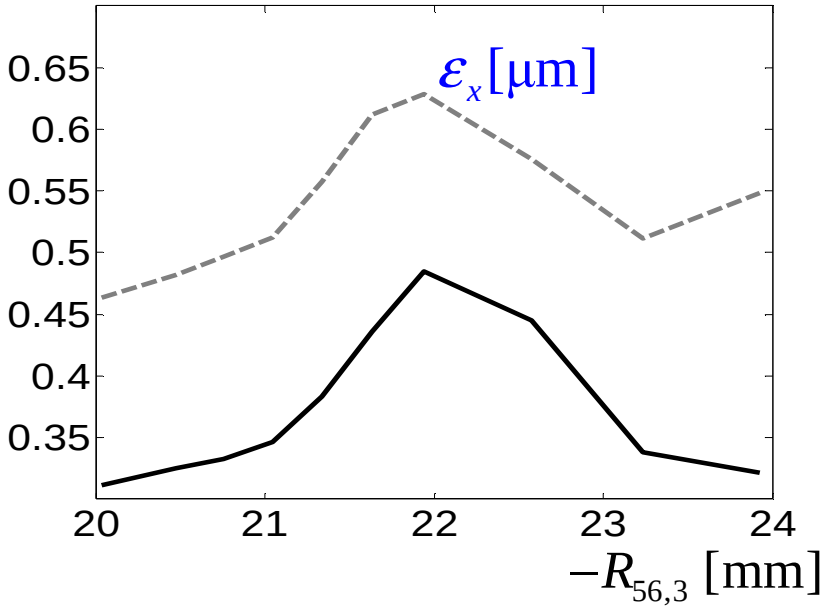


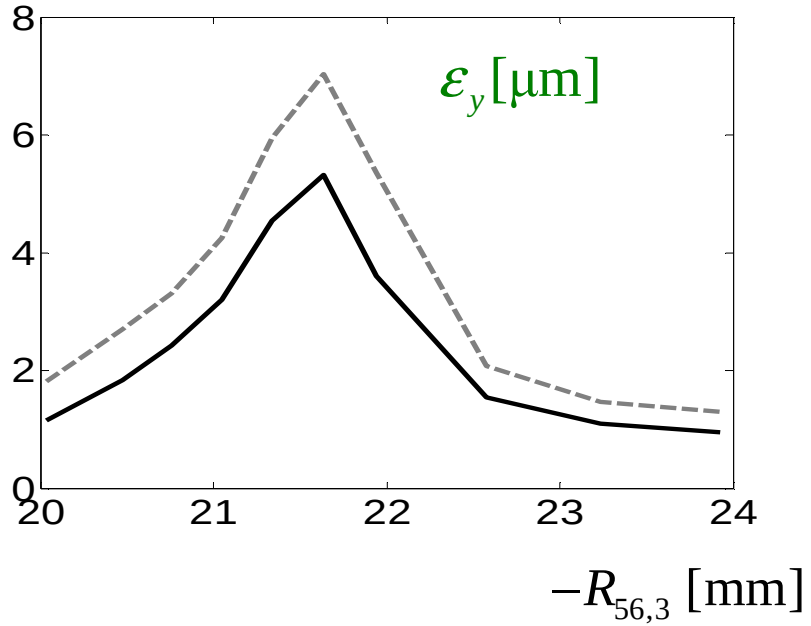


Beam core parameters vs. R_{56}

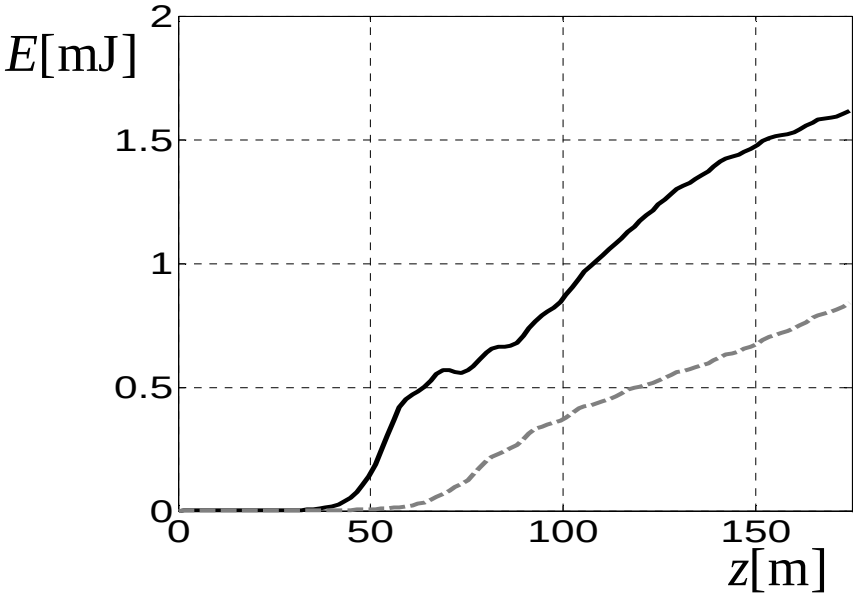


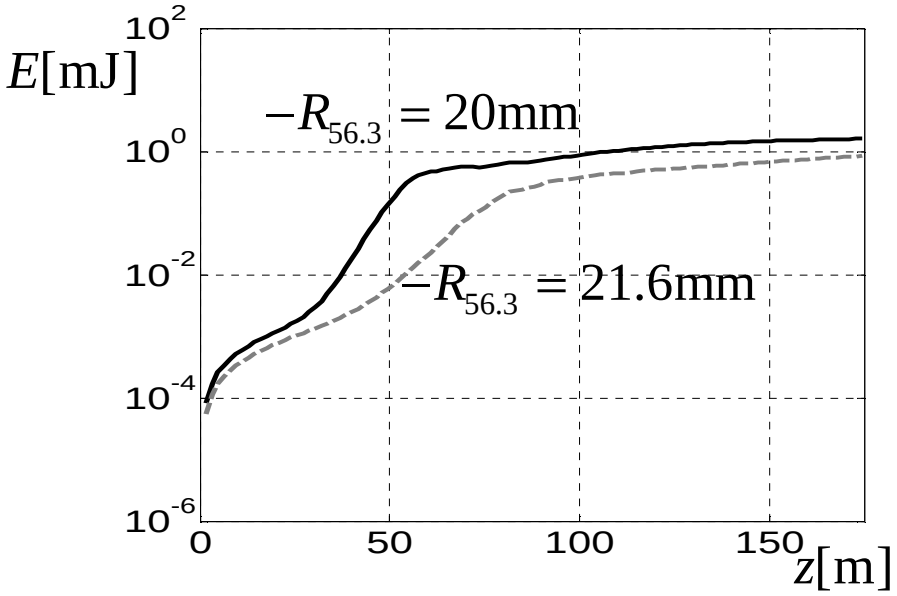


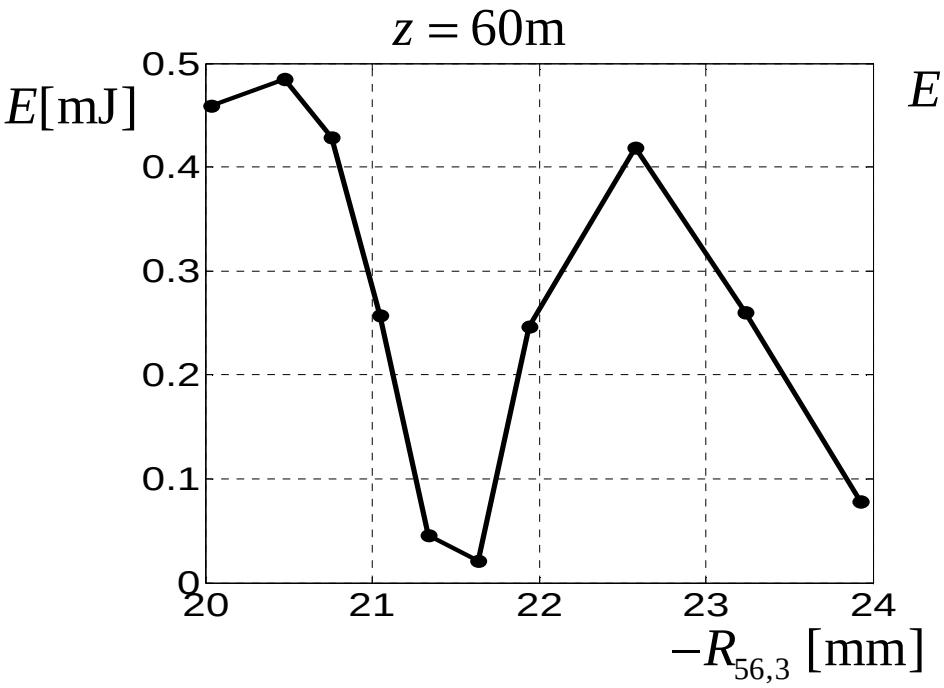


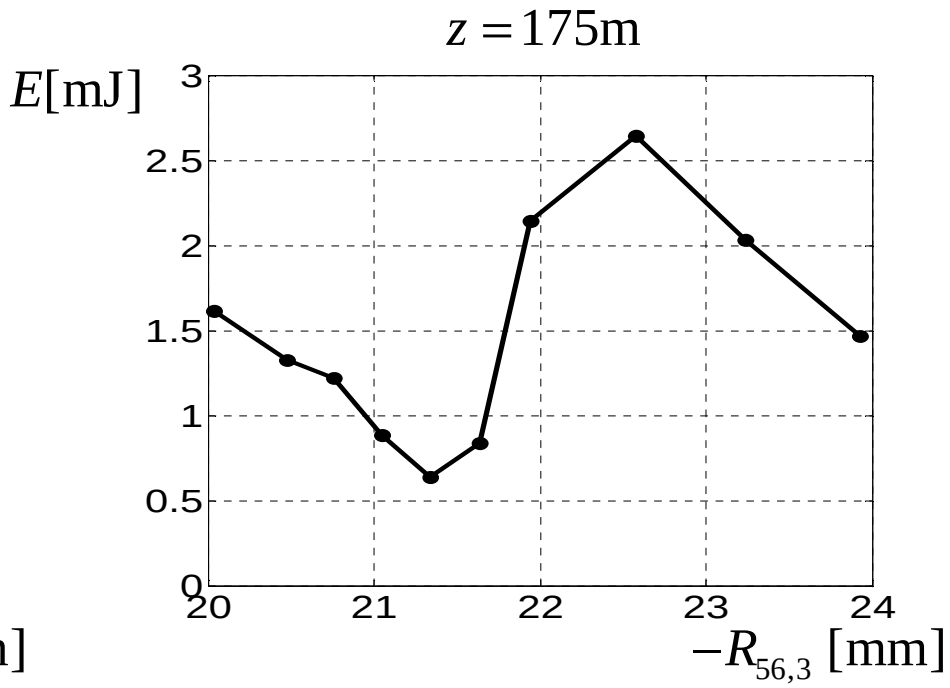


Radiation energy vs. R_{56} without undulator wake (95% of particles)

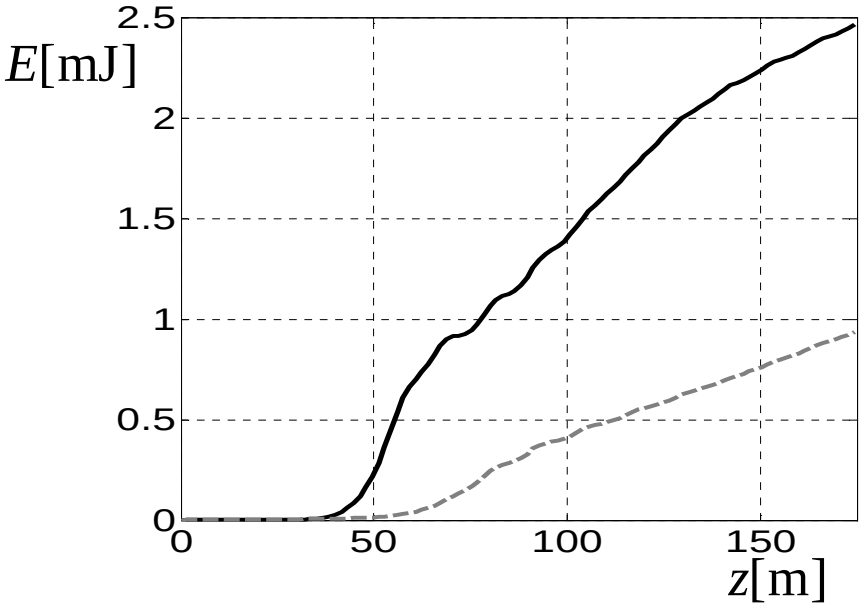


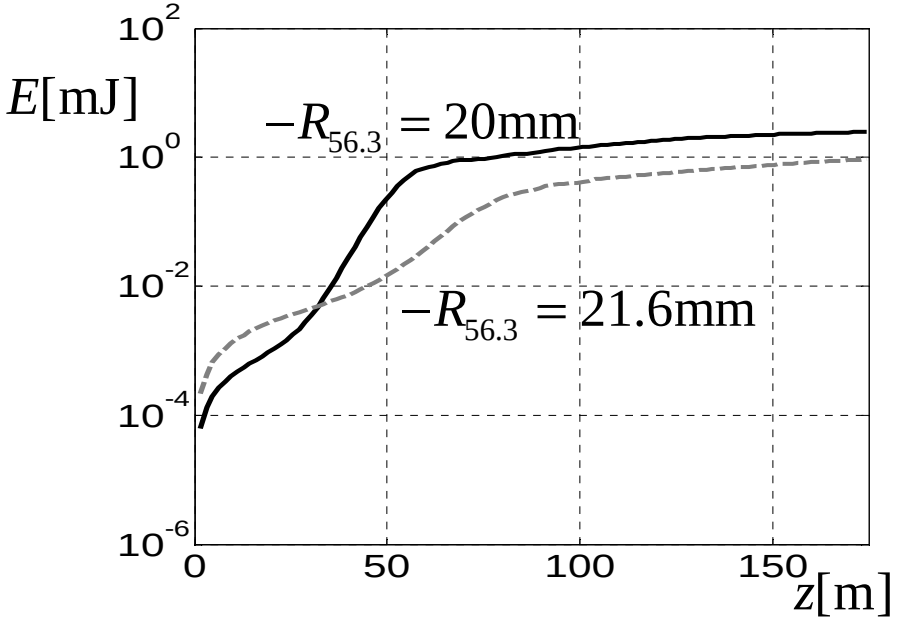


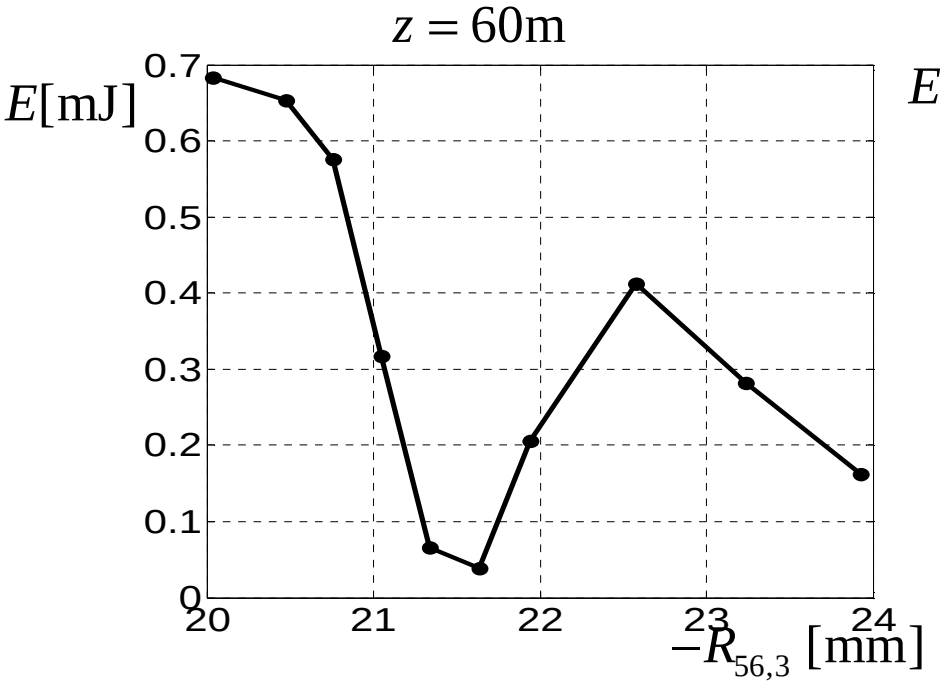


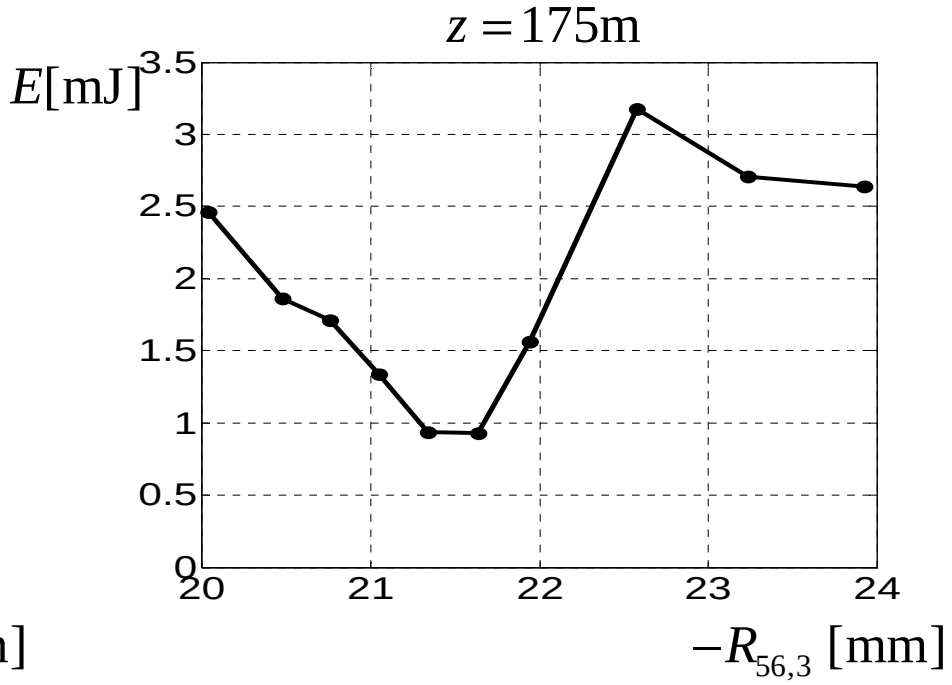


Radiation energy vs. R_{56} with undul. wake and taper (95% of particles)

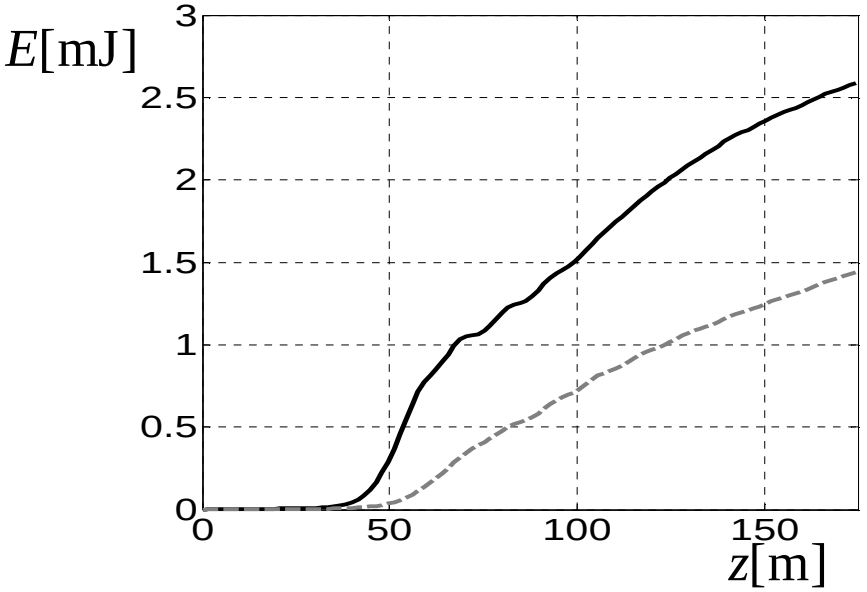


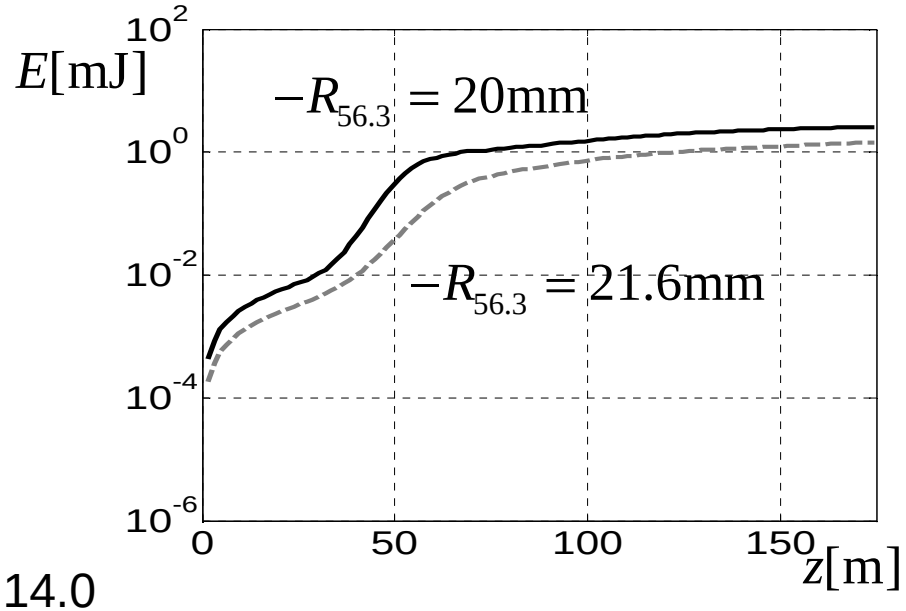






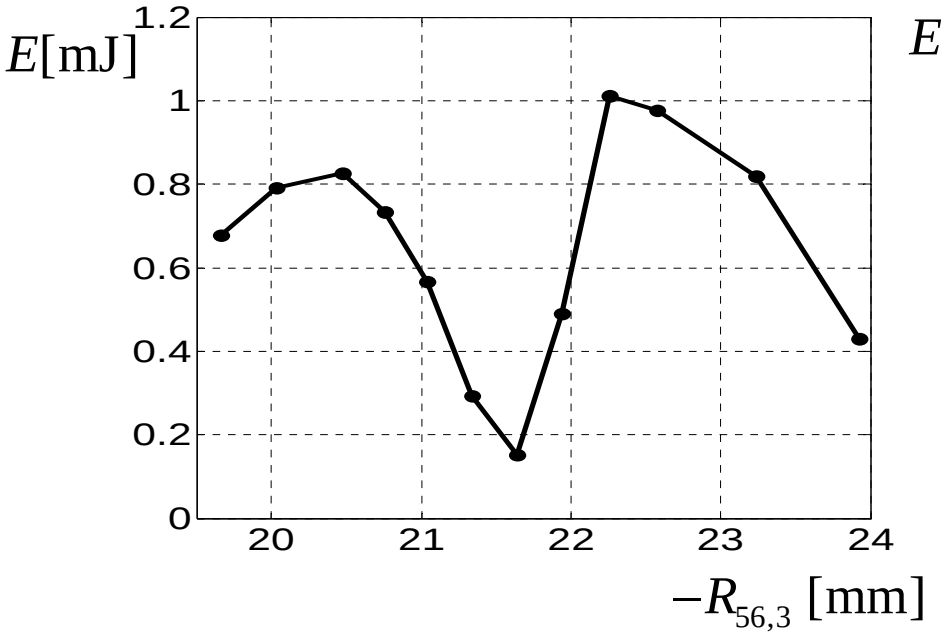
Radiation energy vs. R_{56} with undul. wake and taper (70% of particles)



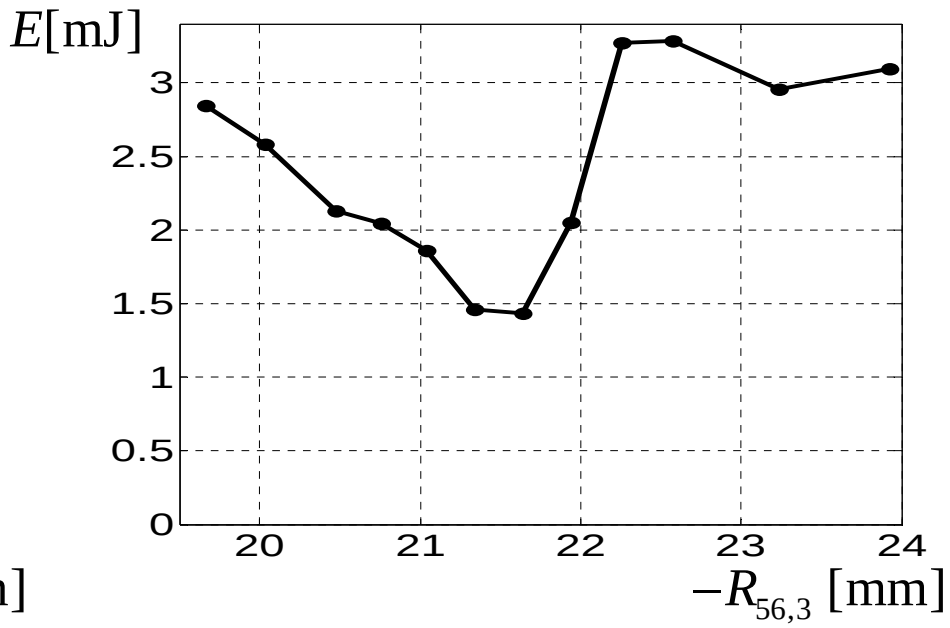


14.0

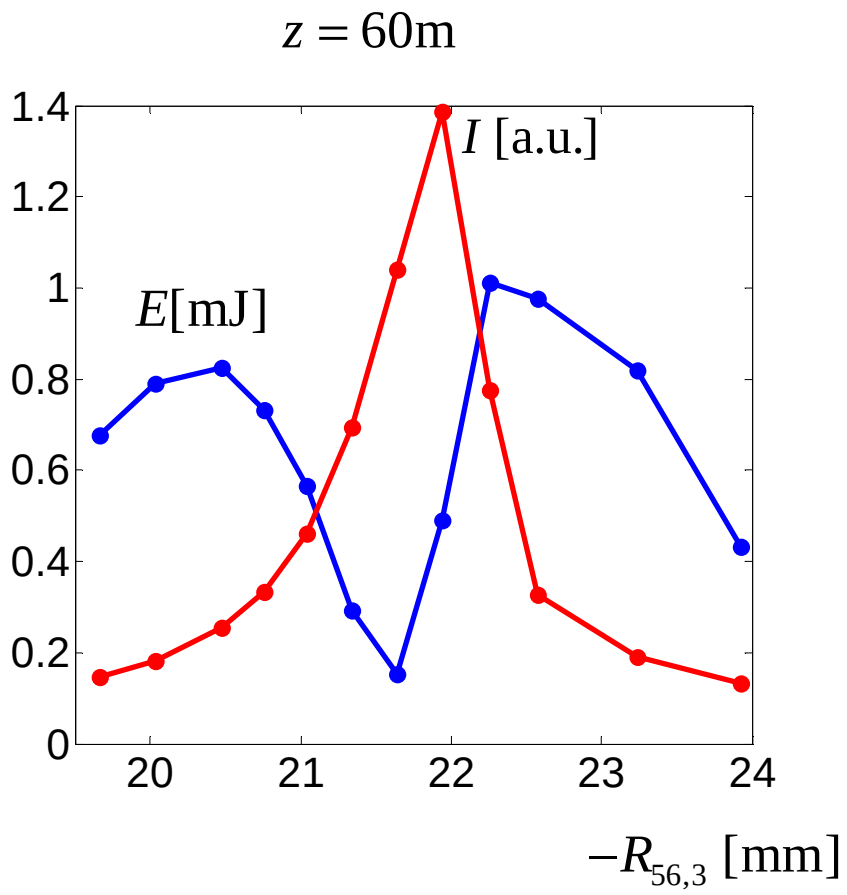
$z = 60\text{m}$



$z = 175\text{m}$



Radiation energy vs. compression rate



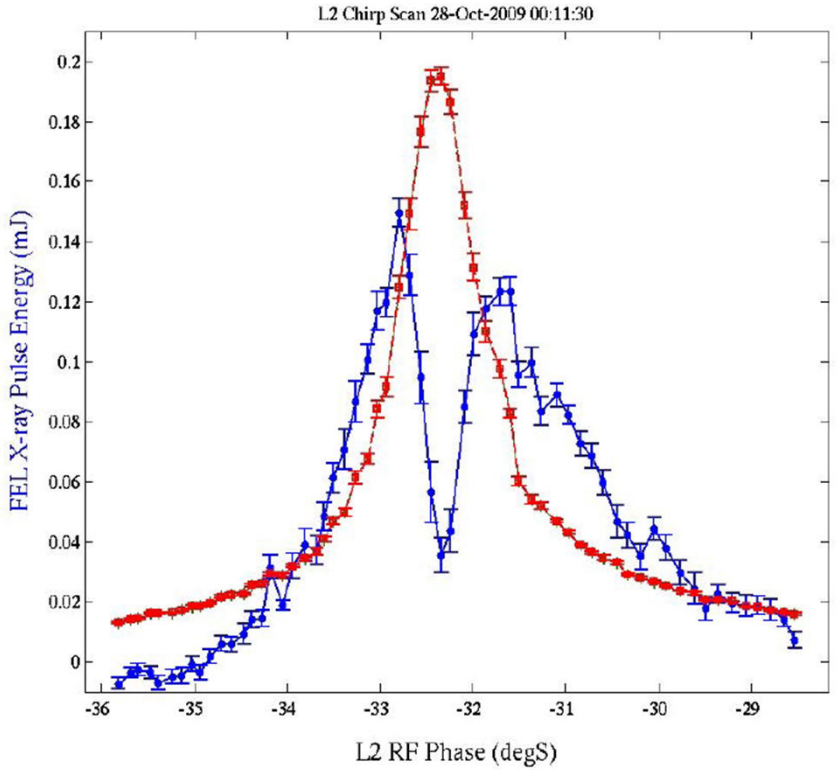
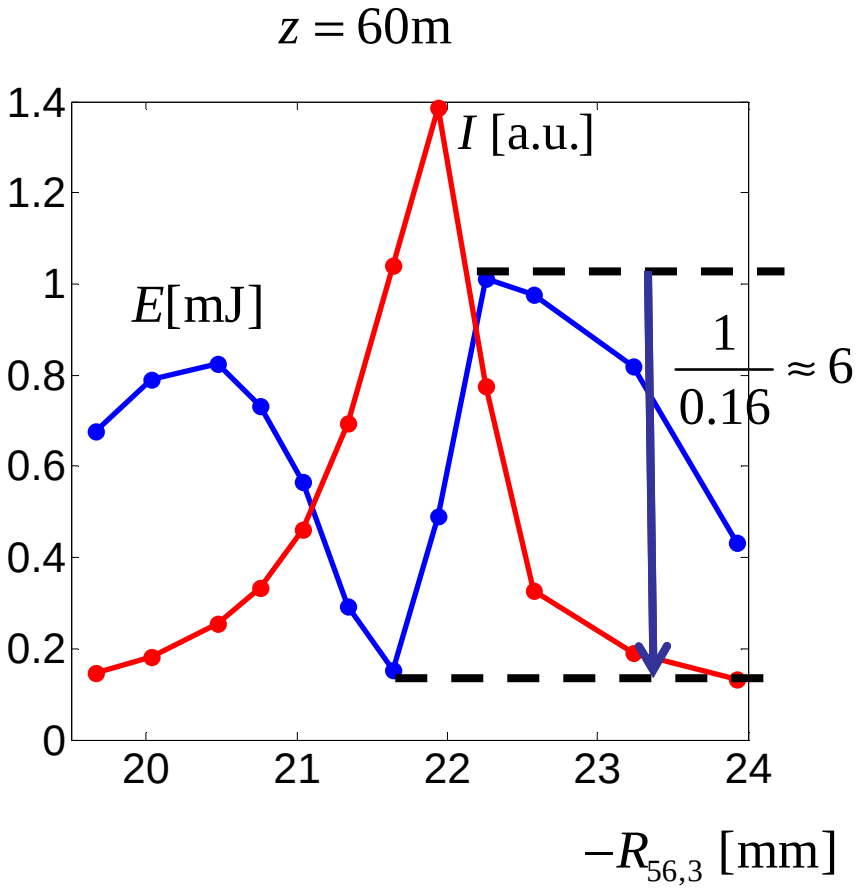


Figure 2: FEL power (blue) and Ipk(red) vs. compression

Radiation energy vs. compression rate



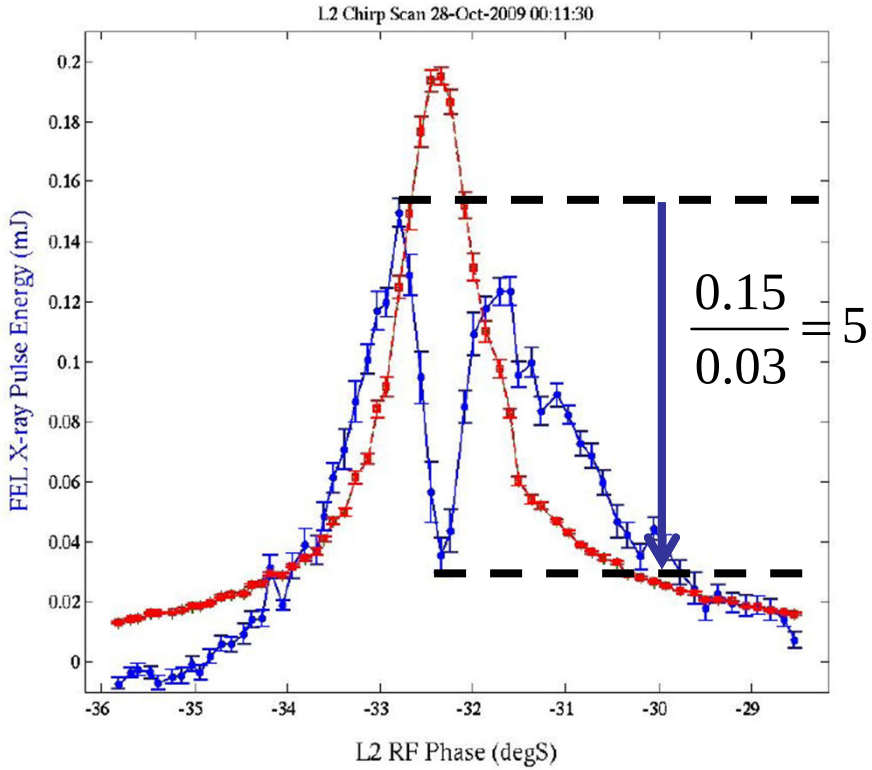


Figure 2: FEL power (blue) and Ipk(red) vs. compression

Radiation power vs. compression rate