Impact of the collimator section wakes on SASE2 performance

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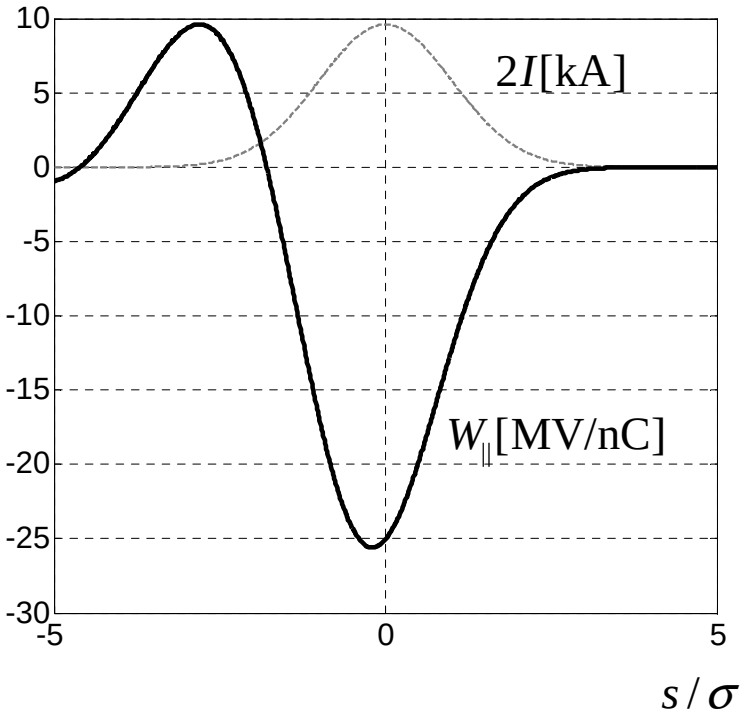
Impedance budget

Section	El. type	Num.	Loss (kV/nC)	%	Spread(kV/nC)	%	Peak(kV/nC)	%
CL								
	PUMCL	78	5,96E+02	4	2,41E+02	3	8,43E+02	3
	PIP 20	1	5,40E+03	32	3,95E+03	47	9,25E+03	36
	KICK	3	3,71E+03	22	1,57E+03	19	5,37E+03	21
	FLANG	500	1,42E+03	8	5,73E+02	7	2,00E+03	8
	COLL	4	5,72E+03	34	2,77E+03	33	8,59E+03	34
	BPMCL	12	8,70E+01	1	3,52E+01	0	1,23E+02	0
			1,69E+04	100	8,37E+03	100	2,56E+04	100
			1,69E+04	100	8,37E+03	100	2,56E+04	100

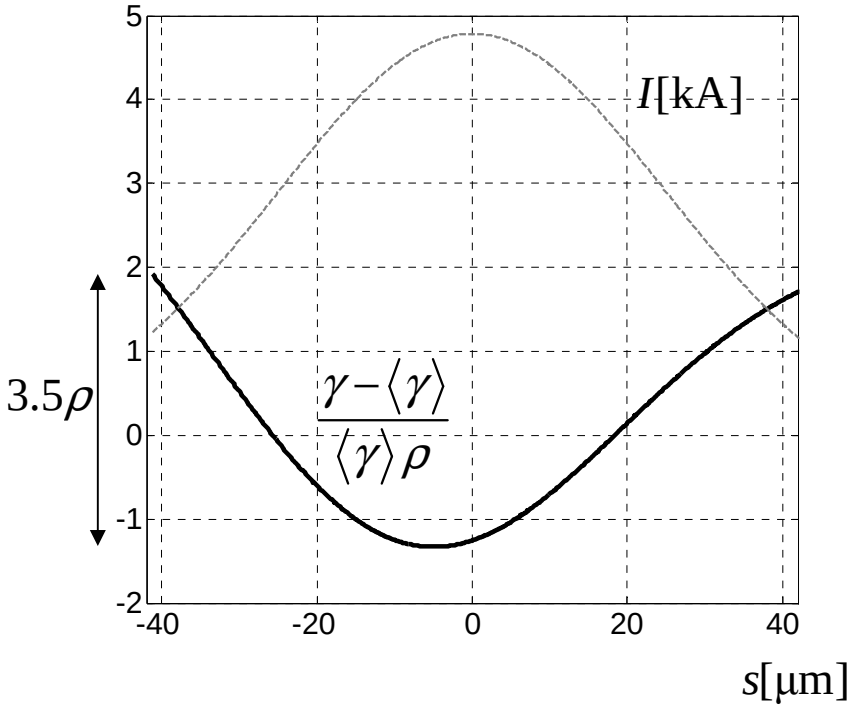
CS wake



$$\left\langle W_{\|} \right\rangle = 17\left[\text{MV/nC}\right]$$

$$W_{rms} = 8.4\left[\text{MV/nC}\right]$$

Correlated energy spread



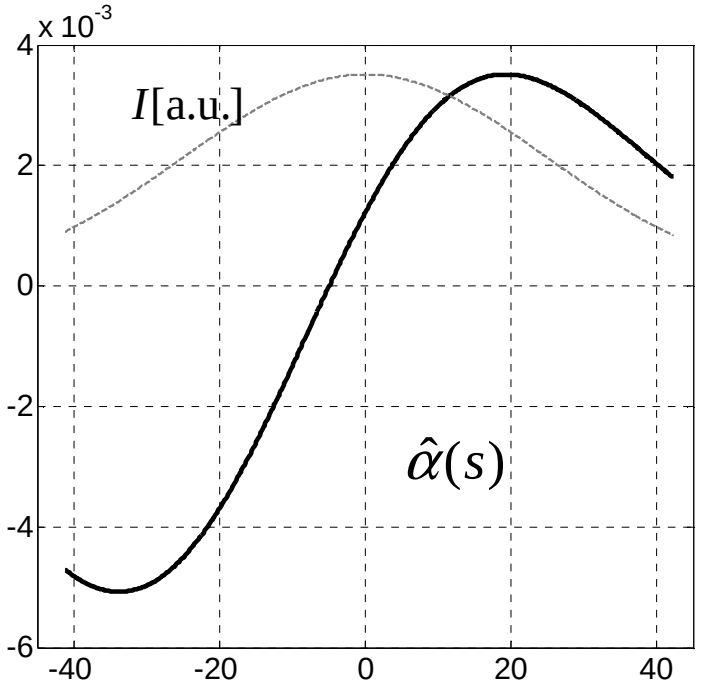
$$\rho = 4\cdot 10^{-4}$$

$$E = 17.5\text{GeV}$$

spectrum bandwith ~ 2ρ

Energy chirp $|\hat{\alpha}(s)| < 0.01$

$$\hat{\alpha}(s) = \frac{1}{\gamma_0 \rho^2 k}\frac{d\gamma}{ds} = \frac{2}{\rho}\left[\frac{L_c d\gamma}{\gamma_0 ds}\right]$$



$\rho = 4 \cdot 10^{-4}$

$E = 17.5\text{GeV}$

$\lambda = 0.1\text{nm}$

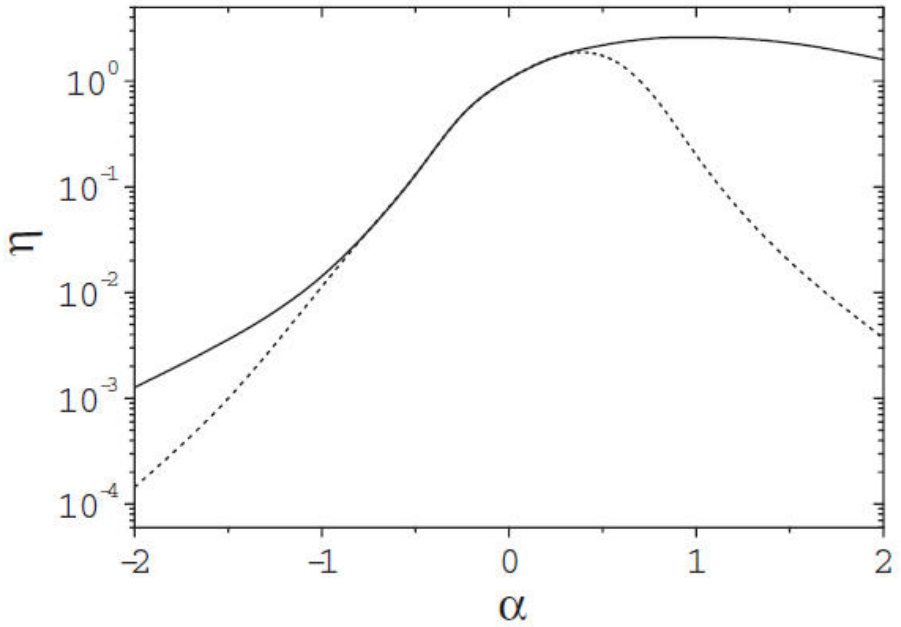


FIG. 2. Normalized output power versus parameter $\hat{\alpha}$. Solid: $\hat{z} = \hat{z}_{sat}(\hat{\alpha})$ (see Fig. 1); dashed: $\hat{z} = \hat{z}_{sat}(0) = 13$.

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Self-amplified spontaneous emission FEL with energy-chirped electron beam and its application for generation of attosecond x-ray pulses

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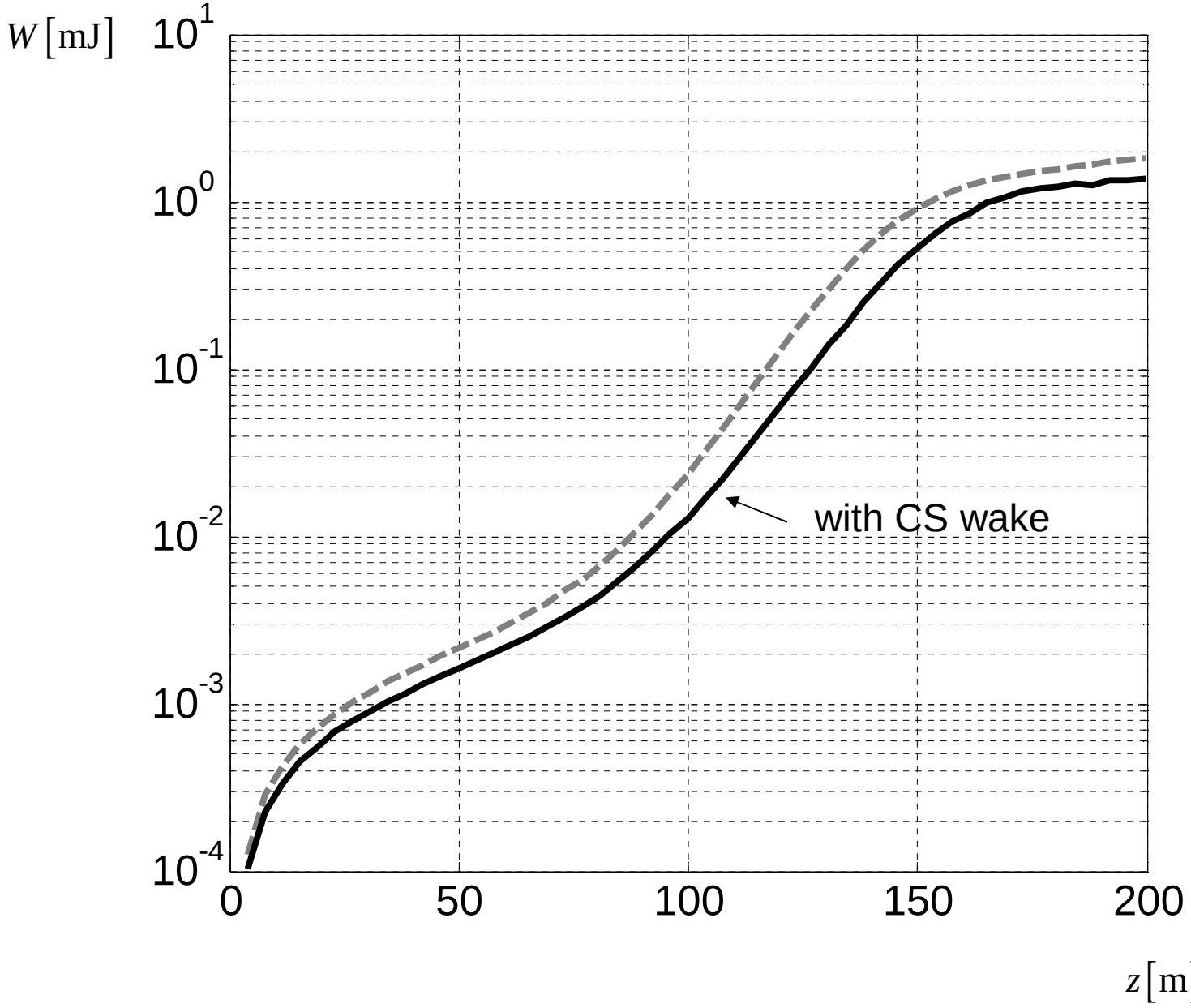


$\sigma_z = 25\mu\mathrm{m}$

$E = 17.5\mathrm{GeV}$

$\sigma_E = 1.5\mathrm{MeV}$

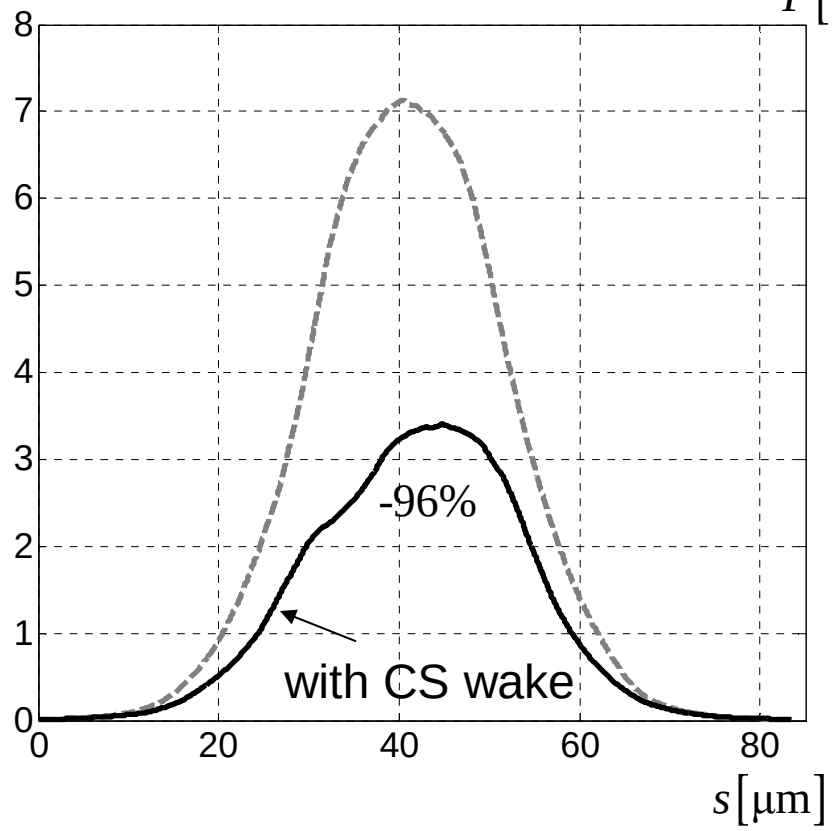
$\varepsilon = 1.4\mu\mathrm{m}$

$\langle\beta\rangle = 40\mathrm{m}$

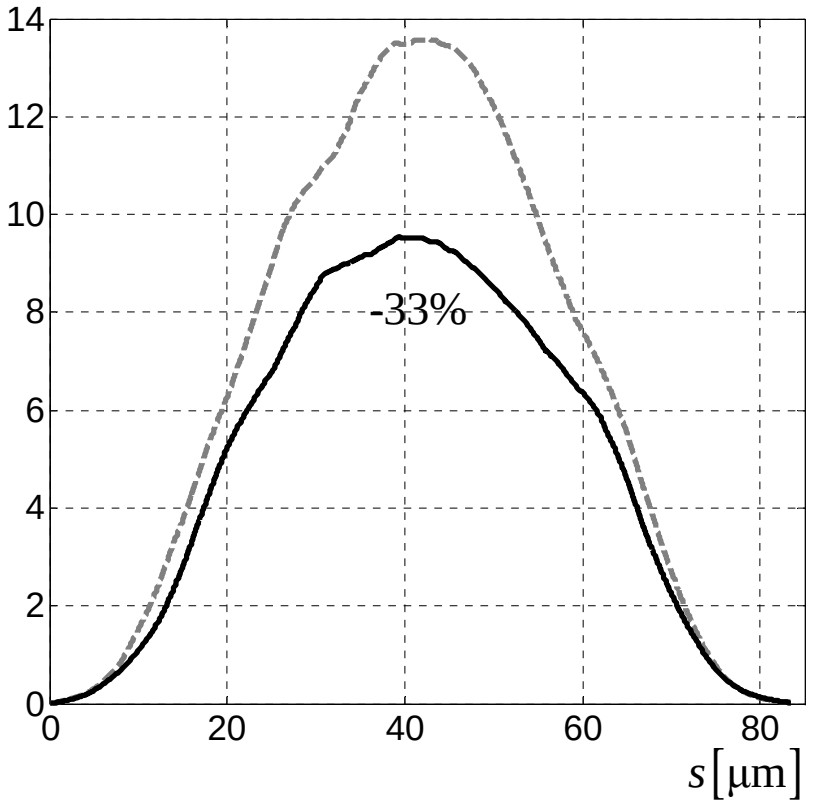
$\lambda = 0.1\mathrm{nm}$

without wakes in the undulator!

$P[\mathrm{GW}]$ $z = 142\mathrm{m}$

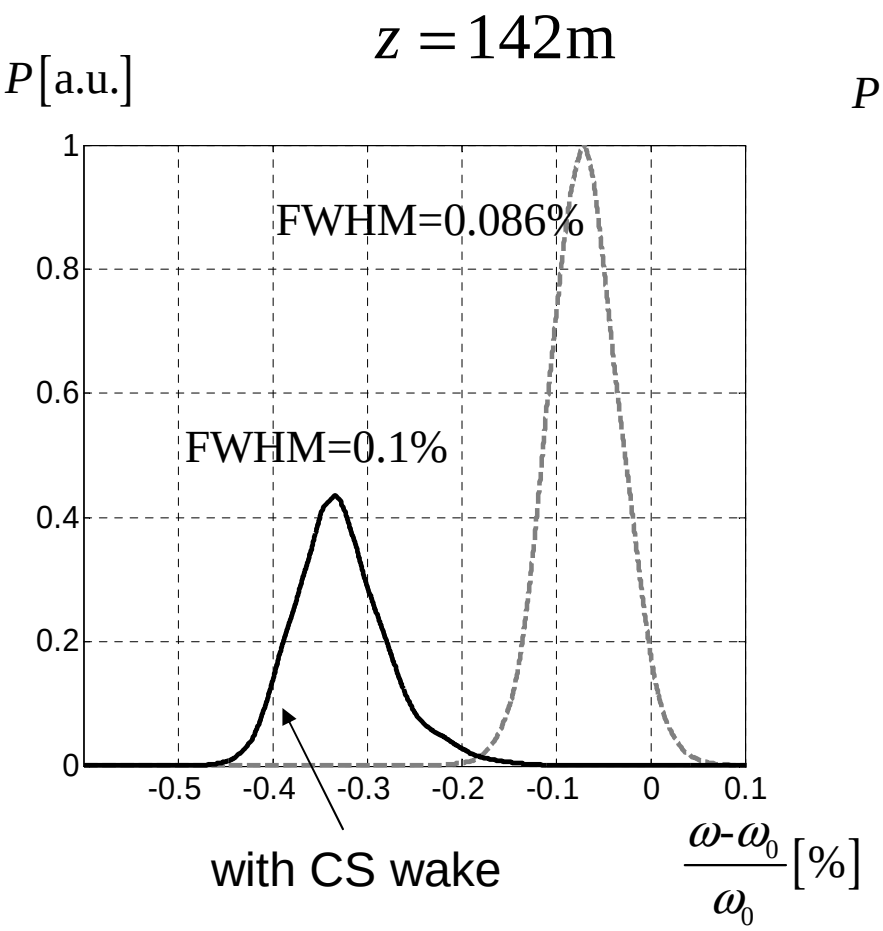


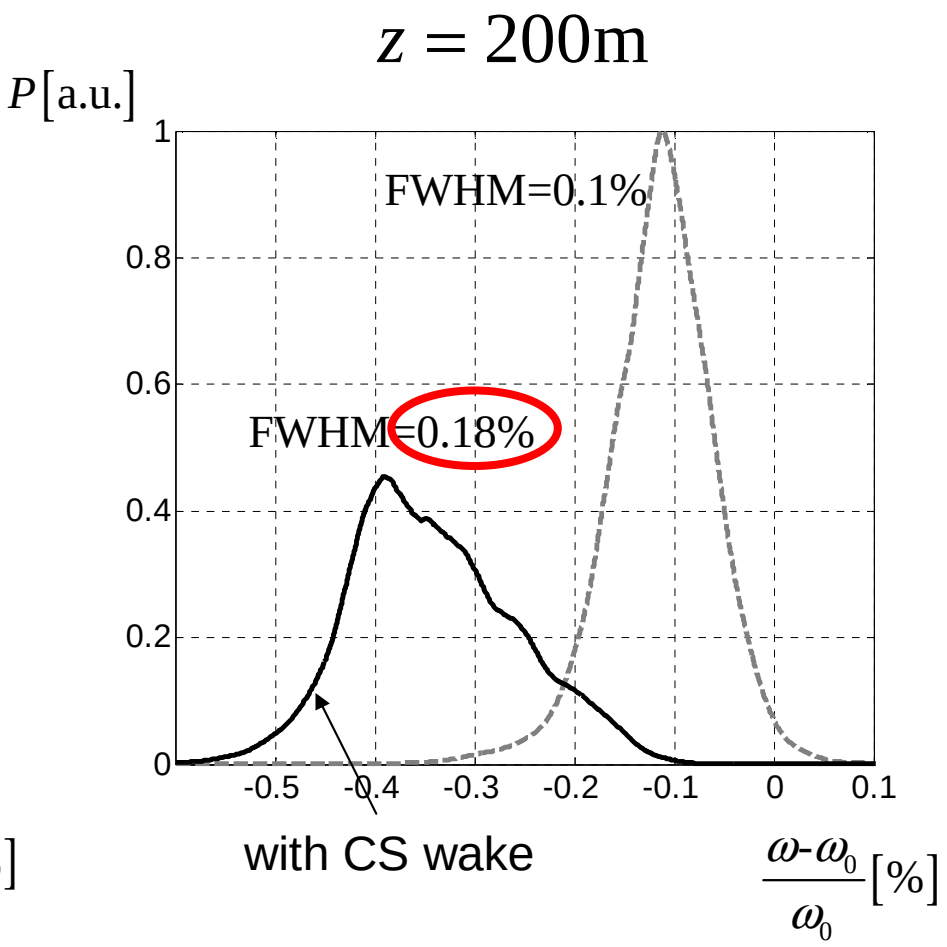
$z = 200\mathrm{m}$



$\lambda = 0.1\mathrm{nm}$

without wakes in the undulator!





$\lambda = 0.1\text{nm}$

without wakes in the undulator!

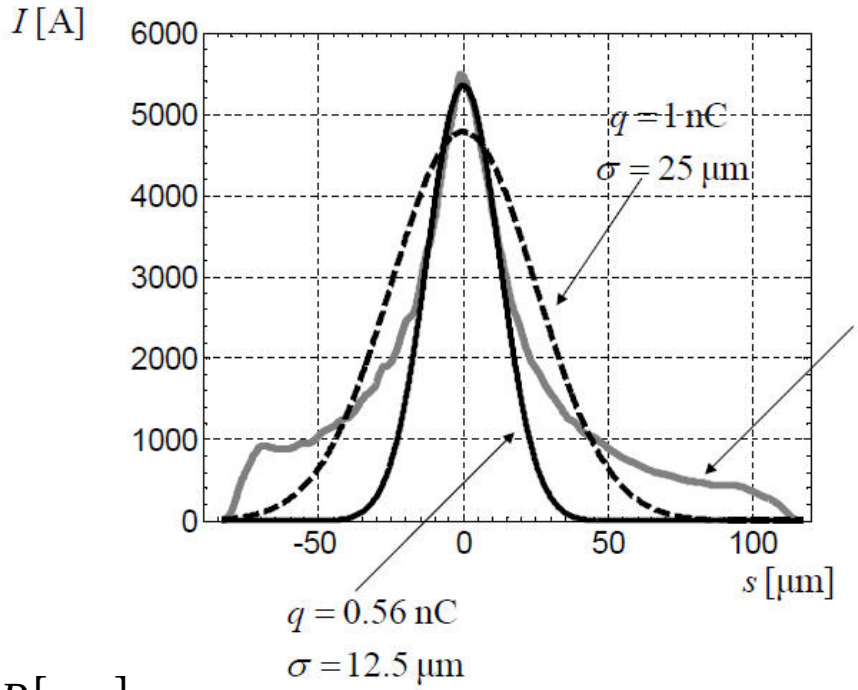
XFEL TDR

	Unit	SASE 1	SASE 2		SASE 3		
Electron energy	GeV	17.5	17.5	17.5	17.5	17.5	10.0
Wavelength	nm	0.1	0.1	0.4	0.4	1.6	4.9
Photon energy	keV	12.4	12.4	3.1	3.1	0.8	0.25
Peak power	GW	20	20	80	80	130	150
Average power	W	65	65	260	260	420	490
Photon beam size (FWHM)	µm	70	85	55	60	70	90
Photon beam divergence (FWHM)	µrad	1	0.84	3.4	3.4	11.4	18
Coherence time	fs	0.2	0.22	0.38	0.34	0.88	1.4
Spectral bandwidth	%	0.08	0.08	0.18	0.2	0.3	0.65
Pulse duration	fs	100	100	100	100	100	100
Photons per pulse	#	10^{12}	10^{12}	1.6×10^{13}	1.6×10^{13}	1.0×10^{14}	3.7×10^{14}
Average flux	#/s	3.0×10^{16}	3.0×10^{16}	4.8×10^{17}	4.8×10^{17}	3.1×10^{18}	1.1×10^{19}
Peak brilliance	B	5.0×10^{33}	5.0×10^{33}	2.2×10^{33}	2.0×10^{33}	5.0×10^{32}	1.0×10^{32}
Average brilliance	B	1.6×10^{25}	1.6×10^{25}	6.5×10^{24}	5.9×10^{24}	1.4×10^{24}	2.8×10^{23}

Table 5.2.2 *XFEL radiation parameters for SASE 1 – SASE 3 as the result of simulations. Brilliance B is given in units of photons/0.1%bw/s/mm²/mrad².*

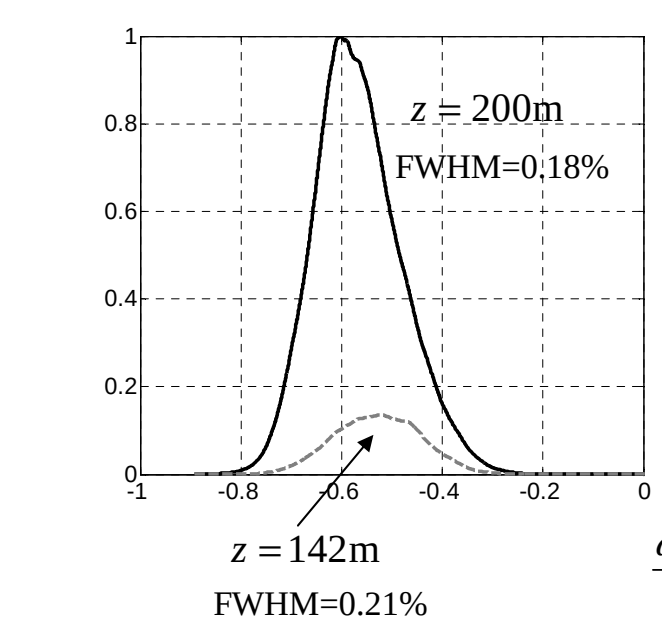
S2E with 2 bunch compressors

without wakes in the undulator!



Bunch shape
from S2E simulations
by Martin Dohlus

$\rho = 4 \cdot 10^{-4}$



3.5ρ