Beam Energy Spread for HGHG in FLASH2

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DESY, Hamburg, Germany

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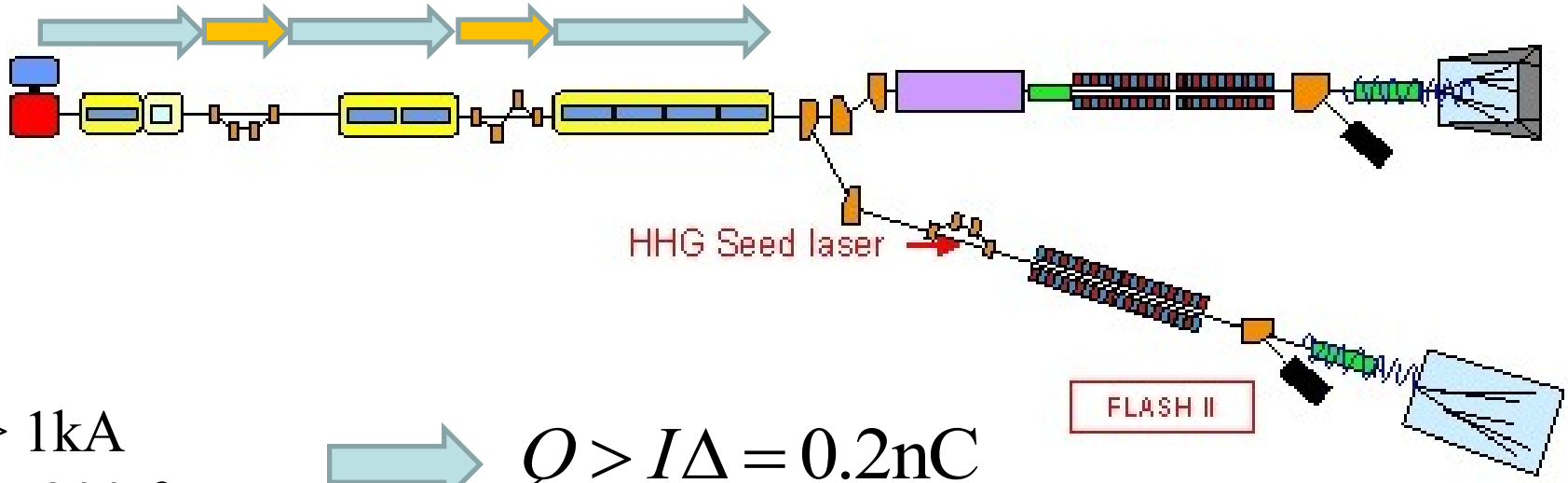
S2E Meeting

Technical constraints and beam parameters

ASTRA+CSRtrack

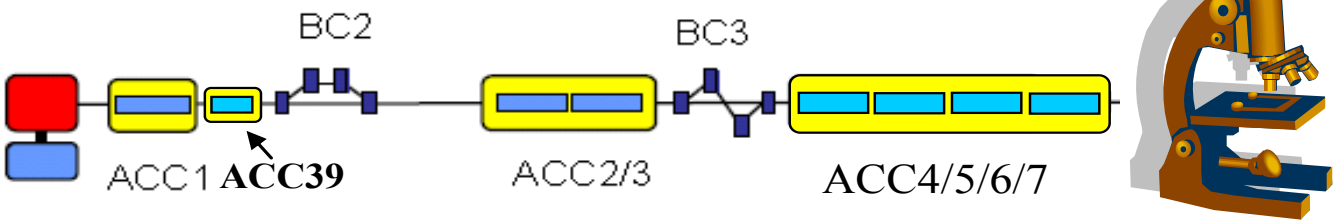


I > 1kA

Δ > 200 fs

$$Q > I\Delta = 0.2\text{nC}$$

Energy spread < 120keV



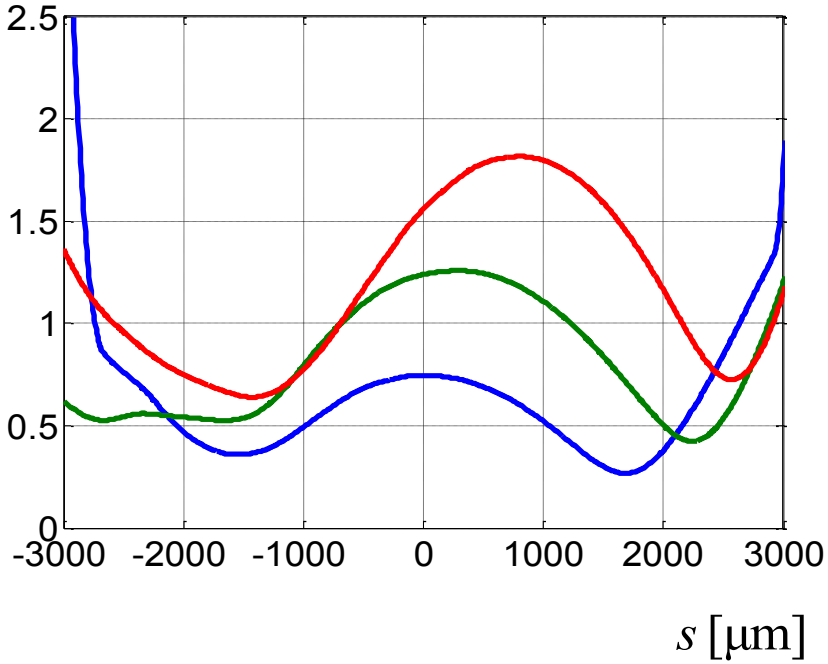
Energy spread vs. charge?

Charge Q, nC	Energy in BC2 E_1, [MeV]	Energy in BC3 E_2, [MeV]	Deflecting radius in BC2 $teta_1$, [grad]	Deflecting radius in BC3 r_2, [m]	Compression in BC2 C_1	Total compression C	First derivative Z_2', [m^{-1}]	Second derivative Z_2'', [m^{-2}]
1	130	450	15	4.78	2.84	48	1	2e3
0.5				4.14	4.63	90	1	3.5e3
0.25				3.68	6.57	150	0.7	4e3

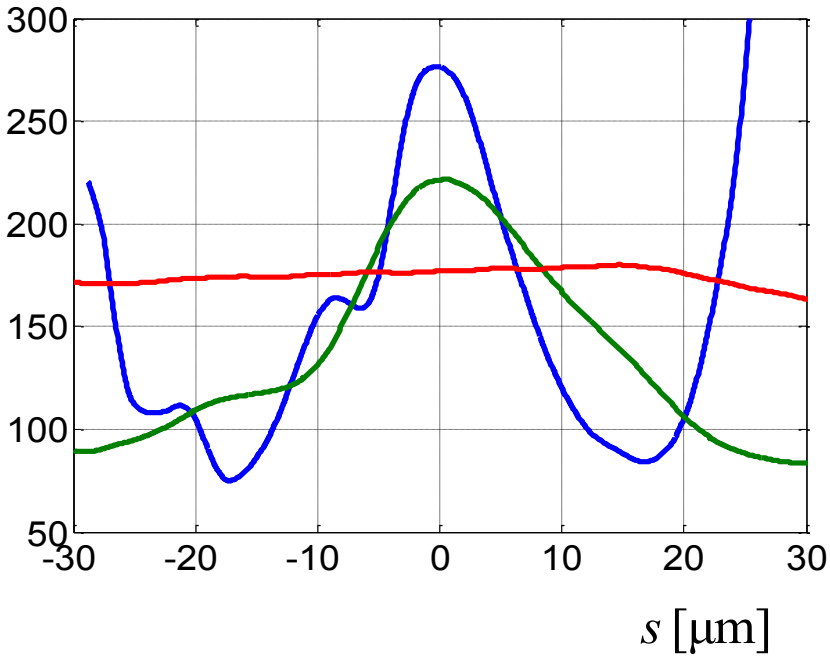
Igor Zagorodnov and Martin Dohlus,
Beam Dynamics and FEL Simulations for FLASH,
08.02.2010,Beam Dynamics Meeting, DESY
http://www.desy.de/fel-beam/data/talks/files/IZ_2010_February.pdf

Energy spread vs. charge?

Slice emittance [um]



Slice energy spread [keV]



$Q = 1\,\mathrm{nC}$ $Q = 0.5\,\mathrm{nC}$ $Q = 0.25\,\mathrm{nC}$

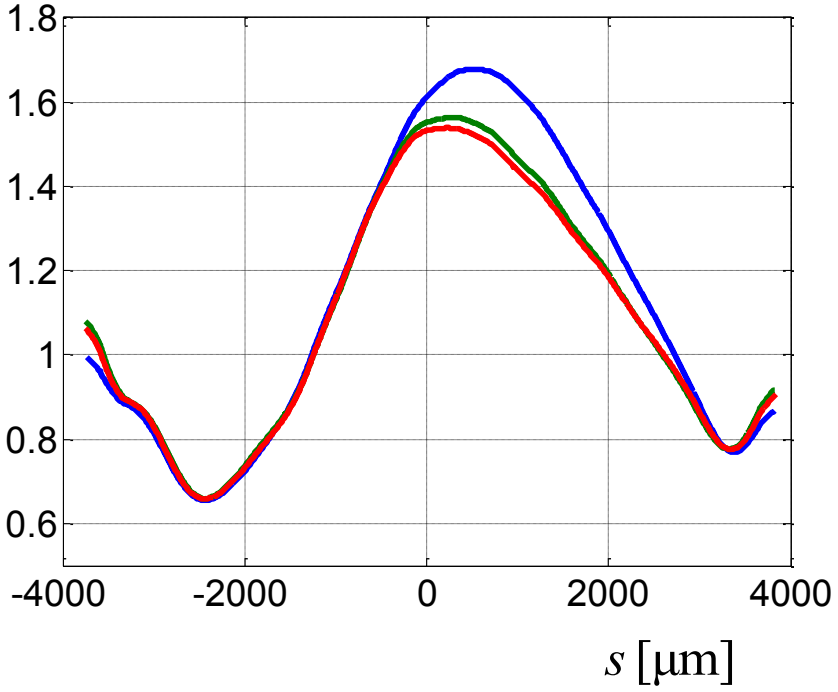
Energy spread after ACC1 (z=14.61 m) for Q=1nC

E in BC 2 = 145 MeV, ACC1 (50%, 50 %)

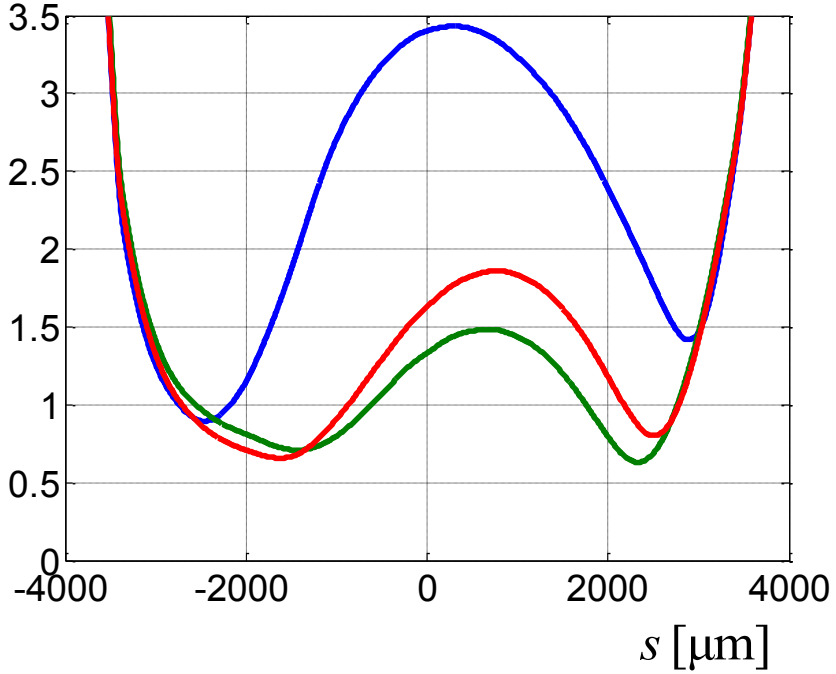
E in BC 2 = 145 MeV, ACC1 (37.5%, 62.5 %)

E in BC 2 = 130 MeV, ACC1(40%, 60 %)

Slice emittance [um]



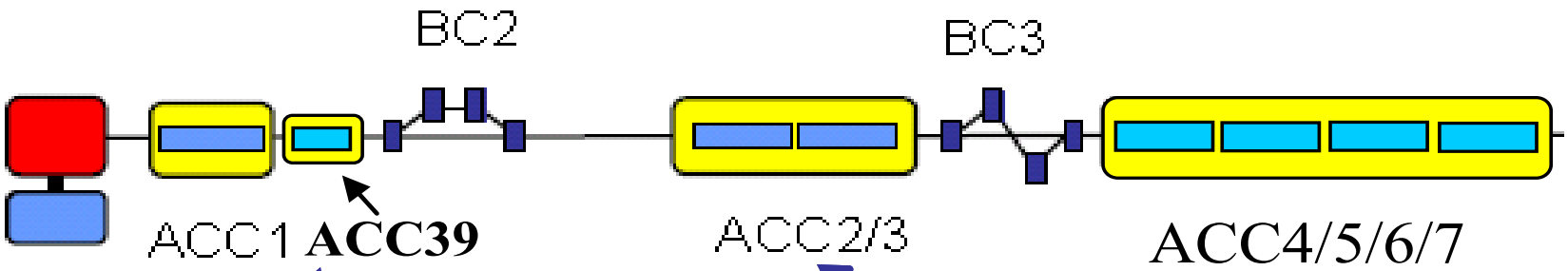
Slice energy spread [keV]

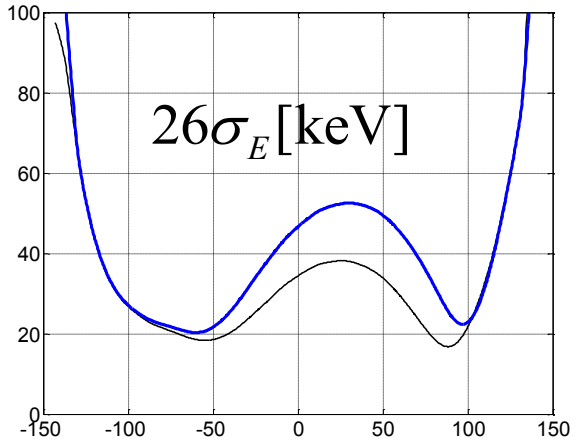


S2E (up z = 152 m) for Q=1nC

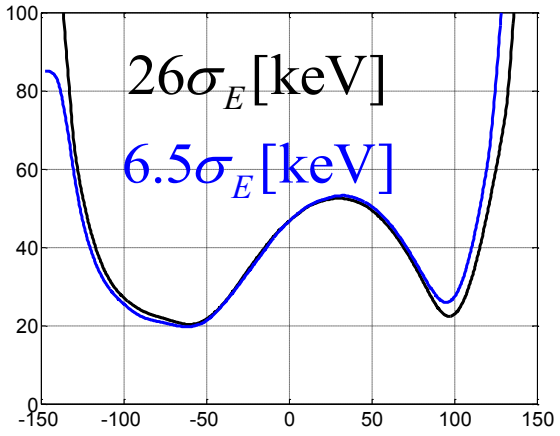
Charge Q, nC	Energy in BC2 E_1, [MeV]	Energy in BC3 E_2, [MeV]	Deflecting radius in BC2 $teta_1$, [grad]	Deflecting radius in BC3 $teta_2$, [grad]	Compression in BC2 C_1	Total compression C	First derivative Z_2', [m^{-1}]	Second derivative Z_2'', [m^{-2}]
1	130	450	18	4.5	4	26	0	0

Energy spread after ACC7 (z=152 m) for Q=1nC

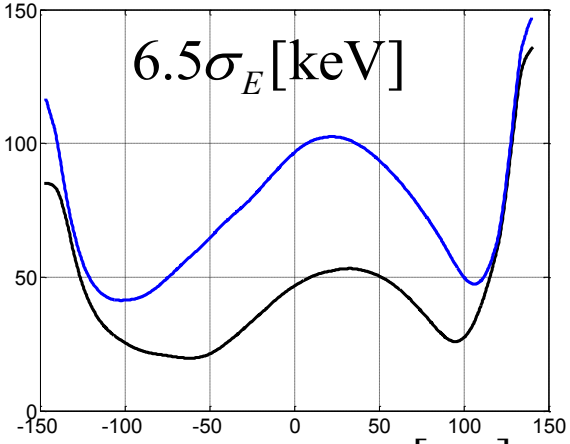




$\frac{s\ [\mu m]}{26}$

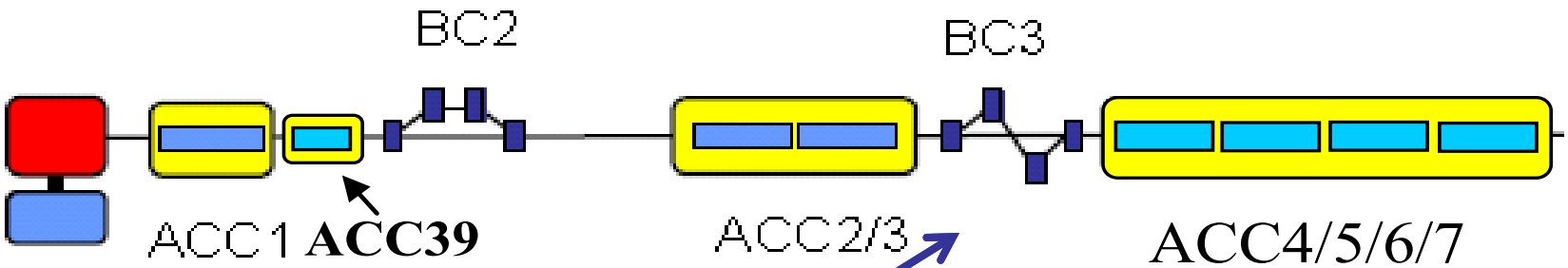


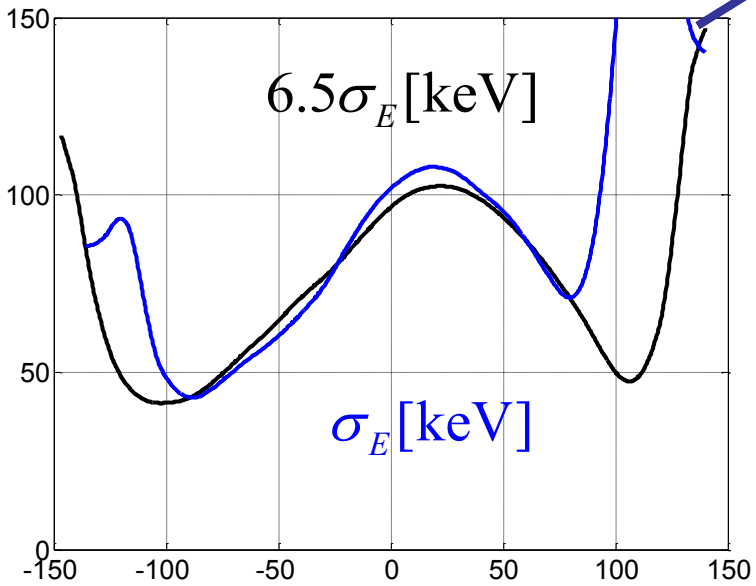
$\frac{s\ [\mu m]}{26}$ $\frac{s\ [\mu m]}{6.5}$



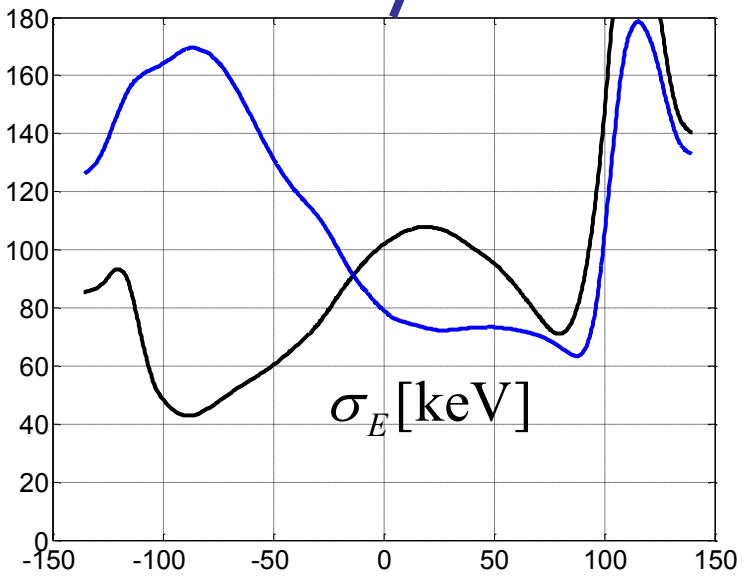
$\frac{s\ [\mu m]}{6.5}$

Energy spread after ACC7 (z=152 m) for Q=1nC

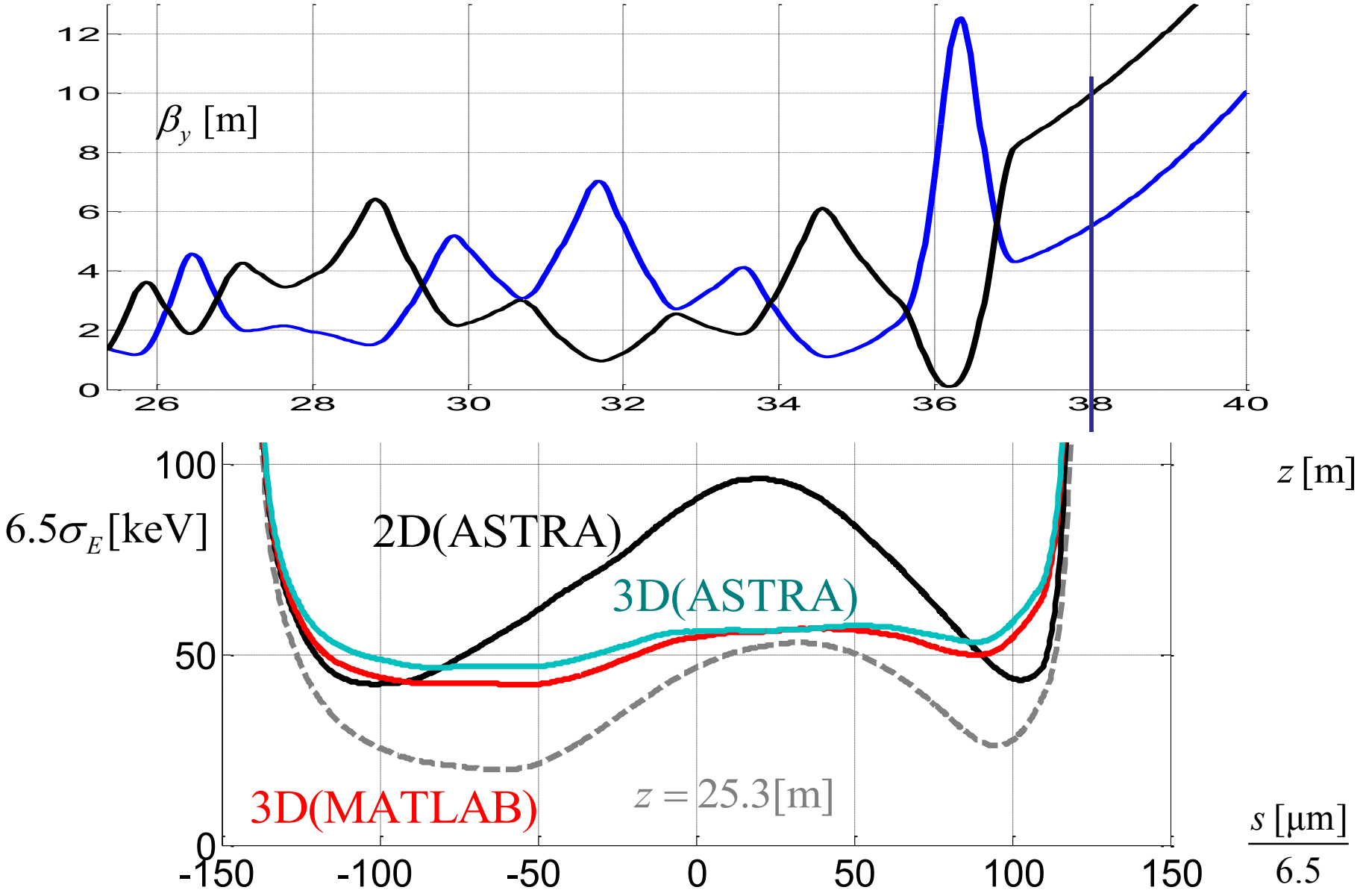




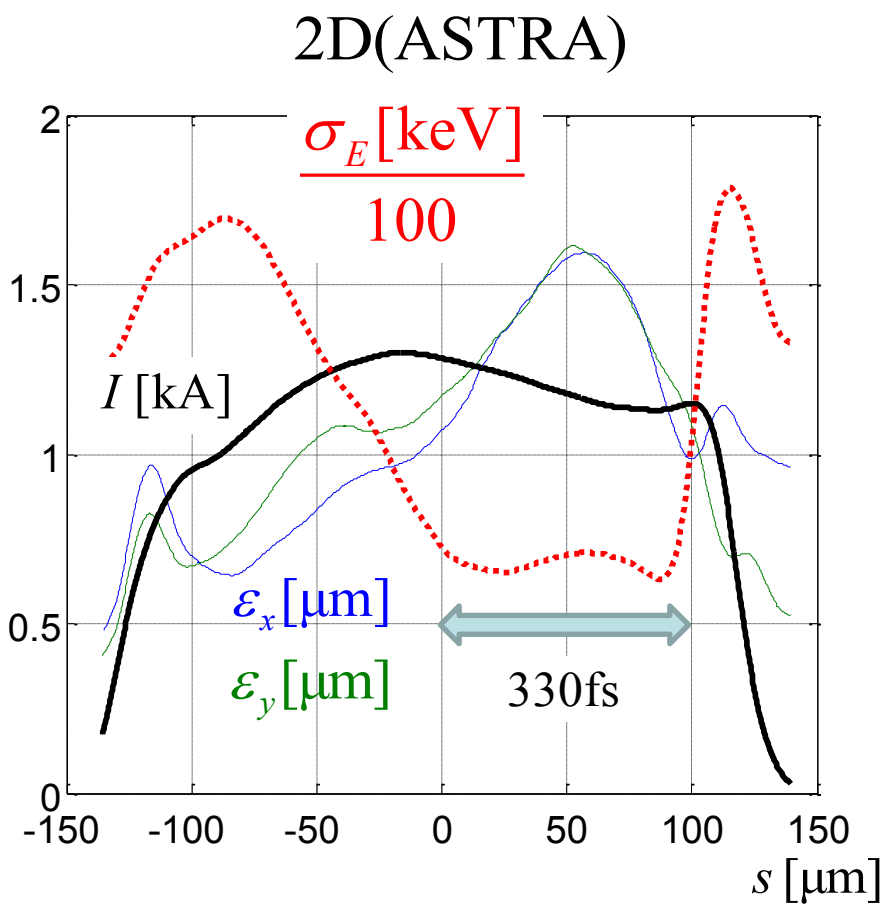
$\frac{s\ [\mu m]}{6.5}$ $s\ [\mu m]$

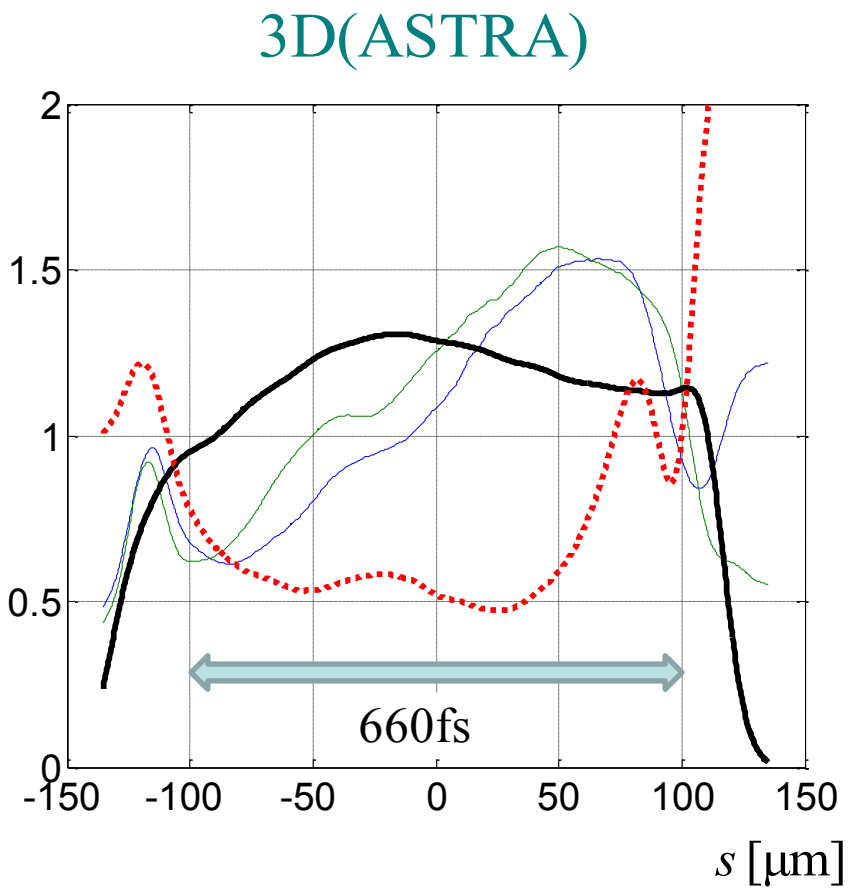


$s\ [\mu m]$


β_y [m]
z [m]
$6.5\sigma_E$[keV]
2D(ASTRA)
3D(ASTRA)
3D(MATLAB)
$z = 25.3$[m]
$\frac{s\ [\mu m]}{6.5}$

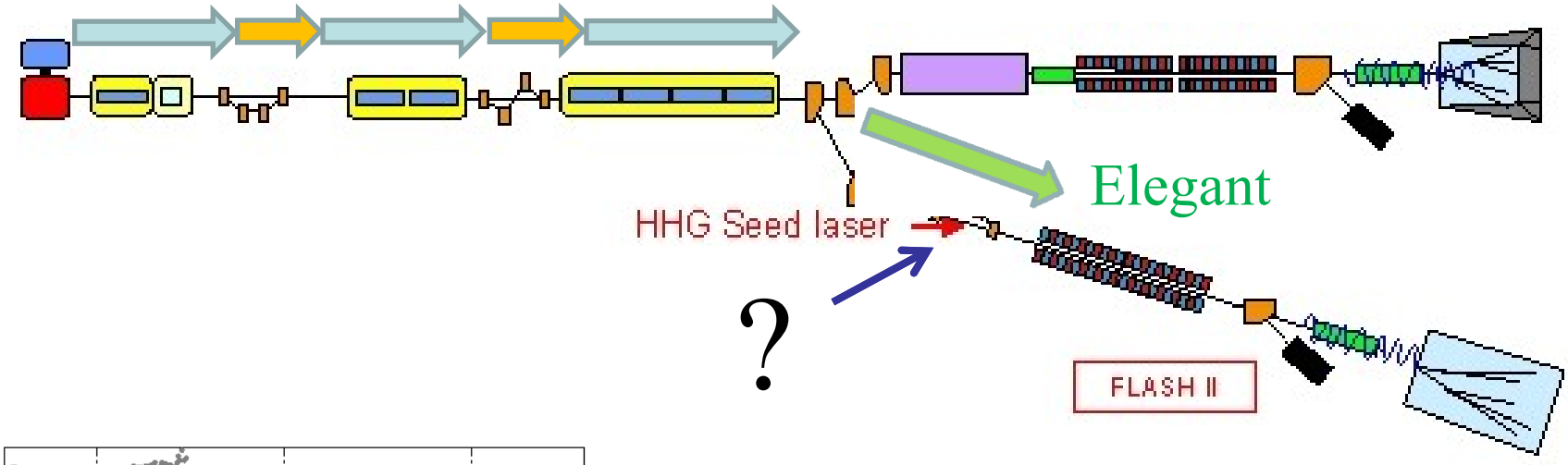
S2E (up z = 152 m) for Q=1nC

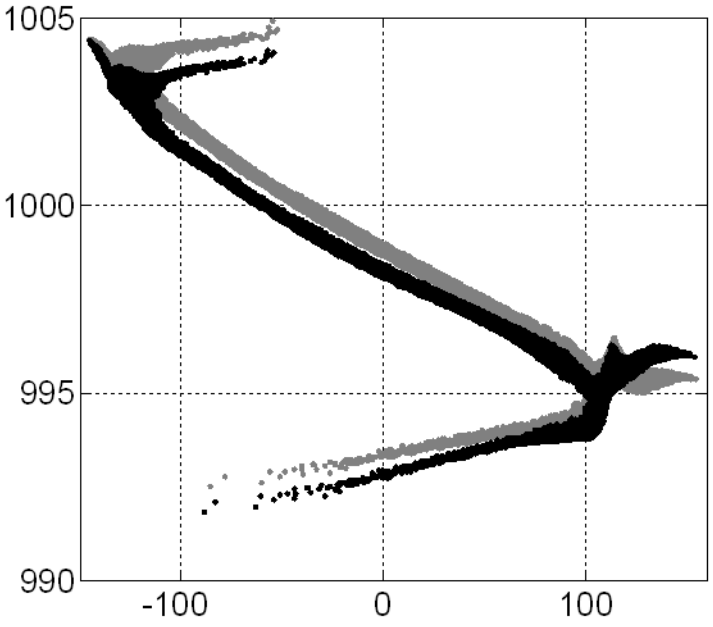


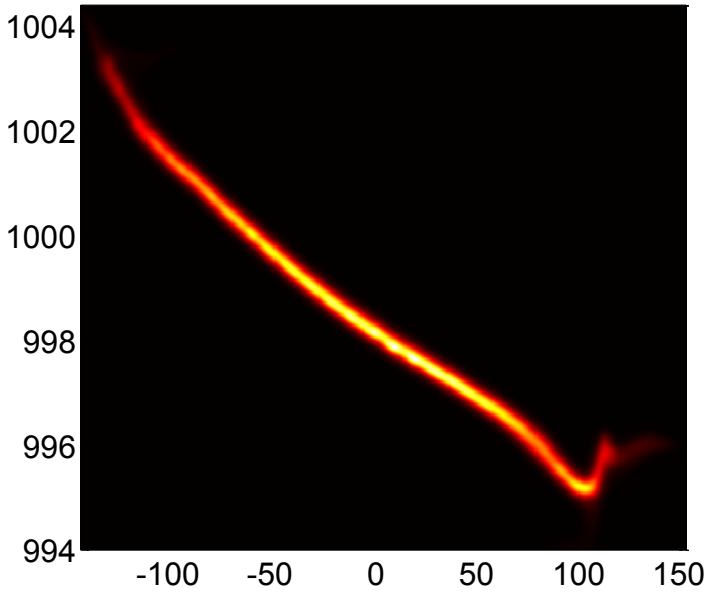


S2E for FLASH2 line (Q=1nC)

ASTRA+CSRtrack

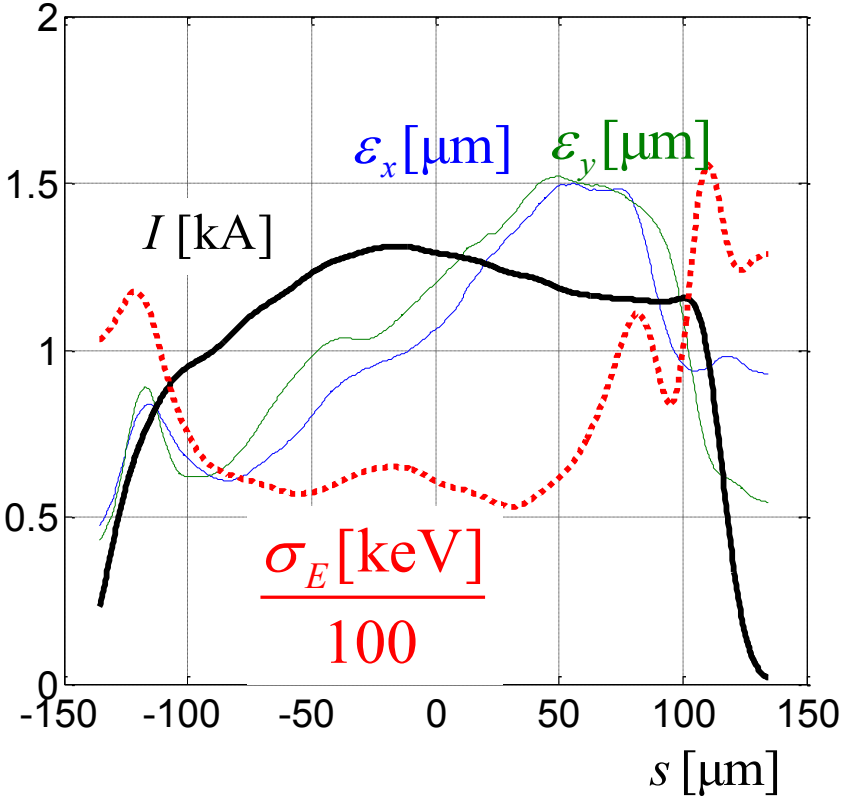




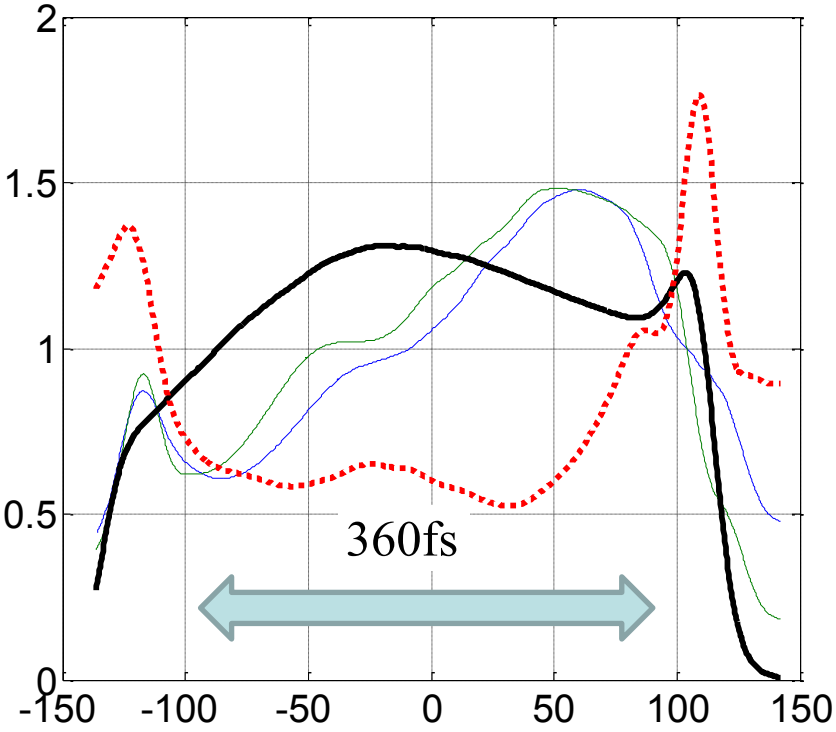


S2E for FLASH2 line at z=194 m (Q=1nC)

200k particles (3D ASTRA)



1000k particles (3D ASTRA)



S2E for FLASH2 line at z=194 m (Q=1nC)

1) the global slice length: ~15 um slice = 50 fs
- Slippage in Modulator ~ 4 um
- Slippage in Radiator ~10 um

* Within this slice, the energy spread should be smaller than 100 keV

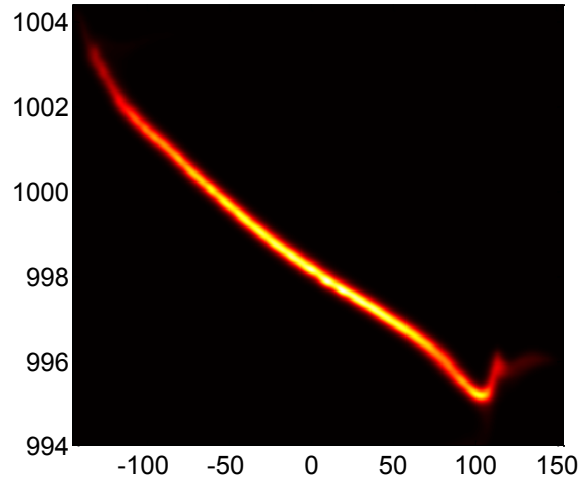
2) min current along the global slice: Should exceed at least 0.5 kA

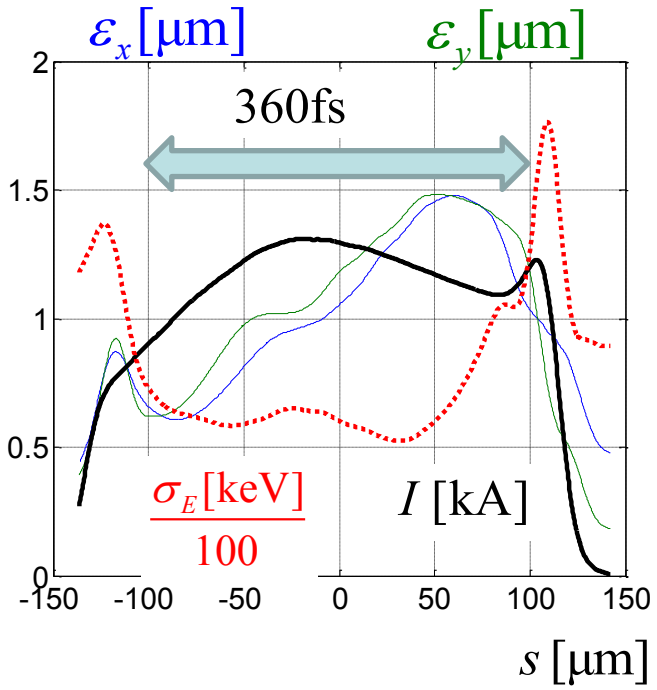
3) how large can be the variation of the current along the global slice:
most important to assure min. 0.5 kA.

4) maximal local slice emittance along the global slice?: 1.5 um

5) maximal local (uncorrelated) energy spread: ~100 keV

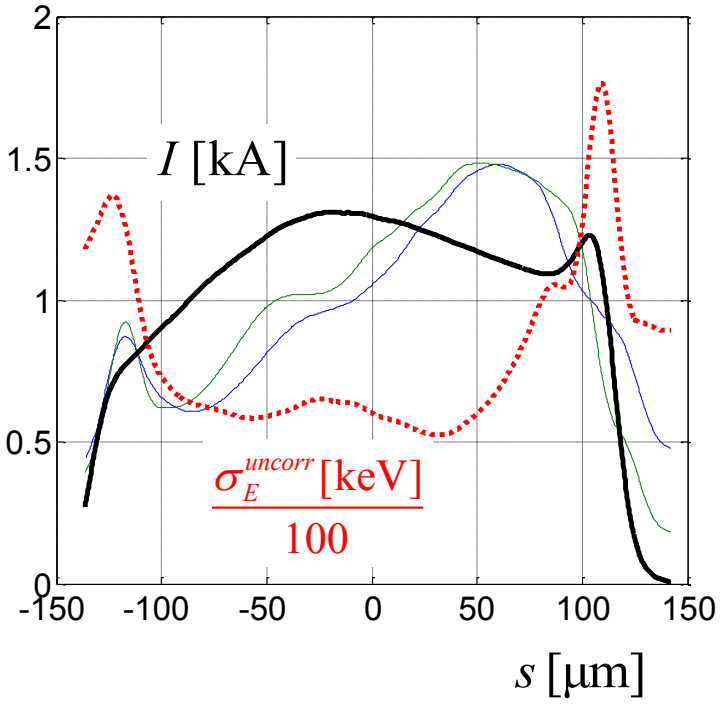
6) maximal energy chirp (correlated energy spread) along the global
slice? ~150 keV





S2E for FLASH2 line at z=194 m (Q=1nC)

uncorreleted energy spread



energy spread in slice of length 10 um and 15 um