



# Beam Energy Spread for HGHG in FLASH

Igor Zagorodnov

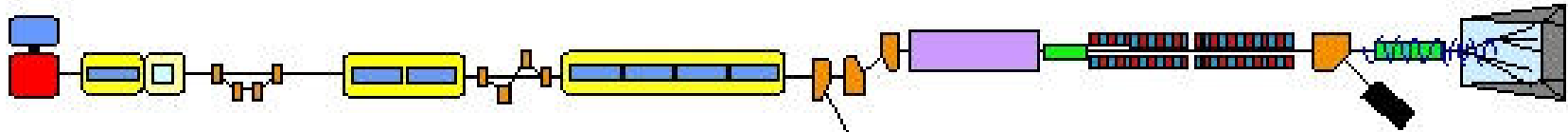
DESY, Hamburg, Germany

25.03.2010

S2E Meeting

# Technical constraints and beam parameters

$$15 \leq \frac{\theta_1}{\text{grad}} \leq 21 \quad 1.7 \leq \frac{\theta_2}{\text{grad}} \leq 5.4$$



$$V_1 \leq 165 \text{ MV}$$

$$V_{39} \leq 22 \text{ MV}$$

$$V_2 \leq 345 \text{ MV} \quad V_3 \leq 750 \text{ MV}$$

HHG Seed laser →

FLASH II

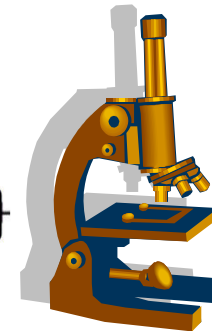
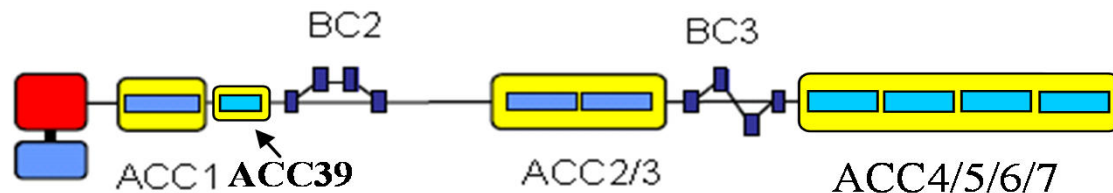
$$I > 1 \text{ kA}$$

$$\Delta > 200 \text{ fs}$$



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

Energy spread < 120keV



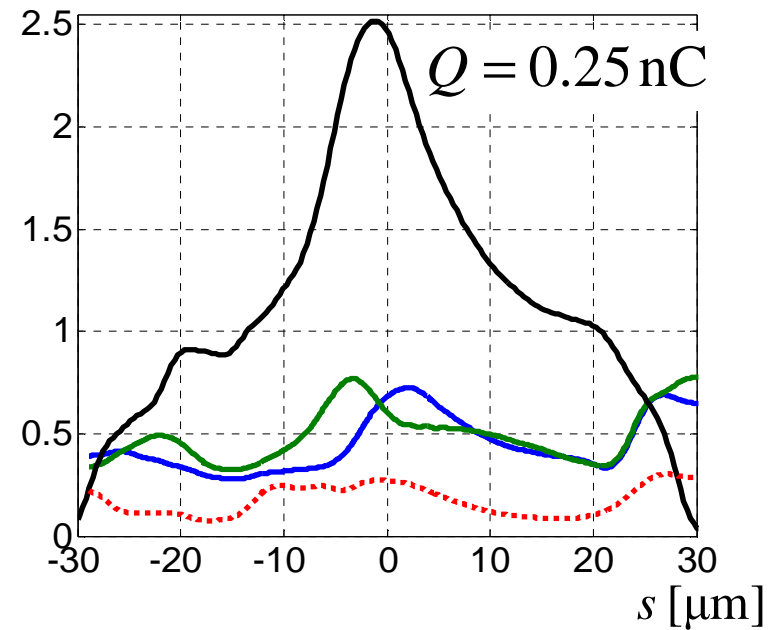
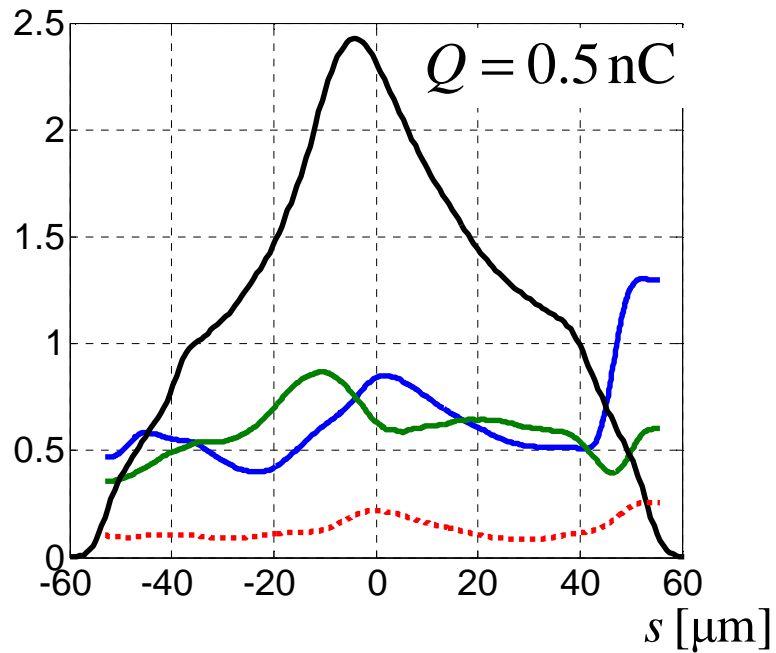
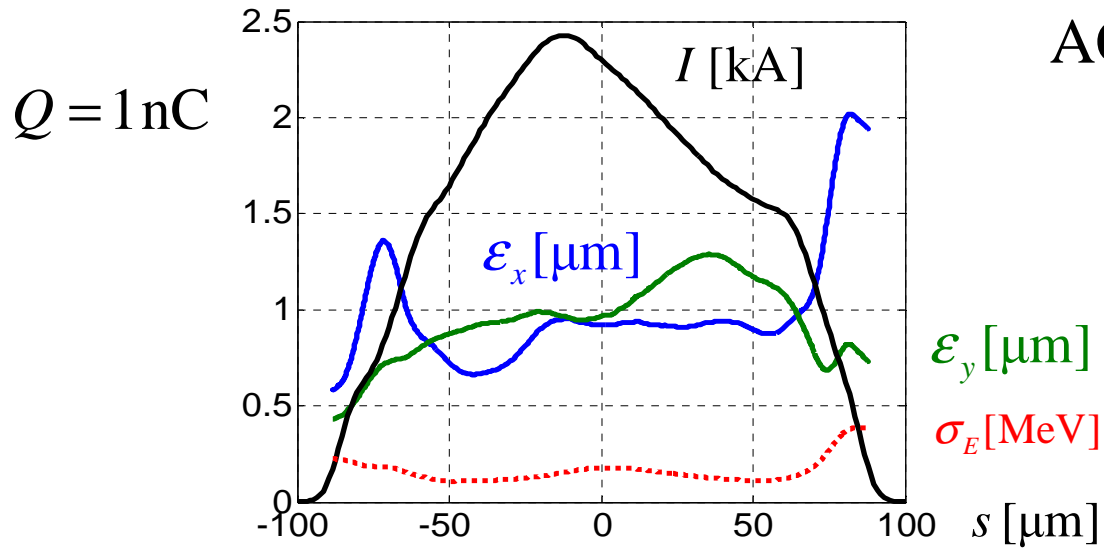
## Energy spread vs. charge?

Charge Q, nC	Energy in BC2 E <sub>1</sub> , [MeV]	Energy in BC3 E <sub>2</sub> , [MeV]	Deflecting radius in BC2 teta <sub>1</sub> , [grad]	Deflecting radius in BC3 r <sub>2</sub> , [m]	Compression in BC2 C <sub>1</sub>	Total compression C	First derivative Z <sub>2</sub> ', [m <sup>-1</sup> ]	Second derivative Z <sub>2</sub> '', [m <sup>-2</sup> ]
<b>1</b>	130	450	15	4.78	2.84	48	1	2e3
<b>0.5</b>				4.14	4.63	90	1	3.5e3
<b>0.25</b>				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](http://www.desy.de/fel-beam/data/talks/files/IZ_2010_February.pdf)

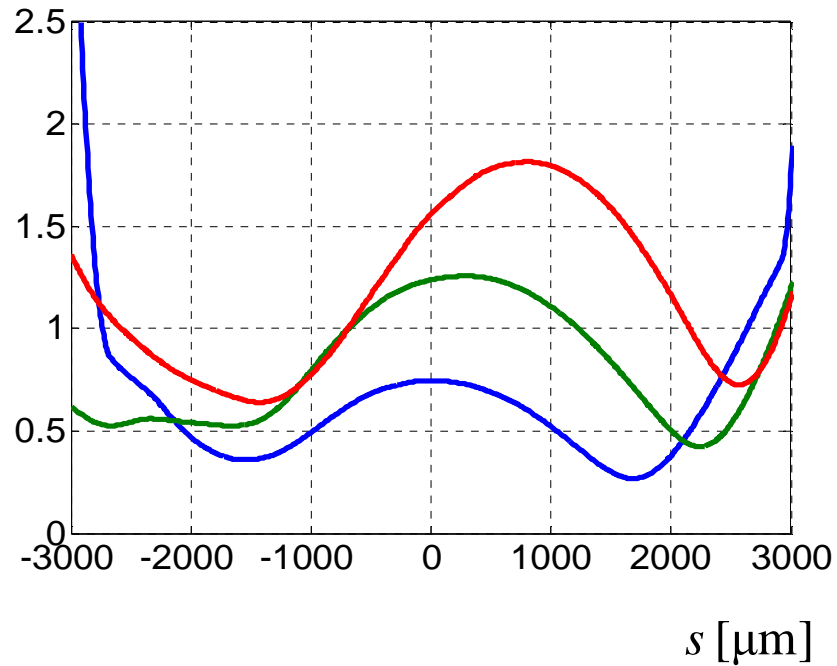
# Energy spread vs. charge?

E in BC2 = 130 MeV  
ACC1 (40%, 60 %)

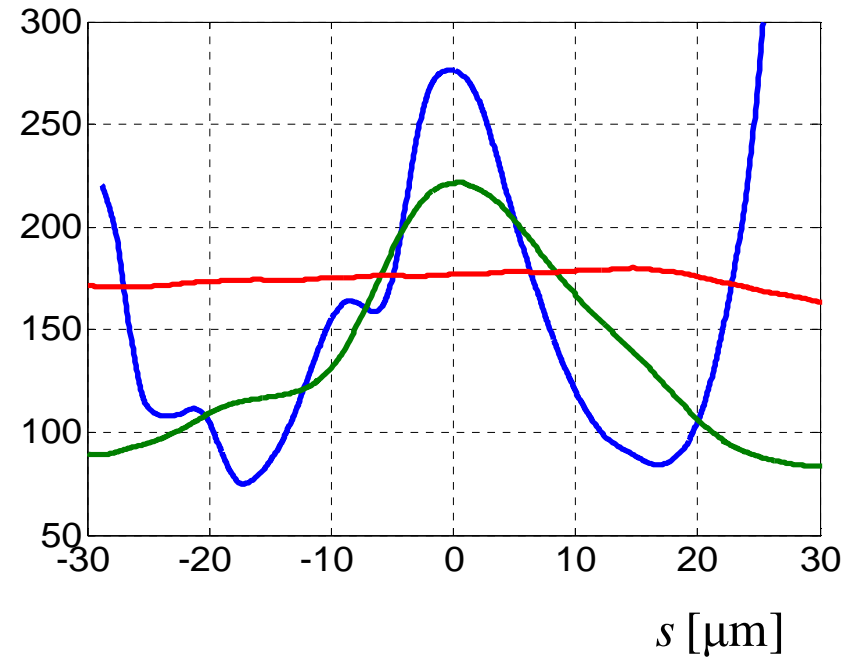


# Energy spread vs. charge?

Slice emittance [ $\mu\text{m}$ ]



Slice energy spread [keV]



$$Q = 1 \text{ nC}$$

$$Q = 0.5 \text{ nC}$$

$$Q = 0.25 \text{ nC}$$

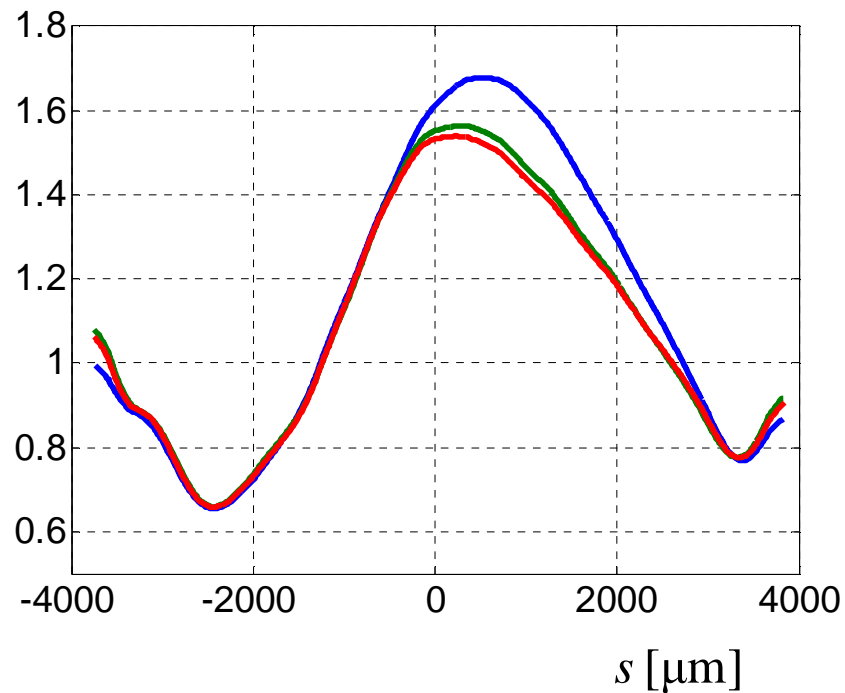
# Energy spread after ACC1 (z=14.61 m) for Q=1nC

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

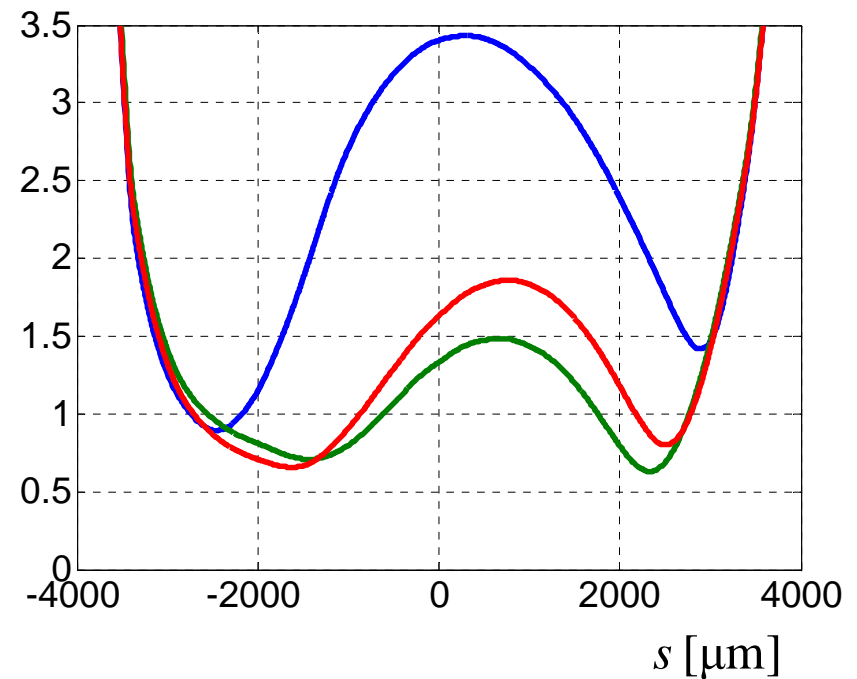
E in BC 2 = 145 MeV, ACC1 (37.5%, 62.5 %)

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

Slice emittance [ $\mu\text{m}$ ]

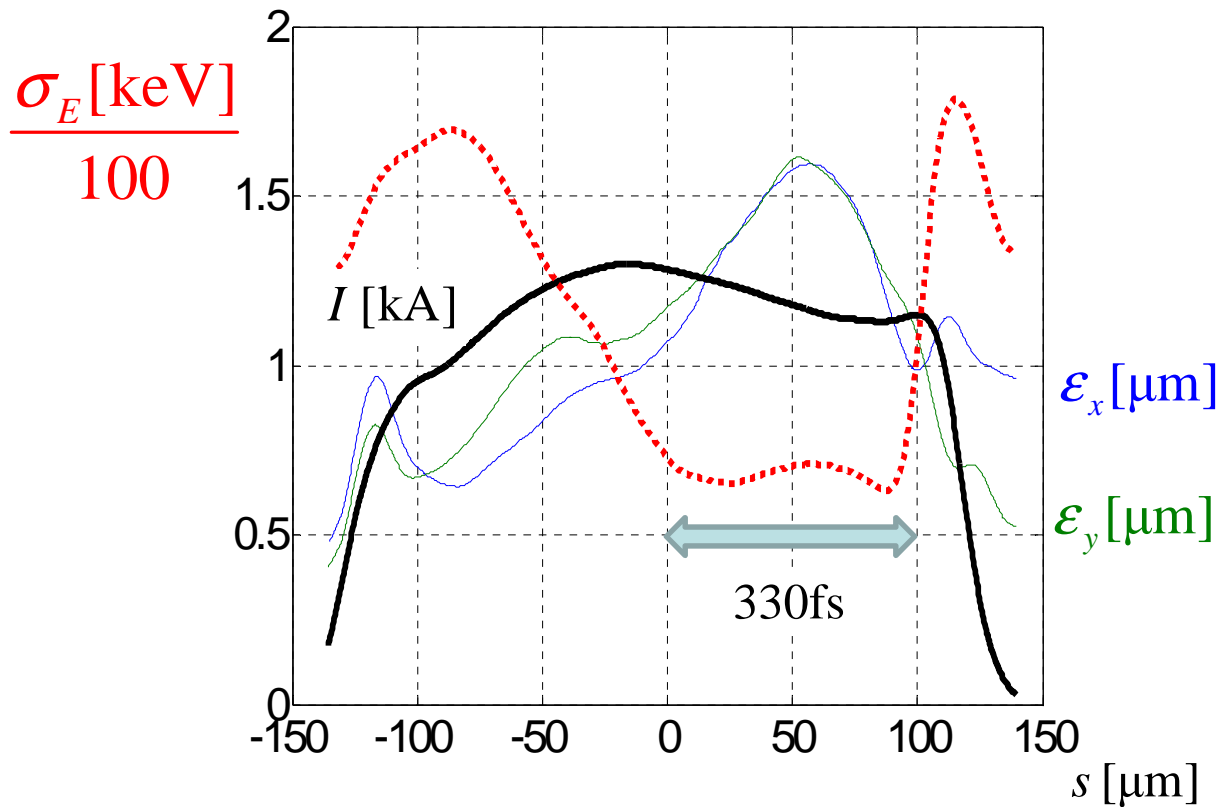


Slice energy spread [keV]

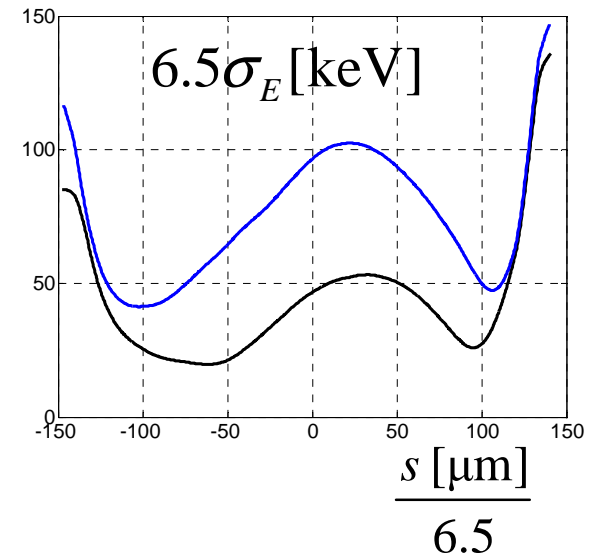
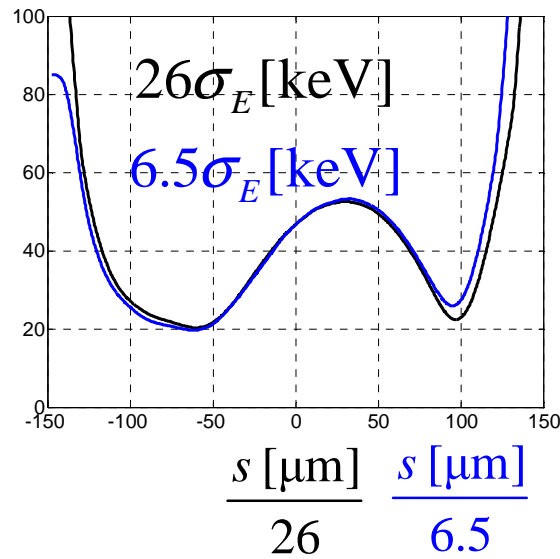
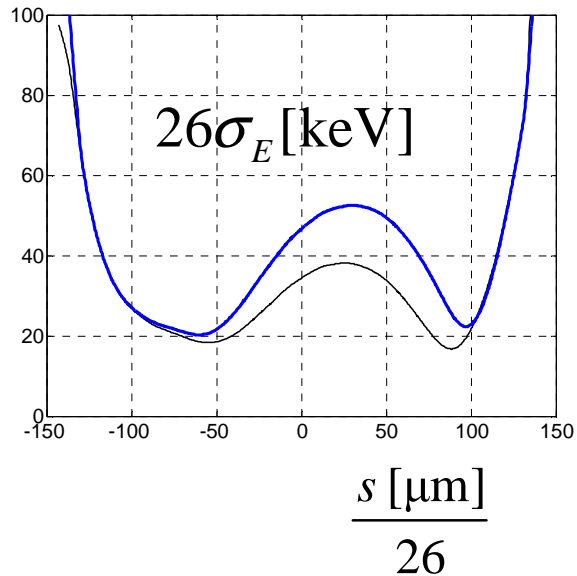
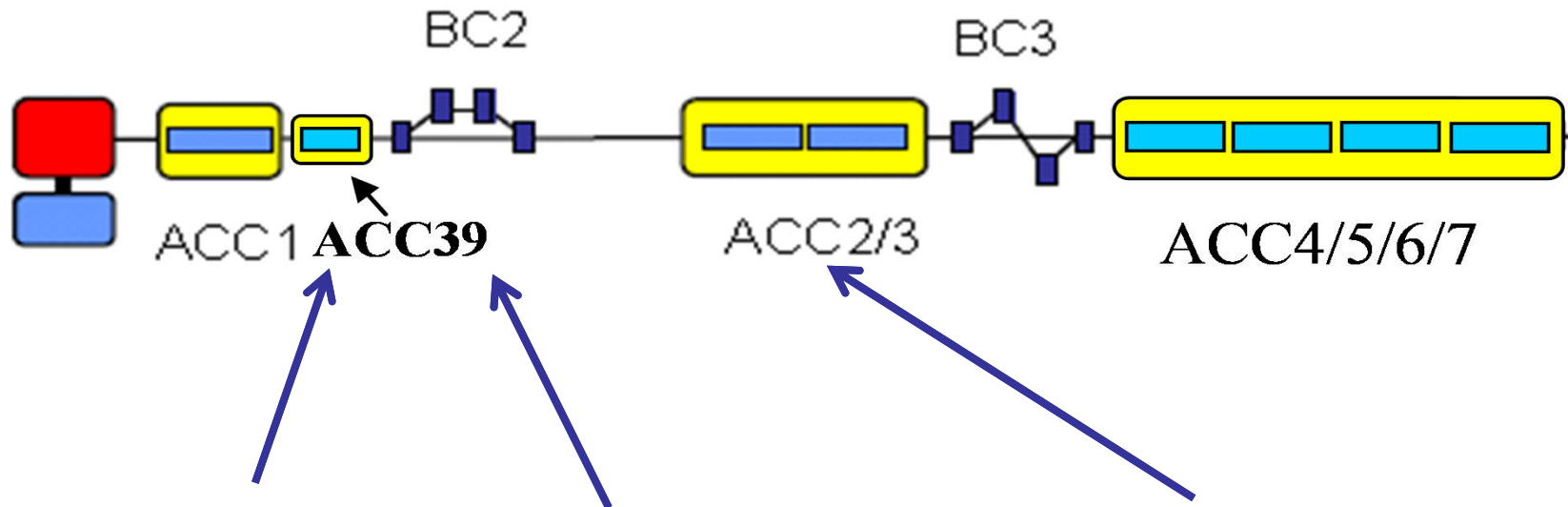


## S2E (up $z = 152 \text{ m}$ ) for $Q=1\text{nC}$

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 <sup>-1</sup> ]	Second derivative $Z_2'',$ [m <sup>-2</sup> ]
<b>1</b>	130	450	18	4.5	4	26	0	0

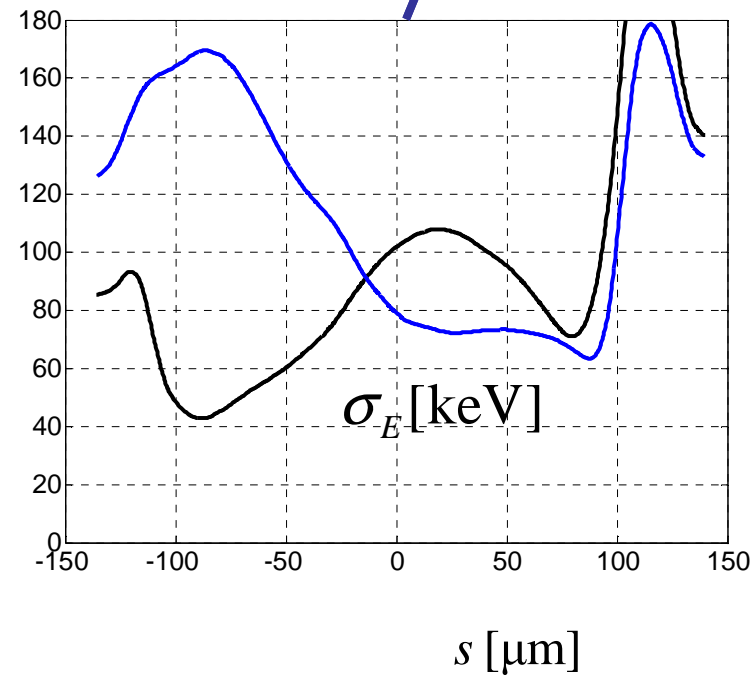
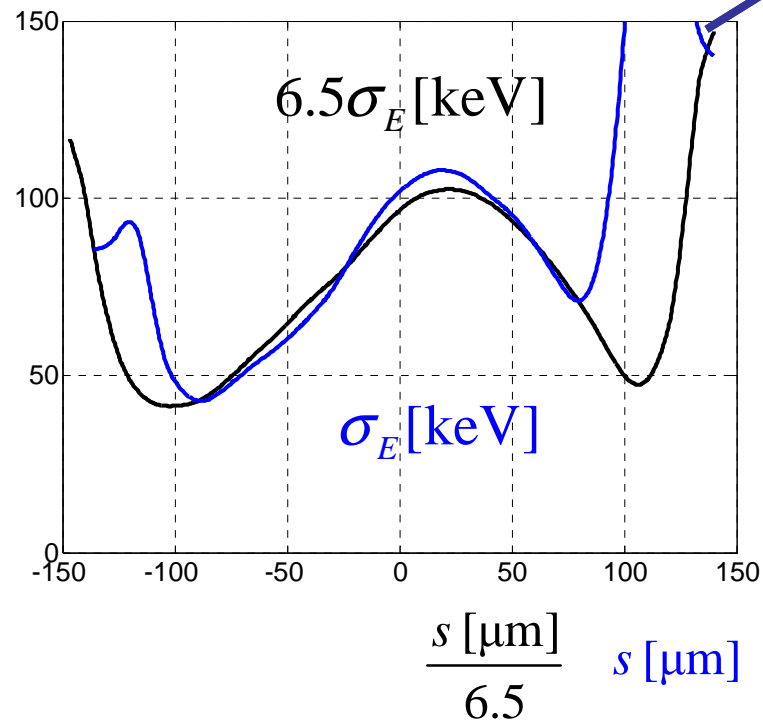
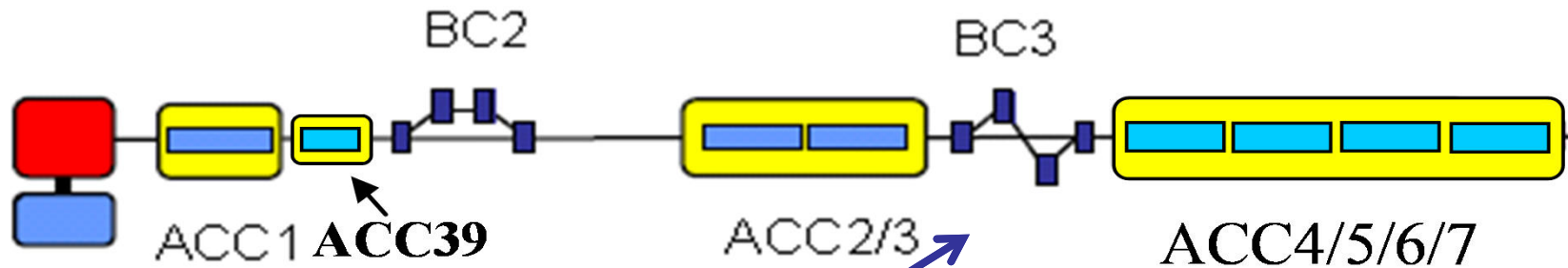


# Energy spread after ACC7 (z=152 m) for Q=1nC

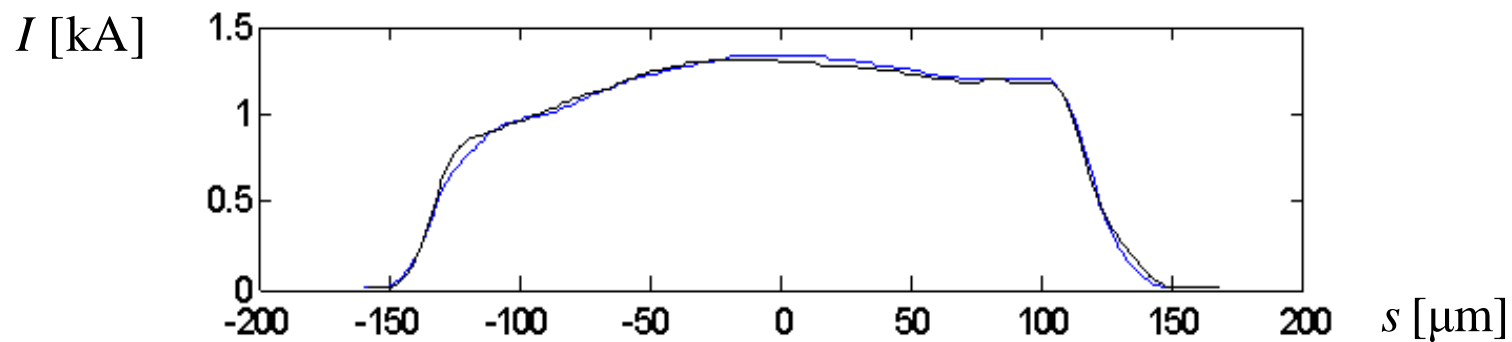
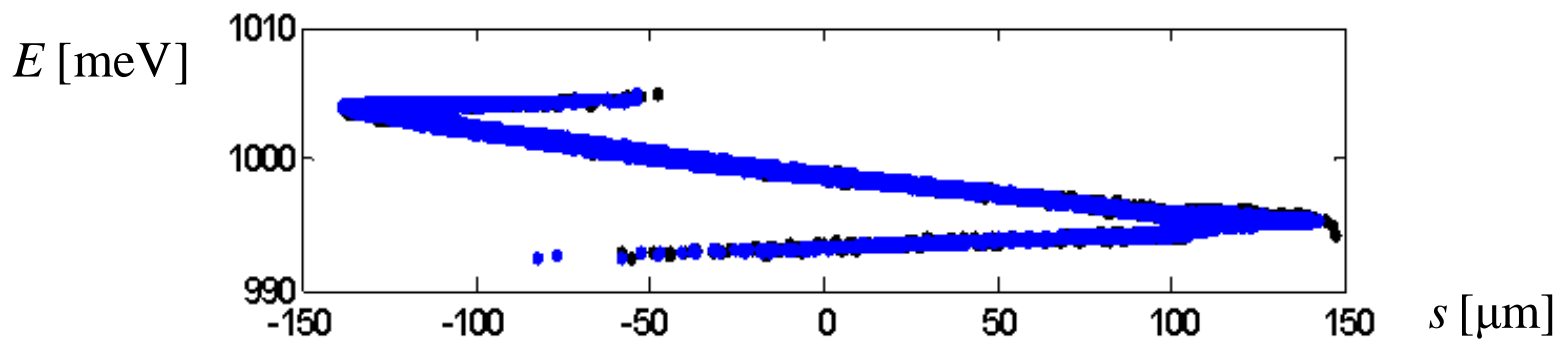
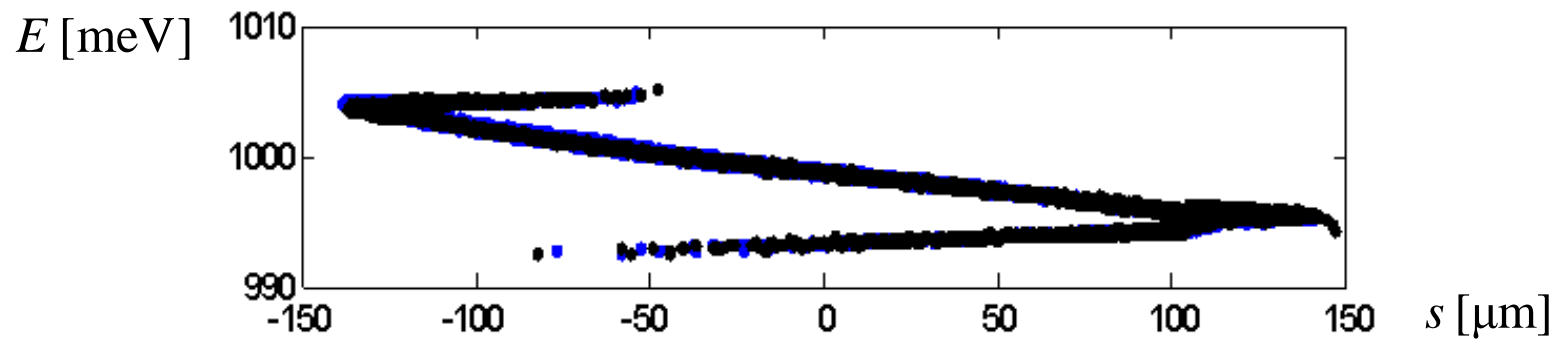




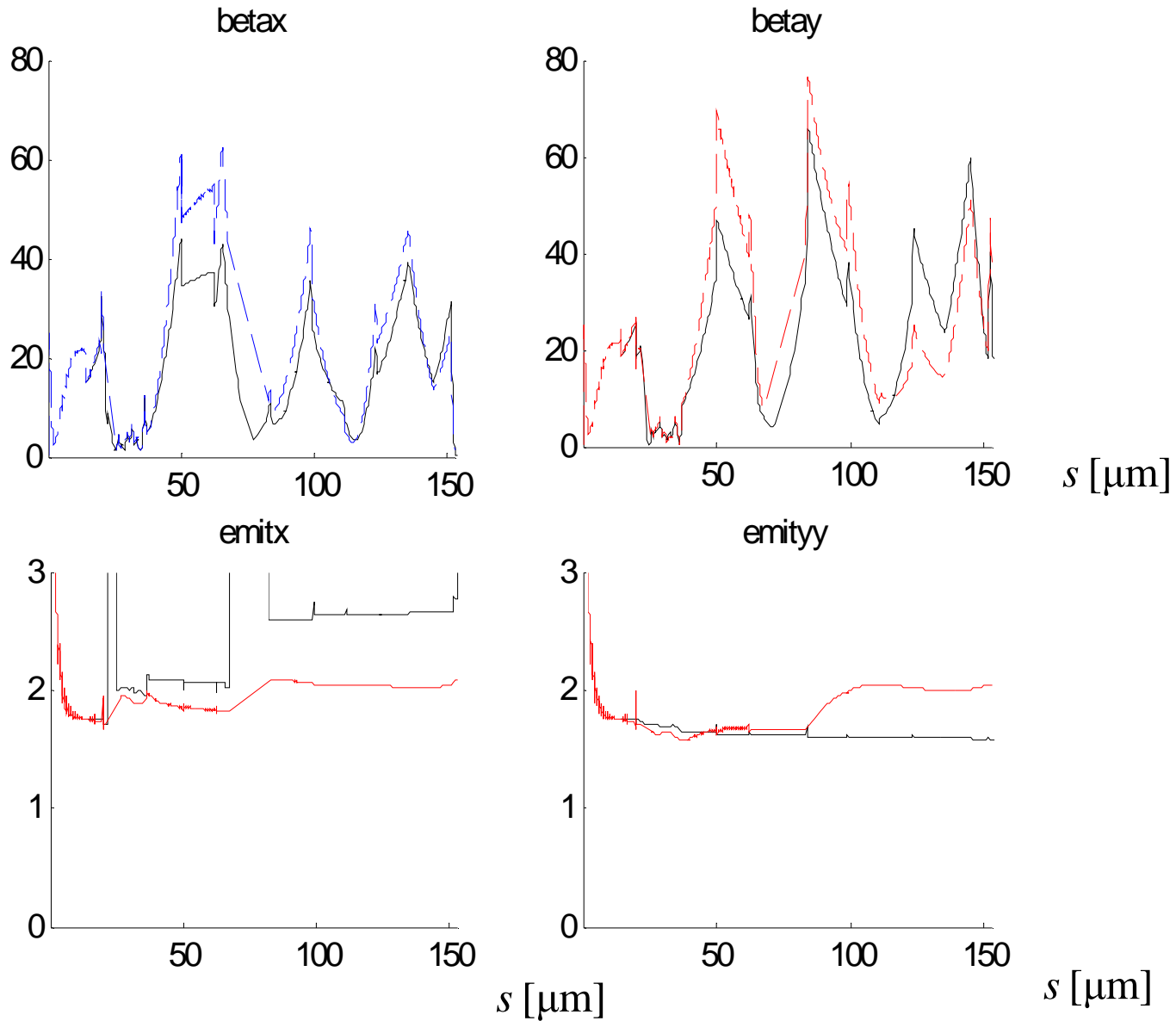
# Energy spread after ACC7 (z=152 m) for Q=1nC



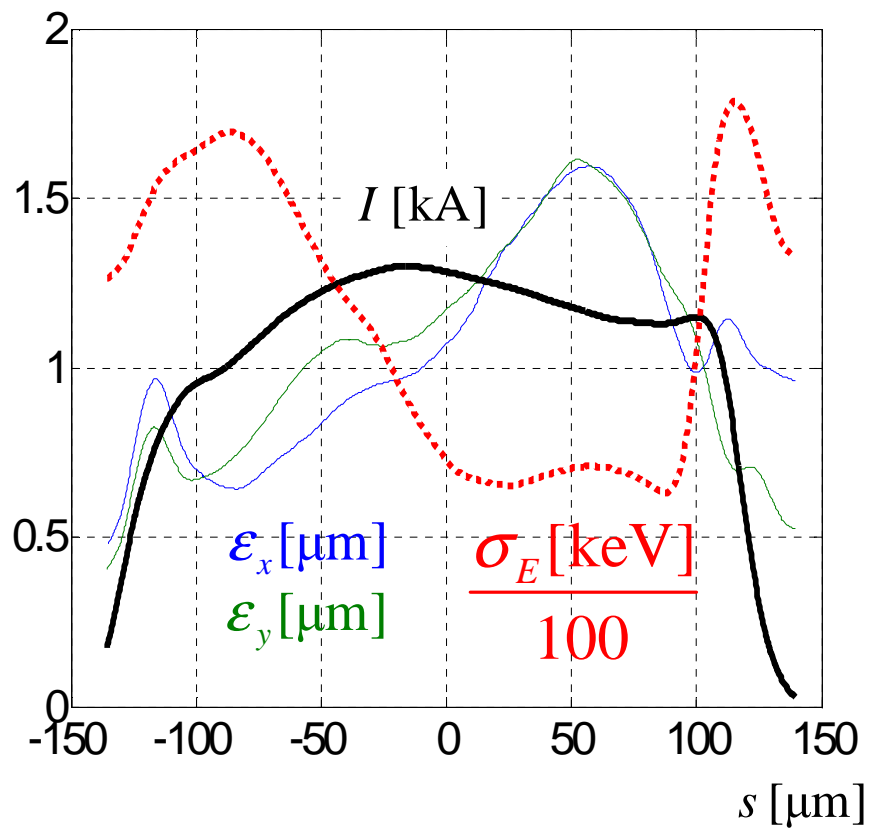
# ASTRA/CSRtrack vs. Elegant



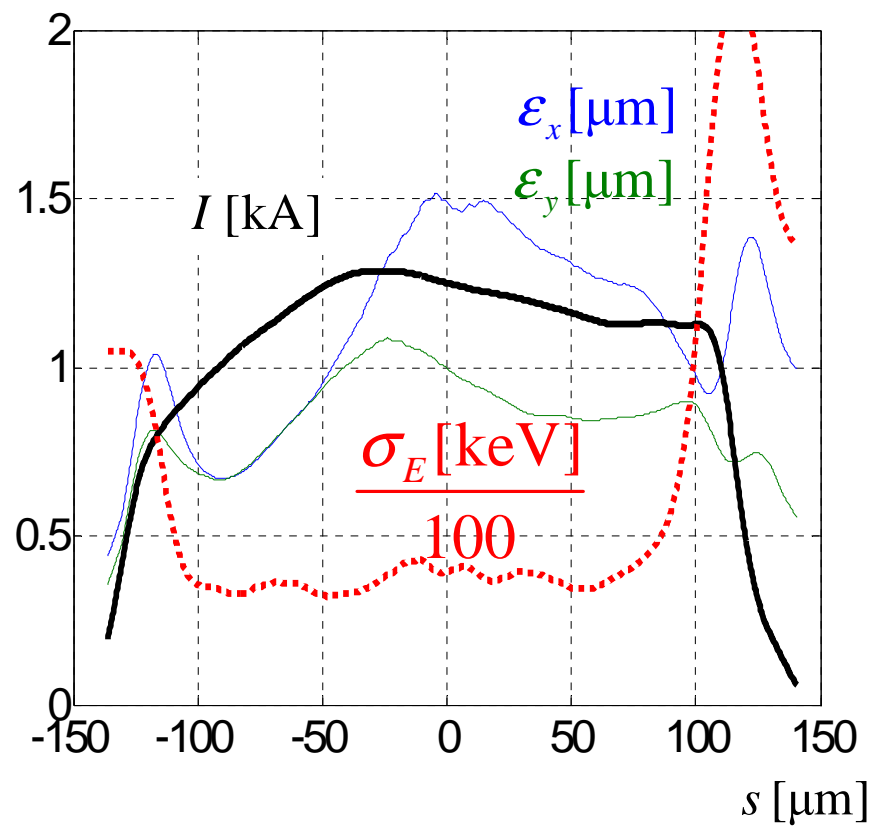
# ASTRA/CSRtrack vs. Elegant



## ASTRA/CSRtrack

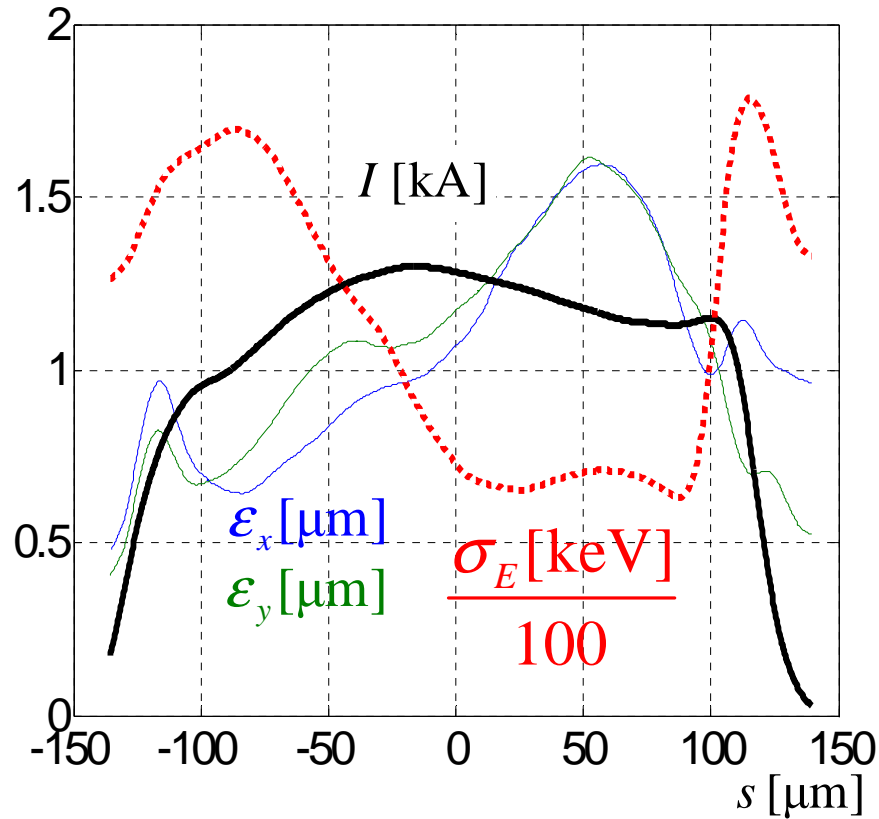


## Elegant

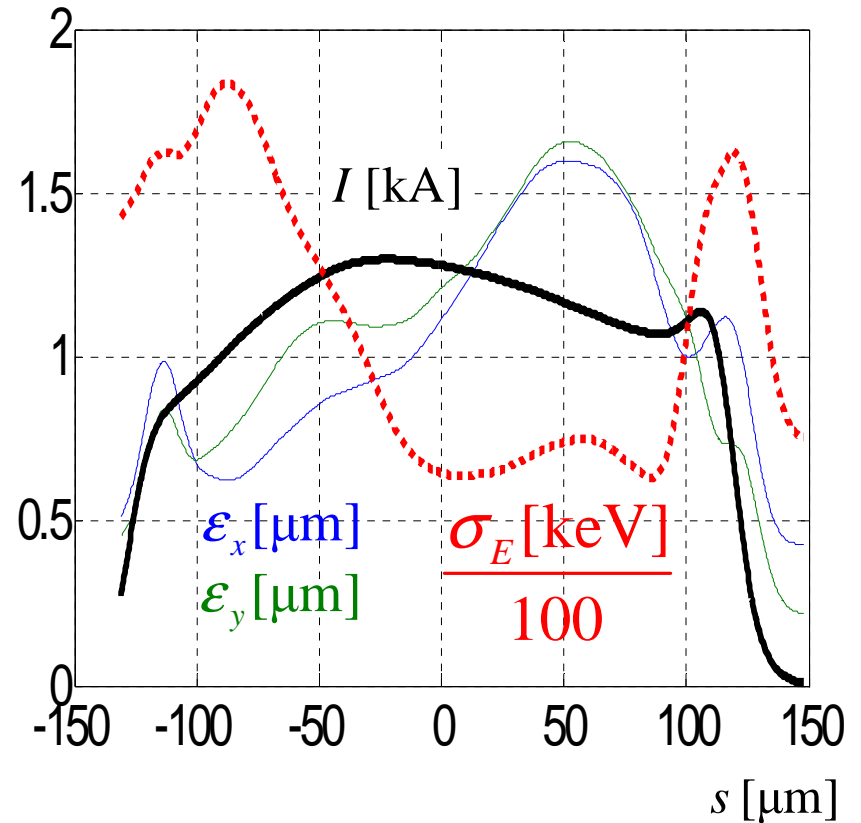


# Convergence of results (ASTRA/CSRtrack)

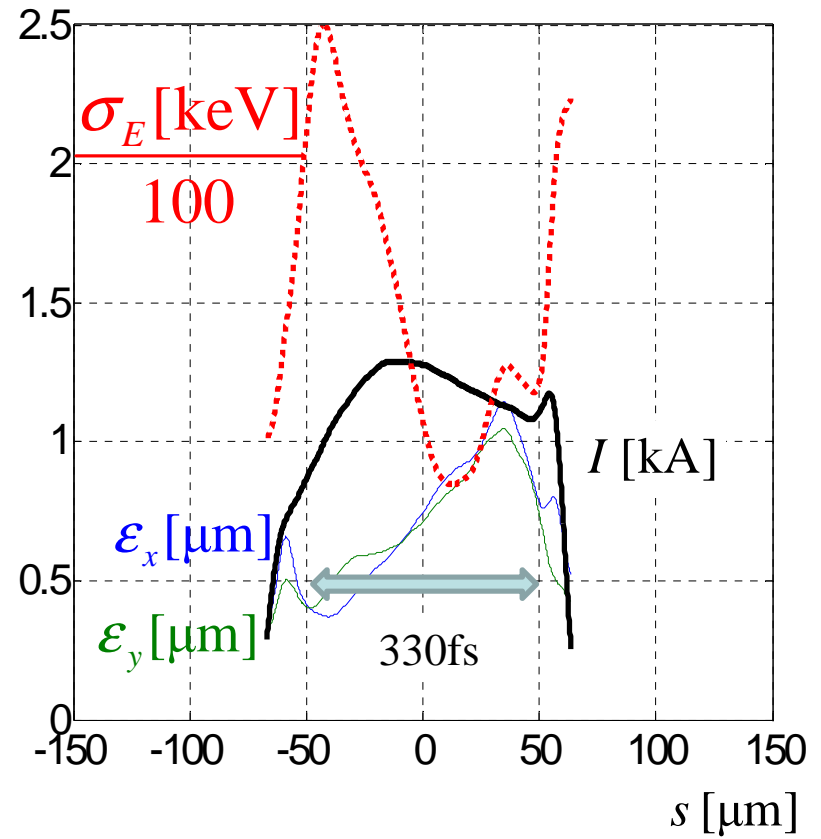
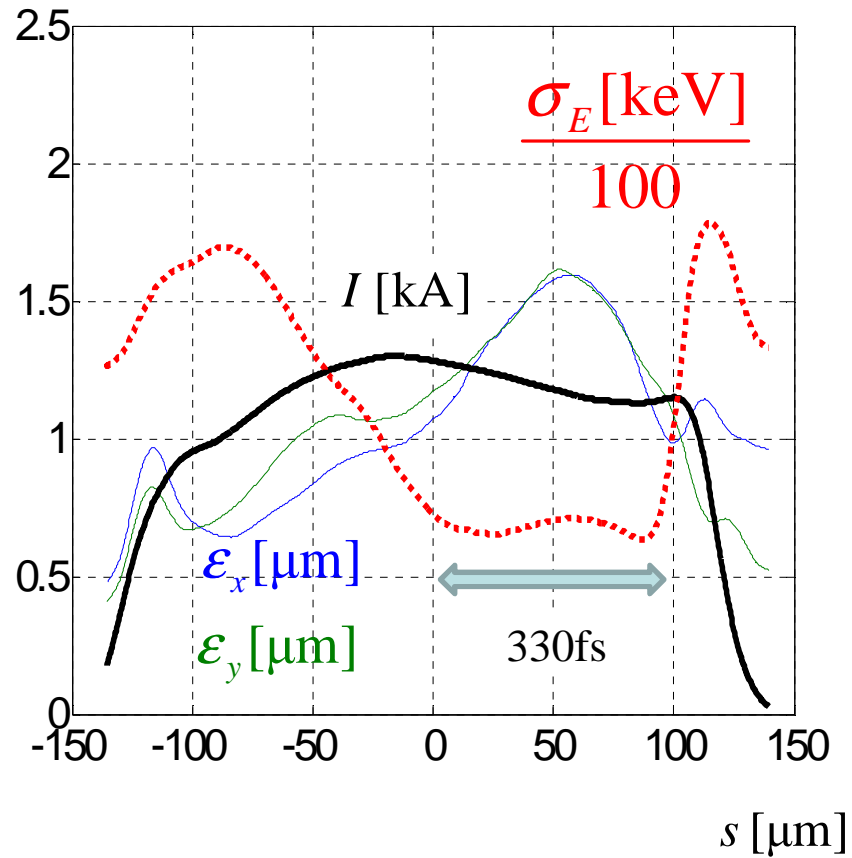
Mesh=30×60  
Particles=200k

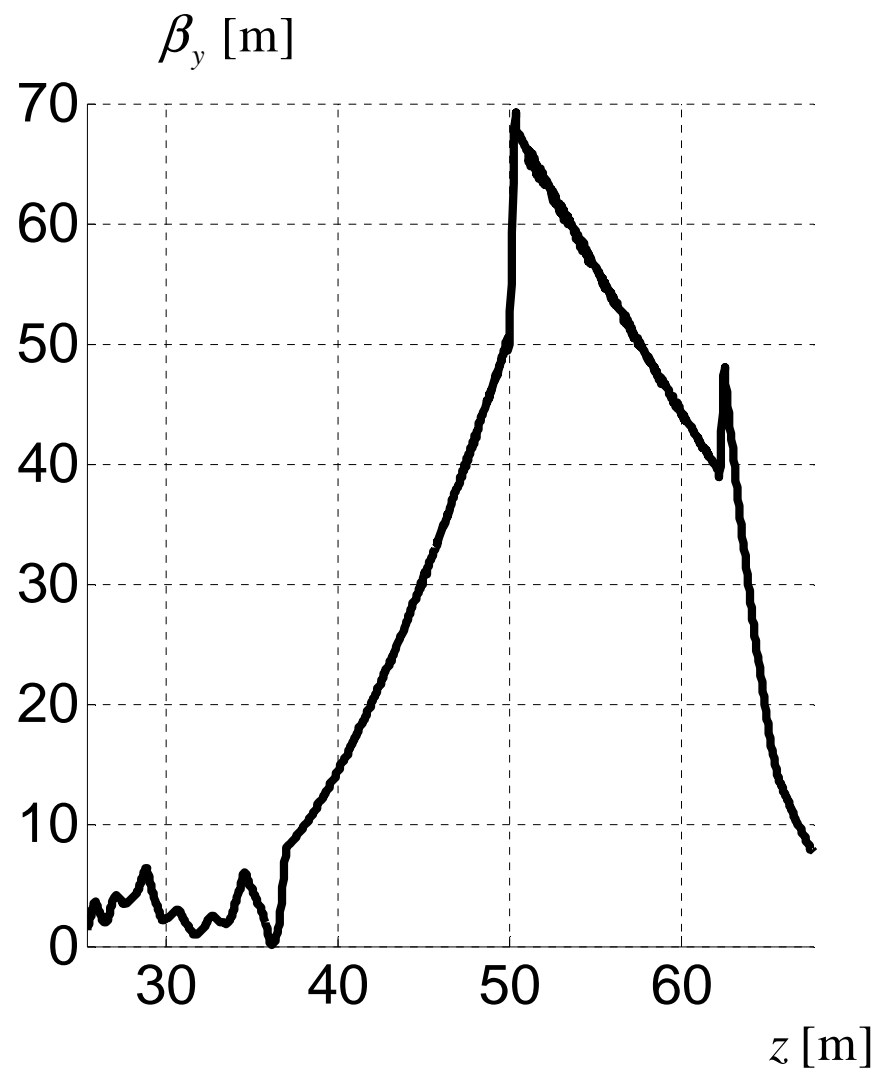
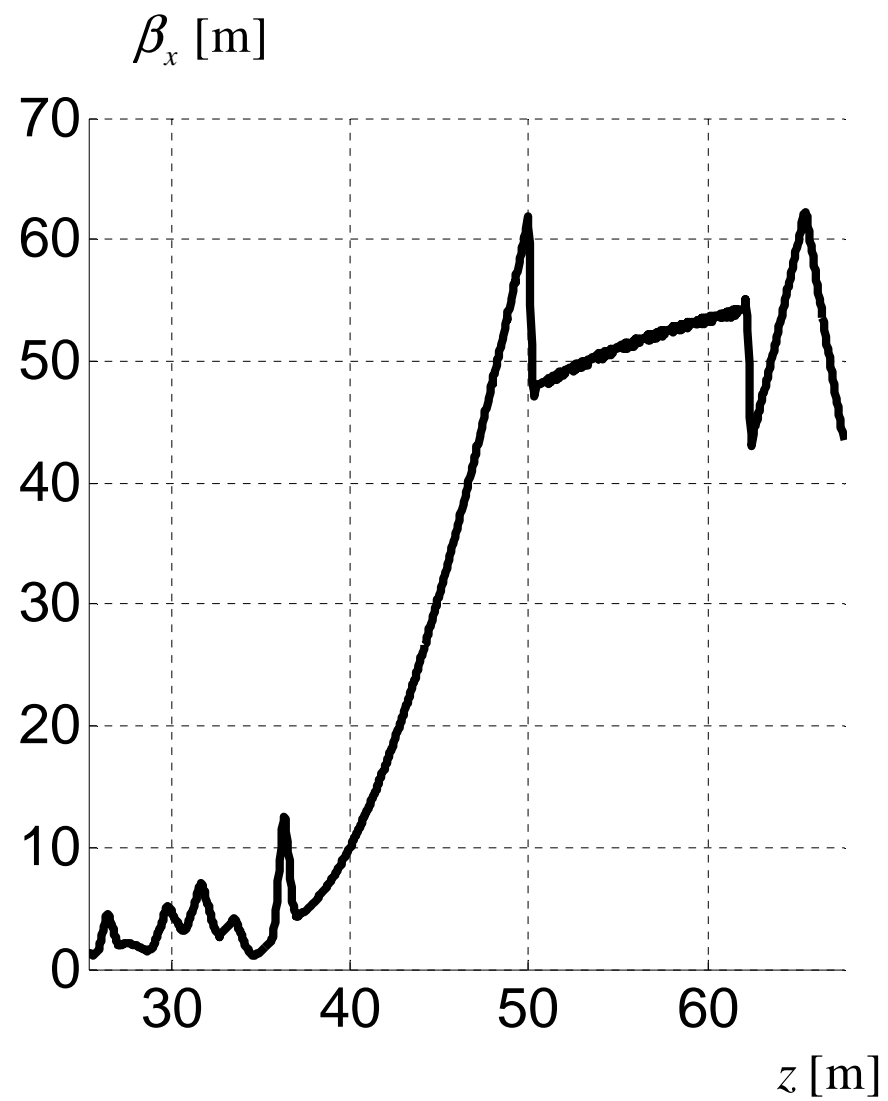


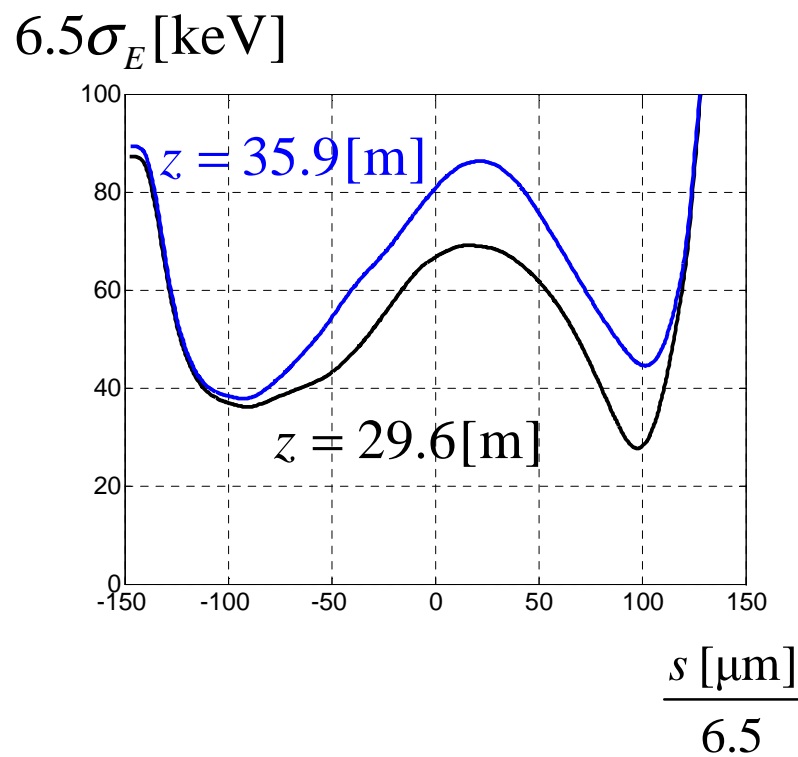
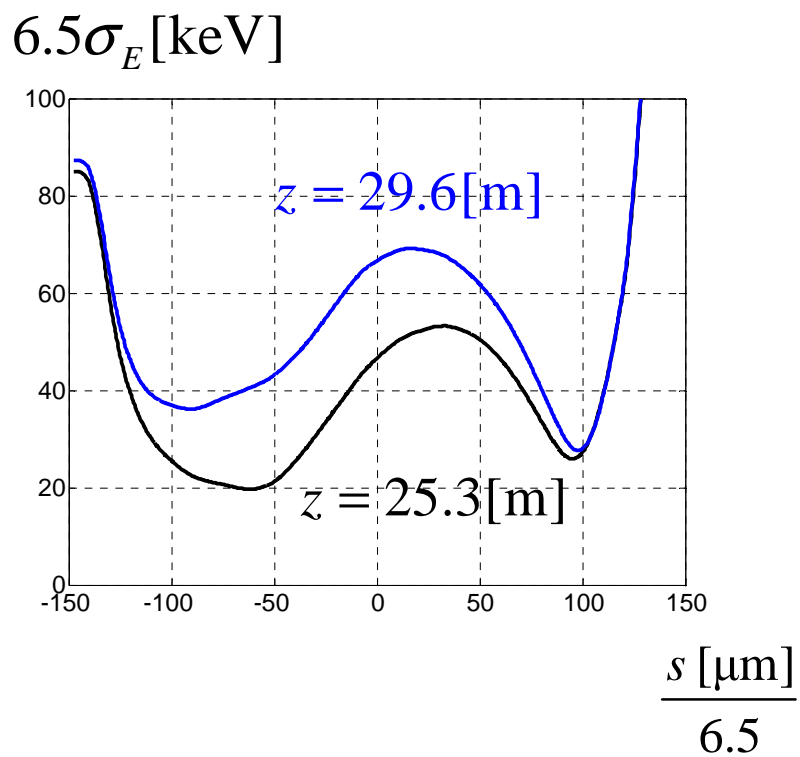
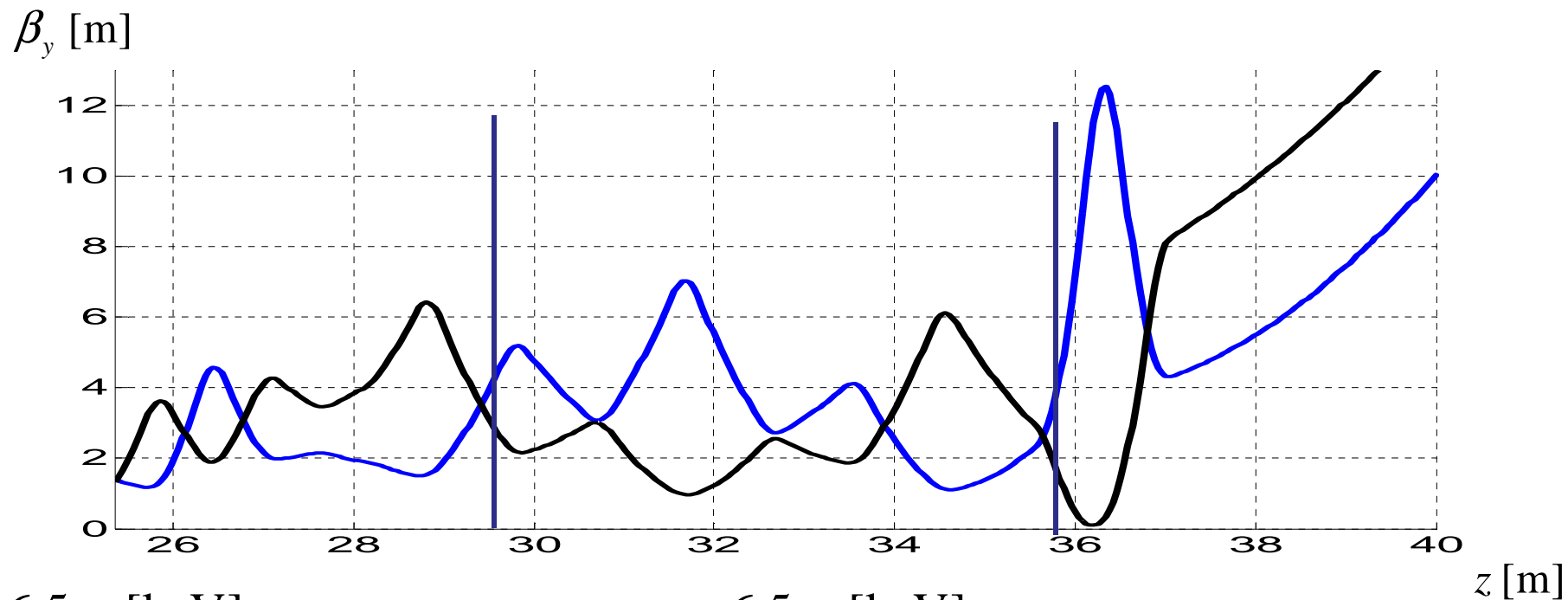
Mesh=60×120  
Particles=800k



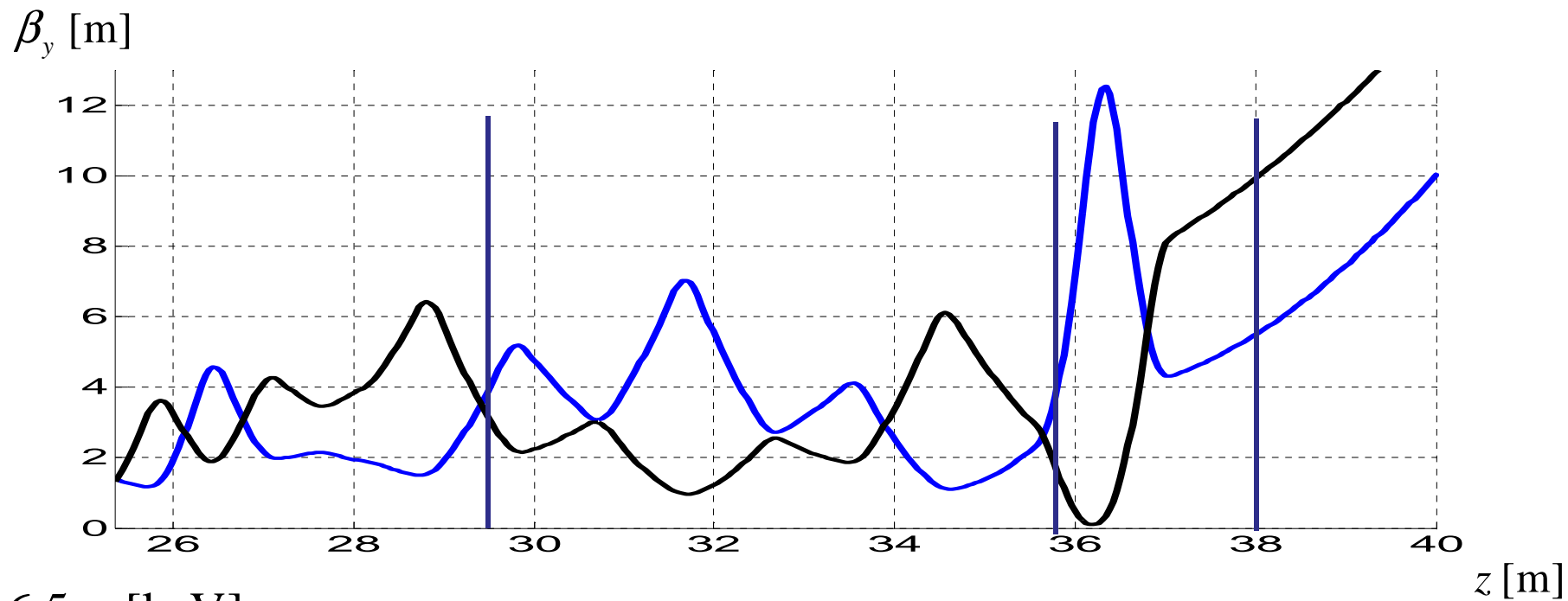
# Q=1nC vs. Q=0.5 nC











$6.5\sigma_E$  [keV]

