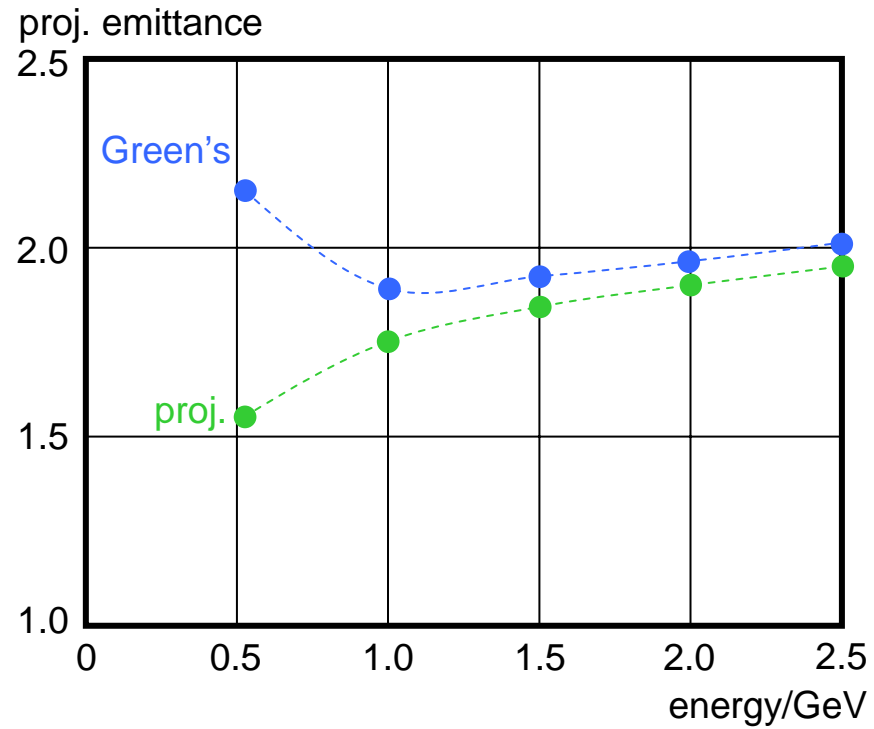


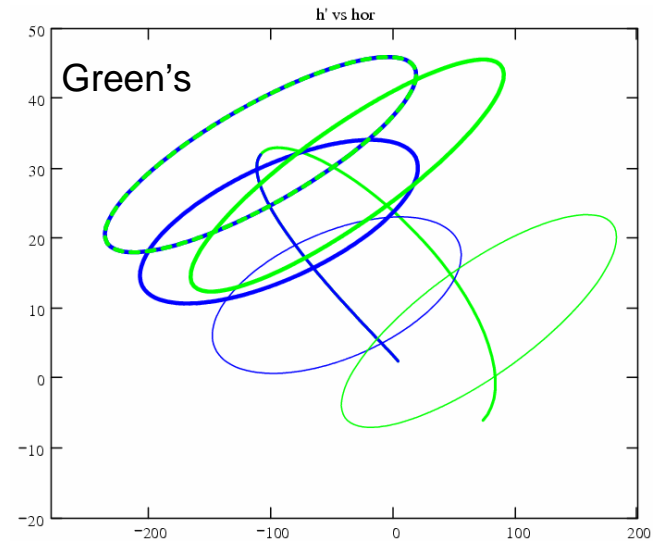
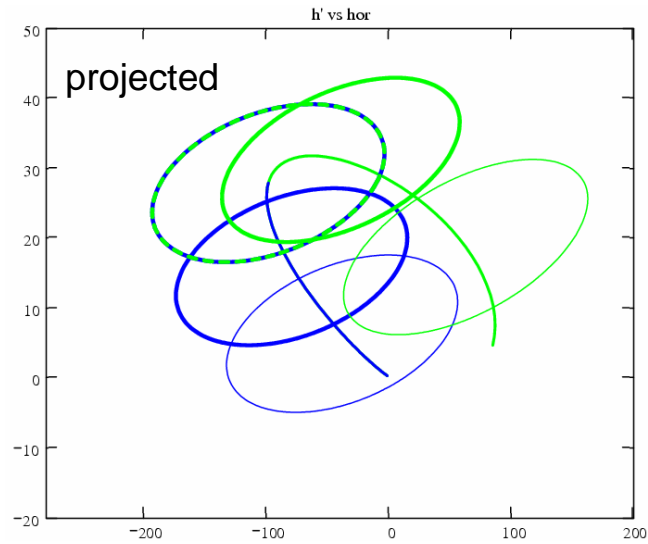
# XFEL-BC2 vs energy, absolute chirp = const

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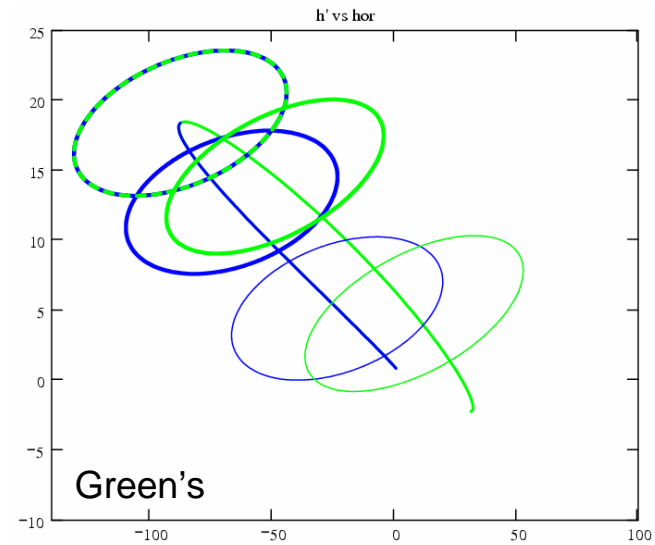


# x-x': 1- $\sigma$ -ellipses & centroids

511 MeV



2500 MeV



# x-x'-centroids

EOM: 
$$x'' + (K^2 - n)x = \frac{K\Delta E + F_x}{E}$$

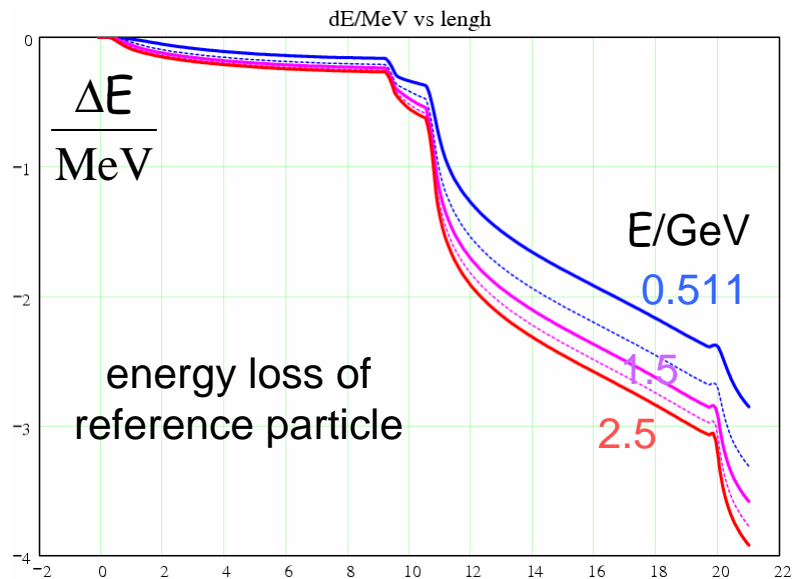
essential terms (1d theory): 
$$x'' \approx \frac{K}{E} \Delta E$$

absolute chirp = const  
compression = const  $\Rightarrow$

$$r_{56} \propto E$$

$$r_{56} \propto \frac{1}{R^2} = K^2$$

$$\Rightarrow x'' \propto \frac{1}{\sqrt{E}} \Delta E$$

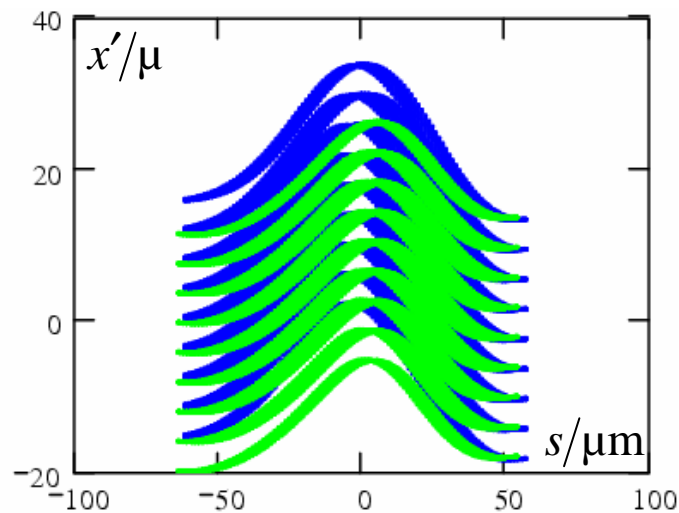
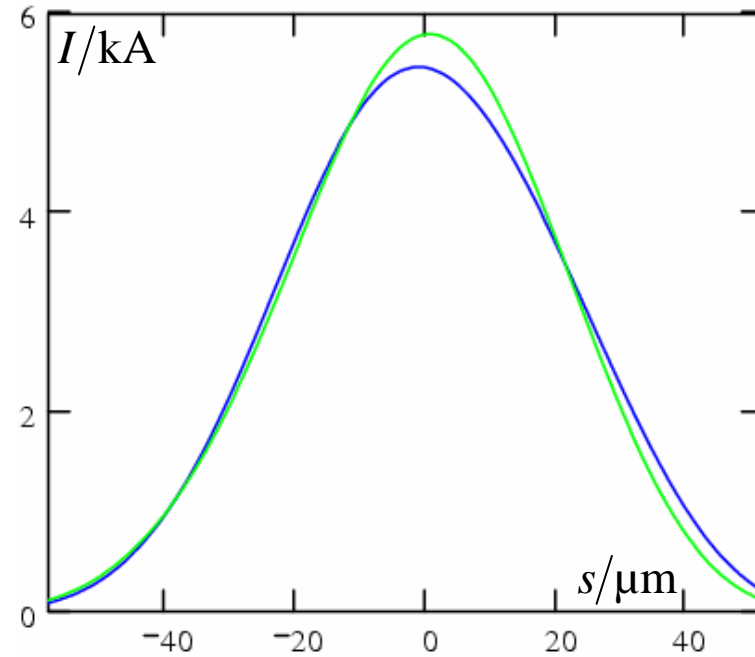
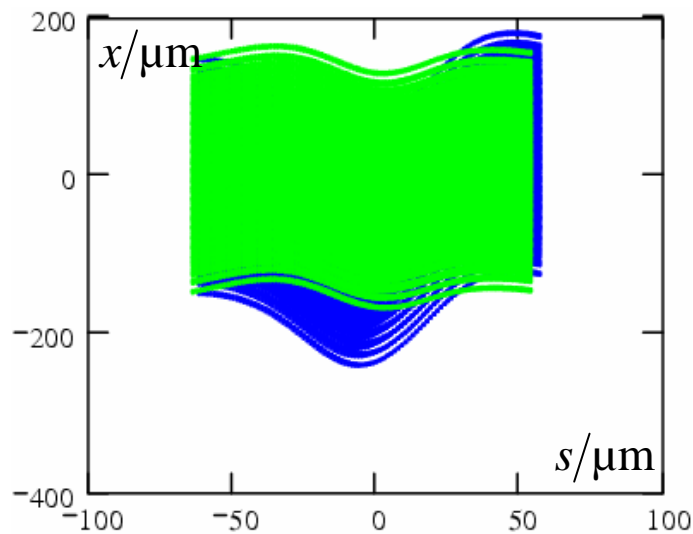


$\Delta E$  scales weak with  $E$



normalized centroid emittance  
and  
normalized projected emittance  
scale weak with energy

2500 MeV: **without** / **with shielding** (h=1cm)

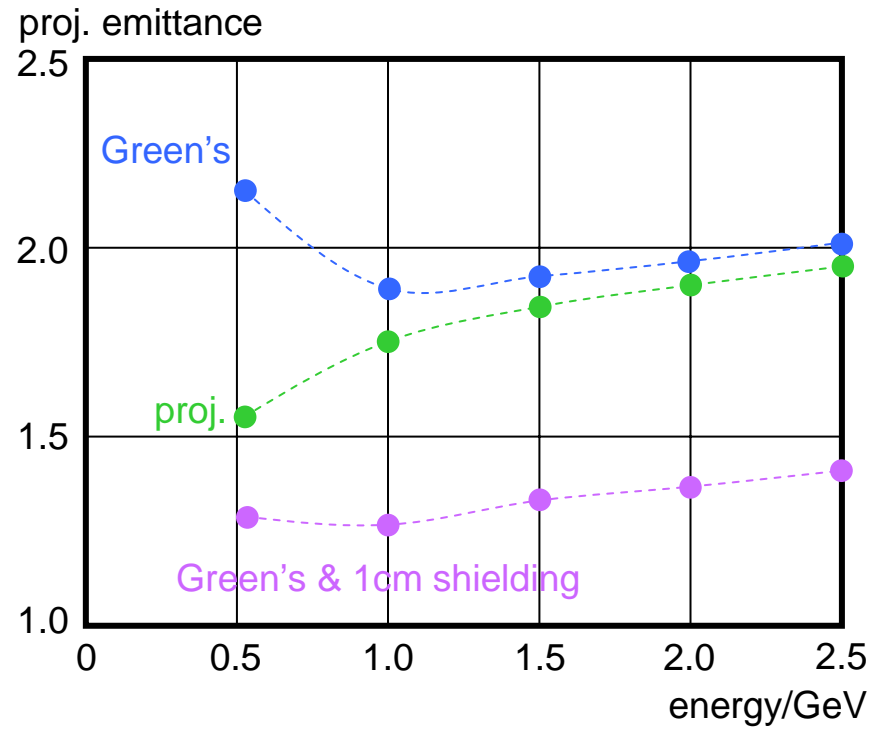


norm. slice emittance =  $1.00 \cdot 10^{-6}$   
 $1.00 \cdot 10^{-6}$

norm. proj. emittance =  $2.00 \cdot 10^{-6}$   
 $1.40 \cdot 10^{-6}$

# XFEL-BC2 vs energy, absolute chirp = const

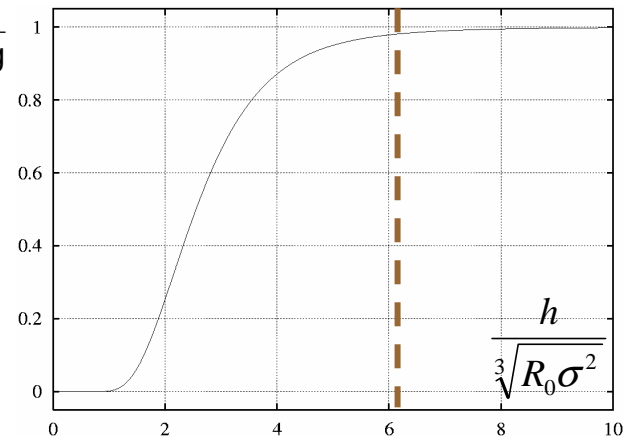
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# about shielding

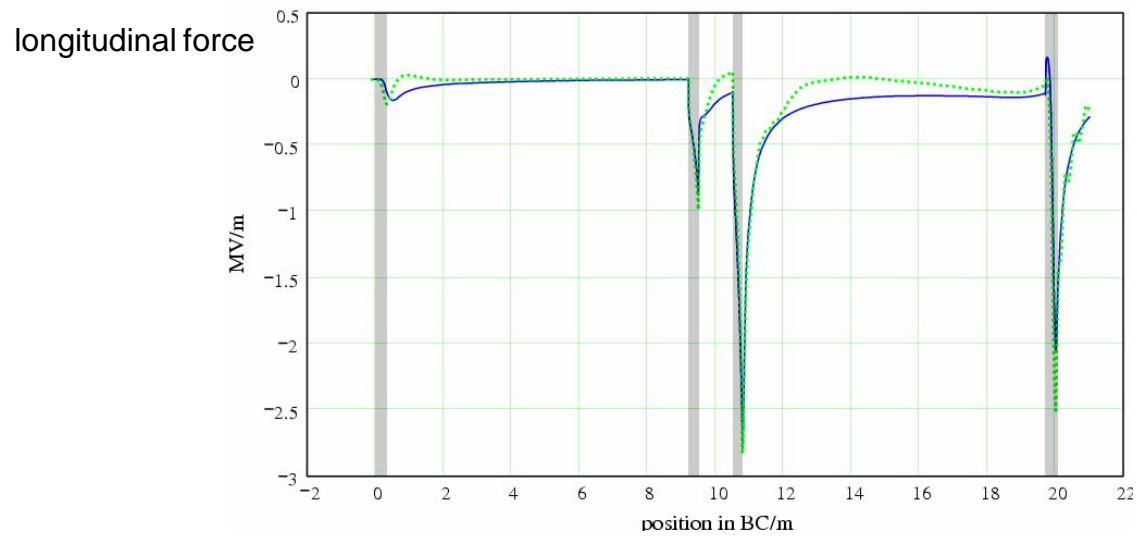
CSR in circular motion:

$\frac{\text{rad. power with shielding}}{\text{rad. power without shielding}}$



e.g.  $h = 1 \text{ cm}$   
 $R_0 = 10 \text{ m}$   
 $\sigma = 20 \mu\text{m}$

reference particle along BC 2500 MeV: **without** / **with** shielding ( $h=1\text{cm}$ )



# about shielding

wave propagation in drifts:

$$\frac{v_g}{c_0} = \sqrt{1 - \left(\frac{\omega_c}{\omega}\right)^2}$$

$$\omega_c \approx \frac{\pi c_0}{h}, \omega_{\text{rms}} \approx \frac{c_0}{\sigma} \rightarrow \frac{v_g}{c_0} \approx \sqrt{1 - \left(\frac{\pi \sigma}{h}\right)^2}$$

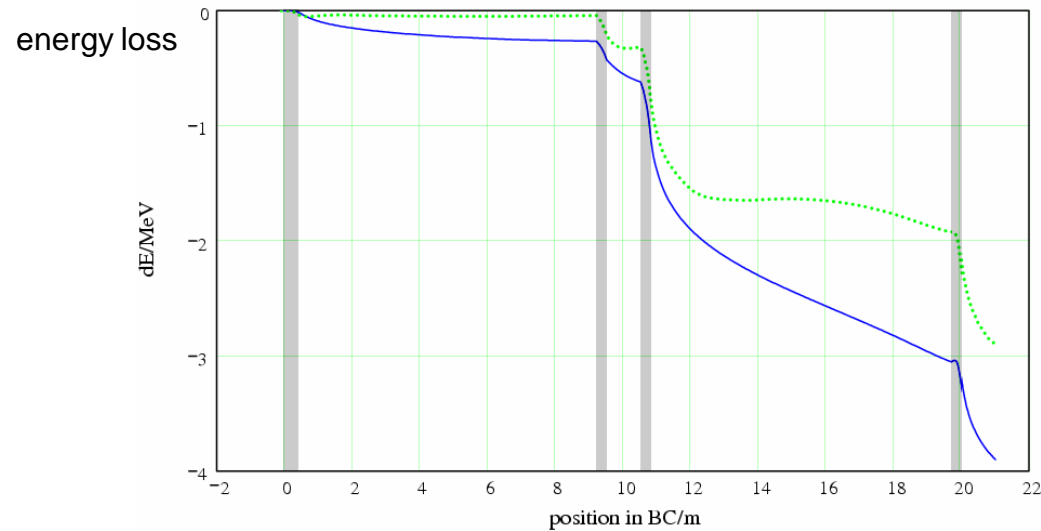
$$c_0 t - v_g t \approx \sigma \rightarrow ct \approx \frac{2}{\pi^2} \frac{h^2}{\sigma}$$

e.g.  $h = 1 \text{ cm}$

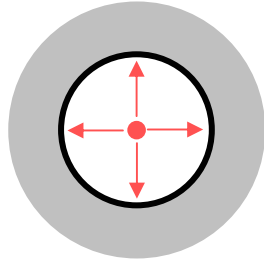
$R_0 = 10 \text{ m}$

$\sigma = 20 \text{ } \mu\text{m} \Rightarrow ct \approx 1 \text{ m}$

reference particle along BC 2500 MeV: **without** / **with** shielding ( $h=1\text{cm}$ )

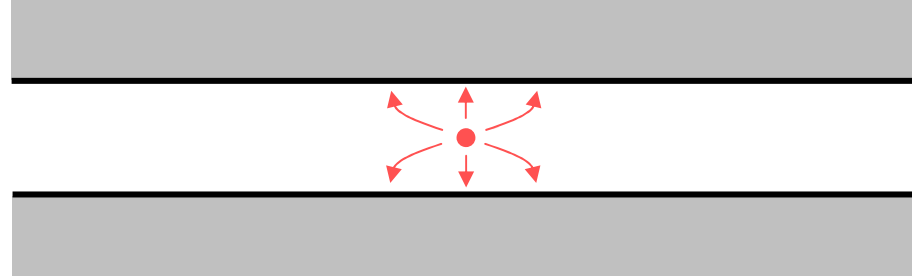


pipe shielding



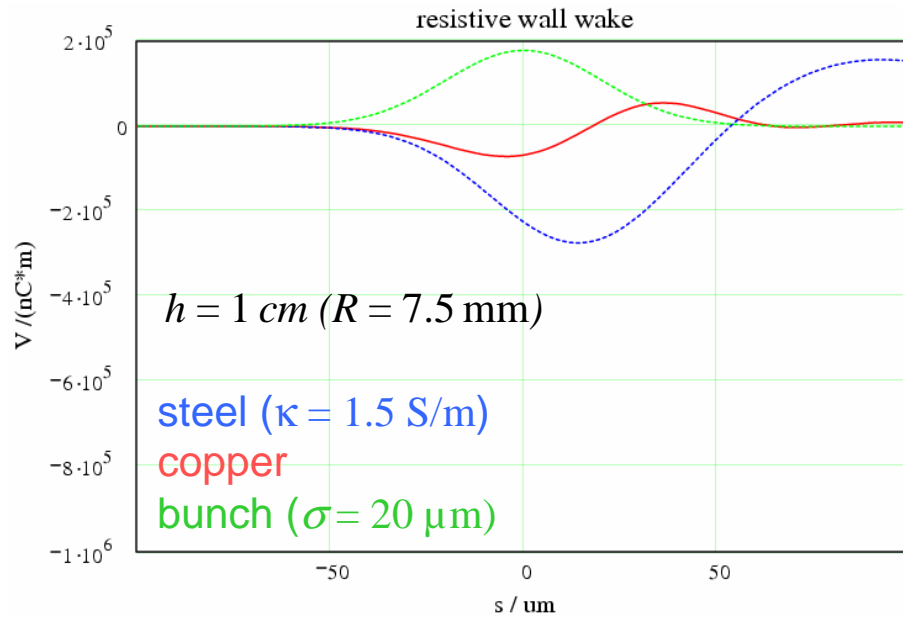
radius  $R$

planar plane shielding

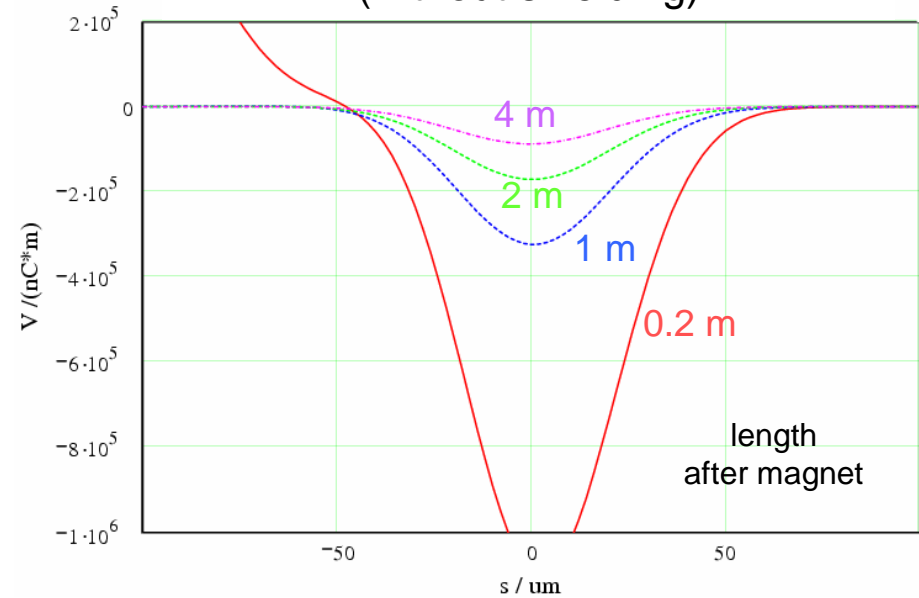


spacing  $h$

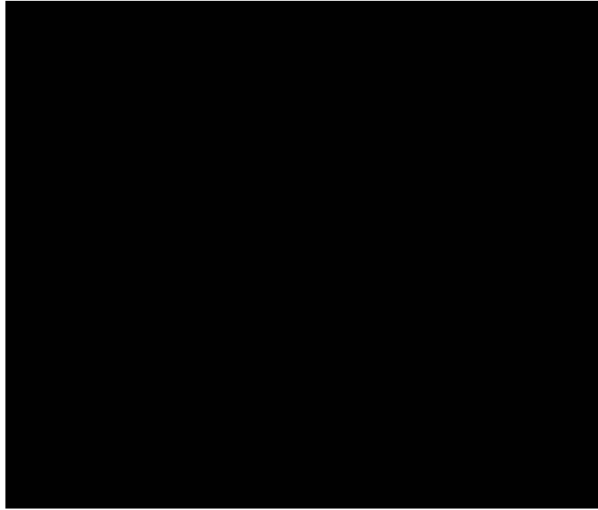
estimation: similar wake for  $R \approx 0.75 h$

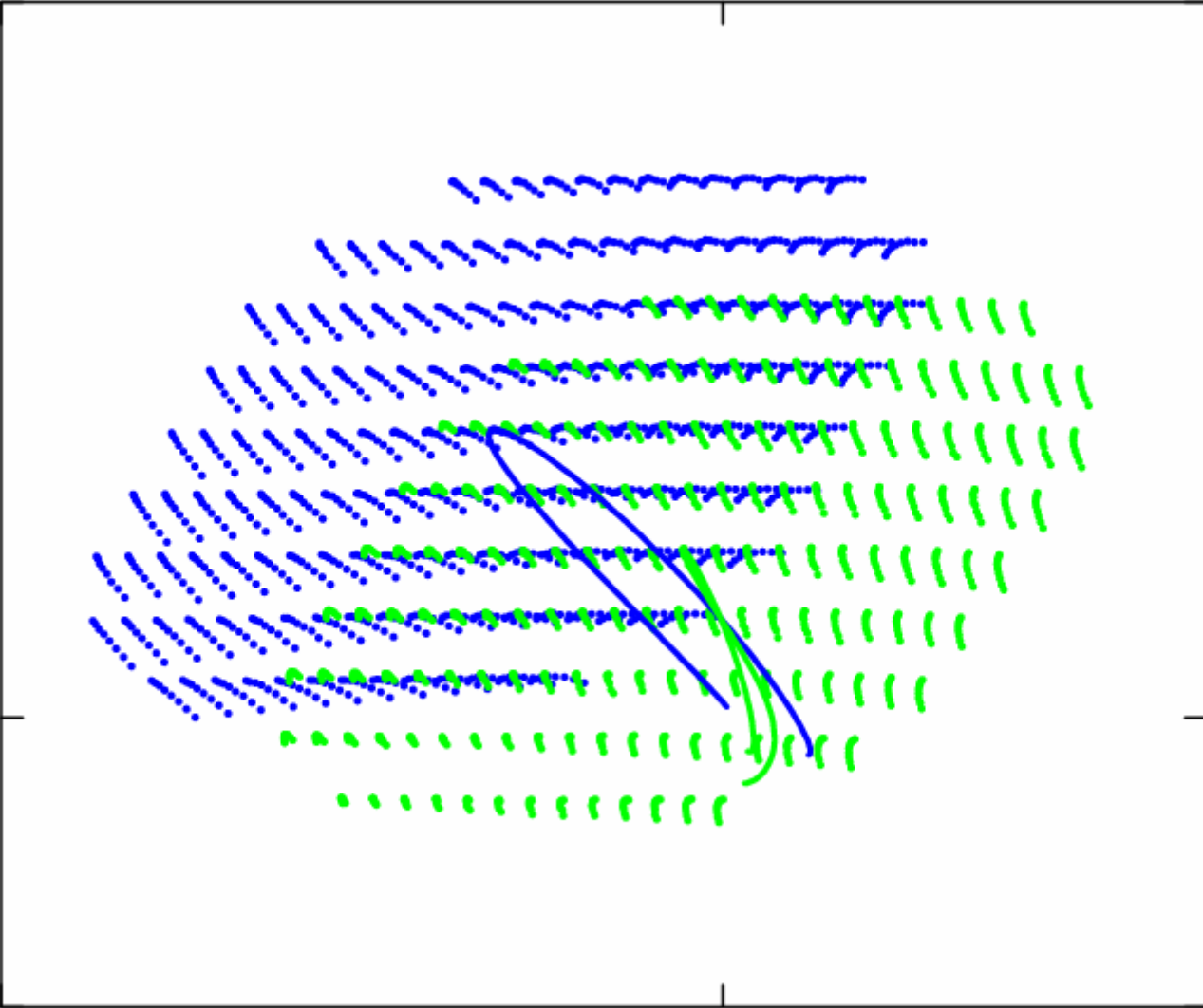


for comparison: wake after magnet 3  
(without shielding)





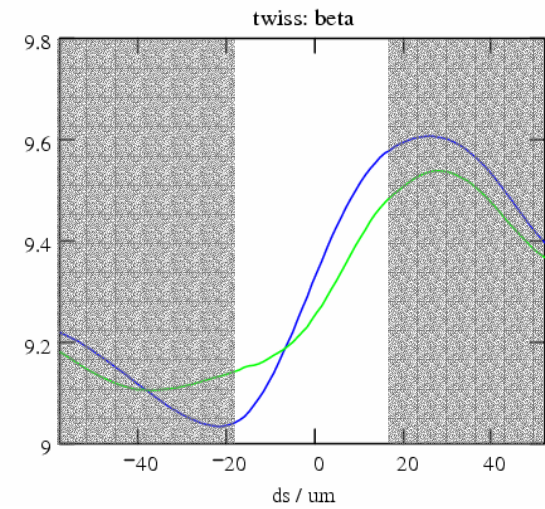
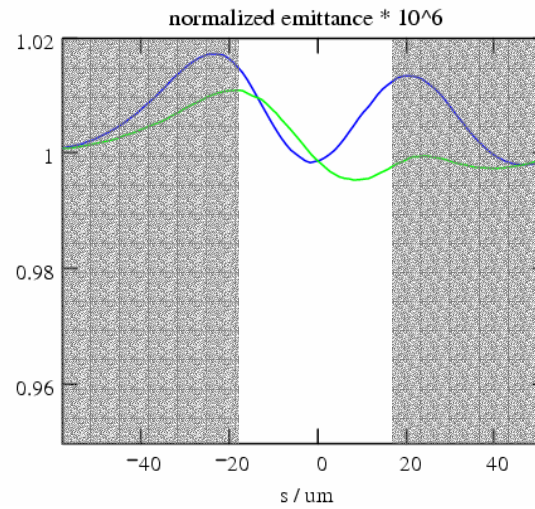
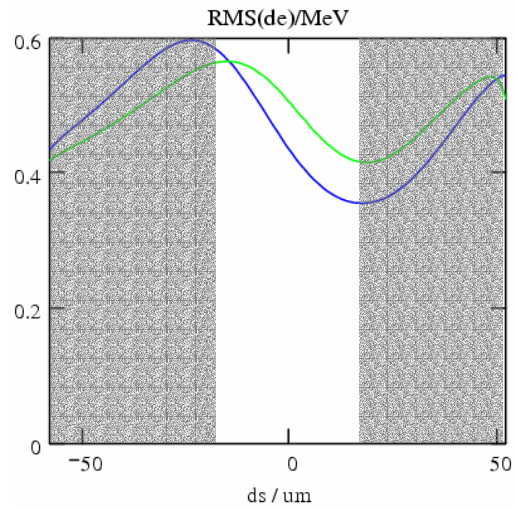
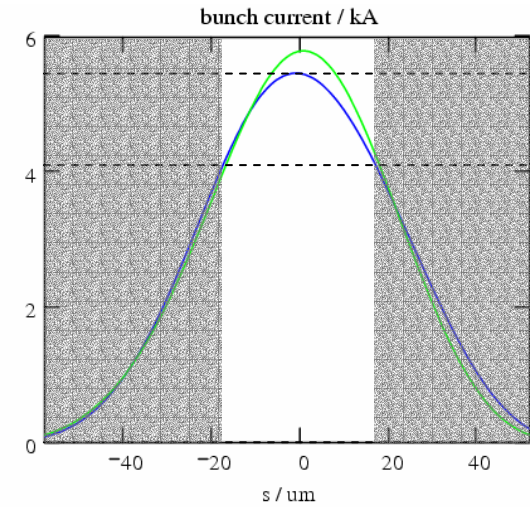
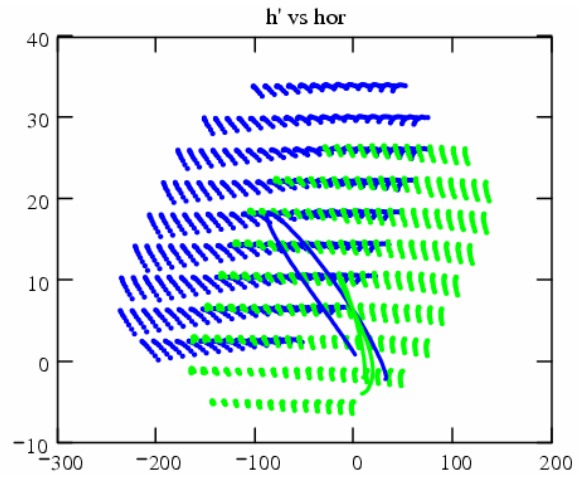




# 2500 MeV: without / with shielding (h=1cm)

slice with  $I_{peak}$ :  
 Green's Green's 1cm shielding

$emittance(x1) = 9.988 \times 10^{-7}$ $emittance(x2) = 9.987 \times 10^{-7}$ $E0 = 2.5 \times 10^9$	slice
$emittance(X1) = 1.996 \times 10^{-6}$ $emittance(X2) = 1.398 \times 10^{-6}$	full

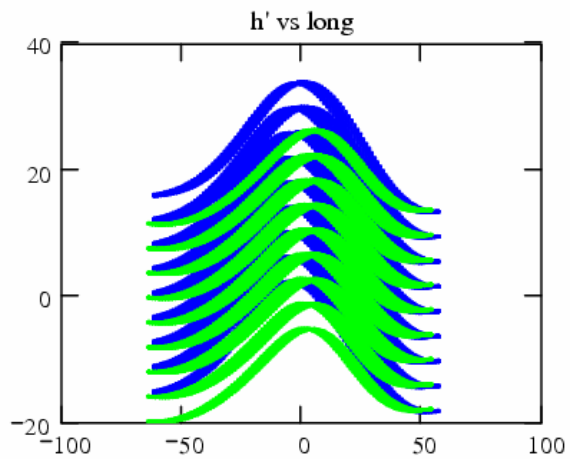
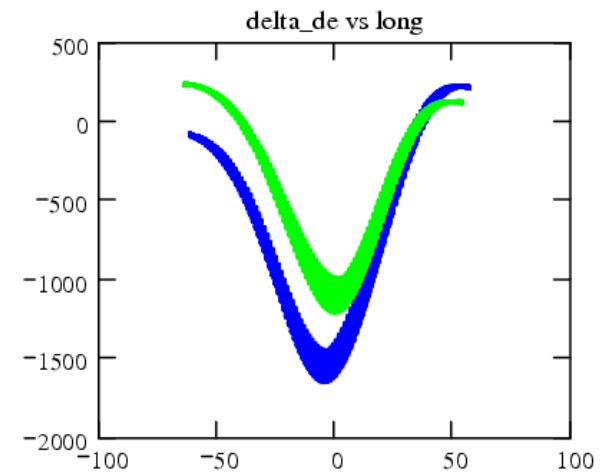
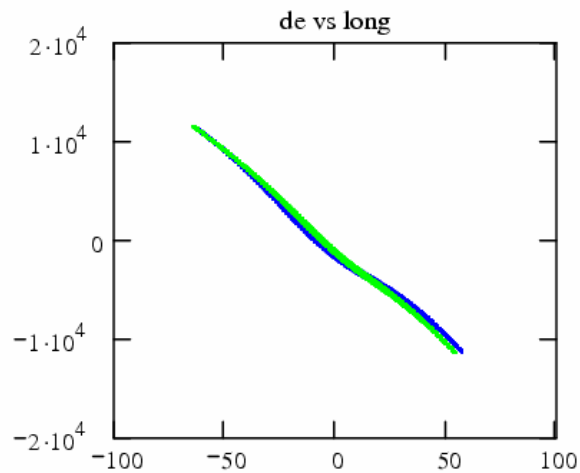
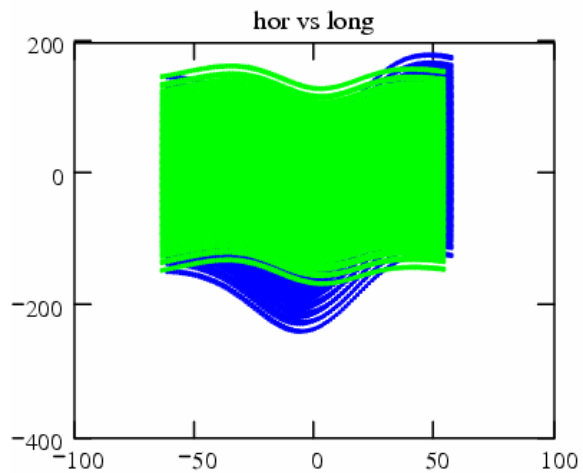


compression factor = 5

1m after BC

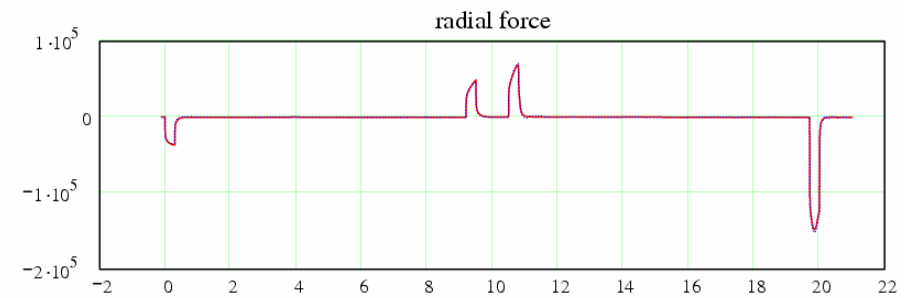
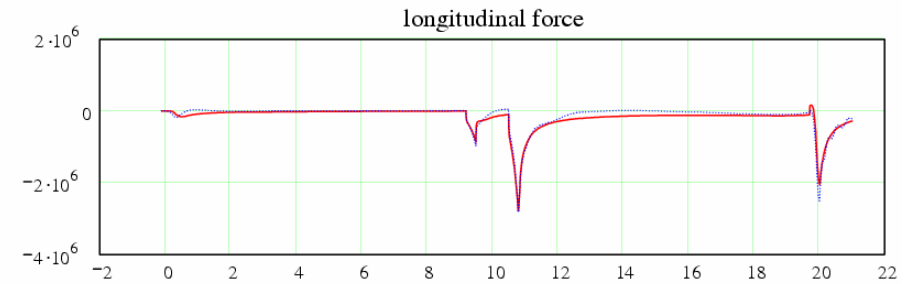
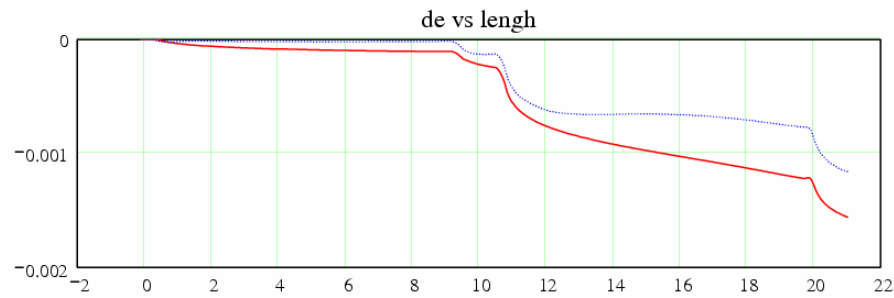
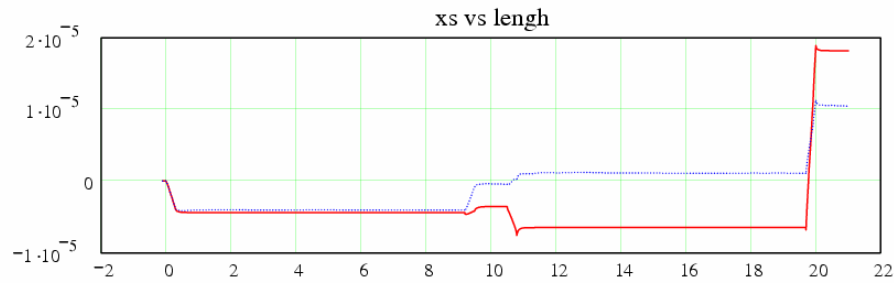
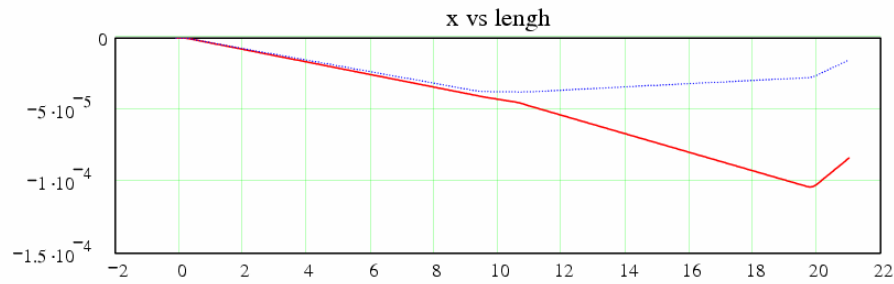
Green's Green's 1cm shielding

$$\frac{E_0}{10^6} = 2.5 \times 10^3$$

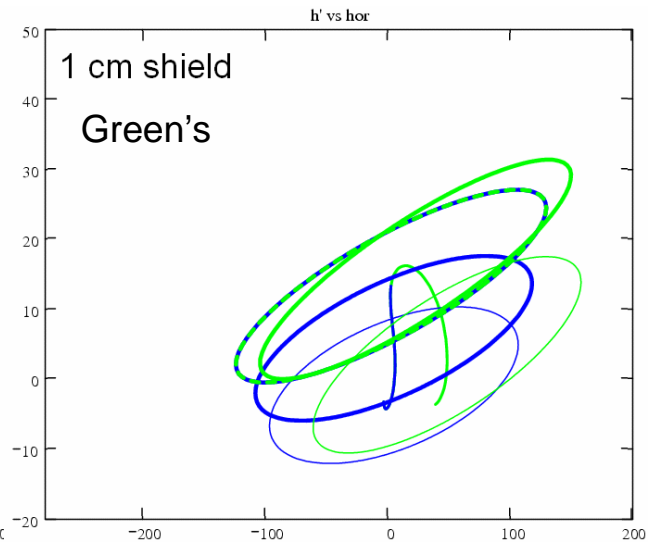
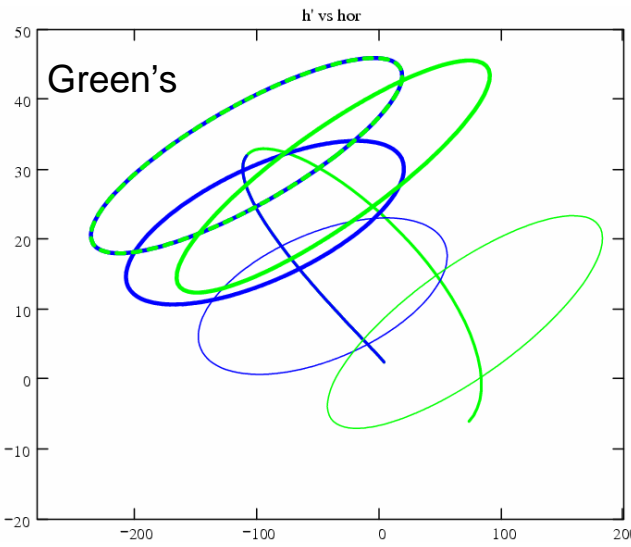
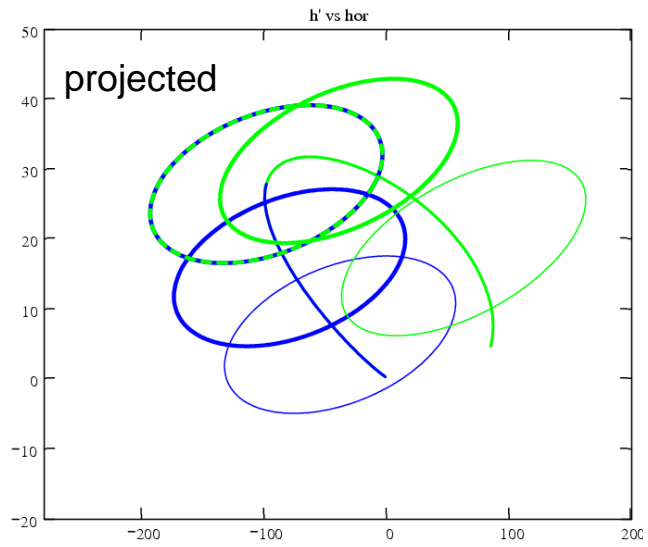


# reference particle along BC

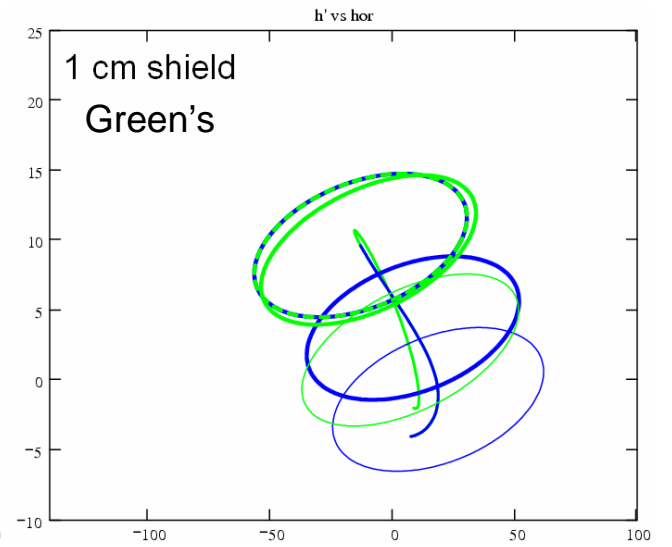
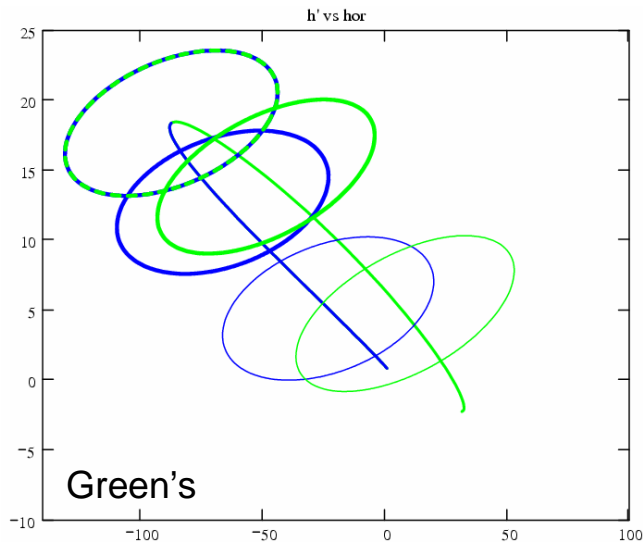
green's, 17000 particles, no shielding ... shielding: h=1cm hmax=30cm

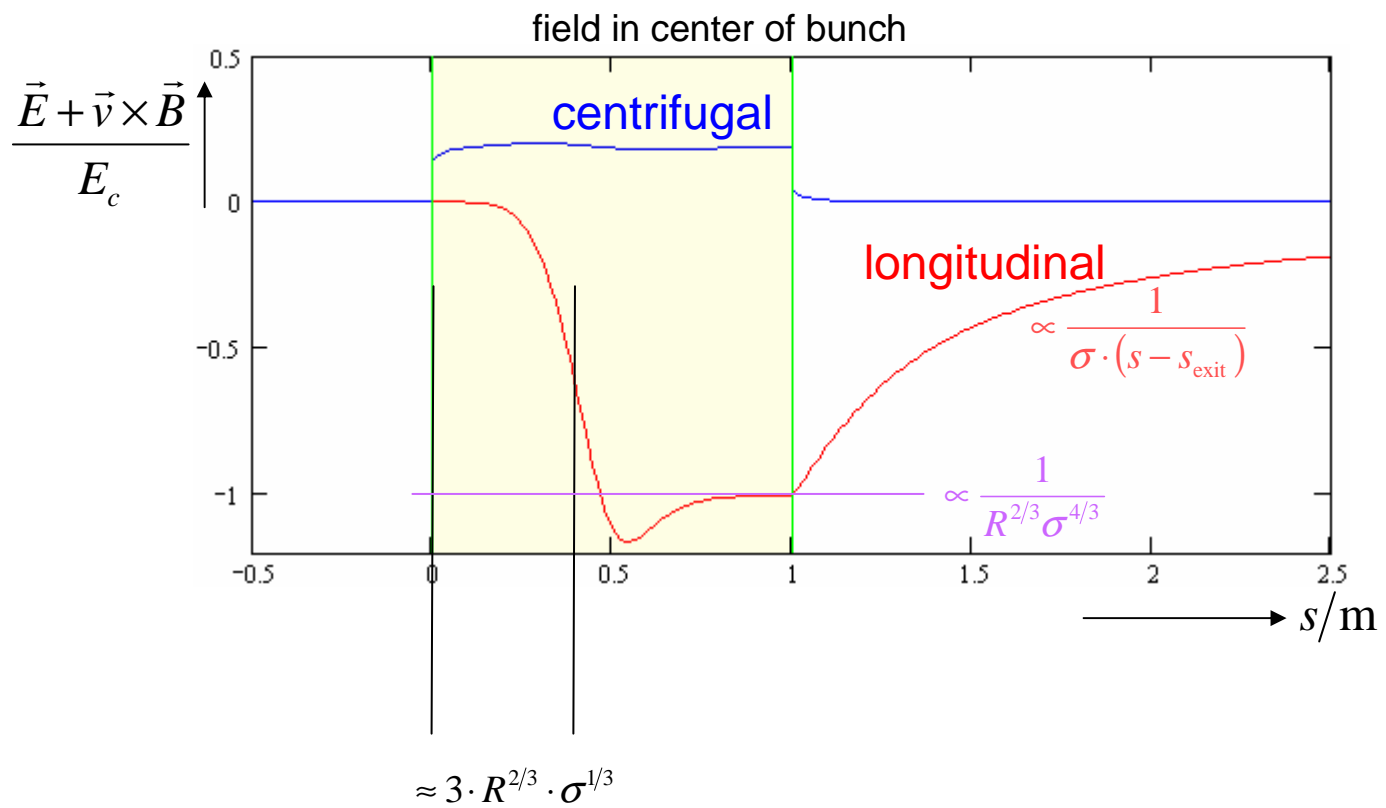


# 511 MeV



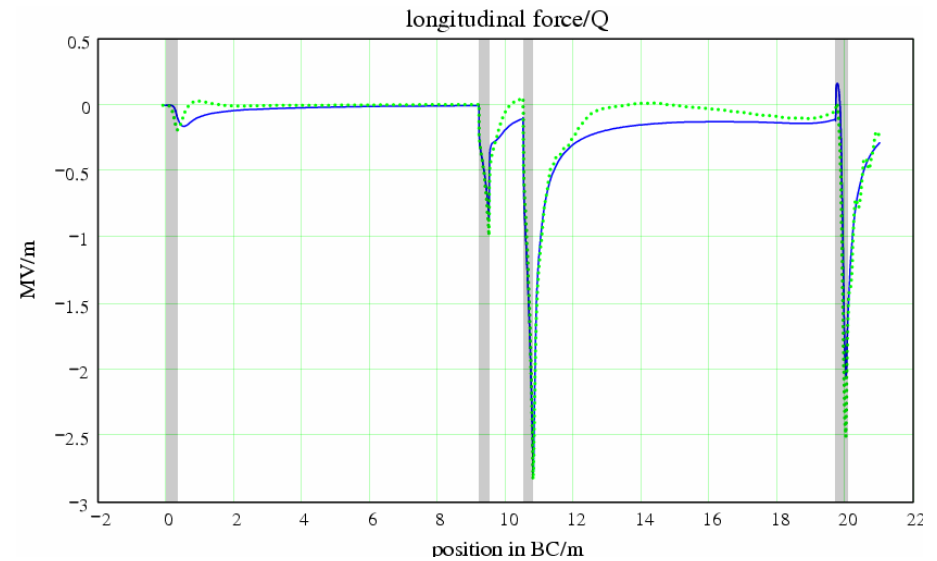
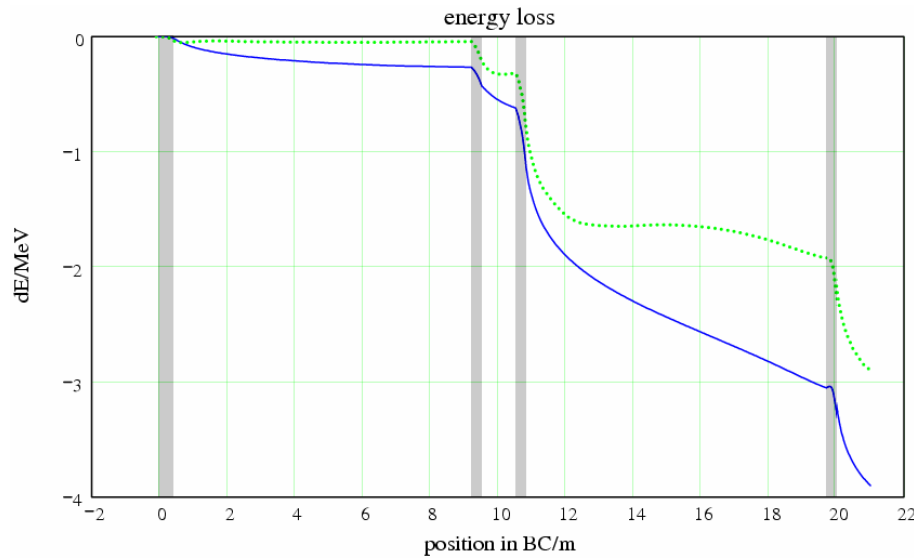
# 2500 MeV





# about shielding

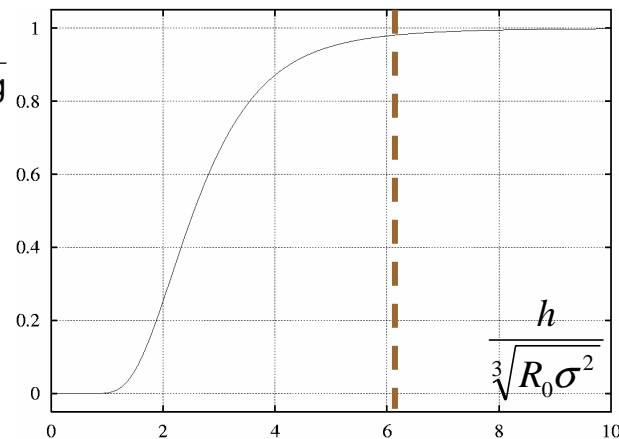
reference particle along BC  
2500 MeV: **without** / **with** shielding (h=1cm)



CSR in circular motion:

$\frac{\text{rad. power with shielding}}{\text{rad. power without shielding}}$

e.g.  $h = 1 \text{ cm}$   
 $R_0 = 10 \text{ m}$   
 $\sigma = 20 \mu\text{m}$



wave propagation in drifts:

$$\frac{v_g}{c_0} = \sqrt{1 - \left(\frac{\omega_c}{\omega}\right)^2} \approx \sqrt{1 - \left(\frac{\pi\sigma}{h}\right)^2}$$

$$c_0 t - v_g t \approx \sigma \rightarrow ct \approx \frac{2}{\pi^2} \frac{h^2}{\sigma}$$

$$ct \approx 1 \text{ m}$$