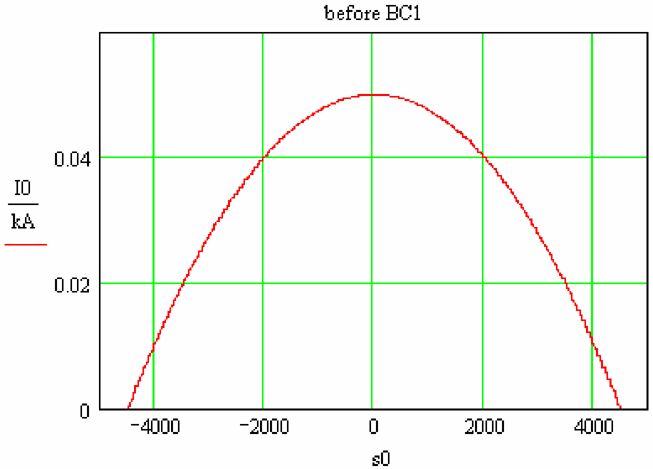
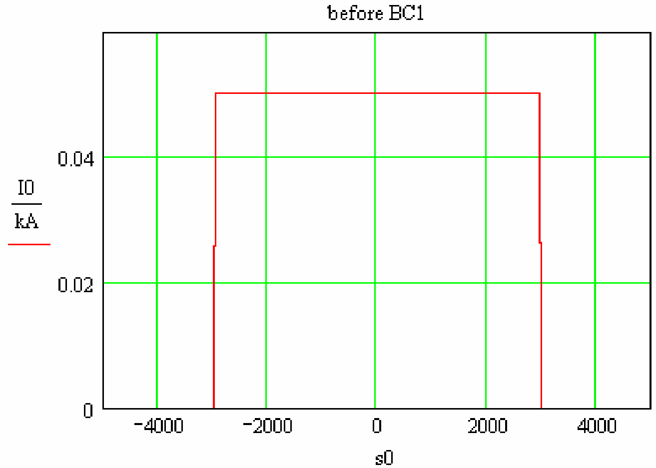
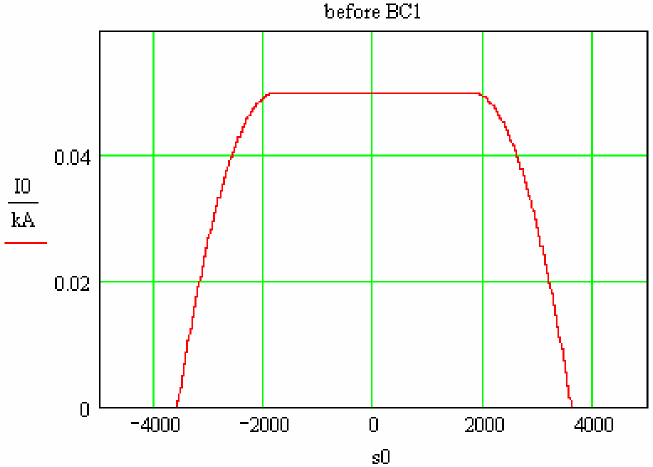
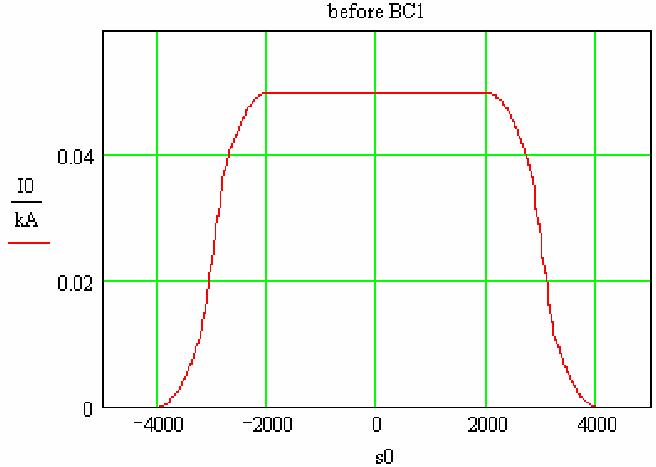
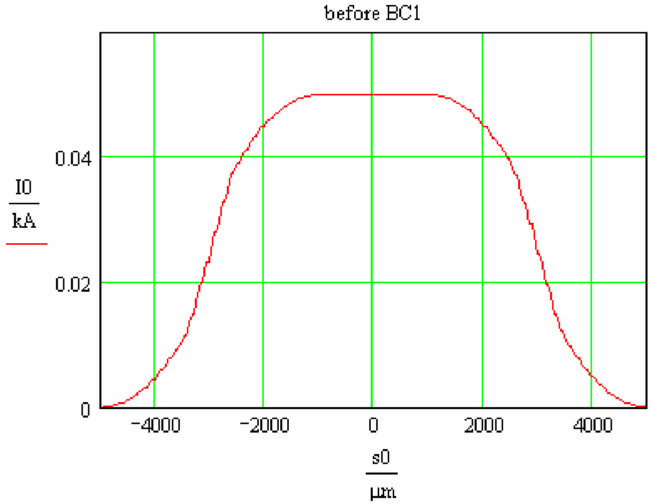
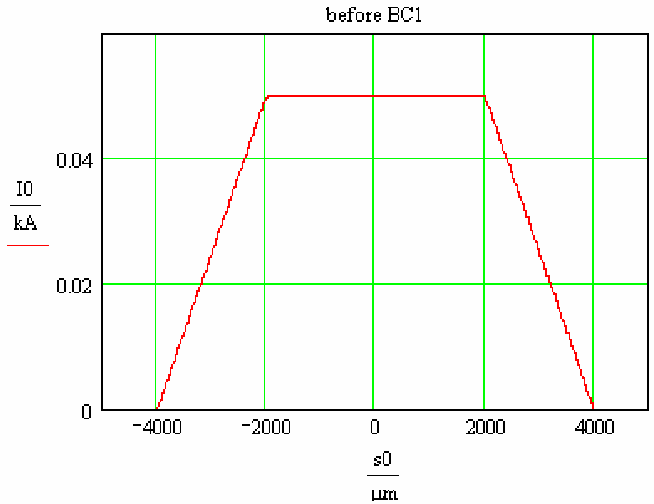

before BC1
0.04
0.02
0
I0
kA
-4000
-2000
0
2000
4000
s0

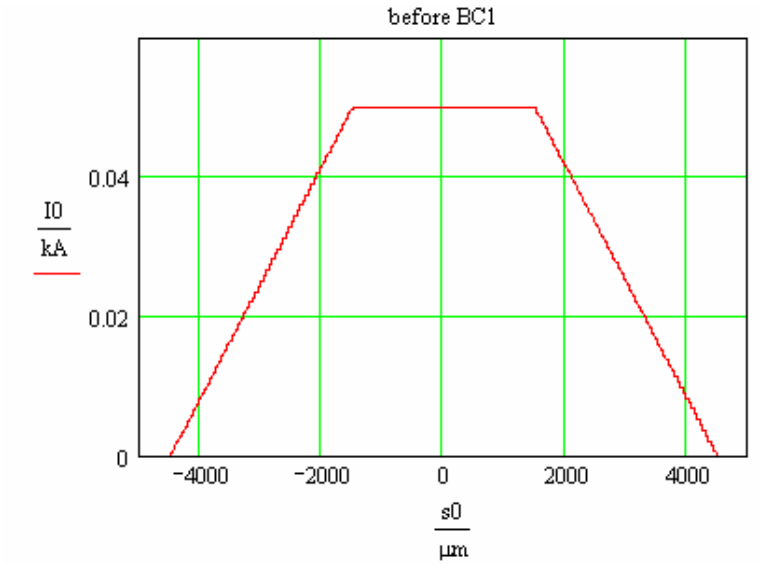

before BC1
0.04
0.02
0
I0
kA
-4000
-2000
0
2000
4000
s0

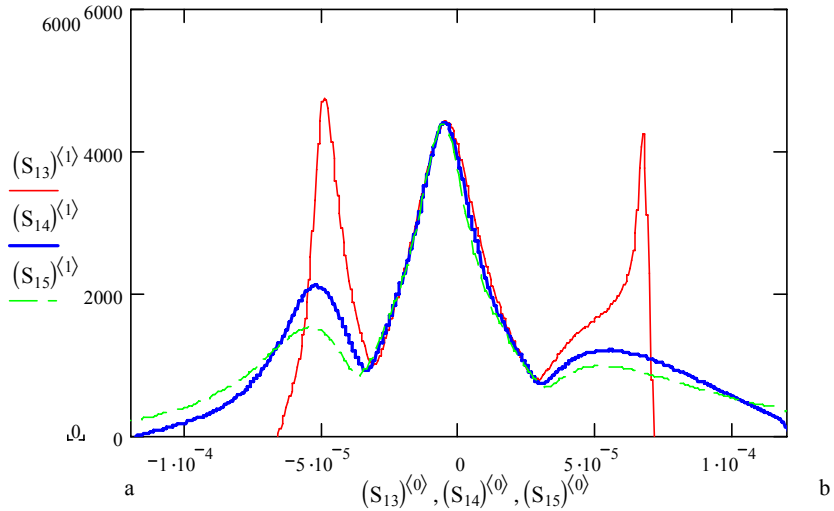

before BC1
0.04
0.02
0
I0
kA
-4000
-2000
0
2000
4000
s0


before BC1
0.04
0.02
0
I0
kA
-4000
-2000
0
2000
4000
s0


before BC1
0.04
0.02
0
I0
kA
-4000
-2000
0
2000
4000
s0
µm


before BC1
0.04
0.02
0
I0
kA
-4000
-2000
0
2000
4000
s0
µm





a b

R1 = 4 R2 = 8.25

$\frac{V1a}{MV} = 579.484$ $\frac{\phi 1a}{deg} = 8.303$

$\frac{V1b}{MV} = 1900$ $\frac{\phi 3}{deg} + 360 = 159.073$

$\frac{V3}{MV} = 82.876$ $\frac{\phi 1b}{deg} = 0$

R1 = 4 R2 = 8.25

$\frac{V1a}{MV} = 574.03$ $\frac{\phi 1a}{deg} = -2.664$

$\frac{V1b}{MV} = 1900$ $\frac{\phi 3}{deg} + 360 = 139.383$

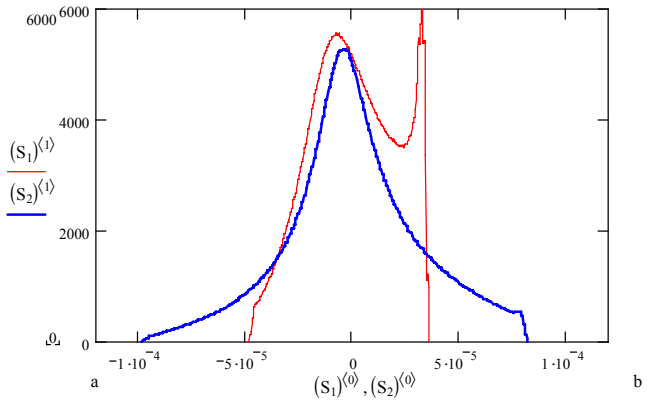
$\frac{V3}{MV} = 101.979$ $\frac{\phi 1b}{deg} = 0$

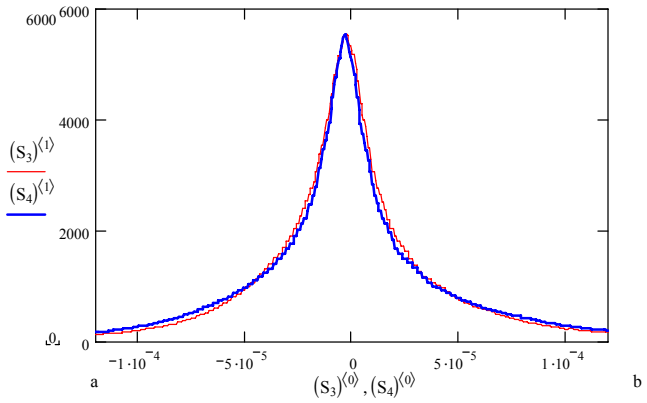
R1 = 4 R2 = 8.25

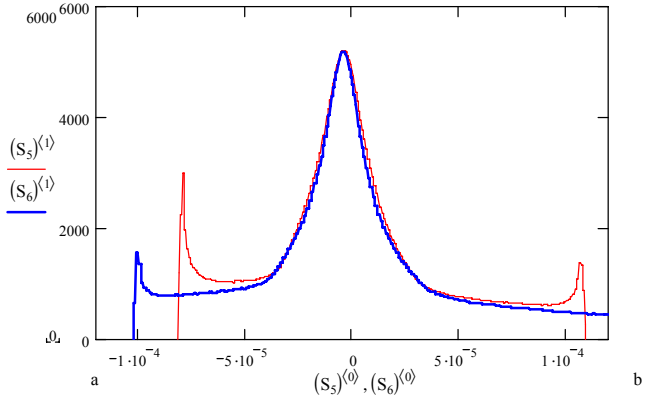
$\frac{V1a}{MV} = 589.559$ $\frac{\phi 1a}{deg} = -13.442$

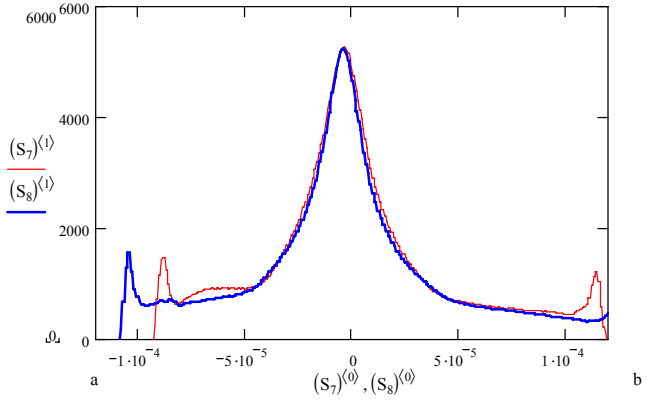
$\frac{V1b}{MV} = 1900$ $\frac{\phi 3}{deg} + 360 = 126.88$

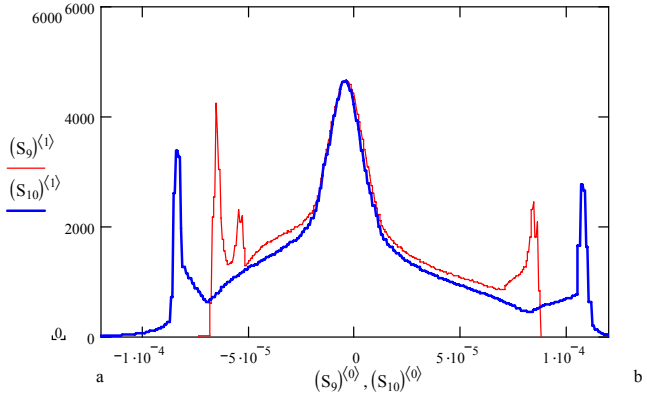
$\frac{V3}{MV} = 128.987$ $\frac{\phi 1b}{deg} = 0$

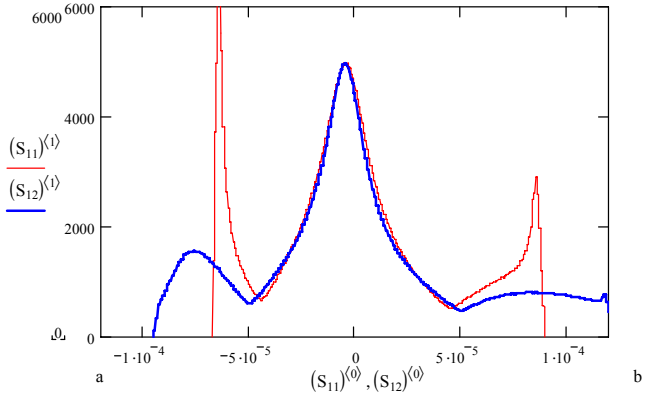

6000
4000
2000
0
$(S_1)^{\langle 1\rangle}$
$(S_2)^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_1)^{\langle 0\rangle}, (S_2)^{\langle 0\rangle}$

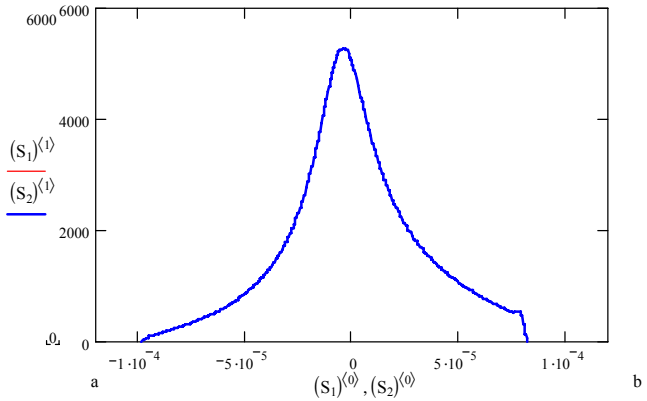

6000
4000
2000
0
$(S_3)^{\langle 1\rangle}$
$(S_4)^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_3)^{\langle 0\rangle}, (S_4)^{\langle 0\rangle}$

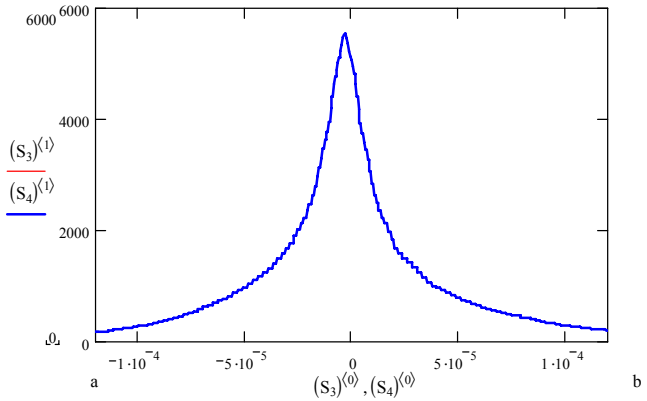

6000
4000
2000
0
$(S_5)^{\langle 1\rangle}$
$(S_6)^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_5)^{\langle 0\rangle}, (S_6)^{\langle 0\rangle}$

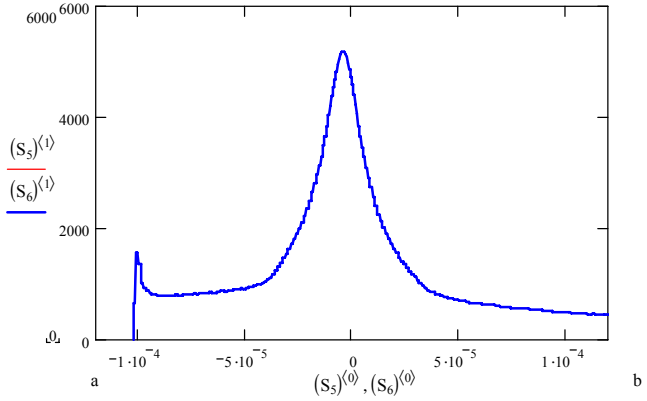

6000
4000
2000
0
$(S_7)^{\langle 1\rangle}$
$(S_8)^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_7)^{\langle 0\rangle}, (S_8)^{\langle 0\rangle}$

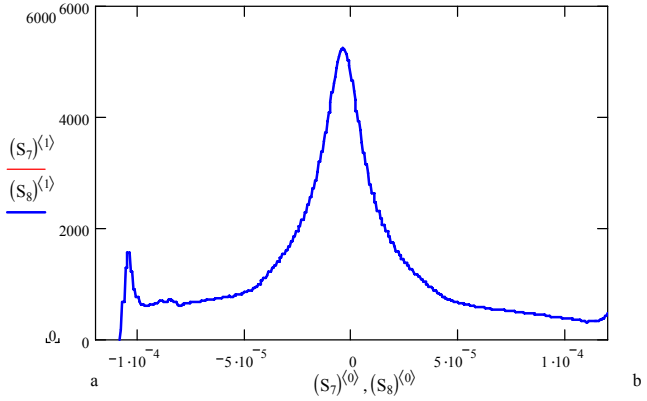

6000
4000
2000
0
$(S_9)^{\langle 1\rangle}$
$(S_{10})^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_9)^{\langle 0\rangle}, (S_{10})^{\langle 0\rangle}$

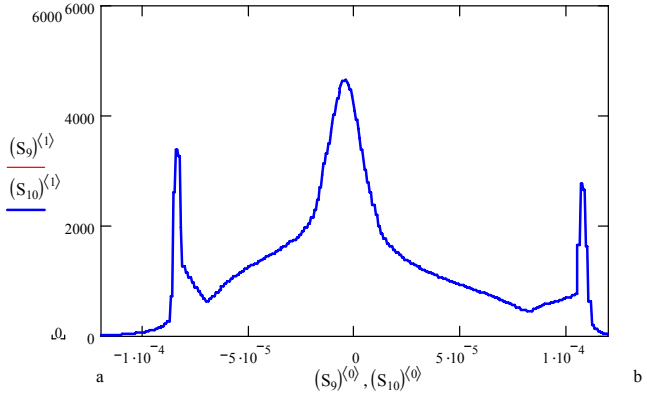

6000
4000
2000
0
$(S_{11})^{\langle 1\rangle}$
$(S_{12})^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_{11})^{\langle 0\rangle}, (S_{12})^{\langle 0\rangle}$

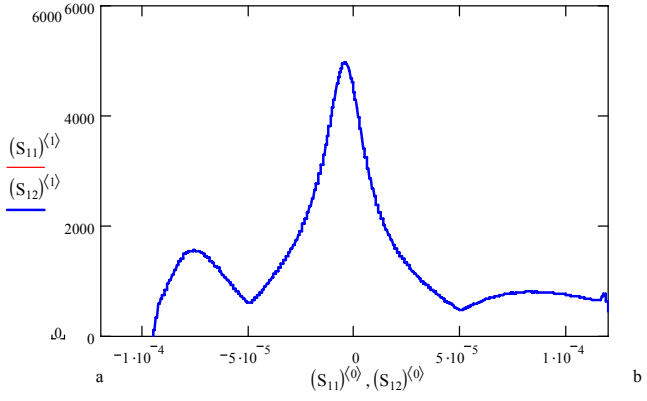

6000
4000
2000
0
$(S_1)^{\langle 1\rangle}$
$(S_2)^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_1)^{\langle 0\rangle}, (S_2)^{\langle 0\rangle}$


6000
4000
2000
0
$(S_3)^{\langle 1\rangle}$
$(S_4)^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_3)^{\langle 0\rangle}, (S_4)^{\langle 0\rangle}$

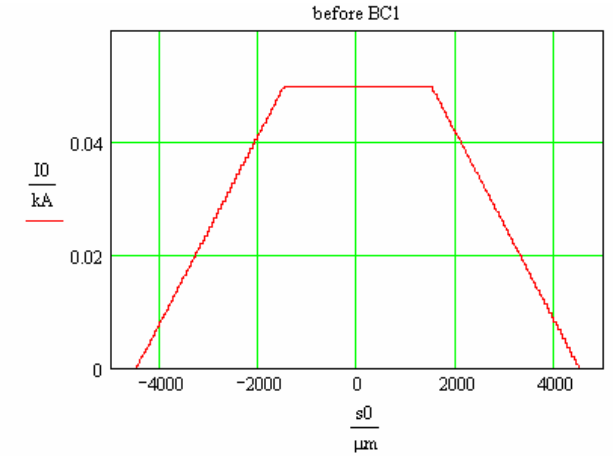

6000
4000
2000
0
$(S_5)^{\langle 1\rangle}$
$(S_6)^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_5)^{\langle 0\rangle}, (S_6)^{\langle 0\rangle}$

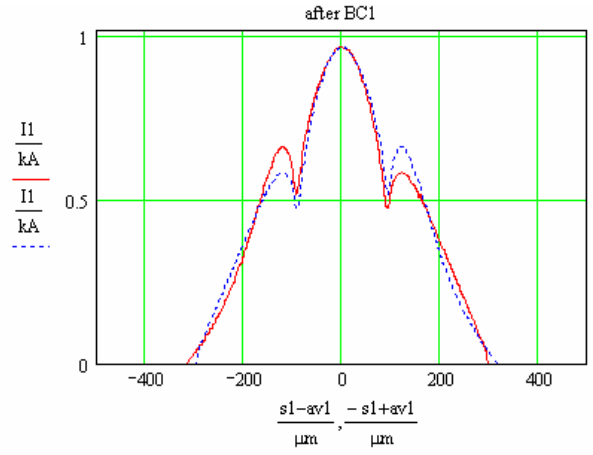

6000
4000
2000
0
$(S_7)^{\langle 1\rangle}$
$(S_8)^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_7)^{\langle 0\rangle}, (S_8)^{\langle 0\rangle}$

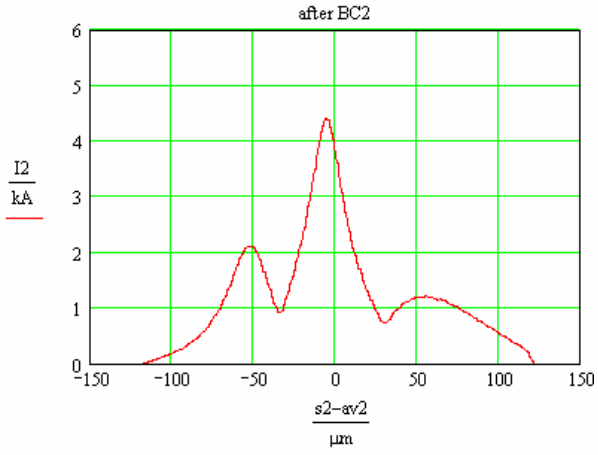

6000
4000
2000
0
$(S_9)^{\langle 1\rangle}$
$(S_{10})^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_9)^{\langle 0\rangle}, (S_{10})^{\langle 0\rangle}$

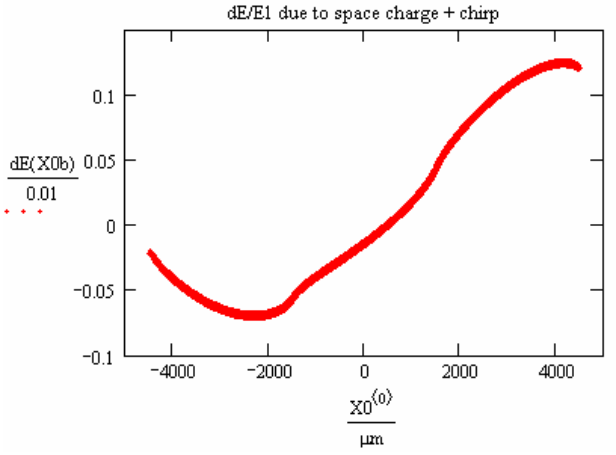

6000
4000
2000
0
$(S_{11})^{\langle 1\rangle}$
$(S_{12})^{\langle 1\rangle}$
$-1\cdot10^{-4}$
$-5\cdot10^{-5}$
0
$5\cdot10^{-5}$
$1\cdot10^{-4}$
a
b
$(S_{11})^{\langle 0\rangle}, (S_{12})^{\langle 0\rangle}$

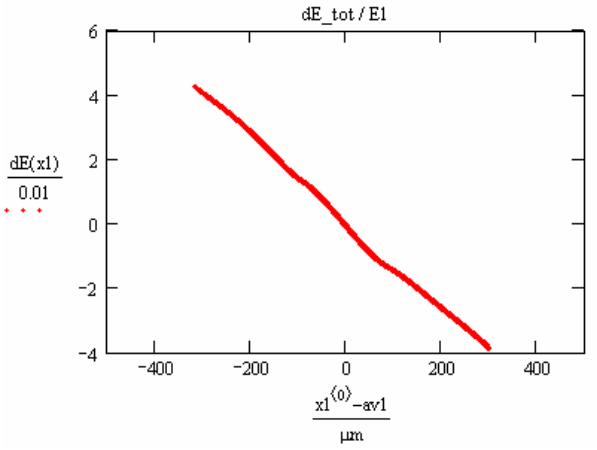
shape 14

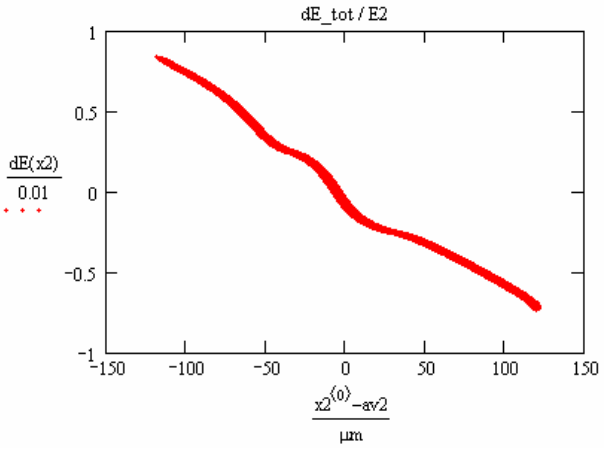












R1 = 4

R2 = 8.25

$\frac{V1a}{MV}$ = 574.03 -0.31

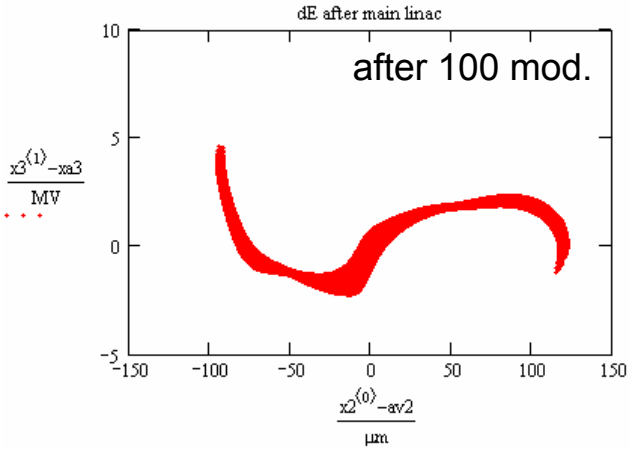
$\frac{\phi 1a}{deg}$ = −2.664 +0.032

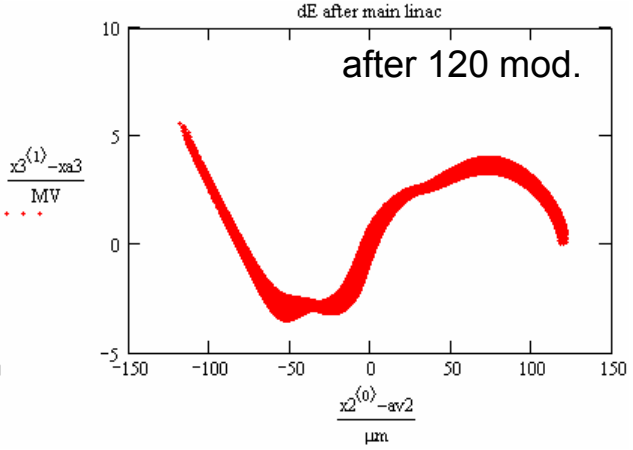
$\frac{V1b}{MV}$ = 1900 -35

$\frac{\phi 3}{deg}$ + 360 = 139.383-0.105

$\frac{V3}{MV}$ = 101.979 +0.115

$\frac{\phi 1b}{deg}$ = 0+3.5





Error Sensitivity

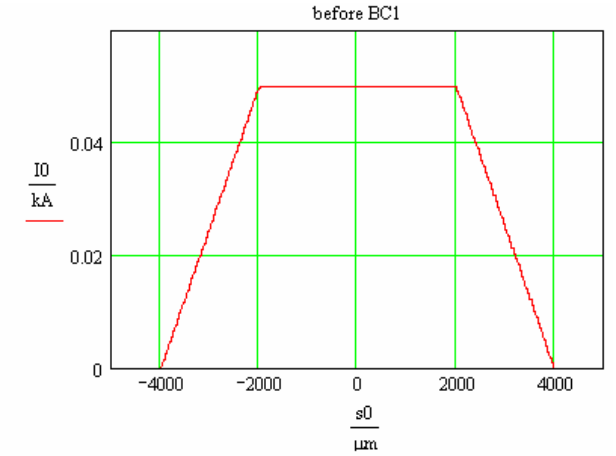
$R1 = 4$ $R2 = 8.25$

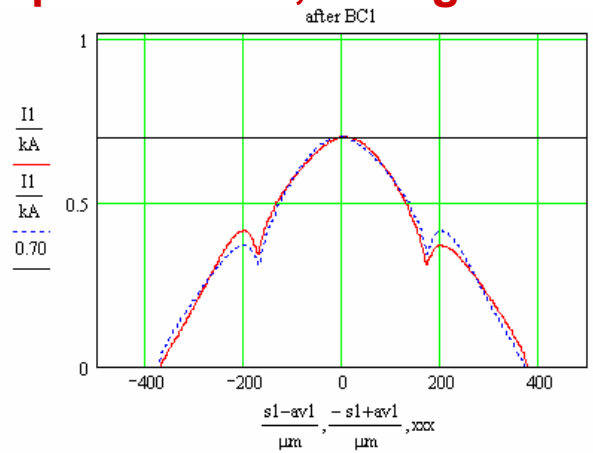
$$\frac{V1a}{MV} = 574.03 \text{ -0.31} \qquad \frac{\phi 1a}{deg} = -2.664 \text{ +0.032}$$

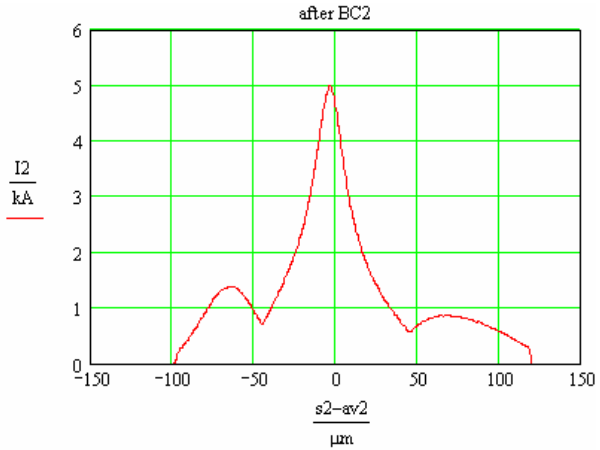
$$\frac{V1b}{MV} = 1900 \text{ -35} \qquad \frac{\phi 3}{deg} + 360 = 139.383 \text{ -0.105}$$

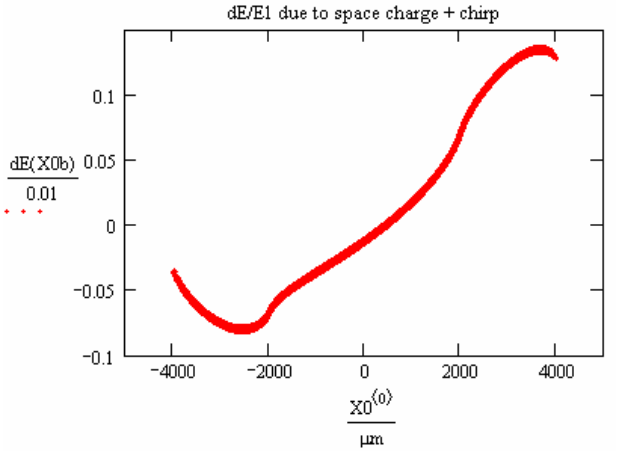
$$\frac{V3}{MV} = 101.979 \text{ +0.115} \qquad \frac{\phi 1b}{deg} = 0 \text{ +3.5}$$

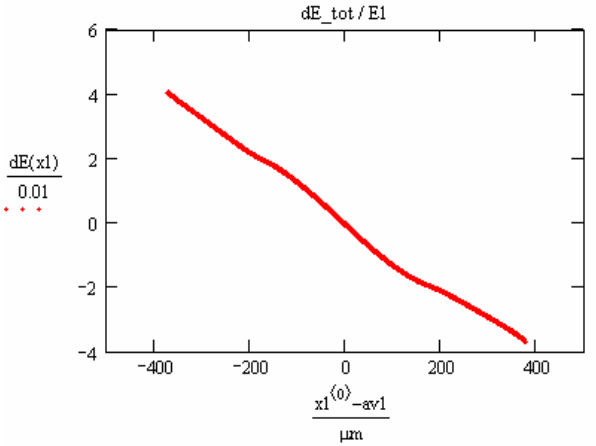
setup 2: 2.4GeV; 20deg in L2

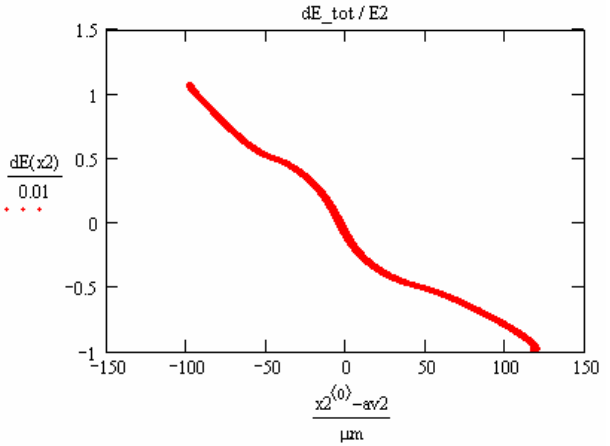












x1=5.5 x2=8

R1 = 4.2

R2 = 8

$\frac{V1a}{MV} = 582.708$ -0.37

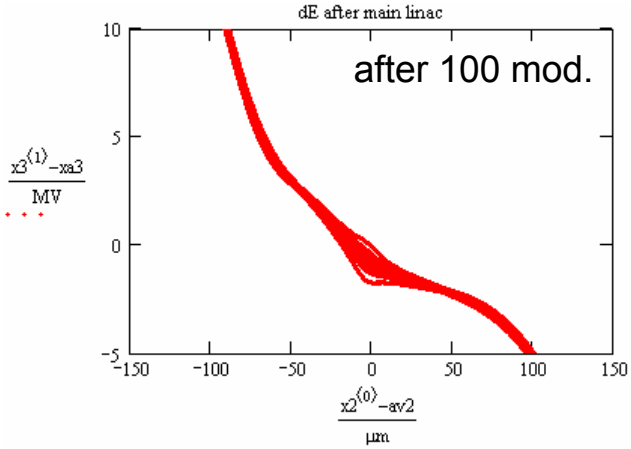
$\frac{\phi 1a}{deg} = -8.422$ +0.0465

$\frac{V1b}{MV} = 2019.384$ -25

$\frac{\phi 3}{deg} + 360 = 131.67$ -0.145

$\frac{V3}{MV} = 120.969$ +0.14

$\frac{\phi 1b}{deg} = 19.8$ +1.05



C-->700A-->5kA

R51a=-93.6 (R=4.2m)
R51b=-25.6 (R=8m)

$R1 = 4.2$ $R2 = 8$

$\frac{V1a}{MV} = 582.708^{-0.37}$ $\frac{\phi 1a}{deg} = -8.422^{+0.0465}$

$\frac{V1b}{MV} = 2019.384^{-25}$ $\frac{\phi 3}{deg} + 360 = 131.67^{-0.145}$

$\frac{V3}{MV} = 120.969^{+0.14}$ $\frac{\phi 1b}{deg} = 19.8^{+1.05}$

Error Sensitivity

a) 1-stage compression

$$C_1(s,x) = \frac{1}{1 - T_1'(E_1(s,x)) \cdot E_1'(s,x)}$$

$$T_1(E) = const + r_{56}\left(\frac{E}{E_{10}}\right) + t_{566}\left(\frac{E}{E_{10}}\right)^2 + O\left(E^3\right)$$

length of trajectory in BC1

E_{10} energy @ BC1

$$E_1(s,x_i) = \Lambda + V_i \cos\left(k_i s + x_i + \varphi_i\right) + \Lambda$$

rf voltage

sensitivity

$$S_1^{xi} = \frac{1}{C_1}\frac{\partial C_1}{\partial x_i} = -\frac{V_i}{E_{10}}\frac{1}{C_1}\left(2\frac{t_{566}}{r_{56}}\left(1 - \frac{1}{C_1}\right)\sin\phi_i + r_{56}k_i\cos\phi_i\right)$$

e.g.: $r_{56} = 0.1\,\mathrm{m}$

$$k_i = \frac{2\pi}{0.23\,\mathrm{m}}$$

$$C_1 = 20$$

$$S_1^{xi} \approx \frac{V_i}{E_{10}}\frac{1}{C_1}\left(2.85\sin\phi_i + 2.73\cos\phi_i\right)$$

b) 2-stage compression

$$C = \frac{1}{\left(1 - T_1' \cdot E_1'\right)\left(1 - T_2' \cdot E_2'\right) - T_2' \cdot E_1'}$$

$$T_2(E) = const + r_{56}^{(2)}\left(\frac{E}{E_{20}}\right) + t_{566}^{(2)}\left(\frac{E}{E_{20}}\right)^2 + O\left(E^3\right)$$

length of trajectory in BC2

E_{20} energy @ BC2

$E_2(s) =$ rf voltage between BC1 and BC2

sensitivity to errors in stage1:

$$S^{xi} = \frac{1}{C}\frac{\partial C}{\partial x_i} = S_1^{xi}\frac{C}{C_1\widetilde{C}_2} - \frac{V_i}{E_{20}}k_i r_{56}^{(2)}\cos(\varphi_i)C + F\left(T_2'', E_2''\right)$$

$$\widetilde{C}_2 = \frac{1}{1 - T_2' \cdot E_2'}$$ compression in BC2 due to chirp from E_2

$$S^{xi} \approx -\frac{V_i}{E_{10}}\frac{C}{\widetilde{C}_2}\left\{2\frac{t_{566}^{(1)}}{r_{56}^{(1)}}\left(1 - \frac{1}{C_1}\right)\sin\phi_i + \left(r_{56}^{(1)} + r_{56}^{(2)}\frac{E_{10}}{E_{20}}\widetilde{C}_2\right)k_i\cos\phi_i\right\}$$