

Bunch Compression Stability and RF parameters

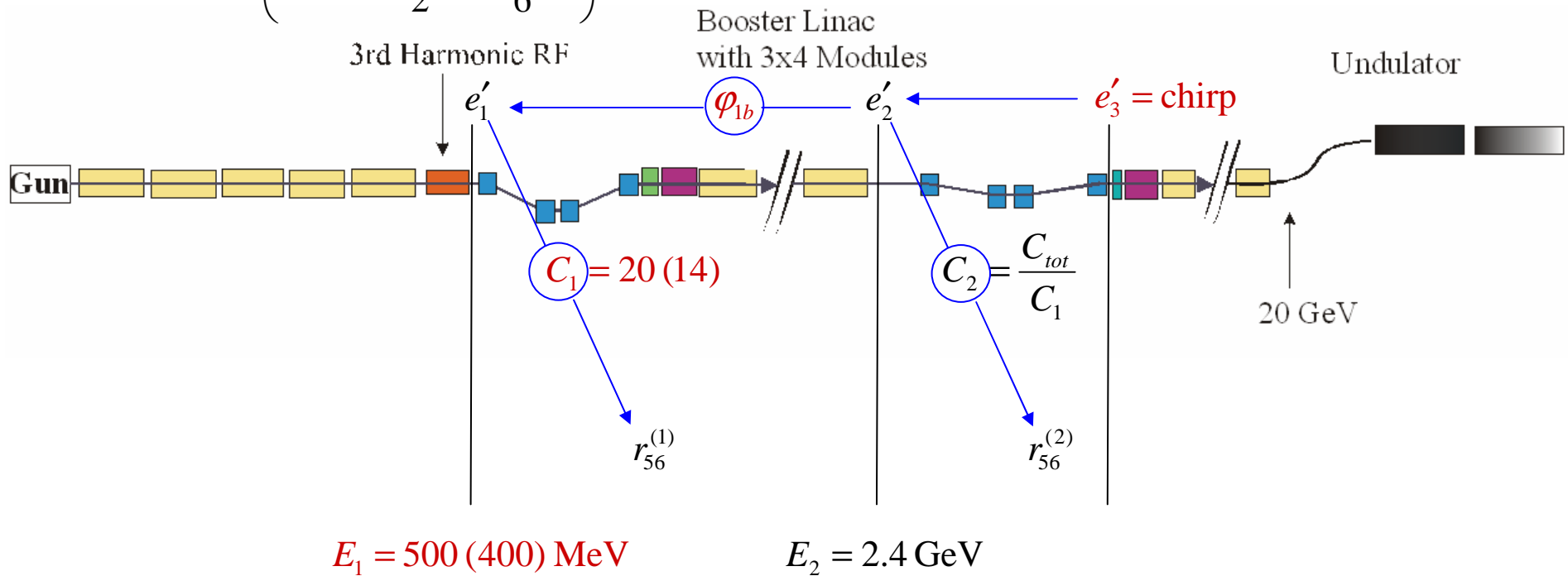
degrees of freedom

$q = 1 \text{ nC}$
 $\hat{I} = 50 \text{ A}$

$C_{tot} = 100$

$q = 1 \text{ nC}$
 $\hat{I} = 5 \text{ kA}$

$$V(t = -s/c) = V_0 \left(1 + se'_1 + \frac{s^2}{2} e''_1 + \frac{s^3}{6} e'''_1 \right) + O(s^4)$$

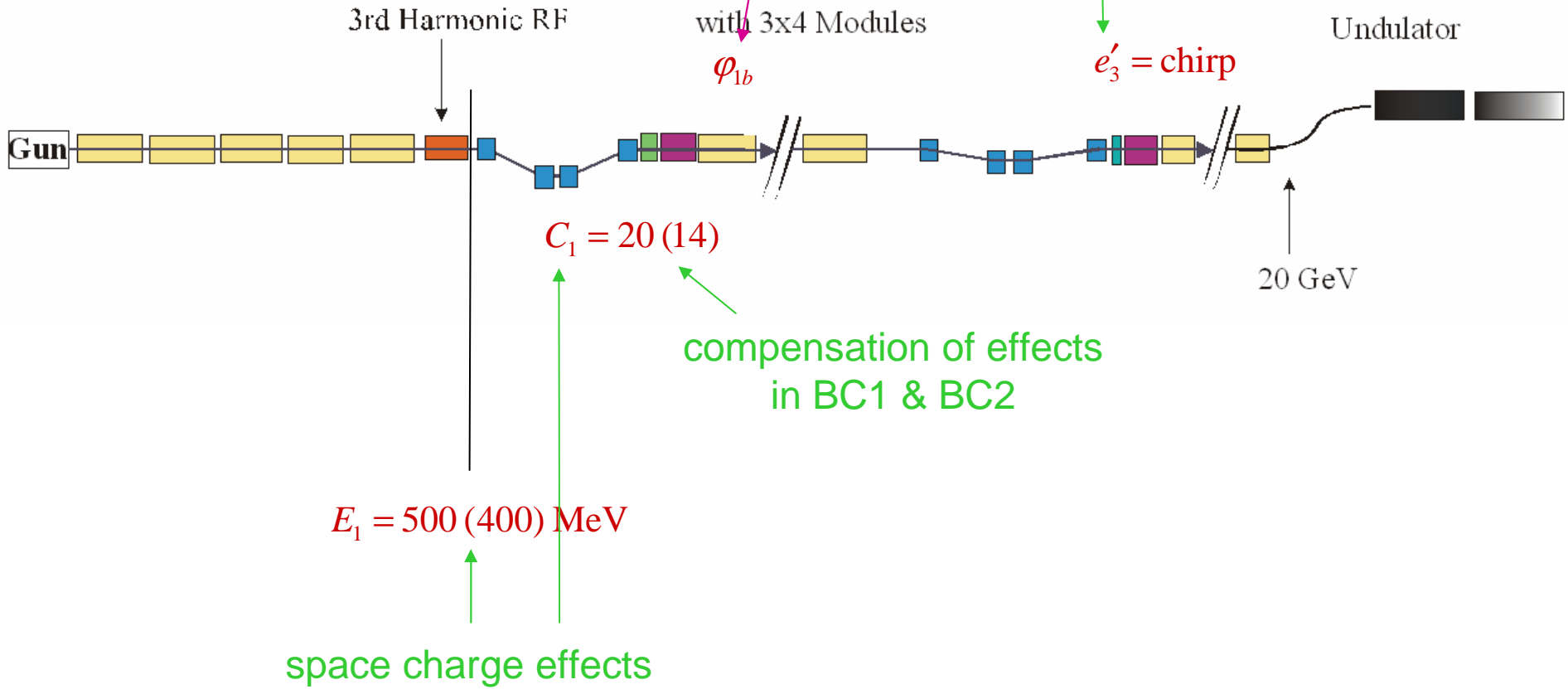


criteria & limitations

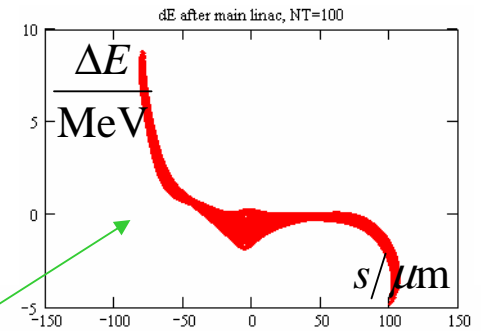
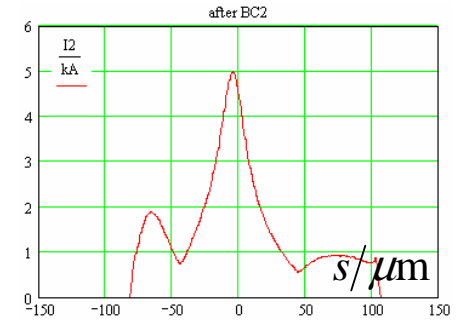
$$V(t = -s/c) = V_0 \left(1 + se'_1 + \frac{s^2}{2} e''_1 + \frac{s^3}{6} e'''_1 \right) + O(s^4)$$

available gradient

compensation of linac wake



setup 1

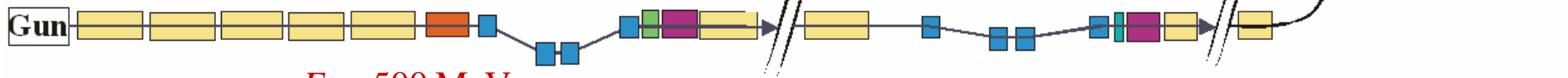


free parameter

$$e_1'''$$

$$\varphi_{1b} = 0$$

$$e_3' = 0.5 \frac{\text{MeV}}{\mu\text{m}} \frac{1}{E_2}$$



$$E_1 = 500 \text{ MeV}$$

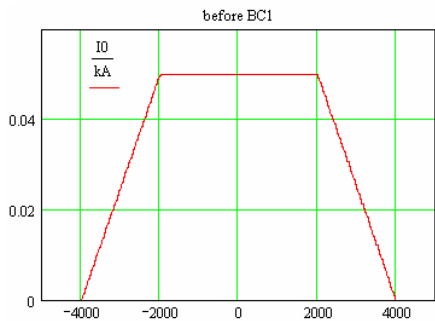
$$C_1 = 20$$

$$r_{56}^{(1)} = 84.4 \text{ mm}$$

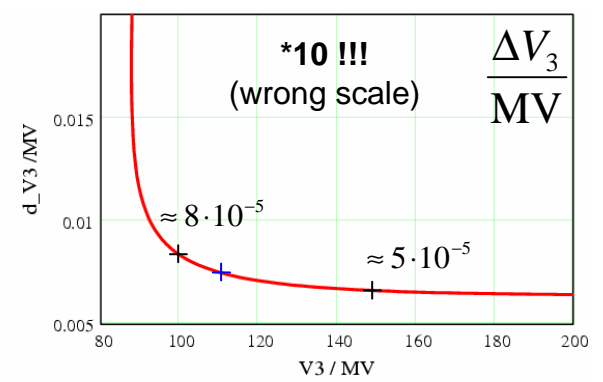
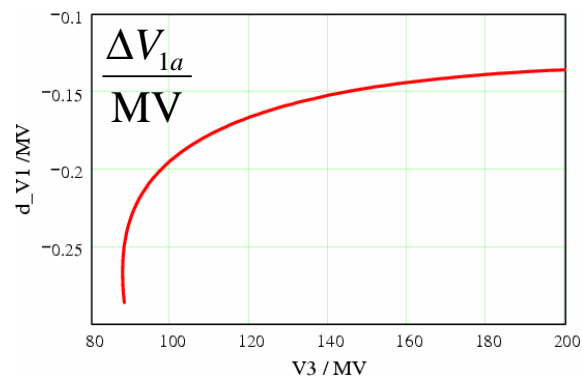
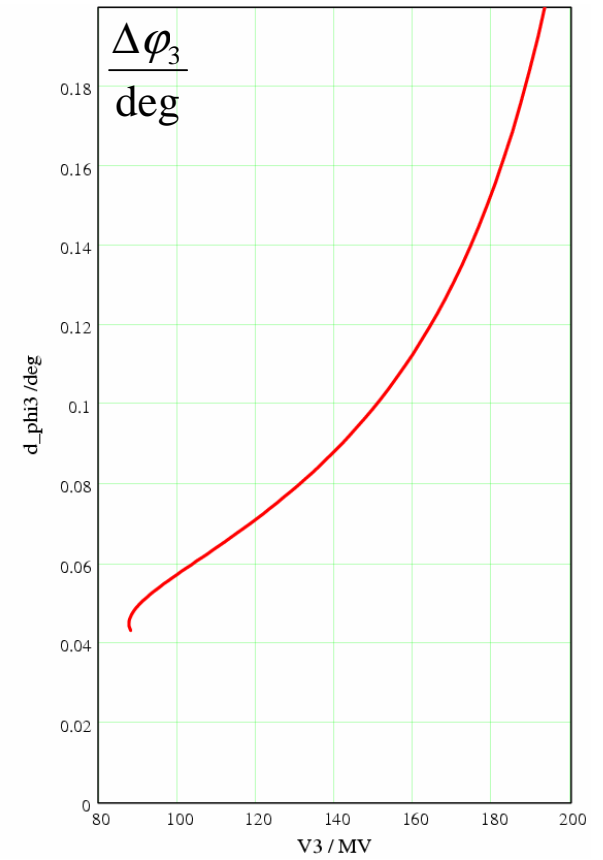
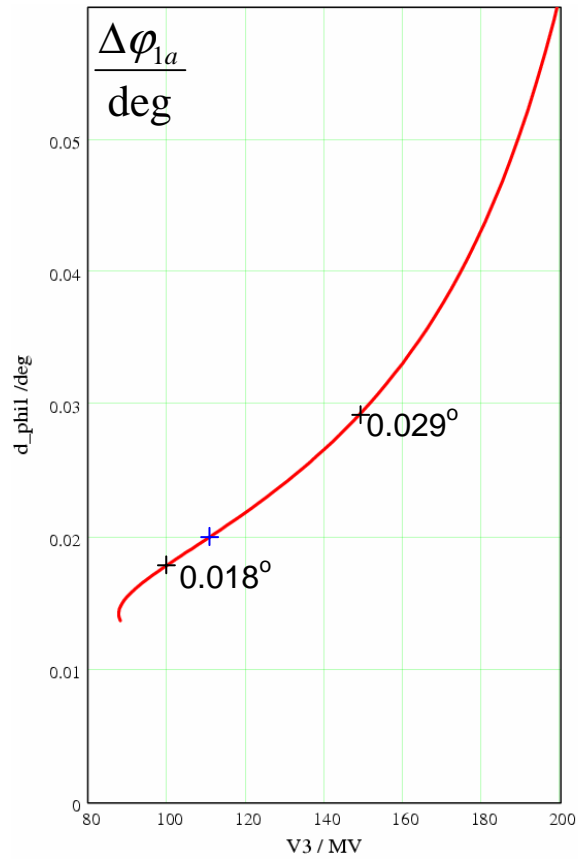
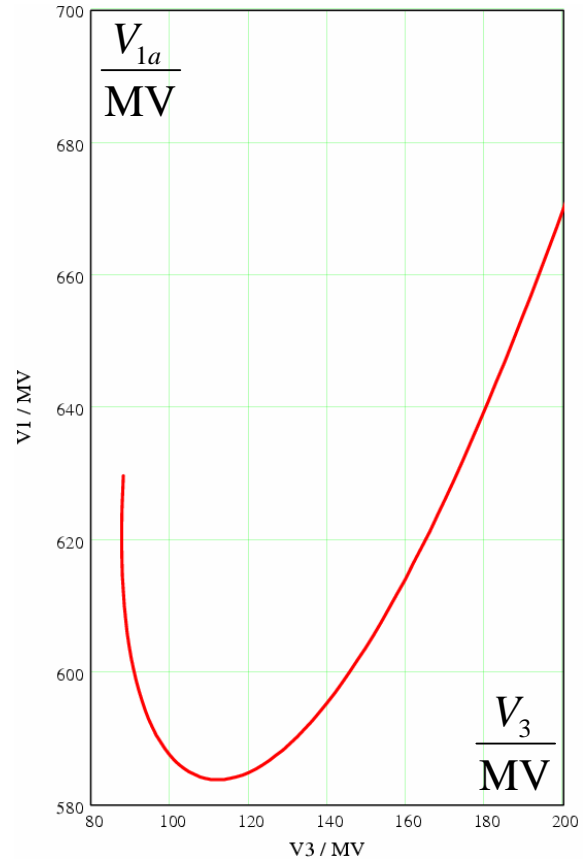
$$C_2 = 5$$

$$r_{56}^{(2)} = 19.2 \text{ mm}$$

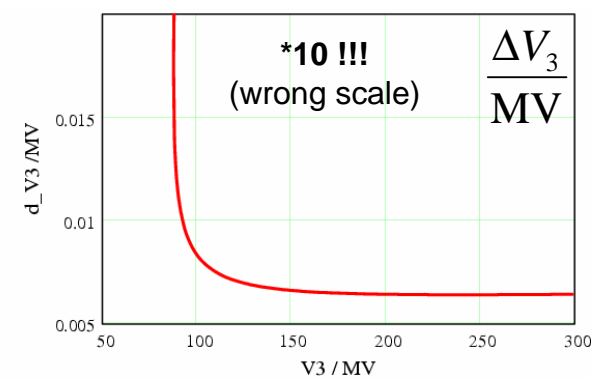
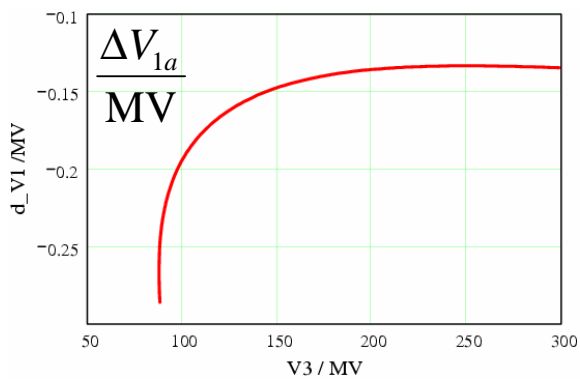
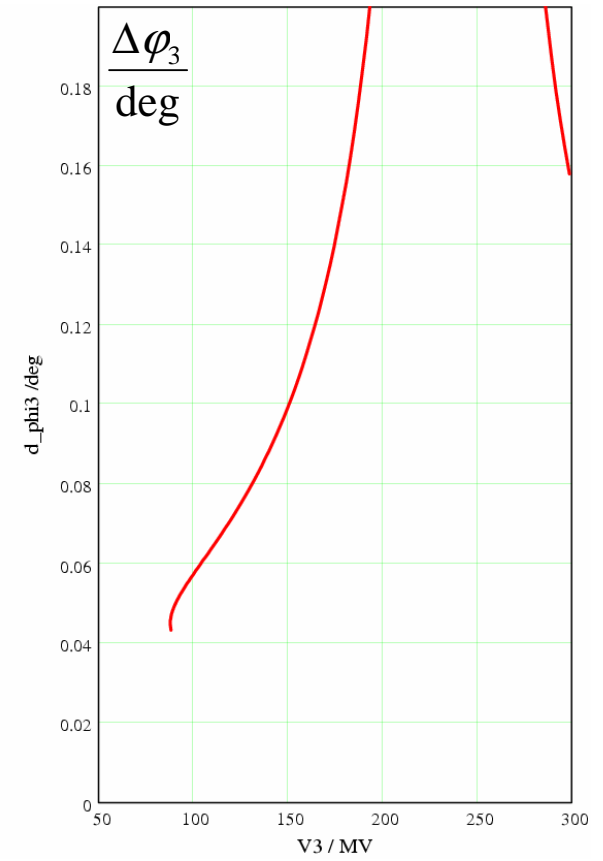
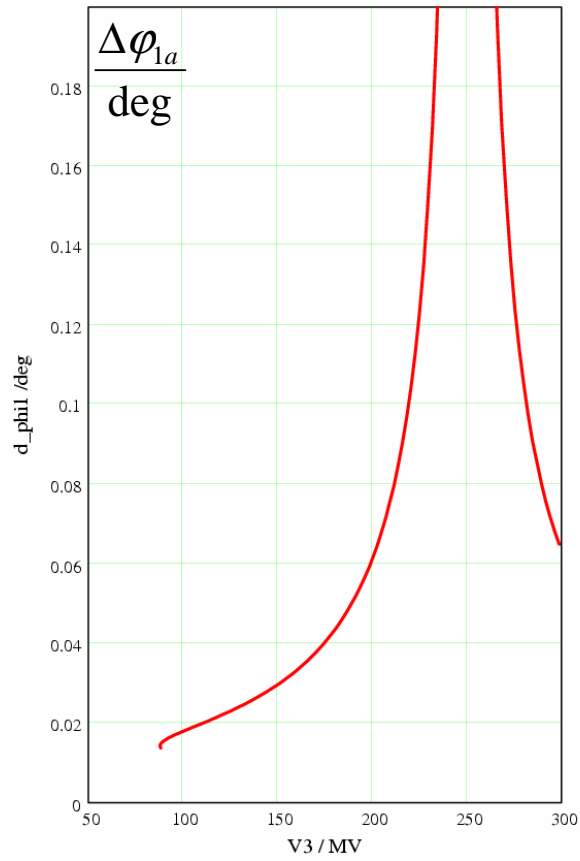
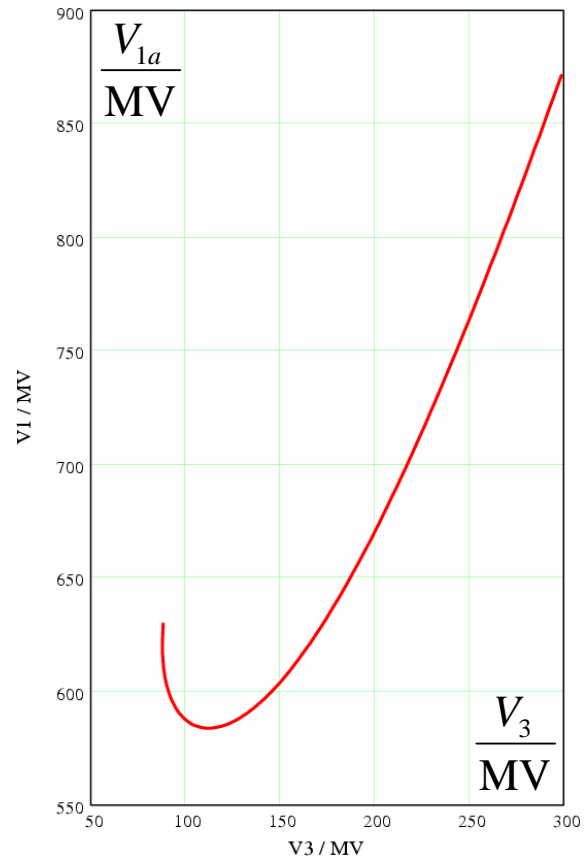
optimal compensation of effects in BC1 & BC2



sensitivity: $\Delta I/I = 0.1$



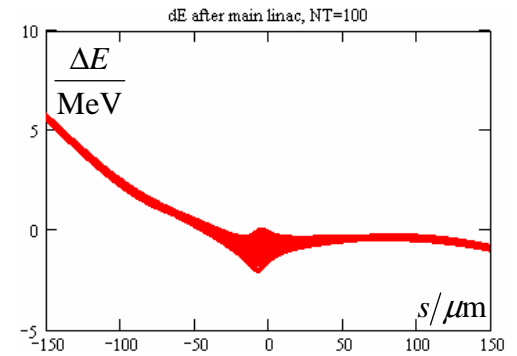
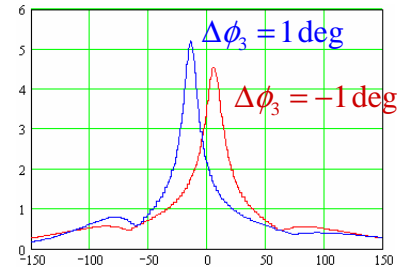
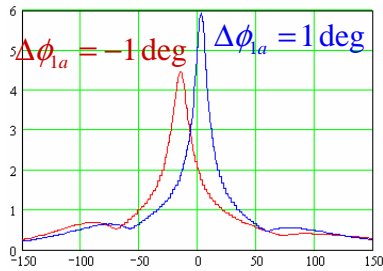
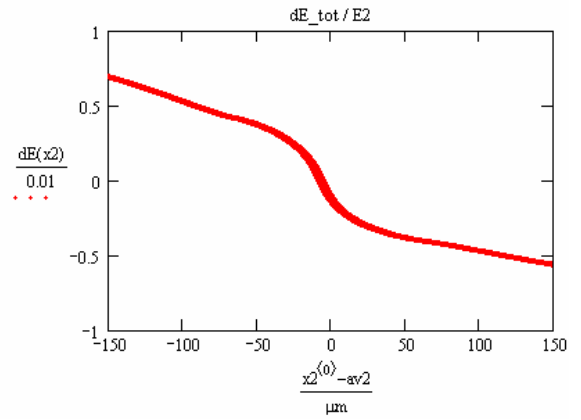
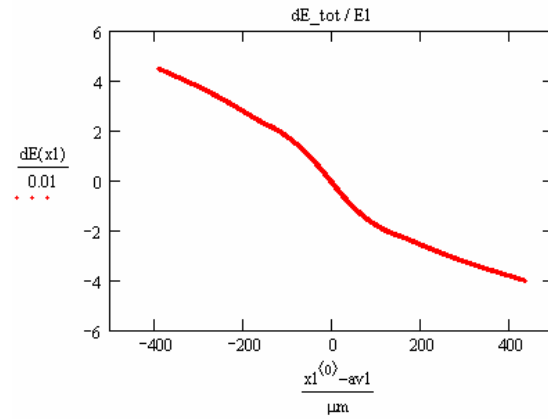
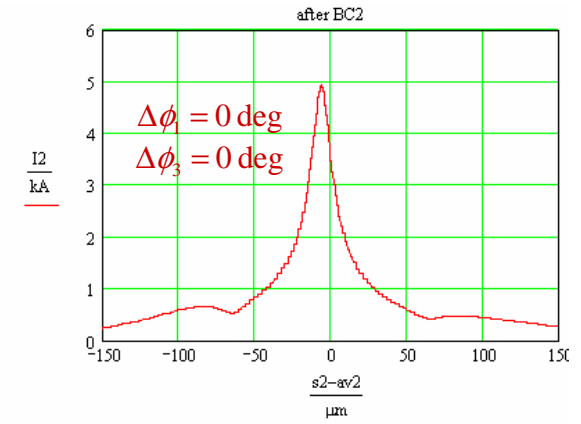
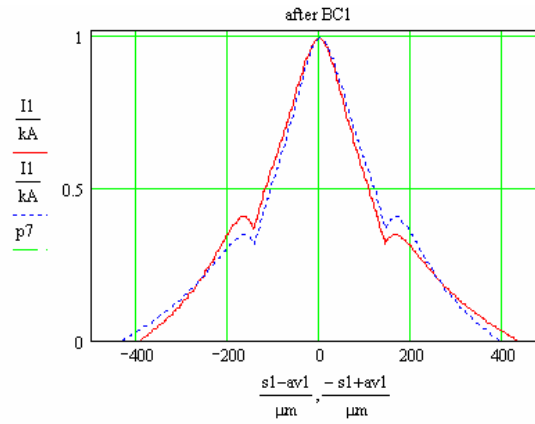
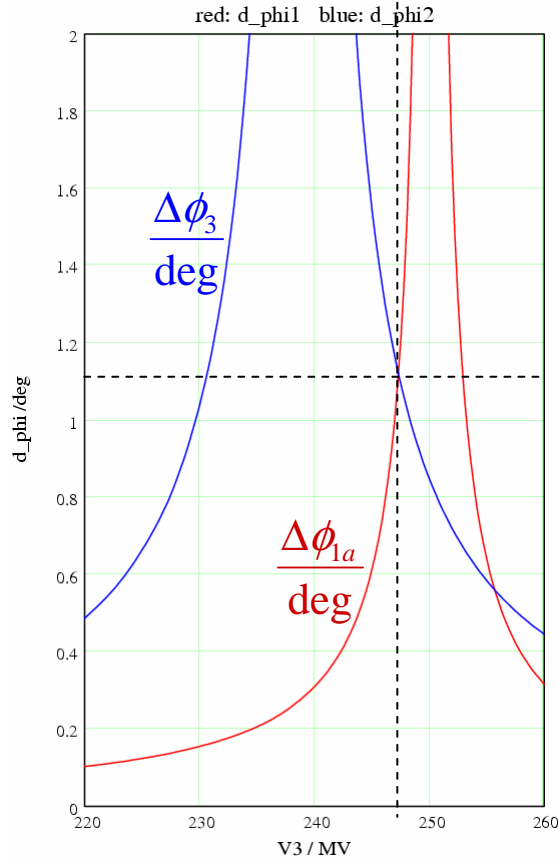
sensitivity: $\Delta I/I = 0.1$



$$V_3 = 247.3 \text{ MV}$$

$$V_{1a} = 758 \text{ MV}$$

minimal sensitivity on phase:



error sensitivity of compression: (example: 1 stage compr.)

$$s_2 = s_1 - D(e)$$

D = length of detour
 e = energy

$$\frac{1}{C} = \frac{\partial s_2}{\partial s_1} = 1 - D'(e) \frac{\partial e}{\partial s_1}$$

C = compression

$$e = e(s_1, x)$$

x = error parameter
e.g.: $e(s_1, x) = a \cos(ks_1 + \varphi_a + x) + b \cos(3ks_1 + \varphi_b)$

$$\frac{\partial C}{\partial x} = -C^2 \frac{\partial}{\partial x} \frac{1}{C} = C^2 \left(D'' \frac{\partial e}{\partial x} \frac{\partial e}{\partial s_1} + D' \frac{\partial e'}{\partial x} \right) = C^2 \left(\left(1 - \frac{1}{C} \right) \frac{D''}{D'} \frac{\partial e}{\partial x} + D' \frac{\partial e'}{\partial x} \right)$$

sensitivity of value sensitivity of slope

e.g. phase sensitivity to fundamental mode: $C = 20$ $\lambda = 0.23$ cm

$$r_{56} = -0.1 \text{ m} \quad t_{566} = -1.5 r_{56}$$

$$\frac{\partial C}{\partial x} = -400 \left(2.85 \frac{\partial e}{\partial x} + 2.732 \frac{1}{k} \frac{\partial e'}{\partial x} \right)$$

e.g. phase sensitivity to fundamental mode:

$$C = 20 \quad \lambda = 0.23 \text{ cm}$$

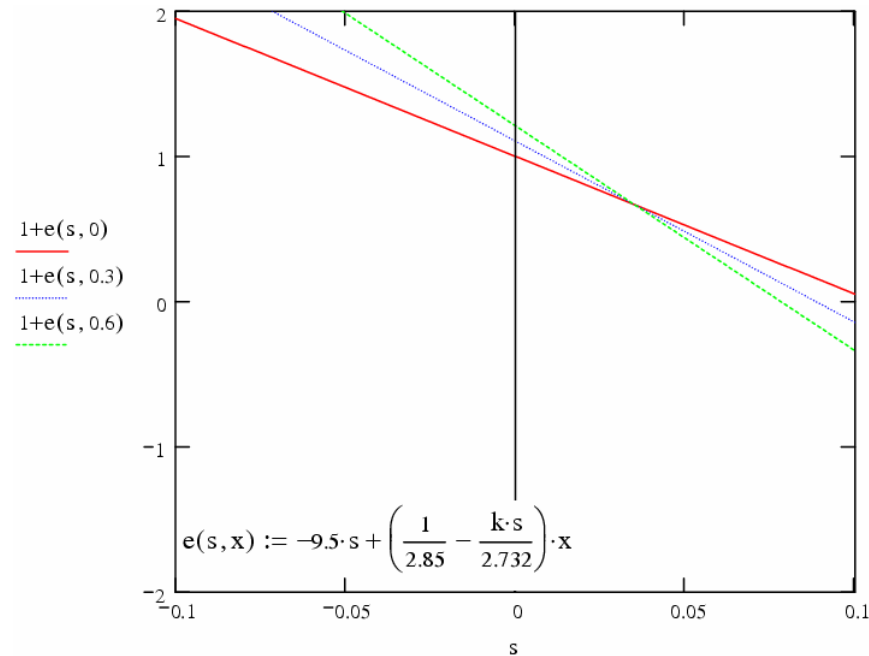
$$r_{56} = -0.1 \text{ m} \quad t_{566} = -1.5r_{56}$$

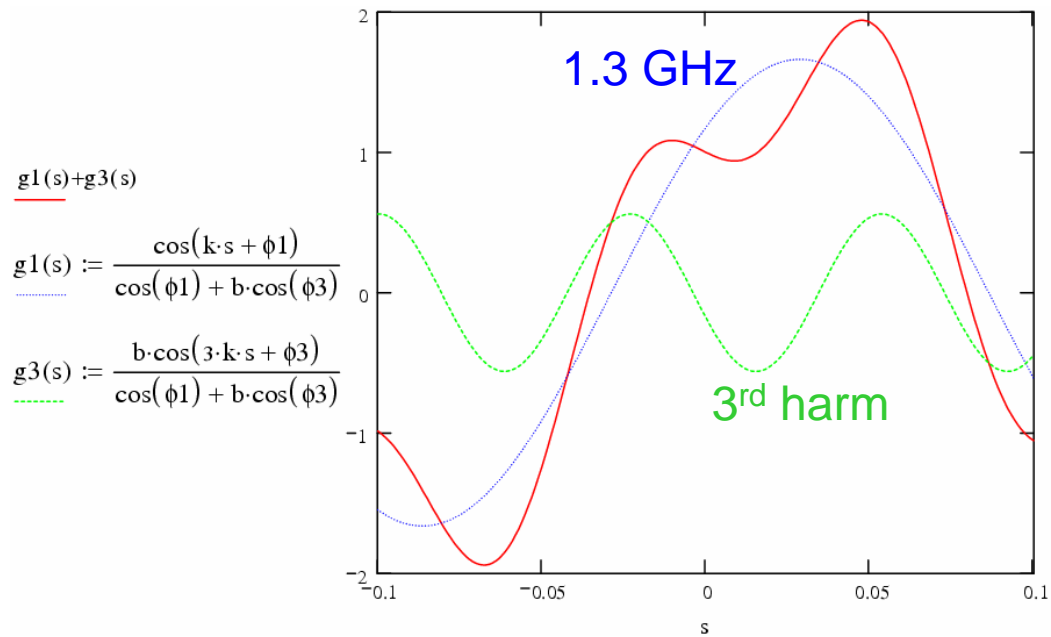
$$\frac{\partial C}{\partial x} = -400 \left(2.85 \frac{\partial e}{\partial x} + 2.732 \frac{1}{k} \frac{\partial e'}{\partial x} \right)$$

$$\frac{\partial e}{\partial s_1} = \left(1 - \frac{1}{C} \right) \frac{1}{r_{56}} = -\frac{9.5}{\text{m}}$$

perfect compensation if:

$$e(s_1, x) = -\frac{9.5s_1}{\text{m}} + \left(\frac{1}{2.85} - \frac{ks_1}{2.732} \right) \cdot x \cdot \text{const}$$

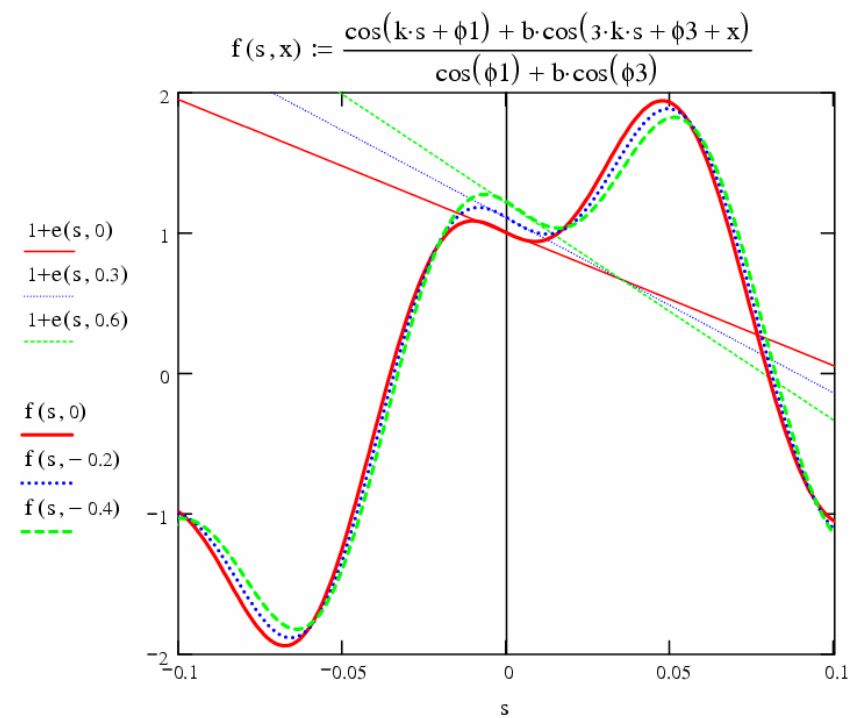
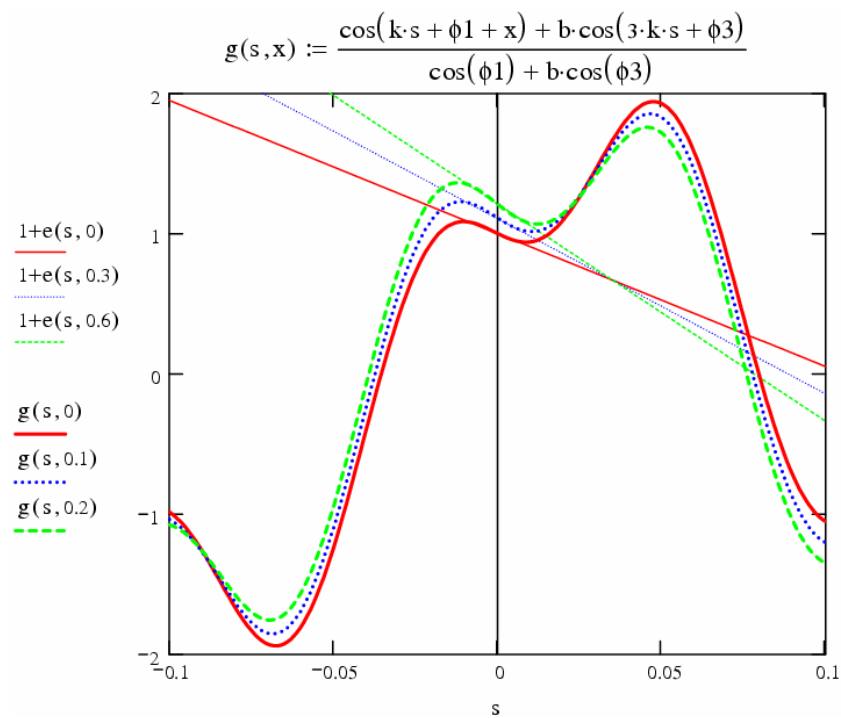




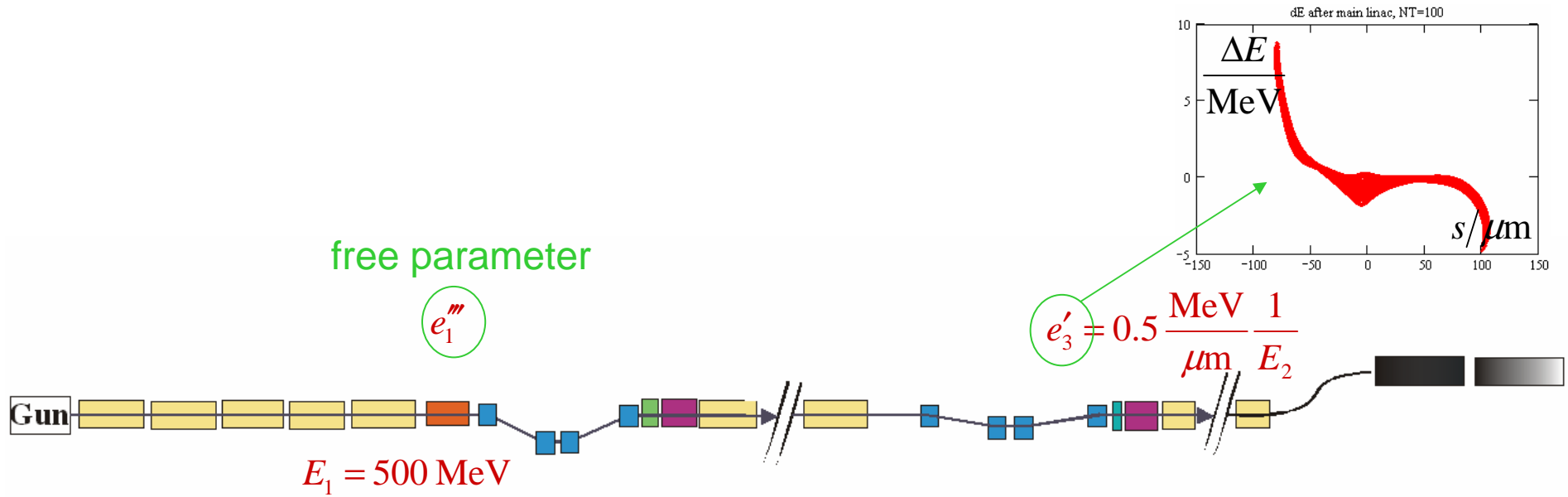
$$\phi_1 = -44.9^\circ$$

$$\phi_2 = 108.4^\circ$$

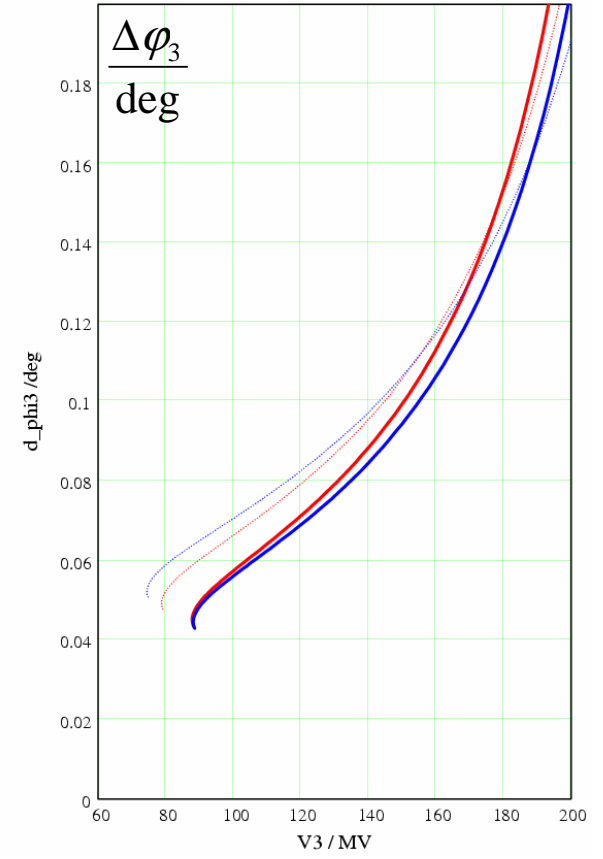
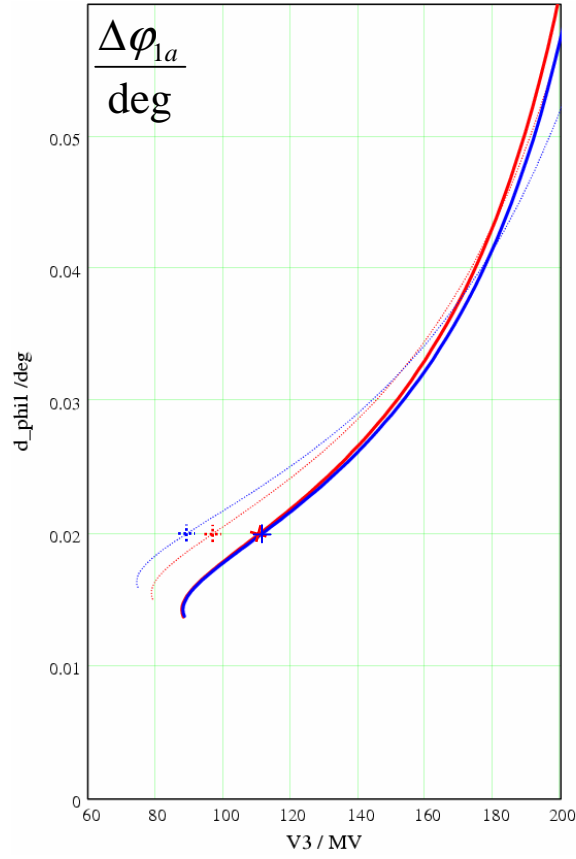
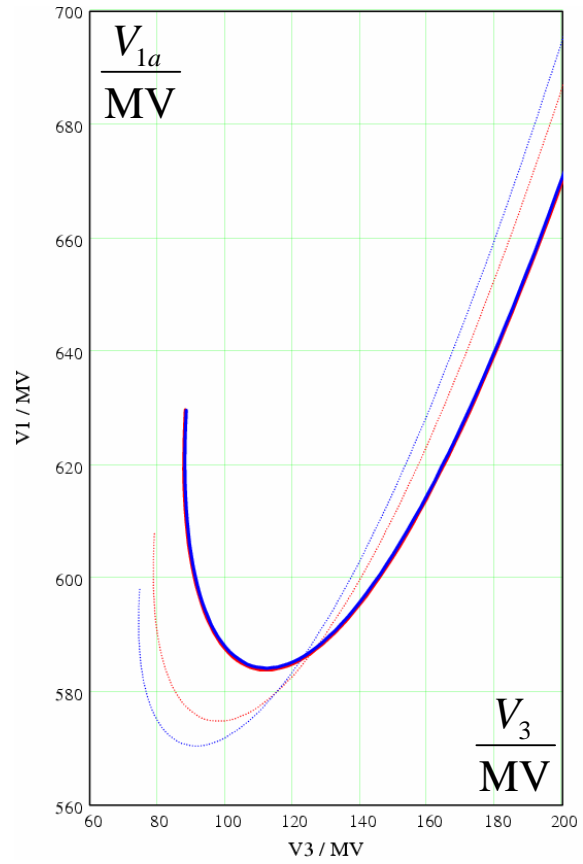
$$b = 0.337$$



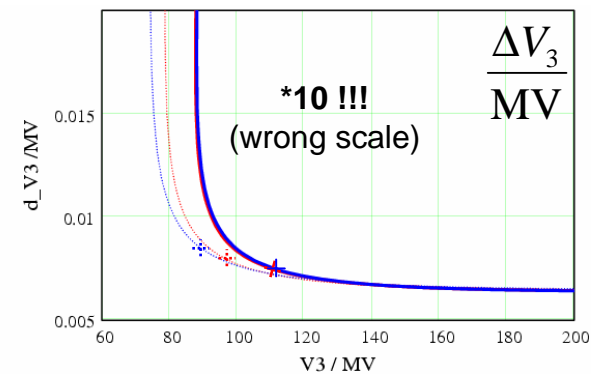
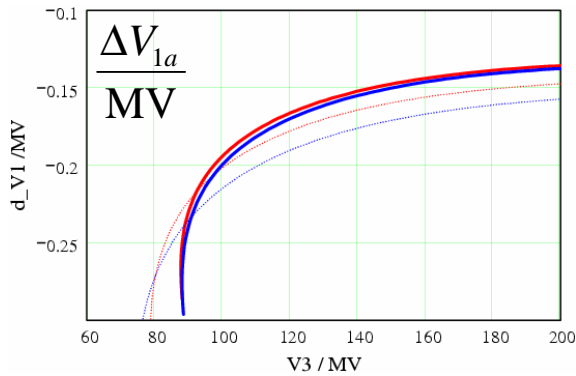
setups 1, 2, 3 and 4

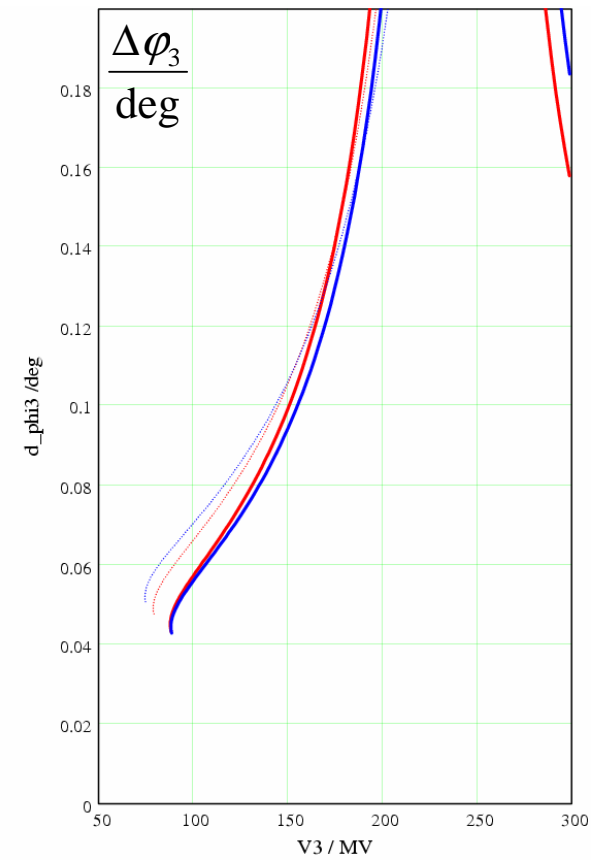
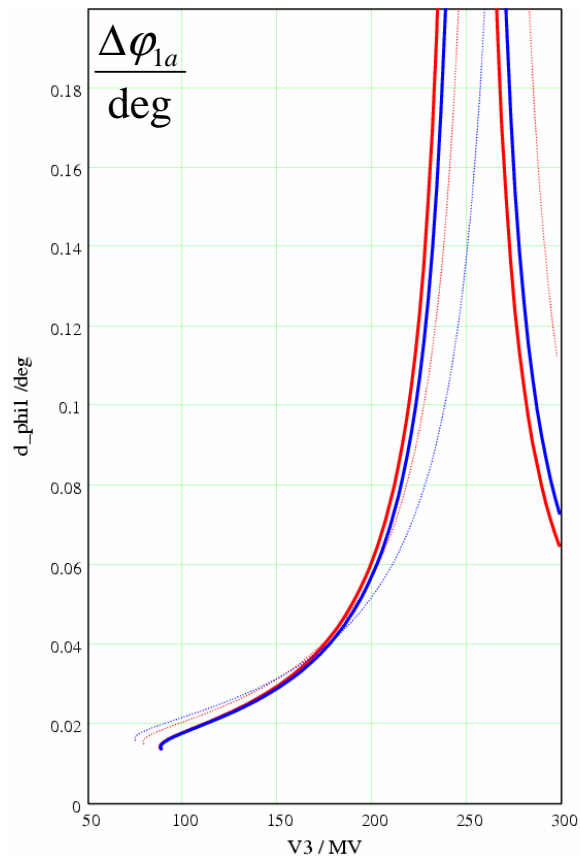
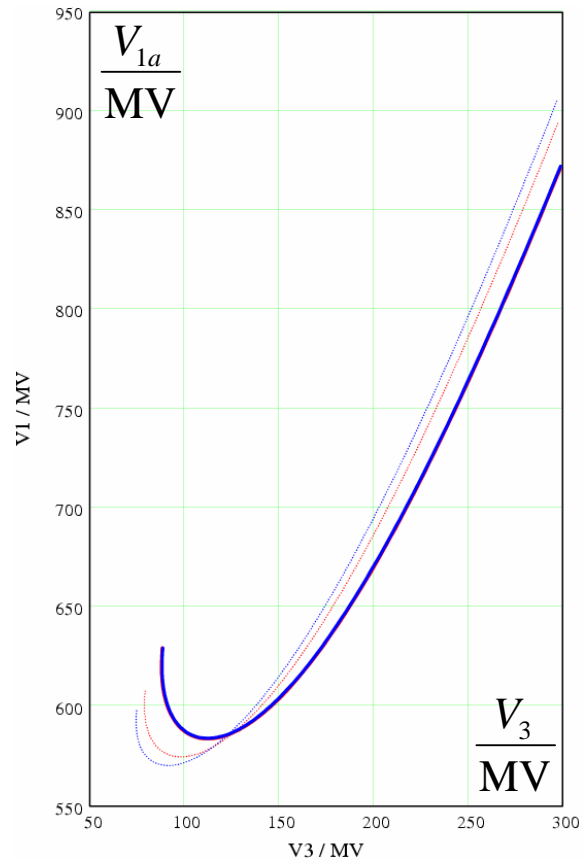


C_1	$\varphi_{1b} / \text{deg}$	\rightarrow	$r_{56,1} / \text{mm}$	$r_{56,2} / \text{mm}$
20	0		84.4	19.2
20	20		101.4	19.0
14	0		82.3	29.0
14	20		109.3	29.3

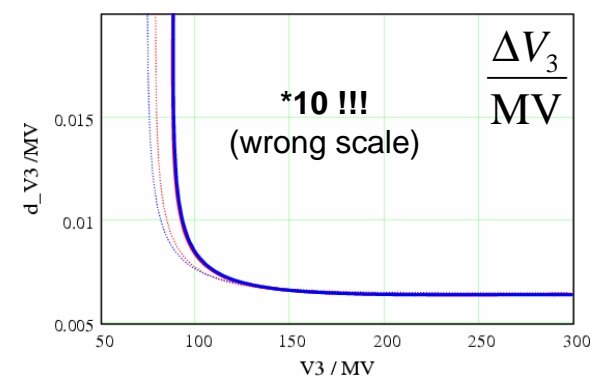
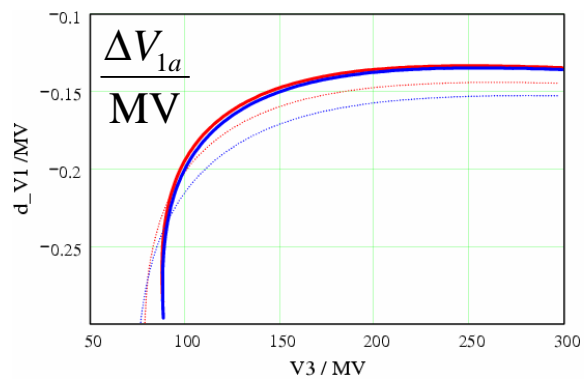


C_1	$\varphi_{1b} / \text{deg}$
20	0
20	20
14	0
14	20

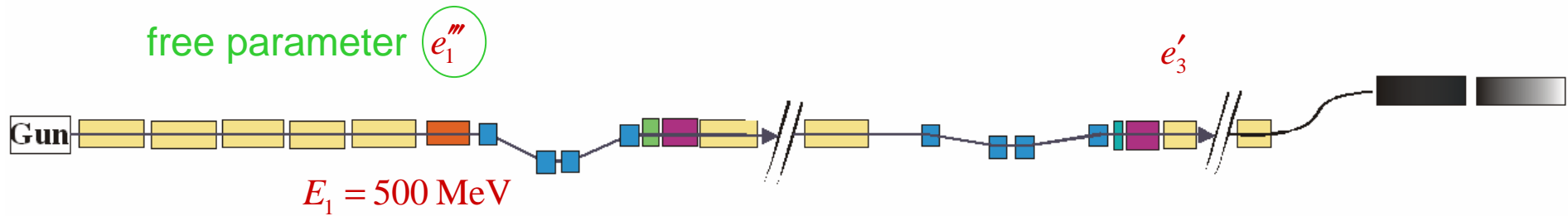




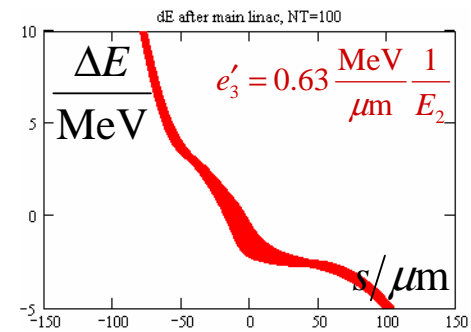
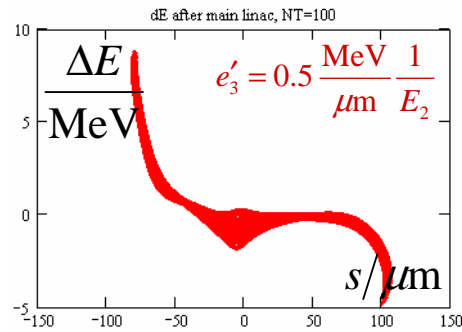
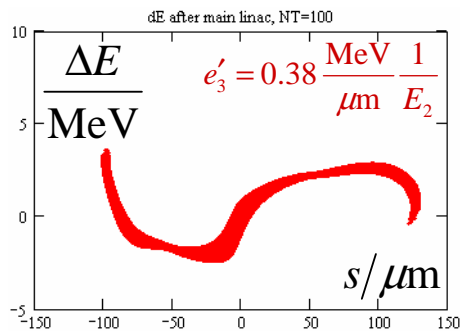
C_1	ϕ_{1b} / deg
20	0
20	20
14	0
14	20

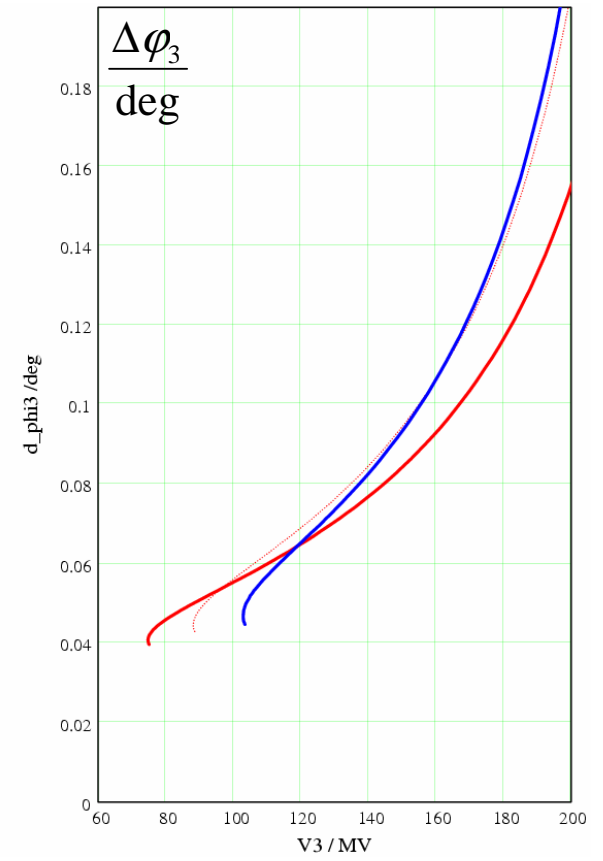
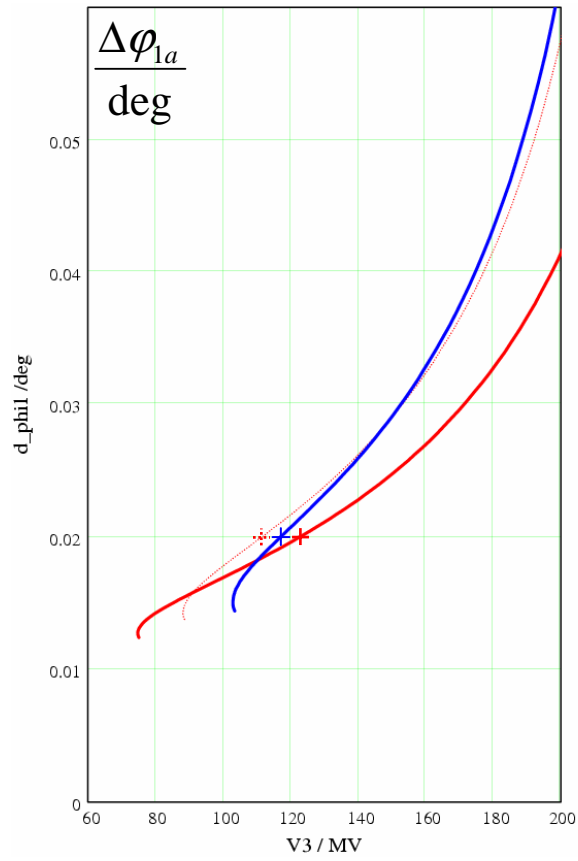
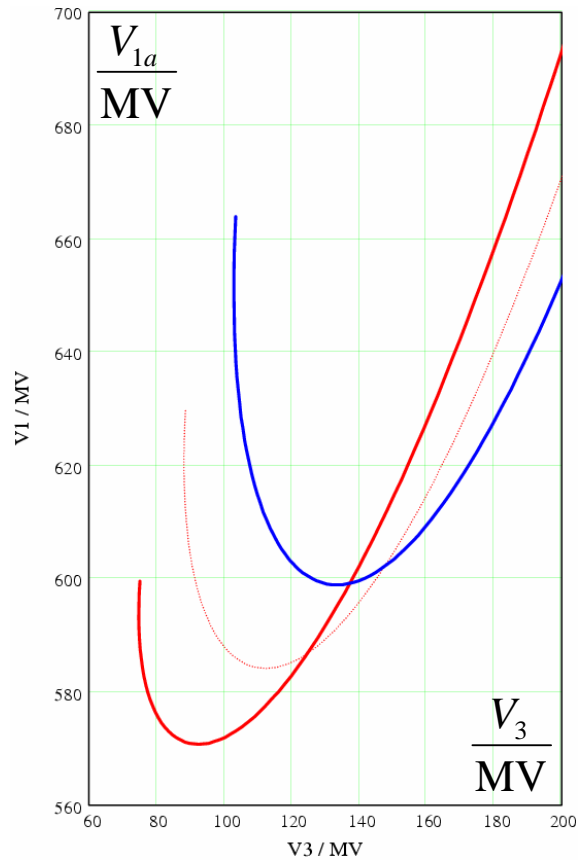


setups 3, 5 and 6 (vary e_3')



e_3'	C_1	$\varphi_{1b} / \text{deg}$	\rightarrow	$r_{56,1} / \text{mm}$	$r_{56,2} / \text{mm}$
0.38	14	0		106.9	39.1
0.50	14	0		82.3	29.0
0.63	14	0		67.8	23.1



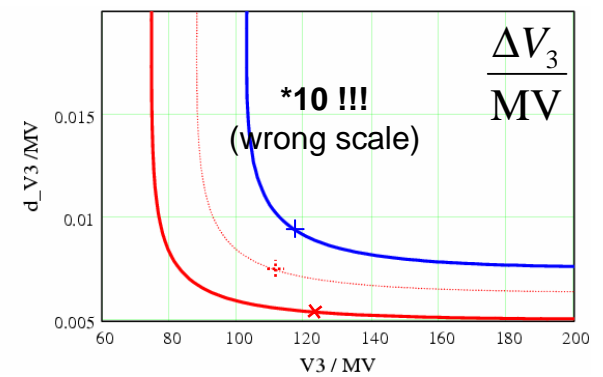
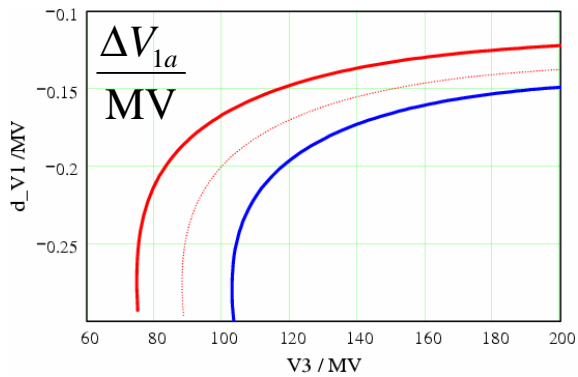


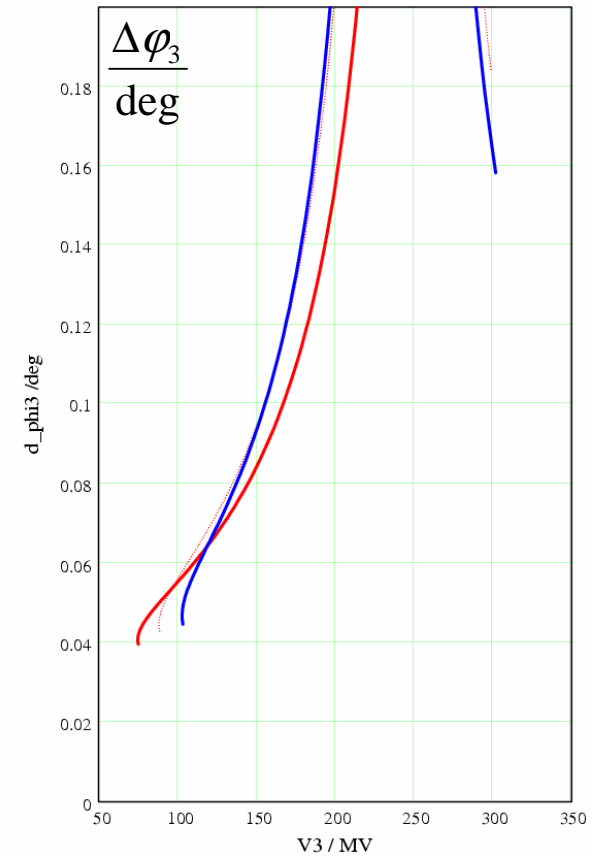
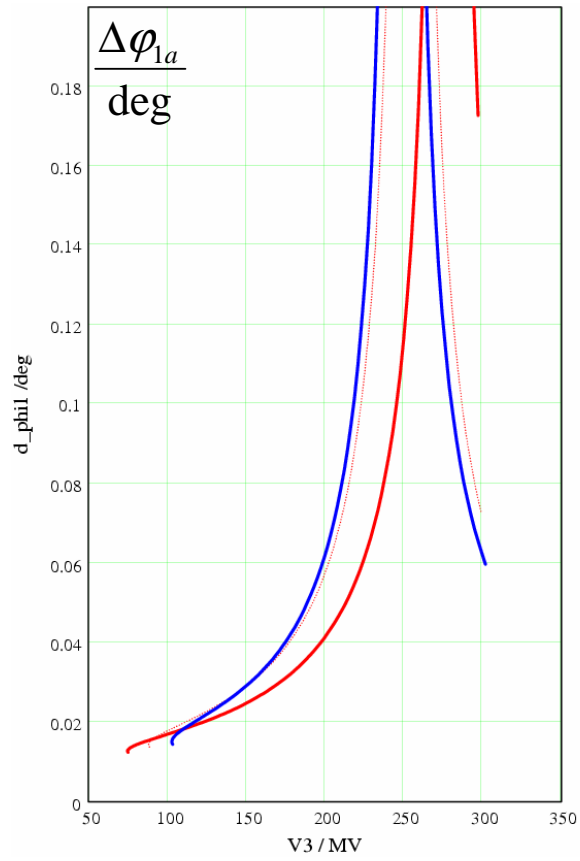
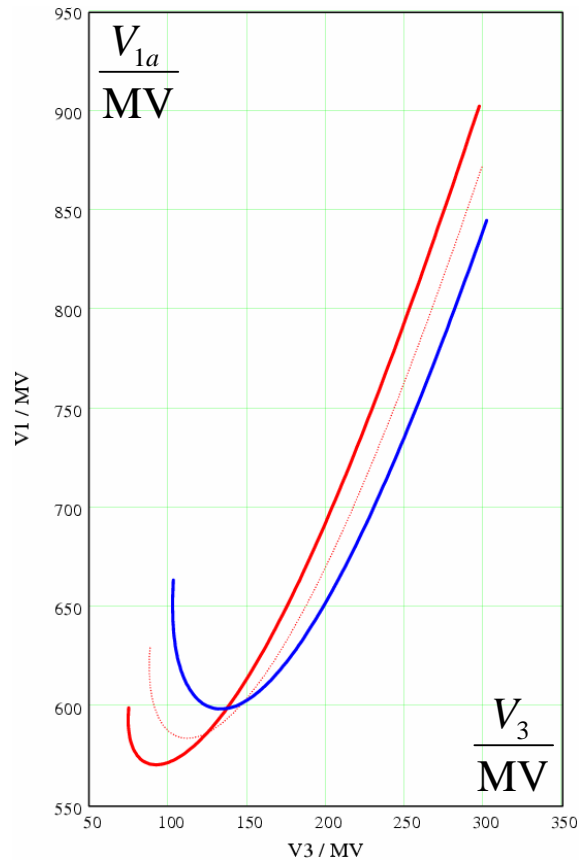
e_3'

0.38

0.50

0.63



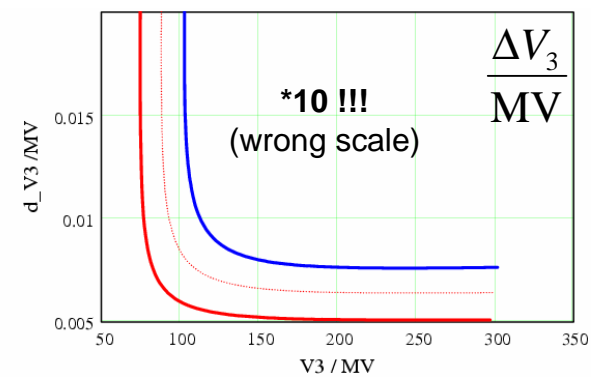
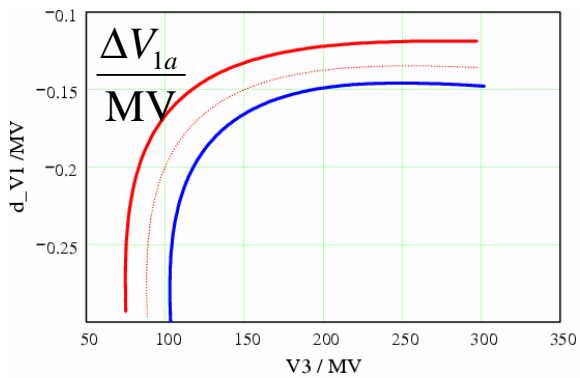


e_3'

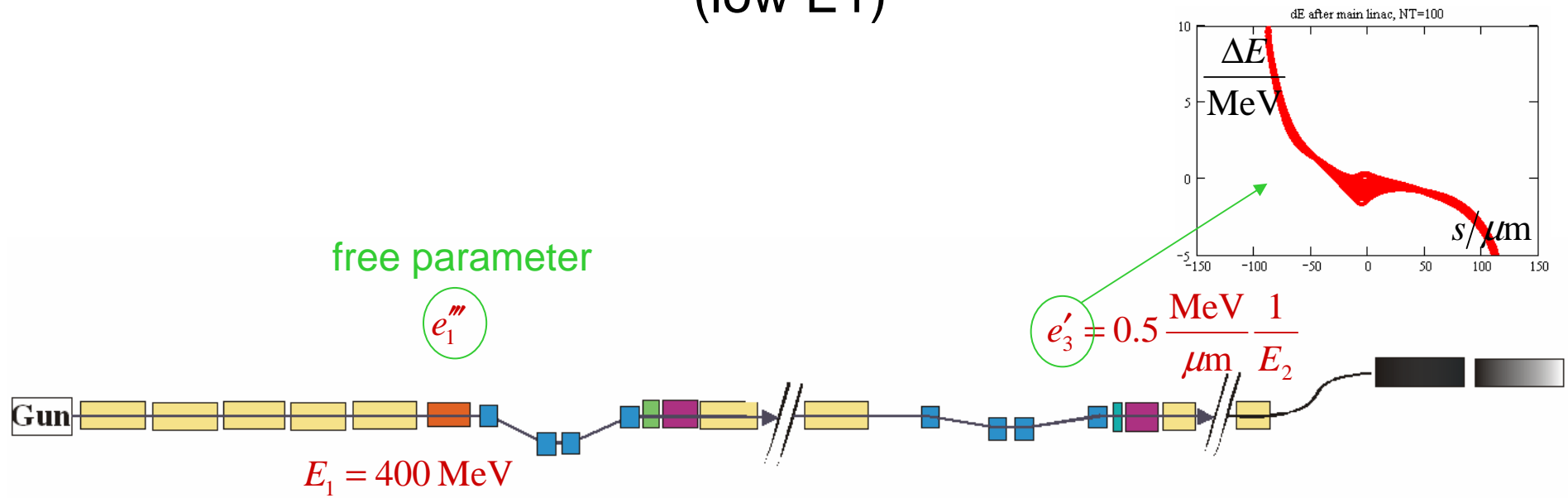
0.38

0.50

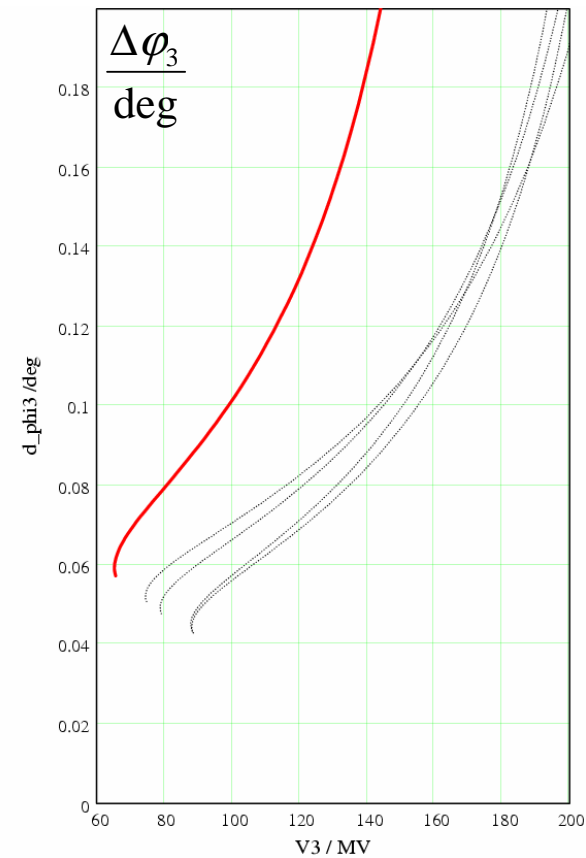
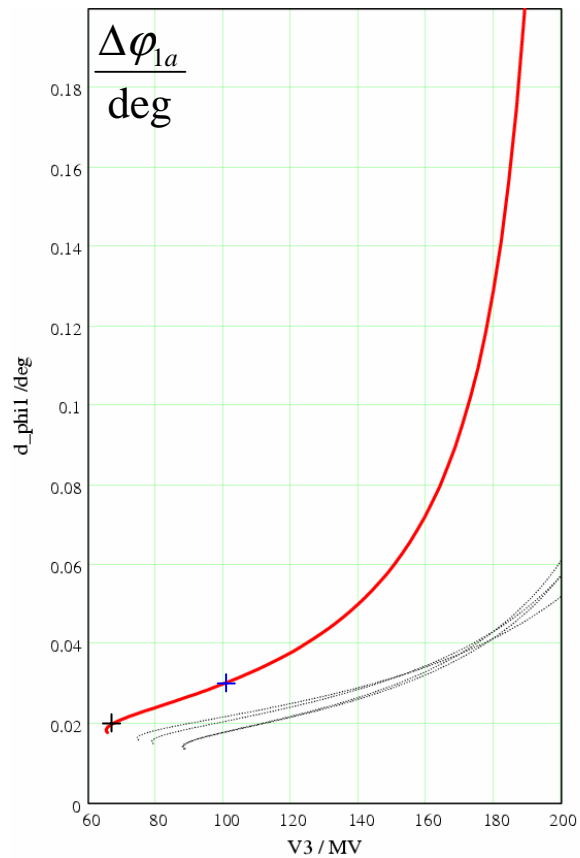
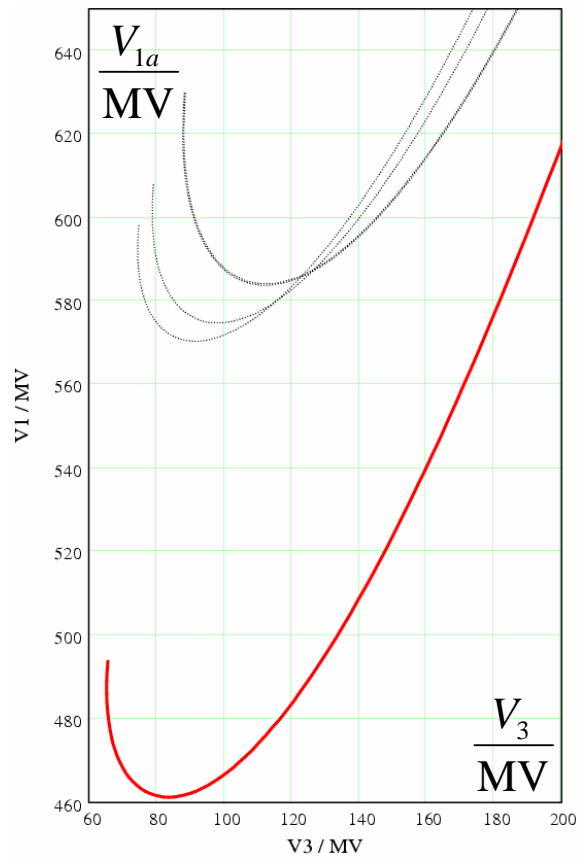
0.63



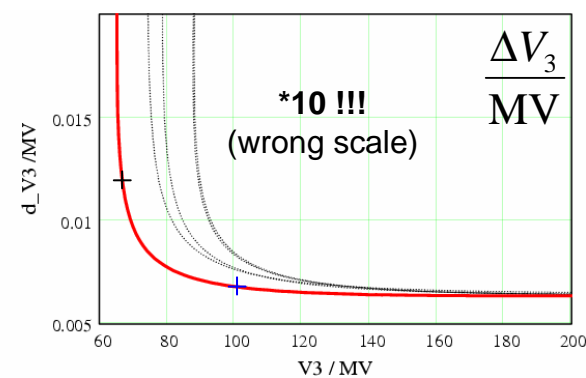
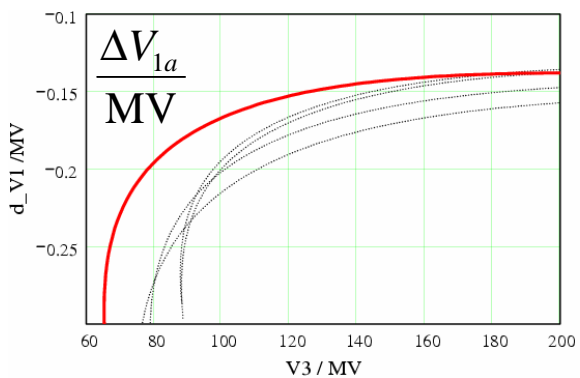
setups 7 (low E1)

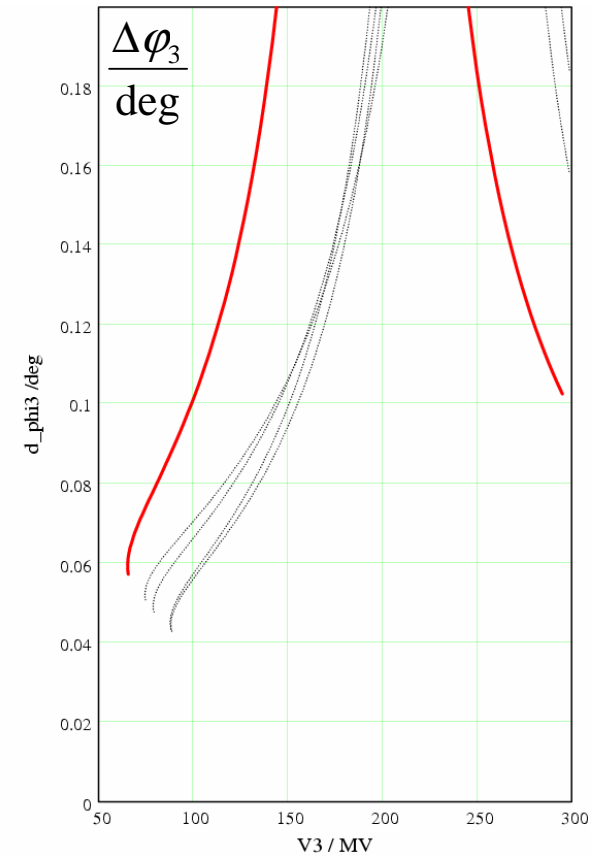
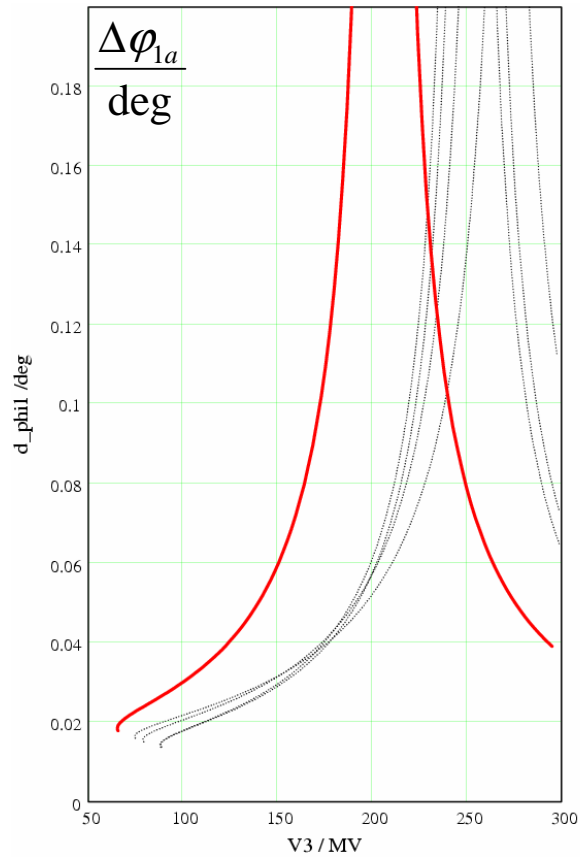
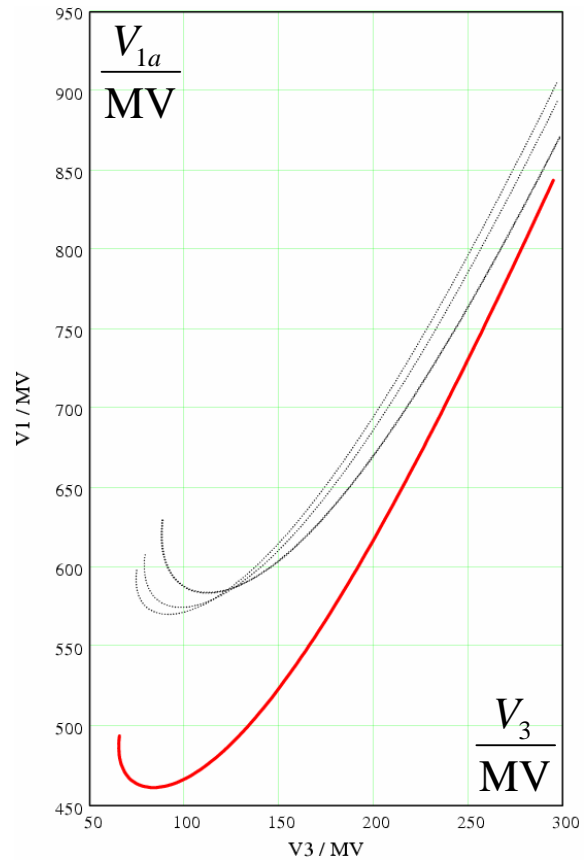


C_1	$\varphi_{1b} / \text{deg}$	\rightarrow	$r_{56,1} / \text{mm}$	$r_{56,2} / \text{mm}$
14	20		89.1	29.3

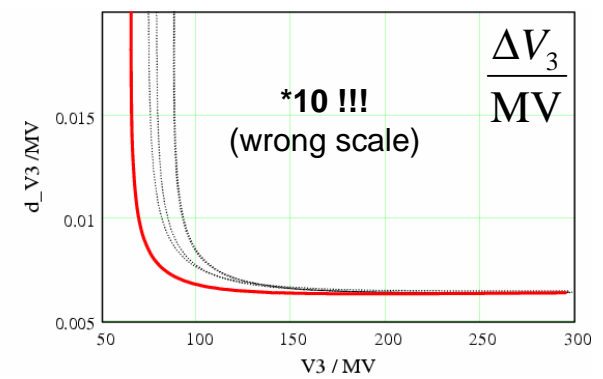
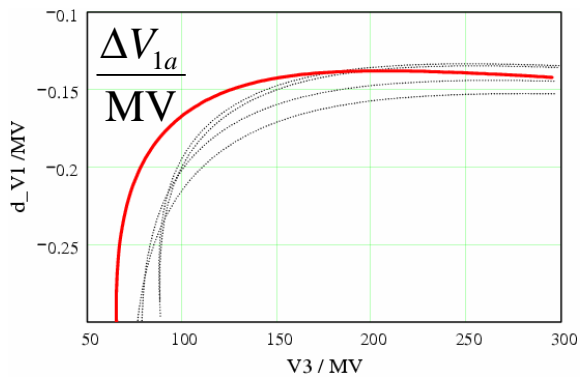


setup 7
 setup 1,2,3,4

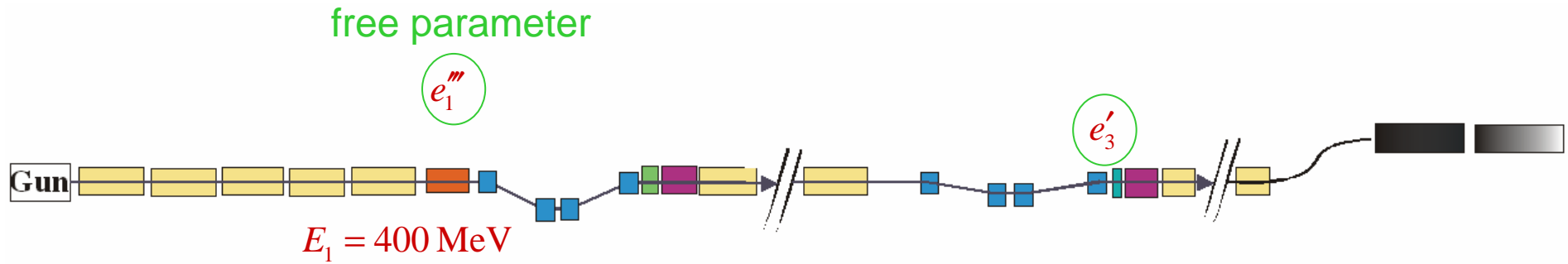




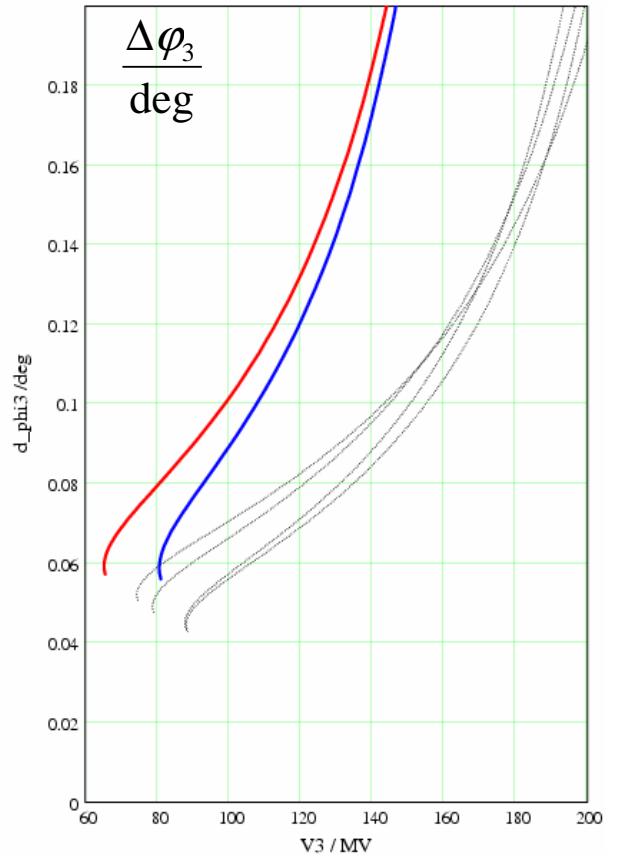
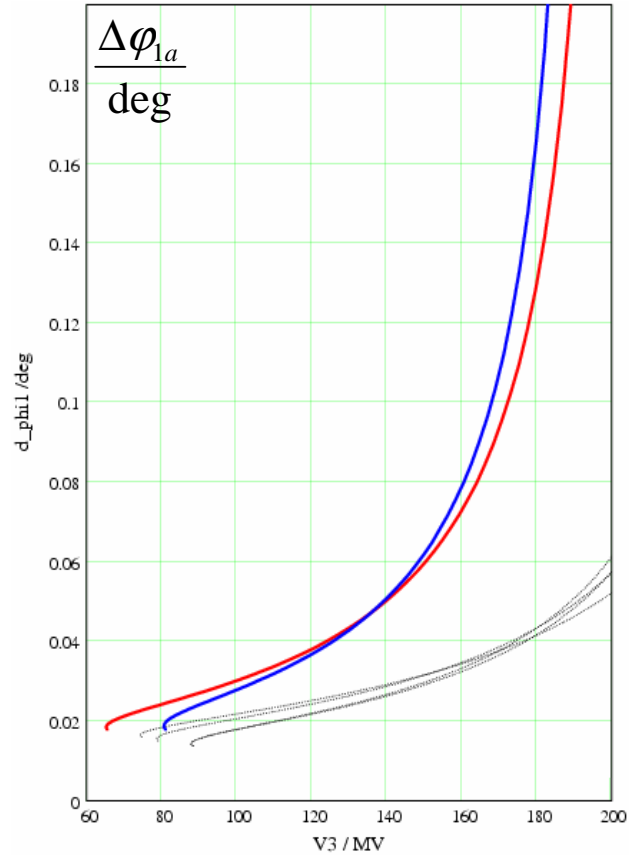
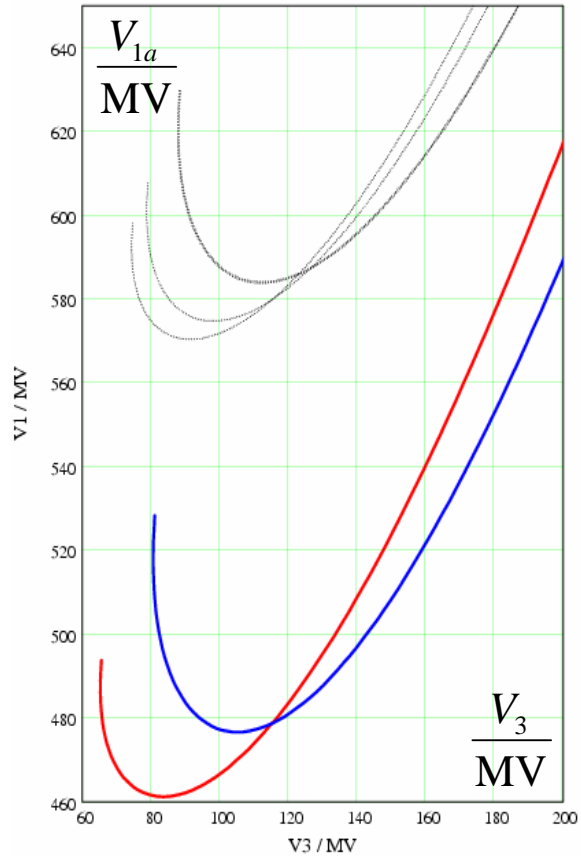
setup 7
 setup 1,2,3,4



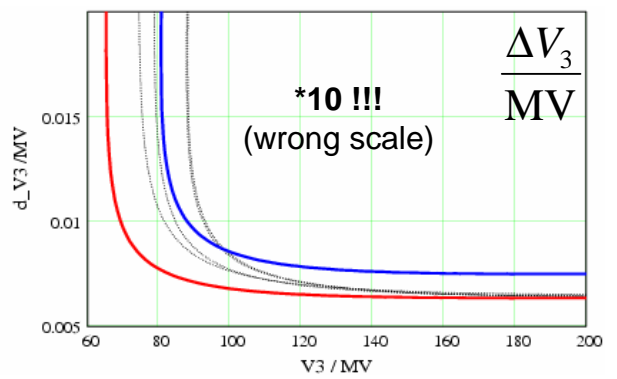
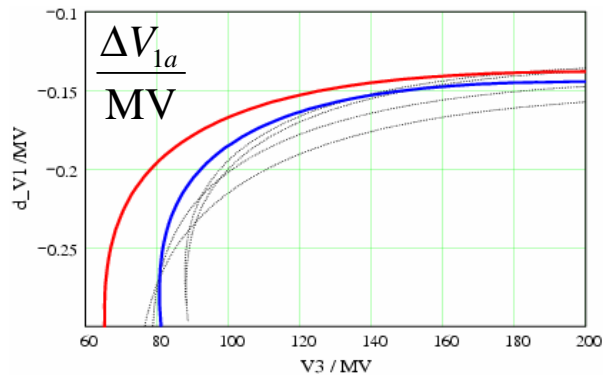
setups 7 and 8 (low E1, chirp e3')

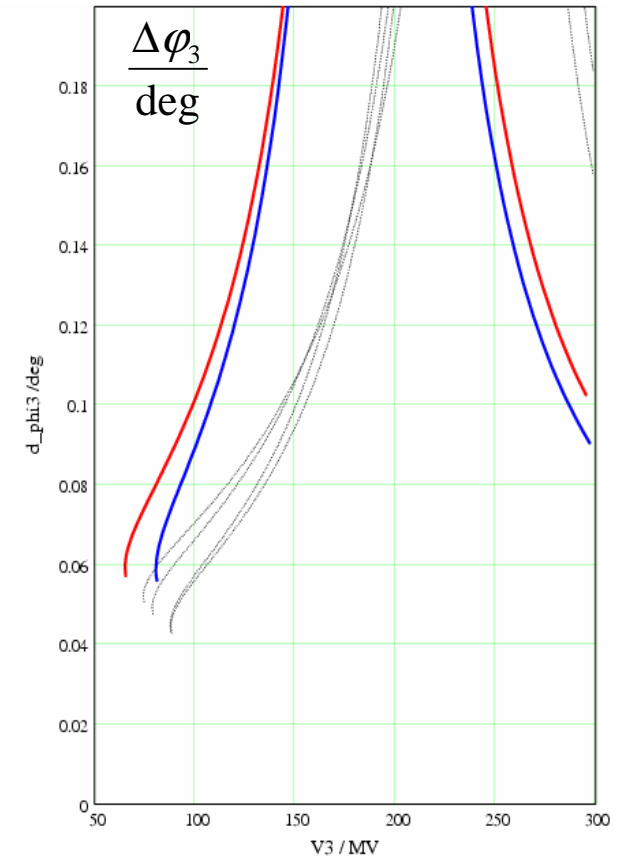
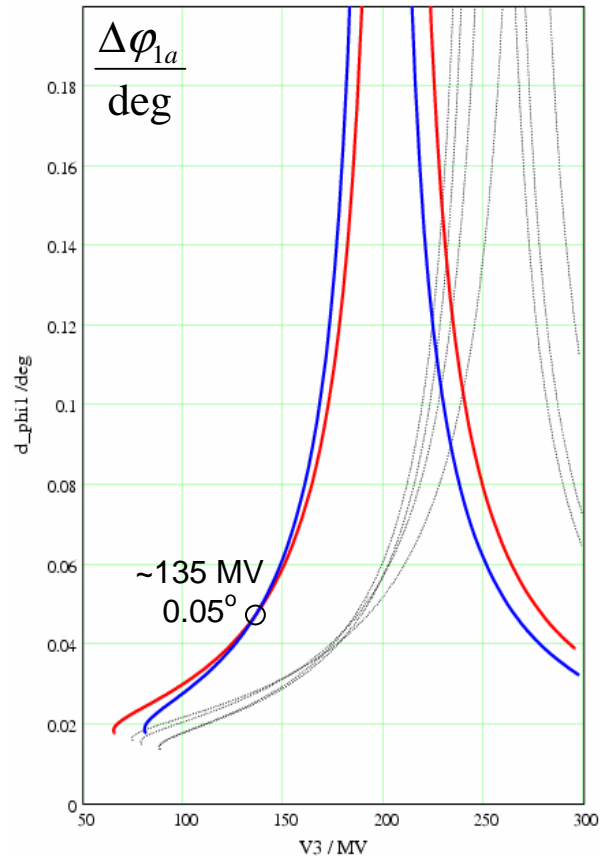
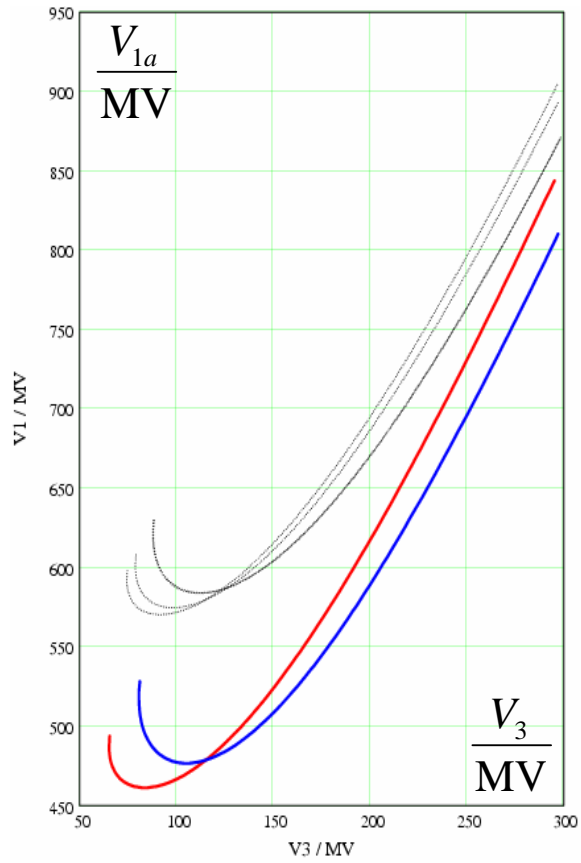


e_3''	C_1	$\varphi_{1b} / \text{deg}$	\rightarrow	$r_{56,1} / \text{mm}$	$r_{56,2} / \text{mm}$
0.50	14	0		89.1	29.3
0.63	14	0		68.4	23.5



setup 7,8
setup 1,2,3,4





setup 7,8
setup 1,2,3,4

