$I_B = 1.4A$

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Analysis of transport experiments with EL-OP

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We analyzed the experimental results of the e-beam transport in a set of experiments on12/12/01 (old cathode) with the aid of EL-OP. The electron optical parameters and the beam spot pictures on screens S1, S2, S3 are shown in sects 1,2.The E-gun and EL-OP simulation results for the e-beam trajectories computed for the given experimental electron-optical parameters, are shown in sect. 3.The computed diameters of the beam on the screen, resonator apertures and inside the wiggler are summarized and compared to the real pictures on the screens in sect.4.

There is fair agreement between the experiment and simulation .It is significant that the simulation shows convergence of the beam after screen S2, and that the computed beam dimensions on the apertures do not exceed the actual aperture sizes.

Because the simulation results predict scalloping of the beam (due to betatron oscillations) and beam dimensions inside the wiggler significantly larger than the optimal (see Table in sect.4), the FEL gain may be reduced. To find better injection parameters we employed Quad-Opt with initial conditions

$2R_x=2R_y=10mm$ - nearly the experimental initial conditions on S1 ($2R_x=9mm$, $2R_y=8.8mm$), and came up with two solutions of proposed set of excitation currents in Q_1-Q_8 which presumably would assure propagation in the wiggler without scalloping .The good transport with these parameters was verified by applying EL-OP as shown in sect.5.

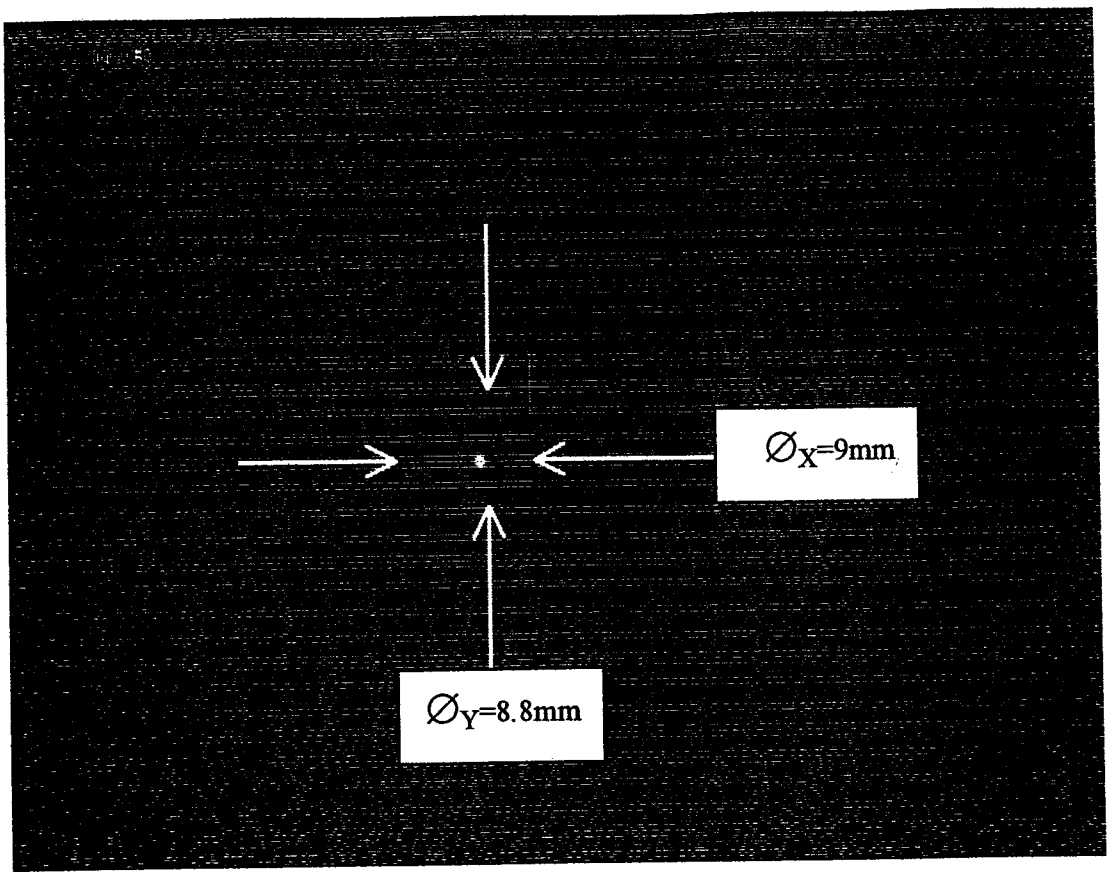
In sect. 6 we summarize in table the experimental excitation currents, the sets proposed by Doron (optimized for initial diameter ∅=15mm) and the new set we propose for better transport with the experimental initial conditions (∅=10mm).

1.Experimental parameters Table1 (EXECEL Table)

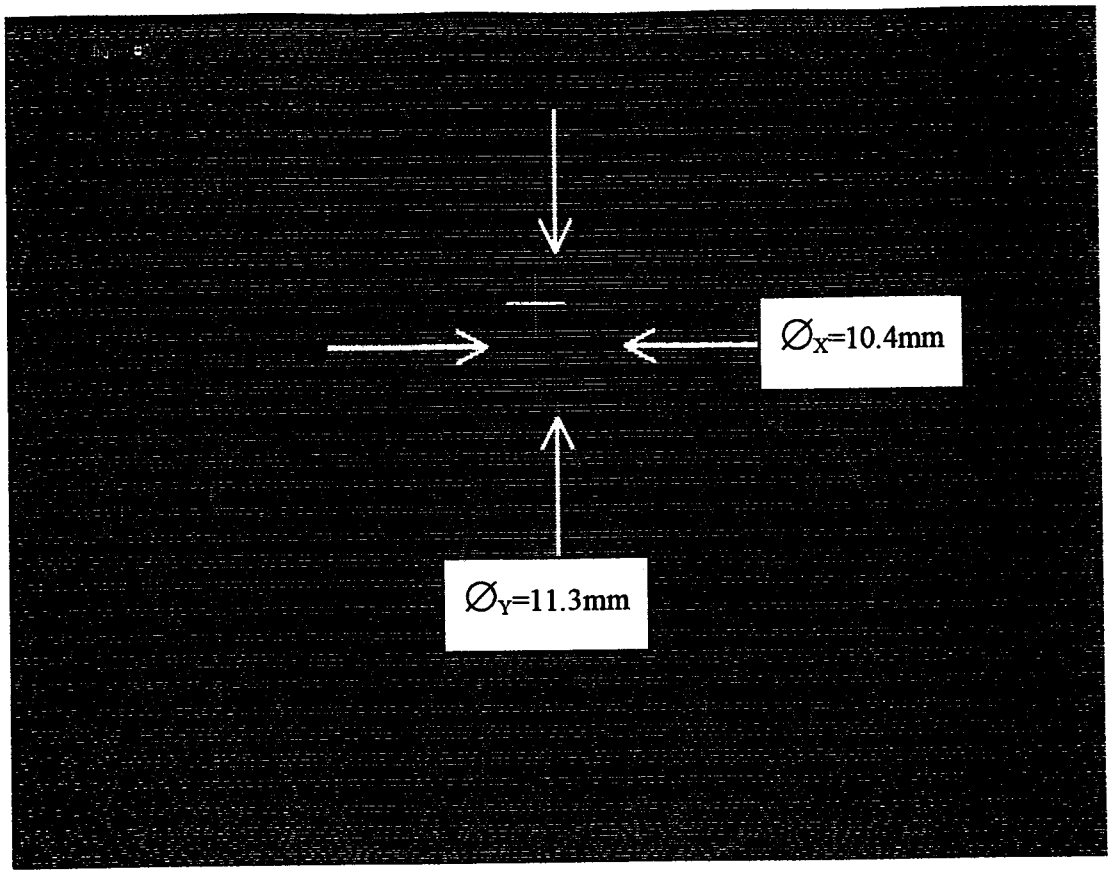
The College of Judea and Samaria - Accelerator Laboratory - The Israel FEL Consortium Electron Beam Transport - Experimental Data		
Date	[redacted]	
Experiment	**1**	
Time	**15:00**	
Operator	yoram	
Function/Input		
P1-cathode(Torr)	4*10^-7	
P2-injector(Torr)	4*10^-7	
P1-collector(Torr)	4*10^-7	
Icathode (A)	1.4	
Iheater (A)	13	
Vheater (A)	9	
Vgrid (kV)	(-2) 15	
Vcathode (kV)	45	
Vdvm (MV)	1.4	
Icharge (E-6 A)	112	
Icorona (E-6 A)		
Idown (E-6 A)	20	
Helmholtz (A)		
Lens C1 (A)	7.6	
Lens C2 (A)	3.1	
Steerer V1 (A)	-1.4	
Steerer H1 (A)	2.6	
Screen SP (mm)		
image		
Steerer V2 (A)		
Lens C3 (A)	2.97	
Lens C4 (A)	0	
Screen S0 (mm)		
Steerer V3 (A)	-2.5	
Steerer H3 (A)	1	

Pearson P1 (A)	(35)~1.16	
Screen S1 (mm)		
image-s1		
Quad Q1 (A)	1.56	
Quad Q2 (A)	-1.19	
Quad Q3 (A)	1.35	
Quad Q4 (A)	-1	
Steerer V4 (A)	-0.7	
Steerer H4 (A)	-1.088	
Pearson P2 (A)	(14.7)~1.2	
Screen S2 (mm)		
image-s2		
Steerer V5 (A)	1.5	
Steerer H5 (A)	1.5	
Steerer V6 (A)	3	
Steerer H6 (A)	-2.97	
Pearson P3 (A)	(12)~.880	
Screen S3 (mm)		
image-s3		
Steerer V7 (A)		
Steerer H7 (A)		
Quad Q5 (A)		
Quad Q6 (A)		
Quad Q7 (A)		
Quad Q8 (A)		
Steerer V7A (A)		
Steerer H7A(A)		
Lens C5 (A)		
Steerer V8 (A)		
Steerer H8 (A)		
Lens C6 (A)		
Vcollector1 (V)		
Icollector (A)		
Vcollector2 (V)		

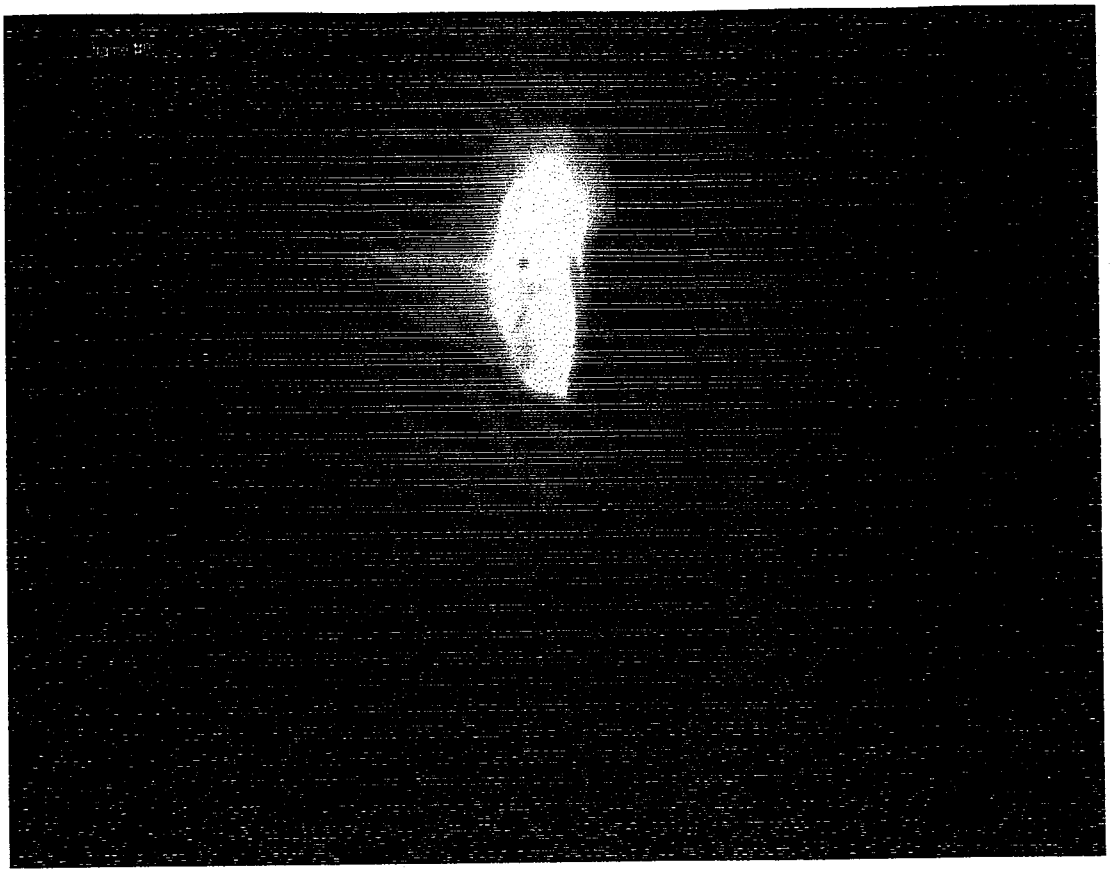
2.Diagnostic pictures



Screen S1



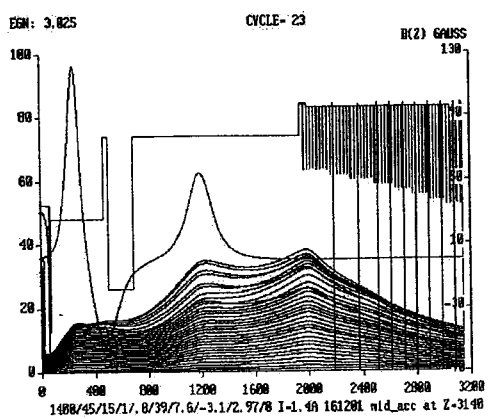
Screen S2

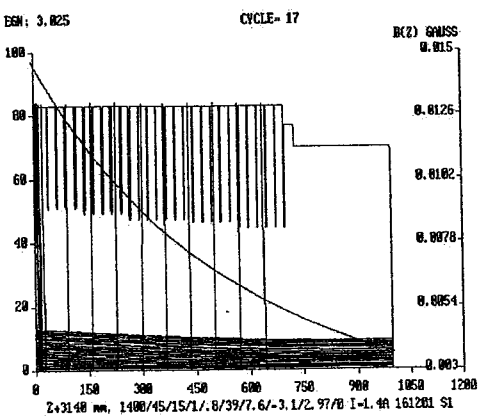


Screen S3

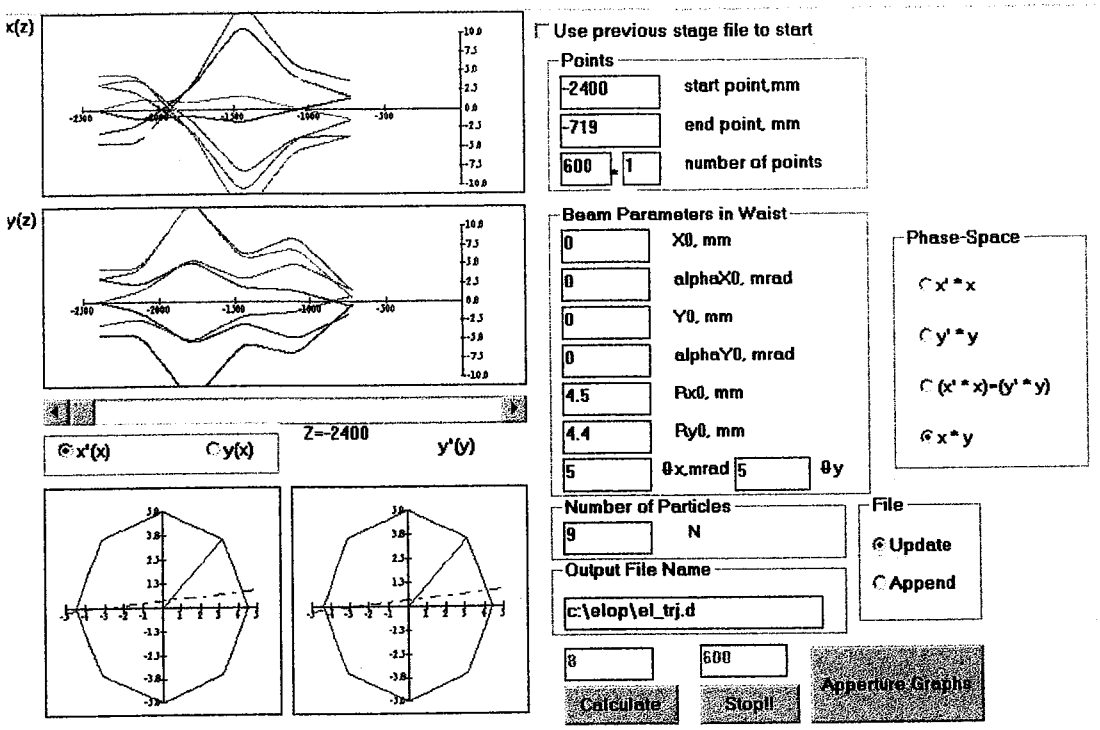
3.Simulation results:

A. From cathode to Screen S1

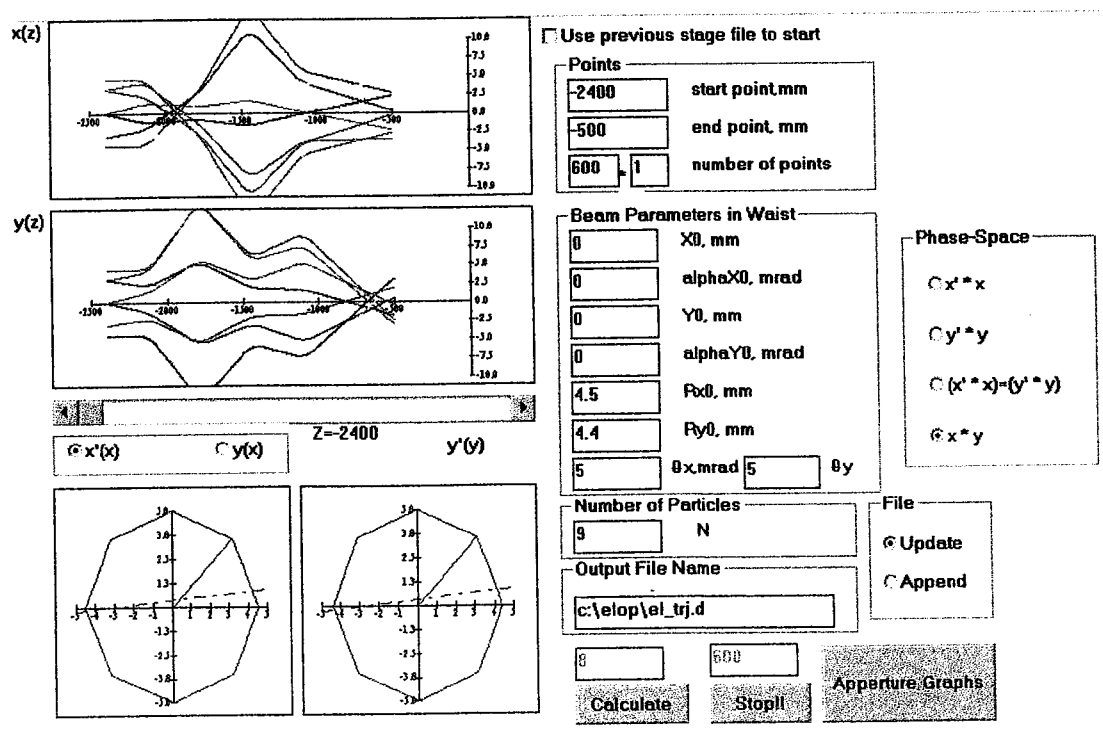




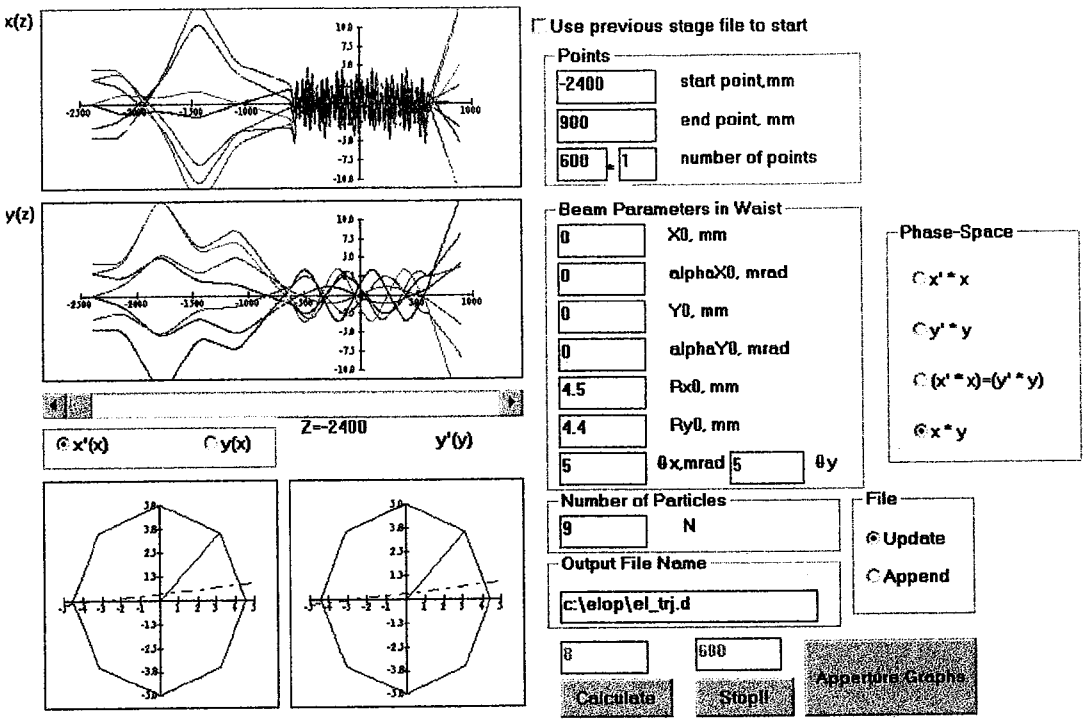
B. From S1 to S2.



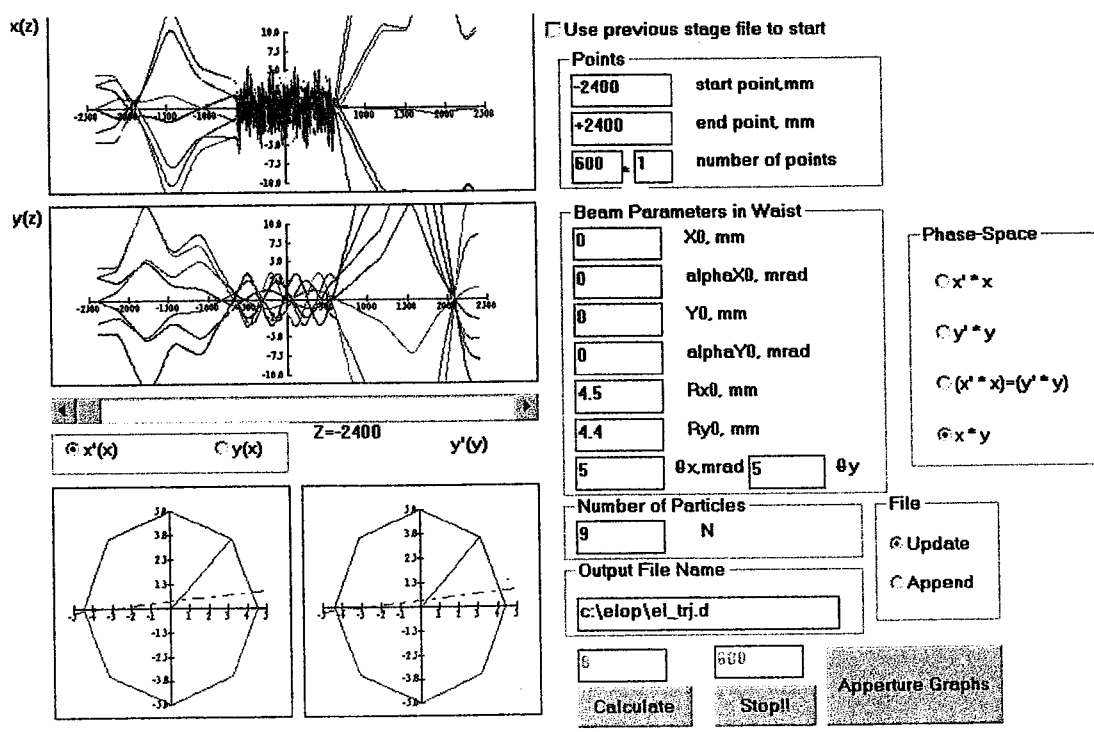
C. Up to –500 without wiggler



D. Up to +900



E. Up to +2400



4.Summary of beam parameters

Spot size ∅ (mm)	Experimental ∅(x,y)	Simulation∅ (x,y)
S1	(9,8.8)	-------
S2	(10.4,11.3)	(10,7)
S3		
Resonator input aperture –646mm	∅=10mm	(6,4)
Resonator Output aperture 671mm	∅=10mm	(6,8)
In wiggler		(10,10) (5.5,3.5) optimal

5.New optimization

Was found two new solutions for I_1-I_4 currents on quads Q_1-Q_8.

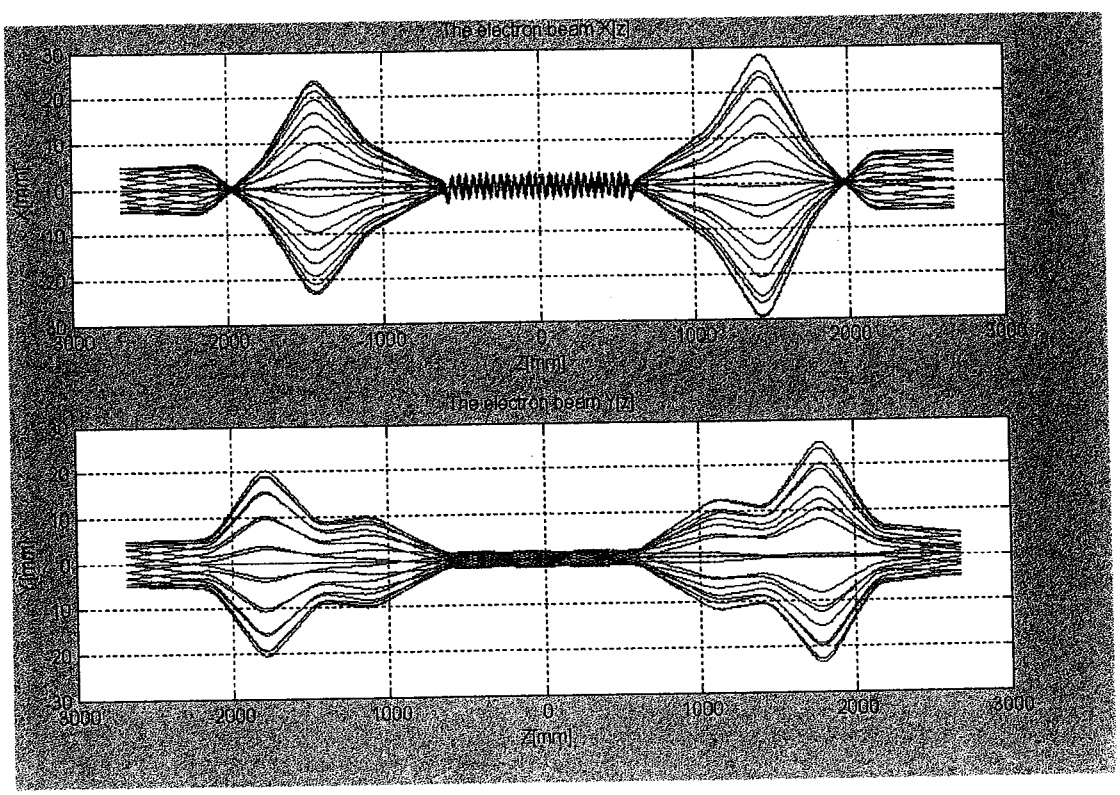
A. First Solution:

I_1= 2.04588

I_2= -1.25513

I_3= 1.29367

I_4= -0.69375



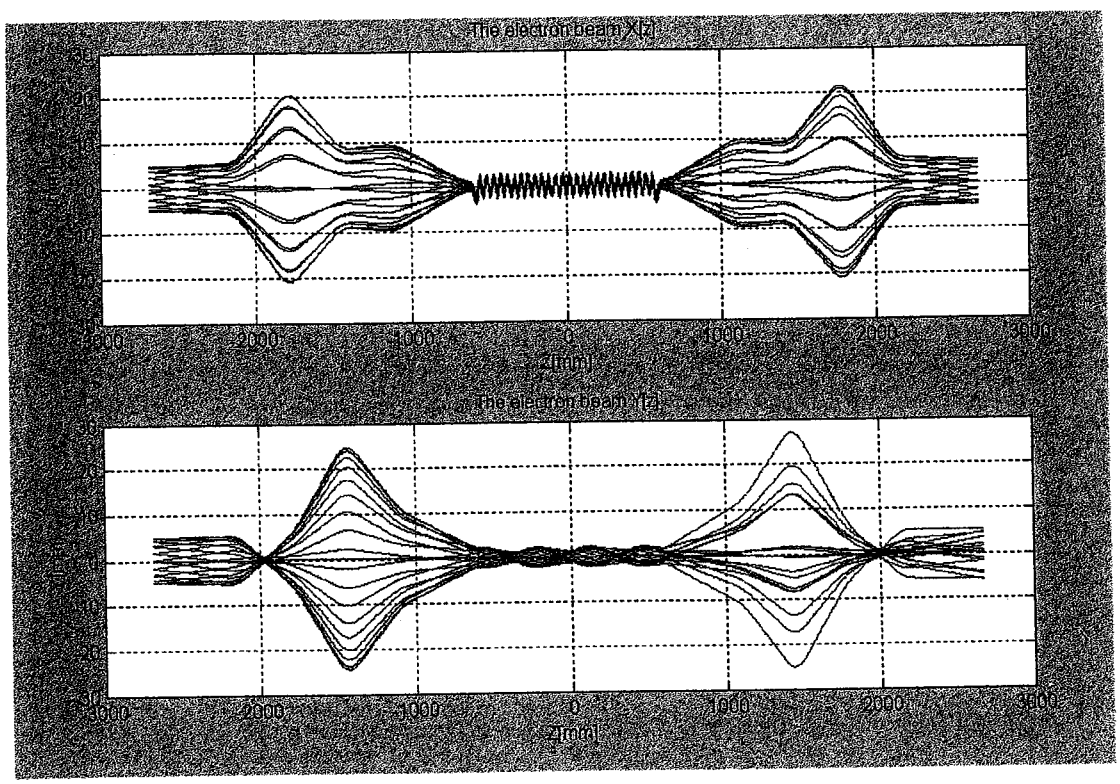
B. Second solution

I_1= -2.10957

I_2= 1.7206

I_3= -1.2843

I_4= 0.71279



6. Summary of excitation currents

	Doron's optimum for $R_x=2R_y=15mm$	Experiment 12/12/01 for $2R_x=9mm, 2r_y=8.8mm$	Proposed new optimum for $2R_x=2R_y=10mm$
Q_1	+1.56404A ——— -1.63883A	+1.56A	+2.04588A ——— -2.10957A
Q_2	-1.19619A ——— +1.20707A	-1.19A	-1.25513A ——— +1.27206A
Q_3	+1.30525A ——— -1.30359A	+1.35A	+1.29367A ——— -1.28430A
Q_4	-0.65048A ——— +1.56404A	-1A	-0.69375A ——— +0.71279A