CESR-c IR region magnetic survey

Alexander Temnykh
Cornell University
Ithaca NY 14850

1. Introduction (VW theory)
2. Setup
3. Permanent quads survey (Q0E, Q0W)
4. SC quads survey (Q2E, Q1E, Q1W, Q2W)
5. Summary and orbit distortion analysis

Introduction (WV Theory)

- Equation for the wire motion driving by AC current.

$$\mu\frac{\partial^2 X}{\partial t^2}=T\frac{\partial^2 X}{\partial z^2}-\gamma\frac{\partial X}{\partial t}+I(t)B(z);$$

$I(t)=I_0$*exp($i\omega t$) - driving AC current

$\mu-$ linear wire density; $T-$ tension; $\gamma-$ decrement;

$X(z=0,t)=X(z=L,t)=0$

- Solution

(sum of standing waves)

$$X(z,t)=\sum_n X_n \sin(\frac{\pi n}{L}z)\exp(i\omega t);$$

$$X_n=\frac{I_0}{\mu}\frac{1}{(\omega^2-\omega_n^2+i\gamma\omega)}B_n;\ \omega_n=\frac{\pi n}{L}\sqrt{\frac{T}{\mu}}$$

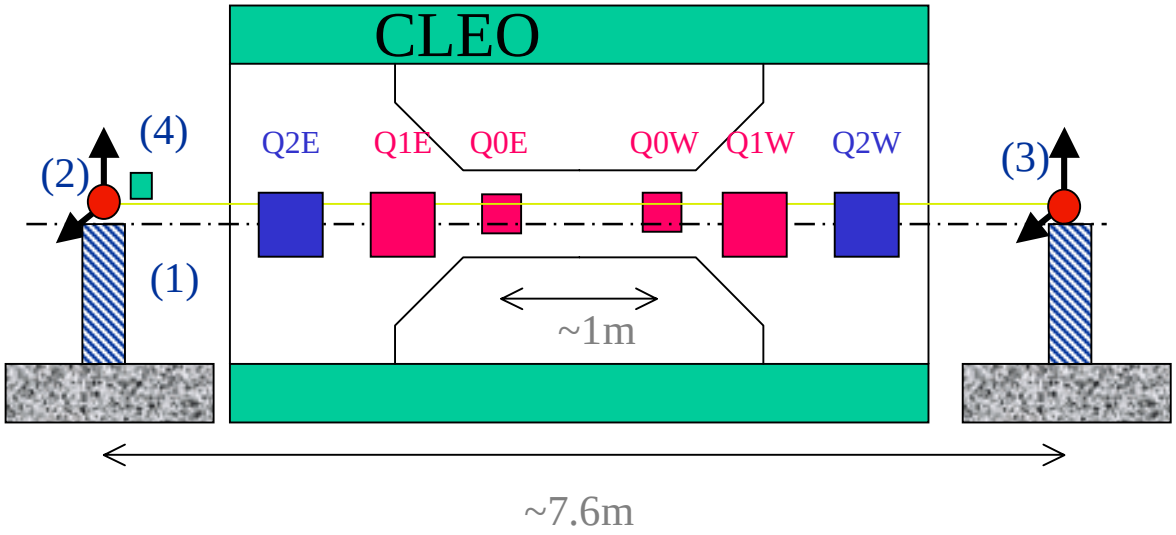
$$B_n=\frac{2}{L}\int_0^L B(z)\sin(\frac{\pi n}{L}z)dz;$$

$X_n \propto B_n$!!!

Reference:
A. Temnykh, Vibrating wire field-measuring technique, Nuc. Inst., A 399 (1997) 185-194

Setup

Wire geometry: $Sag = \frac{g}{32 f_1^2}$!!!

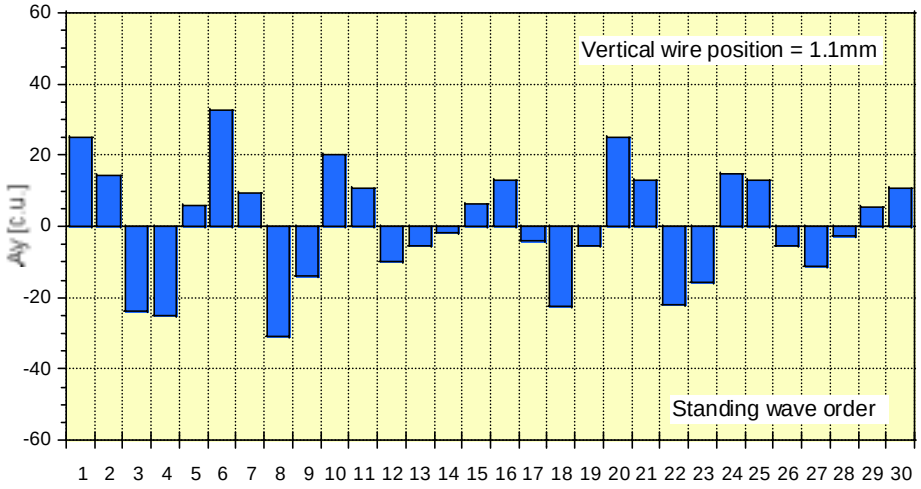


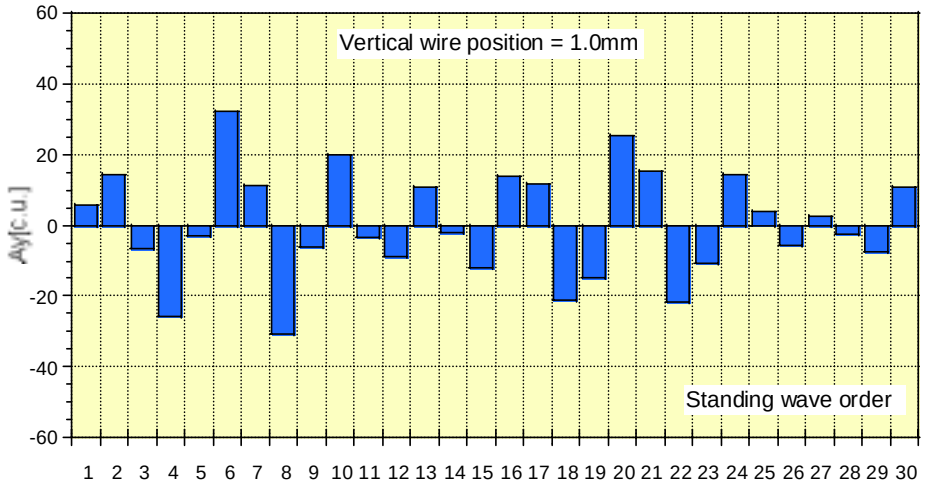
Basic Position		f1[Hz]=	14.7
		Sag[mm]=	1.418
	x(hor)	y(vert)	z(long)
East End	0	0	-3768.4
West End	0	0	3768.4
Wire Shift from Basic Position			
x[mm]=	0	symmetric	
dx[mm]=	0	assymetric	
y[mm]	0	symmetric	
dy[mm]=	0	assymetric	
	x[mm]	y[mm]	z[mm]
East end	0	0	-3768.4
West end	0	0	3768.4
Azimuth[mm]			
	z[mm]	x[mm]	y[mm]
East End	-3768.4	0.000	0.000
Q2E	-2079	0.000	-0.987
Q1E	-1166.9	0.000	-1.282
Q0E	-520	0.000	-1.391
IP	0	0.000	-1.418
Q0W	520	0.000	-1.391
Q1W	1166.9	0.000	-1.282
Q2W	2079	0.000	-0.987
West End	3768.4	0.000	0.000

(1) – 0.1mm copper-beryllium wire (Vibrating Wire)
(2,3) – East and West 2D positioning stages assemblies mounted on survey tripods.
(4) – wire motion sensors
- optical targets at the wire ends

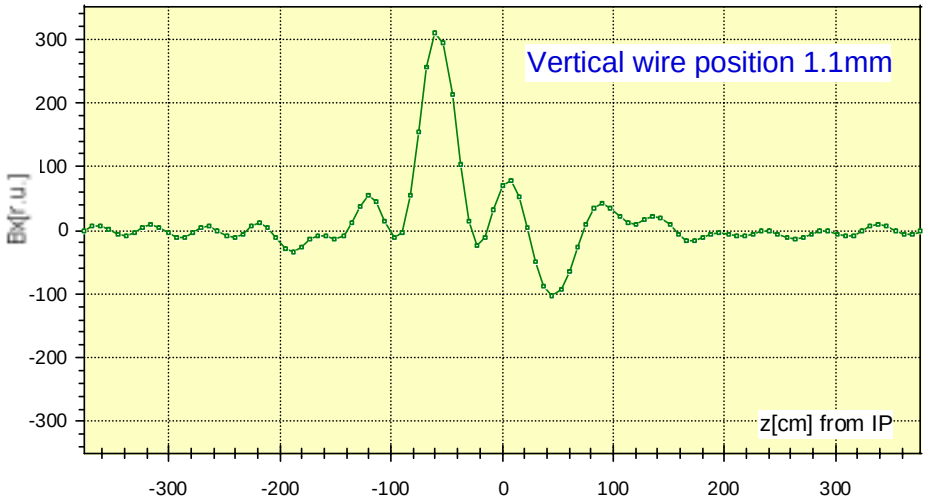
Q0E and Q0W vertical survey: example of analysis

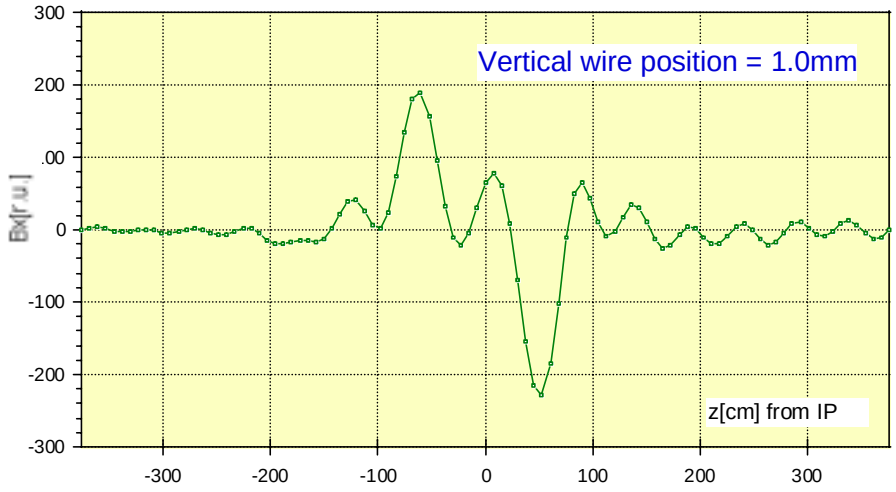
Vertical standing wave amplitudes





Reconstructed horizontal magnetic field

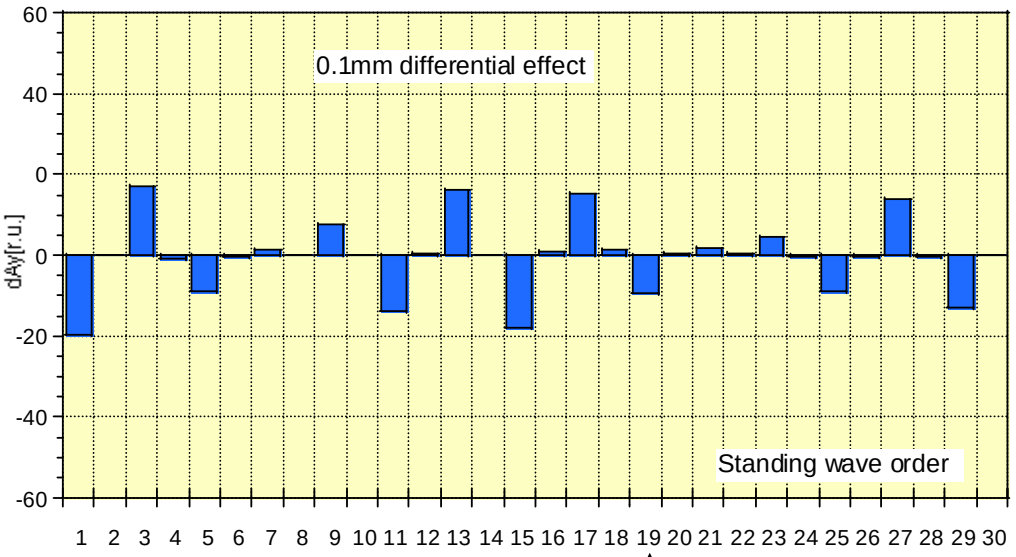




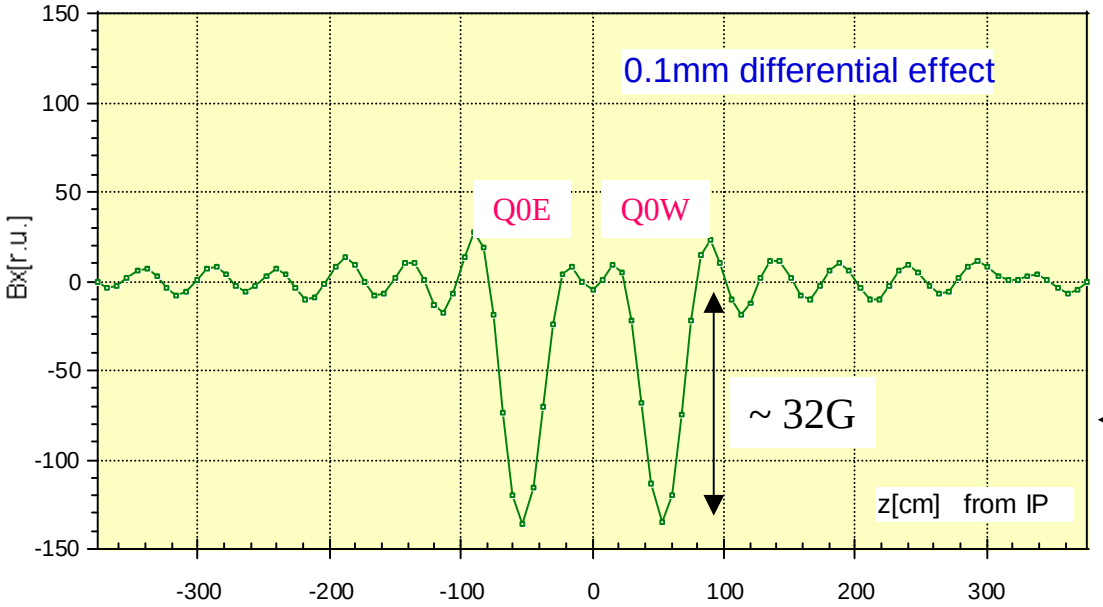
Q0E and Q0W vertical survey: example of analysis

Difference between two measurement:

1) Vertical wire position y = 1.0mm
2) y = 1.1mm

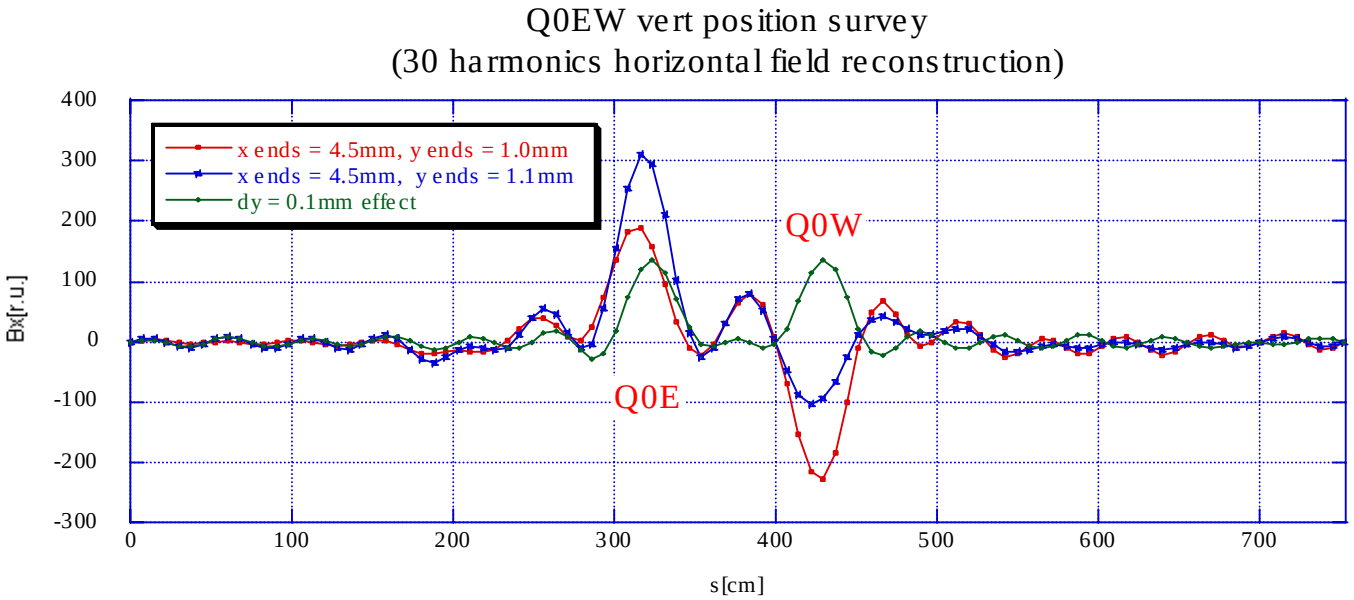


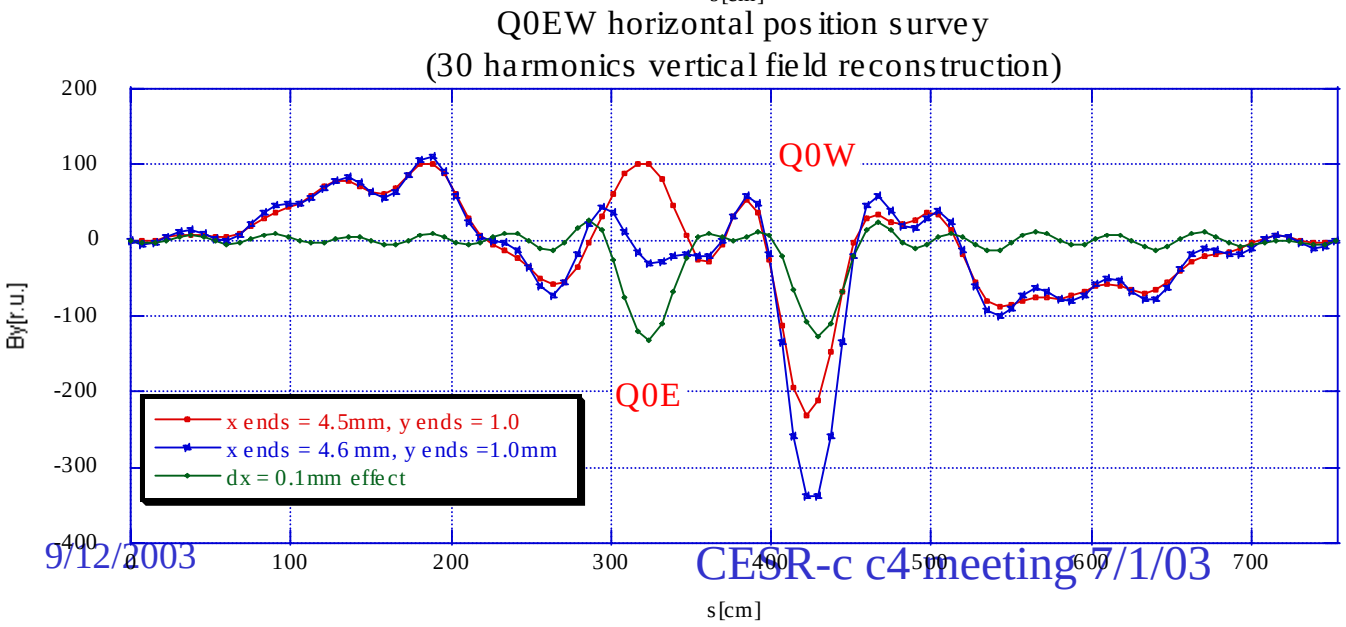
Difference in standing wave amplitudes.



Difference in reconstructed horizontal magnetic field.

Q0E and Q0W survey: 30harmonics field reconstruction
(SC quads OFF)





Y (Q0E) =
= 1.0 – 0.136 – 1.391 =
= -0.527mm

Y (Q0W) =
= 1.0 + 0.171 – 1.391 =
= -0.220mm

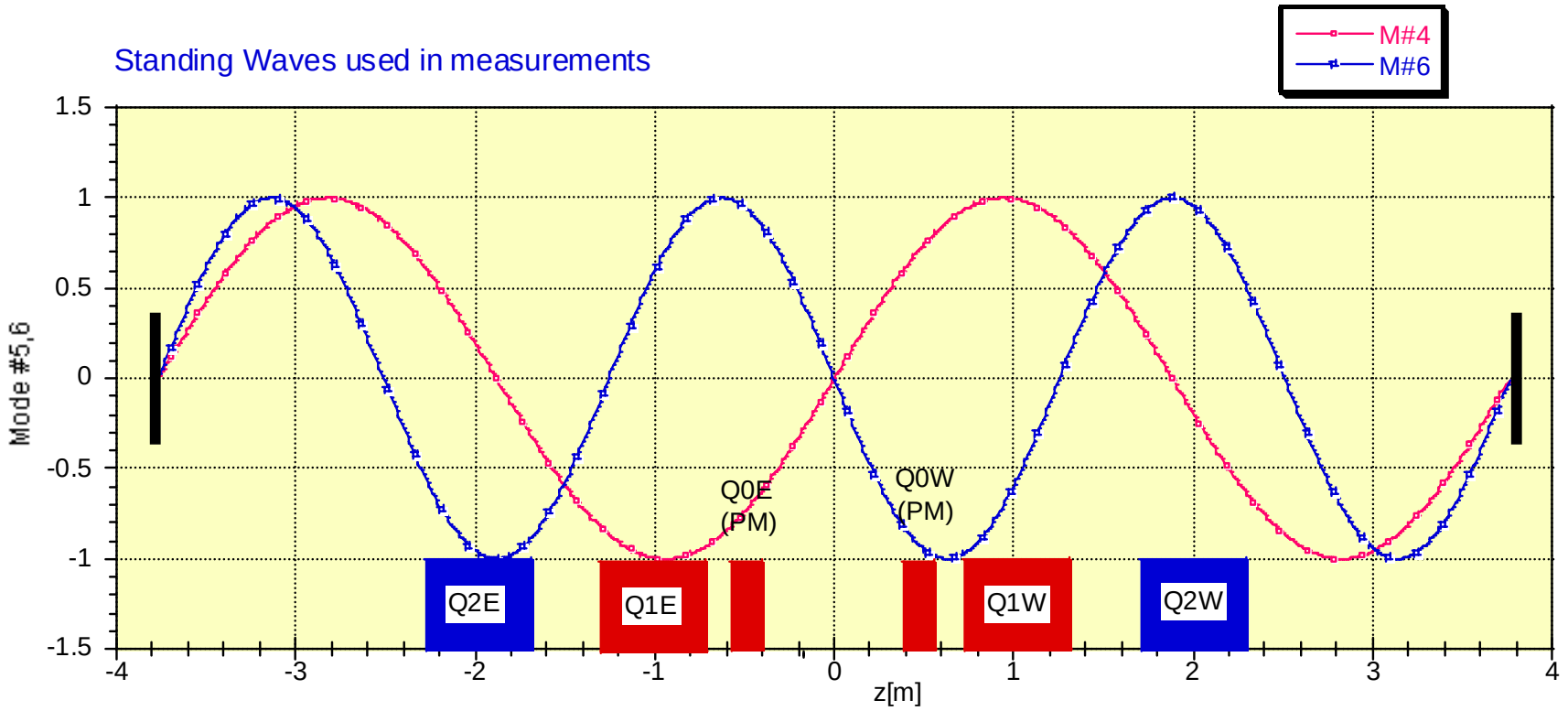
X (Q0E) =
= 4.5 + 0.076 =
= 4.576mm

X (Q0W) =
= 4.5 – 0.176 =
= 4.323mm

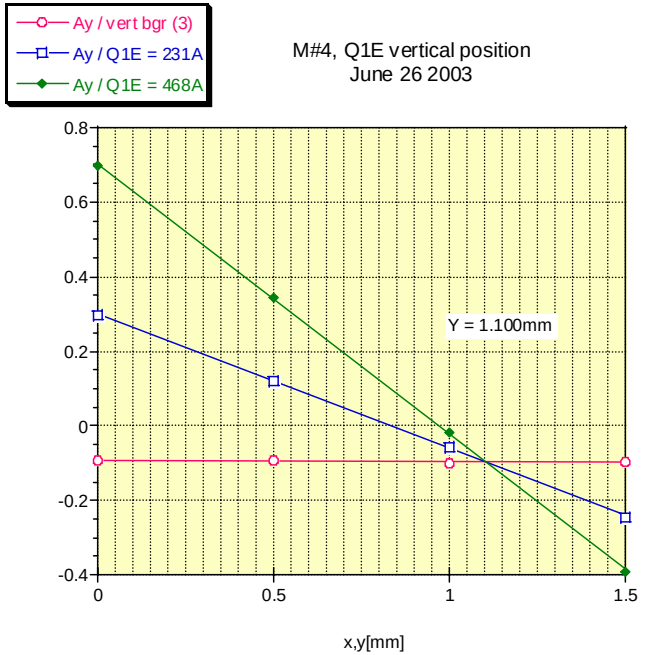
SCIR quads survey using single standing waves

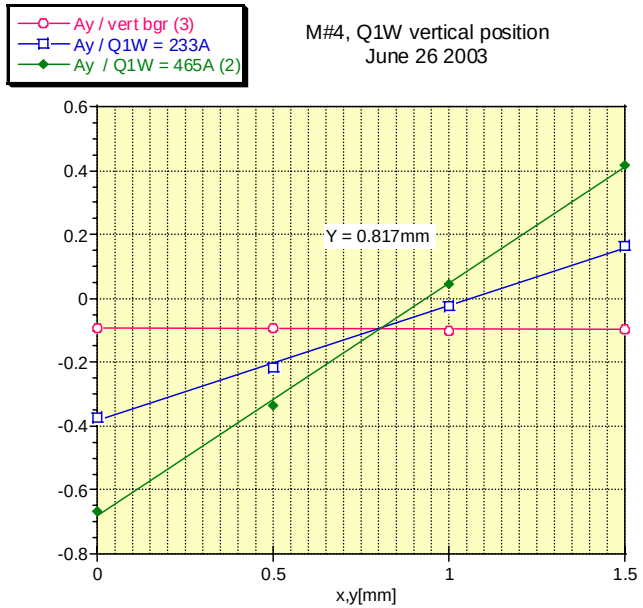
Q1E & Q1W: 4-th order standing wave

Q2E & Q2W: 6-th order standing wave



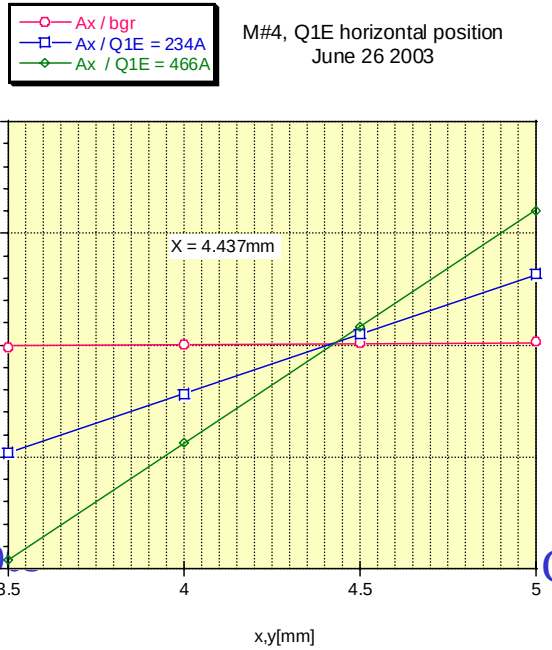
Q1E and Q1W survey: 4-th order standing wave

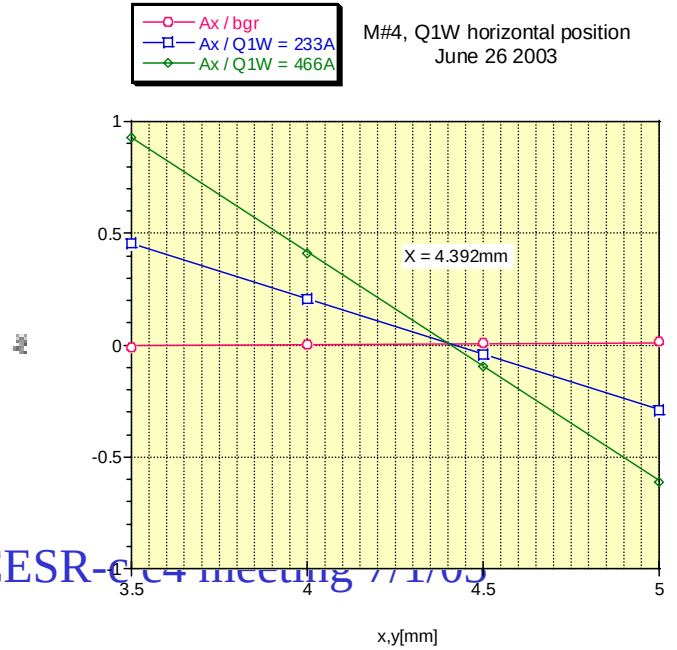




Y (Q1E) =
= 1.1 – 1.282 =
= -0.182mm

Y (Q1W) =
= 0.817 – 1.282 =
= -0.465mm

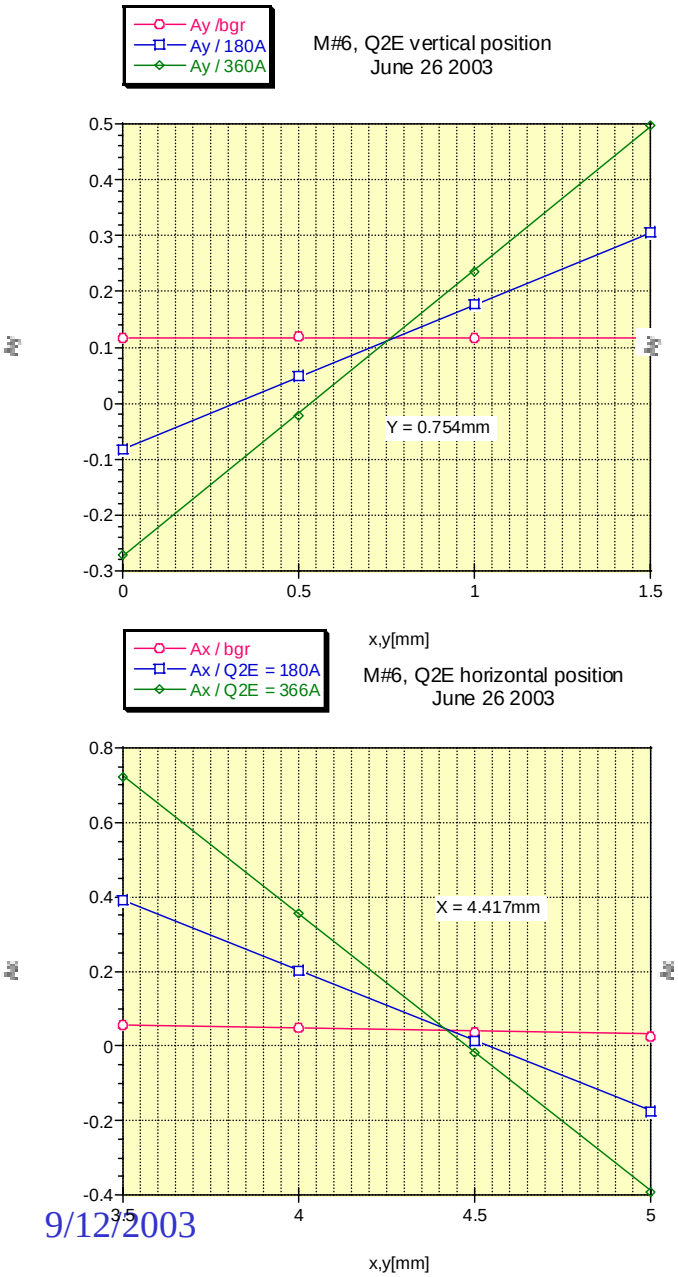


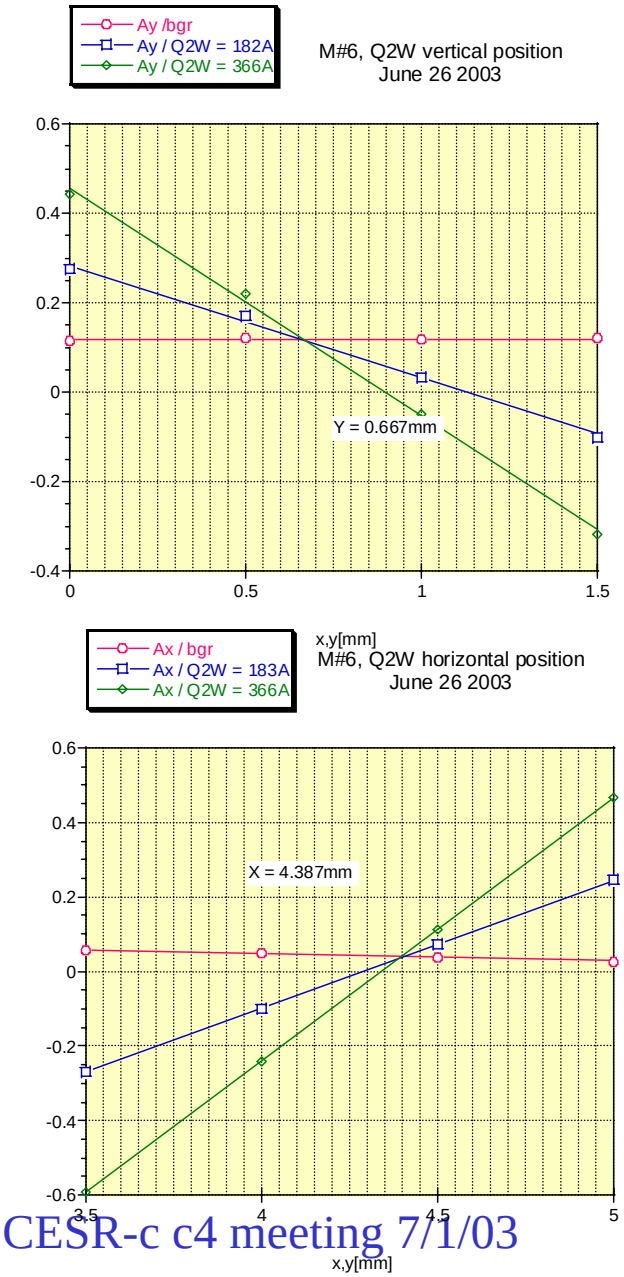


X (Q1E) = 4.437mm

X (Q1W) = 4.392mm

Q2E and Q2W survey: 6-th order standing wave





Y (Q2E) =
= 0.754 – 0.987 =
= -0.233mm

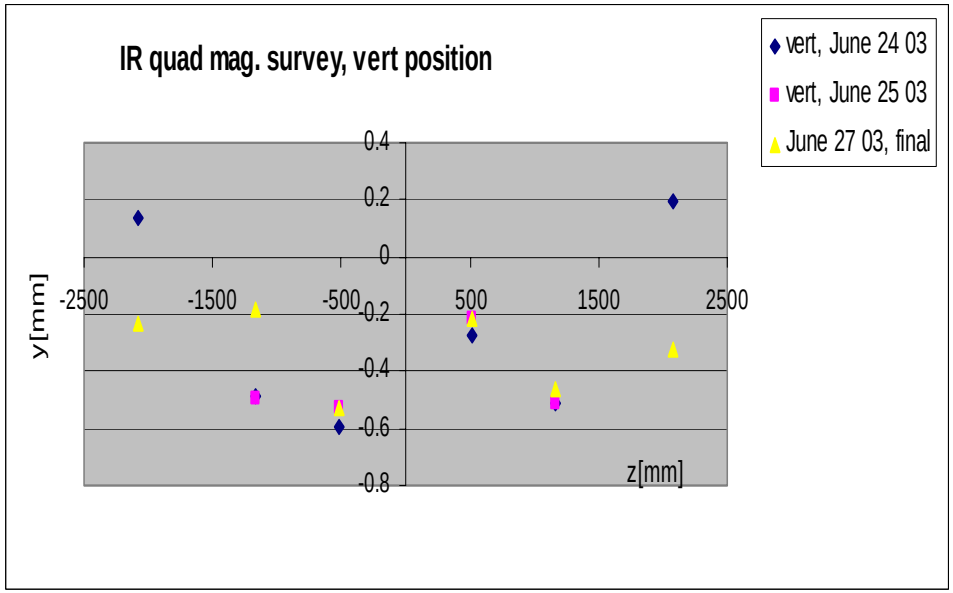
Y (Q2W) =
= 0.667 – 0.987 =
= -0.320mm

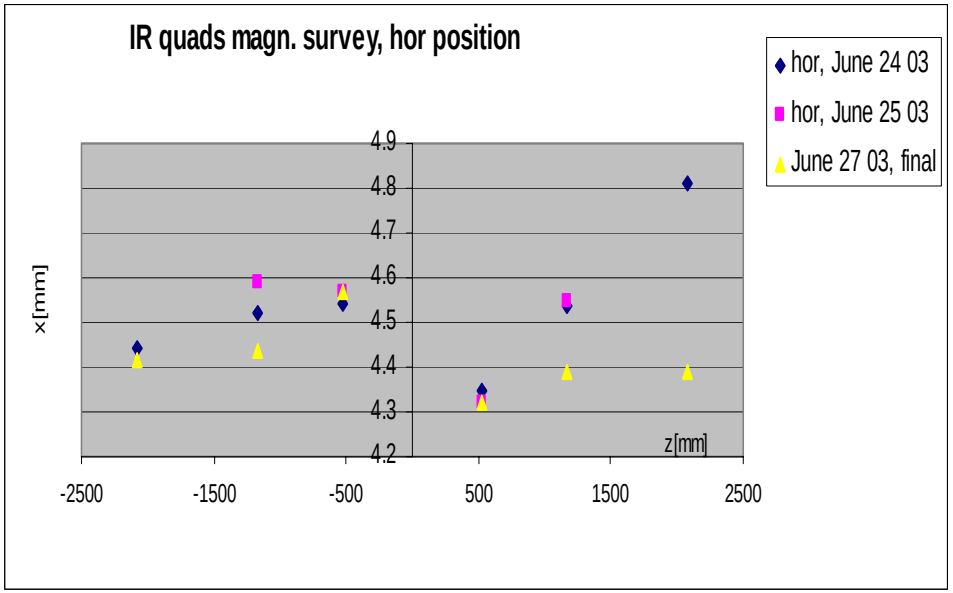
X (Q2E) = 4.417mm

X (Q2W) = 4.387mm

Magnetic survey/alignment summary

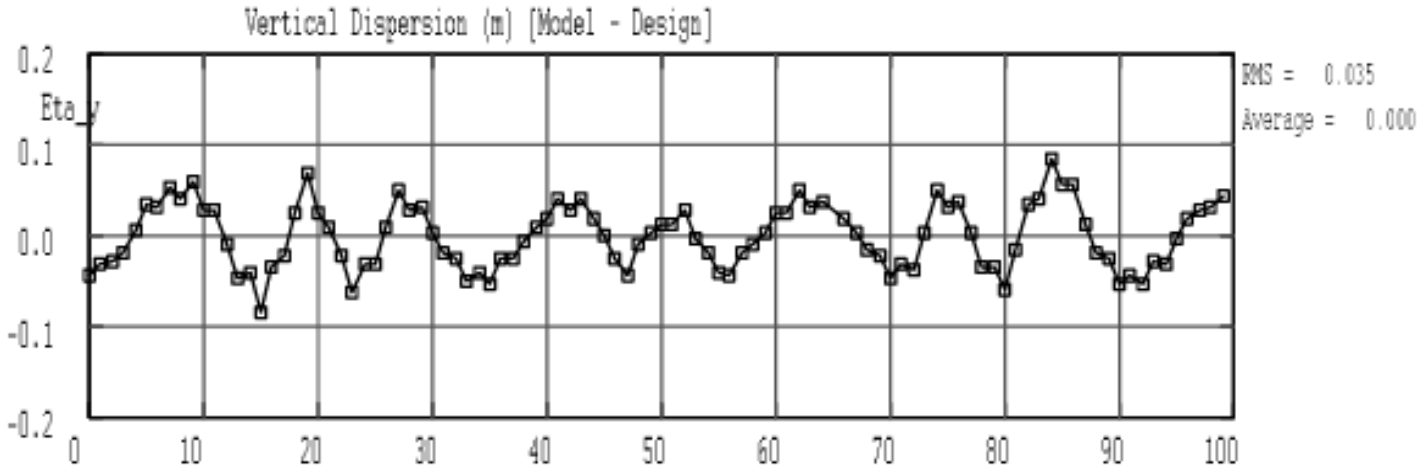
IR region magnetic survey									
		June 24 03		June 25 03		June 26 03			
	z[mm]	x[mm]	y[mm]	x[mm]	y[mm]	x[mm]	y[mm]	dx[mm]	dy[mm]
Q2E	-2079	4.444	0.141	4.444	0.141	4.417	-0.233	0.00	-0.09
Q1E	-1166.9	4.522	-0.488	4.587	-0.495	4.437	-0.182	-0.02	-0.14
Q0E	-520	4.544	-0.598	4.57	-0.527	4.57	-0.527	-0.15	0.20
Q0W	520	4.347	-0.277	4.32	-0.22	4.32	-0.22	0.10	-0.10
Q1W	1166.9	4.539	-0.51	4.55	-0.515	4.392	-0.465	0.03	0.14
Q2W	2079	4.81	0.191	4.81	0.191	4.387	-0.32	0.03	0.00
<>		4.53	-0.26	4.55	-0.24	4.42	-0.32		
std		0.15	0.34	0.16	0.33	0.08	0.14		

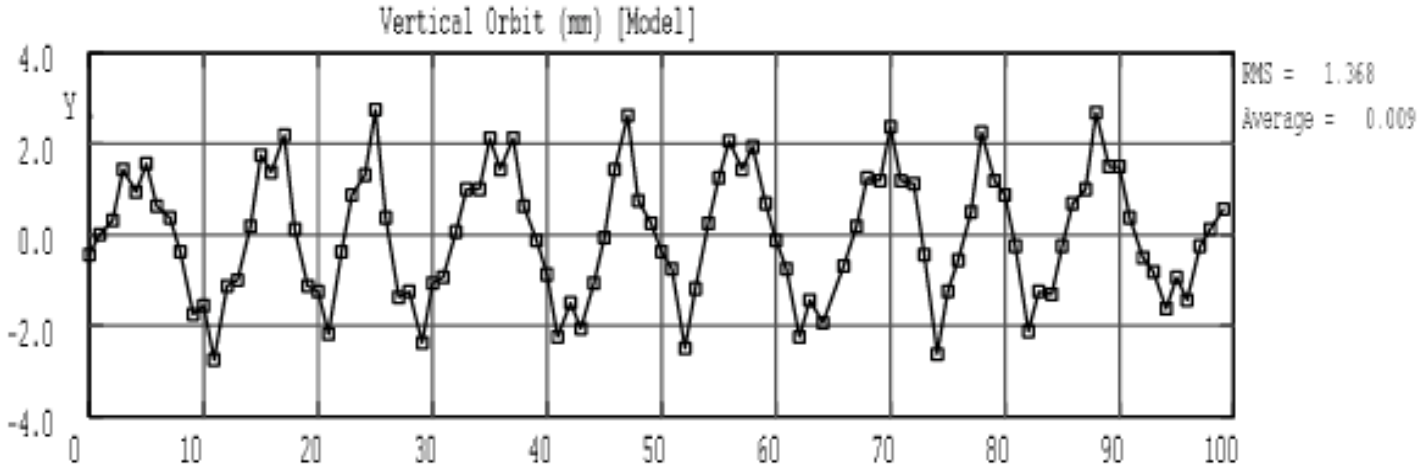




Vertical dispersion and vertical orbit distortion due to IR quads offset

model optics: 1885MEV_1WIG_R1_19OT





Vertical dispersion and vertical orbit corrected with: V01W = -0.42mrad (-921cu), V02W = 0.21mrad (1100cu)