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Discussion On RHIC Lattice

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April 1984

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USDOE Office of Science (SC)

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DISCUSSION ON
RHIC LATTICE

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April 2, 1984

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RHIC Lattice

History: CBA 1 in 1, Symmetric, $\beta_x^* = 40$, $\beta_y^* = 7.5 - 2$ m
CBA 2 in 1, anti-symmetric, $\beta_x^* = \beta_y^* = 7 - 2$ m

RHIC Feasibility Study

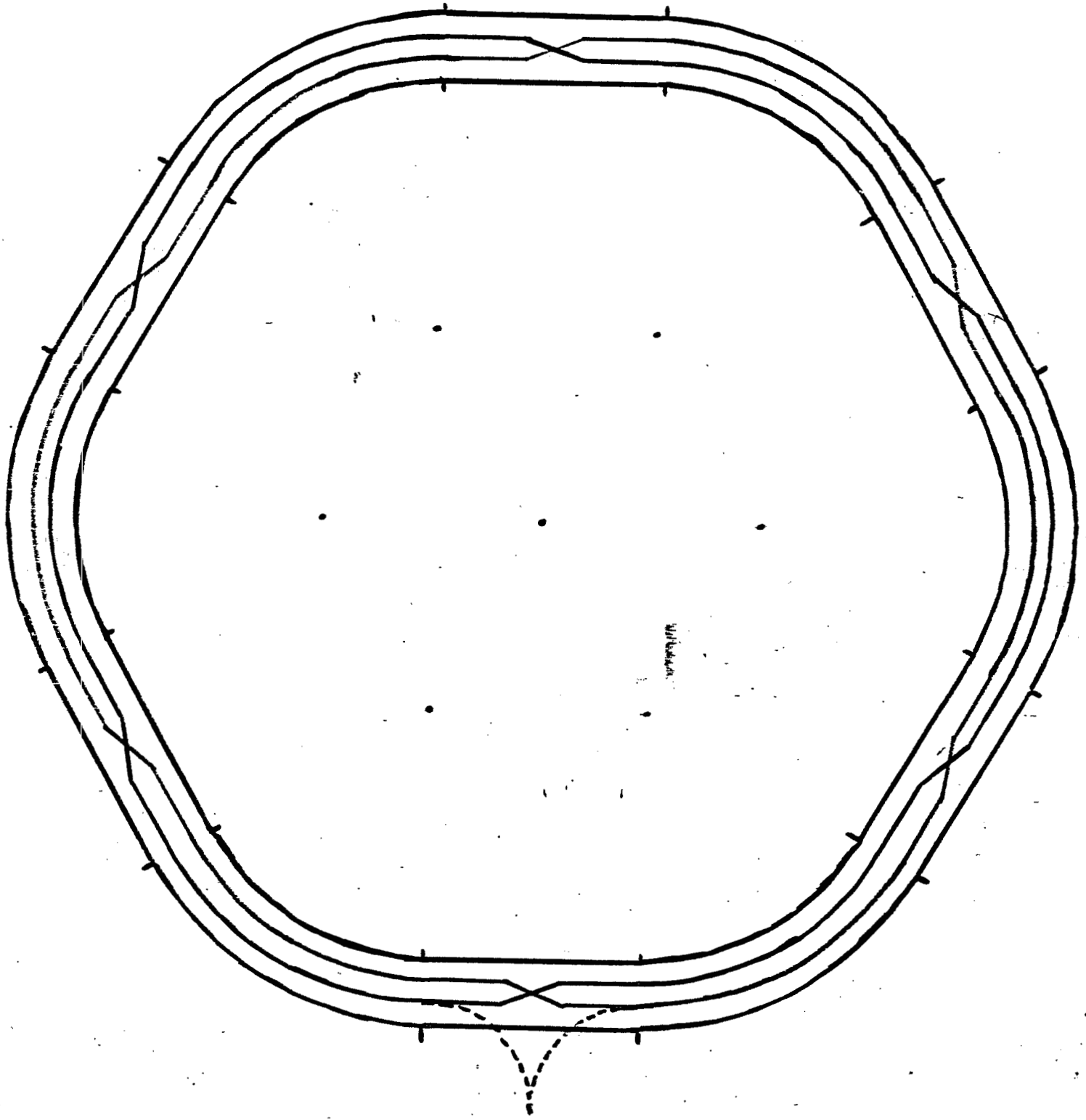
CBA 2 in 1, Symmetric, missing magnets

RHIC 1, symmetric, 9×90 , $\beta_x^* = 40$, $\beta_y^* = 7.5$ m

RHIC 2, symmetric, 12×100 , $\beta_x^* = 17$, $\beta_y^* = 3$ m

RHIC 2 Parameters:

Circumference (m)	3883.845
Radius of Arcs (m)	381.2332
Distance between Rings (m)	0.15 - 0.18 - 0.24 - 0.30
Number of cells / arc	12
Half cell length (m)	14.811
Deflection angle / half cell ($\int B dl / B\rho$ per arc dipole in mrad)	38.85
$\int B' dl / B\rho$ per arc quadrupole (m^{-1})	0.1065
Number of dipoles / ring	144 + 24 + 24
Number of quadrupoles / ring	234
Distance from crossing point to nearest magnet (m)	10.
v_x / v_y	31.6 / 31.6
$\Delta\psi_x / \Delta\psi_y$ per arc cell (units of $\frac{2\pi \text{ rad}}{360^\circ}$)	0.2722 / 0.2722
$\hat{\beta}_x / \hat{\beta}_y$ in arcs (m)	51.58 / 7.46
$\hat{\beta}_y / \hat{\beta}_y$ in arcs (m)	51.58 / 7.46
\hat{x}_p / \hat{x}_p in arcs (m)	1.385 / 0.640
$\Delta\psi_x / \Delta\psi_y$ per insertion (units of $\frac{2\pi \text{ rad}}{360^\circ}$)	2.0 / 2.0
$\beta_x^* / \beta_y^* / x_p^*$ (m)	17.7 / 3.0 / 0.0
$\hat{\beta}_x / \hat{\beta}_y$ (m)	267. / 667.



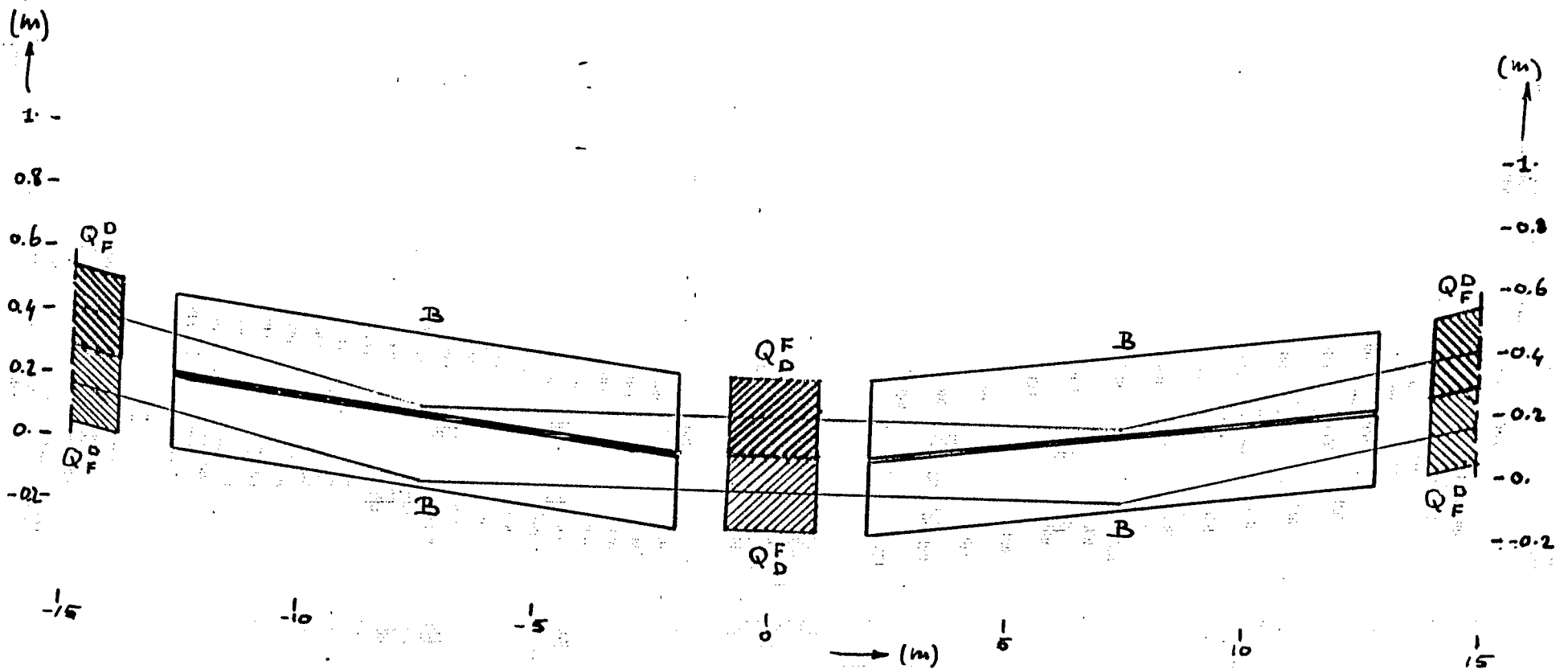
RHIC Regular Cell Pair

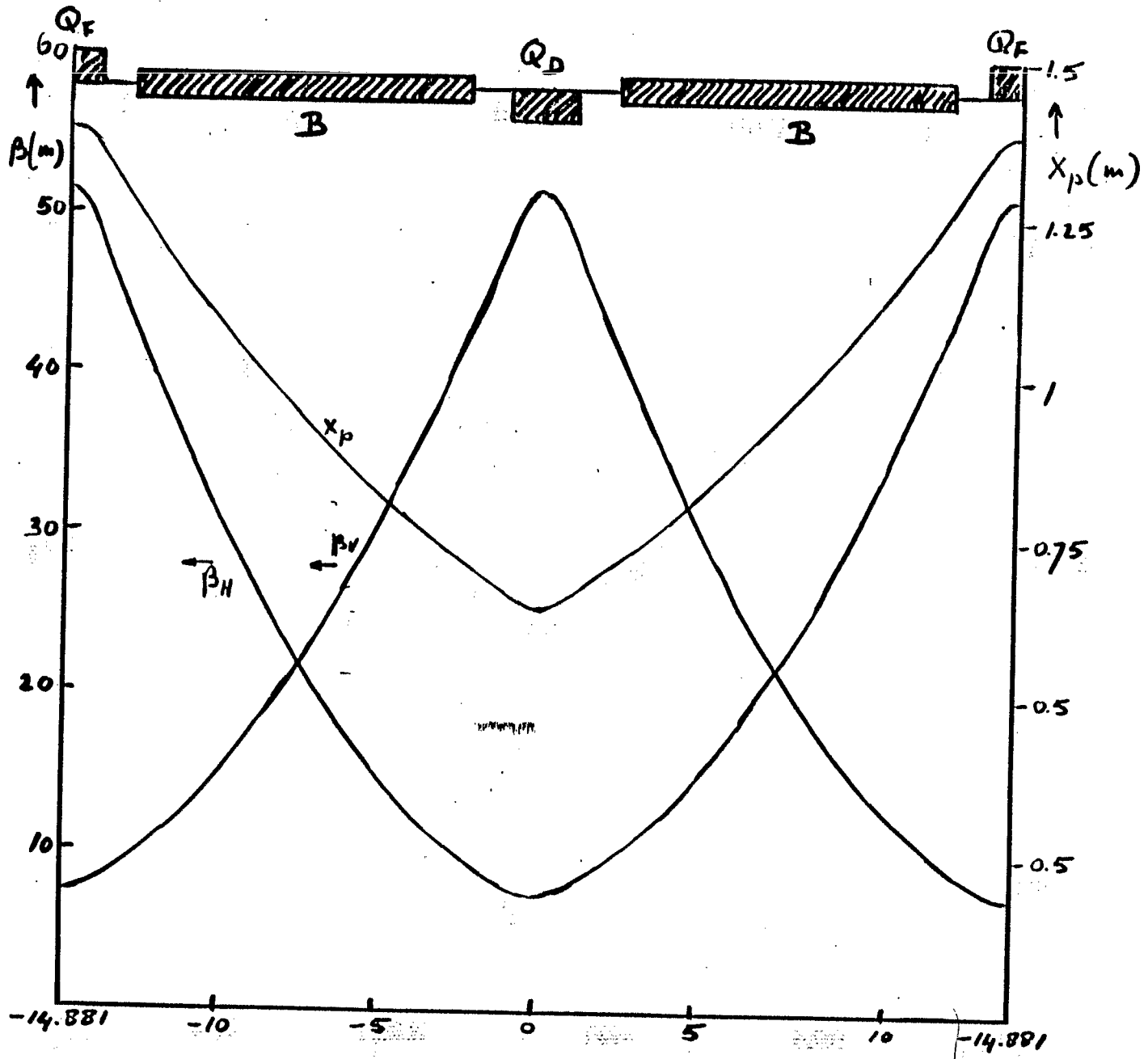
$$\theta_H = \frac{\int B' dl}{B\rho} = 0.03885 \text{ rad}$$

$$\frac{\int B'' dl}{B\rho} = 0.1065 \text{ m}^{-1}$$

$$R_{av} = 381.23 \text{ m}$$

$$L_{HC} = 114.811 \text{ m}$$

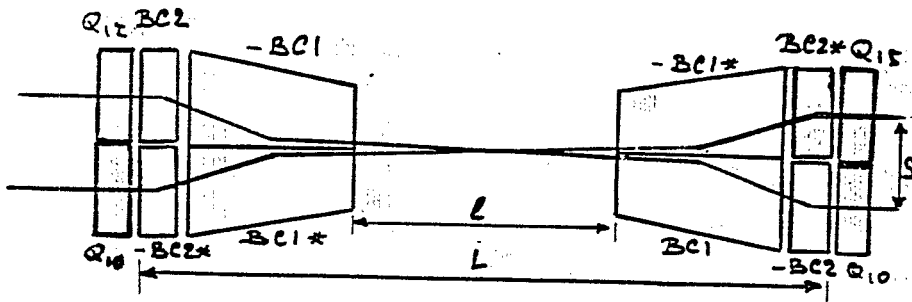




RHIC REGULAR ARC CELL (02/14/84 09.48.54)

Crossing Point Regions

Present arrangement:



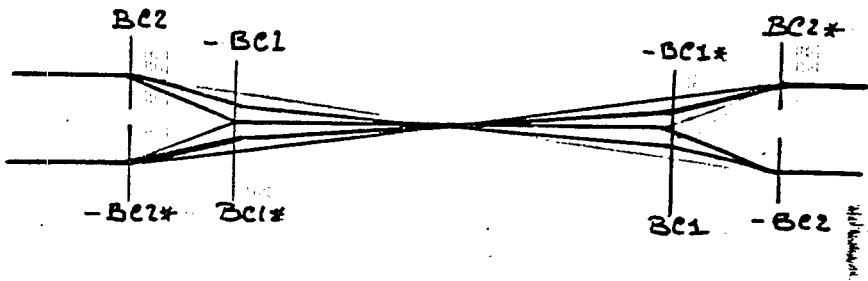
$$l = 22 \text{ m}$$

$$\alpha = 2 - 8.7, 10.8 \text{ mrad}$$

$$S = 0.24 \text{ m}, 0.30 \text{ m}$$

$$L = 58 \text{ m}$$

stylize to:



$\pm BC1, \pm BC2, \pm BC1^*, \pm BC2^*$ are dipoles with parallel entrance and exit edges, \pm indicates polarity.

For operation with equal momenta (B_p values) in the two rings: $(-BC1, BC1^*)$ and $(BC1, -BC1^*)$ can each be a one aperture magnet, but aperture must be large enough to accommodate the desired range of α .

Colinear beams: equal deflection angles in all magnets.

"Natural" crossing angle: no deflection in units $BC1$.

For operation with different momenta $((B_p)_1 / (B_p)_2 \leq 2.5)$

$|BC_2^1| \neq |BC_2^{1*}|$: colinear beams impossible.

In order to minimize α , maximize effective aperture:

Construct $(-BC1/BC1^*)$ and $(BC1/-BC1^*)$ as two aperture septum magnets.

Septum must carry current (for unequal Bp 's) and be thin: low fields and therefore long magnets.

Present arrangement can be improved upon by sectionalizing these magnets into shorter units with increasing fields and septum thicknesses.

Optimisation Problem: L should be minimized at fixed l in order to maximize effective aperture elsewhere in the rings \rightarrow $BC1$ and $BC2$ should be short and therefore strong.

Ring design Problem: the crossing dipoles cause significant dispersion, anti symmetric relative to the crossing point, a major perturbation in an otherwise symmetric lattice.

Present approach: try to live with it.

Consequences: severe loss of symmetry properties, effective aperture and flexibility.

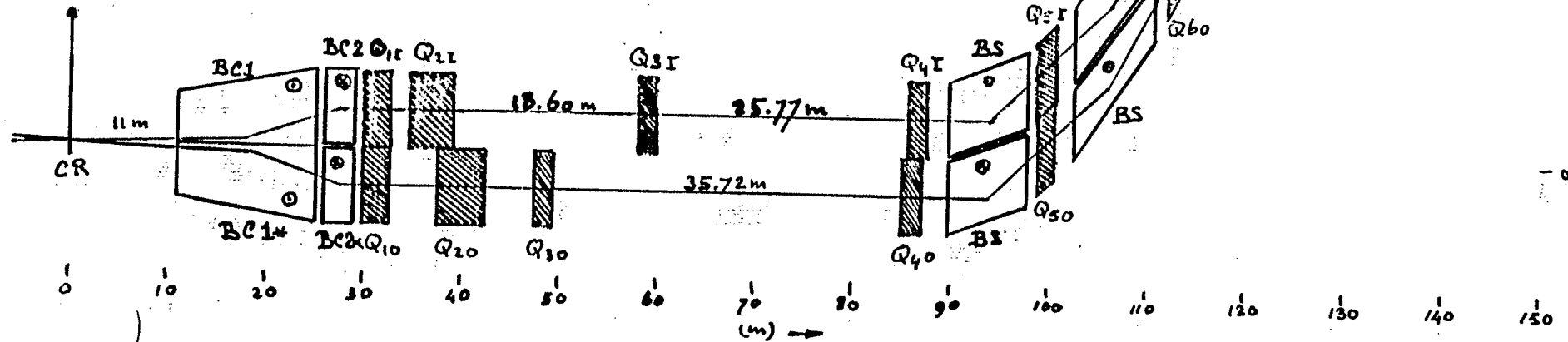
Alternatives: a) introduce extra quad to remove dispersion. Promising results so far.
b) use anti symmetric lattice, like CBA's anti symmetric $2\pi 1$.

RHIC Half Insertion (02/14/84 09:48:54)

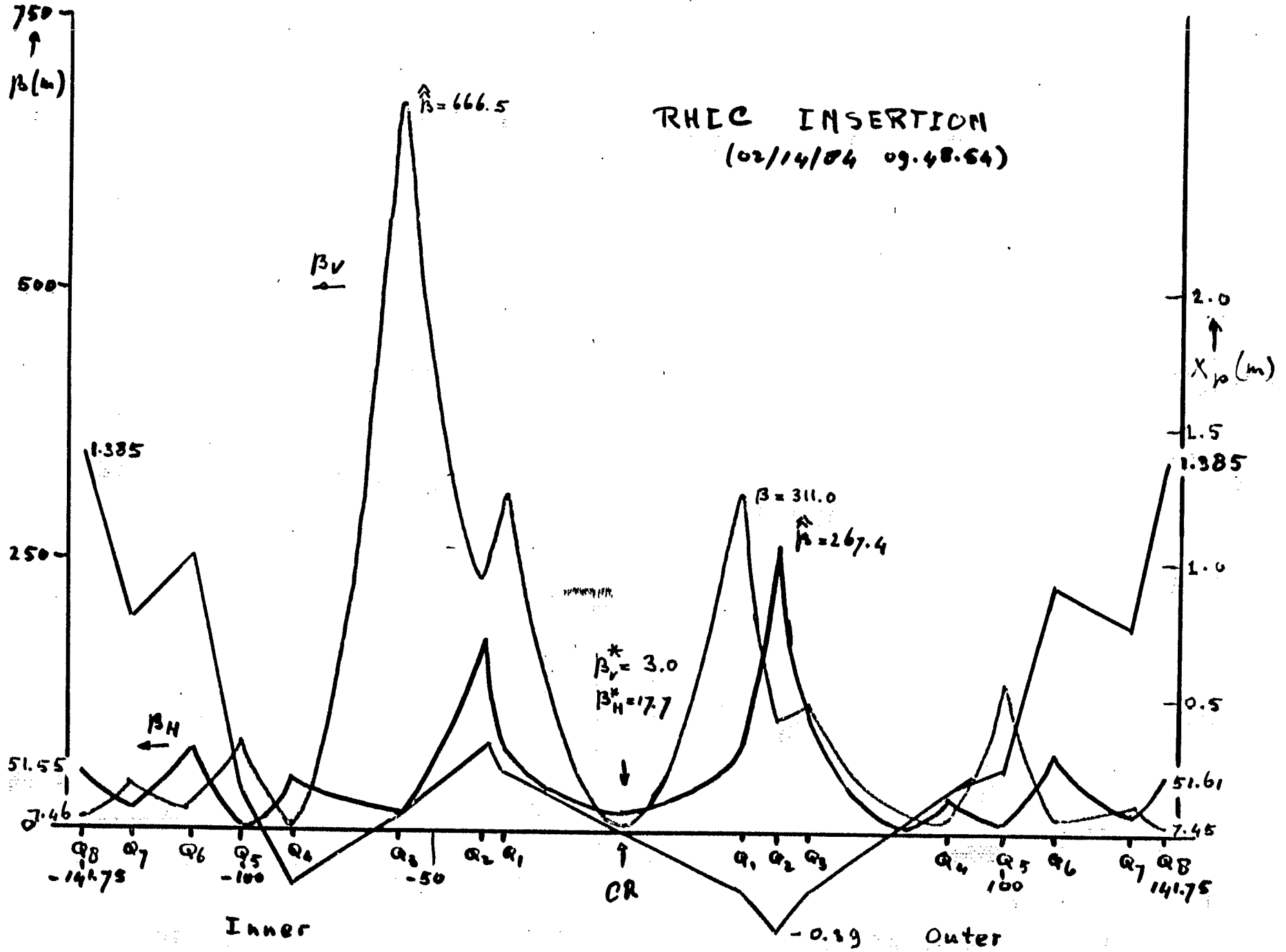
Quad Strengths ($\frac{\int B^2 dl}{B_p}$, m^{-1})

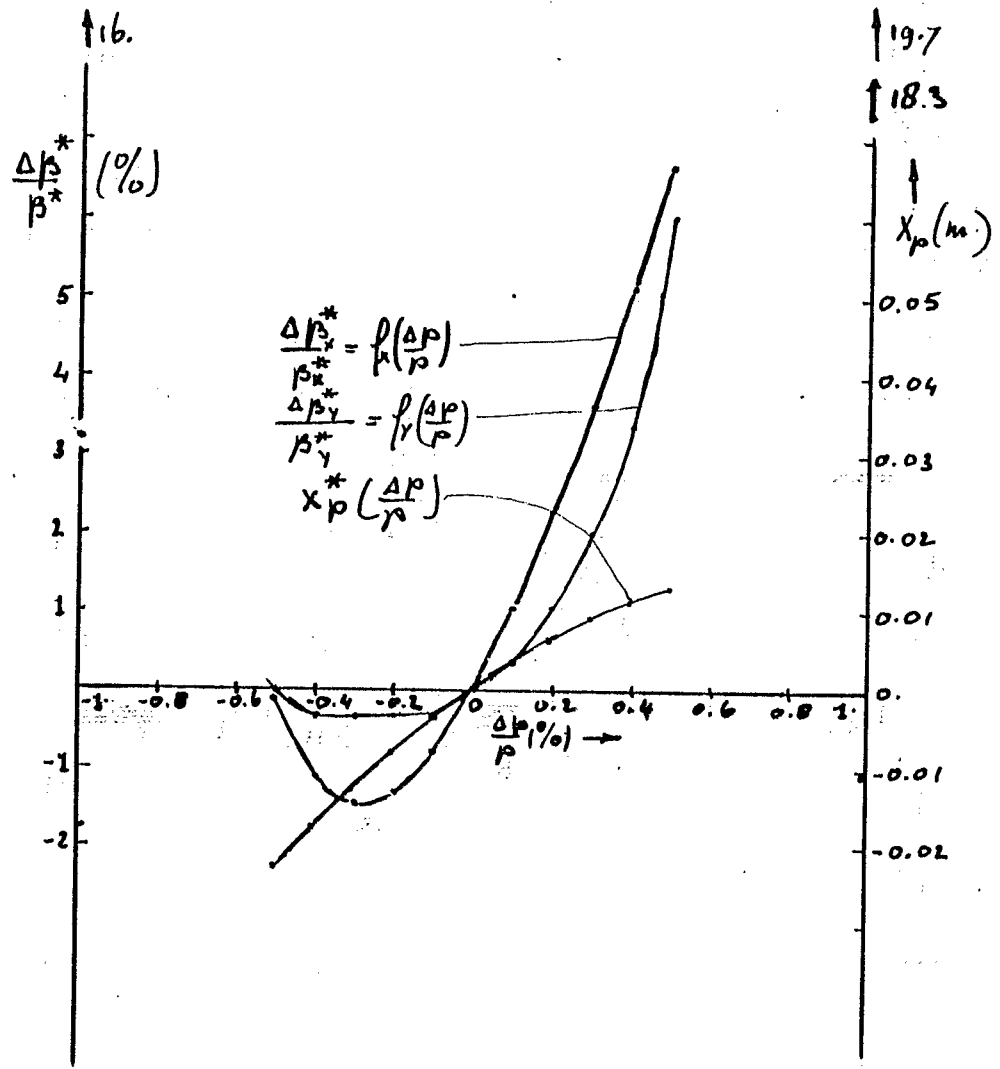
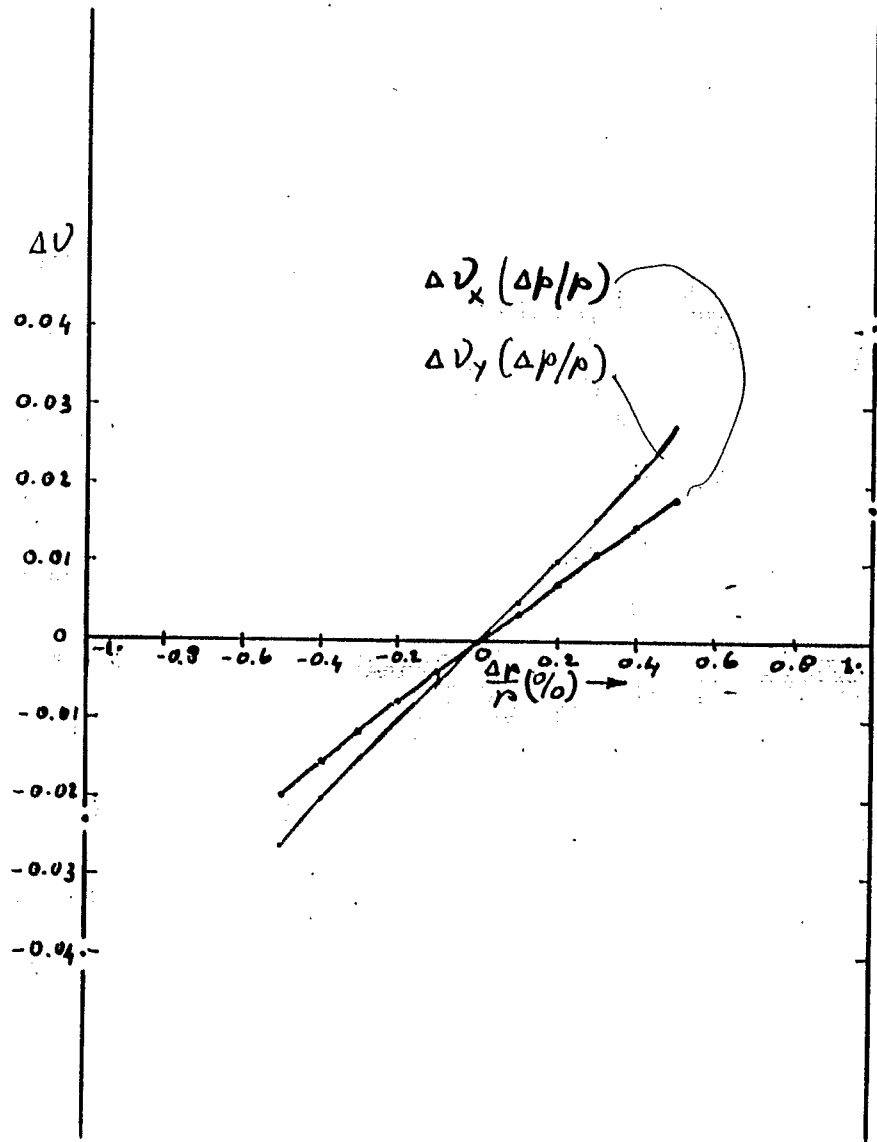
Q1	0.09070	0.09273
Q2	0.11593	0.11919
Q3	0.05906	0.04531
Q4	0.11367	0.12628
Q5	0.13379	0.10985
Q6	0.10440	0.09167
Q7	0.09040	0.12905
Q8/QF	0.08884	0.11272

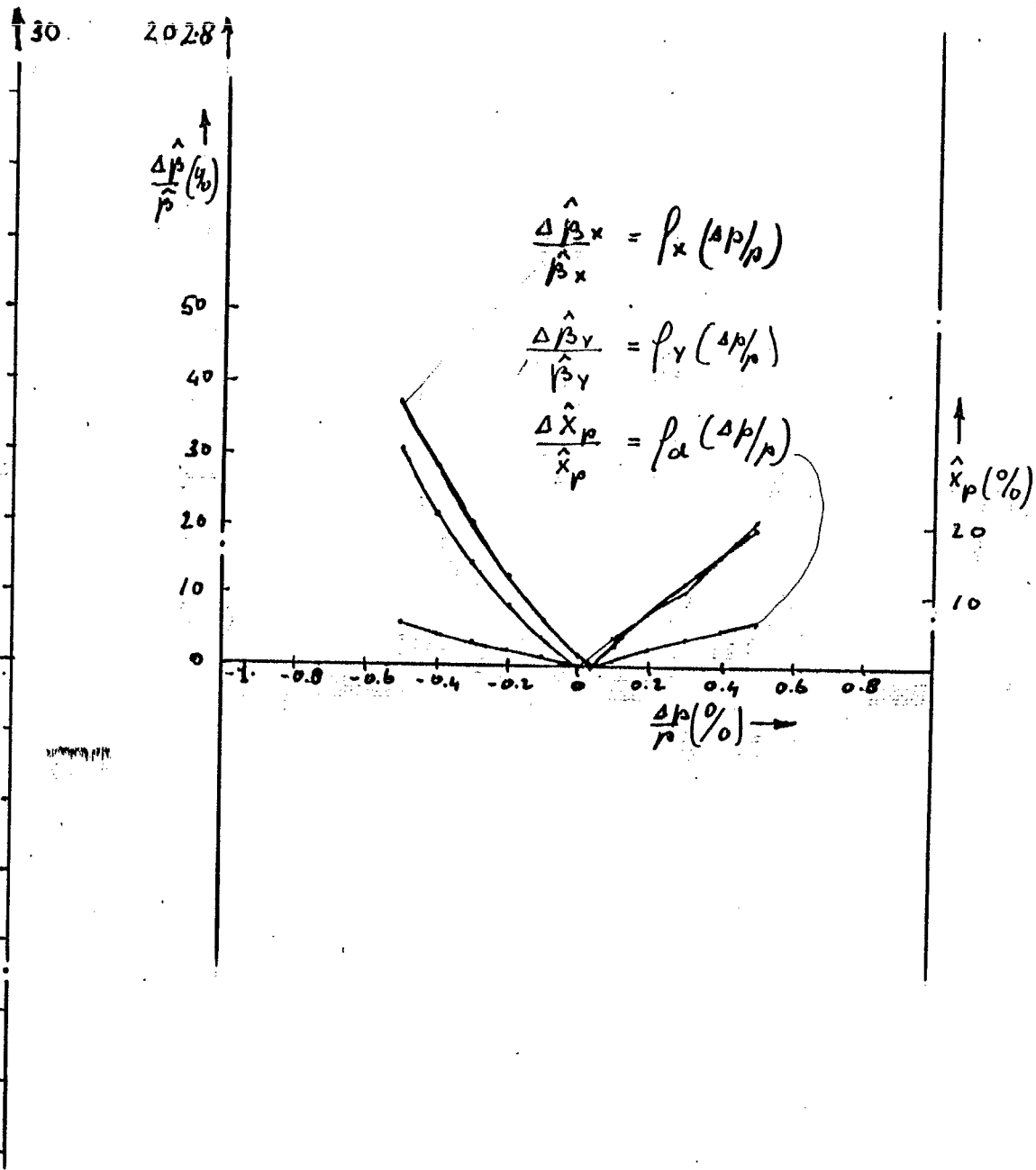
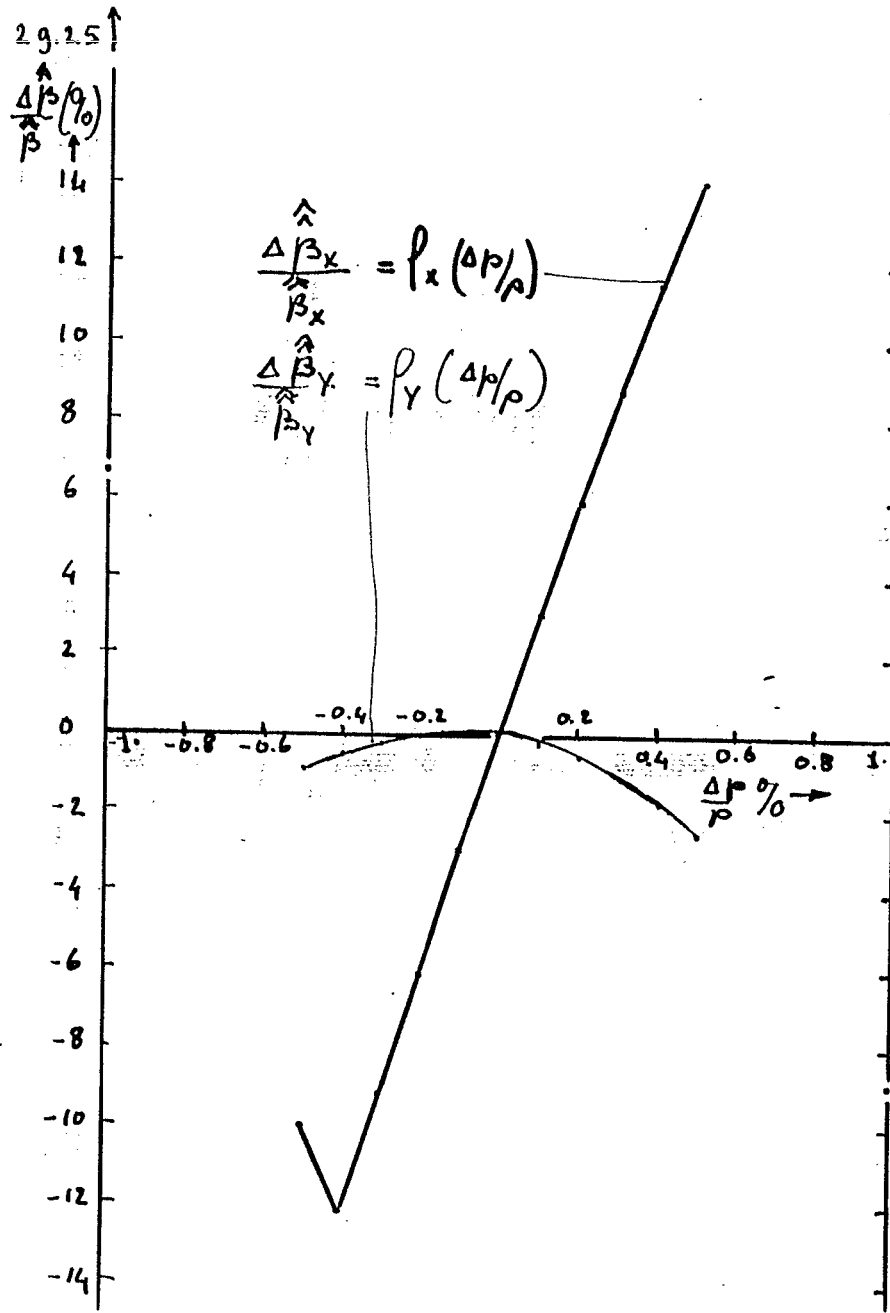
Center at 590.515m



RHEC INSERTION (02/14/04 09.48.64)



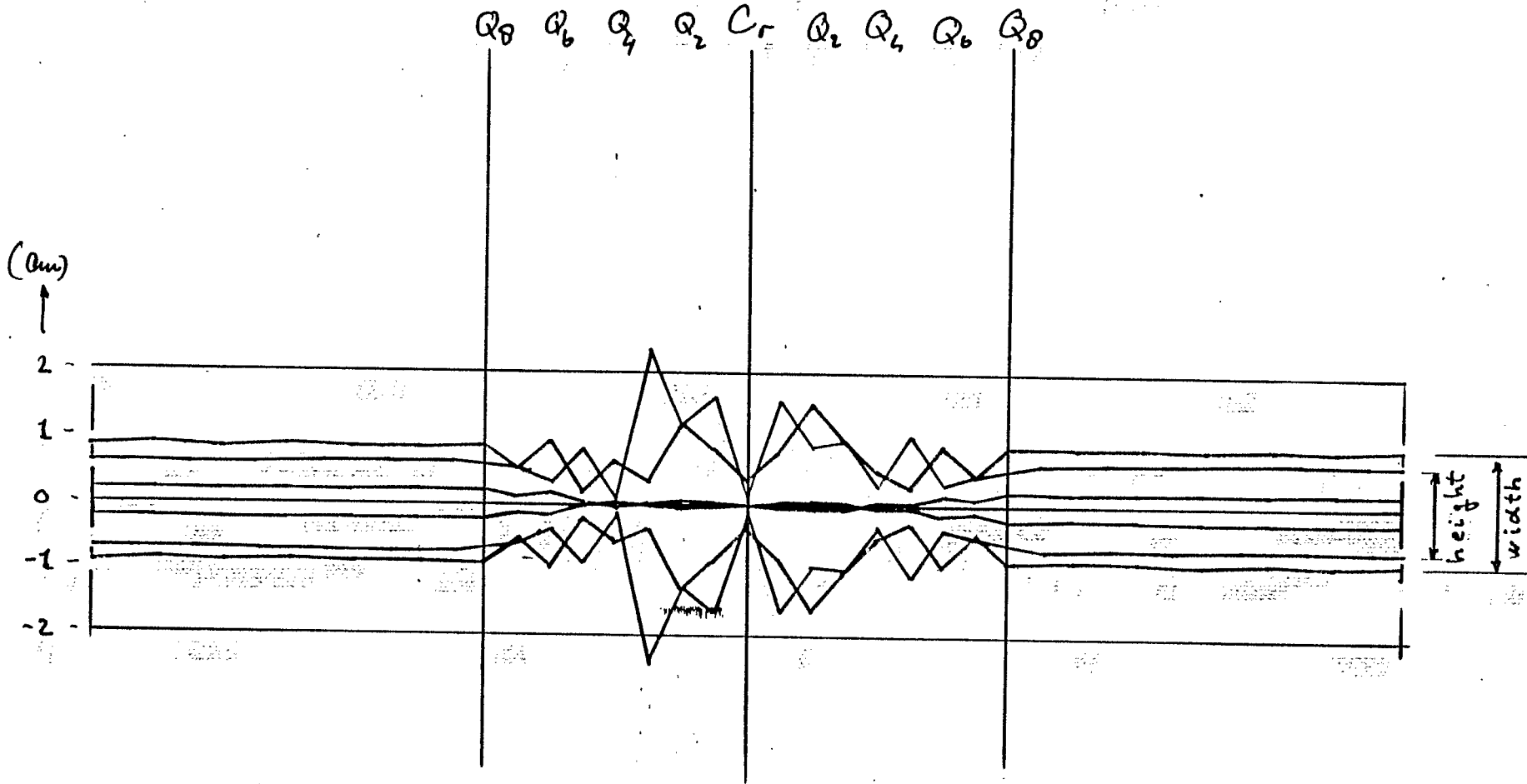




Inner Arc

In section

Outer Arc



Beam dimensions at injection
 $\gamma = 12$

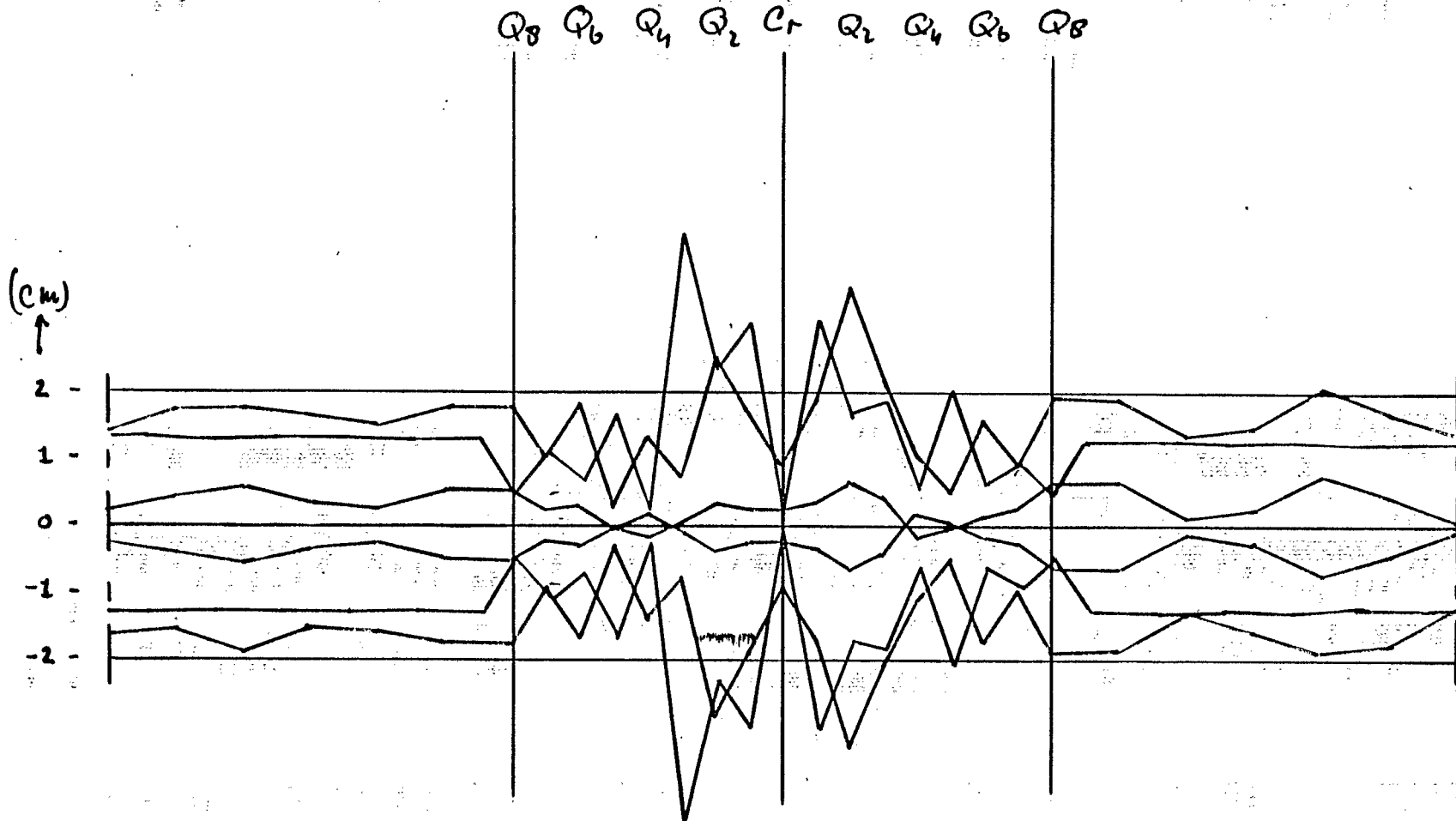
$$\Sigma = 10 \times 10^{-6} \text{ rad-m (2.5\%)}$$

$$\frac{\Delta p}{p} = \pm 1.62 \times 10^{-3}$$

Inner Arc

Insertion

Outer Arc



Beam dimensions after 2hrs
at $\gamma = 12$

$$\sigma = 34.5 \times 10^{-6} \text{ rad-m (2.5\sigma)}$$

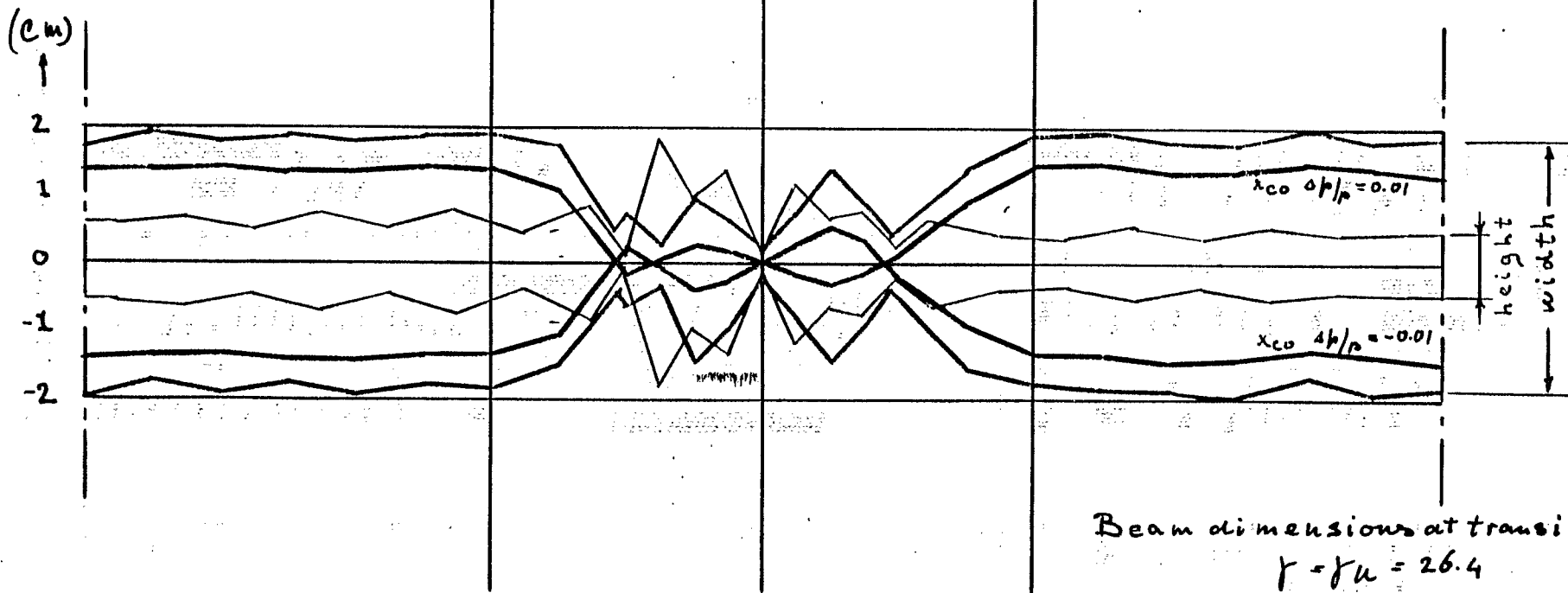
$$\frac{\Delta p}{p} = \pm 3 \times 10^{-3}$$

Inner Arc

Insertion

Outer Arc

Q₈ Q₆ Q₄ Q₂ CR Q₂ Q₄ Q₆ Q₈



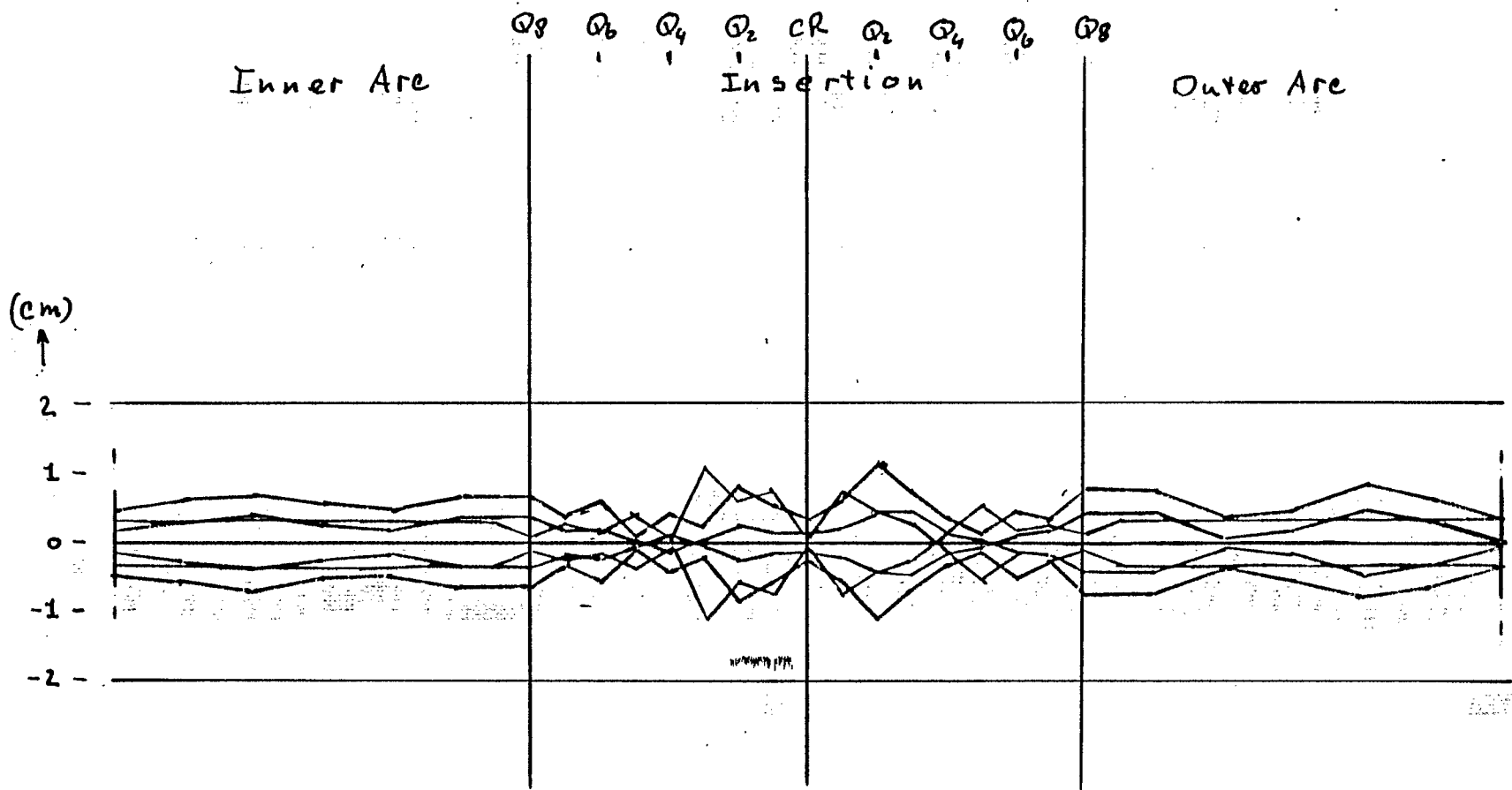
Beam dimensions at transition

$$\gamma = \gamma_u = 26.4$$

$$\epsilon = 10 \times 10^{-6} \text{ rad-m (2.55)}$$

$$\Delta p/p = \pm 0.01$$

02/06/84 16.34.47 JEL



Beam dimensions after 2 hrs
at $f = 100$

$$\varepsilon = 18.4 \times 10^{-6} \text{ rad-m (2.5\sigma)}$$

$$\frac{\Delta p}{p} = \pm 2 \times 10^{-3}$$