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Verification Of The Magnet Enclosure Geometry And Of The Dispersion Killer For The RHIC-PG-12 Lattice

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RHIC-PG-14

VERIFICATION OF THE MAGNET ENCLOSURE GEOMETRY AND OF THE DISPERSION KILLER FOR THE RHIC-PG-12 LATTICE

J. CLAUS

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YEC
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Geometry magnet enclosure: $R^* = 590.3298$ m
$l_1 = 103.772$ m
$l_2 = 38.0052$ m
$\bar{\theta} = 0.057394454$ rad
$r = 239.6523$ m
$\rho = 381.2325$ m
$R = \rho + r = 620.8848$ m.

RHIC work 12.

Cells / super period $N_c = 16$
Dipoles / half super period $N_D = N_c + 1 = 17$
Deflection angle per dipole $\Theta = \pi/6 N_D = 0.030799928$
Half cell length
$L_{HQ} = 0.95$ m
$D = 0.995$ m
$L_D = 7.85$ m
$D = 0.995$ m
$L_{HQ} = 0.95$ m

$L_{HC} = 11.74$ m.

Average radius $\rho_m = L_{HC}/\Theta = 381.1697225$ m
Half arc length $L_{HA} = N_c * L_{HC} = 16 \times 11.74 = 187.84$ m
Dispersion correction $l_2 = 1/2 * L_{HC} = 17.61$
Distance from crossing point to bending point Disp. Cor.:

$$l_1 = C/12 - l_2 - L_{HA} = \frac{3833.845}{12} - 17.61 - 187.84$$

$$= 114.037083$$

$l_2 = 17.61$
$\bar{\theta} = \Theta = 0.030799928$

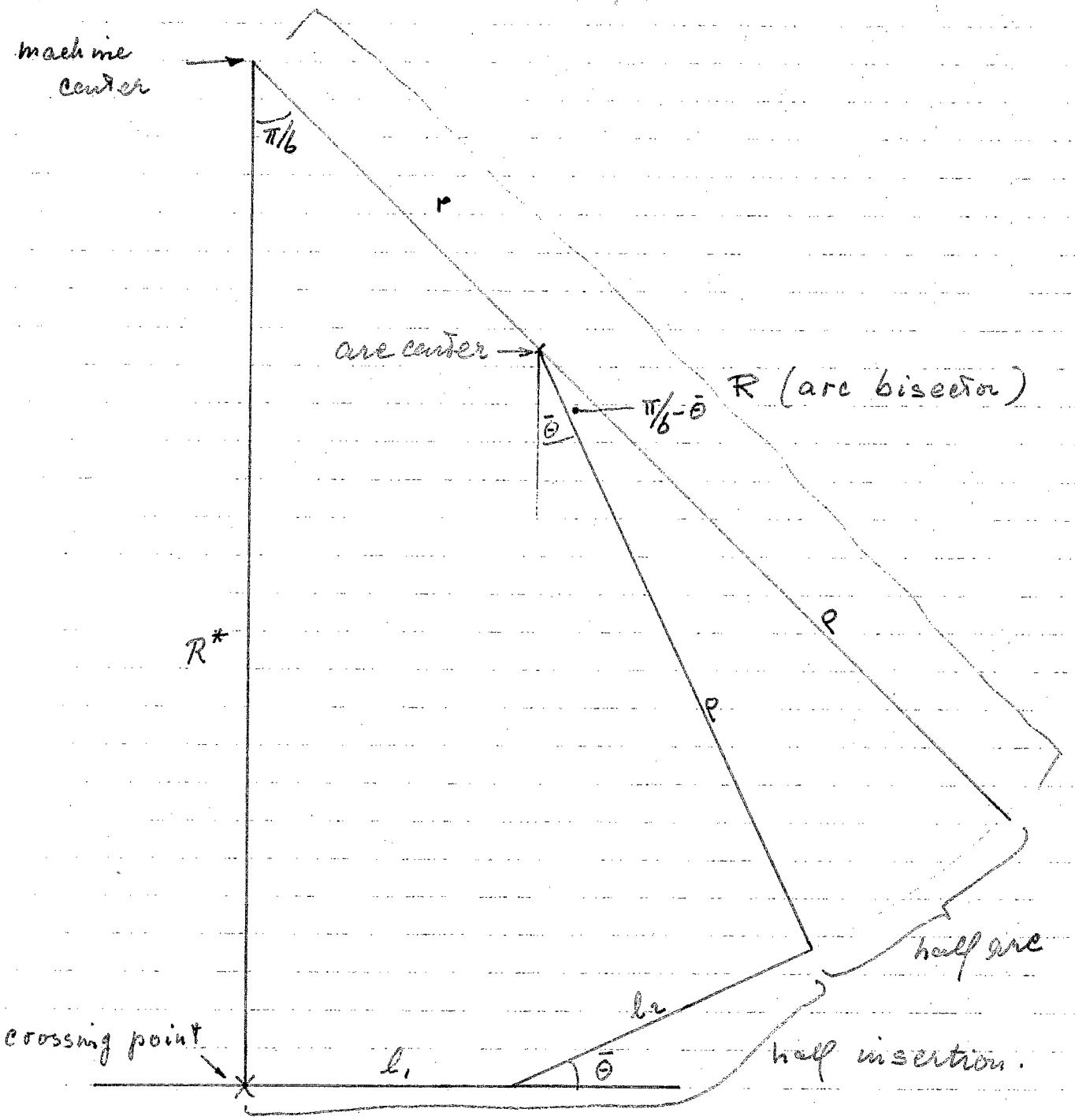
$$R^*_m = (l_1 + l_2 \cos\bar{\theta} - \rho_m \sin\bar{\theta})/\tan\pi/6 + \rho_m \cos\bar{\theta} + l_2 \sin\bar{\theta}$$

$$= 589.2051513 \text{ m}$$

$$\Delta R^* = R^*_m - R^*_t = -1.1246487$$

$$r_m = (l_1 + l_2 \cos\bar{\theta} - \rho_m \sin\bar{\theta})/\sin\pi/6 = 239.8011746$$

$$R_m = r_m + \rho_m = 620.9708971$$



Inspection shows: $r \sin\frac{\pi}{6} = l_1 + l_2 \cos\bar{\theta} - \rho \sin\bar{\theta}$

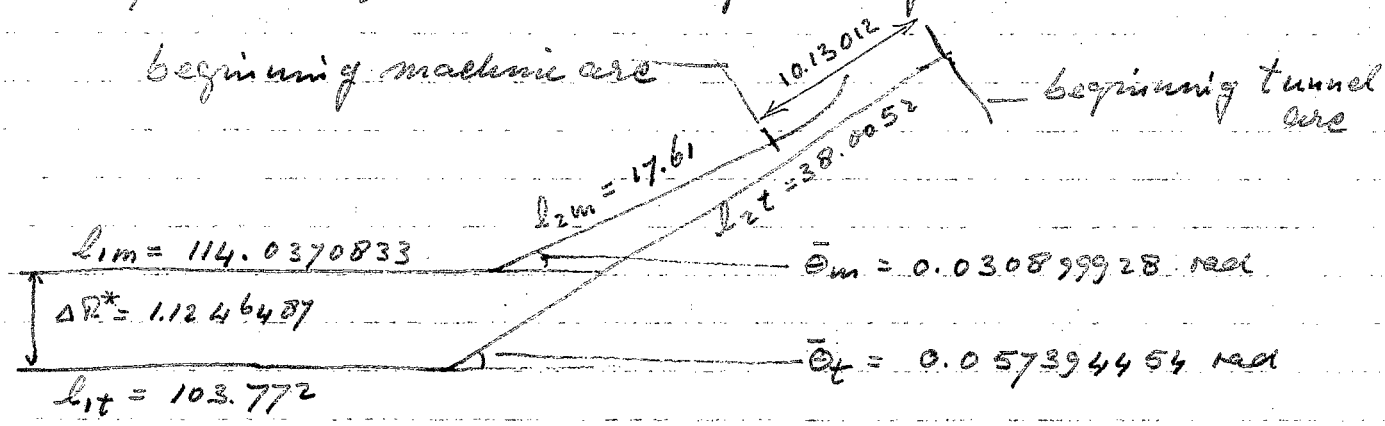
$$R = r + \rho$$

$$R^* = r\cos\left(\frac{\pi}{6}\right) + \rho\cos\bar{\theta} + l_2 \sin\bar{\theta}$$

$$C/12 = l_1 + l_2 + \left(\frac{\pi}{6} - \bar{\theta}\right)\rho$$

$\Delta R = R_m - R_t = 0.0860971 m$

Consequences for insertion geometry.



Conclusions: tilt in tunnel: $\Delta R^* = -1.125 m$.

Short clamping injection by $l_{1t} + l_{2t} - l_{1m} - l_{2m} =$

$0.130167 m$.

and by $\bar{\theta}_t - \bar{\theta}_m = 26.59$ mrad.

Dispersion Corrector:

$$\begin{matrix} \theta \\ \cdot \end{matrix} \begin{matrix} \frac{1}{2}\ell \\ q \end{matrix} \left\| \begin{matrix} \ell \\ q \end{matrix} \right. \begin{matrix} \ell \\ -q \end{matrix} \left| \begin{pmatrix} x_p \\ \theta \end{pmatrix} \right.$$

$$\begin{pmatrix} x_p \\ x'_p \end{pmatrix}_2 = \begin{pmatrix} 1 & \frac{1}{2}\ell \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ q & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ q & 1 \end{pmatrix}\begin{pmatrix} 1 & \ell \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ -q & 1 \end{pmatrix}\begin{pmatrix} x_p \\ 0 \end{pmatrix}_1 + \begin{pmatrix} 0 \\ \theta \end{pmatrix}$$

$$= \begin{pmatrix} 1 - \frac{1}{2}\ell q - (\ell q)^2 \\ q(1 - 2\ell q) \end{pmatrix}\begin{pmatrix} x_p \end{pmatrix}_1 + \begin{pmatrix} 0 \\ \theta \end{pmatrix}$$

We want $x_{p_2} = 0$, $x'_{p_2} = 0$ So

$y = x_{p_2} = 0 \longrightarrow 1 - \frac{1}{2}\ell q - (\ell q)^2 = 0 \longrightarrow \ell q = \frac{1}{4}(-1 + \sqrt{1+16})$

$= 0.780776407$

$\ell q = \sin\frac{\Delta\psi}{2} \longrightarrow \Delta\psi = 2\arcsin \ell q$

$= 1.791814963$ rad

$= 102.6634^\circ$.

$y' = x'_{p_2} = 0 \longrightarrow \frac{\theta\ell}{x_{p_1}} = \ell q(2\ell q - 1)$

$= 0.438447187$

$\frac{x_{p_1}}{\theta\ell} = 2.280776406$

Dispersion for 4 quarter cell: $\frac{x_{p_1}}{\ell\theta} = \frac{1 + \frac{1}{2}\sin\frac{\Delta\psi}{2}}{\sin^2\frac{\Delta\psi}{2}}$

$= 2.280776407$.

Conclusion : Proposed dispersion correction models indeed proposed are adequate, provided that phase advance per cell $\Delta\psi = 1.7918\,\text{rad}$
$= 102.6634°$.