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# Vu-graphs of Presentation by Johannes Claus at RHIC Meeting Wednesday, Nov. 21, 1984

J. Claus

November 1984

Collider Accelerator Department
**Brookhaven National Laboratory**

**U.S. Department of Energy**
USDOE Office of Science (SC)

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High Energy Facilities
Advanced Projects

RHIC-AP-8

BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, New York 11973

RHIC Technical Note No. 8

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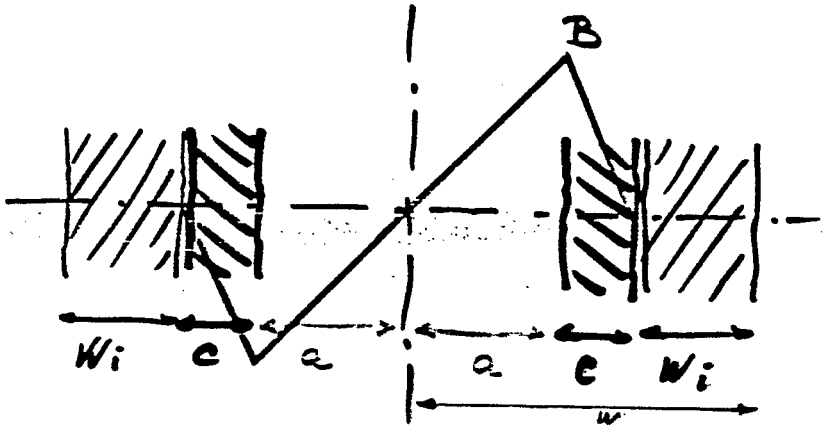
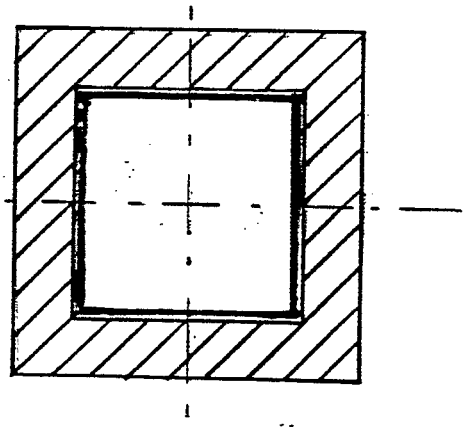
November 26, 1984

$$\varphi = \frac{(\beta\eta)_2/(\beta\eta)_1 - 1}{1 + (\beta\eta)_2/(\beta\eta)_1}\left(\frac{\alpha}{5} - \frac{b}{L}\right)$$

# Aperture and gradient in Quadrupole



Flux in iron: $\psi_i = B_i w_i = \frac{1}{2} \hat{B} (a+c)$

$\therefore w_i = \frac{1}{2} \frac{\hat{B}}{B_i} (a+c)$; $\hat{B} = B_i = 2T \rightarrow 2w_i = a+c \rightarrow w_i = \frac{1}{3} w$

Since $B' = \hat{B}/a$: $B' = \frac{2 B_i w_i}{a(a+c)} = \frac{2B_i}{a} \left(\frac{w}{a+c} - 1\right)$ $\quad a+c = \frac{2}{3} w$

$= \frac{2}{a} = \frac{2}{\frac{2}{3}w - c} = \frac{3}{w - \frac{3}{2}c}$

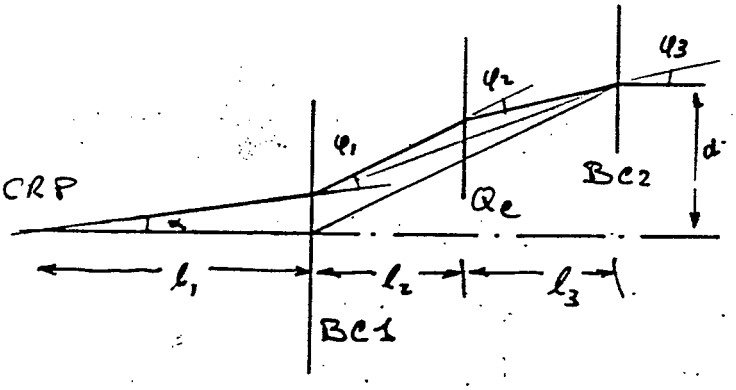
$\infty$

$$\beta = \beta^* + \frac{(l_1 + l_2)^2}{\beta^*} \rightarrow$$ constant beam dimensions at entrance $\varphi_e$ for constant beam dimensions in crossing point regardless of $\varphi_e$.

$\beta^* << l_1 + l_2 \rightarrow \sqrt{\beta} = (l_1 + l_2) / \sqrt{\beta^*}$

Aperture required in $\varphi_e \propto (l_1 + l_2)$

Space available for $\varphi_e \propto l_2$




Freedom of dispersion if

$$\frac{B'}{B\rho} l_{q_e} = \frac{l_2 + l_3}{l_3 (l_1 + l_2)} + \left(1 - \frac{\varphi_1}{\varphi_3}\right) \frac{l_1}{l_3 (l_1 + l_2)}$$

$\alpha + \varphi_1 - \varphi_2 - \varphi_3 = 0$

$\alpha (l_1 + l_2 + l_3) + \varphi_1 (l_2 + l_3) - \varphi_2 l_3 = d$

$l_1 \sim 3m$ $\quad \alpha = 0 - 1$ mrad

$l_2 \sim 6 m$

$l_3 \sim 4 m$

$d \sim 0.175m$ $\quad \varphi_3 = 17.5 - 13.7$ MV/c

| Dipole Fields (T) | | 3.5 | 4 | 4.5 | 5 | 5.5 |
|---|---|---|---|---|---|---|
| $\beta_x^*/\beta_y^*$ | (m/m) | 1.03/5.46 | 1.05/5.34 | 1.06/5.28 | 1.05/5.30 | 1.23/4.57 |
| $\beta_x/\beta_y$ | (m/m) | 321/489 | 294/452 | 277/425 | 268/403 | 268/609 |
| BC1 | (mm×mm×mm) | 4000×81×18 | 3750×82×18 | 3500×77×18 | 3250×78×17 | 3750×75×19 |
| QC | (mm×mm×mm) | 2902×49×49 | 2799×47×47 | 2875×44×44 | 2762×45×45 | 3826×45×45 |
| HWQC | (mm) | 80 | 77 | 74 | 74 | 74 |
| $B/B_i$ | (T/T) | 2/2 | 2/2 | 2/2 | 2/2 | 1.4/1.4 |
| BC2 | (mm×mm×mm) | 4000×47×50 | 3750×46×48 | 3500×45×48 | 3250×45×45 | 3750×42×56 |
| Q1 | (mm×mm) | 20×57 | 20×55 | 20×55 | 21×52 | 18×64 |

Remarks.

1. The first row (labeled Dipole Fields) gives the dipole field in BC1 and BC2 that is necessary for colinear beams ($\alpha$ = 0 mrad) at B$\rho$ = 839.5 Tm.
2. The dimensions for BC1, QC and BC2 are given in the format (length × half aperture width × half aperture height). They are compatible with a 6$\sigma$ emittance of $\bar{\varepsilon} = 6 \times 33.2 \times 10^{-6}/30 = 6.64 \times 10^{-6}$ rad-m and with a distance between beam centerlines of 35 cm; operation with unequal species has not been considered.
3. Changes in beam size/position for off momentum particles have not been taken into account. It is expected that such momentum dependence will be suppressed in the critical places by the sextupole correction system.
4. HWQC represents the half overall width of QC, $\hat{B}/B_i$ the peak field in its aperture and the peak average field in its yoke. This magnet contains a superimposed dipole that is adjusted as function of the crossing angle $\alpha$ to prevent net beam deflection due to beam displacement relative to the magnet's center. The strength of this dipole can be about 0.1 $\hat{B}.LQ_c$.
5. The half aperture dimensions given for $Q_1$ are based on a gradient of 55.78 T/m in all cases.
6. The last column (3.5T, $\hat{B}/B_i$ = 1.4/1.4) shows the consequences of reductions in pole tip field and yoke field in QC. It may also be used as a solution for B$\rho$ = 1200 Tm, i.e. $E_{final}$ = 142.8 GeV/AMU, $E_{final}$ for protons = 357 GeV, provided that BC1 and BC2 are built to sustain 5T and QC to sustain $\hat{B}/B_i$ = 2T/2T.