ENERGY LOSS OF CHARGED BUNCHES IN
A CORRUGATED CYLINDRICAL WAVEGUIDE

II. COMPARISON WITH VARIOUS MODELS

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1. INTRODUCTION

The method for calculating the energy loss of charge distributions travelling along a corrugated cylindrical waveguide is described in [1]. In this paper we shall concentrate on the energy loss of point charges travelling along the axis of the waveguide.

We compare the computational results with two analytical formulae, one given by Lawson [2] and the other given by Sessler [3]; for a description of the latter see [4].

2. RESULTS

The parameters of the waveguide and the bunch are shown in Fig. 1. The formulae used in the comparison are shown in Table I. The results are shown in the figures. The plan of the calculations shown in Figs. 2 to 9 is given in Table II. A logarithmic scale is chosen to show the relative accuracy of the models.

The following conclusions can be drawn:

1) For thin irises, d=g, the Sessler-Vainshtein model affords an excellent description of the radiation loss spectrum. This model seems to improve with increasing γ (Fig. 2 to 4). Further evidence is shown in Figs. 10 to 15.

2) When the iris thickness increases at fixed γ the calculated radiation loss spectrum is between the Lawson and the Sessler-Vainshtein model, gradually moving towards the Lawson model for d >> g (Figs. 3, 5, 6, 7).
3) For thick irisae, $d >> g$, the radiation loss spectrum seems to be more constant as a function of $\gamma$ than predicted by the Lawson model (Figs. 7 to 9).

REFERENCES


Table I. Analytical estimates of the radiation loss

Lawson's diffraction model

\[ U(\omega) \, d\omega = 0.5062 \times 10^{-9} \times \frac{N \omega}{\sqrt{cy^2}} \left( \frac{c \omega}{\gamma^2} \right)^{\frac{1}{2}} K_1 \left( \frac{\omega A}{\gamma^2} \right) \, d\omega \, [\text{eV/electron/cell}] \]

Valid for \( c/A < \omega < cy/A \)

Sessler-Vainshtein model

\[ U(\omega) \, d\omega = 2.4095 \times 10^{-9} \times \frac{NG}{\beta^3 \gamma^2 Ac} \left( \frac{c \omega}{\gamma^2} \right)^{\frac{1}{2}} K_1 \left( \frac{\omega A}{\beta \gamma^2 c} \right) \, d\omega \, [\text{eV/electron/cell}] \]

Valid for \( c/A, c/g < \omega, Gc/A^2 < \omega \)

Table II. Plan of calculation and figure numbers

a = 0.05 m  b = 0.25 m  g = 0.02 m

<table>
<thead>
<tr>
<th>d[m]</th>
<th>20</th>
<th>50</th>
<th>200</th>
<th>500</th>
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<td>0.02</td>
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<td>3</td>
<td>4</td>
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<td>5</td>
<td></td>
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<tr>
<td>0.20</td>
<td></td>
<td>7</td>
<td>8</td>
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</tbody>
</table>
Fig. 3

A = 0.05000  B = 0.25000  R2 = 0.00000  H = 0.00000
D = 0.02000  C = 0.02000  R1 = 0.00000  GAMMA = 50.0
N = 10**18

[Graph showing data and curves]

LOSS IN KEV/ELECTRON/CELL

OMEGA IN GHZ (X10^2)

L
S-V
Fig. 4

\begin{align*}
A &= 0.05000 \\
B &= 0.25000 \\
R_2 &= 0.00000 \\
H &= 0.00000 \\
D &= 0.02000 \\
C &= 0.02000 \\
R_1 &= 0.00000 \\
\text{GAMMA} &= 200.0 \\
N &= 10^{13}
\end{align*}

\begin{axis}
\end{axis}

\begin{axis}
\end{axis}
Fig. 5

A = 0.05000  B = 0.25000  R2 = 0.00000  H = 0.00000
D = 0.04000  C = 0.02000  R1 = 0.00000  GAMMA = 50.0

N = 10^13

LOSS IN KEV/ELECTRON/CELL

OMEGA IN GHZ (X10^2)
Fig. 6

$A = 0.05000, B = 0.25000, R2 = 0.00000, H = 0.00000$

$D = 0.10000, G = 0.02000, R1 = 0.00000, \text{GAMMA} = 50.0$

N = $10^{13}$

![Graph showing loss in keV/electron/cell vs. Omega in GHz (x10^2).]
Fig. 7

A = 0.05000  B = 0.25000  R2 = 0.00000  H = 0.0000
C = 0.20000  G = 0.02000  R1 = 0.00000  GAMMA = 50.0
N = 10^{48}

LOSS IN KE/ION/CELL

OMEGA IN GHz (X10^2)

S-V

L
Fig. 8

\[ R = 0.05000 \quad B = 0.25000 \quad R2 = 0.00000 \quad H = 0.00000 \]
\[ D = 0.20000 \quad C = 0.02000 \quad R1 = 0.00000 \quad \text{GAMMA} = 200.0 \]
\[ N = 10 \times 10^5 \]

Loss in keV/electron/CELL

OMEGA IN GHz (X10^6)
Fig. 9

\[ A = 0.05000, \quad B = 0.25000, \quad R2 = 0.00000, \quad H = 0.0000 \]

\[ D = 0.20000, \quad G = 0.02000, \quad R1 = 0.00000, \quad \text{GAMMA} = 500.0 \]

\[ N = 10^{13} \]
Fig. 10

\[ A = 0.0500, B = 0.2500, A_2 = 0.0000, H = 0.0000 \]
\[ C = 0.01000, C_1 = 0.00000, \text{GAMMA} = 50.0 \]

\[ N = 10^{13} \]

![Graph showing loss in keV/electron/Cell vs. Omega in GHz (x10^2).]
Fig. 11

\[ A = 0.05000 \quad B = 0.25000 \quad R_2 = 0.00000 \quad H = 0.0000 \]

\[ D = 0.03000 \quad G = 0.03000 \quad R_1 = 0.00000 \quad \text{GAMMA} = 50.0 \]

\[ N = 10^{18} \]
Fig. 12

\[ R = 0.05000 \quad B = 0.20000 \quad R2 = 0.00000 \quad H = 0.00000 \]
\[ D = 0.02000 \quad G = 0.02000 \quad R1 = 0.00000 \quad \text{GAMMA} = 50.0 \]

\[ N = 10^{13} \]
Fig. 13

\[ A = 0.05000 \quad B = 0.30000 \quad R2 = 0.00000 \quad H = 0.00000 \]

\[ D = 0.02000 \quad G = 0.02000 \quad R1 = 0.00000 \quad \text{GAMMA} = 50.0 \]

\[ N = 10^{13} \]
Fig. 14

A = 0.04000  B = 0.25000  R2 = 0.00000  H = 0.0000
D = 0.02000  G = 0.02000  R1 = 0.00000  CAMMA = 50.0

N = 10\times 10^{-13}

Loss in KeV/Electron/Cell

\Omega in GHz (\times 10^{-4})

\text{S-V}