



CEBAF TN-90-0214

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A MAFIA Study of the CEBAF Chopper Cavity

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The CEBAF chopper is a square box cavity. The experimental data are as follows:

- Electron energy $E = 100$ KeV.
- The distance between the chopper and lens $\ell = 518$ mm.
- The radial position of slot $r = 0.2$ inches = 5.08 mm.
- The power losses in the cable between the cavity and amplifier output $d \approx 1.5$ dB.
- The required output power of the amplifier $P = 25$ W.
- Q_0 of the chopper ≈ 14000 .
- Coupling coefficient $\beta \approx 1.6$.

Two figures of merit, which describe the deflecting properties of a cavity, are frequently taken to be the transverse shunt impedance

$$R_{\perp} = \frac{\widehat{E}_{\perp}^2}{P_L}$$

and the transverse interaction impedance

$$\frac{R_{\perp}}{Q} = \frac{\widehat{E}_{\perp}^2}{\omega W}$$

where P_L and W are the losses and the stored energy in the cavity, and ω is the angular frequency. As defined, \widehat{E}_{\perp} is an equivalent deflecting electric field integrated through the cavity.

The values for the cavity calculated by MAFIA are summarized below:

$f = 1511.9$ MHz; $Q = 17556$; $P_L = 1.154 \times 10^{-9}$ watt; $W = 2.134 \times 10^{-15}$ J; $\widehat{E}_{\perp} = 0.0129$ V that gives $R_{\perp} = 0.144$ M Ω or $\frac{R_{\perp}}{Q} = 8.21$ Ω .

$\frac{R_{\perp}}{Q}$ is a geometric parameter. Taking into account the power losses in the cable, the power reflected from the cavity, and the actual Q_0 of the cavity, the required output power of the amplifier should be:

$$P = \frac{\widehat{E}_{\perp}^2}{\left(\frac{R_{\perp}}{Q}\right) \cdot Q_0} \times \frac{(1 + \beta)^2}{4\beta} \times 10^{\frac{4}{10}} = 12.5 \text{ W}.$$

It is close to the actual power of 25 W (how accurate is this number?). This example illustrates how accurate the code MAFIA calculates the deflecting properties of a structure.

Special thanks go to B. Yunn for help in running MAFIA and C. Sinclair for providing experimental data.

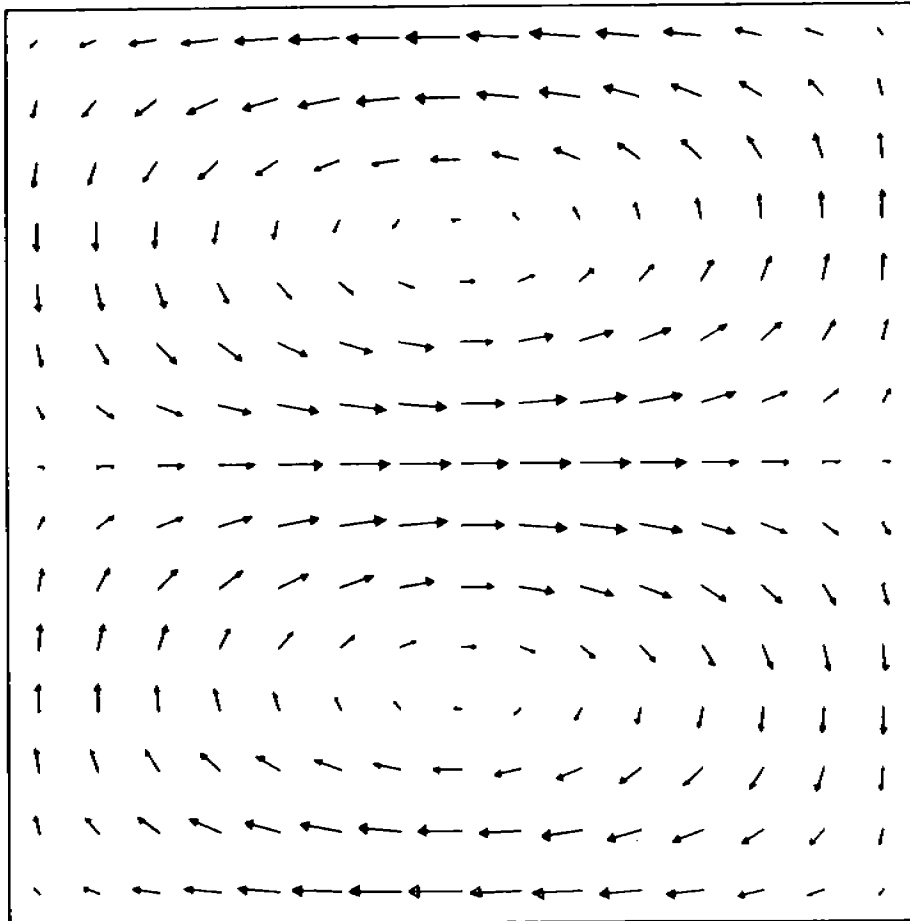
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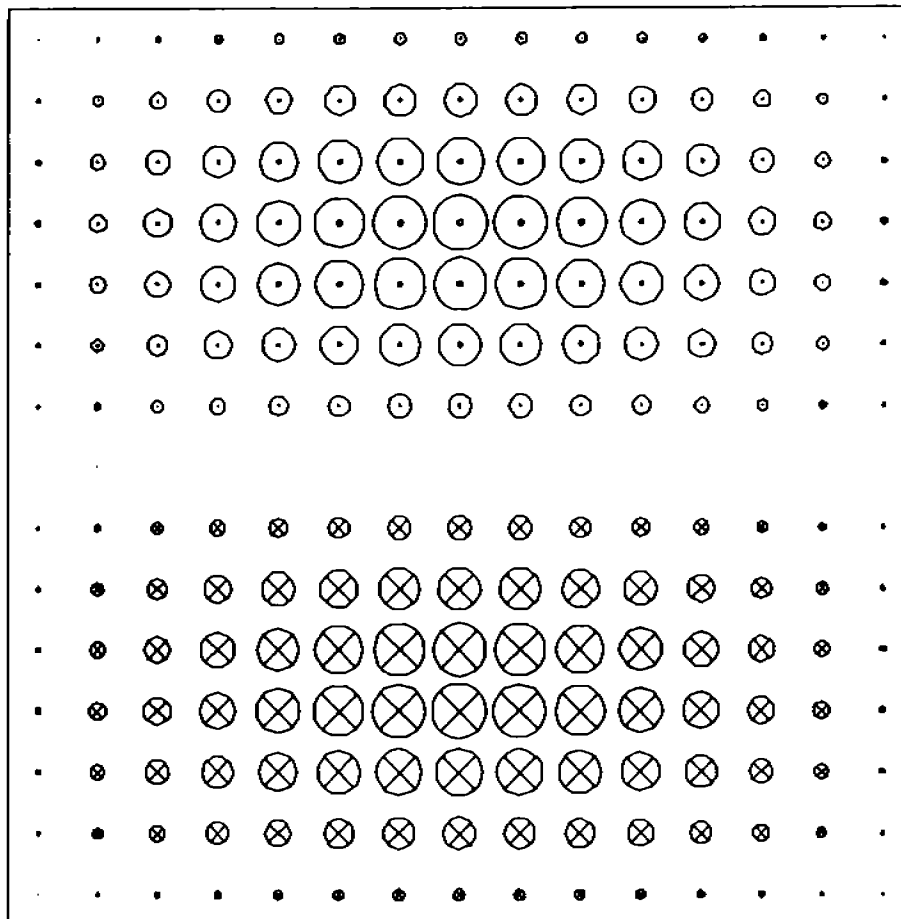
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picture
content
arrow plot

s-field
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frequency
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mesh planes
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max arrow =
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mofo

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