Lecture 9

ACCELERATOR PHYSICS

Melbourne

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Lecture 9 - Accelerating Cavities II -contents

- **Conducting surfaces**
- **Quality Factor, Filling Time and Shunt Impedance**
- **Corrugated structures**
- **Dispersion in a waveguide**
- **Iris loaded wavequide**
- **Feeding, coupling and tuning structures.**
- **Different modes**
- **Standing-wave and travelling wave structures.**

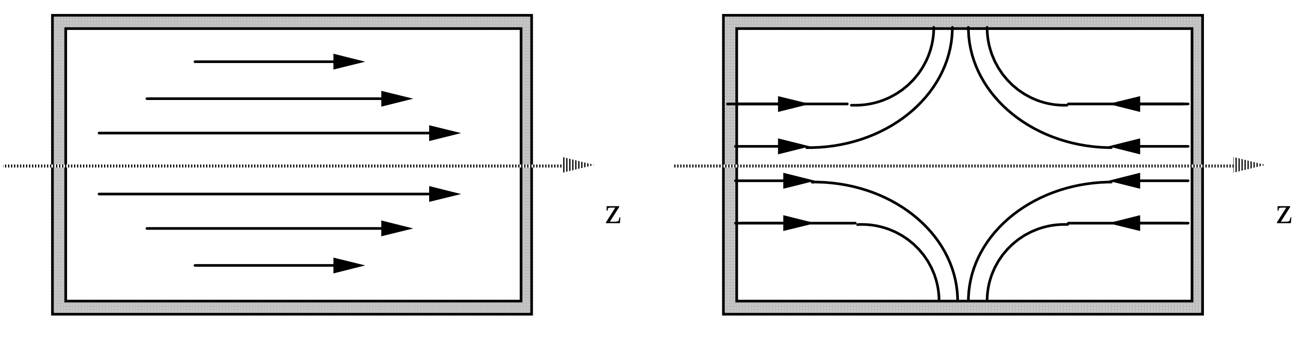
Recap of previous lecture
- Accelerating Cavities I

- Necessary conditions for acceleration
- Waves in free space
- Two travelling waves in a guide.
- A transverse electric (H) mode
- Phase velocity and Group velocity
- Transverse magnetic modes
- Transit time factor
- The cylindrical cavity

Numerical solution of pill box

$$\begin{cases} E = E_0 J_0\left(\dfrac{2.405}{r_0} r\right) \;;\quad \Lambda_{010} = \dfrac{2.405}{r_0} \;,\quad \omega_{010} = \dfrac{\Lambda_{010}}{\sqrt{\varepsilon\mu}} \\ \nu_{010} = \dfrac{\omega_{010}}{2\pi} = \dfrac{1.147\ 10^9}{r_0} \;;\quad \lambda_{010} = \dfrac{1}{\nu_{010}\sqrt{\varepsilon\mu}} = \dfrac{2\pi}{\Lambda_{010}} = 2.61 r_0 \end{cases}$$

Lines of force for the electrical field TM010 (a) and TM011 (b)



(a) (b)

Conducting surfaces

$$\delta = \sqrt{\frac{1}{\pi \mu f \sigma}} \text{ m.}$$

Shunt impedance

$$R_{shunt} = \frac{\hat{V}^2}{2W}$$

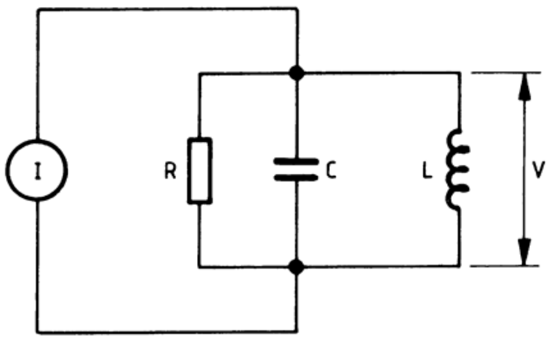
where W is the power that must be provided calculated with:

$$\mathbf{j} = \mathbf{n} \times \mathbf{H}$$

$$W = \frac{R_s}{2} \int_s |H|^2 ds$$

where s is the inner surface
Rs = is the surface resistance
(for copper Rs = 2.61 10-7

Quality factor



Energy stored and dissipated per cycle

$$Q = 2\pi \frac{U_s}{U_d} = \omega \frac{U_s}{W}$$

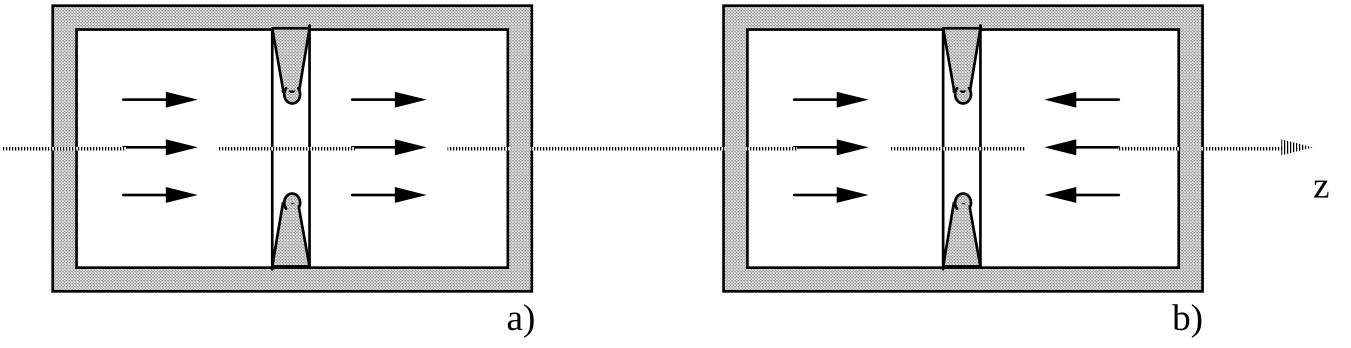
$$U_s = \frac{1}{2}\int \varepsilon \hat{E}^2 dv$$

where W is the power disspated

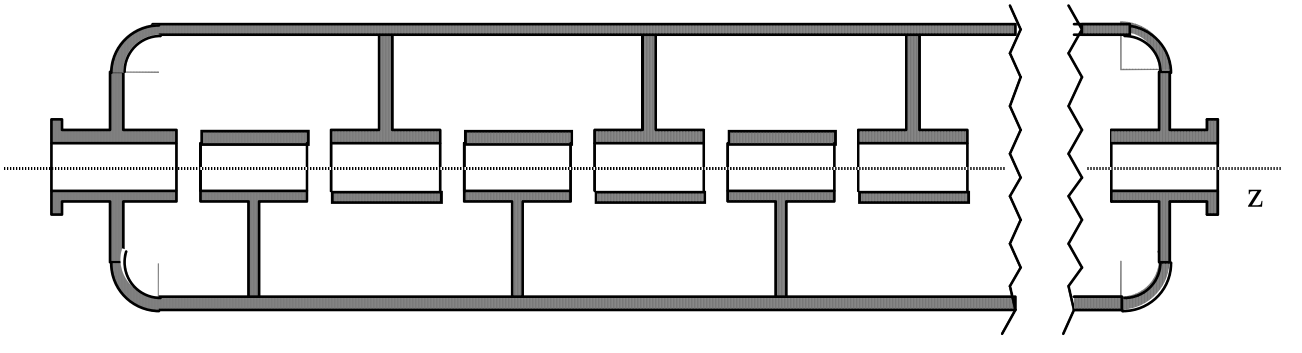
$$W = \frac{V_0}{2} R_s = \frac{1}{2}\int \frac{I_{surf}{}^2}{\sigma\delta} dA$$

Corrugated structures

Ez component for the modes of oscillation zero and π



- **Alvarez structure**

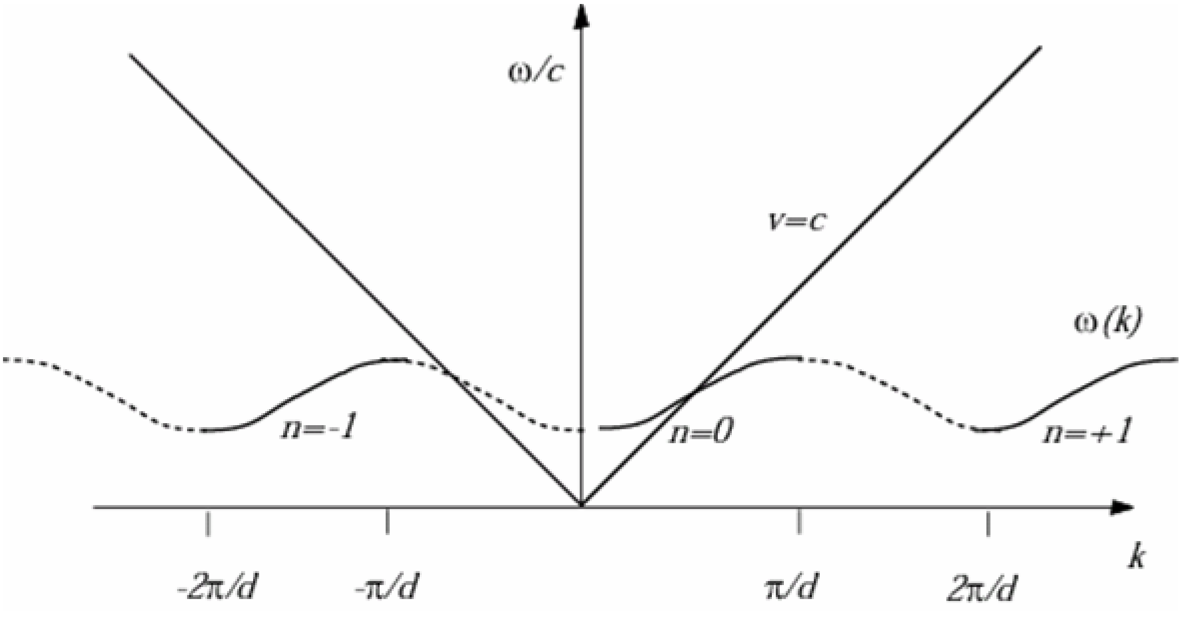


Dispersion in a waveguide

$$\frac{1}{\lambda_g^{\;2}} = \frac{1}{\lambda^2} - \frac{1}{\lambda_c^{\;2}}$$

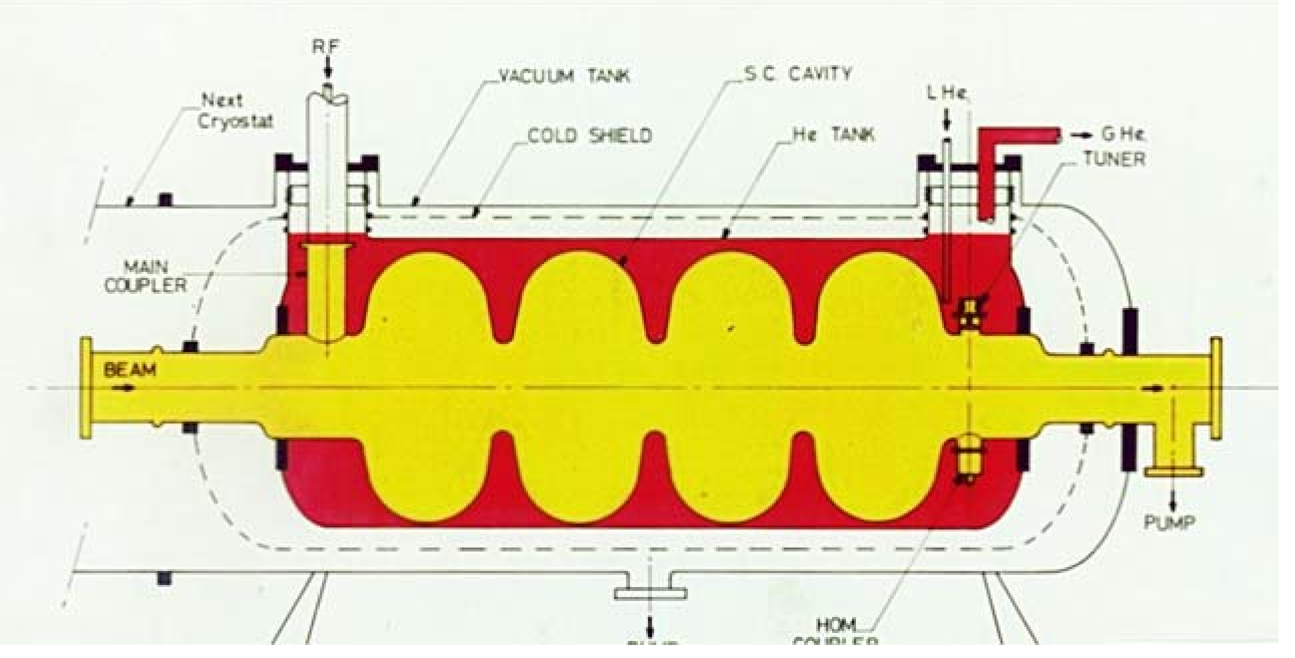
$$c/\omega = \lambda \qquad c/\omega_c = \lambda_c \qquad k = 2\pi/\lambda_g$$

$$k^2 = \left(\frac{\omega}{c}\right)^2 - \left(\frac{\omega_c}{c}\right)^2$$



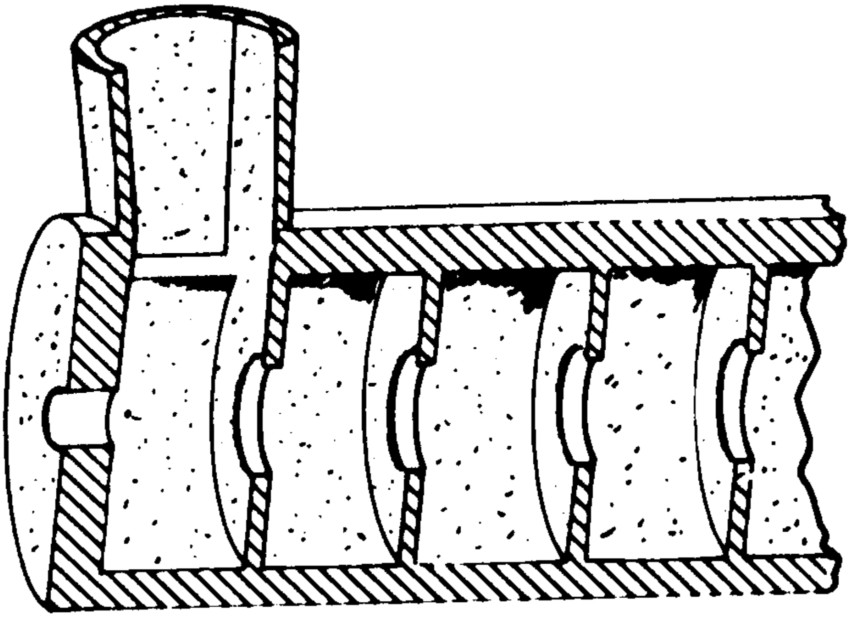
$$v_{ph} = \lambda f = \omega/k \qquad v_g = \frac{d\omega}{dk}$$

LEP CAVITY

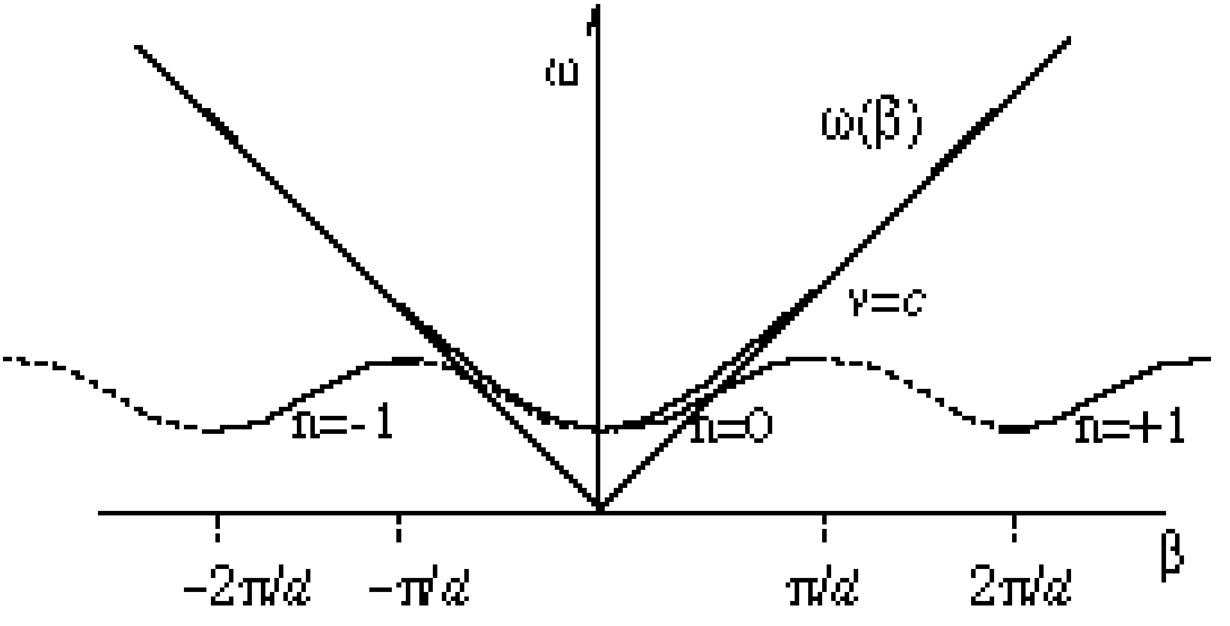


RF
VACUUM TANK
S.C. CAVITY
Next Cryostat
L He
COLD SHIELD
He TANK
G He
TUNER
MAIN COUPLER
BEAM
PUMP
HOM

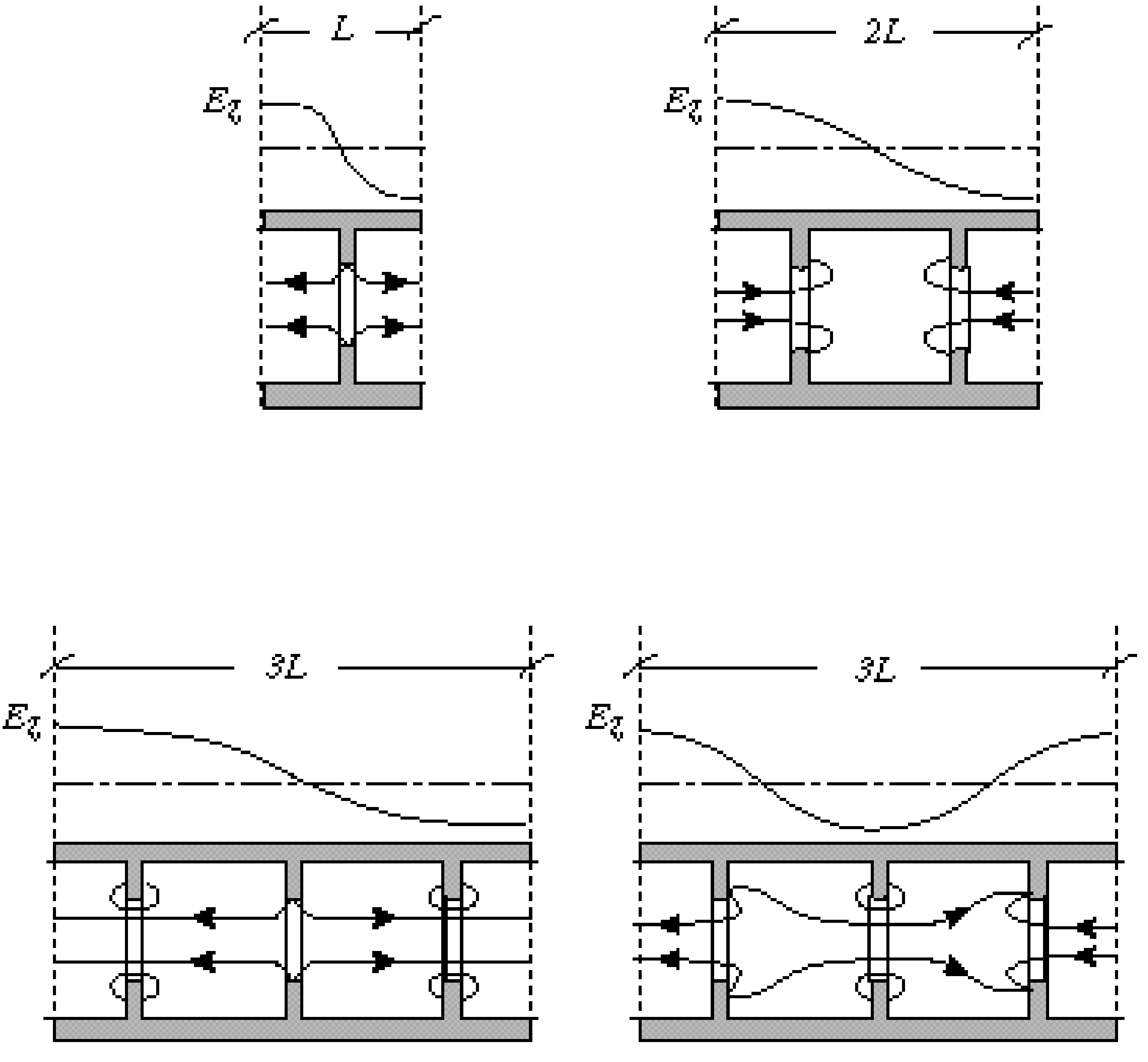
Iris loaded waveguide



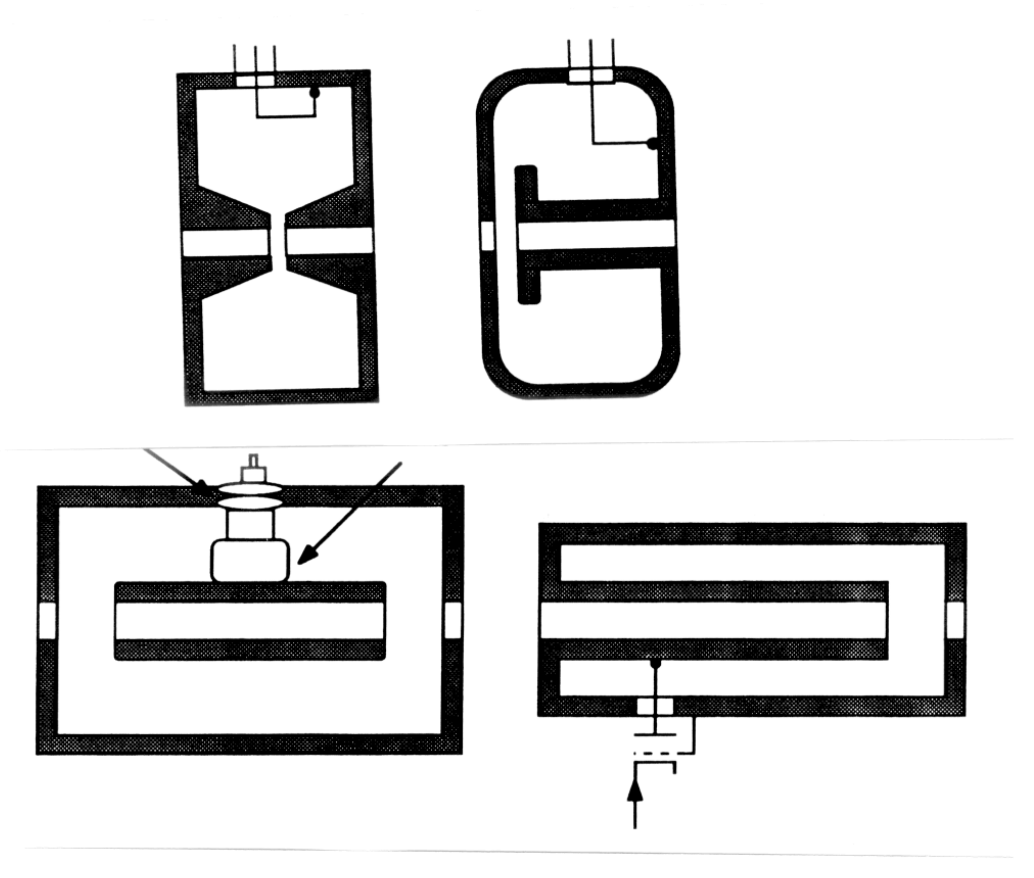
Slowing down the wave

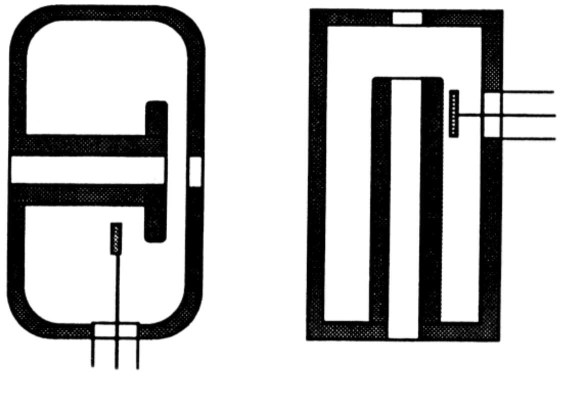


Different modes

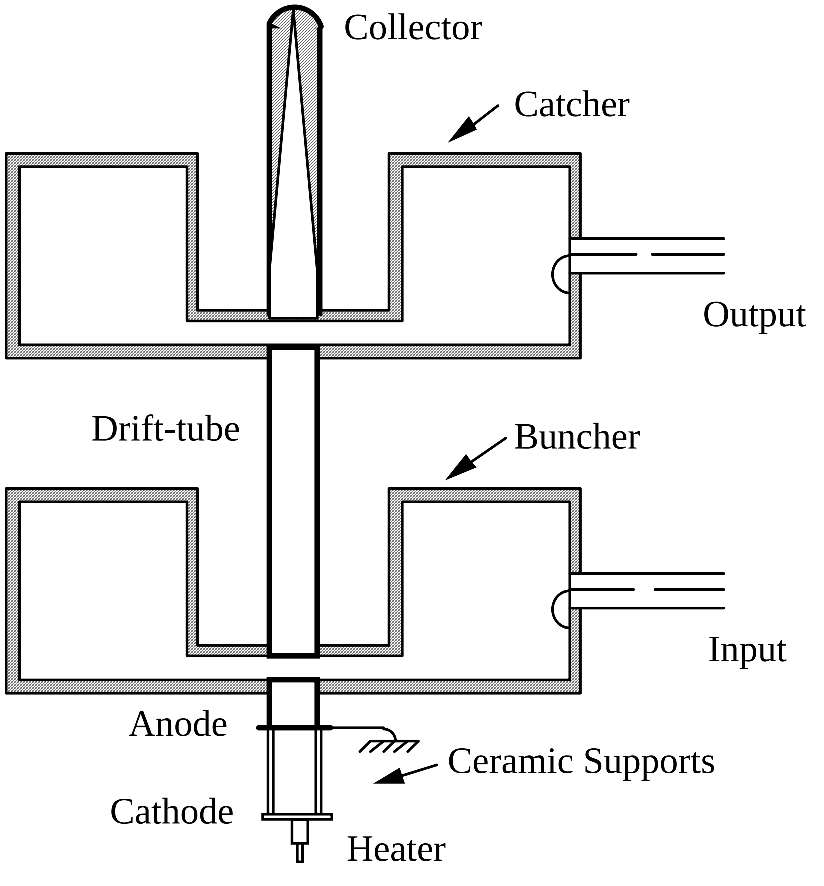


Coupling





Klystron


Collector
Catcher
Output
Drift-tube
Buncher
Input
Anode
Ceramic Supports
Cathode
Heater

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