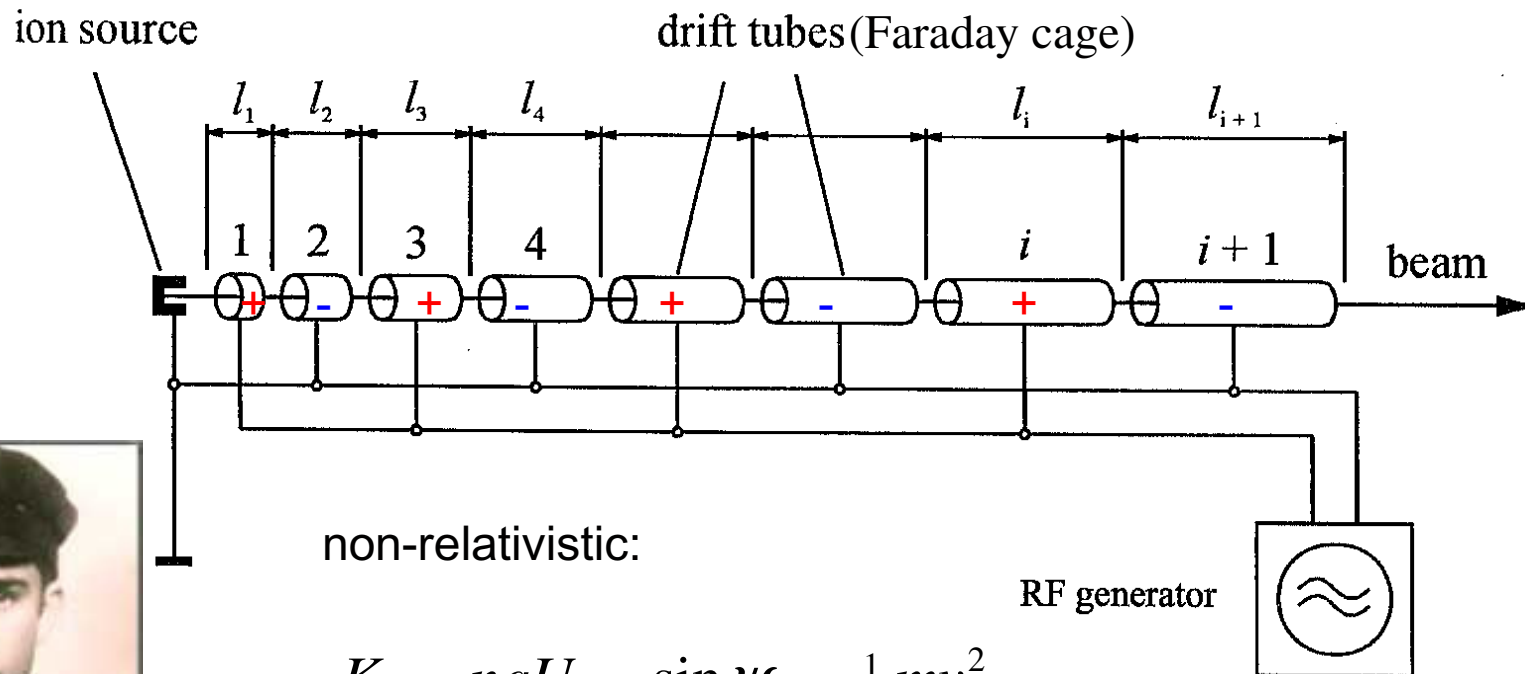




# Wideroe linear accelerator



CHESS & LEPP



non-relativistic:

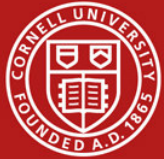
$$K_n = nqU_{\max} \sin \psi_0 = \frac{1}{2} m v_n^2$$

$$l_n = \frac{1}{2} v_n T_{RF} = \frac{1}{2} \beta_n \lambda_{RF} \propto \sqrt{n}$$

Called the  $\pi$  or the  $1/2\beta\lambda$  mode



Wideroe



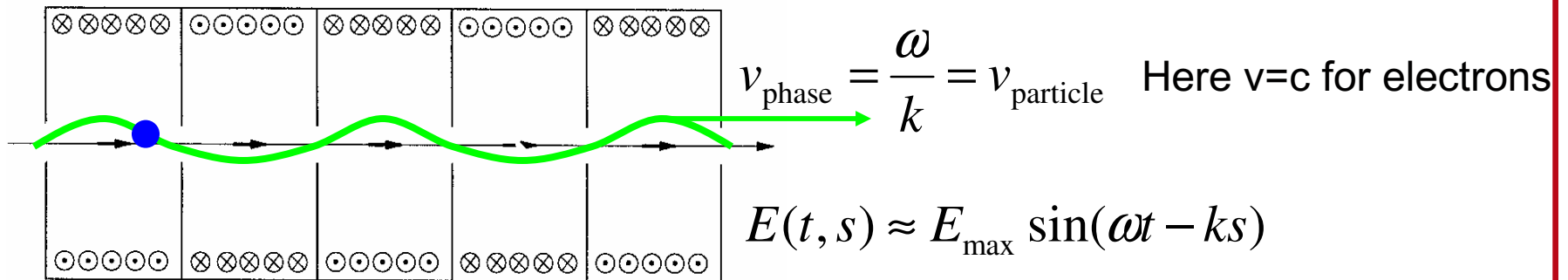
# Accelerating cavities



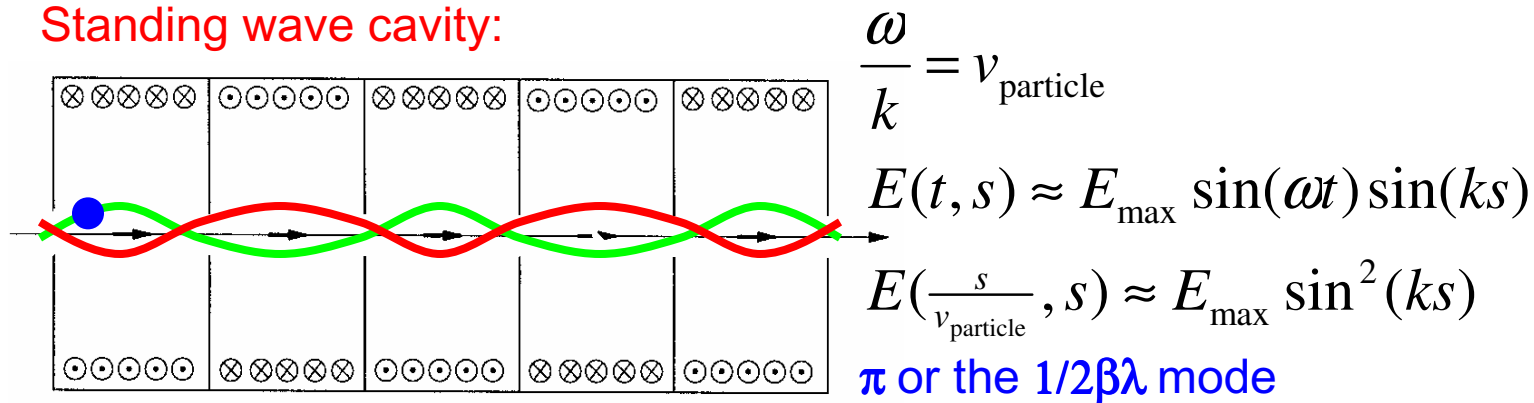
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- 1933: J.W. Beams uses resonant cavities for acceleration

## Traveling wave cavity:



## Standing wave cavity:



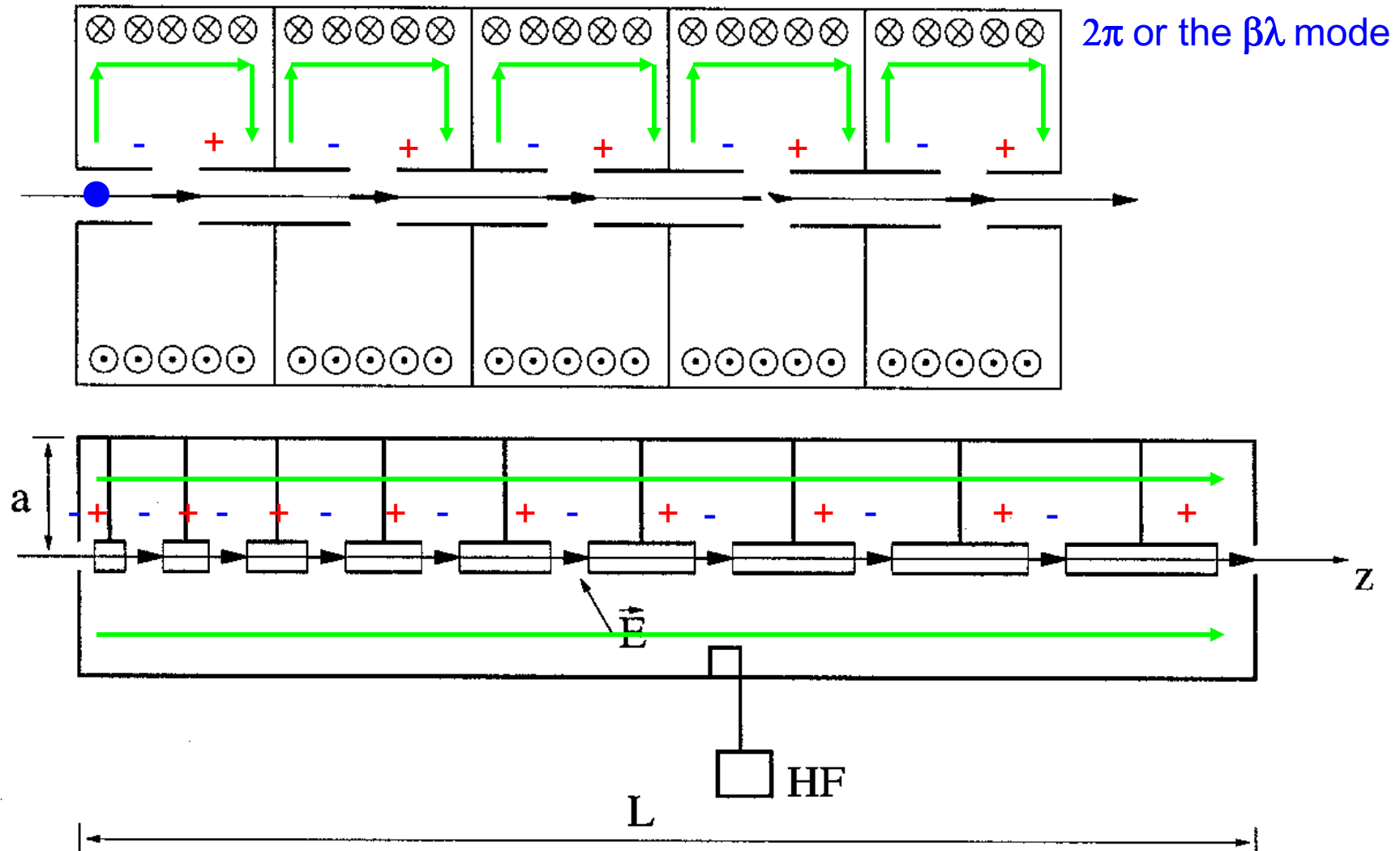
Transit factor (for this example):  $\langle E \rangle = \frac{1}{\lambda_{RF}} \int_0^{\lambda_{RF}} E\left(\frac{s}{v_{\text{particle}}}, s\right) ds \approx \frac{1}{2} E_{\text{max}}$



# The Alvarez Linear Accelerator



CHESS & LEPP



Needs only one power input coupler and walls do not dissipate energy.

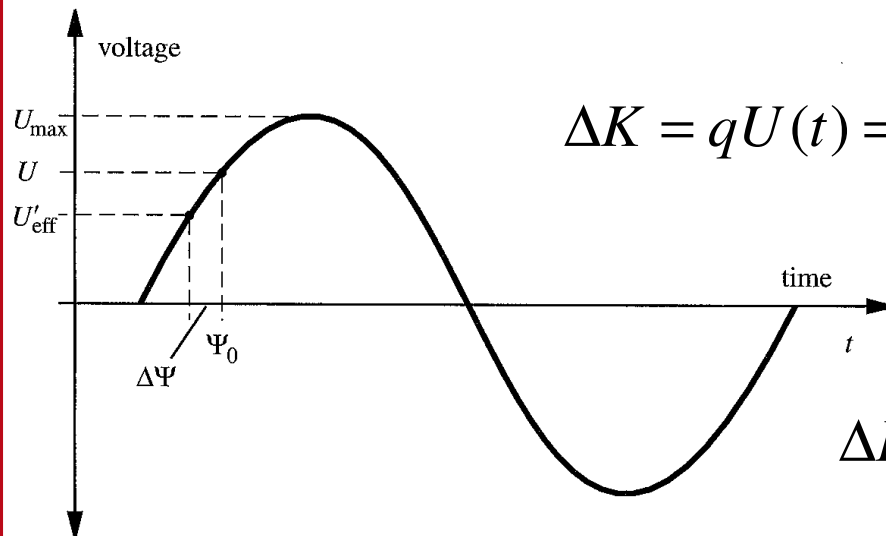


# Phase focusing



CHESS & LEPP

- 1945: Veksler (UDSSR) and McMillan (USA) realize the importance of phase focusing



$$\Delta K = qU(t) = qU_{\max} \sin(\omega(t - t_0) + \psi_0)$$

Longitudinal position in the bunch:

$$\sigma = s - s_0 = -v_0(t - t_0)$$

$$\Delta K(\sigma) = qU_{\max} \sin\left(-\frac{\omega}{v_0}(s - s_0) + \psi_0\right)$$

$$\Delta K(0) > 0 \quad (\text{Acceleration})$$

$$\Delta K(\sigma) < \Delta K(0) \text{ for } \sigma > 0 \Rightarrow \frac{d}{d\sigma} \Delta K(\sigma) < 0 \quad (\text{Phase focusing})$$

$$\left. \begin{array}{l} qU(t) > 0 \\ q \frac{d}{dt} U(t) > 0 \end{array} \right\} \underline{\underline{\psi_0 \in (0, \frac{\pi}{2})}}$$

Phase focusing is required in any RF accelerator.