Requirement for LC

Required Precision of Fabrication of Accelerating Structure

It should be determined from beam dynamics.

- An tentative criteria:

  $$\boxed{\frac{\Delta E}{E} \leqq 1\%}$$ due to phase slip

  eq. to @ inj. $\frac{\Delta E \times 12}{E_{inj}} \sim 0.001$ in 1 DLDS unit.

- Depend on actual RF system:

  meas. beam phase & RF phase

  meas. phase slip in structure

  control cooling water temperature

  etc.

what to measure ⇒ feedback control

Acceleration in a Structure

$$\left[\begin{array}{l} G = \sum_i E_i \cos\phi_i \\ \phi_i = \phi_0 + \sum_{j=0}^{i-1} \delta\phi_j \\ \delta\phi_j = \dfrac{2\pi/3}{v_{gi}/c} \dfrac{\delta f_j}{f_0} \end{array}\right.$$

Approximation :

$$\left(\begin{array}{ll} 1. & E_i = \text{const.} \\ 2. & \sum_{j=0}^{i-1} \delta\phi_j \ll 1 \\ 3. & v_g/c = \text{const} \end{array}\right.$$

Then, due to phase slip

$$\frac{\Delta G}{G} = \tan\phi_0 \frac{2\pi/3}{v_{g0}/c} \mathcal{F}$$

$$\mathcal{F} \equiv \frac{1}{N} \sum_{i=0}^{N-1} \sum_{k=0}^{i-1} \left(\frac{\delta f_k}{f_0}\right)$$

Suppose :

$$\frac{\Delta G}{G} \leqq 0.01, \quad \phi_0 = 17^\circ, \quad v_{g0}/c = 0.05$$

Then

$$\boxed{\mathcal{F} \leqq 9.4 \times 10^{-4}}$$

is required.

Accelerating mode Tolerance

[1] Systematic in 206 disks

$$\mathcal{F} = \frac{N}{2} \frac{\Delta f_0}{f_0}$$

$$\therefore \boxed{\Delta f_0^{sys} = 0.11 \text{ MHz}}$$

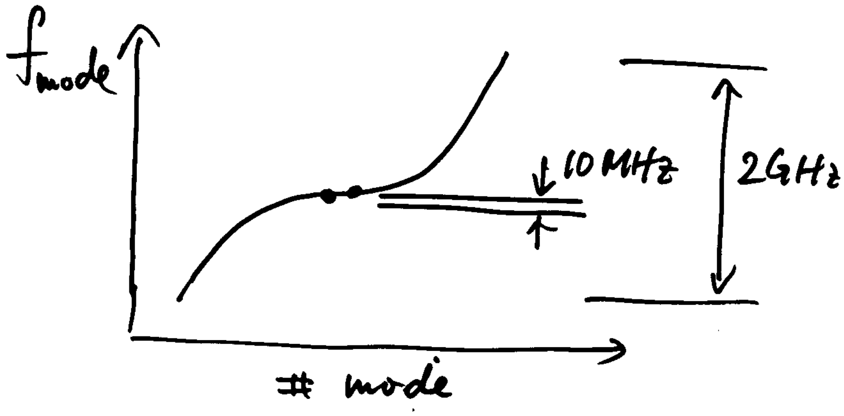
[2] Random in 206 disks

$$\mathcal{F} = \sqrt{\frac{N}{3}} \frac{\delta f_0}{f_0}$$

$$\therefore \boxed{\delta f_0^{Rand.} = 1.36 \text{ MHz}}$$

- Unless any feedback is applied, these are Tolerances in average.
- Looser tolerance on input side
  Tighter " output "

1st HOM Frequency Tolerance



① Severest: mode-to-mode relative frequency

$\ll 10$ MHz

→ tolerance 1 MHz

② Stored energy of a mode spreads ~20 cells

⇓

[1] Systematic errors in 20 cells (disks)

$$\Delta f_1^{sys.} = 1 \text{ MHz}$$

[2] Random errors in 20 cells

$$\delta f_1^{Rand} = \sqrt{20} \sim 4 \text{MHz}$$

[3] Can be relaxed at both end regions

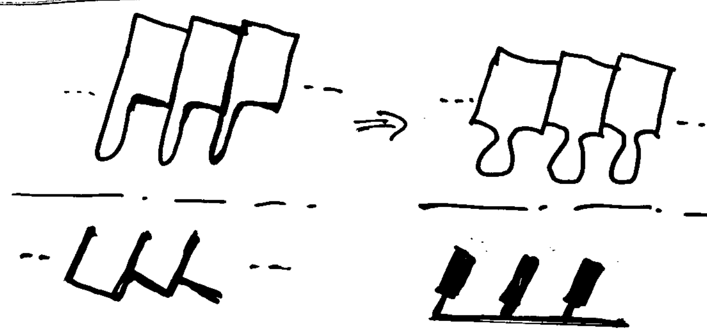
Requirements other than f_a & f_d

① Alignment

cell-to-cell (disk-to-disk), global (long range)

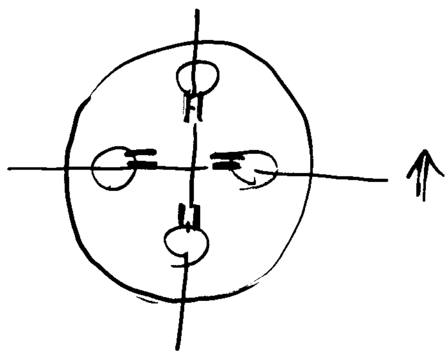
| same as DDS |

② Bookself



?

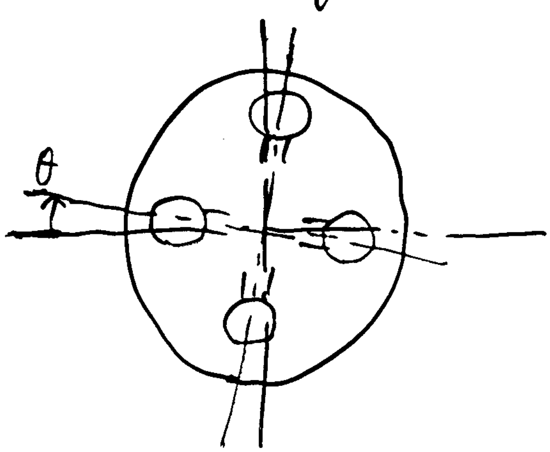
③ Effective cell offset or cell slant due to offset of slits



area of 3mm slits $\sim \frac{1}{10} \times$ cell

∴ | Tolerance of offset ~ 10 × disk alignment. |

④ Rotational alignment of slits



assume beam offset

$X_0 \sim 10\, Y_0$

if $Y_{BPM}(\leftarrow X_0) < \frac{1}{10} Y_{BPM}(\leftarrow Y_0)$

then $X_0 \sin\theta < \frac{1}{10} Y_0$

$\therefore \boxed{\theta < 0.01}$

⑤ HOM coupling coefficient

between cell field and manifold mode

[?]

depend on (h , 1.5mm width , 3.0mm width & depth

relative position of slit/manifold.

⑥ Transmission characteristics of manifold

(transmission in a long chain

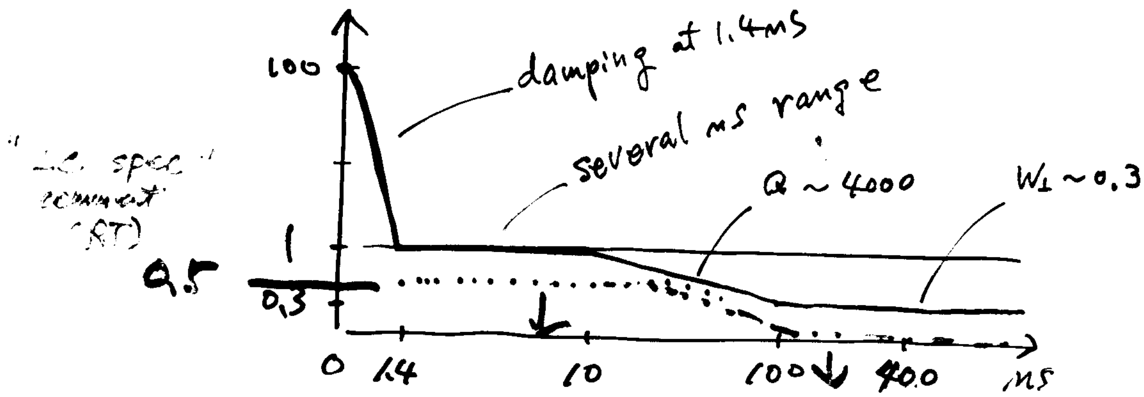
output toward outside : VSWR (ω) [?]

depend on manifold diameter, position

HOM frequency

for RDDS1 ?

Wake field pattern



Requirement on frequency of mode (disk)

1. smoothness $\frac{1}{10} \Delta f^d_{spacing}$ $\frac{1}{2} \Delta f^d_{spacing}$

2. long range deviation

   $\frac{1}{5} \Delta f^d_{spacing}$ with $\frac{\lambda}{2} \sim 20$ modes $\Delta f^d_{spacing}$

3. average of 206 cell

   ~ 100 MHz 100 MHz