CAVITIES NEED ANTENNAS FOR OPERATION

Fundamental power coupler (FPC)

External quality factor $Q_{FPC} \sim 10^7$

Pick-up antenna (PU)

$Q_{\mathrm{PU}} \sim 10^{11}$

High-order mode antenna #1

Unloaded quality factor $Q_0 = \frac{\omega U}{P_{diss}} \sim 10^{10}$

HOM antenna #2

$\Rightarrow$ Loaded quality factor Q_L:

$$\frac{1}{Q_{\mathrm{L}}} = \frac{1}{Q_0} + \frac{1}{Q_{FPC}} + \frac{1}{Q_{\mathrm{PU}}} \approx \frac{1}{1.25 \cdot 1^{\ 7}}$$

J. Manuf. Mater. Process. 2023, 7(2), 62; https://doi.org/10.3390/jmmp7020062

BROADER CAVITY BANDWIDTH REDUCES SENSITIVITY TO DETUNING

- Cavity **with** antennas:

$$Q_L = \frac{f_0}{\Delta f_{3\mathrm{dB}}} \quad \Rightarrow \quad \Delta f_{3\mathrm{dB}} = \frac{1.3\ \mathrm{GHz}}{1.25 \cdot 10^7} = 104\ \mathrm{Hz}$$

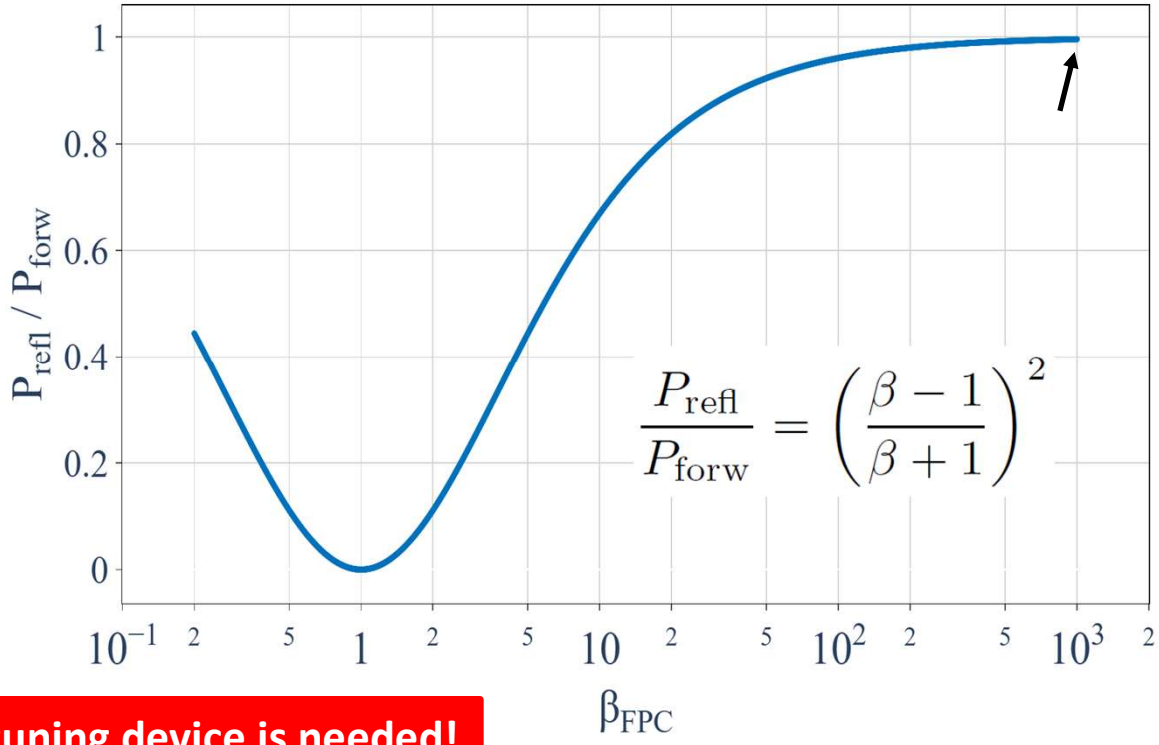
Amplitude drop is less significant, **still within the margin of the RF control system**

- MESA employs 15 kW solid-state RF power amplifiers

- The coupling strength of the FPC is:

$$\beta_{FPC} = \frac{Q_0}{Q_{FPC}} = 10^3$$

Then, **most of the RF po** **Therefore, a faster tuning device is needed!**
maintain E_{acc} will be reflected



H. Padamsee, J. Knobloch, and T. Hays. RF Superconductivity for Accelerators. Wiley-VCH Verlag, Weinheim, 2008

SUMMARY FRT WP

- MESA 1.3 GHz SRF cavities suffer from ±25 Hz detuning due to microphonics
- Detuning might be difficult to be handled by the RF control system, resulting in a significant energy waste
- Mechanical tuners are not fast enough to reduce it and faster solutions are needed such as the FRT
- The FRT can effectively mitigate the detuning as proven in CST
- Operating MESA with FRTs would reduce the forward RF power by a factor of 12
- Thermo-mechanical design is currently under development
- Next goal: build and test a prototype