Lab 3 Cavity Measurements

1. Laboratory Assignment #4
   Tasks 1 to 5.

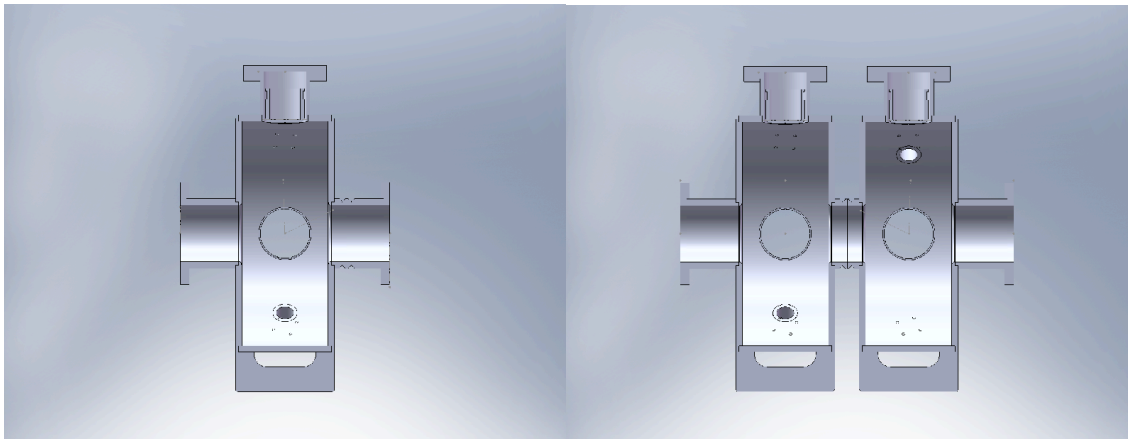
2. Laboratory Assignment #4
   Task 9.

3. Measure the resonant frequency (approximately 1005 MHz) and Q factor of the TM_{010} mode in one of the single-cell aluminum cavities. Measure the resonant frequencies and Q factors of other modes up to 3 GHz. Do not use too much force or screw too tight in assembling or disassembling the cavity, because the aluminum parts can easily be damaged. Compare your results with Table 1. Discuss why the Q factors in the calculations are so different from those of the measurements.

4. Adjust the tuner of another single-cell cavity and tune it to the same resonant frequency as the first one - difference of the TM_{010} mode is no more than 10 kHz. Then couple the two cavities together through the two coupling ports to form a two-cell cavity. Measure the frequencies of different modes up to 2.4 GHz. Please tell which are 0 modes and which are π modes (see the next step), and calculate the intercell coupling constant: $k = \frac{2(\omega_\pi - \omega_0)}{\omega_\pi + \omega_0}$ for each mode.

5. Measure the RF phase variations through different couplers of the two-cell cavity and identify the 0 and π modes. Make sure the orientations of all couplers used in the measurements are in the same direction. Measure the phase of each mode with two couplers in the same cell, then move one of the cables and connect it to a coupler in another cell and repeat the phase measurement. From the phase differences of the two measurements, you should be able to identify 0 and π modes. And in the end, return the two-cell cavity to the original single-cell configuration.

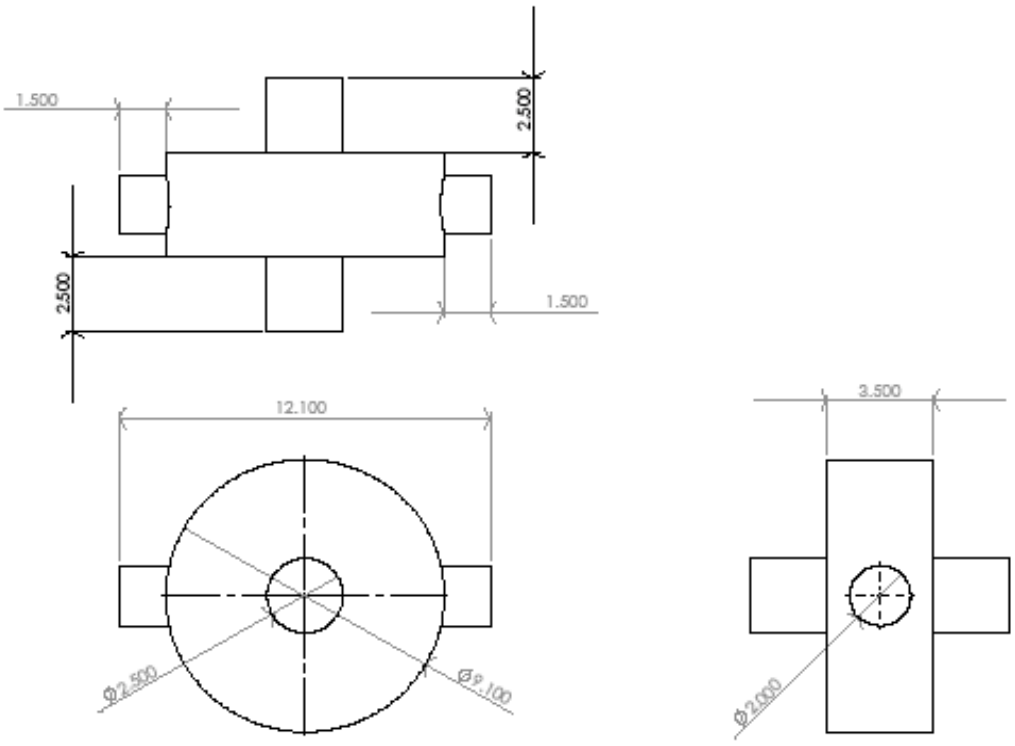
6. Assume RF electric fields are uniformly distributed in the cells only, with no field in the smaller ports. Calculate the geometric betas of the 0 and π modes of the two-cell cavity TM_{010} mode, and then calculate the transit time factors (TTFs) of the 0 and π modes. (Cavity cell center-to-center distance: 4.921 inches)



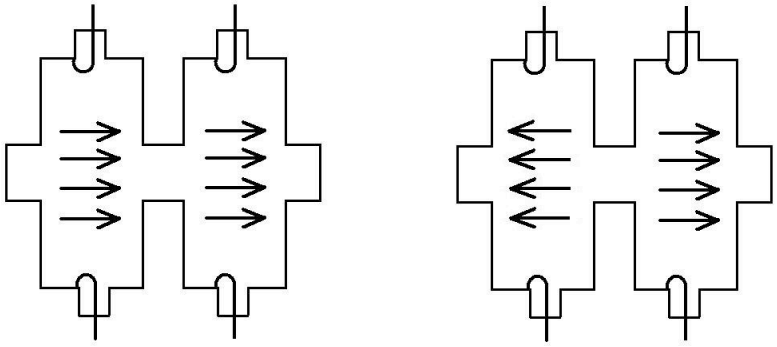
Single-cell Cavity **Two-cell Cavity**

Table 1. Calculated Parameters of the Aluminum Cavity

Boundary Conditions	Mode	*f* (MHz)	Qo (Al)
MME-1	TM010	1,007.3	18,990
MME-2	TM210	2,105,7	27,290
MME-3	TM020	2,322.1	32,030
MME-4	TM012	3,1150	34,740
MMM-1	TM011	1,969.4	16,720
MMM-2	TE211	2,100.2	2,2530
MMM-3	TM211	2,684.3	19,100
MMM-4	TM411	2,766.4	25,050
MMM-5	TM021	2,903.3	21,940
MEE-1	TM110	1,548.4	21,740
MEE-2	TE112	2,622.4	31,310
MEE-3	TM310	2,689.7	18,270
MEM-1	TE111	1,772.1	19,840
MEM-2	TM111	2,199.9	15,860
MEM-3	TE311	2,417.2	23,950



Inner Dimensions of the Cavity (Units: inch)



0 Mode **π Mode**

Electric Fields of 0 and π Mode (TM_{010}) in the Cavity

In the RF phase measurement, make sure the orientation of all couplers is known. The best solution is that all couplers are aligned in the same direction as shown in the above figure, it will make the task of mode identification easier.