Radial Tuning Devices for 1.3 GHz TESLA Shape Cavities*.

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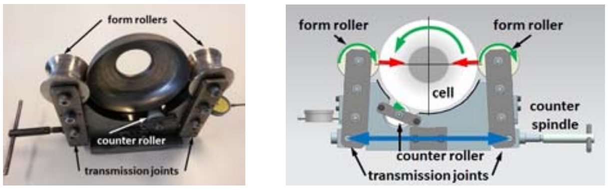
Abstract

Radial tuning devices at DESY can be applied to any TESLA shape 1.3 GHz cavity to reduce its elongation due to excessive additional material removal (>300 µm) or to compensate critical manufacturing uncertainties. Radial deformation of cavity cells can be provided by a special chain or a rolling device with three rollers. The chain distributes the radial forces on the equator area around the cell. The rollers are moving radially in relation to the rotating cavity and provide an equator diameter reduction. Both devices have the contour close to the cell shape at the equator area. The required equator radius deviation depends on the tuning target and usually varies between (0.02...0.60) mm. Different aspects of the tuning procedure and material properties are described using the example of cavity rolling.

Radial Tuning Devices

(a) (b)

Figure 1: Reshaping chain made of stainless with eight brass pressing shoes (a), which distribute the radial forces (b, red arrows) by chain compression (blue arrow)



(a) (b)

Figure 2: Rolling tool consists of two stainless form rollers and elastic counter roller (a), which distribute the radial forces (b, red arrows) from form rollers during cavity rotation (green arrows)

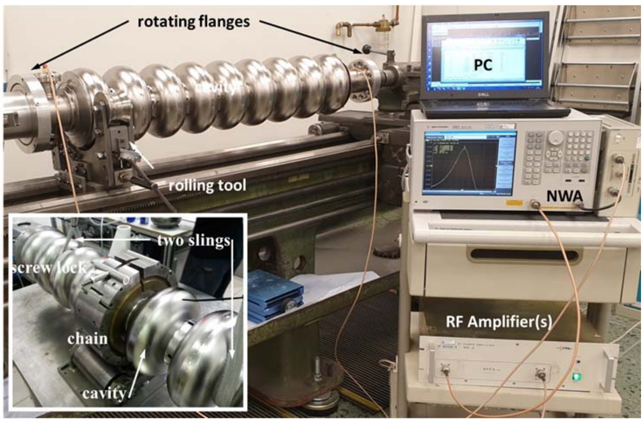
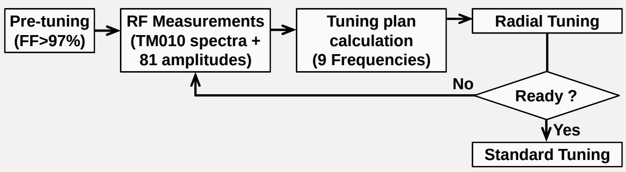


Figure 3: Devices "in operation" with measurement facility: network analyzer (NWA), RF amplifier(s) and PC

Tuning Procedure



Example of Rolling

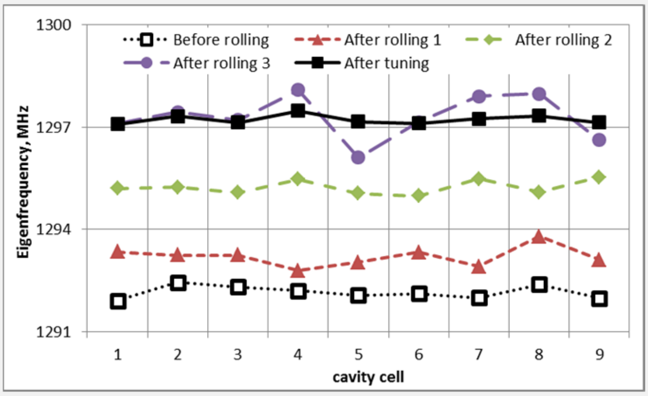


Figure 4: Cavity cells eigenfrequencies before and after each of 3 rolling

Table 1: Cavity characteristics during rolling

	F, MHz	dF, MHz	FF, %	L, mm	dL, mm	ECC, mm
before rolling	1292.17	5.20*	98	1062.8	3.8*	0.63
after rolling 1	1293.21	1.04	86	1062.6	-0.2	0.34
after rolling 2	1295.24	2.03	87	1062.3	-0.3	0.29
after rolling 3	1297.31	2.07	87	1059.9	-2.4	0.28
	dF SUM	**5.14**		**+ dL SUM**	**-2.9**	
after tuning	1297.23	0.14*	98	1059.9	0.9*	0.37

* - deviation from nominal frequency 1297.37 MHz and length 1059.0 mm

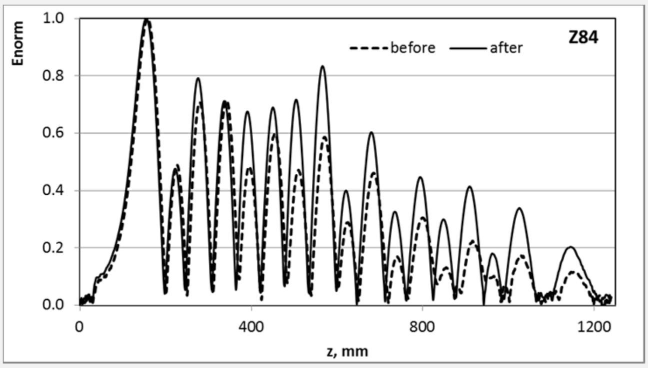


Figure 5: Normalized field distribution |E(r=0,z)| on cavity axis for second monopole mode TM011 (before rolling and after final standard tuning)

Summary

Radial tuning comparatively to conventional one is not reversible and can be applied only in one direction. Cell equator radius can only be reduced. So precision and predictability of radial tuning is more important than for conventional cell length tuning. We can propose two ways of improvement of rolling accuracy:

1. **Length fixation is only in one direction (preventing elongation). It is useful only for hard cavities. So length reduction has to be prevented either for soft cavities or for strong deformations (> 200 µm).**
2. **Divide the planned deformation in several iterations. Small deformation could be done with higher predictability and possible inaccuracies can be compensated by the next iteration.**

Reduction of cells equator radii was successfully approved for TESLA shape cavities of TTF, EXFEL and LCLS-II projects.

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