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SUPPRESSION OF HOMs IN A MULTICELL SUPERCONDUCTING CAVITY FOR CORNELL'S ERL

Abstract

Minimization of power of higher order modes (HOMs) in a multicell cavity was done using derivatives of the parameter defining losses with respect to geometric parameters of the cavity cells. For the Cornell Energy Recovery Linac most dangerous are dipole modes causing beam break-up (BBU). As a start point of optimization the shape with minimal losses at the fundamental mode was taken. Further changing the shape for better propagation of HOMs was done with degradation of the fundamental mode loss parameter GR/Q parameter within 1 % while decrease of the BBU parameter was nearly 3 orders of magnitude. The BBU threshold current tends to be inversely proportional to this parameter.

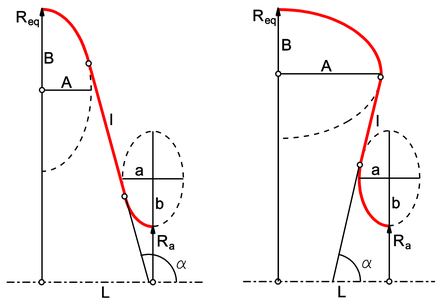
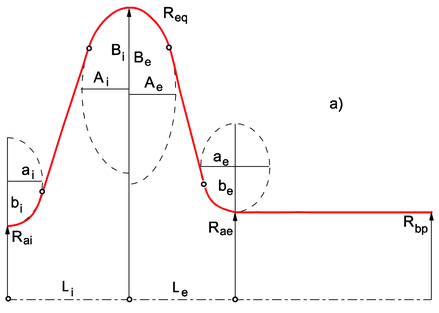


Figure 1. Geometry of the inner cell: non-reentrant (left) and reentrant (right) shapes.



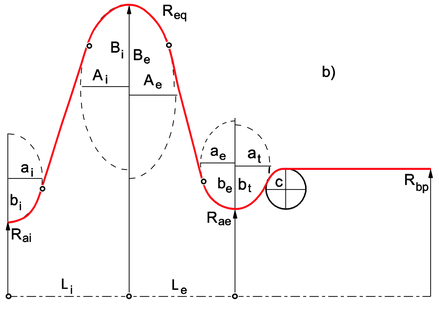


Figure 2. Two possible end cells of a multicell cavity: type *a* - with a simple transition to the beam pipe (a), and type *b* - with an iris in a broader beam pipe.

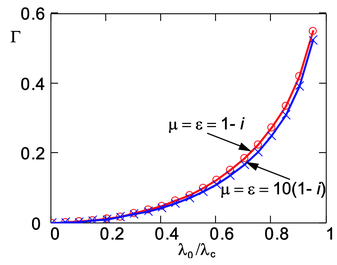


Figure 3. Coefficient of reflection from the lossy material in the waveguide.

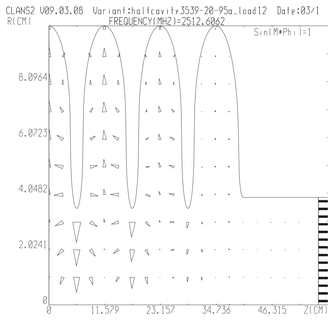


Figure 4. A half-cavity with a disc-shape load at the end of the beam-pipe for the data presented at Figure 5 and a dipole mode with high

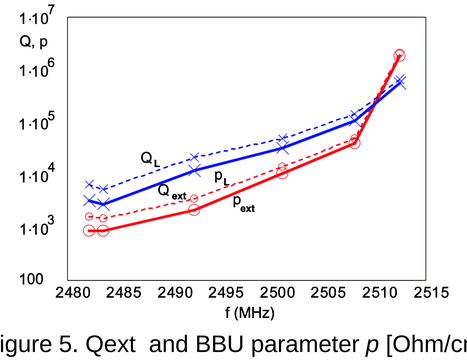


Figure 5. Qext and BBU parameter *p* [Ohm/cm²/GHz] for the cavity optimized for minimum losses, before HOM optimization.

	f:	1739	1867	1883	2467	2511	2513	3073	3400	q
dp/dq =		−87	−19	21	0	−5024	7001	1427	−248	A_a
		30	9	−5	0	2180	−1957	−508	147	B_a
		0	−1	−2	0	−107	−166	−35	105	a_a
		4	−3	−6	0	119	−144	−65	18	b_a
		221	−102	−145	261	−28	−16	279	−53	A_b
		−95	27	41	69	12	6	−92	26	B_b
		86	37	63	−43	0	0	−26	−8	a_b
		−20	−5	−4	−5	0	0	5	−2	b_b
	p:	2270	1209	2158	1918	2261	2259	2145	2259	

Figure 6. Matrix of derivatives *dp/dq* and associated frequencies, *p*'s, and *q*'s
The biggest derivatives correspond to half-axes *Aa* and *Ba* but they have different signs. So, further decrease of *p* is limited.

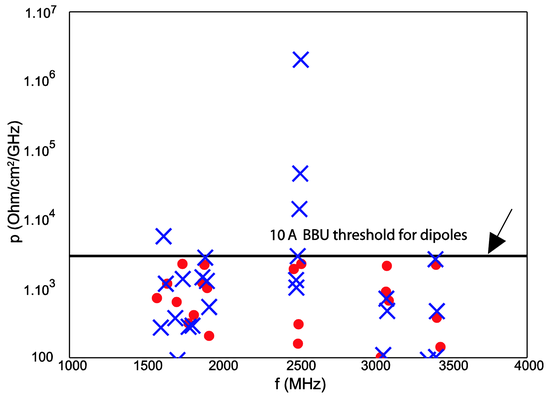


Figure 7. BBU parameter *p* vs frequency for the cavity with minimal fundamental losses before and after optimization for minimal *p*.

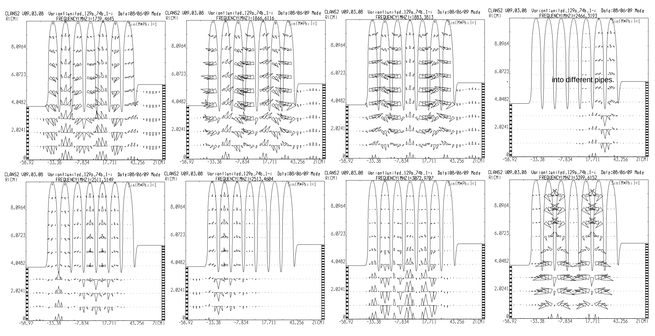


Figure 8. Electric field of eight modes with biggest *p*.

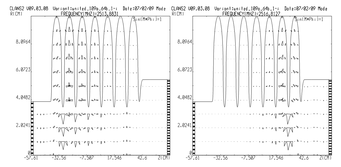


Figure 9. Redirection of modes with maximal *dp/dq* into different pipes. Compare to modes 2511 and 2513 MHz on the left

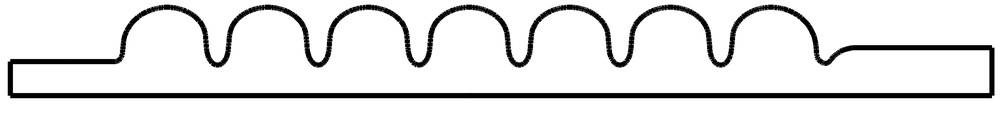


Figure 10. The scaled view of the cavity with the end cells of different types.

CONCLUSIONS

A possibility to control tuning of the HOMs propagation into the beam pipes was demonstrated. Usage of derivatives of the BBU parameter with respect to cell dimensions is a powerful method of suppression of the HOMs. Minimization of the BBU parameter of dipole HOMs was done changing the shapes of the end half-cells of the cavity with increase of power losses of the fundamental mode by 0.8 %. Decrease of the BBU parameter was nearly 3 orders of magnitude compared to the original shape tuned for minimal losses. The BBU threshold current was increased the same value, up to 10 A.

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