MONOPOLE HOMS DAMPING IN THE LCLS-II 1.3 GHZ STRUCTURE*

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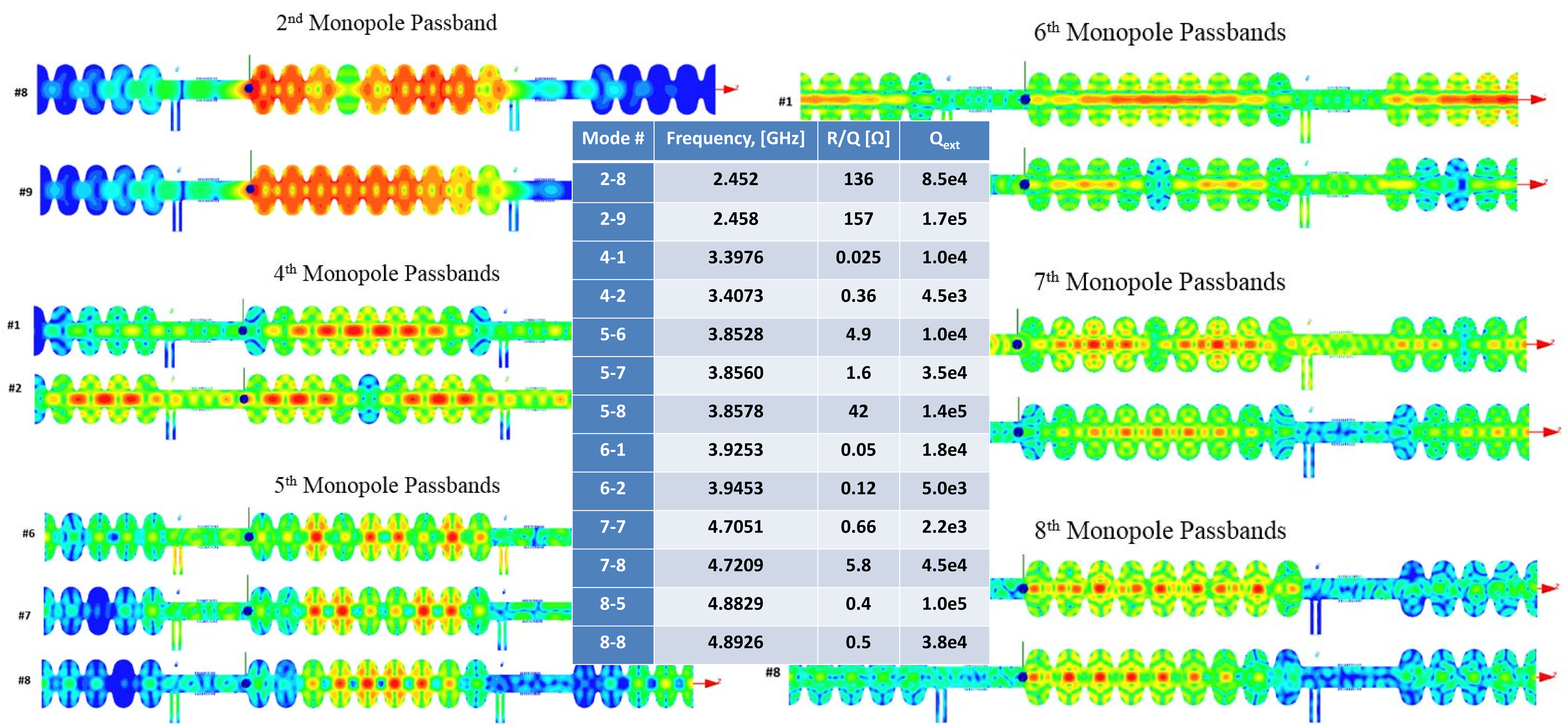
Introduction

A continuous operation regime of the 1.3 GHz LCSL-II accelerating structure at the nominal gradient of 16 MV/m sets an extra caution on possible overheating of HOM couplers feedthroughs. The HOM feedthrough coupling antenna is made of a solid Niobium, which does not produce significant amount of RF losses until its temperature is keeping below critical and the niobium surface is in a superconducting state. A radiation of HOMs and an operating mode leaking through the notch filter can cause RF heating of the feedthrough internal parts and then a heating of the antenna itself by a thermal conductivity. This effect may initiate a thermal runaway process, produce a sharp temperature rise and end up by a cavity quench.

MONOPOLE HOMS SPECTRUM



Mode #	Frequency, [GHz]	R/Q [Ω]	Q_{ext}
2-8	2.452	136	8.5e4
2-9	2.458	157	1.7e5
4-1	3.3976	0.025	1.0e4
4-2	3.4073	0.36	4.5e3
5-6	3.8528	4.9	1.0e4
5-7	3.8560	1.6	3.5e4
5-8	3.8578	42	1.4e5
6-1	3.9253	0.05	1.8e4
6-2	3.9453	0.12	5.0e3
7-7	4.7051	0.66	2.2e3
7-8	4.7209	5.8	4.5e4
8-5	4.8829	0.4	1.0e5
8-8	4.8926	0.5	3.8e4

- The TM01 mode in the cavity transforms to the dipole TE11 mode in the beam pipe due to asymmetries introduced by HOM couplers
- The dipole TE11 mode is freely propagating through the beam pipe
- The TE11 signal reaches to neighbour cavities and reflects back forming a standing wave pattern, which has a strong influence on a coupling with the HOM
- Most of the HOM power is radiated to a single HOM coupler

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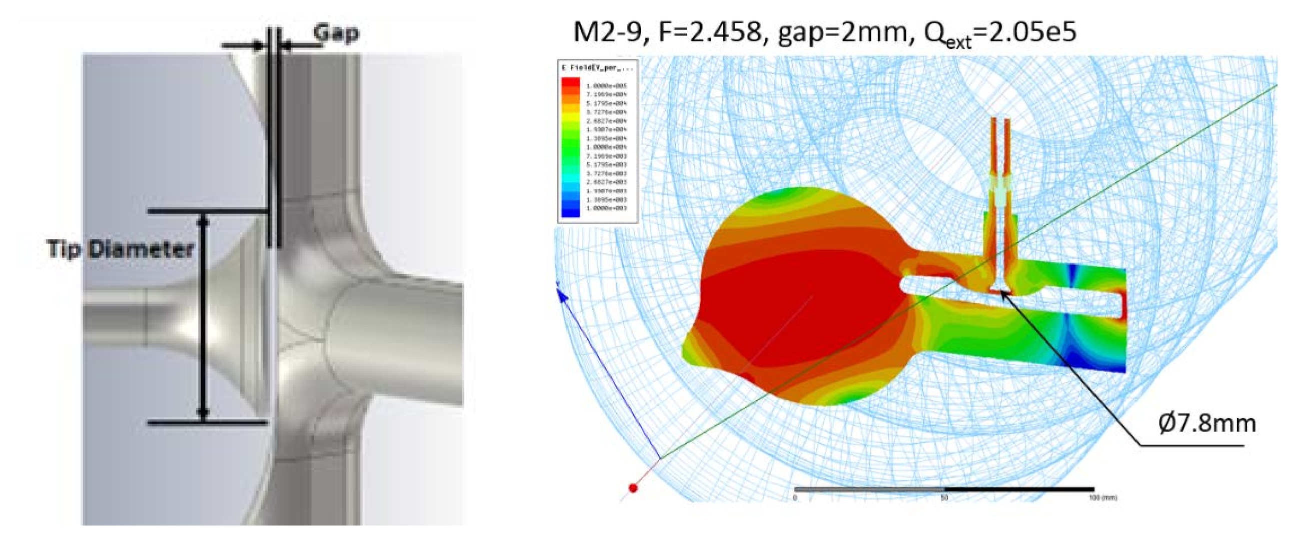
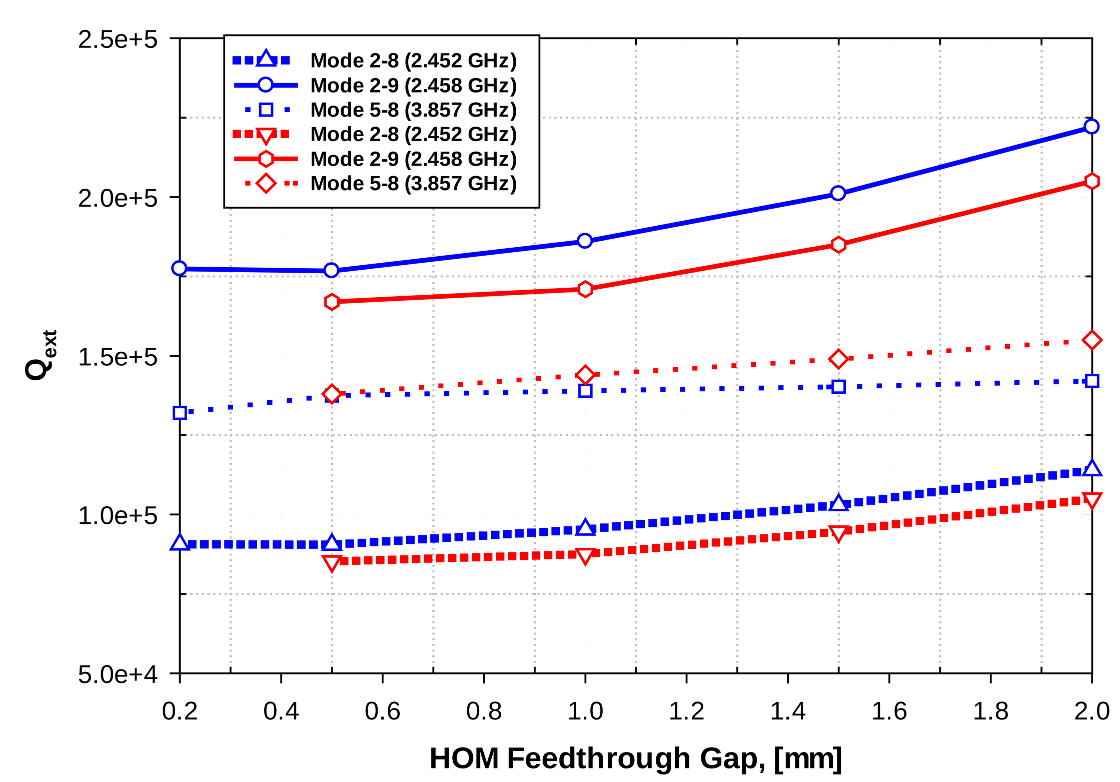
Optimization of HOM Coupler Parameters

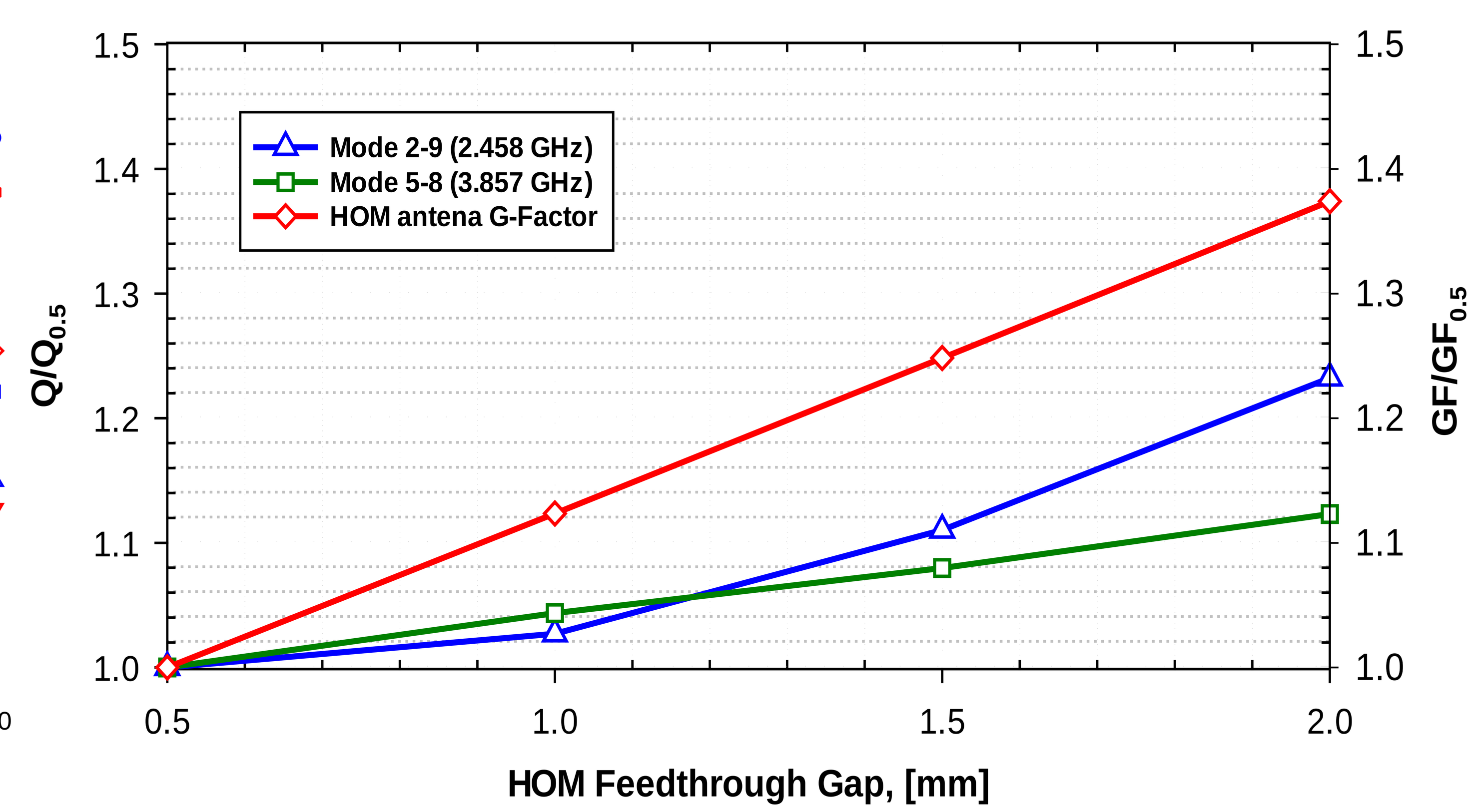
- Reflections from feedthrough ceramic and the antenna tip form a low-Q resonator, which impacts on the monopole HOMs coupling.
- Small antenna can produce better coupling.
- The efficiency of damping monopole HOMs is almost constant for gaps less than 1 mm



Map of electric field in the 1.3 GHz LCLS-II HOM coupler.

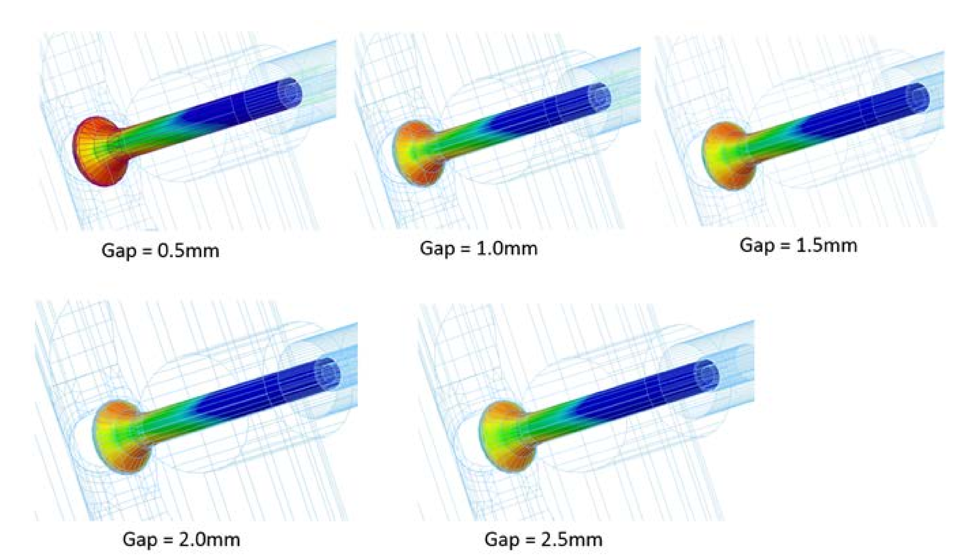


Monopole HOMs damping in the 2nd and 5th passbands by the ILC (blue) and XFEL (red) HOM couplers.



Normalized Q_{ext} and G-factors for different sizes of the HOM feedthrough gap.

- The antenna tip (Ø 7.8 mm) of the XFEL feedthrough has a better than the ILC (Ø 11 mm) coupling with the 2nd monopole passband.
- The antenna G-factor grows rapidly with gap sizes than the quality factors of associated monopole HOMs.
- For the gap of 1.5 mm one can expect about 25% less RF losses while there is only 10% growing of the HOM quality factors.



Surface magnetic field on the HOM feedthrough antenna tip.

Conclusions

We performed simulations of monopole HOM spectrum in the 1.3 GHz structure for LCLS-II linac with actual geometries of HOM feedthroughs. Local RF losses on the antenna tip were estimated for various sizes of the gap between the antenna and the HOM coupler f-part. Finally, we conclude that the gap size can be safely increased up to 2.0 mm in order to minimize heat load in the HOM feedthrough and to suppress a multipactor occurrence simultaneously.