SPWR023, THOP09, THPO109

A New Spherical Pulse Compressor Working with Degenerated "Whispering Gallery" Mode

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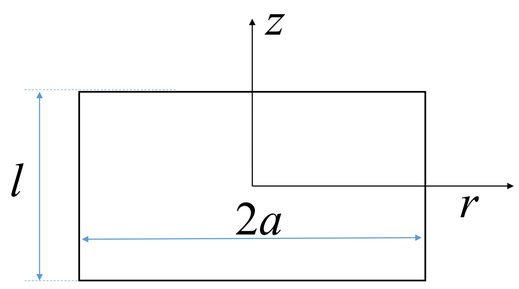
Introduction

CLIC is focusing on the Compact Linear Collider. This work is to make an alternative design for CLIC pulse compression scheme. There are several kinds of pulse compressor: SLED, SLED-II, BOC, spherical pulse compressor and so on. Usually, a spherical cavity can offer a higher Q factor compared with a cylindrical cavity. This design utilizers a spherical cavity working with degenerated "Whispering Gallery" mode.

BOC & Whispering Gallery mode

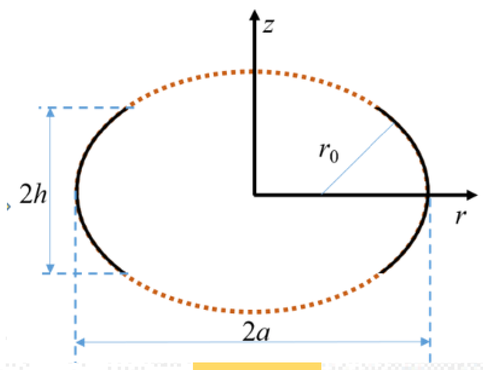


Cylindrical Cavity

Resonant frequency of TM_{mnp}:

$$k^2a^2 = v_{mn}^2 + \left(\frac{p\pi a}{l}\right)^2$$

m: φ direction (T)
n: *r* direction (T)
p: *z* direction (L)



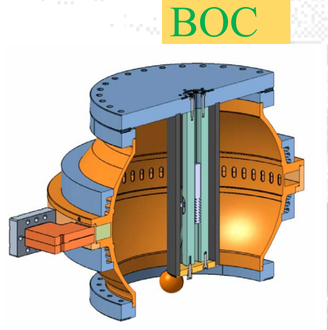
BOC

Resonant frequency of TM_{mnp} :

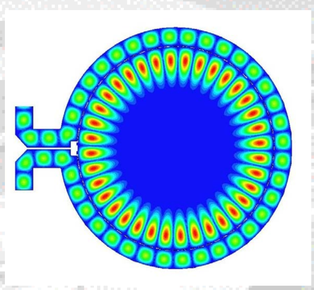
$$ka = v_{mn} + \frac{(p-1/2)\alpha}{\sin\theta}$$

m: φ direction (T)
n: *r* direction (T)
p: *z* direction (L)

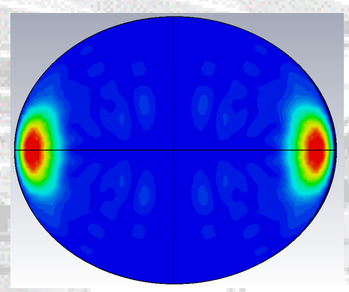
$$Q_0 = \frac{a}{\delta}$$



Cavity



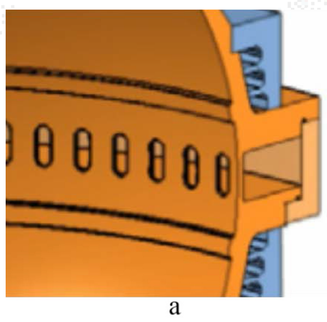
E-field: Top-view



E-field: Side-view

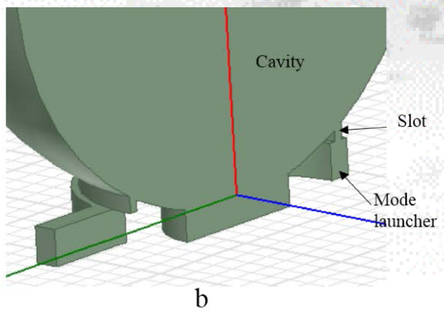
Spherical cavity is a special BOC.

Analysis & RF Design



a

Traditional BOC, coupling apertures



b

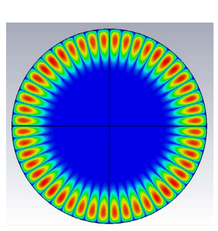
New design, coupling slot

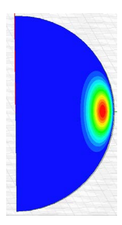
The new design will make the machining more precisely.

1. $TM_{24,1,1}$ (Whispering Gallery) mode

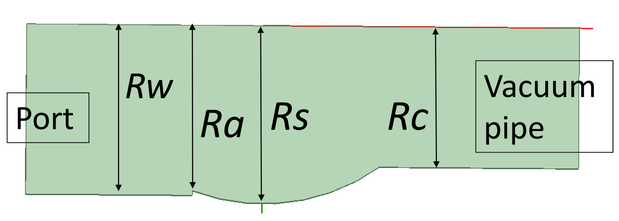
For $TM_{24,1,1}$ mode, both the theory of BOC and spherical cavity can be used, and they give the same result.

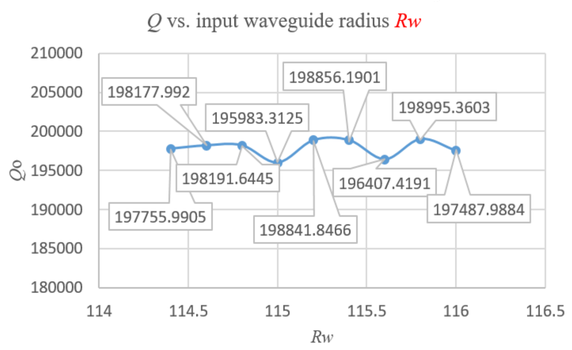
$TM_{24,1,1}$	
Radius /mm	120.3
Frequency /MHz	11995.8
Q_0	199374





A vacuum pipe and a power port are introduced to the cavity.

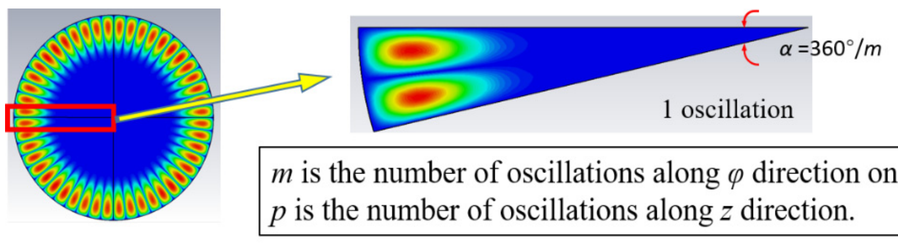




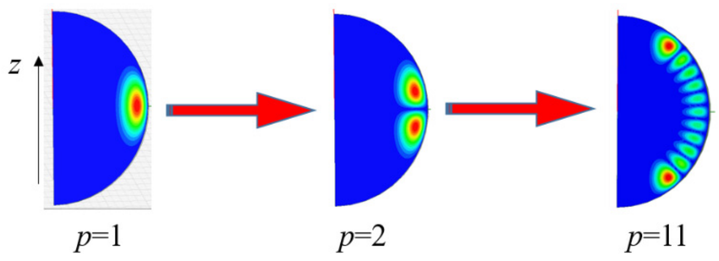
According to the simulation results, the vacuum pipe won't influent the cavity performance. As for the power port, the Q factor is reduced by about 0.5%, which is acceptable.

2. $TM_{14,1,11}$ and $TM_{9,1,16}$ mode

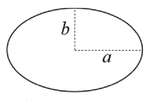
The size of mode launcher for $TM_{24,1,1}$ mode is too big. To reduce the size, the degenerated Whispering Gallery modes are investigated.



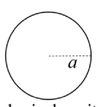
m is the number of oscillations along φ direction on equator plane.
p is the number of oscillations along *z* direction.



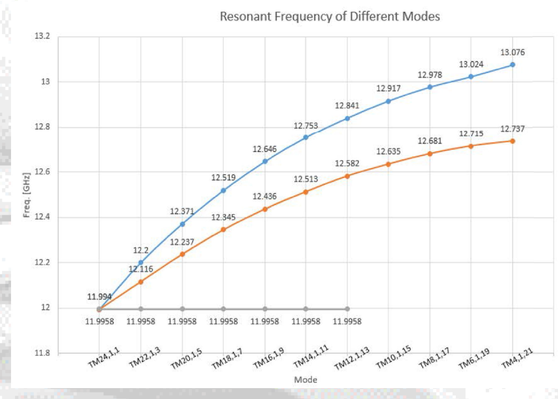
It won't work for an elliptical BOC cavity. The two different radii: the major axis and the minor, result in the frequency difference between these modes. But for a spherical cavity, all these modes have the same resonant frequency, which can be called as degenerated modes.



BOC, elliptical cavity, two radii



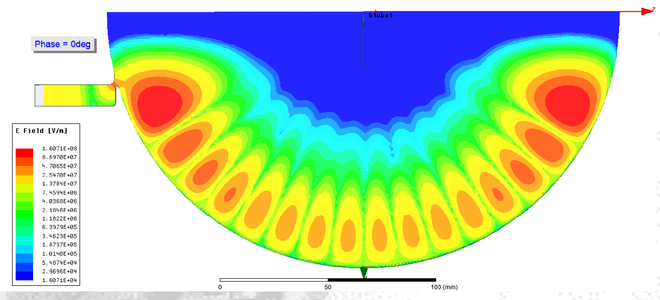
Spherical cavity



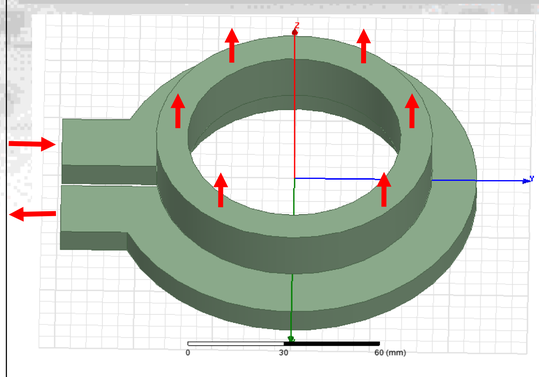
For different modes, as long as *n*=1, *m*+*p*=25:

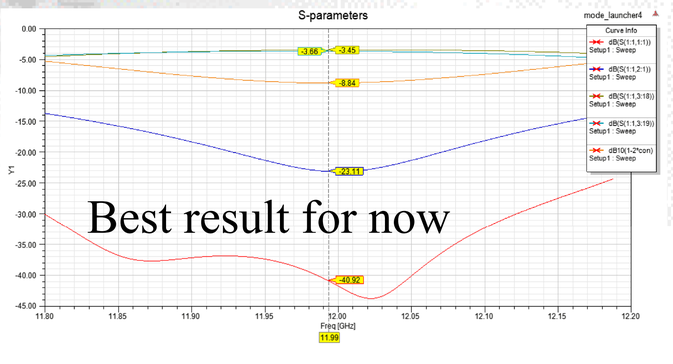
- For elliptical BOC, their frequencies are different.
- The smaller the difference between *a* and *b* is, the smaller the frequency difference will be.
- If *a*=*b*, the frequency difference becomes 0. All these modes are degenerated.

$TM_{14,1,11}$ and $TM_{9,1,16}$ mode are checked. We want the mode launcher as small as possible, so finally $TM_{9,1,16}$ mode is chosen.



3. Mode launcher design (being optimized)





Conclusion

- This work is to design a spherical pulse compressor using degenerated Whispering Gallery mode.
- Some investigations on Whispering Gallery mode and its degenerated modes are presented.
- The structure is being designed. Some preliminary results are presented.

References

[1] I. Syratchev, *The Progress of X-Band "Open" Cavity RF Pulse Compression Systems*, 1994.
[2] J. W. Wang, S.G. Tantawi, X. Chen, *New SLED 3 system for Multi-mega Watt RF compressor*, arXiv preprint arXiv: 1408.4851(2014).
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[5] J. Hirshfield, S. V. Kuzikov, M. I. Petelin, and V. G. Pavelyev, *Whispering Gallery Pulse Compressor*, 2004.

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