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Simulative study of simple ring resonator-based brewster plate for power system operation stability

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ABSTRACT

This study has outlined the simulative study of simple ring resonator based Brewster plate in the air. The obtained results are achieved with the variations of space length, curvature radius, and phase angle of the spherical mirror. Beam radius criterion and stability parameters are measured with the variations of refractive index and thickness of Brewster plate in the air. The negative and positive effects of increasing operating parameters are observed on the performance of ring resonator system efficiency.

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1. INTRODUCTION

The previous studies concentrate on the performance parameter for ring resonators that are namely factor quality, resonance frequency and tunneling frequency [1-5]. The resonance frequency of this circuits resonance is determined by the exacting of two elements such as inductors and capacitors. The gain in the resonance case is high [6-9]. Some resonator circuits composed from resistors, inductors, and capacitors that are different in values. Many types of research are attempted to measure the best candidate values of these components for resonator circuits to have a high gain [10-12].

Another important parameter in the resonator circuit is the quality factor which is in relation to the resonance frequency of the circuit resonance [13-15]. The quality factor is estimated by the multiplication of the resonance frequency with inductance value and divided by resistance value. The larger inductance value the greater quality factor [16, 17]. The lower the resistance value the greater the quality factor [18, 19]. The resonance frequency is determined by the square root of the division of inductance value on the capacitance value. More attempts for increasing the quality factor the ring resonators [20].

2. RING RESONATOR DESCRIPTION AND RESEARCH METHOD

Figure 1 has presented the basic schematic view of the simple ring resonator. L1 is the space length which is ranged from 100 mm to 1200 mm. M1 is the spherical mirror with R is the curvature radius of the mirror and alpha is the phase angle of the spherical mirror in degree. The curvature radius is positive for concave mirror and negative for a convex mirror. The alpha phase angle ranges from 1 degree to 10 degrees. d1 is the space length between the spherical mirror and Brewster plate in the air whose thickness ranges from 1 mm to 10 mm and its refractive index ranges from 1.3 to 1.5. d2 is the space length between the Brewster plate in the air and spherical mirror M2 whose R parameter is the curvature radius of the mirror and alpha parameter is the phase angle of the spherical mirror in degree.

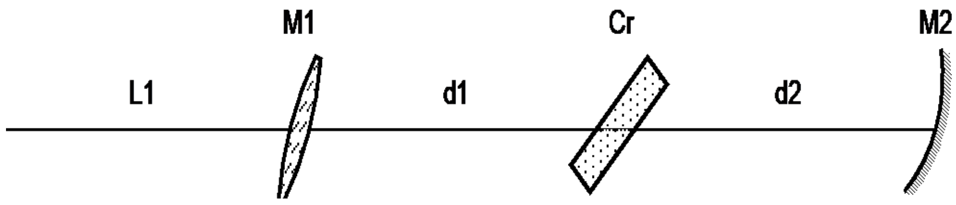

Figure 1. Basic schematic view of the simple ring resonator

So M1, M2 are the spherical mirrors with R parameter is the curvature radius of the mirror and alpha parameter is the phase angle of the spherical mirror in degree. L1, d1, d2 represents the space lengths between resonator elements in mm units. Usually, its values range from 100 mm to 1200 mm or less than values in other applications. While the different elements in the simple resonator system are the Brewster plate in the air whose its thickness (t) measured in mm and n is the refractive index.

3. RESULTS AND ANALYSIS

We have presented the simulative study of simple ring resonator based Brewster plate in the air. The variation of space length and empty space are applied in the range of 100 mm to 50 mm. The variations of curvature radius and phase angle of spherical mirrors are applied to measure the stability criterion and beam radius over the stability region. As shown in Figure 2, the beam radius variations versus empty space variations in S plane and T plane. It is clear beam radius radiation increases with increasing empty space in both planes under study. The variations of beam radius against variations of the curvature radius of the spherical mirror are shown in Figure 3. A curvature radius of spherical mirror increases leading to a decrease in beam radius variations in S plane and T plane. The beam radius variations in relation to variations of the phase angle of the spherical mirror as shown in Figure 4. It is observed that as the phase angle of the spherical mirror increases leading to an increase of beam radius in the S plane and slightly decrease and increase in T plane.

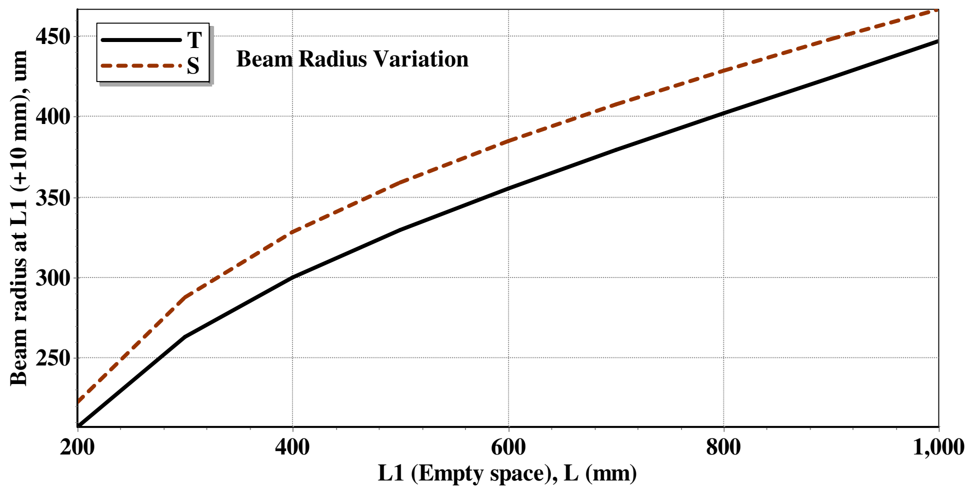

Figure 2. Beam radius variations versus empty space variations in S plane and T plane

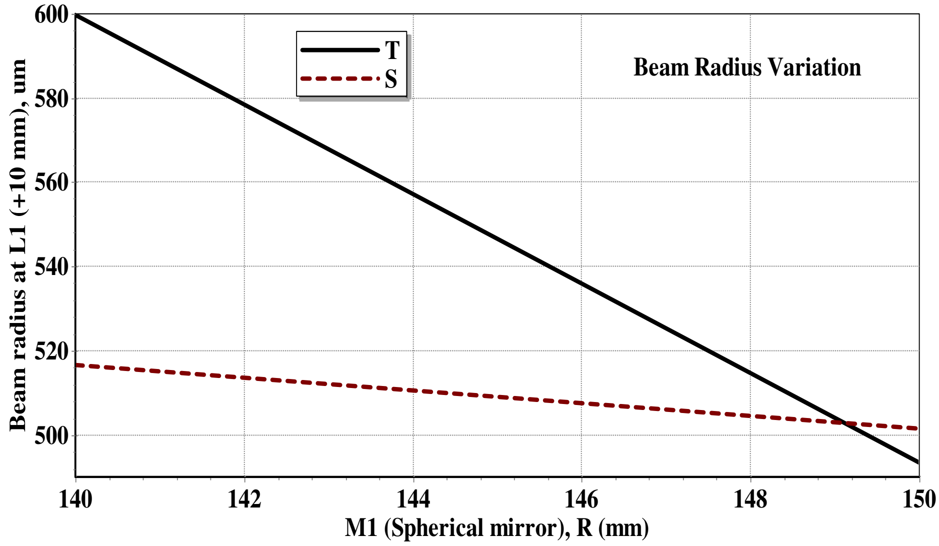

Figure 3. Variations of beam radius against variations of the curvature radius of the spherical mirror

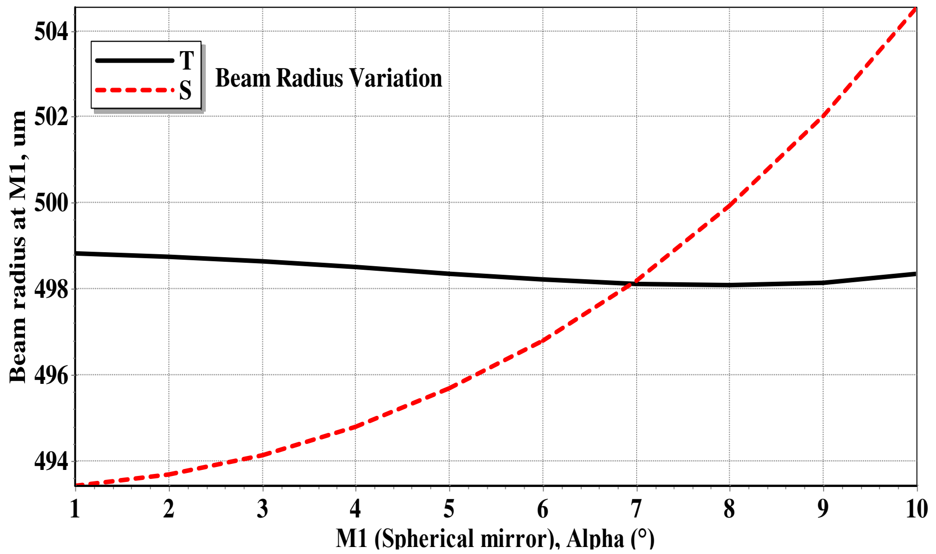

Figure 4. Beam radius in relation to variations of the phase angle of the spherical mirror

Figure 5 shows the variations of beam radius versus variations of empty space. As empty space increases leading to a decrease of beam radius that ranges from 450 µm to 630 µm in T plane only. There are no variations of beams radius radiation in S plane. Figure 6 shows the beam radius variations in relation to refractive index variations of Brewster plate in the air. As refractive index variations of Brewster plate in air increases leading to an increase of beam radius in both S and T planes. Beam radius has a greater value in T plane in compared with the S plane. The variations of stability criterion against variations of empty space variations as shown in Figure 7. As empty space increases from 50 mm to 90 mm this leading to stability parameter increases in T plane and S plane. But from empty space ranges from 90 mm to 150 mm this leading to stability parameter decreases in both S and T planes.

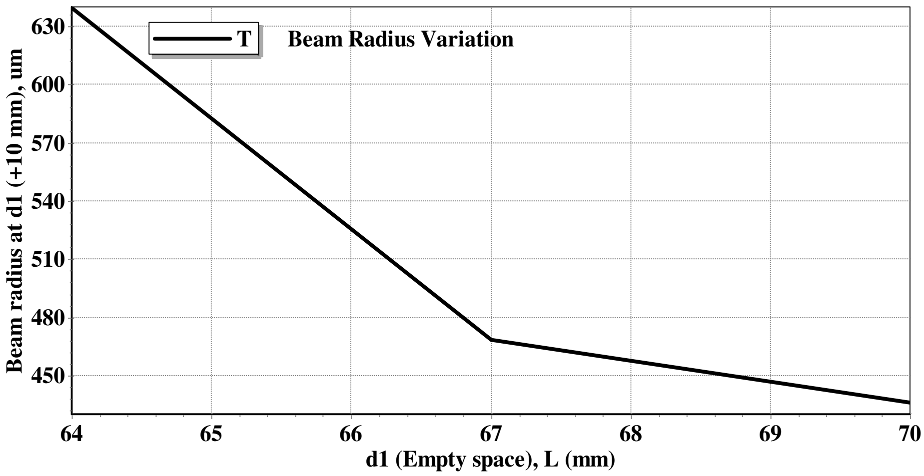

Figure 5. Variations of beam radius versus variations of empty space

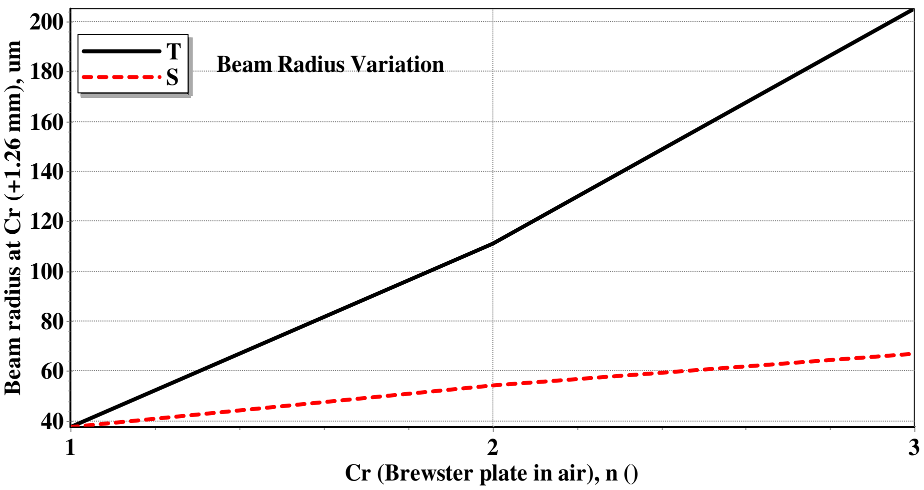

Figure 6. Beam radius variations in relation to refractive index variations of Brewster plate in the air

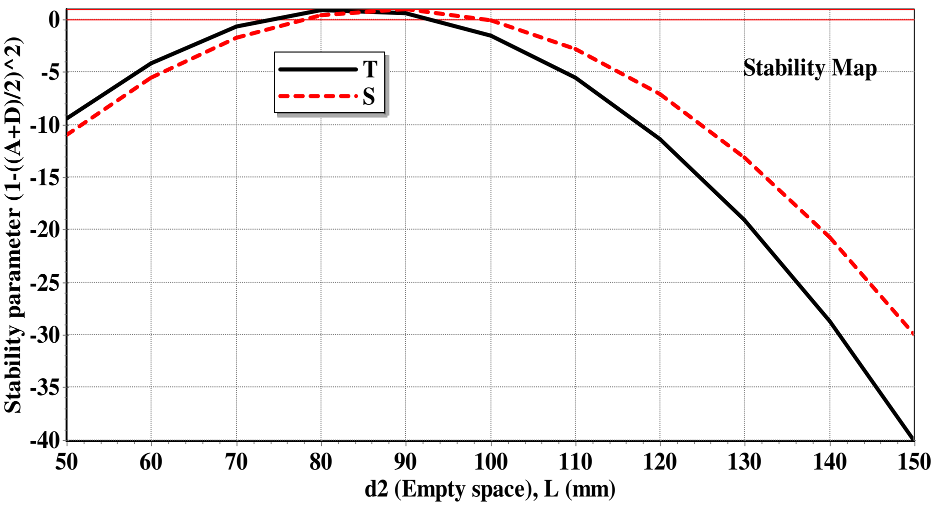

Figure 7. Variations of stability criterion against variations of empty space variations

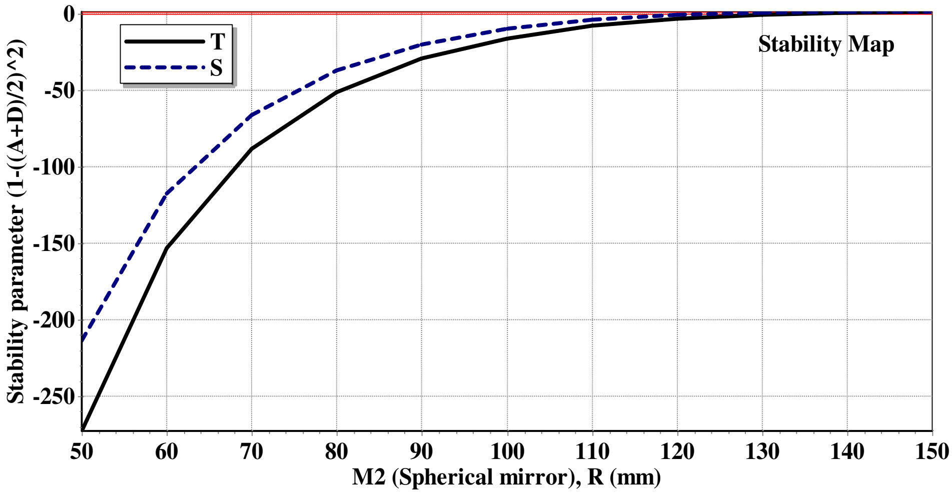

Figure 8. Stability criterion in relation to the curvature radius of spherical mirror variations

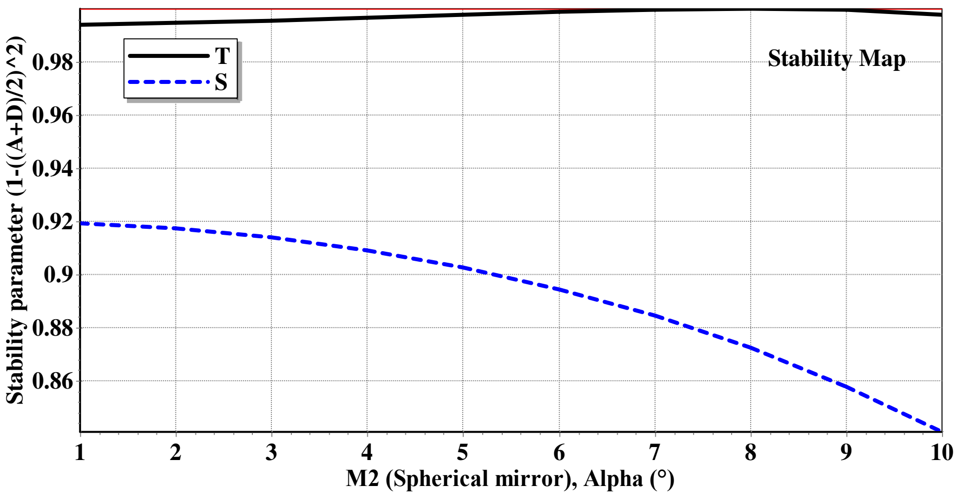

Figure 9. Stability parameter variations versus phase angle variations of the spherical mirror

Figure 8 clarifies the stability criterion in relation to the curvature radius of spherical mirror variations. It is observed that the stability parameter increases in both S and T planes from the curvature radius ranges from 50 mm to 120 mm. But stability parameter is almost constant from the curvature radius ranges from 120 mm to 150 mm. Stability parameter variations versus phase angle variations of the spherical mirror is shown in Figure 9. As phase angle of spherical mirror increases leading to decreases in stability parameter in T plane. But stability parameter increases with increasing of the phase angle of the spherical mirror from 1 degree to 7 degrees. While the performance degraded from the phase angle of spherical mirror variations from 8 degrees to 10 degrees.

4. CONCLUSION

In summary, the simple ring resonator is simulated based on a Brewster plate. It is clear that the positive or negative effects of the operating performance parameters on the simple ring resonator system performance efficiency. Stability parameter and beam radius variations are measured in both S and T planes. The stability parameter increases in both S and T planes from the curvature radius ranges from 50 mm to 120 mm. But stability parameter is almost constant from the curvature radius ranges from 120 mm to 150 mm. The phase angle of the spherical mirror increases leading to decreases in stability parameter in the T plane.

But stability parameter increases with increasing of the phase angle of the spherical mirror from 1 degree to 7 degrees. While the performance degraded from the phase angle of spherical mirror variations from 8 degrees to 10 degrees.

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Dr. IS Amiri has been doing research on several topics such as the optical soliton communications, laser physics, fiber lasers, fiber grating, electro-optical modulators, nanofabrications, semiconductor design and modelling, Lumerical modelling, plasmonics photonics devices, nonlinear fiber optics, optoelectronics devices using 2D materials, semiconductor waveguide design and fabrications, photolithography fabrications, E Beam lithography, quantum cryptography and nanotechnology engineering.

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