

16-July-2023

Dear Reviewer,

Thank you for your comments concerning our manuscript entitled “Analysis and Experiment of Laser Energy Distribution of Laser Wireless Power Transmission Based on Powersphere Receiver” (ID: photonics-2514612). Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We have studied comments carefully and have made correction which we hope meet with approval. The red font highlighted the changes of the content in the revised manuscript. The main corrections in the paper and the responds to the reviewer’s comments are as following:

Responds to reviewer’s comments:

Responses to Reviewer 2’s Comments

[Reviewer 2’s Concern 1]

Include units in table 1 and table 2 (at least in the caption if not for each columns), and any other similar omissions.

Response 1:

Thank the reviewer for this valuable comment. Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We make further revisions according to 1nd reviwers’ comments.

We added units

“Table 1. Original Parameters.

Surface	r(mm)	d (mm)	n(mm)
1	28.45	3.79	1.4970
2	−373.80	0.03	1.4970
3	27.31	3.08	1.4970
4	162.76	1.88	1.4970
5	−335.17	1.64	1.8061
6	27.03	0.03	1.8061
7	14.07	3.79	1.4970
8	46.93	Infinite	1.4970

Table 2. Optimized Parameters.

Surface	r(mm)	d(mm)	n(mm)
1	28.45	3.79	1.4970

2	-373.80	0.03	1.4970
3	27.31	1.64	1.4970
4	162.76	14.23	1.4970
5	-335.17	3.08	1.8061
6	27.03	21.12	1.4970
7	14.07	3.79	1.4970
8	46.93	Infinite	1.4970

”from L237 to L238 and “ The spot diameters in these positions are 58.00 mm and 68.00 mm. Then the divergence angle is:” in the L459.

[Reviewer 2's Concern 2]

The authors should verify and adjust the number of digit accuracy?

For example 57.754mm, is it really precise to a micron...?

Response 2:

Thank the reviewer for this constructive comment.

We have adjust the number of digit accuracy to two decimal places.

For example: The surface receivers are added at the incident end of the beam expander (10.06 mm), the output end of the beam expander (57.75 mm), and 200.00 mm.

[Reviewer 2's Concern 3]

In addition, I'm not sure I understand why the incident light is supposed to be reflected so many times, I thought most of the light would be absorbed upon incidence with the first cell it reaches, and only a very small fraction would make it to more than 1 or 2 reflections. The authors should explain this topic better and be more quantitative on their statement.

The related descriptions was not convincing for me: “The powersphere is a closed spherical space structure composed of many photovoltaic cells. It can “trap” the incident laser in a relatively closed cavity, such that the unabsorbed laser can reach every part of the sphere surface after multiple reflections. In this way, the light intensity of each part of the spherical surface is equal, which solves the problem of nonuniform distribution of laser intensity on the photovoltaic receiving surface.”

Response 3:

Thank the reviewer for this valuable comment. Those comments are all valuable and very helpful for revising and improving our paper.

We deleted” The powersphere is a closed spherical space structure composed of many photovoltaic cells. It can “trap” the incident laser in a relatively closed cavity, such that the unabsorbed laser can reach every part of the sphere surface after multiple reflections. In this way, the light intensity of each part of the spherical surface is equal, which solves the problem of nonuniform distribution of laser intensity on the photovoltaic receiving surface.” **from L153 to L157.**

And we added “The powersphere is a enclosed spherical structure, which is spliced by multiple photovoltaic cells. When the laser enters the powersphere through an incident hole and irradiates the inner wall of the powersphere, some of the laser is absorbed, while the rest is reflected to other locations on the inner wall of the powersphere. Absorption and reflection occur again, and so on, the luminous flux of each reflected light is the previous luminous flux multiplied by the absorption rate, and the total luminous flux of reflected light is shown in equation (1)[27]:

$$E_{\Sigma} = E_1 + E_2 + E_3 + \cdots + E_n = \rho E_B + \rho^2 E_B + \rho^3 E_B + \cdots + \rho^n E_B = \frac{\rho(1-\rho^n)}{1-\rho} E_B , \quad (1)$$

” from L145 to L152

and “It can be seen from the above equation that only when the number of reflections is sufficient, $\rho^n \approx 0$, and the luminous flux at any point on the inner wall is equal. Otherwise, due to the difference in the number of reflections, the right side of the equation is not equal, and the total luminous flux is not equal. Therefore, the use of powersphere instead of photovoltaic panels can improve the light uniformity of the receiving surface.” **from L158 to L162.**

[Reviewer 2’s Concern 4]

Verify and correct typo errors: ‘aera’ for example, etc

Response 4:

Thank the reviewer for this valuable comment. Those comments are all valuable and very helpful for revising and improving our paper.

We have corrected the typo errors.

For example: We change ‘aera’ to ‘area’ and so on.

[Reviewer 2’s Concern 5]

Some figures have small fonts or could be clearer.

Response 5:

Thank the reviewer for this valuable comment. Those comments are all valuable and very helpful for revising and improving our paper. We make the small fonts in the picture clearer by enlarging the picture.

[Reviewer 2's Concern 6]

The paper is long, so perhaps cutting some less critical parts could improve the manuscript.

Response 6:

Thank the reviewer for this valuable comment. Those comments are all valuable and very helpful for revising and improving our paper. According to your comments, we have deleted the part of the comparison of different Fresnel focal lengths in the simulation and experiment:

We deleted”The color in the range of 70° – 120° is blue, the light intensity is basically close to 0, and the light intensity distribution fluctuates minimally. Similar to the optical tracing diagram, the light density in this area is also lower than those in other areas, indicating that the irradiated light in this area should be the light reflected 3 times or more.” **from L372 to L375 and**

“ When the focal length of the Fresnel lens changes, the position of the focal point of the lens will also change, which will lead to a change in the direct irradiation area, and the light intensity distribution on the inner wall of the powersphere will inevitably change. To understand the changes in the light intensity distribution caused by the focal point, a Fresnel lens with a focal length of 100 mm is used to replace the original lens with a focal length of 40 mm. The simulation results are shown in Figure 12. Figure 12(a) is the result of ray tracing. As the focal length increases, the closer the focal point is to the circle center, the smaller the direct irradiation area will be, and the light density in areas outside the direct irradiation will decrease. Figure 12(b) is the light intensity distribution. The maximum light intensity becomes 1.27 W/sr, which is much larger than the original maximum light intensity (0.456 W/sr). Nonetheless, the directly irradiated area and the area irradiated by the laser after the first reflection are significantly reduced, and the area with a small light intensity or 0 light intensity in the middle increases. This condition will inevitably lead to a decrease in the uniformity of the light on the inner surface of the powersphere and a decrease in the conversion efficiency of the system.

” from L382 to L400

and “By replacing the lens with a focal length of 100mm with a lens of focal length 70mm, the influence of focal length on the energy distribution was studied, and the energy distribution is shown in Figure 19. Figure 19(a) represents the beam profile measured by the beam quality analyzer. Comparing it with Figure 19(b), it can be observed that there are still numerous concentric circles in the beam spot, indicating that the focused beam with the Fresnel lens is composed of concentric circles. However, in the case of the 70mm lens, the white area at the center of the beam spot is reduced, indicating a decrease in energy in the central region. Figure 19(c) and Figure 19(d) show the corresponding distribution curves in the vertical and horizontal directions, respectively. Comparing them with Figure 18(c) and Figure 18(d) , it can be observed that although both directions still exhibit a Gaussian distribution, the maximum intensity is smaller than that of the lens with

a focal length of 100mm. This suggests that a shorter focal length results in a lower power density and improved uniformity of the light.

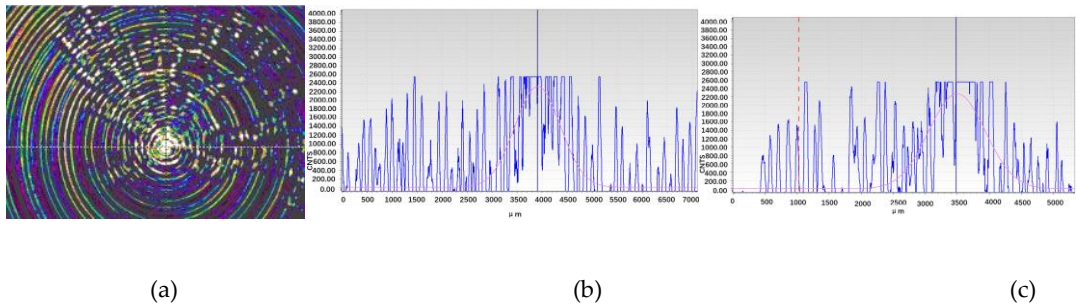


Figure 19. Power distribution of laser in a Fresnel lens at a focal length of 70mm:(a)Spot;(b) Distribution curves in the vertical direction;(c) Distribution curves in the horizontal direction.”
from L524 to L540

and “The voltage and current values of each branch are remeasured using a lens with a focal length of 70 mm instead of a lens with a focal length of 100 mm. The distribution curve of voltage and current plotted in accordance with the measured value is shown in Figure 22. Figure 22(a) is the voltage distribution curve, and Figure 22(b) is the current distribution curve. To simplify the measurement work, three adjacent groups of circuits are connected in series into one group, such that the photovoltaic cells in the powersphere are divided into 22 groups. From Figure 22, it can be observed that as the focal length decreases, both the voltage and current values decrease. This is because when the focal length becomes smaller, the diameter of the beam spot increases, resulting in a decrease in the power density of the beam spot, which leads to a corresponding decrease in the output voltage and current of the cells. In Figure 22, the voltage and current curves under different focal lengths have an inconsiderable change. The main reason is that the focal length variation range is minimal. The uniformity of light intensity distribution can be further improved if the focal length continues to decrease.

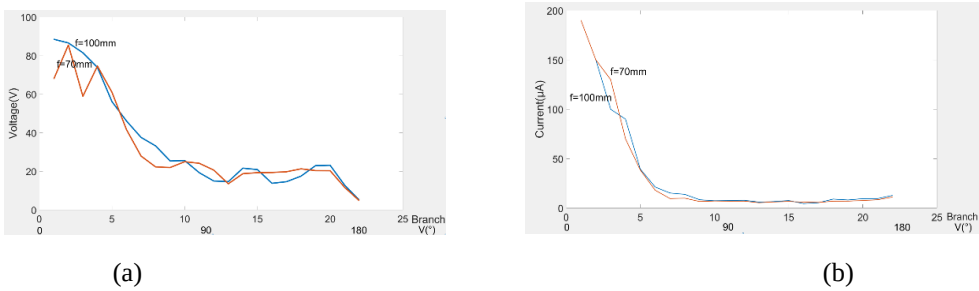


Figure 22. Output curve of the powersphere with a Fresnel lens at a focal length of 70 mm:(a)Voltage curve;(b)Current curve.” from L601 to L618 and so on.

The grammar and spell check in the revised manuscript are not listed on the summary above.

Thank you and all the reviewers and editor for the kind advice.

Sincerely yours,

Tiefeng He