Journal of Physics Special Topics
An undergraduate physics journal

P1_1That Lucky Old Sun

J. Cowen, T. Hyde, T. Johnstone, G. Sutlieff, P. Doyle

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

November 20, 2018

Abstract

In this paper we assessed the plausability of the Archimedes II orbital laser, found in the Fallout New Vegas videogame, by assessing the potential destructive output of the laser. We found that the laser would be a lot weaker than presented in game, providing a temperature raise of only $0.58 \pm 2.2 \times 10^{-5} K$. This inconsistency is most likely due to the low power output of the Helios One when compared to modern day solar plants.

Introduction

In the game Fallout New Vegas, published by Bethesda Softworks, there exists a solar power plant named Helios One [1] which is locaded near the former city of Las Vegas. This power plant houses the control sytem for Archimedes II, a satellite based artillery weapon which utilises the energy collected by the solar panels in Helios One in order to direct a high energy laser beam at the earths surface.

Equipment

In order to measure the length of objects in the game, we used a '9 iron' golf club as a standard yardstick, as the standard length for a male 9-iron is 35.5" (90.17 cm) [2] . We also used an in-game time manipulation ability (sgtm) to slow time and increase the prescision of time measurements, and an onscreen ruler program to measure fractions of the 9-iron.

Results

Using this equipment, we found that the solar panels consisted of a rectangle with length $122 \pm 5\,\text{cm}$, and width $175 \pm 5\,\text{cm}$, with a rectangle of $22.0 \pm 5\,\text{cm}$ width and $86.3 \pm 5\,\text{cm}$ length on the top and bottom of the panel. Using these values, we found the area of one solar panel was $2.51 \pm 0.14\,\text{m}^2$ and the total area of the 375 panels was $941.25 \pm 0.14\,\text{m}^2$. The diameter of the Archimedes II beam was 2.73 ± 0.06 9 irons ($246 \pm 5\,\text{cm}$). And the laser fired for $1.41 \pm 0.1\,\text{s}$.

Analysis

Using our results for the total area of the solar panels and equation 1, and assuming the solar cells present in Helios One to have the standard efficiency of solar panels using current technology (170 W/m^2) [3].

$$E_{Total} = Eff \times A_{Total} \times T_{Sunlight} \qquad (1)$$

where $E_{Total}$is the total energy produced in a day in J, Eff is the efficcency of the Solar Panel in W/m^2, A_{Total} is the total area of the solar array in m^2, and $T_{Sunlight}$ is the total time the solar array spends under sunlight in s. Using the sunrise/sunset table for Las Vegas, Nevada [4], and taking the value on the 15th of each month we produced a bar chart showing the total energy produced on a typical day in each month in Nevada (Figure 1).

From this chart, we used the maximum value of $2330 \pm 0.14\,\text{kJ}$, and the time fired to calculate the laser power to be $1652 \pm 10\,\text{kW}$. Since 23% of the laser power would be absorbed by the atmosphere [5], the power transferred to the ground would be 1272 ± 10 kW.

$$I = \frac{P}{A} \tag{2}$$

where I is the intesity of the laser in W/m^2, P is the power of the beam in W and A is the area covered by the beam in m^2. [6].

$$P_r = \frac{I}{c} \tag{3}$$

Where P_r is the radiation pressure in Pa, and c is the speed of light in m/s [6].

Using equations 2 and 3, and the laser diameter, we calculated the intensity of the laser to be 267 ± 11 kW/m^2 and the radiation pressure to be 0.892 ± 0.04 mPa. Assuming all the energy which is absorbed in the ground (48%) [5] goes into heating the ground 0.5 m below, and modelling the ground as a cylinder of constant density 1600kg/m^3 [7], and using equation 4 and the specific heat for dry soil (800 J/kg [8]).

$$Q = mC\Delta T \tag{4}$$

Where Q is the energy added to the system in J, m is the total mass of the system in kg, C is the specific heat capacity of the material in J/kg and Δt is the temperature rise in K [6].

We calculated the rise in temperature of the ground below the laser to be $0.58 \pm 2.2 \times 10^{-5}$ K.

In conclusion, these results are much smaller than we would expect of an orbital laser, and we believe the reason behind this is the low power output of the Helios One when compared to modern day solar plants (which produce $10 - 7200$ MWh [9]).

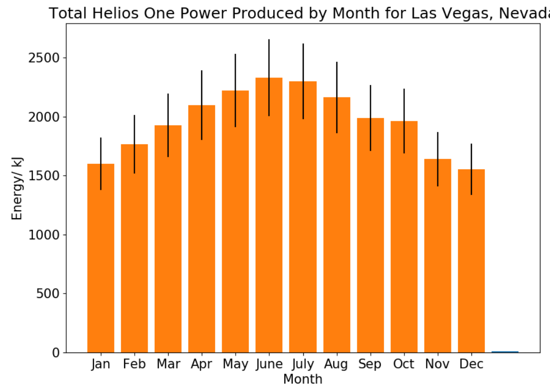

Figure 1: A graph of Helios One power produced per day for a typical day in Las Vegas by month

References

[1] Fallout Wikia. Helios one. http://fallout.wikia.com/wiki/HELIOS_One. Accessed 29/09/2018.

[2] Erika Henritz. Standard Length of Golf Clubs for Women and Men. https://www.livestrong.com/article/348393-standard-length-of-golf-clubs-for-women-and-men/. Accessed 01/10/2018.

[3] Greenmatch. How efficient are solar panels? https://www.greenmatch.co.uk/blog/2014/11/how-efficient-are-solar-panels. Accessed 30/09/2018.

[4] UNSO. sun rise/set table for las vegas, nevada. http://aa.usno.navy.mil/cgi-bin/aa_rstablew.pl?ID=AA&year=2018&task=0&state=NV&place=Las+Vegas. Accessed 30/09/2018.

[5] NASA. Earth's energy budget. https://earthobservatory.nasa.gov/Features/EnergyBalance/page4.php. Accessed 30/09/2018.

[6] P.A. Tipler and G. Mosca. *Physics for Scientists and Engineers*. Physics for Scientists and Engineers: Standard. W. H. Freeman, 2007.

[7] My Agriculture Information Bank. Density of soil: Bulk density and particle density. http://www.agriinfo.in/?page=topic&superid=4&topicid=271l. Accessed 02/10/2018.

[8] The Engineering Toolbox. specific heat of common substances. https://www.engineeringtoolbox.com/specific-heat-capacity-d_391.html. Accessed 02/10/2018.

[9] Max Roser Hannah Ritchie. A sense of units and scale for electrical energy production and consumption. https://ourworldindata.org/scale-for-electricity. Accessed 02/10/2018.