

Space Based Solar Power Orbital Simulations

Company: Space Power (<http://www.space-pwr.com>)

Project open to: 3rd/4th year undergraduate, final year undergraduate, and Masters students

Application closing date: 31st May 2021

Expected duration of project: 6 months

Latest start date: October 2021

Application link: <https://forms.gle/2wtwhrryPRQcJ2Do8>

Organisation description

Space Power is a satellite to satellite solar power concentrator, providing retrofittable wireless energy to existing photovoltaic (PV) systems to improve duty cycles by charging customers' spacecraft, primarily in the Earth's shadow.

Cubesat platforms are intrinsically power limited using the Sun. Cubesats are inherently limited in size and PV technology is struggling to make significant improvements in power conversion. These factors limit Cubesats to the power of 2 incandescent lightbulbs; not very space age!

Space Power will enable significantly higher power payloads to be employed by beaming LASERs to our customers, improving mission cost, data transmission bandwidths and payload effectiveness.

Feasibility has been demonstrated, a table-top demonstrator is planned for Q3 2021, and a launched prototype is scheduled for Q4 2023. Help us build the new In-Orbit Power Infrastructure to energise the new Space Age!

Project description

Background

Satellite orbits fundamentally determine the amount of sunlight spacecraft have access to and consequently how the amount of power that can be generated in an orbit.

Space Power is launching a solar power plant into LEO, and needs to maximise the amount of sunlight, and therefore power, that can be accessed and delivered. We like to think outside the box and would like you to research, simulate and report on various mission orbital styles, taking key mission parameters into account and challenging the status-quo of traditional mission design, which is based on circular orbits. Different operational regimes should be considered: a network of satellites operating at a high altitude providing 24/7

power, a constellation specific power plant, or even ad hoc power plants on the busiest orbital paths.

The project is largely desktop-based and will use simulation tools such as GMAT mission analysis software (NASA: OpenSource). Programming skills are desirable, MATLAB is particularly useful.

Aims

1. Report on the benefits and shortcomings of various orbital styles, considering the requirements of different mission types based on orbital models and simulations.
 - To allow Space Power to make a data driven decision by understanding the optimum orbit to deliver power to customers in different scenarios e.g. total LEO coverage, power plant per constellation, power plants for several constellations, etc.
2. Model the benefits of auxiliary power for different types of satellites, e.g. SAR satellites with powerful payloads (to maximise power), small cubesats, and last-mile delivery platforms.
 - To enable potential clients to try out different scenarios, selecting their satellite type and seeing the benefits of Space Power through increased satellite efficiency in terms of power, availability and cost.

Outputs - Measurements and Calculations

A literature review is required to outline historical orbits used in various types of missions, including a pros and cons lists, with simulations to verify the expected values of current orbits, simulations to test new orbit styles (designed for novel mission optimisation points and efficiencies), and Key Process Outputs to demonstrate the advantages and disadvantages of each new orbit compared to traditional ones.

It will be important to understand system requirements and limits for both the power plant and customers (temperatures, time in sunlight, traffic, access to customers, etc.).

Calculations include the ratio of 'sunlight received to eclipse', the temperature variations through orbits, the cost of getting to and maintaining these orbits, the access to our customer's satellites, and the overall power generated per orbit.

Cost implications should be considered for each of the simulations, with customers able to input values for their capital expenditure (spacecraft cost, number of satellites, operational cost per satellite), and understand how the different orbits affect the business case for their satellite.

The project will be guided and managed by in-house engineering leads to guide the approach to the project, however it will be necessary to be able to work independently and teach yourself NASA GMAT, using the extensive tutorials and forums online to develop the simulations. We will be there to support you and work through any problems!

The simulations will ideally take data from several databases to generate the small satellite database, e.g. nanosats.eu, or NewSpace.im, and this project will form the bedrock for future simulation work.

Person specification

We are looking for bright, creative, technical students to help us answer some key questions, reduce mission risk and inform our customers.

Students should have a degree that includes dynamics and modelling: ideally Mechanical, Aeronautical or Aerospace Engineering.

A strong programming and modelling background is highly desirable, and will make the task much easier to tackle, with a higher chance of achieving a Gold-standard outcome with extensive outputs generated, including model validations. Experience with MATLAB is highly desirable.

Subject specific information is not expected from the student and any key topics will be explained with personal support throughout the project to help understanding relevant topics such as Beam Divergence, End-to-End System Efficiencies and Orbital Mechanics. Clearly, any previous experience in these fields will be strongly favourable.

It is presumed likely that the successful candidate(s) will be studying a Mechanical-based engineering course (Mechanical, Aeronautical or Aerospace), Physics or Maths. Candidates from any other relevant courses (sciences or mathematics) will also be assessed on their individual merit, rather than solely on the course being studied.