

LyceanEM : Open Source Electromagnetics for Space Based Solar Power, Sensing, and Communications

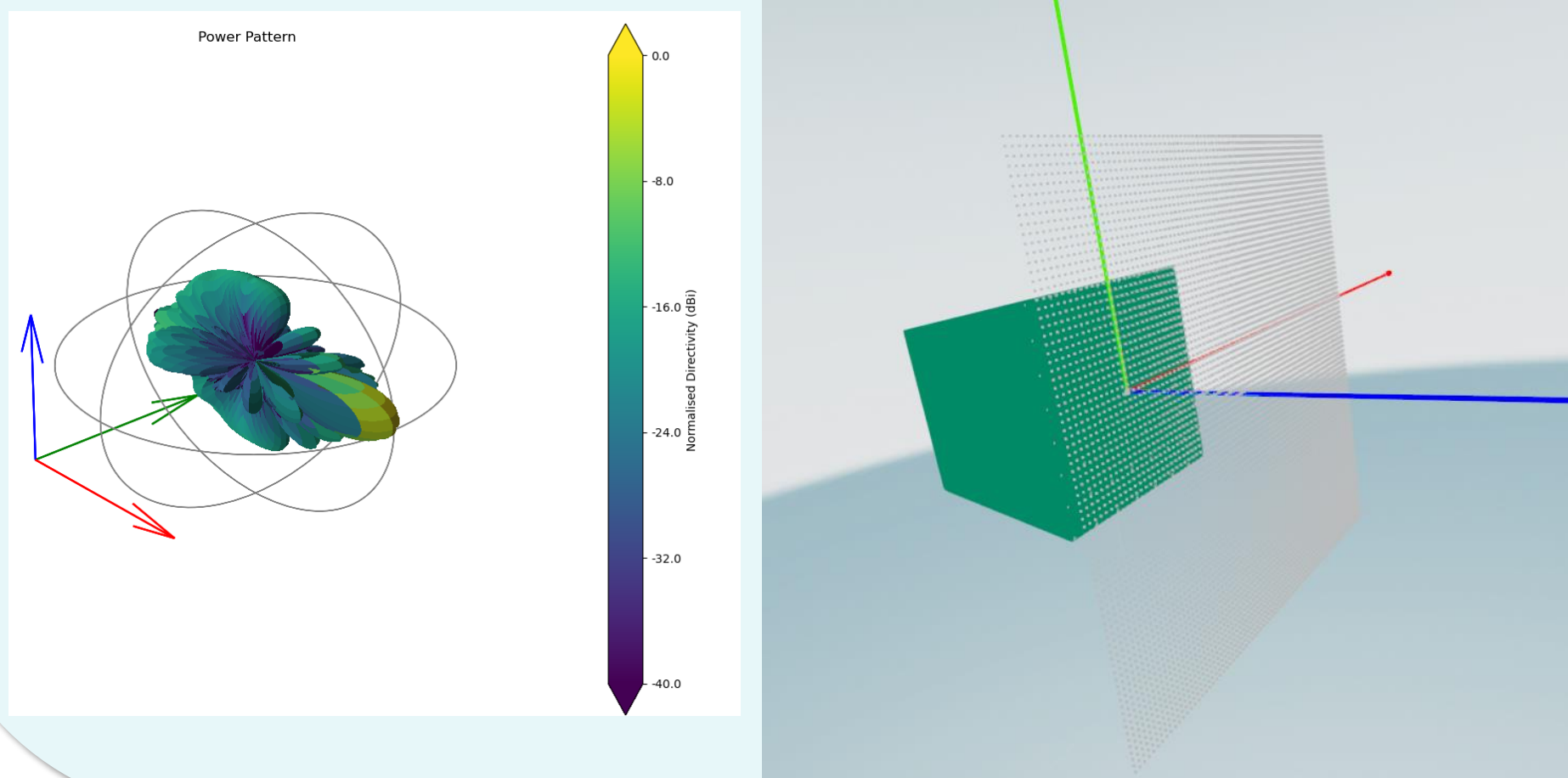
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1 Introduction

Space Based Solar Power represents an attractive source of clean and sustainable energy, which could form part of the UK Net Zero commitment. The reliable transfer of solar power to earth requires efficient new tools to design, optimize, and control these ultra large scale antenna arrays. One feasibility study suggested a requirement for diameters of 1.7km in space, and 13km by 6.7km on earth, requiring billions of antennas, implying 877Gb just to store positions and orientations, and antenna patterns in the hundreds of Tb [1]. This scale of computational modelling is not feasible within the current generation of electromagnetics models.

3 Solution

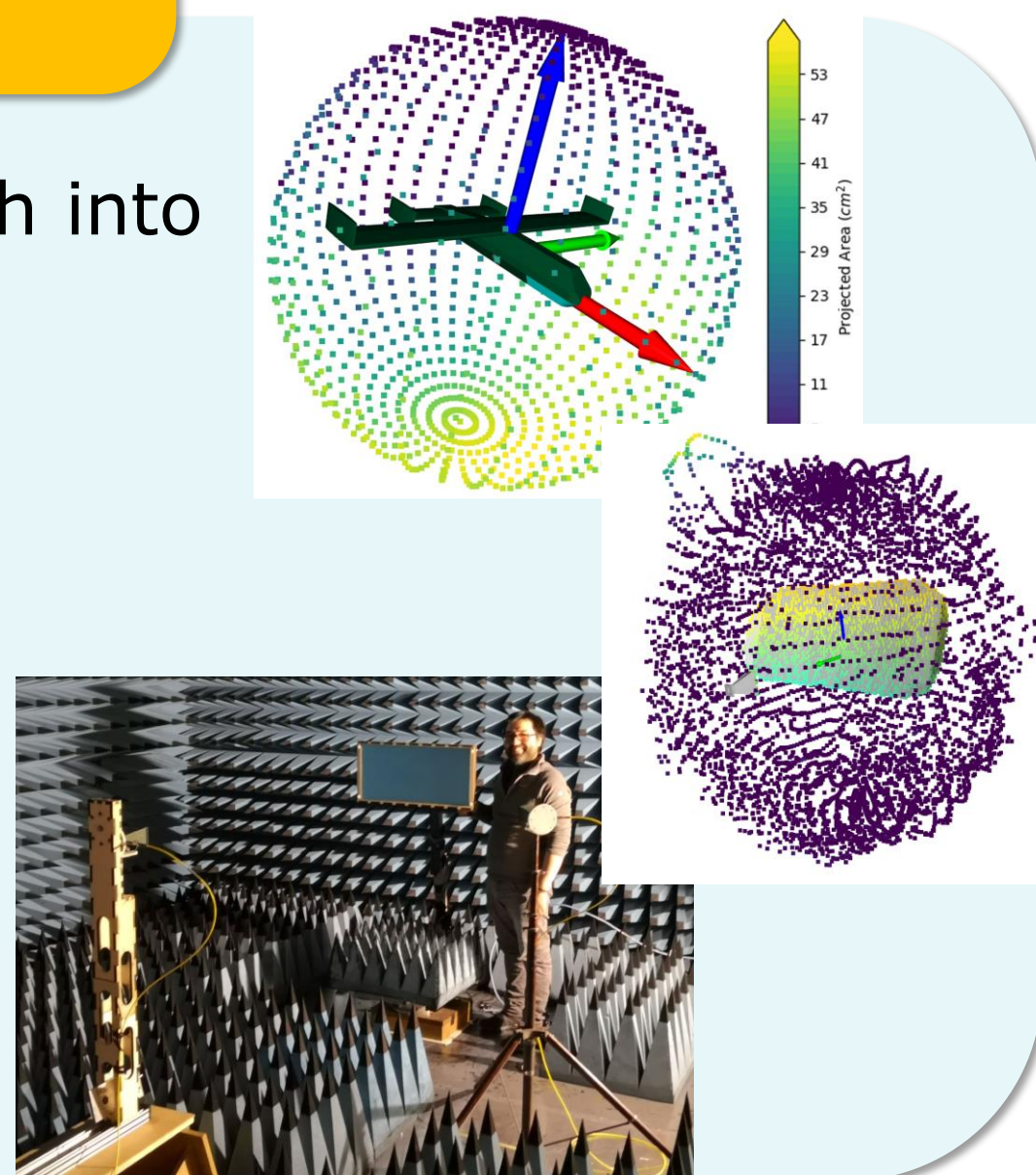
LyceanEM is an open source Python library for modelling electromagnetic propagation for sensors and communications [3]. The model is built upon a ray tracing approach, allowing for efficient modelling of large, low density spaces at over 1.1 million rays per second [4]. This combination of efficient modelling and rapid virtual prototyping tools supports rapid performance predictions for antennas and antenna arrays, which in turn allows different designs to be evaluated, optimised, and operated.



4 Applications

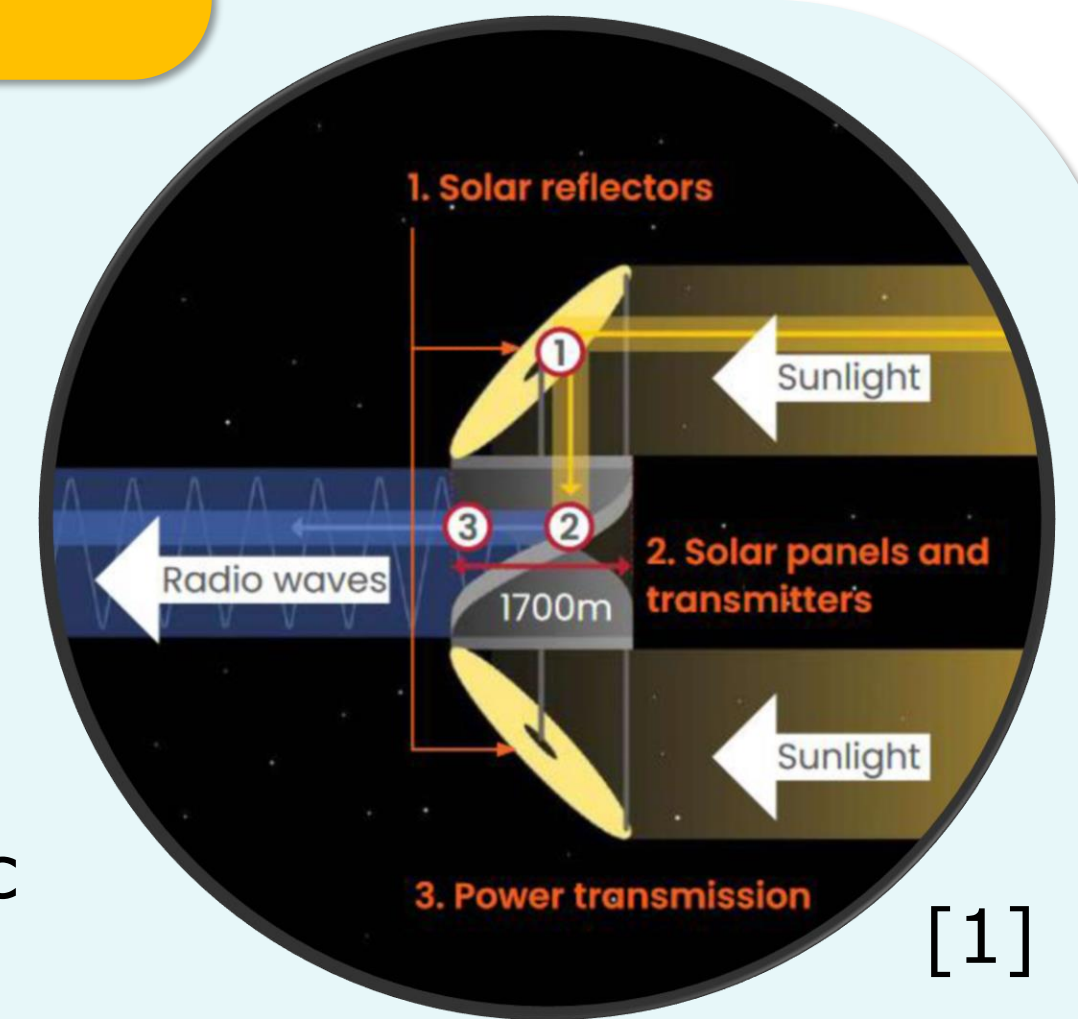
LyceanEM supports research into

- Antenna Array Design
- Mobile Communications
- Radar Cross Section
- Cooperative Radar
- Satellite Communications
- Medical Imaging
- Space Based Passive Radar



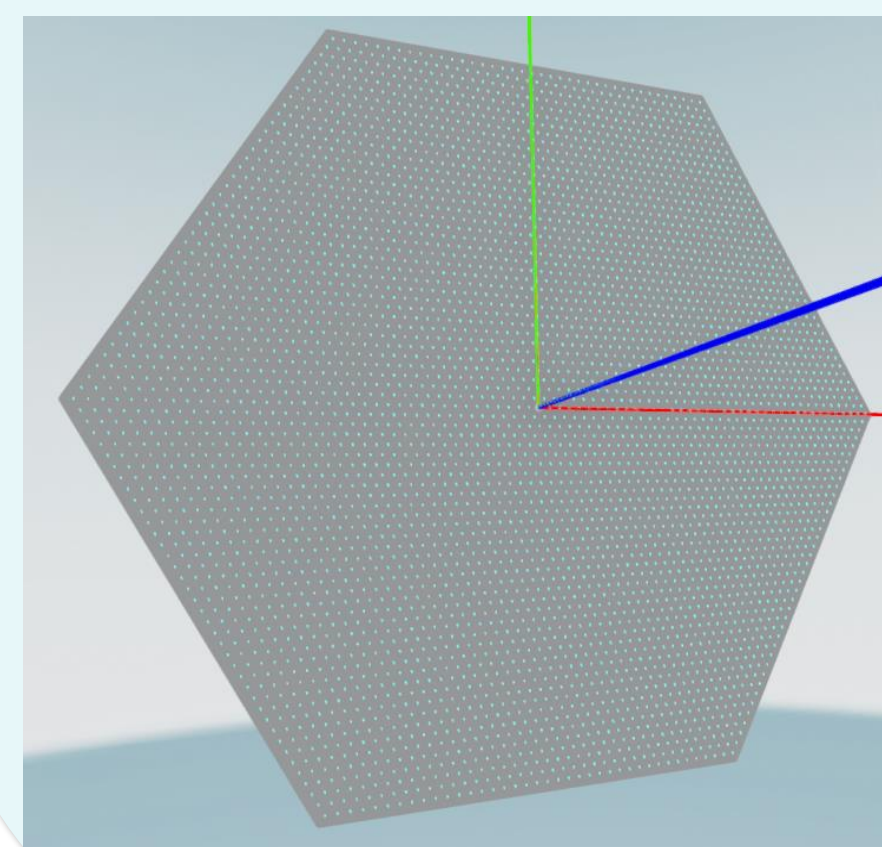
2 Space Based Solar Power

In order to transfer the solar energy to the national grid, wireless power transfer is required to transfer over 2GW of power over 35,000km to a terrestrial receiver, accounting for atmospheric diffraction, local structures and topography and relative motion at scales of computing impossible for current modelling architectures. In addition to the scale required, a wide range of antenna array designs are being considered, preventing optimisation towards a single modelling solution.



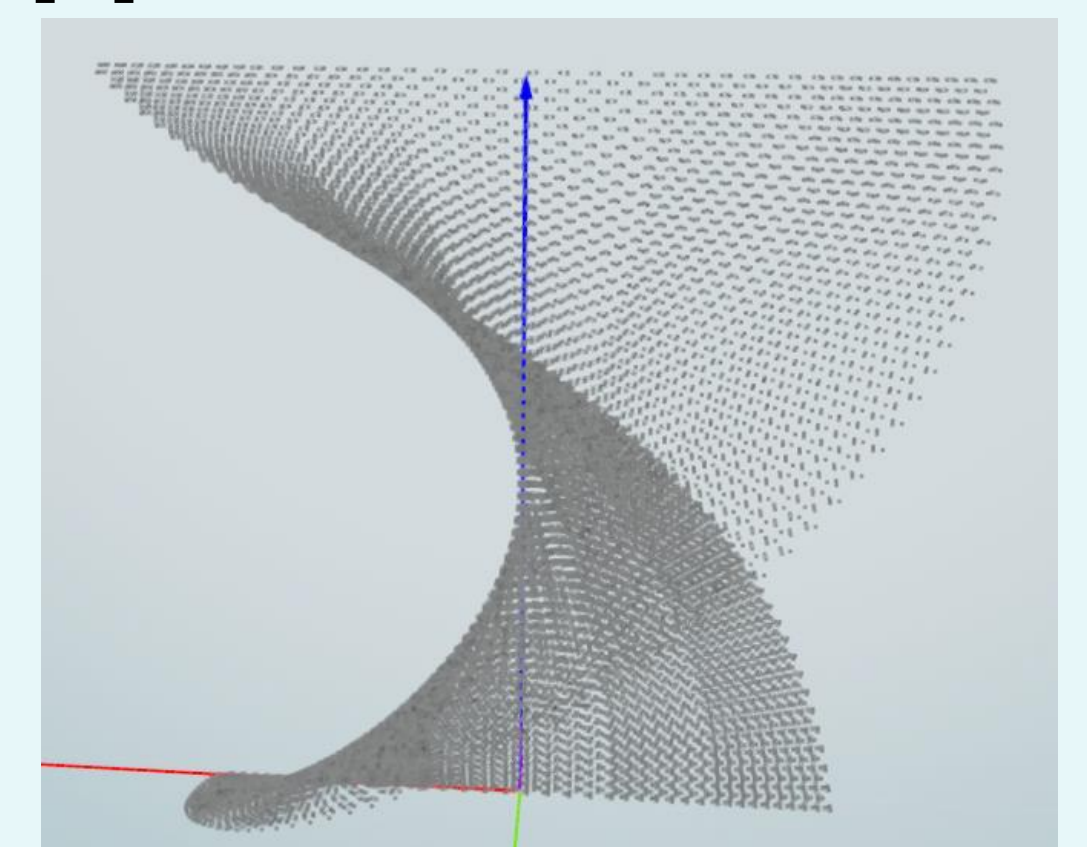
VIRTUS SOLIS

Hexagonal tile based circularly polarised antenna array with ground plane.



SPACE SOLAR

Triple-dipole, vertically polarised antenna elements, arranged on a helical surface [2].



5 Next Steps

- Develop LyceanEM from proprietary CUDA architecture to more scalable high performance computing frameworks, providing access from notebooks to cloud computing and dedicated HPC resources.
- Move to volumetric attenuation models to predict microwave power absorption by each layer of the atmosphere – supporting environmental impact, and development of safety case for GW wireless power transfer.

The Power of the Sun : Clearing the way for Space Based Solar Power

The University of Bristol is hosting a multi-disciplinary workshop on Space Based Solar Power on the 4th of May 2023 in support of this research.

6 References

- [1] - Space Based Solar Power: De-risking the pathway to Net Zero, Frazer-Nash, <https://www.fnc.co.uk/discover-frazer-nash/news/frazer-nash-report-for-uk-government-shows-feasibility-of-space-solar-power/>
- [2] - Cash, I. (2019). CASSIOPEIA - A new paradigm for space solar power. *Acta Astronautica*, 159, 170–178. <https://doi.org/10.1016/j.actaastro.2019.03.063>
- [3] - T. G. Pelham, G. Hilton, E. Mellios and R. Lewis, "Conformal Antenna Array Design Using Aperture Synthesis and On-Platform Modeling," in *IEEE Access*, vol. 9, pp. 60880-60890, 2021, doi: 10.1109/ACCESS.2021.3074317.
- [4] - Pelham, T. G. (2022). Rapid antenna and array analysis for virtual prototyping. *International Conference on Radar Systems (RADAR 2022)*, 278–282. <https://doi.org/10.1049/ICP.2022.2330>

