Space Physics Research at UoA

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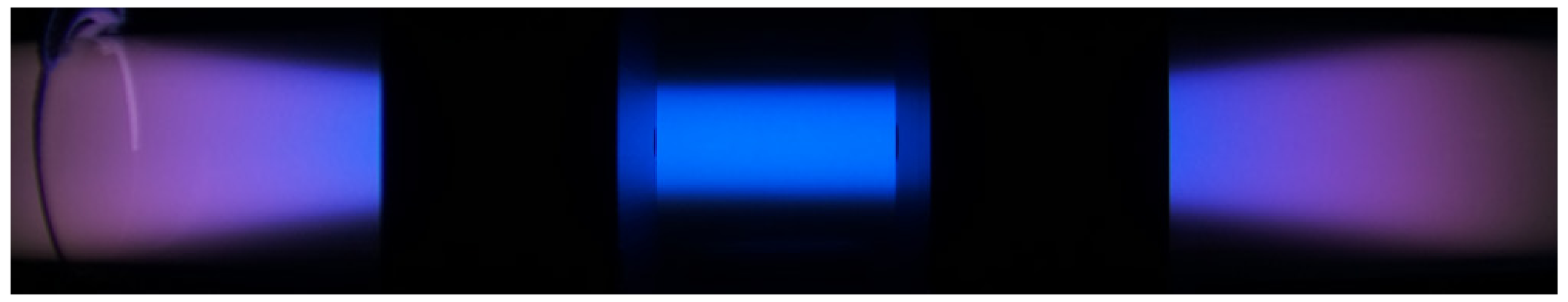
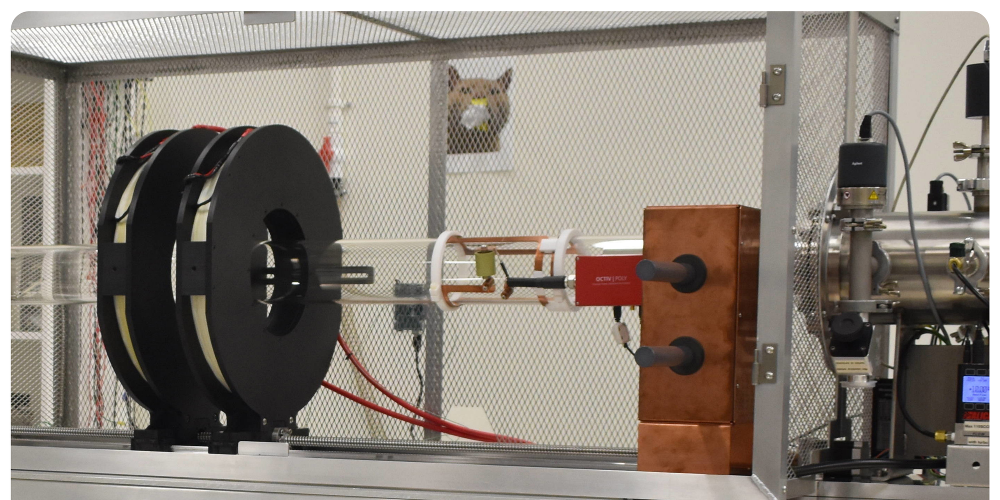
Plasma Propulsion

Electric propulsion systems rely upon the acceleration of reaction mass using magnetic and/or electric fields. Such systems use propellant mass much more efficiently than conventional chemical systems and are therefore being increasingly used in spacecraft missions.

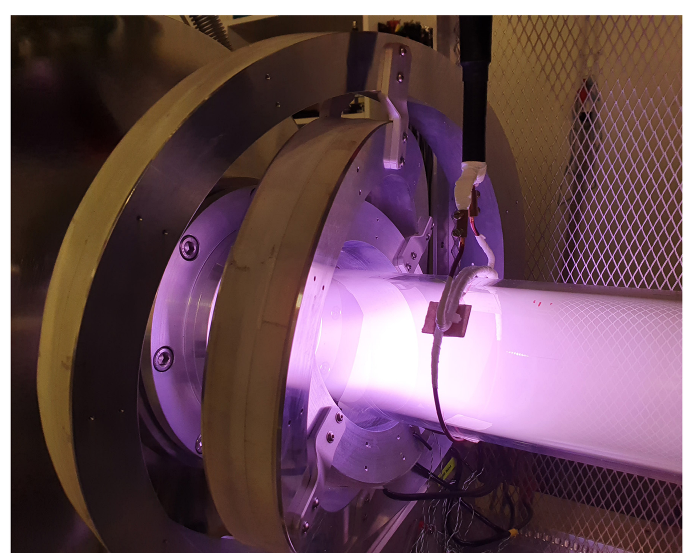
Key to several important types of electric propulsion is the generation and manipulation of plasma. One experiment has been to investigate the generation and response of plasma to a magnetic nozzle: a converging-diverging magnetic field [1].



A linear RF plasma apparatus, named Huia, was designed and built to allow expeimeriments into fundamental plasma physics [2].


The Huia experiment

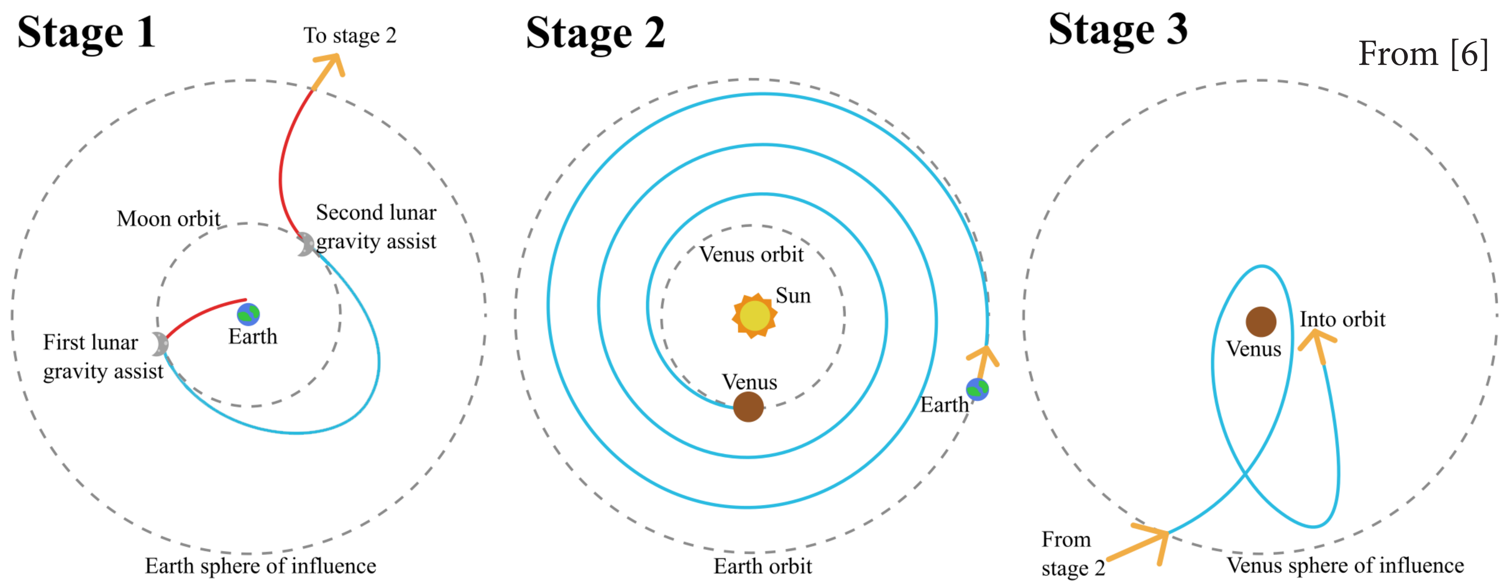
Moving mechanical parts on a spacecraft are a point of failure. Spacecraft thrusters are often mounted on a pivotable gimbal. The Moa experimental apparatus is being used to investigate how a magnetic nozzle can be manipulated to deflect the mass ejected from an electric propulsion system, providing a steering effect without moving parts [3].


The Moa experiment

Simulating how plasma forms and interacts with its environment is another area of current research. Studies on electrothermodynamics and ion beams is done with probes built inhouse [4,5].

Trajectory Optimisation

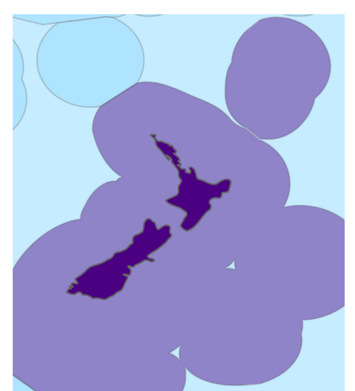
Spacecraft trajectory design is a key element of a space mission. The spacecraft must travel to its destination(s) while satisfying a number of constraints, including for example fuel usage and maximum thrust. Trajectory optimisation is a field of study at The University of Auckland and recent work has been on the optimisation of a trajectory for a spacecraft comprising a low delta-v thruster system, such as those under study by the plasma propulsion group [6]. The target of the spacecraft mission was Venus, a planet whose atmosphere has come under recent scrutiny as a potential environment suitable for life processes.

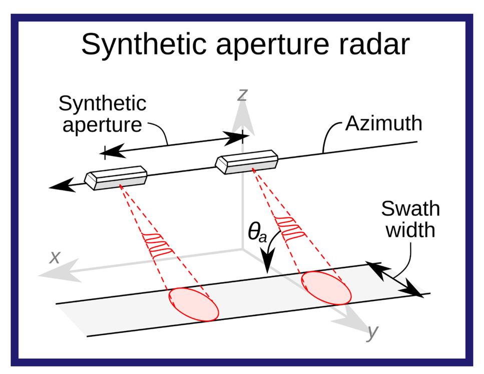


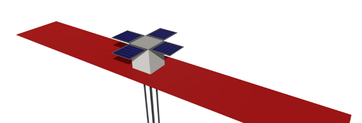
From [6]

Synthetic Aperture Radar

New Zealand has a relatively large exclusive economic zone (EEZ). There are economic and security motivations to detect and report the incursion of illegal and unreported fishing vessels in the EEZ. Recent work at the University of Auckland, in collaboration with the DLR has investigated what are the minimal requirements for a space mission to detect a typical fishing trawler (30m length by 7m beam) in NZ's EEZ using synthetic aperture radar (SAR) [7]. SAR is a well-known technique by which the movement of the radar system through its orbit is advantageously used to provide radar images of higher resolutions than that possible using the same radar antenna from a static position.

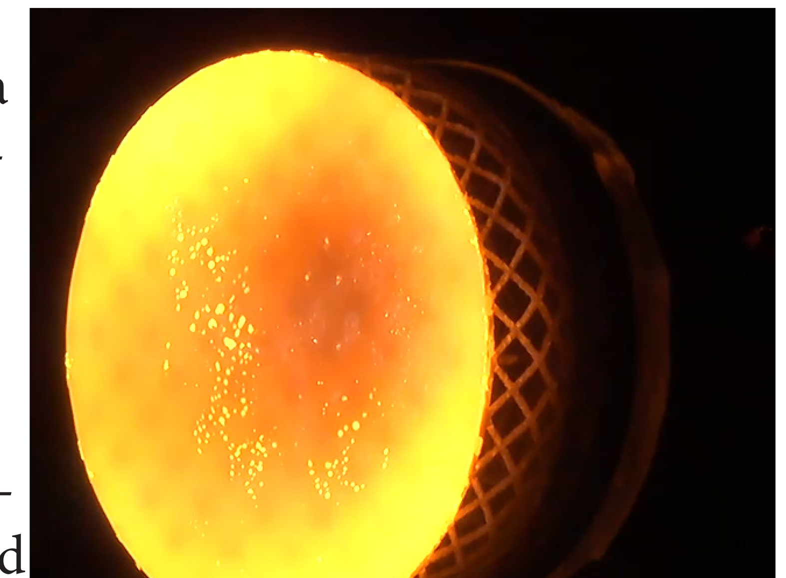

NZ's EEZ




A NZ SAR mission was defined at the UNSW-C Concurrent Design Facility

Additive Manufacturing

Returning spacecraft payloads safely from space is required for a number of use cases. Heat shielding is a critical element of a system to bring material back from space through the Earth's atmosphere. We conducted research into what extent additively manufactured titanium structures could be designed and optimised to minimise mass while at the same time maximising protection for a payload returning to Earth [8].


Novel additively manufactured titanium heat shielding material undergoing plasma wind tunnel tests at DLR

Capacity Building

The Ministry of Business, Innovation and Employment comprises the New Zealand Space Agency (NZSA). New Zealand is a relatively new entrant to the space-capable nations and we have been active in building capacity and providing feedback to the NZSA. Space is a challenging environment, demanding the highest levels of technical expertise. It also offers unique opportunities to further fundamental and applied science research. These opportunities come with risks and these have to be managed appropriately to ensure that New Zealand is considered a responsible actor in space [9]. We promoted and supported the use of the UNSW-C Concurrent Design Facility and ANU's National Space Test Facility for space mission design and spacecraft testing. Now, local facilities such as The University of Auckland's Te Pūnaha Ātea Space Institute are available for space mission designers [10]. Tertiary education providers are now also working to provide training for new generations of graduates to service the local and international space sector [11].

References

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