Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: **PROPHY / SPEXPLO**
Corresponding author: **TISAEV Mansur**
e-mail of corresponding author: **m.tisaev@surrey.ac.uk**
Type: **Oral**
Status of corresponding author: **Student (PhD)**
For student corresponding author: student member of one of the following: **RAeS**

Development of a neutraliser for air-breathing electric propulsion in very-low Earth orbit

Mansur Tisaev [1], Andrea Lucca Fabris [2]*

** Corresponding author*
[1] PhD student, Surrey Space Centre, University of Surrey, Guildford, GU2 7XH, UK, m.tisaev@surrey.ac.uk
[2] Senior Lecturer, Surrey Space Centre, a.luccafabris@surrey.ac.uk

Abstract
Air-breathing electric propulsion (ABEP) refers to a spacecraft operating in very low Earth orbit (VLEO) that uses upper atmospheric Air as propellant for an electric thruster. The thrust is intended to counteract drag, resulting in an extended mission lifetime which is not limited by on-board propellant. The University of Surrey is developing a novel neutraliser operating on Air, partly within the scope of the EU H2020 AETHER [1] project, as a key component of a high-specific-impulse ABEP thruster system. The hollow cathode neutralisers typically used in electric propulsion experience poisoning of the thermionic electron emitter when exposed to oxygen, leading to significantly reduced emission currents. The neutraliser pursued in this study is based on a microwave (MW) plasma electron source design, which targets an emission current in the 1A range with Air as propellant. The resulting prototype is termed the AMPCAT (Air-breathing Microwave Plasma CAThode).

The neutraliser operates via ionisation of the Air particles and collection of the ions on the internal neutraliser walls, achieved via a directly-inserted 2.45GHz MW antenna and negatively-biased plasma-interfacing surfaces, allowing emission of an equal electron current. The neutraliser design has been developed through iterative prototype standalone testing using an extraction anode. This has demonstrated 0.9A of extracted current at 70W input MW power and 120V of total relative bias, across a mass of flow rate range of 0.05-0.15mg/s for a 0.48O2+0.52N2 Air mixture representing VLEO conditions and corresponding to a power cost of around 140W/A. The neutraliser testing includes comparison with Xenon and analysis of materials exposed to Air plasma, as well as the effects of magnetic field and antenna isolation. The finalised neutraliser prototype is coupled with a Cylindrical Hall Thruster to investigate: a) the effect of the neutraliser compared to a conventional hollow cathode when running on Xenon, and b) the effect on the thruster discharge of Air as the neutraliser propellant. These tests include both thrust measurement and plasma diagnostics of the thruster discharge, using a Wien filter (ExB probe), Faraday probe, Langmuir probes and Optical Emission Spectroscopy. Operation of the thruster-coupled neutraliser is shown in Figure 1.

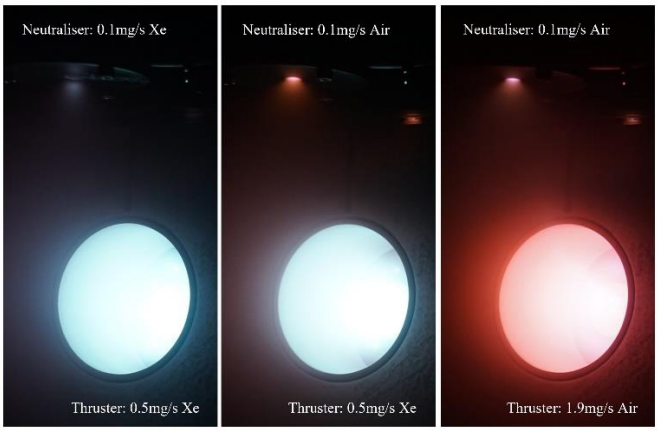

Figure 1: Neutraliser operation coupled with thruster showing different combinations of Xe and Air propellants.

References
[1] Andreussi, et al. *The AETHER project: development of air-breathing electric propulsion for VLEO missions*. CEAS Space J 14, 717–740 (2022). https://doi.org/10.1007/s12567-022-00442-3