# Department of Aerospace Engineering SEMINAR

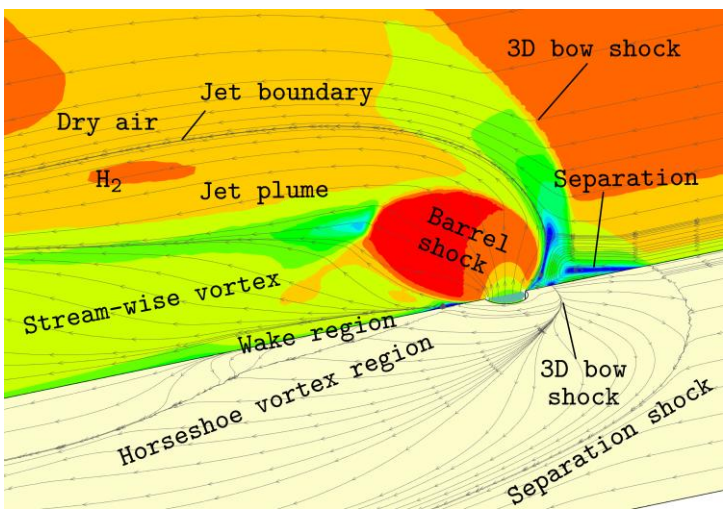
## Design Optimisation of Robust Fuel Injection using Flexible Orifice Geometry for Scramjet-Powered Ascent Flight


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In a scramjet combustor, the injected hydrogen must mix with air that crosses the duct in about a millisecond, yet the shock and vortex system that drives this mixing also destroys the total pressure of the stream. For over three decades this trade-off has been explored with only a handful of fixed orifice shapes—circular, elliptical and diamond. This seminar presents a free-form alternative: the injector footprint is described by a Bézier curve and optimised, together with the injection angle and momentum-flux ratio, using Kriging surrogates trained on one thousand RANS solutions and the NSGA-II algorithm. Relative to a circular injector, the optimised designs raise the mixing efficiency by up to 14% while cutting the total-pressure loss by 11–32%. The talk will also examine the physics behind these gains: why mixing is governed by the lateral spread of the fuel rather than its penetration depth, and how a short, laterally bulged orifice removes almost half of the loss by a mechanism that no fixed-shape catalogue can reach.


Mehmet AKSAY received his B.Sc. (2016) and M.Sc. (2019) degrees from the Department of Aerospace Engineering at METU. Between 2016 and 2019 he worked as a Propulsion Systems Researcher at TÜBİTAK SAGE. In 2019 he joined the Space Transportation Systems Engineering Laboratory at Kyushu University, Japan, as a doctoral student funded by the Ministry of National Education of Türkiye, carrying out his thesis research in collaboration with the JAXA Kakuda Space Center. In 2024 he was awarded a scholarship to attend an entrepreneurship bootcamp at Babson College, Harvard Business School and MIT. His main research interests are high-speed propulsion, supersonic mixing and surrogate-based design optimisation.