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Turbulent boundary layer injected with low blowing ratio effusion film[1] JEREMY BASLEY, KEVIN GOUDER, JONATHAN F MORRISON, Imperial College London — Effusion cooling of turbine blades is used in jet engines to alleviate the thermal and shear strain they sustain while beneath the hot flow exiting the combustion chamber. This study focuses on the mechanisms underlying the interactions between the film-injected momentum and the incoming high Reynolds number turbulent flow. A large-scale low-velocity experiment is carried out in the closed-loop 10x5 wind-tunnel facility. The scaled-up effusion device consists of a plenum located directly underneath a thick plate pierced along a staggered grid of inclined $D = 16$mm diameter holes with a pitch of $5D$. This setup is placed in a turbulent boundary layer, tripped and developing over 15 m. A range of injected velocities with respect to free-stream velocity (blowing ratio) is investigated with time-resolved planar PIV, complemented with hot-wire anemometry profiles, and wall-pressure measurements. The resulting time-resolved and space-extended data sets explain the favourable outcome of low blowing ratios, for which the shear-driven mixing of the effusion film is limited to near-wall region of the boundary layer. Results also suggest the effusion film effectively restricts the penetration of fluid from the outer region into the near-wall region of the boundary layer.

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Jeremy Basley
Imperial College London

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