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Turbulent Boundary Layers: An Energy Harvesting Perspective[1]
PIERRE LEMAIRE, INSA de Lyon, France, HUSEYIN DOGUS AKAYDIN, NIELL ELVIN, YIANNIS ANREOPOULOS, The City College of New York — A turbulent boundary layer (TBL) carries mechanical energy distributed over a range of temporal and spatial scales. The inherent unsteadiness in the TBL induces a strain field on a solid body immersed in it. The induced strain can be converted to electrical energy using a solid body of piezoelectric material. This energy harvesting method can be used for developing self-powered flow sensors. In the present work, we experimentally investigate the interaction of a TBL with a thin flexible beam. The vibration frequency and amplitude of the beam is measured using strain gages. Three relevant parameters are the length of the beam (l), the distance of the beam from the wall (h) and the free stream speed (V_∞). While V_∞ changes the TBL characteristics, h and l primarily affect the fluid-structure interaction. In our wind tunnel tests we traversed the piezoelectric beam across the TBL by varying these three parameters for the purpose of finding values maximizing the vibrations. We present a "power map" of the TBL indicating the optimal h and V_∞ values for a given value of l. We also discuss the effect of l in flow-induced vibrations by presenting spectrum analysis of strain signals at various h and V_∞.

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