Experimental investigation of aeroacoustics at the inlet of a turbofan engine using a Rod-Linear Cascade (RLC) setup

MSc candidate: Sidharth Krishnan Kalyani
Supervisor: Dr. Daniele Ragni

Aircraft noise during take-off and landing is regulated by the FAA, requiring the aircraft to meet certain noise certification standards. According to FAA, a maximum day-night average sound level of 65 dB is incompatible with residential communities and this value is set to reduce in the forthcoming years. In the recent times, most of the civil aviation banks on the high bypass ratio (HBPR) turbofan engines which comes with an improved overall efficiency when compared to its turbojet counterpart. But herein lies an acoustic penalty, since, with an increase in bypass ratio, the distance between the fan (rotor) and outlet guide vanes (OGVs) is reduced. This reduction enables the fan wake to be more coherent on the OGVs thereby contributing to the leading edge interaction noise. The presence of the bypass duct and the OGV cascade further modify this noise signature. For a successful and targeted implementation of noise mitigation techniques, isolation and quantification of the different factors modifying the acoustic radiation from the bypass duct is necessary.

Figure 1: RLC setup

This master thesis will be dedicated to an attempt to isolate the effect of cascades which modifies the sound propagated to the far-field using a RLC setup (Figure 1). In this process of isolating the effect of cascades, the isolation of the vortex-leading edge interaction noise will also be performed using a rod – single airfoil configuration. Here, the rod mimics the fan (rotor) and scaling is done to obtain a similar fan vortex shedding of first Blade Passage Frequency (BPF) as that of an actual SDT test rig (~ 2.87 kHz). Aerodynamic measurements to be performed include PIV (for estimating the integral length scale of the shed vortices at a location upstream of the impingement location) and hot wire anemometry (to obtain velocity statistics at various locations, in clean flow, in rod wake and in the passage between cascade blades, in an attempt to address the propagated far field noise). Acoustic measurements include obtaining noise directivity using a circular microphone arc (downstream, away from flow) and a scaled down multi spiral beamforming array, upstream of the linear cascade, to analyse the upstream propagation of noise, against the flow, when compared to the downstream.
