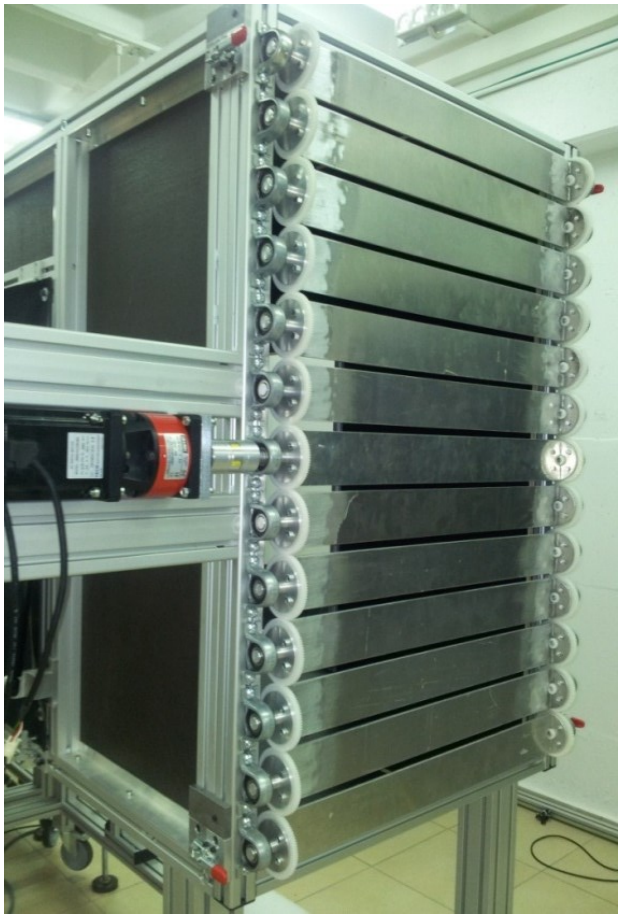
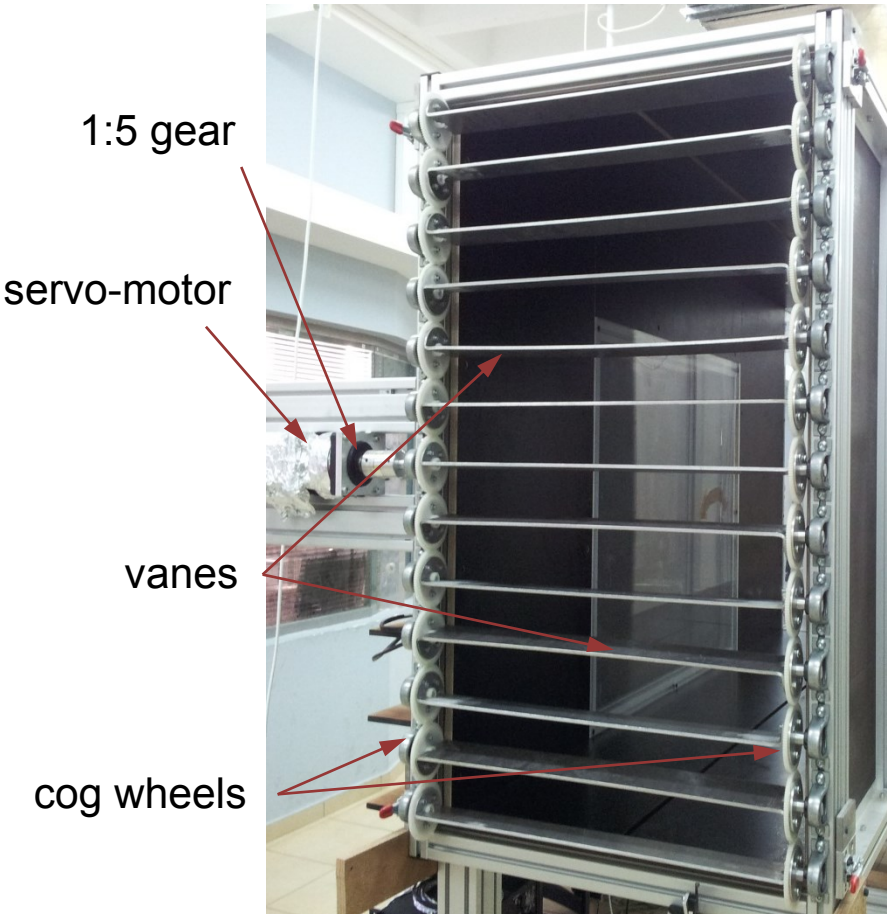
Unsteady Low-Speed Wind Tunnel

Much of our research is aimed at unsteady aerodynamics and thus we built a dedicated unsteady tunnel. Equations governing the unsteady flow response and the acoustics were used to down-select the variable-geometry open-return blow-down configuration seen here. Convention was reversed by designing for unsteady flow – with flows speeds between ~0m/s and 55m/s – while leaving a steady-flow option available. Presently, unsteady flow is enforced by servo-motor-driven louver vanes that dynamically varied the flow exit area and thereby the total head losses (see the photographs). Air power is supplied by a laterally-symmetric, double-entry centrifugal blower in order to both avoid unsteady lateral forces and provide a smooth pressure rise within the blade-stall regime. The test section length and plenum volume are both variable as can be seen in the photograph: the former to vary the frequency bandwidth; and their combination to vary acoustic properties. Downstream of the louver, a radial diffuser diverts the air stream into the laboratory that doubled as the return loop. Theoretical considerations, validated by measurements, indicated that the bandwidth is proportional to the test section length and inversely proportional to the mean wind speed. The Helmholtz frequency was well predicted and the acoustic damping was proportional to the isentropic Mach number. This configuration is scalable may also be considered as a viable choice for unsteady mildly compressible studies.




1:5 gear
servo-motor
vanes
cog wheels