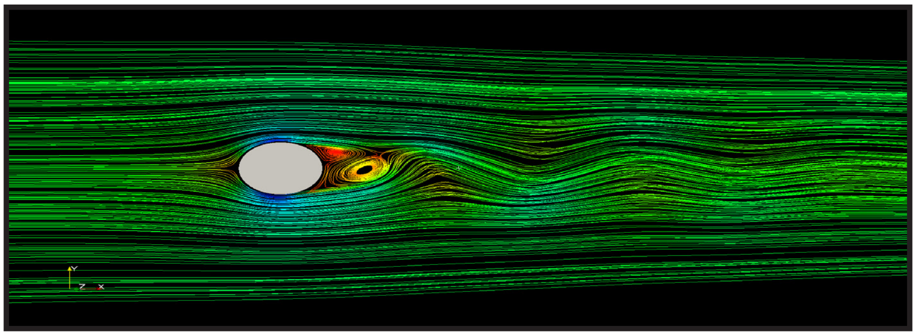
Access state-of-the-art facilities for aerospace research



World-class experimental facilities are fundamental to cutting-edge and breakthrough research. At the University of Glasgow we have committed significant investment to continuously upgrade and enhance our facilities. These facilities, in combination with our pioneering researchers place us at the forefront of aerospace sciences research. This aerospace sciences 'hub' provides an integrated capability for research and industry - we are committed to provide at least 25% industrial access, providing a vital resource for UK and European Industry. The facilities provide state-of-the-art testing capabilities for renewable technologies, space, autonomous vehicles, greener transport and infrastructure, and to address cross sector opportunities.

Experimental facilities

Low-speed tunnels

Our wind tunnel facilities cover a speed range from 2m/s up to 80m/s, with test section sizes up to 2.7m x 2.1m. We currently house:

- Hanley Page Tunnel

Test section 2.1m x 1.5m Max speed 60m/s

- De Havilland Tunnel

Test section 2.7m × 2.1m Max speed 80m/s

- Anatomy Tunnel

Test section 1.15m × 0.95m Max speed 30m/s

- Visualisation Tunnel

Test section 0.9m × 0.9m Max speed 4m/s

National Wind Tunnel Facility Hub

The University's de Havilland wind tunnel is a hub of the National Wind Tunnel Facility.
www.nwtf.ac.uk

In addition to the 'diagnostics' detailed later, key instrumentation includes a three axis model positioning (pitch, roll, yaw). Platform load cells can be mounted to the turntable base to permit 2-D section and cantilever wing testing and other streamlined or bluff body configurations. The 3-component LDA system incorporates a traverse with a range of probe sizes and focal lengths. Hydraulic actuation is available to drive a gust generator, and compressed air and 3-phase services are on tap.

High-speed tunnels

We have some of the most advanced and modern experimental facilities for the analysis and understanding of compressible high-speed flows and their interactions. These include:

- Trisonic Tunnel

Test section 20 x 25 x 48cm (w x h x l)
Mach number range M = 0.8 to 5.0

- Shock Tunnel

Mach numbers M = 6 to 10.0
Useful running time of 20 to 80ms

- High Speed Intake Facility

Test section 10 x 10 x 98cm (w x h x l)
Mach numbers M = 0.4 to 4.0

Test rigs

- Environmental Chamber

Test section 100 x 100 x 100cm (w x h x l)
Can test any pressures up to ambient and combination of phases including steady and unsteady jet injections.

- Shock Tube

Test section 11 x 11cm
Can use Air, He, Co2

- AWE Multi-phase Compressible Tubulence Facility

Can drive innovation in advanced propulsion systems and high-speed engineering research with applications in aerospace, energy, safety and security.

The University of Glasgow has delivered pioneering aerospace research for over 70 years. We have strong partnerships with researchers and industry, providing access to our leading edge facilities. Our researchers are keen to develop new collaborative partnerships to advance innovations in aerospace and related disciplines.

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Diagnostics

Pressure

Pressure Sensitive Paints (PSP), Pitot tube, Pressure transducers

We utilise some of the most advanced data acquisition systems and have developed a number of in-house operating programs for data acquisition.

Velocity

Particle Image Velocimetry (PIV), Hot-wire anemometry, Laser Doppler Anemometry (LDA) with full traverse system

Temperature

Temperature Sensitive Paints (TSP), Thermocouples, Infrared Imaging (IR), Liquid crystals

Flow visualisation

High speed schlieren/shadowgraph photography and video photography up to 1million frames per second, black/white or colour, smoke and oil-flow visualisation.

Force and moments

6-component strain gauge force balances, Skin friction, Shear stress liquid crystals

Shape displacement and strains

3D Digital image correlation (DIC) system, laser vibrometers

Flow control

Plasma systems with various voltage and frequency outputs (DBD, nano-pulse, sliding discharges, spark-jets, lasers, microwaves)

Synthetic jets, blowing (steady and pulsed) and suction systems, micro-jets, circulation control, Vortex generators, grooves, piezo-electrically driven surfaces

Fluid Thrust Vectoring, Counter-flow Fluidic Spoilers

Design and manufacture

Dedicated design software:

- Pro-Engineer
- SolidWorks

Specialist technical staff for the manufacture of high quality and precision components made from wood, metals, or composite.

Our manufacturing facilities include a wide range of tools from lathes and sheet cutters to three axis CNC machines.

Simulation packages

Simulation packages suitable for individual applications.

From low speed flows around U-bends and turbine blades to supersonic and hypersonic flows of intakes and projectiles, including flow control actuators.

Our simulation capabilities include:

- Star CCM
- Fluent and Gambit
- DIVEX
- LES
- URANS
- DNS
- DSMC
- Discrete and hybrid methods
- CFD Solver - Core HMB2
- Optimisation techniques including adjoint methods

Autonomous systems laboratories

Autonomous systems research is supported by a well-equipped micro-UAV laboratory with indoor flying area. A motion capture system allows accurate tracking of multiple bodies within an indoor flight volume, offering a wealth of possibilities in multi-agent autonomous systems research. The Division also hosts an autonomous underwater vehicle development lab and a sight-line control lab.

Rotorcraft facilities

The division of Aerospace Sciences is a member of the UK Vertical Lift Network, and research is underpinned by strong industrial and academic links with unrivalled facilities. These include excellent CFD capabilitiy, fixed and moving base simulators, and experimental systems for unsteady aerodynamics.

The de Havilland wind tunnel is a host to the National Rotor Rig, which provides a testing capability for helicopter, propeller and tilt rotor aerodynamics, Wind turbine concepts may also be tested in the low-speed wind tunnels.

ESA/ESTEC plume-regolith interaction facility

The facility allows the study of the interaction between the hovering and landing plumes with the regolith of planetary surfaces and its impact on the mission objectives and engine performance.

It also fulfils the following objectives:

- Assessment of scaling phenomena, vacuum effects and pulsing of rockets;
- The erosion effect of the plume impingement on the planet surface (airless bodies and Martian conditions)
- The lateral extent and depth of the regolith contamination due to rocket plumes;
- The impact of the plume/regolith interaction on the spacecraft (forces and moments);
- The effect of the regolith liberated by the rocket plume impingement on the spacecraft forces and moments and particularly on the engine and engine-nozzle during lunar/planetary landing operations;
- Brown out due to plumes and surface dust.

It is also capable of allowing small, controlled blasts to initially assess the fragmentation of structures in reduced atmospheres.

The image on the front page shows simulations of subsonic flow around a rapidly rotating cylinder demonstrating the well-known Magnus effect.