



# Engine Testing and Instrumentation

505H3

**Department of Engineering & Design  
University of Sussex  
Falmer, Brighton, BN1 9QT**

# Engine Testing and Instrumentation 2008-09

## Teaching Pattern

20 hours of lectures every Monday morning from 9:00am through to 11:00pm.

Project discussion/tutorial time: Monday 11-13:00pm in every odd week.

## Course Convenor

Dr. W.J.Wang

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Office: 3A10 EnggII

## Course material

[www.sussex.ac.uk/~tafb8/eti.html](http://www.sussex.ac.uk/~tafb8/eti.html)

## Assessments

- 2 individual projects.
- Project reports are required to be handed in to the department office in week 6 and week 10 on the relevant Thursday before 16.00pm.
- Each of the two projects will have an equal weighting of 50%.
- Mark will be deducted in the normal fashion if you are late in handing in.

## Course outline

- Engine testing procedures.
- Consideration of experimental methods and standard test codes. Introduction to practical test bed technologies.
- Test design.
- The use, calibration and installation of a wide range of measurements relevant to engines are considered including temperature, pressure, force, torque, velocity, laser techniques, displacement, mass flow, vibration and emissions.
- Practical aspects of testing. Interpretation of results.

# Learning outcomes

The aim of this module is to develop skills and knowledge in experimental methodology, engine testing and the necessary instrumentation and machinery required to undertake measurements on combustion engines.

- On successful completion of the course the student will be able to:
- develop an understanding of engine testing procedures and design experiments for engines,
- be able to quantify the error associated with calibration and measurement,
- be able to develop a measurement strategy for temperature, pressure, mass flow, velocity, displacement, vibration and emissions,
- appreciate the standards relating to measurement and performance, scheme out a test programme,
- to be able to understand the requirements of combustion analysis,
- to be able to review gaseous emission data and comment upon its validity,
- to be able to design a base engine test laboratory.

## Library

Plint M, Martyr A. Engine testing theory and practice, 2nd ed., Butterworth Heinemann, 1999.

Doebelin. Measurement Systems, McGraw Hill.

Childs P R N. Practical Temperature Measurement, Butterworth Heinemann, 2001.

Zhao H, Ladammatos N. Engine combustion instrumentation and diagnostics, SAE, 2001.

Bosch R. Automotive Handbook, 5th ed., Bentley Publishers, 2000. ISBN: 0837606144.

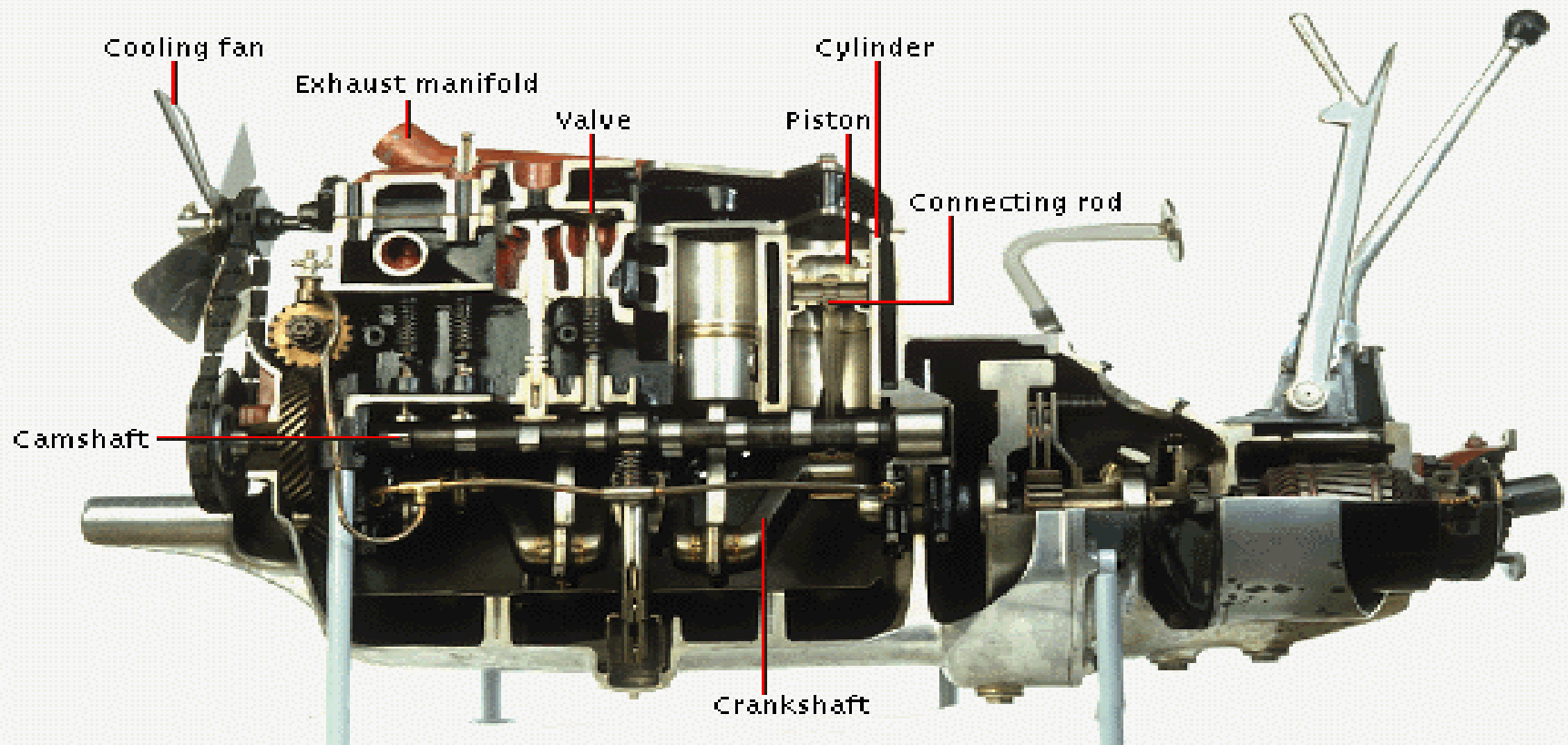
# Internal-combustion Engines

Internal-combustion Engines are Heat engines. Fuel is burned inside the engine, contrasting with an external combustion engine (e.g. steam engine) in which fuel is burned in a separate unit.

The diesel engine and petrol engine are internal-combustion engines.

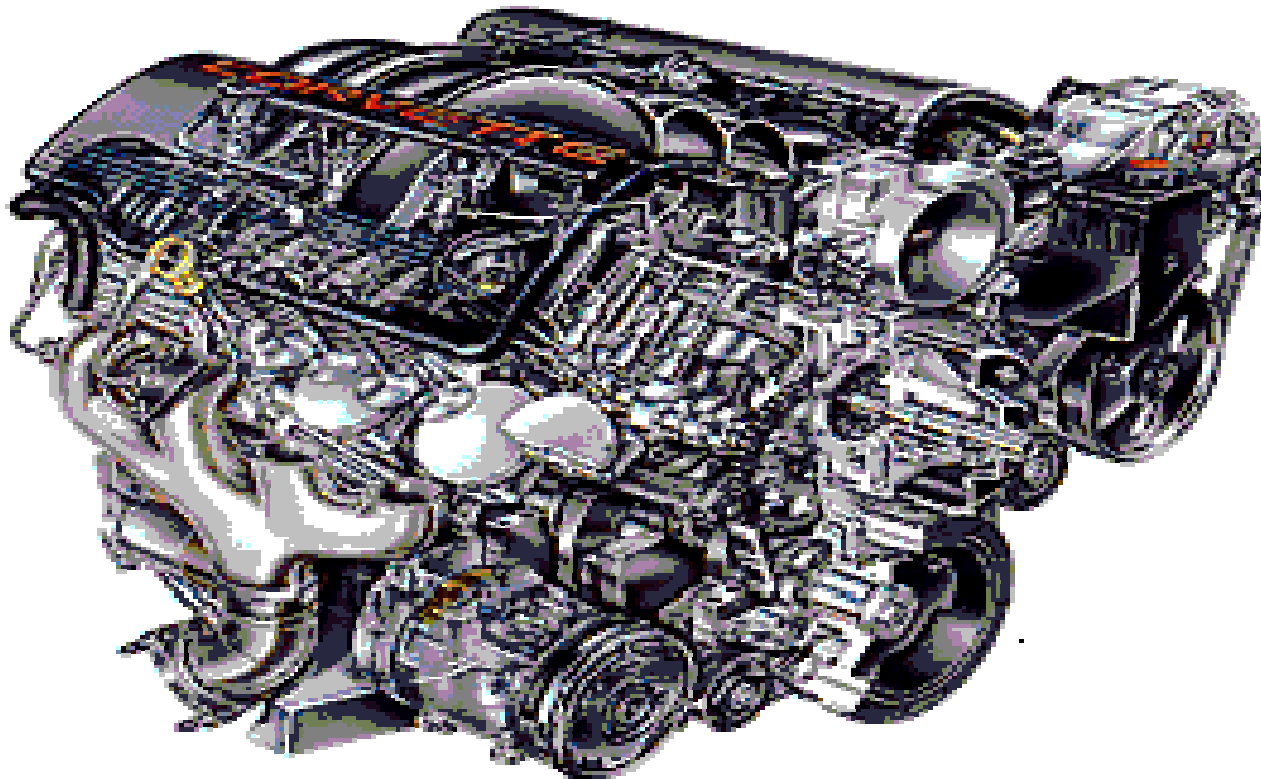
Gas turbines and jet and rocket engines are also internal-combustion engines.  
( Fuel is burnt inside their combustion chambers.)

## An engine of 1930's





# Modern engine brings technology complications



## High specific power



**20 cylinder ( 4.5 litre/ cylinder) 2017kW (2705HP)**



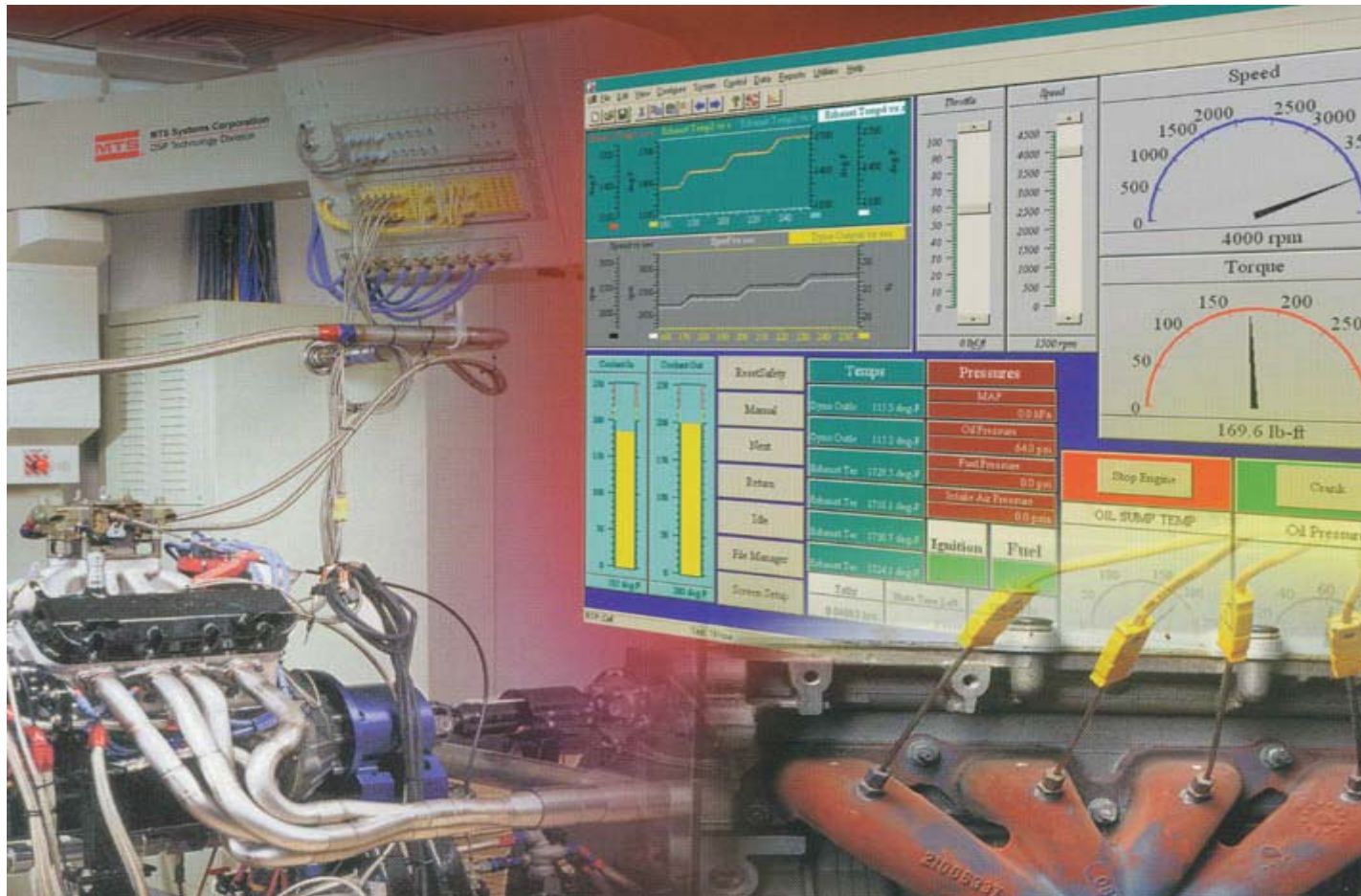
## Rolls Royce gas turbine engine

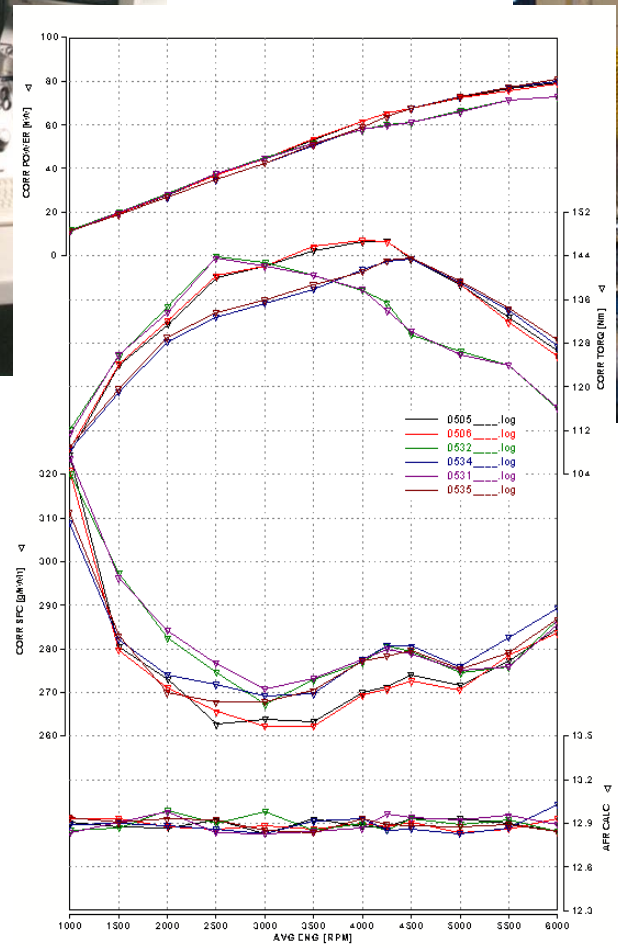
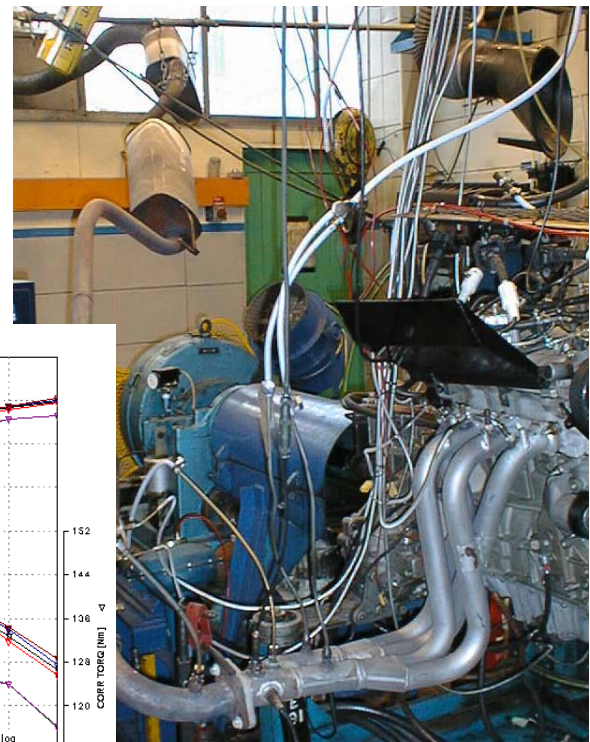
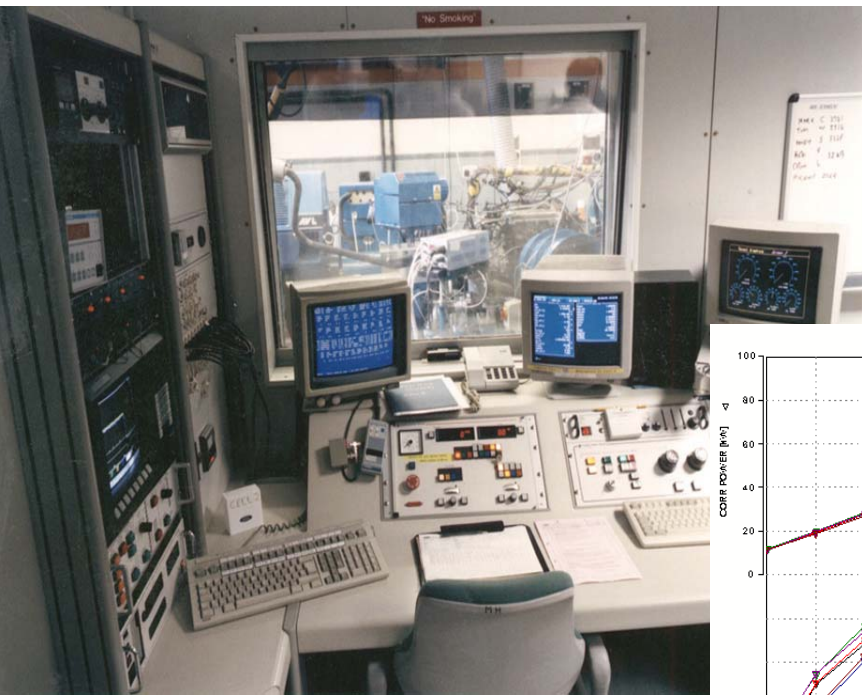






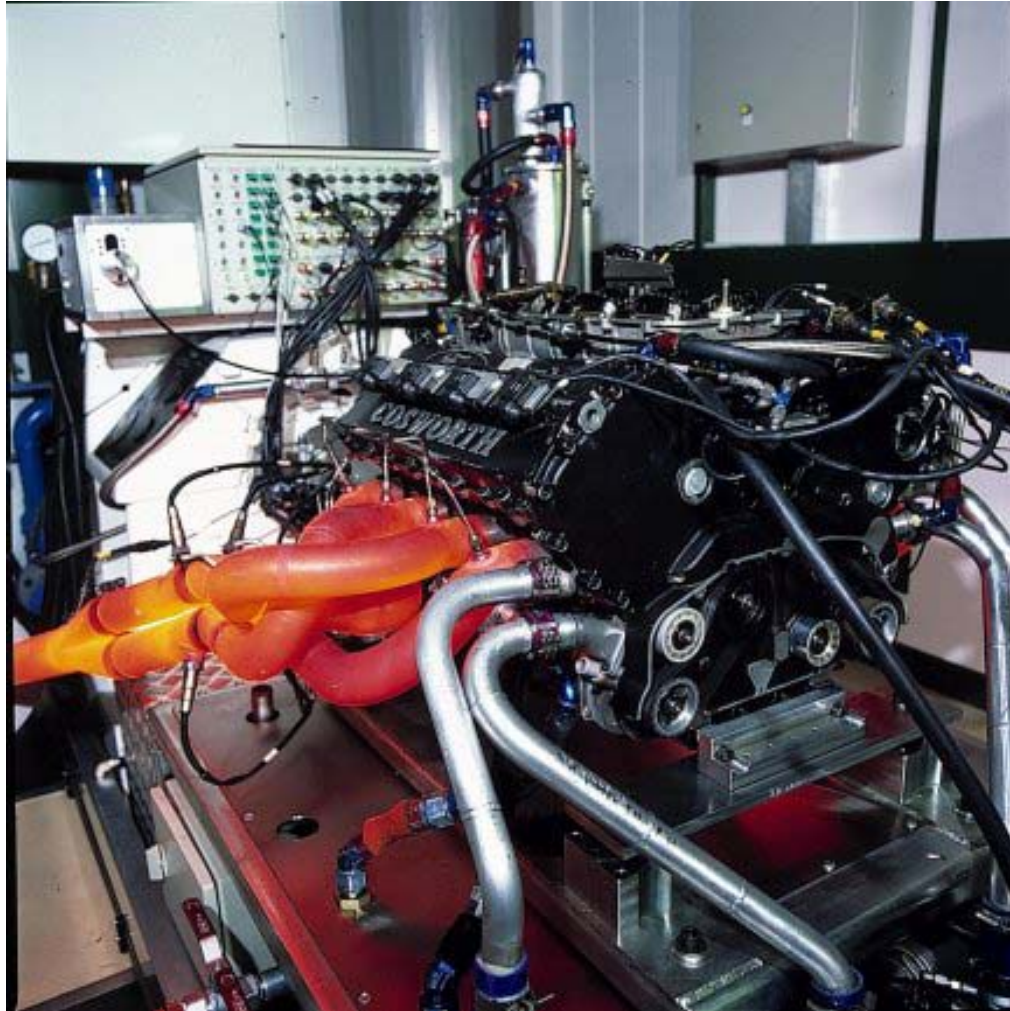
# Engines have to be tested in test rooms before installation







## Nicholson McLaren



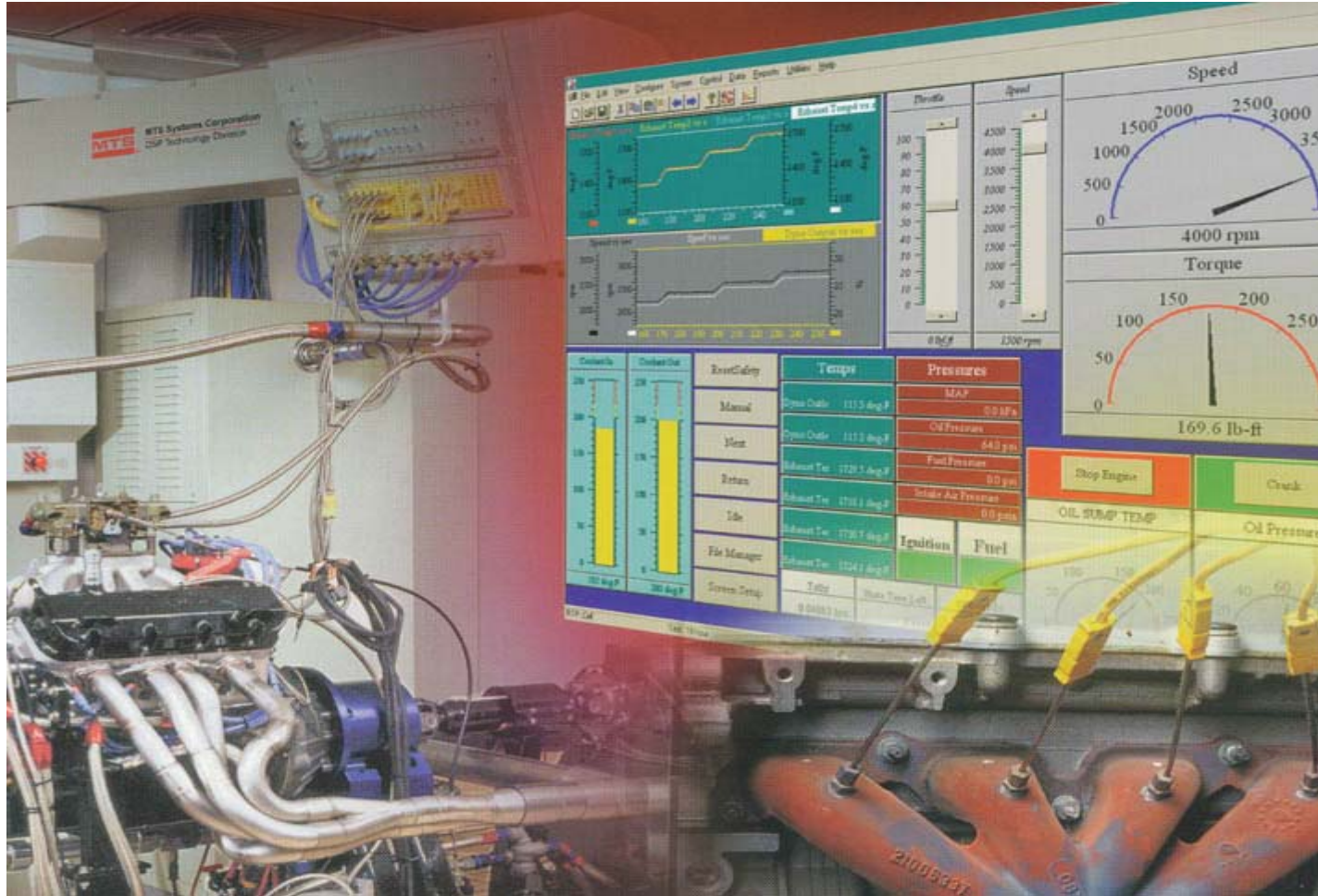


## Data acquisition and control at Nicholson McLaren 2005

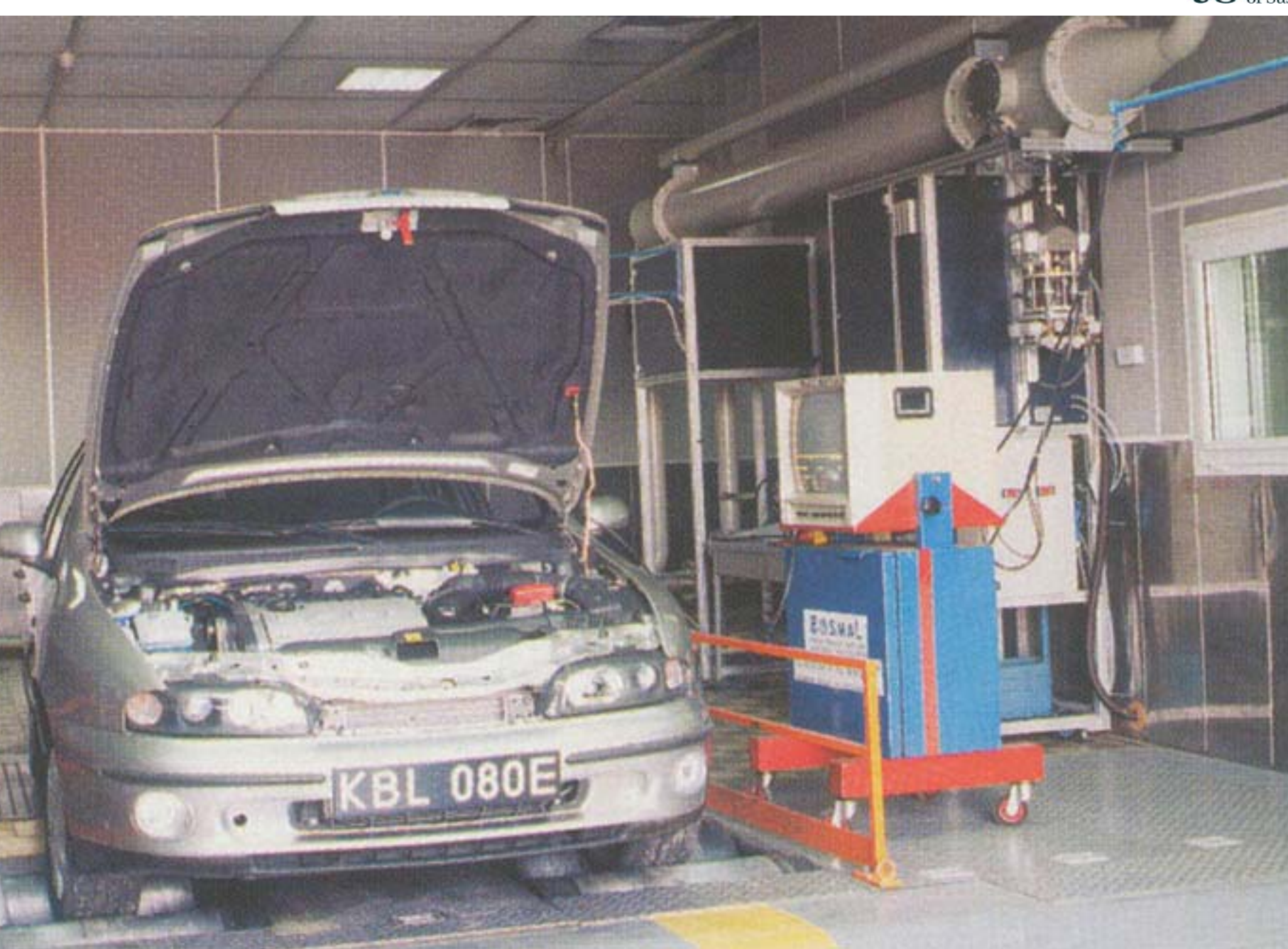




# Test equipment & instrumentation







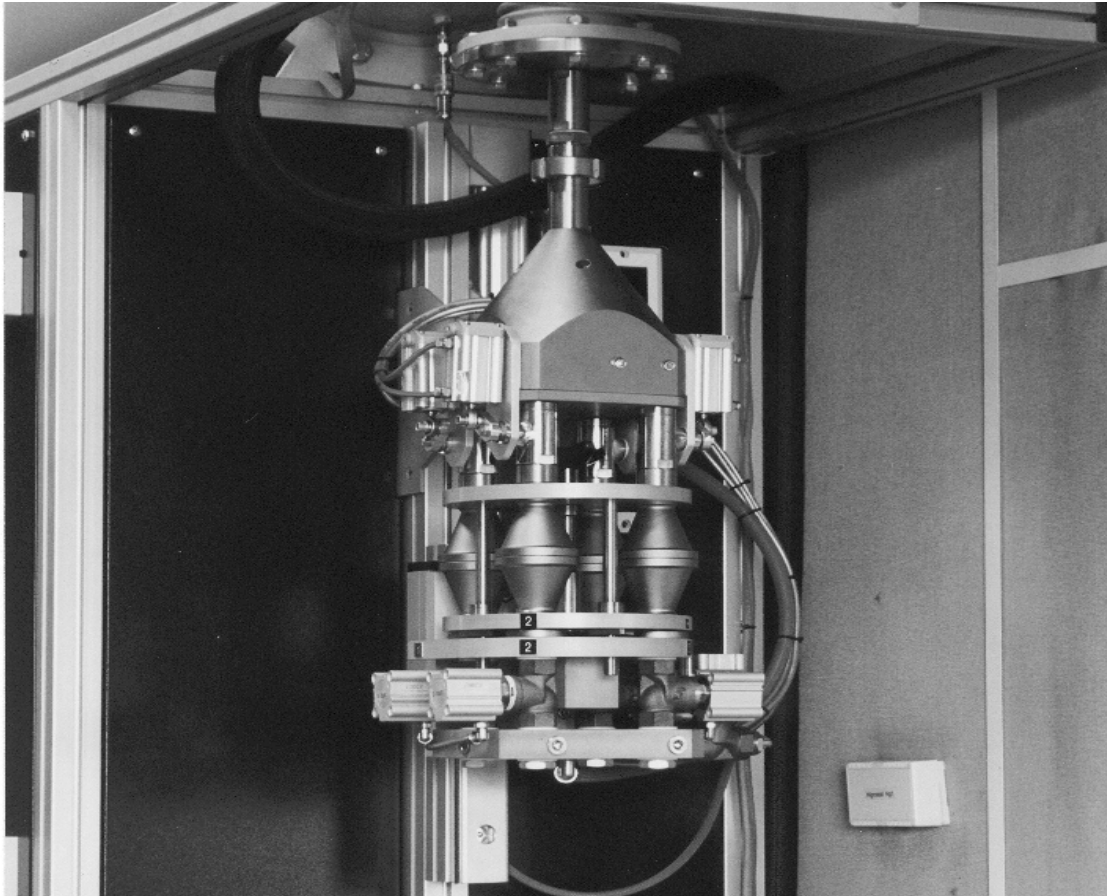
# Emissions measurement system



**Exhaust Emission Laboratory of BOSMAL Automotive R&D Centre**



## 4 way particulate sampling unit

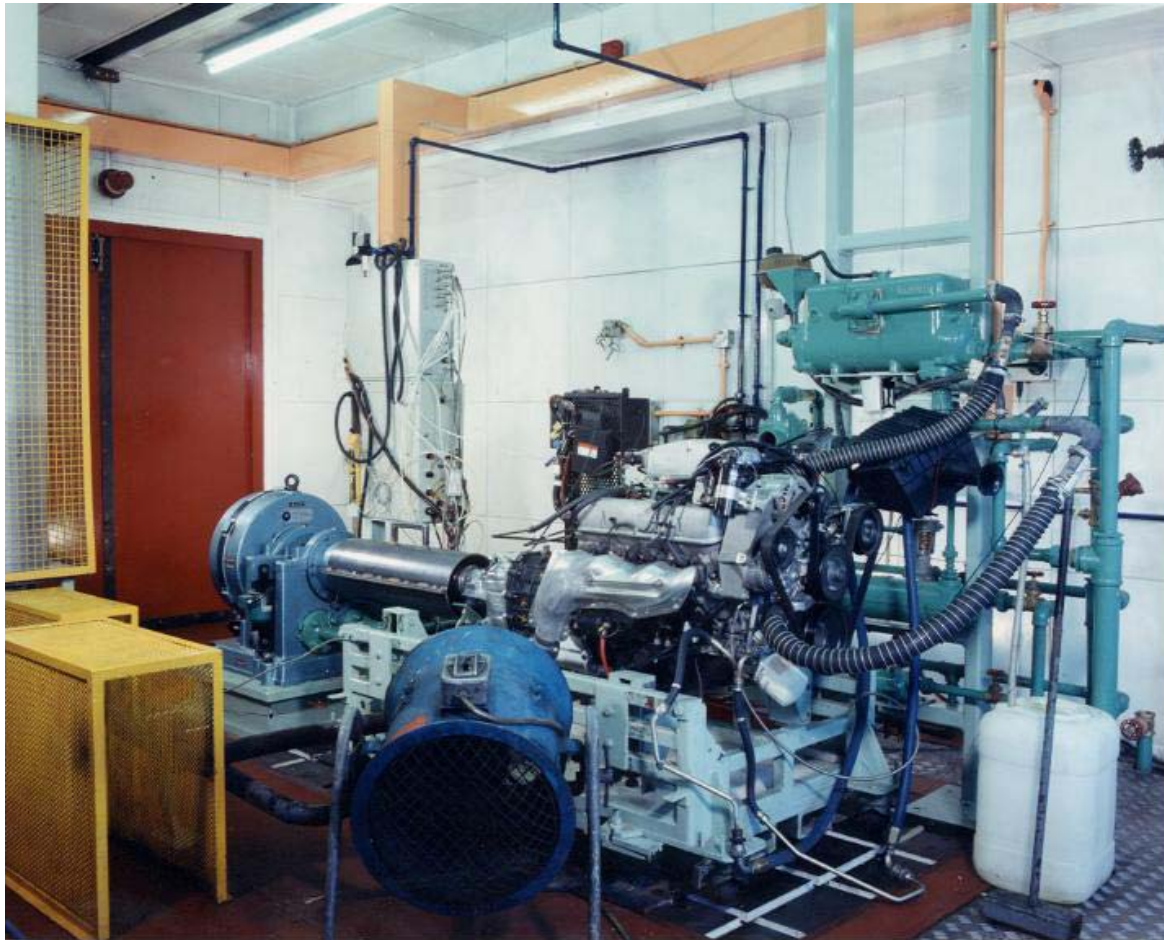








## Land Rover at Gaydon



**Prodrive** - Design, build and run motorsport and vehicle technology programmes for vehicle manufacturers (Banbury Oxfordshire)



## Running a test



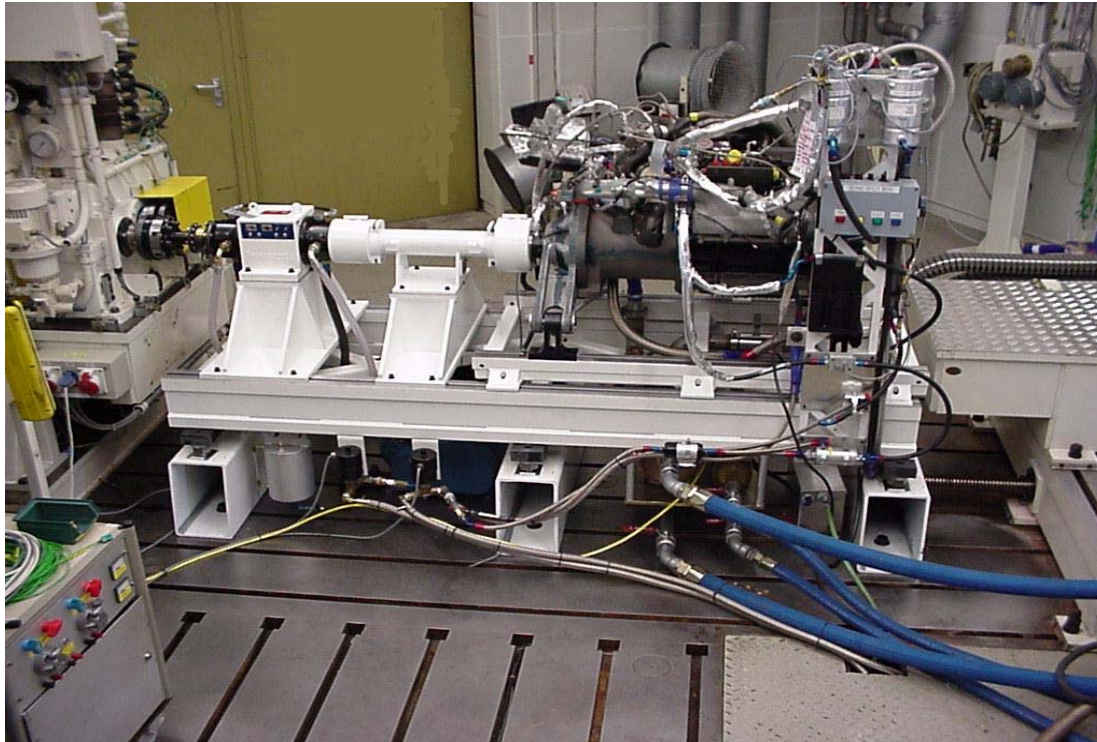


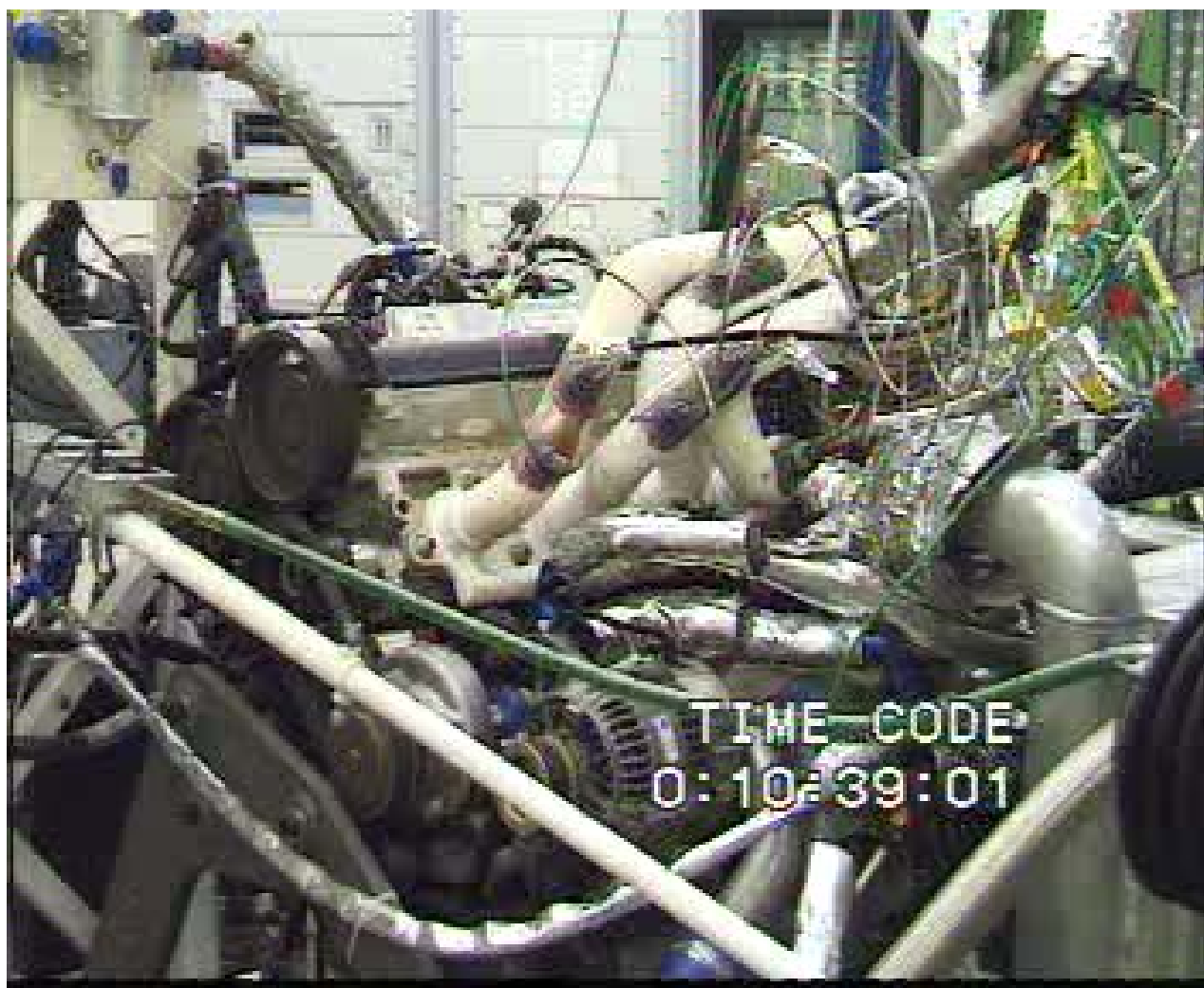
# Transient test bed Ford Focus Rally Engine

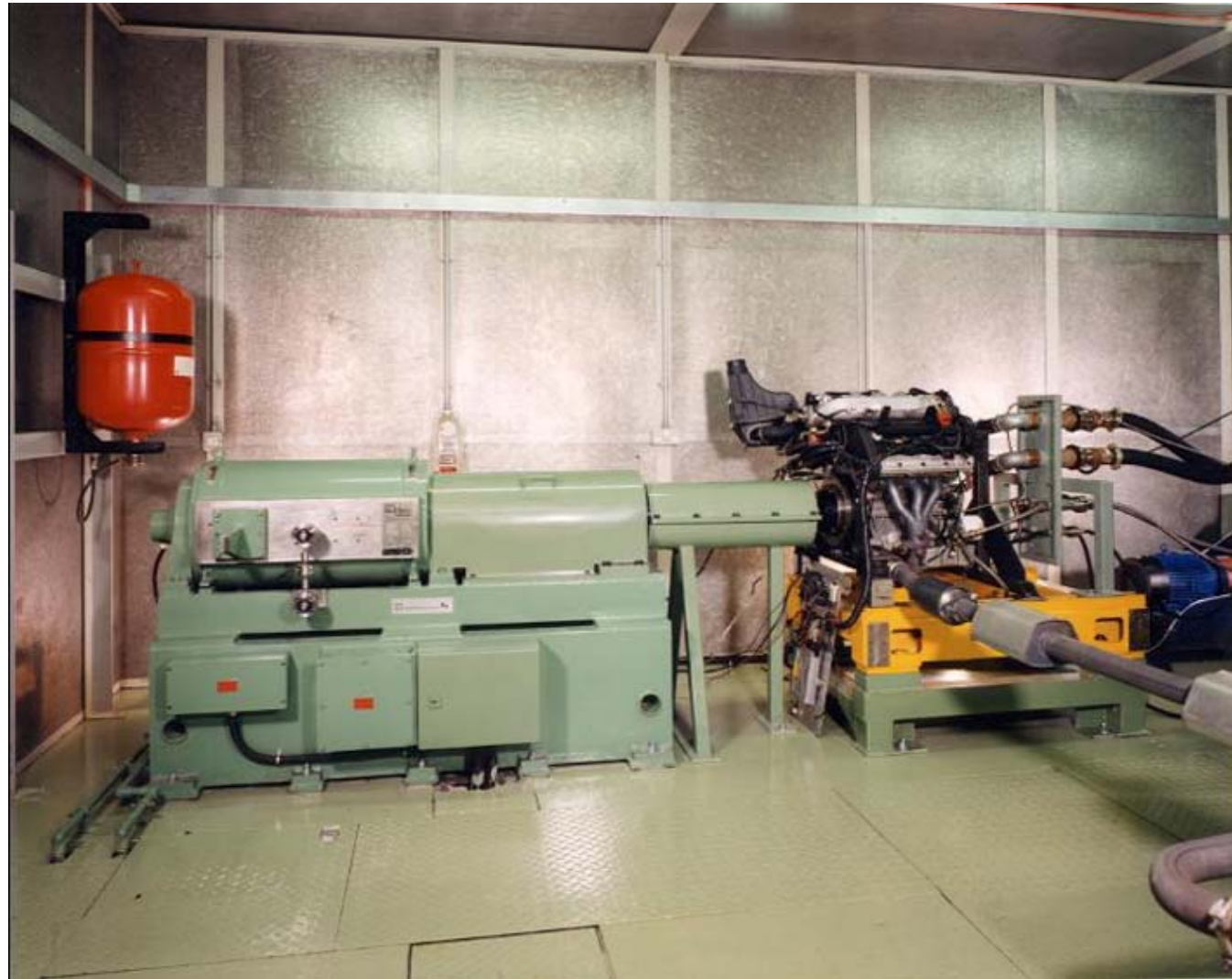
Maximum speed 10,000 rev/min

Maximum torque 1,000Nm

Speed Gradient 10,000 rev/min/second







## Test control area at Millbrook 2003

Millbrook (Bedford) provides comprehensive range of test and development resources



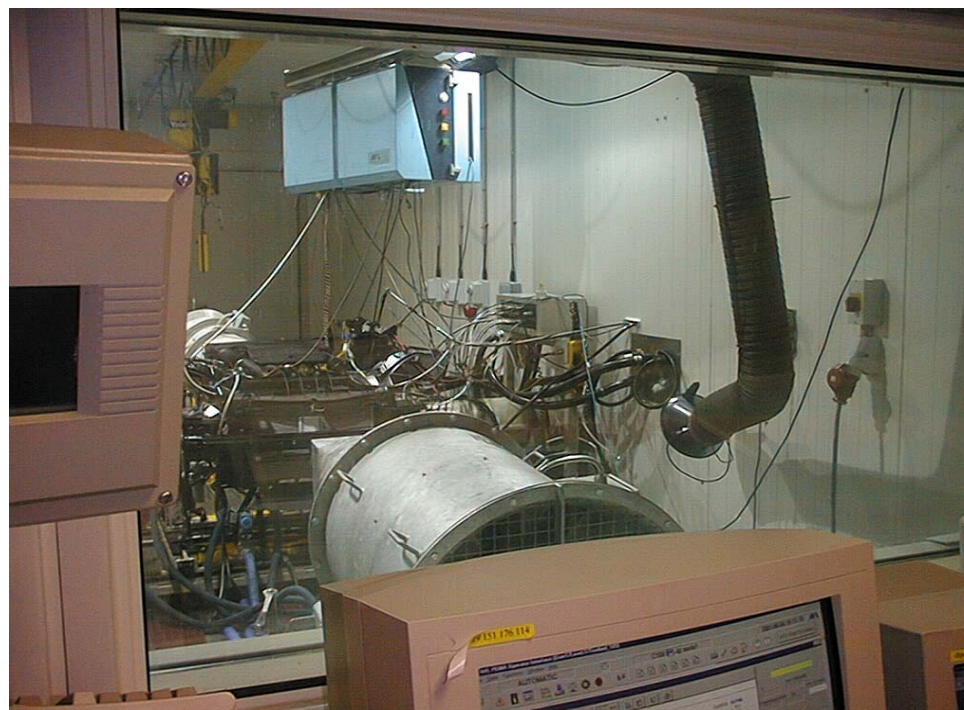




## Test Control mid 1980's

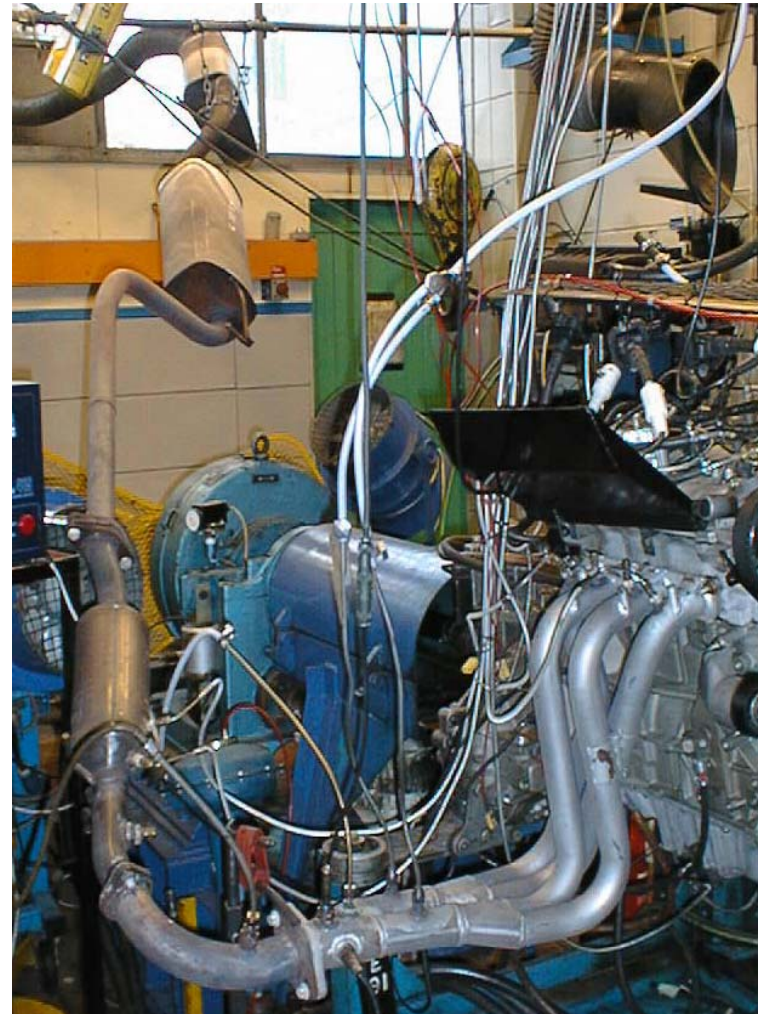


## A typical engine testing control room 2000



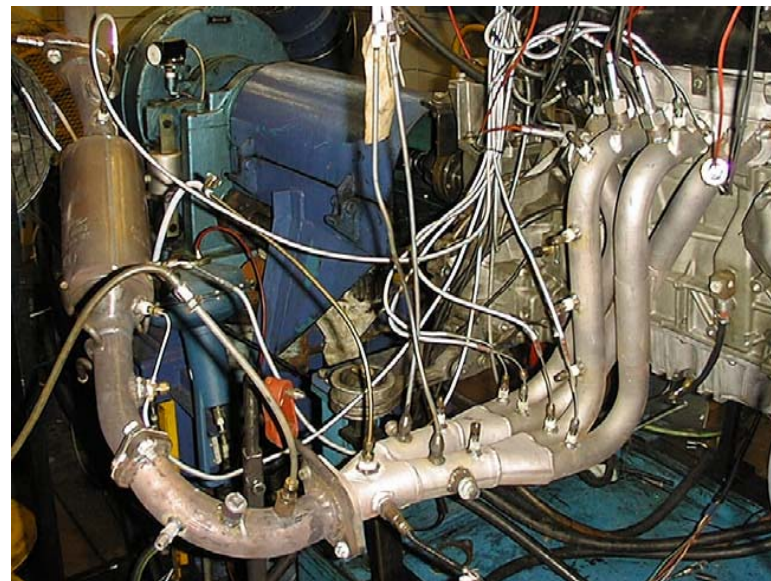
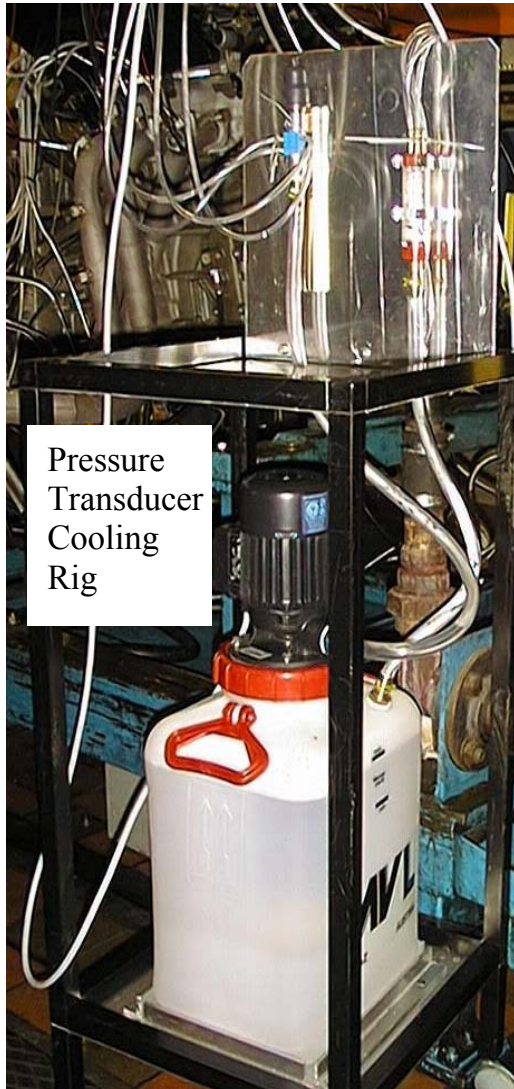
# A Test cell of 1970's to 1990's Ford Dunton

- 72 Channels Primary Data
  - (Pressure Temperature)
- 72 Channels Calculated Data
  - CorrTorque, Vol Effy, AFR Calc
- Eddy Current Dynamometer
  - (150 kW @ 8000rpm Typical)
- Pierburg Fuel Flow Meter
- Horiba Emission Analysis
  - MEXA 9000, 7000 series
- THC (total hydrocarbon), NO<sub>x</sub>, CO, CO<sub>2</sub>, O<sub>2</sub> Analysis
- Full Induction & Exhaust System





# Manifold Wave Dynamics



# Control Room Layout 2002

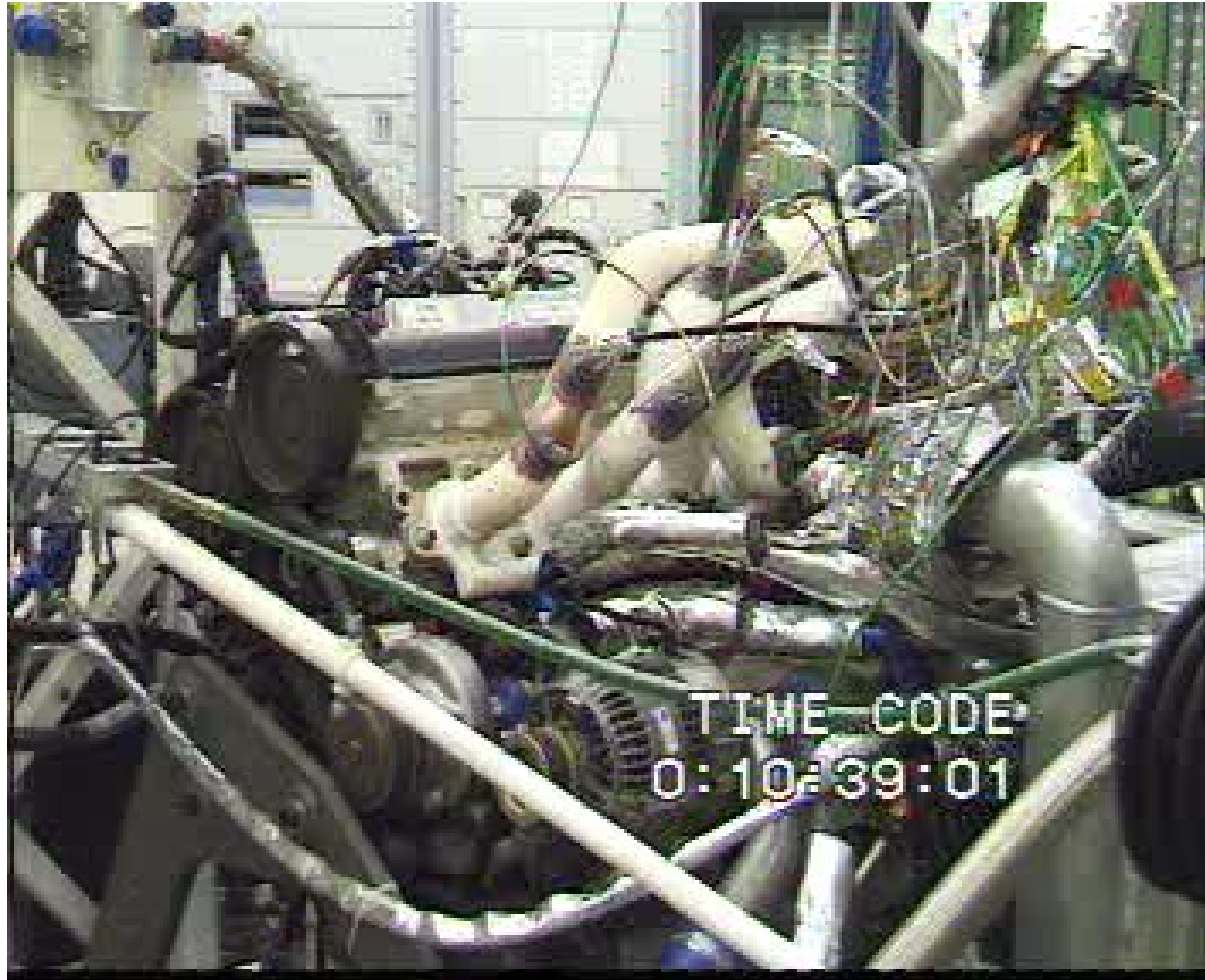


Electronic supply of test program instructions

Electronic configuration of Channel data acquisition system

Automation of basic test programs leading to full test automation

Electronic test result data storage

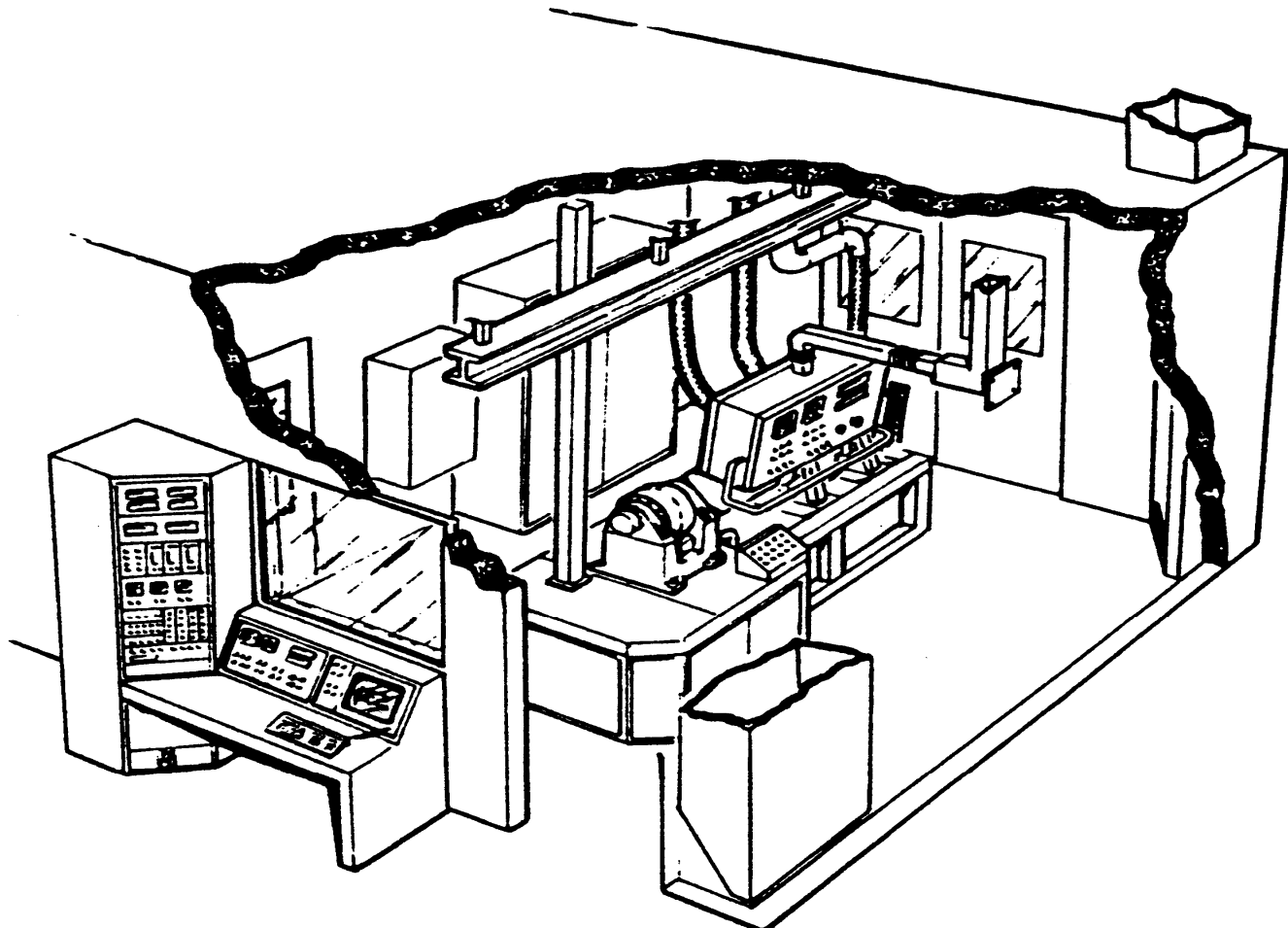


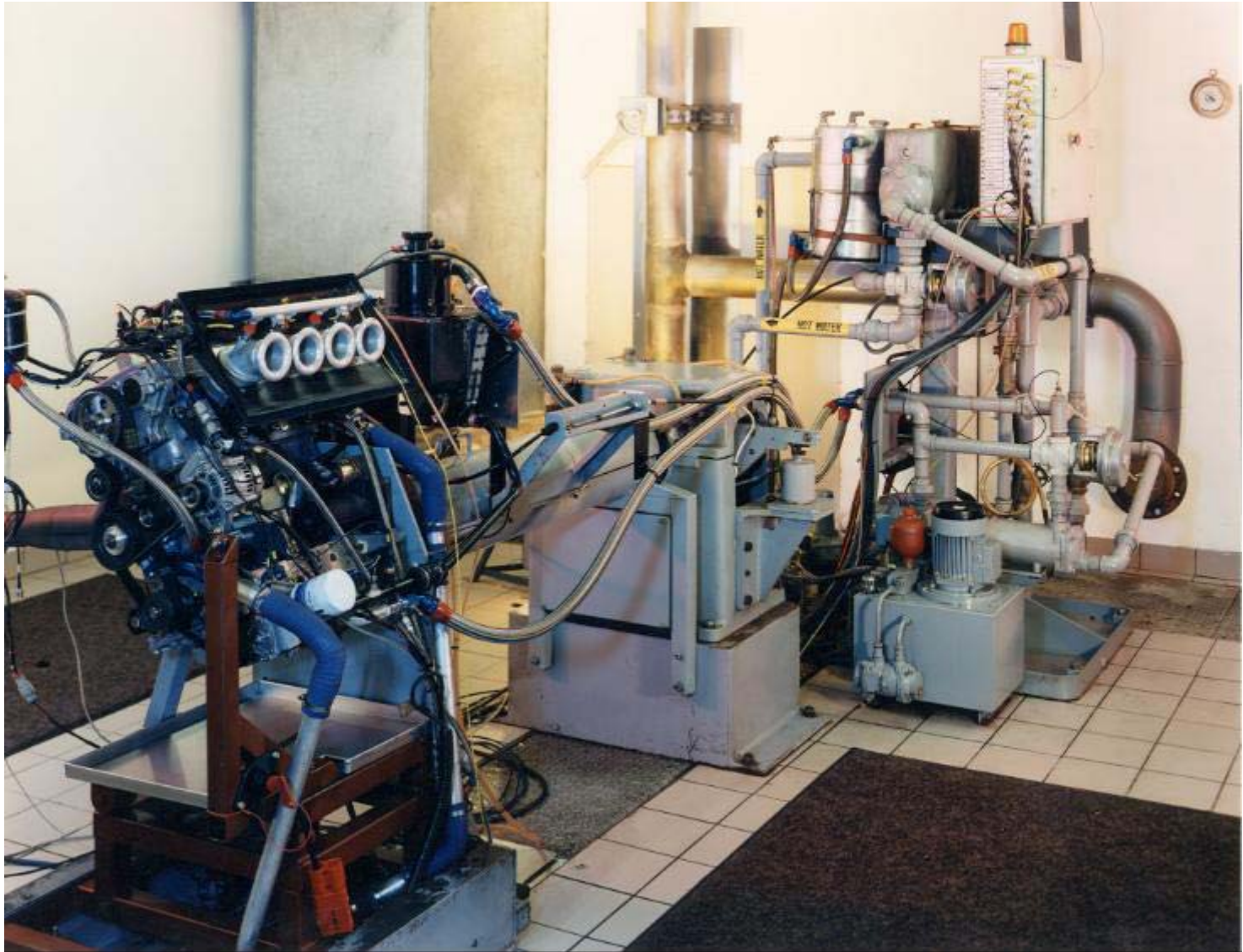


## Caterpillar Truck Race engine 1650 BHPc

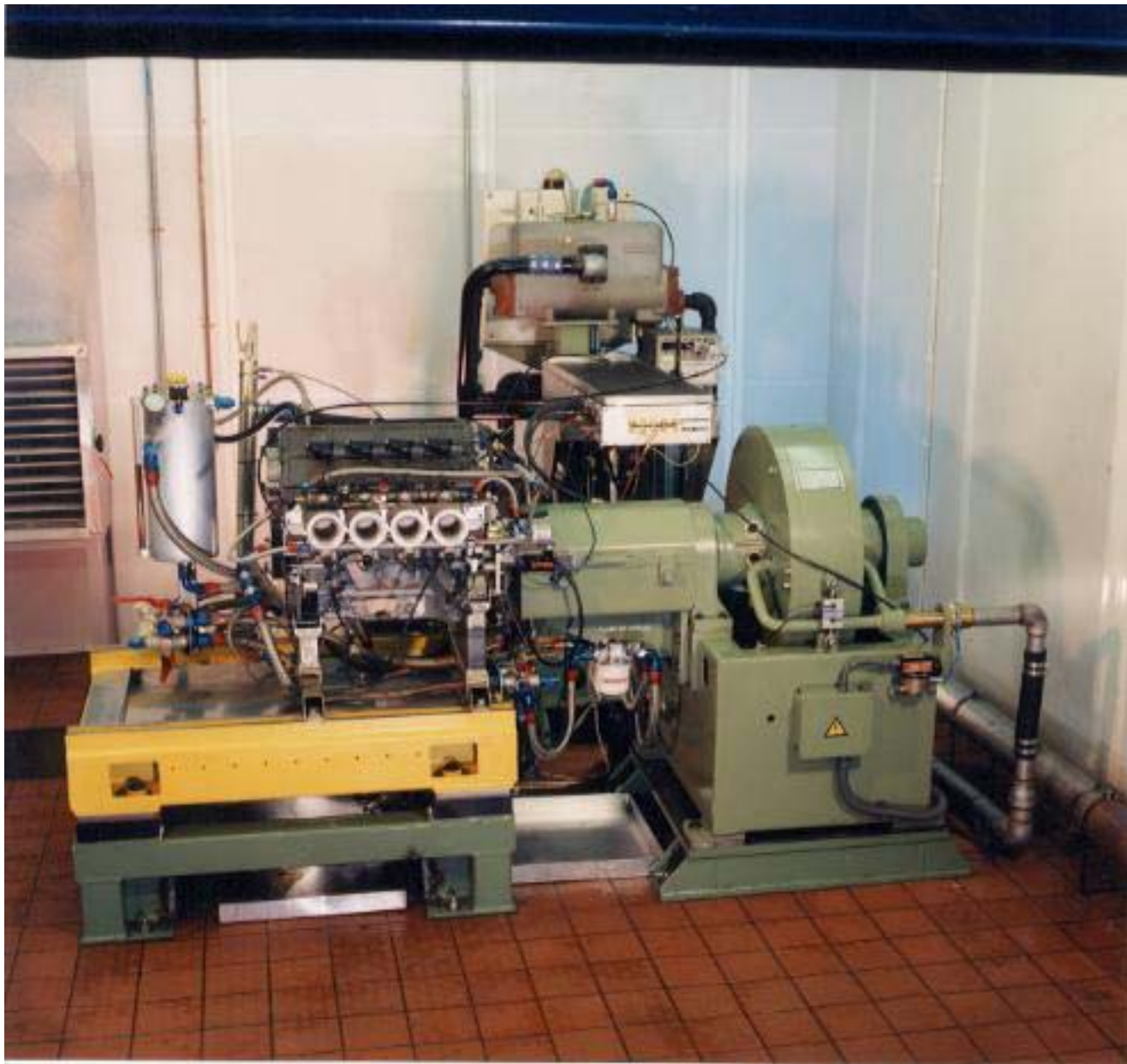


# Layout of A Typical Test Laboratory











Outside look: CRITT M2A - Automotive Research Centre at Bethune 2006





Reception area: Ground Transport Research centre at Valenciennes