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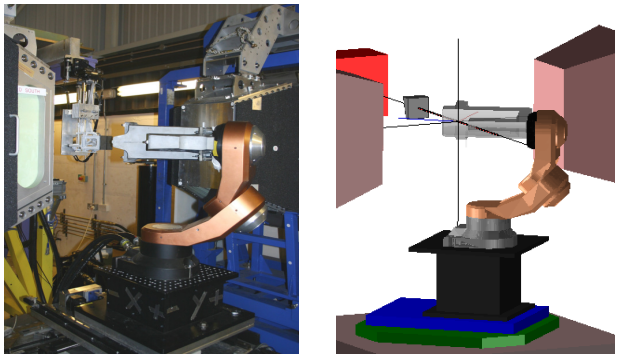
Contacts : Anna.Paradowska@stfc.ac.uk
Shu-Yan.Zhang@stfc.ac.uk

Engin-X : Neutrons for Materials Engineering
Recent Advances and Developments

The ENGIN-X beam-line is a dedicated engineering science facility at ISIS. The primary purpose of the beamline is the determination of residual stresses within the interior of bulk engineering components and test samples, in particular for the development of modern engineering processes and structural integrity investigations. A second important function of the beamline is for studies of fundamental material behavior, such as composite and rock mechanics, the basic deformation mechanisms of metals, and phase transformations in shape memory alloys and ferroelectrics.

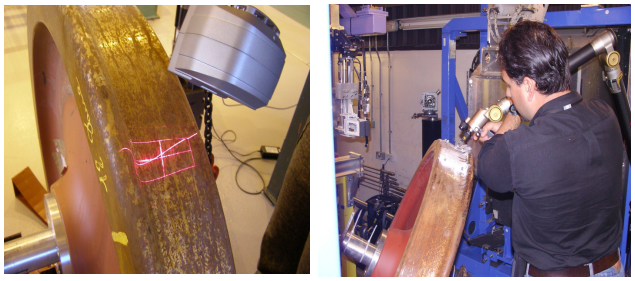
Automated full tensor strain measurement

Strain diffractometers typically measure only one or two strain components simultaneously (two in the case of ENGIN-X); therefore sample rotations are required to determine the full elastic strain tensor. Such manipulation of heavy and bulky engineering samples in the vicinity of delicate instrumentation is not trivial, and has traditionally been performed manually. The automation of this process has been addressed on ENGIN-X via the acquisition of a 3-axis, 25kg capacity rotary arm, known as the Cybaman Manipulator (Fig. 1a) combined with advances to SScanSS, the unique virtual laboratory strain scanning software (Fig. 1b). SScanSS employs serial robotic kinematics to bring a specified sample point to the instrument focus, and align the specified sample direction(s) along the instrument scattering vector(s) [Nuc Inst Meth A571 (2007) 709]. Additionally, for precise and quick alignment during scaning experiment two robotic arms with laser and touch probe were installed on Engin-X [Fig.2].



(a) (b)

Figure 1. (a) The Cybaman Manipulator on ENGIN-X; (b) accurate representation of the experiment within the SScanSS virtual laboratory..



(a) (b)

Figure 2. The Engin-X robotic arm with (a) laser probe during scanning prior to experiment; (b) touch probe during the alignment setup.

Cryogenic rig for mechanical testing

The study of mechanical properties at cryogenic temperatures is important for applications such as shape memory alloys, cryogenic steels and superconducting wires. To address this area, a novel cryogenic testing device has been developed, constituting a vacuum chamber with cooling provided by CCRs down to 75K to samples under applied loads of up to 100kN (Fig. 3).

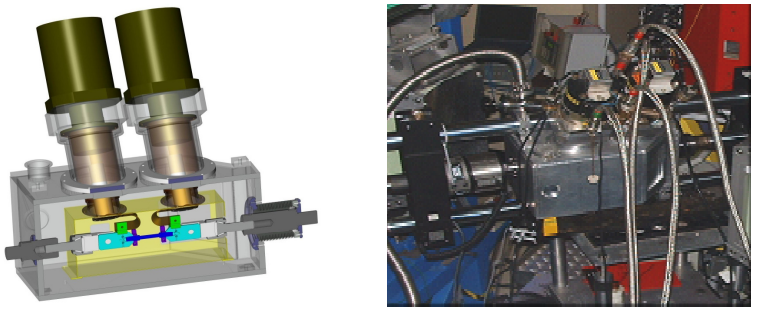


Figure 3. Engin-X Cryogenic Rig (the design model and overview photograph).

High temperature inert gas furnace for mechanical testing

The growing interest in properties of materials at high temperatures may be attributed to the dynamic development in technologies where materials are exposed to high temperature environment for example in aero-space industry or fission and fusion nuclear reactors. The new ENGIN-X furnace for neutron scattering measurements of internal stress in engineering materials under load was designed to permit a range of gases to provide non-oxidizing atmosphere for hot samples. The operation temperature of the furnace is up to 1000º C. The furnace has four focusing infrared elements which are well suited to fit around the sample on our 50kN and 100kN stress rigs (Fig. 5).

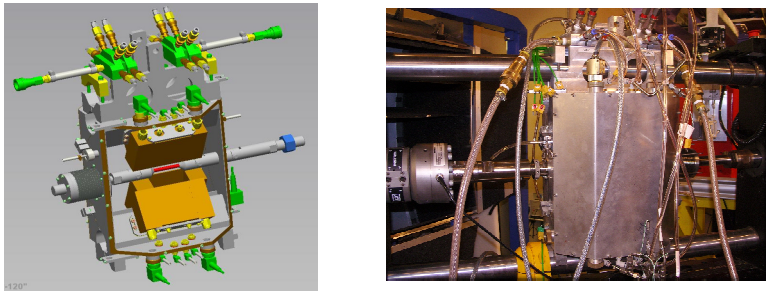


Figure 4. Engin-X Inert Gas Furnace (the design model and overview photograph).