RAL
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RUTHERFORD APPLETON LABORATORY
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INFRARED SPACE OBSERVATORY (ISO).

The Infrared Space Observatory is an ESA astronomical spacecraft, due to be launched in 1993, which will provide astronomers with a unique and powerful view of the sky at infrared wavelengths. At the centre of ISO is a 60 cm diameter telescope, as shown in Figure 1, with four instruments mounted behind the primary mirror arranged to share the focal plane. The instruments together provide observing facilities for infrared wavelengths from 3 μm to 200 μm. The telescope and instrument assembly is mounted inside a cryostat so that it can be cooled to liquid helium temperature, at around 3 degrees Kelvin. At this temperature, the infrared emission from the telescope and instruments is largely removed so that very high sensitivity measurements can be made, and it also provides the operating temperature for the infrared detectors. The spacecraft is stabilised in 3 axes so that the telescope can be pointed to view various parts of the sky, whilst the instruments are operated to detect and analyse the infrared image formed at the focal plane.

With a lid installed to close off the cryostat, the outer container of the cryostat, seen in Figure 1, forms a vacuum vessel which, when evacuated, allows the toroidal tanks to be filled with liquid helium for the cooling. In this configuration, the spacecraft is prepared for the launch into space with the European launcher, Ariane 4. In orbit, in the vacuum of space, the cryostat lid is then ejected, allowing the telescope to have an unobstructed view of the sky through the open end of the cryostat. Another dominant feature of the spacecraft, as shown in Figure 1, is the arrangement of solar panels which, apart from providing the electrical power for the spacecraft, also form a shield against the intense radiation from the Sun.

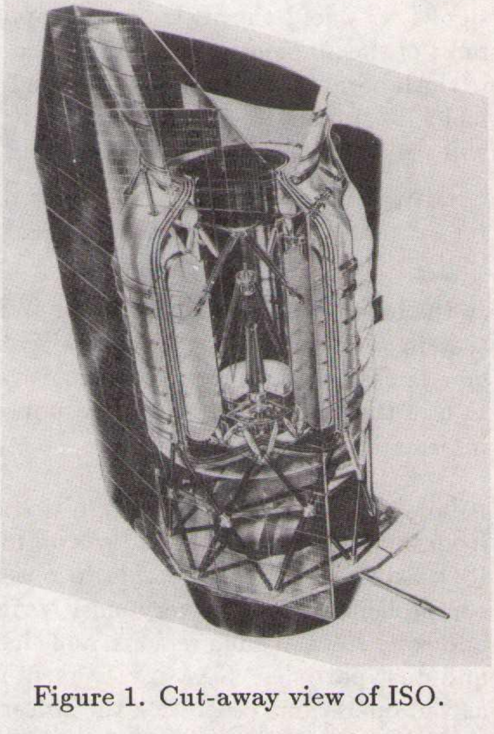

Figure 1. Cut-away view of ISO.

The four focal plane instruments have been selected and designed to form an integrated facility for infrared astronomy. An infrared camera (ISOCAM) can take images at wavelengths from 3 to 17 μm using two 2-dimensional arrays of detectors, and facilities are included for polarimetric mapping and for imaging in selected spectral bands. A photo-polarimeter (ISOPHOT) is included as an assembly of four sub-instruments with shared input optics.

These provide multiband photometry and mapping at wavelengths out to 200 μm, and an Ebert-Fastie spectrometer to give mid-resolution spectra over the wavelength range from 2.5 to 12 μm. Spectroscopy is provided by the other two instruments. A short wavelength spectrometer (SWS) covers the wavelength range from 2.5 to 45 μm with an echelle grating to give a spectral resolving power of around 1000. This range is extended up to 180 μm with a long wavelength spectrometer (LWS) which uses a grating to give either a resolving power of around 200 or, when combined with a Fabry-Perot interferometer, a resolving power of around 10,000.

The ISO instruments are being built by consortia made up from groups from many countries and involve research institutes, universities and industry, all with national funding. The UK has direct involvement with three of the instruments (ISOCAM, ISOPHOT and the LWS) through RAL, Queen Mary and Westfield College, University College London, Imperial College and the Royal Observatory Edinburgh.

In particular, for the long wavelength spectrometer (LWS), RAL provides the overall project management, the integration and test facilities, and the ground operations hardware and software. Figure 2 shows the LWS instrument in the process of assembly. For testing, it is mounted into a cryostat which can be cooled with liquid helium to reproduce the conditions within ISO. The cryostat is also designed to shield the instrument from most of the ambient infrared radiation in the laboratory, to give a background which is similar to the level which it will see when operated in space.

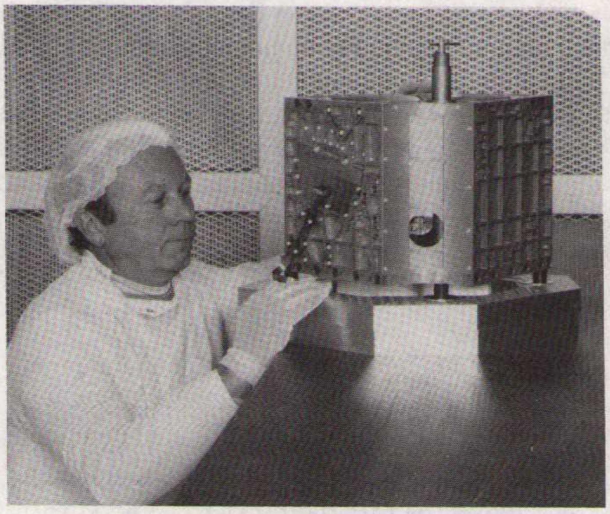

Figure 2. Assembling the LWS instrument.

In the laboratory, test signals from an infrared laser can be given to the LWS with an optical system which matches the images given by the ISO telescope. The laser can be adjusted to give emission at a large number of wavelengths within the LWS sensitivity range. Operation of the instrument and its response to this test radiation, provides the main calibration information.

A large fraction of the energy emitted or absorbed by astronomical objects, on all scale sizes from small clouds of dust and gas up to whole galaxies, occurs at infrared wavelengths. Using ISO, astronomers will be able to observe and analyse this energy for the first time with a comprehensive range of very sensitive instruments to determine, for example, the temperature and conditions of such regions, and the presence and conditions of the ions, atoms, molecules and dust particles. RAL involvement in the ISO programme is a natural sequel to its work as the operations centre for the Infrared Astronomical Satellite (IRAS) which mapped the sky photometrically in four infrared bands, in the early 1980's. These maps provide the most important identification of those regions which should now be studied in detail with ISO.

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