RAL

DESIGN & DISCOVERY

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RUTHERFORD APPLETON LABORATORY

SCIENCE AND ENGINEERING RESEARCH COUNCIL

The James Clerk Maxwell Telescope

An Astronomical Telescope to Receive Millimetre-wave Signals

The James Clerk Maxwell Telescope is a large astronomical instrument of exceptional capability. It was engineered by a team at SERC's Rutherford Appleton Laboratory to satisfy the demands of astronomers in the UK (and world-wide) for a telescope to observe in a previously unexplored region of the spectrum. The millimetre-wave region fills a gap between the highest radio frequency observations and the lowest infra-red observations; a region where extra-terrestrial molecular lines can be discovered and interstellar gas clouds - the birthplace of stars - can be explored most effectively.

The astronomers' specification for the instrument, when it was defined in the 1970s, appeared to be unachievable and no commercial organisation was willing to tackle the job at an affordable price. About ten years ago, SERC decided to fund the project for in-house development, design and build by a team at RAL and a collaboration was set up with the Netherlands at a 20% level.

Millimetre-waves will not penetrate the atmosphere down to sea-level so the telescope had to be built where the atmosphere is thin and dry. Thus, the environment in which the JCMT must operate is very harsh which added greatly to the difficulty of designing to a stringent specification. The site is on a 4000 m mountain-top (Mauna Kea, Hawaii) which is subject to extremely high winds, low temperatures, intense solar radiation and earthquakes; a site chosen solely for its excellent astronomical 'seeing'.

The JCMT came into service in 1987, following its opening by Prince Philip, and has exceeded expectations by a significant margin. For example, the surface deviations of the 15 m diameter reflector were specified to be not greater than 50 microns rms, a reflector 'precision' (D/e) of 300,000, and as such it was to be state-of-the-art. Recently, the reflector has been re-set and shown to have surface errors of only about 20 microns rms, a precision of 750,000 allowing observations to be extended to the limit of the atmosphere's transparency.

Many novel problems needed to be solved and a few are highlighted here:

* The basic structure had to be 'homologous' - that is maintain its accurate paraboliodal shape - even though no construction material is stiff enough to avoid significant gravitational distortions at this level of precision.

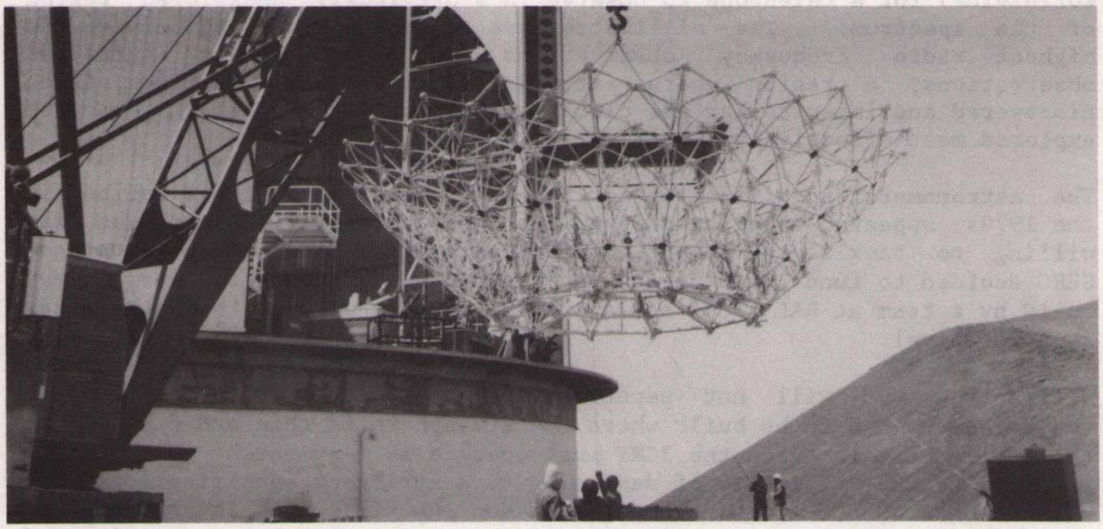
* All temperature variations across the structure had to be severely constrained necessitating a sophisticated thermal analysis and the employment of a protective enclosure, carefully selected finishes and other special features.

* A construction technique for shaped honeycomb reflector panels was developed to ensure accuracy and stability.

* Several innovative measuring techniques were developed to permit the surface to be measured and set to the required accuracy.

* A unique, PTFE-fabric wind shield and solar screen was constructed to permit astronomical observations to continue under all but the severest of weather conditions.

As a result of this endeavour the UK (and her NL partner) can boast of the leading astronomical instrument of this type in the world on the world's best site.



The telescope dish structure being hoisted into its enclosure

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