Foreword

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This annual report for the Central Laser Facility (CLF) at the CCLRC Rutherford Appleton Laboratory is an account of the scientific research which has been carried out by users of the Facility and its staff over the financial year 2004-05.

The research of the CLF covers a wide range of disciplines, including physics, chemistry and biology as well as the development of the facilities themselves and the associated instrumentation. The laser systems involved span a wide range of characteristics and include short pulse high repetition rate systems with wide tuning range to ultra-high power lasers which are capable of producing extremely high intensities and are used for novel studies and applications in plasma physics.

The high intensity laser programme is carried out with both the Astra and Vulcan laser systems which have complementary characteristics. The Astra laser is a TiS system which provides pulses of 40 fs with energies of typically 0.5 J per pulse (peak power ~10TW) and repetition rates of up to 10 Hz, providing focused intensities of up to 10^{19} W/cm^2, whereas the Vulcan system, operating in the short pulse CPA mode, can deliver up to one Petawatt (10^{15} W) in pulses of ~500J, producing intensities of up to 10^{21} W/cm^2.

An overview of a major project to increase the power and capability of the Astra Laser (Astra Gemini Project) is presented in this report and, when this is completed in 2007, it will deliver into a new target area two independent synchronised 0.5 PW beam lines capable of being focused to a maximum intensity of ~10^{22} W/cm^2 each. This will complement the existing Vulcan programme. The experimental programmes of both Vulcan and Astra have been strongly supported by theoretical modelling of the laser plasma interactions carried out by collaborators in UK universities. The increasing role of modelling in the design and interpretation of experiments will be indicated by the substantial strengthening of the theoretical support provided by the CLF over the next few years.

The versatility and unique properties of the laser systems which have been developed within the Lasers for Science Facility (LSF) are demonstrated by a wide range of innovative studies in chemistry, biology and physics. A significant feature of the LSF programme is the increasing impact of ultrashort lasers in the life sciences.

The high level of demand for access to the CLF both from UK and international scientists continues greatly to exceed the time available for the scheduling of experiments. This confirms the internationally leading position of the CLF in many areas. The ongoing challenge for the CLF and its users is to maintain the highest standards of research against a background where the complexity of experiments continues to increase.