IN CONFIDENCE

18 December 1974

SRC 107-74

(P/AL/25)

SCIENCE RESEARCH COUNCIL

Proposal for a Central Laser Facility
Memorandum by the Chairman of the Science Board

1. Council will recall that at their meeting on 17 July 1974 they approved in principle the provision of a high powered laser facility subject to the availability of funds, appropriate arrangements being made with the AEA, and the outcome of a preliminary study which they asked the Rutherford Laboratory to undertake.

2. The attached paper by Dr G H Stafford presents the results of this preliminary study and discusses possible arrangements with the AEA.

3. The paper was discussed by the Science Board at its meeting on 4 December. The Board accepted the proposals put forward in the paper and would wish to include provision for such a facility in their Forward Look. In particular, they were reassured that the arrangements proposed with the AEA would safeguard the interests of the academic community.

4. Council is INVITED:

(a) to approve a joint programme with the UKAEA, ~~generally~~ along the lines proposed in Dr Stafford's paper.

(b) to endorse the principles concerning security and general arrangements which it is proposed should be followed and which have been set out in paragraphs 6.4 and 6.6

(c) to approve inclusion of the SRC part of the Joint Programme in the Rutherford Laboratory programme.

(d) to approve capital expenditure ~~amounting~~ up to £1.9M at November 1974 prices on the provision of the glass lasers, experimental equipment, an electron beam generator and the buildings required to set up the facility, this expenditure falling mainly in the years up to and including 1977/78.

(e) to note the estimated requirement for an overall capital and recurrent expenditure by the SRC in the range of £0.9-1.25M per annum at November 1974 prices. Within this total the capital expenditure is expected to range from £400-700K per annum while the recurrent costs will rise to a steady level of £700K by the end of the fourth year.

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Proposal for a Central Laser Facility

G H STAFFORD

Contents

PROPOSAL FOR A CENTRAL LASER FACILITY

1. INTRODUCTION

1.1 At its meeting on 17 July 1974 Council considered a memorandum (SRC 63-74) by the Chairman of the Science Board and the Director, Rutherford Laboratory, on the setting up of a High Powered Laser Facility, and the Science Board report (SB 30/74) containing the scientific case.

1.2 Dr W Marshall was present for the UKAEA; he informed Council about the AEA interests which would be served by such a facility and the possible security implications which could affect some of the work which the SRC and universities might wish to do.

1.3 Council recognised that, before it could take firm decisions on the project, further study was needed of the technical requirements, of their capital costs, of the resources needed to operate and develop the facility, and of the organisational arrangements. This study would be made by the Rutherford Laboratory in consultation with university scientists, the AEA and other appropriate bodies, and a report submitted to Council in December. At the same time some aspects of the scientific case should receive further attention.

1.4 Council (a) approved the expenditure of up to £20K on the preliminary study by the Rutherford Laboratory;

(b) approved in principle the provision of high powered laser facilities on the scale indicated in Appendix I to SRC 63-74, subject to the availability of funds, appropriate arrangements being made with the AEA and the outcome of the preliminary study.

1.5 In this paper, specific proposals are made for setting up facilities jointly by the SRC and the AEA. First, a summary is given of the scientific case for a facility for use by university scientists after which the AEA interests are outlined. Next are presented the technical requirements of the laser installations, the experimental facilities, the necessary buildings, and the financial and manpower resources which will be needed. (The full scientific case and details of the central requirements are given in the Appendices). There follows a statement of the security requirements. Finally proposals are made for setting up a collaborative programme with the AEA and recommendations are made for decision by Council.

1.6 The proposals have been formulated with the advice and assistance of the Laser Laboratory Steering Committee* and are acceptable to the Director of the Research Group of the UKAEA. There has also been appropriate consultation with university scientists from the user community.

1.7 Dr Marshall has advised that the AEA have approved a collaborative programme with the SRC at the broad level of expenditure implied by this paper and are seeking the agreement of the Department of Energy to go ahead. Before proceeding further the Department of Energy is awaiting the decision of the SRC.

*Footnote: Terms of reference and membership of the Laser Laboratory Steering Committee.

Terms of Reference

To advise and assist the Director, Rutherford Laboratory, to prepare a proposal to Council for a high power laser facility and to provide for consultation with the university community.

Membership of the Committee

Professor D J Bradley (Chairman)
Dr G H Stafford (Vice Chairman)
Professor S A Ramsden
Professor S D Smith
Professor B R Coles
Professor C Grey Morgan
Professor A F Gibson
Mr M O Robins
Mrs J O Paton
Dr J M Valentine
Dr L C W Hobbis
Dr P R Williams (Secretary)

2. THE SCIENTIFIC CASE

2.1 A full account is given in Appendix I of the case for providing high power laser facilities for the use of university groups. The principal scientific objectives of the proposal are:

(a) to create and study in the laboratory superdense plasmas generated by the laser compression of matter;

(b) to study non-linear interactions of very intense laser radiation with matter;

(c) to develop more efficient and new high power lasers for future experiments in laser compression and other fields.

2.2 Carefully designed high power laser beams delivering, say, 500 joules in 300 picoseconds, can be optically focussed to intensities of at least 10^{15} watt cm^{-2}. Subsequent thermal focussing and hydrodynamic compression occurring in a uniformly irradiated target should produce a final power density of 10^{19} watt cm^{-2} and a matter density of 10^3 - 10^4 times that of the normal solid. Already in 1974, substantial compression of spherical shells has been achieved in the US with a laser system of intermediate power (50J, 300ps), confirming the practical feasibility of entering the field of compression studies with existing laser technology.

2.3 Crucial to the study and interpretation of compression experiments is an understanding of the processes of energy transfer from the laser beam to the plasma produced, and of the detailed relationships between absorptive and radiative mechanisms. Study of these non-linear interactions, which are also a field of rapidly increasing scientific interest in their own right, will be possible using lasers of intermediate power.

2.4 Laser radiation of at least two different wavelengths is required for these interaction experiments. At a later stage in the programme of compression studies, systems of higher energy and efficiency than now available will be needed in the wavelength region of 1μm and shorter. Development of such systems will be another important central function.

2.5 The availability of terawatt laser pulses will open the way to the exploration of the generation of intense X-ray point sources and to the development of XUV and X-ray lasers, of considerable potential importance for other branches of physics, and with possible applications in medicine and industry.

2.6 The studies outlined above would be a logical extension of the substantial activity already extant in several UK university laboratories. This research is of international standing but progress will only be maintained if operations are continued on a scale appropriate to a central facility.

2.7 While the justification for this proposal is the study in its own right of a novel and important state of matter, nevertheless much of the world-wide interes in this field arises from the possibility of energy production by laser-induced controlled nuclear fusion. The programme of research proposed will be a necessary stage of any national effort on laser fusion that may subsequentl be mounted.

2.8 The availability of a laser centre will greatly extend the opportunities for training research students and post-doctoral workers in high-power laser techniques. This will generate a pool of experienced laser scientists who will play an important role in stimulating laser technology in the UK.

2.9 Finally, it can safely be predicted that the creation of such high electro-magnetic energy densities will stimulate important developments in other branches of science.

3. THE AEA PROPOSALS

3.1 The Atomic Energy Authority have always undertaken research upon problems of a long term nature likely to affect the Authority's future programme or the development of nuclear energy in general. After reviewing recently the possible application of high power lasers in the field of thermonuclear energy and other areas of interest to the AEA, the Authority have made a proposal to include a major laser activity as a component of their underlying research programme.

3.2 The AEA's initial objective will be to establish during the first few years an adequate base of experience from which to advance in the subject as its general development permits, including the exploitation of any major breakthrough which might be made elsewhere during this initial period.

3.3 An experimental and theoretical scientific programme is envisaged directed mainly towards achieving densities of $\sim$ 1kg cm^{-3} by implosion and, as in the case of the SRC proposals, this implies the need for a wide range of experimental and theoretical studies on the interaction of intense photon beams and matter.

3.4 Considerable effort will be required on the development of computer codes to describe the physical processes involved eg the absorption and scattering of laser radiation, energy transport and atomic and nuclear processes in dense matter. Theoretical work will also be required in the development of high power lasers and optics.

3.5 In addition to the laser compression studies the AEA have identified a number of other topics of interest to them, some of which are listed below:

(a) Equations of state studies relevant to materials technology.
(b) Equations of state studies relevant to laser-induced fission.
(c) Laser-produced X-rays for special technological applications.
(d) X-ray lasers, with a wide field of interesting applications.
(e) Fusion-fission symbiosis,

and there are other more speculative possibilities which may eventually be possible if laser-induced fusion can be produced with substantial energy outputs.

3.6 To support such a scientific programme the AEA have envisaged the provision of laser installations and experimental equipment closely resembling that suggested to the SRC by the university community. They also propose a development programme covering the extension of existing laser systems in both power level and beam control, the development of new lasing systems, of target manufacturing and delivery systems, and of a wide range of diagnostic equipment.

3.7 After a first phase of activity of duration up to 3 years, a second phase would be entered, entailing the modification and extension of the facilities beyond the initial level of about 1kJ, possibly incorporating new laser designs. The aims and objectives of this second phase would be heavily dependent on laser developments and on the results of research into laser-induced compression.

3.8 Being aware of the content of the extended university programme which was receiving consideration by the SRC, the AEA have proposed that a collaborative project should be adopted between the universities, the SRC, and the AEA, with the costs being shared roughly equally between the SRC and the AEA. A preliminary estimate suggested that the total cost would amount to about £2M per annu

3.9 The AEA have proposed the following specific objectives of the collaboration:

(a) To set up a major facility using high power lasers for the pursuit of a programme of fundamental and applied studies into the interaction of intense photon beams with matter, especially in the fields of high compression and high energy densities.

(b) To pursue a theoretical and computational programme to guide, support and interpret the studies.

(c) To develop existing and new lasing materials and associated techniques in support and extension of the interaction studies.

(d) To ensure that the AEA can control and protect studies that are classified or that have security sensitivity.

3.10 The AEA considered that the main compression facility would have to be located on a site under its control in order for it to discharge the security responsibility. (This and other security requirements are discussed in section 5). Supporting work on laser development, experimental apparatus and diagnostics could be conducted at an SRC establishment or in university departments. A natural solution would be to base the central facilities on the use of AERE and Rutherford Laboratory resources at the Harwell/Chilton site.

4. INSTALLATIONS AND RESOURCES

4.1 In formulating proposals for the laser installations, the experimental apparatus, the buildings and the resources required to establish and operate a central facility, account has been taken of the programme requirements of the university scientists and of the UKAEA. It was concluded that the requirements of both parties could be satisfied by the same laser installations and a common development programme for new and improved lasers. The technical and staffing proposals were therefore evolved in close consultation with Authority staff and are given in detail in Appendix II. They are summarised in this section without consideration of the managerial implications of a joint programme which are discussed subsequently in sections 5 and 6.

Glass lasers

4.2 To launch the research programme it is proposed to provide two neodymium-glass lasers, each giving high quality beams capable of achieving power densities exceeding 10^{15} watt cm^{-2} on targets. In its most straightforward form the main compression laser would produce a total of 500 joules in two beams with a tailored pulse of 300psec duration to irradiate a 100μm diameter sphere with a power density exceeding 4.5×10^{15} watt cm^{-2}. A further, intermediate energy, single beam laser would produce at least 10 joules in 100psec and could be focussed to power densities in excess of 10^{15} watt cm^{-2}. This second laser would also be used for component testing, diagnostic development and as a driver for the development of higher energy systems.

4.3 The glass laser estimated costs given in Table I are based on budgetary estimates obtained from industry in the US and France. Further enquiries are being made in this country and abroad to determine if it is possible to proceed initially to a higher energy compression system of say 1kJ at acceptable cost and on an acceptable time scale.

Diagnostics and experimental equipment

4.4 Instrumentation will be needed for measuring and monitoring laser performance and for alignment purposes. Apart from the optical components of the main laser chains a wide range of optical items is needed for use with the diagnostic equipment. Nearly all the signals to be measured are very fast transients requiring high speed oscilloscopes for their observation.

4.5 A particularly extensive range of instrumentation will be needed in the target area including micromanipulators for target positioning, a multiplicity of radiation monitors, and sophisticated streak cameras to produce temporal and spatial resolution.

4.6 Comprehensive listings have been made to cover the basic requirements which will be the subject of the initial capital provision. Specific additional items will be met from the operating budget.

Laser development

4.7 It is proposed to provide an electron beam (e-beam) generator capable of delivering a 30ns 100kA electron pulse of energy at least 1MeV for use in the development programme. Its function will be to trigger chemical lasers (eg HF) or to excite quasi-molecular lasers, high power CO_2 and exotic gas mixtures.

4.8 In the light of developments in these and other areas it will be possible in due course to choose the best way to extend the glass lasers to higher powers or to complement them by the introduction of new installations.

Buildings

4.9 A purpose-built building of area approaching $3000m^2$ will be required to house the complete activity of the laser centre. It can be sited between AERE and the Rutherford Laboratory and will be designed so that it can be extended if required to accommodate an expanded programme.

4.10 This building will take at least two years to construct so the lasers and the project team will be housed initially in temporary accommodation which can be made available within AERE. This will enable work with both the glass lasers to begin as soon as they are delivered. (Nine months from ordering for the smaller, 15 months for the larger).

Manpower

4.11 The staff of the centre will provide the laser installations and experimental equipment, operate the lasers, support the university research programmes, undertake research and development on new and improved lasers, and pursue an in-house physics programme. It has been estimated in consultation with the AEA that this will require a direct complement rising to 66 by the end of the first two years. This figure includes any university scientists who might be attached as part of the staff, an arrangement which would be particularly appropriate during the construction stage.

Finance

4.12 Estimated costs of the major capital items required to set up the centre are tabulated below.

	£000
High power (1.5TW) glass laser	1400
Intermediate power (100GW) glass laser	175
Diagnostics and experimental equipment	600
e-beam system	280
Buildings	1000
Contingency	305
Total:	3760

4.13 These capital costs have been consolidated in Table I together with the estimated minor capital and recurrent costs to show how the programme is expected to develop up to 1980/81 and the estimated overall expenditure by years. Allowance has been made for extension of the facilities in the later years, and a contingency of 10% of the capital expenditure has been included. It can be seen that the programme can be accommodated within an estimated annual expenditure on capital and recurrent costs, excluding staff costs, in the range of £1.6-2M per annum. The cost to the SRC is considered later in section 7 after giving detailed attention to the framework for the joint programme.

TABLE I. LASER CENTRE JOINT PROGRAMME ESTIMATED COSTS, EXCLUDING STAFF COSTS, £000, NOVEMBER 1974 PRICES, INCLUDING VAT.

MAJOR CAPITAL ITEMS	*74/75	75/76	76/77	77/78	78/79	79/80	80/81
1) 1.5TW Laser £1.4M	250	900	250				
2) 100GW Laser £175K	75	100					
3) Diagnostics and Experimental equipment £600K	200	100	180	120			
4) e-beam £280K			160	120			
5) Buildings £1M		200	350	350	100		
6) Extension of facilities			100	200	900	1000	1000
7) Contingency		130	110	90	100	100	100
Total - Major Capital A	525	1430	1150	880	1100	1100	1100
Minor capital and recurrent costs excluding staff costs							
8) e-beam support			25	50	50	50	50
9) Target production		50	75	90	100	100	100
10) Operating costs	10	200	300	500	650	650	650
11) Laser R&D			100	100	100	100	100
Total - Minor Capital & Recurrent B	10	250	500	740	900	900	900
TOTAL A + B	535	1680	1650	1620	2000	2000	2000

*The capital expenditure shown in 1974/75 depends on obtaining Government approval early in 1975.

5. SECURITY

5.1 The attention of the SRC has been drawn to issues of national security associated with work involving high power lasers. Before discussing a possible framework for a joint SRC/AEA programme it is appropriate to review the security constraints in greater detail than hitherto. It has been stated that if the SRC decides to undertake such work, then the AEA would be responsible for the security categorisation of all programmes within the project and then, in turn, would be responsible for the security control of studies that are classified or that have security sensitivity. The statements on security in 5.2-5.9 below have therefore been based on advice from Dr W Marshall, Director, UKAEA Research Group, and have been approved by him.

5.2 It is convenient to discuss security with reference to three main categories:

(a) Subjects which are unclassified and unambiguously will remain so.

(b) Subjects where initial experiments or computations would be unclassified but where the natural curiosity of those concerned may possibly lead them on to classified topics.

(c) Subjects which would be classified and which would be recognised as such from the beginning.

5.3 Large areas of experimental and theoretical work and essentially all laser development, construction and operation will be in category (a).

5.4 Category (b) will include some experiments which start off with modest attempts at compression and lead on to experiments at high compression and also would include much of the initial theory and computation connected with processes leading to high compression.

5.5 The most sensitive areas are those in both theory and experiment which are closely related to classified areas of weapon technology. These areas will fall in category (c).

5.6 This categorisation will be time-dependent because steady declassification is likely to take place on a time scale of about a decade, but one cannot be certain about the rate of declassification at this stage. A few months ago Dr Marshall estimated that 10% of the whole area of work, measured by effort deployed, would fall into category (c) but a recent declassification decision

by the USAEC will now permit a corresponding relaxation in the UK Classification Guide, and the present estimate is that category (c) will correspond initially to less than 3% of the total effort.

5.7 Work in category (a) can be done in an Open Area. Work in category (b) would need to be done in an area where prudent arrangements for security could easily be made when necessary. The most sensitive work in category (c) would have to be carried out inside the main AERE security fence. Category (a) work could be done within the Rutherford Laboratory without any geographical separation from the main programme of the Laboratory. Category (b) work would best be done in a new building adjacent to, but not physically part of, either Harwell or the Rutherford Laboratory; but by taking care it could alternatively be done in a segregated section of the Rutherford Laboratory. In either case the Harwell authorities would need to have full administrative control over these areas, ie they would in effect be Authority premises for all control purposes. In the beginning work in the new building or the segregated area would be entirely declassified and free access would be permitted. Subsequentl if parts of the work lead into security-sensitive topics, portions of the building or area could be made secure for given periods to allow work on such topics to continue.

5.8 Because of their possible proximity to classified work all SRC and university personnel working on the laser project would be invited to sign the Official Secrets Act. Those working on subjects in category (c) would require security clearance at an appropriate level. Those scientists wishing to start work in category (b) would be advised at the outset that this might lead them naturally on to work in category (c) and depending upon whether this seemed likely to happen quickly or slowly they could volunteer to obtain security clearance immediately or postpone their decision.

5.9 At present only British nationals could participate in classified work, but as the project evolves non-British nationals might be able to participate in classified work subject to Government agreement.

5.10 Dr Marshall emphasises that, while these arrangements may sound formal, formidable and alien to traditional University thinking, they are designed only to make prudent provision for problems that might arise in the future. These problems might not arise at all and there is therefore no need for the security protection to be "heavy-handed".

6. SRC/AEA JOINT PROGRAMME

6.1 The merits of pursuing a joint programme are clearly considerable because the common and complementary scientific interests of the AEA and of the SRC, acting on behalf of the university community, could be served by one set of installations with the two parties sharing the costs. Also, it will require all the expertise available in the UK to be combined effectively if the facilities desired by the various parties are to be provided on an acceptable time scale.

6.2 Principles are proposed in 6.4 and 6.6 below to be followed in setting up and managing a joint programme. These proposals and those in 6.7-6.11 are acceptable to the UKAEA. Detailed arrangements can be made in due course and should be kept under review.

6.3 In the discussions between the SRC and the AEA leading to the formulation of these proposals, it has been clear to both parties that the managerial arrangements adopted must be such as to serve the scientific wellbeing of the venture, whatever the special features of these arrangements which may be required to enable the AEA to discharge its responsibilities for the control of classified work. It is considered that the proposals set out below will satisfy this criterion both day-to-day and in the longer term.

6.4 SRC policy concerning classified work would be governed by the following principles.

(a) SRC will normally support only unclassified work by SRC or university scientists.

(b) All classified work will normally be supported by the AEA.

(c) Decisions on classification and the administration of security procedures will be the responsibility of the AEA.

(d) SRC staff will in general not have any security clearance.

(e) Only unclassified work will be done on Rutherford Laboratory controlled premises (or university premises with SRC support).

(f) Very sensitive classified work will be done within the main AERE security area.

(g) Any new central facility will be designed and sited so that both classified and unclassified work can be carried out within it.

6.5 These principles leave unaffected the open committee procedures of the SRC and the open character of its establishments. The individual university scientist has a free personal choice whether he wishes to pursue classified studies, since he can look for support in that work to the AEA. The suggestion that less than 3% of all the work is likely to be classified is important in limiting the overall implications for university science and for its support by the SRC. It is considered acceptable that SRC staff should be invited to sign the Official Secrets Act (paragraph 5.8).

6.6 Taking account of the principles of 6.4, the following principles are proposed for the general arrangements and executive responsibilities.

(a) There will be a joint SRC/AEA programme for the development and research use of high power lasers.

(b) There will be a central facility for the work which will contain laser installations for compression studies and other closely related laser installations. It will be known as the Joint Laser Centre.

(c) Parts of the joint programme will be carried out within AERE, the Rutherford Laboratory, or on university premises. On the SRC side this will primarily concern laser development and support for university use of the central facilities.

(d) During both the construction and operational phases executive responsibility for the various parts of the Joint Programme will lie with the Director Rutherford Laboratory and the Director AERE.

(e) The capital and operating costs will be shared so as to reflect the balance of the SRC and AEA interests in the programme. The division of the costs will be reviewed from time to time.

6.7 Some proposals concerning detailed arrangements follow which it is desirable that Council should discuss or note at this stage.

(a) The main compression facility described in this document will be owned and operated by the AEA. Ownership and operation of the other installations will be by the SRC or the AEA as appropriate.

(b) SRC-supported use of all the facilities will be the responsibility of the Rutherford Laboratory.

(c) AEA-supported use of all the facilities will be the responsibility of AERE

(d) The SRC will carry out development work on laser systems and experimental equipment for their use.

(e) The SRC may also develop and operate lasers and related equipment which are not concerned with the joint programme.

6.8 It is proposed that for the construction phase the Directors of AERE and the Rutherford Laboratory should form a project team containing appropriate SRC, AEA and university effort. This team would operate under a project leader reporting to a Management Committee.

6.9 The Management Committee would be set up jointly by the Directors of AERE and the Rutherford Laboratory with one of them (or his nominee) acting as Chairman, and the other as Vice-chairman. Its terms of reference would be to advise the Directors on the construction of the Joint Laser Centre and it would include university scientists in its membership. One of these university scientists would chair a users' committee which would advise the Directors through the Management Committee on the scientific requirements.

6.10 The joint project team approach will be the quickest way to get started since it will minimize short-term personnel management problems. At the same time the detailed allocation of responsibility will need to take account of the various responsibilities expected to obtain in the operational phase. The SRC-supported effort which will be needed is summarised in section 7.

6.11 The following committee structure is proposed for the operational phase.

(a) Once the new facilities have been set up, the Directors of AERE and the Rutherford Laboratory will be advised on overall programme coordination by a Joint Laser Centre Programme Committee (JLCPC). This committee will not normally deal with classified topics. It will have a university scientist as Chairman and representation of the university community, the SRC and the AEA, and will have a joint SRC/AEA secretariat.

(b) An appropriate sub-committee will consider experiment proposals and will advise on the allocation of experiment time and resources taking account of the scientific merit of proposals and the agreed funding relationship between the SRC and the AEA.

(c) There will also be separate SRC and AEA committees as required to match their normal internal procedures. For the SRC a Laser Committee of the Science Board (analogous to the present Neutron Beam Research Committee) would be appropriate.

(d) Finally, there should be an appropriate users' committee.

7. SRC RESOURCES

7.1 It is proposed that during the construction phase and the early years of operation the capital and recurrent costs, excluding staff costs, should be met equally by the SRC and the AEA. At the same time the SRC and the AEA should contribute equal man-years of effort and each party would meet its own staff costs. These arrangements would then correspond to equal laser time for SRC and AEA-supported programmes in the initial years of operation. Such a division of costs would be acceptable to the AEA.

7.2 On this basis the SRC contribution to the major capital items required to set up the facility (glass lasers, experimental equipment, e-beam and buildings as listed in 4.12) would amount to £1,880K, largely falling in the years up to and including 77/78. Starting in 76/77 there would also be a contribution to additional facilities which it is envisaged would rise to a level of £500K per annum in 78/79 and subsequent years. The SRC recurrent costs, including staff costs, would reach £690K per annum by 78/79. The overall annual expenditure by the SRC would rise to £1,240K by this time. Details of individual items are given in Appendix II, Table III.

7.3 These estimated requirements for the SRC capital and recurrent costs are summarised in Table II together with the estimated man-years of SRC effort.

TABLE II. SUMMARY OF SRC COSTS AND EFFORT REQUIRED

	£000 including VAT, November 1974 prices						
	74/75	75/76	76/77	77/78	78/79	79/80	80/81
Major capital	263	715	575	440	550	550	550
Operation and development	5	125	250	370	450	450	450
Staff and overheads*	10	65	165	240	240	240	240
Total:	278	905	990	1050	1240	1240	1240
Effort in man-years (Direct/Indirect)	1/.3	9/3	23/8	33/10	33/10	33/10	33/10

*Overheads and indirect man-years based on current Rutherford Laboratory ratios.

8. SUMMARY

8.1 High power laser installations and experimental equipment have been described which it is proposed should be provided by the UKAEA and the SRC to serve a joint research programme of the AEA and of UK universities. The programme would be carried out at a Joint Laser Centre on the Harwell/Chilton site and would include development of laser systems which might be used to extend or replace the initial installations. The total cost would initially be approximately £2M per annum rising to £2.5M pa in 1978/79 and later years. The total of SRC and AEA direct staff numbers required is estimated to be 66 by the end of the second year.

8.2 The setting up and operation of the new facilities would be a joint responsibility of the Directors of the Rutherford Laboratory and of AERE, Harwell, with the capital and operating costs, and the effort, shared appropriately between the SRC and the AEA. SRC-supported use of the facilities would be the responsibility of the Rutherford Laboratory.

8.3 The AEA would be responsible for the exercise of any necessary security control of the theoretical and experimental studies and for the support of any classified work carried out by university scientists. The SRC would not normally support any classified work. A new building to house the main central facilities would be designed and sited so that both classified and unclassified work could be carried out within it.

8.4 For the construction phase a project team made up of SRC, AEA and university effort should operate under a project leader reporting to a joint management committee of AERE and the Rutherford Laboratory and including university scientists in its membership.

8.5 In the operational phase the programme should be guided by a joint programme committee chaired by a university scientist. The SRC and the AEA would also need separate committees to match their normal internal procedures.

8.6 The whole programme would be reviewed after gaining experience of using the facilities and in the light of developments in laser systems and their use generally.

9. CONCLUSION

9.1 At its 17 July 1974 meeting Council approved in principle the provision of high-power laser facilities and is now invited to consider whether it wishes to proceed in a Joint Programme with the UKAEA, generally along the lines proposed in this paper.

9.2 If it is desired so to proceed, then Council is invited:

(a) to endorse the principles concerning security and general arrangements which it is proposed should be followed and which have been set out in paragraphs 6.4 and 6.6.

(b) to approve inclusion of the SRC part of the Joint Programme in the Rutherford Laboratory programme.

(c) to approve capital expenditure amounting to £1.9M at November 1974 prices on the provision of the glass lasers, experimental equipment, an electron beam generator and the buildings required to set up the facility, this expenditure falling mainly in the years up to and including 1977/78.

(d) to note the estimated requirement for an overall capital and recurrent expenditure by the SRC in the range of £0.9-1.25M per annum at November 1974 prices. Within this total the capital expenditure is expected to range from £400-700K per annum while the recurrent costs will rise to a steady level of £700K by the end of the fourth year.