1974 FORWARD LOOK: EPIC

Supplementary Paper

[redacted]

24 June 1974

ELECTRON-POSITRON PHYSICS AT CERN

1. EPIC Stage I is a colliding beam machine in which very energetic electrons (14 GeV) collide head-on with equally energetic positrons. This is not possible on any of the accelerators at CERN.

2. Conventional accelerators such as the 400 GeV SPS now under construction at CERN accelerate a beam of protons which collides with a stationary proton target. If this conventional technique were to be adopted to study e^+e^- collisions, it would require the construction of an accelerator with an energy of almost 1,000,000 GeV. This is impossible. With EPIC therefore we will have access to an entirely new energy region.

3. The other major difference is that in colliding electrons with positrons - matter with anti-matter - we are able to produce a state of pure energy. No accelerator at CERN is able to do this.

4. If an e^+e^- colliding beam project were to be sited at CERN, none of the existing equipment there could be used. It would be more expensive than EPIC and could not be funded without an increase in the CERN budget.

5. The relationship of the research that can be done on the proton accelerators at CERN with that which can be done on the electron-positron EPIC is complex but a discussion of this will be found in the attached report, RL 74-078, section 2 (pages 4-8) and sections 3.1 and 3.2 (pages 9-15). These sections go into increasing degrees of detail.

AVAILABILITY OF e^+e^- MACHINES IN OTHER COUNTRIES

6. In the United States the Lawrence Berkeley Laboratory and the Stanford Linear Accelerator Center in California have submitted a joint proposal to the US Atomic Energy Commission proposing the construction of a positron-electron colliding beam storage ring machine (PEP). The PEP construction schedule assumes an expenditure of $900,000 in Fiscal Year 1975 for "partial advanced design" and assumes full authorization of the project in Fiscal Year 1975. Beam tests are scheduled to begin in April 1979. The machine specification follows very closely that proposed for EPIC and the timescale for funding approval also follows closely that proposed for EPIC, except that our schedule for EPIC beam trials is early in 1980. Portents for its funding appear to be favourable.

7. There are two other proposals being considered in Europe:

(a) A 10 GeV e^+e^- colliding beam machine at Frascati in Italy. This is not considered to be a very realistic proposal and is unlikely to be funded.

(b) A proposal at DESY in Hamburg, the German equivalent of the Rutherford Laboratory. Their proposal is very similar to the EPIC proposal and indeed DESY appear to have advanced their plans for a new accelerator on learning of our proposals.

8. A Working Party of ECFA, the European Committee on Future Accelerators, has been studying, inter alia, the relationship between CERN and the National Laboratories. It will be reporting to the plenary meeting of ECFA in the autumn. The Working Party has emphasised the important role that is to be played generally by the National Laboratories in supporting the main European activity in high energy physics at CERN. In particular it strongly supports the construction of a machine of the EPIC type in a National Laboratory.

9. A meeting has also been held under the auspices of ECFA attended by the Directors of the Rutherford, Frascati and DESY Laboratories, together with the Directors-General of CERN. The conclusions of this meeting were (a) that the proposal for an e^+e^- colliding beam machine did not clash with any future development plans that CERN is likely to have and (b) that one e^+e^- colliding beam machine was necessary in Europe but not two. The Chairman of the meeting, Professor B P Gregory from France, expressed his personal opinion that the EPIC proposal was the one that he favoured.

THE CASE FOR A NATIONAL FACILITY

10. High energy physicists have long recognised the need to carry out their research activities away from their home universities at a limited number of national or international centres. The cornerstone of the Nuclear Physics Board's programme is the international programme at CERN in Geneva. One half of the Nuclear Physics Board's funds go directly to CERN, the level being fixed by an internationally agreed convention. A similar pattern of expenditure is broadly followed throughout Europe and the ECFA Working Party mentioned above considered that the present balance between the CERN and the domestic programmes in the Member States should not be allowed to move any further in favour of CERN. With the trend towards higher energies it

becomes increasingly difficult to propose any new domestic accelerator on which front-line research can be done and which cannot be done as well or better on the new accelerators at CERN.

11. EPIC is, however, such a machine and there are NO foreseeable alternatives. As EPIC would also be scientifically the most advanced accelerator of its kind in the world and as all the recent experimental results point to the crucial contribution that e^+e^- experiments would make if EPIC were approved there is no doubt whatever that the United Kingdom would find itself in a leading world position in this area of research. Because of the flexibility which has been designed into Stage I of EPIC the United Kingdom would be in a very powerful position to become the site for a future international electron-proton accelerator.

12. A favourable decision on EPIC now would settle the course of the domestic programme for the remainder of this century.

13. In the United Kingdom rather more than in some other countries we have always emphasised the need to preserve basic research as a predominantly university based activity to ensure that the maximum benefit flows from this experience into the teaching of scientists, engineers and doctors. On the other hand, the time-scale for most experiments is measured in years and it is difficult to conceive of any satisfactory arrangement in which a university high energy physicist can base all his research programme on an accelerator in a foreign country and yet play the full role in teaching, in university and in civic affairs which we in the United Kingdom believe to be essential.

14. This was the reason for the setting up of the Rutherford Laboratory and the construction of Nimrod through the creation of the National Institute for Research in Nuclear Science in 1957. This situation has not changed. The need is even greater today.

15. The prime justification for building EPIC is scientific. The reason for urging its construction in the United Kingdom is that it will enable the high energy physicists to continue to play a full role in the affairs of their universities and their country by maintaining a balance between the research that they will do abroad and that which they will do at home. The reason for urging its construction now is its scientific timeliness. Furthermore in view of the rationalization of the domestic programme that has taken place during the past 18 months we are now poised to grasp the opportunity to secure this project for the United Kingdom.

16. It has been stated above that there is no foreseeable accelerator project which presents itself as an alternative to EPIC. The Rutherford Laboratory was set up to support basic research centred on the large 7 GeV proton accelerator, Nimrod. All scientific research tools have a finite useful life and hence it follows that were Nimrod not replaced by a comparably large project the Science Research Council would be bound to encounter problems of redundancy in its Laboratories.

17. We do not use redundancy as an argument in making the case for EPIC. However, when the scientific case is overwhelmingly strong the avoidance of redundancy is not a factor to be ignored.

SIZE OF THE COMMUNITY

18. The most recent (1973) survey of manpower in high energy physics gave a figure of 363 for the total number of experimentalists in the United Kingdom of whom 45% hold tenured posts in the universities or SRC laboratories. If EPIC is built, it is to be expected that this community will divide its research effort, on average, equally between working at CERN and working on EPIC. The total community in Europe is about 2,000 experimentalists and we are confident that EPIC would attract demands for experimental time from many of the most able high energy physicists throughout Europe and also the USA.

CAPITAL COST OF EPIC

19. In preparing the Five Year Forward Look the capital cost of the EPIC machine at end 1973 prices was estimated to be £20M spread over the years 1975 to 1981. This is not yet a firm estimate. The Rutherford Laboratory intends to submit a detailed costed proposal to the Science Research Council in November 1974 for the construction of EPIC Stage I.

20. Because of the well understood technological nature of the project the costs will then be firm.

COST IMPLICATIONS BEYOND THE FYFL PERIOD

21. As stated above the capital cost of the EPIC machine is spread over the years 1975 to 1981. In addition provision has to be made for R & D expendi-

ture during this period and as the construction of EPIC nears completion funds have to be found for its research exploitation. The Nuclear Physics Board has projected the cost of its Five Year Forward Look programme forward for a further five years, ie until 1984/5 when EPIC is expected to be at full exploitation.

22. The cost of its full programme is, on average, constant through the next five years, but the cost of the domestic high energy physics programme will be about £0.5M less in 1984/5 than the level it is in 1974/5.

THE FINANCIAL SITUATION IF EPIC IS NOT BUILT

23. Plans for EPIC were first proposed in the 1974/75 to 1978/79 FYFL. The aim was to try to fund the new project entirely by a diversion of existing resources, in particular the closure of NINA in 1977/78; Nimrod in 1979/80; a severe reduction in all other long term development research; and a reduction in the domestic high energy physics programme particularly by Laboratory staff.

24. The object was to secure a long term benefit through the maximum possible short term sacrifices.

25. Financially there was no difference between a programme including EPIC and that making full use of Nimrod.

26. This year Council has been forced to plan its programme on the basis of further severe cuts. The model programme prepared for the 1975/76 to 1979/80 FYFL now shows the "without-EPIC" programme (Programme C) differing from the "with-EPIC" programme (Programme A) by the following amounts:

	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80
£M	0	0	0.2	1.15	1.70	2.75

The two programmes show no significant difference in cost until the year 1977/78.

27. At most therefore it is possible to re-equip our domestic high energy research programme for very little in the way of additional funds. It should furthermore be borne in mind that EPIC will make use of over £7M worth of capital equipment from Nimrod and NINA, buildings worth £8M, and many millions of pounds worth of experimental apparatus and laboratory equipment.

EPIC I AS AN INTERNATIONAL PROJECT

28. As mentioned above there will be only one EPIC type machine in Europe and the benefits that will accrue to the country in which the machine is built are known to be so substantial that there is no possibility of organizing the construction of EPIC as an international project. There are indeed many advantages to be gained by retaining the managerial control in the United Kingdom by having full ownership. However, once it is clear that the construction of EPIC has been funded then the prospects of international participation in the experimental utilization are very good (with, of course, an appropriate financial contribution).

29. Discussions along these lines have already been initiated by the Director of the Rutherford Laboratory with senior French and Italian physicists.

THE CRITICAL FINANCIAL POINT

30. The Science Research Council has not, as yet, considered this question directly. It is therefore unable to provide a quantitative reply. However, the following comments may be useful:

(a) The statements provided by the Science Research Council on the four alternative programmes in this year's Forward Look exercise give to the ABRC the best present indications of Council's priorities at the four different rates of growth. On the basis of these statements and the ABRC commentary on them, DES will decide on the rate of growth to be accorded to Council in this year's Forward Look.

(b) Within this allocation Council will wish to maintain its freedom of action regarding decisions on EPIC and all its other scientific programmes. In particular the relationship between decisions on EPIC and projects in other areas of Council will depend on a complex balance of arguments regarding the health and scientific importance of all these areas.

CONFIDENTIAL

Extract from an ABRC Document:

The Council put forward a strong case for the support of all its areas including these major new projects. The Board notes that despite the declining share of the Council's overall budget to be allocated to nuclear physics and ASR activities these would still be consuming very substantial resources (£47M per annum) at the end of the period even if the Council's allocation were held steady at its present level. The Board recognizes the high scientific merit of the Council's proposals in these fields including both the proposed major projects; but in view of the needs of the other Research Councils and of the activities covered by the Science and Engineering Boards and in view of the forecast slow rate of growth of the science budget it is concluded that the Council should be advised that in recommending the allocation proposed for 1975/76 and the growth guideline for subsequent years it has only been able to take into account one of the major projects put forward.

The Board recommends an allocation of £81.9M for 1975/76 representing a reduction of 1.9% over 1974/75 and a guideline of +0.7% per annum for the further period.

EXTRACTS FROM REPORT OF WORKING GROUP 3 OF ECFA (1 August 1974)

5. NATIONAL INSTITUTES AND CERN

5.1 Background

Since its inception ECFA has always had a concern for a balance in the development of high energy physics at CERN and at the National Laboratories. The main impact of the ECFA report of 1967 was undoubtedly to establish the case for the building of the 300 GeV accelerator. It will be recalled, however, that this report urged also the development of the National Laboratories, including the construction at them of new accelerators. The role of national or regional laboratories in preparation of large pieces of equipment for use at international accelerators was equally stressed. From time to time ECFA has returned to a consideration of the national programmes. Most recently in May 1972 ECFA received an account from the Directors of the National Institutes of the current programmes and of the planned developments of their Laboratories. These accounts were up-dated for the Working Group by each of the Institutes or Laboratories.

5.2 The Working Group confined its consideration to National Laboratories or Institutes in the larger member states of CERN and to the work of these Laboratories in particle physics. The institutions concerned are:

France	(i)	Saclay (CEA)
	(ii)	IN2P3
Germany		DESY
Italy		Frascati, INFN
UK	(i)	Rutherford Laboratory
	(ii)	Daresbury Laboratory

Each of these institutions controls considerable resources in money and manpower which are applied to the high energy physics programme domestically or at CERN. However, they differ considerably, both in their present mode of operation and in their future plans. IN2P3 is a federal institute comprising 10 University Laboratories one of which, Orsay,

operates high energy accelerators. The other are unitary laboratories each at present operating a high energy accelerator. Frascati, DESY and Rutherford have long term plans for new high energy accelerators for particle physics. At present Saclay and Daresbury have no such plans. Most of the institutions are already engaged in large scale support of the experimental programme at the CERN accelerators.

5.3 The diversity of the National Laboratories makes it hard to generalise either about their present or their future role. However, it is clear that, jointly, they form a very large resource in support of the high energy physics programme. For this they employ in total approximately 4500 people and dispense funds of approximately 500M Swiss Francs per annum as compared with the manpower and expenditure figures for the more capital intensive CERN programme of approximately 3500 people and a budget of 570M Swiss Francs. The large resources of the National Laboratories mean that, apart from their contribution to the high energy physic programme, they represent an important scientific asset to the respective member States. In this respect, the development of their scientific programme is of close concern to the national scientific decision making bodies. In some cases it may be that, as a matter of national policy, a laboratory will be diverted away from high energy physics into some other aspect of science considered more appropriate within the national scientific programme. For example, at least a large part of the domestic programme of the Daresbury Laboratory in future years is likely to be devoted to nuclear structure work. Saclay will continue to support a HEP programme but Saturne has recently moved towards a programme of nuclear structure. For that matter national bodies may decide to site at their Laboratories projects divorced from nuclear physics. Whether this is so or not the Working Group believes that a major theme or focus of interest and activity is necessary to the efficient functioning of a large laboratory. It remains important that ECFA should study the scale of activity necessary and

desirable at the National Laboratories in the two important roles already stressed in the report of 1967: firstly, in the running and exploitation of their present accelerators and in the development of possible future accelerators away from CERN; secondly, in the support of the CERN programme in all its aspects.

5.4 Reflection on developments since 1967 has led the Working Group to note the high degree of centralisation of the European high energy physics programme resulting from the decision to site the SPS at Meyrin. The Working Group has come to the view that further centralisation should not be encouraged. On the contrary efforts should be made to preserve the balance of activities between CERN and the National Laboratories at something like its present level.

See 7.11

5.5 Support role of the National Laboratories

It has always been appreciated by ECFA that an important part of the domestic programme must be devoted to support of CERN. The support is administered in different ways in different member states, but, with appropriate definition, it is clear that under this heading the National Laboratories have a continuing and very important role. Already some of them provide a local, easily accessible, centre for the preparation of apparatus and for subsequent data analysis. The relative ease of access to such national centres can be of particular assistance to University physicists with teaching responsibilities and may significantly reduce the time they have to spend away from their families and from their normal teaching duties. In addition some of the laboratories carry out important work in building equipment and in technical development in support of activity at CERN or elsewhere. Examples of this are to be found in the development of super conducting techniques or of various types of bubble chamber.

5.6 The Working Group is convinced of the continuing importance of all these activities and believes that adequate channels for their co-ordination should be maintained between the National Laboratories and CERN.

See 7.12

5.7 Policy for Future Accelerators

The Working Group received reports on accelerator developments proposed at National Institutes in France, Germany, Italy and the United Kingdom. It received also a description of the thinking about developments at CERN following on the completion of the "300 GeV" accelerator programme, and some information about plans for accelerator development in the United States possibly including collaboration with the USSR.

5.8 The Working Group has already concluded that it would be unwise to concentrate all of the future European accelerator programme in high energy physics in one large laboratory (CERN). This is in accord with earlier ECFA and CERN thinking, and for that matter, with present plans in the USA. The earlier ECFA thinking, however, has to be reviewed in the light of present knowledge concerning the limitation of resources in money and manpower available for high energy physics. Clearly there must be a strong case in physics for any new particle physics accelerator. Reasons of economy suggest in addition the necessity to avoid any unnecessary duplication.

5.9 Undoubtedly the main accelerator development of recent years in the European National Laboratories has been that concerning electron-positron storage rings. The pioneer work at Frascati and Orsay has culminated, respectively, in the construction of the single-ring Adone (1.5 GeV per beam) and of the double-ring D.C.I. (1.8 GeV per beam). The double ring DORIS at Desy is coming into operation, first at an energy of around 2 GeV per beam, with a planned increase at least to 4.5 GeV per beam. The interest of the results from e^+e^- rings, from the USA and USSR, as well as from Western Europe, suggest the importance of developing e^+e^- rings to higher energies.

5.10 The European National Laboratories are well placed to take part in such developments, which have the added advantage of being complementary to the present lines of the CERN programme. At present three laboratories in Europe (DESY, Frascati and Rutherford) are engaged in active plans for construction of a large e^+e^- colliding beam

machine at the maximum possible energies (10 - 20 GeV or above). The Working Group considers that there is a very strong physics argument for the construction of an e^+e^- machine in this energy range in Europe. It notes that this would be complementary to the future plans of CERN and welcomes the design effort now being applied to this end. Another interesting direction for development, though one still requiring further study, is an e-p colliding beam machine with protons of energy 100 GeV or above. Moreover, whereas the construction of an e^+e^- machine seems within the financial capability of a single country the greater cost of a large e-p machine might require international collaboration in its construction.

See 7.13

See 7.14

5.11 Whatever proposals may emerge any attempt at the unnecessary duplication of similar accelerators would be damaging to the credibility and, hence, to the future prospects for high energy physics. The Working Group accordingly recommends that there should be continuing discussions aimed at securing the harmonisation of the accelerator policies of the National Laboratories and of CERN. Informal discussions of this sort have already been started at the suggestion of the Working Group. For the future it is proposed that ECFA should set up a framework for the continuation of such discussions, the content of which should be reported to ECFA from time to time.

See 7.15

National Institutes and CERN

7.11 The Working Group notes the present high degree of centralisation of the European high energy physics programme at CERN (Meyrin). It recommends that the balance of activities between CERN and the National Laboratories (or Institutes) should not shift significantly further towards CERN.

7.12 The Working Group endorses the importance of activities at the National Institutes in support of the international high energy programme and considers that adequate channels for their co-ordination should be maintained.

7.13 The Working Group accepts that there are strong arguments for the construction in Europe of a high energy e^+e^- machine. It notes that the construction of such a machine would be complementary to the future plans at CERN and welcomes the design effort being applied to this end at the DESY, Frascati and Rutherford Laboratories.

7.14 Related developments towards and e-p colliding beam machine (with protons of energy around 100 GeV or more) are also welcomed, though it is noted that such a project requires further study.

7.15 The Working Group reports to ECFA its concern that there should be no unnecessary duplication of plans for similar accelerators at the European National Laboratories. It recommends that discussions on the harmonisation of future accelerator programmes should be maintained between the National Laboratories and CERN, and that these discussions should be reported to ECFA.

7.16 The Working Group recommends that international use of National Laboratories be extended to include, for example, use of computing facilities.

EXTRACT FROM SRC 20-72:

NUCLEAR PHYSICS BOARD POLICY AND PROGRAMME 1972/3 - 1977/8 15 March 1972

1. INTRODUCTION

It is now approximately a year since the UK Government decision to join the 300 GeV accelerator project was followed in February 1971 by the decision to initiate the project at CERN. In its presentation to Council in March 1971 the Nuclear Physics Board was able to make only an interim report on its programme in the light of the immense developments taking place at CERN, and of the restrictions of budget and manpower which the Board had accepted from the Council at the time of the 300 GeV decision. At its meetings over the last year the Board has devoted itself to a study of all the aspects of its programme, scientific and organisational. It is the Board's hope in the present paper to meet the Council's request for a clear statement of its programme over the next five years and of likely developments beyond this period.

It may be useful firstly to recall the various limitations of future resources placed on the Board, by Council, in the period leading up to the Forward Look statement of May 1971. These were as follows:

(a) the budget should remain constant in real terms at a figure notionally established as £21.9M per annum in 1970 prices,

(b) the complement employed on the nuclear physics programme at the Rutherford and Daresbury Laboratories should be reduced from a total of about 1700 to about 1500 over a five-year period,

(c) the number of experimentalists engaged in the programme would be somewhat reduced from the 1970 figures of 370 in high energy physics and 230 in nuclear structure.

The Board recognises that the limitations (a) and (b) above in no way form a guarantee of future resources. In Section 6 below we describe the severe effects on our programme that would follow from the further reductions in budget proposed in the Council guideline of November 1971. The present programme is, however, in accordance with Council instructions, based on the resources described in (a) and (b).

EXTRACT FROM SRC MINUTES OF 15 NOVEMBER 1972

Minute 127:

127. THE FUTURE OF NINA AND NIMROD ACCELERATORS (SRC 91-72)

127.1 The Chairman introduced the paper by pointing out that the second sentence of the section on Possible Improvements to NINA and Nimrod should begin "There is very little that can be done about NINA." The paper was a personal assessment of the future of the two machines. He had discussed the problem with many senior physicists in the UK and at related laboratories abroad. The paper represented the views of an overwhelming concensus of physicists on the immediate decisions that were required. At the same time, he acknowledged that there was room for different views on many points. The international scientific community had been impressed by the UK's desire to consult them so fully about the decision.

127.2 He said that NINA had been constructed towards the end of an era of rapid expansion and later financial stringencies had prevented the design being exploited to its fullest extent. He wished to emphasise, however, that the physics being done at Daresbury was of the very highest quality by international standards.

127.3 The unfavourable comparison of NINA as a facility with the improved DESY was an area of possible dissent, although it was the conclusion of the majority of the people consulted. From a European point of view, the closure of NINA would be greatly regretted but it would not be disastrous.

127.4 Both Rutherford and Daresbury could continue to provide staging post effort but there was some doubt as to how long Daresbury could operate satisfactorily as a staging post if NINA were closed down.

127.5 Professor Ashmore said that the decision not to proceed with the HFBR had had serious repercussions on the nuclear physics programme in the longer term. He agreed with the assessment of the improved Nimrod, but thought that the paper was too critical of NINA in the comparison made with DESY. The basic machines were very similar; DESY had a much larger staff than Daresbury but the increase in the physics done had not been proportional. The new Storage Rings at DESY would provide electron/electron collisions, which NINA could not, but would not improve DESY's capability on electron/proton collisions and

photon physics, which he considered more important. NINA would remain competitive with DESY for experiments using electron/photon beams. Secondary meson beams required much higher energies than would be available even at DESY. The NINA Booster would have made NINA superior even to the improved SLAC over a considerable area of physics and would have provided meson beams superior to those which would be obtained on the improved Nimrod. Finally he did not accept the proposition that Daresbury was not a highly technological laboratory and was convinced that, apart from the argument for having a staging post and accelerator on the same site, Daresbury could with its experience and expertise form an excellent staging post. He pointed in particular to its data processing capability and its proximity to several universities.

127.6 Professor Matthews welcomed the paper and thanked the Chairman on behalf of the NP Board for the considerable effort he had made to produce it. It was gratifying to the Board to have its decisions confirmed from a different point of view. He particularly welcomed the idea that the longer term NP programme might include a post-Nimrod machine. The Board had tentatively been studying this possibility. He had, however, two points to make:-

(a) He agreed with Professor Ashmore that in some areas NINA would remain comparable to DESY. The case for phasing out NINA was therefore not as strong as had been indicated in the paper. However, the NP Board had for different reasons come to the same conclusion as the Chairman;

(b) There was a difference between the paper and the NP Board view on the question of staging post effort for CERN experiments. The NP Board hoped to be able to switch this support work from one laboratory to the other as a means of ensuring a more orderly run down of staff.

127.7 In further discussion the following points were made:

(i) Dr Pringle said that the estimates of staff numbers to be redeployed appeared to be much higher than envisaged in the NP Board Forward Look;

(ii) The provision of radiation facilities alternative to NINA was under consideration by a sub-committee of the Physics Committee;

(iii) Redeployment of staff would have been easier if the various SRC establishments had been on a single site. Several Council members thought that a more detailed study of the considerations to be taken into account before decisions on the siting of new facilities was urgently required and in this context the proposal to site the Nuclear Structure Facility at Daresbury (SRC 96-72 - next item on the agenda) was perhaps premature. However, other Council members were not yet convinced that this degree of concentration was desirable.

127.8 The Council:

(1) agreed that Nimrod, with its new injector, should continue to operate beyond the immediate 5-year period, and that, although as much effort as could be spared should be devoted to the NINA experimental programme for the next few years, NINA should gradually be phased out as a national high energy physics facility, the exact time scale being a matter for the NP Board to propose in the light of its total programme;

(2) invited the Science Board to continue its examination of the feasibility and costs of providing a substitute for NINA as a radiation facility;

(3) invited the NP Board in the light of the decision in (1) above to include in their Forward Look detailed proposals for their future use of Daresbury and Rutherford;

(4) invited the other Boards to consider how to use the expertise of the Daresbury and Rutherford Laboratories on the basis of information to be provided by the Directors;

(5) invited the Office, in consultation with the Directors, to examine the manpower implications, and to submit a paper as a basis for discussion in January 1973, with particular reference to the siting of the NSF.

(P/AD/05)