

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCEGENERAL PURPOSES COMMITTEEEffect of University expansion on Rutherford Laboratory budgets

Note by T. G. Pickavance

1. The number of research workers in nuclear or high energy physics now using or planning to use the Rutherford Laboratory is approximately 210, of whom 170 are university staff and research students. The figures given in the draft Five Year Forecast (NI/GP/64/2) are estimated to provide for about this number, and follow the philosophy of the Adams-Cassels review (NI/63/17). The P.L.A. is nearly fully occupied already, but Nimrod is capable of providing for many more users and more people will wish to use it. To quantify this, a figure can be obtained by assuming that the planned growth of university numbers recommended in the Robbins report will be spread uniformly over all disciplines. A plausible figure, recognising the difficulty of reaching the Robbins target in the early years, has been taken in certain university physics departments to be a total growth of staff numbers of 50 per cent spread linearly between the academic years 1962/3 and 1967/8. If we take this figure to apply to demands on the Institute, we shall ignore the fact that, for budgetary reasons, we have not attempted to attract those potential users in university departments who have not yet volunteered experimental proposals. The assumption is, therefore, a modest one.
2. The number of additional users of the Rutherford Laboratory arising from an application of Robbins growth to nuclear and high energy physics would then be the following, taking 170 university physicists in 1964/65 as the base, assuming no corresponding increase in Institute research staff, and assuming a constant rate of growth until the end of the financial year 1969/70:

| 1964/5 | 1965/66 | 1966/67 | 1967/68 | 1968/69 | 1969/70 |
|--------|---------|---------|---------|---------|---------|
| -      | 17      | 34      | 51      | 68      | 85      |

3. The load which these additional users would put upon the Rutherford Laboratory budget has been estimated from current figures. The recurrent cost per visiting scientist is estimated to be £6000 per annum in 1964/65. This figure includes the direct cost of E.M.R. and Experimental Agreements with universities, and Rutherford Laboratory R. and D. budgets, and the indirect cost of increasing the supporting staff of the Laboratory. To this should be added an allowance proportional to the number of visitors, to take account of "scientific inflation" caused by the increasing complexity of the work. This addition has been taken to be 4 per cent simple per annum. There would be additional non-capital costs, only roughly proportional to the number of visitors over these particular years, for more intensive operation of Nimrod and the three large bubble chambers (non-capital). There would also be consequential capital expenditure for advancing the starting date of a major capital scheme to construct a second major experimental area and its associated beam equipment, and for building works and capital equipment associated with an increasing population of scientists and their supporters.



Strictly speaking some proportion of the additional annual cost of advancing the starting date of the possible new computer, mentioned in the forecast under future major schemes, should be added to the capital expenditure. This computer would not necessarily be located at the Rutherford Laboratory and would have to serve all high energy physics in the country (including U.K. use of C.E.R.N.). I have not attempted to quantify this.

4. The following table shows the results of these estimates; the totals have simply been added in the Five Year Forecast paper NI/GP/64/2, against the remark "add for Robbins growth in universities, if this is to be applied in high energy physics as in other disciplines":

|  | 1964/65 | 1965/66 | 1966/67 | 1967/68 | 1968/69 | 1969/70 |
|--|---------|---------|---------|---------|---------|---------|
| Number of extra visitors                       | 0       | 17      | 34      | 51      | 68      | 85      |
| Number of extra Laboratory staff needed        | -       | 23      | 47      | 71      | 96      | 121     |
| <u>Non capital expenditure</u>                 |         |         |         |         |         |         |
| £ million                                      |         |         |         |         |         |         |
| Per capita at £6000, plus 4 per cent per annum | -       | .1      | .22     | .34     | .47     | .61     |
| Bubble chamber and Nimrod operations           | -       | .07     | .14     | .2      | .25     | .29     |
| total non-capital                              | -       | .17     | .36     | .54     | .72     | .9      |
| <u>Capital expenditure</u>                     |         |         |         |         |         |         |
| £ million                                      |         |         |         |         |         |         |
| Plant and buildings (general)                  | -       | .06     | .08     | .1      | .11     | .12     |
| Advancing "Experimental Area" project          | -       | -       | .06     | .21     | .09     | -       |
| total extra expenditure                        | -       | .23     | .50     | .85     | .92     | 1.02    |

5. The load placed on Nimrod by an expansion of high energy research in universities would not, in my view, be reduced by the coming into operation of Nina. Nina will be needed by the schools of physics in the northern universities, where the existing high energy machines will be obsolescent by then. The proposed nuclear structure machine is for a different field of physics to which, however, a similar argument can be applied.
6. The question arises as to whether Nimrod and the P.L.A. would support as many as 300 research workers. I believe that they would, and that the bubble chambers at Nimrod would be especially valuable in making this possible. However, I feel that there would not be much scope for further expansion without seriously diluting the work of the universities, either by making the individual teams too big or by lengthening unduly the intervals between experimental runs by particular groups.
7. The cost per research worker is an interesting parameter, and the following table shows what this would be according to present estimates on the present plan (keeping to about 210 research workers) and on the expanding plan discussed in this note:



1964/65 1965/66 1966/67 1967/68 1968/69 1969/70

Existing plan

|   |     |     |     |     |     |     |
|---|-----|-----|-----|-----|-----|-----|
| Number of nuclear physicists                    | 210 | 210 | 210 | 210 | 210 | 210 |
| Budget for nuclear and H.E. physics (£ million) | 6.0 | 6.7 | 7.0 | 7.3 | 7.8 | 8.1 |
| Annual cost per nuclear physicist (£ thousands) | 29  | 32  | 33  | 35  | 37  | 39  |

Expanding plan

|   |     |      |     |      |      |      |
|---|-----|------|-----|------|------|------|
| Number of nuclear physicists                    | 210 | 227  | 244 | 261  | 278  | 295  |
| Budget for nuclear and H.E. physics (£ million) | 6.0 | 6.93 | 7.5 | 8.15 | 8.72 | 9.12 |
| Annual cost per nuclear physicist (£ thousands) | 29  | 31   | 31  | 31   | 31   | 31   |

Figures of this kind are often quoted to make comparisons between one field and another. I should add, therefore, that many of the so-called support staff in a high-energy laboratory are research workers in applied physics, the results of whose work are of independent value. They are not included in the numbers given in the table. There are about 70 staff in the Rutherford Laboratory who belong to this category. The present annual cost per research worker is therefore about £21,000.

The number 210 which I have taken for the strength of the high energy and nuclear physics effort is only approximate. Many of the university physicists who base their work on the Laboratory do not visit us, but some of their support comes from elsewhere. I have tried to be conservative and therefore the true number may be larger. This does not appreciably affect the estimates of the cost to the Institute, of which all the non-capital part is based on present totals divided by 210, but any error would be reflected in the figures for cost per man. Similarly, I cannot be sure that the unmodified forecast will support only 210 people. We may be able to squeeze in a few more, in which case the additional costs presented in this note may have been over-estimated.