ATLAS UK submission to PPESP, Oct. 2nd, 1995

Introduction

In the ATLAS UK bid to the PPESP in June this year we presented a detailed case for funding of the UK contribution to ATLAS at the LHC. We requested £ 32.84M and additional manpower totalling 476 SY over the period of the construction of the ATLAS experiment from 1995 to 2004. This is the level of support, commensurate with our physicist numbers and technical support and with the level of the UK's CERN subscription, which would enable us to make leading contributions in three principal areas of the ATLAS project, the precision tracking, Level 1 and Level 2 triggering. The PPESP has requested that we consider how our proposals might be adapted to one of three possible levels of funding, £ 26.25 M, £ 22.5 M and £ 19.5 M, with corresponding support manpower levels of 32, 31 and 30 SY/Y, respectively. Additionally, we were asked to review in some detail the resources available in our different institutions, taking into account any other, present or foreseen commitments of the participants. Finally, we were invited to comment on the problems which would be presented by relatively flat spending and manpower resource profiles. The present document addresses all of these issues.

'Optimised', 'mid' and 'unoptimised' funding

The 'optimised' level would already entail a reduced level of commitments from our original bid. The ATLAS UK groups would propose a pro-rata scaling based on the sub-project bids given in our June submission to the PPESP. This would entail the loss of some of our proposed UK contribution, in particular the silicon vertex layer, and would also require detailed consultation with the ATLAS collaboration with respect to overall funding of all sub-projects. It should still allow us to retain a major share in all three main activities, but will inevitably weaken the UK leadership of the projects in which we are most active. It is worth noting that even this level of funding represents a contribution to the projects which is lower than a UK share commensurate with the CERN subscription.

The 'mid' - funding option would dilute the UK contribution to the extent that it is highly probable that we would have to abandon one major area of activity. It would be premature to decide at this stage which area should suffer, however, not least before the ATLAS-wide implications can be discussed. We are also painfully aware of how easily the momentum of any activity can be lost by introducing uncertainty into its future in the UK programme. Whichever project is curtailed will mean a reduction in the range of UK activity and failure to exploit the full range of expertise within the UK community. It will also result in our having to give away the results of our previous investments and losing leadership and influence within ATLAS. We would therefore propose to continue to pursue our R&D and prototyping activity during the next two years on all of our sub-projects and to eliminate one (or more, if required), of our areas of activity only in 1997 when the final production must begin.

The 'un - optimised' funding level would force us to consider the loss of yet another major activity, with probable impact on the scientific prospects for ATLAS. There would be a catastrophic loss of intellectual prominence of the UK within ATLAS, and a corresponding loss of morale among the UK participants. Once again, we would prefer not to define the areas to be cut until the overall funding level is more definite and ATLAS - wide agreements have been reached, so as to maintain the necessary momentum to ensure success in each sub-project activity which is maintained.

This scenario represents an extremely poor return on the UK investment in CERN and on the UK effort and manpower.

The following subsections address some of the options for the three major sub-projects more specifically. For each of the levels of funding, however, it should be noted that a flat spending and manpower profile is very poorly matched to our requirements. At the lowest funding level which we are asked to consider, in particular, we believe that a detailed re-examination of the balance between manpower and capital allocations would be necessary.

Level - 1 trigger

In the light of the PPESP request, we have examined closely our estimates of the cost of the various components of the level - 1 calorimeter trigger, and we have found that these are still the best estimates which can be made at the present time. No change in the trigger design has been identified which could reduce costs without a detrimental effect on the physics performance of the trigger. This would not be acceptable to ATLAS. Therefore, as far as we can see, no obvious reduction in the cost of the level - 1 trigger can be made.

For the 'optimised' level of funding, assuming that the reduction is spread evenly amongst the various UK activities, the money available for the level - 1 trigger is a total of k£ 2914. Removing from this the UK-specific R&D and infrastructure cost of k£ 250, we have a sum of k£ 2664 available, to be compared with the figure of k£ 3483 which was requested. We are asked to respond to this reduction and give the implications for the successful implementation of the level - 1 trigger.

The level - 1 calorimeter trigger for ATLAS is supported by a small collaboration consisting of groups from Sweden, Germany and the UK. The project is led by the UK groups, who also provide the majority of the physicists involved. Therefore it is difficult for significant reductions in UK funding to be compensated by increases from our collaborators. However, at this 'optimised' level, this approach seems to represent the only possibility, and is one which we will now have to pursue. We should add though that the total resources requested by all of the collaborators in the level - 1 calorimeter trigger are just sufficient for the task.

In the 'mid' scenario, if we were to scale resources equally across all UK ATLAS activities, the resources available in the UK for the level - 1 trigger are less than 50% of the total cost. It is highly improbable that the shortfall can be made up by our Swedish and German collaborators. Furthermore, it would produce a very negative reaction within ATLAS, where the UK groups are perceived to be leading this activity.

In the 'unoptimised' scenario, equal scaling of resources leads to a situation where it will be completely inconceivable for the groups involved to provide the level - 1 calorimeter trigger.

On the manpower side, the difference in the three suggested levels of support is very small. On a pro-rata basis, the level - 1 trigger, over the construction period, will get approximately 45 SY total, to be compared with the 67 SY requested. This is of course complemented by the contribution of 8 SY engineering and 15 SY technical effort in the UK University groups. The RAL effort, though considerably less than requested, may be just viable as a UK contribution, as it may be possible to obtain slightly more manpower effort from our collaborators than is forseen at present.

Level - 2 trigger

The original bid to the PPESP would have permitted the UK groups working on the level - 2 trigger system to take responsibility for areas corresponding to 75% of the cost of the SCT local trigger and 100% of the global trigger. The areas of activity covered by the UK level - 2 bid are underfunded within ATLAS as a whole. It is not at all clear that any reduction in UK funding can be met by other ATLAS groups.

For the 'optimised' funding model we would maintain the SCT buffer and global system expenditures at the bid level and reduce other local costs to match the available funding. This would correspond to reducing the UK involvement in processing and algorithm development for track triggering by approximately 50%.

In order to comply with the 'mid' - level funding model we have considered two scenarios, both of which involve abandoning major projects. In the first, we would cease work on SCT buffers and concentrate on local processor, algorithm and global activities. In the second, we would abandon all work on the global system and maintain the local activity at the bid level. For the 'un - optimised' funding model we would have to scale down these options. Any of these drastically under - utilise the skills of the groups currently involved and represents a poor return on UK intellectual input to the project. Furthermore, this would produce a serious imbalance between the physics and technology programmes at the institutes involved.

With respect to manpower requirements, the UK groups have made a thorough revision of their Level - 2 projects, reducing the RAL non-PPD staff-years required. While the original bid assumed major assistance from RAL in the design of systems, we now assume that all necessary design work can be carried out in the universities and other equipment will be commercial. The university manpower is well matched to our requirements in terms of expertise. The non-PPD staff bid for 96-98 is seen as support for RAL PPD activity and from 1999 onwards it is for the testing, installation and commissioning of systems.

The resources available in university groups and RAL PPD are summarised in Table ??, the financial profile in Table ?? and the revised estimate of additional effort from RAL, now totalling 28 SY, in Table ??.

From now until the end of 1997 the work on level - 2 triggering is seen as continuing along the current lines indicated in the PPESP proposal.

Semiconductor Tracker (SCT)

The MSGC/Forward silicon tracking option

UK groups have contributed greatly to the co-ordinated R&D efforts to define the optimal choice between microstrip gas avalanche chambers and silicon microstrip detectors for the precision forward tracker in ATLAS. The competing solutions were reviewed by the ATLAS Inner Tracker Review Panel on September 6th, following presentations of the progress made by proponents of the two technologies. The Panel acknowledged the very real progress made in each case and the substantial achievement of their milestones, and resolved to recommend to the ATLAS collaboration at its November Collaboration Board meeting the acceptance of the silicon option for the forward tracker. It may be assumed with reasonable certainty that this recommendation will be accepted by ATLAS.

Assuming that the silicon option is ratified by the standard ATLAS procedure at its November Collaboration Board meeting, the UK effort in the area of forward precision tracking will be collectively focused on the silicon technology. Detailed discussions will take place over the next few months to incorporate the available effort in the most efficient manner into the integrated semiconductor tracker (SCT) activity.

The SCT and 'optimised', 'mid' and 'unoptimised' funding

Even with the 'optimised' funding, the reduced contribution to the SCT would mean the loss of UK investment in the innermost vertex layer of the silicon tracker, a critical component for the early physics programme at low luminosities in an area in which the UK has extensive previous experience. The UK groups would have to reduce by $\sim$ 50% their commitment to the alignment

and monitoring activity in which they have hitherto had complete control. Our contribution to the development of appropriate electronics and our influence in design choices in this area would also be reduced. This level of funding would, however, permit the UK groups to accept responsibility for a reduced, though still significant share of the precision semiconductor tracker, (both silicon and GaAs).
While the 'optimized' funding should be adequate for this reduced level of activity, the flat spend profile is not appropriate for any of the projects separately or in combination, as indicated in Table ?? which shows our projected requirements. We believe it should be possible to overcome this difficulty, for example by short-term borrowing from CERN, but the overall level and flatness of the profile in the manpower provision is a more serious difficulty.

The SCT Manpower

Available manpower resources and requirements for the triggering projects have already been discussed. A thorough review of the available resources in our university groups is still in progress. A summary of our present understanding of the tracking effort available within our university groups for the duration of the ATLAS construction period and the projected manpower profile required for this project is shown in Figure ??. In spite of the available integrated effort matching reasonably well the total number of SY required, there is likely to be a shortfall at the height of the build activity. The level of support should be adequate, however, during the first two years required to complete the R&D and prototyping phases and build up towards series production. This means that we have some time to review and refine our manpower planning ideas and to endeavour to find alternative ways of filling the manpower gap.

Conclusions

Following the discussion in the preceding sections, we may summarise our responses to the PPESP as follows:

The bid presented to the PPESP in June still represents our best estimate of the level of funding required by the UK groups to achieve the level of excellence in our ATLAS physics programme which is required by PPARC as well as sought by us.

With the 'optimised' level of funding, it would still be possible for the U.K. groups to maintain their intellectual leadership in the R&D phase of the ATLAS developments in all three areas of activity, and to continue to exercise, thereby, a high level of control in the evolution of the final design of the tracking and triggering projects. As discussed above, funding at this level would, however,

- weaken our tracking position, especially with respect to early running of ATLAS at low luminosity, through the loss of a significant input to the vertex silicon layer;

- reduce significantly our influence on crucial electronics choices still to be made;

- jeopardise our unique position in the area of detector alignment and position monitoring, in which there is already some potential for commercial exploitation of our work;

- entail a loss of control of precision track trigger feature extraction activity in the level - 2 trigger activity;

- restrict our opportunities to develop the comprehensive understanding of the whole semiconductor tracker required for the realisation of the full physics potential of ATLAS, by limiting our participation in its construction and our involvement in the trigger design, realisation and testing.

One possible Common Fund spend profile for the 'optimised' funding level is indicated in Table ??.

With the 'mid' - level of funding, one major area of UK activity would almost certainly have to be cut. The choice would be made only in 1997, when a more comprehensive picture is available of ATLAS funding elsewhere and the optimum choice for the UK groups is clearer. ATLAS UK groups are wholeheartedly committed to make their best possible contributions to the design, construction and exploitation of the physics potential of the ATLAS detector. The lowest, 'non-optimised', funding level suggested by the PPESP, however, would force us to abandon at least two of our major interests in ATLAS and represents, in our opinion, an extremely unbalanced investment in the experimental exploitation of the LHC machine compared to the subscription costs of UK participation in CERN. It would almost certainly create major difficulties within the wider ATLAS context. At this level, too, UK groups would be forced to hand over the results of many years of research and development effort and intellectual leadership in ATLAS to non-UK groups. A resultant decline in the health and vigour of UK experimental particle physics activity is a very likely consequence of such inadequate support.

Finance/year	95	96	97	98	99	00	01	02	03	04
Spend (k£)	170	600	900	2700	2800	2200	1450	530	220	80
Cum. total	170	770	1670	4370	7170	9370	10820	11350	11570	11650

Table 1: SCT - spend profile at the £ 26.25M funding level

Finance/year	95	96	97	98	99	00	01	02	03	04
Spend (k£)	115	80	35	140	330	650	1180	250	68	66
Cum. total	115	195	230	370	700	1350	2530	2780	2848	2914

Table 2: Level - 1 trigger - spend profile at the £ 26.25M funding level

Finance/year	95	96	97	98	99	00	01	02	03	04
Level-2 Spend	81	45	40	60	40	220	840	1060	130	70
Cum. total	81	126	166	226	266	486	1326	2386	2516	2586

Table 3: Level - 2 trigger spend profile at the £ 26.25 M level

Finance/year	95	96	97	98	99	00	01	02	03	04	Total
Common Fund		450	450	600	2800	3000	600	500	350	350	9100

Table 4: Possible Common Fund spend profile at the £ 26.25 M level

Category/year	95	96	97	98	99	00	01	02	03	04	Total
Engineers	2.0	2.5	3.0	4.0	3.5	3.5	3.0	3.0	1.0	1.0	26.5
Technicians	0.5	1.0	0.5	2.0	2.0	2.0	3.0	3.0	3.0	1.5	18.5

Table 5: Level - 1 trigger manpower request

category/year	95	96	97	98	99	00	01	02	03	04
Physicists	6	6	7	7	7	7	8	8	8	8
Electronics Eng.	3	3	3	3	3	3	3	3	3	3
Computing Eng.	3	3	3	4	4	4	4	4	4	4
Electronics Tech.	4	4	5	5	6	6	7	7	5	5
Computing Tech.	-	-	-	-	-	-	-	-	-	-
Engineer/Technician										
year total	10	10	11	12	13	13	14	14	12	12
running total	10	20	31	43	56	69	83	97	109	121

Table 6: Level - 2 trigger University and RAL PPD staff - SY/Y (f.t.e.)

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Figure 1: SCT University manpower and estimated overall requirements (SY/Y)

category/year	95	96	97	98	99	00	01	02	03	04
Electronics Eng.	-	0.5	0.5	0.5	1	1	1	0.5	0.5	-
Computing Eng.	-	-	-	-	0.5	1	1	0.5	0.5	-
Electronics Tech.	-	0.5	0.5	1.5	1.5	1	2	3	1.5	1.5
Computing Tech.	-	-	-	-	-	-	1	2	1.5	1.5

Table 7: Level - 2 trigger manpower request