REPORT TO THE OVERSIGHT COMMITTEE ON THE ATLAS UPGRADE PROJECT 2010-2013. REPORT DETAILING PERIOD APRIL 2010-JANUARY 2011

1. CONTENTS

Preface

This first report to the OsC describes the context of the project, the effect of the 70% descope and the resulting baseline, and a description of the work carried out in the past nine months. We expect that future reports will be briefer focusing on the progress of the project, subject to agreement with the OsC.

2. INTRODUCTION

2.1 Executive summary

Introduction

The development and construction of the ATLAS experiment took 15 years from the Letter of Intent to successful recording of LHC collision data in 2009. ATLAS operated remarkably well during the first year of LHC running and has already produced a number of results, including observation of top quarks and setting world-leading limits on new physics processes. The primary aim of the ATLAS physics programme over the next few years is the discovery of the Higgs boson. However, in the longer term both the energy and luminosity of the LHC will be increased, with the aim of probing the energy frontier to discover new physics, make precision measurements, and search for rare processes. The LHC luminosity will evolve towards its design luminosity of $10^{34}cm^{-2}s^{-1}$ and a total integrated luminosity of $700fb^{-1}$, and will then be upgraded to $5x10^{34}$ $cm^{-2}s^{-1}$ with the aim of reaching a total integrated luminosity of $3000fb^{-1}$. The increased luminosity requires that the experiments develop and construct upgrades of their detector systems. The UK's contribution to the ATLAS Upgrade programme covers the tracker, trigger and computing, building on the UK's successful leadership of these areas in the current experiment.

The tracker upgrade must address the increased radiation dose and tracker occupancy that will result from the increase in the LHC luminosity. The dose to the tracker will scale approximately linearly with the increase in luminosity. The current ATLAS tracker was designed to survive 7 years of operation, corresponding to a total integrated luminosity of $700fb^{-1}$. The LHC upgrade will deliver $3000fb^{-1}$ over a similar time, requiring ATLAS to install a new detector system with increased radiation tolerance. The rise in luminosity will also significantly increase the number of pile-up events, from around 25 to 400. This will result in a much more complicated event environment, and will increase the number of tracks per event from about 750 to 12000 distributed between 400 vertices. This is a significant challenge for pattern recognition, which can be addressed by installing a new tracker system with increased granularity. The proposed new tracker consists of three distinct sub-systems, which are in order of increasing radii: pixel, short-strip tracker, long-strip tracker. The UK is playing a leading role in the development of the short-strip tracker with the aim of the building short strip staves in the UK during the build phase, and playing a leading role in the integration and commissioning of the full tracker system at CERN. The UK is also pursuing pixel R&D, with the objective of joining the ATLAS Upgrade pixel project and taking a leading role in the construction of a future pixel system for the tracker upgrade.

The increase in detector occupancy will result in higher trigger rates, potentially exceeding current data recording limits in ATLAS. Raising the trigger thresholds to control rates would result in loss of physics signals, while the increased occupancy both reduces the effectiveness of isolation to reject background in isolated lepton triggers, and also increases the complexity of pattern recognition. A set of trigger upgrades are therefore essential to maintain the physics capabilities of ATLAS. Studies are underway in the UK to develop a topological trigger for the Level-1 Calorimeter Trigger, eventually using higher-granularity calorimeter information and incorporating spatial data from the muon trigger. The UK has also proposed the development of a Level-1 track trigger, which extracts tracker information at Level-1 to identify high-p_T tracks as an additional primary trigger signature. The HLT is software-based, and requires continuous development of the trigger algorithms to optimise the acceptance of interesting events and rejection of backgrounds in a

limited time budget as the luminosity increases. The HLT algorithms also have to be developed to take account of upgrade e.g. an additional inner pixel layer (IBL).

The tools required to guide the design and evaluate the performance of the ATLAS upgrade require the development of software able to cope with large numbers of pileup events. There is also the technical issue of how to optimise the memory and CPU use when running upgrade simulations. New technical solutions such as using GPUs are being investigated. A critical area where the UK has unique expertise is in the calculation of the expected radiation levels within ATLAS.

As indicated in the ATLAS Upgrade proposal, the plan is for the total UK participation in the Upgrade project to be on a scale comparable to the original experiment build.

2.1.1 International Context: LHC and ATLAS Upgrade schedules

The current LHC schedule anticipates a shutdown in 2013 for about 15 months, to repair the magnet splices and allow the energy to be increased. The LHC will restart in 2014 and operate at 12-14 TeV centre of mass energy, and the luminosity will increase towards the design luminosity. There will be a further LHC shutdown in 2017/18 to commission LINAC4, which is required to reach the design luminosity and above. The LHC will then operate for several years (Phase-I), reaching around twice the design luminosity before by 2020. The main LHC upgrade requires the installation of many components, including new high-beta quadrupoles, which will be installed in a major shutdown in 2020-22. With all experiment and LHC upgrades complete, ATLAS will run with LHC luminosity up to $5x10^{34}\,cm^{-2}s^{-1}$ (Phase-II).

The ATLAS upgrade programme for the tracker will start with the installation of the IBL (inner B-layer) pixel system in the 2013/14 shutdown. This necessitates the IBL construction schedule being speeded up as is discussed in the tracker section. The pixel system will be reaching the end of its design lifetime in 2017/18 and the feasibility of installing an upgraded pixel system within the current tracking system is being investigated. The tracker will be constructed in 2015-2019 followed by commissioning on the surface and installation in ATLAS ready to take data in 2022.

The L1Calo project timescale for 2017/18 shutdown is determined by the electronics development timescale in relation to LHC shutdowns. Some of the upgrades can be installed incrementally, and none require intervention on the detector itself. For the large 2020 upgrade, the schedule depends on the timetable replacing electronics in the FE in all ATLAS calorimeters. The replacement of the FE electronics is a major undertaking and can only be done during a major shutdown. Originally this was planned for the 2020 shutdown, but installation of a small number of prototype channels is now being considered for the 2017/18 shutdown.

The L1Track trigger will include looking at L1 rates of high pt leptons as the luminosity evolves to provide input for upgrade designs for phase-I and phase-II running. The track trigger must be fully integrated within the tracker design and so the L1Track project for phase-II must follow the tracker schedule..

The HLT and computing upgrades programmes are less tied to the LHC upgrade schedule. The HLT algorithms and selection criteria will be developed to take advantage of hardware upgrades e.g. the IBL and the Fast-Tracker-Processor but will also evolve continuously as the luminosity evolves. The development of software and hardware within the computing programme supports the whole upgrade project and is driven by the development of technology rather than the LHC schedule.

2.1.2 International Upgrade Management

The recent election of Phil Allport to the position of Upgrade coordinator demonstrates the UK's high profile within the international ATLAS Upgrade project. Allport will lead the international ATLAS upgrade management, which has recently been strengthened to reflect the growing importance of the upgrade within ATLAS. The Upgrade Steering Committee (USC) now manages the Upgrade, with membership including project leaders from both the upgrade and the current ATLAS subsystems. The ATLAS Technical Co-ordination works through the Upgrade Project Office (PO) to ensure that the Upgrade projects are compatible with current ATLAS and to develop detailed schedules for installation and maintenance. A dedicated Upgrade Resources Board (URB) is being setup to liaise with funding agencies and identify and obtain funding for the Upgrade. The USC has set up two sub-committees to organise the two main areas of the Upgrade: the Inner Tracker subcommittee (ITk-SC) [P.Allport is a member] and the Phase-I Trigger/Detector Compatibility Task Force PH1-Tf [N.Konstantindis is co-chair, N. Gee is a member]. The involvement of the UK in the ATLAS Upgrade management ensures that the UK Upgrade programme is both influential in and responsive to changes in the ATLAS Upgrade programme. The UK upgrade management is described in section 2.5.

ATLAS upgrade plans require approval through CERN management, notably the LHC committee. To this end, ATLAS is preparing an Upgrade Letter of Intent, which will cover all upgrade work (both Phase I and Phase II), and is intended for submission at the end of 2011. More detailed information will be presented, separately for each subsystem, in detailed Technical Design Reports. The Inner Tracker TDR is planned for end of 2014. The first TDAQ Technical Proposal is that for the Level-1 trigger upgrades (including L1Calo and L1Track), which is being prepared for mid-2011. If a Pixel Upgrade goes ahead in 2017/18 then there will be a TDR early in 2013.

2.2 UK Context

A three-year STFC-funded PRD project from April 2007 to June 2010 provided funding for R&D of the strip tracker upgrade. This met its objectives with numerous deliverables. Some highlights are designed and tested full size sensors, 250nm ASIC modules, supermodule concepts, designs and prototypes; electrically functional stavelets and a full sized thermomechanical stave. Invaluable studies of radiation hardness and other material properties were also undertaken along with extensive studies of cooling systems and service issues. Taken together with all the other outcomes this has placed the UK in leadership positions across the tracker upgrade project.

The present three-year project funds a continuation of the tracker R&D and new R&D in the area of pixels, trigger and computing. The aim is ensure that the UK maintains its leadership within the Upgrade programme. To this end, top-level the project deliverables are:

- Strip tracker: Full electrical 250nm tracker stave, a full length 130nm thermo-mechanical stave, and a 130nm electrical short stave (stavelet)
- Pixels: IBL sensors, layout of pixel system for upgrade, delivery of 4-chip prototype module for pixel upgrade
- L1Calo: trigger performance studies for input to phase-I and phase-II trigger upgrade; conceptual design of a topological processor; technology evaluation for L1Calo hardware
- Track trigger: performance studies and conceptual design of a track trigger

- HLT : Upgrade and optimisation of the HLT tracking, trigger selections and steering software.Computing: Software for full simulation of events with pile-up; Improved use of memory in software; Updated radiation level calculations

A list of detailed deliverables and milestones are given in the WP reports.

2.2.1 The first 6 months and effect of the 70% Descopes

The proposal was submitted in September 2009 and the project started in April 2010. STFC staff and limited travel were funded for the first six months by bridging while awaiting the final award. The final award was announced in August 2010. This corresponded to a descope of around 70% across the projects. In addition, the ATLAS-FP project (WP1) was not funded. The WP and area managers have developed a programme based on the 70% descope option presented to PPRP, and taking into account the changes to the LHC schedule and the ATLAS Upgrade programme. A number of WP meetings have been held and the progress of the WPs has been monitored by area managers. After agreement of the budget with STFC, new posts were released in January 2011. All of the WPs have established programmes but some, particularly in the area of the trigger and computing, have incurred delays while waiting for new posts to be appointed.

The cancelation of ATLAS-FP project (WP1) resulted in the transfer of some staff to other WPs according to their expertise. The remaining staff effort was removed from the project.

The programme developed has, to a large extent, followed the 70% descope option presented to PPRP. This has generally focussed on maintaining the R&D activities and descoping or removing completely the areas of the programme directed towards production of the detector elements. In light of the changes to the LHC schedule this has been the correct course of action. However, we wish to emphasise that as this is an R&D programme the milestones, deliverables and schedules may change in response to changes in the LHC schedule and the international ATLAS Upgrade programme. Such changes will be monitored within the areas (see 2.4 for area definitions) and the PMB and reported to the OsC.

There has been good progress in the past year across the whole project, which is covered in the WP reports. Many results were presented at the November ATLAS upgrade week [33 talks and several session chairs]. The ATLAS upgrade week in Oxford at the end of March will provide the next opportunity for the UK present its work in an international context.

Highlights of work completed since the start of the project include:

- Tracker: Completion of the first (international) 250nm multi-module object (stavelet), followed by its successful readout and refinement.
- Tracker: Initial testing and evaluation of the 250nm thermo mechanical stave
- L1Trk: Estimates of L1 muon trigger rates at 2x1034$cm^{-2}s^{-1}$ have been made and demonstrate that additional information is required to maintain current trigger rate
- L1Calo: Successful implementation of the calorimeter trigger in simulation with pile-up and first assessment of level-1 trigger performance at luminosities up to $5x10^{34}cm^{-2}s^{-1}$
- L1Calo: Development of possible architectures for the phase-II level-1 trigger.
- HLT: Infrastructure has been put in place to benchmark trigger tracking code with simulated high luminosity data and has been used to target the code optimisation work.

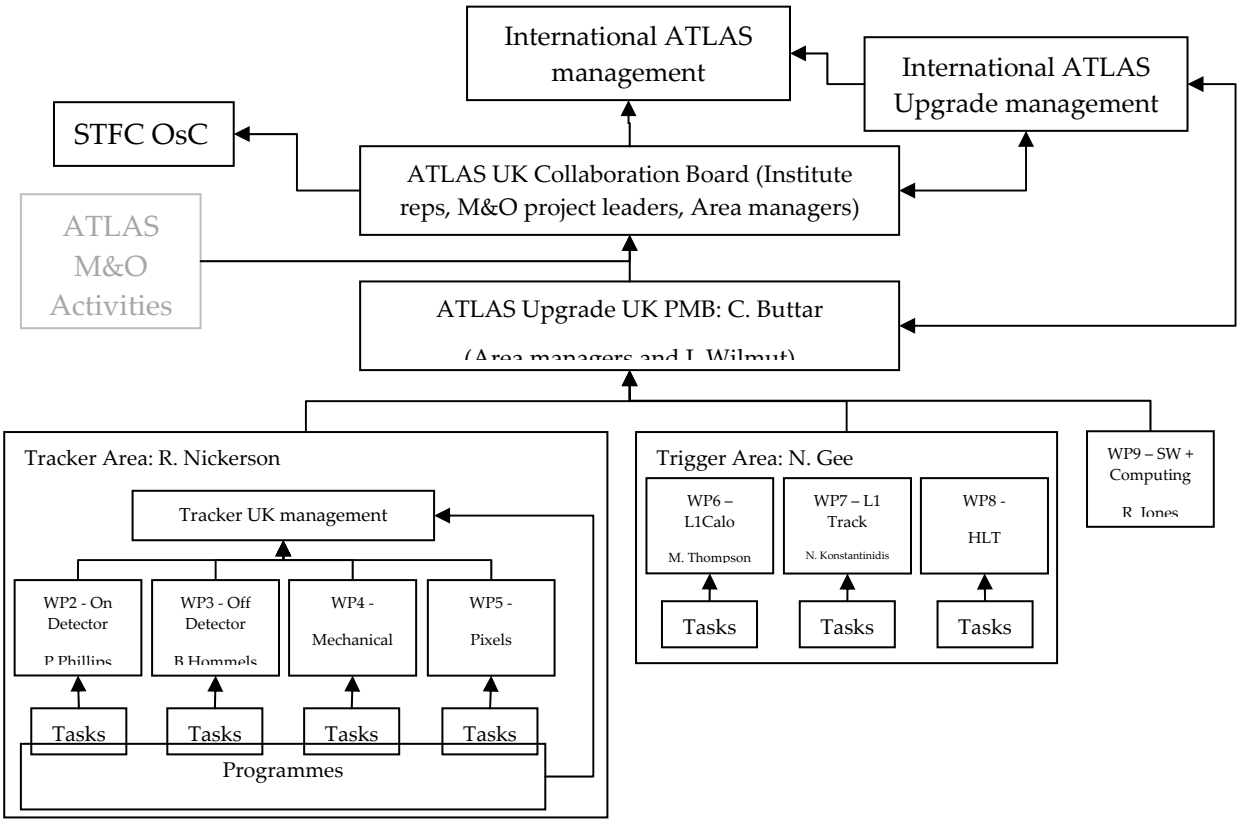
- HLT/Computing: Two components of the L2 Inner Detector pattern recognition code have been successfully implemented on Graphical Processor Units and encouraging measurements obtained
- Computing: The simulation infrastructure has been adapted to incorporate different upgrade geometries (requiring 64-bit identifiers)
- Computing: Perfromance studies have highlighted issues with electron efficiency, which has prompted the investigation of more radical lay-outs.
- Computing: Studies of the 7TeV data have lead to an improved material description in FLUKA, and good agreement is emerging with the predicted and measured fluences. Reliable estimates of the 1 MeV neutron equivalent damage fluences have been obtained from data.

2.3 Actions from previous meeting

None – this is the first meeting of this phase of the project.

2.4 Management Plan

The ATLAS-UK management structure is summarised in the following diagram (which is based upon that presented to and agreed with the PPRP).



Overlaid onto this there are a multitude of connections between the different Tasks, Programmes and Areas within the project and to the international ATLAS Upgrade programme. The arrows in the diagram above indicate the main direction of reporting/communication. The groups detailed above function in the following way:

ATLAS UK Collaboration Board This long-established body is the senior decision-making organ of ATLAS UK. It is chaired by the ATLAS-UK spokesman, and oversees all ATLAS operational and R&D activities in the UK. The UK CB meets typically twice a year for face-to-face meetings, with additional teleconferences and email communication as required. With regard to the ATLAS upgrade, the UK CB regularly reviews the project progress, and ratifies any documentation submitted to STFC including to STFC OsC.

International ATLAS Upgrade Management Upgrade management for the ATLAS experiment as a whole is coordinated by the international ATLAS Upgrade Steering Committee (USC), with subgroups responsible for aspects of the upgrade and technical coordination of installation via the Upgrade project Office. The UK holds many key roles in these bodies, including the most senior position following the recent election of Phil Allport to the position of Upgrade co-ordinator. Financial aspects (MoUs etc) are dealt with by the ATLAS RRB. There is an STFC representative (Tony Medland) on the the RRB and the ATLAS-UK Spokesperson also attends by invitation. **ATLAS-UK Upgrade Project Management Board (PMB)** This body consists of the Project PI (C. Buttar), Project Engineer (I. Wilmut) and the area managers. It meets monthly by phone to review progress and manage issues that impact the work areas and thus the whole project. It is through this body that Working Allowance calls, changes in task scope, preparation for OsC and responses to CERN schedule changes are discussed and actions proposed for approval by the UK CB.

Tracker UK Management (WP2,3,4,5) This is a team consisting of the Area manager (R. Nickerson), Project Engineer, WP 2-5 leaders, and a CERN management representative (P. Allport). These WPs are very closely linked and will produce common deliverables, so regular meetings are needed to ensure good progress towards common goals. Cross-WP Programmes are discussed in detail and actions on specific WPs created to ensure consistent motion towards common goals. At these meetings costs and schedules are reviewed and updates from CERN are digested.

Trigger UK Management (WP6,7,8) This group is made up of the Area manager (N. Gee), Project Engineer, and WP 6-8 leaders. The trigger WPs are independent of each other and will produce different and independent deliverables. The group meets to monitor progress in the WPs and to prepare a report for the PMB and discuss global ATLAS trigger issues.

Computing and Software (WP 9) As WP9 plays a central role in many aspects of the project as well as being a WP in its own right, the manager (R Jones) is a member of the upgrade PMB.

WP Management The WP manager directs the work of the WP and is responsible for the staffing and budget. Internally to each of the workpackages are weekly or biweekly phone meetings where task managers and other group members report progress or problems. These meetings are where all management issues are addressed, including selection of speakers for meetings, any budget matters etc. In addition to the phone meetings, there are periodic physical meetings which usually focus on particular areas in need of more extended discussion. The WP manager reports at the relevant area management meetings.

Schedule control and project reviewing The top level project schedule is the responsibility of CERN and the international ATLAS management. However, the UK representation on the various project management bodies influence that, and whilst we only formally reschedule the UK activities when official top level schedules are released, we remain abreast of what likely changes might be.

3. REPORTS FROM TRACKING WORK PACKAGES

3.1 Summary of tracker project

Summary of Tracker Programme The approved UK tracker programme has two main strategic goals. The first is to exploit the UK's world-leading expertise to ensure a viable and effective design emerges from the international strip tracker programme and to fully develop, prototype and prepare for production of the strip detectors that the UK groups plan to produce. This mandates full participation in the detector and system development and integration studies. The second goal, vital to the UK in the longer term, is to expand participation in pixel detectors, which are seen as taking a more central role in future experiments. This pixel work has an early focus on detectors for IBL and as a later goal UK leadership in the disk regions of the upgraded pixel tracker.

Strip Programme Updates In the case of the strip detector, the major change to the programme recommended by the PPRP was, in essence, to delay implementation of readiness for stave production. The funding approved is sufficient to fully develop both the design and the assembly methodology, but insufficient to equip and qualify production sites. On the schedule proposed by ATLAS management at the time of the PPRP proposal this could potentially have presented significant challenges to UK participation in the build phase of the programme. The recent re-evaluation of the likely machine upgrade schedule has worked in the UK's favour in this context; the delay (~2 years) is consistent with allowing the UK to implement production readiness on the longer time scale that the PPRP effectively wanted.

One other major benefit of the stretched schedule is that the work on developing the best possible staves with the most cost effective production methods can be fully and thoroughly completed ensuring that the best value for money is achieved in the long term. Some examples of such efforts are found in the WP descriptions below.

The UK community is also remaining engaged with the stave backup programme which is being pursued at the University of Geneva and KEK (Japan). This is continuing development of the supermodule local support option. There is no active UK effort directed specifically at this after the ATLAS review selected staves as the basis for common future international work, however, as much of the UK effort is relevant to the supermodule programme, the UK is effectively staying engaged and capable in the supermodule area.

In response to a call from the International collaboration, the UK has adapted its strip programme to exploit the 130nm chip design capability at RAL. A tightly proscribed design effort aimed at the hybrid controller chip, HCC, which the UK has been specifying, has proved essential to help expedite the delayed 130nm chip development programme.

Pixel Programme Updates The evolution of the ATLAS programme for the pixel tracker has been more complex. As described earlier, the schedule alterations have resulted in a situation where the likely upgrades will take place in 2013/14, 17/18 and 21/22. Whilst the long lead time for strip tracker fabrication mean this is essentially a straight forward delay of ~2 years for strips, the new schedule allows for various options with regard to pixel trackers. The early UK work is largely unaffected as it is dedicated to sensor development, including use in the IBL, and to software studies. However the longer-term scenarios are quite uncertain and the UK Tracker Upgrade Management team is monitoring this situation very closely. There is undoubted enthusiasm in the international community for UK participation, and the UK focus will remain the forward regions of the pixel tracker, however the form of the mechanics and even the schedule for likely replacements is in flux. It is the consensus view of the UK community that the most likely scenario is that a major

pixel tracker upgrade will take place at the same time as the strip tracker for many technical reasons. This is not assured. One important update to the pixel programme has been the start of an exploratory participation in the NewPix upgrade being considered for the 2017/18 shut-down. The UK pixel team will look at 4-chip modules for this programme, an effort which meshes well with the rest of the pixel work.

International Tracker Upgrade Organisation Management of the International Tracker Upgrade Programme has been reorganised since the PRPP programme approval. The structure of the work is also under development. Under the umbrella of the ATLAS Upgrade Management there now exists an Inner Detector management, the ITk. Within this there are, to date, five groups. An integration group, a local supports group, a simulation group, a services group, and a strip module group. It is anticipated that there will also be formally a pixel group. Three of these five have UK coordinators. The UK is also represented in the ITk. The formation of this structure is recent and it is a work in progress. It would be disingenuous to suggest that the exact boundaries between these working groups are as yet precisely defined, however the UK is fully committed to helping improve the management even further and is playing a leading role in the evolving structures.

UK Tracker Programmes One facet of the UK tracker upgrade work which has evolved since approval is the need for 'programmes'. These are mentioned in the management section of this report, and are one outcome of the Tracker Area Management process. Some work naturally spans multiple workpackages, (for example production of a thermo-mechanical prototype stave), so there is a need to ensure that such programmes are monitored and progressed. The top level deliverables in the programme are serviced by these programmes.

The major top level deliverables are a fully functional full length stave built using 250nm ASICS; a full size advanced thermo-mechanical stave developed for 130nm ASICs and a short electrical stave (stavelet) using 130nm modules.

Programme managers have been identified to ensure that the pan-workpackage programmes are properly monitored and managed. The programmes are: Stavelet250, Stave250, Stave130, B180, and Radiation Studies. The B180 and Radiation Studies programmes enable crucial testing work at CERN and other facilities and have been established in response to the international programme. By identifying a programme manager for the UK contribution (Huffman), a high UK profile is ensured in what will be a programme vital to both the technical developments and also to the formation of the build phase collaboration.

Industrial Collaboration Wherever possible the work is being done in collaboration with British Companies. Development work, for example in carbon fibre, is aimed at techniques which are not (yet) industry standard, such as co-curing electrical tapes with carbon fibre skins. This is an example of work of interest to local industry. A UK company is also investigating production of a non-standard low temperature pre-preg for the collaboration. In the ideal world it will be possible to export these techniques to industrial partners in the longer term. Other companies are working as collaborators are developing hybrid manufacture methods and on aspects of ASIC work.

Summary of Programme work The tracker programme has made excellent progress in all areas. There have been some hold-ups due to delayed delivery of components from industry (such as detector wafers), but on the whole the programme has run reasonably close to the revised schedule. All the necessary software and hardware has been prototyped to enable production of electrically functional stavelets and a full sized thermo mechanical stave. The design of these has been driven in part by integration studies, including manufacture of a full size model of the stave end region.

Much detailed work has been accomplished to understand the radiation hardness of components, including cold fibres. A materials data base is close to completion. Implementation of serial powering has been accomplished and DC-DC work established. These have required establishing a HSIO based DAQ system.

Mass reduction is a critical area for the final detector and a large effort has been directed at this, both in conceptual studies and in the module construction and stave core work. 130nm ASICs are another crucial element to mass reduction, amongst other things, and work in this area is underway.

The pixel programme has seen successful production of detector wafers for the IBL project and encouraging developments in bump bonding at RAL. The software effort has ramped up and is putting the UK in a position to take a leading role in the simulation effort. The programme has adapted to the changing schedule and international conditions and will focus on 4 chip module for NewPix as a near term goal.

3.2 WP2: On-Detector Electronics

3.2.1 Impact of 70% descope on WP2

The on-detector workpackage was originally conceived to do the development, prototyping and preparation work in on-detector components to take each of the two proposed UK production clusters through to full production readiness. In accordance with the PPRP approval, the revised programme aims to deliver a reduced number of components commensurate with the three stave programme defined above; to perform enabling work such as the industrialisation of hybrid manufacture and the optimisation of build techniques; and to transfer production skills and processes between the clusters, both within the UK and the international community. Expenditure on infrastructure items has been reduced to the minimum needed to support the R&D programme: before preparation for full production readiness, a further capital injection will be needed to achieve the required production rate.

3.2.2 Progress of project to date

The ABCN-25 ASIC, in IBM 250nm technology, is at the heart of the present programme. Twenty-four wafers of these chips were screened at RAL and diced by industrial partner Micross Components Ltd. This provides sufficient tested ASICs to support the international programme in its current phase.

The next phase of the project will use ASICs in IBM 130nm technology, with the first ABCN-13 chips scheduled for delivery in Q3/2012. Specification of the companion Hybrid Controller Chip (HCC) is a UK responsibility and must be completed on a similar timescale. It has proved necessary to secure design effort from the RAL TD ASIC group to ensure that this work is completed on time. This represents a modest and tightly proscribed redirection of existing effort within the workpackage. Additional support for HCC activities will be achieved through use of RG resources at UCL.

Three batches of panellised hybrids have been produced by industrial partner Stevenage Circuits Ltd. A yield of greater than 90% has been achieved, with each circuit being dimensionally accurate to better than 100 microns in two dimensions. The addition of passive components to the resulting 184 circuits is ongoing, by industrial partner Hawk Electronics Ltd, using automated pick and place techniques. Development of novel, low cost die attach tooling has continued at Liverpool such that

20 ABCN-25 ASICs may now be glued to a hybrid simultaneously, to a precision of better than 15 microns.

A total of 20 modules have been built at Liverpool, the last five having improved control of glue layer thicknesses as a result of improved techniques and tooling. The export of module construction skills to multiple sites has also commenced, with training sessions having been held at Liverpool for personnel from Cambridge, and international collaborators from LBNL and UCSC. Duplicate sets of module construction tooling have been produced for use at these locations and two further overseas institutes are making their own jigs to the Liverpool design. As a first step towards a dedicated stavelet to study DC-DC powering, an updated module test frame PCB was made to facilitate the first, successful, test of a stavelet module with each hybrid powered by a dedicated DC-DC converter.

A revised power tape for the planned DC-DC stavelet was successfully designed and fabricated. A dedicated computer controlled knife cutter has been commissioned to facilitate the production of service tapes with cover layers. These tapes cannot currently be fabricated in UK industry.

The Versatile link project, which will form the basis of the on-stave optical interface, has made significant progress in the last year. System level specifications of the optical link are complete based upon expected SLHC radiation levels at the inner tracker volume and the power margin fits within component performance after radiation. Prototype systems exist at CERN and at SMU with a full set of front-end components and a mechanical prototype of the connector package. Of particular importance is the fact that UK personnel are fully versed in these systems.

3.2.3 Plans for next 6 months

Due to over production at IBM, the international community was able to obtain four more ABCN-25 wafers at a discounted price. These wafers will be screened in part at RAL and, looking towards the sharing of the future ASIC screening load, in part at Glasgow. Work to develop verilog models of the HCC chip will continue at RAL and UCL.

Cambridge will populate a small number of hybrids, using a copy of the Liverpool tooling to attach ABCN-25 die. A further iteration and submission of the hybrid design is planned to improve the flatness of the panellised circuits.

A series of dummy modules will be produced, using glass in place of the silicon sensor, in order to further optimise the glue pattern used to attach the hybrids. Additional sites, both UK and international, will produce their first electrical modules. Together, the collaboration will make sufficient modules to support a further two single sided stavelets, one with DC-DC powering and one with serial powering, destined to form the basis of system evaluation activities at CERN. Further modules will be constructed for the stave prototyping programme.

Tests will be undertaken to determine the minimum amount of material needed to screen a stave module against various aggressor signals, looking towards a possible reduction in service tape mass. A computer controlled gantry system will be delivered: this will form the basis of a large area flying probe system to be used to test service tapes.

3.2.4 WP milestone plan

Milestones achieved in the last six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status

Milestones due in the next six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
M2.1	WP2	Modules available for DC-DC Stavelet	Mar 2011			On Track
M2.2	WP2	Modules available for SP Stavelet	May 2011			On Track

Overall Milestone List

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status	Delay due to		Affects Critical Path?	See Note
							UK?	Other Collaborators?		
M2.1	WP2	Modules available for DC-DC Stavelet	Mar 2011							
M2.2	WP2	Modules available for SP	May 2011							

		Stavelet								
M2.3	WP2	Modules available for Stave	Oct 2011							
M2.4	WP2	Final sensors available	Jun 2012			Delayed	N	Y		2.1
M2.5	WP2	ABCN-13 ASIC Evaluated	Jul 2012			Delayed	N	Y		2.1
M2.6	WP2	First ABCN-13 Hybrid	Aug 2012			Delayed	N	Y		2.1
M2.7	WP2	First ABCN-13 Module	Sep 2012			Delayed	N	Y		2.1
M2.8	WP2	HCC ASIC Evaluated	Oct 2012			Delayed	N	Y		2.1
M2.9	WP2	First HCC+ ABCN-13 Hybrid	Nov 2012			Delayed	N	Y		2.1
M2.10	WP2	First HCC+ ABCN-13 Module	Dec 2012			Delayed	N	Y		2.1

2.1 Delayed due to revised ASIC Schedules. The UK has redeployed resources to work on the ASIC designs to minimise this delay.

3.2.5 Deliverable summary

Deliverable and description	Target Date (original)	Target date (revised)	Status
Modules for DC-DC Stavelet	Mar 2011		On Track (75% complete)
Probe last four ABCN-25 Wafers	Apr 2011		On Track (25% complete)
Modules for SP Stavelet	May 2011		On Track
Modules for 250nm Stave	Oct 2011		On Track
Power Tape Testing Machine complete	Feb 2012		Deliverable reduced in scope: now one machine instead of two.
Modules for 130nm stavelet	Feb 2013		Delayed due to revised ASIC schedules

3.3 WP3: Off-Detector Electronics

3.3.1 Impact of 70% descope on WP3

As originally proposed there were two main tasks in WP2: Support services for the stave prototype programme; and developing these service systems in support of the final upgraded strip detector.

As the WP3 work entails a significant proportion of service work rather than fabrication of infrastructure, cutting back to 70% funding level resulted in a reduction in the number of tasks which can be accomplished. Priority has been assigned to providing support to systems required by the current prototype programme.

The *Serial Powering* work is scaled back and the equipment budget is cut by sharing facilities, potentially causing delays later in the programme. However by staging the remaining, crucial, hardware purchases, and relying on our international collaborators to take on essential tasks, milestones can still be met.

The *passive optics* task is defined within the Versatile Link collaboration. UK institutes will have to assume more modest role within the collaboration. Milestones will be met but on a delayed schedule. The depth of understanding of the optical network performance in heavy radiation will potentially be less than ideal, compromising proper anticipation of all issues.

The *data acquisition* work gives up all tasks that are not strictly essential in providing a readout system for the stave(let) prototypes currently under design or construction. Development of DAQ for module production Q&A, and Versatile Link integration will be delayed, and studies towards a DAQ system for the final upgraded detector postponed.

Finally the work on *system evaluation* has been scaled back in line with the reduction of planned stave prototypes. The effort listed in this subtask has been redirected to work on the development of the testing centre for stave/stavelets and their components in B180 at CERN

3.3.2 Progress of project to date

The first serial powering constant current source, and its successor have been designed and built. These have been evaluated in detail on a testbench, and have been used to power the stavelets. The first prototypes of the power protection chip in 130nm technology chip have been submitted after and extensive development and simulation programme in collaboration with our US colleagues. UK institutes are producing test equipment in anticipation of the chip prototypes.

The UK contribution to the passive optical components evaluation within the Versatile Link project has focused on providing a reliability analysis of both MultiMode (MM) and Single Mode (SM), high-bandwidth optical fibres, as well as optical couplers and connectors. A large temperature dependency to radiation induced damage in optical fibres has been observed. In consequence, a CO_2 cooling system has been designed, built and commissioned to enable cold irradiation of candidate optical fibres. The SM fibres show promising characteristics, whereas the accelerated tests of MM fibres indicate a relatively short usable lifespan in sLHC conditions. More investigation is needed.

A HSIO-based DAQ was developed in the UK for stavelet readout. For use in the current programme, a batch of HSIOs to UK specification, and associated interface boards, has been produced. The UK team has developed the software and firmware and provided associated support to the international collaboration. Within the prototyping programme, extending the feature set of the DAQ is a ongoing process, and is led by UK institutes.

3.3.3 Plans for next 6 months

The serial powering effort will mainly focus on fine-tuning the current source, using a stavelet as the ultimate testbench. The development work will focus on the transition to the 130nm chipset, and integrating the serial powering concept further with the on-detector electronics.

Candidate fibres will be assessed for their reliability at CERN, in cold conditions. Test processes and fixtures will be designed to commence testing of connectors and couplers.

With stable versions of the DAQ firmware and software now in place for roll-out, developing the support for features for future stave prototypes will take priority.

System evaluation and testing will focus on preparing the facility in B180 at CERN for testing of the DC-DC stavelet, and possibly a prototype supermodule.

WP milestone plan

Milestones achieved in the last six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
3.1	WP3	Programmable Power Supply evaluated	Oct 2010	22/10/10	22/10/10	Completed

Milestones due in the next six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
3.2	WP3	CERN facility ready for DC-DC stavelet testing	Apr 2011			On Track
3.3	WP3	Programmable current source ready at CERN	May 2011			On Track

Overall Milestone List

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status	Delay due to		Affects Critical Path?	See Note
							UK?	Other Collaborators?		
M3.1	WP3	Prototype programmable supply evaluated	Oct 2010		20/11/20	Achieved	N/A	N/A	N	
M3.2	WP3	Test facility at CERN ready for DC-DC stavelet	Apr 2011			On Track	N/A	N/A		
M3.3	WP3	Programmable current source ready at CERN	May 2011			On Track				
M3.4	WP3	HSIO-DAQ adapted for ABCn-13	Jun 2012							
M3.5	WP3	HSIO-DAQ modified for ABCn-13 + HCC	Sep 2012							
M3.6	WP3	Cold testing of fibres at CERN	Aug 2011			On Track				
M3.7	WP3	DAQ ready for Stave-250	Nov 2011			Delayed	Y	Y	N	

3.3.4 Deliverable summary

Deliverable and description	Target Date (original)	Target date (revised)	Status
Hardware between HSIO and EOS controller, including Versatile Link	Feb 2011	01/02/11	Completed (see Note 1)
Test procedure and setup for production fibre, pre- and post irraidation	May 2011		Ongoing, small delay due to revised temperature requirement of fibre investigation
Specifications and evaluation test setup for the programmable power source	Nov 2011		On track
Provision of Stave09 services systems: cooling, power, and readout at a CERN test stand	Jul 2011		On track: effort ongoing in conjunction with work for B180 (CERN) test facility.

Note 1: in order to comply with the 70% budget restriction, the Versatile Link integration was not pursued.

3.4 WP4: Mechanical

3.4.1 Impact of 70% de-scope on WP4

The original aims of the WP4 workpackage were: to iterate and optimise the existing mechanical staves, reducing material and improving performance; to fully develop the tooling and processes needed to begin production; to understand how the inner detector will be integrated and be pro-active in this development work with international collaborators; and to have a fully developed quality policy for the build program that will ensure high quality production.

The major loss to the programme in the de-scope has been in preparations for production readiness: specifically cuts have been made to: the purchase of major items of capital equipment needed for the production phase of the project, (unless needed for development work); the procurement of production materials; site preparations for assembly; travel; and finally TD effort. The strategy has been to maintain the goals but to pull back on the more advanced milestones relating to production readiness, effectively significantly stretching the programme.

3.4.2 Progress of project to date

A comprehensive list of thermal and mechanical properties of candidate materials has been compiled and a draft summary document is imminent.

Orbital welding of thin-walled stainless steel tubes (beyond current commercial limits) has been demonstrated. Bending of larger bore titanium tubes has been accomplished and work is now evolving to smaller bore tubes. Procurement of 2.2mm OD titanium tube from UK industry for future prototyping and also for the ATLAS IBL has been completed. Two CO_2 'blow-off' systems have been constructed and are in use.

A thermo-mechanical stave has been completed and is under test at RAL. This is the most complete, most realistic thermal prototype built within the international stave community and is a significant achievement. Preparations are being made to allow the deformations of the stave to be studied

optically with ESPI. The co-curing of pre-preg to bus tapes using custom-made curved jigs and cure-cycles for optimal laminate flatness has being studied. This development work is of interest to UK industry. The development of custom, low-cost corrugated cores has been demonstrated. Two stavelets (a 0.5m long mini-stave) have been delivered to the international stavelet programme. Links with UK industry to produce low temperature cure pre-preg have been established. Stave FEA simulations from different authors now agree at the 5% level.

A first generation module mounting system has been used to mount 24 modules on the UK thermo-mechanical stave and 4 electrical modules on the first stavelet. The development programme leading to a prototype of the final system has been designed to co-exist with the request from the international stave community to provide module mounting facilities during 2011 for stavelets (2 UK + 2 US) and a full length stave (Stave250). The first phase of engineering design for the Test/Transport system is in progress. The opportunity to supply frames for 2011 stavelets is being studied and this will be incorporated in to the planning and the first prototype frames will be used on electrical stavelets.

In the area of integration studies, the feasibility of in-situ welding of cooling tubes has been demonstrated with a realistic services layout. Custom tooling has been designed and manufactured and welding trials are continuing. FEA studies of stave-to-cylinder interfaces and measurements of the performance of prototypes are beginning to inform the engineering design of the support cylinders with respect to material optimisation. An alternative, lower mass, support structure idea has been developed to the conceptual level, backed up with the results from FEA, using a small amount TD effort.

Work presented by WP4 members at CERN shows that reduction of material in the tracking volume will benefit significantly from a better understanding of the mechanical interface between the stave and the global support structure. The stiffness of staves could be exploited to reduce the material in the global support structures. This work is important as the savings in material are very advantageous, particularly if the half-length of the barrel increases to 1.6m as has been proposed.

3.4.3 Plans for next 6 months

The international stave collaboration has recently reviewed the requirements for staves and stavelets. It is now expected that UK groups will supply a further two stavelet cores by 2011/Q3 followed by one 2012. These represent a small change to the original programme, but the effective extra cost is negligible. The development of stave/stavelet assembly tooling would already have resulted in similar items. Similarly, a requirement for stavelet handling frames has been identified by the international stave community. Work within WP4 task 'Test / Shipping Container' is scheduled to deliver prototype stave frames by 2011/Q3 (see below) and with a minor change to the programme will develop the (smaller) stavelet frames required.

By task area the plans are: In *materials* to use the draft material document to inform the future measurement programme; in *cooling* to develop bending and welding of 2.2mm OD titanium tube and to deliver circuits to the stave/stavelet development programmes; in *Stave Assembly* to complete analysis of the thermo-mechanical stave using ESPI and to develop stave assembly tooling to improve geometrical accuracy. Also to supply stavelets to the international stave programme as described above; in *Module Mounting* to provide module mounting capability to the international stave programme including development of system components incorporating new traversing stages, optics and software; in *Test/Transport Systems* to develop test/shipping frame design and supply frames to international stave programme.; and in *Integration* to develop support structure requirements, evaluate spider-web support structure design in terms of mechanical performance and radiation length and compare with cylinders, and to complete the services model with the

addition of representative electrical services. It will also be necessary to evaluate the implications on the thermo-mechanical requirements of ATLAS ITk-SC initiative for longer barrel staves (1.6m). These will include the impact on cooling and tape design of the stave and the more global issues of handling and integration.

3.4.4 WP milestone plan

Milestones achieved in the last six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
M4.1	WP4	Evaluation of titanium tube completed.	Dec 2010		31/12/10	Done. Stavelet with 1/8″ titanium tubes constructed. Welding issues identified.

Milestones due in the next six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
M4.2	WP4	Prototype test/shipping container evaluated.	Dec 2011			On track.

Overall Milestone List

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
M4.1	WP4	Evaluation of titanium tube completed.	Dec 2010		31/12/10	Done. Stavelet with 1/8″ titanium tubes constructed. Welding issues identified.

M4.2	WP4	Prototype (stavelet) test/shipping container evaluated.	Dec 2011			On track.
M4.3	WP4	Functional prototype of full-scale module mounting system.	Nov 2011			On track. International stave programme assumes module mounting capability at RAL during 201. Need to maintain capability during system development.
M4.4	WP4	Final stave core selected and prototyped.	May 2012			On track. Experience in the manufacture of the Thermo-mechanical stave and stavelets will be used to iterate the tooling design and subsequently manufacture a new round of prototypes.
M4.5	WP4	Bending and orbital welding of 2.2mm OD titanium tubes demonstrated	Dec 2011			On track. Procurement of 2.2mm OD titanium tube (shared with ATLAS IBL project) completed. Tube bending / welding studies starting. Prototype tubes will be supplied to stave (and stavelet) assembly task.
M4.6	WP4	Define Production Frame	Feb 2012			On track.
M4.7	WP4	Full set of measured material's properties	Nov 2011			On track.

3.4.5 Deliverable summary

Deliverable and description	Target Date (original)	Target date (revised)	Status
Final set of material choices with fully characterised properties	Nov 2011		Draft document used to identify further work
Evaluation of titanium tube, spec and plans for mass manufacture	May 2012		Completed for 1.8″ OD tubes and work now starting for 2.2mm OD. Preparations for mass manufacture removed due to funding cut.
Delivery of 1st core for suitable for 130nm ASICs	Dec 2012		FEA will still be ongoing for verification
Deliver core suitable for 1st 130nm electrical stave	Mar 2013		
Prototyped full scale test/shipping system with tooling to fabricate	Sep 2012		Prototype stave and stavelet shipping systems will be developed.
Full sized Module mounting system complete	Jun 2012		
Complete feasibility study of strawman v14 service layout & input CERN integration group for next generation layouts.	Dec 2011		

3.5 WP5: Pixel detector

3.5.1 Impact of 70% descope on WP5

The original aim of WP5 was primarily R&D with the objective of positioning the UK to take part in the pixel R&D programme that would lead to the UK taking and ultimately taking a leading role in the construction of an element of the ATLAS pixel upgrade. Initially, discussions with the pixel community showed that there was little planning or effort on the forward disk region and that this would be a natural area for the UK to participate in the pixel tracker upgrade. This required maintaining a programme in the areas of sensors, modules and interconnects, layout and mechanics. The option of dropping one area to achieve the 70% descope was considered carefully, but at this stage it would have limited the UK's ability to build a pixel system for the upgrade and it was decided that the cut should be applied across the programme, resulting in potential delay. Constant re-evaluation of the appropriate programme is undertaken, as is evident in the report below.

Cancelling the UK contribution to the ATLAS-FP project (WP1) has resulted in the transfer of additional RG staff into WP5 within the budget as agreed with STFC. These RG staff have skills covering sensors, modules, electronics and mechanics that will be valuable to the pixel programme.

3.5.2 Progress of project to date

The initial pixel programme was directed towards the UK taking a leading role in the development and construction of the forward pixel system in the full tracker upgrade in 2020. However with the changes in the LHC schedule the possibility of a pixel upgrade around 2017/18 is under discussion. The UK programme is being adapted to include this upgrade scenario and discussions are being held with the pixel project leaders to establish the UK contribution to this programme.

In the area of *sensors* there is an established programme for both planar and 3D development directed initially towards the IBL. Planar n-in-n, 3D Si and CVD diamond are under evaluation. Sensor qualification is underway using unirradiated and irradiated FE-I4 modules. A review in June will select the technology. The UK-led work on 3D sensor technology continues to show good progress with four wafers from FBK delivered to IZM for bump-bonding. Other manufacturers will provide wafers soon. Micron Semiconductor Ltd will fabricate 4 planar sensor wafers with n-in-n devices designed according to the IBL baseline within the IBL planar programme (funded by an STFC PRD grant). This will allow Micron to act as a backup supplier for the IBL planar pixel production. Wafers of n-in-p are also being fabricated at Micron for evaluation for the sLHC pixel upgrade.

In response to the LHC schedule changes, ATLAS requires IBL installation during the 2013/14 shutdown. Pre-production planar sensors will be fabricated by CiS and 3D sensors by CNM and FBK. The UK will contribute around 14% of the funds for the IBL sensor production The UK institutes involved in the IBL programme will contribute to the sensor testing using systems supplied by international collaborators, now expected in March due to production delays.

In the area of *Modules* the UK is aiming to fabricate a 4-chip module. This change to the original proposal is mandated by the revised schedule and possible 2017/18 upgrade. This is a critical element in establishing the role of the UK in the pixel programme. The UK will contribute to the construction of a 4-chip prototype module in the areas of 4-chip sensor fabrication, bump-bonding and data-merging.

On *Interconnects* bump-bonding is a bottleneck in module fabrication. To address this bottleneck we have been investigating UK bump-bonding. RAL is currently commissioning an Indium based bump-bonding process. Wafers of FE-chip and wafers of sensors for to facilitate mechanical and electrical tests will be provided. This will not be a full production process but will provide a UK facility to support the development of pixel module construction. In the longer term RAL might provide a small production bump-bonding process that would be used during the construction of the sLHC pixel upgrade. This has applications including space science, CMS upgrade and devices for Diamond and XFEL.

On *Layout and mechanics* the plans have changed to adapt to circumstances. In the proposal, the programme consisted of the construction of a thermo-mechanical prototype and layout studies to understand the optimum configuration for the modules and services on disks. The design of the tracking system for the pixel upgrade in 2017 is currently less certain, in particular, a tapered barrel design is being considered. It is not yet appropriate to proceed with detailed mechanical design and prototyping. The efforts of the group on mechanics have been focussed on establishing a simulation

framework to evaluate the new proposals. Discussions with experts on the available tools have been held and the consensus is that the most appropriate tool for these studies is FATRAS. The WP5 team has started working with the FATRAS experts to ensure that the package is able to represent the geometries required; which requires significant upgrade.

3.5.3 Plans for next 6 months

The sensor programme will focus on the IBL sensor qualification. IBL FE-I4 modules will be tested in the lab and in a testbeam. Expertise in testing pixel modules with FE-I3 and FE-I4 chips will be exported to the additional UK groups. FE-I3 and FE-I4 test systems are due for delivery in March – late due to delays in production.

Following the sensor qualification programme there will be an MoU for the construction of the IBL. The MoU will be sent to funding agencies in July with the aim of having agreement in August to allow the schedule for installation in 2013 to proceed.

The module programme will focus on designing a 4-chip pixel module and procuring the components: FE-I4chips, hybrids, flex cables. A four-chip planar sensor mask will be designed and submitted to Micron to provide test pieces for the 4-chip module programme. Alternatives to bump-bonding at IZM will be investigated, both through RAL as described below and VTT who bump-bonded the ALICE pixel sensor.

In the area of interconnects, RAL will continue to commission their bump-bonding process. Initial electrical tests will be made with daisy chains. WP5 will procure test wafers required for this commissioning for mechanical and electrical testing.

Mechanics and layout studies will concentrate on establishing which of the proposed forward detector geometries provides the best performance using ATLAS tracking tools. Once this is known, detailed engineering designs of the appropriate mechanical and cooling structures can start.

3.5.4 WP milestone plan

Milestones achieved in the last six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status

Milestones due in the next six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
5.1	WP5	USBPix readout system setup in institutes	March 2011	May 2011		Pending delivery
5.2	WP5	Report on sensor qualification tests	June 2011			

Overall Milestone List

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status	Delay due to		Affects Critical Path?	See Note
							UK?	Other Collaborators?		
5.1	WP5	USBPix readout system setup in institutes	March 2011	May 2011		Pending delivery		Y		1

5.2	WP5	Report on sensor qualification tests	June 2011					Y		1
5.3	WP5	3D sensor delivery	June 2012							
5.4	WP5	Delivery of 4-chip planar sensors	Oct 2011			Design starting				
5.5	WP5	Electrical 4-chip planar module ready	August 2012							
5.6	WP5	Thermo-mechanical prototype design ready	Feb 2012							

1. USBPix systems were lost in transit and are being replaced by non-Uk collaborators. This has delayed UK institutes setting up systems to test pixel modules for IBL programme.

3.5.5 Deliverable summary

New deliverables for discussion

	Target Date (original)	Target date (revised)	Status
UK contribution of tested IBL sensors	Sept 2012		Pre-production sensors delivered for IBL technology evaluation programme
Evaluation of sLHC design 3D sensors	March 2013		
Results from planar 4-chip module	March 2013		
Layout design for sLHC pixel upgrade	November 2011		Starting; identifying tools
Results from thermo-mechanical tests	March 2013		

4. REPORTS FROM TRIGGER WORK PACKAGES

The three-level ATLAS trigger system was described in detail in the initial bid for UK upgrade funding. The overall goal of the upgrade project is to retain the trigger sensitivity to new physics as the LHC luminosity rises, in stages, to 5 x 10^{34}cm^{-2}s^{-1}.

4.1.1 International Context

ATLAS Trigger and Data Acquisition (TDAQ) is managed internationally by a two-person Trigger-DAQ Management Team (TDMT). TDAQ upgrade matters are managed by an enlarged team ("TDMT+3", which includes N. Gee and N Konstantanidis as members) and by the TDAQ Steering Group (J Baines is a member). Under this leadership, the 73 institutes contributing to ATLAS trigger and data acquisition (TDAQ) have agreed on a common upgrade R&D proposal, which is now in the final stages of formal approval within ATLAS.

The TDAQ R&D proposal foresees that TDAQ will not be completely replaced at any stage of the LHC upgrade, but will rather evolve in a sequence of steps required by the changing physics, detector, and luminosity. Decisions on scheduling will have to take account of the complex relationships between, for example, calorimetry readout and muon detector changes and L1Calo, the Fast track Trigger (FTK) and Insertable B-Layer (IBL) project and HLT, and the effect of the overall inner detector architecture on L1Track. The ATLAS-wide Phase-I Task Force mentioned above is charged with ensuring overall compatibility for the Phase I upgrades.

It is worth repeating that the UK trigger upgrade projects are essential to the overall success of the ATLAS upgrade. While the connections between the UK trigger activities may not be as direct as in the case of the tracker projects, there are strong links via the representation in influential bodies of ATLAS upgrade management.

4.2 WP6: Level 1 Calorimeter (L1Calo) Trigger

4.2.1 Context

This section describes the UK part of the L1Calo trigger project. It should be considered provisional as the international L1Calo collaboration is currently discussing the overall plan and the division of tasks (this will be discussed in depth at the L1Calo management meeting which takes place on the 23rd March).

4.2.2 Impact of descope on WP6

The main impact of the descope with respect to the original proposal was to delay the prototyping of the planned topological processor. Given the current operational plan for the LHC, and following-on from the discussions with PPRP, it is now planned that the Phase-I topological processor should function as a prototype for the Phase-II upgrade. This means proceeding at a slower rate than the original and is thus compatible with the reduced level of funding. The exact nature of the topological processor and its place in the Phase-II upgrade is contingent on the results of the simulation studies, which are underway.

Despite proceeding at a slower rate, the UK is retaining its leading role in the ATLAS-wide L1Calo upgrade project where the UK has a leading role in: the detailed trigger simulation studies with pile-up; the development of firmware to drive elements of the current system at high clock speeds; studies of the implementation of topological trigger algorithms in firmware; developing the new L1Calo system architecture for the Phase-II upgrade.

The main deliverables of the descoped funded project (Q1 2010 – Q4 2013) are:

- to develop detailed designs for the Phase-I and Phase-II L1Calo upgrade such that the construction phase could begin in phase of funding.
- to prototype the key elements of an ATCA based system operating at 5-10 GHz by constructing a demonstrator/test slice.

4.2.3 Progress on the project to date

The effort in WP6 the past 12 months has focused on three main directions:

(a) Validation of the ATLAS high-luminosity simulation of L1Calo trigger rates and, in particular, to fully understand the limitations of the current system with the aim of understanding the impact on physics sensitivity and the requirements of the topological trigger processor. These ongoing studies are central to defining the details of the L1Calo upgrade project.

(b) Understanding the challenges and technological solutions to triggering at high luminosities at the LHC. These studies have included the evaluation of ATCA options; studies of memory/processing limitations of FPGA-based topological algorithms; studies of over-clocking the Cluster Processor modules (the first step in the Phase-I upgrade); and developing a plan for a test-bed for the development of multi-GHz processing foreseen for the Phase-II upgrade.

(c) Developing the model(s) for the Phase-II L1Calo trigger system (Phase-II). This UK led work has produced a realistic strawman model for the final L1Calo system. In this model the "level-1" trigger is based in two stages, a hardware-based level-0 accept including a

topological processor and a level-1 system with longer latency and more detailed processing.

Simulation The simulation of high luminosity events is extremely challenging in the ATLAS software environment. It requires going back to the simulated analogue signals from the calorimeters. Because the analogue pulse from the LAr calorimeter spans approximately 30 bunch-crossings, the simulation of pile-up also needs to be performed at the bunch-train level. Consequently, the required computer memory and CPU resources are significant. In the last 12 months the UK has made the central contribution to the development of a reliable simulation L1Calo at high luminosities. The UK developed "stand-alone" overlay software where only the aspects of the overlay relevant to L1Calo where simulated. In developing and validating this software, at least two major bugs (which resulted in trigger rates being wrong by about one order of magnitude) where identified in the existing simulation software. These fixes have been propagated to official ATLAS simulation, thus allowing the full simulation of pile-up, or just the L1Calo aspects. Using the software developed in the UK, it is possible to simulate pile-up for luminosities up to $10^{35}cm^{-2}s^{-1}$. This has been used to begin to understand how the performance of the current system evolves with luminosity. A first full study will be presented at the April ATLAS upgrade meeting. In addition to studying the performance of the current system, studies of the potential impact of using finer-grained information have started, although it is to early to draw any conclusions.

Technology Demonstration

Design The UK is leading the work on the design of the Phase-II upgrade. Several conceptual designs have been considered. The level-0 accept (L0A) is generated within the 3μs latency imposed by the on-detector buffers. The level-0 system incorporates topological information in the L0Topo processor. The current intention would be to roll-out a prototype of the topological processor as part of the Phase-I upgrade. In this model it is envisaged that muon trigger regions of interest (RoIs) will be used at this stage. The data from events passing the L0A would then be buffered and processed asynchronously thus allowing the level-1 accept (L1A) to use finer granularity calorimeter information and the results from the track trigger. The implementation of the level-0 system, with its tight timing requirements would be hardware/FPGA based. The input and output data rates of such a level-0 system are such that it could be implemented in a relatively small number of ATCA crates. The level-1 system could potentially be processor based, here the details need to be worked out. It should be noted that the strawman system described above is just one possible design for the Phase-II upgrade. The intention is to continue to refine this option (and others) and thus understand the technology requirements. This work will run in parallel with the design and implementation of the technology demonstrator.

4.2.4 Plans for next 6 months

The main focus of the WP6 work in the coming six months will be:

- Completing the L1 trigger rate studies for electrons and jets and in particular understanding how this impact physics. The aim is to chose a fixed trigger budget for each trigger type (e.g. 20 kHz for electrons) and then determine how the required threshold evolves with luminosity. In this way the impact on ATLAS physics can be evaluated and areas where

topological triggers are required will be identified. This work will feed into the definition of the functional requirements of the topological processor.

- Specifying, designing and simulating a high-speed demonstrator module, which will carry signals in the 5-10 Gbps range. Such signal frequencies will be required in the upgraded trigger to cope with the high bandwidth of data. However, they pose a significant challenge to PCB design due to increased risk of reflection, cross-talk, etc. Designing this board will equip us with the knowledge and tools necessary to design multi-gigabit PCBs reliably. Crucially, once the board has been built (in the fourth quarter of 2011) we will extract from it an electrical model that will allow the predicted and observed behaviour of the high-speed signals to be compared, such that more accurate models and better PCB designs can be produced. This module will be the first in a hardware demonstrator programme that will culminate in the construction of a complete processing 'slice' through the phase 2 trigger.
- Work on the design of the Phase-I and Phase-II L1Calo upgrade architectures will continue.

4.2.5 WP milestone plan

Milestones achieved in the last six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status

Milestones due in the next six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
M6.1	WP6	Simulation Impact of pile-up	Mar 2011			On target

Overall Milestone List

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status	Delay due to		Affects Critical Path?	See Note
							UK?	Other Collaborators?		
M6.1	WP6	Simulation Impact of pile-up	Mar 2011			On target				1
M6.2	WP6	Simulation Topological Processor	Sep 2011			Starting	Delay in recruiting PDRA			2
M6.3	WP6	Simulation (Phase-II Requirements)	Mar 2013			Not started				3

M6.4	WP6	Firmware (Operation of CP at 80 MHz)	Jun 2012							4
M6.5	WP6	Conceptual hardware design of TP in L1Calo	Sep 2011			Started	Descope			
M6.6	WP6	Detailed Conceptual Design of Phase-II upgrade	Mar 2013			Started				
M6.7	WP6	Construction of ATCA based high speed demonstrator	Mar 2013			Started design				5

1. First studies of L1Calo trigger at high luminosity
2. Evaluation of physics impact of topological triggers. Results will feed into design of Topological processor.
3. Complete study of triggering at Phase-II luminosities. Results will feed into design of Phase-II system including interface to LAr.
4. The target date is somewhat dependent on the timescale for the introduction of the CMM++ (upgraded merger modules) which will be constructed by MSU deliverable pending funding.
5. The demonstrator and slice system will be used to evaluate hardware options and to gain a detailed understanding of operating with the latest generations of FPGA at very high clock speeds 5-10 GHz. Ultimately it will be used to prototype the Phase-II system.

4.2.6 Deliverable summary

Deliverable and description	Target Date (original)	Target date (revised)	Status
Detailed understanding of performance of existing L1Calo	Mar 2011		In progress, on track
Understand physics impact of options for L1Calo upgrade	Jun 2012		Follows from above
Full definition of system architecture for Phase-I TP and Phase-II upgrade	Mar 2013		Started
Hardware demonstrator for Topological processing and Phase-II system	Mar 2013		Design started

4.3 WP7: Level 1 Track Trigger

4.3.1 Impact of 70% descope on WP7

The descope in WP7 has required some of the planned tasks had to be reduced in scope or abandoned. These include the evaluation of track trigger processor technologies, the development of the full pattern recognition strategy, and the discrete event simulation work. However, the remaining programme is still a substantial amount of work and the UK is able to retain its leading role ATLAS-wide in the L1Track project.

The long delay between the original submission of the ATLAS-UP Upgrade proposal and the approval of funds, which inevitably caused a delay in recruiting the two PDRAs awarded in WP7, has led to slower progress in the work package. The two PDRAs represent nearly 50% of the total FTE count in WP7. One of these positions (UCL) was filled in January 2011 and the other (RHUL/Sussex) is currently advertised and will be filled as soon as possible. The new appointments are expected to boost progress in WP7 significantly.

4.3.2 Progress of project to date

The work in the past 12 months has focused on two directions:

(a) Validate the ATLAS high-luminosity simulation; evaluate trigger rates; explore ideas and develop tools for addressing questions related to the physics requirements of a L1 track trigger; and

(b) Feasibility studies to test ideas for an RoI-based L1Track and interactions with the Tracking Upgrade community to give and receive feedback about the requirements for a hardware track trigger.

The simulation of high luminosity events is very challenging for the ATLAS software, as it requires significant amounts of computer memory and CPU time. Over the period reported here, the validation of high luminosity simulated datasets has led to finding and fixing several bugs that

were not easy to identify in simulated samples without pile-up. The latest round of production of events at luminosity 2e34cm^{-2}s^{-1} started recently and appears to be good for giving reliable estimates of L1 trigger rates. Figure 1 shows the L1Muon efficiency for various thresholds in ttbar events as a function of the p_T of the hardest truth muon in the event. It can be seen that the turn-on of the L1_MU40 trigger is very similar to that of the L1_MU20. This is because the ATLAS L1Muon system does not have the resolution to distinguish higher p_T muons, above 20GeV or so. This is one of the main arguments in favour of L1Track.

Some of the questions addressing the physics requirements of L1Track may be addressed with generator-level studies or in fast simulation. For this reason, a tool was developed that overlays simulated proton-proton collision events at the generator level. These events can be used to study, for example, track-based isolation for electrons and muons, which will provide input on the minimum track pT requirement for L1Track. They can also be used as input to the ATLAS fast simulation and studies are currently ongoing to compare these generator-level "pile-up" events with full simulation.

The studies for assessing the feasibility of the RoI-based L1Track approach also continued. Assuming narrow lepton RoIs, various data compression techniques were investigated and quantities such as the number of bits per layer per RoI or the frequency with which modules appear inside an RoI and therefore they receive a request for regional data. An example is shown in Figure 2 for the barrel Pixel layers of the tracker upgrade layout. It can be seen that central modules appear in RoIs more frequently, and in particular this is more pronounced for the innermost Pixel layer (layer 0), since the RoIs have to be extended in z to account from the size of the LHC luminous region. This implies that depending on the latency constraints etc, reading out some of the innermost layers of the tracker may not be viable and the pattern recognition studies should take this into account. Once the Trigger rate studies have advanced and we have more information about the L0 rate and the number of RoIs per event, the above studies will crucially provide some of the required parameters for the tracker readout architecture.

4.3.3 Plans for next 6 months

The main focus of the WP7 work in the coming six months will be on completing the L1 trigger rate studies for generic trigger signatures, such as electrons and muons, and on evaluating trigger efficiencies for benchmark physics channels for a variety trigger thresholds, with and without the L1Track information, and under different assumptions for the capabilities of L1Calo and L1Muon. The aim of these studies is to strengthen the physics case for L1Track and their results will be included in the ATLAS L1 Trigger Upgrade Technical Proposal.

On the hardware side, the interaction with the Tracker Upgrade electronics and chip design experts will continue in order to incorporate as much of the L0/L1 functionality into the next iteration of the ABCN and HCC ASIC designs and so that the overall stave design takes into consideration the L1Track requirements. As part of this effort, alternative data formats will be studied both for the normal readout and for the L1Track data readout in order to optimize the overall latency, dead time and use of the available bandwidth.

Finally, work will start on developing a fast and flexible framework for performing the pattern recognition studies and for optimizing the design parameters of L1Track, as well as for performing simulation studies at higher luminosities more effectively.

4.3.4 WP milestone plan

Milestones achieved in the last six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status

Milestones due in the next six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
M7.1	WP7	L1 Upgrade TP	Jun 2011			

Overall Milestone List

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status	Delay due to		Affects Critical Path?	See Note
							UK?	Other Collaborators?		
M7.1	WP7	L1 Upgrade TP	Jun 2011							1
M7.2	WP7	Pattern Rec.	Mar 2012							2
M7.3	WP7	RoIMapper	Sep 2012							3

1. L1 Upgrade TP: ATLAS Level-1 Trigger Upgrade Technical Proposal

2. Pattern Rec.: First Implementation of pattern recognition for L1Track
3. RoIMapper: Complete design of RoIMapper

4.3.5 Deliverable summary

Deliverable and description	Target Date (original)	Target date (revised)	Status
L1 trigger rates for muons & electrons vs. p_T at luminosities > 1e34cm^{-2}s^{-1} for the L1 Upgrade TP	Jun 2011		In progress
Document the physics requirements and the key design parameters of L1Track	Jun 2012		Started
Hardware demonstrator for RoIMapper	Mar 2013		Started

4.4 WP8: High Level Trigger

4.4.1 Impact of 70% descope on WP8

This work package covers the upgrade of the High Level Trigger to provide necessary changes to match upgrades of the ATLAS detector, increase of the LHC luminosity above design values and changes to track the evolution in computing and network infrastructure. As presented in the interactions with the PPRP, the result of the 70% de-scope is to delay part of the work for Phase-II, retaining the part needed to support WP6 and WP7, and reduce the scope of the Phase-I work to concentrate on the core areas of UK leadership in Trigger Tracking and selection software. This is in line with the current LHC and ATLAS planning which advances parts of the work, such as preparations for the Insertable B-Layer, while allowing some delay in part of the phase-II work.

Following the descope, WP8 focuses on the following tasks:

I. Optimise HLT Tracking software for Phase-I

II. Optimise trigger selections for Phase-I

III. Upgrade Trigger Steering Software

IV. Perform simulation studies to optimise the trigger selection strategy for Phase-II

The effect of the descope has been alleviated to some extent by a transfer of 0.9 FTEy from WP1 to WP8 to work on Tasks II and III. New effort has been reduced from the 4.5 FTEy requested to 2.3 FTEy, with a consequent de-scoping of Task 3. The delay in the start of the new posts has had a significant impact on the ramp-up of the project and delayed some deliverables. One post (NP2) has still to be filled, with a consequent further delay. In order to partially compensate for this loss of effort, we request to transfer part of the under-spend on this post in year-1 to extend NP1 to the end of year-3.

In addition to the reduction in effort, the equipment budget has been reduced by £5k (25%) by reducing the UK contribution to a large-scale system at CERN. Travel has been cut by £3k.

4.4.2 Commentary of project to date (WP8)

The work of the first 12 months has been focussed on three areas:

- Benchmarking existing ID and Muon tracking code
- Design of an upgraded L2 ID software package
- Assessment of the potential speed-up for trigger code implemented on Graphical Processor Units (GPU)

We have set up the infrastructure to bench-mark and optimize the performance of the tracking code using simulated high luminosity data. Monte-carlo simulated datasets have been copied to the UK and a software chain set up to run the trigger on this data to extract information of execution times and track reconstruction performance. Work to date has focussed on muon track reconstruction in pile-up data. This has already enabled some areas for optimisation and improvement to be identified and will provide a reference for performance measurements with other trigger selection chains.

Work has started on the design of a new L2 ID tracking software package (L2Star), building on existing trigger and offline code and adding the flexibility to further enhance performance for upgrade luminosities. Work is ongoing to optimize the EF muon code to minimize execution time. Performance measurements are underway with simulated high luminosity data.

In order to assess the potential benefit of implementing trigger code on commercial Graphics Processor Units (GPU), two components of the L2 tracking code (z-finder and fitter) have been implemented on GPU (NVidia Tesla C2050) and performance compared with equivalent code running on general purpose processors. First results are encouraging; a factor of 35 speed-up has been measured for the z-finder code and a factor of 12 improvement for the fitter.

4.4.3 Plans for next 6 months (WP8)

The work for the next 6 months will focus on:

- Extending the benchmarking of L2 ID tracking code to cover all trigger chains
- Optimizing components of the L2 ID tracking code
- Benchmarking and optimizing the EF ID and Muon tracking code
- Implementing a complete tracking chain on GPU

The first step of the L2 ID reconstruction (z-finder) will be optimized for high luminosity running. The bench-marking of the L2 ID code will be extended to all trigger chains in order to identify additional optimization issues that are unique to specific trigger signatures. Continued bench-marking of the EF ID and muon code will enable software configurations, optimized for upgrade luminosities, to be developed for the offline tools used at the EF.

A complete chain will be implemented for L2 ID tracking on GPU and performance measurements made. Possibilities for further optimization of the fitter code, exploiting further parallelization, will be explored. Once new post NP2 is filled, work will start on the High Level Trigger Steering software to add the necessary extensions, such as infrastructure for the IBL and FTK, and provide the flexibility needed to support studies of various options for optimizing the trigger selection software.

Milestones achieved in the last six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
M8.1	WP8	First GPU measurements : Zfinder & fitter	New	Dec 2010	Dec 2010	Complete

Milestones due in the next six months

Milestone No.	Work Package	Milestone Description	Original Date	Target Date	Actual Date	Status
M8.2	WP8	L2 Zfinder optimized	New	Sep 11		

Overall Milestone List

		Milestone Description	Original Date	Target Date	Actual Date	Status	Delay due to		Affects Critical Path?	See Note
							UK?	Other Collaborators?		
M8.1	WP8	First GPU measurements : Zfinder & fitter	Dec 2010		Dec 2010	Complete				
M8.2	WP8	L2 Zfinder optimized	Sep 11							
M8.3	WP8	HLT Tracking Code updated for IBL	Dec 11			Delayed	N	Y	N	1

M8.4	WP8	Trigger Selections Defined for MC Productions	Dec 11							
M8.5	WP8	Steering Code upgraded	Dec 12			Delayed	Y	N	N	2
M8.6	WP8	GPU speed-up measured for complete L2 tracking chain	Mar 12							
M8.7	WP8	HLT Selections updated for upgraded LVL1	Mar 13			Delayed	Y	N	N	2
M8.8	WP8	HLT Tracking code optimised for Phase-I	Mar 13							

Notes:

1. Delays to IBL simulation software provided by non-UK groups.
2. Delayed due to delay in new posts.

4.4.4 Deliverable summary

Deliverable and description	Target Date (original)	Target date (revised)	Status
Steering software upgraded	Dec 12		
HLT Tracking optimized	Mar 13		
Selection software optimized	Mar 13		

5. WP9: COMPUTING AND SIMULATION

5.1 Impact of the 70% Descope on WP9

The 70% descope has essentially resulted in the removal of most of the 'technology tracking' activity; the remaining effort in this area focuses on parallization and optimal exploitation of multi-cores, both stand-alone and on the Grid. A minimal effort remains positioning us to restart the coprocessor/GPGPU activity when appropriate, but most of this work has now been handed-over to WP8 (trigger) with support from WP9.

5.2 Progress of project to date

Delays in the confirmation of the upgrade grants have led to delays in the hiring of new effort and some loss of existing effort due to employment uncertainties. However, the activity has made good progress using the continuing and Rolling Grant effort.

Since April 2010, efforts continued to study electron inefficiencies and Inner Detector endcap performance under conditions with 400 pileup events per beam crossing. At the same time, the baseline machine scenario has evolved such that it is expected that the maximum pileup will be reduced to around 200: in the current ("Utopia") test layout studied by the Layout Task Force through 2009, the reduced level will result in lower, though still noticeable, fake rates in endcap pattern recognition. Further studies, taking advantage of the flexibility in changing the full simulation layout, have emphasized the need to minimize material in the barrel-endcap transition in order to increase the electron reconstruction efficiency.

These observations have added impetus to renewed study of more radical layout concepts in, for instance, the pixel endcaps. One possibility involves "bent staves" in a new conical section layout inspired by the successful BaBar Silicon Vertex Detector. This new design requires substantial development in the ATLAS simulation and reconstruction infrastructure, but promises to allow lower mass in the endcap region.

The upgrade software infrastructure has been integrated more closely with data-taking releases, allowing for more stability. Software adaptations made for the IBL project, including a different pixel digitization model appropriate for the FEI-4 readout chip, have been incorporated. A plan to migrate upgrade-related patches into the main ATLAS software, rather than keeping them as a branch with special build requirements, is being refined.

The visualization activity has been active since October 2010 (with the start of the new rolling grant). The initial focus has been on preparing Atlantis for the larger event sizes expected, particularly in pile-up events at high luminosities. Handling these will require some refactoring and optimization of the existing code, and this in turn can only be done reliably when a suite of tests is in place to verify the behaviour of the application. Work has begun on implementing such tests and on refactoring the code where appropriate. We have also been capturing wider requirements by consulting client groups working towards the Letter of Intent.

The radiation background analysis effort in 2010 focused on obtaining measurements to allow comparison with the Monte Carlo simulations. There have been two areas of good progress on this front. First the SCT modules detected small increases in leakage currents during 2010, which when averaged over hundreds of modules have yielded reliable estimates of the 1 MeV neutron equivalent damage fluences [1]. The second set of measurements involve the so-called RadMons, which are radiation sensitive devices installed in and around the ATLAS inner detector. In addition

to 1 MeV neutron equivalent fluences, the RadMons also measure the ionising-dose which is important for determining damage to detector electronics.

In addition to the measurements, a new detailed and final description of the inner detector material and services was implemented into the FLUKA simulations. The simulations for the case of 7 TeV collisions have been performed and fluence and dose predictions established at the LHC centre of mass collision energy of 7 TeV. Special emphasis was placed on the SCT and RadMon regions.

The results from the simulations and measurements are made available on the collaboration TWiki pages. Preliminary comparison shows good agreement between simulation and measurement for the SCT barrel and RadMons, though larger differences are seen in the inner most modules of the SCT end-caps which is currently under investigation.

We have completed a case study of possible performance improvements by parallelizing the GEANT4 tracking.

The PPRP indicated we should invest minimal effort into the coprocessor/GPU studies at this time. Accordingly, we have completed investigative work into their use in tracking, and handed the products over to WP8; we will maintain a minimal involvement to allow offline exploitation when appropriate. We have successfully ported the tracking Z finder algorithm which is used as input for the Level 2 tracking – this one of the slowest parts. We achieved a factor of 3000% performance improvement for design luminosity. This has been packaged up and documented and transitioned to WP8 for further study where they plan to do a full chain study. We've also helped with their Kalman filter design and have created good synergy with WP8.

We have been successful in creating several new partnerships with industry: we were awarded a Professor Partnership with NVIDIA and have initiated a close working relationship with Dell R&D. The first output is white paper research program with Dell, focusing on the optimal offline usage of upcoming storage solutions for ATLAS; this uses effort outwith the ATLAS upgrade.

Results have been presented at CHEP 2010, GTC 2010, and Berkeley winter school of computing.

In related work that will benefit the ATLAS upgrade programme, a new research theme has been created: “New techniques for ATLAS and GridPP to utilize modern computer architectures”, with support from the National eScience Centre.

5.3 Plans for next 6 months

The next 6 months will see more progress on layout studies under more recent LHC machine scenarios, with a maximum of 200 pileup. Recent improvements to both the speed and memory footprint of digitization will be incorporated into the upgrade software infrastructure, and the pileup tools are to be exercised in simulation production on grid systems. Possible changes to the pixel endcaps will be examined more thoroughly, starting with relatively straightforward changes to the number and position of the current pixel disks, and moving to a conical layout if deemed necessary by the new Inner Tracker Steering Committee. It is also planned that Atlfast modifications, including new track resolution models, will be designed for use in upgrade physics feasibility studies, with full simulation providing the relevant histograms and tuning parameters.

Recruitment of new effort at Edinburgh, Oxford and Sheffield has been delayed by the late release of upgrade funding, and will be completed over the next quarter.

In the next six months, work will continue on profiling the Atlantis code for speed and memory usage in simulated high luminosity events, and on improving its performance. Work will also begin

on implementing the upgrade geometry, beginning with the Inner Detector, which is best understood. The ongoing consultation with clients over requirements will continue.

The main radiation task goal over the next 6 months is a final conclusive report on the benchmarking of the backgrounds at 7TeV. In addition, updated simulations for the ATLAS inner tracker upgrade will be performed and a new ATLAS Upgrade report produced taking into account the new benchmarking results.

The main objective in the next six months for the interface work is to demonstrate that the parallelized AthenaMP con worth by Grid submission to special queues on the Grid. Performance studies will be made, to be complete by July. If time permits, the performance of leading-edge disk storage when supporting the io for AthenaMP reconstruction on multicore processors will be benchmarked, as input to the design of a modern io framework.

5.3.1 WP milestone plan

Overall Milestone List

		Milestone Description	Original Date	Target Date	Actual Date	Status	Delay due to		Affects Critical Path?	See Note
							UK?	Other Collaborators?		
Simulation tools for the LoI										
		Pileup tools	Sep 2011			On Track				
M9.1	WP9	Strip and pixel simulation release for LoI	Dec 2011			On Track				
M9.2	WP9	Initial Atlfast modifications and tune for large pileup and new detectors	Dec 2011			On Track				
Simulation tools for the TDR										
M9.3	WP9	upgrade simulation as default	Apr 2013			On Track				
M9.4	WP9	TDR pixel simulation	Jan 2013			On Track				
M9.5	WP9	Atlfast tuned for TDR studies	Mar 2013			On Track				
Visualization for Upgrade TDR										
M9.6	WP9	LoI detector geometry implemented	Dec 2011			On Track				
M9.7	WP9	Performance profiling and optimization for	Jul 2012			On Track				

		high luminosity								
M9.8	WP9	Atlantis release for TDR with TDR detector	Mar 2013			On Track				
Validated radiation model for upgrade										
M9.9	WP9	Validation of 7TeV inner detector fluences and doses	Dec 2011			On Track				
M9.10	WP9	Validation of 7TeV cavern fluences and impact for ATLAS Upgrade	Dec 2012			On Track				
M9.11	WP9	Radiological assessment and proposals for inner detector operations	Mar 2013			On Track				
Optimization, parallelization, frameworks and interfaces										
M9.12	WP9	AthenaMP on the Grid	Aug 2011			On Track				
M9.13	WP9	Parallelized analysis study	Apr 2012			On Track				
M9.14	WP9	Optimized parallelized code release	Mar 2013			On Track				

6. APPENDICES

6.1 Finance tables

6.1.1 Commentary on presentation of Rolling Grant figures

This note describes the funding of the ATLAS Upgrade through the project new money line (NM) and the RG line.

The project award letter from PPAN stated a total project cost of £13.97M corresponding to the 70% descope option presented to PPRP.

The NM was reduced to 70% of the award (£9.88M) in the spirit of the 70% descope presented to PPRP and taking account of the comments made in the award letter. In addition a further reduction was applied to take account of some WP1 RG effort that was transferred to other WPs following cancellation of WP1 (ATLAS-Forward Physics project).

The project NM cost is £9.50M and NM posts to the Universities were released on the basis of this.

To determine the RG costs, GLs revised their RG costs on the Upgrade project based on their PPGP award. The numbers returned total £6.08M compared to £6.75M in the proposal (the individual group numbers are given in column RG awarded by PPGP). The reductions correspond to staffing that was not funded by the PPGP, WP1 staff moved to other projects and some of the 10% post-prioritisation cut, which has been taken into account in different ways but the groups. No group increased their RG costs.

There is a resulting discrepancy between the PPAN award: £13.97M and the project total that takes account of the PPGP funding through the RG: £15.5M.

Therefore column 1, which is the PPAN approved budget, has an artificial scaling of the RG contributions to give a total project cost of £13.97M. Column "RG costs with PPGP input) reflects the realistic project cost taking into account the current level of RG costs, as supplied by GLs based on their PPGP awards.

All the financial calculations are made with reference to column "Approved (excluding contingency)" which corresponds to the PPAN approved total and the resulting difference is presented as a variance in the table. The current level of RG costs are given in the column: "RG awarded by PPGP".

The project costs, both RG and NM, are being reviewed to bring them in line with the PPRP/PPAN recommendation.

6.1.2 *Whole project (all 8 WPs)*

ATLAS Upgrade All WPs			Approved (excluding contingency) (1)	RG including PPGP input	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Projected (7-1-1a)
HEI / Universities	Birmingham	Rolling Grant	203.22	276.84	-	-	36.65	48.87	101.39	126.58	-	36.65	276.84	- 166.57	73.62
		New Money	63.94		-	-	-	-	15.97	47.98	-	-	63.94	- 63.94	-
	Cambridge	Rolling Grant	475.59	647.88	-	-	136.78	182.37	221.10	244.41	-	136.78	647.88	- 338.81	172.29
		New Money	164.80		-	-	2.85	3.80	61.00	100.00	-	2.85	164.80	- 161.95	-
	Edinburgh	Rolling Grant	22.00	29.97	-	-	3.49	4.65	10.95	14.37	-	3.49	29.97	- 18.51	7.97
		New Money	288.10		-	-	27.75	37.00	137.30	113.80	-	27.75	288.10	- 260.35	-
	Glasgow	Rolling Grant	257.23	350.42	-	-	83.28	111.04	116.24	123.14	-	83.28	350.42	- 173.95	93.19
		New Money	-		-	-	-	-	-	-	-	-	-	- -	-
	Lancaster	Rolling Grant	189.39	258.00	-	-	60.17	80.23	86.03	91.75	-	60.17	258.00	- 129.22	68.61
		New Money	35.33		-	-	6.51	8.67	13.22	13.44	-	6.51	35.33	- 28.83	-
	Liverpool	Rolling Grant	618.55	842.63	-	-	167.80	223.73	282.26	336.64	-	167.80	842.63	- 450.75	224.08
		New Money	-		-	-	-	-	-	-	-	-	-	- -	-
	Manchester	Rolling Grant	600.91	818.60	-	-	169.44	225.93	301.17	291.51	-	169.44	818.60	- 431.46	217.69
		New Money	-		-	-	-	-	-	-	-	-	-	- -	-
	Oxford	Rolling Grant	1,015.72	1,383.68	-	-	335.33	447.11	461.19	475.38	-	335.33	1,383.68	- 680.39	367.96
		New Money	137.59		-	-	20.64	27.52	55.04	55.04	-	20.64	137.59	- 116.95	-
	QMUL	Rolling Grant	468.31	637.96	-	-	144.48	192.64	212.19	233.13	-	144.48	637.96	- 323.83	169.65
		New Money	89.45		-	-	-	-	71.56	17.89	-	-	89.45	- 89.45	-
	RHUL	Rolling Grant	32.86	44.77	-	-	3.83	5.10	17.85	21.82	-	3.83	44.77	- 29.04	11.91
		New Money	212.78		-	-	10.65	14.20	98.52	100.06	-	10.65	212.78	- 202.13	-
	Sheffield	Rolling Grant	282.48	384.81	-	-	71.48	95.30	127.09	162.42	-	71.48	384.81	- 211.00	102.33
		New Money	159.54		-	-	13.20	17.60	70.63	71.30	-	13.20	159.54	- 146.34	-
	Sussex	Rolling Grant	14.71	20.04	-	-	3.29	4.39	6.75	8.91	-	3.29	20.04	- 11.42	5.33
		New Money	89.80		-	-	13.28	17.70	35.80	36.30	-	13.28	89.80	- 76.53	-
	UCL	Rolling Grant	282.84	385.30	-	-	87.53	116.70	134.30	134.30	-	87.53	385.30	- 195.31	102.46
		New Money	292.60		-	-	45.15	60.20	120.40	112.00	-	45.15	292.60	- 247.45	-
Total HEI / University Staff															
Total - Rolling Grant			4,463.81	6,080.89	-	-	1,303.54	1,738.05	2,078.49	2,264.36	-	1,303.54	6,080.89	- 3,160.28	1,617.08
Total - New Money			1,533.94		-	-	140.02	186.69	679.44	667.81	-	140.02	1,533.94	- 1,393.92	-
STFC	RAL PPD		2,497.91		-	-	230.80	670.37	851.76	975.78	-	230.80	2,497.91	- 2,267.11	-
	TD		2,119.77		-	-	138.90	510.74	778.02	831.01	-	138.90	2,119.77	- 1,980.87	-
Total STFC Staff			4,617.68		-	-	369.70	1,181.12	1,629.78	1,806.79	-	369.70	4,617.68	- 4,247.98	-
Recurrent															
Equipment			2,360.75		-	-	141.00	353.10	1,319.92	687.73	-	141.00	2,360.75	- 2,219.75	-
Consumables			169.54		-	-	-	53.52	54.06	61.96	-	-	169.54	- 169.54	-
Travel			567.16		-	-	75.47	165.53	199.23	202.40	-	75.47	567.16	- 491.69	-
Other															
Total Recurrent			3,097.45		-	-	216.47	572.15	1,573.21	952.08	-	216.47	3,097.45	- 2,880.97	-
Project total			13,712.87		-	-	2,029.73	3,678.00	5,960.91	5,691.04	-	2,029.73	15,329.95	- 11,683.15	1,617.08
Working Margin			254.13		-	-	-	74.65	80.60	98.88		-	254.13	- 254.13	-
Contingency															
Project Total (including margin/contingency			13,967.00		-	-	2,029.73	3,752.65	6,041.51	5,789.92	-	2,029.73	15,584.08	- 11,937.27	1,617.08
Rolling grant			4,463.81		-	-	1,303.54	1,738.05	2,078.49	2,264.36	-	1,303.54	6,080.89	- 3,160.28	1,617.08
Project Total (less rolling grant			9,503.19		-	-	726.19	2,014.61	3,963.02	3,525.56	-	726.19	9,503.19	- 8,777.00	-

6.1.3 WP2

ATLAS Upgrade WP2			Approved (excluding contingency) (1)	RG awarded by PPGP	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Current financial year 10/11 Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Total Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Variance Projected (7-1-1a)
Staff															
HEI / Universities	Oxford	Rolling Grant	296.65	370.4	-	-	101.0	134.7	134.7	134.7		101.0	404.1	- 195.6	107.5
		New Money	-		-	-	-					-	-	-	-
	Sheffield	Rolling Grant	146.30	134.9	-	-	31.4	41.8	61.7	95.8		31.4	199.3	- 114.9	53.0
		New Money	-		-	-	-					-	-	-	-
	Glasgow	Rolling Grant	85.90	91.3	-	-	21.3	28.4	41.5	47.0		21.3	117.0	- 64.6	31.1
		New Money	-		-	-	-		-	-		-	-	-	-
	Cambridge	Rolling Grant	155.64	192.6	-	-	49.1	65.5	77.9	68.6		49.1	212.0	- 106.5	56.4
		New Money	-		-	-	-					-	-	-	-
	Birmingham	Rolling Grant	35.04	41.6	-	-	10.7	14.3	16.6	16.9		10.7	47.7	- 24.3	12.7
		New Money	-		-	-	-		-	-		-	-	-	-
	Liverpool	Rolling Grant	263.33	287.2	-	-	76.1	101.4	109.8	147.5		76.1	358.7	- 187.3	95.4
		New Money	-		-	-	-					-	-	-	-
	Lancaster	Rolling Grant	108.09	121.4	-	-	32.3	43.1	45.9	58.2		32.3	147.3	- 75.7	39.2
		New Money	-		-	-	-		-	-		-	-	-	-
	QMUL	Rolling Grant	52.25	64.0	-	-	17.4	23.3	23.3	24.6		17.4	71.2	- 34.8	18.9
		New Money	-		-	-	-		-	-		-	-	-	-
Total HEI / University Staff															
Total - Rolling Grant			1,143.2	1,303.4	-	-	339.4	452.6	511.4	593.4		339.4	1,557.3	- 803.8	414.1
Total - New Money			-		-	-	-		-	-		-	-	-	-
STFC		RAL PPD	206.1		-	-	42.5	64.4	73.7	68.0		42.5	206.1	- 163.6	-
		TD	314.3		-	-	6.2	74.9	122.3	117.1		6.2	314.3	- 308.1	-
Total STFC Staff			520.4		-	-	48.7	139.3	196.0	185.2		48.7	520.4	- 471.7	-
Recurrent															
Equipment			947.7		-	-	42.4	169.0	444.8	333.9		42.4	947.7	- 905.3	-
Consumables			73.0		-	-	-	21.0	21.0	31.0		-	73.0	- 73.0	-
Travel			118.1		-	-	20.9	35.1	41.5	41.5		20.9	118.1	- 97.2	-
Working Margin			50.9		-	-	-	15.2	7.2	28.5		-	50.9	- 50.9	-
Total excluging University			1,710.1		-	-	112.0	379.6	710.4	620.1		112.0	1,710.1	- 1,598.0	-
Total including University			2,853.3		-	-	451.4	832.1	1,221.9	1,213.4	-	451.4	3,267.4	- 2,401.8	414.1

6.1.4 WP3

ATLAS Upgrade WP3			Approved (excluding contingency) (1)	RG awarded by PPGP	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Current financial year 10/11 Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Total Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Variance Projected (7-1-1a)
Staff															
HEI / Universities	Oxford	Rolling Grant	210.07	253.95	-	-	68.0	90.7	95.3	100.2		68.0	286.2	- 142.1	76.1
		New Money	-		-	-	-		-	-		-	-	-	-
	Cambridge	Rolling Grant	187.86	216.76	-	-	54.6	72.7	89.5	93.7		54.6	255.9	- 133.3	68.1
		New Money	-		-	-	-		-	-		-	-	-	-
	Liverpool	Rolling Grant	58.97	67.37	-	-	17.5	23.4	26.5	30.5		17.5	80.3	- 41.4	21.4
		New Money	-		-	-	-		-	-		-	-	-	-
	UCL	Rolling Grant	31.49	39.33	-	-	10.7	14.3	14.3	14.3		10.7	42.9	- 20.8	11.4
		New Money	-		-	-	-		-	-		-	-	-	-
	RHUL	Rolling Grant	-	-	-	-	-	-	-	-		-	-	-	-
		New Money	-		-	-	-		-	-		-	-	-	-
	QMUL	Rolling Grant	22.56	26.85	-	-	7.1	9.5	10.2	11.0		7.1	30.7	- 15.4	8.2
		New Money	-		-	-	-		-	-		-	-	-	-
Total HEI / University Staff															
Total - Rolling Grant			511.0	604.25	-	-	157.9	210.6	235.8	249.7		157.9	696.1	- 353.0	185.1
Total - New Money			-		-	-	-		-	-		-	-	-	-
STFC		RAL PPD	456.9		-	-	77.7	124.4	159.9	172.6		77.7	456.9	- 379.2	-
		TD	105.8		-	-	0.2	42.3	27.6	36.0		0.2	105.8	- 105.6	-
Total STFC Staff			562.8		-	-	77.9	166.7	187.5	208.6		77.9	562.8	- 484.9	-
Recurrent															
Equipment			133.2		-	-	16.0	40.2	44.0	49.0		16.0	133.2	- 117.2	-
Consumables			-		-	-	-	-	-	-		-	-	-	-
Travel			48.8		-	-	1.7	12.0	18.4	18.5		1.7	48.8	- 47.1	-
Working Margin			-		-	-	-	-	-	-		-	-	-	-
Total excluging University			744.8		-	-	95.6	218.9	249.9	276.0		95.6	744.8	- 649.2	-
Total including University			1,255.7		-	-	253.5	429.4	485.6	525.8	-	253.5	1,440.8	- 1,002.2	185.1

6.1.5 WP4

ATLAS Upgrade WP4			Approved (excluding contingency) (1)	RG awarded by PPGP	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Total Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Variance Projected (7-1-1a)
Staff															
HEI / Universities	Oxford	Rolling Grant	487.82	595.02	-	-	160.4	213.9	220.7	229.9		160.4	664.5	- 327.4	176.7
		New Money	-		-	-	-					-	-	-	-
	Sheffield	Rolling Grant	96.12	116.66	-	-	31.0	41.4	44.3	45.3		31.0	130.9	- 65.1	34.8
		New Money	-		-	-	-					-	-	-	-
	Glasgow	Rolling Grant	37.88	57.13	-	-	17.9	23.9	15.3	12.4		17.9	51.6	- 20.0	13.7
		New Money	-		-	-	-	-	-	-		-	-	-	-
	Liverpool	Rolling Grant	110.13	121.03	-	-	29.4	39.1	52.5	58.4		29.4	150.0	- 80.8	39.9
		New Money	-		-	-	-	-	-	-		-	-	-	-
	lancaster	Rolling Grant	79.28	102.00	-	-	27.0	36.0	39.0	33.0		27.0	108.0	- 52.3	28.7
		New Money	-		-	-	-	-	-	-		-	-	-	-
	Edinburgh	Rolling Grant	8.05	5.72	-	-	1.1	1.5	3.1	6.4		1.1	11.0	- 6.9	2.9
		New Money	-		-	-	-	-	-	-		-	-	-	-
	QMUL	Rolling Grant	271.88	339.51	-	-	92.6	123.5	123.5	123.5		92.6	370.4	- 179.3	98.5
		New Money	-		-	-	-	-	-	-		-	-	-	-
Total HEI / University Staff															
Total - Rolling Grant			1,091.2	1,337.06	-	-	359.4	479.2	498.4	508.8		359.4	1,486.5	- 731.7	395.3
Total - New Money			-		-	-	-	-	-	-		-	-	-	-
STFC		RAL PPD	416.8		-	-	67.0	81.2	138.3	197.3		67.0	416.8	- 349.8	-
		TD	1,126.7		-	-	129.0	300.7	408.9	417.1		129.0	1,126.7	- 997.7	-
Total STFC Staff			1,543.5		-	-	196.0	381.9	547.2	614.3		196.0	1,543.5	- 1,347.5	-
Recurrent															
Equipment			519.4		-	-	82.6	98.9	288.6	131.8		82.6	519.4	- 436.8	-
Consumables			51.5		-	-	-	17.5	18.1	16.0		-	51.5	- 51.5	-
Travel			142.5		-	-	23.3	37.9	50.8	53.8		23.3	142.5	- 119.2	-
Working Margin			85.8		-	-	-	30.2	30.2	25.4		-	85.8	- 85.8	-
Total excluging University			2,342.7		-	-	301.9	566.4	934.9	841.4		301.9	2,342.7	- 2,040.8	-
Total including University			3,433.8		-	-	661.3	1,045.7	1,433.3	1,350.2	-	661.3	3,829.1	- 2,772.5	395.3

6.1.6 WP5

ATLAS Upgrade WP5			Approved (excluding contingency) (1)	RG awarded by PPGP	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Total Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Variance Projected (7-1-1a)
Staff															
HEI / Universities	Glasgow	Rolling Grant	133.45	162.1	-	-	44.0	58.7	59.4	63.7		44.0	181.8	- 89.4	48.3
		New Money	-		-	-	-	-	-	-		-	-	-	-
	Birmingham	Rolling Grant	-	-	-	-	-	-	-	-		-	-	-	-
		New Money	-		-	-	-	-	-	-		-	-	-	-
	Oxford	Rolling Grant	-	-	-	-	-	-	-	-		-	-	-	-
		New Money	-		-	-	-					-	-	-	-
	Manchester	Rolling Grant	565.09	663.8	-	-	162.4	216.5	284.9	268.4		162.4	769.8	- 402.7	204.7
		New Money	-		-	-	-	-	-	-		-	-	-	-
	Liverpool	Rolling Grant	157.06	166.0	-	-	37.2	49.6	79.3	85.1		37.2	214.0	- 119.9	56.9
		New Money	-		-	-	-					-	-	-	-
Total HEI / University Staff															
Total - Rolling Grant			855.6	991.9	-	-	243.6	324.8	423.6	417.2		243.6	1,165.6	- 612.0	310.0
Total - New Money			-		-	-	-	-	-	-		-	-	-	-
STFC		RAL PPD	200.0		-	-	43.6	59.2	60.3	80.5		43.6	200.0	- 156.4	-
		TD	74.8		-	-	3.5	12.8	26.8	35.2		3.5	74.8	- 71.3	-
Total STFC Staff			274.8		-	-	47.1	71.9	87.2	115.7		47.1	274.8	- 227.7	-
Recurrent															
Equipment			574.0		-	-	-	29.0	466.0	79.0		-	574.0	- 574.0	-
Consumables			36.0		-	-	-	12.0	12.0	12.0		-	36.0	- 36.0	-
Travel			61.8		-	-	12.2	20.6	20.6	20.6		12.2	61.8	- 49.6	-
Working Margin			58.0					18.0	23.3	16.7					
Contingency			-		-	-	-					-	-	-	-
Total excluging University			1,004.6		-	-	59.3	151.6	609.1	244.0		59.3	946.6	- 887.3	-
Total including University			1,860.2		-	-	302.9	476.3	1,032.7	661.1		302.9	2,112.1	- 1,499.3	310.0

6.1.7 WP6

ATLAS Upgrade WP6			Approved (excluding contingency) (1)	RG awarded by PPGP	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Total Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Variance Projected (7-1-1a)
Staff															
HEI / Universities	Birmingham	Rolling Grant	168.18	145.4	-	-	26.0	34.6	84.8	109.7		26.0	229.1	- 142.2	60.9
		New Money	63.9		-	-	-	-	16.0	48.0		-	63.9	- 63.9	-
	QMUL	Rolling Grant	121.62	119.0	-	-	27.3	36.4	55.2	74.0		27.3	165.7	- 94.3	44.1
		New Money	89.5		-	-	-	-	71.6	17.9		-	89.5	- 89.5	-
	Cambridge	Rolling Grant	103.84	111.9	-	-	30.4	40.6	40.9	60.0		30.4	141.5	- 73.4	37.6
		New Money	164.8		-	-	2.9	3.8	61.0	100.0		2.9	164.8	- 162.0	-
Total HEI / University Staff															
Total - Rolling Grant			393.6	376.3	-	-	83.7	111.6	180.9	243.7		83.7	536.2	- 309.9	142.6
Total - New Money			318.2		-	-	2.9	3.8	148.5	165.9		2.9	318.2	- 315.3	-
STFC		RAL PPD	917.7		-	-		273.5	305.2	339.1		-	917.7	- 917.7	-
		TD	498.2		-	-		80.2	192.4	225.6		-	498.2	- 498.2	-
Total STFC Staff			1,415.9		-	-		353.6	497.6	564.7		-	1,415.9	- 1,415.9	-
Recurrent															
Equipment			135.0		-	-	-	12.0	53.0	70.0		-	135.0	- 135.0	-
Consumables			-		-	-	-	-	-	-		-	-	- -	-
Travel			45.0		-	-	1.5	15.0	15.0	15.0		1.5	45.0	- 43.5	-
Working Margin			50.0					10.0	15.0	25.0					
Contingency			-		-	-						-	-	- -	-
Total excluging University			1,845.9		-	-	1.5	390.6	580.6	674.7		1.5	1,595.9	- 1,594.5	-
Total including University			2,357.7		-	-	88.0	506.1	910.0	1,084.3		88.0	2,450.3	- 2,219.7	142.6

6.1.8 WP7

ATLAS Upgrade WP7			Approved (excluding contingency) (1)	RG awarded by PPGP	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Total Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Variance Projected (7-1-1a)
Staff															
HEI / Universities	Liverpool	Rolling Grant	29.06	32.1	-	-	7.7	10.3	14.2	15.2		7.7	39.6	- 21.4	10.5
		New Money	-		-	-	-					-	-	- -	-
	Sheffield	Rolling Grant	-	-	-	-	-	-	-	-		-	-	- -	-
		New Money	-		-	-	-	-	-	-		-	-	- -	-
	Sussex	Rolling Grant	14.71	14.4	-	-	3.3	4.4	6.7	8.9		3.3	20.0	- 11.4	5.3
		New Money	89.8		-	-	13.3	17.7	35.8	36.3		13.3	89.8	- 76.5	-
	UCL	Rolling Grant	131.55	149.6	-	-	36.0	48.0	65.6	65.6		36.0	179.2	- 95.5	47.7
		New Money	200.0		-	-	30.0	40.0	80.0	80.0		30.0	200.0	- 170.0	-
	RHUL	Rolling Grant	23.69	22.4	-	-	3.8	5.1	13.5	13.7		3.8	32.3	- 19.9	8.6
		New Money	133.3		-	-	10.7	14.2	59.0	60.1		10.7	133.3	- 122.6	-
Total HEI / University Staff															
Total - Rolling Grant			199.0	218.5	-	-	50.8	67.7	100.0	103.4		50.8	271.1	- 148.2	72.1
Total - New Money			423.1		-	-	53.9	71.9	174.8	176.4		53.9	423.1	- 369.2	0.0
STFC			-		-	-						-	-	- -	-
			-		-	-						-	-	- -	-
Total STFC Staff			-		-	-	-	-	-	-		-	-	- -	-
Recurrent															
Equipment			20.5		-	-	-	-	7.5	13.0		-	20.5	- 20.5	-
Consumables			-		-	-	-	-	-	-		-	-	- -	-
Travel			42.0		-	-	5.9	12.0	15.0	15.0		5.9	42.0	- 36.1	-
Working Margin			2.1					-	0.8	1.3					
Contingency			-		-	-						-	-	- -	-
Total excluging University			64.6		-	-	5.9	12.0	23.3	29.3		5.9	62.5	- 56.6	-
Total including University			686.6		-	-	110.7	151.6	298.0	309.1		110.7	756.7	- 573.9	72.1

6.1.9 WP8

ATLAS Upgrade WP8			Approved (excluding contingency) (1)	RG awarded by PPGP	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Total Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Variance Projected (7-1-1a)
Staff															
HEI / Universities	UCL	Rolling Grant	9.47	11.8	-	-	3.2	4.3	4.3	4.3		3.2	12.9	6.2	3.4
		New Money	92.6		-	-	15.2	20.2	40.4	32.0		15.2	92.6	77.5	-
	RHUL	Rolling Grant	9.18	4.4	-	-	-	-	4.4	8.1		-	12.5	9.2	3.3
		New Money	79.5		-	-	-	-	39.5	40.0		-	79.5	79.5	-
	Manchester	Rolling Grant	35.82	32.8	-	-	7.1	9.4	16.3	23.1		7.1	48.8	28.8	13.0
		New Money	-		-	-	-					-	-	-	-
	Oxford	Rolling Grant	-	-	-	-	-	-	-	-		-	-	-	-
		New Money	-		-	-	-					-	-	-	-
Total HEI / University Staff															
Total - Rolling Grant			54.5	49.0	-	-	10.3	13.7	25.0	35.5		10.3	74.2	44.2	19.7
Total - New Money			172.1		-	-	15.2	20.2	79.9	72.0		15.2	172.1	157.0	-
STFC		RAL PPD	300.3		-	-		67.7	114.3	118.3		-	300.3	300.3	-
			-		-	-						-	-	-	-
Total STFC Staff			300.3		-	-		67.7	114.3	118.3		-	300.3	300.3	-
Recurrent															
Equipment			15.0		-	-	-	-	10.0	5.0		-	15.0	15.0	-
Consumables			-		-	-	-	-	-	-		-	-	-	-
Travel			18.0		-	-	4.8	6.0	6.0	6.0		4.8	18.0	13.2	-
Working Margin			3.8					-	3.0	0.8					
Contingency			-		-	-						-	-	-	-
Total excluging University			337.1		-	-	4.8	73.7	133.3	130.1		4.8	333.3	328.5	-
Total including University			563.7		-	-	30.2	107.6	238.2	237.6		30.2	579.6	529.6	19.7

6.1.10 WP9

ATLAS Upgrade WP9			Approved (excluding contingency) (1)	RG awarded by PPGP	Transfers (1a)	Actual spend in previous years (2)	Current financial year 10/11 Actual spend April 10-Jan 11 (3)	Projected (4)	Latest estimate of future requirement 11/12	12/13 (5)	13/14	Total Actual spend (2+3) (6)	Total Projected spend (2+4+5) (7)	Variance Actual (6-1-1a)	Variance Projected (7-1-1a)
Staff															
HEI / Universities	Oxford	Rolling Grant	21.17	24.2	-	-	5.9	7.8	10.5	10.5		5.9	28.8	15.3	7.7
		New Money	137.6		-	-	20.6	27.5	55.0	55.0		20.6	137.6	117.0	-
	UCL	Rolling Grant	110.33	137.8	-	-	37.6	50.1	50.1	50.1		37.6	150.3	72.8	40.0
		New Money	-		-	-	-					-	-	-	-
	Cambridge	Rolling Grant	28.26	19.0	-	-	2.6	3.5	12.8	22.1		2.6	38.5	25.6	10.2
		New Money	-		-	-	-	-	-	-		-	-	-	-
	Sheffield	Rolling Grant	40.06	42.3	-	-	9.1	12.1	21.1	21.4		9.1	54.6	31.0	14.5
		New Money	159.5		-	-	13.2	17.6	70.6	71.3		13.2	159.5	146.3	-
	Edinburgh	Rolling Grant	13.95	13.4	-	-	2.4	3.2	7.9	8.0		2.4	19.0	11.6	5.1
		New Money	288.1		-	-	27.8	37.0	137.3	113.8		27.8	288.1	260.4	-
	Lancaster	Rolling Grant	2.02	3.0	-	-	0.8	1.1	1.1	0.6		0.8	2.8	1.2	0.7
		New Money	35.3		-	-	6.5	8.7	13.2	13.4		6.5	35.3	28.8	-
Total HEI / University Staff															
Total - Rolling Grant			215.8	239.7	-	-	58.4	77.8	103.5	112.7		58.4	294.0	157.4	78.2
Total - New Money			620.6		-	-	68.1	90.8	276.2	253.6		68.1	620.6	552.5	-
STFC			-		-	-						-	-	-	-
			-		-	-						-	-	-	-
Total STFC Staff			-		-	-		-	-	-		-	-	-	-
Recurrent															
Equipment			16.0		-	-	-	4.0	6.0	6.0		-	16.0	16.0	-
Consumables			9.0		-	-	-	3.0	3.0	3.0		-	9.0	9.0	-
Travel			91.0		-	-	5.2	27.0	32.0	32.0		5.2	91.0	85.8	-
Working Margin			3.6					1.2	1.2	1.2					
Contingency			-		-	-						-	-	-	-
Total excluging University			119.6		-	-	5.2	35.2	42.2	42.2		5.2	116.0	110.8	-
Total including University			956.0		-	-	131.7	203.8	421.9	408.4		131.7	1,030.5	820.7	78.2

6.1.11 Notes on finance tables

1. Spend to date of capital and STFC staff is derived exclusively from SSC figures. It only reports on actuals not commit, and includes full overheads on staff costs.
2. A superficial look at the bookings suggest that no large payments have either been made or taken incorrectly. It is possible that some bookings have been made to other cost codes, and these will need correcting at a later date – if this is the case these costs will be incurred at a later date, and there is no robust way to check against this.
3. Over the last 12 months universities have been buying things internally and then charging back to STFC, this would also increase the cost of the project, but should become less common as SSC provided direct access to non-STFC staff.
4. At the end of the last phase of the project there was still capital, and STFC effort left over, we were allowed to stretch this money as a zero cost extension from April 1st –Jun 30th 2010. The money spent in this time is not part of this phase of the project and is thus not shown. To be explicit:
    - University costs are from April 1st 2010
    - STFC staff costs, Capital costs and Travel costs in WP2-5 are from July 1st 2010
    - Travel costs in WP6-9 are from 1st April 2010
    - Capital and STFC staff costs in WP6-9 are from 1st April 2010
5. In this period 42.6k was charged to WP9 (as shown in SSC) this is understood to be a miss booking and should be removed in the future – thus it does not appear in these accounts.
6. Due to the uncertainties in the funding situation in the earlier part of this year not every item reported in the tables had a unique cost centre; this has meant that in some cases retrospective divisions have had to be overlaid. Much of this has been done by scaling the booking by the numbers of areas that were sharing the code. The effect of this is that whilst the totals are correct, some of the WP by WP breakdowns are a little artificial.
7. TD and PPD effort fractions seem inconsistent in first year due to zero cost extension of last grant partially supporting these staff.
8. The figures in the spend to date column should not be considered final, it is very likely that corrections will be applied to SSC over the next few weeks that will correct miss bookings etc and this these figures may go down as well as up. Once the FY is closed these numbers will be fixed, and next year will hopefully be more stables as our understanding of SSC is improving.
9. In WP2-4 column 3 is titled "Actual spend April 10-Jan 11" this denotes actual spend against this project, and due to the timing of when we started drawing on this project includes no spend before July 1st 2010.
10. The working margin has not been re-profiled with the capital and consumable costs.

6.2 Manpower usage

6.2.1 Notes on Manpower tables

1. PPD had anticipated that Richard Holt work on WP2-4. In the last round of redundancy Richard left, and with a little rearrangement of tasks that work has now been taken over by TD. For now the effort is costed as if it were PPD, but charged at TD rates. If it becomes clear that within this project there is no way PPD can fulfil this role the money will be transferred to TD.
2. Aside from the obvious categories of Rolling Grant, New Money and STFC there are a number of other key rolls that are funded from elsewhere. These are listed as "Other" and are included to show key roles within the UK supported by other means.

6.2.2 WP2

				FTE totals			
Institute	**Name**	**Role**	**type**	**10/11**	**11/12**	**12/13**	**Total**
Birmingham	C.M Hawkes	Ac	RG	0.00	0.10	0.10	0.20
	J.A.Wilson	Ac	Other	0.05	0.10	0.10	0.25
	R.J Staley	E	RG	0.10	0.10	0.10	0.30
	S. Pyatt	T	RG	0.25	0.25	0.25	0.75
Cambridge	B. Hommels	Ac	RG	0.10	0.10	0.10	0.30
	D Robinson	Ph	RG	0.30	0.30	0.30	0.90
	MA Parker	Ac	RG	0.20	0.20	0.20	0.60
	MJ Goodrick	E	RG	0.20	0.30	0.20	0.70
	RJ Shaw	T	RG	0.40	0.50	0.50	1.40
Glasgow	Bates	Ap	RG	0.05	0.05	0.10	0.20
	Doherty	T	RG	0.30	0.40	0.40	1.10
	McEwan	T	RG	0.00	0.10	0.10	0.20
	O'Shea	Ac	RG	0.10	0.10	0.15	0.35
	Blue	Ap	RG	0.30	0.40	0.40	1.10
Lancaster	A. Chilingarov	Ph	RG	0.70	0.70	0.70	2.10
	H. Fox	Ac	Other	0.03	0.03	0.03	0.10
	H. Fox	Ac	RG	0.02	0.02	0.02	0.06
	I. Mercer	Tec	RG	0.00	0.00	0.20	0.20
Liverpool	Affolder A	Ap	RG	0.27	0.27	0.29	0.83
	Allport P	Ac	RG	0.09	0.09	0.09	0.26
	Carroll JL	E	RG	0.05	0.05	0.05	0.14
	Casse G-L	Ap	RG	0.23	0.23	0.24	0.69
	Dervan P	Ap	RG	0.09	0.14	0.19	0.42
	Greenall A	E	RG	0.54	0.54	0.57	1.65
	Sutcliffe P	E	RG	0.05	0.05	0.05	0.14
	Tsurin I	E	RG	0.09	0.00	0.00	0.09
	Use of Liverpool LSDC facility	T	NM	0.05	0.10	0.10	0.25

			RG	0.05	0.08	0.13	0.26
	Use of Liverpool workshop	T	NM	0.20	0.30	0.40	0.90
			RG	0.40	0.50	0.70	1.60
	Whitley M	T	RG	0.05	0.09	0.10	0.23
	Wormald MP	T	RG	0.36	0.36	0.38	1.10
Oxford	A.R. Weidberg	Ac	RG	0.20	0.20	0.20	0.60
	Electrical Techs	T	Other	0.17	0.17	0.17	0.50
			RG	0.34	0.34	0.34	1.01
	Mechanical Techs	T	Other	0.17	0.17	0.17	0.50
			RG	0.34	0.34	0.34	1.01
	P. Lau	E	RG	0.20	0.20	0.20	0.60
	R. Wastie	E	RG	1.00	1.00	1.00	3.00
QMUL	A.Bevan	Ac	RG	0.15	0.15	0.15	0.45
	A.Martin	Ac	RG	0.10	0.10	0.10	0.30
	G.Beck	Ph	RG	0.10	0.10	0.10	0.30
	J.Mistry	T	RG	0.10	0.10	0.10	0.30
	J.Morris	E	RG	0.10	0.10	0.10	0.30
	M.Bona	Ac	RG	0.20	0.20	0.30	0.70
RAL (PPD)	J. Matheson	Ap	PPD	0.10	0.10	0.10	0.30
	M. Tyndel	Ac	PPD	0.40	0.30	0.25	0.95
	P. Philips	Ap	PPD	0.20	0.20	0.20	0.60
RAL (TD)	eng support	E	TD	0.80	0.50	0.47	1.77
	I. Church	E	TD	0.10	0.25	0.25	0.60
	R. Matson	E	TD	0.20	0.25	0.25	0.70
	M. Key-Charriere	E	TD	0.67	0.50	0.45	1.62
	P. Booker	E	TD	0.10	0.10	0.10	0.30
Sheffield	E. Paganis	Ac	RG	0.10	0.20	0.20	0.50
	I. Dawson	Ph	RG	0.00	0.10	0.30	0.40
	P. Hodgson	Ph	RG	0.30	0.30	0.30	0.90
	P. Johansson	Ph	RG	0.00	0.00	0.20	0.20
	R.S. French	E	RG	0.20	0.30	0.30	0.80
Grand Total				11.92	12.78	13.84	38.54

6.2.3 WP3

				FTE totals			
Institute	**Name**	**Role**	**type**	**10/11**	**11/12**	**12/13**	**Total**
Cambridge	B. Hommels	Ac	RG	0.40	0.50	0.50	1.40
	CG Lester	Ac	RG	0.10	0.15	0.20	0.45
	D Robinson	Ph	RG	0.20	0.20	0.20	0.60
	JC Hill	Ph	RG	0.25	0.30	0.40	0.95
	MJ Goodrick	E	RG	0.20	0.30	0.20	0.70
Liverpool	Affolder A	Ap	RG	0.09	0.09	0.10	0.28
	Burdin S	Ac	RG	0.02	0.03	0.03	0.08

	Dervan P	Ap	RG	0.18	0.23	0.29	0.69
	Greenall A	E	RG	0.09	0.09	0.10	0.28
	Greenshaw T	Ac	RG	0.03	0.03	0.03	0.09
	King BT	Ph	NM	0.00	0.00	0.05	0.05
	Use of Liverpool LSDC facility	T	Other	0.00	0.00	0.00	0.01
			RG	0.01	0.01	0.01	0.02
	Vossebeld J	Ac	RG	0.07	0.07	0.07	0.20
Oxford	A. Barr	Ac	RG	0.04	0.15	0.20	0.39
	A.R. Weidberg	Ac	RG	0.10	0.10	0.10	0.30
	B.T. Huffman	Ac	RG	0.20	0.30	0.30	0.80
	C. Issever	Ac	RG	0.00	0.00	0.20	0.20
	M. Jones	E	RG	0.50	0.50	0.50	1.50
	Mechanical Electrical support	T	NM	0.17	0.17	0.17	0.50
			RG	0.34	0.34	0.34	1.01
	Mechanical Technical support	T	NM	0.17	0.17	0.17	0.50
			RG	0.34	0.34	0.34	1.01
	S. Yang	E	RG	0.20	0.20	0.20	0.60
QMUL	A.Martin	Ac	RG	0.05	0.10	0.15	0.30
	G.Beck	Ph	RG	0.10	0.10	0.10	0.30
RAL (PPD)	B. Gallop	Ap	PPD	0.50	0.50	0.50	1.50
	G. Villani	E	PPD	0.50	0.50	0.50	1.50
	J. Matheson	Ap	PPD	0.30	0.30	0.30	0.90
	P. Philips	Ap	PPD	0.30	0.30	0.30	0.90
	M Gibson	E	PPD	0.15	0.05	0.15	0.35
RAL (TD)	Tech support	E	TD	0.49	0.11	0.21	0.81
UCL	M. Warren	E	RG	0.35	0.35	0.35	1.05
	J. Butterworth	Ac	RG	0.05	0.05	0.05	0.15
Grand Total				6.46	6.61	7.29	20.36

6.2.4 WP4

				FTE totals			
Institute	**Name**	**Role**	**type**	**10/11**	**11/12**	**12/13**	**Total**
Edinburgh	A.Main	T	RG	0.05	0.10	0.20	0.35
	P. Clark	Ac	Other	0.10	0.10	0.10	0.30
Glasgow	Bates	Ap	RG	0.20	0.15	0.10	0.45
	McEwan	T	RG	0.40	0.20	0.20	0.80
Lancaster	H. Fox	Ac	RG	0.02	0.05	0.05	0.12
	H. Fox	Ac	Other	0.03	0.05	0.05	0.13
	I. Mercer	Tec	RG	0.90	0.90	0.70	2.50
Liverpool	Allport P	Ac	RG	0.01	0.01	0.01	0.04
	Burdin S	Ac	RG	0.05	0.07	0.07	0.18

	Carroll JL	E	RG	0.05	0.05	0.05	0.14
	Greenshaw T	Ac	RG	0.01	0.01	0.01	0.04
	Jones TJ	Ap	RG	0.36	0.54	0.57	1.47
	Muskett DA	T	NM	0.00	0.00	0.10	0.10
	Sutcliffe P	E	RG	0.05	0.05	0.05	0.14
	Use of Liverpool workshop	T	Other	0.10	0.10	0.20	0.40
			RG	0.20	0.20	0.20	0.60
	Whitley M	T	RG	0.05	0.09	0.10	0.24
Oxford	Electrical Techs	T	NM	0.17	0.42	0.67	1.26
			RG	0.34	0.84	1.34	2.51
	G. Viehhauser	Ac	RG	0.60	0.60	0.60	1.80
	M. Dawson	E	RG	0.38	0.13	0.10	0.61
	Mechanical Techs	T	NM	0.22	0.42	0.50	1.14
			RG	0.44	0.84	1.01	2.28
	P. Lau	E	RG	0.40	0.40	0.40	1.20
	R.B.Nickerson	Ac	RG	0.50	0.50	0.50	1.50
	S.Yang	E	RG	0.20	0.20	0.20	0.60
	Senanayake	E	RG	0.43	0.55	0.50	1.48
	W. Lau	E	RG	0.43	0.40	0.40	1.23
QMUL	A.Bevan	Ac	RG	0.15	0.15	0.15	0.45
	A.Martin	Ac	RG	0.20	0.20	0.20	0.60
	F.Gannaway	E	RG	0.40	0.40	0.40	1.20
	G.Beck	Ph	RG	0.70	0.70	0.70	2.10
	J.Mistry	T	RG	0.70	0.70	0.70	2.10
	J.Morris	E	RG	0.30	0.30	0.30	0.90
RAL (PPD)	Ass Tech	T	PPD	0.05	0.05	0.70	0.80
	J. Matheson	Ap	PPD	0.25	0.25	0.25	0.75
	M. Gibson	E	PPD	0.45	0.45	0.25	1.15
	M. Tyndel	Ac	PPD	0.20	0.30	0.15	0.65
	R. Preece	E	PPD	0.00	0.00	0.50	0.50
	S. Haywood	Ac	PPD	0.10	0.20	0.20	0.50
RAL (TD)	eng support	E	TD	0.64	0.85	0.85	2.34
	I Wilmut	E	TD	0.71	0.95	0.95	2.61
	J Hill	E	TD	0.53	0.70	0.70	1.93
	J Noviss	E	TD	0.38	0.50	0.50	1.38
	S Canfer	E	TD	0.19	0.25	0.25	0.69
	R Bennett	E	TD	0.75	1.00	1.00	2.75
	P Booker	E	TD	0.20	0.20	0.20	0.60
Sheffield	D. R. Tovey	Ac	RG	0.00	0.10	0.10	0.20
	R.S. French	E	RG	0.50	0.50	0.50	1.50
Grand Total				14.06	16.71	18.52	49.29

6.2.5 WP5

				FTE totals			
Institute	**Name**	**Role**	**type**	**10/11**	**11/12**	**12/13**	**Total**
Birmingham	J.A.Wilson	Ac	Other	0.05	0.10	0.10	0.25
Glasgow	Bates	Ap	RG	0.35	0.40	0.45	1.20
	Buttar	Ac	RG	0.10	0.10	0.10	0.30
	Doherty	T	RG	0.30	0.20	0.20	0.70
	McEwan	T	RG	0.20	0.20	0.20	0.60
	O'Shea	Ac	RG	0.05	0.10	0.10	0.25
	Blue	Ap	RG	0.50	0.50	0.45	1.45
Liverpool	Affolder A	Ap	RG	0.05	0.09	0.10	0.23
	Allport P	Ac	RG	0.01	0.01	0.01	0.04
	Burdin S	Ac	RG	0.07	0.07	0.07	0.20
	Carroll JL	E	RG	0.00	0.18	0.14	0.32
	Casse G-L	Ap	RG	0.23	0.23	0.24	0.69
	Greenshaw T	Ac	RG	0.06	0.06	0.06	0.17
	Jones TJ	Ap	RG	0.05	0.18	0.19	0.42
	Sutcliffe P	E	RG	0.00	0.05	0.05	0.09
	Tsurin I	E	RG	0.45	0.45	0.48	1.38
	Use of Liverpool LSDC facility	T	RG	0.00	0.10	0.10	0.20
	Use of Liverpool workshop	T	NM	0.10	0.10	0.10	0.30
			RG	0.10	0.20	0.20	0.50
	Whitley M	T	RG	0.00	0.00	0.10	0.10
	Wormald MP	T	RG	0.09	0.09	0.10	0.28
Manchester	Da Via	Ac	RG	0.70	0.70	0.70	2.10
	Freestone	E	RG	0.50	0.50	0.50	1.50
	Hasi	Ap	RG	0.00	1.00	1.00	2.00
	Kelly	Ap	RG	0.40	0.35	0.30	1.05
	Kolya	Ap	RG	0.20	0.25	0.20	0.65
	Pater	Ph	RG	0.60	0.60	0.60	1.80
	Snow	Ph	RG	0.40	0.40	0.40	1.20
	Thompson	E	RG	0.50	0.50	0.50	1.50
	Watts	Ac	RG	0.10	0.10	0.10	0.30
RAL (PPD)	J. Matheson	Ap	PPD	0.35	0.35	0.35	1.05
	M. Gibson	E	PPD	0.00	0.00	0.20	0.20
	M. Tyndel	Ac	PPD	0.20	0.20	0.20	0.60
RAL (TD)	eng support	E	TD	0.03	0.20	0.30	0.53
Grand Total				6.72	8.55	8.88	24.15

6.2.6 WP6

				FTE totals			
Institute	**Name**	**Role**	**type**	**10/11**	**11/12**	**12/13**	**Total**
Birmingham	A. Watson	Ac	RG	0.10	0.10	0.20	0.40
	D. Charlton	Ac	RG	0.00	0.10	0.20	0.30
	J. Bracinik	Ph	RG	0.00	0.20	0.30	0.50
	M. Krivida	E	NM	0.00	0.20	0.60	0.80
	R.J Staley	E	RG	0.30	0.40	0.50	1.20
	S. Hillier	Ph	RG	0.10	0.30	0.30	0.70
	S. Pyatt	T	RG	0.10	0.15	0.15	0.40
Cambridge	B. Hommels	Ac	RG	0.10	0.10	0.10	0.30
	J. Chapman	Ph	RG	0.30	0.30	0.30	0.90
	M. Goodrick	E	RG	0.10	0.10	0.30	0.50
	M. Thomson	Ac	RG	0.30	0.30	0.30	0.90
	PDRA #2 50%	Ph	NM	0.00	0.75	1.00	1.75
	S. Sigursson	T	NM	0.10	0.10	0.40	0.60
QMUL	E Rizvi	Ac	RG	0.00	0.10	0.20	0.30
	L.Cerrito	Ac	RG	0.12	0.12	0.12	0.36
	M.Landon	Ph	RG	0.40	0.60	0.80	1.80
	PDRA #2 50%	Ph	NM	0.00	1.00	0.25	1.25
RAL (PPD)	B. Barnett	Ax	PPD	0.35	0.50	0.60	1.45
	D. Sankey	Py	PPD	0.60	0.60	0.60	1.80
	N. Gee	Ac	PPD	0.40	0.40	0.50	1.30
	R. Middleton	Ac	PPD	0.65	0.65	0.65	1.95
	W.Qian	E	PPD	0.70	0.80	0.85	2.35
RAL (TD)	I. Brawn	E	TD	0.85	0.85	0.85	2.55
	RAL EID Design Engineer 1	E	TD	0.00	1.15	1.45	2.60
Grand Total				5.57	9.87	11.52	26.96

6.2.7 WP7

				FTE totals			
Institute	**Name**	**Role**	**type**	**10/11**	**11/12**	**12/13**	**Total**
Liverpool	Affolder A	Ap	RG	0.09	0.09	0.10	0.28
	Allport P	Ac	RG	0.01	0.01	0.01	0.04
	Greenall A	E	RG	0.09	0.09	0.10	0.28
	King BT	Ph	RG	0.00	0.00	0.15	0.15
	Mehta A	Ac	RG	0.00	0.03	0.03	0.07

	Sutcliffe P	E	RG	0.00	0.05	0.05	0.09
	Use of Liverpool LSDC facility	T	Other RG	0.00 0.01	0.00 0.01	0.00 0.01	0.01 0.02
RHUL	A Misiejuk	Ph	rg	0.00	0.09	0.09	0.18
	B Green	E	NM	0.30	0.40	0.40	1.10
	P Teixeira-Dias	Ac	rg	0.09	0.09	0.09	0.27
	PDRA – new request G7pt31	Ph	NM	0.00	0.50	0.50	1.00
	V Boisvert	Ac	rg	0.18	0.18	0.18	0.54
Sussex	A. De Santo	Ac	RG	0.10	0.20	0.20	0.50
	L1Track PDRA2	Ph	NM	0.50	0.50	0.50	1.50
	P.-F. Salvatore	Ac	RG	0.10	0.10	0.20	0.40
	V.Bartsch	T	Other	0.30	0.30	0.30	0.90
UCL	G. Crone	Pr	RG	0.50	0.50	0.50	1.50
	M. Warren	E	RG	0.40	0.40	0.40	1.20
	Nikolaos Konstantinidis	Ac	RG	0.30	0.30	0.30	0.90
	B. Cooper/D. Wardrope	Ph	NM	1.00	1.00	1.00	3.00
	Vice-Lyapine	E	NM	0.00	0.20	0.20	0.40
Grand Total				3.97	5.04	5.30	14.32

6.2.8 WP8

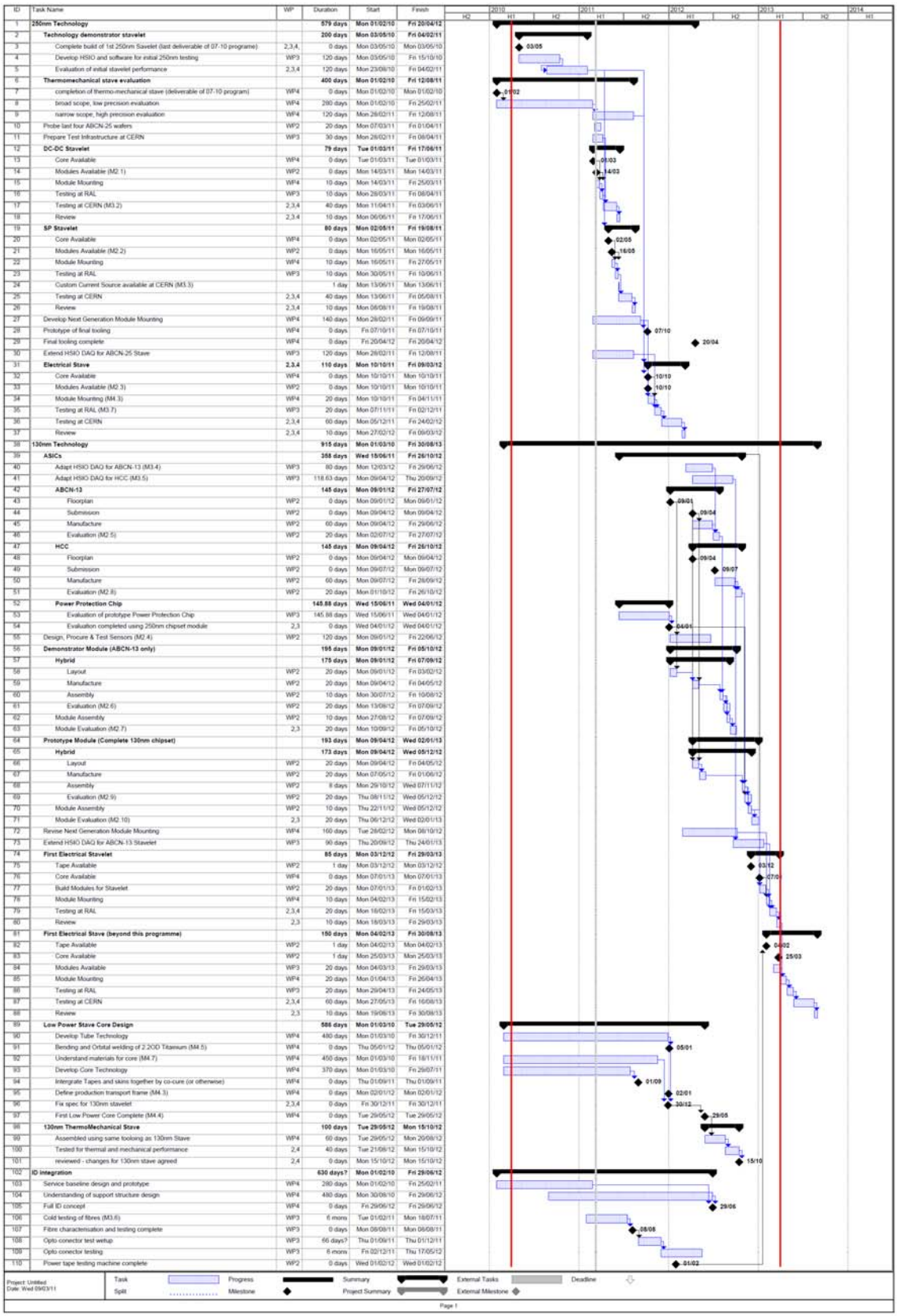
				FTE totals			
Institute	**Name**	**Role**	**type**	**10/11**	**11/12**	**12/13**	**Total**
Manchester	Oh (RSF)	Ac	Other	0.10	0.10	0.10	0.30
	Yang	Ac	RG	0.10	0.10	0.10	0.30
	Masik	Ph	RG	0.10	0.10	0.20	0.40
	Owen	Ph	RG	0.00	0.10	0.10	0.20
	Schwanenberger	Ac	Other	0.10	0.10	0.10	0.30
RAL (PPD)	D Emeliyanov	PP	PPD	0.00	0.10	0.10	0.20
	F Wickens	Ac	PPD	0.20	0.10	0.00	0.30
	J Baines	Ac	PPD	0.00	0.20	0.20	0.40
	J Kirk	Ph	PPD	0.00	0.10	0.15	0.25
	M Wielers	Ac	PPD	0.00	0.10	0.10	0.20
	S Burke	Ph	PPD	0.50	0.65	0.75	1.90
RHUL	PDRA – new request G7pt31	Ph	NM	0.00	0.50	0.50	1.00
	R Goncalo	Ph	rg	0.00	0.00	0.09	0.09
	S George	Ph	rg	0.00	0.00	0.09	0.09
UCL	E. Nurse	RS Fellow	Other	0.20	0.20	0.20	0.60
	P. Bernat	Ph	NM	0.50	0.50	0.50	1.50
Grand Total				1.80	2.95	3.28	8.03

6.2.9 WP9

				FTE totals			
Institute	**Name**	**Role**	**type**	**10/11**	**11/12**	**12/13**	**Total**
Cambridge	CP Ward	Ph	NM	0.00	0.10	0.20	0.30
	JR Batley	Ac	RG	0.10	0.10	0.10	0.30
Edinburgh	A. Buckley	Ph	Other	0.20	0.20	0.20	0.60
	AN Other	Ph	RG	0.00	0.80	1.00	1.80
	P. Clark	Ac	RG	0.10	0.10	0.10	0.30
	V. Martin	Ac	RG	0.00	0.15	0.15	0.30
	AN Other 2	Ph	NM	0.50	1.00	0.50	2.00
	A. Washbrook	Ph	Other	0.20	0.20	0.20	0.60
Lancaster	R Henderson	PP	NM	0.10	0.15	0.15	0.40
	RWL Jones	Ac	RG	0.04	0.04	0.04	0.12
	TWL Jones	Ac	Other	0.06	0.06	0.06	0.18
Oxford	A. Abdesalam	Ph	NM	0.70	0.70	0.70	2.10
	J. Tseng	Ac	RG	0.20	0.20	0.20	0.60
Sheffield	D. R. Tovey	Ac	RG	0.10	0.10	0.10	0.30
	I. Dawson	Ph	RG	0.10	0.20	0.20	0.50
	L. Nicolas	Ph	NM	0.25	1.00	1.00	2.25
UCL	Jon Butterworth	Ac	RG	0.05	0.05	0.05	0.15
	M. Campanelli	Ac	RG	0.20	0.20	0.20	0.60
	P. Sherwood	Ph	RG	0.40	0.40	0.40	1.20
	Waugh	Ph	RG	0.10	0.10	0.10	0.30
	G. Hesketh	Ph	Other	0.10	0.10	0.10	0.30
Grand Total				3.50	5.95	5.75	15.20

6.3 Scheduling

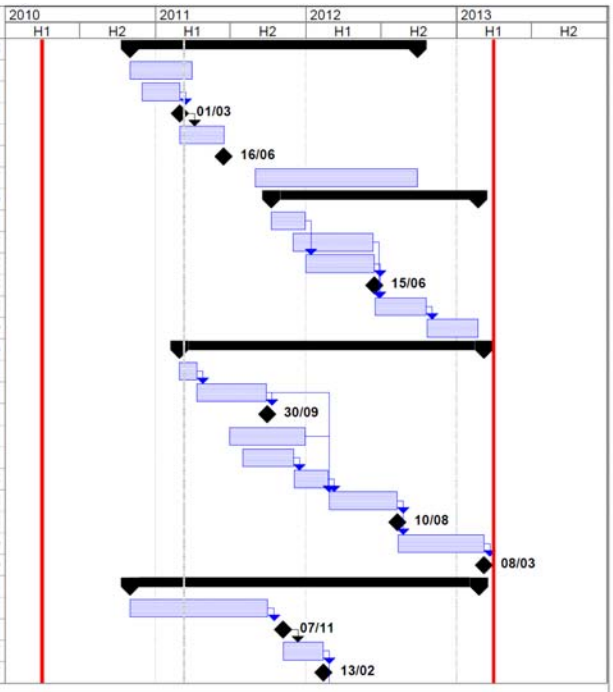
6.3.1 Strip Tracker



ID	Task Name	WP	Duration	Start	Finish
1	**250nm Technology**		**579 days**	**Mon 01/02/10**	**Fri 20/04/12**
2	**Technology demonstrator stavelet**		**200 days**	**Mon 03/05/10**	**Fri 04/02/11**
3	Complete build of 1st 250nm Savelet (last deliverable of 07-10 programe)	2,3,4,	0 days	Mon 03/05/10	Mon 03/05/10
4	Develop HSIO and software for initial 250nm testing	WP3	120 days	Mon 03/05/10	Fri 15/10/10
5	Evaluation of initial stavelet performance	2,3,4	120 days	Mon 23/08/10	Fri 04/02/11
6	**Thermomechanical stave evaluation**		**400 days**	**Mon 01/02/10**	**Fri 12/08/11**
7	completion of thermo-mechanical stave (deliverable of 07-10 program)	WP4	0 days	Mon 01/02/10	Mon 01/02/10
8	broad scope, low precision evaluation	WP4	280 days	Mon 01/02/10	Fri 25/02/11
9	narrow scope, high precision evaluation	WP4	120 days	Mon 28/02/11	Fri 12/08/11
10	Probe last four ABCN-25 wafers	WP2	20 days	Mon 07/03/11	Fri 01/04/11
11	Prepare Test Infrastructure at CERN	WP3	30 days	Mon 28/02/11	Fri 08/04/11
12	**DC-DC Stavelet**		**79 days**	**Tue 01/03/11**	**Fri 17/06/11**
13	Core Available	WP4	0 days	Tue 01/03/11	Tue 01/03/11
14	Modules Available (M2.1)	WP2	0 days	Mon 14/03/11	Mon 14/03/11
15	Module Mounting	WP4	10 days	Mon 14/03/11	Fri 25/03/11
16	Testing at RAL	WP3	10 days	Mon 28/03/11	Fri 08/04/11
17	Testing at CERN (M3.2)	2,3,4	40 days	Mon 11/04/11	Fri 03/06/11
18	Review	2,3,4	10 days	Mon 06/06/11	Fri 17/06/11
19	**SP Stavelet**		**80 days**	**Mon 02/05/11**	**Fri 19/08/11**
20	Core Available	WP4	0 days	Mon 02/05/11	Mon 02/05/11
21	Modules Available (M2.2)	WP2	0 days	Mon 16/05/11	Mon 16/05/11
22	Module Mounting	WP4	10 days	Mon 16/05/11	Fri 27/05/11
23	Testing at RAL	WP3	10 days	Mon 30/05/11	Fri 10/06/11
24	Custom Current Source available at CERN (M3.3)		1 day	Mon 13/06/11	Mon 13/06/11
25	Testing at CERN	2,3,4	40 days	Mon 13/06/11	Fri 05/08/11
26	Review	2,3,4	10 days	Mon 08/08/11	Fri 19/08/11
27	Develop Next Generation Module Mounting	WP4	140 days	Mon 28/02/11	Fri 09/09/11
28	Prototype of final tooling	WP4	0 days	Fri 07/10/11	Fri 07/10/11
29	Final tooling complete	WP4	0 days	Fri 20/04/12	Fri 20/04/12
30	Extend HSIO DAQ for ABCN-25 Stave	WP3	120 days	Mon 28/02/11	Fri 12/08/11
31	**Electrical Stave**	**2,3,4**	**110 days**	**Mon 10/10/11**	**Fri 09/03/12**
32	Core Available	WP4	0 days	Mon 10/10/11	Mon 10/10/11
33	Modules Available (M2.3)	WP2	0 days	Mon 10/10/11	Mon 10/10/11
34	Module Mounting (M4.3)	WP4	20 days	Mon 10/10/11	Fri 04/11/11
35	Testing at RAL (M3.7)	WP3	20 days	Mon 07/11/11	Fri 02/12/11
36	Testing at CERN	2,3,4	60 days	Mon 05/12/11	Fri 24/02/12
37	Review	2,3,4	10 days	Mon 27/02/12	Fri 09/03/12
38	**130nm Technology**		**915 days**	**Mon 01/03/10**	**Fri 30/08/13**
39	**ASICs**		**358 days**	**Wed 15/06/11**	**Fri 26/10/12**
40	Adapt HSIO DAQ for ABCN-13 (M3.4)	WP3	80 days	Mon 12/03/12	Fri 29/06/12
41	Adapt HSIO DAQ for HCC (M3.5)	WP3	118.63 days	Mon 09/04/12	Thu 20/09/12
42	**ABCN-13**		**145 days**	**Mon 09/01/12**	**Fri 27/07/12**
43	Floorplan	WP2	0 days	Mon 09/01/12	Mon 09/01/12
44	Submission	WP2	0 days	Mon 09/04/12	Mon 09/04/12
45	Manufacture	WP2	60 days	Mon 09/04/12	Fri 29/06/12
46	Evaluation (M2.5)	WP2	20 days	Mon 02/07/12	Fri 27/07/12
47	**HCC**		**145 days**	**Mon 09/04/12**	**Fri 26/10/12**
48	Floorplan	WP2	0 days	Mon 09/04/12	Mon 09/04/12
49	Submission	WP2	0 days	Mon 09/07/12	Mon 09/07/12
50	Manufacture	WP2	60 days	Mon 09/07/12	Fri 28/09/12
51	Evaluation (M2.8)	WP2	20 days	Mon 01/10/12	Fri 26/10/12
52	**Power Protection Chip**		**145.88 days**	**Wed 15/06/11**	**Wed 04/01/12**
53	Evaluation of prototype Power Protection Chip	WP3	145.88 days	Wed 15/06/11	Wed 04/01/12
54	Evaluation completed using 250nm chipset module	2,3	0 days	Wed 04/01/12	Wed 04/01/12
55	Design, Procure & Test Sensors (M2.4)	WP2	120 days	Mon 09/01/12	Fri 22/06/12
56	**Demonstrator Module (ABCN-13 only)**		**195 days**	**Mon 09/01/12**	**Fri 05/10/12**
57	**Hybrid**		**175 days**	**Mon 09/01/12**	**Fri 07/09/12**
58	Layout	WP2	20 days	Mon 09/01/12	Fri 03/02/12
59	Manufacture	WP2	20 days	Mon 09/04/12	Fri 04/05/12
60	Assembly	WP2	10 days	Mon 30/07/12	Fri 10/08/12
61	Evaluation (M2.6)	WP2	20 days	Mon 13/08/12	Fri 07/09/12
62	Module Assembly	WP2	10 days	Mon 27/08/12	Fri 07/09/12
63	Module Evaluation (M2.7)	2,3	20 days	Mon 10/09/12	Fri 05/10/12
64	**Prototype Module (Complete 130nm chipset)**		**193 days**	**Mon 09/04/12**	**Wed 02/01/13**
65	**Hybrid**		**173 days**	**Mon 09/04/12**	**Wed 05/12/12**
66	Layout	WP2	20 days	Mon 09/04/12	Fri 04/05/12
67	Manufacture	WP2	20 days	Mon 07/05/12	Fri 01/06/12
68	Assembly	WP2	8 days	Mon 29/10/12	Wed 07/11/12
69	Evaluation (M2.9)	WP2	20 days	Thu 08/11/12	Wed 05/12/12
70	Module Assembly	WP2	10 days	Thu 22/11/12	Wed 05/12/12
71	Module Evaluation (M2.10)	2,3	20 days	Thu 06/12/12	Wed 02/01/13
72	Revise Next Generation Module Mounting	WP4	160 days	Tue 28/02/12	Mon 08/10/12
73	Extend HSIO DAQ for ABCN-13 Stavelet	WP3	90 days	Thu 20/09/12	Thu 24/01/13
74	**First Electrical Stavelet**		**85 days**	**Mon 03/12/12**	**Fri 29/03/13**
75	Tape Available	WP2	1 day	Mon 03/12/12	Mon 03/12/12
76	Core Available	WP4	0 days	Mon 07/01/13	Mon 07/01/13
77	Build Modules for Stavelet	WP2	20 days	Mon 07/01/13	Fri 01/02/13
78	Module Mounting	WP4	10 days	Mon 04/02/13	Fri 15/02/13
79	Testing at RAL	2,3,4	20 days	Mon 18/02/13	Fri 15/03/13
80	Review	2,3	10 days	Mon 18/03/13	Fri 29/03/13
81	**First Electrical Stave (beyond this programme)**		**150 days**	**Mon 04/02/13**	**Fri 30/08/13**
82	Tape Available	WP2	1 day	Mon 04/02/13	Mon 04/02/13
83	Core Available	WP2	1 day	Mon 25/03/13	Mon 25/03/13
84	Modules Available	WP3	20 days	Mon 04/03/13	Fri 29/03/13
85	Module Mounting	WP4	20 days	Mon 01/04/13	Fri 26/04/13
86	Testing at RAL	WP3	20 days	Mon 29/04/13	Fri 24/05/13
87	Testing at CERN	2,3,4	60 days	Mon 27/05/13	Fri 16/08/13
88	Review	2,3	10 days	Mon 19/08/13	Fri 30/08/13
89	**Low Power Stave Core Design**		**586 days**	**Mon 01/03/10**	**Tue 29/05/12**
90	Develop Tube Technology	WP4	480 days	Mon 01/03/10	Fri 30/12/11
91	Bending and Orbital welding of 2.2OD Titanium (M4.5)	WP4	0 days	Thu 05/01/12	Thu 05/01/12
92	Understand materials for core (M4.7)	WP4	450 days	Mon 01/03/10	Fri 18/11/11
93	Develop Core Technology	WP4	370 days	Mon 01/03/10	Fri 29/07/11
94	Intergrate Tapes and skins together by co-cure (or otherwise)	WP4	0 days	Thu 01/09/11	Thu 01/09/11
95	Define production transport frame (M4.3)	WP4	0 days	Mon 02/01/12	Mon 02/01/12
96	Fix spec for 130nm stavelet	2,3,4	0 days	Fri 30/12/11	Fri 30/12/11
97	First Low Power Core Complete (M4.4)	WP4	0 days	Tue 29/05/12	Tue 29/05/12
98	**130nm ThermoMechanical Stave**		**100 days**	**Tue 29/05/12**	**Mon 15/10/12**
99	Assembled using same tooloing as 130nm Stave	WP4	60 days	Tue 29/05/12	Mon 20/08/12
100	Tested for thermal and mechanical performance	2,4	40 days	Tue 21/08/12	Mon 15/10/12
101	reviewed - changes for 130nm stave agreed	2,4	0 days	Mon 15/10/12	Mon 15/10/12
102	**ID integration**		**630 days?**	**Mon 01/02/10**	**Fri 29/06/12**
103	Service baseline design and prototype	WP4	280 days	Mon 01/02/10	Fri 25/02/11
104	Understanding of support structure design	WP4	480 days	Mon 30/08/10	Fri 29/06/12
105	Full ID concept	WP4	0 days	Fri 29/06/12	Fri 29/06/12
106	Cold testing of fibres (M3.6)	WP3	6 mons	Tue 01/02/11	Mon 18/07/11
107	Fibre characterisation and testing complete	WP3	0 days	Mon 08/08/11	Mon 08/08/11
108	Opto conector test wehup	WP3	66 days?	Thu 01/09/11	Thu 01/12/11
109	Opto conector testing	WP3	6 mons	Fri 02/12/11	Thu 17/05/12
110	Power tape testing machine complete	WP2	0 days	Wed 01/02/12	Wed 01/02/12

6.3.2 *Pixel*

ID	Task Name	Duration	Start	Finish
1	**IBL sensors**	**500 days**	**Mon 01/11/10**	**Fri 28/09/12**
2	IBL sensors delivery for qu	109 days	Mon 01/11/10	Thu 31/03/11
3	USBPix in institutes	65 days	Wed 01/12/10	Tue 01/03/11
4	USBPix ready	0 days	Tue 01/03/11	Tue 01/03/11
5	Sensor studies	77.88 days	Wed 02/03/11	Fri 17/06/11
6	Sensor review	0 days	Thu 16/06/11	Thu 16/06/11
7	Delivery of tested IBL sens	282 days	Thu 01/09/11	Fri 28/09/12
8	**Sensors**	**360 days**	**Mon 10/10/11**	**Fri 22/02/13**
9	3D sensor design	60 days	Mon 10/10/11	Fri 30/12/11
10	3D module design	137.5 days	Fri 02/12/11	Tue 12/06/12
11	3D sensor fabrication	120 days	Mon 02/01/12	Fri 15/06/12
12	3D sensor delivery	0 days	Fri 15/06/12	Fri 15/06/12
13	3D module fabrication	90 days	Mon 18/06/12	Fri 19/10/12
14	3D module evaluation	90 days	Mon 22/10/12	Fri 22/02/13
15	**Modules**	**529 days**	**Tue 01/03/11**	**Fri 08/03/13**
16	4-chip planar sensor desigr	30.13 days	Tue 01/03/11	Tue 12/04/11
17	4-chip sensor fabrication	120 days	Tue 12/04/11	Tue 27/09/11
18	4-chip planar sensor delive	0 days	Fri 30/09/11	Fri 30/09/11
19	Design and procurement of	131 days	Fri 01/07/11	Fri 30/12/11
20	Mechanical 4-chip module	90 days	Mon 01/08/11	Fri 02/12/11
21	Mechanical module evaluat	60 days	Mon 05/12/11	Fri 24/02/12
22	Electrical module fabricatio	120 days	Mon 27/02/12	Fri 10/08/12
23	Delivery of 4-chip module	0 days	Fri 10/08/12	Fri 10/08/12
24	Electrical module evaluatio	150 days	Mon 13/08/12	Fri 08/03/13
25	Report on electrical module	0 days	Fri 08/03/13	Fri 08/03/13
26	**Layout and mechanics**	**605.13 days**	**Mon 01/11/10**	**Mon 25/02/13**
27	Layout studies	240 days	Mon 01/11/10	Fri 30/09/11
28	Report on Layout studies	0 days	Mon 07/11/11	Mon 07/11/11
29	TM protoype design	70 days	Mon 07/11/11	Mon 13/02/12
30	TM prototype design ready	0 days	Mon 13/02/12	Mon 13/02/12



Project: WP5
Date: Thu 10/03/11

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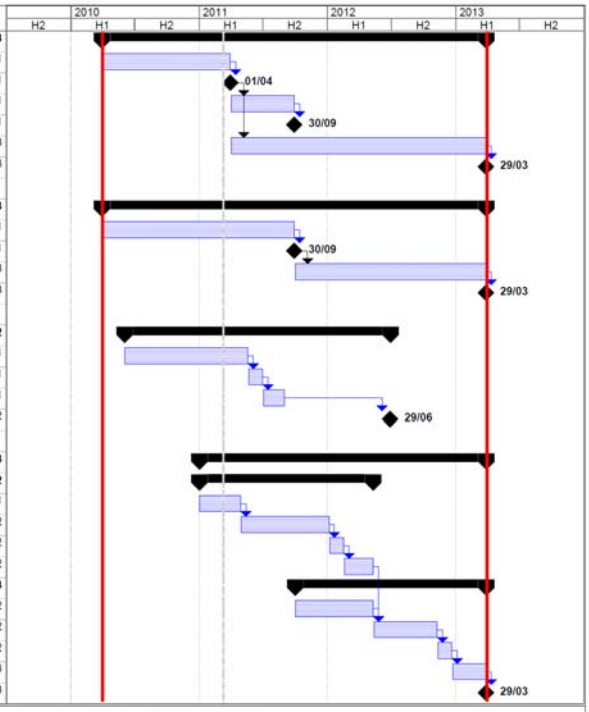
6.3.3 *L1Calo*

ID	Task Name	Duration	Start	Finish
1	**Simulation Studies**	**783 days**	**Wed 31/03/10**	**Fri 29/03/13**
2	MC studies of existing L1Calo	262 days	Wed 31/03/10	Thu 31/03/11
3	M6.1: Impact of pile-up understood	1 day	Fri 01/04/11	Fri 01/04/11
4	MC Studies of Topological Processor	129 days	Mon 04/04/11	Thu 29/09/11
5	M6.2: Simulation of Topological Processor	1 day	Fri 30/09/11	Fri 30/09/11
6	MC Studies of Phase-I + Phase-II algorithms	519 days	Mon 04/04/11	Thu 28/03/13
7	M6.3: Phase-II requirements specified	1 day	Fri 29/03/13	Fri 29/03/13
8				
9	**System Studies**	**783 days**	**Wed 31/03/10**	**Fri 29/03/13**
10	Conceptual design of Phase-I + Phase-II systems	392 days	Wed 31/03/10	Thu 29/09/11
11	M6.5: Conceptual hardware design of TP in L1Calo	1 day	Fri 30/09/11	Fri 30/09/11
12	Detailed design of Phase Phase-II system	389 days	Mon 03/10/11	Thu 28/03/13
13	M6.6: Detailed Conceptual Design of Phase-II upgrade	1 day	Fri 29/03/13	Fri 29/03/13
14				
15	**CP Backplane Upgrade**	**541 days**	**Fri 04/06/10**	**Fri 29/06/12**
16	H/w & f/w Feasibility Studies	251 days	Fri 04/06/10	Fri 20/05/11
17	Upgrade firmware	30 days	Mon 23/05/11	Fri 01/07/11
18	Backplane System Test	44 days	Mon 04/07/11	Thu 01/09/11
19	M6.4: Operation of CP at 80 MHz	1 day	Fri 29/06/12	Fri 29/06/12
20				
21	**Demonstrator Programme**	**585 days**	**Mon 03/01/11**	**Fri 29/03/13**
22	**High-Speed Demonstrator**	**355 days**	**Mon 03/01/11**	**Fri 11/05/12**
23	specification	85 days	Mon 03/01/11	Fri 29/04/11
24	Board Design	9 mons	Mon 02/05/11	Fri 06/01/12
25	Manufacture	6 wks	Mon 09/01/12	Fri 17/02/12
26	Test	60 days	Mon 20/02/12	Fri 11/05/12
27	**Topological Processor Prototype**	**390 days**	**Mon 03/10/11**	**Fri 29/03/13**
28	specification	8 mons	Mon 03/10/11	Fri 11/05/12
29	Board Design	130 days	Mon 14/05/12	Fri 09/11/12
30	Manufacture	30 days	Mon 12/11/12	Fri 21/12/12
31	Commissioning	69 days	Mon 24/12/12	Thu 28/03/13
32	M6.7: ATCA-based high speed demonstrator	1 day	Fri 29/03/13	Fri 29/03/13



Project: L1calo_OSC_rev2.mpp
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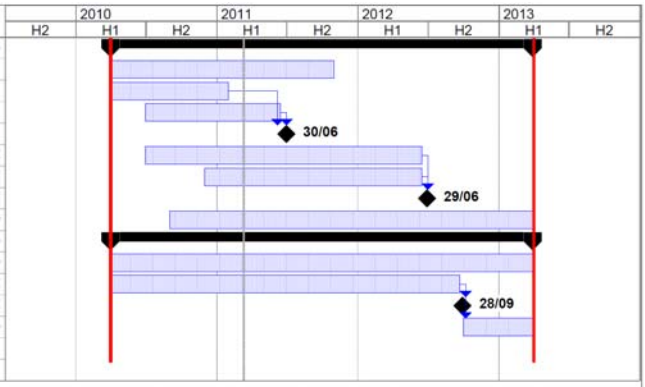
6.3.4 *L1 Track Trigger*

ID	Task Name	Duration	Start	Finish
1	**WP7 - L1Track Simulation Stu**	**782 days**	**Thu 01/04/10**	**Fri 29/03/13**
2	L1Track-specific software t	413 days	Thu 01/04/10	Mon 31/10/11
3	Development of the Descre	218 days	Thu 01/04/10	Mon 31/01/11
4	Physics and trigger rate stu	250 days	Thu 01/07/10	Wed 15/06/11
5	L1 Trigger Upgrade Techni	0 days	Thu 30/06/11	Thu 30/06/11
6	Physics and trigger rate stu	512 days	Thu 01/07/10	Fri 15/06/12
7	Use of DES in system desi	403 days	Wed 01/12/10	Fri 15/06/12
8	Specify the required perfor	0 days	Fri 29/06/12	Fri 29/06/12
9	Pattern recognition studies	673 days	Wed 01/09/10	Fri 29/03/13
10	**WP7 - Off-detector hardware**	**782 days**	**Thu 01/04/10**	**Fri 29/03/13**
11	WP7 - On-detector electron	782 days	Thu 01/04/10	Fri 29/03/13
12	RoIMapper design work	647 days	Thu 01/04/10	Fri 21/09/12
13	RoIMapper design complet	0 days	Fri 28/09/12	Fri 28/09/12
14	Construction of RoIMapper	130 days	Mon 01/10/12	Fri 29/03/13



Project: Untitled
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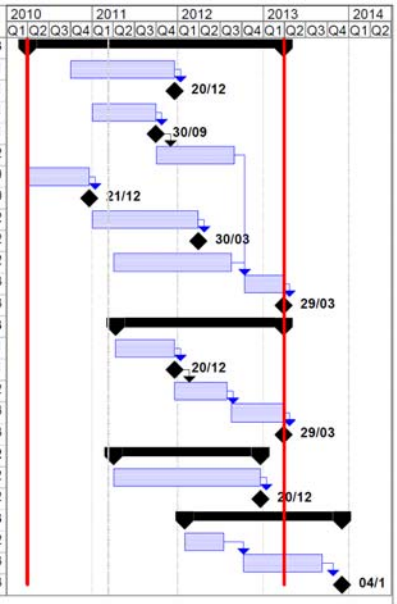
6.3.5 *HLT*

ID	Task Name	Duration	Start	Finish
1	**WP8.1 Optimise HLT ID Tracking sw for Phase-I**	**781.88 days**	**Thu 01/04/10**	**Fri 29/03/13**
2	Update L2 tracking for IBL	15.89 mons	Fri 01/10/10	Tue 20/12/11
3	M8.3:Tracking Code adapted for IBL	0 days	Tue 20/12/11	Tue 20/12/11
4	Optimise L2 Zfinder	9.74 mons	Mon 03/01/11	Fri 30/09/11
5	M8.2: L2 Zfinder optimized	0 days	Fri 30/09/11	Fri 30/09/11
6	Optimise L2 Pat. Rec. for different RoI types	12 mons	Mon 03/10/11	Fri 31/08/12
7	Implement Zfinder and Fitter exploiting GPU	187.88 days	Thu 01/04/10	Tue 21/12/10
8	M8.1: First GPU meaurements: Zfinder & Fitter	0 days	Tue 21/12/10	Tue 21/12/10
9	Implement L2 Data Prep. & Pat. Rec. code to exploit GPU	323.88 days	Tue 04/01/11	Fri 30/03/12
10	M8.6: GPU measurements for complete L2 chain	0 days	Fri 30/03/12	Fri 30/03/12
11	Optimise config. of EF tools	18 mons	Mon 04/04/11	Mon 20/08/12
12	Performance measurements & optimisation	6 mons	Mon 15/10/12	Fri 29/03/13
13	M8.8: HLT Tracking code optimized for Phase-I	0 days	Fri 29/03/13	Fri 29/03/13
14	**WP8.2 Optimise HLT Selection sw for Phase-I**	**513 days**	**Wed 13/04/11**	**Fri 29/03/13**
15	Define Trigger Menus for MC productions	9 mons	Wed 13/04/11	Tue 20/12/11
16	M8.4: Trigger Selections Defined for MC producutions	0 days	Tue 20/12/11	Tue 20/12/11
17	Develop Selections for upgraded L1	8 mons	Wed 21/12/11	Tue 31/07/12
18	Performance measurements & optimisation	8 mons	Mon 20/08/12	Fri 29/03/13
19	M8.7: Trigger Selections optimised for upgraded L1	0 days	Fri 29/03/13	Fri 29/03/13
20	**WP8.3 core HLT sw updates**	**448.88 days**	**Mon 04/04/11**	**Thu 20/12/12**
21	Steering software updates	22.44 mons	Mon 04/04/11	Thu 20/12/12
22	M8.5: Steering software updated	0 days	Thu 20/12/12	Thu 20/12/12
23	**WP8.4 Define Phase-II Trigger Selection Strategy**	**480 days**	**Wed 01/02/12**	**Wed 04/12/13**
24	Define Trigger Menus for Phase-II studies	6 mons	Wed 01/02/12	Wed 18/07/12
25	Measure and compare performance of different options	12 mons	Wed 10/10/12	Wed 11/09/13
26	Performance of different options reviewed	0 days	Wed 04/12/13	Wed 04/12/13



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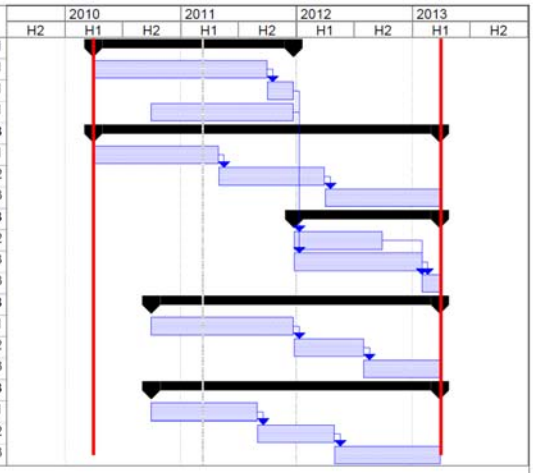
6.3.6 *Computing and Simulation*

ID	Task Name	Duration	Start	Finish
1	**Simulation tools for Letter of Intent**	**452 days**	**Thu 01/04/10**	**Fri 23/12/11**
2	Pileup tools	392 days	Thu 01/04/10	Fri 30/09/11
3	Strip and pixel release	60 days	Mon 03/10/11	Fri 23/12/11
4	Initial Atlfast tune	321 days	Fri 01/10/10	Fri 23/12/11
5	**Validated upgrade radiation model**	**782 days**	**Thu 01/04/10**	**Fri 29/03/13**
6	Validation of 7TeV ID fluences & doses	282 days	Thu 01/04/10	Fri 29/04/11
7	Validation of 7TeV cavern fluences	240 days	Mon 02/05/11	Fri 30/03/12
8	Assessment & operation proposals	260 days	Mon 02/04/12	Fri 29/03/13
9	**Simulation tools for design proposals**	**330 days**	**Mon 26/12/11**	**Fri 29/03/13**
10	Automated Atlfast tuning	200 days	Mon 26/12/11	Fri 28/09/12
11	Design proposal pixel simulation	289 days	Mon 26/12/11	Thu 31/01/13
12	Upgrade default release, tuned Atlfast	41 days	Fri 01/02/13	Fri 29/03/13
13	**Visualization for Design Proposal**	**651 days**	**Fri 01/10/10**	**Fri 29/03/13**
14	LoI geometry implemented	321 days	Fri 01/10/10	Fri 23/12/11
15	High luminosity profiling & optimization	157 days	Mon 26/12/11	Tue 31/07/12
16	Atlantis release for Design Proposal	173 days	Wed 01/08/12	Fri 29/03/13
17	**Performant parallel running on Grid**	**651 days**	**Fri 01/10/10**	**Fri 29/03/13**
18	AthenaMP on Grid	239 days	Fri 01/10/10	Wed 31/08/11
19	Analysis study	173 days	Thu 01/09/11	Mon 30/04/12
20	Optimised parallel running	239 days	Tue 01/05/12	Fri 29/03/13



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6.3.7 *Notes on Gantt charts*

In a drive to make these charts as accessible as possible we have tried to limit the length of these to a couple of hundred lines, this naturally means a lot of detail is missed. We hope in doing this we have succeeded in capturing the core structure of the project, with the key flows of work, without confusing the reader. Beneath this top level schedule work packages carry much more detailed project planning.

Strip Tracker The Strip tracker presents here an integrated chart for all three WPs. In the past we have worked with separate Gantt charts and made the links between them – this is an attempt to make changes easier, and make the connections between WPs more apparent. Time will tell to the success of this approach.

6.4 Risk Register

Ref	Risk Description	Potential impact on project	Level of Collaboration control (0-10, 0 is low)	Inherent Risk Score			Existing Controls	Mitigating factors	Residual risk score			Comment	Proposed Action	Cost	Colour
				Likelihood	Impact	Total			Likelihood	Impact	Total				
	GLOBAL														
0.1	Insufficient resources or delays with international partners failing to complete deliverables needed by project	TP and TDR delayed.	0	3	3	9	Review by international Project Office and Steering Group	Major UK roles in international decision process	2	2	4	Delay with consequent higher costs	Delay in upgrade pre-production qualification with knock on for SLHC	2M year (note 1)	GREEN
0.2	LHC starting luminosity ramp up delayed	Delay in gaining the necessary experience from operation and radiation levels	0	3	3	9	Review by UK project management	SLHC start delayed Safety factors in assumptions	1	3	3	Costs of extra time	Accelerated software effort once adequate data taken	2M year (note 1)	GREEN
0.3	UK funds insufficient	Completion of project delayed	1	2	3	6	Review by UK project management	Contingency and International Collaborators	1	3	3	Significant cost uncertainties	Call on contingency, look to international collaborators	2M year (note 1)	GREEN
0.4	Project definition changes dramatically	TDR delayed. UK leadership and impact diminished	3	3	3	9	Review by international Project Office	Major UK roles in decision	1	3	3	Many UK roles	Adapt scope of programme and, if needed, call on contingency ¯ß	>2M year (note 2)	GREEN
0.5	Key UK staff leave project	UK leadership and impact diminished	0	3	3	9	Review by UK project management	Pool of expertise	2	2	4	Delays and potential risk to deliverables	Examine responsibility and scope in light of funding	50k year (note 3)	GREEN
0.6	Shortage of appropriate staff	Risk to quality and schedule	0	2	3	6	Monitoring by UK project management and regular reviews	Pool of expertise	1	3	3	Technical staff do not FEC and are less expensive	Hire additional technical staff	50k year (note 3)	GREEN
0.7	Experience from ATLAS changes project specification	Higher hit rate than simulation	3	2	3	6	Review by international Project Office	Safety factors in design	1	2	2	Higher radius = larger	Revisit layout and/or technologies	Unknown (note 4)	GREEN
		Higher radiation levels than simulation	3	2	3	6	Review by international Project Office	Safety factors in design	1	3	3	area = cost	Revisit layout and/or technologies	1M per m^2 (note 5)	GREEN
		Different physics priorities	1	2	2	4	Review by international Project Office	High luminosity bound to be desirable	1	1	1	Technologies developed likely to be needed in any scenario	Revisit layout and/or technologies	Unknown (note 6)	GREEN
0.8	Currency fluctuations result in a dramatic reduction in our buying power	Major purchases will consume far more of a WP budget than expected	0	3	4	12	Reduce scope of UK orders to match new price regime	Contingency possible through greater sharing of projects with collaborators	3	2	6	Sensors and CFRP are most likely to be a problem	Reduce scope if appropriate, call upon contingency	200k (note 7)	GREEN
0.9	Lost of key skilled personnel	Difficulty in delivering more technical aspects of package	0	3	4	12	Spread of institutes and skills	Training and cross-coverage of tasks	3	2	6		Avoid reduction in cross-coverage	0 (note 16)	GREEN
0.10	Significant delay in filling new posts	loss of position in community Schedule slippage	5	4	5	20	New money funding and JeS forms approved	International collaboration can do some of the work	4	2	8	Efforts are being made to fill these posts at present		0 (note 16)	AMBER
0.11	Loss or damage of parts when transit	Delay to next steps	0	1	5	5	insurance for transit - collaboration drive critical parts	Try to maintain a surplus of critical parts - minimise transport	1	3	3	This has happened with USBPix from Bonn	New parts in preparation	0 (note 10)	GREEN
	Tracker Specific														
1.1	Required components not available in time	Upgrade Tracker TP and TDR delayed	8	2	5	10	Review by UK project management, international SG and PO	Delay in programme	2	3	6	Extra costs	Delayed start to production phase	2M year (note 1)	GREEN
1.2	Prototypes fail to perform either thermally, electrically or mechanically	Upgrade Tracker TDR delayed	5	2	5	10	Review by UK project management, international SG and PO	Revisit stave design	2	3	6	Need time to build new prototype	Delayed start to production phase	30k (note 8)	GREEN
1.3	CERN project office reverse stave/supermodule decision of June '08	UK tracker effort need to redirect expertise into non-preferred solution	5	3	6	18	UK project management actively working within CERN to ensure this doesn't happen	Formal CERN review directed us toward staves. Even if it does happen ~80% of tracker R&D is still appropriate. Forward community is working on Stave like Petals	3	2	6	Short term loss of position in collaboration	Maintain active pressure on supermodule community making sure the stave community addresses any criticism.	Unknown (note 9)	GREEN
2	**WP2**														
2.1	Sensor costs underestimated.	Sensor R&D cost overrun.	5	3	3	9	Review by UK project management, international SG and PO	Scope of project Alternative suppliers Past experience in buying similar sensors	1	3	3	Higher risk with reduced Prototyping	Reduce scope to fit budget Encourage competitor companies	0 (note 11)	GREEN

2.2	Delays in joint international orders	Overall delay to programme	5	4	2	8	Review by UK project management, international SG and PO	Delays in programme Alternative suppliers	3	1	3	Costs of extra time, If orders are placed early outstanding stock mitigates	Reduce scope to fit budget Encourage competitor companies	0 (note 12)	GREEN
2.3	ASIC programme costs underestimated	ASIC R&D cost overrun.	5	2	3	6	Review by UK project management, international SG and PO	Scope of project	1	2	2	Higher risk with reduced Prototyping	Reduce scope to fit budget	0 (note 12)	GREEN
2.4	<2.4cm length strips needed for short strips	Project cost underestimated. Upgrade Tracker TP and TDR delayed.	3	1	2	2	Review by international SG and PO of available technology options	Novel Interconnects R&D	1	1	1	Likely costs higher with higher channel density	Switch R&D emphasis to novel Interconnects	Unknown (note 13)	GREEN
2.5	ABCN 130nm program is delayed	Overall delay to programme	1	2	3	6	Review by UK project management, international SG and PO	international team now working - firm schedule for submissions	1	2	2			0 (note 12)	GREEN
2.6	ABCN 130nm program fails to produce working ASIC	Have to use ABCN 250nm	1	1	5	5	Review by UK project management, international SG and PO	Experts consider very unlikely ABCN 250nm is working today so represents robust fall back	1	3	3	Would result in higher material and heat loads	continue to contribute to ABCN130 efforts	0 (note 14)	GREEN
2.7	Tape definition fails to converge	Upgrade Tracker TP and TDR delayed	8	2	2	4	Review by UK project management, international SG and PO	Delay in programme	1	1	1	Probable extra costs	Delay start to stave construction	10k (note 15)	GREEN
2.8	ASIC development falls behind project office schedule	Overall schedule delayed	5	3	3	9	Review by ATLAS Upgrade PO, SG	Many developments still able to proceed	4	2	8	Costs of extra delay - or costs of extra effort to assist ASIC development	Adapt programme and schedule to accommodate any revised ASIC dates; provide extra effort to assist ASIC program	100k per year (note 17)	AMBER
2.9	STAVE09 geometry (side mounted SMC) not final stave adopted	Schedule impacted. Rework of tooling needed.	4	1	2	2	Review by ATLAS Upgrade Layout, SG and PO	Alternatives already studied	1	2	2	Potential costs of extra time	Adapt hardware programmes to accepted final geometry	20k (note 18)	GREEN
3	WP3														
3.1	Poor outcome from versatile link irradiation	Project cost underestimated. Upgrade Tracker TP and TDR delayed.	3	1	2	2	Review by UK project management, Versatile Link project, CMS and ATLAS SG and PO	Slower delivery	1	1	1	Compressed R&D timescales	Switch other effort to programme	30k (note 19)	GREEN
3.2	Serial powering not feasible.	No solution to powering SLHC tracker with existing services	3	1	5	5	Review by UK project management, international SG and PO	Delay in programme R&D into DC-DC	1	2	2	Extra costs and long installation phase requiring faster build	Existing services cannot be used and must be replaced	0 (cost to UK)	GREEN
		Upgrade Tracker TP and TDR delayed	3	3	3	9	Review by UK project management, international SG and PO	Delay in programme	2	2	4	Probable extra costs	Delay start to stave construction	2M year (note 1)	GREEN
3.3	DC-DC selected over serial powering	Probably more material - probably less robust	5	3	5	15	Decision will be subject to CERN review	SP is still superior solution	3	5	15	the independence of DC-DC powering is appealing, making review outcome uncertain	Maintain profile of SP community, attack shortcomings of DC-DC. Should DC-DC be selected re-direct efforts to support.	20k (note 20)	AMBER
3.4	Upgrade HSIO driven DAQ & read-out without sufficient features	Cumbersome use for stave work delay	8	2	4	8	Review by UK Project Management	Current read-out expertise Presently works so we can only improve	1	3	3	Current read-out working	Invest more effort	75k year (note 21)	GREEN
4	WP4														
4.1	Measurements fail to match FEA simulations	Need redesign and better tools. Delay	5	2	2	4	Review by UK project management, international SG and PO	Revisit module concept	1	2	2	Fixes and minor changes	Redesign and rebuild	0-10k (note 22)	GREEN
4.2	Required components not available in time	Section of UK tracker program delayed	5	2	5	10	Review by UK project management.	Delay in programme	1	3	3	Probable extra costs and/or reduced scope	Delay start to stave construction	0 (note 16)	GREEN
4.3	Tape dimensionality is poor	Harder stave assembly	8	5	2	10	Review by UK Project Management	design can be revised to make dimensionality less important	2	2	4	Slower stave bonding	revised bonding processes - more manual	2k (note 23)	GREEN
4.4	Welding pipes near ASICs rejected	Redesign of EoS region needed	5	2	2	4	Review by UK project management, PO, SG	none	2	2	4	none	Redesign EoS region	0 (note 24)	GREEN
4.5	Mass production techniques prove problematic	Overall delay to programme	8	1	2	2	Review by UK project management	Integration studies raise interface problems with other sub-systems	1	2	2	none	Redesign of stave to improve mass manufacturability	300k (note 25)	GREEN
4.6	Integration studies raise interface problems with other sub-systems	Programme delays	6	1	3	3	Review by UK project management, PO, SG	none	1	3	3	Important to be active to keep this risk minimised	Work with other systems to avoid such issues.	Unknown (note 13)	GREEN
5	WP5					0									
5.1	Sensors for highest dose regions prohibitively expensive for full detector.	Final detector cost untenable		1	3	3	Review by UK project management, PO, SG	Geometry Dependent	1	2	2	Compressed R&D timescales	Redesign Layout to move sensors to lower does regions		GREEN
5.2	TSV, or other methods prove infeasible	Detector Layout requires revision		1	3	3	Review by UK project management	Other layouts possible	1	2	2	more massive detector	Revert to undesirable geometry.		GREEN
5.3	FE-I4 chip is delayed	Delay to R&D and production by 6-9 months		2	4	8	FE-I4 is critical to ATLAS IBL project so has significant external resource	Schedule would be modified in short term. If long term issue, then IBL would use FE-I3	1	4	4	See proposal			GREEN

5.4	FE-I4 sensors have yield problem	Delay to R&D and production		2	4	8	R&D plan with devices being manufactured in three different companies	Use FE-I3 sensors or FE-I4 planar sensors in region far from the beam.	1	4	4				GREEN
5.5	Radiation tolerance of local electronics	Lifetime of detector		2	4	8	Detailed work from FP420 design report	Radiation review in 2010. RD will choose from various options.	1	4	4	See proposal			GREEN
	SPECIFIC TRIGGER RISKS														
6	**WP6**														
6.1	Simulation fails to identify viable topological triggers when detailed pileup is taken into account	Topological trigger technique not viable. ATLAS performance compromised at Phase I. Need to seek alternatives.		1-2	5	10	Detailed simulation studies underway	Early studies show likely benefit from topology	1	5	5	Outcome depends on results from simulation with pileup. This is a developing study within ATLAS.	Continue simulation studies	unknown, (note 26)	GREEN
6.2	Trigger processor too complex or processing outside latency	Topological technique not viable. Need to seek alternative technique		1-2	5	10	Engineering studies will start when funding is available	Firmware test benches will establish viability and latency early in project	1	5	5	Initial studies already show some topological options with existing hardware	Initiate firmware studies when funding is available	unknown, (note 26)	GREEN
7	**WP7**														
7.1	SLHC high pile-up simulation too slow for L1 trigger rate studies	Not possible to evaluate benefits of L1Track at SLHC.	6	2	5	10	Major effort to improve the performance of ATLAS full simulation	Investigate the use of fast simulation tools for Level-1 trigger rate studies	2	3	6		Situation will improve with additional effort	100k/year (note 27)	GREEN
7.2	L1Track trigger leads to significant increase in the tracker material	ATLAS does not approve L1Track, due to impact on offline tracking and calorimeter performance.	3	1-2	5	10	Simulations and evaluation of alternative designs	Investigate the use of fast simulation tools for Level-1 trigger rate studies	1	5	5	Initial estimates of the RoI-based L1Track approach encouraging	Careful evaluation of alternative designs	unknown (note 26)	GREEN
8	**WP8**														
8.1	Phase-I simulated pile-up data samples not available in time.	Not possible to optimize HLT tracking and selection algorithms with appropriate data samples		2	4	8	Review by ATLAS and UK project management	Alternative solutions based on overlay of real events and extrapolation from lower luminosity data.	1	2	2	Potential cost of extra effort	Pursue multiple options for generating datasets	100k/year (note 27)	GREEN
8.2	HLT tracking software too slow or fails to achieve required performance	Potential delay will alternative techniques are developed		2	4	8	Review by UK project management	Potential speed-up from GPU, RoD-level pre-processing and pre-HLT tracking info.	1	3	3	Potential cost of extra effort	Pursue hardware and software options for speed-up	100k/year (note 27)	GREEN
	SPECIFIC COMPUTING RISKS														
9.1	Software not ready in time.	Layout not decided.	3	2	3	6	Review by ATLAS Upgrade Layout Group, SG and PO	Slowdown in R&D programme	1	2	2	Costs of extra time	More software effort		GREEN
9.2	Early data not matching Simulation	Revisit layout and revise software	0	2	3	6	Review by ATLAS Upgrade Layout Group, SG and PO	Slowdown in R&D programme Safety factors in assumptions	1	2	2	Costs of extra time	More software effort		GREEN
9.3	Dependence on operating system features	Refactoring required to retain performance gains	0	3	4	12	Use of widely-accepted OS	Use of open standard languages	1	3	3		Enforce open software etc	30k (note 28)	GREEN
9.4	Prohibitive cost of new technologies	Inability to provide capacity or develop on new technology	0	3	5	15	More than one technology path under investigation	Strong links with providers	1	3	3		Avoid premature technology choice	16k (note 29)	GREEN
9.5	Delay in the LHC running and energy ramp	Knock on delays in deliverables	0	3	5	15	Multi-strand activity	Focus on later simulation and radiological milestones and return to benchmarking when data available	3	3	9		Constant review of schedule		AMBER

Notes:

The costs associated with these risks are very hard to meaningfully quantify. In many cases the cost will be beyond the scope of this program indicated by FUTURE).

1. Cost is of supporting all of ATLAS UK (ex RG) for 12 months - it is assumed capital and travel will be required FUTURE.
2. As note 1 but with the proviso that a loss of leadership is likely to impact technical choices, and increase costs further.
3. Worst case is assumed to be to employ STFC staff instead (recruiting may be needed) and this is likely to ass 50k per FTE of effort.
4. ranging from 0 to very high depending on exact discoveries. To date all discoveries have resulted in 0 cost increase, and the likelihood of anything larger coming forward is diminishing all the time.
5. 1 square meter increase of area will be 100 modules at ~4k each - on top of this there will be effort, readout, spares etc. This cost would be spread over maybe 2017-2019 and shared by all collaborators. Given the proposed UK contribution the UK could expect perhaps 20% of these costs FUTURE.
6. Impossible to quantify due to non-specific nature of risk
7. Can only impact capital aspect of the project - this is a worst case assuming all parts that must be sourced abroad are 20% more expensive
8. Approximate cost of remaking average price full prototype (stavelet) from scratch.
9. The timing of this would have a huge impact on the cost - from 0 to ~1/3rd of the capital allocation of the tracker - clearly willingness to spend will drop should such a change look likely
10. parts are insured in transit so the capital loss will be 0 - there will be a time loss, but generally re-scheduling is possible.
11. As we are not yet in production there is no quota we need to fill, and much of the WP2 Working allowance is associated with this purchase - we might have to adjust the prototyping plan should this risk be realised
12. It is assumed international orders will not be allowed to slip the TDR date so there is no cost from that - the risk will be realised be having to redefine UK scope
13. Impossible to quantify - depending on when the risk was realised, and the magnitude of the change it would range from trivial to very high.
14. Assuming the costs incurred would be considered zero as they have been budgeted, then the fabrication costs are negligible, but the running costs will be higher, and the performance poorer.
15. Nominal cost for extra iterations (capital only) - if it effect the TDR then note 1 - very unlikely.
16. This results is loss of leadership and position not in capital risk

17. 100k is the cost of providing 1FTE of STFC effort from the UK to assist in the ASIC development
18. Cost of reworking prototypes and tooling - very approximate.
19. Cost of two new irradiation runs (assuming SCK - might be lower at Birmingham if that proved possible)
20. Nominal sum to switch effort to DC-DC.
21. 50:50 university STFC effort, unlikely more than 6 months would be needed.
22. Assumed to be small effects that can be investigated in subsequent prototypes - upper limit is dedicated prototype cost.
23. The per stave cost - assumed a stave takes 1 week longer to bond (very unlikely)
24. Use connectors - cost neutral
25. Cost of new module mounting tooling and all stave build tooling + development of next version .
26. Trigger problems if realised would compromise the ATLAS performance, there is no obvious solution by use of extra resources
27. Cost given is for 1 additional STFC staff to work on problem. Effort required is not quantifiable, would be an ATLAS collaboration problem
28. Half a year of PDRA effort to enable virtualisation or change code (upper limit)
29. Given the intended late purchase of hardware the budget will remain largely intact until program end, at that point extra cost may be incurred - approximated by doubling capital budget.

6.5 Glossary of terms

SCT	Semi Conductor Tracker, the strip tracker of the present ATLAS experiment
Stave	The smallest modular element of the proposed strip tracker – presently considered 12 modules long, with detectors on either side
Stavelet	A 4 module long stave used for prototyping purposes (mainly electrical)
The proposal	The document submitted to the PPRP titled "ATLAS UK Upgrade Proposal" on October 30th 2009. This formulates what we requested funds for in the 2010-2013 period.
TD	Technology Department at STFC (includes Technology at RAL and DL along with the resources of the ATC in Edinburgh)
SP	Serial powering
IBL	Insertable B layer – innermost pixel layer that more or less sits on the beam pipe – the first upgrade ATLAS will get.
Phase 1	This refers to the period of running between the LHC shutdowns in 2017/18 and 2020
Phase 2	This refers to the period of running after the 2020 LHC shutdown
HSIO	High Speed Input Output – an FPGA readout board made at SLAC for interface to all staves (250 and 130nm) and stavelets. Presently used as the primary interface for all strip tracker objects.
IBL	Inner B-layer pixel detector; upgrade to the pixel detector
HLT	High level trigger: level 2 and EF software triggers
EF	Event filter: level 3 software trigger