CERN-RRB-2002-017
31st March, 2002

Summary of the ATLAS April 2002 RRB Progress Report

1. Introduction

The progress report on the ATLAS project, which will be presented at the RRB meeting on 23rd April 2002, will cover the main progress and concerns since the last RRB in October 2001 (ATLAS RRB – D 2001 – 117). The report is based on detailed follow-up reports made in particular to the LHCC ATLAS referees, updating the LHCC Comprehensive Review that took place in July 2001.

The overall LHC project schedule is currently under revision. Reference in this report is made to an ATLAS construction and installation schedule that would deliver a fully commissioned initial detector ready for collisions in Autumn 2006. The ATLAS Collaboration is highly motivated to meet this date, and all the technical construction progress as well as the planning indicate that this is well feasible.

ATLAS has presented already in previous RRBs its detector concept for the first physics run. The initial staged detector configuration is constrained in the current LHC project planning essentially by resources considerations. A staging concept has been developed such that the initial detector is still able to address all the physics potential of the first physics run at moderate luminosity. The initial staged detector, the physics impact of the staging configuration, as well as of alternative and more restrictive staging scenarios, has been documented in an RRB note (ATLAS RRB – D 2001 – 118).

The additional resources needed to complete this initial detector have been presented to the RRB at the last meeting in October 2001, and documented in an RRB note of the overall cost to completion (ATLAS RRB – D 2001 – 121). Since then these costs have been further consolidated and scrutinized internally and externally to the Collaboration. Furthermore fall-back scenarios have been evaluated for the eventuality that the necessary funds to cover the cost to completion would not become fully available in time for the first physics run. These scenarios, providing flexibility over the forthcoming years to cover supplementary costs on the time-critical highest-priority components, are discussed in a separate document (CERN-RRB-2002-025).

The new Technical Coordination organization has now been in place and operational for one year, and very clear benefits in terms of detector integration progress are visible. The emphasis on these activities has increased very much, with important engineering progress in defining and checking all detector component envelopes and 3D FEA modelling of the full detector. Also the very complex installation planning has started seriously. Significant contributions from the collaborating Institutions and from CERN can be acknowledged for strengthening the Technical Coordination, which will demand further increased manpower approaching now the installation phase.

In parallel, the Civil engineering work at LHC point 1 has progressed remarkably well, the major contracts for the large infrastructure items for the experimental area are running on schedule, and an efficient site management involving fruitful collaboration with many groups from the technical and machine divisions at CERN is being set up by the Technical Coordination of ATLAS.

In the meantime, detector construction has progressed significantly since the last RRB, and more and more components accumulate at CERN ready for integrations and pre-assemblies. These activities become particularly visible now for the LAr and Tile Calorimeters, as well as for the toroid magnet system. Major emphasis is also given for the current activities on large system tests, for example in the silicon tracking system and the muon instrumentation.

Globally speaking, and for most components, the project is advancing well and as planned. Some delays with respect to the initial planning also exist and have to be dealt with. In particular on the time-critical path is the Barrel Toroid integration, with a new problem arising with the initial contractor, and also the End-Cap Toroid cold mass fabrication issue is remaining still problematic. A new technical problem arose in the barrel Transition Radiation Tracker (TRT) for which an alternative wire joint needs to be qualified as the present one failed under extended radiation tests.

The progress is displayed in an integrated way by the fraction of LHCC milestones passed as compared to the planning in Figure 1. Visible in this figure are the baseline changes of milestones at the beginning of 2000 and mid 2001, which kept critically delayed components flagged as such in order to display the true construction status. The second baseline change of the milestones reflects the LHC project schedule change of Spring 2001.

This curve will be further adapted to the new LHC project schedule that is expected to be fixed in the coming months. ATLAS in turn will optimise its installation schedule once the overall LHC time scale is fixed. The best current understanding of the detector construction and installation is displayed in Figure 2. This working schedule shows that the staged initial detector will be installed, ready, and fully commissioned for October 2006. In this scenario the installation phase has been stretched already with respect to the planning shown at the last RRB in order to take into account the recommendations from an internal review requiring more time for the installation of the magnet system. As mentioned in previous reports, ATLAS aims at achieving in the construction phase a 4-month float (contingency) for each sub-system. The new construction planning for all components can essentially respect this requirement, still leaving even in the most critical cases (Barrel Toroid and LAr Calorimeter) a couple of months of float.

For completeness, also included in this report, are the budget commitments and payment profile plots, as they will be discussed at the forthcoming RRB.

2. Construction Status of the Large Components of the Common Projects

2.1 Magnet System

The Solenoid construction and initial acceptance tests have been completed, and the solenoid is now stored at CERN awaiting the final integration with the LAr cryostat in 2003.

The Barrel Toroid B0 prototype coil has been successfully cooled down and operated for the first time at the nominal current of 20.5 kA during July 2001. Further tests before the end of 2001 have demonstrated a safety margin of 10% in the current (20% on the forces). Given these successful tests, one can now conclude with confidence that the B0 project (CEA/INFN/CERN) was indeed highly beneficial for 'learning on-the-job' all steps of the engineering and fabrication for the final coils. The B0 played a fundamental role for the ATLAS magnet project. The Collaboration gratefully acknowledges the Magnet Laboratories and Funding Agencies that have contributed to the B0 R&D project.

Conductor fabrication for the Barrel Toroid (BT) has proceeded; about 85% has been produced so far. Coil winding and double pancake fabrication and impregnation have passed the 50% construction milestone. The BT coil-casing is now under smooth construction, the first two of the eight casings have been accepted and further ones are under construction. The vacuum vessels are in continuous construction. The first one is accepted and the second almost ready. Their deliveries are expected to occur every five weeks during this year. The fabrication of other components, such as the tie-rods, proceeds as well.

A new problem has developed for the BT coil integration stage-1 (coils into casings). The contractor has notified ATLAS of large over-cost claims and stopped essentially work at the end of November 2001. In spite of intense negotiations, no financially and schedule-wise acceptable solution has been found. The work is therefore now being re-organized (currently still under negotiation) to be executed at CERN in Hall 180, involving expert manpower for the second lowest initial bidder and from the ATLAS magnet team, as well as contractual manpower from Dubna which is already foreseen for the second integration step (assembly into cryostats). This re-organization of work is expected to be cost neutral and to recover the accumulated delay of four months, as there will be fewer transports involved in the overall operation.

About 70% of the conductor for the End-Cap Toroid (ECT) has been produced. A dummy coil has been wound, but the cold mass fabrication, an in-kind contribution from the Netherlands, has continued to accumulate serious delays because of a company take-over, as already reported at the last RRB. This matter receives highest attention from the magnet project and the NIKHEF and ATLAS managements. The contractor has now finally resumed work after several technical problems have been solved. However there are non-resolved financial claims for over-costs that will require further negotiations.

The vacuum vessel construction is progressing very well and on schedule, the first of the two vessels is at CERN and the second is arriving in April 2002. The integration and completion of the ECTs at CERN is suffering from the delays in the cold mass fabrication, but is still expected to meet the installation schedule as the ECTs are among the last components to be installed.

The design of the Common Magnet Services has progressed well. The Test Station in CERN Hall 180 is operational and has been fully commissioned with the B0 coil.

2.2 LAr Cryostats and Cryogenics Plant

The industrial fabrication of the Barrel Cryostat is finished, and it is at CERN since July 2001. A small leak in one of the warm cover plates, noted after the transport, has recently been repaired.

The End-Cap Cryostats are also progressing well after some initial technical problems reported at previous RRBs. The first of the two cryostats just arrived at CERN in March 2002, and the second one is expected to be at CERN in September 2002.

The signal and HV feed-throughs (FT) are in fabrication. For the barrel, 53 out of the 64 FTs are produced and installed in the cryostat, for the end-caps 27 out of 55 are produced, most of them are already at CERN awaiting for integration into the cryostat. Further good progress has been achieved for the Cryogenics Plant.

2.3 Infrastructure and Support Structures

The design of the shielding, the support structures, and other infrastructure components has been vigorously pursued, with the schedule driven by the goal to get specifications in time to solicit further in-kind contributions. These efforts have led also to significant design changes and simplifications.

A particular emphasis was given to the support feet and rail structure, including the movable parts ('trucks') for the calorimeters and ECTs. The contracts for the feet and rails have been placed in January 2002 according to a tight schedule. The concept for the trucks went through a major change involving an accepted Engineering Change Request (ECR) for the cavern floor. The final specifications have been worked out and their delivery is expected to be on time. These supports are on the critical path for the detector installation as they are the first ATLAS detector elements to be installed.

3. Construction Status of the Detector Systems

3.1 Inner Detector (ID)

For the Pixel detector sub-system the pre-series of sensors qualified the two producers. The next step is a 10% production batch during Spring 2002. The developments of the hybridisation and of the local support and services systems have passed a Production Readiness Review (PRR) during the last six months. The overall design concept as an independent and insertable sub-system is now fixed, and an ECR is being finalized. The new concept will also facilitate future upgrades and replacements.

The most critical component for this sub-system is the front-end (FE) electronics. In a great effort the new design in Deep Sub-Micron (DSM) technology has been pursued with successful test results from fully functioning prototypes. The yield still needs to be improved from the last pre-series. But given this major step with the FE electronics passed, the Pixel group can now move forward with module construction and system tests. The project plan for the sub-system foresees to meet the installation requirements for the initial detector configuration with two Pixel layers, still with a considerable float.

There is steady progress for the Silicon Tracker sub-system (SCT). The silicon detector production is running smoothly and more than 60% have already been delivered and accepted. After the successful step of the PRR for the rad-hard DMILL versions of the FE electronics, about 25% of wafers have been delivered and partially tested. The barrel module components are in production, as well as the barrel support cylinders. For the end-cap modules further development work was required for the hybrids because of excessive noise observed in early system tests last Summer. Very recently new designs have been demonstrated to achieve the required performance, and a decision was made to pursue the design that matches best the existing end-cap engineering layout. The details of the design still have to be consolidated, with the aim to have a Final Design Review (FDR) in June or July 2002.

Substantial progress can be reported for the design of the optical links, power supplies and off-detector electronics. Growing system tests are continuing both for the barrel and end-cap regions, equipped with prototype cooling and opto-harnesses, to optimise the electrical grounding and shielding configurations. The SCT sub-system delivery remains consistent with the schedule, provided the system tests continue to make good progress.

The straw reinforcement for the Transition Radiation Tracker sub-system (TRT) is finished, and the end-cap straw preparation is 50% complete. The end-cap wheel construction has now started at the two sites. A new problem was encountered for the barrel module production when long-term irradiation tests with the final gas mixture showed failure in the glass wire joints. With highest priority a programme has been initiated to develop and qualify alternative solutions, with well-defined milestones for a decision path before the end of May 2002. In the meantime mechanical module production continues, with the aim to resume stringing of the wires in June 2002. A detailed schedule has been worked out leading to completion of the barrel modules by May 2003, still compatible with the overall TRT and ID schedules.

Both chips of the rad-hard FE electronics (DMILL) have given very satisfactory results. For cost reasons the digital chip is also developed in DSM, with a decision milestone in May 2002.

Based on schedule and resources considerations the end-cap wheel construction strategy has been changed to give priority to the production of all type 'A' and 'B' wheels that are linked mechanically to the end-cap SCT. As a consequence the outermost wheels of type 'C' will be staged for the initial detector configuration.

Continued special attention and efforts are spent on the overall ID engineering. Definitive progress has been achieved in the critical area of the services routing through the calorimeters and muon system, with major relocations of patch panels outside the first muon chamber layer. Another critical area is the development of the evaporative cooling system for Pixels and SCT. The so-called 'phase II' set-up with a capacity of about one-sixth of the final evaporative system is now operational, aiming at an FDR in July 2002. Good progress can also be noted on the overall thermal management and the environmental gas issues for the ID.

The integration and commissioning work for the entire ID will take place at CERN from 2003 to 2006 in a new large clean room near the experimental pit. This vital facility requires a large amount of new infrastructure and substantial human resources coming from the ID Institutes. The building has progressed well after further revisions of the plans to minimize costs.

3.2 LAr Calorimeter

The LAr calorimetry (pre-samplers, EM, hadronic end-caps, and forward calorimeters) is in a steady production phase, and the technical issues reported at previous RRBs are now off the critical path. For example, the industrial EM read-out electrode fabrication has proceeded well with a high yield (90%) and rate, and is expected to be finished in July 2002 including an additional 9% replacements of losses that occurred mostly in the start-up phase. Also the electrode bending process is now running very smoothly.

The absorber fabrication for the LAr EM calorimeter has progressed further, with about 55% for the end-caps and about 68% for the barrel made. Stacking and cabling of modules proceeds at the three barrel and the two end-cap assembly sites. By now the first 10 of 32 series barrel module are finished and 6 cold-tested and accepted. The rate of cold testing has improved with a third test station at CERN. For the end-caps 5 out of 16 modules are made, and 3 cold-tested. In both cases the completion is anticipated for Spring 2003.

Production of the barrel LAr pre-samplers is ongoing and the sub-system is expected to match the required delivery dates. A total of 15 out of 64 barrel sectors are made by now, and also the end-cap modules are in production.

The LAr hadronic end-cap series production is running smoothly. As of end of February, 86 out of 134 modules have been completed and 76 cold tested and accepted. A critical issue remaining and followed up is the capacity for machining Copper plates for front-modules.

The module production for all LAr forward calorimeter modules is now also in full swing. The absorber structure for the side 'C' modules is almost complete. A schedule risk remains for the W-rod delivery, even though the situation has improved since the last RRB.

Large pre-series of various LAr electronics components were tested successfully in test beams already some time ago. A total of 11 different chips have been transferred successfully into radiation tolerant DMILL technology, and the large SCA controller chip and a few smaller ones also into DSM. The first radiation tolerant, complete Front End Board (FEB) operated successfully (except for the still missing negative voltage regulators). The off-detector component development and fabrication is on schedule.

A very major LAr integration activity has started in CERN Hall 180 where the modules will be assembled into half-barrel rings and wheels for the end-caps, and then introduced into the barrel and the two end-cap cryostats respectively. This pre-operation activity will also include complete cold tests of the three fully equipped LAr calorimeter units. The detailed planning for the final installation in the cavern has started. Overall, the system delivery milestones are respected with only a slightly reduced float for the barrel and the second end-cap unit.

3.3 Tile Calorimeter

Series production is progressing very smoothly at all sub-module and module assembly sites, nearing now already completion. All scintillator tiles have been produced and prepared, and also the first sub-module sites have completed their task. About 75% of all the modules forming the barrel and the two extended barrel cylinders have been finished and equipped with their optical components, and are at CERN. They are ready for the initial detailed Cs-source calibrations, and most of them have also been equipped with all mechanical connection pieces. The instrumentation uniformity of the optical components has been measured to surpass significantly the specifications.

All of the electronics components are in the procurement phase and integration into the so-called 'drawers', housing PMTs, the read-out electronics chain and the high-voltage, has started. About 80% of the PMTs have been delivered and tested with good results. The first pre-series of the 'drawers' have been used in the final beam calibrations of several series modules.

The next major step will be the pre-assembly of the complete tile calorimeter cylinders that will start in Summer 2002. For this major pre-operation activity the timely procurement of the support structures ('saddles') and of the manipulation tool are on the critical path now. Globally the Tile Calorimeter construction is however following well the expected schedule for in-time delivery.

3.4 Muon Spectrometer Instrumentation

Since the last RRB the MDT precision chamber fabrication has continued in 11 out of the 13 production sites, the two others are on schedule to join the effort during 2002 as planned. In terms of series MDT tubes, about 30% have been assembled and tested. A rigorous quality test control procedure is applied at all sites, which resulted in a steady decrease of rejected tubes, well below the acceptable level.

A total of 237 bare MDT chambers (20.4% of the total) have been assembled until the end of February 2002. The quality of sample series MDT chambers is regularly monitored with the X-ray facility, and all sites in production are found to fulfil well the required high accuracy. A revised production planning has been adopted that conforms to the required installation dates for the initial detector. Pre-series FE MDT electronics have been successfully tested.

The construction for the CSC chambers was initiated with a pre-series of four chambers in September 2001 that are now undergoing thorough tests. All materials for the remaining chambers of the initial staged detector configuration are expected to be available within one month from now. With a construction rate of one chamber per week starting in April 2002, no problems are foreseen to have production completed in June 2003, which meets well the required sub-system delivery schedule.

Both trigger chamber technologies are in series production. For the RPCs a pre-series of 24 chambers is under tests. Most of the components and facilities for the assembly of the next 85 chambers are ready. The on-chamber RPC electronics component production is well advanced. The full production start-up has been substantially delayed (more than one year) with respect to initial planning, partially due to lengthy procurement steps, but also in order to finalize major improvements for the industrial gas volume production, in line with the RRB recommendations. Also new QA/QC procedures have been implemented in view of problems experienced by another experiment (BaBar at SLAC). With these improvements, a new production schedule has been made, which is still consistent with timely completion of the project.

The TGCs are in continuous series production, with about 60% of the material needed for all three sites having been machined and prepared. About 40% of the TGCs have been produced so far at the first site and 25% at the second site. Systematic acceptance testing with cosmic rays is underway, catching up with the produced chambers. A new third site is now ready to start, but its start-up is resources-limited. The FE electronics board production for all TGCs is completed and tested (with a failure rate of < 0.25%). Globally the TGCs are expected to meet the schedule.

Also during the past months the muon detector integration issues were given major attention. They are very closely linked to the overall detector integration. A lot of common work together with Technical Coordination has converged for the integration of all the services and for access and installation scenarios. Examples are the shielding design, and the design of the large movable end-cap chamber support structures ('big-wheels'), affecting also the overall cavern infrastructure layout, which has progressed well within new fixed baseline dimensions.

A second-generation large system test facility (for end-caps and barrel) in the SPS H8 beam is now becoming operational with first series chambers for tests in 2002. Remaining concerns that have to be dealt with include the constant struggle to secure space for storage/testing/pre-assembly (but progress has been achieved since the last RRB), as well as cost issues of common muon system items, as reported previously.

3.5 Trigger and DAQ

The level -1 trigger (calorimeter, muon, and central processor logic) developments have progressed steadily. Full-functionality prototypes of custom integrated circuits and electronics modules are becoming available. As planned, a major emphasis has been put on setting up large-scale system tests ('slice-tests') to confirm the final design. They include the central trigger and timing processors. The first such slice test integration was performed at the end of the year 2001 for the muon TGC trigger at KEK. The next ones are planned this year for the barrel RPC muon trigger and the calorimeter triggers.

The development of High-Level Trigger (HLT), Data Acquisition (DAQ), and Detector Control (DCS) systems has been vigorously pursued with many coherent activities both in software and hardware. They focus on refinement of subsystem designs and on integration of subsystems into an optimized overall HLT/DAQ/DCS architecture. After the Phase 1 Integrated Prototype system assembled in the first half of 2001, a more extensive Phase 2 Integrated Prototype system has been developed. The goal is to demonstrate full functionality and performance scaling. The plan is that the event filter will use the offline software frame mentioned in the next section.

These activities have streamlined the progress on the online software development providing the functionality for configuration, control and monitoring. Central architectural activities occurred in the area of the data flow design, comprising the read-out system (ROS), data collection and HLT data flow. The prototype ROS, data collection, and event filter test-beds are now providing important measurements to guide the further optimisation of the HLT/DAQ system design, in view of the future Technical Design Report (TDR) in this area.

A major effort is underway for evaluating and optimising the trigger and event rates. Most important aspects are the delicate balance between full flexibility to exploit the broad and rich discovery potential of the LHC, and the cost optimisation for both the HLT/DAQ system and the offline computing needs.

The basic building blocks of the DCS, which are a common SCADA supervision system (used by all LHC experiments) and a general-purpose I/O system (used throughout ATLAS), continue to be used in developments by all detector systems. Radiation qualification as specified has now been demonstrated for the microprocessor-based embedded local monitoring board that is a key element of the I/O system. The software interfacing the Online Software System to DCS is progressing well, and was used with prototype DCS subsystems in detector beam tests in 2001.

The dedicated Detector Interface Group (DIG), which facilitates the interfacing of the DAQ and the various detector system read-out electronics, has reached its goals for last year. The DIG has indeed fostered successful test beam implementations of prototype systems for the Tile Calorimeter and the Muon System in 2001, and is now preparing further implementations together with other sub-systems.

The Trigger, DAQ and DCS system are expected to be ready in time for the commissioning of the ATLAS detector.

3.6 Computing

The broad and coherent computing and software activities have been focussed by the preparation for the Data Challenges (DCs). These DCs require that most, if not all, the key software components have to be brought together to work. A first incomplete stage, called DC0, is currently underway albeit with a few months of delay. The development of the framework ('Athena') has further progressed and is acting as a backbone for the whole software chain. Another core software effort is the database work for the Event Data Storage. In this area a major change of direction has been taken by going away from Objectivity, as also the other LHC experiments, and adapting ROOT I/O for the next generation of DCs. The work continues on C++ versions of the reconstruction codes that are interfaced with Athena, as well as on some existing Fortran codes.

The DC1 is planned to provide a very high statistics simulation sample (10^7 events) of events for the HLT/DAQ TDR performance evaluation during the second half of 2002.

In the area of simulation the very active and fruitful cooperation with the GEANT4 Collaboration has continued in order to validate physics performance of the code, in particular still important and ongoing for hadronic calorimetry. Further work concentrates on very detailed representations of the ATLAS detector in GEANT4. Note that GEANT3 needs to be maintained during this transition time in order to answer urgent performance-impact questions, and as a reference for the DCs. Nevertheless, GEANT4 will be tested in large production mode during the DC1.

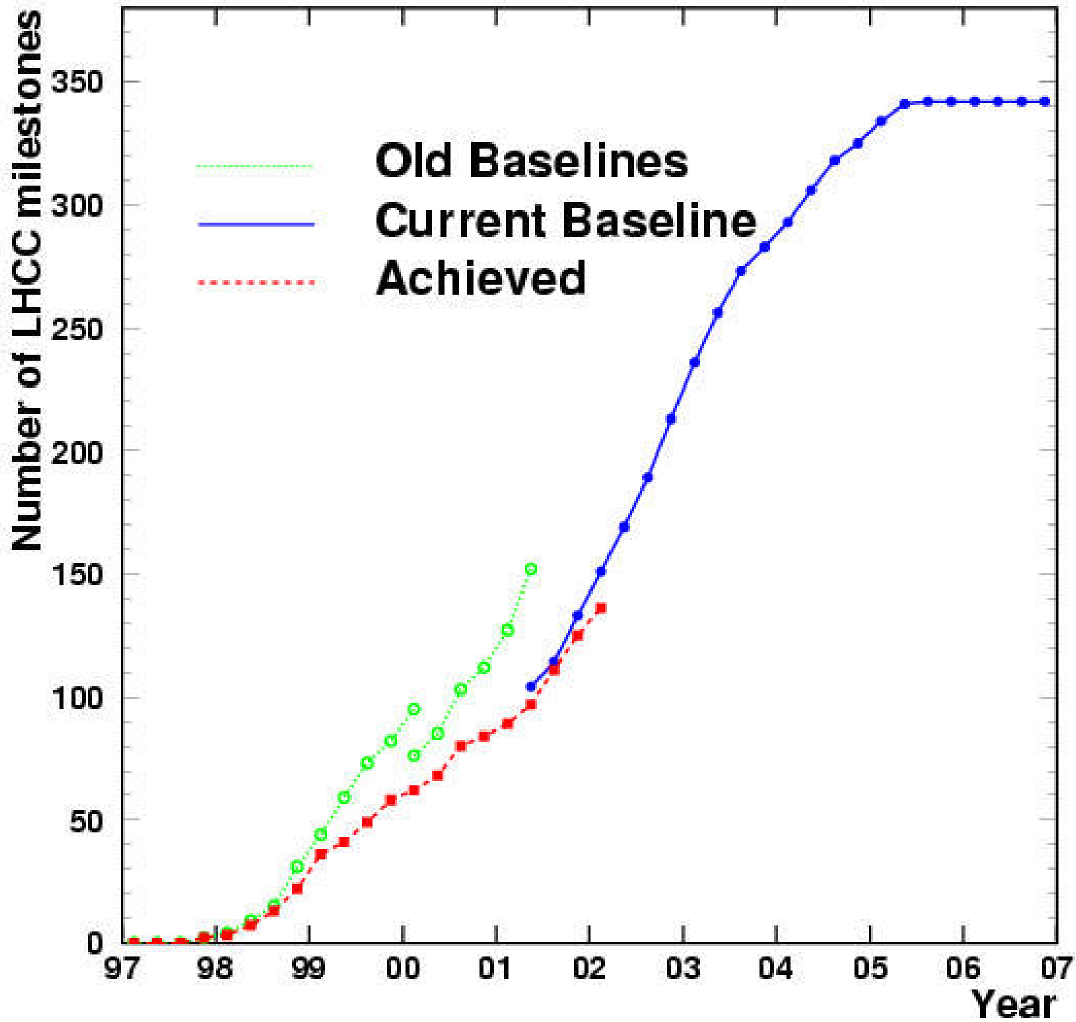
The ATLAS computing management and experts are strongly involved in the CERN LHC Computing Grid Project (LCG). ATLAS is putting high expectations on this common effort and considers the LCG as fundamental for the testing and development of the ATLAS software and world-wide computing model. The DCs will be embedded naturally into this framework as soon as possible.

The computing progress has been reviewed critically by a broad, strategic ATLAS overview review, with invited external reviewers. The conclusions have revealed good progress in many areas, but also emphasized the need for significant improvements in a few key areas like Event Data Model and Detector Description, which are being followed up urgently. Another voiced area of concern is the lack of manpower for computing infrastructure tasks.

The ATLAS National Computing Board addresses sharing of computing responsibilities, and resources planning. This body has approved the first few ATLAS Software Agreements that are expected to be incorporated into an overall Memorandum of Understanding for Computing in due time. The board is now working out a draft policy for the world-wide collaboration computing model and sharing of resources.

4. Commitment and Payment Profile Plots

Based on the budget reports, which will be presented separately for this RRB meeting, Figure 3 displays the cumulative payment and commitments profiles, compared to the planning from the Memorandum of Understanding.



Number of LHCC milestones
0
50
100
150
200
250
300
350
97
98
99
00
01
02
03
04
05
06
07
Year
Old Baselines
Current Baseline
Achieved

Figure 1

ID	Task Name	Start	Finish
1	*UX 15 Hand-over*	14 Apr '03	14 Apr '03
3	PHASE 1: Infrastructure & Feet	29 Mar '03	23 Jun '04
4	Phase 1a: Infrastructure in UX15	29 Mar '03	23 Jun '04
138	*UX available for ATLAS*	7 Nov '03	7 Nov '03
139	Phase 1b: ATLAS Bedplates & Feet	7 Nov '03	12 Dec '03
151	PHASE 2: Barrel Toroid & Barrel Calorimeter	15 Dec '03	18 Mar '05
152	Phase 2a: Barrel Toroid	15 Dec '03	6 Jan '05
153	Phase 2b: Barrel Calorimeter	15 May '04	18 Mar '05
156	PHASE 3: End-cap Calorimeter C & Muon Barrel	20 Oct '04	5 Jul '05
157	Phase 3a: Endcap Calorimeter C	25 Oct '04	23 Jun '05
158	Phase 3b: Inner Detector Services	20 Oct '04	1 Jul '05
159	Phase 3c: Muon Barrel	20 Oct '04	5 Jul '05
165	PHASE 4: End-cap Calorimeter A	28 Mar '05	6 Dec '05
166	Phase 4a: Endcap Calorimeter A	28 Mar '05	6 Dec '05
175	PHASE 5:Big Wheels & Inner Detector	5 Jul '05	20 Jan '06
176	Phase 5a: Big Wheels	5 Jul '05	24 Nov '05
177	Phase 5b: Inner Detector	5 Jul '05	20 Jan '06
183	PHASE 6: Toroid End-Caps & Small Wheels	8 Sep '05	1 May '06
184	Phase 6a: Endcap Toroid	8 Sep '05	4 Mar '06
185	Phase 6b: Small Wheels & Toroid Shielding	23 Jan '06	10 Apr '06
186	Phase 6c: End wall Chambers (EO)	6 Mar '06	1 May '06
190	PHASE 7: Beam Vacuum, Closing, Shielding	3 Mar '06	6 Jun '06
191	Phase 7a: Completion of the Beam Vacuum	3 Mar '06	5 May '06
222	Phase 7b: Magnet test & Shielding	2 May '06	6 Jun '06
225	Global Commissioning	7 Jun '06	29 Aug '06
226	Cosmic Tests	30 Aug '06	24 Oct '06
227	ATLAS Ready For Beam	24 Oct '06	24 Oct '06

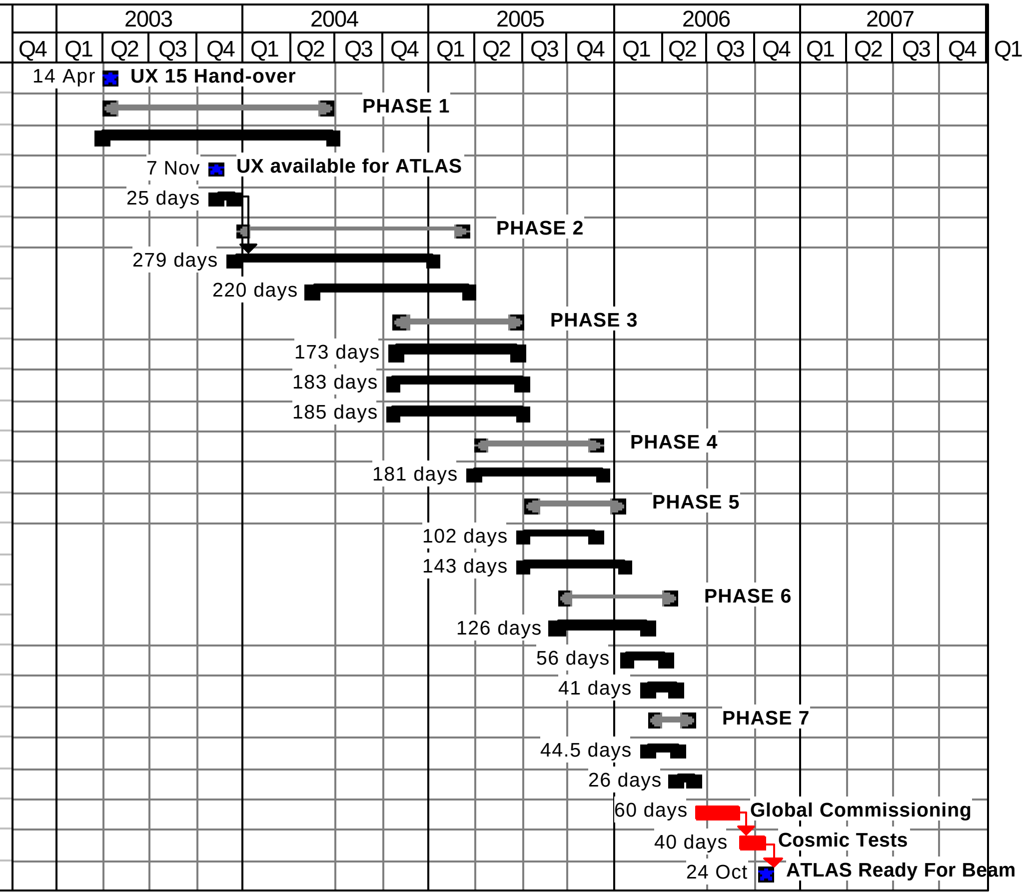
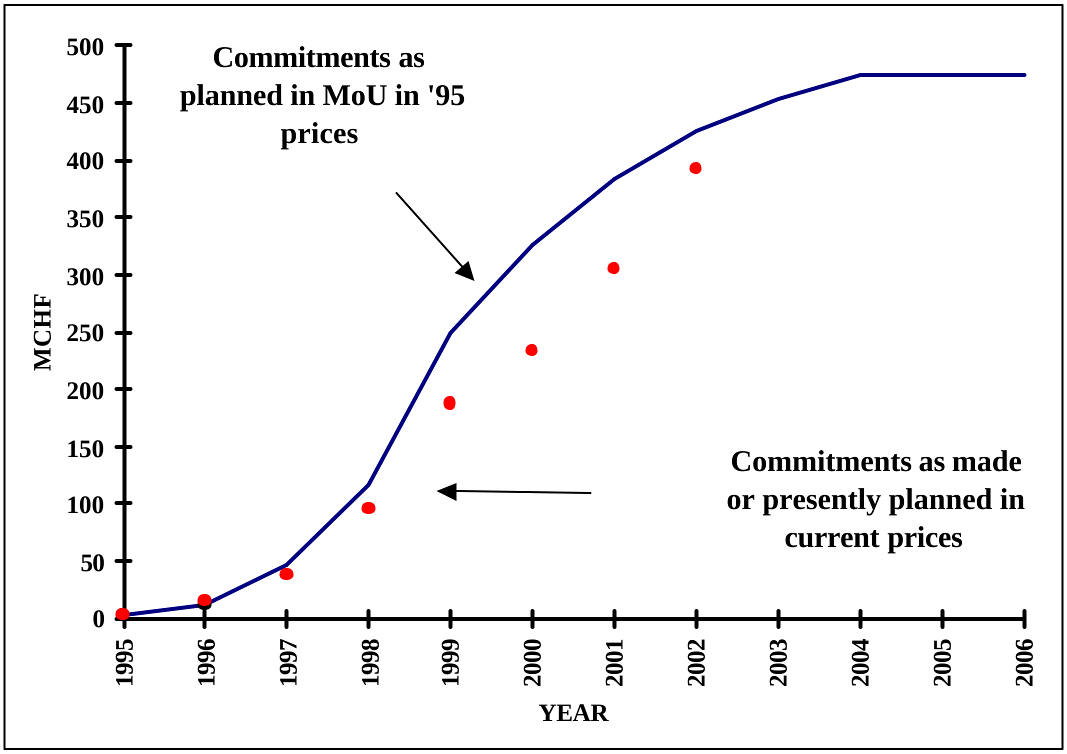


Figure 2

ATLAS Detector Construction – Evolution of Commitments



ATLAS Detector Construction – Evolution of Payments

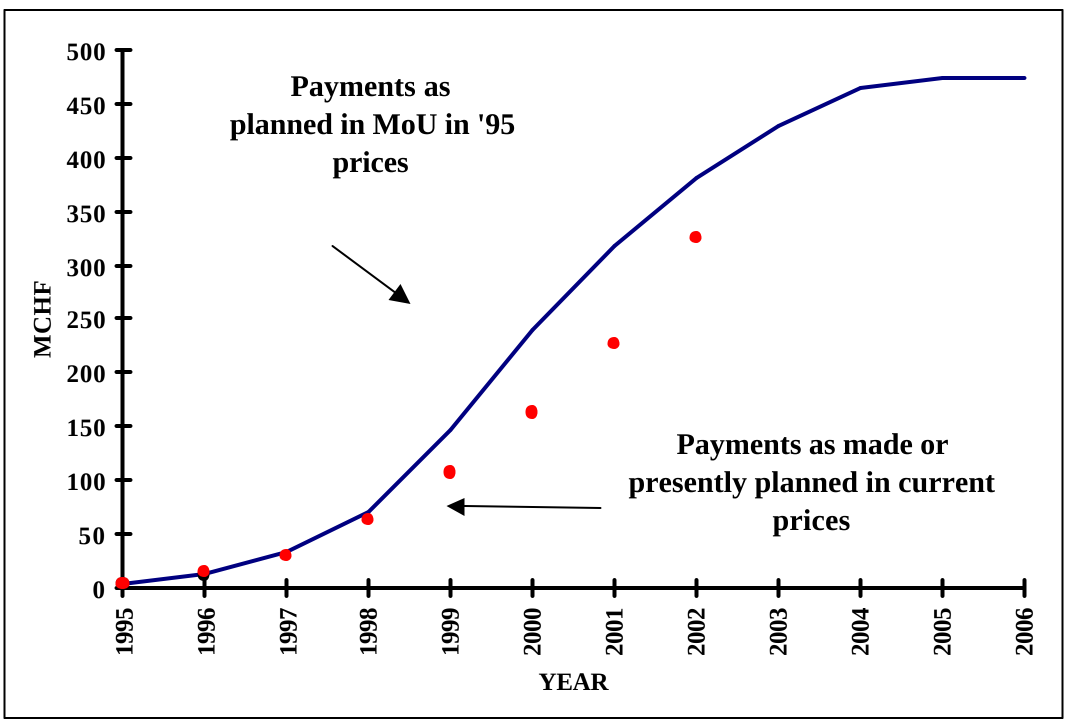


Figure 3