CERN-RRB-2007-016
31st March 2007

Updated ATLAS Progress Report for the April 2007 RRB

1. Introduction and Collaboration Composition and Management

After the successful completion of the distributed construction of components, the technical efforts have been fully concentrated on the remaining surface integration work at CERN, and most importantly on the continuation of the massive underground installation activity. Directly coupled to this is the quickly developing detector, trigger and data acquisition commissioning. In parallel, the distributed computing and physics analysis tools are being set up and exercised, employing fully the Worldwide LHC Computing Grid Project (WLCG) as a backbone. The Collaboration has further evolved its internal working structures to reflect the transition from construction to commissioning, and towards data taking.

It can be briefly recalled from previous reports that the ATLAS detector concept uses a superconducting magnet system with a central solenoid around the inner detector and large air-core toroid magnets for the muon spectrometer. Between the two are the liquid Argon (LAr) and tile calorimeters. A hierarchical 3-level trigger and data acquisition system collects the data for the collaboration-wide computing and physics analysis activities.

The financial framework for the construction was defined in the Completion Plan for the staged initial configuration of the detector. This plan takes into account the Cost to Completion (CtC) for the parts which are not fully covered as deliverables, including the Commissioning & Integration (C&I) pre-operation costs, as well as the available resources, as presented and approved at the October 2002 RRB (CERN-RRB-2002-114rev1). At the last RRB this initial framework was updated after a re-assessment of the final costs expected for the initial detector, showing an increase of 4.4 MCHF (corresponding to a 0.7% increase w.r.t. total initial detector costs evaluated in 2002), together with a proposal to absorb the additional costs within the 2002 CtC funding scheme. The project completion has progressed within this framework.

The ATLAS Collaboration consists today of 164 Institutions from 35 countries with roughly 1800 scientific authors (including almost 400 PhD students). There was no new Institution admitted since the last RRB, and a new Expression of Interest to join ATLAS, from the University of Göttingen, Germany, will be considered by the Collaboration Board (CB) in July 2007 following the standard procedures defined in the Construction MoU.

At the last two CB meetings the ATLAS Management was re-appointed, all with a term of office ending in February 2009: P. Jenni (CERN) as Spokesperson together with F. Gianotti (CERN) and S. Stapnes (University of Oslo and CERN) as Deputies, M. Nessi (CERN) as Technical Coordinator and M. Nordberg (CERN) as Resources Coordinator. In 2007 the CB Chairperson remains C. Oram (TRIUMF), and the CB elected K. Jon-And (Stockholm University) as Deputy CB Chairperson, taking over the CB Chair in 2008-9.

2. Magnet System

The ATLAS superconducting magnet system comprises the central solenoid, the barrel toroid (BT), two end-cap toroids (ECT), and their common services.

Status: The first component, the solenoid, has been successfully commissioned at full current and its safety systems tested in-situ during August 2006, followed by a field mapping measurement. A very major milestone was achieved in November 2006 with the first full excitation of the BT in the cavern. Its operation and safety systems were tested at 21.0 kAmp current, above the standard operation current of 20.5 kAmp. The mechanical behaviour as well as the magnetic field measurements (made in some sample sectors where the muon chambers carrying the probes were available) have confirmed expectations. Cosmic ray muon tracks bent by the BT field have been recorded during the testing period. The cryogenics cooling power of the plant at Point 1 was increased, based on its first operation, to cope efficiently with the full system.

The ECT integration and testing has made significant progress, after implementing the necessary design changes on the cold mass force transfer mechanics reported previously. The first ECT has been completed and is now undergoing a test programme after successful cool-down to liquid Nitrogen temperature. The integration of the second ECT is advancing rapidly, tests will follow in May 2007, and both ECTs are expected to be ready for installation in June and July 2007, respectively.

Changes: ECT cold mass force transfer design changes were implemented.
Concerns: None.
Plans: Complete the Magnet System, with the ECT surface tests and with their underground installation in June-July 2007, followed by the cryogenic and electrical connections and in-situ tests. The full system is planned to be operational in December 2007.

3. Inner Detector

The Inner Detector (ID) combines three concentric sub-system layers, from inside out the Pixel detectors, the Silicon detectors (SCT) and the Transition Radiation Straw Tracker (TRT).

Status: The distributed module production has been finished for a while, and the integration work in the clean room facility SR1 at the Pit 1 surface area is close to completion as well. Substantial parts of the integrated barrel and end-cap TRT+SCT devices have been operated on the surface in cosmic ray tests to demonstrate design performance, and immunity against sub-system cross talks. Also one of the Pixel end-caps has undergone successful cosmic ray tests in SR1.

A very large effort has been concluded with the installation of the ID services (cables and pipes) prior to the installation of the barrel TRT+SCT. The installation and commissioning of the off-detector electronics in the underground control rooms USA15 and US15 have proceeded according to plans.

After the installation of the barrel TRT+SCT and the connections to its services a serious problem was encountered with the evaporative cooling system. The heaters at the exhaust pipes did not function correctly, and in February one of them failed in a catastrophic way by developing a short. The evaporative cooling system is used both for the SCT and Pixel sub-systems. The barrel heaters (44 in total) are located in the TRT+SCT end-cap regions, and therefore preclude installation of these end-caps before the repair and tests of the faulty components. This in turn delays the installation of the Pixel subsystem which will be done as a completely integrated unit containing also the beryllium beam pipe. A large crash effort is currently underway to repair and qualify the heater system, as well as to develop a back-up design at an alternative location. The current delay means that the TRT+SCT end-cap units and the Pixels cannot be installed before April and June 2007 respectively, and this has a critical impact on the overall schedule of ATLAS (see Section 7).

Changes: Repair and re-qualification of the heater components (200 in total) for the evaporative cooling system of the SCT and Pixel sub-systems is needed.
Concerns: Technical and high schedule risks for the system to be installed and commissioned for LHC start-up.
Plans: Repair and re-qualify evaporative cooling system, followed by the end-cap TRT+SCT installation, Pixel sub-system installation, commissioning in-situ with cosmic ray data.

4. Calorimeters

Status: All three calorimeter cylinders with the outside rings of Tile Calorimeters around the LAr cryostats are installed in the cavern and the main activities concentrate on completing electronics installation and system commissioning in the cavern. Major points of attention remain the late availability of low- and high-voltage power supplies for both calorimeter types which impact the commissioning progress. For the LAr calorimeters the HV power supply faults have been solved with the original vendor, and the remaining issue is the tight delivery schedule. For the LV power supplies, sitting on the detector, a retro-fitting campaign for replacing faulty components has been launched with a new firm, and this action is on the critical path for the calorimetry. For the Tile Calorimeter a solution is being implemented on the faulty power supply system as reported before; the critical remaining issue is a rework on a fraction of the on-detector electronics ‘drawers’ which show instabilities.

4.1 Barrel Calorimeter

The barrel calorimeter is in its final position, and the LAr electromagnetic part is cold since August 2006. Commissioning is proceeding all the time independently on both calorimeter types, interleaved with several periods of common running and cosmic ray data collection through segments of the final DAQ system.

4.2 End-Cap and Forward Calorimeters

The Tile Calorimeters in the end-caps (often referred to as ‘extended barrels’) are being commissioned in parallel with the barrel part, and are affected by the same critical issues. The first LAr end-cap (side A) with its electromagnetic, hadronic and forward sub-systems has been cooled-down successfully over the past months and filled with LAr, ready for commissioning work to start. The cool-down of the second end-cap (side C) has just started.

Changes: Major rework on the low and high voltage power supply systems.
Concerns: Tight schedule for on-detector power supply component readiness, given the limited time with access to the calorimeter cylinder ends in-situ. For the Tile Calorimeter system delicate interventions are needed on a part of the on-detector electronics drawers.

Plans: Complete missing power supply installations, and the drawer repair work for the Tile calorimeter, continue in-situ commissioning, and gradually expand to overall system tests with cosmic ray data. Complete the cool-down of LAr end-cap side C.

5. Muon Spectrometer

The Muon Spectrometer is instrumented with precision chambers for the momentum measurement (Monitored Drift Tube chambers, MDTs, and for a small high-radiation forward area Cathode Strip Chambers, CSCs) and with fast chambers for triggering (Resistive Plate Chambers, RPCs, in the barrel, and Thin Gap Chambers, TGCs, in the end-caps).

Status: The series construction of all the chamber sub-systems has been completed for the initial detector. The main activities concentrate now on the installation and commissioning, including the complex alignment systems which are crucial to achieve the expected performance. A serious concern is the late delivery of power supplies from a single vendor who is also late in delivering power supplies to the other LHC experiments. It is already known that this will imply that not all chambers will be operational for the LHC start-up run at the end of 2007.

5.1 Barrel Chambers

By the end of last year (2006) almost 95% of the chamber units were mechanically mounted, and more than half of them placed into their final position. The remaining installation work has now been resumed, after access is again possible given the overall ATLAS installation sequence. Much progress has been achieved in gradually commissioning trigger and precision chambers, culminating in November 2006 with cosmic ray muon data taken in the first sector triggered by the RPCs and with the BT field on.

5.2 End-Cap Chambers

The main activity continued with the assembly and integration of fully tested sectors for the end-cap wheels, including their alignment system, and their installation. The so-called ‘Big Wheels’ in the middle station consist of a total of 2 MDT wheels and 6 TGC wheels, preassembled in 32 MDT sectors and 72 TGC sectors. At this stage the underground installation of two TGC wheels and one MDT wheel is completed, and the sector preassembly is in full swing, with projected completion in June 2007. In-situ commissioning of the TGC and MDT Big Wheels has started as well. The preassembly of the chambers for the first station (so-called ‘Small Wheels’ with TGC, MDTs and CSCs mounted on the shielding disk ‘JD’) and of the third station (MDT chambers mounted on the cavern end-walls) is also proceeding.

Changes: Parallel installation of Big Wheels on both sides (A and C) has been implemented, which required additional tooling.
Concerns: Tight and constrained installation schedule. Due to the delayed availability of power supplies for the whole system, not all chambers can be powered for the LHC start-up in 2007.
Plans: Complete barrel and end-cap installation and continue with commissioning.

6. Trigger and DAQ System

Status: Components of the final Level-1 Trigger, the High Level Trigger (HLT), the Data Acquisition (DAQ) and the Detector Control System (DCS) are now being installed at Point-1, both in the underground control room as well as in the surface

HLT/DAQ computer room. They are being used more and more heavily and routinely for the commissioning of the ATLAS detector during its installation.

6.1 Level-1 Trigger
The level-1 trigger system (with the sub-systems calorimeter, muon and central trigger processor (CTP)) is in final production and installation for both hardware and software. The muon trigger sub-system proceeds on a tight schedule coupled to the muon trigger chamber installation and commissioning. The calorimeter trigger installation is keeping up with the growing availability of the corresponding detector signals in the underground counting room. The major parts of the CTP sub-system is already in place and all components are available, and it is routinely used during combined detector commissioning runs.

6.2 High Level Trigger, DAQ and Detector Control System
The HLT, DAQ and DCS activities proceed according to plan. It can be noted that major emphasis is put on all aspects of the software development. Data from combined cosmic ray running were collected successfully through final segments of the whole chain. The Read-Out System (ROS), fully installed and commissioned, and the Event Builders, one-third installed and commissioned, have been demonstrated in internal, technical runs to approach the required performance and data throughput rates. HLT algorithms have been successfully used at Point-1 with physics events pre-loaded in the ROS, and also with cosmic ray muons. The DCS is operational, at least to a very large extent, in the underground installations at Point-1.

Changes: None.
Concerns: The performance of the initial system remains limited by the availability of funds, implying deferrals of processors as foreseen by the Completion Plan, in the case where not all the Cost to Completion funding becomes available.
Plans: Continued optimization of the HLT/DAQ/DCS system and its software, and build up gradually the full system at Point-1. Operate at the same time the online software infrastructure as well as DAQ and DCS tools for detector commissioning.

7. ATLAS Detector Installation Schedule

Status: The detector installation is now in its final stages. The installation status and the critical path for the detector components have been addressed in the previous sections. It must be stressed that the whole schedule is strongly affected by the recent ID heater problem mentioned in section 3, which makes it very difficult today to give a definite plan. The schedule is furthermore constrained by the fixed contractual dates for the two ECT transports and the lowering into the cavern, planned for June and July 2007. Given the effects on the overall installation sequence because of the delay accumulated with the ID system, and with the ID end-caps and Pixel installation before the ECT dates, time will not be sufficient to complete the end-cap muon instrumentation for a beam pipe closure at the end of August 2007. ATLAS is prepared to close the beam pipe at this moment if required; otherwise the wheel installation will continue. Completion of the installation will then immediately resume after the technical run of the LHC. It has been verified that the forward shielding is not needed for the technical LHC run at 900 GeV, gaining additional installation time. A new schedule with these constraints is currently being worked out, and will be available for the RRB meeting.

It should be noted that the installation of the services and cables, with their cable trays, patch panels and movable chains, one of the most manpower-intense activities in the underground cavern, progressed very well over the past year, and is nearing completion.

For completeness Figure 1 shows the LHCC milestone progress for the ending construction phase in an integrated way, by the fraction passed as compared to the baseline planning from the last revision agreed with the LHCC in 2003.

Changes: The installation sequences, and the overall schedule, are affected in a very substantial manner by the heater problem of the ID evaporative cooling system. As a consequence, the full initial detector configuration will not be available for a beam pipe closure at the end of end August 2007. Re-scheduling and optimization work is currently under way by Technical Coordination.
Concerns: Serious schedule risk due to the repair work for the ID heater failures.
Plans: Completion of the barrel region with the installation of the small fraction of remaining muon stations and the major remaining installation work of the ID (end-caps and the Pixels). Continuation of the installation of muon end-cap chambers (wheels and end-wall). Installation of the End-Cap Toroids in June and July 2007. Closure of the beam pipe as required by the LHC start-up schedule.

8. Computing, Software and Physics Preparation

The Collaboration-wide distributed computing infrastructure part is fully embedded into the framework of the WLCG (discussed in the Computing RRB) of which ATLAS is a very active partner. However it must be stressed that in addition there is a large, experiment-specific effort needed, and ongoing, to efficiently interface the ATLAS software suite and analysis framework to the WLCG infrastructure.

Status: During the past year ATLAS and WLCG successfully performed large data transfer exercises, with increasing data volumes, from the Tier-0 to all Tier-1s and many Tier-2s, known as Service Challenges. The WLCG is also consistently used for running large simulation productions, needed to develop and exercise more and more realistic approaches to the data collection and analysis, including detailed trigger, calibration and alignment aspects, known within ATLAS as Computing System Commissioning (CSC). The core computing infrastructure and services tasks, defined as M&O category A, play a crucial role for the smooth operation.

Many specific tools and procedures, encompassing online and offline aspects for the whole ATLAS software, are being developed and implemented within Collaboration-wide task forces. Particular emphasis is being put on the usability of the whole analysis suite. Another important goal, and indeed already an ongoing activity, is to collect, distribute, and analyze real cosmic ray data from Point-1, which will be used to demonstrate all these steps.

The preparations for the physics data taking remain at this stage very much driven by a detailed planning for the very early phase of the LHC operation. The main goal is to debug the detector, computing and software, and to gain as efficiently and quickly as possible an excellent understanding of the detector performance to ensure the quality of the data. These preparations are organized within a framework guiding the future operation of the experiment, as internally documented in ATLAS in the Operation Model.

Changes: None.
Concerns: None, even though the Collaboration needs to significantly increase its efforts on the computing infrastructure and operation tasks in order to deliver the efficient framework needed for extracting the early physics.
Plans: Consolidate and commission the software and computing for a Collaboration-wide, distributed approach, in full coherence with the WLCG infrastructure backbone. Further improve the usability of the software, and implement all minimally required functionalities for data taking.

9. Updates on the Completion Planning

The framework of ATLAS completion was laid down at the RRB meeting in October 2002, when the Completion Plan for the initial ATLAS detector was approved. This plan (CERN-RRB-2002-114rev1) took into account the Cost to Completion (CtC) for the parts that are not fully covered as deliverables, and included the Commissioning and Integration (C&I) pre-operation costs until 2006. It fitted into the framework of the available resources agreed to at that RRB meeting by the Funding Agencies (called category 1 funding in Annex 2 of the above document). The document also included an indication of further funding prospects, without commitments yet, from the Funding Agencies (called category 2). The detailed implementation of the plan was understood to evolve within the specified overall framework when further financial commitments would become available. The CtC envelope in 2002 was set at 68.2 MCHF, imposing on ATLAS at that time a scheme to stage and defer components and activities from its initial detector configuration, in order to fit into available resources. Since then the detector construction has continued within this framework.

In October 2006 the RRB has accepted a new assessment of the CtC which resulted in an additional cost increase of 4.4 MCHF (from the magnet system, Big Wheel support structures, LAr cryogenics, and installation efforts, see CERN-RRB-2006-069). The Collaboration stressed that these additional costs could be accommodated within the 2002 Completion Plan provided all funding partners contribute their full calculated share to the CtC, thanks to the fact that CERN contributed a larger than calculate share, and provided that all Funding Agencies fulfill their baseline Common Fund obligations (Construction MoU).

The ATLAS Collaboration is very grateful to all Funding Agencies that committed, initially and during all these years, funding towards the full CtC. The current situation is given in Table 1, where an encouraging progress can be seen towards pledges covering the full calculated 2002 CtC, therefore making it not necessary to request additional CtC funding. A total of 71.1 MCHF have been pledged to cover the total needed CtC funds of 72.6 MCHF (68.2 MCHF + 4.4 MCHF), and a number of Funding Agencies have kindly indicated that they may help temporarily with the resulting cash flow issue.

However, it has to be noted that the Collaboration currently also still faces a deficit of about 7 MCHF due to late payments of baseline Common Fund contributions, as discussed in the corresponding budget document CERN-RRB-2007-018.

The Collaboration urges most strongly all Funding Agencies that have not yet committed to their full calculated share of CtC funding, or have not yet financed their baseline Common Fund contributions, to continue their utmost efforts to secure the missing resources. Only a strong and solid solidarity across all funding partners will allow the Collaboration to complete its powerful detector to fully exploit the great LHC physics opportunities as early as possible.

Cost to Completion Funding Planning (all in kCHF)

(revised 31st March 2007)

Funding Agency	Cost to Completion 2002 (CtC) calculated share			Member Fee 2004-6 (incl. in CC)	New funding (category 1) incl. Member F	New funding requests (category 2)	CtC 2006 proposed sharing
	Total	CC	C&I		Total	Total	Total
Argentina					75		
Armenia	66	48	18	38	45		
Australia	357	242	115	75	357		
Austria	67	52	15	38	67		
Azerbaijan	43	38	5	38	38		
Belarus	85	75	10	75	75		
Brazil	64	47	17	38	41		
Canada	2090	1528	562	263	2090		
China NSFC+MSTC	141	99	42	38	141		
Czech Republic	316	196	120	113	316		
Denmark	422	290	132	38	58	375	
France IN2P3	5890	4176	1714	225	5890		
France CEA (1)	1940	1379	561	38	1940		
Georgia	42	37	5	38	38		
Germany BMBF	4531	3250	1281	338	4531		
Germany DESY					38		
Germany MPI	1093	761	332	38	1093		
Greece	261	173	88	113	261		
Israel	739	497	242	113	739		
Italy	6638	4650	1988	450	6288		
Japan	4362	3029	1333	563	4362		
Morocco	57	47	10	38	41		
Netherlands	1934	1368	566	75	1934		
Norway	581	391	190	75	581		
Poland	136	94	42	75	136		
Portugal	446	265	181	38	339	107	
Romania	140	85	55	38	140		
Russia	2991	1995	996	263	1759		
JINR	1066	660	406	38	521		
Serbia					300		
Slovak Republic	72	53	19	38	82		
Slovenia	223	152	71	38	223		
Spain	1706	1109	597	113	1706		
Sweden	1691	1121	570	150	1691		
Switzerland	2372	1701	671	75	2372		
Taipei	445	318	127	38	445		
Turkey	85	75	10	75	75		
United Kingdom	4387	3063	1324	450	4387		
US DOE + NSF (2)	12245	8438	3807	1238	12245		
CERN	8452	5770	2682	38	9300		4400
Total	**68176**	47272	20904	5563	**66685**	482	**4400**

(1) The commitment shown does not include a 1 MCHF additional engineering contribution provided on the initial BT contract (see MoU Annex 8.A)
(2) The remaining 4.5 MCHF to C&I is provided on a best effort basis
New funding requests as prospects (category 2) are without firm commitment from the Funding Agencies

Table 1

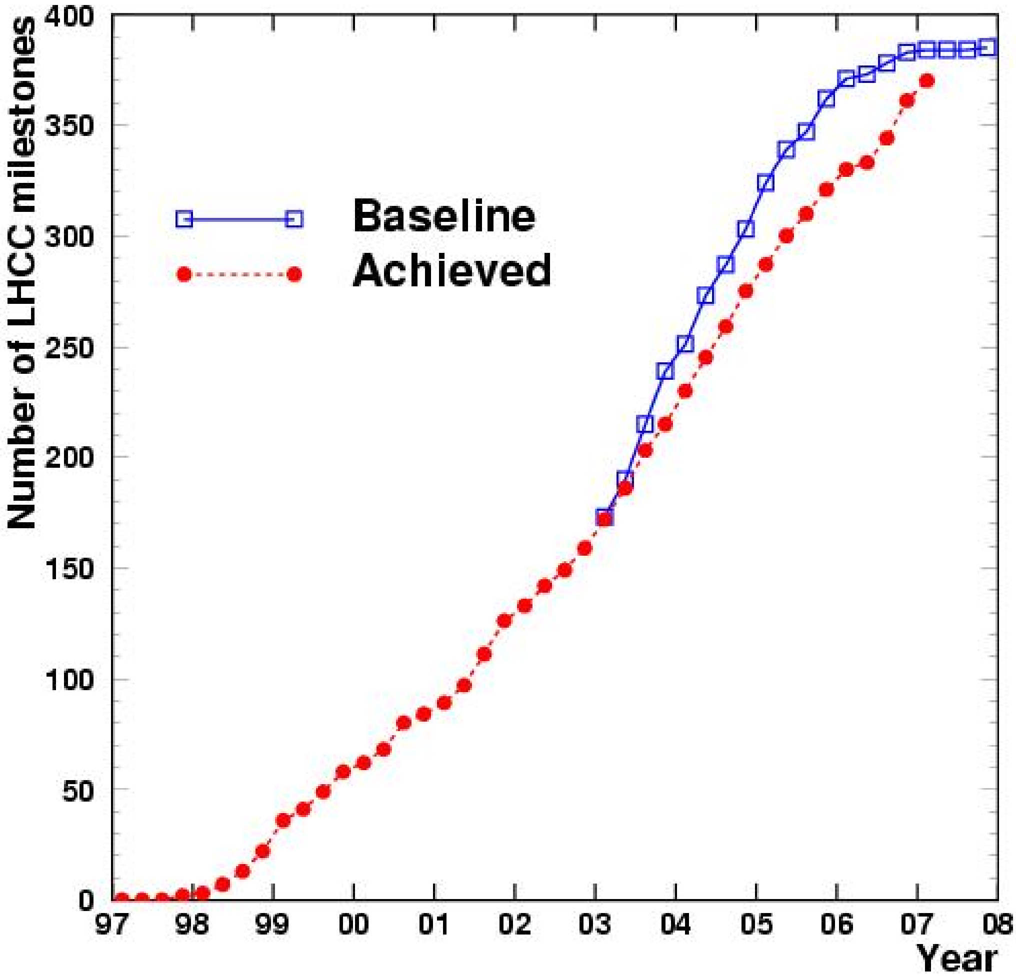

Figure 1: Integrated LHCC Milestone Plot