CERN-RRB-2010-081
6 October 2010

ATLAS Progress Report for the October 2010 RRB

1. Introduction and Collaboration Composition

The period since the April 2010 meeting of the RRB witnessed the beginning of the ATLAS high-energy physics programme. From shortly before that meeting when the LHC produced first collisions at 7 TeV in the centre of mass, it has provided excellent periods of physics operation at progressively improving luminosity. With accelerating growth of integrated luminosity, ATLAS has conducted a progressive programme of commissioning and tuning detector performance, of standard model physics measurements, and of first searches for new physics. ATLAS observed its first candidate W-boson at the beginning of April and its first candidate Z-boson near the beginning of May. In July at the International Conference on High Energy Physics (ICHEP), ATLAS presented its first candidate top pairs and its first search result that achieved record-breaking sensitivity for new physics. Several physics results have now been published or submitted for publication, and many more results have been presented at conferences. The much larger data sample now accumulated enables many further and new physics studies.

The ATLAS detector 'as built' and its basic performance have been documented in a comprehensive publication in the *Journal of Instrumentation* (JINST). It can be briefly recalled that the 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 and Tile Calorimeters. A hierarchical three-level Trigger and Data Acquisition system collects the data for the collaboration-wide computing and physics analysis activities. The initial staged detector configuration, now operational, corresponds to the financial framework which was defined in the Completion Plan as presented and approved at the October 2002 RRB (CERN-RRB-2002-114rev1) and updated at the October 2006 RRB (CERN-RRB-2006-069).

Early data-taking experience has demonstrated that the ATLAS detector performs very well, with only a few percent of non-operational channels and with data-taking efficiency of approximately 95%. Detector performance is very good, now generally very close to nominal. The Collaboration is able to extract results very quickly, demonstrating that the whole experiment from detector operation to analysis on the WLCG operates efficiently.

The ATLAS Collaboration now consists of 174 institutions from 38 countries with ~3000 active scientists, ~1900 with Ph.D. (hence contributing to M&O costs) and ~1000 students. At its July 2010 meeting, the Collaboration Board endorsed the admission of a joint South African team from the Universities of Johannesburg and Witwatersrand.

At its July 2010, the Collaboration Board also re-elected Fabiola Gianotti (CERN) as Spokesperson for the term March 1, 2011 to February 28, 2013.

2. Maintenance and Operation of the Magnet System

The ATLAS superconducting magnet system comprises the Central Solenoid (CS), the Barrel Toroid (BT), two End-Cap Toroids (ECT), and their common services.

Status: The magnet system has operated with 100% availability for data-taking with stable beams throughout 2009-2010. Some difficulties in operation have been encountered, including power converter unit failures, clogged cold circuit filters, and current lead problems. Failures of power converter units arising from problems in the units' current meter caused a few slow dumps of the toroid magnets in the last year. The power converter manufacturer is expected to provide a reliable solution. A hidden defect in the heat exchanger of the shield refrigerator cold circuit allowed water into the compressor oil, eventually leading to clogging of the filters in the cold box. Installation in the circuit of a dryer in July 2010 eliminated further problems. A permanent dryer will be installed in this circuit and the main refrigeration circuit during the 2012 LHC shutdown. Hot spots in the aluminum-copper bus bars were repaired. Further repairs will be made during the end-of-year technical stop; however, a permanent solution requires a technical upgrade during the 2012 shutdown. Further major consolidation work on the magnet services is planned for the 2012 LHC shutdown. Plans include installation of a redundant main refrigerator compressor and adoption of booster compressors, which will preclude a possible year-long ATLAS downtime in case of main compressor failure. Consolidation work is also foreseen for the electrical, vacuum, and controls services.

Changes: Dryer installed in shield refrigerator cold circuit.
Concerns: None.
Plans: Routine maintenance and operation of magnet system and services. Consolidation work during 2012 LHC shutdown, including installation of redundant main refrigerator compressor.

3. Maintenance and Operation of the Inner Detector

The Inner Detector (ID) combines three concentric sub-systems, the Pixel detectors, the Silicon strip detectors (SCT), and the Transition Radiation Straw Tracker (TRT), listed from inside to outside.

Status: The entire Inner Detector has continued to operate with very high efficiency. ID performance has now been studied with high transverse momentum tracks and tracks from known resonances, allowing further refinement of the alignment, especially in the end cap regions. Regions with non-optimal modeling of the material in the Monte Carlo were identified, and an improved description of the Pixel support structures and patch panels has been made. Special data sets were recorded with different values for the TRT high threshold (used for electron identification), and show that the present choice is near optimal. The Inner Detector performance paper based upon cosmic ray data was accepted without modification for publication in the European Journal of Physics C.

The evaporative cooling plant has been operating with close to 100% efficiency, and has been always available during collisions. Modifications to the compressors and surrounding pipe work have reduced the rate of appearance of new leaks. A programme of regular maintenance, for example exchanging piston rings, has been followed. Redundancy is provided by seven compressors in the plant; whereas, the full ID can operate with just four. Trials of a new, stiffer valve spring in the inlet valves are in progress in order to address the problem that caused failure of the inlet valves on three compressors in February 2010. Only one of 204 cooling loops is not being operated, affecting just 13 of 4088 SCT modules. Additional sensors installed on the distribution racks have allowed more frequent leak down measurements to track the evolution of leaks inside the detector volume. These tests have so far revealed that the number of Pixel circuits with high leak rate is stable and that one new SCT circuit has developed a leak. A design for a thermo-siphon system to replace the compressors in 2012 is being developed.

There have been no additional failures of the thermal enclosure heater pads since three of eight barrel pads failed during June/July 2009. These pads are large-area copper-kapton heaters that should ensure thermal neutrality of the silicon volumes compared to the TRT, and of the Inner Detector volume compared to the outside. Although a thermal configuration that does not lead to over-cooling of the TRT has been established, there are concerns for the longer term, after the SCT modules have been exposed to significant radiation and need to operate at reduced temperature. A risk analysis continues, along with more refined studies of bias voltage and leakage current evolution as a function of radiation dose and temperature. A more effective coolant mixture is also being investigated, and laboratory tests of blends of C_2F_6 and C_3F_8 are ready to start. A new control card for the heater pad power supplies, to reduce the chance of further failures, is being manufactured.

The recently replaced off-detector optical transmitter plug-ins used in both the Pixels and SCT ran smoothly for a number of months (about twice as long as the previous batch that was replaced during 2009); however, they began to fail in April 2010, with a maximum rate of over twenty per week. Resulting inefficiencies in data taking have remained small because failed Pixel plug-ins are replaced every few days, while most of SCT modules can be recovered by using built-in redundancy. A new production of replacement plug-ins has been launched, and VCSEL arrays (the active electro-optical component) will be purchased from a different vendor. The Pixel on-detector arrays are the same type as the off-detector units, although they do not operate at as high rate, leading to possible future lifetime concerns. A task-force has studied this problem. Aging tests of the on-detector boards are being made, and preparation of replacement parts is underway, in case replacement is necessary during the 2012 accelerator shutdown. The SCT on-detector optical transmitters use a different technology, and aging tests already performed during prototyping and production showed that the lifetime of the SCT arrays should not be a concern.

Changes: None
Concerns: Maintenance of the compressor plant remains at a high level. A new failure mode of compressor inlet valves was observed in February 2010. Barrel thermal enclosure heater pad failures may affect long-term thermal management and hence silicon detector lifetime. Replacement off-detector optical transmitters have limited lifetime. Pixel on-detector optical transmitters may have limited lifetime.
Plans: Closely monitor leak rates of pixel cooling circuits. Develop alternative technology (a thermo-siphon system) to replace the compressor plant. Refine models for silicon radiation damage as a function of temperature. Investigate alternative supplies of VCSEL arrays for optical transmitters. Perform aging tests of on-detector optical transmitters. Prepare contingency plan for replacement of Pixel on-detector optical transmitters in case needed.

4. Maintenance and Operation of the Calorimeters

The calorimeter systems include a liquid argon (LAr) electromagnetic calorimeter, a barrel and two extended barrel Tile hadronic calorimeters, end-cap liquid argon hadronic calorimeters (HEC), and liquid argon forward calorimeters (FCal).

Status: All calorimeter systems have performed well throughout data-taking. Data taking efficiency is very high, and nearly all data acquired is usable for physics analysis. For instance, 99.7% of Tilecal data is presently usable, and 100% will be usable after the next reprocessing. Calibration precision is nearing nominal. For instance, LAr calibration precision is ~1%. Timing has been adjusted and calibrated to the one nanosecond level. The excellent performance of the electromagnetic calorimeter is illustrated by the measured mass resolution for $Z \rightarrow ee$ decays, which is already close to the nominal resolution. A paper on readiness of the Tile calorimeter for collisions was submitted to *European Physical Journal C* (EPJC) in July 2010. (Two LAr performance papers were submitted to EPJC already at the time of the April RRB status report.)

Two detector-mounted components of the LAr calorimeter are of concern, low voltage power supplies and optical transmitters. Five LAr low voltage power supplies (LVPS) have lost redundancy without leading to any data loss (last in February 2010). Optical transmitters (OTx) on twenty-six Front End Boards (FEB) (which corresponds to 2% of the total number of channels, leading to a ~5% loss of acceptance for electrons and photons) and on three controller boards have now failed. Because medium and long-term reliability of the present retrofitted LAr LVPS is a concern, an order to procure 68 newly designed LVPS was placed in May 2010. The new LVPS will be available for installation in the 2012 accelerator shutdown, and will be operated on a large-scale test bench prior to installation. The cause of the OTx failure is still being investigated. The width of the optical spectrum of the VCSELs, the electro-optical component of the OTx, has been found to be a good indicator of weak units (among the 17 OTx that failed since the optical spectra were measured, 16 had a narrow spectrum, and the other failed OTx is most probably not a VCSEL failure). Failed or misbehaving FEBs and controllers in the front-end crate will be replaced when accessible during the end-of-year technical stop. Two OTx backup solutions for possible future installation are in development.

The LAr endcaps and the barrel presampler sections have experienced some unexpected noise and high voltage issues during 2010 running. In the first months of data taking (April-July), large anomalous signals appeared in the HEC, correlated with beam. Intensive study of these signals has not yet led to an understanding of their cause. Nonetheless, the rate of these anomalous signals has been decreasing since July, and it is no longer a concern for the quality of LAr data. Since July, two new issues have appeared. Firstly, trips of high voltage power supplies (HVPS) and noise bursts in the LAr endcaps have both increased during periods of stable beam, although the two effects do not seem to be correlated. This issue has a significant impact on LAr data quality (5-10% reduction in good data). The cause is still under investigation. Meanwhile, the sensitivity of the HVPS is being reduced, and an automatic recovery procedure is being prepared. Secondly, the number of noisy cells in the barrel presampler has increased significantly. While the cause is under investigation, as a preventive measure, the high voltage on the barrel presampler has been lowered from 2000V to 1600V, which has only a small impact on physics performance.

In the Tile calorimeter, five LVPS and three front-end drawers (out of 256 units) have failed, affecting 3.1% of the Tile calorimeter cells. The five failed LVPS will be replaced with refurbished units during the end-of-year technical stop, given access to both ends of the detector. Due to the high rate of LVPS failures (~3-4 LVPS per year), all existing LVPS will be replaced with new improved units that are under development. Pre-production of twenty-five new LVPS has started, and installation on the detector of the first five is planned for the end-of-year technical stop. Full replacement LVPS production will be complete in time for installation during the 2012 LHC shutdown. The first delivery of 4% spare photomultipliers arrived and is being certified. First results show that they meet the specifications.

Changes: None.
Concerns: Long-term reliability of the LAr and Tile calorimeter low voltage power supplies requires replacement. Long-term reliability of LAr optical transmitters may require future replacement. The increase in barrel presampler noise may indicate detector damage. LAr noise bursts and increased presampler noise may require intervention on the detector during the end-of-year technical stop.
Plans: Continue development of long-term backup solutions in areas of concern. Installation of replacement LAr low voltage power supplies in 2012 LHC shutdown. Installation of pre-production replacement Tile calorimeter low voltage power supplies in end-of-year technical stop, followed by installation of production replacement supplies in 2012 LHC shutdown.

5. Maintenance and Operation of the Muon Detectors

The Muon Spectrometer is instrumented with precision chambers for 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 complete muon chamber instrumentation for the initial detector configuration was available for the LHC start-up in 2008. Installation of additional chambers in the region between barrel and end-caps was started during the 2009 shutdown and will be completed during subsequent shutdowns. During all LHC technical stops, standard maintenance operations, including repairs of gas leaks and electronics, are performed. Ventilation of the top barrel RPC sectors was improved in order to reduce the ambient temperature in that region, although the temperature remains somewhat high in certain locations. For 2010/2011 running, the fraction of live channels is 99.7% for MDT, 98.5% for CSC, greater than 97.0% for RPC, and 98.6% for TGC. Because of redundancy, the trigger coverage for both the RPCs and TGCs is nearly 100%.

The major improvement in 2010 for the muon system was the deployment of a new version of the Read Out Driver (ROD) firmware and software for the CSC system. Throughout the 7 TeV data-taking period, the CSCs have been read out successfully, without causing any down time. Recently, large improvements in the maximum attainable LVL1 trigger rate have been achieved, bringing the system very close to the design performance.

Collision muons have been used extensively for commissioning, for standalone performance studies of the Muon Spectrometer, and for studies of the combined reconstruction of muons using both the Muon Spectrometer and the Inner Detector. Chamber resolutions and efficiencies have been measured and agree with cosmic-ray measurements performed in 2009. A special collision run, taken with toroids off (B=0 in the Muon Spectrometer), was successfully used to align the CSC chambers to better than 500 μm. Trigger timing has been finalized both for the RPC and the TGC systems, placing more than 98% of muon triggers in the correct bunch crossing. The MDT calibration procedure is operational and performing to specifications. A Muon Spectrometer performance paper based on cosmic-ray muon data has been accepted for publication in EPJC.

A small number of maintenance issues continue to be monitored. CAEN high voltage and low voltage power supplies require regular replacement, and Wiener VME power supplies are also showing failures. RPC gas inlets are fragile, and broken inlets are being replaced as needed during maintenance periods. A batch of RPC high voltage connectors is fragile, and a plan to change all of them during the end-of-year technical stop has been developed. Cracking on a few gas jumpers of MDT chambers has been observed.

Changes: Full integration of CSCs into ATLAS data-taking and achieved performance close to design value. Completion of trigger timing of RPCs and TGCs using collision data. Alignment of the CSC chambers using B=0 runs. Evaluation of muon performance and muon combined performance with collision data.
Concerns: High ambient temperature in some regions of the top barrel RPC sectors may lead to RPC ageing.
Plans: Complete improvements to CSC readout rate. Refine muon trigger timing using collision data, and optimize trigger to sharpen the turn-on of the LVL1 trigger. Finalize alignment of the full Muon Spectrometer to design level (<50 micron), possibly using B=0 runs. Finalize MDT calibration (channel-by-channel timing offsets) with high statistics, and include MDTs in the ATLAS prompt calibration loop. Provide additional cooling during the end-of-year LHC technical stop in order to further reduce ambient temperature in the top barrel RPC sectors. Monitor maintenance concerns, and implement remedies as needed.

6. Forward Detectors

The forward detectors for the first phase of ATLAS consist of a Luminosity Cerenkov Integrating Detector (LUCID) placed around the beam pipe inside the forward shielding at 17 m from the Interaction Point (IP), of a Zero Degree Calorimeter (ZDC) placed in the absorber structure TAN where the beams enter separate beam pipes at 140 m away from the IP, and of an Absolute Luminosity for ATLAS (ALFA) detector in Roman Pots at 240 m from the IP. A proposal for an ATLAS Forward Physics project (AFP) is being considered as a possible upgrade project.

Status: Both LUCID and ZDC have been part of ATLAS data taking throughout 2010. LUCID is now the standard monitor for the luminosity delivered to ATLAS. During a series of beam position scans between the end of April and the beginning of May 2010, the first direct calibration of LUCID (and of other ATLAS luminosity monitoring detectors) exclusively using machine parameters was performed. The obtained error in the absolute luminosity scale is at the moment around 11 %, dominated by knowledge of the beam current. The LHCf experiment, which was previously installed just in front of the ATLAS ZDC, was removed during the summer, providing space to complement the ZDC with its missing electromagnetic module. The ZDC electromagnetic module is now in the process of being commissioned.

Changes: Production of ALFA detectors completed. Operation of all ALFA detectors validated in test beam. LHCf removed, and the ZDC electromagnetic module installed.
Concerns: None.

Plans: Install remaining ALFA mechanics and detectors in the end-of-year LHC technical stop. Finish commissioning the electromagnetic module of the ZDC.

7. Maintenance and Operation of the Trigger and DAQ System

The major sub-systems of the Trigger and Data Acquisition System are the Level-1 Trigger (with the sub-systems calorimeter, muon, and central trigger processor (CTP)), the High Level Trigger (HLT), the Data Acquisition (DAQ), and the Detector Control System (DCS).

Status: The complete Trigger and Data Acquisition chain continues to perform very well and has proven to be able to adapt efficiently to the changing data-taking needs of the experiment. Through the course of 2010, the operational efficiency during collision periods has averaged more than 95%. Typically the system is operating at a Level-2 input rate of ~10-15 kHz, a Level-2 output rate of ~2-3 kHz, and an Event Filter output rate of 200-300 Hz.

As planned, HLT computing power has been increased during the third quarter of 2010 from thirty-five percent of its foreseen capacity to fifty percent. This increase has allowed throughput of the event building system to reach design specification. Periods of time without collisions continue to be used to test and deploy enhancements to the system with the aim of further consolidating system operation. The scope and quality of operations documentation has been expanded.

Further improvement in the timing of the Level-1 sub-systems was performed during the first half of 2010. In particular, dedicated data sets were acquired for Level-1 muon and calorimeter timing studies. In the case of the Level-1 calorimeter trigger, a timing of 2 ns has been achieved. For the RPC and TGC systems, more than 98% of the muon triggers are now associated with the correct bunch crossing.

The first trigger selection (“menu”) specifically aimed at high-p_T physics (*cf.* to commissioning and minimum-bias physics) was deployed in order to manage the progressive increase in instantaneous luminosity delivered during the course of 2010. With this deployment, the HLT is now used for the online selection of events.

Operational efficiency continues to be improved by closely working with the detector systems to better define and subsequently automate operational procedures. During the course of 2009, procedures for the automatic exclusion and re-insertion of faulty detector elements without interrupting data taking were implemented. These procedures have now been widely adopted by all the detector systems. During the course of 2010, additional semi-automatic start and end of run sequences have been defined and implemented. These sequences automatically initiate the procedures (*e.g.* ramping of voltages) that certain detector systems require during machine operations, for instance during the energy ramp of the beams. These new procedures contribute significantly to the achieved average data-taking efficiency of 95% stated earlier.

The plan for procurement of the outstanding HLT capacity will continue to be adapted to the evolution of the LHC schedule and the evolving needs of the ATLAS experiment. The plan will be reviewed at the end of the 2010 data-taking period. The rolling replacement of computing hardware that has reached the end of warranty continues during the latter half of 2010. Of note, the computer nodes supporting data acquisition configuration, control, and monitoring applications will be replaced.

Changes: Event selection by the HLT activated. Improvements to efficiency of operations.
Concerns: None for the initial system. However, it is reminded that in accordance with the Cost-to-Completion plans, the initial TDAQ configuration was limited in funds. High-Level Trigger processors are being added to the initial configuration as deferred funds become available.
Plans: Continue to operate and consolidate the full TDAQ system for data-taking at high luminosity. Continue to optimize the efficiency of trigger selection. Purchase additional HLT capacity during the course of 2011 according to operational needs.

8. Detector Operations

Status: ATLAS has operated quite successfully throughout data-taking in 2010, despite the rapid evolution of LHC luminosity and beam conditions. In particular, peak luminosity has increased from approximately 10^{27} $cm^{-2}s^{-1}$ to $7x10^{31}$ $cm^{-2}s^{-1}$, requiring frequent redefinition of operating procedures. For instance, new procedures were needed to cope with the rapid change of LHC clock phase during the beam energy ramp and to change the configuration of the trigger at the transition from unstable to stable beams. Efficient operation has also required continual maintenance of general infrastructure, such as electricity, cooling, and ventilation, of individual detector elements, and of control, trigger and data acquisition systems. (Detail of specific maintenance activities is covered in other sections of this document.) A mechanism to disable, recover, and re-enable faulty detector channels during an LHC fill, without stopping the data acquisition, was implemented in order to minimize data loss. Constant maintenance and development work has enabled ATLAS to achieve a global efficiency in taking data of approximately 95%.

Over the course of 2010, steps have been taken to streamline Operation Tasks (OTs) in order to reduce the overall effort required and to enable more tasks to be performed at remote sites. Planning for further reductions is ongoing. Operation Tasks include all activities essential to the operation of ATLAS, from central shifts and on-call tasks at Point-1 to the computing and data preparation tasks, some of which can be executed remotely. Operation, in this broad sense, requires very substantial effort (600-700 FTE, exclusive of shifts). Responsibility for Operation Tasks is shared among the Institutions in proportion to their number of authors.

Concerns: Operation requires significant resources for which Funding Agencies need to plan.
Plans: Continue to operate ATLAS throughout the extended 2010/2011 LHC data-taking period. Perform minimal urgent repairs during the end-of-year technical stop, and more extensive repair and consolidation work during the 2012 shutdown.

9. Computing and Software

The collaboration-wide distributed computing infrastructure is fully embedded into the framework of the WLCG, of which ATLAS is a very active partner. In addition to this Grid infrastructure, a very sizable experiment-specific effort is required to interface effectively the ATLAS software suite and analysis framework to the WLCG infrastructure.

Status: The entire ATLAS and WLCG computing and software chain has performed very well throughout 2010 data taking. Data has been routinely processed by the Tier-0 centre and distributed worldwide within a few hours of data-taking. In addition, intensive calibration work has been performed at the CAF (Calibration and Alignment

Facility) at CERN. The global Tier-1 computing infrastructure and the reconstruction software have been successfully used several times in the first half of 2010 to reprocess all available detector and simulated data, and another full reprocessing cycle this year is underway. Large-scale programmes of distributed data analysis at Tier-2 centres have led to the results presented at the summer conferences and in recent publications. Simulation production continues using all available resources at Tier-1 and Tier-2 centres, with an average of approximately fifty thousand jobs running concurrently and with approximately one billion events simulated to date. Shifts are operated at the Point-1 control room and worldwide to support production operations and user analysis.

ATLAS has made efficient use of the computing resources made available at all WLCG sites, including opportunistic usage of idle CPU cycles in the Tier-2's and of not-yet-unoccupied disk space. For instance, additional copies of event summary data ESD have been distributed in order to ease access to the complete information for the events to all members of the Collaboration during detector commissioning. Tools have been developed to remove from disk these additional copies when disk space is needed for new and more popular data. Analysis on the WLCG is in full swing, with several hundreds of people routinely submitting jobs. More than a thousand different ATLAS members have performed analysis on the grid.

The present LHC machine schedule, with long data-taking periods through 2011, will require the full computing resources requested for 2011. Timely availability of these resources will be critical to timely ATLAS physics productivity, and to the ability of everyone in the Collaboration to access the data easily and quickly.

Adequate manpower is not available to fully address ongoing software developments in several technical areas, and progress to address this issue has been slow despite efforts. The core computing infrastructure and services tasks, defined as M&O Category A, play a crucial role for the smooth operation of the full software and computing chain. They enable ATLAS to exploit the large investments of computing resources made worldwide by the WLCG collaboration partners.

Changes: None.
Concerns: Manpower in technical software and computing areas.
Plans: Continue to operate and consolidate software and computing infrastructure. Expand processing and storage capacity as required by 2010/2011 data-taking.

10. Data Collection and Physics Output

Since the last RRB in April, the LHC accelerator has been operating almost continuously, and has spent a substantial part of the time commissioning the necessary steps to obtain this year's instantaneous luminosity target of 10^{32} $cm^{-2}s^{-1}$. Between accelerator commissioning steps, there have been several periods of data collection at progressively higher luminosity. By the end of August 2010, a total integrated luminosity of 3.5 pb^{-1}, approximately eight hundred million events, had been recorded by ATLAS, with a data-taking efficiency of ~95%. In the last few days of September this total further increased rapidly (Fig. 1) as LHC operation with trains of bunches is commissioned.

In addition to high data-taking efficiency, the quality of data is also good. Typically, 90% of data collected is used in physics analysis. Intensive efforts on alignment and calibration of the detector are now able to use substantial data samples of various types of physics objects, leading to high quality physics measurements of quantities such as jet differential cross-sections and W and Z cross-sections. Results from both of these analyses have recently been submitted for publication, and a wealth of further preliminary measurements in the soft and hard QCD, b and c-physics, electroweak and top sectors are also available. One of many highlights at the ICHEP conference in Paris was the reporting of the first handful of candidate top events. To set the scale, a total of 91 conference notes based on collision data results have been made public by ATLAS so far this year.

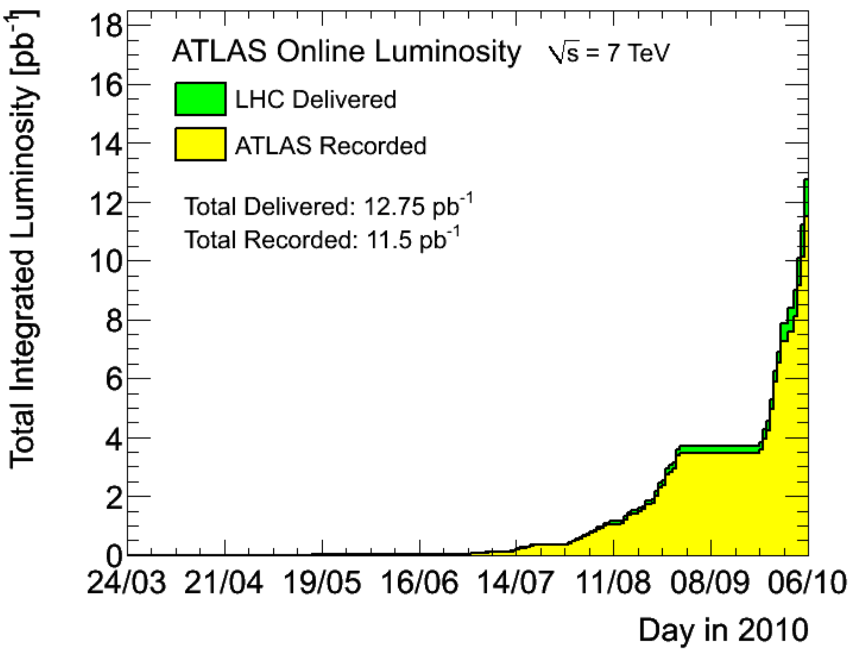

Figure 1: Integrated luminosity vs. time in 2010 data taking. Cumulative totals indicate the luminosity delivered by the LHC in stable beam conditions, and that recorded by ATLAS. (Snapshot of 6 October 2010.)

The speed and effectiveness of the ATLAS distributed computing system on the WLCG is well illustrated by the production of results searching for possible new physical phenomena, the *raison d'être* of the LHC. At ICHEP, sensitivity to new physics at a mass scale beyond the Tevatron reach was demonstrated in the dijet channel, looking at the dijet mass distribution. Results were presented in the Friday session of the conference, using data which had been collected on the Monday morning of the same week. The study had been done on WLCG resources, not at CERN. This analysis is now in press with *Physical Review Letters*, as the first publication from the LHC to push beyond previous sensitivity to new physics. In the meantime, the 95% confidence level lower limit on the mass of an excited quark has been raised from 1.26 to 1.53 TeV (see Fig. 2), by adding more data.

A second publication using angular distributions of dijet events, on a larger event sample, has also been submitted for publication to *Physics Letters*. The greatest sensitivity comes from an angular variable χ. Analysis of the distribution in this angle excludes quark contact interactions with a compositeness scale below 3.4 TeV, at 95% confidence level, significantly exceeding previous limits. Many other search channels are being vigorously investigated, and a plethora of preliminary results have been reported at conferences.

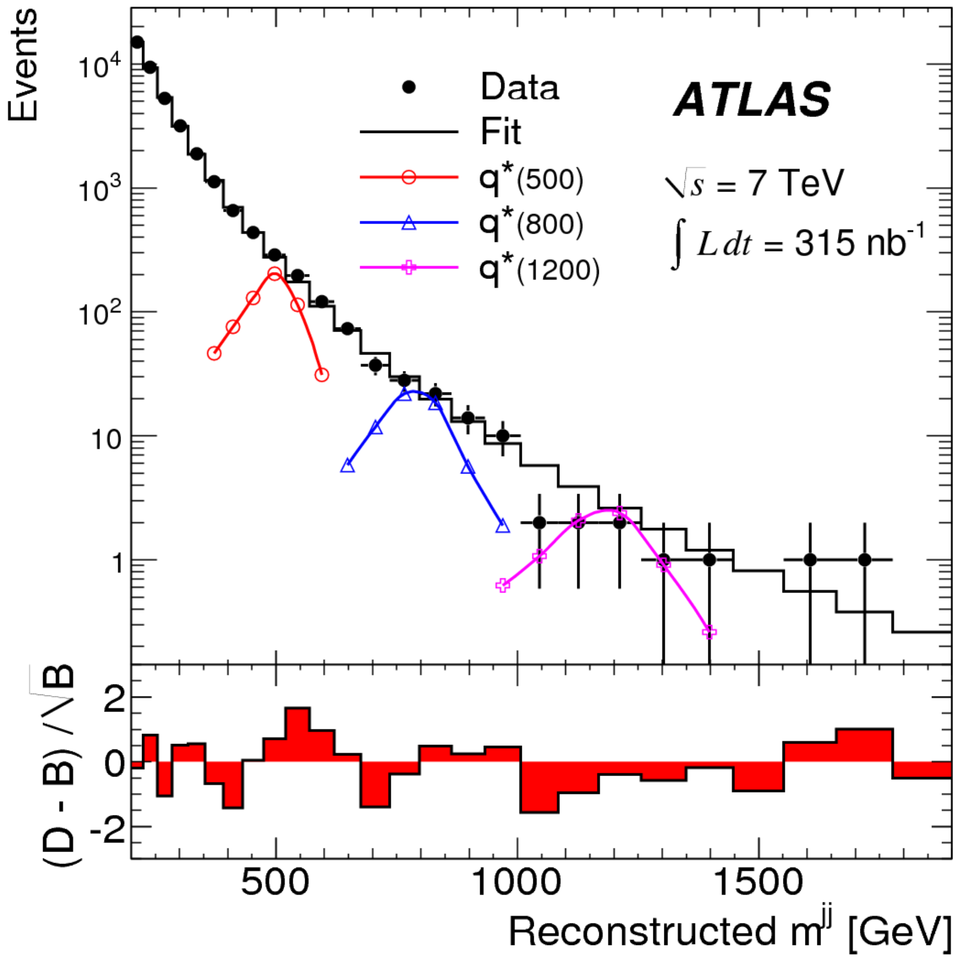

Figure 2: Reconstructed dijet mass spectrum observed in the data, compared to a background fit, and possible contributions for different hypothesised excited quark masses. Production of excited quarks with mass less than 1.53 TeV is excluded at 95% CL.

11. Updates on Due Construction Contributions

ATLAS is grateful to the Funding Agencies for their continuous support over nearly two decades. At present, the Collaboration still faces an income deficit of 4 MCHF in the total accepted construction costs (CORE+CtC), including open commitments, mainly due to late payments of baseline Common Fund contributions. Due contributions arriving from Funding Agencies are reported elsewhere (CERN-RRB-2010-085).

The Collaboration most strongly urges 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 solidarity across all funding partners will allow the Collaboration to unstage the full detector and to exploit completely the immense LHC physics potential as early as possible.

12. Status of FDL Activities and Planning for LHC Luminosity Upgrades

The 2002 Completion Plan reduced the scope of the Full Design Luminosity (FDL) detector as a temporary measure. The staged items included common elements, such as shielding and processors, as well as components of the Inner Detector, Calorimeter systems, and Muon systems. Some of these items have meanwhile been restored; whereas, the fate of other items depends upon the measured performance of the ATLAS detector. It is clear that infrastructure, particularly shielding and cooling/gas/cryogenic systems, will require improvement and consolidation during the 2012 LHC shutdown.

An Interim Memorandum of Understanding is now being signed by the Institutes and Funding Agencies concerned for the insertable replacement of the Inner Detector pixel b-layer (IBL, Insertable B-Layer) as a part of the FDL detector. A final draft Technical Design Report (TDR) was submitted to the LHCC at its September 2009 meeting, and approval of the TDR by the ATLAS Collaboration Board is anticipated at its 8 October 2009 meeting. A status report on FDL detector activities is provided in CERN-RRB-2010-118.

As previously reported (CERN-RRB-2009-020, April 2009), in accordance with CERN plans to upgrade the luminosity of the LHC, ATLAS established an R&D programme to study the detector improvements required to operate at higher than design luminosity. Two phases of detector improvements are being planned. The first phase is targeted at the ultimate LHC luminosity of approximately 2×10^{34} $cm^{-2}s^{-1}$ following the Phase 1 LHC upgrade, with installation foreseen for 2016. In addition to the IBL, improvements for this phase will include upgrades that enhance ATLAS trigger capabilities in order to maintain good physics selectivity in face of higher luminosity and background rates. The second phase of detector improvements is targeted at very high integrated luminosity during the High Luminosity LHC (HL-LHC) era, with installation foreseen for 2020. Improvements for this phase must address the challenges of achieving good physics sensitivity in face of peak luminosity of approximately 5×10^{34} $cm^{-2}s^{-1}$ and with high radiation and event pile-up levels. This phase will require replacing the full Inner Detector, as well as other detector and trigger upgrades. In preparation for transition from the R&D phase to the construction project phase, ATLAS is presently reorganizing its upgrade activity. ATLAS plans to proceed by drafting a Letter of Intent for the upgrades, followed by Technical Proposals, and Memoranda of Understanding of appropriate nature.