PROJECT PERIODIC REPORT

Grant Agreement number: 212114

Project acronym: SLHC-PP

Project title: SLHC-PP Preparatory Phase of the Large Hadron Collider Upgrade

Funding Scheme: Combination of CP & CSA

Date of latest version of Annex I against which the assessment will be made: January 30, 2009

Periodic report: 1st ☐ 2nd ☐ 3rd X 4th ☐

Period covered: from April 2010 to March 2011

Project co-ordinator name, title and organisation: Dr. R. Garoby, European Organization for Nuclear Research, CERN

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Declaration by the project coordinator

I, as co-ordinator of this project and in line with my obligations as stated in Article II.2.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate):

  ☐ has fully achieved its objectives and technical goals for the period;

  X has achieved most of its objectives and technical goals for the period with relatively minor deviations[1];

  ☐ has failed to achieve critical objectives and/or is not at all on schedule.

- The public Website is up to date, if applicable.
- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section 3.6) and if applicable with the certificate on financial statement.
- All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 5 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

Name of Coordinator: .Roland Garoby

Date: 25 / 05 / 2011

Signature of Coordinator: ....

[1] If either of these boxes is ticked, the report should reflect these and any remedial actions taken.

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List of Acronyms

ATLAS	A Toroidal LHC ApparatuS, general-purpose detector at the LHC
CMS	Compact Muon Solenoid, a general-purpose detector at the LHC
CMS2	The CMS experiment upgrade for sLHC
EVM	Earned Value Management, IT-based management tool
FLUKA	FLUtuierende KAskade, Monte-Carlo code for particle transport
HIPPI	High Intensity Proton Pulsed Injector, sub-project of CARE
LHC	Large Hadron Collider
Linac4	Linear accelerator, first injector within the sLHC injector chain
LLRF	Low Level Radio Frequency
LP-SPL	Low Power Super Proton Linac, second injector within the sLHC injector chain
PS2	Proton Synchroton 2, third injector within the sLHC injector chain
RF	Radio Frequency
S-ATLAS	ATLAS experiment upgrade for sLHC
SNS	Spallation Neutron Source, at Oakridge USA
SPL	Super Proton Linac, future high-intensity stage of the LP-SPL
SPS	Super Proton Synchrotron, highest energy injector within the sLHC injector chain

1. Publishable Summary

Project objectives and organization

The preparatory phase project for the Large Hadron Collider luminosity upgrade (SLHC-PP: http://slhcpp.web.cern.ch/SLHCPP/) was aimed at preparing for an order of magnitude increase of performance of the LHC during its second decade of operation. It concerned the chain of LHC injectors, the LHC itself (new focusing magnets in the interaction regions) and the general purpose LHC experiments ATLAS and CMS. The need for an upgrade that would extensively use the investment made in the construction of the collider and fully exploit its unique discovery potential was realized early during the LHC project. It had to begin before the LHC started because of the known technological and managerial challenges and the notoriously long lead times for implementation. It materialized in 2006-2007 into the SLHC-PP project proposal submitted to the European Commission which was formally approved and launched on the 1st of April 2008, more than 6 months before the first beam entered in the collider.

The SLHC-PP comprises Management, Coordinating, Support and Technical activities arranged in 8 work packages. The coordinating activities (WP2, WP3 and WP4) play a central role in the organisation of collaborations for the accelerators and the upgrades of the ATLAS and CMS detectors, putting in place project structures and collaboration management tools for the implementation phase. The support activity in WP5 addresses crucial safety issues in the radioprotection domain. The technical developments address the construction of Nb-Ti high field magnets with large aperture (WP6), the study of a new H$^-$ ion source as well as field stabilization in superconducting accelerating structures (WP7), and novel solutions for the powering of a central tracking detector (WP8). The SLHC-PP project initially run in parallel with two construction projects (Linac4 and Inner Triplet Phase-1 upgrade) and an extensive R&D programme involving numerous laboratories and universities world-wide concerning the study of new injectors (LP-SPL and PS2), the upgrade of the SPS, and the development of new solutions for many detector elements. A sketch of the CERN accelerator complex is shown in Figure 1, the present injectors being represented in green and the new ones under study in red.

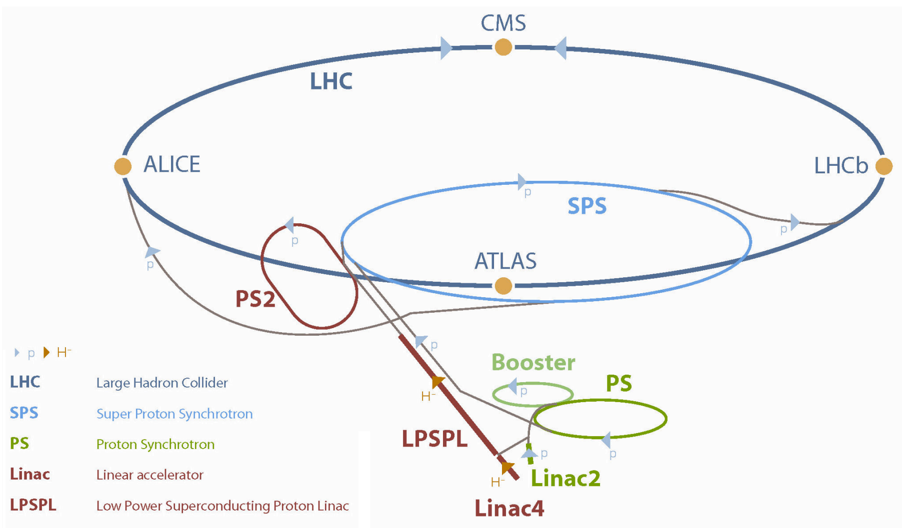


Figure 1: LHC and its injectors. During the SLHC-PP, Linac4 has been in construction for replacing Linac2, and the replacement of PS and PSB by LP-SPL and PS2 has been studied.

LHC context and plans

Beam commissioning in the LHC began on September 10, 2008, in the presence of the public media. This successful event was unfortunately followed on September 19 by an electrical fault which damaged 53 magnets (39 dipoles and 14 quadrupoles) and interrupted beam commissioning until the end of November 2009 [1]. As a result, the operation schedule of the LHC has been reconsidered as well as the planning and strategy of the luminosity upgrade [2, 3]. Concerning operation, the plan is now to run the LHC quasi-continuously for 2-3 years periods. This is illustrated in Figure 2 which also gives an estimate of the foreseeable peak and integrated luminosities until 2020. Concerning the luminosity upgrade, the decision has been taken to upgrade the LHC in a single stage and to upgrade/consolidate the existing injectors instead of building new ones (except Linac4 for replacing Linac2).

During the first period, in 2010-2012, data will be collected at 7 TeV centre of mass energy (3.5 TeV/beam), because of remaining dubious electrical interconnections ("splices"). An integrated luminosity of ~3 fb^{-1} is expected at the end of 2011, and hopefully of more than 10 fb^{-1} at the end of 2012. During the first long shutdown in 2013-2014, the main activities for the accelerators will be the complete renovation of the magnet splices and the installation of additional collimators in the dispersion suppressor region in IP 3. For the detectors, the central vacuum chambers will be replaced and an "Insertable B layer" (IBL) will be added to the ATLAS tracker. Linac4 will be ready and may be connected if enough resources are available; else it will be kept as a back-up until the second long shutdown.

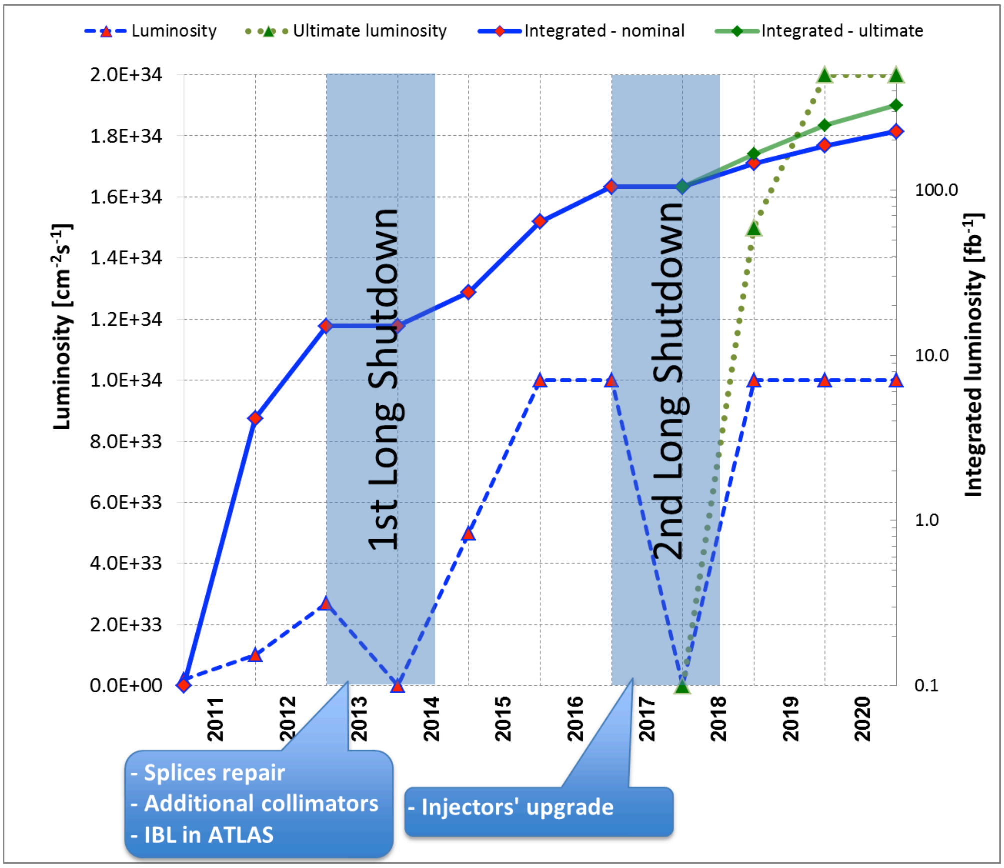


Figure 2: Very preliminary estimate of the evolution of the LHC instantaneous and integrated luminosities until 2020.

When the LHC will resume operation for physics, late in 2014, it will be at nominal energy with the potential to progressively reach nominal luminosity during the period 2015-2016 (2017). It is during the second long shutdown beginning in 2017 or 2018 that the injectors will be extensively upgraded. Immediately after, during the third LHC operation period, the characteristics of the beam delivered by the injector complex will be progressively brought up to the level required for the highest luminosity, and the integrated luminosity is expected to reach 200-300 fb^{-1}. The third long shutdown will therefore be the ideal time for upgrading the LHC insertions and finalizing the upgrade of the detectors. High luminosity runs will begin after this shutdown, with the goal of accumulating an integrated luminosity of ~3000 fb^{-1} during the second decade of operation of the LHC, 10 times more than during the first one.

SLHC-PP evolution and achievements

Throughout the difficulties encountered by the LHC during recent years, it remained clear that its upgrade would remain necessary. The planning and the precise means of upgrade have significantly evolved, but the work accomplished within the SLHC-PP project has established the basis for its implementation.

A significant accomplishment of WP1 has been to quickly and correctly communicate the latest news about the future planning of LHC and its upgrade beyond the circle of persons immediately concerned. It has also eased the exchange of information between accelerator scientists and physicists. The management and coordination Work Packages have produced tools which have already started being used for the Linac4 project (WP2) and they have set-up collaboration structures and instruments for the first phases of upgrade of the ATLAS (WP3) and CMS (WP4) experiments. The support activity on radioprotection (WP5) has provided preliminary estimates of radioprotection needs for the PS, of the activation of inner triplets equipment and contributed for example to the definition of protection measures of the workers involved in the construction of Linac4. The technical activities for accelerators (WP6 and 7) have started prototyping key components for the future accelerator upgrades (H- ion source, field stabilization in pulsed superconducting cavities, large aperture superconducting quadrupoles using Nb-Ti). The new powering techniques prototyped and validated in the context of WP8 will be used in the future central trackers.

2. Project objectives for the period

At the beginning of its 3rd year, the objectives of the SLHC_PP have been slightly modified, to better match with the new strategy and planning of the LHC upgrade. It concerned mainly the accelerators' part:
- the decision to renounce to new injectors made it irrelevant to pursue the establishment of a collaboration framework for their construction within WP2 and to continue the corresponding radioprotection studies within WP5. The other objectives of both of these work packages were however fully preserved.
- the new strategy of implementation of the LHC upgrades with the cancellation of "Phase 1", lead to transforming the objective of WP6 into a technological demonstration of a new technique for assembling long Nb-Ti quadrupoles with wide aperture, in view of its use in the future upgrade presently under design.

The activities related to the experiments (WP3, 4 and 8) were less concerned, the main impact being the adaptation of the planning.

In this context, the overall progress during this 3rd year has been fairly satisfying, as documented in the published deliverables. Two technical activities are not terminated (WP 6 and task 2 in WP 7), but their continuation is part of the plan of CERN and its partners, on their own resources.

Concerning Project management (WP1), the second annual report was published on time (deliverable 1.1.2), explaining the proposed changes for adapting to the new strategy and planning of the LHC upgrade. Answers were provided to the feedback received for the European Commission. The second public event was meant to present officially the new plans for the LHC and its upgrade. It was therefore held on June 23, 2010 [4], after the CERN Council had been informed and had approved the new strategy. The third annual project meeting was organized by the CEA in Saclay in February 2011 (milestone 1.4) [5]. The achievements of the SLHC-PP were presented and discussed, and plans were drawn for the preparation of the last deliverables, including the present report. The third annual public meeting, which took place at CERN one month later, in March 2011 [6] was used to present the two projects that will take care of the upgrade of the LHC ("HL-LHC") and its injectors ("LIU"), and the up-to-date plans for the upgrade of the ATLAS and CMS experiments. It was followed on the following days by a "Common ATLAS CMS Electronics Workshop for SLHC" [7], with the participation of many students and which the SLHC-PP contributed to support as part of its dissemination policy.

Concerning the coordination of the accelerators' part of the LHC upgrade (WP2), the expected work has been accomplished during the 3rd year of the SLHC-PP, and the 3 foreseen deliverables have been published (deliverables 2.1.1, 2.1.2 and 2.1.3). Improved versions of the CERN management tools for Quality Assurance, data management (EDMS) as well as financial (APT) and project progress monitoring (EVM, milestone 2.2) have been prepared and applied for the present Linac4. They start being used by the new projects launched at the end of 2010 for taking care of the LHC luminosity upgrade, the "LHC Injectors Upgrade" and "High Luminosity LHC" project.

All the objectives for the coordination of the upgrade of the ATLAS detector (WP3) have been attained and the 4 associated corresponding deliverables have been duly published (deliverables 3.1.2, 3.1.3, 3.2.2, 3.2.3). The recent work has focused on the upgrade planned for the first shutdown, currently foreseen for 2013-2014. The largest and most significant is the insertion of a new pixel sensing layer ("Insertable B Layer"), implementing several novel technological solutions, which requires also the implementation of a new beam-pipe. For this first project ATLAS has produced a Technical Design Report, an Interim Memorandum of Understanding, and a detailed Cost Book, which have gone through all the approval steps inside the Collaboration. The project is now entering the construction phase. The managerial framework established within WP3 (milestone 3.1) has been fully proven through the steering of the IBL project, and constitutes a solid basis for the further upgrade projects planned for the successive accelerator shutdowns.

The main goal of the third year for the coordination of the upgrade of the CMS detector (WP4) was the preparation of the Upgrade Technical Proposal. This has been achieved (deliverable 4.2.3) and a detailed document has been published describing all the parts of the CMS upgrade that are planned through 2020, as well as a preliminary view of the further upgrades required in the following decade. For the upgrades to be completed within this decade, the document contains technical descriptions of the devices to be built, an evaluation of the costs of the various parts ("Cost Book") (deliverable 4.1.2), as well as preliminary construction schedules. Proposals for sharing costs and construction responsibilities among the funding agencies have been prepared, and will be discussed at the Resources Review Board meetings during 2011. In summary, WP4 has created the framework to promote the necessary R&D activities and to evolve them into a coherent project that will deliver the upgrades of the CMS detector, as required for the high-luminosity operation of the LHC.

Monitoring equipment has been installed in the LHC in the context of the support activity on Radioprotection and safety issues for accelerators and experiments (WP5) to measure the radiation flux in a number of places in view of calibrating. Unfortunately, because of the reduced maximum energy of the proton beam and of the lower than expected beam intensity until the end of 2010, these measurements are still too close to the noise level for being used. The radiation levels in the most critical place of the ATLAS experiments has nevertheless been estimated and published as planned (deliverable 5.1.2), based on the FLUKA code. Work on the radiological impact of the upgrade has continued, focused on the existing PS which is now planned to stay in operation and on the activation of equipment in the inner triplet. The outcome of these studies has been published (deliverable report 5.3.1). WP5 has highlighted the importance of investigating radioprotection and safety issues as early as possible in the upgrade projects. It is an important responsibility of the new HL-LHC and LIU project to enlarge these investigations and calibrate the simulation codes with measurement data as soon as it becomes meaningful.

As a result of the change of plans for the LHC, and because of the decision to proceed with a horizontal assembly of the Nb-Ti quadrupoles, using an innovative self-locking collaring process, the objectives of WP6 during its third year had significantly evolved, as explained in the second annual report. Collaborative efforts have been aimed at calculating mechanical deformations of the collar packs. The construction of instrumented collar packs has well progressed, although at a slower pace than foreseen, their full characterization at cold being expected by May 2011, 2 months after the end of the SLHC-PP (deliverables 6.2.1 and 6.2.2). All the tooling (especially the collaring press) and components necessary for building the 2 m long quadrupole prototypes have been procured. However, more measurements and tests are required (e.g. with the instrumented collar packs) before the assembly will take place. CERN and its partners are fully committed to complete construction of the two prototype magnets during the autumn of 2011 (as explained in deliverable 6.3.2). Concerning the corrector magnets, dipole and quadrupoles are being assembled and a sextupole and an octupole of superferric type have been developed and built (deliverable 6.3.1) which will be tested in an adapted vertical cryostat in June 2011. The design work made for the interaction region of the LHC phase 1 upgrade has been published (deliverable 6.1.2). In summary, WP6 has evolved differently than initially planned following the change of assembly technique from vertical to horizontal, which resulted in the need for new tooling and numerous intermediate steps of testing. It has however been confirmed that the future inner triplets will extensively exploit the outcome of this development to minimize the use of magnets using Nb-Sn which are more delicate to design and more costly. The continuation of the work started within WP6 is therefore a clear commitment of CERN and its partners on their own resources.

In the work package WP7 concerning the "Development of critical components for the injectors", the task 1 on the H^- source has fully met its last objectives of finalizing the plasma generator (as documented in deliverable 7.1.3) and extensively using it (deliverable 7.1.4). The experience gained and the experimental set-up built during task 7.1 are now being used for the development of an alternative ion source for Linac4. Concerning task 7.2 on “Field stabilisation in pulsed superconducting low beta cavities”, the measurements on the cavities built in the frame of the “HIPPI” JRA within “CARE” have been published (deliverable 7.2.1). Part of the work during the third year has been aimed at improving the modelling of the SPL RF system (deliverable 7.2.2) which has allowed to specify components for the SM18 test place at CERN. Another part has been dedicated to the design of a new electronics card which will be installed in the CERN test place (deliverable 7.2.3). This new card being still in production, the system test in Saclay could not yet take place. This work will in any case continue because of its importance for CERN and the ESS project, and the complete test is now planned to be completed within a year (as explained in deliverable 7.2.4).

The technical activity on powering of tracking detector (WP8) has continued to progress exactly as planned and achieved all its goals. During this third year, two ASICs technologies have been qualified for DC-DC conversion reaching the required power conversion ratios and tolerating the radiation levels of the targeted locations in the detectors. Prototype ASICs have been designed and produced, and their performance validated (deliverable 8.1.2). Power modules have been realized using the ASICs prototypes and custom-made air-core inductors that enable operation in high magnetic fields. The prototype power modules have been integrated in the full electronics system, demonstrating the electromagnetic compatibility with the sensitive silicon detectors (deliverable 8.1.3). A set of dedicated ASICs and circuitry has been developed to enable serial powering of silicon detectors and serially powered detector sub-assemblies have been realized to study in detail all the relevant system aspects. Experimental results confirm that the modules powered serially can be read out without degradation of noise, and can be operated safely also in the case where individual hybrids need to be bypassed. Safety and robustness of a serially powered chain of modules has been demonstrated against all expected failure modes (deliverable 8.2.3). In summary, local DC-DC conversion and serial powering are today proven options for the upgrade of the CMS and ATLAS trackers. The success of the developments has attracted a lot of interest of the High Energy Physics community, and the future use of these technologies is likely to be even broader than initially expected, extending to other collaborations and other particle detector types.

References

[1] Report of the Task Force on the Incident of 09/2008 at the LHC, P. Lebrun (Chair), LHC Project Report 1168, http://cdsweb.cern.ch/record/1168025/files/LHC-PROJECT-REPORT-1168.pdf
[2] LHC Performance Workshop, Chamonix, 25-29 January 2010, http://indico.cern.ch/conferenceDisplay.py?confId=67839
[3] LHC Performance Workshop, Chamonix, 24-28 January 2011, http://indico.cern.ch/internalPage.py?pageId=3&confId=103957
[4] SLHC – The high luminosity upgrade (public event), CERN, 23 June 2010, http://indico.cern.ch/conferenceDisplay.py?confId=95580
[5] Third SLHC-PP annual meeting, CEA-Saclay, 7-8 February 2011, http://indico.cern.ch/conferenceDisplay.py?confId=116438
[6] SLHC – The high luminosity upgrade (public event), CERN, 8 March 2011, http://indico.cern.ch/conferenceDisplay.py?confId=117411
[7] Common ATLAS CMS Electronic Workshop for SLHC, CERN, 9-11 March 2011, http://indico.cern.ch/conferenceDisplay.py?confId=113796

3. Work progress and achievements during the period

3.1 Progress within the individual work packages

Work Package 2: Coordination for the sLHC accelerator implementation

Task 2.1 Project Management preparation

The task headed to conclusion during year 3 of the contract with a number of significant achievements for the last deliverables:

Deliverable 2.1 1, “Common fund, Financial Management System (software) and user requirements and user guide document”:
The aim of this deliverable was the establishment of the tools necessary for administering the financial aspects of a scientific collaboration centred around the construction or the upgrade of an accelerator at CERN. The work could be based on experience made with managing international collaborations in the “physics” sector. In the financial management of these collaborations one has to distinguish the planning, construction and upgrade phases, where the participating institutes (or groups of institutes) pledge the delivery of components of the experiment, and the operation phase, where the cost of consumables continuous maintenance must be paid. There is a shift in responsibilities between these two phases; in the operation phase it is necessary that the host institute (in this case, CERN) has funds at its disposal for the running expenses. This is usually called a “common fund” to which all collaborating institutes contribute according to a predefined key (e.g. number of collaborators affiliated to the institute).
The standard financial planning tools of CERN were only adapted to manage projects where CERN was the only contributor and consumer of funds.
As a first step to opening these tools to international collaboration, the Activity Planning Tool (APT) has successively been opened to external institutes participating in CERN projects or collaborations.
The Contract-Follow-Up (CFU) application accompanies the lifecycle of supply- and of maintenance contracts at CERN. CFU is particularly important in the period before concluding a contract with external partners. It accompanies the full purchasing process from the internal review of the request to the conclusion of a contract.
Finally, the manpower dedicated to a large project is monitored by the PPT application with help of timesheets. Handling timesheets by a large workforce, distributed over numerous employers, and subject to frequent fluctuations is a tedious task for the project management.
A software implementation for “time sheets” has been developed at CERN Paper timesheets are replaced by entries into a data base. Supervisors give electronic signatures to approve. Managers receive a summary view about the working time spent on their project. The data collected in the time sheets can be linked to work units in APT, and thus to tracking of project progress. After successful testing and debugging the new application within SLHC-PP, the tool will be generalized to personnel management in future collaboration projects.

Deliverable 2.1.2, Quality Assurance plan for the implementation phase.
At CERN, a Quality Assurance Working Group (QA WG) has been constituted with representatives from the Directorate’s Project Support Unit, the Accelerator and Technical Sector and the administrative sector. Part of the work of the QA WG, in the domain of Quality Assurance for supplies and services, has been supported by the SLHC preparatory phase project.
The production of the QAWG comprises of a set of revised templates for all phases of the purchasing process, thus ensuring the application of common practice across the Organization and the collaborating institutes.
The Quality Assurance Working Group will continue its work beyond the duration of the SLHC-PP contract and it is starting to treat the quality assurance aspects of in-kind contributions, i.e

contributions in the form of materials or manpower by member institutions of a collaboration. The aim is to unify and simplify the process. The means of achieving this are

- A set of unified templates for memoranda of understanding concerning in-kind contributions
- A guideline document for the conclusion of such memoranda

Deliverable 2.1.3. Earned Value management system (software) with user requirements and user guide document.

The approach of “Earned Value Management” (EVM) has been chosen at CERN for project progress tracking. The integration of the EVM approach into APT has been carried out in 2010. Implementation and user documentation have been delivered on-time (end of 2010).

The LINAC-4 subproject of sLHC was monitored using this EVM module during the whole year 2010. This enabled to consolidate the EVM implementation and to enhance report features.

The prototype delivered in Milestone 2.2 evolved to a production application fully integrated in APT. In addition to the basic EVM features, advanced features such as “baseline management” and “progress report reminders” were implemented.

The user document (see attached document) was written to become the reference document for EVM users in APT. It recalls the EVM principles and explains in details how a project can be monitored with APT.

Task 2.2: Networking and communication

Task 2.2 has been completed within the second year of the contract.

Work Package 3: Coordination for the S-ATLAS experiment implementation

Task 3.1

In the ATLAS experiment the upgrade project definition and approval process is now agreed and established (ref 1), and the main upgrade project that is scheduled for installation during the LHC shutdown in 2013-14 is already in the construction phase, namely the Insertable B-Layer (IBL) project (ref 2). Several other smaller projects are also being studied but the IBL project remains the reference project for the initial upgrade. An Interim MoU and cost-books for the phase I pixel system upgrades foreseen for this shutdown (IBL) have been produced (ref 3), and have been presented to and agreed by the Collaboration during 2010.

The first significant LHC machine shutdown is currently foreseen for 2013-14 and the major upgrade the ATLAS collaboration has foreseen for this shutdown is the insertion of a new PIXEL layer including replacement of the current central beampipe (IBL). Other upgrade projects considered are: FTK (Fast Track Trigger) (ref 4), new small muon wheels, new topological trigger at L1, possibly new calorimeter electronics and possibly a new warm FC. Among these the largest and most significant project, the IBL, has prepared a Technical Design Report, an Interim Memorandum of Understanding and a detailed Cost Book, including the installation work. The FTK project has the similar steps in progress, while the other projects mentioned is being considered.

The organization of the ATLAS upgrade projects is shown in figure 1.

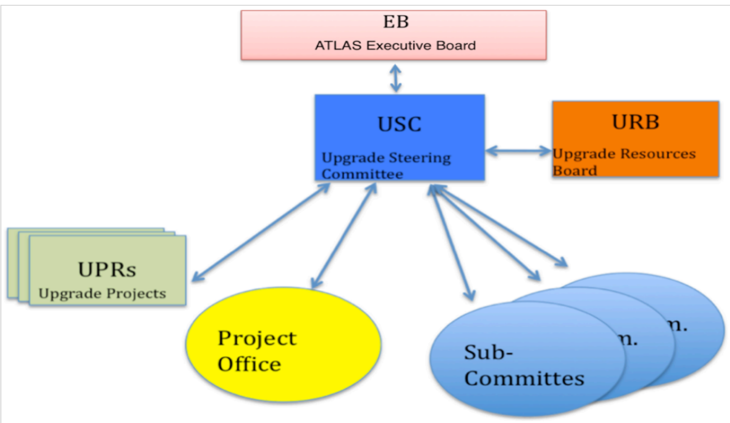


Figure 1: The ATLAS upgrade organization, showing the various bodies that are involved in setting up, costing, defining and approving the cost estimates and Interim Memorandum of Understanding for the upgrade projects (from ref 1).

Every major project that is intended as a part of the ATLAS upgrade has to pass through several steps. The process is illustrated in figure 2 (from ref 1) below where the steps are numbered from 1 to 6:

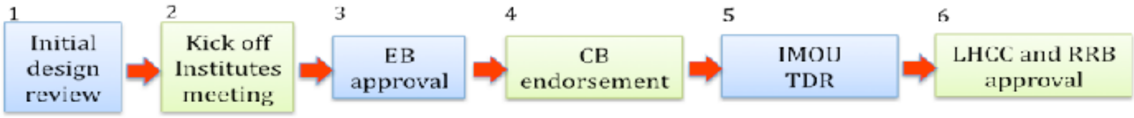


Fig. 2: Stages in Upgrade Project approval process

The key scientific, technical and resource documentation is a Technical Design Report (TDR), written by the main responsible groups in the upgrade project. The Technical Design Report for the IBL upgrade project was written in the Spring 2010. It is a 200 page document containing a full technical description of the project, a cost estimate (table 43, page 200), the organization structure, and a list of the participating institutes (see table 1 below). The schedule and detailed planning are also included in the document.
The ATLAS CB (Collaboration Board) consisting of one member per institute of the collaboration provides the final approval of the upgrade plans for the experiment – based on the TDR, before it is presented the LHC Committee (LHCC). LHCC is the external scientific programme committee installed by CERN to review the LHC experiments at regular intervals, and also major upgrade projects are reviewed by this committee. The IBL TDR was presented to the LHC Committee (LHCC) in 2010 at two occasions, once initially and the second time to provide answers to a list of the questions by the review committee.

The Interim Memorandum of Understanding, included a detailed cost estimate (ref 3), was prepared in parallel (August 2010), and presented the Resource Review Board (RRB) in October 2010. The Resources Review Board (RRB) comprises the representatives of each Experiment's Funding Agencies and the managements of CERN and of each Experiment's Collaboration. It is chaired by the CERN Director for Research and Computing.

The role of the RRB includes:

- reaching agreement on the Memorandum of Understanding
- monitoring the Common Projects and the use of the Common Funds
- monitoring the general financial and manpower support
- reaching agreement on a maintenance and operation procedure and monitoring its functioning
- endorsing the annual construction and maintenance and operation budgets of the detector.

The management of the Collaboration reports regularly to the RRB on technical, managerial, financial and administrative matters, and on the composition of the Collaboration.

References

1) ATLAS upgrade organization definition: https://edms.cern.ch/document/1093133/3

2) CERN-LHCC-2010-013, ATLAS-TDR-019 ATLAS Insertable B-Layer Technical Design Report: http://cdsweb.cern.ch/record/1291633

3) Interim Memorandum of Understanding including costbook as annex (CERN-RRB-2010-118)

4) Proposal to prepare a technical design report for FTK, a hardware track finder upgrade to the ATLAS trigger: https://edms.cern.ch/document/903426/1

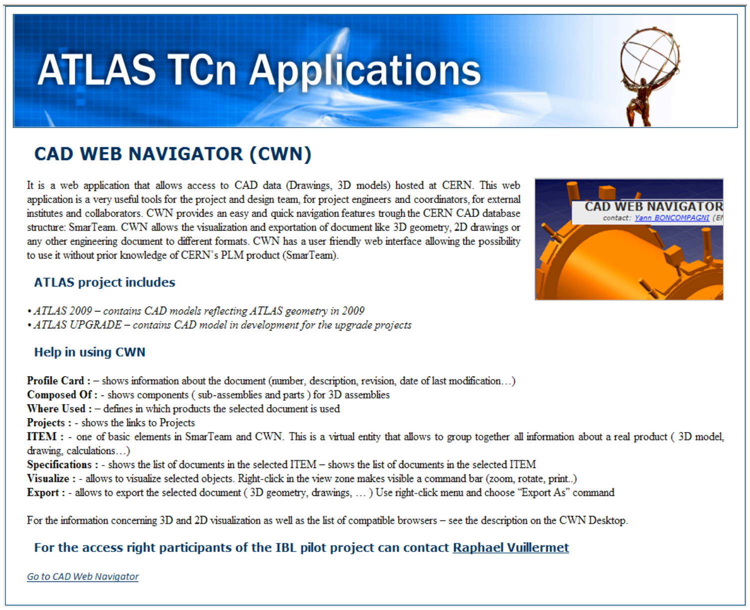
Task 3.2

The ATLAS detector was constructed during the time frame of 1996-2008 and the Technical documentation and drawings, at CERN or held by collaborating institutes, represent the legacy and complete documentation of the project as built. Upgrading the detector in the future will need a similar set of documentation, while the tools available have developed and changed. As a result it was decided to move central existing drawings to the new tools and a formidable conversion work was initiated. This work was not only important for keeping access to the as built system, but the upgrade implementation could only be made efficiently if the existing detector systems and future upgraded systems could be made accessible from the same set of software tools.

The upgraded ATLAS detector is described with a set of technical documentation, drawings and CAD information and the work to prepare this information has been a major part of activity the last year. The currently used tools for CAD drawings are CATIA and SmarTeam, while the standard tool used during the initial construction of the experiment was Euclid. The technical documentation is stored in the EDMS system at CERN. A large effort was needed to convert the existing drawings and make them compatible and suitable as the basis of documentation of the existing experiment and the upgraded elements.

After a large effort culminating early 2011 the work is now completed in two important aspects:

1) 8000 models are converted to CATIA and accessible from the ATLAS WEB pages (figure 1). Archiving, control and approval of drawings happens with the help of the CDD system.
2) The ATLAS upgrade drawings are available in this system.



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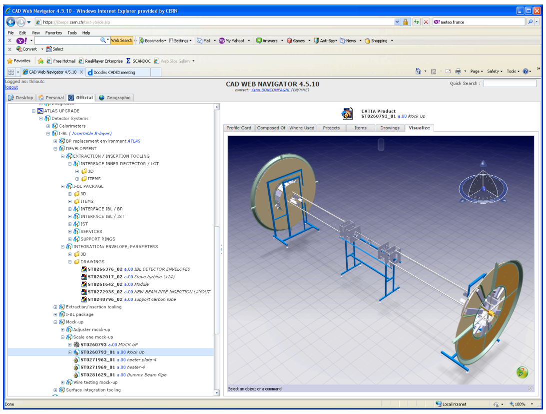


Figure 1: Left: WEB access to the ATLAS CAD drawings, split into two main groups, the detector in 2009, and the drawings related to the upgrade project. Right: The upgrade drawing repository.

As a result technical documentation, drawing and CAD information for the existing experiment and the upgraded elements are available and organized in repositories that are now fully available for the collaboration. Furthermore, the information for the phase I upgrade parts is already entered in these systems.

Work Package 4: Coordination for the CMS2 experiment implementation

Task 4.1

A detailed costing of the CMS2 upgrade project has been prepared as part of the work done for the Technical Proposal which has been submitted to the CERN LHCC (The scientific review committee for LHC experiments), and is attached to the report on Deliverable 4.2.3. First steps towards a Memorandum of Understanding have been taken with the presentation of the costs of the proposal to the CERN LHC Resource Review Board, and an agreement in principle as to the format for the MOU agreements.

During the final year of the SLHC-PP project, the CMS collaboration produced a detailed Technical Proposal outlining the scientific justification for the upgrades, as well as the scope and conceptual design of each piece of the upgrade project. As part of this process a detailed estimate of the costs of each piece of the upgrade was prepared. The methodology for the cost book has been defined, and first steps were taken towards the agreement of the sharing of costs with the funding agencies.

The costs for the upgrades of CMS which are to be constructed during the years 2011-2020 and are described in the CMS Technical Proposal. They are summarized in the following table.

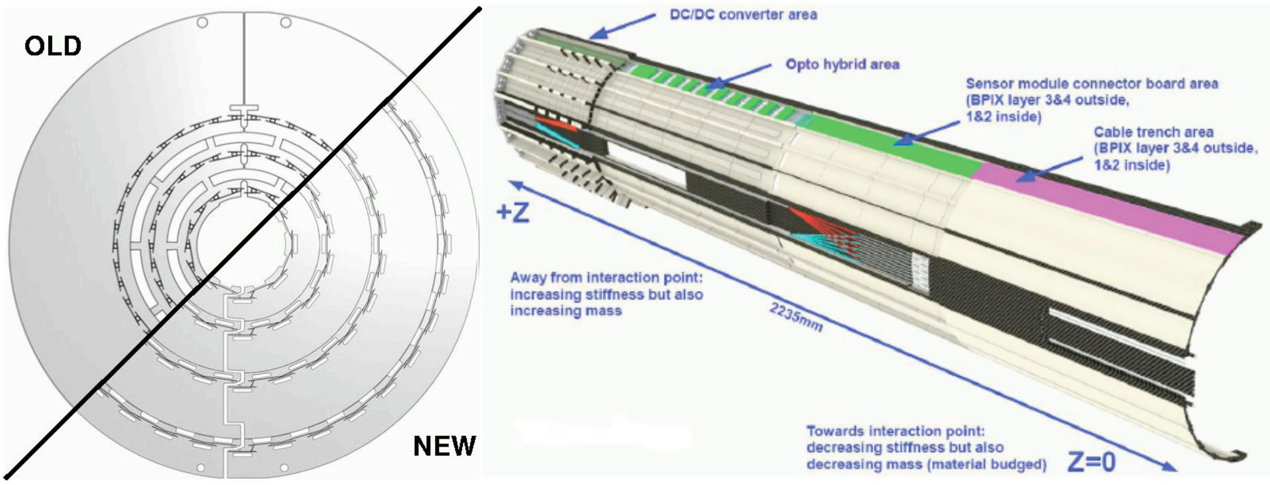
Detector	Cost (M&S Only)
	kCHF
CSC	5,570
DT	2,200
RPC endcap	4,220
HCAL	5,817
HF - Phototubes	1,990
Pixel Tracker	17,350
Trigger	4,600
DAQ	6,700
Beam Instrumentation	1,540
Magnet, Power and Cryogenics	1,330
Infrastructure	6,315
Test Beam facilities	610
Safety Systems	964
Electronics Integration	1,575
Engineering Integration	3,666
Total	64,447
10% of which, Common Fund	6,445

Costs which appear in this table were prepared with an agreed methodology for the “cost book”. These allowed different funding agencies which are involved in the project to compare costs they might be expected to bear in a uniform way.
The top level cost table shown was presented to the CERN LHC Resources Review Board in October of 2010. This board is chaired by the CERN director of research, and is attended by representatives of each agency which funds CERN.

Task 4.2

The CMS collaboration has prepared a Technical Proposal describing its plans for the upgrades of the detector during the period 2011-2020. The document outlines the scope of the project, the conceptual design of each piece of the project, and initial estimates of the cost and schedule for the project. This document was submitted to the CERN LHC Committee for Scientific Review in November 2010, and forms the pilot design and schedule of the project.

Many components of the detector will be upgraded, and each are described in the proposal. Two of the largest upgrade projects comprise a replacement of the Silicon Pixel detector with a lighter more performant Pixel detector, and the replacement of the photo-detectors in the Hadronic calorimeter with Silicon Photomultipliers (SiPM). The first figure shows a bidimensional cut of the proposed layout of the new Pixel barrel detector, which features 4 cylindrical layers, to be compared to the 3 layers of the presented detector; the barrel will be complemented by two endcaps composed of 3 disks each, while the present endcaps are made of two disks. The three-dimensional model in the same picture shows the arrangement of the services onto the support tube: the new detector will have significantly less material in the tracking volume compared to the current one, resulting in substantially improved performance.



It is proposed to replace the Hadron Calorimeter photodetectors with SiPMs. These will offer much improved performance and reliability. In addition, replacing the readout electronics will allow CMS to segment the readout of the calorimeter longitudinally. This segmentation allows different weightings to be applied in different background conditions, giving improved rejection of backgrounds in the high luminosity environment of SLHC where the pile-up renders the data from the first layers less useful.

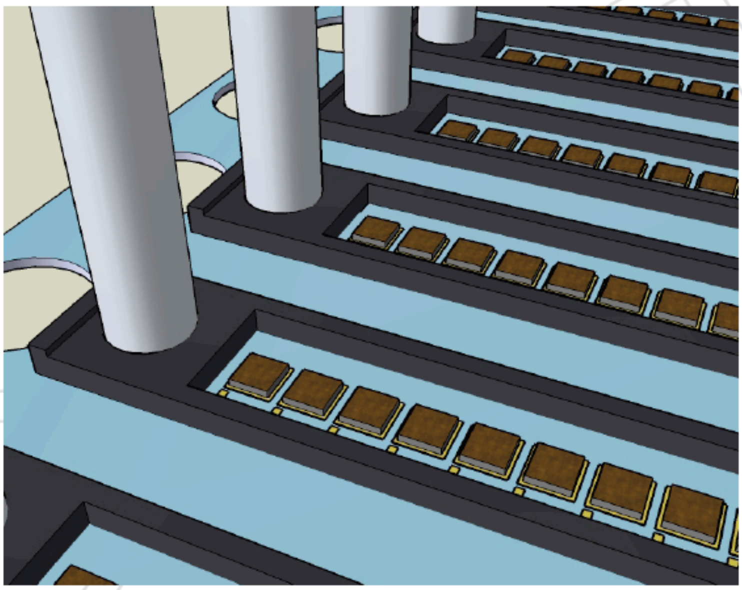


Figure 4.24: EDU detail showing linear arrays of SiPMs

The schedule for the upgrades has been developed for each sub-detector project. The overall schedule for upgrades will be coordinated by the CMS technical coordination team.

Work Package 5: Radiation protection and safety issues for accelerator and experiments

Task 5.1 Experiment Radiation & Activation

In the SLHC-PP project it had been planned to expose various dosimeters to the first beams with energy E=7 TeV in LHC during 2009, in order to compare their indication to predictions of prompt radiation effects. Good performance of a particular code in this area would greatly enhance the confidence one can have in it.

Due to the incident with one of the magnets in LHC in September 2008 and the ensuing long stop of more than one year, the planned work programme could not be realised in the planned lapse of time. For the LHC run 2009/2011, numerous dosimeters have been placed in LHC and in the experiments ATLAS and CMS. A first set of passive detectors, placed by the partner Paul-Scherrer-Institut (CH), has been removed from the experimental caverns of CMS and ATLAS during the technical stop of LHC in December 2010. Unfortunately, the integrated luminosity of LHC achieved at that moment had not generated sufficient stray radiation to induce a significant signal in the passive detectors: the readings taken from the monitors were close to the detection threshold and compatible with fluctuations of the intrinsic background.
Other passive detectors placed in the experimental caverns will not be evaluated before the end of 2011, when the integrated luminosity and thus the levels of stray radiation, are expected to have increased by an order of magnitude.
Within the ATLAS-MPX project under leadership of CTU-Prague (CZ) a network of 16 Medipix2-based, single-quantum-sensitive devices has been installed before the LHC startup at 2008 at various positions in the ATLAS experimental and technical caverns. The aim of the network is to perform real-time measurements of spectral characteristics and composition of the radiation environment inside the ATLAS detector during operation. With the devices a large dynamic range in radiation monitoring can be covered. An important goal is the determination of the neutron component of the mixed radiation field. ATLAS-MPX devices have operated almost continuously starting from early 2008 (background and cosmic radiation measurements) through the stable LHC operation during the 2010 and 2011 run periods up to nowadays. Radiation induced signal is acquired continuously by each detector station, with exposure times (0.05s - 100s) for the frames adaptable to the local intensity. In the recorded frames one can recognize the different types and determine the rates of incidence, normalized per area and per unit of luminosity during regular LHC running. Measured flux rates of different particles are found to be largely in agreement with the original simulations, mostly within a factor of two (for an example, see Fig 1 and 2 for the fluence of thermal neutrons within ATLAS).

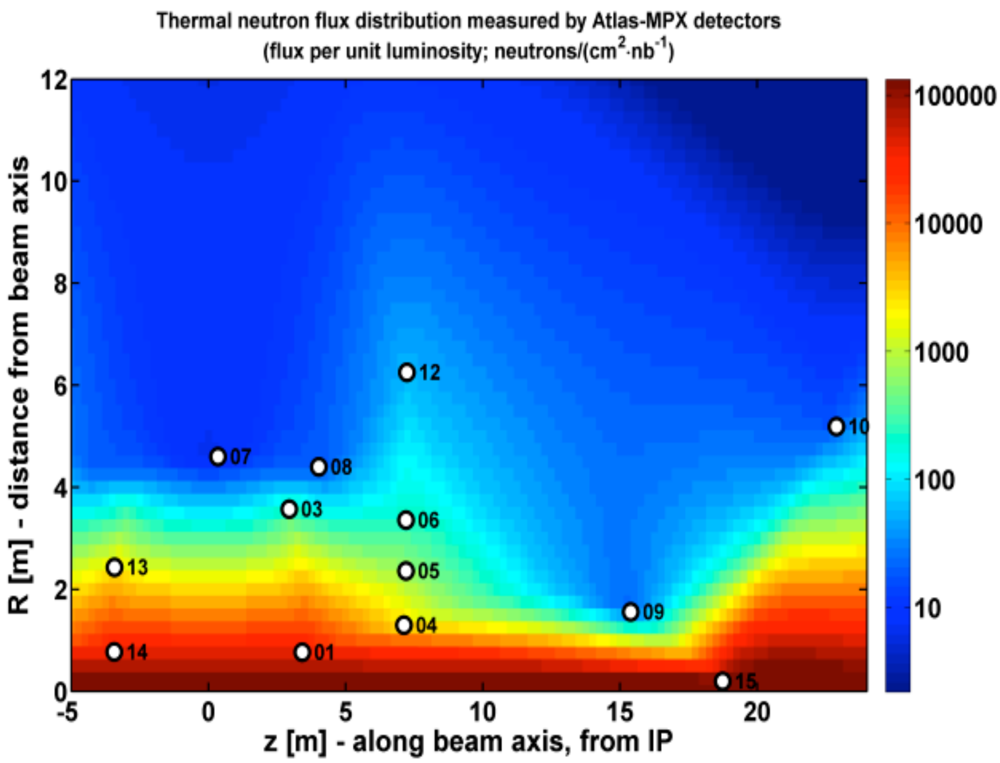


Fig.1): Measured spatial distribution (in one quadrant of the ATLAS detector) of thermal neutron fluence per unit luminosity. The iso-fluence curves are interpolated from measurements with the ATLAS-MPX network.

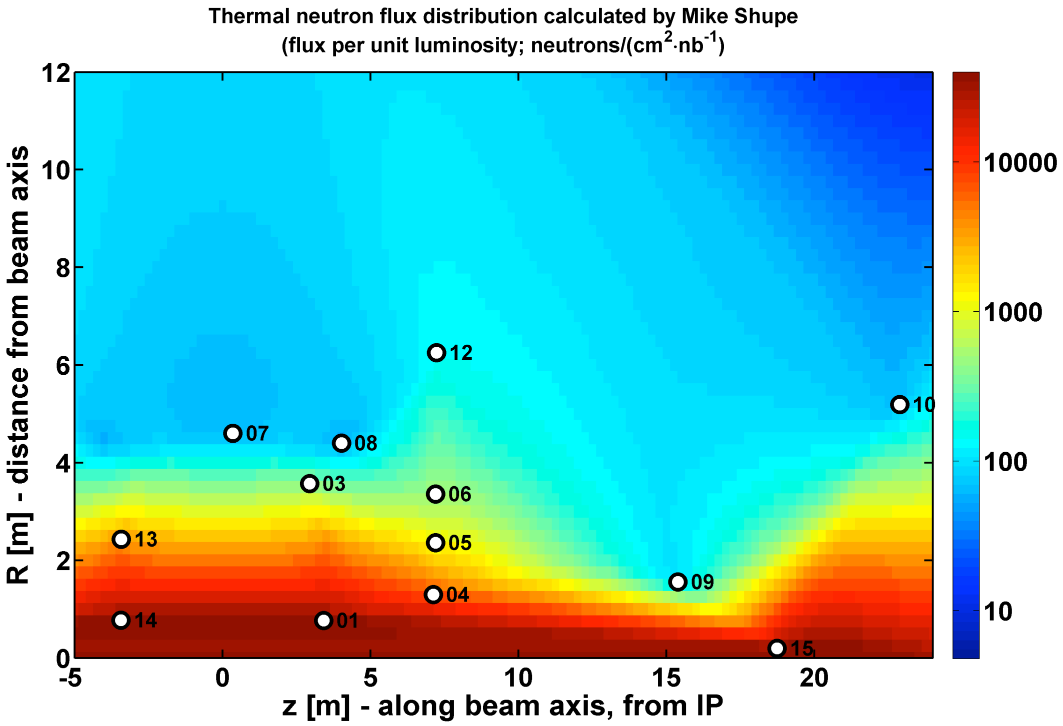


Fig 2): Predicted thermal neutron fluence per unit luminosity as calculated by PHOJET G3/GCALOR Monte Carlo simulations. The circles represent positions of individual ATLAS-MPX detectors (4 detectors are not shown in the figure).

Task 5.3 Impact Study

The environmental impact of underground accelerator facilities can be classified into releases of radioactivity during operation and disposal of radioactive waste, predominantly after the end of the life of the facility.

The change of the accelerator strategy of CERN, decided in early 2010, implies the use of the 52-year old Proton Synchrotron (PS) for periods well beyond the year 2020. The PS accelerator has been revised and consolidated at numerous occasions, so that, with exception of the magnet yokes, hardly any original parts are left of the original machine. This makes it possible to accelerate proton beams in the PS with an intensity of a factor 1000 higher than originally anticipated. The accelerator building, however, has not changed, and is to a large extent in the same state as in the 1960s. It has been build as a circular tunnel close to the surface, covered with a radiation shielding hill formed from the excavated earth. The ventilation system of the PS does not follow the prescriptions which are nowadays applicable to facilities where radioactive air is generated.
A working group has analysed, among other topics, the stray radiation and the radioactive air released from the PS and it has made a number of recommendations to assure the safe operation of this accelerator for the coming decades: weak points in the shielding of the PS must be consolidated by a reinforcement of concrete or iron, thus reducing the levels of stray radiation to acceptable values. The environmental impact of the release of radioactive air from the PS has been estimated, it is more than a factor of 100 below the relevant limit in European legislation. However, it is recognised that only measurements constitute a proof of the absence of all risk for the environment. The upcoming renovation of the ventilation system shall be used to modify the air-flow in a way that enables a state-of-the-art measurement of the released radioactivity.

For the upgrade of LHC to SLHC (or to High-Luminosity LHC) it will be necessary to change a few elements of the accelerator. Notably the collimators and the inner triplet magnets will have to be replaced by new, more performant units. Coincidentally, these devices and their surroundings will be among the most radioactive ones at the time of the upgrade, around the year 2020. For the upgrade of the inner triplets, very detailed technical plans are already available and the radiation protection group, together with the Magnet Group of the TE department, has made estimations for the activity and the dose equivalent rate in the triplet areas. The radiation levels are so high that the dismantling work of the old, activated triplet magnets cannot proceed in the conventional way, by unscrewing the vacuum flanges (often secured with 12 tightly fastened bolts). Instead, tools are envisaged which allow cutting the vacuum tubes in a minimum of time. Normally, all triplet magnets would be destroyed in this process and would become radioactive waste. Optimisation of the procedures makes it now possible to recuperate half of the old magnets, reducing the volume of radioactive waste by two and providing spare magnets for the focussing triplets at the ALICE and LHCb-experiments.

Finally, the activation of the earth surrounding the beam dumps of SPL and PS2, two elements of the originally planned SLHC injector chain, has been estimated. These beam dumps would absorb up to 5 % of the accelerated beam intensity in the respective accelerators, at an energy of 4 to 5 GeV. The activation of earth and ground water could not be excluded. The calculations, performed that the partner institute Gesellschaft für Schwerionenforschung (DE) show that there is indeed some activation of the soil. Infiltrated water creeping into the tunnel would have to be separated from raw water (form cooling purposes etc.) because it could transport soluble radioactive isotopes (^{3}H, ^{22}Na) in a concentration higher than legal guidelines.
The simulation calculations and resulting estimates are of use for other facilities planning to build high-intensity proton accelerators, for example the European Spallation Source in Lund (SE).

Work Package 6: Development of Nb-Ti quadrupole magnet prototype

The objectives for the period (year 3) include the complete interaction region design (Deliverable 6.1.2), the construction of two instrumented collar packs (Deliverable 6.2.1), the assessment of the collaring procedure and definition of final coil size (Deliverable 6.2.2), the construction of a corrector magnet package (Deliverable 6.3.1), and the assembly of a 2-m-long prototype quadrupole (Deliverable 6.3.2).

Furthermore the complete cryomagnet design (Milestone 6.4), the electrical test of the collared coil (Milestone 6.5) and the cold test of corrector magnets (Milestone 6.7).

Deliverable 6.1.2: Complete interaction region design

The goal of the Phase-1 Upgrade was to provide more flexibility for focusing of the beams in the collision points of the ATLAS and CMS experiments, and to enable reliable operation of the LHC at the luminosity of 2×10^{34} cm^{-2} s^{-1}. The upgrade concerned mainly the low-β triplet magnets while keeping the same machine interfaces to the experiments.

In view of the consolidation of the LHC machine, its revised operational schedule, and the optics limitations imposed by a minimum β^* of 30-40 cm, WP6 was re-scoped in 2010. The baseline is now to concentrate on one single upgrade at a later stage around 2020, which will allow studying the potential of Nb_3Sn superconductor technology and a mitigation of the above-mentioned constraints. Nevertheless, the layout of the interaction region of the Phase-1 upgrade was completed in order to document the limitations on the machine performance and the reasoning that lead to the above-mentioned decision.

Achievements in year 3

In year 3 the working group at CERN has completed the layout for the Upgrade Phase-1 option (changing only the triplet and D1 magnets) and the studies of constraints associated with underground space requirements, radioprotection, existing or missing infrastructure, and associated equipment to be installed for the new triplets. The limitations, mitigation measures and the expected performance within the boundary conditions of Phase-1 are presented in the report on Deliverable 6.2.1. It was established that the new low-β quadrupole magnets feature a 120 mm bore (or *aperture*), compared to 70 mm of the present ones, and use the technology of Nb-Ti superconductor cables developed for the LHC dipoles. The separation dipoles (D1), the TAS and TAN absorbers, as well as other elements in the insertions must also be modified to comply with the larger beam aperture of the triplet. However, the present cooling capacity at 1.9 K of the cryogenic system and other main infrastructure will remain unchanged. Moreover, due to the lengthy intervention needed to reposition cryo-magnets, it has been decided that the magnets in the matching sections will remain unchanged in the Phase-1 Upgrade.

The 120 mm aperture quadrupoles based on the well-proven Nb-Ti technology will serve as a backup solution if the Nb_3Sn technology performs below expectations. These magnets will extensively use the technological developments made for the LHC. Nevertheless, the design of the new magnets is not without concerns due to higher stored energy, forces and stresses, and increased heat loads and radiation dose; see reports on Deliverables 6.2.1 and 6.2.2.

The available space in the LHC tunnel is almost fully occupied, and integration of the new equipment required lengthy studies. Solutions have been found where the major part of the equipment can be located in a parallel passageway. For both experimental zones the power convertors and feed-boxes are identical, details of equipment location and the routing of the superconducting link are, however, specific for each experimental area.

<u>Deliverable 6.2.1: Construction of 2 instrumented collar packs</u>

In the progress report for the second year, it was explained that the engineering design challenges require model magnet assemblies and additional tests including the validation of the porous cable insulation, the validation of a more porous ground plane insulation scheme, and the testing of the collaring procedure that also allows the positioning of the coil-pack in horizontal position. These objectives are met by the manufacture of two “instrumented collar packs”.

Achievements in year 3

The instrumented collar pack is also needed for the qualification of the assembly and collaring procedure. In order to keep the 4-fould symmetry, necessary for a good field quality in the quadrupole magnet, a spring-loaded, split assembly mandrel was developed and procured from European industry.

Moreover, the instrumented collar pack can be cooled to cryogenic temperatures in order to study the loss of pre-stress. The results of these tests are crucial for the production of magnet coils, because both the coil size prior to the collaring and the elastic modulus must be known in order to calculate the required coil shimming. This shimming will guarantee the appropriate pre-stress in the coil after cooldown and excitation.

In order to allow the percolation of helium into the superconducting coil blocks, the ground plane insulation was also redesigned. The second instrumented collar pack serves for heat-transfer measurements and for the experimental validation of this new ground plane insulation. Therefore solid blocks of invar are used instead of the superconducting coils. In the invar block, only thermal conduction plays a role and the understanding of the complex behavior of (superfluid) helium in (micro)-channels is not required. The use of invar has an additional benefit: the thermal contraction of this material is much smaller than the thermal contraction of the other materials (stainless steel collars) used in the construction of the mock-up, such that pressure can be generated artificially during cooldown, without the need of obtaining 50 MPa under the collaring press.

The second collar pack requires special collars for the routing of the instrumentation. Both strain gauges and capacitive pressure transducers are used for measuring the residual pre-stress after the removing from the collaring press and cooldown to cryogenic temperatures. This type of transducers is produced on-site at CERN and each gauge has to be calibrated at both room and cryogenic (77 K) temperatures. A special setup has been developed for the calibration at cryogenic temperature on the tensile machine delivering 0.1 to 200 kN of force. The test of this instrumented collar pack with capacitive pressure transducers is important for the validation of the mechanical calculations presented in the report of Deliverable 6.2.2. Assembly of this collar pack depends on the completion of the size and elastic modulus measurements of the coil stacks; see also report on Deliverable 6.2.2. Now with this heavy tooling fully commissioned, CERN will proceed to assemble the second collar pack by the end of May 2011.

Deliverable 6.2.2: Assessment of the collaring procedure and definition of final coil size

In order to guarantee the required field quality of the magnet, the nominal size of the superconducting coil must obtain tight tolerances (on the order of 0.02 mm) under operational condition, i.e., after cool-down and excitation. Moreover, it is required that the coils be loaded with a pre-stress of about 90 MPa after collaring, resulting in a residual stress of 50 MPa after cool down, in order to avoid unloading at full excitation, which would results in so-called training quenches. To obtain the correct level of pre-stress after the coil collar pack is removed from the press, appropriate azimuthal shimming must be applied. The choice of these shims depend on the mechanical properties of the steel, and more importantly, on the mechanical properties of the superconducting coil. Although we use LHC main dipole cable for the fabrication of the MQXC insertion quadrupole magnet, the insulation was changed in order to improve the percolation of the superfluid helium.

Achievements in year 3

Collaborative efforts within WP6 have aimed at calculating the mechanical deformations of the collar pack, the calculation of the unloading of the coil when removed from the press and during cool-down, the design and construction of instrumented collar packs (Deliverable 6.2.1), the measurement of the coil's elastic modulus with so-called ten-stacks and the arch of a trial coil, and the design and procurement of a modulus measurement device. This work has now been completed. However, the experimental verification of the shim sizes for the production coils (Deliverable 6.3.2) is still outstanding and will be performed in the first half of 2011.

A 700-mm-long coil mockup was realized at CEA/Saclay using LHC inner layer dipole cable 01, with the new porous insulation. The required size of the compacted, insulated coil at cold conditions is given by numerical field computation (CERN's field computation program ROXIE), assuming an average insulated cable width of 2.17 mm and a compacted insulation thickness of 0.135 mm. A first curing cycle was realized at constant volume and the conductor stack less compacted (by 0.2 mm) than at nominal. After this first curing cycle, compression tests were made in the coil's straight part to identify its mechanical behaviour in the azimuthal direction.

E-modulus testing will establish the azimuthal oversize of each coil layer under a chosen pressure and will thus help to optimize the size of the compacted stack during curing, in order to make sure that the cable insulation thickness will be nominal under operational conditions of the magnet. Mechanical calculations show that this residual stress should be about 53 MPa. The aim is thus to obtain nominal coil size (as determined by magnetic field calculations) when the azimuthal stress is about 53 MPa on the unloading curve. For this purpose, a new press-insert tool was procured from European industry. It is shown in the report on the Deliverable 6.2.2. Now, after the series manufacturing of the coils has started (see Deliverable 6.3.2), the experimental verification of the shim sizes is the next important step towards the final assembly of the magnet cold mass. CERN and its partner CEA/Saclay are committed to the assembly of up to three 2-m-long magnet cold masses during 2011 and early 2012, well exceeding the goal stipulated in the second year report of SLHC-PP (WP6).

Deliverable 6.3.1: Construction of corrector magnet package

The study of the Phase-1 upgrade of the LHC insertion regions around ATLAS and CMS proposes the corrector magnets be grouped in a dedicated cryo-assembly, denoted *corrector package*. This corrector package contains horizontal and vertical orbit correctors (MCXB), skew-quadrupole (MQXS), and higher-order multipole correctors. In addition, a pair of MCXB magnets will be installed in the Q2 cryo-assemblies.

The correction of the higher order field imperfections of the triplet quadrupoles and the separation dipole magnets will require local correctors of the same multipole order as in the LHC. The strength requirements are 0.055 Tm at 40 mm reference radius for the sextupole corrector (MCSX) and 0.035 Tm at 40 mm for the octupole corrector (MCOX). The baseline requirements for the higher order correctors can be met by a super-ferric design featuring a pole gap of 140 mm. The simple racetrack coils are wound with single, enameled superconducting wire and are impregnated with epoxy resin or with more radiation-hard, cyanate-ester resin. The advantage of super-ferric magnets is that the coils are located at a larger radius from the bore, which reduces the radiation dose on the coil.

Achievements in year 3

The comprehensive report on Deliverable 6.3.1 shows the progress on the development and manufacture of two superconducting corrector magnets (a sextupole and an octupole) at CIEMAT. In parallel, work at CERN has aimed at the design and manufacture of orbit corrector magnets with Rutherford type superconducting cable. All tooling and magnet components have been procured from European Industry. First assembly tests have been made successfully. Moreover, the design of a skew quadrupole magnet has been completed. Although the Milestone on the coldtest of the corrector magnet package has not been reached to date, CERN and its partners (CIEMAT, and STFC/Ral) are fully committed to complete the tasks defined within WP-6 by the end of 2011. This will not only make the best use of the investments but will also qualify the new techniques to cope with higher heat-load from particle debris in the insertion regions of the LHC.

The nested dipole correctors based on epoxy-impregnated coils of the type used in the present triplets are not considered appropriate for the performance goals of the Phase-1 upgrade. Although not originally foreseen in WP-6, an alternative solution using Rutherford-type cables has been developed; see report on Deliverable 6.3.1. In addition to improved helium transparency, this type of coil profits from the larger temperature margin offered by cooling to 1.9 K. However, the design requires careful optimization of the complete powering circuit, including the power convertors, since bipolar powering in the 2-3 kA range will be necessary.

Deliverable 6.1.2: Assembly of a 2-m-long prototype quadrupole

This workpackage concerns the assembly of a 2-m-long model quadrupole magnet for the new inner triplet required for the LHC luminosity upgrade. The heat load from particle debris in the inner triplets calls for a new, more porous coil and ground plane insulation; see also the report on Deliverable 6.2.1. The collaring of the nearly 10-m-long quadrupole magnets cannot be done with the standard presses used for the long dipole magnets. The reason is that the four-fold symmetry of the quadrupoles has to be guaranteed in order to avoid non-allowed multipole field error in the aperture field. A novel self-locking collar pack design was therefore developed in 2009. These packs require a spring-loaded and collapsible assembly mandrel. This mandrel is also shown in the report on Deliverable 6.2.1.

Achievements in year 3

The MQXC magnet design takes full advantage of the features implemented in the CERN field computation program ROXIE. In particular, the design and manufacture of the coil end-spacers follows the integrated approach with data transfer from ROXIE to CAD (CATIA) and the 5-axis CNC machining of the pieces. By means of trial coil windings both at CEA and CERN, the shape of these spacers was optimized.

After two iterations with trial coils, the optimum shape of the end spacers was established. It was found that the minimum bending radius on the cables broad face must be located at the nose of the end spacer. No gaps appear on the inner and outer diameter of the coil and thus potting of the coil ends can be avoided. This is important for the penetration of the helium and will thus improve the heat transfer across the laminated collars and yoke to the bayonet heat exchanger.

The collars were developed for the horizontal assembly technique. Under the press, all collars move in together so that they are self-locking and quarantee the 4-fold symmetry of the quadrupole. The collar shape was then modified to allow for passive magnetic shims to be inserted at a later stage between the collars and the yoke. These shims allow the compensation of non-allowed mutlipole field errors and are therefore known as “tuning shims”. The heat transfer was optimized by the stamping of dimples into the collars, in order to reduce the stacking factor to 94%. The production of the collars was optimized to meet the required tolerances at minimum cost. In high tolerance edges (+- 0.02 mm) are electro eroded, while the “lower” tolerance edges (+- 0.07 mm) could be machined with the less expensive laser cutting. Each 2-m-long magnet will contain about 800 centre-section collars and inserts, as well as 430 end-section collars and inserts. The total production for the set of magnets will use comprise more than 4000 parts.

The novel design for the quench heaters (a sandwich of two heaters for the inner and the outer layer coils) was already described in earlier report. The design guarantees faster heat up, and simultaneously, increased channels for the cooling medium. The in-house manufacturing includes chemical edging of stainless steel strip, pre-forming to the outer radius of the inner layer coil, water-jet cutting of holes in the Kapton strip, and electrical testing at 3 kV.

As has been said in the report of the second year, the assembly of the 10-m-long magnet cannot be done with the coil in vertical position. For this reason the collaring press was designed and manufactured such that it can be used also with the coil in the horizontal position. For this purpose the coil would need to be supported by an assembly table that was estimated to about 200 thousand Euros. This investment is not justified in view of the re-scoping of the SLHC-PP workpackage 6. This collaring press has been the largest investment within the WP6 activities. The press is now fully commissioned and the collaring procedure is validated with the assembly of the first instrumented collar pack; see report on Deliverable 6.2.1. The assembly of the first 2-m-long collared coil requires the experimental validation of the final coil size (and therefore the required shims) with the dedicated modulus press that is also fully commissioned. The final assembly is planned for Summer 2011.

Milestones:

Milestone 6.4: Complete cryomagnet design

Since the triplet chain is an extension of the LHC machine, which needs to be connected to machine elements upstream, and since there is no transverse free space in the congested zones around the ATLAS and CMS experiments, the transverse overall dimensions of the triplet Phase-1 upgrade cryostats are constrained to those dimensions of the LHC main ring magnets.

This opens areas where the resources required for the project could be reduced: The cryo-magnet assembly benches in operation at CERN can be used after some modifications for the assembly of the triplet magnets into their cryostats. Also the cryogenic test benches in operation at CERN can be used, with minimal modification, to carry out performance testing of the magnets. Moreover, the equipment required to transport LHC magnets underground, and to install them in their final position in the LHC, can be used for the new cryo-magnets.

It was shown that the outer diameter of the MQXC can be constrained to 580 mm, which is that of the LHC main ring magnets. Further significant reduction in resources and cost can thus be obtained by keeping the design of the cryostats very close to the LHC main dipole cryostats. Taking advantage of this standardization, the existing cryo-magnet tools have been modified and adapted; see report on Milestone 6.4.

Milestone 6.5: Electrical test of collared coil

As stated in the report of the second year, CERN and its partners had planned to advance the assembly of the 2-m-long model quadrupole magnets (MQXC) to meet a milestone where electrical tests prove the integrity of the collared coil. Although this milestone has not been met, the tests were established for both inner and outer layer coils of the first production batch. These tests will serve as a reference for the subsequent assembly steps.

Five kinds of electrical tests were realized: 1) Coil resistance was measured between each cable extremities with a micro-ohmmeter. 2) Measurement of the insulation resistance between cable and angular wedges. 3) Measurement of inductance. 4) Test with constant voltage (at 100 V, 500 V and 1kV) with a mega-ohmmeter to check for leakage currents to ground. For this test, each cured layer is positioned on the grounded, metallic winding mandrel. Then the metallic coil protection sheet, normally used in the curing mould, is put on the coil and connected to ground. 5) A pulse tests is performed at 1 kV with a universal winding tester to check for inter-turn shorts.

Milestone 6.7: Cold test of corrector magnets

The comprehensive report on Deliverable 6.3.1 shows the progress on the development and manufacture of two superconducting corrector magnets (a sextupole and an octupole) at CIEMAT. In parallel, work at CERN has aimed at the design and manufacture of orbit corrector magnets with Rutherford type superconducting cable. All tooling and magnet components have been procured from European Industry. First assembly tests have been made successfully. Moreover, the design of a skew quadrupole magnet has been completed.

A new insert for the vertical test cryostat at CIEMAT is being fabricated, and a new data acquisition system has been developed. Cold test of the sextupole magnet will be done in the first half of 2011. The refurbishment of the CERN cold test facilities will also be completed in due time. Although the Milestone on the coldtest of the corrector magnet package has not been reached to date, CERN and its partners (CIEMAT, and STFC/Ral) are fully committed to complete the tasks defined within WP6 of SLHC-PP by the end of 2011. This will not only make the best use of the investments but will also qualify the new techniques to cope with higher heat load from particle debris in the insertion regions of the LHC.

Work Package 7: Development of critical components for the injectors

Task 7.1

Task 7.1 aims to develop towards a pulsed plasma generator with a 1.2 ms pulse length and a 50 Hz repetition rate, driven by 100 kW of 2 MHz RF power. The plasma generator will be used to design the 1 ms duration pulsed negative hydrogen ion source for a future Superconducting Proton Linac (SPL) at CERN. The plasma generator should operate at an average power of 6 kW. The principle objective of the WP 7.1 is the simulation, design, construction and test of such a plasma generator. The test results shall be compared to the non-caesiated DESY volume H^- ion-source currently commissioned at 1 Hz on the 3 MeV test stand of Linac4.

Summary of progress

Plasma ignition mockup: The mockup where the plasma chamber is replaced by a quartz tube was operated from 1 to 50 Hz and used to assess the ignition system and the dynamic of the gas injection. The ignition system relies on gaseous discharge and unfortunately requires a high gas thickness (pressure × distance). Modification of the spark gap geometry into an arc discharge slightly increased the operation pressure range. But separating the ignition from the plasma gas parameters would be an asset. A radioactive source, for example a YSr beta source, provides such independence.
Systematic testing of the pumping system demonstrated a strong reduction in the effective pumping speed with increasing gas flow, resulting in pressures above the nominal parameters of the high voltage system required to operate the future SPL ion source. Hence, as the option was foreseen, we tripled the pumping speed of the vacuum system.

Eddy current heating: A mockup reproducing the geometry of the magnets and ferrites around the RF solenoid was produced and operated. The major outcome of the test was as anticipated from simulation, the measurement of a 6-fold reduction in eddy current heating in the magnets due to the installation of a copper cage, and the demonstration that without the Copper-cage, the magnets would be heated above the Curie point. The ferrites were heated above 240 °C, a dedicated software package was purchased to address this point and a compressed air cooling system implemented in the 8-pole cusp configuration.

Plasma generator prototype 1: The plasma generator prototype (12-pole cusp) was completed by September 2010. The test conditions, results and actions are: *Low repetition rate tests:* 12 pole system operational at low power, at power above 40 kW partial discharge induced by air ionization perforated the kapton insulation of the RF-solenoid. Increased kapton thickness improved the situation and 90 kW were reached for a short time. It was deemed mandatory to increase the distance between the RF solenoid and the grounded Cu housing of the magnets. An octupole magnet cage was therefore designed, produced and tested. Above 50 kW RF power, the ignition is no longer needed to ignite the plasma, but a jitter of the ignition time is observed.

RF matching network & plasma coupling: The SPL plasma chamber RF matching network was designed, produced and tested; the measurements of the contribution of the plasma to the RF load impedance and of the plasma coupling (70% for Linac4 IS and 40% for sLHC-PG) were presented and published at the Negative Ion Beam Symposium (NIBS)-2010 in Takajama, Japan. While operated at high power the heat load on the matching network's tunable inductance coil required the production of a water cooled and silver coated tunable inductance solenoid. Flexible control of the RF frequency and amplitude is now complemented by real time measurements of the RF coupling efficiency to the plasma. With the new configuration, RF coupling efficiencies to the plasma of up to 60% were achieved.

Optical emission spectrometry: The power dependence and time structure of the $H\alpha$ and $H\beta$ hydrogen lines of the linac4 ion source and of the sLHC plasma generator were measured and then presented and published at the NIBS-2010 symposium. $H\alpha\beta\gamma\delta$ filtered phototube based plasma monitoring system was assembled and tested.

Measurement techniques: A gas analyzer is currently being operated, the preliminary results require analysis and will be published at the International Ion Source Conference (ICIS)-2011. The Langmuir gauge delivery was delayed and should arrive at CERN by the 30thMarch. This important plasma parameter measurement will be done and published at the ICIS-2011 conference.

Thermal modeling: The thermal simulation of the sLHC plasma generator was presented and published at the NIBS-2010 symposium. Following eddy current heating tests, the hysteresis losses induced in the ferrites by the 2 MHz RF were simulated; an air cooling circuit is necessary. It was designed and is implemented on the octupole plasma generator (multicusp prototype 2).

Multicusp prototype 2: The requirement to increase the insulation distance between the solenoid antenna and the copper RF-shielding cage, requires changing to an octopole multicusp magnetic configuration in order to keep the same magnetic field strength at the plasma chamber wall. Temperature monitoring apertures and compressed air cooling holes have been implemented in this design.

Pulsed injection of H_2 ; pressure measurement: Gas flow measurements were achieved from 1 Hz up to 50 Hz. While individual flow regimes can be reliably simulated, a pulsed flow that includes from viscous up to molecular flow regimes with very different geometrical dimensions (10^{-6} to 10^{-2} m) is not yet within reach. The measurement showed a major reduction in the pumping speed with increasing gas flow. The pumping speed was tripled in order to ensure a vacuum compatible with the high voltage systems that extract ion beams from plasma generators.

Modeling of magnetic field: The 3D-Magnetic field distribution of the Linac4 ion-source was measured and simulated with the OPERA software package. A very detailed cusp field simulation was achieved for 6, 8 and 12 poles in standard and Hallbach configurations of the permanent magnets. Systematic measurements of the individual magnets were performed, showing acceptable field homogeneity. The assembled magnet muticusp field maps were measured.

Significant results:
The plasma generator prototype was submitted to a 50 Hz 1.2 ms 50 kW RF power corresponding to a 3 kW average power close to SNS' record value of 3.2 kW. Tests at 1-2 Hz repetition rate for 1.2 ms pulses at the maximum RF power of 100 kW were successful, however, after one hour, sparks developed through a weakness of the epoxy insulator. Two reinforced units were produced and are currently being tested.
To our knowledge, within this work the time dependent structure of the Balmer lines in sub millisecond pulsed RF induced plasma were measured for the first time.
The measurement of the RF coupling was usually measured via the reflected RF-power, for the first time in RF driven ion sources' plasma, the measurement of a time resolved coupling to the plasma was achieved down to 2 MHz and is a crucial input to further emission spectroscopy and plasma simulation.

Deviations from Annex I
No deviation from annex 1 in terms of results.

Statement use or resources and deviations
During the third and last year, the work package was completed on budget and on schedule.

Corrective actions
n.a.

<u>Task 7.2</u>
The work on the simulations of the Low Level RF (LLRF) system has progressed well. Results have been published and tools are available to simulate the different RF stations with different configuration of the SPL Linac, i.e. a different number of cavities driven from a single klystron. Simulations were presented at a joint collaboration meeting with the European Spallation Source (ESS) in Lund, Sweden, and the results were well received and triggered ESS to adopt a similar effort to simulate their planned LLRF system.

In the reference period testing of the INFN cavity at CEA Saclay was performed and the results are planned to be published at an international conference. Differences in the tuning system from CEA Saclay and INFN were clearly seen and give valuable input for the future design of such cavities, tuning systems and the associated low level RF system.

Following the successful tests with prototype low level hardware and consolidated low level RF board has been designed and is now in production. The final validation of this board has not yet taken place as described in the report with regard to deliverable 7.2.4. The collaboration with CEA Saclay is planned however to continue so that CERN and CEA will work jointly to achieve the objective within the framework of this future collaboration. At CERN development work for a superconducting cavity and cryostat continues and the experience gained with 50 Hz pulsing in the unique test facility at Saclay is giving valuable input to the design and construction of a test stand at CERN. The tests at CEA Saclay also revealed that for an exact calibration of forward and reflected power it is best to use a continuous wave experiment. The necessary equipment for these tests is being commissioned by CEA Saclay and can be used for the future planned tests. It consists of an IOT amplifier driven by a solid state amplifier permitting to operate the cavity at reduced power in cw-mode for the calibration runs.

Results have been presented at the Annual Meeting in February at CEA Saclay as well as at the collaboration meetings for SPL in June hosted by ESS Lund in Sweden and in November 2010 at CERN.

Corrective actions

Deliverable 7.2.4 could not be delivered within the time frame of the sLHC-PP project, and the future actions are described in the deliverable report associated with this item.

Work Package 8: Tracking detector power distribution

Task 8.1: DC-DC Conversion

A solution based on buck DC-DC converters has been demonstrated in the previous periods of the project as a feasible option for delivering power to the front-end electronics in future tracking detectors suitable for the High Luminosity LHC environment. The work on efficiency optimisation, qualification of radiation hardness of custom designed ASICs and integration of the converters on the detector modules has continued.

The qualification of two radiation tolerant microelectronics technologies, up to the total ionising doses and particle fluencies expected at the targeted locations has been a key factor to enable the success of the project. The baseline technology from On Semiconductor, formerly known as AMIS, has been used for development and production of the AMIS2 power converter ASIC. A second technology from the German foundry IHP was also initially qualified and some radiation tolerance issues are still being studied on the latest release of devices. Both technologies appear to be adequate for our applications and will enable a power conversion with efficiencies greater than 80%.

The qualified AMIS2 ASIC has been used to develop a power converter plug-in module. The module is fitted with a compact connector so that it can be easily plugged into different front-end systems. This converter delivers an output current up to 3 A with a nominal output voltage of 2.5 V, which can be tuned up to 5 V by modifying a pair of resistors to match the needs of specific systems. The module uses a custom made air core inductor that enables operation in magnetic field up to 4 T present in the trackers volume. The AMIS2 device is primarily designed to match the power required by future tracker front-end systems that are being developed in a 130 nm technology. It must be noted that the systems available at this moment for tests are still implemented in the former 250 nm technology that requires currents above 4 A. In order to test the compatibility of these systems with DC-DC converters, a plug-in module equivalent to the AMIS2 module but delivering up to 5 A has been developed on the basis of a commercially available device from Linear Technology. This alternative power module is a direct replacement of the AMIS2 module as it is implemented with the same form factor, using the same connector.

These power modules will be located in close proximity of the sensitive detectors; therefore the electromagnetic compatibility with the front-end system is a critical aspect of this development. The board layout and component placement have been optimised to minimize emission of noise. The selected toroidal structure of the coil results in reduced emissions of magnetic field; the addition of a low mass shield brings the ultimate noise confinement for both electric and magnetic field radiated noise. The modules produced at CERN using the AMIS2 and the off-the-shelve device were used to power ATLAS tracker front-end modules at the University of Liverpool and at the University of Geneva. The compatibility has been fully validated through tests with full detector modules. Power modules using the AMIS2 ASIC were also produced at the RWTH Aachen University. Those were used to power the sensitive CMS tracker silicon strip modules validating also their compatibility.

The concepts of modules and front-end systems for the upgrade trackers are now under development and integration of converters on various module options being developed has been successfully carried out. In the case of the ATLAS tracker, a stavelet structure comprising 4 modules and 8 converters that were specially produced to be glued and bonded, is now being produced in the UK. Similarly a supermodule structure with 8 double sided modules is being assembled now at the University of Geneva. The SM01C converter to be used in this assembly has been designed and produced in large quantity. At the RWTH Aachen University, the PIX_V7 converter has been developed for the upgrade of CMS pixel detector that is now under development.

<u>Achievement of objectives.</u> The objectives of task 8.1 have been fully reached. The radiation tolerance of the AMIS2 ASIC from On Semiconductor has been fully qualified, enabling it for integration into front-end systems. Prior to this, the integration of this ASIC into a power module capable of delivering the required voltages and currents while minimizing the conducted and radiated noise emissions has been demonstrated. An optimization method has been worked out and several power modules have been produced for both ATLAS and CMS tracker upgrade programs, all of them resulting in very low levels of emitted noise. The DC-DC converters from the Aachen University are decided to be used in the upgrade of the CMS Pixel Detector. These power converters are now being considered also for the powering of calorimeters in the CMS, LHCb and ATLAS experiments.

<u>Task 8.2: Serial powering</u>

The serial powering concept and the specific custom designed components developed in the previous periods of the project have been used to build and test a full scale super-module, called stavelet. This task has been realised in close cooperation with the ATLAS Inner Detector Upgrade community. The silicon strip detectors assembled in the stavelet are read out by eight hybrids powered serially, each one comprising twenty 128-channel ABCN-25 readout ASICs, resulting in a total number of 160 readout ASICs powered through a single set of cables. This should be compared to the silicon strip detector modules used in the current ATLAS Semiconductor Tracker with twelve readout ASICs powered through an individual set of cables. Thus, more than 10-fold reduction of the cable count for a given number of silicon strips have been achieved in the developed prototype.

The stavelet project has been developed by the ATLAS Inner Detector Upgrade community, which is much wider than the SLHC-PP collaboration. Through a very close collaboration between the SPLC-PP members and other ATLAS Upgrade groups the serial powering concept has been integrated into the stave concept along with all other critical aspects, like sensor design, overall readout scheme, mechanical and thermal design of the stave as a building block of the future silicon strip tracker. The silicon strip detectors are read out by the ABCN-25 ASICs, which include dedicated circuitry for the serial powering. A fast real-time bypass circuit protects against failure of the serially powered chain of hybrids and a slow control system allows to switch off and bypass individual hybrids in the serial chain.

Experimental results confirm that the modules powered serially can be read out without degradation of noise, compared to individual module performance. It has been demonstrated that the stavelet can be operated safely and without impairing performance also in configurations when individual hybrids need to be switched off and bypassed. This demonstrates that switching hybrids on or off is possible with serial powering, addressing main concerns about robustness and safety of the serially powered chain of modules against various possible failure modes. Further stavelets will be constructed and the experience gained will be used to design a prototype of 24-module double-sided stave for the tracker upgrade. The conclusions from this work will remain valid for future designs using new generation of front-end ASICs developed in 130 nm CMOS technology.

The serial powering solution for the pixel detector has been implemented in the full size prototype of the new ATLAS pixel readout ASIC called FE-I4. The FE-I4 features two ShuntLDOs for serial powering schemes. The two power regulators generate both voltages VDD and VDDA at 1.2 and 1.5 V of the chip from a constant current input. Due to their special design which has been tested with two prototype versions they can be used in parallel generating two different output voltages. First 200 mm wafers have been delivered in September 2010 and extensively tested since then. In particular all major blocks of the chip work within expectations and only minor failures have been identified. The ShuntLDO circuits have been using bare chips and bump bonded assemblies. Stable output voltages are achieved up to a load current of 600 mA with an output resistance below 100 mΩ. First tests powering the chip or assembly using the ShuntLDO are ongoing, in particular the influence of the power regulators to the noise figure is studied in detail.

Together with the LBNL Berkeley a pixel stave concept for the outer barrel layers of an upgraded ATLAS pixel detector for HL-LHC has been developed. This low mass design features a low mass power and signal cable integrated into the carbon foam structure of the stave. To reduce the material further the power lines are made of aluminium tab bonded to copper signal traces. Usage of serial powering will reduce the material even further because only four power lines are needed for the entire stave with 32 modules. The module is made of four FE-I4 chips bump bonded to one sensor and eight modules are connected to one serial powering chain. The eight ShuntLDOs of each module are connected in parallel to the serial powering chain generating the needed supply voltages on chip.

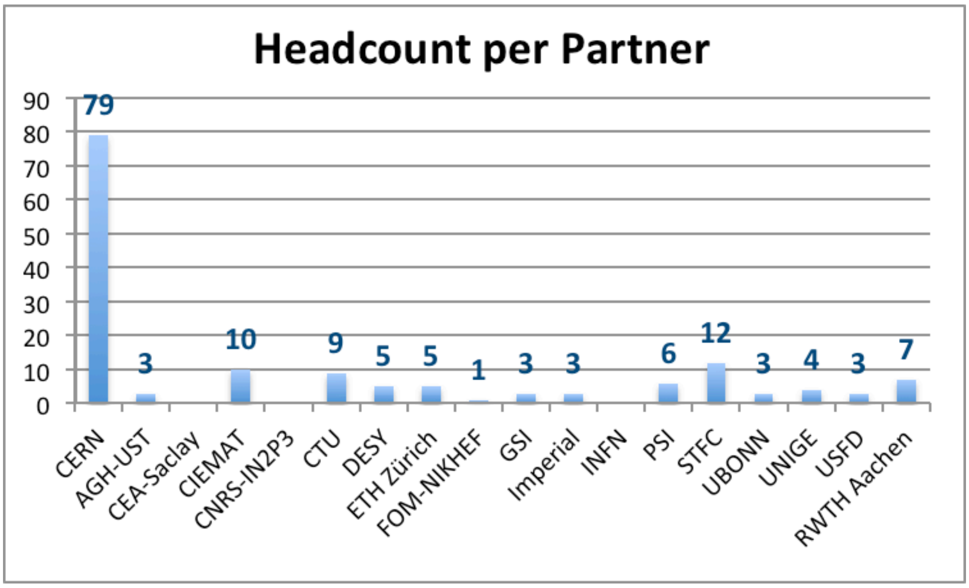
<u>Achievement of objectives</u> The objectives of task 8.2 have been fully reached. The concept of serial powering of silicon strip detector modules has been demonstrated for the prototype stavelet designed and built by the ATLAS Inner Detector Upgrade community, using the custom components developed within the SLHC-PP framework and by other members of the ATLAS Upgrade Community. The extensive testing of the stavelet has provided a solid proof of principle that the serial powering is a feasible and efficient option to be used in the Inner Detector Upgrades. Although a new generation of front-end ASICs in 130 nm technology for the phase2 upgrade of the silicon trackers is under development the experience gained with serial powering of the stavelet based on ABCN-25 front-end chips and the conclusions from this work are fully applicable to future designs. The developed ShuntLDO regulator has been implemented in the pixel readout ASIC FE-I4, which will be used for building ATLAS Insertable B-Layer pixel detector.

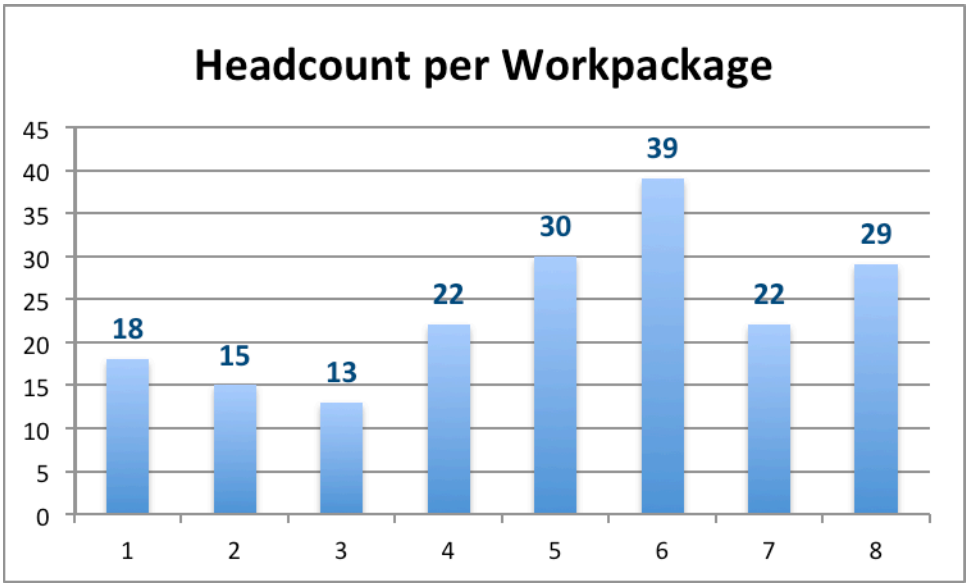
3.2 Overall personnel effort:

A summary table presenting the budgeted resources for the whole project, as they appear in 'Annex I – Description of Work', and the use of resources as declared by each partner for Period 1, 2 and 3 is shown below. The last column shows the percentage of use of resources in the three years of the project versus budget. Overall, the project has been accomplished with 1178 person-months.

Partners needing personnel resources above the nominal, have in no case requested a revision of the nominal personnel usage.

The Project Progress Tracking (PPT) IT tool used by 15 out of the 18 SLHC-PP partners, permitted recording timesheets and personnel statistics for the whole duration of the project. The figures below show the headcount during the 3 years of the project broken down by partner and workpackage. In no case, headcount shown represents the number of full time equivalent working in the project at a given moment.





Beneficiary	Management				Coordination										Support				RTD										TOTAL		% Used
	WP1				WP2			WP3			WP4				WP5				WP6			WP7			WP8						
	P1	P2	P3	Sum	P1	P2	P3	P1	P2	P3	P1	P2	P3	Sum	P1	P2	P3	Sum	P1	P2	P3	P1	P2	P3	P1	P2	P3	Sum	Budget	Actual	%
CERN	17.4	23.5	21.4	62.3	3.3	13.8	15.4	5.0	12.5	17.3	16.6	31.0	24.7	139.5	16.1	45.3	47.9	109.3	23.4	47.4	3.3	24.4	48.0	61.5	20.1	33.4	26.2	287.7	513	599	117%
AGH-UST																									7.4	12.6	16.9	36.9	36	37	103%
CEA-Saclay					0.0	0.0	0.0							0.0					16.2	43.2	8.6	15.8	63.5	19.2				166.5	78	167	213%
CIEMAT					0.0	3.6	2.1							5.7					5.5	4.4	26.0							35.9	34	42	122%
CNRS-IN2P3																			4.1	13.7								17.8	18	18	99%
CTU															11.1	9.0	5.1	25.2											18	25	140%
DESY											1.2	6.1	2.6	9.9								3.0	0.0	0.0				3.0	20	13	65%
ETH Zurich											3.7	5.2	6.2	15.1															15	15	101%
FOM-NIKHEF								6.4	6.0	6.9				19.3															20	19	97%
0 GSI															1.4	4.7	7.6	13.7											16	14	86%
1 Imperial											3.6	6.1	4.9	14.6															9	15	162%
2 INFN																						1.7	5.4	5.4				12.5	7	12	178%
3 PSI															0.1	2.7	13.4	16.2							4.2	0.0	11.6	15.8	32	32	100%
4 STFC					1.0	0.0		6.5	6.0					13.5					2.8	0.8		0.6	0.3		15.0	14.8		34.2	84	48	57%
5 UBONN																									23.1	27.0	27.0	77.0	48	77	161%
5 UNIGE								6.4	8.3	8.2				23.0															10	23	230%
7 USFD															2.9	4.0	2.1	9.0											8	9	112%
3 RWTH achen																									2.3	6.5	5.6	14.4	10	14	144%
TOTAL P-M	17	24	21	**62**	4	17	18	24	33	32	25	48	38	**241**	32	66	76	**173**	52	110	38	45	117	86	72	94	87	**702**	**976**	**1178**	121%

Summary table presenting the budgeted resources for the whole project, as they appear in 'Annex I – Description of Work', and the use of resources as declared for Period 1, Period 2 and Period 3

4. Deliverables and milestones tables

Deliverables (excluding the periodic and final reports)

Reports of all deliverables are available at the url http://cern.ch/SLHC-PP/MILESTONES.htm

TABLE 1. DELIVERABLES[2]

Del. no.	Deliverable name	WP no.	Lead participant	Nature	Dissemination level	Due delivery date from Annex I	Delivered Yes/No	Actual / Forecast delivery date	Comments
1.2.1	SLHC-PP web-site operational (intranet + public pages)	1	CERN	O	Public	M03	Yes	M03	
3.1.1	Project management structure and review office for R&D phase in place	3	CERN	O, R	Public	M06	Yes	M06	
2.2.1	Functioning collaboration communication structure	2	CERN	O	Public	M12	Yes	M12	
2.2.2	Project web site linked to the technical databases: Machine layout database, hardware baseline database, project notes and reports	2	CERN	O	Public	M12	Yes	M12	
4.1.1	Project Structures for construction of systems and sub-systems	4	CERN	O, R	Public	M12	Yes	M13	
4.2.1	Personnel and working practices of the Technical Coordination unit in place	4	CERN	O, R	Public	M12	Yes	M13	

[2] For Security Projects the template for the deliverables list in Annex A1 has to be used.

6.1.1	Basic design of the triplet	6	CERN	R	Public	M12	Yes	M12	
7.1.1	Finite element thermal study of the Linac 4 design source at the final duty factor	7	CERN	R	Public	M12	Yes	M12	
8.1.1	Evaluation report on DC-DC conversion technologies	8	SFTC	R	Public	M12	Yes	M12	
8.2.1	Evaluation report on generic serial powering studies and specification of serial powering components	8	SFTC	R	Public	M12	Yes	M12	
4.2.2	Key structural requirements (information repository, tools, coordination framework, safety and quality systems, integration office) and scheduling and reporting mechanisms in place	4	CERN	O, R	Public	M18	Yes	M19	
7.1.2	Design of a high duty factor plasma generator	7	CERN	R	Public	M18	Yes	M20	
7.2.1	In depth characterisation of the two tuners plus cavities developed in the frame of the “HIPPI” JRA , FP6 (tuner/cavity characteristics)	7	CERN	R	Public	M22	Yes	M35	
3.2.1	Document the technical scope of the upgrade including an initial cost-estimate	3	CERN	R	Public	M24	Yes	M25	
5.1.1	Validation of simulation tools with measurements at LHC	5	CERN	R	Public	M24	Yes	M24	
5.2.1	Estimation of radiation and activation levels for critical areas of sLHC and its injectors	5	CERN	R	Public	M24	Yes	M24	
8.2.2	Custom serial powering circuitry and evaluation of generic high-current serial powering ASIC	8	AGH-UST	R	Public	M24	Yes	M24	

5.1.2	Estimation of radiation and activation levels for critical areas of the experiments at sLHC	5	CERN	R	Public	M26	Yes	M33	
6.3.1	Construction corrector magnet package	6	CERN	P	Public	M26	Yes	M36	
7.2.2	Design of RF system architecture including modeling of RF components, simulation of the RF system and simulation of beam dynamics of the full LINAC; RF system and high power modulator specifications	7	CERN	R	Public	M27	Yes	M36	
2.1 1	Common fund, Financial Management System (software) and user requirements and user guide document	2	CERN	O	Public	M30	Yes	M36	
2.1.2	Quality Assurance plan for the implementation phase	2	CERN	R	Public	M30	Yes	M36	
7.1.3	Construction of the plasma generator and sub-systems (e.g. 2Hz RF generator, hydrogen gas injection and pumping)	7	CERN	D	Public	M30	Yes	M30	
7.2.3	Production of a prototype electronic system and other elements for a full system demonstration; Definition of demonstration procedure	7	CERN	P	Public	M30	Yes	M37	
8.1.2	Prototypes and viability report	8	AGH-UST	P, R	Public	M30	Yes	M30	
3.2.2	Schedule for the upgraded detector parts and for the S-ATLAS installation	3	CERN	R	Public	M32	Yes	M37	
6.2.1	Construction of the model	6	CERN	D	Public	M32	Yes	M36	
6.2.2	Assessment of the design	6	CERN	D	Public	M33	Yes	M36	
2.1.3	Earned Value management system (software) with user	2	CERN	O	Public	M36	Yes	M36	

	requirements and user guide document								
3.1.2	Establish the initial Memorandum of Understanding for the upgrade	3	CERN	R	Public	M36	Yes	M37	
3.1.3	Develop detailed cost books for the upgrade including the installation phase	3	CERN	R	Public	M36	Yes	M37	
3.2.3	Technical documentation, drawing and CAD information for the existing experiment and the upgraded elements	3	CERN	R	Public	M36	Yes	M37	
4.1.2	Cost book and MoU for the upgrade and installation phase	4	CERN	R	Public	M36	Yes	M37	
4.2.3	Pilot design and schedule for the upgrade project published.	4	CERN	R	Public	M36	Yes	M37	
5.3.1	Impact Study (dose rates, environmental impact and waste production from activated material) for SLHC	5	CERN	R	Public	M36	Yes	M36	
6.1.2	Complete Interaction Region design	6	CERN	R	Public	M36	Yes	M36	
6.3.2	Assembly of a 2m long prototype quadrupole	6	CERN1/	D	Public	M36	Yes	M36	
7.1.4	Plasma generation and study of the thermal and vacuum conditions	7	CERN	R	Public	M36	Yes	M36	
7.2.4	Full test and validation of RF system. Final report	7	CERN	D	Public	M36	No	M48	
8.1.3	Integration in full-scale detector modules	8	AGH-UST	D	Public	M36	Yes	M36	
8.2.3	Full-scale super-module with custom serial powering circuitry	8	AGH-UST	D	Public	M36	Yes	M36	

Milestones

Reports of all milestones are available at the url http://cern.ch/SLHC-PP/MILESTONES.htm

TABLE 2. MILESTONES

Milestone no.	Milestone name	Due achievement date from Annex I	Achieved Yes/No	Actual / Forecast achievement date	Comments
6.6	Electrical test of collared coil	M28	No	M43	The electrical tests of the first production coils have successfully been completed. They yield the reference for identical tests at the collared coils, once they will become available (Autumn of 2011).
6.7	Cold test of corrector magnet	M28	No	M43	Although the Milestone on the coldtest of the corrector magnet package has not been reached to date, CERN and its partners (CIEMAT, and STFC/Ral) are fully committed to complete the tasks defined within WP6 of SLHC-PP by the end of 2011.
1.4	Third Annual Meeting and Final Project Review	M36	Yes	M36	

5. Project management

During the third year of the SLHC-PP project, the project management has had an important focus on internal actions to follow up the status of milestones and deliverables. This work was consolidated during the third and last annual project meeting, held in Saclay (FR), where the focus was on project closing.

The management team has been in charge of the following concrete actions:

- Organizing the work related to the SLHC-PP Second Periodic Report and timely submission of the report to the Commission. This includes communication with the Commission and partners to solve any further clarification requested.
- Organizing the work for the Third and Final Reports, being responsible of the final editing and collection of project statistics. For the final report, the management put special emphasis on outreach and dissemination of the project objectives and achievements, also involving the project key players.
- Administration of the community financial contribution regarding its allocation between beneficiaries and activities, keeping partners informed of the status at all times.
- Keeping the records of the Community financial contribution paid to each beneficiary.
- Maintaining the Consortium Agreement.
- Monitoring of the compliance of the beneficiaries with their obligations under the Grant Agreement, by monitoring and informing of expenditure of resources and work progress. In this respect, several Steering and Governing board meetings were held along the year.
- Reviewing the deliverables and milestones reports to verify consistency with the project tasks before transmitting them to the Commission. Reports have been made public on the SLHC-PP web pages: http://cern.ch/SLHC-PP/MILESTONES.htm.
- Co-Organizing together with CEA-Saclay the Third SLHC-PP Annual Meeting at CEA (Gif-sur-Yvette, France, France) on the 7-8 February 2011. The third Annual Meeting was attended by about 50 members of the project and assembled all participating institutes to discuss the results obtained during the 3 years of the project, the plans for its completion, and ideas for the future of the LHC upgrade. The workshop was in addition open to everyone interested in the international R&D effort towards the LHC luminosity upgrade. The meeting comprised parallel sessions devoted to the work within the individual work packages, as well as plenary sessions where the overall program of work was presented. A closed management meeting of the Governing Board also took place. The meeting organization and content can be found at http://indico.cern.ch/event/116438.
- Organizing and hosting the 3rd SLHC-PP Public event at CERN. A series of presentations discussed the current status and physics highlights of the major LHC experiments, followed by comprehensive talks on the future upgrades for the LHC machine and the ATLAS and CMS experiments and the impact of the SLHC-PP project on these plans. The event poster and slides can be found at: http://indico.cern.ch/event/117411.
- Guaranteeing the long-term storage of all SLHC-PP documentation based on the Engineering and Data Management System of CERN (EDMS). The following url is the entry point to the system: https://edms.cern.ch/nav/CERN-0000072367. EDMS ensures that documentation for the project is safeguarded, organized, verified and remains retrievable on a long-term basis.
- Maintaining and updating the project web site. The SLHC-PP the site is divided in 3 major sub-units: the project pages (http://cern.ch/SLHC-PP), the password-protected internal pages (https://cern.ch/SLHC-PP/Internal) and a set of pages targeting the general public (http://cern.ch/slhcpp/).
- Administrating and maintaining the Project Progress Tracking (PPT) IT tool, that keeps record of timesheets for most SLHC-PP beneficiaries. The tool permits to monitor reported hours on a monthly basis and it is used to monitor work progress.

Co-ordination activities:

WP1: SLHC-PP project management
Status and plans of the SLHC-PP were presented and discussed at the 2010 annual meeting of EuCARD [http://indico.cern.ch/conferenceDisplay.py?confId=73614]. In a period of change of the LHC plans, the SLHC-PP public events in 2010 and 2011 were essential for transmitting up-to-date information to a large audience. During the third public event on 8 March 2011, the new projects in charge of upgrading the LHC ("HL-LHC") and its injectors ("LIU") were presented, together with the up-to-date plans for the upgrade of the ATLAS and CMS experiments; the relevance of the work accomplished during the SLHC-PP was in every case outlined. More generally, the presentation of the work accomplished within the SLHC-PP in international conferences (e.g. LINAC'10), workshops and collaboration meetings (e.g. SPL collaboration meetings) has been systematically encouraged in view of strengthening the existing links world-wide and possibly extending them.

WP2: Coordination for the sLHC accelerator implementation
Within CERN, WP2 acts as a mediator between the accelerator sector, the experimental sector and activities in the Finance and Purchasing department, concerning resource planning, project follow-up and quality assurance. This function was highlighted by the implication in the Quality Assurance Working Group, which reviewed the CERN purchasing process. The procedures, which are also applicable for scientific and technical collaborations at CERN, were streamlined and a common approach to the editing of purchasing documents is assured across CERN.

WP3: Coordination for the ATLAS upgrade implementation
In ATLAS there are meetings on average every 6-8 weeks to coordinate the upgrade activities for the collaboration. These meetings involve all main responsible for upgrade of various part of the ATLAS detector and the Upgrade Management. The bi-yearly Upgrade Weeks involved the entire community and are planned to address key issues in the project development. There are regular reports to the ATLAS collaboration board about major developments in the Upgrade project.

WP4: Coordination for the CMS2 experiment implementation
In WP4 there are monthly meetings to coordinate the upgrade activities for the collaboration. These meetings are attended by the leaders of the upgrade activities for each CMS sub-detector. In addition there are two annual meetings for setting the overall strategy, and reviewing the goals for the upgrade activities. The upgrade project manager reports monthly to the CMS Management Board, and several times a year to the CMS Collaboration Board which acts as the institute board for the upgrade project.

WP5: Radiation protection and safety issues for accelerator and experiments
WP5 brings together Radiation protection specialists from 3 leading European accelerator laboratories - CERN, PSI and GSI - and serves as a forum for professional exchange in the domain of radiation protection for future accelerators. The work program has been completed with studies of radioactive waste generated during the upgrade of environmental impact of the sLHC injector PS. Many of the findings are applicable not only at CERN's future projects but at other European high-energy accelerators, for example the European Spallation Source. At a workshop in Lund (SE), the preliminary design of beam dumps for SPL and PS2 was presented and discussed with ESS specialists.

WP6: Development of Nb-Ti quadrupole magnet prototype
The activities within workpackage 6 must be coordinated among the international partners (CEA, Siemat, STFC/RAL) and comprises a core team of engineers from four different sections in the Technology and Engineering departments at CERN. Regular coordination meetings are held at CERN on Wednesday mornings to discuss the design and construction work. Irregular meetings are added for the coordination of component and tooling supplies and their in-house manufacture.

Regular bilateral meetings are attended by the project engineers of CERN and its international partners.

WP7: Development of critical components for the injectors
For the plasma generator task (7.1) CERN provides the majority of the effort, designing and producing all the equipment assembled for the study of the plasma generator. STFC have assisted in the measurements at the test stand in CERN, being present for two extended periods. Not only was their experience valuable, and they made rapid simulations of the electric field distribution from the RF antenna in order to find high fields that would cause the ignition of sparks (allowing immediate improvements to be made).
The measurements of the RF cavity characteristics (in task 7.2) were made at CEA Saclay, using their horizontal cryostat, 704MHz RF cavity with RF coupler and tuner. The low level RF system was provided by CERN (highly modified from the LHC design) and transported to CEA for the measurements. INFN provided comparative data for the warm tuning of their RF cavity design before moving it to CEA for testing, leading to a joint paper at the Linear Accelerator Conference in 2010.

WP8: Tracking detector power distribution
WP8 has played a central role in organizing the activity related to building final demonstrators for the two power distribution technologies being developed. WP8 has delivered critical custom designed components for the DC-DC and the serial powering scheme while the demonstrators, silicon strip detector modules equipped with DC-DC converters and the serially powered silicon strip detector super module, have been built by much larger groups from the ATLAS and CMS collaborations. All WP8 partners are members either of the ATLAS or the CMS collaboration and they ensure efficient communication of the WP8 technical results to the communities working on development of the tracking detectors. Platforms for communication between WP8 and the experiments are: ATLAS and CMS Upgrade Week meetings, in which members of WP8 report the results, meetings of the Power Working Group organized by CERN with strong contributions from WP8, and frequent meetings of smaller working groups. The WP8 members have been also very active in organizing the Power Working Group meeting associated with the TWEPP 2010 conference in Aachen

Deviations of planned milestones and deliverables:

During the third and last year of the SLHC-PP project (April 2009 till March 201), two technical activities could not achieve the foreseen objectives. In both cases the amount of work has been initially underestimated, but continuation is part of the plan of CERN and its partners, on their own resources:
- in the case of task 2 in WP7 (Stabilisation of field in pulsed superconducting cavities), the new electronic card required for the system test is still in construction, although its design is finished (deliverable 7.2.3). The system test in Saclay could therefore not yet take place. This work will in any case continue because of its importance for CERN and the ESS project, and the complete test is now planned to be completed within a year (as explained in deliverable 7.2.4).
- in the case of WP6 (Development of Nb-Ti quadrupole magnet prototype), the change of assembly technique from vertical to horizontal has resulted in the need for new tooling and numerous intermediate steps of testing which were not initially foreseen. All the tooling (especially the collaring press) and components necessary for building the 2 m long quadrupole prototypes have been procured, but more measurements and tests are required before the assembly will take place (e.g. with the instrumented collar packs which are presently being assembled). As a result, milestones 6.6 and 6.7 have not been met. It has however been confirmed that the future inner triplets will extensively exploit the outcome of this development to minimize the use of magnets using Nb-Sn which are more delicate to design and more costly. The continuation of the work started within WP6 is therefore a clear commitment of CERN and its partners on their own resources.

Documents have been issued for all deliverables and milestones, with proper explanations in the few cases where the objectives have not been met.

List of project meetings, dates and venues:

Project Meeting	Date	Location
Internal Meetings		
SLHC, the High-Luminosity Upgrade (public meeting)	23/06/2010	CERN, Geneva
SLHC-PP Steering Meeting	5/10/2010	CERN, Geneva
SLHC-PP Annual Meeting	7-8/02/2011	CEA Saclay, France
SLHC-PP Governing Board Meeting	7/02/2011	CEA Saclay, France
SLHC, the High-Luminosity Upgrade (public meeting)	7/03/2011	CERN, Geneva
SPL Plasma Generator Engineering Meetings	Bi weekly	CERN, Geneva
WP-6 coordination meeting	Weekly	CERN, Geneva
CERN Source Physics Meetings	Monthly	CERN, Geneva
Other meetings organized with SLHC-PP participation		
Coil winding at CEA	6-8/04/2010	CEA, Saclay, France
ATLAS Upgrade Week	19-24/04/2010	DESY, Germany
Procurement of E-mod tooling	28-29/04/2010	Galbiatti, Italy
CMS Tracker Upgrade Power Working Group Meeting	16/06/2010	CERN, Geneva
ATLAS IBL General Meeting	16-18/06/2010	CERN, Geneva
4th SPL Collaboration Meeting jointly with ESS	30/06-2/07/2010	Lund, Sweden
Production readiness review at Woodings	24-25/08/2010	Hythe, England
ATLAS-CMS Power Working Group Meeting	21/09/2010	RWTH Aachen University, Germany
3. Detector Workshop of the Helmholtz Alliance	4/10/2010	University of Heidelberg, Germany
CMS Tracker Upgrade Power Working Group Meeting	14/10/2010	CERN, Geneva
ATLAS IBL General Meeting	27-29/10/2010	CERN, Geneva
ATLAS Upgrade Week	8-11/11/2010	CERN, Geneva
Fifth SPL Collaboration meeting	25-26/11/2010	CERN, Geneva

Production review at Isovolta	24-25/11/2010	Wackersdorf, Germany
Visit to CERN, D. Faircloth, Commissioning	12/2010	CERN, Geneva
Visit to RAL J. Lettry, meeting with D. Faircloth	01/2011	Chilton Didcot UK
Visit to IPP Garching, Visit by J. Lettry and M. Kronberger.	02/2011	Garching, Germany.
Plasma Generation high power tests, Final deliverable report draft. Visit by D. Faircloth	02/2011	CERN, Geneva
Strip Tracker Stave Meeting – Stave 09 meeting	1-2/02/2011	RAL, UK
Coordination meeting STFC/RAL	2/02/2011	STFC/RAL, England
Collaring press commissioning	7-9/02/2011	Cudell, Porto, Portugal
ATLAS IBL General Meeting	16-18/02/2011	CERN, Geneva
CMS Pixel Upgrade Meeting	16/02/2011	CERN, Geneva
CMS Tracker Upgrade Power Working Group Meeting	17/02/2011	CERN, Geneva
ATLAS-CMS Power Working Group Meeting	8/03/2011	CERN, Geneva
ACES 2011 - Common ATLAS CMS Electronics Workshop for SLHC	9-11/03/2011	CERN, Geneva
ATLAS Upgrade Week	28/03-1/04/2011	Oxford, UK

Dissemination Activities:

Dissemination Type	**Reference**
Journal publications (peer reviewed)	*S. Russenschuck, B. Auchmann, J.C. Perez, D. Ramos, P. Fessia, M. Karppinen, G. Kirby, T. Sahner, N. Schwerg: Design Challenges for a Wide-Aperture Insertion Quadrupole Magnet, presented at ASC Washington, excepted for publication in IEEE Transactions on Applied Superconductivity, 2011*
Journal publications (peer reviewed)	*L. Feld, R. Jussen, W. Karpinski, K. Klein, J. Sammet, M. Wlochal, Radiated electromagnetic emissions of DC-DC converters, Journal of Instrumentation, 5 (2010) C12055 doi: 10.1088/1748-0221/5/12/C12055*
Journal publications (peer reviewed)	*M. Bochenek, W. Dabrowski, F. Faccio, S. Michelis, Switched capacitor DC-DC converter ASICs for the upgraded LHC trackers, Journal of Instrumentation, 5 (2010) C12031 doi: 10.1088/1748-0221/5/12/C12031*
Journal publications (peer reviewed)	*L. Gonella , F.Hügging, N.Wermes, Towards minimum material trackers for high energy physics experiments at upgraded luminosities, Nucl. Instr. And Methods A, in press, doi.org/10.1016/j.nima.2010.11.162*
Journal publications (peer reviewed)	*L. Gonella, D. Arutinov, M. Barbero, A. Eyring, F. Hügging, M. Karagounis, H. Krüger, N, Wermes, A serial powering scheme for the ATLAS pixel detector at sLHC, Journal of Instrumentation 5*

	(2010) C12002, doi: 10.1088/1748-0221/5/12/C12002
Journal publications (peer reviewed)	*B. Allongue, G. Blanchot, F. Faccio, C. Fuentes, S. Michelis, S. Orlandi, Low noise DC to DC converters for the sLHC experiments, Journal of Instrumentation 5 (2010) C11011, doi: 10.1088/1748-0221/5/11/C11011*
Journal publications (peer reviewed)	*K. Klein, L. Feld R, Jussen, W. Karpinski, J, Merz. J Sammet , DC-DC conversion powering schemes for the CMS tracker at Super-LHC, Journal of Instrumentation 5 (2010) C07009, doi: 10.1088/1748-0221/5/07/C07009*
Journal publications (peer reviewed)	*L. Feld, R, Jussen, W. Karpinski, K. Klein, J. Sammet, DC-DC buck converters for the CMS Tracker upgrade at SLHC, Journal of Instrumentation 6 (2011) 6 C01020, doi: 10.1088/1748-0221/6/01/C01020*
Journal publications (peer reviewed)	*J. Matheson, Progress and advances in Serial Powering of silicon modules for the ATLAS Tracker Upgrade, Journal of Instrumentation 6 (2011) C01019 doi: 10.1088/1748-0221/6/01/C01019*
Journal publications (peer reviewed)	*D. Lynn, J. Kierstead, P. Kuczewski, M. Weber, C. Musso, J. Matheson, P. Phillips, G. Villani, Serial power protection for ATLAS silicon strip staves. Nucl. Instr. and Meth. A633 (2011), 51-60*
Journal publications (peer reviewed)	*F. Faccio, B. Allongue, G. Blanchot, C. Fuentes, S. Michelis, S. Orlandi, R. Sorge, TID and Displacement Damage Effects in Vertical and Lateral Power MOSFETs for Integrated DC-DC Converter, IEEE Trans. on Nucl. Sci. 57 (2010) 1790- 1797, doi: 10.1109/TNS.2010.2049584*
Journal publications (peer reviewed)	*F. Faccio, S. Michelis, S. Orlandi, G. Blanchot, C. Fuentes, S. Saggini F. Ongaro, Development of custom radiation-tolerant DCDC converter ASICs, Journal of Instrumentation 5 (2010) C11016, doi: 10.1088/1748-0221/5/11/C11016*
Int. Conference/Workshop presentation/poster	*R. Garoby, Overall status of SLHC-PP, SLHC-PP 3rd Annual Meeting, 7 February 2011*
Int. Conference/Workshop presentation/poster	*R. Garoby, SLHC-PP public event in 2011 and Conclusions, SLHC-PP 3rd Annual Meeting, 7 February 2011*
Int. Conference/Workshop presentation/poster	*R. Garoby, Present status and plans of the SPL R&D, Fifth SPL Collaboration meeting, 25 November 2010*
Int. Conference/Workshop presentation/poster	*R. Garoby, Welcome and Introduction, SLHC the High-Luminosity Upgrade public meeting, 23 June 2010*
Int. Conference/Workshop presentation/poster	*Thomas Otto, Coordination for the SLHC accelerator implementation, SLHC_PP Annual Meeting, February 2011*
Int. Conference/Workshop presentation/poster	*S. Russenschuck: Hardware Challenges and Limitations for the IR Upgrade, Proceedings of the Chamonix 2010 workshop on LHC Performance*
Int. Conference/Workshop presentation/poster	*J. Lettry et al, Measurement of optical emission from the hydrogen plasma of the Linac4 ion source and the SPL plasma generator , 2nd International Symposium on Negative Ions, Beams and Sources, November 2010, Takayama, Japan. To be published in AIP Conference Proceedings.*
Int. Conference/Workshop presentation/poster	*M. Kronberger et al, Magnetic Cusp Configuration of the SPL Plasma Generator , 2nd International Symposium on Negative Ions, Beams and Sources, November 2010, Takayama, Japan. To be published in AIP Conference Proceedings.*
Int. Conference/Workshop presentation/poster	*M. Paoluzzi et al, CERN Linac4 H- Source and SPL Plasma Generator RF Systems, RF Power Coupling and Impedance*

	Measurements, 2nd International Symposium on Negative Ions, Beams and Sources, November 2010, Takayama, Japan. To be published in AIP Conference Proceedings.
Int. Conference/Workshop presentation/poster	*W. Hofle et al, Testing of Super Conducting Low-Beta 704 MHz Cavities at 50 Hz Pulse Repetition Rate in view of SPL - First Results, 25th Linear Accelerator Conference, September 2010, Tsukuba, Japan.*
Int. Conference/Workshop presentation/poster	*M. Kronberger et al, SPL Source R&D, 5th SPL Collbaoration Meeting, CERN, Geneva, Switterland, November 2010.*
Int. Conference/Workshop presentation/poster	*W. Hofle and M Hernandez-Flano, RF Layout, LLRF and simulation results, 5th SPL Collbaoration Meeting, CERN, Geneva, Switterland, November 2010.*
Int. Conference/Workshop presentation/poster	*F. Faccio, S. Michelis, S. Orlandi, G. Blanchot, C. Fuentes, S. Saggini F. Ongaro, Development of custom radiation-tolerant DCDC converter ASICs, Topical Workshop on Electronics for Particle Physics Aachen, Germany, September 20-24, 2010*
Int. Conference/Workshop presentation/poster	*J. Matheson, Progress and advances in Serial Powering of silicon modules for the ATLAS Tracker Upgrade, Topical Workshop on Electronics for Particle Physics Aachen, Germany, September 20-24, 2010*
Int. Conference/Workshop presentation/poster	*L. Feld, R, Jussen, W. Karpinski, K. Klein, J. Sammet, DC-DC buck converters for the CMS Tracker upgrade at SLHC, Topical Workshop on Electronics for Particle Physics Aachen, Germany, September 20-24, 2010*
Int. Conference/Workshop presentation/poster	*K. Klein, L. Feld R, Jussen, W. Karpinski, J, Merz. J Sammet , DC-DC conversion powering schemes for the CMS tracker at Super-LHC, Topical Workshop on Electronics for Particle Physics Aachen, Germany, September 20-24, 2010*
Int. Conference/Workshop presentation/poster	*B. Allongue, G. Blanchot, F. Faccio, C. Fuentes, S. Michelis, S. Orlandi, Low noise DC to DC converters for the sLHC experiments, Topical Workshop on Electronics for Particle Physics Aachen, Germany, September 20-24, 2010*
Int. Conference/Workshop presentation/poster	*L. Gonella, Towards low material trackers for high energy physics experiments at upgraded luminosity, Pixel 2010, Grindelwald 09/09/2010*
Int. Conference/Workshop presentation/poster	*L. Gonella, D. Arutinov, M. Barbero, A. Eyring, F. Hügging, M. Karagounis, H. Krüger, N, Wermes, A serial powering scheme for the ATLAS pixel detector at sLHC, Topical Workshop on Electronics for Particle Physics Aachen, Germany, September 20-24, 2010*
Int. Conference/Workshop presentation/poster	*L. Feld, R. Jussen, W. Karpinski, K. Klein, J. Sammet, M. Wlochal, Radiated electromagnetic emissions of DC-DC converters, Topical Workshop on Electronics for Particle Physics Aachen, Germany, September 20-24, 2010*
Int. Conference/Workshop presentation/poster	*M. Bochenek, W. Dabrowski, F. Faccio, S. Michelis, Switched capacitor DC-DC converter ASICs for the upgraded LHC trackers, Topical Workshop on Electronics for Particle Physics Aachen, Germany, September 20-24, 2010*
Int. Conference/Workshop presentation/poster	*E. G. Villani, Progress and advances in Serial Powering of silicon modules for the ATLAS Tracker Upgrade, Topical Seminar on Innovative Particle and Radiation Detectors, IPRD10,Siena, Italy,June 7 - 10, 2010*