

The management of large cabling campaigns during the Long Shutdown 1 of LHC



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Cabling and Optical Fibre activities during LS1

The Large Hadron Collider (LHC) at CERN entered into its first 18 month-long shutdown period (Long Shutdown 1, LS1) in February 2013. During this period the entire CERN accelerator complex will undergo major consolidation and upgrade works, preparing the machines for LHC operation at nominal energy (7 TeV/beam). During LS1 one of the most challenging activities is the consolidation and upgrade of the cabling infrastructure (copper and optical fibre cables) serving the CERN data acquisition, networking and control systems. About 1000 km of copper and optical fibre cables will be replaced or newly installed, representing an investment of about 15 MCHF. This implies an extraordinary challenge in terms of project management, including resource and activity planning, work execution and quality control.

Challenges

Reliability of the installations

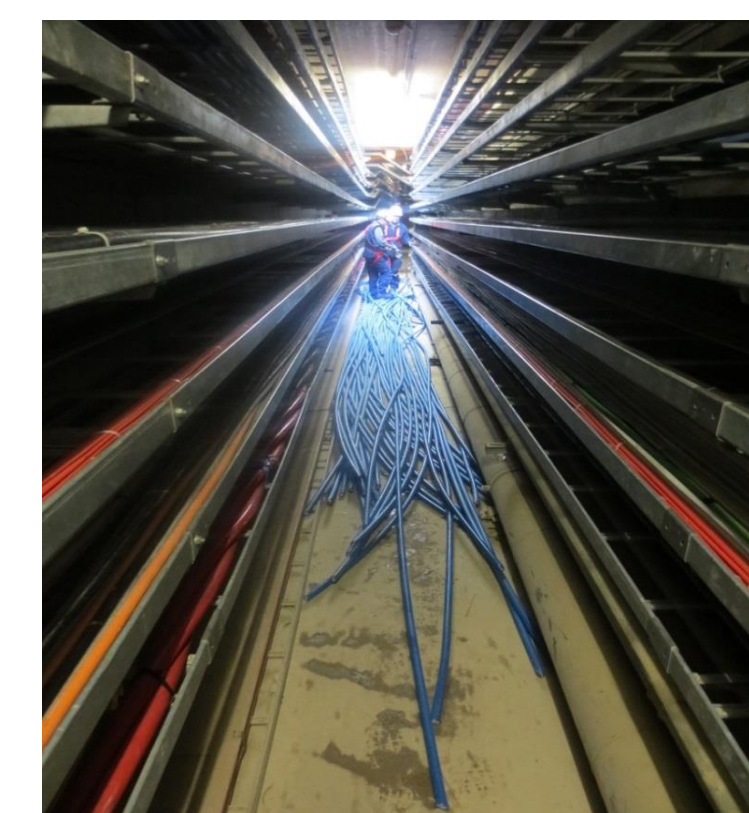
The cabling system (copper and optical) plays a vital role in the operation of the whole CERN accelerator complex. The LS1 represents a unique opportunity to plan for an intense renovation and upgrade of the infrastructures. Massive replacement of irradiated and aged cables and fibres is organized as well as the extension of the existing installations.

Coordination of large cabling campaigns

The exceptionally large cabling activity (37 large projects accounting for a workload four times higher than 2011) requires an intensive coordination effort, including the management of external contractors, in order to cope efficiently with the set deadlines. Forecast of the needs, real time monitoring of the on-going activities and fast adaptability to condition changes are the main challenges that the project coordination has to face.

Organization of the field activities

Cabling activities are often performed in a harsh radioactive environments requiring special procedures, training and tooling. Most of the CERN cable trays are overloaded preventing efficient cable removal or installation. In addition, documentation is scarce for those areas where cabling has been operating for many decades. In these conditions the contractors work is complicated requiring more time and execution efforts.



Example of cabling worksite in LHC

Strategy

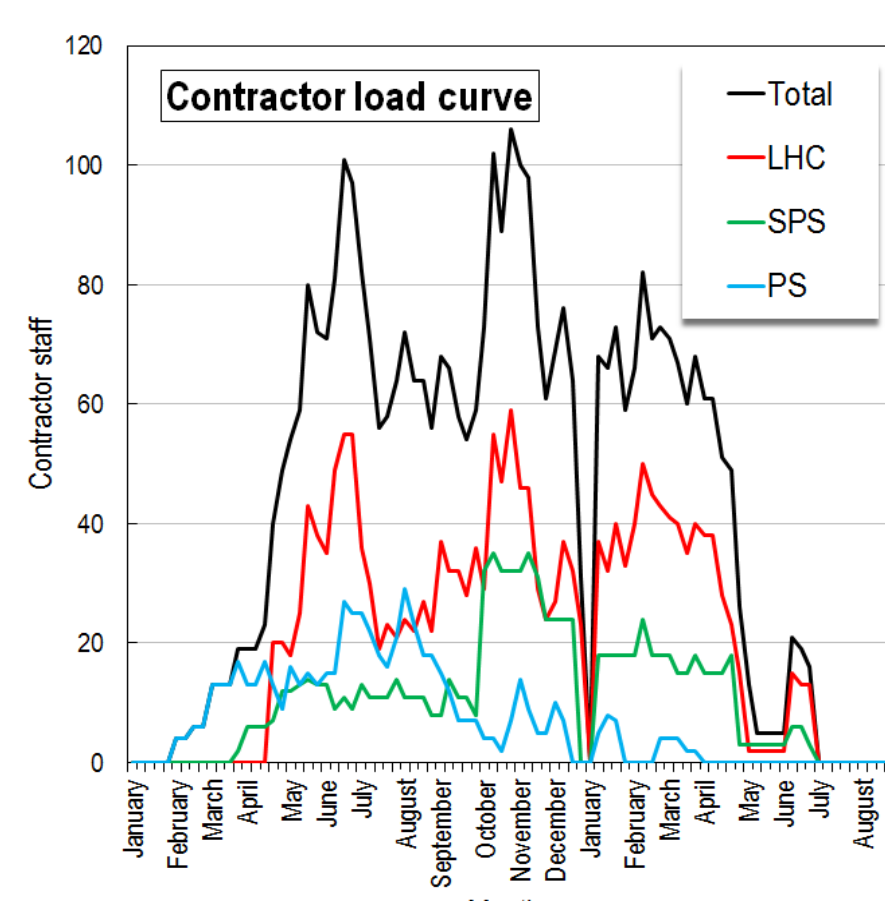
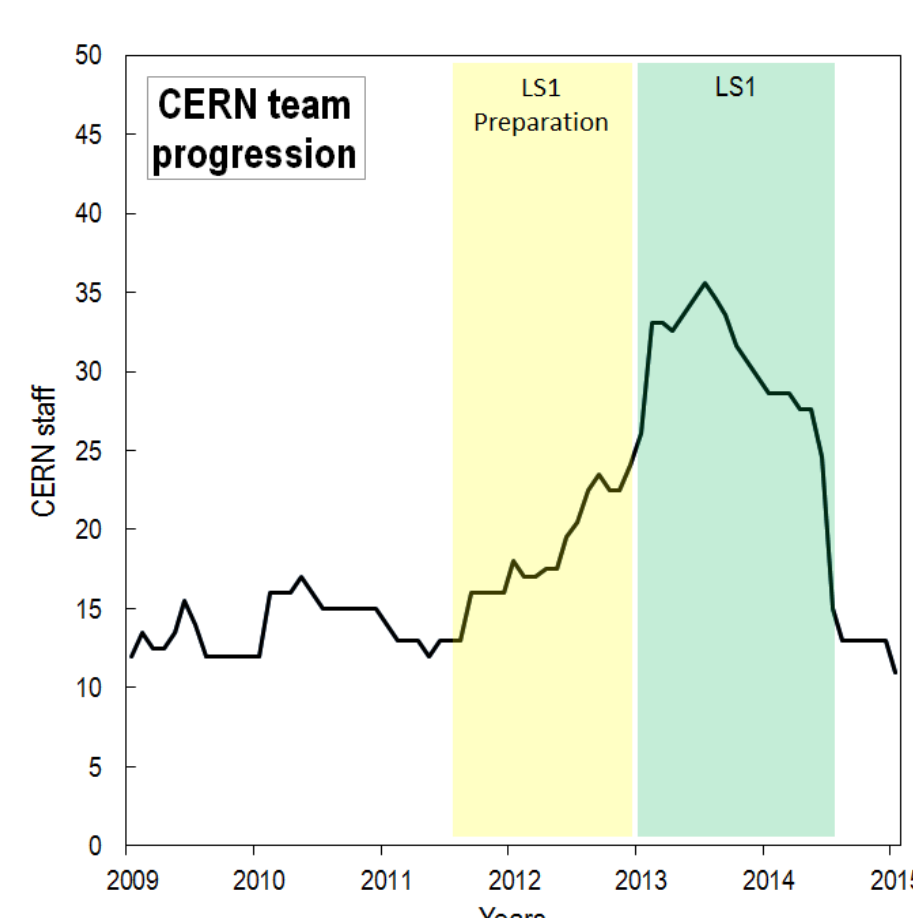
Workforce enhancement

1. CERN team structure

- Progressively doubling the number of project managers and work supervisors by means of new recruits plus internal mobility (over 35 staff on the activity peak).
- Reinforcing the team coordination by introducing new support functions for monitoring the schedule and budget evolution, addressing the safety and contract related aspects and ensuring the overall quality of the activities.

2. External contractors

- Forecast load-curves based on early estimation of project installations.
- Five external contractors have been engaged (four for copper cables and one for optical fibres) for a total of more than 100 staff with a high turnover.

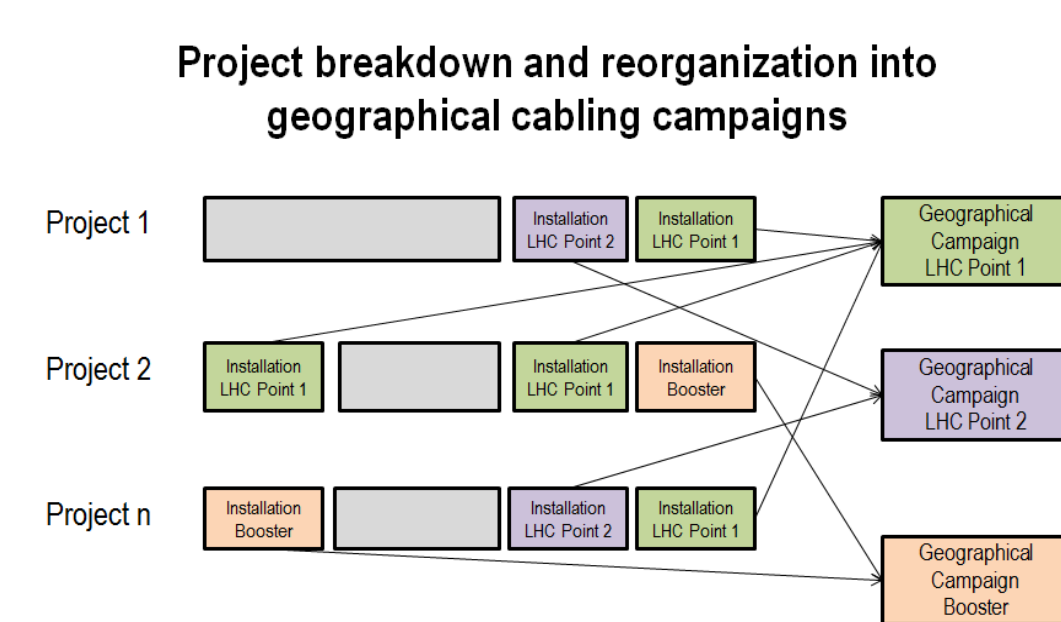
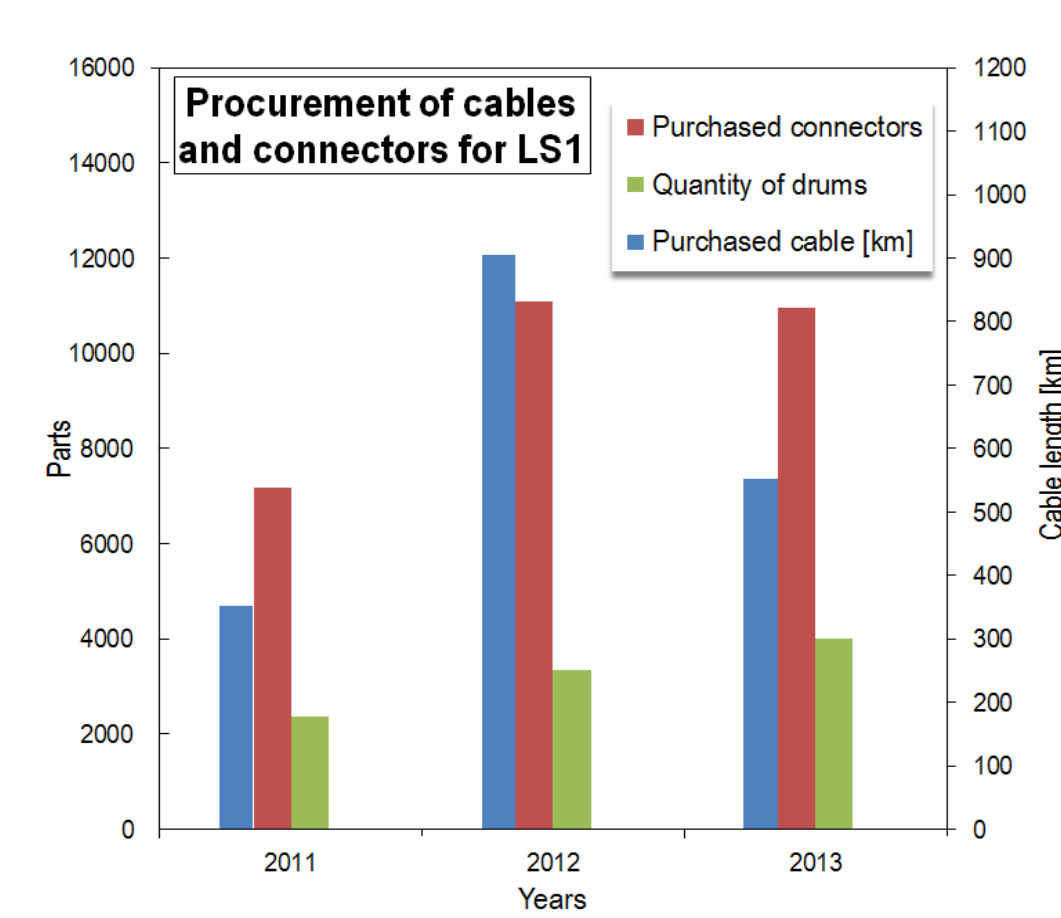


Procurement anticipation

Early processing of the installation requests enabling:

- Award and lead off of new copper cabling and optical fibre contracts.
- Placement in advance of all contract orders for material procurement (104 contracts and 635 orders since July 2011).

Managing of a very large storage (roughly 4000 cable drums plus connectors and installation tools), including logistics for ensuring the stock availability and delivery of the material to the worksites.



Work optimization

1. Preparation and procedures

CERN strict rules in terms of safety and quality standards require accurate preparation of the cabling activities. Working in high radioactive environments implies, for example, a very precise estimation of the radiation doses absorbed by the workers and the development of specific work procedures aiming at keeping As Low As Possible Achievable (ALARA principle) the dose absorption.

2. Training and tests

More than 12 training courses (mainly focused on connector fitting) were organized for preparing the contractors to the LS1. The overall working method and contractor reliability were tested during two large pilot projects (LINAC4 and PSS) during 2012. Additional test sessions were organized to evaluate the realistic time for basic operations in order to minimize the dose absorption.

Planning agility

All cabling activities must fit in the LS1 planning, aiming at maximizing the parallelism and smoothing the contractor load-curves. Accelerator priorities and access constraints must be taken into account. With agile planning management, activities can be anticipated when new access slots become available, which allows reducing the workload peaks.

Geographical campaigns

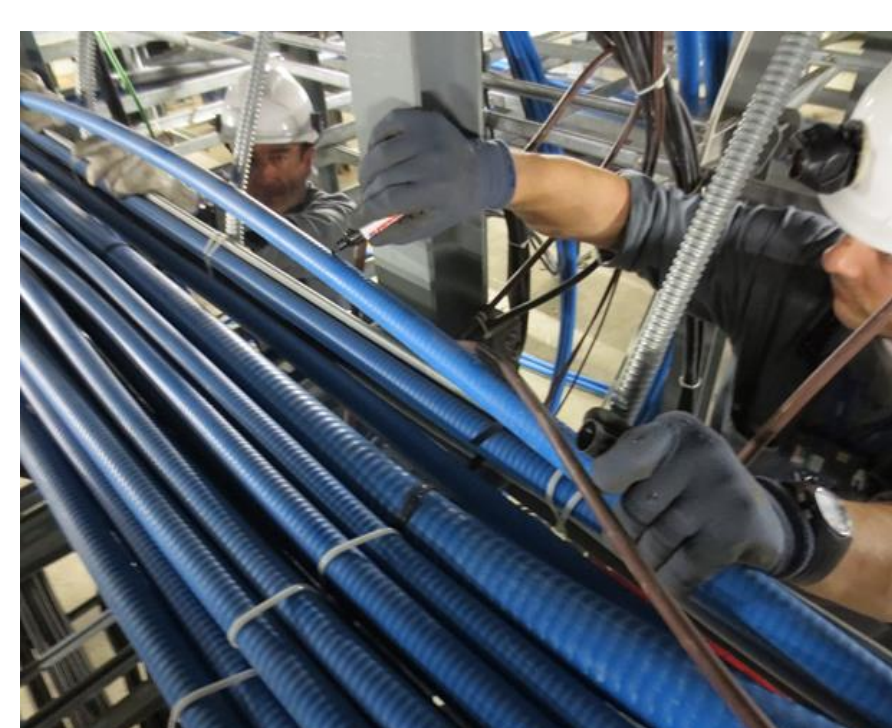
Activities sharing the same working areas are grouped by "geographical campaigns" and fitted into the same planning slot. This allows optimizing the resource distribution and the installation time over the entire CERN site. The project breakdown and re-organization into geographical activities is managed with the aid of dedicated cabling databases.

Execution

Installation and quality control

Copper cabling installations are typically constituted by: mechanical works (installation of cable trays and racks), old cable removal, laying of new cables, connector fitting and testing. The same for optical fibre installations, the difference being that optical cables are instead "blown" into pre-installed ducts by means of compressed air.

Roughly 10.000 copper cables (20.000 connectors) and 500 multi-fibre optical cables (9.000 optical connectors) are to be installed and tested during LS1. CERN staff daily supervises the worksites and the installation progress. A final validation is scheduled at the end of each installation to guarantee the respect of the technical specifications. Re-works can be decided in case of identified non-conformities.



Copper cabling installation



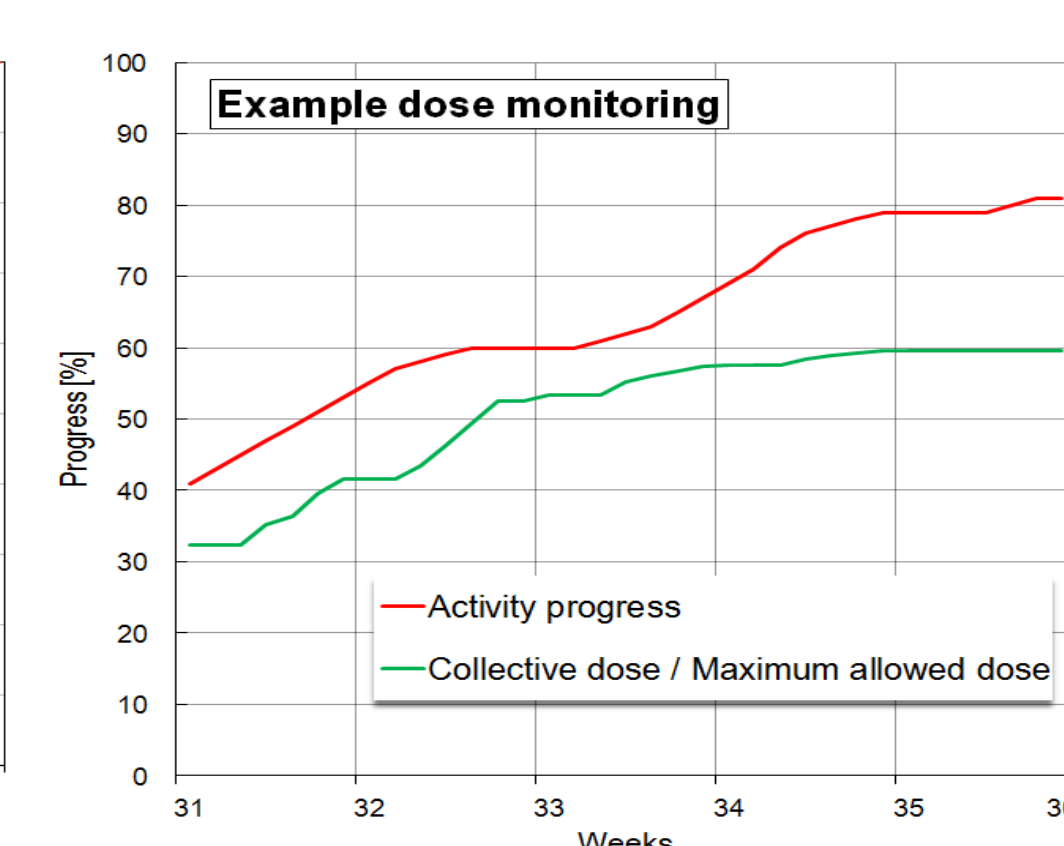
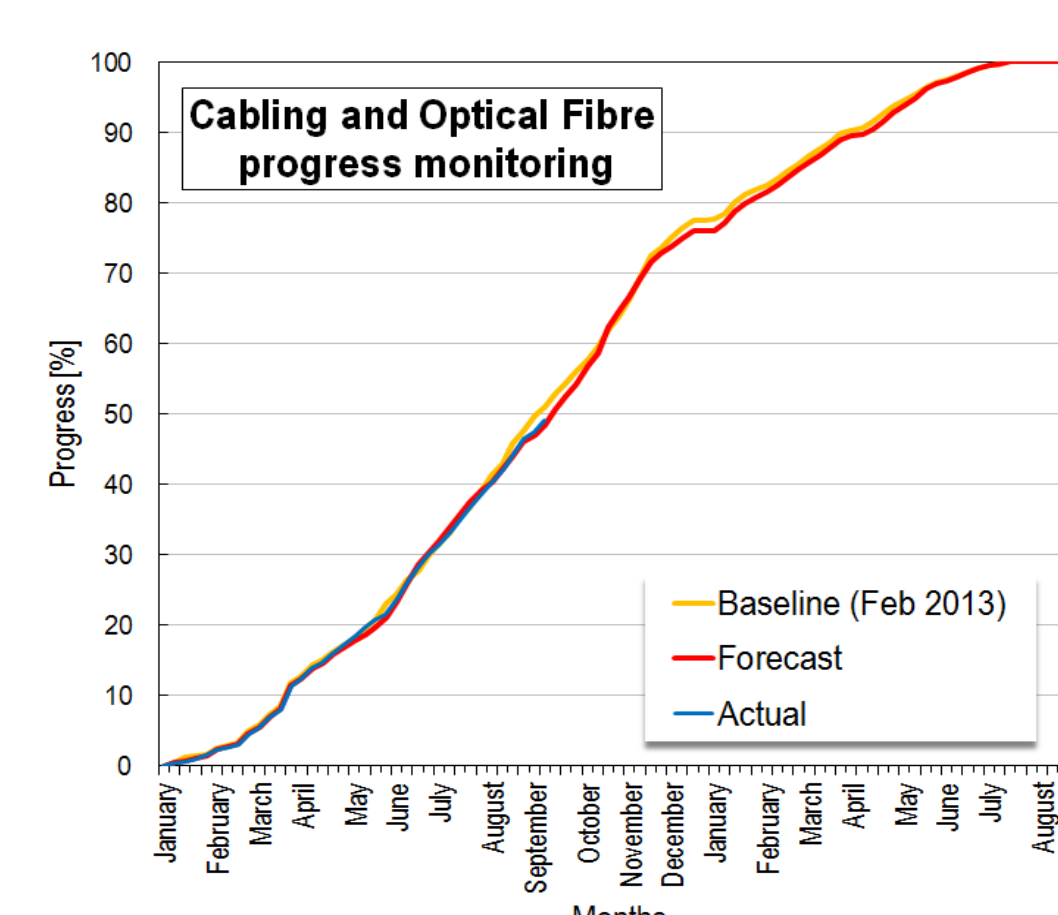
Optical cabling installation

Activity monitoring and follow up

Planning deviations may provoke unrecoverable delays and domino effects compromising the respect of the deadlines.

An automatized tool that monitors weekly the activity progress was developed. It displays the evolution of the installations in comparison with the baseline and forecast curves.

A monitoring for the collective radioactive dose absorbed by the personnel is also used to alert in case of higher dose than expected. Schedule issues are addressed in weekly meetings organized with contractors and accelerator planning coordinators.



Contingency measures

Contingency measures were put in place to cope with unexpected problems:

- An extra contractor compensating for activity delays and lack of manpower.
- Work in 2 shifts for solving unforeseen coactivity conflicts.
- CERN staff with interchangeable expertise to compensate for the temporary loss of internal resources.

Conclusions

The management of very large cabling campaigns during LS1 is a challenging activity requiring anticipated strategic actions and massive deployment of resources on-site. The installation working method for copper cables and optical fibres was proven to be solid and reliable over the years. This was enhanced during LS1 by reinforcing the resource and planning coordination and by optimizing the work organization. A tool for monitoring the LS1 activity progress was also developed.

The new methodologies, procedures and tools represent a valuable test-bench for the LS2 when the Cabling and Optical Fibre team will be again heavily involved.



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