NORTH AREA AND EAST AREA CONSOLIDATION

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Abstract

The PS East Area and the SPS North Area are world-wide unique facilities of CERN that provide secondary beams to numerous different experiments every year, doing research covering fundamental particle physics, detector prototype testing for LHC, space experiments and medical applications. They represent a core activity of the laboratory, complementary to the LHC. The size of the installations is large, in terms of km of tunnels, number and diversity of installed equipment, infrastructure needs, comparable to that of the SPS accelerator. The relevant consolidation items identified by the groups as presented in the IEFC sessions are summarised.

INTRODUCTION

CERN has a unique set of high-energy general-purpose experimental areas that can provide a wide spectrum of particle beams from the injector complex for experiments and R&D projects. This paper covers the consolidation program for the PS East Area (EA) and the SPS North Area (NA).

Over the years the East Area has served, in addition to the DIRAC and CLOUD experiments and an ad-hoc irradiation facility, a multitude of test beam users (**Error! Reference source not found.**). Recently the T10 beam line was mostly used by the ALICE collaboration, whereas T9 served many different users: the SPS or LHC experiments, also linear collider community, space experiments, and R&D projects from all over the world.

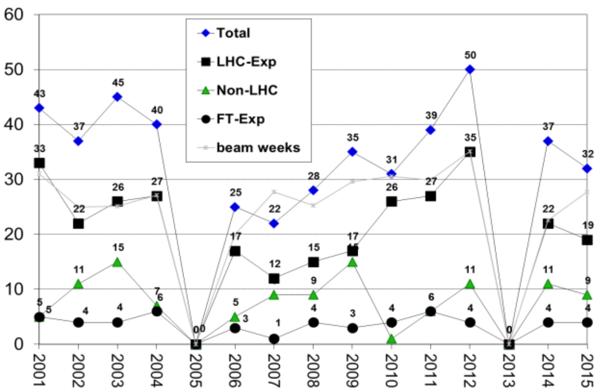

Figure 1: The evolution of the beam time user requests and the available beam time (weeks) in the PS East Area beam line complex over the last 15 years.

The East Area test beams are suitable for users that need beam momenta below the lower limit of the North Area test beams (typically limited to ≧ 10 GeV/c). Some experiments prepare their set-up in the East Area before running in the North Area. Also some users that prefer the North Area beams accept running in the East Area, as the North Area beam lines are increasingly over-booked. Recently users are more willing to come to the East Area since we have added some minimal beam instrumentation (a scintillator and a delay wire chamber) at the end of each beam line.

The SPS North Area has a long history of experiments and R&D tests. With the decline of the big Fixed Targets experiments, the beam lines were and are used for R&D tests of detector components initially for LEP and recently for LHC detectors. The yearly available beam time in the NA beams is nowadays completely booked, and several tests are often scheduled in parallel in a configuration of main and parasitic user mode with several experiments coexisting in the same experimental zone or spread over the several zones in the same beam line (Figure 2). The test beam experiments are typically short-term installations with variable set of beam tunes, while the remaining Fixed Targets experiments operate with continuous data-taking with constant beam conditions and gradual upgrades of their apparatus.

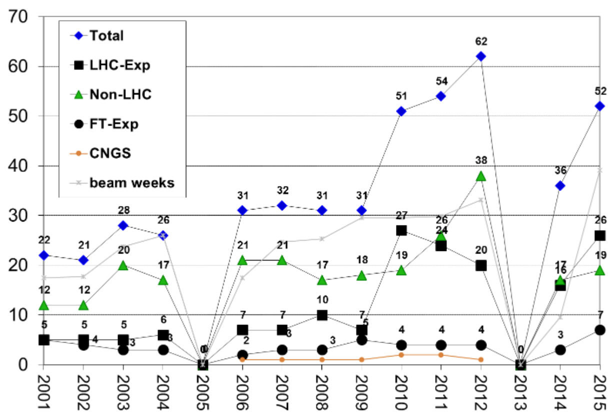

Figure 2: The evolution of the beam time user requests and the available beam time (weeks) in the SPS North Area beam line complex over the last 15 years.

This need for beam time in the Secondary Beam Areas is expected to continue in the forthcoming years, and could even further increase with respect to a possible R&D program for future projects, like FCC or a linear collider. In addition, future projects for new installations and experimental facilities in the North Area premises are being discussed in the scientific community, and/or are in the process of approval, which would substantially change the landscape of the installations.

For those reasons, both the EA and the NA will have to continue operation for many years to come. Whereas the past strategy in the EA was to perform minimum maintenance (in view of replacing the PS with a new ring), the NA benefited from a solid exploitation plan. Beam instrumentation, magnets, power supplies, controls, survey, cooling and ventilation, handling, and many others, the installations were correctly maintained over the years, which prevented major breakdowns and loss of beam time for the experiments. In this framework, the TAX blocks downstream the primary targets in the NA were renovated between 2000 and 2004, as well as the beam instrumentation and regular cable exchange campaigns were performed in the high-radioactive areas of the NA.

However, today the installations also in the NA show their age with an increase of the frequency of failures on major components that are hard to cover in a yearly maintenance scenario. A dedicated effort, e.g. in the framework of the discussed consolidation and with the confirmed availability of personnel resources, is required. In addition, the installed equipment of several systems is now obsolete, making it hard to find replacement parts, and not anymore compliant to today's safety standards and practices.

Therefore to assure the proper operation of both EA and NA beam facilities a consolidation project needs to be established.

RISK ASSESSMENT

The consolidation/renovation activities concern groups in EN, TE, BE and GS Departments as described in a series of presentations in the IEFC Committee and summarized in this paper. The activities are identified in terms of risk and impact to operations and classified accordingly, including a projection of upgrades and needs arising from new projects and usage of the facilities within the knowledge of the authors.

For the risk analysis, the following factors are identified:

- Probability of failure (P, 1-4)
- Impact on CERN scientific objectives (I_o, 1-4)
- Impact on CERN's reputation (I_r, (1-3)
- Financial impact of failure (I_f, (1-5)
- Safety impact in case of failure (I_s, (1-5)

For each activity the combined risk score (R_s) is calculated as the probability of failure (P) multiplied by the maximum of I_f and I_s. As the North Area beam lines have a strong, direct service goal to users, for each activity the combined priority score (P_s) is calculated as P multiplied by the maximum of the I_o and I_r.

Further, the analysis distinguishes between the following scenarios:

- Baseline - including the high priority actions to be carried out immediately to prevent any imminent damage that would lead to harm of personnel or material damage and that would therefore jeopardize near-term operation;
- Preservation scenario - a consolidation plan, compliant with planned operations until 2030, taking into account foreseen LHC and injector maintenance periods and actions and operation phases;
- Value-added scenario - activities, which in addition to the preservation scenario will accommodate new infrastructures or significant upgrades.

Figure 3 summarizes the budget needed with respect to the different scenarios and with respect to timeline, not taking into account the availability of CERN personnel resources, which strongly depends on priority defined by CERN management.

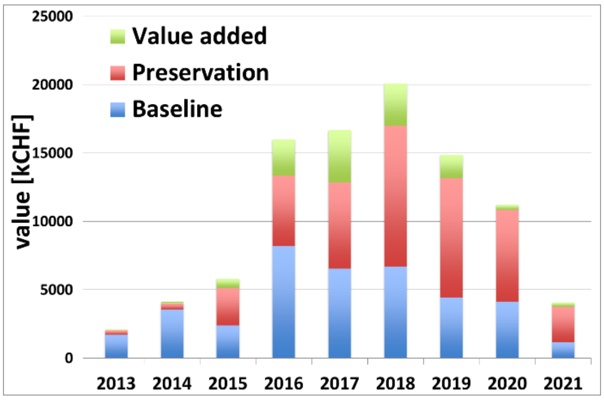

Figure 3: Possible budget for the NA consolidation activities

CONSOLIDATION ITEMS

A Product Breakdown Structure of the consolidation activities for the East and the North Area has been established. A detailed list of the about 200 work units, which have been identified, with their risk assessment has been presented to the consolidation project team ([2-3] for the East Area, [4] for the North Area).

The consolidation of the power converters and magnets is a key item for both areas. Inter-relations of the activities should also be taken into account in the final definition of the Work Packages. For instance, the renovation of the power supplies is strongly related to the ones of the magnets, the electrical network and the cooling system. Furthermore, in the value added scenario a replacement towards energy saving investments could be considered. As an example, as both the East and the North Area are partially equipped with magnets with non-laminated yoke, therefore operated in DC mode, a consolidation of such magnets could cover a change to laminated yokes, where the additional investment costs could be counter-balanced with the reduced operational costs in the coming years. The additional gain of the environmental impact and on CERN's reputation cannot be quantified in terms of money. The spare policy for magnets, especially the ones in the high radiation areas of targets, should be reviewed. A break-down of such a magnet could cause the stoppage from weeks to months of several beam lines at once as spares are not available and an in-situ repair would cause large collective dose even after a dedicated cool-down period.

The renovation plan for the electric power network of the North Area can be split into two main subjects [5]:

- To identify the most worn-out low voltage installations (48V) for which a systematic replacement must be done assuring a reliable and safe network.
- To identify components in the electric pulsed network, that is the power system "upstream" the power converters, which must be replaced for a long term reliability of the system. It contains high and low voltage switchboards as well as transformers; much which dates to installation of the north area. The dimensioning of the new power system depends mainly on the ratings chosen for the new power converters.
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A very urgent item of the consolidation concerned the elements in target switchyard of the NA in TDC2/TCC2. In this area the installed elements are exposed to high radiation levels limiting their lifetime and further the high induced activity constraints maintenance interventions. The central position in operating the North Area makes it indispensable and a break-down of one element could dramatically reduce the operability of larger parts of the North Area complex. Being a high-priority item, the consolidation of this area including the renovation of the target stations, and a refurbishment of the TAX motorizations as well as infrastructure improvements around the splitter region was scheduled and completed during LS1.

For the Civil Engineering of the buildings, the major concern is the state of the roofs for the big experimental halls, in particular for EHN1 that has the highest occupancy of users during beam operation, and of BA81 building that houses a large number of power supplies for the beam lines. This is considered as a baseline must, where the wish for a dedicated users' building with offices etc. is clearly a value-added scenario.

The upgrade of the gas detection system responding to the increased need, also given by the EHN1 extension, is not necessarily a part of the consolidation. However, the consolidation item of replacing PVC cabling is obsolete if the new detection system relies on a bus system.

The alarm system for electrical power, relating input from an AUL or the GS/ASE systems for cutting the power, relies on an outdated PLC system. These PLCs show more and more failures, but spare parts/replacements are no more available from the industrial supplier. With this opportunity all active alarm systems of the general infrastructure in the Secondary Beam Areas were reviewed and a common approach proposed [6]. The today's needs for the safety systems is included in the preservation scenario.

FUTURE PROJECTS AND RELATED IMPROVEMENTS

Not being part of the consolidation program, it is most important tackling any consolidation item in view of on-going or future projects optimizing the long-term perspectives and resources.

In the autumn of 2012 it was decided to stop and dismantle the DIRAC experiment and to install a proton irradiation facility IRRAD and a mixed field facility CHARM [7] in its location. This allowed suppressing the T7 secondary beam and the old irradiation facility. It also relieves significantly the pressure on proton cycles, as the DIRAC cycles no longer needed. However, due to the huge workload involved, the LS1 shutdown had to be almost entirely dedicated to the dismantling of DIRAC and the design and installation of the upgraded irradiation facilities. The work on the primary beam line and test beams had to be postponed to LS2, with all the risks this implies for reliable operation of the test beams and CLOUD.

In the NA within the framework of the CERN Neutrino Platform, the future extension of EHN1 [8] in the North Area will host detector tests for neutrino R&D. The CE works started in January 2015, where the building and the infrastructure will be available for the detector installation from early 2017 onwards, with several large detectors foreseen (WA104, WA105, LBNF/DUNE, NESSiE and others). Due to this extension, the need to consolidate and bring to today's standards the installations in the whole EHN1 building comes as an increased priority.

Also currently reviewed by the SPSC, the SHiP proposal [9] is considered for installation in the SPS North Area. If realized, would also increase the infrastructure needs in the NA and would call for an upgrade in the TT20 beam line installations. Also the close vicinity to existing installations urges considering common infrastructure, where upgrades should be included in the planning phase of the consolidation project.

CONCLUSIONS

A number of equipment failures have marked the recent operation the Secondary Beam Areas, where the equipment dates largely from its initial installation in the 1970's. In the East Area, the magnet system is identified as key consolidation item as there are many different types of magnets. Without spares and with respect to the radiological environment, the repairs are costly in time and in radiation dose to personnel. In the North Area, the consolidation of the power converters is the key item to ease operations, improve the beam quality and avoid maintenance overhead. Today the regular failure of power supplies hampers the daily exploitation of the secondary beam lines. In view of their age the situation is expected to further worsen significantly in the coming years. General infrastructure needs of the large experimental halls require immediate consolidation actions, as well as the electrical network distribution that needs to be upgraded in order to comply with today's safety standards.

This overview shows the consolidation needs for the East and the North Area in total of about 100 MCHF, where high priority items are defined. The consolidation timeline will be discussed in the CERN wide framework evaluating the available personnel resources.

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