KEEPING THE PRESENT LHC INJECTOR COMPLEX RUNNING FOR 25 YEARS

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Abstract

Even if SPL and PS2 go ahead, it is unlikely that they will deliver nominal LHC beams before the early 2020's. This means that the existing LHC Injector chain, SPS, PS & PSB, with LINAC4 replacing LINAC2, will have to continue to run with high reliability for more than 10 more years. This talk will examine what additional actions would need to be taken to ensure that the same Injector chain will continue to run reliably for the next 20-25 years i.e. the lifetime of the LHC.

Introduction

I have summarised information that has been received from CERN equipment groups concerning the consolidation activities that would be necessary to keep the current LHC proton Injector chain (PSB, PS & SPS) running at the current reliability and performance levels for the lifetime of the LHC (i.e. around 25 years). Potential upgrades and improvements in beam intensity/quality are not included. In addition, as LINAC4 will replace LINAC2 around 2015 issues concerning LINAC2 are not addressed.

Vacuum systems

It is estimated that some 50-70% of the vacuum system hardware will need to be systematically replaced for operation until 2025 and the remaining hardware should be replaced for operation until 2035. It will also be advisable to develop new target windows for the NORTH AREA targets. Finally it should be noted that any hardware consolidation campaign in the Injectors will require major vacuum system intervention (including replacing magnets, septa, kickers, RF cavities, scrappers etc…)

RF

At the PSB major work will be needed on the C02, 4 & 16 systems. This includes HV power supplies, cavity tuning systems, interlocks and low-level systems. The total cost is estimated at 12-15MCHf. Similar work is needed at the PS, where the present system of 10MHz RF power tubers will also need complete replacement. At the SPS the consolidation work will have to be coordinated with the upgrade scenarios that are proposed for the SPS [1], [2]

Magnets

The magnet group strongly recommends maintaining a vigorous maintenance plan. Some spares are needed at the PSB, but these are included in the current consolidation programs and will be completed by 2013.

For the PS it is not felt necessary to fully renovate the remaining 50 main magnet units. However, it is proposed to obtain additional spare PS main magnet bus bars and 50 sets of PFW's.

Under these conditions PSB & PS magnets should be able to continue for another 25 years of operation. This is true for PSB operation at 1.4Gev but this statement will have to be re-examined if it is decided to increase the PSB extraction energy from 1.4 to 2.0GeV.

At the SPS there are some concerns with erosion inside the water cooling manifolds due to the high cooling water velocity, and with the mechanical fixing of the pole face shims. Both of these problems will need to be addressed and consolidation actions proposed. 244 of the SPS dipole water cooling manifolds have already been refurbished over the last 3 shutdowns. [3]

Beam Transfer systems

PSB injection systems will be replaced as part of the LIANC4 project. On top of this a list of replacement and additional spare parts requirements has been established. One urgent item is the study for a new PS extraction septum 16 with a thinner blade to reduce the losses at PS extraction of the CT beam for SPS FT and CNGS operation.

Beam Instrumentation

A new fast wire scanner prototype has been developed, which will be ready for deployment from 2014. The new BLM system will be installed at the PSB as part of the LINAC4 project. This system should also be extended to PS and SPS. The PS beam trajectory measurement has recently been replaced and it is planned to replace the SPS system from 2013. Additional hardware such as BCT torroids will need replacing in the coming 5 years.

Electrical Network

There is an existing consolidation plan of some 44MCHf, which targets the most urgent items, However, for a further 25 years of operation the following items should be considered [4]:-

PSB & PS

- Replace all cabling (48 MCHF)
- Replace low voltage switchboards, UPS, safety lighting etc. (14MCHf)
- Renovate HV substations ME16, ME49 & M76 (2MChF)

SPS (not including 18kV loops which are already covered in the existing consolidation program)

- Replace 2 400/18kV transformers (8MCHf)
- Replace SMB 18kV cable network (7MCHf)
- Replace all TGBT switchboards (7MCHf)
- Replace 40/72 18/4kV transformers (2.3MCHf)
- Cable replacement in tunnel (40MCHf)
- Remove unused cables (30MCHf)

The replacement of the SPS SMD cabling is felt to be a most urgent item and should be started as soon as possible

The proposed cable replacement campaigns are also very important in the long run as many installed cables are no longer in use and should be removed to make space for new installations. These campaigns are very labour intensive and therefore very expensive. A careful analysis is needed to decide which cables should be removed. This work also includes the regular replacement of irradiated cables in particular at the SPS LSS2 & 6.

Power Converters

Approximately 50% of the installed converters for the PSB will need to be replaced at a cost of around 7MCHf. The news POPS main PS power supply will replace the old PS motor generator set by 2012. The renovation of the SPS main power converters has started and the main SPS transfer line supplies were recently upgraded. A considerable amount of work will be needed in the North and East areas if these experimental areas will continue long-term operation.

Access & Safety systems

The replacement of the PS Personnel Protection System (PPS) has started, but the current obsolete system will have to be maintained until the new one is fully operational in 2014. It is planned to start replacing the SPS PPS system in 2011. The safety and fire alarms will be maintained as long as is necessary.

Interlocks

Today the PSB and PS do not have beam interlock systems. Studies are starting on the possible deployment of the LHC Beam Interlock Controller (BIC) for the PS as part of the new PPS project. The PSB and PS still have their original hard-wired magnet interlock systems. These could be replaced with the LHC Warm Interlock Controller (WIC) as installed at LEIR. At the SPS the LHC-style BIC is already in operation and the WIC could be used to replace the ageing SPS magnet interlock chain.

Dumps & Collimators

Again the importance of maintenance of safety system items such as beam stoppers etc. is essential. The PS and SPS beam dumps are already under consolidation. The SPS scrapers will be critical for clean injection into the LHC, and their refurbishment is already planned. Other critical items are the PSB beam dump and certain slits which are extremely radio-active and therefore cannot be repaired. In the experimental areas target stations, collimators and other motorised devices also need urgent attention [5]

Cooling & Ventilation

Major consolidation work has started (mainly for the "ex-LEP" LHC installations). Additional items to be considered for a further 25 years of Injector operation include [6]:-

- PS & PSB Ventilation systems. Here there are also radio-protection considerations, which may mean a redesign of the system concept rather than a simple replacement.
- Replacement of PS chilled water circuits, compressed air systems and demineralised water production
- Replacement of certain heat exchangers on the Meyrin cooling stations

Other systems

The Control system renovation project ACCOR has started. Cranes and other handling equipment are covered under the existing consolidation plans. The replacement of the ARCON radiation monitoring system with RAMSES is underway. Studies have been started to examine tunnel and underground infrastructure for the Injector chain

Conclusions

A more detailed analysis of all these points is planned for the IEFC workshop in February 2010 [7], and the following actions are planned:-

- Pull all the information together to make a coherent plan for the coming 15 years.
- Performa risk analysis of the proposed actions and their beneficial effect in order to assign priorities
- The plan should separate LHC Injector backbone, East & North experimental areas & the ion chain. AD Consolidation is not included as this is

approved to 2016 and an extension will be linked to the ELENA project

- Performa risk analysis of the proposed actions and their beneficial effect in order to assign priorities

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[3] The PS Booster, PS and SPS Magnets for the next 25 years. By D Tommasini CERN EDMS Document 1057909

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