CONTROL AND INTERLOCK SYSTEMS FOR THE LIGHT PROTOTYPE


ABSTRACT

The Prototype Interlock Systems (PIS) reduce the risk of harm to the personnel and the machine caused by erroneous situations or conflicting commands (3). The main requirements include [2]:

- Mode independency is required for the interlock systems and for the same operators of different models.
- Uniform interlock interfaces for the compatibility of all devices to the interlock system.
- Fail safe interface design assures the safe state of the connected equipment upon a disconnected wire or a break.
- Manual acknowledgement of the interlocks by an operator is required to reset the interlocks upon a resolved interlock condition.

INTRODUCTION

ADAM S.A. is a CERN spin-off founded in 2007 in Geneva (Switzerland) developing applications of detectors and accelerators to medicine and is a subsidiary of London-based Advanced Oncotherapy PLC. ADAM S.A. is developing the linear accelerator to be used in the Linac for Image Guided Hadron Therapy (LIGHT) project of Advanced Oncotherapy PLC [1].

The control and interlock systems for the LIGHT bunker support conditioning and beam commissioning activities for the accelerator. Additionally, CERN rules and regulations had to be considered during design and implementation. Thus, the needs differ from the final LIGHT system [2]. Nevertheless, the aim was to keep the architecture close to the final layout to reuse hardware and software in the LIGHT system.

ARCHITECTURE

The Prototype Control System (PCS) requirements and influences to the final systems can be summarized as follows:

- Remote monitoring to allow for beam commissioning and interaction through a single interface without the need to enter the bunker.
- Remote archiving of essential monitoring information for further analysis in dedicated standalone expert applications.
- Local control systems for equipment without dedicated control such as vacuum and cooling.
- Standalone test systems to execute 200kHz pulse tests on individual accelerator devices. Operating while changing settings concurrently on different devices at 200kHz is not anticipated.
- No unified interfaces are required as the system is operated by system experts.

The PCS controls the accelerator to generate beam and monitor beam parameters and relies on Siemens/ETM WinCC OA at its core providing the following functionality:

- User Interfaces to the connected equipment
- Integration of equipment for control, monitoring and archiving through existing or custom protocol drivers.
- Archiving of monitored information to a central Oracle database for further processing.
- Reporting of reduced safety related information through a dedicated web server to the CERN Control Centre.

INTEGRATION

Light Access Safety and Access System

The LIGHT Access Safety System (LASS) provides access control and assists in the patrol to make sure that no person is accidentally left in the bunker. It reduces the risk of harm to personnel by interlocking.

- Beam Generation through the proton source
- RF generation/High Voltage through modulator and inductive output tubes.

The RF/HV equipment is connected to the LIGHT-Access PLC which distributes the interlocks and, upon feedback from the devices, generates a sum feedback for the LASS. The source is connected directly to the LASS to have redundancy in case the LIGHT-Access PLC fails.

Machine Protection System

Machine Protection System (MPS) is responsible to reduce the risk to the accelerator equipment of harm caused by erroneous situations.

- Since the personnel protection functionality is a part of the LASS and access system, the MPS is not subject to CERN safety.

CONCLUSION

Most of the initial development of the accelerator sub-systems has been carried out using the LIGHT prototype accelerator installed on the CERN premises and used extensively for commissioning and test activities.

- Software reuse remains a concern, partly due to unique requirements and changing suppliers.
- Hardware reuse looks promising with more than 90% percent reuse anticipated for the LIGHT system.
- No custom electronics development so far for the control systems.
- Early involvement of the control system group essential to minimize prototype specific developments and risks.
- Good learning experience for software and electronics developers new to accelerator control systems.

Current activities include (a) porting to LIGHT test software and hardware stack, (b) development of additional test procedures and (c) standalone commissioning systems.

The control system group started to work on the final LIGHT system in parallel, building upon the knowledge acquired with the prototype accelerator.

REFERENCES


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Figure 2: Prototype Control System layout and connections.

Figure 3: Building layout for the LIGHT Prototype in Geneva, Switzerland.

Figure 4: Custom Driver Integration LASS.

Figure 5: Standalone Beam Diagnostics.

Figure 6: FrontEnd Controller: Cooling System.

Figure 7: Prototype Access System Control Panel and Interlocks.