MEBT and D-Plate Control System Status of the Linear IFMIF Prototype Accelerator (LIPAc)

J. Calvo, D. Jiménez-Rey, E. Molina, J. Mollá and I. Podadera
National Fusion Laboratory, Ciemat. Madrid, Spain.

Introduction

On the way to nuclear fusion there are several milestones, the IFMIF project, a linear accelerator-based neutron source, is a crucial one. The objective of IFMIF is to gain the knowledge in radiation effects materials for the design of a demonstration fusion power plant. For the validation of the IFMIF accelerator facility, LIPAc (Linear IFMIF Prototype Accelerator) is being built, see Fig 1. LIPAc is capable of generating, accelerating and transporting an intense deuteron beam in continuous wave to an energy of 9 MeV with a current of 125mA, developing intense a power of 1.125MW for that given energy. Therefore, due to the spatial charge issues associated with these beam properties, the operational requirements of such magnitudes make a complex control system but fundamental to proper operation of the prototype accelerator

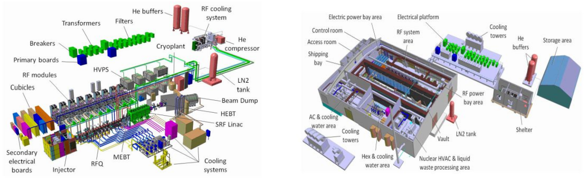

Figure 1. LIPAc accelerator and facility 3D models

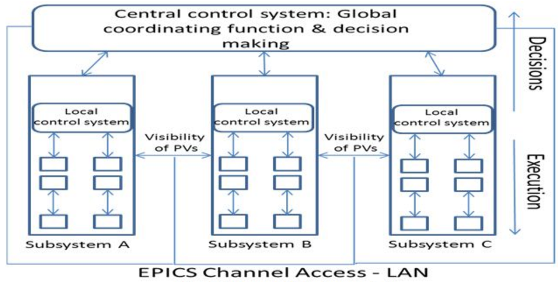

Figure 2. LIPAc general distributed process control

LIPAc Control System

LIPAc control system consists of the remote control, monitoring and data acquisition of all devices, systems, subsystems and operations carried out in the accelerator vault. It uses EPICS as the main set of control software tools. General distributed process control can be seen in Fig. 2.

Main functional requirements of the LIPAc control system are the following:

- Able to remotely monitor and control operations of all the facility.
- Acquisition and archiving of all the data, including control and diagnostic during the operation.
- Protection of the machine components from possible damages.
- Providing the control and monitoring of each subsystem.

Medium Energy Beam Transport (MEBT)

The MEBT subsystem is responsible of the transport and matching of the RFQ beam into the SRF Linac. In order to minimize the beam losses caused by the strong space charge forces affecting the beam in this area, while keeping the sufficient freedom in beam optics optimization, a very compact scheme based in two sets of quadrupole magnets with steerers and two re-buncher cavities has been built, see Fig. 2.

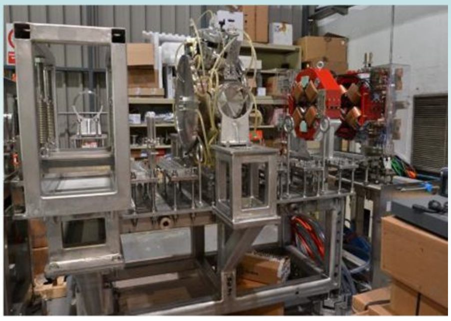

Figure 3. MEBT support integration at Ciemat

A detailed control system architecture of the MEBT is shown in Fig. 4.

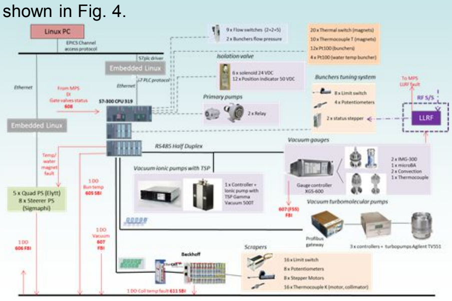

Figure 4. MEBT control system architecture

Diagnostic Plate (DP)

DP is a movable set of diagnostics that is placed downstream from the SRF Linac, in the HEBT. Main parameters of the beam are measured in the DP: current, phase, beam position, transverse profiles, mean energy, emittance measurements, micro losses, energy spread, etc. Beam measurements play a critical role in LIPAc due to its uncommonly high beam current and high beam power.

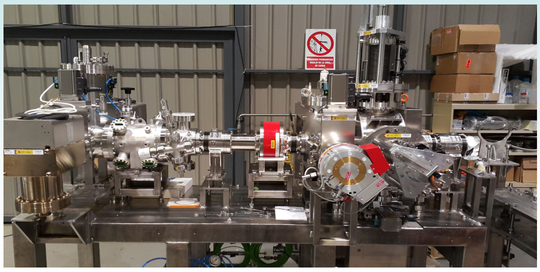

Figure 4. D-Plate support integration at Ciemat

Control of the power supplies in MEBT

Figure 8. MEBT quadrupole magnet

Transverse and longitudinal focusing for the beam is achieved using quadrupoles and steerers. The control of the 5 quadrupole power supplies and the 8 steerers bipolar power supplies is being carried out with EPICS over Modbus protocol.

Elytt Energy is manufacturing the five power supplies (0-180 A, 0-20 V) for the quadrupoles.

Figure 8a and 8b. MEBT power supplies view

Sigmaphi Electronics is manufacturing the eight power supplies (+/- 25 A, +/-5 V) for the steerers.

Control of the bunchers and scrapers in MEBT

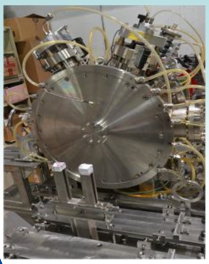

Figure 9. MEBT buncher cavity

Bunchers final integration in the beamline is now being achieved at Ciemat. Its control tuning system is based on a S7plc EPICS driver. A LLRF system controls the stepper motors status.

Figure 10. MEBT scraper support

Scrapers manufacturing of the second unit is finished. Its control system is firstly attained using a Beckhoff system, then a S7plc EPICS driver is used in order connect the PLC via TCP/IP to an EPICS IOC.

Fluorescence Position Monitors in DP

Figure 5. FPMs solution based on a Vertilon system

A solution based on a Vertilon data acquisition system has been developed, Fig 5. High voltage control for the PMT is required, the acquisition system delivers 64 data points for both FPMs of the D-plate.

Control software is based on a client-server architecture, Fig 6. Vertilon device is accessed from an EPICS IOC (client) using TCP/IP protocol, connecting with a LabVIEW application (server), which is the one that gets direct access to the device.

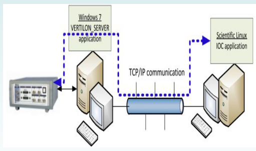

Figure 6. Client-server control architecture

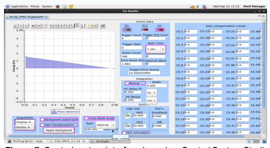

Figure 7. Control system interface based on Control System Studio

Test are now carrying out. As it can be seen in Fig 7, PMTs are properly acquiring with different gain levels.

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