Preliminary Design for the SPES Tape System Control Architecture

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INTRODUCTION

At Legnaro National Laboratories, EPICS [1, 2] was recently chosen as the framework to implement the control system for the entire SPES Project [3]. At the same time, EPICS will be used in the upgrade of the existing facilities, including the accelerators and the beam lines. Within the SPES project, we are presently developing an interceptive diagnostic system based on a tape station (STS). It will be used to characterize the radioactive ion beams extracted from the SPES-β target ion source, as summarized in another contribution to this Annual Report [4]. The project is carried on in collaboration with IPN Orsay (France) and iThemba Laboratories (South Africa).

In order to comply with the SPES requirements, the control system for STS is made in EPICS. This allows taking advantage from the features provided by EPICS and the expertise developed at iThemba laboratories in the development of EPICS-based Motion control systems.

THE MOTION CONTROL SYSTEM

Figure 1 shows a 3D sketch of the core part of the system, namely the tape cassette. The box contains two disks which host the mylar tape and allow to roll it in either direction, just like a movie tape. To do so, three motors and a feedback system are employed. One stepper motor defines the velocity and rotation direction of the tape, while two DC motors controlled by the feedback system roll the tape around the disks, keeping the proper tension. In addition to

![Fig. 1. Mechanical layout overview of the tape cassette.](image)

the cassette, the main components of the tape station system are (see figure 2):

- the vacuum system
- the detection system (data acquisition and detector’s power supply)
- the electrostatic beam deflector

![Fig. 2. Global scheme of one STS. The Motion control system is shown in orange, while its fast connection to the other subsystems are shown in green.](image)

The control system to be implemented has three main tasks. First, it has to drive the motion of the tape cassette according to user-programmable parameters like tape speed, number of steps, number of cycles. Second, it has to coordinate the movement with the other subsystems, acting as master handler. Third, it has to provide a global user interface (CSS-based) capable of dialing with all the aforementioned subsystems and to allow the user setting all the experiment parameters. The approch chosen is to implement the master functions on the same EPICS server that is controlling the motion of the cassette and to dialogue with the other subsystems using either EPICS variables (slow controls) or digital signals (real-time controls). Doing so, the control servers of the other subsystems are kept independent and there is no need for real-time software communication.

Fig. 1. Mechanical layout overview of the tape cassette.
IMPLEMENTATION

Regarding the implementation steps, the following contribution were given:

- IPN Orsay provided the preliminary control system design both regarding the main hardware parts and the algorithms.

- iThemba Labs, in collaboration with LNL, defined the set of new hardware compatible with the new control system architecture. In addition, iThemba, provided the low level integration software layer required to communicate with every single sensor and actuator.

- LNL is in charge of writing the high level control software layer required by the diagnostic station and of developing the logic required to integrate the device into the control system architecture.

An additional task (and critical part), consists in adapting the software provided by iThemba Labs to fully comply with the SPES control system guidelines. It is mandatory to convert the code to the SPES standards in order to guarantee:

1. full integration to the entire distributed control system
2. the compliance with the naming convention for EPICS variables
3. easy maintenance for the software

At present, a preliminary test bench has been realized with the double objective of verifying the set of hardware chosen (Beckhoff controllers and motors [5]) and the communication protocol (Ethercat [6]). The test bench available in Legnaro (visible in Figure 3) is a sort of proof of concept for testing the EPICS low level software layer. At present, the entire set of Beckhoff modules chosen for the tape station is controlled under EPICS: every single device (stepper and servo motors, potentiometers, encoder, etc.) are completely interfaced into the EPICS framework and basic commands are already available for first tests. This software, provided by iThemba Labs, must now be fully integrated in the SPES framework. Above this software layer, the code for the high level control (algorithms and state machine) must be written and verified: the algorithm has been provided by IPN and the related code will be soon realized. Testing the full system will require the mechanical components to be available and assembled, that is expected to for fall 2017.

CONCLUSION

The tape station is the first SPES diagnostic tool whose control system is completely designed and built using EPICS. The mechanical design and operating procedures have been borrowed for the existing BEDO (IPN Orsay) setup [7], but several upgrades are needed. One of the most crucial point is the update of the motion and control hardware specifications using newer and more maintainable components. As a consequence, new control software has to be developed. Thanks to the collaboration with iThemba Laboratorites, a set of suitable Beckhoff motors and controllers was identified. The EPICS drivers and low level software has been developed starting from an existing framework developed at iThemba. This allowed the implementation of a fully working test bench which verifies both hardware chosen and the low level EPICS software developed. Further tests will be carried on when the mechanical parts will be available.

Ongoing work regard the development of the EPICS application, providing the higher level software needed for the real operation of the Tape Station. Later, a Graphical User Interface will be implemented in order to allow the user a straightforward operation of the machine.

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