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Control & Monitoring Software for Fibre Optic Link Stabilization

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Introduction

The Compact Linear Accelerator for Research Applications (CLARA[1]) at Daresbury Laboratory, utilises precise timing information distributed as laser pulses via fibre optic links[2]. The timing signal distribution system consists of several active subsystems (per link) which maintain the laser pulses:

- Closed loop length stabilization, using a piezoelectric fibre stretcher, mitigates timing jitter and drift produced along the transmission fibre.
- A motorized delay stage (MDS) is used for calibration and to prevent saturation of the fibre stretcher.
- An amplification stage is used to maintain sufficient signal strength through the link.
- Active polarization control.

We specified a piece of software to control and monitor these systems, to facilitate their commissioning and operation.

Goals

- User friendly interface
- Maintainable code base
- High performance control
- Robust long-term operation
- Extendable functionality
- On schedule

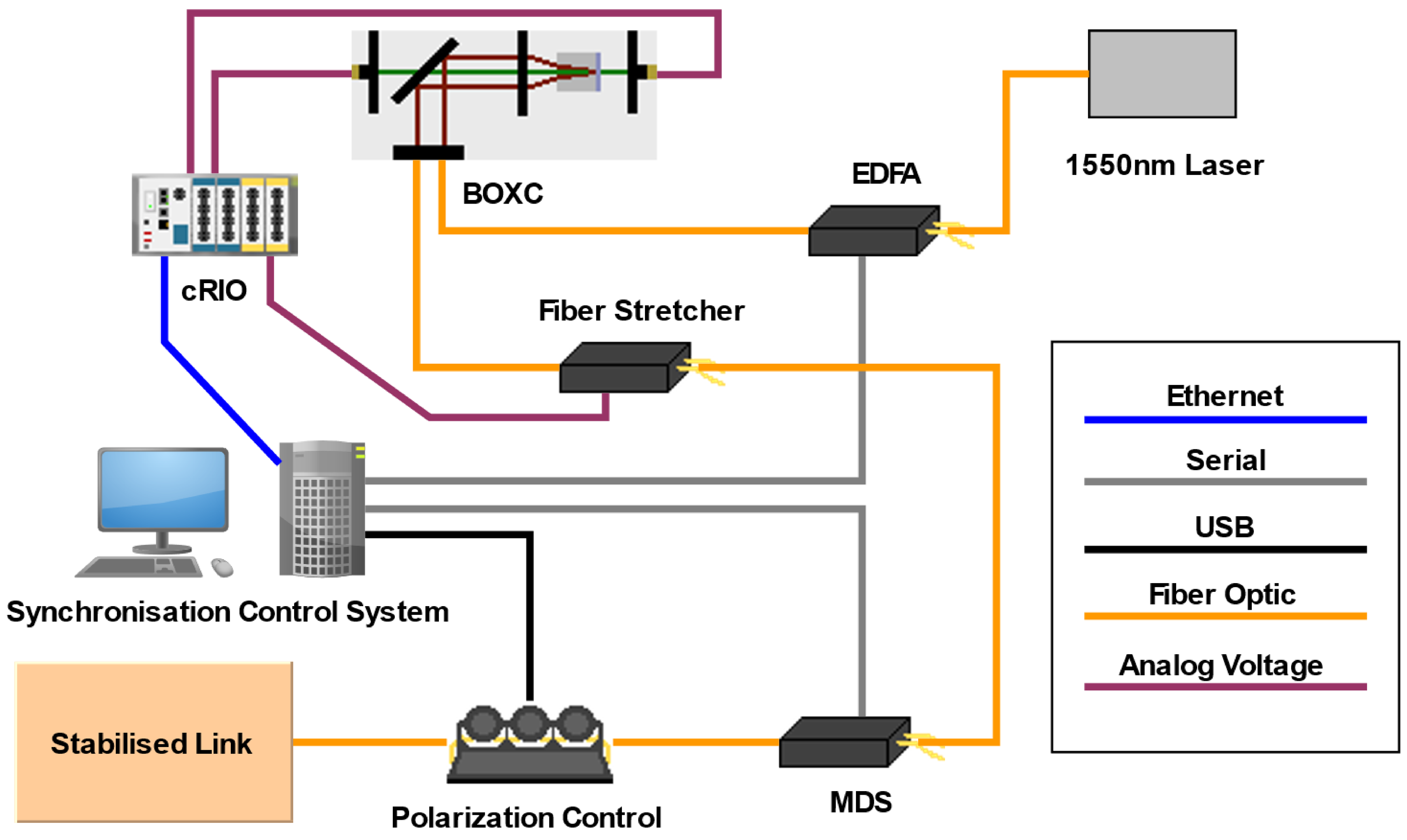
Hardware

- PC
- National Instruments (NI) CompactRIO (cRIO)
- OZ Optics ODL-650-MC motorised delay stage
- IPG EAU-50-C3-D modular Erbium Doped Fibre Amplifier (EDFA)
- Thorlabs MPC320 motorized polarization controller

Development Environment

We selected LabVIEW as the development environment, for its ease of development with the CompactRIO hardware.

A Queued Message Handler (QMH) architecture is used, which allows control routines for the many devices to run in parallel rather than sequentially. This is important to meet the specified performance targets.



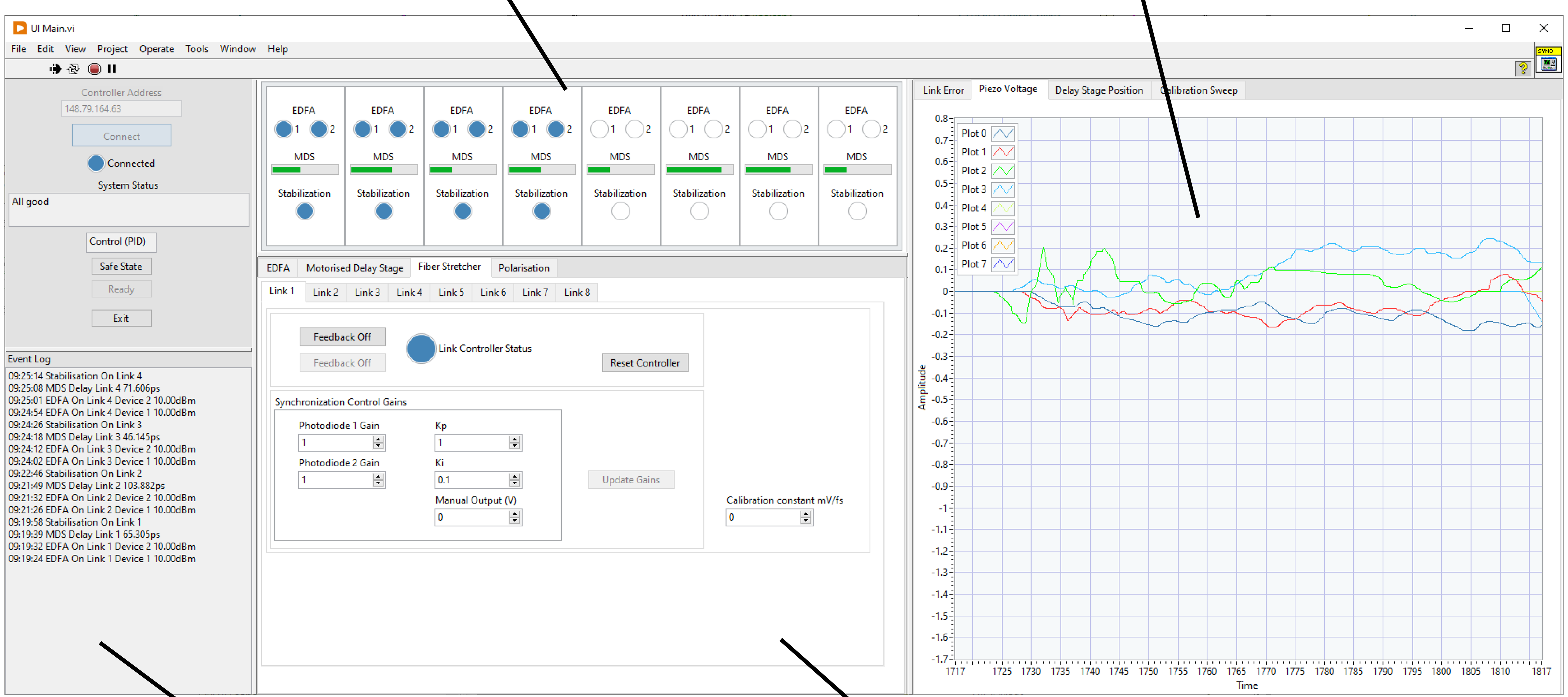
Control & Communication

The Synchronization Control System (SCS) communicates with the cRIO over Ethernet, using methods adapted from standard LabVIEW methods.

The EDFAs and MDSs both use serial communication protocols, which have been programmed into the SCS in a modular way. This will make it possible to use alternative hardware if required.

Entire system status visible at a glance

Live charts show changes over time



Detailed logging of changes

Controls organised logically and without clutter

Summary

The SCS has been developed to provide a single integrated control system for commissioning and operating the stabilized fibre optic timing network on CLARA. It aims to reduce workload for operators and increase resilience and maintainability of the network. It will also be extendable and adaptable for use on synchronization systems for future accelerators.

References

[1] D. Angal-Kalinin et al. (2020). Design, specifications, and first beam measurements of the compact linear accelerator for research and applications front end. Physical Review Accelerators and Beams. 23. 10.1103/PhysRevAccelBeams.23.044801.

[2] J. Christie et al., "Developing a two-colour all-fibre balanced optical cross-correlator for sub-femtosecond synchronisation", in Proc. IPAC'23, Venice, Italy, May 2023, pp. 4135-4138. doi:10.18429/JACoW-IPAC2023-THPA073