

MicroTCA System Integration

Boost the integration of your MTCA.4 based application with Cosylab

Initially started as a group of physicists turned engineers, Cosylab has had more than 17 years of experience in Control Systems for Scientific Applications. Focusing on software development and system integration we have worked with a myriad of different hardware platforms - from VME/VxWorks and Single Board Computer based PCs, over newer chassis like cPCI, up to modern platforms such as MTCA.4.

Cosylab is involved in the majority of today's Large Experimental Physics projects and is providing on-site staff to many sites. This makes us uniquely positioned to co-create and follow the latest developments in the area of hardware platforms and their applications to accelerator (and other big physics) projects.

Our main area of expertise is helping physicists and engineers go from a lab prototype to an integrated full-system solution. We help hardware vendors with software development and the particularities of different control system environments at different labs and we help lab people in providing professional and experienced engineers that shorten the needed development time.

Being an ISO 9001 and 13485 certified company, we can help with the entire system engineering process that starts with requirements gathering and results in a fully integrated and tested device, delivered together with documentation, test reports and warranty for the delivered code.

Coming from the community, Cosylab understands the need for flexibility when working for scientific experiments. Our work can start anywhere in the development process - be it as early as support in the prototyping phase and help with the selection of digitizing hardware or later on, with integration of specific processing algorithms on the FPGA, software integration and GUI design.

Our competence in Control System Integration

- Systems Engineering
- Requirements gathering
- System Architecture (selecting appropriate hardware and software components)
- Prototyping
- Software development
- Driver Development
- FPGA programming
- Schematics, PCB layout
- Rack Assembly and Wiring
- Tests and Validation



Key Benefits for You

- Faster development when your key resources are overloaded
- Reduce overhead by standardizing software and firmware components across different use-cases: reduce development time, simplify maintenance, reduce the learning curve for new project members
- Reduce project risks by relying on our wide experience with proven best practices and community-supported solutions
- Mitigate peak work-loads during critical project phases
- Integration of MTCA.4 components in specific environments (e.g. CODAC / NDS) makes it possible to eliminate entry barriers for MTCA.4 modules in specific projects
- Commitment to providing open-source solutions
- Warranty, documentation, training and support for delivered solutions
- Minimizing total cost and risk by taking your integration projects off the critical path

A. MTCA.4 Development for ESS

When completed, the European Spallation Source (ESS) will be a research center with the most powerful neutron source in the world. It is currently under construction in Lund, Sweden.

Cosylab has been involved in the ESS project since the beginning, consulting on the design and planning of all aspects of the facility's Integrated Control System.



Several important sub-projects were based on the MTCA.4 platform, the Struck SIS8300 DIGITIZER:

Generic Support and application specific integration of BCM, BPM, LLRF

Integration of the SIS8300(L) board consisted of several sub-projects, all deriving from support for the generic digitizer functionality as exposed by the stock firmware provided by vendor. This included the kernel module, user space library in C, EPICS driver and engineering screens. The architecture of the software stack was such, that all the applications realized on the mentioned board used the same kernel module and only extended the user-space library and EPICS driver with application specific functionality.

All three application specific extensions of the Struck board – Beam Position Monitor Prototype, LLRF Integration and Beam Current Monitor consisted of a user-space library and EPICS driver extension (NDS) as well as application-specific Engineering screens displaying additional control data.

The Beam Current Monitor (BCM) Work Order executed for ESS also included extension of the generic FPGA code for application specific real-time data processing/filtering and interlock functionality. The Low Level RF (LLRF) Application additionally included Screens for Loop calibration and Board setup.

Tests of Compatibility of MTCA.4 Components used at ESS

Various combinations of MCHs, PSUs, FMC boards, Crates etc. were tested in the first two years upon ESS adaptation of the MTCA.4 standard. A team of 4 engineers was working closely with the ICS and Accelerator group to test and debug the delivered systems.

B. Other Customer References

White Rabbit Timing Receiver for GSI / FAIR: GSI has chosen the White Rabbit based timing system for the FAIR facility. Cosylab has developed several form factors for the timing receivers, including MTCA receivers. The AMC board was recently approved for production by GSI.

A key requirement to implement was that card is operational in MTCA.0, MTCA.4 crates and additionally on the LIBERA platform B, where it provides extra trigger lines to the backplane for Libera equipment.

The project is based on the GSI PCIe form-factor. The prototype boards were successfully tested and we are preparing the production of several hundred units.

Dose Delivery System for MedAustron Cancer Therapy: MTCA.4 was chosen as the platform for DDS components due to its diagnostic and hot-swap capabilities. Interfaces to different devices can be abstracted away with the help of FMC carriers, while the ruggedness of the platform and backplane interlocks allow for the safe design required in medical applications

SIS8300 driver improvements for DESY: Cosylab extended an existing driver by adding DMA functionality and contributed with testing and debugging.

C. Internal Developments for a Generic DAQ Solution

We developed a **general-purpose digitizer application** in-house. The main goal of the solution is to provide a well-tested base that can easily be extended with application specific functionality that can be added in FPGA (for high speed algorithms and data processing) and/or in the software. It has outputs to the Machine Protection System and an integration provision into any archiving or alarm service. Custom analog front-ends can be developed for applications that require them (new RTM).

There is support for timestamping in the firmware, so the waveforms are stamped by the MRF timing system at the moment they are acquired. Additional functionality such as support for FPGA programming through Matlab Simulink etc. is in development.

The solution allows for integration into a CS framework of choice (EPICS is implemented).

Nominal Device Support is a Cosylab developed open source (GPL licensed) framework for digitizer-like devices and is being used at ITER and ESS. The goal is to capture common functions for such devices within the framework so that only application-specific and hardware-specific customizations are needed on top.

NDS is CS middleware agnostic and it is extensible. The example projects on Github (<https://github.com/Cosylab/nds3>) work with EPICS & Tango.

D. xTCA Hardware References

We have worked with, and developed software for or simply integrated into a Control System all these MTCA.4 boards

- MRF MTCA.4 based boards - mTCA-EVM-300 and mTCA-EVR-300 (KIT and in-house timing system development setup)
- Teledyne ADQ7 and ADQ14 integration into EPICS using Nominal Device Support (NDS)
- IOxOS IFC-1410
- Struck SIS8300(L) with several different RTMs (SIS8900, DS8VM1, DWC8VM1) at ESS (LLRF, BCM, BPM) and DESY
- Vadatech AMC523 with MRT523 and MZ523B (generic DAQ solution)
- TEWS TAMC 261-21R (PMC Carrier) as an intermediate solution for MRF-based timing at ESS (before native MTCA.4 boards were available)
- FPGA development for ATCA based boards (LLRF) at SLAC