Timing-system Solution for MedAustron; Real-time Event and Data Distribution Network

cosylab CONTROL SYSTEM LABORATORY

ebg MedAustron

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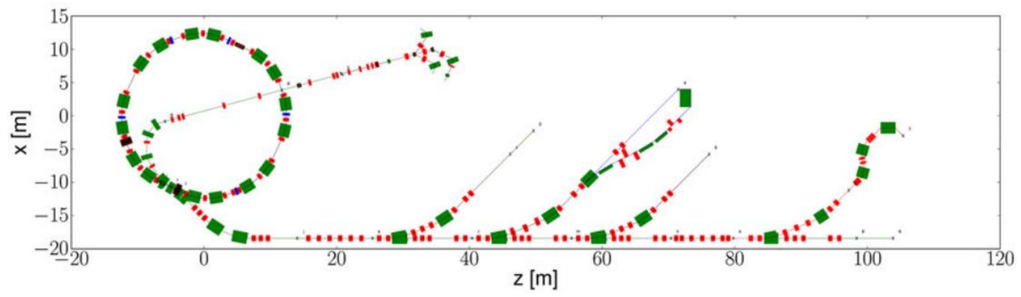
About MedAustron

☑ Location: Wiener Neustadt, Austria (50 km south of Vienna)



☑ Synchrotron Based Accelerator:
- ✔ 3-5 ion sources (p, Co, other light ions)
- ✔ 5 beam lines, thereof 1 a rotating gantry
- ✔ Up to 800 MeV, dynamic pulse-to-pulse modulation (cylic)

☑ Applications:
- ✔ Ion beam therapy applications and related research
- ✔ Serves as blueprint for further applications

☑ Development follows defined process and QM standards
☑ Hardware and software COTS where possible

MedAustron Control System (MACS) is developed in cooperation with Cosylab.

Non-RT Interface

Two main messaging services via Ethernet network. Both are based on National Instruments' Simple Messaging Service (STM) and integrated into the Real-Time OS compatible Front End Control System (FECOS) framework done in LabVIEW.

Simple Messaging Mechanism

☑ Interface to the PVSS-based supervisory control system
☑ For execution control and configuration of accelerator cycles

Publish-Subscribe Mechanism

☑ For communication between software components
☑ Used e.g. for non-real-time commands and timing event distribution

Configuration of SW Components

Software support for the timing system is fully integrated into MACS and benefits from the software mechanisms provided by the FECOS framework.

XML-Based configuration

☑ Structurally-rich information represented in XML format
- ✔ Startup and configuration parameters for software components
- ✔ Shared variable locations, any user-defined information
- ✔ ACC sequence definitions, Timing event response configuration

Process Variables

☑ For online configuration and monitoring of end devices
☑ Implemented in LabVIEW shared variable engine, connected via OPC to the SCADA server of the supervisory interface

Conclusion

☑ Timing System design time greatly reduced by using COTS product from MRF (total time from requirements to product < 1.5 years)
☑ We took MRF's well proven, stable transmission layer and built a pulse-to-pulse modulation real-time accelerator timing appl. on top
- ✔ This is THE WAY to build a robust but versatile solution, coping with different complex use cases.

☑ Flexible and reusable SW support, fully integrated into MACS

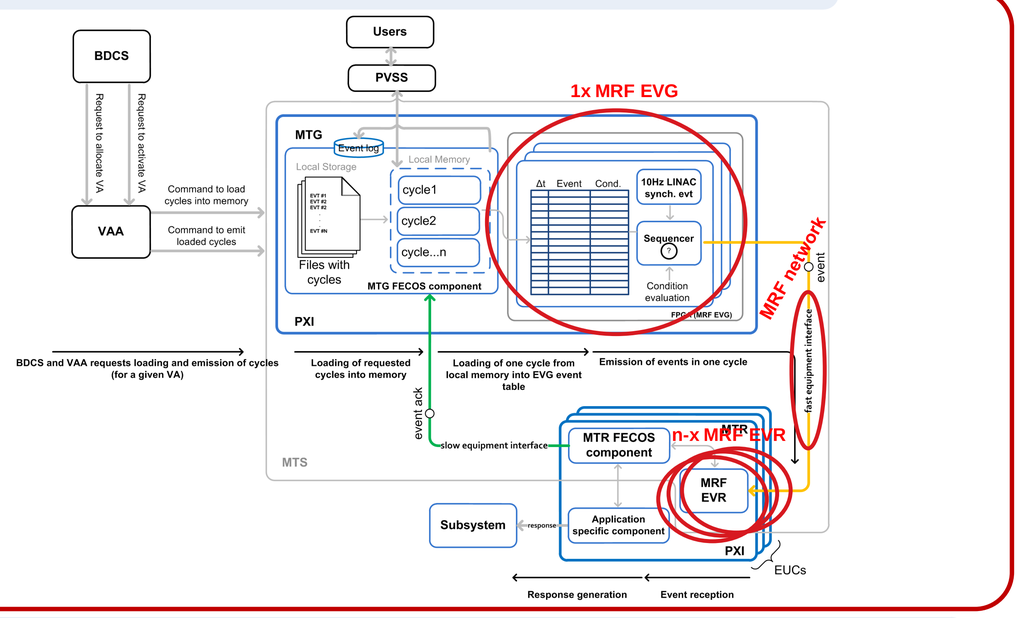
Timing System Hardware - Technology Choice

☑ Front End Controllers based on National Instruments PXIe
☑ A deterministic network protocol is required; reliable event/data distribution and fast response times from the timing system master to all (about 300) controlled devices

Upgrade of the MRF Transport Layer

☑ MRF satisfies MedAustron synchronization requirements well and is excellent for machines with low decision-flow requirements
☑ MRF lacks high-level real-time logic for different modes of operation and a generic accelerator timing system application
☑ We designed and implemented a generic and reusable high level logic above transport layer in generator and receiver FPGA. The system is suitable for small to mid-size accelerators

MedAustron Timing System Overview



MedAustron Timing System Services

Rich Event Response Possibilities

User can easily configure the event receiver via Labview API to:

☑ Trigger external device (via TTL, fiber optic, etc.)
☑ Trigger PXI/PXIe neighboring cards (via star trigger lines)
☑ Provide neighboring cards with real-time data (via trigger bus)
☑ Provide software applications IRQs
☑ Subsribe any component to any response
☑ Delay, invert or otherwise "post-shape" response to timing event

Virtual Accelerator (VAcc) Support

Timing Events are scheduled in 5 separate, concurrently usable execution slots (ES), providing concurrently operating virtual accelerator functionality. This concept enables users to:

☑ Program individual, concurrently running VAccs as if separate
☑ Events from all VAccs piped through the same link (fiber optic)
☑ Timing events from different VAccs are prioritized
☑ Receivers can be linked to any combination of VAccs

Real-time data distribution

☑ Timing event concept extension, based on pipes
☑ Abstraction of communication channel
☑ Provides data payload - useful for distribution of real-time data
☑ Payload not limited by protocol
☑ Lowest priority, near real-time

Prioritization Scheme: