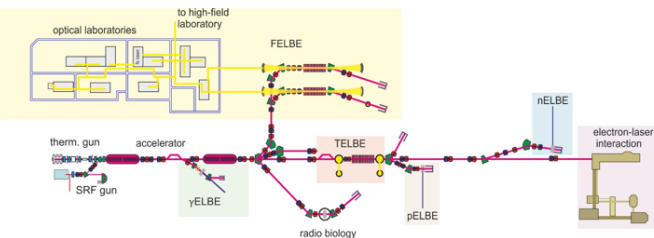**ICALEPCS 2021**

Upgrade of Timing System at HZDR ELBE facility

Žiga Oven[†], Luka Krmpotić, Uroš Legat, Urša Rojec (**COSYLAB**, Ljubljana, Slovenia)
Matthias Justus, Michael Kuntzsch, Andreas Schwarz, Klaus Zenker (**HZDR**, Dresden, Germany)

THPV031

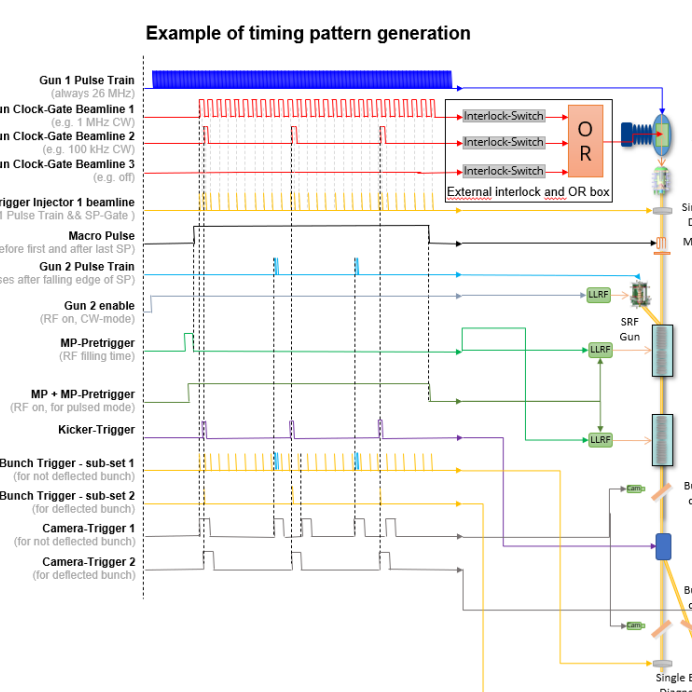## Introduction and Motivation

- The ELBE center for high power radiation sources operates an electron Linac (in pulsed or continues wave mode) to generate various secondary radiation
  (neutrons, positrons, intense THz and IR pulses and Bremsstrahlung).
- Current timing system has been updated over the last two decades to enable new experiments.
- Part of this system uses obsolete parts which make maintenance more complex.
- New timing system based on the Micro Research Finland (MRF) hardware platform will be adapted for use at ELBE.
- It enables parallel operation of two electron sources and subsequent kickers to serve multiple end stations at the same time.
- Hardware enables low jitter emission of timing patterns and a delay compensation of the distribution network.
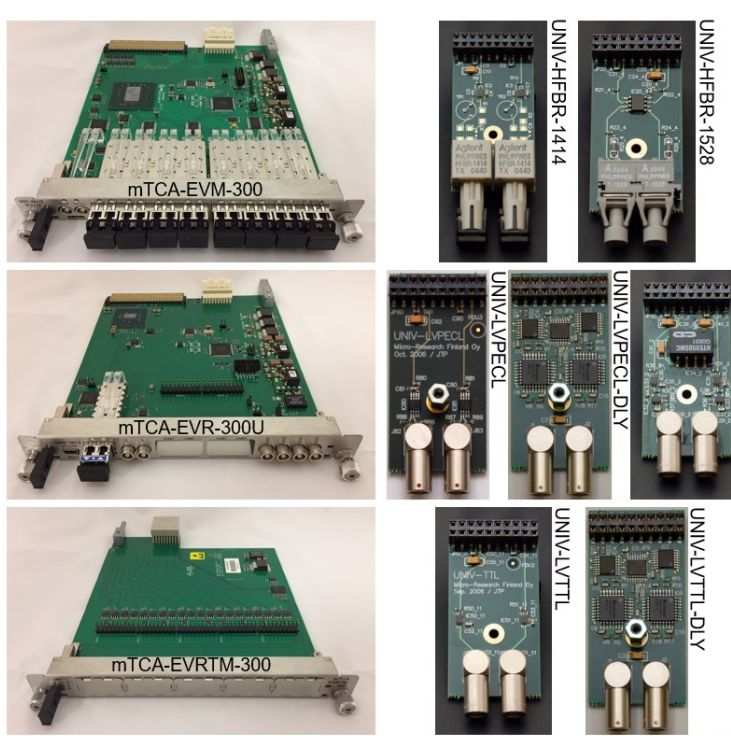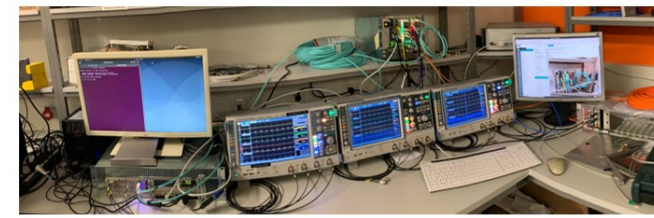

Example of timing pattern generation

THPV031

Hardware

- MicroTCA based Micro Research Finland hardware (http://mrf.fi)
  - Event Clock Rate derived from RF
    - From 50 MHz, to 166 MHz,
    - ELBE will use 130 MHz
  - Delay Compensation Feature
- Two EVMs (event master), one per injector
- mTCA EVRs (event receiver) for machine timing (diagnostics LLRF, kicker) and selected users
- mTCA RTM (rear transition module) to extend number of trigger outputs per receiver
- PCIe receiver for compact and cost effective user timing station
- Extendable topology
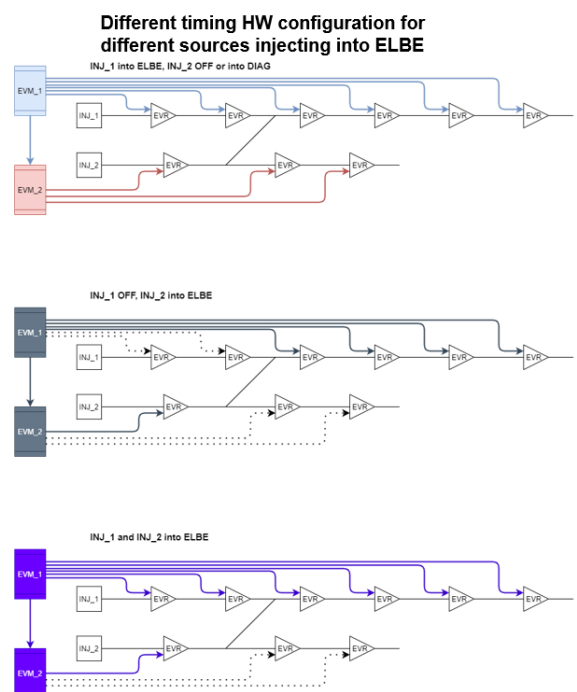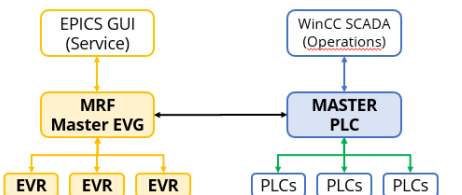- Universal Output modules for selection of trigger signals

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THPV031

Software

- EPICS based control system for timing
  - Implementation for timing based on MRFIOC2
- Custom solution for event pattern generation based
  - Based on exiting operation modes
    - 2 modes of operation (Macro Pulse and Single Pulse)
    - Continues wave operation up to 26 MHz
    - Single shot
    - Flexible patterns for user beam
  - Options to extend functionality in future
    - Additional kickers, increased beam rate of Gun 2
- Interfacing with other systems through MPS Siemens PLC
  - Responsible for verifying beam parameters with MPS restrictions
  - Interface towards existing Operator Screens

Different timing HW configuration for different sources injecting into ELBE

THPV031

Output Jitter Performance

- 4.5 ps rms [1Hz; 1MHz] @ 13MHz for TTL
- 7.8 ps rms [1Hz; 1MHz] @ 13MHz for LVPECL-DLY
  - Module with 10ps delay tuning setpoint
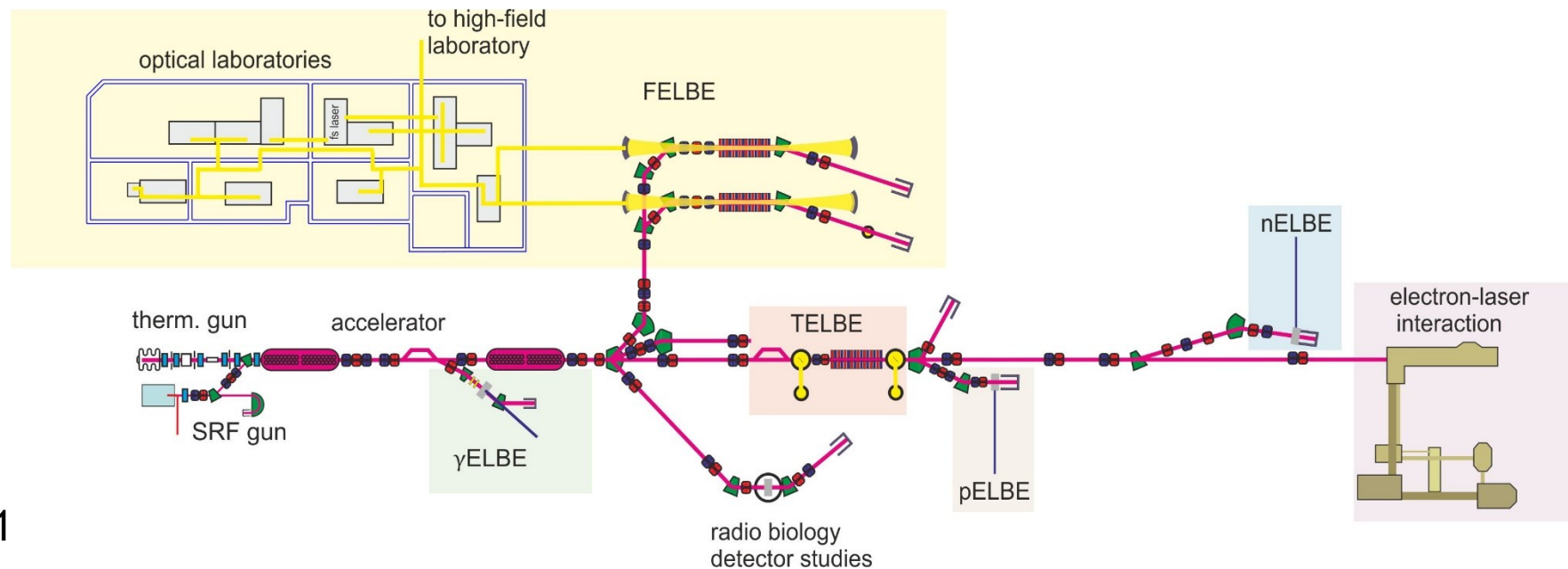

Work in Progress

- All major modes implemented
- Debugging on test benches
- Machine Protection PLC interface defined but not tested yet
  - Restructuring of MPS needed to include new functionality of the timing system
- Long term stability monitoring

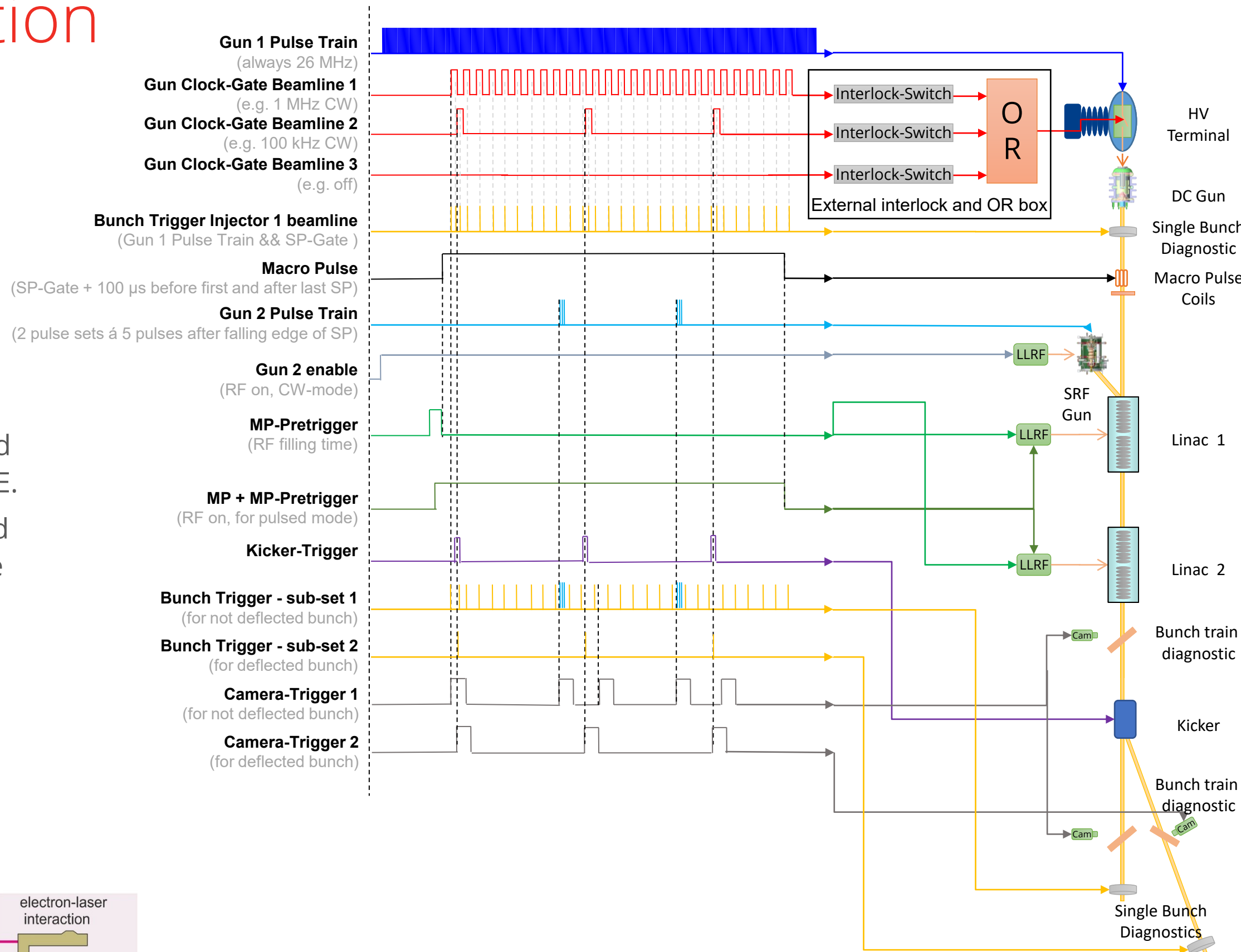- Commissioning at ELBE with all components scheduled for 2022

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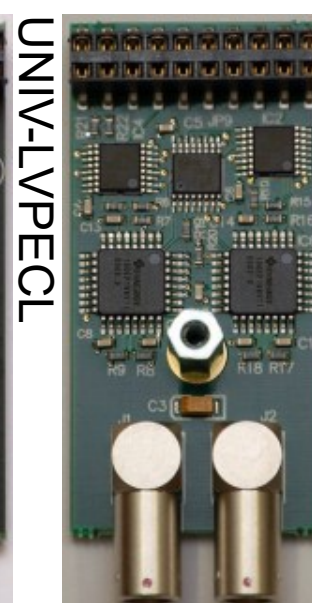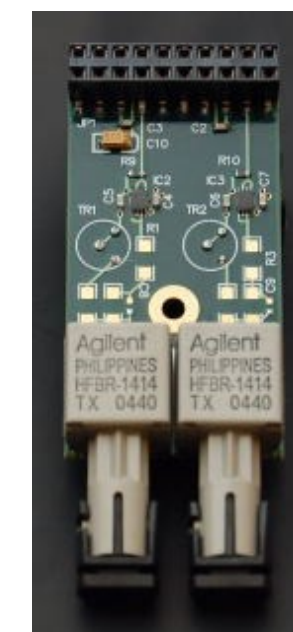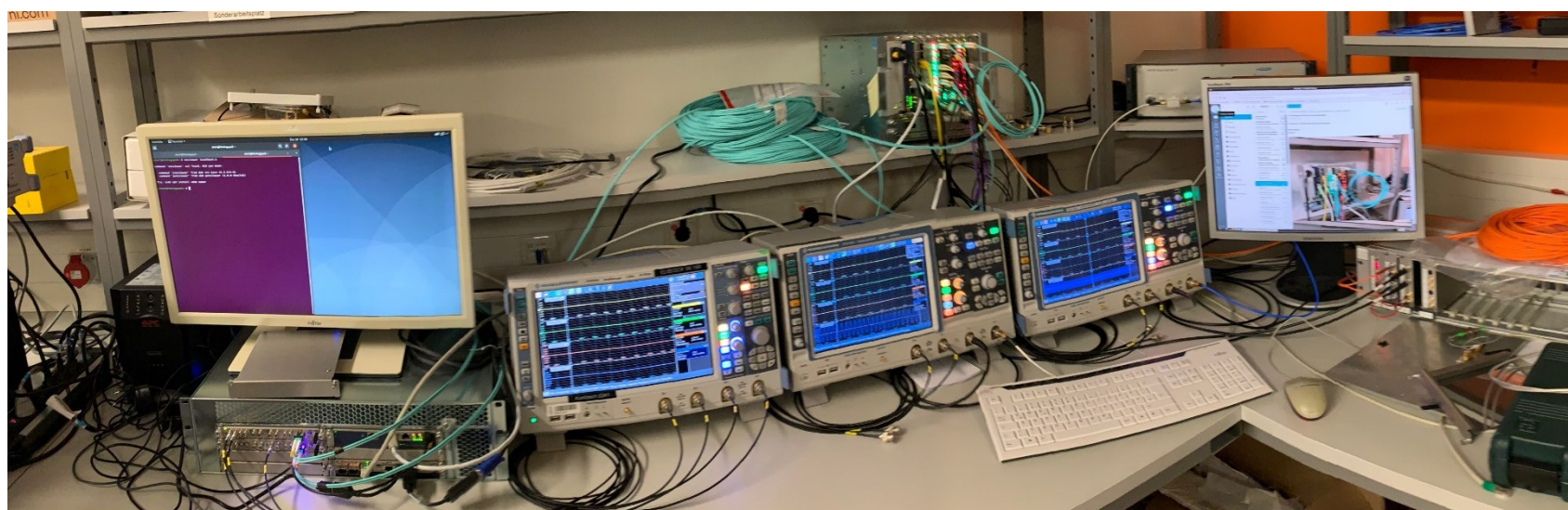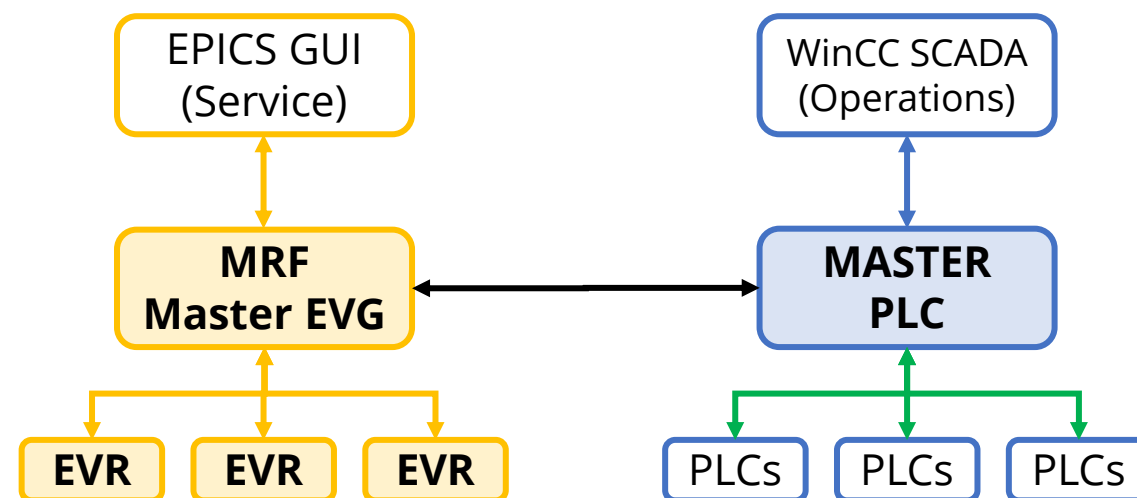
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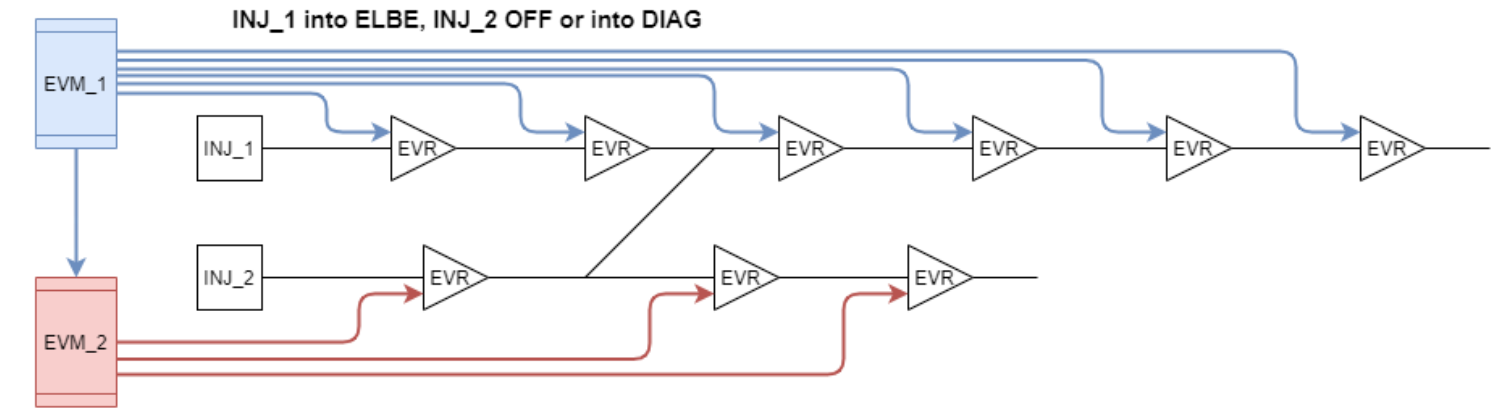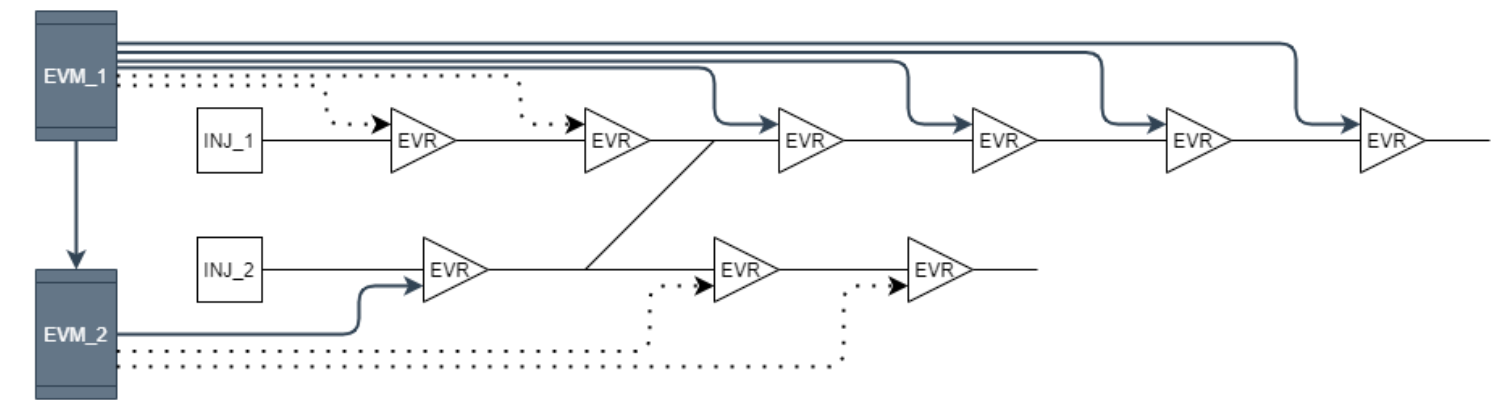- Universal Output modules for selection of trigger signals

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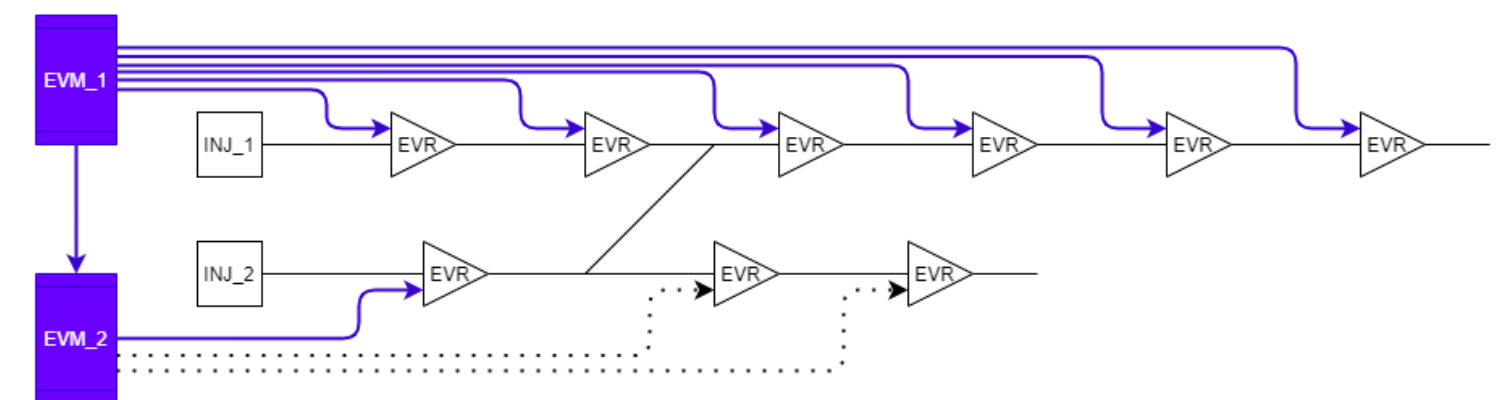 - Interface towards existing Operator Screens

Different timing HW configuration for different sources injecting into ELBE

INJ_1 into ELBE, INJ_2 OFF or into DIAG

INJ_1 OFF, INJ_2 into ELBE

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