High-Level Software Tools for LLRF System Dedicated to Elliptical Cavities Management of European Spallation Source Facility

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Agenda

- European Spallation Source
- LLRF control system
- EPICS and E3
- Piezo Driver management and monitoring software
- LO Distribution Tool
- IPMI Manager supporting software

European Spallation Source

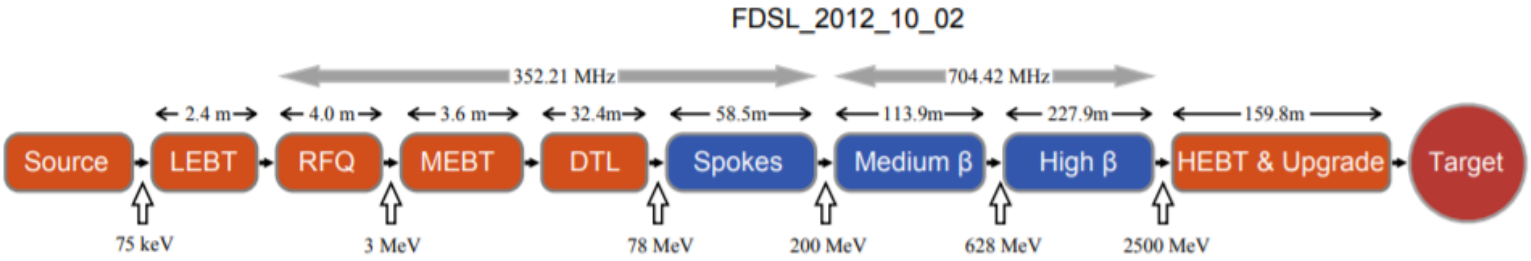

Fig. 1 Block diagram ot the ESS accelerator

- ESS is an accelerator-driven neutron spallation source.
- It generates protons from the ion source.
- They are accelerated to suitable energy and driven to target.
- Protons are accelerated with energy from Radio Frequency system.
- High Beta and Medium Beta sections are composed of 84 and 36 elliptical cavities.

Low Level Radio Frequency Control System

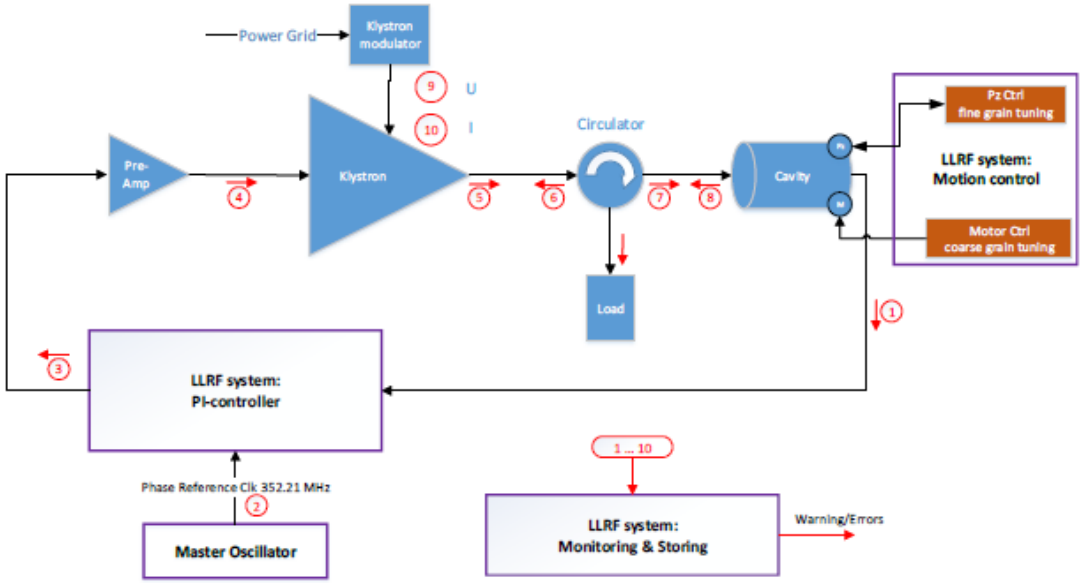

Fig. 2 Schematic of the LLRF section

- Control of electrical field's parameters in the superconductive cavities (phase and amplitude).
- Compares current value against a group of desired data.
- Uses PI controller.

EPICS and E3

Fig. 3 Logos of EPICS and E3

- Experimental Physics and Industrial Control System (EPICS) – software toolkit for distributed control system.
- Bases on client/server idea.
- Data stored and accessed in Process Variables (PVs).

- ESS EPICS Environment (E3) – environment where EPICS applications are compiled and launched.
- Helps to keep consistency, easier long term maintenance.
- Focuses on device integration.

IOCs Architecture and E3

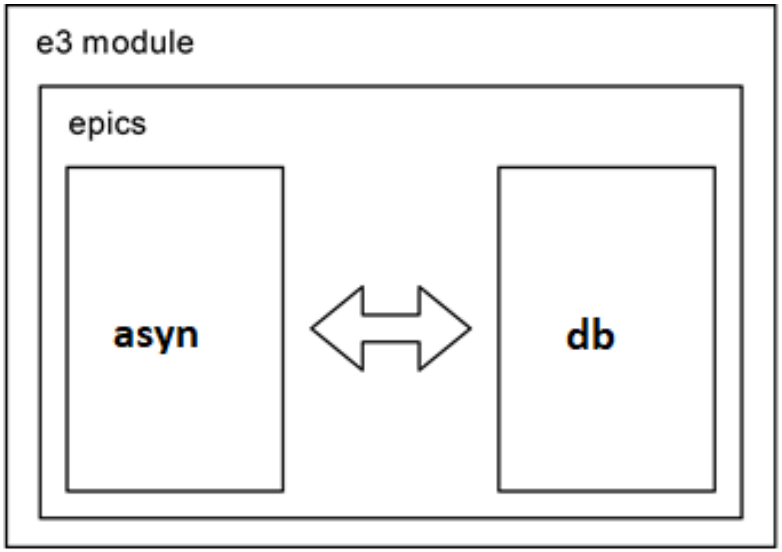

Fig. 4 Standard IOC structure

- EPICS structure is encapsulated into E3 module.
- IOC uses C++ asyn class to communicate with device.
- Asyn reads/loads data from/to PVs in database.
- PVs are used by users to set device parameters.

Piezo Driver - Overview

- Piezo elements are used for fast compensation of detuning.
- Detuning can be caused by the Lorentz force, microphonics.
- Designed as Rear Transition Module (RTM), MicroTCA.4 standard
- Bases on FPGA board.

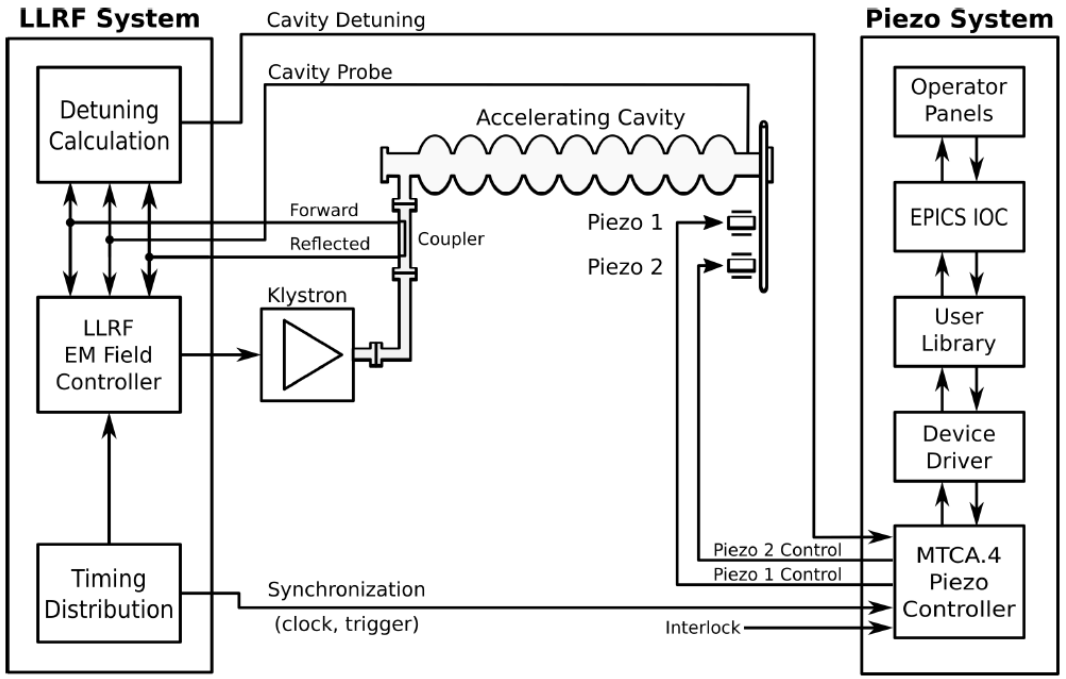

Fig. 5 Piezo control system of the ESS accelerator

Piezo Driver – IOC structure

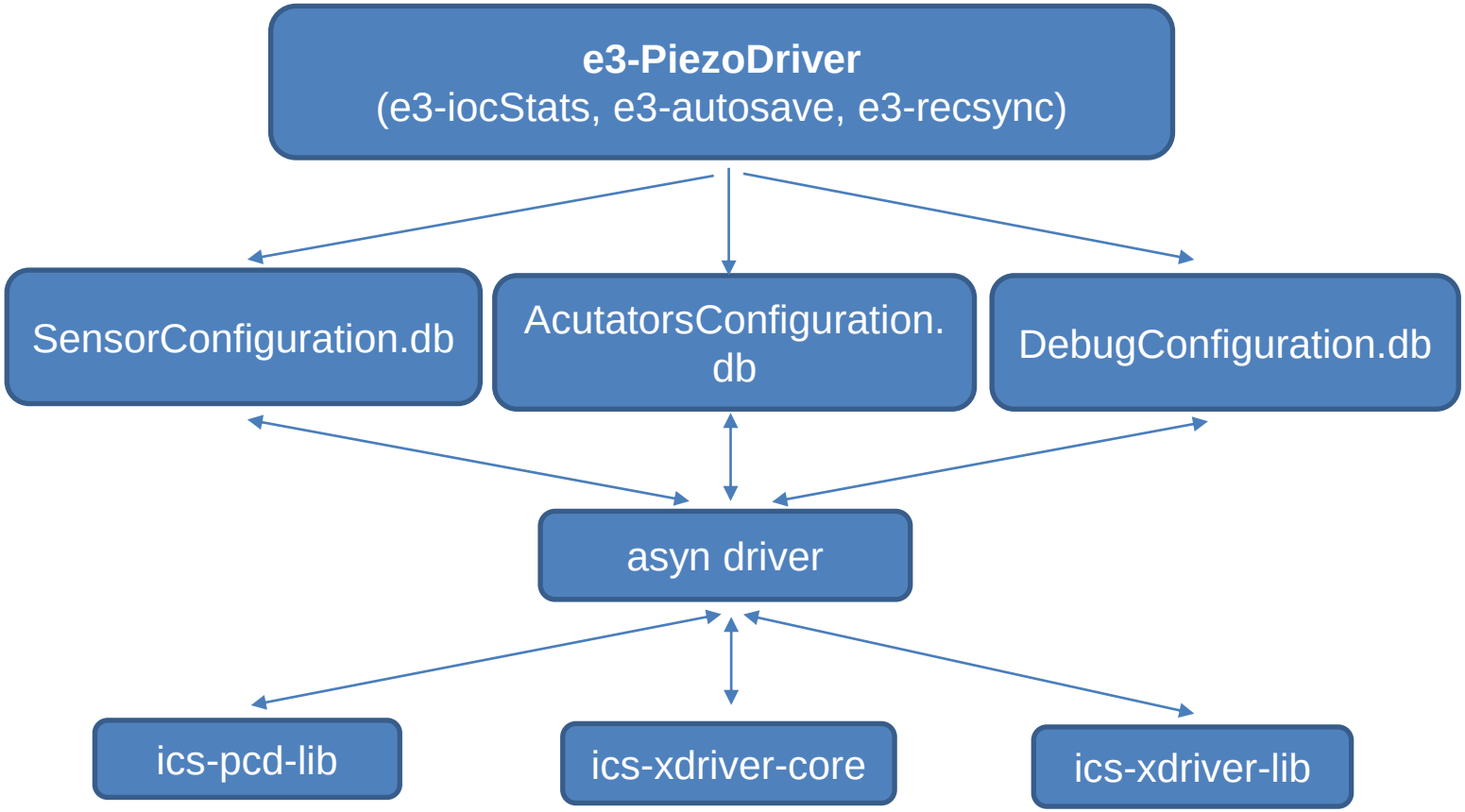

Fig. 6 Piezo Driver IOC block diagram structure

LO Distribution Tool – Overview

- LLRF control system needs to master phase reference clock and propagate system clock.

- Local Oscillator (LO) RTM device is responsible for the generation of the local oscillator signal.
- It is used for RF down-conversion.

- The device was implemented as RTM module in MTCA.4 standard.
- Uses same drivers as Piezo Driver.

LO Distribution Tool – IOC structure

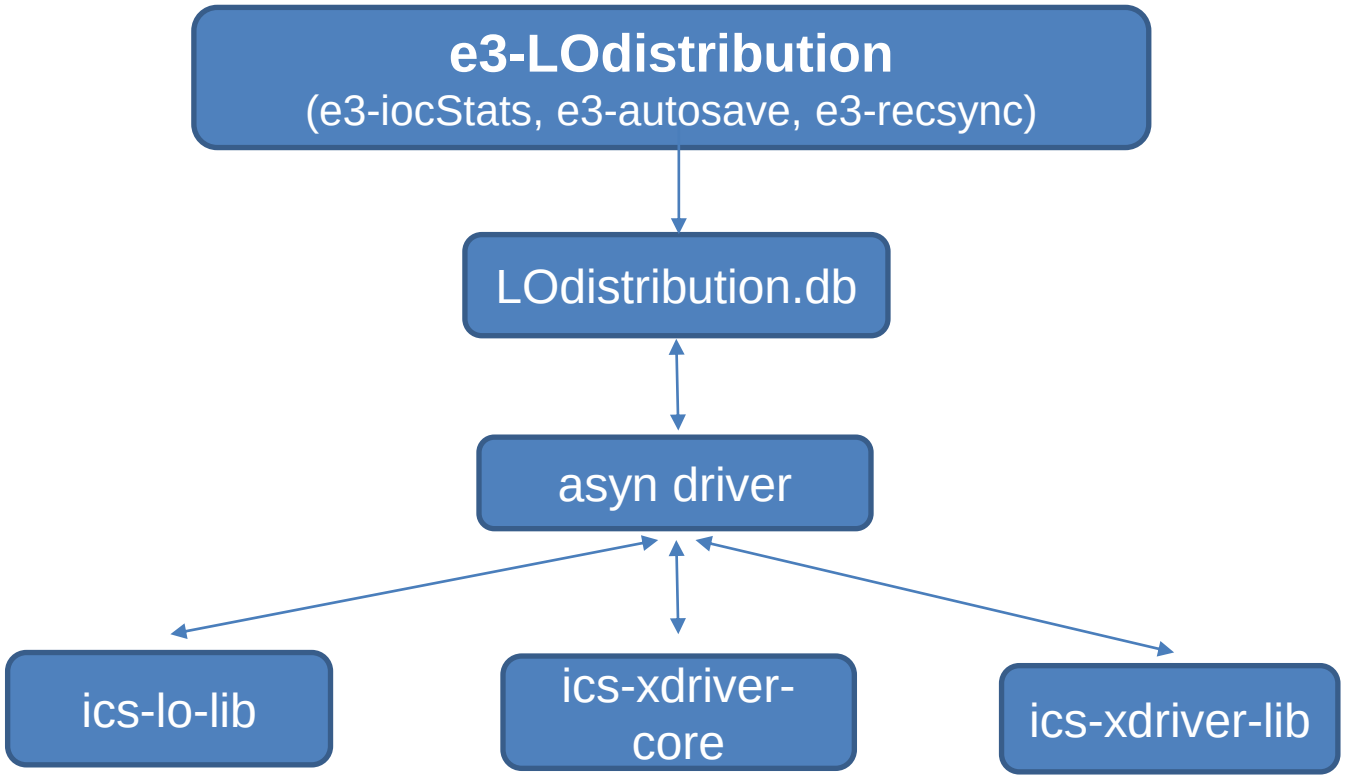

Fig. 7 LO IOC block diagram structure

IPMI Manager – Overview

- Major part of the LLRF system is based on MTCA.4 architecture.
- Its control layer bases on IPMI (Intelligent Platform Management Interface) protocol.
- It can be used to monitor the whole system and attached modules.

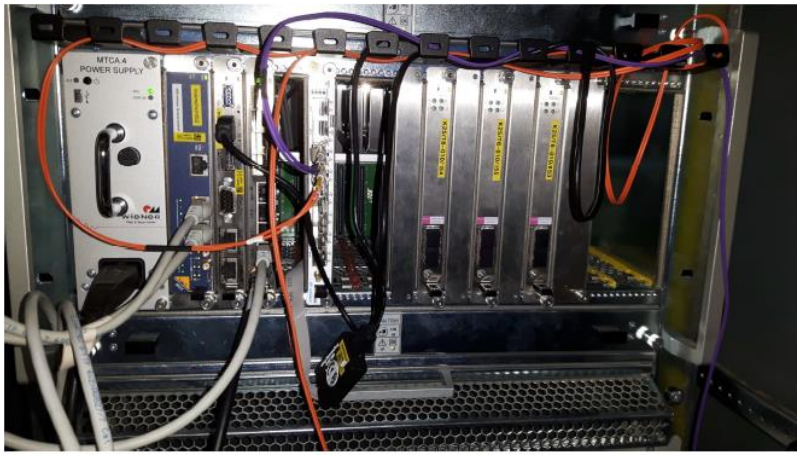

Fig. 8 MTCA.4 crate

- IPMI Manager is a scalable software.
- Dynamical detection of available modules and generation of PVs.
- Uses OpenIPMI library.

IPMI Manager – IOC structure

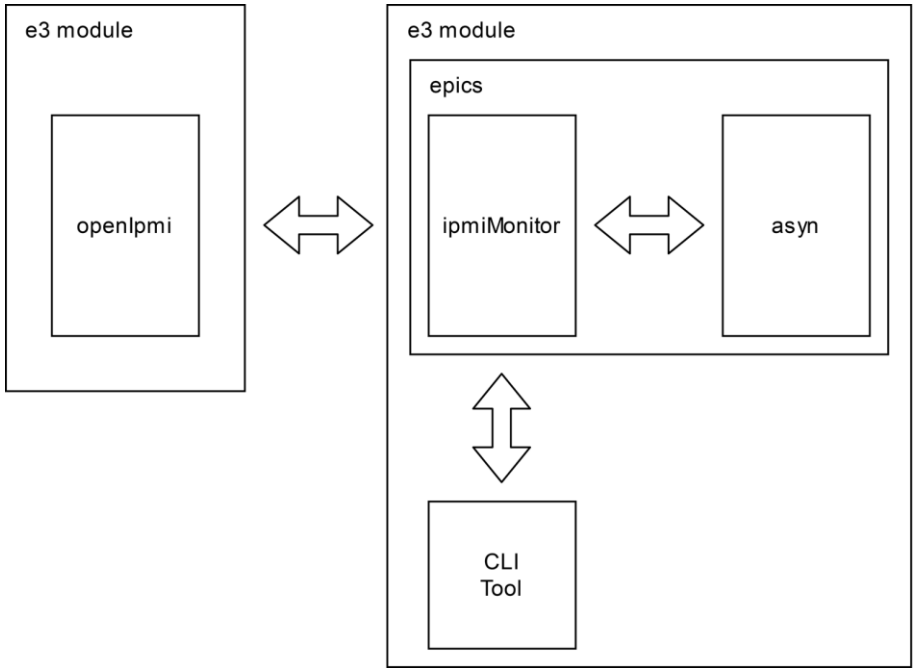

Fig. 9 IPMI IOC structure

Summary

- All the tools are still being developed (looking for bugs, making them more user-friendly).
- They have been tested with real devices.
- Those measurements and their results were recorded as videos.