ESS LLRF RAMI Analysis

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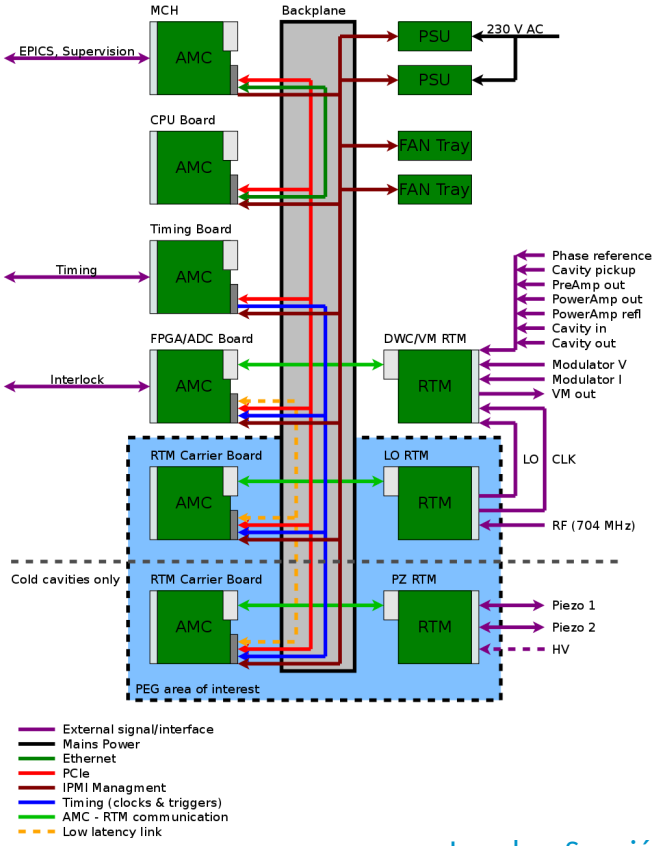
Agenda

- Layout of the equipment
- Subsystems
- Safety and RAMI requirements
- Failures description
- Means of the transportation of the equipment to the facility
- Acceptance test
- Conventional hazards

Layout of the equipment

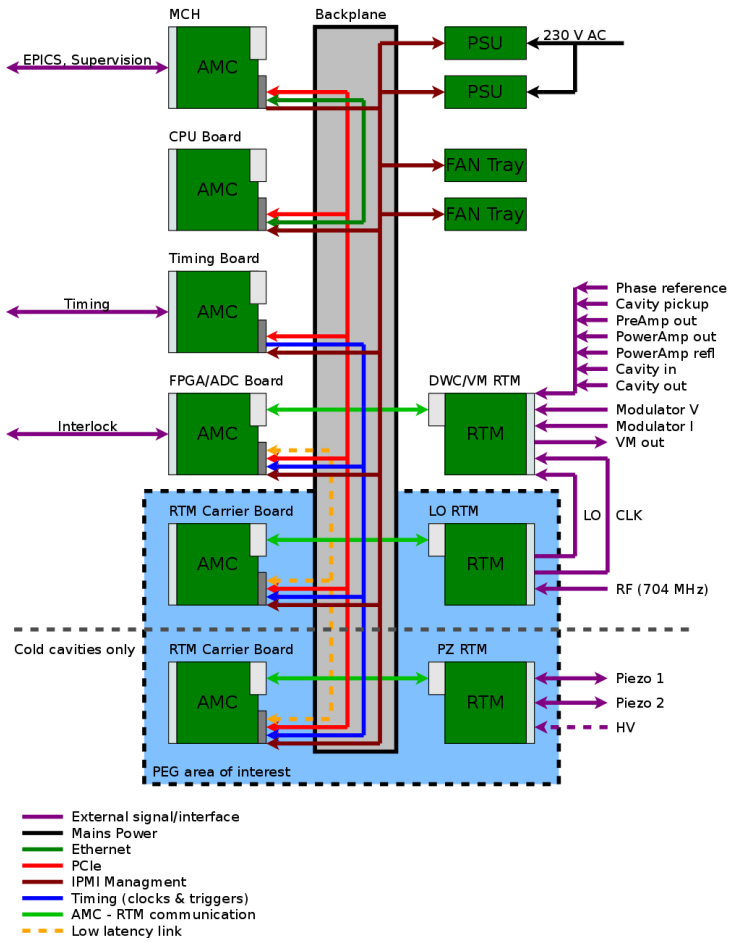
LLRF Systems will be implemented in the MTCA.4 form factor standards, where single LLRF unit supporting one RF feedback loop (amplifiers, cavity, etc.), will be implemented using one MTCA.4 crate.



Subsystems

Single LLRF unit will be made of following components:

- MTCA.4 chassis
  - Power supply
  - Fans
  - MCH – MicroTCA Connection Hub, the core crate management unit
- CPU board
- Timing board
- FPGA & ADC board
- DWC/VM board
- Piezo external power supply
- **RTM Carrier AMC board (designed by PEG)**
- **LO RTM board (designed by PEG)**
- **Piezo driver RTM board (designed by PEG)**



SAFETY AND RAMI REQUIREMENTS

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Applicable regulations and standards

- In case of components purchased from the market, it is vendor responsibility to make particular item fulfil all required regulations and standards.
- Concerning the designed devices, the RTM Carrier and LO RTM use only 12V and lower voltages, and does not have to fulfill any special regulations.
- Piezo driving RTM have to drive piezo stacks with voltage of +/-100V order of magnitude, and will have to fulfil following regulations:
  - **PN-EN 61010-1:2011** – safety requirements for measurement, automation and laboratory electrical devices
  - General requirements defines **EN 61010-1:2010** norm.

Radiation safety analysis

- Described system will not generate any radiation by itself, and will not be exposed to ionizing radiation.

LO RTM Internal failure

- **Probability**: unlikely
- **Caused by:** internal
- **Affects**: Down-converters of 4 RF section will not operate, resulting in LLRF system failure

LO RTM external failure

- **Probability**: depends on reliability of the external systems
- **Caused by:**
  - RTM Carrier failure
  - FPGA code error / software error / wrong parameters
  - Improper power level on one of the RF inputs
- **Affects**: Down-converters of 4 RF section will not operate, resulting in LLRF system failure

Piezo RTM Internal failure

- **Probability**: unlikely
- **Caused by:** internally
- **Affects**: Selected cavity may become detuned, or in the worst case piezo stack may become damaged

Piezo RTM external failure

- **Probability**: depends on reliability of the external systems
- **Caused by:**
  - RTM Carrier failure
  - FPGA code error / software error / wrong parameters
  - External power supply failure
  - Improper power level on the one of the inputs (in piezo sensor mode)
- **Affects**: Selected cavity may become detuned, or in the worst case piezo stack may become damaged

RTM Carrier #1 (LO RTM) Internal failure

- **Probability**: unlikely
- **Caused by:** internally
- **Affects**: LO Generation for given RF section (LO RTM external failure)
  - Communication with LO RTM lost in the best case
  - LO RTM damaged in the worst case

RTM Carrier #1 (LO RTM)
External failure

- **Probability**: depends on reliability of the external systems
- **Caused by:** MTCA components (power supply, etc.)
- **Affects:** LO Generation for given RF section (LO RTM external failure)
  - Communication with LO RTM lost in the best case
  - LO RTM damaged in the worst case

RTM Carrier #2 (Piezo RTM) Internal failure

- **Probability:** unlikely
- **Caused by:** internally
- **Affects:** Piezo resonance control for given cavity (Piezo RTM external failure)
  - Communication lost with the Piezo RTM in the best case
  - Piezo RTM damaged (and possibly the stack) in the worst case

RTM Carrier #2 (Piezo RTM) External failure

- **Probability**: depends on reliability of the external systems
- **Caused by:** MTCA components (power supply, etc.)
- **Affects**: Piezo resonance control for given cavity (Piezo RTM external failure)
  - Communication lost with the Piezo RTM in the best case
  - Piezo RTM damaged (and possibly the stack) in the worst case

Means of transportation of the equipment to the facility

Each LLRF system (one MTCA.4 chassis) will be packed into a single box, which should not weight more than 25 Kg, therefore no special equipment Is required for handling.

Acceptance test

Upon delivery of the LLRF systems, which was assembled and tested in Poland, commissioning at ESS site is needed. Foreseen procedure for commissioning is following:

After delivery and installation of the LLRF systems, which were assembled and tested in Poland, commissioning at the ESS site will be performed. Procedure for commissioning will be following:

- **Visual inspection,** if there are no problems caused by the transportation.
- **Installation in the rack**, connection of the cavity simulator
- **MTCA.4 crate power-on**
- **Confirm proper operation** of the MTCA components (MCH, CPU, power supplies and fans)
- **Close the feedback** and check the performance with Cavity Simulator
- **Power-down the crate**
- **Re-attach the signals** from the cavity simulator to the machine

Detailed acceptance test procedure will be agreed with the ESS before shipment.

Conventional hazards

In case of piezo cable damage, there is risk of electrical shock,

due to output voltage of +/- 100V.

The End

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Thank You for Your Attention !