Software Design and Implementation of the SHINE LLRF System

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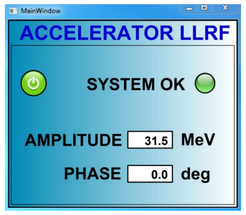
Introduction

This report presents the design and implementation of the SHINE LLRF system software. The software architecture is designed in a layered approach, consisting of two layers. The lower layer is responsible for low-level control of individual sites, specifically for each cavity. It implements EPICS IOC (Input/Output Controller) on the Zynq platform to handle various operating scenarios including normal operation, equipment maintenance, and fault handling. The upper layer is the management software that oversees all the sites and implements collaborative logic between them. It monitors the status of all the sites and handles any faults that may occur. It also includes fault analysis capabilities for troubleshooting purposes.With this software architecture, the system can effectively manage and monitor multiple sites, allowing for coordinated operation and efficient fault handling.

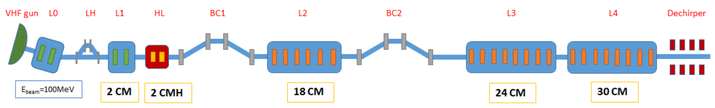
goal

The ideal LLRF software should provide users with a clear and simple operating interface[1].

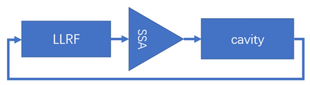


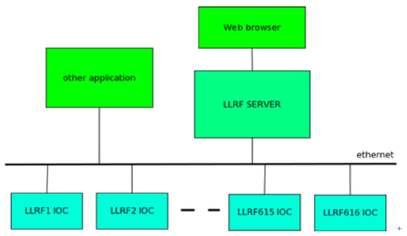
- make it simple
- need to do a lot of work
- from operability to automation and ultimately to intelligence

struct



- accelerator linacs has 77 modules
- a RF interlock for each module
- each module has 8 cavities

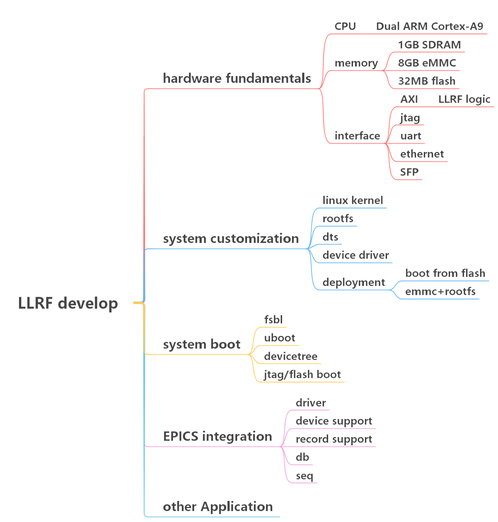




1. **Single LLRF station:**Coordinate hardware and firmware, responsible for controlling a single superconducting cavity.
2. **LLRF server:** Responsible for implementing control logic between multiple superconducting cavities

Single LLRF station

1. normal operation
   - status monitor
   - parameter configure
   - waveform acquisition and transmission
   - tune relation
   - parameter management
2. equipment maintenance
   - Automatic start/stop
   - cavity condition
   - tune relation
   - calibration and testing
   - Remote update algorithm logic
3. fault handling
   - fault handle
   - data transmission

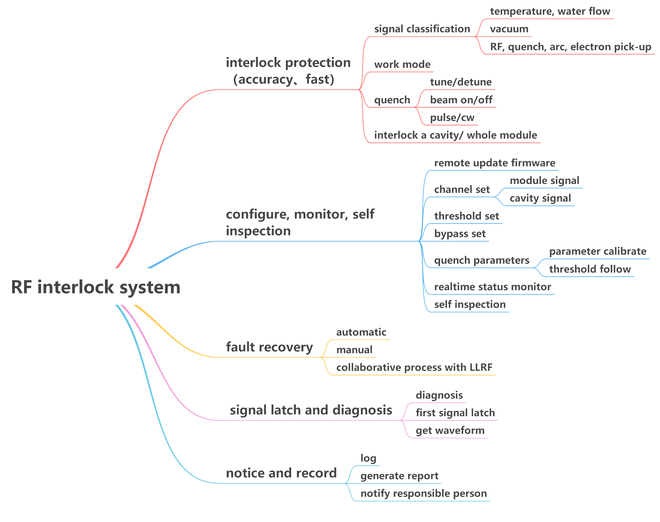


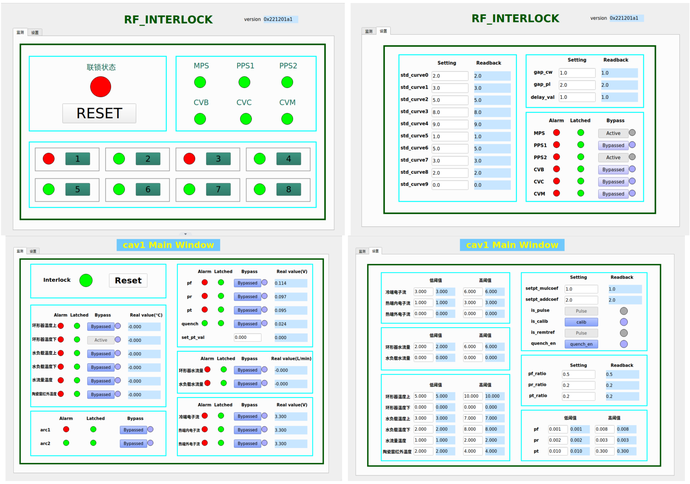
LLRF server

LLRF server implements collaborative logic between various LLRF stations,manages RF resources, and provides access interfaces to external systems.

1. Implement a web server
   - Provide fault station display page
   - provide stations status viewing page
   - provide parameter setting page
2. parameter management and automated operation
   - Parameter management for all LLRF stations
   - Automatic adjustment of control parameters during operation
3. fault handling
   - record fault logs
   - notify the responsible person via email or WeChat
   - Process the fault data uploaded from various sites, analyze the cause of the fault, and generate a fault report

RF interlock





References

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