Operation Status of J-PARC MR Machine Protection System and Future Plan

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Abstract

The J-PARC MR's Machine Protection System (MR-MPS) was introduced from the start of beam operation in 2008. Since then, MR-MPS has contributed to the improvement of safety including stable operation of the accelerator and the experiment facilities. The present MR-MPS needs to be reviewed from the aspects such as increase of connected Component, addition of power distribution building, flexible beam abort processing, module uniqueness, service life etc.
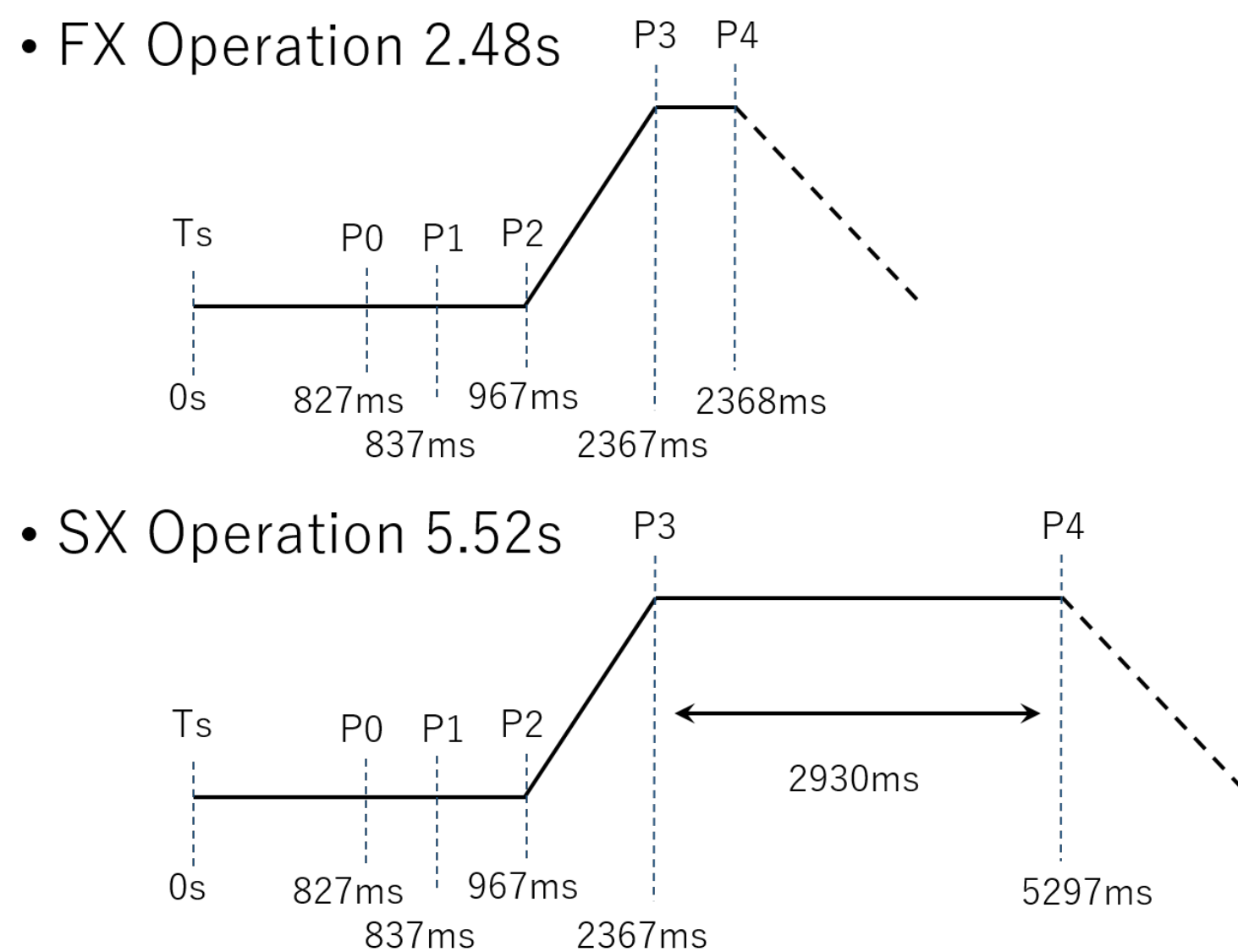In this poster, we show the performance of MR-MPS and show future consideration of upgrade.
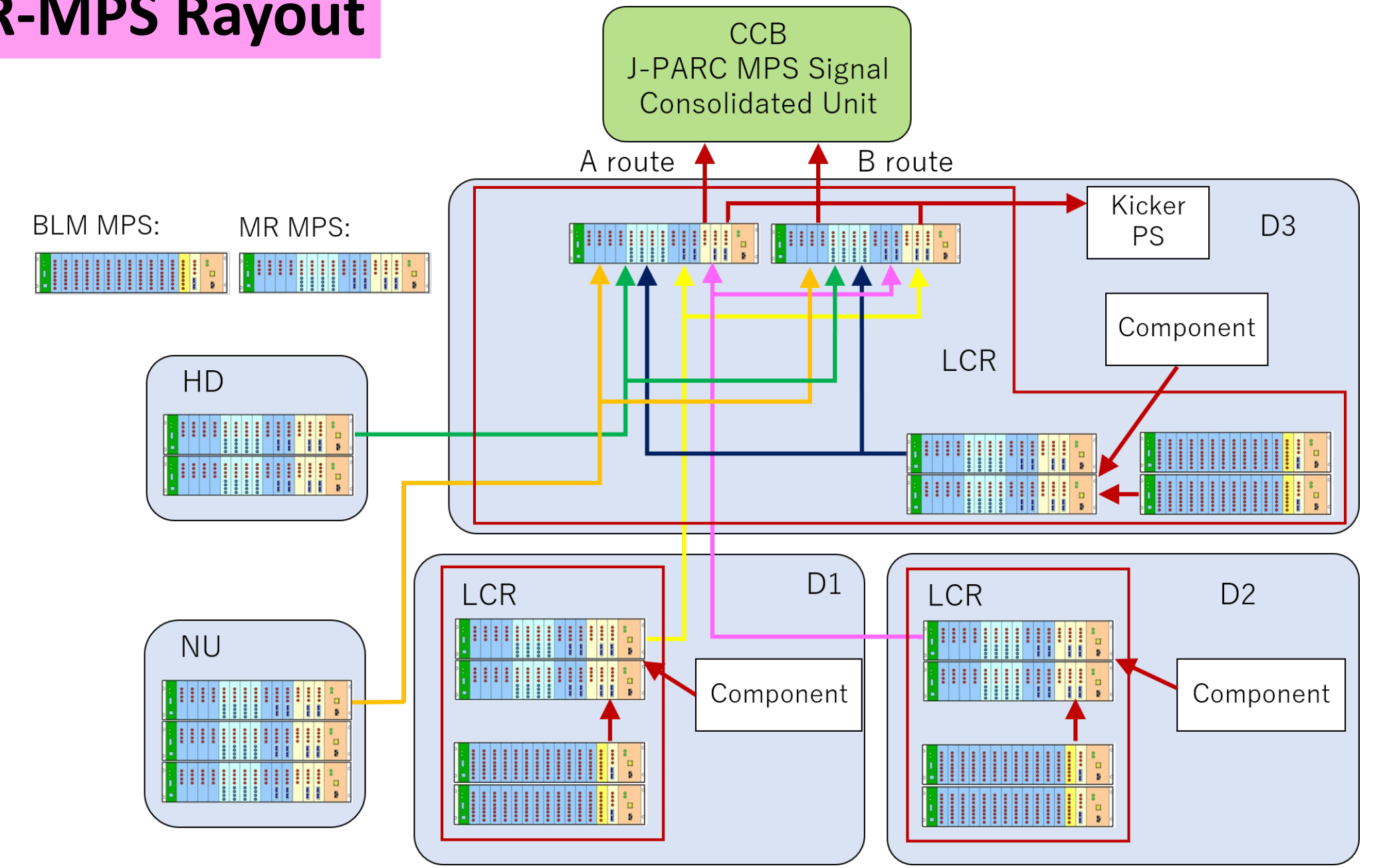
J-PARC MR-MPS

J-PARC Overview

MR Operation Mode

- FX Operation 2.48s
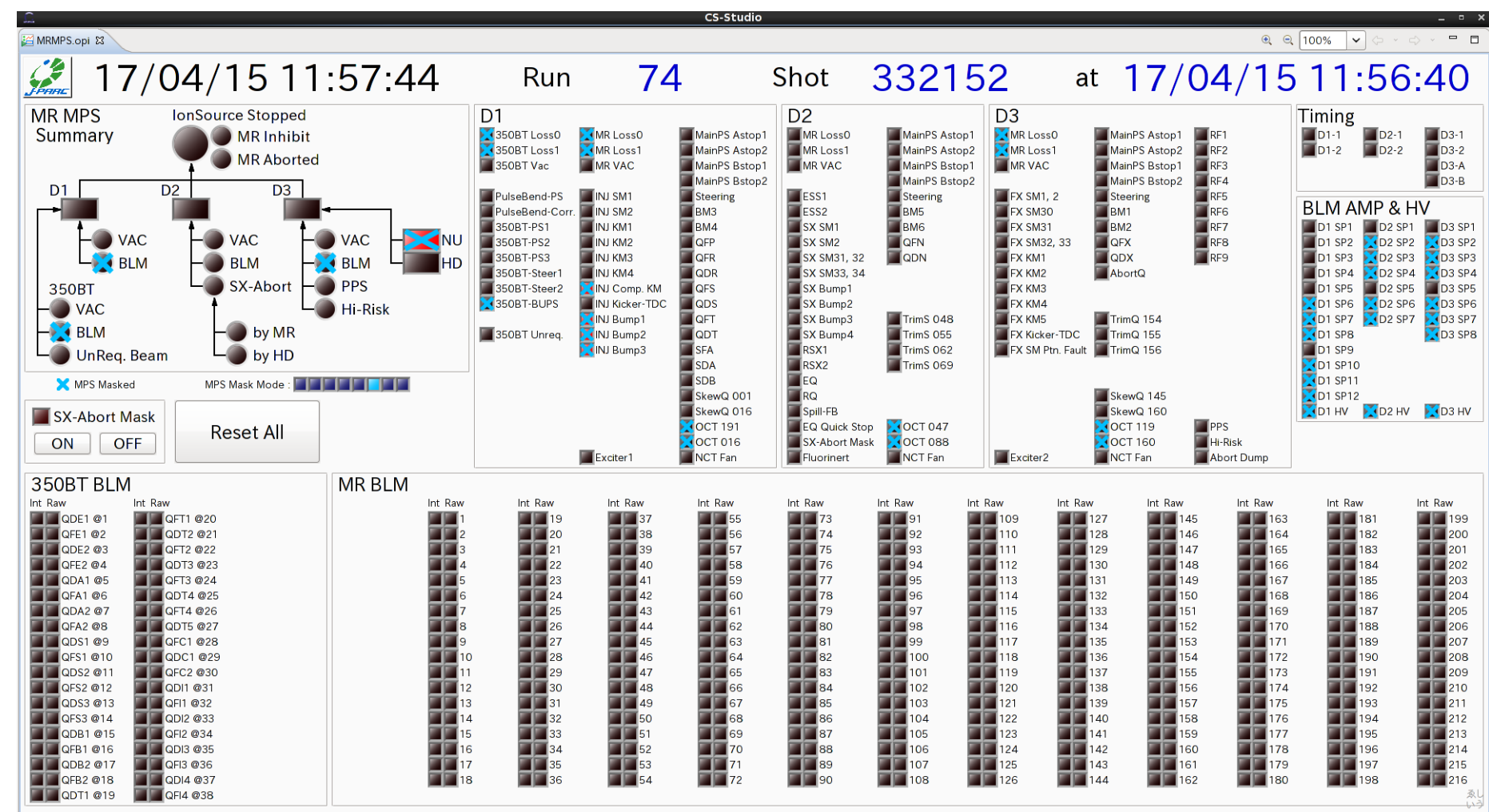

- SX Operation 5.52s
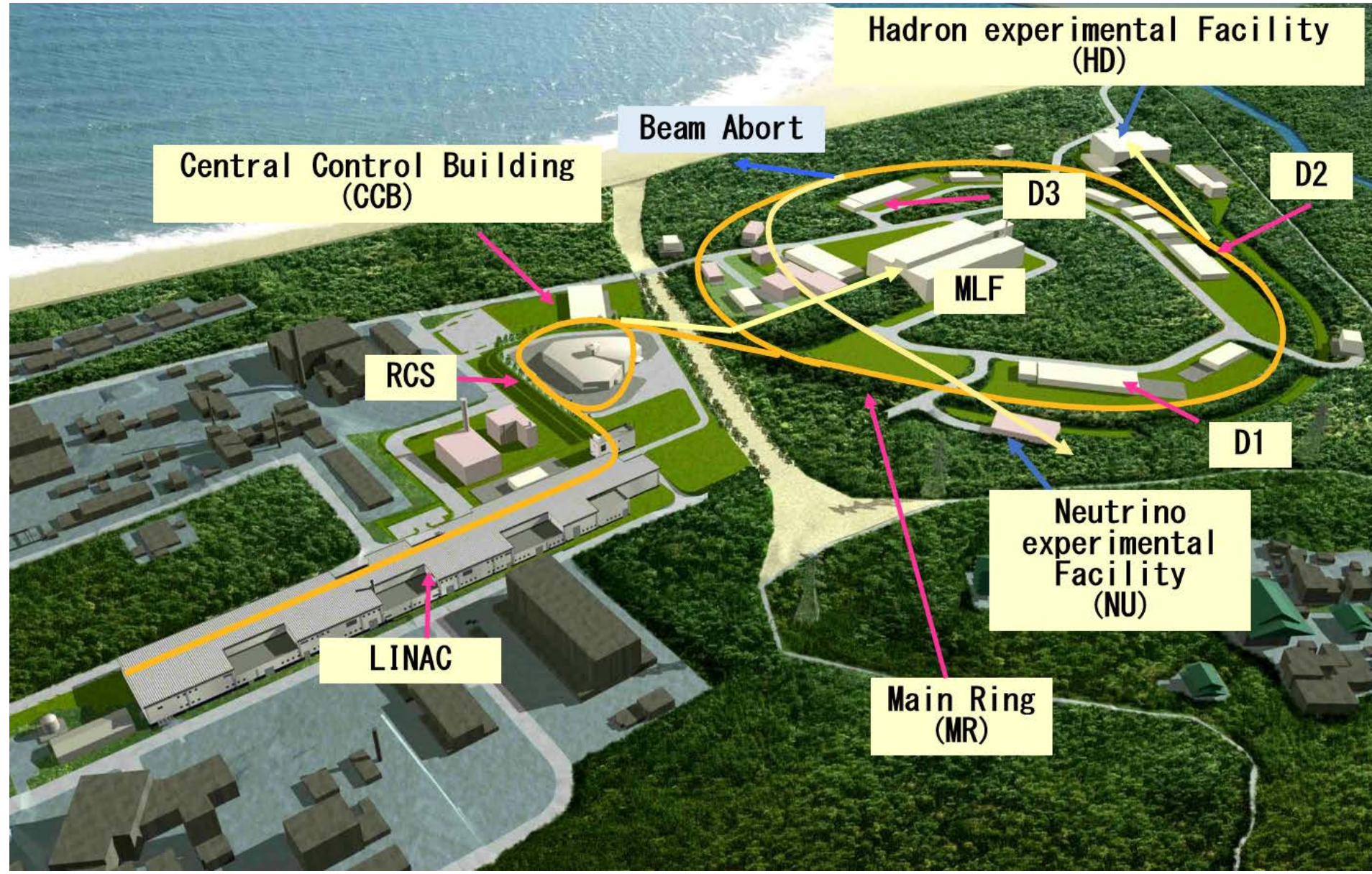
MR-MPS Rayout

MR-MPS operation status

MR-MPS Display

MR-MPS Unit

- CPU board
  - FPGA: ALTERA Cyclone V
  - CPU: ARMv7
  - Memory: 1GB
- Contact signal input board
- Optical signal input board(ST connecter)
- TTL signal input board
- Optical transceiver board(SC connecter)
- Power supply

MPS Output Signal Mask

- Beam operation stop process
  - All stop
    - J-PARC all accelerator beam operation stop
  - MR inhibit
    - MR only beam operation stop
- Beam abort process
  - Abort
    - Scheduled (P4) timing beam abort
  - Extra abort
    - msec Abort
      - Immediately (perform in about millisecond) beam abort
        - After 2017 summer shutdown, system deployment for FX operation
        - After 2019 summer shutdown, system deployment for SX operation
    - SX Abort
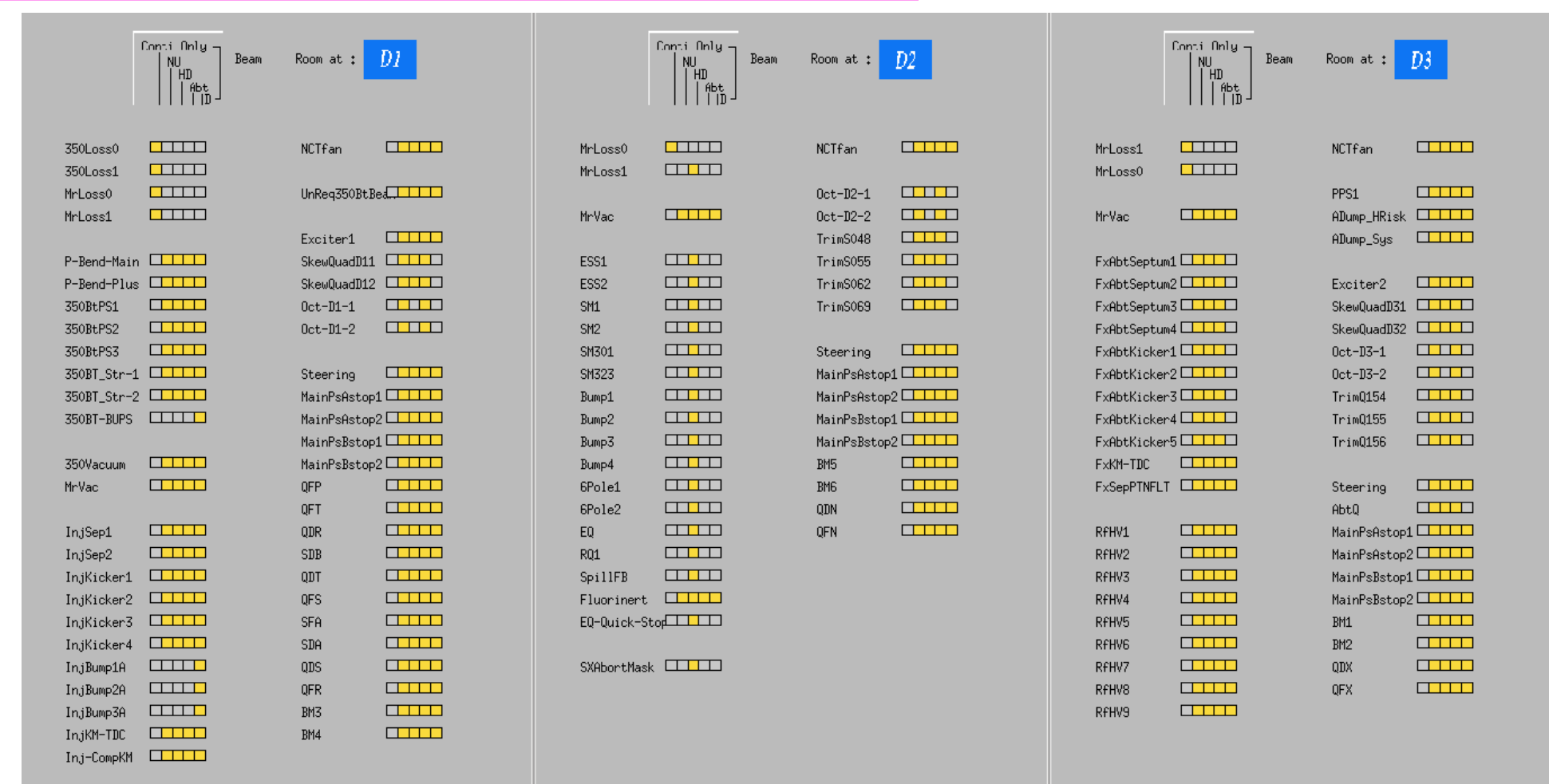   - Slow Extraction component stop

Number of Input Signals

	D1	D2	D3	Total
MR-MPS input signals	51	38	45	134
BLM-MPS input signals	110(38)	72	72	254

MPS Signal Process

NU or Abort Dump   Acceleration term   MR inhibit + Abort
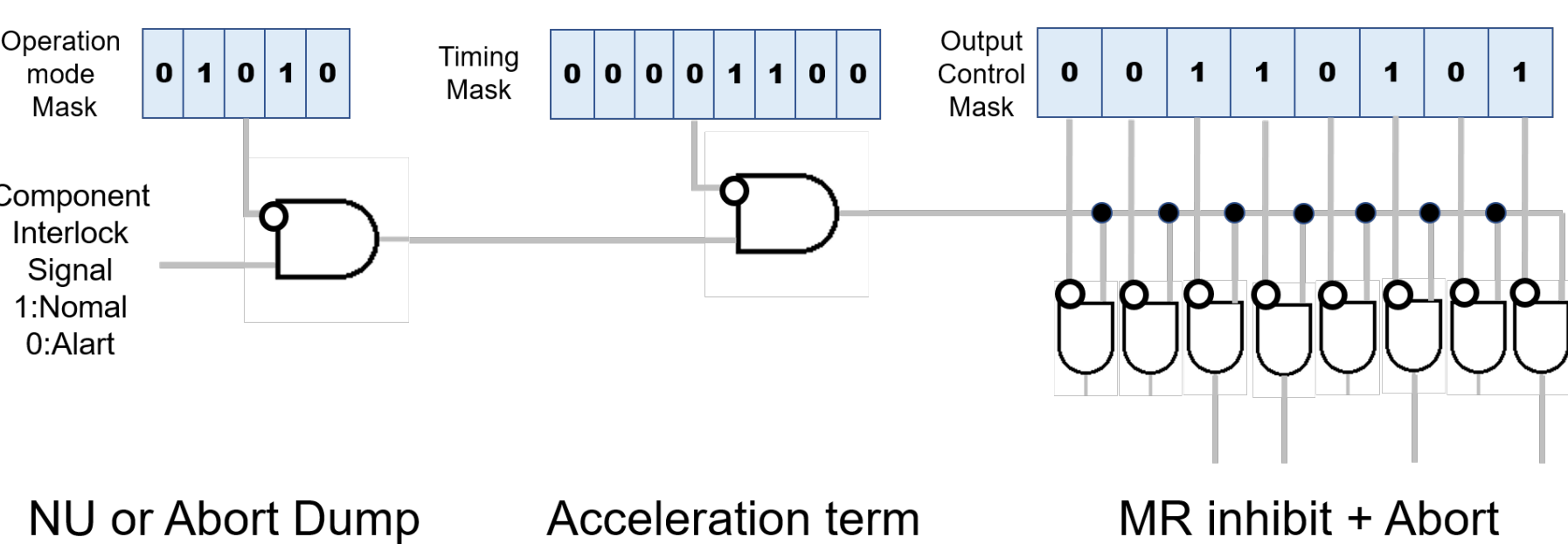
MPS Operation Mode Mask

- Mask the MPS signal according to operation mode
  - some components are not used depending on the operation mode
- MPS CPU boards get operation mode using EPICS
- Change the mask according to the config file
  - Abort mode
    - FX operation, SX operation: beam destination is MR Abort Dump
  - NU mode
    - FX operation: beam destination is NU target
  - HD mode
    - SX operation: beam destination is HD target
  - Continuance mode
    - MR is Continuous operation: beam destination is anywhere

MPS Timinig Mask

MR-MPS Future Plan

Adding New Function
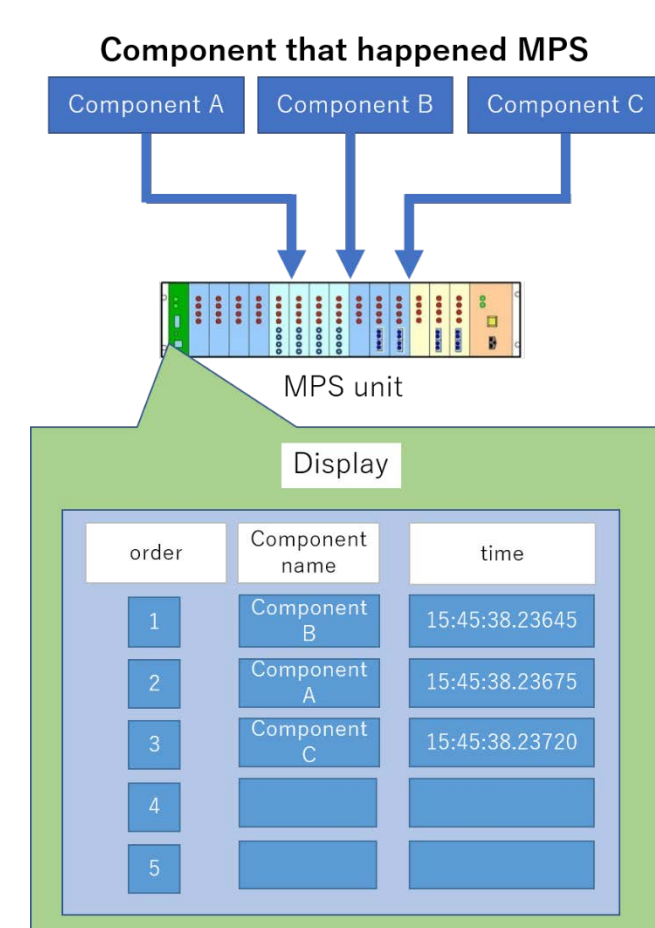
- Currently, record component states every 1 msec using EPICS
  - We cannot know the order of alerts
- Future plan, record component states every 1.5 μsec using CPU (MPS unit)
- Recording is reset every 10 sec
- Recording is asynchronous with the MR operation cycle, so it is necessary to synchronize with the program
- Adjust to MR operation cycle using software

Improve Noise Resistance
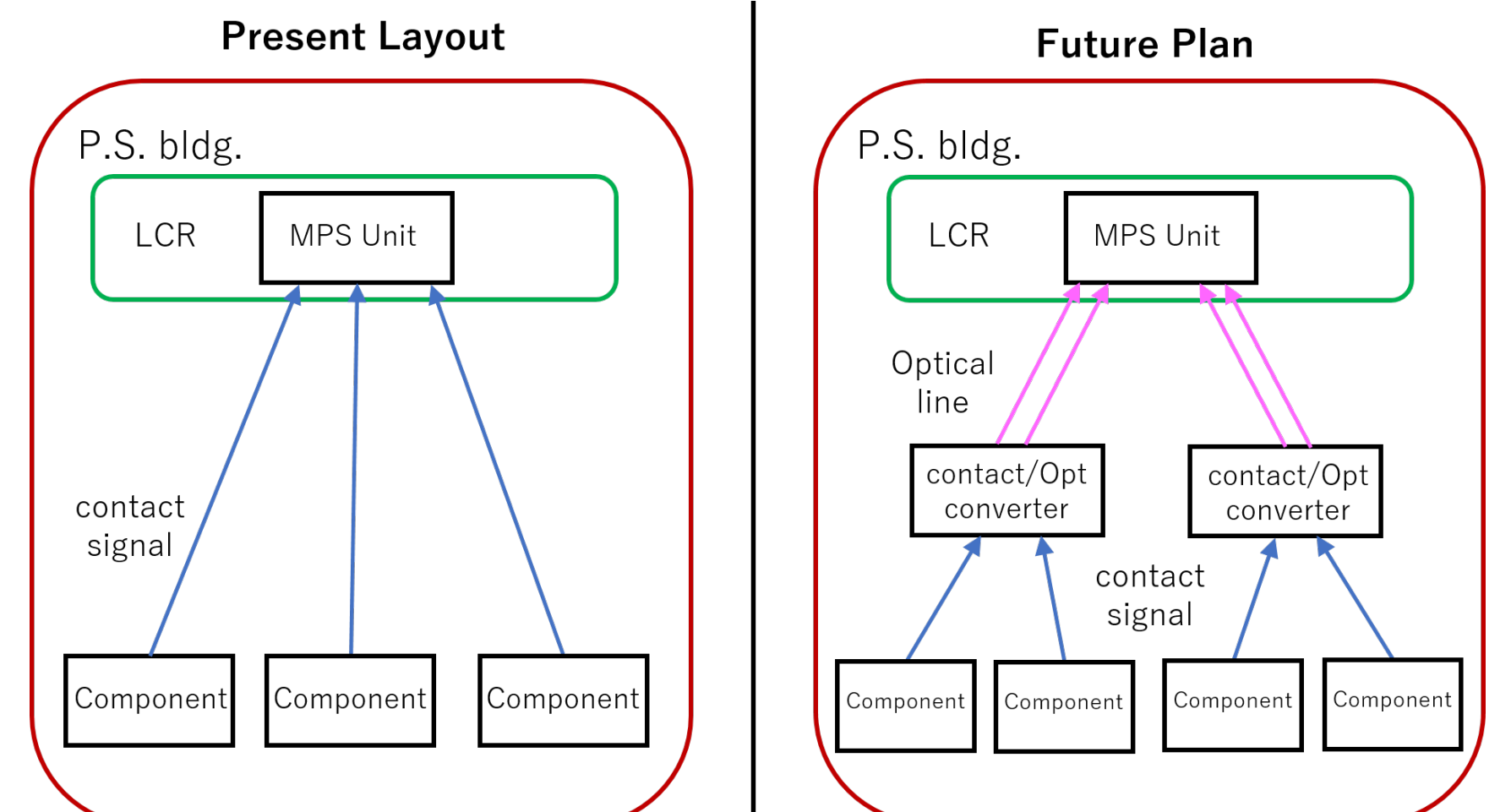
Development of New MPS

- Current MPS problems
  - MPS Unit update is necessary for 10 years from the start of operation
  - Impossible to reproduce the backplane
  - Increase MPS signal
    - Currently it is possible to output 4 types of 8 channel signals
    - 5 types of MPS signals are already required
    - There are no problems if 4 types can be used in one operation mode
      - However, work is required when changing the operation mode
    - There is a possibility that MPS signal further increases

- Selection of backplane
  - The current MPS unit was developed in-house
    - Advantages are cost saving
    - Disadvantages become difficult to reproduce over the years
  - μTCA
    - Long-term productivity can be expected

- Design
  - Management of MPS signal using FPGA
  - Stability improvement by limiting to simple signal processing
  - Increase MPS signal output from 8 channels to 16 channels
  - Tree structure to consolidate in D3 power distribution building
  - Monitoring MPS alert status using network

- First phase
  - Make the same function as present using μTCA
  - Trial operation of the new MPS unit in one power distribution bldg.
- Second phase
  - Replace all MPS units
- Third phase…