

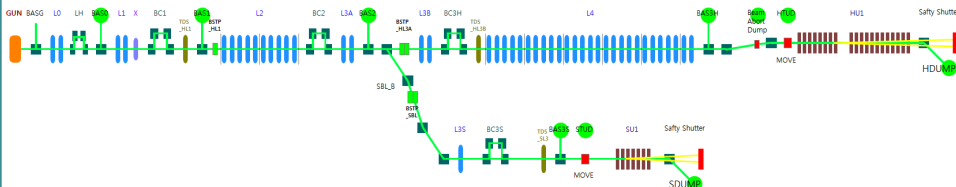
# Beam Loss Monitor for Undulators in PAL-XFEL\*

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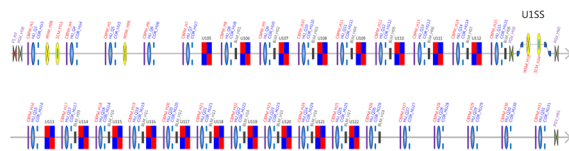
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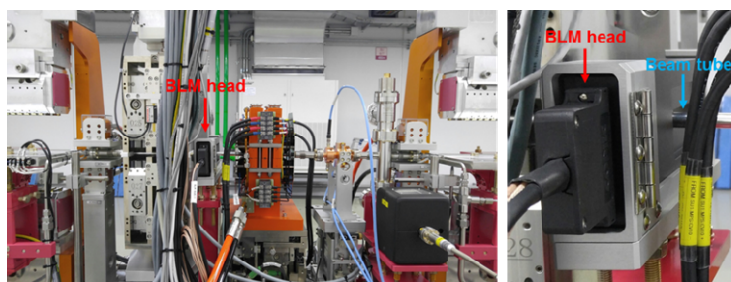
## Lattice of PAL-XFEL



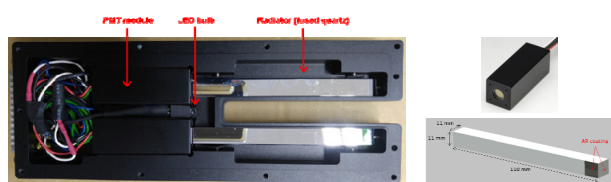
## HX Undulator Lattice



## Installation of BLM Head



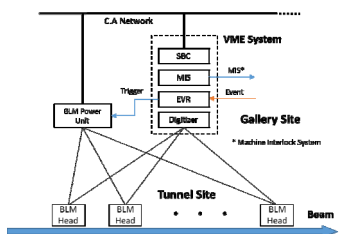
## BLM Head



- Radiator, PMT modules and LED bulb
- Convert Cherenkov radiation into electric signal
- Radiator: fused quartz rods with Al and AR coating
- PMT module: Hamamatsu H10722-110 (230 – 700-nm spectral range)
- LED bulb: with 480 – 520-nm wavelength for heartbeat signal

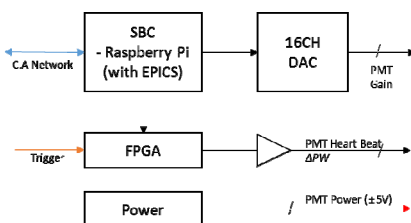
## ADC System

### ADC system

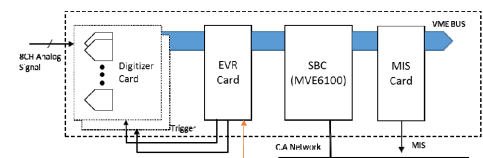


- 3 ADC for HX and an ADC for SX

### Power unit

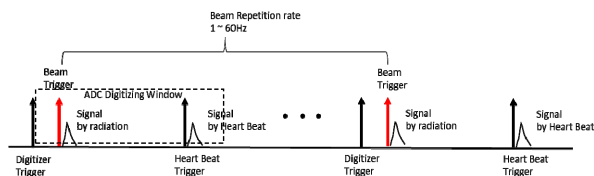


### VME system

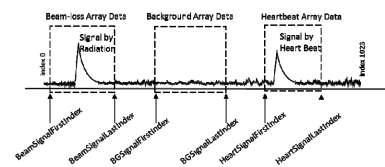


- Switch sampling frequency with 0.78, 1.56, 3.125, 6.25, 12.5, 25, 50, 100 MS/s

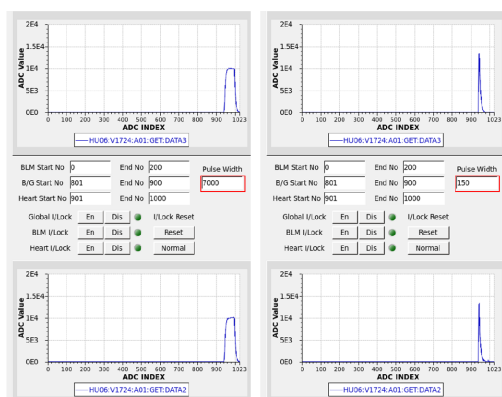
## Event trigger



## Trigger timing window



## Calibration and Operation



- Calculate beam loss signal

$$L_{beam} = \frac{\int(\text{beam loss signal})}{\Delta t_{beam}} - \frac{\int(\text{background signal})}{\Delta t_{back}}$$

- Calibration

- Adjust  $V_{ctrl}$  for set PMT gain
- flat top of the heartbeat signal became 10000 AD unit

- Operation

- $V_{ope} = V_{cal} + 0.6 V$
- $G_{PMT,n} = a_n \cdot V_{ctrl,n}^{8.6}$

## Summary

- BLM system based on Cherenkov radiator was developed for undulators
- Consists of BLM head and ADC part
- BLM head with radiator, PMT modules and LED bulb
  - Radiator: fused quartz rod
  - PMT module: 230 – 700-nm spectral range
  - LED bulb: heartbeat signal
- ADC system: power unit and VME system
- Event trigger with beam loss, background, and heartbeat
- Calibration with heartbeat signal