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JASRI/SPring-8

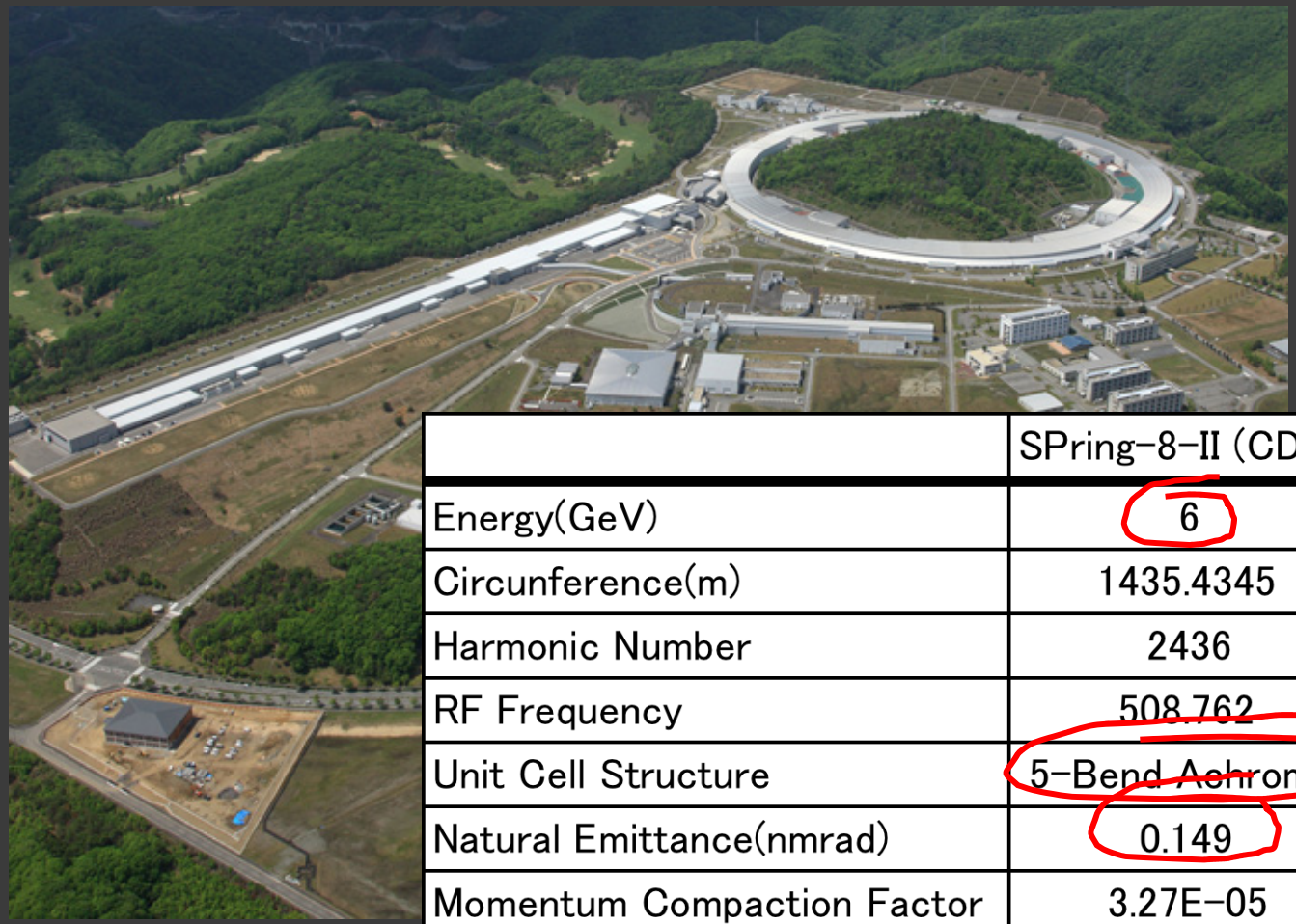
STATUS OF THE CONTROL SYSTEM FOR THE SACLA/SPRING-8 ACCELERATOR COMPLEX

Contents

- Overview of the SACLA/SPring-8
- Design of the Control System
  - Conceptual Design
  - Software Framework
  - Equipment Control
- Status of the Project
- Summary

Overview of the SACLA/SPring-8

Overview of the SACLA/SPring-8

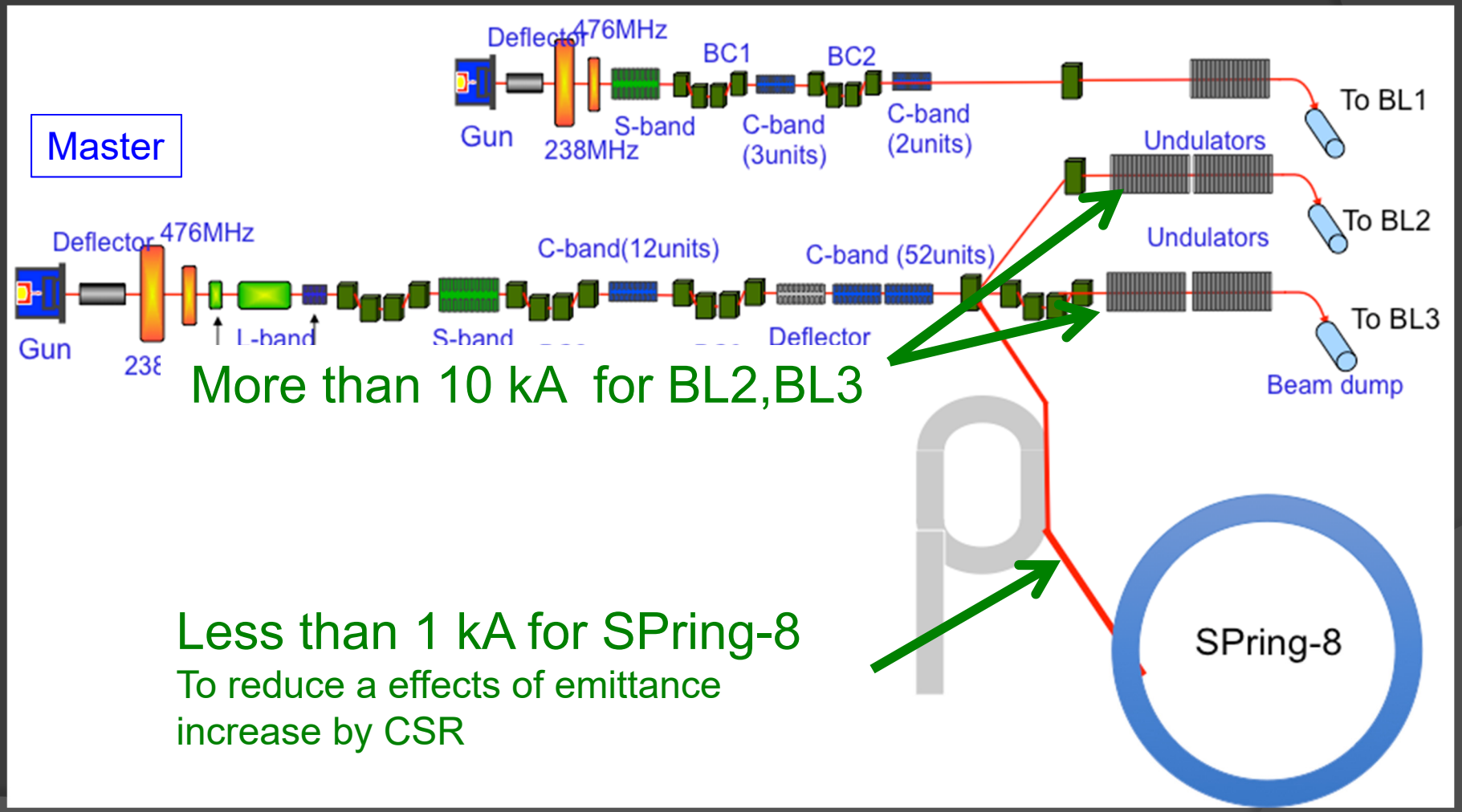


	SPring-8-II (CDR)	SPring-8 (Present)
Energy(GeV)	6	8
Circunference(m)	1435.4345	1435.9488
Harmonic Number	2436	2436
RF Frequency	508.762	508.58
Unit Cell Structure	5-Bend Achromat	Double-Bend
Natural Emittance(nmrad)	0.149	2.4
Momentum Compaction Factor	3.27E-05	1.60E-04
Relative Energy Spread(%)	0.093	0.109

Design of the Control System

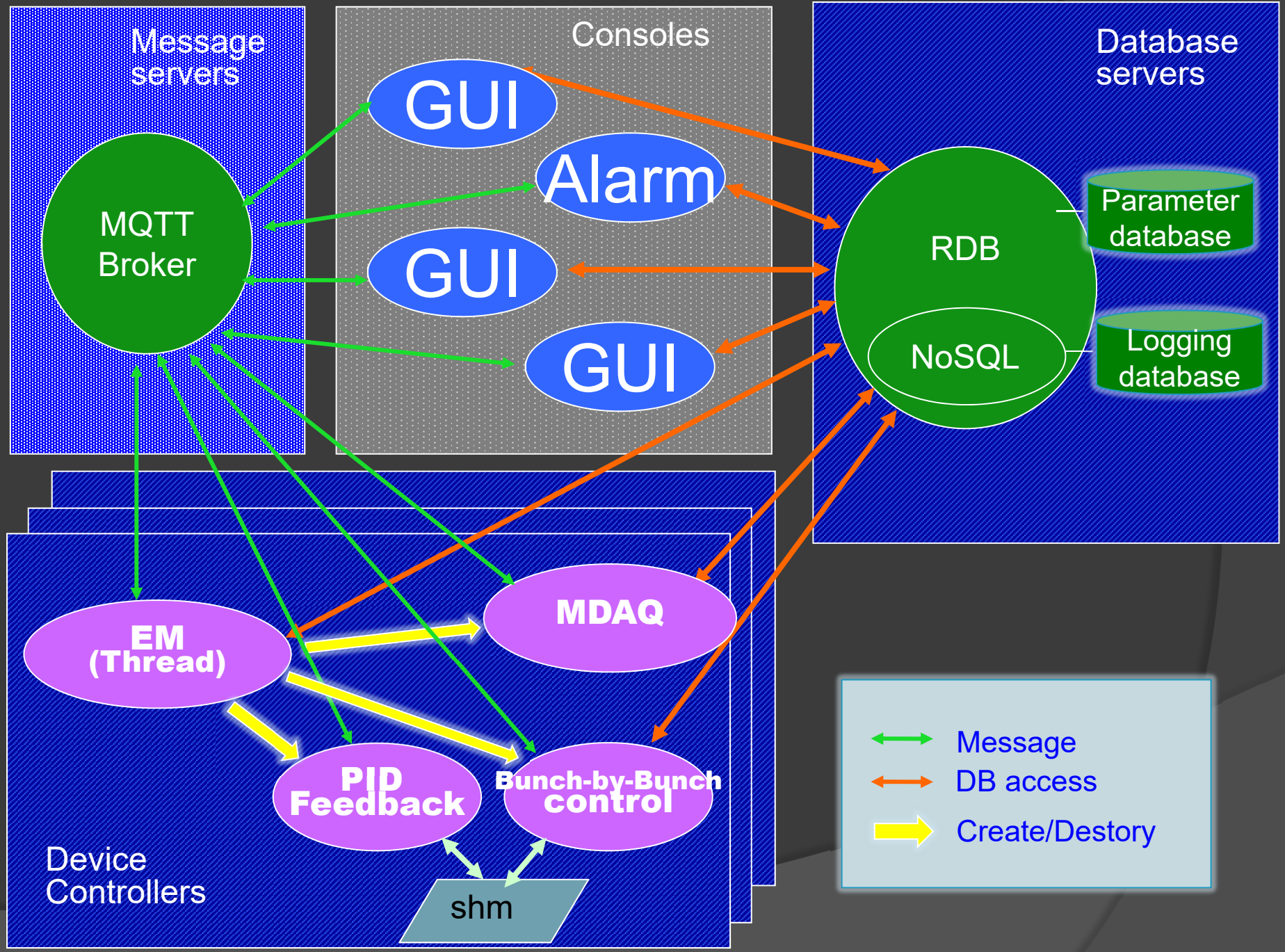
- Requirements
  - SACLA to be used as a full-energy injector for the SPring-8-II
    - Dynamic aperture will be narrower than that in the current SPring-8
      - We can not use existing injectors
    - Save a operation cost, because SACLA is always running for user experiments independently from SPring-8-II
  - Enable operation by SACLA users experiments and beam injection to SPring-8-II in parallel
    - SACLA has to control the beam energy and peak current on a bunch-by-bunch basis

Schematic view of SACLA/Spring-8



Design of the Control System

- We keep a concept of the MADOCA
  - Message oriented communication with S/V/O/C style syntax
  - RDBMS for a parameter database
  - Distributed control system with the network
- We redesign the framework by using a modern Information Technology
  - Many Core CPU with multi-thread
  - MQTT
  - OSS – MariaDB & Cassandra


Message servers
MQTT Broker
Consoles
GUI
Alarm
GUI
GUI
Database servers
RDB
NoSQL
Parameter database
Logging database
EM (Thread)
MDAQ
PID Feedback
Bunch-by-Bunch control
shm
Device Controllers
Message
DB access
Create/Destory

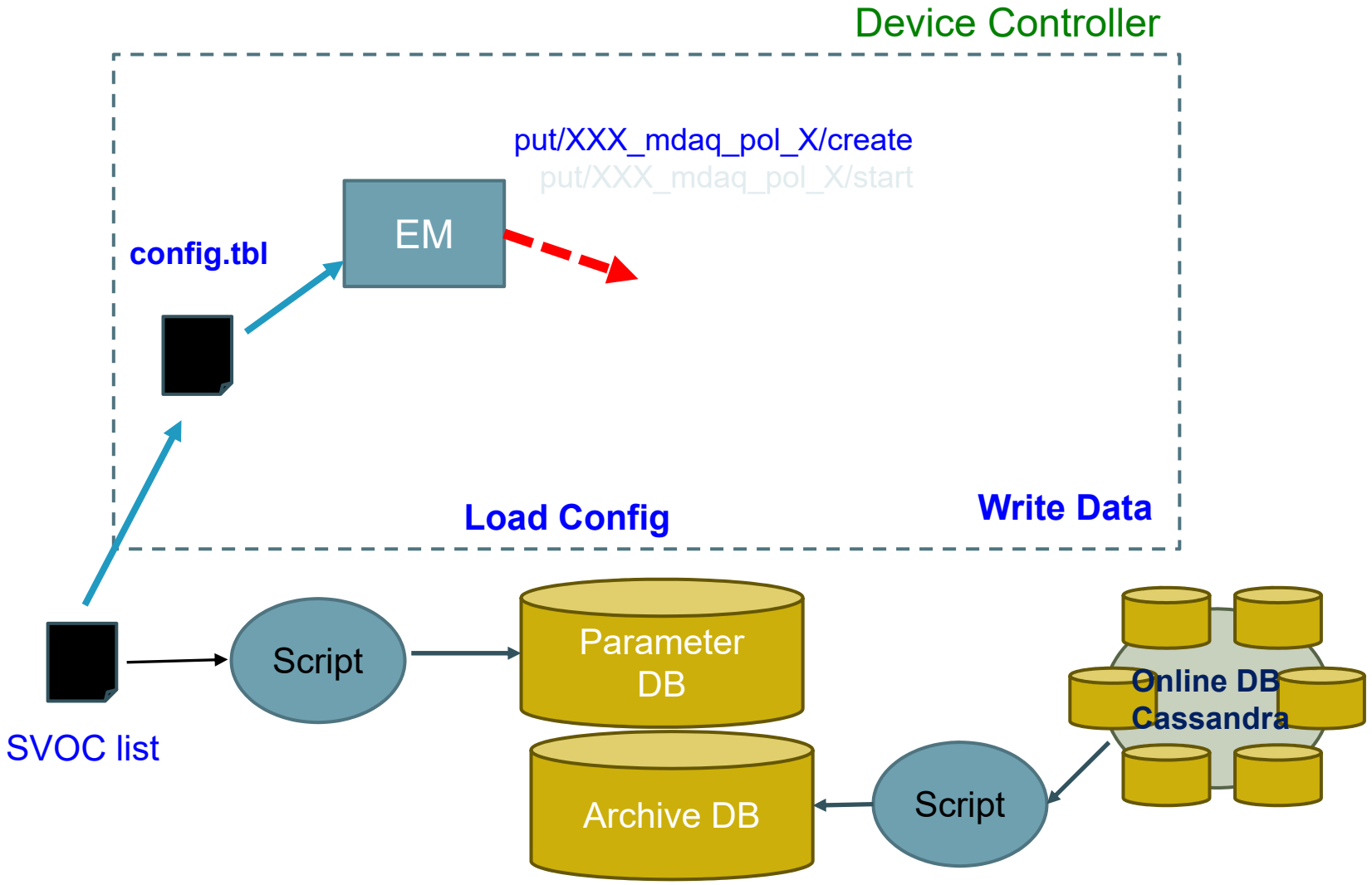
Software Framework

- Use MQTT(MQ Telemetry Transport)
  - Lightweight Publish/Subscribe messaging protocol
  - Topics are using a slash (/) as a separator
    - Same as MADOCA message
  - Reliable communication with QoS, retain and will
- EM(Equipment Manager) as an only process at a boot-up
  - Implemented with multi-thread
  - Shared memory to communicate between processes

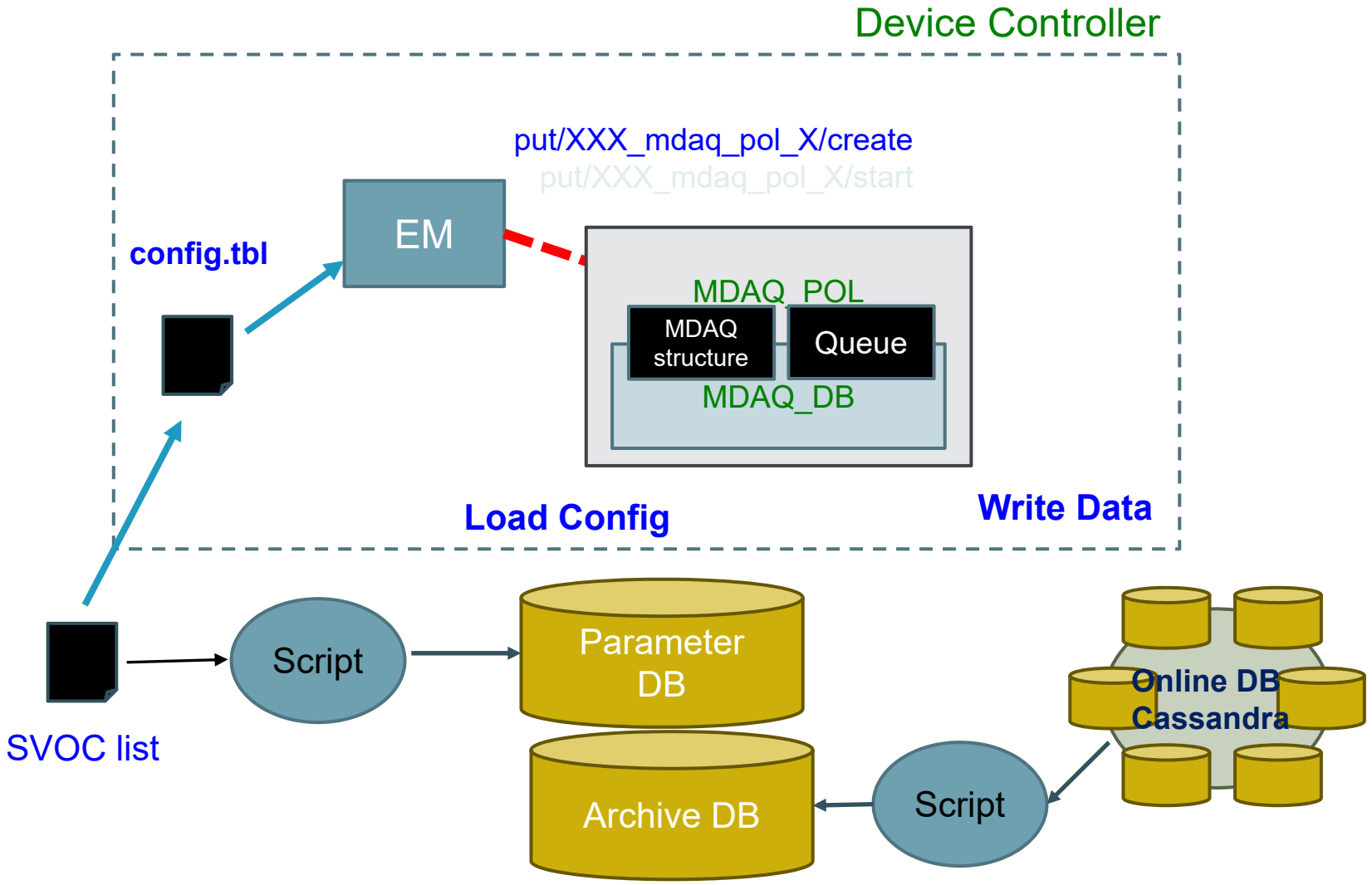
Software Framework

- Use Cassandra for OnlineDB, MariaDB for ArchiveDB and ParameterDB (TUBPA03)
- Data acquisition process, called MDAQ
  - Point data with fixed acquisition interval
  - Point data acquired by triggered event
  - One-dimensional array
  - Two-dimensional array
- MDAQ has a keep alive function to report MDAQ status to parameterDB

MDAQ


Device Controller
put/XXX_mdaq_pol_X/create
put/XXX_mdaq_pol_X/start
EM
config.tbl
Load Config
Write Data
Script
Parameter DB
Online DB Cassandra
SVOC list
Archive DB
Script

MDAQ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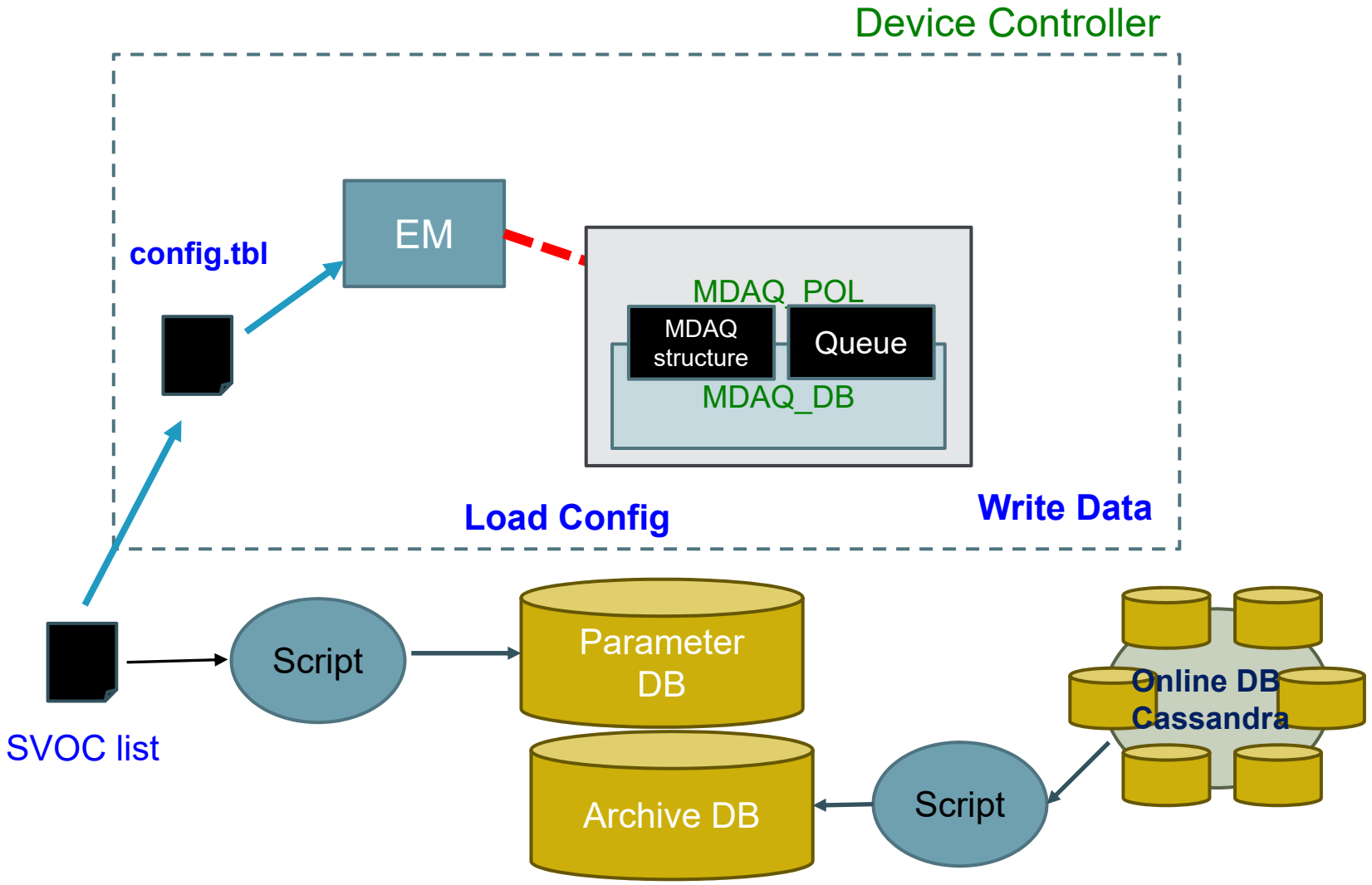
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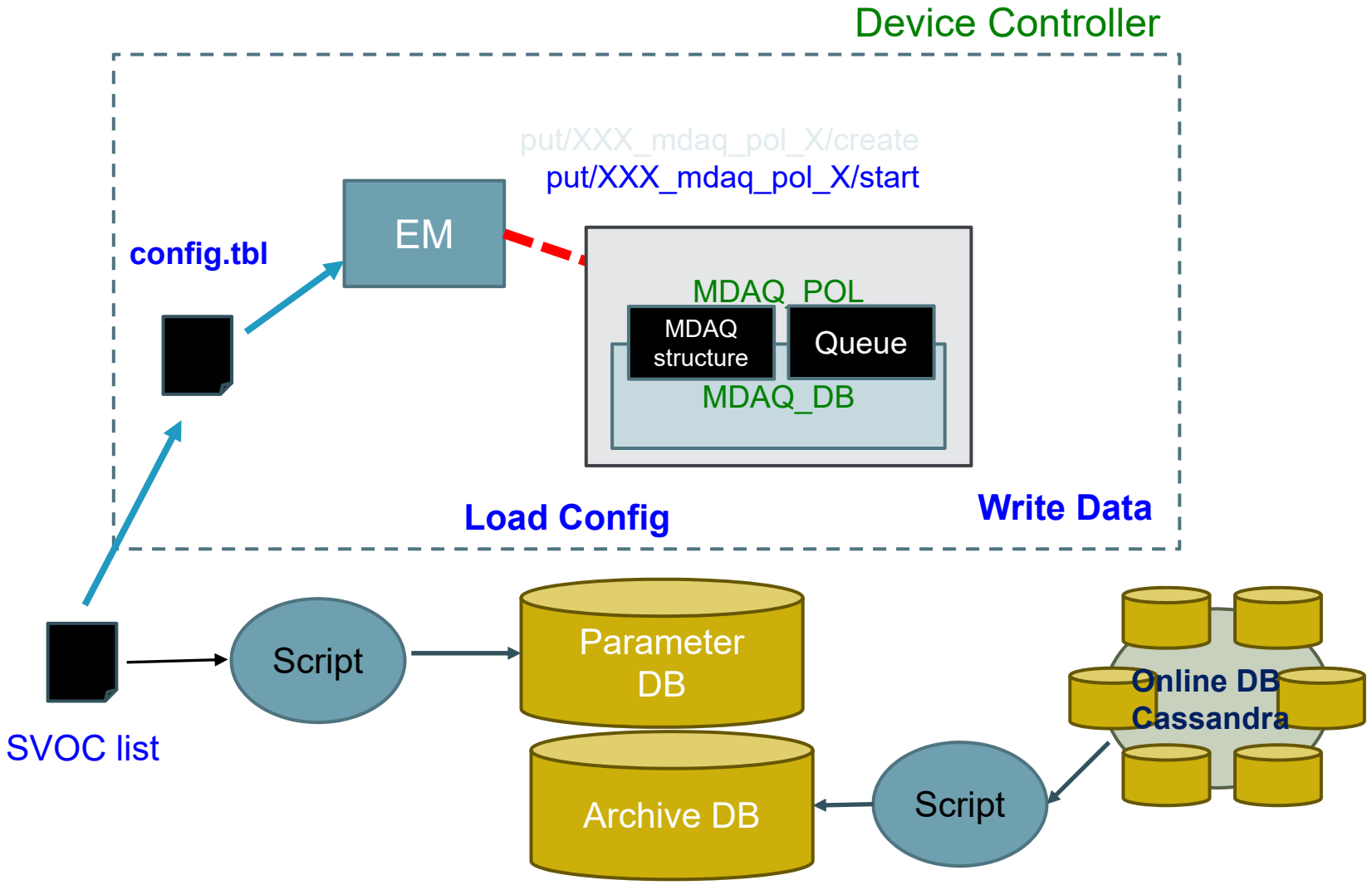
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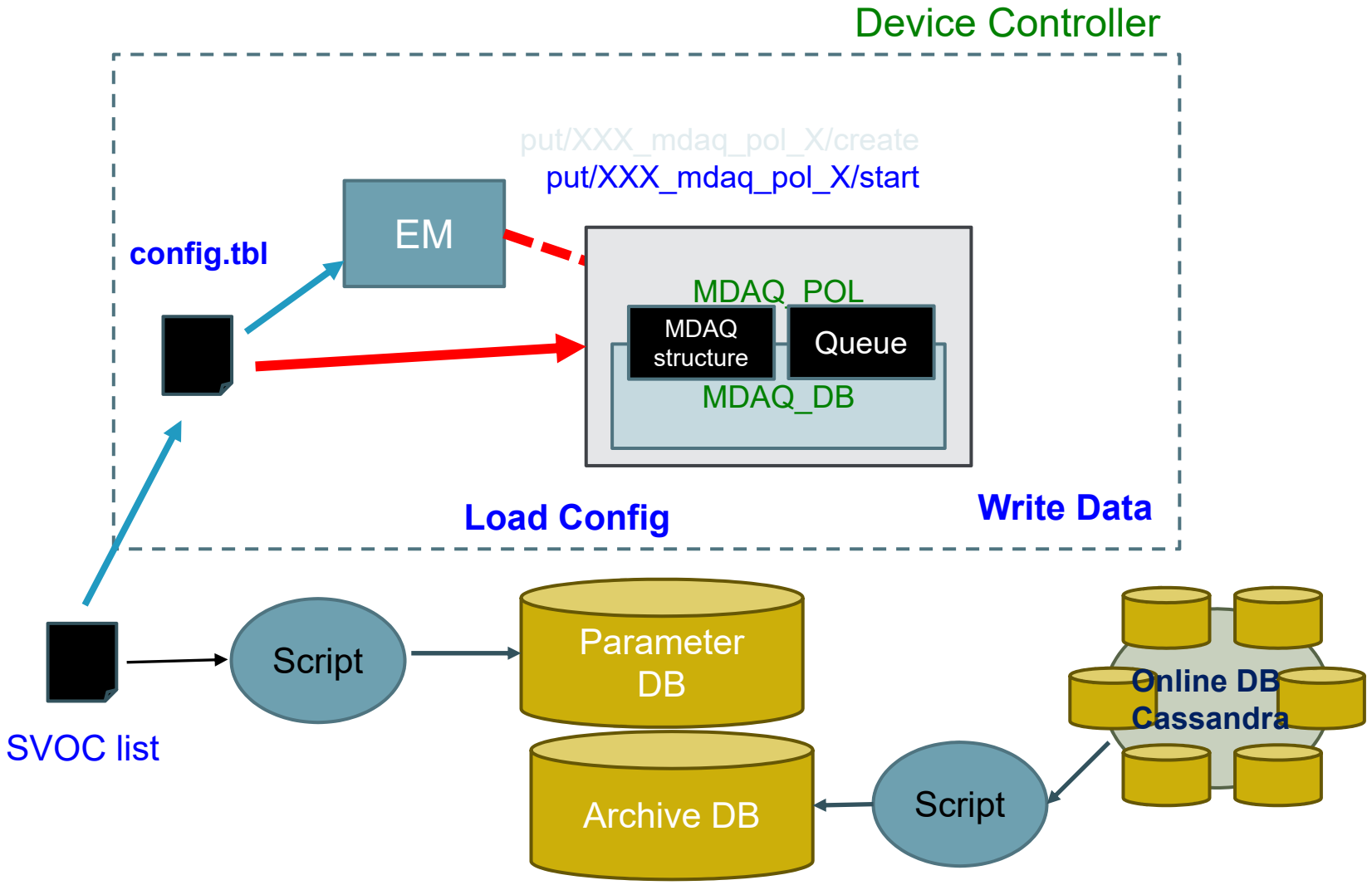
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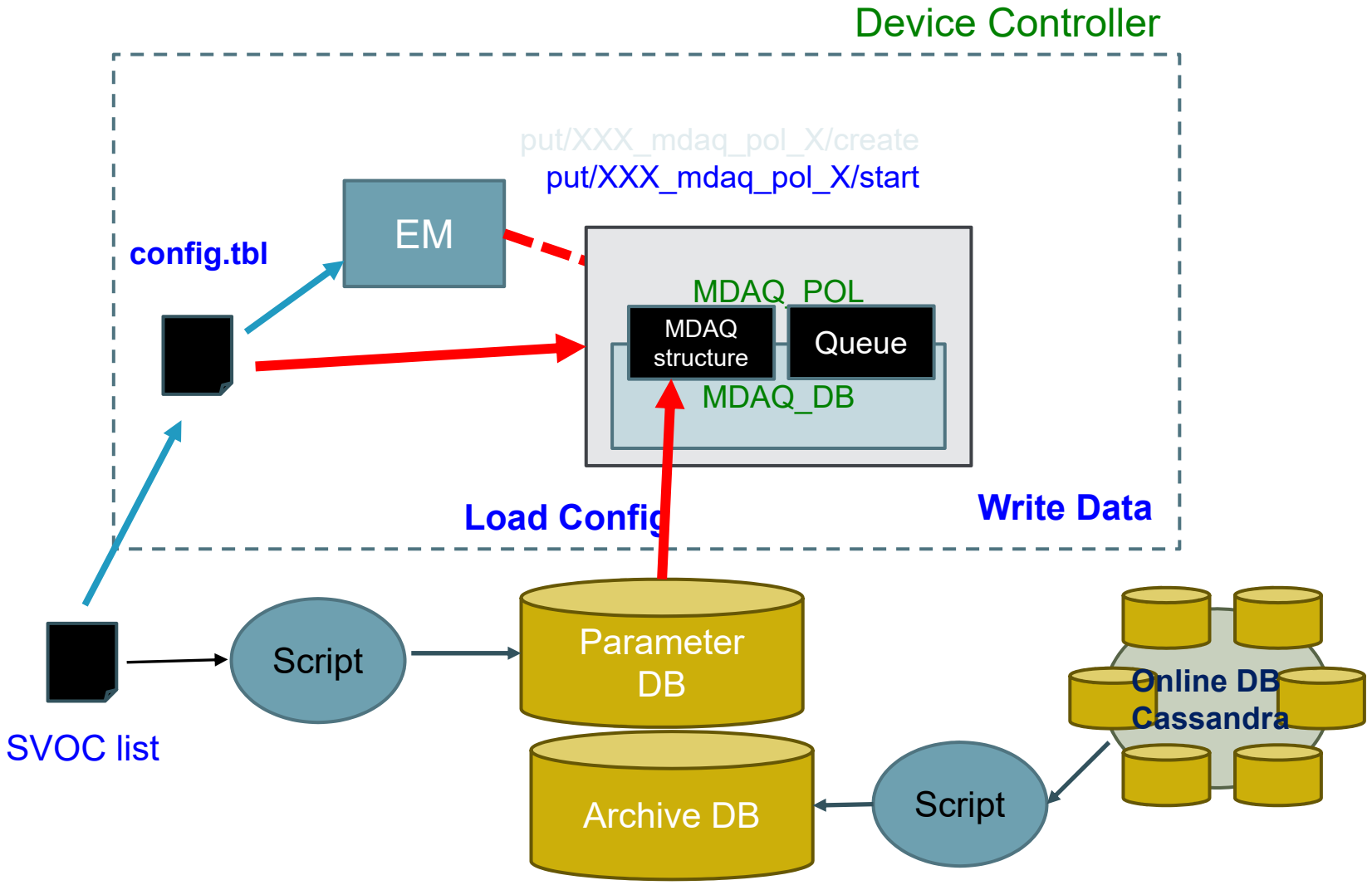
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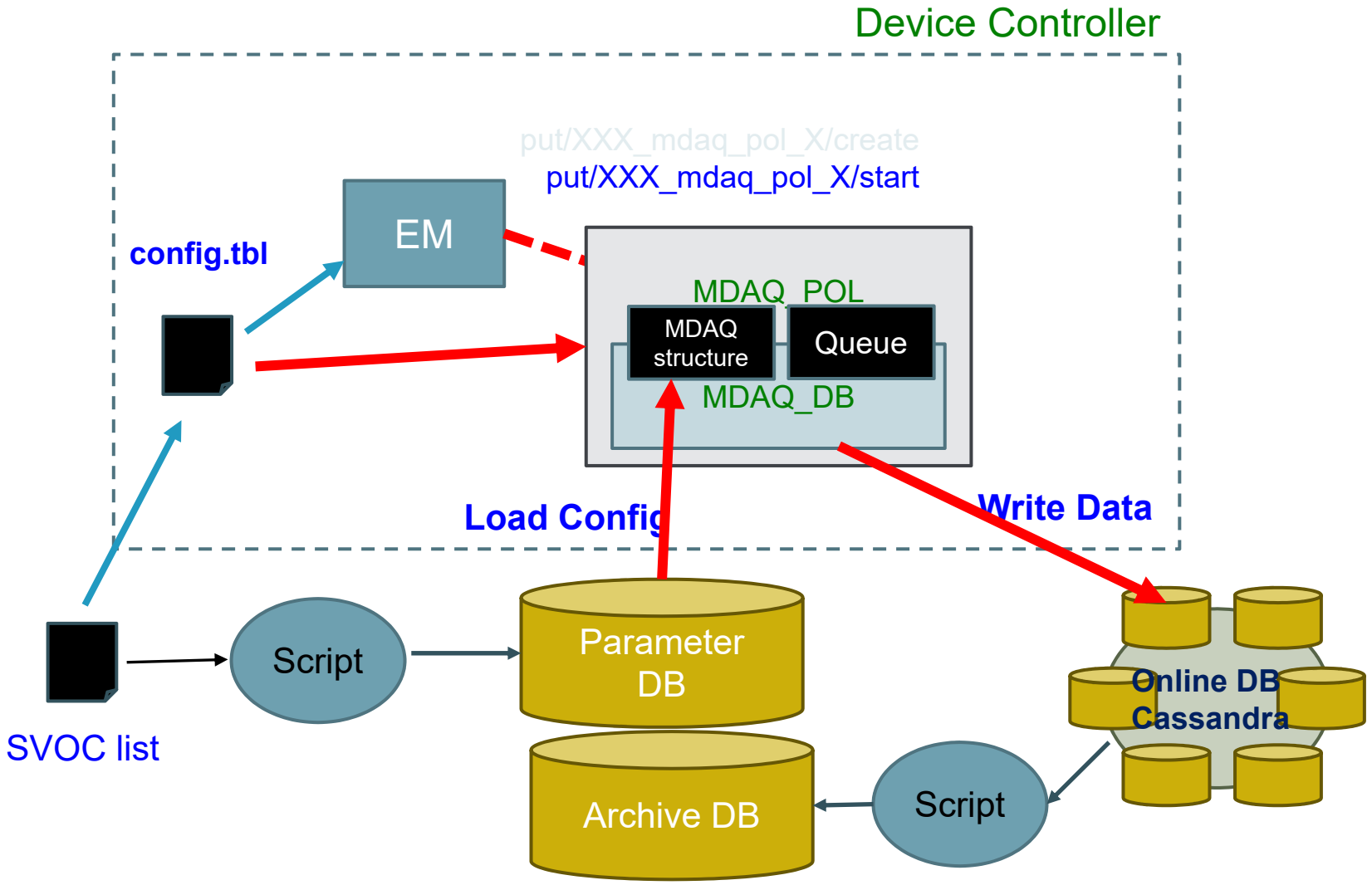
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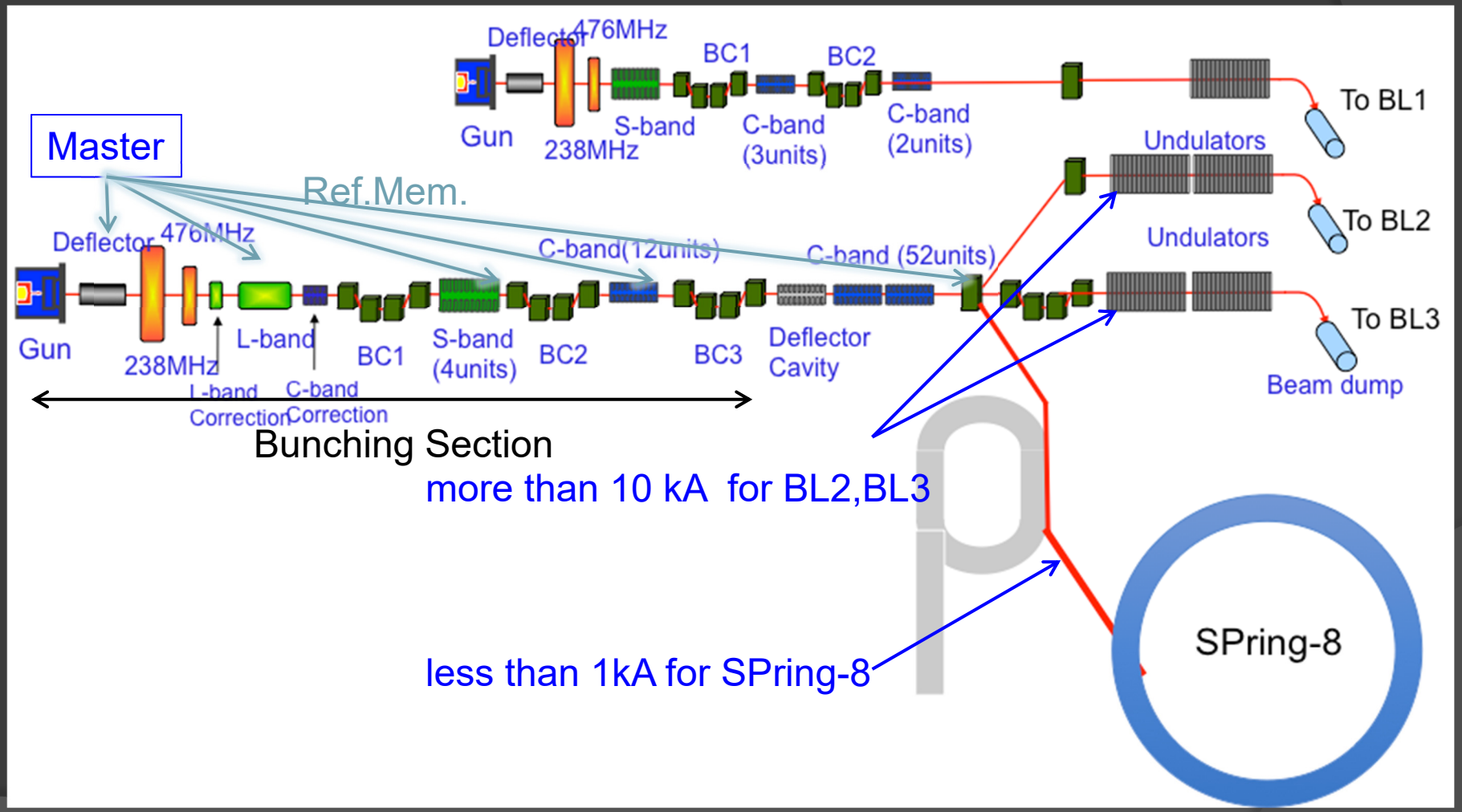
Software Framework

- Bunch-by-Bunch basis, beam parameter control with Reflective Memory
- Master controller distribute a parameters to Lowlevel-RF system and kicker magnet
- Pattern consist of 60 rows correspond to the parameter for 1 sec
  - System has to receive last, present and next parameter

Schematic view of SACLA/Spring-8



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- Master controller distribute a parameters to Lowlevel-RF system and kicker magnet
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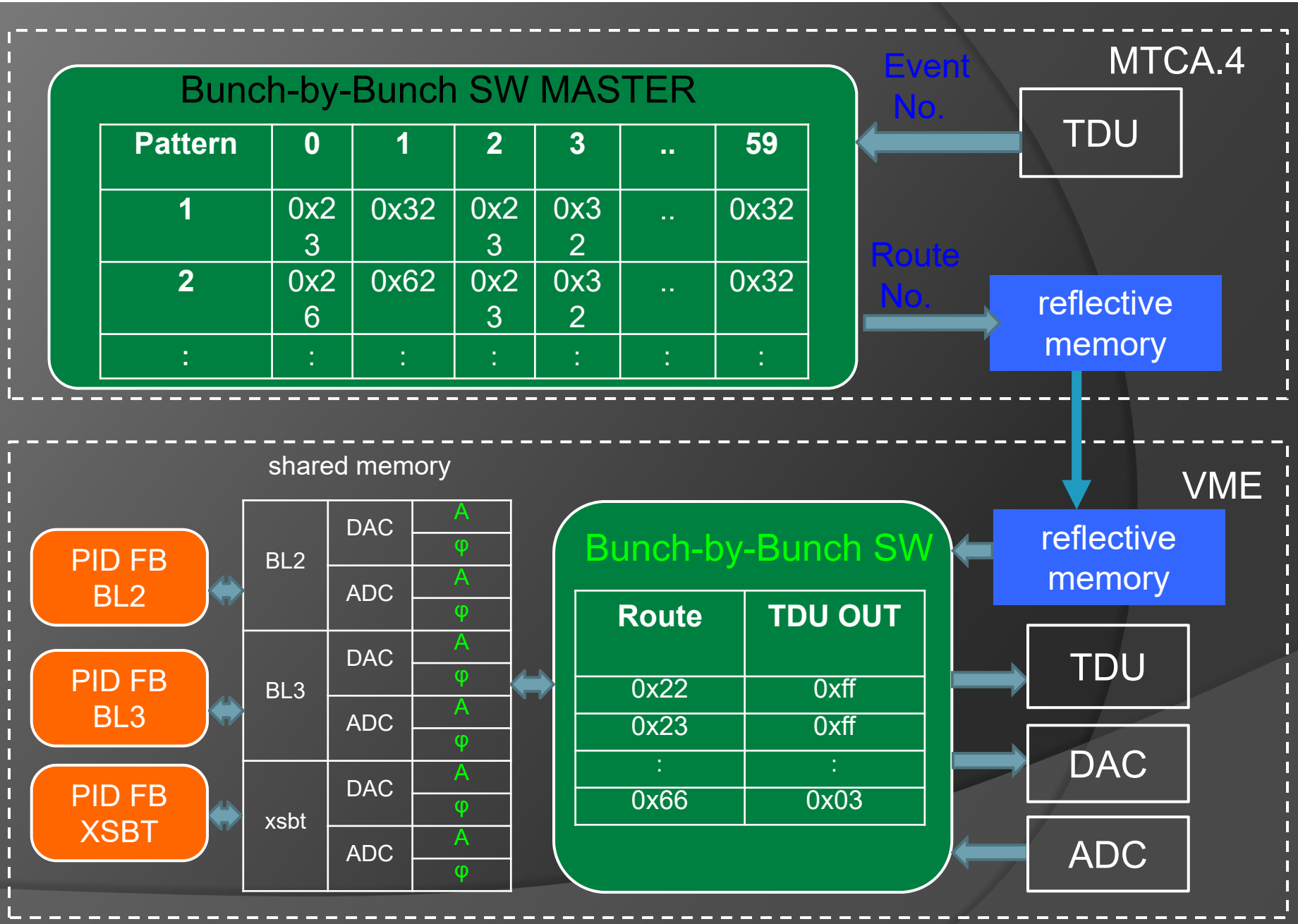
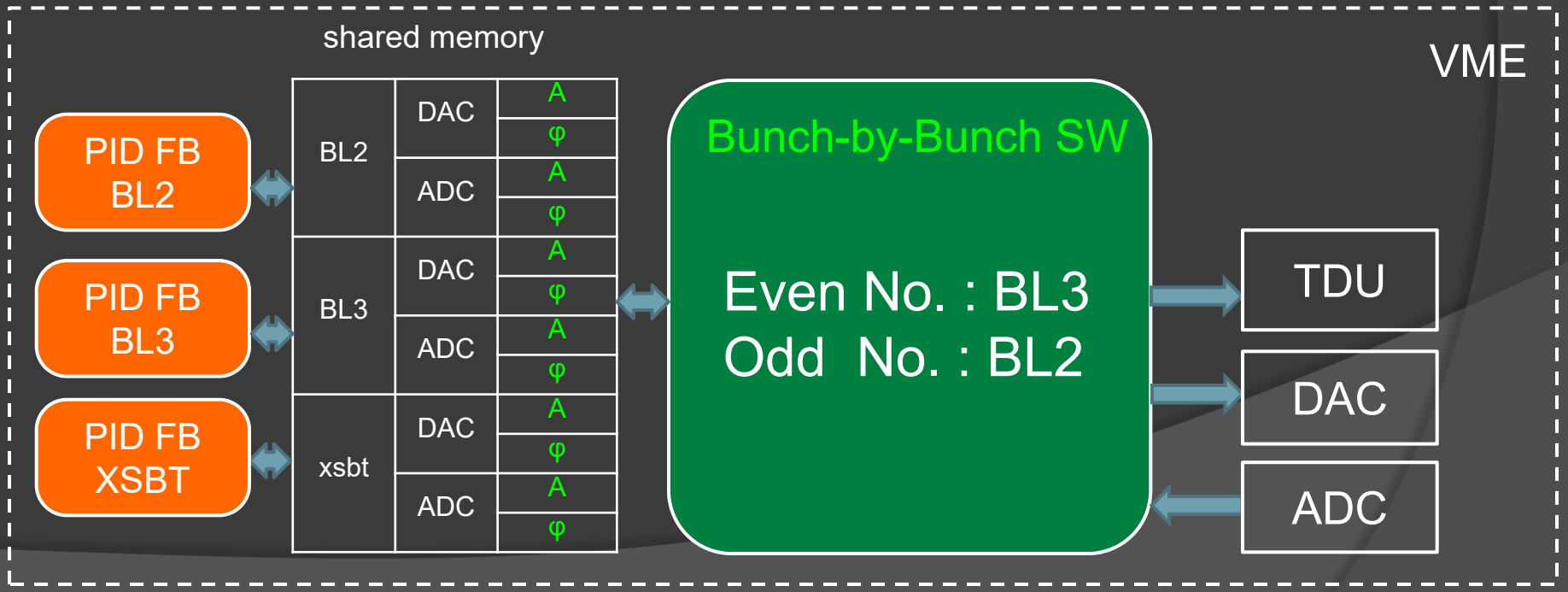
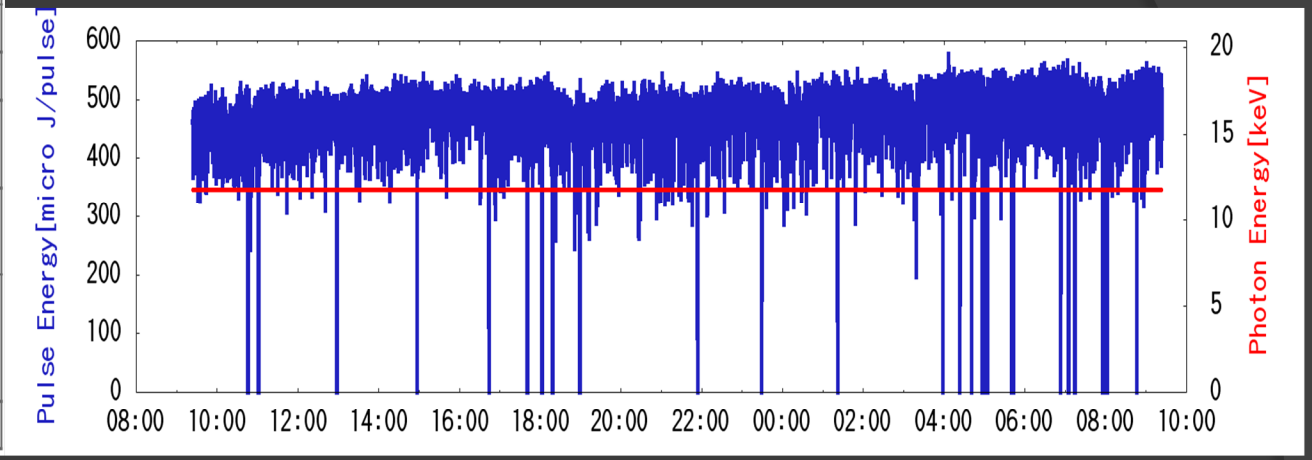
Schematic of parameter control by Bunch-by-Bunch basis



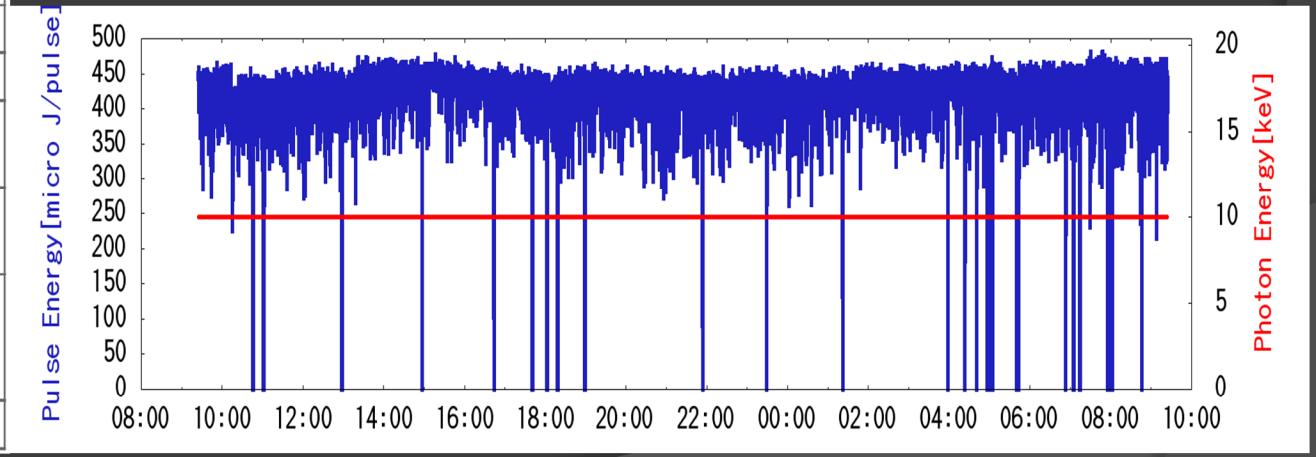
- We start a operation with bynch-by-bunch basis
  - 30Hz for BL2, 30Hz for BL3
- Beam quality of BL2 is same as BL3



Operation Mode	
BL3 User Operation	
Hutch in Use	
BL3 EH4	
Pulse Energy	Photon Energy / Wavelength
450.5 micro J/pulse	11.8 keV / 0.105 nm
Repetition Rate	Intensity Fluctuation in 30 shots (STD)
30 Hz	21.0 %



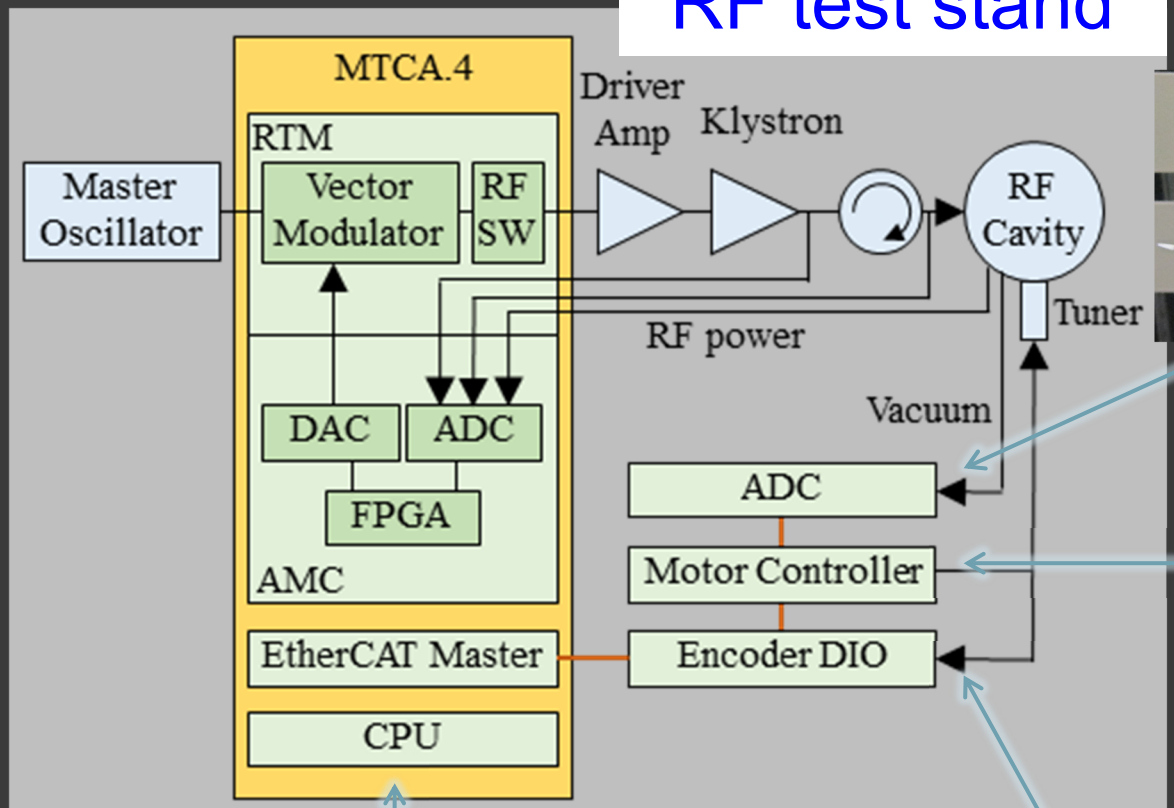
Operation Mode	
BL2 User Operation	
Hutch in Use	
BL2 EH3,4b	
Pulse Energy	Photon Energy / Wavelength
385.4 micro J/pulse	10.0 keV / 0.124 nm
Repetition Rate	Intensity Fluctuation in 30 shots (STD)
30 Hz	14.7 %



Equipment Control

- Use MTCA.4 for high speed digital signal processing (TUPHA081)
  - We will replace the SR A-st lowlevel-RF system to the fully digital feedback system in March 2018.
- Use PC and PLC for slow control
- Reduce the amount of wiring, EtherCAT as a remote I/O system (TUPHA148)
  - We already started to use the EthetCAT for the kicker magnet control
  - We will use stepping motor control and position readout of insertion device in March 2018
  - Fully digital controlled magnet power supply using EtherCAT is under development

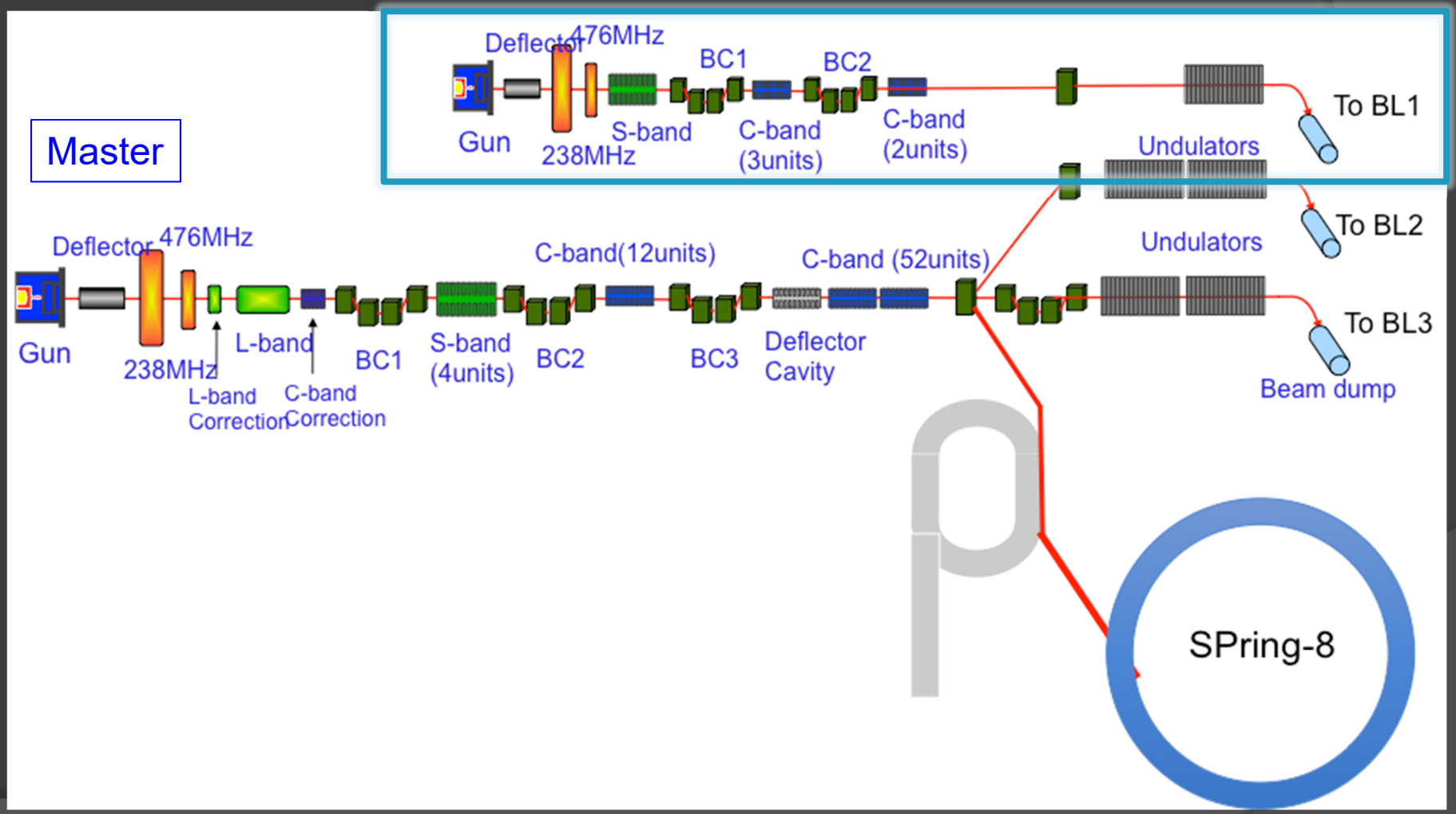
RF test stand



Status of the Project

- Started to design the control system in 2016 to meet the requirement of SPring-8 upgrade
- Replace the Dedicated Accelerator for BL1 in summer 2017
  - Control system is working well since the replacement
- We will replace the control system of SPring-8 in March 2018 and that of SACLA in summer 2018
- We will start a the injection from SACLA to SPring-8 in March 2019

Schematic view of SACLA/Spring-8



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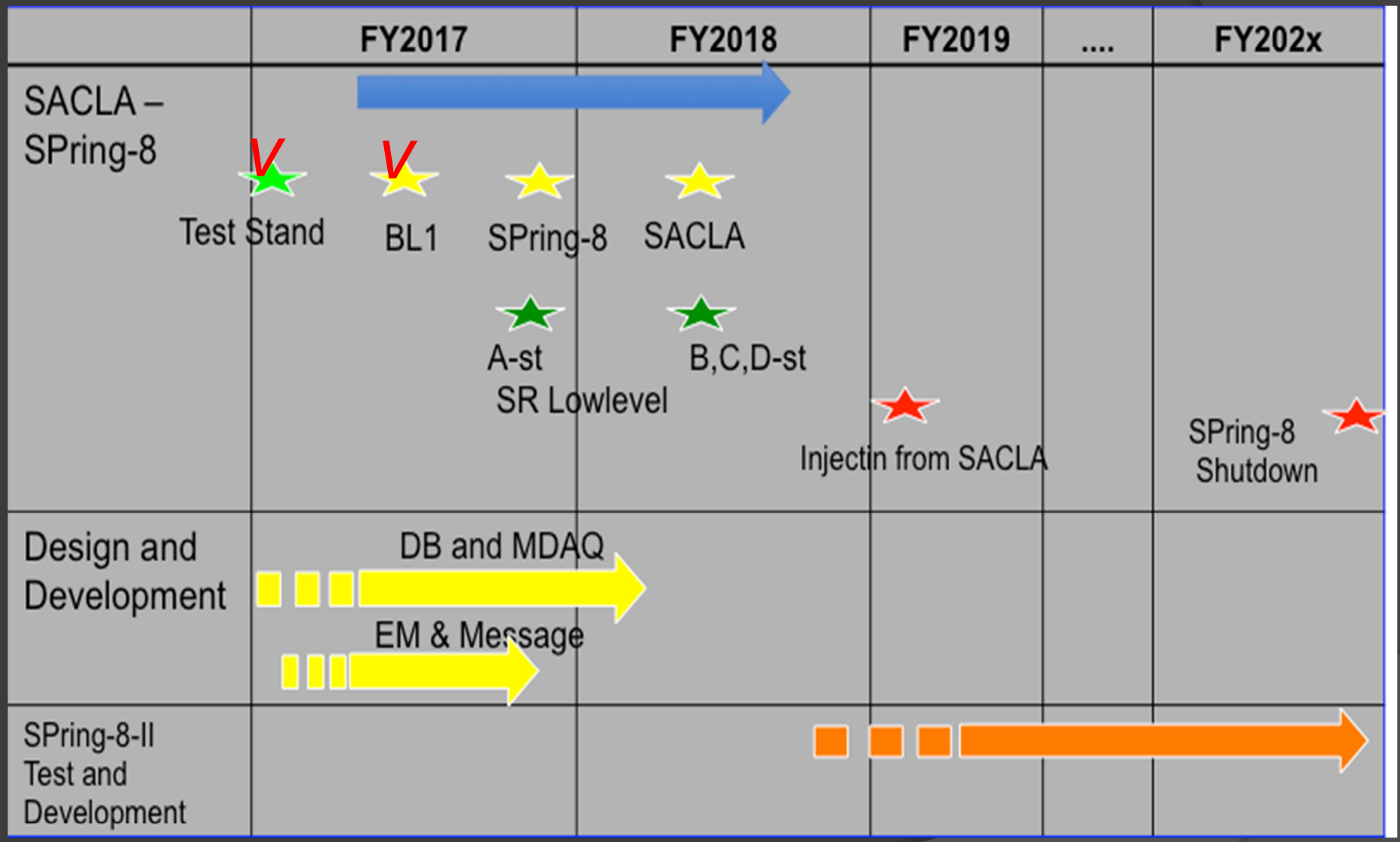
FY2017
FY2018
FY2019
....
FY202x
SACLA – SPring-8
V
V
Test Stand
BL1
SPring-8
SACLA
A-st
SR Lowlevel
B,C,D-st
Injectin from SACLA
SPring-8 Shutdown
Design and Development
DB and MDAQ
EM & Message
SPring-8-II Test and Development

In Japan there is a project to construct a new light source which will perform emittance around 1 nmrad with beam energy of 3GeV ....

Good News!!

- MEXT requested a budget of design and R&D for new light source to the MOF
- We are waiting to be approved the budget
  - A decision will be make at end of this year
- We will propose the new control system for the light source and we hope to be selected

MOF : Ministry of Finance
MEXT : The Ministry of Education, Culture, Sports, Science and Technology

Summary

- We redesign the control system for the SACLA and the SPring-8 / SPring-8-II
  - Cassandra for onlineDB
  - MariaDB for ArchiveDB & ParameterDB
  - MQTT for messaging
  - MTCA.4 for high speed data, PC and PLC for slow control and EtherCAT to reduce a wiring
- We succeeded in replacement the control system of the dedicated accelerator for BL1 in summer 2017.
- We will replace the control system of the SPring-8 and SACLA in summer 2018
- We will use this control system for SPring-8 upgrade, called SPring-8-II