UPGRADE OF THE NEWSUBARU CONTROL SYSTEM

N. Hosoda[1,2], T. Fukui[2], Y. Hamada[1], M. Ishii[1,2], A. Kiyomichi[1], K. Okada[1], T. Sugimoto[1,2]
[1]Japan Synchrotron Radiation Research Institute, Hyogo, Japan
[2]RIKEN SPring-8 Center, Hyogo, Japan

ICALEPCS 2021

INTRODUCTION

- NewSUBARU: soft X-ray synchrotron radiation facility with a 1.5 GeV electron storage ring,118 m circumference.
- sharing the SPring-8 linac as an injector.
- SPring-8 Upgrade Project (SPring-8-II): shutdown SPring-8 linac & use SACLA linac.
- Built a new 1 GeV linac to replace SPring-8 linac to continue the operation of NewSUBARU.

- Control framework: new MADOCA which is already used at SACLA/SPring-8.
- Replaced a file server, database servers, and computer networks for seamless operation of the new linac and the existing storage ring.
- Newly prepared 5 MicroTCA.4s, 3 PC servers
- Remained VMEbus system of the storage ring.

Table 1: History of upgrade.

Mar. 2019	new annex building constructed.
Jul. 2020	finished a beam injection from the SPring-8 linac started an installation work of the new linac.
Feb. 2021	started the new linac beam commissioning.
Apr. 2021	Resumed the NewSUBARU user experiments.

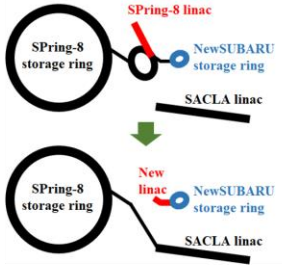

Figure 1: Layout of the NewSUBARU before and after installation of the new linac.

Figure 2: NewSUBARU building and new annex building for the new linac.

2

EQUIPMENT CONTROL OF THE NEW LINAC

MicroTCA.4

- Struck SIS8325 AMC board: 10-channels 250-Ms/s 16-bit ADCs, 2-channels 250-Ms/s 16-bit DACs, modified FPGA logic.
- MDT MMETRG01B AMC board: trigger TRX with SFPx5. event by a bit rate of 1 Gbps and 8B/10B encoding.
- Advanet AdXMC1573 XMC EtherCAT master board on Vadatech AMC105 PMC/XMC carrier.

Table 2: AMC modules used in five MTCA.4

Host	Target equipment	AMC modules
1	linac master trigger, storage ring injection magnets/monitors trigger	MMETRG01B × 1
2	linac LLRF/HPRF/vacuum of gun, 238, 476	MMETRG01B × 1, AdXMC1573 × 1, SIS8325 x3
3	linac LLRF/HPRF/vacuum of S-band, BPM × 3, CT × 4	MMETRG01B × 1, AdXMC1573 × 1, SIS8325 × 3
4	linac LLRF/HPRF/vacuum of C-band1, C-band2, BPM × 2	MMETRG01B × 1, AdXMC1573 × 1, SIS8325 × 5
5	linac LLRF/HPRF/vacuum of C-band3, C-band4, BPM × 4, CT × 1	MMETRG01B × 1, AdXMC1573 × 1, SIS8325 × 6

EtherCAT

Table 3: A number of slaves for six EtherCAT masters

Host	Target equipment	# of slaves
1	linac gun PLC, 238 PLC, 476 PLC, vacuum PLC	4
2	linac S-band PLC, vacuum PLC × 2	3
3	linac C-band1 PLC, C-band2 PLC	2
4	linac C-band3 PLC, C-band4 PLC, vacuum PLC	3
5	linac magnet power supplies	65
6	linac beam profile monitor × 8, collimator, resolver counter	13

GigE camera

- For 8 beam profile monitors
- JAI Go-2400M camera
- PCIe-PoE354at PoE type network interface boards
- RCB-LVDS-TRIG8 trigger input counter board
- Aravis open source library

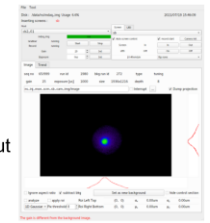

Figure 3: Captured beam profile image

3

EQUIPMENT CONTROL OF THE EXSISTING STORAGE RING

- VMEbus system with Solaris 10 OS working since 2000
- Changing the VMEs would require a lot of work, such as checking the I/O of the equipment.
- As the control equipment for the storage ring was unchanged, the same VME hardware were utilized.
- Updated all equipment control software running on VME CPU.
- Prepared an RF test bench to make sure no problems in operation.

Table 4: VMEmodules

Host	Target equipment	VME modules
1	Magnet power supply	Remote I/O
2	Monitor (DCCT, BPM)	Remote I/O, GPIB, interrupt register
3	RF (High-power, Low-level)	AI, DI, DO, TTL, DI, TTL DO, pulse train generator
4	Safety interlock	FL-net
5	Vacuum (CCG, SIP, PIG, RGV, TSP)	Remote I/O
6	Beam charge monitor	FL-net, interrupt register

CONTROL FRAMEWORK

- Characterized by messaging and database access.
- 4 types of DAQ: fixed time interval (1~10 sec), trigger synchronized (1~20 Hz), waveform (max. 20 Hz), and image (max. 1 Hz).

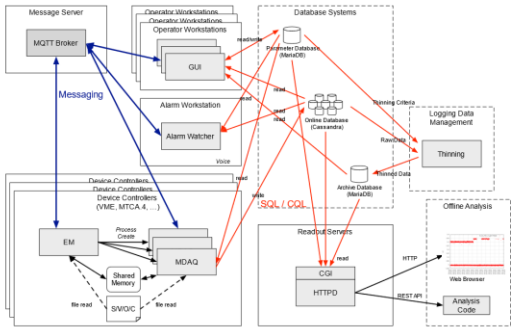

Figure 4: Schematic View of the new control framework

4

OPERATION GUI

- Operational applications such as, accessing the log database and handling control messages are essential for maintaining the operational logic and/or sequence. They are usually in the GUI form.
- The open source version of Qt5 was selected to create GUIs.
- We prepared Qt plug-ins and function libraries in advance.

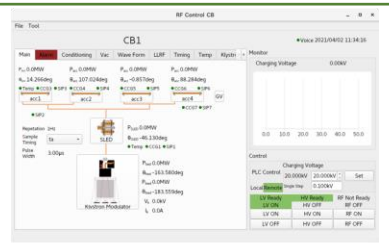

Figure 5: RF control GUI for C-band

CONCLUSION

- NewSUBARU's high-performance dedicated new injector linac has started its operation.
- It enabled NewSUBARU to continue user experiments after the shutdown of SPring-8 linac.
- New linac: prepared 5 MTCA.4s, 3 PC servers
- Storage ring: remained 6 VMEs
- Replaced: file server, database servers, MQTT broker server, computer networks.
- For the 3 GeV synchrotron radiation facility under construction in eastern Japan, we will use same equipment control hardware and control framework.

Figure 6: NewSUBARU control room

5

INTRODUCTION

- NewSUBARU: soft X-ray synchrotron radiation facility with a 1.5 GeV electron storage ring,118 m circumference.
- sharing the SPring-8 linac as an injector.
- SPring-8 Upgrade Project (SPring-8-II): shutdown SPring-8 linac & use SACLA linac.
- Built a new 1 GeV linac to replace SPring-8 linac to continue the operation of NewSUBARU.

- Control framework: new MADOCA which is already used at SACLA/SPring-8.
- Replaced a file server, database servers, and computer networks for seamless operation of the new linac and the existing storage ring.
- Newly prepared 5 MicroTCA.4s, 3 PC servers
- Remained VMEbus system of the storage ring.

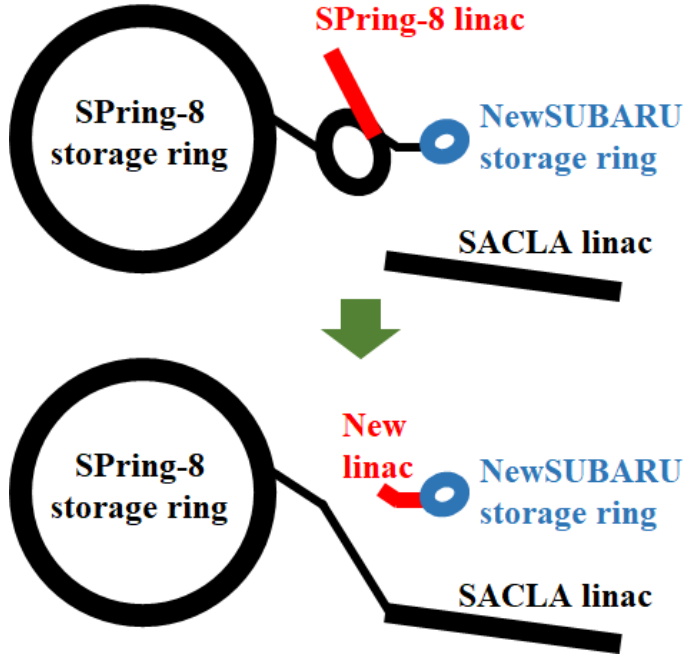

Figure 1: Layout of the NewSUBARU before and after installation of the new linac.

Table 1: History of upgrade.

Mar. 2019	new annex building constructed.
Jul. 2020	finished a beam injection from the SPring-8 linac started an installation work of the new linac.
Feb. 2021	started the new linac beam commissioning.
Apr. 2021	Resumed the NewSUBARU user experiments.

Figure 2: NewSUBARU building and new annex building for the new linac.

EQUIPMENT CONTROL OF THE NEW LINAC

MicroTCA.4

- Struck SIS8325 AMC board: 10-channels 250-Ms/s 16-bit ADCs, 2-channels 250-Ms/s 16-bit DACs, modified FPGA logic.
- MDT MMETRG01B AMC board: trigger TRX with SFPx5. event by a bit rate of 1 Gbps and 8B/10B encoding.
- Advanet AdXMC1573 XMC EtherCAT master board on Vadatech AMC105 PMC/XMC carrier.

Table 2: AMC modules used in five MTCA.4

Host	Target equipment	AMC modules
1	linac master trigger, storage ring injection magnets/monitors trigger	MMETRG01B × 1
2	linac LLRF/HPRF/vacuum of gun, 238, 476	MMETRG01B × 1, AdXMC1573 × 1, SIS8325 x3
3	linac LLRF/HPRF/vacuum of S-band, BPM × 3, CT × 4	MMETRG01B × 1, AdXMC1573 × 1, SIS8325 × 3
4	linac LLRF/HPRF/vacuum of C-band1, C-band2, BPM × 2	MMETRG01B × 1, AdXMC1573 × 1, SIS8325 × 5
5	linac LLRF/HPRF/vacuum of C-band3, C-band4, BPM × 4, CT × 1	MMETRG01B × 1, AdXMC1573 × 1, SIS8325 × 6

EtherCAT

Table 3: A number of slaves for six EtherCAT masters

Host	Target equipment	# of slaves
1	linac gun PLC, 238 PLC, 476 PLC, vacuum PLC	4
2	linac S-band PLC, vacuum PLC × 2	3
3	linac C-band1 PLC, C-band2 PLC	2
4	linac C-band3 PLC, C-band4 PLC, vacuum PLC	3
5	linac magnet power supplies	65
6	linac beam profile monitor × 8, collimator, resolver counter	13

GigE camera

- For 8 beam profile monitors
- JAI Go-2400M camera
- PCIe-PoE354at PoE type network interface boards
- RCB-LVDS-TRIG8 trigger input counter board
- Aravis open source library

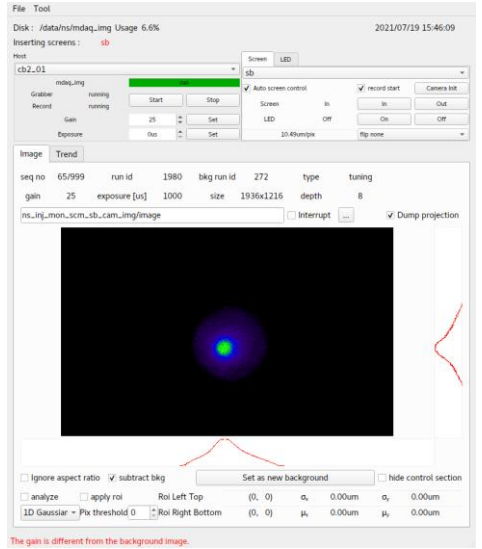

Figure 3: Captured beam profile image

EQUIPMENT CONTROL OF THE EXSISTING STORAGE RING

- VMEbus system with Solaris 10 OS working since 2000
- Changing the VMEs would require a lot of work, such as checking the I/O of the equipment.
- As the control equipment for the storage ring was unchanged, the same VME hardware were utilized.
- Updated all equipment control software running on VME CPU.
- Prepared an RF test bench to make sure no problems in operation.

Table 4: VMEmodules

Host	Target equipment	VME modules
1	Magnet power supply	Remote I/O
2	Monitor (DCCT, BPM)	Remote I/O, GPIB, interrupt register
3	RF (High-power, Low-level)	AI, DI, DO, TTL, DI, TTL DO, pulse train generator
4	Safety interlock	FL-net
5	Vacuum (CCG, SIP, PIG, RGV, TSP)	Remote I/O
6	Beam charge monitor	FL-net, interrupt register

CONTROL FRAMEWORK

- Characterized by messaging and database access.
- 4 types of DAQ: fixed time interval (1~10 sec), trigger synchronized (1~20 Hz), waveform (max. 20 Hz), and image (max. 1 Hz).

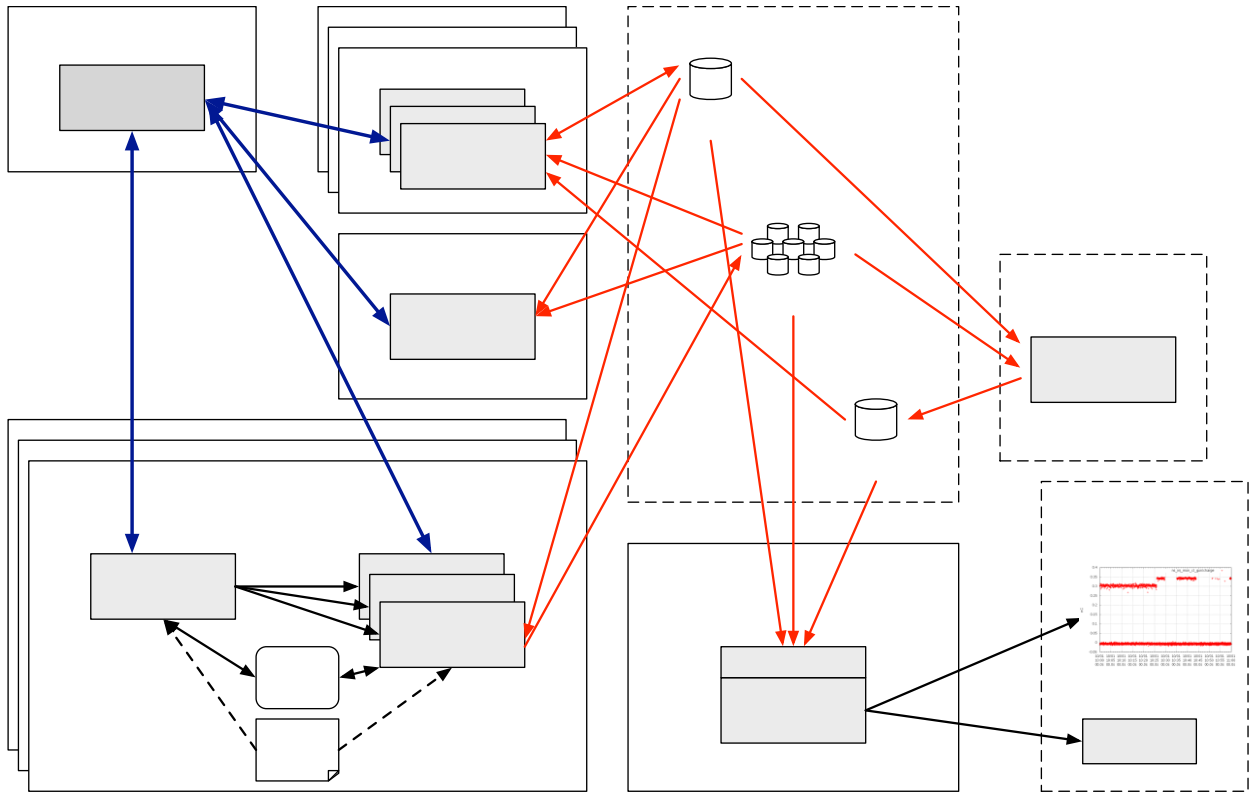

Figure 4: Schematic View of the new control framework

OPERATION GUI

- Operational applications such as, accessing the log database and handling control messages are essential for maintaining the operational logic and/or sequence. They are usually in the GUI form.
- The open source version of Qt5 was selected to create GUIs.
- We prepared Qt plug-ins and function libraries in advance.

CONCLUSION

- N ’ high-performance dedicated new injector linac has started its operation.
- It enabled NewSUBARU to continue user experiments after the shutdown of SPring-8 linac.
- New linac: prepared 5 MTCA.4s, 3 PC servers
- Storage ring: remained 6 VMEs
- Replaced: file server, database servers, MQTT broker server, computer networks.
- For the 3 GeV synchrotron radiation facility under construction in eastern Japan, we will use same equipment control hardware and control framework.

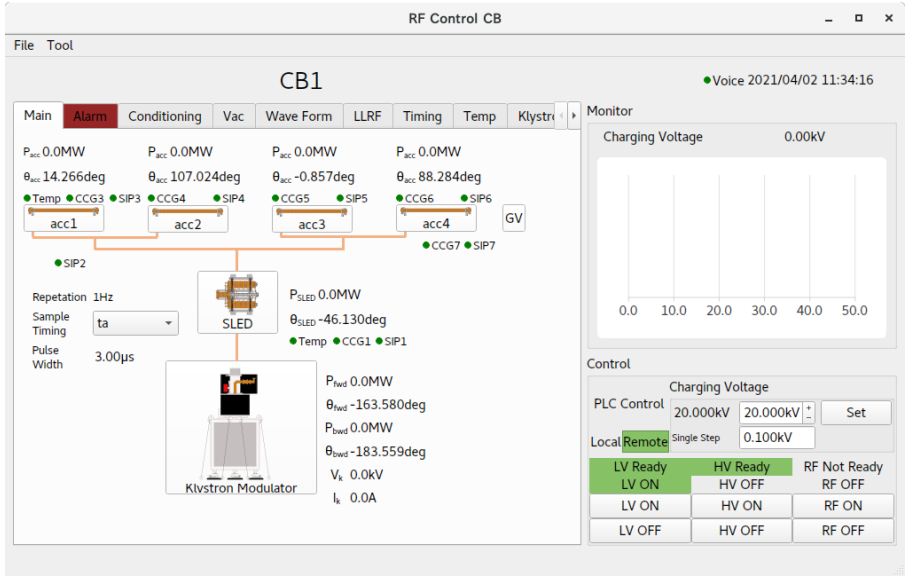

Figure 5: RF control GUI for C-band

Figure 6: NewSUBARU control room