EPICS-based Control System for New Skew Quadrupole Magnets in J-PARC MR

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Abstract

In J-PARC Main Ring (MR), a control system for new skew quadrupole (Skew-Q) magnets has been constructed. This system is based on EPICS (Experimental Physics and Industrial Control System). The system comprises a YOKOGAWA F3RP61-2L (a PLC CPU running Linux), a function generator (Tektronix AFG3000), and commercial bipolar-DC Amplifiers. The function generator is controlled using VXI-11 protocol over Ethernet. The DC amplifiers are connected to PLC I/O modules with hardwires. Both devices are controlled by the F3RP61-2L.

Conslusion

The control system was developed in 2012, and has been in operation successfully since January, 2013.
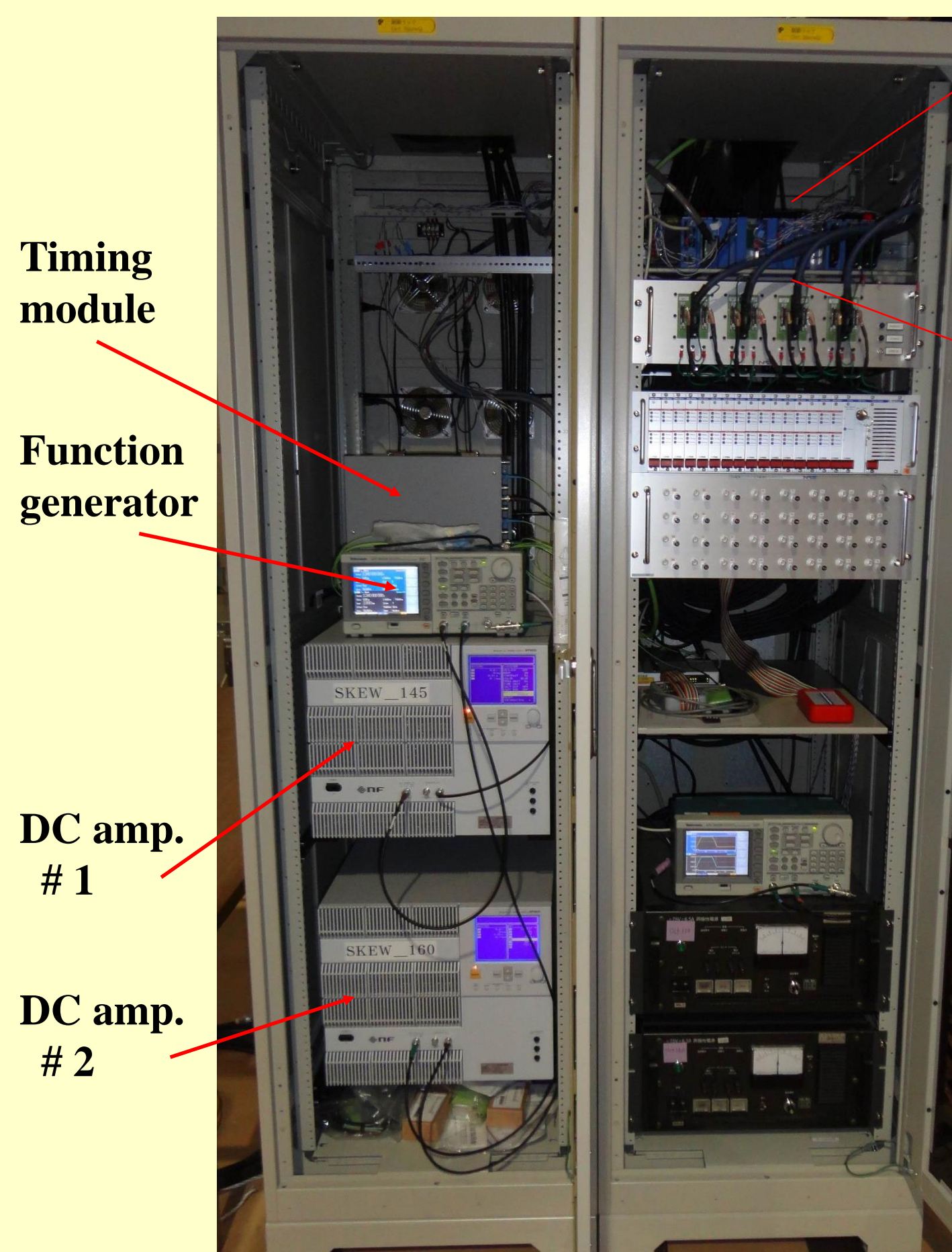
Overview of Skew-Q control
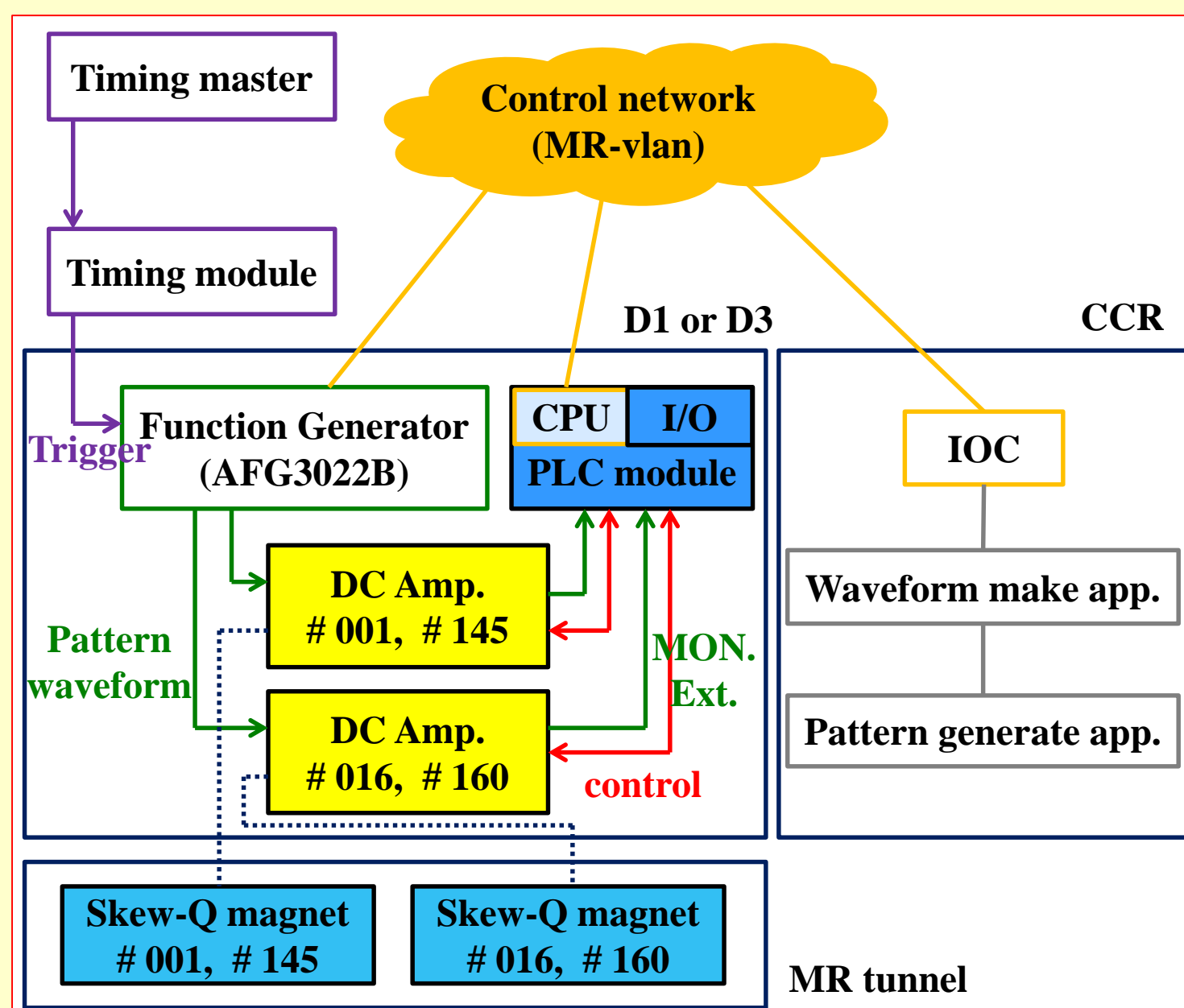
1. DC amplifier

- Commercial product.
- Output ±20A (CC).
- Controlled by PLC.
  - F3RP61-2L as a CPU module.
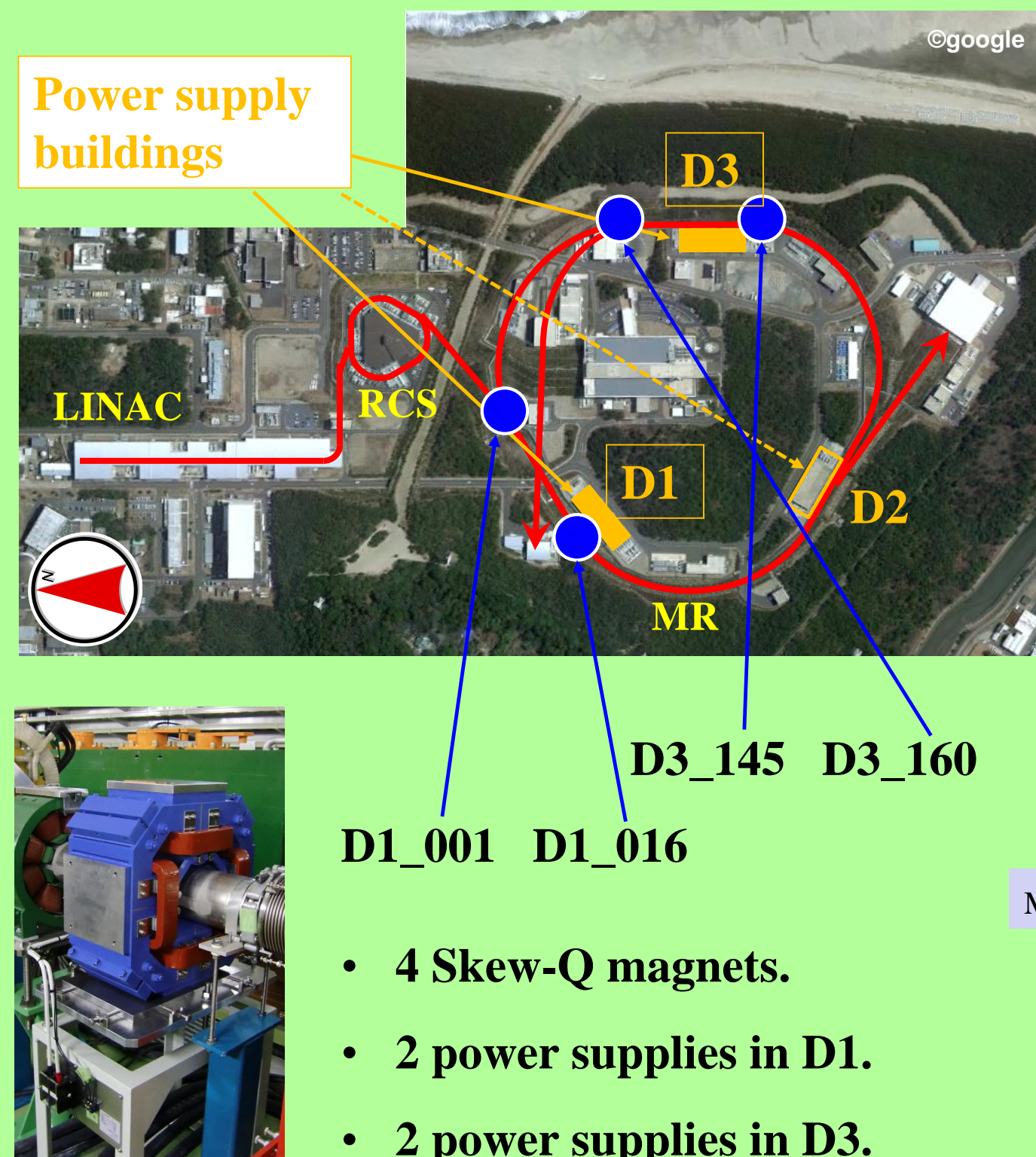   - ppc-linux + EPICS
  - I/O module

2. Function generator

- Controlled via LAN with VXI-11 protocol.
- Pattern operation
  - Create ramp waveform for each MR cycle.

Photo of the skew-Q control

- Timing module
- Function generator
- DC amp. # 1
- DC amp. # 2

J-PARC MR

- Power supply buildings
- D3, D3_145, D3_160
- D1_001, D1_016
- LINAC, RCS, MR, D1, D2

- 4 Skew-Q magnets.
- 2 power supplies in D1.
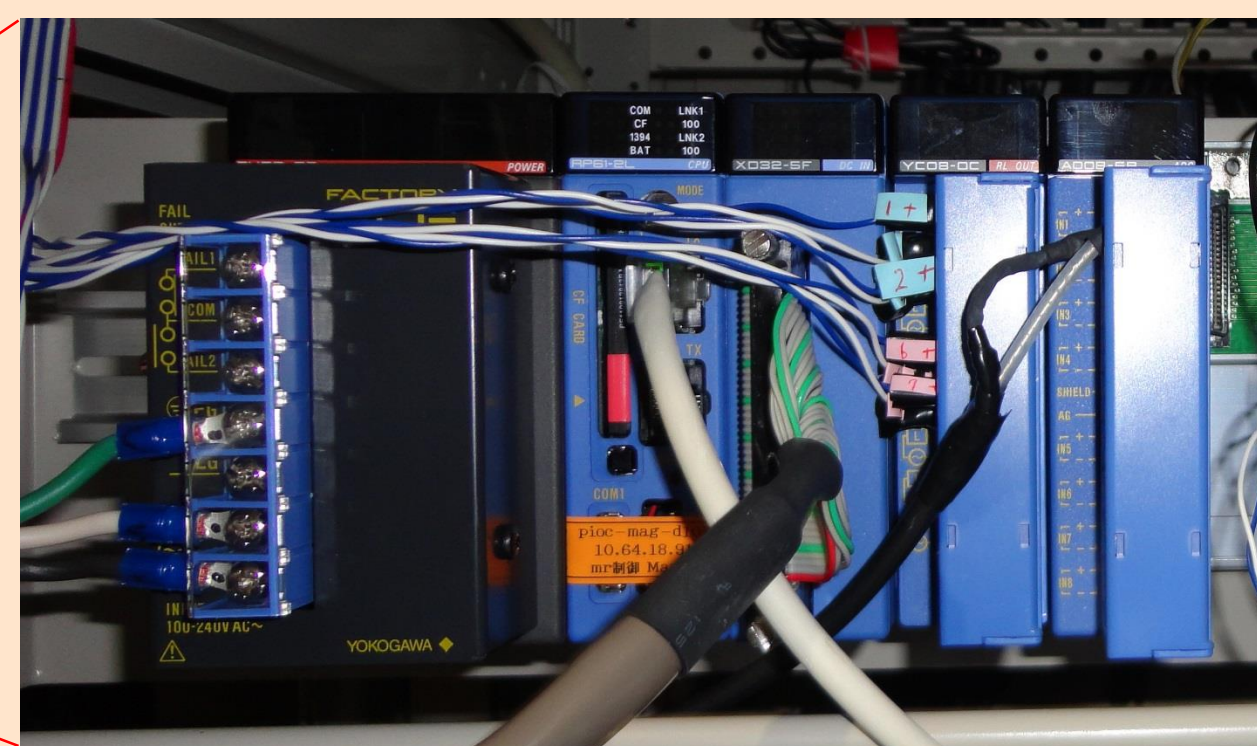- 2 power supplies in D3.

Configuration

1. PLC-module (YOKOGAWA)

- Consist of a CPU module and I/O modules.
- Control and monitor the bipolar DC amp.
- Control the function generator with VXI-11.

SLOT	MODULE	TYPE	
1	F3RP61-2L	CPU/Linux	→ FG control
2	F3XD32-5F	Digital Input	
3	F3YC08-0C	Digital Output	— DC amp. control
4	F3AD08-5R	Analog Input	

2. VXI-11 protocol

- F3RP61-2L is a protocol converter between EPICS and VXI-11.

Example: Turn ON function-generator ch1.

（manual operation）
Push ON button.

⬇

(EPICS)
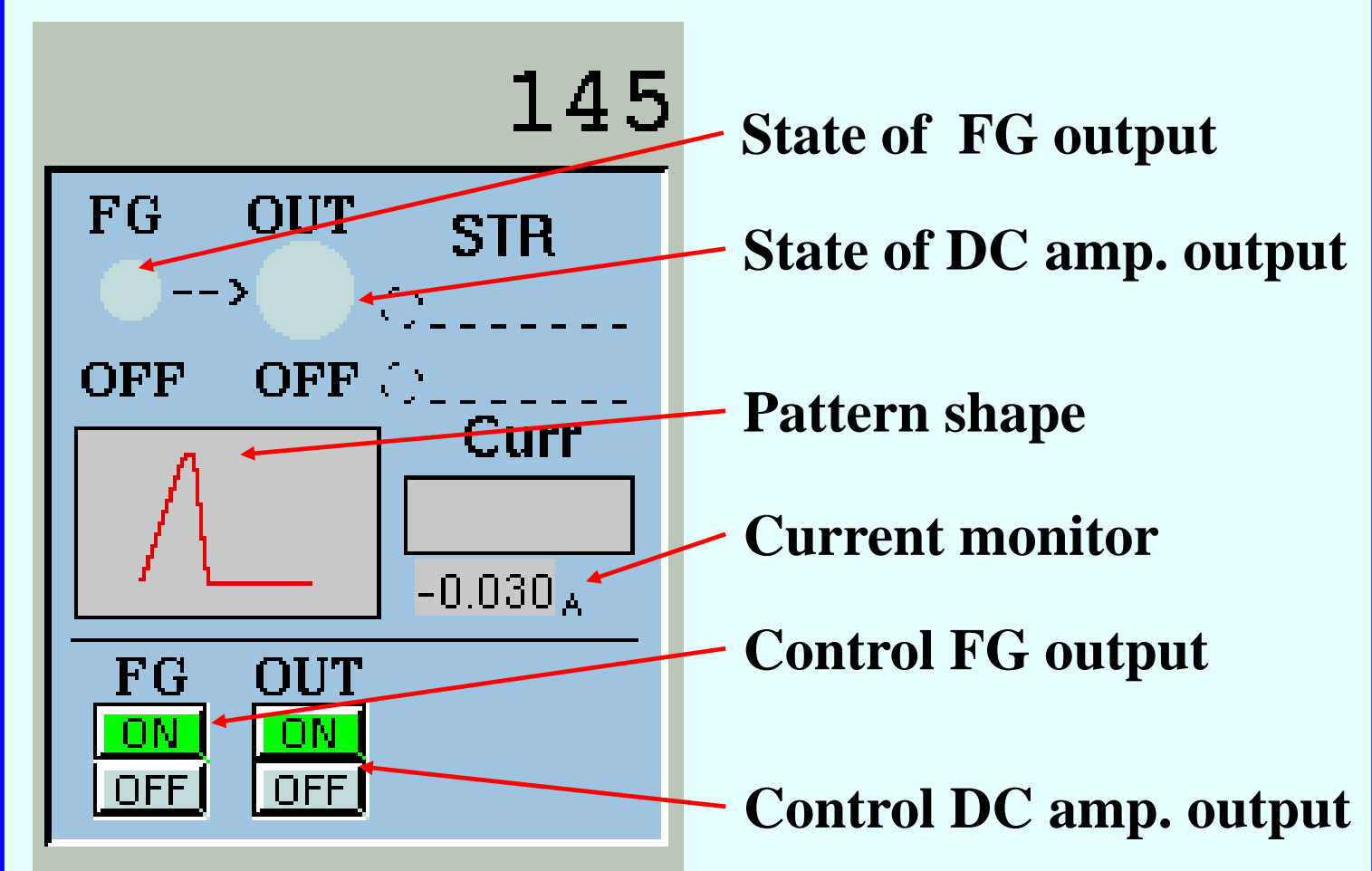caput MRMAG:SKQPS_D1_001:SET:PTNOUT on

⬇

（VXI-11）
OUTP1:STAT on

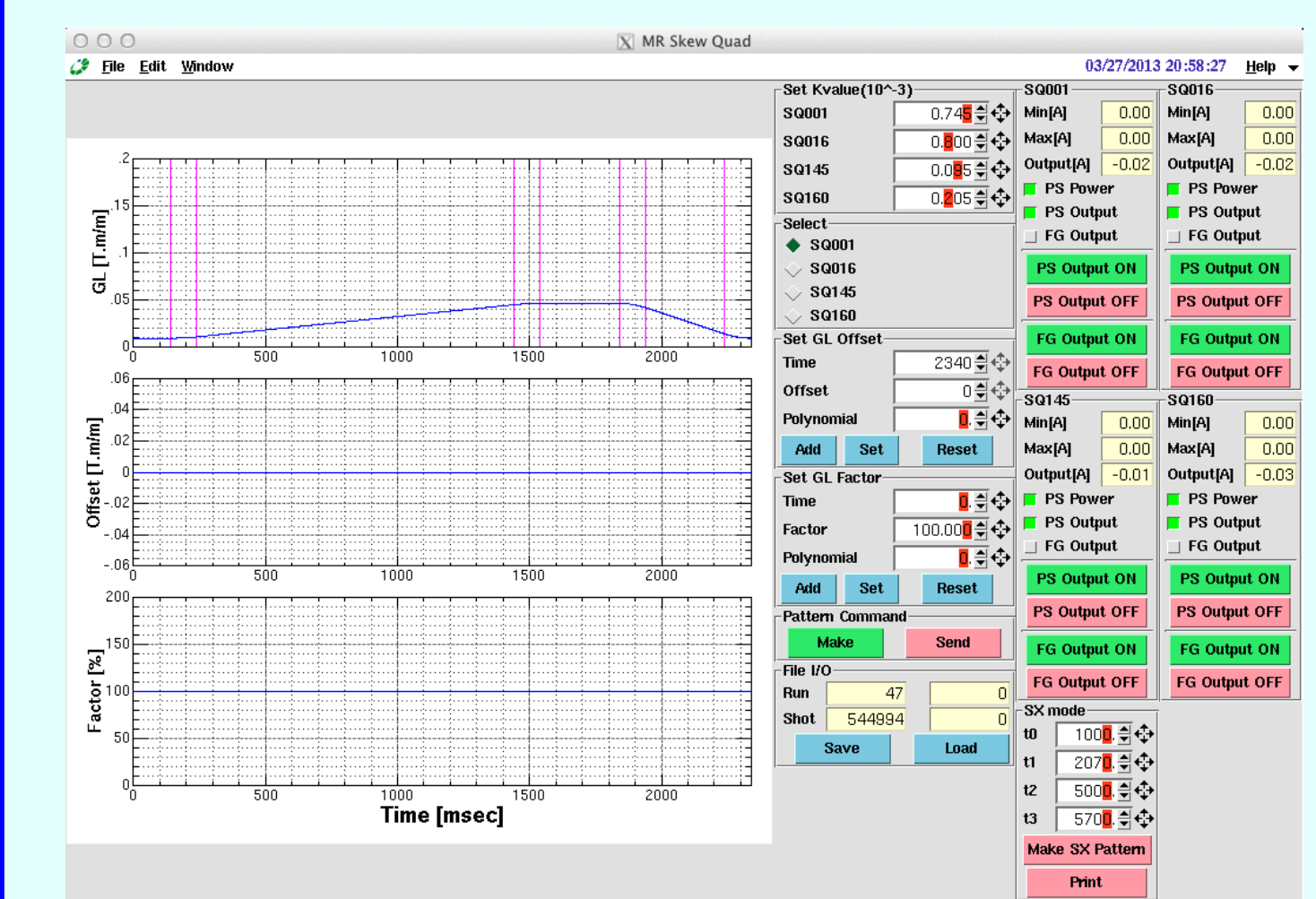## EPICS System development

1. EPICS PVs (Process variable)

(Case of D1_016)

MRMAG:SKQPS_D1_016

NAME	TYPE	FUNCTION
:STAT:PWR	bi	State of Power ON/OFF
:STAT:OUT	bi	State of output ON/OFF
:OPE:OUT_ON	bo	Forced output ON
:OPE:OUT_OFF	bo	Forced output OFF
:STAT:OC	bi	State of over current
:STAT:BUSY	bi	State of soft busy
:VAL:CUR	ai	Monitored current

MRMAG:SKQPS_D1_016

NAME	TYPE	FUNCTION
:SET:PTNOUT	longout	FG output ON/OFF
:RB:PTNOUT	longin	FG output readback
:SET:CURRENT	waveform	Waveform
:SET:NSAMPLE	ao	Number of samples
:RB:CURRENT	waveform	Readback of waveform

2. GUI example by EDM

- State of FG output
- State of DC amp. output
- Pattern shape
- Current monitor
- Control FG output
- Control DC amp. output

3. Pattern generator app. by SAD

- This application generates a ramp waveform for each magnet.

Operation

2012 Oct. Tested in MR study.

2013 Jan. Started to use in user's beam time.