

A Control System of New Magnet Power Converter for J-PARC Main Ring Upgrade

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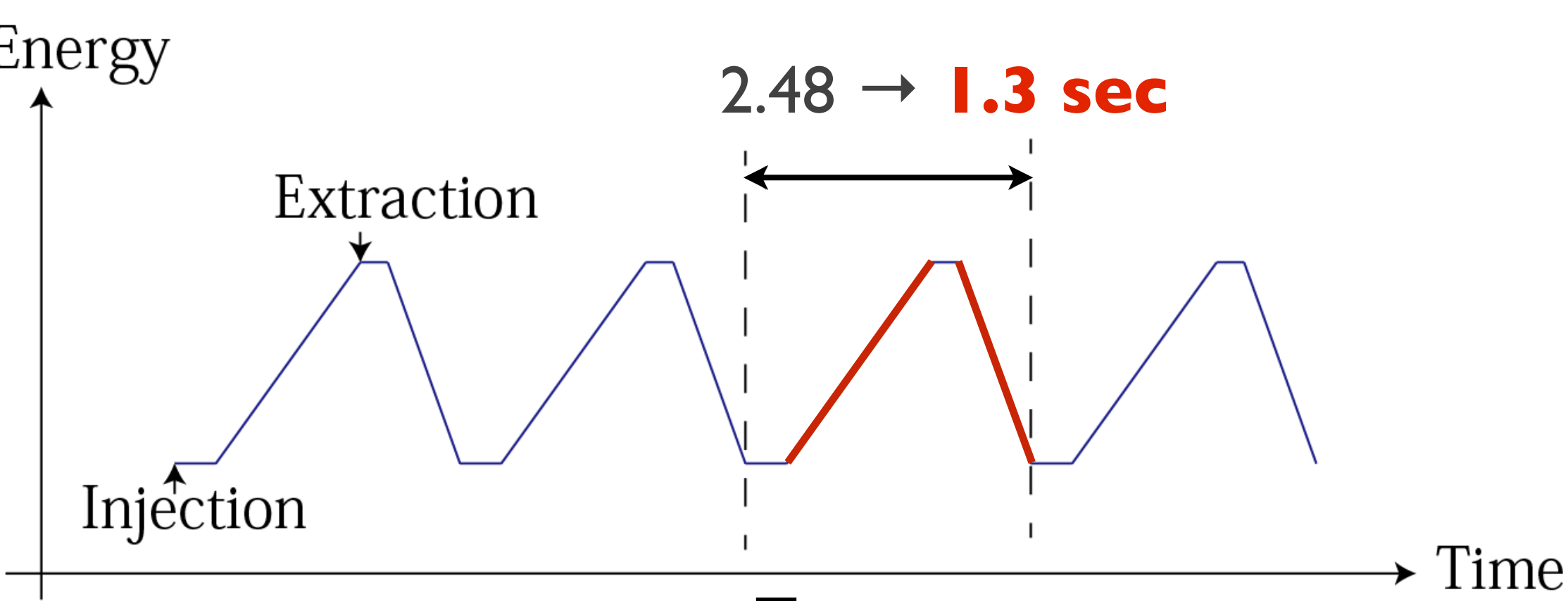


Introduction

J-PARC (Japan Proton Accelerator Research Complex)
MR (Main Ring) : Proton synchrotron (3-30 GeV)

J-PARC MR upgrade : toward **750 kW** operation in FX
 (present beam power : 500 kW)

→ Increase repetition rate : **0.40 Hz** → **0.77 Hz**



Shorten ramping-up/down period in output voltage of power converter for magnet

$$V = L \frac{dI}{dt} + RI$$

L : load inductance
 R : load resistance

Need to replace power converters for magnet

Rated of power converters for main magnets (bending, quadrupole, sextupole)

magnet family	Flat Bottom Current [A]	Flat Top Current [A]	Output Voltage [kV] @ 1.3 sec repetition	#. of power converters
Bending	190	1570	6.0	6
Large quadrupole	80	1000	7.0	4
Small quadrupole	70	1000	1.5	7
Sextupole	20	200	0.8	3

Design of new power converters which consist combination of power unit for various rated

For high output voltage

→ power units are connected in series

For high output current

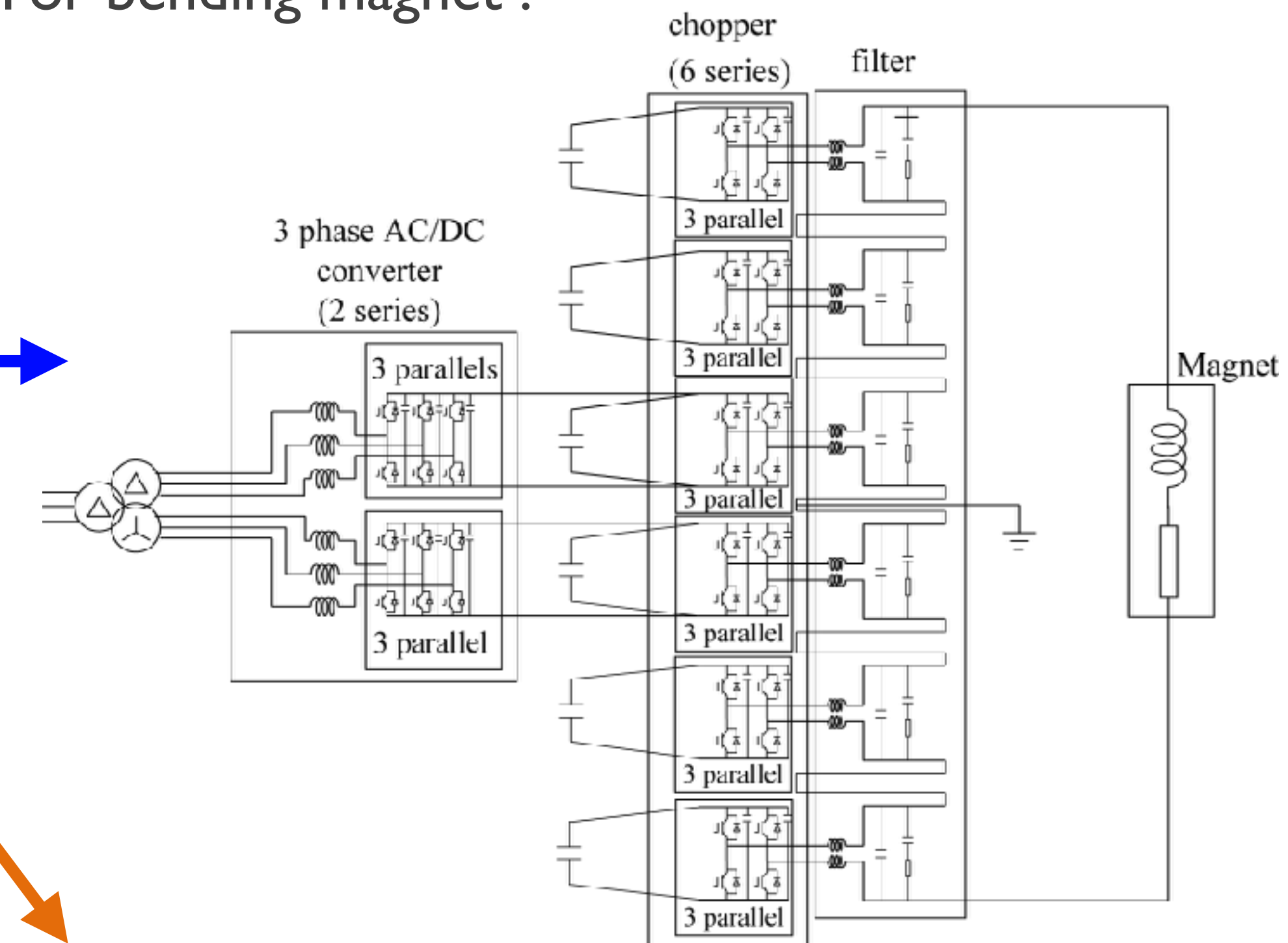
→ power units are connected in parallel

Controller is required

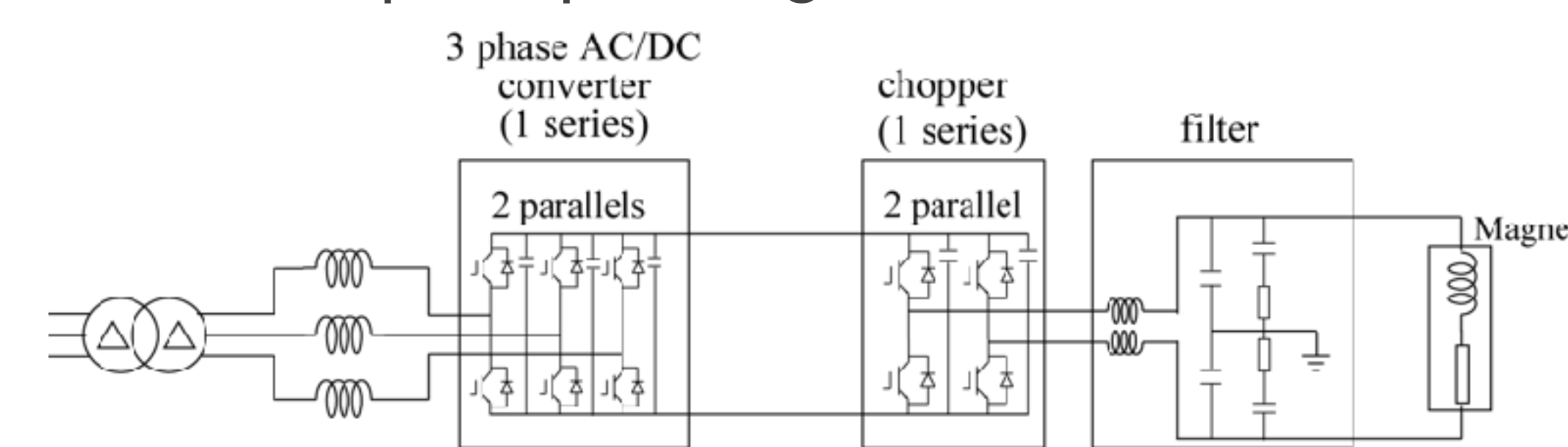
flexibility for configuration of power converter

Design of power converter

For bending magnet :



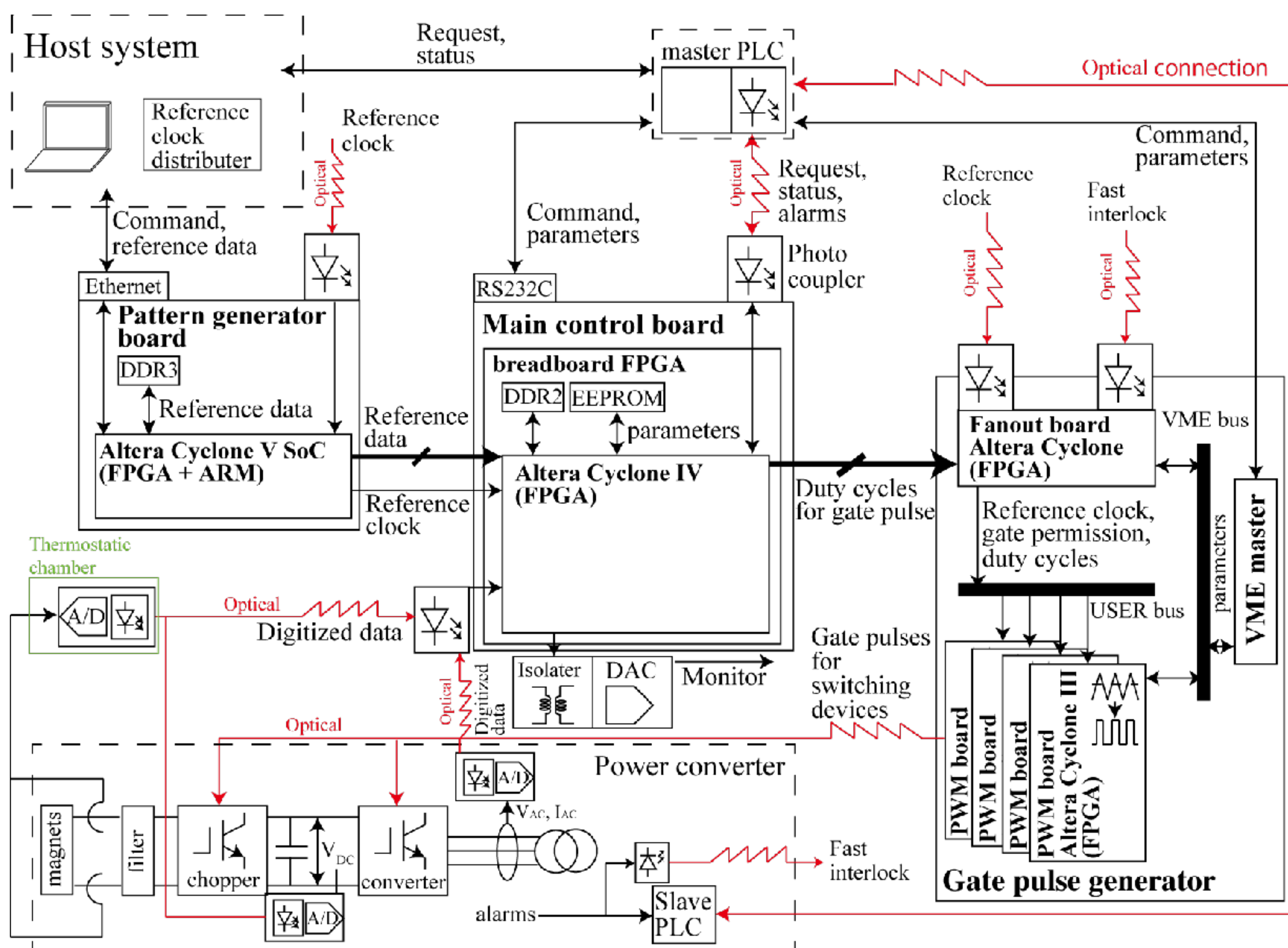
For small quadrupole magnet :



Control system

Main works of control system are ...

- Summarizing alarms and failure protection
- Feedback control of power converter with several monitors
- Generating gate pulse for power unit with calculated duty cycles
- Managing sequence of power converter operation
- Monitored status and controlled from host system via ethernet



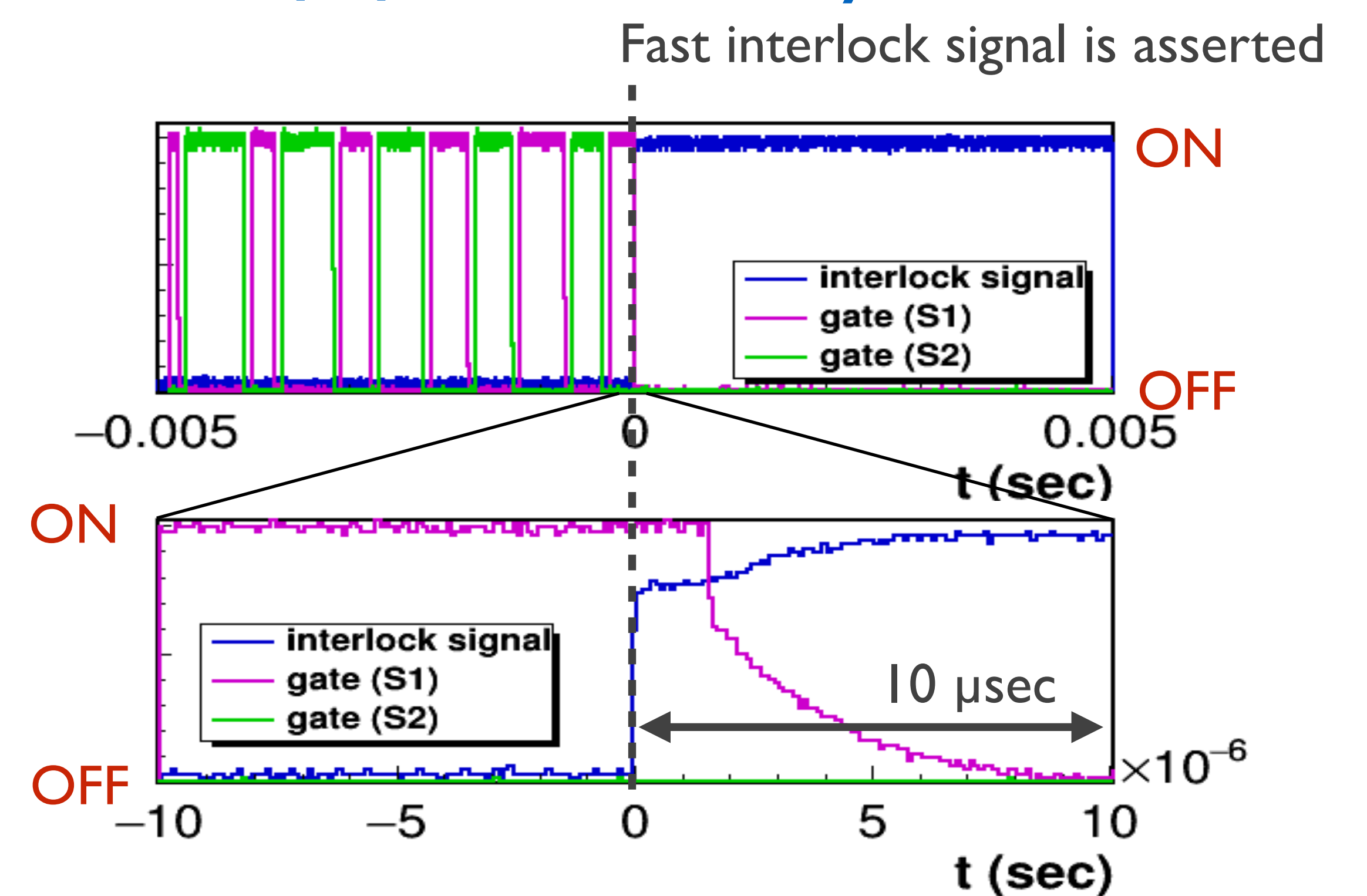
Features

- ◆ "Fast interlock system" for emergency gate closing to protect power circuit from fatal failure
- ◆ Separate components such as the main control board for feedback control, the gate pulse generator and so on, for expandability
- ◆ Isolating between controller and power circuit with optical connection for avoiding noise contamination

Conclusion

- ◆ A control system of new power converter for main magnet in J-PARC MR is designed and succeeded in controlling with new power converter for small quadrupole magnet
- ◆ Combine test with new power converter for bending magnet is on going
- ◆ We are ready to apply this control system to new power converters

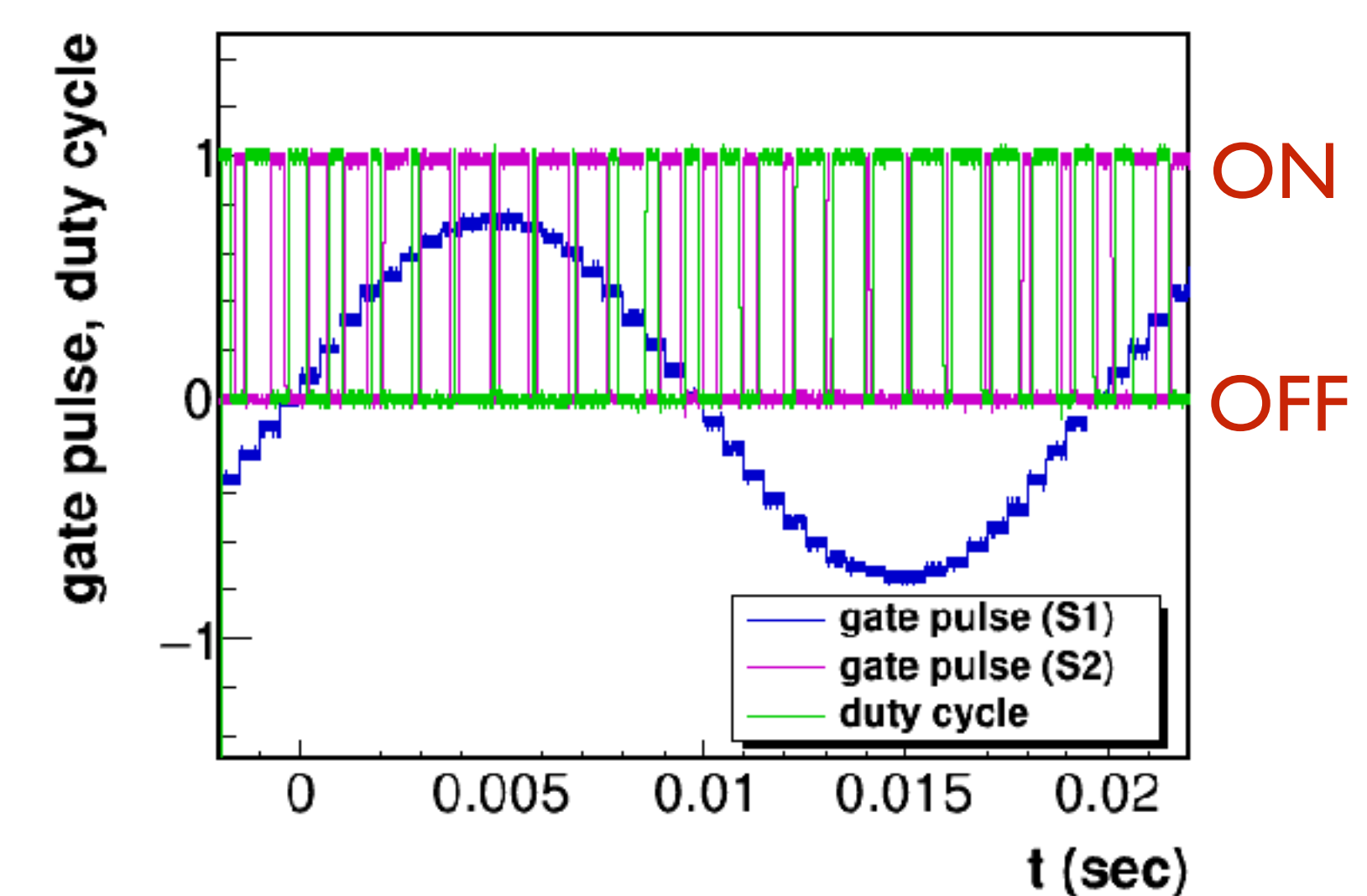
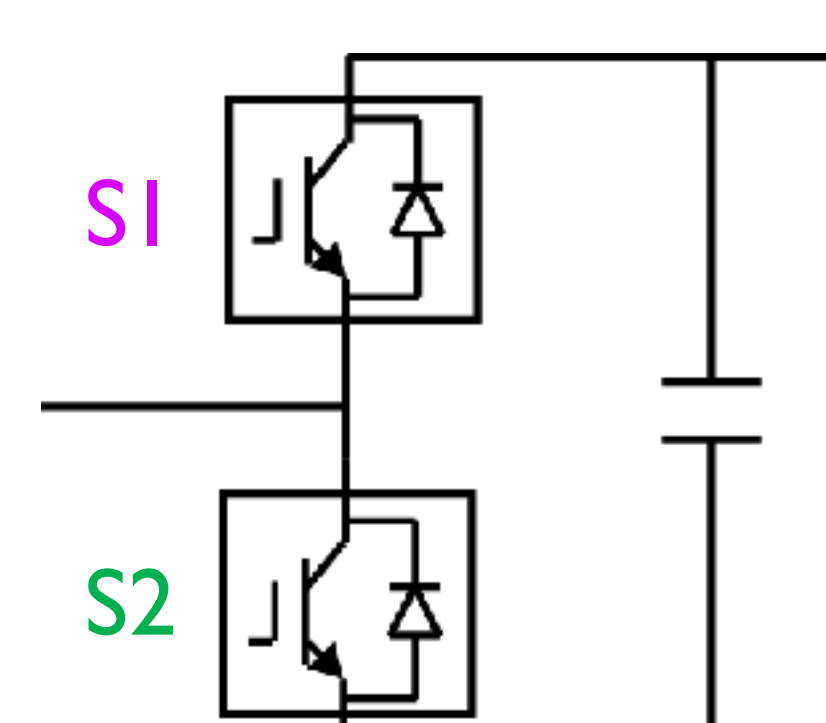
Demonstration of "fast interlock system"



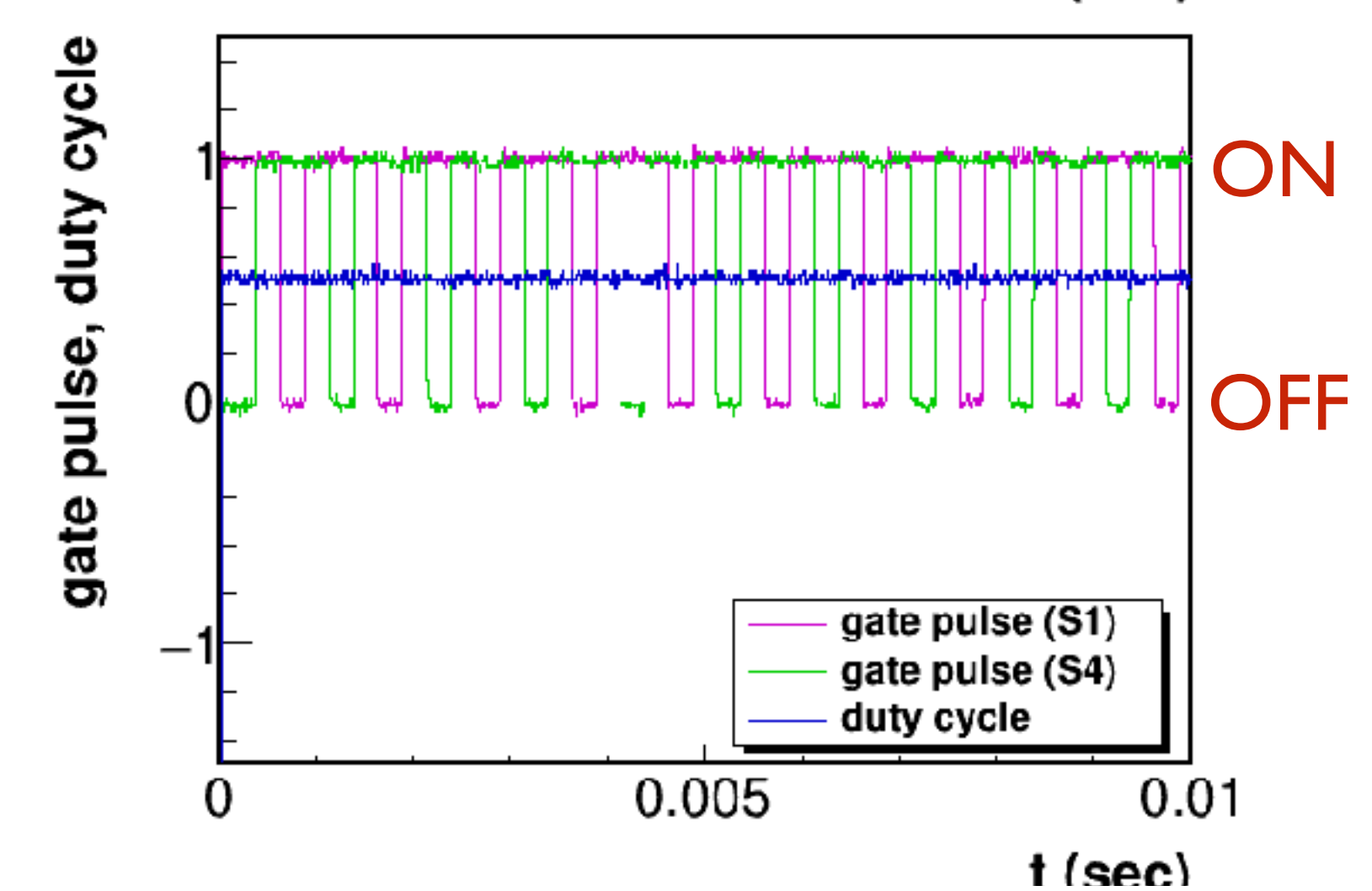
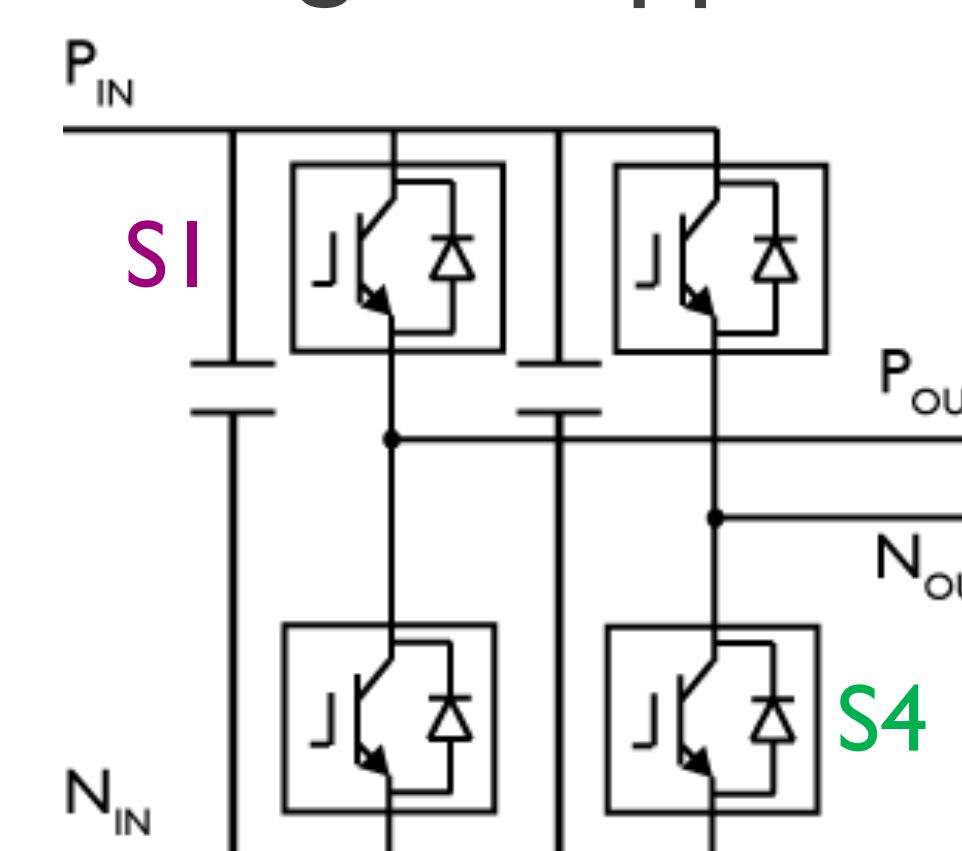
Confirmed that gate pulses are turned off within 10 μ sec after detection of alarm signal for "fast interlock system"

Demonstration of output gate pulse from control system (Frequency of gate pulse : 1 kHz)

Half-bridge AC/DC converter



Full-bridge chopper



Demonstration of combined with power converter

- Succeeded in controlling new power converter for small quadrupole magnet
- No fatal error in two years operation

