

## TIMING DELAY MANAGEMENT DATABASE FOR J-PARC LINAC AND RCS

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### Abstract

J-PARC Timing System is defined two kinds of timing, the scheduled timing and the synchronization timing. The scheduled timing is defined by a delay determined in advance from the 25Hz trigger clock sent from the central timing control. Most devices and power supplies run with the scheduled timing.

The scheduled timing system is configured one transmitter module in central control room and many receiver modules in device installed rooms (in total more than one hundred modules). Three signals which are the 12MHz master clock, the 25Hz trigger clock and the type, and Look-up Table (LUT) are distributed to the all receiver modules from transmitter module. An LUT is delay data block which is 256 \* 8 array (The "256" is the number of "type", the "8" is the number of "trigger fan-out (channel)" per one receiver module). Then, a great number of "delay data" have to be managed for accelerator operation.

The paper presents about the database to manage the timing delay for Linac and RCS.

### INTRODUCTION

J-PARC consists of Linac, RCS (3GeV Rapid Cycling Synchrotron) and MR (50GeV synchrotron) [1]. The each accelerator is operated at the different repetition rate. The Linac and the RCS have different beam destinations in each pulse. For example, the RCS is operated 25Hz. And, four beam pulses in the 91 pulses are injected to the MR and the others (87 pulses) are injected to the MLF (Material and Life science Facility). To realize these operations, J-PARC Timing System is defined two kinds of timing, the scheduled timing and the synchronization timing [2].

At the scheduled timing system, each delay of trigger (or gate) signals is able to defined independently. This enables the various operations. On the other hand, each delay has to be defined in relation to other delays. Therefore, we have started to design the timing delay management system. Then, we have developed the database (DB) for management of the relational expressions, the parameters and the functions to generate delays for accelerator operation.

### SCHEDULED TIMING SYSTEM

#### Hardware Configuration

The scheduled timing is defined by a delay determined in advance from the 25Hz trigger clock sent from the central timing control. This timing system is configured one transmitter module and many receiver modules. The outline of hardware configuration is shown in Fig.1.

One transmitter module is installed in one VME crate with one VME CPU board and two Reflective Memory boards (RM) (transmitter VME), and some receiver modules (max. 10 modules) are installed in one VME crate with one VME CPU board and one RM (receiver VME). And one transmitter VME is in central control room and some receiver VME are in each device installed room. Then, one receiver module is connected to the timing NIM modules, Trigger Fan-out module or Gate Fan-out module. And, NIM modules are connected to each device (magnet power supply and etc.) and supply the timing signals (50  $\Omega$ , TTL).

Number of VME modules and NIM modules are shown in Table 1. As shown by this table, more than one hundred receiver modules are used for Linac and RCS.

Table 1: Number of Equipment for Schedule Timing System for Linac and RCS

Equipment	Number of equipment	
	Linac	RCS
VME Crate	43	10
<b>Receiver Module</b>	<b>70</b>	<b>34</b>
CPU board	43	10
Reflective Memory	43	10
EO, OE Module	61	23
Trigger Fan-out	65	24
Gate Fan-out	63	10

#### Signal-Flow

There are the control signals (the 12MHz master clock, the 25Hz trigger clock and the Type), LUT and the timing information (the number of type, the trigger tag, the beam tag and etc) in the scheduled timing system.

The control signals are distributed to the all receiver module from the transmitter module via the optical cable. On the other hand, the timing information is distributed to the all receiver VME from the transmitter VME via RM.

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And, LUT are distributed all receiver VME from Timing Server via RM.

One LUT is a delay data block which is 256 \* 8 array (The "256" is the number of "type", the "8" is the number of "channel" per one receiver module). As previously explained, more than one hundred receiver modules are used, then, a great number of "delay data", which is more than 204,800 data (= 256 \* 8 \* 100), have to be managed for accelerator operation.

### TIMING DELAY MANAGEMENT DB

#### Table Configuration

Then, Timing Delay Management DB was developed to manage and generate a great number of delay data. This DB is using PostgreSQL which is same as other DB [3].

First, the parameters and functions for the generation of the timing delay are considered. At the result, it is cleared that these are divided into six types, which are the type (the kind of beam) definition parameters, common parameters and functions both Linac and RCS, the local parameters and functions each of Linac and RCS, and the functions to calculate the timing delay. Then, it was decided that this DB is configured the six kinds of table, Type Definition Table, Common Parameter Table, Common Function Table, Local Parameter Table, Local Function Table and Delay Function Table. Timing delay data file is generated by Timing Delay Generation Software using the parameters and functions defined in these tables.

#### Type Definition Table

This table defines the relation of the DB tables (except Parameter Definition Table) and the relation between the "Type" and beam parameters, which are the beam destination (MLF or MR) and the signal type (beam or

no-beam). As an example, the definition of "Type 1" is shown in Table 2. This means that the timing signals for MLF, Beam ON and 100μ sec width beam. By the DB table naming convention realized the beam parameter (for example, in Table 2, the "master\_100u" means the "Common Parameter Table" for the 100μ sec width beam), the definition of each type is cleared and the management of type becomes much easier.

Table 2: Example of the Type Definition

Item	Parameter
Type number	1
Beam destination	MLF
Signal type	Beam
Common Parameter Table	master_100u
Common Function Table	master_exp
Local Parameter Tables	Linac: local_5mA_IS700_RF Q700_MON_5 RCS: rcs_local
Local Function Tables	Linac: local_exp RCS: rcs_local_exp

#### Common Parameter Table and Common Function Table

These tables are inserted the parameters and the functions commonly used in Linac and RCS. For example, as the common parameters, "Linac beam width", "BMIN position of RCS main magnet" and etc are inserted in "Common Parameter Table". Then, as the common functions, "Beam start position ("BMIN position of RCS main magnet" - "Linac beam width" / 2) and etc is inserted in "Common Function Table".

By these tables, the beam parameters are able to be changed in relation to Linac and RCS.

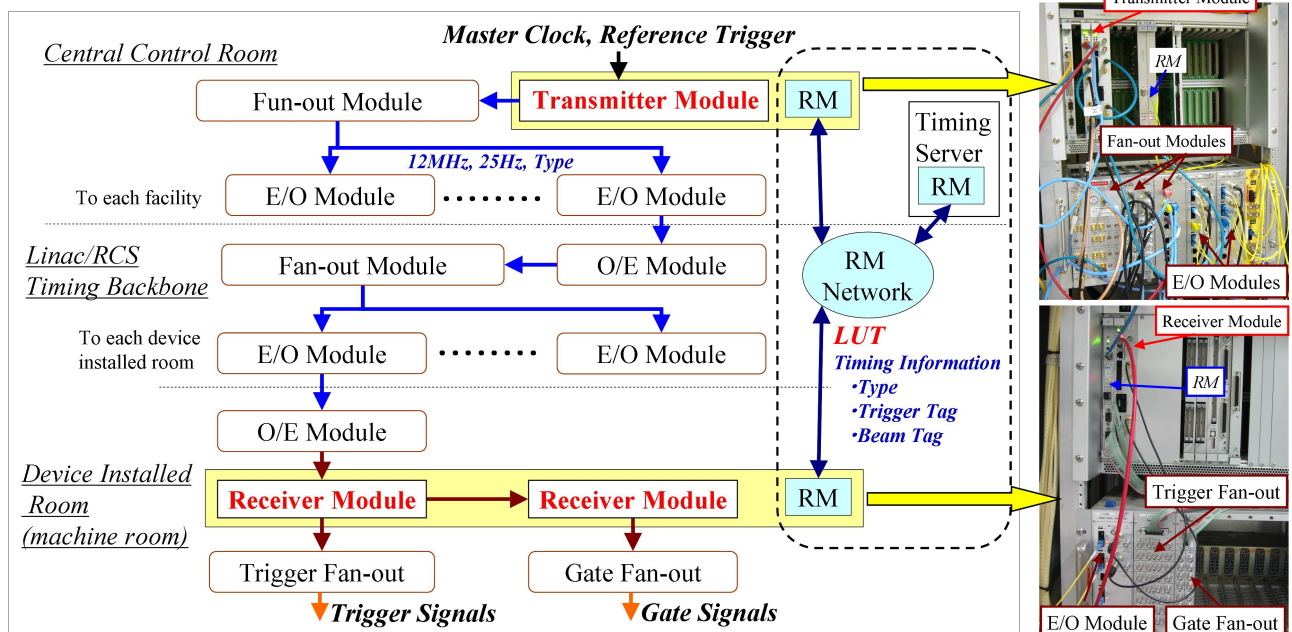


Figure 1: Outline of hardware configuration.

### Local Parameter Table and Local Function Table

There are the tables for Linac and for RCS, and the tables for each facility are inserted the each parameters and functions. For example, as the local parameters, "High voltage width for RF" and etc are inserted in "Local Parameter Table for Linac". Then, as the local functions, "Klystron HV start" and etc are inserted in "Local Function Table for Linac".

By these tables, the intrinsic parameters and functions in Linac and RCS are able to be changed independently.

### Delay Function Table

There is also the table for Linac and for RCS, and the table for each facility is inserted the each functions to calculate the timing delay for each channel of all receiver modules. Every one channel, the four kinds of function are defined in this table, which are "MLF and Beam", "MLF and No-Beam", "MR and Beam" and "MR and No-Beam". It is selected which function to use by "Type Definition Table".

This table is not changed or upgraded too often, and at the present status, the timing delays for various operations (commissioning for Linac and RCS, beam shared and etc.) are defined by changing the parameters and functions in the other tables.

### Relation Between Each DB Table

The relation between each DB tables is shown in Table 3. As shown by this table, "Local Parameter Table" and "Local Function Table" are not able to refer the local tables for other facility (for example, "Local Parameter Table for Linac" is not referred from "Local Parameter Table for RCS"). Then, if local table needs to refer the parameters and functions in the local table for other facility, these are shared via "Common Parameter Table" and "Common Function Table".

### Application for Timing Delay Generation

This application generates the timing delay data for all receiver modules of Linac and RCS, referring the DB tables. First, two arguments, the name of "Type Definition Table" and "Delay Function Table", are entered to this application. And, this application refers the

entered "Type Definition Table", and selects the target tables ("Common Parameter Table", "Common Function Table", "Local Parameter Table" and "Local Function Table"). Next, the functions are calculated using selected tables. Finally, the timing delays are generated using the "Delay Function Table". The parameters and functions are selected in this table, then, the timing delays of all channels are calculated and outputted as the "Timing Delay File" (Fig. 2).

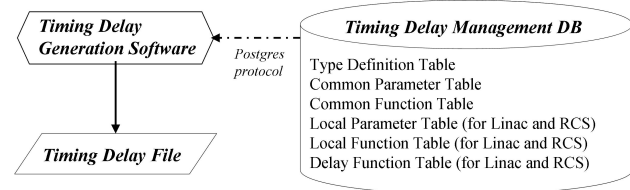


Figure 2: Configuration of Timing Delay Generation system.

## CONCLUSION

At the present, all of the timing delays for Linac and RCS are generated using this DB and application. And, the timing signals for the various operations are possible to be provided to all devices.

Then, since the relation of the DB tables and the relation between the "Type" and beam parameters are aggregated in "Type Definition Table", the management of the timing delay becomes easier. And, it is possible to avoid or decrease the human error in generation of timing delay. This system will be able to generate the timing delay for the future operation

## REFERENCES

- [1] Y.Yamazaki, "THE JAERI-KEK JOINT PROJECT FOR THE HIGH-INTENSITY PROTON ACCELERATOR, J-PARC", Proceedings of the 2003 Particle Accelerator Conference.
- [2] F.Tamura, et al., "J-PARC TIMING SYSTEM", Proceedings of ICALEPCS2003 in Korea.
- [3] H.Takahashi, et al., "DATABASE FOR CONTROL SYSTEM OF J-PARC 3GeV RCS", Proceedings of ICALEPCS07, in USA.

Table 3: Relation for Reference Between Each Tables

Reference target	Common Parameter Table	Common Function Table	Local Parameter Table for Linac	Local Function Table for Linac	Local Parameter Table for RCS	Local Function Table for RCS
Common Function Table	O	O	O	O	O	O
Local Function Table for Linac	O	O	O	O	---	---
Local Function Table for RCS	O	O	---	---	O	O

O: referable, ---: non referable