

## INSTALLATION OF BEAM MONITOR SENSORS IN THE LINAC SECTION OF J-PARC

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### Abstract

In the LINAC section of J-PARC, we have several types of sensors of monitor to characterize beam dynamics, i.e. beam position monitor, beam profile monitor, beam size monitor, beam current monitor, beam phase monitor. Those sensors are being installed currently. In this paper, procedure, and remarks during installation, and status are described.

### MONITORS IN LINAC SECTION

In the LINAC section, 38 slow current transformers (SCT's) as the beam current monitors[1], 61 fast current transformers (FCT's) as the beam phase monitors [1], 20 wire scanners (WS's) as the beam profile monitors [2], 16 carbon plate scanners as the beam size monitors (BSM's) [1]with the WS, and 102 beam position monitors (BPM's) [3] are allocated. Figure 1 shows the location of these monitors along the beam line. Each arrow corresponds each monitor (For easiness of eye guiding, each arrow tip is pointing only the position in z-direction, but not in x- nor in y- direction. And because the number of BPMs is larger, the arrows for BPM's are pointing from both sides of beam line simply for easiness of eye guiding). Four different colors show type of the monitors, namely purple for the SCT, blue for FCT, red for BPM, and green for WS/BSM. In A0BT, four WS's in down stream (out of the 8 WS's arrows) are optional, when needed. Note that there are also 124 beam loss monitors (BLM's) along the LINAC beam line, which are out of scope of this paper.

### ORDER OF INSTALLATION

As delivery of monitors and parts on the beam line are not at a time, the sensors of monitors are installed in the following order in subsection of LINAC.

- (1) MEBT subsection
- (2) L3BT subsection
- (3) DTL subsection
- (4) SDTL subsection
- (5) A0BT subsection

Installation in the first subsection, MEBT, began in the last summer of 2005. Most of the monitors in the MEBT have been functioned in the DTL-1 commissioning at KEK until 2005. After position calibration of each BPM by the test bench, re-installation in the MEBT, (which were also transported from KEK to JAEA in 2005) began. And installation in the last subsection, A0BT, began in the April 2006 and is just currently on going. Each of the monitors is handled and supervised by J-PARC staffs all through the installation.

### NUMBER OF SENSORS

In each subsection, depending on the number of cavities (e.g. 3 DTLs, 30 SDTLs (in day-1)), monitors are allocated. Table 1 shows each number of sensors installed (namely, not including optional position where only cables are installed). In upper stream, e.g. MEBT, DTL, SDTL, due to the smaller physical space in z-direction, different types of monitors are welded on each other.

Table 1: Number of monitors in each subsection.

| Subsection<br>in LINAC section | Type<br>of monitors | Number<br>of monitors |
|--------------------------------|---------------------|-----------------------|
| MEBT<br>(with LEBT)            | BPM                 | 8                     |
|                                | WS                  | 4                     |
|                                | SCT                 | 6                     |
|                                | FCT                 | 5                     |
| DTL                            | SCT                 | 3                     |
|                                | FCT                 | 3                     |
| SDTL                           | BPM                 | 29                    |
|                                | WS                  | 4                     |
|                                | SCT                 | 15                    |
|                                | FCT                 | 44                    |
| A0BT                           | BPM                 | 17                    |
|                                | WS                  | 4                     |
|                                | SCT                 | 3                     |
|                                | FCT                 | 4                     |
| L3BT                           | BPM                 | 40                    |
|                                | WS/BSM              | 20                    |
|                                | SCT                 | 7                     |
|                                | FCT                 | 4                     |
| Beam Dump<br>(0 degree)        | BPM                 | 2                     |
|                                | WS/BSM              | 1                     |
|                                | SCT                 | 1                     |
| Beam Dump<br>(30 degree)       | FCT                 | 1                     |
|                                | BPM                 | 2                     |
|                                | WS/BSM              | 1                     |
| Beam Dump<br>(90 degree)       | SCT                 | 1                     |
|                                | BPM                 | 2                     |
|                                | WS/BSM              | 1                     |
| Beam Dump<br>(100 degree)      | SCT                 | 1                     |
|                                | BPM                 | 2                     |
|                                | WS/BSM              | 1                     |
|                                | SCT                 | 1                     |

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## REMARKS DURING INSTALLATION

Each type of monitors has its own remarks during installation. These are simply technical details but in real case, those points are critical for the time-constrained installation. Therefore some emphases in this paper are on this section.

### *Slow and Fast Current Transformer (SCT and FCT)*

Except for MEBT and DTL subsection, each current transformer has its inductive core outside of vacuum chamber in order to avoid any outgas from the monitor parts. Therefore a small ceramic block is used for RF signal to be transmitted through (toward the inductive core) while vacuum enclosure is tightly kept. During transportation and installation, no tension is put on the

ceramic so that vacuum leak is not occurred. Installation of each CT began only when its supporting structure (cavity, beam duct, and/or other monitors) on both sides (upstream and downstream) of the CT's, is fixed and finalized. As each FCT has its own surveyed point (to be exact, has a dedicated table on itself, for a metal surveyed ball), the view angle for the survey work, is left open without any cable or any connectors.

### *Wire Scanner, and, Beam Size Monitor (WS and BSM)*

There are thin wires (e.g. 30 micro-meters of gold-plated tungsten-made wires in most (i.e. except in MEBT[2]) of WS's) in the chamber. And each wire is positioned with tension by small springs on its both sides. Great care is taken during transportation between manufactures and the J-PARC site in Tokai.

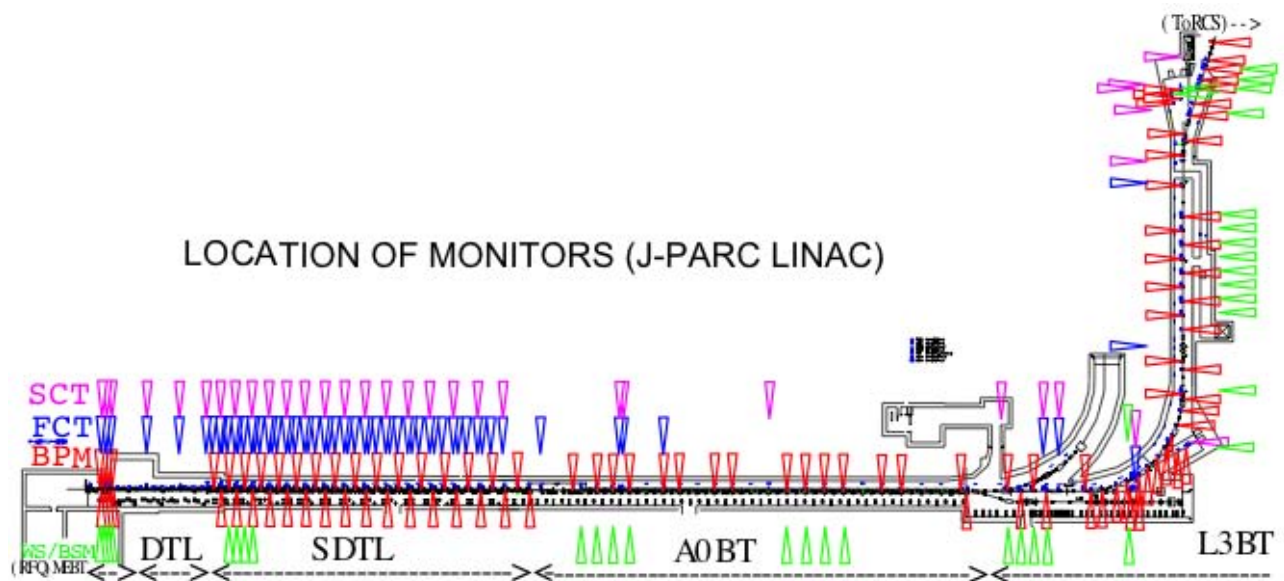


Figure 1: Location of monitors along the beam line in J-PARC LINAC section. Each arrow corresponds to each monitor. (For easiness of eye guiding, each arrow tip is pointing only the position in z-direction, but not in x- nor in y-direction.)

Four different colors show type of the monitors, namely purple for the SCT, blue for the FCT, red for the BPM, and green for the WS/BSM. In A0BT, the 4 (in down stream) out of 8 WS's are optional, when needed.

Before and after each transportation (even it is short distance), resistance of the wire is measured, so that no single cut-down nor shorten-circuit is unfound. In the L3BT subsection where larger duct diameters (120mm) of WS/BSM's are used, each of WS/BSM's is suspended on its own dedicated frame containing spring structure (spring constants are a few kgf/mm), in order to adjust position in three dimensional direction (x-, y-, and z-direction) with beam ducts on its both sides. Figure 2 shows the frame structure. Without the spring structure, reasonable position adjustment of such larger structure was impossible.

### *Beam Position Monitor (BPM)*

In the LINAC section, BPM's are designed to be mounted on quadrupole magnet yoke to get position on the beam line. This was one of time-constraints for BPM installation. In the L3BT subsection, for example, some months were used for magnet installation, and during those period J-PARC staff from monitor group needed to be manned for each time of BPM installation. Other example of time-constraint is in SDTL section. Just after the BPM installation, survey of the quadrupole magnets is scheduled, therefore no delay of parts derivation, including spare gaskets or chain cramps, was allowed.

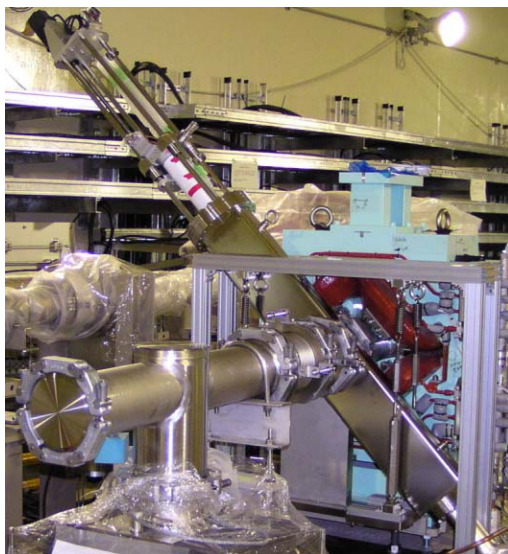


Figure 2: Mounting frame with spring structure for a wire scanner and beam size monitor (WS/BSM), in the L3BT subsection.

Calibration methods against position of quadrupole are described elsewhere [4, 5]. Figure 3 shows the mounted posture of BPM in a quadrupole magnet. After closing upper half of the magnet (as the figure shows) BPM is almost fully contained inside the magnet yokes. To keep the best positioning of BPM, we use shim plates between BPM supports and the magnet yokes, where needed. In that case, we put the shims in symmetric manner, so that systematic error is minimum possible.

#### *Cabling from Monitors to Readout Electronics*

Most of readout electronics are located in the 1st floor (some pre-amplifier circuits are located in the 2nd basement), while sensors of monitors are in the 2nd basement where accelerator is located. Nearly a hundred meters length of signal cables are installed for each pickup of each detector. Moreover, 4 (excluding one additional spare) cables from four pickups (right, left, top, and bottom) of each BPM, 2 cables from each CT (one for signal, the other for calibration), 3 cables from each WS/BSM (one from beam size monitor, the other two from two wires (one for horizontal profile, and the other for vertical profile)). The connection on the both sides of the cable is on going currently, so that signal check on them is soon possible.

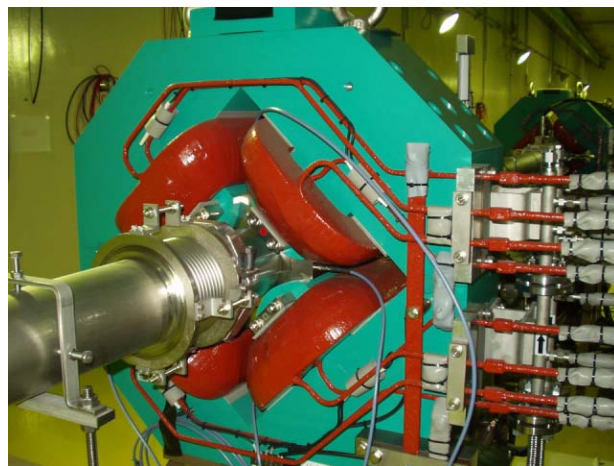


Figure 3: Mounting scheme of a beam position monitor (BPM) on a quadrupole magnet, in the L3BT subsection. BPM is fully contained inside the magnet yokes.

### SUMMARY

- In J-PARC LINAC section, 38 SCT's, 61 FCT's, 36 WS/BSM's, and 102 BPM's are being installed. Remaining installation is for the A0BT subsection.
- Due to small physical space, some of the monitors are welded on each others.
- CT's and WS/BSM's require great care during transportation and installation.
- BPM's are mounted on quadrupole magnet, therefore adjustment along the magnet yoke is required.
- Cable connection for signal check is currently on going.

### REFERENCES

- [1] J-PARC Design Report (JAERI-Tech 2003-044, KEK Report 2002-13)
- [2] H. Akikawa, et al., Proceeding of 1st annual meeting of Particle Accelerator Society of Japan (2004), p162.
- [3] T. Tomisawa, et al. Proceeding of 1st annual meeting of Particle Accelerator Society of Japan (2004), p165.
- [4] S. Sato et al. Proceeding of LINAC 2004 (2004) p429.
- [5] S. Sato et al. Proceeding of PAC 2005 (2005) p277.