# COMMISSIONING OF SPRING-8 LINAC CONTROL SYSTEM

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*Abstract*

After a year from the installation of linac components, we have started the beam commissioning and accelerated the purpose energy. We think that the installation time is much short. As one of the answer of this, we follow the success of automatic RF conditioning. It works very good job, and the RF conditioning had finished for 400∼550 hours. The conditioning system is based on VME computers and Work Station (WS).

And, at the beam commissioning, we have designed new type beam fluctuation monitor using image process. This monitor is very useful for the measurement of energy fluctuation.

In this paper we report the history of the construction and the beam commissioning on the linac control system.

Table 1: SPring-8 Linac I/O boards.The VME CPU board is operated by OS-9. These VME boards are installed into the VME cage which is taken aganist EMI.

| Name | Function | Number of boards |
|---|---|---|
| MVME147s | CPU(68030) | 21 |
| AVME9350 | AI(16ch) | 34 |
| AVME9210 | AO(6ch) | 25 |
| DVME-DIN3 | DI(64ch) | 53 |
| DVME-DOUT3 | DO(64ch) | 31 |
| VPAK601 | MotorControl(2ch) | 55 |
| EVME-GPIB21 | GPIB | 18 |
| ADVME2210 | JPEG image | 1 |

## 1 THE HISTORY OF THE CONSTRUCTION

The SPring-8 injector linac was completed at end of July 1996, and the beam commissioning has begun since 1st August. At 8th August 1996, we succeed in the 1 GeV electron acceleration which is the purpose energy. Figure 1 shows the history of our project. Left parts shows hardware installation history, and right part shows software installation. The installation of hardware had started since June 1995. And the pre-alignment had started since October. Since February in 1996, the consistency test between hardware and software had started.

The linac is 140 meter long, and have many number of parameters. Table 1 shows the number of linac control parameters. These parameters is controlled by VME computers which are commercial product.

The total number of man-days that required for the consistency testing was about 10 people. Though the testing done a small number of people, we had no big trouble, and

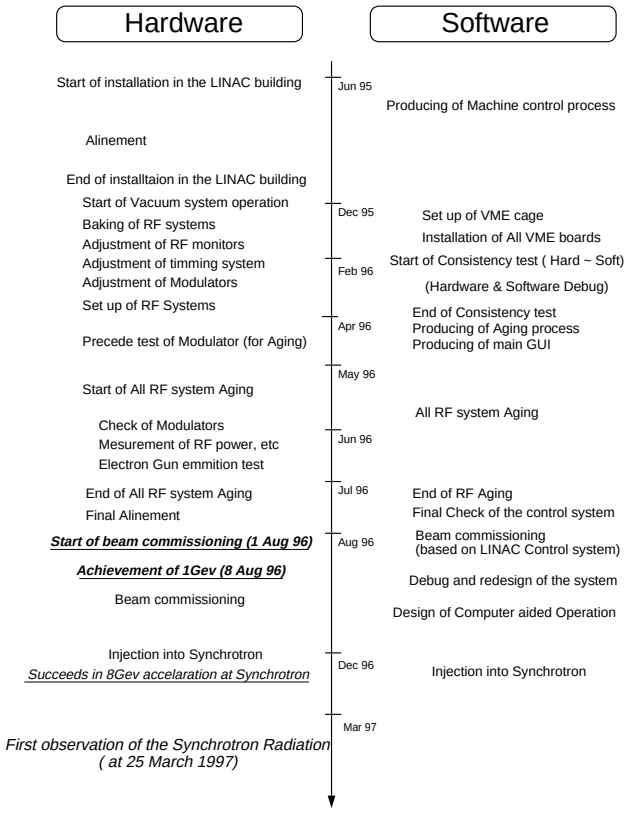


Figure 1: History of the soft and hard construction.

we could do the testing and checking smoothly. This test had done for about two month. In the testing, we took care of the electronic noise of linac component.

A rehearsal for the non beam linac operation has begun since a last week of July. And, we had started on the beam commitioning since August 1th.

## 2 THE PF CONDITIONING SYSTEM

### *2.1 Guide line of automatic RF conditioning*

We choose 80MW klystron (Toshiba E3712, 2856MHz) RF system. The number of E3712 are 13, and usually drive one about ∼60MW, ∼60pps, ∼3$\mu$sec[1]. We must achieve near this power until the beam commissioning. However, if the conditioning start, we have to work night and days for this plan. Because, the conditioning staff have very few. For these problems, we designed the automatic RF conditioning system[2]. Figure 2 shows sequence for the automatic RF conditioning system. This sequence was get from the precede test of RF component. These sequence was operated in the VME computers.

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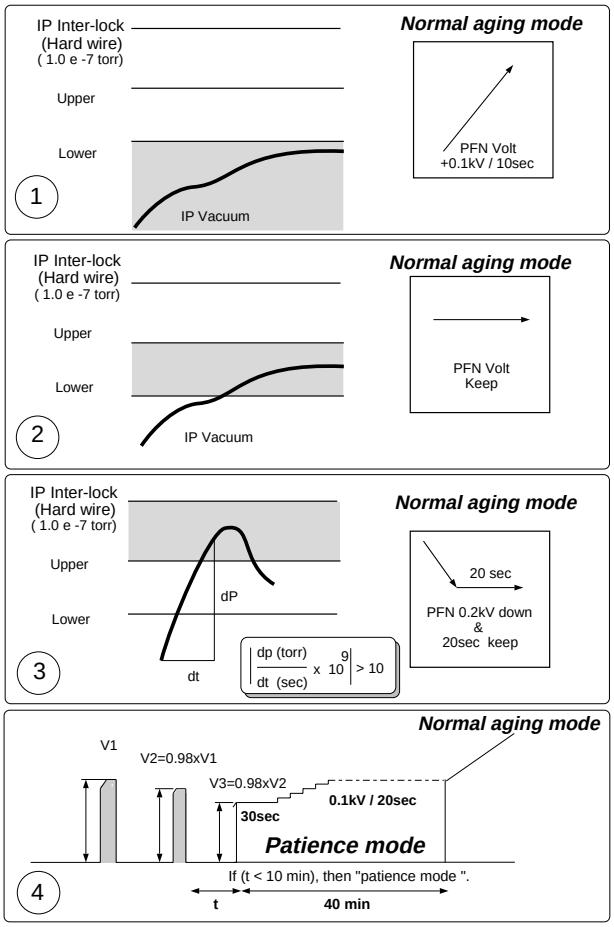


Figure 2: The sequence of automatic conditioning. This sequence is based on an expert in linac operation. He has operated many linac for about 30 years.

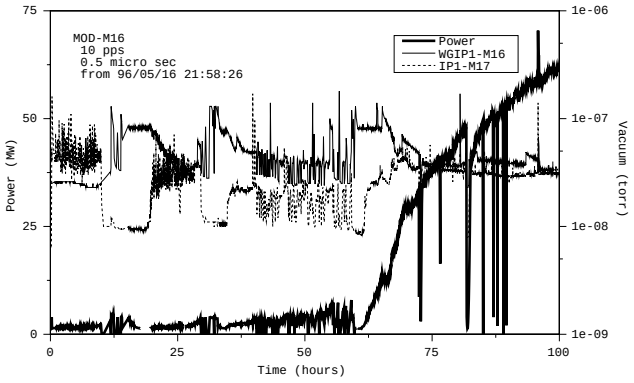


Figure 3: Process of automatic conditioning.

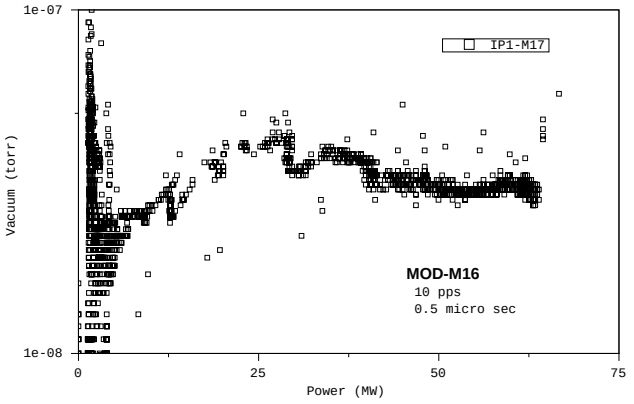


Figure 4: the spectrum of automatic conditioning. The value of vacuum is at near the accelerator tube.

### *2.2 The result of conditioning system*

The automatic RF conditioning system is very stable and good job, so that all the RF conditioning has finished for $\sim$550 hours. It is very short time. Figure 3 shows a progress of automatic RF conditioning. The pulse width is 0.5 micro sec. Firstly, the RF system generate discharges at a low-level power. At the these power, the RF-window have many kind of out-gas mechanism, so it operated more carefully and wasted long time. Figure 4 is the spectrum of RF conditioning. The horizontal axis means input power of the RF conditioning, and the vertical axis means the vacuum value of input power. As stated above, low-level input power causes the electronic discharge on the RF window, and the spectrum shows bad vacuum on this power domain. At first, we had designed an automatic RF conditioning system using fuzzy logic[3]. However, we could not ready for it.

## 3 MEASUREMENT OF THE BEAM FLUCTUATION

### *3.1 Guideline of fluctuation monitor*

At the beam commissioning and the injection into synchrotron, we have to supply the very stable beam which have the no fluctuation. However we are able to measure two type beam fluctuations on that. One is a beam current fluctuation, other is a beam energy fluctuation. The measurement of current fluctuation is comparative simplicity. But the energy fluctuation does not. So we designed the beam energy fluctuation monitor using image process.

Figure 5 shows the guideline of measurement system. The current monitor(OSC) and screen monitor are watched by CCD camera which made as NTSC (National Television System Committee) regulation. The video switch collects all NTSC video signal and send to the VME camera interface board. At the VME board, the video signal convert digital-value and compress JPEG (Joint Photographic Expert Group) data file. The data file is send to WS using the SCD (SPring-8 Linac Control Datagram) [4].

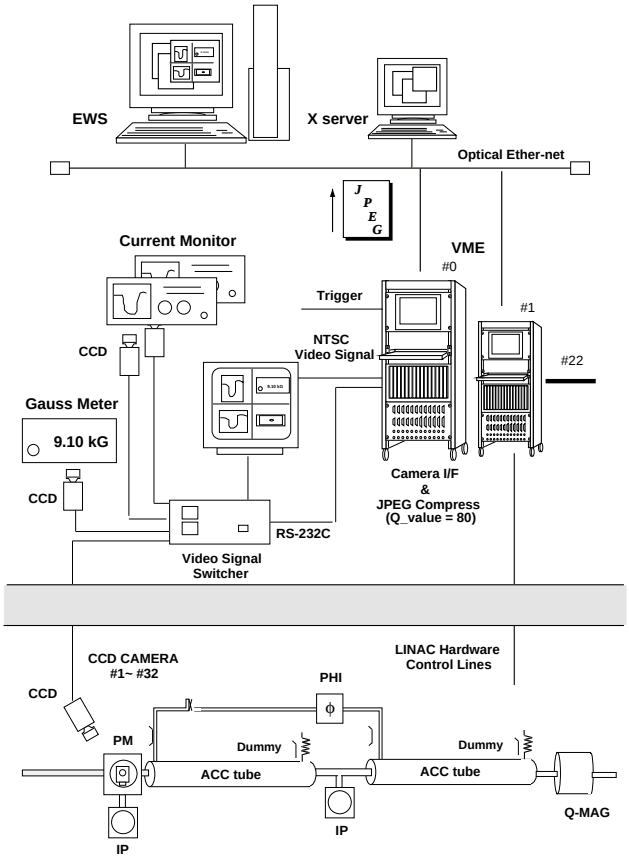


Figure 5: Guidline of the analyzer system. The image data is compressd into the VME board.

### *3.2 Human interface and the measurement data*

Figure 6 shows the human interface of the monitor. The image data is send from a VME computer to the WS. The monitor is recognize the highest intensity part on image data as the beam center part, and recording. If this part have big fluctuations, then we can understand the beam energy also fluctuate. Figure 7 shows result of energy monitoring at the 1GeV bending magnet. So that we can say that the beam energy fluctuation is under 0.3% at 1GeV. Probably, this fluctuation is cause from the RF phase fluctuation at every klystrons. Because, we do not control the RF phase fluctuation.

## 4 CONCLUSION

The SPring-8 linac had completed, and the beam commissioning has started. Since the commissioning, the linac control system has no big troubles, and be stable. Special mention should be made of the automatic RF conditioning system. It worked very good job, and we got plenty time.

Now, we design the injection control system which based on the image monitor. It may be that the system is going to use some mathematical theories. To use it, so that we will be able to get more simple operation[5]. And, we will try to control the RF phase fluctuation.

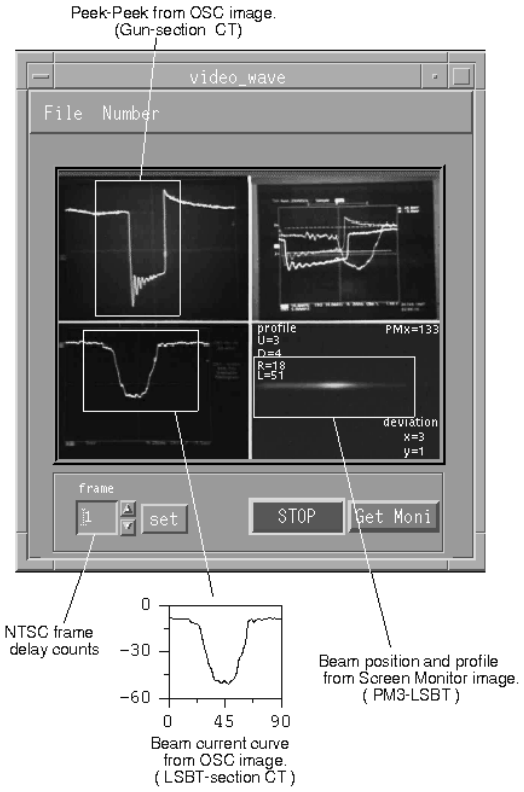


Figure 6: Human interface of the monitor.

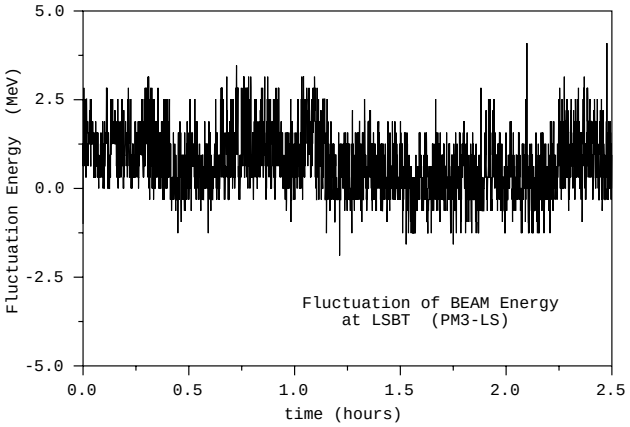


Figure 7: Fluctuation of beam energy at the 1GeV energy place.

## 5 REFERENCES

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[5] H.Sakaki et al., Proc. of IWCSMSA96, in Tsukuba, (1996).