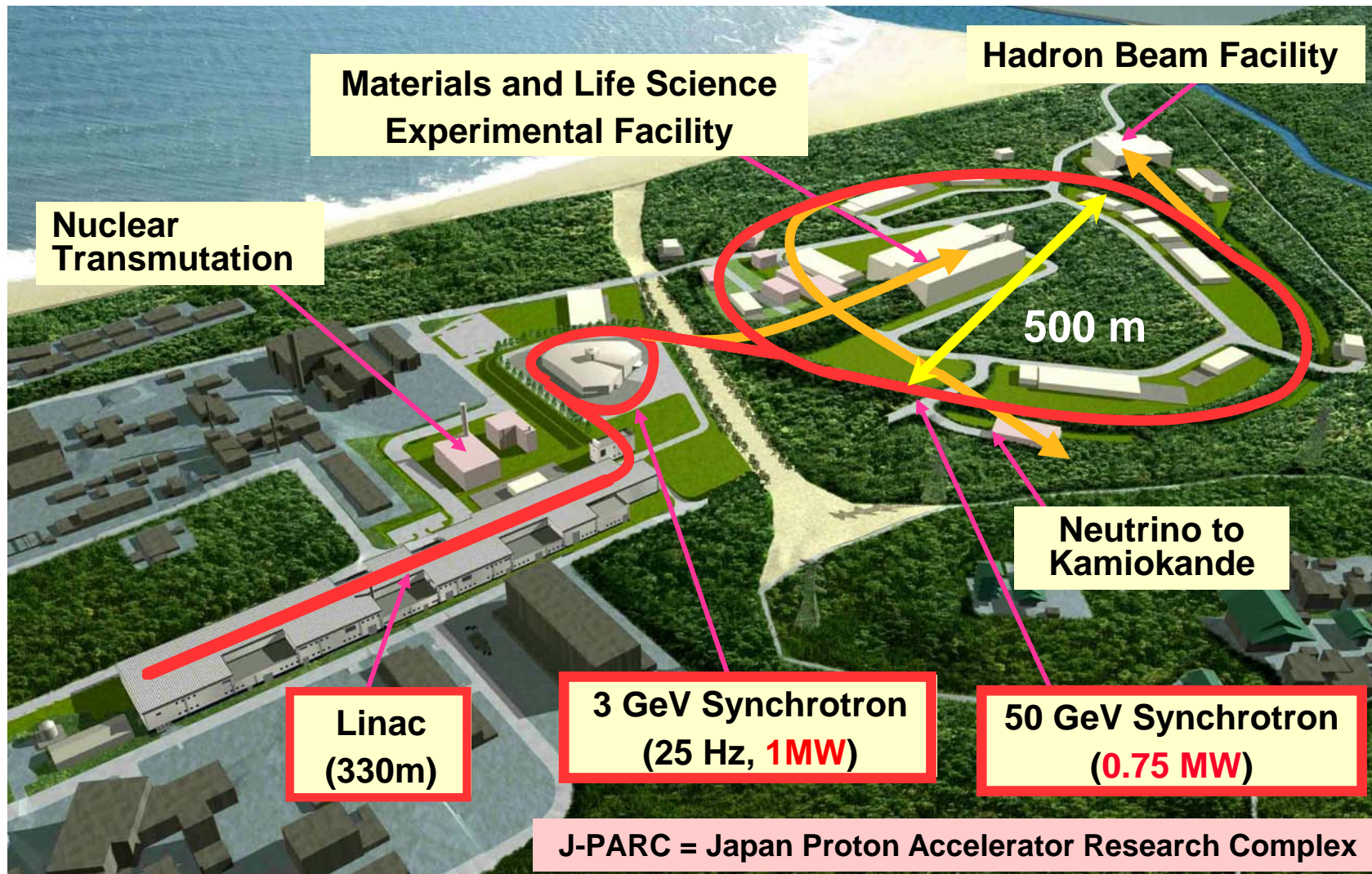




October 16, 2007  
ICALEPCS2007 at Knoxville

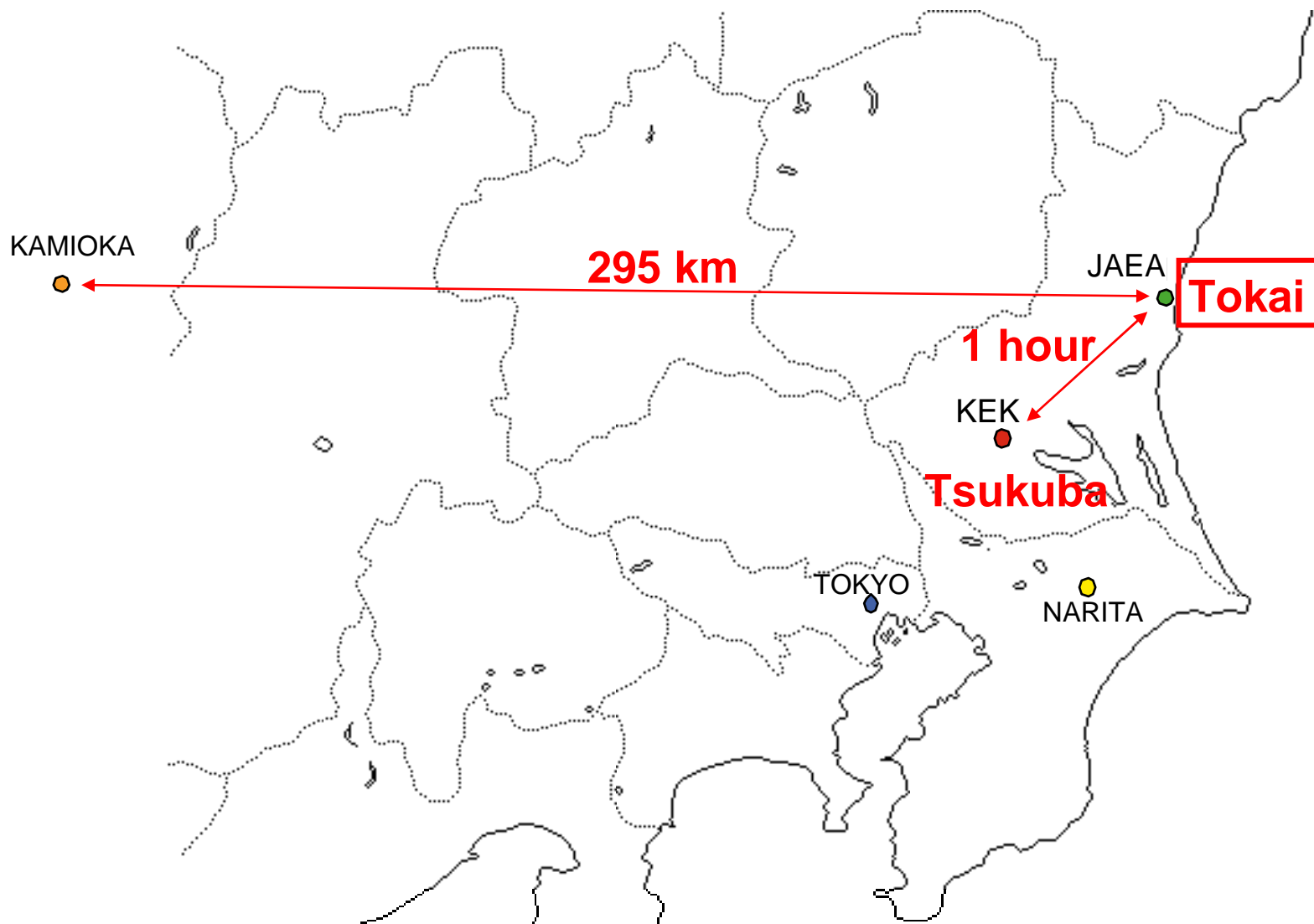
# Current Status of The Control System for J-PARC Accelerator Complex

**Hiroshi YOSHIKAWA**  
**J-PARC Center at KEK/JAEA**

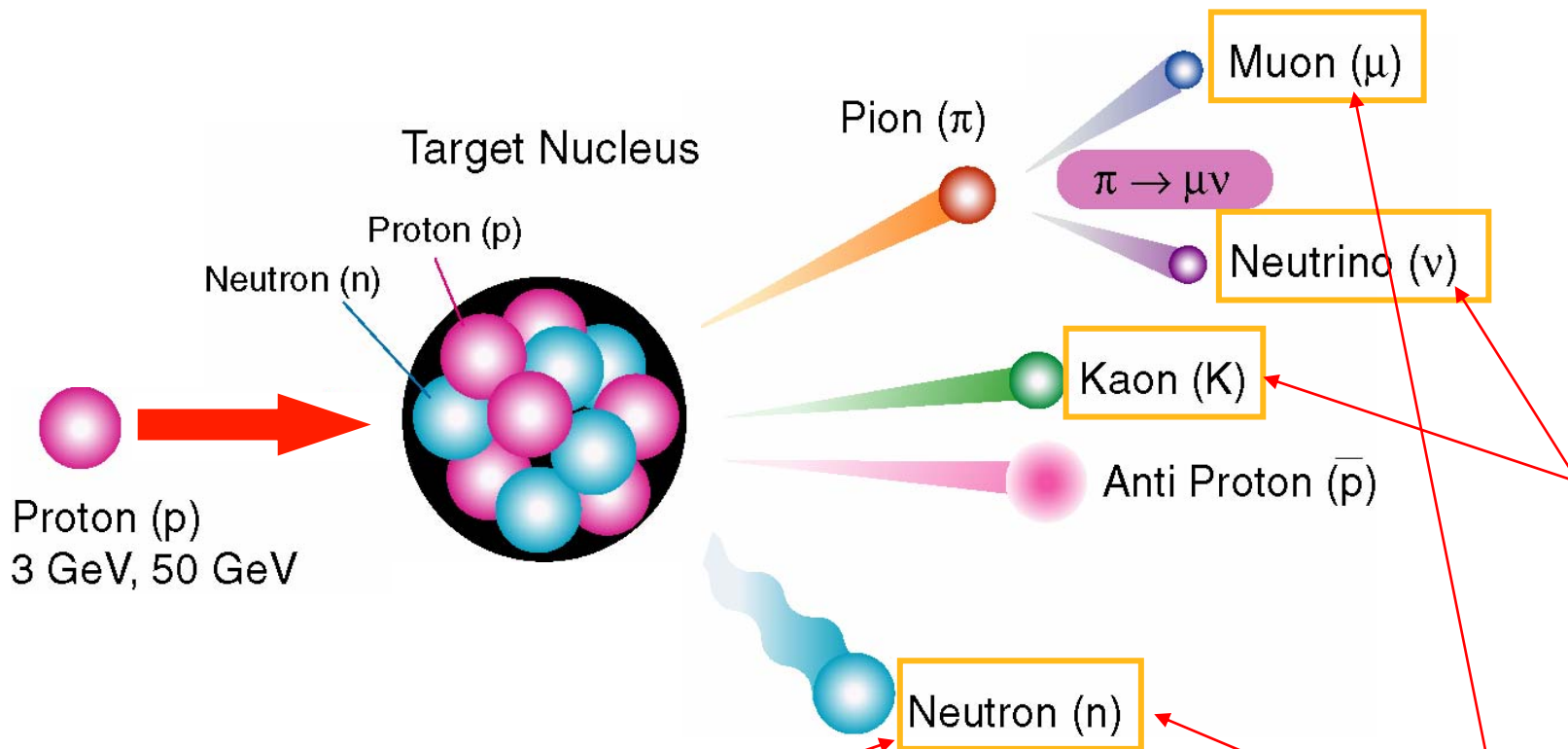


**Joint Project between KEK and JAEA**

# Location of J-PARC at Tokai



# Goals at J-PARC

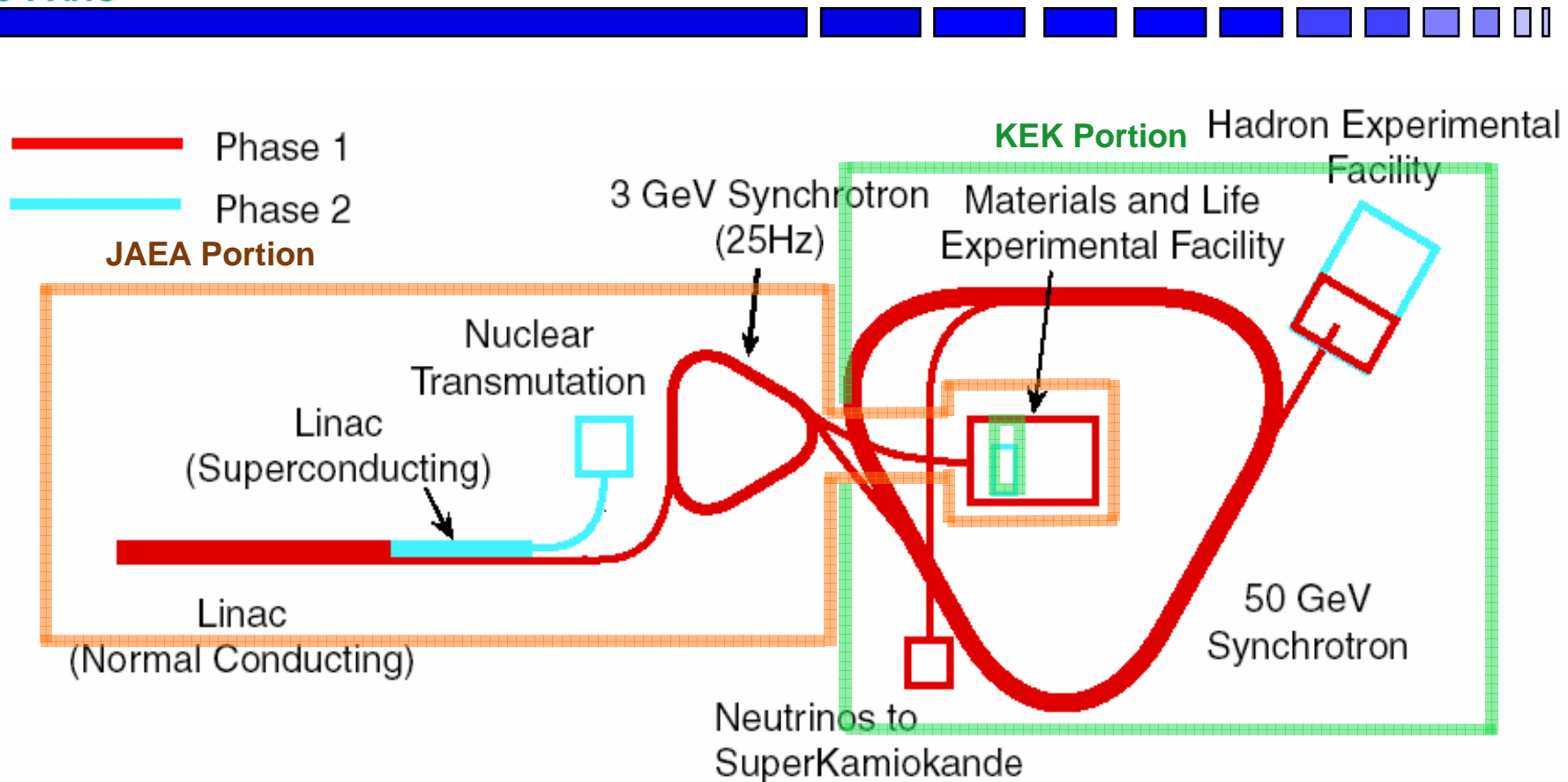


Need to have high-power proton beams

→ MW-class proton accelerator  
(current frontier is about 0.1 MW)

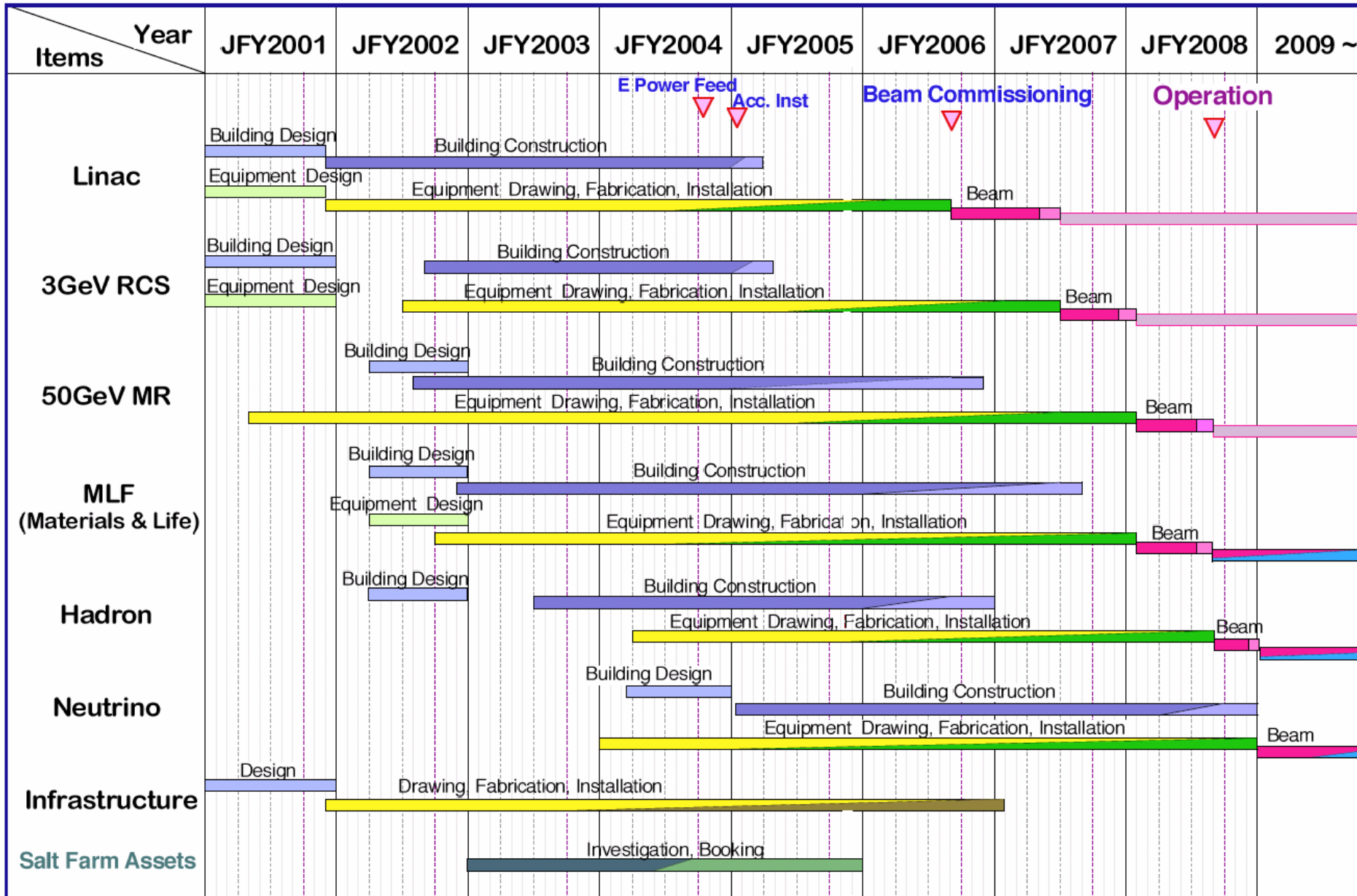
Materials & Life Sciences at 3 GeV  
Nuclear & Particle Physics at 50 GeV  
R&D toward Transmutation at 0.6 GeV

# Phase 1 and Phase 2



- Phase 1 + Phase 2 = 1,890 Oku Yen (= \$1.89 billions if \$1 = 100 Yen).
- Phase 1 = 1,527 Oku Yen (= \$1.5 billions) for  $\sim 8$  years.
- JAEA: 860 Oku Yen (56%), KEK: 667 Oku Yen (44%).

# J-PARC Construction Schedule



## ■ Protect from Radiation

### – Intelligent Beam Control

- Keep stability of electro-magnetic field
- Keep minimum beam loss
- Predict beam behavior
  - System identification and definition of response function
  - By link of operation and simulation
  - By link of operation and database

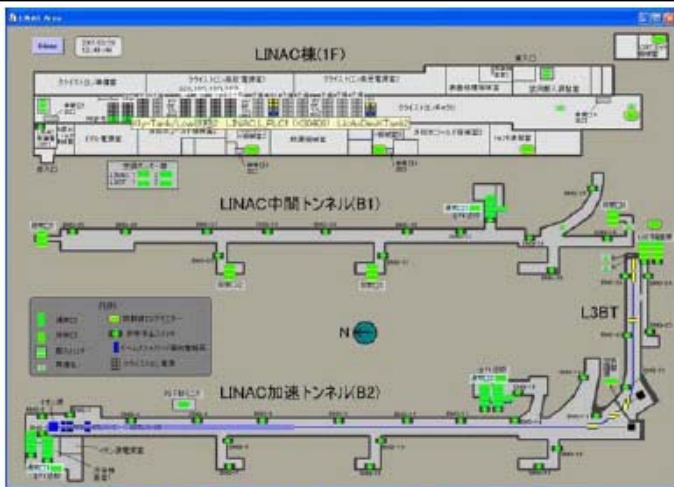
## ■ Integrated Operation Environment

### – Effective use of software technology

In the process of developing

- Radiation Measurement System
  - Legal management of the area boundary
- Personnel Protection System (PPS)
  - Make and keep the boundary condition of closed space which is allowed existence of the beam
  - Stop the beam when the condition breaks
- Machine Protection System (MPS)
  - Protect machine from high power beam bombardment
  - Stop the beam when something is wrong
- Computer Control System
  - Automatic correction, FB, FF
  - Suggest the optimum parameters





**PPS Status Monitor**



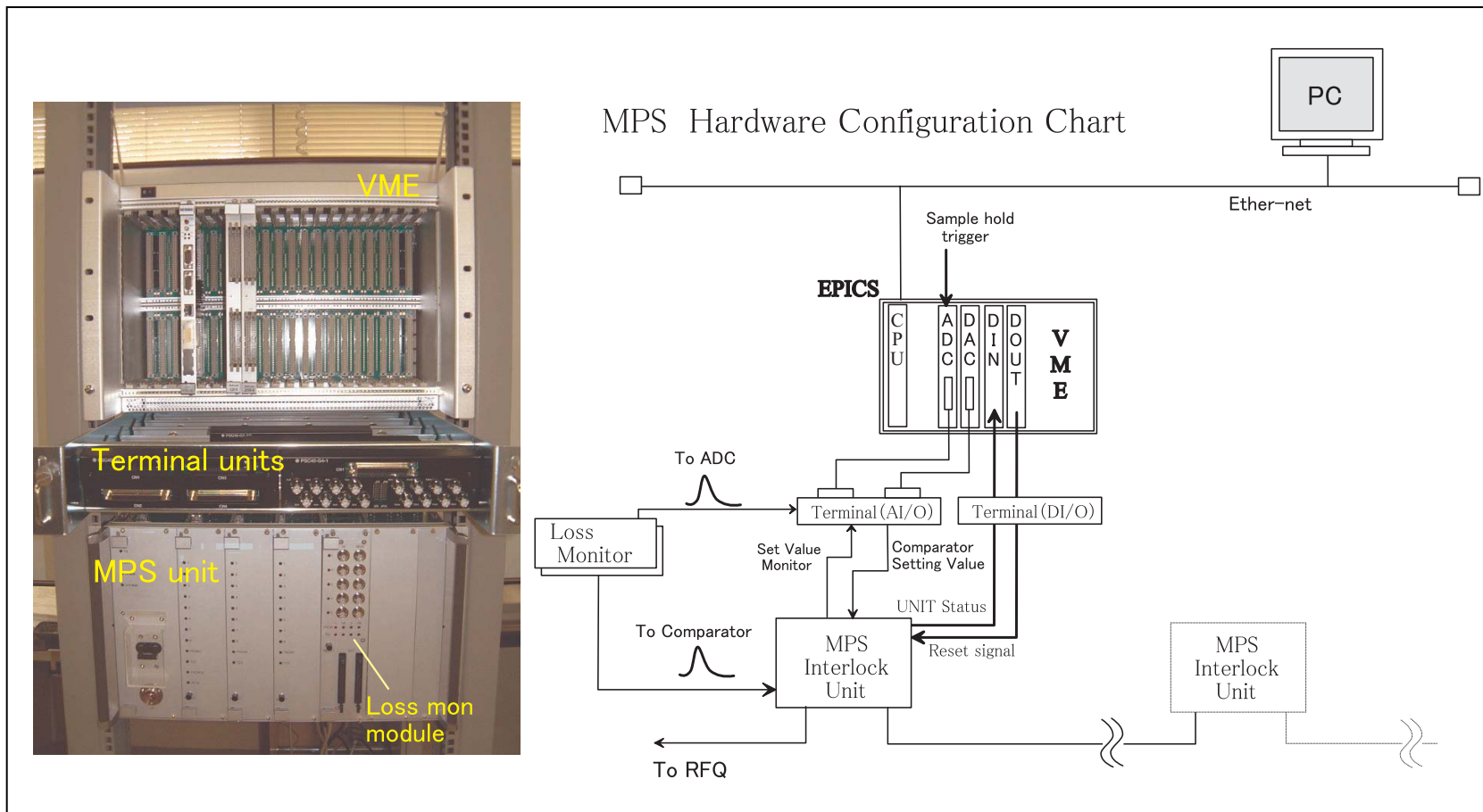
**PPS Operator Console**



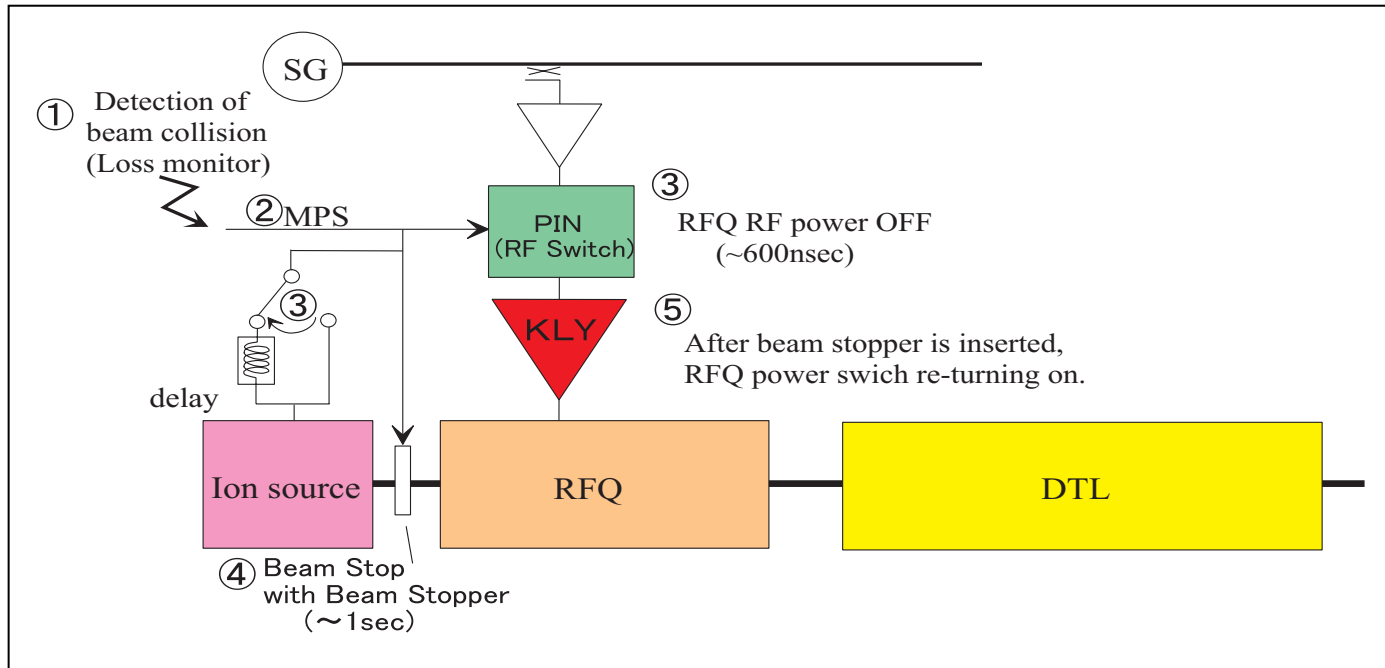
**Access Control Table**



**TV Monitors of an Access Point**



MPS hardware configuration. When the threshold is exceeded, the loss monitor module with only the analog circuit is fired.



## Fast beam stop procedure using Machine Protection System (MPS)

- 1: The beam loss is detected by the loss monitor.
- 2: Loss signal transmission to the RFQ part using MPS.
- 3: RFQ power off and Ion source injection timing removing.
- 4: Insertion of the Beam stopper
- 5: Because MPS don't want to cool the RFQ, power is turned on again quickly.



LINAC MPS

File Setup Tool Help

### LINAC Inter Lock (From MPS Unit)

Error  
Mask  
Normal

RESET

### LINAC Beam Loss Level(From Monitor)

High  
80%~  
60%~  
40%~  
HV OFF  
Low

DTL	SDTL	ACS	L3BT	..

log 5V ~  
log 0V

### Error Events

```
2007/01/23 12:29:18:542 LI_SDTL3:MPS18:STAT:SDTL03_LLRF01 Error
2007/01/23 12:27:18:367 LI_SDTL4:MPS19:STAT:SDTL04_LLRF01 Error
2007/01/23 12:24:08:325 LI_SDTL5:MPS20:STAT:SDTL05_LLRF01 Error
2007/01/23 12:21:29:035 LI_SDTL15:MPS30:STAT:SDTL15_LLRF01 Error
2007/01/23 12:19:32:262 LI_SDTL8:MPS23:STAT:SDTL08_LLRF01 Error
2007/01/23 12:15:15:792 LI_SDTL10:MPS25:STAT:SDTL10_LLRF01 Error
2007/01/23 12:12:50:123 LI_SDTL7:MPS22:STAT:SDTL07_LLRF01 Error
2007/01/23 12:12:22:125 LI_SDTL3:MPS18:STAT:SDTL03_LLRF01 Error
```



LINAC MPS

File Setup Tool Help

### LINAC Inter Lock (From MPS Unit)

Error  
Mask  
Normal

RESET

### LINAC Beam Loss Level(From Monitor)

High  
80%~  
60%~  
40%~  
HV OFF

Low

DTL	SDTL	ACS	L3BT	..

20:12:01  
20:11:01  
20:10:01  
20:09:01  
20:08:01  
20:07:01  
20:06:01  
20:05:01  
20:04:01  
20:03:01

log 5V ~  
log 0V

### Error Events

```
2007/01/23 20:10:43:615 LI_SDTL11:MPS26:STAT:SDTL11_LLRF01 Error
2007/01/23 20:04:13:653 LI_SDTL13:MPS28:STAT:SDTL13_LLRF01 Error
2007/01/23 19:52:36:742 LI_SDTL6:MPS21:STAT:SDTL06_LLRF01 Error
2007/01/23 19:48:36:610 LI_SDTL13:MPS28:STAT:SDTL13_LLRF01 Error
2007/01/23 19:47:02:724 LI_SDTL9:MPS24:STAT:SDTL09_BLM01 Error
2007/01/23 19:46:20:783 LI_SDTL8:MPS23:STAT:SDTL08_BLM02 Error
2007/01/23 19:35:48:448 LI_SDTL10:MPS25:STAT:SDTL10_LLRF01 Error
2007/01/23 19:34:22:642 LI_SDTL11:MPS26:STAT:SDTL11_LLRF01 Error
```



LINAC MPS

File Setup Tool Help

### LINAC Inter Lock (From MPS Unit)

Error  
Mask  
Normal

RESET

### LINAC Beam Loss Level (From Monitor)

High  
80%~  
60%~  
0%~  
HV OFF

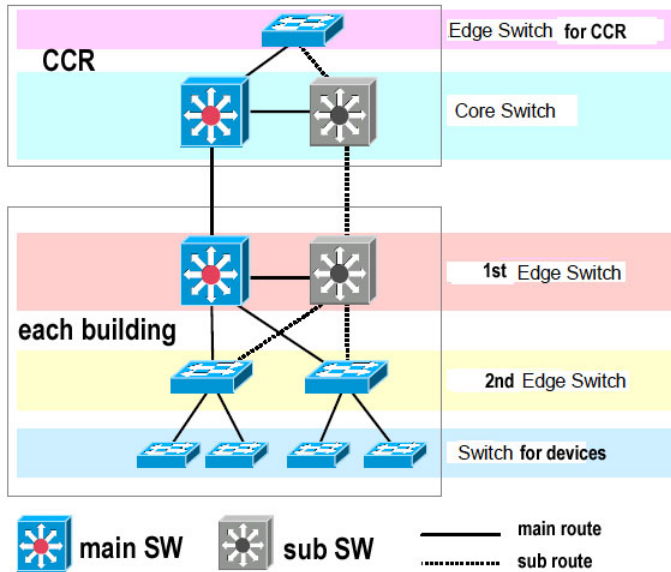
DTL	SDTL	ACS	L3BT	..

Low

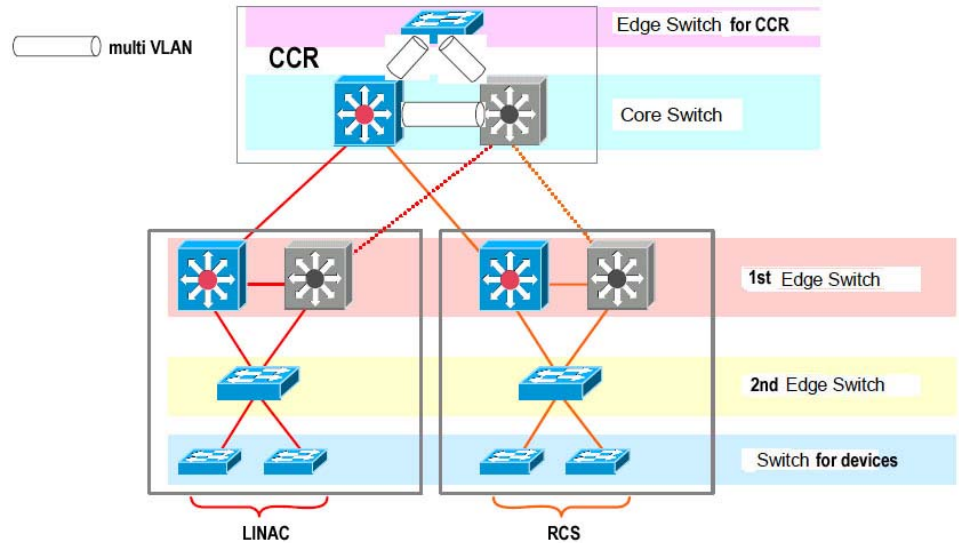
log 5V ~  
log 0V

### Error Events

```
2007/01/23 22:31:05:199 LI_SDTL6:MPS21:STAT:SDTL06_LLRF01 Error
2007/01/23 22:26:13:154 LI_SDTL14:MPS29:STAT:SDTL14_LLRF01 Error
2007/01/23 22:13:42:106 LI_SDTL7:MPS22:STAT:SDTL07_LLRF01 Error
2007/01/23 22:13:12:009 LI_DTL1:MPS13:STAT:DTL01_LLRF01 Error
2007/01/23 22:13:11:635 MaskModule RF DTL Error
2007/01/23 22:08:40:296 LI_SDTL4:MPS19:STAT:SDTL04_LLRF01 Error
2007/01/23 21:39:26:338 LI_SDTL13:MPS28:STAT:SDTL13_LLRF01 Error
2007/01/23 21:38:26:327 LI_SDTL13:MPS28:STAT:SDTL13_LLRF01 Error
```



Basic Composition

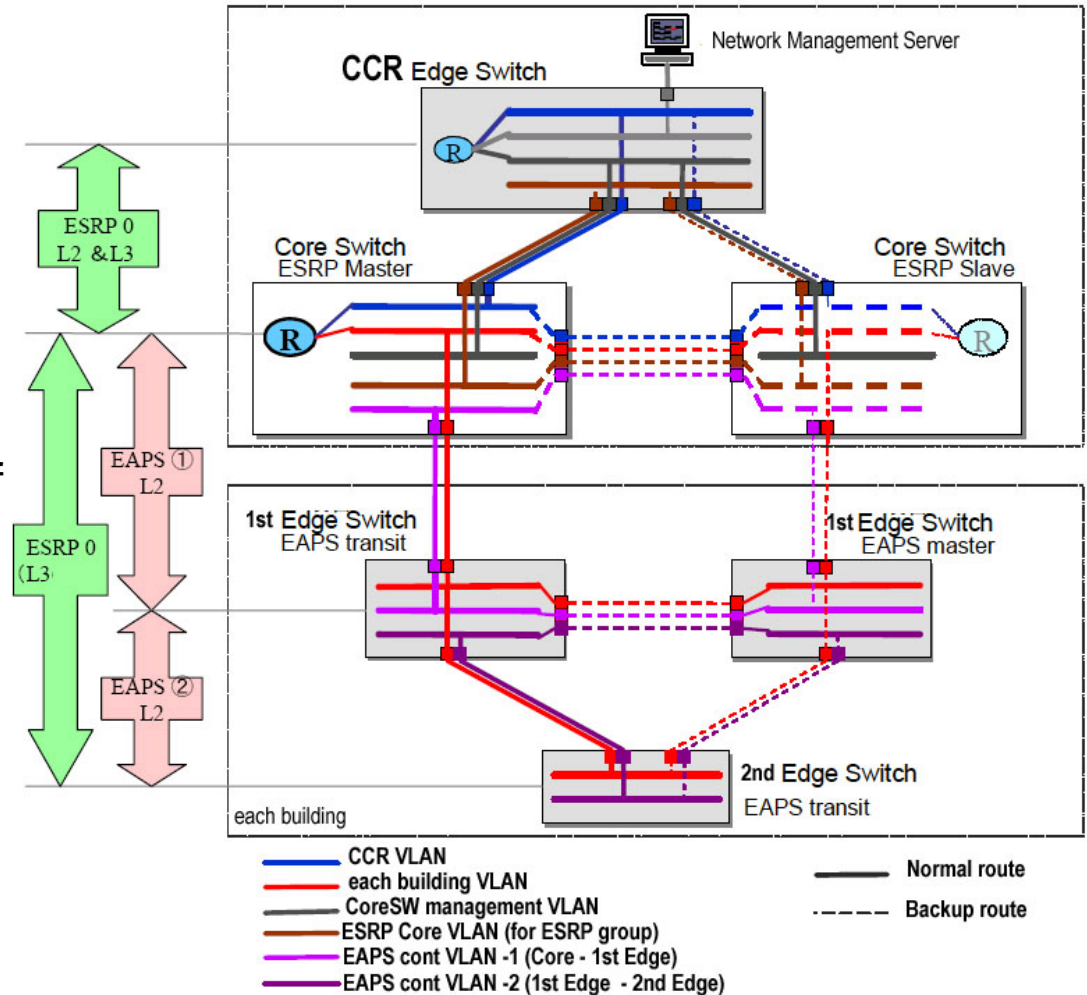


Star Connection around CCR

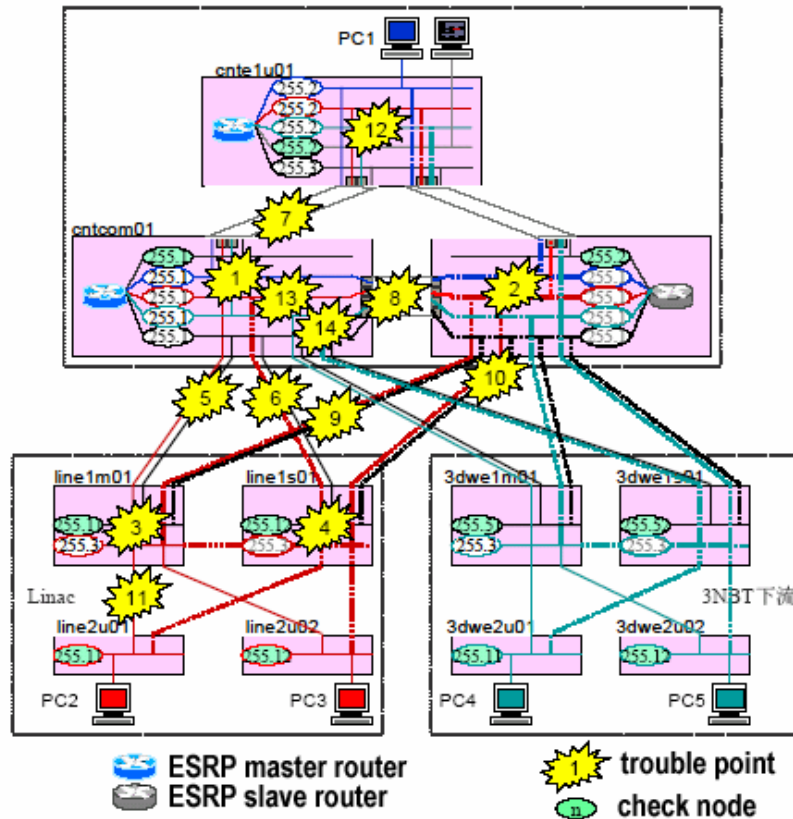
Standard protocol for redundancy can not make the performance that no connection loss when the pass way is switched.

We selected the protocol of the vender dependence.

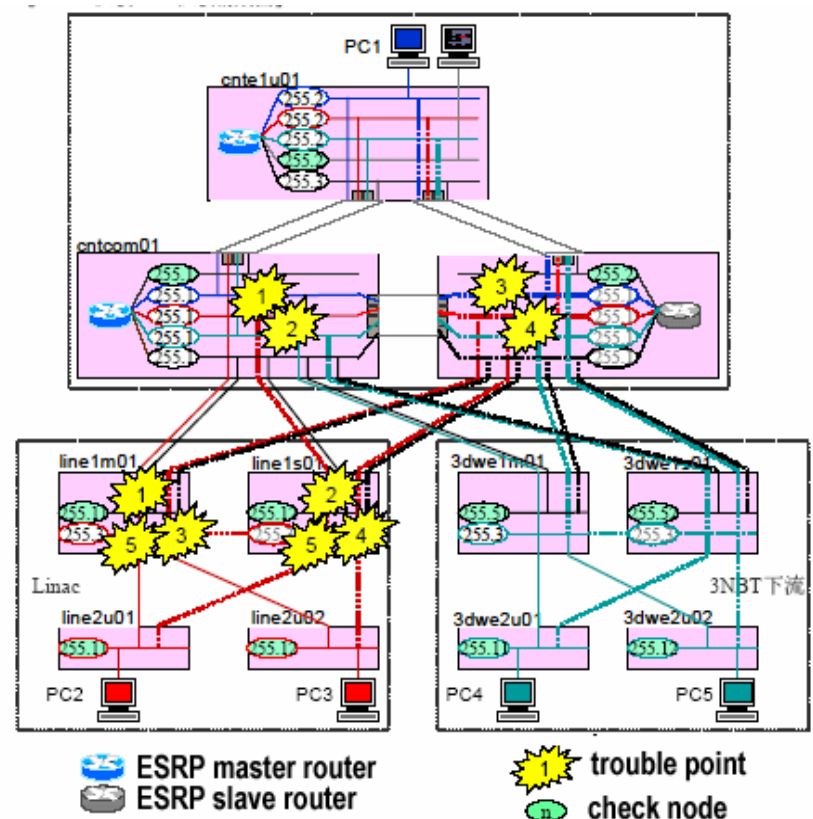
For ease of physical fiber topology, we use the combination of **ESRP** and **EAPS**.







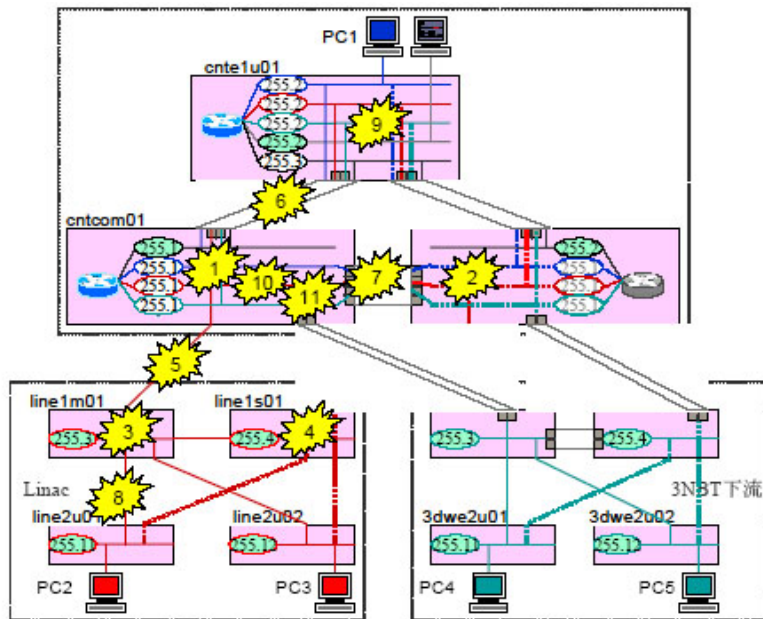
ESRP test by single fault



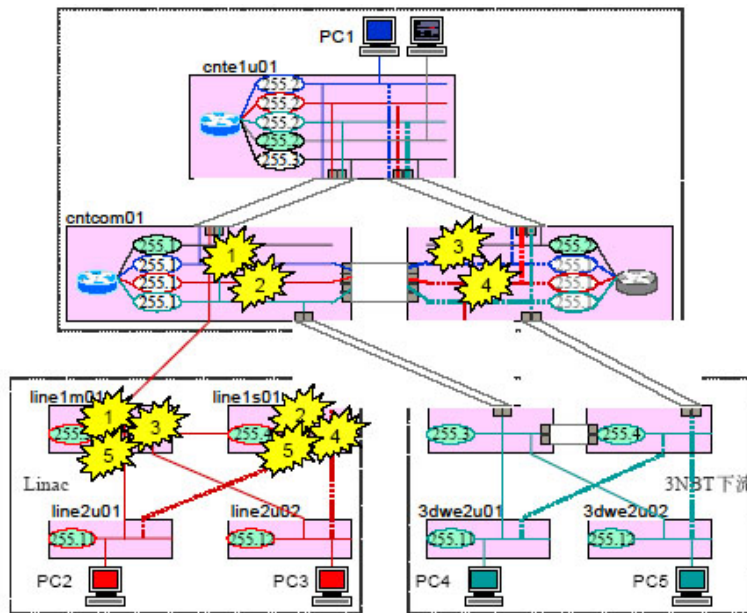
ESRP test by double fault

No matter appears when the power of switch is down, or when fiber is disconnected.

When the route revives, the connection doesn't become interrupted.



EAPS test by single fault

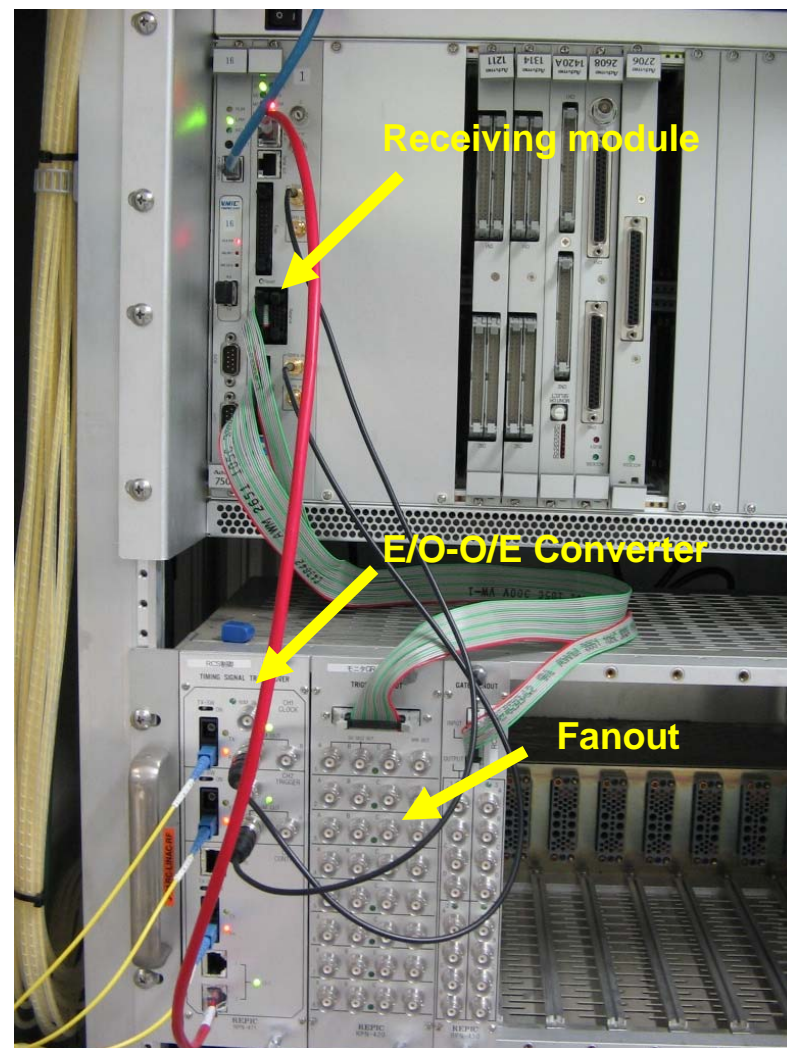
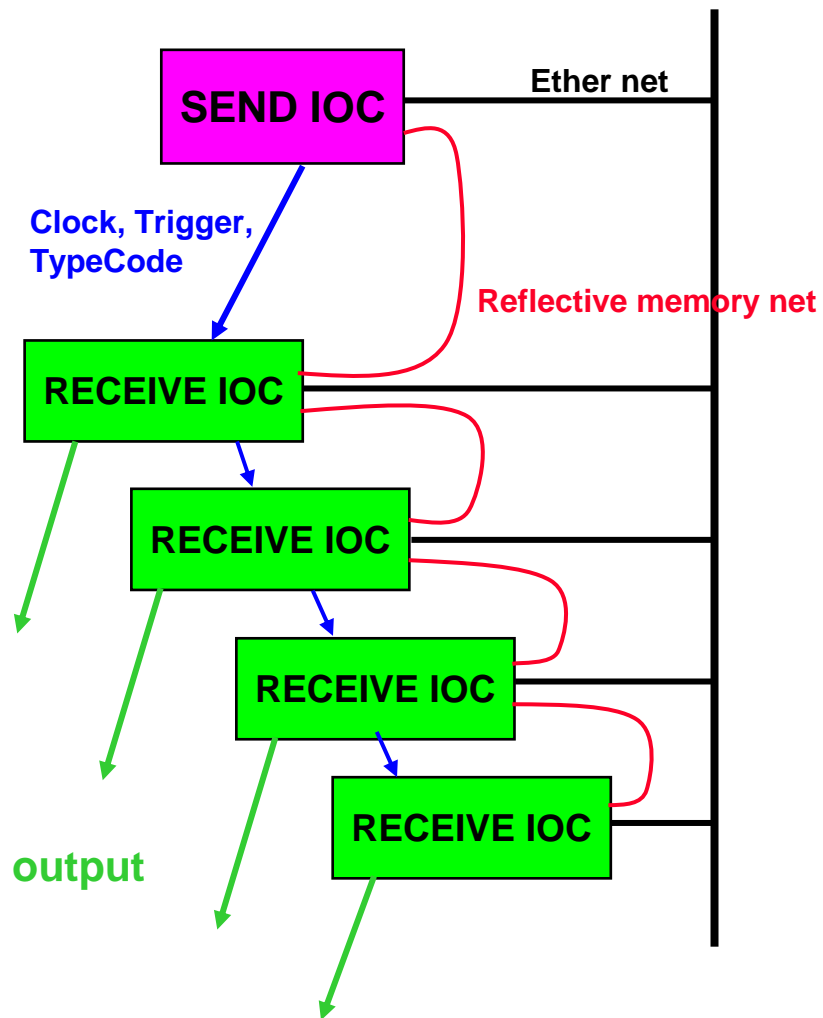


EAPS test by double fault

## Time of route change < 1.2sec

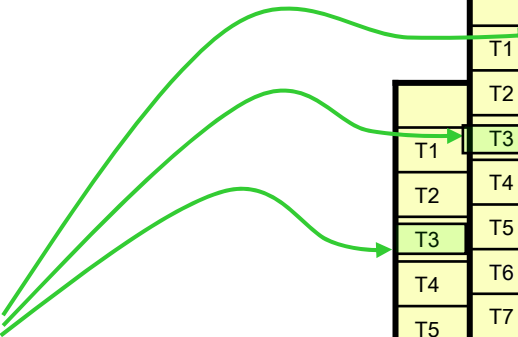
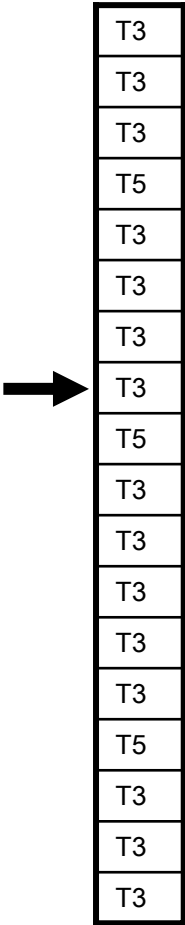
(including route reviving. Any **TCP connection is not closed** at this route change.)







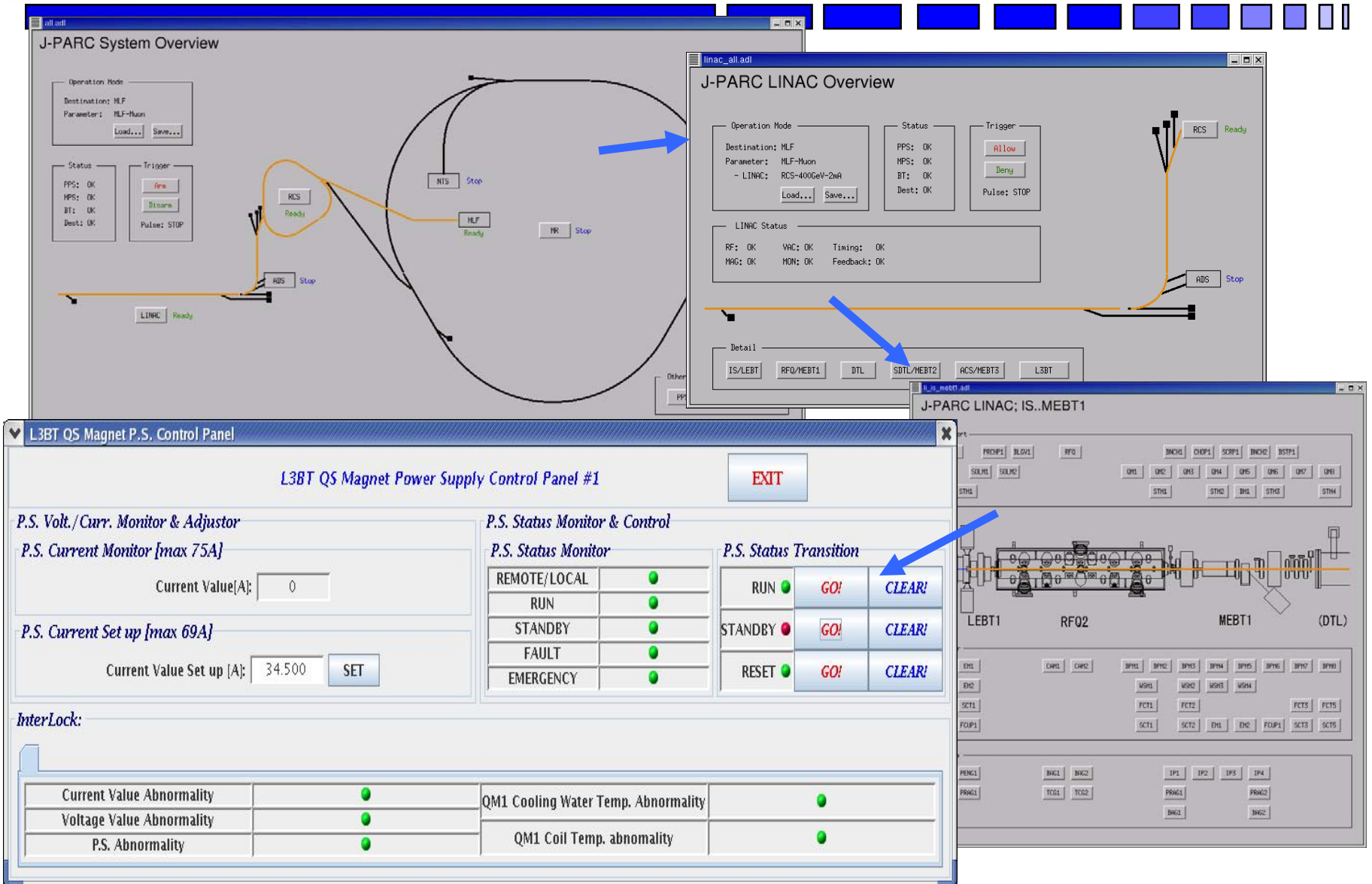
Type train of sending module



LUT of a receiving module

	Ch1	Ch2	ch3	ch4	vh5	ch6	ch7	h8
T1								
T2								
T3								
T4								
T5								
T6								
T7								
T8								
T9								
T9								
T8								
T7								
T6								
T5								
T4								
T3								
T2								
T1								
...								
...								
...								
...								
...								
...								
...								
...								
...								

- Single Shot is generated for the initial commissioning
  - Effective to reduce activation
- Type code means operation mode and beam course
- Individual delay trimming can be done without stopping the beam
  - Two way of changing delay time.
- Delay time changing of selected channels can be done simultaneously



The screenshot displays the J-PARC control interface, which is organized into several windows:

- J-PARC System Overview:** Shows the overall system layout with components like RCS, HLF, NTS, ADS, and LINAC. A blue arrow points from the LINAC component to the LINAC Overview window.
- J-PARC LINAC Overview:** Provides detailed status for the LINAC, including operation mode (MLF), parameters (MLF-Muon, RCS-400GeV-2uA), and various status indicators (PPS, MPS, BT, Dest). A blue arrow points from the LINAC Overview window to the L3BT QS Magnet P.S. Control Panel.
- J-PARC LINAC; IS..MEBT1:** Shows a detailed schematic of the MEBT1 section with various beamline components.
- L3BT QS Magnet P.S. Control Panel #1:** A detailed control panel for the magnet power supply, divided into several functional areas:
  - P.S. Volt./Curr. Monitor & Adjustor:** Displays current value (0 A) and allows setting a current value (34.500 A).
  - P.S. Status Monitor & Control:** Shows status indicators for REMOTE/LOCAL, RUN, STANDBY, FAULT, and EMERGENCY.
  - P.S. Status Transition:** Includes buttons for RUN, STANDBY, and RESET, each with a 'GO!' indicator and a 'CLEAR!' button. A blue arrow points to the 'CLEAR!' button for the RUN state.
  - InterLock:** A table monitoring various system abnormalities.

J-PARC LINC Monitor

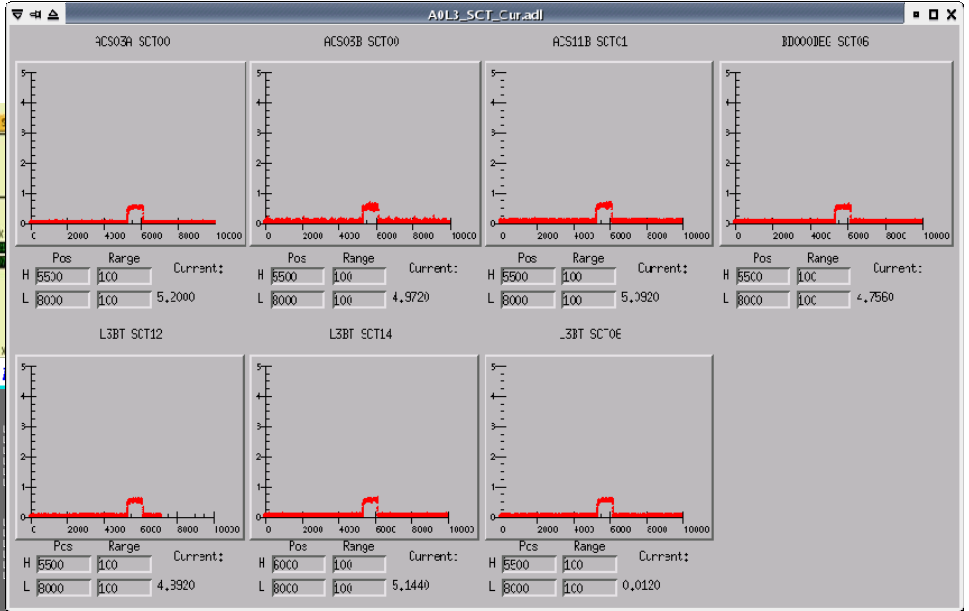
QPERT1 QPTL QPTUAL QPCT-I QPCT-II QPERT2 QPH-L3  
 QPHSE-I QPCT-I QPCT-II QPHGE  
 QPHSE-II QPH-I QPH-II QPHGE

BPH Position (mm)

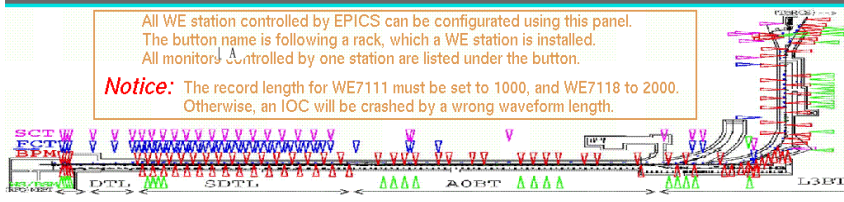
MEBT1 X	Y	SBL1 X	Y	SBL2 X	Y	SBL3 X	Y	SBL4 X	Y	ACS X	Y	L3BT X	Y
01	014	028	028	077	077	110	110	141	141	017	017	07	07
02	013	027	027	076	076	109	109	140	140	016	016	06	06
03	022	036	036	077	077	120	120	141	141	017	017	07	07
04	030	044	044	088	088	130	130	151	151	018	018	08	08
05	046	060	060	098	098	140	140	161	161	019	019	09	09
06	044	058	058	098	098	140	140	161	161	019	019	09	09
07	056	070	070	108	108	150	150	171	171	020	020	10	10
08	054	068	068	108	108	150	150	171	171	020	020	10	10

Configuration

MEBT1 DTL S01 S04  
 L1\_MEBT1\_SCT01 L1\_DTL1\_SCT01 L1\_S01A\_FCT00 L1\_S04A\_FCT00  
 L1\_MEBT1\_SCT02 L1\_DTL1\_SCT02 L1\_S01B\_FCT00 L1\_S04B\_FCT00  
 L1\_MEBT1\_SCT03 L1\_DTL1\_SCT03 L1\_S01B\_FCT02 L1\_S04B\_FCT02  
 L1\_MEBT1\_SCT04 L1\_DTL1\_SCT04 L1\_S01B\_FCT00 L1\_S04B\_SCT00  
 L1\_MEBT1\_SCT05 L1\_DTL1\_SCT05 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT06 L1\_DTL1\_SCT06 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT07 L1\_DTL1\_SCT07 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT08 L1\_DTL1\_SCT08 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT09 L1\_DTL1\_SCT09 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT10 L1\_DTL1\_SCT10 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT11 L1\_DTL1\_SCT11 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT12 L1\_DTL1\_SCT12 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT13 L1\_DTL1\_SCT13 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
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 L1\_MEBT1\_SCT39 L1\_DTL1\_SCT39 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
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 L1\_MEBT1\_SCT41 L1\_DTL1\_SCT41 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT42 L1\_DTL1\_SCT42 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
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 L1\_MEBT1\_SCT65 L1\_DTL1\_SCT65 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT66 L1\_DTL1\_SCT66 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
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 L1\_MEBT1\_SCT74 L1\_DTL1\_SCT74 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT75 L1\_DTL1\_SCT75 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT76 L1\_DTL1\_SCT76 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT77 L1\_DTL1\_SCT77 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT78 L1\_DTL1\_SCT78 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT79 L1\_DTL1\_SCT79 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT80 L1\_DTL1\_SCT80 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT81 L1\_DTL1\_SCT81 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT82 L1\_DTL1\_SCT82 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT83 L1\_DTL1\_SCT83 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT84 L1\_DTL1\_SCT84 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT85 L1\_DTL1\_SCT85 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT86 L1\_DTL1\_SCT86 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT87 L1\_DTL1\_SCT87 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT88 L1\_DTL1\_SCT88 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT89 L1\_DTL1\_SCT89 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT90 L1\_DTL1\_SCT90 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT91 L1\_DTL1\_SCT91 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT92 L1\_DTL1\_SCT92 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT93 L1\_DTL1\_SCT93 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT94 L1\_DTL1\_SCT94 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT95 L1\_DTL1\_SCT95 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT96 L1\_DTL1\_SCT96 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT97 L1\_DTL1\_SCT97 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT98 L1\_DTL1\_SCT98 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT99 L1\_DTL1\_SCT99 L1\_S01B\_BPM01 L1\_S04B\_BPM01  
 L1\_MEBT1\_SCT100 L1\_DTL1\_SCT100 L1\_S01B\_BPM01 L1\_S04B\_BPM01



All WE station controlled by EPICS can be configured using this panel.  
 The button name is following a rack, which a WE station is installed.  
 All monitors controlled by one station are listed under the button.  
**Notice:** The record length for WE7111 must be set to 1000, and WE7118 to 2000.  
 Otherwise, an IOC will be crashed by a wrong waveform length.







LINAC Commissioning Console
[Icons]

File Edit View Tool Help

**PPS**

mode: **IS standalone**

status: ? Interlock  
? Emergency

permits: ? Beam On  
 IS Hi-Volt  
 LEBT:BSTP  
 LEBT:BLGV  
 MEBT:BSTP  
✗ L3BT:BM3  
✗ L3BT:BM4  
✗ L3BT:BPLG

**MPS**

target: **L3BD 0deg**

status:  Inhibit  
? Interlock  
? Vacuum lock

permits:  IS Timing  
 BLGV's

13:32    **Total Particles**    14:32

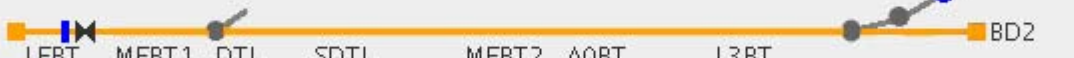
L3BD0

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L3BD30

BEAM ON OFF

PPS: Beam denied



🔒 LEBT-BSTP1  
🔒 LEBT-BLGV1  
🔒 MEBT1-BSTP1

🔒 L3BT-BM3  
🔒 L3BT-BM4  
🔒 L3BT-BPLG1

- Infrastructure of the J-PARC control system was completed.
  - Covered area will be extended to MR, MLF next year.
- Fundamental function of PPS, MPS and TS are successfully established for the 1<sup>st</sup> stage of commissioning.
- High Level Application is developed on the Integrated Operation Environment
  - IOE is written in java, and it's API can marge several simulation and other IOE tools