October 16, 2007
ICALEPCS2007 at Knoxville

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

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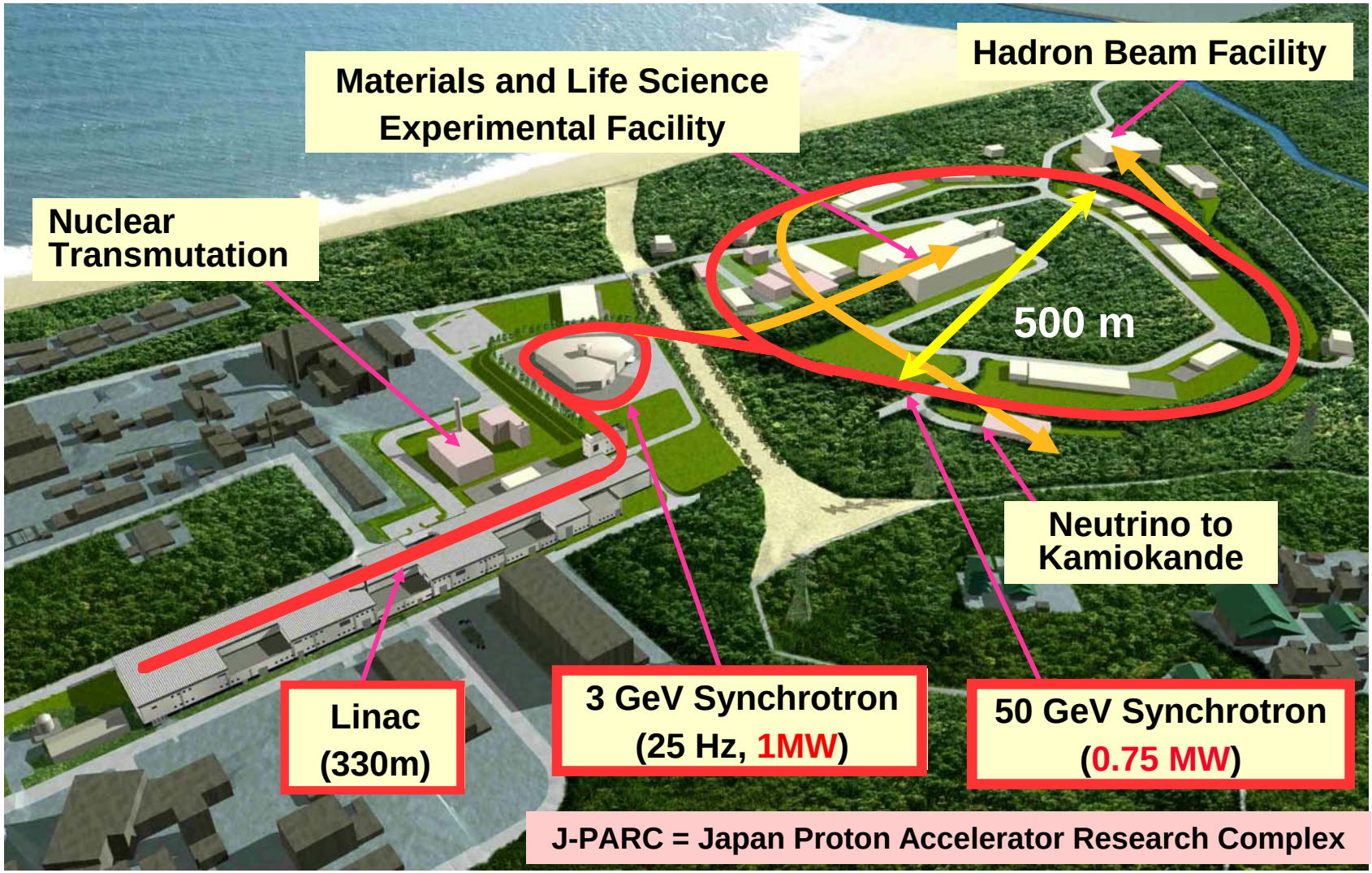
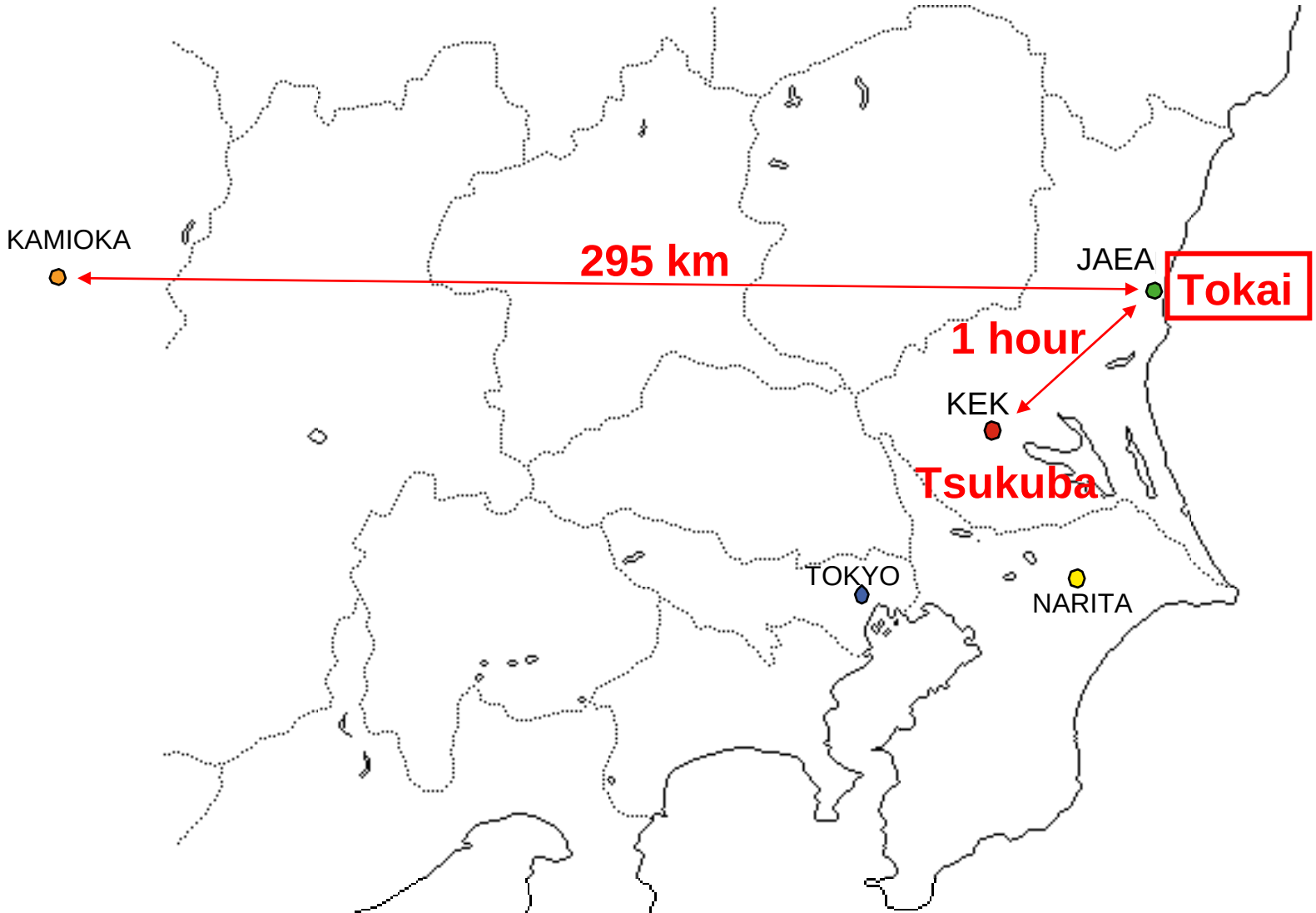
J-PARC Center at KEK/JAEA

J-PARC Facility

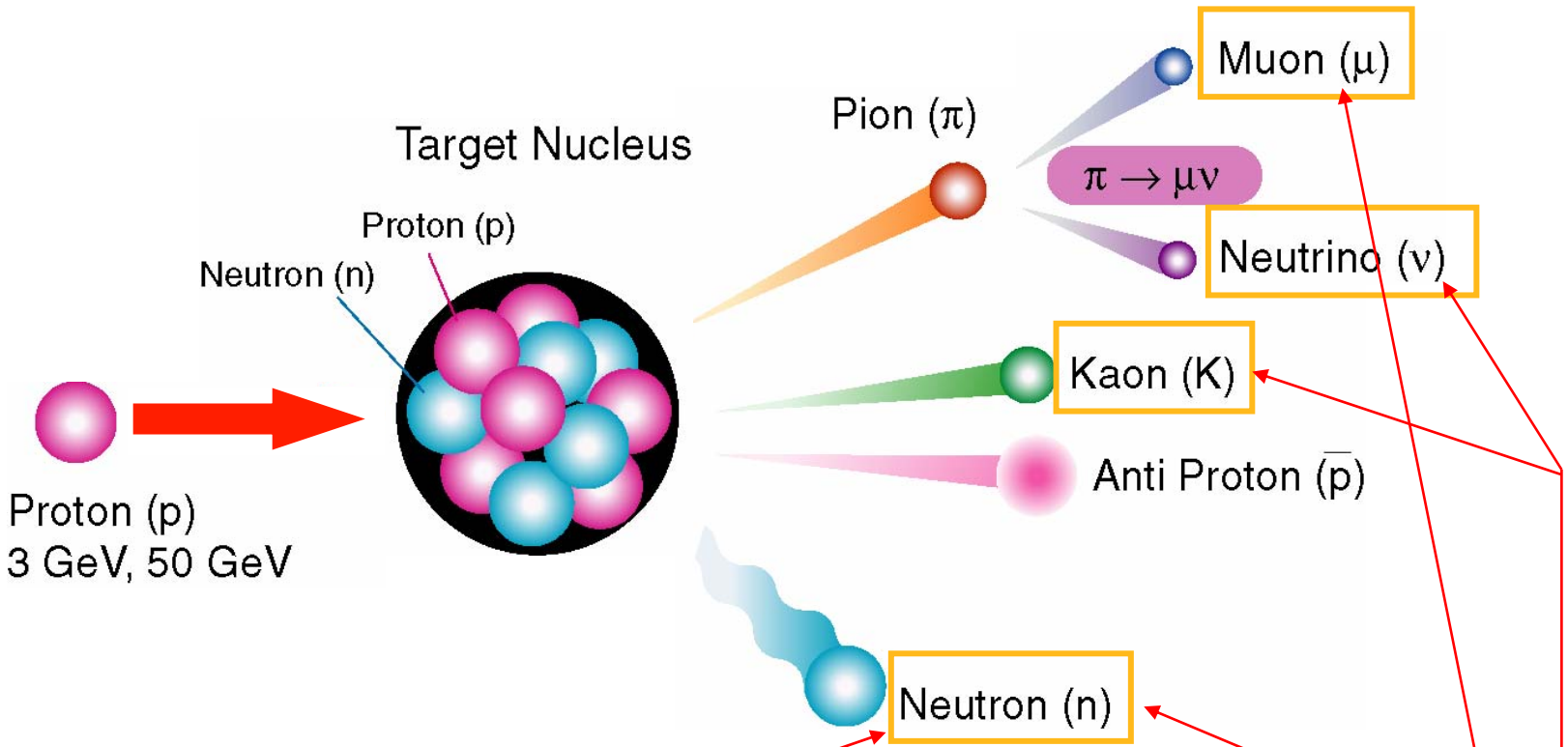


Joint Project between KEK and JAEA

Location of J-PARC at Tokai



Goals at J-PARC

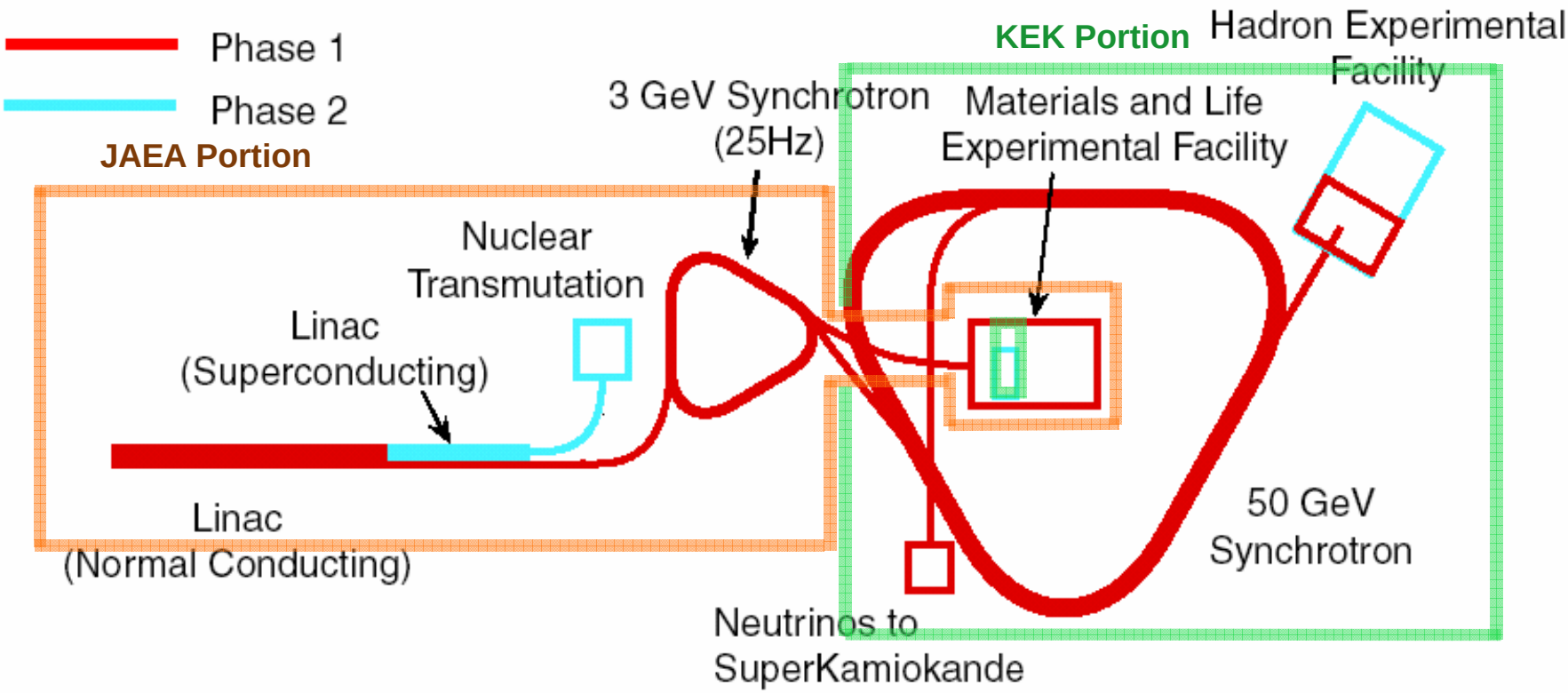


Need to have high-power proton beams

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

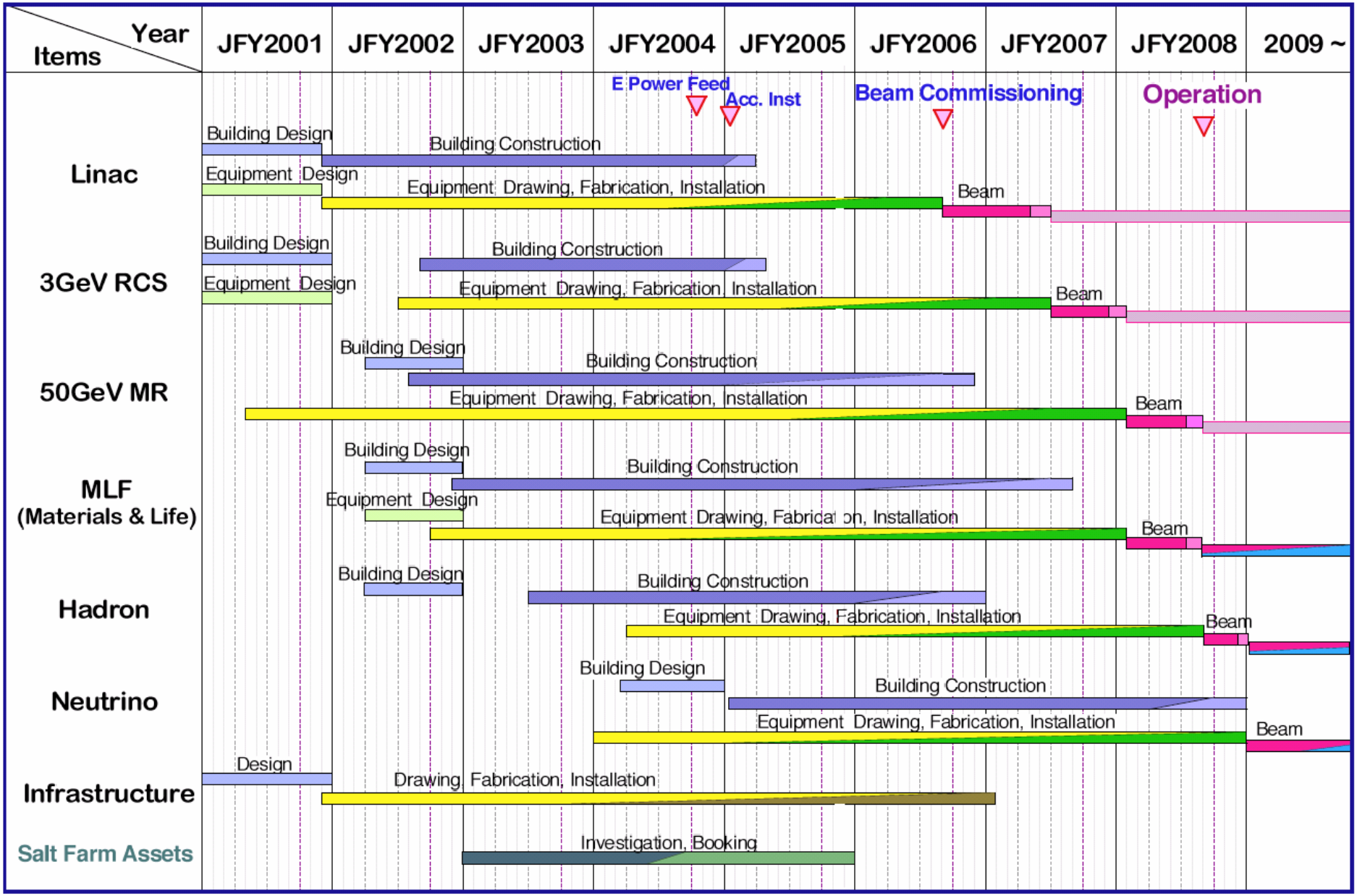
Materials & Life Sciences at 3 GeV
Nuclear & Particle Physics at 50 GeV
R&D toward Transmutation at 0.6 GeV

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 ~8 years.
- JAEA: 860 Oku Yen (56%), KEK: 667 Oku Yen (44%).

J-PARC Construction Schedule



J-PARC Control System

- 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

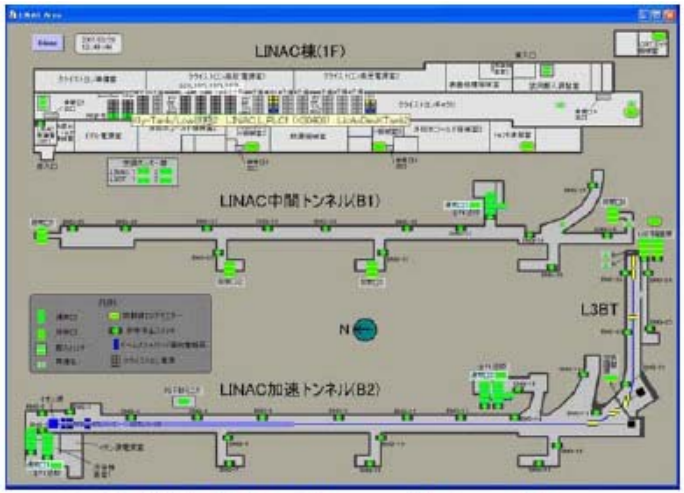
- Integrated Operation Environment
  - Effective use of software technology

In the process of developing

Function of Safety

- 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



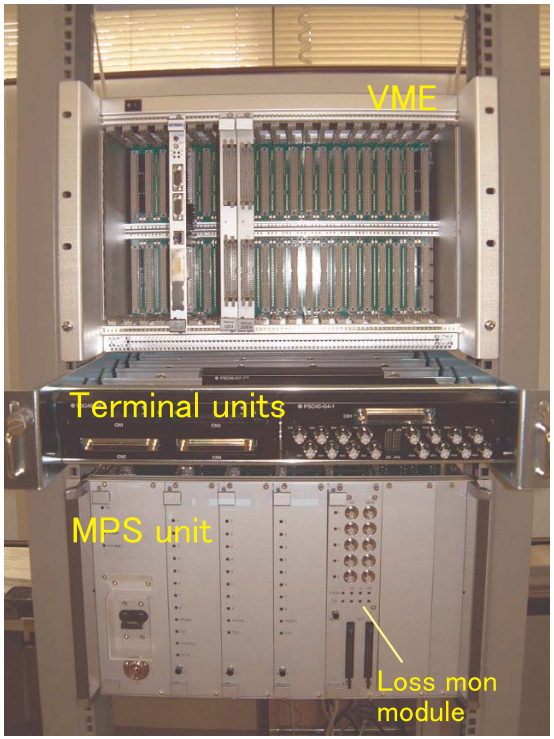
PPS Status Monitor

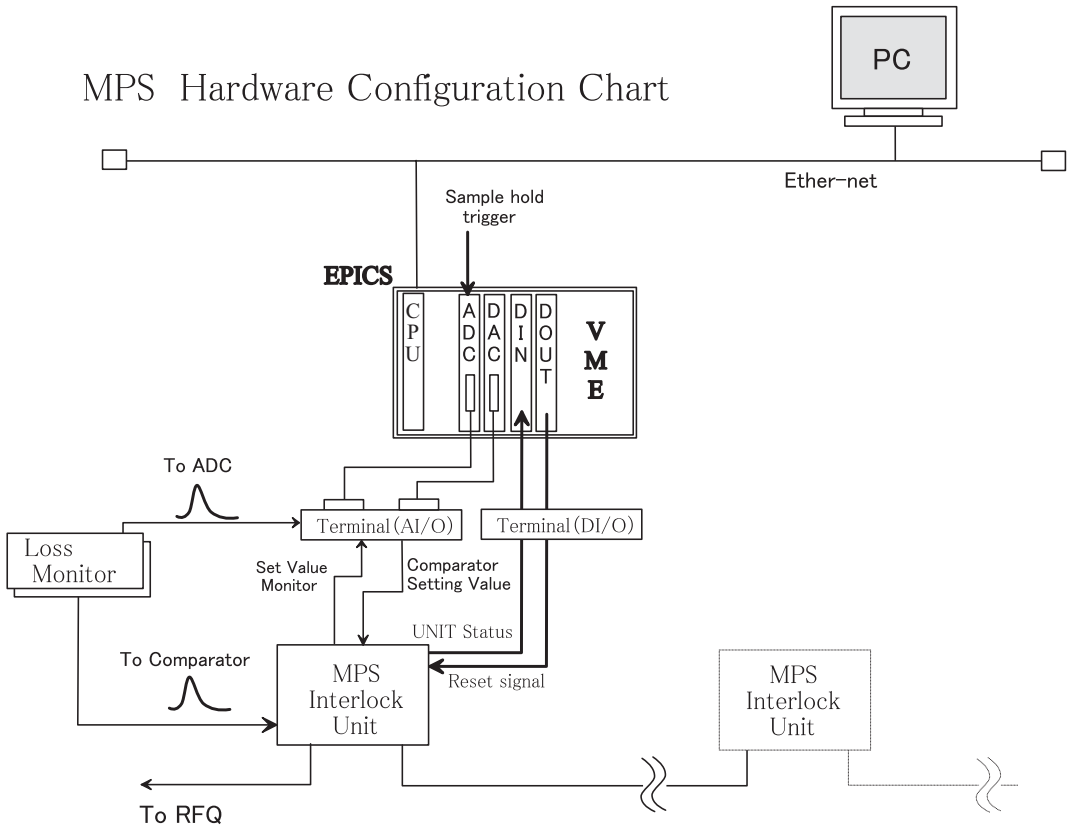
PPS Operator Console

Access Control Table

TV Monitors of an Access Point

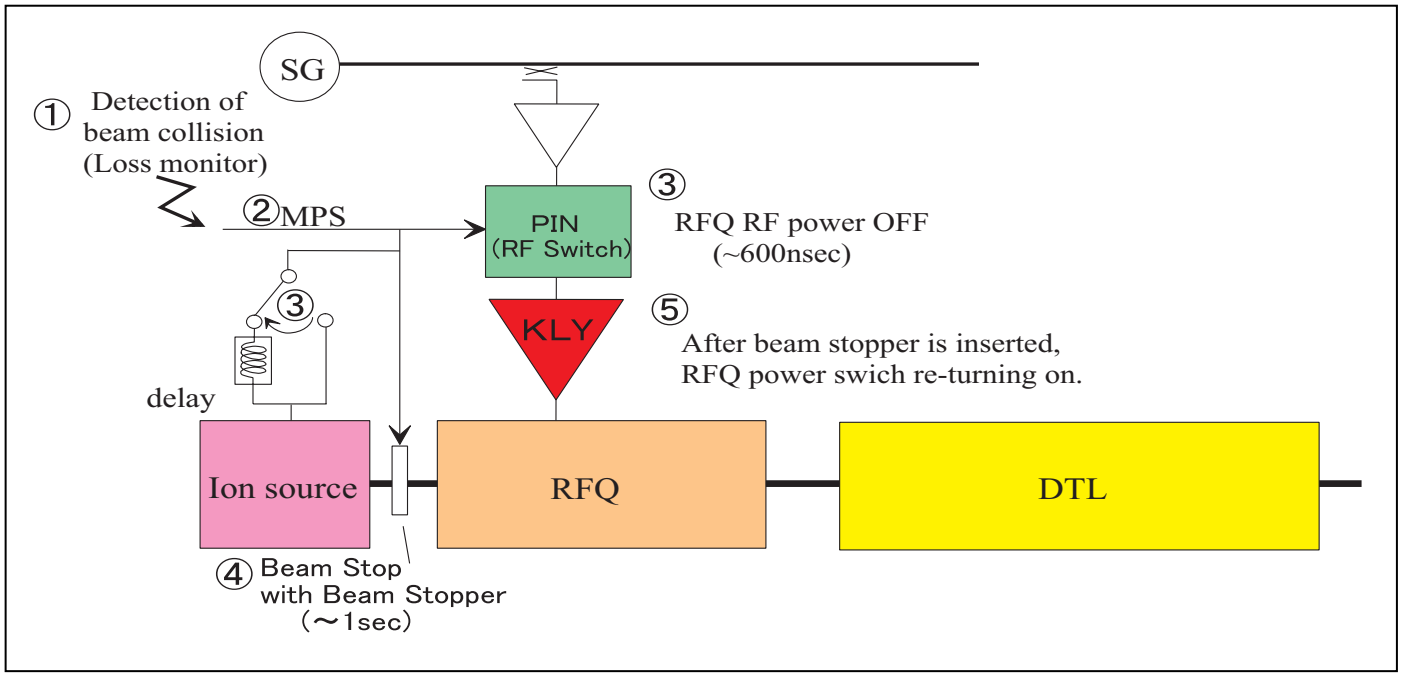
MPS





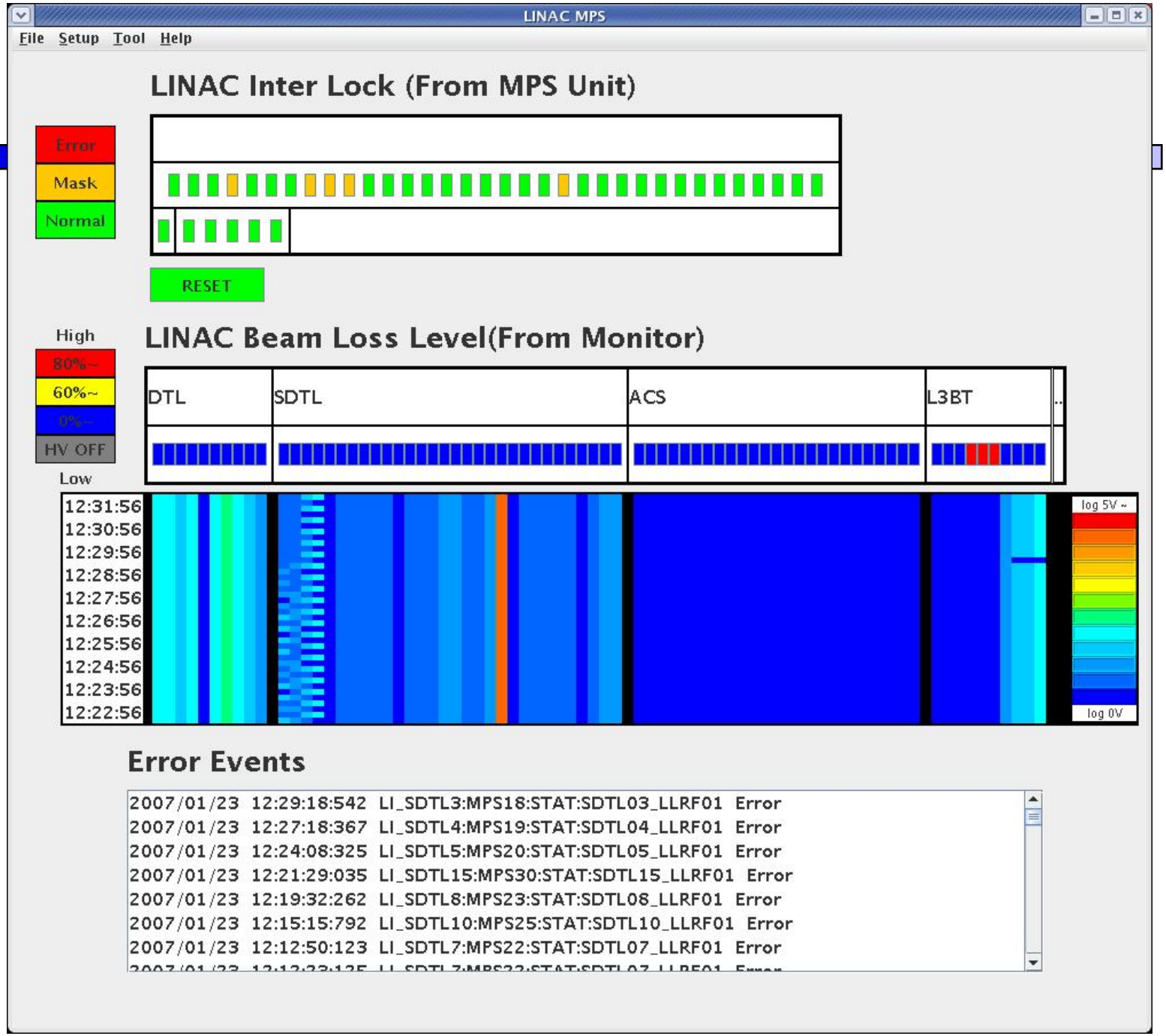
MPS hardware configuration. When the threshold is exceeded, the loss monitor module with only the analog circuit is fired.

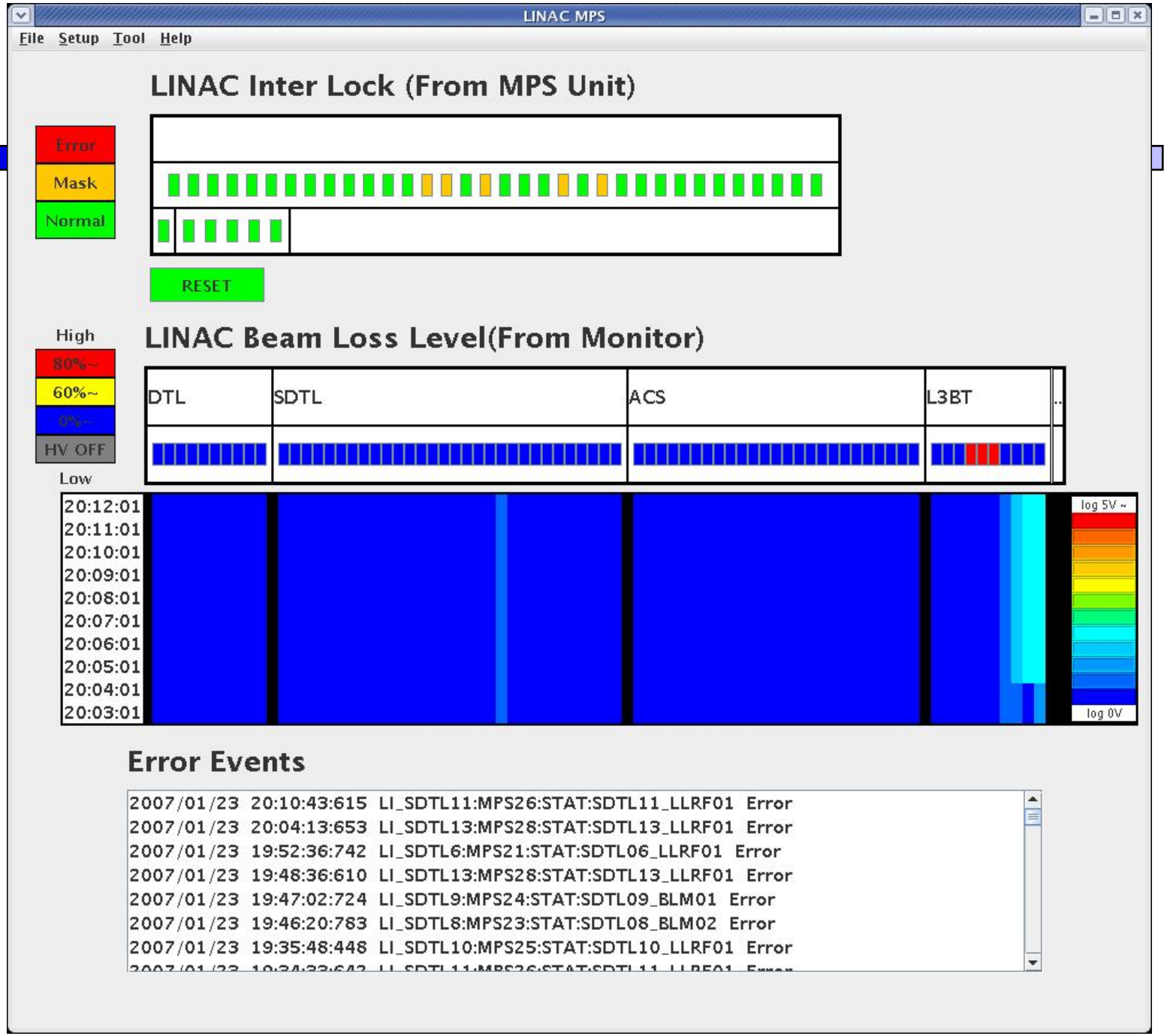
MPS

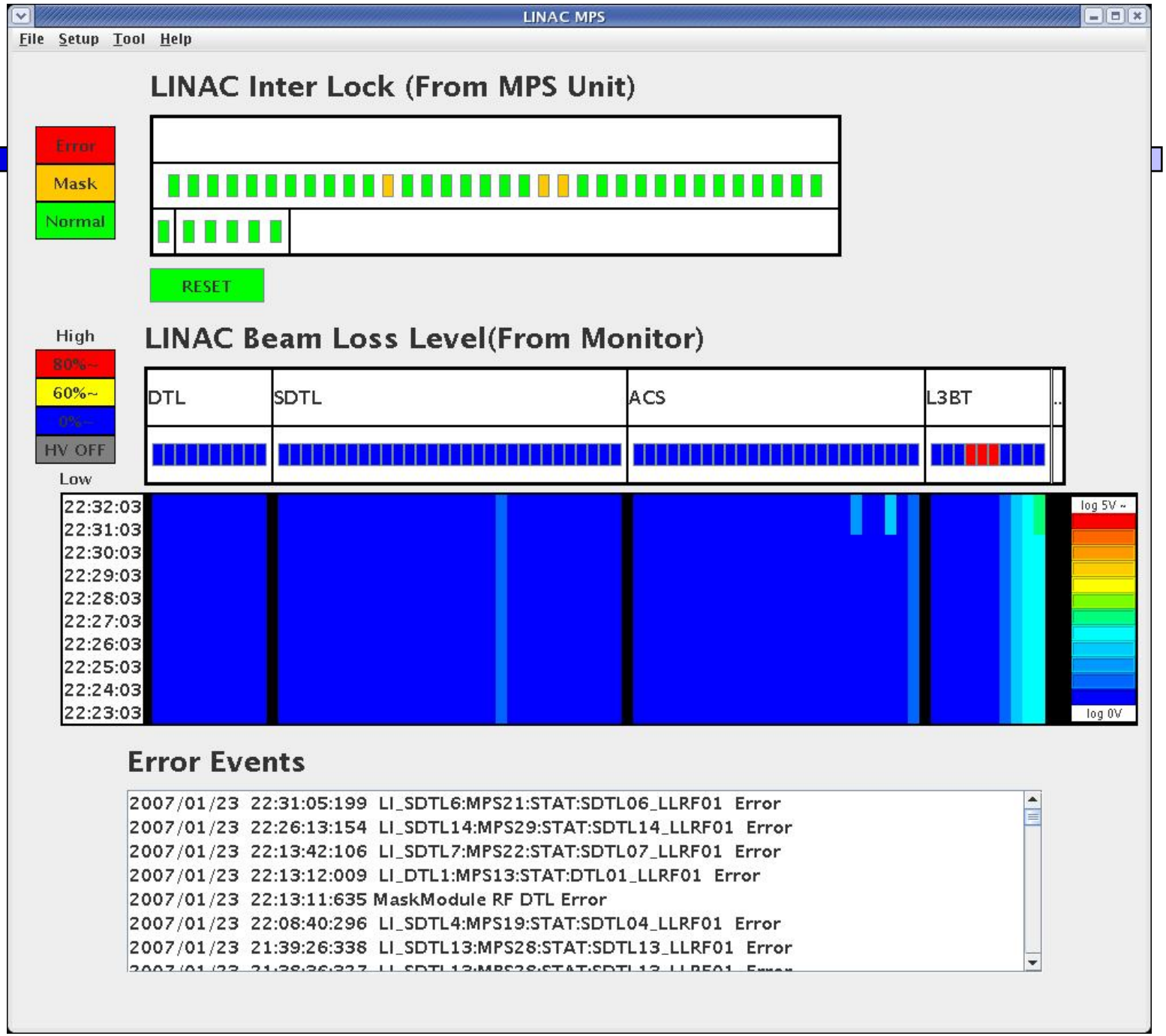


Fast beam stop procedure using Machine Protection System (MPS)

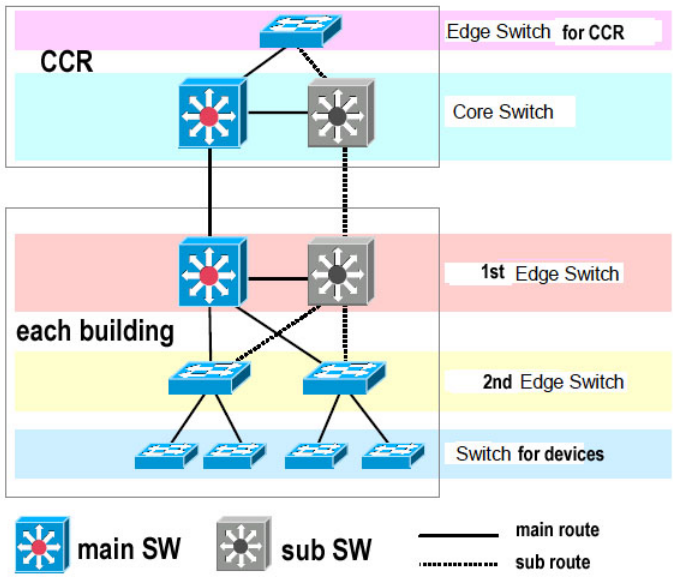
1: The beam loss is detected by the loss monitor.
2: Loss signal transmission to the RFQ part using MPS.
3: RFQ power off and Ion source injection timing removing.
4: Insertion of the Beam stopper
5: Because MPS don't want to cool the RFQ, power is turned on again quickly.


LINAC MPS
File Setup Tool Help
LINAC Inter Lock (From MPS Unit)
Error
Mask
Normal
RESET
High
80%~
60%~
0%~
HV OFF
Low
LINAC Beam Loss Level(From Monitor)
DTL
SDTL
ACS
L3BT
12:31:56
12:30:56
12:29:56
12:28:56
12:27:56
12:26:56
12:25:56
12:24:56
12:23:56
12:22:56
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

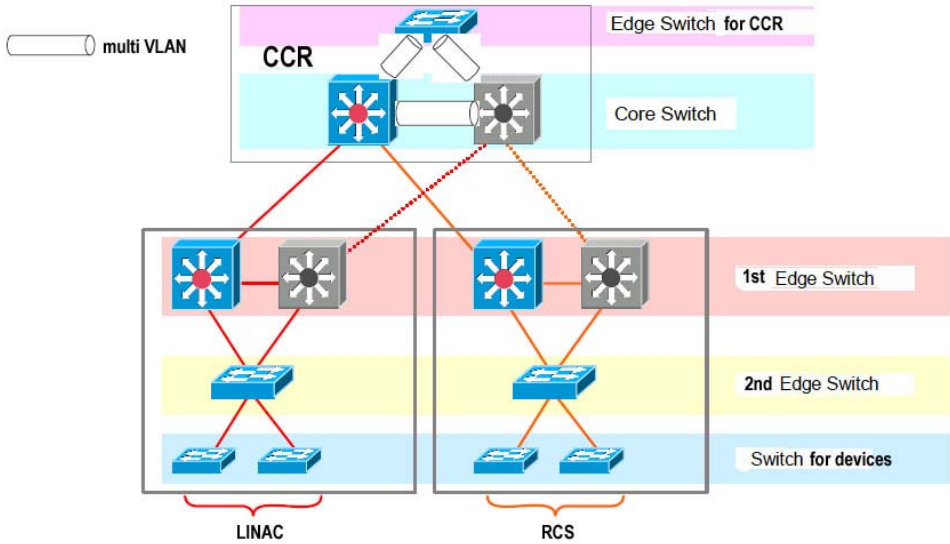

LINAC MPS
File Setup Tool Help
LINAC Inter Lock (From MPS Unit)
Error
Mask
Normal
RESET
High
80%~
60%~
0%~
HV OFF
Low
LINAC Beam Loss Level(From Monitor)
DTL
SDTL
ACS
L3BT
20:12:01
20:11:01
20:10:01
20:09:01
20:08:01
20:07:01
20:06:01
20:05:01
20:04:01
20:03:01
log 5V ~
log 0V
Error Events
2007/01/23 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


LINAC MPS
File Setup Tool Help
LINAC Inter Lock (From MPS Unit)
Error
Mask
Normal
RESET
High
80%~
60%~
0%~
HV OFF
Low
LINAC Beam Loss Level(From Monitor)
DTL
SDTL
ACS
L3BT
22:32:03
22:31:03
22:30:03
22:29:03
22:28:03
22:27:03
22:26:03
22:25:03
22:24:03
22:23:03
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

NETWORK



Basic Composition



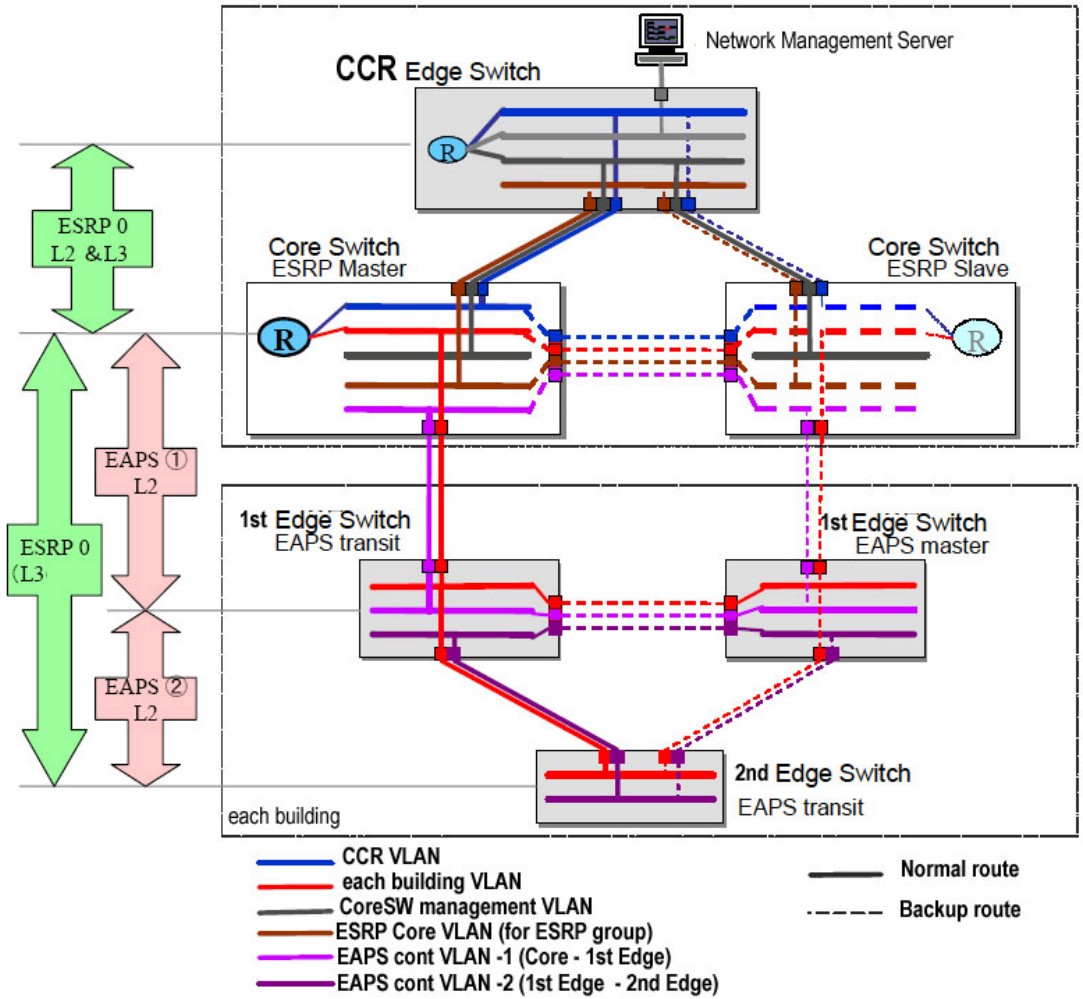
Star Connection around CCR

NETWORK

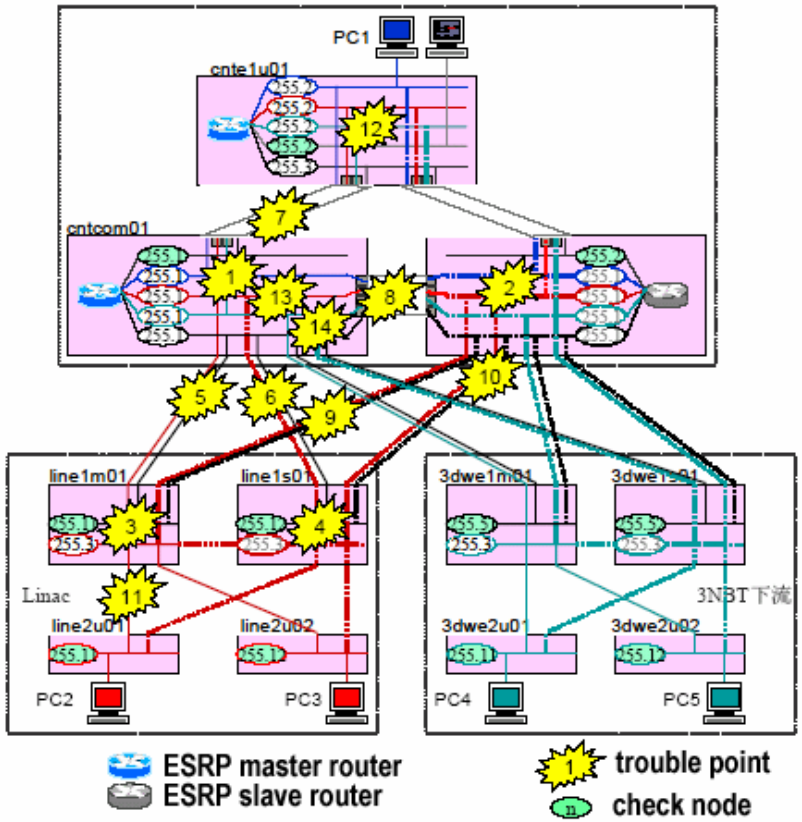
Standard protocol for redundancy can not make the performance that no connection loss when the pass way is switched.

We selected the protocol of the vender dependence.

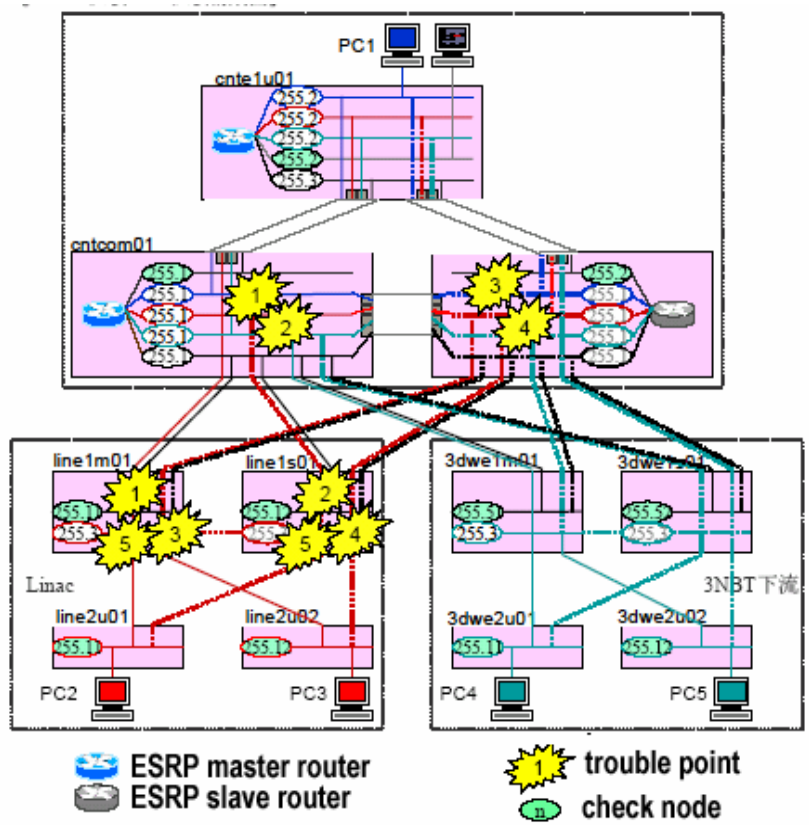
For ease of physical fiber topology, we use the combination of ESRP and EAPS.



NETWORK



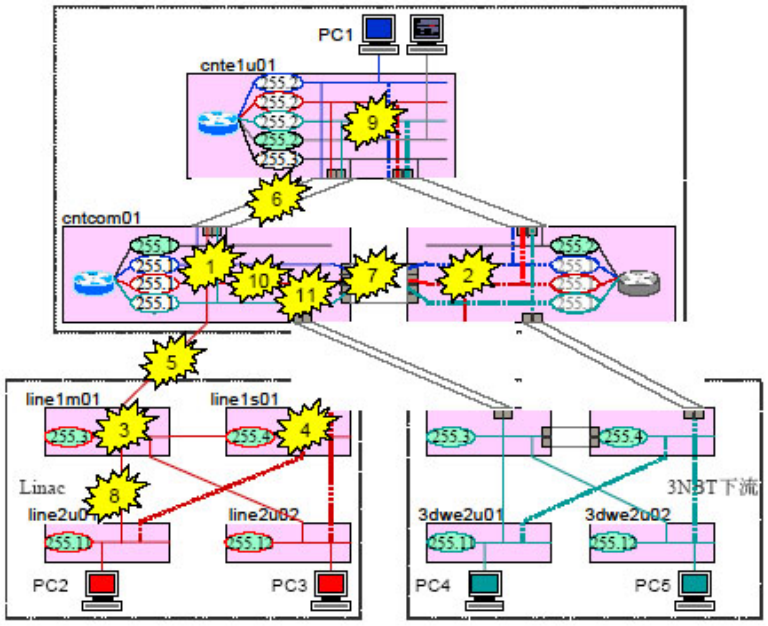
ESRP test by single fault



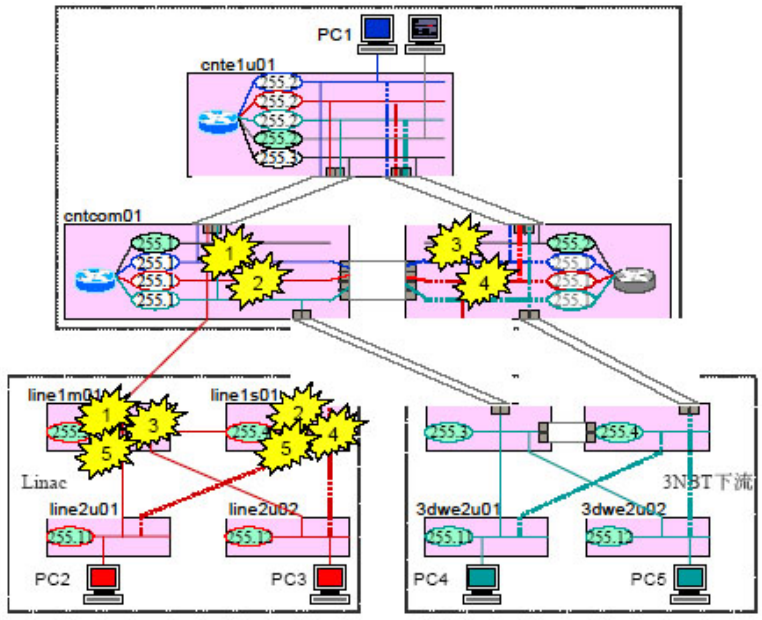
ESRP test by double fault

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

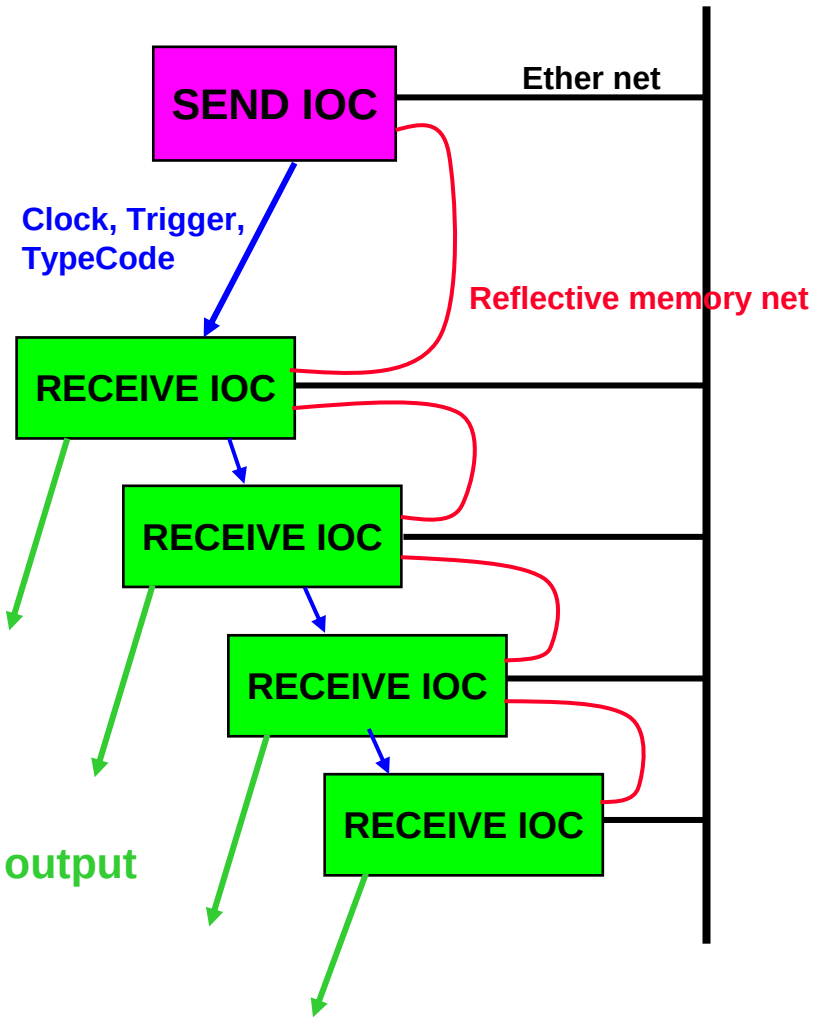
Time of route change < 1.2sec

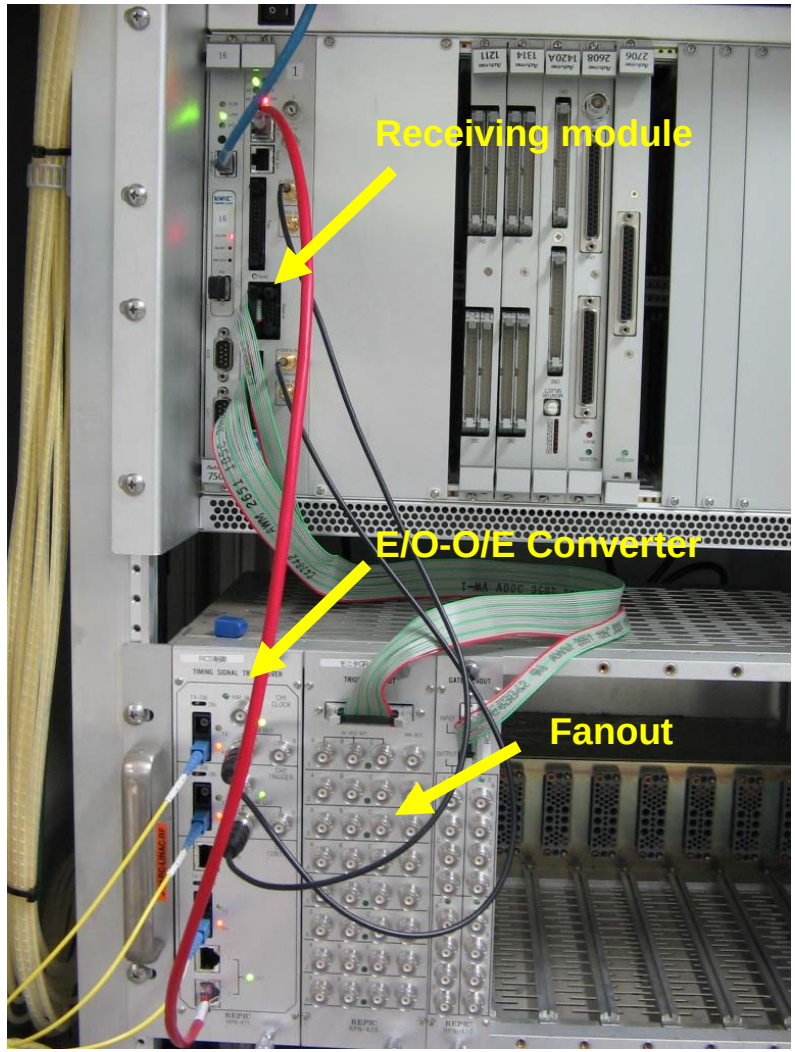
(including route reviving. Any TCP connection is not closed at this route change.)

J-PARC

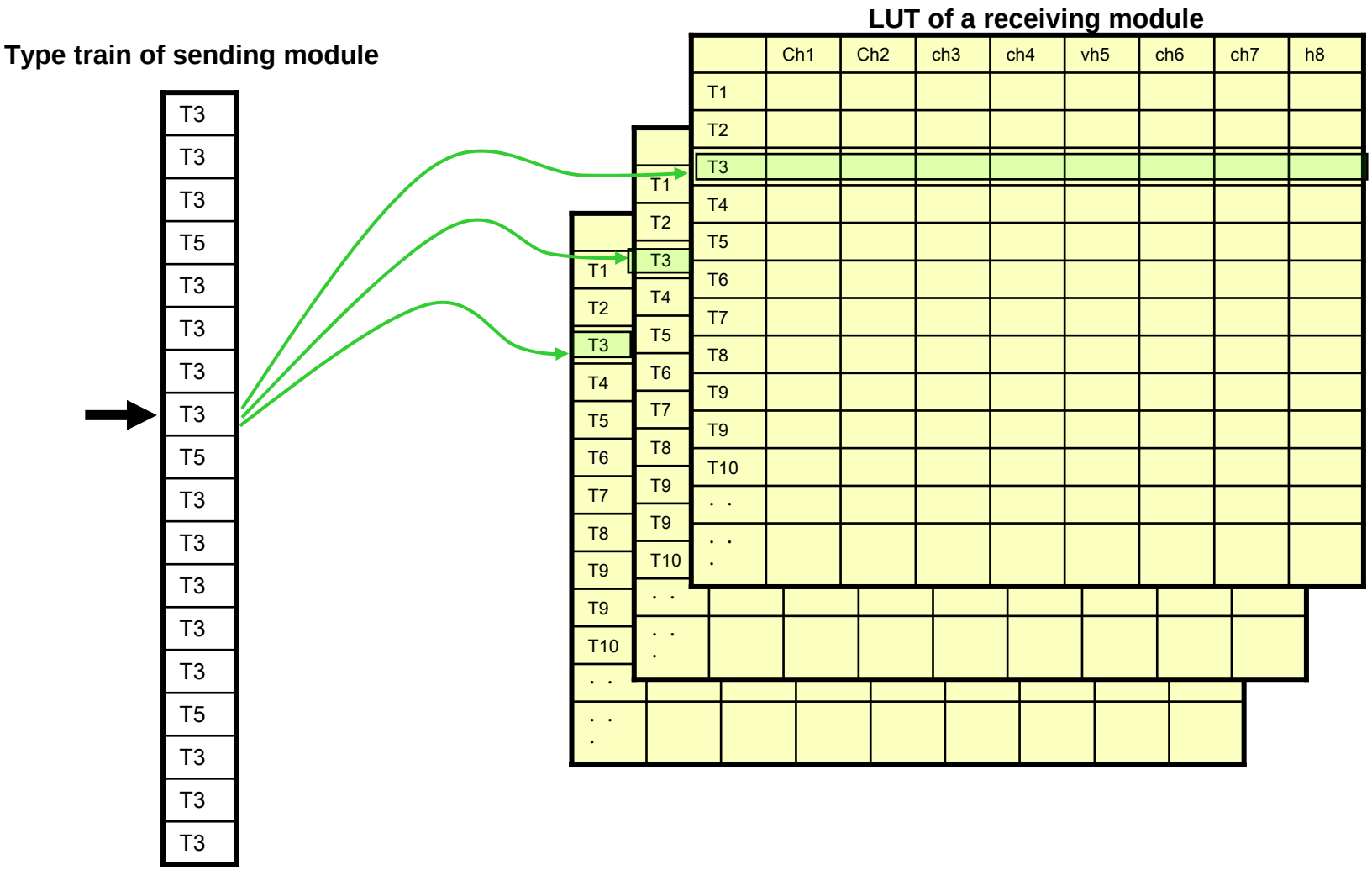
NETWORK

TIMING SYSTEM





TIMING SYSTEM

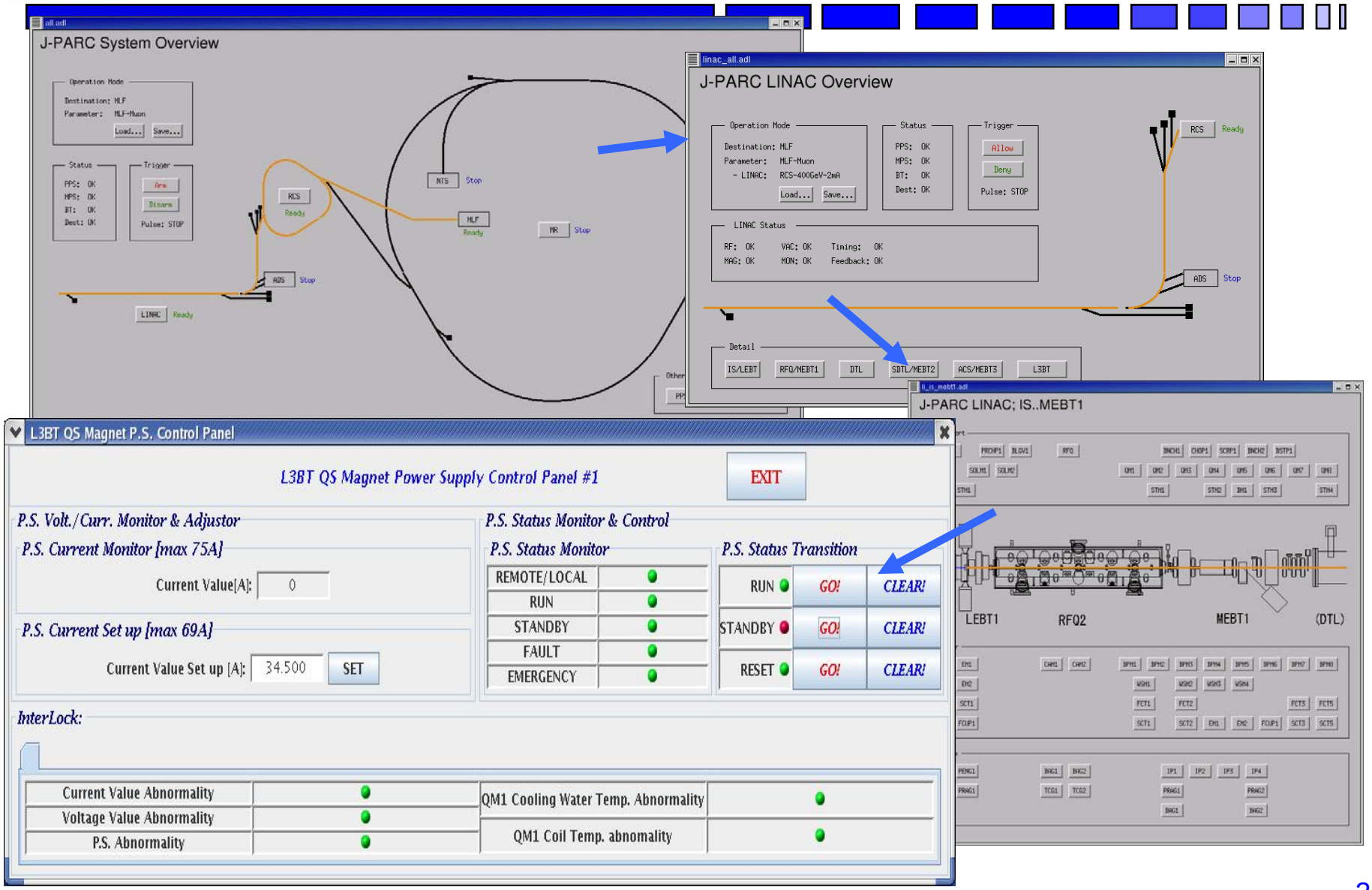


TIMING SYSTEM

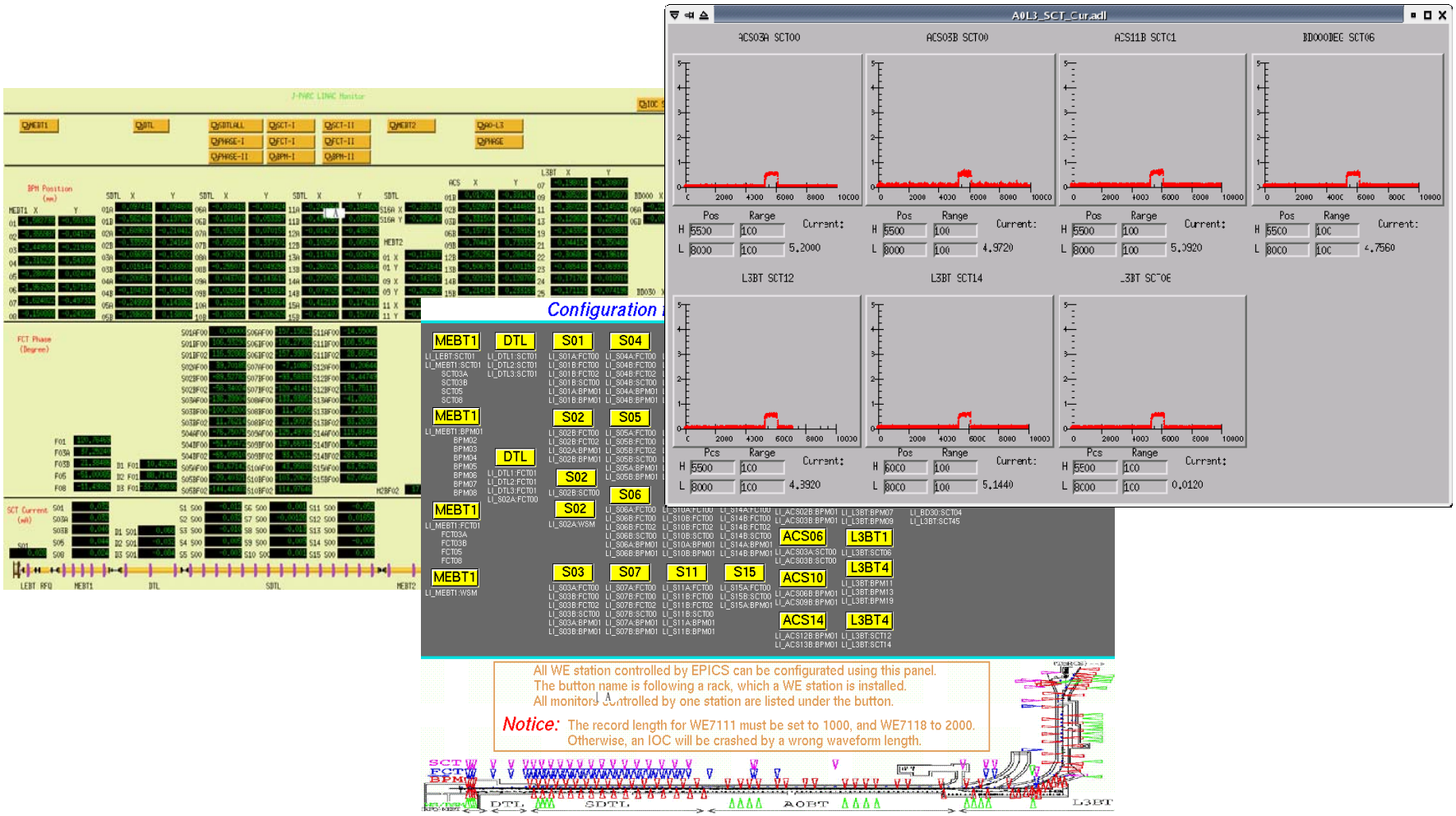
- Single Shot is generated for the initial commissioning
  - Effective to reduce activation
- Type code means operation mode and beam course

- 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

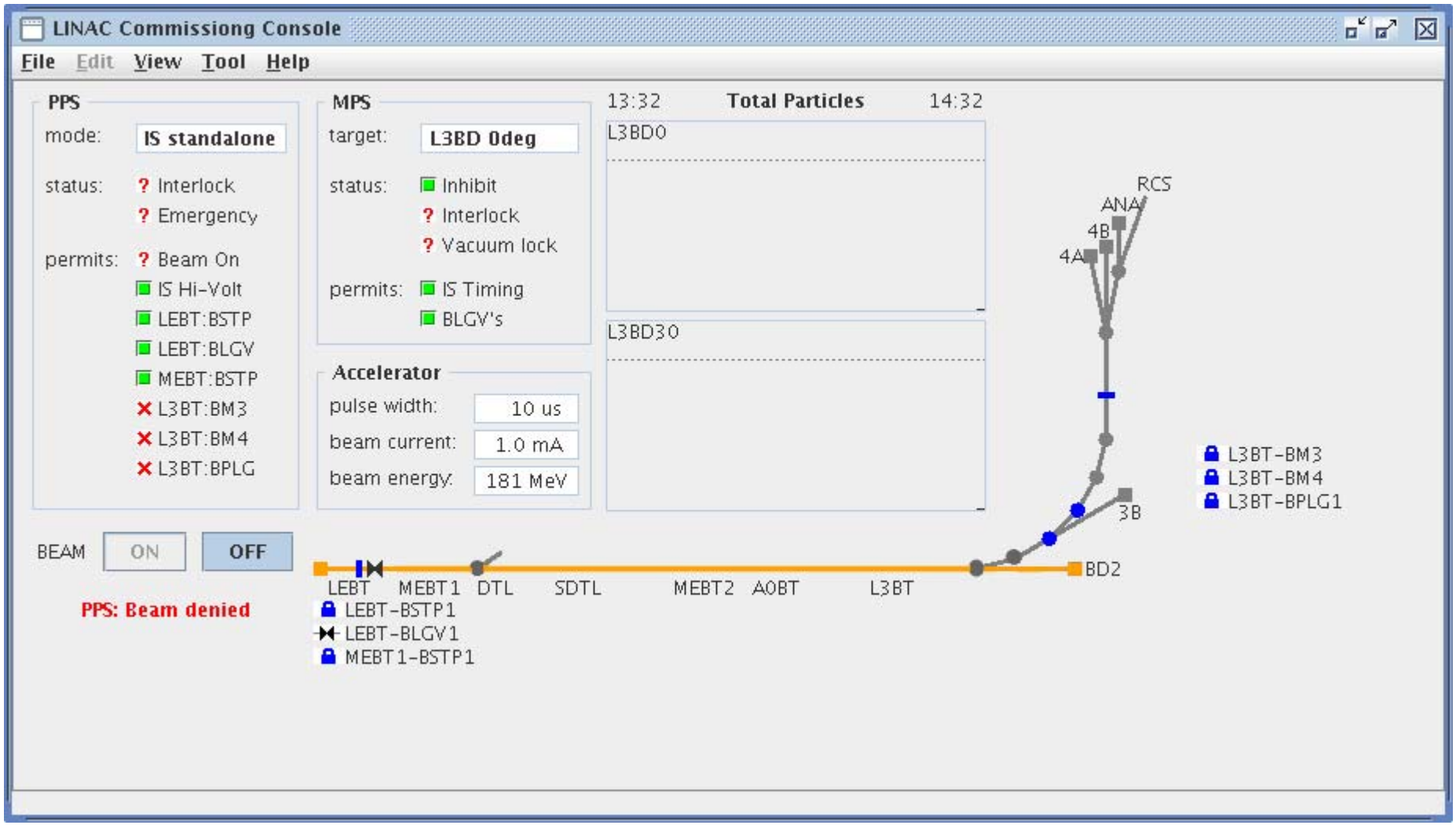
GUI


J-PARC System Overview
J-PARC LINAC Overview
J-PARC LINAC; IS..MEBT1
L3BT QS Magnet P.S. Control Panel
L3BT QS Magnet Power Supply Control Panel #1
EXIT
P.S. Volt./Curr. Monitor & Adjustor
P.S. Current Monitor [max 75A]
Current Value[A]:
P.S. Current Set up [max 69A]
Current Value Set up [A]:
SET
P.S. Status Monitor & Control
P.S. Status Monitor
REMOTE/LOCAL
RUN
STANDBY
FAULT
EMERGENCY
P.S. Status Transition
GO!
CLEAR!
InterLock:
Current Value Abnormality
Voltage Value Abnormality
P.S. Abnormality
QM1 Cooling Water Temp. Abnormality
QM1 Coil Temp. abnomality
LEBT1
RFQ2
MEBT1
(DTL)

GUI


A0L3_SCT_Cur.adl
ACS03A SCT00
ACS03B SCT00
ACS11B SCT01
BD000DEC SCT06
L3BT SCT12
L3BT SCT14
Configuration
MEBT1
DTL
S01
S04
S02
S05
S06
S03
S07
S11
S15
ACS06
ACS10
ACS14
L3BT1
L3BT4
All WE station controlled by EPICS can be configurated 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.
DTL
SDTL
ACCT
L3BT

GUI


LINAC Commissiong Console
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
Accelerator
pulse width: 10 us
beam current: 1.0 mA
beam energy: 181 MeV
13:32 Total Particles 14:32
L3BD0
L3BD30
BEAM ON OFF
PPS: Beam denied
LEBT MEBT1 DTL SDTL MEBT2 A0BT L3BT
LEBT-BSTP1
LEBT-BLGV1
MEBT1-BSTP1
RCS
ANA
4B
4A
3B
BD2
L3BT-BM3
L3BT-BM4
L3BT-BPLG1

SUMMARY

- 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 1st 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