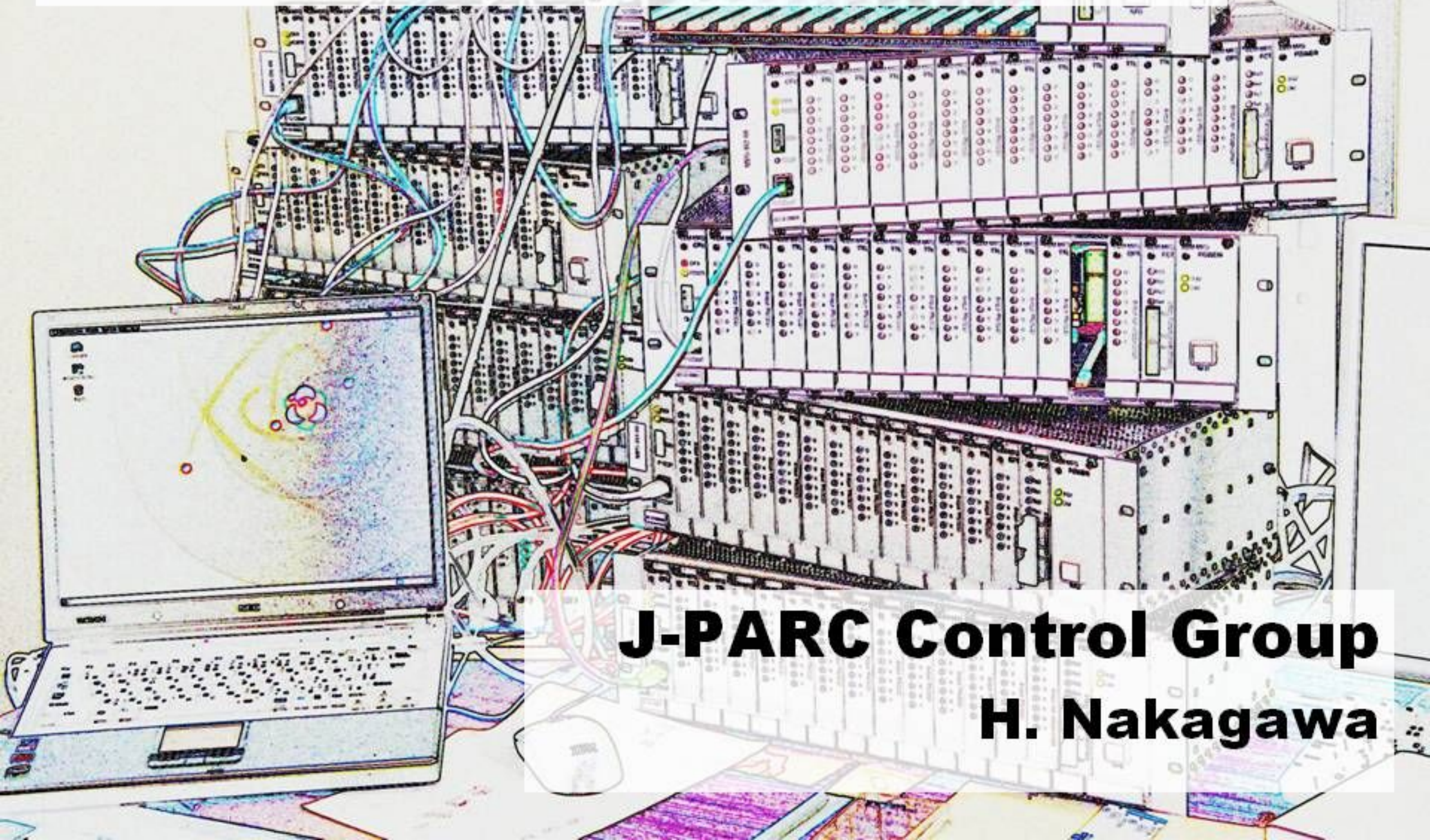
The Accelerator Protection System Based on Embedded EPICS for J-PARC



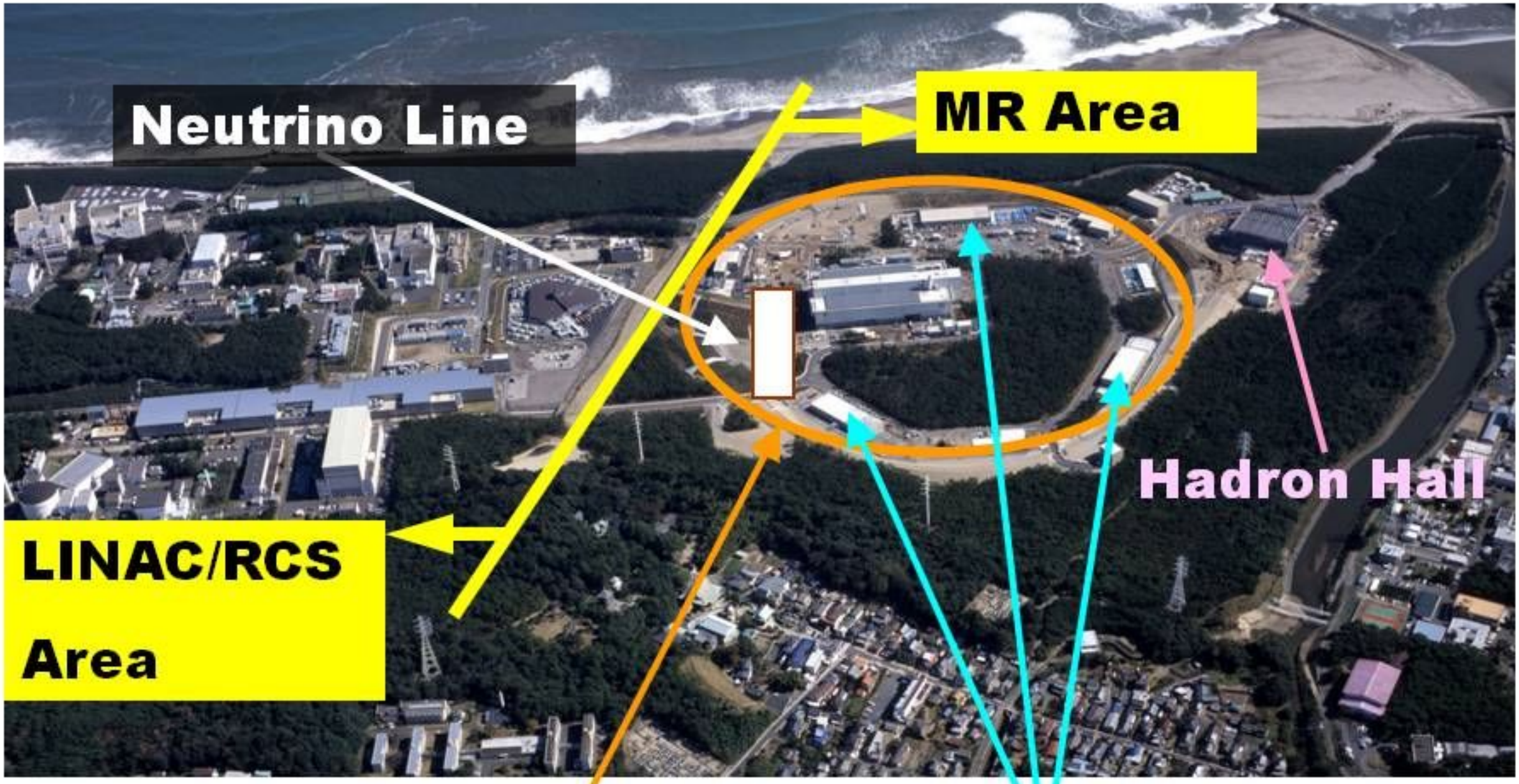
J-PARC Control Group

H. Nakagawa

Contents

- **J-PARC MR**
- **MR MPS design**
- **MR MPS modules**
- **Signal Handling for Quick Response and Maintainability**
- **Operational Results**
- **Summary**

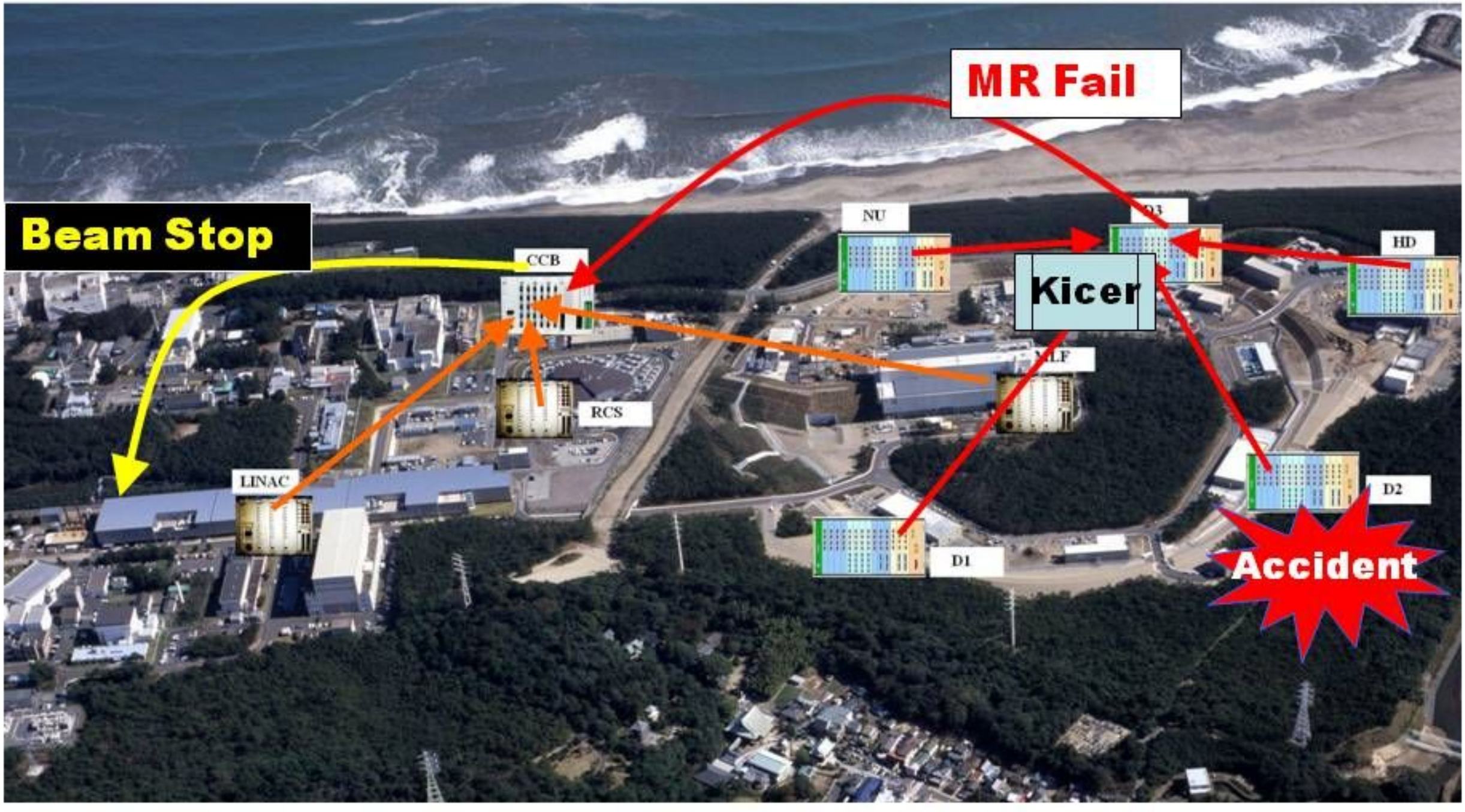
MR area of J-PARC



Goal of MPS(MR)

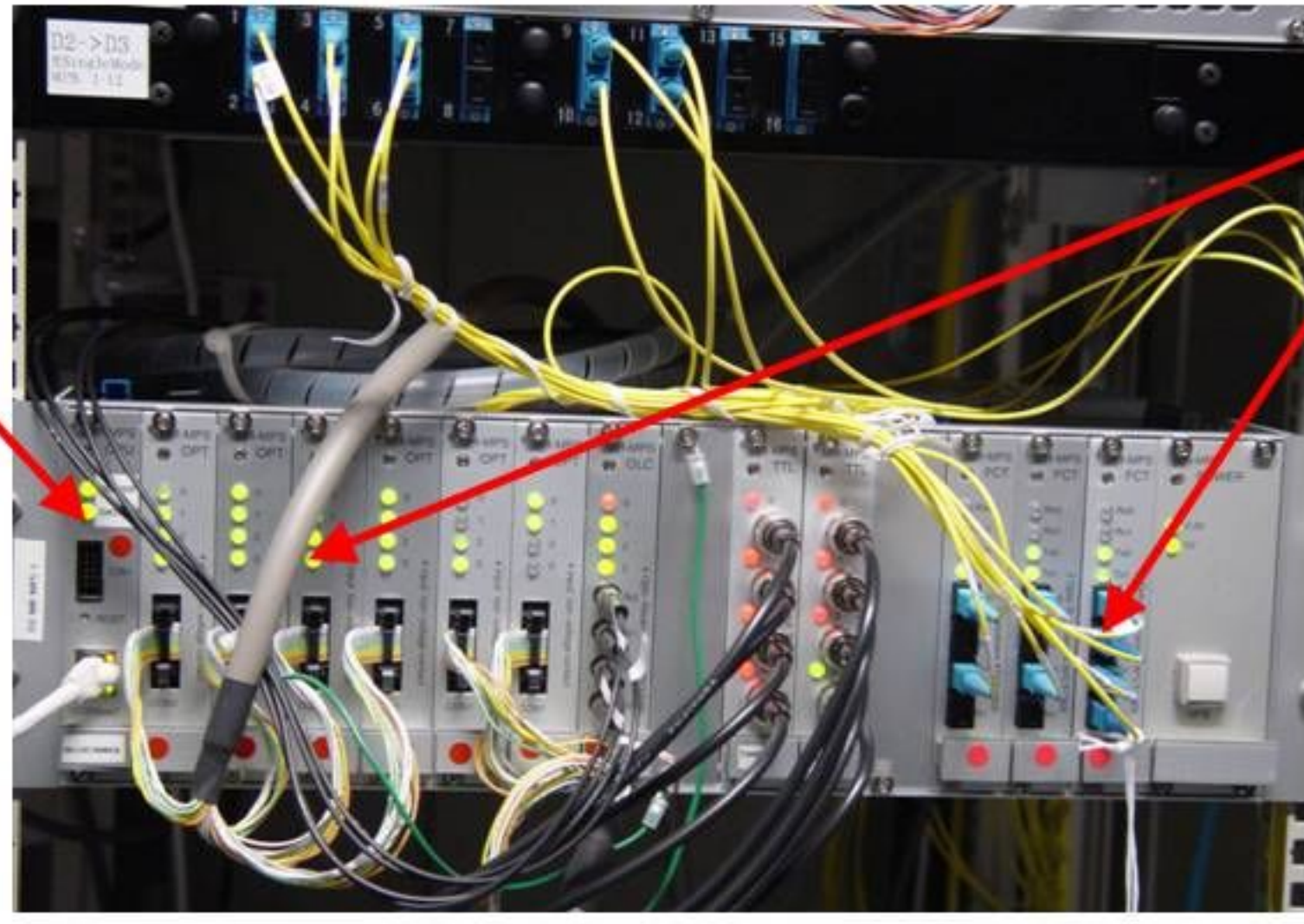
- **MR Design Guidelines**
  - **Response Time (<10us)**
  - **Flexibility of the Logic**
  - **Flexibility of the System**
  - **High Reliability**
  - **Maintainability**

System Configuration



= Subrack for MR MPS

An MPS Subrack



MR MPS Modules

Category	Function	Name	ID Code
MR-MPS/Abort	Backplane	MR-MPS-BUS	
	Contact Signal Input	MR-MPS-OPT	2
	Optically Isolated Input	MR-MPS-OLC	3
	TTL Input	MR-MPS-TTL	4
	Long-Distance Optical Transceiver	MR-MPS-FCT	1
	TTL/Contact Input	MR-MPS-GIO (TTL/Contact)	5 / 6
	CPU(IOC)	MR-MPS-CPU	
	Power Supply	MR-MPS-POWER	
MR Beam Loss	Backplane	BLM-MPS-BUS	
	TTL Input(8 channels)	BLM-MPS-TTL	8
	Contact Signal Input	BLM-MPS-OPT	7
	Long-Distance Optical Transceiver	BLM-MPS-FCT	9
	CPU(IOC)	BLM-MPS-CPU	
	Power Supply	BLM-MPS-POWER	

Module ID check is carried out at the start-up time

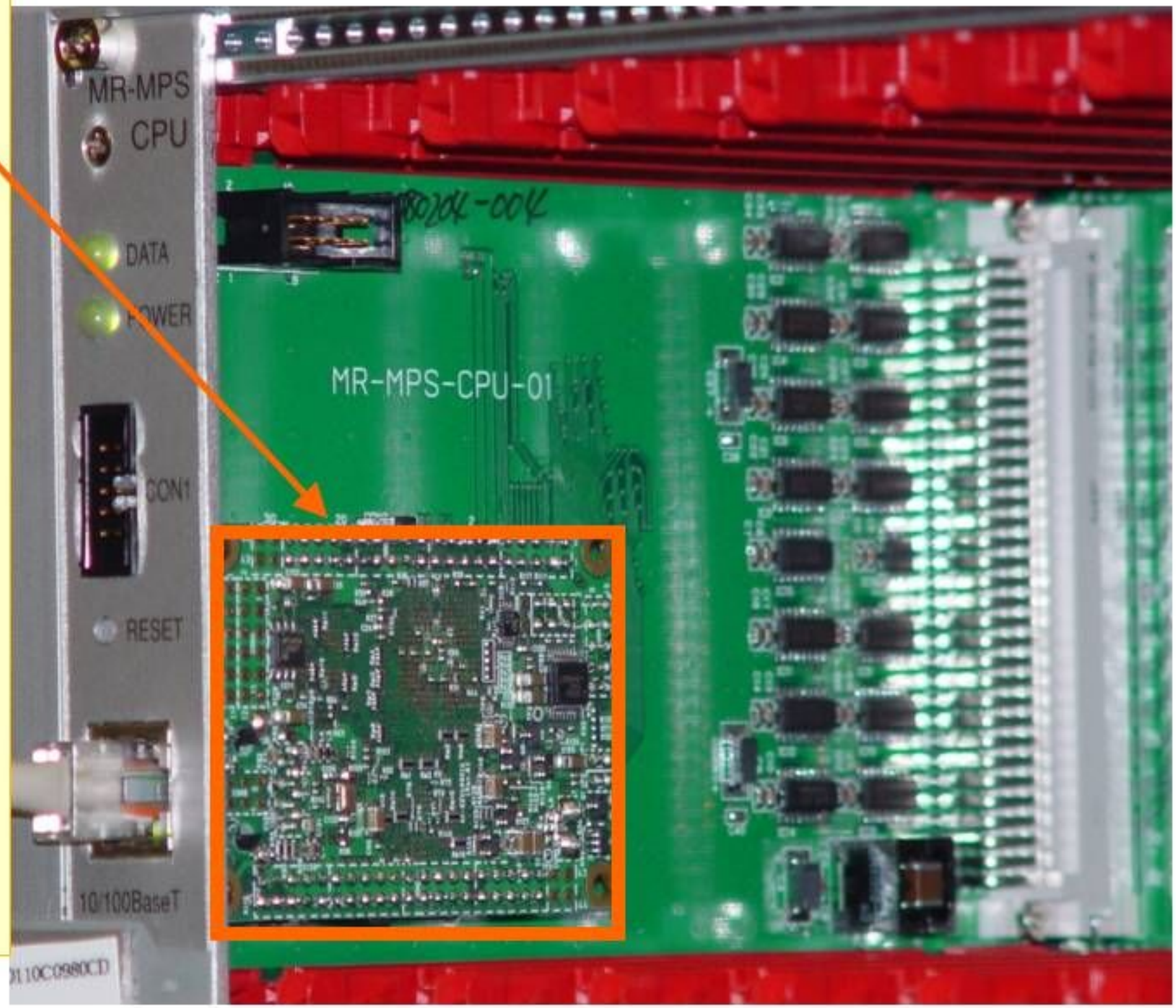
CPU module

SUZAKU

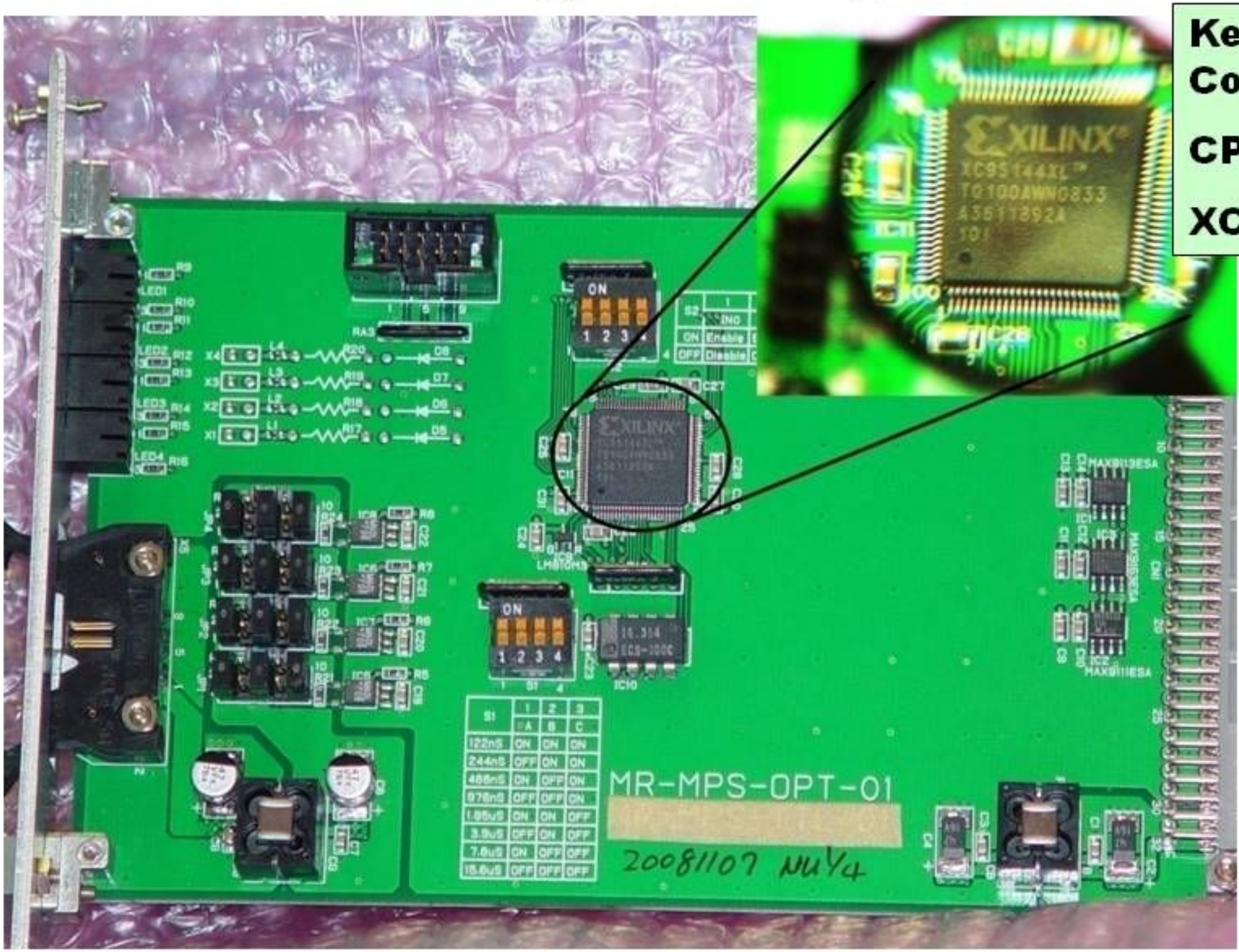
Virtex-4 FX
XC4VFX12
(Xilinx FPGA)

CPUcore:
PowerPC405
&
DRAM 64MB
Flash 8MB

 # Commercial products



Contact Signal Input Module

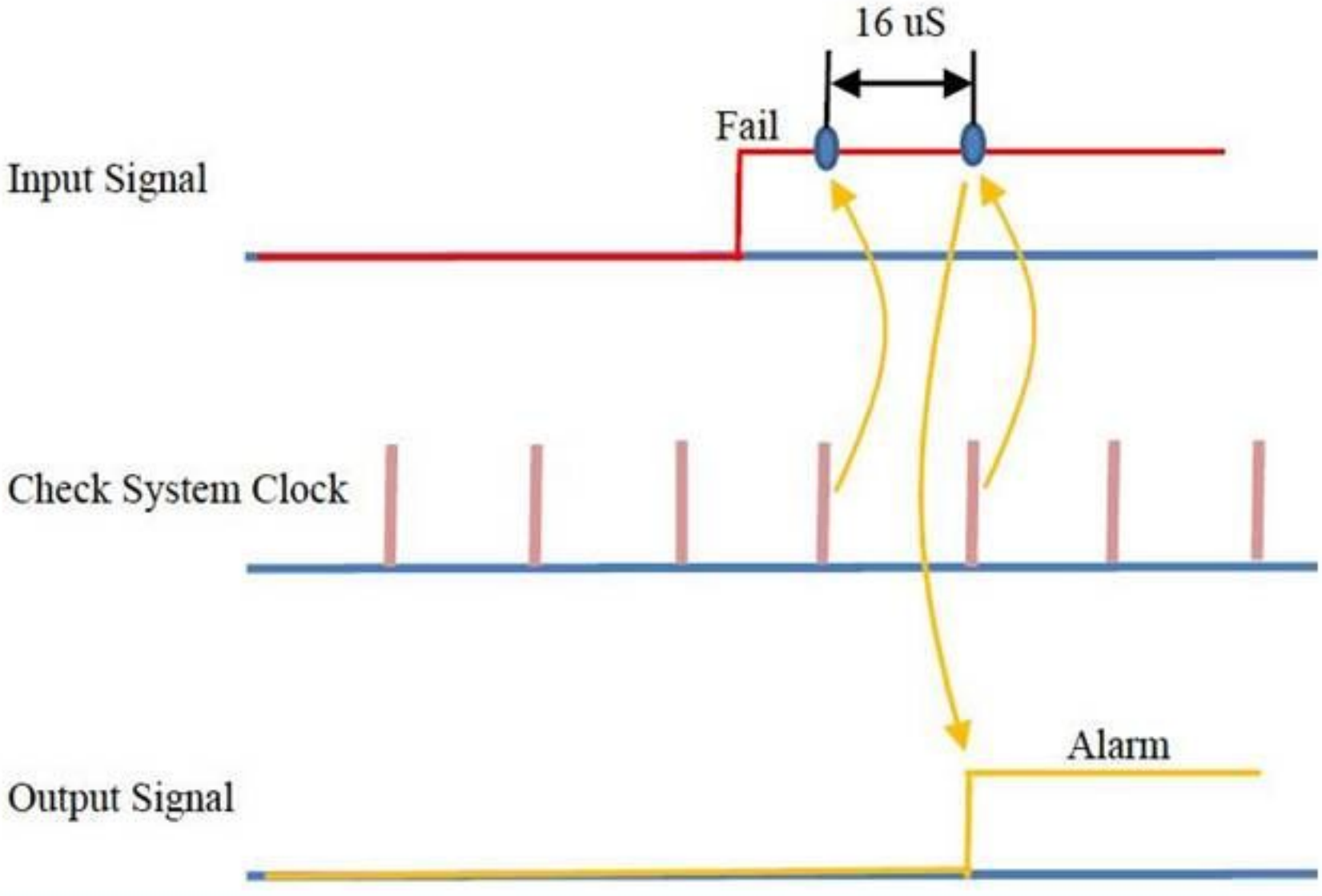


Key Component

CPLD

XC95144XL

Signal Confirmation
(MR-MPS-OPT)



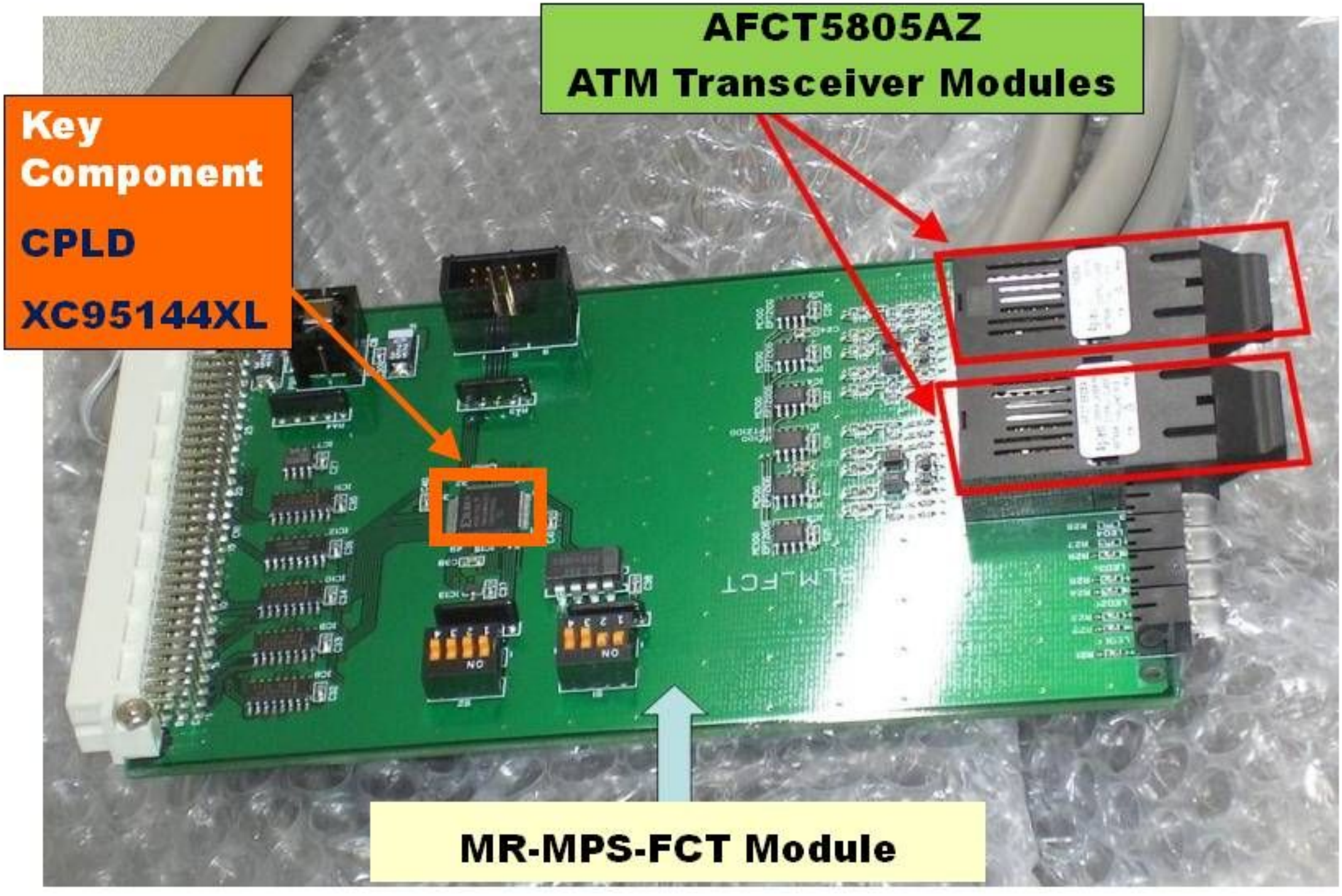
Twice check by CPLD

=> High reliability

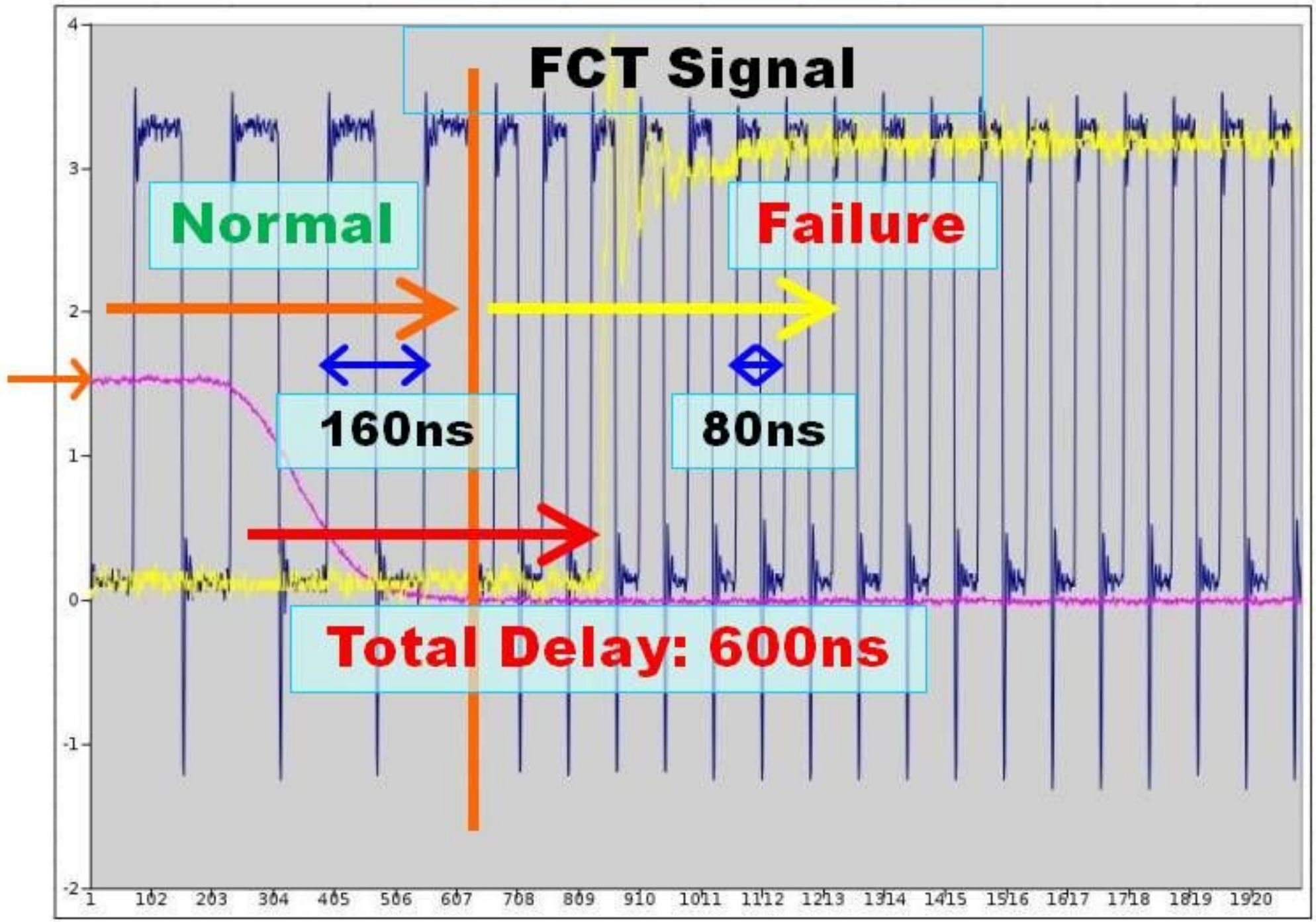
Second sampling after the 16 micro seconds

Link Module

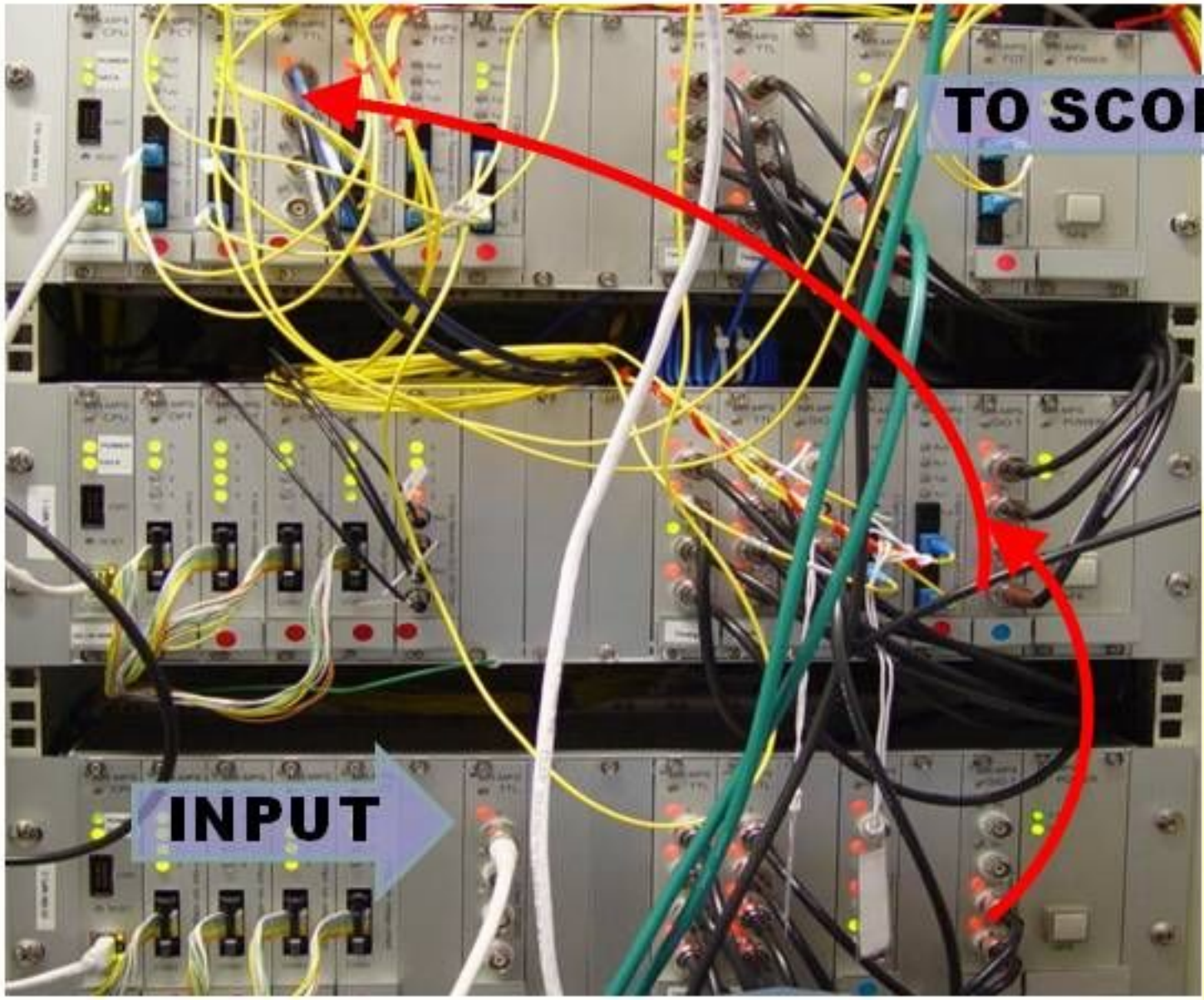
.

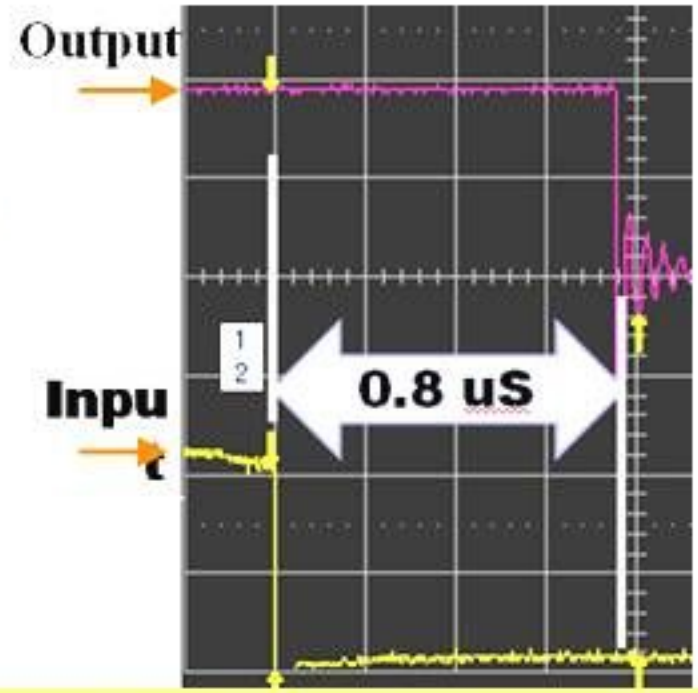

AFCT5805AZ
ATM Transceiver Modules
Key Component
CPLD
XC95144XL
MR-MPS-FCT Module

Link Signal


FCT Signal
Normal
Failure
160ns
80ns
Total Delay: 600ns
4
3
2
1
0
-1
-2
1
102
203
304
405
506
607
708
809
910
1011
1112
1213
1314
1415
1516
1617
1718
1819
1920

Response Time





1) Subrack 3 stage

0.8 us

2) Inter-building

3-4 us

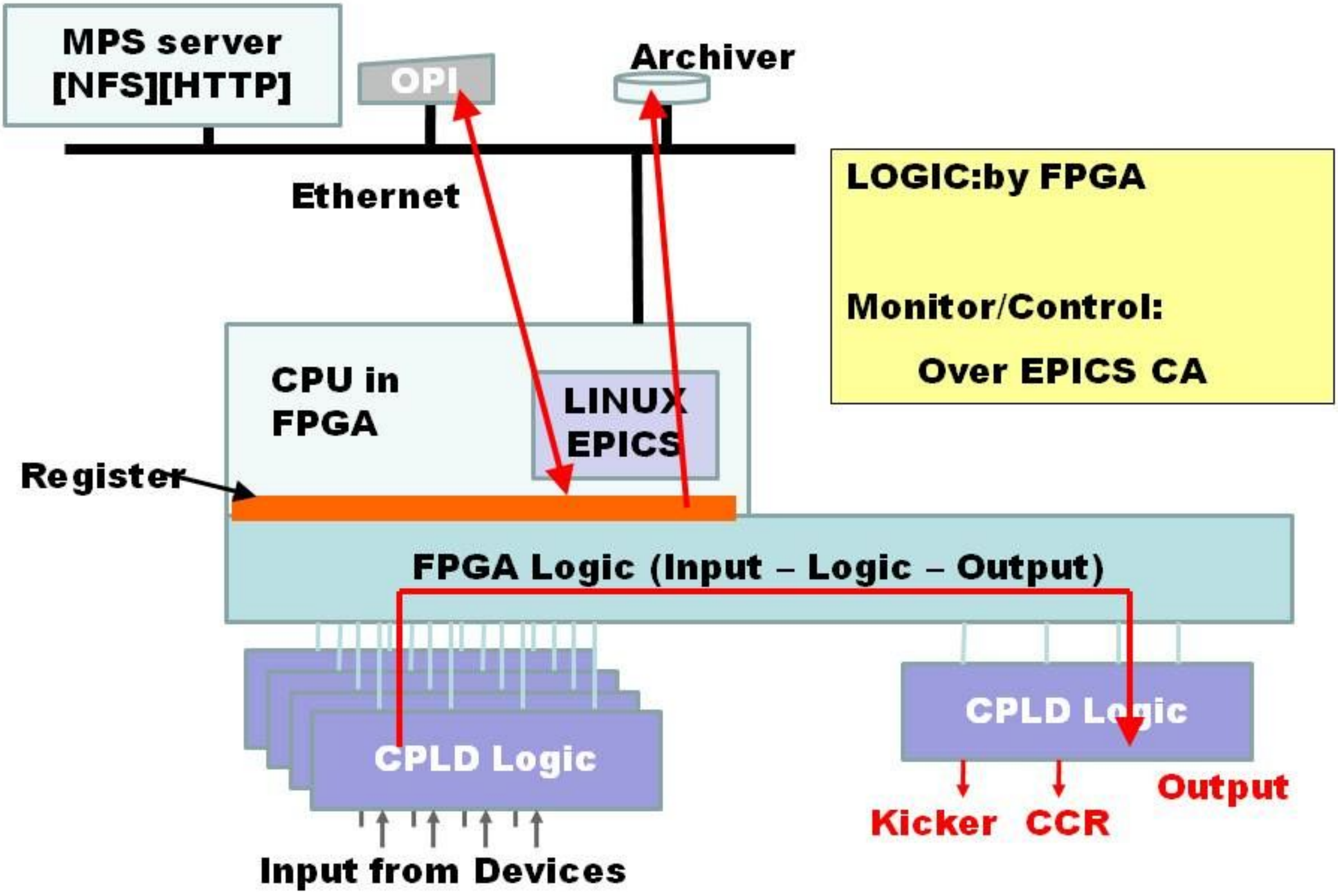
3) Link Module

0.6 us

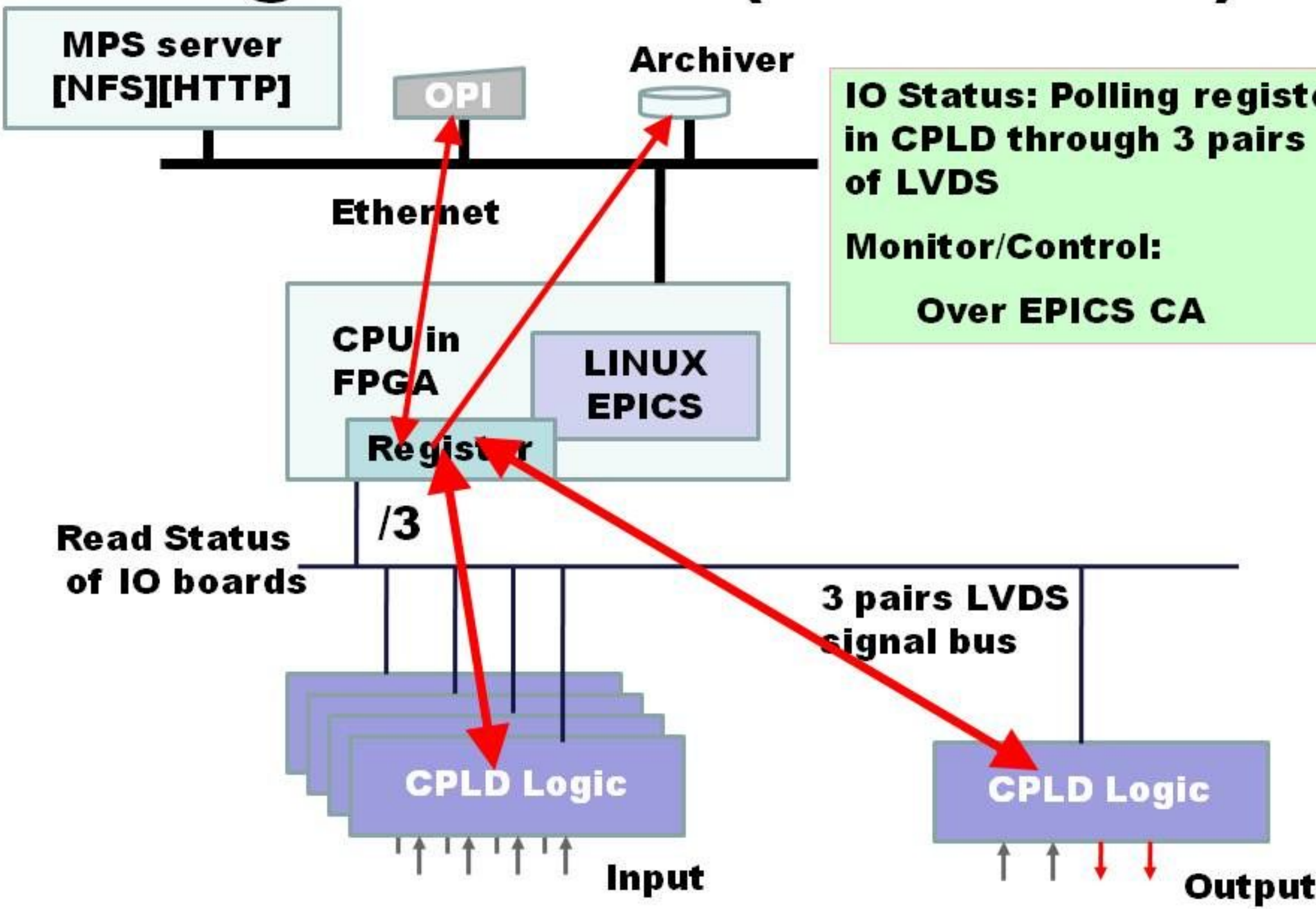
Total : about 6 us

Signal Handling for Quick Response and Maintainability

Signal Flow (Logic)



Signal Flow (IO Status)



IO Status: Polling register in CPLD through 3 pairs of LVDS

Monitor/Control:

Over EPICS CA

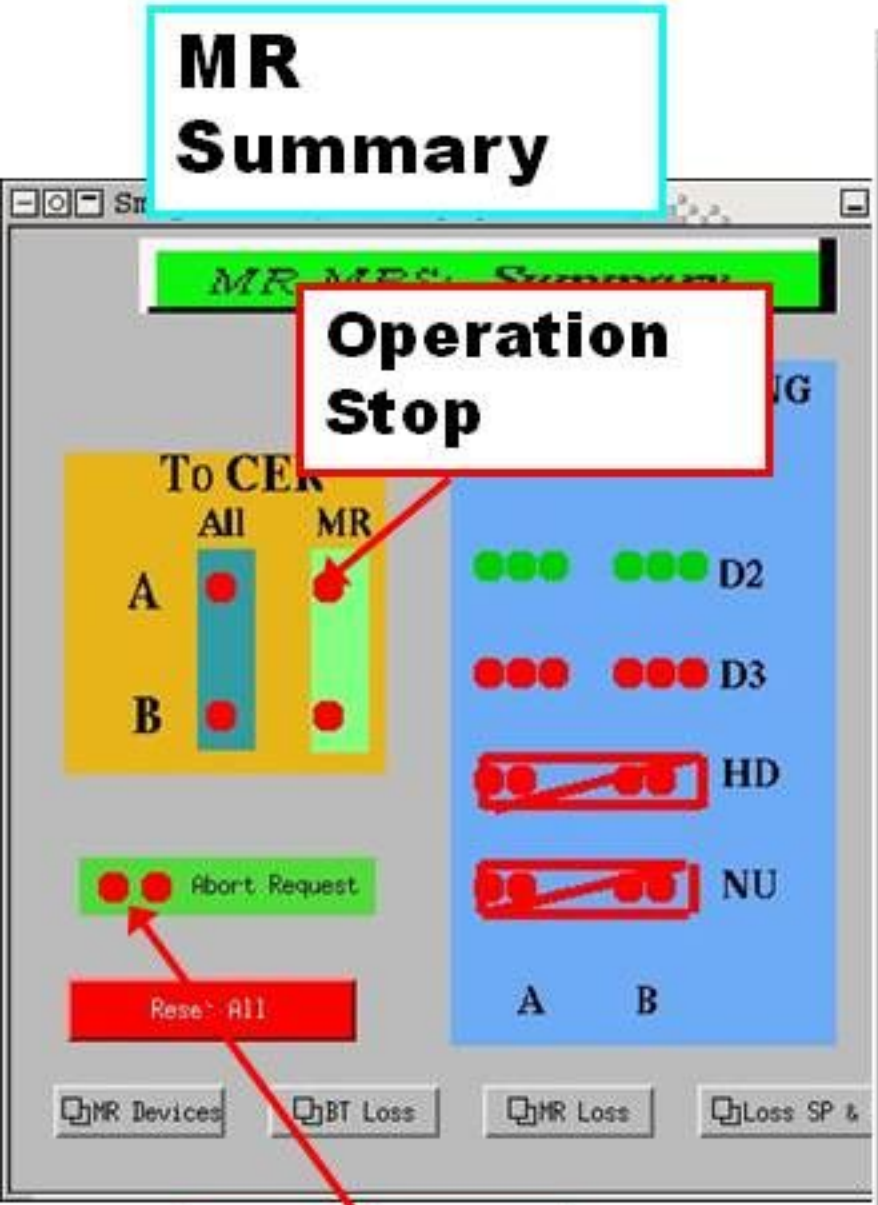
Status Display for MR MPS

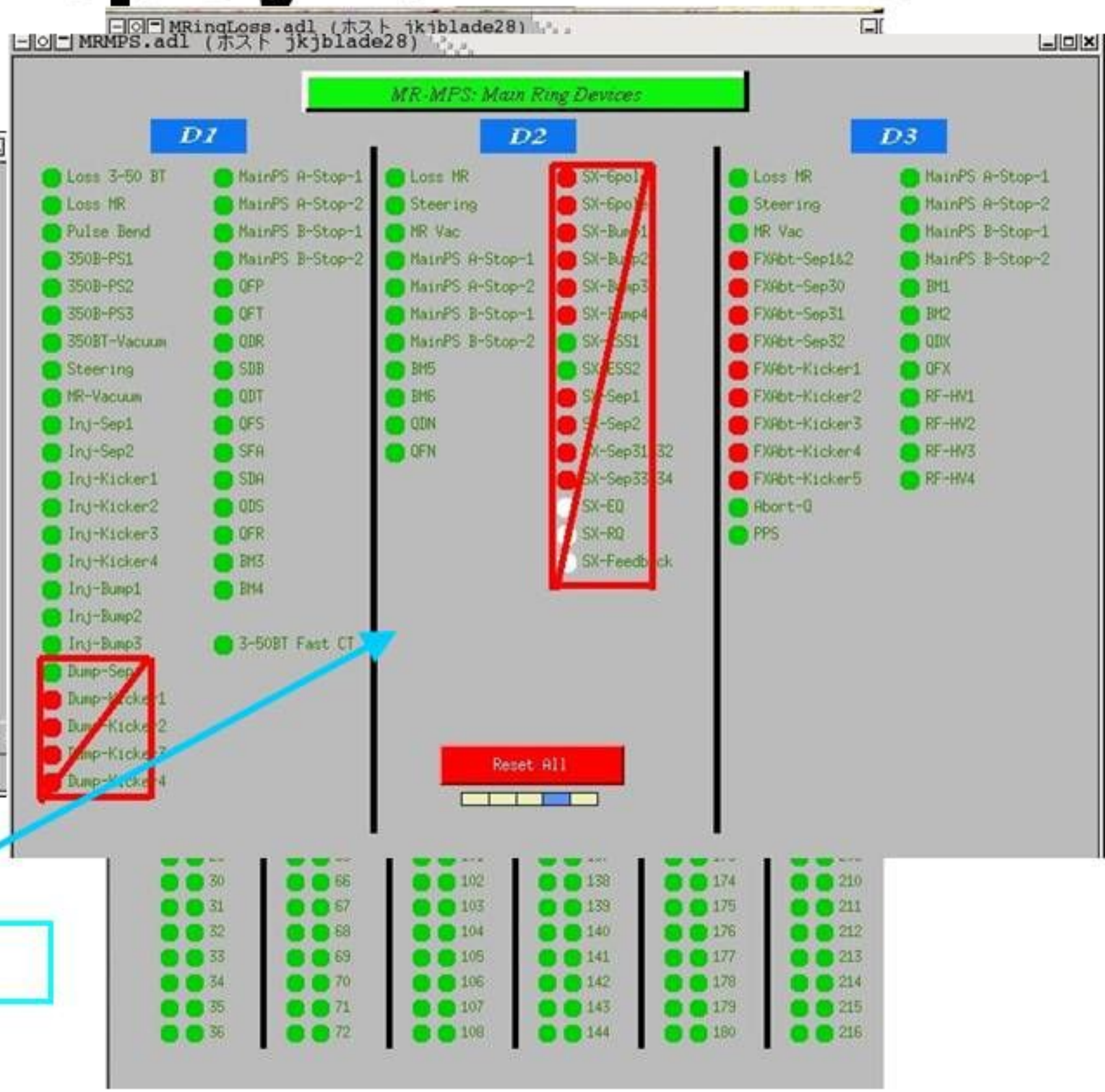
MR Summary

Operation Stop

Dispose

MR Devides





Operational Results

Month	Operating Hours	# of Shots	# of Equipments	# of Events	# of Malfunctioning
Jan	117	630	11	61	0
Feb	87	5194	4	6	0
March	0	0	0	0	0
April	81	2955	13	13	0
May	95	2764	5	13	1
June	122	3484	2	2	0
Total	502	15027	35	95	1

- **One event tells conflict of MPS display and condition of the equipment.**
- **95 events are detected in 500 hours of operation successfully.**

Summary

- **The MR MPS was developed using Virtex-4(FPGA) in the module structure.**
  - **Response time < 10 us** **OK**
  - **High reliability by CPLD** **OK**
  - **Flexibility by FPGA & EPICS** **OK**

- **This MPS system has been used for J-PARC MR**
  - **500 hours since Jan. 2009**
  - **95 MPS events was handled in the successful.**
  - **Only 1 report tells conflict of MPS display and condition of the equipment.**

Members about MPS

- A. Akiyama: Design about System
- J. Odagiri : MPS part of Loss Monitor
- Y. Katoh : Test (Main Job : Linac/RCS)
- H. Nakagawa : Operation of MPS(MR)

N. Yamamoto, N. Kamikubota, T. Kato
H. Yoshikawa, H. Sakaki

Beam Monitor Group

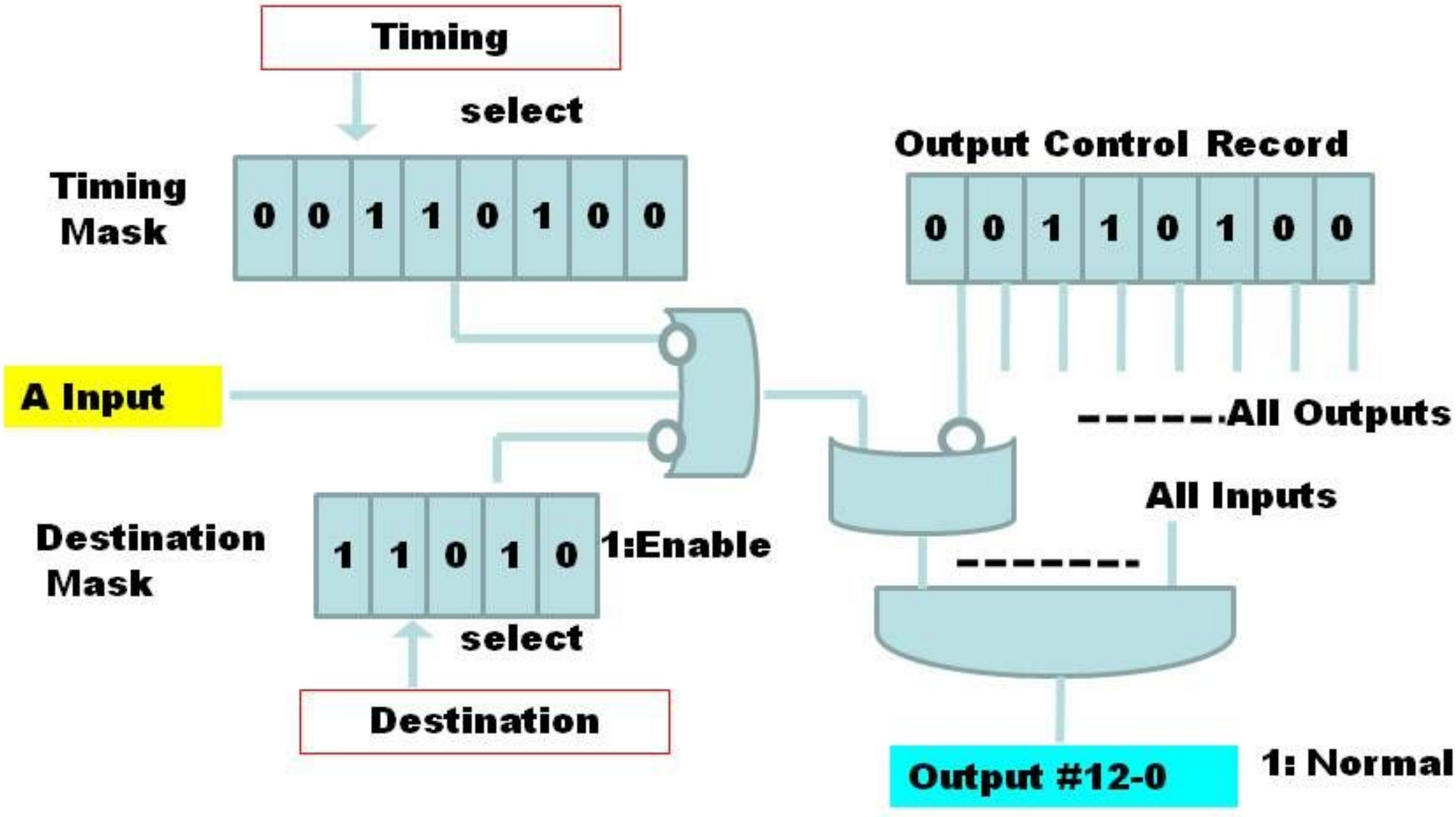
We can get enough power by this system for MPS.

2 kinds of Signal Masks

- **SW (in Modules)**
  - **Semi-rigidity (Field setting)**
  - **Everlasting**

- **Register (in FPGA)**
  - **Alterability from the central control room**
  - **Result is changed based on one destination**
  - **Temporary change returns to the default in the reboot**

Input &Output Mask (Register)



EPICS Environment etc.

- **FPGA Development: EDK (Windows XP) [VHDL]**
- **Soft Development: ATDE(VMware on WindowsXP)**
  - **LINUX: Ver. 2.6.18 (Deb. 4.1…)**
  - **GCC: Ver. 4.1.2**
  - **EPICS: 3.14.9**
    - **Homemade Register Control Driver**
- **Files on Server: NFS mount**
  - **Base, DB, etc.**
  - **Copy to RAM disk, if need**
- **OPI: MEDM**
- **Archive: camonitor etc**

Operation Statistics

Month	Operaton (h)	Shot	Devices	MPS Counts	Confirmation need
Jan.	117	630	11	61	0
Feb.	87	5194	4	6	0
Apr.	81	2955	13	13	0
May	95	2764	5	13	1
Jun.	122	3484	2	2	0
Total	502	15027	35	95	1

The report of misoperations and equipment tests etc. is not counted.