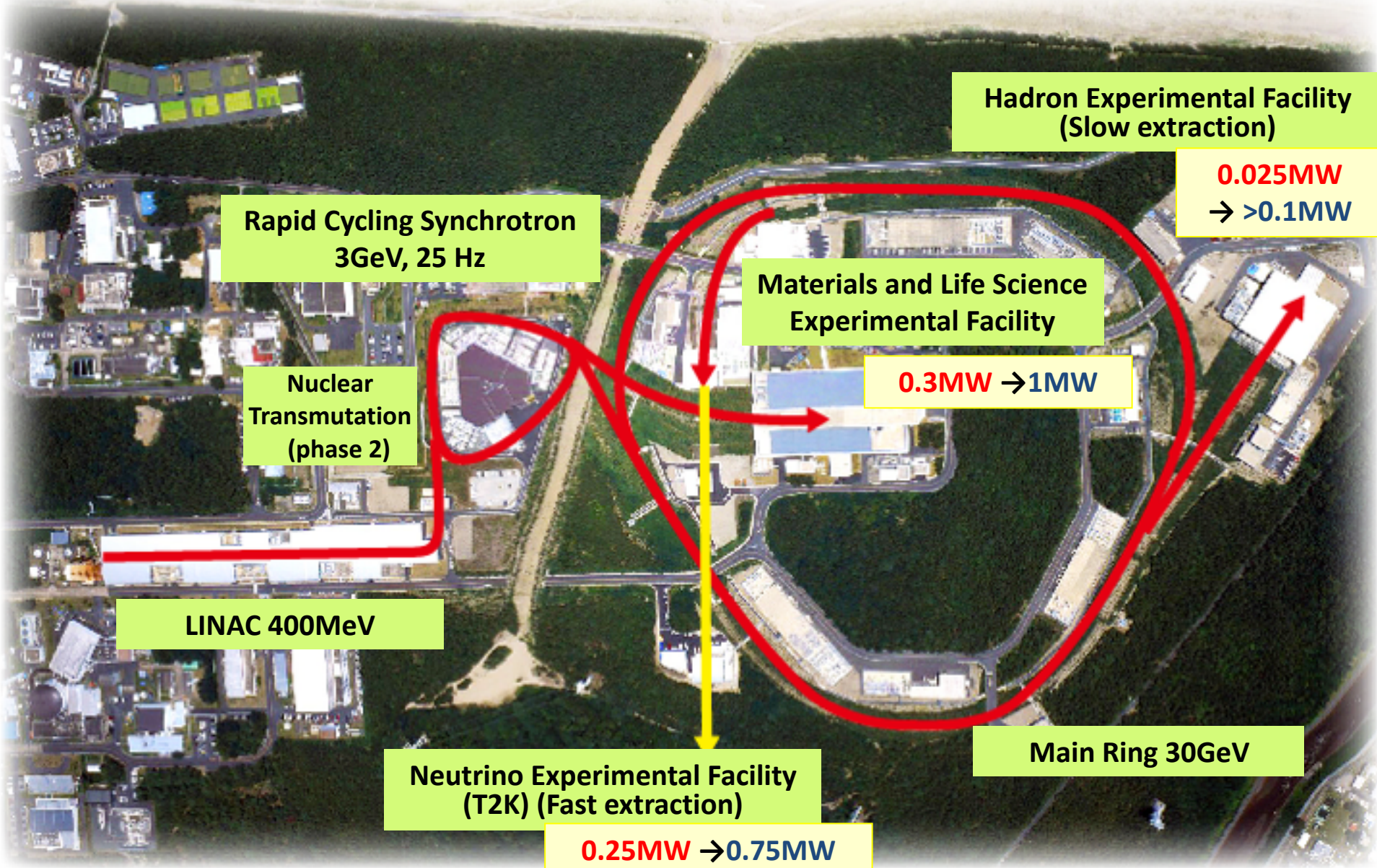


# Radioactive Material Leak at the Hadron Experimental Facility of J-PARC

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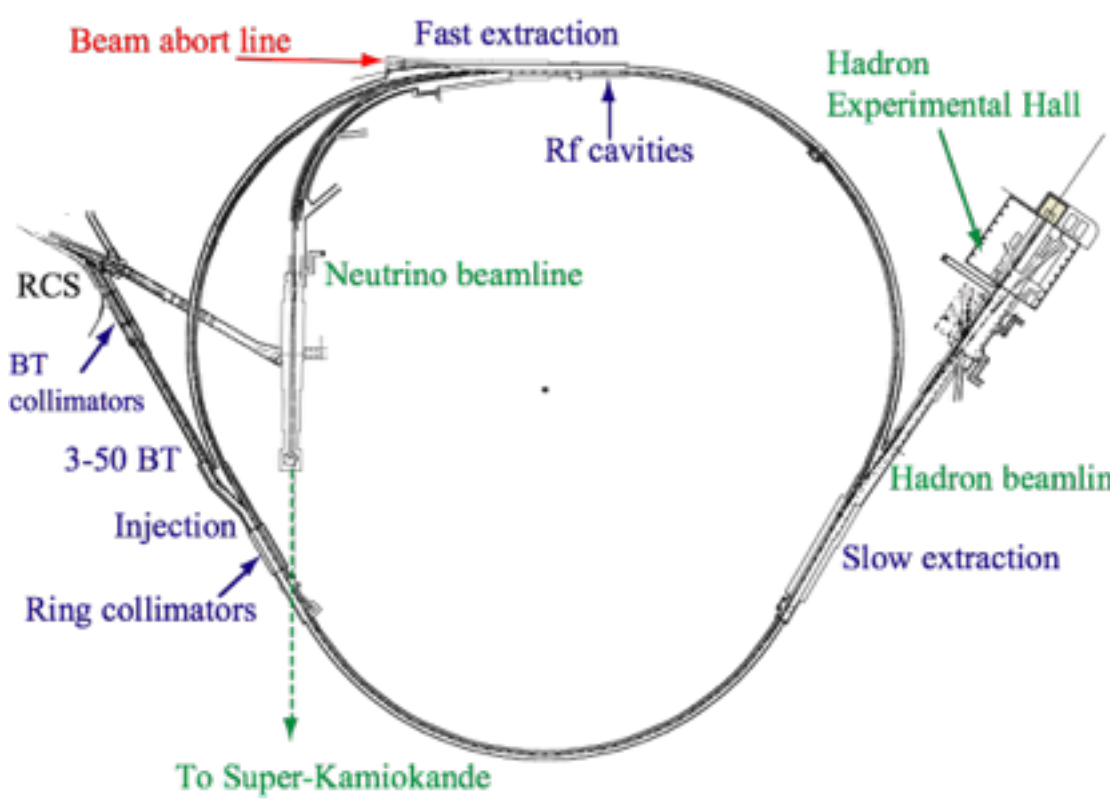
Japan Proton Accelerator Research Complex, since 2009  
J-PARC is jointly built and operated by KEK & JAEA.  
(JAEA: Japan Atomic Energy Agency)

**ABSTRACT:**  
In J-PARC, a radioactive material leak accident occurred at the Hadron Experimental Facility (HD facility) on May 23, 2013. The accident was triggered by a malfunction of the slow extraction system of the Main Ring synchrotron (MR). A beam of  $2 \times 10^{13}$  protons was extracted within a very short time of 5 ms and delivered to the gold target in the HD facility, whereas normally a total of  $3 \times 10^{13}$  protons were extracted for 2 s. The gold target was instantaneously heated up to an extraordinarily high temperature due to the short-pulse beam and partially damaged. As a result, the radioactive material dispersed from the gold target and leaked into the primary beamline room, because the target container was not hermetically sealed. Since airtightness of the primary beamline room was not sufficient, the radioactive material leaked into the hadron experimental hall (HD hall) and workers were exposed to radiation. Additionally, due to operation of ventilation fans in the HD hall, the radioactive material was released into the environment outside of the radiation controlled area of the HD facility. In this poster, the causes and preventive measures of the accident are presented.



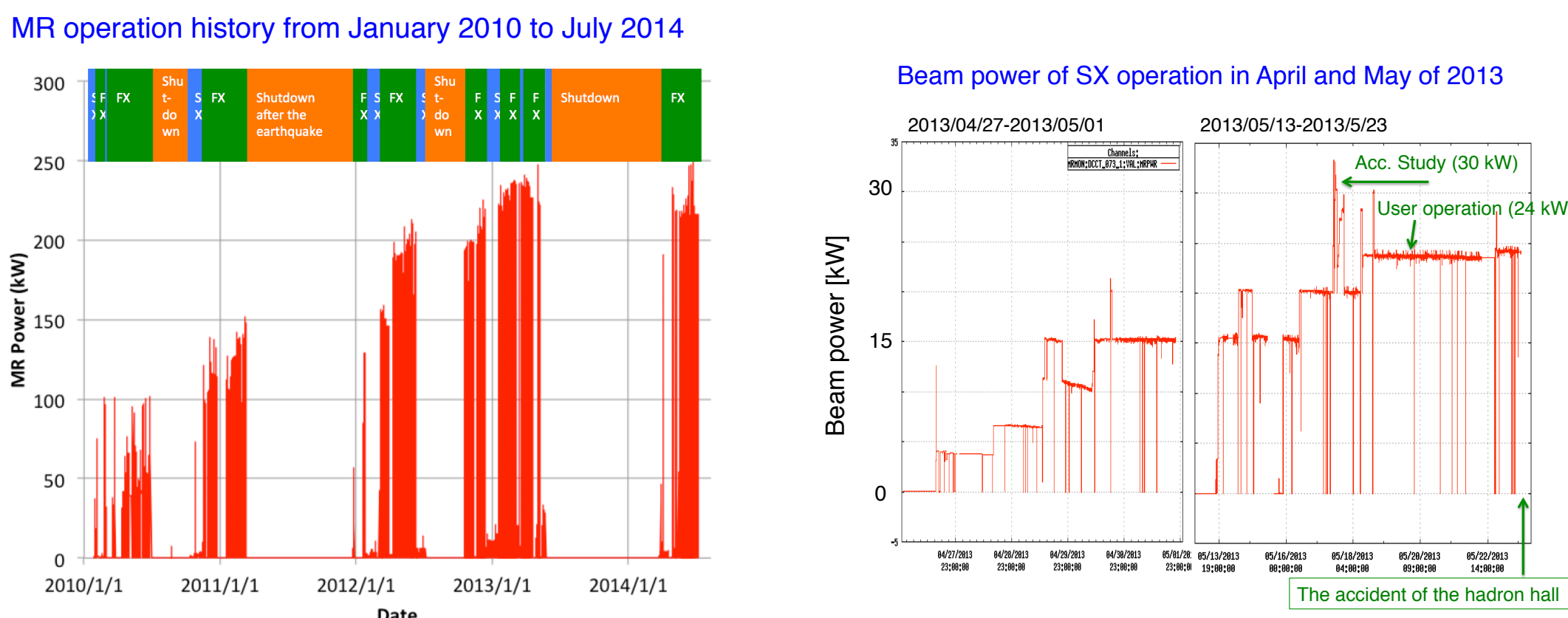
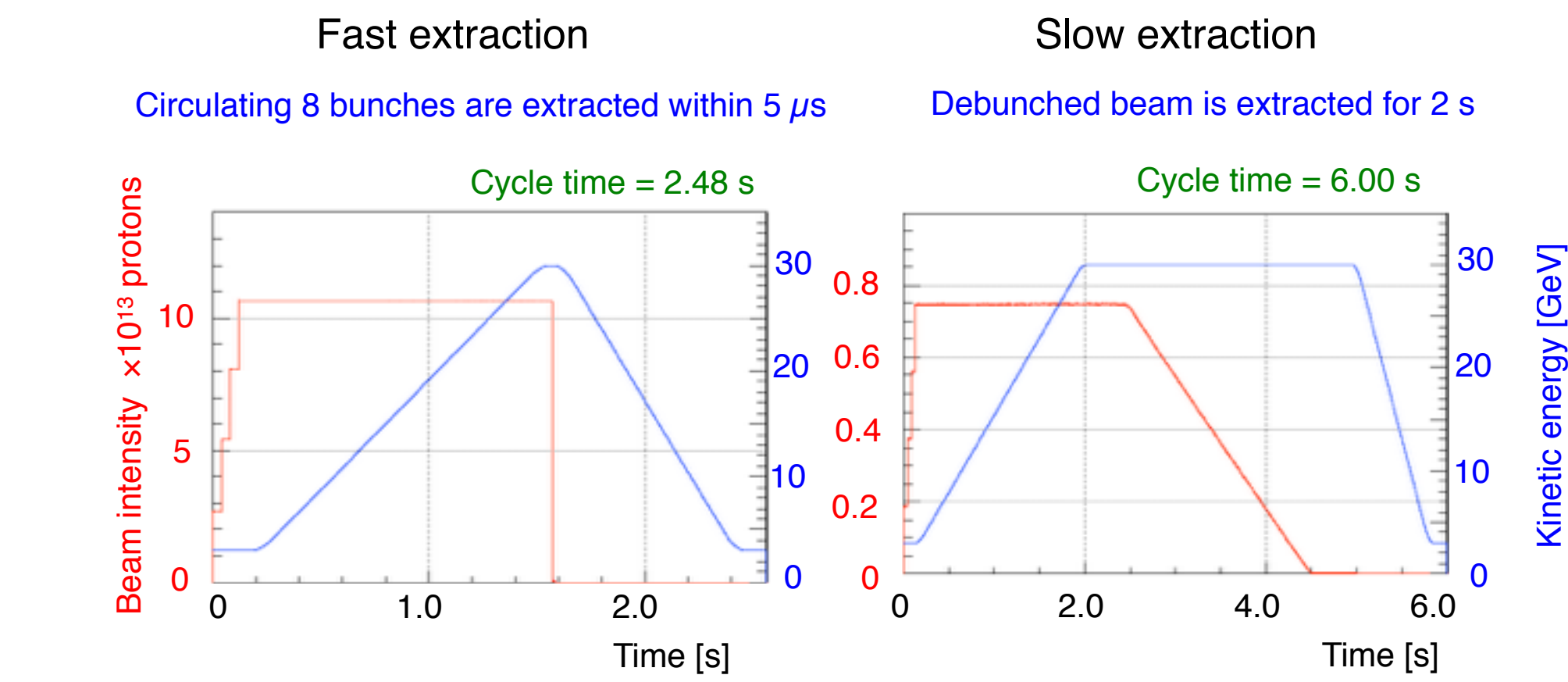
## Main parameters of MR

Circumference 1567.5 m  
Repetition rate ~0.3 Hz  
Injection energy 3 GeV  
Extraction energy 30 GeV (1st phase)  
50 GeV (2nd phase)  
Superperiodicity 3  
h 9  
Number of bunches 8  
RF frequency 1.67 - 1.72 MHz  
Transition  $\gamma$  j 31.7 (typical)  
Number of dipoles 96  
quadrupoles 216 (11 families)  
sextupoles 72 (3 families)  
steerings 186  
Number of cavities 5

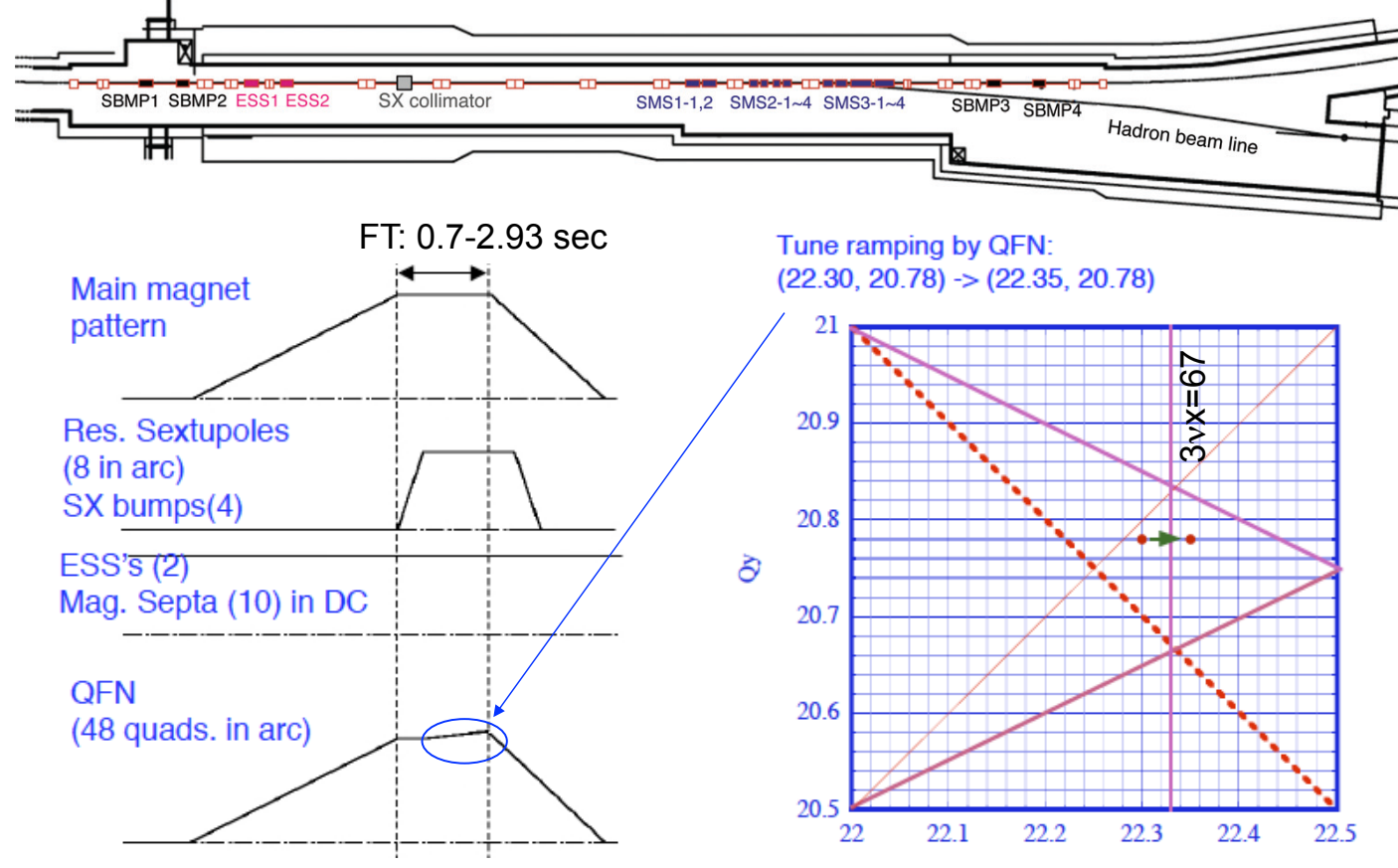


Three dispersion free straight sections of 116-m long:  
- Injection and collimator systems  
- Slow extraction (SX)  
to Hadron experimental Hall  
-MA loaded rf cavities and Fast extraction (FX) (beam is extracted inside/outside of the ring)  
outside: Beam abort line  
inside: Neutrino beamline (intense  $\nu$  beam is sent to SK)

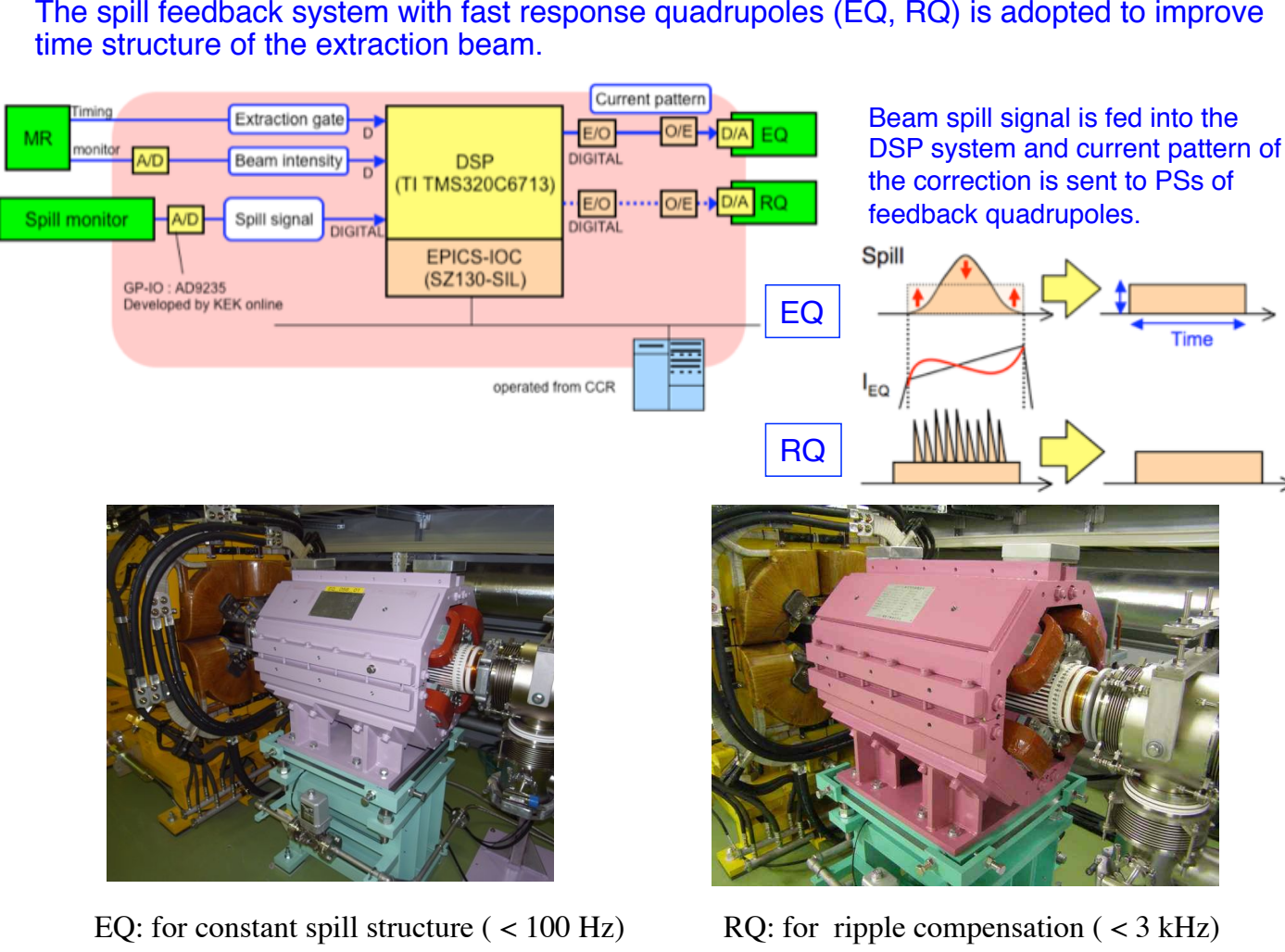
## Beam extraction modes



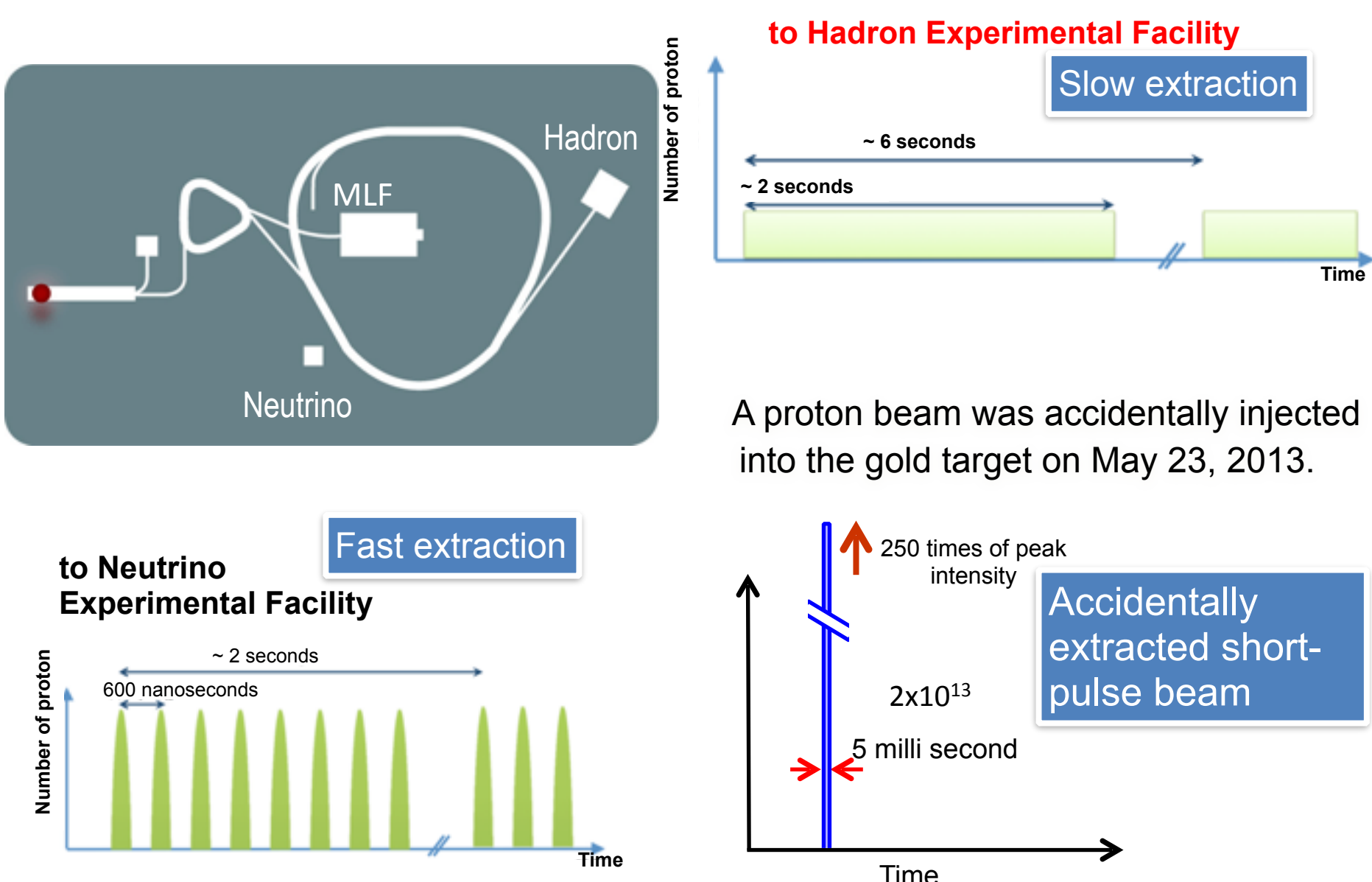
## Slow extraction



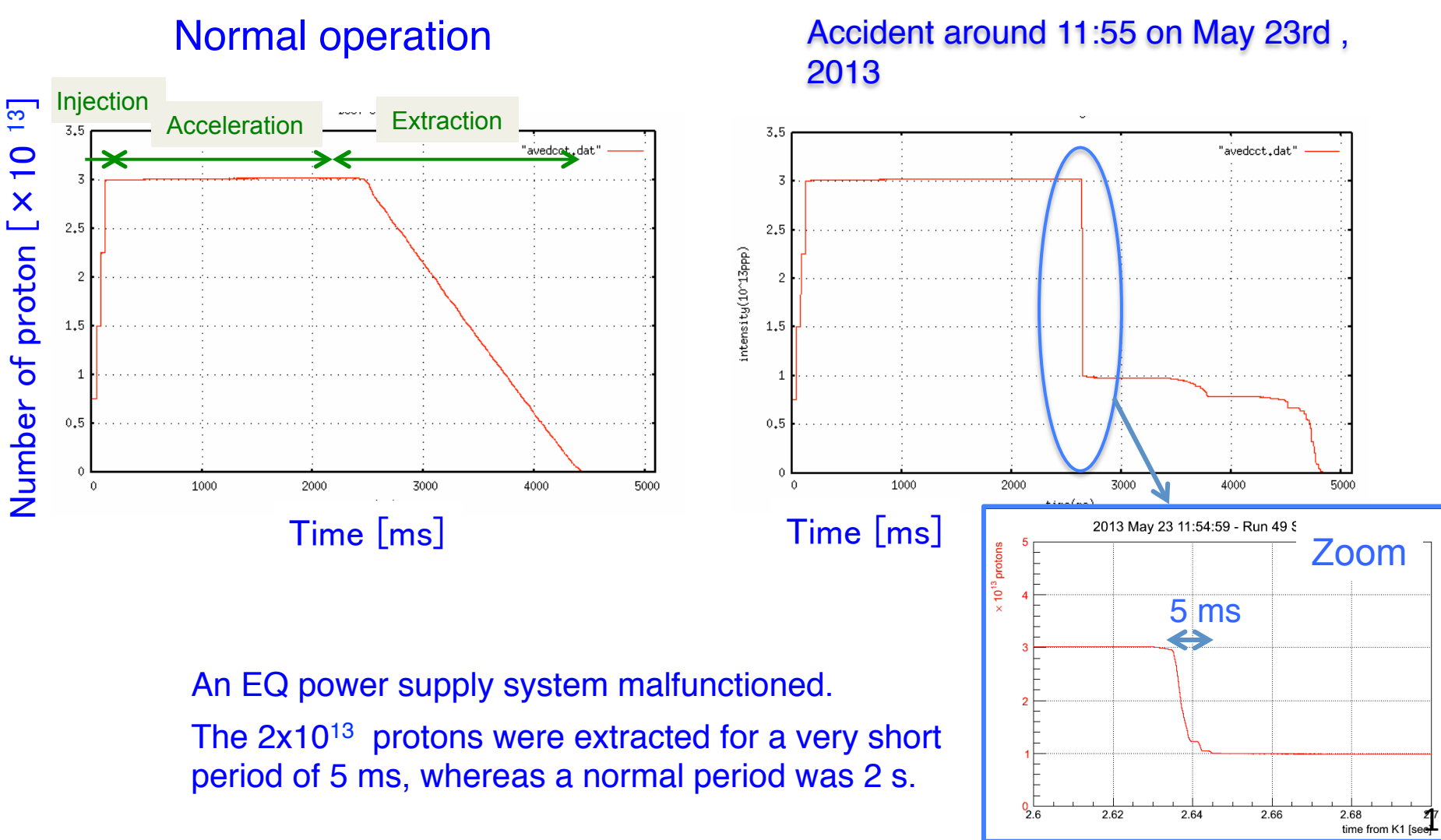
## Spill feedback system



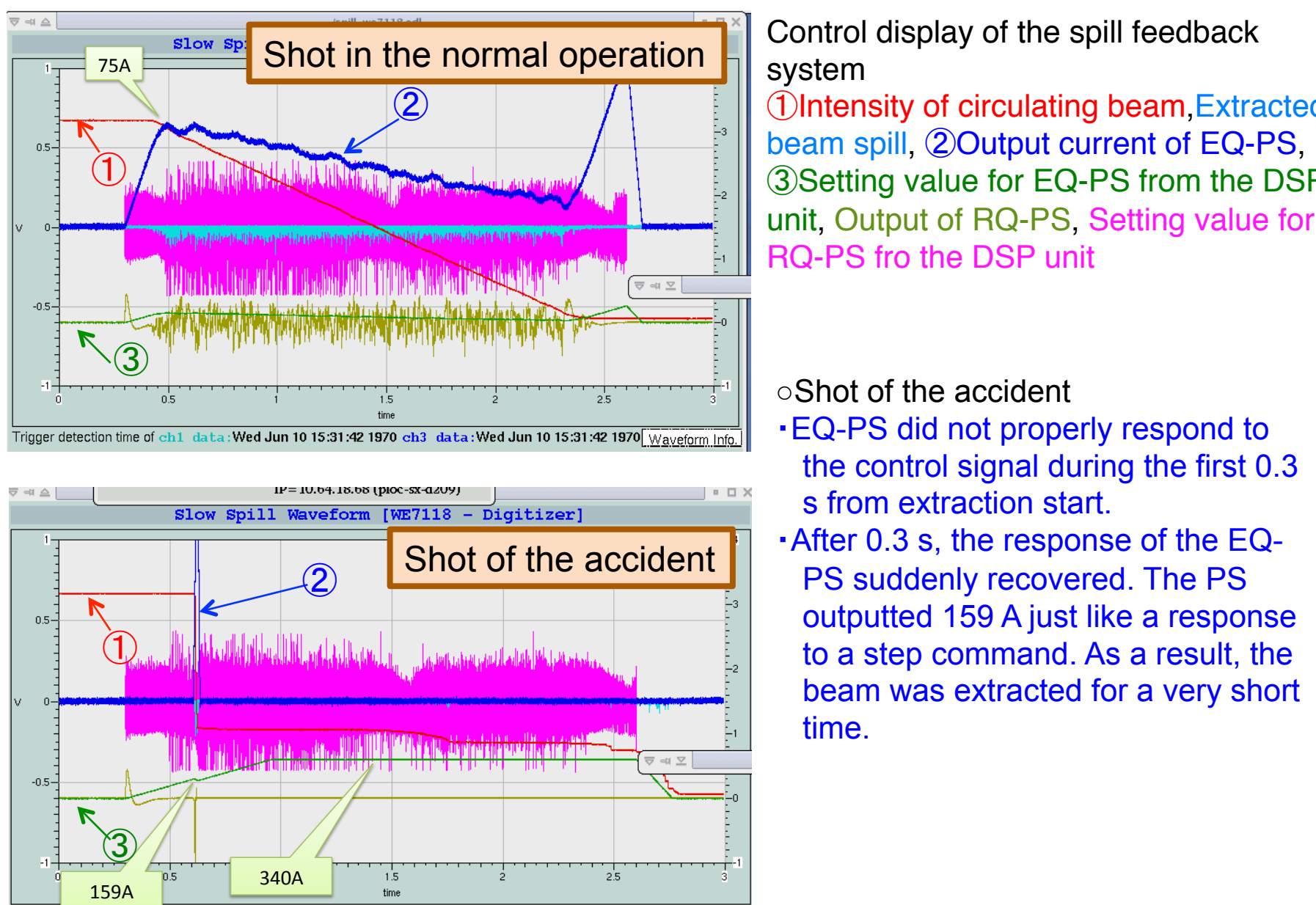
## Accident at Hadron Facility



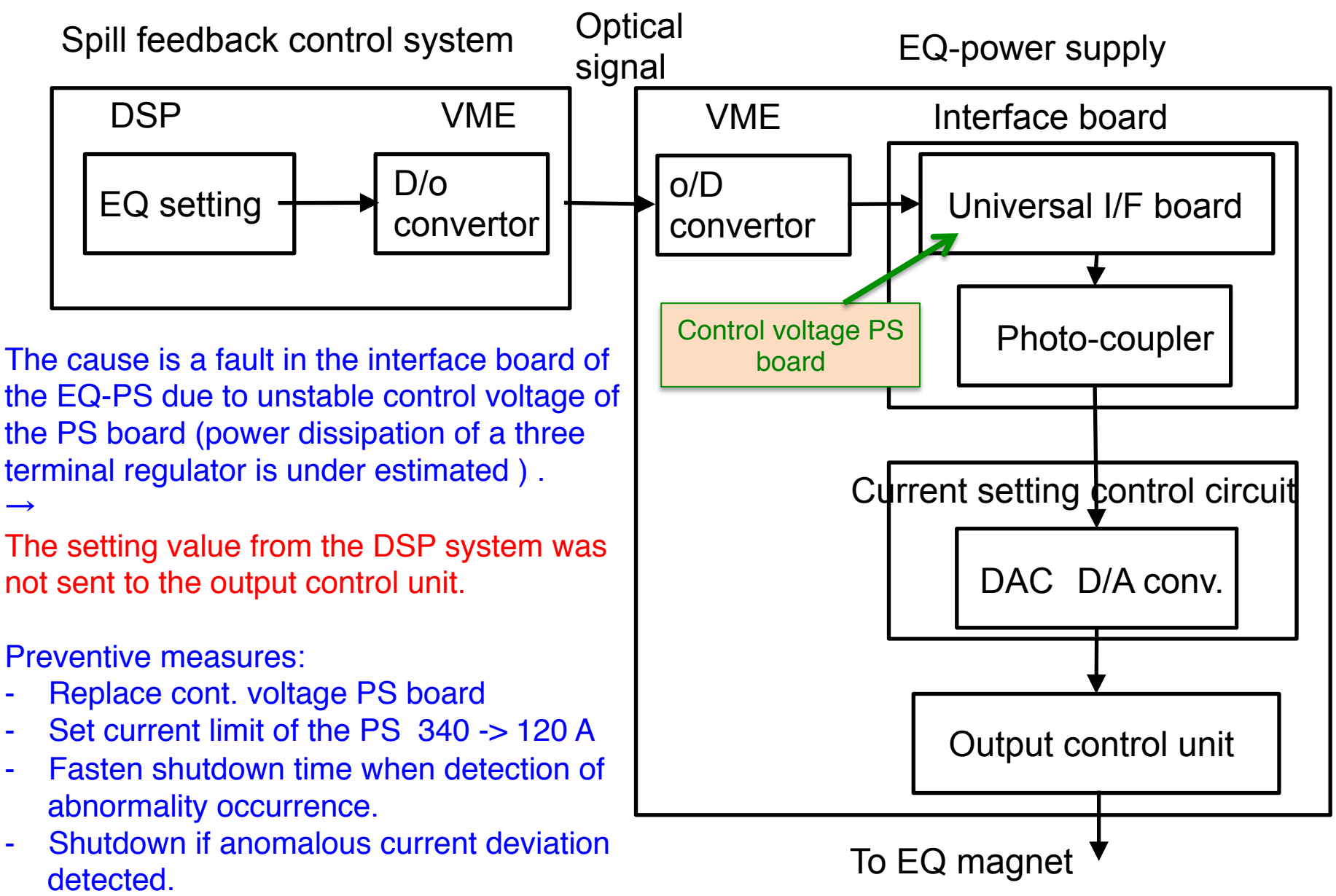
## Comparison of DCCT signal between the shots of normal operation and shots of the accident



## Malfunction of the EQ-power supply



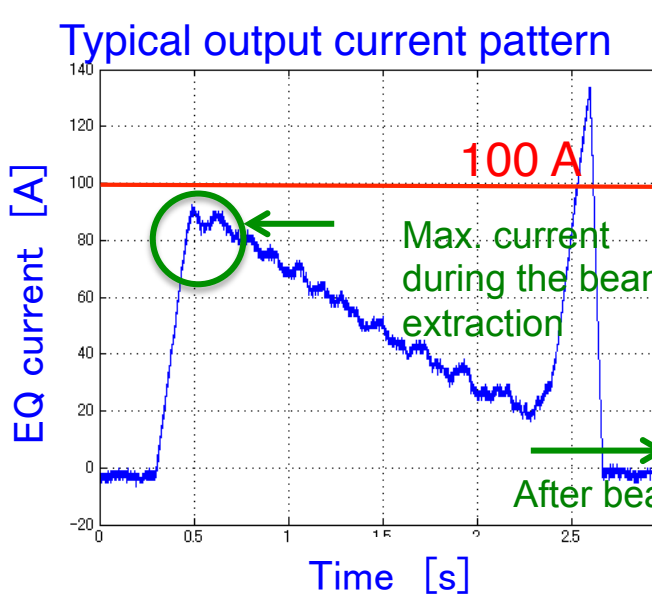
## The cause of the malfunction



## Preventive measures of the EQ system

- Replace cont. voltage PS board

	Present status	Preventive measures
Anomalous current deviation in the EQ-PS and feedback system	Only warning	Stop the beam operation and shutdown the power supply
Current limit	340 A (Max. of the PS)	120 A
Response time of shutdown when detection of abnormality occurrence	> 6 ms	< 1 ms



The measures are taken to prevent the beam extraction for very short time if the PS malfunction occurs. They do not affect on the beam quality for user operation.



## Hadron Experimental Hall :

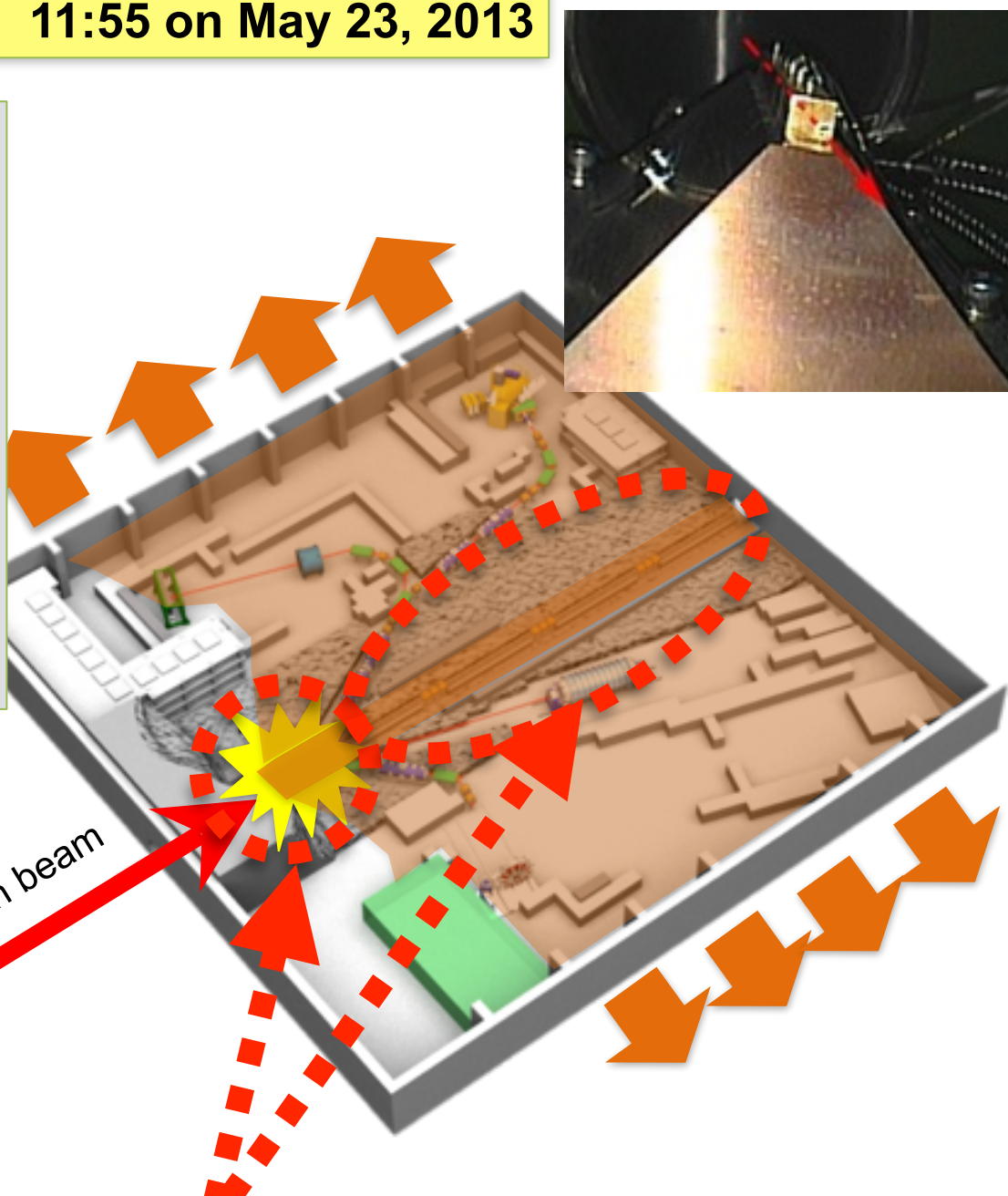
The building is 56 m long, 60 m wide, 16 m roof height with 6 m deep semibasement structure to accommodate experimental instruments.

## Hadron Experimental Facility:

It consists of the Hadron experimental hall and associated machine and power supply buildings, etc.

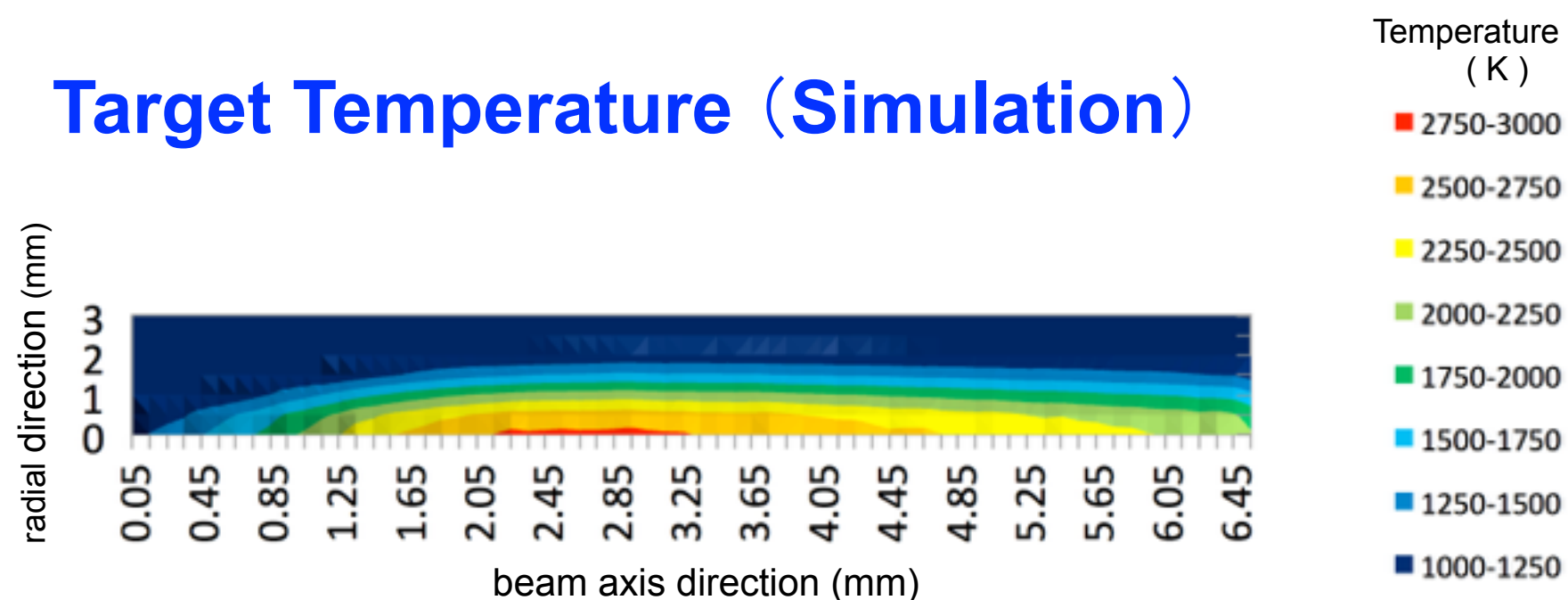
## What happened in Hadron hall ? 11:55 on May 23, 2013

1. A short-pulse beam to the target accidentally
2. Heating of the target to melting
3. Release of radioactive material from the target.
4. Leak of the radioactive material into the HD hall, because the target container did not have air-tightness.
5. Release of the radioactive material into the environment outside of the controlled area, because ventilation fans in the HD hall was operated.

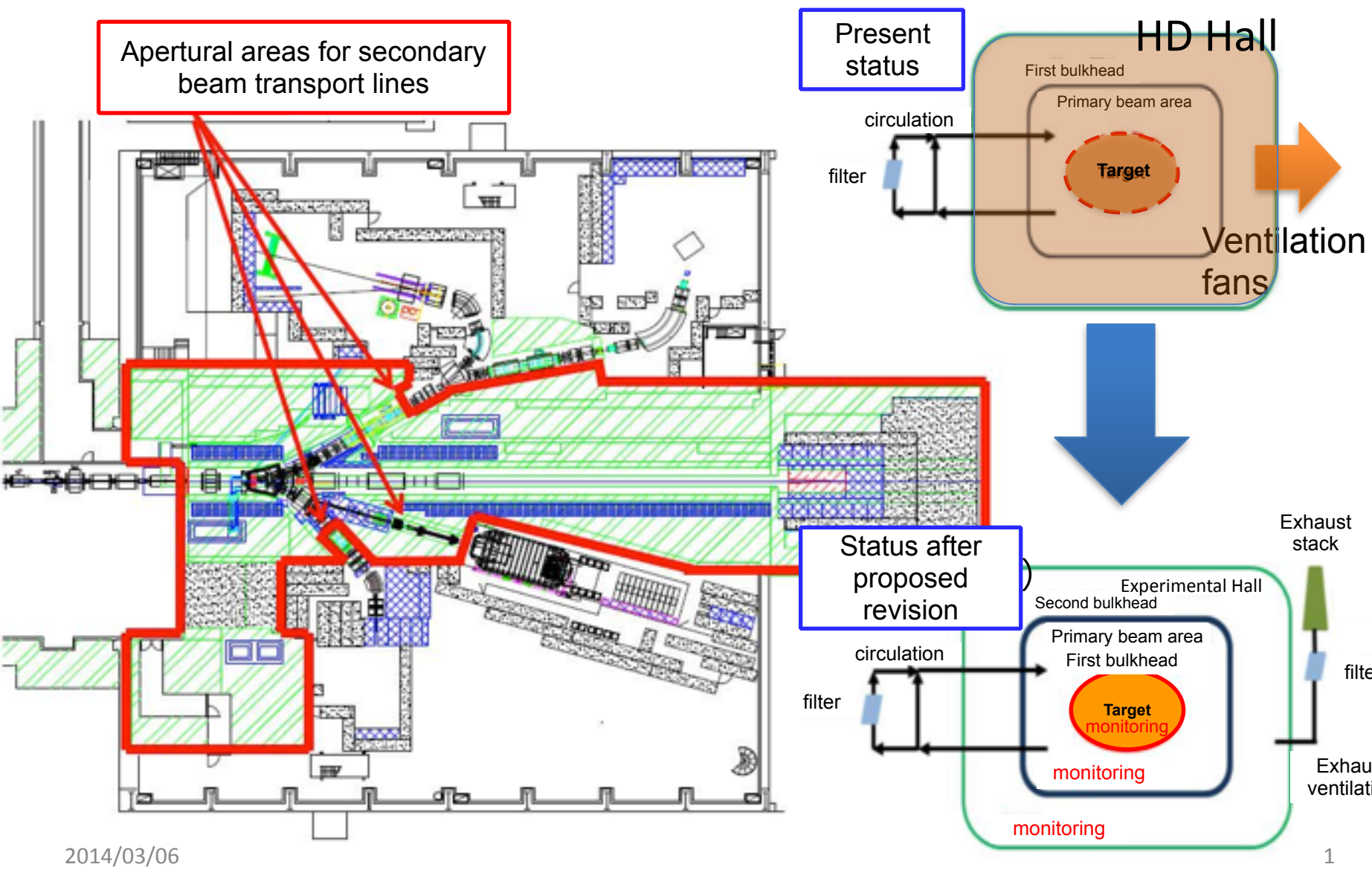


Target chamber & the beam-line had no air-tightness

## Target Temperature (Simulation)



## Improvement of Hadron Experimental Hall



## Summary

- Overview of the accident
  - occurrence, hall contamination, exposure, leakage of radioactive material to the outside of the radiation controlled area
- Investigation and improvements: facilities and instruments, and safety management
- Rebuilding trust from local community
- User Operation Resumed for MLF & T2K !