

Status and Plans at J-PARC Linac

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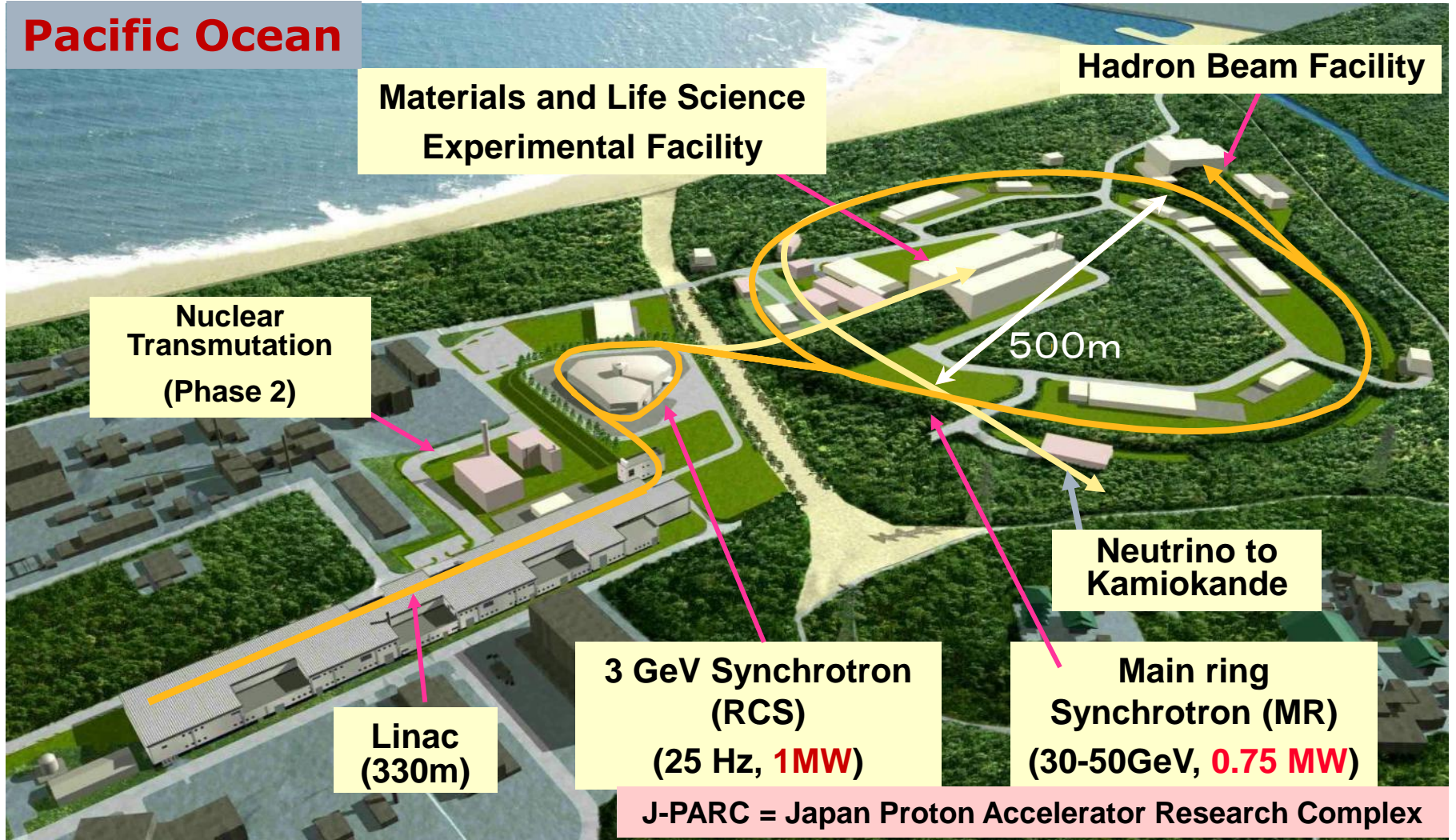
J-PARC Center/Japan Atomic Energy Agency

**Collaboration meeting between CERN and J-PARC
December 18, 2013, CERN**

Outline

- Introduction of J-PARC**
- Operation in JFY2012**
- Hadron facility accident in May**
- Status and Plan of Linac upgrade:**
 - Front end**
 - Energy**

J-PARC Facility

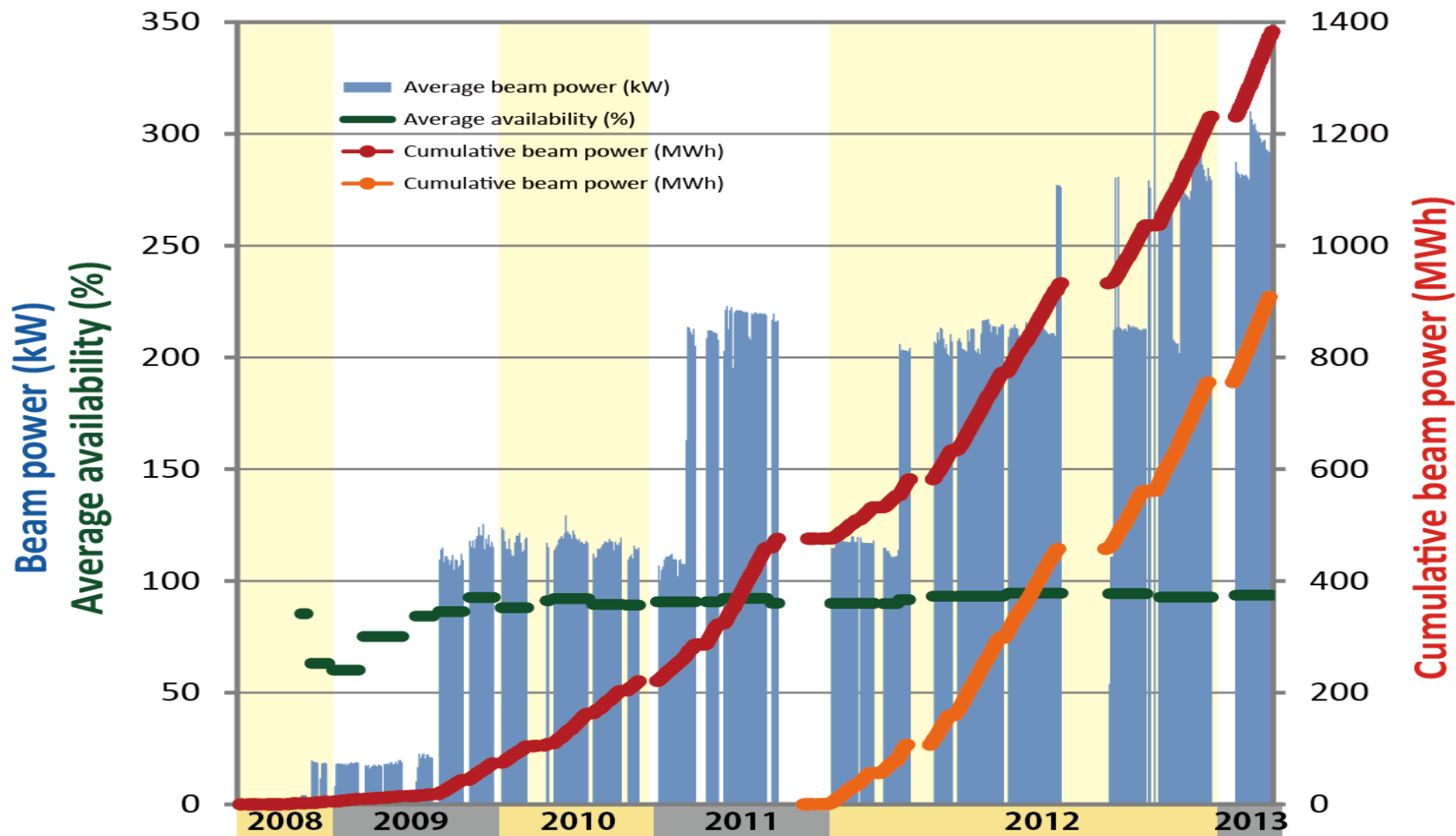


Joint Project of KEK and JAEA

History of beam delivery from RCS to MLF (3GeV)



May 2008- March 2013

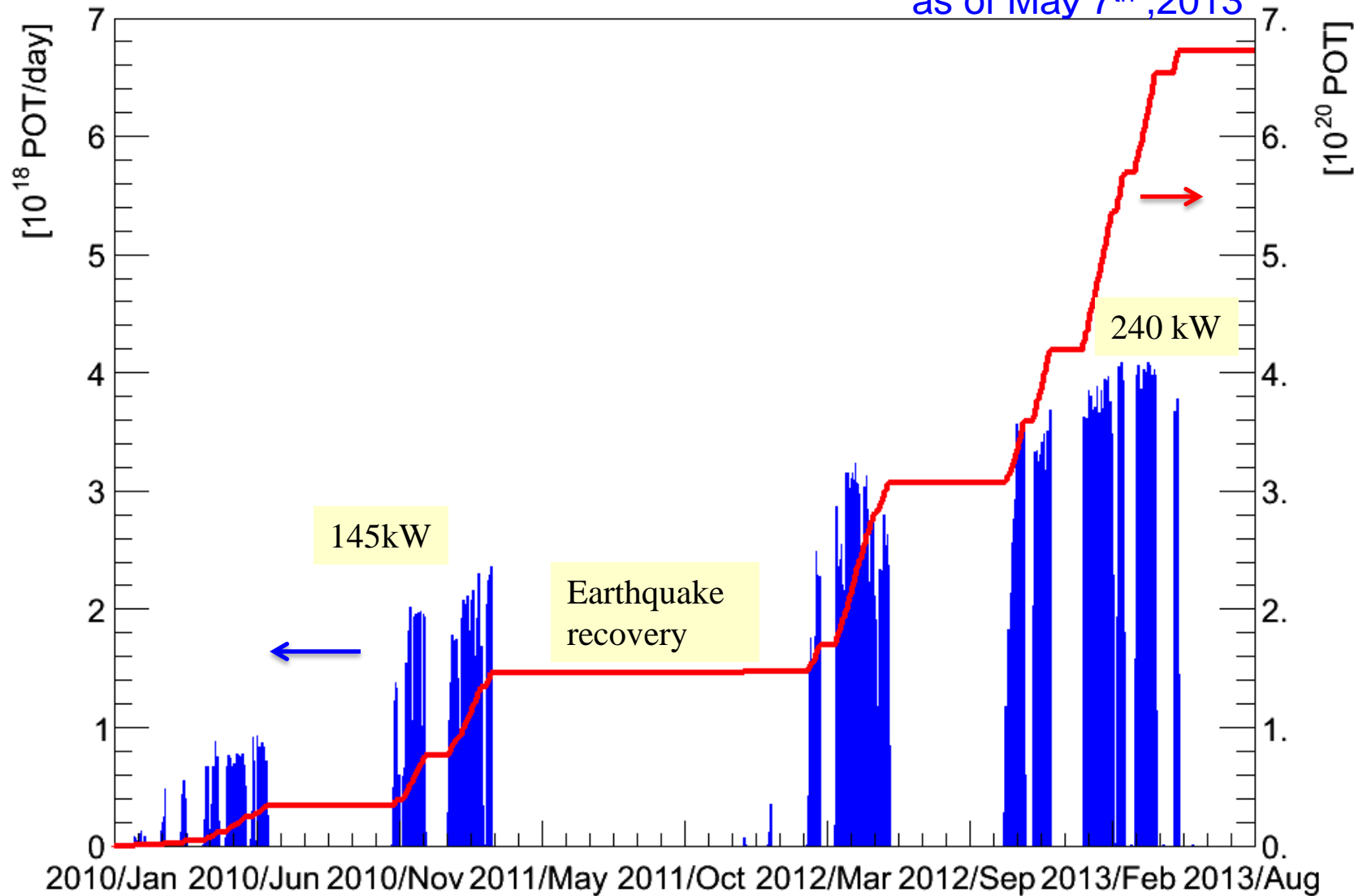


Beam delivery of ~ 300 kW was started in Jan. 2013.

History of delivered beam to the T2K (neutrino) experiment (30GeV)

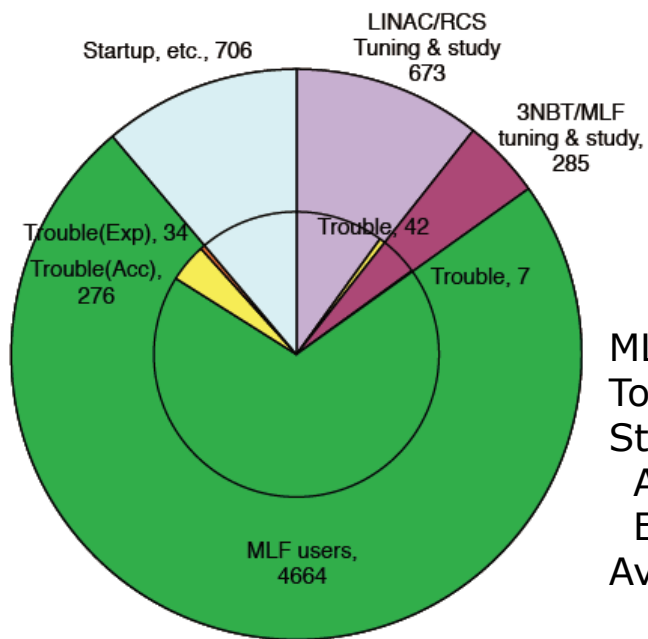


as of May 7th, 2013

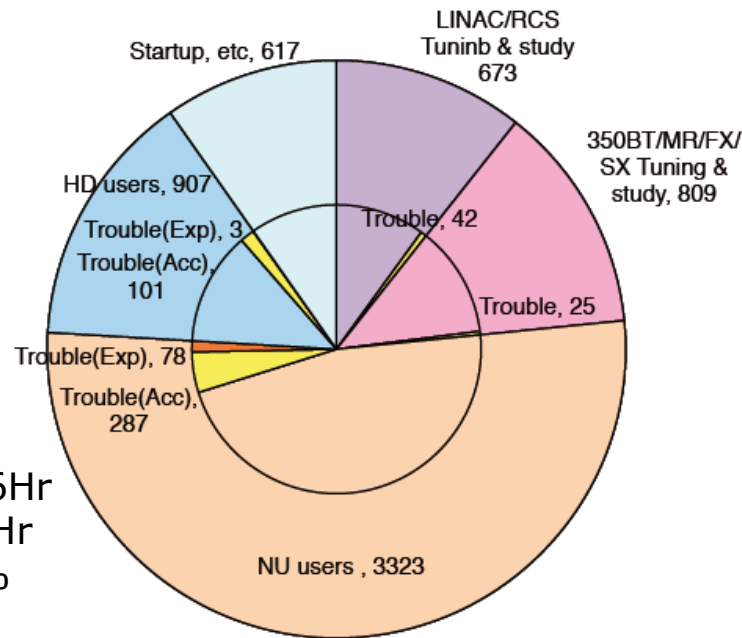


Accumulated number of proton $\sim 6.7 \times 10^{20}$ POT.

Operation in JFY2012 (Apr 2012- Mar 2013)



MLF
 Total 4664Hr
 Stop 310Hr
 Acc. Trouble 276Hr
 Exp. Trouble 34Hr
 Availability 93.3%

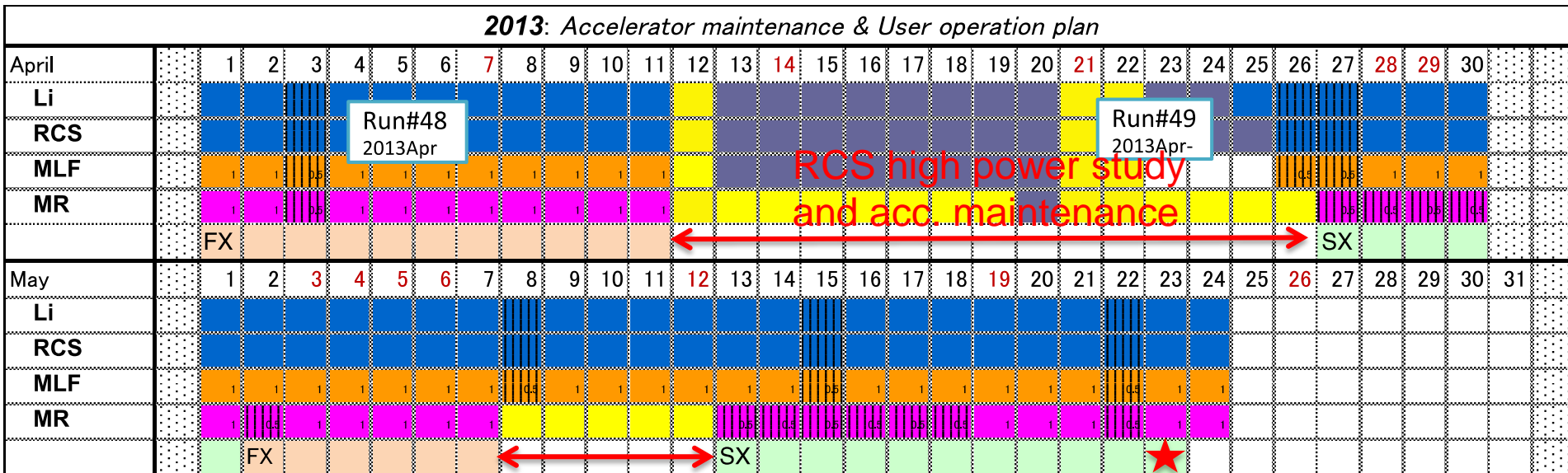


Operation Statistics in FY2012 (Total: 6,328 hours)

	User Operation Power (FY2012)	Availability (FY2012)	Study or Demonstration
Linac	(15~18mA, 500us)	(>94%)	(28mA, 500us)
RCS	200 → 300kW	(>94%)	539kW-single, 524kW-25Hz-35sec
MLF	200 → 300kW	93%	
MR-FX(NU)	150→240 kW	89%	240kW
MR-SX(HD)	3 → 15kW (24kW in FY13)	88%	20kW (30kW in FY13)

Operation of the April-May, 2013

2013: Accelerator maintenance & User operation plan



A trouble of injection septum

The accident of the hadron experimental facility

The RCS delivered 300 kW beam to the MLF users stably.

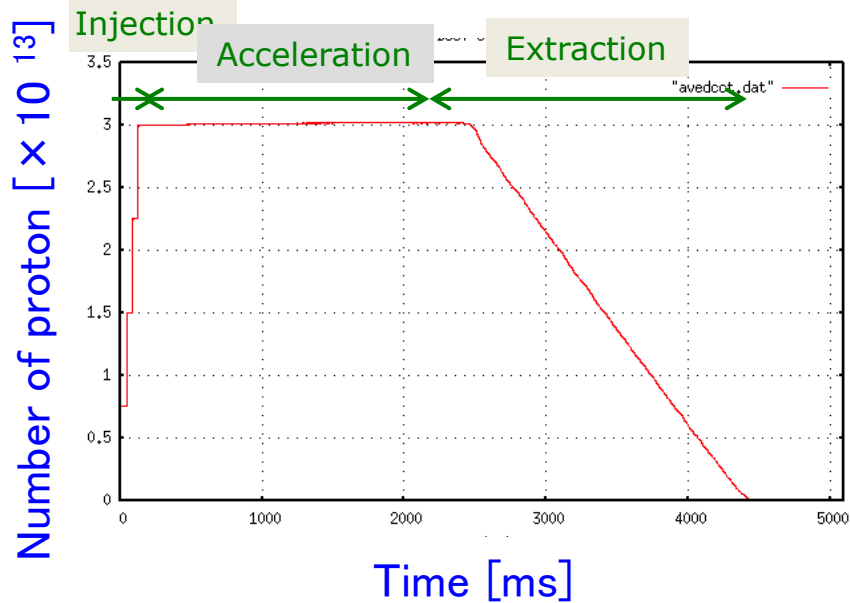
The MR had a trouble of injection septum and the accident of the hadron experimental facility.

The all facilities has been shutdown since the accident of the hadron hall.

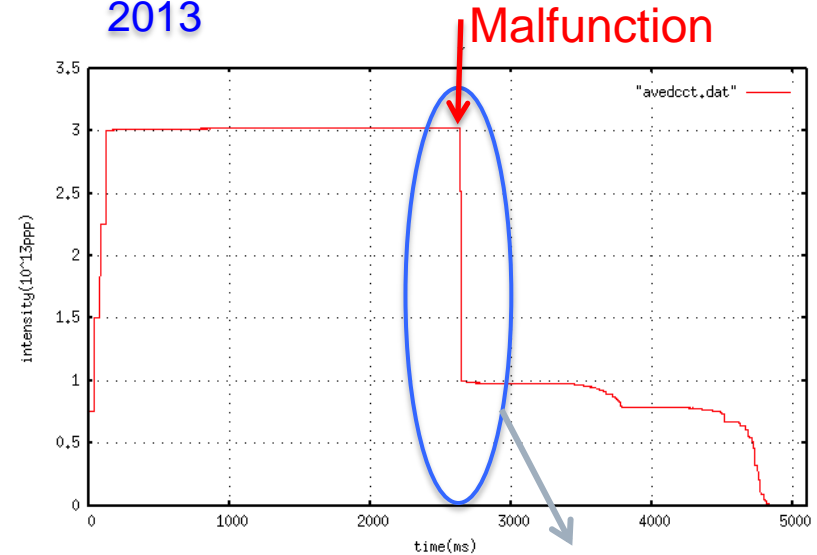
The malfunction of the EQ magnet power supply - A trigger of the accident in the HD hall -



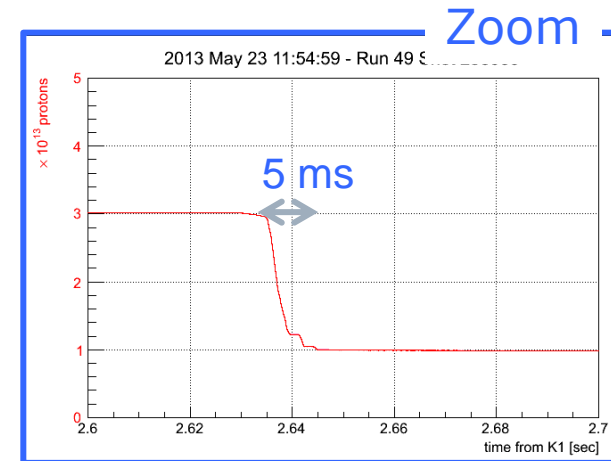
Normal operation



Accident around 11:55 on May 23rd, 2013



A spill feedback system is adopted to improve time structure of the extraction beam. The power supply of the feedback quadrupoles, malfunctioned.

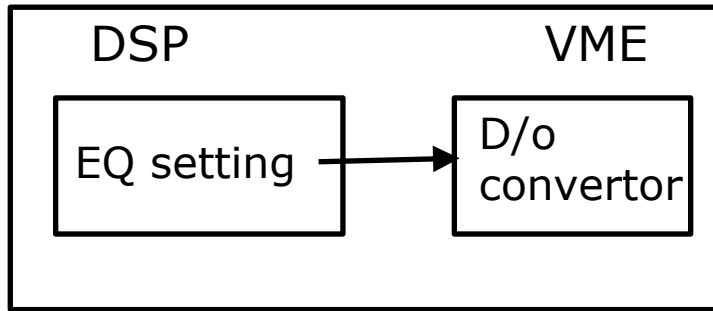


The 2×10^{13} protons were extracted for a very short period of 5 ms and transported to the Au target in the HD facility.

The cause of the malfunction

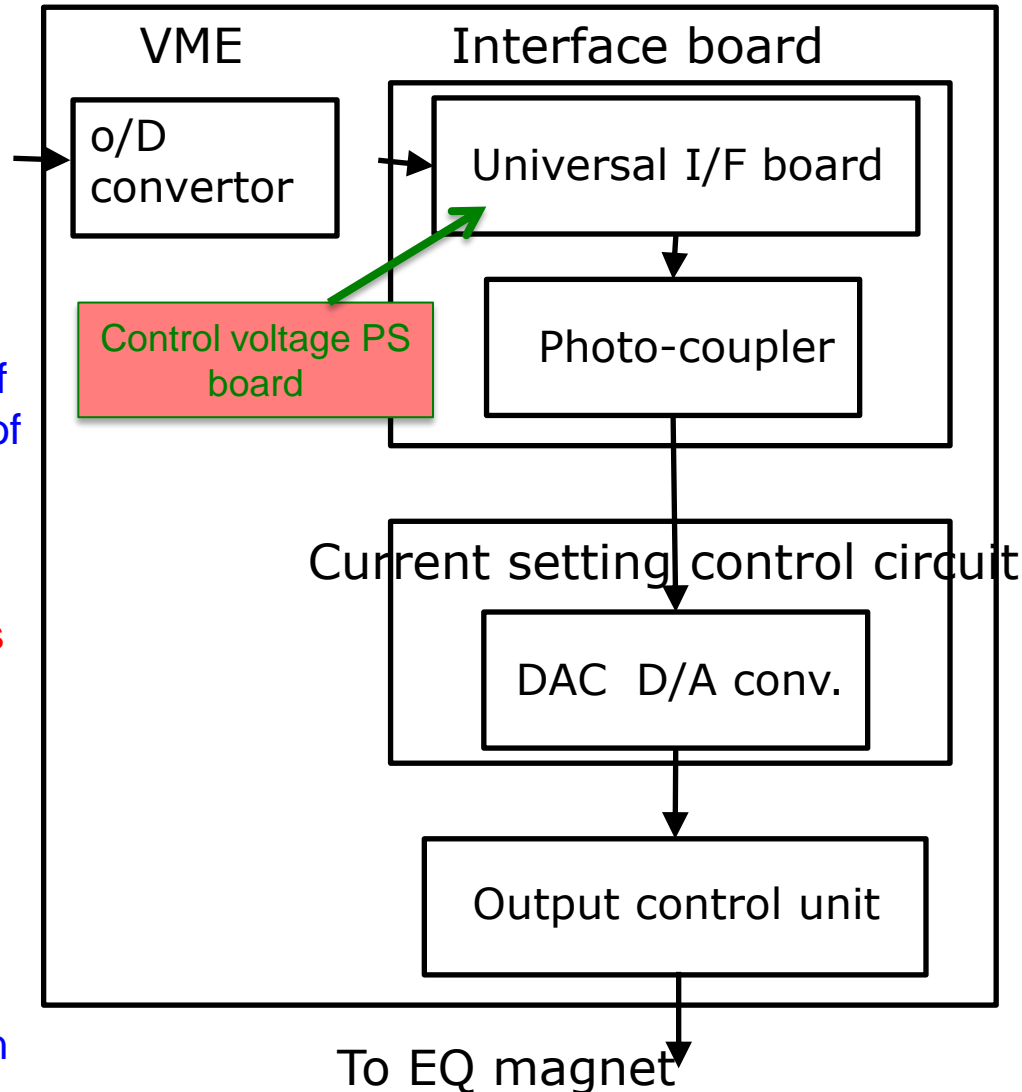


Spill feedback control system



Optical signal

EQ-power supply



The cause is a fault in the interface board of the EQ-PS due to unstable control voltage of the PS board (power dissipation of a three terminal regulator is under estimated) .

→

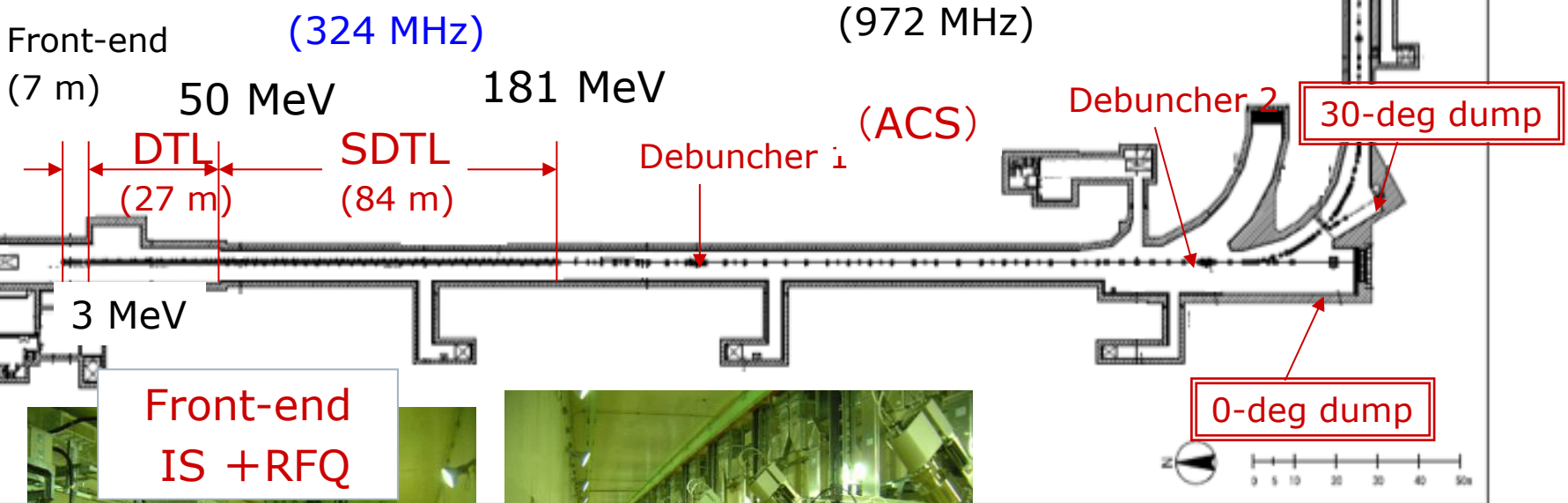
The setting value from the DSP system was not sent to the output control unit.

Preventive measures:

- Replace cont. voltage PS board
- Set current limit of the PS 340 -> 120 A
- Faster shutdown time when detection of abnormality occurrence.
- Shutdown if anomalous current deviation detected.

Linac: Parameters and Layout

- **Particle:** H⁻
- **Energy:** 181 MeV -> 400 MeV
- **Peak current:** 30 mA at 181 MeV
50 mA at 400 MeV
- **Repetition:** 25 Hz
- **Pulse width:** 0.5 msec

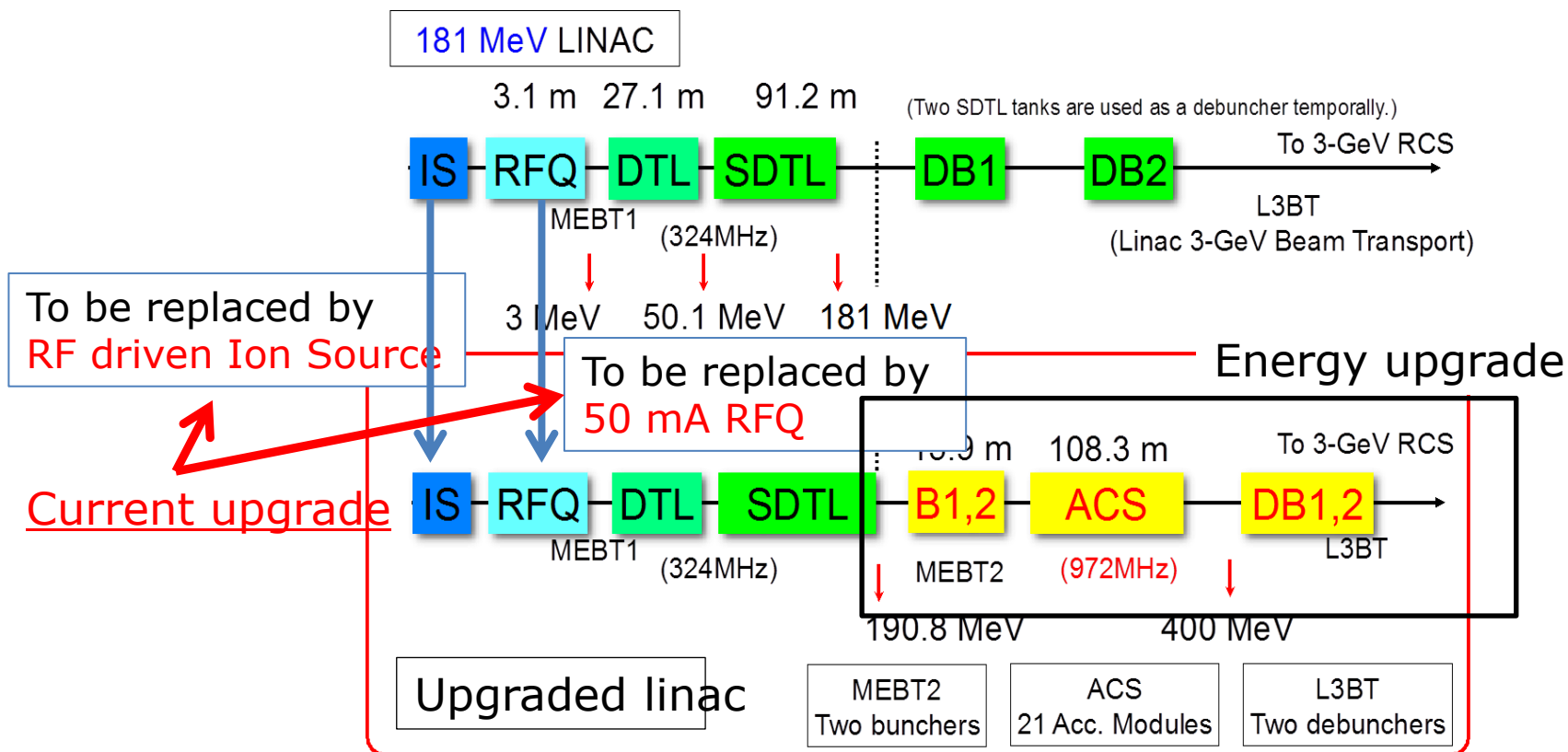


Upgrade plan of J-PARC linac



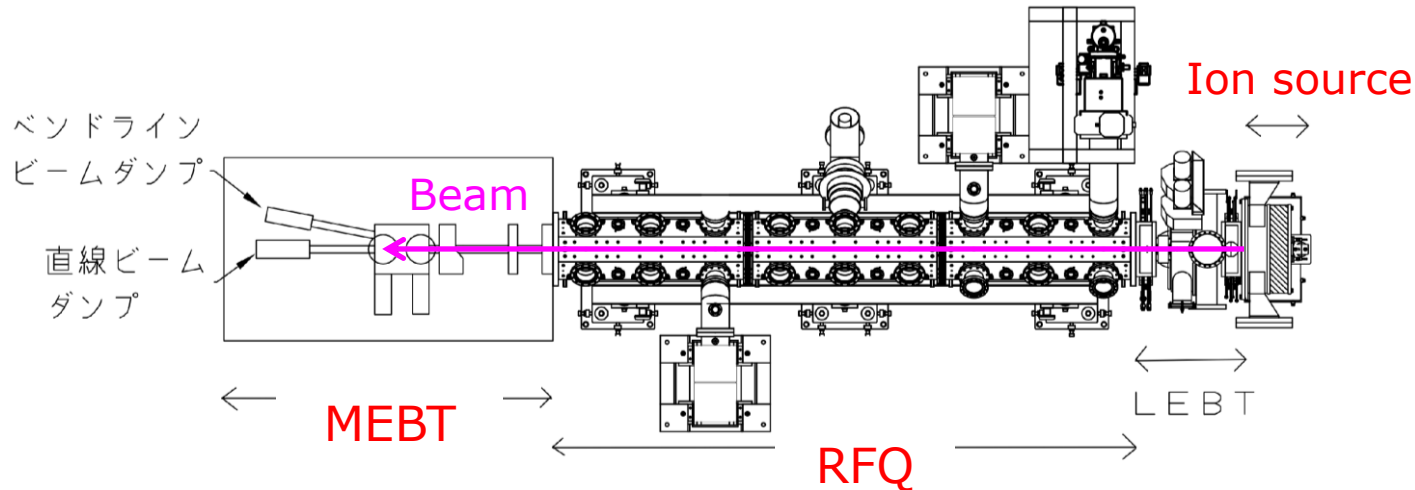
➤ The original design intensity (400 MeV, 50mA, 2.5 %) is necessary for the J-PARC facility to reach nominal performance (Beam power: 1MW@RCS, 0.75MW@MR)

- Energy is upgraded with ACS,
- Beam current is upgraded with new ion source and RFQ.



Front-end test beam line

The 3 MeV front-end test beam line was constructed in the linac building.

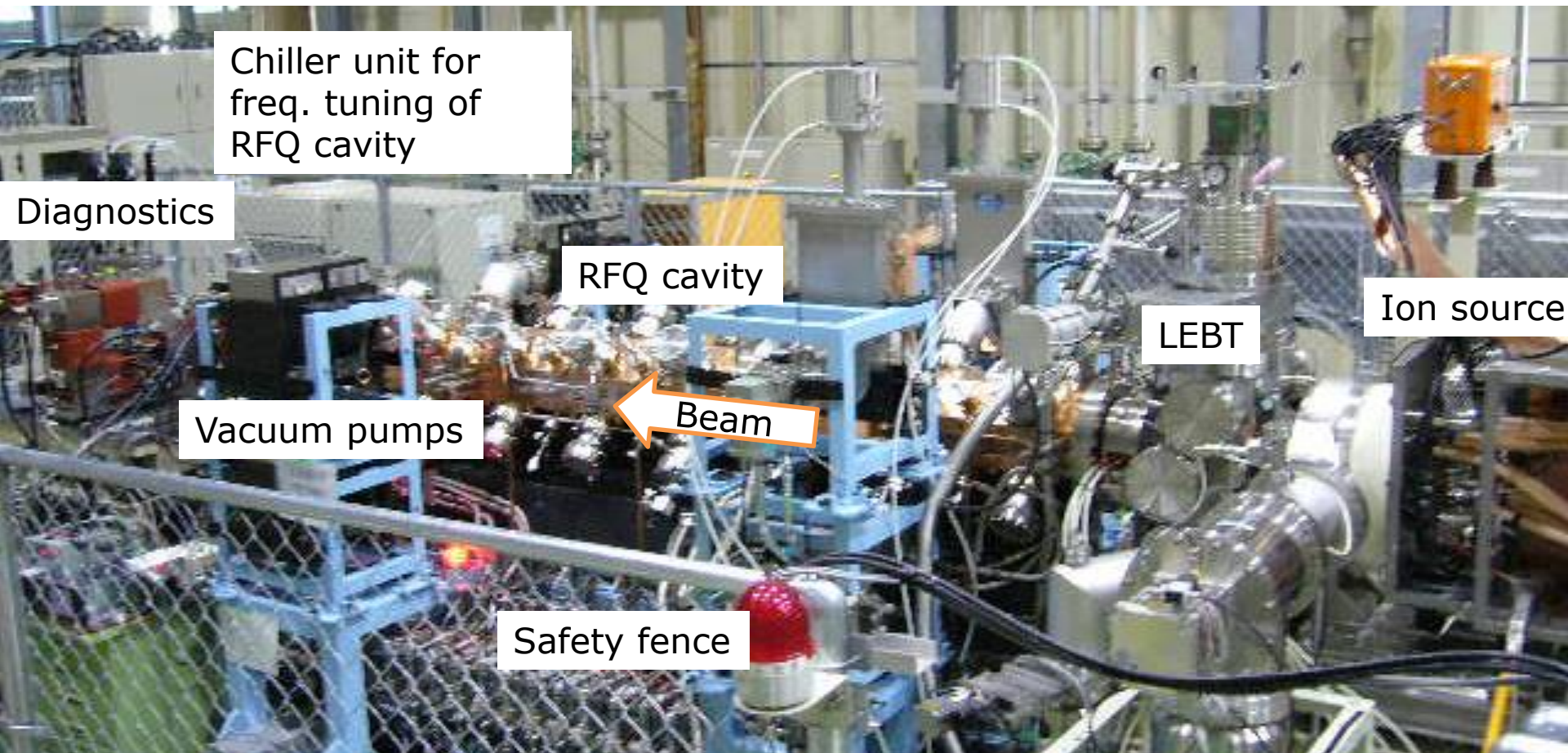


Schedule (before Hadron facility accident)

JFY	2013	2014	2015
Test stand	Both Fil-IS & RF-IS with RFQ3 1MW		
Installation	RF-IS & RFQ3		
Operation	Fil-IS & RFQ1	RF-IS & RFQ3	

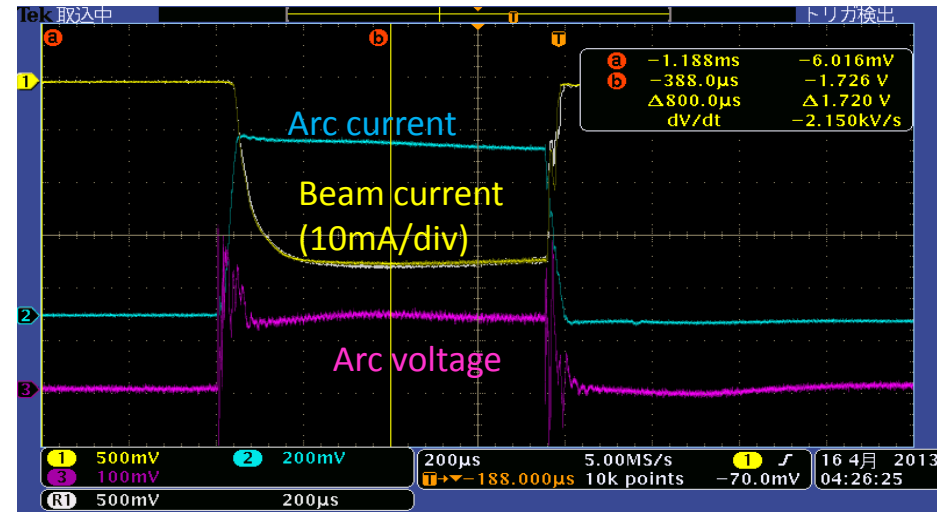
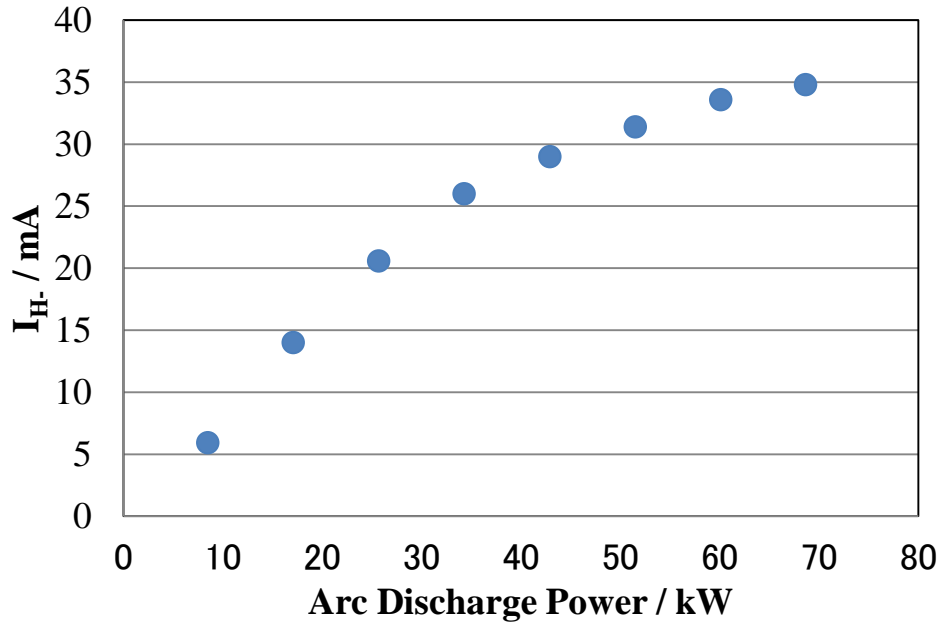
Activity was stopped due to the accident.

RFQ test stand



- RFQ test stand consists of the ion source, the RFQ, beam line with diagnostics and the beam dump.
- In this test stand, we will confirm the performance of the new RFQ with RF driven ion source.
- The beam acceleration was started on May 8th 2013. But it was stopped due to the accident on May 23.
- We restarted test operation and we passed the inspection for licensing on December 12.

RFQ-TS Ion source (Filament, 20130416)

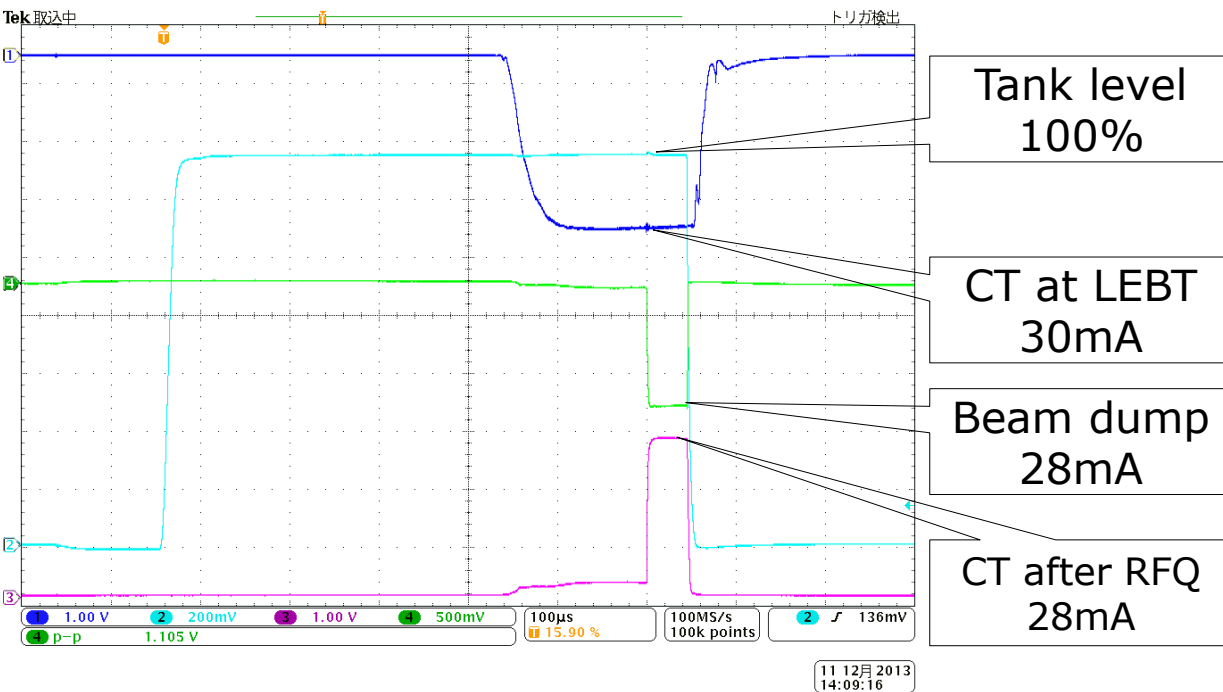


Parameters

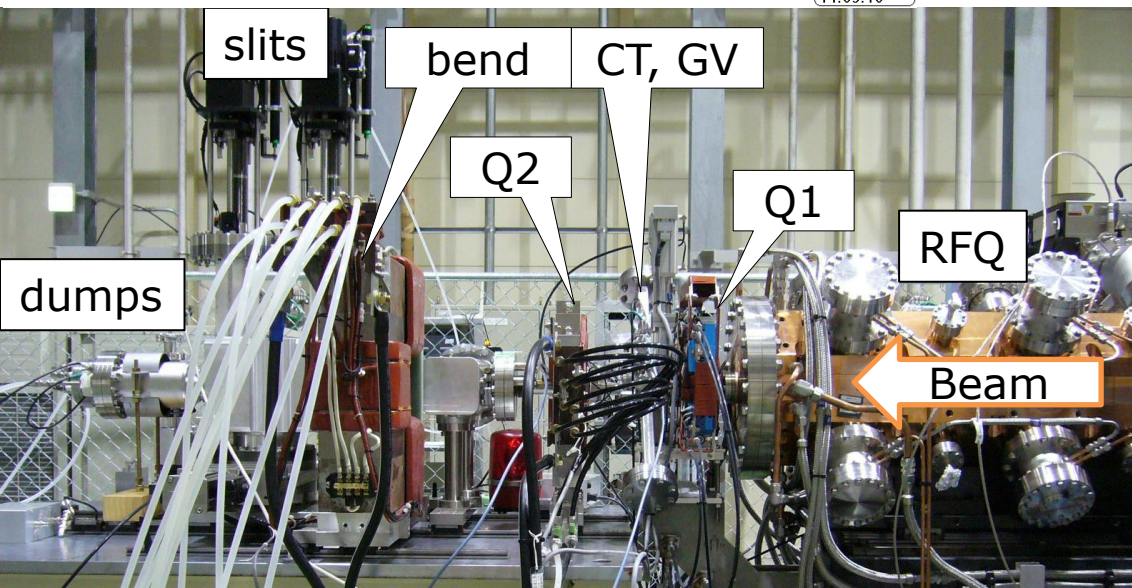
Solenoids	:530A
Extraction	:9.57kV
Acceleration	:41.5kV
LaB6 filament	:6.9V、110.1A
H2 gas feed	:15.5sccm
Arc discharge	:170V、400A
Bias voltage	:12V
Repetition	:25Hz

- LaB₆ filament ion source
- More than 30mA H⁻ is injected to RFQ stably.

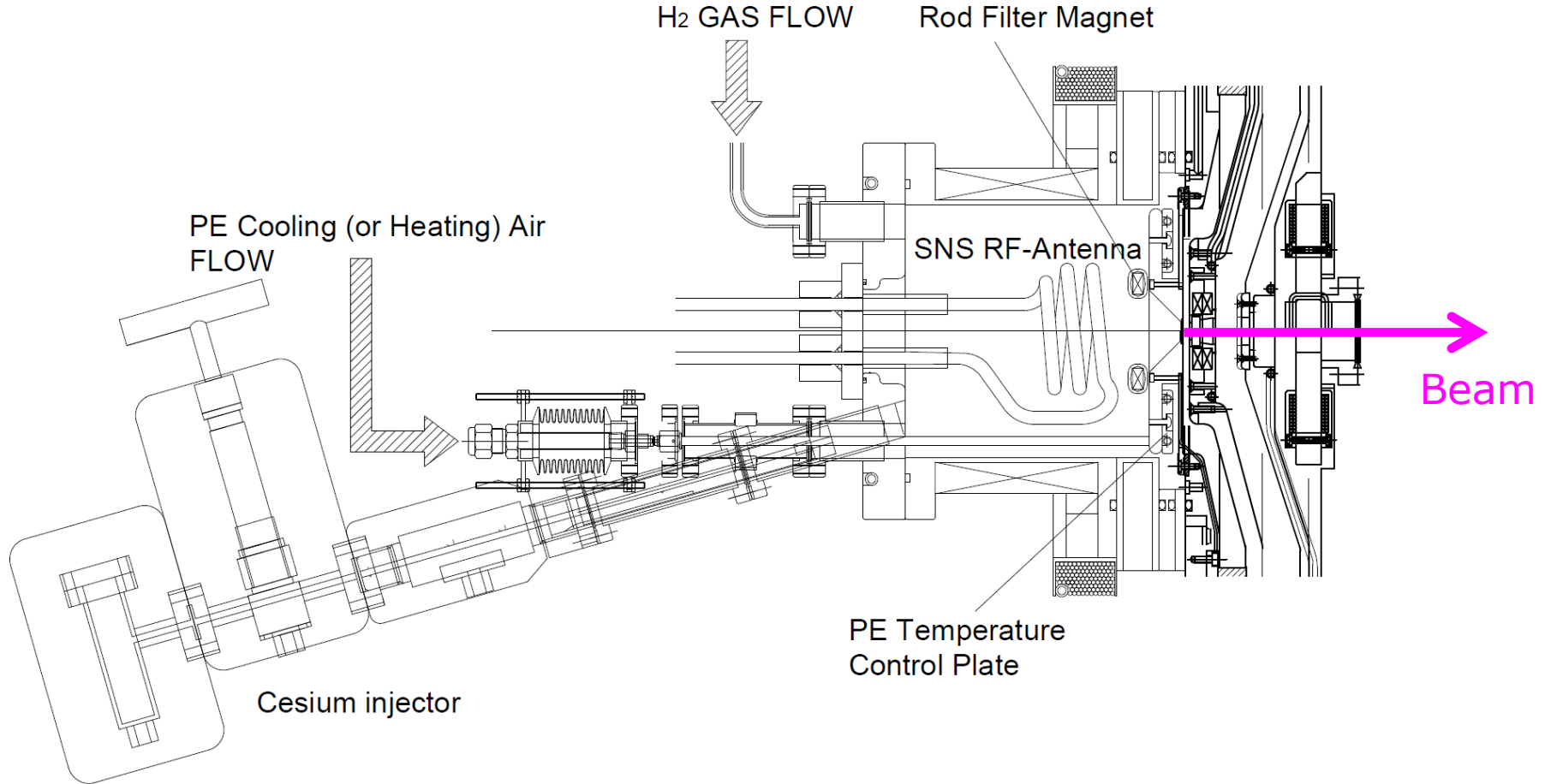
Beam test



- The beam operation was restarted Dec. 2nd 2013.
- RFQ transmission
-93% at 30 mA, preliminary
- BT and monitors
 - Two quadrupole magnets and bend magnet
 - Straight line and bend line beam dumps.
 - CT for current measurement
 - FCTs for time of flight measurement
 - Slits for emittance measurement
- Currently, we are doing
 - Tuning the Quadrupole magnets
 - Bending beam for energy separation
 - Emittance measurement

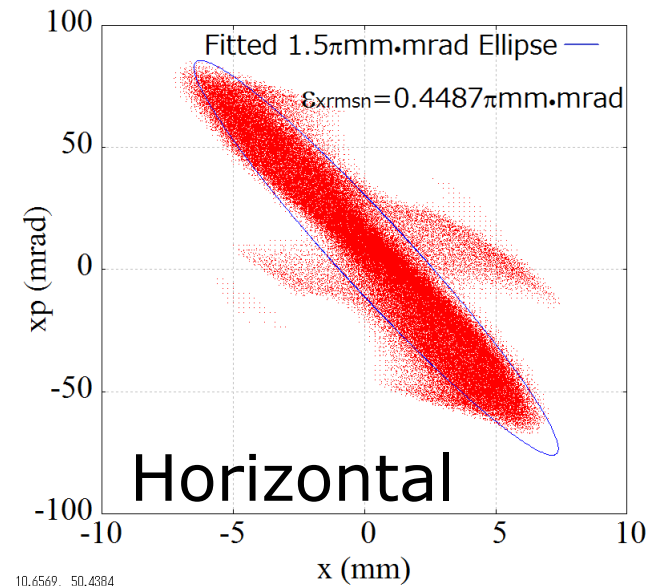
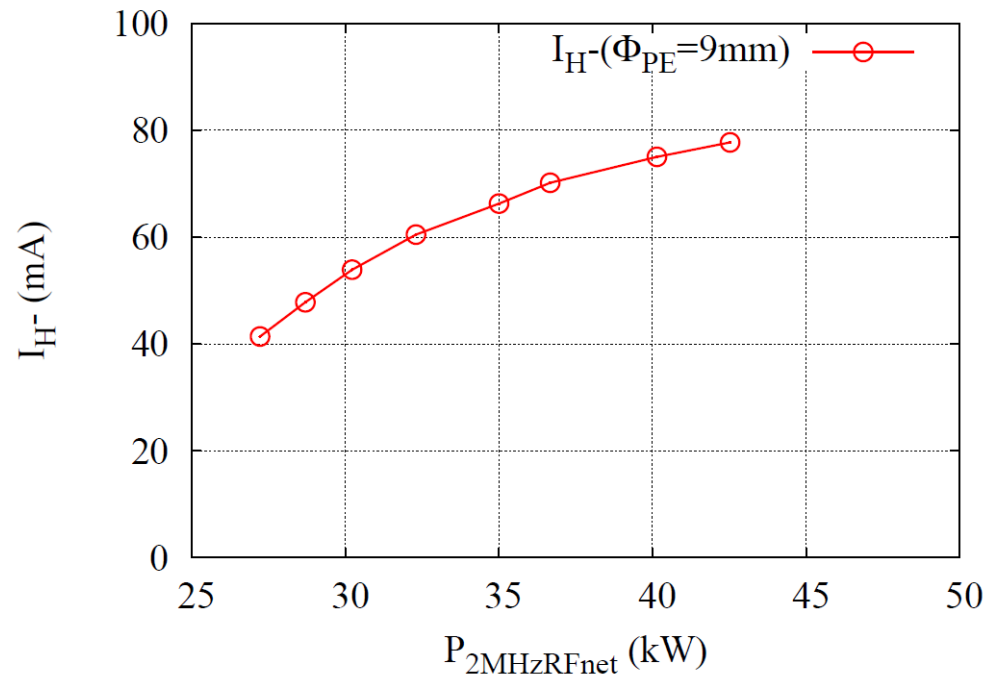


J-PARC RF-driven Ion Source



- 2MHz-RF with internal-antenna (developed at SNS)
- 120 mm in inner diameter of plasma chamber
- Cesium seeded using an oven
- Temp. of plasma electrode is controlled by air flow.
- Rod filter magnet

RF-driven I.S.: Beam current



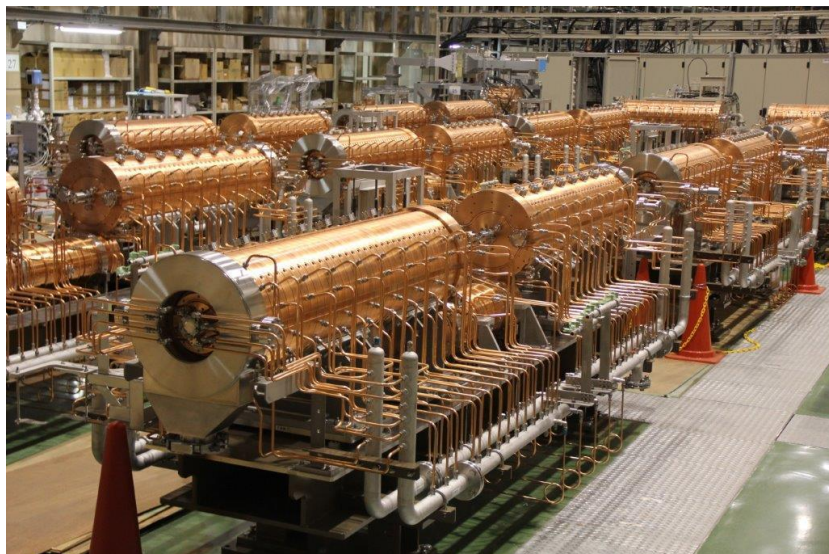
□ H⁻ beam current increased with the 2MHz-RF power and reached **77mA** at 43kW.

- *Pulse width: 500 μs
- *Pulse repetition rate: 25 Hz
- *H₂ gas flow rate: 20 SCCM

Beam current : **77mA**
Norm. RMS emittance
H: $0.45\pi\text{mm}\cdot\text{mrad}$
V: $0.44\pi\text{mm}\cdot\text{mrad}$

H⁻ within the ellipse of $\epsilon=1.5\pi\text{mm}\cdot\text{mrad}$ is calculated to be > **60mA.**

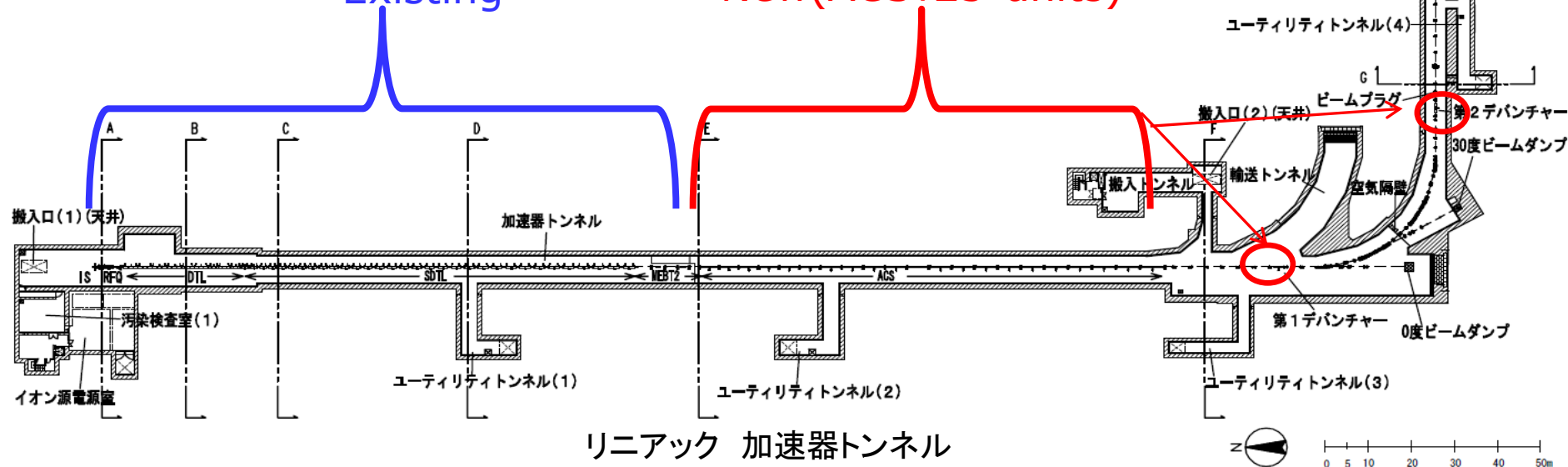
Energy upgrade



- 181 MeV \Rightarrow 400MeV
- New Annular-ring Coupled Structure (ACS) linac is installed.

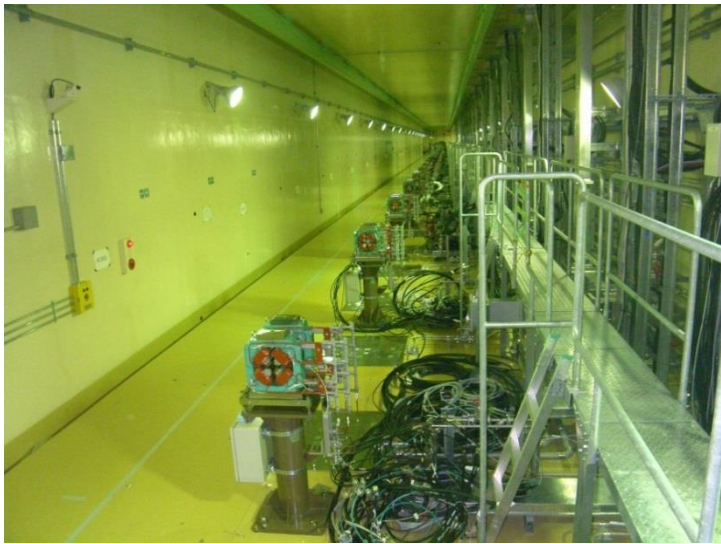
Existing

New(ACS: 25-units)



Energy upgrade

- Installation was finished by the first week of October for 25 units of ACS. **One module per one day!**
- High power conditioning is underway; 24 hours a day.



Before installation of ACS



Finished Installation



Installation of ACS

Energy upgrade



Installation and beam commissioning schedule

	Month (2013)						Month(2014)		
	7	8	9	10	11	12	1	2	3
Preparation		↔							
Installation, piping, vacuum, etc.			↔						
High power conditioning					↔				
Beam commissioning						↔			
RCS Beam commisioning							↔		
						Tentative and not official			

Summary



- Operation in JFY2012 was successful.
 - 300 kW for MLF
 - 240 kW for neutrino, 23 kW for hadron.
- All the activities except for maintenance work were stopped for several months by the Hadron Facility Accident on May 23.
- Upgrade work of linac was approved.
 - Beam commissioning of the front-end (ion source and RFQ) has restarted. We will replace the filament-type ion source with RF-driven one this week.
 - Installation of ACS was finished and high power conditioning is underway. Beam commissioning is expected to start soon.